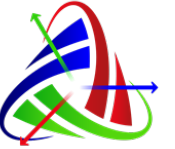




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אל טסט בע"מ
שרותי מבדקה למתקני חשמל

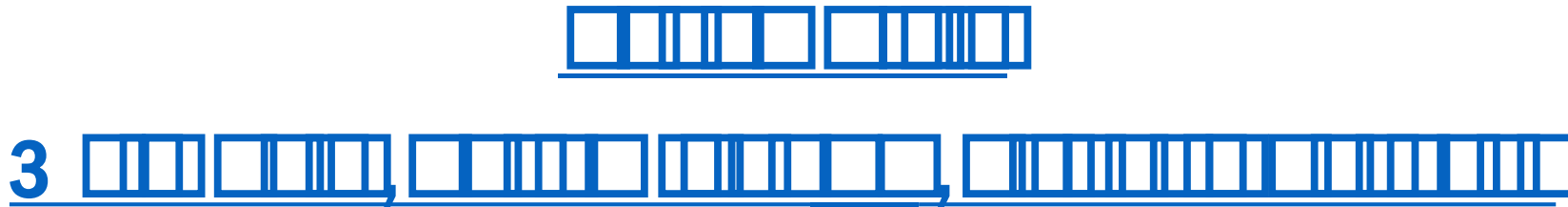
אמצעי בדיקה מתקדמים לממסרי הגנה



התאגדות מהנדסי חשמל, אלקטרוניקה ואנרגיה

Electricity & Energy 2024

The 23rd International Annual Convention of SEEEI | 12-16.11.2024 | Eilat, Israel

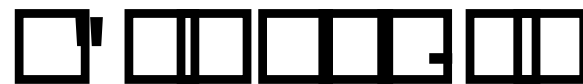


al@alozdernik.com, 0526004991



4 מהנדסים + 4 

הנדסאים



4 בודקים סוג 3 

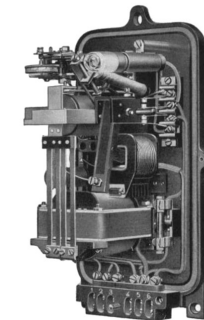
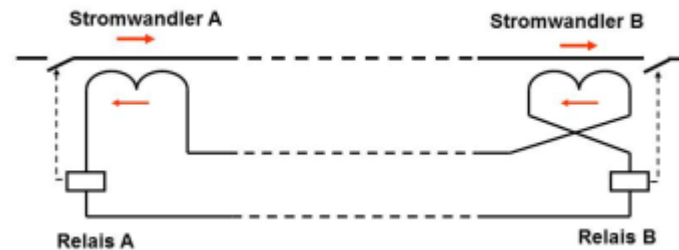
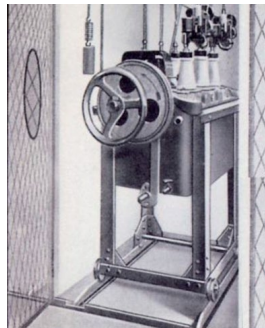
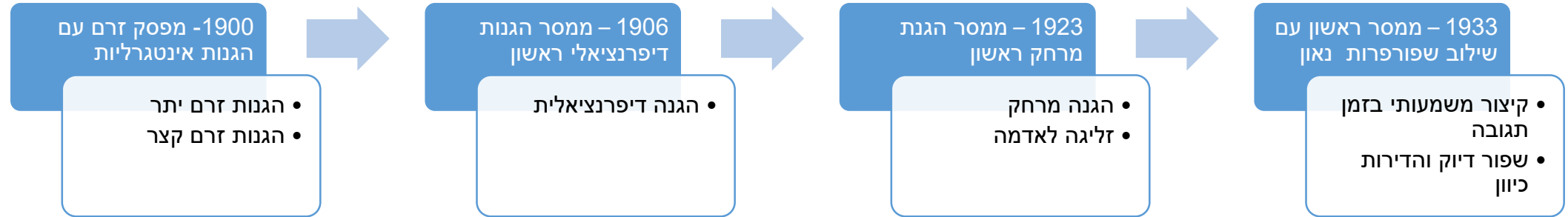
- סימולציה מערכות חשמל

