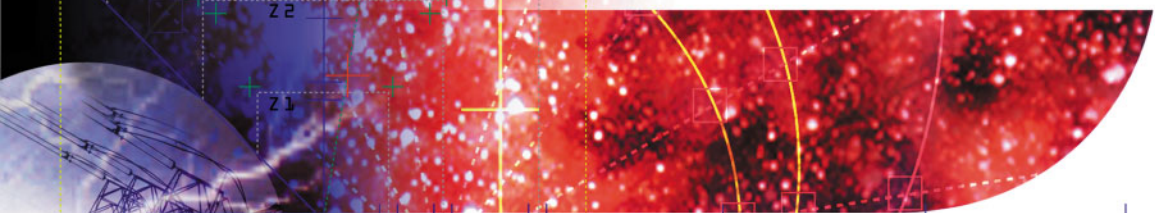




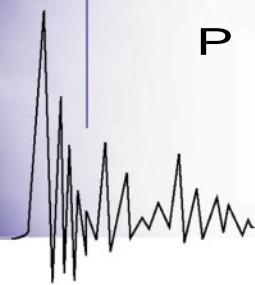
OMICRON



Protection

P A C K A G E

User Manual



TEST UNIVERSE

Version 2.2

Article Number VESD4002 - Manual Version: PROT.AE.9

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OMICRON electronics translates this manual from its source language English into a number of other languages. Any translation of this manual is done for local requirements, and in the event of a dispute between the English and any non-English versions, the English version of this manual shall govern.

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1 Introduction

This *Protection* manual provides a detailed overview of the *Protection Package* software as well as one or more specific test examples for each test module that is part of the package.



Detailed information about the individual test modules is found in their module-specific online help systems. You are encouraged to use this reference first whenever you have a question or need further explanation about a specific topic. Start the online help by clicking the `HELP TOPICS...` command on the `HELP` pull-down menu of the individual test module or tool.

If this does not meet your needs, please fax or e-mail your question(s) to us or contact us directly by phone (refer to section "Contact Information / Technical Support").

For detailed information about the OMICRON *Control Center* (OCC), please refer to the manual *The Concept*. The PDF file can be found at *OMICRON Test Universe installation path\Doc*. You find a direct hyperlink to this manual in the online help topic "User Manuals of OMICRON Test Universe". In addition, the online help also provides detailed information about *Control Center* under the table of contents entry --- **OMICRON Control Center** ---.

The *Protection Package* software provides full-range functionality to define and perform comprehensive tests of any protective relay. It contains several function-orientated test modules that can operate in stand-alone mode for simple tests.

The test modules are designed to automate tests and provide automatic assessments. To create complete multi-functional tests, all test modules can also be embedded into an OMICRON *Control Center* document (test plan) once or more. The OMICRON *Control Center* is the dominant automation tool taking advantage of the document-oriented approach to testing.



Tip for new users: The *QuickCMC* test module is a good starting point to become familiar with the *Test Universe* test software.

1.1 Preface

We assume that you understand and are comfortable using the Windows™ operating system¹. Please take time to become familiar with your computer's operating system before using *OMICRON Test Universe*.

This manual uses the following conventions:




Mouse




Click	Press and release the primary mouse button. The primary mouse button is the button you use most often. For most people, this is the left mouse button.
Right-click	Press and release the secondary mouse button. The secondary button is the button you use least often. For most people, this is the right button.
Double-click	Press and release the primary mouse button twice.
Drag	Move the mouse while you hold down the primary mouse button.
Release	Remove your finger from a mouse button.
Scroll	Scroll bars along the right and bottom sides of a window can be used to move the contents up and down and left and right within the window. To use a scrollbar, either click and hold one of the arrow buttons at either end of the bar, or drag the scroll bar slider.







1. Windows is a US registered trademark of Microsoft Corporation.

1.2 Scope of the Protection Package Software

The OMICRON *Test Universe* "Protection Package" contains:

Control Center (OCC) - Create Multifunctional Test Documents	
	<i>Control Center</i> Automation tool, document-oriented test plan, template and report form.
	<i>Test Wizard</i> Creates a new test document (test plan) in a quick and easy manner. A sequence of dialog boxes guides the user through the process of creating a new test document. Start from <i>Start Page</i> by clicking "Open Empty Document..." or from <i>Control Center</i> by clicking the <i>Test Wizard</i> icon.
	

Control Center Helper Modules	
Start any Helper Module from the <i>Control Center</i> by selecting the pull-down menu item INSERT TEST MODULE...	
	<i>Pause</i> Provides a special functionality to pause, stop or continue a Control Center test procedure. The <i>Pause Module</i> is not visible from the <i>Start Page</i> but it can be accessed through the OCC.
	<i>ExeCute</i> Starts an executable program, a batch procedure or opens a document that is associated with an application. Allows launching an external application out of a <i>Control Center</i> test document.
	<i>TextView</i> Displays the contents of an ASCII text file. With <i>TextView</i> embedded into an OCC document, the contents of the text file are updated and displayed in the OCC document during runtime, i.e., while executing the test.

Test Modules	
<p>Start a test module either in "stand-alone" mode from the <i>Start Page</i> or embed it into the <i>Control Center</i> via INSERT TEST MODULE...</p>	
	<p><i>QuickCMC</i></p> <p>With <i>QuickCMC</i>, a <i>CMC</i> test set outputs analog and digital values statically. In addition, the <i>CMC</i> inputs can be monitored and simple measurements can be taken with the binary inputs. <i>QuickCMC</i> represents a good starting point for new users.</p>
	<p><i>Ramping</i></p> <p>Variation of amplitude, frequency, and phase along a staircase (or ramp) function. Automatic assessment and reporting of pick-up / drop-off values. Simultaneous ramps of two signal parameters (e.g. amplitude and frequency). Calculation of pick-up / drop-off ratio. Automatic repetition of tests with average calculation. Step back and zoom function for higher resolution at the threshold.</p>
	<p><i>Pulse Ramping</i></p> <p>Testing of pickup values of multifunctional protection relays with more than one protection function and/or elements without reparameterization of the relay.</p>
	<p><i>State Sequencer</i></p> <p>Output of a sequence of states. Can be used to determine trip times or other time measurements with automatic assessment. Permits setting of amplitude, frequency, and phase of each generator in each single state. Includes automatic report creation and Z Shot function for distance applications.</p>
	<p><i>Overcurrent</i></p> <p>Designed for overcurrent relays. Tests the operation characteristic to verify the trip time with automatic assessment. Includes automatic pick-up / drop-off test and automatic report creation. Simulates phase-ground, phase-phase, three-phase, negative sequence, and zero sequence faults.</p>
	<p><i>Autoreclosure</i></p> <p>Testing of the autoreclosure function with integrated distance protection fault model and distance XRIO interface.</p>



Test Modules

Distance

Provides the functionality to define and perform tests of distance relays by impedance element evaluations using single-shot definitions in the Z-plane with graphical characteristic display.

Definition of relay characteristics

A graphical editor makes the definition of the nominal relay characteristics and settings quick and easy. Start, trip, extended, and no-trip zones can be defined by using predefined elements. A complete overview of all defined zones is provided.

The standard XRIO interface, supported by various relay manufacturers, makes it possible to directly import the relay data from relays' parameter setting software. The impedance settings for the zones are entered and displayed in primary or secondary values, as chosen by the user.

Definition of tests

Tests are defined in the impedance plane: Test points are added to a test point table with the mouse or by entering from the keyboard. This table is separated into several tabs, each tab belonging to a fault loop, e.g., A-N (L1-E), B-N (L2-E), C-N (L3-E), A-B (L1-L2)... etc. Test points can be defined for several fault loops at the same time (e.g. for all single-phase loops) or for every fault loop separately.

When a test is performed, the test point lists belonging to the individual fault loops are worked off. The reaction of the relay is compared to the specified nominal settings and an assessment is made. The results are displayed graphically in the impedance plane as well as numerically in the test point table.








For a more in-depth analysis of the results, the voltages and currents belonging to a test point and the relays reaction (switching of output contacts) can be graphically displayed. Time measurements by using cursors are possible.

Reporting

Distance automatically generates a test report containing the relay settings, the test settings, the test points and the results in tabular and graphical form.



Test Modules	
<p><i>Differential</i></p>	<p>Provides a compact testing solution for generator, busbar, and transformer differential protection relays. Performs single-phase tests of the operating characteristic (pick-up value, slope test) and the inrush blocking function (harmonic restraint test).</p> <p>For the test of the operating characteristic, test points are defined in the I_{diff}/I_{bias} plane either using the mouse or entering from the keyboard. A graphical user interface makes the test definition easy.</p> <p><i>Differential</i> also provides an appropriate testing environment for testing the harmonic restraint function. The amplitude of the fundamental and the percentage of the superimposed harmonic can be defined for each test point. The test currents belonging to the test points are injected to the relay and the reaction of the relay is assessed.</p> <p>By inserting several <i>Differential</i> modules into an OMICRON <i>Control Center</i> document, different fault loops can be tested automatically.</p>
<p><i>CB Configuration</i></p>	<p>The test set <i>CMC 256</i> offers a CB simulation that emulates the action of the auxiliary contacts (52a / 52b) of a circuit breaker during tripping and closing.</p> <p><i>CB Configuration</i> configures the Circuit Breaker (CB) simulation state machine in the CMC firmware. This module automatically maps the routed binary input and output signals to the simulation inputs and outputs of the state machine.</p>

Test Tools		
	<i>TransPlay</i>	Plays back transient data (COMTRADE files) using a <i>CMC</i> test set.
	<i>Harmonics</i>	Creates a signal sequence consisting of a pre-signal with fundamental frequency, followed by a signal with definable spectral combination (all harmonics up to 3 kHz if supported by the connected hardware), followed by a post-signal with fundamental frequency. <i>Harmonics</i> can generate up to three currents and three voltages, each with individual harmonics composition.
	<i>Binary I/O Monitor</i>	Displays the status of all given inputs and outputs of OMICRON <i>CMB</i> and <i>CMC 256</i> hardware and all the given inputs for all other OMICRON <i>CMC</i> hardware. It can also display state changes of <i>CMB</i> and <i>CMC 256</i> inputs.
	<i>Polarity Checker</i>	Determines if the polarity is correct by injecting a special polarity test signal at a certain location. The polarity check itself is then done with the accessory <i>CPOL</i> , a portable easy-to-use polarity checker.
	<i>Overcurrent Characteristics Grabber</i>	Supplements the <i>Overcurrent</i> test module. It helps to extract overcurrent characteristics from graphical representations. This is most helpful in cases where the inverse-time characteristic is not known by a given formula but only by a graphical representation, e.g. an image in a relay manual.
	<i>AuxDC</i>	Sets the auxiliary DC output of the <i>CMC 256</i> test set or of a <i>CMB</i> binary input/output unit.
	<i>License Manager</i>	License browser, license merge tool and license file editor.

Additional	
<i>Field Calibration Software</i>	Facilitates and automates the calibration and testing of the OMICRON CM product line. The <i>Field Calibration Software</i> runs calibration/test procedures at test points specified by templates and checks whether the test set is within the specifications. After calibrating/testing a test set, the Field Calibration Software provides a report summarizing the test conditions and results.
<i>CM Engine</i>	Programming interface for software developers. Provides full control over the functions of the OMICRON test sets.

2 QuickCMC



QuickCMC controls an OMICRON CMC test set in the way a front panel control would do.

You can output voltages, currents and frequencies statically or as ramped output signals, work with binary (digital) outputs and inputs and take simple measurements at the analog inputs. Applications such as the manual testing of an inrush blocking or a synchronizer function can be done with *QuickCMC*. It is not necessary to start other modules like *Ramping* or *State Sequencer* to perform quick manual checks.

There is no upper limit regarding the number of outputs (generators) that can be controlled. In order to test a busbar protection, for example, a *CMC 256* test set and two *CMA 156* amplifiers are connected. *QuickCMC* allows the simultaneous control of all 16 generators.

QuickCMC represents a good starting point for new users.

2.1 QuickCMC Features

- Numeric or graphic control of analog CMC output values (absolute or relative to nominal) for up to 16 voltage or current generators in terms of amplitude, phase angle and frequency.
- Integrated fault calculator for 2 or 3 phase networks introducing new set modes of operation (setting of voltage and current generators directly or as impedances, symmetrical components, powers and fault values).
- Manual setting of binary outputs.
- Display of measured values at the analog CMC inputs (± 20 mA / ± 10 VDC).
- Manual or automatic stepping of the analog output quantities.
- Step function for all values accessible in the "multifunctional input gid¹" (i.e., powers, impedances, etc.).
- Pulse ramp function as valuable enhancement of the step/ramp function.
- Control of the step function by mouse wheel.
- Measurement of binary input with status and timer, i.e., the first state transition at any binary input after the last change of an output. Shows slope and time.
- "Switch off on trigger" feature to turn off the analog CMC outputs the moment a trigger signal occurs at the binary input (with defineable delay time).
- "Switch off on time" feature to set the maximum time span that has to elapse before *QuickCMC* turns off the analog CMC outputs in case no trigger signals occurs.
- "Unit Manager" to switch the units between seconds and cycles, secondary and primary values, absolute and relative.
- "Prefault" button to output a prefault state at the analog CMC outputs, i.e., nominal voltage ($U = U_{nom}$) and zero current output ($I = 0$ A).
- "Hold" button to switch from prefault to fault state.
- Context menus for a quick setting of values.
- Impedance plane for manual tests of distance relays.
- Vector diagram to show the specified quantities graphically.
- Vectors can be set in the Vector View by dragging with the mouse.
- User-defined reports and assessment.
- "Add to report" button to add all data and actual values at the time the trigger signal occurs at a binary input to the test report.



1. For information on the "multifunctional input gid" and the fault calculator check the *Test Universe* online help. Go to the index and enter "multifunctional...".

2.2 Example 1: Pick-up, Drop-off, and Trip Time



Sample file: `QuickCMC_overcurrent.qcm`

Stored at:

`...OTU installation path\Test Library\Samples\SW Manual Examples\Protection`



Task

Test of the pick-up, drop-off and trip times for a generic overcurrent relay. A report should be generated.

Given settings:

Pick-up:	1.2 A
Pick-up / drop-off ratio:	0.9
Trip time:	300 ms.



Solution

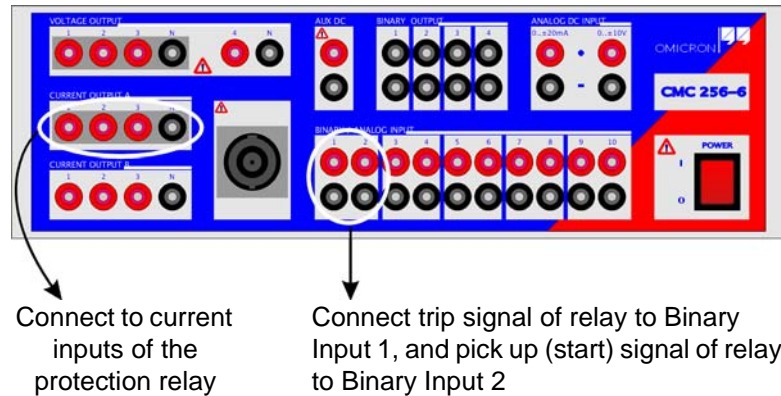
With *QuickCMC*, OMICRON *Test Universe* offers a dedicated test module to easily and quickly perform manual tests. It is typically used in stand-alone mode, although it can also be used as part of the OMICRON *Control Center*.

The difference between the operational modes "stand-alone" and "embedded" is explained in chapter 2 "The Test Universe Start Page" in the "Concept" manual.

2.2.1 Wiring Between Relay and the CMC Test Set

1. Connect the current inputs of the protection relay to the corresponding current outputs of the CMC test set.
2. Connect the trip signal of the protection relay to Binary Input 1 and the pick up (start) signal of the relay to Binary Input 2 of the CMC test set.

Figure 2-1:
CMC 256 test set,
front view



2.2.2 Starting QuickCMC

1. Launch the OMICRON *Start Page*.
2. Click "QUICKCMC" in the Test Modules section.



If you open the above mentioned sample file `QuickCMC_overcurrent.qcm`, and you want to make changes to the test object, hardware configuration or test settings, you need to clear the test results first.



To do so, select TEST | CLEAR or use the respective toolbar button.

2.2.3 Setting up the Test Object

To configure the relay you are testing, use the **Test Object** software function.



In QuickCMC, open **Test Object** either by using the pull-down menu item **PARAMETERS | TEST OBJECT** or by clicking the "Test Object" button in the toolbar. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

1. Click "TEST OBJECT" or select "PARAMETER | TEST OBJECT" to open the dialog for the test object specific data.
2. Click to open the device folder or use the "EDIT" button.
3. Enter the protection relay (test object) and some general parameters on the **Device Settings** tab.
4. Click OK to close the device settings of the **Test Object**.

Why is there a Distance block in QuickCMC's Test Object?

The concept of the OMICRON *Control Center* (OCC) is to centrally store test object or substation data that can also be used by other test modules in Test Object. Therefore, inserting a *QuickCMC* test module into an OCC document behind a Test Object adds a Distance block to the Test Object.

If *QuickCMC* is started in stand-alone mode from the *Start Page* (i.e., not inserted into an OCC document), Test Object also contains a Distance block.

This is because *QuickCMC* can use parts of the Distance Test Object, such as

- CT Starpoint connection
- The impedance diagram (all defined Distance zones of the test object)
- Line angle (in all set modes where angels are relevant)
- Line length (in the Z%- set modes)

2.2.4 Configuring the Hardware



In **Hardware Configuration** you "configure" the used hardware components, i.e., you reflect your actual hardware setup (the connections, the signal routing etc.) in the software.

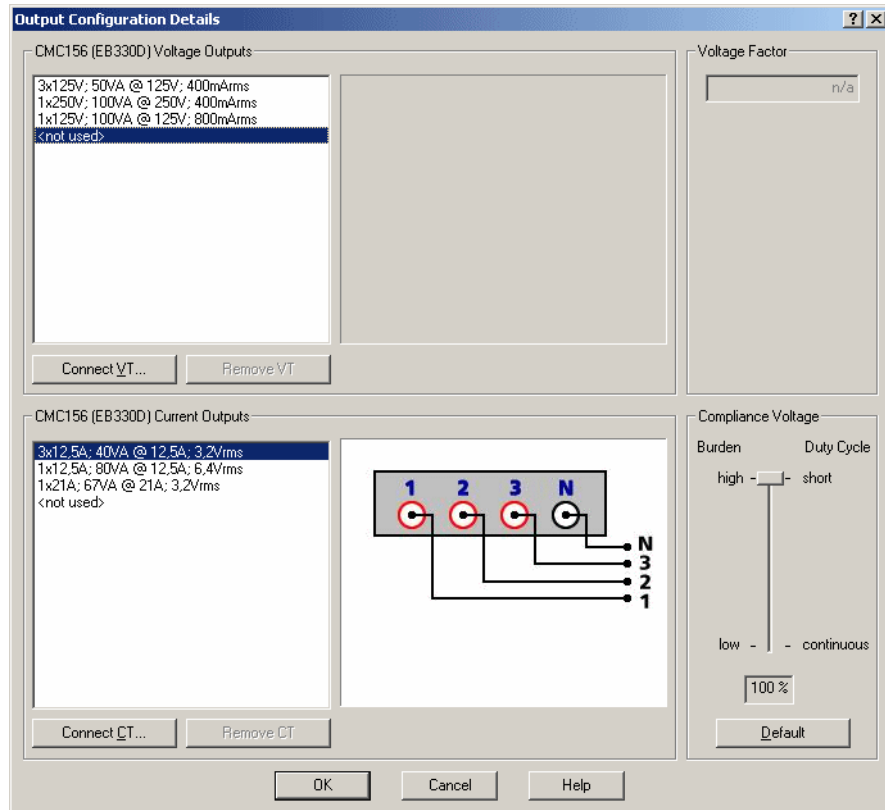


A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

1. Click "HARDWARE CONFIGURATION" or select "PARAMETER | HARDWARE CONFIGURATION" to open the **Hardware Configuration**.
2. On the **General** tab, click the "DETAILS..." button to open the **Output Configuration Details** dialog box (as shown in figure 2-2), and select the correct test set to reflect your actual configuration.

Click OK to confirm your settings and to close this dialog box.

Figure 2-2:
Output configuration details



3. Select the **Analog Outputs** tab.
4. Define the displayed names for each current signal, i.e., IL1, IL2 and IL3 (or IA, IB, IC,...).
Note that phase names can be preset in the **System Settings**, which can be accessed from the *Start Page*.
5. Specify the connection terminal on the protection scheme in the column "Connection Terminal".
6. Ensure that the wiring matrix is specified correctly, i.e., that IL1 of the relay is connected to IL1 of the CMC test set.
7. Select the **Binary / Analog Inputs** tab.
8. Define binary input 1 as "Trip" and binary input 2 as "Start" (keep the defaults).
9. Define binary inputs 1 - 4 as "Potential free" by selecting the relevant check box. If wet contacts are used, the trigger level of each input can be specified separately.
10. Click OK to confirm your settings and to return to the *QuickCMC Test View*.

2.2.5 Entering the Default Currents

1. In the *QuickCMC Test View*, the main view to specify all required test parameters, select the set mode "Direct", which enables you to directly control the routed CMC generators in phase, amplitude and frequency.
2. In the field for the amplitude IL1, set a value of 1 A.
3. Right-click the field for the amplitude IL1 to open the context menu and select EQUAL MAGNITUDES. This sets the currents of all three phases to 1 A.
Voltage amplitudes, phase angles and frequency are all entered in the same way. In this example, however, the voltage fields are hidden, because the voltage outputs were specified as "Not used" in the Hardware Configuration.
4. Right-click the vector diagram to open the context menu and select "Optimize" to adjust the scaling. The vector diagram graphically displays the voltage and current vectors.
5. Set the frequency of each channel to 50 Hz.
To output DC, right-click the frequency field. This opens the context menu. Select "DC". The phase angle fields will automatically be disabled.
6. If the computer is connected to a CMC test set, the status of the binary inputs are shown on-line.
7. At "On Trigger", clear the checkbox "Switch off".



8. To switch on the current outputs, click the F5 "Outputs ON/OFF" button on the toolbar. This applies the set fault values to the CMC test set's analog outputs and turns ON all selected binary outputs.

A red lightning symbol next to the button signifies the active outputs.

De-activating F5 "Outputs ON/OFF" button turns off the analog and binary outputs. A transparent lightning symbol next to the button signifies the OFF condition.

"F5" denotes that your keyboard's function key <F5> fulfils the same task as clicking the button. Alternatively you can use the pull-down menu item TEST | OUTPUTS ON.

Binary Outputs

This test example does not require any binary outputs. Nevertheless a brief explanation for the sake of completeness:

Each one of the 8 Binary Outputs available on your CMC test set can be set to OFF or ON. An OFF output (check box clear) provides a binary "0" signal to the connected test object, and an ON output (check box selected) provides a binary "1" signal.

A binary output may be set to ON at any time, however, its actual output depends on the status of the analog outputs: only if any of the analog outputs becomes active (by activating F5 "Outputs ON/OFF" or F8 "Set Prefault"), the selected binary outputs provide an ON signal. If the analog signal output stops, also the binary outputs shut off.

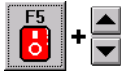


The number of available binary outputs and their routing are defined in the **Hardware Configuration**.

If you use a *CM ASB2* switching box, binary outputs 5 - 8 run *CM ASB2*.

2.2.6 Running the Test

The target is to find the pick-up and drop-off value of the mentioned overcurrent relay. This could be done either manually or by using the automatic ramping function. Both possibilities are described here.



Step 1: Manually stepping the currents

1. At "Step/Ramp", select the current IL1 of the CMC as the "Output" to step.
2. As "Quantity", select to step the magnitude.
3. Specify a step size of 5 mA.
4. Specify a time per step of 500 ms
5. At "Binary Inputs/ Trigger", select the checkbox binary input 2, "Start".



6. Click the "Up" button until the relay picks up.
7. Monitor the binary input 2 where the start contact of the relay is connected. When the relay picks up, the binary input 2 "Start" shows the pick up time, and the value displayed in IL1 indicates the searched pick-up current of the relay.

Note: If you keep the "Up" button "pressed" continuously, a step takes place after the specified time. The time indicated is a minimum value and may have a positive tolerance of approximately 200 ms. In **Pulse Ramp** mode, "Time" is performed in real time and the "Reset" time may have a positive tolerance.



Up / Down commands can also be issued with the mouse wheel. To do so, click the mouse wheel button. It then appears "pressed". Now move your mouse wheel forward/backward to increase/decrease the ramp. To turn off the mouse wheel control, click the button once again.

Step 2: Automatic ramping of the current

1. Set the current to nominal current, i.e., 1 A for all phases.
2. At "Step/Ramp", specify a time per step of 500 ms.
3. Select the "Auto Step" check box.
4. At "Binary Inputs/ Trigger", select the checkbox binary input 2, "Start". That way the CMC output ramp will stop when the "Start" signal occurs but the outputs will stay on.



5. Click the "Up" button once.

Note: The current IL1 slowly ramps up at a rate of approximately 5 mA per 0.5 seconds. Also note how the "Up" button stays "pressed in". To stop the automatic ramp, click the "Up" button again to de-select it.

As soon as any of the binary inputs pick-up or drop-off, the ramp will stop. The outputs will stay ON when any of the binary inputs pick-up.

6. When the relay picks up, the binary input 2 "Start" shows the pick-up time and the value displayed in IL1 indicates the searched pick up current of the relay.



7. Press F10 or click the F10 "Add To Report" button if the results are to be documented. Enter the corresponding test's title and comment if applicable. Manually assess the test as either passed or failed by clicking the respective button.

For detailed information on reporting please refer to section 5.2 "Test Reports" on page 78 in the "Concept" user manual.

Step 3: Finding the drop-off value



1. Click the "Down" button once. Note how the current IL1 slowly ramps down at a rate of approximately 5 mA per 0.5 seconds.

Note: As soon as any of the binary inputs drops off, the ramp will stop again. The outputs will stay on when any of the binary inputs trigger.

2. The value displayed in IL1 after *Quick CMC* triggers indicates the drop-off current of the relay and the binary input 2 "Start" shows the particular drop-off time.



3. If the result should be documented press F 1 0 or click the F10 "Add To Report" button and enter the corresponding test's title and comment if applicable. Assess the test manually as either passed or failed by clicking the respective button.
4. Disable the "Auto Step" check box.

Step 4: Using the Hold function

Multiple quantities can be stepped at once (e.g., simulation a 3-phase fault):



1. Specify the default current configuration, i.e., the prefault current.
2. Click the F9 "Hold" button or select TEST | HOLD VALUES to freeze the outputs of the CMC in the current configuration.

As long as the analog outputs are switched on (F5 "Output ON/OFF"), any change of an analog output value and/or a binary output state is applied instantly. Activating F9 "Hold", however, allows you to change multiple analog values and/or binary output states that will not be applied to the outputs until you click F9 "Hold" once more to release it.

"F9" denotes that your keyboard's function key <F9> fulfils the same task as clicking the button.

3. Enter the current of the new fault state, e.g., IL1 = 2 A.
4. While pointing at the field for the amplitude of IL1, click the right mouse button. On the context menu, select EQUAL MAGNITUDES. Note that the values on the outputs of the CMC are not automatically updated.
5. Click the F9 "Hold" button. The CMC outputs are updated instantaneously with the new values specified for IL1, IL2 and IL3.

Step 5: Performing a trip time test using the Hold function

The timing functionality in the *QuickCMC* records the time from the last change applied to any of the outputs until any of the binary inputs pick-up or drop-off.

The "last change applied" can be the manual change applied to a voltage amplitude, current amplitude, phase angle, or frequency, binary output, or any of the values from the set mode section. These quantities can be stepped manually, switched on or off, or held. If an automatic ramp is running, the time from the last step change, i.e., the last time the step quantity was changed, is displayed.

1. Specify nominal currents for all three phases.
2. At "On Trigger" select the checkbox "Switch off". Also select the trigger checkbox at the binary input "Trip" to have the CMC switch off when the trip occurs. Clear the trigger checkbox for the binary input 2 "Start".
3. Click the F9 "Hold" button.
4. Increase all currents to 2 A.

5. Click the F9 "Hold" button once more.

Note: The timing function only works in the on-line mode, i.e., connected to a CMC test set.

6. The trip time of the relay as well as the binary input which triggered is then shown in the "Binary Inputs" field.
7. If the result should be documented press F10 or click the F10 "Add To Report" button and enter the corresponding test's title and comment if applicable. Manually assess the test as either passed or failed by clicking the respective button.

For detailed information on reporting please refer to section 5.2 "Test Reports" on page 78 of the "Concept" user manual.

2.3 Example 2: Distance Relay - Zone Reach and Trip Time



Sample files:

- QuickCMC-Distance.qcm
- QuickCMC-Distance.ohc
- QuickCMC-Distance.rio

Stored at:

...OTU installation path\Test Library\Samples\SW Manual Examples\Protection



Task

The zone reach and the trip time of zone 1 of a distance relay need to be tested. The used distance relay in this example is an **Alstom PD 552**. The test is performed manually so just a quick check is needed. A report should be compiled.

The following settings are given:

Zone reach on imaginary X-axis: 6,77 Ohm

Trip time of zone 1: 0 s

Trip time of zone 2: 250 ms

Trip time of zone 3: 500 ms



Solution

With *QuickCMC*, OMICRON *Test Universe* offers a dedicated test module to easily and quickly perform manual tests.

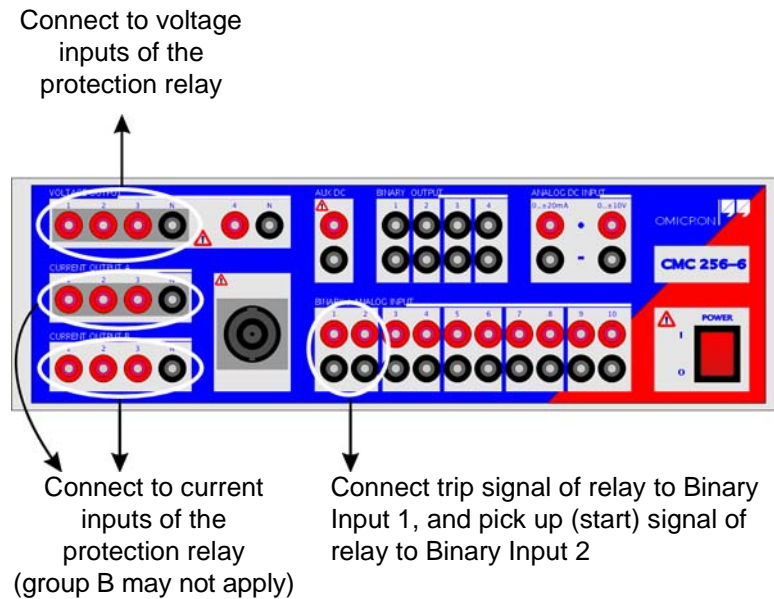
QuickCMC offers the advantage, that it is simple to operate, yet provides the functionality to independently adjust up to 16 voltage or current generators in terms of amplitude, phase angle and frequency, to manually step or automatically ramp / pulse ramp all quantities and to perform simple timing tests. A vector diagram shows the specified quantities graphically. Also a reporting function is incorporated.

QuickCMC is ideally used in stand-alone mode, although it can also be used as part of the OMICRON *Control Center*.

2.3.1 Wiring Between the Relay and the CMC

1. Connect the relay inputs of the protection relay to the corresponding current and voltage outputs of the CMC test set.
2. Connect the trip signal of the protection relay to Binary Input 1 and the pick up (start) signal of the relay to Binary Input 2 of the CMC test set.

Figure 2-3:
CMC 256 test set,
front view



2.3.2 Starting QuickCMC



1. Launch the OMICRON *Start Page*.
2. Click "QUICKCMC" in the Test Modules section.



If you open the above mentioned sample file `QuickCMC-Distance.qcm`, and you want to make changes to the test object, hardware configuration or test settings, you need to clear the test results first.



To do so, select `TEST | CLEAR` or use the respective toolbar button.

2.3.3 Setting up the Test Object

To configure the relay you are testing, use the **Test Object** software function.



In QuickCMC, open **Test Object** either by using the pull-down menu item `PARAMETERS | TEST OBJECT` or by clicking the "Test Object" button in the toolbar. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

1. Click "TEST OBJECT" or select "PARAMETER | TEST OBJECT" to open the dialog for the test object specific data.
2. Click to open the device folder or use the "EDIT" button.
3. Enter the protection relay (test object) and some general parameters on the **Device Settings** tab.
4. Click OK to close the device settings of the **Test Object**.

2.3.4 Defining the Test Parameters

Determine the reach of zone 1:

1. In the *QuickCMC* Test View, the main view to specify all required test parameters, select the set mode "Z-I const."
2. By default, the tault type is set to "A-N" (L1-E) and the test current to 1 A.
3. In the Impedance View (`VIEW | IMPEDANCE VIEW`), place a shot outside zone 3 on the imaginary X-axis in order not to cause the distance relay to trip in zone 2 or 3.
4. In Test View, at "On Trigger" select the option "Switch off".
5. At "Binary Inputs/ Trigger", clear the checkbox binary input 1, "Trip". That way, the CMC test set switches off when the tip occurs.

For the CMC test set to pulse ramp the impedance, the *QuickCMC*'s Pulse Ramp function is used in order to prevent Zone 2 and Zone 3 from tripping.

Pulse ramping generates a sequence of pulses (each pulse width representing the fault time) with an increasing (or decreasing) step size. In between two consecutive ramp pulses a "reset" state is inserted ($U = UN, I = 0$). Therefore, a pulse ramp is actually a ramp that is interrupted after each pulse for a defined period of time.

6. Select the options "Auto Step" and the "Pulse Ramp" to enable this function.

- In the "Step/Ramp" section of the *QuickCMC* Test View, set the output to "XFault", quantity to be varied to "Magnitude", size to "0.1 Ohm", Time to "100 ms" (to avoid trip in zone 2 or 3) and Reset time to "300 ms".

2.3.5 Running the Test



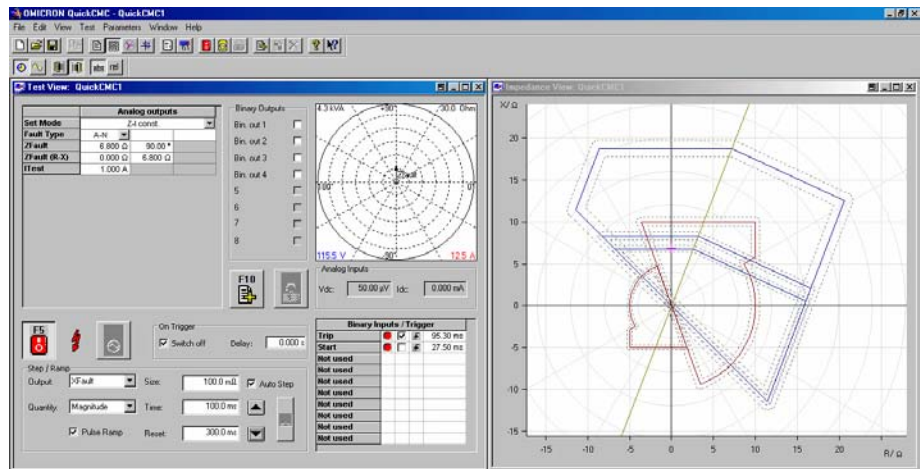
- To switch on the currents outputs, click the F5 "Outputs ON/OFF" button on the toolbar. This applies the set fault values to the CMC test set's analog outputs and turns ON all selected binary outputs.

A red lightning symbol next to the button signifies the active outputs.



