

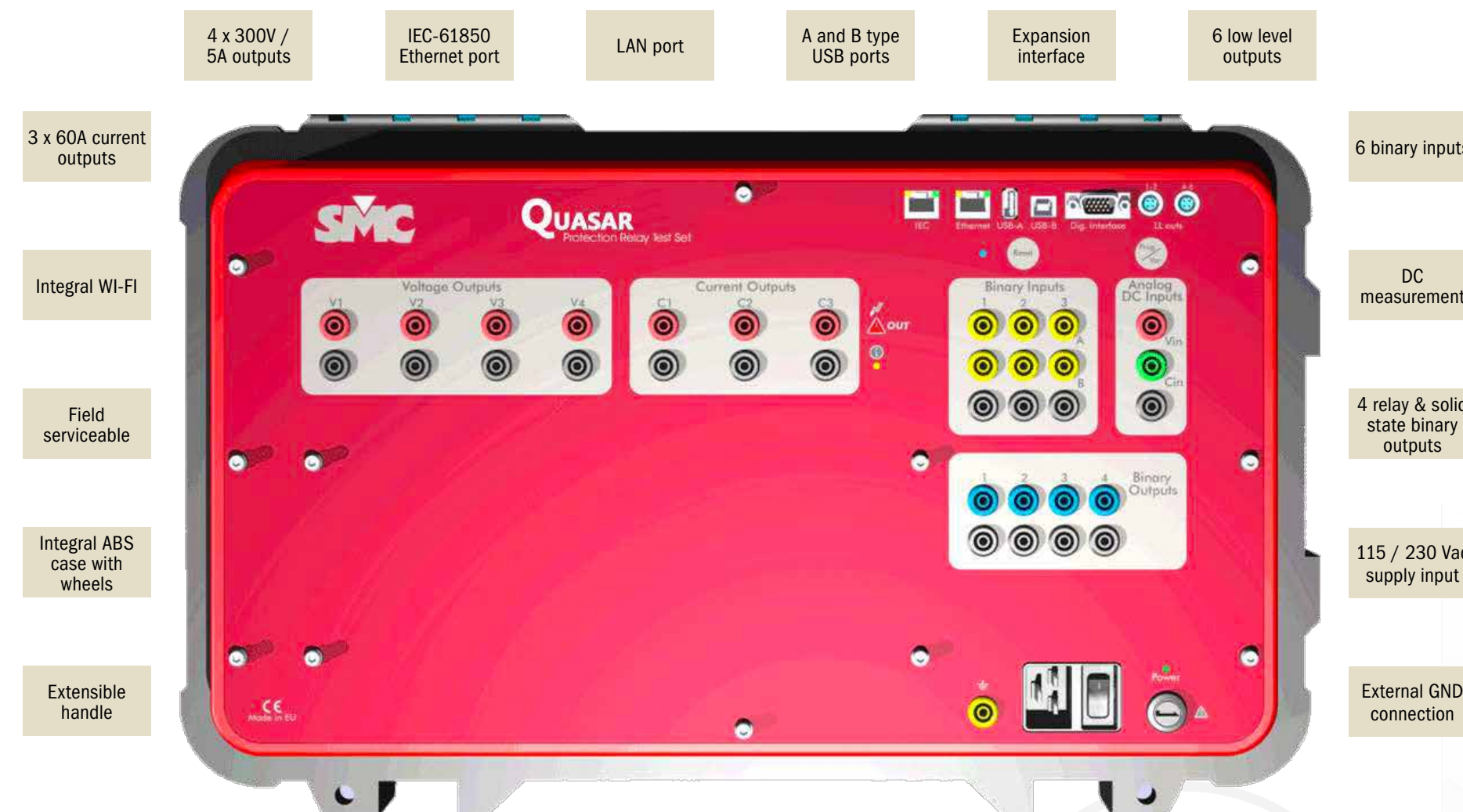
QUASAR

PROTECTION RELAY TEST SYSTEM

SECONDARY INJECTION TEST EQUIPMENT

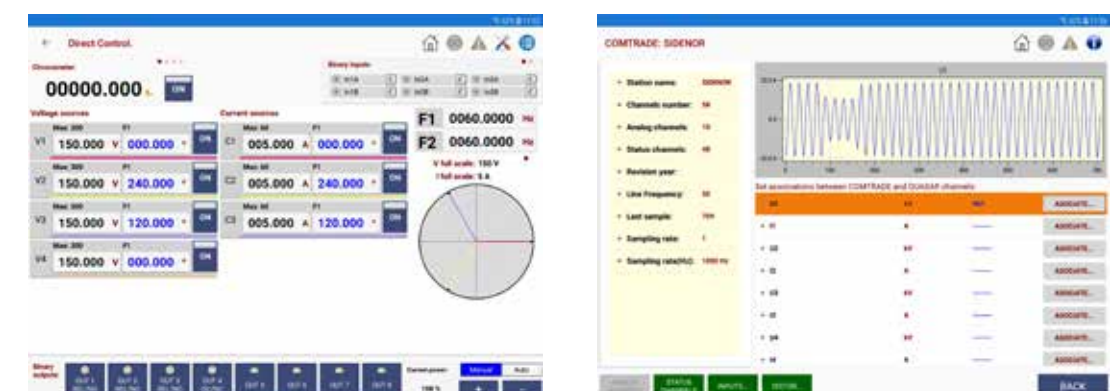


QUASAR, EXACTLY WHAT YOU NEED



IEC-61850 inside

The Quasar features a dedicated Ethernet port complying with the latest specifications dictated by the IEC for modern control, automation and protection architecture. You can interchangeably use the same test routines for any relay type regardless the environment (wired or message based) where it will be installed.



Direct for simple, automated for complex

You can do a fast, simple verification on a few characteristic points of a working protection from your tablet or PC using the supplied software, or run ROOTS in your Windows computer for comprehensive, fully automated testing and reporting of the protection function. The Quasar is the perfect companion for any of the two control approaches.

50,51,67,76	Overcurrent	21	Distance / Impedance
24	Volts / Hertz	25	Syncho Check
27,59	Under-, overvoltage	32	Directional power
78	Out Of Step	79	Recloser
81	Frequency	87	Differential
91,92	Voltage directional	94	Tripping

Born to be industrial

The Quasar is built for endurance in aggressive work conditions including extreme temperature, dust, and harsh transportation. It is encapsulated in first class protection ABS casing and features integral wheels and extensible handle, which makes it remarkably transportable when added to its compact size and reduced weight. You will save the money and annoyance of adding a bulky transport case.

All the connections are clearly identified on the top surface and you can remove the cover by just sliding it to one side if you wish.

Everything in the Quasar's operation is designed for testing speed, accuracy and efficiency. Collecting a report with the results of your tests will be a matter of making the connections and running the procedures that you have prepared and saved beforehand for each relay type.

The flexible AC input will accommodate virtually any supply with 50 or 60 Hz.