- יעוץ וליווי הנדסי

- פיקוח וניהול פרויקטים

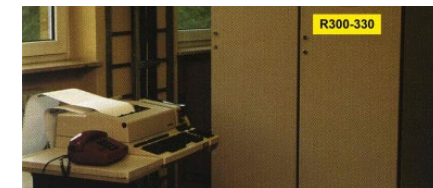
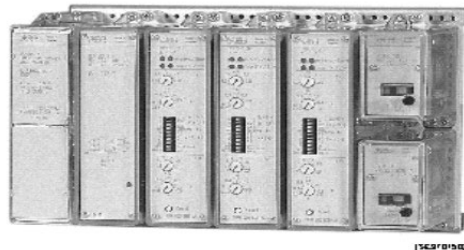
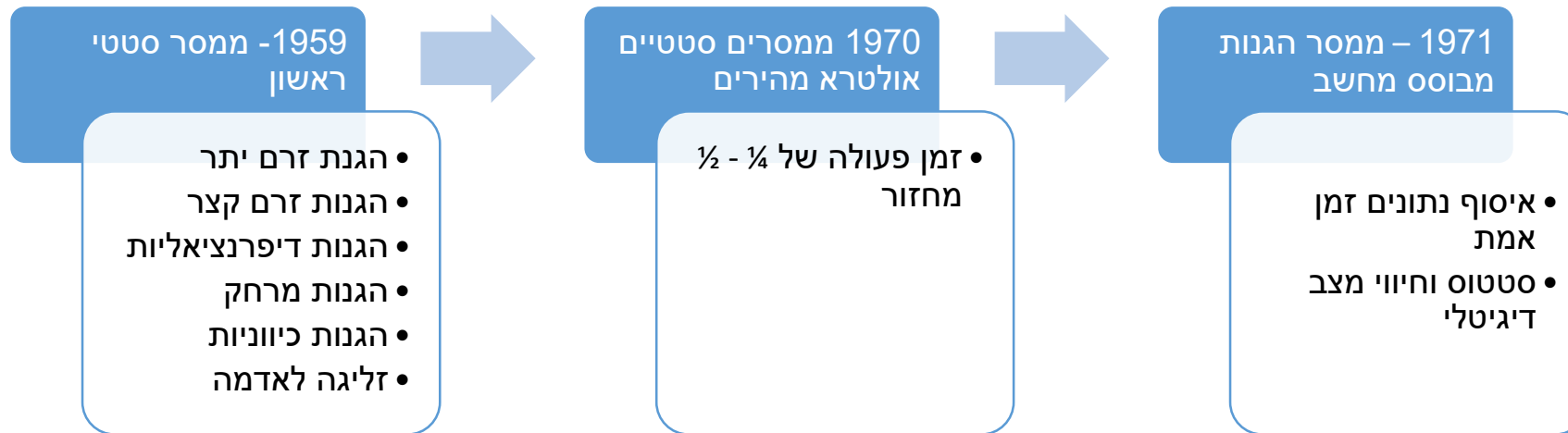
- בדיקות חשמל

היסטוריה של ממסרי הגנה ממסרים אלקטרו מכניים

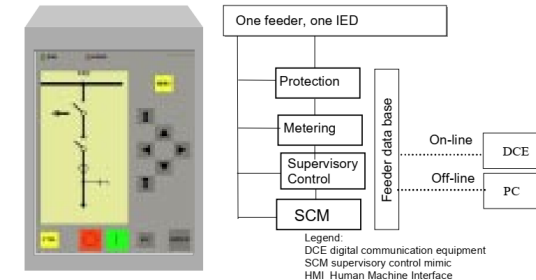
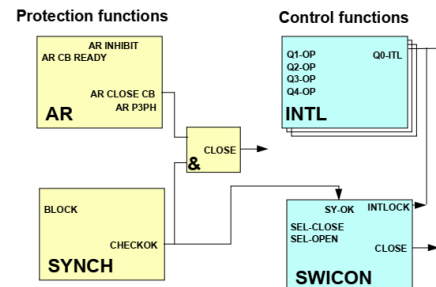
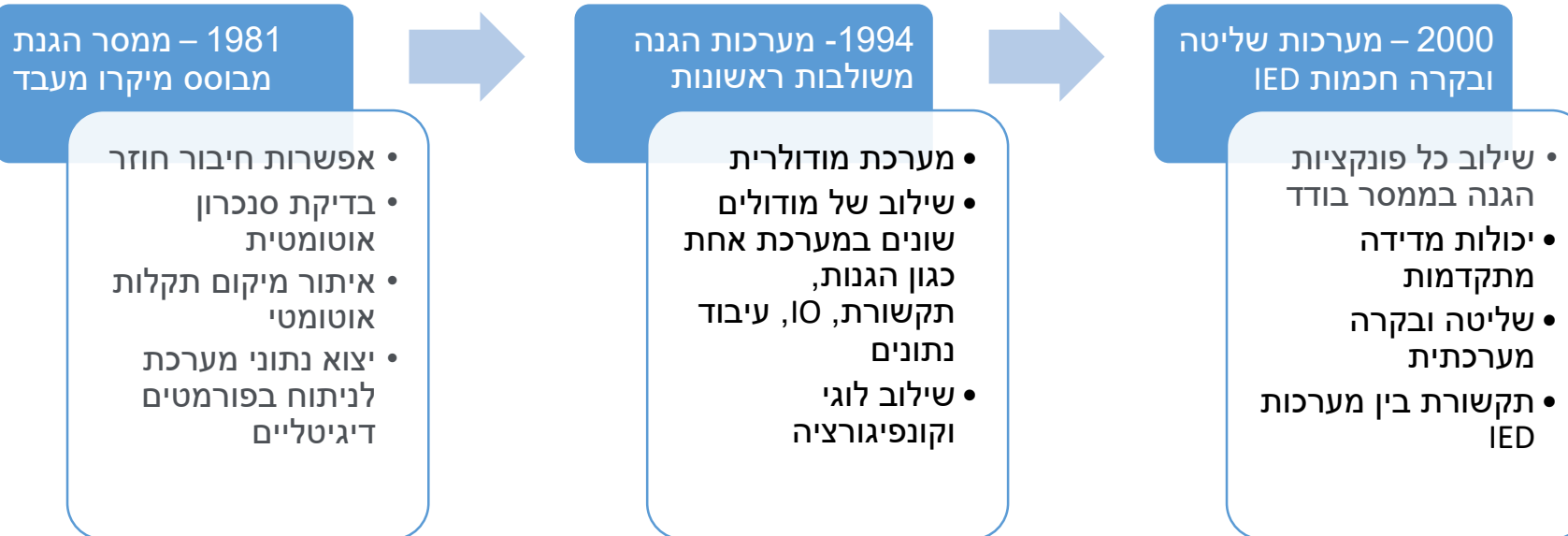