- Click the "Step Down" button. The output impedance value will be pulse-ramped in the specified 100 mOhm steps. Once the relay's trip occurred (in this example at 6.8 Ohm), the trip signal of the relay is interpreted at the CMC's Binary Input 1 as the trigger, and the CMC will be switched off. The impedance reach is thus determined with 6.8 Ohm.

Figure 2-4:
Pulse Ramping with
QuickCMC



- Click the F10 "Add To Report" button and enter the corresponding test's title and comment if applicable. Manually assess the test as either passed or failed by clicking the respective button

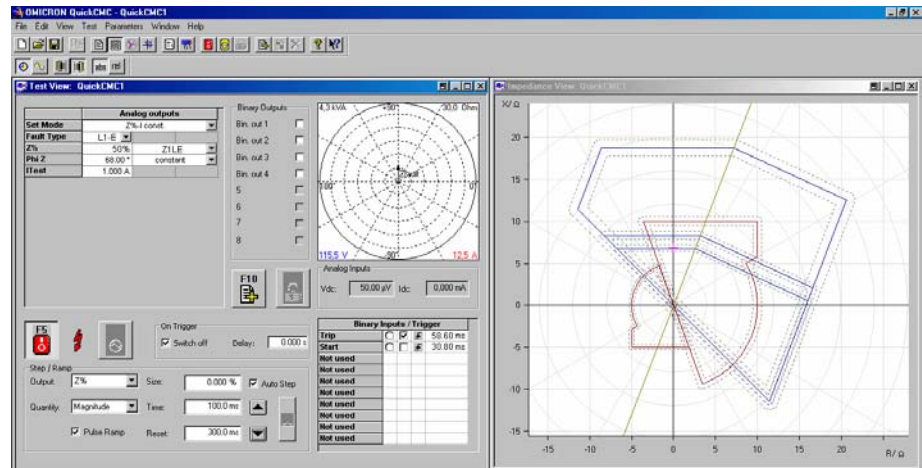
For detailed information on reporting please refer to section 5.2 "Test Reports" on page 78 of the "Concept" user manual.

- At "Set Mode", change the mode to "Z%-I const." for defining a relative shot to ZL1E to determine the trip time of zone 1.
- Set Z% to "50% of ZL1E" (or ZAN) and PhiZ to the "68°" (68° refers to the line angle and can be selected on the context menu).



6. Turn on the CMC's outputs by clicking the F5 "Outputs ON/OFF" button. The measured trip time of 58.60 ms reflects the inherent time of the distance relay as the trip time of zone 1 is set to 0.

Figure 2-5:
Trip time of zone 1



7. Click the F10 "Add To Report" button and enter the corresponding test's title and comment if applicable. Manually assess the test as either passed or failed by clicking the respective button.

Note: Some distance relays require a pre-fault condition for testing. An easy way to simulate a pre-fault condition is to switch to Direct Mode first. There a regular load situation (pre-fault) can be defined by use of the context menus. Afterwards the F9 "Hold" button needs to be clicked before changing to one of the Z-modes. In the Z-mode a shot can be defined and then be released by the F9 "Hold" button again.

Application Hint:

As it is not possible to switch on the CMC and to start the pulse ramp at the same time, it is necessary to put the starting point of the pulse ramp outside zone 3 to determine the reach of zone 1. This is obviously a little bit time consuming in comparison to the possibility of starting the pulse ramp close to the reach of zone 1.

Therefore, the following function is implemented in *QuickCMC*. The starting point of the pulse ramp can now be set just outside of zone 1 in zone 2. By pressing "Shift" on the keyboard and clicking the "Step Down" button at the same time, CMC will start immediately with the pulse ramp.



By using this new function, it is not necessary anymore to start the *Pulse Ramp* outside zone 3 for determining the reach of zone 1.

3 Ramping



The *Ramping* test module provides the user with a versatile tool for defining various types of ramp tests using a CMC test set. Its main field of application is the measurement and assessment of threshold values.

Two functions of any signal combination can be ramped simultaneously with up to five ramp states (depending on the ramp characteristics). For each ramp state, *Ramping* is able to perform an unlimited number of measurements, which are automatically assessed according to user-defined tolerance parameters.

3.1 Ramping Features






The most significant features:

- 5 predefined ramp characteristics of different complexity (1...5 ramp states per characteristics).
- Simultaneous ramping of two output signal combinations possible
- Ramping of superimposed signals
- Every ramp state is executed by the CMC in real time
- Minimum step time of 1 ms
- Ability to perform an unlimited number of measurements for each 5 individual ramp state via binary inputs of the CMC
- Automatic assessment of test points with each single one displayed
- Automatic assessment of calculated quantities, e.g., pick-up / drop-off ratio, or maximum torque angle
- Automatic test repetition with statistic calculations
- Binary output signals definable for each of the five ramp states
- All CMC output values displayed in real time during test
- Ability to define static output conditions for the non-ramped CMC outputs for each single ramp state

A wide variety of tests can be performed using the *Ramping* module. The following are a few examples:

- Relay pick-up test
- Relay drop-off test
- Pick-up / drop-off ratio
- Directional test
- Synchronization test (synchro-check)
- Voltage regulator test for transformers
- Voltage regulator test for generators

Ramping provides 5 different views:

- Test View 
- Detail View 
- Measurement View 
- Report View 
- Signal View 

3.1.1 Test View



In *Ramping's* Test View, you can select the shape of the ramp and set the individual ramp parameters. Furthermore, in the Test View you can set the number of test repetitions and enable the "Average Calculation" feature. This feature carries out a mean value calculation by adding the measured actual values of each ramp state and dividing them by the number of ramp executions.

3.1.2 Detail View



In the Detail View you can:

- set the static values (magnitude, phase angle and frequency) of the non-ramped analog CMC outputs for each individual ramp state.
- activate or deactivate the binary outputs and the transistor outputs of the CMC test set during the execution of the individual ramp states.
- set individual stop conditions for each ramp state (trigger).



Note regarding the phase setting "Force absolute phases" on the Detail View's **Analog Out** tab:

Because it is not likely for a ramp state transition to take place exactly at the signal's zero-axis crossing, phase jumps can occur at the transition from one ramp state to the other. In order to avoid such a phase jump, the execution of the ramp state is stopped at this point by one of the specified options.

In this case, the *Ramping* module adds by default the phase angles at the moment when the execution was stopped to the user-defined start values of the subsequent ramp state.

However, for certain applications it may be necessary for a ramp state to start with absolute phase angle values (i.e. the user-defined values), regardless of the actual phase angle values of the preceding ramp state. To do so, the feature "Force absolute phases" has to be enabled.



For a more detailed description, please refer to the online help. Open the online help, click the "Testing with Ramping" entry in the table of contents and navigate to "Detail View | Analog Out Tab Details | Force Absolute Phases" .

3.1.3 Measurement View

The Measurement View is divided into two tables. The upper table serves to define the measurement conditions and to display the test results; the lower table serves to define calculations of signal relations, e.g., the pick-up / drop-off ratio.

During the output of a ramped signal, an unlimited number of measurements can be performed. The ramp parameters are set independently from the measurement settings. User-specified conditions in the upper table start the measurements, a likewise user-defined trigger stops the ramp (set on the **Trigger** tab of the Detail View).

The measurement is an optional feature. It is not necessary to specify measurement conditions to output a ramped signal.

If no ramp, no condition or no signal was selected, the measurement is invalid, and nothing is measured during the ramp output. If no nominal value or no tolerance value was set, the measurement is performed but not assessed. The measured value, however, can still be used for a calculated condition, such as ratio.

3.1.4 Report View



The Report View displays the test document with data and the assessment results from testing.

3.1.5 Signal View



The Signal View displays the ramp state definition as well as the output ramp states in real-time with the responses acquired on the binary inputs.

The time and signal values can be determined by two markers (cursor sliders).

The displayed values are r.m.s. values in volts for the magnitudes of voltage, in ampere for the magnitudes of current, in degrees for the phase angles, and in Hertz for the frequency.

A context menu allows the following:

- Showing or hiding certain diagrams of the view
- Showing or hiding certain signals in a diagram
- Zooming

Additional Functions in the Signal View

- Marker (cursor slider)

The sliders act as anchor points for the measuring cursors.

In addition they are used to move the cursor horizontally along the time axis. This is done either by using the cursor arrow keys of the PC keyboard or by clicking and dragging with the mouse to the position of your choice. If you prefer to use the cursor arrow keys on your PC keyboard, use the <Tab> key or <Shift> + <Tab> to switch between the cursor sliders.

- Cursor Data dialog box

The Cursor Data dialog box appears every time the Time Signal View is active. This dialog box displays the positions of the cursors 1 and 2 on the time axis and the time difference Δt between the cursors. Furthermore the corresponding values of the signals are also displayed in the *Ramping* test module.

Instead of moving the cursors along the time axis as described above you can also enter the cursor positions directly into the corresponding input fields. The value Δt is a pure display value and cannot be overwritten.

Note: The cursors "stick" at the events to ease the definition of their positions.

- Ramp state transitions

Ramp state transitions from one ramp state to another are represented by vertical lines which are displayed in all diagrams of the view. The ramp states section displayed at the top of the view shows the transitions from one ramp state to the next. Each ramp state transition is designated with the name of the ramp state which starts at that point. This means that the first ramp state transition is displayed at position $t = 0s$ and named "State 1".

- Ramped quantity

The changed signal quantities are displayed as a time function in a diagram. A different line format is used for each quantity that is changed. The assignment between line type and generator output is displayed at the bottom of the diagrams. If more than one quantity is changed simultaneously, an additional ordinate with a corresponding scaling is displayed for the second quantity on the right hand border of the diagram. The displayed values are effective values standing in volts and ampere for the magnitudes of voltage and current, in degrees for the phase and in Hertz for the frequency.

- Binary output signals

The binary output signals are labeled with the designations assigned in the hardware configuration. The binary state 0 is represented by a thin line and the binary state 1 is represented by a stylized rectangle.

- Binary input signals

Like the binary output signals, the binary input signals are also labeled with the designations assigned in the hardware configuration. The binary state 0 is represented by a thin line and the binary state 1 is represented by a stylized rectangle.

3.1.6 Navigation Toolbar

Figure 3-1:
Ramping navigation
toolbar



The navigation toolbar is used to move between the various consecutive ramp states.



For a more detailed description, please refer to the online help. Open the online help, click the "Menus, Toolbar, Status Icons" entry in the table of contents and navigate to "The Navigation Toolbar".

3.2 Example: Pick-up Test for a Generator Protection



Sample file:

Ramping-Generator_Frequency_Protection.occ

Stored at: ...OMICRON Test Universe installation path\
Test Library\Samples\SW Manual Examples\Protection



Task

The tester's job is to secondary-test the generator (frequency) protection 7UM511 (Siemens relay) at a power station as part of a main test. Of particular interest is to test the pick-up / drop-off value of the first generator protection stage which has a parameter setting of 49.5 Hz.



Solution

This is performed using the *Ramping* test module.

3.2.1 Considerations Prior to the Test

1. To carry out a pick-up / drop-off test for a generator (frequency) protection, you have to define two consecutive ramp states in the *Ramping* test module.
 - Ramp state 1: Ramp state from 50 Hz to 49 Hz for the pick-up test of the generator protection.
 - Ramp state 2: Ramp state from 49 Hz to 50 Hz for the drop-off test.
2. You can automate the assessment of the pick-up / drop-off values by entering the nominal values of the generator protection (49.5 Hz for pick-up or 49.52 Hz for drop-off) and the corresponding tolerances (± 0.01 Hz).
During the test, the *Ramping* test module analyzes and evaluates whether the measured values are within the defined tolerance band and assesses the test with "passed" or "failed". All entered values and the measured values are recorded automatically to allow a detailed view of the test process after completion of the test.
3. If you have to perform only one test, it may be advantageous to start the *Ramping* test module as a stand-alone program (without having started the OMICRON *Control Center* (OCC) previously).

Normally all the available protection functions of a relay are tested sequentially. For these cases, it makes more sense to copy and embed the test module multiple times in the Control Center test document. The settings for each copied test module can be modified for a specific test.

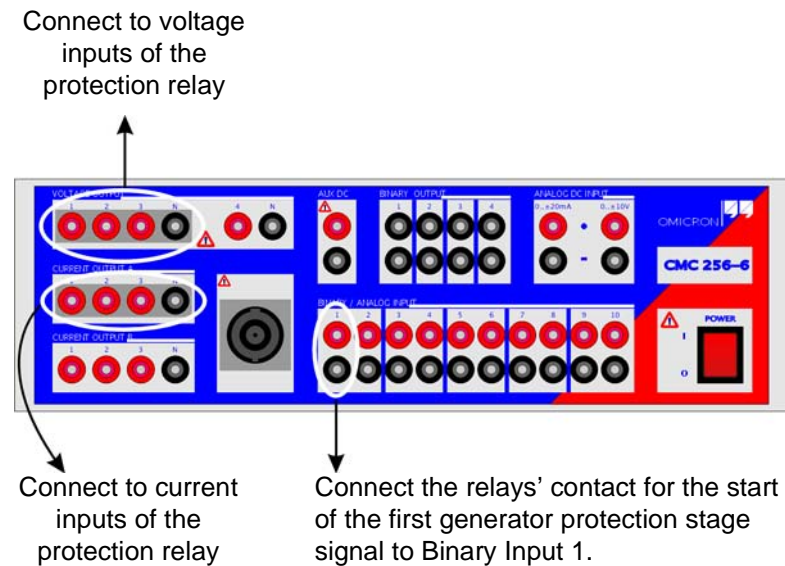
Then the OMICRON *Control Center* can sequentially process all the tests in the test document.

In the following example, the *Ramping* test module is embedded in a test document of the OMICRON *Control Center*.

3.2.2 Wiring Between Generator Protection and CMC

1. The start of the first generator protection stage is attached to a particular contact of the relay. Connect this contact to the binary input of the CMC using suitable test cables. In the example the binary input BinIn1 is used.
2. Connect the current and voltage inputs of the protection relay to the corresponding current and voltage outputs of the CMC test set.

Figure 3-2:
CMC 256 test set,
front view



3.2.3 Starting Ramping from the OCC

Start the OMICRON *Control Center* from the *Start Page* by clicking OPEN EMPTY DOCUMENT. Insert *Ramping* into the OCC document by selecting the menu item INSERT | TEST MODULE... | OMICRON RAMPING.

3.2.4 Setting up the Test Object

To configure the relay you are testing, use the Test Object software function.



Open **Test Object** either by using the pull-down menu item PARAMETERS | TEST OBJECT or by clicking the TEST OBJECT icon in the toolbar. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

3.2.5 Configuring the Hardware



Configure the hardware according to the wiring described in section 3.2.2 "Wiring Between Generator Protection and CMC".



A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

3.2.6 Defining the Test

Step 1: Inserting the Ramping test module into the test document



1. Click the *Ramping* icon in the test modules toolbar
or

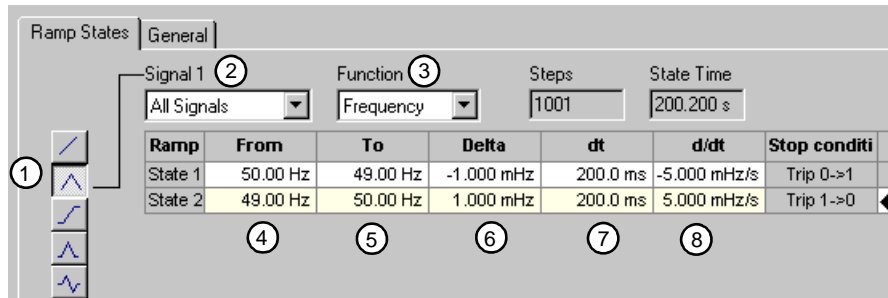


2. select INSERT | TEST MODULE or click the appropriate icon and then select "OMICRON Ramping".

Step 2: Defining the ramp states

1. In the *Ramping* module's Test View, define two consecutive ramp states by clicking the corresponding icon DUAL RAMP (figure 3-3, 1).

Figure 3-3:
Ramp Settings tab

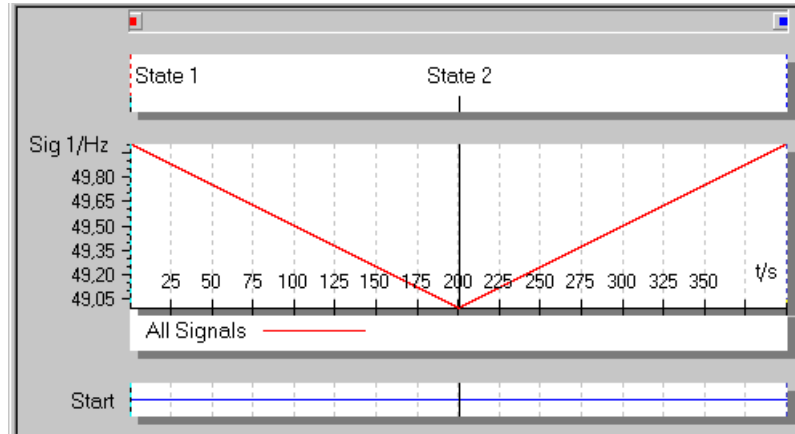


2. As shown in figure 3-3, define the output frequency (3) of all signals (2) as the function to be ramped.
3. Ramp state 1 has to perform the pick-up test of the generator protection at 49.5 Hz.
 - Consequently its frequency range is ramped from 50 Hz (4) to 49 Hz (5).
 - The step size Δf of the signal is defined with 0.001 Hz (6).
 - The step time Δt shall be greater than the tripping time of the relay. In the example Δt was selected with 0.200 s (7).
 - This results in a ramp state with a differential change df/dt (8) of $0.001 \text{ Hz}/0.2 \text{ s} = 0.005 \text{ Hz/s}$.

Note: Instead of changing the step size Δf , you can also input the differential change of the ramp state df/dt directly into the input field (8).

4. Ramp state 2 is defined in the same way but the ramp state 2 parameters have to be opposed to ramp state 1.
5. The defined ramp states are automatically displayed in the Signal View.

Figure 3-4:
Signal View for the
defined ramp states



Step 3: Defining the static output values

All values that are static during the output of the ramp state are defined on the **Analog Out** tab in the Detail View of the *Ramping* test module.

The ramped values are shown on a grey background; the static values are shown on a yellow or white background. You can edit the static values manually by overwriting them.

Figure 3-5:
Display of the static and
the ramped output
signals

Analog Out Binary Out Trigger			
Ramp state 1			
V L1-E	57.735 V	0.00 °	50.000 Hz
V L2-E	57.735 V	-120.00 °	50.000 Hz
V L3-E	57.735 V	120.00 °	50.000 Hz
I L1	1.000 A	0.00 °	50.000 Hz
I L2	1.000 A	-120.00 °	50.000 Hz
I L3	1.000 A	120.00 °	50.000 Hz

Step 4: Defining the trigger conditions

You have to inform the test module which contacts (i.e. binary inputs of the CMC) react to the pick-up or drop-off of the relay.

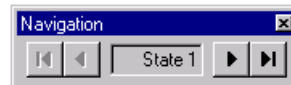
In the example, the start contact is connected to binary input 1 of the CMC and is named "St_UnderFreq".

1. Select the **Trigger** tab in the Detail View (figure 3-7).

Please note that the trigger condition has to be defined individually for each ramp state.

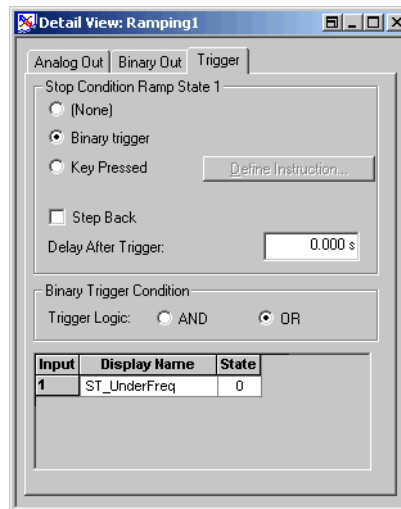
Use the navigation toolbar to change between individual ramp states.

Figure 3-6:
Navigation toolbar of the
Ramping test module



2. During ramp state 1, the start contact should close, i.e. switch from state "0" to state "1". Consequently, you have to set the binary trigger condition $St_UnderFreq = 1$ for ramp state 1 on the "Trigger" tab.
3. Set the binary trigger condition $St_UnderFreq = 0$ for ramp state 2.

Figure 3-7:
Trigger tab of the Detail
View



The feature "Step Back" enables a sub ramp to be executed which makes it possible to find pick-up values in a quick and exact manner. For a more detailed description, please refer to the online help. Open the online help, click the "Testing with Ramping" entry in the table of contents and navigate to "Detail View | Trigger Tab Details | Step Back" .

Step 5: Defining the nominal values and tolerances

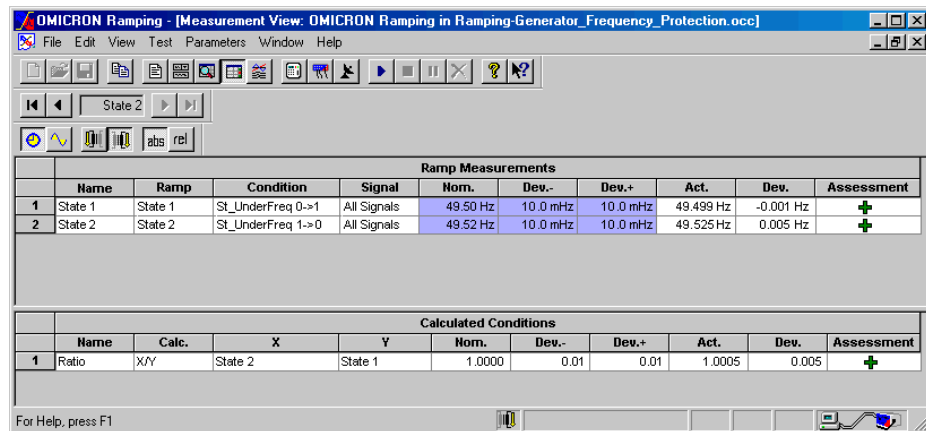
Change to the Measurement View. This View is divided into two tables. The upper table serves to define the measurement conditions and to display the test results; the lower table serves to define calculations of signal relations.

During the output of a ramped signal, an unlimited number of measurements can be performed. The ramp parameters are set independently from the measurement settings. User-specified conditions in the upper table trigger the measurements.

The measurement is an optional feature. It is not necessary to specify measurement conditions to output a ramped signal. If no ramp, no condition or no signal was selected, the measurement is invalid, and nothing is measured during the ramp output. If no nominal value or no tolerance value was set, the measurement is performed but not assessed. The measured value, however, can still be used for a calculated condition, such as ratio.

Figure 3-8, column "Act.", shows the value of the ramped function at the moment the trigger condition is fulfilled.

Figure 3-8:
Measured values and
assessment of each
ramp state



The screenshot shows the 'Measurement View' of the OMICRON Ramping software. The window title is 'OMICRON Ramping - [Measurement View: OMICRON Ramping in Ramping-Generator_Frequency_Protection.occ]'. The interface includes a menu bar (File, Edit, View, Test, Parameters, Window, Help), a toolbar with various icons, and a control panel with 'State 2' and 'abs rel' buttons. Below the control panel are two tables:

Ramp Measurements										
	Name	Ramp	Condition	Signal	Nom.	Dev.-	Dev.+	Act.	Dev.	Assessment
1	State 1	State 1	St_UnderFreq 0->1	All Signals	49.50 Hz	10.0 mHz	10.0 mHz	49.499 Hz	-0.001 Hz	+
2	State 2	State 2	St_UnderFreq 1->0	All Signals	49.52 Hz	10.0 mHz	10.0 mHz	49.525 Hz	0.005 Hz	+

Calculated Conditions										
	Name	Calc.	X	Y	Nom.	Dev.-	Dev.+	Act.	Dev.	Assessment
1	Ratio	X/Y	State 2	State 1	1.0000	0.01	0.01	1.0005	0.005	+

At the bottom of the window, there is a status bar with the text 'For Help, press F1' and a small icon.

An automatic assessment of the measured pick-up and drop-off values is performed when a nominal value and tolerances are entered.

Figure 3-8 shows the nominal and the actual values as well as the automatic assessment after a performed test.

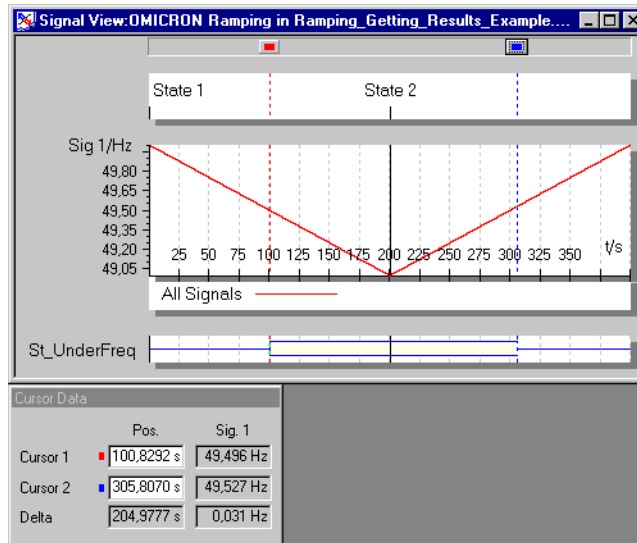
3.2.7 Running the Test

You can start the actual test after you have finished the input of the relevant data and performed the necessary settings.



1. To start the test, click the **START** icon in the toolbar of the *Ramping* test module.
2. After the test is complete, the result in the Measurement View will look similar to figure 3-8.
3. The test results are also displayed in the Signal View (figure 3-9).

Figure 3-9:
Test results displayed in
the Signal View



3.2.8 Defining the Test Report

Select **PARAMETERS | REPORT**. A dialog box appears where you can define the scope of the report.



A detailed description about defining test reports can be found in the "Concept" manual's section 5.2 "Test Reports", or in the online help under the **--- Test Reports ---** entry of the table of contents.



Select **VIEW | REPORT** to display the test report.

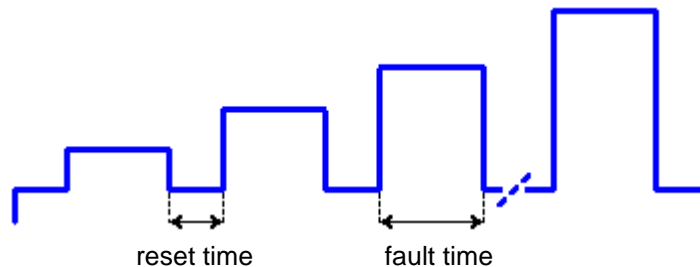
4 Pulse Ramping



The test module *Pulse Ramping* provides functionality to ease the testing of pick-up values of a multi-functional protection relay with more than one protection function and/or elements.

To do so, *Pulse Ramping* generates a sequence of pulses (each pulse width representing the fault time) with an increasing (or decreasing) step size. In between two consecutive ramp pulses, a "reset" state is inserted. Therefore, a pulse ramp is actually a ramp that is interrupted after each pulse for a defined period of time. The ramp pulses are increased by the step size as long until the ramp either reaches its maximum value or the pick-up threshold (depends on the setting "Stop Ramp on measurement" on the **Test Conditions** tab).

Figure 4-1:
A typical pulse ramp



Pulse Ramping does not require one or more start contacts to be wired to the CMC, all measurements can be done using the trip contact. Therefore, parameterizing and wiring of start contacts are not required. Furthermore, *Pulse Ramping* determines all pick-up values of a multi-functional relay without the necessity of disabling interfering relay elements.

The fault time must be set just long enough for the function under test to trip. The other function(s) of the protection relay, the ones that have a longer trip time than the function under test, will not trip. After each fault pulse, a reset state resets the relay. Therefore, the duration of the fault time actually determines the function and/or element of the protection relay to be tested. The fault time must be set longer than the trip time of the function under test but shorter than the trip times of the upstream protection elements.

The reset time must be long enough for the relay to properly reset.

A pulse ramp can be generated on one or more CMC current or voltage output(s), ramping any CMC output quantity of your choice: magnitude, frequency or angle. This way, A-N (L-E), A-B (L-L) and A-B-C (L-L-L) faults can be simulated.

The following example shows a typical application example of *Pulse Ramping*.

4.1 Example: Pick-Up Test I>> Element of a Multifunctional Generator Protection Relay



Sample file: PulseRamping_7UM511.pra

Stored at: ...OMICRON Test Universe installation path\
Test Library\Samples\SW Manual Examples\Protection



Task

Commissioning the multifunctional generator protection relay 7UM511 (SIEMENS). Among other test points the tester has to determine the pick-up value of the instantaneous overcurrent element I>>. It is not permitted to change any settings at the relay for testing purposes. The test is done with the trip contact.

Relay settings:

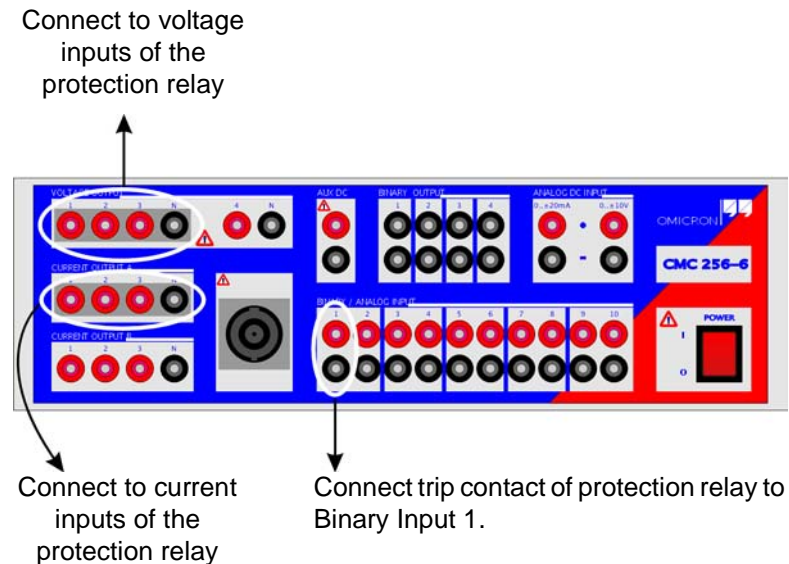
CV/VT Data	
Nominal Current Secondary	1 A
Nominal Current Primary	1000 kA
Nominal Voltage Secondary	100 V L-L
Nominal Voltage Primary	10500 V L-L

Protection Function	Pick-up	Trip time
51 I>	1.2 A	3 s
50 I>>	2.5 A	100 ms
32 Reverse Power	-1% of nominal power	10 s
46 Negative Sequence Overcurrent	60%	3 s
27 V<	75 V L-L	1.5 s
40 Loss Of Field	$\lambda 1 = 0.4$ $\alpha 1 = 80^\circ$ $\lambda 2 = 0.35$ $\alpha 2 = 90^\circ$	5 s
40 Loss of Field Instantaneous	$\lambda 3 = 1.1$ $\alpha 3 = 90^\circ$	1.5 s

4.1.1 Wiring between Protection Relay and CMC Test Set

1. Connect the current and voltage inputs of the protection relay to the corresponding current and voltage outputs of the CMC test set.
2. Connect the relay's trip contact to the CMC test set's Binary Input BinIn1.

Figure 4-2:
CMC 256 test set,
front view



4.1.2 Starting the Pulse Ramping Test Module

Start the *Pulse Ramping* test module in stand-alone mode from the OMICRON *Start Page* by clicking *Ramping...* | *Pulse Ramping*.

4.1.3 Setting up the Test Object

To configure the relay you are testing, use the Test Object software function.



Open **Test Object** either by using the pull-down menu item **PARAMETERS** | **TEST OBJECT** or by clicking the **TEST OBJECT** icon in the toolbar. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

4.1.4 Configuring the Hardware



In the Hardware Configuration reflect the wiring as described in 4.1.1 "Wiring between Protection Relay and CMC Test Set":

- 3 currents (here: IA, IB, IC)
- 3 voltages (here: VL1, VL2, VL3)
- and the trip contact (binary input "Trip").



A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

4.1.5 Defining the Pulse Ramp

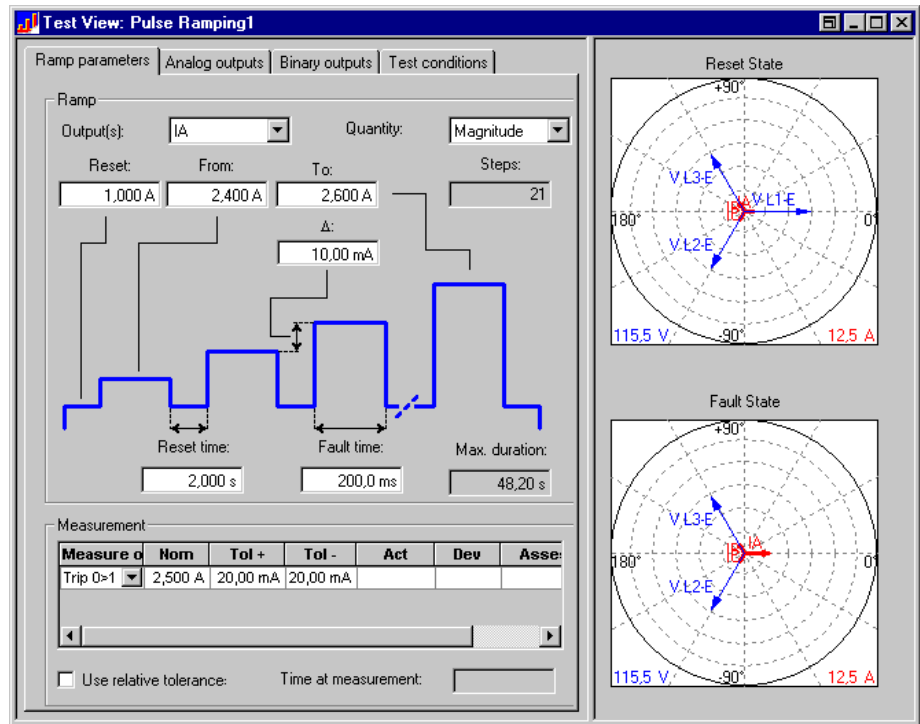
Step 1: Setting the ramp parameters

In *Pulse Ramping's* Test View, select the **Ramp Parameters** tab, and define a ramp according to the following table:

Table 4-1:
Ramp parameters to set

Field	Value	Comment
Output(s)	IA	The test is made for fault loop IA-N (IL1-E)
Quantity	Magnitude	We ramp the current magnitude
Reset	1 A	After each pulse the relay will reset because it detects normal operating conditions (nominal current).
From	2,4A	We know the pick-up should be around 2.5A
To	2,6A	
Δ	10mA	We are satisfied with an accuracy of +- 10mA
Reset Time	2s	The relay will be reset if it sees nominal operating conditions after the fault for at least 2s
Fault Time	200ms	t>> is 100ms. Therefore, 200ms will be sufficient to cause the relay to trip for the I>> function, however, it will not cause a trip for any other function.
Measure On	Trip 0>1	
Nom	2.5A	This is the expected pick-up value.
Tol+	20mA	2.52A is the upper tolerance limit.
Tol-	20mA	2.48A is the lower tolerance limit.

Figure 4-3:
Pulse Ramping Test View. On the **Ramp Parameters** tab the pulse ramp is defined



Step 2: Setting the analog outputs

On the **Analog Outputs** tab set the values of the CMC's static analog outputs, i.e., the outputs that are not ramped. The analog output values are set independently for the reset state and the fault state.

