

# User Guide

# RW-30

# RW-31

## Three-Phase Field Testing

## Portable Three-Phase Meter Site Source Analyzer



DW001302

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**R A D I A N**  
**WECO**  
Power and Energy Measurement Solutions



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# Introduction

WECO's next generation Meter Site Analyzer delivers three-phase field-testing utilizing the Radian Research RD-3X series reference standard integrated within the unit. The RW-3X allows you to execute a multitude of tests at the customer's site which includes testing with sources to ANSI requirements. Testing the meter with the customer's load, performing CT burden and ratio tests, and verifying system wiring gives you the peace of mind that the entire metering installation is correct. The RW-3X series also provides for Harmonic Analysis, CT Testing, Vectors, and Trends Testing all without ever pulling the meter from its socket. Using the RW-3X is a familiar process due to the Microsoft™ Windows® 7, 64-bit operating system embedded within the unit. Large internal storage allows for numerous test results, as well as custom site configuration and test sequences to be saved locally on the RW-3X. The convenient touch screen interface allows instant access to the Winboard Embedded application without the need for an external keyboard, mouse, or monitor. These, however, can be easily connected to the RW-3X, providing you with additional options. A durable screen protector supplies an extra safeguard for the 8.4" LCD touch screen while shielding against glare for better visibility. The RW-3X feature-rich software, designed with user-friendly screens, lead you through installation, wiring checks, testing, and record keeping. Unlimited test profiles, sequences and site configurations may be created and saved. Test results are fully compatible with WECO's industry specific WATT-Net™ software, providing centralized record keeping with data editing and report generation. Data can also be exported as Microsoft™ Excel, user-defined, or PDF files.

## Welcome

Welcome to the RW-3X User Guide. The purpose of this manual is to familiarize you with the RW-3X, its workflow, and feature set.

This document is not intended as an exhaustive discussion of every feature, editor, screen and option of the RW-3X. If you find you need more information or clarification of some function, you are urged to explore the RW-3X's Help System or contact Watthour Engineering at 601.933.0900.

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## About This User Guide

Watthour Engineering Company, Inc. makes no warranty on the accuracy of the information contained in this User Guide and accepts no liability for its use. The information contained in this User Guide remains the property of Watthour Engineering Company, Inc. It is provided in good faith for the operation and servicing of this Watthour Engineering Company, Inc. product. We reserve the right to take legal action where this information is divulged to third parties without our written consent or in circumstances that may cause us commercial harm. The operation of this equipment requires training and experience in electric meter testing. The information in this User Guide is designed to supplement existing knowledge and experience already attained and practiced by journeyman-level meter test technicians. Novice meter test technicians should not attempt to operate this equipment without first gaining the basic knowledge of meter testing and the application of meter testing equipment from a certified training course. Copyright © 2016 Watthour Engineering Company, Inc. Watthour Engineering Company reserves the right to change any information in this document without notice.

## Warning

Extreme caution should be observed when using this product. Any work with energized meters can present the danger of electrical shock. Electric Utility specified procedures for setting and removing watthour meters should be followed and performed by qualified personnel. Watthour Engineering Company, Inc. assumes no liability for the failure to comply with existing applicable safety precautions as well as those listed in this warning statement.

## General Safety Summary

- The operation of this equipment requires training and experience in electric meter testing. The information in this manual is designed to supplement existing knowledge and experience already attained and practiced by journeyman-level meter test technicians. Meter Technicians classified as beginners should not attempt to operate this equipment without first gaining the basic knowledge of meter testing and the application of meter testing equipment from a certified training course.
- Refer to and follow procedures and guidelines provided by your Electric Utility.

- Operation of this equipment involves high voltage. Always wear the appropriate personal protective equipment and follow all safety precautions specified for high voltage activities.
- Follow proper grounding techniques when using this equipment.
- Follow all safety guidelines contained in this User Guide.

## **FCC RF Radiation Exposure Statement**

**IMPORTANT NOTE:** To comply with the FCC RF exposure compliance requirements, the antenna used on this transmitter must be installed to provide a separation of at least 20 cm from all persons and must not be co-located or operating in conjunction with any antenna or transmitter. This device contains a low power transmitter. When this device is operational, use only with the supplied, or recommended antenna. Unauthorized antenna, modification, or attachments could damage the transmitter and may violate FCC regulations. Changes or modifications not expressly approved by the manufacturer or party responsible for compliance could void the user's authority to operate the equipment.

### **FCC Interference Statement**

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. This device may not cause harmful interference
2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates and radiates radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for assistance.



### **IC (Industry Canada) Statement:**

“This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device”

Le present appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de license. L'exploitation est autorisee aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioelectrique subi, meme si le brouillage est susceptible d'en compromettre le fonctionnement.

### **Europe – R&TTE Compliance Statement:**

Hereby, Radicom Research Inc. declares that this equipment complies with the essential requirements and other relevant provisions of DIRECTIVE 1999/5/CE OF THE EUROPEAN PARLIAMENT AND THE COUNCIL of March 9, 1999 on radio equipment and telecommunication terminal Equipment and the mutual recognition of their conformity (R&TTE).

### **CE Declaration of Conformity**

For the following equipment:

Radicom Research Inc. WiFi USB Modem Module Model(s):

WiFiHU2-a, WiFiHU2-c, WiFiHU2-a-1-NE, WiFiHU2

Model(s): WiFiHU2-a, WiFiHU2-c, WiFiHU2-a-1-NE, WiFiHU2

is herewith confirmed to comply with the requirements set out in the Council (European parliament) Directive on the Approximation of the Laws of the Member States relating to Electromagnetic Compatibility of Radio and Telecom device (1999/5/CE). For the evaluation regarding this Directive, the following standards were applied:

EN 61000-3-2:2006+A2:2009, EN 300 328 V1.7.1, EN 62311: 2008,

EN 301 489-1, V1.8.1, EN 61000-3-3:2008, EN 301 489-17 V2.1.1

EN 60950-1:2006+A11:2009+A1: 2010+A12:2011



This equipment is marked with the  and can be used throughout the European community.

France – 2.4GHz for Metropolitan France:

In all Metropolitan departments, wireless LAN frequencies can be used under the following conditions, either for public or private use:

- Indoor use: maximum power (EIRP\*) of 100 mW for the entire 2400-2483.5 MHz frequency band

- Outdoor use: maximum power (EIRP\*) of 100 mW for the 2400-2454 MHz band and with maximum power (EIRP\*) of 10 mW for the 2454-2483 MHz band

**Caution: Exposure to Radio Frequency Radiation.**

To comply with RF exposure compliance requirements, for mobile configurations, a separation distance of at least 20 cm must be maintained between the antenna of this device and all persons.

## **A Note On Existing Data**

Every effort is made at the factory to ship demo units that don't have any preexisting data stored on them (i.e. sites, test results, etc.). However, if your unit arrives with preexisting data present, it will be necessary to delete that information to ensure that your unit matches the unit described in this guide. Please contact WECO customer support at 601.933.0900 for assistance in removing data from your unit.

## **Overview**

To begin, we will familiarize you with the basics of the RW-3X. This section will introduce you to some of the major features that the RW-3X delivers.

## **True Three-Phase Reference Standard**

Accuracy of meter test results is ensured because the RW-3X incorporates a Radian Research three-phase, NIST traceable reference standard that is both powerful and easy to test for certification. The RW-30 ships with a powerful Radian Research three-phase reference standard, the RD-30, which boasts a 0.04% accuracy class. If your utility demands higher levels of accuracy, then you may choose the RW-31 complete with a Radian Research RD-31, supplying 0.02% accuracy. Accuracy verification of the embedded standard can be automated using the RW-3X's standards compare routine by utilizing a suitable external RD Standard. The unit can also be verified on a Radian RS-703A or a RS-933 system without disassembling the unit.

## **Site Analyzer Functions**

Site analysis is performed by auto-sequence testing and test profiles. The RW-3X's wiring check feature allows you to detect the service type (single-phase, WYE, Delta), display the potential and current for all three phases in an easy to read vector diagram, and alerts you to any possible wiring errors. Metric analysis

allows you to view primary and secondary metric information (instantaneous, averages, in-line or static data) for volts, amps, phase, power factor, delta phase, frequency, watts, VARS, and VA. Trend analysis allows you to track and graph metric information over time for all three phases. You can use waveform analysis to view potential and current waveform graphs for all three phases.

Furthermore, the harmonic capable reference standard expands metric analysis to include metric information for both potential and current THD per element. This allows you to display harmonic data (both RMS and % of fundamental) for all three phases up to the 60th harmonic as well as view harmonic data as either a bar graph or raw numbers. All site analyzer data can be saved and recalled for later use. Data can also be exported to a number of different formats including Microsoft® Excel. Harmonic data can also be saved in a format that allows you to perform ANSI testing of your meters using waveforms with specific harmonic content.

## **Measurement Functions**

The RW-3X system provides four quadrant, three-phase, simultaneous measurements for active, reactive, and apparent energy. Measurement functions include: watthours, VARhours, VAhours, Qhours, Volt hours, Amp hours, Volt squared hours, Amp Squared hours, Volts, Amps, phase angle, power factor, and frequency.

## **Customer Load Testing**

Using the direct connect current leads or optional clamp-on / flexible current probes allows you to perform a test of the meter using customer load. The RW-3X system ensures that a true meter accuracy test is being performed. Additional accessory options are available for the necessary meter pulse sensors and pickups.

## **Controlled Testing**

The RW-3X comes with electronic potential and current sources allowing a controlled parameter test of the meter. In addition, the RW-3X allows the user to create six independent harmonic waveforms, allowing for distinctive waveforms on all three phases of both the potential and current axes. Whether sinusoidal or distorted, both types of tests are solely under the user's control, and the test parameters can be repeated in the field or back at the meter shop. With the RW-3X, meters can be completely tested and analyzed for a wide range of repeatable test conditions.

## RW-3X Winboard Embedded Software

Using the RW-3X is a familiar process due to the Microsoft™ Windows® 7, 64-bit operating system embedded within the unit. Large internal storage (120 GB minimum) allows for numerous test results, as well as custom site configuration and test sequences to be saved locally on the RW-3X.

The RW-3X's user interface Winboard Embedded software was designed for ease of use with a high degree of functionality. Each function is accessible through the large touch screen. Enter test parameters using the touch screen or with one of the other options available such as a barcode scanner, mouse, or keyboard. You can also control the RW-3X from your iPhone or iPad by using WECO's Winboard Embedded Remote App — available for free in the iTunes App Store. Various test profiles may be created and saved. Saved profiles will appear as a selection list for the operator. Data can be exported to Microsoft™ Excel files and user-defined files. RW-3X test data is compatible with WECO's WATT-Net™, WATT-Net Plus™, and WATT-Net Express™ software, allowing the user to edit data and generate reports.

## Warranty

The RW-3X is warranted to be free from defects in material and workmanship. Any instrument or component will be repaired or replaced therein which, within two years after shipment, proves to be defective upon examination. Accessories carry manufacturer's warranty.

## Details

This section details the various specifications, features, options, and accessories of the RW-3X.

## RW-3X Base System Configuration

- Standard: RD-30-361 three-phase reference standard with measurements of Watt hours, volts, amps, phase angle, power factor, VAR hours, Q hours, watts, VA hours, VA, VARS, frequency, forward and reverse energy flow. Optionally test average responding Va hrs, VA, Volts, Vhrs, amps, Ahrs. Harmonic and transducer testing capable.
- Computing module consisting of an embedded computer, and Windows® 7, 64-bit embedded operating system
- Winboard Embedded Software
- Embedded WiFi Module ready for wireless connection

- Potential cable set with alligator clips (4 wire cable assembly)
- Current cable set with alligator clips (3 cable assembly, color-coded, one per phase)
- Current transformer Saf-T-Plug cable set for test switches to get in series with the current transformer secondaries
- Shop power cable for auxiliary power input using a standard wall outlet
- Field power cable for auxiliary power input with alligator clips
- 8.4", 640 x 480 pixel resolution, sunlight readable color LCD touch-screen display
- Ethernet cross-over cable
- Cable carrying case with removable shoulder strap

## Features

- Microsoft Windows<sup>®</sup>7, 64 bit operating system
- RW-30: three-phase Radian Research RD-30, 0.04% high-accuracy internal standard recognized and accepted by NIST
- Optional RW-31: three-phase Radian Research RD-31, 0.02% high-accuracy internal standard recognized and accepted by NIST
- Fuse protection on all voltage leads at the point of connection
- Auxiliary power is protected by the circuit breaker / power switch
- 2 USB ports
- 1 VGA port
- 1 Ethernet 10/100 port
- 1 Embedded WiFi Adapter
- 1 COM port
- 1 simple three wire KYZ input
- Advanced I/O port:
  - 4 KYZ inputs
  - 2 KZ inputs (can be configured as 1 KYZ input)
  - 1 KYZ output
  - 2 KZ outputs (can be configured as 1 KYZ output)
- Optical communications port
- 5 pin REDEL<sup>®</sup> connector for meter optical probes
- BNC connector for pulse out (standard pulses or test pulse), click switch input, and external standard compare pulse input
- Pulse LED
- Audio pulse volume control with mute
- 3 potential status LED's and 3 current status LED's (1 each per phase)
- 3 current transformer clamp-on inputs (1 per phase)
- Per phase color coded safety jacks for potential and current inputs/outputs
- Potential and current distinctively sized safety jacks to ensure effortless accurate connections

- 4 quadrant, 3 phase, simultaneous measurements for active, reactive and apparent energy and power. Functions include: Watt hours, volts, amps, phase angle, power factor, VAR hours, Q hours, watts, VA hours, VA, VARS, frequency, forward and reverse energy flow. Optionally test average responding Va hrs, VA, Volts, Vhrs, amps, Ahrs.

## Specifications

- **Voltage Sources:**
  - Voltage output: 20 to 600 volts AC with 100mV resolution, 30VA per phase
  - Voltage accuracy: +/- 0.2%, +/- 10mV true RMS
  - Voltage harmonic distortion: Less than 1% THD worst case (pure sine wave selection)
  - Harmonics sourcing: Through the 60th order, user-defined per phase
- **Current Sources:**
  - Current output: 0.01-30A per phase with 1mA resolution, 50VA per phase, 2.5V max compliance
  - Current accuracy: +/- 0.2%, +/- 1 mA true RMS
  - Current harmonic distortion: Less than 1% THD worst case (pure sine wave selection)
  - Harmonics sourcing: Through the 60th order, THD user-defined per phase
- **Energy Measurement Error Direct (0.2A to 30A and 30V to 600V):**
  - Energy Error for active, reactive and apparent power is subject to the selected integrated Radian Reference Standard:
    - RD-30 : 0.04% Accuracy class
    - RD-31 : 0.02% Accuracy class
- **Power Measurement Error, Indirect with MN03 clip on CT and RC-CTA1 adapter (0.2A to 100A, PF = 1):**
  - Active and Reactive: 0.20% Accuracy class
- **Phase Control:** 0°-359.95° in 0.05° steps
- **Phase Accuracy:** +/- 0.10°
- **Test Frequency:** 45-65Hz in 0.001Hz steps
- **Test Frequency Accuracy:** 0.005%
- **Auxiliary Power Input Range:** 90-300V AC; 6 amp breaker
- **Input Frequency Range:** 45-65Hz (fundamental)
- **Case Dimensions and Base Weight:** 20"W × 9"D × 16.5"L, 43.6 lbs (508mm W × 228.6mm D × 419.1mm L, 19.77kg)

- **Temperature:**
  - 0°C to 55°C (32°F to 131°F) operation
  - -20°C to 70°C (-4°F to 158°F) storage
- **Humidity:**
  - 0%-95% non-condensing

## Touring the Unit

Now we'll take a look at the RW-3X's hardware, leads, and accessories.

## The Basic Unit

The RW-3X ships from Watthour Engineering's factory loaded with accessories that save you time and effort both in the field and back at the shop.

## Standard Leads

Many common connections you'll need for day-to-day testing and to keep you and your equipment safe are included.

### Cable Sets

**(BW0157XX) RW-30 / RW-31 Portable Three-Phase Meter Site Source Analyzer Basic Cable Set** ---- The RW-3X ships with this Basic Cable Set which includes the following:



**(BW0115XX) RW-3X Analog Sense Cable** ---- The Analog Sense Cable easily clips to the output terminal of a transducer permitting accuracy testing for a wide variety of transducers.



**(BW0148XX) RW-3X Potential Cable Assembly Set, 2mm Right Angle Plugs** ---- Connect your RW-3X into the meter test switch and take control of the amount of potential applied to the meter. Our standard potential leads are 8 ft long with alligator clips which are designed for safety and durability. 1000V, 550mA inline fuses provide over-current protection for the RW-3X voltage channels.



**(CF000076) Fuse 6.3 x 32, 500mA 1KV, Very Fast Acting** ---- Replacement fuses for BW0148XX. 3 spare fuses are included with the basic cable set.



**(BW0149XX) RW-3X Braided 'A', 'B', 'C' Phase Current Cable Set with Saf-T-Plugs** ---- The current cable set with Saf-T-Plugs connects the RW-3X to the test switch allowing you to read the secondary current of the transformer as well as burden test the current circuit. This is a braided, 3 color-coded (red, yellow, blue) 8 ft cable.



**(BW0096XX) RW-3X Bypass Current Cable Set for Use with Saf-T-Plugs** ---- This cable set is used with the Phase Current Cable (BW0149XX) to jumper around the test switch and inject current into the meter.



**(BW0150XX) RW-3X Braided 'A', 'B', 'C' Phase Current Cables with Alligator Clips** ---- The current cable set with alligator clips allows you to connect the RW-3X to the current tabs of on a meter test switch. Once connected the RW-3X can control the current applied to any transformer rated meter. This is a braided, 3 color-coded (red, yellow, blue) 8 ft cable.



**(BW0151XX) RW-3X Field Power Cable** ---- Each RW-3X shipment includes a field power cord with alligator clips that connect to the bottom of the test switch, providing a convenient and safe way to power the unit at the site.



**(CE000040) CAT5e RJ45M to RJ-45M Cross-Over Cable, 10 ft, Orange** ---- With the supplied Ethernet crossover cable, it is a cinch to directly connect the RW-3X to an external laptop for control of the unit without having to connect it to a network.



**(CE110021) Shop Power Cord, 9 ft 10 in** ---- Back at the shop, the AC shop power cord provides a convenient way to power the RW-3X from a standard 120VAC power outlet.



**(CH001003) Test Switch Current Isolator** ---- Don't waste time hunting around the shop for something to use to isolate currents in the test switch. The RW-3X ships with a set of six current isolators that are portable, durable, and provide great current isolation between test switches.





**(CM000180) Nylon Portfolio Bag** ---- The RW-3X's nylon portfolio bag gives meter testers the ability to grab-and-go. With ample storage room for all of the cables and leads that come standard with the RW-3X, this bag is both convenient and portable.

**(BW0193XX) RW-30 / RW-31 Portable Three-Phase Meter Site Source Analyzer Alternate Basic Cable Set, 8mm / 4mm pins, South America** ---- The RW-3X ships with this *Alternate* Basic Cable Set which includes the following:



**(BW0115XX) RW-3X Analog Sense Cable** ---- The Analog Sense Cable easily clips to the output terminal of a transducer permitting accuracy testing for a wide variety of transducers.



**(BW0191XX) RW-3X Potential Cable Assembly Set, 2mm Right Angle Plugs** ---- Our standard potential leads are 8 ft long and are terminated with 4mm pins. 1000V, 550mA inline fuses provide over-current protection for the RW-3X voltage channels.



**(CF000076) Fuse 6.3 x 32, 500mA 1KV, Very Fast Acting** ---- Replacement fuses for BW0191XX. 3 spare fuses are included with the basic cable set.



**(BW0192XX) RW-3X Braided Current Cables terminated with 8mm Pins** ---- This provides the current connections to the meter under test.



**(BW0190XX) RW-3X Field Power Cable terminated with 4mm Pins** ---- A convenient way to power the unit at the site.



**(CE000040) CAT5e RJ45M to RJ-45M Cross-Over Cable, 10 ft, Orange** ---- With the supplied Ethernet crossover cable, it is a cinch to directly connect the RW-3X to an external laptop for control of the unit without having to connect it to a network.



**(CE110021) Shop Power Cord, 9 ft 10 in** ---- Back at the shop, the AC shop power cord provides a convenient way to power the RW-3X from a standard 120VAC power outlet.



**(CM000180) Nylon Portfolio Bag** ---- The RW-3X's nylon portfolio bag gives meter testers the ability to grab-and-go. With ample storage room for all of the cables and leads that come standard with the RW-3X, this bag is both convenient and portable.

## RW-30 Standard

The RW-30 base unit ships with a powerful NIST traceable, RD-30-361 Radian Research® reference standard integrated within the unit that boasts a guaranteed 0.04% accuracy margin of error.

## RW-31 Standard

The RW-31 unit ships with a powerful NIST traceable, RD-31-361 Radian Research® reference standard integrated within the unit that boasts a guaranteed 0.02% accuracy margin of error.

## RW-3X Optional Accessories

Add unprecedented versatility to your RW-3X with optional accessories designed to prepare you for almost any testing situation.

## Optics Options

**(AW0005XX)RW-3X OPTOCOM™ Optics Kit** ---- Increase the versatility of your field testing with WECO's OPTOCOM™ option. Attach the optic coupler head to properly equipped solid state meter and forget about alignment. When the test is complete, you can program the meter right at the site without having to change out optic heads. Connects to Optics Port 1.



**(AW0017XX)RW-3X Reflect and Solid State Optics with Meter Band Clamp** ---- This optics solution combines both reflect optics for mechanical meters and pulse detecting optics for solid state meters in one convenient package. Lock down optics arm, easy mode selection, LED indicators, and a secure grip band clamp make this a valuable addition to any field test kit. Connects to Optics Port 2.





**(AW0040XX) RW-3X Magnetic Mount Optics, Visible, IR and Mechanical Meter Disk Sensor** ---- This option combines both reflect optics for mechanical meters and pulse detecting optics for solid state meters into one handy tool. Attach this optics solution with the flip of a switch to any can-mounted meter. The LED indicators and mode selection make testing a snap. Connects to Optics Port 2.



**(AC0015XX) Magnetic Mount Optics Kit, IR and Mechanical Meter Disk Sensor** ---- This has been a workhorse for many years, however operation in direct sunlight is a challenge. The AW0017XX and AW0040XX have been developed to address this issue and will perform in direct sunlight. Connects to Optics Port 2.



**(AW0006XX) RW-3X Solid State Optics Probe Assembly, Suction Cup, IR Detector** ---- When you are faced with a meter enclosure that does not accommodate magnetic or clamp based optics use WECO's Solid State IR Optics Probe Assembly with suction cup attachment to detect the meter's IR emitter. Connects to Optics Port 2.



**(AW0007XX) RW-3X Solid State Optics Probe Assembly, Suction Cup, Visible Detector** ---- Don't let enclosures that prevent magnetic or clamp based optics attachments keep you from getting quick test results. WECO offers the Visible Solid State Optics with Suction Cup attachment to make sure you can test meters equipped with visible LEDs. Connects to Optics Port 2.



**(AW0008XX) RW-3X Click Switch Adapter** ---- Sometimes optics just are not an option, and that's when you turn to WECO's Click Switch Adapter. Visually observe the disk's rotation and manually register revolutions with the click of a button. Connects to Optics Port 3.



**(AW0020XX) RW-3X Power Cable for Radian RM-DS Meter Disk Sensor** ---- This adapter cable plugs into the RW-3X Optics Port 2 to power Radian's RM-DS meter disk sensor. This cable plugs into Optics Port 2. The RM-DS connects to Optics Port 3.



**(AW0033XX) RW-3X Optics Extension Cable, 33 ft (10 meters) -**

--- When your standard optics cable just isn't long enough, reach for WECO's Optics Extension Cable. This cable adds 33 ft (10 meters) to the allowable distance between your optics sensor for the Optics 2 Input and RW-3X. This cable is used with any of the optics that connect to Optics Port 2.

## External Current Probe Options



**(AW0027XX) RW-3X 20 amp .47"[12mm] Jaw Transformer Rated Probe Kit, 5 ft + 25 ft Leads** --- This small, compact probe with a .47" jaw opening is used to measure currents from 40mA to 10A, 600 V maximum.