היסטוריה של ממסרי הגנה

ממסרים סטטיים



היסטוריה של ממסרי הגנה ממסרים דיגיטליים





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כמה נתונים מעניינים מכנס CIGRE 27/03/2023



- Life cycle of Power System Equipment, Protection, Automation and Control Systems (PACS) and related intelligent electronic devices (IEDs) are very different:
 - ✓ **Primary equipment life cycle:** 40-60 years
 - ✓ **PACS life cycle:** ~20 years
 - ✓ **IEDs production life cycle:** 10 – 15 years
- Continuous evolution of functionality embedded in IEDs
 - ✓ **Retrofitting along life cycle forces re-configuration of PACS**
- Large-scale integration of renewables and distributed generation are requiring more flexibility in applying PAC functionalities along the life cycle
 - ✓ **Software applications need to become independent from hardware**



מעבר להגנות דיגיטליות בלתי תלויות בחומרה

New approaches and architectures for PACS

- Separation of PAC application functions and hardware
 - ✓ **New approaches in design, commissioning and maintenance**
 - ✓ **New architectures for IEDs and PACS**
- New features and expected benefits like:
 - ✓ **Portability of application functions between different hardware platforms**
 - ✓ **Flexible re-allocation of functions**
 - ✓ **Cost-efficient redundancy approaches**
 - ✓ **New levels of scalability from multiple devices to “station in a box”**
 - ✓ **New system management approaches over the entire life cycle supporting efficient operation and new business models**
 - ✓ **Enabling future evolutions towards cloud-based applications**
- Key elements of function independent from hardware
 - ✓ **Separation of hardware related to process IO from hardware executing application functions**
 - ✓ **Using standardized data modelling supporting the virtualization of functions and related information exchange independent from hardware and communication protocols**
 - ✓ **Improved reliability by using redundant communication between distributed functions (e.g., process IO and application functions)**
 - ✓ **Definition of scalable hardware and software platforms hosting application functions**



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שלבי בדיקה של מערכות דיגיטליות



Test of PACS with FIH

- Virtualized IEDs are hardware independent and would allow in principle to be deployed and simulated in full-scale on a temporary hardware allowing a full system test
- Together with a model-based software-in-the-loop testing systems a full functional and communication test could be achieved (both could be seen as digital twins)
- Tests could start before final hardware is manufactured and assembled
- Tests with final hardware should validate the specified performance

Testing stage	Implementation in case of FIH	Testing site	Comments
Function testing	Implemented virtually	Lab	May include function interoperability testing
Functional Subsystem verification	Implemented virtually	Lab	
Functional System verification	Implemented virtually	Lab	
Performance testing after deployment on target hardware	Implemented physically	Factory/Site	
Communication testing between physical IED	Implemented physically	Factory/Site	Here simplified test program will be enough because all communications are tested during system verification.
System validation	Implemented physically	Site	

Example: Testing stages



סיכום ביניים

- במהלך שנות התפתחות, ובמיוחד בשני עשורים אחרונים מערכות הגנות עברו שינוי טכנולוגי משמעותי
- ממסר הגנה אינו מבצע יותר רק פעולת הגנה אלה משמש כמרכיב בפלטפורמה רב שימושית לניהול ובקרה של מתקני אנרגיה
- אמצעי בדיקה של מערכות הגנה צריכים לתת מענה לשינויים אלה



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אמצעי בדיקה מתקדמים



OMICRON Test Universe

Test Modules & Tools

Test Modules
Stand-alone Startup

- QuickCMC
- Ramping
- Pulse Ramping
- State Sequencer
- Advanced TransPlay
- Annunciation Checker
- Overcurrent
- Distance
- Advanced Distance
- VI Starting
- Autoreclosure
- Power
- Advanced Power
- Single-Phase Differential
- Diff Configuration
- Diff Operating Characteristic
- Diff Trip Time Characteristic
- Diff Harmonic Restraint
- Synchronizer
- Meter
- Transducer
- PQ Signal Generator

Configuration Modules
Configuring CMC Test Set Features

- CB Configuration
- AuxDC Configuration
- ISIO Connect

IEC 61850
Testing Power Utility Communication

- GOOSE Configuration
- Sampled Values Configuration
- IEC 61850 Client/Server
- IEDScout

