

# TRF-250

automatic, 3-phase transformer turns ratio finder



**Vanguard Instruments**  
A DOBLE COMPANY





# TRF-250

## 3-phase transformer turns ratio finder

### Product Overview

The TRF-250 is Vanguard's fourth generation transformer turns ratio tester. This latest design provides a higher turns-ratio test voltage of 250Vac, provides a wireless Bluetooth PC interface, and features a 44-key "QWERTY"-style membrane keyboard. All these features greatly improve the accuracy of the turns ratio readings, ease of operation, and reliability.

The TRF-250 determines the turns ratio of the transformer under test using the IEEE C57.12.90 measurement method. The turns-ratio range is from 0.8 to 50,000 to 1. Transformer turns ratio, excitation current, and winding polarity are displayed on the built-in 128 x 64 pixels graphic LCD screen. The TRF-250 can be used as a standalone unit or can be computer-controlled.

### The 250V Test Voltage Advantage

The 250V test voltage provided by the TRF-250 provides more accurate test results when measuring the transformer turns ratios of very large transformers with a built-in LTC. The three figures below show the turns ratio test results and corresponding percentage error of a 600MVA transformer with an LTC in the Lowest position using 40V, 100V, and 250V test voltages. At the 250V test voltage, the percentage error is less than 0.5% as specified in IEC 60076-1 and IEEE C57.12.00-2006-1 standards.

Test results using 40V test voltage				
RECORD NUMBER 6				
TRANSFORMER TEST RESULTS				
DATE:06/17/14		TIME:08:56:31		
TEST VOLTAGE = 40 V				
TYPE: YNyn0				
H TAP: _____	H VOLTAGE:310,500			
X TAP: _____	X VOLTAGE:141,500			
CALCULATED RATIO: 2.1943				
PHS	M-RATIO	mA	PHASE	%DIFF
A	+2.2071	5.9	-0.04	0.58
B	+2.2054	4.9	0.09	0.51
C	+2.2073	5.6	-0.07	0.59

%Error > 0.5%

Test results using 100V test voltage				
RECORD NUMBER 7				
TRANSFORMER TEST RESULTS				
DATE:06/17/14		TIME:08:57:19		
TEST VOLTAGE = 100 V				
TYPE: YNyn0				
H TAP: _____	H VOLTAGE:310,500			
X TAP: _____	X VOLTAGE:141,500			
CALCULATED RATIO: 2.1943				
PHS	M-RATIO	mA	PHASE	%DIFF
A	+2.2059	8.0	0.24	0.53
B	+2.2044	6.6	0.39	0.46
C	+2.2056	7.9	0.69	0.51

%Error > 0.5%

### outstanding features

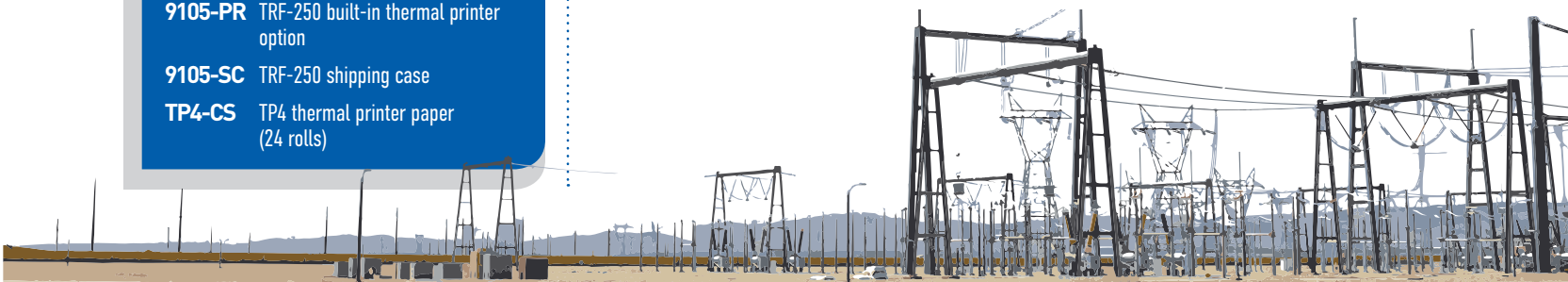
- Ratio range: 0.8 – 50,000 : 1
- Capable of detecting 130 different 3-phase transformer types defined by ANSI, IEC, and Australian standards
- 4 test voltages: 4Vac, 40Vac, and 100Vac, and 250 Vac
- Phase angle and excitation current measurement
- Bluetooth and USB PC interfaces
- 4.5" wide thermal printer (optional)

