Megger

User Manual
TTRU3

True 3Ø Transformer Turns Ratiometer

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User Manual

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Contents

1 INTRODUCTION

1.1 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.

1.2 Product overview

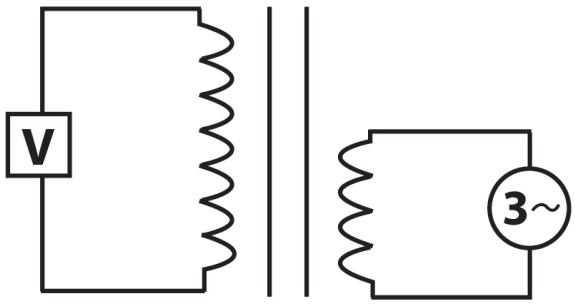
The TTRU3 ratio meter test set is a fully automatic, self-checking, menu-driven turns ratiometer. The test set measures the turns ratio, vector relationship, excitation current as well as transformer diagnostic health indicators of power, distribution, and instrument transformers. The design of this instrument is such that it operates properly, independent of line voltage quality and frequency. This allows use of any generator driven power source of 500W or higher. The test set is a lightweight portable instrument housed in a sturdy plastic case and comes complete with a canvas carrying bag to hold all 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 and IEC 60076-1 standards. For three-phase measurements, the test set is connected to all three phases of the transformer to be tested. The TTRU3 applies all three phases simultaneously which permits automatic measurement of all phases without changing connections. The TTRU3 is also designed to operate single phase on three phase transformers to help isolate transformer phase related issues. The TTRU3 measures turns ratio, phase deviation and excitation current readings which are displayed on the built in 7 inch color display or customer PC.

1.3 Step Up vs Step Down

Unlike other transformer ratiometers, the TTRU3 operates in both step up and step down ratio mode. Step down ratio excites the primary and measures the induced voltage on the secondary, while step up excites the secondary and measures the induced voltage on the primary.

The advantage to step up ratio testing is the ability to overcome voltage dependence exhibited by large transformers. As transformers grow in size, more voltage is required to generate flux. The TTRU3 manages this electrical phenomenon by using the transformers construction to achieve sufficient flux.



1.4 Model Variation & Accessories

The TTRU3 is available with different hardware and software configurations. Verify the model you received is the model that was ordered by observing the labels on the outside of the instrument and the version information displayed on the Help screen.

Use the ordering information table below to confirm that all included accessories, optional accessories, and required accessories were delivered with your TTRU3.

ORDERING INFORMATION

Item (Qty)	Cat. No.
3Ø Transformer Turns Ratio Test Set	TTRU3-EXP TTRU3-PRO TTRU3-ADV
Including Accessories	
AC Power Cord & Adapters	2009-874
USB 2.0 Cable	CA-USB
Tap Changer	1011-622
Canvas carrying bag for test leads	2005-265
Ground Cable	2011-716
Thumb Drive	1011-585
Triple Function Pen	2011-538
Optional Hardware Accessories	
1:1 Test Jig	2005-249
Beacon	1004-639
Transit Case (for instrument)	2005-340
TRS1+ Calibration Standard	TRS1PLUS
TRS1D Calibration Standard	TRS1D
Calibration Certificate	CERT-NIST
USB Printer	90029-573
USB Printer Paper (x20)	90029-573-P
OLTC Multi-contact connector	1011-622-A

Item (Qty)	Cat. No.
ADV/PRO Software Options	
TTRU3-EXP includes all software options and will receive automatic activation of new features upon their release	
PowerDB Control	SW-POWERDB
Phase Shifting	SW-PHASESHIFT
Required Accessories	
Lead P/Ns 2008-XXX-XX (8 total) can be used with the TTRU3 and qualify as required accessories	
3Ø universal shielded test lead sets compatible with MTO3XX, MWA3XX, TTRU3 instruments (up to 10A max), complete with color-coded Kelvin Clamps: Choose Kit or mix & match H & X	
5 m (15 ft) H & X	2008-15KIT2
9 m (30 ft) H & X	2008-30KIT2
18 m (60 ft) H & X	2008-60KIT2
30 m (100 ft) H & 18 m (60 ft) X	2008-100KIT2
5 m (15 ft) H	2008-300-15
5 m (15 ft) X	2008-301-15
9 m (30 ft) H	2008-300-30
9 m (30 ft) X	2008-301-30
18 m (60 ft) H	2008-300-60
18 m (60 ft) X	2008-301-60
30 m (100 ft) H	2008-301-100

1.5 Top Panel

1. **Speaker**
   Used for sounding countdown for test.

2. **AUX Port**
   Used for connecting auxiliary equipment.

3. **USB On the Go**
   TTRU3 appears as a thumb drive containing PC SW, user manual, and data sheet.
   Enables PC Control after PC SW Installed.

4. **USB A**
   Print, export

5. **Emergency Stop**
   Used to immediately interrupt voltage output.
   Prevents tests from starting if engaged.
   Rotate clockwise to disengage.

6. **Fan**
   Automatically enabled when internal temperature exceeds factory limit.

7. **Warning Indicator**
   Indicates when voltage is applied to test leads.

8. **Manual OLTC Control Switch**
   Controls connected OLTC tap changer up/down.
   Requires OLTC cable connected to transformer.

9. **Touchscreen**
   Primary GUI control interface. Designed for outdoor (1100 NITS) and industrial environments.

10. **Rotary and Directional Control Knob**
    Supplemental GUI control interface.

1.6 Side Panel

11. Power Input

IEC 320 interface to mains power.
Integrated fuse holder and filter.
O = Off
I = On

12. OLTC Connection

Used in conjunction with Manual OLTC Control

13. Ground

14. Lead Connections

Latching connectors (press tab to release)

Color coded windings
silver/black for primary/secondary

Color coded phases
red, gold, blue, white

15. Beacon Connection

Optional accessory
Functions similar to Warning Indicator

16. Side panel reference

Quick reference for the various connections

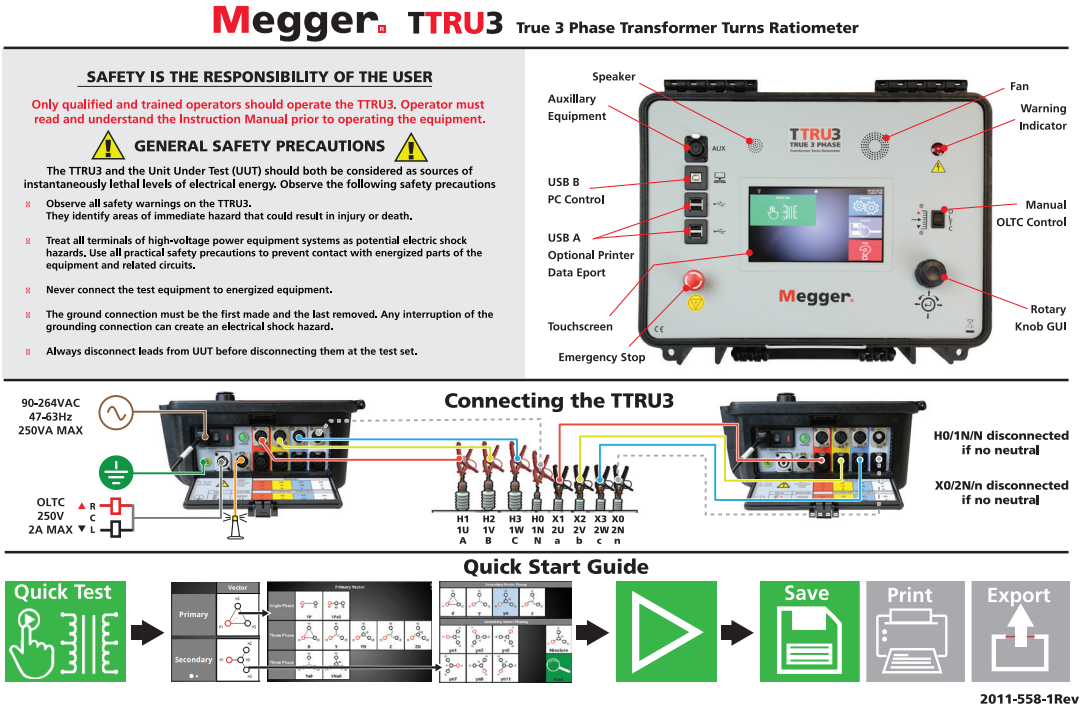
1.7 Quick Start & Feet

17. Quick Start Guide

Safety and connection reference in lid.

18. Feet

Rotate out to provide a better viewing angle.



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2 SAFETY

2.1 Responsible User

Only qualified and trained operators should operate the TTRU3. 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.

2.2 Symbols

Caution, possibility of electric shock

Warning, refer to User Manual

Emergency Stop

2.3 General Precautions

The TTRU3 and the Unit Under Test (UUT) should both be considered 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 the TTRU3 and 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.
    - The ground connection must be the first made and the last removed. Any interruption of the grounding connection can create an electrical shock hazard.
    - Always disconnect leads from UUT before disconnecting them from the TTRU3

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

2.4 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:

85V to 250V, 47 - 63 Hz, 250VA

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.