**(AW0013XX) RW-3X Current Probe, 100 amp .47"[12mm] Jaw Transformer Rated Probe Kit, 5 ft Leads + 25 ft Extension** --- The "clothespin" style current probe is most often used for secondary current measurements from 400mA to 100A, 600V maximum.



**(AW0014XX) RW-3X 1000 amp, 2.25" Clamp On Probe Kit, 25 ft Leads, 600 Volts** --- The circular clamp-on probe is used for current measurements with a range of 2.0A to 1000A, 600 V maximum for conductors up to 2.25" maximum.



**(AW0028XX) RW-3X 3000 Amp Square Jaw Probe Kit, 25 ft Leads, 600 Volts** --- This square clamp is great for higher currents, up to 3000A. The square jaw permits multiple conductors or bus bar positioning.



**(AW0010XX) RW-3X AmpFlex® Current Probe Kit , 100/1000 Amps, 1000 Volts, 36 in, 25 Ft Current Probe**--- The AmpFlex® current probe kit includes a flexible current sensor for measurements on conductors where standard clamp-on probes cannot be used. The 36 inch sensor with electronic module and a calibration adapter can measure up to 1000 amps, 1000 V maximum.



**(AW0052XX - 24 in), (AW0026XX - 36 in) RW-3X AmpFlex® Current Probe Kit, 3000 Amps, 1000 Volts, 25 Ft Current Probe Extension Cable (AW0018XX) ----** The AmpFlex® current probe kit includes a flexible current sensor for measurements on conductors where standard clamp-on probes cannot be used. The sensor with electronic module and a calibration adapter can measure up to 3000 amps, 1000 V maximum.



**(AW0011XX) RW-3X High Voltage Current Probe Kit, 2000 Amps, 150kV ----** The high voltage current probe kit includes a fiber optic isolated current probe with 3.85" wide jaw for current measurements of primary conductors above 600V to 150kV. Use to test CT Ratios. Detachable line hanger, adapter and probe with hot stick mounting capability all come in a convenient carrying case.



**(AW0059XX) RW-3X CT Current Boost, 200 Amps, 150kV ----** Use this CT Current Boost module at sites where current is low. For use with through-hole CTs only.

## External Voltage Probe Options



**(AW0023XX) RW-3X 600V Voltage Probe Kit for Low Voltage PT Testing ----** The 600V PT Probe allows you to check the voltage on systems that are 600 volts and less, allowing you to verify the potential transformer is working correctly.



**(AW0012XX) RW-3X High Voltage Probe Kit, 40kV ----** This high potential kit is a power quality tool for 10kV to 40kV applications. Determine primary voltage from primary conductors. Use to test PT Ratios. A fiber optic link provides the isolation. Kit comes complete with carrying case, hot stick mounting capability, and adapters.

## Probe Options — Extensions and Adapters



**(AW0018XX) RW-3X Current Probe Extension Cable, 25 ft** ---- Extend the distance from the RW-3X to the test location by 25 ft with this cable. Connect up to four to increase the overall distance to 100 ft. This option works with all probes listed above.



**(AW0019XX) RW-3X Adapter Kit for Customer Supplied Sensor Link Probe** ---- For customers who already own compatible sensor link voltage or current probes, this low cost adapter kit makes it possible to use with your RW-3X. Note: for reliable accuracies, send your probe to WECO for calibration.

## KYZ Cables Options



**(AW0009XX) RW-3X Form-C KYZ Cable Set, 6.5 ft (3 wire front panel jacks)** ---- All you need is a KYZ cable set to conduct a KYZ test or use the KYZ connection to test the meter. Three plugs connect right to the RW-3X front panel jacks by standard yellow, black, and red cables with alligator clips to the meter.



**(AW0022XX - 8 ft), (AW0025XX - 12 ft), (AA0029XX - 18 in) RW-3X Advanced I/O KYZ Breakout Cable** ---- This cable is used to connect KYZ outputs from meters into the RW-3X's Advanced I/O Connector. The connector has two Form A input channels that can be independently configured as four Form C input channels. The Advanced I/O Connector also has two Form A output channels and one Form C output channel.

## Additional Voltage And Current Lead Options



**(AW0046XX) RW-3X Voltage and Current Cable Alternate Termination Assembly Set, Right Angle, Customer End Unterminated** ---- This set includes a RW-3X Potential Cable with right angle, customer unterminated ends and a RW-3X 'A', 'B', 'C' Phase Current Cable with right angle plugs, customer unterminated ends.





**(AW0048XX) RW-3X Voltage and Current Cable Set, Switchboard Meters, 4mm Plugs for Test Paddle Terminations**



**(AW0049XX) RW-3X Voltage and Current Leads Extension Kit, 12 ft** ---- This extension kit increases the distance from the RW-3X to your test switch by 12 ft. It supports up to 600V and 15A per phase. This also includes a 12 ft optics and optics coupler extension.



**(AW0050XX) RW-3X Braided 'A', 'B', 'C' Phase Current Cables with Open CT Saf-T-Plugs, Right Angle Plugs** ---- Right Angle Plugs are highly recommended. The special Saf-T-Plugs have a protection circuit at the test switch connection which will short the CT if an open circuit condition is detected.

## Standards Compare Kits

Use an external standard and a WECO Standards Compare Kit you can make sure your RW-3X's internal standard is delivering the high accuracy results you need. All of the necessary cables are included, and the RW-3X's on-board software provides simple to use test step entry to make the standards compare test a snap.



**(AL0032XX) RW-3X Standards Compare Kit for an External RD-2x or RD-3x Standard**



**(AL0033XX) RW-3X Standards Compare Kit for an External RM Standard**



**(AW0047XX) RW-3X Cable Set for RM/RD/uJoule Interchange Standard** ---- This cable set allows for an external Radian standard or uJoule to be put in series with the RW-3X during a meter test for tie line testing.

## Miscellaneous Options



**(AX0023XX) RW-3X, Barcode Scanner Option** ---- The RW-3X's onboard software has been built from the ground up to take full advantage of barcode scanning to save you valuable time when meter testing in the field. With just one scan of a barcode you can automatically enter the meter's faceplate information, load the appropriate test sequence, and recall the last saved results for that particular meter.



**(CA000581) TTS-8 Temporary Test Switch for 5S meter** ---- This allows you to remove a socket meter, plug in the adapter with the test switch and then plug the meter into the adapter for 5S meters.



**(CA000579) TTS-13 Temporary Test Switch for 6S and 9S meters** ---- This allows you to remove a socket meter, plug in the adapter with the test switch and then plug the meter into the adapter for 6S and 9S meters.



**(AE0016XX) Model 3230 M3230 3-Phase Shop Stand Adapter for RW-3X, Integrated Smart Socket, USB Interface** ---- This allows you to utilize the RW-3X's features while on site in the van, as well as back at the shop.

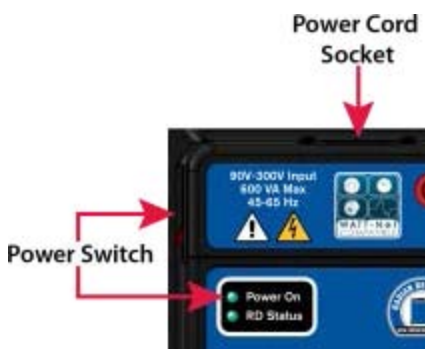


# The Front Panel



The RW-3X front panel serves as the primary point of interaction between the user and the unit. The front panel features numerous connections for meter and transformer connections, auxiliary power, optics, and optional input devices. The RW-3X's Winboard Embedded software can be completely controlled through the unit's full color 8.4" touch screen.

## The Top Panel



The auxiliary power panel contains the connections necessary to power the unit from either an electrical outlet or from the potential provided (between 90 and 300 Volts) at a customer's site. It is vital to the safety of both the user and the unit that the ground wire be connected to the earth ground connection.



The RW-3X requires a minimum potential of 90 Volts and a maximum potential of 300 Volts to operate. (600 VA Max. 45-65 Hz)



The symbol is a friendly reminder to read the manual. If you find you need more information or clarification of some function, you are urged to contact Watthour Engineering at 601.933.0900.



Winboard Embedded test results are fully compatible with the WECO industry specific WATT-Net™ software, providing centralized record keeping with data editing and report generation.

The green LED labeled **Power On** indicates when the unit is powered up.

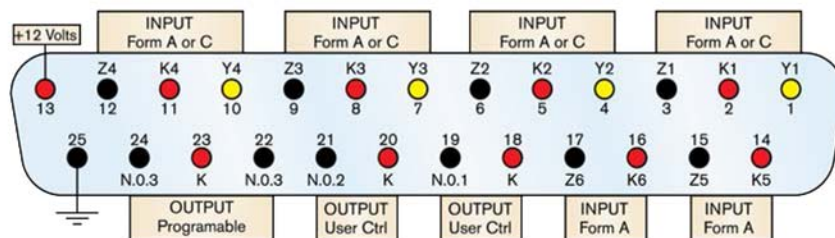
The **RD Status** LED is a tri-color LED. Green indicates the standard is ready to use. If there is an error, the LED will blink out an error code using a color for each phase: red, yellow, or green.

### KYZ and Advanced I/O



The KYZ and Advanced I/O connectors are located on the left of the top panel. The KYZ connectors are color coded with red indicating the K connection, yellow indicating the Y connection, and black indicating the Z connection.

The advanced I/O connector provides many capabilities for the testing of solid state meter. It can accommodate up to six Form A contact inputs or four Form C and two Form A contact inputs. For outputs, it has one programmable output allowing 0.01 to 40 seconds between contact transitions and a quantity of pulses (1 to 4094) to output. In addition, two outputs can be software set high or low. There is also an unregulated 12VDC output. The following illustration depicts the connection diagram of the advanced I/O connector:

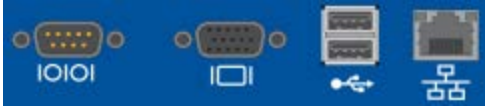


*Test example for KWH test using advanced I/O connector*

To test a Form 9 that has a KYZ1 constant of 0.5, you need to set that constant in the Form Defaults editor or Site Information editor. After the constant is set, you can then setup a test sequence for that meter with the optics set to KYZ1. When it

comes time to test the meter, you make the proper connections, open the Meter Testing screen, select the Form 9 and the correct test sequence, and run the test. Alternatively, if you are using site information you would load the site information, open the Meter Testing screen (all the correct set up information automatically loads), and run the test.

### Input / Output Panel



your RW-3X.

The I/O panel, located on the right side of the top panel, contains a number of connectors that allow you to extend the functionality of

The RS232 connector located on the left side of the I/O panel is a multi-function connector that can be used for a variety of operations including barcode scanning, meter programming via an external PC, or external control of the internal RD Standard.

To the right of the RS232 connector is a VGA connector used to connect an external monitor to the RW-3X.

To the right of the VGA connector are two USB 2.0 ports located one above the other. These can be used for connecting an optional keyboard, mouse, or other input device. The optional Model 3230 Smart Shop Stand is connected using one of these USB ports.

On the far right of the I/O panel is an 10/100 Ethernet port that can be used to connect the RW-3X to a local area network. This can be very useful for transferring test results from the RW-3X to a central database. With the provided crossover cable, the unit can be controlled from an external computer using Remote Desktop or VNC software.

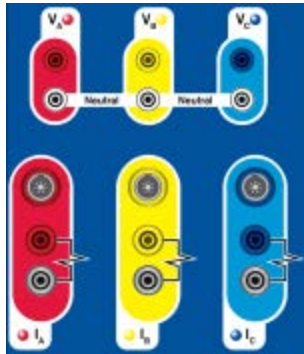
### The Main Panel

#### Radian Reference



The RW-3X Portable Three-Phase Meter Site Analyzer utilizes a NIST traceable Radian Research RD-3X series reference standard integrated within the unit.

## Test Lead Connection Panels



The test lead connection panel houses the mating connectors for the potential and current test leads. This panel contains color-coded red, yellow, and blue markings, to distinguish between the A, B, and C phases, respectively.

The top half of the test lead connection panel contains the 2mm sockets necessary for connecting the unit's potential test leads. The color-matched connectors represent "Line." The white connectors represent "Neutral." Note that all three neutral connectors are shorted together internally. The potential cable set included with the unit has only one neutral lead which can be plugged into any of the three potential neutral connectors.

The lower half of this panel's connectors are used for any of the supported current lead sets or external clamps. Use the 7-pin REDEL<sup>®</sup> connectors for connecting optional external CT/PT measurement clamps or probes. Below the clamp inputs, the color-matched 4mm sockets provide current source (+) connections with the black sockets providing current return (-) connections.

Six color-coded LEDs accompany their respective potential and current connections. When lit, these LEDs indicate that the unit is currently generating voltage and/or current.

## Optics Connection Panel



The optics connection panel contains three different connectors, each suited to a particular type of optics. The connector labeled "1" is reserved for an OPTICOM optics cable. OPTICOM optics allows the user to not only detect pulses from solid state meters but also allows the user to program the meter without changing the optical head. This connector may also be used for custom pickups as required. Contact Watthour Engineering for any special needs that may not be met by the standard set of pickups.

Connector "2" is a REDEL<sup>®</sup> connector reserved for a wide variety of optional optics accessories, including clamp-on and suction-cup based reflect and solid state optics.

Connector "3" is a BNC connector reserved for an optional click-switch adapter that is used when other optics aren't suitable. The BNC connector is also used

when conducting a standards compare test. During normal testing, when Input 3 is not the source, this connector also outputs the test pulse.

The red LED at the top of the optics panel provides a visual indication that the unit has detected a pulse.

### Volume Control



The volume control is used to control the volume of the audible pulse the unit generates to echo pulses detected when conducting a meter test. The buttons on the top and bottom raise and lower the volume respectively. Clicking the middle button will mute the unit. The blue LED above "Volume" illuminates to indicate that the unit is muted.

### Under the Hood



The RW-3X's built-in computer boasts an embedded Intel® Atom™ N450, 1.66 GHz processor running Microsoft® Windows® 7, 64-bit embedded, 2GB RAM and a minimum 120GB, 2.5" solid state hard drive. The red HDD LED flashes to indicate hard drive activity.

### Touchscreen



Most of the interaction between the user and the unit takes place through use of the RW-3X's full-color touchscreen. Through the use of the included stylus, the user controls the various aspects of the on-board software—setting up and running tests, setting options, entering site data and more. For more information see "Using The Stylus" on page 30. A durable screen protector supplies an extra safeguard for the 8.4"

LCD touchscreen while shielding against glare for better visibility.

Click on one of the eleven buttons on the main screen to access various testing screens, features, and editors of the RW-3X.



**Meter Testing:** Access the Meter Testing screen where basic meter testing functions are preformed. For more information See "Meter Testing" on page 48.



**CT Testing:** Access the Current Transformer Testing screen to perform current transformer ratio and burden testing functions. For more information See "Current Transformer Testing" on page 58.



**PT Testing:** Access the Potential Transformer Testing screen to perform potential transformer testing features. For more information See "Potential Transformer Testing With The RW-3X" on page 68.



**Power Quality:** Access the Power Quality screen to conduct a wiring check, primary check, secondary check, trend analysis, waveform analysis, or harmonic analysis. For more information See "Power Quality Testing" on page 76.



**Customer Load Testing:** Access the Customer Load screen to perform a meter test using the customer's load. For more information See "Customer Load Testing" on page 55.



**Site Information:** Access the Site Information screen to edit sites and create site reports.



**Administration:** The Administration screen provides access to test results and system options.



**Utilities:** The Utilities screen provides access to numerous editors used for customizing many features and functions of the RW-3X.



**Transducer Testing:** Access the Transducer Testing screen where transducer testing functions are preformed. For more information See "Transducer Testing" on page 87.



**About:** Clicking the About button retrieves information including the current software version, firmware versions, and serial numbers for the RW-3X, internal RD standard, and 3230 shop stand if connected.





**Help:** Use Help to access the RW-3X's Help System.



**Shutdown:** Clicking the shutdown button will exit Winboard Embedded and command the operating system to shut down. Note: Once the screen turns solid white, it is safe to power down the unit.

### Lower Panel

The lower panel indicates the model type of RW-3X, Three-Phase Meter Site Analyzer.



### Serial Number Section



The serial number section contains unique identifying information for each RW-3X. The Assembly No. field details the specific revision of the RW-3X hardware. The Serial No. field displays the unique number given to a particular unit. This number is useful when calling for customer support. The MFG. Date field shows the month, day and year that the unit was produced.

# Setting Up The RW-3X

This chapter details the basic operations of the RW-3X.

## Using The Stylus

The RW-3X's touchscreen allows you to make selections in the software without needing to use a keyboard or mouse. Touch the stylus to the screen to perform a mouse click, make selections, or even type in data using the on-screen keyboard.

Note: The virtual buttons used to interact with the RW-3X Winboard Embedded software are set to single click. It is not necessary to "double click" any button within the Winboard Embedded software.

To perform a right click using the stylus, click and hold the stylus to the touchscreen for a few seconds.

## Powering the Unit On and Off

To avoid data loss and ensure continued computer performance, it is important to follow the proper procedures when powering the RW-3X on or off.





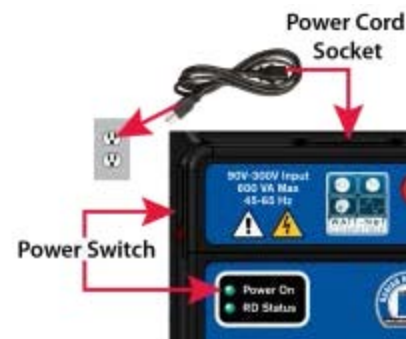
## Powering Up the Unit

You can power the RW-3X from either a standard 120V grounded outlet in the shop, or pull power from the service at the site. The service voltage must be between 90V to 300V phase to neutral. The auxiliary power panel contains the connections necessary to power the unit from either scenario. It is vital to the safety of both the user and the unit that the ground wire be connected to the earth ground.

## Powering Up in the Shop

To power up the RW-3X using the shop power cord:

1. Connect the shop power cord to the power cord socket. Make sure the cable is secure before continuing.
2. Insert the plug end of the shop power cord into a 120V grounded outlet.
3. To power up the unit, turn on the power switch and the RW-3X's software will automatically launch. Since the internal PC will have to boot up, it may take a few minutes for the unit to launch after turning on the power switch.

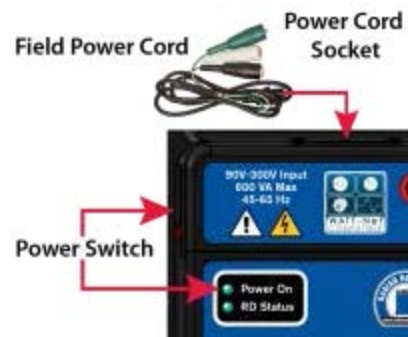


## Powering Up in the Field

In the field you can use the field power cord to draw power directly from the meter test switch.

To do so:

1. Make sure the line-to-neutral potential is between 90 and 300 volts.
2. Connect the field power cord to the power cord socket. Make sure the cable is secure before continuing.
3. Clamp the field safety ground cable to the meter block ground lug.
4. Before connecting the white lead from the field power cord, verify the voltage is 300V or less measured to the ground terminal.
5. Clamp the white lead from the field power cord onto the lower side of the neutral test switch.



6. Clamp the black lead from the field power cord onto the lower side of the phase A test switch. Depending on the service, you can alternately connect to the B or C phase test switch.
7. When the last connection is made, turn on the power switch and the RW-3X's software will automatically launch. After turning on the power switch the internal PC will boot and may take a few minutes for the unit to launch.



*Image: Typical Test Switch*

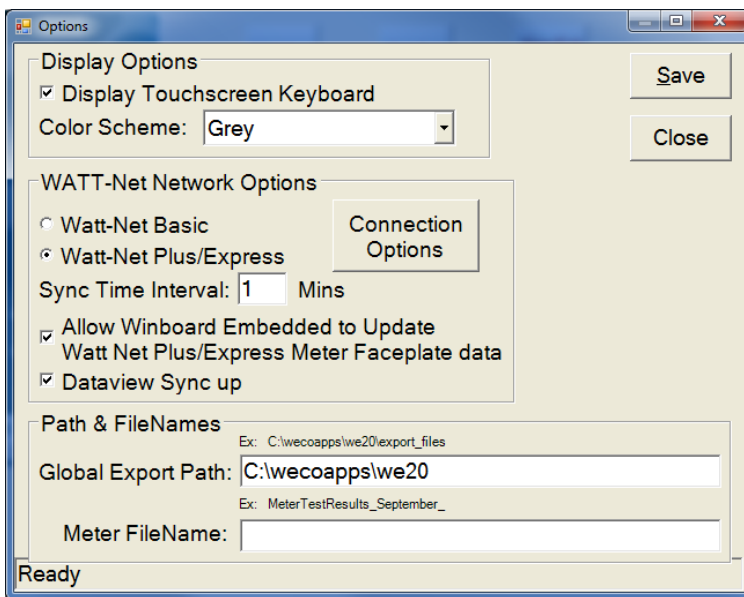
## Powering Down the Unit

To power down the RW-3X:

1. From the Startup screen click Shutdown. Shutdown is used to properly power down the RW-3X. It is important to follow the proper procedure when

- powering off the unit to avoid data loss. When the screen turns white you may then turn off the unit's power switch.
2. At any time you may disconnect the test leads from the unit and / or the test block.
  3. Disconnect the power cable's black clip from the test switch.
  4. Disconnect the power cable's white clip from the test switch.
  5. Disconnect the power cable's green ground clip from the grounding location.
  6. Disconnect the power cord from the unit.

## Set Up Options



You might find it helpful to set up the following options before continuing to explore the RW-3X. To access, go to Administration / Options.

### Activating the Touchscreen Keyboard

**Display Touchscreen Keyboard** Enabling the Touchscreen Keyboard makes it possible to enter values and data into fields without the need of an external keyboard.

To enable the Touchscreen Keyboard:

1. Click Administration on the Startup screen.
2. Click Options on the Administration screen.
3. Check the Display Touchscreen Keyboard check box.
4. Click Save button in Options Screen.

**Note:** The RW-3X's meter testing software uses a custom engineered virtual keyboard designed to facilitate entering values during field testing. This keyboard is a

part of the meter testing software and doesn't function in other programs. Windows 7 also provides an onscreen keyboard that can be used with any application. It shows as a small tab on the left side of the screen. Activate it by clicking on it with the stylus.

### Set the Color Scheme



The RW-3X's display and touchscreen have been carefully selected to

provide the highest level of sunlight readability. To further improve viewing in extremely bright situations, WECO has developed a high contrast color scheme. You can easily change the RW-3X's display from the default color scheme (useful for use indoors) to a high contrast mode (uniquely suited for viewing outdoors in direct sunlight).

To change the color scheme:

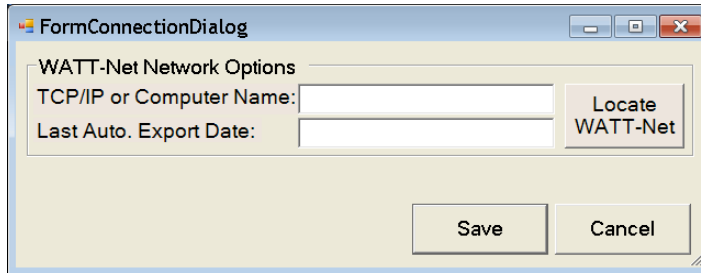
1. Click Administration on the Startup screen.
2. Click Options on the Administration screen.
3. Select High Contrast from the Color Scheme drop-down.
4. Click Save on Options Screen.

**WATT-Net™ Network Options:** This field is for synchronization with the WATT-Net Basic or WATT-Net Plus / Express Central Database. The WATT-Net Basic option is the default. Should you need to sync with WATT-Net Plus / Express, this option will need selecting.

**Sync Time Interval:** This field is for setting how often Winboard Embedded will sync with the Central WATT-Net Basic / Plus / Express Database.

By checking the boxes to the left of **Allow Winboard Embedded to Update WATT-Net Plus / Express Meter Faceplate Data** and / or **Dataview Sync Up** you will enable synchronization of these items with the WATT-Net Plus / Express Central Database.

**Connection Options:** Opens a dialog box for entering the IP address / Computer Name of the WATT-Net database server and also lists the last automatic export date of test records.



