MENTOR SOFTWARE OVERVIEW

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MENTOR 12

SOFTWARE ELEMENTS

SOFTWARE/MODULES	FUNCTIONALITY	MENTOR 12	ROOTS OVERCURRENT	ROOTS DISTANCE	ROOTS DIFFERENTIAL	ROOTS VOLTAGE	ROOTS FREQUENCY
FULL DIRECT CONTROL	Powerful, fast and easy manual testing, no PC needed	●					
CONFIGURATION CONTROL	Easy control of all Power source combinations, Binary I/O configurations, visual connection guide	●					
ASSISTED CONTROL	**NEW!** On screen direct regulation of complex magnitudes: Impedance, Fault, Power (P,Q,S, Power Factor), Sequences (Symmetrical components), Vline and Homopolar Voltage, Open Delta. Also available in State Sequencer.	●					
VECTOR VIEW	**NEW!** Full control at your fingertips of individual or grouped phasors, with module and angle lock functions.	●					
TEST FUNCTIONS	The most complete Built-in Test functions, with on-screen graphic configuration, to carry out typical test for protection relays and protection schemes.	●					
FAULT	Three-state Fault function, pre-fault, fault and post-fault configuration	●					
RAMPS	Single or double Ramps, upward or downward, of any MENTOR parameter	●					
PULSE RAMP	Pulse ramping with preset condition state, of any output parameter	●					
BINARY SEARCH	Effective search of trip values through adaptive pulses	●					
STATE SEQUENCER	A simple programmable multi-step tool to test protection schemes and logical sequences.	●					
STATE SEQUENCER WITH ASSISTED CONTROL	**NEW!** The Assisted Control is now available in the State Sequencer, allowing the programming of complex magnitudes sequences.	●					
FAULT PLAYBACK (COMTRADE)	Playback and processing of COMTRADE files and similar, for transient fault analysis and relays reaction	●					
RESULTS MANAGER	Results and Test saving in USB pendrive, semi-automatic routines tests collection. Test Reporting in PC with Mentor Report Viewer.	●					
REMOTE CONTROL	Local mode or remote control, through serial or Ethernet connection	●					
BATTERY SIMULATOR	Auxiliary DC supply setting for relay powering	●					
HARMONICS	New control to select the desired Harmonic content and angle in each channel	●					
METER & MEASURING	Testing of transducers, counters, measuring devices, analogue and binary measurement	●					
LOGGER	On-screen event list, automatic recording for all events, such as sources switching and I/O status change.	●					
SMART TEST TOOLS*[1]	Importing RIO files and ROOTS test, execution of tests with no need of PC, just a USB pendrive, and storage of results	●		●			
IEC-61850 – GOOSE *[2]	Testing with GOOSE according to IEC 61850, with configuration tool and no need of PC	●					
POWER SAVING TRIMMER	Energy saving system with auto-adjustment to load and regulation of working cycle	●					
INTERNET UPGRADING & MAINTENANCE	All MENTOR elements can be upgraded via internet, update and diagnostics	●					
CAPE TEST FILES CONVERTER	SS1 CAPE converter and execution of this network simulation program files	●					
BINARY I/O MONITOR & CONFIGURATION	On-screen display of all binary I/O status and flexible configuration	●	●	●	●	●	●
FREE LIFETIME UPDATES*[3]	EuroSMC free unlimited updates, new releases and modules	●	●	●	●	●	●
DEVICES CONFIGURATION, DEVICES MANAGEMENT & TEST LIST	Data settings and Devices template configuration. Several Test Modules added to every device, each module with its specific relay´s settings, protective elements and Test List. Easy Device Management and search of devices with a quick classification tool.		●	●	●	●	●
AUTOMATIC REPORTING & REPORT CONFIGURATION	Immediate reporting in PDF format, or XML, with selection of data to display. **NEW!** Now available the report export to Word editable RTF format.		●	●	●	●	●
DATABASE MANAGEMENT	Administration of Databases of Devices with relay definitions, test values, test routines, results and reports. Databases can be exported to XML.		●	●	●	●	●
RIO FILES IMPORT	Direct import of RIO files , relay definitions and settings		●	●	●	●	●

MENTOR 12

SOFTWARE ELEMENTS (Cont'd)

SOFTWARE/MODULES	FUNCTIONALITY	MENTOR 12	ROOTS OVERCURRENT	ROOTS DISTANCE	ROOTS DIFFERENTIAL	ROOTS VOLTAGE	ROOTS FREQUENCY
AUTOMATIC IMPORT OF RELAY SETTINGS TOOL	**NEW!** Tool to automate the import of variables/settings and/or update existing ones, from a text file, using Pattern recognition and Templates. Source file can be generated by the Relay software, or from the Engineering file issued to adjust the device settings		●	●	●	●	●
DATA SETTINGS PANEL	**NEW!** Besides the edition of the data associated with the device (Formulas, Custom and Default Variables) included in previous versions, this new Data Settings window includes a tree classification system, displayed to the user´s convenience		●	●	●	●	●
GENERAL REPORT	**NEW!** Tool to select and combine the different reports of executed tests in different modules, in a single General Report, for the selected device.		●	●	●	●	●
CHARACTERISTICS EDITOR & TEMPLATES	Powerful Graphic Editor for protective areas and curves of Elements, with pre-defined templates		●	●	●	●	●
FORMULAS	User-programmable test engine in Visual Basic.Net language. Function definition window		●	●	●	●	●
FAULT CALCULATION & SEQUENTIAL TEST EXECUTION	Accurate fault calculation and Test Assessment for the specified settings in every test point sequence.		●	●	●	●	●
CLICK SEQUENCE	Automatic sequential injection of test points, with pre-fault, Fault and Post-Fault conditions, and assessing of results.		●	●	●	●	●
PICK UP/DROP OUT	Finding of the pickup and dropout values of the active elements in the relay under test		●			●	●
RECLOSE	Verification of the relays reclose function, with any number of reclosing cycles		●	●			
COLD LOAD	Evaluation of protection devices that support the cold load function		●				
SOTF (Switch On To Fault)	Performance of the relay during a SOTF condition		●	●			
I2/I1 RATIO	Generation of faults to evaluate relays with this function		●				
CB FAILURE	CB failure scheme evaluation		●	●	●		
FUSE FAIL	Test elements behavior during the Fuse Fail condition		●	●			
SELECTIVE OVERCURRENT LOGIC	Verify the correct logic behavior of the protective devices on signal reception with forward faults and reverse faults		●				
RESET TIME	Testing of reset timing function		●				
DISTANCE SEARCH	Impedance element evaluation to find the boundary values of distance zones in selected directions.			●			
DISTANCE VERIFICATION	Impedance element evaluation without zone geometry			●			
EVOLVING FAULT	Evaluation of relay´s behavior under evolving fault conditions during a single-phase recloses cycle.			●			
TRIP ON RECLOSE	Test to evaluate the relay´s trip acceleration function during a reclose cycle.			●			
ZONE 1 EXTENSION TEST	Evaluation of the relay when this clearing-fault function is active			●			
LOSS OF LOAD	Test module to evaluate LOL function in diverse circumstances (also called Remote End Opened)			●			
LOAD ENCROACHMENT	Module to verify the proper operation of a distance relay under heavy load conditions.			●			
DIFFERENTIAL VERIFICATION	Test to check the consistence between the protected device, the relay settings, the Differential module's setup, and connections.				●		
DIFFERENTIAL SEARCH	Test to find the boundary trip values which corresponds with the characteristic of the relay				●		
DIFF. HARMONICS RESTRAINT	Evaluates the response of the relay to the harmonic content variation in measured current signals				●		
SET OF DIFFERENTIAL MODULES	Differential 87C Classic; Differential 87T Transformer; Differential 87GM Generator / Motor; Differential Bar 87B				●		
SET OF VOLTAGE MODULES	Single Phase and 3-Phase Voltages Modules to test the operation of protective devices with functions 27, 47 and 59					●	
PICK UP/DROP OUT FREQUENCY	Test to search for pickup and drop out values of the active frequency elements						●

MENTOR 12

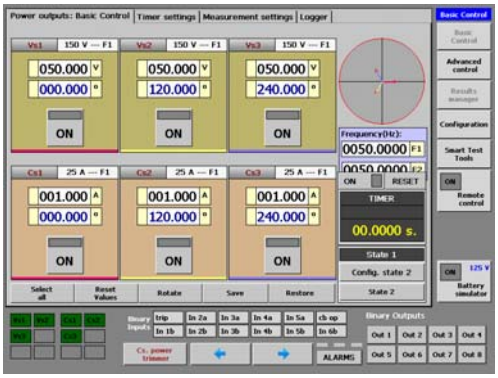
SOFTWARE ELEMENTS (Cont'd)

SOFTWARE/MODULES	FUNCTIONALITY	MENTOR 12	ROOTS OVERCURRENT	ROOTS DISTANCE	ROOTS DIFFERENTIAL	ROOTS VOLTAGE	ROOTS FREQUENCY
VOLTAGE INHIBIT FREQUENCY	Searching of the minimum voltage value that prevents the frequency elements to operate when the measured voltage is below the setting.						●
CLICK SEQUENCE DF/DT	Generation of test points list, each one being a frequency ramp, to evaluate the trip setting of df/dt element						●
PICK UP DF/DT	This test allows searching for pickup values of active df/dt elements in the device with the desired accuracy.						●
VOLTAGE INHIBIT DF/DT	Test for searching the inhibition voltage of df/dt elements, through frequency ramps.						●
CLICK SEQUENCE VOLT/HZ	Evaluation of trip times for the series of test points selected in the V/Hz characteristic						●
PICK UP/DROP OUT VOLT/HZ	Search for pickup and drop out values of active V/Hz elements in the device with the desired accuracy. It is performed by injecting consecutive faults						●

*[1] - Smart Test Tools – optional license

*[2] - Optional Plug & Play board needed.

*[3] - ROOTS can be ordered with the license/s activated for one, several or all Protection Modules, or also including free rights for future modules.



MENTOR 12 - SOFTWARE ELEMENTS

FULL DIRECT CONTROL

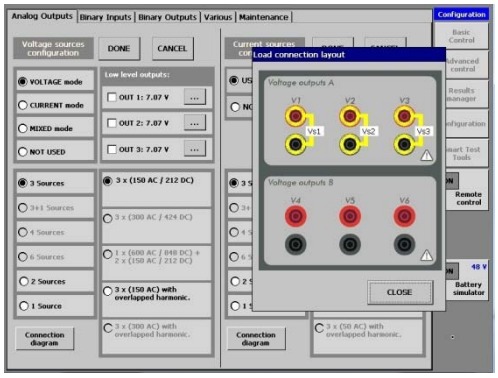
The MENTOR 12 is the most advanced three-phase relay test set available for type and field testing of electromechanical and digital protections of any kind, providing the most complete and straightforward Manual Control of the market. The MENTOR 12 is controlled via a touch screen panel and a rotary selector. An external mouse, monitor and keyboard can also be used if desired.

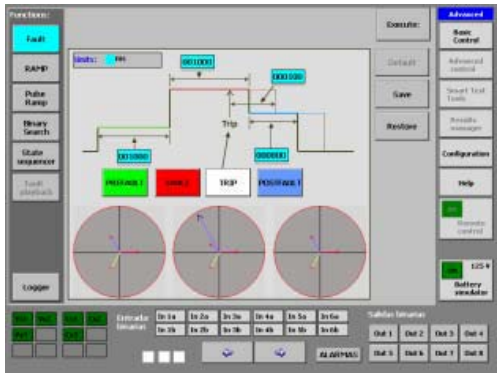
The MENTOR 12's intuitive interface is organized to complete the job safely and accurately in the shortest possible time. Locating the necessary controls and the relevant test information will take just a few seconds to the untrained expert. Adjusting a few values and testing a handful of trip points in the relay is a snap, at the reach of your fingertip.

The optimized Control Panel refers to the control of the equipment in **local mode** for total control over all its functions:

- Power source controls: Current source/ Voltage source, Amplitude, phase angle, low level outputs, harmonic content, channel selection, on/off activation, channel combination, frequency control. New Vector View.
- Measurement display: multifunction timer, countdown timer, analogue input measurement, binary input pulse counter and frequency measurement.
- Function keys: channel selection, memory and dynamic fault shortcuts
- Battery simulator: Auxiliary DC supply setting for relay powering
- I/O states: monitoring of power sources, binary inputs, binary outputs activation/status.
- On-screen access to Alarms reports
- Output Power trimmer: Energy saving system with auto-adjustment to load and regulation of working cycle.
- Fine/coarse tuning.
- Real-time representation of power vectors. Direct regulation in Vector View.
- Timer operation/trip setup and preferences, binary I/O setting.
- Event Logger, with event description and time of the event. Automatic recording for all events, such as sources switching and I/O states.
- External measurement, for testing of transducers, meters and sensors.
- Hardware configuration and maintenance, with internet upgrading capacity.
- Results Manager, and storage of results.
- STT: Importing RIO files and ROOTS test, execution of tests with no need of PC, just a USB pendrive.
- Advanced built-in Test Functions: Fault, Ramp, Double Ramps, Pulse Ramps, Binary Search, State Sequencer, Fault Playback (COMTRADE)
- New Assisted Control for complex magnitudes: Impedance, Fault, Power, Sequences, Vline and Homopolar Voltage, Open Delta.

The MENTOR 12's standard equipment build up one of the most advanced basic configurations available on the market for quick, simple and easy testing, for both commissioning and maintenance, without the need of any PC.
One of the biggest advantages of the MENTOR 12 is the "plug & play" modularity. New amplifiers connected by the user are automatically recognized and added to all the test and configuration screens by the MENTOR 12, with no software adjustment.





CONFIGURATION CONTROL

One of the greatest advantages of the MENTOR 12 is its modular design. You can start with a basic 6-channel unit and add more channels later on. The plug and play technology makes adding or replacing channels an easy operation, with no need to return the unit to the factory. Depending on the device being tested, the default hardware configuration can be quickly changed at any time:

Power Outputs Configuration: Easy control of all Power sources configurations.
Regardless the number of amplifiers in your MENTOR 12, you can also combine them in series and in parallel to attain greater voltage and current levels. The output configuration screen displays a menu with all the possible combinations and a visual guide to help the user at connecting the relay. There is no need to calculate partial current, voltage or phase angle values as the MENTOR 12 manages and shows each group of combined channels as if it were a single “virtual “one.

