

## Test Report

Test Report Number: **TS0816-001**  
Date of issue: **2018-05-31**

**Subject:**

**Hardware Type Test for Product Family SIPROTEC 5, V07, Edition 6**  
**For device types see range of validity**

**The tests were conducted by:**

SIEMENS AG  
Type Test Department  
EM DG PRO LM&D PMV D4  
Wernerwerkdam 5  
13629 Berlin  
Germany

external tests  
see subcontracting

**The tests were conducted for (client):**

SIEMENS AG  
Products  
EM DG PRO LM&D  
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90459 Nuremberg  
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This test report consists of 56 pages.

**Hardware Type Test Product Family SIPROTEC 5, V07**  
For device types s. range of validity

**Applied Standards:** IEC/EN 60255 series, VDE 0435, IEC/EN 61000-6-2/4/5  
IEEE Std C37.90.1/2, UL 508  
*further standards s. specific tests*

**Performed tests:** 1 Ratings at reference conditions

2 Product safety tests

3 Enviromental tests

4 Electromagnetic compatibility tests

5 Approvals

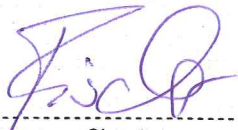
**Test results:** The equipment has successfully passed the type test. The equipment did not show any changes and was fully in order subsequent to these tests.

SIEMENS AG - EM DG PRO  
Energy Management Division  
Digital Grid

Place : EM DG PRO LM&D PMV D4  
13629 Berlin (Siemensstadt)  
Germany

Date: 2018-05-31

**Tested:** Fischer, Kai-Uwe

  
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Signature

**Reviewed:** Eckelmann, Florian

  
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Signature

**Scope of protocol**

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**Range of validity****SIPROTEC 5 devices:****Product designation of modular devices****Basic devices**

Line Protection	7SA84, 7SA86, 7SA87 7SD84, 7SD86, 7SD87 7SL86, 7SL87
Generator Protection	7UM85
Breaker Management	7VK87
Paralleling Device	7VE85
Overcurrent Protection	7SJ85, 7SJ86
Bay Control Unit	6MD85, 6MD86, 6MD89
Transformer Protection	7UT85, 7UT86, 7UT87
Railway Protection	7ST85
Fault Recorder	7KE85
Motor Protection	7SK85
Busbar Protection	7SS85

**Product designation of non-modular devices**

Overcurrent Protection	7SJ82
Motor Protection	7SK82
Transformer Protection	7UT82
Line Protection	7SA82, 7SD82, 7SL82

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**Range of validity****SIPROTEC 5 Platform and Hardware Characteristics**

*The SIPROTEC 5 series includes both modular and non-modular devices.*

*Modular devices consist of a base module (1/3 of 19 inches) and can be expanded with expansion modules (1/6 of 19 inches). The device type identifier for modular devices is XXX85, XXX86 or XXX87, for example, 7SA86*

*Type XXX84 devices have the same hardware properties as the modular devices, but they cannot be expanded with expansion modules.*

*All non-modular devices consist of just a base module (1/3 of 19 inches) and cannot be expanded with expansion modules (1/6 of 19 inches). The device type identifier for non-modular devices is 7XX82, for example, 7SJ82.*

**Hardware Characteristics of Modular Devices**

*A modular device always consists of a base module and optionally of expansion modules. The modules can be chosen according to hardware characteristics. These characteristics are:*

- *Module size*
- *Type of construction*
- *Mounting of the on-site operation panel*
- *Layout (or design) of the on-site operation panel*
- *Input and output module*
- *Plug-in modules*

*The modules are available in 2 sizes:*

- *Base module (1/3 of 19 in)*
- *Extension module (1/6 of 19 in)*

*The devices are available in 3 designs:*

- *Flush-mounting devices with on-site operation panel fitted directly on the device*
- *Surface-mounting devices with integrated on-site operation panel*
- *Surface-mounting devices with detached on-site operation panel*

*The on-site operation panels of the base modules can be selected from 3 variants:*

- *With a large display, keypad, and 16 2-colored LEDs*
- *With a small display, keypad, and 16 2-colored LEDs*
- *Without a display, without a keypad (standard), but with 16 2-colored LEDs*

*The on-site operation panels of the extension modules can be selected from 3 variants:*

- *With 16 1-colored LEDs and 2 key switches*
- *With 16 1-colored LEDs*
- *Without display elements*

The base module always contains the central processor board CP200/CP300, the power-supply module PS201 and an input and output module IO2XX.

