Megger

Three-Phase TTR®
Transformer Turns Ratio Test Set

- **Fully automatic operation**
- **Measures three phases simultaneously**
- **Highest ratio measurement (20,000:1); highest accuracy (0.1%)**
- **Built-in storage and downloading capabilities**
- **Measures ALL power transformers, PTs and CTs**
- **Displays % error vs. name plate and pass/fail limits**
- **Operator choice of "quick" test or complete "full" test**

DESCRIPTION

The Three-Phase Automatic TTR is designed to measure the turns ratio of power, instrument, and distribution transformers in a substation or manufacturing environment. At 16.5 lbs (7.5 kg), it weighs less than any other commercially available instrument. A rugged and robust design makes this TTR well suited for use in a variety of harsh environments. The TTR is also particularly suited for testing in power transformer manufacturing environments where testing of complex, three-phase substation power transformers can be performed quickly while minimizing the possibility of errors.

This new TTR measures the highest turns ratio range in the industry (10,000:1) and also provides the highest accuracy (0.1%). No other instrument's performance is comparable that is commercially available today.

Another excellent feature of this new TTR is the ability to measure phase deviation (in minutes or centiradians) of the transformer primary versus secondary. This will quickly indicate problems in a transformer such as partial shorted turns and core faults. This measurement is also useful in verifying phase errors of all types of PTs and CTs.

The TTR also features special software capabilities. The TTR comes equipped with sufficient onboard memory to store up to 200 test results in the field for later retrieval in the office. Test results can be printed on an optional serial printer whenever a hard copy is desired, or the data can be downloaded to a PC. Identification of individual test readings is also easily done. The system software allows entry of the transformer alphanumeric serial number, transformer type and tap information for each test performed.

This new TTR also comes with a unique optional, remote control software program. This Windows® based program permits control and operation from a PC keyboard, download of test data from the TTR to a PC, print out a test results report and assist in the preparation of management and/or analysis reports using either Excel® or Access®.

Realizing the extreme environments in which the TTR must operate, special attention has been paid to making it extra rugged (with a hard, shock resistant case), yet incredibly light weight (16.5 lbs). It features a high contrast LCD screen which can be seen in bright or ambient light and comes equipped with specially designed leads which provide the necessary flexibility needed in cold weather conditions.

APPLICATIONS

The proper operation of a transformer relies almost entirely on the electrical properties of its windings. To ensure continued proper operation, transformers are tested to verify that their electrical properties have not changed from design specifications.

A TTR is an extremely useful instrument for testing transformer windings, because it can locate several types of problems within a transformer. It is also ideal to use for testing in Meter shops for the upcoming inspection of CTs and PTs. It can determine the no load accuracy of all CTs and PTs and also determine the need to further test faulty CTs and PTs.

The new TTR applies voltage to the high voltage winding of a transformer and accurately measures the resulting voltage from the low voltage winding. In addition to turns ratio, the unit measures excitation current, phase angle deviation between the high and low voltage windings and percent ratio error.

Transformer Turns Ratio

Transformer Turns Ratio is the ratio of the number of turns in the high voltage winding to that in the low voltage winding. A Transformer Turns Ratio Test Set such as the Three-phase Automatic TTR can directly measure the ratio of most types of transformers. Transformer ratio can change due to several factors, including physical damage from faults, deteriorated insulation, contamination and shipping damage. If a transformer ratio changes more than 0.5 percent from the rated voltage ratio, it may not operate reliably. To measure small ratio changes such as this, the accuracy of a Biddle TTR is needed.

Exciting Current

The exciting current is the current that maintains the magnetic flux excitation in the core of a transformer.

A Transformer Turns Ratio Test Set such as the Three-phase Automatic TTR is capable of measuring exciting current because they apply voltage to one of the transformers windings. An accurate measurement of exciting current can provide information about the condition of a transformer's core. Unwanted circulating currents or unintentional grounds can affect the exciting current and indicate a problem.

Phase Angle Deviation

The phase angle deviation is the relationship between the voltage signal applied to the high voltage winding and the voltage signal extracted from the low voltage winding.

The phase deviation between the high and low side of a transformer is generally very small. If there is deterioration or damage in the transformer core, however, the phase deviation can change significantly. The Three-phase TTR can measure this phase relationship with the resolution necessary to detect a problem.

THREE PHASE TRANSFORMER TEST

TEST: 105 ID: A13579CV0246 DIAG: 31 Yzn11

TAPS TESTED:	3 - 16 R	
H VOLTAGE:	25000	X VOLTAGE: 5000
CALCULATED TURNS RATIO:	5.000	
TEST VOLTAGE:	80 V	

	A	B	C
RATIO	5.102	5.015	4.986
% DEVIATION	2.04	0.30	-0.28
PHASE (min.)	1.2	2.4	1.8
Iexc (mA)	20.6	10.5	7.78

SELECT: 1 - PRINT 2 - STORE 3 - NEXT TEST
4 - PRINT TEST 5 - MAIN MENU

Example of the TTR LCD screen which shows test data from a three-phase transformer test.

