

**Instruction Manual
for
Three-Phase Ratio & Winding Resistance
Transformer Test Set**

MWA300 series

Catalog Numbers. MWA300, MWA300-47

HIGH-VOLTAGE EQUIPMENT

Read this entire manual before operating equipment

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**Three-Phase Ratio & Winding Resistance
Transformer Test Set**

MWA300 series

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If the product or its individual instruments are used for purposes other than those specified herein, confirmation of their validity and suitability must be obtained from Megger. Refer to the warranty information below. Specifications are subject to change without notice.

WARRANTY

Products supplied by Megger are warranted against defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair must first be authorized for return via email to VFsupport@megger.com, and upon receipt of an RA # be shipped prepaid and insured. The warranty is void in the event of abuse (failure to follow recommended operating procedures) or failure by the customer to perform specific routine maintenance as indicated in this manual.

Megger.

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Upon Receipt of Product

Prior to operation, check for loosened hardware or damage incurred during transit. If these conditions are found, a safety hazard is likely, DO NOT attempt to operate equipment. Please contact Megger as soon as possible.



MWA300 Transformer Ratio & Winding Resistance Test Set

Megger.

1

MWA300 Product Overview

The MWA300 test set is an automatic unit which is designed to be controlled via a computer running PowerDB Lite software. The test set measures the turns ratio, phase shift, excitation current and winding resistance of power, distribution, and instrument transformers. A “-47” suffix added to the catalog number denotes a 230V /50 Hz input power supply frequency. The test set is a portable instrument housed in a sturdy plastic case. A carry bag is supplied for accessories.

The test set can be used to test single-phase and three-phase transformers, both with and without taps in accordance with the requirements of the IEEE C57.12.90 – 2013 as well as IEC 60076-1 standards. For three-phase measurements, the test set is connected to all three phases of the transformer to be tested. Operating condition (error) messages identify incorrect test connections, abnormal operating condition, or winding problems. Test results are saved to an external PC.

It is recommended that the user becomes familiar with the MWA300 before ever connecting to a transformer.

Top Panel Controls



Figure 1-1 Top Panel Controls

1. **Power input receptacle. ON/OFF switch, and Mains fuse holder.**
ON/OFF power switch and input power receptacle provides power to the test set.
2. **H – Cable receptacle.** Plug receptacle for connecting test leads to the high-voltage (H) winding of a transformer
3. **X – Cable receptacle.** Plug receptacle for connecting test leads to the low-voltage (X) winding of a transformer.
4. **PC Input.** USB host for PC control connection of MWA. Switch used to select external (MWA300 always in this position) as well as internal (MWA330A only) control of instrument. Software provided is PowerDB Lite version 11.03 and higher.
5. **HV Strobe Input Connector.** When the optional HV Strobe (Cat # 1004-639) is attached, the user will have a highly visible indication of the test voltage or test current being applied to the Unit Under Test (UUT).
6. **Safety Interlock Input.** These connections are used when there is requirement for additional safety while testing a transformer.
7. **Ground lug.** Special twist lock terminal allows connection of test set to Station Earth ground.
8. **Voltage ON light.** Flashing **Red** indicator lamp indicates ac test voltage or dc test current is being supplied to the Unit Under Test (UUT).
9. **Test Mode Indicator.** LEDs light up to indicate which test state instrument is in (MTO or TTR).

2

SAFETY

Safety is the responsibility of the user

Only qualified and trained operators should operate the MWA300. Operator must read and understand this entire Instruction Manual prior to operating the equipment. Operator must follow the instructions of this Instruction Manual and attend the equipment while the equipment is in use. In the event of equipment malfunction, the unit should immediately be de-energized and returned to Megger for repair. The Safety precautions herein are not intended to replace your Company's Safety Procedures. Refer to IEEE 510 - 1983, IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing, for additional information.

General Safety Precautions

The MWA300 and the Unit Under Test (UUT) should both be considered as sources of instantaneously lethal levels of electrical energy. Observe the following safety precautions:

- Observe all safety warnings on the equipment. They identify areas of immediate hazard that could result in injury or death.
- Use this equipment only for the purposes described in this manual. Observe strictly the Warning and Caution information provided in this manual
- Treat all terminals of high-voltage power equipment systems as potential electric shock hazards. Use all practical safety precautions to prevent contact with energized parts of the equipment and related circuits.
- Use suitable barriers, barricades, or warnings to keep persons not directly involved with the work away from test activities.
- Never connect the test equipment to energized equipment.
- Do not use in an explosive atmosphere.
- Use the grounding and connection procedures recommended in this manual. Always disconnect test leads from power equipment before attempting to disconnect them at the test set. The ground connection must be the first made and the last removed. Any interruption of the grounding connection can create an electrical shock hazard.

- Personnel using heart pacemakers should obtain expert advice on the possible risks before operating this equipment or being close to the equipment during operation.

Input Power Precautions

This instrument operates from a single-phase, sine wave, power source. It has a three-wire power cord and requires a two-pole, three-terminal (live, neutral, and ground) type input source. The voltage to ground from the live pole of the power source must be within the following rated operating voltage:

Cat. No MWA300 120 V 10%, 60 Hz, 2 Hz, 660VA

Cat. No. MWA300-47 230 V 10%, 50 Hz, 2 Hz, 660VA

The neutral pole must be at ground potential. Before making connection to the power source, determine that the instrument rating matches the voltage of the power source. The power input plug must be inserted only into a mating receptacle with a ground contact. Do not bypass the grounding connection. Any interruption of the grounding connection can create an electric shock hazard. Determine that the receptacle is properly wired before inserting the plug.

For test sets energized with 230 V input (MWA300-47), the neutral terminal of the input supply cord (white or blue lead) must be connected to the neutral pole of the line power source. The ground terminal of the input supply cord (green or yellow/green lead) must be connected to the protective ground (earth) terminal of the line power source. The black or brown cord lead is the live (hot) lead.

The control circuits of the instrument are protected by two mains circuit fuses. These fuses are located in the ON/OFF switch module and are replaceable by the operator. To avoid electric shock and fire hazard, use only the fuse specified in Section 3 that is identical in respect to type, voltage rating, and current rating.



WARNING

Before replacing the fuses, disconnect the power input plug from the live power source.

3

SPECIFICATIONS

Electrical

Input Power

Cat. No. MWA300:	120 V, $\pm 10\%$, 60 Hz, ± 2 Hz, 660 VA <i>IEC 1010-1 installation category II</i>
Cat. No. MWA300-47:	230 V, $\pm 10\%$, 50 Hz, ± 2 Hz, 660 VA <i>IEC 1010-1 installation category II</i>

Protective Devices (Fuses)

Main Input Fuse :	Qty 2: 6.3 amp, 250V, 5x20mm, SLO-BLO (120V Ceramic) Qty 2: 4.0 amp, 250V, 5x20mm, SLO-BLO (230V Ceramic)
TTR portion:	
MWA300:	1.0 amp, 250 V, 5x20mm, SLO-BLO (120V)
MWA300-47:	0.5 amp, 250V, 5x20mm, SLO-BLO (230V)

RATIO SPECIFICATIONS

Output AC Test Voltage and Current

Test Voltages:	80 V rms, 40 V rms, 8 V rms.
Current:	up to 500 ma

Test Frequency

Same as line frequency.

Loading of Test Transformer

Less than 0.2 VA

Measuring Ranges

Turn ratio:	80 V ac: 0.8 to 45,000, 5 digit resolution 40 V ac: 0.8 to 25,000, 5 digit resolution 8V ac: 0.8 to 8,000, 5 digit resolution
Excitation Current:	0 to 500 mA, 3 digit resolution
Phase Angle Deviation:	± 90 degrees, 1 decimal point for the minutes display, 2 decimal point for the degree display

Accuracy

80 V ac:	±0.1% (0.8 to 2000) ±0.15% (2001 to 4000) ±0.25% (4001 to 10000) ±0.3% (10001 to 45000)
40 V ac:	±0.1% (0.8 to 2000) ±0.15% (2001 to 4000) ±0.3% (4001 to 10000) ±0.35% (10001 to 25000)
8 V ac:	±0.1% (0.8 to 2000) ±0.25% (2001 to 4000) ±0.35% (4001 to 8000)
Resolution:	5 digits for all ratios
Excitation Current (rms):	±(2% of reading + 1 digit)
Phase Angle Deviation:	±3 minutes (± 0.05 degrees)

Measurement Method

In accordance with ANSI/IEEE C57.12.90-2013 & IEC 60076-1

Transformer Winding Phase Relationship

ANSI C57.12.70-2011

CEI/IEC 76-1:2011, IEC 60076-1 and CIGRE TB 445

AS-2374, Part 4-2003 (Australian Standard)

Measuring Time

8 to 37 seconds depending on mode of operation and type of transformer

WINDING RESISTANCE SPECIFICATIONS

DC Output Current (User selectable Ranges)

10 mA
100 mA
1 A
2.5 A
5.0 A
7.5 A
10 A

Open Circuit Test Voltage

40 V dc

Measurement Voltage

20 V dc

Max Power

200 VA continuous

Resistance ranges:

Current Range (A)	Resistance Range (Ω)	Resolution (Ω)
10 A	10 $\mu\Omega$ to 0.2 Ω	0.000001
10 A	0.2 Ω to 2 Ω	0.0001
1 A	100 $\mu\Omega$ to 2 Ω	0.00001
1 A	2 Ω to 20 Ω	0.001
100 mA	1 m Ω to 20 Ω	0.0001
100 mA	20 Ω to 200 Ω	0.01
10 mA	10 m Ω to 200 Ω	0.001
10 mA	200 Ω to 2000 Ω	0.1

Accuracy: +/-0.25% Range +/-0.25% Rdg

Display

Via external PC (user supplied)

Memory Storage

Via external PC (user supplied)

Communication Interface

USB 2.0 Serial

Safety/EMC/Vibration

Conforms to the requirements of:

IEC1010-1: 2010 CE

ASTMD999.75

IEC 61326-1:2012*

*At radiated frequencies 80MHz – 100MHz, performance may be deteriorated.

Environmental Conditions

Operating temperature range:	23 to 122 F (-5 to 50 C)
Storage temperature range:	-22 to 140 F (-30 to 60 C)
Relative humidity:	0 to 90% noncondensing

Physical Data

Dimensions:

Instrument: 11.5 H x 11.5 W x 18 D in.
(290H x 290 W x 460D mm)

Weight:

Instrument with standard provided accessories: 34 lbs. (15.5 kg)

Instrument with Optional Leads, 30ft (9.0m)
52 lbs. (23.6 kg)

4

SOFTWARE INSTALLATION

PowerDB Lite Setup & Installation

PowerDB Lite software is included at no extra charge software tool that is designed specifically to control and/or extract data from the MWA300. PowerDB Lite will present your test data into a professional looking data form that can be sent to a printer or .pdf file.

PowerDB Lite allows you to use a sub-set of the standard PowerDB forms that are appropriate for specific Megger instruments.

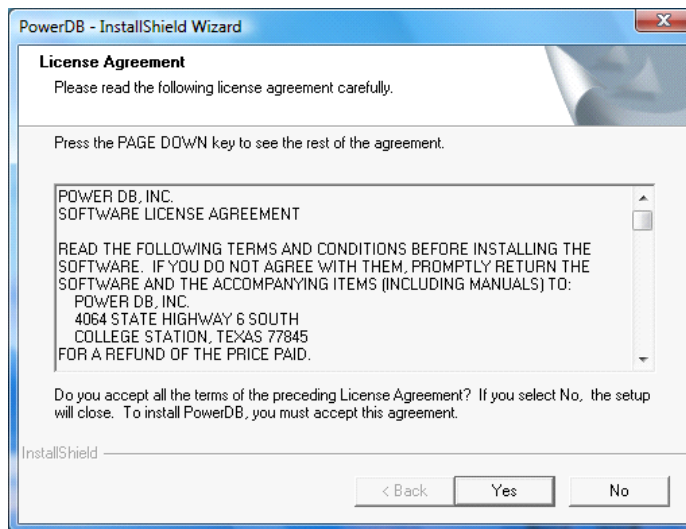
Minimum Recommended System

- Operating System: Windows XP or later
- RAM: 2GB RAM minimum, >4GB RAM recommended
- >2G free memory space
- Processor: 2.0 GHz Pentium Class processor minimum,
- For more information please visit *www.powerdb.com* or contact your local sales representative

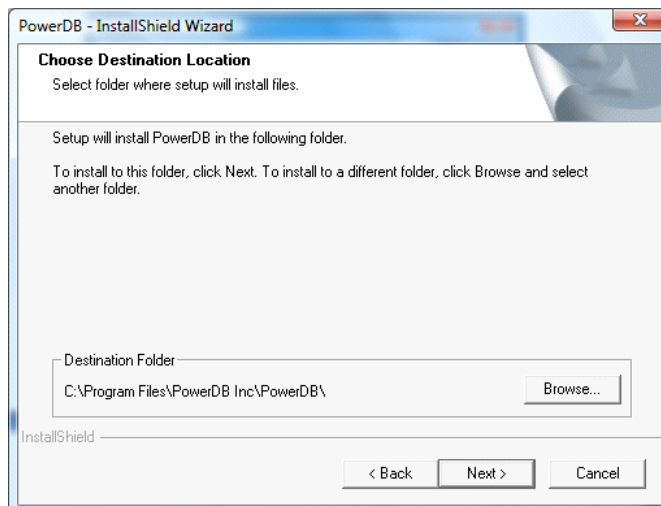
Software Installation

To install PowerDB Lite, load the PowerDB Lite CD (or USB) into your computer drive and follow the on-screen instructions. For latest version, please go to website www.powerDB.com/download and download latest Lite version available. The model is contained within the software and not obvious until Lite software is loaded.