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 fuse protected. Fuse is located in the ON/OFF switch module on side panel and is replaceable by the operator. To avoid electric shock and fire hazard, use only the fuse specified below switch module on side panel.

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

3 SPECIFICATIONS

Input Power

90-264VAC, 47-63Hz, 250VA Max

Output

Voltage: 3Ø, 1 - 48VAC, up to 250V on Primary
Frequency: 50-480Hz
Current: 0.1mA - 1A, Max 1A @ 48V

Turns Ratio Measurement Methods

3Ø Step Up
3Ø Step Down
1Ø Step Up
1Ø Step Down

Turns Ratio Range and Accuracy - Guaranteed

Step Down Excitation
25-48V
±0.05% 0.8 - 1000
±0.10% 1001 - 2000
±0.30% 2001 - 15000

1-24V
±0.10% 0.8 - 1000
±0.20% 1001 - 2000
±0.60% 2001 - 15000

Step Up Measurement
25-125V | ADV model
25-250V | EXP / PRO models
±0.05% 0.8 – 200 (most Power Tx)

1-24V
±0.10% 0.8 – 200

5 digit resolution

Excitation Current Measurement

Resolution: 0.1mA 0.1mA - 100mA
1mA 101-1000mA
Accuracy: ± 1% ±0.1 mA

Frequency Measurement

Resolution: 0.1 Hz
Accuracy: ±0.1% ±0.1 Hz

Transformer Phase Measurement

Range: 0 - 360 Degrees
Accuracy: ± 0.05 Degrees

Weight

6.5kg 14lbs

Dimensions

406 x 304 x 254mm 16 x 12 x 8in

Environmental

Operating -20°C to +50°C (-4°F to +122°F)
Storage -30°C to +70°C (-22°F to +158°F)
Relative Humidity 0-90%, non-condensing

Regulatory

Safety
IEC 61010-1:2010 + AMD1:2016

EMI/EMC
IEC 61326-1:2012

RoHS2
EN50581

Vibration/Drop/Shock
MIL-STD-810G

Touchscreen

180mm (7 in.)
800 x 480 Resolution
1100 NITS

Transformer Testing Standards

IEEE C57.152-2013

Case

Ruggedized case with fold out feet
Canvas carrying bag for leads and accessories

Internal/External Data Storage

Up to 2000 sets of 3 phase results internal storage
Transferable via USB 2.0/3.0 thumb drive

Communication/Control Software

180mm (7in) built it display running custom GUI
USB Interface for PC Control running custom GUI

Printer Output

51mm (2in) thermal printer
Prints all measurement data displayed on GUI

4 PREPARING FOR TEST

4.1 Site Preparation

Choose a location that meets the following conditions:

- The location is as dry as possible.
- There is no flammable material stored in the vicinity.
- The test area is adequately ventilated.
- The test area is flat surface.
- Be sure all equipment is de-energized and all terminals of the UUT are accessible.
- Erect suitable safety barriers to protect the operator from traffic hazards and to prevent intrusion by unauthorized personnel. User provided Warning lights are recommended.
- Verify that the Local station ground is intact and has impedance continuity to earth.

Ensure UUT is completely de-energized. Check every winding. Ensure all terminals are disconnected from line or load at the UUT. Grounds may be left in place.

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

4.2 Making Circuit Connections

Connections should be made in the order listed below.

1. **Ground**
   Use the Megger supplied Safety Ground Cable to connect the TTRU3 ground terminal directly to local station earth ground. Ensure that the transformer chassis also has a low impedance connection to local station earth ground potential.

2. **Input Power**
   Ensure the Input Power Source meets the requirements as listed in Section 2 Safety and Section 3 Specifications. Make sure ON/OFF switch is in the OFF position. Connect power cable to the TTRU3 first, then to the source. At this time, leave the ON/OFF switch in the OFF position.

3. **Primary & Secondary/Tertiary leads to TTRU3**
   With the clamps disconnected from the UUT, connect the primary and secondary/tertiary leads to the TTRU3. Be sure that all plugs are fastened securely to the TTR so they will not become loose even in the event of the operator inadvertently tripping over the leads.

4. **Primary & Secondary/Tertiary leads to UUT**
   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 above and in Sections 2 Safety.

   Environmental conditions can lead to corrosion of the UUT terminals. Ensure that the leads are making direct contact with metal.

   Use leads of appropriate length for the UUT. Ensure leads are not tightly coiled, as this may influence the ratio measurement.

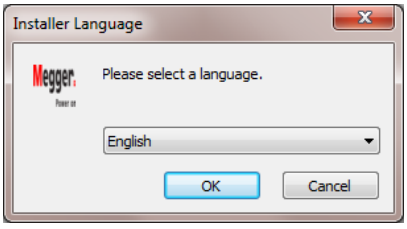
5. **OLTC Leads to OLTC**
   Refer to the OLTC wiring diagram for proper lead connection.

4.3 PC Software Installation

Before installing PC software, contact your IT department. Your IT department can assist with install and provide administrator approval if required.

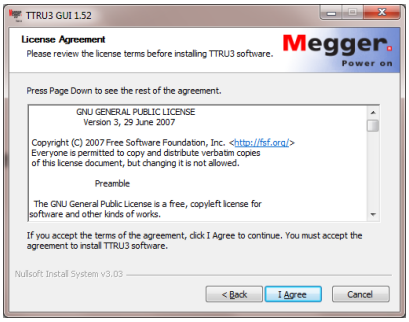
The TTRU3 can be controlled from the Touchscreen or from a connected PC with the PC SW installed. To install the PC SW:

1. Insert the included thumb drive
   -OR-
   Connect the TTRU3 to your PC with the included USB Cable and turn the TTRU3 on. After initialization, a CD drive will appear on your PC which contains the software
   -OR-
   Download the latest PC SW from www.megger.com/TTRU3
2. Locate the file named TTRU3_installer_X.xx.exe. X.xx is the version.
3. Double click to launch the installer.
4. Select a Language for the install and click OK.

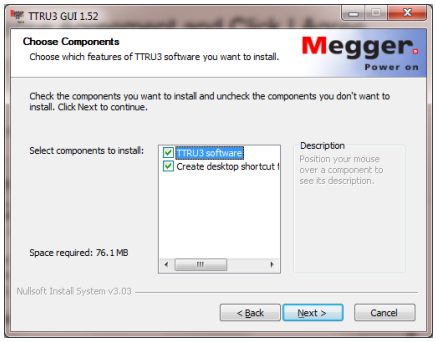


5. Click Next.

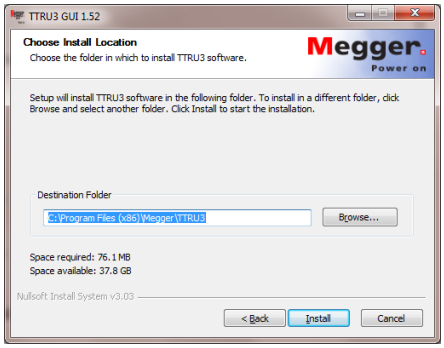
6. Review License Agreement and Click I Agree.



7. Choose components and Select Next. Defaults recommended.



8. Select Destination folder and click Install. Defaults recommended.

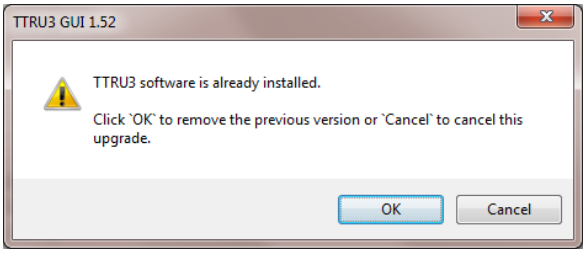


9. Click Finish to complete the installation.

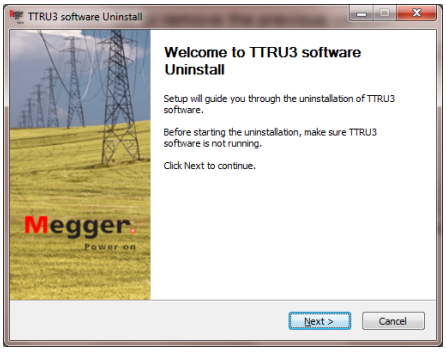
4.4 PC Software Update

If a previous version of PC Software is installed, you will be required to uninstall before installing the new version.

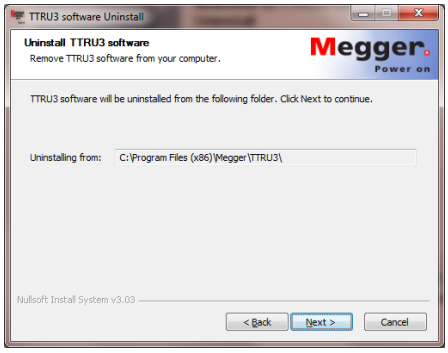
1. Locate the installer for the TTRU3 TTRU3_installer_X.xx.exe.
   X.xx is the version.
2. Double click to launch the installer.
3. Click **OK** to remove the previous version.