Figure 4-4:
The **Analog Outputs** tab showing IA as the ramped output

	Reset state			Fault state		
V L1-E	57,73 V	0,000 °	50,00 Hz	0,000 V	0,000 °	50,00 Hz
V L2-E	57,73 V	-120,0 °	50,00 Hz	57,73 V	-120,0 °	50,00 Hz
V L3-E	57,73 V	120,0 °	50,00 Hz	57,73 V	120,0 °	50,00 Hz
I L1	1,000 A	0,000 °	50,00 Hz	2,400 A	0,000 °	50,00 Hz
I L2	1,000 A	-120,0 °	50,00 Hz	1,000 A	-120,0 °	50,00 Hz
I L3	1,000 A	120,0 °	50,00 Hz	1,000 A	120,0 °	50,00 Hz

In this example, the magnitude of IA is ramped, therefore the values of all magnitudes but IA can be set here.

Since the relay needs to reset properly, the Reset state is set to 3-phase nominal current (1 A) and nominal voltage (57.73 V).

The Fault state simulates an IA to earth fault. Therefore, IB and IC are kept at nominal current. For the voltages we assume that the fault causes VA-N (VL1-E) to drop to 0 V with VB-N (VL2-E) and VC-N (VL3-E) remaining at nominal values.

Binary outputs

Binary outputs are not required for this test.

Test Conditions

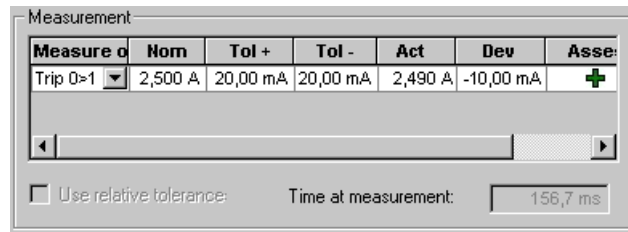
The settings on the **Test Conditions** tab are left at their default settings. This results in an immediate start of the test as soon as the **PLAY** button is pressed, and a stop of the ramp if the trip occurred.

4.1.6 Running the Test



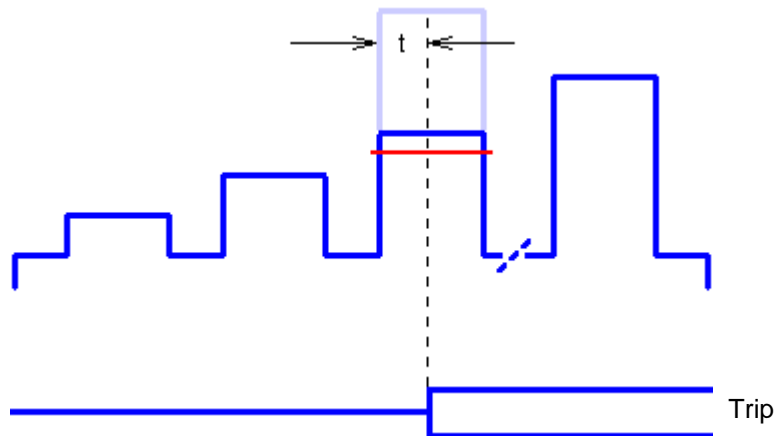
- To start the test, either left-click the PLAY button or select the pulldown menu item TEST | START / CONTINUE.
- Both the ramped signal and the static values are now output.
- When the test is finished, the result will look like figure 4-5:

Figure 4-5:
Test results



Note: "Time at measurement" displays the elapsed time (t) since the beginning of the pulse in which the trip occurred and the actual trip. The red line in figure 4-6 indicates the trip threshold.

Figure 4-6:
"Time at Measurement"



According to the norm, measuring the trip time would require twice the trip value (shown as a light blue pulse in figure 4-6). This is not the case here. To correctly determine the trip time, we recommend test modules like *State Sequencer*.

4.1.7 Defining the Test Report

Select **PARAMETERS | REPORT**. A dialog box appears where you can define the scope of the report.



A detailed description about defining test reports can be found in the "Concept" manual's section 5.2 "Test Reports", or in the online help under the --- **Test Reports** --- entry of the table of contents.



Select **VIEW | REPORT** to display the test report.

4.1.8 Saving and Printing the Test



To save and/or print the test, use either the respective toolbar icons or the pull-down menus **FILE | SAVE** and **FILE | PRINT**.

A saved *Pulse Ramping* test file gets the file name extension **.pra**.

5 State Sequencer



The test module *State Sequencer* allows:

- a sequence of states to be defined,
- the output of each state's values to a test object in real time,
- to repeat the output of the user-defined states in an infinite loop.

The test object's responses can be measured and recorded as functions of time and analyzed either automatically or manually after testing.

Trigger conditions can be specified to control the sequence progression. These trigger conditions may be defined by:

- state duration
- change of the output state of a test object
- manual control
- external signals.

5.1 State Sequencer Views

State Sequencer comprises a total of seven Views:



Table View

Provides an overall view of the sequence whereby the Detail View provides an in-depth view of all parameters for one state at a time.



Report View

Permits using either a default report setting or a customized setting, which includes only those elements of the test settings and results that are of interest to you.



Detail View

Used for defining the parameters for each state of the sequence.



Vector Diagram View

Used for defining the parameters for each state of the sequence.



Impedance View

Displays the fault impedance calculated by the Fault Calculator. It gets the ZFault value in the complex plane, i.e., it returns the actual absolute value of ZFault. It will be empty if a set mode without a fault type is selected in the Multifunction Input Grid. Calculating the fault voltage and/or the fault current is now done by the fault calculator server. Therefore neither the fault type nor the test model setting is needed.

The Impedance Plane displays the distance relay characteristic of an actual loaded XRIO file. For line to ground faults, the k-factor set in the Test Object / XRIO is taken into consideration.

You can switch between primary and secondary values using the Unit Manager (refer to chapter 5.3.3 "The Unit Manager" in the **Concept** manual), e.g., you are in secondary value mode but you want to display your impedances in primary values mode. The Impedance View diagram displays a title according to the status of the Unit Manager.

More details can be found in the online help topics "Impedance View" and "Multifunctional Input Grid (Fault Calculator)".



Measurement View

Allows specification of timing events and assesses the measurements as either "passed" or "failed" based on the expected nominal time and given deviation margins. Interactive time measurement is also possible within the Time Signal View. Also assesses the levels of binary inputs as either "passed" or "failed" based on the time tolerance and the level condition of various binary inputs.



Time Signal View

Shows voltage and current traces, binary input states (1 or 0), and state transitions as functions of time.

5.2 Z Shot

The Z Shot function appends an impedance fault state to the current sequence.

This impedance state is comprised of a total of three states, which are inserted after the currently selected state of the sequence: a pre-fault state, a fault state, and a post-fault state.

It allows the setting of parameters such as

- line impedance $|Z|$ and $\text{Phi } |Z|$
- grounding factor $|k0|$ and $\text{Phi } |k0|$
- fault type
- location of the fault (realized by a multiplier for the line impedance value to build the actual fault impedance)

In order to insert a Z Shot, select the menu item `EDIT | INSERT Z SHOT`.

Inserting a Z Shot creates a new entry at the end of the measurement table and sets the focus to the post-fault state to allow the entry of another shot.

The Z Shot function requires the following preconditions:

- The generator voltage triple VA-N (VL1-E), VB-N (VL2-E), VC-N (VL3-E) is routed. This triple is used for the output of the voltages of the three-phase model.
- The generator current triple IA (IL1), IB (IL2), IC (IL3) is routed. This triple is used for the output of the currents of the three-phase model.

In case of either a one- or two-phase fault, the fault currents start at zero at transition. In case of a three-phase fault, IL1 (IA respectively) starts at zero.

5.3 Z State

Z State is a reduced version of the feature Z Shot. It inserts one fault state with a user-defined duration after the currently selected state.

There is no trigger and measurement condition created. All other issues mentioned in Z Shot also apply to Z State.

5.4 Example 1: Fuse-Fail Function



Sample file:

Sequencer_Fusefail.seq

Stored at: ...OMICRON Test Universe installation path\
Test Library\Samples\SW Manual Examples\Protection



Task

Test the Fuse-fail (also called "Loss of Potential" or "VT Fail") function of a distance relay.

Solution

A multi-step automatic program is required for testing the fuse-fail function.

- Step 1: Tests the conditions of the healthy system.
- Step 2: Tests the fuse-fail condition, whereby one voltage is stepped to zero Volts for a time longer than the fuse-fail timer.
- Step 3: To verify that the fuse-fail function definitely blocks the trip signal, a ground fault (zero volts, high current) should be injected, for which the relay is then not allowed to trip.

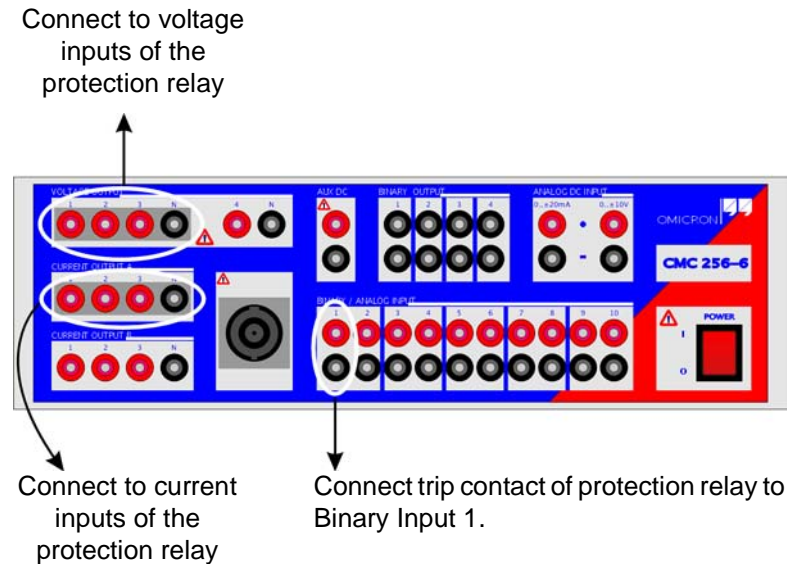
This is an ideal application for the *State Sequencer*, where any number of voltage or current states can be defined. Transition from one state to the next is instantaneous and depends either on a fixed time or on a trigger condition as defined for the binary inputs.

If only the fuse-fail function needs to be tested, the *State Sequencer* test module can be used stand-alone. Also, if only a manual test is required, it can be performed using *QuickCMC*.

5.4.1 Wiring Between Protection Relay and CMC Test Set

1. Connect the current and voltage inputs of the protection relay to the corresponding current and voltage outputs of the CMC test set. The starpoints of the input CTs and VTs of the relay have to be connected to "N" of the CMC.
2. Connect the relay's trip contact to the CMC test set's Binary Input BinIn1.

Figure 5-1:
CMC 256 test set,
front view



5.4.2 Starting State Sequencer from the OCC

Start the OMICRON *Control Center* from the *Start Page* by clicking OPEN EMPTY DOCUMENT. Insert *State Sequencer* into the OCC document by selecting the menu item INSERT | TEST MODULE... | OMICRON STATE SEQUENCER.

5.4.3 Setting up the Test Object



For configuration of your relay under test, the correspondingly named software function **Test Object** is used. Open **Test Object** with the pull-down menu item **PARAMETERS | TEST OBJECT**. Alternatively, click the Test Object icon in the toolbar. In **Test Object** browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

5.4.4 Configuring the Hardware



Configure the hardware according to the wiring described in section 5.4.1 "Wiring Between Protection Relay and CMC Test Set".

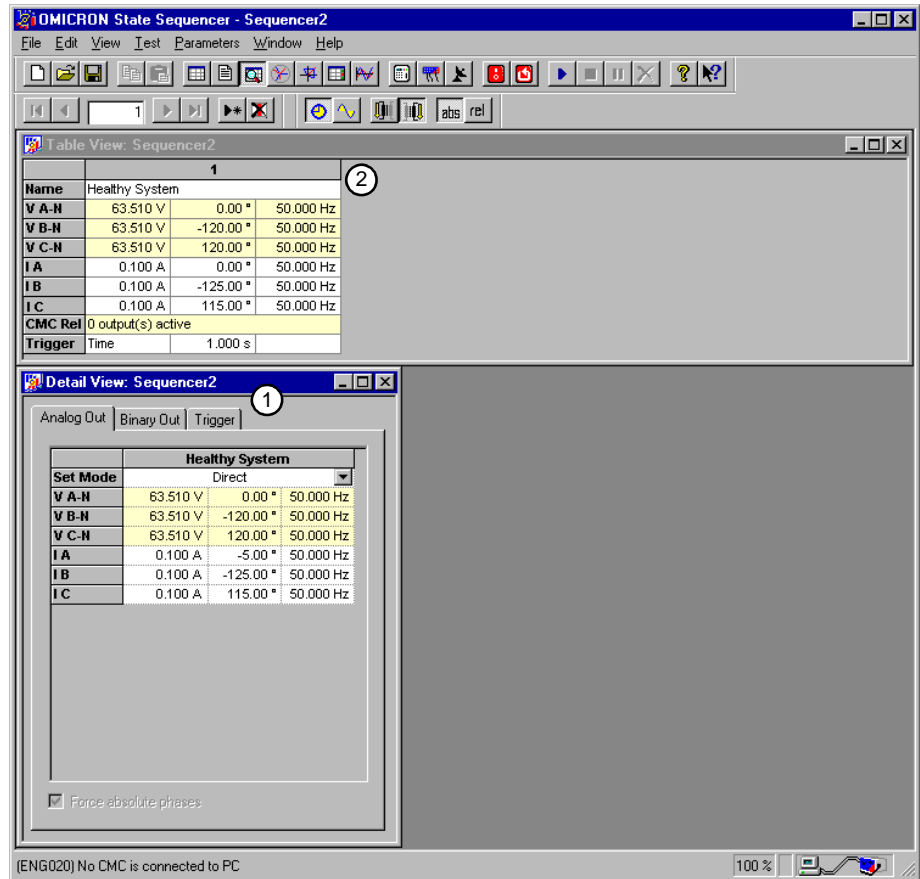


A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

5.4.5 Defining the Test

Step 1: Defining state 1, healthy system

Figure 5-2:
Test View, defining
state 1



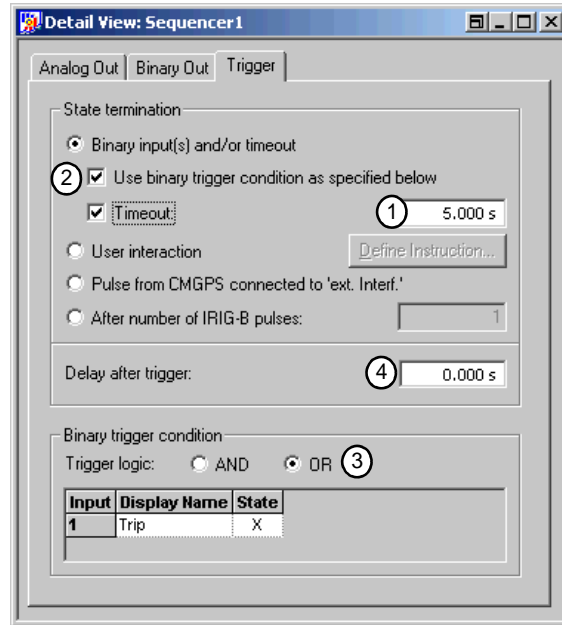
1. Define state 1 in the "Detail View" (figure 5-2, 1):
Balanced nominal voltages at 63.51V with balanced angles. Balanced load current at 0.1A and a load angle of 5° lagging. Enter a name "Healthy system".

Note: The properties sheet (right mouse click) to equal magnitudes, balance angles, etc. is available for all fields.

The values entered in the "Detail View" are automatically transferred to the "Table View" (2).

2. Select the **Trigger** tab in the "Detail View".

Figure 5-3:
Detail View, Trigger tab



Each state of a sequence must have its individual trigger condition. Only if the trigger condition of state *n* is fulfilled and terminates the state, *State Sequencer* will run state *n+1*.



For a detailed description about trigger conditions, please refer to the online help. Open the online help, click the "The State Sequencer View" entry in the table of contents and navigate to "Detail View". The Detail View topic contains a section "Trigger tab".

3. The healthy state should be output for a max. period of 5 seconds (figure 5-3, 1). The 5.000 s at "Timeout:" represent the maximum state time. If in this time period a binary trigger (2) occurs, *State Sequencer* terminates this state prematurely and runs the next state. If no trigger is detected in that time, this state terminates after "Timeout:" elapsed and runs the next state.

A binary trigger condition is defined by selecting "Use binary trigger condition as specified below" (2). Define a trigger condition AND or OR at (3). The binary inputs available here depend on the inputs defined and routed in the **Hardware Configuration** on the the **Binary/Analog Inputs** tab.

A fixed time delay after a trigger condition can be defined (4).

4. Select the **Analog Out** tab.

Note: The **Analog Output** page is not available if no analog outputs are routed in the **Hardware Configuration**.

Step 2: Defining state 2, fuse-fail state



1. Click the New State icon or select **EDIT | INSERT STATE**.
2. Edit the amplitude of "V A-N" (VL1-E) to 0V. Leave all other voltages and currents as is. Enter a name "Fuse-fail State".
3. The fuse-fail state should be output for a fixed time of 15 seconds.

Step 3: Defining state 3, A-N (L1-E) fault

1. Define another new state.
2. Define a new name and edit I A = 2A at -75° .
3. This state should be output for a maximum of 1 second (figure 5-4, 1). Set a binary trigger condition (2) for the trip signal (3) for the event that the relay trips. Also define a delay after trigger of 40 ms (4).

Figure 5-4:
Test View, defining
state 3

The screenshot displays the OMICRON State Sequencer software interface. The main window is titled "OMICRON State Sequencer - Sequencer2". Below the menu bar and toolbar, there is a "Table View: Sequencer2" window showing a table of states and their parameters. The table has three columns for states 1, 2, and 3. State 1 is "Healthy System", State 2 is "Fuse-fail State", and State 3 is "A-N Fault". The table lists parameters for voltages (V A-N, V B-N, V C-N), currents (I A, I B, I C), and CMC Rel. State 3 is configured with 2,000 A at -75° and a 1,000 s timeout.

	1			2			3		
Name	Healthy System			Fuse-fail State			A-N Fault		
V A-N	63,510 V	0,00°	50,000 Hz	0,000 V	0,00°	50,000 Hz	0,000 V	0,00°	50,000 Hz
V B-N	63,510 V	-120,00°	50,000 Hz	63,510 V	-120,00°	50,000 Hz	63,510 V	-120,00°	50,000 Hz
V C-N	63,510 V	120,00°	50,000 Hz	63,510 V	120,00°	50,000 Hz	63,510 V	120,00°	50,000 Hz
I A	0,100 A	-5,00°	50,000 Hz	0,100 A	-5,00°	50,000 Hz	2,000 A	-75,00°	50,000 Hz
I B	0,100 A	-125,00°	50,000 Hz	0,100 A	-125,00°	50,000 Hz	0,100 A	-125,00°	50,000 Hz
I C	0,100 A	115,00°	50,000 Hz	0,100 A	115,00°	50,000 Hz	0,100 A	115,00°	50,000 Hz
CMC Rel	0 output(s) active			0 output(s) active			0 output(s) active		
Trigger	Time 5,000 s			Time 15,000 s			Time, Bin 1,000 s		

The "Detail View: Sequencer2" window is open, showing the configuration for state 3. The "State termination" section is set to "Binary input(s) and/or timeout". The "Use binary trigger condition as specified below" option is checked, and the "Timeout" is set to 1,000 s. The "Delay after trigger" is set to 40,00 ms. The "Binary trigger condition" section shows "Trigger logic" set to "OR". The "Input" table shows a trigger condition for "Trip" (3) with state "X".

The "Vector Diagram: Sequencer2" window shows a circular vector diagram with three voltage vectors (V A-N, V B-N, V C-N) and one current vector (I A). The current vector I A is shown at -75° with a magnitude of 12,5 A. The voltage vectors are shown at 0° , 120° , and 240° with a magnitude of 115,5 V.

The "Table View" lists all voltages and currents for all three states in one table.



4. Click the Vector Diagram icon or select **VIEW | VECTOR DIAGRAM** to display a vector diagram for the currently selected state, in this case state 3.

Note: The Vector View disappears if no analog outputs are routed. The menu option and toolbar button is disabled in this case. They are enabled as soon as the analog outputs are routed again.

5.4.6 Running the Test



Running a test is only possible, if no test results are present. If necessary, clear the results by clicking the Clear icon or selecting **TEST | CLEAR**.

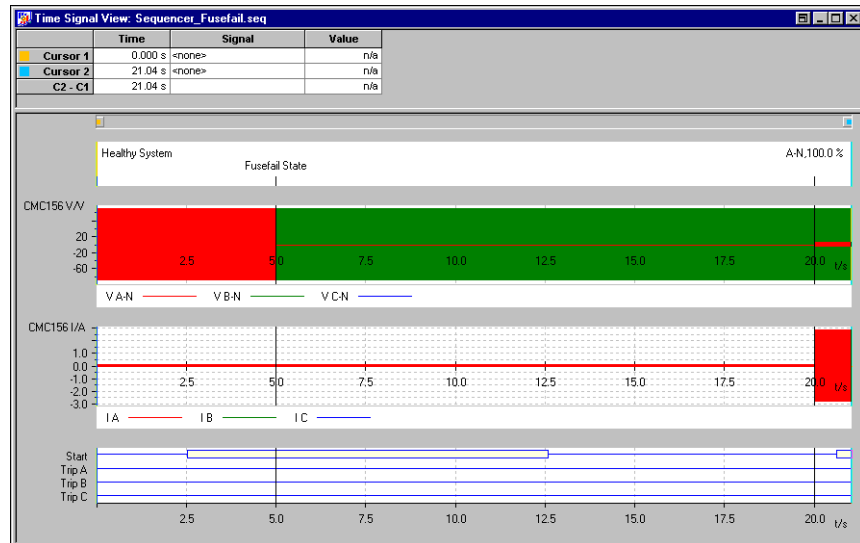


1. Click the Start/Continue Test icon or select **TEST | START**.



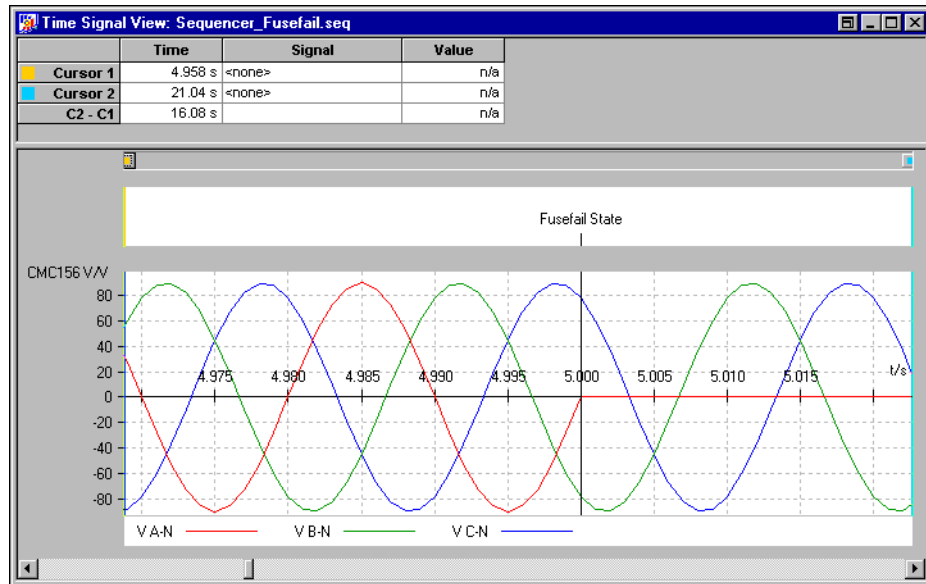
2. To view the output voltages and currents, click the Time Signal View icon or select **VIEW | TIME SIGNAL**.

Figure 5-5:
Time Signal View



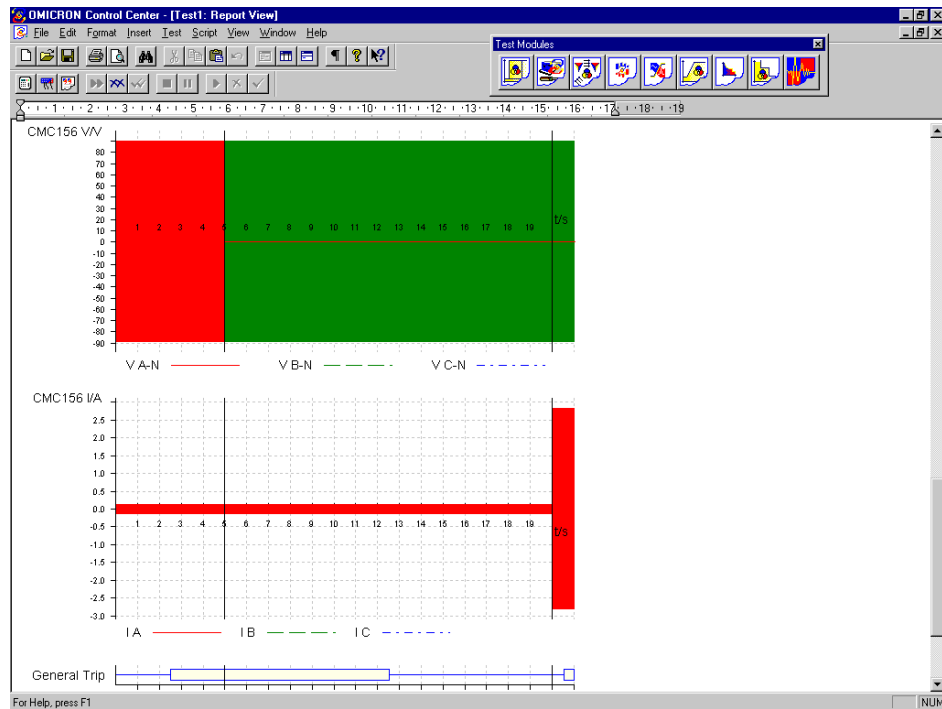
3. You can zoom in or out on the time signal display. The signals shown can be switched off using the properties sheet (right mouse click of the Time Signal View window).

Figure 5-6:
Time Signal View -
voltage signals zoomed



4. Close *State Sequencer* and return to the *Control Center*.

Figure 5-7:
Time Signal View



5.4.7 Defining the Test Report

Select **PARAMETERS | REPORT**. A dialog box appears where you can define the scope of the report.



A detailed description about defining test reports can be found in the "Concept" manual's section 5.2 "Test Reports", or in the online help under the --- **Test Reports** --- entry of the table of contents.



Select **VIEW | REPORT** to display the test report.

5.5 Example 2: Feeder Autoreclosure



Sample file:

Sequencer_ARC.seq

Stored at: ...OMICRON Test Universe installation path\
Test Library\Samples\SW Manual Examples\Protection



Task

The auto-reclose function of a feeder protection scheme is to be tested with an unsuccessful auto-reclose sequence for an A-N (L1-E) fault.

The following settings are provided:

Tripping scheme:	Single pole / three pole tripping
Ground fault ARC sequence:	single pole trip ⇔ three pole trip ⇔ lock-out.
Dead time for single pole trip:	500 ms
Dead time for three pole trip:	1 s
Typ. instantaneous tripping time:	50 ms



Solution

The following sequence of states needs to be simulated for a complete unsuccessful ARC cycle:

- Prefault: Nominal voltages and load currents for 1 s.
- A-N (L1-E) fault at 1Ω until phase A trips.
- Dead time No. 1: The A pole open (i.e. no voltage and current on phase A, but nominal voltages and load currents on phase B and C), until the ARC signal is issued.
- Shot No. 1: Same as A-N (L1-E) fault.
- Dead time No. 2: All three poles open (i.e. no voltage or current on any phase), until the ARC signal is issued.
- Shot No. 2: Same as A-N (L1-E) fault.
- Lock-out: Same as dead time No. 2.

Seven states need to be simulated, one after another. The transition from one state to the next should be instantaneous. The OMICRON *Test Universe* offers the *State Sequencer* test module, which is designed for situations as described above.

To test a complete distance protection scheme, all primary and auxiliary functions of the scheme need to be tested sequentially. In order to test such a scheme with one complete and automatic test procedure, the *State Sequencer* test should be embedded into an OMICRON *Control Center* document.

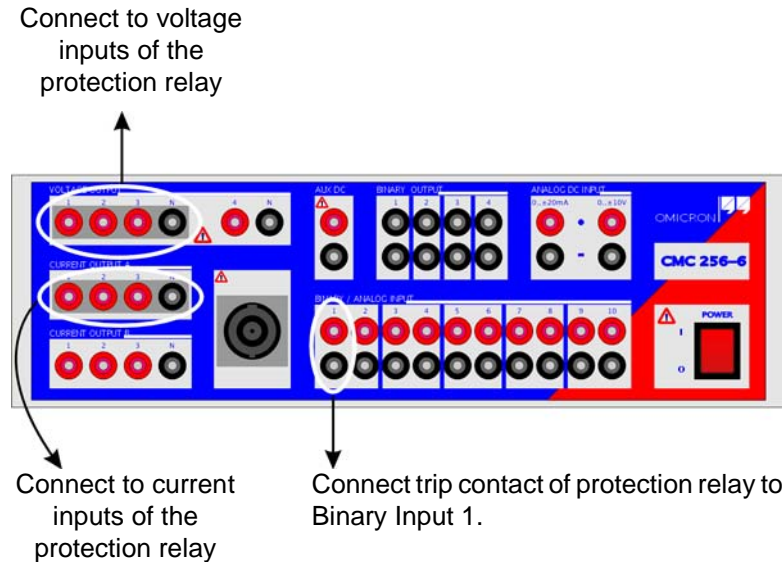


The *State Sequencer* can, however, also be used stand-alone; this example for the *State Sequencer* is in the stand-alone mode.

5.5.1 Wiring Between Relay and CMC

1. Connect the voltage inputs of the protection relay to the corresponding voltage outputs of the CMC test set.
2. Connect the current inputs of the protection relay to the corresponding current outputs of the CMC test set. Make sure that the current outputs of the relay, i.e., the output side of the current transformers, are connected together in a starpoint.
3. Connect the trip signals from the relay for phases A, B and C to Binary Inputs 1, 2 and 3 of the CMC test set.
4. Connect the ARC initiate signal from the protection relay to Binary Input 4 of the CMC test set.

Figure 5-8:
CMC 256 test set,
front view



5.5.2 Starting State Sequencer

Start *State Sequencer* in stand-alone mode from the OMICRON *Start Page* by clicking STATE SEQUENCER.

5.5.3 Setting up the Test Object

To configure the relay you are testing, use the Test Object software function.



Open **Test Object** either by using the pull-down menu item PARAMETERS | TEST OBJECT or by clicking the TEST OBJECT icon in the toolbar. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

5.5.4 Configuring the Hardware



Configure the hardware according to the wiring described in section 5.5.1 "Wiring Between Relay and CMC".



A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

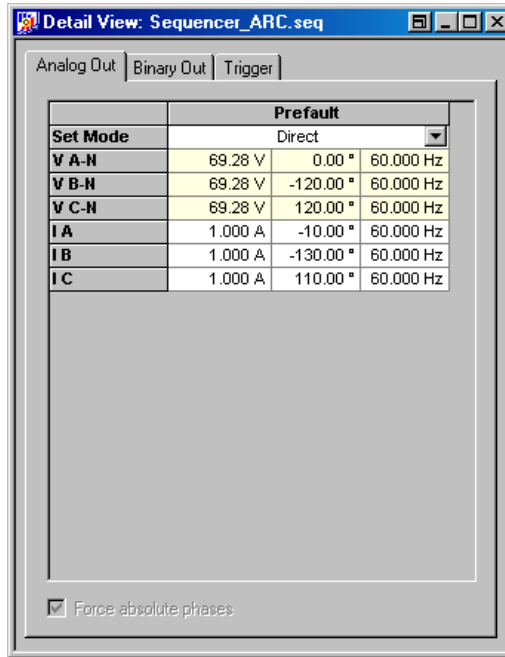
5.5.5 Defining the Test

Step 1: Defining the predefault state

1. In the "Name" field of the Table View, rename the default state "State 1" to "Prefault".
2. Either in the Table View or the Detail View, for this predefault state enter:
 - the voltages: 69.28 V, balanced at 0° for V A-N (L1-E), 60 Hz
 - the currents: 1 A, balanced at -10° for I A, 60 Hz

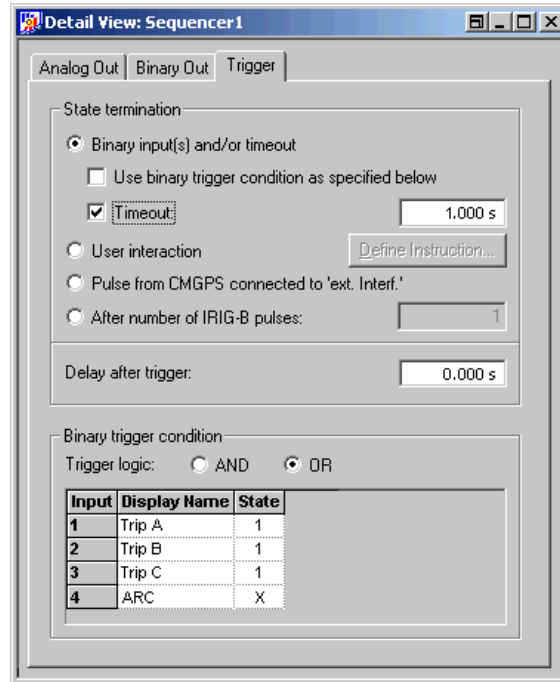
Note: A context menu (right mouse click) is available for all entry fields (amplitude, phase angles, and frequency).

Figure 5-9:
Defining the predefault
state on the **Analog Out**
tab of the Detail View



5. Select the **Trigger** tab.

Figure 5-10:
Defining the trigger
condition on the **Trigger**
tab



For a detailed description about trigger conditions, please refer to the online help. Open the online help, click the "The State Sequencer View" entry in the table of contents and navigate to "Detail View". The Detail View topic contains a section "Trigger tab".

6. At "Timeout", define the maximum state time 1.000 s.
7. Ensure that all other trigger conditions are disabled, because this state should be output for exactly 1 s.

Note: All the parameters entered are automatically copied to the Table View.

Step 2: Defining the A-N (L1-E) fault state

1. Click the New State icon in the Navigation toolbar or select **EDIT | INSERT STATE**. A new state is appended to the first one.

Figure 5-11:
Navigation toolbar



The parameters of this state are identical to those of the previous state.

2. Edit the parameters for **V A-N (V L1-E)** and **I A (I L1)** to represent an A-N (L1-E) fault with 1Ω fault impedance ($V_{A-N} = 10 \text{ V} @ 0^\circ$; $I_A = 10 \text{ A} @ -75^\circ$).

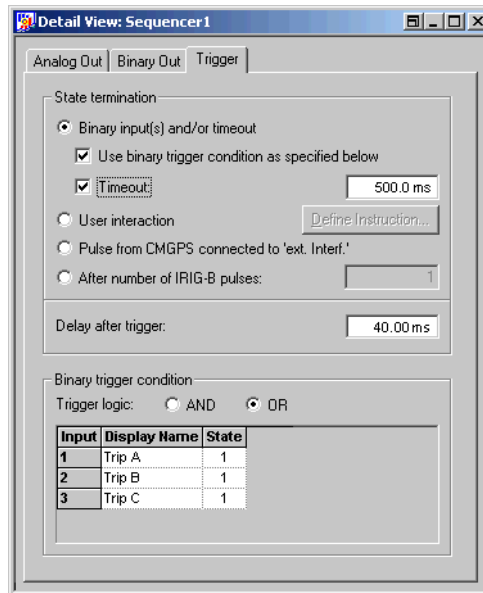
Note: A special feature to insert a state in terms of fault impedance is available: Select **EDIT | INSERT Z SHOT**.