The extension module contains an input and output module IO2XX or a plug-in module assembly with integrated power supply CB202.

The 1<sup>st</sup> extension module in the 2<sup>nd</sup> device row always contains the power supply module PS203.

The plug-in modules are available for various applications. The following plug-in modules can be installed in the base module or in an extension module with plug-in module assembly with integrated power supply CB202:

- Communication module
- Measuring-transducer module
- Arc-protection module

### **Hardware Characteristics of Non-Modular Devices**

A non-modular device always consists of just one module (1/3 of 19 inches) and cannot be expanded with expansion modules (1/6 of 19 inches). These hardware characteristics are:

- Module size: 1/3 of 19 in.
- Type of construction: Flush-mounting devices with on-site operation panel fitted directly on the device

The on-site operation panels can be chosen from 2 variants:

- With a large display, keypad, and 16 2-colored LEDs
- With a small display, keypad, and 16 2-colored LEDs

The module always contains the central processor board CP100, the power supply module PS101 and an input and output module IO10X. The input and output module IO10X includes the terminals for current and voltage transformers.

Optionally, the module can be equipped with an additional input and output module IO110 for extra binary inputs and outputs.

The plug-in modules are available for various applications. The following plug-in modules can be installed in the module:

- Communication modules
- Measuring-transducer modules
- Arc-protection module

### **Range of validity**

All hardware type tests were performed at various combinations with all modules of the SIPROTEC 5 platform. Therefore all realized devices were covered:

**Functional description of boards for modular devices**

Module	Functional description
PS201	Power Supply Board (DC: 24 V/48 V or 60 V to 250 V and AC: 100 V to 230 V), mounted in 1/3 19-inch size housing, including 3 binary inputs, 2 binary outputs and one status life contact
PS203	Power Supply Board for the 2 <sup>nd</sup> device row, (DC: 24 V/48 V or 60 V to 250 V and AC: 100 V to 230 V), mounted in 1/6 19-inch size housing
CB202	Plug-in module assembly, including an additional power supply, (DC: 24 V/48 V or 60 V to 250 V and AC: 100 V to 230 V), mounted in 1/6 19-inch size housing
CP200	Processor (Single Core CPU) Board, mounted into the front cover of the 1/3 19-inch size housing, different variants for the available device designs
CP300	Processor (Dual Core CPU) Board, SD-Slot, mounted into the front cover of the 1/3 19-inch size housing, different variants for the available device designs
IO201	Input Output Module, 4 current inputs, 8 binary inputs, 6 binary outputs, reduced assembled variant of IO202
IO202	Input Output Module, 4 current measuring inputs, 4 voltage measuring inputs, 8 binary inputs, 6 binary outputs, mounted in 1/6 or 1/3 19-inch size housing
IO203	Input Output Module, 8 current measuring inputs, 4 binary inputs, 4 binary outputs, mounted in 1/6 19-inch size housing
IO204	Input Output Module, 10 binary inputs, 4 binary outputs, 4 power relays for controlling 2 motors, mounted in 1/6 19-inch size housing
IO205	Input Output Module, 12 binary inputs, 16 binary outputs, mounted in 1/6 19-inch size housing
IO206	Input Output Module, 6 binary inputs, 7 binary outputs, mounted in 1/6 19-inch size housing, reduced assembled variant of IO205
IO207	Input Output Module, 16 binary inputs, 8 binary outputs, mounted in 1/6 19-inch size housing
IO208	Input Output Module, 4 current measuring inputs, 4 voltage measuring inputs, 4 binary inputs, 11 binary outputs, mounted in 1/3 or 1/6 19-inch size housing
IO209	Input Output Module, 8 binary inputs, 4 High Speed Outputs, mounted in 1/6 19-inch size housing
IO210	Input Output Module, 4 current measuring inputs, 3 voltage measuring inputs, 7 binary outputs, 4 high-speed transducer inputs current/voltage, mounted in 1/6 19-inch size housing
IO211	Input Output Module, 8 voltage measuring inputs, 8 binary inputs, mounted in 1/6 or 1/3 19-inch size housing
IO212	Input Output Module, 8 binary inputs, 8 high-speed transducer inputs current/voltage, mounted in 1/6 19-inch size housing
IO214	Input Output Module, 4 current measuring inputs, 4 voltage measuring inputs, 2 binary in-puts, 5 binary outputs, mounted in 1/6 or 1/3 19-inch size housing, reduced assembled variant of IO202
IO215	Input Output Module, 4 current measuring inputs, 4 voltage measuring inputs (designed for a measuring range up to 7.07 V) 8 binary inputs, 6 binary outputs, mounted in 1/6 or 1/3 19-inch size housing
IO230	Input Module, 48 binary inputs, mounted in 1/6 19-inch size housing
IO231	Input Output Module, 24 binary inputs and 24 binary outputs
IO233	Input Module, 48 binary inputs, mounted in 1/6 19-inch size housing
PB201	Process-Bus Module, 7 LC Duplex interfaces of which 1 is a service port, mounted in 1/6 19-inch size housing