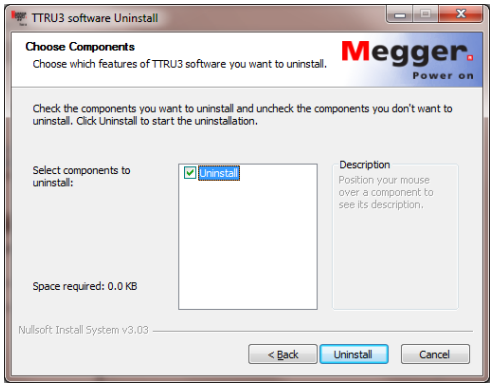
4. Click Next



5. Click Next



6. Click Uninstall.



7. Click Finish.
8. Proceed with the installation instructions in section 4.3.

4.5 PowerDB Installation

TTRU3 data can be imported into PowerDB. In addition, the TTRU3 can be controlled from PowerDB. To install PowerDB, download the latest version from www.powerdb.com. Follow the instructions on screen to install PowerDB.

When prompted, choose to install the optional software for the TTRU3 and proceed with the installation instructions from section 4.3.

5 OPERATIONS

5.1 Initialization & Interface

Turn on the TTRU3 using the Input AC Module. A boot screen with the Megger Logo will appear, followed by the Home Screen.

The TTRU3 graphical user interface (GUI) utilizes a resistive touchscreen. Gloves or moisture will not interfere with operation of the touchscreen.

The rotary control knob can also be used to control the TTRU3. To enable the control knob, use the directional functions. A yellow highlight will show the cursors current position.

5.2 Options

Options are displayed a few different ways within the TTRU3. A brief explanation can be found below:

Option Type	Description
Pills ●●●●●●	When less than seven options are available, pills are displayed. Pills indicate the number of options available, and the largest pill indicates which option is selected.
Multiple Selection |< < > >|	When seven or more options are available, a multiple selection screen is displayed. Use the page left/right and first/last buttons to navigate to additional options.
Numpad	When entering voltages or error limit values, a numpad will be displayed
Keypad	For Test ID, a keypad is displayed

5.3 Confirm/Cancel

Settings can either be saved or discarded using the buttons below:

Button	Description
✓	**Confirm** Accept changes
✗	**Cancel** Discard changes

5.4 Menu Bar

The Menu bar has three sections

1 2 3

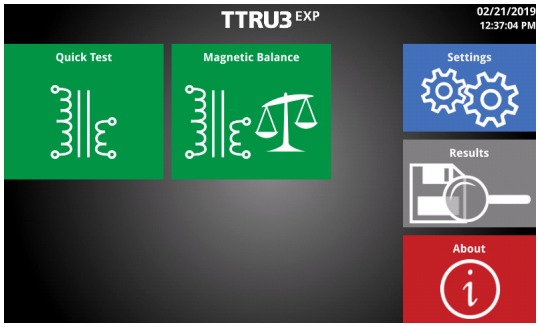
Button	Description
1 Home	Available when not on the Home screen
2 Navigation	Information about the current screen
3 Notification	Date & time, notifications

5.4.1 Menu Bar Buttons

Button	Description
	**Home** Return to the Home Screen
	**PC Connected** See Connected PC info
	**Emergency Stop Engaged**
	**Alert** Displays error message

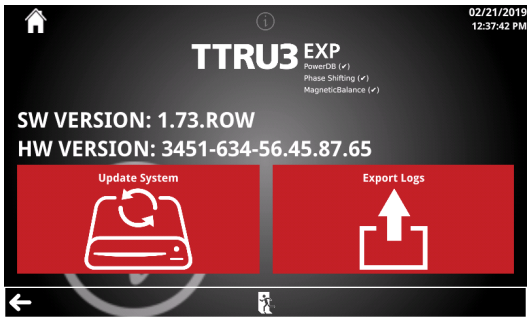
5.5 Home Screen

The home screen appears after boot up. All major functions can be initiated from the Home screen. When in doubt, return to the home screen with the home button to get your bearings.



5.6 About Screen

The help screen is where you will find useful system information, including model, SW, and HW versions. You can also update your TTRU3 system and export logs for troubleshooting



5.5.1 Home Screen Buttons

Button	Description
	**Quick Test** Set up a quick test
	**Magnetic Balance** Set up a magnetic balance test ⓘ Optional SW Feature
	**Settings** Modify instrument and test settings
	**Results** View saved results
	**Help** View system information Update TTRU3 Export Logs

5.6.1 Help Screen Buttons

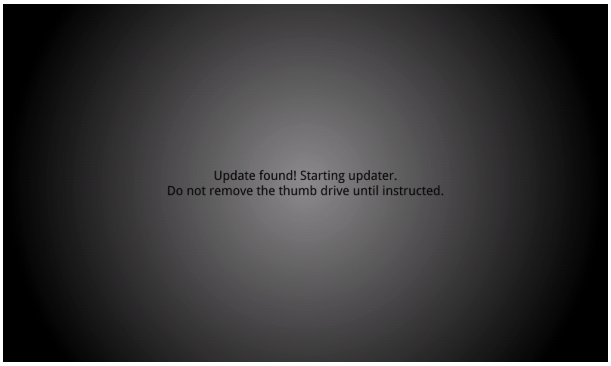
Button	Description
	**Update** Check USB drive for updates
	**Export Logs** Export logs to USB drive
	**Exit** Return to the Home

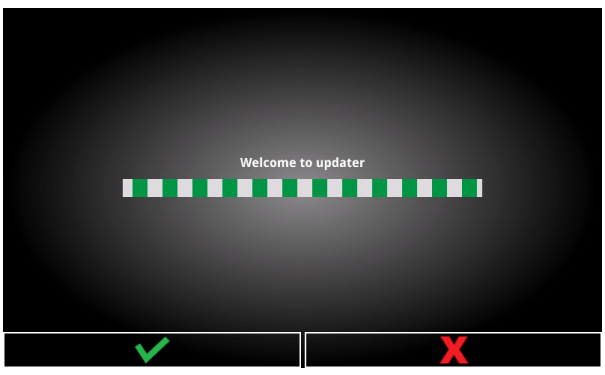
5.6.2 Update

Updates can be performed at an ASC or Megger Factory. If the user chooses to install updates, they accept responsibility for all intended and unintended changes to the TTRU3.

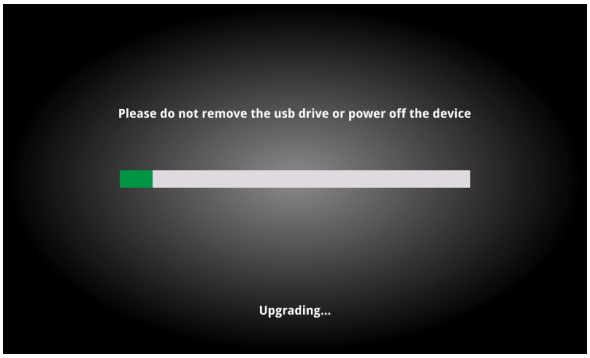
To update the system:

1. Check www.megger.com/TTRU3 for updates from a PC.
2. If an update is available, review the patch notes. It is recommend to update only when absolutely necessary.
3. Download the update
4. Extract to the root of a thumb drive
5. Remove thumb drive from PC
6. Insert thumb drive into any USB A port
7. Select Update
8. Press continue to proceed with the update





9. Wait for the update to complete

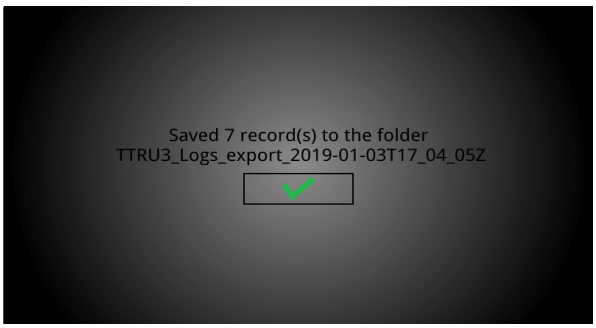


10. Remove the thumb drive and click Reboot

5.6.3 Export Logs

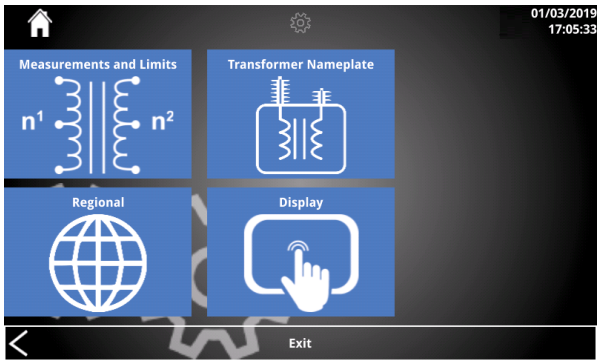
To export logs:

