ATRT-01 S3 and ATRT-01B S3 SINGLE PHASE TRANSFORMER TURNS-RATIO METERS

USER'S MANUAL





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SAFETY SUMMARY

This manual applies to both the ATRT-01 S3 and ATRT-01B S3 current transformer turns-ratio meters. The operating procedures are virtually the same for both models, and any differences are clearly described where applicable.

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from procedures described in this User's Manual may create one or more safety hazards, damage the ATRT-01/01B S3, 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-01/01B S3.

SAFETY WARNINGS AND CAUTIONS

The ATRT-01/01B S3 shall be used only by **trained operators**. All transformers under test shall be **off-line** and **fully isolated**. 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-01/01B S3 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 the ATRT-01 S3 and ATRT-01B S3. •
- A key, switch, or knob on the ATRT is indicated as [KEY], [SWITCH], [KNOB].
- Menu names are referenced as "MENU NAME" •
- ATRT screen output is shown as: ٠



٠ rectangle as shown below (option 3 should be selected):

			ويستعد المتلاجر والمستعد والم
1. 2.	OPTION OPTION	1 2	HECK
3.	OPTION	3	
4.	OPTION	4	
5.	OPTION	5	

Warning messages are indicated as: •



Important notes are indicated as: ٠



1

1.0 INTRODUCTION

1.1 General Description and Features

The ATRT-01 S3 is Vanguard's fourth generation, micro-processor based, single phase, automatic transformer turns-ratio tester. This portable test unit is available in two models, the ATRT-01 S3 (line power only), and the ATRT-01B S3 (rechargeable-battery powered).

The ATRT-01 S3 uses the IEEE C57.12.90 measuring method to determine the transformer turns-ratio. The transformer turns-ratio is determined by precisely measuring the voltages across the unloaded transformer windings. The ATRT-01 S3's measuring circuitry self adjusts before each measurement to ensure turns-ratio accuracy. Two selectable test voltages, 4Vac and 40Vac, offer flexibility in testing different types of transformers.

The ATR-01 S3 can measure turns-ratios ranging from 0.8 to 15,000 and can be used to test voltage regulators, power transformers, current transformers (CT), and potential transformers (PT). The ATRT-01 S3 also measures and displays transformer-winding excitation current, winding polarity, and winding phase angle. Test results are displayed on a back-lit LCD screen (128 x 64 pixels) that is viewable in bright sunlight and low-light conditions.

In addition to measuring a transformer's turns-ratio, the transformer's name plate voltages can also be entered, and the ATRT C1 S3 will then display the turns-ratio percentage error. This convenient feature eliminates any user-calculation errors when testing transformers.

When testing a 3-phase transformer, the ATRT-01 S3 provides connection information (H and X test leads to the transformer bushings) for phase A, B and C tests. The three phase test results (turns-ratio, excitation current, winding polarity, phase-angle, and percentage error) are displayed on the LCD screen.

User Interface

The ATRT-01 S3 features a back-lit LCD screen (128 x 64 pixels) that is viewable in direct sunlight and low-light levels. A rugged 16-key membrane keypad is used to enter test information and to operate the unit.

Test Record Storage

The ATRT-01 S3 can store 128 records of 33 readings internally, and up to 999 test records on an external USB Flash drive. Test records can be recalled using the included Transformer Analysis PC software.

Computer Interface

A Windows[®]-based (XP/Vista/7) Transformer Analysis Software is provided with each unit and can be used to remotely control the ATRT-01 S3 via the RS-232C port. Using the Transformer Analysis software, the user can retrieve test records (from the ATRT-01 S3's memory or a USB Flash drive), analyze test results, and print test results on a desktop printer. Test results are automatically exported to PDF, Excel, and XML formats.

Battery Power for Exceptional Portability

The ATRT-01B S3 is powered by a 6-volt, 7 ampere-hour, lead acid battery. This high capacity battery, coupled with the ATRT-01B S3's low power consuming circuitry, allows the unit to be used continuously for up to 4 hours per charge. A built-in charger allows the unit to be used during charging.

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1.2 **Technical Specifications**

1.2.1. ATRT-01 S3 Technical Specifications

Table 1. ATRT-01 S3 Technical Specifications

TYPE	Transformer Turns Ratio Tester		
PHYSICAL SPECIFICATIONS	Dimensions: 12" x 10" x 8" (30.4 cm x 25.4 cm x 20.3 cm) Weight: 8 lbs (3.6 Kg)		
INPUT POWER	120 or 240 Vac (Selectable), 50/60 Hz		
MEASURING METHOD	ANSI/IEEE C57.12.90		
RATIO MEASURING RANGE	0.8 - 15,000 (5 digit resolution)		
TURNS-RATIO ACCURACY	40 Vac: 0.8-1,999 (0.1%), 2,000-3,999 (0.25%), 4,000-15,000 (1%) 4 Vac: 0.8-1,999 (0.1%), 2,000-3,999 (0.25%), 4,000-15,000 (2%)		
TEST VOLTAGE	4 Vac @ 1.0A, 40 Vac @ 0.6A		
PHASE ANGLE MEASUREMENT	0 - 360 degrees, Accuracy ±0.2 degree (±1 digit)		
POLARITY READING	In-Phase or Out-of-Phase indication		
EXCITATION CURRENT READING RANGE	0-2 Amperes, Accuracy: 2% of reading (±1 mA)		
DISPLAY	Back 1: LCD (128 x 64 pixels), viewable in direct sunlight and low light levels		
COMPUTER INTERFACE	RS-232C		
PC SOFTWARE	Windows XP/Vista/7 Transformer Analysis Software (included with purchase)		
INTERNAL TEST RECORD STORAGE	D 128 records of 33 readings E		
EXTERNAL TEST RECORD STORAGE	Up to 999 test records on external USB Flash drive.		
SAFETY	Designed to meet IEC 61010 (1995), UL 61010A-1, and CSA-C22.2 standards		
ENVIRONMENT	Operating: -10°C to 50°C (15°F to +122°F) Storage: (-30°C to 70°C (-22°F to +158°F)		
HUMIDITY (MAX)	90% RH @ 40° C (104° F) non-condensing		
ALTITUDE (MAX)	2000m (6562 ft) to full safety specifications		
CABLES	One 15 ft. (4.6m) Single phase cable, one power cord, one cable bag		
OPTIONS	Transportation Case (Can hold unit and cables)		
WARRANTY	One year on parts and labor		



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-01B S3 Technical Specifications

Table 2. ATRT-01B S3 Technical Specifications

TYPE	Transformer Turns Ratio Tester	
PHYSICAL SPECIFICATIONS	S Dimensions: 12" x 10" x 8" (30.4 cm x 25.4 cm x 20.3 cm) Weight: 9 lbs (4.3 Kg)	
INPUT POWER	90 to 240 Vac, 50/60 Hz Battery: SLA battery delivering up to 4 hours of continuous operation per charge.	
MEASURING METHOD	ANSI/IEEE C57.12.90	
RATIO MEASURING RANGE	0.8 - 15,000 (5 digit resolution)	
TURNS-RATIO ACCURACY	40 Vac: 0.8-1,999 (0.1%), 2,000-3,999 (0.25%), 4,000-15,000 (1%) 4 Vac: 0.8-1,999 (0.1%), 2,000-3,999 (0.25%), 4,000-15,000 (2%)	
TEST VOLTAGE	4 Vac @ 500mA, 40 Vac @ 70mA	
PHASE ANGLE MEASUREMENT	0 - 360 degrees, Accuracy ±0.2 degree +1 digit)	
POLARITY READING	In-Phase or Out-of-Phase indication	
EXCITATION CURRENT READING RANGE	0-2 Amperes, Accuracy: 2% of reading (±1 mA)	
DISPLAY	Back & LCD (128 x 64 pixels), viewable in direct sunlight and low light levels	
COMPUTER INTERFACE	RS-232C	
PC SOFTWARE	Windows XP/Vista/7 Transformer Analysis Software (included with purchase)	
INTERNAL TEST RECORD STORAGE	128 records of 33 readings	
EXTERNAL TEST RECORD STORAGE	Up to 999 test records on external USB Flash drive.	
SAFETY	Designed to meet IEC 61010 (1995), UL 61010A-1, and CSA-C22.2 standards	
ENVIRONMENT	Operating: -10°C to 50°C (15°F to +122°F) Storage: (-30°C to 70°C (-22°F to +158°F)	
HUMIDITY (MAX)	90% RH @ 40° C (104° F) non-condensing	
ALTITUDE (MAX)	2000m (6562 ft) to full safety specifications	
CABLES	One 15 ft. (4.6m) Single phase cable, one power cord, one cable bag	
OPTIONS	Transportation Case (Can hold unit and cables)	
WARRANTY	One year on parts and labor	



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

NOTE

1.2.3. Controls and Indicators

The ATRT-01 S3 and ATRT-01B S3 controls and indicators are shown in Figure 1 and Figure 2, 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.

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Figure 1. ATRT-01 S3 Controls and Indicators

ltem Number	Panel Markings	Functional Description	
1	USB MEM	USB Flash drive interface	
2	RS-232C	RS-232C computer interface port	
3		Back-lit LCD screen (128 x 64 pixels), viewable in direct sunlight and low light levels	
4		H and X lead connector (16-pin male).	
5		Voltage selection switch	
6	120/240 Vac, 2A, 50-60Hz Fuse: 250Vac, 3A Fast-Blow	Input power connector and fused power switch with third-wire safety ground.	
7		Rugged alpha-numeric keypad	



Figure 2. ATRT-01B S3 Controls and Indicators

Table 4. Functional Descri	ptions of ATRT-01B S3	Controls and Indicators

ltem Number	Panel Markings	Functional Description
1	USB MEM	USB Flash drive interface
2	RS-232C	RS-232C computer interface port
3		Back-lit LCD screen (128 x 64 pixels), viewable in bright sunlight and low light levels
4		H and X lead connector (16-pin male).
5	120-240 Vac, 2A, 50-60Hz Fuse: 250Vac, 3A Fast-Blow	Input power connector
6		Rugged alpha-numeric keypad
7	CHARGER	Battery charging indicator. LED lights up when battery is being charged.
8	POWER	Power switch

2.0 PRE-TEST SETUP

2.1 ATRT-01 S3 Operating Voltage

The ATRT-01 S3 can be operated from 120 Vac or 240 Vac. The power voltage can be set using the voltage selector switch on the front panel (see Figure 1, item #5)

2.2 ATRT-01B S3 Operating Power

The ATRT-01B S3 is powered by a rechargeable (6 Vdc / 7 AH) sealed lead acid gel battery. The unit can operate continuously for up to 6 hours between charges. It can also be used while charging. Plugging the ATRT-01B S3 into an ac power outlet after the battery is fully charged will not damage the battery.

It is recommended that the ATRT-01B S3 be plugged into an ac outlet when it is not in use.
 NOTES • The ATRT-01B S3 uses the Genesis model Ni²7-6 battery. It can also be replaced

2.3 LCD Screen Contrast Control

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

with the Panasonic model LC-R122R2PU battery.

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

For the ATRT-01B S3, the back-light turns off after 30 seconds of operation to conserve power. Press any key on the keypad to re-light the back-light.

3.0 OPERATING PROCEDURES

3.1 ATRT Transformer Connection Diagrams



Figure 3. Typical Single-Phase Transformer Connection



Figure 4. Typical Auto Transformer Connection



Figure 5. Typical CT Connection



Figure 6. Typical Bushing CT Connection on a Single Transformer

3.2 Setting the Test Voltage

The ATRT offers two test voltages, 4 Vac and 40 Vac. The unit always defaults to 40 Vac at power-on. The 4 Vac test voltage can be used in situations where the 40 Vac excitation voltage may saturate the CT's. To set the test voltage:

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



ATRT-01 S3 "START-UP" menu

Press the [2] key (SETUP).

b. The following screen will be disclayed:



RECORD ID 1. 2. TEST VOLTAGE 3. PRINT RECORD 4. SAVE/RESTORE RECORD 5. SET TIME 6. SET LANGUAGE 7. SET 50/60 HZ

ATRT-01 S3

ATRT-01B S3

Press the [2] key (TEST VOLTAGE).

c. The following screen will be displayed:



Press the [1] key (4 VOLTS) to select 4 volts as the test voltage or press the [2] key (40 *VOLTS*) to select 40 volts as the test voltage.

