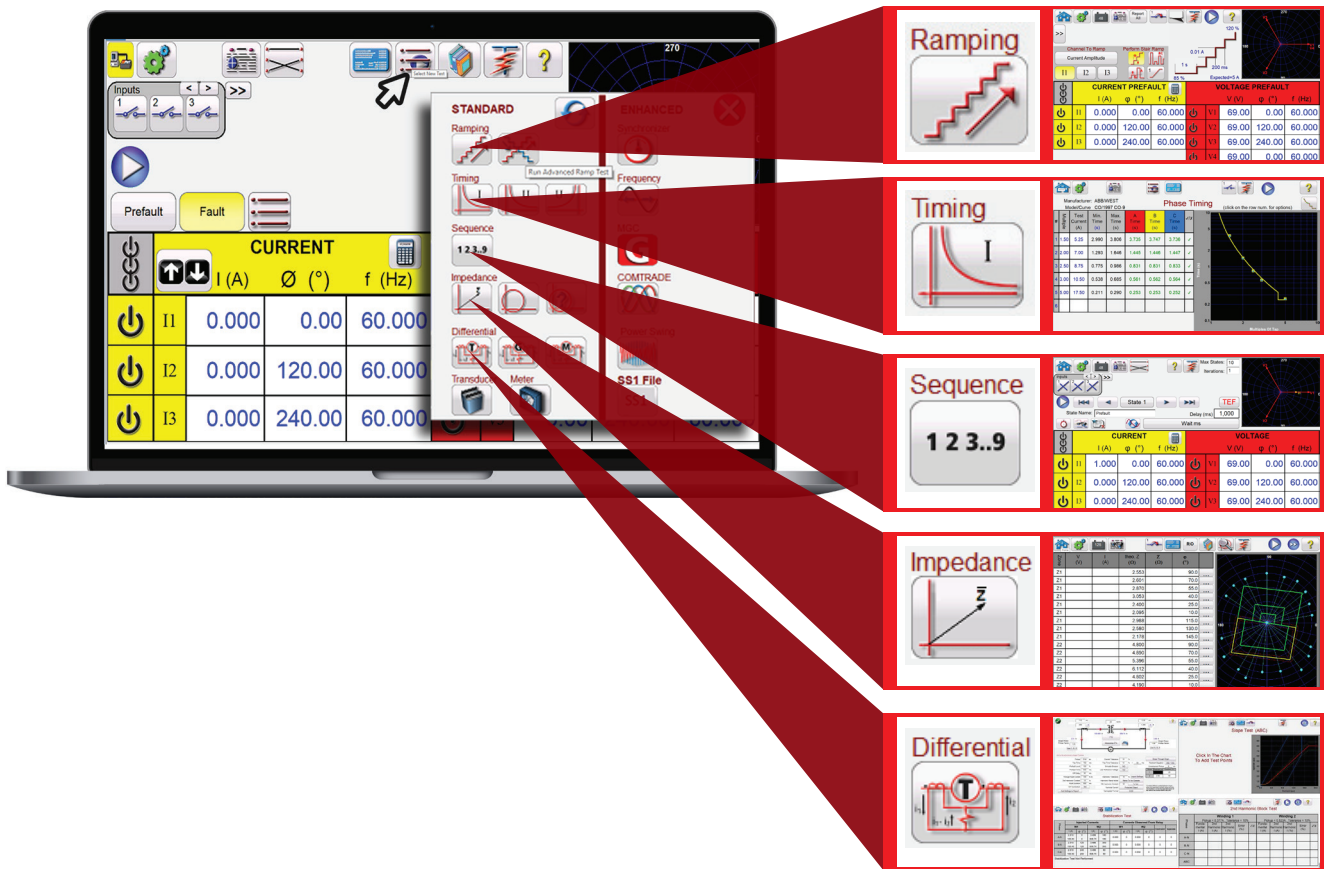


## RTMS Relay Test Management Software



### DESCRIPTION

RTMS (Relay Test Management Software) is the culmination of over 35 years of automatic relay testing experience. RTMS is a Microsoft® Windows® XP® Service Pack 3/ Vista™/7/8/10/11 compatible software program designed to manage all aspects of protective relay testing used with the Megger SMRT/FREJA Family of relay test sets. RTMS also runs on the STVI, Smart Touch View Interface Hand-held controller and the onboard display of the SMRT D and FREJA Display models.

Every SMRT/FREJA unit is supplied with RTMS Standard for installing on a PC. RTMS Standard does not require a security dongle or license to operate and can be loaded on as many customer owned PC's as required. RTMS has two different levels, Standard and Enhanced.

**RTMS Standard** includes the manual test screen, semi-automatic and automatic tests for Simple and Advanced Ramping, Pickup and Timing of Over Current, Under Voltage and Over Voltage relays, Directional Over Current, Sequence tests for Reclosing and Transient Earth Fault simulation, Impedance (both generic and relay specific from various manufacturer's), Three-phase and Single-phase Transformer Differential, IEC 61850 Megger GOOSE Configurator (MGC) and IEC 61850-9-2-LE Sampled Values (SVA), and other special test applications such as the Fault Calculator, Harmonics Generator, Symmetrical Components, Simplified Power Swing, Relay Library and Template Manager and much more.

**RTMS Enhanced** is hardware enabled when connected to a test set, which has the RTMS Enhanced feature enabled; see the SMRT/FREJA Ordering Information for details. Enhanced includes tests for Synchronizer, Under/Over, and df/dt (ROCOF) Frequency relay Pick-up and Timing Tests, IEEE/IEC COMTRADE Transient Waveform playback, Enhanced Power Swing/Out of Step Simulator, and SSI File Converter and playback.

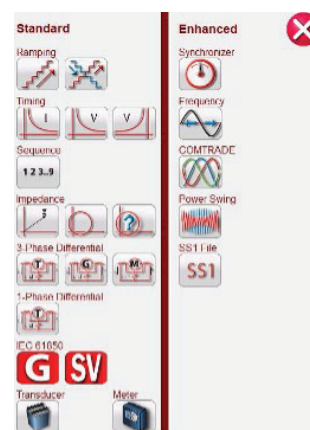


Figure 1: Select New Test screen showing RTMS Standard and Enhanced

## RTMS Relay Test Management Software

### RTMS TEMPLATE MANAGER AND RELAY LIBRARY

Included in RTMS Standard is a Relay Library with over 200 specific relays from 31 different relay manufacturers and a Template Manager with over 400 fully automatic relay test templates from the different relay manufacturers. The Template Manager allows the user to download all or new versions of relay templates as they are released by Megger and loaded into the Megger Cloud. The new or updated templates will be updated in the user's local PC database (Internet connection is required). The Template Manager provides a one-stop shop with documents, guides, and how-to videos, ensuring seamless testing support.



Figure 2: Page 1 of the Relay Library

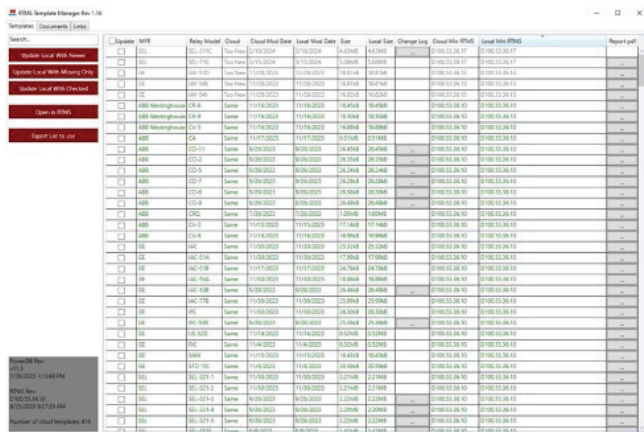


Figure 3: Part of Page1 of the Template Manager

### RTMS STANDARD FEATURES

The most significant feature of RTMS Standard is its ability to provide the user with an amazingly simple way to test protective relays, for both commissioning and maintenance, from the simple overcurrent to some of the most complex relays manufactured today. The operation is simplified using enhanced graphics, intuitive menu screens, and touch screen icon buttons to select the desired test function quickly and easily. The Manual Test Screen offers unparalleled flexibility with precise parameter control for both manual and automated relay testing (no PC required), using either the stand-alone Smart Touch View Interface™ (STVI) handheld controller, or the integrated onboard display on the D models or using the thumbwheel on a mouse or up/down arrows on a PC for simple or complex tests. These features using a SMRT/FREJA with RTMS delivers a complete testing solution unmatched by any competitor.

