MWA300_330A-UG-EN-V05
May 2017

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

MWA3XX Series

Catalog Numbers. MWA300, MWA300-47,
MWA330A, MWA330A-47

HIGH-VOLTAGE EQUIPMENT

Read this entire manual before operating equipment

Valley Forge Corporate Center
2621 Van Buren Avenue
Norristown, PA 19403-2329
U.S.A.

610-676-8500

www.megger.com

Three-Phase Ratio & Winding Resistance Transformer Test Set

MWA3XX Series

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.

Valley Forge Corporate Center
2621 Van Buren Ave
Norristown, PA 19403-2329

610-676-8500 (Telephone)
610-676-8610 (Fax)

www.megger.com

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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

1

MWA300 PRODUCT OVERVIEW

The MWA300/330A test set is an automatic unit which is designed to be controlled via a computer running PowerDB Lite software. The MWA330A includes a built-in 12 inch controller which is used in place of a PC. 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 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 MWA300/330A 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).

MWA330A Optional Controller with Display

The optional industrial 12 inch controller is:

1. **Industrial 300 mm (12 inch) Touch Display:** Used in place of a PC. Designed to run PowerDB Lite with focus on selected Megger instrument control related to transformer testing. When turned on, defaults to MWA transformer forms.

2. **Built-in Printer:** Designed to print individual results and is active within specific forms via 'print icon' located within selected forms.

3. **USB Port:** Used for various functions including external memory and external mouse/keyboard control.

4. **Rear USB Port Hub:** Used for external Megger instrument control such as Delta4000, S1/MIT Insulation test set, MLR10.

5. **Rear Ethernet Port**: Used for external Megger instrument control – specifically the Delta4000.

The MWA330A 300 mm (12 inch) display is meant to replace a customer PC with an industrial controller designed to work in harsh environments. This built-in display features protection against accidental shut down of the instrument by safely turning off Windows operating system together with PowerDB after shutdown (switch is turned off) is detected. This safe shutdown prevents damage to the internal memory, and to the software operating system.

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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 MWA300/330A 108-132V, (207-253V*), 60 Hz, 2 Hz, 660VA

Cat. No. MWA300/330A-47 207-253V, (108-132V*) 50 Hz, 2 Hz, 660VA

**- Requires a fuse change for correct operation – see Specifications below*

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 230V input, 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.

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SPECIFICATIONS

Electrical

Input Power

Cat. No. MWA300/330A:	108-132V, 60 Hz, ±2 Hz, 660 VA (207-253V with fuse change to 4.0 amp*) *IEC 1010-1 installation category II* ***Calibration of phase may differ if nominal line frequency changes.*
Cat. No. MWA300/330A-47:	207-253V, 50 Hz, ±2 Hz, 660 VA (108-132V with fuse change to 6.3 amp*) *IEC 1010-1 installation category II* ***Calibration of phase may differ if nominal line frequency changes.*

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:	0.5 amp, 250V, 5x20mm, SLO-BLO

RATIO SPECIFICATIONS

Output AC Test Voltage and Current

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

Test Frequency

Same as line frequency

Loading of Test Transformer

Less than 0.2 VA

Measuring Ranges

Turns Ratio:	80V ac: 0.8 to 45,000, 5 digit resolution 40V 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

80V ac:	±0.1% (0.8 to 2000) ±0.15% (2001 to 4000) ±0.25% (4001 to 10000) ±0.3% (10001 to 45000)
40V ac:	±0.1% (0.8 to 2000) ±0.15% (2001 to 4000) ±0.3% (4001 to 10000) ±0.35% (10001 to 25000)
8V 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 and 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

40V dc

Measurement Voltage

20V dc

Max Power

200VA continuous

Resistance Ranges

Current Range (A)	Resistance Range (Ω)	Resolution ((Ω)
10 A	10 µΩ to 0.2 Ω	0.000001
10 A	0.2 Ω to 2 Ω	0.0001
1 A	100 µΩ to 2 Ω	0.00001
1 A	2 Ω to 20 Ω	0.001
100 mA	1 mΩ to 20 Ω	0.0001
100 mA	20 Ω to 200 Ω	0.01
10 mA	10 mΩ to 200 Ω	0.001
10 mA	200 Ω to 2000 Ω	0.1

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

Display

MWA300: Via external PC (user supplied)

MWA330A: Size: 12 inch (305mm), Brightness: 1600 NIT, Operating Temp Range: -10C to +50C operation, Type: 4 wire resistive (touch)

Memory Storage

MWA300: Via external PC (user supplied)

MWA330A: 32GB internal

Communication Interface

MWA300: USB 2.0 Serial

MWA330A: Internal for MWA operation or external port USB 2.0 Serial, or Ethernet 10/100 for Delta4000/S1/MIT/MLR10 operation. (The 12 inch display is able to control above instruments via PowerDB software installed within the instrument.

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:	14° to 122°F (-10 to 50 °C)
Storage Temperature Range:	-22° to 158°F (-30 to 70 °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:

MWA300 with standard provided accessories:	34 lbs. (15.5 kg)
MWA330A with standard provided accessories:	39 lbs (18.0 kg)
with Optional Leads, 30 ft (9m)	Add 18 lbs (+8 kg)

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SOFTWARE INSTALLATION

PowerDB Lite Setup & Installation (PC Control only)

PowerDB Lite software is included at no extra charge software tool that is designed specifically to control and/or extract data from the MWA300/330A. 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 subset of the standard PowerDB forms that are appropriate for specific Megger instruments.

Minimum Recommended System

- Operating System: Windows 7 or later
- RAM: 2GB RAM minimum, >4GB RAM recommended
- >2G free memory space
- Processor: 2.0G Hz Pentium Class processor minimum,

For more information please visit *www.powerdb.com* or contact your local sales representative.

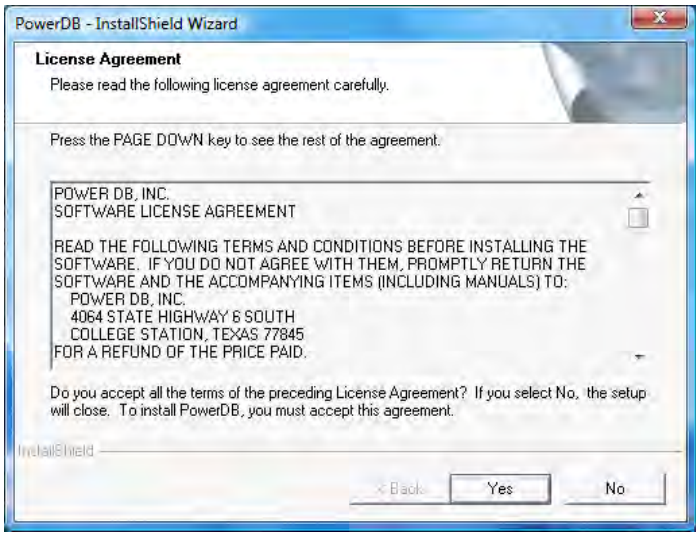
The MWA330A has PowerDB Lite preloaded on the built-in industrial controller, and will turn on at the 'MWA Test Forms' selection screen. MWA330A is designed to make testing more intuitive for end users, and so restricts the use of the built-in controller to PowerDB functions. The presentation and testing methods within the built-in controller are identical to the PowerDB Lite PC version. No difference in operation exists, except where upgrades between the PC and the MWA330A are not maintained. Upgrading the MWA330A is different than upgrading a PC. Please refer to Megger website similar to: *http://us.megger.com/my-account/software-downloads/* for latest 'On Board' download software and instructions.

Software Installation (PC portion only)

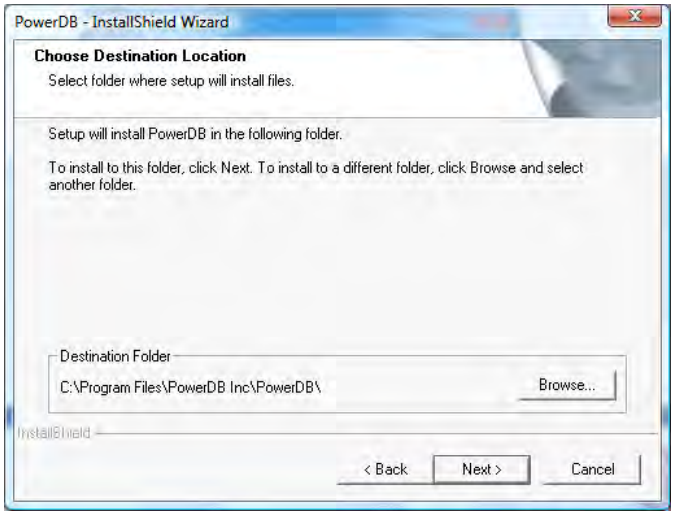
To install PowerDB Lite load the PowerDB Lite USB into your PC computer drive and follow the on-screen instructions. For latest version, please go to website *www.powerDB.com/download* and download latest PowerDB Lite version available.

NOTE:	*For MWA330A, software version is available on our www.megger.com website located under "Software Support" and requires a user login. It will load onto the MWA330A via the USB memory port on the controller portion. The model is contained within the software and not obvious until PowerDB Lite software is loaded.*

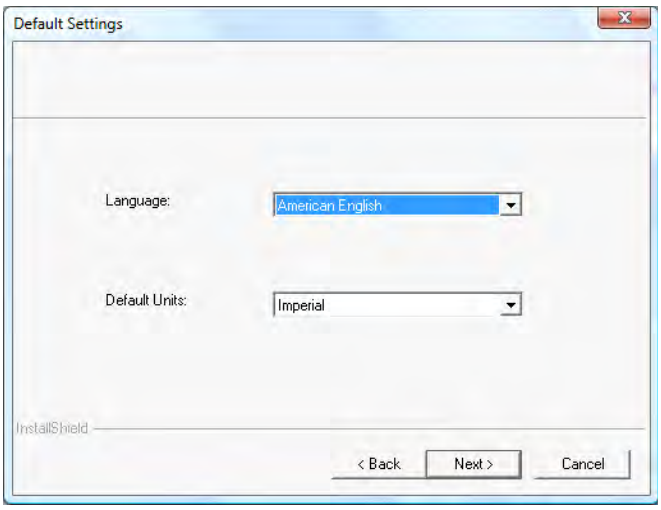
1. Accept the terms of the License Agreement.