Figure 5-12:
Defining the A-N (L1-E)
fault state

Table View: TU 1.3 ARC Sequencer Example.seq						
	1			2		
Name	Prefault			A-N fault		
V A-N	69.28 V	0.00 °	60.000 Hz	10.00 V	0.00 °	60.000 Hz
V B-N	69.28 V	-120.00 °	60.000 Hz	69.28 V	-120.00 °	60.000 Hz
V C-N	69.28 V	120.00 °	60.000 Hz	69.28 V	120.00 °	60.000 Hz
I A	1.000 A	-10.00 °	60.000 Hz	10.000 A	-75.00 °	60.000 Hz
I B	1.000 A	-130.00 °	60.000 Hz	1.000 A	-130.00 °	60.000 Hz
I C	1.000 A	110.00 °	60.000 Hz	1.000 A	110.00 °	60.000 Hz
Bin. Out						
Trigger	Time	1.000 s		Time Bin	0.500 s	

3. Select the **Trigger** tab.

Figure 5-13:
Defining the trigger
condition



4. At "Timeout", define a maximum state time of 500 ms.

5. Select a binary trigger condition and ensure, that Trip A, Trip B and Trip C are all set to "1" with a logic "OR" trigger condition.

Note: The transition from the present to the next state can be delayed after the trigger condition has been met, by specifying a time for "Delay After Trigger" - in this case set to 40 ms to simulate the relay trip time.

Step 3: Defining the remaining states

Define the remaining states by copying one of the present states and then updating the relevant parameters.

The remaining states to be defined are:

- Dead time No. 1
- Fault shot No. 1
- Dead time No. 2
- Fault shot No. 2
- Lock-out

The "Dead time No. 1" state is similar to the "Prefault" state with the difference that the voltage and current of phase A is zero and the trigger condition is set on the ARC signal. "Dead time No. 2" and "Lock-out" are similar to "Dead time No. 1" with the difference that the voltages and currents of all phases are zero. "Fault shot No. 1" and "Fault shot No.2" are identical to "Fault A-N" (L1-E).



1. Select the state to be copied, in this case the "Prefault state" (click the column of the state in the Table View).
2. Click the the New State icon in the Navigation toolbar. The new state, which is appended to the last state, is identical to the "Prefault state".

To insert a new state between two existing states, select the state before (or after) and then select **EDIT | INSERT STATE**.

3. Set the voltage and current of phase A to zero.
4. Set the trigger conditions to trigger on the "ARC" signal.

Figure 5-14:
Table View - all states defined

	1	2	3	4	5	6	7
Name	Pre-fault	A-N fault	Deadtime No. 1	Fault shot No. 1	Deadtime No. 2	Fault shot No. 2	Lock-out
V A-N	69.28 V 0.00 * 60.000 Hz	10.00 V 0.00 *	0.00 V 0.00 *	10.00 V 0.00 *	0.00 V 0.00 *	10.00 V 0.00 *	0.00 V 0.00 *
V B-N	69.28 V -120.00 * 60.000 Hz	69.28 V -120.00 *	69.28 V -120.00 *	69.28 V -120.00 *	0.00 V -120.00 *	69.28 V -120.00 *	0.00 V -120.00 *
V C-N	69.28 V 120.00 * 60.000 Hz	69.28 V 120.00 *	69.28 V 120.00 *	69.28 V 120.00 *	0.00 V 120.00 *	69.28 V 120.00 *	0.00 V 120.00 *
I A	1.000 A -10.00 * 60.000 Hz	10.000 -75.00 *	0.000 A -10.00 *	10.000 -75.00 *	0.000 A -10.00 *	10.000 -75.00 *	0.000 A -10.00 *
I B	1.000 A -130.00 * 60.000 Hz	1.000 A -130.00 *	1.000 A -130.00 *	1.000 A -130.00 *	0.000 A -130.00 *	1.000 A -130.00 *	0.000 A -130.00 *
I C	1.000 A 110.00 * 60.000 Hz	1.000 A 110.00 *	1.000 A 110.00 *	1.000 A 110.00 *	0.000 A 110.00 *	1.000 A 110.00 *	0.000 A 110.00 *
Bin. Out							
Trigger	Time 1.000 s	Time Bin 0.500 s	Time Bin 0.500 s	Time Bin 0.500 s	Time Bin 1.000 s	Time 0.500 s	Time 1.000 s



5. Repeat step 1 to 4 for the Fault shot No.1, Dead time No. 2, Fault shot No.2 and Lock-out.
To visualize the various states defined, a vector diagram is provided. This shows the vector configuration of the present selected state.



6. Click the Vector Diagram icon in the *State Sequencer* toolbar or select **VIEW | VECTOR DIAGRAM**.
The size of the vector diagram can be changed by dragging the edges of the window. The scaling of the vectors as well as the properties of the diagram be changed by clicking the right mouse button somewhere in the Vector Diagram.
7. Click the icon in the navigation toolbar, to select the first state of the test sequence.
8. Repeatedly click the icon in the navigation toolbar to move through the various states, while watching the vector diagram.

Step 4: Defining the timing measurements

The following parameters need to be defined for timing measurements:

Name:	The name of the event to be timed.
Start:	The event to start the timer (e.g. start of a specific state).
Stop:	The event to stop the timer (e.g. pick-up of a trip signal).
Ignore before:	In long test sequences repeated pick-ups (or drop-offs) of the same input signal need to be timed. A filter function of all earlier pick-up and drop-off events up to a specific event is available for determining the pick-up and drop-off times.
Tnom:	Theoretical pick-up / drop-off time.
Tdev-:	Maximum allowed negative deviation.
Tdev+:	Maximum allowed positive deviation.

In this example the following events need to be timed:

- Trip for the A-N (L1-E) fault, Shot No.1 and Shot No.2.
- The Auto-reclose times for Dead time No. 1 and Dead time No.2.

Proceed as follows to define the timing measurements:



1. Click the Measurement View icon in the *State Sequencer* toolbar or select VIEW | MEASUREMENT to open the Measurement View window.

Enter the parameters to measure the trip time for the A-N (L1-E) fault:

- Name: Trip 1
- Start: Fault A-N (L1-E)
- Stop: Trip A 0>1
- Tnom: 50 ms
- Tdev-: 40 ms
- Tdev+: 50 ms

Note: The columns for the actual measured time (Tact), the deviation of the actual time from the nominal pick-up time (Tdev) and the assessment, i.e. if this deviation is within the band defined by Tdev- and Tdev+, will be completed after an actual test was executed.

2. To define a new measurement condition, right-click anywhere in the Measurement View window and select INSERT or select EDIT | INSERT MEASUREMENT CONDITION.

3. Define the parameters for the following four time measurements:

Table 5-1:
Parameters for time measurements

Name	Start	Stop	Ignore	Tnom	Tdev-	Tdev+
Trip shot No.1	Fault shot No.1	Trip A 0>1	Fault shot No.1	50 ms	40 ms	50 ms
Trip shot No.2	Fault shot No.2	Trip A 0>1	Fault shot No.2	50 ms	40 ms	50 ms
ARC No.1	Dead time No.1	ARC 0>1	Dead time No.1	500ms	100ms	100ms
ARC No.2	Dead time No.2	ARC 0>1	Dead time No.2	500ms	100ms	100ms

Figure 5-15:
Measurement View

Name	Ignore before	Start	Stop	Tnom	Tdev-	Tdev+	Tact	Tdev	Assess
1 Trip 1		A-N fault	Trip A 0>1	0.0500 s	0.0400 s	0.0500 s			
2 Trip shot No.1	Fault shot No. 1	Fault shot No. 1	Trip A 0>1	0.0500 s	0.0400 s	0.0500 s			
3 Trip shot No.2	Fault shot No. 2	Fault shot No. 2	Trip A 0>1	0.0500 s	0.0400 s	0.0500 s			
4 ARC No.1		Deadtime No. 1	ARC 0>1	0.5000 s	0.1000 s	0.1000 s			
5 ARC No.2	Fault shot No. 2	Deadtime No. 2	ARC 0>1	0.5000 s	0.1000 s	0.1000 s			

5.5.6 Running the Test



Running a test is only possible, if no test results are present. If necessary, clear the results by clicking the CLEAR icon or selecting TEST | CLEAR.



Click the START/CONTINUE TEST icon in the *State Sequencer* toolbar or select TEST | START.

This will execute the test sequence as specified.

Note: The actual time, the deviation, and an assessment is given for each timing measurement specified. If running this test sequence in the offline mode, i.e. without a CMC connected, the results shown in the Measurement View are purely random values.



If this test was embedded into the *Control Center*, it could also be run from there by clicking the icon in the OCC or selecting TEST | START.

5.5.7 The Time Signal View

A Time Signal View is available for displaying the voltage and current quantities with respect to time.

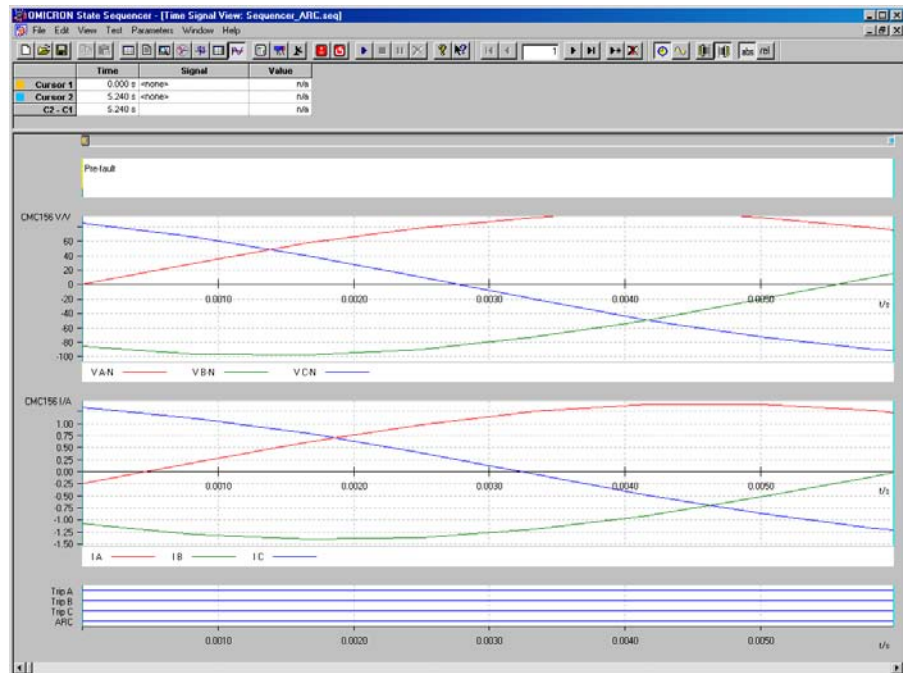
Note: It is possible to preview the Time Signal View before performing a test.

It is possible to zoom in and out of the time signal display and signals / diagrams shown can be switched off via the properties sheet (right mouse click anywhere in the Time Signal View window.) The settings of the diagram (visibility, zoom) are stored per document.



For a detailed description about the Time Signal View, please refer to the online help. Open the online help, click the "The State Sequencer View" entry in the table of contents and navigate to "Time Signal View".



Figure 5-16:
Time Signal View



5.5.8 The Cursor Data Table

The cursor data table is now located within the Time Signal View. The table displays the position of the two cursors in the "Time" column in the Time Signal View. It is possible to change the cursor position by entering a time. In the "Signal" column, an analog signal can be assigned to each cursor. The momentary value of the selected signal is displayed in the "Value" column. If the signals assigned to the two cursors are of the same physical quantity (e.g., two voltages) then the difference is shown in the third line.

Figure 5-17:
Cursor Data table

	Time	Signal	Value
 Cursor 1	0.00 s	<none>	n/a
 Cursor 2	1.00 s	<none>	n/a
C2 - C1	1.00 s		n/a

5.5.9 Defining the Test Report

Select **PARAMETERS | REPORT**. A dialog box appears where you can define the scope of the report.



A detailed description about defining test reports can be found in the "Concept" manual's section 5.2 "Test Reports", or in the online help under the --- **Test Reports** --- entry of the table of contents.



Select **VIEW | REPORT** to display the test report.

6 Overcurrent



The *Overcurrent* test module allows manual or automatic testing of directional and non-directional overcurrent relays with definite time and inverse time, thermal I^2t , and custom curve characteristics. In addition, the ground fault protection functions of two- and three-phased relays can be tested.

It can also be used to test non-differential generator and motor productive units by using zero and negative sequence fault models.

This module tests tripping time of each tripping region for overcurrent relays by using device tolerance. Test objects can be defined with parameters characteristic for the relays.

6.1 Overcurrent Features

The *Overcurrent* test module has several useful features for testing directional and non-directional relays.

6.1.1 Fault Simulation

This test module, using a positive sequence fault model, allows the testing of one-, two-, and three-phase faults. Using the zero sequence and negative sequence fault models, testing of those elements found in generator and motor protective relays is also possible.

6.1.2 Characteristic Definition

The test module allows you to choose between several predefined characteristics available in the *CMC.DCC* file. (Manufacturer specific definite time or inverse time characteristics according to IEC, IEEE, etc.)

Special or custom characteristics that are not predefined can be inserted easily in the form of a current-time table and saved.

6.1.3 Testing the Trip Characteristics

The trip time corresponding to the applied current for overcurrent relays is tested taking the device tolerances into account. Test points and test sequences can be defined easily by clicking point of your choice directly in the characteristic curve. The module tests automatically whether the measured tripping times are inside or outside of the tolerances and performs an automatic assessment of the actual results.

Additionally, the minimum pick-up test is integrated into the *Overcurrent* module.

6.1.4 The Overcurrent Views

Overcurrent comprises of three views:



Test View

In the Test View, define the test parameters and settings.



Report View

In the Report View either a default report setting or a customized setting can be used that will include only those elements of the test settings and results that are of interest to you (preferences can be saved as user-defined report forms). For more details about test reports refer to chapter 5.2 "Test Reports" in the **Concept** manual.

The online help also contains a detailed topic about test reports. For a quick access, search for the term "test report" on the **Index** tab.



Vector Diagram View Vector diagram and table showing the test parameters.

6.2 Example: Pick-Up Values and Trip Times



Sample files:

- Overcurrent_7SJ600.ovt
- Overcurrent_7SJ600.occ

Stored at: ...*OMICRON Test Universe installation path*\
Test Library\Samples\SW Manual Examples\Protection



Task

A Siemens 7SJ600 overcurrent relay is to be tested using an automatic test.

The pick-up current and the trip-time are tested with a PSM (plug setting multiplier) of 2, 5, 10, and 20 for all fault loops. Then, a template should be created for future test procedures.

The following settings are given for a ground fault:

Pick-up I>	0.2A
Time Multiplier	1.0
Characteristic	IEC normally inverse
Instantaneous I	2A

The following settings are given for a phase fault:

Pick-up I>	1.2A
Time Multiplier	0.5
Characteristic	IEC very inverse
Instantaneous I	12A

Solution

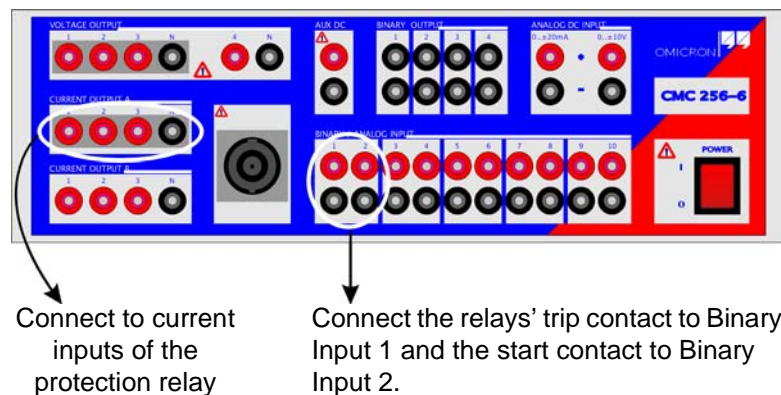
If only a manual test of pick-up and trip time was required, the test could have been performed using *QuickCMC*.

However, since an automatic test is wanted, use the *OMICRON Control Center* and insert the *Overcurrent* test module into a test document for each fault loop or test to be run. First the test for the A-N (L1-E) fault loop is defined. This test is then copied six times and modified such that the fault type is different in each test. If only one fault loop had to be tested, the *Overcurrent* module could have been used stand-alone.

6.2.1 Wiring Between Relay and CMC

1. Connect the current inputs of the protection relay to the corresponding current outputs of the CMC test set.
2. Connect the starpoint of the input CTs to socket "N" of the Current Output group of item 1).
3. Connect the relay's trip contact to the CMC test set's Binary Input BinIn1.
4. Connect the relay's start contact to the CMC test set's Binary Input BinIn2.

Figure 6-1:
CMC 256 test set,
front view



6.2.2 Starting Overcurrent from the OCC

Start the OMICRON *Control Center* from the *Start Page* by selecting OPEN EMPTY DOCUMENT. Insert *Overcurrent* into the OCC document by selecting the menu item INSERT | TEST MODULE... | OMICRON OVERCURRENT.

6.2.3 Setting up the Test Object

To configure the relay you are testing, use the Test Object software function.



Open **Test Object** either by using the pull-down menu item PARAMETERS | TEST OBJECT or by clicking the TEST OBJECT icon in the toolbar. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

Step 1: Define the overcurrent protection parameters

Figure 6-2 shows the **Overcurrent Protection Parameters** tab that is started by double-clicking "Overcurrent" in the **Test Object** tree.

1. Enter the current tolerances allowed for the pick-up (figure 6-2, (1)).
2. Enter the tolerances allowed for the trip times. The absolute value is of relevance to the instantaneous element (2).
3. Specify if the relay has a directional element (3). In our case it is a non-directional relay.

Note: In case of a directional relay, you need to define the location of the potential transformers (PTs) (4) and the direction (polarity) of the current transformer (CT) starpoint connection (5).

4. Specify the fault group for which the settings are to be entered (6).
5. Specify the number of stages the fault group has by checking the appropriate check box (7). In our case the relay has one pick-up stage and one instantaneous stage.
6. Enter the pick-up value and the trip-time or time-multiplier for each stage (8). The pick-up values of all stages are entered in multiples of the nominal current.

Figure 6-2:
Protection Device tab

The screenshot shows the 'Overcurrent Protection Parameters' dialog box with the following settings:

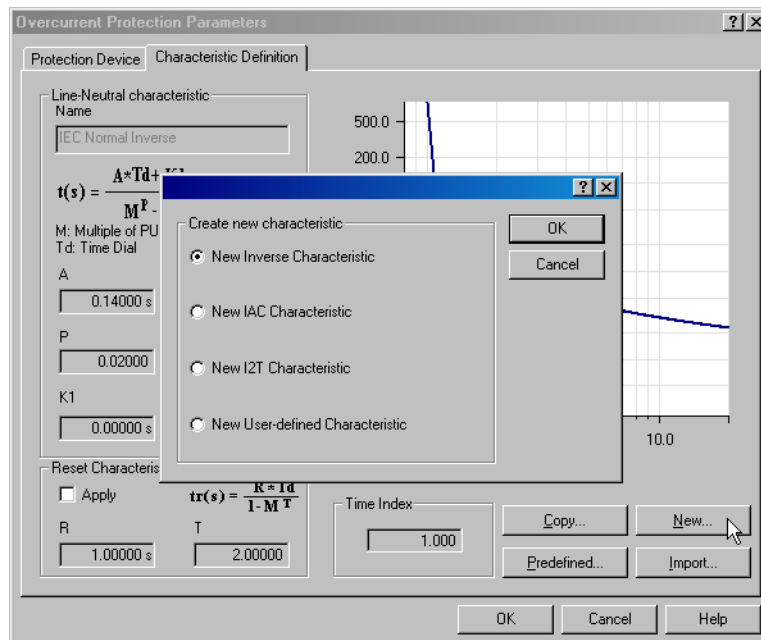
- Current Tolerances:** relative: 5.00 % (1), absolute: 0.100 In
- Time Tolerances:** relative: 10.00 % (2), absolute: 0.100 s
- PT connection:** On Line (4)
- Fault Group selection:** Line-Neutral (6)
- Directional behavior:** Non-Directional (3)
- CT Starpoint connection:** Towards Line (5)
- I/t parameters of the selected Fault Group:**
 - Settings for the Line-Neutral group
 - Active (7): checked for all stages
 - Stage 1 (I>): I pickup 0.200 In (8), Time 1.000, Tripping Characteristic IEC Normal Inverse
 - Stage 2 (I>>): I pickup 2.000 In, Time 0.050 s, Reset Ratio: 0.95
 - Stage 3 (I>>>): I pickup 10.000 In, Time 0.050 s

Step 2: Defining the characteristic

Select the **Characteristic Definition** tab.

1. Select the required characteristic. You can
 - use **Predefined** standard IEC characteristics,
 - **Copy** a characteristic of a different fault group to the currently selected fault group,
 - **Import** a characteristic from a .DCC file or
 - create a **New** custom characteristic. Any inversely dependent or I^2t characteristic can be defined with an equation or a table of points.

Figure 6-3:
Creating a new
characteristic



Step 3: Defining the settings for the phase fault group

Return to the **Protection Device** tab and define the settings for the phase fault group (repeat the previous steps starting with no. 4. of step 1).

Note: A separate characteristic for a negative sequence and zero sequence element can be entered for those elements.

6.2.4 Configuring the Hardware



Configure the hardware according to the wiring described in section 6.2.1 "Wiring Between Relay and CMC".



A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

6.2.5 Defining the Test

Step 1: Inserting the Overcurrent test module into the test document

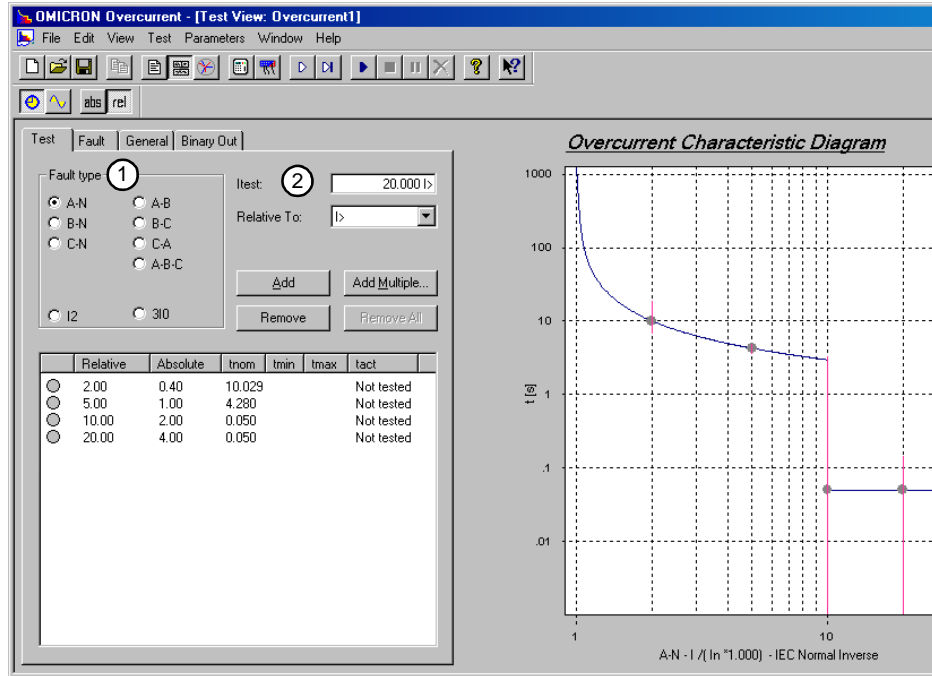


1. Click the *Overcurrent* icon in the test modules toolbar
or
2. select INSERT | TEST MODULE or click the appropriate icon and then select "OMICRON Overcurrent".

Step 2: Defining the test for the A-N (L1-E) fault loop

1. In the **Test** tab, select the fault type (figure 6-4, 1). In our case select an A-N (L1-E) fault.

Figure 6-4:
Overcurrent Test View



2. Define the test currents in multiples of the pick-up current (figure 6-4, 2) and click **ADD**. Execute the first shot at a current of 2 times the pick-up value. Further shots should be executed at 5, 10 and 20 times the pick-up value.

Note: Test points can also be defined directly in the diagram by pointing at the required test current (i.e. vertical line) and then pressing the <Ctrl> key and the left mouse button (or right mouse click and select **ADD TEST POINT**) to add the test point to the list.

Individual manual shots can be executed immediately from the characteristic diagram by placing the mouse pointer at the required test current, holding the <Shift> key and clicking the left mouse button (or right mouse click and select **SHOT AT X.XX**). The test current can also be entered in absolute currents by selecting **VIEW | ABSOLUTE CURRENTS**.

The width of the columns of the test table can be adjusted with the mouse.

3. Select the **General** tab.
4. Define a pick-up test for "Relays with Start contact".

Note: This test is only possible if a start or pick-up contact is available from the relay. This input must be also configured as a "Start" contact in the hardware configuration.

Figure 6-5:
Test View - General

Input	Display Name	State
1	Trip	1
2	Start	X

If no Start contact is available and the relay has a delayed reset characteristic (e.g., electromechanical induction disc overcurrent relays), the "EM relays without Start contact" pick-up test can be chosen.

First, this trips the relay at a test current specified by the "Trip value". Then it decreases the current slowly until the relay resets, which is an indicator that the disc is resetting.

By slowly increasing the current again, the disc motion can be reversed and the pick-up current determined.

5. Define the trigger condition for the trip test. In our case the "Trip" contact is the only choice. At least one relay contact must be specified as trigger, i.e., set to "1".
6. Select the **Test** tab.

Step 3: Defining the test report

1. Select **PARAMETERS | REPORT**. A dialog box appears where you can define the scope of the report.

A detailed description about defining test reports can be found in the "Concept" manual's section 5.2 "Test Reports".



2. Select **VIEW | REPORT** to display the test report.
3. Return to the Test View by clicking the **TEST VIEW** icon in the *Overcurrent* toolbar or by selecting **VIEW | TEST**.
4. Return to the *OMICRON Control Center* by closing *Overcurrent*.



Step 4: Copying and pasting the test for all other fault types

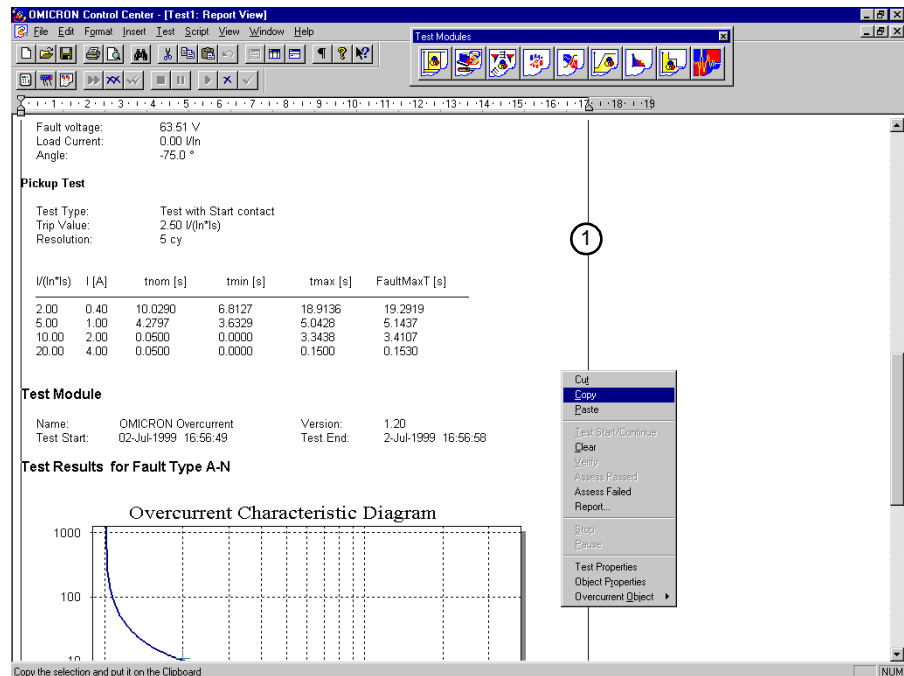
1. Select (highlight) the present test module for the A-N (L1-E) fault.

The black border around the object indicates that it is selected, refer to figure 6-6 (1).
2. Copy the object

Either left-click the Copy button in the toolbar or right-click and select COPY on the context menu.
3. Move to the bottom of the present test by pressing the <Down Arrow> key on the keyboard.
4. Paste the object six times (left-click the PASTE button or right-click and select PASTE).

Note: Before pasting, ensure that you are at the bottom of the document and that no object is selected.

Figure 6-6:
Report View of a test in
the Control Center



5. Change to the List View by clicking the its icon or selecting VIEW | LIST VIEW.
6. Open the Test View of the first test module by double clicking the test module object, i.e., the third line in figure 6-7 (1).

- Select the required fault type. In this case "A-N" (L1-E) should already be selected.

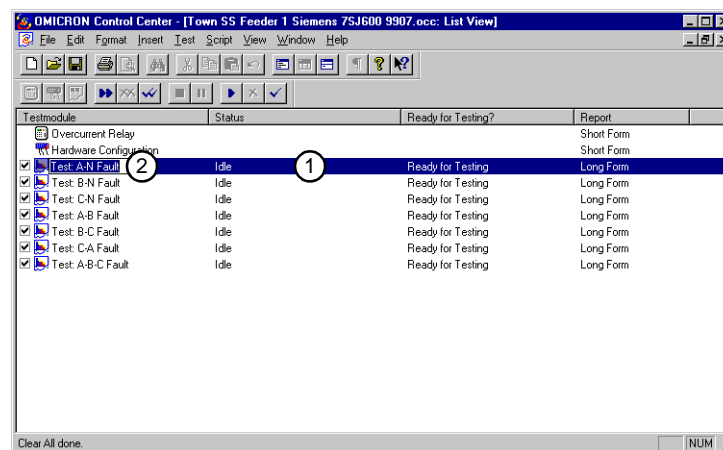


Note: The parameters of a test can only be changed, if no results are present. To clear any results, click the CLEAR icon or select TEST | CLEAR.

- Close the Test View.
- Repeat the last three steps for the next six test modules, such that a test for a "B-N" (L2-E), "C-N" (L3-E), A-B" (L1-L2), "B-C" (L2-L3), "C-A" L3-L1), and "A-B-C" (L1-L2-L3) fault is defined.

Note: A specific heading can be specified for each test in the same way a file name is changed in the Windows Explorer. To do so, first left-click the test's name ("OMICRON Overcurrent") in the List View to highlight it and then left-click the name again. Then the highlighted name can be changed (see figure 6-7 (2)).

Figure 6-7:
List View in the *Control Center*



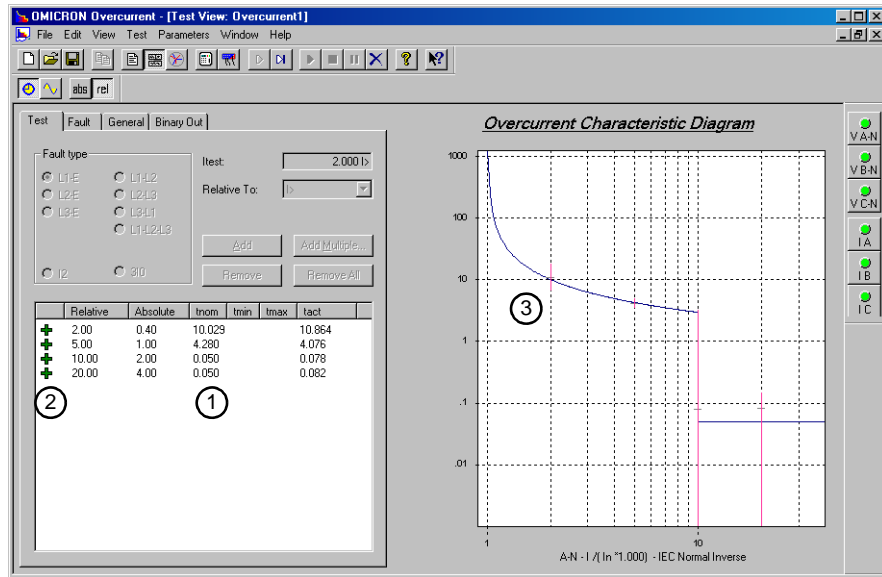
6.2.6 Running the Test

The test can be performed in either stand-alone mode or as part of a test document from the OCC.

Testing from inside a test module

1. Open the Test View of the A-N (L1-E) fault by double clicking the test module object in the List View.

Figure 6-8:
Running a test from
inside a test module



2. Click the Start icon or select TEST | START.

The nominal and actual trip times are displayed (figure 6-8, 1).

An assessment for the tests is displayed in the test table (2) and on the overcurrent characteristic (3).



The green plus is displayed if the assessment of a test passed.



The red "x" is displayed if the assessment of a test failed.



3. To view the report, click the REPORT VIEW icon or select VIEW | REPORT.



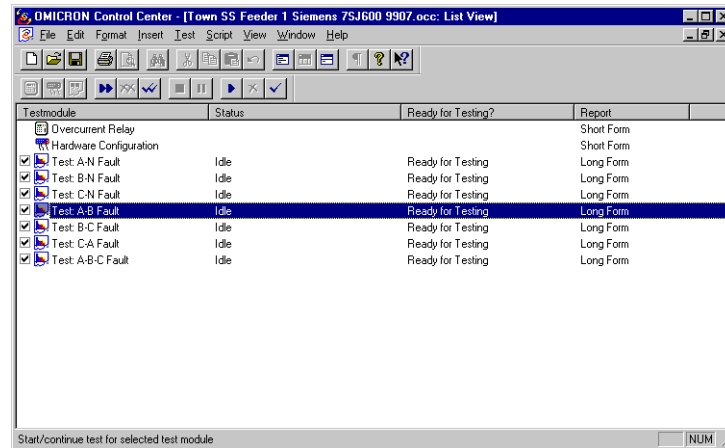
4. To return to the Test View, click the TEST VIEW icon or select VIEW | TEST.

5. Close the Test View to return to the Control Center.

Testing from the Control Center

1. The same test that was run with a stand-alone test module can also be run from the *Control Center* with *Overcurrent* embedded in an OCC document.

Figure 6-9:
Running a test from the
Control Center



2. Select the test module for which a test is to be performed, in this case that's the A-B (L1-E) fault.



3. Click the Start icon or select **TEST | START**.



4. To view the results, click the Report View icon or select **VIEW | REPORT**.

Running a fully automatic test from the Control Center

1. Select the pull-down menu item **TEST | SETTINGS** and change to the **Overall Test** tab. At "On Fail in Test Module" enable the option "Test Module visible during Test".



2. Click the Start All icon or select **TEST | START ALL**.

Note: The test may take several minutes to perform.