The following describes all the Standard level features:

#### Manual Test Screen

From the Manual Test Screen, the user can select from a variety of test options including Manual Control using the STVI control knob (up/down cursor keys on a PC, or the thumb wheel on the mouse controller), an Automatic Smooth (value/sec) Ramp, Step Ramp, Pulse Ramp, or Pulse Ramp Binary Search to determine Pick-up or Drop Out of relay contacts, perform relay specific Timing tests, Dynamic Sequence of tests to include trip and reclose operations or Transient Earth Faults, "Click-on-Fault" impedance relay tests, or test Three Phase Transformer, Generator, or Motor Current Differential relays.

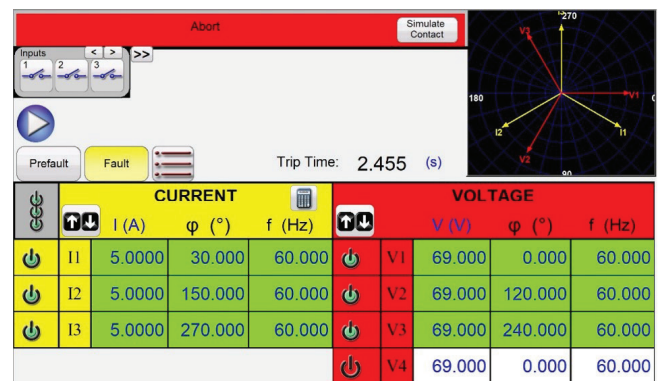


Figure 4: Manual Test Screen

A vector graph indicates the relative phase angles of all the outputs, or the user can select to see Phase to Phase vectors, or the positive, negative, and zero sequence vectors displayed. The user has the option to select to have all output amplitudes metered or have setting values displayed. The user can set Prefault and Fault values, and then toggle back and forth between the two values to monitor contact activity. To do a simple timing test the user can set Prefault time duration in seconds, and then press the blue Run Test button. The Prefault values will be applied, then change to the Fault values and start the Timer running. When the relay trips, it will stop the timer, and may turn selected outputs off depending on the user defined Auto-Off configuration. The test results can be saved to the internal memory of the STVI or the PC's memory or the results can be added to an open or new report for record keeping and auditing.

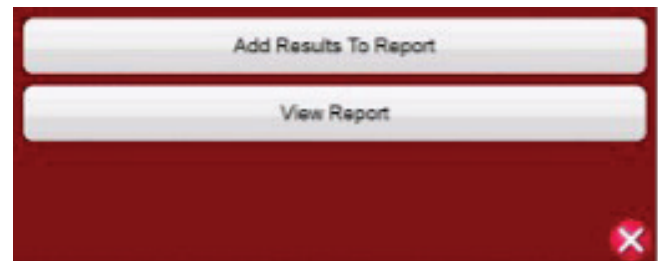


Figure 5: Adding results to Report

## RTMS Relay Test Management Software

The following are descriptions of each feature in the Manual Test screen.

### Fault Calculator

The Fault Calculator is available in the Manual, Ramp, and Sequencer test screens. The Fault Calculator provides the user with seven different modes of operation: Overcurrent, Voltage, Frequency, Impedance, Symmetrical, Power Swing, and Fault Location. Each mode offers a distinct set of fault calculators depending on the type of relay to be tested. For example, the Impedance Mode offers the option to set the healthy Current, Phase Angle and Voltage values and the fault amplitudes and angles are automatically calculated and entered on the test screen ready for use and in addition the user can set to use Constant Current, Constant Voltage or Constant Source Impedance.



Figure 6: Fault Calculator – Impedance Mode Healthy and Fault Values



Figure 8: Fault Calculator – Overcurrent Mode with 2nd Harmonic content

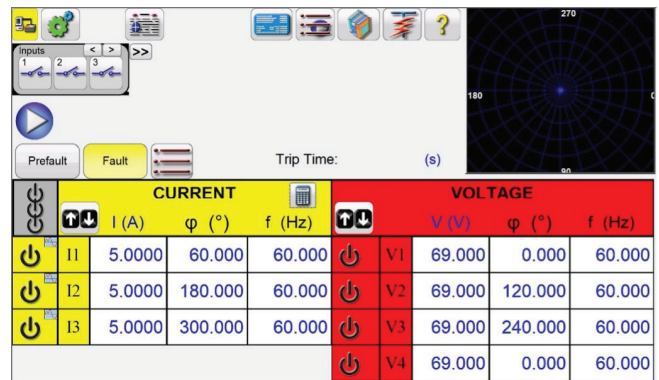


Figure 9: Overcurrent Test Screen

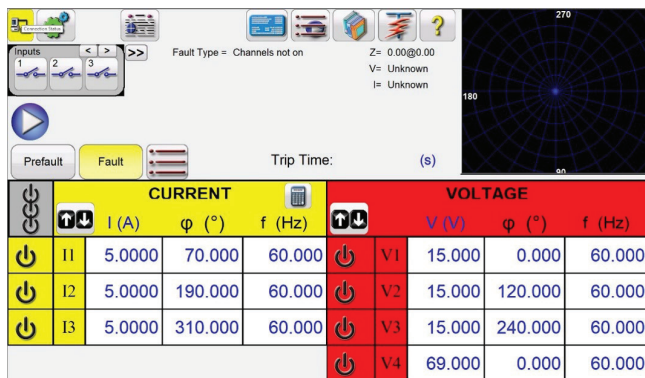


Figure 7: Impedance Test Screen with fault values

In the Overcurrent and Voltage mode, the user can create harmonic waveforms to sum the default Frequency (Fundamental), plus for example a % 2nd harmonic, plus a % 3rd and plus a % 5th harmonic normally used in the testing of harmonic restrained relays. Up to the 15th harmonic is available. In the example in Figure 8 a 2nd Harmonic with 60% content is superimposed on the Fundamental Frequency and distortion of the waveform is evident. In Figure 9 the Fault Screen is shown with the Fault Values and Angles calculated, note on the lefthand side in the Channel On box the “Waveform Indicator” to indicate that a superimposed Harmonic is present on the Fundamental.

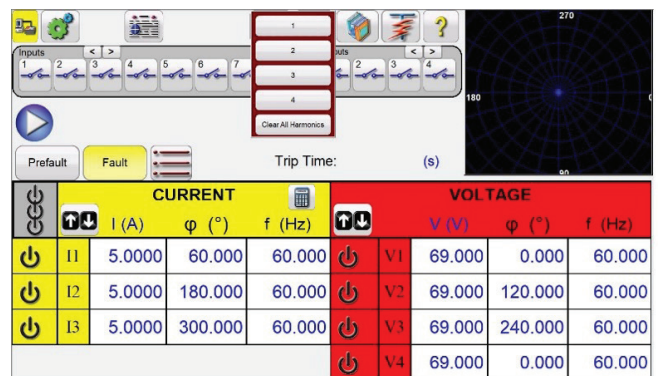


Figure 10: Manual Test Screen with Waveform Button

## RTMS Relay Test Management Software

### Simple and Advanced Ramp Features

RTMS can be used to automatically determine pickup and/or dropout of various types of relays. There are two ramp selections available, Simple and Advanced Ramp. The Simple Ramp button presents three choices: Stair Ramp, Pulse Ramp, and Pulse Ramp Binary Search. The Advanced Ramp button provides three choices: Smooth Ramp, Stair Ramp, and Pulse Ramp.

The Simple Ramp will automatically set a start and stop value based upon the expected pickup value entered. The user can change the % of start and stop values. The Stair Ramp will ramp the output by applying a value and then waiting a specific amount of time before incrementing. For example, to automatically ramp output current the user will select the channel to be ramped; set a predefault time duration, input expected pickup values, an Increment value, and a Delay time in milliseconds, cycles, or seconds. A few ramps can be defined in this manner up to a maximum of twenty-four ramps, monitoring for contacts to close and/or dropout.

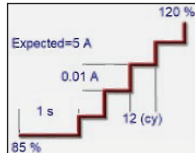


Figure 11: Simple Stair Ramp

Pulse Ramp will start at user defined predefault condition, increment up or down returning to the predefault condition between each increment based upon the dwell time setting. Instead of Delay time the user sets the Pulse time in milliseconds, cycles, or seconds, which applies the fault value to the relay for the specified time. As with the simple Step Ramp, Pulse Ramp can also have up to twenty-four ramps.