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:

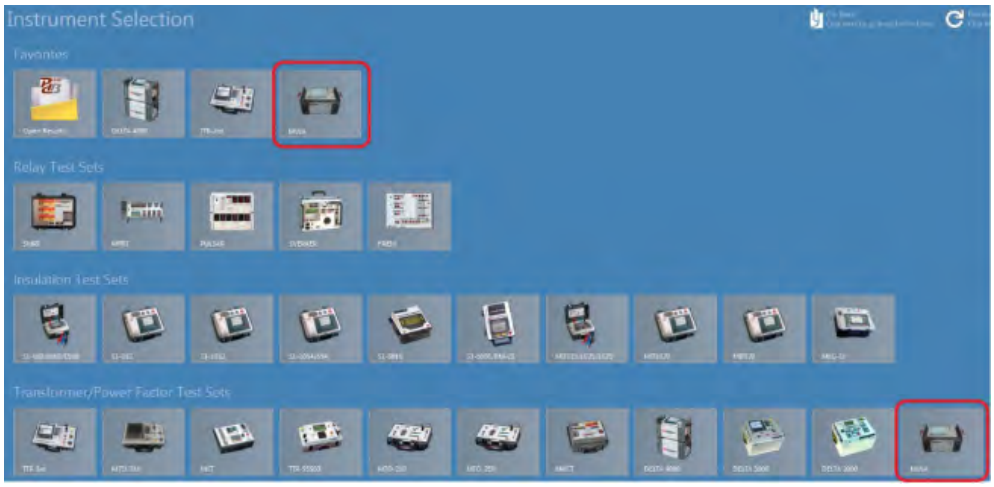
   Once all safety precautions are taken, and all circuit connections are made, the user may safely turn the ON/OFF switch to the ON position and operate the test instrument as described herein.

   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).

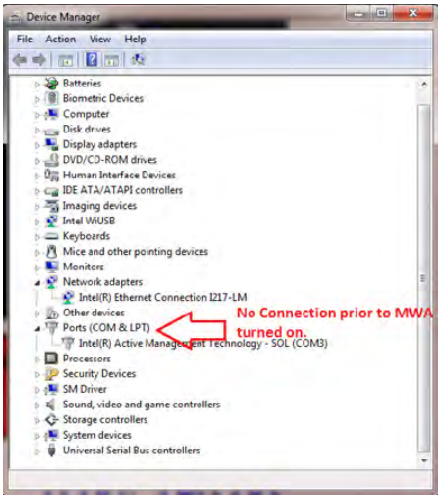
2. Select **PowerDB Lite** from *PC Start Menu* or from shortcut on *Main Window:*

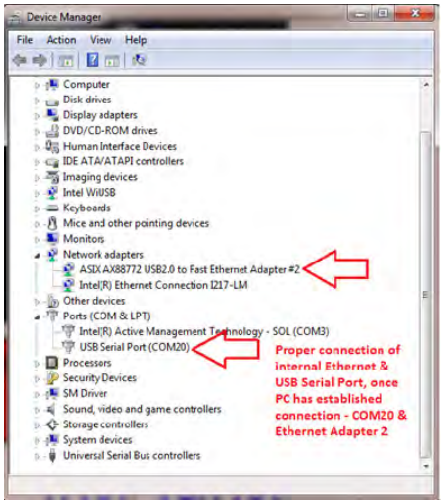
3. Select **MWA** from the *Instrument Setup* screen. It may be located in 'Favorites' or 'Transformer/Power Factor Test Sets' and can be relocated as desired.



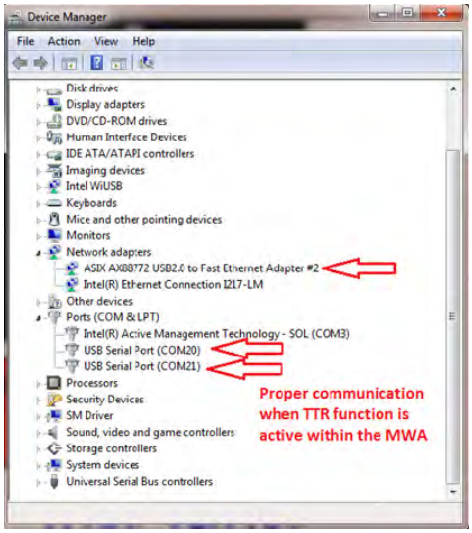
The MWA300 uses USB connection only. Once MWA is selected, the proper settings for USB are pre-selected, and no further changes should be required. PLEASE ALLOW SUFFICIENT TIME FOR DRIVERS TO LOAD WHEN CONNECTING TO MWA300 FOR THE FIRST TIME. Each time one connects to MWA, allow approximately 45-60 seconds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

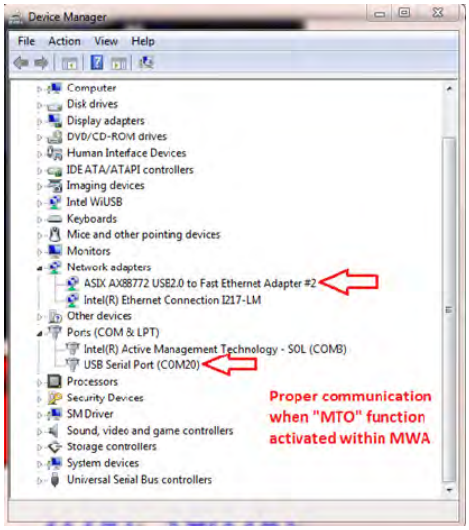
4. From *Device Manager,* one should see the following drivers installed with instrument ON:





Before Connection *After Connection+ MWA300* ***ON***





*MTO Function **ON***

*TTR Function **ON***

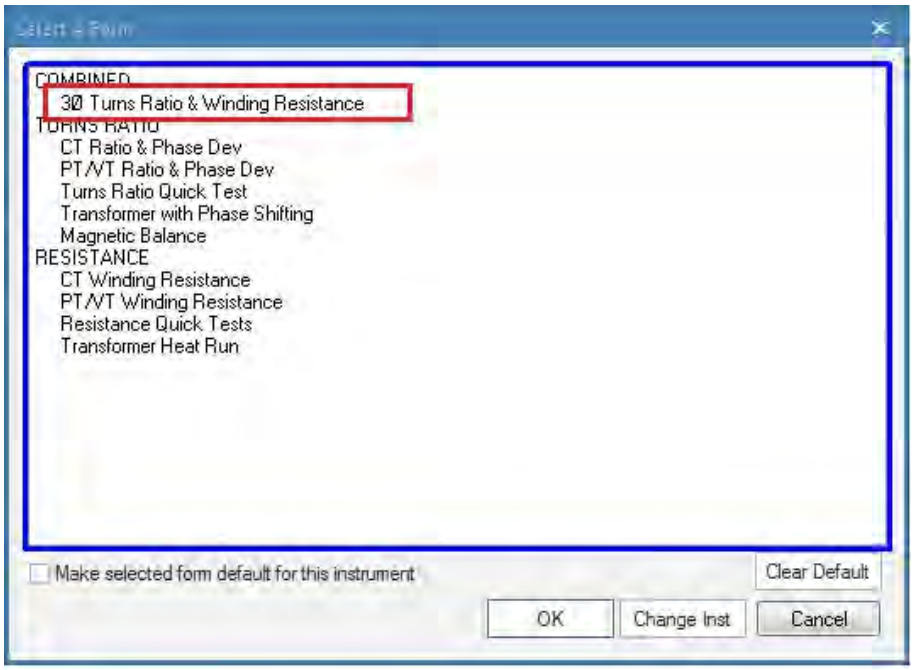
Typical issues encountered relate to the drivers for MWA300, and may require re-installation of the software to re-load drivers properly, but please allow sufficient time for drivers to properly load. IF THE ABOVE DOES NOT RESOLVE ISSUES, PLEASE REFER TO *SECTION 8* OF THIS MANUAL FOR TROUBLE SHOOTING/REINSTALLATION OF DRIVERS. Beyond this, please contact your local ASC or direct to *VTsupport@megger.com.*

5

THREE-PHASE TTR & WINDING RESISTANCE TESTING

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

Select 3Θ 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 *Item 1* above.

ii. **Open:** Results or test setups to be used for viewing past results, appending or retesting.

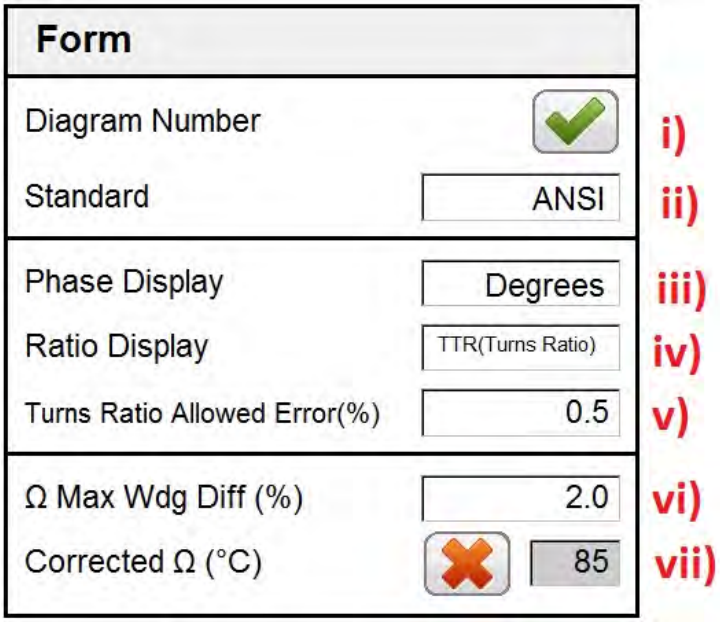
iii. **Save:** Prompts user to save results, or rename file, or save in PDF format.

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 '*Item 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



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.

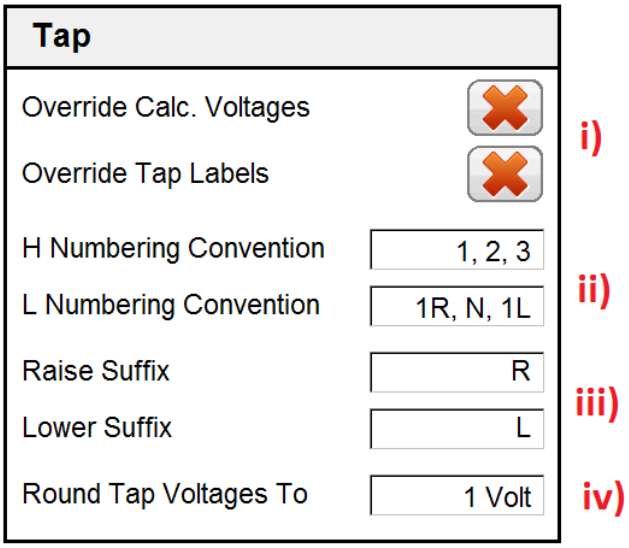
vi. **Ω Max Wdg Diff (%):** Is used to determine winding resistance limits, typically set to 2%. Calculation used:

(Phase 1Ω + Phase 2Ω + Phase 3Ω)/3 = Ravg Ω

% Difference (displayed) = (Ωmax - Ωmin)/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: 0-200°C.