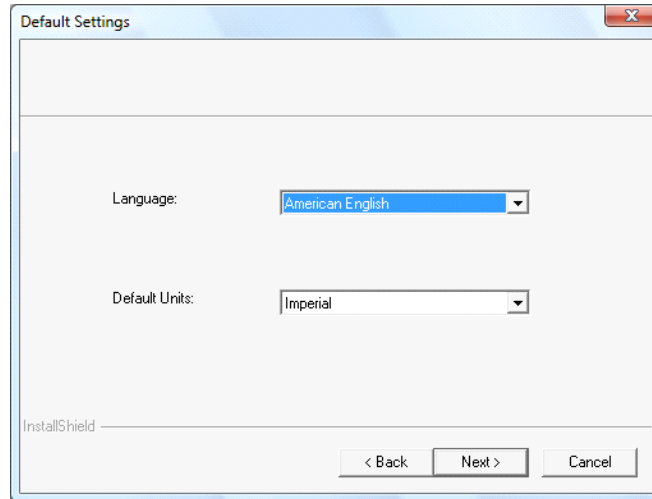
1. Accept the terms of the License agreement.



2. Choose the destination location for the PowerDB Lite files.



3. Select Default Settings (Language and Units of Measure).



4. Install Shield Wizard will complete the installation of PowerDB Lite. Click Finish to close the installation program.

General Testing Procedures

Getting Started

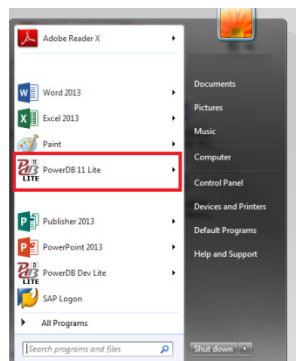
1. To determine that the MWA hardware is operational, observe the following:

Once all Safety precautions are taken, and all circuit connections are made, the user may safely turn the ON/OFF switch to the ON position and operate the test instrument as described herein.

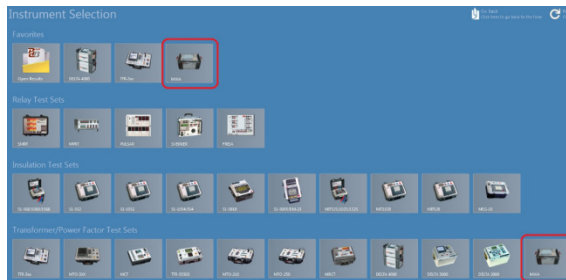
On power up, fans should begin (winding resistance portion) to be heard and ONE audible beep should sound (ratio portion). The MWA performs a self-test check, and all hardware and software variables are initialized.

Proceed to Section below for operation via external PC (supplied by User).

2. Select PowerDB Lite from PC Start Menu or from Shortcut on Main window:

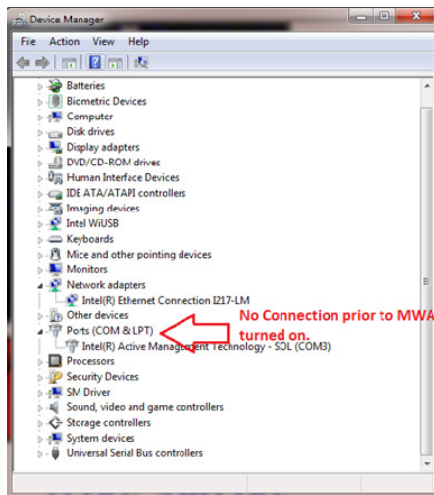


3. Select **MWA** from the Instrument Setup screen. It may be located in “Favorites” or “Transformer/Power Factor Test Sets” and can be relocated as desired.

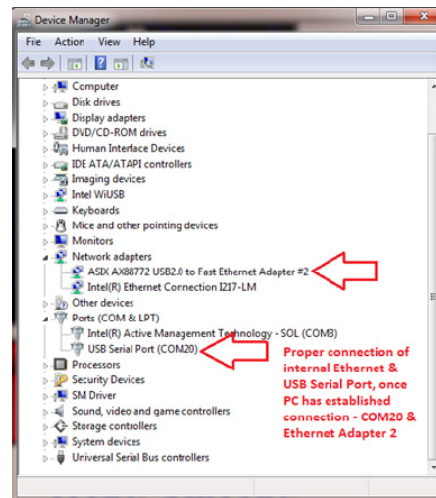


The MWA300 uses USB connection only. Once MWA is selected, the proper settings for USB are pre-selected, and no further changes should be required. PLEASE ALLOW SUFFICIENT TIME FOR DRIVERS TO LOAD WHEN CONNECTING TO MWA300 FIRST TIME. Each time one connects to MWA, allow approximately 45-60 seconds for PC to connect to the instrument once connected.

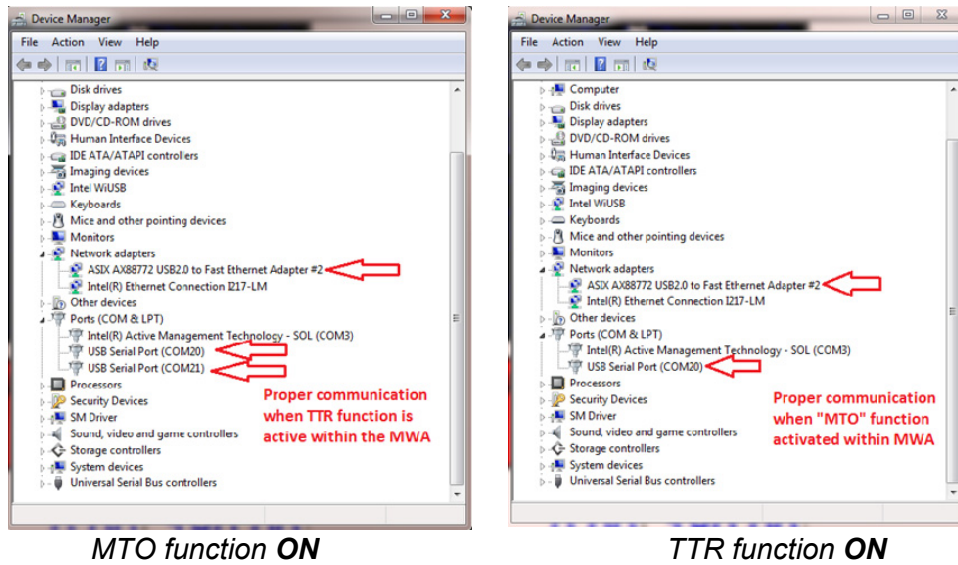
4. From Device Manager, one should see the following drivers installed with instrument ON:



Before connection



After connection+ MWA300 ON



Typical issues encountered may relate to the drivers for MWA300, and may require re-installation of the software to re-load drivers properly. As well, allow sufficient time for drivers to properly load. Beyond this, please contact your local ASC or direct to VFsupport@megger.com.

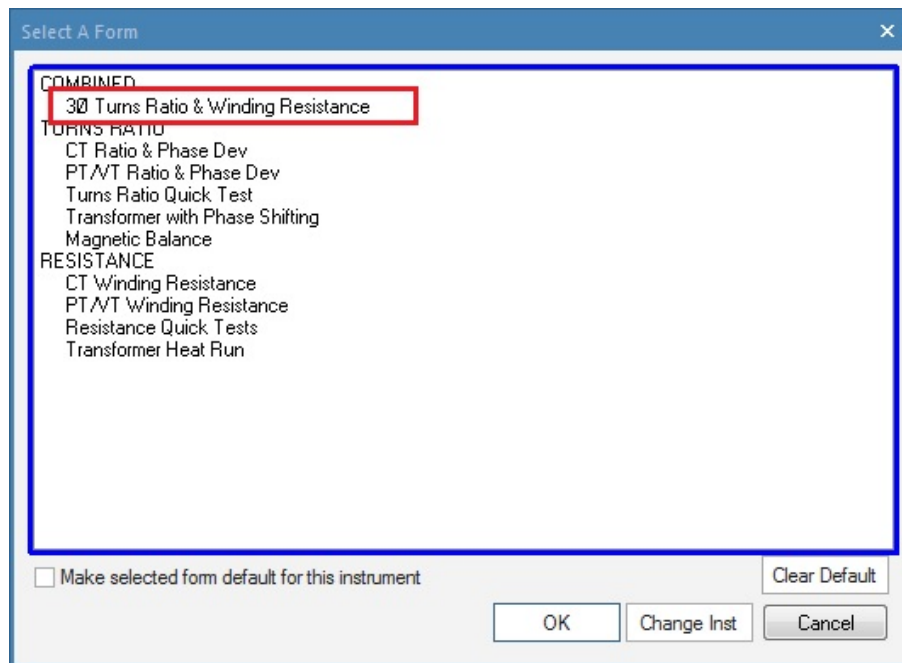
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5

THREE PHASE TTR & WINDING RESISTANCE TESTING

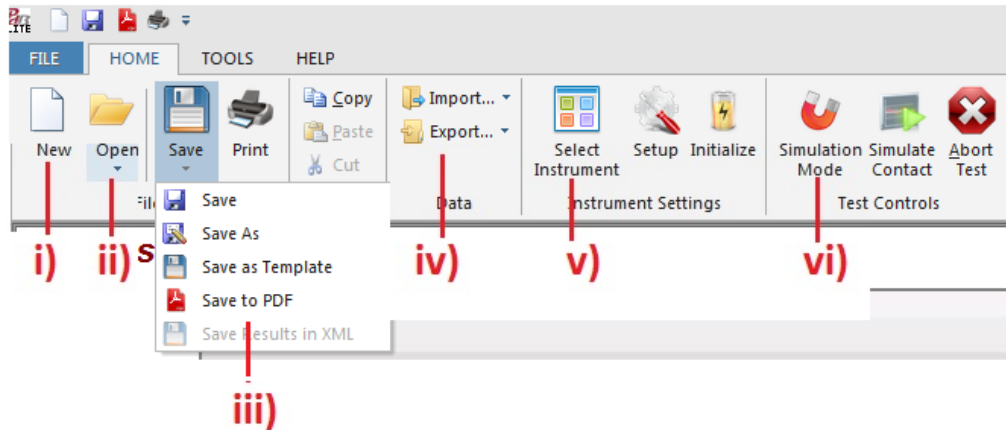
The following is a detailed description of operational aspects of MWA test forms, with 3 θ Turns & Winding Resistance form below used as a reference. All other MWA forms use common methods as described in the example below.

Select 3 θ Turns Ratio & Winding Resistance form



Test Form Controls - General

Once a form is opened, all forms have a set of standard controls which are available across the top of the form as shown below. This allows common functions such as saving, deleting, opening results, together with functions as described below.



- i. **New** allows a different test form to be selected within the MWA -brings up selection list from Menu in 1. above
- ii. **Open** results or test setups to be used for viewing past results, appending or retesting
- iii. **Save** prompts user to save results, or rename file, or save in PDF format
- iv. **Import/Export** allows saving results as a CSV (Excel) file.
- v. **Select Instrument** allows change of test instrument under PowerDB control as noted in “1. Getting Started” above.
- vi. **Simulation Mode** allows use of a test form without the actual instrument connected. Useful for training and demonstration to personnel.