**TCP/IP or Computer Name:** This field is for the IP address or Computer Name of the network PC with WATT-Net™ installed. When on the main menu screen, the RW-3X will poll this network PC to see if WATT-Net is open. You can manually enter the IP address or Computer Name or click the Locate WATT-Net button to automatically find the IP address if WATT-Net is open on the network.

**Last Auto. Export Date:** This field indicates the date and time of the last auto export of test records to WATT-Net. This can be edited if it is necessary to resend records.

**Global Export Path:** This field sets the default path for the location where screen captures are saved or test records are exported.

**Meter File Name:** This field sets a default file name for files to be exported out of the RW-3X and manually imported into WATT-Net. This feature can be accessed in Administration/ View Edit Test Results/ WATT-Net Export.

**After you have made your option choices, click Save to save your changes or click Close to return to the Administration screen without saving any changes.**

# Preparing To Test

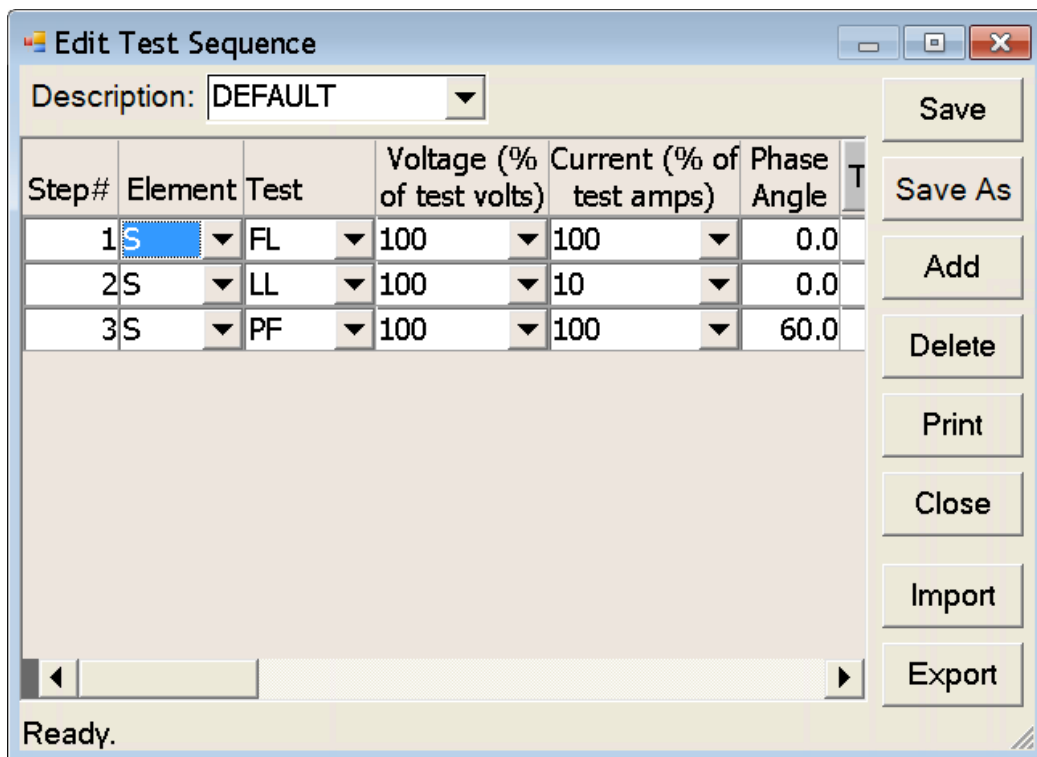
Before you begin testing with the RW-3X it is beneficial to set up some information about the types of tests you'll be running, the types of meters you'll be testing and the sites where you'll be testing.

## Setting Up A Test Sequence

The first thing to do is to enter a test sequence. A test sequence is a series of tests that are run consecutively on a meter. To begin:

1. Click Administration on the Startup screen.
2. Click Edit Test Sequence on the Administration screen.
3. Click ANSI Test Sequence.

The following screen will open. Note that there are a number of fields not visible in the initial view of the Edit Test Sequence screen. You will need to use the scroll bar along the bottom of the screen to see all of the available fields.



Step#	Element	Test	Voltage (% of test volts)	Current (% of test amps)	Phase Angle
1	S	FL	100	100	0.0
2	S	LL	100	10	0.0
3	S	PF	100	100	60.0

Let's set up a basic, three step test sequence for the Form 9 meter.

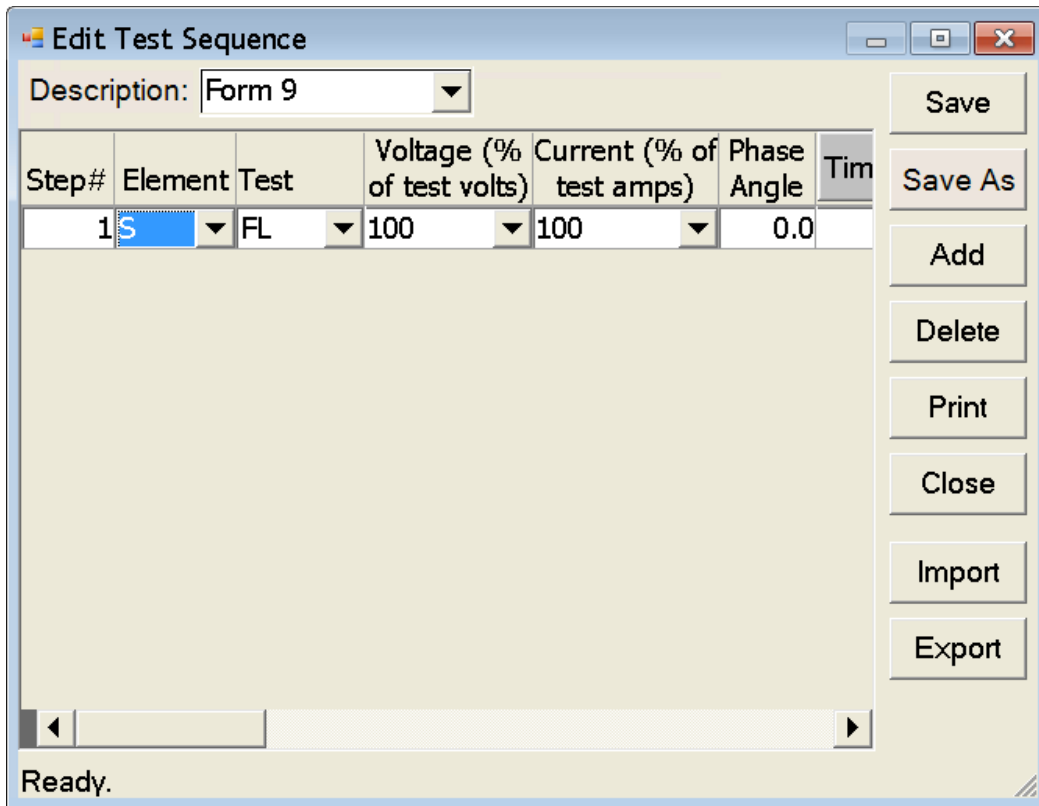
1. Click Add, then Add New Sequence.
2. Enter the sequence name in Description. We will enter Form 9. Click Okay.

3. Select the element or elements to be tested from the Elements box. We will select S. This indicates that all three elements will be tested in series. You may also choose an individual element.
4. Select the type of test to perform from the Test box. We will choose FL. The types of tests that you can choose from are:
  - FL: Full Load**
  - LL: Light Load (defaults to 10% of full load current)**
  - PF: Power Factor (defaults to 60 degree phase angle)**
  - CR: Creep (applies voltage only)**
  - AO: Adjust Optics (applies voltage and current)**
  - DMD: Demand**
5. Enter the percentage of test volts to apply to the meter during the test step in the % of Test Volts box. We will enter 100. Doing so indicates that you want to apply 100% of the potential listed on the meter's faceplate (entered in the Form Default screen).
6. Enter percentage of test amps to apply to the meter during the test step in the % of Test Amps box. We will enter 100. Doing so indicates that you want to apply 100% of the current listed on the meter's faceplate (entered in the Form Default screen).
7. Enter the desired phase angle to be applied between the voltage and current waveforms during the test step in Phase Angle. All tests default to 0 except the PF which defaults to 60. Any value between 0 and 360 can be entered in Phase Angle.
8. Enter the number of revolutions the test step should run for in Time/Revs. All tests go by number of revs except for standards compare tests.
9. Select the desired type of service for the test step from Service. We will select 3P Wye ABC. This indicates we will be testing a three-phase meter with a Wye ABC service.
10. Select the desired standard mode for the test step from Standard Mode. We will select WATT Hrs. This indicates we want to use watthours as the energy measurement for the test.
11. Select the desired type of optics to use for the test step from Optics. We will select Optics 1. This indicates we will be using the optic coupler connection as the optics source for this test.
12. Select if the power should be reversed or not from Reverse. We will select N. This indicates we wish to run the test in the delivered power direction and not the received power direction.
13. Select the desired frequency for the test step from Frequency. We will select 60. This indicates that the potential and current being applied to the meter will have a frequency of 60 hertz. Outside of the United States this number is usually 50 hertz.
14. Enter the desired upper and lower accuracy limits from Upper Limit and Lower Limit. We will enter 100.50 and 99.50. Any accuracy results that fall between these two values will appear in green. Results outside of this

range will appear in red to alert the operator.

15. Leave Desired Accuracy at 100.00. This tells the RW-3X that the meter under test hasn't been adjusted to run fast or slow to compensate for line loss or other factors. An example of when you would enter a value besides 100 in Desired Accuracy would include a perfectly accurate meter that runs with a 2% transformer loss factored in. This meter would normally register a test result of 102% accuracy when tested. However, if you set Desired Accuracy to 102 the software adjusts the math and the test results register as 100%. Alternatively, a perfectly accurate meter set to run 4% slow would normally register a test result of 96%. If you set Desired Accuracy to 96, however, then the test results for this meter would register as 100%.
16. Click Save.

You've now saved the first step in your test sequence for a Form 9 meter. Now your screen should look like this:



Now you will add the next step(s) in the test sequence.

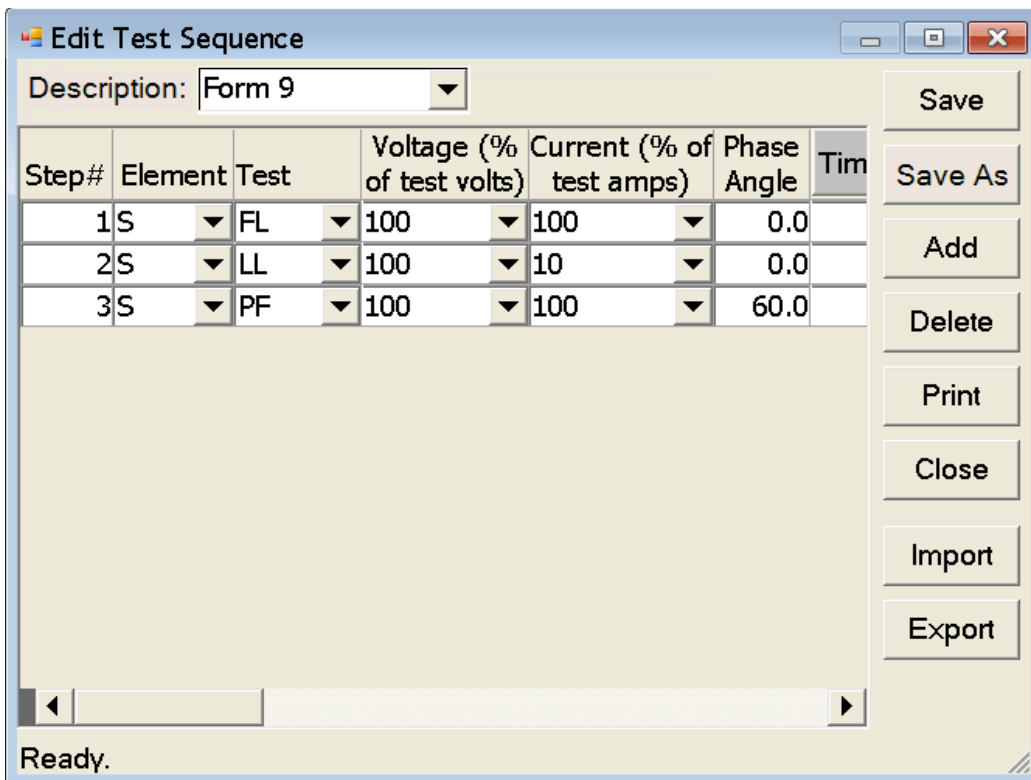
1. Click Add, then select Add Step. This will create a duplicate of your previous test step with a different Step#. In this case, the new Step# will be 2 to indicate that this is the second test in your test sequence. Now all you need to do is change a couple of fields in the new test step.



2. Change Test from FL to LL to indicate the new step is a light load test. This will cause % of Test Amps to default to 10. Edit this value or move on to the next step.
3. Click Add, then Add Step.
4. Change Test from LL to PF to indicate the next step is a power factor test. This will cause Phase Angle to default to 60. Edit this value or move on to the next step.
5. Click Save.

**Note:** All phase angles are measured as lagging referenced from Va.

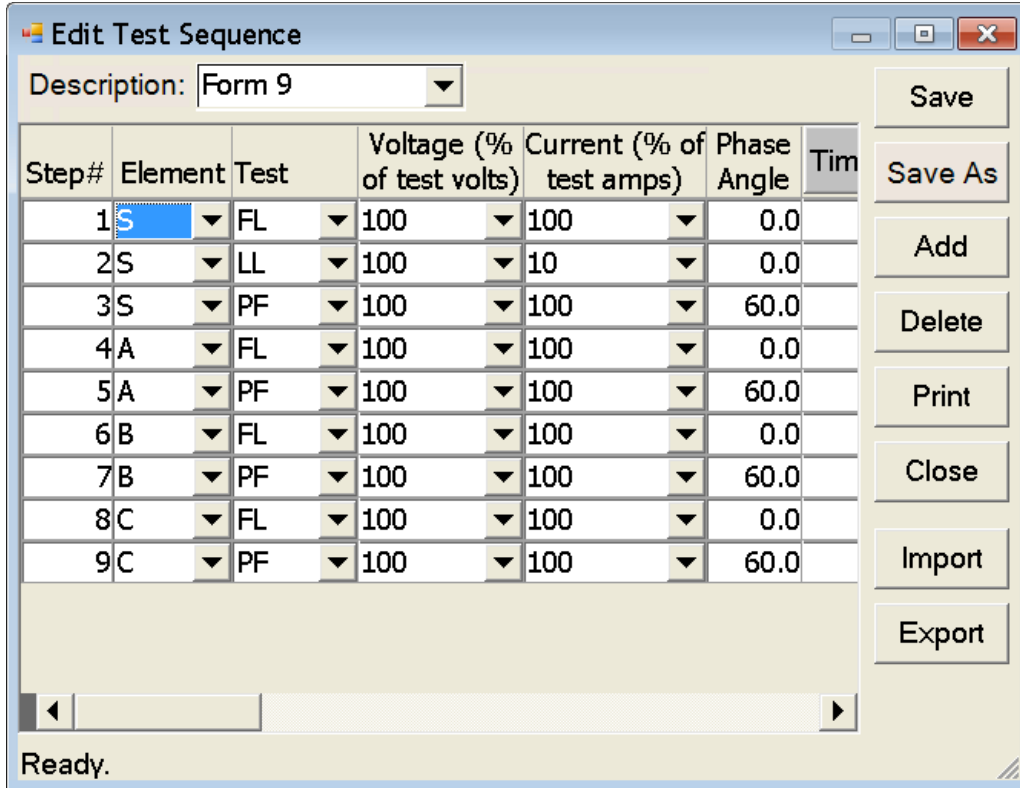
These are three basic tests that are commonly conducted on a Form 9S meter. At this point your Edit Test Sequence screen should look something like this:



Often, however, you'll also want to test the individual elements of the meter. To add these steps to your test sequence follow the steps below:

1. Click Add, then Add Step. Choose an individual element to test from Element.
2. Edit and add steps for element testing using the same steps for series testing.

Repeat these steps for the B and C elements. When you are finished you should have a total of nine steps and your Edit Test Sequence screen should look similar to the following screen. Be sure to save the test sequence.



## Setting Up The Form Defaults

After you have set up a test sequence you'll need to set up a form default for the meter you will be testing. For example, if you plan to test a Form 9 meter, you will need to set up a form default for the Form 9 meter.

The unit comes with all of the ANSI forms already defined. However, you may want to customize some of the settings. Scroll through the list of form defaults to see if a Form 9 is already present and if any of the settings need to be changed to reflect your particular testing needs. If a Form 9 is already defined in your Edit Form Setup screen and you don't need to make any changes, you don't need to actually set anything up, but you still might want to follow along below to get an idea of how to define forms.

To add a Form 9 to the form default list:

1. Click Administration on the Startup screen.
2. Click Edit Form Defaults on the Administration screen.

The following screen will appear:

Now it's time to set up the Form 9 meter default. To set up a form default you will need to enter the faceplate information from the meter into the Edit Form Setup screen. For example:

1. Begin by clicking Add. A blank form default will appear.
2. Check your meter faceplate to find out what information to enter. Let's assume your meter has the following faceplate information: FM9S, Kh 1.8, TV 120, and TA 2.5.
3. You would enter 9 in Form, S in Base, 1.8 in Kh, 120 in Test Volts, and 2.5 in Test Amps.
4. Set Test Sequence to DEFAULT and Customer Load Sequence to CUSTOMER LOAD.

You don't need to worry about filling out any other fields on this screen. Click Save to save your form default. Your new Form 9 meter default should look like the following screen:

If you plan to test other meter types, you will need to follow the above steps for each additional form and base combination. For the purposes of this document, however, the Form 9 will be sufficient.

Next, you will set up a testing site. Return to the main menu by clicking Close and then Exit.

## Setting Up Site Information

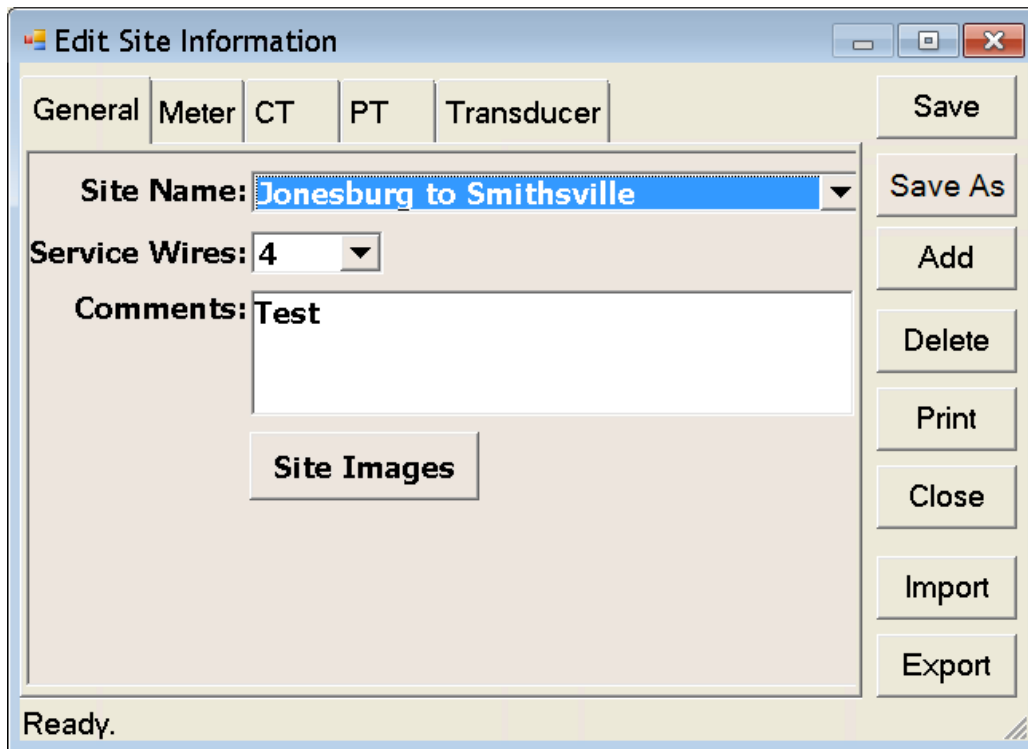
A testing site is a collection of data specific to a location where a meter, current transformer, potential transformer, or combination of these are regularly tested. You enter the information associated with a site once and then load the site before a test so that the information is automatically populated in the necessary fields throughout the various testing screens. That information, such as a meter's serial number, can further access stored DataView information, reducing or negating the need for input from the user.

However, to start using site information in your workflow it is necessary to set up a site and add some information. To begin:

1. Click Site Information on the Startup screen.
2. Click Edit Site Info on the Site Information screen.

The following screen will open. Note that there are five tabs at the top of the screen to simplify where to enter information for each test you will run at that site.

Only enter information that is needed for that site. Any information fields that do not apply to the site you are creating can be left blank. You can edit this site information at any time.



The screenshot shows a software window titled "Edit Site Information" with a standard Windows-style title bar (minimize, maximize, close buttons). The window has a tabbed interface with tabs for "General", "Meter", "CT", "PT", and "Transducer". The "General" tab is active. In the "General" tab, there is a "Site Name" dropdown menu currently showing "Jonesburg to Smithville". Below it is a "Service Wires" dropdown menu set to "4". A "Comments" text area contains the text "Test". Below the comments is a "Site Images" button. On the right side of the window, there is a vertical stack of buttons: "Save", "Save As", "Add", "Delete", "Print", "Close", "Import", and "Export". At the bottom left of the window, the status bar displays "Ready."

Now take some time and enter the information for the site you're going to be testing. A little effort now will save a great deal of time later on.

1. Let's start by clicking Add. We will start with the information in the General tab.
2. Enter a name for the site in Site Name. In this example we'll enter Jonesburg to Smithville.
3. Select the number of service wires for this service from the Service Wires box. For this example we will select 4.
4. Enter any comments about the site that could help you or another tester in Comments. These comments will be viewed each time the site is loaded.
5. Click Site Images. You can click Add, enter a name, and browse to the location of the picture or pictures that could assist you or another tester when testing this site. You can add as many images as you wish.
6. Now click on the Meter tab.
7. Enter the meter's serial number in Meter Sn. Test results are saved and can be sorted according to their serial number. We will enter 12345678.
8. Select the meter's form number from Meter Form No. We will select Form 9.
9. Select the meter test sequence to use when testing this site from Meter Test Seq. We will select the Form 9 sequence we created earlier.
10. Enter the Kh of the meter at the site in Kh. We will enter 1.8.

11. Enter the test volts of the meter at the site in Test Volts. We will enter 120.
12. Enter the test amps of the meter at the site in Test Amps. We will enter 2.5.
13. You may also enter a demand multiplier, demand interval, and any or all of the KYZ Ke values. We will not enter any of these values for this guide.

The Meter tab screen should now look something like this:

Now let's click on the CT tab.

1. Enter the current transformer's ratio in CT Ratio. The first field is the primary. Click on it and enter the primary turns of the CT. We will enter 200. The second field is the secondary. Click on it and enter the secondary turns of the CT. We will enter 5.
2. Enter the serial numbers for each phase you will test at that site in Serial No (s). We will enter R12345 for Phase A, R23456 for Phase B, and R34567 for Phase C.
3. Enter the model numbers for each phase you will test at that site in Model No(s). We will enter R65A in this field for all three phases.
4. Select the class of the current transformer for each phase you will test at that site from Class. We will select 0.3 for all three phases.
5. Select the check boxes for each phase you will test.
6. Select which tests you want to run. Burden, ratio, or both.
7. Select the max burden from the drop down menu.

The CT tab should now look something like this:

**Edit Site Information**

General | Meter | **CT** | PT | Transducer

CT Ratio: 200 : 5

	Phase A:	Phase B:	Phase C:
Serial No.:	R12345	R23456	R34567
Model No.:	R65A	R65A	R65A
Class:	0.3	0.3	0.3

Phases to Test:  A  B  C

Tests To Run:  Burden  Ratio

Max Burden: 0.5

Save  
Save As  
Add  
Delete  
Print  
Close  
Import  
Export

Ready.