Furthermore, each voltage amplifier can be switched to current mode by a simple touch on the configuration screen. This feature allows, for example, to convert a MENTOR 12 3v3i (3 voltage + 3 current channels) to a six-current test set when the need for testing three-phase differential relay arises.
Low Level Outputs and superimposed harmonics for every source can also be activated in this control.

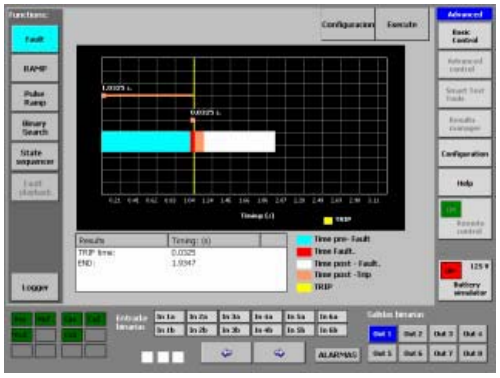
Binary Input Configuration: The MENTOR 12 has 12 (Logic) Binary Inputs grouped together in 6 isolated pairs, in order to be able to detect the behavior of the logic outputs of the relay or protection scheme that is being tested. The Binary Inputs can be configured to detect both Dry Contact operation signals, or Wet Contacts, that is, a signal with voltage applied to them (1.5 or 15V threshold up to 400V pk ac or dc). Each Binary Input can be programmed to be active High or Active Low (NO, NC)

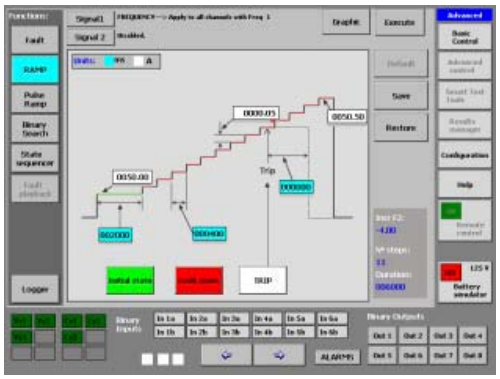
Binary Output Configuration: There are 8 Binary (Logic) Outputs in the MENTOR 12, in order to be able to program their behavior so the action of devices in the protection scheme that is being tested can be simulated. Each Binary Output can be configured as: Relay /Open Collector, and NO/NC mode.

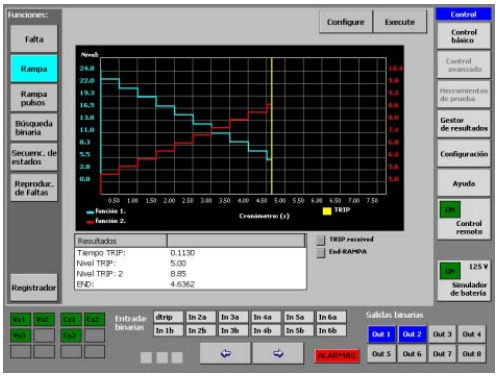
Default Configuration: many other settings can be easily adjusted such as working with primary or secondary values, debounce and glitch time sensitivity of binary inputs, angle notation and direction, default frequency, default values for voltage and current sources, seconds/cycles, language selection and GPS info (if GPS board is installed in the unit)

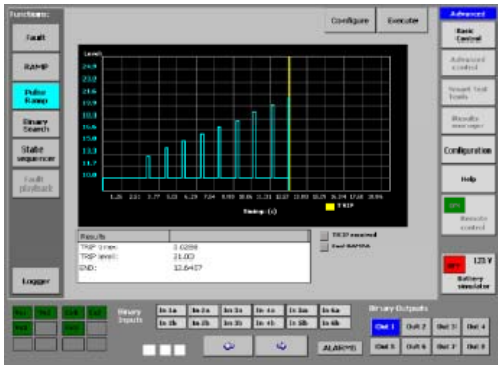
TEST FUNCTIONS

The most complete Built-in Test functions, with on-screen graphic configuration, to carry out typical test for protection relays and protection schemes. These tests allows determining the state of the relay and obtaining readings and results of different relay parameters under different test conditions, configured by the user.
A Logger is available for all functions, to carry out an in-depth study of the performance of the relay tested throughout the function.
The test configuration is similar to all of them, making the MENTOR 12 extremely easy to use, since controls are shared by the functions. The TRIP processing can also be configured in any of them, by combining the twelve available binary inputs in OR or AND logic. Prefault, fault and postfault states of the binary outputs and outputs test signals sources are defined through an intuitive graphical interface.









- **Fault function:** this three-state function allows the user to set a complete simple fault and execute the prefault, fault and postfault values, including duration of the states, logic I/O states, and trip conditions. The fault execution displays the progress timeline and test results in graphical and numeric mode, including the trip time and end function time.

- **Ramp function:** Single and Double Ramps, upward or downward ramps, of any output parameter on the MENTOR 12 can be programmed and executed. The automatic ramps are generally used to systematically determine the trip level of a protection relay with respect to the parameter that is varied. Ramp function operation is provided for finding limiting values, such as pick-up and drop-off. The linear ramp is the best way of handling parameters such as the Phase Angle, Voltage and Frequency, especially the latter, as the real performance of these parameters can be reproduced with great precision.

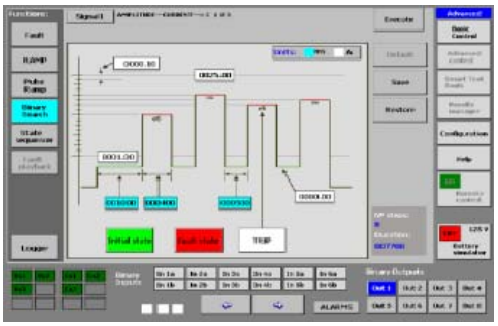
  The flexibility of this module allows two synchronized simultaneous ramps of different variables, each one applied to different types of output quantities, for example, one ramp moving the Voltage and the other moving the Current (Impedance ramp).
  Simultaneous ramps, even of different parameters, can be applied to the same selected output source, for example one ramp moving the voltage and the other moving the frequency at the same time on the same output source, in this case voltage (V/Hz variation ramp).

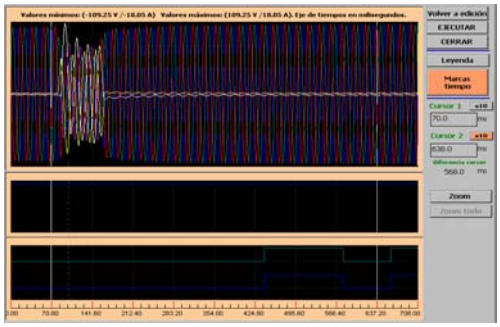
  After ramp and trip conditions are set, the test progress is displayed in an oscillographic fashion, with electrical values evolving along the ramp and trip events being stamped on the timeline as they take place. Relay trip time, trip value and duration of the test are displayed, and test repetition can also be performed if desired, or with different conditions. At the end of a test, user can type a name and a brief description and save it for future use. Since storage takes place on removable USB pendrives, the capacity is unlimited, and it also provides a way to create a collection of automatic test routines.

- **Pulse Ramp function**: It is a way of carrying out a Fault ramp, each state with its pre-fault and its fault. The basic difference with respect to the Ramp function is that instead of continuously increasing the magnitude, a preset condition state occurs between consecutive pulses.

  This function is preferably used when instantaneous or defined time values are sought in Overcurrent elements, as it enables to inject a high current value during a specified time and return to low current conditions or even non-existing current conditions between each programmed pulse, thus eliminating the possibility of damaging the relay tested.
  It is also very useful to verify trip setting values in protection zones, as we can enter the zone for a defined time and exit it without causing the other slower zones to trip.

  The selectivity that is achieved with this function when selecting the trip elements, makes it very interesting to use when testing trip outputs of relays that have different protection functions assigned to them at the same time, thus avoiding the need to change the configuration of the relay being tested. The information about the number of steps (increases) and the total duration of the function (in milliseconds) appears automatically calculated in the screen, as in the ramp function.





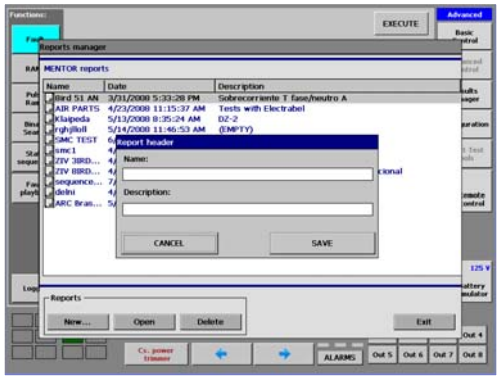
- **Binary Search function**, unlike the ramps, the Binary Search does not use a fixed increase value, as it adapts to different values to make an effective search. Ramp and Pulse Ramp are excellent to verify the accuracy of a trip value within some known margins. The Binary Search function is designed to cover the circumstance when you do not know the trip value or even, to verify a known trip value carrying out the test in a different way.

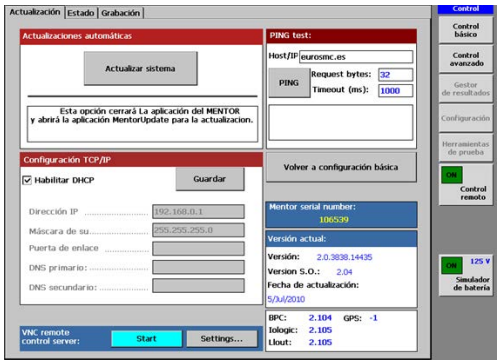
  An initial search point is defined in this function as well as an end point that may be separated from the initial one as much as we want as well as a maximum function Precision or Resolution. After defining the limits, the function will give a first pulse at half the value of the range defined by the initial and end values. If it detects a trip it drops to half the difference between the last applied value and previous. If it does not detect a trip it increases to half the difference that it dropped previously, and so on and so forth. This is a very quick and accurate way of searching for trip values.
  Other difference between a Binary Search and the previous Ramps is that only one trip is detected in the Ramps (going up or down until this occurs) whereas in the Binary Search multiple trips occur for the relay tested, which must be considered.

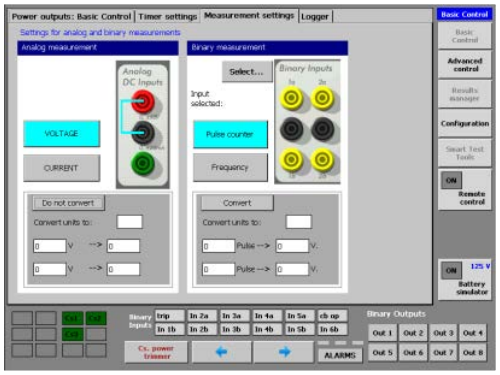
- **State Sequencer function**: The State Sequencer is a very flexible test module to test protection schemes, since it allows programming a sequence of all the outputs available on the MENTOR, analog or binary, as you desire, in a logical sequence of states. The transition from one state to another can be configured either by elapsed time, by any combination of the binary inputs trigger, by both things or by manual initiation.
  The State Sequencer is used to test protection functions that are closely connected to times and actions dependent on each other, such as reclosing cycles, protection schemes with segregated or selective trips, sending orders and signals to other protections, communication schemes, etc…
  To use this function it is important to study the data contained in the Logger in detail as well as their correlation with the changes in state, depending on what the protection or scheme tested are expected to do under the injected conditions.
  Within one state, all configured test signals (voltage and current outputs) of the test device can be set independently in amplitude, phase, and frequency.

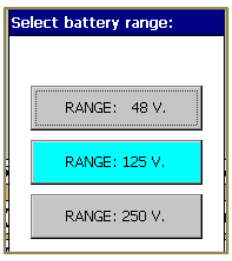
- **Fault Playback:** This function allows the playback of **COMTRADE** fault description files, both binary and ASCII, according to IEEE STD C37.111-1999. This is very useful to analyze the protection´s behavior against a previously recorded fault, or a simulated fault (from network simulation programs), reproducing this transient faults recordings at a specific sampling frequency.
  In this function, the MENTOR internal amplifiers radically change its normal perfectly sinusoidal wave reproduction, to play sample by sample the registered wave in the COMTRADE file, with a 3 Khz bandwidth. The MENTOR 12 includes this feature as standard, and a PC is not needed.

  COMTRADE files can be directly read from a USB pendrive, plug it into the unit and press Playback. User can assign each in the recording to specific current and voltage channels for the playback, select the section to be played – all the record or some cycles before and after the trigger – and analyze the response of the relay at the binary inputs in the MENTOR 12. User can edit and discard the unneeded signal's sections or adjust the best transformation ratio for the playback.
  If the GPS option is installed, it is possible to synchronize the file playback through this external time reference.
  This makes it possible to check if the relay´s reaction differs between the recording and its behavior during playback, and also to analyze how other protection device operates under the same conditions.









Results Manager: The Results Manager allows saving both the test results and configuration of Advanced test functions, so that they can be repeated as desired. Results are saved in a USB pendrive.
The system can save as many tests as needed in Report files, being a way to automate tests for specific relays. The reports can be displayed on the PC, exported and/or printed, using the Report Viewer for Windows, which is included as standard in every MENTOR.
After any advanced function test, we can add the results to any existing report, with a new name for this test and a description. The test is recorded with date and time and the function type. The saved collection of user-defined and customized test routines will provide a valuable asset of ready-to-use test tools for each relay type and protective function. The user only needs to choose one from the list in the Results Manager and press Execute.