Tap Settings



i. **Override Calc. Voltages/Tap Labels:** Allows individual entry for each field. Typically used for custom transformers.

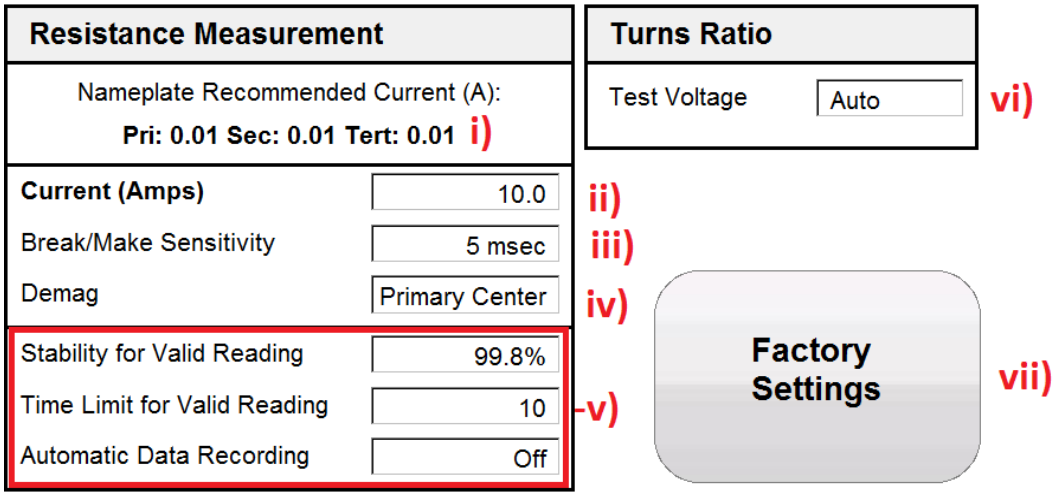
NOTE:	*When checked, all fields in tables below remain empty until manually populated.*

ii. **H and 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



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 OLTC. Detection occurs when current drop below 90% of the set current level within the time set. Lower time settings denote good OLTC operation.

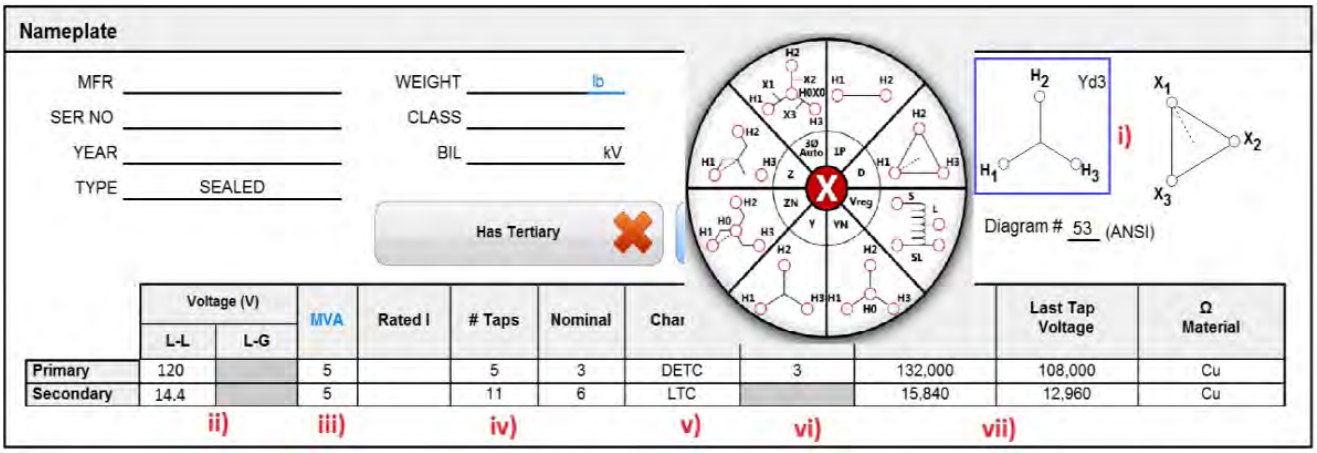
iv. **Demagnetization:** The default winding is selected, but allows change to any primary/secondary, single or three phase method (all methods are built-in). Field results shows that the optimum winding used for demagnetization is primary side center winding at same dc current as is used for testing.

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



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

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.

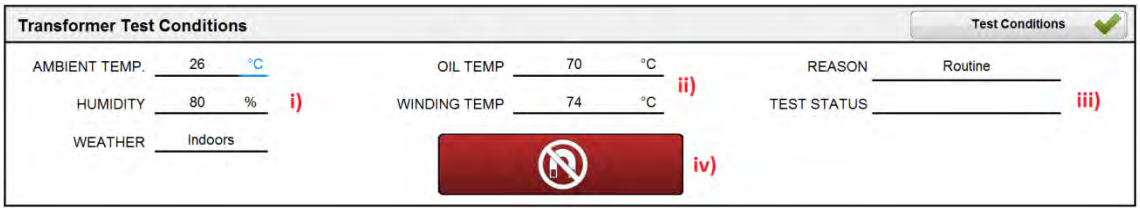
iv. **# Taps:** Input from nameplate. As well, confirm NOMINAL tap positions are correct.

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 (and ratio) for each tap position as well as % Ratio Error Calculations.

Transformer Test Conditions



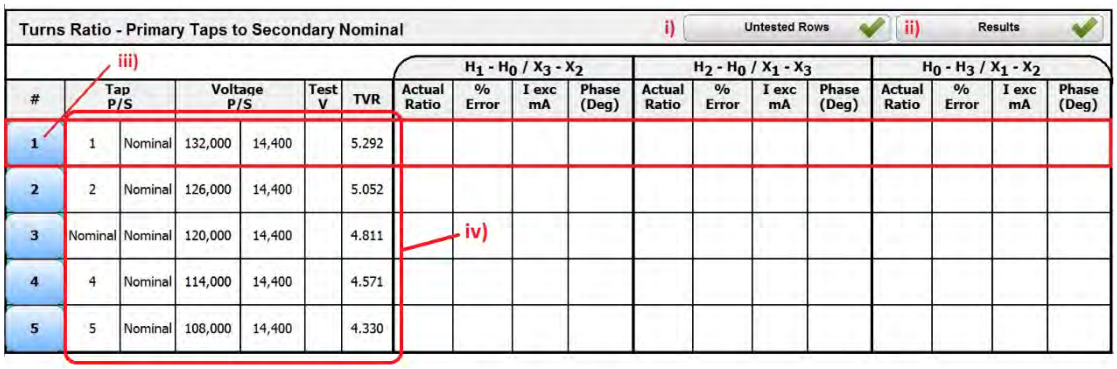
i. **Environmental (Weather) Test Conditions:** Input.

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



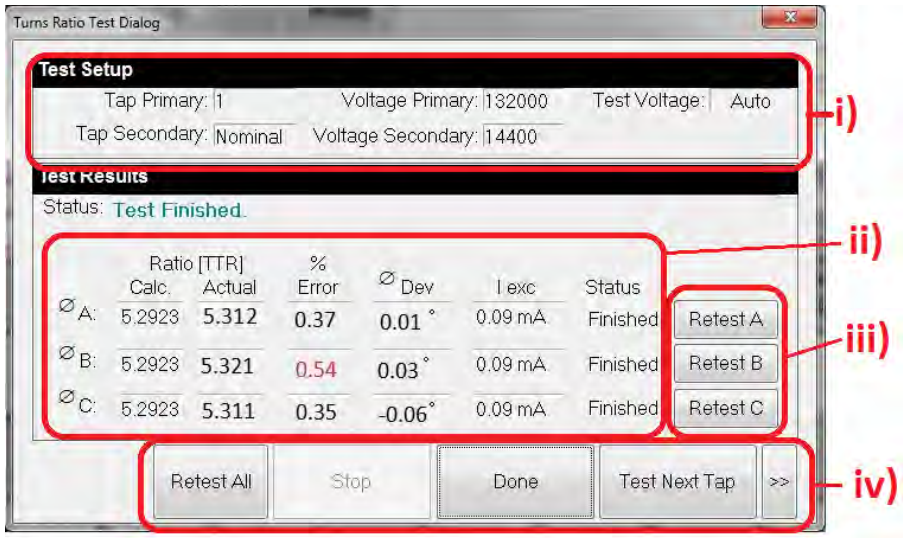
i. **Untested Rows:** Hides or shows untested rows.

ii. **Results:** Hides or shows results table for this winding.

iii. **# Test:** Depress to begin testing of individual row. This action will activate *Test Dialog (Ratio Test)* below

iv. **Tap Values:** Are filled when Transformer Nameplate above is 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.

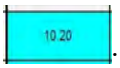
iv. **Retest or Test Tap or Done:** Retest a tap, terminates test, or allows continuation to test next tap.

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 - 

.