**Edit Site Information**

General | Meter | CT | **PT** | Transducer

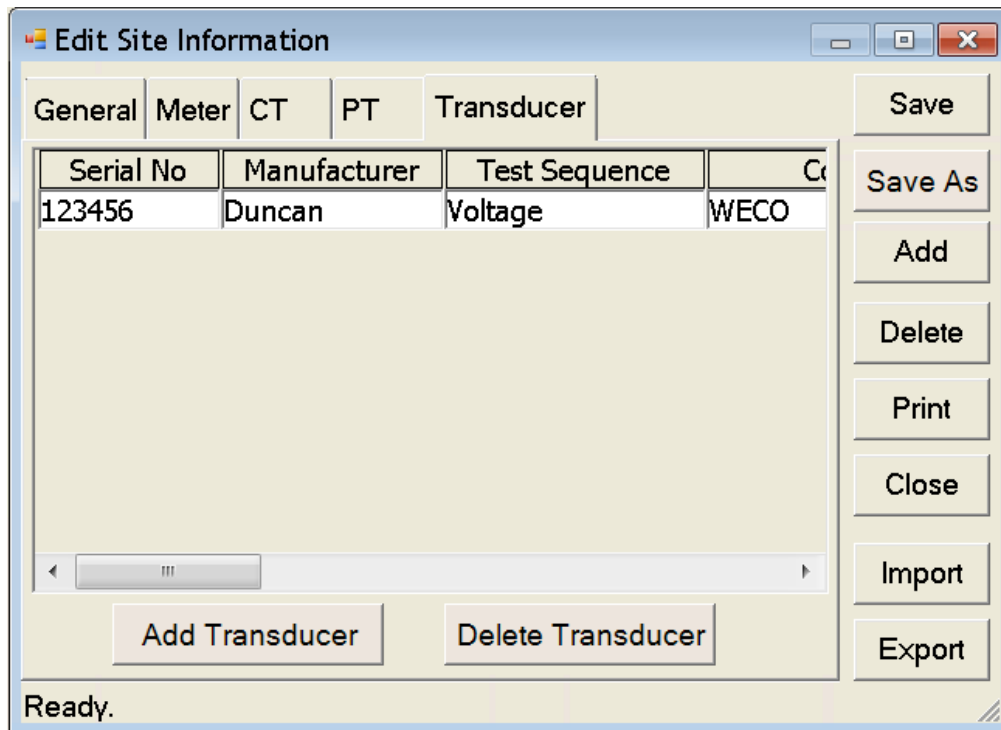
PT Ratio: 1 : 1

	Phase A:	Phase B:	Phase C:
Serial No.:			
Model No.:			
Class:			

Save  
Save As  
Add  
Delete  
Print  
Close  
Import  
Export

Ready.

1. The same process applies to the PT testing tab. We will leave this tab blank for the purposes of this guide.
2. Click Save to save this site.



Now let's click on the Transducer tab.

1. Click Add Transducer at the bottom of the page.
2. Enter the Serial No. of the transducer.
3. Enter the Manufacturer of the transducer.
4. Select the Test Sequence to use from the drop down menu. Reference the Transducer Testing portion of the guide for instructions on setting up a custom test sequence.
5. You can use the scroll bar at the bottom of the screen to view the remaining fields.
6. Enter the company.
7. Select the Type from the drop down menu.
8. Enter the Scale and multiplier if applicable. This is the input range of the transducer.
9. Enter the Output.
10. To add another transducer, simply click Add Transducer at the bottom of the page again. You can add as many transducers as you need.



**Note:** Any information not known for a site can be left blank. This information can be entered later during testing at the site. The site information will be updated with any information entered on site.

**Note:** The information entered above might not necessarily reflect your site's testing needs and you may need to enter different values for some or all of the fields. If you are not sure of your testing site's needs do not continue with this exercise.

Once you've set up a site, it is necessary to load that site so that the information you entered is loaded into the system. To do so:

1. Return to the Startup screen.
2. Click Site Information on the Startup screen.
3. Click Load Site Info on the Site Information screen.
4. Select Jonesburg to Smithsville from Site Name.
5. Click OK to load the site.
6. A dialog appears confirming that the site has been loaded plus any comments you entered for this site. If you click the Images button you can browse through images you loaded. Click OK to continue to the testing windows.

**Note:** The site will stay loaded until you unload the site information from the Site Information menu or you close the RW-3X application.

Now that you've created a site and loaded it, you're ready to start testing. You've successfully set up a site that will test a Form 9 meter and Phase A, B, and C current transformers and test a voltage transducer. After the site is loaded any information you add or change (such as a meter's serial number or adding information for a potential transformer test) is updated and saved in the site's information.

# Meter Testing

In this section we'll get down to the nuts and bolts of testing with the RW-3X. Due to the number of variables involved with testing a meter from installation to installation, it is impossible to cover every possible situation. What follows is by no means meant to be exhaustive. Rather, this section should be used as a rough guide to the basic steps involved with testing a meter.

## Connecting The RW-3X To The Meter

To begin testing meters with the RW-3X it's necessary to connect the unit to a test switch. The following example shows how to connect the unit to a fairly common test switch. It is important to note that there are many different types of test switches in use, and the one detailed here might not correspond to one you are using. If you have any questions or concerns about connecting the RW-3X to a test switch, you are urged to contact Watthour Engineering for assistance.

To connect to the RW-3X:

The auxiliary power panel contains the connections necessary to power the unit from either an electrical outlet or from the potential provided (between 90 and 300 Volts) at a customer's site. See "Powering Up in the Field" on page 31

**Note:** It is vital to the safety of both the user and the unit that the ground wire be connected to the earth ground connection.

1. Plug the red, yellow and blue leads from the potential cable assembly into the corresponding potential connectors on the RW-3X.
2. Plug the white lead from the potential cable assembly into any of the white neutral connectors on the front of the RW-3X.
3. Plug the red current cable with alligator clips into the current connections of Phase A (red) on the front of the RW-3X.
4. Plug the yellow current cable with alligator clips into the current connections of Phase B (yellow) on the front of the RW-3X.
5. Plug the blue current cable with alligator clips into the current connections of Phase C (blue) on the front of the RW-3X.

First prepare the test switch for the potential and current cable assembly connections.

1. Open all meter test switches.
2. Clip the white lead from the potential cable assembly onto the neutral spade.

To connect the RW-3X to Phase A of the meter test switch:

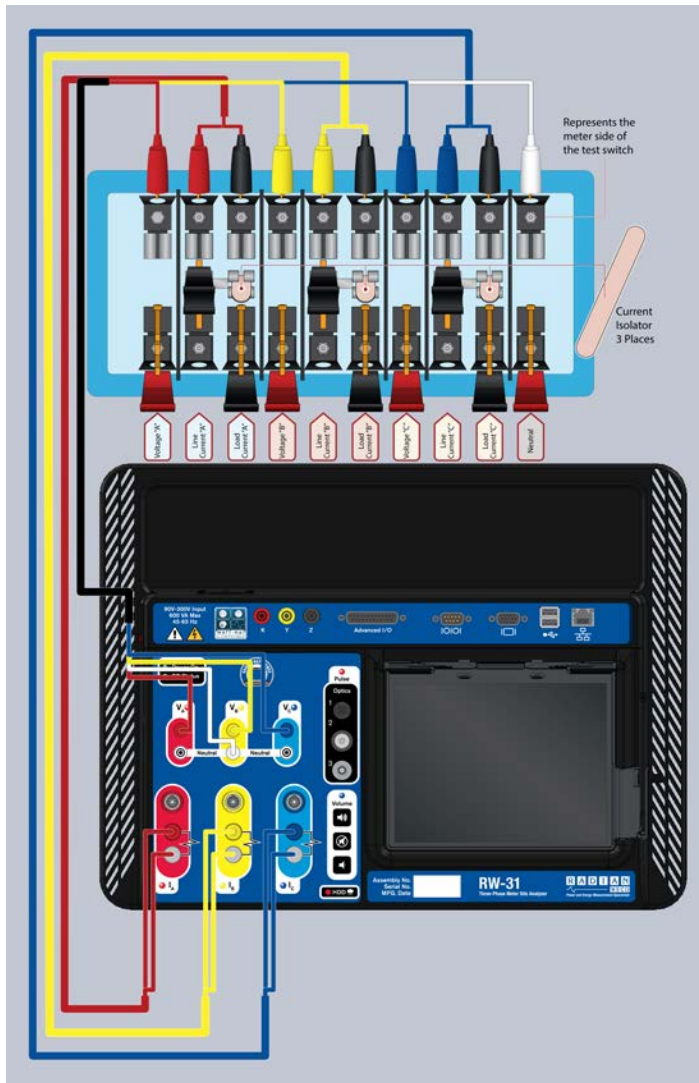
1. Clip the red lead from the potential cable assembly onto the Phase A potential spade
2. Clip the red lead from the red current cable with alligator clip onto the meter's line side connection of Phase A.
3. Clip the black lead from the red current cable with alligator clip onto the meter's load side connection of Phase A.
4. Insert a current isolator into the load side of the Phase A meter test switch.

To connect the RW-3X to Phase B of the meter test switch:

1. Clip the yellow lead from the potential cable assembly onto the Phase B potential spade.
2. Clip the yellow lead from the yellow current cable with alligator clip onto the meter's line side connection of Phase B.
3. Clip the black lead from the yellow current cable with alligator clip onto the meter's load side connection of Phase B.
4. Insert a current isolator into the load side of the Phase B meter test switch.

To connect the RW-3X to Phase C of the meter test switch:

1. Clip the blue lead from the potential cable assembly onto the Phase C potential spade.
2. Clip the blue lead from the blue current cable with alligator clip onto the meter's line side connection of Phase C.
3. Clip the black lead from the blue current cable with alligator clip onto the meter's load side connection of Phase C.
4. Insert a current isolator into the load side of the Phase C meter test switch.



To finish the connection:

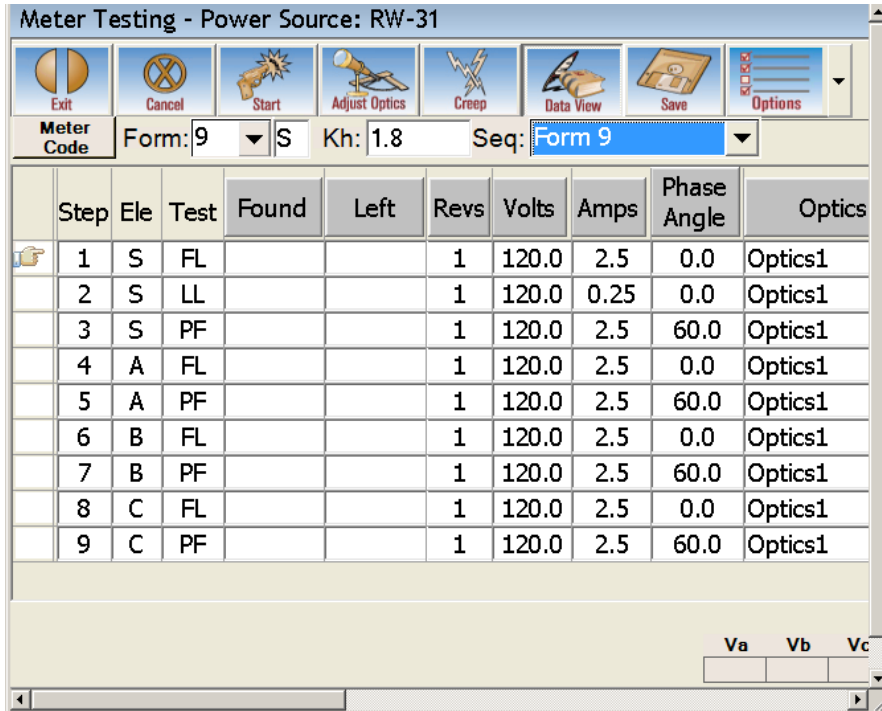
1. Connect your selected optics sensor to the appropriate input on the front panel. For this example the Optocom will connect to the Optics 1 input.
2. Position your selected sensor to detect meter pulses.
3. You are now ready to conduct a meter test.

**Note:** Your meter installation might be different than the one pictured above. Be very careful when connecting the RW-3X to test switches. If you are not sure how to connect the unit to your particular meter installation, do not proceed with the meter test.

# Conducting The Meter Test

Now that you've defined your Form 9S default, built a test sequence, defined your site information, loaded that site information, and connected the RW-3X to a 9S meter, it's time to conduct a meter test. To begin:

Return to the Startup screen and click Meter Testing. The following screen appears:



If you have not previously created site information, you will need to perform the actions listed below.

**Note:** Several of the items below can be loaded automatically by entering the meter's AEP code in the Meter Code dialog. This AEP code can also be scanned in using an optional barcode scanner.

1. Select the meter form number from the Form drop-down menu.
2. Select the meter base type from the Type drop-down menu.
3. Enter the Kh for the meter being tested in Kh.
4. Select the proper test sequence from the Seq Drop-down menu.
5. Enter the Test Voltage and Test Amps listed on the meter's name plate by clicking the Volts and Amps buttons, respectively. These buttons are also the column headers in the sequence summary.
6. Click Data View to bring up additional information fields that you can fill in

and save alongside your test results. These fields are fully customizable and can even integrate barcode technology to automate data entry. Since you defined a site and loaded it, this information has automatically been populated and you're ready to test.

**Note:** Data View information can be entered while the test is running. This allows more efficient use of your time at the test site. If a site is loaded, any additional data view information created during this process will be added and saved to the previous site information.

After the site has been loaded, begin the meter test by following these steps:

1. If you are testing an electromechanical meter that requires you to align optics, then you will begin by clicking Adjust Optics. This applies potential and current to the meter, causing the disk to turn, making it possible to position your optics option of choice so that it detects the black mark. Click Creep to apply potential to the meter. This gives solid state meters like the Form 9 time to boot up.
2. Once the meter is ready, click Start to begin the test. Instantaneous metrics of the load conditions currently being applied to the meter (voltage, current, and phase angles) are shown beneath the test sequence summary. The status of the test appears in the Status bar at the bottom of the Meter Test screen.
3. The results for the meter test will appear in Found and Left located in the test sequence summary (If you run the test more than once, only the Left values will change).
4. Click Save to save your results.

Your results screen should look something like this, depending on the accuracy of the meter being tested:

Meter Testing - Power Source: RW-31

Exit Cancel Start Adjust Optics Creep Data View Save Options

Meter Code Form: 9 S Kh: 1.8 Seq: Form 9

Step	Ele	Test	Found	Left	Revs	Volts	Amps	Phase Angle	Optics
1	S	FL	100.006	100.006	1	120.0	2.5	0.0	Optics1
2	S	LL	99.166	99.166	1	120.0	0.25	0.0	Optics1
3	S	PF	100.017	100.017	1	120.0	2.5	60.0	Optics1
4	A	FL	99.916	99.916	1	120.0	2.5	0.0	Optics1
5	A	PF	98.794	98.794	1	120.0	2.5	60.0	Optics1
6	B	FL	100.132	100.132	1	120.0	2.5	0.0	Optics1
7	B	PF	100.179	100.179	1	120.0	2.5	60.0	Optics1

Va Vb Vc Ia Ib Ic Pa Pb Pc Pab Pac Revs Left

Test sequence complete.

Test results that are outside the limits will appear in red but will not keep you from being able to save the test data. Now that you've conducted a meter test, let's go look at the results screen.

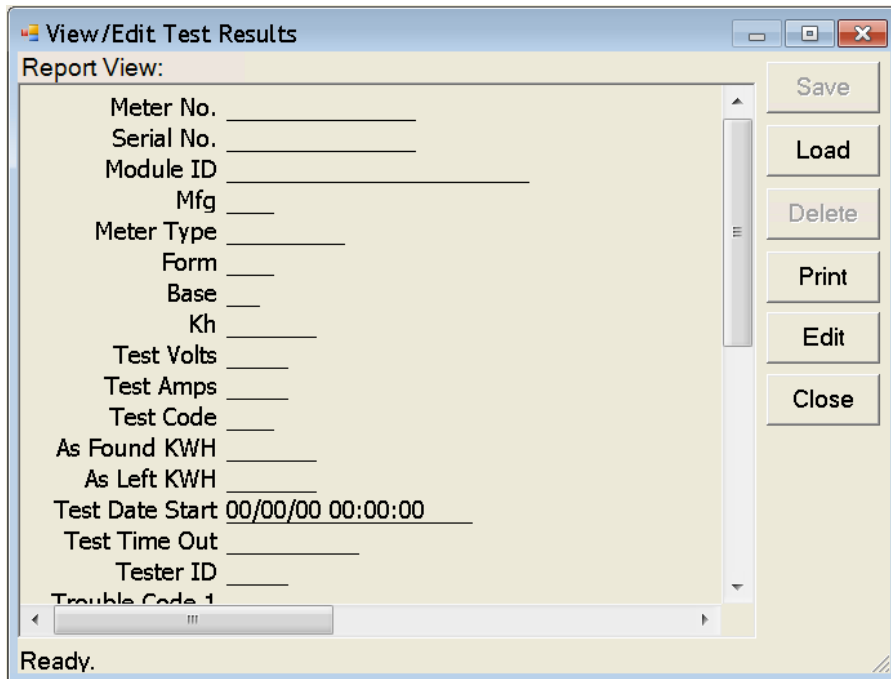
## Viewing Meter Test Results

To view your saved meter test results you'll need to close the meter testing screen and return to the startup screen. From there:

1. Open the Administration screen by clicking Administration.
2. Click View/Edit Test Results.
3. Click Meter Test Results.

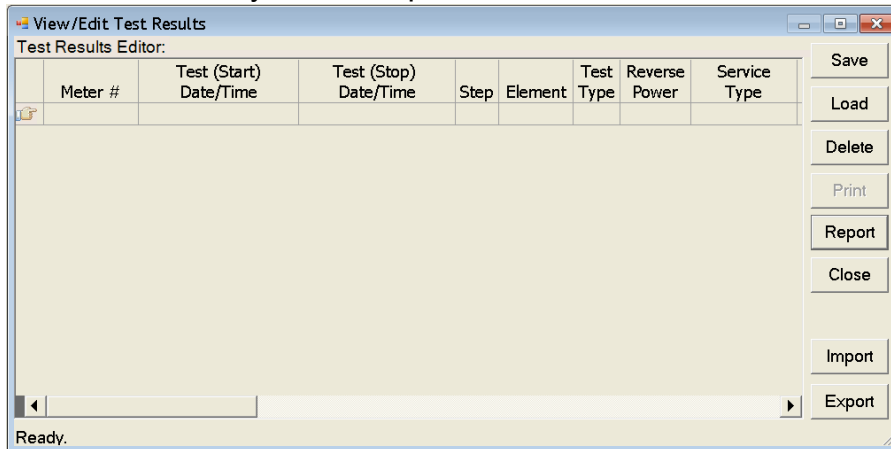
The View/Edit Test Results screen opens.

There are two different options for loading the test results. First is the Report View screen below. This shows the accuracy results and data view information in a report style format. From this screen you can print results to PDF or a printer.



Another option is to click the edit button on the right side of the screen. This accesses the Test Results Editor, showing the results with each individual test step. Use the scroll bar below the results to review details of the test. Some of the data view fields can be edited from this screen.

From this screen you can Export to various different file formats.



To access the results for either view, click the load button on the right side of the screen. The results are sorted by serial number and date/time stamp. Then select the appropriate meter test and click okay.



# Customer Load Testing

This section quickly outlines the basic steps necessary to conduct a meter test using the customer's load. What follows is by no means meant to be exhaustive. Rather, this section should be used as a rough guide to the basic steps involved with testing a meter with a customer's load.

## Connecting The RW-3X To The Meter

To begin testing meters with customer's load, it's necessary to properly connect the unit to a test switch. The following example shows how to connect the unit to a fairly common test switch for a customer load test. It is important to note that there are many different types of test switches in use, and the one detailed here might not correspond to one you are using. If you have any questions or concerns about connecting the RW-3X to a test switch, you are urged to contact Watthour Engineering for assistance.

To connect cables to the RW-3X:

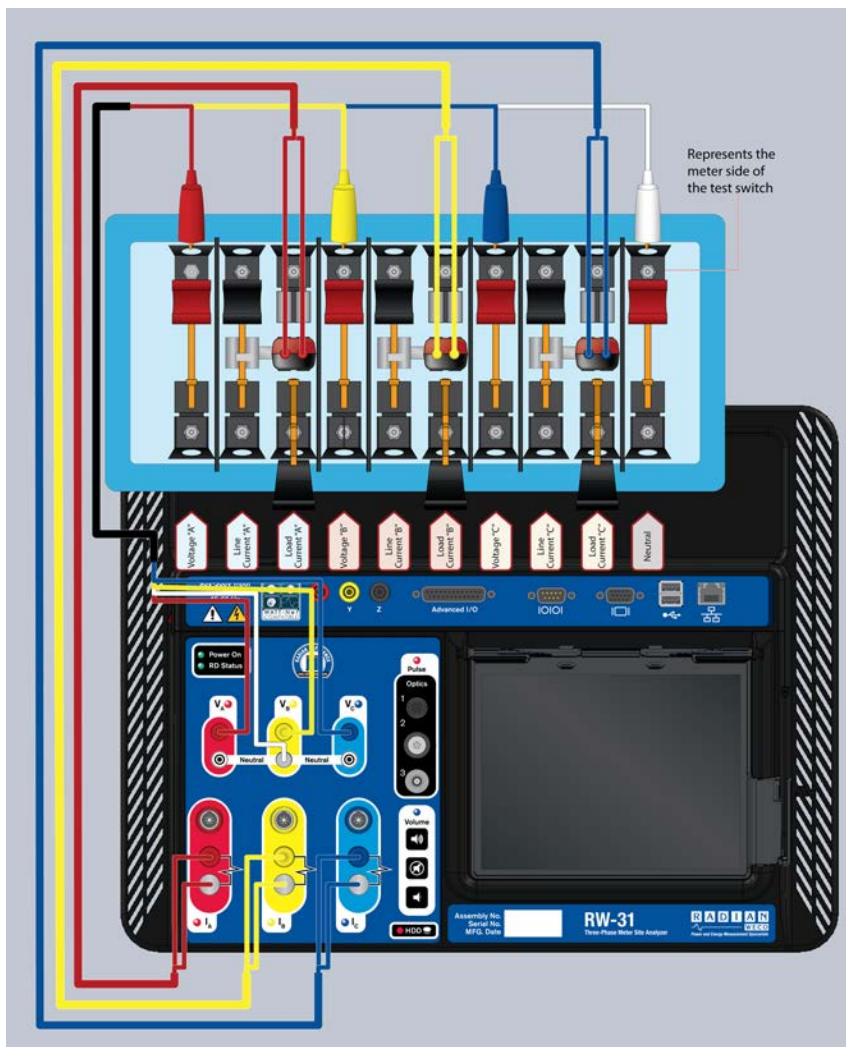
1. Plug the red, yellow and blue leads from the potential cable assembly into the corresponding potential connectors on the RW-3X.
2. Plug the white lead from the potential cable assembly into any of the white neutral connectors on the front of the RW-3X.
3. Plug the red current cable with Saf-T-Plug into the current connections of Phase A (red) on the front of the RW-3X.
4. Plug the yellow current cable with Saf-T-Plug into the current connections of Phase B (yellow) on the front of the RW-3X.
5. Plug the blue current cable with Saf-T-Plug into the current connections of Phase C (blue) on the front of the RW-3X.
6. Connect optics to the RW-3X's front panel.

To connect the RW-3X to the meter test switch:

1. Ensure you have the leads connected to the RW-3X's front panel.
2. Open the three load-side current switches to allow the Saf-T-Plugs to be inserted into the current circuit.
3. Clip the white lead from the potential cable assembly onto the neutral spade.
4. Clip the red lead from the potential cable assembly onto the Phase A potential spade.
5. Clip the yellow lead from the potential cable assembly onto the Phase B potential spade.
6. Clip the blue lead from the potential cable assembly onto the Phase C

potential spade.

7. Plug the red current cable with Saf-T-Plug into the load side of the Phase A meter test switch. Make sure that the red side of the Saf-T-Plug faces the "source." In the diagram below the source is at the top of the test switch, so the Saf-T-Plugs are connected with the red side facing up.
8. Plug the yellow current cable with Saf-T-Plug into the load side of the Phase B meter test switch. Make sure that the red side of the Saf-T-Plug faces the "source." In the diagram below the source is at the top of the test switch, so the Saf-T-Plugs are connected with the red side facing up.
9. Plug the blue current cable with Saf-T-Plug into the load side of the Phase C meter test switch. Make sure that the red side of the Saf-T-Plug faces the "source." In the diagram below, the source is at the top of the test switch, so the Saf-T-Plugs are connected with the red side facing up.
10. Connect optics sensor to the meter.