3. To view the results, click the **REPORT VIEW** icon or select **VIEW | REPORT**.

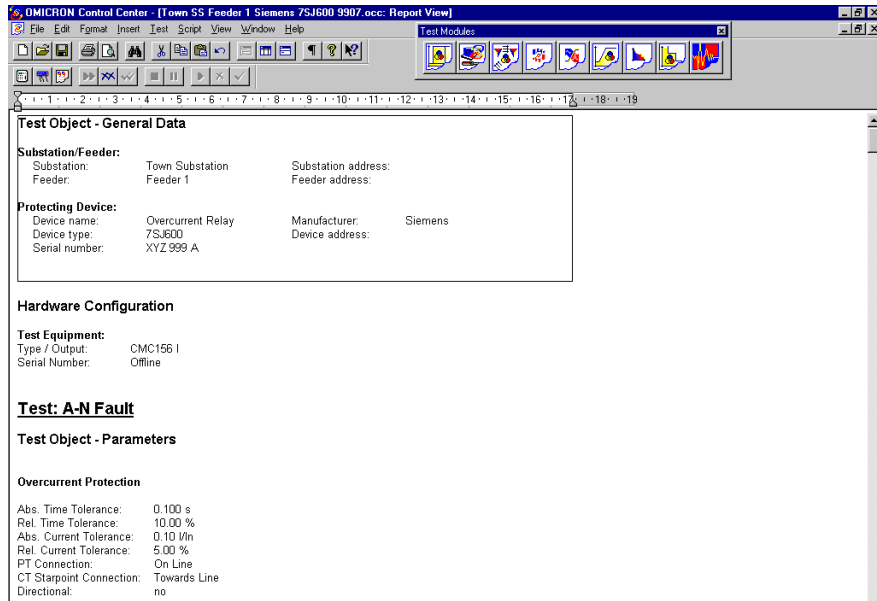
6.2.7 Converting the Test Report to a Test Template



A detailed description about defining test reports can be found in the "Concept" manual's section 5.2 "Test Reports", or in the online help under the --- **Test Reports** --- entry of the table of contents.

Before converting the test report to a test template, be sure that you have saved the test report.

Figure 6-10:
Creating a test template
from a test report



1. Click the Clear All icon or select TEST | CLEAR ALL.

2. Click YES to clear all test results.



3. **Do not** click the Save icon, because this overwrites the test report file with the test template file. All results will be lost.

Save the test template under a NEW file name and preferably also in a separate directory for test templates.

7 Distance



The *Distance* test module provides the functionality to define and perform tests of distance relays by impedance element evaluations using single-shot definitions in the Z-plane with graphical characteristic display.

Definition of relay characteristics

A graphical characteristic editor makes the definition of the nominal relay characteristics and settings quick and easy. Starting, trip, extended, and no-trip zones can be defined by using predefined elements. A complete overview of all defined zones is provided.

Using the RIO/XRIO format¹ (Relay Interface by **OMICRON**), supported by many relay manufacturers, makes it possible to directly import the relay data from your relay parameter setting software (contact your relay manufacturer for details).

The impedance settings for the zones can be entered and displayed in either primary or secondary values.

Definition of distance tests

Tests are defined in the impedance plane: Test points are added to a test point table, with the mouse or by keyboard entry. This table is separated into several tabs, each tab belonging to a fault loop, e.g., A-N (L1-E), B-N (L2-E), C-N (L3-E), A-B (L1-L2), A-B-C (L1-L2-L3). Test points can be defined for several fault loops at the same time (e.g. for all single-phase loops) or for every fault loop separately.

When a test is performed, the test point lists belonging to the individual fault loops are worked through. The reaction of the relay is compared to the specified nominal settings and an assessment is made. The results are displayed graphically in the impedance plane as well as numerically in the test point table.

The voltages and currents belonging to a test point and the relay's reaction (switching of output contacts) can be graphically displayed for a more in-depth analysis of the results. Time measurements by using cursors are possible.

1. XRIO represents the second generation of RIO file technology. More about that subject in chapter 3.1 "XRIO" in the **Concept** manual. For technical background information about the XRIO file format, please see the XRIO manuals that were installed with the *Test Universe* software (unless deselected) into the "Doc" folder. You find direct hyperlinks to these manuals in the online help topic "User Manuals of OMICRON Test Universe".

7.1 Example: Primary Distance Protection Test



Sample files:

- Distance-LFZR111.dst
- Distance-LFZR111.ohc
- Distance-LFZR111.rio

Stored at: ...*OMICRON Test Universe installation path*\
Test Library\Samples\SW Manual Examples\Protection



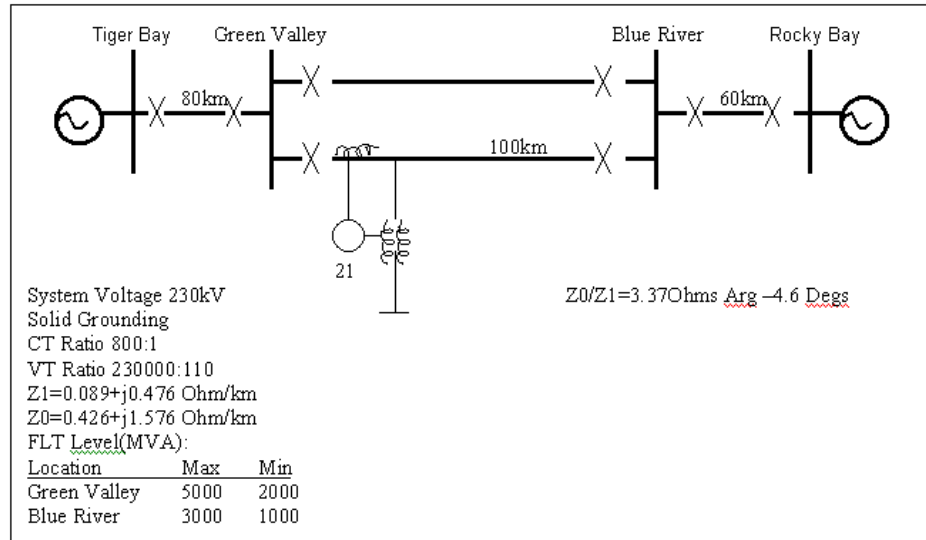
Task

As part of routine maintenance within Green Valley transmission substation, the operation of the primary distance protection relay on feeder 2 has to be checked (Device 21; refer to figure 7-1). The relay in question is the LFZR 111 set with a basic Mho characteristic three zone operation. No schemes such as POR or PUR are used.

It is assumed that the relay has previously been programmed with the necessary data and that the relay test engineer confirms these settings and correct operation. Testing of any DEF, Inst' Overcurrent, IDMT Overcurrent, or Power Swing Blocking features are not covered in this example. However, other modules within the *Protection Package* are capable of these tests.

1. The relay operates correctly for faults occurring within the respective zones of protection. For example, zone 1 single phase to earth fault is seen as a zone 1 event.
2. Various trip times are within nominal trip tolerances.
3. The results are displayed in both tabular and impedance plane formats.
4. The report of results is suitable for inclusion in the substation file without alteration or editing.
5. Fault types to be tested are: Single phase to earth, phase to phase, and three phase.

Figure 7-1:
Schematic diagram
showing an example
transmission system.
The relay to be tested is
at Green Valley
Substation.



Solution

This test example uses the *Distance* test module in stand-alone mode.

Time for this example 30 - 60 minutes (off-line or with a relay).

Equipment required:

- OMICRON Test Universe – consisting of *CMC 256* or *156* three-phase test set, *Protection Package Software*, and connection leads.
- Multimeter, i.e. *EnerLyzer* for *CMC 256* or Fluke.
- All associated manuals for the relay.
- System parameters and interconnection knowledge.
- Relay Settings Sheet – for settings used in this example.

7.1.1 Starting the Distance Test Module

Start the *Distance* test module in stand-alone mode from the OMICRON *Start Page* by clicking DISTANCE.

7.1.2 Setting up the Test Object

To configure the relay you are testing, use the **Test Object** software function.



Open **Test Object** either by using the pull-down menu item PARAMETERS | TEST OBJECT or by clicking the Test Object toolbar icon. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

In this example we want to import the test object parameters from a file.

1. Select PARAMETERS | TEST OBJECT to open the dialog box for the test object-specific data.

Using the RIO/XRIO¹ format, relay data and parameters can easily be imported (and exported) from and to files ("Import" / "Export" buttons).

Some relay manufacturers also use the RIO/XRIO format to export parameters from their relay parameterization software for direct import into the Test Universe (e.g. Disgi by Siemens). Contact your relay manufacturer for details.

2. Import the file Distance-LFZR111.rio to load the parameters for the protection device.
3. Now look through the settings for:
 - System Settings,
 - Zone Settings,
 - Default Test Settings.

Figures 7-2 to 7-4 show the corresponding standard pages of the distance protection parameters.

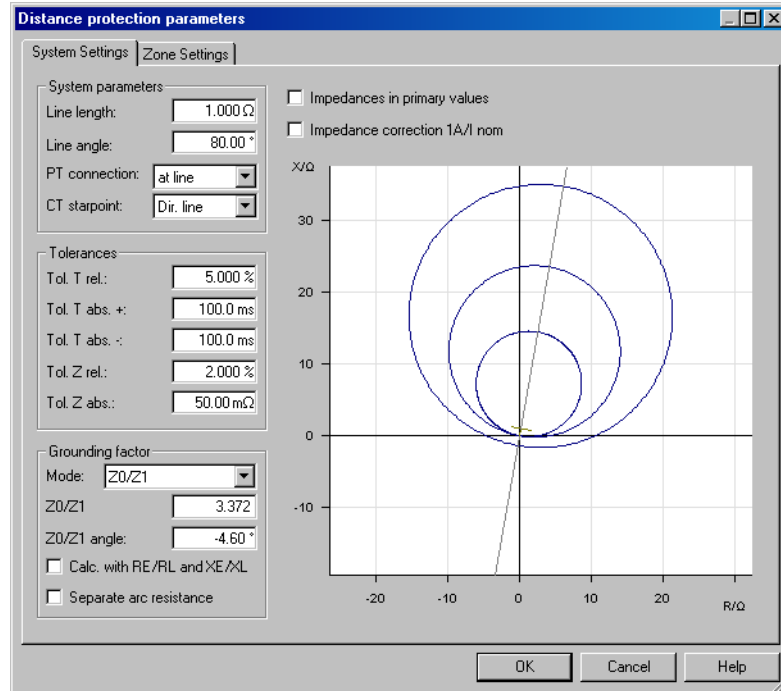
4. When satisfied that all test object parameters are correct, return to the Test View.



1. For technical background information about the XRIO file format, please see the XRIO manuals that were installed with the *Test Universe* software (unless deselected) into the "Doc" folder. You find direct hyperlinks to these manuals in the online help topic "User Manuals of OMICRON Test Universe".

System Settings

Figure 7-2:
Standard Test Object
page for the system
settings after loading
the file Distance-
LFZR111.rio



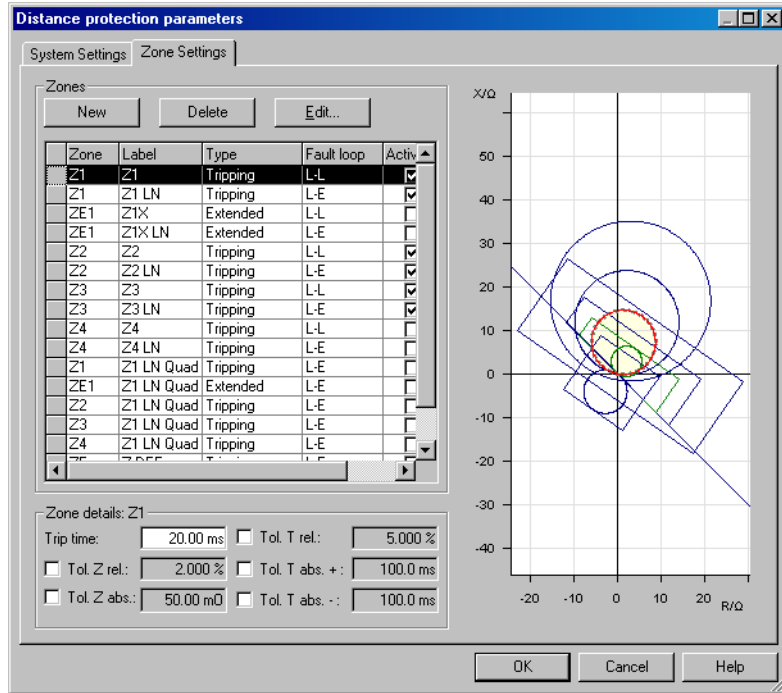
"System parameters" and "Grounding factor" can be entered from the calculated settings data. Tolerances come from the data sheets for the relay and can be entered as absolute or relative values.

Note: Tolerance values can also be entered or edited individually for each zone on the **Zone Settings** tab.

CB simulation is set to 100 ms (at the **Test Object's** CB Configuration block).

Zone Settings

Figure 7-3:
Standard Test Object
page for the zone
settings after loading
the file Distance-
LFZR111.rio



For information on how to define new characteristics or edit existing ones, refer to section "Tip 2: Entering Characteristics" on page 110.

Default Test Settings

Figure 7-4:
Standard Test View
page for the default test
settings after loading
the file Distance-
LFZR111.rio

The screenshot shows the 'Settings' tab of the software interface. It is divided into several sections:

- Test model:** A dropdown menu is set to 'Constant test current'. Below it, 'ITest' is set to '1.000 A'.
- Maximum fault impedance:** Three input fields are shown: 'L-E: 34.64 Ω', 'L-L: 60.00 Ω', and 'L-L-L: 69.28 Ω'.
- Checkboxes:** 'Allow reduction of ITest' is checked. 'Extended zones active' is unchecked. 'Switch off at zero crossing' is checked.
- Fault inception:** A dropdown menu is set to 'random'. Below it, 'Angle:' is set to 'n/a'. 'DC-offset' is checked.
- Times:** Three input fields are shown: 'Pre-fault: 1.500 s', 'Max fault: 3.000 s', and 'Post-fault: 2.000 s'.
- Time reference:** A dropdown menu is set to 'Fault inception'.

The "Test Model" is Constant Test Current (refer to section "Tip 1: The Constant Test Current Model" on page 110 for more information).

- "Fault inception" is selected as random.
- "DC offset" is selected.
- "Time reference" is selected as Fault Inception.
- "Prefault", "Fault", and "Post Fault" times can be set as required.

7.1.3 Configuring the Hardware



In this example we want to import the hardware configuration.

1. Click the Hardware Configuration icon to open the Hardware Configuration window.
2. Click the "Import" button and select the file `Distance-LFZR111.ohc` to load the hardware configuration data.

In this example, three voltage and three current channels are used (**Analog Outputs** tab) as well as one binary input for each trip relay output contact connection (**Binary / Analog Inputs** tab).

3. When finished, click OK and return to the Test View.

Note: Any changes in the hardware configuration can be saved to a new OHC file and preserved for future use.

The physical connections between test set and relay under test are not described here because they may change according to test block configuration, secondary wiring anomalies, and other practical engineering constraints.



A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

7.1.4 Defining the Test

The procedure described below can be followed for educational purposes. However, as a time saver, you can also open the file `Distance-LFZR111.dst` to automatically load all data used in this example.

If you are creating the test new (i.e., not using the provided example file `Distance-LFZR111.dst`), save this test using the `FILE | SAVE AS` command. Give the file a name of your choice (`name.dst`).

Step 1: Defining the test settings



In the *Distance* Test View select the **Settings** tab.

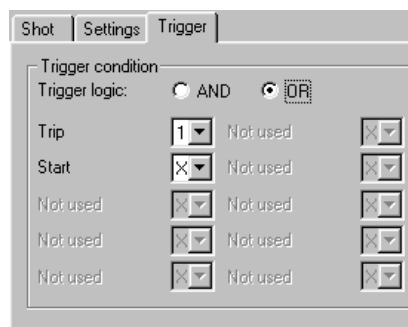
For this example we want to use the default test settings defined at the test object parameters as described in section "Default Test Settings" on page 101.

Click the "Apply Test Object Defaults" button to load these settings. The **Settings** tab then displays the settings as shown in figure 7-4 on page 101.

Step 2: Defining the trigger conditions

The Test View's **Trigger** tab configures the trigger conditions for the binary inputs. Figure 7-5 shows the contents of this tab. Note that only one binary input is used for this test (the relay should have been set to use this contact for any trip).

Figure 7-5:
Trigger tab

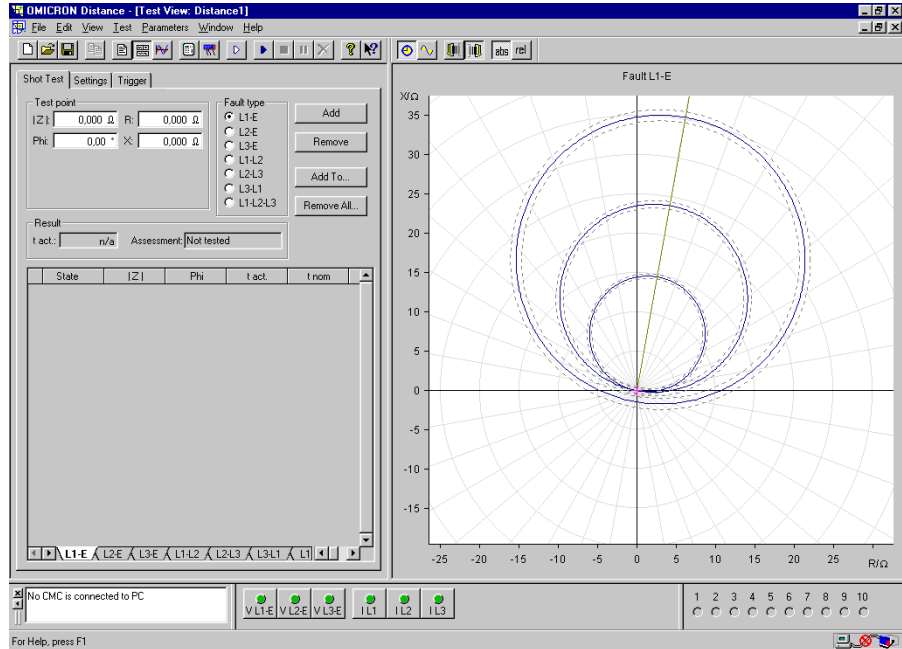


The Trigger logic is set to OR. The Start contact is not used in this case. This condition is denoted by the "X" in the selection window.

Step 3: Defining the test points

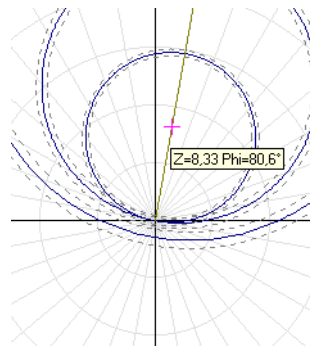
The impedance plane in the **Shot** tab shows the relevant zone data. Now the test points can be defined.

Figure 7-6:
Distance Test View prior to setting the test procedure



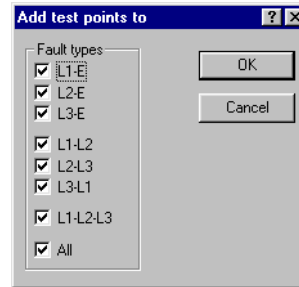
1. Select each test point in the impedance plane diagram with a left mouse click (refer to figure 7-7).

Figure 7-7:
Selecting a shot using the mouse in the impedance plane



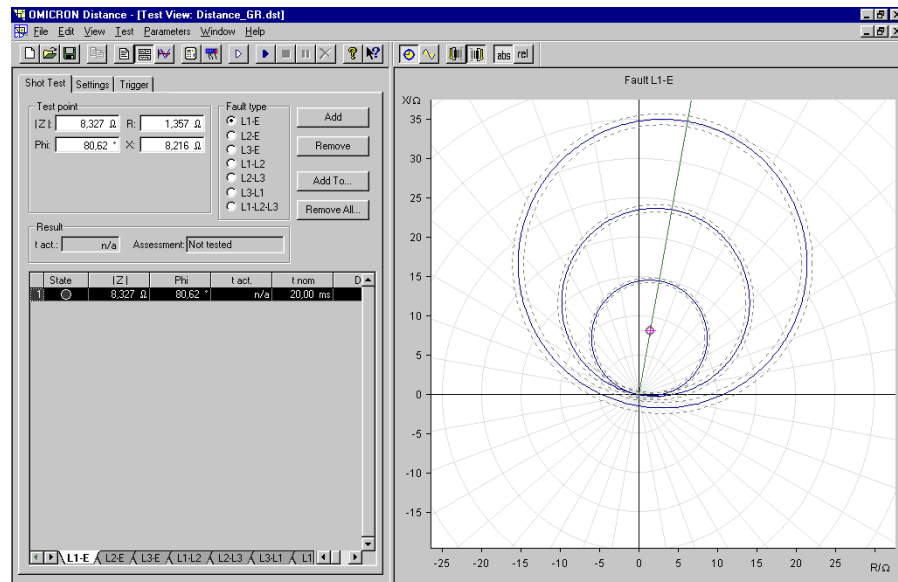
- To add this test point to the test point tables of all fault types (i.e., L1-E, L2-E, L1-L2, etc.), click the "Add To" button and then select the checkbox "All" in the appearing dialog box. Click OK to close this dialog box (refer to figure 7-8).

Figure 7-8:
Adding a test point to
the test point tables of
all fault types



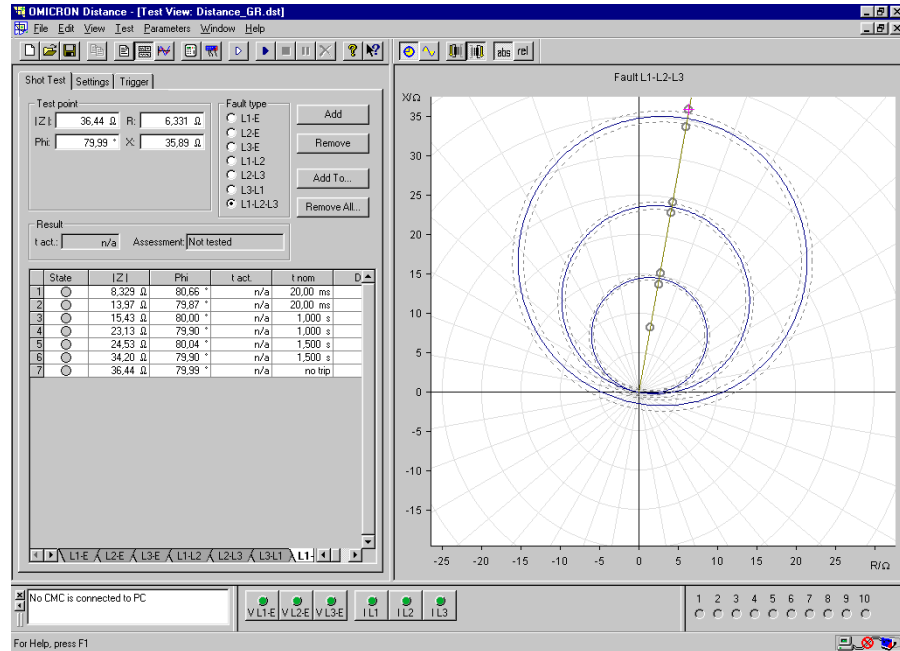
- The test point is added to the test point tables of all selected fault types as shown in figure 7-9.

Figure 7-9:
One test point added to
the test point table



- In this example, the engineer chooses test shots along the characteristic angle of the protected line to show the accuracy of the zone reach settings. The points are shown in figure 7-10, with the process for entering each point being the same as described above.

Figure 7-10:
Completed entry of test points (L1-L2-L3 tab).
The same test points are defined for the other fault types.



- Save this test routine. Choose FILE | SAVE or the "Save" icon from the toolbar, which saves the file under the name previously chosen, say name .dst.

7.1.5 Defining the Test Report

Select PARAMETERS | REPORT. A dialog box appears where you can define the scope of the report.



A detailed description about defining test reports can be found in the "Concept" manual's section 5.2 "Test Reports", or in the online help under the --- Test Reports --- entry of the table of contents.



Select VIEW | REPORT to display the test report.

7.1.6 Running the Test

Step 1: Running the test

Once at the job site, set up the equipment, and then retrieve the test routine name .dst. Set up and check the wiring. Then the test of the LFZR111 distance relay can begin.



Start the test by clicking the "Start" toolbar icon.



Pause the test with the "Pause" toolbar icon.



Stop the test with the "Stop" toolbar icon.

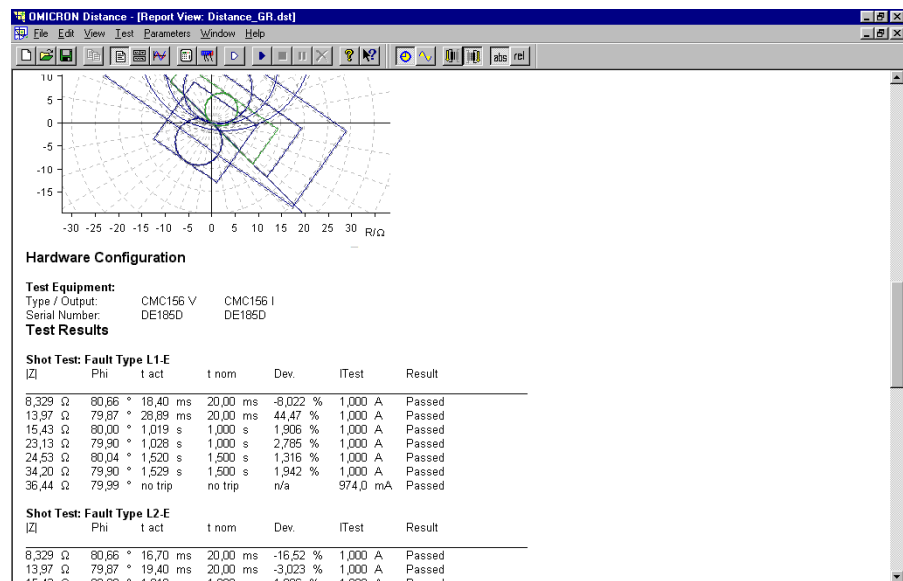
During the test each test point (shot) is highlighted when being tested. A green cross following testing indicates that the test point has passed (red cross = failed). Use the context sensitive help system for more information about the other results symbols and their meaning. The test should run automatically until the final test point in the L1-L2-L3 tab has been tested.

Step 2: Viewing the test report



Select VIEW | REPORT to display the test report. Figure 7-11 shows the report produced in this example. You can scroll through the report to inspect the results and finalize any report content formatting.

Figure 7-11:
Report View after the
test is finished



7.1.7 Investigating Particular Test Points

If you want to investigate the relay's response to one particular test point within the test, you can

- either perform a single shot test without recording results to report
- or view the signals.

Single shot test without recording the results



Highlight the test shot point in the relevant fault type tab and click the "Single Test" icon in the tool bar.

The shot is made and the relay's reaction can be repeatedly assessed. No results are recorded.

Viewing the Signals

It is possible to view the waveforms applied to the test object by the test set in the magnitude versus time plot of the Signal View.



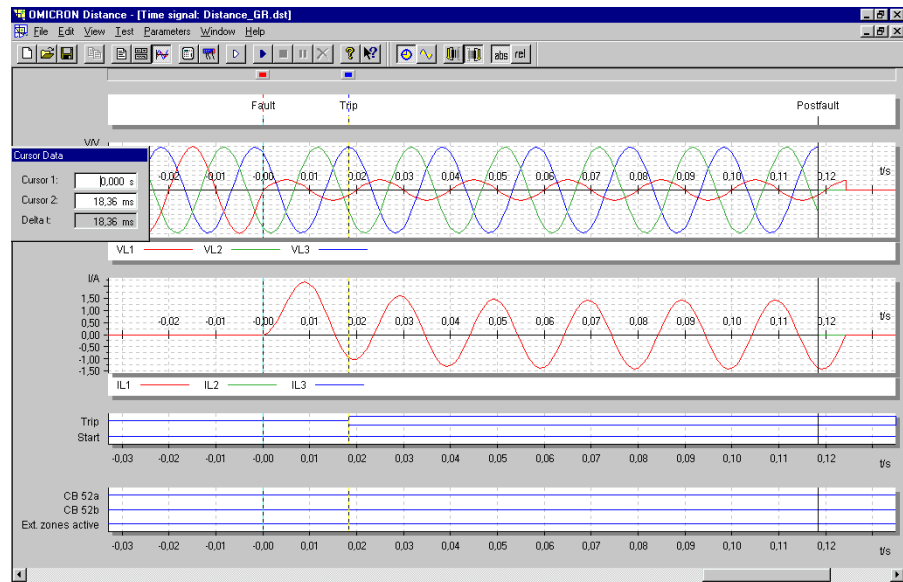
1. Select a test point of interest in the relevant fault type table.
2. Click the "Signal View" toolbar icon or select **VIEW | TIME SIGNAL**.

The waveforms output to the test object are displayed along with the graphical representation of the binary inputs, which were the trip signal condition in this case.

By means of the cursors, measurements can be made; for example, an indicated trip time can be assessed (figure 7-12).

Note: The signal view of a test shot can be exported to the test report.

Figure 7-12:
Time Signal View
showing the waveforms
applied to the relay and
the condition of the
binary input trip channel



3. Choose **FILE | SAVE**, and enter a name for .DST file.

7.1.8 Tips

Tip 1: The Constant Test Current Model

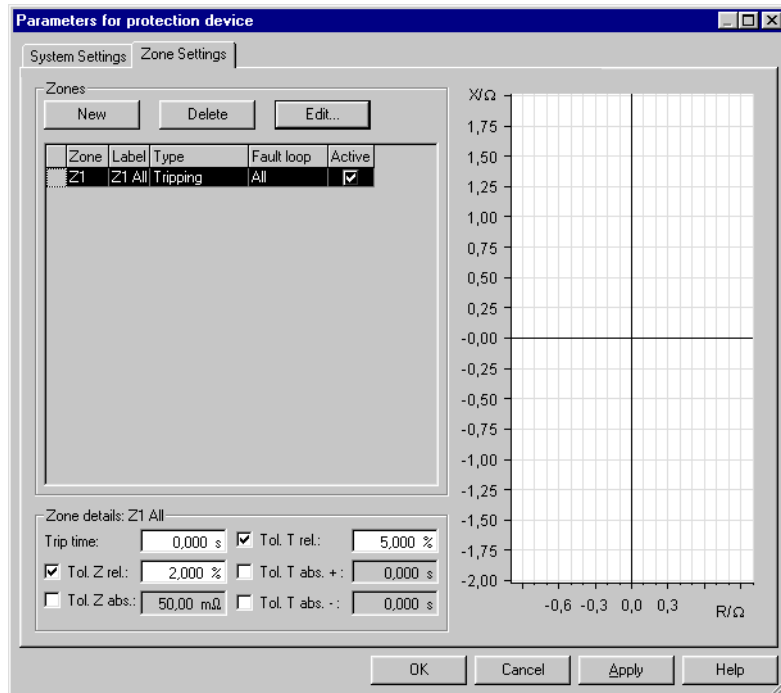
The Constant Test Current Model assumes a theoretical current source (infinitely high internal impedance) connected to the fault loop. The test voltage is calculated from the product of the constant current and the total fault loop impedance.

Tip 2: Entering Characteristics

Entering characteristics is described using the standard pages for the test object-specific data.

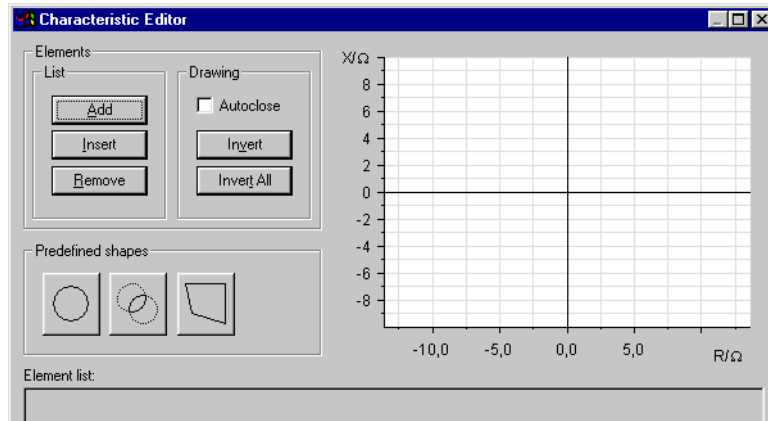
1. To enter new zone detail, click New in the **Zone Settings** tab of the "Parameters for Protection Device" window. Figure 7-13 shows the **Zone Settings** tab.

Figure 7-13:
Standard page when
adding a new zone
characteristic. Click
"New" then "Edit..."



2. Now click EDIT... to open the Characteristic Editor.

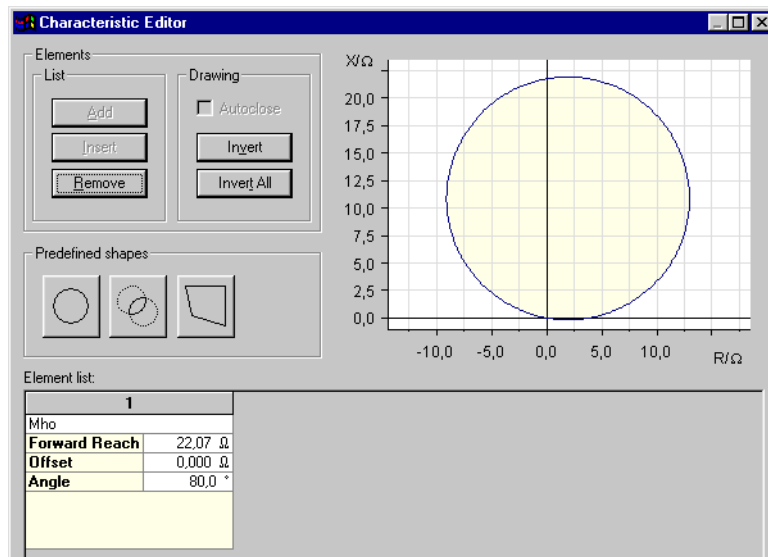
Figure 7-14:
Characteristic Editor



3. To input a zone 1 Mho tripping characteristic, first click the "Mho" icon in the "Pre-defined Shapes" section. Adjust the forward reach to the value required from settings sheet.

The result should be as shown in figure 7-15.

Figure 7-15:
Defining a Mho
characteristic using
predefined shapes and
adjusting the forward
reach



4. Click OK to return to the **Zone Settings** tab.

The characteristic is shown in the impedance plane on the right bound by the relevant tolerance borders shown with a broken line. Highlighted in black, the associated information is entered into the table on the left hand side. Currently Z1 is active, the Mho shown is functional for all fault loops (i.e. P-E, P-P, 3P), and it is defined as a tripping characteristic.

The relative tolerances for Z (measurement) and T (operating time) can be set here also along with the nominal tripping time for Z1.

5. Repeat the above process for adding additional zones.

Tip 3: Editing an Existing Zone

Editing an existing zone is described using the standard pages for the test object-specific data.

1. Highlight the correct zone in the list.
2. Click "Edit...."
3. Perform the necessary adjustments to data in the Characteristic Editor and click OK.

Tip 4: Relay Settings

CTR/VTR = 0.38

Reach Z1 Setting

$0.8 \times 100 \times 0.484 \angle 80^\circ \times 0.38 = 14.71 \angle 80^\circ$ Ohms sec

Reach Z2 Setting

$(100 + 30) \times 0.484 \angle 80^\circ \times 0.38 = 23.9 \angle 80^\circ$ Ohms sec

Reach Z3 Setting

$160 \times 1.2 \times 0.484 \angle 80^\circ \times 0.38 = 35.31 \angle 80^\circ$ Ohms sec

Offset Z3 Reverse

$0.1 \times 14.71 \angle 80^\circ = 1.41 \angle 80^\circ$ Ohms sec

Ground Fault Neutral Compensation Factor (kzn)

$Kzn = (Zl0-Zl1) / 3Zl1 = 0.79 \angle -6.5^\circ$

Relay setting used $kzn = 0.79 \angle 74^\circ$

8 ARC



The *Autoreclosure* test module is used for testing autoreclosing processes together with a line protection.

For testing the autoreclosing (ARC) processes, the *Autoreclosure* test module emits an adjustable mains short circuit to the line protection. The trip commands of the protection and the circuit breaker (CB) close commands of the autoreclosure are measured and fed to an integrated circuit breaker simulation. By using this method, the current and voltage signals of a dead time are simulated in real-time and emitted to the test object.