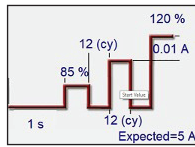


Figure 12: Simple Pulse Ramp

The Pulse Ramp Binary Search is used to quickly determine the pickup value of a relay with a questionable or unknown set point or operating characteristic. More importantly, this feature is excellent for testing relays, which require a predefault condition prior to sensing a fault condition.

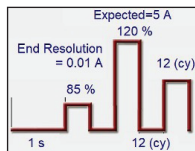


Figure 13: Pulse Ramp Binary Search

The Smooth Ramp is found in the Advanced Ramp. It will ramp up the output by applying a value based upon entry of an increment value/second. Amplitude, Phase Angle or Frequency can be ramped.

### Pickup and Timing Test Feature

Pickup and timing tests are provided for a wide variety of protective relays, including Overcurrent, Under Voltage, and Over Voltage relays. To make it even easier and faster RTMS has ANSI, IEC, BS142, and IEEE Standards time curve algorithms built in. Included in RTMS are time curves and time curve algorithms for hundreds of specific relays. The user can select from a pull-down list of different manufacturers (over twenty-five different manufacturers and growing), then select the relay model number, and/or curve shape (inverse, very inverse, definite time etc.). The list includes relay manufacturer's digitized log-log, and semi-log, electromechanical relay time curves.

### Overcurrent Test Feature

The Overcurrent test feature can perform all tests associated with electromechanical and microprocessor-based overcurrent relays such as:

- Ground Pickup
- Neutral Pickup
- Phase Pickup
- Instantaneous
- Ground Instantaneous
- Neutral Instantaneous
- Phase Directional
- Ground Directional
- Neutral Directional
- Phase Timing (A, B, C, A-B, B-C, C-A, and ABC)
- Neutral Timing (A, B, C)
- Ground Timing

In the following example, the ABB CO-9, Very Inverse curve relay with a 3.5 Amp Pickup, and a number 1 Time Dial was tested.

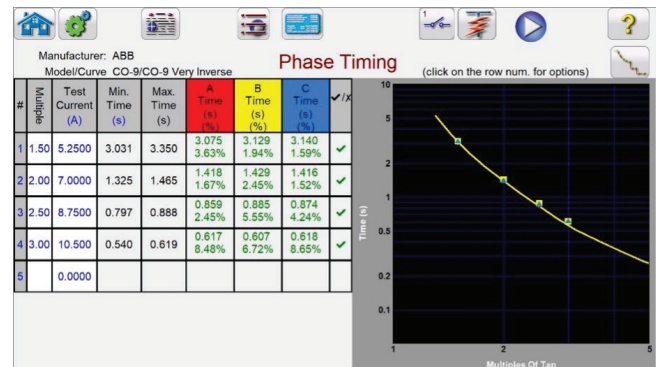


Figure 14: ABB CO-9

By entering the appropriate values in the setting screen, when the timing test is conducted the test results will automatically be plotted and compared to the theoretical values from the relay specific time curve that was selected. It will then automatically provide a Pass/Fail assessment of the results. Up to fifteen test points may be selected. If the test Multiple is changed, the appropriate theoretical trip time will change automatically.

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### Report Options

To view the test result, press the Report Options and View Report button. The user can now enter appropriate information relative to the test in the Test Report header. See the following example report.

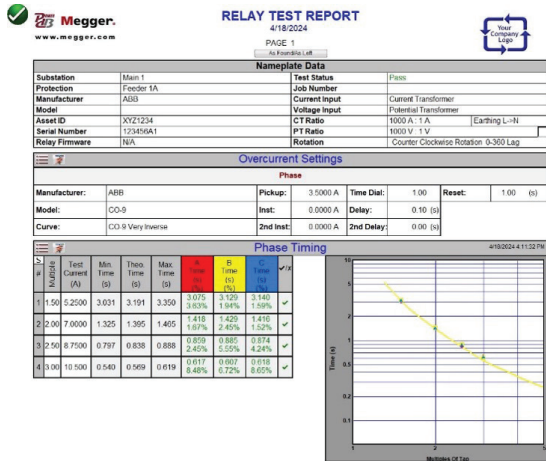


Figure 15: Test Report ABB CO-9

Note that the software automatically compared the Operating Time to the Theoretical Time and made a Pass/Fail determination based upon the manufacturer's time curve characteristic. If the recorded test point is out of specification, it will appear red in color and if it is within specification, it will be green in color. This provides excellent visual As Found reporting. If the data is imported into a PC, reports can be generated that summarize the comments and failures of every test you perform for future reporting and audit requirements.

Tests can be performed in any sequence such as phase pickup, phase directional, phase timing etc. and all test results are automatically recorded in that sequence and added as additional pages to the report.

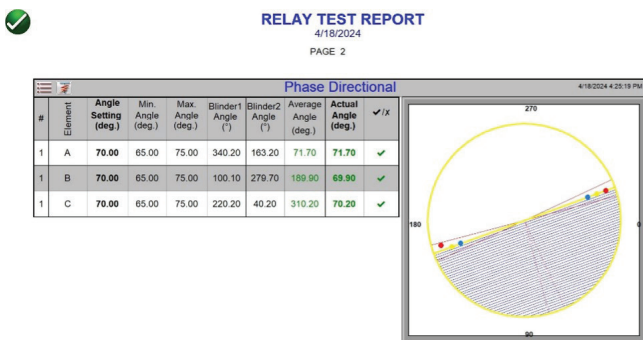


Figure 16: Phase Directional added to Test Report

### Sequence Timing Test Feature

Pressing the Sequence button on the Select New Test menu list takes the user to the Sequence Timing Test Screen. There are up to two hundred programmable states available, with up to 99,999 iterations.

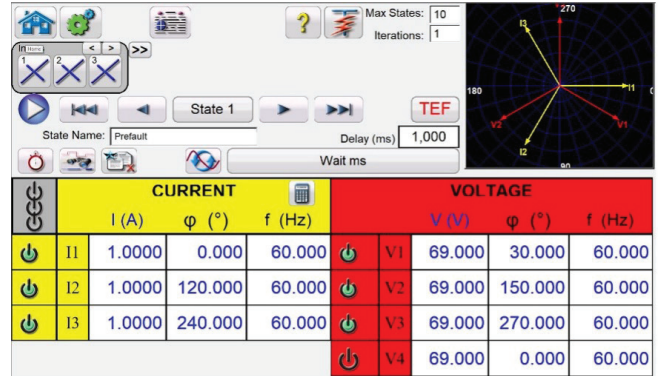


Figure 17: Multi-Phase Sequence Test Screen

By default, seven states are already labeled as Pre-fault, Trip1, Reclose 1, etc. up to Lockout in step 7. Therefore, it is initially set up for a three-shot trip, reclose to lockout scenario. The user is free to change the labels or use the default labels. With each state the user may input values of voltage, current, phase angle, frequency and set the Binary Input sensing for each state. Both single pole and three pole trips can be simulated. There are default values and binary settings for a single-phase trip and reclose scenario already programmed in. The user can either use the defaults or change them to suit the application. The Total Time to Lockout may also be included in the setting. This allows for 1, 2, 3, or 4 shots to lockout including trip and reclose times. The user can set conditional settings such as Wait IRIG time setting (for dynamic End-to-End tests), Wait milliseconds, wait cycles, Wait for Any contact (OR), and Wait All contacts (AND). The user can set the Binary Outputs to simulate the breaker 52a and/or 52b contacts.

Once all the Binary Inputs, Outputs, Prefault, Fault and Reclose settings are completed, the user can then press the Preview button to get a visual representation of the voltage and current outputs, as well as a visual of the binary inputs and outputs for each stage of the simulation. The following figure illustrates a sample sequence.



Figure 18: Sample Sequence Voltage, Current, Binary Inputs and Outputs

# RTMS Relay Test Management Software

## Transient Earth Fault Simulator

The Transient Earth Fault simulator is part of the State Sequencer test. It is designed for testing the directional operating characteristics of transient and intermittent transient earth fault relays by simulating residual current IO and residual voltage V0 transient signals. The test feature simulates intermittent transient faults found in compensated cable networks.

