



BIDDLE[®] **Three-Phase TTR[®]**

- Fully automatic operation
- Measures three phases simultaneously
- Highest ratio measurement (10,000:1); highest accuracy (0.1%)
- Built-in storage and downloading capabilities
- Measures ALL power transformers, PT's and CT's
- Displays % error vs. name plate and pass/fail limits
- Operator choice of "quick" test or complete "full" test
- CE certified

Transformer Turns Ratio Test Set

DESCRIPTION

The Biddle 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 new 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 manager 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 most 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 Biddle 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 Biddle 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 transformers 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 when a test voltage is applied. If there is deterioration or damage in the transformer core, however, the phase deviation can change significantly. The Biddle Three-phase

TTR can measure this phase relationship with the resolution necessary to detect a problem.

More information about a transformers electrical properties can be found in the IEEE Standard Test Code for Transformers, C57.12.90, or by contacting AVO International.

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 its 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 $\pm 0.1\%$ 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 UC.

SPECIFICATIONS

Input Power

120 or 230 V ac ($\pm 10\%$)

Frequency

50/60 Hz (± 2 Hz)

Battery operation

Optional inverter 12 V dc to 120 V/240 Vac 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 10000, 5 digit resolution

80 V ac: 0.8 to 10000, 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 centiradian display

Current (rms) accuracy

$\pm(2\% \text{ of reading} + 1 \text{ digit})$

Turns Ratio Accuracy

8 V ac: $\pm 0.1\%$ (0.8 to 2000)

$\pm 0.25\%$ (2001 to 4000)

40 V ac: $\pm 0.1\%$ (0.8 to 2000)

$\pm 0.15\%$ (2001 to 4000)

$\pm 0.3\%$ (4001 to 10,000)

80 V ac: $\pm 0.1\%$ (0.8 to 2000)

$\pm 0.15\%$ (2001 to 4000)

$\pm 0.25\%$ (4001 to 10,000)

THREE PHASE TRANSFORMER TEST		
TEST: 105	ID: A13579CV0246	
TAPS TESTED:	3 - 16 R	DIAG: 31
H VOLTAGE:	25000	X VOLTAGE: 5000
CALCULATED TURNS RATIO:	5.000	Yzn11
TEST VOLTAGE:	80 V	
RATIO	5.102	A
% DEVIATION	+2.04	B
PHASE (min.)	1.2	C
lexc (mA)	20.6	
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.

Phase Deviation Accuracy

± 3 minutes

PC/Printer Interface

RS232C port, 9-pin

9600 baud

Display

LCD module, 256 x 128 dots (this translates to 47 characters by 16 lines)

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 Dmm)

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 metal case for storing/shipping
the instrument, all leads and other
accessories

OPTIONAL ACCESSORIES**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
TTR serial number, 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
below.

AVO INTERNATIONAL AUTOMATIC TRANSFORMER TESTER CAT. NO. 550503		
TRANSFORMER TEST REPORT		
COMPANY:		
SUBSTATION:		
MANUFACTURER:		
TRANSFORMER RATING:	MVA/MVA	
AMBIENT TEMPERATURE:		
RELATIVE HUMIDITY:		
TTR SN: 18992		
OPERATOR(S):		
COMMENTS/NOTES:		
DATE: (M/D/YR): 08/06/99 14:45		
TEST: 014		
TRANSFORMER ID: 28979 8831		
TYPE: THREE-PHASE TRANSFORMER Dyn		
H VOLTAGE: 250000		
X VOLTAGE: 50000		
TAPS TESTED: 3 - 16L		
CALCULATED TURN RATIO: 5.000		
TEST VOLTAGE: 60 V		
A B C		
RATIO:	5.006	4.998
% DEVIATION:	+ 0.12	- 0.04
PHASE (min.):	5.3	6.5
LEADS (mils.):	8.5	9.1
7.9		

