Saturn Studio II - STL Analysis Suite
Version 1.04

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1 Saturn Studio II – STL Analysis Suite

The Saturn Studio II – STL Analysis Suite is a fully automatic analysis package for typical high voltage tests.

The Short-Circuit Testing Liaison (STL) provides a forum for voluntary international collaboration between testing organizations. The basic aim is the harmonized application of IEC and Regional Standards to the type testing of electrical power equipment.

The analysis is based on the recommendations of the short-circuit testing liaison STL www.stl-liaison.org.

2 Saturn Studio II – Button bar functions

Saturn Studio II is launched and comes up with a login screen which allows selecting from different screen setups and user levels. ***STL Analysis- Wizard*** will launch the Software with a specific screen setup and additional functions for STL Analysis.

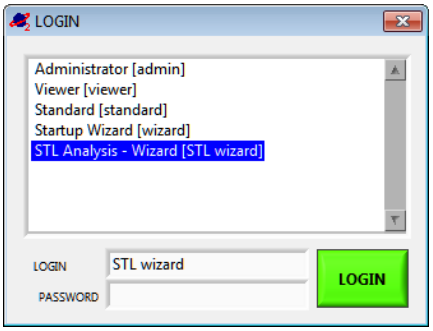


Figure 1: Login

After selecting **"STL Analysis – Wizard"** and pressing ***LOGIN*** the STL specific button bar of Saturn Studio II shows up on top of the screen:

Figure 2: Button Bar

In addition the "Startup Wizard" window is opened:

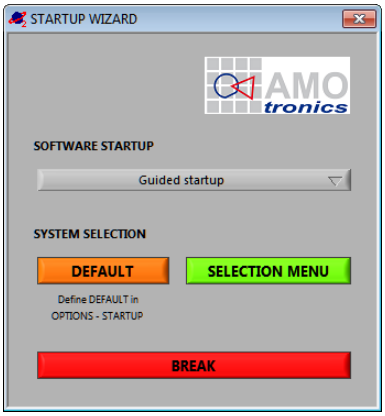


Figure 3: Startup Wizard

For using the software for *offline analysis* the button ***BREAK*** is the right choice.

For connecting with a Saturn System and for performing measurements the user has the choice between ***"Guided Startup"*** and ***"Manual configuration"***. In the latter case the user has to set up everything manually.

Guided startup will guide the user step by step through the process of connecting with a Saturn System, configuring a measurement and the screen display.

The two buttons ***"DEFAULT"*** and ***"SELECTION MENU"*** define how the software should connect to the Saturn System. *"DEFAULT"* follows the startup settings as configured in the global menu OPTIONS of the software. This is the right choice if the software has been setup to automatically connect with a dedicated Saturn System.

Otherwise the user should choose ***SELECTION MENU***.

This will open the **"SELECT SYSTEM"** dialog which allows to search for Saturn Systems on the same PC or via the network, allows to (re-)start the server software on the Saturn System and also allows to remotely (re-)boot or shut down the Saturn System.

The Button "EDIT SYSTEM LIST" allows it to define the IP addresses of known Saturn Systems within the network.

Figure 4: Select System

By choosing ***CONNECT*** the software connects to the server on the selected Saturn System. After the connection is established properly the SETUP screen is opened, if *"Guided Startup"* was selected ion the previous dialog. For details how to configure the channels, please refer to the Saturn Studio II - manual.

The following chapters describe the function of the individual buttons of the main menu bar and how they are used.

2.1 Project

The ***PROJECT*** button opens the project management window to navigate in previously stored projects with ***LOAD***. You can also use the project management window to individually store data with ***SAVE*** or ***SAVE AS*** functions. Standard storage works with CAMPAIGN management.

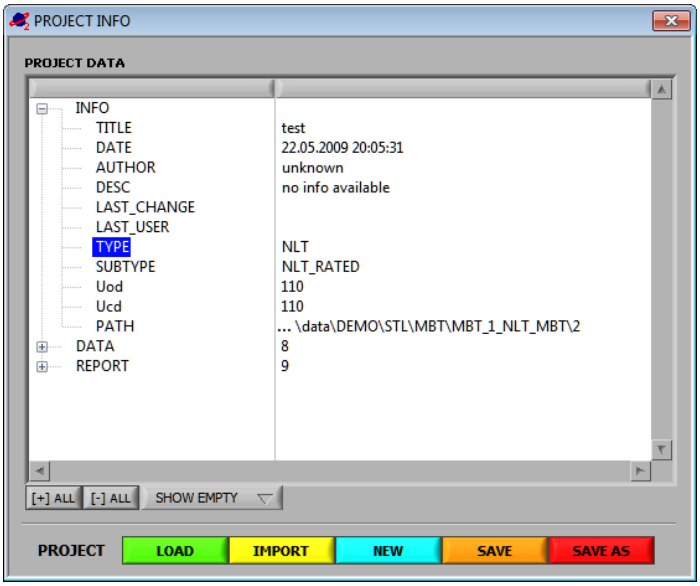


Figure 5: Project Info

2.2 New Campaign

To start a new measurement series/campaign the ***NEW CAMPAIGN*** button is used to configure the path where the project will be stored.

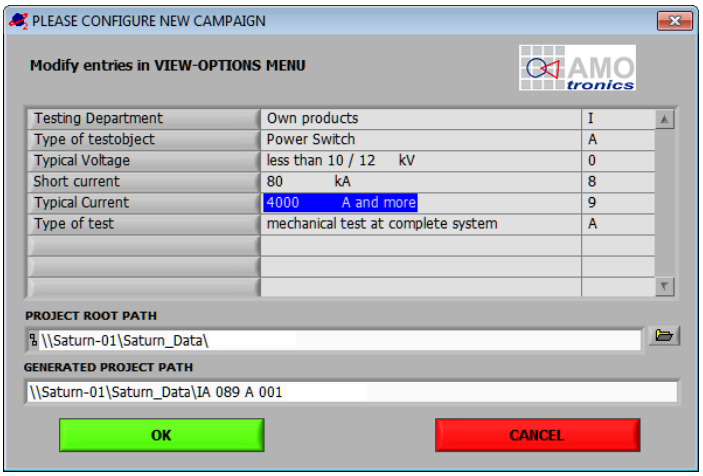
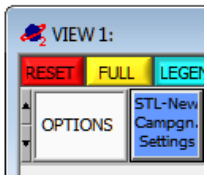


Figure 6: Path Generator

The path generator helps to organize the tests and shots. The storage structure itself needs to be defined by the customer to perfectly need the individual requirements. Confirm the selection with ***OK***. The path structure is automatically generated from the chosen parameters and easily can be customized.



To modify the available entries open a view window, select the ***OPTIONS*** menu and point to ***STL-New Campgn. Settings***. How to modify the definition file is described in detail in ANNEX A.

Figure 7: Path Generator Options

2.3 New Project

The campaign management of Saturn Studio II supports different types of tests within one campaign / series. STL typical No Load tests prior to e.g. Synthetic tests this way can be filed within a single campaign. ***NEW PRJ*** opens the configuration window to define the type of measurement for the next shot. Consequently this selection has to be done for each shot. Depending on the selection the software automatically generates the file structure for the further automatic analysis.

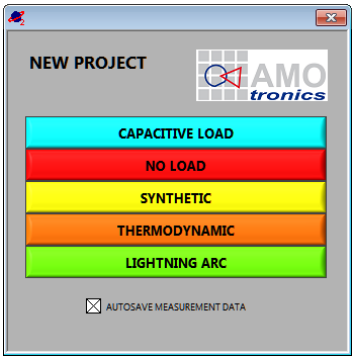


Figure 8: New Project

It can also be defined whether to ***AUTOSAVE*** the data directly after the shot or not. Auto-save is recommended.

2.4 Edit Project

EDIT PRJ opens a window displaying the current project information. The entries can be modified, which is recommended for experienced users only to ensure valid file and folder structures for later automatic analysis.

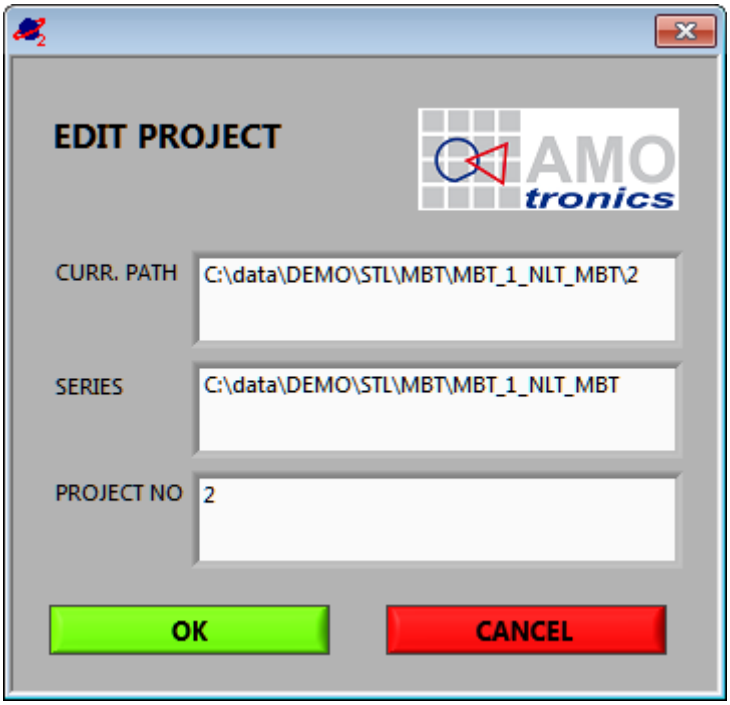


Figure 9: Edit Project

2.5 Save Project

SAVE PRJ stores the project and measurement data at the destination defined in the campaign. This is what the auto-save does automatically. Overwrite control is available to prevent accidental loss of data.

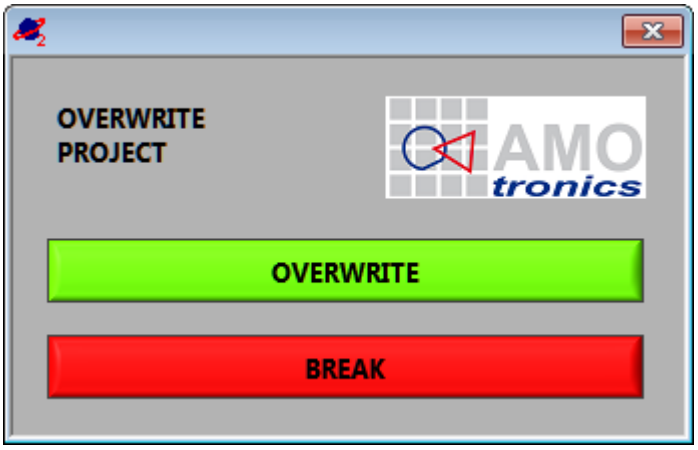


Figure 10: Overwrite Project

2.6 Channels

The ***CHANNELS*** button opens the Saturn Studio II standard AVAILABLE CHANNELS window. Refer to the according manual for further details.

Figure 11: Available Channels

2.7 Setup

The ***SETUP*** button opens the Saturn Studio II standard setup window. Refer to the according manual for further details.

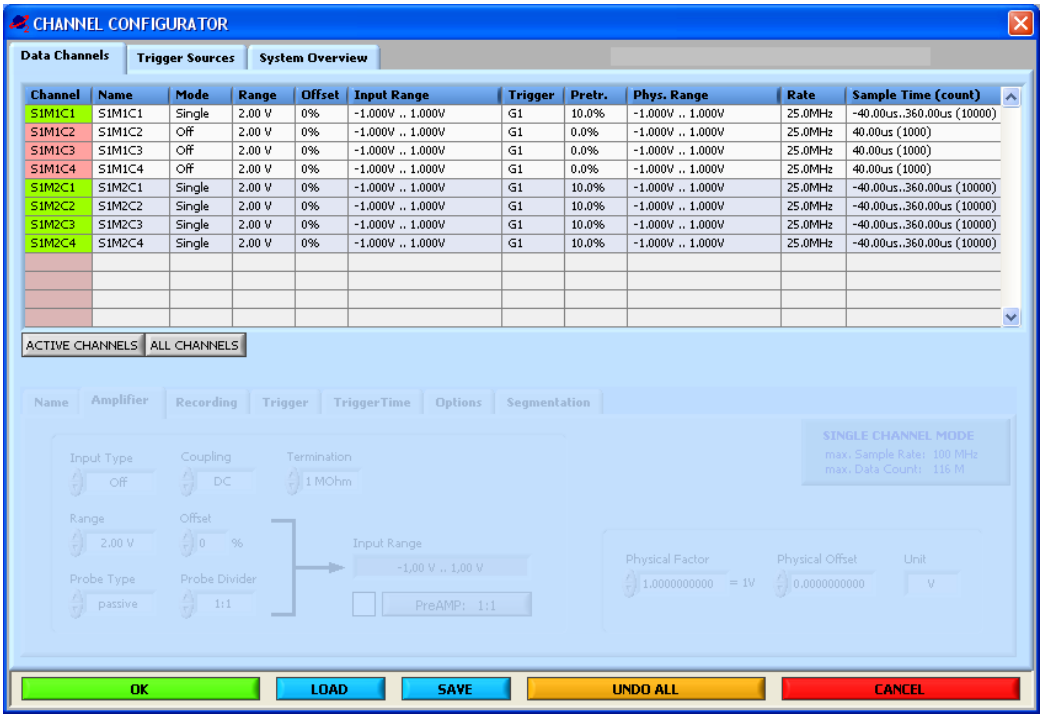


Figure 12: Channel Setup

2.8 Control

The ***CONTROL*** button opens the Saturn Studio II standard CONTROL window.

The ARM button arms the system to expect a trigger.

Refer to the according manual for further details.

Figure 13: System Control

2.9 Live Monitor

Point to ***LIVE MONITOR*** to open the Saturn Studio II live monitor window. It allows display of up to 8 channels to monitor attached signals. The display speed of the monitor channels is limited to human eye capabilities. However, the sample speed configured in the setup is the sample speed for the channel. For the monitor display the sampled data is integrated.

Please note!

Keep in mind that due to its structure and purpose of a monitor the display speed is limited.

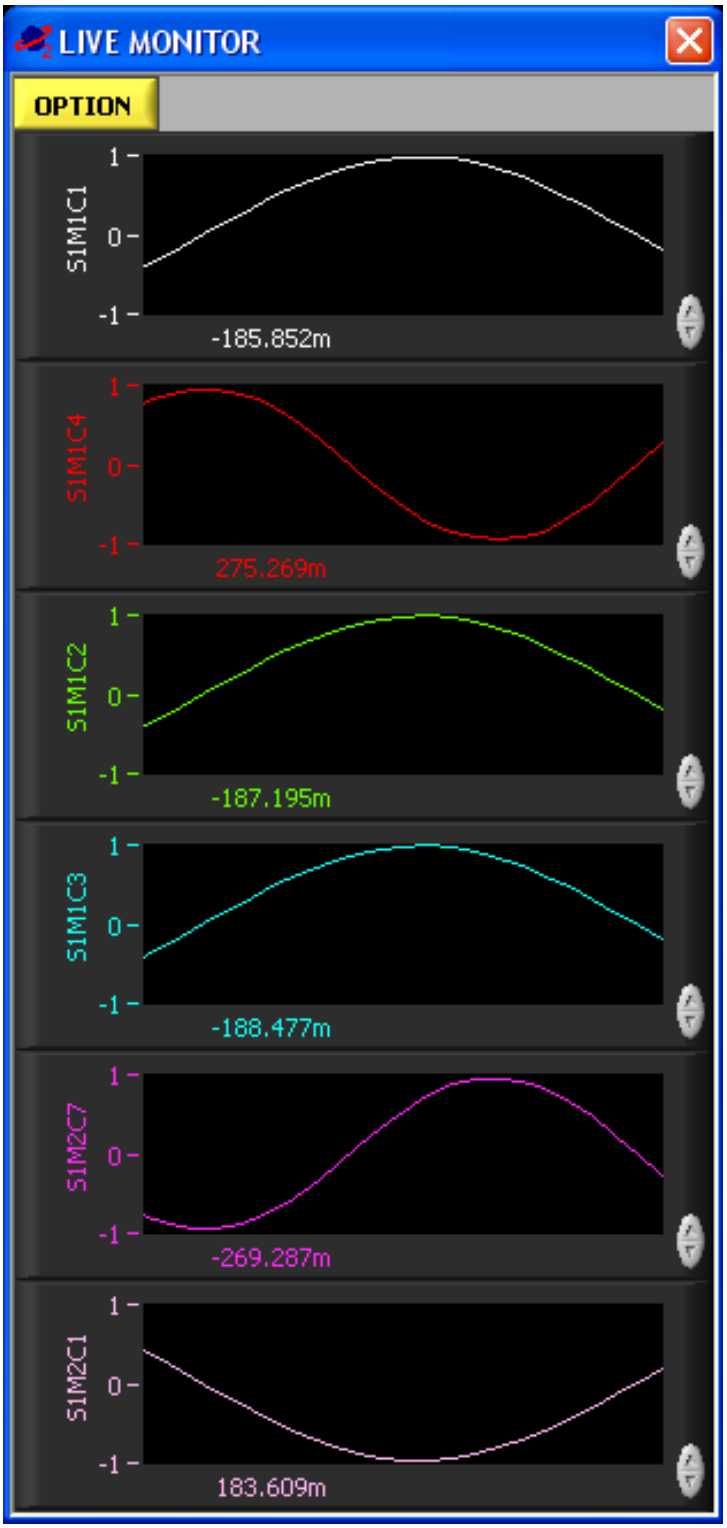


Figure 14: Live Monitor with xy display

Figure 15: Live Monitor with alternative displays

The color changes continuously from green via yellow to red indicating a temperature level.

Alternatively to the standard x-y charts special display types are available. They can be selected individually per channel with the UP-DOWN arrows in the bottom right corner of each channel. Depending on the input signal one type or the other might be preferred for display.

2.9.1 Digital value

Huge numbers display the current average value of the attached signal with 6 digits precision.

2.9.2 Gauge

The gauge and digital value both show the current average value of e.g. acceleration or velocity.

2.9.3 Slide

The slider bar moves to display the current average value of the attached signal. It is e.g. useful for a way signal.

2.9.4 Tacho

Analog tacho (speedometer) and digital value both show the average value of the connected signal.

2.9.5 Temperature

The thermometer column shows the average value next to the digital display in level and color. It might be picked for a temperature channel.

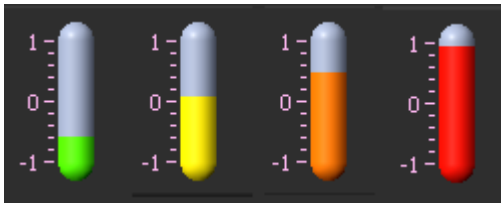


Figure 16: Thermometer column

For the standard xy display it can be selected from three different types of display to show the range of the input signal; Simple ***Average, Average + MinMax*** display or ***Average + MinMax Line***.

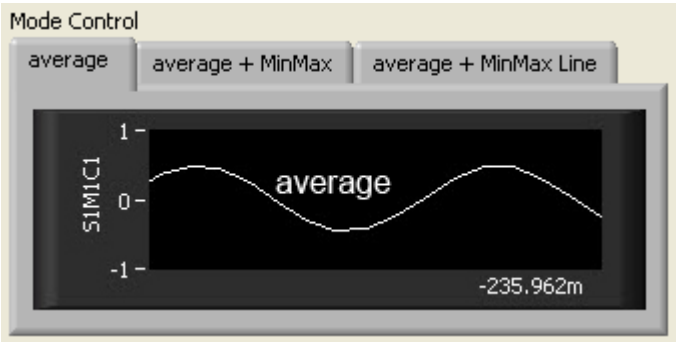


Figure 17: Mode Control - Average

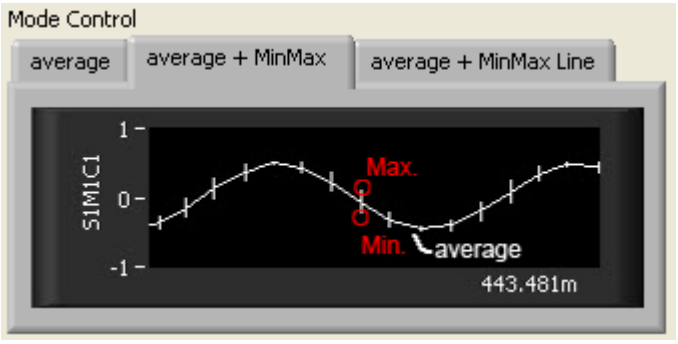


Figure 18: Mode Control - Average + MinMax

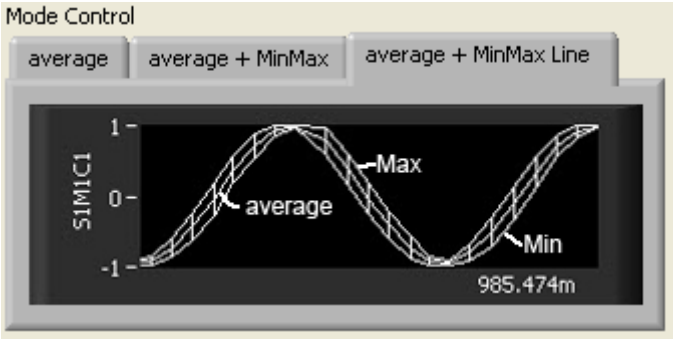


Figure 19: Mode Control - Average + MinMax Line

In the right part of the ***OPTION*** window the available channels are listed, by individual or multi select and pointing to the ***LEFT*** arrow <-- the channels can be selected for monitoring. The ***RIGHT*** arrow --> disables monitoring of selected channels from the left list. Confirm the selection with ***OK***.

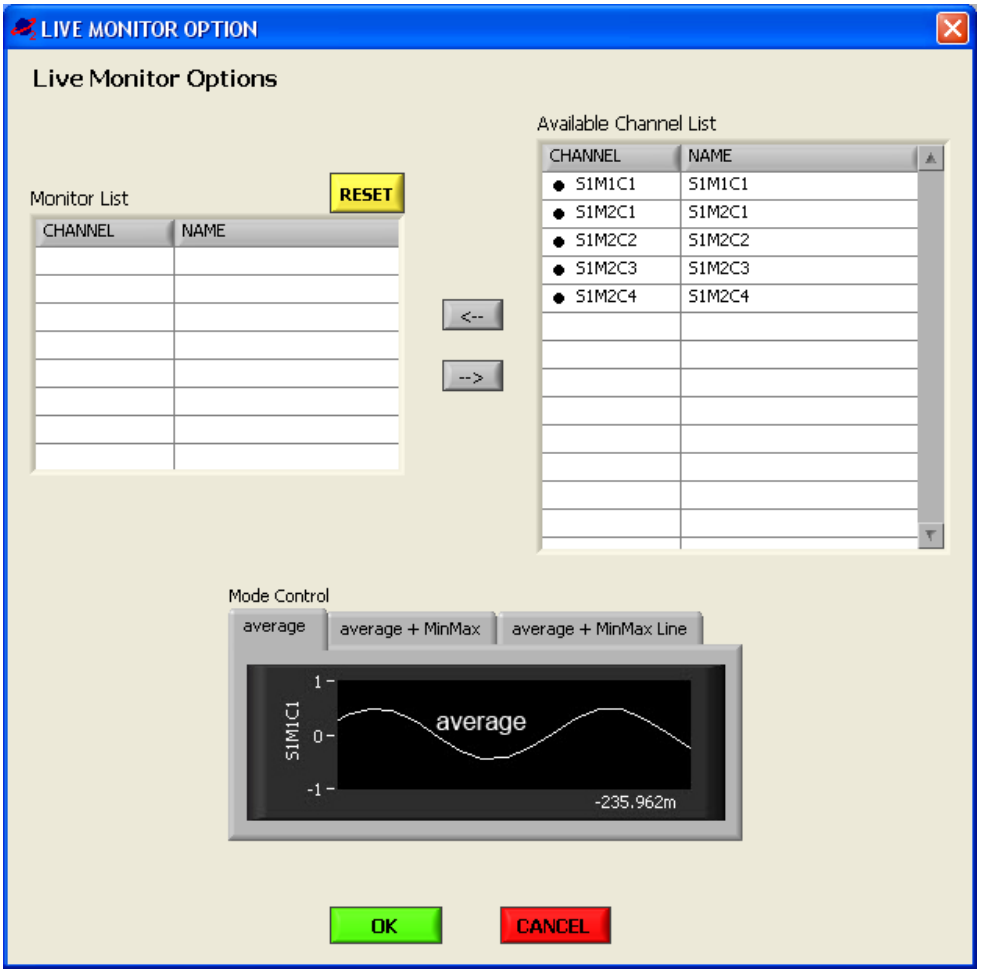


Figure 20: Live Monitor Options

2.10 Analysis

The ***ANALYSIS*** button gives access to the main analysis selection window. The different types of analysis are described in detail later in this document. The menu tree only is shown here.

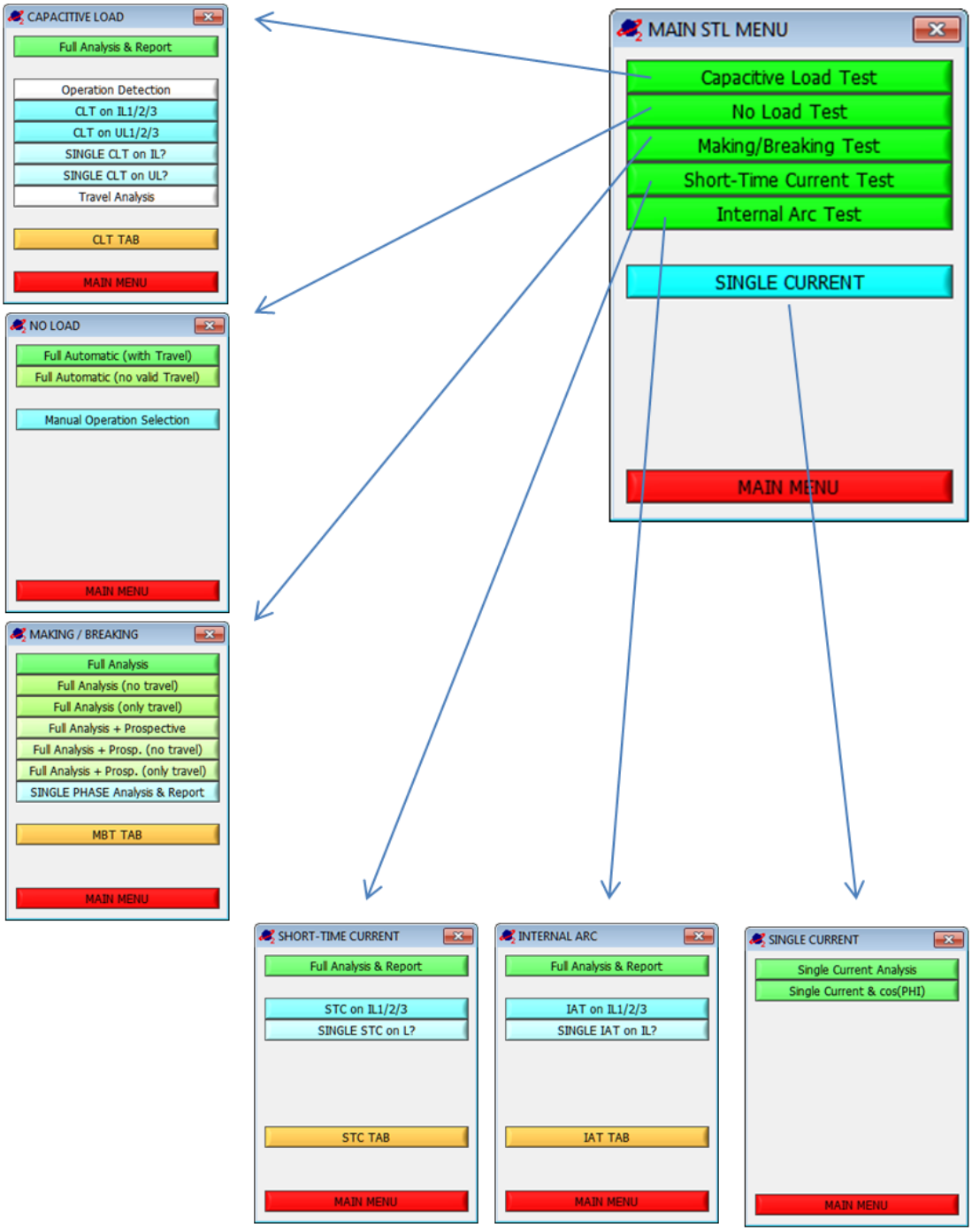


Figure 21: Analysis Main Menu Tree

2.11 Analysis – CLT, NLT, SYT, TDT, LAT

The specific analysis button is defined “empty” at startup. After the type of test is selected with the ***NEW PRJ*** function (compare chapter 2.3) the according analysis button is shown for single click

access. CLT, NLT, SYT, TDT or LAT can be accessed directly without need for menu navigation. The quick access menu helps to speed up and does not implement further functions.

2.12 Options

The ***OPTIONS*** button provides access to the Saturn Studio II standard function. Please refer to the according manuals for further information.

The most important options setting is the root path where to store the data. In a local system it can be a local destination e.g. c:\data\... In a network setup the storage path is defined as UNC network path e.g. \\192.168.0.1\data\... or \\dns\data\...

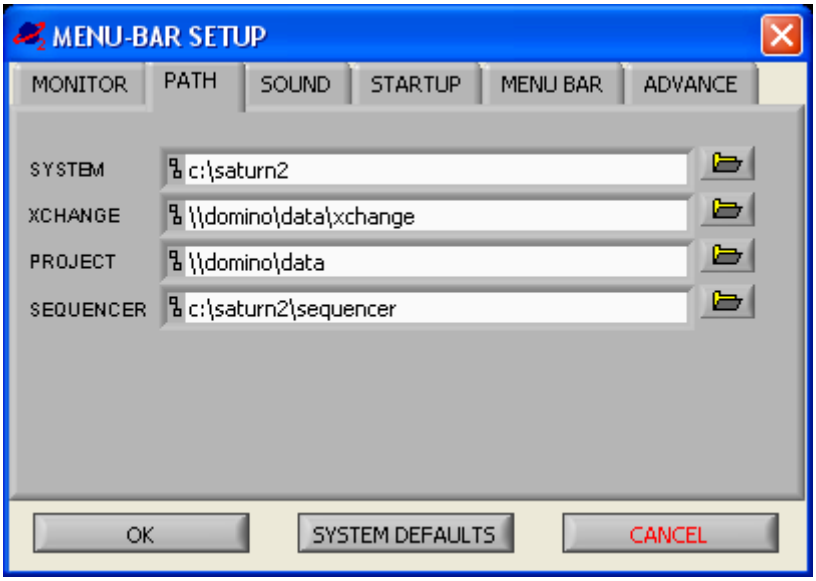


Figure 22: Path Setup

Please note!

The given path is used for the automatic path generator, available in NEW CAMPAIGN. It is transferred to the Saturn System as specified here. Hence it has to be specified to allow the Saturn System to access the destination.