You will find plenty of serviceable parts inside! Actually, the Quasar is made up of plug in modules that are easy to replace, and the software includes a guided calibration process that can be followed by any qualified laboratory. You will never need to return your Quasar for service. Furthermore, it is furnished with upgrade ports for additional test channels and functional enhancements.

Cloud bound technology

We will keep your software up to date and will notify you of any changes or additions so that you can safely download the newest version from Google's or Apple's stores or from our server via Internet.

The results of your testing can be saved in your device's storage or directly on your favourite cloud based service, and shared with your colleagues or your clients at your convenience.

You can connect and drive your Quasar via Wi-Fi or using Ethernet wiring if required by your control device.

It had to be small

The Quasar is the smallest and lightest relay tester during transportation because it is built directly inside a Pelicase™ 1510, which provides unbeatable ABS protection, wheels and extensible handle. You can take it with you inside the aircraft's cabin as hand luggage with most airlines.

56 x 23 x 35 cm
(22" x 9" x 14")



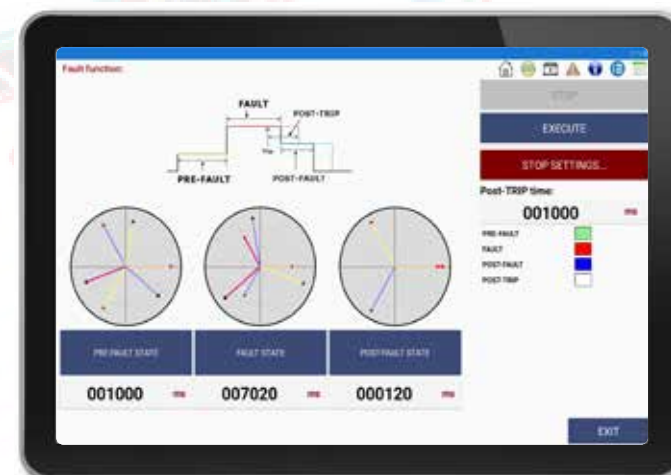
The Quasar is the most advanced three-phase relay test set available for type and field testing of electromechanical and digital protections of any kind, in traditional or IEC-61850 based substations, providing the most complete and straightforward software control of the market. Tablet refers to the control of the equipment in Direct mode for total control over all its functions, using a wireless connection and running an application in any Android tablet: - Power source controls: Current source/ Voltage source, amplitude, phase angle, low level outputs, harmonic content, channel selection, on/off activation, channel combination, frequency control (frequency control of the analogics output). - 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.
- 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 configuration, for testing of transducers, energy meters and sensors.
- Hardware configuration and maintenance, with internet upgrading capability.
- Remote control activation/setup.
- Results Manager, and storage of results.
- Advanced built-in Test Functions: Fault, Ramp, Double Ramps, Pulse Ramps, Binary Search, State Sequencer, (Comtrade) Playback. The Quasar standard equipment builds up one of the most advanced configurations available on the market for quick, simple and easy testing, for both commissioning and maintenance, using a tablet or a Windows PC.
- Goose messages.



Quasar direct control

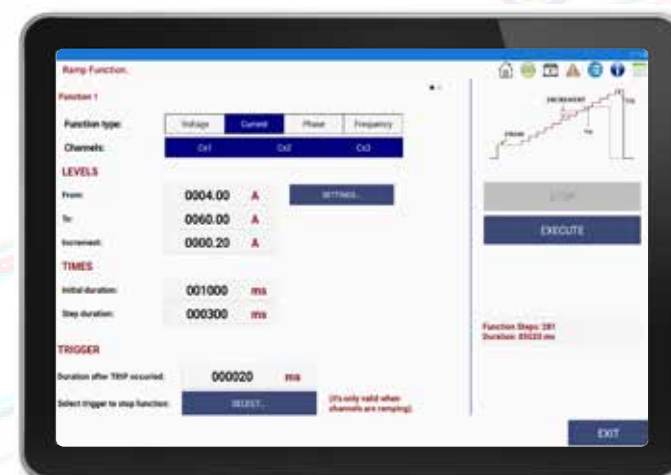
The Quasar's human interface is first in its class to add a full wireless control, capable to connect directly creating an access point, even without need of being connected to any network. It is organized to complete the job safely and accurately in the shortest possible time. Locating the necessary controls and the relevant test information will take just a few seconds to the untrained expert. The Interface panel has been designed especially for them. Adjusting a few values and testing a handful of trip points in the relay is a snap, thanks to the standard software for mobile or Windows computers supplied with the unit. There is no need to even look at the relay, as its response is displayed on the control screen in real time. The Quasar includes the transient fault Playback as standard. You only need to copy your COMTRADE files into a USB pendrive, plug it into the unit and press Playback. If you want, you can assign each current and voltage signal in the recording to specific current and voltage channels for the playback. You can map the recorded binary information and the response of the relay to any of the binary outputs and inputs in the Quasar. You can also discard the unneeded signal's sections or adjust the best transformation ratio for the playback. Press Playback to examine the streamed signals and the relay's reactions in the screen.



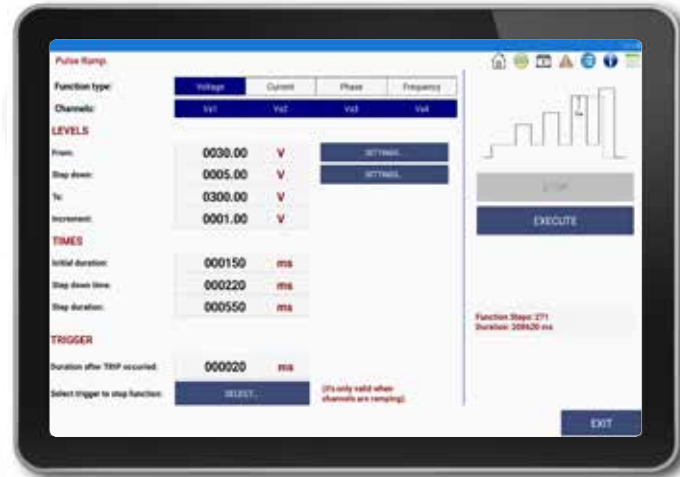
Advanced test functions

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 allow 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.