### ordering information

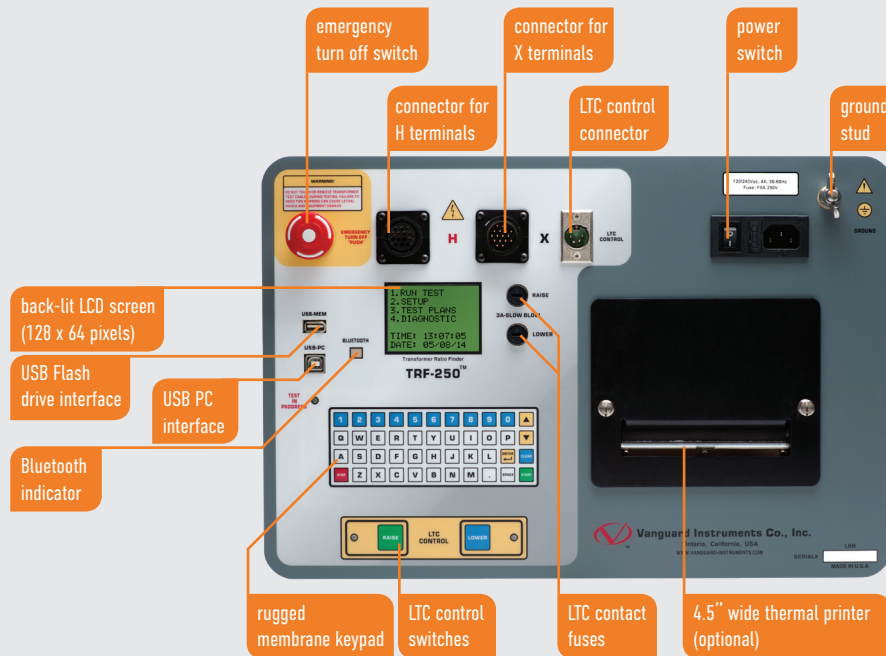
Part No.	Description
9105-UC	TRF-250, cables, and PC software
9105-PR	TRF-250 built-in thermal printer option
9105-SC	TRF-250 shipping case
TP4-CS	TP4 thermal printer paper (24 rolls)

Test results using 250V test voltage				
RECORD NUMBER 8				
TRANSFORMER TEST RESULTS				
DATE:06/17/14		TIME:08:58:15		
TEST VOLTAGE = 250 V				
TYPE: YNyn0				
H TAP: _____	H VOLTAGE:310,500			
X TAP: _____	X VOLTAGE:141,500			
CALCULATED RATIO: 2.1943				
PHS	M-RATIO	mA	PHASE	%DIFF
A	+2.2047	10.4	0.11	0.47
B	+2.2039	8.2	0.00	0.44
C	+2.2042	9.2	0.02	0.45

%Error < 0.5%



# TRF-250 Controls & Indicators



## Auto-Detect Transformer Configuration

The TRF-250 can automatically detect 130 specific vector groups for different transformer types defined by ANSI, CEI/IEC, and Australian standards.

## Transformer Test Voltages

To prevent an accidental wrong test-lead hook-up (e.g., when the operator reverses H and X leads), the TRF-250 outputs a low-level test voltage to verify the hook-up condition before applying the full test voltage to the transformer. Four test voltages (4 Vac, 40 Vac, 100 Vac, 250 Vac) allow the TRF-250 to test CT's and PT's, as well as power transformers.

## Load Tap Changer Control

Voltage regulator or LTC tap positions can be changed remotely using the unit's built-in transformer load tap changer. This feature eliminates the need to manually raise or lower tap positions from the transformer control panel.

## Optional Built-in Thermal Printer

The TRF-250 offers an optional built-in 4.5" wide thermal printer that can be used to print test results.

## User Interface

The TRF-250 features a back-lit LCD screen (128 x 64 pixels) that is viewable in both bright sunlight and low-light levels. The test results screen displays the transformer turns-ratio, excitation current, phase angle, and percentage error. The unit is controlled via a rugged, 44-key, "QWERTY"-style membrane keypad.

## Computer Interface

In computer-controlled mode, the unit can be controlled via the Bluetooth or USB interface using the supplied PC software (Transformer Turns-Ratio Analyzer application provided with each unit). This Windows®-based application can be used to run tests and to store test results on a PC. Test results can also be exported to Excel, PDF, and XML formats for further analysis.