**Note:** Your meter installation might be different than the one pictured above. Be very careful when connecting the RW-3X to test switches. If you are not sure how to connect the unit to your particular meter installation, do not proceed with the customer load test.

You are now ready to conduct a customer load test.

## Conducting The Customer Load Test

After connecting the unit to the test switch for a customer load test, the steps for testing are nearly exactly the same as a regular meter test. Therefore, we won't go into detail here.

To access the Customer Load Test Screen:

1. Return to the Startup screen.
2. Click Customer Load Test.

**Note:** This test is performed using customer voltage and current, therefore there are no controls of the test parameters except for the number of Test Revs. You may create a customer load test that has several tests to verify watthrs, varhrs and other energy metrics using different KYZ inputs for the desired metric.

# Current Transformer Testing

This section quickly outlines the basic steps necessary to use the RW-3X to conduct a current transformer test. What follows is by no means meant to be exhaustive. Rather, this section should be used as a rough guide to the basic steps involved in testing a current transformer.

## Connecting The RW-3X To A Current Transformer

In this example we will connect cables to run a simultaneous ratio and burden test on Phases A, B, and C. The following diagram illustrates a fairly common test switch. However, the test switch you're testing may vary from the one pictured. If you have any questions or concerns about connecting the RW-3X to a test switch, you are urged to contact Watthour Engineering for assistance.

The ratio and burden tests are independent of each other, and it's possible to run either one without running the other or to run both simultaneously. In this example we will test both simultaneously. You'll need the following cables to run the current transformer burden and ratio test described in this chapter:

Burden Test: Current cables with Saf-T-Plugs

Ratio Test: Current cables with Saf-T-Plugs, voltage cable, and current probe

First, make the connection to the RW-3X:

1. Plug the current cables with Saf-T-Plugs into the RW-3X front panel (Ia, Ib, Ic) matching phase and connector colors. Connect the cable for each phase that you desire to test. For the purposes of this example connect all three cables.

**Note:** The following steps, 2 and 3, are not necessary for performing a Burden Test.

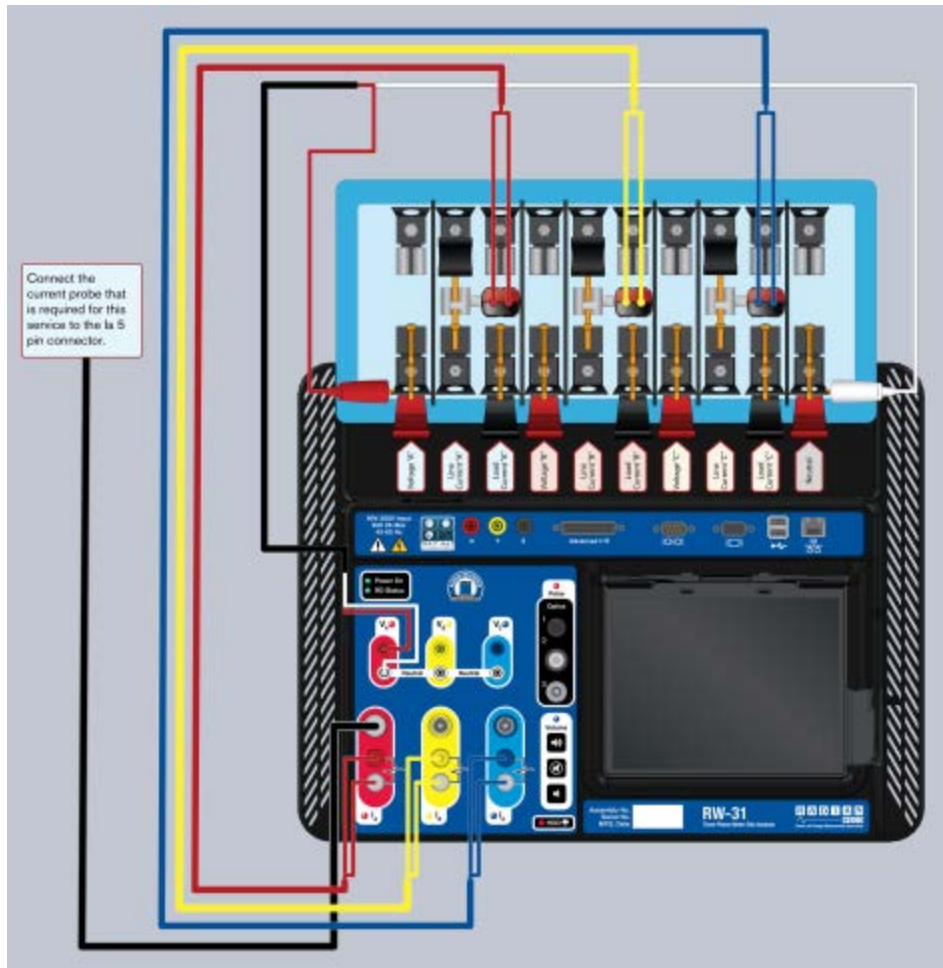
2. Plug a current probe into Phase A (red) REDEL<sup>®</sup> external clamp input on the front panel of RW-3X.
3. Connect the red voltage cable to Phase A (Va) on RW-3X front panel. The white cable can connect to any of the white Neutral connections on the front panel.

Now connect the RW-3X to the current transformers at the meter test switch:

1. Open all the meter test switches.
2. Plug the current cable with Saf-T-Plug into the load side current test switch of Phase A, B, and C. Make sure that the red side of the Saf-T-Plug faces the "source." In the diagram below, the source is at the top of the test switch, so the Saf-T-Plugs are connected with the red side facing up.
3. Ensure you have leads connected to the RW-3X and close the line side current test switch of Phases A, B and C.

Note: The following steps, 4 and 5 are not necessary for performing a Burden Test.

4. Connect the voltage cable to the Phase A potential tab and neutral (ground) tab. These two switches can be left either open or closed for a current transformer test.
5. Clamp the current probe around the primary conductor according to the manufacturer's instructions.

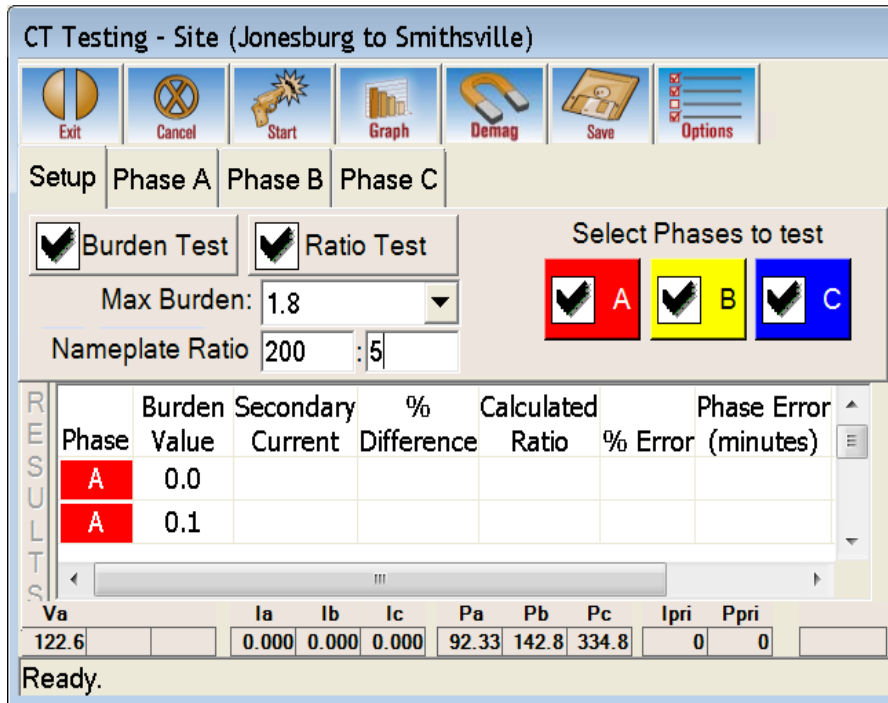


You are now ready to conduct a current transformer ratio and burden test for Phases A, B, and C.

## Conducting A Current Transformer Test

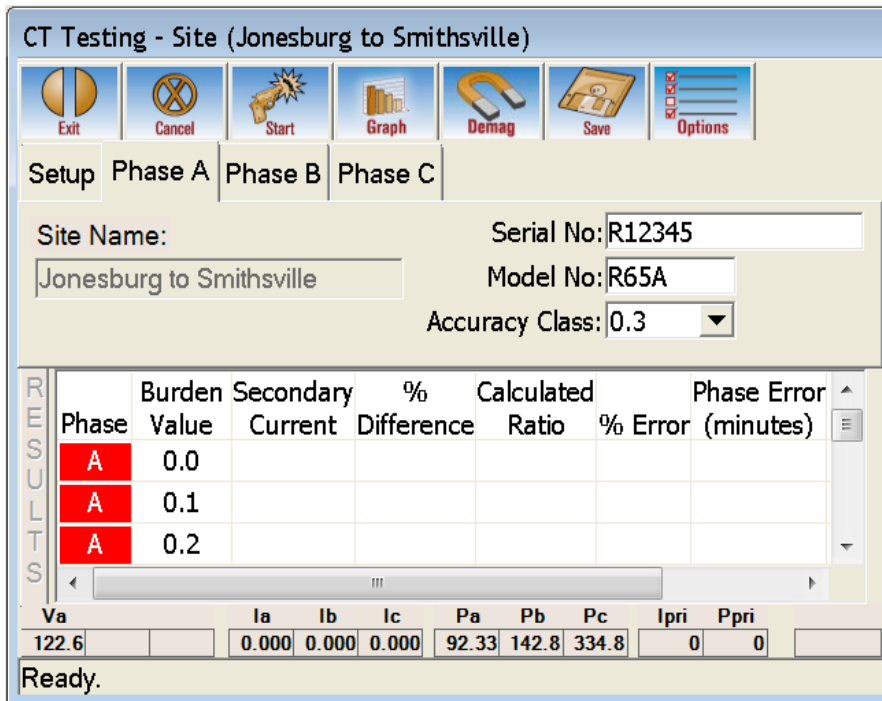
After connecting the unit to the test switch, you're ready to set up the test. At the end of the test cycle, all the results will be saved at once. To begin:

1. Return to the Startup screen.
2. Click CT Testing on the Startup screen. A screen like this appears:



You'll notice the test parameters are already populated. This information is pulled from the Site Information you loaded earlier. If you hadn't used Site Information, you'd need to perform the following steps:

3. Enter the nameplate ratio of the current transformer being tested in Nameplate Ratio.
4. Place a check in the Ratio and Burden check boxes.
5. Place a check in Phases A, B and C by clicking each color coded box. This indicates that you'll be testing the current transformers of all three phases. It is possible to test any combination of phases, but for now we'll test all three.
6. Select 1.8 from Max Burden. This sets the maximum burden applied to the CT secondaries.
7. Click the Phase A tab. The following screen appears:



Again, you'll notice that Serial No., Model No., and Accuracy Class are already filled. If you didn't use site information, you would need to perform the following steps:

8. Enter the serial number of the current transformer being tested in Serial No.
9. Enter the model number of the current transformer being tested in Model No.
10. Select the accuracy class of the current transformer being tested in Accuracy Class.
11. Repeat steps 8-10 for each phase being tested. To select the current transformer information for a different phase, select the tab for that particular phase.

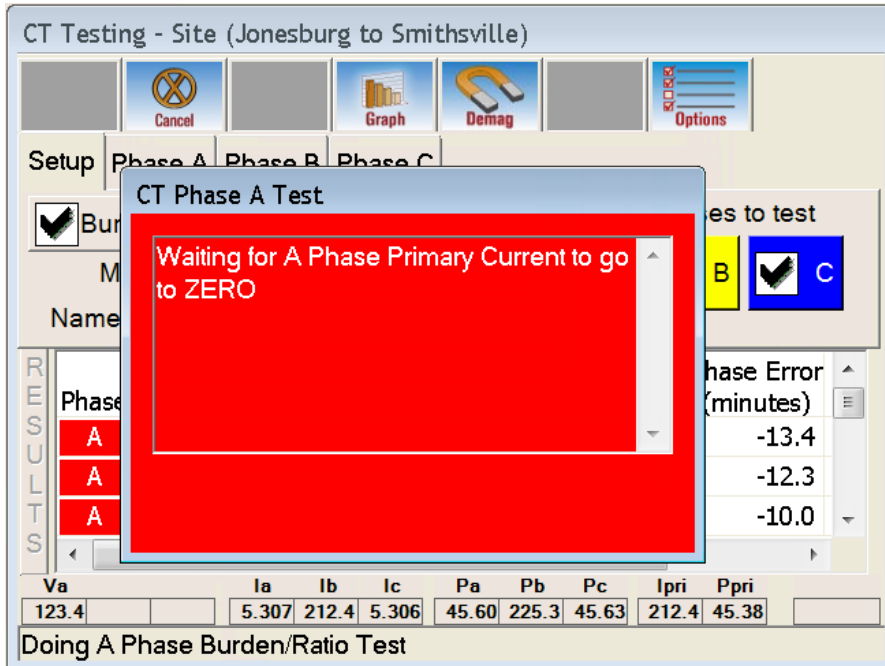
Since you used a site information based workflow, you can go straight to testing the current transformer.

12. Click Start on the toolbar.

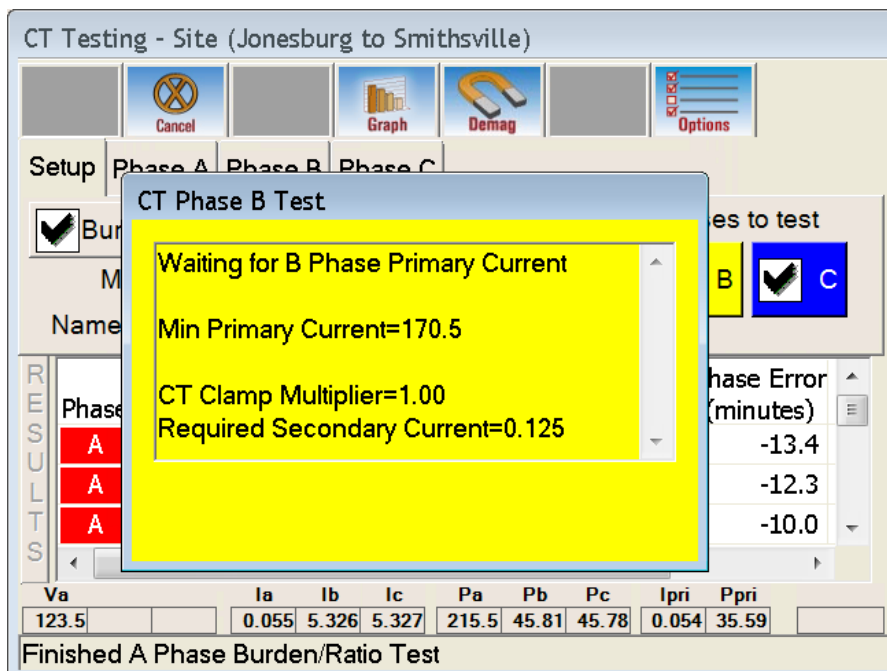
The current transformer test results appear in the results area. When the Phase A portion of the test is complete, the RW-3X will wait for the Phase A primary current



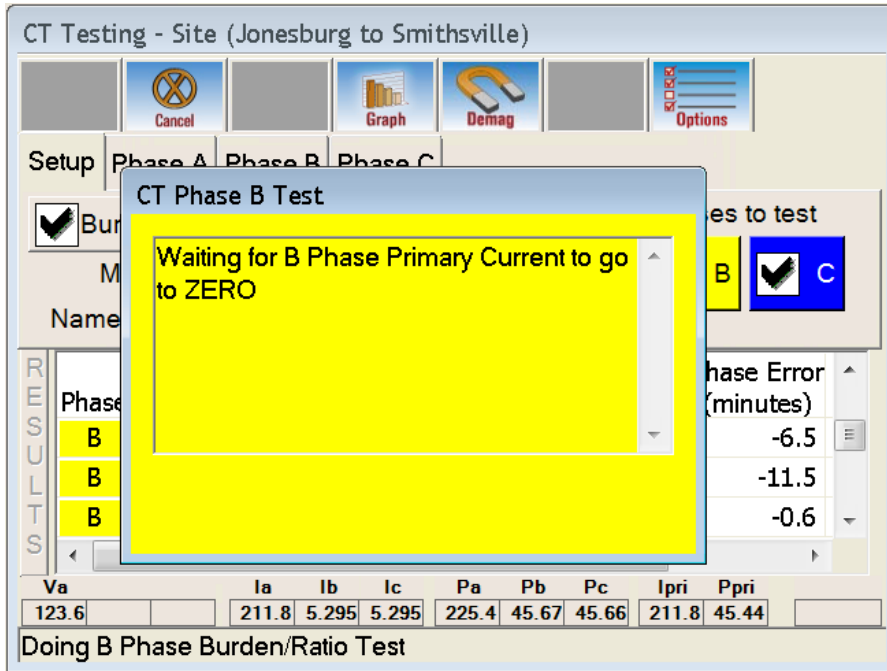
to go to zero, as pictured below.



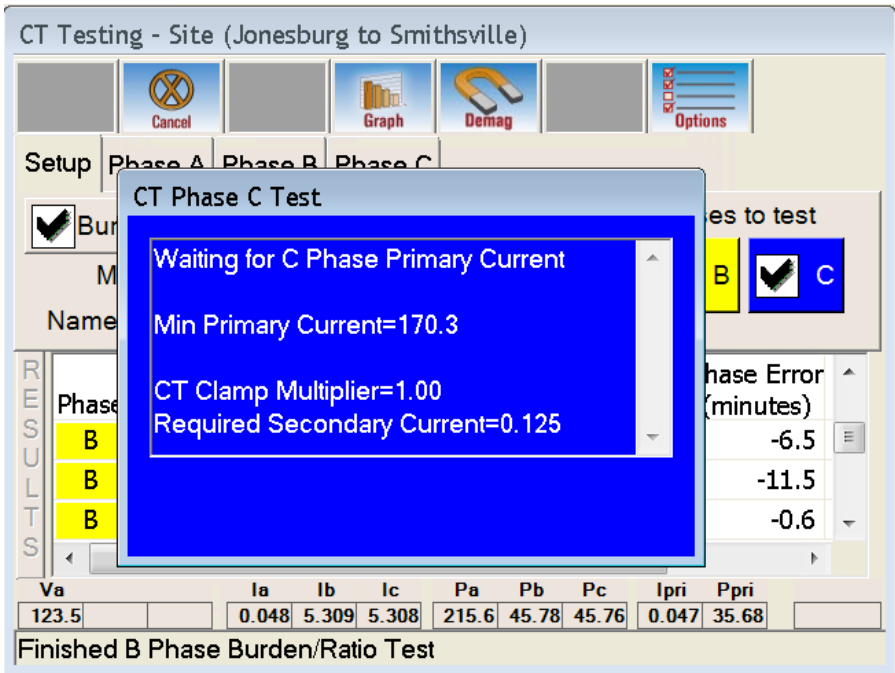
This indicates that you should remove the clamp from the Phase A primary conductor. After you do so, you will be prompted to connect the clamp to the Phase B primary conductor, as pictured below.



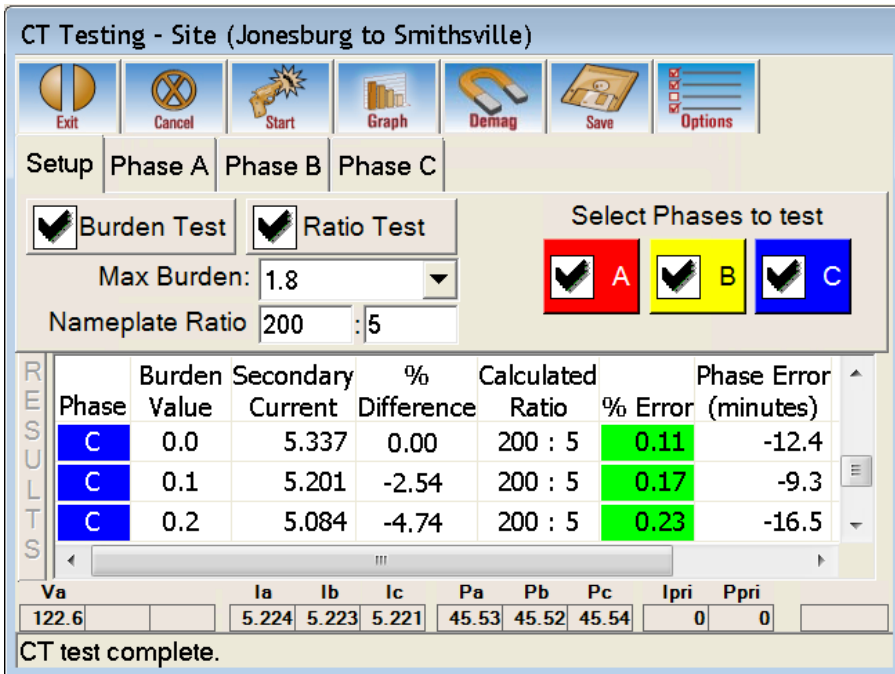
The current transformer test results appear in the results area. When the Phase B portion of the test is complete, the RW-3X will wait for the Phase B primary current to go to zero, as pictured below.

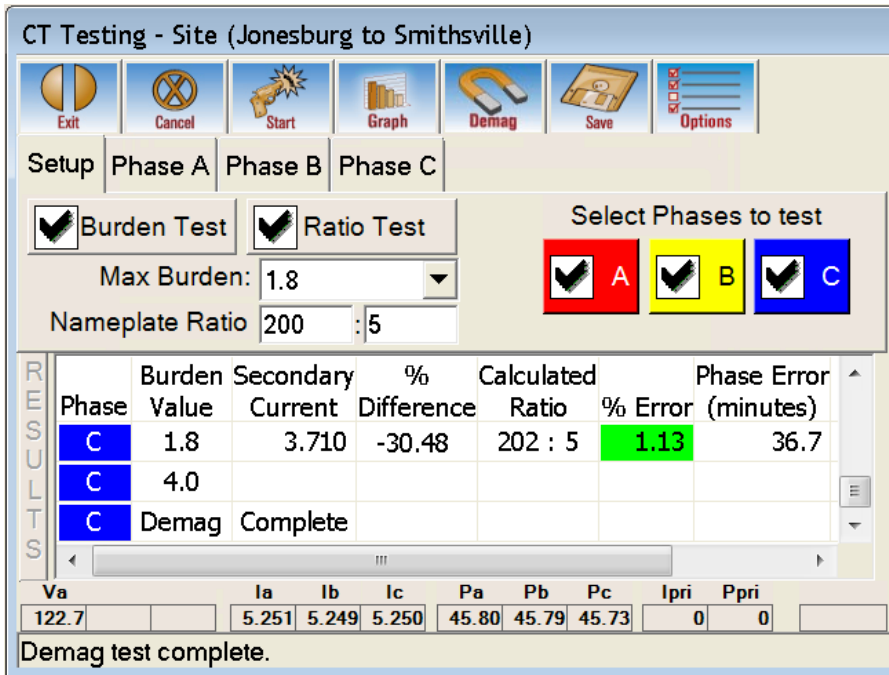


This indicates that you should remove the clamp from the Phase B primary conductor. After you do so, you will be prompted to connect the clamp to the Phase C primary conductor, as pictured below.



When the Phase C portion of the current transformer test is complete, the results can be viewed in the Results area of the screen. Click Save to save your test results to the RW-3X.





While the Current Cables with Safe-T-Plugs are connected between the RW-3X and the meter test switch, clicking the **Demag** button will start the process of demagnetizing the cores of the current transformers. This process will automatically step through each of the selected phases running the Demag sequence on each. In the results area, the Demag step for each corresponding phase will show "Complete" once the process has finished.

Now we'll go look at the current transformer test results.