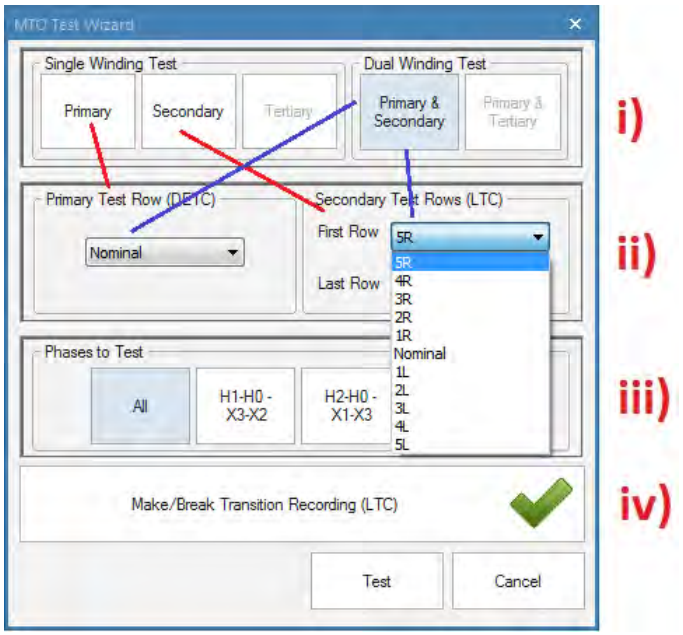
First method allows automation of testing by the:

i. **Resistance Test Wizard:** Method 1 allows an automated sequence of winding resistance testing defined by *Transformer Nameplate Input* above and *Operator Setup* - see below.

ii. **Demagnetization:** Once depressed, begins demagnetizing transformer winding, and confirms 'demagnetization' once complete.

iii. **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* above is 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.*

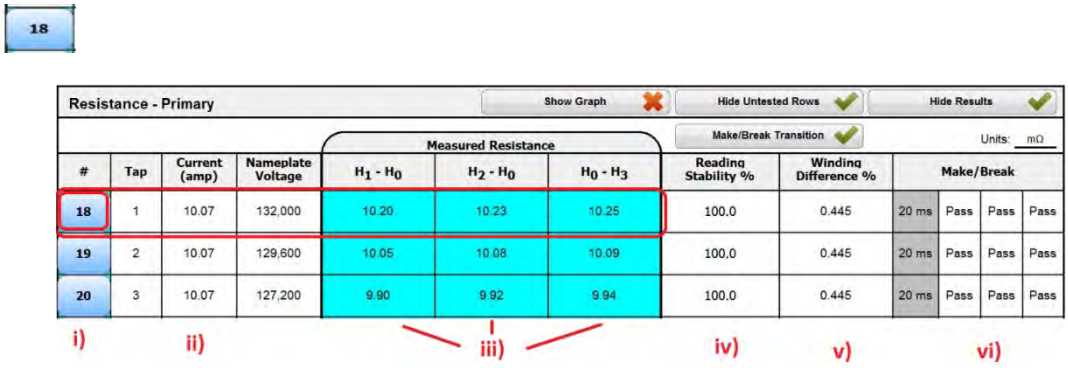
i. **Winding Selection:** Allows choice of winding(s) to be tested.

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 *Resistance/Ratio Settings* above.

Method 2 – Measuring Tap – All Phases Winding Resistance -



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.

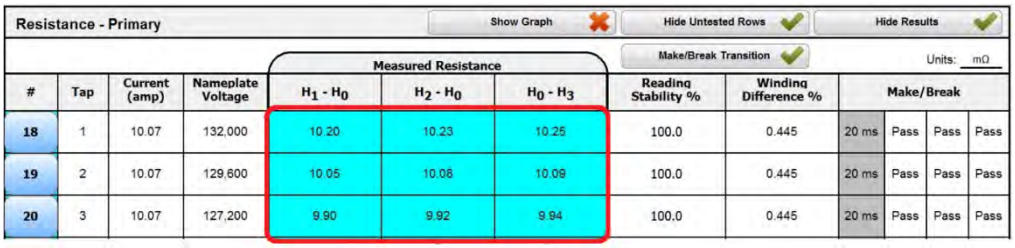
iii. **Measured Resistance:** Displays results once test is complete.

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 | Make/Break Transition | Units: mΩ

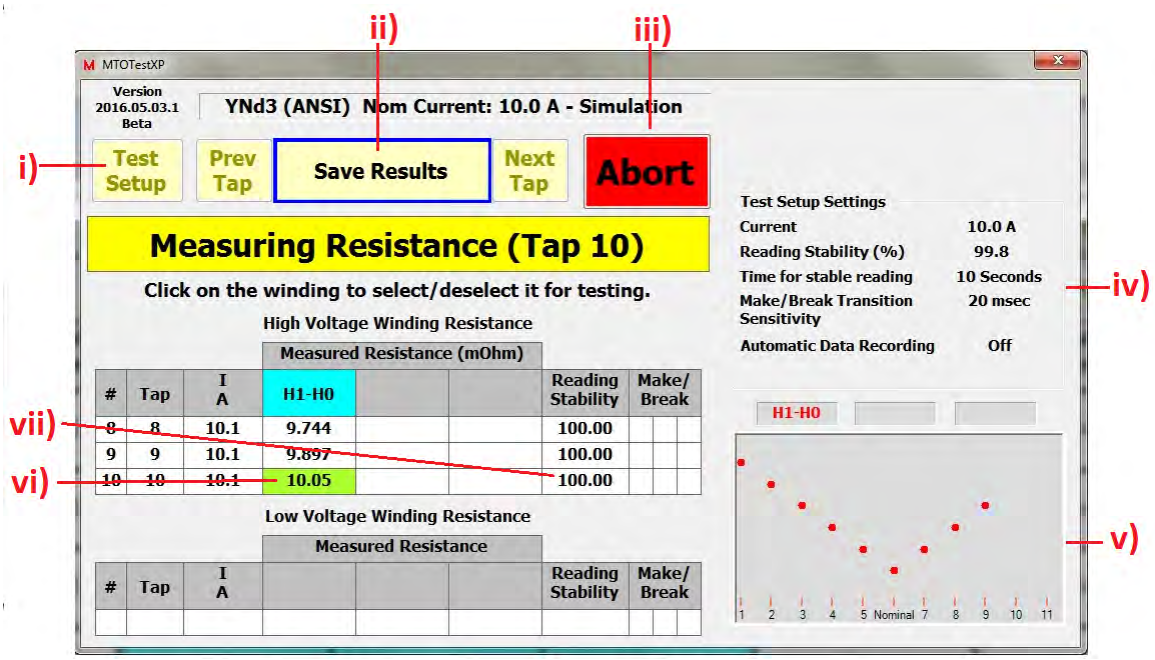
#	Tap	Current (amp)	Nameplate Voltage	Measured Resistance $H_1 - H_0$	Measured Resistance $H_2 - H_0$	Measured Resistance $H_0 - H_3$	Reading Stability %	Winding Difference %	Make/Break			
18	1	10.07	132,000	10.20	10.23	10.25	100.0	0.445	20 ms	Pass	Pass	Pass
19	2	10.07	129,600	10.05	10.08	10.09	100.0	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:



i. **Test Setup:** Allows changes to test parameters, which can be seen in *Item iv* above (and described in *Item 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 *Item 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 and Time for Stable Reading* settings as shown in Item 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* is reached.

Basic Connections to MWA300/330A

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 Safety and Section 3 Specifications*. 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 below* 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 4 above –Using Software Installation* for details. **When using an MWA330A, the switch position located above switch must be set to internal for built-in controller control or to external for user PC control.**

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

6

TRANSFORMER TESTING APPLICATIONS – RATIO & WINDING

The setup and connection instructions included in *Section 6,* 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 (8V, 40V, or 80V) 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 and 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.

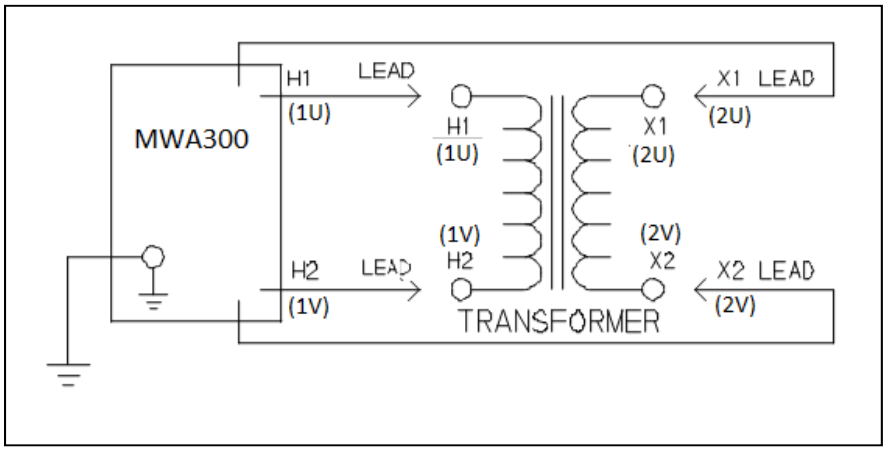


*Figure 6-1 Setup for Testing Single-Phase Transformer (Vector Diagram **1P0**)*

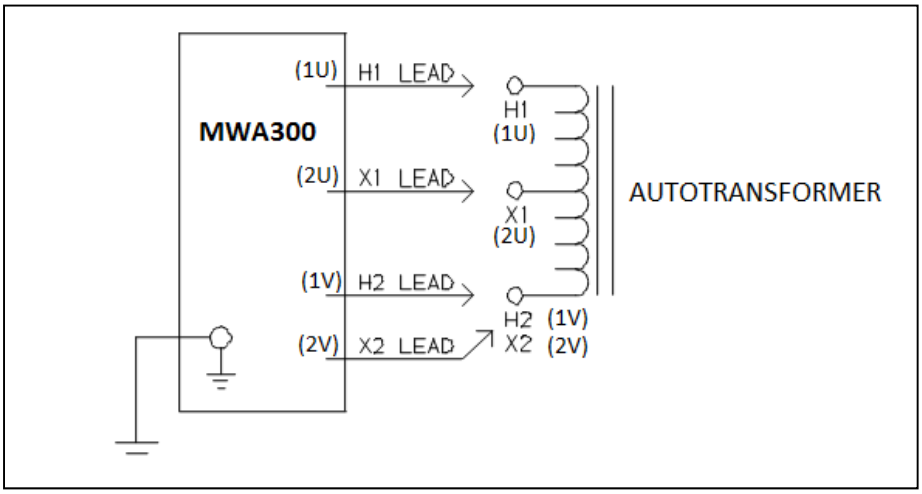


*Figure 6-2 Setup for Testing Single-Phase Autotransformer (Vector Diagram **1P0**)*

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.

