Test Report

Report no.:	**518/TTS/1/1**
Subject:	**Type Test Summary**
Date:	2019-11-11
Place:	SIEMENS, SI DG SPD R&D Hamilton Laboratory Hebburn
Client:	Siemens AG, Humboldtstr. 59 D-90459 Nuremberg, Germany
Object:	**REYROLLE 5 Protection Relays**
Type:	**REYROLLE 5 Devices**
Manufacturer:	SIEMENS AG EM DG PRO MF GOA

Test Program
Details the results of the environmental and functional type tests for the Reyrolle 5 Overcurrent protection relays, and the Reyrolle 5 Transformer protection relays, which have IEC 61850 communication capability.

The relays used in the hardware and functional tests were selected from the range of hardware variations available to the Reyrolle 5 series and the functional tests applied to prove the Reyrolle 5 with IEC 61850 communication capability.

All tests were carried out within testing facilities within Siemens and demonstrate that the relays performed within the claims of the Performance Specification and in compliance with the relevant Standards.

Summary and Test Result
The tests were passed successfully and the specified requirements were met.

Prepared by:	Miss Shaunna Coyle Test Engineer Siemens SI DG SPD R&D 4	Scoyle Digitally signed by Coyle Shaunna DN: serialNumber=Z0035X8C, givenName=Shaunna, sn=Coyle, o=Siemens, cn=Coyle Shaunna Date: 2019.11.11 12:46:24 Z Signature	Date
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This report consists of 12 pages

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1 Introduction

This report identifies the environmental type tests that were applied to relays representing the range of hardware builds on the Reyrolle 5 platform with IEC 61850 communication capability and the functional type tests that were applied to the Reyrolle 5 Overcurrent relays and Transformer relays.

The relay operational and functional claims made in the Technical Documentation are mainly based on IEC Product Standards. Where Product Standards are not available, reference may be made to either the IEC Generic Standards or other current Standards such as EATS.

The Technical Documentation for the Devices consists of the following set of documents:

1. Introduction
2. Basic Structure of the Device Functionality
3. Device Functionality
4. Application Function Templates
5. Protection and Automation Functions
6. Supervision Functions
7. Control Functions
8. Instruments and Meters
9. Functional Tests
10. Technical Data

The Technical Documentation for the Hardware consists of the following documents:

1. Introduction
2. Devices and Front Fascia Panels
3. Electronic Modules
4. Working with the Device
5. Technical Data
6. Ordering Information

The requirements of the quoted standards are generally similar to those of other standards authorities throughout the world and form a basis for demonstrating relay compliance with the claims of the Performance Specification.

Also included in this report are the production software references and the product reference codes which are termed the MLFB structure.

2 Software / Firmware References

The production software references are applicable for versions up to and including:

REYROLLE 5 Non-Directional Overcurrent 7SR5110	v02.00
REYROLLE 5 Directional Overcurrent 7SR5111	v02.00
REYROLLE 5 Two Winding Transformer 7SR542	v02.00
REYROLLE 5 Three Winding Transformer 7SR543	v02.00

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3 MLFB Structure – Reyrolle 511 (Overcurrent)

REYROLLE

ORDER-No.:	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16	
	n	a	a	n	n	n	n	-	n	a	a	n	n	-	n	a	a	n	-

ORDER-No.:	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16	
	7	S	R	5	1	1	n	-	n	A	A	n	n	-	0	A	A	0	-

Overcurrent: I/O Configurations — 7 / 8

4CT, 8BI, 6BC	0	-	1	1
4CT, 13BI, 8BO	0	-	2	1
4CT, 38BI, 18BO	0	-	7	6

Directional Overcurrent: I/O Configurations — 7 / 8

4CT, 4VT, 9BI, 8BO	1	-	1	1
4CT, 4VT, 14BI, 10BC	1	-	2	6
4CT, 4VT, 39BI, 20BC	1	-	7	6

CPU/ Data Comms — 11

Standard: 1 x USB (front) , RS485 (rear) ports, plus:-

2 x RJ45 ports	1
2 x Optical LC ports	2

Case & Fascia — 12

Size 6 case	1
Size 12 case	6

Export Data
HS: 8536900
ECCN: EAR99
AL: N

CT inputs: 1 A / 5 A, 50 Hz / 60 Hz
VT inputs: 40 V to 160 V, 50 Hz / 60 Hz
PSU: DC 24 V to DC 250 V, AC 100 V to AC 230 V
BI: DC 24 V / DC 110 V / DC 220 V
IEC 61850 ethernet, Modbus RTU, IEC 60870-5-103, DNP 3.0