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



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

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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 **[5]** key (SET TIME)

c. The following screen will be displayed:



Type in the date using the alpha-numeric keypad. The following screen will be displayed:



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

3.4 Setting the Interface Language

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

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



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

b. The following screen will be displayed:



Press the [6] key (SET LANGUAGE).

c. The following screen will be displayed:



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



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

3.5 Setting the Frequency (ATRT-01B S3 Only)

Follow the steps below to set the preferred frequency (50 or 60 Hz):

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



Press the [2] key (SETUP).

b. The following screen will be displayed:



Press the [7] key (SET 50/60 HZ).

c. The following screen will be displayed:



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



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

3.6 Performing Tests

b.

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. Follow the steps below to enter the test header information:

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

1. TES	T TRANSFORMER	
3. CAL	CULATOR	
TIME: DATE:	14:21:34 05/24/11	082245.com
Press the	[2] key (<i>SETUP</i>).	N.510
2. TES	T VOLTAGE	
4. SAV	E/RESTORE RECORD	
6. SET	LANGUAGE	

Press the [1] key (RECORD ID).

c. The following screen will be displayed:



Type the company name using the alpha-numeric keypad.

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



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

e. The following screen will be displayed:



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

f. The following screen will be displayed:



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

g. The following screen will be displayed:



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

h. The following screen will be displayed:



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

i. The following screen will be displayed:



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

j. The following screen will be displayed:



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

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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:



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

b. The following screen will be displayed:



Press the [1] key (SINGLE PHASE).

c. The following screen will be displayed:





Option 3 (USE PREV DATA) will be listed only if you had provided name plate voltages for a previous test.

NOTE

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:

```
NAME PLATE VOLTAGE:
H : X
Ø :
```

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



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

NAME PLATI	59	VOLTAGE:
Н	:	Х
500	:	0

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

NAME PLATE VOLTAGE:
н:х
500 : 10

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. **Continue to step d**.

3. USE PREV DATA

Press the **[3]** key (*USE PREV DATA*) to use the name plate voltage values entered when performing the last test. **Continue to step d.**

d. The following screen will be displayed:



Press the [START] key to start the test.

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



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



D

The percentage error (ERR) will be displayed only if name plate voltage values were entered.

NOTE

The polarity is displayed as either a plus sign (+) for "in-phase" or a minus sign (-) for "out-of-phase".

Press any key to continue.

f. The following screen will be displayed:

KE	EP THIS	READING?
1.	YES	
2.	NO	

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

g. The following screen will be displayed:



Press any key to continue.



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:

PRE	EVIOUS	DATA	IN	BUF
1.	APPENI	PREV	. D	IATA
2.	CLEAR	PREV.	DA	ITA

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:



h. The following screen will be displayed:



Press the [2] key (NO).

i. The following screen will be displayed:



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

j. The test record will be saved and the following screen will be displayed:





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

NOTE

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

3.6.3. Testing a Three Phase Transformer

Follow the steps below to test a three phase transformer:

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



.51082245.com Press the [1] key (TEST TRANSFORMER).

b. The following screen will be displayed:

XFI	MR CO	NFIG:
2.	DY	
3.	YD	·INV
4.	DD	Littp."
5.	YY	11000
6.	NEXT	PAGE

- 6			
- 6			
- 4			
- 8			
- 10			

You can press the [6] key (NEXT PAGE) to view additional transformer types. The following screen will be displayed:

NOTE	XFMR CONFIG:
	1. DZ
	2.ZD
	3. YZ
	4. ZY
	5. TT
	6. PREVIOUS PAGE

Select a three-phase transformer test by pressing the corresponding key ([2] to [5]). For this example, press the [2] key (Dy) from the first page to select the Delta to Y phase transformer test.

c. The following screen will be displayed:

X0 1.	ACCESSIBLE? YES
2.	NU

Press the **[1]** key (*YES*) if X0 is accessible or the **[2]** key (*NO*) if it is not accessible.

d. The following screen will be displayed:

1.	DY1
2.	DY3
3.	DY5
4.	DY7
5.	DY9
6.	DY11

Select the transformer configuration by pressing the corresponding key ([1] to [6]). For this example, press the [1] key (Dy1).

e. The following screen will be displayed:





Option 3 (USE PREV DATA) will be listed only if you had provided name plate voltages for a previous test.

- NOTE
 - 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:

NAME PLATE VOLTAGE: н: Х 0 :

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

```
NAME PLATE VOLTAGE:
       Н: Х
      500 :
```

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

```
NAME PLATE VOLTAGE:
H : X
500 : 0
```

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



Press the [ENTER] key. Continue to step f.

2. NO

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

3. USE PREV DATA

Press the **[3]** key (*USE PREV DATA*) to use the name plate voltage values entered when performing the last test. **Continue to step f.**

f. The following screen will be displayed momentarily:

TESTING	ΑT	40	VOLTS	

Then the following screen will be displayed showing the Phase A cable connections for the selected test (this will differ depending on the test selected):

PH	IASE A	l
CABLE		XEMR
X1,X2	TO	X1,X0
H1,H2	TO	H1,H3
"START"	WHEN	READY

Make the cable connections per the instructions and then press the [START] key to run the Phase A test.

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



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



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

h. The following screen will be displayed showing the Phase B cable connections for the selected test:

	PHASE	В	
CABLE		<u>XEMR</u>	
X1,X2	TO	X2,X0	
H1,H2	то	H2,H1	
"STAR	T" WHE	N READY	

Make the cable connections per the instructions and then press the [START] key to run the Phase B test.

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



The Phase A and B test results will be displayed on the LCD screen when testing has finished:

RATIO	I	MA	%DIFF
+15.003 +15.015		001 001	0.02 0.10
"ENTER"	то	CONT	TINUE

Line 1 of the results shows the Phase A test results, and line 2 shows the Phase B test results.

Press the [ENTER] key to continue.

N.51082245.com j. The following screen will be displayed showing the Phase C cable connections for the selected test:

P	HASE	С
CABLE X1,X2	то	XEMR X3, X0
H1,H2	ΤŌ	H3,H2
		ttp://v.
"START"	' WHE	N READY

Make the cable connections per the instructions and then press the [START] key to run the Phase C test.

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



The Phase A, B, and C test results will be displayed on the LCD screen when testing has finished:

TEST RESULTS:				
RATIO MA	A %DIFF			
A +15.003 0	0.02			
B +15.015 0	01 0.10			
C +15.000 0	0.00			
181.4° 183.2	2° 181.8°			
XFMR TYPE: I	DYN1			

The phase angles for Phase A, B, and C are also displayed at the bottom of the test results from left to right, respectively. Press any key to continue.
I. The following screen will be displayed:



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

m. The following screen will be displayed:



Press any key to continue.



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:

PRE	EVIOUS	DATA	IN	BUF	
1.	APPENI	PREV	. D	IATA	
2.	CLEAR	PREV.	DA	ITA	

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:



n. The following screen will be displayed:



Press the [2] key (NO).

o. The following screen will be displayed:



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

p. The test record will be saved and the following screen will be displayed:





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.

3.7 Working With Test Records

3.7.1. Viewing the Contents of the Working Memory

Whenever a test is performed or a test record is retrieved, the data is stored in the ATRT's working memory. You can view the test data using the steps below:

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





Press the [3] key (PRINT RECORD).

c. The basic test record information will be displayed as shown:



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



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

3.7.2. Saving Test Results to a Test Record

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

a. Perform a test or restore a test record to the working memory (see section 3.7.3 and 3.7.4), and then start from the "START-UP" menu:



Press the [2] key (SETUP).

b. The following screen will be displayed:



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

c. The following screen will be displayed:





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

Press the [2] key (SAVE RECORD).

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

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

d. The following screen will be displayed:



1. SAVE INTERNALLY

Press the [1] key (SAVE INTERNALLY) to save the test record to the unit's Flash 510822 EEPROM. Continue to step e.

2. SAVE TO THUMB DRIVE

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



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

e. The following screen will be displayed:



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

3.7.3. Restoring a Test Record From Flash EEPROM

Use the steps below to restore a test record from the ATRT'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 [4] key (SAVE/RESTORE RECORD).

c. The following screen will be displayed:



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

NOTE

Press the [1] key (RESTORE RECORD).

d. The following screen will be displayed:



1. ENTER RECORD NUMBER

Press the **[1]** key (*ENTER RECORD NUMBER*) 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:

RECORD RESTORED! DISPLAY RECORD?
1.YES 2 NO
2000

Press the [1] key (YES) to display the test record.

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



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

1 SINGLE PHASE 40 VOLTS			
RATIO	MA	%DIFF	
1.003	0002	0.3	

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

2. SCROLL TO SELECT

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

2.1. The following screen will be displayed:

RECORDS	DIRECTORY
"UP" TO S	CROLL FWD
"DWN" TO	SCROLL RVS

Press the **[Contrast** \land] button or the **[Contrast** \lor] key to display the next or previous test record, respectively.

The basic test record information will be displayed as shown:

#1 05/25/11 09:52 SINGLE PHASE 1 TESTS

When you have located the test record that you would like to restored, press the **[ENTER]** key. **Continue to step 1.2 on page 40.**

3.7.4. Restoring a Test Record From a USB Flash Drive

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

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



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

c. The following screen will be displayed:



Press the [1] key (RESTORE RECORD).

d. The following screen will be displayed:



Press the [2] key (THUMB DRIVE).

e. The following screen will be displayed:



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

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



Press the [1] key (YES) to display the restored test record.

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



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

1 SINGLE PHASE 40 VOLTS		
RATIO 1.003	MA 0002	%DIFF 0.3

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

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3.7.5. Copying Test Records to a USB Flash Drive

Use the steps below to copy one or all test records from the unit's Flash EEPROM to a connected USB Flash drive:

a. Make sure a USB Flash drive is connected to the unit's "USB MEM" port, and then start from the "START-UP" menu:

1. TEST	TRANSFORMER
2. SETU	P
3. CALC	ULATOR
TIME:	14:21:34
DATE:	05/24/11



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

c. The following screen will be displayed:



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

d. The following screen will be displayed:



1. COPY SINGLE RECORD

Press the **[1]** key (*COPY SINGLE RECORD*) to copy a single test record from the ATRT's Flash EEPROM to the connected USB Flash drive. The following screen will be displayed:



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

REC_000 SAVED TO THUMB DRIVE

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

2. COPY ALL RECORDS

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



3.7.6. Viewing the Test Record Directory

Use the steps below to browse through a directory of the test records stored in the ATRT's Flash EEPROM memory:

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



Press the [2] key (SETUP).

b. The following screen will be displayed:



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

c. The following screen will be displayed:



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

NOTE

Press the [3] key (RECORD DIRECTORY).

d. The following screen will be displayed:



Press the **[Contrast** \land] or **[Contrast** \lor] key to scroll through the test record directory. The test record header will be displayed as shown:

SINGLE PHASE NUM TESTS: 1 05/27/11 15:25:57	a 15.com
unalli -	N.51082240

You can continue to scred through the record directory by pressing the **[Contrast** \land] and **[Contrast** \lor] keys. Press the **[STOP]** key to return to the "START-UP" menu.

3.7.7. 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:



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

b. The following screen will be displayed:



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

c. The following screen will be displayed:



Press the [4] key (ERASE RECORD).

d. The following screen will be displayed:



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:



1. ENTER RECORD NUMBER

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

ERASE RECORD NUMBER:



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 contoknow the test record number, you can first view the test record directory using the instructions in section 3.7.6.

The following screen will be displayed while the record is being erased:



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



Press any key to continue. You will be returned to the beginning of step d.