## USB Flash Drive Interface

A built-in USB Flash drive interface provides a convenient method for transferring test plans and test records to or from a USB Flash drive. The user can store up to 999 transformer test plans and test records on a USB Flash drive, and the supplied PC software can be used to view the test records.

## Internal Test Record Storage

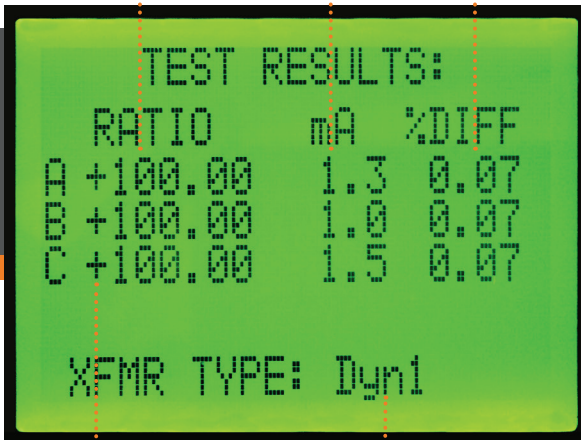
Up to 112 test records can be stored in the TRF-250's Flash EEPROM memory. Each test record may contain up to 99 turns-ratio, excitation current, phase angle and nameplate voltage readings. Test records can be recalled locally or transferred to a PC via the available interfaces (Bluetooth, USB port, USB Flash drive port).

## Transformer Test Plans

The TRF-250 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 to derive the percentage error and Pass/Fail results. By using 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 PC software and can be transferred to the TRF-250 via the available interfaces (Bluetooth, USB port, USB Flash drive port).



Measured Ratio for Phase A, B, and C  
Excitation Current Reading  
Percentage Error



Winding Polarity

Transformer Type

## typical test results screen

RECORD NUMBER 1				
TRANSFORMER TEST RESULTS				
DATE: 01/26/15	TIME: 14:29:53			
COMPANY: VANGUARD	STATION: LAB			
CIRCUIT: DY TRANSFORMER TAP3	MFR: GE			
MODEL: DIS TRANS	S/N: F639943			
KVA RTG: 500	OPERATOR: V1			
TEST VOLTAGE = 40 V, 60 Hz				
TYPE: Dyn1				
H TAP: _____	H VOLTAGE: 12,000			
X TAP: _____	X VOLTAGE: 208			
CALCULATED RATIO: 99.926				
PHS	M-RATIO	mA	PHASE	%DIFF
A	+99.996	2.16	A	0.07
B	+100.04	2.11	B	0.12
C	+100.04	2.12	C	0.12

## thermal printer output (optional)

Test results can be quickly printed in the field on the TRF-250's optional built-in thermal printer without the need to connect the unit to a PC.



### Vanguard Instruments Company, Inc.

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#### TRANSFORMER TURNS RATIO REPORT

Filename: test001.tst Date: January 26, 2015 Time: 04:02 PM Page (1/1)

Company: VANGUARD  
Location: LAB  
Circuit: DY TRANSFORMER TAP3  
Operator:  
Comment:

MFR: GE  
Device: Transformer  
Type: Dyn1  
Model: DIS TRANS  
Rating: 500  
Serial #: F639943  
Max Deviation %: .3  
Test Voltage: 40V

HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	VECTOR GROUP	PHASE	INTERNAL JUMPER	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	MEAS RATIO	URNS RATIO	NOTES
		Dyn1	A		H1-H3	X1-X0	$\frac{V_{H1}}{V_{X1}}$	$\frac{V_{H2}}{V_{X2}}$	
			B		H2-H1	X2-X0	$\frac{V_{H2}}{V_{X2}}$	$\frac{V_{H1}}{V_{X1}}$	
			C		H3-H2	X3-X0	$\frac{V_{H3}}{V_{X3}}$	$\frac{V_{H2}}{V_{X2}}$	

TEST	H VOLT	H TAP	X VOLT	X TAP	C-RATIO	M-RATIO	DEV [%]	P/F	I[mA]	DEGREE	RES
1	12000		208		99.9260	A: +99.996	0.07	P	2.600	0.050	
						B: +100.042	0.12	P	2.100	0.060	
						C: +100.043	0.12	P	3.200	0.060	

## desktop printer output

Test reports can be generated with the included TTRA S2 PC software. Test records can be exported to Excel, PDF, and XML formats for further analysis.