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4 MLFB Structure – Reyrolle 54 (Transformer)

REYROLLE

	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16	
ORDER-No.:	n	a	a	n	n	n	n	-	n	a	a	n	n	-	n	a	a	n	-

	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16	
ORDER-No.:	7	S	R	5	4	n	n	-	n	A	A	n	6	-	0	A	A	0	-

2 Wdg. Transformer: I/O Configurations	6	7		8
8CT, 16BI, 8BO	2	0	-	2
8CT, 4VT, 12BI, 8BO	2	1	-	1
8CT, 4VT, 37BI, 18BC	2	1	-	6

3 Wdg. Transformer: I/O Configurations	6	7		8
12CT, 24BI, 10BO	3	0	-	3
12CT, 4VT, 35BI, 16BO	3	1	-	5

CPU/ Data Comms	11
Standard: 1 x USB (front) , RS485 (rear) ports, plus:-	
2 x RJ45 ports	1
2 x Optical LC ports	2

Case & Fascia	12
Size 12 Case	6

Export Data
HS: 8536900
ECCN: EAR99
AL: N

CT inputs: 1 A / 5 A, 50 Hz / 60 Hz
VT inputs: 40 V to 160 V, 50 Hz / 60 Hz
PSU: DC 24 V to DC 250 V, AC 100 V to AC 230 V
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5 Environmental Tests

Standard	Test Description	Severity	Test Result
IEC 60255-27 IEC 60255-1 IEC 60068-2-1	Temperature cold heat	Operate : 96hrs @ -10°C. Storeage : 96hrs @ -25°C.	Pass
IEC 60255-27 IEC 60255-1 IEC 60068-2-2	Temperature dry heat	Operate : 96hrs @ +55°C. Storeage : 96hrs @ +70°C.	Pass
IEC 60255-1 IEC 60068-2-14	Cyclic temperature	+20°C(ambient), -25°C, +70°C, -25°C, +70°C, +20°C(ambient).	Pass
IEC 60255-27 IEC 60255-1 IEC 60068-2-78	Relative humidity - steady state	56 days @ +40°C 93% r.h.	Pass
IEC 60255-27 IEC 60255-1 IEC 60068-2-30	Relative humidity - cyclic	+25°C 97%rh, +40°C 93%rh, 6 cycles of 24hr duration.	Pass
IEC 60255-27 BS EN 60529	Enclosure	IP54 – Front Panel IP4X – Rear Metal Box IP2X – Rear Wiring Terminal Access	Pass
IEC 60255-27 IEC 60255-21-1	Vibration tests (sinusoidal)	Class 1, 0.5gn operational, 1gn endurance.	Pass
IEC 60255-27 IEC 60255-21-2	Shock and bump tests	Class 1, 5gn operational, 10gn and 15gn withstand.	Pass
IEC 60255-27 IEC 60255-21-3	Seismic tests	Class 1, 1gn horizontal and 0.5gn vertical.	Pass
IEC 60255-27	Aux supply - Reverse polarity and slow ramp	Single wide voltage range PSU.	Pass
IEC 60255-26 IEC 61000-4-11	Aux supply - A.C. and d.c. Voltage interruptions	Single wide voltage range PSU, 50ms withstand at minimum voltage.	Pass
IEC 60255-26 IEC 61000-4-29	Aux supply - A.C. and d.c. Voltage dips	Single wide voltage range PSU, 50ms withstand at minimum voltage.	Pass
IEC 60255-26 IEC 61000-4-17	A.C. component in d.c. (ripple)	Single wide voltage range PSU, 15%.	Pass
IEC 60255-26	Gradual shutdown/start-up (for d.c. power supply)	Single wide voltage range PSU.	Pass
IEC 60255-27	Aux supply - Burden	Single wide voltage range PSU.	Pass
IEC 60255-1	Aux supply - Inrush	Single wide voltage range PSU.	Pass
EATS 48-4	DC supply voltage - high burden trip relays - capacitive discharge.	ES 1 & 2, Binary inputs pick-up, drop-off, operate time, switched non-operate current, capacitive discharge, thermal withstand.	Pass
IEC 60255-27 EATS 48-5	Thermal requirements - CT inputs.	4xIn continuous, transducer burden, relay dc burden, transducer thermal withstand.	Pass
IEC 60255-27 EATS 48-5	Thermal requirements - VT inputs.	300V continuous, transducer burden, relay dc burden, transducer thermal withstand.	Pass
IEC 60255-27	Insulation - dielectric.	2.5KVrms, 50Hz, 1min common mode, 1KVrms, contacts.	Pass
IEC 60255-27	Insulation - impulse voltage.	5KVpk, 1.2/50µs.	Pass