2. SCROLL TO SELECT

Press the **[2]** key (*SCROLL TO SELECT*) to scroll through the test record directory and locate the test record that you would like to erase. The following screen will be displayed:

RECORDS DIRECTORY
"UP" TO SCROLL FWD "DWN" TO SCROLL RVS

Press the **[Contrast** \land] or **[Contrast** \lor] key to scroll through the test record directory. The test record header will be displayed as shown:

SINGLE PHASE NUM TESTS: 1 05/27/11 15:25:57

You can continue to scroll through the record directory by pressing the **[Contrast** \land] and **[Contrast** \lor] keys. Once you have located the test record you would like to erase, press the **[ENTER]** key. The selected test record will be erased and the following screen will be displayed:



Press any key to continue. You will be returned to the beginning of step d.

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:



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 with the displayed during the erasure process:



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



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

3.7.8. Erasing Test Records from a USB Flash Drive

Follow the steps below to erase test records from a USB Flash drive:

a. Make sure a USB Flash drive is connected to the unit's "USB MEM" port, and then start from the "START-UP" menu:

1. TEST	TRANSFORMER
2. SETU	P
3. CALC	ULATOR
TIME:	14:21:34
DATE:	05/24/11

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

b. The following screen will be displayed:



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

c. The following screen will be displayed:



Press the [4] key (ERASE RECORD).

d. The following screen will be displayed:



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



e. The following screen will be displayed:



1. ERASE SINGLE REC.

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

REC_ 51082243	
to Ilmn	

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

THUMB DRIVE ERASED!	RE000

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

2. ERASE ALL RECORDS

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

ERASE ALL RECORDS!	THUMB DRIVE
ARE	YOU SURE?
"ENTER" 1	TO CONTINUE.

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

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



Using the Turns Ratio Calculator 3.8

The ATRT-01 and ATRT-01B S2 feature 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 and the unit will calculate the turns ratio. Follow the steps below to use the turns ratio calculator.

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

		1
	1. TEST TRANSFORMER 2. SETUP	
	3. CALCULATOR	
	TIME: 14:21:34 DATE: 05/24/11	15.com
	Press the [3] key (CALCULATOR).	× 08224
b.	The following screen will be displa	yed:
	XFMR CONFIG: 1. SINGLE PHASE	

XF	MR CONFIG:
1.	SINGLE PHASE
2.	DY
3.	YD
4.	DD
5.	YY
6.	NEXT PAGE

Select the transformer configuration by pressing the corresponding key on the keypad. You can press the [6] key (NEXT PAGE) to view additional transformer configuration types. For this example, press the **[3]** key (*Yd*) to select the Y-dT transformer type.



The following steps will differ for other transformer configuration types.

NOTE

c. The following screen will be displayed:



1. YES

Press the [1] key (YES) if H0 is accessible. The following screen will be displayed:



Select the transformer configuration by pressing the corresponding key. **Continue to step d.**

2. NO

Press the **[2]** key (*NO*) if H0 is not accessible. The following screen will be displayed:

1. 2.3. 4. 5.	YD1 YD3 YD5 YD7 YD9 YD11		

Select the transformer configuration by pressing the corresponding key. **Continue to step d.**

d. The following screen will be displayed

```
NAME PLATE VOLTAGE:
H : X
0 :
```

Type the H name plate voltage value using the keypad. The screen will be updated:

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

```
NAME PLATE VOLTAGE:
H : X
1,734 : 0
```

Type the X name plate voltage using the keypad. The screen will be updated:

Press the **[ENTER]** key. The ratio will be calculated and displayed at the bottom of the screen:

```
NAME PLATE VOLTAGE:
H : X
1,734 : 100
RATIO = 15.017
```