Network Simulation
System-based Protection Testing

- RelaySimTest
- NetSim
- Transient Ground Fault

Data Management
Asset and Test Set Management

- ADMO

Device Link
Test Set Association

- Device Link

Test Tools
Additional Applications

- Enerlyzer (CMC 256/356)
- Enerlyzer Live (CMC 430)
- TransPlay
- TransView
- Harmonics
- Binary I/O Monitor
- Polarity Checker
- O/C Characteristics Grabber
- OCC Batch
- CMControl P

OMICRON

OMICRON's PTT

Protection Testing Library (PTL)

-- all vendors -- (536) -- all applications -- (536)

Fulltext Search

Showing 1 to 25 of 536 entries

Relay	Vendor	Application	Date (yyyy-mm-dd) -
▼ AQ-F255A v2.5.7.1 Feeder	Arcteq	Feeder	2024-10-28 NEW
▼ AQ-F255R v2.5.7.1 Feeder	Arcteq	Feeder	2024-10-28 NEW
▼ AQ-F255S v2.5.7.1 Feeder	Arcteq	Feeder	2024-10-28 NEW
▼ AQ-F255V v2.5.7.1 Feeder	Arcteq	Feeder	2024-10-28 NEW
▼ 411L R127 Line	SEL	Line	2024-10-25 NEW
▼ 411L-1 R127 Line	SEL	Line	2024-10-25 NEW
▼ 411L-A R131 Line	SEL	Line	2024-10-25 NEW
▼ 411L-B R131 Line	SEL	Line	2024-10-25 NEW
▼ 421 R317 Line	SEL	Line	2024-10-25 NEW
▼ 421-1 R317 Line	SEL	Line	2024-10-25 NEW
▼ 421-2 R317 Line	SEL	Line	2024-10-25 NEW



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תבנית בדיקה



OMICRON Control Center - Schneider MiCOM P642 B1 Transformer RAX

File Home Insert Text View

Cut Copy Paste Start/Continue All Clear All Stop Pause Start/Continue Clear Set All Reports Report Settings Comment Test Documentation Test Documentation Extras

Schneider MICOM P642 B1 T...

- Schneider MICOM P642 B1 Transformer RAX.occ
 - P64231SDBM0B20L
 - Hardware Configuration
 - Connection Diagram
 - Instructions
 - Wiring Test Information
 - Wiring Test
 - Initial Test
 - Differential Protection Side 1 and Side 2
 - Current Protection Test Information
 - Overcurrent Protection Side 1
 - Overcurrent Protection Side 2
 - Overcurrent Pickup and Dropout Side 2 A-B-C
 - Overcurrent Trip Times Side 2 A-B-C
 - Earth Fault Protection Side 1 (EF Input derived)
 - Earth Fault Pickup and Dropout Side 1 A-N
 - Earth Fault Trip Times Side 1 A-N
 - Earth Fault Protection Side 2 (EF Input derived)
 - Earth Fault Pickup and Dropout Side 2 A-N
 - Earth Fault Trip Times Side 2 A-N
 - Earth Fault Protection Side 1 (EF Input measured)
 - Earth Fault Protection Information
 - Hardware Configuration
 - Connection Diagram Earth Fault Side 1
 - Earth Fault Pickup and Dropout Side 1 A-N
 - Earth Fault Trip Times Side 1 A-N
 - Earth Fault Protection Side 2 (EF Input measured)
 - Earth Fault Protection Information
 - Hardware Configuration
 - Connection Diagram Earth Fault Side 2
 - Earth Fault Pickup and Dropout Side 2 A-N
 - Earth Fault Trip Times Side 2 A-N
 - CB Test
 - Hardware Configuration
 - Connection Diagram
 - CB Trip Time Test Information
 - CB Trip Time

Test Object - Device Settings

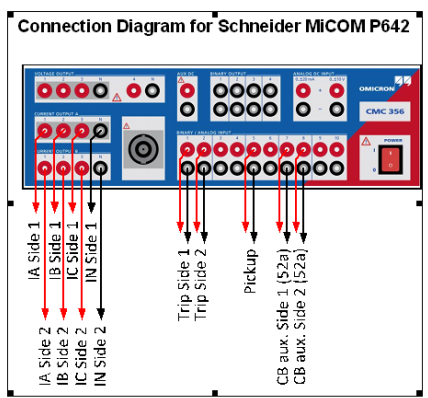
Substation/Bay:			
Substation:	substation bay	Substation address:	substation address
Bay:		Bay address:	bay address

Device:			
Name/description:	P64231SDBM0B20L	Manufacturer:	ALSTOM
Device type:	Transformer differential	Device address:	1
Serial/model number:	123456M		
Additional info 1:	information		
Additional info 2:	MICOM P642		

Hardware Configuration

Test Equipment	
Type	Serial Number
CMC356	DN635E

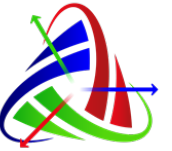
Hardware Check		
Performed At	Result	Details
4/29/2023 8:38:47 PM	Passed	