Form Settings:

Form	
Diagram Number	<input checked="" type="checkbox"/>
Standard	<input type="text" value="ANSI"/>
Phase Display	<input type="text" value="Degrees"/>
Ratio Display	<input type="text" value="TTR(Turns Ratio)"/>
Turns Ratio Allowed Error(%)	<input type="text" value="0.5"/>
Ω Max Wdg Diff (%)	<input type="text" value="2.0"/>
Corrected Ω (°C)	<input checked="" type="checkbox"/> <input type="text" value="85"/>

- i) **Diagram Number:** relates to TTR/MTO function where each vector combination has a specific diagram number associated with it.
- ii) **Standard:** ANSI/IEC/AUS depending on national standard used
- iii) **Phase Display:** when testing ratio, accompanying phase result displayed as “Degrees or Minutes (60 Minutes = 1 Degree)”
- iv) **Ratio Display:** defaults as “Transformer Turns Ratio”, but allows display of “TNR – Transformer Nameplate Ratio”
- v) **Turns Ratio Allowed Error (%):** sets a % error limit for each measured ratio versus expected ratio (ratio calculated from Transformer Nameplate entries. Default is 0.5% as this is typical for power transformers.
- vi) **Ω Max Wdg Diff (%):** is used to determine winding resistance limits, typically set to 2%. Calculation used:

$$(\text{Phase } 1\Omega + \text{Phase } 2\Omega + \text{Phase } 3\Omega)/3 = \text{Ravg } \Omega$$

$$\% \text{ Difference (displayed)} = (\Omega_{\text{max}} - \Omega_{\text{min}})/\text{Ravg} * 100$$
- vii) **Corrected Ω (°C):** Resistance corrected to a set temperature e.g.: 85C. Once selected (checked), resistance in tables below are corrected to a standard temperature level. Range: 0-200C

Tap Settings

Tap		
Override Calc. Voltages	<input checked="" type="checkbox"/>	i)
Override Tap Labels	<input checked="" type="checkbox"/>	
H Numbering Convention	<input type="text" value="1, 2, 3"/>	ii)
L Numbering Convention	<input type="text" value="1R, N, 1L"/>	
Raise Suffix	<input type="text" value="R"/>	iii)
Lower Suffix	<input type="text" value="L"/>	
Round Tap Voltages To	<input type="text" value="1 Volt"/>	iv)

- i. **Override Calc. Voltages/Tap Labels:** allows individual entry for each field. Typically used for custom transformers. Note: When checked, all fields in tables below remain empty until manually populated.
- ii. **H & L Numbering:** allows labeling to follow transformer nameplate convention.
- iii. **Raise/Lower Suffix:** allows labeling to follow transformer nameplate convention.
- iv. **Round Tap Voltages:** is used to help match tap voltages, listed in the form, to actual nameplate voltages.

Resistance/Ratio Settings

Resistance Measurement		Turns Ratio	
Nameplate Recommended Current (A): Pri: 0.01 Sec: 0.01 Tert: 0.01 i)		Test Voltage	Auto vi)
Current (Amps)	10.0 ii)	<div style="border: 1px solid gray; border-radius: 15px; padding: 10px; width: fit-content; margin: auto;"> Factory Settings vii) </div>	
Break/Make Sensitivity	5 msec iii)		
Demag	Primary Center iv)		
Stability for Valid Reading	99.8% -v)		
Time Limit for Valid Reading	10		
Automatic Data Recording	Off		

- i. **Nameplate Recommended:** DC Test Current is provided as a guide for test current limits for each winding. NOTE: for high ratio transformers, testing windings in series may not give timely or accurate results because of insufficient test current for secondary windings.
- ii. **Current (DC Amps):** selection of test current for winding resistance testing
- iii. **Break/Make Sensitivity:** used for detection of poor operation of (O)LTC. Detection occurs when current drop below 90% of the set current level within the time set. Lower time settings denote good OLTC operation.
- iv. **Demagnetization:** The default winding is selected, but allows change to any primary/secondary, single or three phase method (all methods are built in). Field results shows that the optimum winding used for demagnetization is primary side center winding at same DC current as is used for testing.
- v. **Reading Stability INDICATOR:** settings give operator confidence of good readings, allowing both “stability” condition (when reading turns **green**) PLUS a Time Limit for Stability, after which % Stability turns **green**. For good confidence of accurate readings, setting should be increased to 99.9% **PLUS** a longer stability time (15-30 seconds or more). Reading stability is dependent on transformer characteristics, and after the first readings on a transformer are taken, these 2 indicators should be reviewed, and adjusted up or down. Once experience is gained, “Automatic Data Recording” can be turned on for efficient testing, minimizing the need for manual acceptance of stable readings.
- vi. **Turns Ratio Test Voltage:** allows selection of test voltage of winding – 80/40/8 or Auto select.
- vii. **Factory Settings:** reverts settings to original factory values.

Transformer Nameplate.

Nameplate

MFR _____ WEIGHT lb OIL VOLUME GAL
 SER NO _____ CLASS _____ COOLANT OIL
 YEAR _____ BIL _____ kV IMPEDANCE _____ %
 TYPE SEALED

Has Tertiary Detect Transformer Type

Diagram # 53 (ANSI)

	Voltage (kV)		MVA	Rated I	# Taps	Nominal	Changer	Tap Setting	First Tap Voltage	Last Tap Voltage	Ω Material
	L-L	L-G									
Primary	120		5		5	3	DETC	3	132,000	108,000	Cu
Secondary	14.4		5		11	6	LTC		15,840	12,960	Cu

ii) iii) iv) v) vi) vii)

Nameplate

MFR _____ WEIGHT lb
 SER NO _____ CLASS _____
 YEAR _____ BIL _____ kV
 TYPE SEALED

Has Tertiary

Diagram # 53 (ANSI)

	Voltage (V)		MVA	Rated I	# Taps	Nominal	Char	Tap Setting	First Tap Voltage	Last Tap Voltage	Ω Material
	L-L	L-G									
Primary	120		5		5	3	DETC	3	132,000	108,000	Cu
Secondary	14.4		5		11	6	LTC		15,840	12,960	Cu

ii) iii) iv) v) vi) vii)

- i. **Vector Selection:** Once form setting (above) selects proper standard, one depresses the vector and a pop up Vector Selector will appear, or 'right click' to select primary and secondary vector until it matches transformer nameplate.
- ii. **Transformer Nameplate Voltages:** (line to line only), in volts.
- iii. **Nameplate Power Rating:** typically with no cooling operation. Depress "MVA" to toggle to "KVA". Once filled in, "Rated I" will calculate and display using parameters provided.
- iv. **# Taps:** input from nameplate. As well, confirm NOMINAL tap positions are correct.
- v. **Tap Changer:** toggle to "DETC/OLTC type for Primary/Secondary/Tertiary (if applicable) PROPER INPUT IS REQUIRED FOR AUTOMATED WINDING RESISTANCE TESTING.
- vi. **Tap Setting:** Tap # of position DETC is found. This is also used to confirm that DETC is left in proper position when testing is complete.
- vii. **First/Last Tap Voltage:** required for calculation of expected voltages (& ratio) for each tap position as well as % ratio error calculations.

Transformer Test Conditions

Transformer Test Conditions			Test Conditions			
AMBIENT TEMP.	26 °C		OIL TEMP	70 °C	REASON	Routine
HUMIDITY	80 %	i)	WINDING TEMP	74 °C	TEST STATUS	iii)
WEATHER	Indoors					

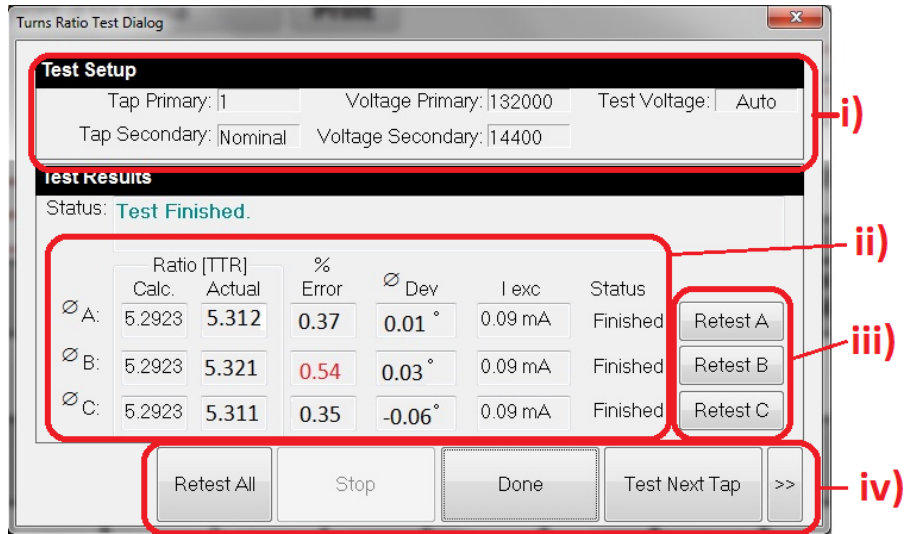
- i. **Environmental (Weather) Test Conditions** input
- ii. **Oil/Winding Temperature:** readings input from transformer temperature gauges and used for optional correction of results to normalized temperatures
- iii. **Test Status:** Once testing is complete, indicates condition of the asset under test.
- iv. **Demagnetization:** Once depressed, begins demagnetizing transformer winding, and confirms “demagnetization” once complete.

Ratio Test Set Up

Turns Ratio - Primary Taps to Secondary Nominal							Untested Rows				Results						
#	Tap P/S	Voltage P/S	Test V	TVR	$H_1 - H_0 / X_3 - X_2$				$H_2 - H_0 / X_1 - X_3$				$H_0 - H_3 / X_1 - X_2$				
					Actual Ratio	% Error	I exc mA	Phase (Deg)	Actual Ratio	% Error	I exc mA	Phase (Deg)	Actual Ratio	% Error	I exc mA	Phase (Deg)	
1	1	Nominal	132,000	14,400	5.292												
2	2	Nominal	126,000	14,400	5.052												
3	Nominal	Nominal	120,000	14,400	4.811												
4	4	Nominal	114,000	14,400	4.571												
5	5	Nominal	108,000	14,400	4.330												

- i. **Untested Rows:** Hides or shows untested rows.
- ii. **Results:** Hides or shows results table for this winding.
- iii. **# Test:** Depress to begin testing of individual row. This action will activate Section 8 (Ratio Test) below
- iv. **Tap Values:** are filled when Transformer Nameplate, Section 5 above completed.

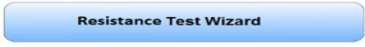
Ratio Test





- i. **Test Setup**: reflects input from Transformer Nameplate (5.) above and tap under test
- ii. **Test Results for each phase**
- iii. **Retest A/B/C**: Depressing will retest individual phase
- iv. **Retest or Test Tap or Done**: Retest a tap, terminates test, or allows continuation to test next tap.

Winding Resistance Testing

Descriptions for the following testing methods described below involve 3 methods of performing testing.

1. An automated sequence is determined and test operates through each winding and tap as required – 

2. All phases of a winding tap are measured in sequence – 

3. Basic test method where ONLY one reading is measured and taken at a time - 

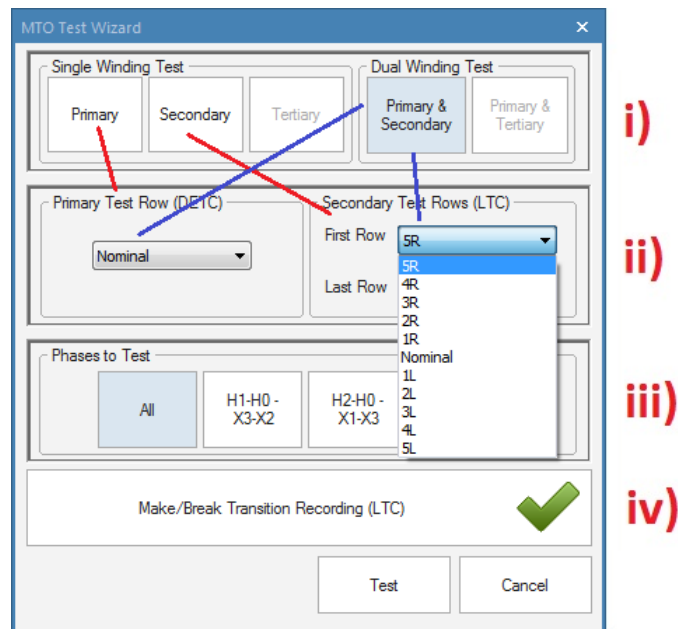
First method allows automation of testing by the:



- Resistance Test Wizard:** Method 1 allows an automated sequence of winding resistance testing defined by transformer nameplate input (section 5) and operator setup in section 10. - see below.
- Demagnetization:** Once depressed, begins demagnetizing transformer winding, and confirms “demagnetization” once complete.
- Read Last Resistance Test:** allows population of form from an interrupted test sequence. Software keeps past results within internal log files in the event of an interruption.