2.13 About

The ***ABOUT*** button provides access to the Saturn Studio II standard function. Please refer to the according manuals for further information.

2.14 Quit

QUIT terminates the Saturn studio II software and the DIAdem reporting tool after security confirmation.

2.15 Saturn icon

The yellow ***SATURN ICON***  with a left click opens a graphical overview of the connected hardware and allows disconnecting with a right click. If no hardware is connected, the icon turns blue  and pointing displays the system selection window. Please refer to the according manuals for further information.

3 Saturn Studio II - Series Tests

Starting a series measurement with Saturn Studio II is very simple and straight forward. The procedure is identical for all types of test; the windows might vary from test to test. As an example this chapter gives a step-by-step introduction for the typical No Load test. The following chapters define the specific parameters for the different types of test.

3.1 How to configure a series test

After the setup of channels and system is completed, either manually or by software guide, point to ***NEW SERIES*** (= "NEW CAMPAIGN") to define the path where to store the data.

The automatic project path generator helps organize shots following a custom defined pattern.

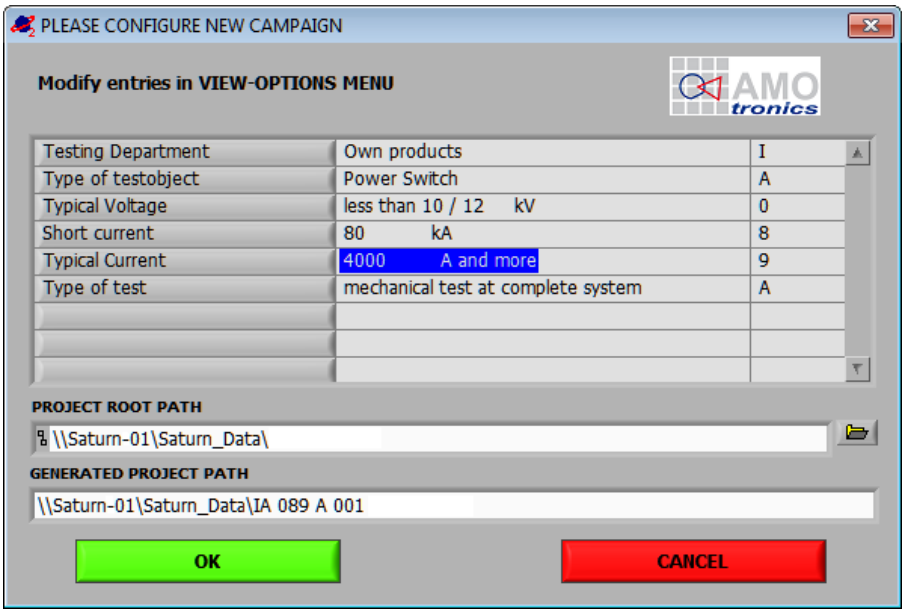


Figure 23: Path Generator

Each shot needs information about its type of test to enable the automatic STL analysis. Therefore each shot is started with ***NEW PRJ*** to define the type of test. The New Project selection window comes up to specify the next project type.

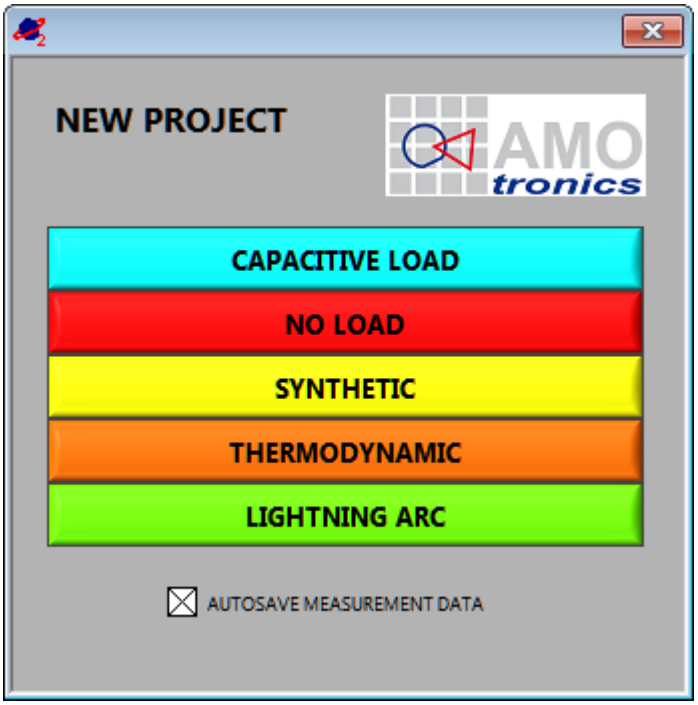


Figure 24: New Project

AUTOSAVE is enabled and ***NO LOAD*** is selected.

As an example the typical STL No Load test is picked to demonstrate the process chain. For the No Load test, the system should be setup to measure the channels, shown in the ***AVAILABLE CHANNELS*** list. Full automatic single phase No Load analysis with or without travel signal is possible.

Please note!

The channel recognition uses the channel names. If standard channel names are not used the automatic analysis either fails or asks for the channels to be specified manually.

Which channels to configure and which names to use in detail is described in the according chapters for the different tests below.

Via drag-and-drop the channels can be dropped to any view window to display the channel data. Refer to the standard manuals for further information on VIEW windows and features.

Next step the support voltage is selected. The information is gathered for full reporting only. The No Load analysis is not influenced by these parameters. In the example ***RATED*** support voltage is selected.

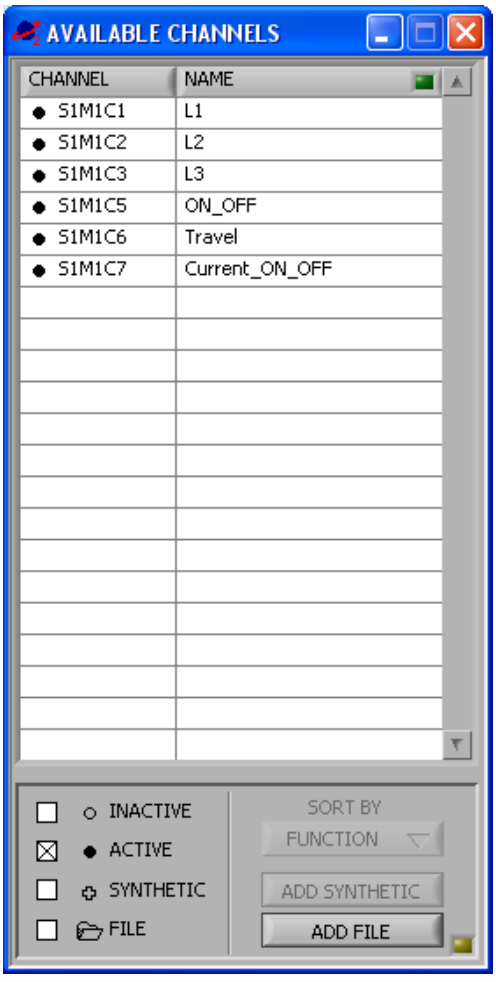


Figure 25: Available Channels

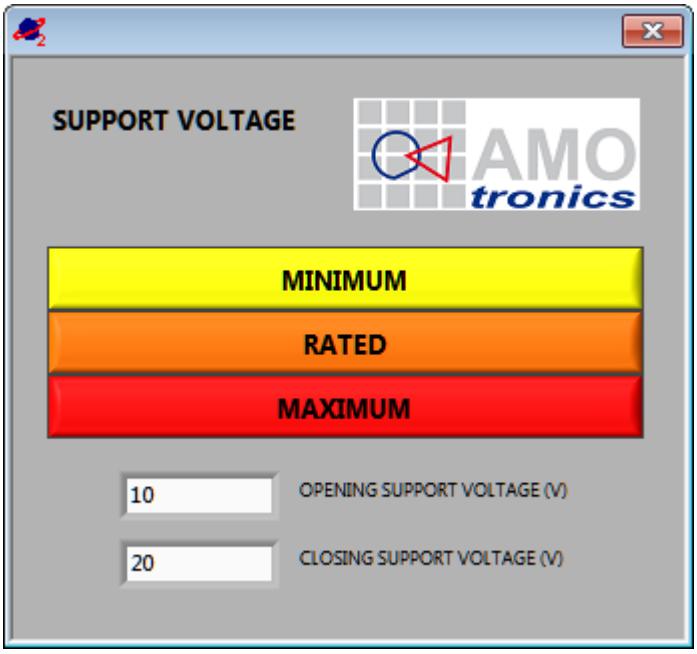


Figure 26: Support Voltage

Basic Project information and details are complete now and stored to the specified destination folder. The menu bar automatically adapts to the specified type of test which is the No Load Test in this example.

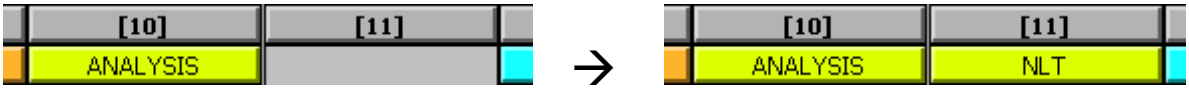


Figure 27: Automatic Menu Bar Adaption

3.2 How to start the acquisition

The system is now ready for the first No Load shot. The System can be armed for a single triggered shot by pointing to the top left arrow in the ***CONTROL*** window. The acquisition will start with the first detected trigger.

If the trigger signal is missing or the configuration is not valid the acquisition can be released manually with the green crossed red line – manual trigger button.

Because AUTOSAVE was enabled in the ***NEW PROJECT*** window the data is automatically stored after the measurement is completed. In case AUTOSAVE is disabled, ***SAVE PRJ*** stores the measured data.

Figure 28: Control

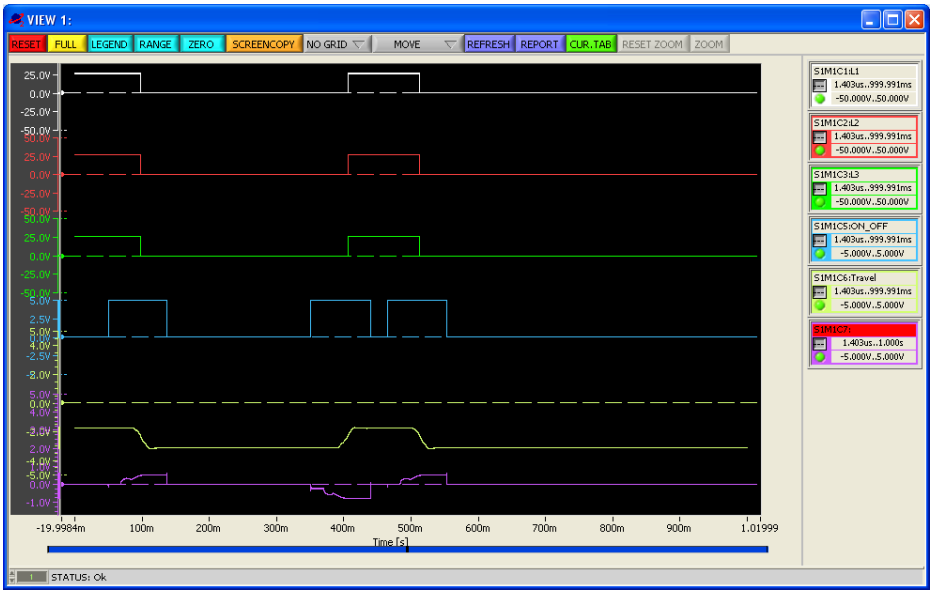


Figure 29: No Load View Display

The channels have been arranged to ***VIEW 1***, as described above, the measurement signals will now be displayed in ***VIEW 1***. Data acquisition is finished, either a next shot can be performed or the automatic analysis can be started directly, which might be recommended.

3.3 How to analyze a test

To start the No Load analysis point to ***ANALYSIS*** and select ***NLT*** or use the quick access button alternatively and point to the ***NLT*** button below button number 11 to open the ***NO LOAD ANALYZE*** window.

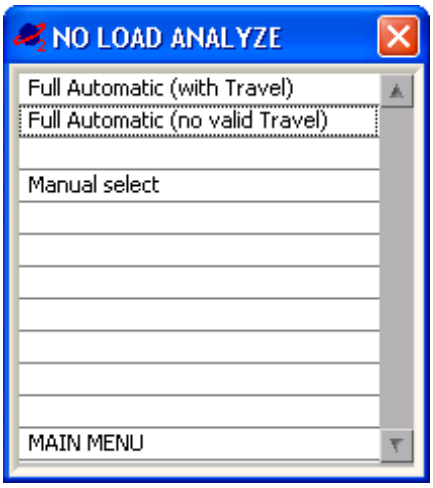


Figure 30: No Load Analysis Menu

From the menu select the type of analysis you want to do. Make sure all necessary channels are available and named correctly. In the example a valid travel signal is available and therefore the first entry is picked from the menu.

Figure 31: DIAdem transaction

The software automatically runs the DIAdem analysis and reporting module to start the requested analysis.

Please note!

First time DIAdem startup takes longer to launch the module before the data can be transferred, following analysis processes will be faster.

The Analysis can be terminated with the top right red STOP button in the DIAdem transaction window if needed.

The analysis automatically extracts all parameters and generates results and reports to be stored in the projects report folder.

Generation and storage of pdf files per phase

Generation and storage of a summary pdf file

Storage of all calculated values in highest precision (calc.txt)

Storage of all calculated values in formatted values (result.txt)

Transfer of results into word file (No_Load_E.doc) (Available only if MS Word is installed)

```
[RESULT]
tcl_L1_1=-
top_L1_1=47.8
tcl_L1_2=54.7
top_L1_2=47.5
Test_1=3
Test_2=3
trial=CLT_1 NLT_CO
topen_L1=97.241
tclose_L1=405.801
operation=OCO
travel=YES
tcl_L2_1=-
top_L2_1=47.9
tcl_L2_2=54.8
top_L2_2=47.5
topen_L2=97.321
tclose_L2=405.871
tcl_L3_1=-
top_L3_1=48.0
tcl_L3_2=54.8
top_L3_2=47.5
topen_L3=97.381
tclose_L3=405.881
CT=-2282.656
CS=-2260.312
CT_rel=60.141
CS_rel=61.795
U_MAX=-1744.245
U_MIN=-3095.041
tcl=54.8
top=47.9
Uod_1=242
Uod_2=242
Ucd_1=-
Ucd_2=242
op_1=O
op_2=CO
```

```
[RESULT]
tcl_L1_1=-
top_L1_1=0.04782
tcl_L1_2=0.05472
top_L1_2=0.04745
Test_1=3
Test_2=3
trial=CLT_1 NLT_CO
topen_L1=0.097241403
tclose_L1=0.405801403
operation=OCO
travel=YES
tcl_L2_1=-
top_L2_1=0.0479
tcl_L2_2=0.05479
top_L2_2=0.04751
topen_L2=0.097321403
tclose_L2=0.405871403
tcl_L3_1=-
top_L3_1=0.04796
tcl_L3_2=0.0548
top_L3_2=0.04754
topen_L3=0.097381403
tclose_L3=0.405881403
TRAVEL_HIST_PEAKS=2.000000000000
TRAVEL_HIST_PEAK_1=-3.095040525064
TRAVEL_HIST_PEAK_2=-1.744245182652
CT=-2.28265625
CS=-2.2603125
CT_rel=0.601411812401866
CS_rel=0.617952993214722
U_MAX=-1.744245182652
U_MIN=-3.095040525064
tcl=0.05477
top=0.0478933333333333
Uod_1=242
Uod_2=242
Ucd_1=-
Ucd_2=242
op_1=O
op_2=CO
```

Figure 32: Result.txt and Calc.txt

The left column show the results of result.txt in a formatted style. The right column shows the high precision results, not formatted, in calc.txt.

The pdf reports provide a graphical overview with the results in graphs and tables. The description of the different result values in calc.txt and result.txt is given in ANNEX B. The results in the word file have the same precision as the result.txt defines.

Test Results
No-Load Operations

Test performed: No-load operations
Date of test: 13th September 2006
Condition of test object before test: Factory new.
Gas pressure (abs. rel. to 20 °C): -

Test No.	CLT_1 NLT_CO		3					
Operating sequence			O-0.3s-CO		O-0.3s-CO		O-0.3s-CO	
C-Operation	Voltage of closing device	V	-	242				
	Closing time L1	ms	-	54.7				
	L2	ms	-	54.8				
	L3	ms	-	54.8				
O-Operation	Voltage of opening device	V	242	242				
	Opening time L1	ms	47.8	47.5				
	L2	ms	47.9	47.5				
	L3	ms	48.0	47.5				

Legend: -
Remarks:

Figure 33: No Load MS Word report from template

3.4 How to customize reports

One of the most popular features of the Saturn Studio II analysis suite is the capability to customize.

The pdf reports can be customized as well as the word files. Both work with templates to be modified by experienced users.

Please note!

Whenever changes are done to the template files make sure a working backup copy is stored to a secure destination.

The templates for reports and word files are stored in different folders.

3.4.1 NI DIAdem PDF report templates

The pdf report templates are loaded from C:\Saturn2\definitions\STL\...; the DIAdem report tool is needed to modify the pdf report templates. To learn how to modify the reports in detail refer to the DIAdem manual or online help.

To simply exchange the AMOtronics logo e.g. by your own logo or your customer's logo launch DIAdem, select the ***REPORT*** tab and open the report template. Double click the logo to edit the path for the embedded file. The file request window opens to select the new file from any folder.

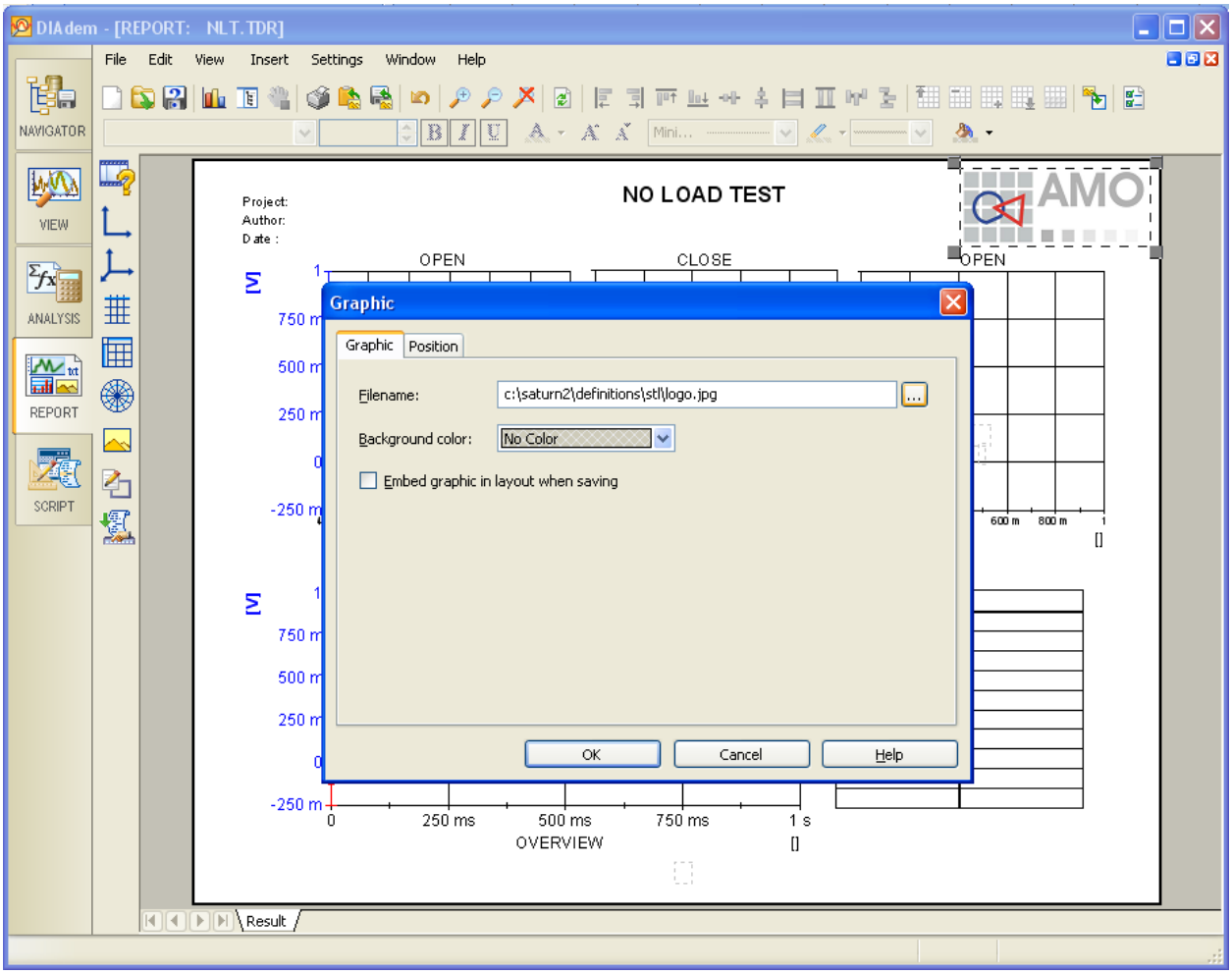


Figure 34: DIAdem No Load report template

3.4.2 MS Word report templates

The word report templates are predefined and as standard loaded from C:\STL\Temp-Tab\EN_AMO\...). MS Word is needed to modify the word templates as it is also needed to use the automatic fill-in function. All grey shown table cells in the example will be filled automatically, if values are available. The rest of the document can be modified at will.

RECOMMENDATION!!!

It is recommended to keep the original templates in the original folder and use the custom folder for customizing the report templates.

Customizing the templates path settings is very simple. To do changes to the path configuration edit the definition file by selecting OPTIONS from the VIEW menu and point to the ***STL-Doc Templates*** button. The WINDOWS notepad application opens to edit the definition file for the templates paths.

Figure 35: View Menu - Options

Figure 36 shows the default path settings for the MS Word templates. The defaults are pre-defined and can be customized to any valid folder by simply exchanging the path definition.

Please note!

The path and document names may be changed do NOT change the keywords in this file.

```
[RESULT_DOC]
LAT=C:\STL\Temp-Tab\EN_AMO\LAT.doc
CLT=C:\STL\Temp-Tab\EN_AMO\CLT.doc
TDT=C:\STL\Temp-Tab\EN_AMO\TDT.doc
NLT=C:\STL\Temp-Tab\EN_AMO\NLT.doc
SYT=C:\STL\Temp-Tab\EN_AMO\SYT.doc
```


Figure 36: STL_doc.ini - Standard

MS Word templates differ from values to be filled-in automatically and from the basic setup like headlines and further parameters. Exemplary the NLT standard template is shown in Figure 37.

Test Results
No-Load Operations

Test performed:				No-load operations							
Date of test:				21/04/2010 18:48							
Condition of test object before test:				Factory new.							
Gas pressure (abs. rel. to 20 °C):				-							
Test No. →											
Operating sequence				O-0.3s-CO		O-0.3s-CO		O-0.3s-CO			
C-Operation →	Voltage of closing device		V								
	Closing time	L1	ms								
		L2	ms								
		L3	ms								
O-Operation →	Voltage of opening device		V								
	Opening time	L1	ms								
		L2	ms								
		L3	ms								

Legend: -

Remarks:

Figure 37: MS Word No Load report template

4 STL – Capacitive Load Test (CLT)

Circuit-breakers have to fulfill diverse requirements concerning interruption capabilities and dielectric strength. Typically a high switching duty and a distinctive dielectric strength are in the main focus of design, construction, and testing of circuit-breakers. This meets with the needs of short-circuit currents and overvoltage stress respectively. Additionally switching of capacitive loads i.e. capacitor banks, cable loads or overhead lines, represents a specific operating condition that requires extensive performance.

To determine the performance of a circuit breaker when a capacitive load is connected, one necessary test of a circuit breaker during the complete acceptance test procedure is the *Capacitive Load Test* also known as *Cable-Charging Current Switching Test.*

In generally two tests are possible: Open Test (O) and Close-Open-Test (CO)

The Saturn Studio II STL Analysis Suite provides fully automatic analysis routines which fulfill the requirements of the corresponding international standards. How to perform a typical CLT analysis is described in the following chapter.

4.1 Channel configuration

To perform a 3-phase Capacitive Load Test “CLT” with fully automatic analysis a set of 11 signals is measured. The current is measured on all 3 phases by use of a shunt. The phase and load voltage is measured; the ON-OFF signal which is the control signal for the circuit breaker and the travel signal is measured. The travel signal is a signal corresponding to the mechanical movement of the circuit breaker mechanics.

In the example some pressure channels (Druck) are measured for documentation purpose only but will not be used for analysis.

Automatic recognition of all channels for the CLT analysis is supported with the names constraints in Table 1.

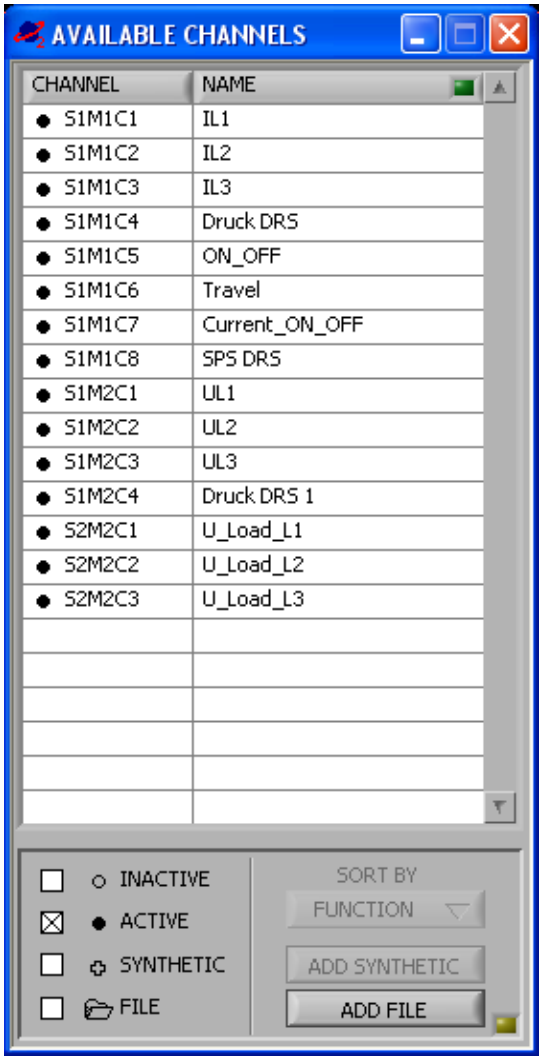


Figure 38: Available Channels – CLT

Standard names	Alternatively accepted names				
L1 L2 L3	IWL1 IWL2 IWL3				
UL1 UL2 UL3	US1 US2 US3				
U_Load_L1 U_Load_L2 U_Load_L3	U_LoadL1 U_LoadL2 U_LoadL3	ULastR ULastS ULastT	UWL1 UWL2 UWL3		
ON_OFF	On_Off	on_off	EIN_AUS	Ein_Aus	ein_aus
TRAVEL	Travel	travel	WEGGEBER	Weggeber	

Table 1: CLT - Names constraints

4.1.1 Current channel configuration for IL1, IL2 & IL3

To automatically recognize the channels for the CLT the 3 current channels are named according to Table 1 for the 3 phases. The following values are recommendations only for typical 50Hz tests to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 80kS
Physical factor: according to probes / dividers / shunts ()
Physical unit: A

4.1.2 Phase voltage channel configuration for UL1, UL2 & UL3

To automatically recognize the channels for the CLT the 3 phase voltage channels are named according to Table 1. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 80kS
Physical factor: according to probes / dividers / shunts ()
Physical unit: V

4.1.3 Load voltage channel configuration for U_Load_L1, U_Load_L2 & U_Load_L3

To automatically recognize the channels for the CLT the 3 phase voltage channels are named according to Table 1. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 5MS/s
Sample length: 4MS
Physical factor: according to probes / dividers / shunts ()
Physical unit: V

4.1.4 ON-OFF channel configuration

The ON-OFF signal is the control signal for the circuit breaker. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 80kS

4.1.5 Travel channel configuration

The travel signal is corresponding to the mechanical movement (way) of the circuit breaker internal mechanics. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 80kS

4.1.6 Trigger configuration

Any trigger may be used to make sure the complete Capacitive Load Test sequence is acquired with a single shot. It might be applicable to define a pre-trigger and use the ON-OFF signal for trigger.

4.2 Display of Capacitive Load Test

The acquired data within the Capacitive Load Test can be displayed in single or multiple views. An example how to display is shown in Figure 39 to Figure 42. Any or no display is ok; the fully automatic analysis does not require any display.