1. Insert thumb drive into any USB A port.
2. Select Export Logs.
3. Logs will be exported with a date/time stamp.



5.7 Settings Screen

The settings screen displays options for configuring the TTRU3 system and default test parameters

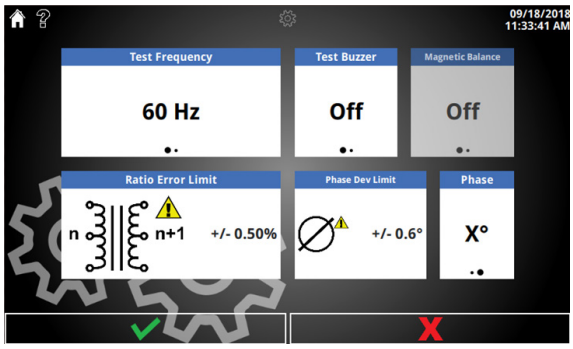


5.7.1 Settings Screen Buttons

Button	Description
	**Measurement & Limits** Modify test settings
	**Transformer Nameplate** Set default transformer settings
	**Regional** Adjust regional settings
	**Display** Adjust display settings
	**Exit** Return to home

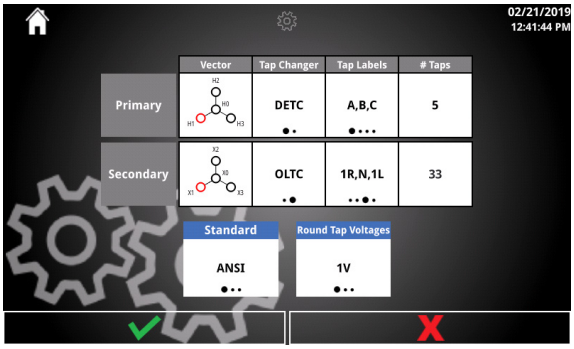
5.8 Measurement & Limits

The measurement & limits settings provide options for running and evaluating turns ratio tests.



5.9 Transformer Nameplate

The default transformer nameplate for running a test can be set here.



5.8.1 Measurement & Limits Options

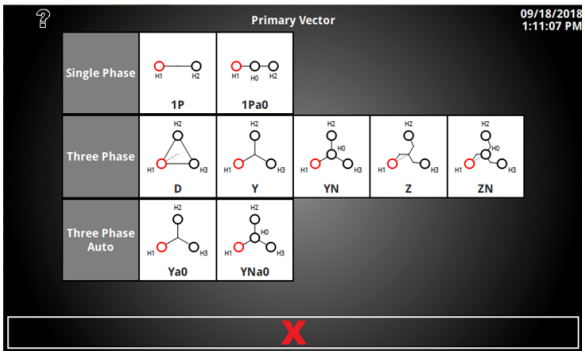
Option	Available Settings
Line Frequency	50Hz 60Hz
Test Buzzer	On Off
TNR/TVR	TNR TVR
Imbalance Limit	0.1% - 9.9% (0.1% steps) ⓘ Optional SW Feature
Ratio Error Limit	0.1% - 9.9% (0.1% steps)
Phase Deviation Limit	0.1° - 9.9° (0.1° steps) 6” - 594” (6” steps)
Phase	° - Degrees ” - Minutes

5.9.1 Transformer Nameplate Options and Buttons

Option	Available Settings
Primary Vector	See Primary Vector Selection Screen (5.9.2)
Secondary Vector	See Secondary Vector Selection Screen (5.9.3)
Primary Tap Changer **Secondary Tap Changer**	DETC OLTC *Only one can be OLTC
Primary Tap Labels **Secondary Tap Labels**	A,B,C 1,2,3 1R,N,1L +1,0,-1
Primary # Taps **Secondary # Taps**	1 - 99
Standard	ANSI IEC AUS
Round Tap Voltages	1 V, 5 V, 10 V

5.9.2 Primary Vector Select

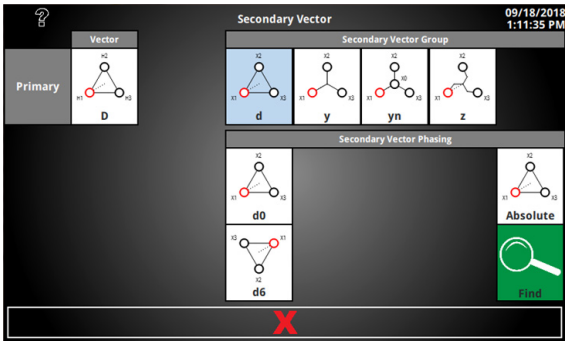
The available primary vectors are displayed below. Select a primary vector to proceed to the Secondary Vector selection screen.



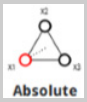
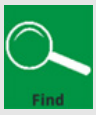
5.9.3 Secondary Vector Select

Secondary vector groups and phasing displayed are determined by the standard and primary vector selected.

Secondary vectors are separated by group and by phasing. Only typical vector phases are displayed as selectable options.



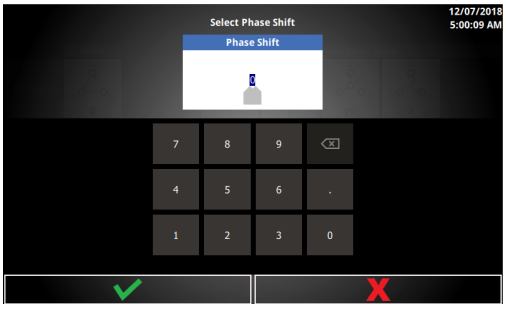
5.9.4 Secondary Vector Select Buttons

Button	Description
Primary Vector	See Primary Vector Selection Screen (5.9.2)
	Absolute Vector Expert Model Only See Absolute Vector selection (5.9.5)
	**Test Voltage Output** **Find Vector** See Find Vector (5.9.6)

5.9.5 Absolute Vector Selection

Expert Model Only

After selecting a secondary vector group, the absolute vector selection screen can be used to enter a non-standard (30°) phase shift.



5.9.6 Absolute Vector Option

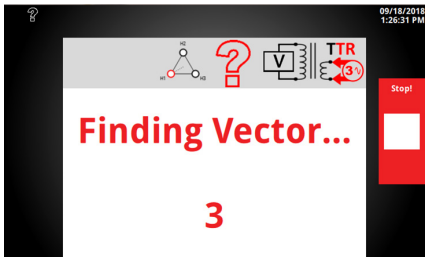
Option	Available Settings
Phase Shift	0° - 360° (0.1° steps)

5.9.7 Find Vector

Find vector should be used as a last resort. If the vector found does not match the nameplate, operator MUST check nameplate and validate this condition. When connected to the system, improper transformer phasing may result in catastrophic failure.

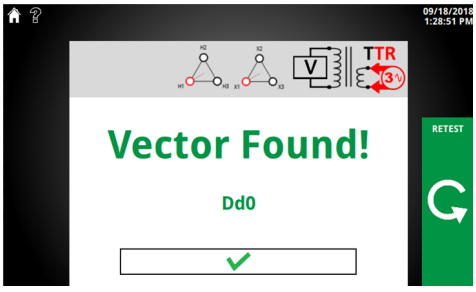
After selecting a secondary vector group, the find vector function will execute a test to find the phase shift.

1. First, a brief countdown is displayed



2. After the countdown, the test begins.

3. If no connection issues are detected, the vector found screen will be displayed. Select the confirm button to accept the results of find vector. This will update the secondary vector to the found vector.

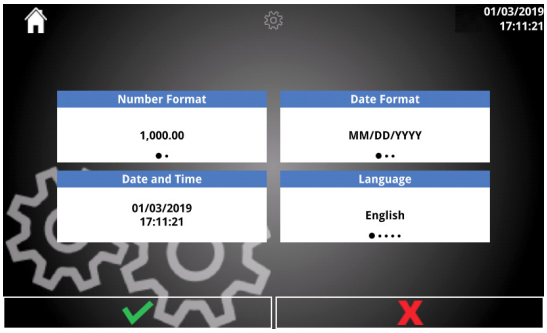


5.9.8 Find Vector Buttons

Button	Description
	**Stop!** Stop the test Emergency Stop recommended if safety hazards arise
	**Retest** Rerun the find vector test

5.10 Regional

Regional settings will configure the TTRU3 instrument for a specific locale.



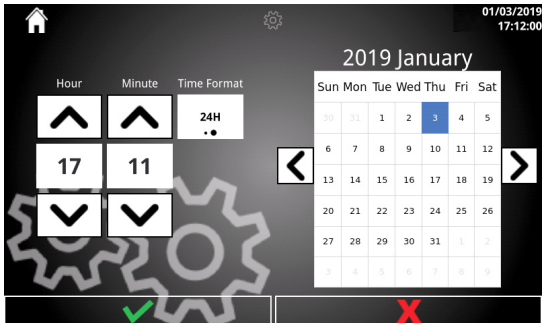
5.10.1 Regional Options

Option	Availabe Settings
Number Format	1,000.00 1.000,00
Date Format	MM/DD/YYYY DD/MM/YYYY YYYY/MM/DD
Date and Time	Date and Time screen
Language	English Deutsch Español Français Ukrainian

5.10.2 Date and Time

Unavailable from the PC application. Use your PC to set the date and time in the PC applicaion.