Method 1 - Resistance Test Wizard -

Resistance Test Wizard



Resistance Test Wizard is designed to automate the winding resistance test, allowing the transformer nameplate input (*Section 5*) combined with operator selection of taps to complete a test sequence with minimal button presses. This wizard also allows testing of OLTC taps without discharge of test current during transition (between) of taps, making testing both more efficient (less time charging and discharging winding and less button pressing) as well as diagnostic by indication of a make break condition.

NOTE: *When selecting “All” Phases, multiple phases are tested concurrently. This approach improves test time, BUT has a potential drawback when testing WyeN and 3 phase Auto windings. The resistance of the neutral bushing is excluded in the first measurements because test current does not flow through the neutral bushing. This results in lower than expected readings on the outer 2 phases, which can exceed the “% Difference” limit for testing. To correct this situation, select individual tests for each phase.*

- i. **Winding Selection:** allows choice of winding(s) to be tested.
- ii. **Tap Selection:** enables selection of tap(s) to be tested, as well as test direction via tap changer (OLTC) direction in which test will be conducted.
- iii. **Phases to Test:** allows choice of which single, or 3 phase windings are to be tested.
- iv. **Make-Break Transition Recording:** for OLTC tap changers can be enabled/disabled within this control. Pass/fail criteria are controlled in “Section 4. Ratio/Resistance Settings” above.

Method 2 – Measuring Tap – All Phases Winding Resistance - 18

Resistance - Primary												
Show Graph Hide Untested Rows Hide Results												
#	Tap	Current (amp)	Nameplate Voltage	Measured Resistance			Reading Stability %	Winding Difference %	Make/Break			
				H ₁ - H ₀	H ₂ - H ₀	H ₀ - H ₃			20 ms	Pass	Pass	Pass
18	1	10.07	132,000	10.20	10.23	10.25	100.0	0.445	20 ms	Pass	Pass	Pass
19	2	10.07	129,600	10.05	10.08	10.09	100.0	0.445	20 ms	Pass	Pass	Pass
20	3	10.07	127,200	9.90	9.92	9.94	100.0	0.445	20 ms	Pass	Pass	Pass

i)
ii)
iii)
iv)
v)
vi)

- i. **Test #:** depressing this button commences testing for a specific tap row (circled). Testing is conducted sequentially (up to 2 windings at once), ensuring optimization of magnetized core.
- ii. **Test Current:** records the dc current amplitude recorded for the result.
- iii. **Measured Resistance:** displays results once test is complete
- iv. **Reading Stability %:** to ensure reliable resistance readings, instrument includes a reading stability indicator. For large inductive transformers, readings are often obtained prematurely and this ensures proper time for valid readings. See *Resistance/ Ratio Settings* for more detail.
- v. **Winding Difference %:** displays a calculation between 3 phases of each tap versus a calculated average. Useful in providing a quick pass/fail condition for each tap position. Limit defaults to 2% (from IEC/IEEE standards) but can be changed in *Form Settings*, above.
- vi. **Make/Break:** validates proper basic operation of an OLTC during transition between taps. Optimal (good quality) tap changers will pass with a sensitive setting of 5mS. Each OLTC will be different, so various levels are available including disabled. Control is set from *Resistance/ Ratio Settings* above.

Method 3 – Measuring Individual Tap Winding

Resistance - Primary												
Show Graph Hide Untested Rows Hide Results												
#	Tap	Current (amp)	Nameplate Voltage	Measured Resistance			Reading Stability %	Winding Difference %	Make/Break			
				H ₁ - H ₀	H ₂ - H ₀	H ₀ - H ₃			20 ms	Pass	Pass	Pass
18	1	10.07	132,000	10.20	10.23	10.25	100.0	0.445	20 ms	Pass	Pass	Pass
19	2	10.07	129,600	10.05	10.08	10.09	100.0	0.445	20 ms	Pass	Pass	Pass
20	3	10.07	127,200	9.90	9.92	9.94	100.0	0.445	20 ms	Pass	Pass	Pass

To begin testing an individual winding, simply depress using (right click) the reading or space which requires testing. This will begin the test, applying the conditions previously set (% Stability, Test Current etc.).

NOTE: Test method 3 cannot validate “make before break” operation of OLTC tap changers because test current is discharged between each test. Test Wizard (Method 1) is required for proper validation.

Resistance Test Screen

Once a test sequence begins from Method 1-3 above, the following screen will appear:

The screenshot shows the MTOTestXP software interface. At the top, it displays 'Version 2016.05.03.1 Beta' and 'YNd3 (ANSI) Nom Current: 10.0 A - Simulation'. Below this are four buttons: 'Test Setup' (greyed out), 'Prev Tap', 'Save Results', and 'Next Tap'. A red 'Abort' button is also present. The main area is titled 'Measuring Resistance (Tap 10)' and instructs the user to 'Click on the winding to select/deselect it for testing.' It shows 'High Voltage Winding Resistance' with a table of measured resistance values. A 'Test Setup Settings' panel on the right shows parameters like Current (10.0 A), Reading Stability (99.8%), and Time for stable reading (10 Seconds). At the bottom right, there is a 'Results Graph' showing resistance values for different taps.

High Voltage Winding Resistance						
Measured Resistance (mOhm)						
#	Tap	I A	H1-H0		Reading Stability	Make/Break
8	8	10.1	9.744		100.00	
9	9	10.1	9.897		100.00	
10	10	10.1	10.05		100.00	

Low Voltage Winding Resistance						
Measured Resistance						
#	Tap	I A			Reading Stability	Make/Break

- i. **Test Setup:** allows changes to test parameters, which can be seen in *item iv* above (and described in *section iv.* below). This button is 'greyed out' once testing begins or MTO instrument connection is not established.
- ii. **Test Mode:** enables various testing to Start, Continue, Save Results etc. as testing is conducted. This button guides operator through testing, providing instruction for next steps.
- iii. **Abort/Exit:** allows disruption of test and/or exiting once test is concluded.
- iv. **Test Setup Settings:** display settings from *i* above for operator review.
- v. **Results Graph:** plots resistance results for diagnostic review. This is useful in determining that each past result is following an expected pattern. Different OLTC tap changers develop different shaped patterns such as V, Saw Tooth, Slope curves. Familiarity with these tap changers helps improve diagnostic capability.
- vi. **Measured Resistance:** result with color background changes using "Reading Stability + Time for stable reading" setting as shown in *section iv*) above. When condition is reached, background turns green.
- vii. **Reading Stability:** monitors readings, and calculates the change continuously, changing background color to green once Reading Stability Setting (from *Section 5* above) is reached.

Basic Connections to MWA300

Connections should be made in the order as listed below.

Ground. Use the Megger supplied Safety Ground Cable 15 ft (4.6 m) to connect the MWA300 Ground Lug Terminal directly to Local Station Earth ground.

Input Power Source Ground. Input Power Source Ground Terminal should be less than 0.1 Ω of impedance to Local Station Earth Ground.

Connect the Input Power Cord. Before making this connection, Ensure the Input Power Source meets the requirements as listed in Section 2 and Specifications Section 8. Also make sure that the ON/OFF switch (*Figure 1-1, No. 1*) is in the OFF position. Connect the input power cable to the MWA300 first, then to the power source. At this time, leave the ON/OFF switch in the OFF position.

Connect the H and X leads (to the MWA300 end only at this time). With the clamps disconnected from the UUT, connect the Bayonet Plug on the Cable labeled “H” to the MWA side panel connector also labeled “H”. Repeat this process for the “X” labeled cable.

Connect the H and X clamps. (Refer to *Section 6* for Transformer Type) With the ON/OFF Switch in the OFF position, connect the H and X kelvin clamps to the transformer in accordance with *Section 6* below.

Connect the USB cable. MWA300 only operates with PowerDB Lite software provided. Connect the provided USB cable between the MWA300 and your PC. Once connected, if issues communicating to the MWA300 are experienced, one can navigate to **Control Panel – Device Manager** within PC software and validate proper communication. See Section 3 above – “Using PowerDB Lite” for details.

For any issues encountered, please contact your local ASC or direct to VFsupport@megger.com

Megger.

6

TRANSFORMER TESTING APPLICATIONS – RATIO & WINDING

The setup and connection instructions included in Section 4 herein, pertaining to ratio, polarity, phase relation and winding resistance, assume that the transformer under test, connections, and terminal markings comply with the requirements of ANSI C57.12.70-2011 *American National Standards Terminal Markings and Connections for Distribution and Power Transformers* or IEC 60076-1 *Test Procedures for Power Transformers*. The H test leads of the test set are the exciting (high voltage) leads (8 V, 40 V, or 80 V) as well as the ability to provide test current up to 10A. The X test leads are the low voltage return leads (ratio measurement), as well as having the ability to provide 10A dc of test current (winding resistance measurement).

When testing high-voltage transformers, caution must be used at all times and all safety precautions followed. Read, understand, and employ all safety precautions and circuit connections described in Sections 2 and 3 herein.



WARNING

Ensure that the transformer to be tested is completely de-energized. Check every winding. Ensure that all terminals of the transformer are disconnected from line or load at the transformer. Connections to ground may be left in place.



WARNING

For all testing as described herein, care shall be taken to ensure any and all unused clamps shall be isolated from each other, from ground, and from personnel.



WARNING

Except for CTs as described herein, never interchange connections between the high- and low-voltage transformer terminals. The MWA is protected against this condition BUT failure to observe proper connections may result in a safety hazard and may result in damage to the test set or transformer.

Single-Phase, Two-Winding Transformers –including Typical Pole Type transformers with Dual Secondary’s

Perform the following setup procedure for single-phase, two-winding transformers:

1. Connect the heavy-duty clamps marked H1(1U) and H2(1V) & X1(2U) & X2 (2V) of the test lead to the corresponding (high-voltage & low-voltage windings) terminals of the transformer under test. Figures 6-1 and 6-2 show test setups for single-phase transformers. Figures 6-3 and 6-4 show test setups for regulators. Figure 6-5 shows connections to a Pole Type Transformer with 2 secondary windings.
2. **On/OFF Switch.** It is only after all of the above connections are safely made and all safety precautions of sections 2 and 3 are satisfied, should the On/OFF switch be turned to the ON position.