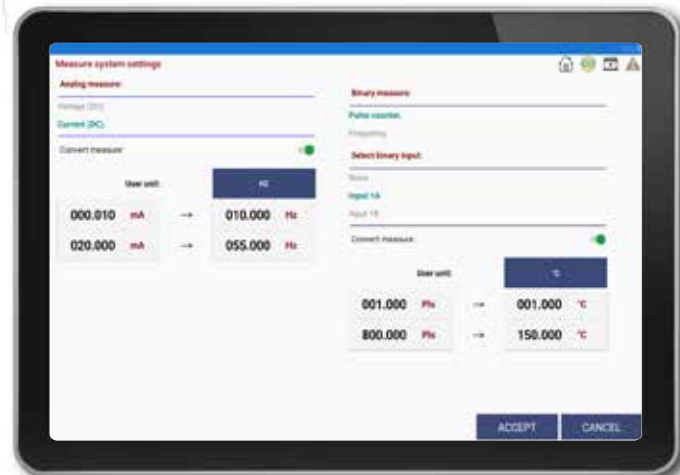
Fault function: This three-state function allows the user to set a complete simple fault and execute the pre-fault, fault and post-fault values, including duration of the states, logic I/O states, and trip conditions. The fault execution displays the progress timeline and test results in graphical and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



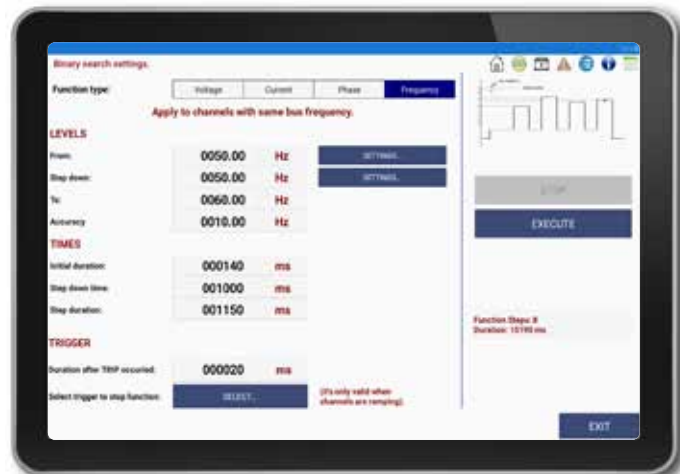
Ramp function: Single and Double Ramps, upward or downward ramps, of any output parameter on the Quasar can be programmed and executed. Ramp function operation is provided for finding limiting values, such as pick-up and drop-off. The linear ramp is the best way of handling parameters such as the Phase 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), or applied to the same selected output source. For example one ramp moving the voltage and the other moving the frequency at the same time (V/Hz variation ramp).



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 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.



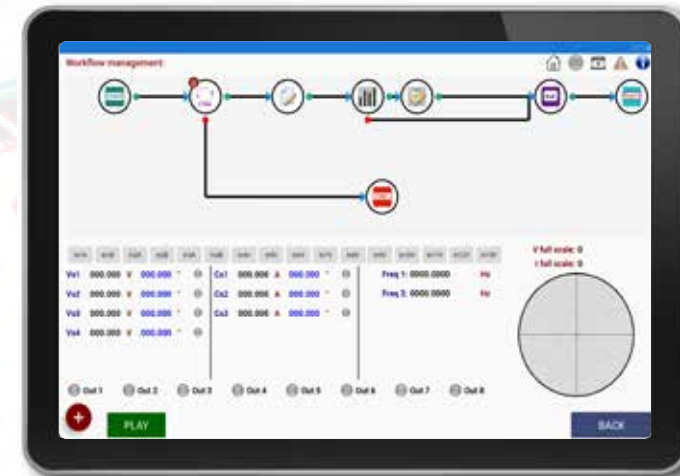
Meter & Measuring: Measurement configuration section to configure the settings for analog and binary measurement. This functionality, specifically designed to test transducers with analog output VDC or mADC or counters with analog or digital output by pulses, makes the conversion from the magnitude measured 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, 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 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. 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.



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 Quasar, analog or binary, as you desire, in a logical sequence of states. 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.



Workflow management: The Work Flow allows us to make a graphical programming test according to our needs.

It employs an intuitive and powerful methodology that allows us to save time and reduce efforts. It allows to set a sequence of actions or decisions flexible enough so that they can be adapted to most practical needs.

The management process of the graphic designer is very simple and is based on the selection of blocks that can be placed anywhere on the design screen. Each block has connecting elements which can be input or output. Linking blocks establish the desired execution order as the case required.



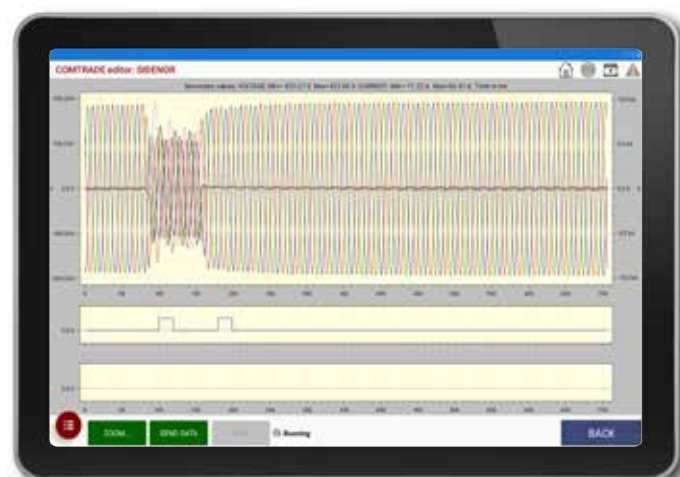
Assisted control: Instead of setting voltage, current or angle arbitrarily in each channel to configure a specific electrical situation, the Assisted Control incorporates a powerful algorithm that calculates those magnitudes whilst you set a single-phase, phase to phase or three-phase test directly in terms of :

- Fault impedance
- Power
- Symmetric components
- Phase and neutral voltages
- Open delta



Native IEC-61850 interface

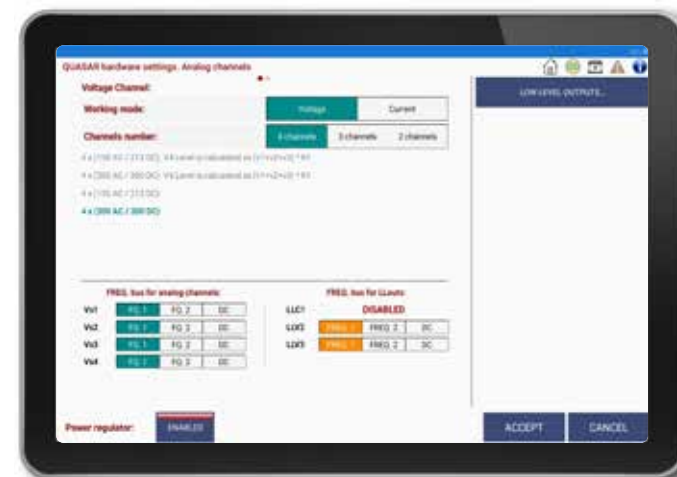
Quasar has an ability from this moment on it starts to sniff all the GOOSE messages that are circulating in the network, and creates a list in the screen of all the “GOOSE” issued by all the publisher devices existing in the network. If the user wants to analyze the content of the messages (its data and time) of one of those “GOOSE”, he only needs to subscribe by selecting it with a click. Then the user will be able to assign a name to the different data which he could be interested in, filter or not the different data show the History with the changes that happened along the time, etc. All in all, a personalized analysis for each case



Comtrade playback from the tablet

This function permits playing back oscillographic logs in COMTRADE format, both type ASCII and in binary following IEEE Std C37.111. The Fault playback provides a very efficient method to analyse the behaviour of a protection or of a complete scheme faced with a previously logged fault or, even, synthesised by means of a simulation program. Logs of this type include all the frequencies permitted by their sampling velocity, so they are the most realistic way of analysing the behaviour of the protection system.