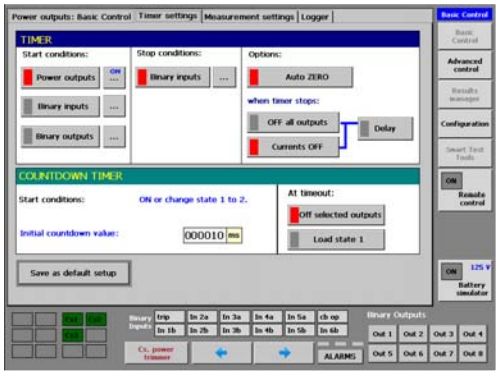
Internet upgrading and Maintenance: the MENTOR 12 will never become obsolete because all its functional elements are completely programmable. The user can upgrade its software over the internet and install plug-and-play hardware options with no external assistance. All hardware and software configurations can be updated by internet. The user enjoys free updates and upgrades of new features and new modules made by EuroSMC.
MentorUpdate module automatically updates the unit through direct connection of the MENTOR unit to internet. Other option is to update the unit through a USB pendrive, which previously have loaded the update files, downloaded via a computer connected to the Internet from our servers, using the program MentorSynch.
VNC Remote Control Server is a tool which allows remote control of MENTOR from any external computer connected in the corporate network or a computer connected to the Internet. It is very useful to allow remote control of the unit, especially for checking and diagnosis of the unit operation by our service specialists.

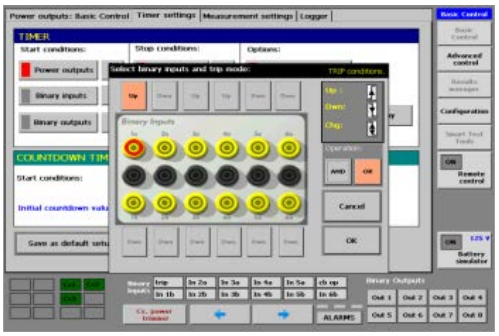
Meter & Measuring: Measurement configuration section to configure the settings for analog and binary measurement. This functionality, specifically designed to test transducers with analog output in VDC or mA DC or counters with analog or digital output by pulses, makes the conversion from the magnitude measured at the input (V, mA, Pulses) to the units that are assumed to be the nominal ones of the element to be tested (V, A, KVA, Kw, Kvar, Kw, time, etc) entering the ratio between both. Optical scanning heads for capturing pulses emitted by the energy meters (non-visible infrared LED and visible) are optional accessories available. The multifunction display in the main control panel shows the values measured in the analog input and binary input in real time.

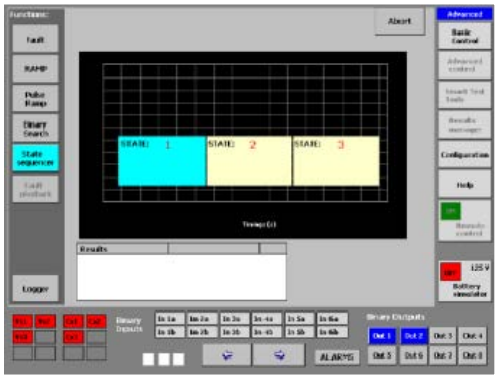
Binary I/O Monitor: The MENTOR 12 is permanently monitoring the Binary Inputs states, and reflecting any change at both the screens of test results and in the Logger; furthermore, the user can also monitor on-screen any status change of all the Binary Inputs at any time, which facilitate testing and verifying the relay´s reaction during the test execution.

Similarly, Binary Outputs status is displayed on the screen, monitoring the pre-programmed activity of them at any of the functions; besides that, the user can also activate or deactivate manually any of the Binary Outputs, if required by the simulated protection scheme, from the Binary Outputs control on the main screen.

Battery Simulator: The MENTOR 12 has a built-in battery simulator up to 250 Vdc, which must be used to supply the relays being tested and which require an auxiliary power supply. The Battery Simulator control is available in all the accessible function screens.







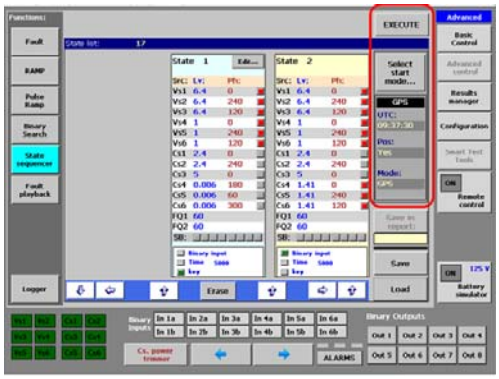
Timer Settings: Timer start and stop conditions can be quickly adjusted to the test needs. The timer can be programmed to start by the status changes in the Power Outputs, by the action of a Binary Input combination, or by the status change of any Binary Output. Timer stops by the trip action at the Binary Input logic, which setting is straightforward selected. After the stop of the timer, voltage and/or current outputs can be immediately switched off or delayed to simulate switch time.
A countdown timer can also be programmed to stop the outputs or to load the previous state with the desired time in milliseconds.

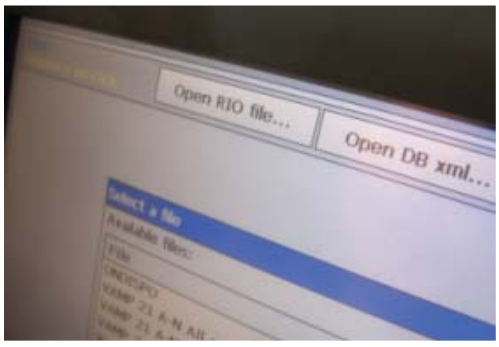
Logger: Automatic recording available in MENTOR 12, where any event is registered, such as the activation of the outputs, and changes at the binary inputs and outputs. The events listing are displayed with the time recorded for each, to correctly analyze the performance of the relay.

Harmonics: set of controls to easily regulate different harmonics contents in the voltage and/or current channels. The control allows selecting the desired Harmonic (2 to 33 in 60 Hz base frequency and 2 to 40 in 50 HZ base frequency) for the channel group. On each channel it is possible to regulate both the harmonic content in percentage and the angle where it is going to be inserted into the fundamental waveform. The possibility to work with the two parameters makes possible to generate with the desired Crest Factor (also called Form Factor), which is important mainly in testing old electromechanical and electronic analog relays, which are sensitive to this parameter. In this way the user does not need to run pieces of external software or make any kind of calculations to be able to determine the exact pickup or blocking values of the restraining harmonic elements in differential and ground relays, by just using the regulating control as with any other parameter in the MENTOR 12.

Cape Test files converter: Now all the EuroSMC's MENTOR 12 users may convert the Cape SS1 files into a file directly readable from a USB pendrive by the MENTOR 12 test set, and perform the test in few seconds by using the EuroSMC's CAPE SS1 to MENTOR converter software, which allow the user to directly download the sequence values into the States Sequencer and perform the test immediately. The States Sequencer may be triggered either manually or through the GPS or IRIG-B time synchronized options available for the MENTOR 12 unit, making an ideal tool for End-to-End testing. The Cape software is a popular program for network simulation and shorcircuit analysis, which allow the user to calculate the fault values in a network point and make possible to obtain a file which contains all the information of the prefault, fault and post fault values and the duration of each state. It is also possible to obtain a full states sequence corresponding to a reclosing cycle.

IEC-61850– GOOSE module: MENTOR 12 is IEC-61850 compatible. The option MENTOR IEC 61850 is a GOOSE Messages Interface Board which consists in a plug & play electronic board that installs into the Control Bus of any MENTOR 12 unit just by sliding it inside. The configuration software tool is included in the MENTOR 12 internal software, avoiding the use of an external computer, and allows to subscribe/publish the GOOSE messages.
This option works through the RJ-45 connector, which connects with the IEC-61850 bus and use the information contained in the GOOSE messages as logic inputs and also it is able to broadcast GOOSE messages that acts as logic outputs, exactly in the same way that the current MENTOR 12 electrical I/O works, but avoiding the wiring of the I/O to the relay inputs and outputs.
The IEC 61850 option can be installed in any existing or future MENTOR 12.





MENTOR-GPS/IRIG-B: Certain kind of test requires the setup of two or more MENTOR 12 units (or one MENTOR 12 and other test set) separated on different locations and synchronized with each other. In this case a very high precision reference clock is necessary, in order to obtain the required timing to trigger the state sequencer or the reproduction of Fault playback (COMTRADE files) on separate units.

The MENTOR 12 equipment allows for this synchronism by the use of two alternatives of very precise time reference inputs: GPS and IRIG/B. Any of these two options can be chosen. It requires the installation of the corresponding Printed Circuit Board.
The GPS signal is broadcasted via satellite, and can thus be received at any place of the terrestrial globe. On the contrary, the utilization of an IRIG/B signal requires the presence of a local setup that generates this signal and transmits it via cable to the MENTOR 12.
The precision in time measurement of either two technologies is very high, allowing the MENTOR 12 to trigger pre-programmed sequences with precision of microseconds.

GPS and IRIG/B boards are plug & play; once the hardware has been detected and the signal is received, the unit is in disposition to initiate a state sequence or execute a COMTRADE file in a previously defined instant with a precision of microseconds. User can upgrade the MENTOR 12 with these optional boards at any time by themselves, without needing to send back the unit to factory.

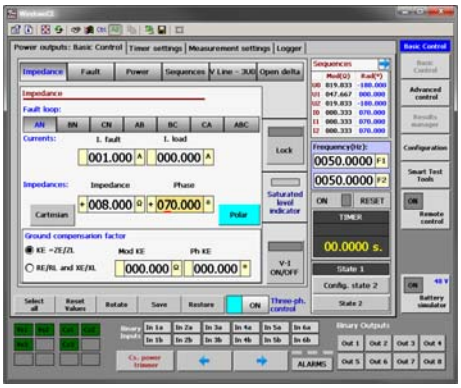
Smart Test Tools (STT): This optional functionality can be enabled at any time with the optional software Smart Test Tools, for automatic stand-alone testing of distance elements. Among the advanced test features provided by this component, the possibility of executing ROOTS-originated test files is possibly the most outstanding, because it avoids the connections and preparation overhead usually associated to an external computer.

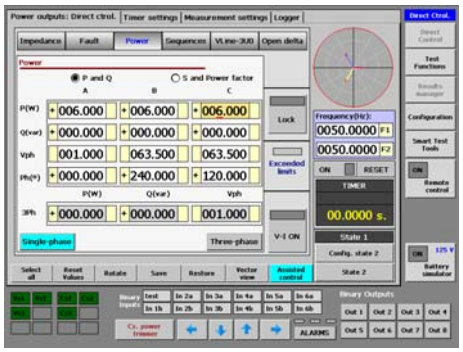
Any number of relay entries, each one containing a batch of different tests, can be stored from ROOTS onto a USB removable memory and then read and executed by the MENTOR 12. It is also possible to modify the test settings and even the test points before running the pre-defined tests.
The results are automatically appended to each test point and saved back into a new file in the USB memory. Later on, ROOTS will retrieve the complete test records from the USB and will associate them all to the corresponding relays in the original database, for future reference and/or immediate reporting.

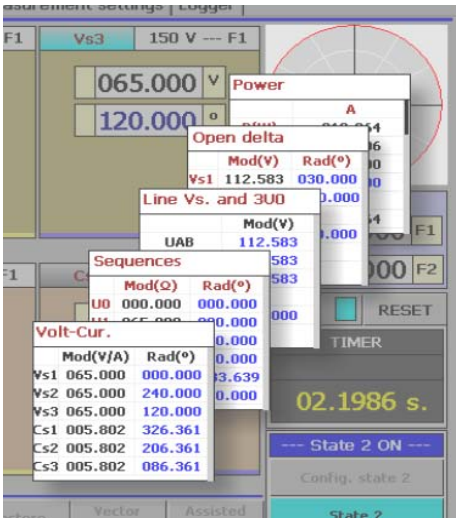
Another useful feature in STT is the RIO file import. This can save the time of defining your relay's operation characteristic. Once a RIO file has been read from your USB removable drive onto the STT, the user only needs to enter the values of as many points to test or, even easier, add test points by just touching at different spots on the displayed characteristic's graphics.
STT effectively leverages the outstanding power of ROOTS by allowing you to put your test plan inside your pocket, execute it with no manual intervention and no external computer on the field, and produce as many reports as you need once back in your desk.

MENTOR NEW SOFTWARE MODULES

▶ NEW! (2015)







Vector View: Full control at your fingertips of individual or grouped phasors, with module and angle lock functions. It offers an alternative way of regulating the amplitude and phase angle of the channels. Instead of modifying the numerical fields, you can touch and drag its representative vectors on the screen whilst you observe the values that each channel takes. To prevent it from changing the module of a vector whilst it is dragging it circularly, you can activate the *Lock level* button. If you wish to vary the amplitude without modifying the angle, you can activate the *Phase lock* button.

Assisted Control: On screen direct regulation of complex magnitudes (Impedance, Fault, Power, Sequences, Homopolar, Open Delta); The Assisted Control It is also available to be selected when programming sequences in the State Sequencer Test Function.
Instead of setting voltage, current or angle arbitrarily in each channel to configure a specific electrical situation, the Assisted Control incorporates a powerful algorithm that calculates those magnitudes whilst you set a single-phase, phase by phase or three-phase test directly in terms of:

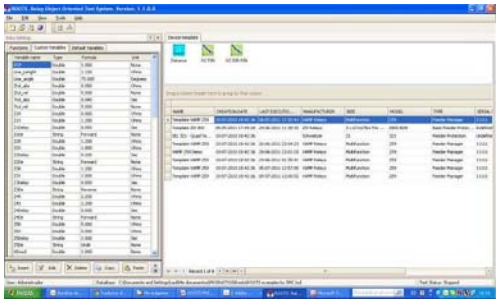
- Fault Impedance: in Cartesian format (R-X) or polar format (Module-Angle). It includes options and settings of Ground Compensation Factor.
- Fault Voltage, Current and Angle, for any of the Fault loop (single-phase, two-phase, three-phase)
- Power disturbance: Single-phase and 3-phase modality for Active/Reactive, or Apparent/Power factor
- Symmetric components:
  Voltage settings: module and angle for
    - Positive or direct sequence
    - Negative or reverse sequence
    - Zero or homopolar sequence

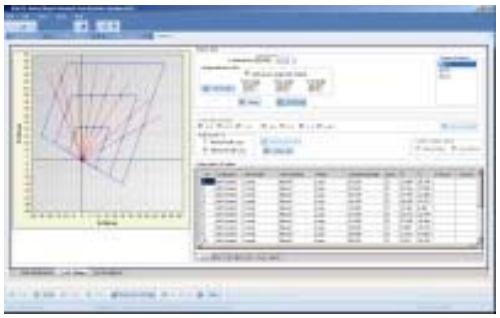
  Current settings: module and angle for
    - Positive or direct sequence
    - Negative or reverse sequence
    - Zero or homopolar sequence
- Line Voltages (AB, BC, CA) and Zero Sequence Voltage.
- Open delta, AB and AC voltage vectors and Zero Sequence Voltage.