Configure the date and time of the TTRU3

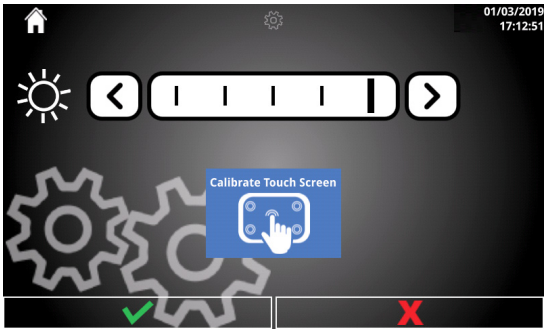


5.10.3 Date & Time Options

Option	Availabe Settings
Hour	1 - 24 *Based on Time Format*
Minute	0 - 59
AM/PM	AM PM *Based on Time Format*
Date Select	01/01/2019 - 01/01/2119
Time Format	12H 24H

5.11 Display

Set screen brightness and calibrate touchscreen



5.11.1 Display Options

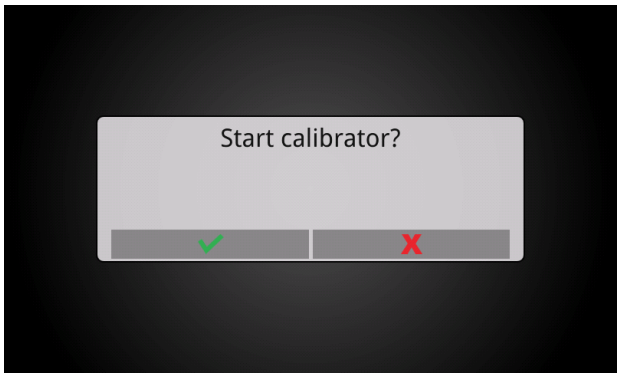
Option	Availabe Settings
Brightness	50% - 100%

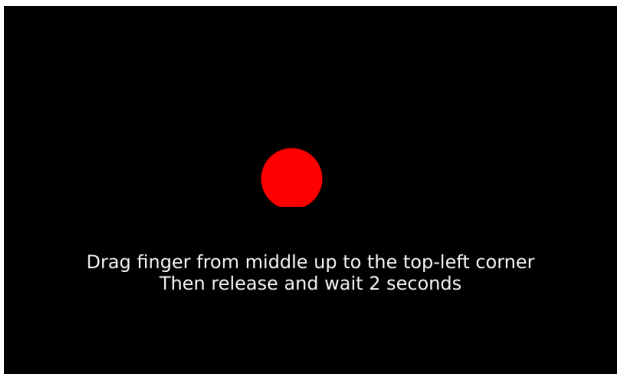
5.11.2 Display Buttons

Option	Availabe Settings
	Calibrate Touch Screen

5.11.3 Calibrate Touch Screen

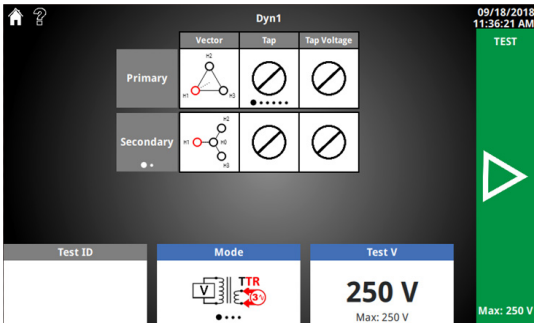
Follow the directions on screen to calibrate the TTRU3.





5.12 Quick Test Setup

Quick test is a simple ratio test. Includes phase deviation and excitation current measurements. Calculated ratio and error % available if tap information is entered



5.12.1 Quick Test Options

Options	Available Settings
Primary Vector	See Primary Vector Selection Screen (5.9.2)
Secondary	Secondary Tertiary
Secondary Vector	See Secondary Vector Selection Screen (5.9.3)
Primary Tap **Secondary Tap**	Options based on Default Nameplate
Primary Tap Voltage **Secondary Tap Voltage**	0 - 999,999V
Test ID	13 character Alphanumeric
Mode	Auto 3Ø Step Up 3Ø Step Down 1Ø Step Up 1Ø Step Down
Test V	1 – 125V Step Up (ADV model) 1 – 250V Step Up (EXP / PRO model) 1 - 48V Step Down

5.12.2 Quick Test Buttons

Options	Available Settings
	 **Test Voltage Output** Starts test

5.12.3 Test Modes

During every test, low voltage (less than 1V) is applied as a safety and connection test. If no safety or connection failures are found, the test progress as per the test mode selection.

Auto test mode uses the results of the safety and connection test to determine:

1. If the test can be performed in step up mode, and
2. If a 3Ø test is possible. If a 3Ø test is not possible, a 1Ø test is executed if no safety or connection issues are present.

Step up applies voltage to the secondary/tertiary and induces voltage on the primary.

Step down applies voltage to the primary and induces voltage on the secondary/tertiary.

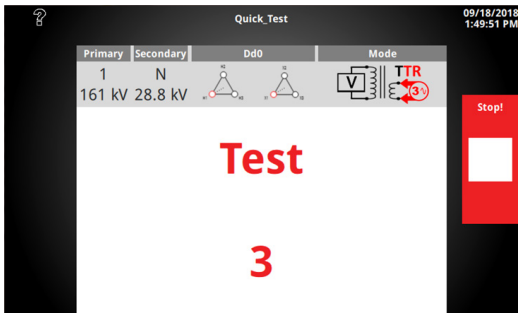
3Ø applies and measures voltage on all three phases simultaneously.

1Ø applies and measures all three phases individually.

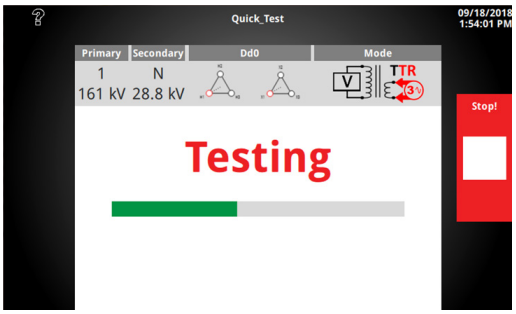
5.13 Test in Progress

After clicking Test, a prompt will appear to confirm the default Test ID if none was entered. If a Test ID was entered, or if the prompt is confirmed:

1. A brief countdown is displayed if Test Buzzer is enabled



2. After the countdown, the test begins.



5.13.1 Test in Progress Buttons

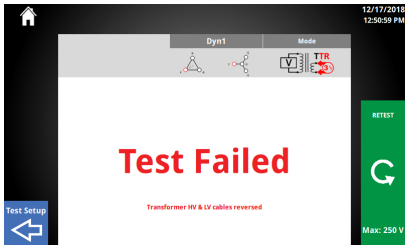
Button	Description
	**Stop!** Stop the test Emergency Stop recommended if safety hazards arise

5.14 Test Failed

A test can fail for a number of reasons, including but not limited to:

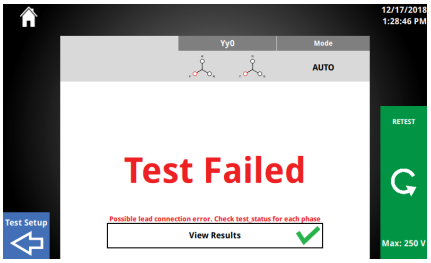
- Improper lead connections
- Improper vector selection
- Excessive current draw

If continuing a test is not possible due to safety or connection issues, the Test Failed screen will be displayed. Read the error message and the trouble-shooting guide to determine the cause and resolution to the failure.



5.14.1 With Results

When using Auto mode, a test with failures will continue in 1Ø mode if no safety or connection issues are present. A short circuit between leads is an example of a failure that would allow a test to continue in 1Ø mode.

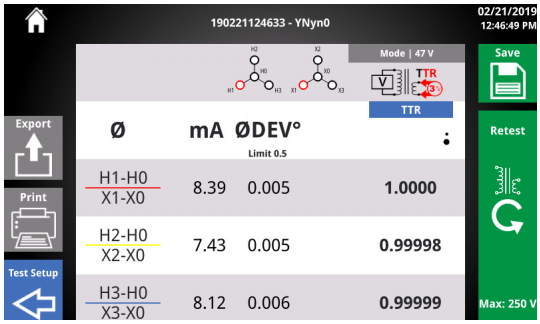


5.14.2 Test Failed Buttons

Button	Description
	Retest
	View Results
	Return to Test Setup

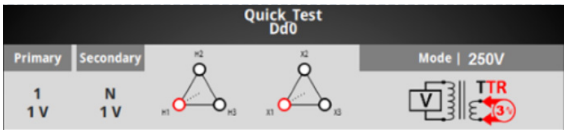
5.15 Test Success

When a test completes successfully, the screen below will be displayed.