The Quasar loads the COMTRADE files contained in a flash drive directly through its files folder tablet, so that there is no need to use an external computer.



Hardware configuration

Quasar will allow users to define each details of its capabilities in order to give exactly what is needed everytime. For example:

Current channels configurations:

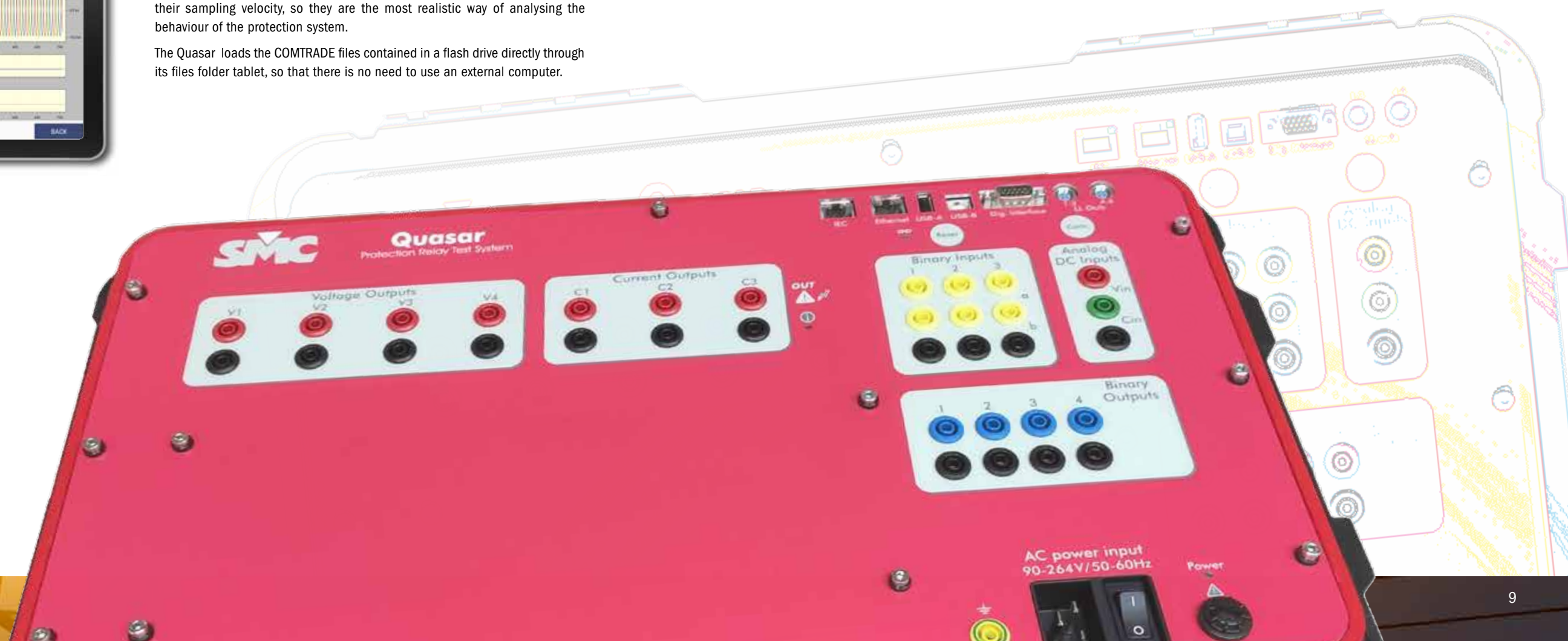
- 3 x (35 Aac / 35 Adc - 275 VA)
- 3 x (60 Aac / 60 Adc - 100 VA)
- 1 x (70 Aac / 70 Adc - 550 VA) + 1 x (35 Aac / 35 Adc -275 VA)
- 1 x (120 Aac / 120 Adc - 200 VA) + 1 x (60 Aac / 60 Adc - 100 VA)
- 1 x (105 Aac / 105 Adc - 825 VA)
- 1 x (180 Aac / 180 Adc - 300 VA)

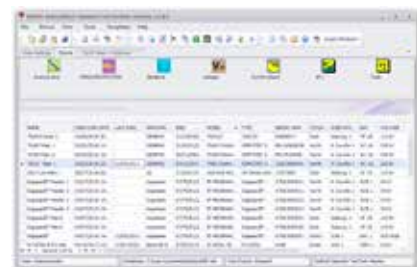
Voltage channels configurations:

- 4 x (150 Vac / 212 Vdc - 100 VA)
- 4 x (300 Vac / 300 Vdc - 100 VA)
- 3 x (150 Vac / 212 Vdc - 100 VA) + Battery Simulator
- 3 x (300 Vac / 300 Vdc - 100 VA) + Battery Simulator
- 2 x (600 Vac / 600 Vdc - 100 VA)

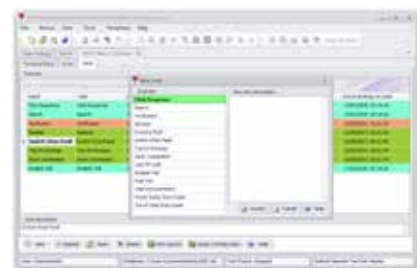
Voltage channels working in current mode

- 4 x (5 Aac / 5 Adc - 100 VA)
- 3 x (5 Aac / 5 Adc - 100 VA) + Battery Simulator

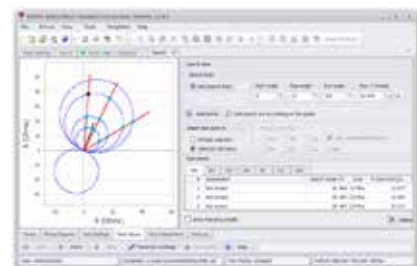




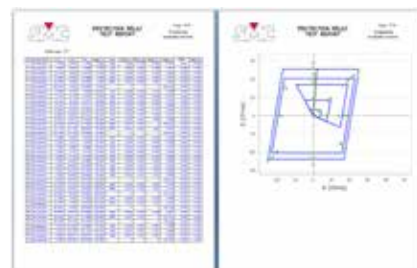
Device panel



Test list screen



Test screen



Test report

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.

ROOTS is an optional product for PC-operation of SMC's **Quasar, 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 and X-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.

Main features

- Continuously updated relay definitions library.
- Powerful, fully customizable automation via Test Plans and Workflow definition.
- 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**.
- ROOTS storage files are self-contained **databases**: relay data & protective characteristics, custom formulas, test routines, test equipment configuration, reporting preferences, workflows and test plans.
- Database management functions for the **import/export** of device (relay), test definitions and results between databases.
- Ability of using **formulas** instead of fixed values when entering test values, settings, options or otherdata.
- Direct import of **RIO and X-RIO** relay description files supplied by a number of relay manufacturers.
- Intuitive graphical zone and elements **Characteristics Editor**, with factory- and user-defined relay Templates.
- **Modular architecture**, with specialized test modules matching specific protective functions.
- **Modular pricing**, ROOTS can be purchased with one or more functional modules, providing a price-optimized solution.
- **Free updates**, the core ROOTS program and all licensed modules are covered by lifetime updates with corrections and occasional functional improvements.