Table 6-1. Test Lead Markings for Single-Phase Transformers

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

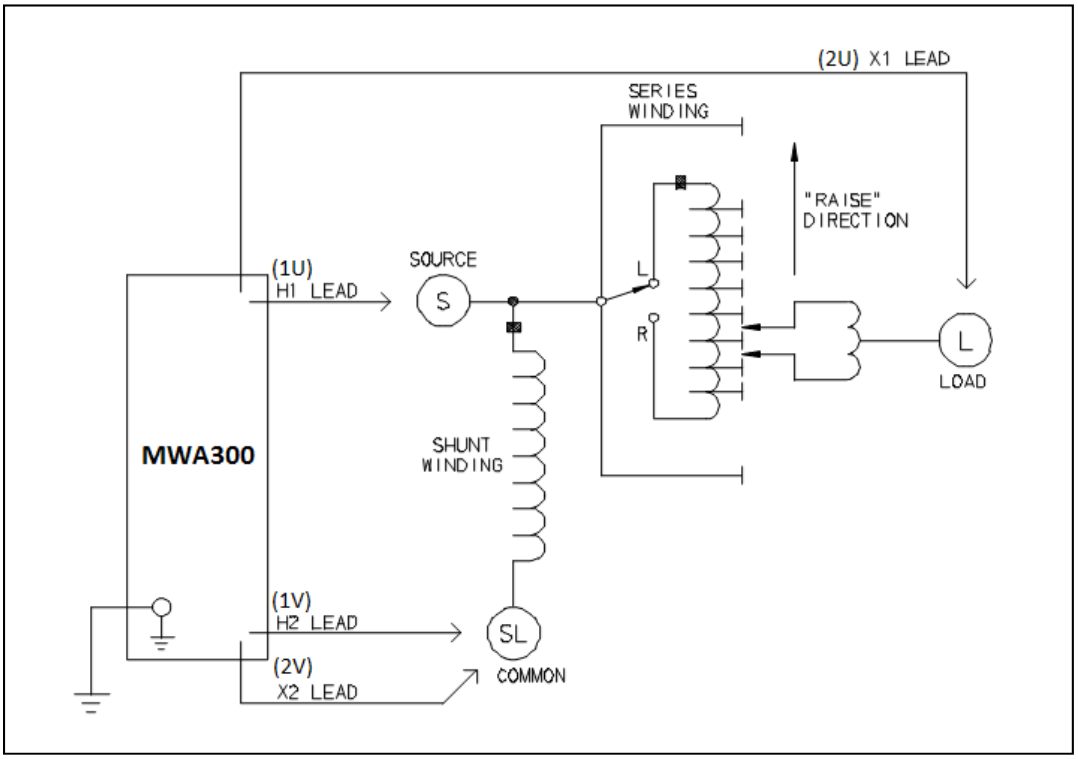


*Figure 6-3 Setup for Testing Single-Phase, Type A (Straight Design) Step Voltage Regulator (Vector Diagram **VREG**)*

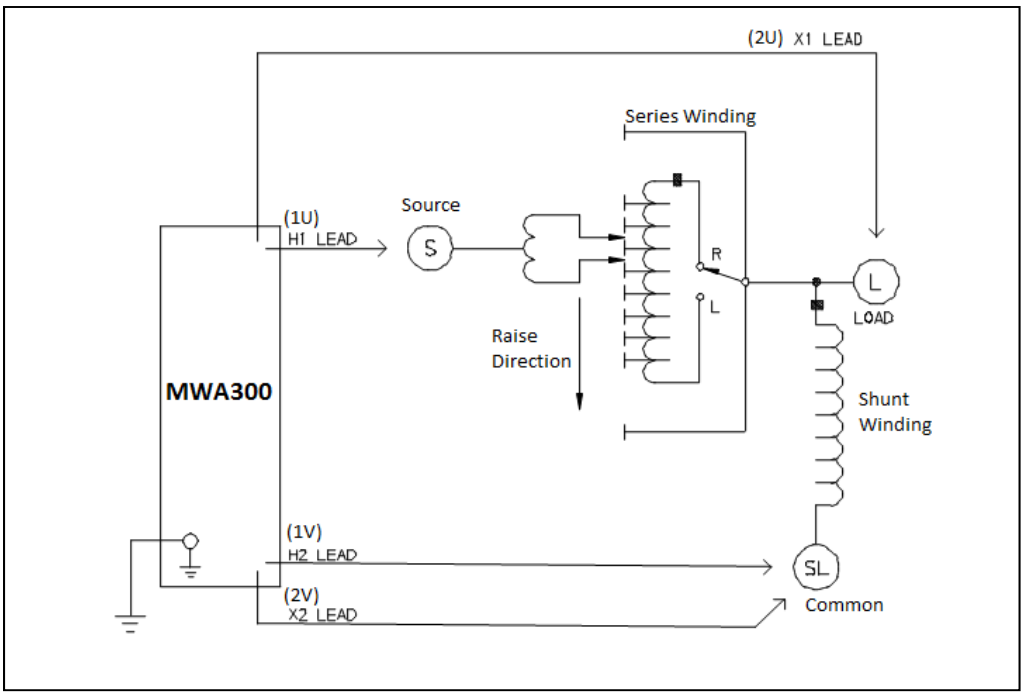


Figure 6-4 Setup for Testing Single-Phase, Type B (Inverted Design) Step Voltage Regulator (Vector Diagram VREG)

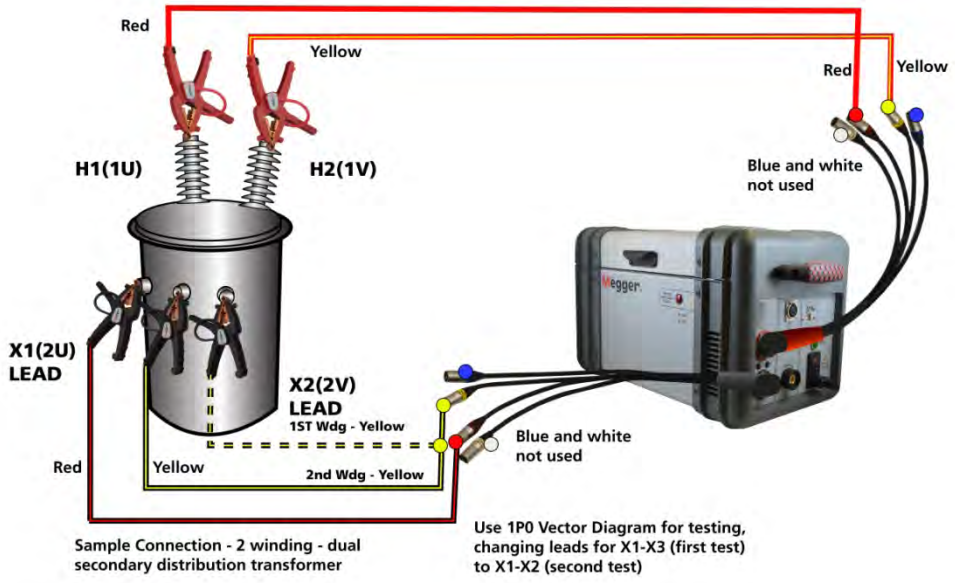


Figure 6-5 Showing connections to a Pole Type Transformer with 2 secondary windings. To test with PowerDB requires choice of 1P0, with 2 taps, changing leads between tests.

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 in *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	Heavy-Duty Clamp	Test Lead
ANSI	CEI/IEC	Australian	Terminal Voltage	Boot Color	Color Band
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.

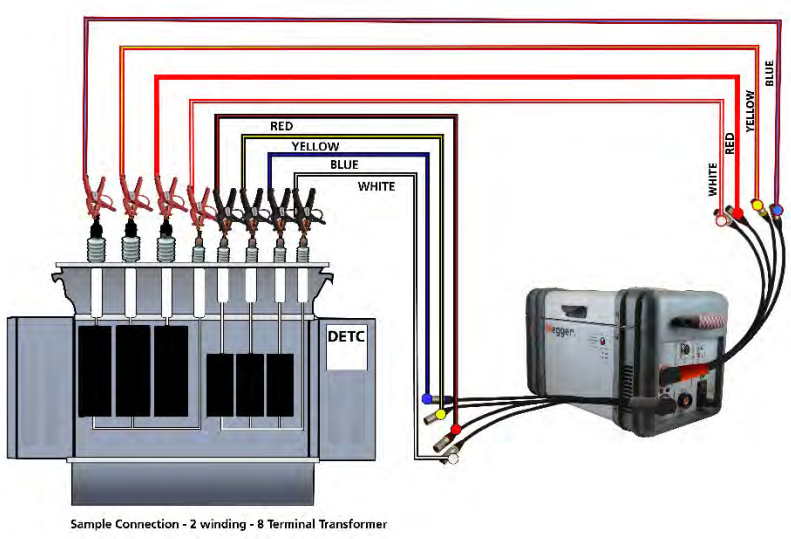


Figure 6-6 Shows a Typical Connection to a 2 Winding YNyn or ZigZag – 8 Terminal Transformer

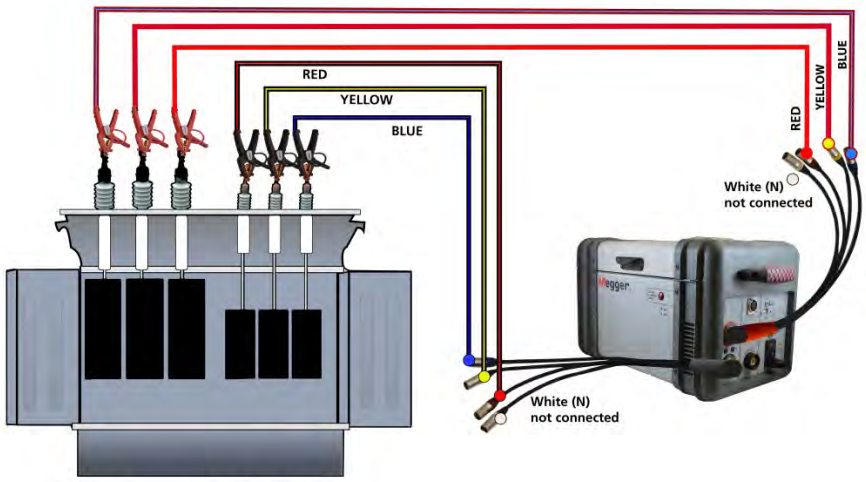


Figure 6-7Shows a Typical Connection to a Delta Delta or Yy (no neutral) 6 terminal transformer.

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 *Sections 2 and 3*.

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.

NOTE:	*Dots on the housing of the transformer are commonly used to identify terminals of the same polarity.*

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 80V ac.

Most CTs can be tested with 8V 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 8V ac excitation voltage. Some current transformers with turn ratio of <100:5 may become saturated at 8V ac. 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 V ac.