More information about a transformer's electrical properties can be found in the IEEE Standard Test Code for Transformers, C57.12.90, or by contacting Megger.

FEATURES AND BENEFITS

- Measures the widest turns ratio range in the industry (10,000:1) and also provides the highest accuracy (0.1%).
- Enables the operator to enter the ratio of the transformer and all of it's taps. This allows the operator to know immediately when a tap is outside the acceptable limits. Also allows for a pass/fail limit so problem taps can be easily flagged.
- Comes equipped with "remote-control" switch for single person testing. This allows the operator to test transformers with "LTCs" very quickly.
- Records ratio errors for bushing CTs to an accuracy of ±0.1% nameplate. This reduces the need for additional test equipment and improves set-up time.
- Measures the phase deviation (in minutes) of the transformer primary versus secondary. This quickly indicates problems in the transformer such as partial shorted turns and core faults. This measurement is also useful in verifying phase errors in all types of PTs and CTs.
- Perfect for meter shops, the TTR can be used for inspection purposes by using it to determine the no-load accuracy of most CTs and PTs. Also, it can be used to determine the need to further test potentially faulty CTs and PTs.
- This instrument is also ideal for use by power transformer manufacturers. Its unique testing procedures and storage capability allows an operator to set up and test difficult three-phase transformers (with multiple tap changers and bushing CTs) in a quarter of the time than it used to take with the former Biddle TTR. This test also includes a pass/fail limit of individual ratios.
- A "Quick Test" Mode provides a fast determination of the turns ratio for single and three-phase transformers, thus saving time.
- Displays all values for each test including measured and calculated ratio, exciting current, ratio error, and phase angle deviation, thus providing comprehensive and conclusive data.
- Automatic self-calibration for each test.
- Rugged, lightweight design ideally suited for a harsh field and substation environment.
- Three user selectable standards: ANSI, IEC, and Australian. Also meets IEC 1010 as well as other safety standards such as CSA and UL.
- Six user selectable languages: French, German, Italian, Portuguese, Spanish and English.

SPECIFICATIONS

Input Power

Cat. No. 550503:
120 V ac ±10%, single phase, 50 ±2 Hz or 60 ±2 Hz, 100 VA
Cat. No. 550503-47:
230 V ac ±10%, single phase, 50 ±2 Hz or 60 ±2 Hz, 100 VA
Frequency: 50/60 Hz (±2 Hz)

Battery operation
Optional inverter 12 V dc to 120 V/230 V ac for operation from vehicle battery.

Excitation Voltage
8, 40, or 80 V rms, automatically or manually selected

Excitation Current Range
0 to 500 mA, 3 digit resolution

Turns Ratio Range
8 V ac: 0.8 to 4000, 5 digit resolution
40 V ac: 0.8 to 15,000, 5 digit resolution
80 V ac: 0.8 to 20,000, 5 digit resolution

Phase Deviation Range
±90 degrees, 1 decimal point for the minutes display, 2 decimal points for the degree display, or for the centi-radian display

Current (rms) accuracy
±(2% of reading + 1 digit) Phase Deviation Accuracy: ±3 minutes

PC/Printer Interface
RS232C port, 9-pin 9600 baud

Display
LCD module, 256 x 128 dots
(this translates to 42 characters by 16 lines)

Turns Ratio Accuracy
8 V ac: ±0.1% (0.8 to 2000)
±0.25% (2001 to 4000)
±0.50% (4001 to 8000)
40 V ac: ±0.1% (0.8 to 2000)
±0.15% (2001 to 4000)
±0.3% (4001 to 10,000)
±0.50% (10,001 to 15,000)
80 V ac: ±0.1% (0.8 to 2000)
±0.15% (2001 to 4000)
±0.25% (4001 to 10,000)
±0.50% (10,001 to 20,000)

Test Result Storage
Internal, nonvolatile memory for storing up to 200 sets of three-phase measured and calculated ratio, exciting current, phase, ratio error, plus serial number and transformer type.

Computer Software
Included software for data storage, report printout, and download of data to a PC. Optional software for remote control of the TTR and database construction.

Test Leads
Supplied with one complete set of three-phase leads. A set of single-phase leads is also available as an optional accessory.

Transformer Winding Phase Relationship
ANSI C57.12.70-1978
CEI/IEC 76-1:1993 and Publication 616:1978
AS-2374, Part 4-1982 (Australian Standard)

Safety/EMC/Vibration
Meets the requirements of IEC-1010-1, CE and ASTM D999.75

Temperature Range
Operating: 23° F to 122° F (-5° C to 50° C)
Storage: -58° F to 140° F (-50° C to 60° C)

Relative Humidity
Operating: 0 to 90% noncondensing
Storage: 0 to 95% noncondensing

Protective Devices
Type T fuses per IEC 127 designation, HV & LV shorting relays, heavy-duty varistors, transient voltage suppressors, and gas surge voltage protectors.