5.15.1 Test Success Header

The header contains useful information about the test setup and how the ratio test was executed.



Information	Description
Test ID	From Test Setup Found at top of header
Vector Configuration	From Test Setup Found below Test ID Displayed as both ASCII text and vector
Primary Tap/Voltage **Secondary Tap/Voltage**	From Test Setup Found to the left of vector
Test Mode/Test Voltage	From Test Setup Test Voltage is voltage applied phase to phase

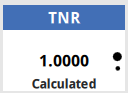
5.15.2 Ø Information

Below the header is Ø information. If a single Ø test is run, only one row of results will be available.

Winding	mA	ØDEV° 0.6	% 0.5	1.0000 Nameplate
H1-H3 / X1-X3	26.0	0.00	0.00	1.0000
H2-H1 / X2-X1	21.7	0.00	0.00	1.0000
H3-H2 / X3-X2	21.5	0.00	0.00	1.0000

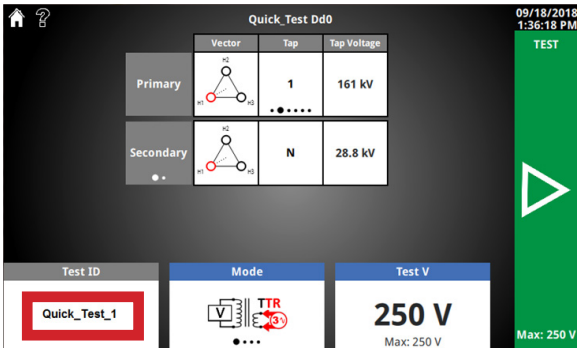
Information	Description
1st Row **Column Descriptions**	**Ø Labels** **mA** Current draw **Ø Deviation** ° or ″ based on settings **Limit displayed based on settings** **% Error** **Limit displayed based on settings** **Ratio** Nameplate/calculated ratio from tap voltages
2nd, 3rd, 4th rows **ØA, ØB, ØC Data**	**Ø Labels** Based on nameplate settings and selected vector **mA Current draw** **Ø Deviation** **Will display in red if exceeds limit** **% Error** Error calculated from nameplate ratio & measured ratio **Will display in red if exceeds limit** **Ratio** **Will display in red if exceeds % error limit**

5.15.3 Test Success Buttons

Button	Description
	**TNR/TTR** Change ratio display from phase to neutral (TNR) to phase to phase (TTR)
	**Save Result** Save and return to setup with new Test ID
	**Export Result** Exports to thumb drive, saves, and returns to setup with new Test ID
	**Print Result** **Available if optional printer connected.** Prints, saves, and returns to setup with new Test ID
	**Test Setup** Return to setup without saving result
	**Retest** Retest without saving result

5.15.4 Test ID Grouping

Test IDs will be incremented after each save, export, or print (_1, _2, _3, etc). This allows for quickly testing multiple taps, and when exported from the All Results screen the results will be grouped into excel and PDF reports.



5.15.5 Export Success

Insert a thumb drive to export results. A brief progress bar followed by the screen below will be dis-played after a successful export. The folder can be found in the root of the thumb drive.

5.16 OLTC Tap Change Home Screen

Pressing the physical tap up or tap down button while on the home screen will display a notification that the tap change is in progress. An progress bar will display while the tap change button is depressed.

After releasing the tap change button, a message will appear alerting the user to update the OLTC tap label and voltage. This message will disappear after two seconds.

OLTC operation assumes the tap changer cable has been connected to the OLTC. There is no feedback that the tap has been changed - it is the responsibility of the user to confirm the tap position before beginning the next test.

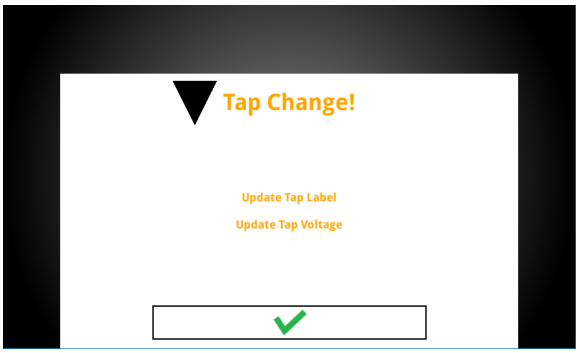
5.16.1 OLTC Buttons

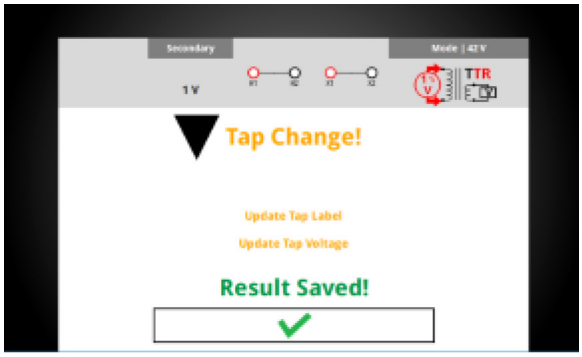
Button	Description
✓	**Confirm** Dismiss tap change notification (automatically disappears after 2s)

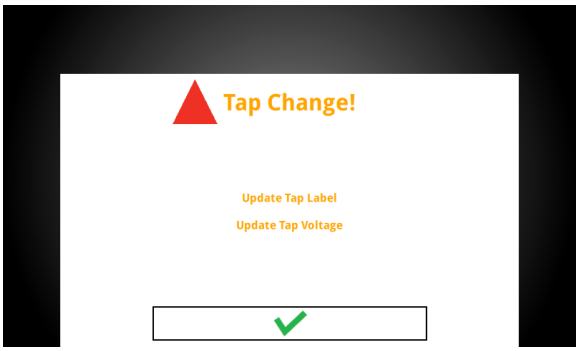
5.16.2 OLTC Tap Change Test Success

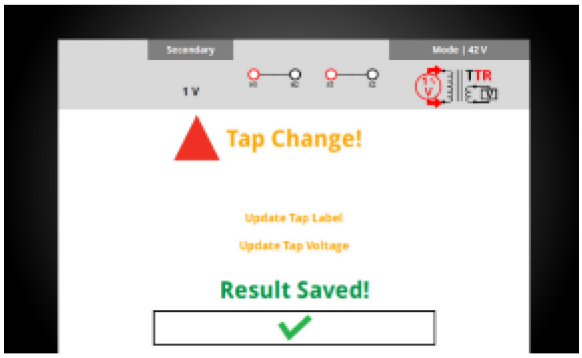
Pressing the physical tap up or tap down button while on the test success screen will display a notification that the tap change is in progress.

After releasing the tap change button, a message will appear alerting the user that the result has been saved, and to update the OLTC tap label and voltage.









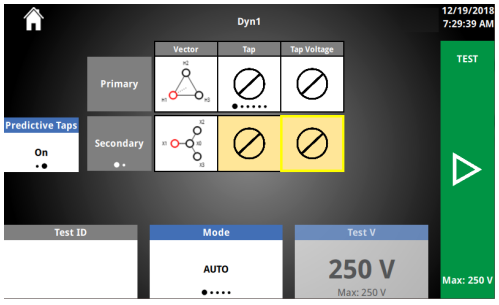
5.16.3 Quick Test Setup Predictive Taps

If the primary or secondary/tertiary is set to OLTC in settings and if the manual OLTC up/down button is activated while in Quick Test Setup or Quick Test Success, a new setting will appear: Predictive Taps.

Predictive Taps allows you to quickly test a transformer with an OLTC, without having to set up a test plan. After using the manual tap up/down button:

1. The OLTC winding tap label and voltage is highlighted yellow.
2. If a tap label was selected, the next tap label will be displayed.
3. If two tap labels and tap voltages have been entered, the next tap voltage will be displayed.
4. The rotary control knob will default to the OLTC tap voltage, allowing for quick adjustment of the voltage.

Predictive Taps will not predict correct tap labels and voltage for every OLTC tap change. It is the responsibility of the user to match the tap labels/voltages to the nameplate and adjust accordingly.



5.16.4 Predictive Taps Options

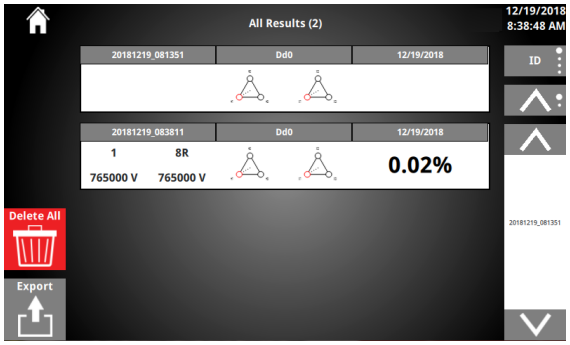
Option	Available Settings
Predictive Taps	On Off

5.17 Results

After running a test and saving a result, the results button will be enabled on the Home Screen.

Clicking on the results button will bring you to the all results screen.

Note that the max Ø % error is displayed for each individual result, if available.