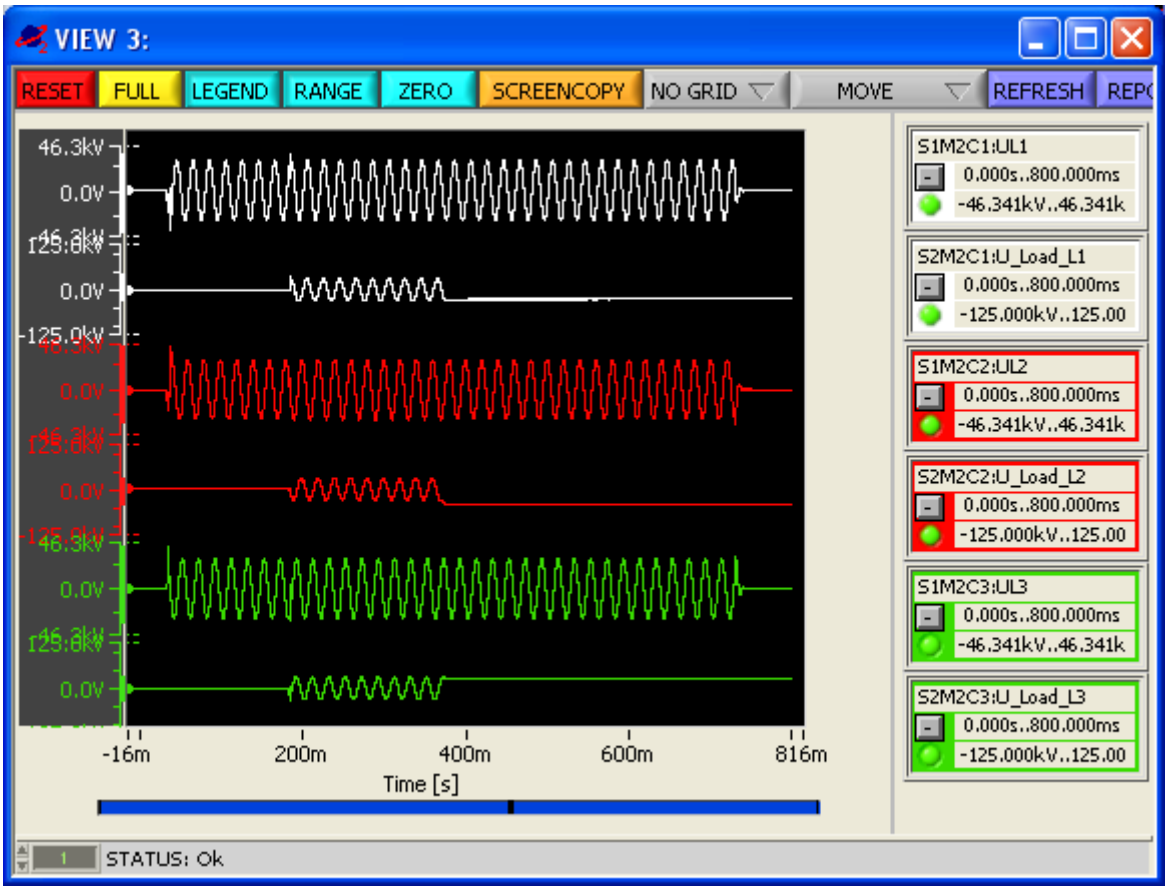


Figure 39: CLT View display – voltage

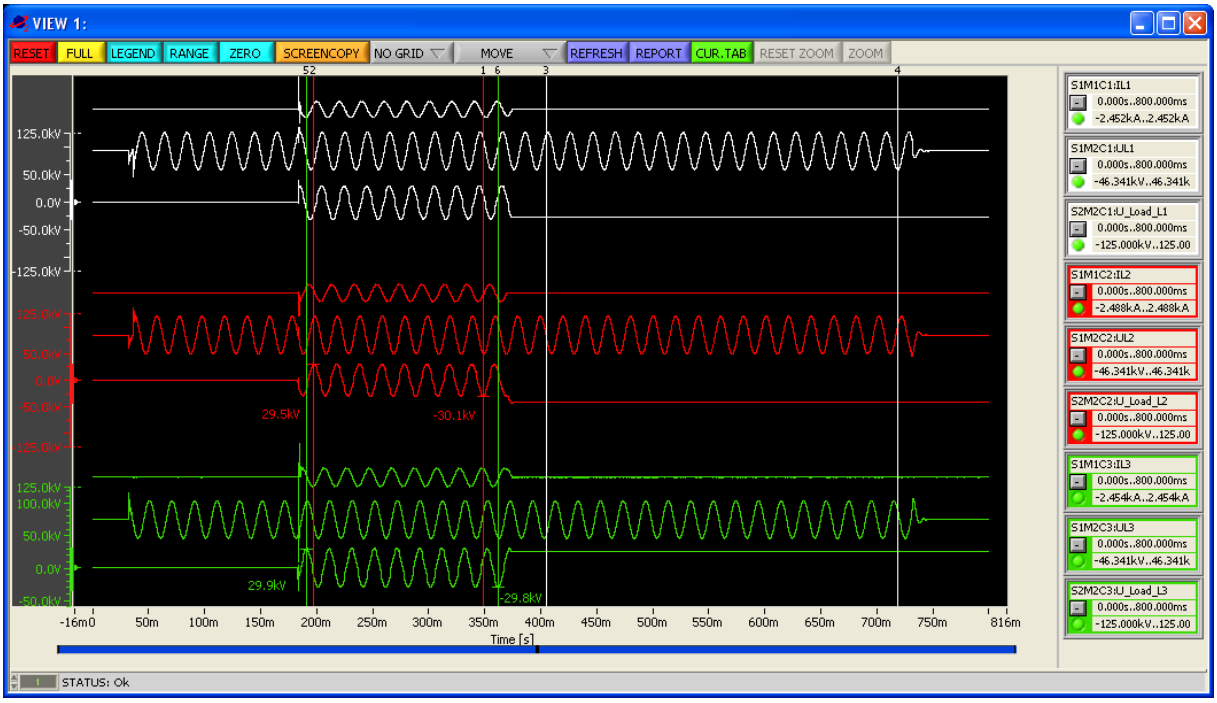


Figure 40: CLT View display – current and voltage per phase

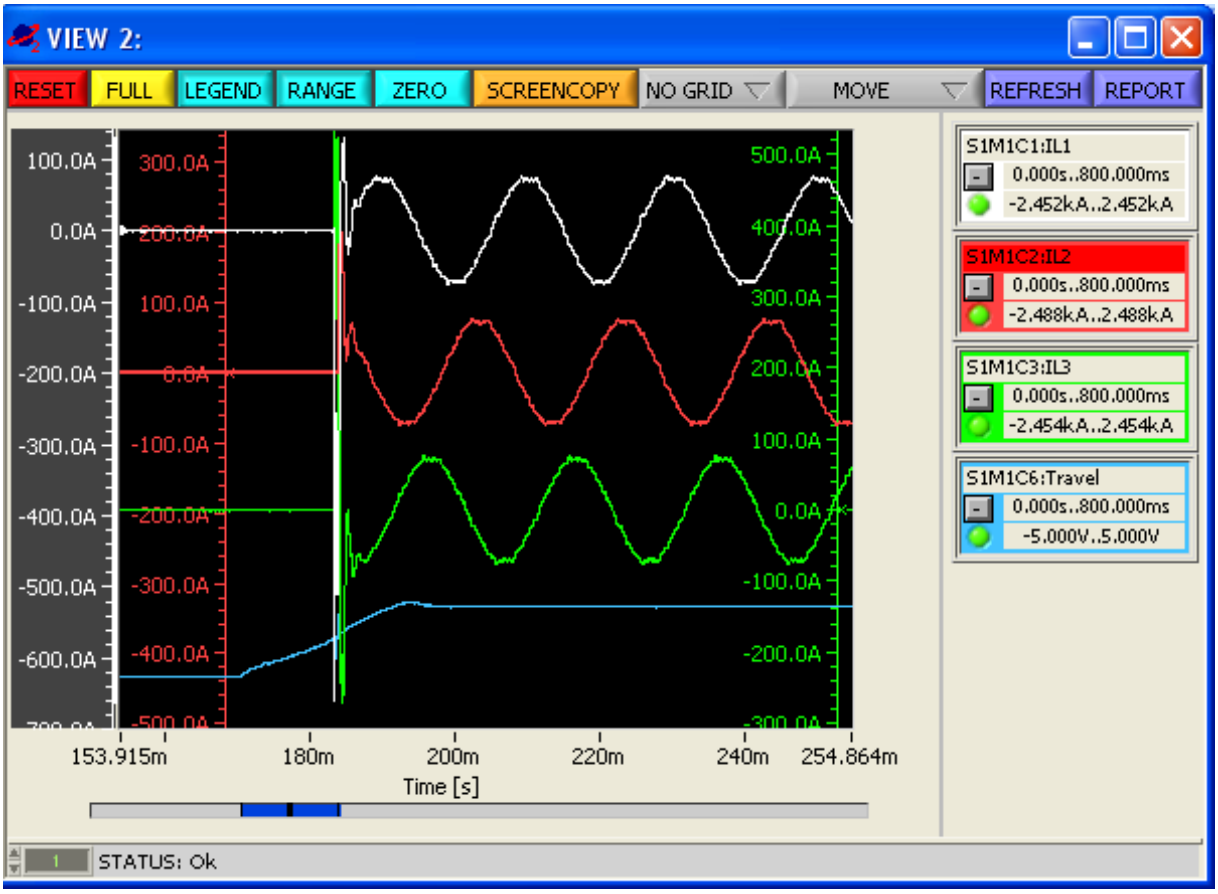


Figure 41: CLT View display – zoom to current and travel

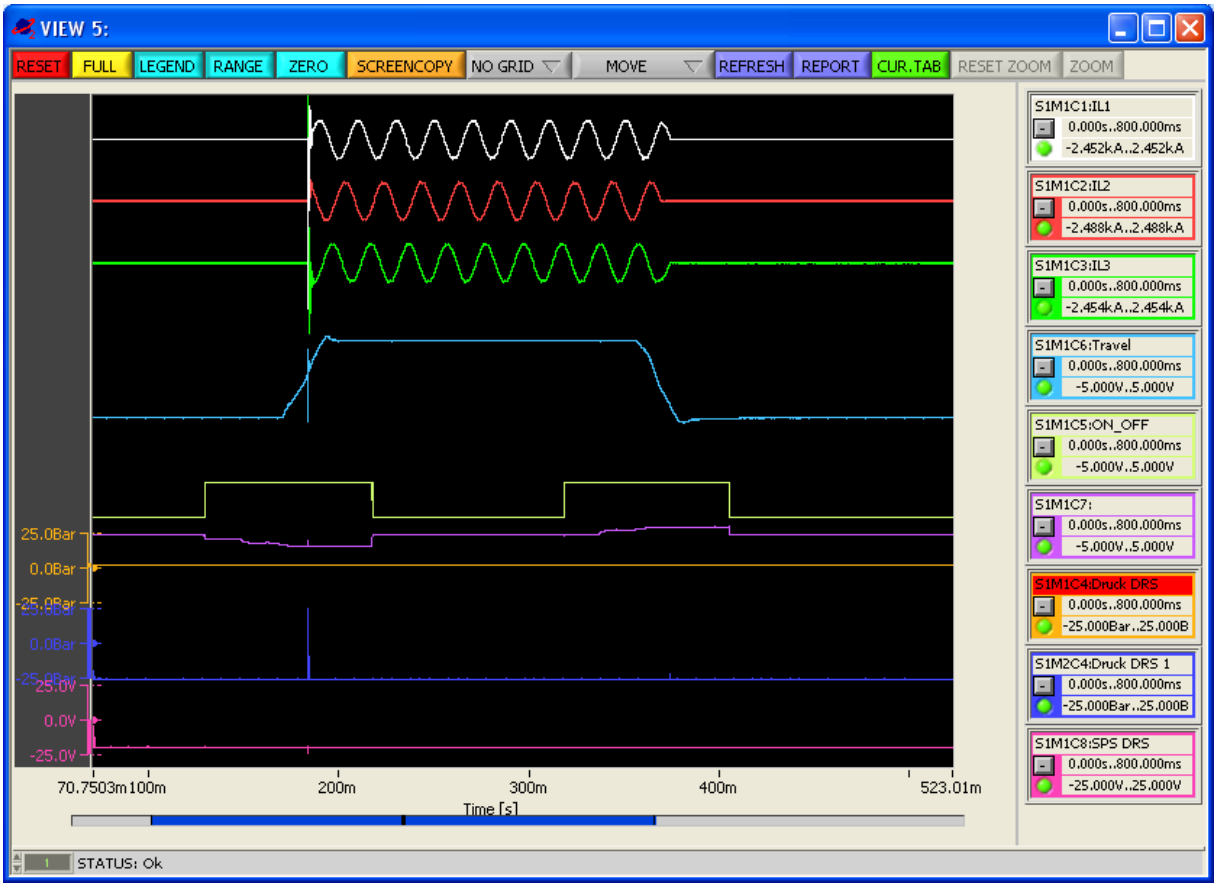
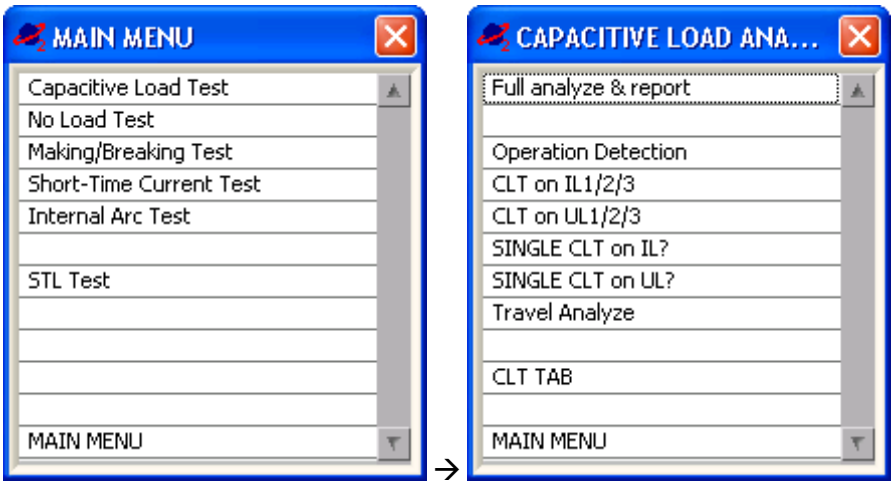


Figure 42: CLT View display – currents, travel and pressure signals

4.3 Automatic Analysis of Capacitive Load Tests

After the acquisition of Capacitive Load Test signals is finished the project is stored and analysis can be started. Therefore point to the ***ANALYSIS*** button to open the analysis ***MAIN MENU***. Select ***Capacitive Load Test*** from the menu or use the test sensitive ***CLT*** button (below button 11) and further select the analysis to run.



For fully automatic analysis the first entry ***Full analyze & report*** is selected. If named corresponding to the above given conventions the channels automatically will be recognized for calculation.

To get highest precision results the mechanical parameters from a No Load Test need to be available. Therefore upfront a Capacitive Load Test series typically some No Load Tests are performed. For optimum analysis results the user can pick one of the available No Load Tests within the current series. No Load test results from other series alternatively can be selected. To specify the NLT the ***SELECT NO LOAD TEST*** window automatically opens to pick any available No Load Test from the list. Confirm selection with ***OK.*** For the fully automatic CLT analysis everything is complete and the analysis is started in the DIAdem report tool.

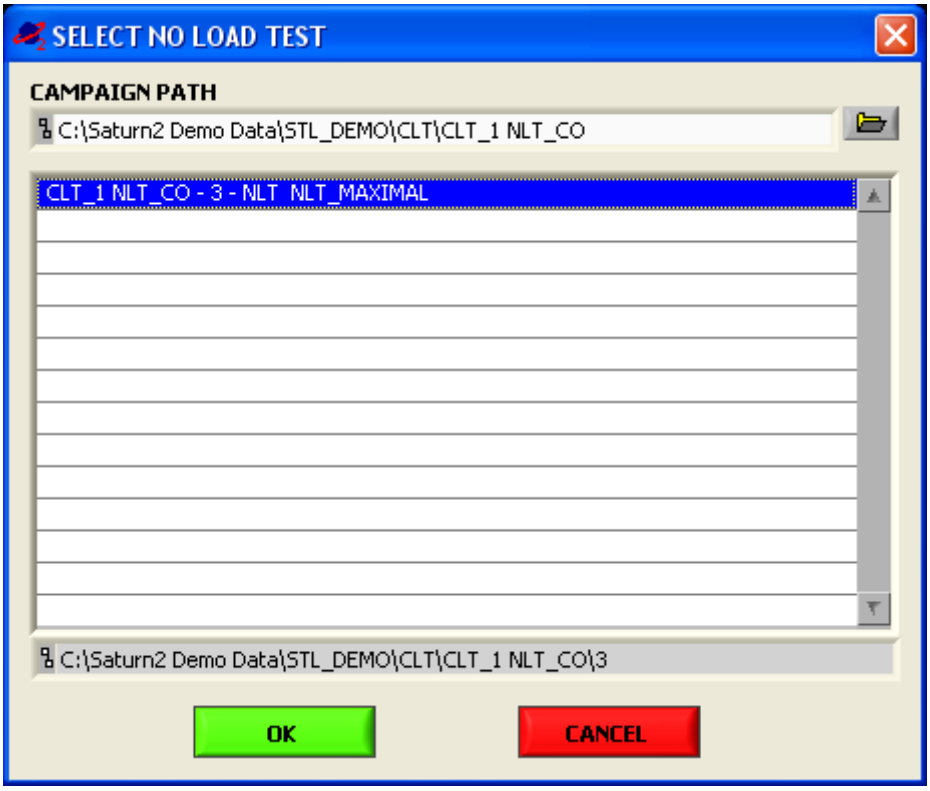


Figure 43: No Load Selection

4.4 Manual Analysis of Capacitive Load Tests

Each step of analysis for the CLT can be done separately by pointing to the individual entry of the CLT main menu (Figure 44). The analysis will run in DIAdem and generate the according report, which again will be stored in the project management. It can be selected from Operation Detection only (Figure 45), CLT on all 3 current phase (Figure 46, Figure 47) or voltage phases (Figure 48, Figure 49).

Single phase analysis is supported as well. To select pick one off ***SINGLE CLT IL?*** or ***SINGLE CLT UL?*** to either perform a single phase current or voltage analysis.

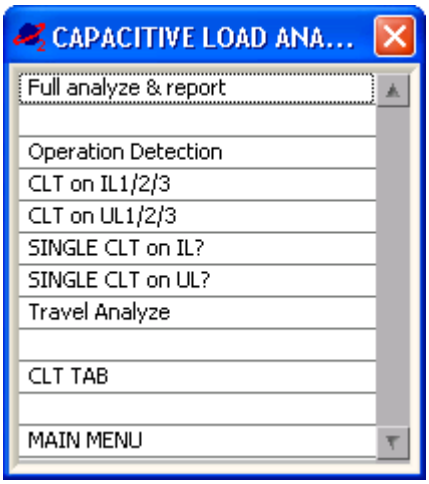
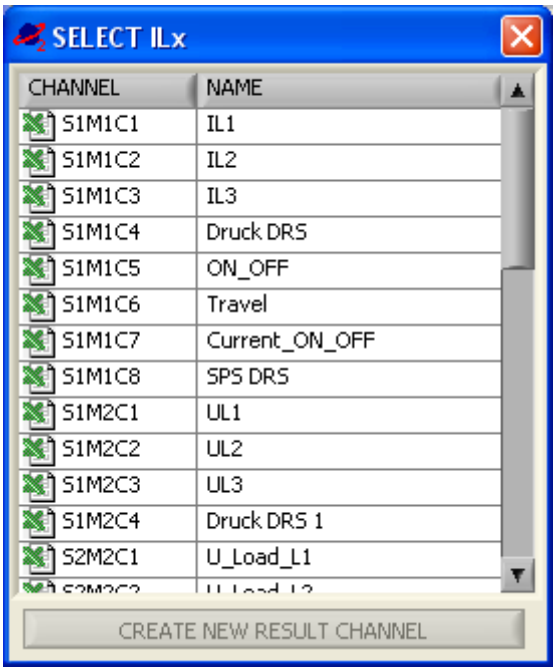
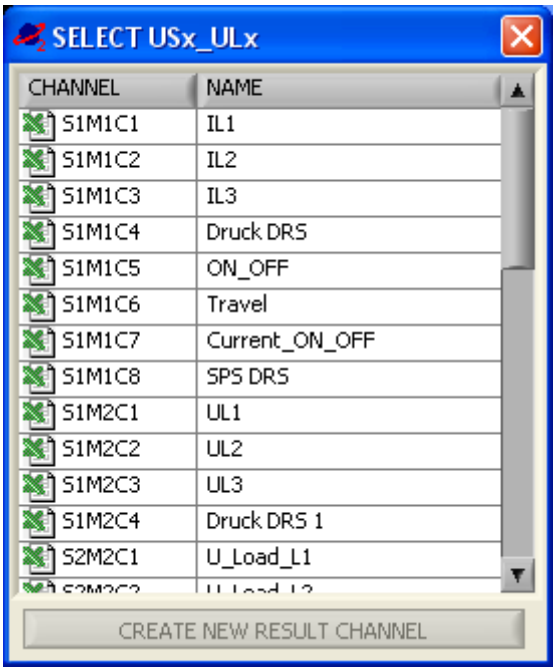


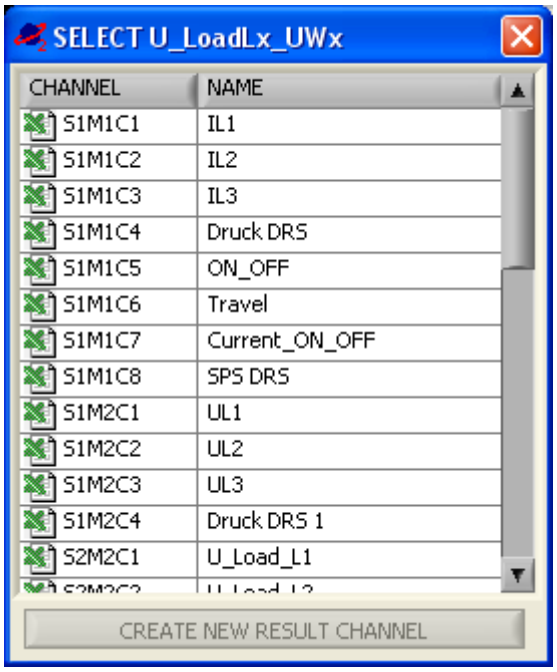
Figure 44: CLT main menu

For the current CLT analysis a selection window ***SELECT ILx*** comes up to request the current channel to be analyzed.



For the voltage CLT analysis a selection window ***SELECT USx_ULx*** comes up to request the voltage channel to be analyzed and next step a selection window ***SELECT U_LoadLx_UWx*** is displayed. After selection is finished the analysis starts and all parameters will be filled into the reports.





Travel analyze allows separate analysis of travel signal and generates the according report. Selecting CLT TAB finally generated a MS Word report from the predefined template.

The analysis runs automatically with the above defined names constraints and calculates the parameters for all 3 phases on current and voltage. For each phase an overview report and a detailed report is generated containing the results in graphic und tabular form. The example shows a typical

close-open (CO) sequence with a “Cable Charging Current Switching Test”. The figures Figure 45 to Figure 50 exemplary show the phase 1 results.

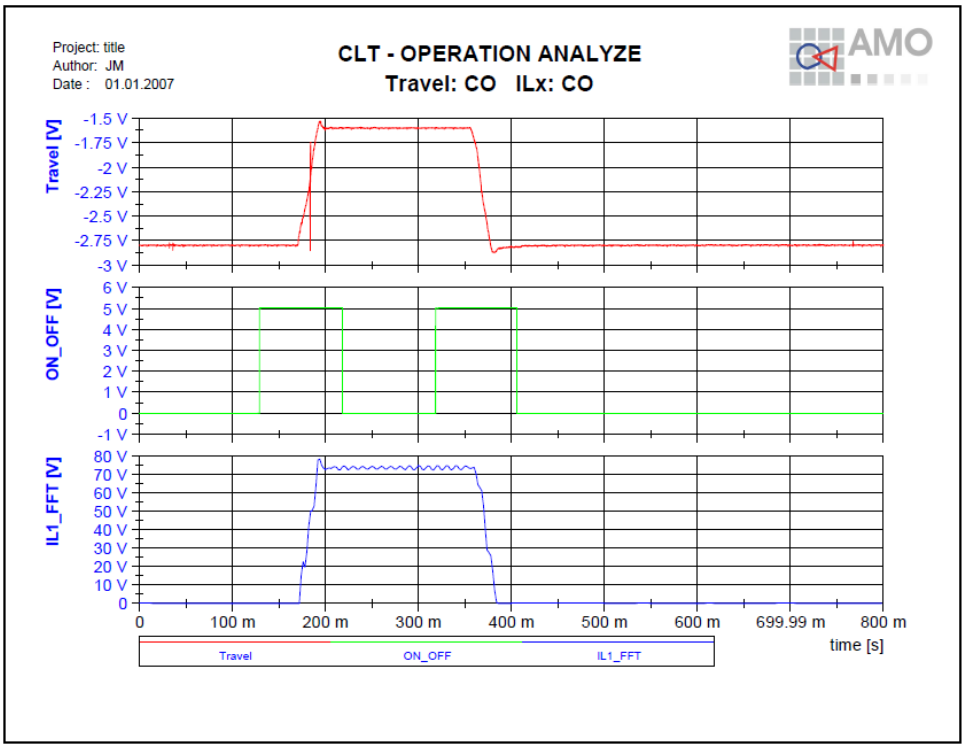


Figure 45: CLT - Operation Detection

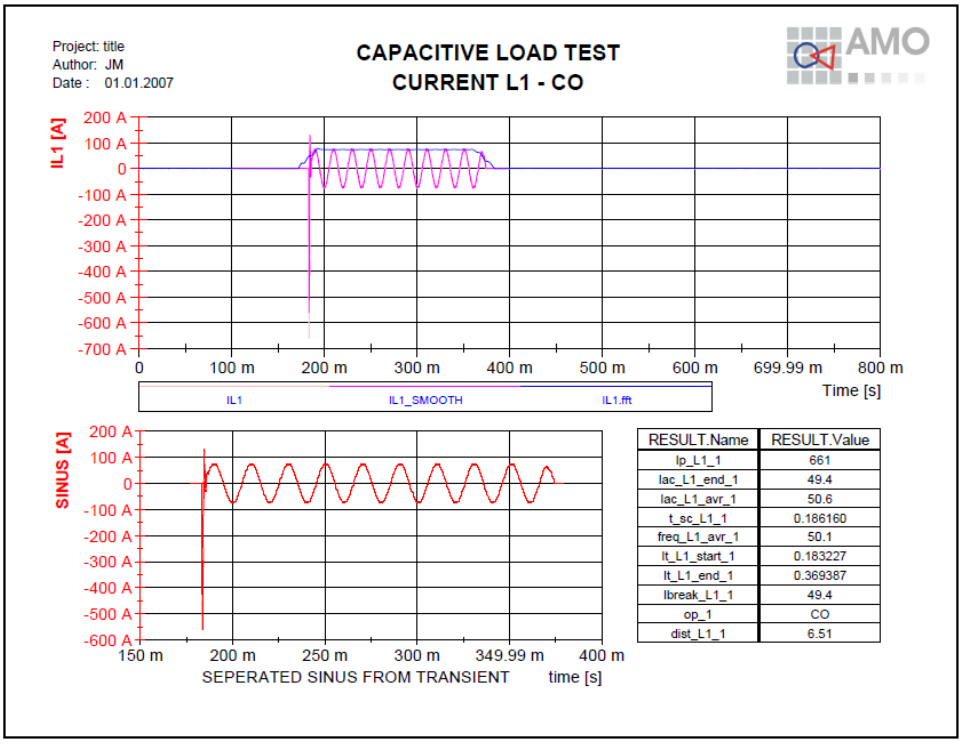


Figure 46: CLT - Current L1 overview

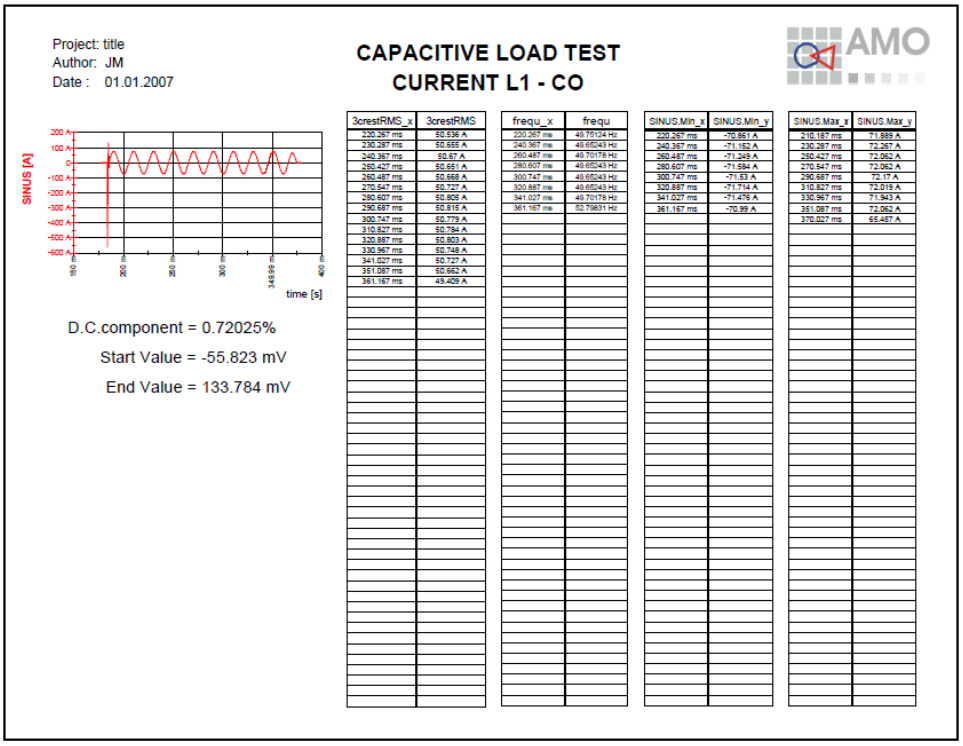


Figure 47: CLT - Current L1 details

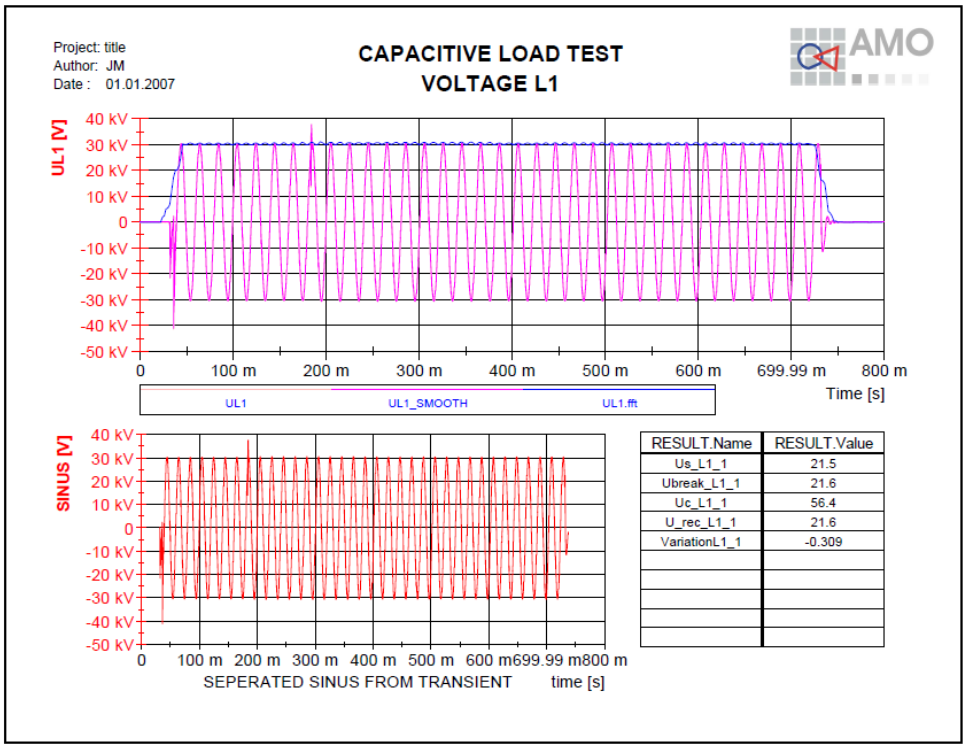


Figure 48: CLT - Voltage L1 overview

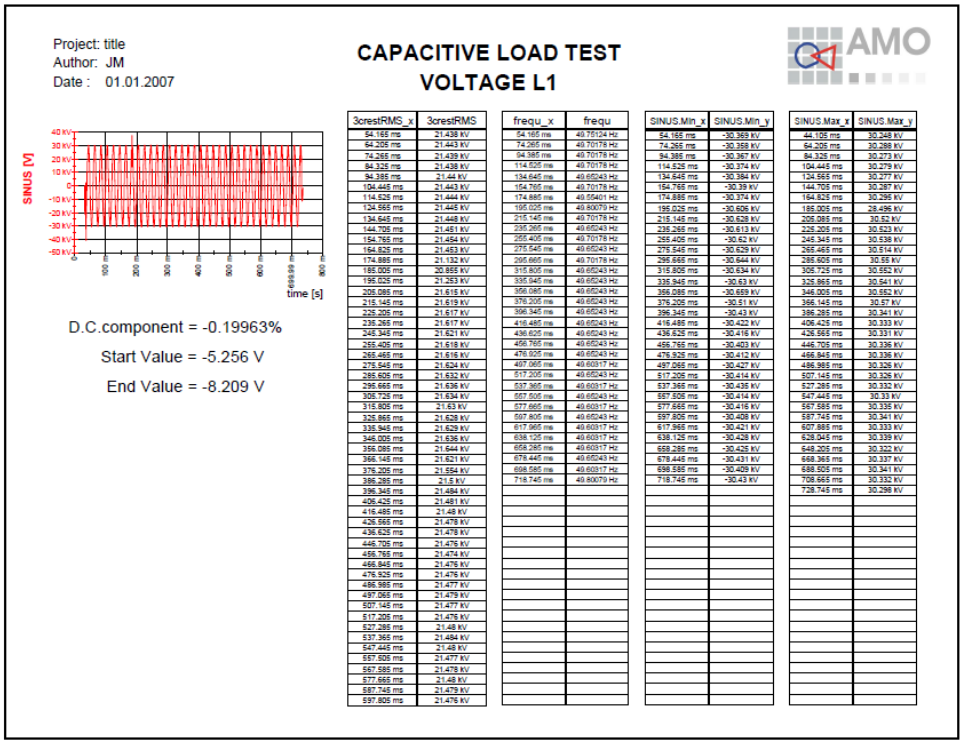
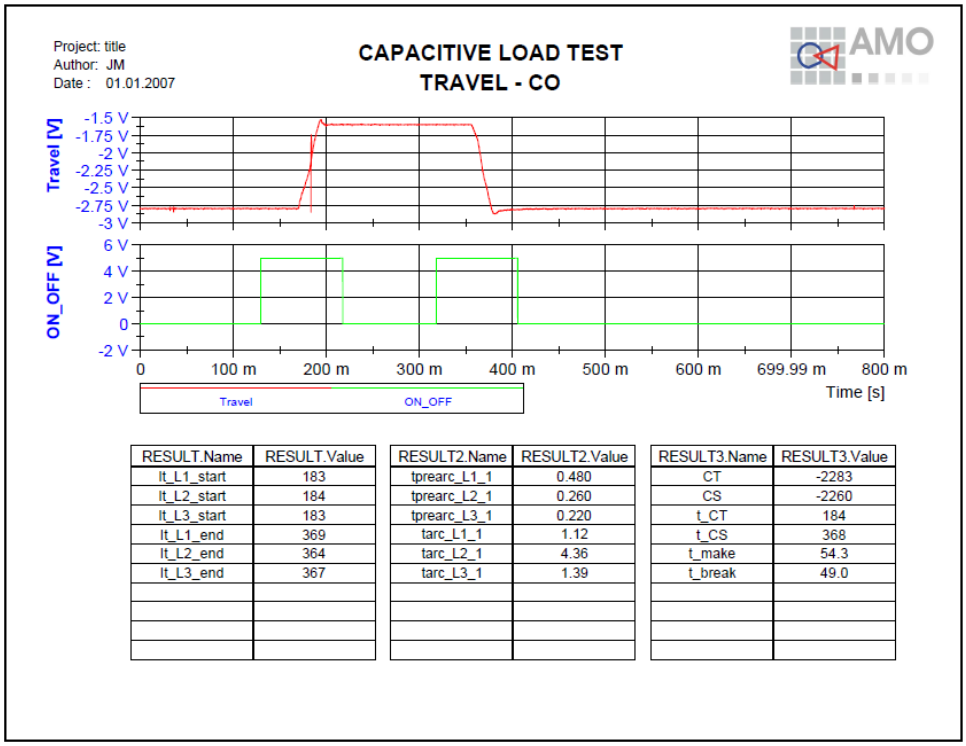