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Standard	Test Description	Severity	Test Result
IEC 60255-27	Insulation - dc resistance.	>100MΩ @ 500Vdc.	Pass
IEC 60255-26 IEC 61000-4-18	1MHz - Slow Damped Oscillatory	2.5kVpk common mode & 1kVpk differential mode, 1MHz exponentially decaying.	Pass
IEC 60255-26 IEC 61000-4-2	Electro Static Discharge	Class 4 ±15KV air discharge.	Pass
IEC 61000-4-3	Radiated e/m field disturbance (RFI), inc. Radio telephones.	10V/m, 80% modulated. Sweeps 80MHz - 1000MHz, 1400MHz - 2700MHz Spot 80, 160, 380, 450, 900, 1850, 2150 MHz.	Pass
IEC 60255-26 IEC 61000-4-4	Fast transient/burst immunity (Electrical Withstand Tests).	Zone A, 4kV, 5kHz, General, 2kV, 5kHz, Comms.	Pass
IEC 60255-26 IEC 61000-4-5	Surge Immunity	Analog Inputs Line to Earth – 4kV. Case, Aux Power & I/O Line to Earth – 4kV. RS485 Comms port Line to Earth – 4kV. RJ45 Ethernet port Line to Earth – 4kV. Analog Inputs Line to Line – 2kV. Case, Aux Power & I/O Line to Line – 2kV.	Pass
IEC 60255-26 IEC 61000-4-6	Conducted RFI Immunity.	10Vrms 80% modulated. Sweep 0.15MHz - 80MHz. Spot 27, 68 MHz.	Pass
IEC 60255-26 IEC 61000-4-8	Power frequency magnetic field immunity.	Level 5, 100A/m Continuous, 1000A/m Pulsed.	Pass
IEC 60255-26	Power frequency interface - general.	Zone A, Binary outputs at 300V common and 150V differential modes.	Pass
IEC 60255-26 CISPR 22	Conducted Emissions	0.15 - 0.5 MHz 79 µVdB or 66µVdB Ave., 0.50 - 30 MHz 73 µVdB Quasipeak or 60µVdB Ave.	Pass
IEC 60255-26 CISPR 11 CISPR 22	Radiated Emissions	30 – 230MHz 50 µVdB Quasipeak @ 3m 230 – 1000MHz 57 µVdB Quasipeak @ 3m 1 – 3GHz 56 µVdB Average @ 3m 76 µVdB Quasipeak @ 3m 3 – 6GHz 60 µVdB Average @ 3m 80 µVdB Quasipeak @ 3m	Pass
IEC 60255-27 IEC 60255-1	Contact performance	Mechanical Endurance Loaded Contact ≥10000 cycles Making ≥1000 cycles Breaking ≥1000 cycles Limited Making Capacity ≥1000W @ L/R = 40ms Contact Current Continuous ≥5A Short Term ≥30A, 200ms Limited Breaking Capacity ≥30W @ L/R = 40ms	Pass

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6 Functional Tests

IEC Function	Description	Overcurrent	Directional OC	2-Winding Transformer	3-Winding Transformer	Test Result
21LB	**Load Blinder** Used to block tripping during sustained heavy load periods in distribution networks		X	X		Pass
24DT	**Over Fluxing (DTL)** The flux in the transformer core is directly proportional to the applied voltage and inversely proportional to the frequency. An increase in transformer terminal voltage or a decrease in frequency will result in an increase in the flux. Over-excitation results in excess flux, which causes transformer heating and increases exciting current, noise and vibration. DTL elements.			X	X	Pass
24IT	**Over Fluxing (IDMTL)** The flux in the transformer core is directly proportional to the applied voltage and inversely proportional to the frequency. An increase in transformer terminal voltage or a decrease in frequency will result in an increase in the flux. Over-excitation results in excess flux, which causes transformer heating and increases exciting current, noise and vibration. IDMTL elements			X	X	Pass
27	**Under Voltage** Used to indicate that voltage has decreased to below an acceptable level or ceased to flow, or a low voltage situation exists. For this reason simple Definite Time Lag (DTL) elements may be used. Identical DTL elements.		X	X	X	Pass
27Vx	**Vx Under Voltage** DTL element, configured as an Under Voltage function		X	X	X	Pass
32	**Directional Power Voltage Protection: Power** 32 Power is derived from three phase voltages and currents and is generally applied as a reverse element to detect that the motor has stopped acting as a generator.		X			Pass
37	**Undercurrent** Used to indicate that current has ceased to flow or that a low load situation exists. For this reason simple Definite Time Lag (DTL) elements may be used.	X	X	X	X	Pass
37G	**Undercurrent – Measured E/F** Used to indicate that current has ceased to flow or that a low load situation exists. For this reason simple Definite Time Lag (DTL) elements may be used.	X	X	X	X	Pass
46BC	**Broken Conductor / Open Circuit** Allows the detection of a broken conductor.	X	X	X	X	Pass
46DT	**Instantaneous Negative Phase Sequence Overcurrent** Measures the quantity of unbalanced current in the three phase system.	X	X	X	X	Pass
46IT	**Time Delayed Negative Phase Sequence Overcurrent** Measures the quantity of unbalanced current in the three phase system.	X	X	X	X	Pass