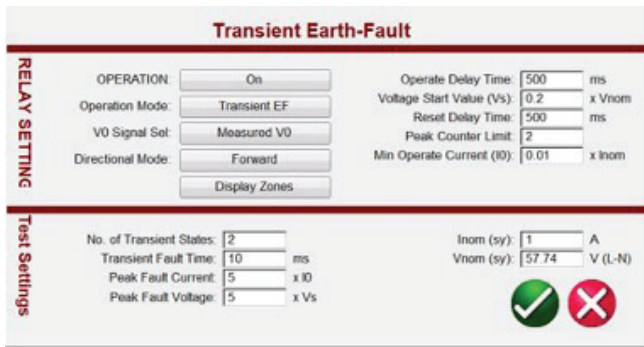


Figure 19: Transient Earth Fault Test Setting Screen

Selecting the Sequence TEF button, the user will note that the TEF sequence test is already set for testing a relay programmed to sense 2 transient earth faults, with an instantaneous trip operation upon sensing the second transient.

## Impedance Relay Click-On-Fault

Click-On-Fault (COF) is one of the choices in the Standard test menu list. COF provides automatic tests of Impedance (distance and loss of excitation) relays. It includes Pulse Ramp, Pulse Ramp Binary Search, and Shot test capabilities.

## Selection of Relay Operating Characteristics

Select from one of the predefined generic relay characteristics of MHO, Half Circle, QUAD (Quadrilateral), IEEE QUAD, or select the specific relay from the Impedance Relay Library files. The Impedance Relay Library currently includes distance relays from ABB, ALSTOM, AREVA, ERL, GE, MICOM, Schneider, SEL, PROTECTA, SIEMENS, SIFANG, NARI, SPRECHER, TOSHIBA, and ZIV Relays. RTMS supports the import of relay settings in various file formats. Relay setting import files supported are MCE/RIO, XRIO, TEAX, SEL RDB, and RTMS CSV files. The Megger Characteristic Editor, MCE, is a tool for creating impedance relay operating characteristics using a combination of Lines, Arc's and/or MHO circles. Virtually any impedance characteristic can be created using this tool and then imported into the Click on Fault test screen. Impedance settings can be changed in the MCE for testing the same type of relay. If you do not have the relay settings in one of the previously mentioned file formats, enter the relay manufacturer's settings manually and the operating characteristic will be created from the settings entered.

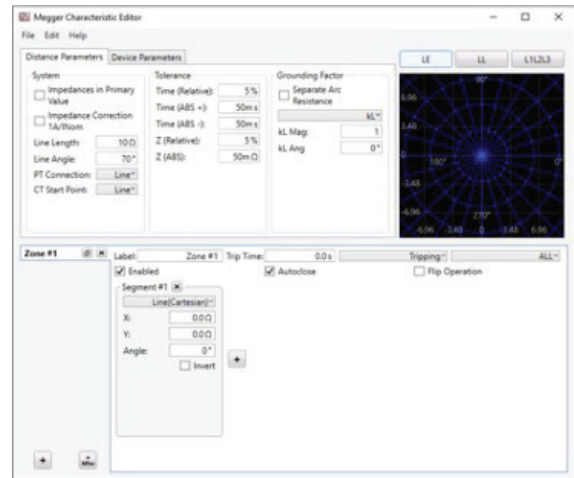


Figure 20: MCE Settings Screen

## Definition of Operating Characteristic and Tests

There are several new innovations in the new COF that make testing distance relays easier and faster. For example, selecting the Generic QUAD characteristic provides the following user input screen.

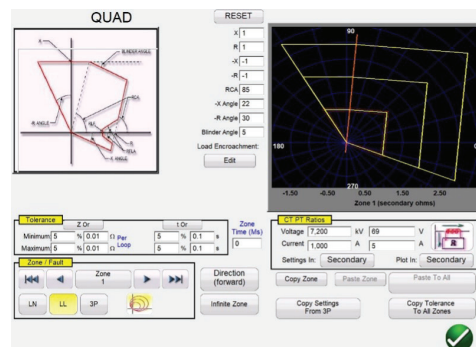


Figure 21: Generic QUAD Setting Screen

Here the user selects which Zone (up to twenty zones may be defined), type of fault, direction, tolerance values, inputs the reach, max torque (line) angle; any offset, or load encroachment settings. For phase to ground faults there are four types of compensation factors to choose from depending on the type of impedance characteristic. The software draws the operating characteristic(s) of the relay defined by the user settings.

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The user may select to view single zone or multiple zones. Pressing the green check button takes the user to the COF test setup screen, as shown in the following figure.

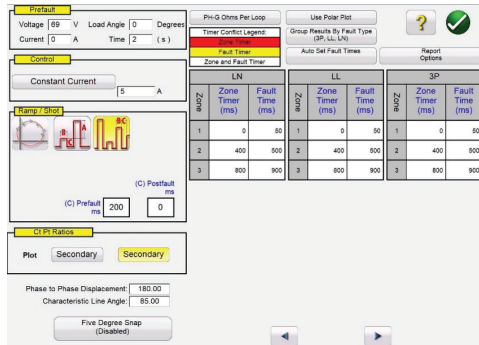


Figure 22: Generic QUAD Test Setup

From this screen the user can select:

### Test

- Pulse Ramp
- Pulse Ramp Binary Search
- Shot

### Timing of

- Phase to Ground
- Phase to Phase
- Three Phase

### Test Source

- Constant Voltage
- Constant Current
- Constant Source Impedance
- Constant Source (RX)

### Displayed

- Primary Values
- Secondary Values

### Creating Search Lines or Shot Test Points

The user can easily define up to thirty-six search lines or test points per fault type, per zone. There are three modes to choose from, Auto Generate, IEC 60255, and Origin Test Points. In the defaulted auto generate mode the user may select any test line, at any angle, around the operating characteristic by clicking at a point outside and then inside the operating characteristic(s) to define the desired test line. With the Origin Test option, the user clicks a point outside the operating characteristic, and the test line will be drawn to the origin or the intercept of the R and X-axis. The Shot Test Points option is used to create one or more test points, each to replicate a fault at a particular magnitude and angle. This type of test provides a quick GO, NO/GO test of the relay after a settings change. The user does not even have to draw the test lines. There are two Quick Test Options the user may select. The first option draws three test lines for any of the selected Quick Test solutions. The second Quick Test the user may select the desired number of test points by pressing the Test Points button and select from the list. If none of the standard test points or phase rotations meets the user's needs, they can enter the desired values in the window provided.

### IEC 60255 Test Option

To comply with regulations, which require testing to the IEC 60255 standard, the IEC 60255 option is provided. All defined test lines will automatically be drawn perpendicular to the relay operating characteristic.

### Prefault Settings

For testing relays, which require a prefault load condition, the user can set the prefault load voltages and currents. This is normally used when testing accelerated tripping or dynamic over-reach characteristics.

### Performing Tests

To start a test the user selects the blue Run Test button, and the test will begin. In the test screens the user has the option to select the Run All button and all the tests will be executed automatically for all defined zones and faults in sequence. Based upon the user input the software will calculate all the fault values and angles for each defined test point, and then make a PASS/FAIL determination of the test results.

A real-time test screen will display the relay operating characteristic with the defined test lines in the right half of the screen with the test vector moving in the impedance plane. In the left half it will display either the test vectors of voltage and currents being applied in real-time, or it will display the Positive, Negative and Zero Sequence vectors being applied, as shown in the following example.

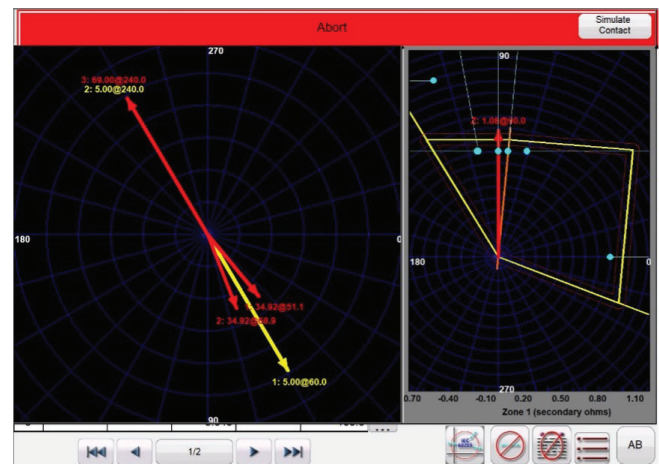


Figure 23: Generic QUAD Real-Time Test Screen

In the above figure a Zone 1, Pulse Ramp, Phase L1-L2 fault is being performed. Note the real-time test amplitudes and angles are displayed in the left half, with the test results displayed in the right half. The tests are being performed to the IEC 60255 standard.