5.17.1 Results Buttons

Button	Description
	**Delete All** Delete all results
	**Export** Exports all results
	Individual Result Click to review the result details

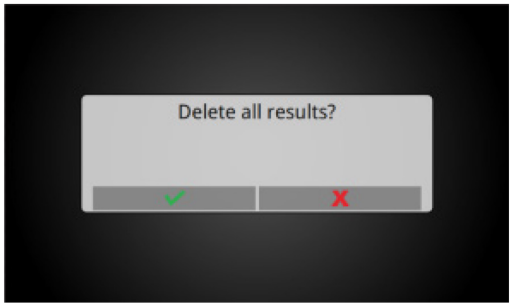
5.17.2 Results Options

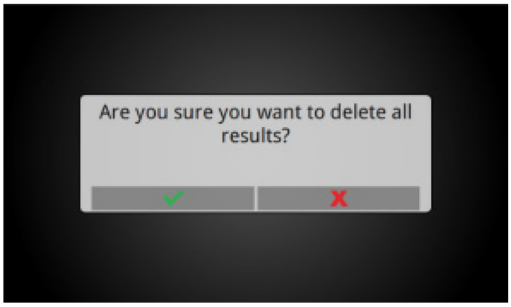
Button	Description
Sort Type	ID Date Vector # or Results
Sort Order	Ascending Descending
Scroll Bar	Scroll through available results

5.17.3 Delete All Results

Deleting all results requires double confirmation that the action is intended.

After deleting all results, the TTRU3 will return to the Home screen.



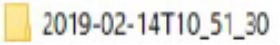


5.17.4 Export All Results

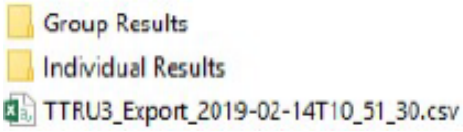
Periodically export all results and store locally, preferably on a network with sched-uled backups. **THE TTRU3 IS NOT INTENDED TO BE A PERMANENT REPOSITORY FOR YOUR TEST DATA.**

Insert a thumb drive to export results. A brief pro-gress bar followed by the screen below will be dis-played after a successful export.

Results are exported to the root of a thumb drive in a folder with a date/time stamp.

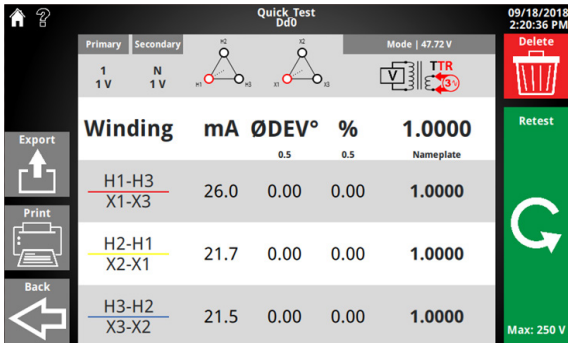


Within the date/time stamp folder, there is a CSV file will all the results for importing into PowerDB, a folder with grouped results based on file names (see section on Test ID Grouping), and a folder with individual re-sults.

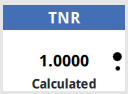


5.17.5 Review Result

The review result screen is nearly identical to the test success screen.

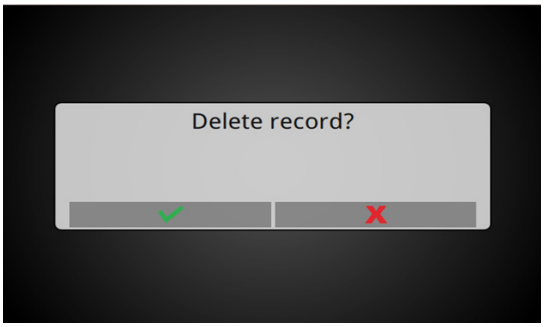


5.17.6 Review Result Buttons

Button	Description
	**TNR/TTR** Change ratio display from phase to neutral (TNR) to phase to phase (TTR)
	**Delete Result** Delete the result. Requires confirmation
	**Export Result** Export result to thumb drive.
	**Print Result** **Available if optional printer connected.** Prints result
	**Back** Return to All Results
	**Retest** Retest with prompt to overwrite.

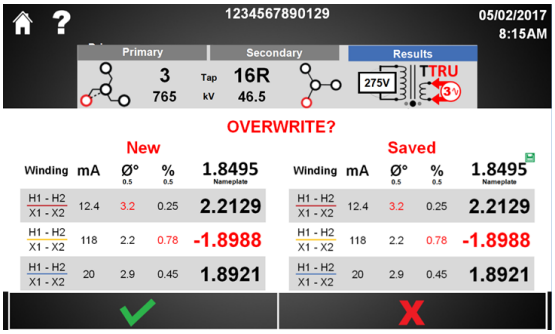
5.17.7 Delete Result

Deleting the result requires confirmation that the action is intended.



5.17.8 Overwrite Result

After retesting from a saved result, the TTRU3 will ask if the result should be overwritten.



5.17.8 Overwrite Result Buttons

Button	Description
✓	**Confirm** Overwrite saved results with new results
✗	**Cancel** Discard new results and keep saved results

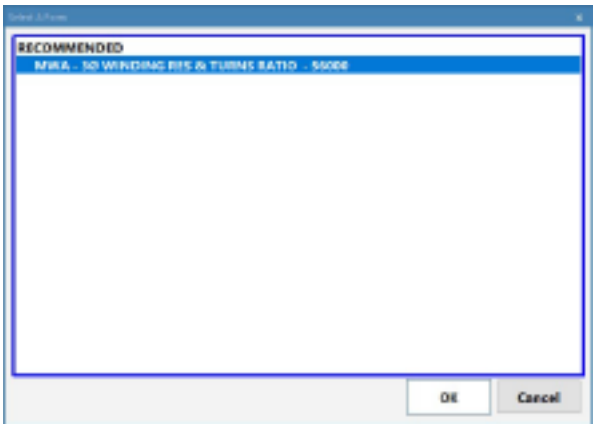
5.18 PowerDB 3Ø Form

PowerDB provides a 3Ø form for importing results and controlling the TTRU3 (as well as data from other Megger instruments).

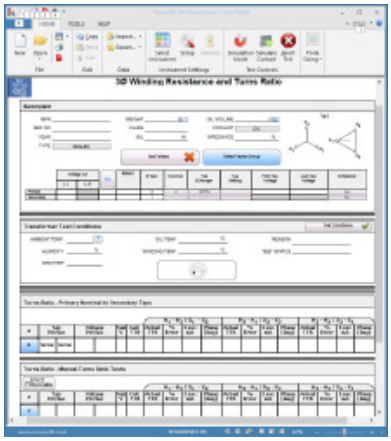
To begin using PowerDB, launch PowerDB Lite.

Next, select the TTRU3 from the Instrument Selection screen.

Select the Recommended 3Ø Form and select OK

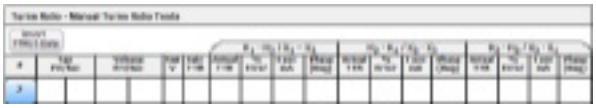


The form below will be displayed

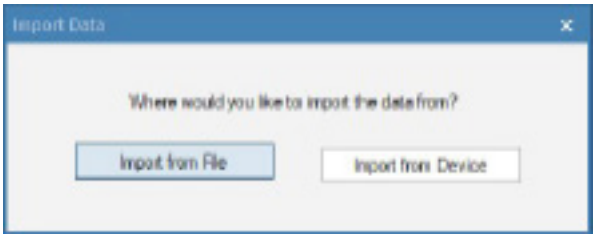


5.18.1 PowerDB Import from File

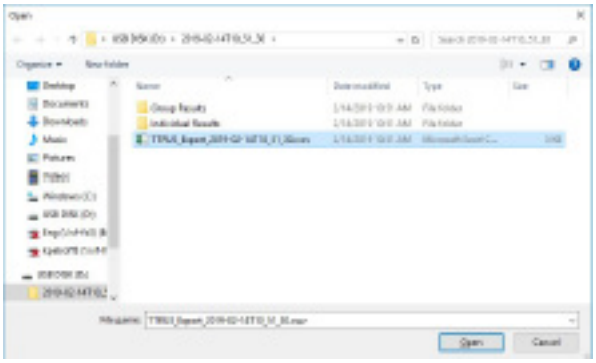
To import data exported to a thumb drive, find the table where there data should be imported and select "Import TTRU3 Data"



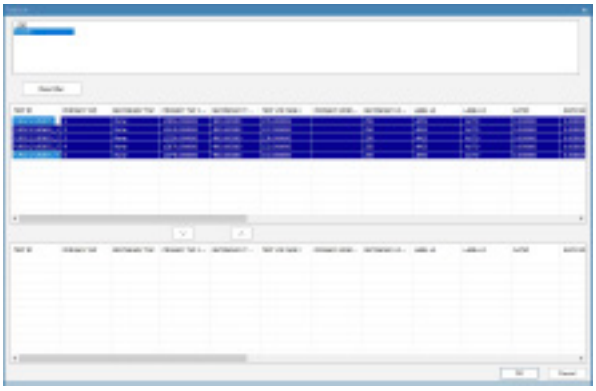
Next, select Import from file



Find the csv file that was exported and select Open

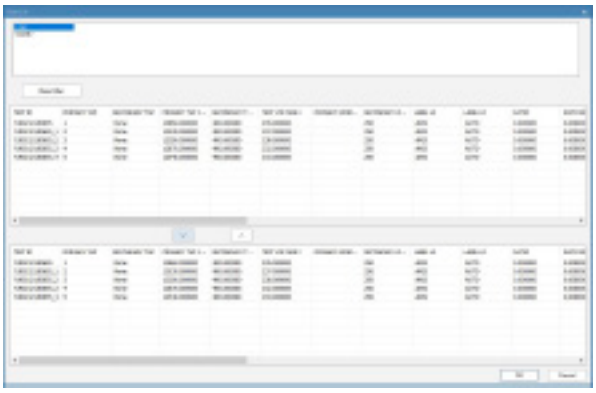


Select results from the top table using shift + left mouse click.