Figure 49: CLT - Voltage L1 details



RESULT.Name	RESULT.Value
It_L1_start	183
It_L2_start	184
It_L3_start	183
It_L1_end	369
It_L2_end	364
It_L3_end	367

RESULT2.Name	RESULT2.Value
tprearc_L1_1	0.480
tprearc_L2_1	0.260
tprearc_L3_1	0.220
tarc_L1_1	1.12
tarc_L2_1	4.36
tarc_L3_1	1.39

RESULT3.Name	RESULT3.Value
CT	-2283
CS	-2260
t_CT	184
t_CS	368
t_make	54.3
t_break	49.0

Figure 50: CLT - Travel CO

For test report and documentation purpose the calculated results automatically will be filled into a customizable MS Word template document (Figure 51). After generation the report is automatically stored to the project and manually can be edited, if wanted. All results will be stored in internal variables and in calc.txt and result.txt (compare 3.3 “How to analyze a test”).

Please note!
The functions are available only when Microsoft Word is installed on your system!!!

Test Results
Cable-Charging Current Switching Tests

Test performed: Cable-charging current switching tests, test duty CC2
Date of test: 21/04/2010 19:10
Condition of test object before test: As after test No. 99999 / 15.
Test arrangement: Direct test circuit, vacuum circuit-breaker stand-alone
Connections to test object: Infeed via copper bars to the lower terminals of the circuit-breaker, upper contacts of the circuit-breaker connected to the capacitor banks via cable.
Gas pressure (abs. rel. to 20 °C): -

Test No.	CLT_1 NLT_CO			17					
Operating sequence				CO					
Applied voltage (rms)				37.2					
Making current (peak)		L1	A	661					
		L2	A	209					
		L3	A	686					
Closing angle (rel. to peak appl. voltage)			°el	≤15	≤15	≤15	≤15	≤15	≤15
Test voltage (rms)		L1	kV	21.6					
		L2	kV	21.8					
		L3	kV	21.6					
	Average value (phase to phase)		kV	37.6					
Breaking current		L1	A	49.4					
		L2	A	50.5					
		L3	A	50.2					
	Average value		A	50.0					
Recovery voltage			—	—	—	—	—	—	—
Across circuit-breaker (peak)		L1	kV	56.4					
		L2	kV	72.9					
		L3	kV	56.5					
	Supply side (rms)	L1	kV	21.6					
		L2	kV	21.8					
		L3	kV	21.6					
	Average value (phase to phase)		kV	37.5					
C-Operation	Voltage of closing device		V	242					
	Closing time		ms	55.0					
	Pre-arcing time	L1	ms	0.480					
		L2	ms	0.260					
		L3	ms	0.220					
O-Operation	Voltage of opening device		V	242					
	Opening time		ms	47.6					
	Arcing time	L1	ms	1.12					
		L2	ms	4.36					
		L3	ms	1.39					
Emission of flame/gas/oil, occurrence of NSDD				no	no	no	no	no	no
Number of valid test				1	2	3	4	5	6
Test result (P / N)				P	P	P	P	P	P

Legend: P: Passed in terms of the applied standard N: Not passed in terms of the applied standard

Remarks: 99999 / 05 to 09: Tests with reduced values.

Condition of test object after test: Test object not inspected.

Figure 51: CLT - MS Word result table

5 STL – Synthetic Test / Making Breaking Test (MBT)

A circuit breaker has two basic positions – open and closed. In the closed position the circuit breaker *makes* hole current. In the open position the circuit breaker *breaks* the hole current. In open position the voltage is on its maximum

The synthetic test is performed to determine the behavior of a circuit breaker when a high voltage condition follows a high current condition. Because it is not possible to have a generator which is capable of delivering both a high voltage and a high current simultaneously, the high voltage is generated in a separate circuit and the current of this circuit is injected into the breaker when the current delivering circuit is disconnected from the breaker

This STL-analysis package provides fully automatic analysis routines which fulfill the requirements of the corresponding European standard EN60427.

5.1 Channel configuration

To perform a 3-phase Synthetic Load Test or Making Breaking Test “MBT” with fully automatic analysis a set of 8 signals is measured. The current is measured on all 3 phases by use of a shunt. The phase voltage is measured; the ON-OFF signal which is the control signal for the circuit breaker and the travel signal is measured. The travel signal is a signal corresponding to the mechanical movement of the circuit breaker mechanics.

In the example some pressure channels (Druck) and safety signals are measured for documentation purpose only but will not be used for analysis.

Automatic recognition of all channels for the MBT analysis is supported with the names constraints in Table 2.

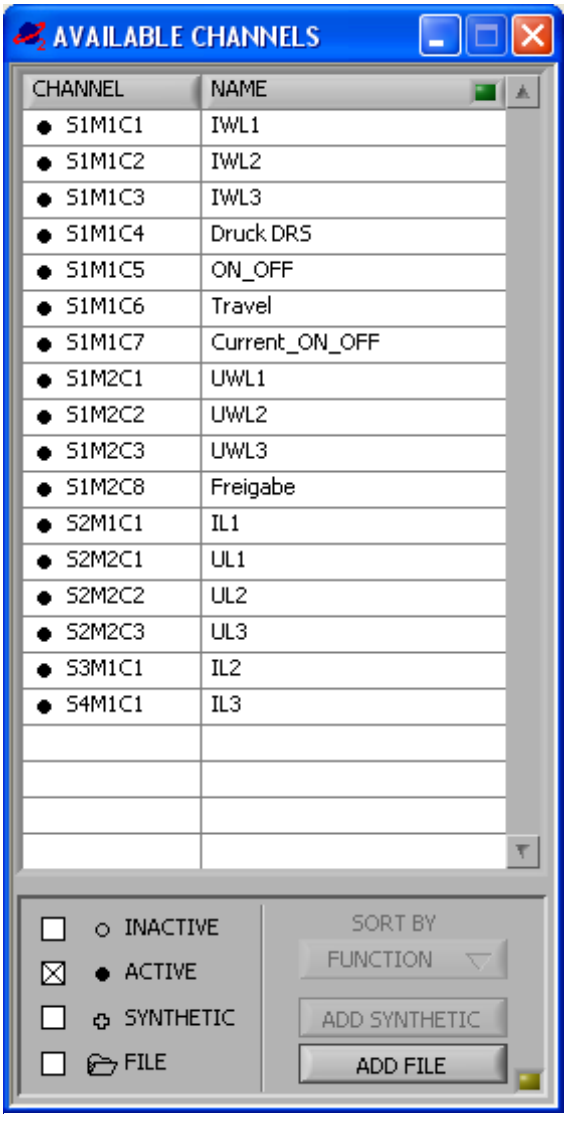


Figure 52: Available Channels – CLT

Standard names	Alternatively accepted names				
IL1 IL2 IL3					
UL1 UL2 UL3	US1 US2 US3				
ON_OFF	On_Off	on_off	EIN_AUS	Ein_Aus	ein_aus
TRAVEL	Travel	travel	WEGGEBER	Weggeber	

Table 2: MBT - Names constraints

5.1.1 Current channel configuration for IL1, IL2 & IL3

To automatically recognize the channels for the CLT the 3 current channels are named according to Table 2for the 3 phases. The following values are recommendations only for typical 50Hz tests to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 1MS/s
Sample length: 990kS
Physical factor: according to probes / dividers / shunts ()
Physical unit: A

5.1.2 Phase voltage channel configuration for UL1, UL2 & UL3

To automatically recognize the channels for the CLT the 3 phase voltage channels are named according to Table 2. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 10MS/s
Sample length: 9.9MS
Physical factor: according to probes / dividers / shunts ()
Physical unit: V

5.1.3 ON-OFF channel configuration

The ON-OFF signal is the control signal for the circuit breaker. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 99kS

5.1.4 Travel channel configuration

The travel signal is corresponding to the mechanical movement (way) of the circuit breaker internal mechanics. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 99kS

5.1.5 Trigger configuration

Any trigger may be used to make sure the complete test sequence is acquired with a single shot. It might be applicable to define a pre-trigger and use the ON-OFF signal for trigger.

5.2 Display of Making Breaking Test

The acquired data within the Making Breaking Test can be displayed in single or multiple views. An example how to display is shown in Figure 53 to Figure 55. Any or no display is ok; the fully automatic analysis does not require any display.

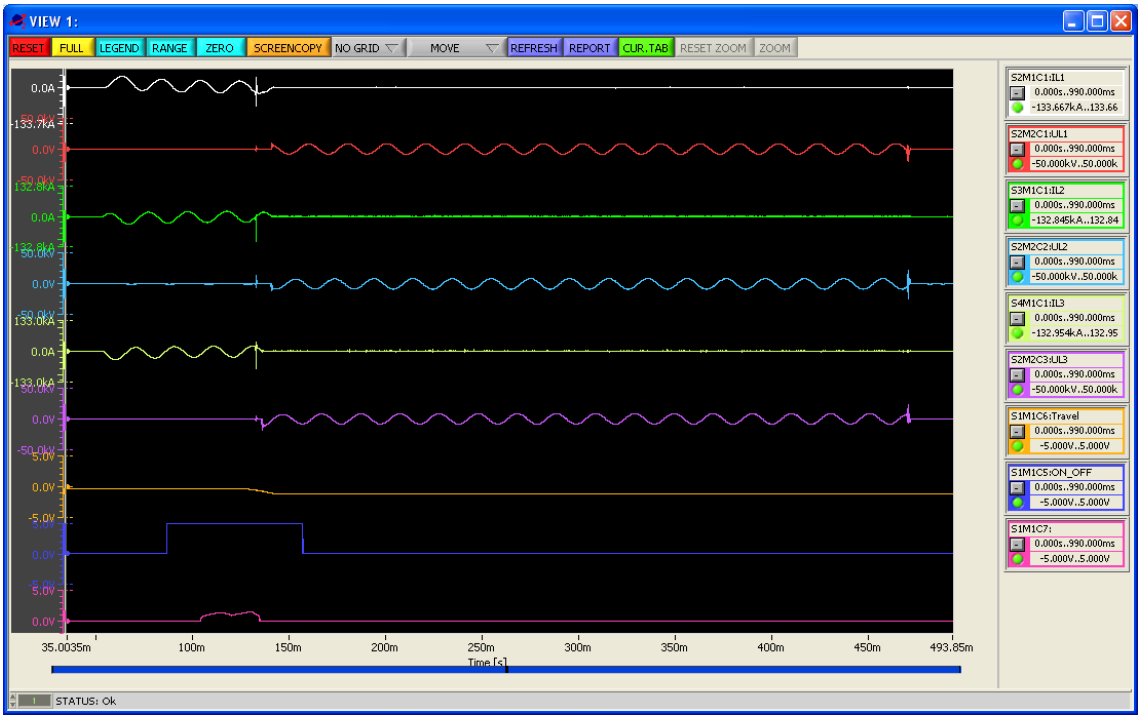


Figure 53: MBT View display – overview

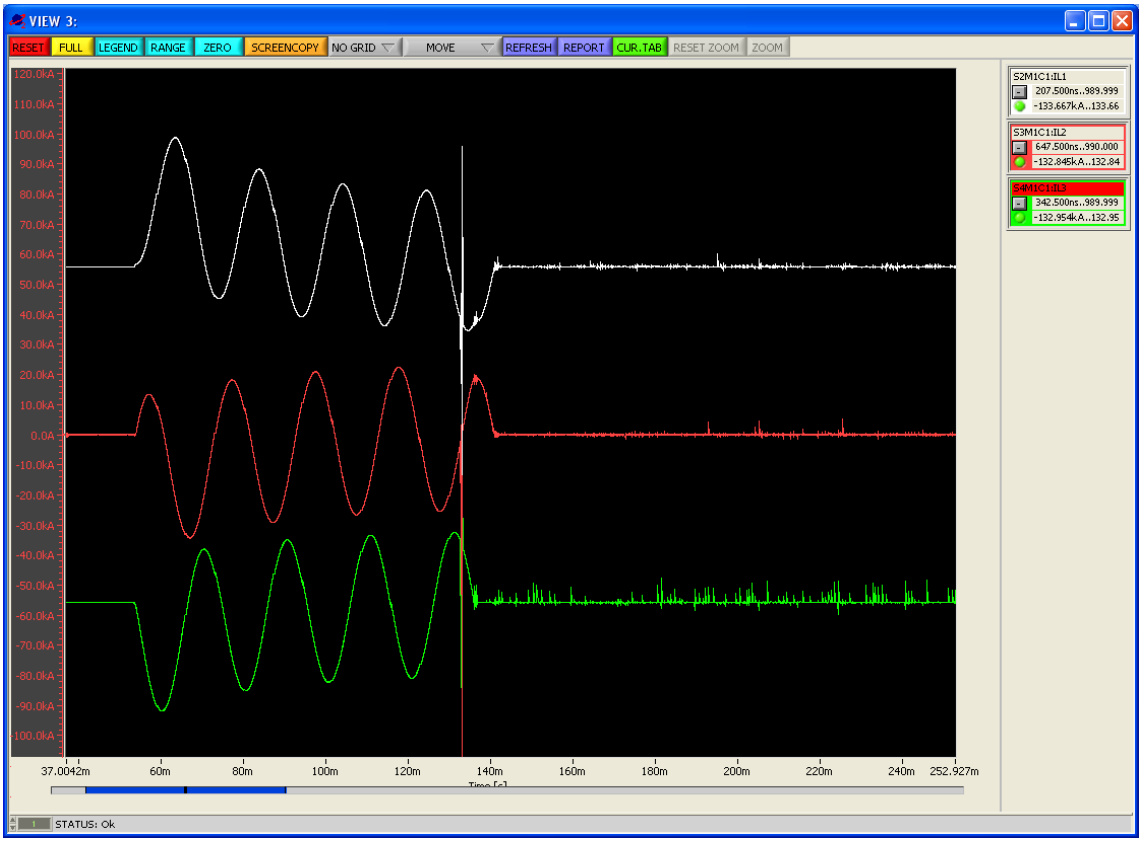


Figure 54: MBT View display – 3 phase currents

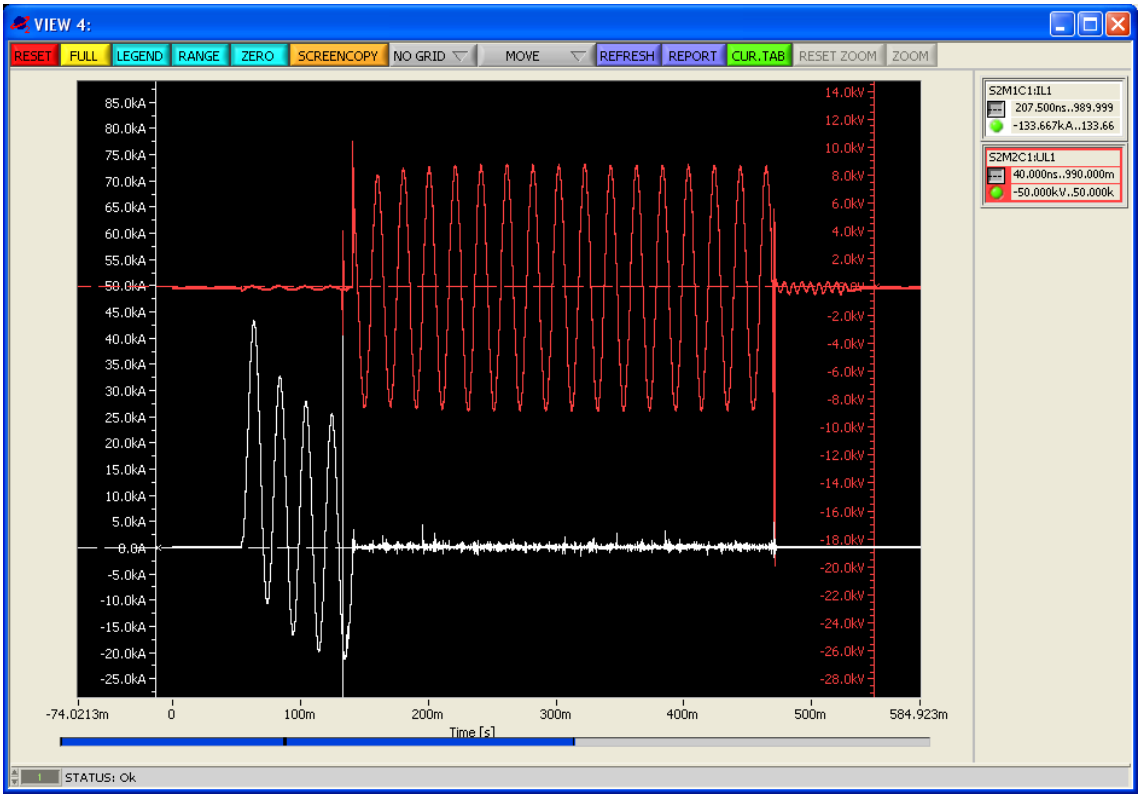
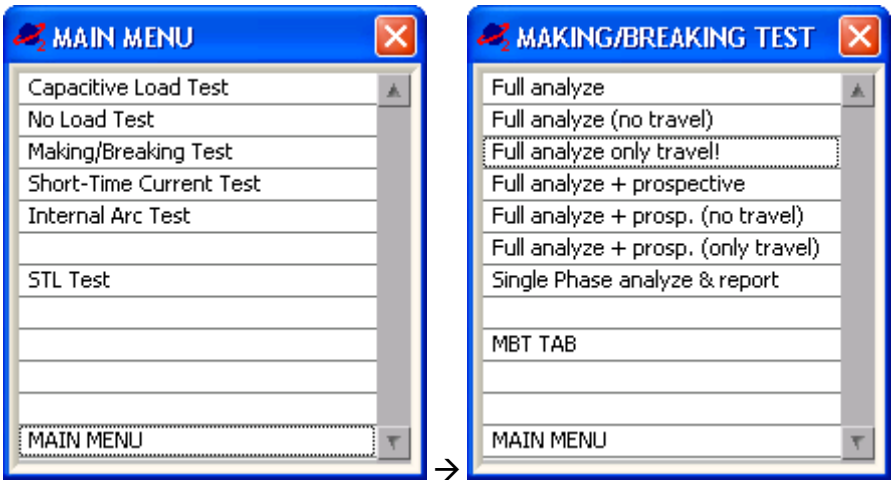


Figure 55: MBT View display – phase 1 current and voltage

5.3 Automatic Analysis of Making Breaking Tests

After the acquisition of Making Breaking Test signals is finished the project is stored and analysis can be started. Therefore point to the ***ANALYSIS*** button to open the analysis ***MAIN MENU***. Select ***Making/Breaking Test*** from the menu or use the test sensitive ***MBT*** button (below button 11) and further select the analysis to run.



For fully automatic analysis the first entry ***Full analyze & report*** is selected. If named corresponding to the above given conventions the channels automatically will be recognized for calculation.

To get highest precision results the mechanical parameters from a No Load Test need to be available. Therefore upfront a Making Breaking Test series typically some No Load Tests are performed. For optimum analysis results the user can pick one of the available No Load Tests within the current series. No Load test results from other series alternatively can be selected. To specify the NLT the ***SELECT NO LOAD TEST*** window automatically opens to pick any available No Load Test from the list. Confirm selection with ***OK.*** For the fully automatic MBT analysis everything is complete and the analysis is started in the DIAdem report tool.

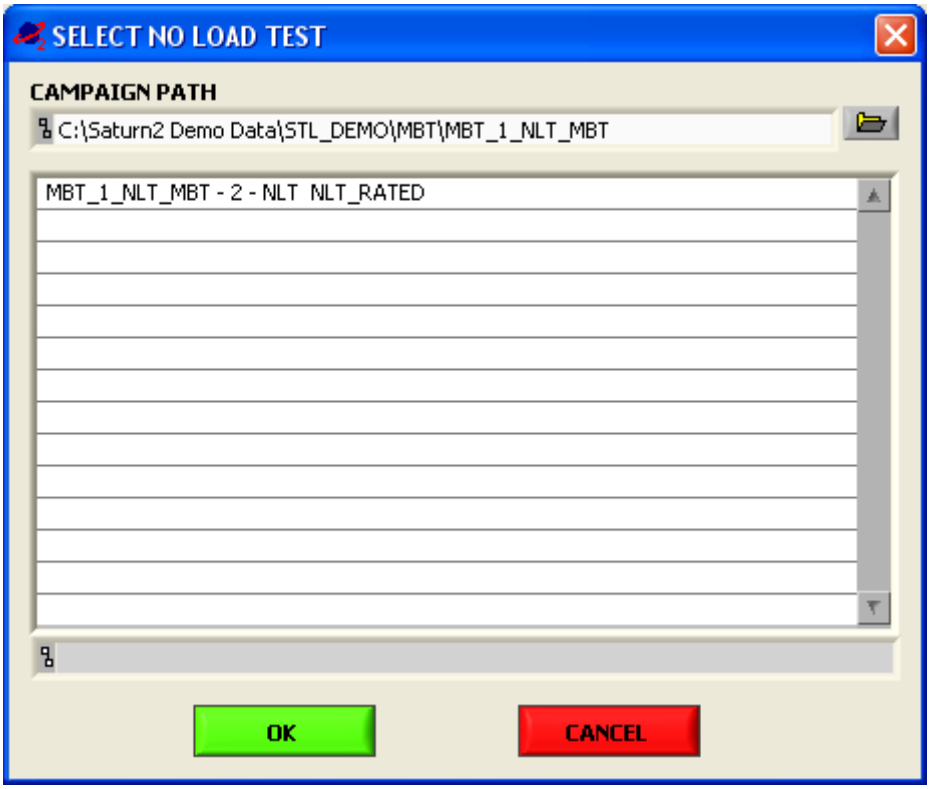


Figure 56: No Load Selection

5.4 Manual Analysis of Making Breaking Tests

Special types of analysis for the MBT are available by pointing to the individual entry of the MBT main menu (Figure 57). Needed details will be requested automatically and the analysis then will run in DIAdem and generate the according report, which again will be stored in the project management. For analysis it can be selected from full MBT ***without travel*** or ***travel only***.

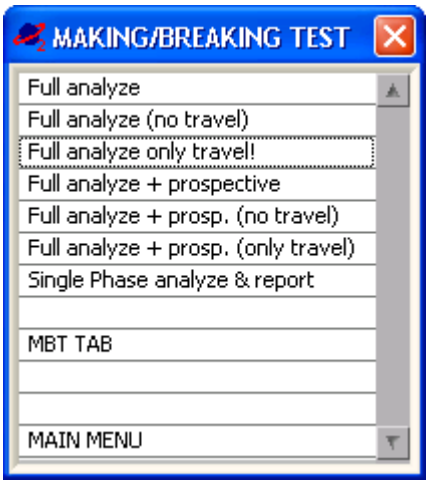


Figure 57: MBT main menu

Optionally prospective tests can be included in the MBT analysis for more precise results. Prospective tests are standard synthetic tests with reduced load to evaluate parameters not available on full load making breaking tests. The missing parameters automatically will be picked from the prospective test and a message informs the user about the automatic selection. Full analyze with prospective test again are available ***with*** or ***without*** travel analysis and ***travel only*** analysis.

Finally single phase measurements are supported as well. To select pick ***Single Phase analyze & report*** to perform a single phase analysis.

All making breaking tests require a No Load test and will request to specify a test in the ***SELECT NO LOAD TEST*** window.

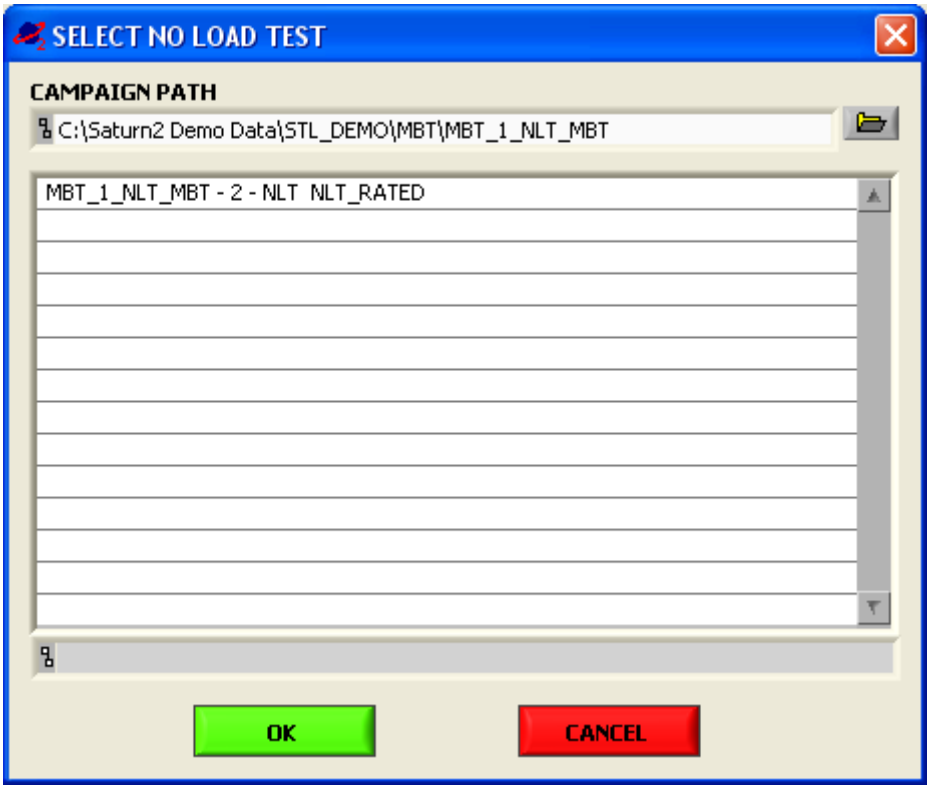


Figure 58: MBT – Select No Load Test

If analysis with prospective test is picked from the main menu the ***SELECT PROSPECTIVE*** window automatically comes up to select the synthetic test with reduced load.