**Range of validity****Functional description of boards for non-modular devices**

Board	Functional description
IO101	Input Output Board, 4 current inputs, 8 binary inputs, 6 binary outputs, reduced assembled variant of IO102
IO102	Input Output Board, 4 current inputs, 4 voltage inputs, 8 binary inputs, 6 binary outputs
IO103	Input Output Board, 8 current inputs, 4 binary inputs, 4 binary outputs
IO110	Input Output Board, 12 binary inputs, 7 binary outputs
IO111	Input Board, 12 temperature sensor inputs

**Functional description of plug-in modules for modular devices and for non-modular devices**

Plug-in module	Functional description
USART-xx <sup>1</sup> -y <sup>2</sup> EL	Serial communication module, electrical connection
USART-xx <sup>1</sup> -y <sup>2</sup> FO	Serial communication module, optical connection
USART-xx <sup>1</sup> -y <sup>2</sup> LDFO	Serial communication module for long distances, optical connection
ETH-xx <sup>1</sup> -2EL	Ethernet module, electrical connection
ETH-xx <sup>1</sup> -2FO	Ethernet module, optical connection
ANAI-CA-4EL	Measuring-transducer module
ARC-CD-3FO	Arc Protection module

Valid for all firmware and DIGSI versions.

<sup>1</sup> 2 letters, unique code of the Module in the product code of the device

<sup>2</sup> 1 = 1 channel, 2 = 2 channels



## Scope of editions

<b>Edition</b>	<b>Date</b>	<b>Modifications or supplements compared to the former edition</b>
1	2016-01-06	First edition for SIPROTEC 5 platform Version 07 with devices and boards according "Range of validity"
2	2016-07-21	Second edition for SIPROTEC 5 platform with updates regarding V7.30 release (IO210, new test reports)
3	2018-05-31	Third edition with update regarding IP-Rating (IEC 60529)
4	2017-07-15	Fourth edition for SIPROTEC 5 platform V7.50 release (6MD89, IO111 and reference to latest test reports)
5	2017-11-12	Fifth edition for SIPROTEC 5 platform V7.50 release (add of IO233, update of climatic test statement regarding crpto chip, update to latest test reports)
6	2018-05-31	Sixth edition for SIPROTEC 5 platform V7.80 release (new device 7VE85, update regarding latest test reports)

**Overview of external test labs and test reports****EMC Test laboratories**

## Test report number

**PRO EMV Labor Strausberg GmbH**

(Dakks: D-PL-12052-01-00)

Garzauer Chaussee

15344 Strausberg

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PLE100502

PLE100621

PLE100720

PLE101213

PLE101214

PLE110116

PLE110117

PLE110204

PLE110501

PLE110825

PLE120513

PLE120903

PLE121006

PLE130105

PLE130216

PLE130601

PLE130807

PLE130809

PLE130902

PLE130921

PLE131210

PLE140415

PLE140509

PLE140911

PLE140918

PLE141104

PLE150810

PLE150818

**Eurofins Product Service GmbH**

(A2LA: 1983.00 / Dakks : D-PL-12092-01-00)