# RTMS Relay Test Management Software

## Easy Z Impedance Relay Test

The RTMS Easy Z provides a quick approach to testing an impedance relay. The following is the Easy Z Impedance Test Screen. All tests are performed from this one screen.

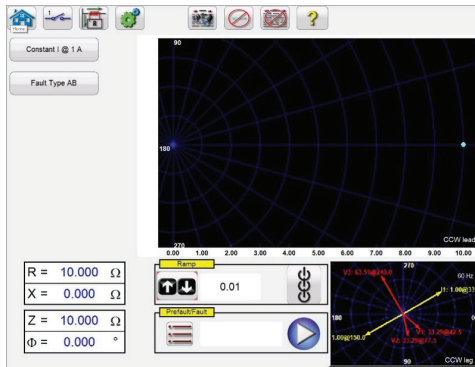


Figure 24: Easy Z Impedance Relay Test

CT Polarity Directional sets the phase angle of the output currents either into or out of the zone.

The Constant Source provides the user with a selection of different methods to perform the tests. Some manufacturers require Constant Voltage and ramp Current, some require Constant Current and ramp Voltage.

The Fault Type selection provides the user with the Fault Type selection window. The user can select a Three-Phase fault, a Phase-to-Phase fault, or a Phase to Ground fault. When a single-phase fault is selected, the Ground Compensation button will appear. There are several types of compensation factors to choose from depending on the type of impedance characteristic to be tested.

In the Ramp selection window, the user can ramp outputs in terms of Z, R, X, or the angle Phi. The increment of the ramp is also selected in this window. For example, the user desires to ramp impedance Z in 0.01 Ohms as shown above.

## Unknown Impedance Characteristic

This test feature is designed to find unknown impedance operating characteristics.

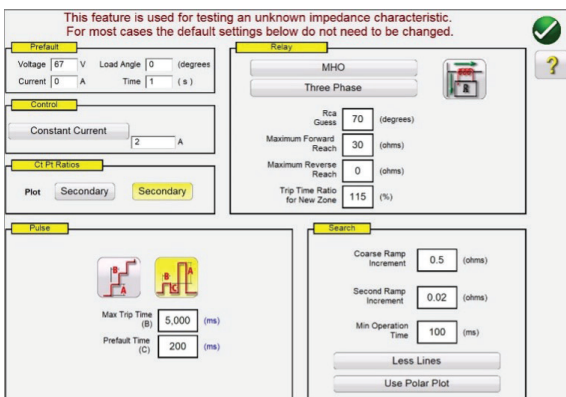


Figure 25: Unknown Impedance Characteristic Setting

The user can input some basic knowledge, or best guess, of the relay to be tested. There are three selections available for the relay type, **MHO**, **QUAD**, or **NONE**. The relay is either a **Three-Phase** or **Single-Phase** relay application. There are four best estimate settings. The **RCA** is a value set in degrees normally associated with the maximum torque angle, line angle, or positive impedance characteristic angle setting of the relay. Enter your best guess. **Maximum Forward Reach** is the estimated longest Ohmic reach of the relay in the forward direction. **Maximum Reverse Reach** is the estimated longest Ohmic reach of the relay in the reverse direction. There are two different ways to determine the operating characteristic of impedance relays and the selection of the type of Ramp is dependent on the relay. To test multi-Zone relays, use the Pulse Ramp Search. The software will automatically calculate the increment required in V, A, and phase angle. The Pulse Ramp Search also includes a **Prefault Time** setting in milliseconds. This is the time that the prefault values will be applied between fault increments. The Stair Step ramp will only determine the characteristic for a single zone relay. There is one common setting for either the stair step or pulse ramps, **Max Trip Time**. Enter the estimated maximum trip time of the longest reaching zone.

## Testing Differential Relays

The **Differential Relay** provides a quick and easy approach to testing three-phase Transformer, Generator, Motor, and single-phase Transformer, differential relays. The *new* multi-instances feature provides the capability to select multiple Differential relays to test and combine into one test result file. For example, some generator differential protection relays also include transformer differential protection.

## Transformer Differential Test Feature

The Transformer Differential Test feature provides automatic tests of three- and single-phase Transformer Current Differential relays.

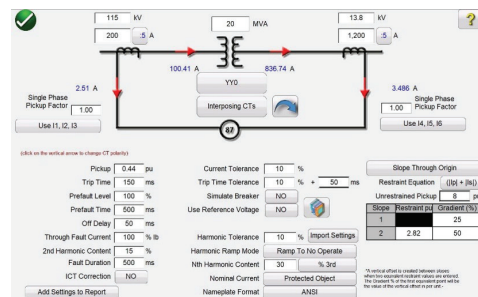


Figure 26: ANSI Transformer Differential Model

There are two transformer differential models to choose from, ANSI and IEC. Each model will present a transformer graphic commonly used for either North American or European style transformer protection. The Transformer Model and Nameplate section includes transformer data, primary and secondary winding configurations, interposing CT's, CT ratios, CT connections, selection of I0 (zero sequence) elimination, and other relay setting values and characteristics. From this information, the software will automatically calculate what values of current and phase angle relationships are applied to the relay in the tests, thus reducing errors and saving time. Test selection includes Stabilization (Through Fault), Pickup, Timing, Characteristic, Characteristic Shot, 2nd Harmonic Block and n<sup>th</sup> Harmonic Shot tests.

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### Definition of Slope Characteristic and Tests

There are several innovations in the new Transformer Differential Test feature that makes testing transformer differential relays easy and fast. For example, the slope characteristics vary by manufacturer design. Five options are provided, which cover the various designs: Line Segments (i.e. G.E. SR 745), Slope Through X Axis (i.e. Siemens 7UT613), Slope Through Origin (i.e. SEL 387 and 587), Slope from Base Point (i.e. ABB RET670 and Areva/Schneider P63x) and Cubic Spline (i.e. G.E. T60). In addition, different relay manufacturers use different I Bias equation methods for restraining the operation of the differential elements.

The Transformer Differential Slope test provides nine different biasing (restraint) equations from which to choose. For example, the Siemens 7UT5X, 7UT6X and SEL 487 and 787 relays use the biasing equation  $(|I_p| + |I_s|)$ . The user simply touches the screen to create test lines associated with the slope characteristic.

The following is an example test being performed with four test lines.

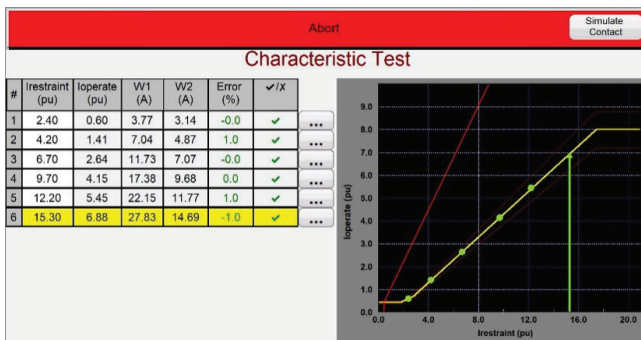


Figure 27: Transformer Differential Slope Test

Note the test amplitudes are displayed in the left half (includes Pass/Fail) with the test results displayed in the right half along with the slope characteristic in real-time.

### IEC 61850 Megger GOOSE Configurator

The Megger GOOSE Configurator (MGC) provides mapping of the binary inputs and outputs of the SMRT/FREJA test set to the desired GOOSE messages. The GOOSE messages are read from available SCL (Substation Configuration Language) files or may be automatically detected by scanning the substation network in search of available published GOOSE messages. This scanning process is known as GOOSE "sniffing." The MGC also provides advanced network troubleshooting tasks such as comparing the GOOSE messages available on the network with the GOOSE messages described in the SCL files with GOOSE MERGE/COMPARE functionality; this is also a powerful tool for validating the horizontal communication description (GOOSE) in the supplied SCD file at Factory Acceptance Tests (FAT) in IEC 61850 substations. This type of verification is also known as GOOSE Consistency Check.