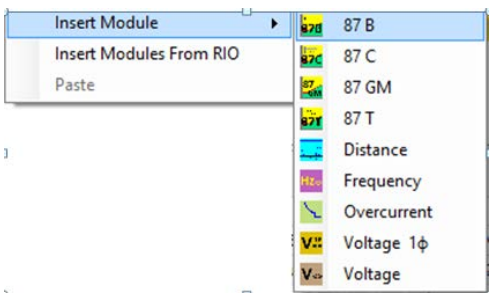
When a parameter is set in any of the tabs under Assisted Control, all the other tabs and even the normal Direct Control view are re-calculated in agreement with the new value. Consequently, the electrical situation is always unique and common to all the tabs, and it can also be seen in terms of voltage, current and angle just by pressing the Assisted control button again to return to the Direct control. The Lock button permits re-setting parameters without modifying the output. When pressed again, the output instantaneously takes on the new parameters entered.

Summary window: This small square area in the upper right-hand corner of the Direct control screen normally offers a simplified vector representation of the values set in the output channels. If you briefly touch it, its content changes to a summary of the impedance, power values, etc., which corresponds to the electrical situation currently set in the different tabs of the Assisted control. This view provides an aid to the regulation whilst working in Direct control, and is also available when configuring State 1 and State 2.

ROOTS - RELAY TESTING SOFTWARE







ROOTS (Relay Object-Oriented Test System) provides the best solution to the testing of today's multifunctional IEDs by performing accurate fault calculation, sequential test execution, and reporting automatically.
A ROOT is an optional product for PC-operation of EuroSMC's **MENTOR 12** and **TRES** relay test sets. ROOTS is developed using the latest Microsoft .NET® technology and is available for 32-bit and 64-bit Windows XP, or later platforms.

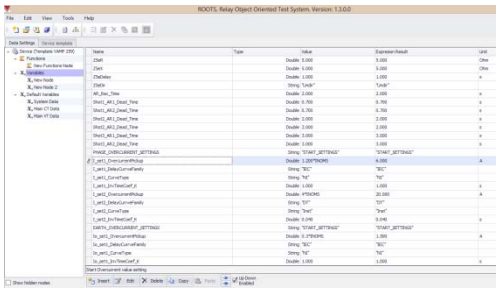
ROOTS implements a friendly, intuitive interface, for the quick and accurate configuration of all equipment features, device settings, test modules, test results, reports, and the permanent storage in a database. Test routines and report definitions are saved according to a simple hierarchy that is flexible and easy to understand. The user can create any number of test databases and each database is organized by Devices (IED); several Test Modules can be added to every Device, protection-specific modules, such as Distance or Overcurrent, or RIO files modules. Each module contains a test kit with test routines (click sequence, search, reclosing, breaker failure, etc) that can be used right off-the-box or quickly and easily customized to the user's needs. In summary, substation/s overall test procedures can easily be built, can be repeated for maintenance testing, and also used as templates for similar substations with minimum adjustments, which saves considerable time.

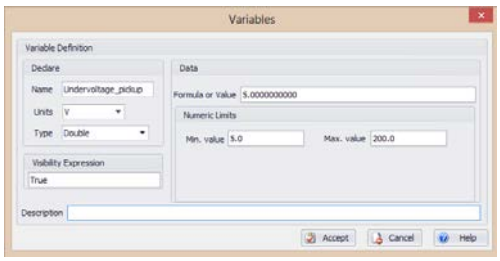
- ✓ The best solution to the testing of today's **multifunctional IEDs.**
- ✓ Spans the testing from the relay to its interactions with the whole **protection scheme.**
- ✓ Accurate fault calculation and sequential test execution.
- ✓ Automatic, customized and exportable **Reporting**. Now, **New General Report.**
- ✓ Roots storage files are self-contained **databases**: relay data, characteristics, custom formulas, test routines and report definitions.
- ✓ Database management functions for the **import/export** of devices, test definitions and results between databases. Databases can be exported to **XML.**
- ✓ **Devices Classification tool**, for easy and quick localization of the devices in the database.
- ✓ Ability of using **formulas** instead of fixed values when entering test values, settings, options or other data.
- ✓ Direct import of **RIO** relay description files supplied by a number of relay manufacturers (SIEMENS, ABB, etc)
- ✓ Intuitive graphical zone and elements **Characteristics Editor,** with pre-defined Templates.
- ✓ **Modular architecture**, different optimized test modules for each protection.
- ✓ **Modular Pricing**, ROOTS can be purchased with one or more functional modules, providing a price-optimized solution.
- ✓ **Free updates**, No other product in its class offers free lifetime updates and the possibility of being upgraded (in software and in hardware) by the user himself.
- ✓ **New Import Settings Tool,** automate the import of settings and/or update existing ones, from a text file.
- ✓ **New Data Settings Panel**, edition of the data associated with the device (Formulas, Custom and Default Variables) and a classification system of settings.

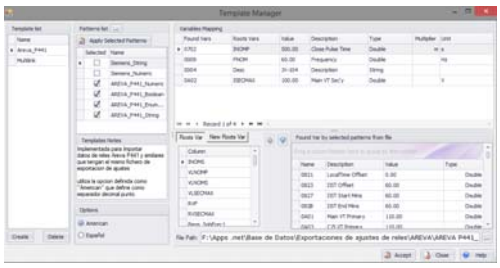
Test procedures defined within **ROOTS** can be directly executed on a connected EuroSMC test set. For a MENTOR 12 equipped with the Smart Test Tools module, the test procedures can also be transferred from **ROOTS** to an USB pendrive that can be read and executed by the MENTOR 12 with no need of an external computer.
New **MENTOR 12** users are entitled to test 100% functional **ROOTS** and **Smart Test Tools** during a free trial period before deciding to purchase a permanent license.

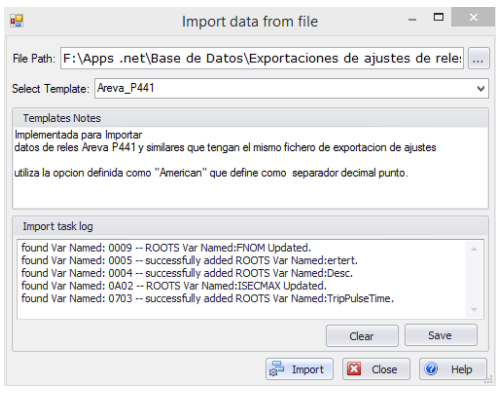
ROOTS - DEVICES MANAGEMENT

▶ NEW! (2015)









Data Settings Panel: the design of ROOTS software provides a universal, vendor-independent approach and templates of settings (and/or also templates of devices with an structured protection modules and tests lists) can be personalized for each relay type. Each cell in the Data Settings Panel can be labeled according to the names used by the relay manufacturer for each setting, as found in the relay's documentation, in the relay management software or in the data entry sheet distilled by the protections department.
It can includes underlying user-defined Formulas that save a lot of time and errors when some settings in a particular relay type can be calculated from a reduced set of data.
The Device Template Edition is an integral part of ROOTS, allowing the user to modify just a few settings for similar relay types, to be re-executed and re-saved along with the new results at any time.
The Settings Editor includes Functions (written in VisualBasic.Net), Custom Variables and Default Variables (such as Nominal Frequency, Main CT and VT data). Functions and Custom Variables are associated with each device under test. It is provided a tree classification system, displayed to the user´s convenience, with nodes that can be relocated to any position in the tree. The management of settings provides a quick way to locate and make visible the concrete settings required.
ROOTS focus on making the data entry an easy process, rather than eliminating the test operator's crucial involvement in verifying the integrity and veracity of the test information.

Automatic Import of Relay Settings: New Tool to automate the import of variables/settings and/or update existing ones, from a Text file, using Pattern recognition and Templates. The source file can be generated by the Relay software, or from the Engineering file issued to adjust the device settings. It is divided in four submenus:

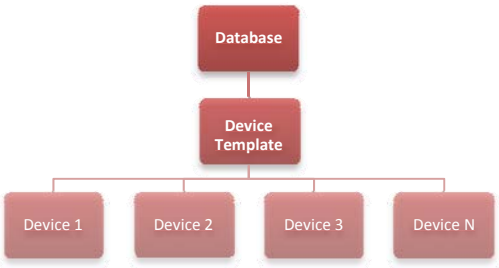
- Import data: It allows to select the Text data file, choose the template and import the settings automatically.
- Template manager: Allows the construction or modification of the templates that are used to import the settings. It includes a Mapped Table of the Variables found in the file by the selected Patterns, to be linked with ROOTS variables. a template for a specific file type is stored in Roots and allows reuse it at any time to import data from a similar file type (from similar relay types that have the same file of export settings)
- Pattern manager: It facilitates the creation, testing and modification of patterns used by templates. The Patterns are used in the analysis of the files in order to capture the required data, through Regular Expressions. The patterns can be produced by an advanced user or required to EuroSMC. The design allows reuse each pattern implemented in several templates in order to economize efforts.
- Options manager: options for the interpretation of data files.

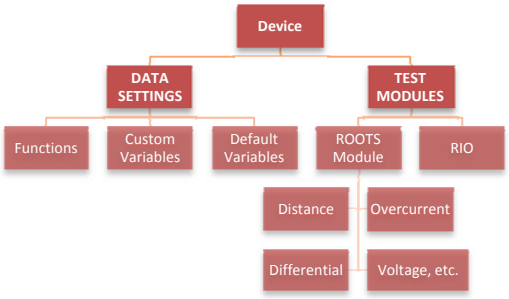
This New Tool for Automatic Import of Settings provides:

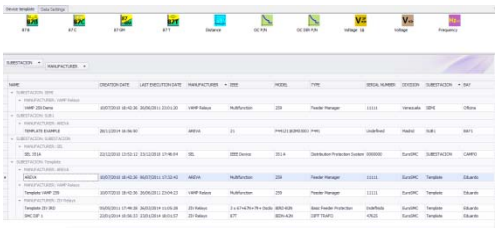
- A quicker and more automated solution than the manual data entry process.
- More guaranteed results in comparison with the RIO files import. The import of RIO files that contain relay settings provide a method to prepare the test quickly. ROOTS also includes the direct import of RIO files. However, the user has no direct way to ensure that the settings (blindly) imported via the RIO file into the test system exactly describe the functionality planned for the tested relay in a particular protective scheme (unless the RIO file has been accountably issued by the protections engineer); in other words, generally speaking, a successful test based on a RIO file just confirms the relay's operation and measurement accuracy, but only guarantees that the relay and the test system share the same settings.
- Test the device with the CORRECT settings, those settings provided by the protection dpt. or when any change is made by them, delivered by any format that at the end can be exported in a text file.
- Provides full independence from the relay and test set manufacturers.
- Allows the customer to seamlessly implement their own engineering procedures across the entire quality assurance cycle, from the system design down to the in-field testing routine.

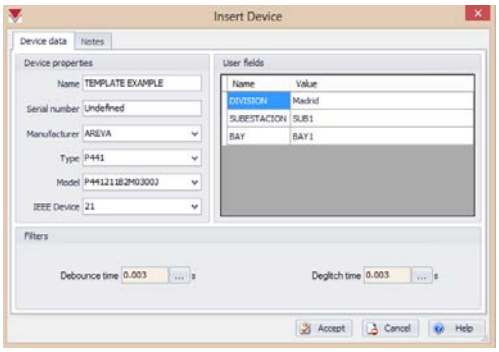
ROOTS - DEVICES MANAGEMENT

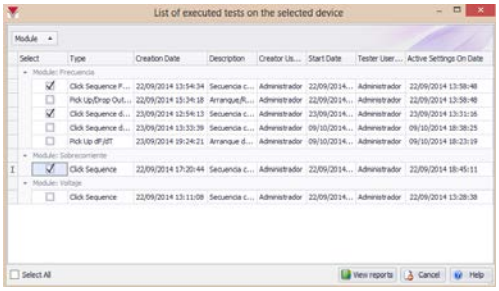
▶ NEW! (2015)











Databases and Devices Panel: ROOTS database files may include as many devices as required and the user can create any number of test databases.
Each database is organized by **Devices,** with its specific device definition, relay settings, protection modules, characteristics, test routines, test results, reports and report definitions.

Each Device can be assigned:

- Functions: They can be used in formulas to define any test value based on the device's settings.
- Custom variables: provide a practical data input method when the users wants to define the test parameters based on the relay settings. An unlimited number of user-created variables can be defined for a device and used in the test modules.
- Default variables: A number of default variables is automatically defined by Roots for each newly created device.
- Test Modules: The Modules (Distance, Overcurrent, Differential, Voltage, Frequency, etc) are configurable for each device separately depending on the characteristics of the device under test. Several test modules of the same type are allowed at the same device. It contains all the test settings, test characteristics/Elements and test results for a variety of protection- and scheme-oriented set of pre-configured tests.

The Device Panel shows a list of devices stored in the database in use.

Devices can be classified/reordered by any column, or group them by the user criteria by simply dragging the column heading to the top of the table, as a tree structure. Each new column dragged will be part of the grouping of information. This makes easier the organization and finding of concrete devices, mainly when a big number of those are included in the database, as well as facilitates the creation of test plans for different devices that can be repeated for maintenance testing as templates for the same or several substations.