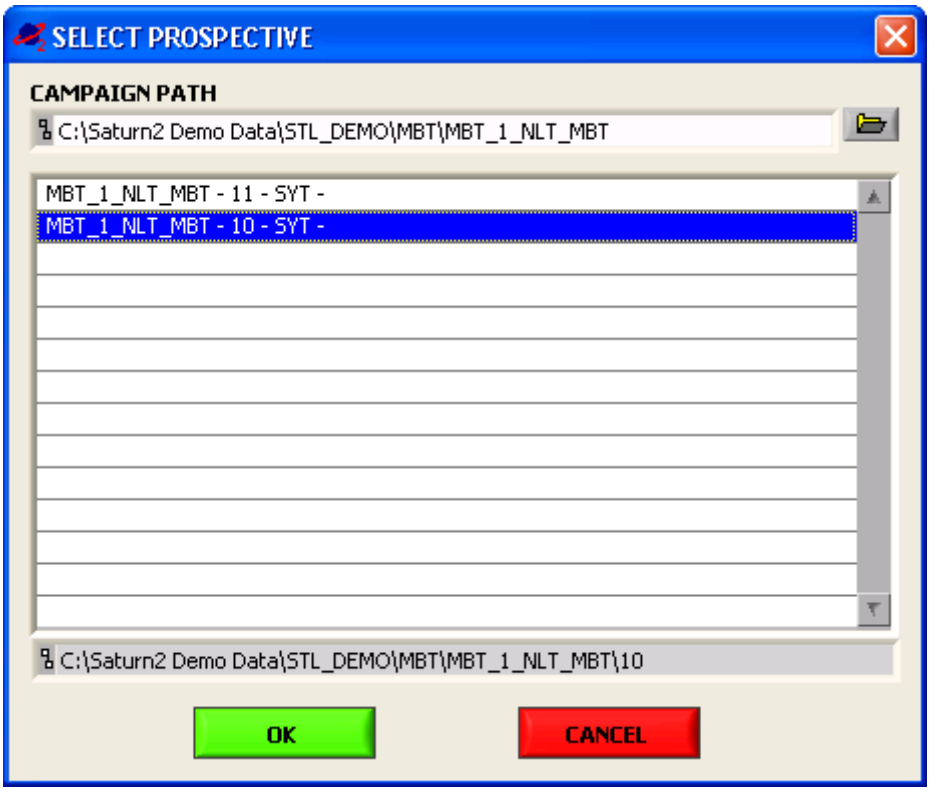
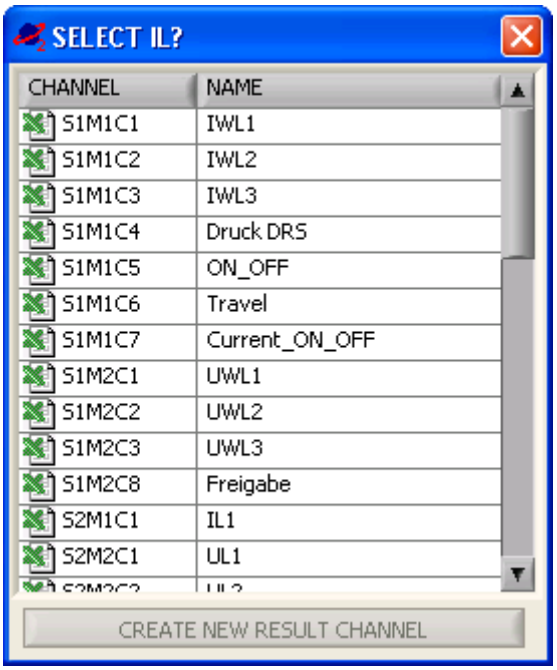
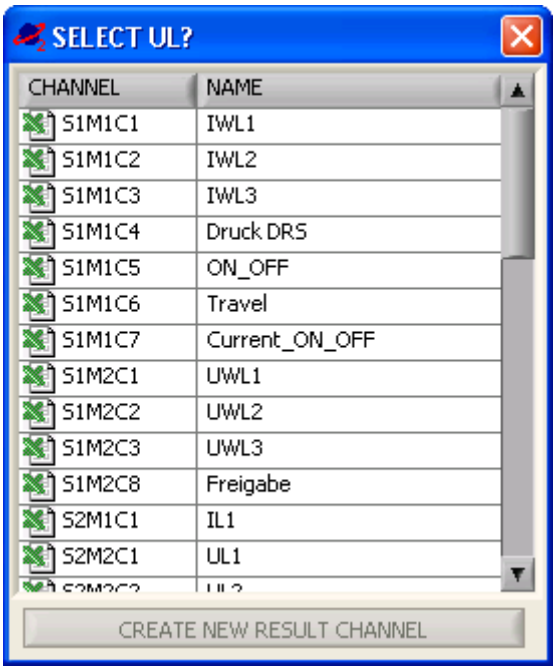


Figure 59: MBT - Select Prospective Test

For the single channel MBT analysis a selection window ***SELECT IL?*** comes up to request the current channel, next step a selection window ***SELECT UL?*** comes up to request the voltage channel to be analyzed. After selection is finished the analysis starts and all parameters will be filled into the reports.





Selecting MBT TAB finally generates a MS Word report from the predefined template.

The analysis runs automatically with the above defined names constraints and calculates the parameters for all 3 phases on current and voltage. For each phase an overview report and a detailed report is generated containing the results in graphic und tabular form. The example shows a typical open (O) test. The figures Figure 60 to Figure 67 exemplary show the phase 1 results.

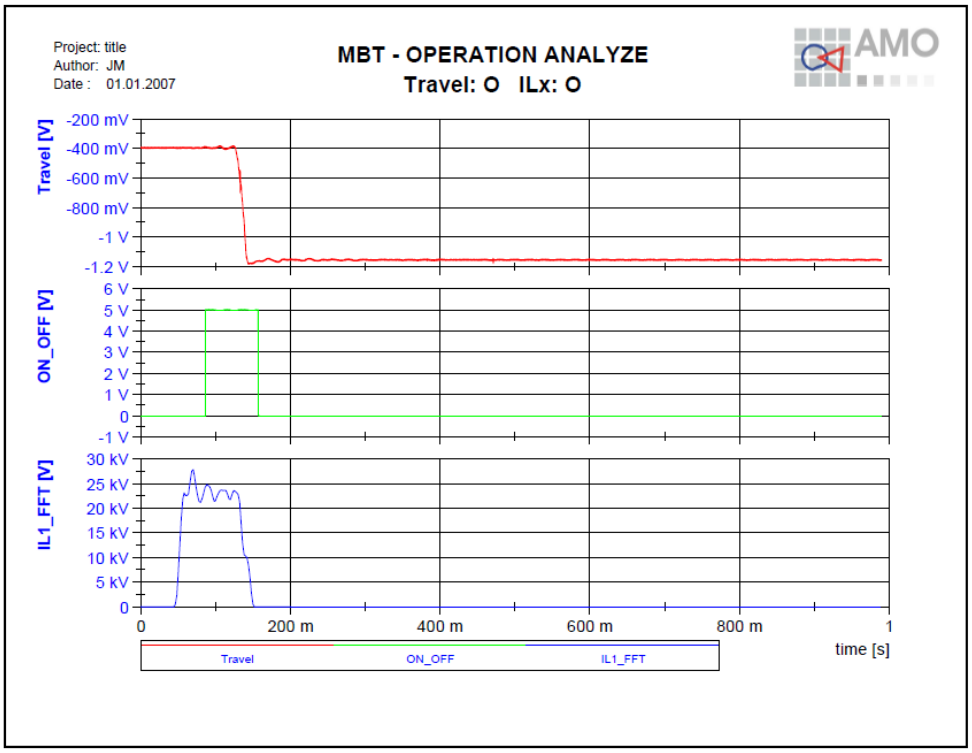


Figure 60: MBT - Operation Detection

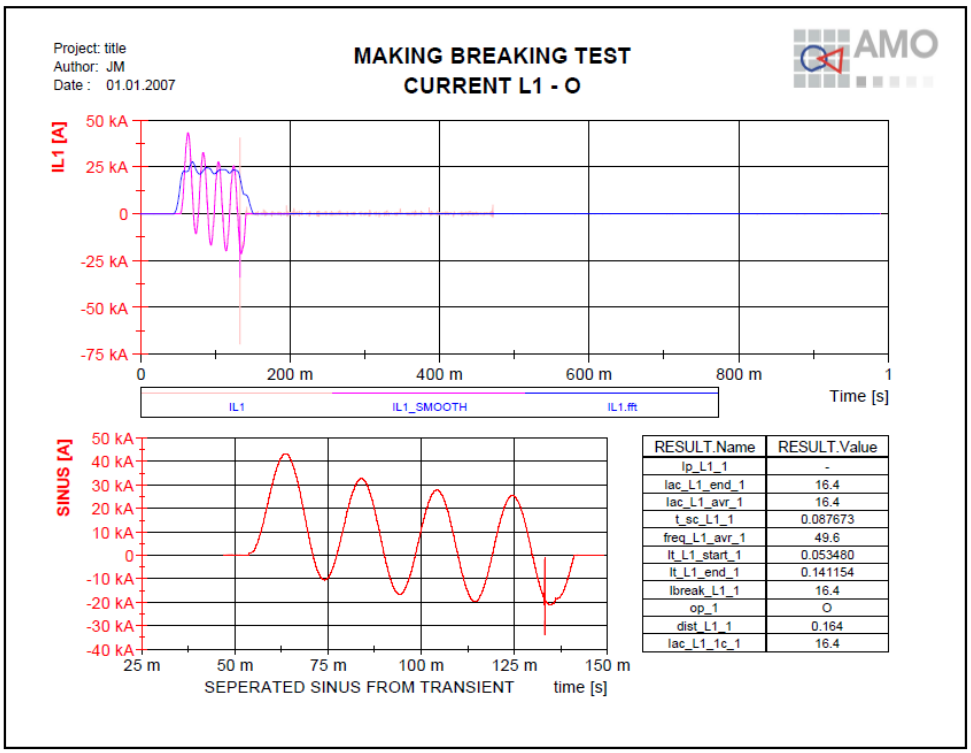


Figure 61: MBT - Current L1 overview

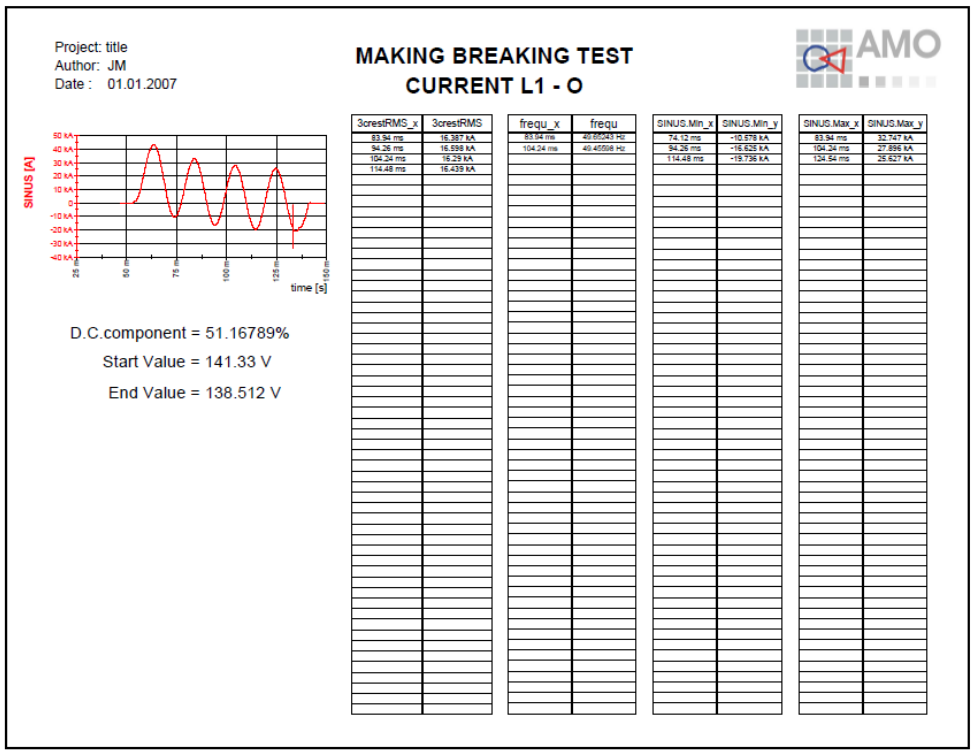


Figure 62: MBT - Current L1 details

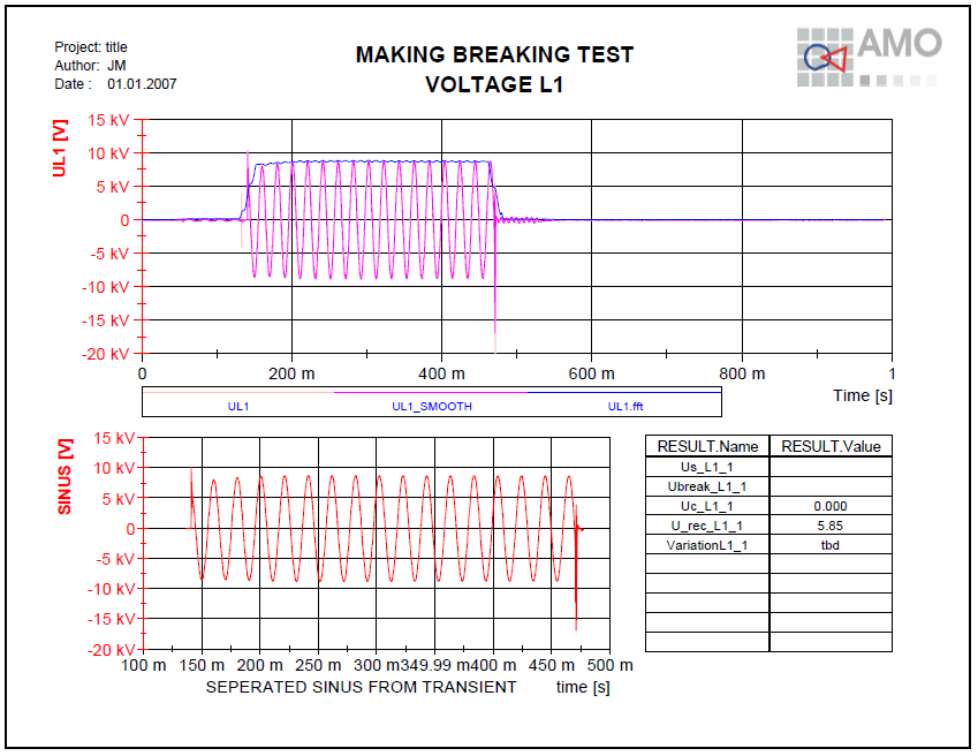


Figure 63: MBT - Voltage L1 overview

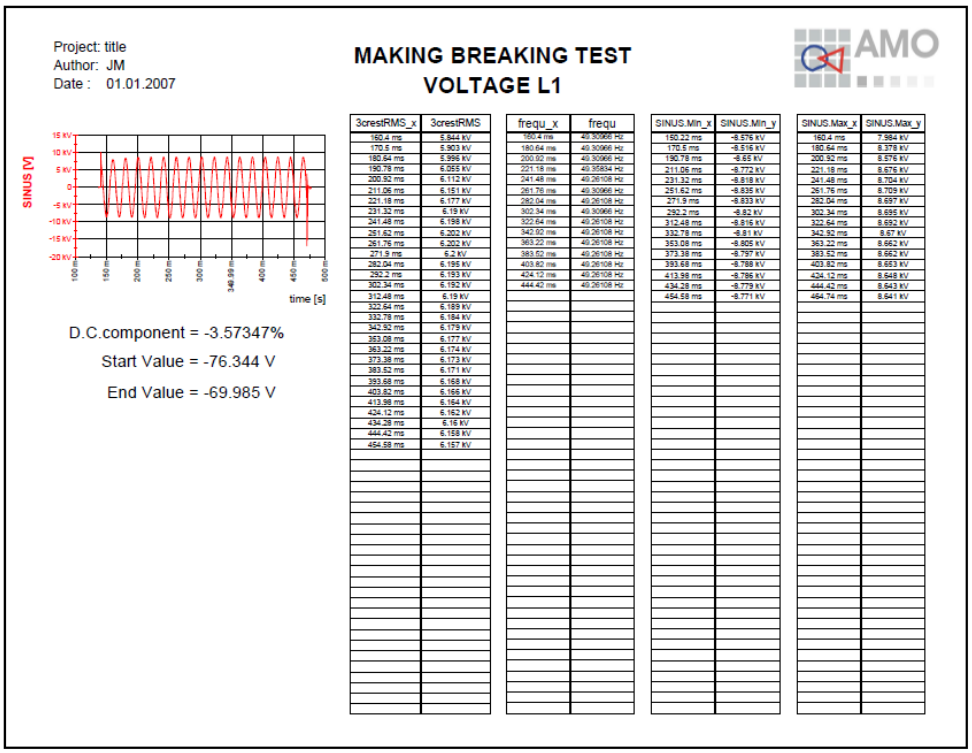


Figure 64: MBT - Voltage L1 details

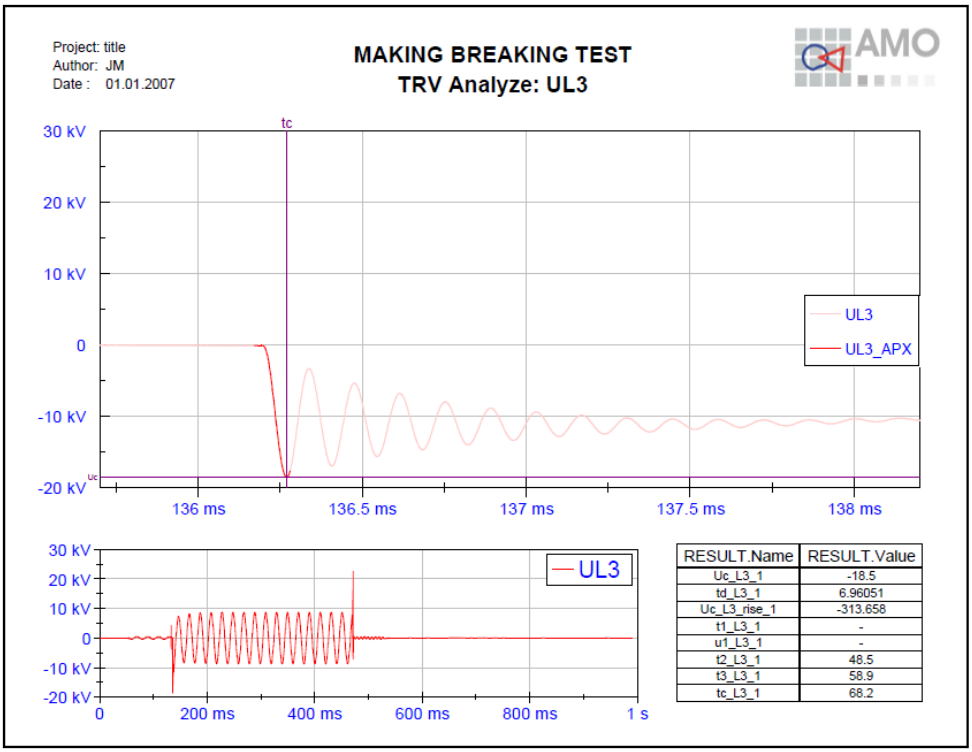


Figure 65: MBT - TRV detect

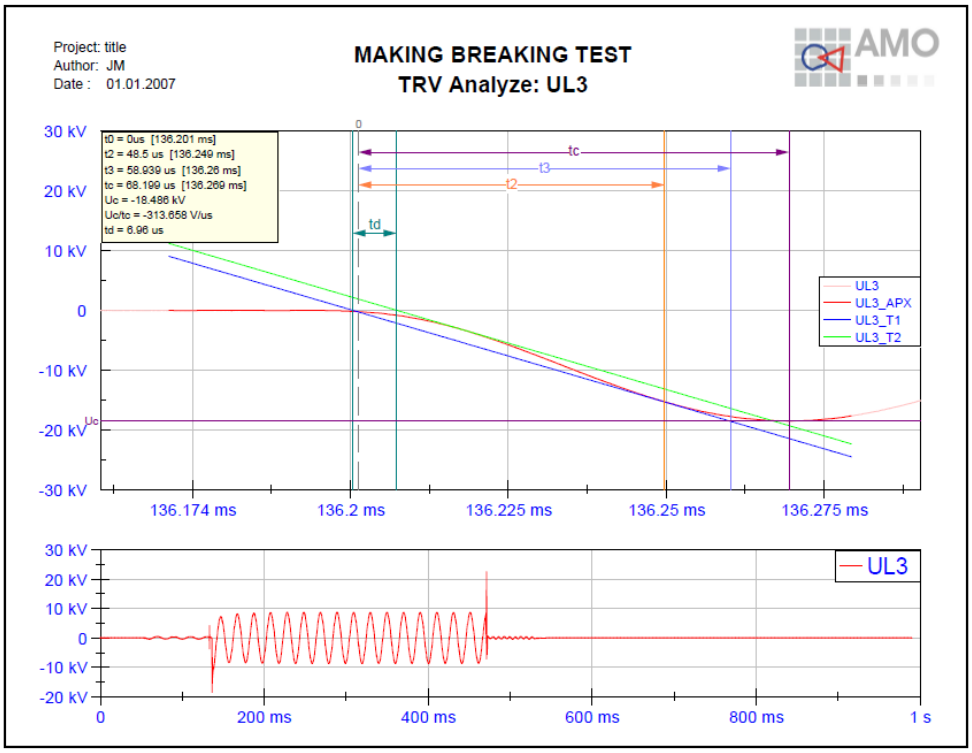
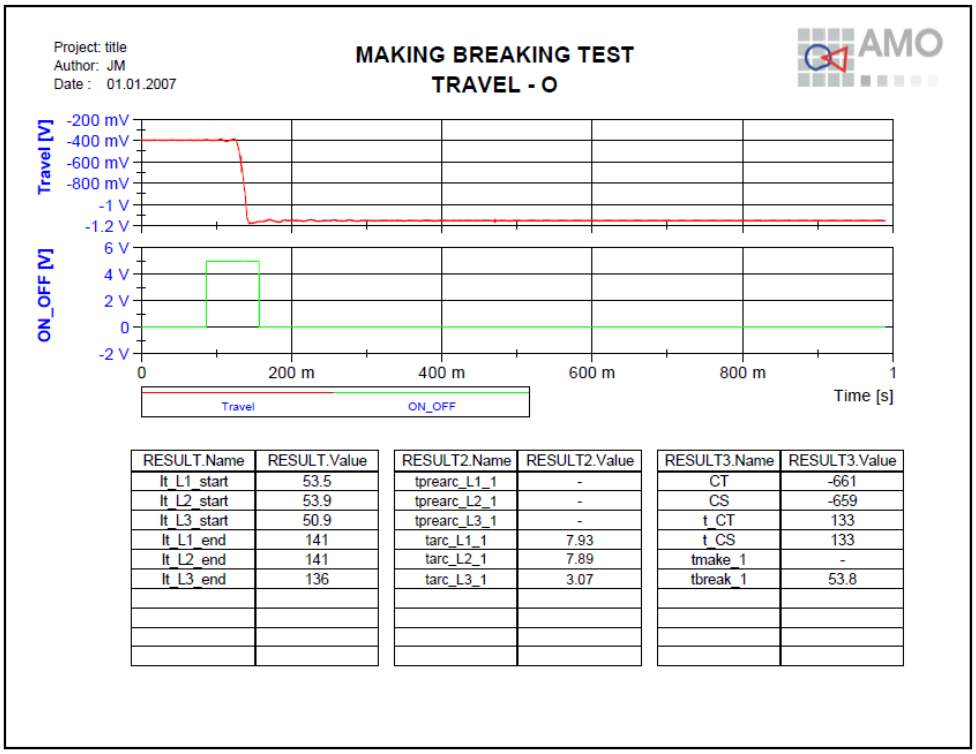


Figure 66: MBT - TRV analysis results



RESULT.Name	RESULT.Value
It_L1_start	53.5
It_L2_start	53.9
It_L3_start	50.9
It_L1_end	141
It_L2_end	141
It_L3_end	136

RESULT2.Name	RESULT2.Value
tprearc_L1_1	-
tprearc_L2_1	-
tprearc_L3_1	-
tarc_L1_1	7.93
tarc_L2_1	7.89
tarc_L3_1	3.07

RESULT3.Name	RESULT3.Value
CT	-661
CS	-659
t_CT	133
t_CS	133
tmake_1	-
tbreak_1	53.8

Figure 67: MBT - Travel O

For test report and documentation purpose the calculated results automatically will be filled into a customizable MS Word template document (Figure 68). After generation the report is automatically stored to the project and manually can be edited, if wanted. All results will be stored in internal variables and in calc.txt and result.txt (compare 3.3 “How to analyze a test”).

Please note!
The functions are available only when Microsoft Word is installed on your system!!!

Date 2010-05-05 Time 22:03:17

Making and breaking Test

Test No. MBT_1_NLT_MBT

10

O

	Applied voltage [kV$_{rms}$]	Making Current [kA]	Breaking Current [kA$_{rms}$]	Recovery voltage [kV]	Current loop (peak) [kA]	Current loop [ms]	Arcing Time [ms]	DC-Component [%]
L1		-	16.4	5.85			7.93	51.2
L2		-	17.1	5.82			7.89	-22.9
L3		-	17.0	5.68			3.07	-24.3
Average value			16.9	10.0				
Duration Current [ms]	86.8							
TRV Uc [kV]	18.5							
Time t_3 [µs]	58.9							
Time delay t_d	6.96							
Voltage of closing device [V]	-							
Voltage of opening device [V]	110							
Closing time	-							
Opening time	45.9							
Break time [ms]	53.8							

	Applied voltage [kV$_{rms}$]	Making Current [kA]	Breaking Current [kA$_{rms}$]	Recovery voltage [kV]	Current loop (peak) [kA]	Current loop [ms]	Arcing Time [ms]	DC-Component [%]
L1								
L2								
L3								
Average value								
Duration Current [ms]								
TRV Uc [kV]								
Time t_3 [µs]								
Time delay t_d								
Voltage of closing device [V]								
Voltage of opening device [V]								
Closing time								
Opening time								
Break time [ms]								

Figure 68: MBT - MS Word result table

5.5 Separate TRV Analysis

The TRV analysis (Transient Recovery Voltage) based on STL recommendations is part of the MBT analysis (chapter 5: STL – Synthetic Test / Making Breaking Test (MBT)). Additionally it is available as a separate package.

Automatic recognition of all channels for the TRV analysis is supported with the names constraints in Table 3.

Standard names	Alternatively accepted names				
UL1 UL2 UL3	US1 US2 US3	U1 U2 U3			

Table 3: Separate TRV - Names constraints

5.5.1 Manual analysis

TRV Analysis can be run manually on single or multiple phases; results will be stored in the project report folder. The calculated results will be stored in ASCII readable files, a graphic report is generated as pdf report (compare Figure 65: MBT - TRV detect and Figure 66: MBT - TRV analysis results).

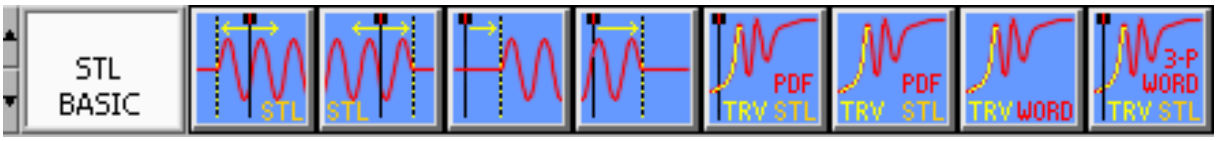
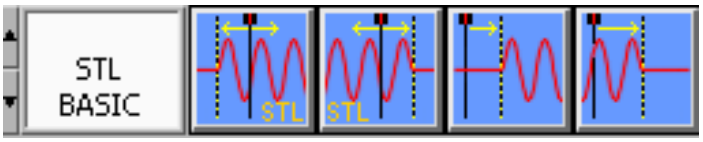


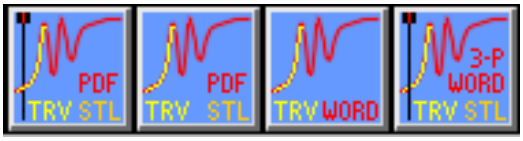
Figure 69: Manual TRV controls

To run the TRV analysis manually a set of functional buttons is available in the view menu in the ***STL BASIC*** tab. For the following functions an active cursor has to be available in the view. To activate a cursor point to the little number above the cursor; for further details refer to the detailed manual.



The four left buttons can be used to move the active cursor to a certain position. The first button analyzes the active signal and moves the active cursor right to the START of TRV position. The second button moves the active cursor to the END position.

The third button moves the cursor to the next right TRV START position of the same signal, button four moves it to the next END position



The four right buttons start specific analysis and report sequences. The first button of the right block (button no. 5) calculates the TRV parameters at the current position of the active cursor and generates a pdf report and ASCII result file.

Button no. 6 works same way but analyzes all TRV positions in the signal. It does not rely on the active cursors position.

Button no. 7 generates a MS Word report from a template file (compare 5.5.3: MS Word report)

The most right button of this menu (button no. 8) performs all steps described in this chapter automatically step by step. It uses the active cursor position and calculates the TRV parameters for up to 3 phases (if named according to channel naming conventions for TRV, compare Table 3: Separate TRV - Names constraints). PDF reports are generated per phase and ASCII readable result files are stored in the project report folder. Last step a MS Word report is generated from a template file as button no. 7 does separately (compare 5.5.3: MS Word report)

5.5.2 Analysis Result List

Each step of the manually initiated TRV analysis sends a state to the ***Result List*** window which automatically displays. The name of the function, the analyzed signal name and the result parameter is given. A full set of result parameters is shown after a TRV analysis is done.

RESULT LIST

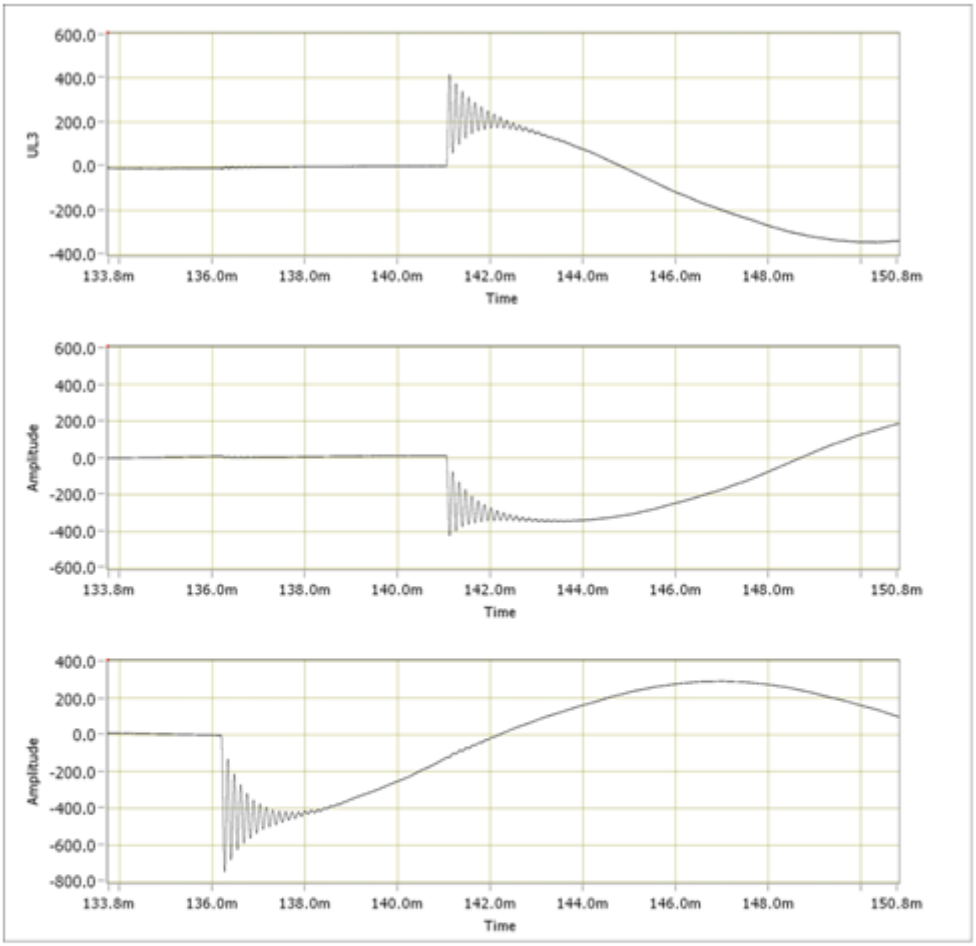
SIGNAL	NAME	VALUE	FROM [s]	TO [s]
	TRV Uc	10.344kV		
UL2	TRV START	141.061ms		
	TRV TD	8.317us		
	TRV t0	141.055ms		
	TRV t2	141.106ms		
	TRV t3	141.116ms		
	TRV UCTC	-177.240V/us		
	TRV Uc	-10.814kV		
UL3	TRV START	136.205ms		
	TRV TD	6.961us		
	TRV t0	136.201ms		
	TRV t2	136.250ms		
	TRV t3	136.260ms		
	TRV UCTC	-313.658V/us		
	TRV Uc	-18.487kV		
UL1	SINUS START	141.061m		
UL1	SINUS END	470.843m		

COPY TO CLIPBOARD | EXCEL | DIADEM | SAVE | LOAD | DELETE | UNSEL | CLEAR

5.5.3 MS Word report

The optional MS Word report can be generated from an adjustable template. By use of above described buttons the generation can be initiated. A 3-phase example report is available in shown in Figure 70: TRV - MS Word Report.