*Sample TTR Test Results Report
Printout.*

Calibration Standard

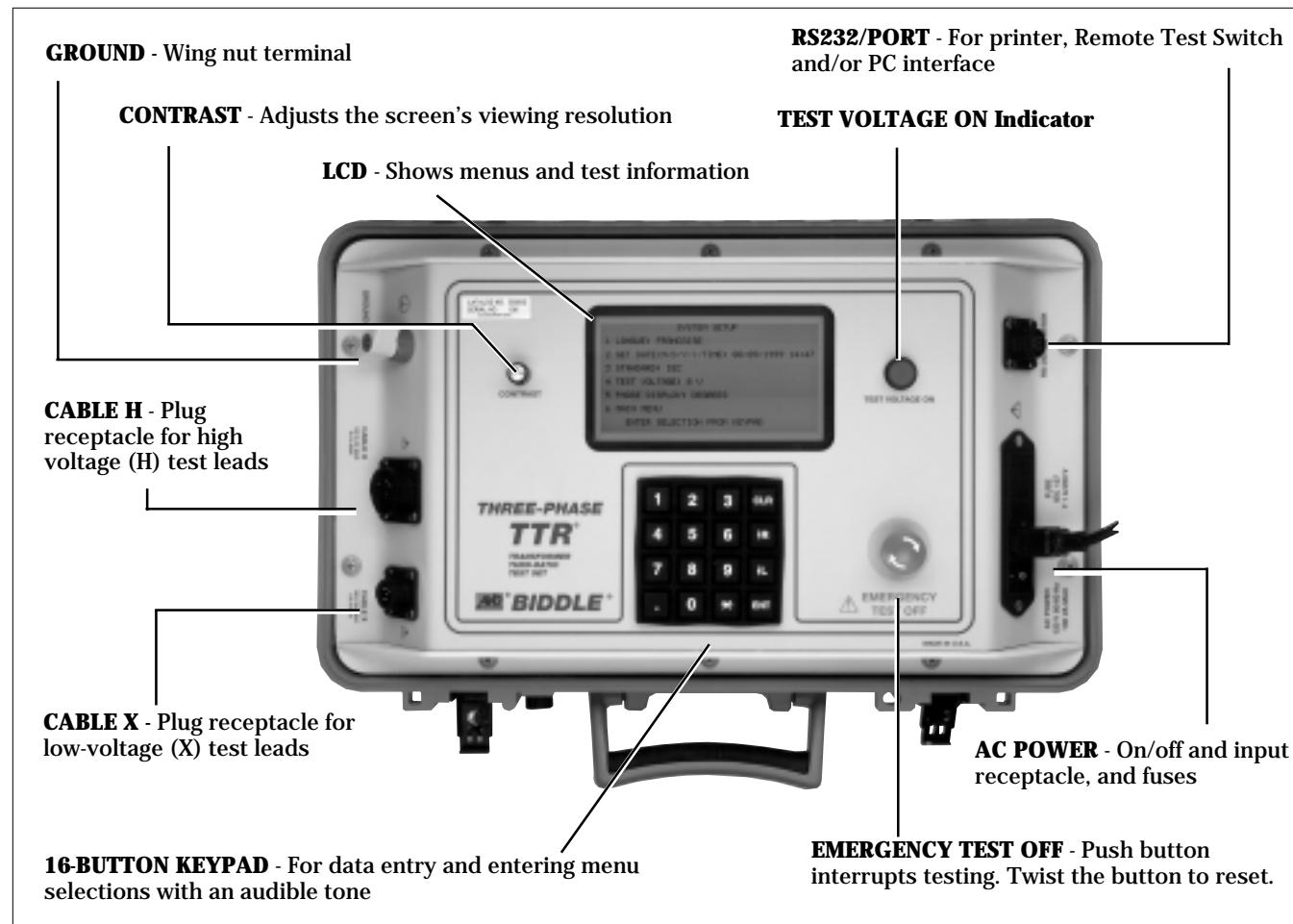
The Calibration Standard has been designed for use as a reference transformer for checking the accuracy of the BIDDLE Three-Phase TTR. The standard is also useful for troubleshooting and repairing the instrument. The Calibration Standard is available with a Calibration Certificate of turns ratio and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



*Optional Calibration Standard,
Cat. No. 550555*

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



ORDERING INFORMATION

Item (Qty)	Cat. No.	Item (Qty)	Cat. No.
Three-phase Transformer Turns Ratio Test Set		Optional Accessories	
120 V ac ±10%, single phase, 50 ±2 Hz or 60 ±2 Hz, 100 VA	550503	Test leads	
230 V ac ±10%, single phase, 50 ±2 Hz or 60 ±2 Hz, 100 VA	550503-47	For single-phase connections, shielded, clip-end terminated	
Included Accessories		H winding, 10 ft (3.1 m)	30915-506
Canvas carrying bag for test leads	30915-211	X winding, 10 ft (3.1 m)	30915-507
Power supply cord, 8 ft (2.5 m)	17032-4	TTR Printer Package	
Ground lead, 15 ft (4.6 m)	4702-7	120 V, 60 Hz	35312-1
Test Leads		230 V, 50 Hz	35312-2
For three-phase connections, shielded, clip-end terminated		Includes	
H winding, 10 ft (3.1 m)	30915-505	Battery/line-powered serial thermal printer	
X winding, 10 ft (3.1 m)	30915-504	Printer interface cable	
Extensions, shielded		Shelf for mounting printer	
H winding, 33 ft (10 m)	30915-503	Calibration Standard	550555
X winding, 33 ft (10 m)	30915-502	TTR Remote Control software	35303-3
Hand-held switch assy for remote operation	30915-220	Inverter with 3 ft (0.91 m) cigarette adapter cord	
Software for downloading test results to a PC	35303-2	12 V dc to 120 V ac, 60 Hz	35271-1
RS232 cable for connecting to a PC	35248	12 V dc to 120 V ac, 50 Hz	35271-3
Bushing clips (Qty 6)	MC7144	12 V dc to 230 V ac, 60 Hz	35271-2
Transformer Vector Voltage Diagram Set (For ANSI Standards, IEC Standards, and AS [Australian] Standards)	35314	12 V dc to 230 V ac, 50 Hz	35271-44
Instruction manual	AVTM550503	Transit case (for instrument leads and accessories)	35313