Storkower Str. 38c

15526 Reichenwalde

Germany

G0M-1507-4895-EE02-V01

G0M-1503-4617-EE01-V02

G0M-1604-5556-EI01GEN-V01

G0M-1612-6162-ES01ET-V01

G0M-1611-6062-EE01GEN-V01

G0M-1706-6597-EI01GEN-V02

G0M-1706-6598-EI01GEN-V01

G0M-1710-6934-EI01GEN-V01

G0M-1710-6934-EI02GEN-V01

**Environmental test laboratories**

## Test report number

**AUCOTEAM GmbH Berlin**(DakkS: D-PL-19102-01-00)  
Storkower Str. 115 a  
10407 Berlin  
Germany6892 / 08  
6893 / 08  
6894 / 08  
6895 / 08  
6799.03 / 08  
7156 / 09  
7352 / 09  
7763 / 10  
7779 / 10  
7828.01 / 10  
7829.01 / 10  
7829 / 10  
7862 / 10  
7827.01 / 10  
7827.02 / 10  
8122 / 10  
8325 / 11  
9291 / 12  
9577 / 12  
9752 / 13  
9760 / 13  
9830 / 13  
9865 / 13  
9889 / 13  
10034 / 13  
10093 / 13  
10094 / 13  
10077.02 / 13  
10134 / 13  
10478.01 / 14  
10478.02 / 14  
10569 / 14  
11605 / 15**RST Rail System Testing GmbH**(Dakks: D-PL-11012-01)  
Walter-Kleinow-Ring 7  
16761 Hennigsdorf  
GermanyP50-09-0057  
P50-09-0102  
P50-10-0111  
P50-15-0191  
P50-15-0376  
P50-16-0239  
P50-17-0239  
P50-17-0568**TZO**Labor für Umwelterprobung und Werkstoffprüfung  
(Dakks: D-PL-11034-01-00)

151/10

**SCUS**Servicecenter Umweltsimulation  
(Dakks: D-PL-11195-01-00)  
Heidelberger Str. 20  
01189 Dresden  
Germany100415-01  
100416-01**VDZ GmbH**(VDA authorized)  
Giselherstraße 34  
44319 Dortmund  
Germany060410  
20141030

**Product Safety Tests****Test report number****I<sup>2</sup>PS**

Institute for International Product Safety  
(listed in ALPHA and LOVAG register under Identity Number D 01)  
Prüflaboratorium Bonn  
Hein-Moeller-Str. 7-11  
53115 Bonn  
Germany

1001769  
1001770  
1001773  
1001774  
1001775  
1001777

**DNV GL – KEMA Test Lab**

(RvA: L218)  
Utrechtseweg 310  
6800 ET, Arnhem  
The Netherlands

1250-15 V1

**Eurofins Product Service GmbH**

(A2LA: 1983.00 / Dakks : D-PL-12092-01-00)  
Storkower Str. 38c  
15526 Reichenwalde  
Germany

G0M-1411-4316-SEC027N-V04  
G0M-1411-4317-SEC027N-V06

**Analytic test of material**

Prüflabor Helmut W. E. Lüdemann  
Labor für instrumentelle Analytik  
Heinrich-Hertz-Str. 16  
23909 Ratzeburg  
Germany

Report no.: 6829

**UL / CSA Certification**

UL International Germany GmbH  
63263 Neu-Isenburg  
Germany

Report Reference for modular  
devices:  
File E194016, volume 1, section 16

Report Reference for non-modular  
devices:  
File E194016, volume 1, section 22

## Technical information; Technical data

## Technical Information; Description:

Manual		Edition
1.	<b>SIPROTEC 5</b> Schutzgeräte Produktinformation Bestell-Nr. C53000-B5000-C001	German
2.	<b>SIPROTEC 5</b> Protection Devices Product Information Part No. C53000-B5040-C001	English
3.	<b>SIPROTEC 5</b> Hardware Handbuch Bestell-Nr. C53000-G5000-C002	German
4.	<b>SIPROTEC 5</b> Hardware Manual Part No. C53000-G5040-C002	English
5.	<b>SIPROTEC 5</b> Betrieb Handbuch Bestell-Nr. C53000-G5000-C003	German
6.	<b>SIPROTEC 5</b> Operating Manual Part No. C53000-G5040-C003	English
7.	<b>SIPROTEC 5</b> Gerätehandbücher	German
8.	<b>SIPROTEC 5</b> Device Manuals	English

For the technical data see the description (Technical Information).

