Three-Phase TTR®
Transformer Turns Ratio Test Set

- Fully automatic operation
- Works in the presence of high interference/high voltage
- Includes software for remote control, data storage and management
- Highest ratio measurement (45,000:1); highest accuracy (0.1%)
- Excel® format test report complete with transformer vector diagram
- Built-in storage and downloading capabilities
- Displays % error vs. name plate with pass/fail limits

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. 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. A rugged and robust design makes this TTR well suited for use in a variety of harsh environments. The TTR is also suited for testing power transformers in manufacturing environments where testing can be performed quickly (including storage of results) while minimizing the possibility of errors.

COMLINK SOFTWARE
The TTR comes complete with a new powerful Windows® based software program (ComLink), at no extra charge. ComLink allows the operator to completely program a test routine for a transformer, save it under the transformer ID number and then recall it in the future as required. ComLink performs tests at each “tap” and displays a PASS/FAIL for the operator prior to storing them. This lets the operator know the condition of the transformer on-site, versus manually calculating PASS/FAIL after each test has been completed. A sample of the test setup screen is shown in Figure 1.

Testing Unique Transformers
Many transformers are custom designed and have taps with ratio changes which are UNEQUAL. To facilitate the testing of such transformers, ComLink includes a feature that allows the user to enter the nameplate voltages for each tap individually. This saves time and simplifies testing and diagnosis of this type of transformer. With this feature any type of unique transformer can be tested quickly and easily.

Figure 1: Test Setup of a Complex Transformer
ComLink Test Report

The ComLink software also includes a database management tool. This allows the operator to save all results and recall them as required for analysis or quality control. ComLink uses Microsoft Excel® and Access® to manage and display data.

Complete reports can be produced showing critical data such as vector configuration, transformer connections, PASS/FAIL, header information etc.

Using Excel, customers can select the data to be included in any user-defined reports. An example test report is shown in Figure 2.

ComLink Remote Control

The ComLink software program serves two main purposes as described above. Its first function is the uploading of data from the TTR, generating an electronic test report in Excel (or printed out as a hard copy) which is then stored for future review.

Second, the ComLink software also allows the user to operate the TTR by remote control. Control of the TTR in this manner offers the following benefits:

- Easy to use interface between operator and instrument.
- Problems such as PASS/FAIL are flagged visually using a RED highlight (see Figure 3).
- Easily recall transformer setups from a custom settings menu (see Figure 4).
- Quickly download test results to the PC for completing a transformer test report.
Phase Angle Deviation and its Application

The phase angle deviation, displayed in either degrees (minutes) or radians, is the phase relationship between the voltage signal applied to the high voltage winding and the voltage signal extracted from the low voltage winding. The phase deviation together with ratio error can be used as a low cost method of verifying accuracy class of all types of PTs and CTs at “zero burden.”

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 of 0.1 minutes (equal to 1/600 of a degree), which is necessary to detect problems.

FEATURES AND BENEFITS

- Measures the widest turns ratio range in the industry (45,000:1) and 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 so problem taps can be easily flagged.
- Comes equipped with a “remote-control” switch for single person testing. This allows the operator to test transformers with “LTCs” very quickly.
- Internal TTR memory records up to 200 three-phase test results.
- 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.
- This instrument is 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 fraction of the time than it used to take with other TTRs. 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.
- 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.

Applications

The 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. Complexity in the measured ratio versus nameplate ratio occurs with most three phase power transformers because multipliers such as $\sqrt{3}$ are required to match the measured ratio to the nameplate ratio. The three-phase TTR automatically applies the multiplier in a form which allows the operator a direct comparison to the nameplate (or expected) ratio. The TTR’s built-in calculator displays the % error versus nameplate for each tap and each winding, without the need of a computer or software.

Exciting Current

The TTR provides accurate measurement of exciting current (to 0.1 mA) which can help provide information about the condition of a transformer’s core. Unwanted circulating currents or unintentional grounds can increase the exciting current and indicate a problem.

Figure 5: Example of the TTR LCD screen which shows test data from a three-phase transformer test
**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

**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 and Accuracy**
0 to 500 mA, 3 digit resolution, ±(2% of reading + 1 digit)

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

**Turns Ratio Range and Accuracy**
- 8 V ac:
  - ±0.1% (0.8 to 2000)
  - ±0.25% (2001 to 4000)
  - ±0.35% (4001 to 8000)
- 40 V ac:
  - ±0.1% (0.8 to 2000)
  - ±0.15% (2001 to 4000)
  - ±0.3% (4001 to 10,000)
  - ±0.35% (10,001 to 25,000)
- 80 V ac:
  - ±0.1% (0.8 to 2000)
  - ±0.15% (2001 to 4000)
  - ±0.25% (4001 to 10,000)
  - ±0.3% (10,001 to 45,000)

**Resolution:** 5 digit for all ratios

**Display**
- LCD module, 256 x 128 dots (42 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.

**Communication/Control Software — ComLink**
- Included ComLink software for data storage, report printout and download of data to a PC, and control of the TTR via PC.

**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**
- 0 to 90% noncondensing

**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

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**ORDERING INFORMATION**

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<thead>
<tr>
<th>Item (Qty)</th>
<th>Cat. No.</th>
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<tr>
<td>120 V ac ±10%, 50 or 60 Hz, Three-Phase TTR</td>
<td>550503</td>
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<tr>
<td>230 V ac ±10%, 50 or 60 Hz, Three-Phase TTR</td>
<td>550503-47</td>
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**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
- 3-ø shielded test leads, H winding, 10 ft (3.1 m) 30915-505
- 3-ø shielded test leads, X winding, 10 ft (3.1 m) 30915-504
- Shielded extensions, H winding, 33 ft (10 m) 30915-503
- Shielded extensions, X winding, 33 ft (10 m) 30915-502
- Hand-held switch assy for remote operation 30915-220
- ComLink software 35794-2
- RS232 cable for connecting to a PC 35248
- Bushing clips (6) MC7144
- Transformer Vector Voltage Diagram Set (For ANSI, IEC, and AS Standards) 35314
- Instruction manual AVTMS550503

<table>
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<th>Item (Qty)</th>
<th>Cat. No.</th>
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<td>Optional Accessories</td>
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<tr>
<td>Test leads, 1-ø clip ends, H winding, 10 ft (3.1 m)</td>
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<tr>
<td>Test leads, 1-ø clip ends, X winding, 10 ft (3.1 m)</td>
<td>30915-507</td>
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<td>Test leads, 3-ø clip ends, H winding, 20 ft (6.2 m)</td>
<td>30915-524</td>
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<td>TTR Printer Package</td>
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<td>120 V, 60 Hz</td>
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<td>230 V, 50 Hz</td>
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<td>Includes Battery/line-powered serial thermal printer, printer interface cable, and shelf for mounting printer</td>
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<td>Calibration Standard (for TTR verification)</td>
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<td>Inverter with 3 ft (0.91 m) cigarette adapter cord</td>
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<td>12 V dc to 120 V ac, 50 Hz</td>
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<tr>
<td>12 V dc to 230 V ac, 60 Hz</td>
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<td>12 V dc to 230 V ac, 50 Hz</td>
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<td>Transit case (for instrument leads and accessories)</td>
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