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IEC Function	Description	Overcurrent	Directional OC	2-Winding Transformer	3-Winding Transformer	Test Result
47	**Negative Phase Sequence Voltage** Allows the detection of unbalance between phases by negative phase sequence voltage.		X	X	X	Pass
49	**Thermal Overload** Provides the thermal overload protection for static plant.	X	X	X	X	Pass
50	**Instantaneous Phase Fault Overcurrent** Allows individually settable instantaneous phase fault overcurrent elements with individually mapped binary outputs.	X	X	X	X	Pass
50AFD	**Arc Flash Detection (Includes 50GAFD)** Optical detection of arcing faults results in fast clearance of the fault.	X	X			Pass
50BF	**CB Fail** Allows the detection of a CB failure.	X	X	X	X	Pass
50G	**Instantaneous Measured Earth Fault Overcurrent** Allows individually settable instantaneous measured earth fault overcurrent elements with individually mapped binary outputs.	X	X	X	X	Pass
50GS	**Instantaneous Sensitive Earth Fault Overcurrent** Allows the use of individually settable instantaneous sensitive earth fault overcurrent elements with individually mapped binary outputs.	X	X			Pass
50N	**Instantaneous Calculated Earth Fault Overcurrent** The 50N function has the facility to allow the use of individually settable instantaneous derived earth fault overcurrent elements, with individually mappable binary outputs.	X	X	X	X	Pass
50SOTF	**Switch Onto Fault** If a fault appears on the line during the Close Pulse. This prevents a CB being repeatedly closed onto a faulted line.	X	X			Pass
50GSOTF	**Switch Onto Fault** If a fault appears on the line during the Close Pulse. This prevents a CB being repeatedly closed onto a faulted line.	X	X			Pass
51	**Time Delayed Phase Fault Overcurrent** Allows the use of individually settable time delayed phase fault overcurrent elements with individually mapped binary outputs.	X	X	X	X	Pass
51CL	**Cold Load Pickup** Allows a group of settings to be dedicated to be Cold Load settings. These Cold Load settings are active during energisation of the protected section of the power system and generally have more robust settings than the nominal settings to allow higher currents to flow during line charging. After stabilisation of the power system the relay settings are transferred to the nominal settings. The relay monitors the protected section of the power system, detects the opening of the associated circuit breaker and transfers the active setting to the Cold Load settings, in preparation for closing of the circuit breaker.	X	X	X	X	Pass

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IEC Function	Description	Overcurrent	Directional OC	2-Winding Transformer	3-Winding Transformer	Test Result
51G	**Time Delayed Measured Earth Fault Overcurrent** Allows the use of individually settable time delayed measured earth fault overcurrent elements with individually mapped binary outputs.	X	X	X	X	Pass
51GS	**Sensitive Earth Fault** Allows the use of individually settable instantaneous sensitive earth fault overcurrent elements with individually mapped binary outputs.	X	X			Pass
51N	**Time Delayed Calculated Earth Fault Overcurrent** The 51N function has the facility to allow the use of individually settable time delayed derived earth fault overcurrent elements, with individually mappable binary outputs.	X	X	X	X	Pass
51V	**Voltage Dependant Overcurrent** Used to increase the sensitivity of the Phase Fault current characteristic. This is achieved by reducing the pick up level of the over current protection when the system voltage drops below a settable level. The increase in current sensitivity is a pre-selected menu option.		X	X		Pass
55	**Power Factor** Low / High Power Factor Protection. Can be blocked if all phase voltages fall below setting.		X			Pass
59	**Over Voltage** Used to indicate that voltage has increased to above an acceptable level. For this reason simple Definite Time Lag (DTL) elements may be used.		X	X	X	Pass
59NDT	**Neutral Voltage Displacement (DTL)** DTL Over-voltage element Vx = directly measured from Auxiliary VT Vn = calculated from Phase VTs		X	X	X	Pass
59NIT	**Neutral Voltage Displacement (IDMTL)** Over-voltage element configurable as DTL or IDMTL Vx = directly measured from Auxiliary VT Vn = calculated from Phase VTs		X	X	X	Pass
59Vx	**Vx Over Voltage** DTL element, configured as an Over Voltage function		X	X	X	Pass
60CTS-I	**CT Supervision (current only)** Allows the detection of a CT failure when only current monitoring is available.	X	X	X	X	Pass
60CTS-V	**CT Supervision (voltage reference)** Allows the detection of a CT failure when current and voltage monitoring are available.		X			Pass
60VTS	**VT Supervision** Allows the detection of a 1, 2 or 3 phase VT failures.		X	X	X	Pass
67	**Directional Instantaneous Phase Fault Overcurrent** The directional element produces forward and reverse outputs which can then be used as controls to each phase fault instantaneous over-current elements.		X			Pass