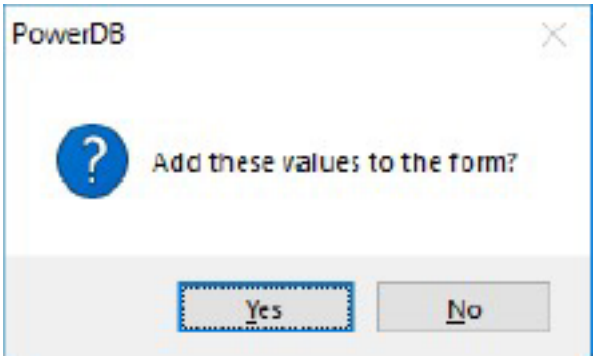


Select the Down arrow to transfer the data to the bot-tom table. Select results one at a time if you want to change the order of the data

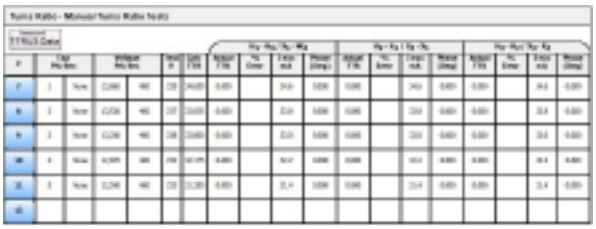
Select the Down arrow to transfer the data to the bot-tom table. Select results one at a time if to change the order of the data



Click Ok, then click Yes to add the data to the form.

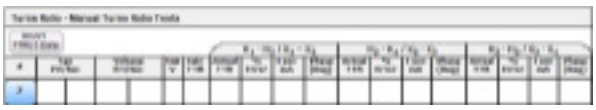


The data will now appear in the table in PowerDB

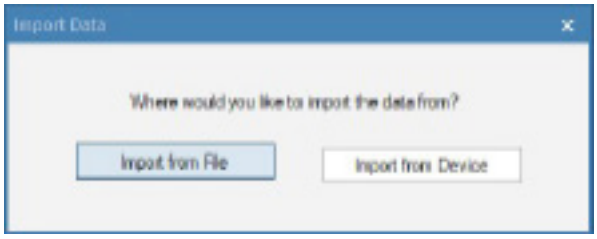


5.18.2 PowerDB Import from Device

To import data directly from the TTRU3, first connect the TTRU3 to a PC with the supplied USB B cable. Find the table where the data should be imported and select "Import TTRU3 Data"



Select Import from Device

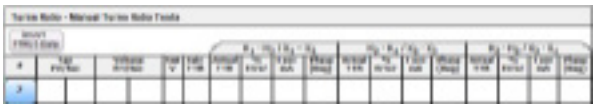


Follow the steps as outlined in 5.18.1 to complete the import.

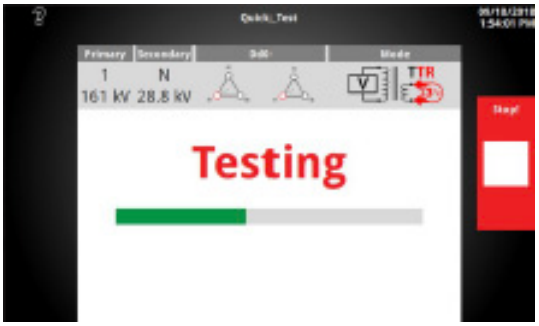
5.18.3 PowerDB Control

PowerDB Control is an optional SW feature

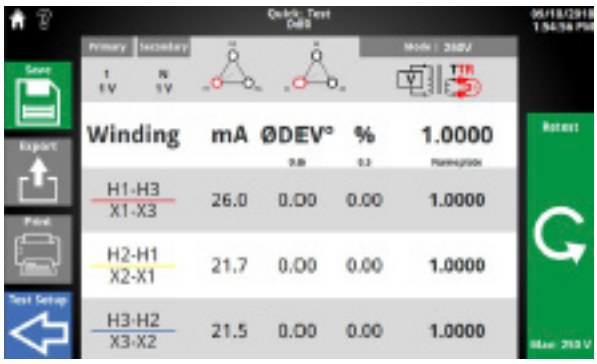
To run a test, click on the blue in the table where the result should be displayed.



The Test In Progress screen will be displayed.



After the test completes, click Save, Test Setup, or close out of the GUI to import the result to the form.



6 SERVICE

6.1 Troubleshooting

The Troubleshooting Guide is arranged to help you evaluate the reasons for TTRU3 malfunction. The possible test set malfunctions and causes are listed below. Electronic circuit repairs should not be attempted in the field. Refer to Repair section.

TTRU3 does not turn on

- Check that the power cord is fully inserted into the TTRU3.
- Check that the power source is outputting voltage at acceptable levels and frequency.
- Check that the power cord is fully inserted into the source.
- Check that the power switch is in the correct position (I).
- Set the power switch to off (O)
  Wait 30 seconds
  Set the power switch to on (I)
- Try another power cord

Self Check

- Connect the leads as described below
  H1 to X1
  H2 to X2
  H3 to X3
  H0 to X0
- Select Dd0, Yy0, or YNyn0 and perform a test
- Verify ratio between 1.0005 and 0.9995

TTRU3 Reports test failed, but still provides data

- Check lead connections. Reference Nameplate to ensure leads are connected to the correct bushing.

Printer not working

- Check battery is inserted into printer
- Charge printer battery using supplied charger
- Check printer paper is inserted properly
- Check USB cable is plugged into printer
- Check USB cable is plugged into TTRU3 USB port
- Check printer is turned on by holding power button
- Try other USB ports

OLTC moving in wrong direction

- Check the OLTC wiring diagram and ensure leads are connected to correct terminals.

Cannot connect TTRU3 to PC

Contact your IT department for primary assistance when connecting any device to your PC.

- Check USB cable is fully inserted into the TTRU3
- Check USB cable is fully inserted into PC
- Check the TTRU3 is powered on
- Check TTRU3 SW is installed
- Check TTRU3 is running
- Move USB cable to another USB port on your PC
- Try another USB Cable
- Try another PC

6.2 Maintenance

Maintenance should be performed only by qualified persons familiar with the hazards involved with high-voltage test equipment. Read and understand Sections 1, 2, 3, 4, and 5 before performing any service.

The TTRU3 requires only periodic inspection. Inspect all hardware items to ensure all are in good condition.

The TTRU3 may be cleaned periodically. In so doing, do not allow water to penetrate panel holes. An all-purpose, household spray cleaner can be used to clean the panel. Polish with a soft, dry cloth. Clean the cables and mating panel receptacles with isopropyl or denatured alcohol applied with a clean cloth.

6.3 Calibration

A complete performance and calibration check should be made at least once every year. This will ensure that the TTRU3 is functioning properly over the entire measurement range. The TTRU3 calibration is performed on each new or repaired unit before sending it to a customer.

6.4 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 and recommends that its customers take advantage of this service for routine maintenance or in the event of any equipment malfunction.

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

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

Your “One Stop” source for all your electrical test equipment needs

- Battery Test Equipment
- Cable Fault Locating Equipment
- Circuit Breaker Test Equipment
- Data Communications Test Equipment
- Fiber Optic Test Equipment
- Ground Resistance Test Equipment
- Insulation Power Factor (C&DF) Test Equipment
- Insulation Resistance Test Equipment
- Line Testing Equipment
- Low Resistance Ohmmeters
- Motor & Phase Rotation Test Equipment
- Multimeters
- Oil Test Equipment
- Portable Appliance & Tool Testers
- Power Quality Instruments
- Recloser Test Equipment
- Relay Test Equipment
- T1 Network Test Equipment
- Tachometers & Speed Measuring Instruments
- TDR Test Equipment
- Transformer Test Equipment
- Transmission Impairment Test Equipment
- Watthour Meter Test Equipment
- STATES® Terminal Blocks & Test Switches
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