An SCL file is an XML (Extensible Markup Language) file that describes the IEDs available in one IEC 61850 substation (SCD file) or can just describe only one single IEC 61850 device (ICD, CID files). In the SCL file there are several IEC 61850 information available (logical nodes in the IEDs, GOOSE messages sent by the IEDs, GOOSE messages received by IEDs, Reporting information to SCADA etc.).

### IEC 61850 Relay Testing – General Description

The SMRT/FREJA relay test system is connected to the IEC 61850 station bus (or directly to the Ethernet port of the relay) and is programmed to map the trip GOOSE message from the tested IED to a chosen binary input. The mapped binary input is programmed to stop the timer of the SMRT/FREJA test set. This last action is done from Relay Test Management Software (RTMS). For testing IEC 61850 relay applications, where the protection relay needs an external signal to allow protection functions (e.g., external direct inter-trip command, or external auto-recloser start, or breaker failure start), it is necessary to "energize" the IEC 61850 relay with a GOOSE message. The SMRT/FREJA relay test set, which is connected to the IEC 61850 station bus, is now programmed to map a binary output to a defined GOOSE message that is published by the SMRT/FREJA unit. The test set activates its binary output when the test requires it, which means that the GOOSE message changes its status from "0" (false) to "1" (true). In a practical situation both applications (publishing of a GOOSE message and subscription of a GOOSE message), are often used simultaneously.

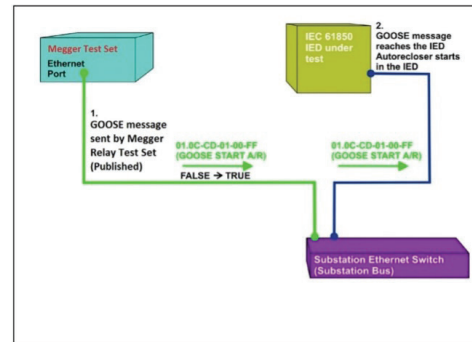


Figure 28: External Energization (auto-recloser start) test on an IEC 61850 IED

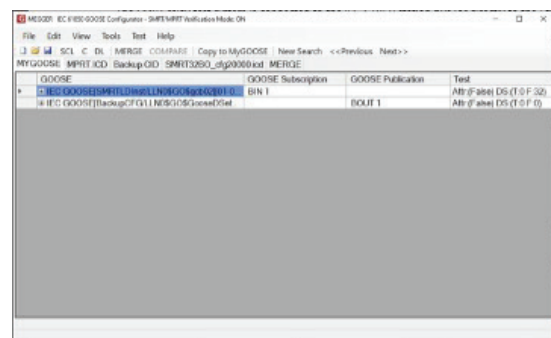


Figure 29: MGC "My GOOSE" with Assigned Binary Inputs and Outputs

After the appropriate assignments of binary inputs and outputs have been made, the My GOOSE test file can be saved for reuse. Use basic test tools or standard test features in RTMS to perform automatic tests.

The MGC provides mappings of Boolean and Bit Strings and/or simulation of Struct, Integer/Unsigned, Float and UTC datasets. The SMRT/FREJA meets the IEC 61850-5 standard, Type 1A, Class P 2/3, for high-speed trip and reclose simulations.

## RTMS Relay Test Management Software

### Sampled Values Analyzer (SVA) IEC 61850 9-2-LE

The Megger Sampled Values Analyzer (SVA) Configurator software provides the capability to configure the SMRT/FREJA test set (with the IEC 61850 Sampled Values hardware enabled) to publish three IEC 61850-9-2 LE data streams of four voltages and four currents per stream for testing or commissioning devices which require Sampled Values. In addition, the SVA software can be used to analyze sampled packet data on the IED Network. When the SMRT/FREJA relay test system IEC 61850 Ethernet port is connected to the IEC 61850-9-2 process bus (or directly to the Ethernet port of the relay) and after configuration using the SVA software is programmed to publish either 50 Hz or 60 Hz IEC 61850-9-2 LE Sampled Values instead of analog values from the output terminals. In some test cases, the Sampled Values is used in conjunction with IEC 61850 Megger GOOSE Configurator (MGC) software, where the mapped binary inputs and/or outputs are programmed to “subscribe to” and/or “publish” GOOSE messages.



Figure 30: SV Analyzer Start Up Screen

### Testing Transducers with RTMS

In conjunction with the Transducer Hardware Option in the SMRT/FREJA units, the Transducer Test provides a quick approach to testing all types of single-phase and three-phase electrical transducers. The transducer hardware “T” option can either be ordered with the new test set or later as a factory hardware upgrade. The user may select from a variety of transducers. Selections available are:

- AC Volts
- AC Current
- DC Volts
- DC Current
- Frequency
- Watts/VAR/VAPF – 1, 1 ½, 2, 2 ½, 3 Element

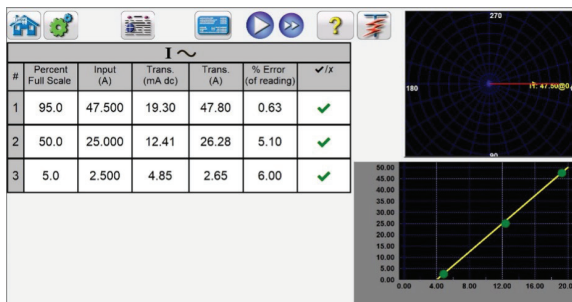


Figure 31: Transducer Test Screen

The test screen defaults to three test points set at 5, 50, and 95 percent of Full Scale. The user can set up to ten test points at any percent value.

### Meter Test

The Meter Test provides a quick and easy approach to testing the metering function of protective relays.

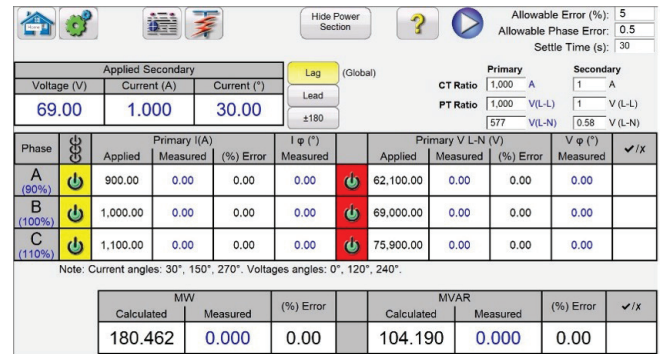


Figure 32: Meter Test Screen

The user simply selects the output channels like the manual vector test screen. Values can be in secondary (default) or Primary by clicking on the Primary Ratios windows and entering the CT and VT ratios. Enter the desired allowable error in % of reading in the window provided.

### Multi-Phase Test Applications

In addition to standard test applications, RTMS is easily configured for multi-phase test applications. Manually testing Bus Differential protection schemes can require a dozen or more test currents. RTMS automatically configures the available channels when multiple Megger SMRT's are interconnected by using RJ45 Ethernet cables. As an example, with two SMRT46 units interconnected RTMS can provide 12 manually controlled currents channels simulating 6 currents into and 6 currents out of the zone of protection. RTMS can automatically configure up to thirty currents.

In the following example test screen, the twelve currents shown represent the Fault application. Selecting the blue Run Test button will apply the Prefault condition and after a select time will apply the simulated fault and start the timer. When the relay operates, the outputs are turned off and records the operating time.



Figure 33: 12-Currents Simulating Bus Differential Scheme

## RTMS Relay Test Management Software

### RTMS ENHANCED FEATURES

As a hardware option in the SMRT/FREJA Family of units, the following additional Enhanced test features are available in RTMS, see SMRT/FREJA Ordering Information for details.

#### Synchronizer Test Feature

The Synchronizer Test feature provides automatic tests of synchronizing and sync-check type relays.