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IEC Function	Description	Overcurrent	Directional OC	2-Winding Transformer	3-Winding Transformer	Test Result
67G	**Directional Instantaneous Measured Earth Fault** The directional element produces forward and reverse outputs which can then be used as controls to each measured earth fault instantaneous over-current elements.		X			Pass
67GS	**Directional Instantaneous Sensitive Earth Fault** The directional element produces forward and reverse outputs which can then be used as controls to each sensitive earth fault instantaneous over-current elements.		X			Pass
67N	**Directional Instantaneous Calculated Earth Fault** The directional element produces forward and reverse outputs which can then be used as controls to each derived earth fault instantaneous over-current elements.		X			Pass
74CCS	**Close Circuit Supervision** Provides circuit supervision elements and monitors the close circuit wiring.	X	X	X	X	Pass
74TCS	**Trip Circuit Supervision** Provides circuit supervision elements and monitors the trip circuit wiring.	X	X	X	X	Pass
78VS	**Vector Shift** Detects a vector shift in all three phase system voltages over a half-cycle window. The function is used to detect islanding or loss of connection between a generator and the main utility supply.		X			Pass
79	**Autoreclose** Multishot Delayed Autoreclose with configurable sequences.	X	X			Pass
81	**Under / Over Frequency** Identical DTL elements, each configurable as Under or Over Frequency function. Inhibited by low voltage detection.		X	X	X	Pass
81HB2	**2nd harmonic / Inrush Detector** Used to block the operation of selected elements during transformer magnetising inrush conditions.	X	X	X	X	Pass
81HB5	**5th harmonic / Inrush Detector** Used to block the operation of selected elements during transformer magnetising inrush conditions.			X	X	Pass
81R	**Rate Of Change Of Frequency** The ROCOF measurements are done on all three phases simultaneously and the final tripping decision is determined from the phase voltage with highest magnitude. The adjustment will be done in Hz per second [Hz/s]. DTL elements with an Inhibit input and a Trip output.		X			Pass
87GH	**High Impedance REF** The single phase current input is derived from the residual output of line/neutral CTs connected in parallel. An external stabilising resistor must be connected in series with this input to ensure that this element provides a high impedance path.	X	X	X	X	Pass
87T-BD	**Biased Differential** Transformer differential element			X	X	Pass

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IEC Function	Description	Overcurrent	Directional OC	2-Winding Transformer	3-Winding Transformer	Test Result
87T-HS	**Differential Highset** Transformer highest element			X	X	Pass
Control & Logic	**Circuit Breaker Control** Configurable settings for the Circuit Breakers.	X	X	X	X	Pass
-	**CT/VT Config (52)** Phase rotation and Phase Connections allocation.	X	X	X	X	Pass
-	**Demand Metering** Statistical analysis of metering over a given time period.	X	X	X	X	Pass
-	**CB Counters (52)** Displays the number of trips and opens issued by the device. Contains CB Total Trip Counter and CB Delta Trip counter	X	X	X	X	Pass
-	**CB Position Monitoring (52)** The position of CB can be monitored.	X	X	X	X	Pass
-	**Measurands - Instruments and Meters** Metering values produced by the relay.	X	X	X	X	Pass
-	**DNP3** Functional check of elements.	X	X	X	X	Pass
-	**Modbus** Functional check of elements.	X	X	X	X	Pass
-	**IEC60870-5-103** Functional check of elements.	X	X	X	X	Pass
-	**IEC61850** Functional check of elements.	X	X	X	X	Pass

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