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.***

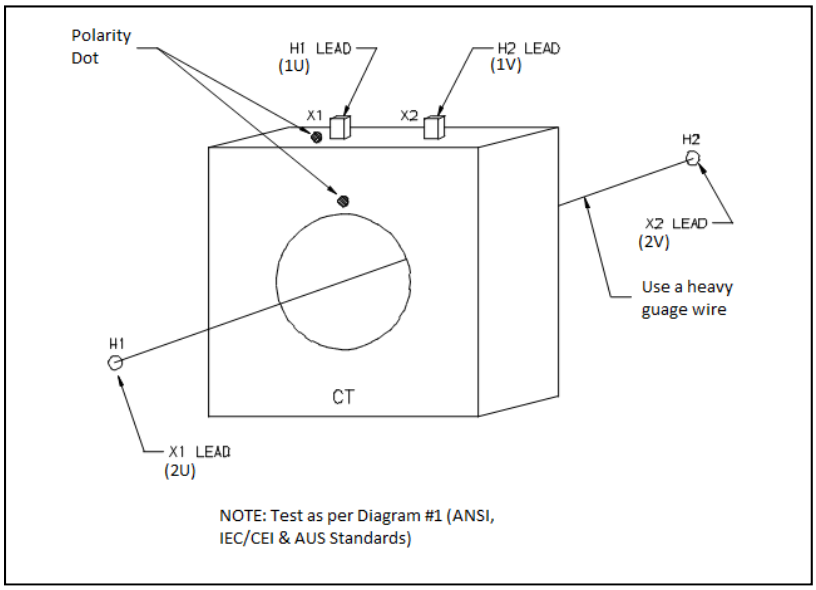


*Figure 6-8 Setup for Testing Unmounted Current Transformer (only X1-X2 winding resistance can be tested for CTs) Use vector diagram **1P0***

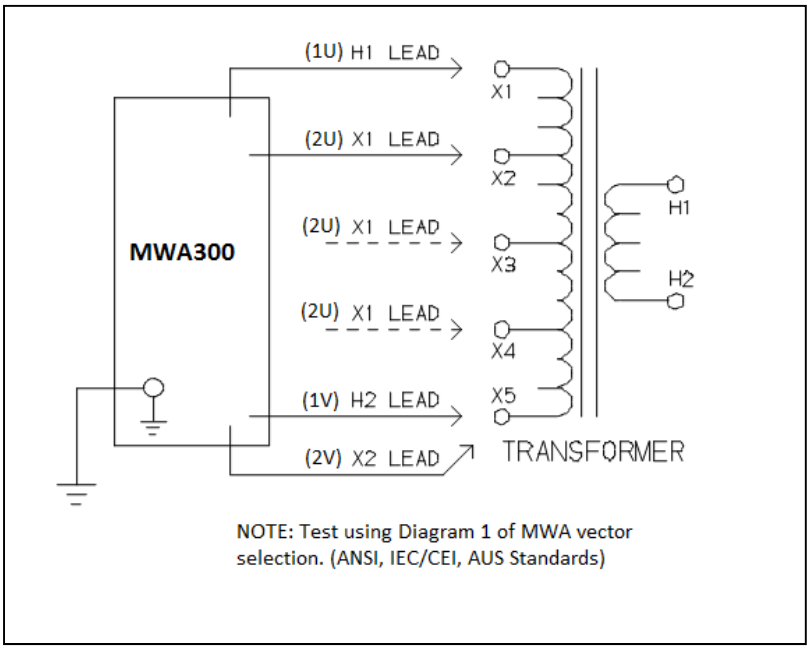


*Figure 6-9 Setup for Testing Taps on Multiple Tap CT (only low side (X) windings can be tested for resistance) Use vector diagram **1P0**.*

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).

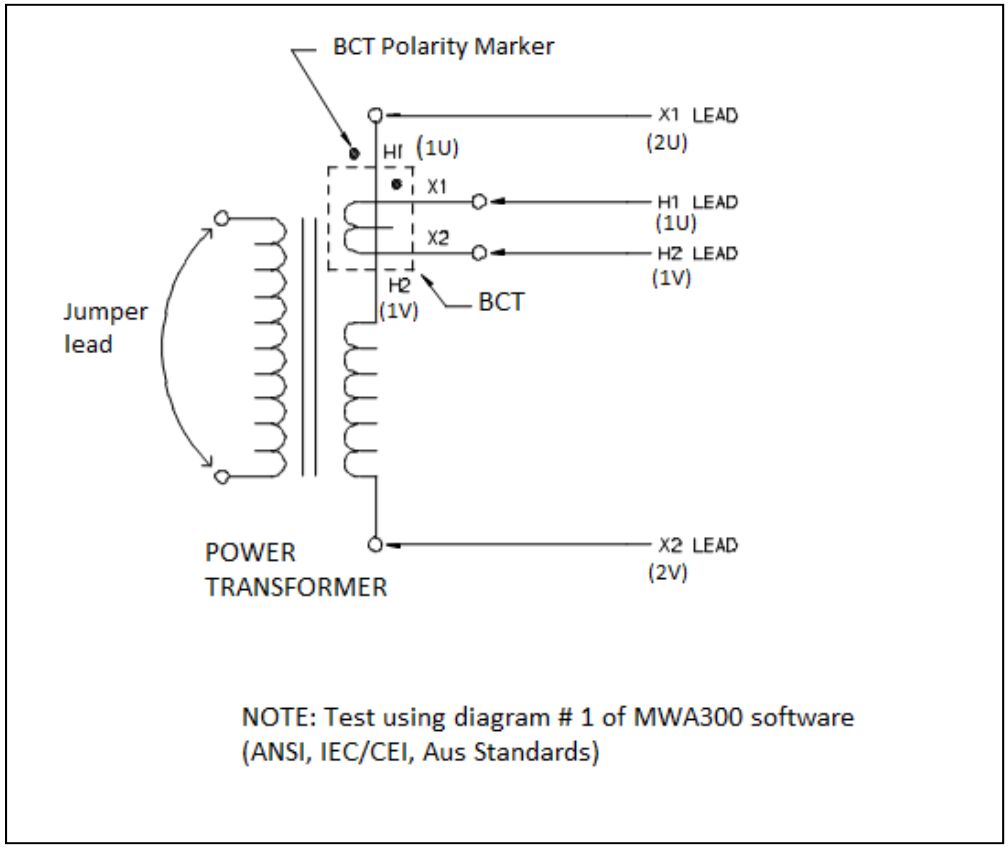


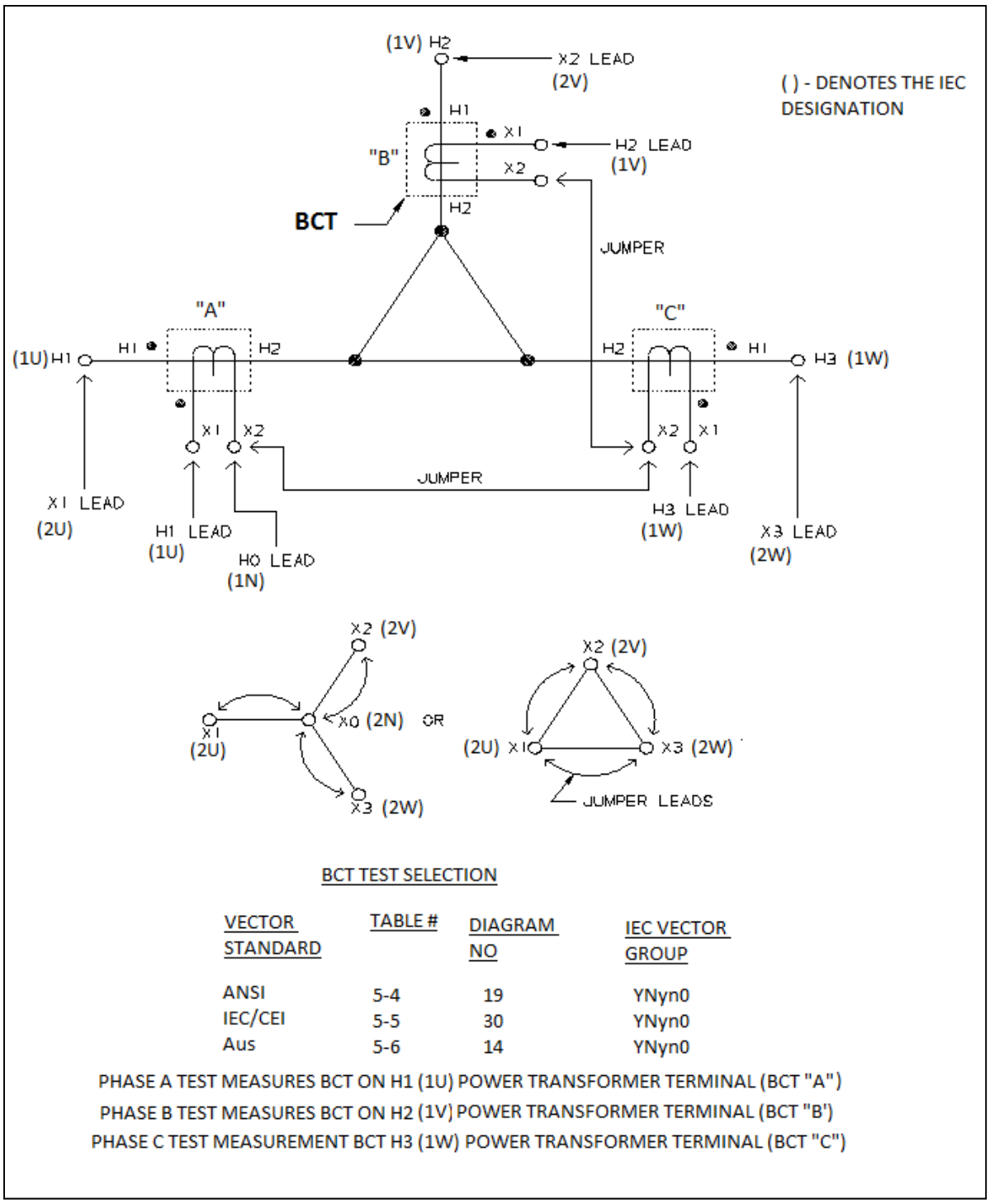
Figure 6-10 Setup for Testing BCT Mounted on Single-Phase Two-Winding Transformer – Use vector diagram 1P0

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.