# TTRA S2 Software

The TRF-250 comes with the Vanguard Transformer Turns Ratio Analysis Series 2 (TTRA S2) PC software. The TTRA S2 software can be used to test winding turns ratios of transformers, voltage regulators, and load-tap changers. Test plans can be created using the TTRA S2 application and then transferred to the TRF-250. Test records can be exported to Excel, PDF, and XML formats for further analysis.

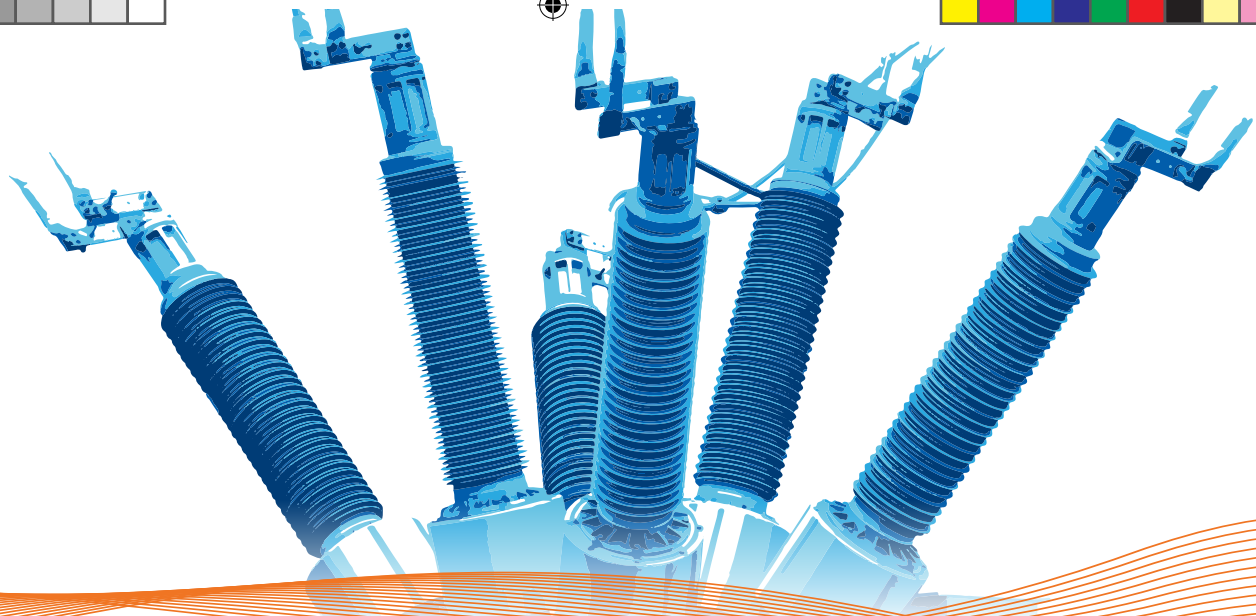
The latest version of the TTRA S2 software can always be downloaded free from the Vanguard web site at [www.vanguard-instruments.com](http://www.vanguard-instruments.com). Please note that you will need to create a free account on our site in order to download software or firmware.

Phase	H Voltage	H Tap	X Voltage	X Tap	Calc. Ratio	Meas. Ratio	Deviation	P/F	I(mA)	Angle	Res
1 A	67000		13717	16R	8.4601	+8.446	0.17	P	2.400	0.020	
B						+8.445	0.18	P	2.300	0.020	
C						+8.445	0.18	P	2.300	0.020	
2 A	67000		13639	15R	8.5085	+8.523	0.17	P	4.400	0.020	
B						+8.523	0.17	P	3.900	0.030	
C						+8.525	0.19	P	4.400	0.040	
3 A	67000		13561	14R	8.5574	+8.581	0.28	P	2.300	0.030	
B						+8.580	0.26	P	1.900	0.030	
C						+8.580	0.26	P	2.200	0.030	
4 A	67000		13483	13R	8.6069	+8.617	0.12	P	2.800	0.030	
B						+8.617	0.12	P	2.400	0.040	
C						+8.617	0.12	P	2.700	359.990	
5 A	67000		13405	12R	8.6570	+8.647	0.12	P	2.300	0.030	
B						+8.648	0.10	P	1.900	0.030	
C						+8.647	0.12	P	2.200	0.030	
6 A	67000		13327	11R	8.7077	+8.730	0.26	P	4.400	0.030	
B						+8.729	0.24	P	3.900	0.030	
C						+8.729	0.24	P	4.400	0.020	