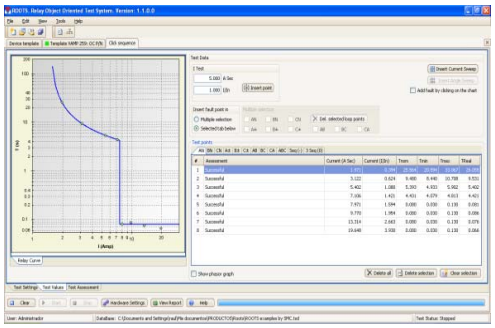
The Device Panel allows creating, editing, duplicating, and export/import the devices to/from XML format (and also to export to Mentor STT file, which is also XML). Using the "import device" tools allows having an unchanged database of many test templates for different devices, to open a "new database", and import the specific device (or devices) to that new database without changing the original template.

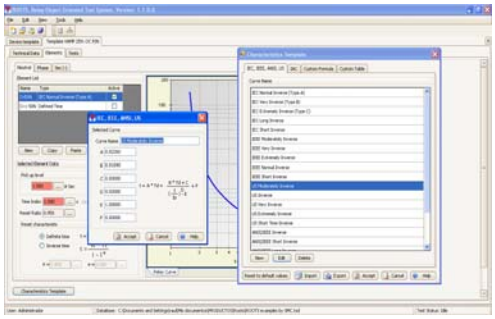
For every device the user can edit the identification fields as required, adding new fields (that can help to locate a particular device within the database) and also write in the Notes tab the additional information about the device tested, general checks or notes to the operator, etc.

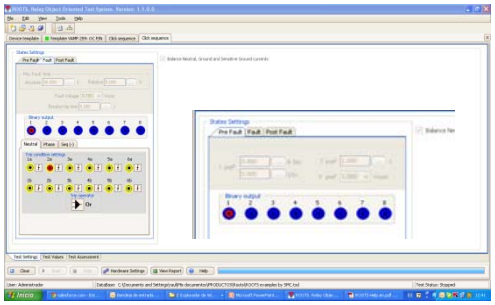
Report Configuration: Upon completion of a test, a report is automatically generated, in PDF or HTML file. Now, it is also available the report export to Word editable RTF format.
The user can choose the sections that must be included in the test report by means of the Report Configuration tool included.
User can also select the image/logo to display on each page of the report.

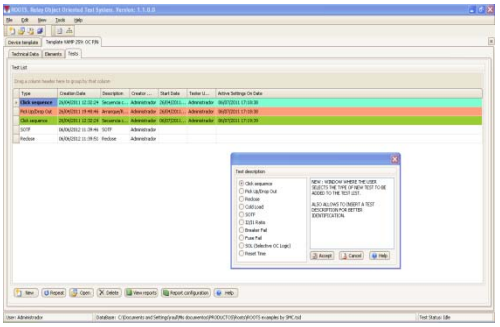
General Report: New Tool to select and combine the different reports of executed tests in different modules, in a single General Report, for the selected device. The list of executed Tests are shown grouped by the module column, and can also be ordered by module type, creation date, etc, and filtered with similar columns dragging action that in the device classification.
User can select which reports wish to combine in a single General Report, or to select all of them.

ROOTS - OVERCURRENT MODULE









The **Overcurrent** test module is used to automatically test the performance of protective devices that implement any combination of the 50, 50N, 51, 51N, 67, 67N, 46 and 49 protection functions. It also includes tests of operating values, and the external scheme tests related to these protective functions.

The module's functionality is distributed in the following sections:

Technical data: general parameters that affect all the tests contained in the Overcurrent module, such as: work with primary values, elements used for phase-ground faults, ground CT data, sensitive ground CT data, Current, time and angle tolerances, directional settings, grounding characteristics and transformer connection.

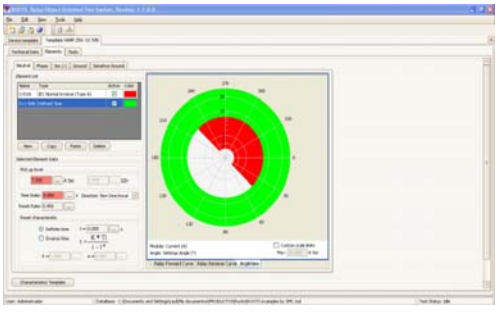
Element list: the test module supports any number of phase, neutral, negative sequence, ground and sensitive ground elements. Different element characteristics can be selected, added and activated in the Element List, and different settings can be adjusted for each one. A Graphical View of the Relay curve is available for Non Directional and Directional Relays (Forward Curve, Reverse Curve and Operation/No Operation zone view)

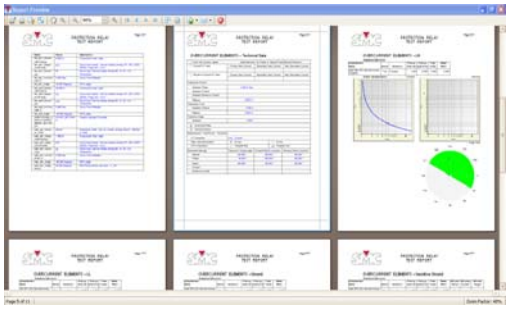
Characteristics Template: access to the edition of the different inverse time characteristics that Roots contain. Groups of pre-defined Characteristics are available depending on specific equations (IEC, IEEE, ANSI, U.S.), user-defined formulas, and curves in tabular form. Each one can be edited through modification of the associated variables. The user can also easily create new curves from scratch.

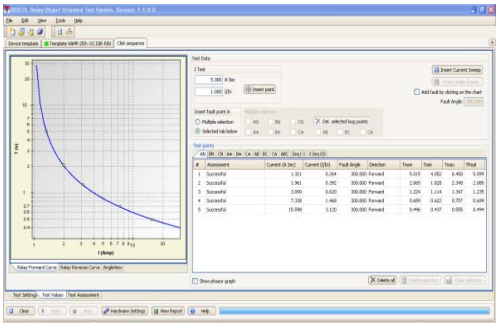
Test List: Multiple tests can be selected and attached to the device under test from a wide choice of test types including scheme-oriented tests like reclosing or CB failure: Click Sequence, Pick up/drop out, Reclose, Cold Load, SOTF (Switch On To Fault), I2/I1 Ratio, Breaker Fail, Fuse Failure, SOL (Selective OC Logic), Reset Time

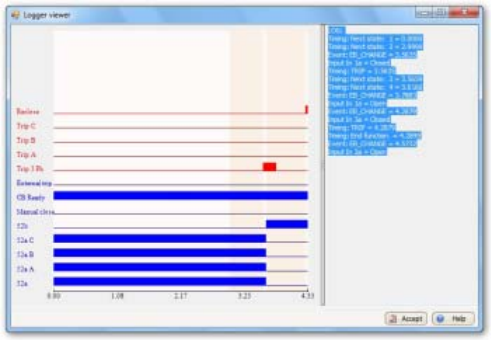
Test Screen: with flexible access and configuration of the various test elements:

- Test Settings (prefault, fault and postfault)
- Test Points: table of test points for each Fault type loop with the set values. With several methods to define and insert test points, individually, interactively clicked right onto the characteristic's drawing or a number of time-saving tools can be used to automatically generate series of test points, supporting separate or multiple fault loops selection (A-N, B-N, C-N, A-B, ABC, etc)
- Test Result Assessment, automatic and manual.
- Test Graph of the protection element: For directional relays, the graph shows three views, time curve for forward and backward faults, and an angular view, indicating the operating area by colors.
- Phasor Graph: allow to view the phasor diagram of every point being tested.
- Hardware Settings: map the MENTOR 12 I/O and power connections to the relay, configuration of operating options in MENTOR 12 for Binary I/O (Relay/Open Collector, NO, NC, Dry/Voltage)
- Report and Report Configuration: automatic report generation with user selection of data to be shown. The report can be produced in PDF format or other data interchange like XML. Reports are saved along with the results in the database.
- Test execution: automatic sequential injection of test settings for every test point, comparing the operating time measurement with the allowable current and time tolerances in technical data, assessing the result as correct or incorrect and printing it both in the test point table and the test graph. The test sequence can be stopped at any time by the operator, and then resumed from the first non-tested point. The user may also decide to reset the tested points and restart the entire test from the beginning, or to repeat the test only for a selection of the points in the list without affecting the other points.

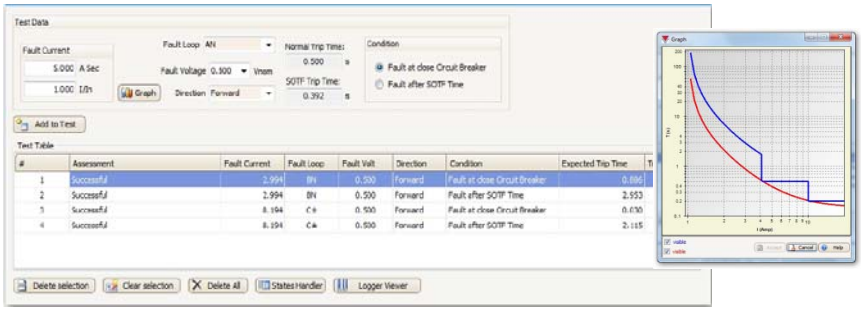


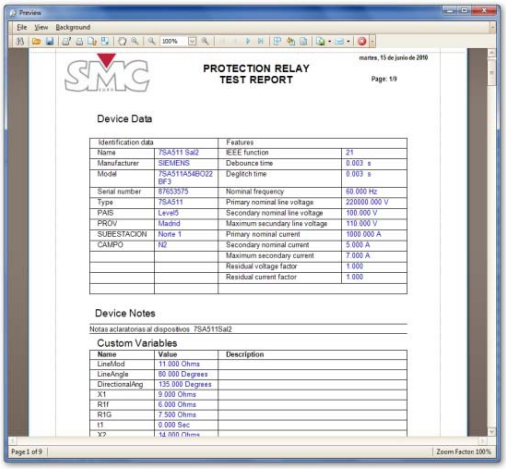


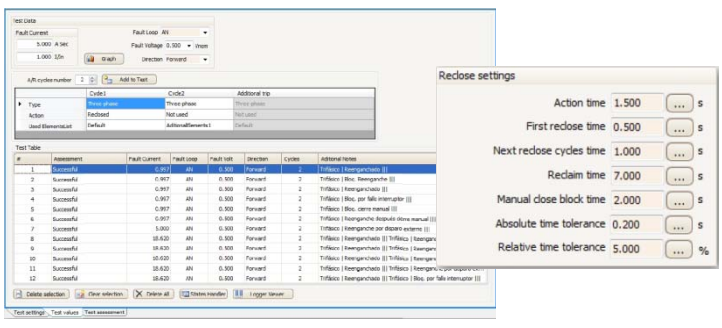




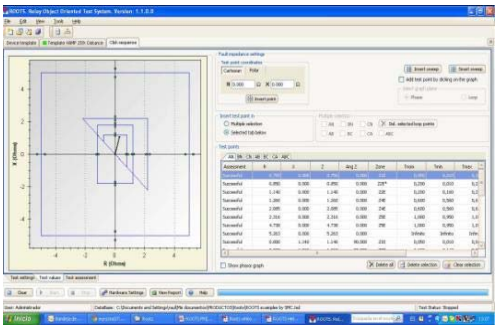
- **Click Sequence***:* this shot test offers the easiest way to check the relay's settings against the geometrical representation of its protective characteristic, through the running of a sequence of test points.
- **Pick up/drop out**: test for finding the pickup and dropout values of the active protection elements in the relay under test.
- **Reclose**: This test allows the verification of the relays reclose function with any number of reclosing cycles, through the generation of reclosing sequences, and any combination of the elements settings for each reclosing cycle.
- **Cold Load**: test to evaluate the performance of protection devices that support the cold load function, through the generation of the necessary states, testing the capacity of the device to vary its normal overcurrent settings during the cold load period.
- **SOTF (Switch On To Fault)**: test to evaluate the performance of the relay during a SOTF condition. The user interface is designed so that the user can vary the position of the fault and the moment on which it happen. It also allows analyzing the behavior of the function related with the Recloser and the temporary acceleration of the overcurrent protection elements during the SOTF action time.
- **I2/I1 Ratio**: This test allows the user to evaluate the performance of those relays that generate alarms or trips when a certain level is reached by controlling this relationship. The user can generate faults with the I2/I1 ratio desired and evaluate the performance of the alarms and/or associated trips.
- **Breaker Failure**: test to evaluate the behavior of the CB failure protection function. The user easily adjusts the desired conditions of the breaker failure settings (stage 1 and stage 2) and the software automatically generates the necessary states to perform the CB Failure Scheme, in different situations such as CB Failure Delay, CB Failure minimum phase current or CB Failure minimum ground current.
- **Fuse Fail**: test to evaluate the different detection methods and performance of the modern relays in front of the lack of secondary voltages in the relay input, being the typical case the fuse blow up or trips of MCBs that protects the VT secondaries, and its capacity to changing their protection function to non voltage-dependent through the logic implemented, and test the elements behavior during the Fuse Fail condition.
- **SOL (Selective Overcurrent Logic)** test to verify the correct logic behavior of the protective devices on signal reception with forward faults and reverse faults, and the capacity of the protective device to selectively operate or change adjustments depending on signals received that are activated by request of other located devices in one direction or another.
- **Reset Time**: this test allows checking the operation of the reset times used by mean of setting different test conditions. Induction electromechanical relays have inherent reset time delay. When a static or digital relays need to be coordinated with an upstream electromechanical, is convenient to use reset timings to ensure coordination. Another situation where reset delays are used is to reduce the clearance time in intermittent faults situations.