Measuring Time
8 to 20 seconds depending on mode of operation and type of transformer

Measurement Method
ANSI/IEEE C57.12.90

Dimensions
10.5 H x 17.5 W x 6.9 D in.
(266.7 H x 444.5 W x 175.3 D mm)

Weight
Approx. 16.5 lbs (7.5 kg), instrument only, not including leads

Instrument Case
Light gray color ABS case with lid and carrying strap

Transit Case
Rugged case for storing/shipping the instrument, all leads and other accessories

OPTIONAL ACCESSORIES

Power Inverter

It may be necessary to have a portable power source in the field. Motor-generators are notorious for poor sine-wave output, as well as frequency instability. Since a vehicle is always available nearby, a power inverter using the vehicle's battery can provide the energy needed to power up the TTR. The optional inverter can be connected to the car's cigarette lighter. The inverter's output provides a true sine wave rated to deliver 125 watts of ac power. It is also protected with features that will automatically shut off in case of under-voltage,

AUTOMATIC TRANSFORMER TURNS RATIO TESTER
CAT.NO.550503

TRANSFORMER TEST REPORT

COMPANY: _____
SUBSTATION:
MANUFACTURER:
TRANSFORMER RATING: _____kVA/MVA
AMBIENT TEMPERATURE: _____
RELATIVE HUMIDITY:
TTR SN: 16892
OPERATOR(S): _____

COMMENTS/NOTES:

_____

DATE: (M/D/YY): 08/06/99 14:45
TEST: 014
TRANSFORMER ID: 2 897 9 6931
TYPE: THREE-PHASE TRANSFORMER Dy6
H VOLTAGE: 250000
X VOLTAGE: 50000
TAPS TESTED: 3 - 16L
CALCULATED TURN RATIO: 5.000
TEST VOLTAGE: 80 V

	A	B	C
RATIO:	5.006	4.998	5.011
% DEVIATION:	0.12	- 0.04	0.22
PHASE (min.):	5.3	6.5	7.9
Iexc (mA):	8.5	9.1	7.6

Sample TTR Test Results Report Printout.

overvoltage, and over-temperature. The power output is limited to 125 Watts, thus protecting it from being overloaded.

Printer

Test results can be documented using an optional thermal printer which is easily attached to the TTR as shown below. A header can be printed that provides spaces to write in the operator name, transformer information, temperature, relative humidity and comments/notes. The header automatically includes the test set catalog number. The test results printout includes ratio, ratio deviation in percent, phase shift, excitation current, test date, test voltage, type of transformer (single or three-phase), the configuration of the high and low voltage windings, transformer tap number and polarity. An example of the TTR test results report is shown in the previous column.

TTR with shelf mounted printer

Calibration Standard

The Calibration Standard has been designed for use as a reference transformer for checking the accuracy of the Biddle Three-Phase TTR. The standard is also useful for troubleshooting and repairing the instrument. The Calibration Standard is available with a Calibration Certificate of turns ratio and phase shift accuracy traceable to NIST.

Optional Calibration Standard, Cat. No. 550555

ORDERING INFORMATION

Item (Qty)	Cat. No.
Three-phase Transformer Turns Ratio Test Set	
120 V ac ±10%, single phase, 50 ±2 Hz or 60 ±2 Hz, 100 VA	550503
230 V ac ±10%, single phase, 50 ±2 Hz or 60 ±2 Hz, 100 VA	550503-47
Included Accessories	
Canvas carrying bag for test leads	30915-211
Power supply cord, 8 ft (2.5 m)	17032-4
Ground lead, 15 ft (4.6 m)	4702-7
Test Leads	
For three-phase connections, shielded, clip-end terminated	
H winding, 10 ft (3.1 m)	30915-505
X winding, 10 ft (3.1 m)	30915-504
Extensions, shielded	
H winding, 33 ft (10 m)	30915-503
X winding, 33 ft (10 m)	30915-502
Hand-held switch assembly for remote operation	30915-220
AVOLink software for downloading test results to a PC	35303-2
RS232 cable for connecting to a PC	35248
Bushing clips (6)	MC7144
Transformer Vector Voltage Diagram Set (For ANSI Standards, IEC Standards, and AS [Australian] Standards)	35314
Instruction manual	AVTM550503

Item (Qty)	Cat. No.
Optional Accessories	
Test leads	
For single-phase connections, shielded, clip-end terminated	
H winding, 10 ft (3.1 m)	30915-506
X winding, 10 ft (3.1 m)	30915-507
For three-phase connections, shielded, clip-end terminated	
H winding, 20 ft (6.2 m)	30915-524
TTR Printer Package	
120 V, 60 Hz	35312-1
230 V, 50 Hz	35312-2
Includes Battery/line-powered serial thermal printer	
Printer interface cable	
Shelf for mounting printer	
Calibration Standard	550555
AVOLink software	consult factory
Inverter with 3 ft (0.91 m) cigarette adapter cord	
12 V dc to 120 V ac, 60 Hz	35271-1
12 V dc to 120 V ac, 50 Hz	35271-3
12 V dc to 230 V ac, 60 Hz	35271-2
12 V dc to 230 V ac, 50 Hz	35271-4
Transit case (for instrument leads and accessories)	35313

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