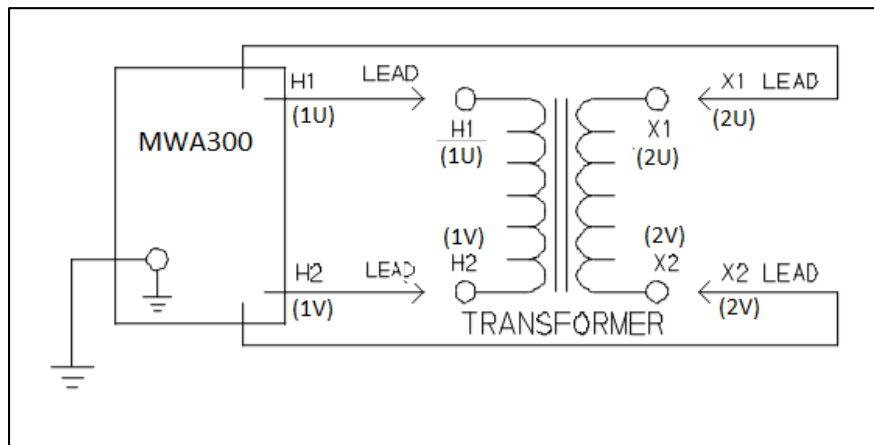


Figure 6-1 Setup for Testing Single-Phase Transformer (Vector Diagram 1P0)

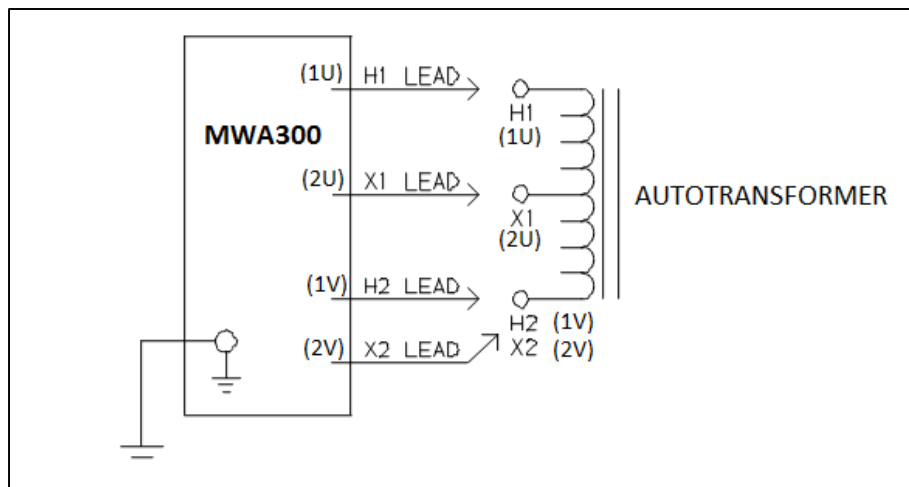


Figure 6-2 Setup for Testing Single-Phase Autotransformer (Vector Diagram 1P0)

Transformer Testing Applications– Ratio & Winding

To test windings other than H1(1U) – H2 (1V) and X1(2U) – X2 (2V), ensure that the heavy-duty clamp marked H1(U1) is connected to the lower numbered terminal and H2(V1) to the higher numbered terminal of the high-voltage winding. Similarly, X1(2U) and X2(2V) should be connected to the low-voltage winding.

Test lead markings for the ANSI, CEI/IEC, and Australian standards are as shown in Table 6-1.

<i>Table 6-1. Test Lead Markings for Single-Phase Transformers</i>					
Test Lead Marking			Transformer	Heavy-Duty Clamp	Test Lead
ANSI	CEI/IEC	Australian	Terminal Voltage	Boot Color	Color Band
H1	1 U	A ₂	High	Red	Red
H2	1 V	A ₁	High	Red	Yellow
X1	2 U	a ₂	Low	Black	Red
X2	2 V	a ₁	Low	Black	Yellow

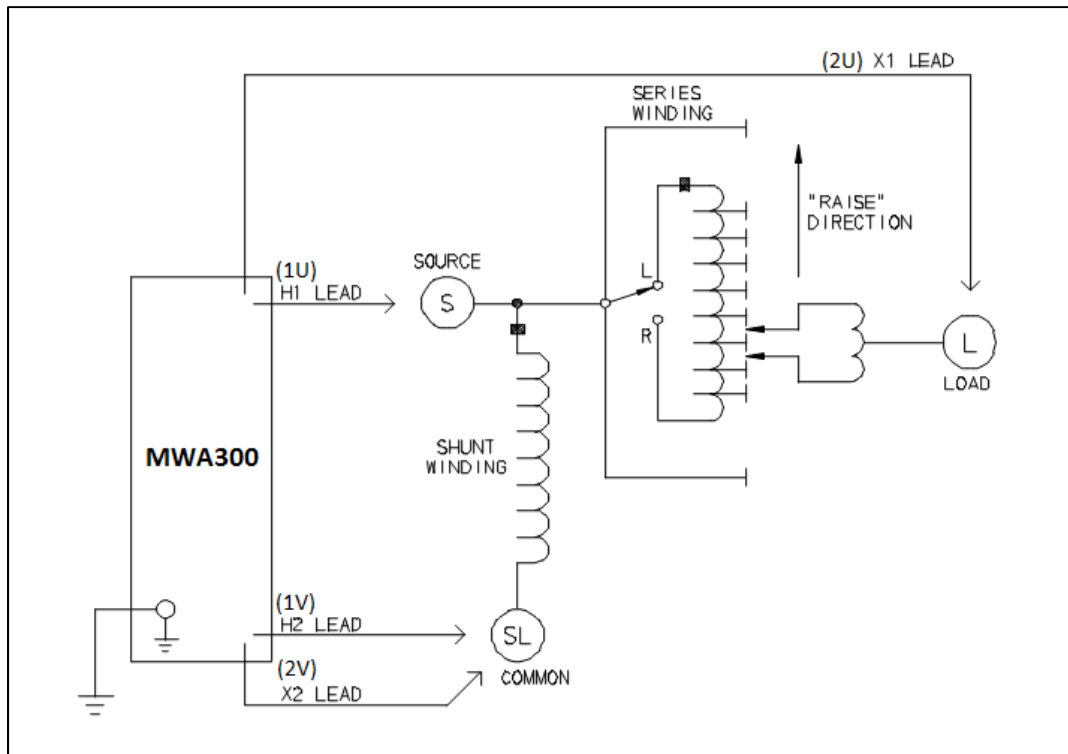


Figure 6-3 Setup for Testing Single-Phase, Type A (Straight Design) Step Voltage Regulator (Vector Diagram **VREG**)

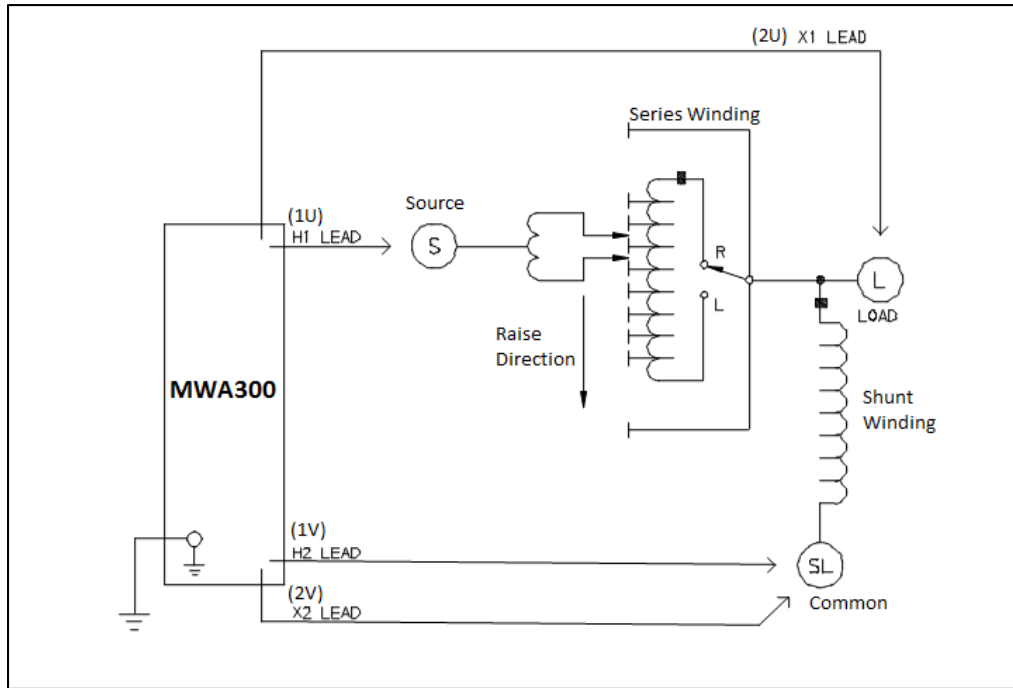


Figure 6-4 Setup for Testing Single-Phase, Type B (Inverted Design) Step Voltage Regulator (Vector Diagram VREG)

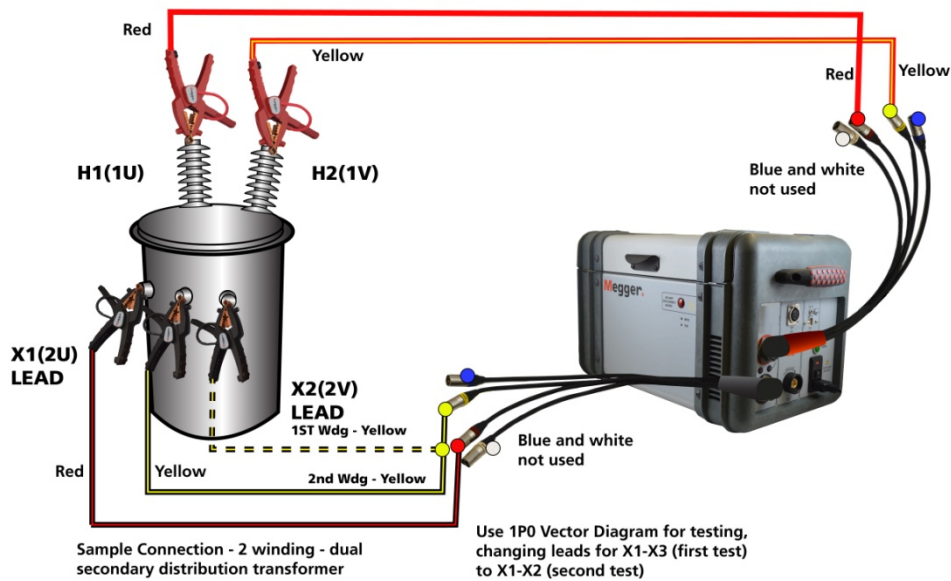


Figure 6-5 Showing connections to a Pole Type Transformer with 2 secondary windings. To test with PowerDB, requires choice of 1P0, with 2 taps, changing leads between tests.

Three-Phase, Two-Winding Transformers

Perform the following setup procedure for three-phase, two-winding transformers:

1. Connect the clamps marked H0(1N), H1(1U), H2(1V), and H3(1W) of the test lead to the corresponding (HV winding) terminals of the transformer under test. Refer to Table 6-2 for test lead markings. With delta connected windings, H0(1N) is not used. With wye connected windings, a neutral connection for H0(1N) is made when neutral is accessible.
2. Connect the clamps marked X0(2N), X1(2U), X2(2V), and X3(2W) of the test lead to the corresponding (low-voltage winding) terminals of the transformer under test. Refer to Table 6-2 for test lead markings. With delta connected windings, X0(2N) is not used. With wye connected windings, a neutral connection for X0(2N) is made when neutral is accessible. (New style test leads provided allow for removal of the neutral lead from the lead set)
3. **On/OFF Switch.** Only after all of the above connections are safely completed and all safety precautions of sections 2 and 3 are satisfied, should the On/OFF switch be turned to the ON position.

Table 6-2. Test Lead Markings for Three-Phase Transformers

Test Lead Marking			Transformer Terminal Voltage	Heavy-Duty Clamp Boot Color	Test Lead Color Band
ANSI	CEI/IEC	Australian			
H0	1N	N	Neutral	Red	White
H1	1U	A ₂ /A ₄	High	Red	Red
H2	1V	B ₂ /B ₄	High	Red	Yellow
H3	1W	C ₂ /C ₄	High	Red	Blue
X0	2N	N	Neutral	Black	White
X1	2U	a ₁ /a ₂ /a ₄	Low	Black	Red
X2	2V	b ₁ /b ₂ /b ₄	Low	Black	Yellow
X3	2W	c ₁ /c ₂ /c ₄	Low	Black	Blue

Note: According to Australian standard, wye and delta transformer winding connections have a numerical suffix of 1 and 2. The zigzag transformers have a numerical suffix of 4. See Table A-3.