Test procedures defined within ROOTS can be directly executed on a connected SMC test set.

The Quasar can read the routine files directly from the tablet, from a networked computer or from removable USB storage, and execute the procedure without any additional intervention



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 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, among others:

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).

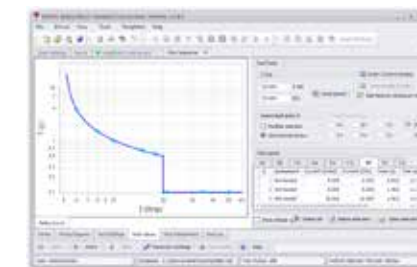
Characteristics template: access to the edition of the different inverse time characteristics that ROOTS contains. Groups of pre-defined Characteristics are available depending on specific equations (IEC, IEEE, ANSI, U.S.), user-defined formulas, and curves in tabular format. Each one can be edited through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

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, relay 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 test set I/O and power connections to the relay, configuration of operating options of 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 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 test points.

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:

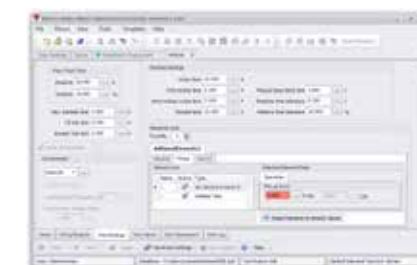
- Click Sequence
- Reclose
- SOTF (Switch On To Fault)
- Breaker Fail
- SOL (Selective OC Logic)
- Pick up/drop out
- Cold Load
- I2/I1 Ratio
- Fuse Failure
- Reset Time



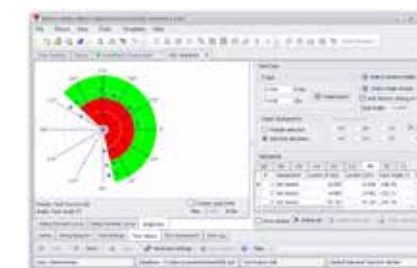
Click sequence test



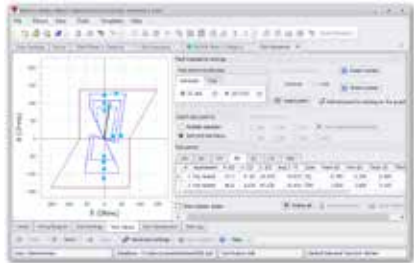
Element list and characteristic templates



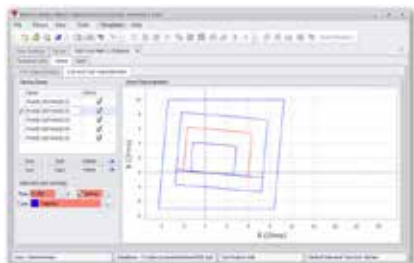
Reclosing settings



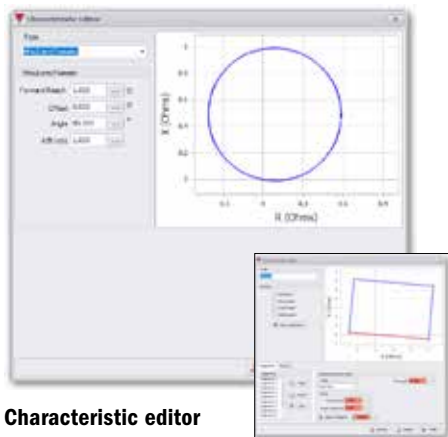
Angle view



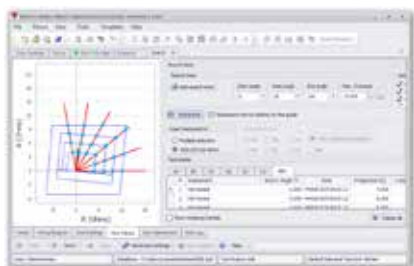
Click sequence test



Distance zones



Characteristic editor



Search test

Distance module

Distance test module is used to test all functions related to ANSI 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, among others:

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 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 sorted 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: allows 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.

Test list: Multiple tests can be attached to the module from a wide choice of test types, including scheme-oriented tests:

- | | | |
|-------------------|------------------------------------|---|
| • Click Sequence | • Switch On To Fault | • Impedances Graph |
| • Reclose | • Zone 1 extension | • Loss of Load |
| • Trip on Reclose | • Fuse Failure | • Load Encroachment |
| • CB Failure | • Out of Step from Impedance Graph | • Power Swing Blocking from Impedance Graph |
| • Search | • Verification Test | • Blocking from Impedances Graph |
| • Evolving Fault | | |

Differential module

The set of differential test modules is used to test the operation of protective devices that implement ANSI 87 and includes the following four modules.

Classic differential 87c: The module is distributed in the following sections, among others: Technical data: 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: For configuration of the characteristic and the operating times of the relay, as well as defining the parameters for the harmonics restrain. 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 3rd or 5th (Blocking by over excitation), harmonics from the second to the eighth can be manipulated.

Transformer differential 87t: Designed for testing numerical relays for differential protection of transformers.

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.

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: Configure the characteristic and the operating times of the relay, as well as defining the parameters for the harmonics restrain. 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.

Generator/motor differential 87gm: Designed for testing rotating machines differential relays. **Technical data:** the setting of generator/motor 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.

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 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: 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.

Search test: This tool provides a method to locate the boundaries of the relay's characteristic. A series of consecutive faults are injected that gradually enter the searched zone. This method reveals the actual accuracy of the relay.

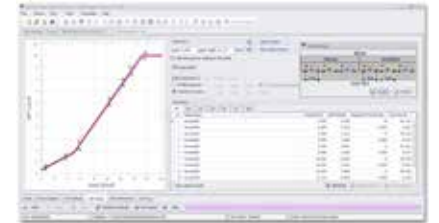
Busbar differential 87b: Designed for testing busbar differential relays.

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.

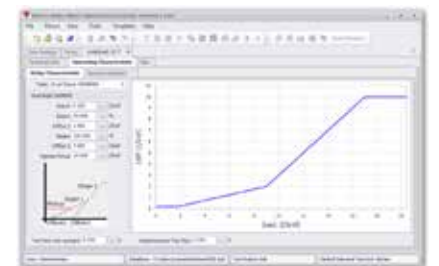
Operating characteristic: ROOTS allows editing of the relay characteristic in a simple way by choosing from a set of predefined types or by custom building one when necessary.