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**Appendix A : List of used standards**

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<b>0</b>	<b>General</b>				
0.1	<b>Standards</b>	For the date references of the standards, only the edition cited applies. For undated references, the currently published edition at the date of issue for this type test protocol applies.			
<b>1</b>	<b>Ratings at reference conditions</b>	reference conditions - VDE 0435-300 - IEC/EN 60255-1 table 1, 2			- Eurofins Product Service GmbH Reichenwalde, Germany Test passed see Report G0M-1411-4316-SEC027N-V04 see Report G0M-1411-4317-SEC027N-V06
1.1	<b>Burden / Power Consumption</b>	- VDE 0435-300 - IEC 60255-1, Section 6.10			
1.1.1	Current Inputs		Burden at the terminals of current input		Flush-mounting and Surface-mounting Housing, modular and non-modular devices
1.1.1.1	Protection transformer inputs	$I_N = 1 \text{ A}$ and $I_N = 5 \text{ A}$			Related to $I_N$ / Phase S approx. 0.1 VA
1.1.1.2	Instrument transformer inputs	$I_N = 1 \text{ A}$ and $I_N = 5 \text{ A}$			Related to $I_N$ / Phase S approx. 0.1 VA

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
1.1.2	Voltage inputs	V = V <sub>N</sub> = 57.735 V in L-N	Burden at L1,L2,L3 and Ven,V4,VX	S ≤ 0.1 VA at 57.735 V/Phase	at 57.735 V S ca. 0.02 VA/Phase S approx. 0.02 VA/Phase
1.1.3	Auxiliary supply voltages and power consumption	modular devices  non-modular devices  1/3 base module without plug-in modules  1/6 expansion module  1/6 plug-in module assembly without plug-in modules  Plug-in module  display back light  each output relay	modular devices in quiescent state  non-modular devices in quiescent state  modular devices only  modular devices only	P ≤ 15 W S ≤ 40 VA S ≤ 30 VA  P ≤ 9 W S ≤ 20 VA S ≤ 15 VA  P ≤ 5 W S ≤ 9 VA  P ≤ 5 W S ≤ 20 VA S ≤ 10 VA  P ≤ 5 W S ≤ 10 VA  P ≤ 2 W  P ≤ 0.5 W	- DC 24 V/48 V - DC 60 V to 250 V and AC 100 V to 230 V, 50/60 Hz  - DC 24 V/48 V - DC 60 V to 125 V - DC 110 V to 250 V and AC 100 V to 230 V, 50/60 Hz  approx. 13 W 33 VA @ 230 V/50 Hz 24 VA @ 115 V/50 Hz  7 W 15 VA @ 230 V/50 Hz 11.5 VA @ 115 V/50 Hz  3 W 6 VA @ 115 V / 230 V/50 Hz  3.5 W 14 VA @ 230 V/50Hz 7 VA @ 115 V/50 Hz  approx. 3.5 W 6 VA @ 115 V / 230 V/50 Hz  1.5 W  0.3 W

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
1.1.4	Binary inputs		Power input at DC: $V_{an} \leq V \leq 300 \text{ V}$		DC: I approx. 0.6 to 2.5 mA (energized)
1.1.4.1	Selectable pickup threshold $U_{anSET}$ (with DIGSI)	for rated control voltage range		LOW = 40 % of rated control voltage HIGH = 80 % of rated control voltage	
	All modules with binary inputs except IO233	Range 1	Operating Voltage DC: 24 V, 48 V and 60 V		$V_{DC_{low}} \leq 10 \text{ V}$ $V_{DC_{high}} \geq 19 \text{ V}$
		Range 2	Operating Voltage DC: 110 V and 125 V		$V_{DC_{low}} \leq 44 \text{ V}$ $V_{DC_{high}} \geq 88 \text{ V}$
		Range 3	Operating Voltage DC: 220 V and 250 V		$V_{DC_{low}} \leq 88 \text{ V}$ $V_{DC_{high}} \geq 176 \text{ V}$
	IO233	Range 1	Operating Voltages DC: 129 V		$V_{DC_{low}} \leq 85 \text{ V}$ $V_{DC_{high}} \geq 105 \text{ V}$
1.2	<b>Limits of operation</b>	at all extremely load cases	V-DC: $0.80 \leq V/V_N \leq 1.20$ V-AC: $0.80 \leq V/V_N \leq 1.15$ at $0.95 \leq f/f_N \leq 1.05$  supervision of all internal voltages	V-DC: $0.80 \leq V/V_N \leq 1.20$ V-AC: $0.80 \leq V/V_N \leq 1.15$	No influence on the accuracy and function, no reaction off the internal voltage supervision
1.3	<b>Switching on/off</b>	- IEC 60255-1 - VDE 0435-300	V-DC: $0.80 \leq V/V_N \leq 1.20$ V-AC: $0.80 \leq V/V_N \leq 1.15$	a 6 A circuit breaker, characteristic C according to IEC 60898 must not trip	No maloperation