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ממשק יבואו נתונים מקובץ



אל טסט בע"מ
שירותי מבדקה למתקני חשמל

המרה של ממסר הגנה

Easergy Studio V9.3.4

Studio Explorer

RAX TEST EXAMPLE.P642.001

View | File comments | Save | Save as | Copy | Paste | Search:

Name	Value	Address (C.R)	User note
GROUP 1 SYSTEM CONFIG			
GROUP 1 DIFF PROTECTION			
Transo Diff	Enabled	31.01	
Set Mode	Advance	31.02	
Is1	1.000 PU	31.03	
K1	30.00 %	31.04	
Is2	1.000 PU	31.05	
K2	80.00 %	31.06	
tDIFF LS	0 s	31.07	
Is-CTS	1.500 PU	31.08	
Is-HS1	6.000 PU	31.10	
HSD Status	Enabled	31.11	
Is-HSD	32.00 PU	31.12	
Zero seq flt HV	Disabled	31.20	
Zero seq flt LV	Disabled	31.21	
2nd harm blocked	Enabled	31.28	
Ih(2) %	20.00 %	31.29	
Cross blocking	Enabled	31.2A	
CTSat and NoGap	Enabled	31.2B	
5th harm blocked	Enabled	31.33	
Ih(5) %	35.00 %	31.34	
Circuitry Fail	Disabled	31.40	
GROUP 1 OVERCURRENT			
GROUP 1 SUPERVISION			
GROUP 1 INPUT LABELS			
GROUP 1 OUTPUT LABELS			
Group 2			
Group 3			
Group 4			

Properties: 001.set

Basic properties

Comment

Name 001.set

General Information

Creation Dat: 01/05/2023 12:41:25

Data Model F.C.: ProgramData\Schr

File Is Hidden: No

File Is Read-Only: No

File Present: Yes

Last Modified: 01/05/2023 13:26:05

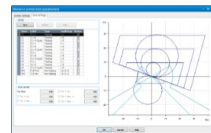
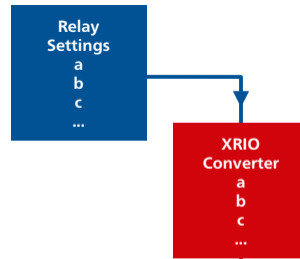
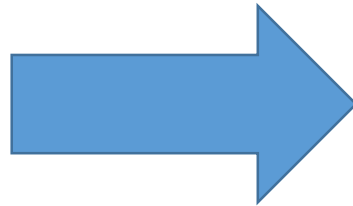
MDS Checks: 5A94C0ED2F0FA1EA

Model Number: P64231S08M0820L

Path: C:\Users\localadmin\T

Size: 632693 B

Type: P642



Test Object

File | View | Function | Block | Parameter | Help

Script Functions

P642

Stat	Name	ID	Foreign ID	Description	Reference value	Value	Unit	Min	Max	Formula
✓	Trans Diff	PARAMET	31.01				Enabled			
✓	Set Mode	PARAMET	31.02				Advance			
✓	Is1	PARAMET	31.03				1.00 PU	0.10	2.50	
✓	K1	PARAMET	31.04				30.00 %	0.00	150.00	
✓	Is2	PARAMET	31.05				1.00 PU	0.10	10.00	
✓	K2	PARAMET	31.06				80.00 %	15.00	150.00	
✓	iDIFF LS	PARAMET	31.07				0.00 s	0.00	10.00	
✓	Is-CTS	PARAMET	31.08				1.50 PU	0.10	2.50	
✓	Is-HS1	PARAMET	31.10				8.00 PU	2.50	32.00	
✓	HS2 Status	PARAMET	31.11				Enabled			
✓	Is-HSD	PARAMET	31.12				32.00 PU	2.50	32.00	
✓	Zero seq flt HV	PARAMET	31.20				Disabled			
✓	Zero seq flt LV	PARAMET	31.21				Disabled			
✓	2nd harm block	PARAMET	31.28				Enabled			
✓	Ih(2) %	PARAMET	31.29				20.00 %	5.00	50.00	
✓	Cross blocking	PARAMET	31.2A				Enabled			
✓	CTSat and NoG	PARAMET	31.2B				Enabled			
✓	5th harm block	PARAMET	31.33				Enabled			
✓	Ih(5) %	PARAMET	31.34				35.00 %	0.00	100.00	
✓	Circuitry Fail	PARAMET	31.40				Disabled			