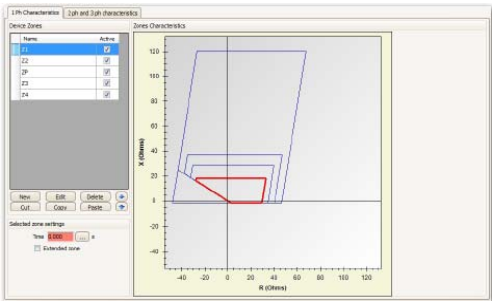


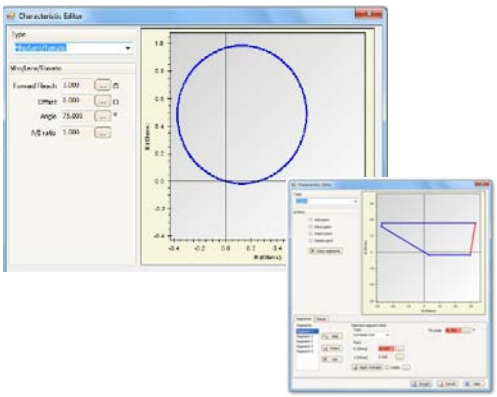


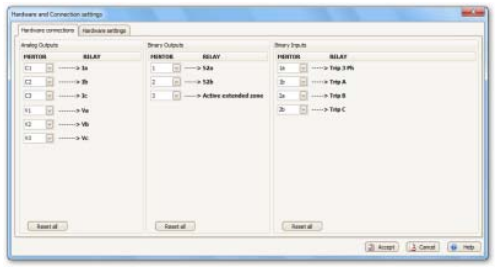


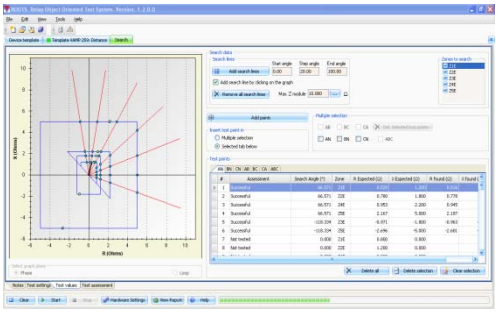
ROOTS - DISTANCE MODULE











Distance test module is used to test all functions related to protection function IEEE number 21. It includes not only the tripping characteristic tests but also external scheme tests related to this protection function.

The module's functionality is distributed in the following sections:

Technical data: general parameters that affect all the tests contained in the Distance module, such as: Line data (line impedance, line angle, ground compensation factor), Impedance and Time Tolerance (both absolute and as a percentage), Transformer connection, and performance parameters of the specific distance relay model

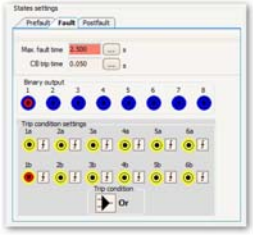
Distance Zones: Zones defined in the relay are listed grouped by single-phase, phase-to-phase or three-phase characteristics, which the user can activate, edit and adjust the operating time for each zone. Also, as standard key feature in ROOTS, the direct import of RIO files with relay characteristics and settings, reduces the data entry process to minor modifications.

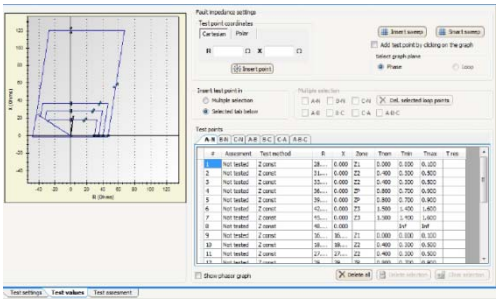
Graphical Characteristic Editor: ROOTS features an intuitive and powerful interactive graphical editor for geometrical definitions of protective characteristics and impedance zones. Lines and curves can be drawn in free hand mode and/or adjusted using numerical values and coordinates. The user can use MHO, Lens and Tomato characteristics shapes or create a customized characteristic as complex as desired.

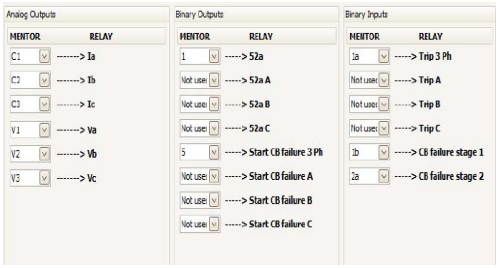
Test List: Multiple tests can be attached to the module from a wide choice of test types, including scheme-oriented tests: Click Sequence, Search, Verification Test, Reclose, Evolving Fault, Switch On To Fault, Trip on Reclose, Zone 1 extension, Loss of Load, CB Failure, Fuse Failure, Load Encroachment.

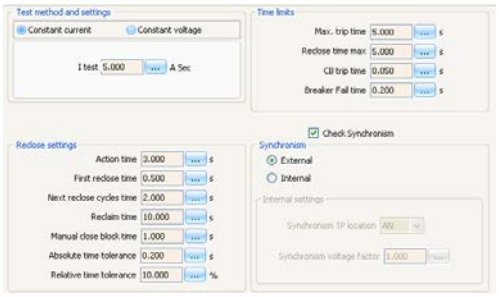
Test Screen: with flexible access and configuration of the different test elements:

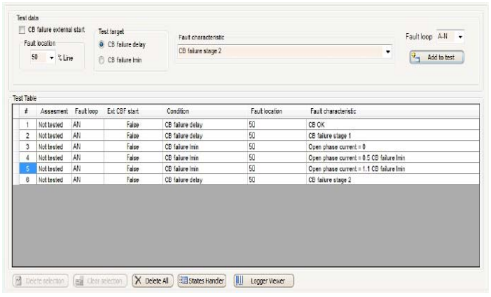
- Test models: fault simulation models of constant test current, constant test voltage, and constant impedance source.
- Test Settings (prefault, fault and postfault)
- Test Points: table of test points for each Fault type loop with the set values. With several methods to define and insert test points, by individual coordinates, by clicking on the graph or with automatic generation of test points, supporting separate or multiple loop plane selection (A-N, B-N, C-N, A-B, ABC, etc). With the Smart sweep function, test points are automatically set at the tolerance boundaries at each side of each zone, and with the Insert Sweep function test points are created along impedance directions, according to the sweep angle and reach defined. The calculated fault parameters are displayed for each point. Test points list can be listed or made visible by any parameter criteria.
- Test Result Assessment, automatic and manual.
- Test Graph of the protection element: show the characteristics of the active zones in the relay, for each selected fault type (single phase fault, phase to phase and three phase fault), and the length and angle of the protected line.
- Phasor Graph: allow to view the phasor diagram of every point and injection values per phase and its angles.
- Hardware Settings: map the test set I/O and connections to the relay, and configuration of operating options in the test set for Binary I/O (Relay/Open Collector, NO, NC, Dry/Voltage)
- Report and Report Configuration: automatic report generation with user selection of data to be shown. The report can be produced in PDF format or other data interchange like XML. Reports are saved along with the results in the devices database.
- Test execution: The entire test sequence will be injected and operation time results will be obtained for each test point. The trip time at each test point is compared with the theoretical value calculated taking into account the tolerances for impedance and the preset time specified in the settings, qualifying the result as Successful or Failed on the table of test points, and in the subsequent test report. If, at the end of a test, the user wants to repeat the execution of some test points, without affecting the others, he just select the test points to be redone and re-test them.
- Test notes and message to the operator, to show at start test, is also available.

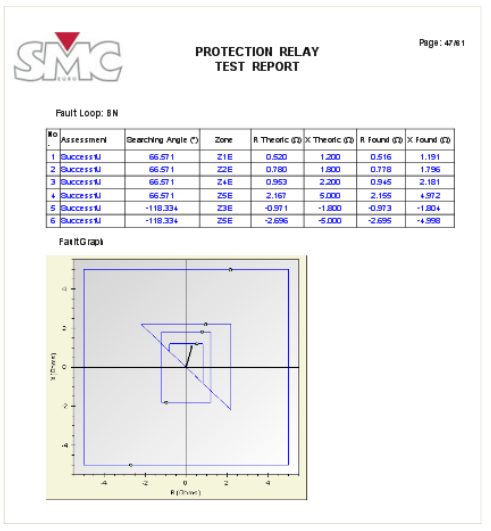






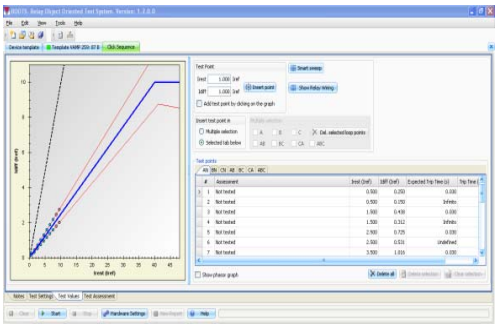






- **Click Sequence***:* this shot test offers the easiest way to check the relay's settings against the geometrical representation of its protective characteristic, through the running of a sequence of test points.
- **Search Test**: test to find the boundary values of distance zones in selected directions. Search will in fact test the relay's accuracy. User can select the type of ramp to be used in the search, pulse ramp or binary search, and its resolution and search interval. Search lines can be easily added by clicking on the graph or by an automatic sweep. Once all search lines have been created, test points are automatically generated in the intersections with the zone boundaries, only for the marked zones.
- **Verification Test**: Impedance element evaluation without zone geometry. The process is similar to a Click sequence test, but no zone graphs are drawn. As in the rest of tests, several methods are available to define the test points, as well as the choice to place them in the various fault loops available.
- **Reclose Test**: Verification of the relays reclose function, with any number of reclosing cycles. The user interface allows the creation of logical sequences, effectively simulating successful reclose cycles and / or the lockout of the reclosing element (by CB failure, by time, manual, etc) In addition, special reclose settings commonly found in modern numerical relays can also be tested. Failed states are highlighted at the end of the test for easier identification of the cause of failure. The States Handler tool allows viewing and editing the states generated by the program to test the sequence.
- **Evolving Fault Test**: Evaluation of relay´s behavior under evolving fault conditions during a single-phase recloses cycle. The program automatically generates a default sequence of states to perform the test. The sequence can then be executed right away or fine-tuned with the States handler in order to match specific test requirements. Events resulting from the test sequence can also be viewed in alphanumeric and graphical form with the Log viewer.
- **SOTF (Switch On To Fault)**: This test module provides an easy method to evaluate the relay's performance in a SOTF situation by allowing trying various fault locations and occurrence times. The operation of the reclose function and the acceleration algorithms is also tested. With a simple setup of general test conditions made by the user (fault loop, fault location, fault at CB close or after the SOTF time), the program automatically generates a default sequence of states to perform the test.
- **Trip on Reclose:** Test to evaluate the relay´s trip acceleration function during a reclose cycle. It also includes the option to verify the protection's return to normal operation after the TOR Action Time has elapsed.
- **Zone 1 Extension Test:** Evaluation of the relay performance when this clearing-fault function is active, under various fault types and locations, as well as for diverse operation behavior by the remote protection. The test fault can be simulated at various locations on the protected line or at the nearest section of an adjacent line.
- **Loss of Load:** This test module allows the evaluation of the LOL function in diverse circumstances. The Loss of Load function, also called Remote End Opened (REO), is commonly used in link lines with CBs at both ends, and basically consists of detecting the tripping of the opposite CB after a short circuit has occurred very close to it. Three LOL characteristics may be tested, with the corresponding choice of fault locations.
- **CB Failure:** Test to evaluate the CB failure protection scheme. Based on a simple setup of general test conditions made by the user, the program automatically generates a default sequence of states to perform the test. The sequence can then be executed right away or fine-tuned with the States handler. Upon execution, the test sequence is transmitted to the state sequencer in the test set, where the relay's reaction is collected and re-transmitted back to the program for final assessment.
- **Fuse Failure Test:** This test module has been designed to allow the testing of the various features and settings in the Fuse Failure function implemented in digital relays.
- **Load Encroachment test**: This module provides test options to verify the proper operation of a distance relay under heavy load conditions. The relay should operate if and only if a fault is simulated in maximum load scenery.

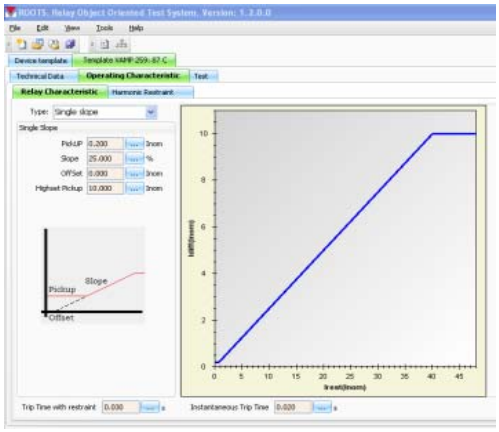
ROOTS - DIFFERENTIAL MODULE



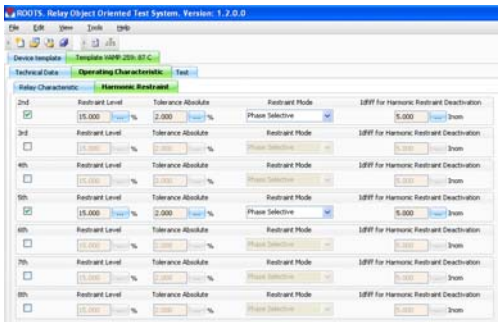
The set of differential test modules is used to test the operation of protective devices that implement the IEEE function 87 and includes the following modules to test the operation values and also the trip blocking by the harmonic restrain:

Classic Differential 87C: Module used to check the operation of conventional differential relays (usually electromechanical or static).
Transformer Differential 87T: Designed for testing numerical relays for differential protection of transformers.
Generator/Motor Differential 87GM: Designed for testing rotating machines differential relays.
Busbar Differential 87B: Designed for testing busbar differential relays.

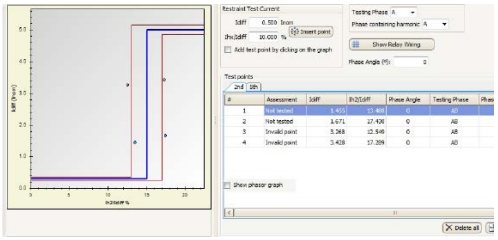
CLASSIC DIFFERENTIAL 87C: The module's functionality is distributed in the following sections:
Technical Data: section to set up the general parameters associated with the data of the protected object, the characteristics of the protective device and the applied settings: number of windings, tap settings, restraint current calculation, current and time tolerances.
Differential Operating Characteristic: section for configuration of the characteristic and the operating times of the relay, as well as defining the parameters for the harmonics restrain. ROOTS allows to edit in a very simple way the relay characteristic, either by implementing various types of predefined characteristics, or by custom design. In tests designed for harmonic restrain in differential relays, ROOTS allows to add a certain component of a harmonic to the fundamental frequency value. Although the common practice is to work with the 2nd harmonic (Inrush Blocking) and 3 ° or 5 ° (Blocking by over excitation), harmonics from the second to the eighth can be manipulated.