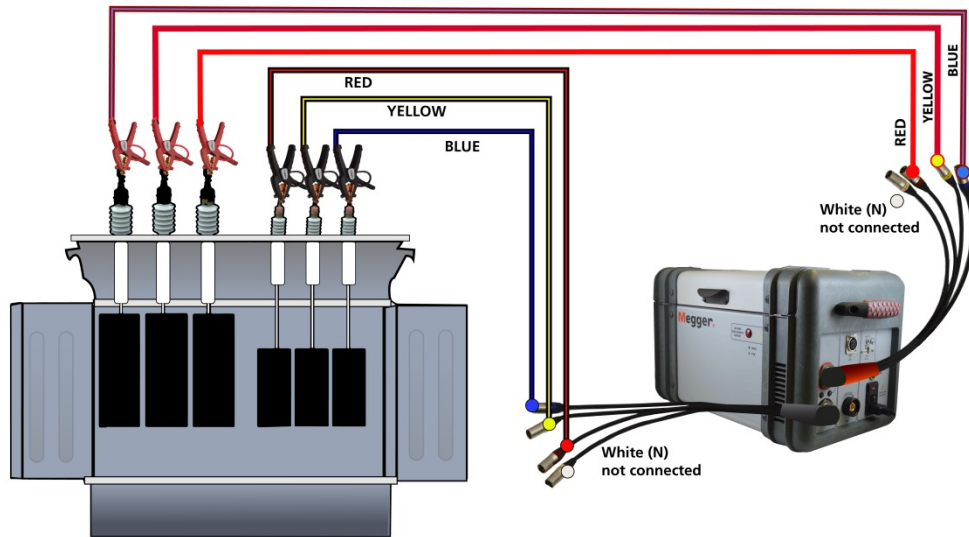


Figure 6-6 Shows a Typical Connection to a 2 Winding YNyn or ZigZag – 8 Terminal Transformer

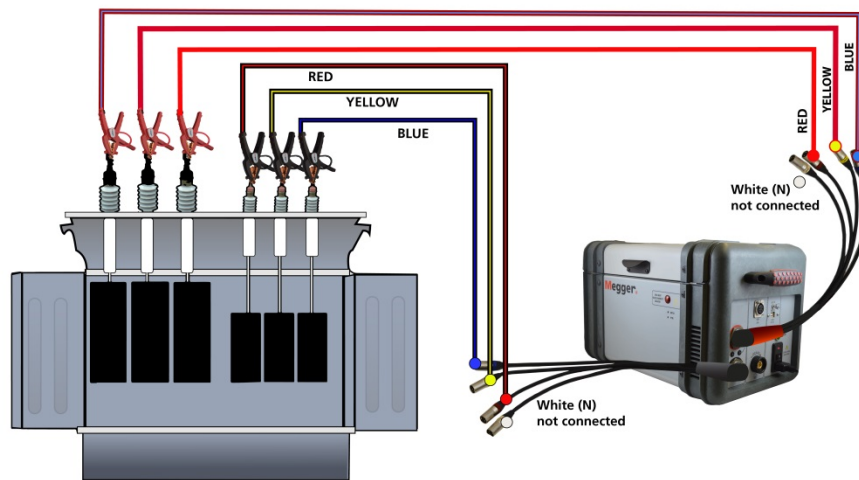


Figure 6-7 Shows a Typical Connection to a Delta Delta or Yy (no neutral) 6 terminal transformer.

Note: Neutral leads can be removed during this testing.

Three-Phase, Three-Winding Transformers

This type of transformers has primary, secondary, and tertiary windings. Primary and secondary windings are tested as a regular three-phase, two-winding transformer. **To test the tertiary winding, we connect to the primary and tertiary winding, and ignore the secondary winding during test procedure: As well, we can connect to the tertiary as a stand-alone winding:**

1. With the ON/OFF Switch in the OFF position, make the circuit connections as described in Section 3.2.
2. Connect the H(1) and X(2) test cables to the respective H(1) and X(2) receptacles of the MWA300.
3. Connect the clamps marked H0(1N), H1(1U), H2(1V), H3(1W) of the test lead to the corresponding terminals of the transformer under test. Refer to Table 4-2 above for test lead markings. With delta connected windings, H0(1N) is not used, and can be detached from the test lead set. With wye connected windings, a neutral connection for H0(1N) is made when neutral is accessible.
4. Connect the clamps marked X0(2N), X1(2U), X2(2V), and X3(2W) of the lead set to the corresponding secondary or tertiary (low-voltage winding) terminals X0(2N), X1(2U), X2(2V), X3(2W) **OR** Y0(2N), Y1(2U), Y2(2V), and Y3(2W) of the transformer under test. Refer to Table 4-2 for test lead markings. With delta connected windings, X0(2N) is not used, and can be detached from the test set. With wye connected windings, a neutral connection for X0(2N) is made when neutral is accessible.
5. **On/OFF Switch.** Only after all of the above connections are safely made and all safety precautions of Sections 2 and 3 are satisfied, should the ON/OFF switch be turned to the ON position.

Current Transformers (CTs)

Connections to CTs are made backwards compared to power or potential transformers. The H(1) terminals on the test set must be connected to the X(2) terminals on the CT; and the X(2) terminals on the test set must be connected to the H terminals on the CT.

<p><i>NOTE:</i> Dots on the housing of the transformer are commonly used to identify terminals of the same polarity.</p>
--



WARNING

Failure to observe proper connections will result in a safety hazard and may result in damage to the test set or CT. Failure to observe voltage rating of low-current X winding may result in damage to the CT.



CAUTION

Never use AUTO mode of operation when testing the current transformers with the rated voltage below 80 V ac.

Most CTs can be tested with 8 V ac excitation voltage. For larger CTs which have high saturation voltage (Relaying CTs fall into this category) higher test voltage results in better ratio and phase accuracy versus nameplate. Test voltage is conditional to the saturation design of the CT under test.

NOTE: Most of the current transformers can be tested at 8 V ac excitation voltage. Some current transformers with turn ratio of <100:5 may become saturated at 8Vac. They require lower excitation voltage for testing and therefore cannot be tested with the Model MWA300. For this case, use the TTR100 or TTR25, which supply a test voltage of 1.5 Vac.

Unmounted CTs

1. Connect the H(1) and X(2) test cables to the respective H and X receptacles of the MWA300.
2. As shown in Figure 6-8, connect the clamps marked H1(1U) and H2(1V) of the test lead to the respective X1 and X2 terminals of the CT.

NOTE: The H and X leads are connected in reverse as compared to the single and three phase transformer testing described in the previous sections.

3. As shown in Figure 6-8, connect the clamps marked X1(2U) and X2(2V) of the test lead to the respective H1(1U) and H2(1V) terminals of the CT. Ensure correct polarity.

*NOTE: The H and X leads are connected in reverse as compared to the single and three phase transformer testing described in the previous sections. Select vector diagram **1P0**.*

Transformer Testing Applications– Ratio & Winding

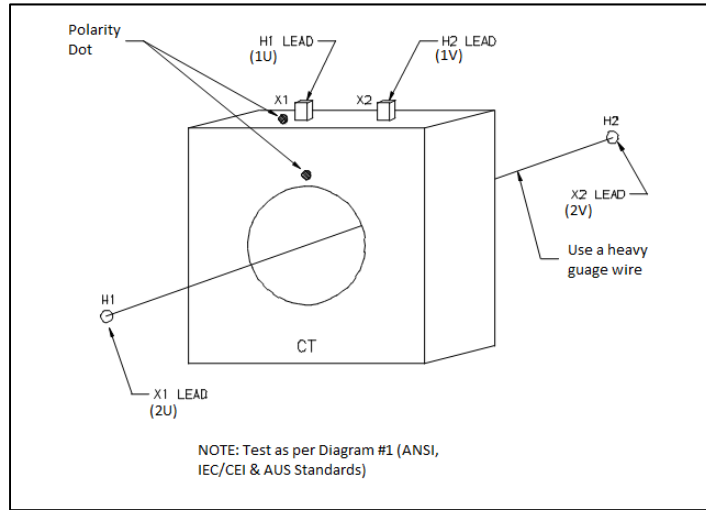


Figure 6-8 Setup for Testing Unmounted Current Transformer (only X1-X2 winding resistance can be tested for CTs) Use vector diagram **1P0**

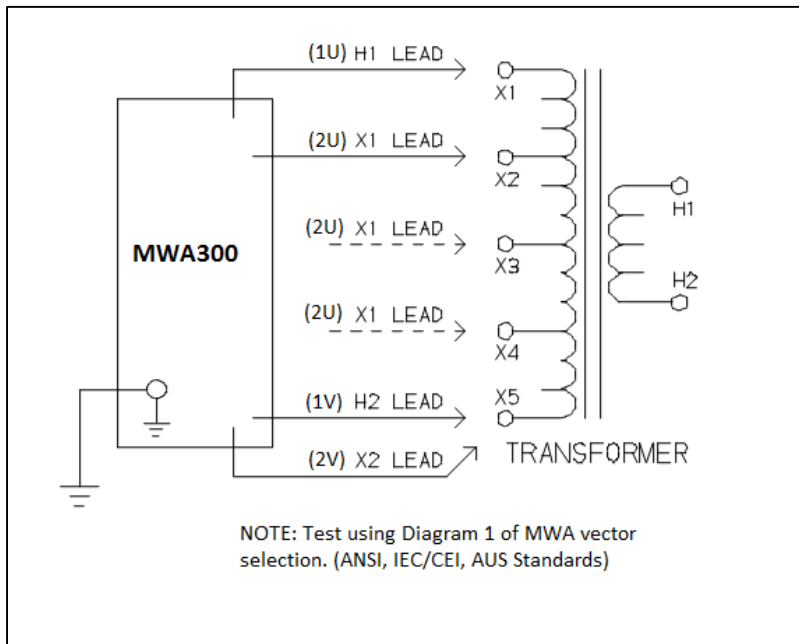


Figure 6-9 Setup for Testing Taps on Multiple Tap CT (only low side (X) windings can be tested for resistance) Use vector diagram **1P0**.

Bushing Current Transformer (BCT) Mounted on Single-Phase, Two-Winding Transformer

A turn-ratio and winding resistance test can be performed on a BCT after it has been mounted on a circuit breaker or power transformer entrance bushing. The test can be performed without removal of the BCT from the equipment. Proceed as follows:

1. Short-circuit the winding on the opposite voltage side of the power transformer with user supplied shorting leads.
2. Connect the clamps marked H1(1U) and H2(1V) of the test leads to the respective X1(2U) and X2(2V) terminals of the BCT as shown in figure 4-7.
3. Connect the clamp marked X1(2U) to the power transformer terminal on which the BCT is mounted and the X2(2V) clamp to the terminal on the opposite side of the power transformer winding (H2(1V) side of BCT). Ensure that the BCT polarity connections are correct. (See Figure 6-10).

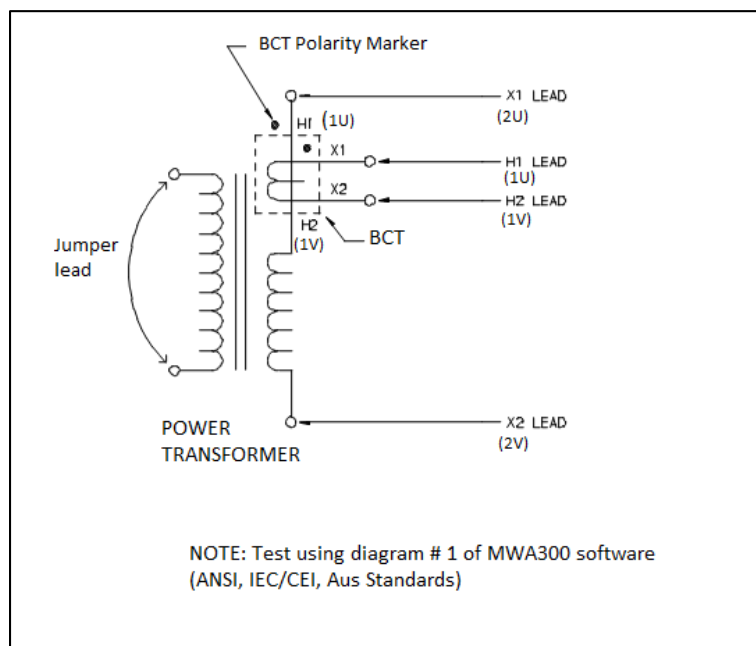


Figure 6-10 Setup for Testing BCT Mounted on Single-Phase Two-Winding Transformer – Use vector diagram 1P0

Bushing Current Transformer (BCT) Mounted on Three-Phase Transformers

A turn-ratio test can be performed on all three BCTs using a single setup. Figure 6-11 shows the proper test connections when the BCTs are mounted on a typical delta winding and Figure 6-12 shows how when mounted on a typical wye winding. For winding resistance measurements, special connections below can be utilized for the BCT, but only X side resistance is recorded, and on separate forms.

1. For ratio testing, short-circuit the winding on the opposite voltage side of the power transformer with user supplied shorting leads. Once ratio test is performed remove shorting for winding resistance tests.
2. Ensure that the BCT polarity connections are correct. Make connections as shown in Figure 6-11 for delta winding configurations and Figure 6-12 for wye winding configurations.