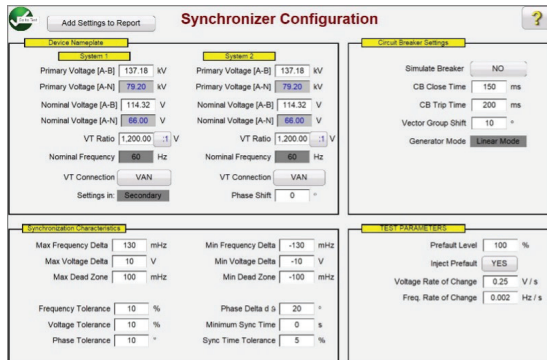


Figure 34: Synchronizer Configuration Screen

In the Device Nameplate section, the user inputs information associated with System 1 and System 2, which includes Phase-Neutral or Phase-Phase Primary and Secondary voltage information. In the Synchronizing Characteristic section, the user inputs the Voltage and Frequency Delta values as well as the tolerance values of the relay under test. In the Circuit Breaker section, the user inputs values associated with the Closing and Trip times of the Circuit Breaker for breaker simulation. In the Test Parameters section, the user inputs the desired Rate of Change for the Voltage and Frequency changes.

#### Creating and Performing Tests

There are three options available to the user regarding the selection of test lines. Selection of the Quick Test, RTMS will automatically draw four test lines with two Delta Voltage lines and two Delta Frequency lines. Selection of the Dynamic Points, as shown in the following figure, draws eight test lines, with two Delta Voltage, two Delta Frequency, and four Dynamic test lines where both Frequency and Voltage are run in Delta. If either of these two options does not meet the user's needs, the user is free to select their own test points by touching or clicking on the test screen points outside and inside the characteristic like the Click-on-Fault for Impedance relays.

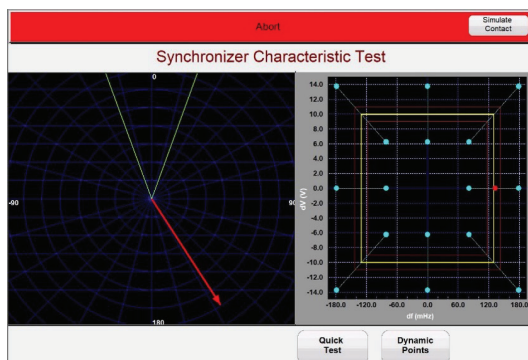


Figure 35: Dynamic Synchronizer Test

In the left side of the test screen the user can observe the synchro scope as the test voltage rotates, while in the right side the user can observe the dynamic test point closing in on the close characteristic for the relay in real time. When the relay close is captured the test results are shown like the above where the green dots indicate a passing test result.

#### Frequency Relay Test Feature

The Frequency Relay Test feature provides automatic tests of Under/Over Frequency and df/dt (ROCOF) type relays.

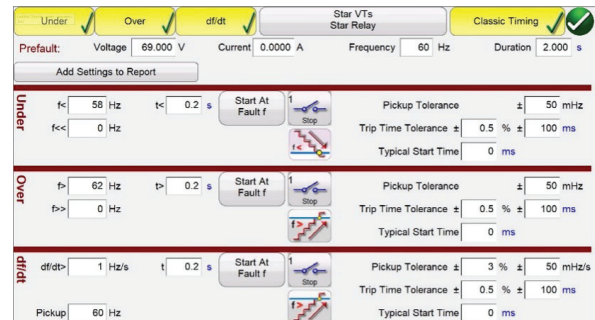


Figure 36: Frequency Relay Test Configuration Screen

In the Frequency Test Configuration screen, the user selects the type of relay to be tested, Under, Over or df/dt. For three phase test applications the user can select how the VT's and the Relay inputs are connected Star, Delta, and Open Delta. The user inputs the Prefault Voltage(s), Current(s), System Frequency and Duration Time of the prefault values before starting the test. For Pickup tests, the user can select a single ramp down or up depending on the relay type or select a double ramp to determine pickup and dropout for dual setting relays.

For timing tests, the user can select the classic timing mode where a step function is used or use the ramp feature and start the timing test at a specific set point. The Timing test records the Prefault Frequency, the frequency ramp up or down depending on the type of relay test, the recorded Fault Frequency and the recorded operating time with Pass/Fail indication see the following example.

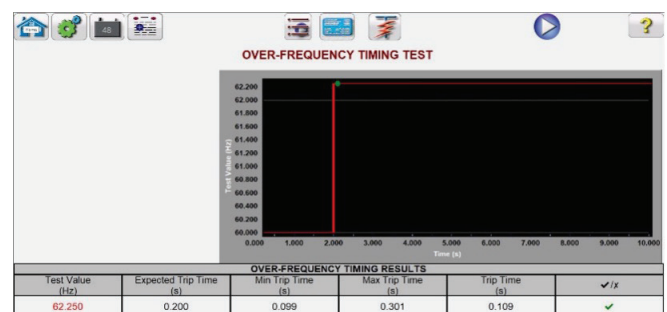


Figure 37: Over Frequency Timing Test

Note the frequency ramp up to a value slightly above the relay set point. The green dot indicates the relay operation was a pass. A red dot would indicate a test fail.

## RTMS Relay Test Management Software

### COMTRADE Viewer and Playback

The COMTRADE test feature supports the IEEE C37.111 and IEC 60255-24 file formats. This test feature provides the capability for the SMRT/FREJA units to test relays with transient waveforms captured from digital fault recorders, or simulated faults using EMTP/ATP type programs. The RTMS COMTRADE feature includes extending the pre-fault data so that relays that require the pre-fault for proper polarizing will function properly under transient test conditions. This is especially important when performing end-to-end tests using the COMTRADE playback feature in RTMS. Timing may be started in conjunction with the fault application, thus timing the replay event.

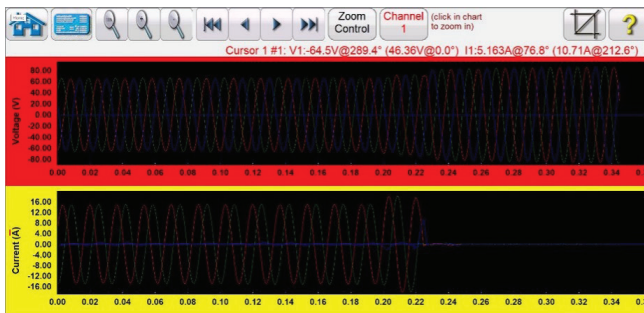


Figure 38 COMTRADE Simulation

End-to-End test capability allows GPS triggering of DFR files to be played back directly from the interface using either a programmable pulse on a binary input, or an IRIG-B time signal from a GPS unit.

Other tools included are for review and evaluation of the waveforms such as zoom control. Displayed values include Cursor #, Sample #, Voltage Channel Selected, RMS Magnitude, RMS Angle, (Peak Magnitude, Phase Angle), Current Channel Selected, RMS Magnitude, RMS Angle, (Peak Magnitude, Phase Angle), Cursor to Cursor difference time in ms. In addition, the Iterations window provides the capability to cycle the relay through multiple iterations of the same fault.

### Power Swing Simulator

The Power Swing simulation tool provides realistic testing of power swing blocking elements in today's modern relays. In addition to power swing block, it can also perform Out-of-Step tests. See the Power Swing input-setting screen in the following figure.



Figure 39: Power Swing Input Setting Screen and Waveforms

The Graphic window displays the power swing waveforms that will be played. If more than one Turn is specified, the display will include each turn.

### SS1 File Converter

SS1 files are generated using Power System Simulation software programs by Electrocon® CAPE™ or Aspen One-liner®. By modeling the power system and using the SS1 files, the relay can then be tested dynamically using realistic system test scenarios. The SS1 File Converter will read the SS1 file and create a dynamic state sequence playback file. This file can be used in two ways. The first method of use is as a standard dynamic test. One application is the testing of impedance relays. By modeling the power system using simulation software, the relay can then be tested dynamically using realistic system test scenarios using actual line load conditions. The dynamic test can be used stand-alone or as part of a more complex test module. The other application is a dynamic End-to-End playback file, like a COMTRADE playback file.

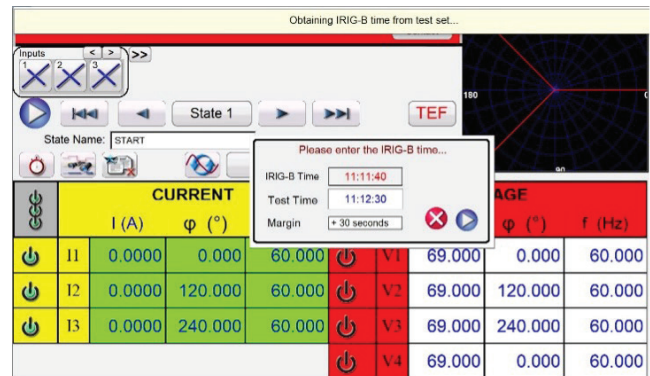


Figure 40: Example SS1 End-to-End Test with IRIG-B

## RTMS Relay Test Management Software

### Ordering Information

A copy of RTMS Standard for PC test applications is supplied with every SMRT/FREJA unit as a standard accessory. RTMS can be loaded on as many PCs as the customer wishes, without need of a software license, or security dongle to operate. The Enhanced test features in RTMS is hardware enabled in the SMRT/FREJA unit and is a purchasable option.