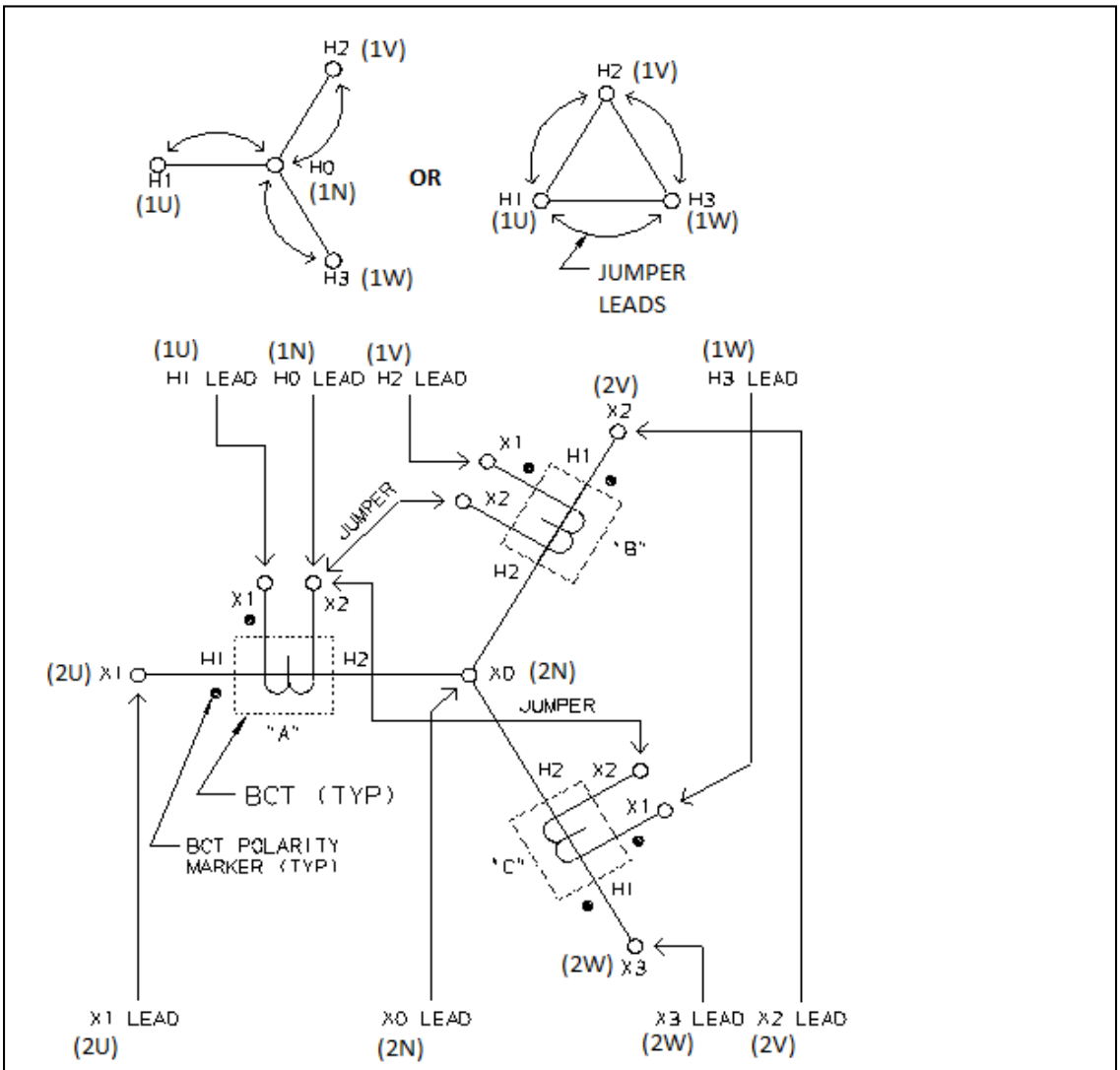


BCT TEST SELECTION

VECTOR STANDARD	TABLE #	DIAGRAM NO	IEC VECTOR GROUP
ANSI	5-4	19	YNyn0
IEC/CEI	5-5	30	YNyn0
Aus	5-6	14	YNyn0

PHASE A TEST MEASURES BCT ON H1 (1U) POWER TRANSFORMER TERMINAL (BCT "A")
PHASE B TEST MEASURES BCT ON H2 (1V) POWER TRANSFORMER TERMINAL (BCT "B')
PHASE C TEST MEASUREMENT BCT H3 (1W) POWER TRANSFORMER TERMINAL (BCT "C")

*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***



BCT TEST SELECTION

STANDARD	TABLE #	DIAGRAM #	IEC VECTOR
ANSI	5-4	7	YNyn0
IEC/EIC	5-5	29	YNyn0
AUSTRALIAN	5-6	13	YNyn0

PHASE A TEST MEASURES BCT ON X1 (2U) POWER TRANSFORMER TERMINAL (BCT 'A')
PHASE B TEST MEASURES BCT ON X2 (2V) POWER TRANSFORMER TERMINAL (BCT 'B')
PHASE C TEST MEASURES BCT ON X3 (2W) POWER TRANSFORMER TERMINAL (BCT 'C')

*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***

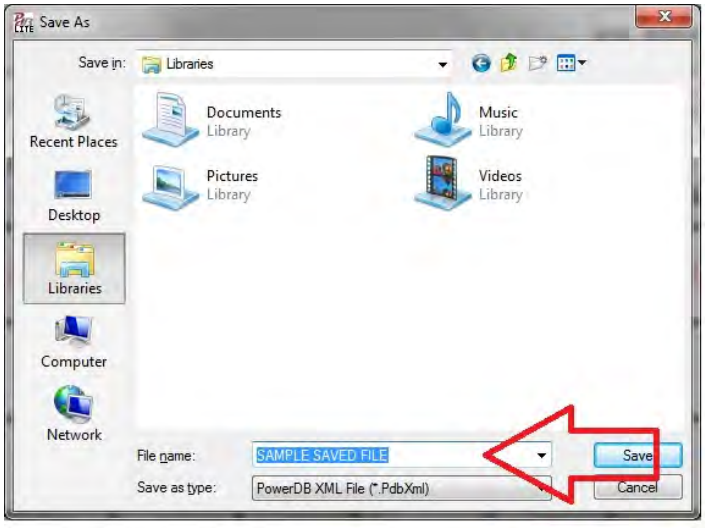
7

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.

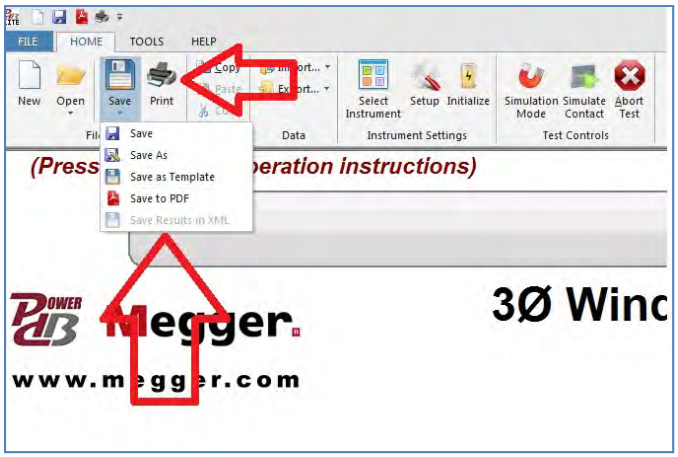
Saving Results/Test Files

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

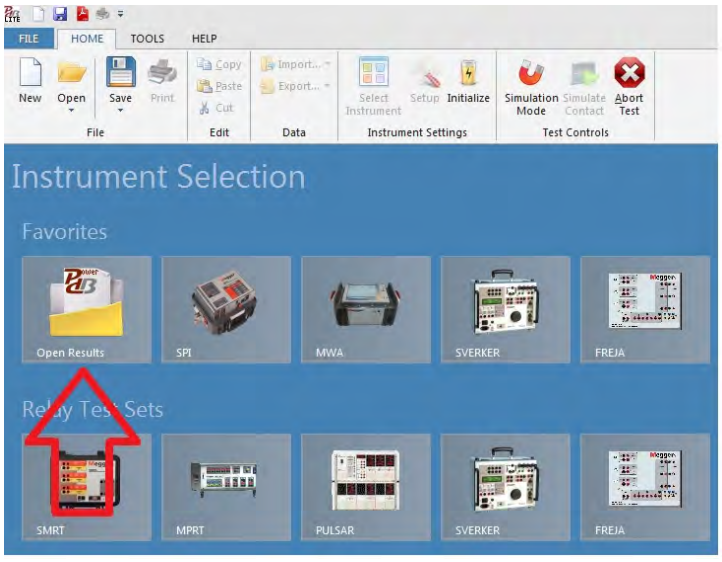
After initial results are saved with a file name as per above, all testing results continue to be saved as testing is conducted.



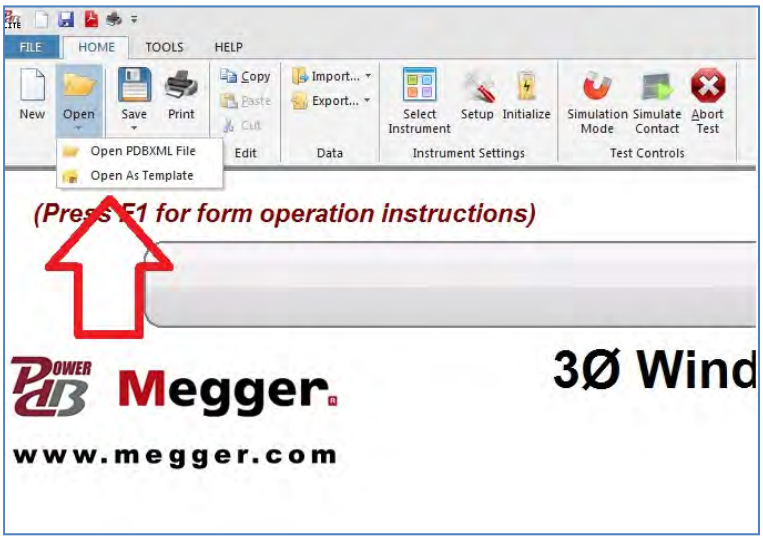
In order to rename a test file (result) user has the option to save result under a different name, as a template or as a PDF (original test file remains unchanged). Results can be also printed by depressing print icon.

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.



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).