Test list: Multiple tests can be attached to each differential module from the test types:

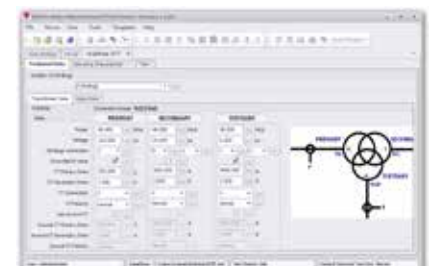
- | | |
|------------------|----------------------|
| • Click sequence | • Verification |
| • Search | • Pickup |
| • CB Failure | • Harmonic Restraint |



Differential shot test



Differential relay characteristic editor



Technical data



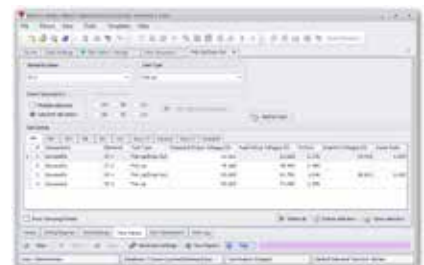
Harmonic restraint test



Inhibit voltage



Click sequence



Pickup / dropout

Frequency

The frequency module allows checking the frequency-dependent functions such as: over-frequency (81O), under-frequency (81U), ROCOF dF/dT (derivative of frequency) (81R) and overexcitation (24).

Technical data:

The general parameters that affect all the frequency-dependent tests are configured, such as the tolerances and the connection of the voltage measuring transformers used by the relay to calculate the frequency.

Element list:

It groups together the information regarding each of the frequency-dependent functions, starting values, operating times, characteristic curve, the cycles used by the relay to validate the starting function. Additionally, it allows selecting the inhibition voltage to block the frequency dependent functions when the voltage is below a certain threshold.

Shows a graphical view of each of the active elements.

Test:

In this section, multiple types of tests can be selected to verify the correct operation of the relay.

Two test modes can be selected using frequency ramps or the software auto-generating COMTRADE files reproduced by the Quasar, guaranteeing a more precise test similar to what happens in reality. This method ensures better evaluation and precision in test results.

Test list:

- Click Sequence
- Inhibit Voltage
- Pick up / Drop out
- ROCOF dF/dT

Voltage

There is a three-phase and a single-phase test module.

The voltage test modules are used to test the operation of voltage protection devices, it allows to check the elements that act on the values of phase to ground, phase to phase,

Positive sequence, negative sequence, neutral and residual.

Technical data:

The general parameters that affect all the tests are configured, such as the tolerances and the connection of the voltage measuring transformers used by the relay to measure.

Element list:

It groups the information referring to each of the voltage functions, starting values, operating times, characteristic curves. The module has no limit of voltage functions, the user can add as many elements as he wishes phase-ground, phase-phase, positive sequence, negative sequence, neutral or residual.

It shows in a graphical view each one of the active elements.

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), 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 zero.

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 (AN, BN, CN, AB, ABC, negative sequence, neutral...).
- Test result assessment, automatic and manual.
- Test graph of the protection element: graphically displays the expected operating time for each of the possible faults.
- Phasor graph: allow to view the phasor diagram of every point being tested.
- Hardware settings: map the test set I / O and power connections to the relay, configuration of operating options of 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 Formats.
- 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 test points.

Test list:

- Click Sequence
- Pick up / Drop out

Synchro check

The test module sync check facilitates testing of protective devices to check the synchronization between two parts of an electrical system.

Synchronization control checks the possibility secure connection between the protected object and the feed bar. During this process the amplitudes of voltage, frequency and phase position to connect both parties are verified.

The connection is allowed as long as the parameters to bind both parties are within setting limits. In some cases the union switch close with either or both ends de-energized are supported.

Technical data:

Technical data contains the characteristics of the two systems to be connected, the relay setting data that are used during the synchronism check process. Connection of voltage transformers and reference voltage for synchronism verification. Simple or compound stresses can be selected for verification.

Synchronism verification settings are configured such as: Threshold for Live / Dead system detection, maximum and minimum voltage allowed; maximum difference in frequency, voltage and phase parameters between both systems to be synchronized.

Test screen:

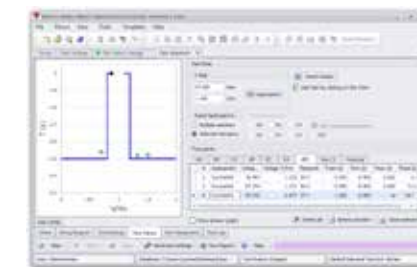
The user selects the conditions prior to the synchronism verification and the conditions at the time of verification, the software automatically evaluates the test based on the maximum limits allowed between both systems to synchronize.

Both the frequency, voltage and phase limits can be verified separately and through a test where all these parameters are different at both ends.

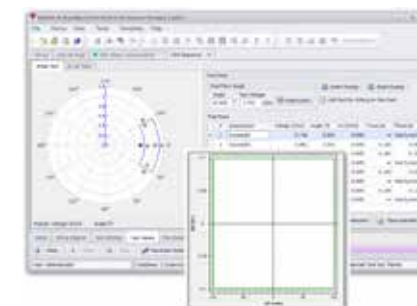
Additionally, shutdown conditions can be tested when only one of the systems is energized.

Test list:

- Click Sequence
- Search
- Check Synchronism Mode



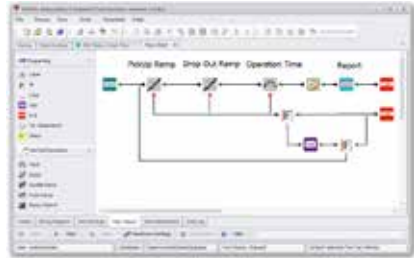
Click sequence



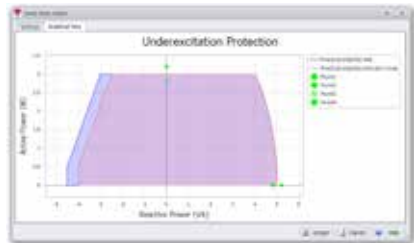
Click sequence



Technical data



Flowchart



Custom chart



States handler



Fault calculator

Flowchart

The flow allows us to carry out a graphic programming of the test according to our needs.

It uses a powerful and intuitive methodology that allows us to save time and reduce efforts. It allows establishing a sequence of actions or decisions flexible enough so that they can be adapted to most practical needs.

The graphic designer handling process is very simple and is based on the selection of blocks that can be placed in any position on the design screen. Each block has connecting elements that can be input or output. Uniting the blocks in the desired way we establish the required order of execution as the case may be.

Programming: This section contains the blocks that allow to control the test execution flow automatically.

This window includes “IF” conditionals, loops, subroutines, variable assignments, timings, and labels.

Test set functions: This section contains the blocks that implement functions included in the test equipment or blocks that control the status of the outputs: fault, ramp, double ramp, pulse ramp, binary search, state sequencer, on and channel shutdown, battery simulator control.