## Viewing Current Transformer Test Results

To view your saved current transformer test results, you'll need to close the current transformer testing screen and return to the Startup screen. From there:

1. Open the Administration screen by clicking Administration.
2. Click View/Edit Test Results.
3. Click CT Test Results.

The Edit Current Transformer Test Results screen appears. This screen will have no results showing until you load them. Click Load, then select the row containing the site name and test date to view the desired test results. Once loaded, the screen will look something like the following:

The screenshot shows a software window titled "Edit CT Test Results". It contains a table with the following columns: Site Name, Test Date, Serial No, and Mode. The table lists 14 test records. To the right of the table is a vertical sidebar with buttons for Save, Load, Delete, Print, Graph, Close, Import, and Export. The status bar at the bottom left says "Ready." and the status bar at the bottom right has a small icon.

Site Name	Test Date	Serial No	Mode
Jonesburg to Smithville	12/10/2015 12:06:20	R12345	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R12345	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R12345	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R12345	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R12345	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R12345	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R12345	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R23456	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R23456	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R23456	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R23456	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R23456	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R23456	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R23456	R6!
Jonesburg to Smithville	12/10/2015 12:06:20	R23456	R6!

Test results are arranged in order based on the date/time stamp and serial number of the current transformer entered during the current transformer test. Each burden step for each phase is saved as a separate record and includes all the information you entered in addition to the percent change, accuracy result, and test date.

# Potential Transformer Testing With The RW-3X

This section quickly outlines the basic steps necessary to use the RW-3X to conduct a potential transformer test. What follows is by no means meant to be exhaustive. Rather, this section should be used as a rough guide to the basic steps involved when testing a potential transformer.

## Connecting The RW-3X To A Potential Transformer

In this example we will connect cables to run a ratio and phase test on Phases A, B, and C. The following diagram illustrates a fairly common test switch. However, the test switch you're testing may vary from the one pictured here. If you have any questions or concerns about connecting the RW-3X to a test switch, you are urged to contact Watthour Engineering for assistance.

You will need either the High Potential Probe Kit (40kv) or Low Potential Probe Kit (600V) as well as the Potential Cable Assembly to run the potential transformer ratio and phase test described in this chapter.

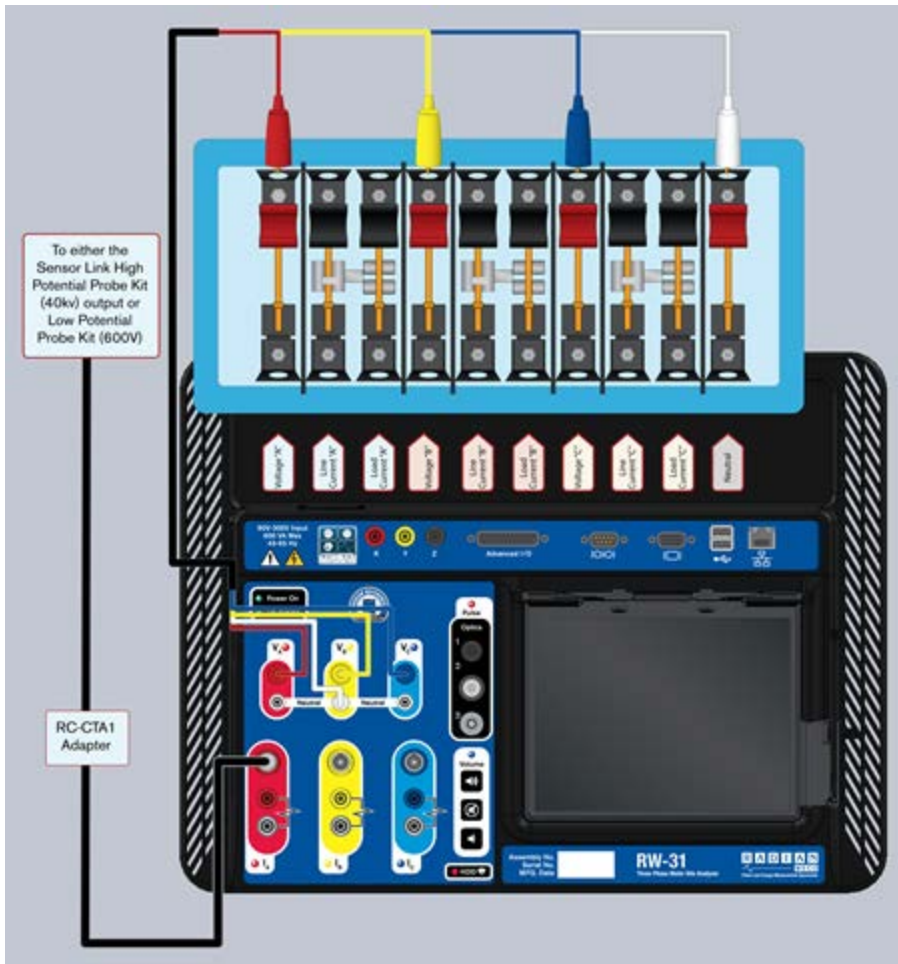
To connect to the RW-3X:

1. Plug the high potential probe kit (40kv) or low potential probe kit (600V) into the Phase A (red) REDEL<sup>®</sup> external clamp input on the front panel of the RW-3X.
2. Plug the red, yellow and blue leads from the potential cable assembly into the corresponding potential connectors on the RW-3X. Connect the cable for each phase that you desire to test. For the purposes of this example connect all three cables.
3. Plug the white lead from the potential cable assembly into any of the white neutral connectors on the front of the RW-3X.

To connect the RW-3X to the potential transformer:

1. Clip the white lead from the potential cable assembly onto the neutral spade.
2. Clip the red lead from the potential cable assembly onto the Phase A potential spade.
3. Clip the yellow lead from the potential cable assembly onto the Phase B potential spade.
4. Clip the blue lead from the potential cable assembly onto the Phase C potential spade.

5. Connect the potential probe to the primary side of the potential transformer according to the manufacturer's instructions.
6. Ensure you have the leads connected to the RW-3X.



You are now ready to conduct a potential transformer ratio and phase test for Phases A, B, and C.

## Conducting A Potential Transformer Test

After connecting the unit to the test switch, you're ready to set up the test. At the end of the test cycle all the results will be saved at once.

During a potential transformer test the high potential probe kit (40kv) or low potential probe kit (600V) measures the primary potential. The potential cable assembly measures the secondary potential. The secondary voltages are measured with the Va, Vb and Vc inputs.

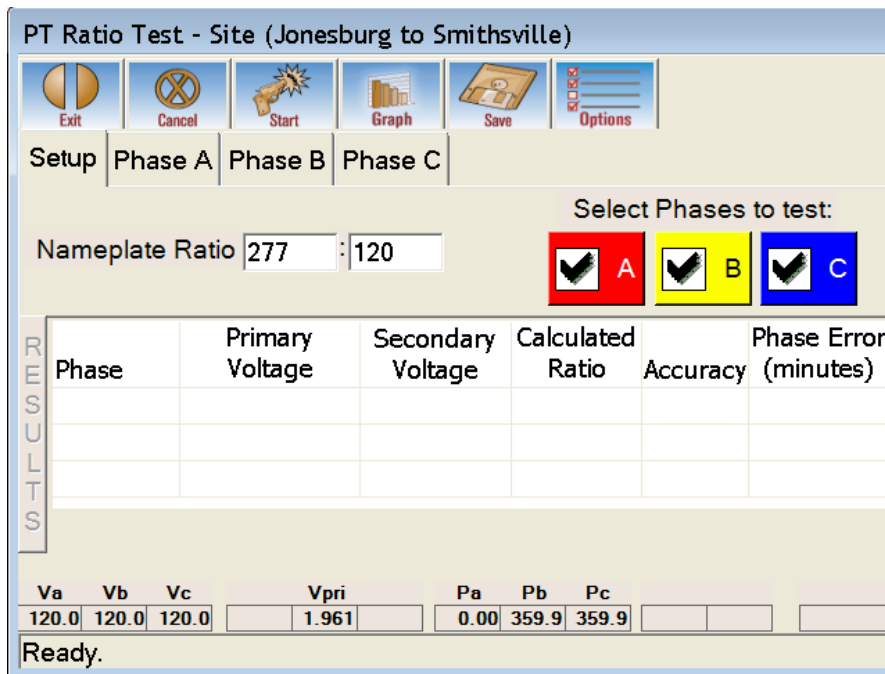
**Note:** The potential transformer test is only a ratio and phase test. It does not

conduct a burden test.

**Note:** The potential probe being used must be set in PT Test Options. A scaling factor can be applied to the primary readings to correct for the probe multiplier. These settings are accessed by selecting Options on the Potential Transformer Test toolbar.

To begin:

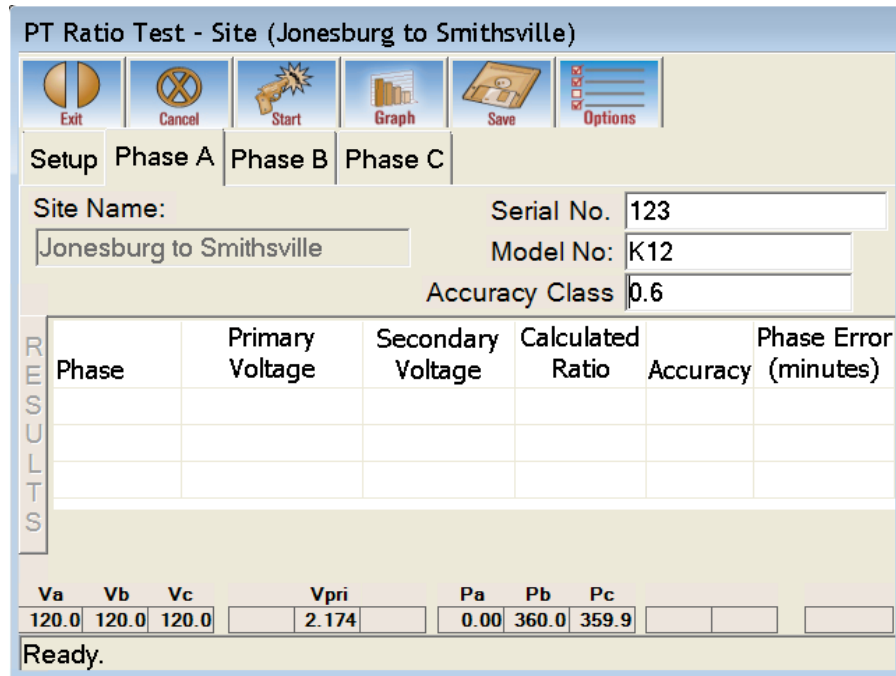
1. Click PT Testing on the Startup screen.
2. Place a check in Phases A, B, and C by clicking each color coded box. This indicates all three potential transformers will be tested. It is possible to test any combination of phases.



If you have not previously created the site information, you will need to perform the following steps. If the site information is set up, follow along to verify that the information is correct.

3. Enter the nameplate ratio of the potential transformer being tested in Nameplate Ratio.
4. Click the Phase A tab. A screen similar to the following will appear.



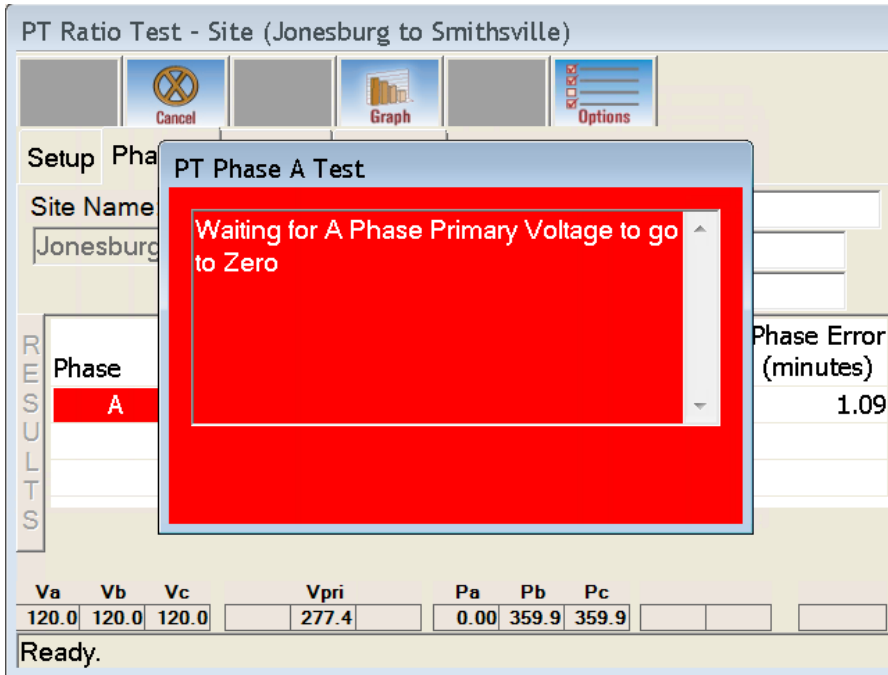


5. Enter the serial number of the potential transformer being tested in Serial No.
6. Enter the model number of the potential transformer being tested in Model No.
7. Select the accuracy class of the potential transformer being tested from the Accuracy Class drop-down menu.
8. Enter a name for the current site in Site Name.
9. Repeat Steps 5–8 to enter the potential transformer information for each phase being tested in the respective tabs. For example, if you are testing Phase A, B, and C, you will repeat these steps under the Phase B tab and then again under the Phase C tab.

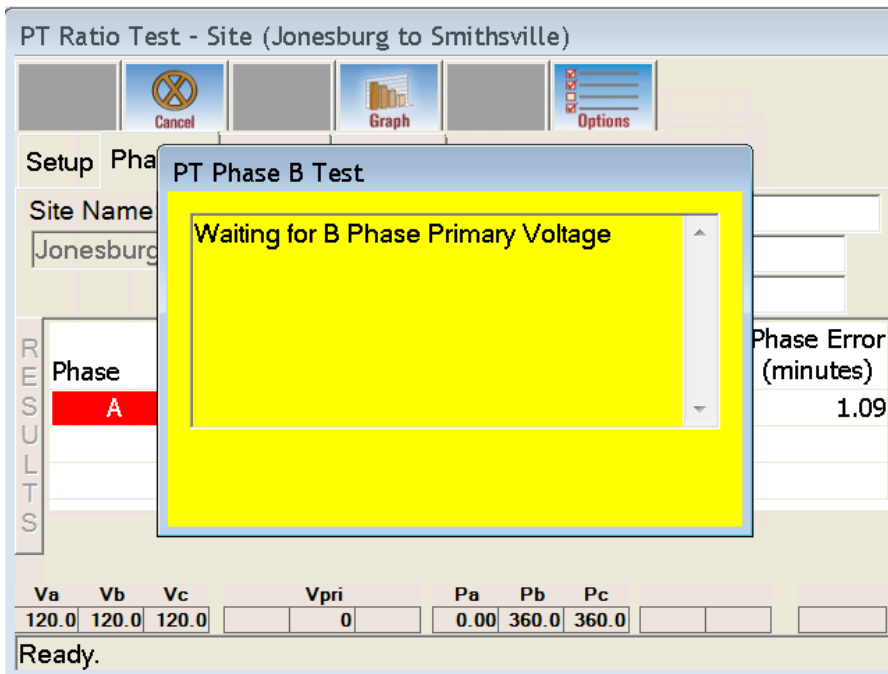
Once you have verified that all information is correct for the current site, you can begin testing the potential transformers.

10. Click Start on the toolbar.

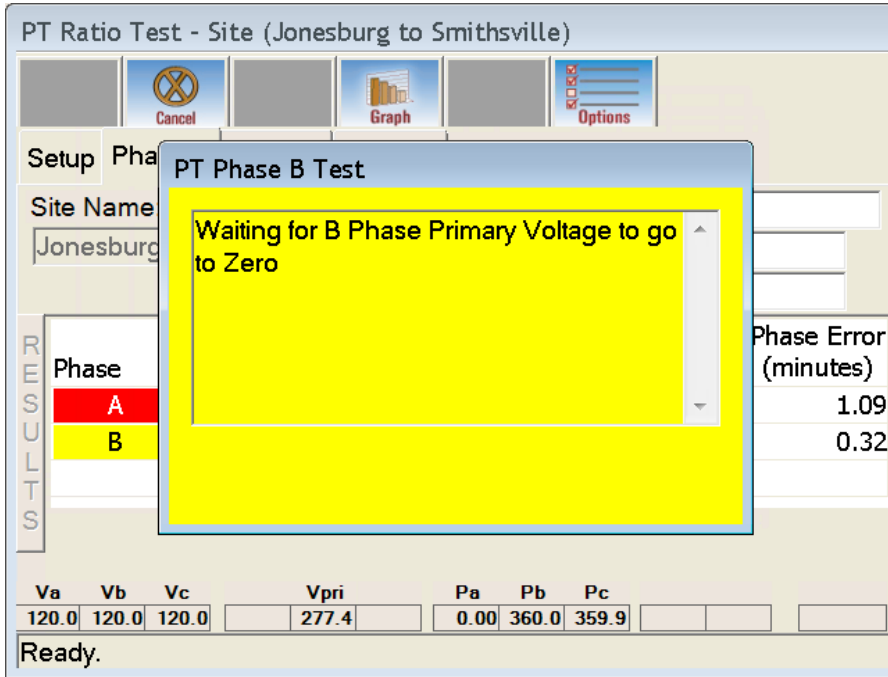
The potential transformer test results appear in the results area. When the Phase A portion of the test is complete, the RW-3X will wait for the Phase A primary voltage to go to zero, as pictured below.



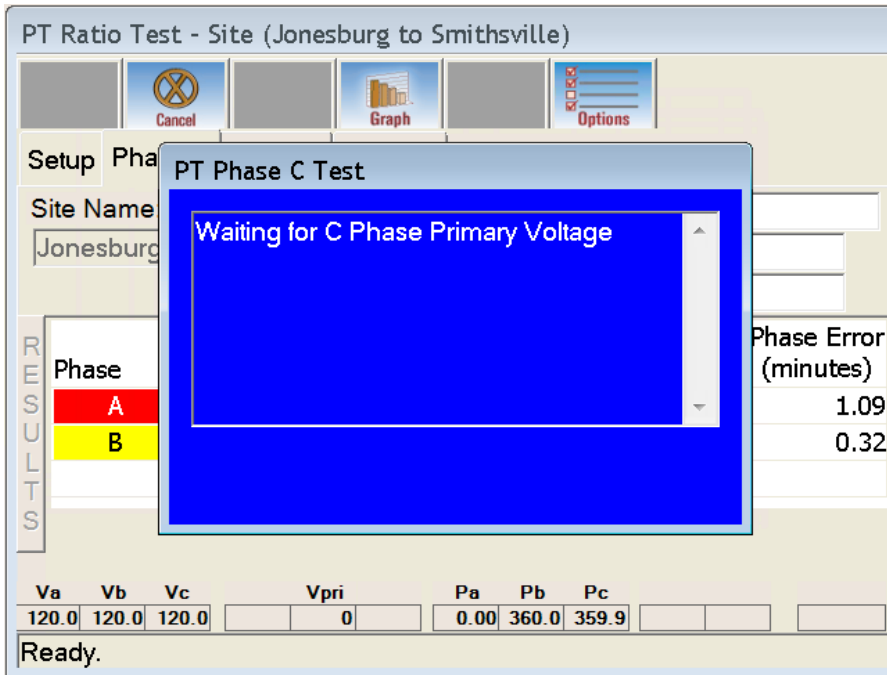
This indicates the potential probe needs removing from the primary of the potential transformer. After you do so, you will be prompted to connect the potential probe to the primary of the Phase B potential transformer, as pictured below.



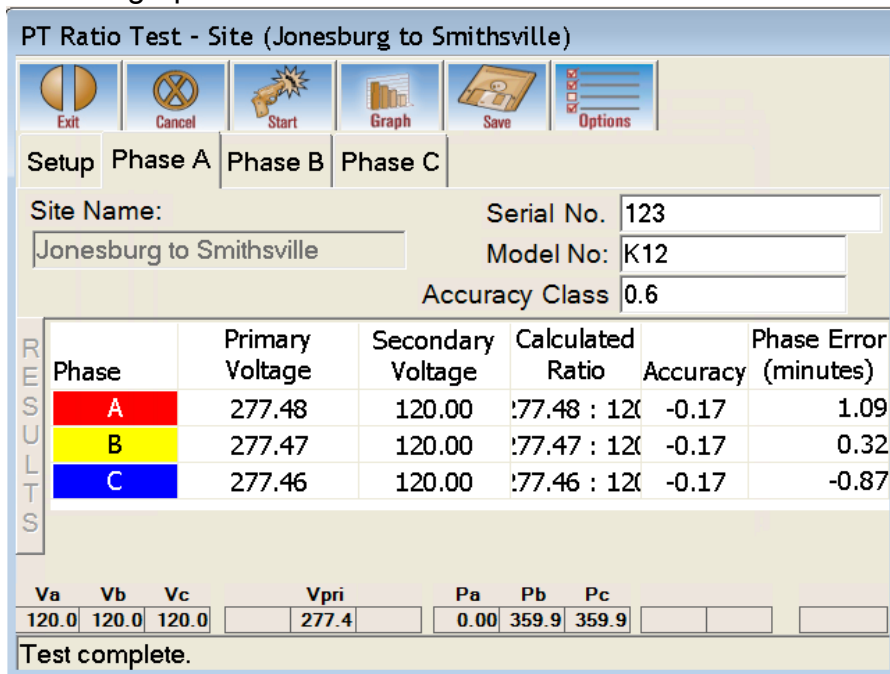
The potential transformer test results appear in the results area. When the Phase B portion of the test is complete, the RW-3X will wait for the Phase B primary voltage to go to zero, as pictured below.



This indicates that you should remove the potential probe from the primary of the Phase B potential transformer. After you do so, you will be prompted to connect the potential probe to the primary of the Phase C potential transformer, as pictured below.



When the Phase C portion of the potential transformer test is complete, the results can be viewed in the results area of the screen. Click Save to save your test results to the RW-3X. Click Graph to view the potential transformer test results plotted on a graph.



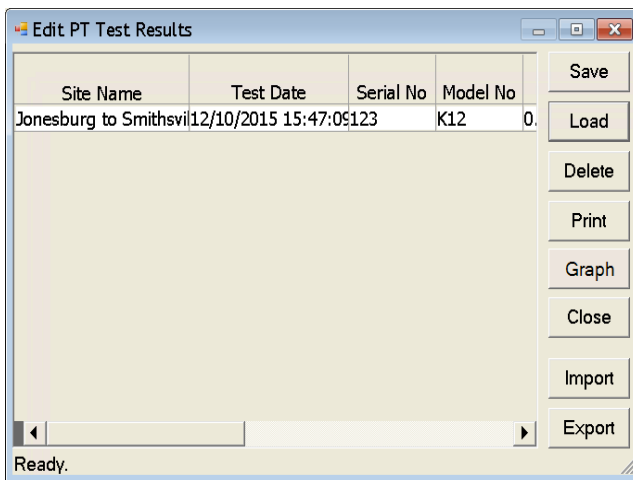
Now, we'll look at these results.

## Viewing Potential Transformer Test Results

To view your saved potential transformer test results you'll need to close the potential transformer testing screen and return to the Startup screen. From there:

1. Open the Administration screen by clicking Administration.
2. Click View/Edit Test Results.
3. Click PT Test Results.

The Edit Potential Transformer Test Results screen appears. Click Load, now select the row containing the site name and date for the desired results. Once loaded you should see something like this:



Test results are arranged in order based on the serial number of the potential transformer entered during the potential transformer test. Each record includes all the information you entered in addition to the calculated ratio, accuracy result, and phase error.

# Power Quality Testing

The power quality testing features of the RW-3X offer a number of ways to analyze the meter installation. In this section we'll go over some of the basics of power quality testing. It is important to note that the degree of variation between meter installations is impossible to cover in a manual of this scope. These instructions for connecting and conducting a power quality test are meant only as a guideline.

## Connecting The RW-3X For A Power Quality Test

Before conducting a power quality test with the RW-3X, it's necessary to connect the unit to the test switch. It is important to note that there are many different types of test switches in use, and the one detailed here might not correspond to one you are using. If you have any questions or concerns about connecting the RW-3X to a test switch, you are urged to contact Watthour Engineering for assistance.