8

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

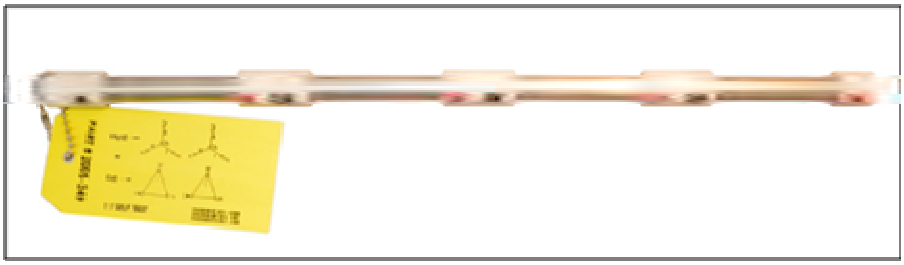
A complete performance and calibration check is recommended once every year. This will ensure that the MWA test set is functioning and is properly calibrated over the entire measurement range. The 3-phase MWA calibration is performed on each new or repaired unit before it is returned to a customer. There 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 and 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 80V 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

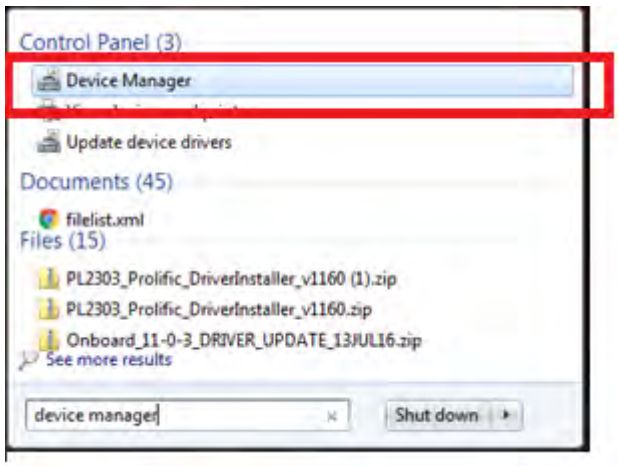
Resolving MWA Connection Issues (PC portion only)

Connection to the MWA from a PC requires installation of software drivers from the original installation. If trouble is encountered in connecting to the MWA, the following steps can be followed to help resolve the issue.

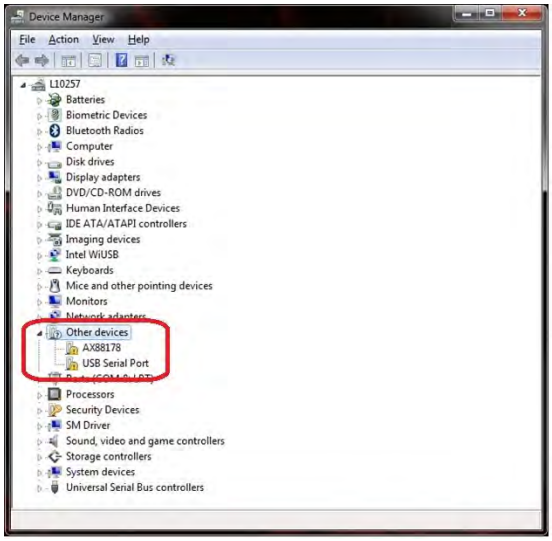
1. Verify PowerDB 11.1 or later is installed.

2. Connect the MWA to your computer.

3. Open *Device Manager* (Start -> type "Device Manager" in the Search Bar).



4. Expand *Other Devices* and look for AX88178 and/or USB Serial Port.



5. Above "!" denotes that drivers were not properly installed.

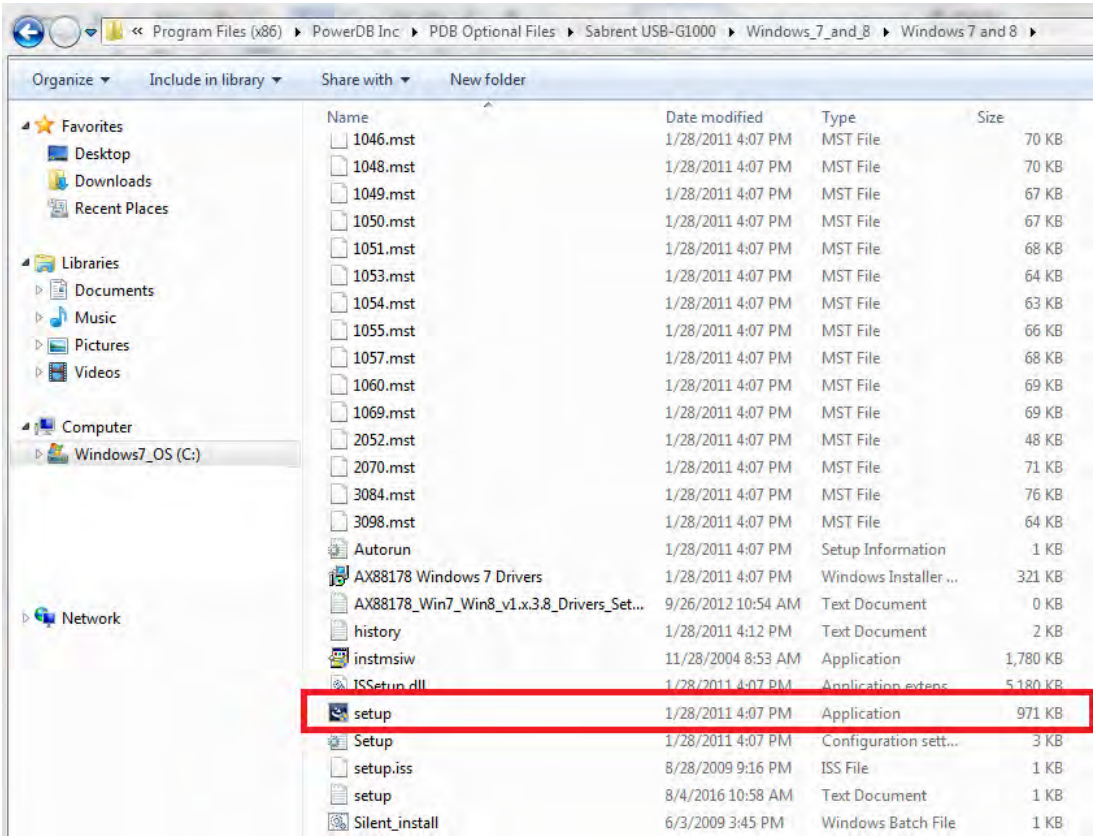
6. Installing the missing drivers:

   a. AX88178

   i. From the Explorer window, go to C:\Program Files (x86)\PowerDB Inc\PDB Optional Files\Sabrent USB-G1000 and open the appropriate file related to your *Operating System* folder (Windows 10 users = Windows_7_and_8).

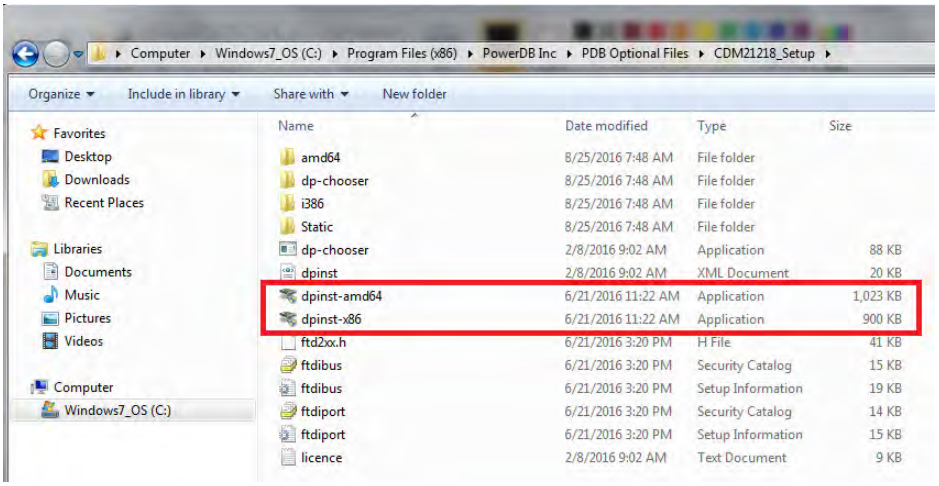
   ii. Open the second folder (same name as previous folder).

   iii. Open the file called setup.exe (see example below).



b. USB Serial Port

Go to C:\Program Files (x86)\PowerDB Inc\PDB Optional Files\CDM21218_Setup and open the appropriate dpinst-***.exe file based on your processor. Example below:



Follow the instructions once driver begins installation.

7. After running the installers, the devices should install as previously shown in the *Device Manager* as seen above.

8. If the instruments do not show up:

   a. Unplug the MWA from your PC.

   b. Wait 30 seconds.

   c. Plug the MWA back into your PC.

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 (40V or 8V).

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 80V or 40V is used) or is higher than 4,000 (if 8V 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 TTR Troubleshooting Guide

Table 8-1 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.

Table 8-1. Troubleshooting Guide

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 Iexc (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.

9

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	
108-132V ac, (207-253V*) single-phase, 60 ±2 Hz, 660 VA	MWA300
108-132V ac, (207-253V*) single-phase, 60 ±2 Hz, 660 VA	MWA330A
207-253V ac, (108-132V*) single-phase, 50 ±2 Hz, 660 VA	MWA300-47
207-253V ac, (108-132V*) single-phase, 50 ±2 Hz, 660 VA	MWA330A-47
**- Requires fuse change for proper operation at this voltage range*	
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), 240V	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-Ø shielded test lead set, X/H windings, 30 ft (9.1m)	2008-30-KIT
3-Ø shielded test lead set, X/H windings, 60 ft (18 m)	2008-60-KIT
3-Ø shielded test lead set, X/H windings, 100 ft (30m)	2008-100-KIT
3-Ø 33 ft (10 m) Extension, X lead set	36486-7

ITEM	CAT. NO.
3-Ø 33 ft (10 m) Extension, H lead set	36486-8
3-Ø 33 ft (10 m) extension, H&X windings	36486-9
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
Resistance Test Shunt, 10 A, 10 mΩ	1006-512-2
TTR Check Box – Ratio & Phase (NOT A STANDARD)	550555
TTR Calibration Standard – 1-Phase	Y550055
Spare Fuses	
MWA300/330A Mains Fuse (2x)	90001-167
MWA300/330A-47 Mains Fuse (2x)	2544-11
MWA300/330-47 XX 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