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 phasedisplacement 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) A5.

```
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

	TRANSF CONFIGL	ORMER JRATION		WINDING TESTED				
STD TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	TURNS RATIO	VECTOR GROUP	NOTES
1	н ₁ 0Он ₂	x ₁ 00x ₂	1Ø	H ₁ – H ₂	x ₁ -x ₂	V _H V _x	1ph0	SNG – PHS
2	H ₁ H ₁ H ₁ H ₁ H ₁ H ₂ H ₃ H ₃	x ₁ 0 a b x ₀ c x ₃	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	$\frac{v_{H} \cdot v_{3}}{v_{x}}$	Dyn1	d t – Y
3	H ^{NO} H ^O H ^O H ^O	X ₁ C C X ₂ b X ₃	A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$\frac{x_1 - x_2}{x_2 - \lambda_3}$	$\frac{V_{H}}{V_{x} \cdot V_{3}}$	YNd1	y – d t
4	H ₁ H ₁ H ₁ H ₁ H ₁ H ₂ H ₃ H ₃	x2 b y y y y y y y y y y y y y y y x3	А В С	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	X ₁ -X ₃ X ₂ -X ₁ X ₃ -X ₂	V _H	Dd0	dt-dt
5	H ² O _B H ₀ O _C H ₃	x ₂ b x ₀ x ₁ c x ₃	A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$x_{1} - x_{0}$ $x_{2} - x_{0}$ $x_{3} - x_{0}$	V _H	YNyn0	у — у

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	TRANSF CONFIGL	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	Р ^Н 2	x ₃ q a x ₁		А	$H_{1} - H_{3}$	$x_{3} - x_{1}$			
1	в	c b		В	$H_2 - H_1$	$x_{1} - x_{2}$	$\frac{v_{H}}{v_{U}}$	Dd6	
	H ₁ O A OH ₃	×2		С	H ₃ – H ₂	$x_2 - x_3$	^		
	н ₂ Q	x ₂ Q		A	H ₁ – H ₃	$x_{1} - x_{3}$	v		
37	в	b/ C	—	В	$H_2 - H_1$	x ₂ -x ₁		Dd0	
	н ₁ фон ₃	х ₁ острана а		С	H3 – H2	x ₃ -x ₂			
	н ₁ Q	X ₃ Q b X ₁		А	H ₁ – H ₂	X3 - X2			
38	C/A	a c		В	H ₂ – H ₃	X1 - X3	V _x	Dd2	
	н ₃ б <u>в</u> он ₂	×2		С	H3 – H1	×2-X1			
	[⊬] 1 R	×₃ A		A	F1-H2	X ₃ – X ₁	v		
39	C/ 🔪	c/a	11.1	NB.	H ₂ – H ₃	X ₁ – X ₂		Dd4	
	н ₃ б _в он ₂	x ₂ d bx	114.	С	H3 – H1	X ₂ – X ₃			
	$\left \begin{array}{c} \mathbf{A} \\ \mathbf{A} \\$	8		A	H ₁ – H ₂	$x_2 - x_3$	V.,	_	
40	C/ \^	c a		В	H ₂ – H ₃	x ₃ -x ₁		Dd8	
	H ₃ O B OH ₂	x ₁ 0 b 0x ₃		C	H ₃ -H ₁	x ₁ -x ₂			
	A^{H_1} $X_1 \bigcirc b$	$X_1 \bigcirc X_2$	x_2	A	H ₁ – H ₂	X ₁ – X ₃	V.,		
41		a C	—	В	H ₂ – H ₃	X ₂ – X ₁	<u></u>	Dd10	
	н ₃ оон ₂	×3		С	H3 – H1	X ₃ – X ₂			
	× R	$A^{a^{1}}$		A	H ₁ – H ₃	X ₁ – X ₀	V _H •V3		
42	A B			В	H ₂ – H ₁	x ₂ - x ₀	$\frac{v_{\rm H}}{v_{\rm X}}$	Dyn1	
	н ₃ 0 <u>с</u> 0н ₂	0 _{X2}		С	H3 – H2	X ₃ – X ₀			
	Å	^b ∕ ^x ²	н ₃ -н ₂	A	H ₁ – H ₃	$x_1 - x_3$	V _H •V3		
2	B/ C	X ₁ O $ (\eta)$	H ₁ -H ₃	В	H ₂ – H ₁	x ₂ -x ₁	$\frac{1}{V_{x}}$	Dy1	NEUTRAL ON
	н ₁ 0 А Он ₃	U _{X3}	^H 2 ^{-H} 1	С	H ₃ – H ₂	$x_3 - x_2$			
	Å	×19, c	H ₃ -H ₂	A	H1-H3	x ₁ – x ₂	VH •V3		NO ACCESSIBLE
61	B C	^b X ₀ X ₂	H ₁ -H ₃	В	H2 – H1	x ₂ – x ₃	$\overline{V_{X}}$	Dy3	NEUTRAL ON
	H ₁ O A OH ₃	×3	^H 2 ^{-H} 1	С	H3 – H2	x ₃ – x ₁			
	Å.	×19, °		A	H1-H3	x ₀ - x ₂	V _H V ₂		
62	B/ C		—	В	$H_2 - H_1$	x ₀ – x ₃	$\overline{v_x}$	Dyn3	
	H ₁ O A DH ₃	×3		С	H3 – H2	$x_0 - x_1$			

	TRANSF CONFIGL	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	H ₂	_ل ه ^x 1		А	H ₁ – H ₃	$x_3-x_0\\$			
3	в С	x ₃ o-a-dx ₀		в	$H_2 - H_1$	$X_1 - X_0$	$\frac{V_{H} \cdot V_{3}}{V}$	Dyn5	
	H ₁ O _A H ₃	° b×2		С	H3 – H2	$X_2 - X_0$	v _x		
	H ₂	۵ ^X 1	н ₃ -н ₂	Α	H1-H3	$X_3 - X_2$			NO
4	в	x ₃ o a b η	н ₁ -н ₃	в	$H_2 - H_1$	$X_{1} - X_{3}$	$\frac{V_{H} \cdot V_{3}}{V}$	Dy5	ACCESSIBLE NEUTRAL ON
	H ₁ O A H ₃	° bx ₂	H ₂ -H ₁	С	H3 – H2	$x_2 - x_1$	v _x		WYE WINDING
	н ₂ Q	X ₃ Q _c		А	$H_{1} - H_{3}$	$x_0 - x_1$	3		
5	в	$X_0 \rightarrow a_0 X_1$	—	В	H ₂ -H ₁	X0-12	$\frac{V_{H} \cdot V_{3}}{V_{v}}$	Dyn7	
	H ₁ $ H_3$	x ₂ d °		С	H3 H2	$x_0 - x_3$			
	H ₂ O	^X ₃ Q _c	н ₃ -н ₂	A S	H ₁ – H ₃	$x_{3} - x_{1}$			NO
6	в	$\eta = 0 x_1$	H ₁ -H ₃	В	$H_2 - H_1$	x ₁ -x ₂	$\frac{v_{H} \cdot v_{3}}{v_{x}}$	Dy7	ACCESSIBLE NEUTRAL ON
	H ₁ O A H ₃	x ₂ d ^b	H ₂ -H ₁	С	H3 – H2	x ₂ -x ₃	^		WYE WINDING
	H ₂	ρ ^x 3	H ₃ -H ₂	Α	H ₁ – H ₃	$X_2 - X_1$			NO
63	в	x ₂ o a x ₀	H ₁ -H ₃	в	$H_2 - H_1$	$X_3 - X_2$	$\frac{V_{H} \cdot V_{3}}{V}$	Dy9	ACCESSIBLE NEUTRAL ON
	H ₁ O A H ₃	°Ъ×₁	^H 2 ^{-H} 1	С	H3 – H2	$X_1 - X_3$	vx		WYE WINDING
	H ₂	ρ ^x 3		A	H ₁ – H ₃	$X_2 - X_0$			
64	в	$x_2 o a o x_0$	—	В	H ₂ – H ₁	$x_3 - x_0$	$\frac{V_{H} \cdot V_{3}}{V}$	Dyn9	
	H ₁ O A H ₃	° b×1		С	H3 – H2	X ₁ – X ₀	٧x		
	H ₂	×2 Q c		Α	H ₁ – H ₃	$X_0 - X_3$			
7	в	$x_0 \rightarrow a \rightarrow x_3$	—	в	H ₂ – H ₁	X ₀ – X ₁	$\frac{V_H \bullet V_3}{V_1}$	Dyn11	
	H ₁ O A H ₃	x10 p		С	H ₃ – H ₂	$X_0 - X_2$	¥x		
	H ₂	^x 2 Q _c	^н з- ^н 2	A	H ₁ – H ₃	X ₂ – X ₃			NO
8	в		н ₁ -н ₃	в	H ₂ – H ₁	$x_3 - x_1$	$\frac{v_{H} \bullet v_{3}}{v_{x}}$	Dy11	ACCESSIBLE NEUTRAL ON
	H ₁ H ₃ H ₃	х ₁ б ^ь	^H 2 ^{-H} 1	С	H ₃ – H ₂	X ₁ – X ₂	^		WYE WINDING
	H ₁ O	×1 Q	н ₂ -н ₃	А	$H_{1} - H_{2}$	$X_{1} - X_{0}$	V		
45	C A		^н 3-н1	В	$H_2 - H_3$	$x_{2} - x_{0}$	$\frac{3}{2} \cdot \frac{V_H}{V}$	Dzn0	
	H ₃ d B H ₂	x ₃ b o ²	^H 1 ^{-H} 2	С	$H_{3} - H_{1}$	$x_{3} - x_{0}$	· x		
	H ₁ Q		H ₂ -H ₃	Α	H ₁ -H ₂	$X_0 - X_2$	V		
46	C/A		^н з- ^н 1	В	$H_2 - H_3$	$x_0 - x_3$	$\frac{3}{2} \cdot \frac{H}{V_{u}}$	Dzn2	
	н ₃ фВ Н ₂	bx ₂	^H 1 ^{-H} 2	С	H ₃ – H ₁	$X_0 - X_1$	×		

	TRANSF CONFIGL	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	μ ¹ Ω	$x_{0} \xrightarrow{b} x_{1}^{X_{1}}$		A	H ₁ – H ₂	$X_3 - X_2$	V.		NO
47	C A		—	в	H ₂ – H ₃	$X_1 - X_3$	$\frac{v_{\rm H}}{v_{\rm x}}$	Dz2	
	н ₃ фрн ₂	bx2		С	H3 – H1	$X_2 - X_1$			NEOTHAL
	н ₁ Q	2 ^{×3}	^н 2 ^{-н} 3	A	H ₁ -H ₂	$x_{3} - x_{0}$	2 V.		
48	C/A	^a X ₀ b	^н з- ^н 1	В	H ₂ – H ₃	$x_{1} - x_{0}$	$\frac{3}{2} \cdot \frac{1}{V_x}$	Dzn4	
	н ₃ фрн ₂	x_2^{O-2} x_1^{O}	^H 1 ^{-H} 2	С	H3 – H1	$x_2 - x_0$			
	н ₁ Q	ρ ^{x₃}		A	H ₁ -H ₂	X ₃ – X ₁	0		NO
49	C A	a n b	—	В	H ₂ – H ₃	X1-12		Dz4	ACCESSIBLE
	н ₃ фрн ₂	x_2^{O-2} x_1^{O}		С	H3 - H1	X ₂ – X ₃			NEOTIAL
	н ₂ А	٩ [×] 2		AS	H-H3	X ₁ – X ₃	V.		NO
9	в	$a \eta X_a$	121	B	H ₂ – H ₁	X ₂ – X ₁	<u></u>	Dz0	ACCESSIBLE NEUTRAL
	H ₁ G _A OH ₃	x003	11.	С	H3 – H2	X3 - X2			
	Å	x ₃ × 2 ^{×1}		A	H ₁ – H ₃	x ₃ -x ₁	V		NO
10	B C	b η a		В	H ₂ -H ₁	$x_1 - x_2$	$\frac{v_{\rm H}}{v_{\rm x}}$	Dz6	ACCESSIBLE NEUTRAL
	H ₁ O A OH ₃	δx ₂		С	H ₃ – H ₂	x ₂ -x ₃			
	A x_2	$x_2^{o} \xrightarrow{b} p^{X_3}$	^н 2- ^н 3	A	H ₁ – H ₂	$x_0 - x_1$	3 VH		
50	C/ A	$a \begin{pmatrix} X_0 \\ X_0 \end{pmatrix}^c$	^H 3 ^{- H} 1	В	H ₂ – H ₃	x ₀ -x ₂	$\frac{1}{2} \cdot \frac{1}{V_x}$	Dzn6	
	н ₃ фон ₂	δ×1	^н 1- ^н 2	С	H3 – H1	$x_0 - x_3$			
	н ₁ Я	٩ ^{×2}	^н 2- ^н 3	A	H ₁ – H ₂	X ₂ – X ₀	2 Vu		
51	C/A	د(x ₀ x	^Н 3 ^{-Н} 1	В	H ₂ – H ₃	x ₃ – x ₀	$\frac{3}{2} \cdot \frac{\pi}{V_x}$	Dzn8	
	н ₃ б в он ₂	X ₁ ^O b	^H 1 ^{-H} 2	С	H3 – H1	X ₁ – X ₀			
	[⊭] 1 R	٩ ^{×2} a		A	H ₁ – H ₂	X ₂ – X ₃	V		NO
52	C/ \^	° X		В	H ₂ – H ₃	X ₃ – X ₁		Dz8	ACCESSIBLE NEUTRAL
	н ₃ б _в он ₂	X ₁ ^O b ^O		С	H3 – H1	X ₁ – X ₂			
	н ₁ Я	$\begin{pmatrix} X_1 \\ Q \end{pmatrix} = \begin{pmatrix} C \\ Y \end{pmatrix} \begin{pmatrix} X_2 \\ Y \end{pmatrix}$	^н 2 ^{-н} 3	A	H ₁ – H ₂	x ₀ - x ₃	a Vu		
53	C/ A		^н з- ^н 1	В	H ₂ – H ₃	$x_0 - x_1$	$\frac{3}{2} \cdot \frac{1}{V_x}$	Dzn10	
	H ₃ O _B OH ₂	×30	^H 1 ^{-H} 2	С	H ₃ – H ₁	x ₀ – x ₂			