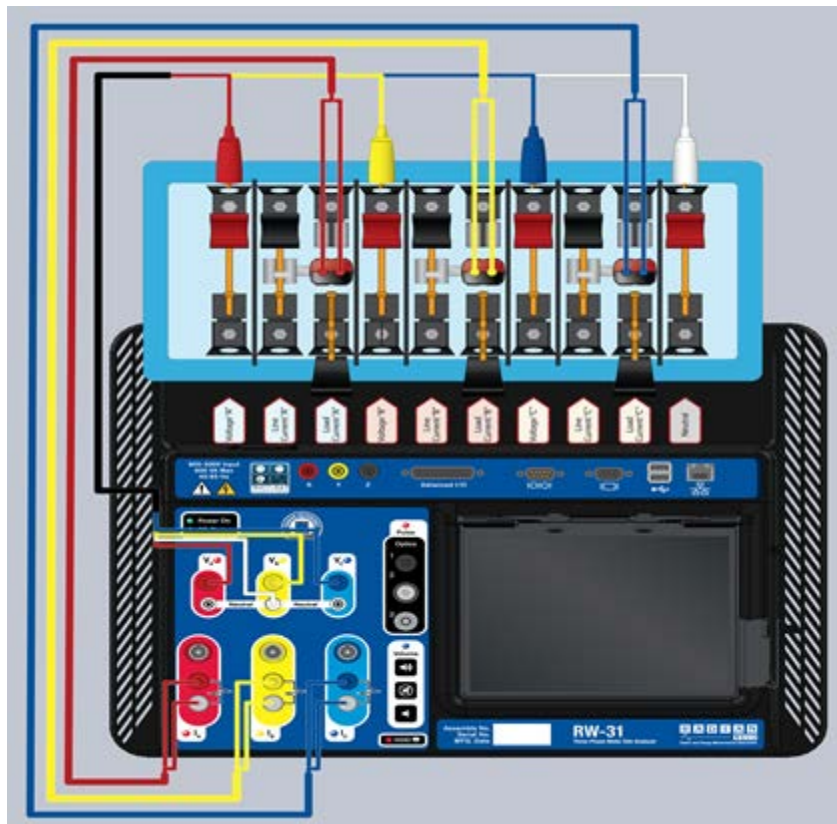
To connect cables to the RW-3X:

1. Plug the red, yellow and blue leads from the potential cable assembly into the corresponding potential connectors on the RW-3X.
2. Plug the white lead from the potential cable assembly into any of the white neutral connectors on the front of the RW-3X.
3. Plug the red current cable with Saf-T-Plug into the current connections of Phase A (red) on the front of the RW-3X.
4. Plug the yellow current cable with Saf-T-Plug into the current connections of Phase B (yellow) on the front of the RW-3X.
5. Plug the blue current cable with Saf-T-Plug into the current connections of Phase C (blue) on the front of the RW-3X.

To connect the RW-3X to the meter test switch:

1. Ensure you have the leads connected to the RW-3X.
2. Clip the white lead from the potential cable assembly onto the neutral spade.
3. Clip the red lead from the potential cable assembly onto the Phase A potential spade.
4. Clip the yellow lead from the potential cable assembly onto the Phase B potential spade.
5. Clip the blue lead from the potential cable assembly onto the Phase C potential spade.
6. Open current line and load side switches for all three phases.

7. Plug the red current cable with Saf-T-Plug into the load side of the Phase A meter test switch. Red is up for current in, and black is down for current out.
8. Plug the yellow current cable with Saf-T-Plug into the load side of the Phase B meter test switch. Red is up for current in, black is down for current out.
9. Plug the blue current cable with Saf-T-Plug into the load side of the Phase C meter test switch. Red is up for current in, black is down for current out.
10. Close the line side current switches after verifying the current cable set is connected to the RW-3X.

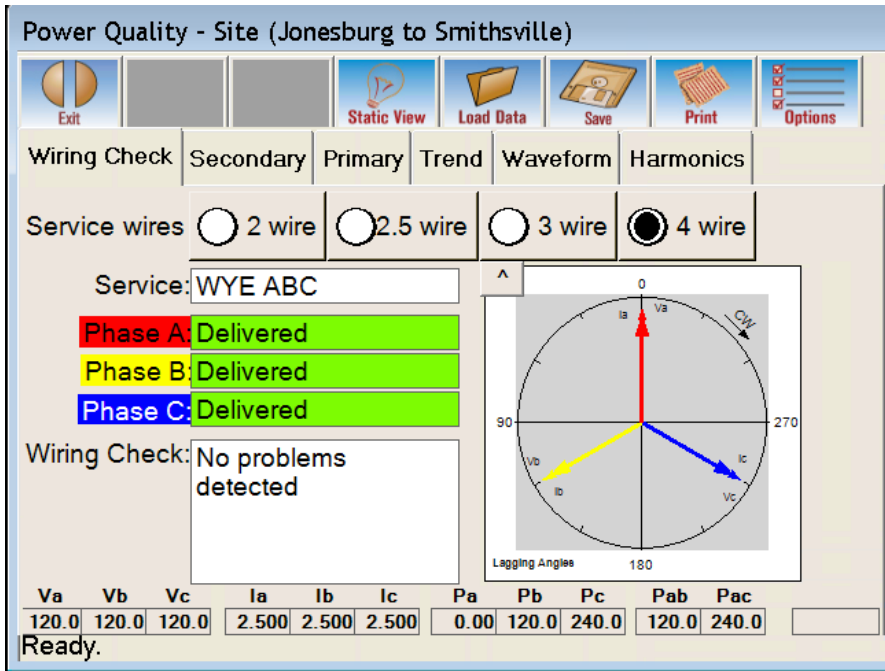


You are now ready to conduct a power quality check.

## Conducting The Wiring Check

After you have connected the RW-3X to the test switch you can proceed with a series of power quality tests. To access the Power Quality test screen, return to the Startup screen.

1. Click Power Quality. The following screen should appear:



The first tab of the Power Quality screen is the wiring check tab. Wiring check is used to make sure that the test switch installation is correct. The test is conducted automatically when you enter the Power Quality screen, and the results of the wiring check appear on the screen.

If the service is wired incorrectly or if you connect the cables incorrectly, the screen will indicate that it detects a vector conflict.

Next, we'll look at the Secondary Check.

## Conducting The Secondary Check

The second tab of the Power Quality screen is the Secondary tab. It is used to provide metrics measured from the secondary side of the potential and current transformers in the meter installation. To perform the secondary check:

Click on the Secondary tab of the Power Quality test screen. The following screen will appear:



Power Quality - Site (Jonesburg to Smithville)

Exit Toggle Static View Load Data Save Print Options

Wiring Check Secondary Primary Trend Waveform Harmonics

Instantaneous	A	B	C	Net
Volts:	120.00	120.00	120.00	
Amps:	2.5000	2.5000	2.5000	
V L-L & NeuA:	208.24	208.27	207.02	0.0079
Phase:	0.0000	120.00	240.00	
P.F.:	1.0000	1.0000	0.9999	
Delta Phase:		120.00	240.00	
Freq:	60.000	60.000	60.000	
Voltage THD:	0.0781	0.2827	0.5655	
Current THD:	0.0864	0.1318	0.1396	
WATTS:	300.00	300.00	299.97	899.97
VARS:	0.2888	-1.7634	-4.0336	-5.5084
VA:	300.00	300.00	300.00	900.01

Ready.

The Secondary tab of the Power Quality screen shows the potential, current, neutral current, phase angle, power factor, delta phase, frequency, potential THD, current THD, watts, VARS, and VA for Phases A, B, C, and total.

By default, the results of the secondary check are shown as instantaneous values. However, if you click Toggle on the Power Quality toolbar you will change the secondary check results from instantaneous to average. Clicking Toggle again changes them back to instantaneous.

You will notice that many of these values are fluctuating. This is because the RW-3X is bringing you real-time information about the state of the installation. To examine the values without fluctuations, click Static View. This provides a static snapshot of the values. Click Live View to resume viewing the results in real-time.

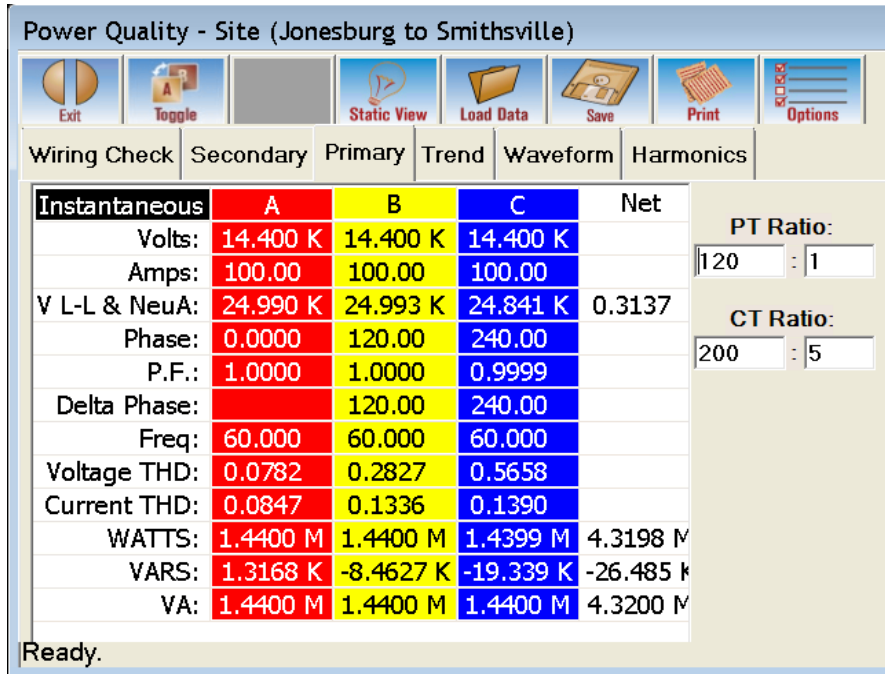
You can save your secondary check values at any point by clicking Save on the Power Quality toolbar. These results can later be reloaded by clicking Load Data on the Power Quality toolbar.

Now we'll look at the Primary tab.

# Conducting The Primary Check

The third tab of the Power Quality screen is the Primary tab. It is used to provide you information on the state of the primary side of the potential and current transformers in the meter installation. To perform the primary check:

1. Click on the Primary tab of the Power Quality test screen. The following screen will appear:



Instantaneous	A	B	C	Net	
Volts:	14.400 K	14.400 K	14.400 K		PT Ratio: 120 : 1
Amps:	100.00	100.00	100.00		CT Ratio: 200 : 5
V L-L & NeuA:	24.990 K	24.993 K	24.841 K	0.3137	
Phase:	0.0000	120.00	240.00		
P.F.:	1.0000	1.0000	0.9999		
Delta Phase:		120.00	240.00		
Freq:	60.000	60.000	60.000		
Voltage THD:	0.0782	0.2827	0.5658		
Current THD:	0.0847	0.1336	0.1390		
WATTS:	1.4400 M	1.4400 M	1.4399 M	4.3198 M	
VARs:	1.3168 K	-8.4627 K	-19.339 K	-26.485 K	
VA:	1.4400 M	1.4400 M	1.4400 M	4.3200 M	

Ready.

2. Enter the ratio for the potential and current transformers in PT Ratio and CT Ratio.

Note: The RW-3X remembers the last ratios entered in PT Ratio and CT Ratio or automatically fills those fields if specific site information has been loaded. This will explain why your PT and CT Ratio might already be filled.

The Primary tab of the Power Quality screen shows the calculated potential, current, neutral current, phase angle, power factor, delta phase, frequency, potential THD, current THD, watts, VARs, VA for Phases A, B, C and total.

By default the results of the primary check are shown as instantaneous. However, if you click Toggle on the Power Quality toolbar, you will change the primary check results from instantaneous to average. Clicking Toggle again changes

them back to instantaneous values.

You will notice that many of these values are fluctuating. This is because the RW-3X is bringing you real-time information about the state of the installation. To examine the values without fluctuations, click Static View. This provides a static snapshot of the values. Click Live View again to resume viewing the results in real-time.

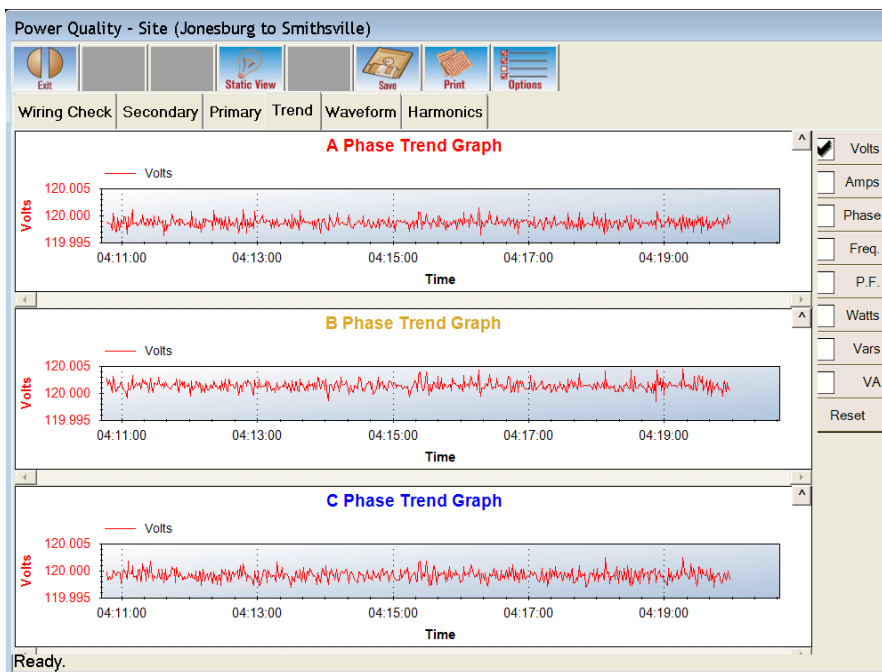
You can save your primary check values at any point by clicking Save on the Power Quality toolbar. These results can later be reloaded by clicking Load Data on the Power Quality toolbar.

Next we'll look at the Trend tab.

## Conducting Trend Analysis

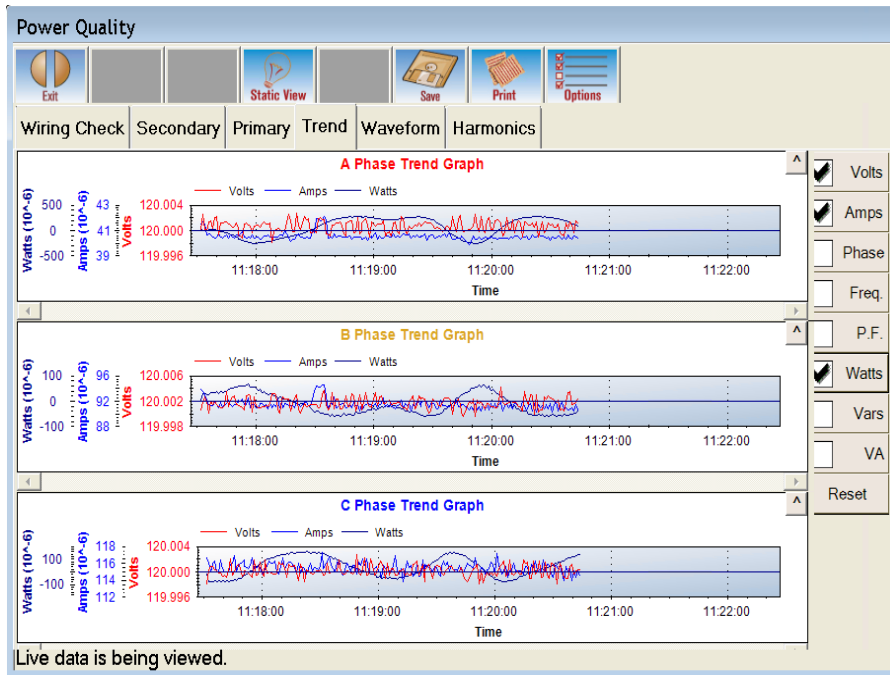
The fourth tab of the Power Quality screen is the Trend tab. Trend analysis allows you to examine many aspects of the meter installation over a period of time. The Trend tab shows graphs for all three phases along with a selection of different metrics that can be plotted along three graphs. To conduct trend analysis:

Click on the Trend tab of the Power Quality screen. The following screen appears:



The Trend tab displays a log of the service metrics for all three phases over a

period of time. The check boxes on the right side of the screen allow you to view multiple metrics simultaneously. The following screen shows trend data for the volts, amps, and watts metrics.



You will notice that the information presented in the graphs fluctuates. This is because the RW-3X is bringing you real-time information about the state of the service metrics. To examine the values without fluctuations, Click Static View. This provides a static snapshot of the service metrics. Click Live View again to resume viewing the results in real-time.

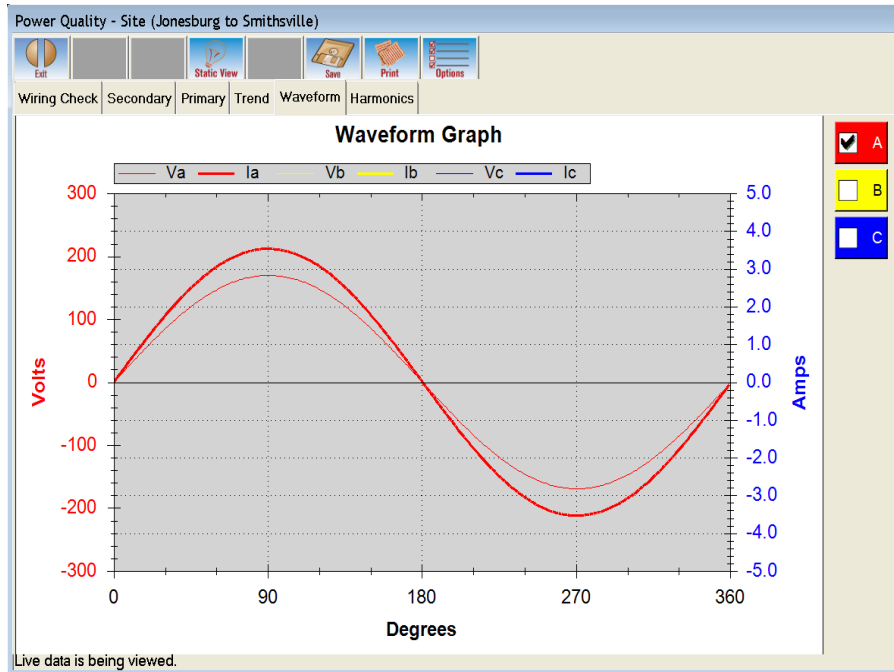
You can interact with the trend graph by using the stylus. Select any point on any plotted service metric to pop-up a numerical measurement for that particular point. This can be really useful for getting exact numerical measurements for the peaks and troughs of a metric. You can zoom in on your results by drawing a box around the area you wish to view. Right clicking (click and hold with the stylus) brings up a menu that allows you to pan (when zoomed in), return to a non-zoomed view, save the results as a file or .jpeg image, and toggle numerical measurement pop-ups.

You can save your trend analysis values at any point by clicking Save on the Power Quality toolbar. These results can later be reloaded by clicking Load Data on the Power Quality toolbar. It is also possible to save your trend analysis information as a .jpeg image by selecting Save Image from the Save dialogue.

# Conducting Waveform Analysis

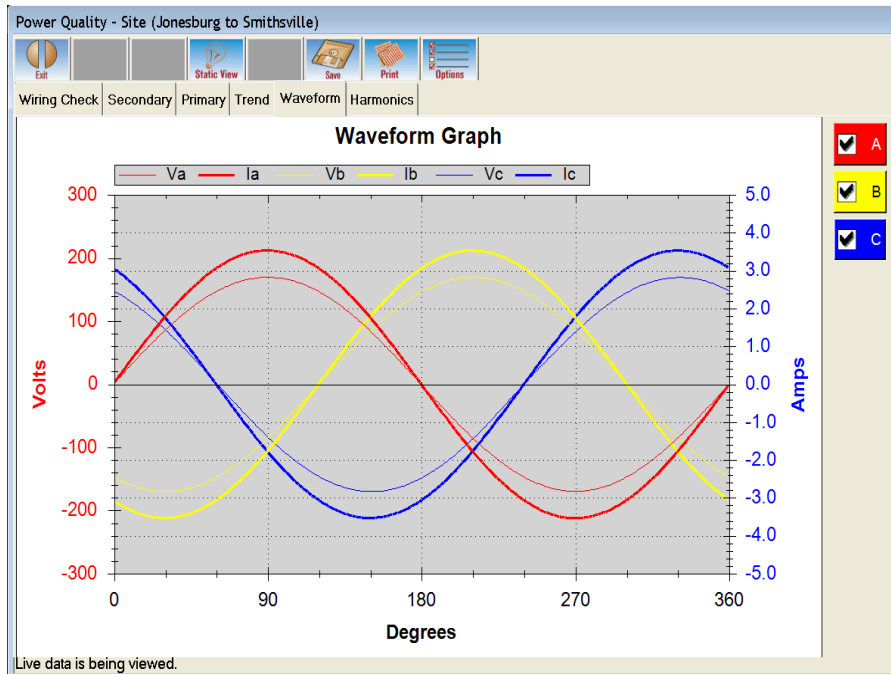
The fifth tab of the Power Quality screen is the Waveform tab. It is used to provide real-time waveform results relating to the meter installation. To perform waveform analysis:

1. Click on the Waveform tab of the Power Quality test screen. The following screen will appear:



2. Select the phase you wish to see waveform information about by placing a check in the corresponding phase check box to the right of the graph.

The Waveform tab of the Power Quality screen plots a single cycle of the potential and current waveform for the selected phase. You can select multiple phases to view simultaneously using the check boxes on the right of the screen. Pictured on the following page is a waveform graph displaying the A, B and C phases.



You will notice that the plotted waveforms fluctuate as time passes. This is because the RW-3X is bringing you real-time information about the state of the meter installation. To examine the waveform graph without fluctuations, click Static View. This provides a static snapshot taken from the secondary side of the potential and current transformers. Click Live View again to resume viewing the results in real-time.

You can interact with the waveform graph by using the stylus. Select any point on any plotted waveform to pop-up a numerical measurement for that particular point. This can be really useful for getting exact numerical measurements for the peaks and troughs of a wave. You can zoom in on your results by drawing a box around the area you wish to view. Right clicking (click and hold with the stylus) brings up a menu that allows you to pan (when zoomed in), return to a non-zoomed view, save the results as a file or .jpeg image, or toggle numerical measurement pop-ups.

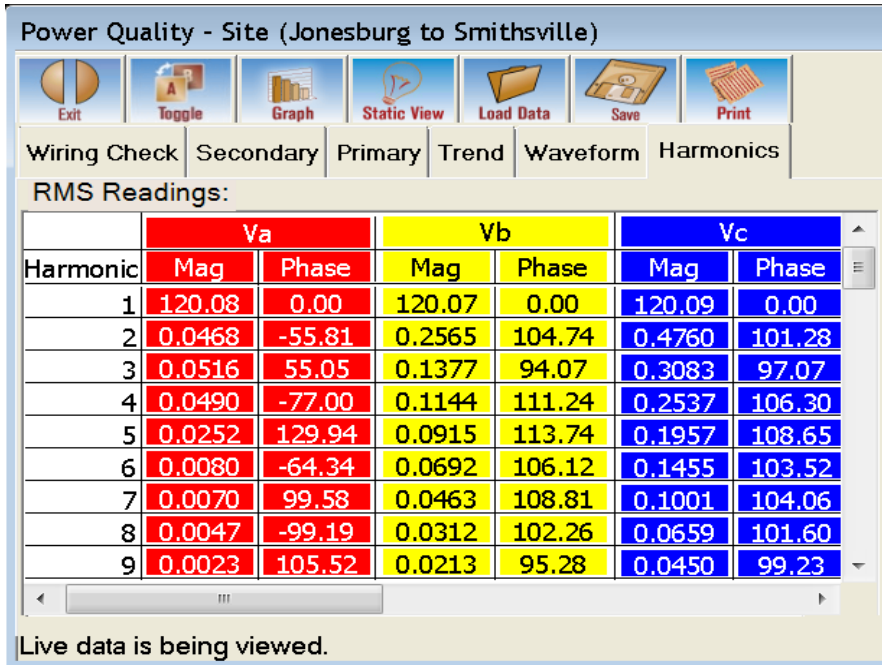
You can save your waveform graph at any point by clicking Save on the Power Quality toolbar. It is only possible to save a waveform graph as an image file (.emf, .png, .gif, .jpg, .tif, or .bmp).