AMOtronics	TRV



TEST NUMBER: [ ]

Operation		[ ]		
Phase		A	B	C
First reference voltage u_1	kV	[ ]	[ ]	[ ]
Time t_1	µs	[ ]	[ ]	[ ]
TRV peak value u_c	kV	10.3	-10.8	-18.5
Time t_2 or t_3	µs	58.2	61.0	58.9
Time delay t_d	µs	6.97121	8.31681	6.96051
Voltage u'	kV	10.3	-10.8	-18.5
Time t'	µs	67.7	68.8	68.2

Figure 70: TRV - MS Word Report

6 STL – No-Load Test (NLT)

High power circuit breakers differ from mechanical specification and individual construction. Therefore each breaker type has specific characteristics. The No-Load test evaluates these typical characteristics and defines values; the No-Load test is a pre-test for other tests as e.g. Making-Breaking / Capacitive Load. No-Load tests use low-voltage electrical signals to accurately detect the contacts separation time. A percentage level is automatically detected during No-Load analysis to define the separation time within the mechanical travel signal. Several No-Load tests can be stored in a measurement campaign/series and are available for selection as a reference for analysis of following tests. No-Load tests are calculated on all 3 phases to check the symmetric timing of all phase breakers. One phase result is picked as a reference.

The No-Load test analysis supports open-close (OC), close-open (CO), open-close-open (OCO) and close-open-close (COC) test sequences.

6.1 Channel configuration

To perform a 3-phase No-Load test with fully automatic analysis a set of 5 signals is measured. The current is measured on all 3 phases by use of a shunt. The ON-OFF signal which is the control signal for the circuit breaker and the Travel signal is measured. The travel signal is a signal corresponding to the mechanical movement of the circuit breaker mechanics.

Automatic recognition of all channels for the No-Load analysis is supported with the names constraints given in Table 4.

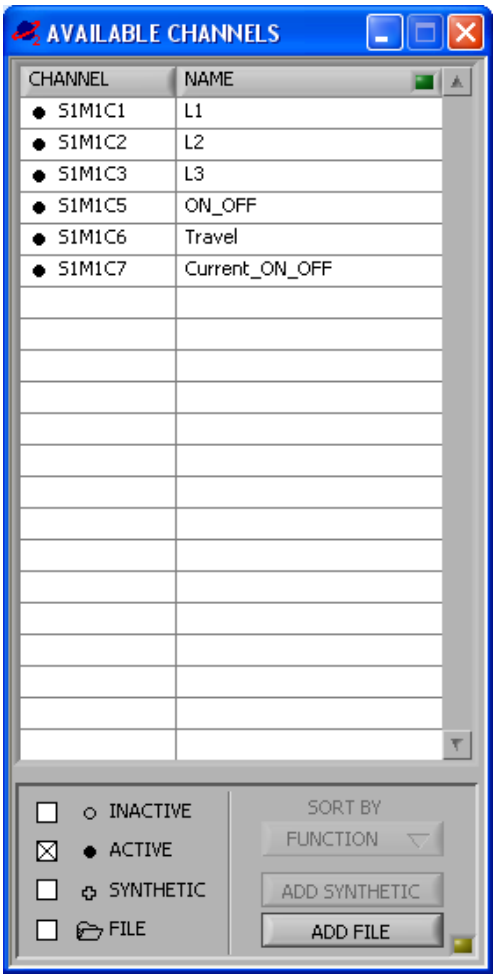


Figure 71: Available Channels – NLT

Standard names	Alternatively accepted names				
L1 L2 L3	IWL1 IWL2 IWL3				
ON_OFF	On_Off	on_off	EIN_AUS	Ein_Aus	ein_aus
TRAVEL	Travel	travel	WEGGEBER	Weggeber	

Table 4: NLT - Names constraints

6.1.1 Current channel configuration for L1, L2 & L3

To automatically recognize the channels for the No-Load test the 3 phase current channels are named according to Table 4. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 100kS
Physical factor: according to probes / dividers / shunts ()

6.1.2 ON-OFF channel configuration

The ON-OFF signal is the control signal for the circuit breaker. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 100kS

6.1.3 Travel channel configuration

The travel signal is corresponding to the mechanical movement (way) of the circuit breaker internal mechanics. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 100kS/s
Sample length: 100kS

6.1.4 Trigger configuration

Any trigger may be used to make sure the complete No-Load test sequence is acquired with a single shot. It might be applicable to define a pre-trigger and use the ON-OFF signal for trigger.

6.2 Display of No-Load test

The acquired data within the No-Load test can be displayed in a view. An example how to display is shown in Figure 72. Any or no display is ok; the fully automatic analysis does not require any display or manual cursor definitions. The displayed cursors show the results of the OCO sequence already.

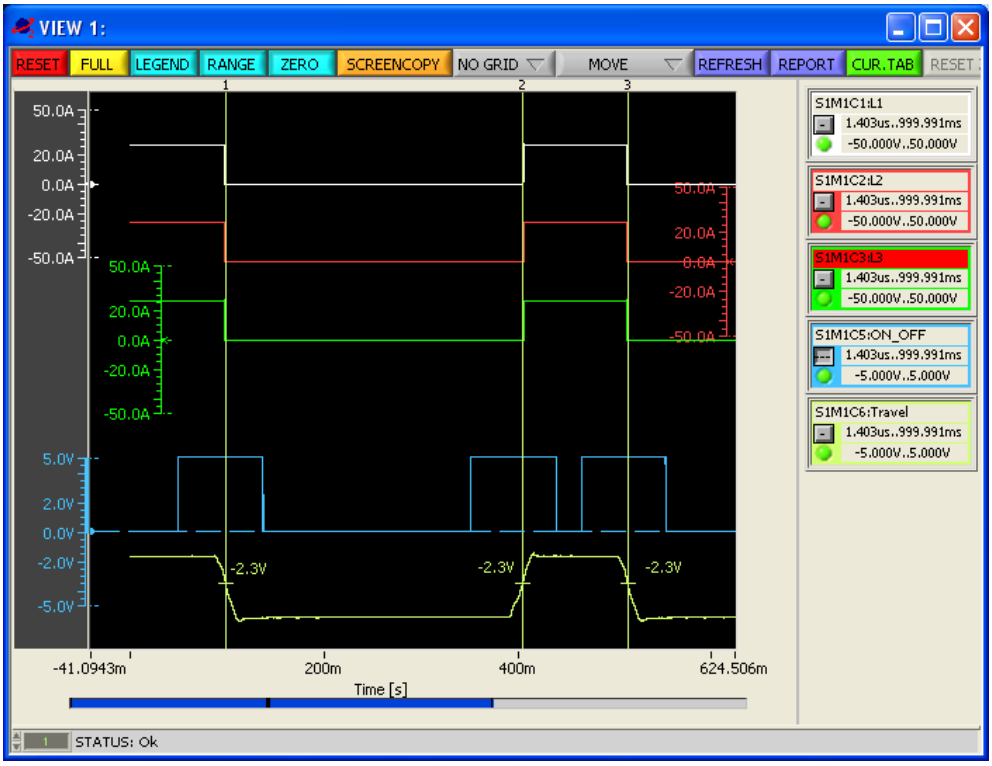
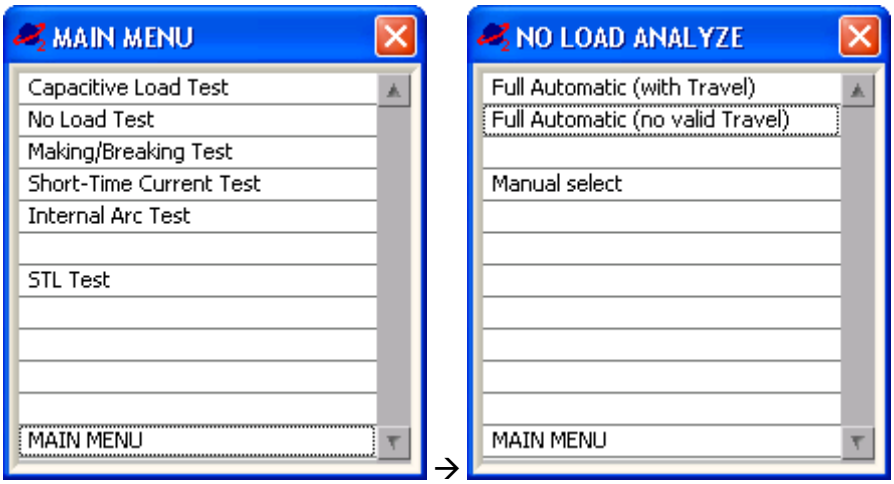


Figure 72: No-Load test overview

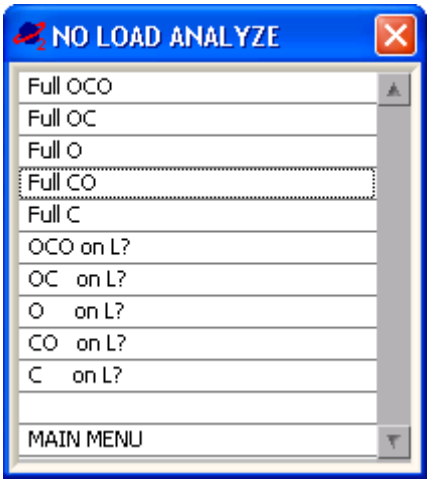
6.3 Analysis of No-Load tests

After the acquisition of No-Load test signals is finished the project is stored and analysis can be started. Therefore point to the ***ANALYSIS*** button to open the analysis ***MAIN MENU***. Select ***No Load Test*** from the menu or by use of the case activated ***NLT*** button and further select the analysis to run.

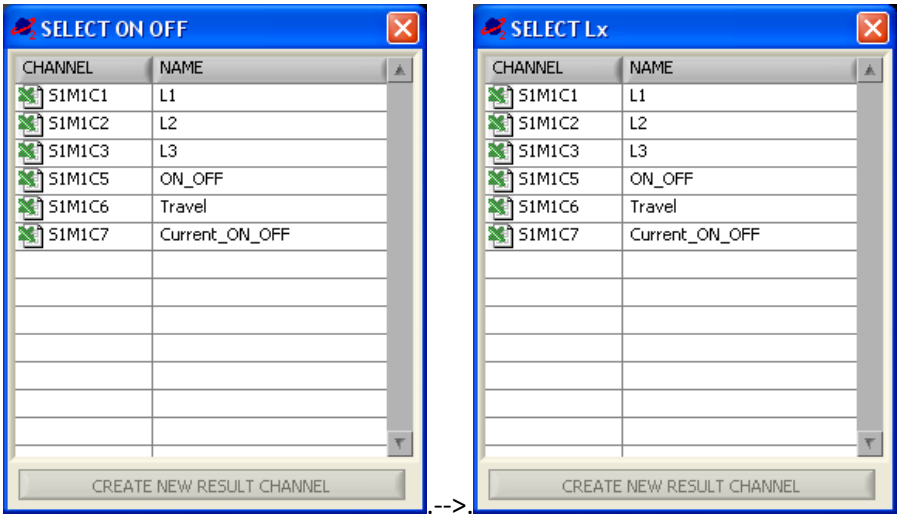


In case a valid Travel signal is not available for analysis ***Full Automatic (no valid Travel)*** is selected. The L1, L2, L3 and ON-OFF signal will be used for calculation then. Due to missing mechanical feedback from the breaker the result will be less accurate without Travel signal.

Finally it can be manually specified which type of analysis to run. Therefore select ***Manual select*** from the above menu to open the lower ***NO LOAD ANALYZE*** menu.



Any typical kind of test can be picked from the list to define the type of test. The top 5 selections starting with “Full” do not require further input if channel naming is valid. Selecting one of the lower 5 entries the ON-OFF signal and the phase is specified manually. Any channel name can be setup in the project when specified by user. The software automatically requests the missing information to be given.



The analysis runs automatically with the above defined names constraints and calculates the opening and closing time for all 3 phases. For each phase a report sheet is generated containing the timing results. The example shows a typical open-close-open (OCO) sequence. (Compare Figure 73 to Figure 76)

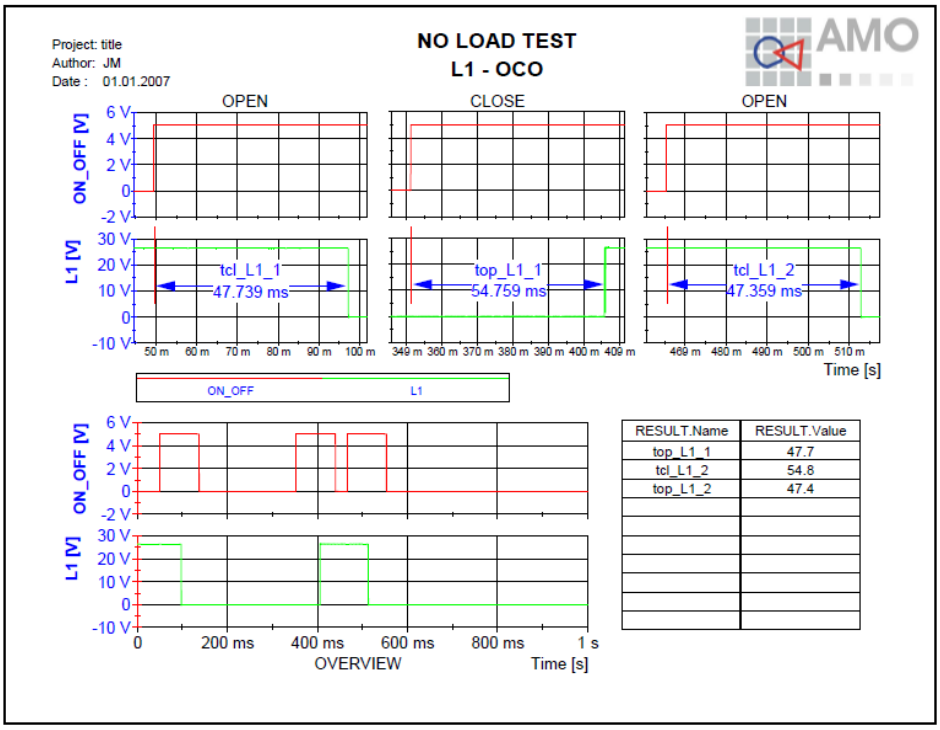


Figure 73: No Load Test - L1 OCO

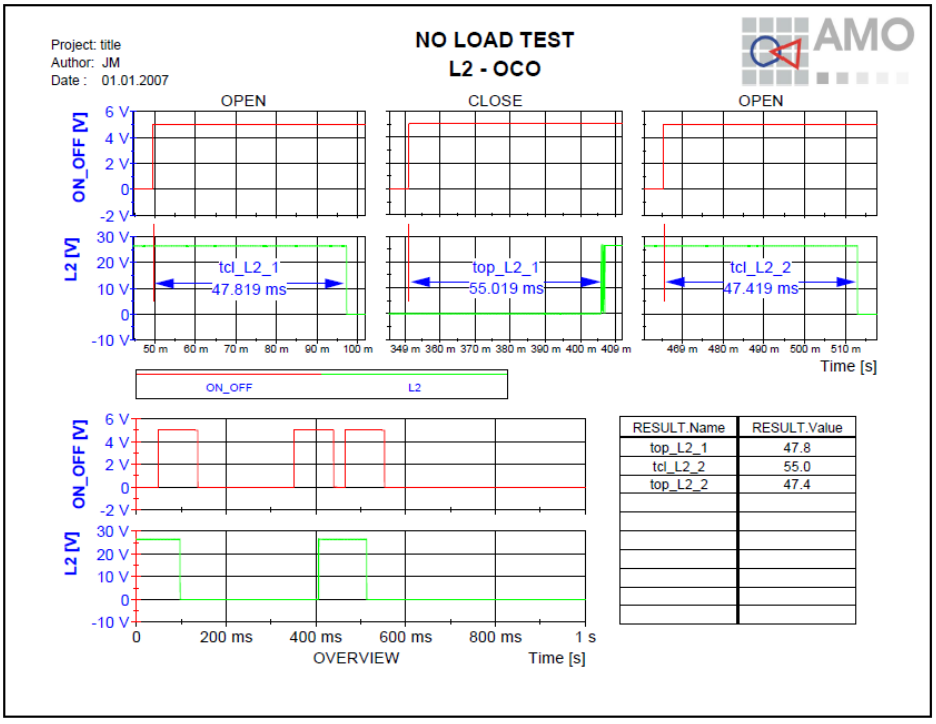


Figure 74: No Load Test - L2 OCO

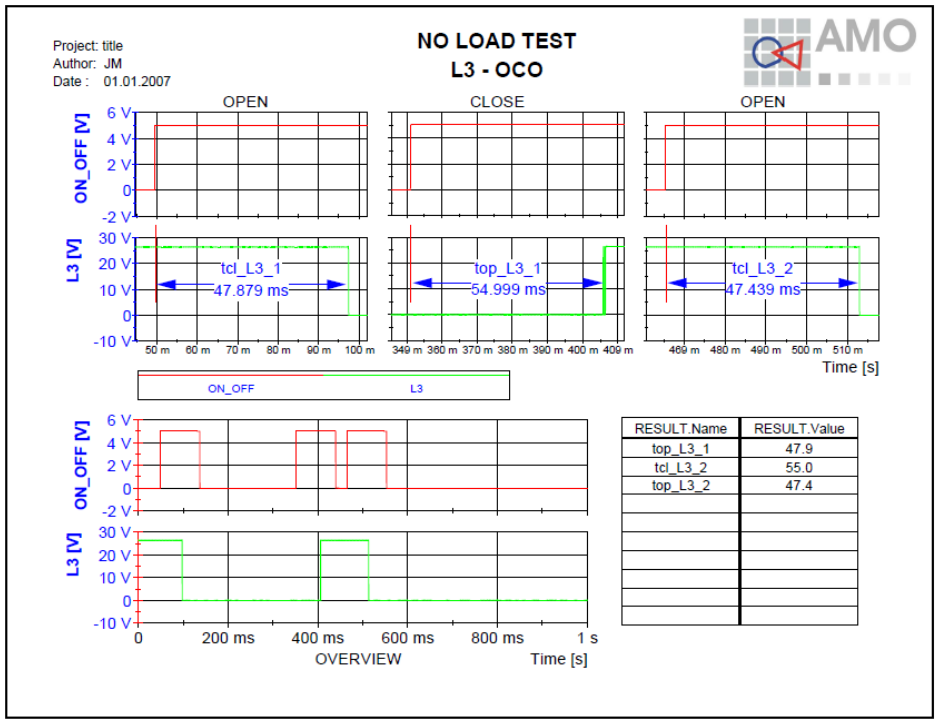


Figure 75: No Load Test - L3 OCO

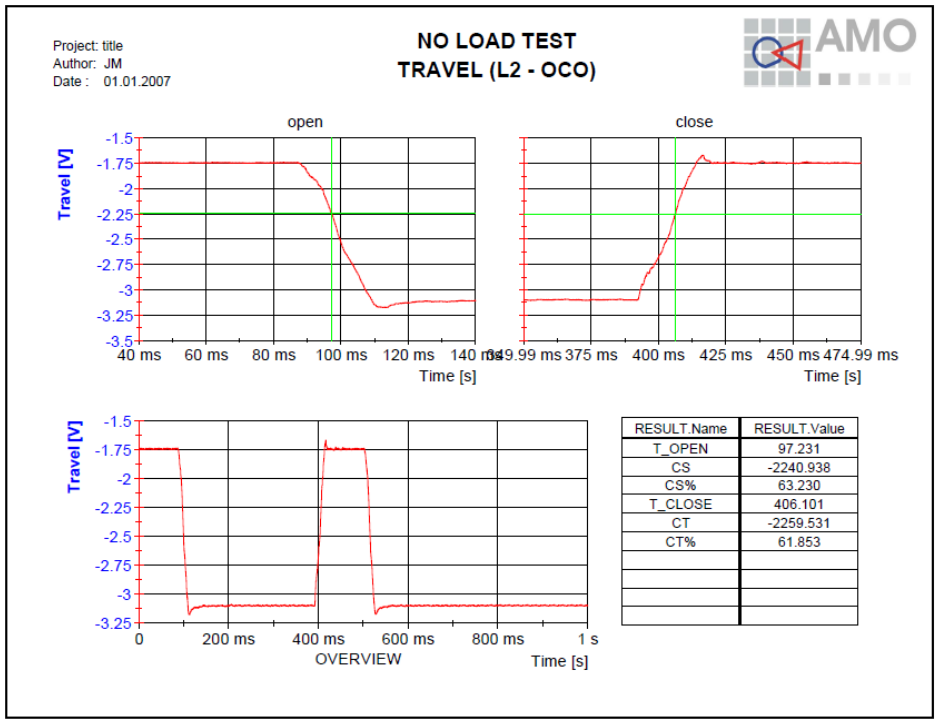


Figure 76: No Load Test - OC level definition (L2 OCO)

For test report and documentation purpose the calculated results automatically will be filled into a customizable MS Word template document (Figure 77). After generation the report is automatically stored to the project and manually can be edited, if wanted. For further use of the No-Load results as a reference the calculated values are stored in internal variables.

Please note!

The functions are available only when Microsoft Word is installed on your system!!!

Test Results
No-Load Operations

Test performed: No-load operations
Date of test: 19th January 2010
Condition of test object before test: Factory new.
Gas pressure (abs. rel. to 20 °C): -

Test No.	CLT_1 NLT_CO		3					
Operating sequence			O-0.3s-CO		O-0.3s-CO		O-0.3s-CO	
C-Operation	Voltage of closing device	V	-	242				
	Closing time L1	ms	-	54.8				
	L2	ms	-	55.0				
	L3	ms	-	55.0				
O-Operation	Voltage of opening device	V	242	242				
	Opening time L1	ms	47.7	47.4				
	L2	ms	47.8	47.4				
	L3	ms	47.9	47.4				

Legend: -
Remarks:

Figure 77: NLT - MS Word result table

No-Load tests should be repeated for each type of circuit breaker to evaluate the mechanical parameters.

7 STL – Short Time Current Test (STC)

The short-time current rating of a circuit breaker relates to the performance of the circuit breaker over a specific current range for a period of time. It defines the ability of the breaker to remain closed for a time interval under high fault conditions. It is specified by both current magnitude and time magnitude. The short-time rating is used by the engineer to determine the ability of the circuit breaker to protect itself and other devices.

7.1 Channel configuration

To perform a 3-phase Short Time Current Test with fully automatic analysis a set of 3 signals is measured. The current is measured on all 3 phases by use of a shunt.

For documentation purpose the voltages and pressures etc. can be measured as well.

Automatic recognition of all channels for the STC analysis is supported with the names constraints defined in Table 5.

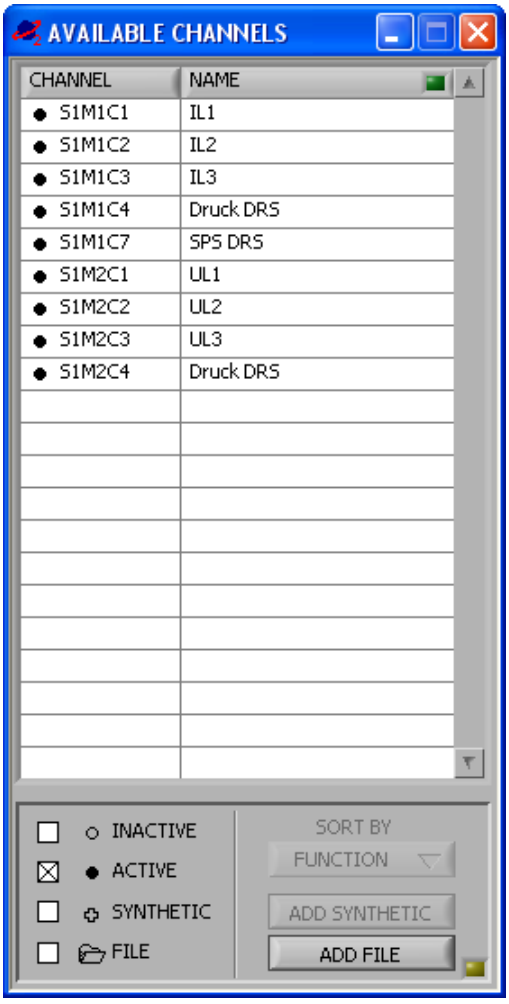


Figure 78: Available Channels – STC

Standard names	Alternatively accepted names				
IL1 IL2 IL3					

Table 5: STC - Names constraints

7.1.1 Channel configuration for IL1, IL2, IL3

To automatically recognize the channels for the STC Test the 3 phase current channels are named according to Table 5. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 1MS/s
Sample length: 400kS
Physical factor: according to probes / dividers / shunts ()
Physical unit: A

7.1.2 Trigger configuration

Any trigger may be used to make sure the complete sequence is acquired with a single shot. It might be applicable to define a pre-trigger and / or use separate trigger signals.

7.2 Display of Short Time Current Test (STC)

The acquired data within the Short Time Current Test can be displayed in single or multiple views. An example how to display is shown in Figure 79 to Figure 80. Any or no display is ok; the fully automatic analysis does not require any display.

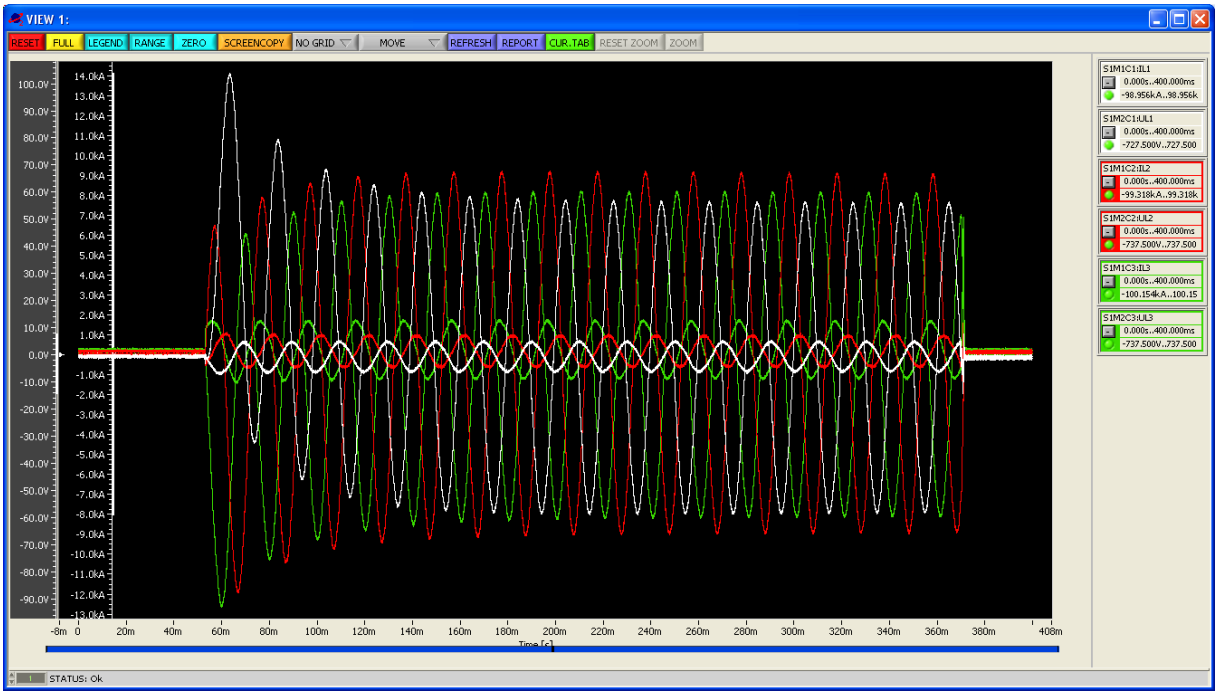


Figure 79: STC - View display

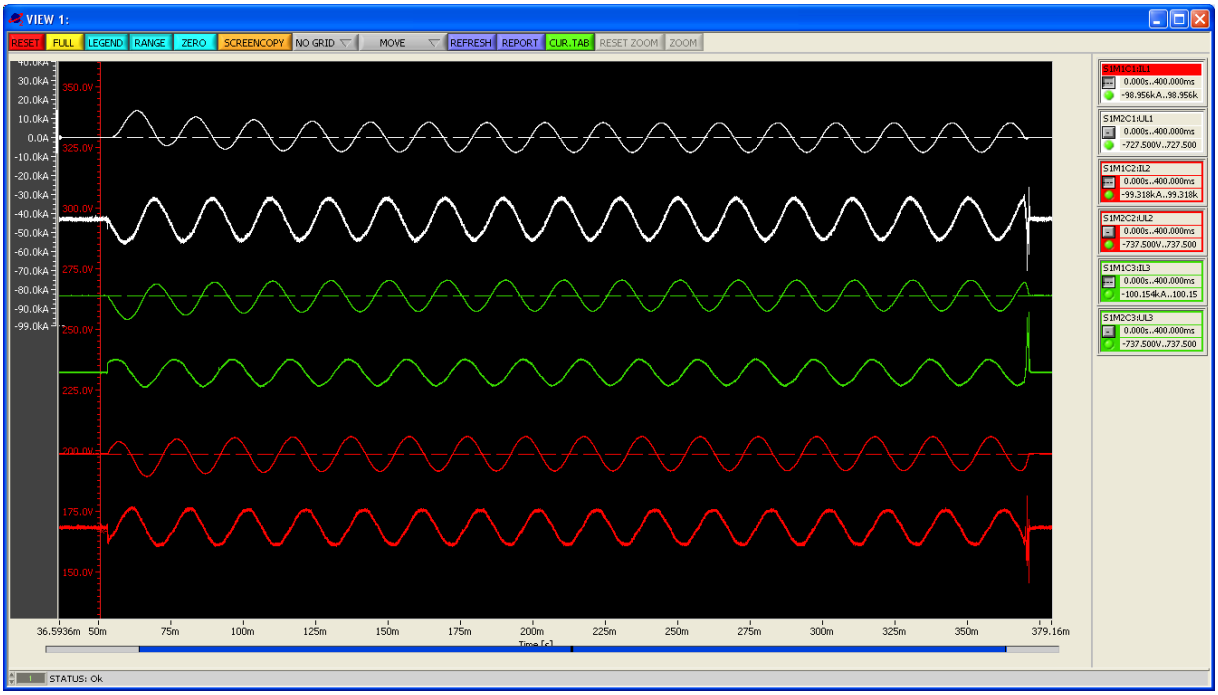
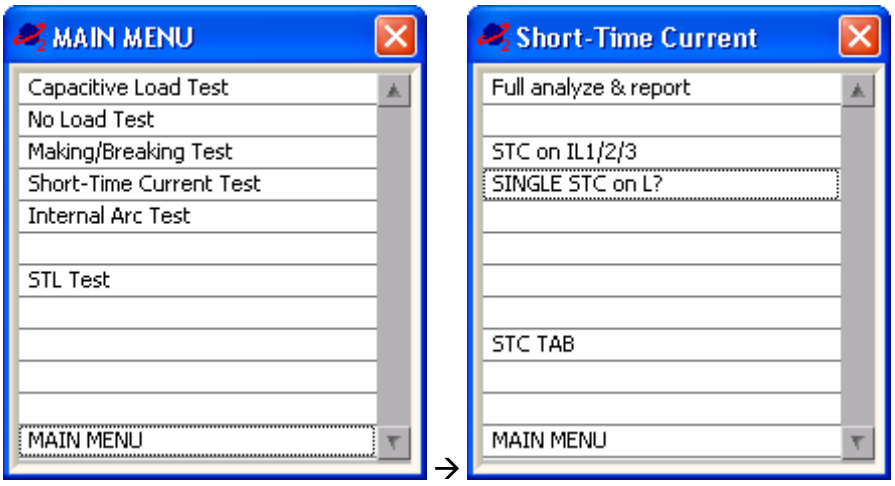


Figure 80: STC - View display

7.3 Automatic Analysis of Short Time Current Tests

After the acquisition of Short Time Current Test signals is finished the project is stored and analysis can be started. Therefore point to the ***ANALYSIS*** button to open the analysis ***MAIN MENU***. Select ***Short Time Current Test*** from the menu or use the test sensitive ***STC*** button (below button 11) and further select the analysis to run.