GROUP 1 SYSTEM CONFIG

GROUP 1 DIFF PROTECTION

GROUP 1 REF PROTECTION

GROUP 1 NFS OVERCURRE

GROUP 1 OVERCURREN

GROUP 1 THERMAL OVERL

GROUP 1 EARTH FAULT

GROUP 1 THROUGH FAULT

GROUP 1 OVERFLURING

GROUP 1 VOLT PROTECTIO

GROUP 1 FREQ PROTECTIO

GROUP 1 RTO PROTECTIO

GROUP 1 CB FAIL

GROUP 1 SUPERVISION

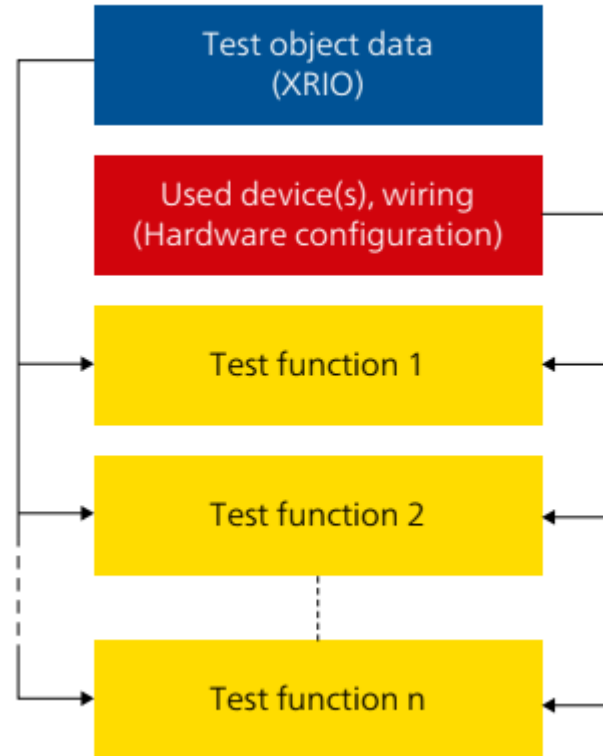
GROUP 1 INPUT LABELS

GROUP 1 OUTPUT LABELS

GROUP 1 RTO LABELS

GROUP 1 CUO PROTECTION

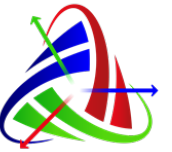
CONTROL CENTER





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WIRING TEST



אל טסט בע"מ
שירותי מבדוק למתקני חשמל

OMICRON Diff Configuration - [Wiring Test in Schneider MiCOM P642 RAX]

File Home View

Test Object Configuration Hardware Configuration Time Trigger Test Setup Start/Continue Test Execution Stop Pause Clear Test Documentation Report Settings * Comment Exit & Return to Schneider MiCOM P642 RAX Manual Assessment *

Test View: Wiring Test in Schneider MiCOM P642 RAX

Test Data Test General Binary Out

Test Points

Itest	Result
1.00	Testing

Itest: 1.00 In

Add Add Sweep... Remove Remove All Passed Failed

Fault type

L1-E L1-L2 L1-L2-L3 L2-E L2-L3 L3-E L3-L1

Single Line View for Protected Object (YY0)

L1-L2-L3

Supply

IL1 = 1.00 A 180.0°
IL2 = 1.00 A 60.0°
IL3 = 1.00 A -60.0°

IL1 = 0.96 A 0.0°
IL2 = 0.96 A -120.0°
IL3 = 0.96 A 120.0°

Phasor View: Wiring Test in Schneider MiCOM P642 RAX

Signal	Magnitude	Phase
P-L1	1.000 A	-180.00 °
P-L2	1.000 A	60.00 °
P-L3	1.000 A	-60.00 °
S-L1	962.0 mA	0.00 °
S-L2	962.0 mA	-120.00 °
S-L3	962.0 mA	120.00 °

1.0 A

Phasor View Report View

Status History Overload Monitor Binary Inputs

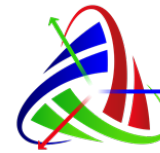
For Help, press F1

0 % (01:51)



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דוגמאות לבדיקות במסגרת התבנית



אל טסט בע"מ
שרותי מבדקה למתקני חשמל

OMICRON Diff Operating Characteristic - [Diff Operating Characteristic A-B-C in Schneider MICOM P642 RAX]

File Home View

Test Object Hardware Configuration Time Trigger Start/Continue Stop Pause Clear Single Test Static Output Report Settings Comment Exit & Return to Schneider MICOM P642 RAX

Test Setup Test Execution Test Documentation

Test View: Diff Operating Characteristic A-B-C in Schneider MICOM P642 RAX

Report View: Diff Operating Characteristic A-B-C in Schneider MICOM P642 RAX

Shot Test Search Test General Binary Out

Test Lines

Ibias	Idiff nominal	Idiff
1.00 In	n/a	0.996 In
1.50 In	n/a	0.987 In
2.00 In	n/a	0.973 In
2.50 In	n/a	0.962 In
3.00 In	n/a	0.958 In
3.50 In	n/a	0.947 In
4.00 In	n/a	1.020 In

Ibias: 4.00 In Add Add Sweep... Remove Remove All

Fault Type
 L1-E L1-L2 L1-L2-L3
 L2-E L2-L3
 L3-E L3-L1

Resolution
Absolute: 0.010 In Relative: 0.100 %

Result
Idiff: 1.020 In Dev.: n/a

Operating Characteristic Diagram

Diff Operating Characteristic A-B-C:

Test Module

Name: OMICRON Diff Operating Characteristic Version: 4.31
Test Start: 02-May-2023 09:45:27 Test End: 02-May-2023 09:47:32
User Name: Manager
Company:

Test Results for Fault Location L1-L2-L3 at Reference Side Primary

Ibias	Idiff Nominal	Idiff Actual	Dev (rel)	Dev (abs)	Check Test	State	Result
1.00 In	n/a	0.996 In	n/a	n/a		Tested	Passed
1.50 In	n/a	0.987 In	n/a	n/a		Tested	Passed
2.00 In	n/a	0.973 In	n/a	n/a		Tested	Passed
2.50 In	n/a	0.962 In	n/a	n/a		Tested	Passed
3.00 In	n/a	0.958 In	n/a	n/a		Tested	Passed
3.50 In	n/a	0.947 In	n/a	n/a		Tested	Passed
4.00 In	n/a	1.020 In	n/a	n/a		Tested	Passed

Test State:
Test passed
7 out of 7 points tested.
7 points passed.
0 points failed.

Phasor View Report View

Status History Overload Monitor Binary Inputs



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דוח מפורט אוטומטי בסיום הבדיקה



OMICRON Control Center - Schneider MiCOM P642 RAX

File Home Insert Text View

Cut Copy Paste Start/Continue All Clear All Stop Pause Start/Continue Clear Set All Reports Report Settings Comment Manual Assessment Open Test Options Verify Extras

Schneider MiCOM P642 RAX...

- Schneider MiCOM P642 RAX.occ
 - Test Object
 - Hardware Configuration
 - Connection Diagram
 - Instructions
 - Wiring Test Information
 - Wiring Test
 - Initial Test
 - Differential Protection Side 1 and Side 2
 - Diff Configuration Test Information
 - Diff Configuration Side 1 A-N
 - Diff Configuration Side 1 A-B-C
 - Diff Configuration Side 2 B-N
 - Diff Configuration Side 2 A-B-C
 - Diff Operating Characteristic C-N
 - Diff Operating Characteristic A-B-C
 - Diff Trip Time B-N
 - Diff Trip Time A-B-C
 - 2nd Harmonic Restraint
 - 5th Harmonic Restraint

OMICRON PTT

Differential Protection

Schneider MiCOM P642 Software Version: B1

Company: EL-TEST LTD

Test Person: Alexander Lozdernik

Test Date: 02-May-23

Report Status:

Number of Test Modules: 15

Number of Test Modules Passed: 13

Number of Test Modules Failed: 0

Test Object - Device Settings

Substation/Bay: Substation address: Bay address:



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RELAYSIMTEST

Transformer Differential Protection - OMICRON Relaysim test

File Home View

Fault Device Infeed Load Busbar Line Transformer Switch Current transformer Voltage transformer Other Text Duplicate elements Delete elements Group elements Ungroup Add to group Remove from group Rotate left Rotate right Flip horizontally Flip vertically Horizontal Vertical Clear all results Enable editing Import SCL Copy graphics to clipboard IEC 61850

Document

- Overview
- Report
- System under Test
- Power system
- Test set configurations
 - Configuration 1
 - CMC 356 - CMC A
- Test cases
 - Test Manager
 - Stability Tests
 - Faults in Protected Area

Settings are read-only due to existing test results.

Power system

System under Test

Nominal frequency:	50.00 Hz
Default voltage L-L (prim.):	110.00 kV
Nominal power:	100.00 MVA
Default grounding:	Solidly groun...

Test steps: 30 Failed: 0
Executed: 30 Issues: 0

Execute Stop

Aux DC Configuration 1



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אל טסט בע"מ
שירותי מבדקה למתקני חשמל

TEST SET CONFIG

The screenshot displays the OMICRON RelaySim Test software interface for a "Transformer Differential Protection" test. The main workspace shows a "Front side" panel with four voltage sources (3x300 V and 1x300 V) and six current sources (3x32 A). The terminals are numbered 1, 2, 3, and 4. Two relays, labeled "3x1" and "3x2", are connected to the terminals. The relays have terminals L1, L2, L3, and N. The interface includes a top menu bar with options like File, Home, and View, and a toolbar with various test set management functions. A left sidebar shows the project structure, including "Test set configurations" and "Test cases". The bottom status bar shows test progress: "Test steps: 30", "Failed: 0", "Executed: 30", and "Issues: 0".

Settings are read-only due to existing test results. Enable editing

Analog outputs Binary inputs Binary outputs

Front side 3x300 V 1x300 V 3x32 A 3x32 A

Voltage: 4x300 V
Current: 6x32 A, 25 Vrms
 Show devices

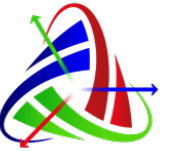
Relay	Terminals
3x1	L1: L2: L3: N:
3x2	L1: L2: L3: N:

Test steps: 30 Failed: 0
Executed: 30 Issues: 0

Execute Stop Aux DC Configuration 1



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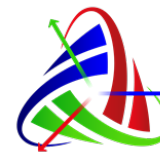
TEST SET CONFIG

The screenshot displays the OMICRON RelaySim test software interface. The title bar reads "Transformer Differential Protection - OMICRON RelaySim test". The interface includes a ribbon menu with tabs for "Test Set Configurations", "Test Sets", "Binary Inputs", and "Test". The "Test Set Configurations" tab is active, showing a list of configurations on the left sidebar, including "Configuration 1" and "CMC 356 - CMC A". The main workspace shows the configuration for a relay terminal labeled "Trip". The terminal is connected to a "Front side" terminal block with 10 terminals. The configuration parameters are: Debounce time: 3.0 ms, Deglitch time: 0.0 ms, and a checked "Show devices" option. The status bar at the bottom shows "Test steps: 30", "Failed: 0", "Executed: 30", and "Issues: 0". There are also "Execute" and "Stop" buttons, and a status indicator for "Aux DC" and "Configuration 1".