The *Autoreclosure* test module offers two test modes:

- Unsuccessful Sequence
- Successful Sequence

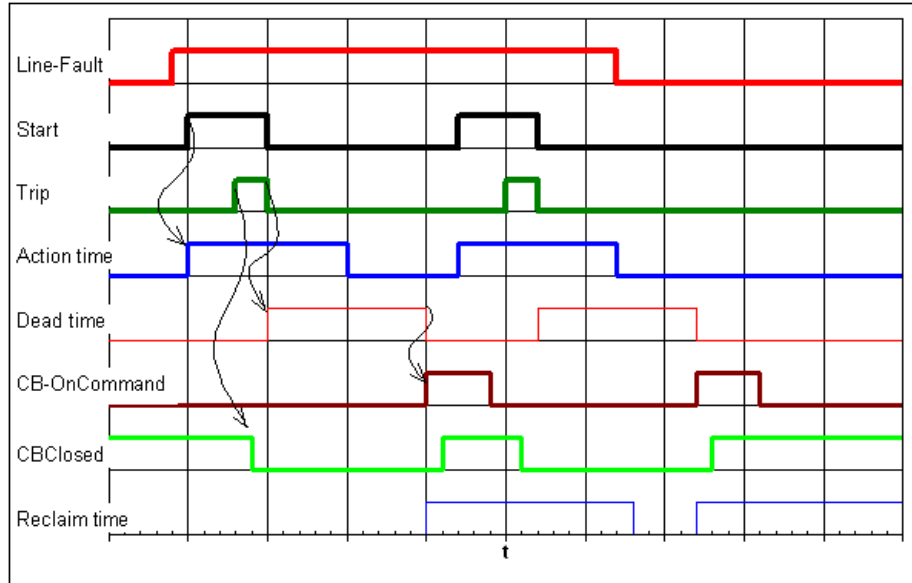
with any number of reclosure cycles (AR cycles).

For each AR cycle, the following quantities are automatically assessed and logged in a tabular test report:

- trip time
- trip mode (single pole / three pole tripping)
- dead time
- duration of CB Close
- final tripping

The current and voltage signals, the trip and CB on commands, as well as other binary signals are displayed in the Time Signal View.

Figure 8-1:
A typical AR sequence



8.1 Configuring the Autoreclosure Test Module

Start the *Autoreclosure* test module in stand-alone mode from the OMICRON *Start Page* by clicking *Autoreclosure*.

8.1.1 Setting up the Test Object

To configure the relay you are testing, use the Test Object software function.



Open **Test Object** either by using the pull-down menu item **PARAMETERS | TEST OBJECT** or by clicking the **TEST OBJECT** icon in the toolbar. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

8.1.2 Hardware Configuration



Click the Hardware Configuration toolbar icon or select **HARDWARE CONFIGURATION** on the **PARAMETERS** pull-down menu.

General Tab

Specify the used test set on the **General** tab.

Analog Outputs Tab

By default the three phase voltages and the three phase currents are selected. The fault voltage and the fault current can be output as well. This allows testing of protection devices that require higher currents.

Binary / Analog Inputs Tab

By default, input 1 is assigned to the trip command of the protection device and input 3 is assigned to the CB on command. Signal 2 is prepared for the recording of any other signal of the protection device. This signal can be set to "not used". The selection of the binary signals determines whether the fault is switched off by a three-pole tripping or by a phase selective one-pole tripping.

If the fault is to be switched off phase selective, do not use the trip command.



A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

8.1.3 ARC Settings in the Test Module

Shot and Times

In this tab set the fault type, the fault voltage, the fault current and the angle between the fault voltage and current.

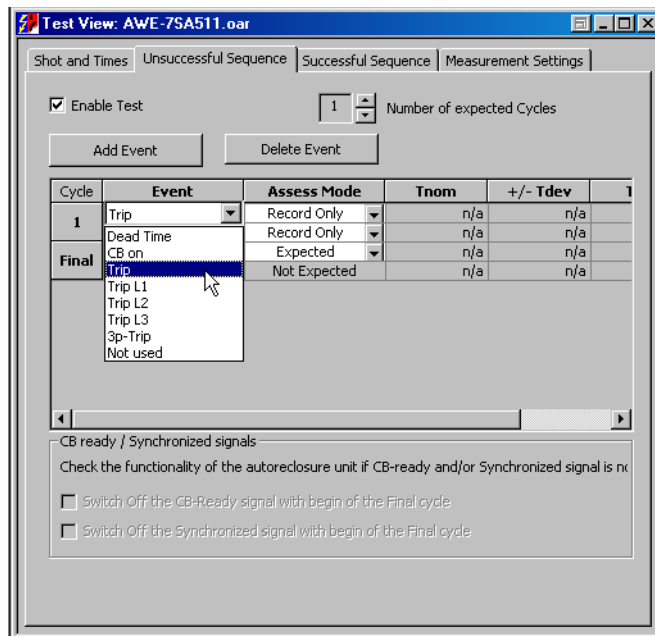
The fault description is automatically created and can be modified. The maximum times for the trip command and the AR pulse are of particular importance. If no trip command is detected within the specified maximum time for the trip command after the fault is output, the test is aborted. The dead time is started as soon as the trip command disappears and ends with the occurrence of the CB on command. If an expected CB on command is not detected within the specified maximum time, the running sequence is aborted as well.

Unsuccessful Sequence

On this tab testing of the unsuccessful sequence can be activated or deactivated and the number of cycles can be specified. The correct setting of the latter depends on the settings at the test object. If, for example, the test object is parameterized to three AR attempts (one short dead time and two long dead time cycles), the number of cycles has to be set to three.

On this tab also the events to be measured and the mode of assessment are defined for each cycle.

Figure 8-2:
Parameterization of an
unsuccessful sequence
test – "Event" column

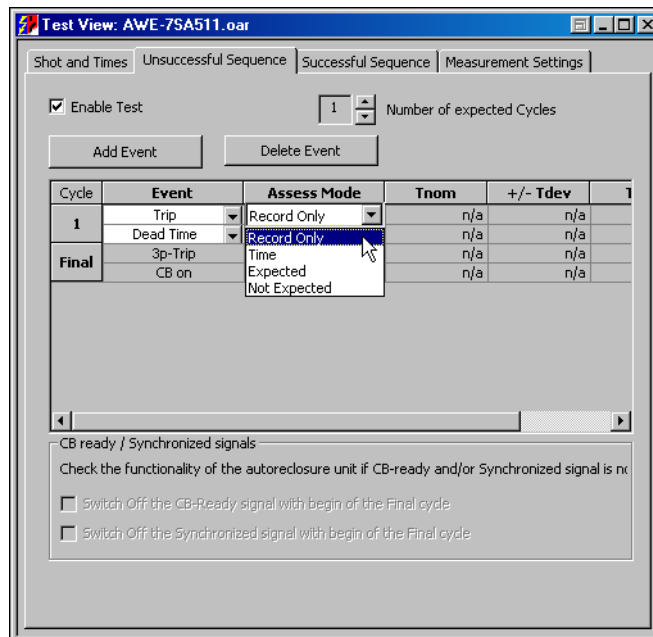


The dead time and the CB on command can always be captured. The signals Trip, Trip L1, Trip L2, Trip L3 can only be selected in the "Event" column if these signals are selected in the hardware configuration (refer to figure 8-2).

In the "Assess Mode" column (refer to figure 8-3) the following settings can be selected:

- Record Only:** The result is only recorded, no assessment is performed.
- Time:** The assessment is performed according to the settings for Tnom and Tdev.
- Expected:** The assessment is positive if the event occurs within the maximum time.
- Not Expected:** The assessment is positive if the event DOES NOT occur within the maximum time.

Figure 8-3:
Parameterization of an
unsuccessful sequence
test – "Assess Mode"
column



The "Final" cycle is configured by default and cannot be changed. With this cycle the final three-phase tripping is tested and it is tested that no further CB on command occurs.

Successful Sequence

On this tab testing of the successful sequence can be activated or deactivated and the number of cycles can be specified. The number of cycles for the successful sequence must be at least 1 **and** smaller or equal to the number of cycles set for the unsuccessful sequence.

The settings for the events and the mode of assessment are taken over from the unsuccessful sequence and cannot be changed here.

The "Final" cycle is configured by default and cannot be changed. With this cycle it is tested whether no new tripping occurs.

8.2 Sequence of an AR Test

Testing an unsuccessful AR and a successful AR can either be performed within one test sequence or by separate test sequences. By default both tests are activated.

In order to set the test parameters for the tests or to display the results, open the corresponding tab **Unsuccessful Sequence** or **Successful Sequence** in the Test View.

The signal curve for the currently selected test is displayed in the Time Signal View.

Each test starts with the output of the prefault state.

After this, the following sequence is repeated according to the specified number of cycles.

- Output of the fault state, waiting for the occurrence of the trip command.
- 50ms after the occurrence of the trip command (CB switching time), the fault state is switched off at the next zero crossing of the currents. The voltage and the current are zero. If the trip command is routed, always a three-phase tripping is performed.
- Start of the dead time, waiting for the occurrence of the CB on command.
- 50ms after the occurrence of the CB on command the fault is output again.

The sequence is aborted, if no trip or CB on command is detected within the maximum time.

When testing an unsuccessful sequence, the fault state is output after the last reclosure in order to test the three-phase tripping. After the maximum trip time all voltages and currents are switched off.

When testing a successful sequence the prefault state (healthy system) is output after the last reclosure in order to test whether no new trip command occurs during the maximum trip time.

If both tests are activated, the unsuccessful sequence is tested prior to the successful sequence. The maximum CB close time is also used as the time between the termination of the unsuccessful sequence and the start of the successful sequence.

8.3 Example 1: Offline Example

Please use the following test task to become familiar to the usage of the module in offline mode before using the module the first time for a particular test.



Test Task

A protection device with ARC function is parameterized in a way that two AR attempts are performed for any case of fault.

- Nominal voltage of the test object: 100V
- Nominal current of the test object: 1A

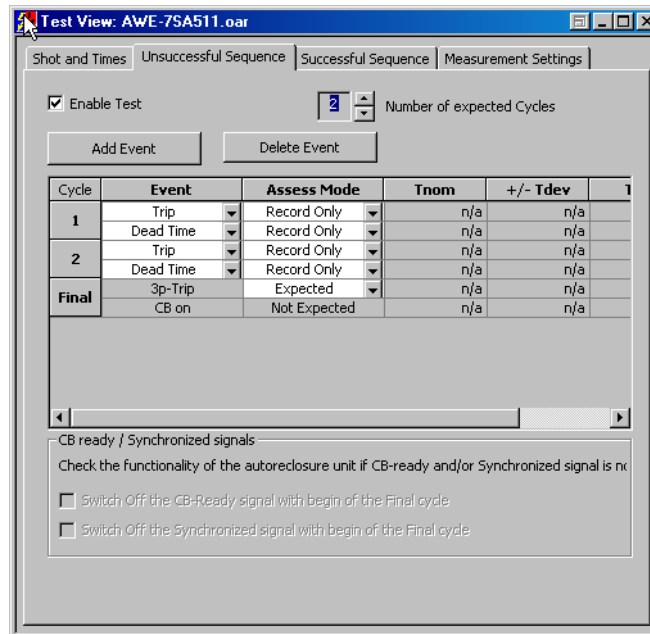
8.3.1 Test Module Settings

In the **Shot and Times** tab keep the default settings.

The fault specified by default is a L1-Ground fault with a fault voltage of 0V and the fault current set to twice the nominal current. The voltages and currents occurring in case of a fault are displayed in the Vector View.

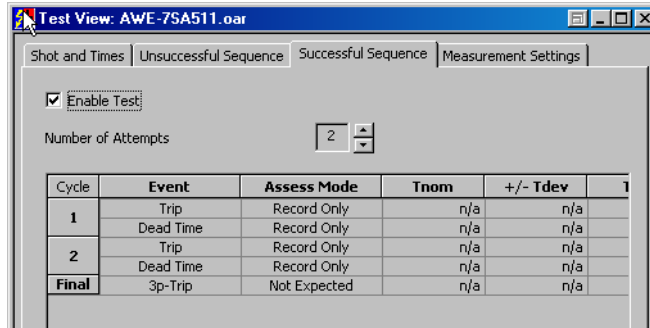
Switch to the **Unsuccessful Sequence** tab. Increase the number of cycles to 2.

Figure 8-4:
Test module settings -
**Unsuccessful
Sequence** tab



In the **Successful Sequence** tab the number of cycles is automatically preset to two cycles as well.

Figure 8-5:
Test module settings - automatic adoption of the number of cycles in the **Unsuccessful Sequence** tab



Please note that in this tab only the activation or deactivation of the sequence and the setting for the number of cycles can be performed. Due to this the entire table is shaded in gray.

8.3.2 Running the Test

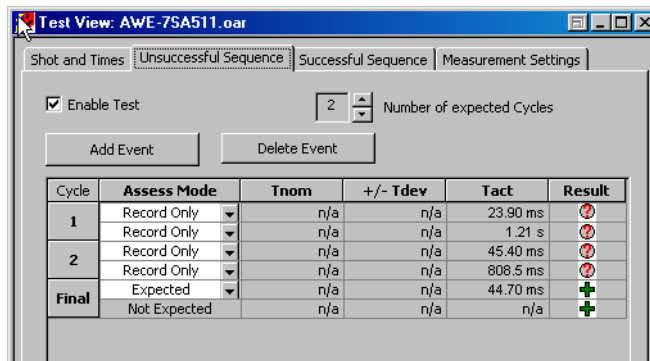


After these settings are done, the test can be started. Start the test by clicking the Start toolbar icon or selecting the menu item **TEST | START / CONTINUE**.

8.3.3 Test Results

The test results are displayed in the tables of the tabs **Unsuccessful Sequence** and **Successful Sequence**.

Figure 8-6:
Display of the test results



In the Time Signal View the currents, voltages and binary signals are displayed along a time axis (see figure 8-7).

Figure 8-7:
Results of the simulation, view optimized using the zoom function



To change the Time Signal View display from the results of the unsuccessful to the ones of the successful sequence, change to the acc. tab in the Test View.

8.4 Example 2: ARC Testing for a SIEMENS 7SA511

The autoreclosure function of a feeder protection shall be tested. The relay in question is a Siemens 7SA511 with the ARC option.



Sample file: AWE-7SA511.oar

Stored at: ...*OMICRON Test Universe installation path*\Test Library\Samples\SW Manual Examples\Protection



Test Task

The autoreclosure function of the protection relay is activated. It is parameterized for two reclosure cycles, one short dead time (rapid autoreclosure) and one long dead time (slow autoreclosure).

Note: For many protection relays the first AR cycle is called short dead time (rapid autoreclosure) and all subsequent cycles are called long dead time (slow autoreclosure).

In a first step the principle function of the ARC shall be tested. Testing of the set time values is performed in a second step.

Equipment Required

1. Test set *CMC 156* or *CMC 256*
2. Test software *OMICRON Test Universe*, version 1.6 or higher
3. Relay manual
4. Knowledge about system parameters and interconnection
5. Optional: *Digsi* software for verifying the relay settings

8.4.1 Test Object Settings

The ARC function of a protection device depends on numerous parameters. The tester must have in-depth knowledge about the meaning of these parameters and their settings.

This example assumes the following parameterization:

- Frequency: 50Hz
- Nominal secondary voltage: 100V
- Nominal primary voltage: 110kV
- Nominal secondary current: 5A
- Nominal primary current: 1000A
- The protection device trips at a fault voltage of 0 V and a fault current of twice the nominal current. Two AR attempts are performed for all fault types (1 short dead time + 1 long dead time).
- Blocking time after a successful AR: 3.0s
- Blocking time after an unsuccessful AR: 3.0s
- Short dead time (1-pole): 1.20s
- Short dead time (3-pole): 0.40s
- Long dead time (1-pole): 0.80s
- Long dead time (3-pole): 0.80s



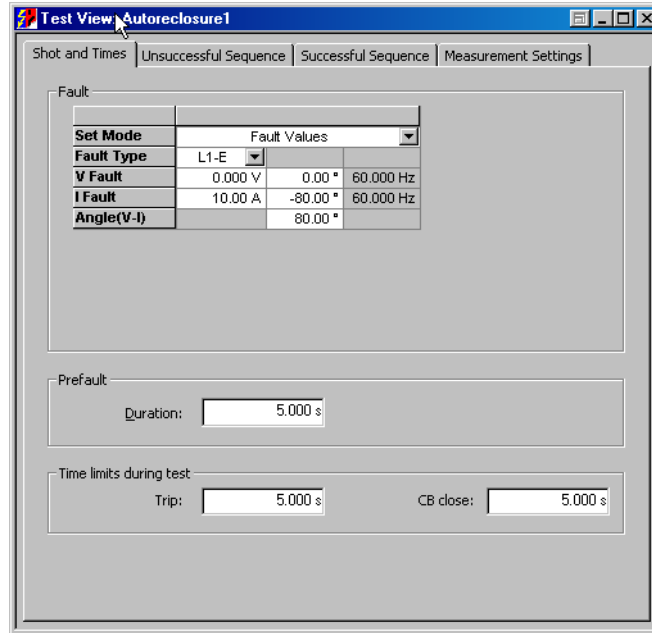
A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

8.4.2 Testing the Reclosure Function

Test Module Settings

The nominal voltages and currents are set as test object parameters. In the **Shot and Times** tab change the current IL1 to 10A.

Figure 8-8:
Changing the current
IL1 in the **Shot and
Times** tab



The maximum CB close time is used by the test module as the dead time between the tests for an unsuccessful sequence and a successful sequence. This is why this time must be higher than the blocking time after an unsuccessful AR.

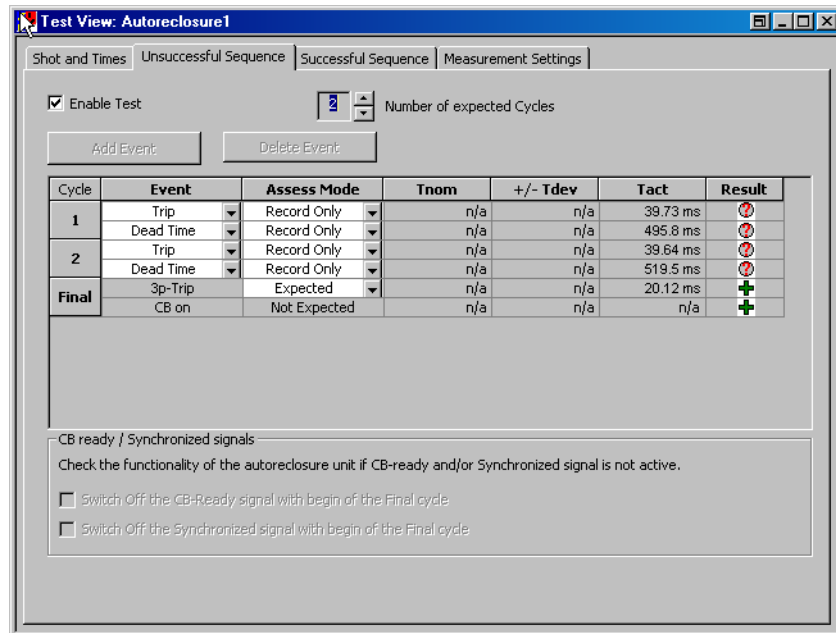
For a first test, the other settings are left unchanged.

In the **Unsuccessful Sequence** tab increase the number of cycles to 2.

Using the Single Test Mode

Using a single test you can quickly test the function of the test object. The single test mode only performs the particular test of the currently selected tab in the Test View. The test results are not added to the test report. For example, the following result is achieved if you start a single test while the **Unsuccessful Sequence** tab is selected:

Figure 8-9:
Result of a single test
for the **Unsuccessful
Sequence** tab



This result confirms the basically proper function of the test object.

8.4.3 Test and Assessment of the Times

The final test shall record the trip commands for the individual phases and test the keeping of important nominal times.

Test Module Settings

In the hardware configuration deactivate the "Trip" signal and activate the signals "Trip L1", "Trip L2" and "Trip L3".

Figure 8-10:
Activation of Trip L1,
Trip L2 and Trip L3 in
the hardware
configuration

Hardware Configuration			CMC156-EP															
			CH767C															
			Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	Binary	
Function	Potential Free	Nominal Range																
Threshold	Test Module Input Signal	Display Name	Connection Terminal	1+	1-	2+	2-	3+	3-	4+	4-	5+	5-	6+	6-	7+	7-	8+
	Not used	Bin. In. 1		X														
	Not used	Bin. In. 2				X												
	Close Cmd	Close Cmd						X										
	Trip L1	Trip L1								X								
	Trip L2	Trip L2										X						
	Trip L3	Trip L3												X				
	Not used	Bin. In. 7														X		
	Not used	Bin. In. 8																X
	Not used	Bin. In. 9																
	Not used	Bin. In. 10																
	Not used	Bin. In. 11																
	Not used	Bin. In. 12																

In the **Unsuccessful Sequence** tab we want to specify 4 events for each cycle.

To do so, select the corresponding cycle by clicking in the "Cycle" column. Then select "Add Event". Repeat this until 4 events are assigned to the cycle.

For the dead time we change the assess mode to "Time" and specify the following parameters according to the nominal times of the test object:

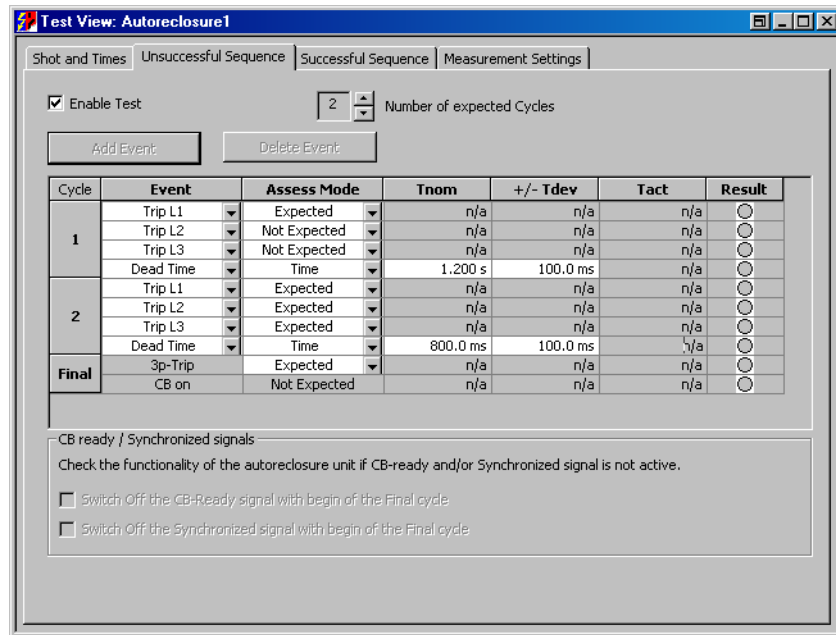
- Short dead time (1-pole): 1.20s
- Short dead time (3-pole): 0.40s
- Long dead time (1-pole): 0.80s
- Long dead time (3-pole): 0.80s

Because an L1-E fault is output, the dead time for the first cycle has to be 1.2s. The dead time for the second cycle shall be 0.8s. For the time tolerances we select a value of 100ms.

In the first cycle, a single pole error shall result in a single pole tripping only. Check this by setting the assess mode for Trip L1 to "Expected", for L2 and L3 to "Not Expected".

Figure 8-11 shows the **Unsuccessful Sequence** tab with the completed configuration.

Figure 8-11:
Unsuccessful Sequence tab with all configuration settings



The settings in the **Successful Sequence** tab are already correct. Now both tests are activated.



Start both tests by clicking the start icon or by selecting the menu item **TEST | START / CONTINUE**.

8.4.4 Test Results

The test results are displayed in the tables of the tabs **Unsuccessful Sequence** and **Successful Sequence**.

Figure 8-12:
Example of a test result
in the **Unsuccessful Sequence**
tab

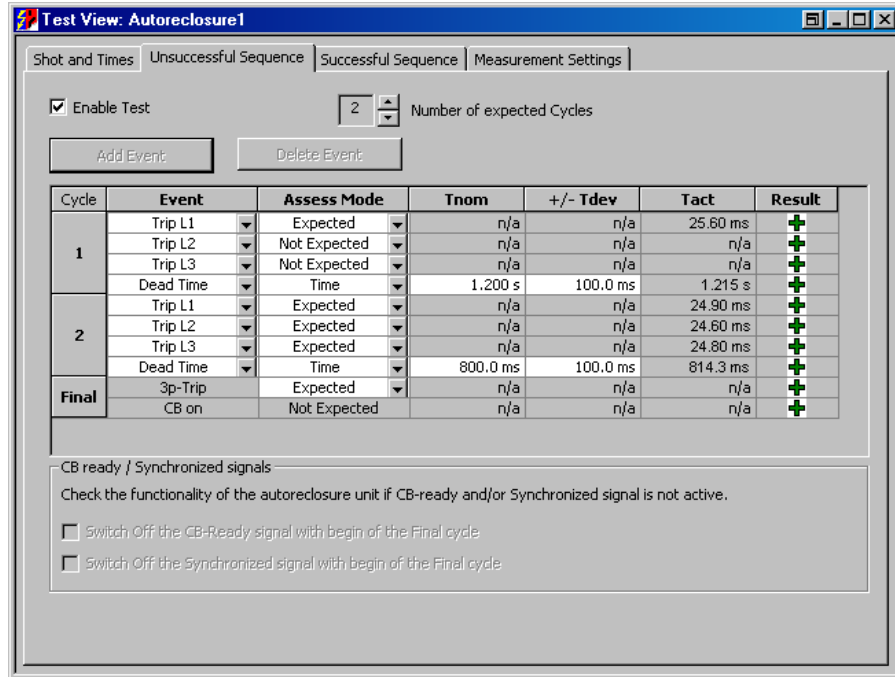
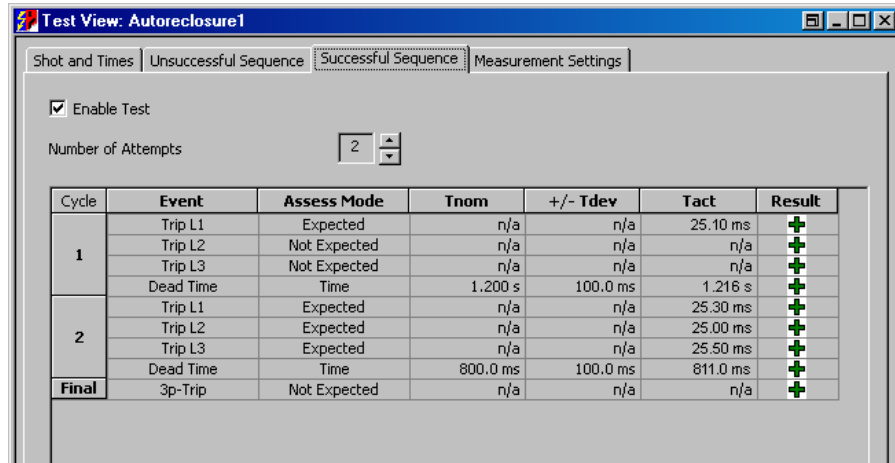


Figure 8-13:
Example of a test result
in the **Successful Sequence**
tab



In the Time Signal View the two cursors are set in a way that the duration of the CB on command can be read.

Figure 8-14:
Test Result in the Time
Signal View



In case of an unsuccessful AR the CB on command is terminated by the trip command. The maximum length of the CB on command only occurs in case of a successful AR. The measured value of 503.5ms meets the test object parameter which is set to 0.50s pretty good.

Report View

With the basic settings the Report View shows the test object parameters, the fault values and the tables for the unsuccessful and successful sequence.

If the Time Signal View shall be added to the test report, the "long" report form must be set using the menu item **PARAMETERS | REPORT**.

The Time Signal View is then added to the report as it is currently set on the screen (incl. the zoom factor and the cursor settings).

9 Differential

The *Differential* test module provides a compact testing solution for generator, busbar, and transformer differential protection relays, performing operating characteristic (pick-up value, slope test) and the inrush blocking function (harmonic restraint test) in **single-phase mode**, e.g., for 3 single-phase protection relays per test object.

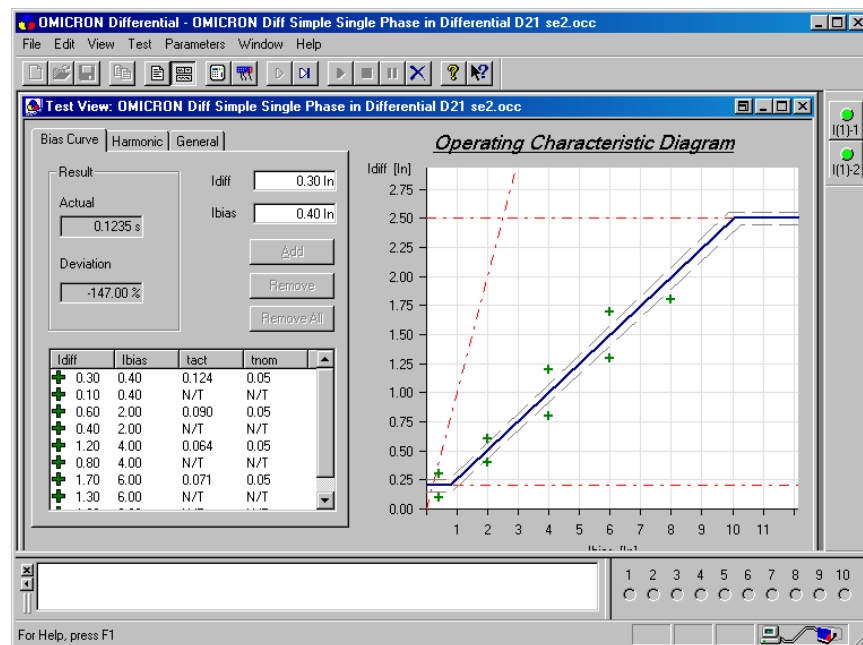


Please note that 3-phase testing taking zero sequence elimination and vector group matching into consideration requires the *Advanced Differential* test module of the *Advanced Protection* package.

9.1 About Differential

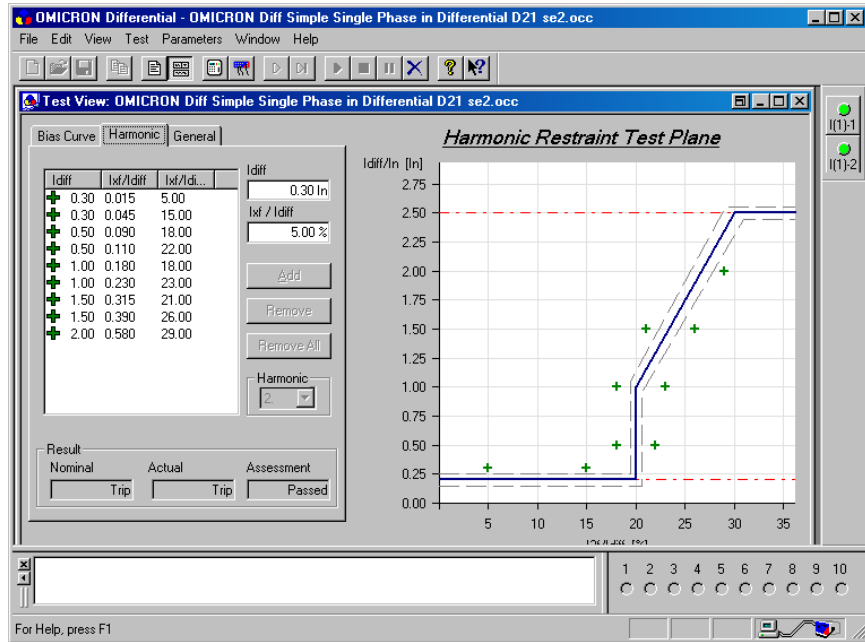
Test points are defined in the I_{diff}/I_{bias} plane either by mouse or using the keyboard for the test of the operating characteristic.

Figure 9-1:
Differential - operating
characteristic diagram



Differential also provides an appropriate testing environment for testing the harmonic restraint function. The amplitude of the fundamental and the percentage of the superimposed harmonic can be defined for each test point.

Figure 9-2:
Differential - harmonic
restraint test plane



The test currents belonging to the test points are injected to the relay and the reaction of the relay is assessed.

By inserting several *Differential* modules into an OMICRON *Control Center* document, different fault loops can be tested automatically.

9.2 Example: Transformer Differential Relay



Sample file:

Differential D21 se2.occ

Stored at: ...OMICRON Test Universe installation path\
Test Library\Samples\SW Manual Examples\Protection



Task

The tester's job is to test a conventional transformer differential protection relay BBC D21 SE2 (Brown Boveri's relay) at a power station as part of a larger test program.

This relay protects a 2 winding transformer with the following nominal data:

Vector group YD5	Y side is grounded
Power:	38.1 MVA
Nominal Voltage (primary):	110 kV
Nominal Voltage (secondary):	11 kV
Nominal Current (primary):	200 A
Nominal Current (secondary):	2000 A



Solution

In the following example we are using the *Differential* test module embedded in the OMICRON *Control Center*.

During the test, the *Differential* test module analyses and evaluates whether the measured values are within the defined tolerance band and assesses the test with "passed" or "failed". All entered values and the measured values are recorded automatically to allow a detailed view of the test process after completion of the test.

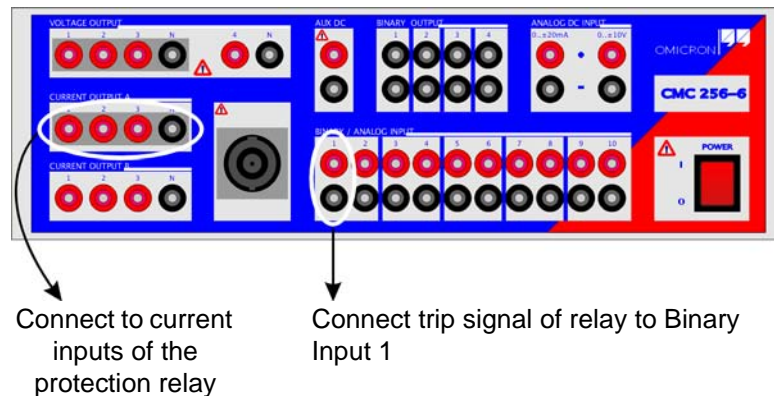
Note: If you have to perform only one test, it may be advantageous to start the *Differential* test module as a stand-alone program (without having started the OMICRON *Control Center* previously).

Normally, however, all the available protection functions of a relay will be tested sequentially. In these cases, it makes more sense to embed the test module multiple times into the test document and then change the settings of each embedded instance for an appropriate test.

9.2.1 Wiring Between Protection Relay and CMC

1. Connect the current inputs of the protection relay to the corresponding current outputs of the CMC test set.
2. Connect the trip signal of the protection relay to Binary Input 1.

Figure 9-3:
CMC 256 test set,
front view



9.2.2 Starting Differential from the OCC

Start the OMICRON *Control Center* from the *Start Page* by clicking OPEN EMPTY DOCUMENT. Insert *Differential* into the OCC document by selecting the menu item INSERT | TEST MODULE... | OMICRON DIFFERENTIAL.

9.2.3 Setting up the Test Object

To configure the relay you are testing, use the Test Object software function.



Open **Test Object** either by using the pull-down menu item PARAMETERS | TEST OBJECT or by clicking the TEST OBJECT icon in the toolbar. In **Test Object**, you can browse, access and edit the test object parameters.



A detailed description of **Test Object** and the closely related subject "XRIO" can be found in section 3 "Setting up the Test Object" of the "Concept" manual, or in the online help under the --- **Test Object** --- entry of the table of contents.