Miscellaneous: This section contains the blocks that implement interactions with the user such as: text, image, conditional text, report, data entry, evaluation

Charts: This section contains the blocks that allow incorporating charts to the workflow test. Each graphical value can be entered as a constant or as a variable, thus providing the possibility of constructing graphs adaptable to most practical needs. The three types of graphic blocks are:

1. Graphic components: made up of a group of blocks that allow displaying graphic images in a plane with cartesian axes or a polar plane.
2. Series of points: this block can contain numerous series of points. Each series stores a set of values that can be displayed on the graphic components as separate points, as linked points, as vectors or as bars.
3. Graphics viewer: This block allows us to display a graphic component together with a group of series.

Tools

The Tools module is an additional option that provides the ability to create, configure, store and run custom tests using state sequences or the oscillogram player.

State sequencer:

In this test the user can build a test using sequences of consecutive states. The generation of the values and parameters is built by the user according to their needs.

For the evaluation of the test, there are all the tools available in the tests with states. You can create as many states as necessary and use different methods to move from one state to the next, such as: binary inputs, time, a combination of time and binary input ...

In each of the states, the values of voltage, frequency, current, phase angle of each of the analog voltage and current channels can be selected; Likewise, the states of the binary outputs used, for example, to simulate the state of the switch can be configured.

The analog values of the outputs can be configured using the fault calculator included in the state sequencer, facilitating the calculations of complex quantities such as the I_2 / I_1 ratio; the fault impedance taking into account the ground compensation factors and others.

Fault playback:

It is a test that allows you to view, edit and reproduce transients starting from a data file in COMTRADE format.

The data file can come both from values stored by the relay during a real fault and from values generated by simulation software.

This functionality allows you to test and evaluate the operation of the device under conditions similar to the real ones of operation.

In this test, ROOTS offers the user powerful tools that will allow the user to program automatic evaluations of the results.

If the COMTRADE file does not have the information regarding the transformation ratio of the CTs and VTs, ROOTS allows editing the file by entering the corresponding transformation ratio or a scale factor.

With ROOTS it is easy to edit the COMTRADE file by adding cycles to the original file or by reproducing only a part of it or of the recorded digital and analog signals.

Network simulator

Different types of network topologies are simulated. This makes it possible to check the operation of the protection devices in conditions close to the real ones. The study allows operating the switches of interest as well as locating faults in the network.

Test settings:

The parameters of the network under simulation are configured as well as the elements that make them up. Parameters such as line impedance, mutual impedance, switch opening and closing times, instrument transformers are easily and simply configured.

Events can be selected at any point of the network under study, such as short circuits in one or more points of the network, trips of the switches, reclosures, arc resistance of the short circuit and thus know the dynamic behavior of the network.

Test value:

According to the simulated network topology and the planned events, the window shows the voltage and current values in each of the system nodes as well as the markers where a certain event begins or ends. Evaluate the test results.

The assistants help to know the values of the signals at each point by simply placing the cursors at the desired point, obtaining useful information such as the impedances, magnitude and phase of each signal.

Available network settings:

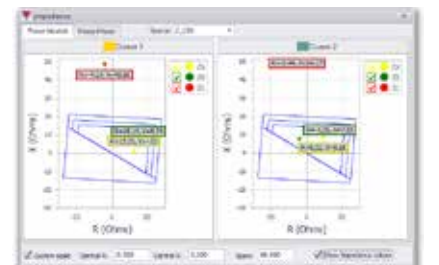
- Simple Line
- Line with Tap
- Parallel lines
- Power swing from circuit model
- Adjacent Lines
- Personalized
- Custom Test
- Out of Step from circuit model
- Parallel Lines with Tap



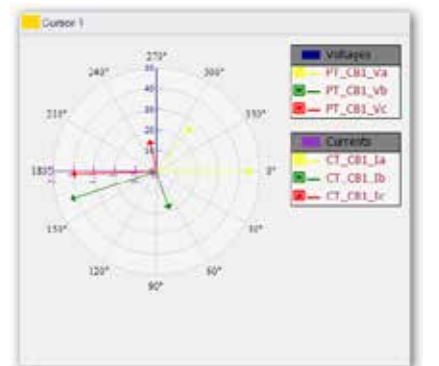
Comtrade

Current	Voltage	Time	Value	Max Value	Total RMS	Frequency
Current 1	CT_C1A Ia	0.000 ms	1.000 A	1.000 A	1.000 A	50.000 Hz
Current 2	CT_C1A Ib	0.000 ms	1.000 A	1.000 A	1.000 A	50.000 Hz
Current 3	CT_C1A Ic	0.000 ms	1.000 A	1.000 A	1.000 A	50.000 Hz
Voltage 1	PT_C1A Va	0.000 ms	1.000 V	1.000 V	1.000 V	50.000 Hz