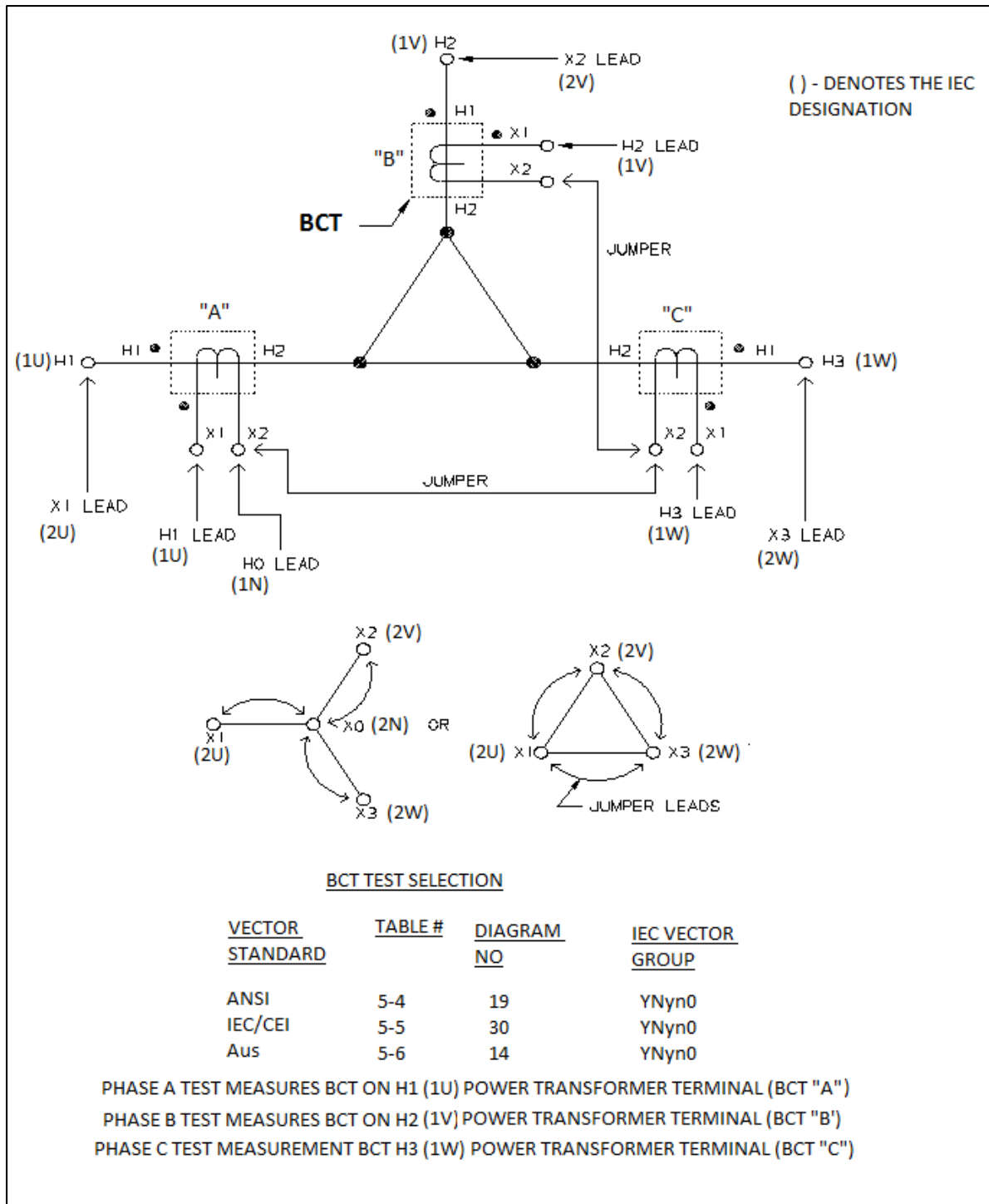


Figure 6-11 Setup for Testing BCT Mounted on Delta Winding on a Three-Phase Power Transformer (Shorting only required during Ratio Test) – Use diagram **YNyn0**

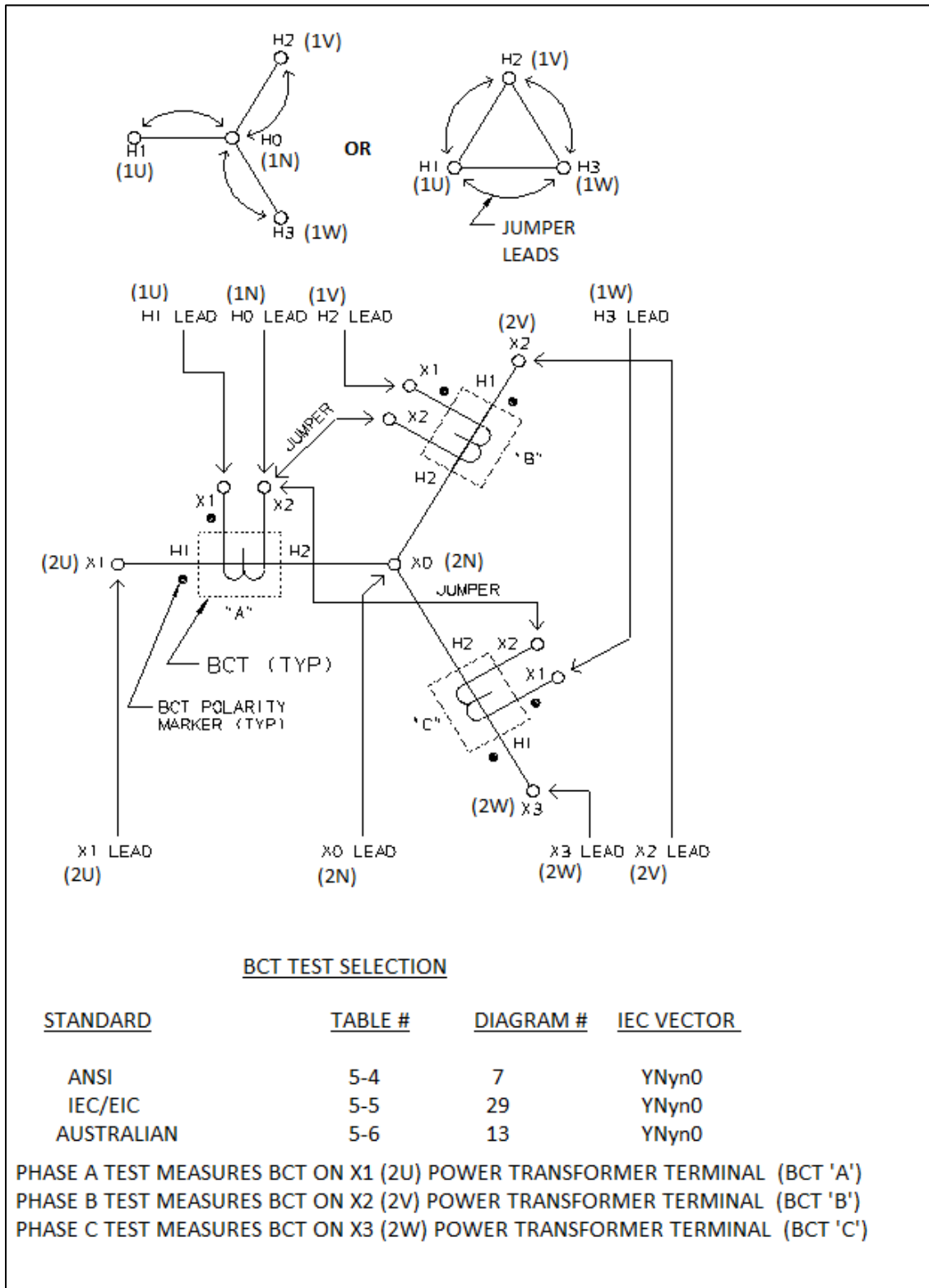


Figure 6-12 Setup for Testing BCT Mounted on Wye Winding of a Three-Phase Transformer (Shorting only required during ratio test) –Vector diagram **YNyn0**

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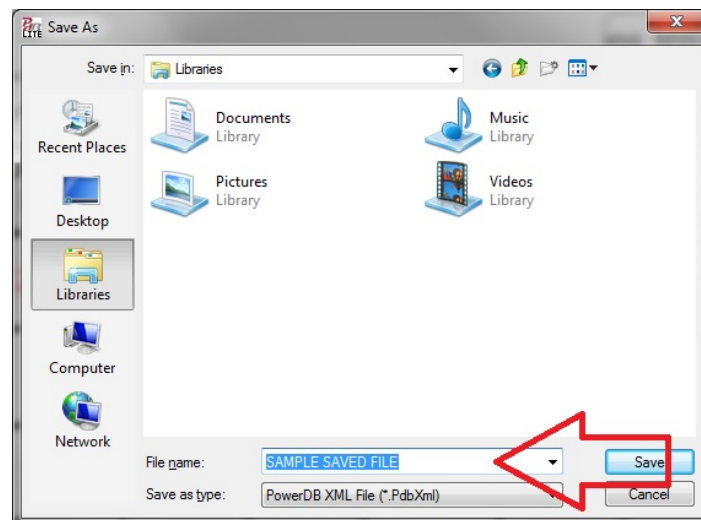
7

TEST & RESULTS FILES - SAVING AND RETRIEVING

When testing, data management is a critical function required after testing. For efficiency, the ability to replicate testing within time intervals is important. The software provided, PowerDB, is able to meet most requirements for large and small companies.

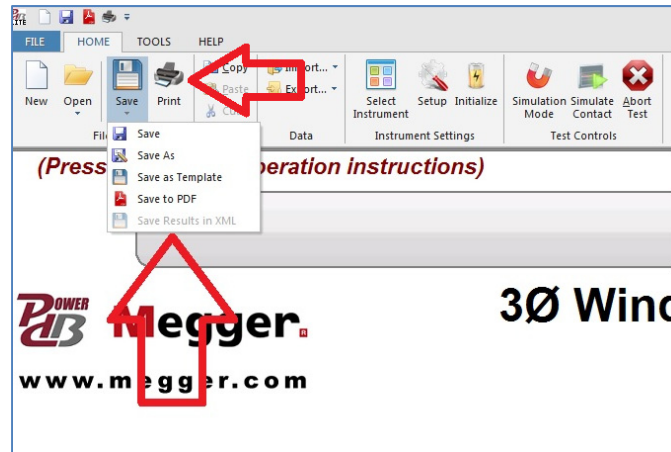
Saving Results/Test Files

While testing, it is critical that results are saved as testing is performed. In order to enable this ability, PowerDB automatically requests a file name each and every time a test result is obtained UNTIL such time as a file name is entered for the result. Once a name is given to the result, all results are saved into a file with this name as shown below. It should be noted here that a result file IS ALSO a test file. One is able to both view results as well as use this file to retest or append previous results.



Above shows window which appears after first test is completed and after each result until file is given a name and saved

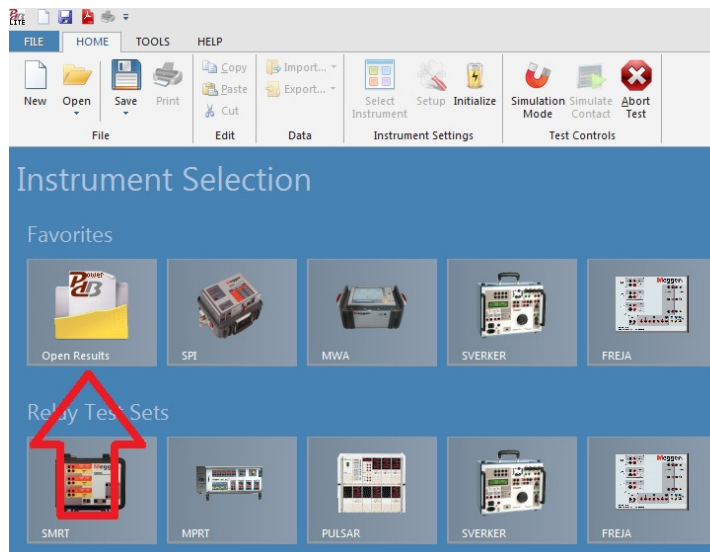
After initial results are saved with a file name as per above, all testing results continue to be saved as testing is conducted.



In order to rename a test file (result) user has the option to save result under a different name, as a template or as a PDF (original test file remains unchanged). Results can be also printed by depressing print icon.