Ways to order a SMRT/FREJA unit with the Enhanced test features, or adding RTMS Enhanced at a later stage, see the SMRT/FREJA Ordering Information in the SMRT/FREJA data sheets.

### PowerDB Pro

PowerDB Pro is a powerful software package providing data collection and management for all your acceptance and maintenance activities. Test data can be imported from many Megger instruments including Protective Relay, Insulation Power Factor, Circuit Breaker, Instrument Transformer, Power Transformer Ratio and Winding Resistance, Insulation Resistance, Battery Impedance, Discharge, and many other test sets. Built-in test forms support consistency in procedures and reports. Data and test results are synchronized to your company's central database. Result and summary reports can be easily generated.

## RTMS Relay Test Management Software

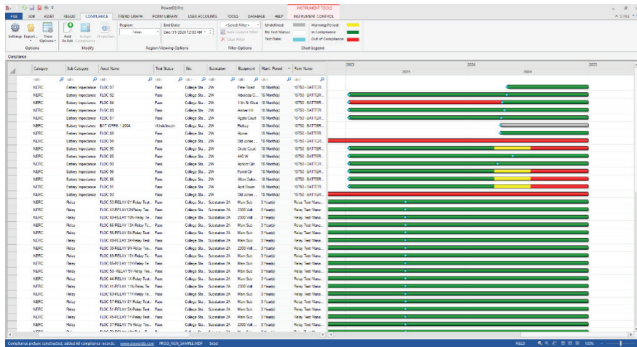


Figure 41: PowerDB Compliance Scheduler

The PowerDB Compliance Scheduler allows you to focus on your priorities by providing a quick visual overview to easily track compliance status and maintain necessary maintenance schedules. The ability to assign risk levels allows you to focus your maintenance on assets that are critical to your operation. Create jobs, work orders, locate test records and manage repair work from the intuitive interface. Manage user access and what can be viewed by individuals, both internal and external to your organization, from compliance officers to managers to technicians.

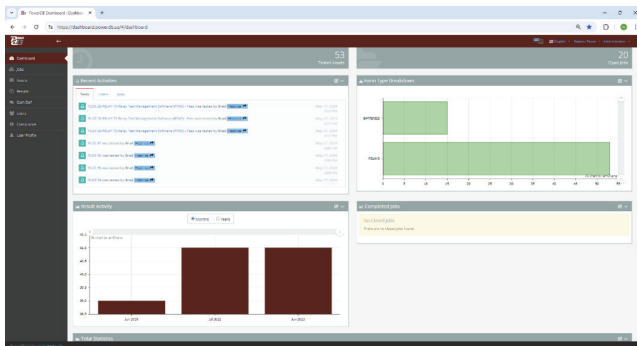


Figure 42: PowerDB Dashboard

The PowerDB Dashboard is a web-based portal that is customized to show you the most important data for your business, where you need it, when you need it. The Dashboard can be accessed on any device using a standard browser program, meaning you have access to your information at virtually any time. The main console includes statistical tools to search, display and print any saved information. Define user types and allow them to see the information that is pertinent to their duties or restrict any information as needed. Views are potentially only limited by the information you have in your database. Easily view maintenance activities, results, asset health, historical data, trending, asset and test equipment locations, or customized data collected from your forms.

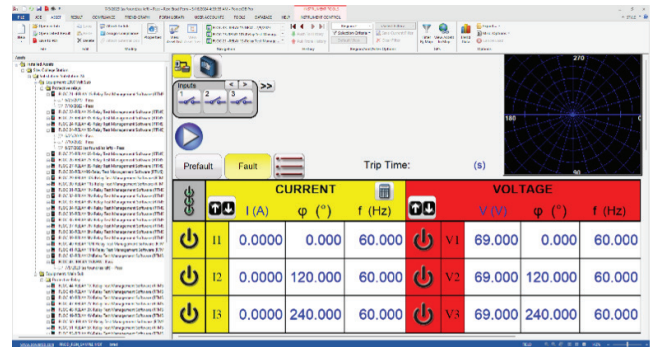


Figure 43: PowerDB Forms view

PowerDB forms offer many features to meet your needs and come in both automated and manual entry versions. The capabilities and features that can be provided in the reports is virtually endless, but access to the form editor tool is limited to only authorized personnel to ensure consistency and content. When testing with most Megger test units, tests can be run directly from the Test Form, which eliminates the chance for human error when inputting test results. Condition based forms can be developed that pull data from other forms, process that information according to your specifications, and deliver an asset condition, or any other measurement you need. Help menus within forms can be customized and can include items like connection diagrams, warnings, or anything that is essential during the testing process. Pairing assets and test forms in your Computerized Maintenance Management System (CMMS) system allows you to pre-load your assets and convert your historical data to PowerDB. This saves time since data does not have to be re-entered and potential errors tied to re-entry are avoided.

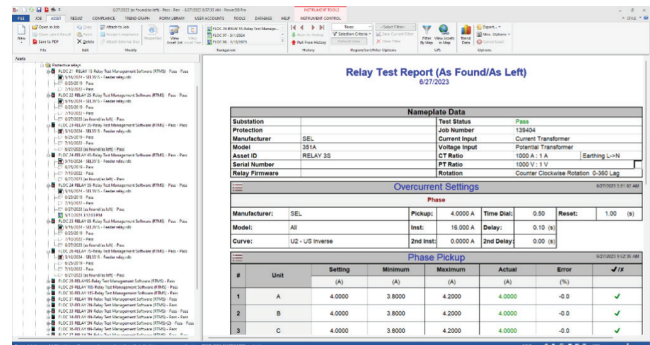


Figure 44: Relay test report

# RTMS

## Relay Test Management Software

### Full database capabilities

An entire organization's results can be synchronized into a single Database, scalable to Microsoft SQL Server, for easy retrieval and review.

- **Centralized Database Management:** PowerDB Pro uses a relational database to store test data. One-step report generation maximizes timeliness and facilitates NERC compliance audits. Field databases are operated in offline mode and synchronized when users get online. This allows the collection of data and ability to view historical test data without the need for constant internet connection.
- **PowerDB Inspection:** Application works on Android and IOS platforms and is completely customizable to suit your needs.
- **Data Analytics:** PowerDB suite of tools Compliance, Dashboard and Data Query help easily view, and trend results over time.
- **Data markers and scheduling:** Data filtering and assets categories support the tracking of maintenance intervals and assist in creating work orders. This is easily applied to specific assets and tests to create intervals for compliance to various standards as needed.
- **Data Collection:** PowerDB allows data imports from various sources as well as integrating with CMMS. This includes direct import from testing instruments and manual entry based on organization requirements. Merge results from multiple test instruments with data imports from other sources to facilitate queries and sorting.
- **Dashboard:** An organization can utilize the existing PowerDB Dashboards or choose to customize the views that are most beneficial to them.
- **Compliance:** Allows for creating test intervals for specific tests allowing compliance with local standards. Tests can be scheduled from this module.
- **Alert Manager:** Adds an alert via text email or both when a certain event occurs in the database.
- **Inspection Application:** IOS or Android based and intended to reduce time on routing inspections.
- **Standardized Forms:** PowerDB suite includes a library of over 480 pre-formatted test forms for data entry and reporting. PowerDB has a powerful forms editor built in allowing the modification of existing forms or the creation of new ones.
- **Routine calibration:** Maintain calibration data for test instruments.

### SALES OFFICE

Megger Limited  
Archcliffe Road Dover  
CT17 9EN England  
T. +44 (0) 1304 502101  
E. UKsales@megger.com

### UNITED STATES

4545 West Davis Street  
Dallas, TX 75211-3422  
T 800.723.2861  
T +1 214.333.3201  
F +1 214.331.7399  
E usasales@megger.com

### RTMS\_DS\_en\_V6

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