	[⊩] 1 A	$\begin{pmatrix} X_1 \\ Q \end{pmatrix} = \begin{pmatrix} X_2 \\ Q \end{pmatrix}$		A	H ₁ – H ₂	X ₁ – X ₃	V		NO
54	C/ 🔪	b 💙 a	—	В	H ₂ – H ₃	X ₂ -X ₁	<u></u>	Dz10	ACCESSIBLE NEUTRAL
	н ₃ фрн ₂	׳Q		С	H3 – H1	$X_3 - X_2$			

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	H ₂	X ₃ Q c		А	H ₁ – H ₀	$X_2 - X_1$			
11	A B HO		—	в	$H_2 - H_0$	$X_3 - X_2$		YNd7	
	H10 C OH3	X ₂ a		С	$H_{3} - H_{0}$	$X_1 - X_3$	•x ••3		
	н ₂ О	a X ₂		А	H ₁ – H ₀	$x_{1} - x_{2}$			
44		X ₁ C	—	В	$H_2 - H_0$	$x_2 - x_3$	$\frac{V_H}{V_X \cdot V_3}$	YNd1	
	H10 COH3	ٽ ک _ک ي		С	H3 – H0	$x_{3} - x_{1}$	~ · ·		
	н ₂ О	a X ₂	н ₃ -н ₂	А	H ₁ – H ₃	X ₁ – X ₂	n		NO
12	A	X ₁ C	н ₁ -н ₃	В	H ₂ – H ₁	X2-X3	$\frac{V_{H}}{V_{X}} \cdot \frac{V_{3}}{2}$	Yd1	ACCESSIBLE NEUTRAL ON
	H10 C OH3	° 'V _{X3}	^н 2-н1	С	H3-042	$X_3 - X_1$			WYE WINDING
	н ₂ О	a 1 X1		AS	H1-H0	X3 - X2	V		
13		X ₃ C b	11791	В	$H_2 - H_0$	X ₁ – X ₂	$\frac{V_H}{V_X \cdot V_3}$	YNd5	
	H10 C OH3	G, P	11.	С	H3 – H0	$X_2 - X_3$			
	н ₂ Ф	a A ^X 1	н ₃ -н ₂	A	H ₁ – H ₃	x ₃ -x ₁	V V5		NO
14	A N	× ₃ b	^H 1 ^{-H} 3	В	H ₂ – H ₁	x ₁ - x ₂	$\frac{v_{\rm H}}{V_{\rm X}} \cdot \frac{v_3}{2}$	Yd5	ACCESSIBLE NEUTRAL ON
	H10 C OH3	° V _{x2}	^H 2 ^{-H} 1	С	H ₃ – H ₂	x ₂ -x ₃			WYE WINDING
	н ₂ О	X ₃ Q c	н ₃ -н ₂	A	H ₁ – H ₃	$x_2 - x_1$			NO
15	B N		^H 1 ^{-H} 3	В	H ₂ – H ₁	x ₃ -x ₂	$\frac{v_{H}}{v_{X}} \cdot \frac{v_{3}}{2}$	Yd7	NEUTRAL ON
	H10 C OH3	X ₂ a	^н 2 ^{-н} 1	С	H3 – H2	$x_1 - x_3$			WYE WINDING
	н ₂ О	×2 ~ c		A	H ₁ -H ₀	X ₁ – X ₃			
16		▷ → ^X 3	—	В	H ₂ – H ₀	X ₂ – X ₁	$\frac{v_H}{v_X \cdot v_3}$	YNd11	
	H10 COH3	x ₁ a		С	H3 – H0	X ₃ – X ₂			
	н ₂ О	X ₂ C	н ₃ -н ₂	A	H ₁ – H ₃	X ₁ – X ₃			NO
17	A N	▷ → ^X 3	^н 1- ^н 3	В	H ₂ – H ₁	X ₂ -X ₁	$\frac{V_{\rm H}}{V_{\rm X}} \cdot \frac{V_{\rm 3}}{2}$	Yd11	ACCESSIBLE NEUTRAL ON
	H ₁ O C OH ₃	x ₁ ^a	^н 2 ^{-н} 1	С	H3 – H2	X3 – X2			WYE WINDING
	н ₂ О	$X_3 \xrightarrow{a} X_1$		A	$H_1 - H_0$	x ₀ - x ₁	v		
18		b X ₀		В	H ₂ – H ₀	x ₀ -x ₂	$\frac{v_{\rm H}}{v_{\rm x}}$	YNyn6	
	H10 C OH3	x ₂		С	H ₃ – H ₀	$x_0 - x_3$			
	н ₂ О	×2 0	H ₂ -H ₀	A	H ₁ – H ₀	X ₁ – X ₂	V		NO ACCESSIBLE
19		a b η	н ₃ -н ₀	В	H ₂ – H ₀	X ₂ – X ₃	<u></u>	YNy0	NEUTRAL ON
	H10 C OH3	x ₁ 0 0 x ₃	H ₁ -H ₀	С	$H_3 - H_0$	$X_3 - X_1$	^		WINDING

	TRANSF CONFIGL	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	H ₂	×2 0	x ₃ -x ₀	А	H ₁ – H ₃	$X_1 - X_0$			
20	A N	a b X ₀	x ₁ -x ₀	В	$H_2 - H_1$	$X_2 - X_0$	$\frac{v_{H}}{v_{v}}$	Yyn0	NEUTRAL ON
	H10 COH3	x ₁ 0 c 0x ₃	x ₂ -x ₀	С	H3 – H2	$X_3 - X_0$	^		WINDING
	н ₂ О	H ₂ X ₂		А	H ₁ – H ₀	$X_1 - X_0$	v		
43		a $\sum_{a}^{b} X_{0}$	—	В	H ₂ – H ₀	$X_2 - X_0$		YNyn0	
	H ₁ O C OH ₃	x ₁ 0 c 0x ₃		С	H ₃ – H ₀	$x_3 - x_0$			
	н ₂ О	×2 0		A	H ₁ – H ₃	X ₁ - X ₃	Ĉ,		NO
21	A N	a b η		В	H ₂ – H ₁	X2-X1	$\frac{v_{\rm H}}{v_{\rm x}}$	Yy0	ACCESSIBLE NEUTRAL
	H10 C OH3	x ₁ 0 ° ° ° x ₃		С	Ha EHa	X3 – X2			
	н ₂ О	$X_{3} \xrightarrow{a} X_{1}$	H ₂ -H ₀	A 5	H1 – H0	X ₂ – X ₁	v.,		NO ACCESSIBLE
22		bη	H3. 170	В	$H_2 - H_0$	X ₃ – X ₂	<u></u>	YNy6	NEUTRAL ON
	H10 C OH3	×2 ttp	H ₁ -H ₀	С	H3 – H0	X ₁ – X ₃			WINDING
	н ₂ О	$X_3 \xrightarrow{a} X_1$	× ₃ -× ₀	A	H ₁ – H ₃	$x_0 - x_1$	v		NO ACCESSIBLE
23	A N	^b ^x o	x ₁ -x ₀	В	H ₂ -H ₁	x ₀ -x ₂	$\frac{v_{H}}{v_{x}}$	Yyn6	NEUTRAL ON HIGH VOLTAGE
	H10 C OH3	×2	x ₂ -x ₀	С	H ₃ – H ₂	x ₀ -x ₃	~		WINDING
	н ₂ 0	$X_3 $ X_1		A	H ₁ – H ₃	x ₃ -x ₁	v		NO
24	A N	υ β	—	В	$H_2 - H_1$	x ₁ -x ₂	<u></u>	Yy6	ACCESSIBLE NEUTRAL
	H10 C OH3	×2		С	H ₃ – H ₂	x ₂ -x ₃			
	^н 2 Q	a. Ib		A	H ₁ – H ₃	$x_1 - x_0$			
65	A HO	X ⁰ X ₀		В	H ₂ – H ₁	x ₂ -x ₀	V _X	YNzn1	
	н ₁ 0 с он ₃	° > 0 X ₃		С	H3 – H2	x ₃ -x ₀			
	н ₂ О	$a \qquad A^2$		A	H ₁ – H ₃	X ₁ – X ₀	V _H • V3		NO ACCESSIBLE
25	A N	X10 X0	—	В	$H_2 - H_1$	X ₂ – X ₀	$\frac{1100}{V_X}$	Yzn1	NEUTRAL ON WYE WINDING
	н ₁ о с он ₃	د ×م ۲3		С	H ₃ – H ₂	X ₃ – X ₀			
	н ₂ Ф		^н з- ^н 2	A	H ₁ – H ₃	X ₁ – X ₂	V V5		NO
26	A N	X ₁ b	^H 1 ^{-H} 3	В	$H_2 - H_1$	X ₂ – X ₃	$\frac{V_{H}}{V_{X}} \cdot \frac{V_{3}}{2}$	Yz1	ACCESSIBLE NEUTRAL
	H10 COH3	° 2×3	^Н 2 ^{-Н} 1	С	H3 – H2	X ₃ – X ₁			
	н ₂ О			A	H ₁ – H ₃	x ₃ -x ₀	VII VI		
27	A	X ₃ X ₀ X ₀	—	В	H ₂ -H ₁	x ₁ - x ₀	$\frac{V_{H} \bullet V_{3}}{V_{x}}$	Yzn5	
	H ₁ O C OH ₃	° x 2		С	H ₃ – H ₂	x ₂ -x ₀			

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	H ₂	ρ ^X 1	н ₃ -н ₂	А	H ₁ – H ₃	X ₃ – X ₁			NO
28	_ ^B N	X20 a b	${}^{H_{1}-H_{3}}$	В	H ₂ – H ₁	X ₁ – X ₂	$\frac{V_{H}}{V_{H}} \cdot \frac{V_{\overline{3}}}{2}$	Yz5	ACCESSIBLE
	H10 C OH3	° ~ ×2	^H 2 ^{-H} 1	С	H3 – H2	$X_2 - X_3$	·x -		NEUTRAL
	H ₂	X ₃ Q		А	H ₁ – H ₃	$X_0 - X_1$			
66		$\begin{bmatrix} 0 \\ X_0 \\ X_0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$	—	в	H ₂ – H ₁	$X_0 - X_2$	V _H • V ₃	YNzn7	
	H10 C OH3	x ₂ 0		С	H3 – H2	$x_0 - x_3$	٧x		
	H ₂	X ₃ Q _c		А	H1 – H3	$x_0 - x_1$	0		NO
29	B N	$ \xrightarrow{b} X_0 \xrightarrow{a} 0^{1} $	—	В	H2-H1	Xu-Xz	$\frac{v_{H} \cdot v_{3}}{v_{x}}$	Yzn7	NEUTRAL ON
	H10 C OH3	x ₂ 0		С	H2 OH2	X ₀ – X ₃			WYE WINDING
	н ₂ О	× ₃ Q _c	H ₃ -H ₂	A.5	H ₁ -H ₃	x ₂ -x ₁			NO
30	^B N		H1-H3	В	H ₂ – H ₁	x ₃ -x ₂	$\frac{V_H}{V_X} \cdot \frac{V_3}{2}$	Yz7	ACCESSIBLE
	H ₁ O C OH ₃	x20 ttp	H ₂ -H ₁	С	H3 – H2	x ₁ - x ₃			
	н ₂ О	X ₂ Q C Y		А	H ₁ – H ₃	X ₀ – X ₃	Vu Va		
67		$b \qquad a^{3}$	—	В	H ₂ – H ₁	$X_0 - X_1$	V _X	YNzn11	
	H ₁ O C OH ₃	x ₁ Ó		С	H3 – H2	X ₀ – X ₂			
	н ₂ О	x ₂ ~ ~ ~ ~		A	H ₁ – H ₃	$x_0 - x_3$			NO
31	A N	$b \xrightarrow{X_0} a^{-3}$	—	В	H ₂ – H ₁	$X_0 - X_1$	$\frac{V_{H} \bullet V_{\overline{3}}}{V_{H}}$	Yzn11	ACCESSIBLE NEUTRAL ON
	H ₁ O C OH ₃	x ₁ o		С	H3 – H2	$X_0 - X_2$	*x		WYE WINDING
	н ₂ О	X ₂ Q _c	н ₃ -н ₂	A	H ₁ – H ₃	X ₁ – X ₃	V., V2		NO
32	AN		^H 1 ^{-H} 3	В	$H_2 - H_1$	X ₂ – X ₁	$V_{\rm X}^{\bullet}$	Yz11	ACCESSIBLE NEUTRAL
	H10 C OH3	x ₁ 0	^H 2 ^{-H} 1	С	H3 – H2	X ₃ – X ₂			
		Å	x ₂ -x ₃	А	H ₁ – H ₀	x ₁ -x ₂	2 V _H		
55	C-QH₀	c a	x ₃ -x ₁	В	H ₂ – H ₀	x ₂ -x ₃	$\frac{2}{3} \cdot \frac{1}{V_x}$	ZNd0	
	н ₃ в - Он ₂	x ₃ d b bx ₂	x ₁ -x ₂	С	H ₃ – H ₀	x ₃ -x ₁			
		Å		A	H ₁ – H ₂	x ₁ -x ₂	V.,		
56	C N	c a		В	H ₂ – H ₃	x ₂ -x ₃		Zd0	NEUTRAL ON
	H ₃ O B OH ₂	x ₃ o b b x ₂		С	H3 – H1	x ₃ -x ₁			
	Q ^H 1 _A	X ₂ X ₃	x ₂ -x ₃	А	H ₁ – H ₀	X ₂ – X ₁	. V.		
57		a c	x ₃ -x ₁	В	H ₂ – H ₀	X ₃ – X ₂	$\frac{2}{3} \cdot \frac{H}{V_x}$	ZNd6	
	H ₃ ^d B [−] OH ₂	x ₁	x ₁ -x ₂	С	$H_{3} - H_{0}$	X ₁ – X ₃	^		
	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
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SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	H ₂ B	a 0 ^{×1}		A	$H_1 - H_0$	X ₃ – X ₁	v _H		NO ACCESSIBLE
33		X ₃ 0-0 b X ₂	_	С В	$H_2 - H_0$ $H_3 - H_0$	$x_1 - x_2$ $x_2 - x_3$	V _{x •} V ₃	ZNy5	NEUTRAL ON WYE WINDING
	Q ^H 2	a P ^x 1	н ₃ -н ₂	А	H ₁ – H ₃	x ₃ -x ₁	V VE		NO
34	A B	X ₃ C n	H ₁ -H ₃	в	H ₂ -H ₁	x ₁ -x ₂	$\frac{v_{H}}{V_{X}} \cdot \frac{v_{3}}{2}$	Zy5	ACCESSIBLE NEUTRAL
	н <mark>о с</mark> -он _з	^υ δ ^x 2	^H 2 ^{-H} 1	С	H ₃ – H ₂	x ₂ -x ₃			
	Q ^H 2	X ₂ ο η		A	H ₁ – H ₀	X ₁ – X ₃			NO
35		a c o x ₃	—	В	H ₂ – H ₀	$x_2 - x_1$	V _X •V ₃	ZNy11	NEUTRAL ON
	н <mark>б с</mark> -он _з	x ₁ 0		С	H3 – H0	x3 - X2			WYE WINDING