## TRF-250 technical specifications

<b>physical specifications</b>	<b>Dimensions:</b> 18"W x 5"H x 12" D (45.7 cm x 12.7 cm x 30.5 cm) <b>Weight:</b> 20 lbs. (9.1 Kg)	<b>input power</b>	100 – 240 Vac, 50/60 Hz
<b>measuring method</b>	ANSI/IEEE C57.12.90	<b>ratio measuring range</b>	0.8 – 50,000 : 1
<b>typical turns-ratio accuracy</b>	<b>4 Vac:</b> 0.8 – 1,000 (±0.08%), 1,001 – 4,000 (±0.1%), 4,001 – 15,000 (±0.25%) <b>40 Vac:</b> 0.8 – 1,000 (±0.05%), 1,001 – 4,000 (±0.1%), 4,001 – 15,000 (±0.25%), 15,001 – 20,000 (±0.4%), 20,001 – 50,000 (±0.5%) <b>100 Vac:</b> 0.8 – 1,000 (±0.05%), 1,001 – 4,000 (±0.1%), 4,001 – 15,000 (±0.25%), 15,001 – 20,000 (±0.4%), 20,001 – 50,000 (±0.5%) <b>250 Vac:</b> 0.8 – 1,000 (±0.03%), 1,001 – 4,000 (±0.1%), 4,001 – 15,000 (±0.2%), 15,001 – 20,000 (±0.4%), 20,001 – 50,000 (±0.5%)	<b>current reading range</b>	0 – 2 Amperes, accuracy: ±0.1mA, ±2% of reading (±1 mA)
<b>test voltages</b>	4 Vac @ 1 Amp, 40 Vac @ 200 mA, 100 Vac @ 100 mA, 250 Vac @ 50 mA	<b>phase angle measurement</b>	0 – 360 degrees accuracy: ±0.2 degree (±1 digit)
<b>display</b>	back-lit LCD screen (128 x 64 pixels) viewable in bright sunlight and low-light levels	<b>computer interfaces</b>	Bluetooth, USB port
<b>printer</b>	built-in 4½" wide thermal printer (optional)	<b>internal test plan storage</b>	stores up to 128 transformer test plans; plans can be transferred to PC.
<b>pc software</b>	Windows®-based transformer turns-ratio analysis software is included with purchase	<b>external data storage</b>	up to 999 test records on external USB flash drive (drive not included)
<b>internal test record storage</b>	stores 112 complete transformer test records, each record holding the test record header and up to 99 readings	<b>humidity</b>	90% RH @ 40°C (104°F) non-condensing
<b>safety</b>	designed to meet UL 61010A-1 and CAN/CSA C22.2 No. 1010.1-92 standards	<b>altitude</b>	2,000 m (6,562 ft) to full safety specifications
<b>temperature</b>	<b>Operating:</b> -10°C to +50°C (+15°F to +122°F) <b>Storage:</b> -30°C to +70°C (-22°F to +158°F)	<b>ltc contact</b>	240 Vac, 2A
<b>cables</b>	One 15-foot (4.57m) single-phase set, one 15-foot (4.57m) 3-phase set, one 25-foot (7.62m) extension set, one safety ground, one USB, cable bag	<b>warranty</b>	one year on parts and labor
<b>options</b>	shipping case, 30' (9.14 m) 3-phase H and X leads, 30' (9.14 m) single phase H and X leads		

**NOTE :** the above specifications are valid at nominal voltage and ambient temperature of +25°C (+77°F). Specifications are subject to change without notice.



## Instruments designed and developed by the hearts and minds of utility electricians around the world.

Founded in 1991 and located in Ontario, California, USA, Vanguard Instruments™ offers a wide range of diagnostic test equipment that accurately and efficiently measures the health of critical substation equipment, such as transformers, circuit breakers, and protective relays.

Our first product was a computerized, extra high voltage (EHV) circuit breaker analyzer, which became the forerunner of an entire line of EHV circuit breaker test equipment. Over the years, our portfolio has grown tremendously to include microcomputer-based precision micro-ohmmeters; single- and three-phase transformer winding turns-ratio testers; transformer winding-resistance meters; mega-ohm resistance meters; and a variety of other application-specific products.

Our instruments are rugged, reliable, accurate, and user friendly. They eliminate tedious and time-consuming operations, while providing fast, complex test-result calculations. Using our equipment helps reduce errors and eliminates the need to memorize long sequences of procedural steps.

In 2017, Vanguard Instruments became a part of Doble Engineering Company, an energy industry leader in hardware, software, and services that diagnose and monitor the health of critical assets.



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A DOBLE COMPANY

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