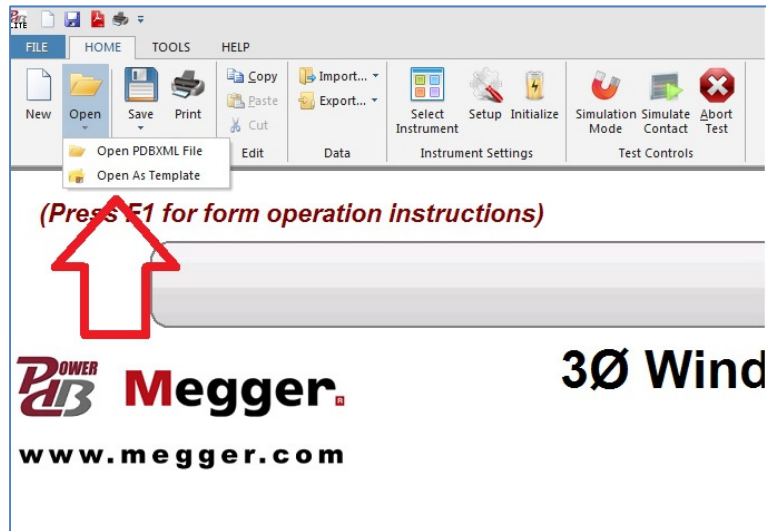
Retrieving Results/Test Files

There are 2 ways to retrieve results and or test files. In PowerDB, the result file is also the test file, which allows user to review results, append results or use result file as a template for new test. This feature makes retesting assets more efficient, more consistent, and easier to conduct testing for new users. Once a file is saved, user has the option to recall the result in numerous ways which are shown below:



Within the Instrument selection window, user is able to open test file for results review, retesting asset or to append existing results.

Test & Results Files - Saving and Retrieving



Once MWA instrument is selected, user can open saved result to view results and/or to retest/append results, or use present form as a template (once settings are entered into form).

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SERVICE

Maintenance

Maintenance should be performed only by qualified persons familiar with the hazards involved with high-voltage test equipment. Read and understand Sections 2, 3, 4, and 5 before performing any service.

The MWA300 requires only periodic inspection. Periodically, inspect all hardware items, including the cable assemblies, to ensure all are in good condition.

Calibration

A complete performance and calibration check is recommended once every year. This will ensure that the MWA test set is functioning and is properly calibrated over the entire measurement range. The 3-phase MWA calibration is performed on each new or repaired unit before it is returned to a customer. There is a special 3-phase MWA final calibration procedure which requires standard traceable test equipment to be used (example NIST in the USA). As a result of this calibration procedure, each MWA test set may be NIST certified.

To check the ratio portion calibration at a customer site or in the field, the Megger Calibration Standard Cat. No. 550055 or equivalent standard should be used.

To perform a quick simplified calibration check, the 1:1 self-test stick Cat # 2005-249 should be used. This simple device is not meant to replace an actual calibrator, and should not be used as such. Instruction for connection and diagram number are contained within the stick.



Ratio Portion – Self check

To ensure that the test set is functioning properly prior to testing a transformer, one can use an accessory (Cat No. 2005-249) provided with the MWA unit. The 1:1 turns ratio & phase deviation can be validated as an approximate accuracy and functional CHECK.



NOTE: 1:1 Test Jig provided with all MWA3XX units

To connect to this accessory, simply follow the connections from the test lead markings matched to the Test Jig markings. Once all 3 phases are connected, choose any 3 phase form within the TTR, and select **YNyn0** or **Dd 0** from the vector selection tool on the test form. Select test voltage as 8, 40 or 80 V with the expected results.

Expected Ratio Result: 1:1.000 +/-0.2%

Phase Deviation: +/- 6 minutes, Excitation Current: 0-0.5 mA

Reason for Possible Inaccuracy in 1:1 Self-test:

The 3-phase MWA test set is designed and optimized for the transformer turns ratio testing. It uses a mixed analog-digital technique to provide the high accurate readings of the tested transformer turns ratio. The test set measurement approach is based on high impedance input and output transformer voltage monitoring circuits. The high impedance of the monitoring circuits is optimized for the accurate transformer turns ratio testing.

When performing a 3-phase MWA functional test, the H and X test leads interconnect the input and output monitoring circuits without a transformer being connected. Such a connection can cause an impedance mismatch and, as a result of the mismatch, the displayed turns ratio reading is not exactly 1:1 as it may be expected. A customer should be aware that a functional test is not a real transformer turns ratio test. Due to the intrinsic and inevitable impedance mismatching, the 3-phase MWA functional test readings may be from 0.9980 to 1.0020. The MWA functional test readings do not represent its calibration. It simply shows that the MWA test set circuitry functions properly. To check the 3-phase ratio calibration, a customer should use the Calibration Standards mentioned in *Calibration* heading above.

Troubleshooting – Ratio Testing

Error Messages

Once testing ratio begins, error message may appear, indicating an abnormal operating test condition which may be caused by operator error (lead misconnection, improper instrument configuration etc), instrument malfunction and/or malfunctioning transformer. Verify the condition by taking a repeat measurement before attempting to take any corrective action.

Open connections, wrong connections, open windings, shorted windings, high resistance windings, other abnormal transformer problems, or a combination of these may cause a large deviation from normal turn ratio or indicate an unusual message. The unusual operating conditions may be caused by an abnormal leakage reactance or capacitive coupling within the transformer windings. If abnormal operating conditions occur during transformer testing, error messages may appear (such as below) and may be accompanied by three short beeps.

CHECK CONNECTIONS

This message indicates that the transformer is not connected to the test set. The message may be caused by poor connection of one of the test leads, as well.

PHASE A (or B, or C) EXCITATION CURRENT TOO HIGH

This message indicates that excitation current exceeds 500 mA. Excitation current can be reduced by using lower test voltages (40 V or 8 V).

TURNS RATIO TOO LOW, <0.8

This message shows that a transformer under test turn ratio is less than 0.8. The TTR is not designed to test a transformer turn ratio under 0.8. This problem is resolved by reversing H with X leads of the transformer, and performing a 1/ratio calculation

PHASE A (or B, or C) TURNS RATIO TOO HIGH

This message shows that a transformer under test turn ratio is higher than 10,000 (if 80 V or 40 V is used) or is higher than 4,000 (if 8 V is used). The message may be caused by poor connection of one of the test leads, as well.

CHECK PHASE A (or B, or C) CONNECTIONS, REVERSED

This message is caused by incorrect connection of the H and X leads. The H and X leads have either been reversed or the test transformer connections or markings do not comply with the requirements of ANSI, IEC, or the Australian standard. The message may be caused by wrong diagram number specified, as well.

CHECK PHASE A (or B, or C) POLARITY

This message shows that the H or X test leads are incorrectly connected or the test transformer connections or markings do not comply with the requirements of ANSI, IEC, or the Australian standard.

The Troubleshooting Guide

Table 6-1 is arranged to help you evaluate the reasons for the TTR portion malfunction. The table lists possible test set malfunctions which may be encountered during operation and lists possible causes. Electronic circuit repairs should not be attempted in the field. Refer to Repair section. Refer to Section 7 for a list of spare parts.

<i>Table 8-1. Troubleshooting Guide</i>	
MALFUNCTION	POSSIBLE CAUSE
Unit is not communicating or responding to commands.	No service power. Defective line cord. Defective fuse(s). Defective communications port (USB/Ethernet). INT/EXT switch in wrong position.
Error message: ANALOG OFFSET VOLTAGE HIGH and/or ANALOG GAIN OUT OF TOLERANCE appears after self-test is complete.	Out of tolerance condition(s) in measurement circuit.
Red TEST VOLTAGE ON lamp does not light on start of testing.	Defective lamp. Problem in measuring circuit.
One of the following messages appears on the test result screen. CHECK CONNECTIONS PHASE A (or B, or C) EXCITATION CURRENT TOO HIGH; TURNS RATIO TOO LOW, <0.8; or PHASE A (or B, or C) TURNS RATIO TOO HIGH; CHECK PHASE A (or B, or C) CONNECTIONS, REVERSED; CHECK PHASE A (or B, or C) POLARITY	Abnormal operating condition. Incorrect setting of TRANSFORMER TYPE in the quick test setup or the full test setup 1 menus. Incorrect connection of leads. Defective test leads. Incorrect marking of a transformer. Problem in test specimen. Problem in measuring circuit.
RATIO and/or I _{exc} (mA) readings erratic.	Defective test leads (open circuit, poor connection). Severe abnormal transient in service power. Problem in test specimen (poor connection). Problem in measuring circuit.

Repairs

Any service or repair of this equipment should be performed only by qualified persons who are aware of electrical hazards and the necessary precautions required to prevent injury.

Megger offers a complete Repair and Calibration Service (in Valley Forge, PA, USA) and recommends that its customers take advantage of this service for routine maintenance or in the event of any equipment malfunction. Megger also offers Authorized Service Centers located around the world. For a center closest to your location, please contact your Megger Sales Representative, or consult the Megger Website at *www.megger.com*

In the event service is required, contact your Megger representative for a product Return Authorization (RA) number and shipping instructions.

Ship the product prepaid, insured and marked for the attention of the Megger Repair Department. Please indicate all pertinent information, including catalog number, serial number, and problem symptoms.

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ORDERING INFORMATION / SPARE PARTS

Table 9-1 Replacement Parts List

Item	Cat. No.
Three-phase Transformer Turns Ratio and Winding Resistance Test Set, PC controlled	
120 V ac $\pm 10\%$, single phase, 60 ± 2 Hz, 100 VA	MWA300
230 V ac $\pm 10\%$, single phase, 50 ± 2 Hz, 100 VA	MWA300-47
Included Accessories	
Canvas carrying bag for test leads	2005-265
Power supply cord, 8 ft (2.5 m), 120V	17032-4
Power supply cord 8 ft (2.5 m), 230 V	17032-13
Ground Lead, 30ft (9m)	2002-131
USB Memory stick contains: PDF manual, PowerDB Lite software and related documents	1009-316
USB 2.0 Standard Type A to B Cable 7 ft (2m) cable for connecting to a PC	CA-USB
1:1 Test Jig (instrument self-test)	2005-249
Optional Accessories	
Universal lead sets, compatible with Megger MWA3XX Series products (up to 10 A DC max) 3-phase, 4-wire shielded test leads (H&X), complete with color coded universal Kelvin clamps	
3- \emptyset shielded test lead set, X/H windings, 30 ft (9.1m)	2008-30-KIT
3- \emptyset shielded test lead set, X/H windings, 60 ft (18 m)	2008-60-KIT
3- \emptyset shielded test lead set, X/H windings, 100 ft (30m)	2008-100-KIT
3- \emptyset 33 ft (10 m) Extension, X lead set	36486-7
3- \emptyset 33 ft (10 m) Extension, H lead set	36486-8
3- \emptyset 33 ft (10 m) extension, H&X windings	36486-9

Item	Cat. No.
3-Ø Universal, 9 m (30 ft) H	2008-113-30
3-Ø Universal, 9 m (30 ft) X	2008-114-30
3-Ø Universal, 18 m (60 ft) H	2008-113-60
3-Ø Universal, 18 m (60 ft) X	2008-114-60
3-ø Universal, 30 m (100 ft), H	2008-113-100
3-ø Universal, 30 m (100 ft), X	2008-114-100
Instruction manual, paper, English	MWA300-UG-EN-V2
Instruction manual, paper, Spanish	MWA300-UG-ES-V2
Instruction manual, paper, French	MWA300-UG-FR-V2
Instruction manual, paper, German	MWA300-UG-DE-V2
Resistance Test Shunt, 10 A, 10 mΩ	1006-512-2
TTR Check Box – Ratio & Phase (<u>NOT</u> A STANDARD)	550555
TTR Calibration Standard – 1 Phase	Y550055
Spare Fuses	
MWA300 Mains Fuse (2x)	90001-167
MWA300-47 Mains Fuse (2x)	2544-11
MWA300 TTR Excitation Transformer Fuse (1x)	27708-5
MWA300-47 TTR Excitation Transformer Fuse (1x)	27708-9
Transit case for instrument leads and accessories	2005-115
HV Strobe with detachable 18 m (60 ft) lead set	1004-639
Remote tap controller, manual operation, model RTC-1, complete with quick guide, and red/black/white (total 3) alligator clips	1007-502