	Q ^H 2	X ₂ Q	$H_{3}-H_{2}$	A	H1 - +13	$X_1 - X_3$			NO
36	A B N	$a \xrightarrow{b} c x_3$	H ₁ -H ₃	NB.	$H_2 - H_1$	$X_2 - X_1$	$\frac{v_H}{v_X} \cdot \frac{v_3}{2}$	Zy11	ACCESSIBLE
	н <mark>б с</mark> —он _з	x ₁ d	H2.H1	С	H3 – H2	X3 - X2			HEOTINE
	۶ ^H 2	J2 2		Α	H ₁ – H ₂	x ₁ - x ₂	V		
58	А	a b	H ₄ -H ₂				$\frac{v_{H}}{v_{U}}$	T-T	
	HO OH3	x ₁ ^o	$x_{1}^{-}x_{2}^{-}$	В	H ₁ – H ₃	$x_1 - x_3$	1 ^	0	
	^H ₂Q	×2	^н 2- ^н 3	Α	H ₁ – H ₃	x ₁ -x ₂	$\frac{V_{H}}{V} \cdot \frac{V_{\overline{3}}}{2}$	T-T	
59	AB	y O b						30	
	н <mark>о</mark> 6 ^г з	^1	x ₁ -x ₂	В	H ₂ – H ₃	x ₁ - x ₃	$\overline{V_x} \cdot \overline{V_3}$	Lag	
	H ₂ Q	X ₂ Q	H ₂ -H ₃	А	H ₁ – H ₃	$x_{1} - x_{3}$	$\frac{V_{H}}{V} \cdot \frac{V_{\overline{3}}}{2}$	T-T	
60	AB	0 ^X 3					V _X 2	30	
	H ₁ Ο δ ^H 3	x ₁ o ^a	x ₁ -x ₃	В	H ₂ – H ₃	x ₂ -x ₁	$\overline{V_{H}}^{*} \overline{V_{3}}^{2}$	Lead	

VANGUARD.050108V7

APPENDIX C – CEI/IEC 60076-1 Transformer Descriptions

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	1V Q	2WQ a 2U		А	1U – 1W	2W – 2U			
1	в	c b	—	В	1V – 1U	2U – 2V	U1 U2	Dd6	
	1U 0 A 1W	0 2V		С	1W – 1V	2V – 2W			
	1V Q	2V Q		А	1U – 1W	2U – 2W			
37	в	b C	—	В	1V – 1U	2V – 2U	U1 U2	Dd0	
	1U 0 0 1W	2U 6 2W		С	1W – 1V	2W – 2V	\mathcal{D}		
	1U Q	2W C b 2U		А	1U – 1V	21/2-27	ĺ		
38	C/A	a c	—	В	1V-01W	2U – 2W	U2	Dd2	
	1WO01V	2V		<u>ç 5</u>	∜W – 1U	2V – 2U			
	1U 8	2W 8	INV	A	1U – 1W	2W – 2U			
39	C/A	0	<u> </u>	В	1V – 1U	2U – 2V	U1 U2	Dd4	
	1W 0 B 01V	2V 0 b 2U		С	1W – 1U	2V – 2W			
	1U Q	X2 Q		А	1U – 1V	2V – 2W			
40	C/A	c/a		В	1V-1W	2W – 2U	U1 U2	Dd8	
	1WO B 1V	2U d b 2W		С	1W – 1U	2U – 2V			
	1U 8	2U Q b 2V		А	1U – 1V	2U – 2W			
41	C/ A	a	—	В	1V – 1W	2V – 2U	U1 U2	Dd10	
	1W 0 B 1V	2W		С	1W – 1U	2W – 2V			
	1U 8	2 ² U		А	1U – 1W	2U – 2N			
42	A B	2WO-C-Q_b	—	В	1V – 1U	2V – 2N	$\frac{U1 \bullet V_3}{U2}$	Dyn1	
	1W O O1V	6 2V		С	1W – 1V	2W – 2N			
	1V Q	_b , Р ^{2V}	1W – 1V	А	1U – 1W	2U – 2V			NO
2	в	2U Ο a Ο η	1U – 1W	В	1V – 1U	2V – 2W	$\frac{U1 \bullet V3}{U2}$	Dy1	ACCESSIBLE NEUTRAL ON
	1U 0 01W	δ _{2W}	1V – 1U	С	1W – 1V	2W – 2U			WYE WINDING
	1V Q	2U Q C	1W – 1V	А	1U – 1W	2U – 2V			NO
61	BC	b a 0 2V	1U – 1W	В	1V – 1U	2V – 2W	U1 •V3	Dy3	ACCESSIBLE NEUTRAL ON
	1U O	2W O	1V – 1U	С	1W - 1V	2W – 2U			WYE WINDING
	1V Q	2U Q c		А	1U – 1W	2N - 2V			
62	в/С		—	В	1V – 1U	2N – 2W	$\frac{U1 \bullet V_3}{U2}$	Dyn3	
	1U 0 1W	2W 0		С	1W – 1V	2N – 2U			

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	1V 8	b ^{2∪}		А	1U– 1W	2W – 2N			
3	B C	2W 0 a 2N		В	1V – 1U	2U – 2N	$\frac{U1 \cdot V_3}{U2}$	Dyn5	
	1U O A01W	čδ₂v		С	1W – 1V	2V – 2N	02		
	1V 8	µ2 2∪	1W – 1V	А	1U– 1W	2W – 2V			NO
4	BC	2W 0 a	1U-1W	В	1V – 1U	2U – 2W	$\frac{U1 \cdot \sqrt{3}}{U2}$	Dy5	ACCESSIBLE NEUTRAL ON
	1U 0 01W	° b 2v	1V _ 1U	С	1W - 1V	2V – 2U			WYE WINDING
	1V Q	^{2W} Q _c		A	1U – 1W	2N – 2U	3		
5	BC	2N 0 2U	—	В	1V – 1U	2'v -2V	$\frac{U1 \bullet V_3}{U2}$	Dyn7	
	1UCO1W	_{2V} 0 -		С	1W_1	2N– 2W			
	1V Q	2WQ _c	1W-1V	AS	10-1W	2W – 2U			NO
6	в		1U-1W	В	1V – 1U	2U – 2V	$\frac{U1 \bullet V_3}{U2}$	Dy7	ACCESSIBLE NEUTRAL ON
		2000	1V-1U	С	1W – 1V	2V – 2W			WYE WINDING
	1V O	, 2 2₩	1W-1V	A	1U– 1W	2V – 2U			NO
63	в	2V 0 a 2N	1U–1W	в	1V – 1U	2W – 2V	$\frac{U1 \bullet V_3}{U2}$	Dy9	ACCESSIBLE NEUTRAL ON
	1U 0 0 1W	ິ 🁌 2U	1V-1U	С	1W – 1V	2U – 2W	02		WYE WINDING
	1V Q	<u>م</u> ا		A	1U– 1W	2V – 2N			
64	в	2V 0 a 2N	—	В	1V – 1U	2W – 2N	$\frac{U1 \cdot V_3}{U2}$	Dyn9	
		° ک ک 2U		С	1W – 1V	2U – 2N	02		
	1V O	2V Q c		A	1U – 1W	2N – 2W			
7	В	2N a 0 2W	—	В	1V – 1U	2N– 2U	$\frac{U1 \cdot V_3}{U2}$	Dyn11	
	1U 0 A 1W	2U O ^b		С	1W – 1V	2N – 2V			
	1V Q	2V Q c	1W–1V	A	1U – 1W	2V – 2W			NO
8	в		1U–1W	В	1V – 1U	2W – 2U	$\frac{U1 \cdot V3}{U2}$	Dy11	ACCESSIBLE NEUTRAL ON
	1U 0 01W	2U O ^b	1V–1U	С	1W – 1V	2U – 2V			WYE WINDING
	1U Q	20	1V–1W	A	1U – 1V	2U – 2N			
45	C/A	c _2N a	1W-1U	в	1V - 1W	2V – 2N	$\frac{3}{2} \cdot \frac{01}{02}$	Dzn0	
		0 2W b 2V	1U-1V	С	1W – 1U	2W – 2N			
	1U Q		1V-1W	Α	1U– 1V	2N – 2V			
46	C A		1W-1U	В	1V – 1W	2N – 2W	$\frac{3}{2} \cdot \frac{01}{02}$	Dzn2	
	1W 0 B 1V	62V	1U–1V	С	1W – 1U	2N – 2U			

	TRANSF CONFIGL	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	1U Q			A	1U – 1V	2W – 2V			NO
47	C A		—	в	1V – 1W	2U – 2W	U1 U2	Dz2	
	1W 0 B 1V	6 _{2V}		С	1W – 1U	2V – 2U			NEOTHAL
	1U Q	9 2W	1V_1W	A	1U – 1V	2W – 2N			
48	C/A		1W-1U	в	1V – 1W	2U – 2N	2 U2	Dzn4	
	1WO B 1V	o, ₀ ₂∪	1U-1V	С	1W – 1U	2V – 2N			
	1U Q	₽ 2W		A	1U – 1V	2W – 2U	0		NO
49	C A		—	в	1V – 1W	213 - 2V	U1 U2	Dz4	ACCESSIBLE
	1W 0 B 1V	°°°°∂		С	1W - 10	2V – 2W			NEOTRAL
	1V Q	2V Q		AF	10-1W	2U – 2W			NO
9	в	a n b 2W	170	NB.	1V – 1U	2V – 2U	U2	Dz0	ACCESSIBLE NEUTRAL
	1U 0 01W		1111	С	1W – 1V	2W – 2V			
	1V Q			А	1U – 1W	2W – 2U			NO
10	BC	b η a		В	1V – 1U	2U – 2V	U1 U2	Dz6	ACCESSIBLE
	1U 0 A 1W	b ₂v		С	1W – 1V	2V – 2W			
	1U Q	°2W 2W	1V-1W	А	1U – 1V	2N – 2U			
50	C/A	a^{2V} a^{2N} c^{2N}	1W –1 U	В	1V - 1W	2N - 2V	2 U2	Dzn6	
	1W 0 B 1V	0 2U	1U-1V	С	1W – 1U	2N – 2W			
	1U Q	2V Q	1V-1W	А	1U – 1V	2V – 2N			
51	C/A	°(2N	1W-1U	В	1V – 1W	2W – 2N	$\frac{3}{2} \cdot \frac{U1}{U2}$	Dzn8	
	1WO B 1V	0O2W	1U- 1V	С	1W – 1U	2U – 2N			
	1U 8	2V Q a		A	1U– 1V	2V – 2W			NO
52	C/A	<u>с</u>	—	В	1V – 1W	2W – 2U	U1 U2	Dz8	ACCESSIBLE NEUTRAL
	1W 0 B 1V	0 JO 2W		С	1W – 1U	2U – 2V			
	1U 8	^{2U} c 2V	1V–1W	А	1U – 1V	2N – 2W			
53	C/A		1W-1U	В	1V – 1W	2N – 2U	$\frac{3}{2} \cdot \frac{U1}{U2}$	Dzn10	
	1WO B 1V	2W 0	1U-1V	С	1W – 1U	2N – 2V			
	1U Q	2U Q °/O 2V		Α	1U – 1V	2U – 2W			NO
54	C/ \A	b a	—	В	1V - 1W	2V- 2U	U1 U2	Dz10	ACCESSIBLE
	1W 0 B 1V	2W 0		С	1W –1U	2W – 2V			

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	1V 0	2W 0 0		А	1U – 1N	2V – 2U			
11		b 2U	—	В	1V – 1N	2W – 2V	$\frac{U1}{U2 \cdot \sqrt{3}}$	YNd7	
	1U O C O1W	2V 0 a		С	1W – 1N	2U – 2W			
	1V _0	a 2U		А	1U – 1N	2U – 2V			
44		2W 🗲 🖒	—	В	1V – 1N	2V – 2W	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd1	
	1UO CO1W	° ℃ 2V		С	1W – 1N	2W – 2U			
	1V O	a 2V	1W-1V	А	1U – 1W	2U – 2V	-02		NO
12	A	2U 🗲 b	1U–1W	В	1V – 1U	2V - 2W	$U^{1}_{2} V_{3}_{2}$	Yd1	ACCESSIBLE NEUTRAL ON
	1UO CO1W	° ℃ 2W	1V-1U	С	1W – 1∀	2W – 2U			WYE WINDING
	1V O	a 2U		A	1U-1N	2W – 2U			
13		2W 🗲 🛛 🗠	1	NB .	1V – 1N	2U – 2V	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd5	
	1UO C 01W	° 70 2V	114.	С	1W – 1N	2V – 2W			
	1V O	a 20	1W-1V	A	1U – 1W	2W – 2U	_		NO
14	B	2WO b	1U–1W	В	1V – 1U	2U – 2V	$\frac{U1}{U2} \cdot \frac{V_3}{2}$	Yd5	ACCESSIBLE NEUTRAL ON
	1U O C O 1W	° 💊 2V	1V-1U	С	1W – 1V	2V – 2W			WYE WINDING
	1V 0	2W 0 c	1W-1V	A	1U – 1W	2V – 2U			NO
15	B	b 2U	1U–1W	В	1V – 1U	2W – 2V	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	Yd7	ACCESSIBLE NEUTRAL ON
	1U 0 C 01W	2V 0 a	1V-1U	С	1W – 1V	2U – 2W			WYE WINDING
	1V 0	2V 0 0		A	1U– 1N	2U – 2W			
16		b 2W	-	В	1V – 1N	2V– 2U	$\frac{U1}{U2 \cdot \sqrt{3}}$	YNd11	
	1U O C O1W	2U a		С	1W – 1N	2W – 2V			
	1V 0	2V c	1W–1V	A	1U– 1W	2U – 2W			NO
17	B	b 202W	1U–1W	В	1V – 1U	2V – 2U	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	Yd11	ACCESSIBLE NEUTRAL ON