For fully automatic analysis the first entry ***Full analyze & report*** is selected. If named corresponding to the above given conventions the channels automatically will be recognized for calculation.

7.4 Manual Analysis of Short Time Current Tests

Partial analysis for the STC can be done separately by pointing to the individual entries of the main menu (Figure 81). The analysis will run in DIAdem and generate the according report, which again will be stored in the project management. It can be selected from STC Test on all 3 current phases or on single phase.

To select pick one off ***STC on IL1/2/3*** or ***SINGLE STC on L?*** to either perform a 3 phase or single phase current analysis.

For the single phase STC analysis a selection window ***SELECT ILx*** comes up to request the current channel to be analyzed.

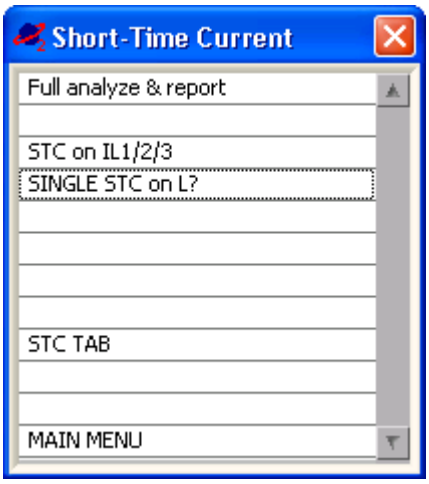
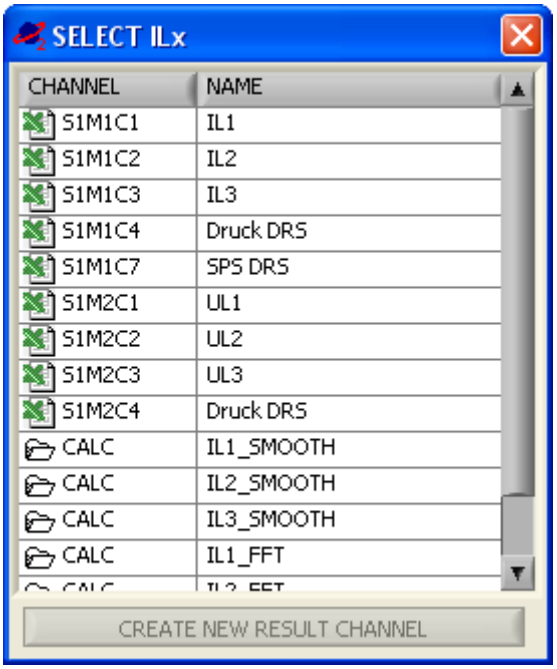


Figure 81: STC - Main menu



Selecting STC TAB finally generates a MS Word report from the predefined template.

The analysis runs automatically with the above defined names constraints and calculates the parameters for all 3 phases. For each phase an overview report and a detailed report is generated containing the results in graphic und tabular form. The example shows a typical test. The figures Figure 82 and Figure 83 exemplary show the phase 1 results.

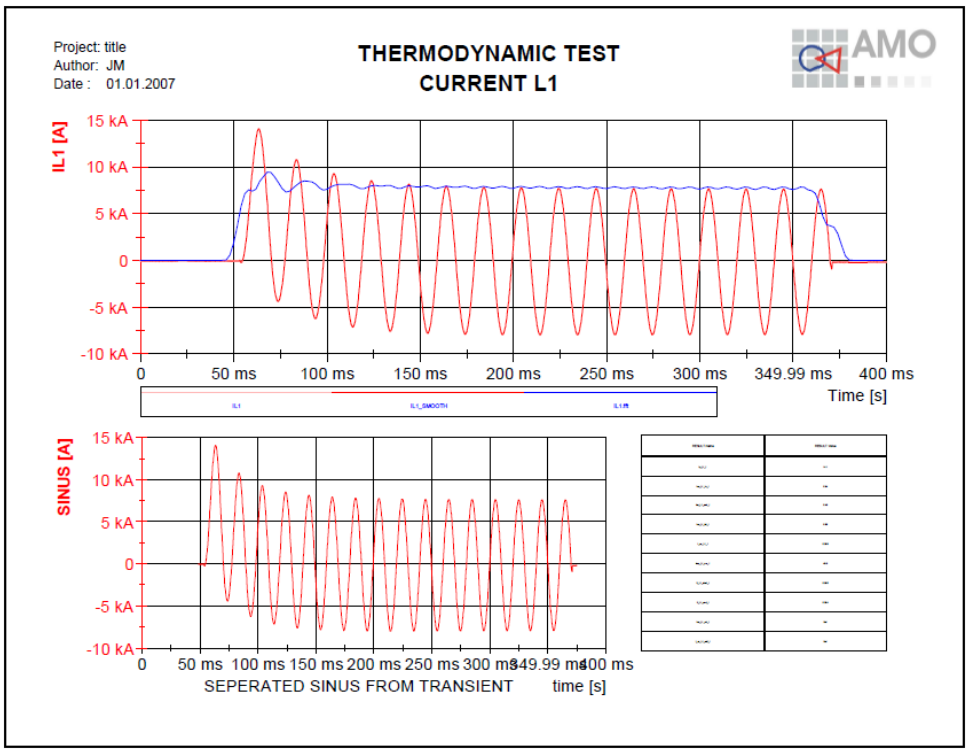


Figure 82: STC - Current L1 overview

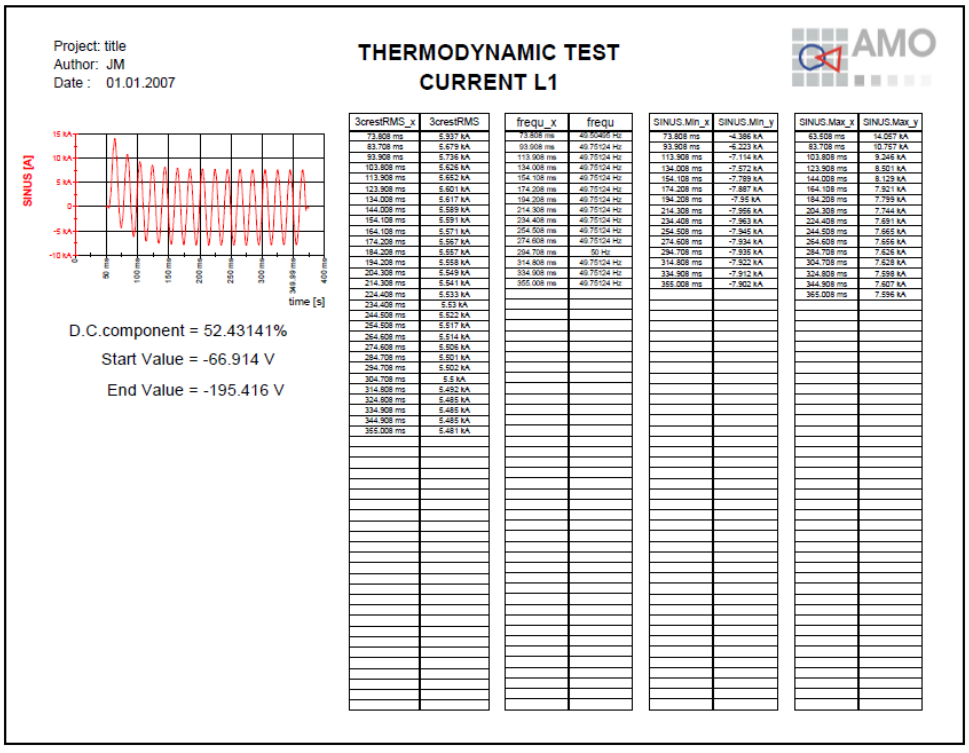


Figure 83: STC - Current L1 details

For test report and documentation purpose the calculated results automatically will be filled into a customizable MS Word template document (Figure 84). After generation the report is automatically stored to the project and manually can be edited, if wanted. All results will be stored in internal variables and in calc.txt and result.txt (compare 3.3 “How to analyze a test”).

Please note!

The functions are available only when Microsoft Word is installed on your system!!!

Test Results
Short-Time Withstand Current and Peak Withstand Current Tests

Test performed: Short-time withstand current and peak withstand current tests
Date of test: 05/05/2010 21:11
Condition of test object before test: Factory new.
Test arrangement: Direct test circuit, vacuum circuit-breaker in metal-enclosed, air-insulated switchgear.
Connections to test object: Infeed via copper bars to the busbars of the metal-enclosed, air-insulated switchgear. Short-circuited at the cable-terminals of the switchgear via copper bar, short-circuit point and switchgear earthed via cable.
Gas pressure (abs. rel. to 20 °C): -

Test No.				STC_1_NLT_STC					
Peak withstand current		L1	kA	14.1					
		L2	kA	11.9					
		L3	kA	12.8					
Short-circuit current	First cycle	L1	kA	5.94					
		L2	kA	6.75					
		L3	kA	6.25					
	Last cycle	L1	kA	5.49					
		L2	kA	6.37					
		L3	kA	5.78					
	Equivalent current	L1	kA	5.56					
		L2	kA	6.39					
		L3	kA	5.84					
	Average value		kA	5.93					
	Duration of short-circuit		s	0.3100					
Short-time withstand current		L1	kA	tbd					
		L2	kA	tbd					
		L3	kA	tbd					
	Average value		kA	0.000					
	Related to rated duration of short-circuit		s	tbd					
Duration of short-circuit			s	0.0000					
Related to rated short-time withstand current			kA	0.000					
Emission of flame/gas/oil				no	no	no	-	-	-
Test result (P/N)				P	P	P	-	-	-

Resistance of the main circuit

	Before test	L1	µΩ				-	-	-
		L2	µΩ				-	-	-
		L3	µΩ				-	-	-
	After test	L1	µΩ				-	-	-
		L2	µΩ				-	-	-
		L3	µΩ				-	-	-

Legend: P: Passed in terms of the applied standard N: Not passed in terms of the applied standard

Remarks:
99999 / 01: Current calibration
99999 / 02: No-load operation
99999 / 03 and 04: Tests with reduced values

Condition of test object after test: No visible or functional change or damage. The change of the resistance values are within the limits of the applied test specifications.

Figure 84: STC - MS Word result table

8 STL – Lightning Arc Test / Internal Arc Test (LAT / IAT)

Internal arc tests are intended to verify the effectiveness of a switchgear design in protecting personnel in case of an internal arc. Internal faults inside metal-enclosed switchgear can occur in a number of locations and can cause various physical phenomena. The arc energy resulting from an arc in any insulating medium within the enclosure will cause an internal overpressure and local overheating which will result in mechanical and thermal stressing of the equipment.

With the IEC 62271-200 new methods and criteria for testing metal/insulation enclosed switchgear under conditions of an internal arc have been defined.

The STL-analysis package fulfills the criteria of the above mentioned standard. The workflow of a typical analysis is described on an exemplary measurement project.

8.1 Channel configuration

To perform a 3-phase Internal Arc Test with fully automatic analysis a set of 3 signals is measured. The current is measured on all 3 phases by use of a shunt.

For documentation purpose the voltages can be measured as well.

Automatic recognition of all channels for the IAT / LAT analysis is supported with the names constraints defined in Table 6.

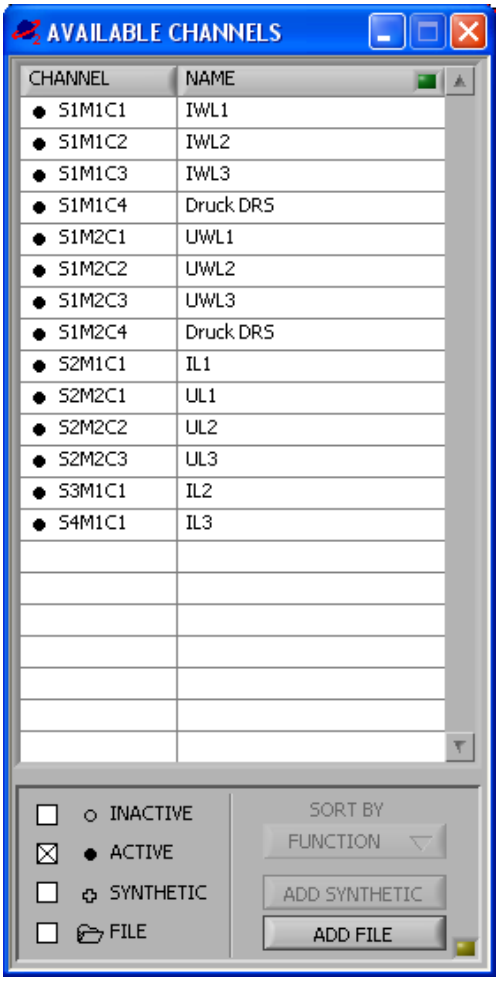


Figure 85: Available Channels – LAT / IAT

Standard names	Alternatively accepted names				
IL1 IL2 IL3					

Table 6: IAT / LAT - Names constraints

8.1.1 Channel configuration for IL1, IL2, IL3

To automatically recognize the channels for the IAT the 3 phase current channels are named according to Table 6. The following values are recommendations only to allow precise results, yet limiting the needed storage to a minimum.

Sample rate: 1MS/s
Sample length: 1.2MS
Physical factor: according to probes / dividers / shunts ()
Physical unit: A

8.1.2 Trigger configuration

Any trigger may be used to make sure the complete IAT sequence is acquired with a single shot. It might be applicable to define a pre-trigger and / or use separate trigger signals.

8.2 Display of Internal Arc Test (IAT / LAT)

The acquired data within the Internal Arc Test can be displayed in single or multiple views. An example how to display is shown in Figure 86 to Figure 87. Any or no display is ok; the fully automatic analysis does not require any display.

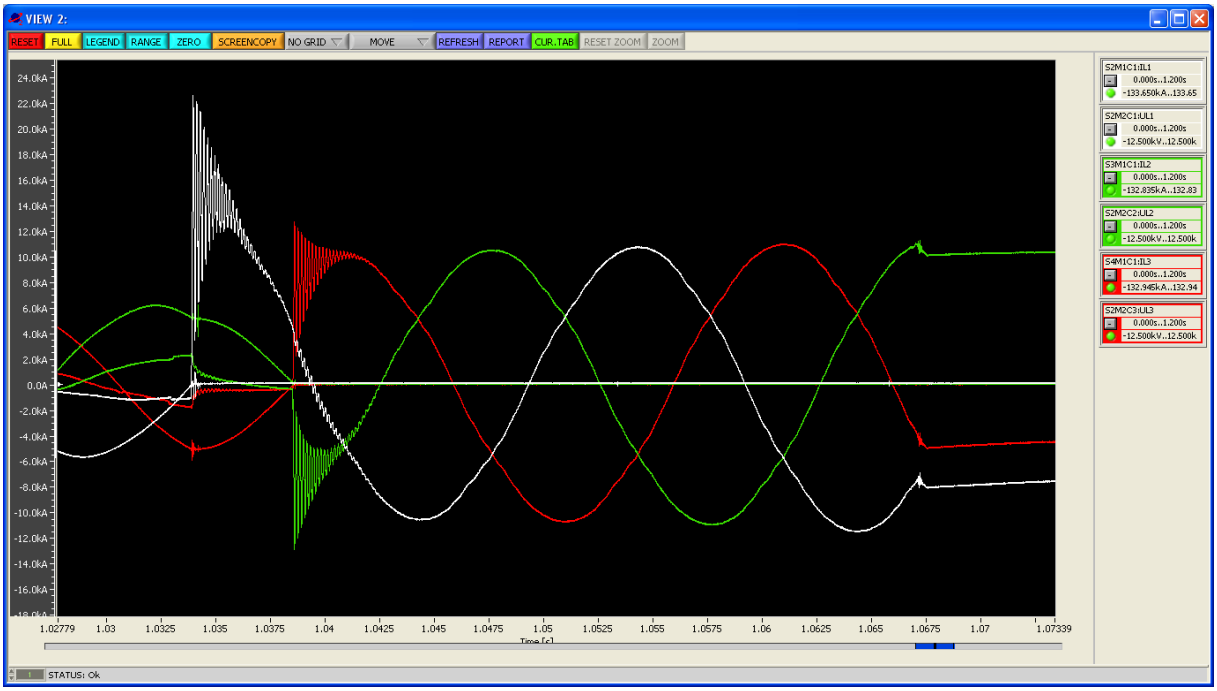


Figure 86: LAT View display

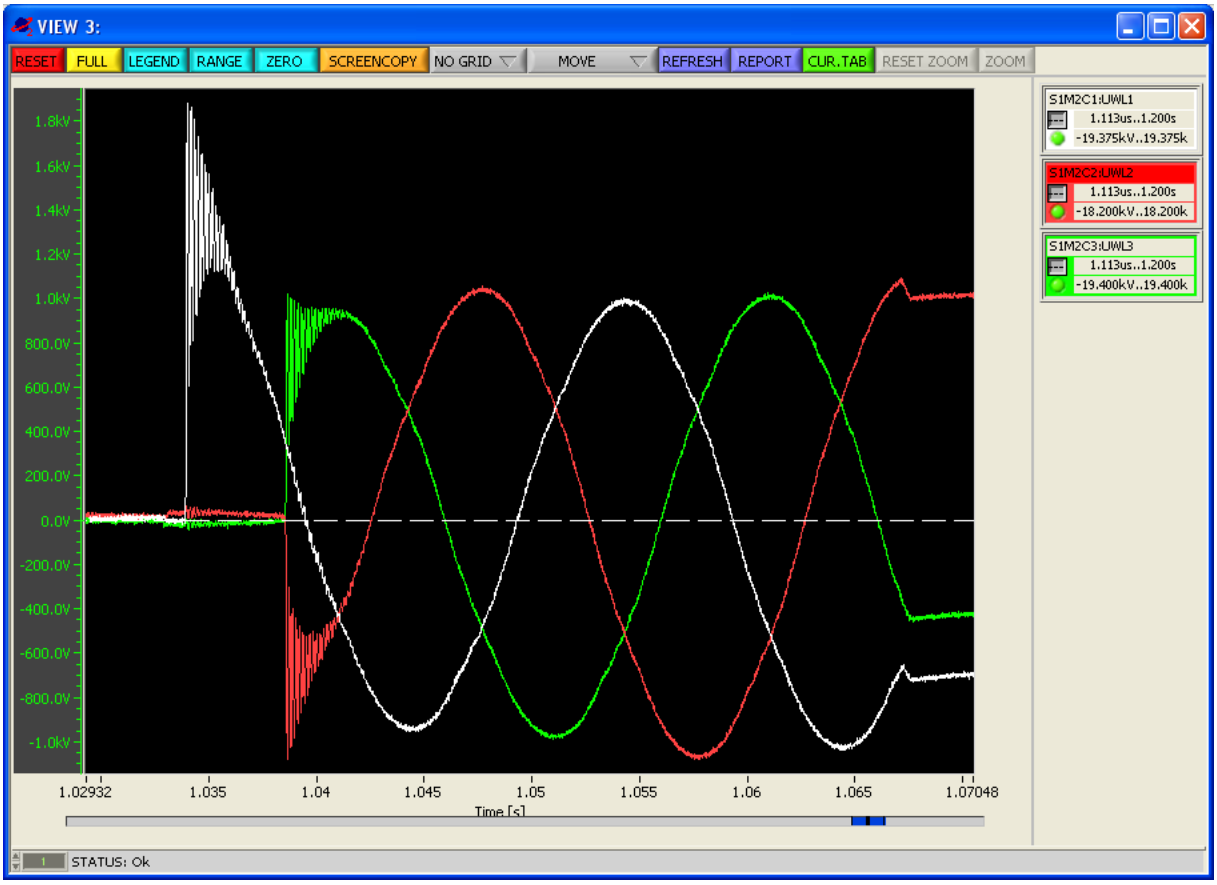
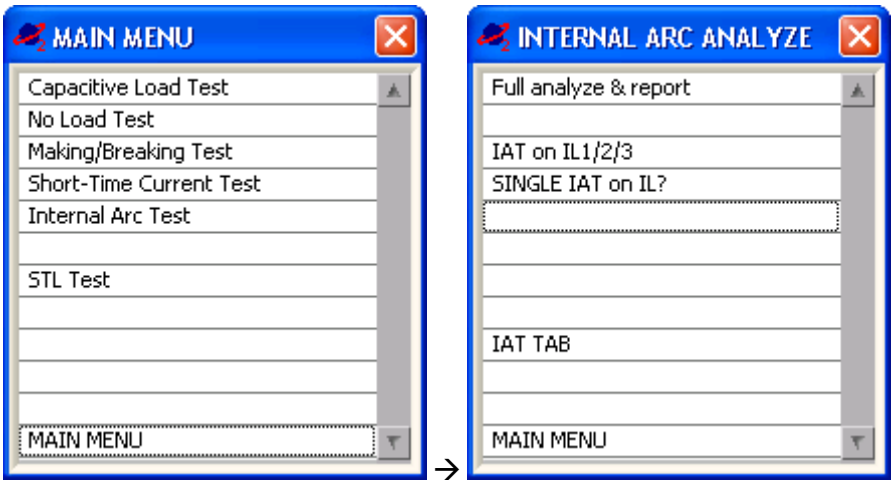


Figure 87: LAT View display

8.3 Automatic Analysis of Internal Arc Tests

After the acquisition of Lightning Arc Test signals is finished the project is stored and analysis can be started. Therefore point to the ***ANALYSIS*** button to open the analysis ***MAIN MENU***. Select ***Internal Arc Test*** from the menu or use the test sensitive ***LAT*** button (below button 11) and further select the analysis to run.



For fully automatic analysis the first entry ***Full analyze & report*** is selected. If named corresponding to the above given conventions the channels automatically will be recognized for calculation.

8.4 Manual Analysis of Internal Arc Tests

Partial analysis for the IAT / LAT can be done separately by pointing to the individual entry of the main menu (Figure 88). The analysis will run in DIAdem and generate the according report, which again will be stored in the project management. It can be selected from IAT / LAT on all 3 current phases or on single phase.

To select pick one off ***IAT on IL1/2/3*** or ***SINGLE IAT on IL?*** to either perform a 3 phase or single phase current analysis.

For the single phase IAT analysis a selection window ***SELECT ILx*** comes up to request the current channel to be analyzed.

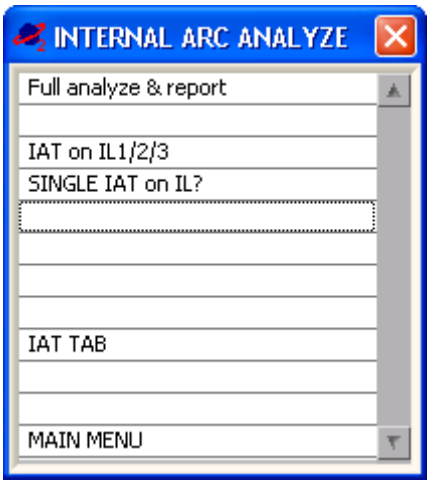
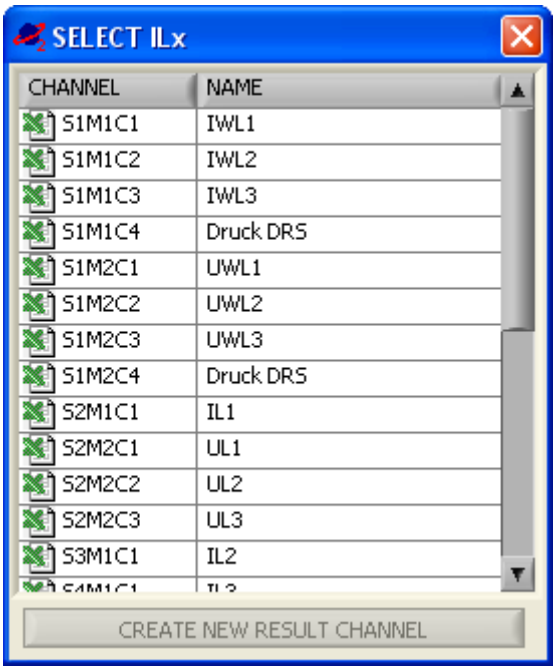
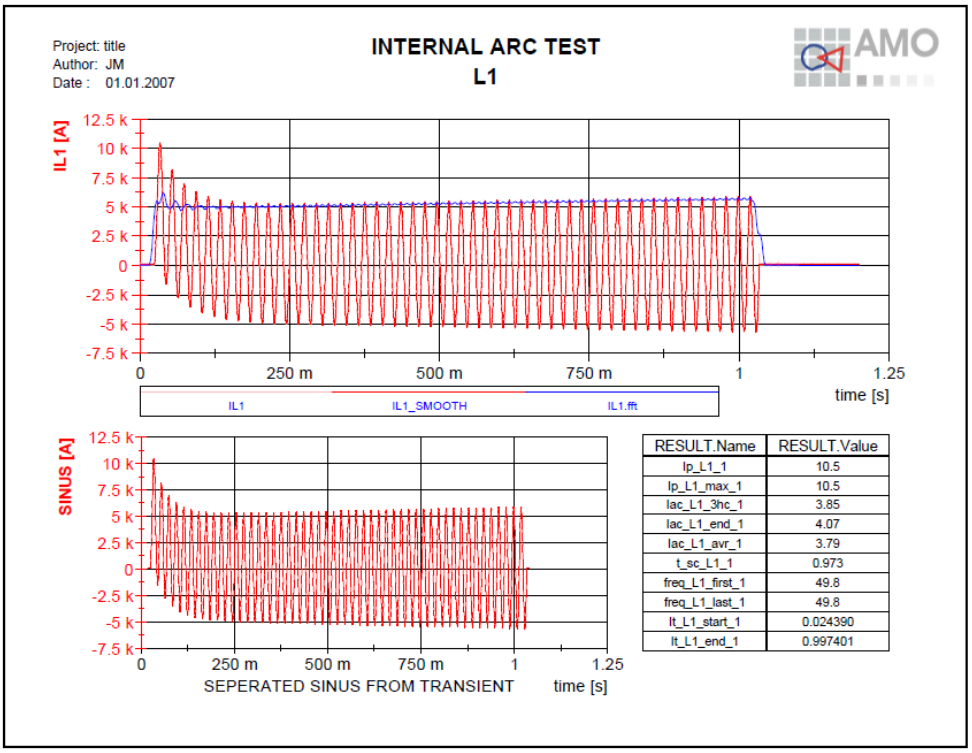


Figure 88: IAT / LAT main menu



Selecting IAT TAB finally generates a MS Word report from the predefined template.

The analysis runs automatically with the above defined names constraints and calculates the parameters for all 3 phases. For each phase an overview report and a detailed report is generated containing the results in graphic und tabular form. The example shows a typical test. The figures Figure 89 to Figure 90 exemplary show the phase 1 results.



RESULT.Name	RESULT.Value
Ip_L1_1	10.5
Ip_L1_max_1	10.5
Iac_L1_3hc_1	3.85
Iac_L1_end_1	4.07
Iac_L1_avr_1	3.79
t_sc_L1_1	0.973
freq_L1_first_1	49.8
freq_L1_last_1	49.8
It_L1_start_1	0.024390
It_L1_end_1	0.997401

Figure 89: IAT / LAT - Current L1 overview

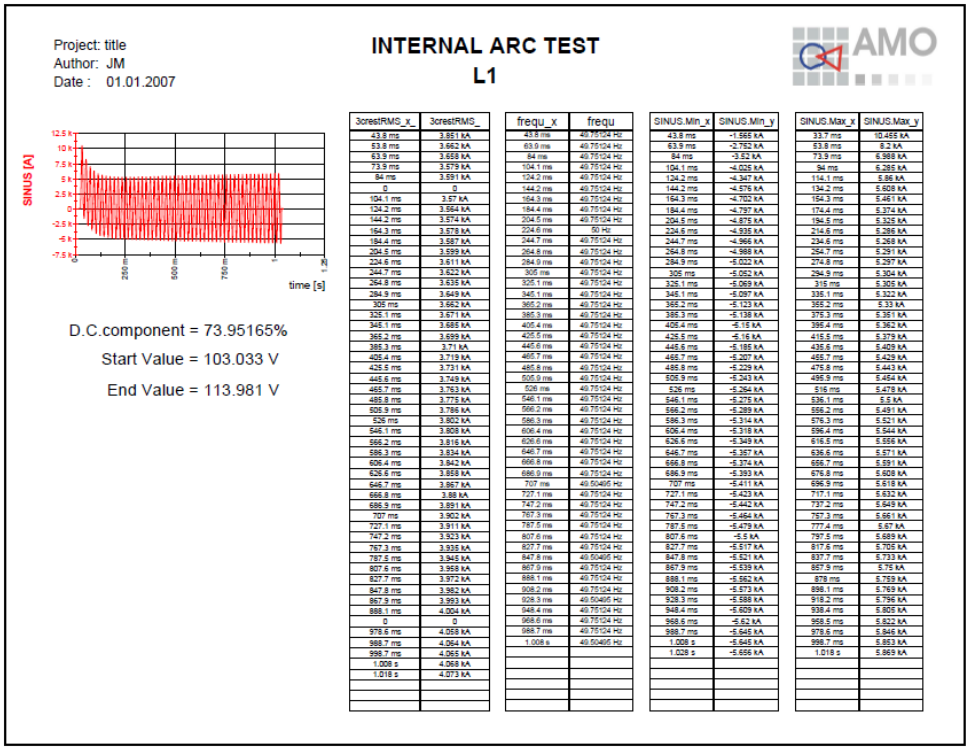


Figure 90: IAT / LAT - Current L1 details

For test report and documentation purpose the calculated results automatically will be filled into a customizable MS Word template document (Figure 91). After generation the report is automatically stored to the project and manually can be edited, if wanted. All results will be stored in internal variables and in calc.txt and result.txt (compare 3.3 “How to analyze a test”).