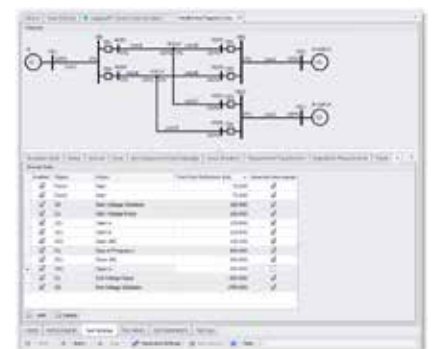
Cursor values



Impedances diagram



Phasorial diagram



Single line diagram

Quasar software elements

FUNCTION	DESCRIPTION	Quasar	Quasar + ROOTS
FULL DIRECT CONTROL	Enter test quantities, output to the relay and start the chronometer in simple, intuitive steps.	●	●
CONFIGURATION CONTROL	Easy setup of numerous options in output and input resources.	●	●
ASSISTED CONTROL	Direct regulation of complex test magnitudes: Impedance, Fault, Power (P.Q.S, Power Factor), Sequences (Symmetrical components), Vline and Homopolar Voltage, Open Delta. Also available in State Sequencer.	●	●
TEST FUNCTIONS	Complete repertoire of functions for changing test quantities with intuitive programming on graphic charts and graphic test results.	●	●
FAULT	Three-state Fault function, pre-fault, fault and post-fault configuration.	●	●
RAMPS	Rising or decaying ramps of one or two quantities.	●	●
PULSE RAMP	Pulse ramping with preset condition state, of any quantity.	●	●
BINARY SEARCH	Effective search for operating value through adaptive pulses.	●	●
STATE SEQUENCER	A simple programmable multi-step tool to test protection schemes with sequences of electrical quantities and control statuses.	●	●
FAULT PLAYBACK (COMTRADE)	Playback and processing of COMTRADE files and similar, for transient fault analysis and relays reaction.	●	●
TEST REPORTS	Configuration, management, formatting and exporting of test reports.	●	●
REMOTE TEST SET CONTROL	Control of the test set via wired Ethernet or Wi-Fi.	●	●
BATTERY SIMULATOR	Auxiliary DC supply setting for relay powering.	●	●
HARMONICS	Superimposed harmonics content setup in test signals.	●	●
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.	●	●
IEC-61850 - GOOSE	Message-based testing with IEC-61850 data sets.	●	●
POWER SAVING TRIMMER	Energy saving system with auto-adjustment to load and regulation of working cycle.	●	●
ONLINE MAINTENANCE	Upgrading, updating and maintenance of firmware and applications via Internet.	●	●
I/O MONITOR	On-screen monitoring of test signals, binary I/O activity, system's status and warning messages.	●	●
FREE LIFETIME UPDATES	Includes minor functional improvements and warranty against defective code.	●	●
MULTI PLATFORM	Compatible with Quasar, Mentor and TRES.		●
PC COMPATIBLE	Runs on any Microsoft supported Windows® version.	●	●
RELAY LIBRARY	Relay centric database with manufacturer info, type description, functional definitions, site information, implementation details, testable elements, saved test procedures, test history and dynamic reporting.		●
RELAY SETTINGS	Management, templatization and import of relay settings in RIO, X-RIO and other formats.		●
TEST WORKFLOW	Visual editor with drag & drop paradigm on elementary test functions for complex automation.		●
USER SECURITY	Access rights management for multiple users.		●
INLINE HELP	Search and display of help topics from within the program		●
MODULAR ARCHITECTURE	Single-, multiple- or subscription based functionality options (protection types and repertoire of test tools)		●
SPECIALIZED MODULES	Each protective function (Overcurrent, Distance, Differential, Voltage & Frequency etc.) can be defined with multiple sets of specialized parameters, protective characteristics and test procedures for each individual relay.		●
SET OF VOLTAGE MODULES	Single Phase and 3-Phase Voltages Modules to test the operation of protective devices with functions 27, 47, 59, 59N...		●
PICK UP/DROP OUT VOLTAGE	Search for pickup and drop out values of active over/under voltage elements (27, 47, 59, 59N ...) in the device with the desired accuracy. It is performed by injecting consecutive faults by means of pulse ramp or binary search until the operation value is found.		●
CLICK & TEST	The user can click on one or more spots in the relay's characteristic graphic (overcurrent, voltage, distance, differential, frequency...) and run the test.		●
PICK UP/DROP OUT OVERCURRENT	Search for pickup and drop out values of active overcurrent elements (50, 51, 50N, 51N, 67, 67N, 46...) in the device with the desired accuracy. It is performed by injecting consecutive faults by means of pulse ramp or binary search until the operation value is found.		●

FUNCTION	DESCRIPTION	Quasar	Quasar + ROOTS
VERIFICATION	A number of test conditions alongside the expected results can be saved and re-utilized at any time for quick testing.		●
RECLOSER	A protective function can be tested on a re-closing scheme to verify any number of reclosing cycles, the operation settings and the recloser's trip-close sequence altogether.		●
COLD LOAD	Evaluation of the relay's performance upon system re-energization after a long interruption in the electrical service.		●
SOTF (Switch On To Fault)	Verification of the relay's reaction when power is restored on a persistent fault.		●
I2/I1 RATIO	Generation of faults to evaluate relays with broken conductor function.		●
CB FAILURE	A protective function can be tested while simulating a circuit breaker failure scenario to check the relay's reaction in these circumstances.		●
FUSE FAILURE	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 reclose 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.		●
POWER SWING BLOCKING & OUT OF STEP	It is possible to program the trajectory and speed of the impedance vector by an easy graphic process to accurately check the power swing blocking function.		●
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	Classic: 87C / Transformer: 87T / Generator & motor: 87GM / Busbar & Line: 87B.		●
PICK UP/DROP OUT FREQUENCY	Test to search for pickup and drop out values of the active frequency elements.		●
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 rendering a frequency ramp or play autogenerated oscillogram method injects a continuous variation of the frequency keeping constant the dF/dT value, 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. The function can also render and inject an oscillographic record with a continuous variation of frequency while the dF/dT ratio is kept constant.		●
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		●
CLICK SEQUENCE SYNCHROCHECK	This test allows defining different conditions between the two systems and evaluating the performance of the relay in each case.		●
SYNCHROCHECK SEARCH	This test allows you to search the operating values of different settings involved in detecting synchronism (live/dead voltage level, slip frequency, angle difference...)		●
CHECK SYNCHRONISM MODE	The test allows checking the operation of the synchronism modes set on the relay. The user can create diverse scenarios (Bus Live & Line Live, Dead Bus & Line Live, Dead Bus & Dead Line, Live Bus & Dead Line) and evaluate the relay's response on each.		●
NETWORK SIMULATOR	This module allows the simulation of small electrical systems. This makes it possible to check the operation of the protection devices in conditions very close to the real ones.		●

Quasar specifications

This equipment is designed for use in high voltage substations and industrial environment. All our products comply with CE Marking directives, related IEC standards and ISO-9001 quality requisites.

Power output				
	Range	Power	Resolution	Accuracy
4 x voltage	0÷300 Vac/dc (2 x 0÷600 V in series)	100 VA / 100 W (t≥ 2 Hr.) (200 VA / 200 W)	10 mVac/ 15 mVdc	AC: 0.1% of value ± 0.03% of range DC: 0.25% of value ± 0.05% of range
6 x current	3 x 0÷35 A (0÷60 A for 3") 3 x 0÷5 A	275 VA / 385 W 100 VA / 100 W	1 mA 1 mA	AC: 0.1% of value ± 0.03% of range DC: 0.2% of value ± 0.03% of range
6 x low level output	0-10 Vacpk (1 mA max.)		250 µV	
Frequency	Bandwidth: 3 kHz Adjustable: 0÷2000 Hz		125 µHz	10 ppm
Phase angle	0÷360° / 0÷ ± 180°		0.001°	± 0.1° of value @50Hz ± 10% of range
Auxiliary DC supply	(4th voltage channel) 0...+300Vdc	100W	15 mV	0.25% of value ± 0.05% of range
Binary I/O				
6 inputs (3 fully isolated pairs)	Modes: Dry (5Vdc/20mA), Wet (±400Vpp)	Thresholds: ±1.5V / ±15V	Count speed: 3kHz (100kHz in one pair)	
4 fully isolated outputs.	Relay mode: max 300V/8A/2000VA/240W.	Solid state mode: max 30mA/ 120V, 10mA/300Vdc	Max speed: 100µs	
Chronometer	0.0001 - 99999.9999 sec			0.1 ms
Measurement inputs	Voltage: max. ±10Vdc	Current: min. ±1mAdc, max. ±20mAdc	Accuracy: 0.02% of value ± 0.02% of range	
Communications	Ethernet IEC-61850, Ethernet LAN, Wi-Fi, USB A, USB B, Digital Expansion			
IEC-61850	State inputs: 16, State outputs: 8, Interface: dedicated RJ-45 Ethernet			
Control	Android app* and Windows software			
Physical				
Power supply	100 - 260 V AC, 50 - 60 Hz - Max. 2200W			
Casing	ABS with wheels and extensible handle			
Operation temperature	0°C to +50°C (32°F to +122°F)			
Size	560 x 230 x 350 mm (22" x 9" x 14")			
Weight	19,5 kg (43 lbs)			
Compliance	CE marking / IEC-61010 / EMC-50081-2 / EN-50082-2			

* iOS version planned

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