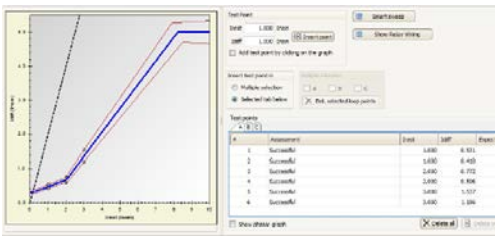


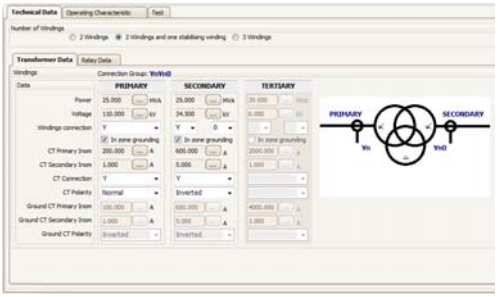
Test List: Multiple tests can be attached to the module from the test types: click sequence, search, and harmonic restraint.
Click Sequence Test: in Test Values window the user can define the test points for each phase, to be inserted in several ways, by coordinates values, clicking on the graph or by Smart Sweep insertion of multiple test points evenly distributed at the limits of the tolerance zone, in the selected fault loops. In the graph the operating characteristic of the relay is shown with the zones of tolerance in the Idiff/Ibias plane. The evaluation of the test points, either trip or no trip, will be done according to its position above or below the characteristic of the relay, or within the tolerance zone, and the different relay behavior in each case.
Search Test: This test allows finding the boundary trip values which corresponds with the characteristic of the relay. It's actually a confirmation of the accuracy of the relay. The test is done by injecting consecutive faults by means of pulse ramps that are coming into the searched zone. The search for a point stops when the protection trips and then starts the search of the next point. There is a window to display the wiring of the analog current channels. In the text setting window the user can establish common parameters for all selected test points, such as the search type, search resolution and interval, and the windings to test.

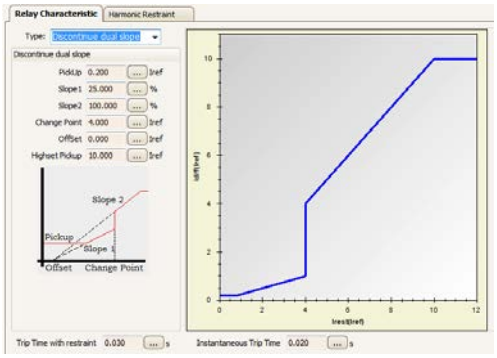


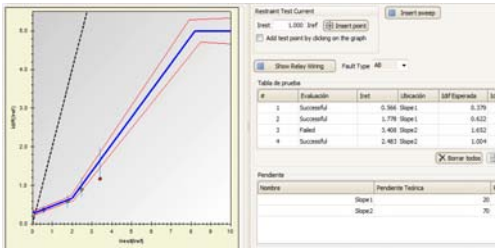
Harmonics Restraint Test: The harmonic restraint test evaluates the response of the relay to the harmonic content variation in measured current signals. Current is injected through one or more phases in a previously selected winding, where it is possible to indicate the phases which contain harmonics or not. The reaction of the relay is evaluated according to the adjusted set parameters. The test points are defined in the harmonic restraint characteristic with the zones of tolerance, where the differential current is drawn over the harmonic content of the test current. For simulating different inrush conditions, the initial phase shift between fundamental and harmonics can be specified. An automatically generated relay connection scheme is shown before the test is executed.

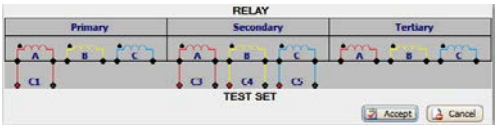


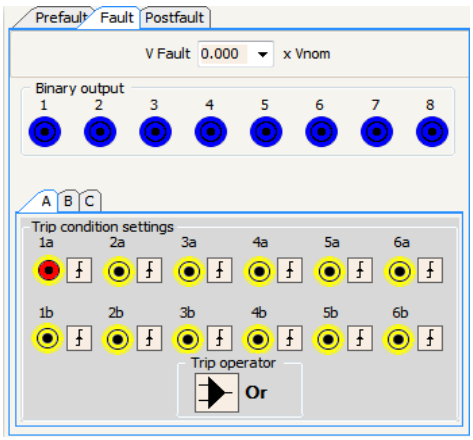






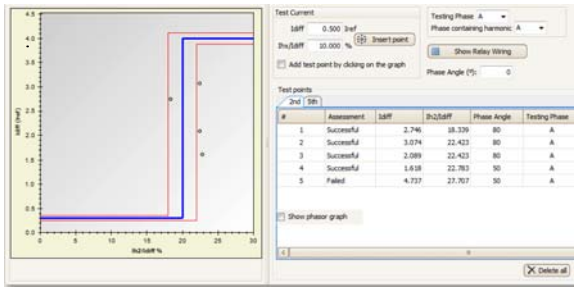


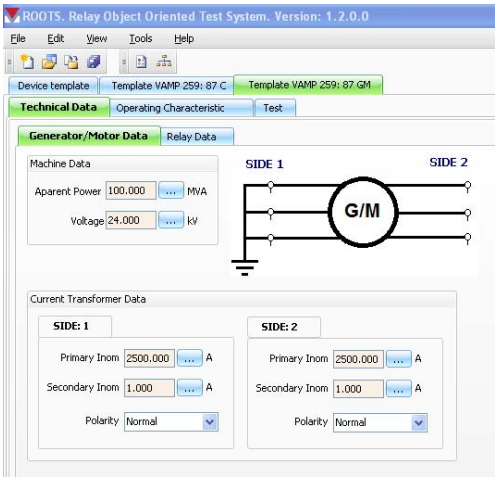


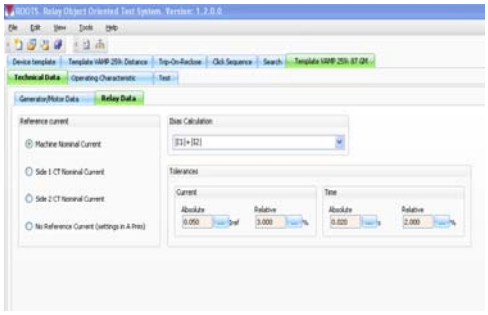


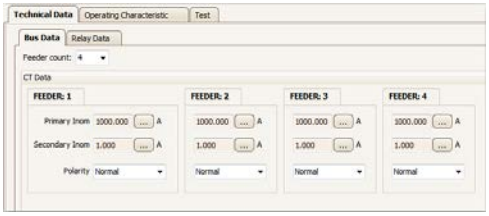
TRANSFORMER DIFFERENTIAL 87T: Designed for testing numerical relays for differential protection of transformers. The module's functionality is distributed in the following sections:

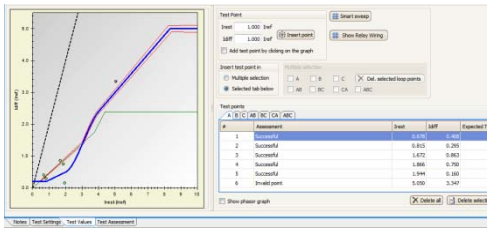
Technical Data: an extensive modeling of the protected device and the relay data gathers all the data for the calculations required to facilitate testing, suitable for transformer differential schemes with up to 3-windings and up to nine currents to be injected.
The automatic calculation of the test currents eliminates the most time consuming and error-prone manual tasks. Testing the correct operation of the relay becomes simple, time saving, and cost efficient.
Adjustments for each winding are available such as: transformer windings, winding connection, CT currents, CT connection and polarity, grounded in zone winding, etc.
The Relay Data gathers all the data defining the operation of the protective relay: reference current, restraint current calculation, phase reference winding, maximum test current, current and time tolerances, remove zero sequence settings, etc.
Differential Operating Characteristic: section to configure the characteristic and the operating times of the relay, as well as defining the parameters for the harmonics restrain. Similar section to the Differential Classic module. It includes single slopes, double continuous and discontinuous slopes and user-defined curves, with easy programming of pickup thresholds, slope of segments, change points and offset. As in the rest of ROOTS modules, the test solution provides evaluation and assessment of results against nominal characteristics and tolerances, and the results report is generated automatically, including the characteristic diagrams.
Test List: Multiple tests can be attached to the module from the test types: verification, click sequence, search, and harmonic restraint.
Verification Test: The verification test has the main purpose of verifying the correspondence between the equipment to protect, the settings of protective equipment, differential module settings, and wiring connections, i.e. to verify that the protection is stable for faults outside the protected zone. The executed test consists of a simulation of load conditions or external faults and checks the behavior of the protection. For these test conditions it is verified that the relay does not trigger (at least for differential protection). It may optionally be verified the correspondence between values of restrain current and differential current measured with the values injected according to the test settings.
Click Sequence Test: This test allows checking the operation characteristic of the differential relay verifying its ability to discriminate between faults inside and outside the protected area. It is composed by a sequence of points defined by the user in the test window. Each test point has a pre-fault, Fault and Post-fault condition. The execution of the test involves injecting sequentially the three conditions in each test point, determine if a trip has been issued, and if so evaluate the operating times. The time obtained in each test point is compared with the theoretical value calculated taking into account the current and time tolerances pre-established, qualifying the result as correct or incorrect and printing it both in the test point table and the test graph. As in the rest of ROOTS modules, the test solution provides evaluation and assessment of results against nominal characteristics and tolerances, and the results report is generated automatically, including the characteristic diagrams.
Search Test: test for finding the boundary values of the characteristic of the relay. It is actually supposed to confirm the accuracy of the relay, so the choice of the size of the increments is very important. It is performed by injecting consecutive faults that will enter in the searched area. The user can establish common parameters for all selected test points, such as the Location of the Fault, if voltage signals are to be applied, search type, search resolution and interval, and available trigger type.
Harmonic Restraint Test: The harmonic restrain test evaluates the response of the relay to the harmonic content variation in measured current signals. It consists in injecting current in one or more phases of previously selected windings, where the presence or no presence of harmonics can be indicated. The blocking function of the relay is evaluated according to the adjusted parameters against the inrush currents and the over excitation.

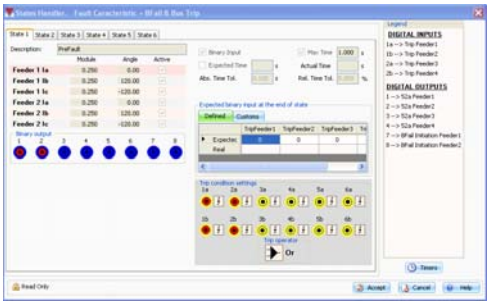












GENERATOR/MOTOR DIFFERENTIAL 87GM: Designed for testing rotating machines differential relays. The module's functionality is distributed in the following sections:

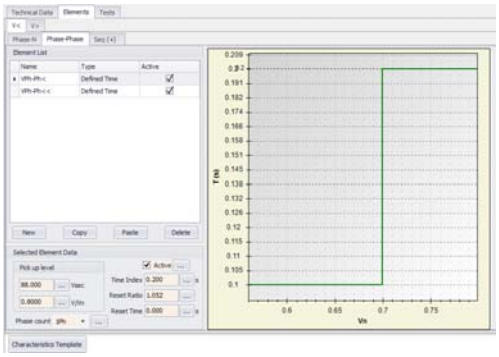
Technical Data: the setting of Generator/Engine Data gather all relevant data from the protected machine and from the current transformers used by the differential protection.
Reference current, Ibias calculation, and time and current tolerances are set in the relay data, in a similar way to rest of ROOTS differential modules.
Operating Characteristic: ROOTS allows editing of the relay characteristic in a simple way by choosing from a set of predefined types or by custom building one when necessary.
Test List: Multiple tests can be attached to the module from the test types: verification, click sequence and search.
Verification Test: The Verification test provides a method to check the consistence between the protected device, the relay settings, the Differential module's setup, and the test connections. This test simulates load conditions and/or external faults under which the relay's differential element should not operate. If the relay features a measurements display, the user can optionally compare the values measured for the restrain and differential currents with the quantities generated by ROOTS. The assessment of each test point consists of verifying that the differential element did not operate and that the quantities measured by the relay fall inside the tolerance threshold set.
Click Sequence Test: The Click Sequence allows the user to verify the accuracy of the relay at determining if a fault falls inside or outside the protected zone. This test generates test sequences from test points defined by the user in the test window. Each test point will include pre-fault, fault and post-fault stages. All test points defined within the test share the same pre- and post-fault conditions. The execution of the test involves injecting the three conditions at each test point sequentially, determine if operation has occurred and evaluate the operation time compared to the theoretical time in the relay's characteristic.
Search Test: This tool provides a method to locate the boundaries of the relay's characteristic. A series of consecutive faults is injected that gradually enter the searched zone. The search for a point is stopped when the relay operates, and the process is resumed for the next point searched. This method reveals the actual accuracy of the relay.