Please note!
The functions are available only when Microsoft Word is installed on your system!!!

Testing under Conditions of Arcing due to an Internal Fault

Test performed: Internal arcing test

Date of test: 05/05/2010 19:42

Condition of test object: Factory new. [1)]

Test arrangement: See sheet 3

Connections to test object: Infeed three-phase via cables to the cable terminals of the right-hand side infeed panel.

Arc initiation: Three-phase by means of a copper wire Ø 0.5 mm across the busbars connecting the circuit-breaker to the cable compartment bushings in the circuit-breaker compartment.

Test No.:		Applied voltage (phase to phase):	Test frequency:	Test duration:
IAT_1 - 1		kV	50.0 Hz	0.977 s
Test current				
	Peak current	AC component: During the first three half-cycles	AC component: At the end of the test	Integral
	kA	kA	kA	kA
L1	10.5	3.85	4.07	3.79
L2	8.59	4.10	4.29	3.97
L3	7.93	4.02	4.24	3.90
			Average value	3.88
Equivalent short-circuit duration	0.379 s	related to a short-circuit current of		10.0 kA.

Remarks:

Test results: The test object passed the test performed in accordance with the applied test specifications.

Achieved class of the circuit-breaker compartment: IAC AFL 25kA 1s

Figure 91: IAT / LAT - MS Word result table

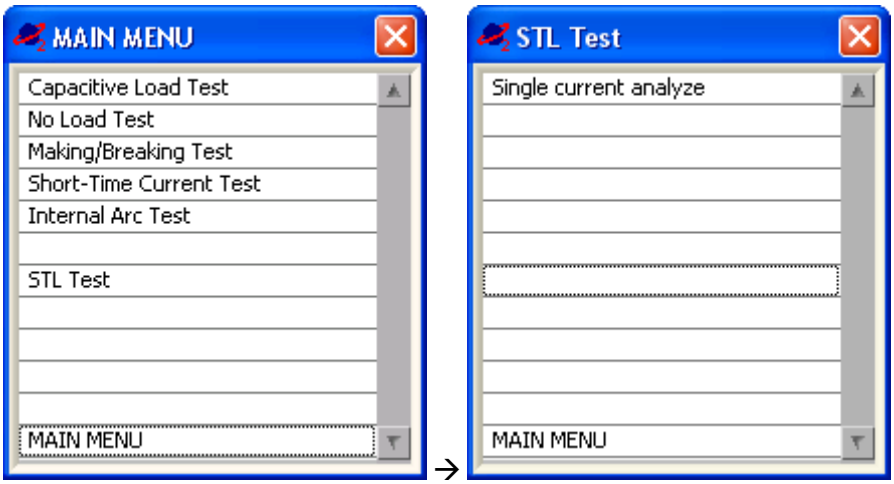
9 STL Test

The STL Test procedure is available for single phase analysis. From a single signal the sinus part is detected and analyzed. The valid range is shown as a blue curve in Figure 93. The parameters to be evaluated are 3crestRMS, frequency and min / max values per period.

The STL-analysis package fulfills the criteria of IEC 62271-200 standard.

9.1 Single current analysis

Single analysis for the can be started manually by pointing to the ***STL Test*** entry in the main analysis menu and select ***Single current analyze*** from the ***STL Test*** menu.. The analysis will run in DIAdem and generate the according report, which again will be stored in the project management.



For the single phase analysis a selection window ***SELECT ILx*** comes up to request the current channel to be analyzed.

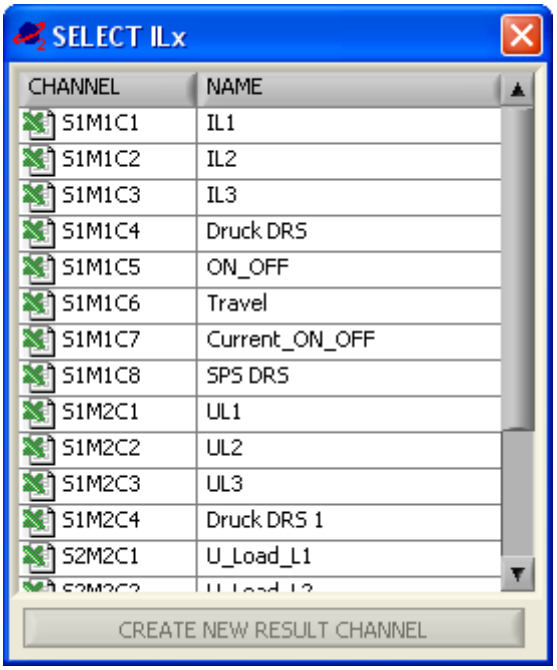


Figure 92: STL Test - Select current channel

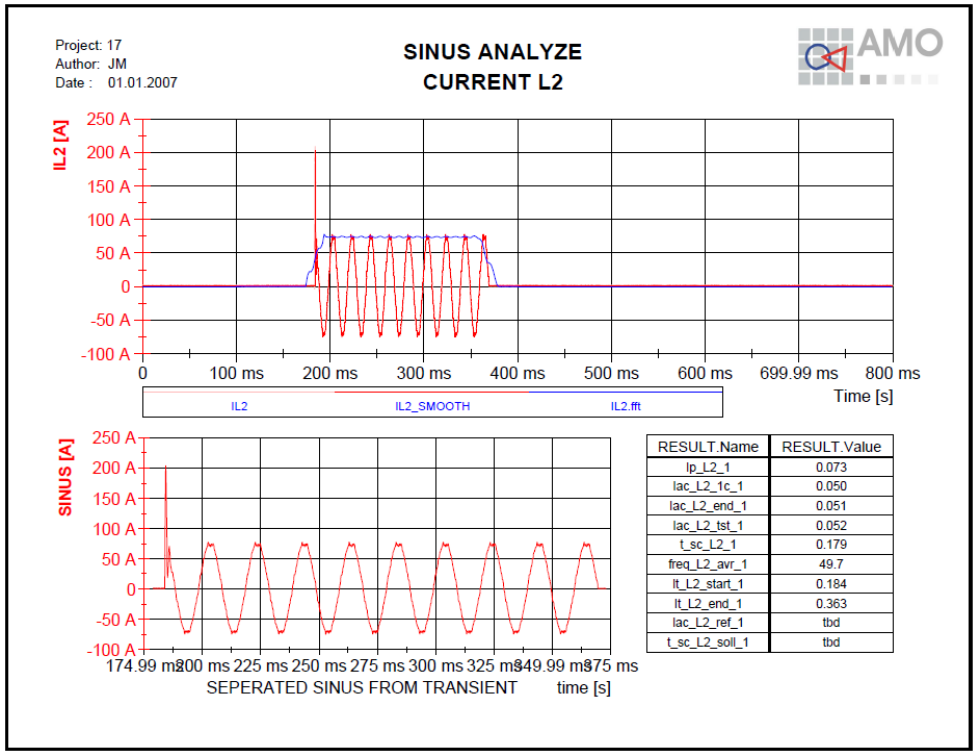


Figure 93: STL Test - Current L2 overview

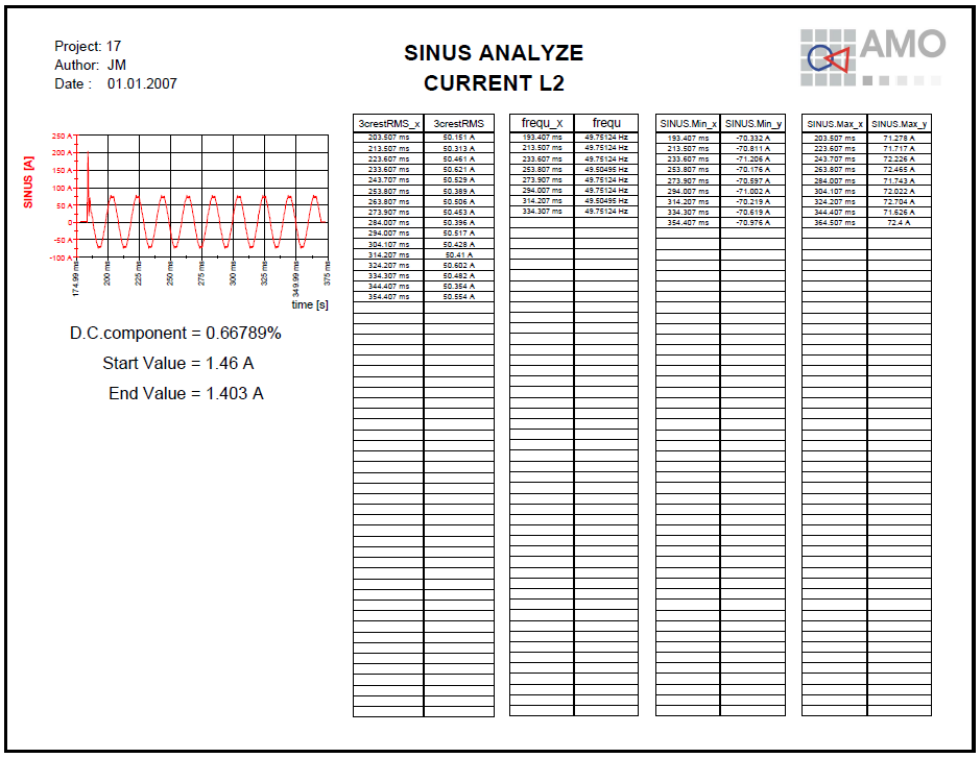


Figure 94: STL Test - Current L2 details

Multiple phases can be analyzed one after the other. Each run generates an individual report.

Analysis of phase IL1 additionally generates a new summarizing report collecting all individual reports of following analysis results until next phase IL1 analysis is done; further phases automatically will be appended to the summarizing report. The next IL1 analysis initializes a new summarizing report.

10 Troubleshooting

In case of trouble with the analysis packages please contact the AMOtronics support team.

11 Please remember

The MS Word functions for table generation are available only when Microsoft Word is installed on your system!!!

First time DIAdem is used the system will need some time to start DIAdem. If DIAdem already runs the analysis can start right away.

Report templates can be adjusted to customer needs. Logos or any other detail can be defined per customer. Compare chapter 3.4 on page 23

12 Certificate of conformity

EC - Declaration of Conformity

The Manufacturer:

AMOtronics UG (haftungsbeschränkt)
Otto-Blumenthal-Straße 25
Tel. +49 241 8867 128
52074 Aachen
Germany

herewith, declares that the consecutively mentioned measurement system for the measurement of electrical voltages,

Transient Recorder
Type: „SATURN"

confirms with the harmonized standards under the Directive 89/336/EEC of the European Standardisation Organisation, *CENELEC*.
The applied standards are the following:

EN 55022:2006
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
(CISPR 22:2005 (Modified))

EN 55024:1998
Information technology equipment - Immunity characteristics - Limits and methods of measurement
(CISPR 24:1997 (Modified))
Amendment A1:2001 to EN 55024:1998
(CISPR 24:1997/A1:2001)
Amendment A2:2003 to EN 55024:1998
(CISPR 24:1997/A2:2002)

Aachen, 01.05.2010 Dipl.-Ing. Jürgen Martini
-Managing Director, AMOtronics UG- (haftungsbeschränkt)

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www.amotronics.de – info@amotronics.de

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Tax No: 201/5943/4176 — VAT ID: DE 815 173 203
Sparkasse Aachen Account No: 107 057 50 20, BLZ 390 500 00
SWIFT: AACSDE33, IBAN: DE87 3905 0000 1070 5750 20
WEEE-Reg.-No. DE62833384

13 Contact

Products of AMOtronics' Saturn transient recorder family are distributed all over the world. Please contact the following address for your inquiries:

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52072 Aachen
GERMANY

www.amotronics.de

info@amotronics.de

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Fax: +49 241 169780 55

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www.axilane.com - info@axilane.com
Tél : +33.(0).950.60.40.20 - Fax : 09.50.60.40.20
N° 478891641 RCS EVRY

ANNEX A Path generator definition file

Customizing the path generator settings is very simple. To do changes to the entries in the path generator window edit the file by selecting ***OPTIONS*** from the ***VIEW*** menu and point to the ***STL-New Campgn. Settings*** button. The WINDOWS notepad application opens to edit the setup file for the path generator window.

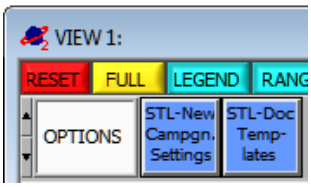


Figure 95: View Menu - Options

Not only the selection entries itself can be changed, but also the structure of the path can be changed with very little changes to the setup file. The below file defines the source for the generator window in Figure 96.

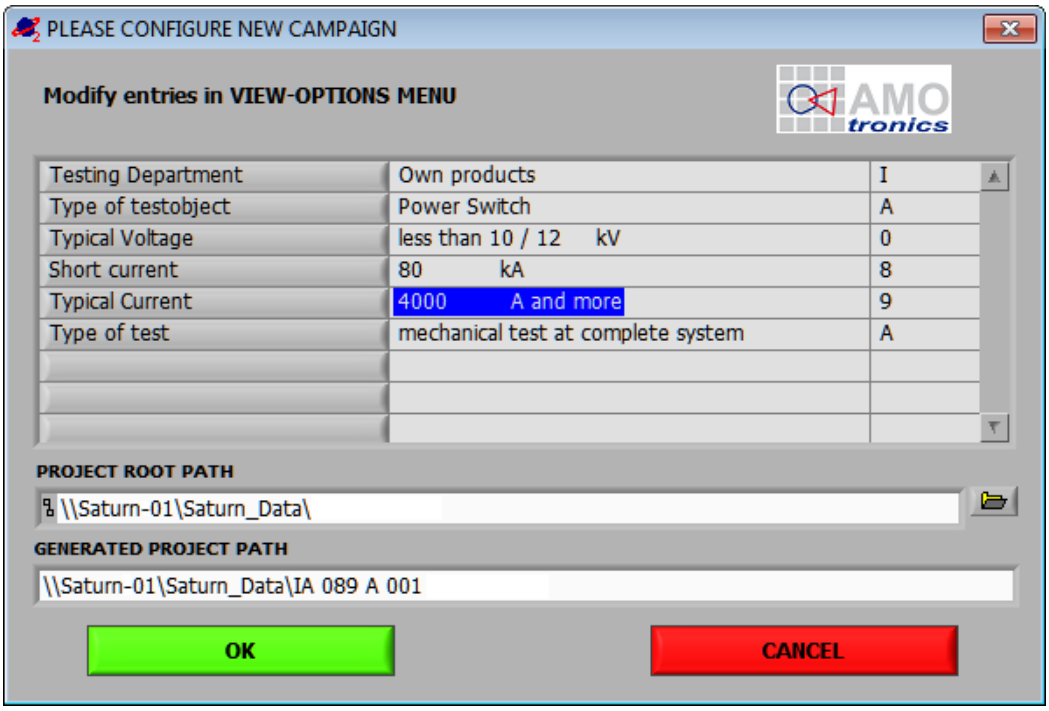


Figure 96: New series path generator window

The following example explains the simple structure for the path generation source file. We recommend storing a backup file before starting to change this file.

The cursive black writing is file contents, the green writing are comments only to explain. Comments are not allowed inside the definition file.

Please note!

Only writing in "…" may be changed.

Values in "#…#" implement special automatic inserts

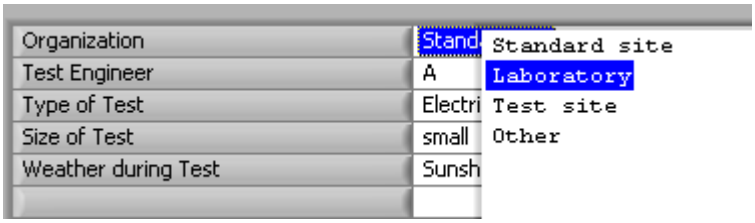
All writing outside "…" are keywords which may not be changed.

[HEADER] ← defines header section
TITLE="PLEASE CONFIGURE TEST SERIES" ← window title
TEXT="Please note!! Modify entries in: c:\saturn2\..\new_campaign.spp" ← bold header

[ICON] ← defines icon
PATH="c:\saturn2\icons\AMOtronics_logo.jpg" ← top right AMOtronics Logo (can be customized)
POS_X="436" ← relative pixel position in window
POS_Y="7" ← POS_X="0"; POS_Y="0" is the top left corner
WIDTH_X="100" ← max. pixel size in X
WIDTH_Y="100" ← max. pixel size in Y

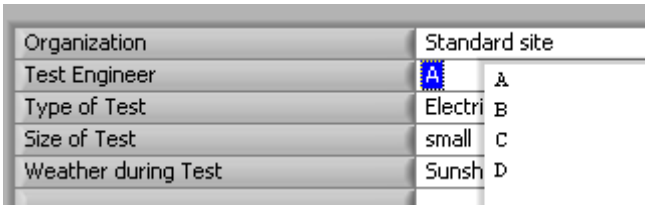
[STRUCT] ← defines the structure of the path
ITEM_1="Letter 1" ← 1st digit of path e.g. "S"
ITEM_2="Letter 2" ← 2nd digit of path e.g. "A"
ITEM_3="#EMPTY#" ← generates a space
ITEM_4="Index 1" ← 3rd digit of path e.g. "0"
ITEM_5="Index 2" ← 4th digit of path e.g. "0"
ITEM_6="#EMPTY#" ← generates a space
ITEM_7="Letter 3" ← 5th digit of path e.g. "A"
ITEM_8="#EMPTY#" ← generates a space
ITEM_9="#number#" ← automatically incrementing index e.g. "001"

[Letter 1] ← defines parameters for 1st digit



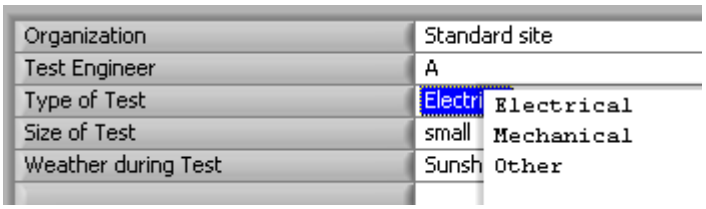
NAME ="Organization" ← selection title
SHORT="Company" ← not used
ITEM_1="Standard site" ← 1st selection item
ITEM_2="Laboratory" ← 2nd selection item
ITEM_3="Test site" ← 3rd selection item
ITEM_4="Other" ← 4th selection item
VALUE_1="S" ← 1st short for path generation
VALUE_2="L" ← 2nd short for path generation
VALUE_3="T" ← 3rd short for path generation
VALUE_4="X" ← 4th short for path generation

[Letter 2] ← defines parameters for 2nd digit



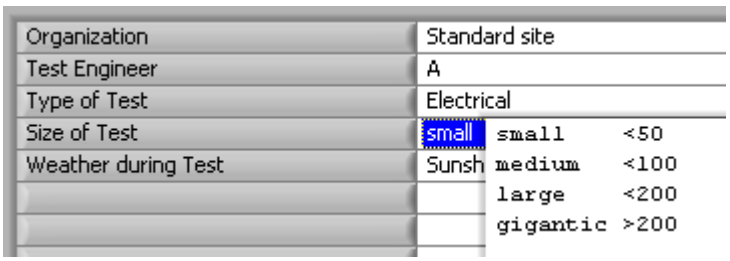
NAME ="Test Engineer" ← selection title
SHORT="User" ← not used
ITEM_1="A
ITEM_2="B"
ITEM_3="C"
ITEM_4="D"
VALUE_1="A"
VALUE_2="B"
VALUE_3="C"
VALUE_4="D"

[Index 1] ← defines parameters for 3rd digit



NAME ="Type of Test" ← selection title
SHORT="Type" ← not used
ITEM_1="Electrical"
ITEM_2="Mechanical"
ITEM_3="Other"
VALUE_1="0"
VALUE_2="1"
VALUE_3="X"

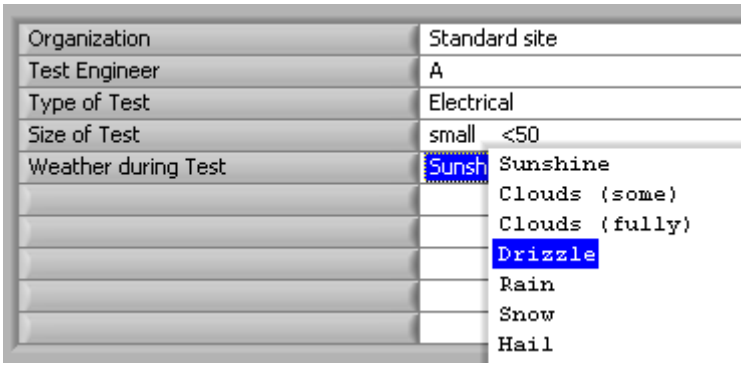
[Index 2] ← defines parameters for 4th digit



NAME ="Size of Test" ← selection title
SHORT="Size" ← not used
ITEM_1="small <50"

ITEM_2="medium <100"
ITEM_3="large <200"
ITEM_4="gigantic >200"
VALUE_1="0"
VALUE_2="1"
VALUE_3="2"
VALUE_4="3"

[Letter 3] ← defines parameters for 5th digit



NAME ="Weather during Test" ← selection title
SHORT="Weather" ← not used
ITEM_1="Sunshine"
ITEM_2="Clouds (some)"
ITEM_3="Clouds (fully)"
ITEM_4="Drizzle"
ITEM_5="Rain"
ITEM_6="Snow"
ITEM_7="Hail"
VALUE_1="A"
VALUE_2="B"
VALUE_3="C"
VALUE_4="D"
VALUE_5="E"
VALUE_6="F"
VALUE_7="G"

ANNEX B Result parameters

B.1 Basic Short-Circuit Test Duty T60

Name	STL parameter	Description
Making Current (peak) L1	Ip_L1_#	
Making Current (peak) L2	Ip_L2_#	
Making Current (peak) L3	Ip_L3_#	
Breaking current (r.m.s.) L1	Ibreak_L1_#	
Breaking current (r.m.s.) L2	Ibreak_L2_#	
Breaking current (r.m.s.) L3	Ibreak_L3_#	
Breaking current (average)	Ibreak_avr_#	
Recovery voltage (r.m.s.) L1	U_rec_L1	
Recovery voltage (r.m.s.) L2	U_rec_L2	
Recovery voltage (r.m.s.) L3	U_rec_L3	
Recovery voltage (Average value between phases)	U_rec_avr	
Transient recovery voltage (TRV)		
Voltage u1	u1_#	
Time t1	t1_#	
TRV peak value uc	uc_#	
Time t3	t3_#	
Time delay td	td	
Rate of rise uc/t3	uc_rise	
Closing Operation		
Voltage of closing device	Ucd_#	
Closing time	tcl_#	
Pre-arcing time	tprearc_#	
Make time	tmake_#	
Opening Operation		
Voltage of closing device	Uod_#	
Opening time	top_#	

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Arcing time L1	tarc_L1_#	
Arcing time L2	tarc_L2_#	
Arcing time L3	tarc_L3_#	
Break time	tbreak_#	

B.2 Cable-Charging Current Switching Tests

Name	STL parameter	Description
Applied voltage (rms)	Us	
Making Current (peak) L1	Ip_L1_#	
Making Current (peak) L2	Ip_L2_#	
Making Current (peak) L3	Ip_L3_#	
Making Current (peak) Closing angle (rel. to peak appl. voltage)		
Test voltage (rms) L1	Ubreak_L1	
Test voltage (rms) L2	Ubreak_L2	
Test voltage (rms) L3	Ubreak_L3	
Test voltage (rms) Average value (phase to phase)	Ubreak_avr	
Breaking current L1	Ibreak_L1_#	
Breaking current L2	Ibreak_L2_#	
Breaking current L3	Ibreak_L3_#	
Breaking current (average)	Ibreak_avr_#	
Recovery voltage - Across circuit-breaker (peak) L1	Uc_L1	
Recovery voltage - Across circuit-breaker (peak) L2	Uc_L2	
Recovery voltage - Across circuit-breaker (peak) L3	Uc_L3	
Recovery voltage - Supply side (rms) L1	U_rec_L1	
Recovery voltage - Supply side (rms) L2	U_rec_L2	
Recovery voltage - Supply side (rms) L3	U_rec_L3	
Recovery voltage - Average value (phase to phase)	U_rec_avr	
Closing Operation		

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Voltage of closing device	Ucd_#	
C-Operation - Closing time	tcl_#	
C-Operation - Pre-arcing time L1	tprearc_L1_#	
C-Operation - Pre-arcing time L2	tprearc_L2_#	
C-Operation - Pre-arcing time L3	tprearc_L3_#	
Opening Operation		
Voltage of opening device	Uod_#	
O-Operation - Opening time	top_#	
O-Operation - Arcing time L1	tarc_L1_#	
O-Operation - Arcing time L2	tarc_L2_#	
O-Operation - Arcing time L3	tarc_L3_#	

B.3 No-Load Operations

Name	STL parameter	Description
Closing Operation		
C-Operation - Voltage of closing device	Ucd_#	
C-Operation - Closing time L1	tcl_L1_#	
C-Operation - Closing time L2	tcl_L2_#	
C-Operation - Closing time L3	tcl_L3_#	
Opening Operation		
Voltage of opening device	Uod_#	
O-Operation - Opening time L1	top_L1_#	
O-Operation - Opening time L2	top_L2_#	
O-Operation - Opening time L3	top_L3_#	

B.4 Short-Circuit Making Tests

Name	STL parameter	Description
Applied voltage (phase-to-phase)		
Pre-arcing voltage L1		
Pre-arcing voltage L2		
Pre-arcing voltage L3		

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Making current L1	Ip_L1	
Making current L2	Ip_L2	
Making current L3	Ip_L3	
Short-circuit current L1	Iac_L1_1c_#	
Short-circuit current L2	Iac_L2_1c_#	
Short-circuit current L3	Iac_L3_1c_#	
Short-circuit current (average)	Iac_1c_avr	
Duration of short-circuit	t_sc_tst	
C-Operation - Voltage of closing device		
C-Operation - Pre-arcing time		

B.5 Out-of-phase Making and Breaking Tests, Test Duty OP2

Name	STL parameter	Description
Applied voltage	Us	
Making Current (peak) L1	Ip_L1	
Making Current (peak) L2	Ip_L2	
Making Current (peak) L3	Ip_L3	
Breaking current (r.m.s) L1	Ibreak_L1	
Breaking current (r.m.s) L2	Ibreak_L2	
Breaking current (r.m.s) L3	Ibreak_L3	
Breaking current (r.m.s) (average)	Ibreak_avr	
Recovery voltage (r.m.s) L1	U_rec_L1	
Recovery voltage (r.m.s) L2	U_rec_L2	
Recovery voltage (r.m.s) L3	U_rec_L3	
Transient recovery voltage (TRV)		
Voltage u1	u1_#	
Time t1	t1_#	
TRV peak value uc	uc_#	
Time t3	t3_#	
Time delay td	td	
Rate of rise uc/t3	uc_rise	
Closing Operation		

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Voltage of closing device	Ucd_#	
C-Operation - Closing time	tcl_#	
C-Operation - Pre-arcing time	tprearc_#	
C-Operation - Make time	tmake_#	
Opening Operation		
Voltage of opening device	Uod_#	
O-Operation - Opening time	top_#	
O-Operation - Arcing time L1	tarc_L1_#	
O-Operation - Arcing time L2	tarc_L2_#	
O-Operation - Arcing time L3	tarc_L3_#	
O-Operation - Break time	tbreak_#	

B.6 Short-Time Withstand Current and Peak Withstand Current Tests

Name	STL parameter	Description
Peak withstand current L1	Ip_L1_#	
Peak withstand current L2	Ip_L2_#	
Peak withstand current L3	Ip_L3_#	
Short-circuit current - First cycle L1	Iac_L1_1c_#	
Short-circuit current - First cycle L2	Iac_L2_1c_#	
Short-circuit current - First cycle L3	Iac_L3_1c_#	
Short-circuit current - Last cycle L1	Iac_L1_end_#	
Short-circuit current - Last cycle L2	Iac_L2_end_#	
Short-circuit current - Last cycle L3	Iac_L3_end_#	
Short-circuit current - Equivalent current L1	Iac_L1_tst	
Short-circuit current - Equivalent current L2	Iac_L2_tst	
Short-circuit current - Equivalent current L3	Iac_L3_tst	
Short-circuit current - Equivalent current (average)	Iac_avr	
Short-circuit current - Duration of short-circuit	t_sc_tst	

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Short-time withstand current L1	Iac_L1_ref	
Short-time withstand current L2	Iac_L2_ref	
Short-time withstand current L3	Iac_L3_ref	
Short-time withstand current (average)	Iac_ref_avr	
Short-time withstand current (Related to rated duration of short-circuit)	t_sc_soll	
Duration of short-circuit	t_sc_rel	
Related to rated short-time withstand current	Iac_ref_avr_soll	

B.7 Basic Short-Circuit Test Duty T100a

Name	STL parameter	Description
Breaking current (r.m.s.) L1	Ibreak_L1_#	
Breaking current (r.m.s.) L2	Ibreak_L2_#	
Breaking current (r.m.s.) L3	Ibreak_L3_#	
Breaking current (r.m.s.) (average)	Ibreak_avr	
Breaking current - last current loop (peak) - L1	Ibreak_peak_L1	
Breaking current - last current loop (peak) - L2	Ibreak_peak_L2	
Breaking current - last current loop (peak) - L3	Ibreak_peak_L3	
Breaking current - Duration of the last current loop L1	tbreak_L1	
Breaking current - Duration of the last current loop L2	tbreak_L2	
Breaking current - Duration of the last current loop L3	tbreak_L3	
DC-component L1	Idc_L1	
DC-component L2	Idc_L2	
DC-component L3	Idc_L3	
Recovery voltage (r.m.s.) L1	U_rec_L1	
Recovery voltage (r.m.s.) L2	U_rec_L2	
Recovery voltage (r.m.s.) L3	U_rec_L3	

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Recovery voltage (Average value between phases)	U_rec_avr	
Transient recovery voltage (TRV)		
Voltage u1	u1_#	
Time t1	t1_#	
TRV peak value uc	uc_#	
Time t3	t3_#	
Time delay td	td	
Rate of rise uc/t3	uc_rise	
Opening Operation		
Voltage of closing device	Uod_#	
Opening time	top_#	
Arcing time L1	tarc_L1_#	
Arcing time L2	tarc_L1_#	
Arcing time L3	tarc_L1_#	
Break time	tbreak_#	