Step 1: Inserting the test object and defining the device settings

1. Select **INSERT | TEST OBJECT** to open the dialog box for the test object-specific data, and specify the device settings for your relay under test.
2. In the dialog box for the test object-specific data, select the test object function "Differential" and define the differential protection parameters as described in the following step 2.

Step 2: Defining the differential protection parameters

Figures 9-4 to 9-6 show the standard pages of the differential protection parameters. The protection relay BBC D21 SE2 has the following additional parameters.

The formulas below can be found in the manual of the relay. The adjustable parameters g and v define the operating characteristic.

$$\text{Offset value: } g = 20\% \quad g = (I_1 - I_2) / I_n \text{ at } I_{\text{bias}} = 0$$

$$\text{Slope: } v = 50\% \quad v = (I_1 - I_2) / 0.5(I_1 + I_2)$$

The following equations are valid according to the data sheet for the different parts of the characteristic:

$$I_{\text{bias}} / I_n = 0 \dots 0.5 \quad I_{\text{diff}} / I_n = 20\% \text{ or } 0.2$$

$$I_{\text{bias}} / I_n = 0.5 \dots 3 \quad I_{\text{diff}} = I_n * g + (I_{\text{bias}} - 0.5 I_n) * v$$

Entering the values into the equation:

$$I_{\text{diff}} = 5A * 0.2 + (I_{\text{bias}} - 0.5 * 5A) * 0.5$$

$$\text{Hence: } I_{\text{bias}} / I_n = 0.5 \dots 3 \text{ and } I_n = 5A$$

$$\mathbf{I_{diff} = 0.5 I_{bias} - 0.25 (1)}$$

Figure 9-4:
Standard page for the differential protection parameters: Protection Device tab

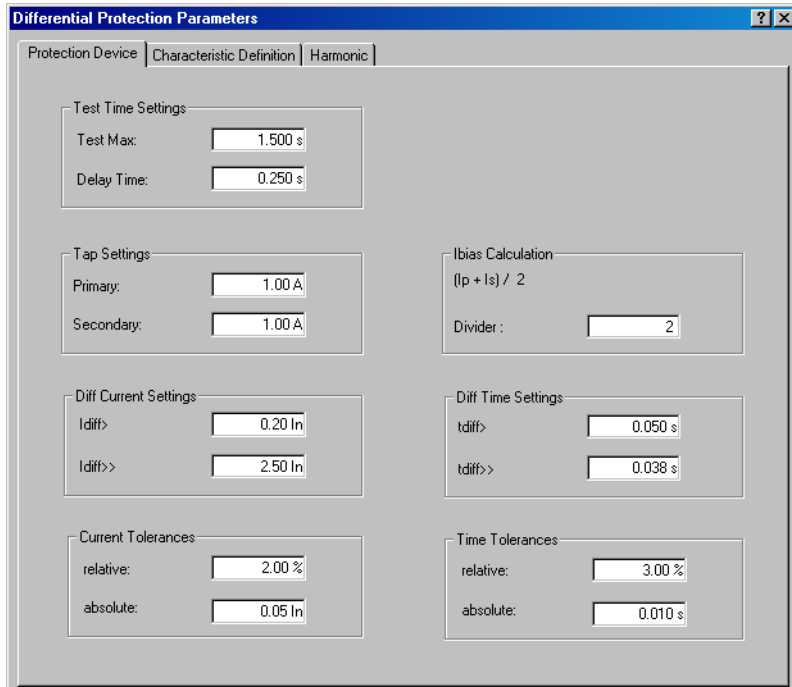
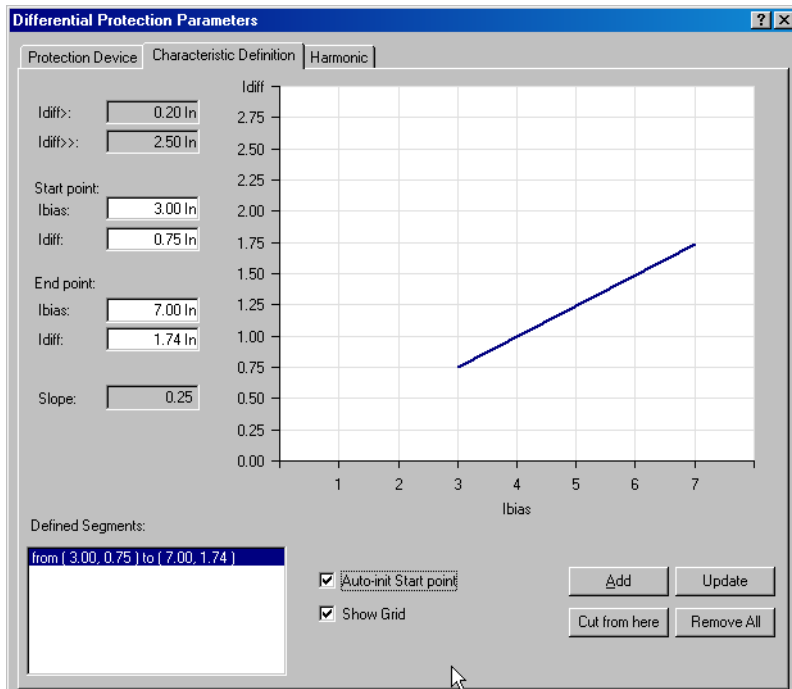
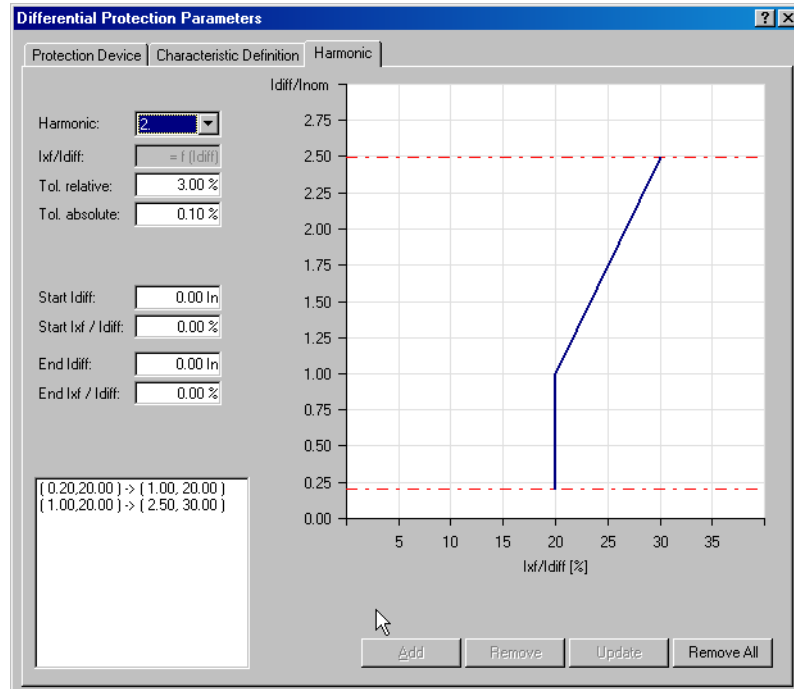


Figure 9-5:
Standard page for the differential protection parameters: Characteristics definition based on equation



The operating characteristic was derived by experiment because the data sheet of the relay does not contain an accurate characteristic. It is only listed that stabilization based on the 2nd harmonic is implemented.

Figure 9-6:
Standard page for the differential protection parameters: Harmonic, experimental derived characteristic of the inrush stabilization



9.2.4 Configuring the Hardware



Configure the hardware according to the wiring described in section 9.2.1 "Wiring Between Protection Relay and CMC".



A detailed description of the **Hardware Configuration** can be found in the "Concept" manual's section 4 "Setting Up the Test Hardware", or in the online help under the --- **Hardware Configuration** --- entry of the table of contents.

9.2.5 Defining the Test

Step 1: Inserting the Differential test module into the test document



1. Click the *Differential* icon in the test modules toolbar
or



2. Select **INSERT | TEST MODULE** or click the appropriate toolbar icon and then select "OMICRON Differential".

Step 2: Defining the operating characteristic test

This test is carried out separately for every phase. If the operating characteristic should be tested for all the three phases, the test accordingly has to be repeated for the other phases. In this section only the test for the first phase is described.

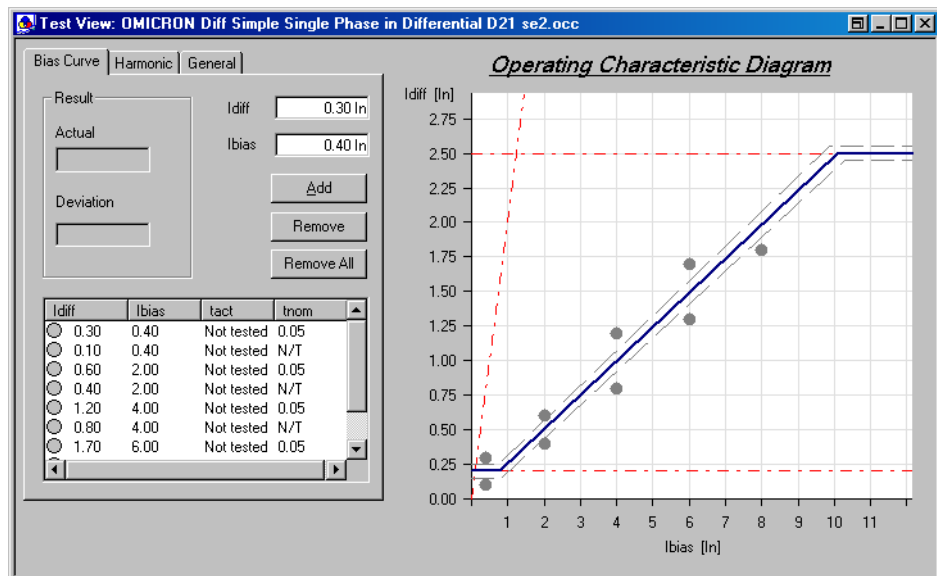
Place the test points directly below and above the characteristic. The relay should stabilize for all points right and below the characteristic; all points left and above the characteristic result in a trip in the typical operating time.

The trip time is determined by the test module and entered into a table; the test points in the diff-bias plane are updated, at the same time the protocol is generated in the background on the basis of the up-to-date data.

Table 9-1:
Test points

Idiff	Ibias	Nominal Time	Idiff	Ibias	Nominal Time
0.30 I/In	0.40 I/In	0.05 s	0.80 I/In	4.00 I/In	No trip
0.10 I/In	0.40 I/In	No trip	1.70 I/In	6.00 I/In	0.05 s
0.60 I/In	2.00 I/In	0.05 s	1.30 I/In	6.00 I/In	No trip
0.40 I/In	2.00 I/In	No trip	1.80 I/In	8.00 I/In	No trip
1.20 I/In	4.00 I/In	0.05 s	0.30 I/In	0.40 I/In	0.05 s

Figure 9-7:
Nine test points for testing the defined operating characteristic



Step 3: Defining the inrush characteristic test

This test is executed separately for every phase, too. The test for the first phase is described.

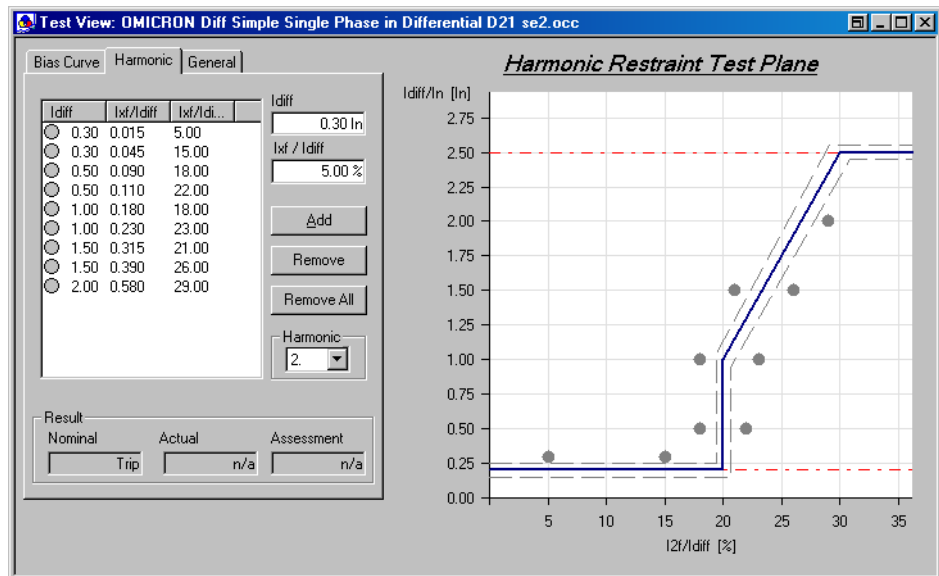
A 2nd harmonic is superimposed on the 50 Hz. The percentage of the harmonic can be chosen according to the test point. The test points are shown in the characteristic (figure 9-7) as in the test of the operating characteristic.

The relay should stabilize for all points right and below the characteristic; points left and above the characteristic result in a trip.

Table 9-2:
Test points

Idiff	I2/Idiff	Nominal Reaction
0.30 I/In	5%	Trip
0.30 I/In	15%	Trip
0.50 I/In	18%	Trip
0.50 I/In	22%	Stabilization
1.00 I/In	18%	Trip
1.00 I/In	23%	Stabilization
1.50 I/In	21%	Trip
1.50 I/In	26%	Stabilization
2.00 I/In	29%	Stabilization

Figure 9-8:
Nine test points for testing the characteristic of the inrush stabilization



9.2.6 Running the Test



1. Click the TEST START/CONTINUE toolbar icon to start the test.
2. After completion, the test results are shown as in the figures 9-9 and 9-10.

Figure 9-9:
Test result of the operating characteristic test with automatic assessment

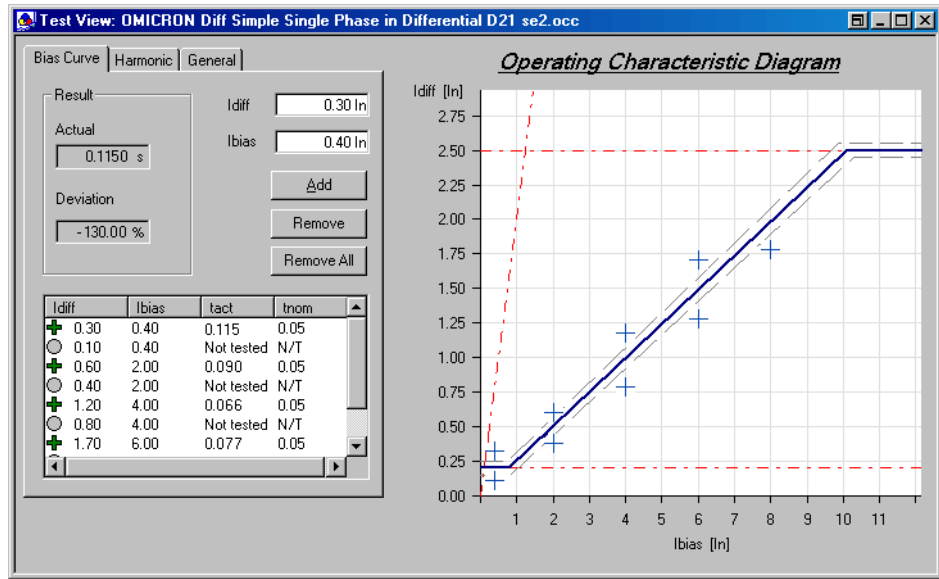
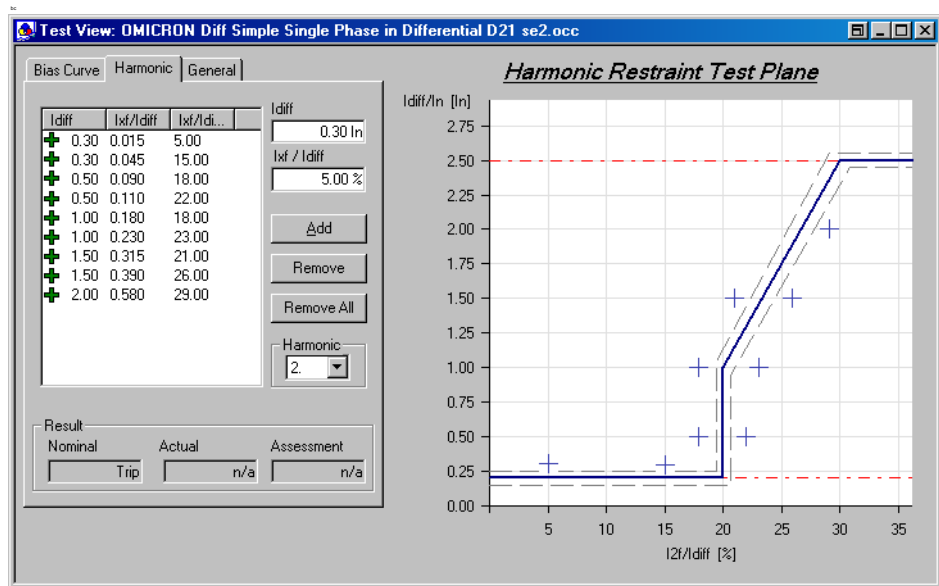


Figure 9-10:
Test result of the inrush stabilization test with automatic assessment



9.2.7 Defining the Test Report

You can define the test report

- either directly in the *Differential* test module using the menu item
PARAMETERS | REPORT
- or in the OMICRON *Control Center* using the menu item
TEST | REPORT.



A detailed description about defining test reports can be found in the "Concept" manual's section 5.2 "Test Reports", or in the online help under the --- **Test Reports** --- entry of the table of contents.

10 Single Phase Testing and Output of Fault Quantities

10.1 Introduction

In order to reach a higher output power (or current, or voltage) the OMICRON test sets and amplifiers allow the serial connection or the paralleling of analog outputs. Knowing this, most electromechanical relays can be tested with the *CMC 256*. For test cases where the power of three-phase testing is not sufficient, OMICRON has developed the *Single-Phase Mode*, which is available in the *Distance*, the *Advanced Distance* and the *Overcurrent* test modules. The following explanations describe how to work with the single-phase mode as well as the *Single-Phase Fault Model*, which is the basis for testing all fault loops with single-phase sources.

10.2 Electromechanical Relays and the Single-Phase Fault Model

Electromechanical relays have special requirements on electronic test sets, since the power demand of the current and voltage inputs can be considerably higher than with modern numerical relays. In the past, power amplifiers were often used together with electronic test sets to drive the high burdens of the electromechanical relays. Compared to its predecessors, the *CMC 256* provides considerably more output power, which greatly extends the application range for three-phase applications. Many electromechanical relays can be tested without additional power amplifiers. All remaining relays that still need higher power can be tested using the OMICRON *CMS 251* or *CMS 252* amplifiers.

In single-phase operation, the test sets can generally output considerably more power than in three-phase mode per phase. To obtain this increased power, multiple phases are connected together. The voltage outputs are generally connected in parallel to increase the output current. Also, the current sources are connected in parallel to increase the output current or they are connected in series to achieve a higher compliance voltage.

The OMICRON test modules *Distance*, *Advanced Distance* and *Overcurrent* can be set up so that they output the commonly named "Fault Quantities". Fault quantities denote currents and voltages that characterize the fault. These fault quantities are assigned to single-phase current and voltage sources. Consequently, a configuration of the test set is chosen, which provides the optimal output power (or current, or voltage).

10.3 Output of the Fault Quantities for Testing Distance Protection

Electromechanical distance relays have a property that can be essential for testing: they are often implemented as single-element relays, i.e. the measurement circuit and the circuit for directional detection is only present once, not per phase. When a starting condition is detected, a phase selection circuit starts operation, which connects the faulted quantities to the circuits for impedance and direction determination.

This single-element relay can be utilized for testing. Due to this fact, it is possible to test such a relay in single-phase mode, which means to test with only one current and one voltage each. The phase selection circuit takes care that this exact current and this exact voltage will be fed to the measurement circuits. The quantities in the non-faulted phases will be ignored by the relay; so it is not necessary to generate them.

The fault quantities are the current and the voltage, which determine the fault impedance. These fault quantities are fed to the impedance measurement circuit by the phase selection circuit. Depending on the fault type, the quantities are different ones. In the two figures below, the situation for phase-to-ground faults and phase-to-phase faults is shown.

Figure 10-1:
Voltages and currents
for phase-to-ground
faults

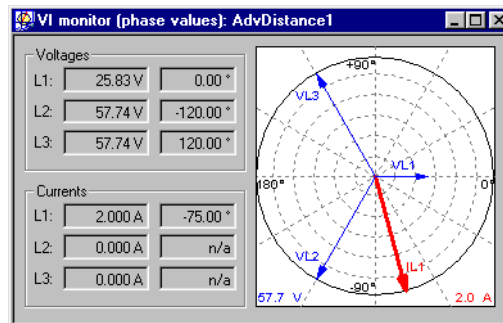
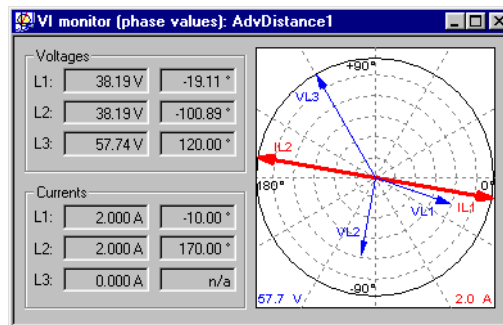


Figure 10-2:
Voltages and currents
for phase-to-phase
faults



In the case of the phase-to-ground faults example, the fault quantities are the phase-to-ground voltage and the phase current of the faulted phase.

In the case of the phase-to-phase example, the phase-to-phase voltage of the faulted phases and the currents in the faulted phase, comprise the fault quantities. The two-phase currents appear in the phase diagram as two currents with identical magnitude and opposite sign. In fact, it is one current that flows into the relay at the one phase and out of the relay at the other. Therefore, also in this case, one source is sufficient to produce this test current.

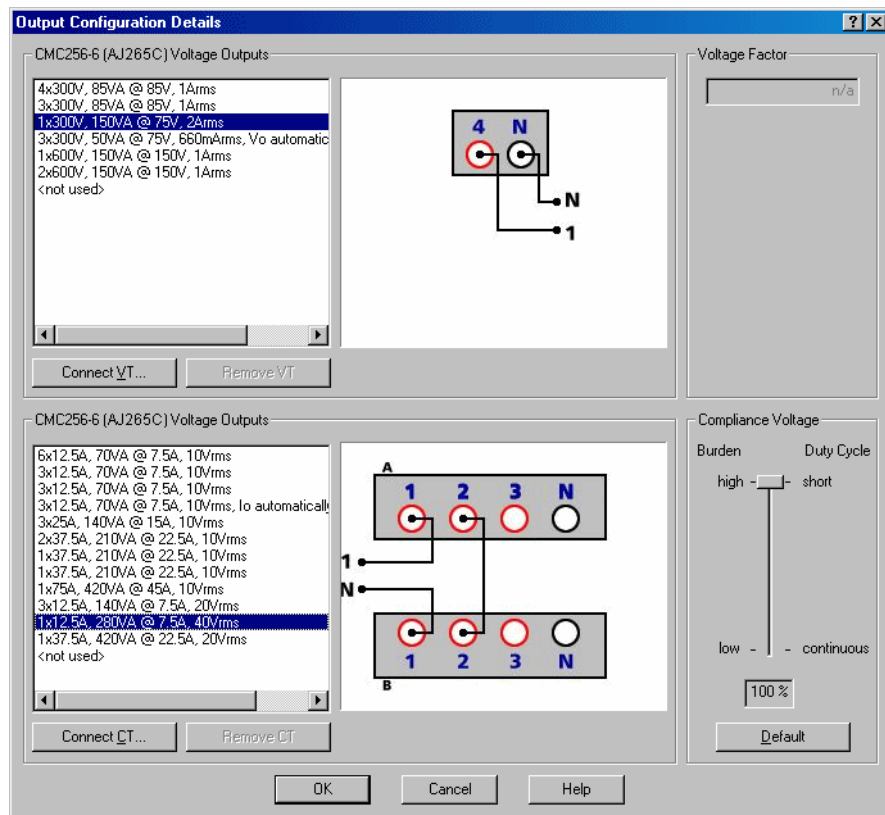
The test software set up this way performs the output of the fault quantities through the single-phase sources without further user interaction. The remaining operation of the test module remains unchanged, which means the specification of the characteristic and the setting of the test points are done as if the relays were three-phase connected. The user has only to check that the sources are connected correctly to the terminals of the relay, according to the fault type. The *(Advanced) Distance* test software reminds the user with a message that the wiring has to be modified accordingly at the start of the test and at any change of the fault type.

10.4 Settings in the Hardware Configuration for using the Single-Phase Fault Model

The usage of the sources present in the test set is determined in the detail View of the hardware configuration. The available combinations of the sources are presented in a list and the necessary wiring is displayed in a graphic beside of it.

Figure 10-3 shows a typical setting of a *CMC 256* for testing electromechanical distance relays with a nominal current of 1 A.

Figure 10-3:
Detail View of the
Hardware
Configuration: one
possible selection for
single-phase operation



The maximum test current of 12.5A is absolutely sufficient for this case. Therefore it is possible to connect four current sources in series, providing a driving voltage of up to 60V (peak value). With the *CMC 256* test set, balancing resistors to assure a leveled voltage distribution when connecting current sources in series are no longer needed.

The available power from the voltage sources in this test set is not determined from the current rating of the amplifiers, but from the respective power supply. The maximum current can be obtained from a single source with the wiring shown.

The mapping of the fault quantities to the single-phase sources is done in the dialog for the analog outputs. The signals I Fault and V Fault are selected for their respective current and voltage source.

Figure 10-4:
Hardware Configuration, Analog Outputs tab: Mapping of the fault quantities in the *Advanced Distance* test modules

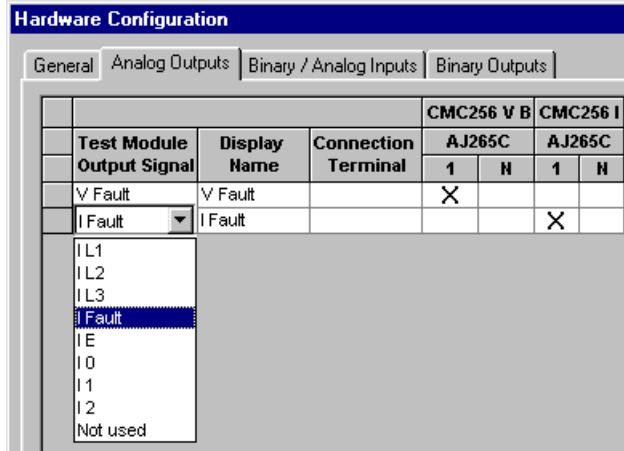


Figure 10-5:
Example of wiring for an A-N (L1-E) fault shown with a special case of an A-N (L1-E) fault

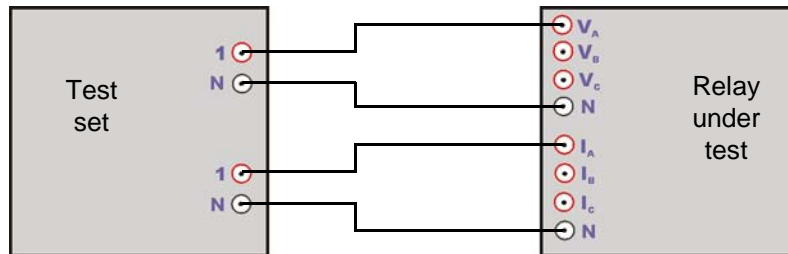
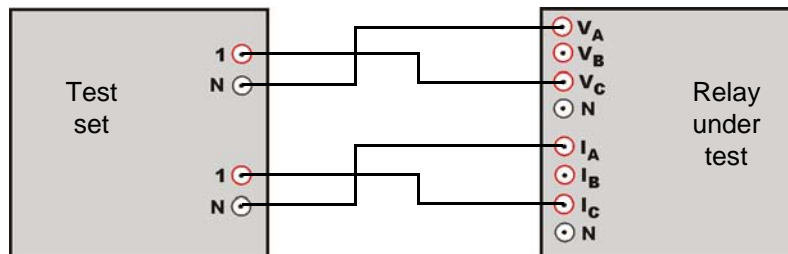


Figure 10-6:
Example of wiring for an phase-phase fault shown with a special case of a C-A fault (L3-L1)



10.5 Output of the Fault Quantities for Testing Overcurrent Protection

Overcurrent relays often require high currents to test the I >> elements. The CMC 256 can generate 25A in three-phase mode. To obtain this increased power, multiple phases are connected together. The voltage outputs are generally connected in parallel to increase the output current. Also, the current sources are connected in parallel to increase the output current or they are connected in series to achieve a higher compliance voltage. If this current is still not sufficient, paralleling the outputs allows the emission of up to 75A in single-phase mode. Additionally, some electromechanical overcurrent relays require high output power of the test device where the serial connection of the current outputs is required, leading again to the use of the single-phase mode.

In the *Overcurrent* test module, the setup of the hardware configuration is performed exactly in the same way as described above, which is by mapping I Fault and V Fault.

The fault quantities are the L-N or L-L fault current and an L-N voltage. Of course, three-phase faults, zero sequence faults, and negative sequence faults cannot be tested.

For non-directional relays, only a current source is needed anyway. The setup is very simple as all L-N and L-L faults are supported.

For directional relays, the supported fault types depend on the combination of the voltage and the current sources.

10.6 Single-Phase Current Source and Three-Phase Voltage Source

Even if a single-phase current source is chosen for reasons of power demands in the current path, feeding the relay with three-phase voltages is still possible in the majority of all cases.

The relay has all the voltages available to perform the directional decision. At L-N faults, the relay can use the L-N voltage of the faulted phase or the L-L voltage of the same phases. At L-L faults, the relay can use the L-N voltage in the same phase, one of the L-N voltages of the faulted phases or the L-L voltage of the faulted phases.

In this case, all L-N and L-L fault types are supported.

Table 10-1:
Generated I fault
depending on the fault
type

Fault Type	I Fault
A-N (L1-E)	$I_A (I_{L1})$
B-N (L2-E)	$I_B (I_{L2})$
C-N (L3-E)	$I_C (I_{L3})$
A-B (L1-L2)	$I_A = -I_B (I_{L1} = -I_{L2})$
B-C (L2-L3)	$I_B = -I_C (I_{L2} = -I_{L3})$
C-A (L3-L1)	$I_C = -I_A (I_{L3} = -I_{L1})$

10.7 Single-Phase Current Source and Single-Phase Voltage Source

With only a single-phase voltage available, testing L-L faults can become especially tricky. Because of this, only L-N faults are supported when using single-phase sources for both current and voltage.

Testing the L-N faults is done under the assumption that the voltage of the faulted phase is used for the directional decision.

Table 10-2:
Generated I fault and V
fault depending on the
fault type

Fault Type	I Fault	V Fault
A-N (L1-E)	$I_A (I_{L1})$	$V_{A-N} (V_{L1-E})$
B-N (L2-E)	$I_B (I_{L2})$	$V_{B-N} (V_{L2-E})$
C-N (L3-E)	$I_C (I_{L3})$	$V_{C-N} (V_{L3-E})$

11 Test Tools

The OMICRON *Test Universe* Test Tools provide additional stand-alone applications for specific testing tasks. You can find them on the *Start Page* under "Test Tools".

11.1 TransPlay

TransPlay is a program that runs independently from the OMICRON *Test Universe* and its embedded test module concept. It performs playbacks of transient data using a CMC test set. Files of any duration can be played back. The only limitation is the capacity of the hard disk of the PC.

Note: *EnerLyzer* and *TransPlay* cannot run in parallel because *TransPlay* is constantly downloading data and requires all available resources. It is possible to run *EnerLyzer* and *Advanced TransPlay* in parallel because *Advanced TransPlay* downloads the entire signal and then all further processing is done in the test set.

11.1.1 TransPlay Features

- Multiple file playback
- Support for transient file formats 16 bit WAV and Comtrade
- Display of transient files data in a time Signal View
- Specification of (external) trigger conditions for starting the playback
- Specification of the playback sampling rate in a range of 1 to 10 kHz
- Specification of transformation ratios and scaling for amplitudes
- Recording of the binary inputs
- Inversion of each channel

11.1.2 TransPlay Example



Sample files:

- Aa12zf.cfg
- Aa12zf.dat

Stored at:

...*OTU installation path*\Test Library\Samples\SW Manual Examples\Protection



Task

The output of a transient signal with three voltage channels and three current channels is required.

The signal is available as a file in COMTRADE format (CFG and DAT file).



Solution

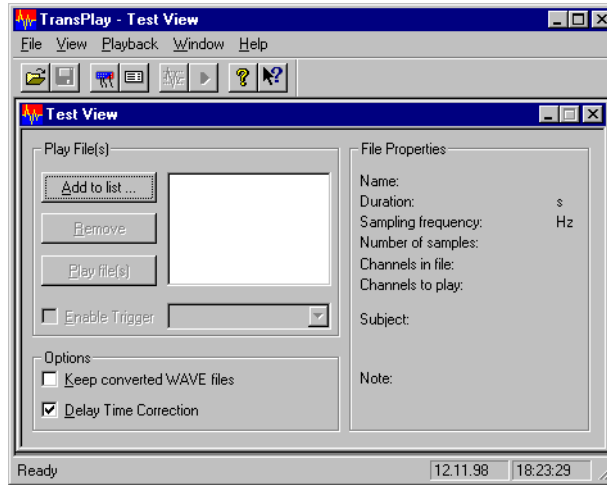
This example is based on a failure report. The recorded signal has a maximum current of approximately 30 A. Because of this, the current amplifier *CMA 156* must be used. This amplifier allows the output of the following maximum current values in one current triple (A or B):

- $25 A_{\text{rms}} \times \sqrt{2} = 35.355 A_{\text{peak}}$
- or, 70.71 A_{peak} if both current triples are connected in parallel.

Step 1: Starting TransPlay

Start *TransPlay* from the OMICRON Test Universe Start Page by selecting TESTING TOOLS... | TRANSPLAY.

Figure 11-1:
TransPlay user interface



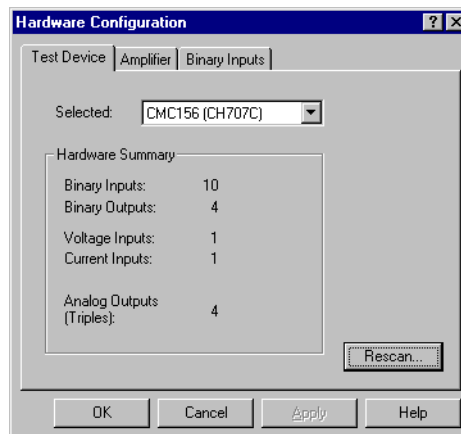
Step 2: Specifying the Hardware Configuration



Click the Hardware Configuration toolbar icon to open the **Hardware Configuration** with the **Test Device** tab.

Test Device tab

Figure 11-2:
Hardware configuration:
information about the
test device

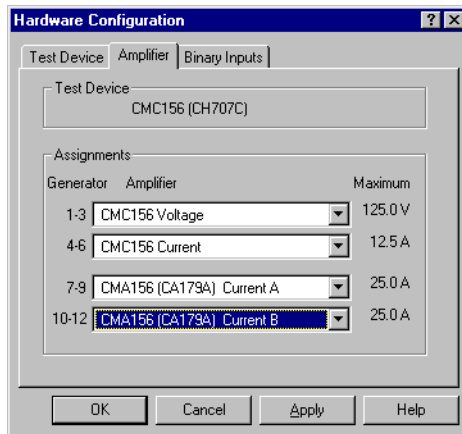


During start-up, *TransPlay* identifies the connected test set; in the example it is a *CMC 156* with the serial number CH707C.