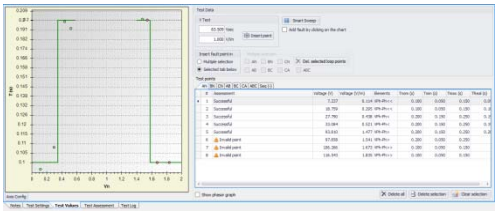
BUSBAR DIFFERENTIAL 87B: Designed for testing busbar differential relays. The module's functionality is distributed in the following sections:

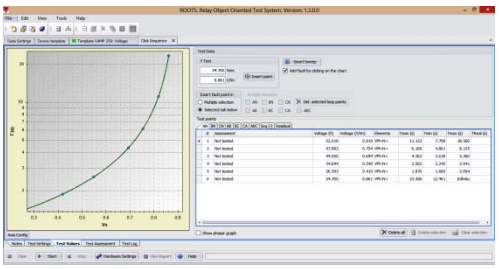
Technical Data: Up to 6 feeders connected to the busbar can be configured, with the corresponding setting of the CT data for each feeder. Directional blocking technique used by some relay manufacturers can also be activated in this module.
Operating Characteristic: ROOTS allows editing of the relay characteristic in a simple way by choosing from a set of predefined types or by custom building one when necessary.
Test List: Multiple tests can be attached to the module from the test types: verification, click sequence, search and breaker fail.
Verification Test: The Verification test provides a method to check the consistence between the protected device, the relay settings, the Differential module's setup, and the test connections. This test simulates load conditions and/or external faults under which the relay's differential element should not operate. The user can also compare the values measured for the restrain and differential currents with the quantities generated by ROOTS.
Click Sequence Test: The Click Sequence test allows the user to verify the accuracy of the relay at determining if a fault falls inside or outside the protected zone. This test generates test sequences from test points defined by the user in the test window. The Smart Sweep tool automatically inserts test points over the tolerance boundaries. The user may set the Ibias values for the first and the last point, as well as the interval used between consecutive points.
Search: This tool provides a method to locate the boundaries of the relay's characteristic. A series of consecutive faults is injected that gradually enter the searched zone.
Breaker Fail: This test evaluates the behavior of the CB failure function in diverse circumstances that are easily configurable by the user. Once the fault condition and the CB failure function's parameters have been entered, ROOTS will generate a sequence of test states automatically. When the Circuit Breaker Failure function is carried out by the busbar differential relay, it must be aware of any protective trip command issued to the managed circuit breakers.

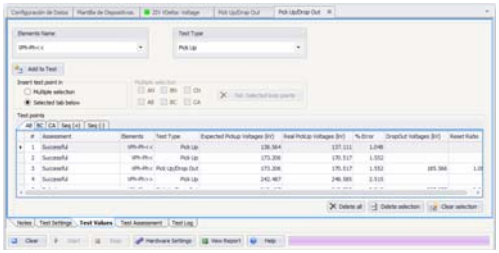
ROOTS - VOLTAGE MODULES

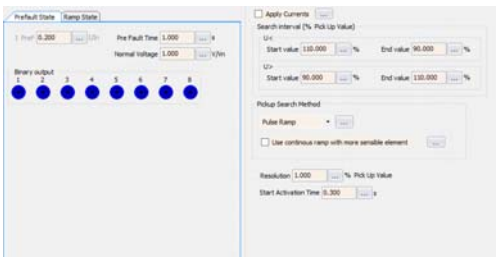
▶ NEW! (2015)











Set of Voltages Modules to test the operation of protective devices with functions 27, 47 and 59. It includes the following modules to test the operation values of voltage relays:

Three-phase Voltage Module: used to check the operation of three-phase voltage relay. Lets you check the elements acting on the values of phase to ground, phase to phase, positive sequence, negative sequence, neutral and residual.

Single-Phase Voltage Module: is used to check the operation of voltage relays with only one measuring voltage.

The module's functionality is distributed in the following sections:

Technical Data: section to set up the general parameters associated with the data of the protected object: Voltage input connection, residual voltage, working with primary values, and voltage and time tolerances.

Elements: section for configuration of the characteristic and the operating times of the relay. It includes characteristic templates, which formulas can be also edited, and also allows for the introduction of a Custom table of over and undervoltage and time curve points. The relays may have independent adjustment for the following:

Over voltage:

Phase-N Elements: Act against increasing of measured or calculated phase voltage.

Phase-phase elements: Act against increasing of measured or calculated line voltage.

Sec (+) Elements: Act against increasing of calculated positive sequence voltage.

Neutral elements: act against increasing of calculated neutral voltage.

Sec (-) Elements: Act against an increase of calculated negative sequence voltage.

Residual Elements: Act against an increase of measured residual voltage.

Under voltage:

Phase-N Elements: Act against decreasing of measured or calculated phase voltage.

Phase-phase elements: Act against decreasing of measured or calculated line voltage.

Sec (+) Elements: Act against decreasing of calculated positive sequence voltage.

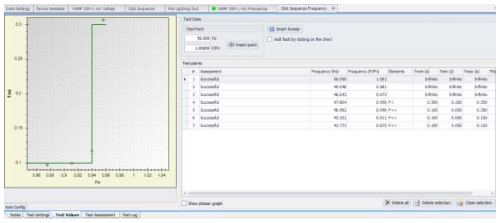
Test List: Click Sequence and Pick up/Drop out tests can be attached to any of the two modules.

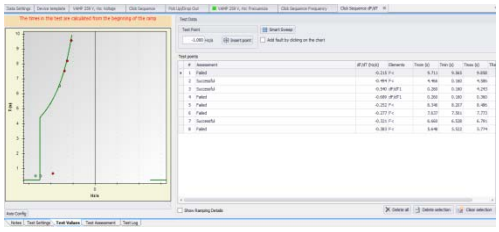
Click Sequence Test: in Test Values window the user can define the test points for each phase, to be inserted in several ways, by coordinates values (the value of the test voltage or optionally in times the nominal voltage), clicking on the graph or by Smart Sweep insertion, in the selected fault loops. In the graph the operating characteristic of the relay is shown for V< and V> elements (under voltage and overvoltage). The working is similar to other shot tests in Roots. In the click sequence test you can select the type of fault that you want to perform. ROOTS, in the 3-phase Voltage module, allows you to select a total of 9 different faults grouped into 5 types: single-phase, bi-phase, three-phase, negative sequence and residual faults.

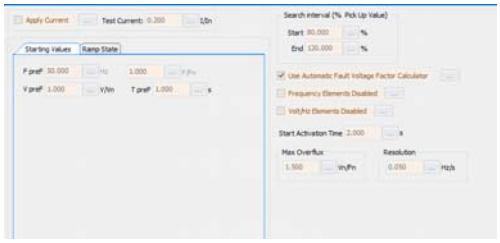
Pick Up/Drop Out test: This test allows finding pickup and dropout values of the active elements in the device with the desired accuracy. It is performed by injecting consecutive faults through ramps that vary the quantities of interest in the selected interval, which is selected in the Test Settings, as well as the resolution. The Pickup Search method allows you to select between pulses ramp or binary search. In the test points list you can see the ramping details for each test point.

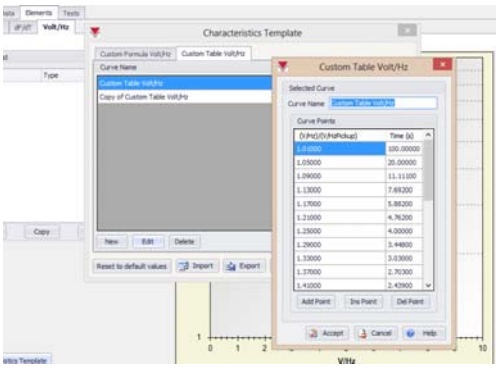
ROOTS - FREQUENCY MODULE

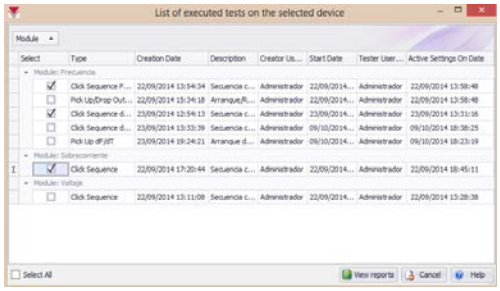
▶ NEW! (2015)











The frequency module is used to test the operation of protective devices with frequency dependent functions. This includes functions of frequency, under and over frequency, Hz/s element (rate of change of frequency), and V/Hz protection (overflux or overexcitation element)

The module's functionality is distributed in the following sections:

Technical Data: configuration of the the general parameters: Voltage input connection, voltage, time, frequency and dF/dT tolerances.

Elements: section for adjustment and configuration of the elements and the operating times available in the relay under tests. It includes elements for:

- Frequency: F< under frequency
  F> over frequency
  Includes parameters such as Starting Cycles Count, Inhibit Voltage, Pick up level, Time Index, Reset Time, Reset Ratio.
- dF/dT: includes similar parameters plus the Direction (if the elements operates with descending frequency, ascending frequency or both) and the Supervising Frequency (which define the frequency threshold level for ascending and descending elements)
- Volt/Hz: includes a Characteristic Template editor, with formulas or custom table of Volt/Hz and time values.

Test List: the following tests can be attached to the module:

Click Sequence Frequency Test: This test generates test sequences from test points defined by the user in the test window. Fault Frequency value can be in Hz or times the nominal frequency. The graph includes the active elements in the relay to be sensitive the test. This also includes frequency and V/Hz elements if exist and are active, unless the settings "Volt/Hz Elements disabled" is selected in the Test Settings.

Pick Up/Drop Out Frequency test: This test allows finding pickup and dropout values of the active elements in the device with the desired accuracy. It is performed by injecting consecutive faults through ramps that vary the quantities of interest in the selected interval, which is selected in the Test Settings, as well as the resolution.

Voltage Inhibit Frequency: allows searching for the inhibition voltage (minimum voltage value for which are taken as valid the frequency measurement in frequency elements). It is performed by voltage ramps at a defined frequency.

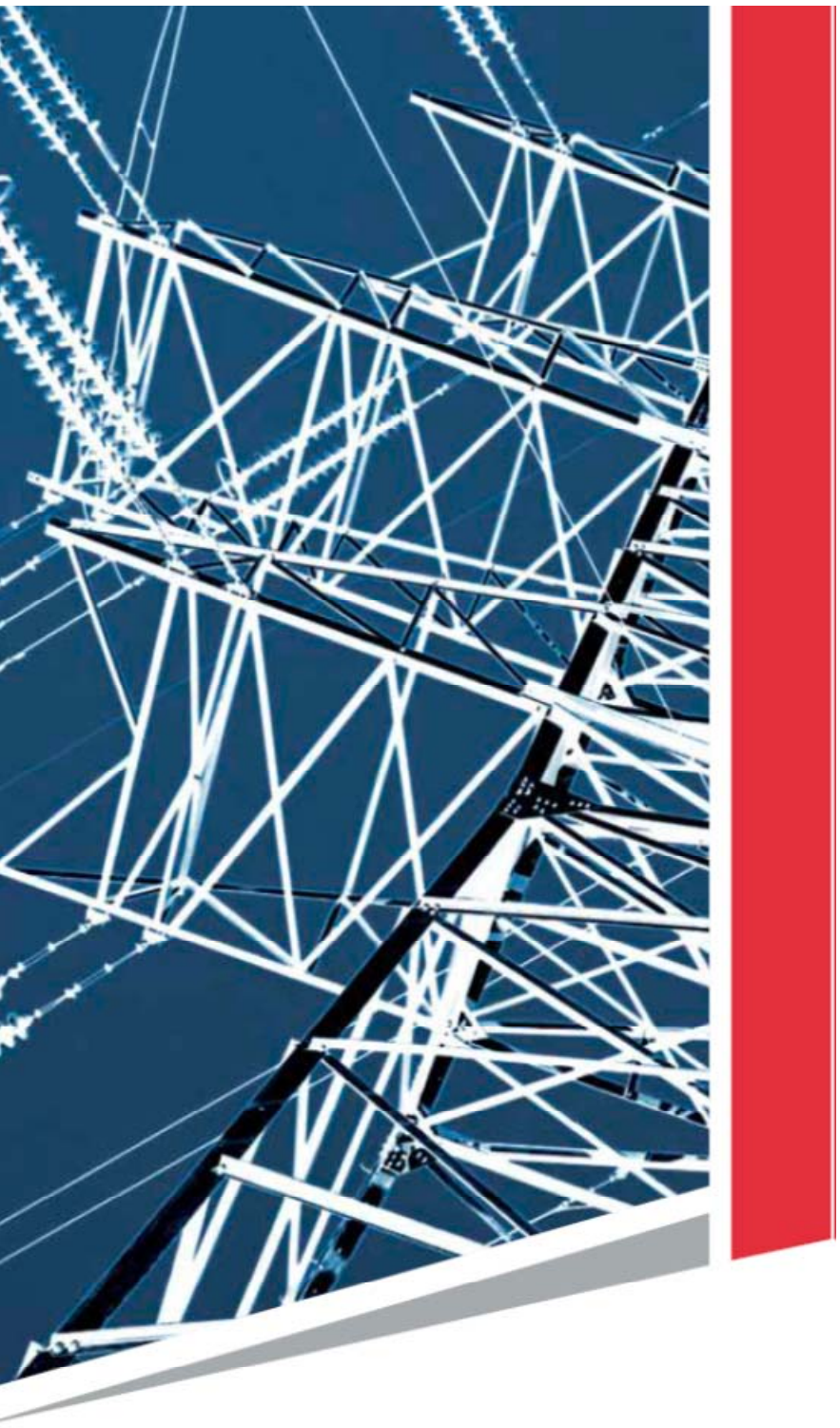
Click Sequence dF/dT: Generation of test points list, each one being a frequency ramp, to evaluate the trip setting of df/dt element. Frequency elements and Volt/Hz elements can be disabled if required.

Pick Up/Drop Out dF/dT: searching of pickup and drop out values of active df/dt elements in the device with the desired accuracy. It is performed by injecting consecutive faults ramps that vary the quantities of df/dt in the selected interval until the operation or the limit range.

Voltage Inhibit dF/dT: Test for searching the inhibition voltage (minimum voltage value for which are taken as valid measurement for df/dt elements). It is performed by frequency ramps at a defined df/dt value by varying the voltage on each one to reach the value of the operation or the limit of the range.

Click Sequence Volt/Hz: with different modes of tests, it evaluates the trip times for the series of test points selected in the V/Hz characteristic. Frequency elements can be disabled. The fault points or overflux values, can be introduced in V/Hz or times the ratio nominal voltage/ nominal frequency.

Pick up/Drop Out Volt/Hz: Test for searching pickup and drop out values for active V/Hz elements in the device with the desired accuracy. It is performed by injecting consecutive faults ramps that vary the quantities of interest in the selected interval until the operation or the limit range. As in similar tests, the search interval, resolution, maximum Overflux and disabling of other elements, are part of the test settings.



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