	1U O C O 1W	2U a	1V-1U	С	1W – 1V	2W – 2V			WYE WINDING
	1V 0	2WOa_O_2U		A	1U – 1N	2N – 2U			
18		b 2N	—	В	1V – 1N	2N – 2V	U1 U2	YNyn6	
	1U O C O 1W	2V		С	1W – 1N	2N – 2W			
	1V Q	2V 0	1V-1N	Α	1U – 1N	2U – 2V			
19		b a	1W-1N	В	1V – 1N	2V – 2W	U1 U2	YNy0	NEUTRAL ON
	1U O C O1W	2U 0 0 2W	1U-1N	С	1W – 1N	2W – 2U			WINDING

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	1V 0	2V	2W-2N	А	1U – 1W	2U – 2N			
20	B A	^b _{2N}	2U-2N	в	1V – 1U	2V– 2N	U1 U2	Yyn0	NEUTRAL ON
	1U O C O1W	2U 0 C 02W	2V-2N	С	1W – 1V	2W – 2N			WINDING
	1U O	2V O		A	1U – 1N	2U – 2W			
43		a A		В	1V – 1N	2V – 2N	U2	YNyn0	
	1WO C 01V	2U 0 0 2W		С	1W – 1N	2W – 2N			
	1V O	2V O		А	1U – 1W	2U – 2W	0		NO
21	B A	b a	—	В	1V – 1U	2V – 2U	U2	Yy0	ACCESSIBLE NEUTRAL
	1U O C O1W	2U O C O 2W		С	1W – 17	2W – 2V			
	1V O	2WOa_O 2U	1V-1N	A	10-1N	2V – 2U			
22	^B A O	b	1W-1N	NB.	1V – 1N	2W – 2V	U2	YNy6	NEUTRAL ON
	1U 0 C 01W	2V	U-1N	С	1W – 1N	2U – 2W			WINDING
	1V 0	2W Q 4 0 2U	2W-2N	А	1U – 1W	2N – 2U			
23	ABN	c O _{2N}	2U-2N	В	1V – 1U	2N – 2V	U1 U2	Yyn6	NEUTRAL ON
	1U O C O 1W	0 2V	2V-2N	С	1W – 1V	2N – 2W			WINDING
	1V	2W 0 a 0 2U		A	1U – 1W	2W – 2U			NO
24	⊿в	c ¥ b	—	В	1V – 1U	2U – 2V	U1 U2	Yy6	ACCESSIBLE
	1U0 C 01W	0 2V		С	1W – 1V	2V – 2W			
	1V 0	Q 2V		А	1U – 1W	2U – 2N			
65				В	1V – 1U	2V – 2N	$\frac{V_{H} V_{3}}{V_{x}}$	YNzn1	
	1U O C O 1W	20 ° 2W		С	1W – 1V	2W – 2N	~		
	1V 0	a O 2V		A	1U – 1W	2U – 2N			
25	B	2U 2N b	—	в	1V – 1U	2V – 2N	$\frac{U1 \bullet V3}{U2}$	Yzn1	NEUTRAL ON
	1U O C O 1W	° 2W		С	1W – 1V	2W – 2N			WTE WINDING
	1V	a O 2V	1W-1V	Α	1U – 1W	2U – 2V			NO
26	B	2U b	1U-1W	В	1V– 1U	2V – 2W	$\frac{U1}{U2} \cdot \frac{V_3}{2}$	Yz1	ACCESSIBLE
	1U O C O 1W	° > 2W	1V-1U	С	1W – 1V	2W – 2U			HEO THE
	1V O	a 0 2U		А	1U – 1W	2W – 2N			NO
27	B A	2W 2N b	—	В	1V – 1U	2U – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Yzn5	ACCESSIBLE NEUTRAL ON
	1U O C O 1W	° 2V 2V		С	1W – 1V	2V – 2N			WYE WINDING

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	1V O	a Q 2U	1W-1V	Α	1U – 1W	2W – 2U			NO
28	B	2W 0 b	1U–1W	В	1V – 1U	2U – 2V	$\frac{U1}{U2} \cdot \frac{V_3}{2}$	Yz5	ACCESSIBLE
	1U O C O1W	° 2V 2V	1V–1U	С	1W – 1V	2V – 2W			NEUTRAL
	1V 0	2W 0 0		Α	1U – 1W	2N – 2U			
66	^B _A _{1N}		—	В	1V – 1U	2N – 2V	$\frac{V_{H}}{V} \cdot \frac{V_{3}}{2}$	YNzn7	
	1U 0 C 01W	2V 0 0 0		С	1W – 1V	2N – 2W	٧x		
	1V	2W 0 C		А	1U – 1W	2N – 2U	0		NO
29	BN	b 2N 2U	—	В	1V – 1U	2N - 2V	$\frac{11 \cdot \sqrt{3}}{12}$	Yzn7	ACCESSIBLE NEUTRAL ON
	1U 0 C 01W	2V 0 "		С	1W – 1V	2iN - 2W			WYE WINDING
	1V	2W 0 0	1W-1V	A	10-1W	2V – 2U			NO
30	⊿в	b 2U	1U–1W	NB.	1V – 1U	2W – 2V	$U_1 V_3$	Yz7	ACCESSIBLE
	1U0 C 01W	2V 0	VIU	С	1W – 1V	2U – 2W	02 2		NEUTRAL
	1V	2VQ C		A	1U – 1W	2N – 2W	V V5		
67	^B _A _{1N}	b 02N 02W		В	1V – 1U	2N – 2U	$\frac{v_{H} \cdot v_{3}}{v_{x}}$	YNzn11	
	1U O C O 1W	2U O		С	1W – 1V	2N – 2V			
	1V	2V 0 0		Α	1U – 1W	2N – 2W			NO
31	"в∐	b 2N 02W	—	в	1V – 1U	2N – 2U	<u>U1 • V3</u>	Yzn11	ACCESSIBLE NEUTRAL ON
	1U 0 C 01W	2U 0 "		С	1W – 1V	2N – 2V	02		WYE WINDING
	1V	2V 0 C	1W-1V	Α	1U – 1W	2U – 2W			NO
32	^B N	b 2W	1U-1W	В	1V – 1U	2V – 2U	$\frac{U1}{U2} \cdot \frac{V_3}{2}$	Yz11	ACCESSIBLE NEUTRAL
	1UO C 01W	200	1V-1U	С	1W – 1V	2W - 2V			
	1U Q	2U Q	1V-1W	А	1U – 1N	2U– 2V			
55		c a	1W-1U	В	1V - 1N	2V – 2W	$\frac{2}{3} \cdot \frac{01}{02}$	ZNd0	
	δ _B −01∨	2W 0 b 2V	1U-1V	С	1W – 1N	2W – 2U			
	10 Q	2U Q		А	1U – 1V	2U – 2V			NO
56		c/a		В	1V - 1W	2V – 2W	U1 U2	Zd0	ACCESSIBLE NEUTRAL ON
	1WO B 01V	2W0 b 2V		С	1W – 1U	2W – 2U			HIGH VOLTAGE
	1U Q	2VQ b 2W	1V-1W	А	1U – 1N	2V – 2U			
57		a c	1W-1U	В	1V – 1N	2W – 2V	$\frac{2}{3} \cdot \frac{U1}{U2}$	ZNd6	
		0 2U	1U-1V	С	1W – 1N	2U – 2W	0.05		

	TRANSF CONFIGU	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	1V Q	a p 2U		A	1U – 1N	2W – 2U			NO
33		2W 0- C	—	В	1V – 1N	2U – 2V	$\frac{U1}{U2 \bullet V_3}$	ZNy5	ACCESSIBLE NEUTRAL ON
	0 C 0 1W	^D ∂ 2V		С	1W – 1N	2V – 2W			WYE WINDING
	™Q	a /2 2U	1W-1V	A	1U – 1W	2W – 2U			NO
34	A B	2W 0 C	1U-1W	в	1V – 1U	2U – 2V	$\frac{01}{02} \cdot \frac{v_3}{2}$	Zy5	ACCESSIBLE NEUTRAL
	0 C 0 1W	^D ∂2V	1V-1U	С	1W - 1V	2V – 2W			
	1V Q B	2V Q		A	1U – 1N	2U – 2W	2		NO
35		a c 0 2W	—	В	1V – 1N	2V-2U	U2 • V3	ZNy11	ACCESSIBLE NEUTRAL ON
	0 C 0 1W	2U O		С	1Woil	2W – 2V			WYE WINDING
	1V Q B	2V Q	1W–1V	AS	10-1W	2U – 2W			NO
36		a c O 2W	1U-1W	В	1V – 1U	2V – 2U	U1 V3 U2 2	Zy11	ACCESSIBLE NEUTRAL
	0 C 01W	2U +10	1V-1U	С	1W – 1V	2W – 2V			
	P ^{1V}	9 2V		A	1U – 1V	2U – 2V		. . .	
58	B	b					U2	0	
	1U 01W	0 2U 22W	1U-1V 2U-2V	В	1U – 1W	2U – 2W			
	140	a 0 2V	1V-1W	A	1U – 1W	2U – 2V	$-\frac{U1}{U2}$ $+\frac{\sqrt{3}}{2}$	Т-Т	
59	AB	0						30	
	0 0 10 1W	²⁰ 2W	2U-2V	В	1V – 1W	2U – 2W	$\frac{U1}{U2}$ $\frac{2}{\sqrt{3}}$	Lag	
	140	Q 2V b 2W	1V-1W	А	1U – 1W	2U – 2W	$U_1 \bullet V_3$ U2 • 2	T-T	
60	AB							30	
	1U 1W	2U O a	2U-2W	В	1V - 1W	2V – 2U	$U_1 \cdot 2$ U2 $\sqrt{3}$	Lead	

APPENDIX D – Australian Std.2374 Transformer Descriptions

	TRANSF CONFIGL	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	B Q	° ⊂^a ⊃a		Α	A – C	c-a			
1	B	b c	—	В	B – A	a – b	HV LV	Dd6	
	A C A C	b		С	C – B	b-c			
	вQ	ра		A	A – C	a – c	шу		
37	B	b/ C		В	B – A	b-a		Dd0	
		ad <u>a</u> c		С	C – B	c – b	$\widehat{\boldsymbol{\mathcal{M}}}$		
	Â	c c b a		A	A – B	Vo2p	ну		
38	C A		—	В	B-95/	a-c	LV	Dd2	
	со в	b		55	C-A	b – a			
	Â	° A	$ N_A $	A	A – B	c – a	ну		
39	C/A	(Tr)	· · —	В	B – C	a – b	LV	Dd4	
	со́ <u></u> в В	bo bo a		С	C – A	b – c			
	Â	ь Х		A	A – B	b – c	ну		
40	C/A	c/a		В	B-C	c – a	LV	Dd8	
	соов			С	C-A	a – b			
	Â	a b b		A	A – B	a – c	ну		
41			-	В	B-C	b-a	LV	Dd10	
	соов	c		С	C – A	c – b			
	Â			A	A-C	a-η	HV • V3		
42	A B			В	B – A	D – 1		Dyn1	
	соов	0 _b		С	C-B	c-η			
	Å	<i>b</i> bb	C-B	A	A-C	a – c	HV •V3	Durt	NO ACCESSIBLE
2		ao		B	B-A	D-a	LV	Dy1	NEUTRAL ON WYE WINDING
		°c	D-A	C	C-B	c – b			
61	Å		C-B	A	R_A		V _H .V3	Dua	NO ACCESSIBLE
01		<i>b</i>	A-C	В		0-0	V _x	Dy3	NEUTRAL ON WYE WINDING
		с а.	D-A			0-a			
	Å			A		n - 0	HV •V3	Dvn2	
62		₀∕ŋ	—	В		n - c	LV	Dyna	
		C		Ľ	0-В	i – a			

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	в	" P "		Α	A – C	$c-\eta$			
3	BC	۰۰ <u>°</u> ďη		В	B – A	a-η	$\frac{HV \bullet \sqrt{3}}{LV}$	Dyn5	
		ζρρ		С	C – B	$b-\eta$	2.		
	в Q	٥٩	C – B	Α	A – C	c – b			NO
4	B C	° • • •	A - C	В	B – A	a – c	$\frac{HV \bullet \sqrt{3}}{LV}$	Dy5	ACCESSIBLE NEUTRAL ON
		်ဝဲ။	B – A	С	C – B	b – a			WYE WINDING
	в А	۰ <i>م</i> ر _د		A	A – C	η – a	\mathcal{O}		
5	B C	$\int_{b}^{a} h^{\circ}$		В	B – A	_15-¢€		Dyn7	
	A C A C	bО		С	CB	η_c			
	в А		С – В	A 5	A-C	c – a			NO
6	B C	$\eta \rightarrow 0 a$	ARCI	В	B – A	a – b	HV • V3 LV	Dy7	ACCESSIBLE NEUTRAL ON
	A O A C	ь ^о +0	B – A	С	С – В	b-c			WYE WINDING
	B Q	، م م	С-В	A	B – C	b-a			NO
63	B C	b O a	A – C	В	B – A	c – b	$\frac{HV \cdot V_3}{LV}$	Dy9	ACCESSIBLE NEUTRAL ON
	AO A C	Ò a	B – A	С	С – В	a – c			WYE WINDING
	B A	۶°		A	A – C	b-η			
64	B C	₅o <u>ª</u> ζη	—	В	B – A	c – η	HV •V3	Dyn9	
	A O O C	် D a		С	С – В	a – η			
	₿ A	• Q c		A	A – C	η – c			
7	$B \subset C$		—	В	B – A	η_a	$\frac{HV \bullet V_3}{LV}$	Dyn11	