Note: Click the "Rescan" button if the software is first operated in the offline mode and the test device is connected or switched on at a later time. The hardware is detected and initialized automatically.

Amplifier tab

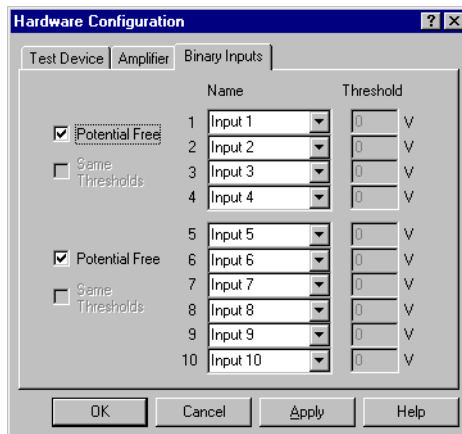
Figure 11-3:
Hardware configuration:
assignment of the
amplifiers



Binary Inputs tab

The binary inputs are set on the **Binary Inputs** tab (potential free or with threshold).

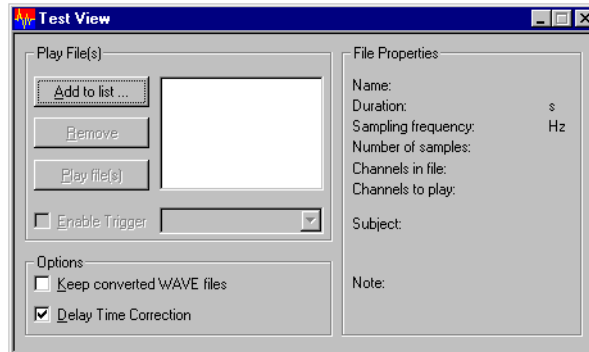
Figure 11-4:
Hardware configuration:
threshold for the binary
inputs



Step 3: Loading the Signal File

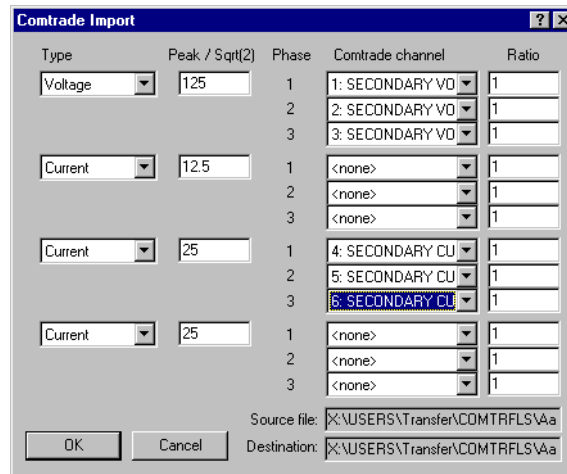
1. Click the "Add to list..." button in the *TransPlay* Test View.

Figure 11-5:
TransPlay Test View



2. A selection dialog box appears. Select the signal file of your choice (in the example the COMTRADE file AA12ZF.CFG) and click the OPEN button.
3. The dialog box for the **Comtrade Import** filter is opened.

Figure 11-6:
Comtrade import filter



In this dialog box you perform the following settings:

- The voltage and current signals (channels) of the Comtrade file have to be assigned to the physical amplifier outputs.
- In the shown example there are one voltage triple with 125 V, one current triple with 12.5 A, and two further current triples with 25 A each.
- Furthermore you may have to enter the transforming ratio of the voltage and/or the current transformer.

This is necessary, if the COMTRADE file contains primary values. In this case, the software already suggests a value.

This example uses secondary values which the selected amplifiers can output over the complete range. Therefore the transforming ratio is 1.

4. Clicking the OK button applies the settings. Now the file is loaded.

During the loading process the signal is converted from the COMTRADE format to the WAV format which is used for audio applications. From now on, this file format is used for all further processes internal to the PC.

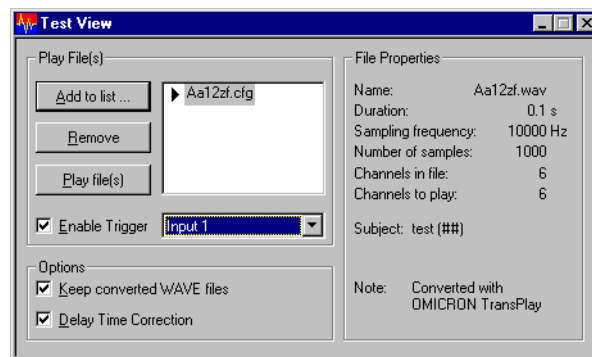
5. The file name AA12ZF.WAV is now displayed (see figure 11-7).

Step 4: After Loading the Signal File

After loading the file AA12ZF.CFG, it is shown in the playback window (see figure 11-7). The right-hand side area "File Properties" lists detailed information about the signal, e.g.

- Name (* . WAV)
- Duration of playback
- Sampling frequency
- Channels in the file

Figure 11-7:
TransPlay after loading
the COMTRADE file.



If you activate the check box "Keep converted WAVE files", the converted WAV file will be also available even after terminating the *TransPlay* test tool. Otherwise the file is deleted when you are exiting the program.

You can also load multiple files into the playback window. These files are then played in the assigned order.

Step 5: Preparing the Signal Output

Because the amplifier *CMA 156* is being used for the current output in this example, you have to activate the check box "Delay Time Correction" before you play the file.

Without this correction, a phase fault may appear of approximately 2° between the voltage (*CMC* test set) and the current (amplifier).

Note: This phase fault is corrected automatically and without any user action for the sine-wave output signals of the remaining test modules.

For this example, the signal output should occur on a specific trigger condition.

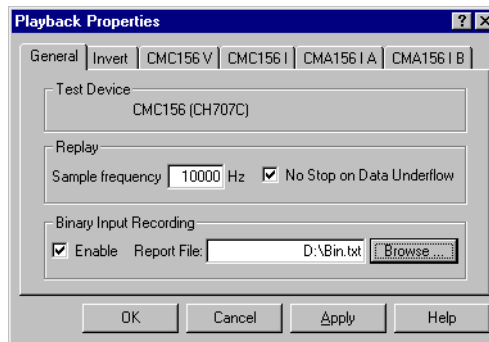
1. Mark the check box "Enable Trigger" and define "Input 1" as the trigger condition.

If you define the trigger condition "Ext. Trigger", *TransPlay* waits for a trigger signal from the external *CMGPS* synchronization unit which is connected to the circular plug on the rear of the *CMC* test device before it starts the output of the transient signal.

2. Open the **Playback Properties** dialog box by clicking its toolbar icon.



Figure 11-8:
TransPlay Playback
Properties: General tab



General tab

Here you can set the playback frequency of the output. The default setting is the frequency with which the signal was recorded. In most cases the signal will be output with the same frequency. Therefore you can leave this value unchanged.

In practice this could be used for example to adapt a fault occurrence in a 60 Hz mains supply to a 50 Hz mains supply by stretching the time axis with the factor 60/50.

Note: The playback frequency is adjustable between 1 and 100 kHz. But the signals are limited to a maximum of 10 kHz by the test device.

Due to the conversion, values calculated by linear interpolations are added or the sample frequency is reduced to 10,000 per second if the recording frequency was higher.

If there were frequencies higher than 5 kHz included, aliasing effects can occur.

TransPlay loads the converted files (*.WAV) to the transient memory of the CMC test set which outputs the signals.

Note: The file to play should be stored on the hard disk, if possible, to guarantee best load time. Loading from a floppy disk or via a PC network could result in speed problems.

Marking the check box "No Stop on Data Underflow" always continues the signal output even if the connected PC is not able to load the output values to the sample buffer in time.

This is only relevant for very long files or slow computers. The transient memory is able to store temporarily

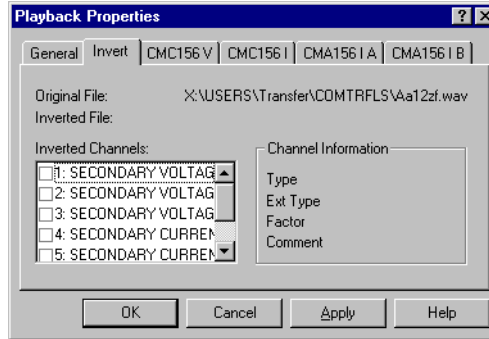
- 2 k of samples (2048 samples) with 6 output channels or
- 1 k of samples (1024 samples) with 12 output channels.

Marking the check box "Binary Input Recording... Enable" logs all changes on one of the 10 binary inputs to a defined text file, when the signal is played back (e.g. test file BIN.TXT in figure 11-15).

Invert tab

On the **Invert** tab you can set a phase shift of 180 degrees for a channel. In this manner, a signal can be inverted.

Figure 11-9:
TransPlay Playback
Properties: inverting
signals



Practical use of this feature: inverting the current flow by changing the starpoint connection (e.g. from Towards Busbar to Towards Line).

This inversion is not used in our example.

CMx15x tabs

On the tabs **CMC156 U**, **CMC156 I**, **CMA156 IA** and **CMA156 IB** you can change the signal assignment to the amplifier outputs which was initially defined when loading the file.

For this example, the signals were assigned as follows:

- Voltage signals to **CMC156 V**.
- Current signals to triple A of **CMA156 I**.

Figure 11-10:
TransPlay Playback
Properties: signal
assignment to
CMC 156 V

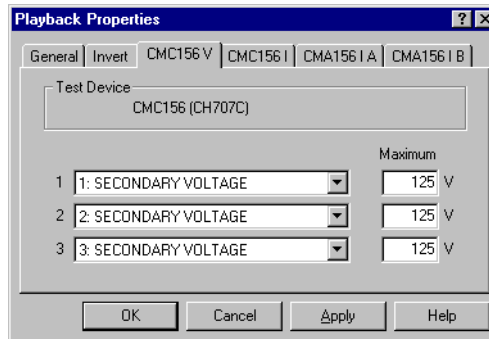


Figure 11-11:
TransPlay Playback
 Properties: signal
 assignment to
 CMC 156 I

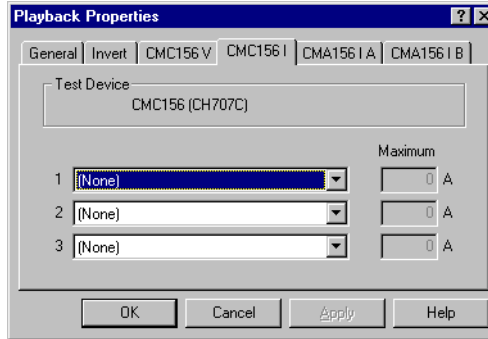


Figure 11-12:
TransPlay Playback
 Properties: signal
 assignment to
 CMA 156 IA

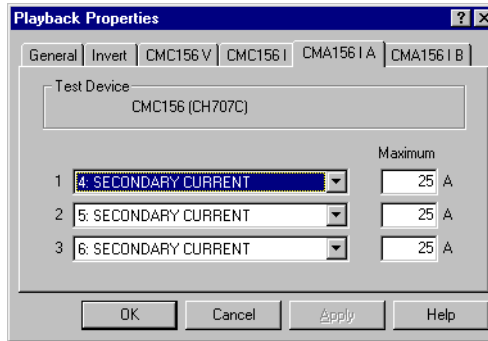
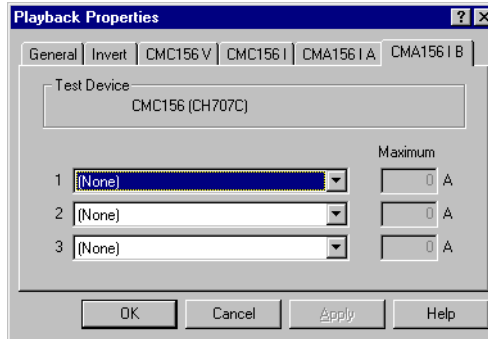


Figure 11-13:
TransPlay Playback
 Properties: signal
 assignment to
 CMA 156 IB

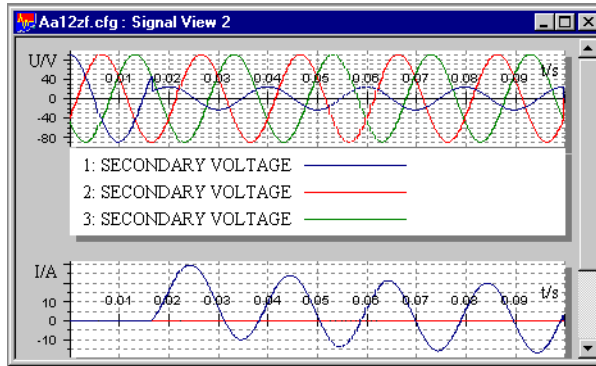


Step 6: Graphical Display of Signal File(s)



The signals to play can be displayed graphically either before or after playback by clicking the icon.

Figure 11-14:
Signal View - graphical display of voltage and current signals.



Clicking the graphic with the right mouse button opens a context menu where you can select the zoom function. This function allows you to display any part of the signal with an enlarged time axis.

Step 7: Playing the Signal File(s)



To play a loaded signal file, click the toolbar respective icon.

If several files were loaded to the playback window, these files will be played in the assigned order.

Step 8: Logging the State Changes of the Binary Outputs

All changes to the binary inputs are logged in the text file (here: BIN.TXT; refer to figure 11-15).

Time is referenced to the start of the output. The entries of a repeated test are appended to the end of the file.

Figure 11-15:
Log file with the binary
inputs as test result

```

Bin.txt - Notepad
File Edit Search Help

Started playback of file D:\Reinhard\OMICRON\CMC\ContradeFiles\Aa12zf(5)_Time_Corrected.wav.
      Input 1  Input 3  Input 5  Input 7  Input 9
Time [s]      Input 2  Input 4  Input 6  Input 8  Input 10
0.000000      0    0    0    0    0    0    0    0    0
0.137067      1    0    0    0    0    0    0    0    0
End of playback.

Started playback of file D:\Reinhard\OMICRON\CMC\ContradeFiles\Aa12zf(5)_Time_Corrected.wav.
      Input 1  Input 3  Input 5  Input 7  Input 9
Time [s]      Input 2  Input 4  Input 6  Input 8  Input 10
0.000000      0    0    0    0    0    0    0    0    0
0.209349      1    0    0    0    0    0    0    0    0
End of playback.

Started playback of file D:\Reinhard\OMICRON\CMC\ContradeFiles\Aa12zf(5)_Time_Corrected.wav.
      Input 1  Input 3  Input 5  Input 7  Input 9
Time [s]      Input 2  Input 4  Input 6  Input 8  Input 10
0.000000      0    0    0    0    0    0    0    0    0
0.056386      1    0    0    0    0    0    0    0    0
End of playback.

Started playback of file D:\Reinhard\OMICRON\CMC\ContradeFiles\Aa12zf(5)_Time_Corrected.wav.
      Input 1  Input 3  Input 5  Input 7  Input 9
Time [s]      Input 2  Input 4  Input 6  Input 8  Input 10
0.000000      0    0    0    0    0    0    0    0    0
0.064084      1    0    0    0    0    0    0    0    0
End of playback.

Started playback of file D:\Reinhard\OMICRON\CMC\ContradeFiles\Aa12zf(5)_Time_Corrected.wav.
      Input 1  Input 3  Input 5  Input 7  Input 9
Time [s]      Input 2  Input 4  Input 6  Input 8  Input 10
0.000000      0    0    0    0    0    0    0    0    0
0.017996      1    0    0    0    0    0    0    0    0
End of playback.

```

11.2 Harmonics

Harmonics allows to create a signal sequence consisting of a pre-signal with fundamental frequency, followed by a signal with definable spectral combination (all harmonics up to 3 kHz if supported by the connected hardware), followed by a post-signal with fundamental frequency.

Harmonics can generate up to three currents and three voltages, each with individual harmonics composition.

The duration of all three parts of the signal sequence can be defined. Furthermore, the middle part can react on a binary input signal ('trip signal') that leads to a direct transition to the post-signal and a time measurement of the trip time.

Besides generating this signal sequence live you may also output the harmonics composition as static state, i.e. manually controlled duration, or export it as Comtrade file set for separate playback, e.g. with the *TransPlay* tool or the *Advanced TransPlay* test module.

For more detailed information about *Harmonics*, please refer to its online help. Start *Harmonics* and click the `Help Topics` command on the `HELP` pull-down menu.

11.3.1 Features of the Binary I/O Monitor

Binary I/O Monitor provides the following functions:

- It displays the status of all given inputs and outputs of OMICRON *CMB* and *CMC 256* hardware and all the given inputs for all other OMICRON *CMC* hardware.
- It displays as many I/O connectors as are detected.
- *Binary I/O Monitor* displays all available inputs and outputs in a grid: one column for the *CMC* I/O connectors and one column for each *CMB* card. Each column has one row for each connector.
- The columns are manually resizable, and *Binary I/O Monitor* will save these settings from session to session.
- If the user does not specify column settings, the columns are automatically resized at start-up to fit the length of the connector label.
- The user can zoom in and out on the display on the context-sensitive menu.
- Each input and output is identified with the same name given in the hardware configuration from the test module that runs in parallel (e.g., 01 Start L1, 04 Trip L1, etc.).
- The state of each connector is indicated with a small symbol: a circle indicates an input and a square indicates an output. If the symbol is white, it means that the connector is inactive (0); if it is red, it means that the connector is active (1); if it is grey, it means that the state is not available. If the check box "Indicate state changes" has been selected, a small yellow arrow is shown to indicate that a change of the binary status was detected.

11.3.2 Using Binary I/O Monitor

Binary I/O Monitor has one button, labelled **HOLD**, which freezes the display of the current states, and a check box, "Indicate state changes." At start-up, the **HOLD** button is released and the check box is cleared.

When the "Indicate state changes" check box is selected, each change of a *CMB* or *CMC 256* input (from 0 to 1 or from 1 to 0) is indicated by a yellow arrow beside the current state information. Each change will continue to be indicated until the **HOLD** button is pressed, or until the check box is cleared.

Note: Only the state changes of *CMB* or *CMC 256* inputs can be displayed; the state changes of any other *CMC* inputs are never indicated by a yellow arrow.

Pressing the `HOLD` button freezes the display of the current states and state change information. As well, if the "Indicate state changes" checkbox has been selected, pressing the `HOLD` button will clear and disable it. Once pressed, the `HOLD` button label changes to `RESET`. Pressing the `HOLD/RESET` button a second time releases the display and *Binary I/O Monitor* once again displays the current states of the connectors.

11.3.3 Context Menu

Binary I/O Monitor offers several options via the context-sensitive menu. This menu can be displayed by right-clicking anywhere on the I/O grid. The context-sensitive menu offers two display options: zoom and automatic resize of the columns.

Zoom

`ZOOM` allows the user either to shrink the display (`ZOOM OUT`) so that more columns and inputs/outputs are visible in the *Binary I/O Monitor* window, or to enlarge the display (`ZOOM IN`). When the display is enlarged, fewer columns may be visible, but the information displayed will be more legible. This is useful on screens with a very high resolution.

By right-clicking anywhere on the I/O grid, the user can access the zoom menu's three options: `IN`, `OUT` and `100%`. Selecting `IN` zooms in on the display. Selecting `OUT` zooms out on the display. Selecting `100%` restores the display to the default view.

The last zoom setting is saved when the program exits. The next time the *Binary I/O Monitor* is launched it will display the I/O grid with the same zoom setting.

Automatic Resize

The `AUTOMATIC RESIZE` option is used to fit the width of the columns of the I/O grid table to the length of the longest input/output label. This ensures that all labels are completely displayed.

The `AUTOMATIC RESIZE` option is located at the bottom of the context-sensitive menu. This option can be activated by right-clicking anywhere on the I/O grid and then selecting `AUTOMATIC RESIZE`. A checkmark will appear next to the option to indicate that it is active.

The column widths can also be adjusted manually. When the pointer is moved over the line between two columns, it changes to a double-headed arrow.

Clicking the column boundary and dragging in the wanted direction will resize the column. When the column sizes are resized manually, the `AUTOMATIC RESIZE` option is deselected and the columns sizes are saved when the the program exits. The next time *Binary I/O Monitor* is launched it will display the columns with the same width.

11.3.4 Options Menu

The `OPTIONS` menu, the second of the *Binary I/O Monitor*'s three pull-down menus, has two display-related choices: `ALWAYS ON TOP`, and `UPDATE SPEED`.

Always on Top

The `ALWAYS ON TOP` option is used to keep the *Binary I/O Monitor* always in the foreground of the screen, even if another window has the focus. This option is useful if the user wishes to work in another window but continue to monitor the activity of *Binary I/O Monitor*.

The `ALWAYS ON TOP` option can be activated by clicking the `ALWAYS ON TOP` option on the `OPTIONS` pull-down menu. A checkmark will appear next to the option to indicate that it is active.

Update Speed

The `UPDATE SPEED` option allows the user to set the speed at which the *Binary I/O Monitor* is updated. The *Binary I/O Monitor*, like all applications, draws on the computer's resources. If the PC slows down because of insufficient resources, reducing the speed at which *Binary I/O Monitor* is updated can free system resources for other tasks.

The update speed can be changed by clicking `UPDATE` on the `OPTIONS` pull-down menu. This will open a submenu with three update speeds: low, medium (the default update speed) and high. The current update speed is indicated by a checkmark.

Note: The CPU load of the PC depends on the number of displayed inputs and outputs and on the update speed. Therefore, the update speed can be improved, while at the same time reducing the use of system resources, by zooming in or reducing the window size to display only the columns necessary.

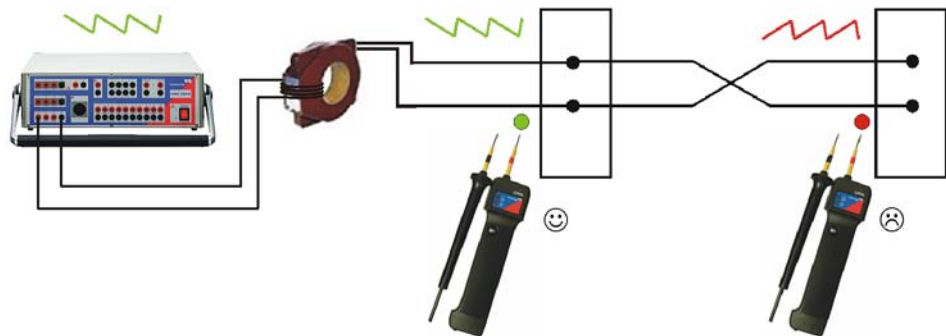
11.4 Polarity Checker

Polarity Checker determines whether the polarity is correct.

To do so, the *CMC* test set injects a special polarity test signal at a certain location. This signal can either be a voltage or a current signal from the *CMC* test set, and has a signal characteristic similar to a saw-tooth signal with a different steepness for the rising and the falling slope.

The polarity check itself is then done with the accessory *CPOL*, a portable easy-to-use polarity checker.

Figure 11-17:
Illustrated setup for a
polarity check



For more detailed information about *Polarity Checker*, please refer to its online help. Start *Polarity Checker* and click the **HELP TOPICS...** command on the **HELP** pull-down menu.

11.5 Overcurrent Characteristics Grabber

The *Overcurrent Characteristics Grabber* is a supplement to the *Overcurrent* test module. It helps to extract overcurrent characteristics from graphical representations. This is most helpful in cases where the inverse-time characteristic is not known by a given formula but only by a graphical representation, e.g. an image in a relay manual.

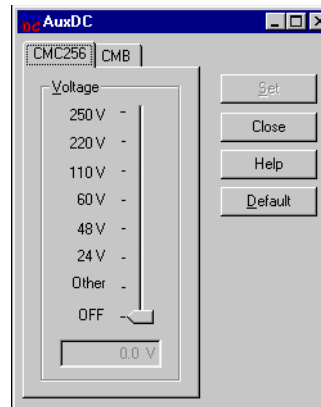


For more detailed information about *Overcurrent Characteristics Grabber*, please refer to its online help. Start *Overcurrent Characteristics Grabber* and click the **HELP TOPICS...** command on the **HELP** pull-down menu.

11.6 AuxDC

The utility *AuxDC* is used to set the auxiliary DC voltage output of the *CMC 256* test set or of a *CMB* binary input/output unit by means of a slider control. By default, there is only one property tab, with the name and serial number of the device connected (either *CMC 256* or *CMB*). If OMICRON Test Universe detects a second device, a second property sheet, with the name and serial number of the device, is created. In off-line mode, only the *CMC 256* property sheet is shown.

Figure 11-18:
AuxDC



Property Sheets

Select the property sheet of the device you wish to set the auxiliary DC voltage output by clicking the appropriate tab.

Slider control

With the slider control select either

- one of the predefined voltage values
- the setting *Other*, which allows you to enter any voltage value of your choice up to the limits of the test set
- to turn auxiliary DC voltage OFF.

Buttons

Set	Switches the currently set voltage value to the auxiliary DC voltage output of the device on the active property sheet (either <i>CMC 256</i> 's or the <i>CMB</i>).
Close	Exits AuxDC.

Help	Calls up the <i>AuxDC</i> online help.
Default	Makes the currently set voltage value the power-up default for the device on the active page (either <i>CMC 256</i> or <i>CMB</i>). When <i>CMC 256</i> or <i>CMB</i> is powered-up the next time, the auxiliary DC output is automatically set to this default value.

This default values applies until it is deliberately changed again.



Setting a power-up default value means, that immediately after *CMC 256* or *CMB* is switched on, this voltage is applied to the auxiliary DC voltage output, regardless whether a PC is connected to it or not.

Caution: This voltage can be life-threatening!

11.7 License Manager

License Manager combines the functionality of a license browser, a merge tool and a license file editor. It searches for OMICRON license files stored on the computer's hard disk(s) and displays their contents. It merges license information from different files into the master license file `Omicron.lic`. It furthermore allows to add license keys manually.

To start *License Manager*, click the License Manager link on the *Start Page* under "Setup".

11.7.1 About License Files in General

The OMICRON Test Universe software is protected from unauthorized installation and use by a license file.

The license file codes specify both the individual test modules and the hardware serial numbers, i.e., each code specifies a pair of "test module X to work with test set A". The license code enabling test module X to work with test set A will differ from the code for test set B, even though A and B might be the same CMC model.

The master license file `Omicron.lic` is automatically installed to `[Common Files]\OMICRON`.

`[Common Files]` holds the full path to the folder defined by Windows to store files shared by applications that are installed on the system. In English Windows, that folder is named "Common Files" and is located in the `[Program Files]` folder. In other language versions of Windows, the common files folder name is localized appropriately by default.

`Omicron.lic` is an ASCII text file that can be viewed with any text editor.

If you purchase additional OMICRON test sets at a later point of time, you need to add their license codes, provided in separate license files, to the master license file. To do so, use the utility *License Manger*.

11.7.2 Finding License Files

- Enter the search path into the entry field "Search in" and click "Search". *License Manager* automatically searches through this folder and all of its subfolders. If you want to search through an entire hard disk, just enter its drive letter, e.g., `C:\`. The "Search in" combo box saves the most recent selections.

or

- Click "Browse" to navigate through the folder structure. Select a folder of your choice and click "Search".

All found license file(s) is / are listed in the upper list field.

The master license file does not have to be searched. As long as it is physically present on the hard disk, it is always displayed.

11.7.3 Contents of a License File

Click a license file of your choice in the upper list field.

- The lower left-hand side list field shows the devices (test sets) the file contains, and their according serial numbers.
- The lower right-hand side list field displays the keys that belong to each device selected in the left-hand side list field. Each key represents exactly one test module licensed to work with the selected device.

11.7.4 Merging License Files into the Master License File



Corresponding menu item: FILE | OPEN FILE AND MERGE...

Navigate through the folder structure and select a license file of your choice. The selected file as a whole is merged into the master license file `Omicron.lic`; the new keys are appended. Double entries in the master license file are prevented: if a key already exists, the new one replaces it.



Corresponding menu item: EDIT | MERGE FILE

In the upper list field select any license file of your choice but the master license file. The selected license file as a whole is merged into the master license file; the new keys are appended. Double entries in the master license file are prevented: if a key already exists, the new one replaces it.

Note: Contents merging is unidirectional, i.e., only merging from any license file into the master license file is possible, not vice versa. Therefore, depending on the selected license file, this button and the corresponding menu items may be disabled.



Corresponding menu item: EDIT | DELETE FILE

Deletes the selected license file. **Caution:** Also the master license file can be deleted that way. Deleted files cannot be restored from the Windows Recycle Bin.

11.7.5 Merging Single Devices and Keys Into the Master License File



Corresponding menu items: EDIT | MERGE DEVICE (MERGE KEY)

Select either a device in the lower left-hand side list field or a key in the lower right-hand side list field and click the according icon. The selected device or key is merged into the master license file. Double entries in the master license file are prevented: if a device with that serial number or a key with that license code already exists, the new one replaces it.



Corresponding menu item: EDIT | DELETE DEVICE (DELETE KEY)

Deletes the selected device or key from the master license file. **Caution:** Deleted items cannot be restored.

Note: Only master license file entries can be deleted. Therefore, depending on the selected license file, this button and the corresponding menu items may be disabled.

11.7.6 Context Menus

In all list fields, a right mouse click opens a context-menu. The context-menu items correspond to the toolbar and pull-down menu commands. They either merge entire license files (in the upper list field), or selected devices or keys (lower list fields) into the master license files. Deletion is also provided.

With the context-menu item ADD LICENSE KEY (corresponding pull-down menu item: EDIT | ADD LICENSE KEY...) you specify a new pair "test set A licensed to work with test module X". To do so, you need a valid device serial number and test module license code. **Note:** A new license key can only be added to the master license file. Therefore, depending on the selected license file, the respective menu items may be disabled.

11.7.7 Sorting the Displayed Data

In the two lower list fields the displayed data can be sorted to show the data in ascending order by device type, serial numbers or module names. To do so, click the respective header (e.g., Device).

11.7.8 Show Only Licenses With Version

Starting with Test Universe 2.0, a "license code versioning" is introduced. Adding the TU version number to a license key permits the user to store identical license keys for different TU versions in one master license file. This master license file can then be used on different computers with different TU versions without the necessity to exchange master license files beforehand.

This combo box represents a display filter: Specify whether all available license keys of the particular file are displayed (default) or just the ones according to your version selection.

11.7.9 Sending Your Master License File to OMICRON by E-Mail

In case you need to send you master license file to the OMICRON support for an analysis, select the pull-down menu item `FILE | SEND MASTER LICENSE FILE...`. This hands over a copy of your master license file to the standard e-mail application of this computer. If there isn't such an application, the Windows **Internet Connection Wizard** will start.

File Name Extensions within OMICRON Test Universe

Control Center OCC

filename.OCC OMICRON Control Center test document

OCC Helper Modules

filename.PAU Pause Module

filename.EXQ ExeCute

filename.TXV TextView

Hardware Configuration

filename.OHC OMICRON Hardware Configuration (import/export from HCW's **General** tab)

Test Object

filename.RIO The term RIO stands for **R**elay **I**nterface by **OMICRON**.

RIO, was developed out of a need for a uniform data format for parameters of protective relays produced by different manufacturers. RIO provides a common structure to allow functionally similar relays from diverse manufacturers to be tested with similar test procedures. Moreover, RIO permits relay characteristics to be imported into the Test Universe software from external sources.

filename.XRIO XRIO represents the second generation of RIO file technology. The term RIO stands for **R**elay **I**nterface by **OMICRON**, a technology that was already available with previous Test Universe versions. The X denotes "extended".

Test Modules

<i>filename</i> . ADT	Advanced Distance
<i>filename</i> ANNUCH	Annunciation Checker
<i>filename</i> . BDF	Differential
<i>filename</i> . CBS	Circuit Breaker Simulation
<i>filename</i> . DST	Distance
<i>filename</i> . GRF	Transient Ground Fault
<i>filename</i> . HRT	(Advanced Differential) Diff. Harmonic Restraint
<i>filename</i> . MEA	EnerLyzer
<i>filename</i> . MET	Meter
<i>filename</i> . NSI	NetSim
<i>filename</i> . OAR	Autoreclosure
<i>filename</i> . OTF	(Advanced Differential) Diff. Operating Characteristic
<i>filename</i> . OUC	UCA-CMC Configuration
<i>filename</i> . OVT	Overcurrent
<i>filename</i> . PQT	PQ Signal Generator
<i>filename</i> . PRA	Pulse Ramping
<i>filename</i> . QCM	QuickCMC
<i>filename</i> . RMP	Ramping
<i>filename</i> . SEQ	State Sequencer
<i>filename</i> . SNC	Synchronizer
<i>filename</i> . TRA	Advanced TransPlay
<i>filename</i> . TRD	Transducer
<i>filename</i> . TST	(Advanced Differential) Diff. Trip Time
<i>filename</i> . VGT	(Advanced Differential) Diff Configuration
<i>filename</i> . VSR	VI-Starting

IEC 61850

<i>filename</i> . OSV	Samples Values Configuration (IEC 61850-9-2 LE Configuration Module).
<i>filename</i> . OGC	GOOSE configuration file
<i>filename</i> . OUC	GSSE configuration file

Test Tools

<i>filename</i> . BIO	Binary I/O Monitor
<i>filename</i> . HOU	Harmonics
<i>filename</i> . LST	TransPlay
<i>filename</i> . TYP	TypConverter

Other file name extension to know about

<i>filename</i> . CFG	COMTRADE configuration file for the description of the failure report channels (signal names, sample frequency etc.). Can be imported with the test module <i>Advanced TransPlay</i> , and loaded with the (optional) test tool <i>TransView</i> .
<i>filename</i> . CML	Comtrade file. Can be loaded with the (optional) test tool <i>TransView</i> .
<i>filename</i> . CSV	<p>Comma Separated Value. This file format is readable by any common database. Data is written in simple a table format. A selectable field delimiter separates the individual values.</p> <p>If a certain value is a text string, the value needs to have a text qualifier (the text may contain the character which is used a field delimiter). As the naming of Boolean values is not consistent throughout different database programs, the True and False values need to be defined as well.</p>
<i>filename</i> . DAT	COMTRADE file with the sample values of the failure report channels. Can be imported with the test module <i>Advanced TransPlay</i> , and loaded with the (optional) test tool <i>TransView</i> .
<i>filename</i> . HDR	"Header file" that contains any data-related text that is not used by the software. Can be loaded with the test module <i>Advanced TransPlay</i>

<i>filename</i> .PDF	<p>Invented by Adobe, Portable Document Format became the standard format for the electronic document distribution and exchange. PDF files look exactly like original documents and preserve the fonts, images, graphics, and layout of any source file - regardless of the application and platform used to create it.</p> <p>To view a PDF file, either the Adobe Reader © or the Foxit Reader (both freeware) is required. If you have no PDF reader on your computer yet, <i>OMICRON Test Universe</i> installs the Foxit Reader.</p>
<i>filename</i> .PL4	<p>PL4 file. Can be imported with the test module <i>Advanced TransPlay</i>, and loaded with the (optional) test tool <i>TransView</i>.</p>
<i>filename</i> .RTF	<p>Rich Text Format. File format used by Microsoft Word or other word processing applications.</p>
<i>filename</i> .TPL	<p>Template file for the test reports (based on RTF)</p>
<i>filename</i> .TRF	<p>TRF file. Can be imported with the test module <i>Advanced TransPlay</i>, and loaded with the (optional) test tool <i>TransView</i>.</p>
<i>filename</i> .XML	<p>XML (eXtensible Markup Language) became accepted as a standard for data exchange, particularly between different platforms. XML and related technologies are W3C (World Wide Web Consortium) recommendations.</p> <p>If you want to learn more about XML, the W3C site http://www.w3.org/XML/ may be a good starting point.</p>

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