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דוגמאות של סימולציות



אל טסט בע"מ
שרותי מבדקה למתקני חשמל

Transformer Differential Protection - OMICRON Relaysim Test

File Home View Fault

Simulation test settings Iterative Closed-Loop Add fault Delete fault Duplicate test steps Delete test steps Manage Test Steps Vary parameters Define measurements Set assessment conditions Assess manually Clear results Export to COMTRADE Copy graphics to clipboard

	Fault on HV Winding	HV Winding Fault - Fault type	HV Winding Fault - Fault resistance (RF)	Trip	Time stamp	Comment
1	Passed	L1-N	0.0000 Ω	25.1 ms	12/23/2016 10:22:44 AM	
2	Passed	L1-N	10.000 Ω	26.3 ms	12/23/2016 10:22:47 AM	
3	Passed	L1-N	100.00 Ω	35.6 ms	12/23/2016 10:22:52 AM	
4	Passed	L3-L1	0.0000 Ω	18.9 ms	12/23/2016 10:22:56 AM	
5	Passed	L3-L1	10.000 Ω	23.2 ms	12/23/2016 10:23:01 AM	
6	Passed	L3-L1	100.00 Ω	37.2 ms	12/23/2016 10:23:04 AM	
7	Passed	L1-L2-L3	0.0000 Ω	17.7 ms	12/23/2016 10:23:09 AM	

Cursors: A: 329.29 ms, B: 600.00 ms, B - A = 270.71 ms

Transformer:

Primary	
I L1:	3.7888 A ∠ 3.35 °
I L2:	11.425 A ∠ -136.02 °
I L3:	8.8985 A ∠ 60.07 °

Secondary	
I L1:	84.828 A ∠ 44.06 °
I L2:	117.65 A ∠ -119.12 °
I L3:	43.953 A ∠ 94.85 °
S:	1.1428 MVA
cos(φ):	-0.9950

CT A:

I L1 sec:	16.702 A ∠ -79.03 °
I L2 sec:	45.700 mA ∠ -136.02 °
I L3 sec:	16.727 A ∠ 100.84 °

CT B:

I L1 sec:	33.900 mA ∠ 44.06 °
I L2 sec:	47.100 mA ∠ -119.12 °
I L3 sec:	17.600 mA ∠ 94.85 °

Relay - 3xl 1: I/A graph showing current waveforms for L1, L2, and L3.

Relay - 3xl 2: I/mA graph showing current waveforms for L1, L2, and L3.

Relay - Binary outputs: Trip signal graph.

HV Winding Fault configuration:

- Name: HV Winding Fault
- Initial state: Inactive
- Fault type: L3-L1
- RF: 10.000 Ω
- RFG: 0.0000 Ω
- Fault inception: At inception angle: 90.00 °

Test steps: 30 Failed: 0
Executed: 30 Issues: 0

Apply configuration Execute Selected Stop Aux DC Configuration 1



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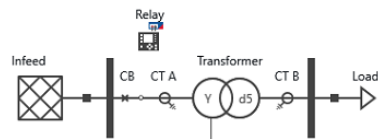
דוח מפורט אוטומטי בסיום הבדיקה



Transformer Differential Protection

Creation date / last modified:	02/05/2023 10:50:45 AM
Created by:	Alexander Lozdernik
Execution date:	12/23/2016 10:27:14 AM
Executed by:	Alexander Lozdernik
Executed:	30 of 30
Issues:	0
Passed:	30
Failed:	0
Overall assessment:	Passed

Power System



System under Test

Nominal frequency: 50.00 Hz

Relay

Manufacturer: _____
 Device type: _____
 Device address: _____
 Serial/model number: _____

CT A	250.00 A : 1.0000 A
Type	Three-phase

CT B	2.5000 kA : 1.0000 A
Type	Three-phase

CB	
Breaker type:	Three-pole
Tripping time	20.000 ms

סיכום

- התפתחות מהירה של אנרגיות מתחדשות ויצור מבוזר נדרש ממערכות הגנה לא רק פונקציונליות חדשה אך גם גמישות שלא הייתה קיימת במערכות הגנה ישנות, לכן מערכות הגנה משתדרגות במהלך חיי המוצר
- שימוש באמצעי בדיקה מתקדמים מבוססים על שיטות בדיקה אוטומטיות עם שימוש בנתוני מערכות נבדקות משפר משמעותית אמינות ויעילות הבדיקה