	AO A O C	aO		С	С – В	η– b			
	₿ A	bQ _c	С – В	A	A – C	b – c	HV •V3		
8	B C	$\eta \overset{a}{\not b} \circ \circ$	A – C	В	B – A	с – а		Dy11	NEUTRAL ON
	A O A O C	aU	B – A	С	С – В	a – b			WTE WINDING
	Â	٩	B-C	A	A – B	a – η	2 11/		
45	C/A	د(h	C – A	В	B-C	$b-\eta$	$\frac{3}{2} \cdot \frac{11}{LV}$	Dzn0	
	со в	со <u>–</u> ов	A – B	С	C – A	c – η			
	Â	°င်္န္နဲ ၇ª	B-C	С	A – B	η – b	зну		
46	C/ 🔺	₀ ⟨ŋ ٬	C – A	A	B – C	η – c	2 LV	Dzn2	
	со́ _в ов	٥p	A – B	В	C-A	η– a			

	TRANSF CONFIGL	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
47			_	A B C	A – B B – C C – A	c – b a – c b – a	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	C C B B		_	A B C	A – B B – C C – A	c – a a – tr D – c	HV LV	Dz4	NO ACCESSIBLE NEUTRAL
9	A O A C C		1212	A NB.5 C	B-A C-B	a – c b – a c – b	HV LV	Dz0	NO ACCESSIBLE NEUTRAL
10		сорова		A B C	A – C B – A C – B	c – a a – b b – c	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	3 • HV 2 • LV	Dzn6	
51			B – C C – A A – B	A B C	A – B B – C C – A	b-η c-η a-η	$\frac{3}{2} \cdot \frac{\text{HV}}{\text{LV}}$	Dzn8	
52				A B C	A – B B – C C – A	b – c c – a a – b	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	3 • HV 2 • LV	Dzn10	
54				A B C	A – B B – C C – A	a – c b – a c – b	HV LV	Dz10	NO ACCESSIBLE NEUTRAL

	TRANSF CONFIGI	ORMER JRATION			WINDING	TESTED			
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	В	Å,		Α	A - N	b–a			
11	$A \stackrel{B}{\longrightarrow} N$	b a	—	В	B – N	c – b	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd7	
	AO COC	a o a		С	C - N	a – c			
	B	°		Α	A – N	a – b	цv		
44		a 🗸 🖉 b		В	B – N	b-c		YNd1	
	AO COC	· Vo		С	C – N	c-a			
	B	° ° b	C – B	Α	A – C	a – b			NO
12	A	a C b	A - C	В	B – A	b-c.	LV 2	Yd1	NEUTRAL ON
	AO COC	00	B – A	С	с- <u>8</u> 2	c-a			WYE WINDING
	B	^a ^a		A	A-N	c – a	ну		
13		° C b	1171	В	B – N	a – b	LV •V3	YNd5	
	AO COC	0 6	11.	С	C – N	b – c			
	в Q	° ° °	C – B	A	A – C	c – a			NO
14	B	° C b	A – C	В	B – A	a – b	$\frac{HV}{LV} \cdot \frac{V3}{2}$	Yd5	NEUTRAL ON
	AO COC	° 70 Þ	B – A	С	С – В	b – c			WYE WINDING
	B Q	°	С-В	A	A – C	b–a			NO
15	A A	b a	A – C	В	B – A	c – b	$\frac{HV}{LV} \cdot \frac{V_3}{2}$	Yd7	NEUTRAL ON
	AO COC	ьо́́	B – A	С	С – В	a – c			WYE WINDING
	в Q	"		A	A– N	a – c	цу		
16		b c	-	В	B – N	b-a		YNd11	
	AO COC	a O Ű		С	C – N	c – b			
	в О	"	С-В	A	A – C	a – c			
17	B A	b >o°	A – C	В	B – A	b-a	$\frac{HV}{LV} \cdot \frac{V_3}{2}$	Yd11	NEUTRAL ON
	AO COC	a o a	B – A	С	С – В	c – b			WYE WINDING
	B Q			A	A – N	η – a			
18	A	μ	—	В	B – N	η-b		YNyn6	
	AO COC	b		С	C – N	η – c			
	В	Ь	B – N	A	A – N	a – b			NO ACCESSIBLE
19		a b	C – N	В	B – N	b-c	HV LV	YNy0	NEUTRAL ON
	AO COC	a0 000	A – N	С	C – N	c-a			WINDING

	TRANSFORMER CONFIGURATION				WINDING TESTED				
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	В	ь О	c – h	A	A – C	a – η	ну		NO ACCESSIBLE
20	B A	a b n	a – h	В	B – C	b-η		Yyn0	NEUTRAL ON
	AO COC	a O C O C	b – h	С	С – В	c-η			WINDING
	в О	b Q		A	A – N	a – η	ну		
43		a b n	—	В	B – N	b-η	LV	YNyn0	
	AO COC	a O C O C		С	C – N	c – η			
	B Q	b O		A	A – C	a-c	CHV HV		NO
21	A	a b		В	B – A	∆b-a	LV	Yy0	ACCESSIBLE NEUTRAL
	AO COC	a O c O c		С	<u> </u>	c – b			
	в Q		B – N	A.S	A – N	b – a	ну		NO ACCESSIBLE
22	A N	b O	C4W	В	B – N	c – b	LV	YNy6	NEUTRAL ON LOW VOLTAGE
	AO COC	Þ ttP	^N A – N	С	C – N	a – c			WINDING
	в Q		c – h	A	A – C	η – a	ну		NO ACCESSIBLE
23	^B η	β	a – h	В	B – A	η_b	LV	Yyn6	NEUTRAL ON HIGH VOLTAGE
		b	b – h	С	С – В	η– c			WINDING
	в Q			A	A – C	c – a	ну		NO
24	A	b	—	В	B – A	a – b	LV	Yy6	ACCESSIBLE NEUTRAL
	AO COC	b		С	С – В	b – c			
	B			A	A – C	a-η	Vu . V3		
65	A N	° γη		В	B – A	b-η	V _X	YNzn1	
		، <i>مر</i>		С	С – В	c-η			
	٩			A	A – C	a-η	V _{H •} V ₃		NO ACCESSIBLE
25	A	aσ jη	—	В	B-A		LV	YZN1	NEUTRAL ON WYE WINDING
	AU COC	° 0°		C	С-В	c – 1			
	B Q		C – B	A	A – C	a-b	HV V3		NO
26	A	a Or 🕊		B	B-A	D-C		Yz1	NEUTRAL
	AU (DC	00	D-A	(0-B	c – a			
	B O			A		c-η	HV Va	Vane	NO ACCESSIBLE
27	A	σų	-	B	<u>в-А</u>		LV	12[15	NEUTRAL ON WYE WINDING
		ЪÞ		C	С-В	μ-α			

	TRANSFORMER CONFIGURATION				WINDING TESTED				
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	В	a Qa	C – B	Α	A – C	с – а			NO
28	A	c O (b)	A – C	В	B – A	a – b	$\frac{HV}{LV} \cdot \frac{V_3}{2}$	Yz5	ACCESSIBLE
	AO COC	٩٩٦	B – A	С	С – В	b – c			NEOTAL
	В	۰ <i>مر</i> د		A	A – C	η – a			
66	$A \xrightarrow{B} N$	b d n a	—	В	B – A	η-b	$\frac{V_{H}}{V_{v}} \cdot \frac{V_{3}}{V_{s}}$	YNzn7	
	AO COC	٥Ö		С	С – В	η-c			
	B O	۰ مر _د		A	A – C	η – a			NO
29	A		—	В	B – A	η_ь_		Yzn7	NEUTRAL ON
	AO COC	ьÓ		С	С – В	Dŋ-c			
	в О	• مرد	С – В	AF	J.A.C	b – a			NO
30	A	b a a a	A – C	18 .	B – A	c – b	$\frac{\text{HV}}{\text{LV}} \cdot \frac{\text{V}_3}{2}$	Yz7	ACCESSIBLE NEUTRAL
	AO COC	ьÓ	B - A	С	С – В	a – c			
	в Q	° Q		A	A – C	η – c	VH • V3		
67	A N		—	В	B – A	η-a	V _X	Yzn11	
	AO COC	ьO		С	С – В	η– b			
	в Q	۳ مر د س		A	A – C	η – c			NO
31	A		—	В	B – A	η-a	HV • V3 LV	YZ11	NEUTRAL ON
	AO COC	۵Ó		С	С – В	η– b			WYE WINDING
	в Q	۳ مې د	С – В	A	A – C	a – c	HV V3	V-44	NO
32	AN	b a c	A – C	В	B – A	b-a	LV 2	YZ11	NEUTRAL
		aÓ	B – A	С	С – В	c – b			
	A	Å	b-c	A	A – N	a – b	2 HV		
55	C-QN		с – а	В	B – N	b-c	3 • LV	ZNd0	
	со _в -ов	сО <u></u> 0Ъ	a – b	С	C – N	c – a			
	A	Å		A	A – B	a – b	HV		
56			—	В	B-C	b-c	LV	Zd0	NEUTRAL ON
	со _в — ов	с О <u></u> О В		С	C – A	c – a			Man VOLIXOE
	قر _م	^b	b — с	A	A – N	b – a	HV	71.10	
57		a c	c – a	В	B – N	c – b	LV	ZNd6	
	со в	a	a-b	С	C – N	a – c			

	TRANSFORMER CONFIGURATION				WINDING TESTED				
SPEC TEST NO.	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
	В	a Qa	C – B	A	A – C	c – a			NO
28	AB	c 0	A – C	В	B – A	a – b	$\frac{HV}{LV} \cdot \frac{V_3}{2}$	Yz5	ACCESSIBLE
	A O C O C	٩٩٦	B – A	С	C – B	b-c			NEUTRAL
	в	ہ مر ر		A	A – C	η – a			
66	$A = \prod_{N=1}^{B} N$	b ano a	—	В	B – A	η-b	$\frac{V_{H}}{V_{H}} \cdot \frac{V_{3}}{V_{3}}$	YNzn7	
	AO COC	bO <i>a</i>		С	С – В	$\eta-c$	**		
	В	• مر _د		A	A – C	η – a			NO
29	A			В	B – A	η-ь _С		Yzn7	NEUTRAL ON
	AO COC	ьО		С	C – B	Dn-c			WYE WINDING
	B O	۰ <i>م</i> ے د	С-В	AE	<u>9.6</u>	b – a			NO
30	A	b a a a	A-C	18 .	B – A	c – b	$\frac{HV}{LV} \cdot \frac{V_3}{2}$	Yz7	ACCESSIBLE NEUTRAL
	AO COC	ь о	В - А	C	С – В	a – c			
	в Q	° a citt		A	A – C	η – c	Vu Va		
67				В	B – A	η-a	V _X	Yzn11	
	AO COC	ьÓ		С	С – В	η−b			
	в Q	• ~ _ _c		A	A – C	η – c			NO
31	A A	b a a a a		В	B – A	η-a	$\frac{HV \bullet V_3}{LV}$	Yz11	ACCESSIBLE NEUTRAL ON
	AO COC	aO		С	С – В	η– b			WYE WINDING
	в Q	۵ مر	C – B	A	A – C	a – c	HV V3		NO
32	AN	b a c	A – C	В	B – A	b – a	LV 2	YZ11	ACCESSIBLE NEUTRAL
	AO COC	aÓ	B – A	С	С – В	c – b			
	A	å	b-c	A	A – N	a – b	2 HV		
55	C-QN	c/ a	с – а	В	B – N	b-c	3 • LV	ZNd0	
	сб _₿ ∽_ов	сО <u></u> оь	a – b	С	C – N	с-а			
	A	Å		A	A – B	a – b	LIV/		NO
56	<u> </u>	c/a	—	В	B – C	b-c	LV	Zd0	NEUTRAL ON
	со _в — ов	с О <u>р</u> ов		С	C – A	c – a			HIGH VOLTAGE
	A	b	b-c	A	A – N	b – a	нν		
57	C N	a c	с-а	В	B – N	c – b		ZNd6	
	со _в — ов	a	a-b	С	C – N	a-c			



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