## Conducting Harmonic Analysis

The last tab of the Power Quality screen is the Harmonics tab. It is used to provide you information about the harmonics present at the meter installation. To perform

harmonic analysis:

Click on the Harmonics tab of the Power Quality test screen. The following screen will appear:

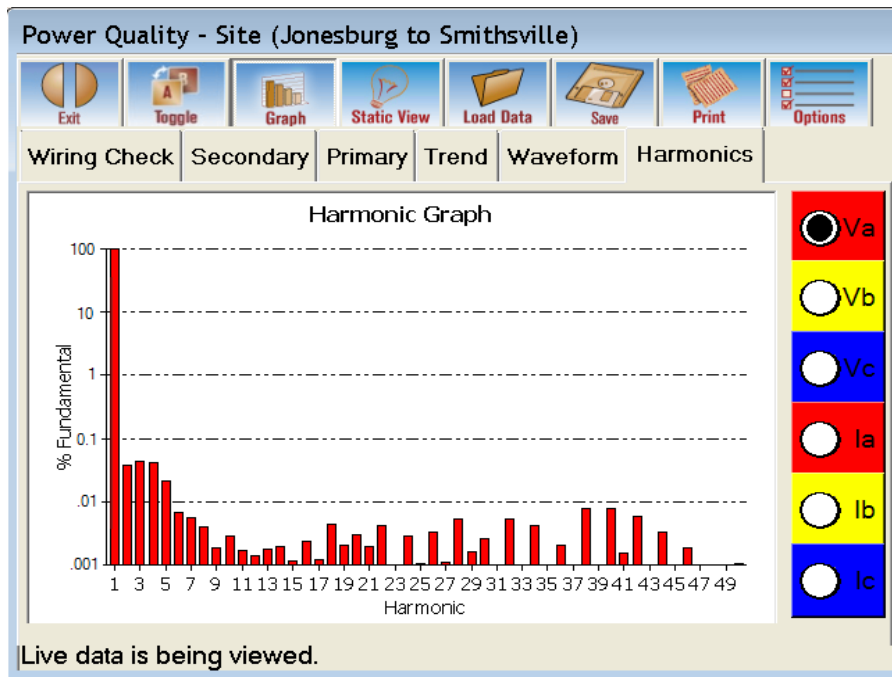


The Harmonics tab of the Power Quality screen shows the magnitude and phase angle for A, B and C potential and current through the 60th harmonic order. Scroll over to see the current measurements.

By default the harmonic analysis values are shown as RMS readings. However, if you click toggle on the Power Quality toolbar you will change the readings from RMS to % of fundamental. Clicking Toggle again changes them back to RMS readings.

You will notice that many of these values are fluctuating. This is because the RW-3X is bringing you real-time information about the meter installation's harmonic content. To examine the values without fluctuations, click Static View. This provides a static snapshot of the harmonic values. Click Live View again to resume viewing the results in real-time.

You can also view harmonic data in real time as a harmonic bar graph. Click Graph in the Power Quality toolbar to switch to the harmonic graph pictured below. Use the check boxes to select which potential or current phase is displayed. Only one phase can be displayed at a time. Click Graph again to return to the numeric harmonic results.



You can save your harmonic analysis values at any point by clicking Save.



# Transducer Testing

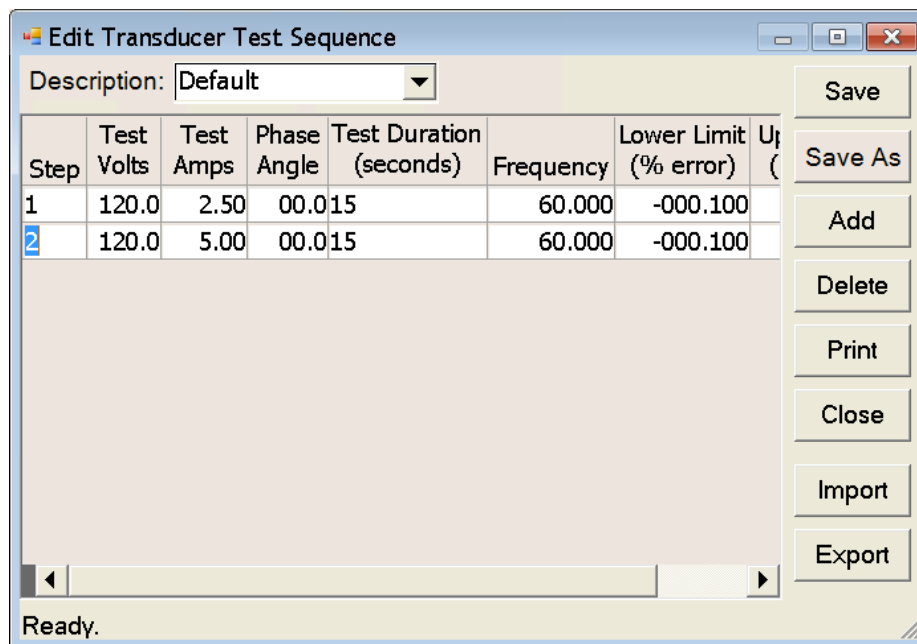
Utilities use transducers to monitor various system conditions throughout their distribution network.

Our software allows you to test several different types of transducers:

- Volt
- Current
- Phase
- Power Factor
- Watts (1, 2, 2.5, or 3 element)
- Vars (1, 2, 2.5, or 3 element)

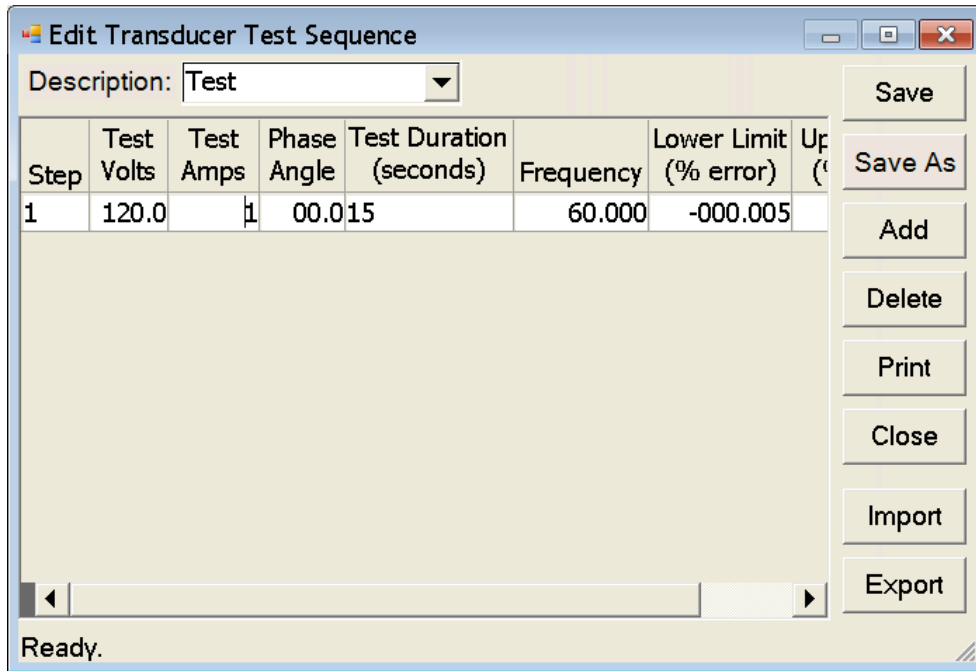
## Creating A Transducer Test Sequence

1. From the Startup window click Transducer Testing.
2. Click Edit Xdcr Seq.



A default sequence is available, but we'll create a new one.

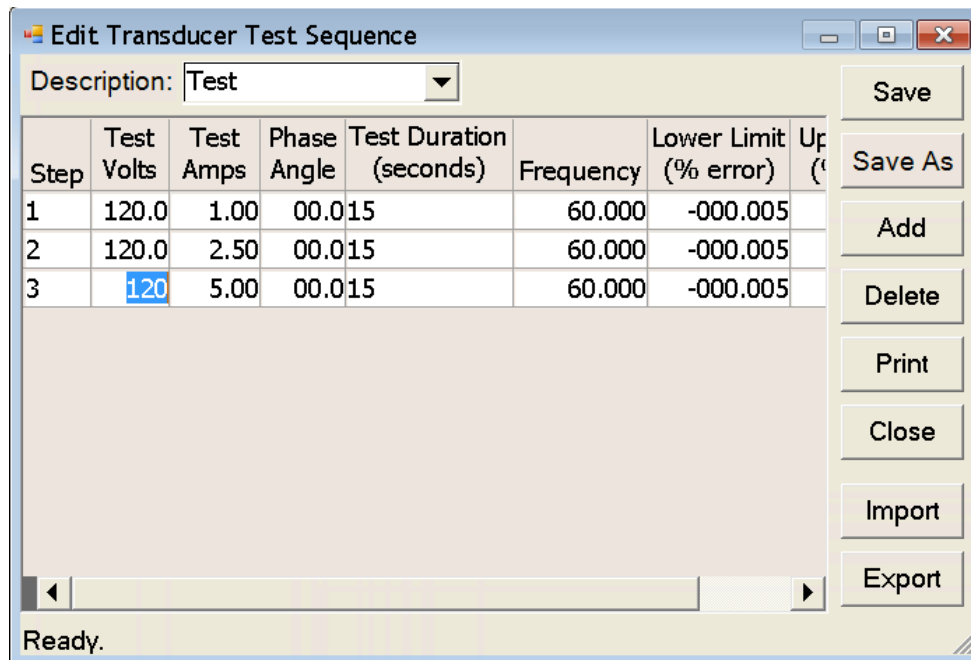
1. Click Add on the right side of the screen.
2. Click Add New Sequence.
3. Type in a name for the transducer test sequence. In this example we'll use the name Test.



Each sequence will have voltage, current, and phase angle in the sequence. Every Sequence must have voltage for reference purposes. Add current and phase angle only as needed.

Now let's enter the values for our test sequence.

1. In Test Volts enter 120.0.
2. In Test Amps enter 1.
3. In Phase Angle enter 0.
4. In Test Duration enter 15 to indicate that the test should run for 15 seconds.
5. Click Add.
6. Click Add Step from the Edit Sequence dialog. A new line, Step 2, will appear identical to the line above it. Change any variables that you need. For this example we'll change Test Amps to 2.5.
7. Click Add.
8. Click Add Step from the Edit Sequence dialog. A new line, Step 3, will appear identical to Step 2. This time we'll change Test Amps to 5.
9. Click Save.



You can create as many different test sequences as you want. Each sequence can have as many steps as you need.

Now let's move on to conducting a transducer test.

## Conducting A Transducer Test

Now we'll look at the steps necessary to conduct a transducer test.

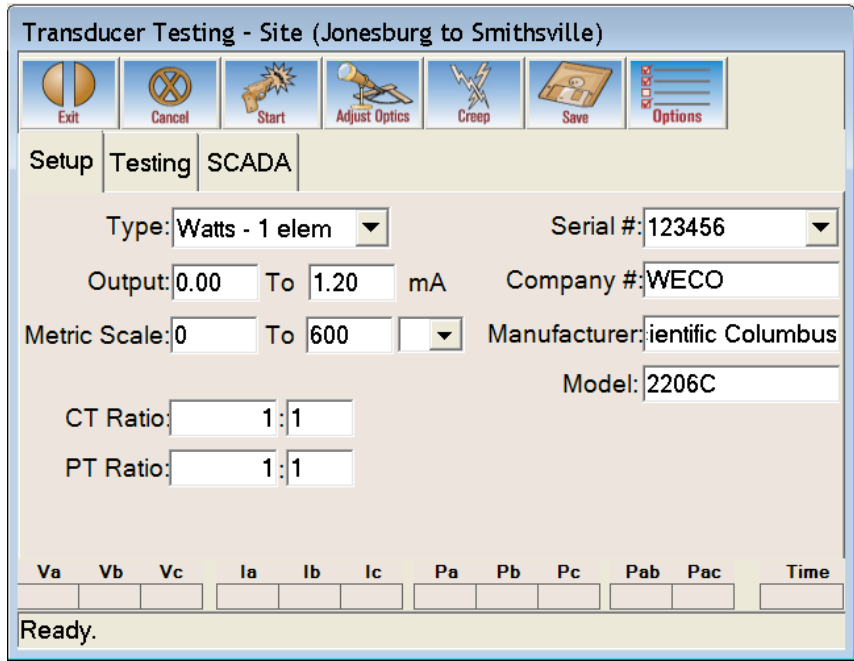
1. From the Startup window click Transducer Testing.
2. Click Run Xdcr Test.

There will be three tabs at the top of the page: Setup, Testing, and SCADA.

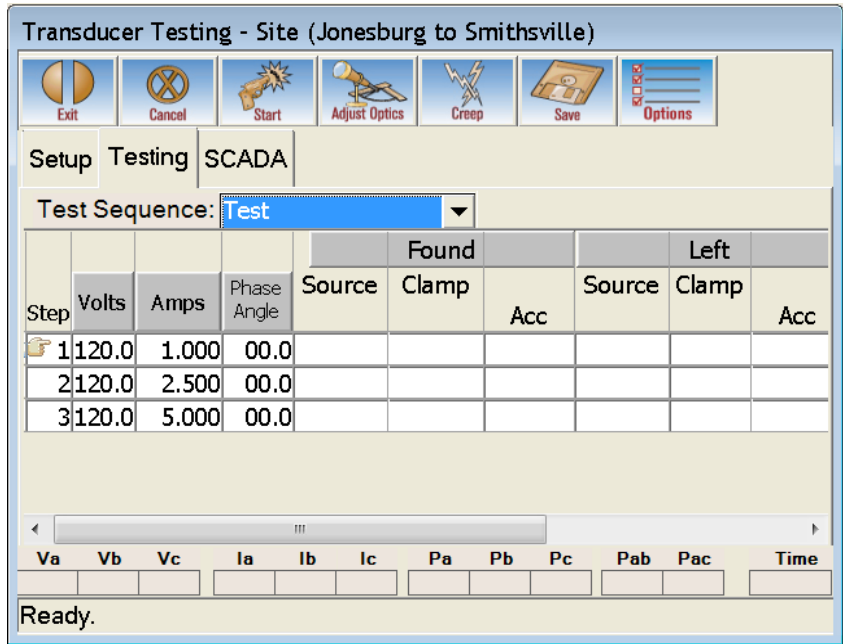
Fill out the information on the Setup tab from the faceplate of the transducer. This information can be preloaded using Site Information.

We will set up a single element Watt test with a Scientific Columbus transducer with the following faceplate information — Output: 0 to 1.2 mA, Max input: 120V, 5A, and Scale: 0 to 600W.

3. From the Type box select Watts - 1 elem.
4. In Output enter 0 and 1.2.
5. In Metric Scale enter 0 and 600.
6. Leave the CT and PT Ratios set to 1 and 1.
7. In Serial # enter 123456
8. In Company # enter WECO.
9. In Manufacturer enter Scientific Columbus.
10. In Model enter 2206C.



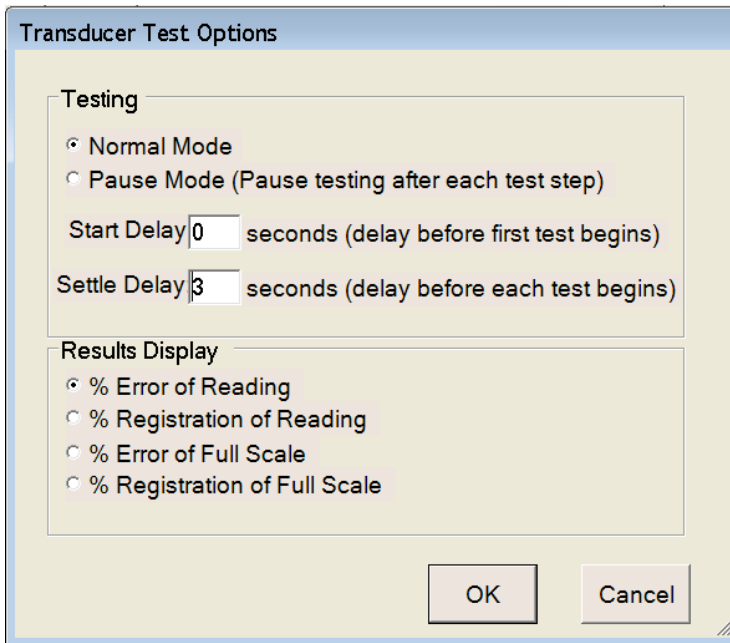
Now go to the Testing tab.



11. Click on the Test Sequence drop-down menu selection and select the test sequence you wish to run. In this case, we'll select the test sequence we created earlier.
12. To customize the test sequence, use the scroll bar at the bottom of the screen to scroll to the right and make any necessary changes. All of these fields can be edited on this screen or in the test sequence editor. See

"Creating A Transducer Test Sequence" on page 87.

13. Click Options to open the Transducer Testing Options window.

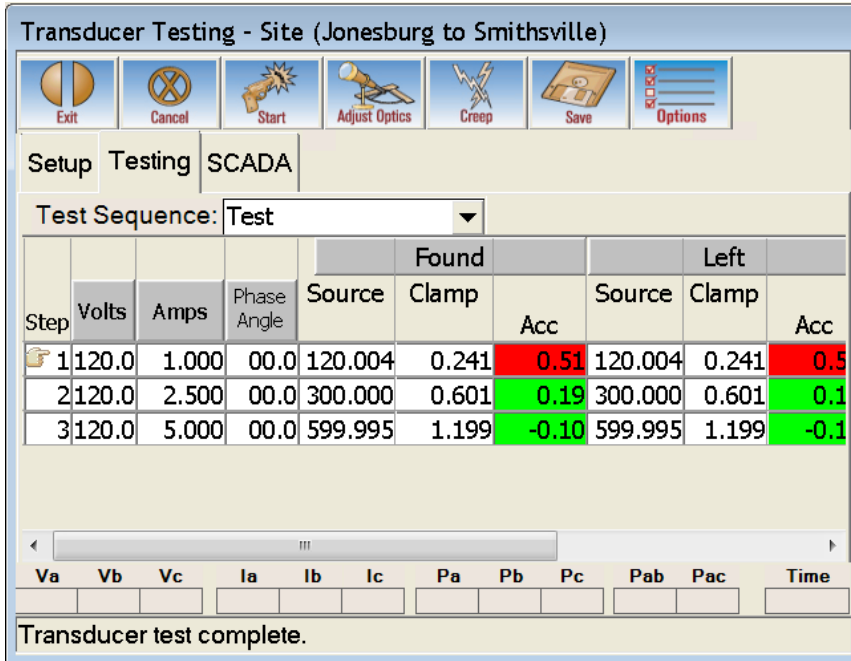


14. Choose a test mode. Selecting Normal Mode runs the test through the entire test sequence before stopping. Selecting Pause Mode will stop the test after each step with voltage and current still applied. It will not continue to the next step until you click Start. If you need to document the SCADA readings we suggest you select Pause Mode.
15. Select delay rates. There may be some delay time necessary for the transducer to begin outputting valid data after a change in the input values. Start Delay is the amount of time before the first test step begins. Settle Delay is the amount of time between subsequent test steps. In this example we've set the Start Delay to 0, and the Settle Delay to 3.
16. Select how you want the transducer test results displayed by selecting one of the options in the Results Display area. In this example we've selected % Error of Reading.
17. Click OK to confirm your options. Now, connect the cables up to the transducer.
18. Using the RW-3X's voltage and current leads, connect voltage and/or current to the transducer as needed.
19. Connect the analog sense cable to the transducer output. Black to +. White to -. Connect the other end of the analog sense cable to Pulse Input 1 on the RW-3X front panel.



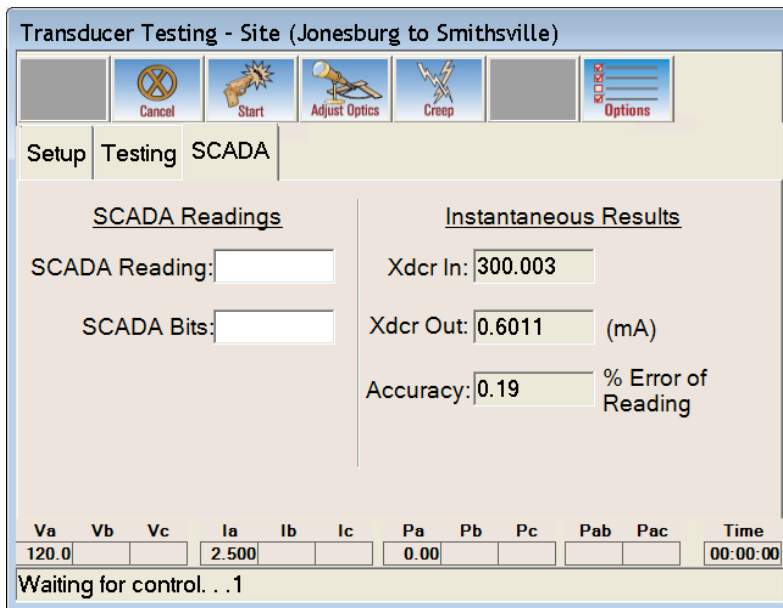
Now we can run the test.

20. At the top of the screen click Start. The transducer test will run. Notice that accuracies inside the defined limits show up highlighted in green. Accuracies outside the defined limits show up highlighted in red.



21. Click Save at the top of the screen to save the test data. The data will be saved by site name and by serial number.

If you need to document any SCADA (Supervisory Control and Data Acquisition) readings, use the pause mode. This will pause the test after each test step. Voltage and current will still be applied when paused. Then click the SCADA tab.



The instantaneous results continuously update every 0.5 seconds. These readings can be compared to the SCADA readings and documented. If a value is



entered into the SCADA readings area, it will be saved when you click Start, and the test moves on to the next step. These values are optional, and you do not have to enter a value into this field. If no value is entered, nothing will be saved in the SCADA fields for that test step.

Another use for the SCADA tab can be to adjust your transducer. You can select a test step, click Adjust Optics, and then go to the SCADA tab to see the instantaneous input and output values. You can then adjust the transducer (with a trim pot) to desired values. You can also go back to the Testing tab, select another step, and click Adjust Optics again, and it will automatically adjust the values for that row. You do not need to cancel the test each time you want to update the values.

# Conclusion

This concludes the RW-3X User Guide. You can find more information on specific features using the system help (accessed through the RW-3X software). If you encounter any technical problems, contact Watthour Engineering Customer Support at 601.933.0900 or [support@watthour.com](mailto:support@watthour.com).

# Glossary

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## C

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### **Creep**

The RW-3X's Creep function applies only voltage to the meter connected to the unit. In order to accurately test some solid state meters, it is necessary to apply voltage prior to the test to allow the meter to "boot-up".

## D

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### **Data View**

The Data View window allows you to enter meter information like the serial number, company number, manufacturer and other pertinent information associated with a meter. This data will be saved along with the accuracy results when the user saves the meter test.

## E

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### **Electromechanical Meter**

An electromechanical meter uses the rotation of a metal disk to record energy use.

## F

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### **Form**

A meter's form is usually a one or two digit number followed by a letter. The meter's form is used to describe how the meter is wired internally. Entering the proper form for a meter being tested, as well as defining the parameters of a form number, is very important.

## M

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### **Meter Test**

A meter test is conducted to determine the accuracy of a particular meter under a variety of conditions and loads.

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## O

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### **Optics**

Optics are optional accessories that can be connected to the RW-3X and used to count the rotation of a disk in an electromechanical meter or count the pulses generated by a solid state meter. There are a number of different optics options available for the RW-3X.

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## S

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### **Solid State Meter**

Solid state meters use small computers to generate pulses that replicate the disk rotations used by electromechanical meters.

### **Steps**

This is a unique number that identifies a particular test condition in an overall test sequence. A test sequence can have as few or as many steps as necessary.

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## T

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### **Test Sequence**

A test sequence is a series of individual tests with different parameter used to replicate a number of different conditions. Test sequences allow the tester to quickly and easily test a meter under these different conditions without having to run each test individually.

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