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
1.4	<b>Temperature</b>	- IEC/EN 60255-1 - VDE 0435-300  For all functions	$-10\text{ °C} \leq T_{amb} \leq +55\text{ °C}$	$\leq 0.5\text{ \%/10 K}$	$0.2\text{ \%/10 K}$ Deviation $\delta$ from measured value at reference conditions
1.5	<b>Frequency</b>	- IEC/EN 60255-1 - VDE 0435-300  For all functions	$0.95 \leq f/f_N \leq +1.05$		No additional deviation detected. Influence negligible

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2	<b>Product safety tests</b>				
2.1	<b>Insulation</b>	For all functions - IEC/EN 60255-5 - IEC/EN 60255-27 - IEC/EN 60870-2-1 - VDE 0435-327 - IEEE Std C37.90  Tests were carried out on a device in housing for panel flush mounting  (the panel surface mounting housings of the modular and non-modular devices are identical to panel flush mounting housings regarding the insulation tests)			- Eurofins Product Service GmbH Reichenwalde, Germany Test passed see Report G0M-1411-4316-SEC027N-V04 see Report G0M-1411-4317-SEC027N-V06
2.1.1	Clearances and creepage distances	- IEC/EN 60255-5 - IEC/EN 60255-27 - VDE 0435-327 - IEC/EN 61010-1	Clearances and creepage distances between all external circuits to each other and to the enclosure:  Clearances and creepage distances between all external circuits to the internal electronic circuit	≥ 4 mm  ≥ 6 mm	confirmed  confirmed

**TYPE TEST**

**Product Family SIPROTEC 5, V07**

**Summary**

**Edition 06**  
**Date 2018-05-31**  
**Report TS0816-001**  
**Sheet 0.6 - 6**

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.1.2	Dielectric test	- IEC/EN 60255-5 - IEC/EN 60255-27 - IEC/EN 60870-2-1 - VDE 0435-300 - IEEE Std C37.90	AC 2.5 kV, 50 Hz, 1 min  DC 3.5 kV, 30 s each polarity  DC 700 V, 30 s each polarity  AC 3.25 kV, 50 Hz, 1 min	all circuits except auxiliary dc voltage input, binary inputs and serial interfaces  auxiliary voltage input and binary inputs  only isolated serial interfaces  components designed for double/reinforced insulation	     Tested by: - DNV GL - Energy KEMA Laboratories, Arnhem Test passed (see KEMA Report 1250-15 V1) - Eurofins Product Service GmbH Reichenwalde, Germany Test passed see Report G0M-1411-4316-SEC027N-V04 see Report G0M-1411-4317-SEC027N-V06  No flash-over, no breakdown; The observed equipment had operated according to design requirements after test.     

**TYPE TEST**

**Product Family SIPROTEC 5, V07**

**Summary**

**Edition 06**  
**Date 2018-05-31**  
**Report TS0816-001**  
**Sheet 0.6 - 7**

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.1.3	Impulse voltage withstand test	- IEC/EN 60255-5 - IEC/EN 60255-27 - IEC/EN 60870-2-1 - VDE 0435-300 - IEEE Std C37.90	5 kV (peak value), 1.2 µs/50 µs, 0.5 J 5 positive and 5 negative shots at intervals of 1 s  6 kV (peak value) 1.2 µs/50 µs, 0.5 J 5 positive and 5 negative shots at intervals of 1 s  1 kV (peak value) 1.2 µs/50 µs, 0.5 J 5 positive and 5 negative shots at intervals of 1 s	Common-mode all circuits (except serial interfaces) differential-mode all circuits (except relay contacts)  components designed for double/reinforced insulation  common-node isolated serial shielded interfaces only	         Tested by: - DNV GL - Energy KEMA Laboratories, Arnhem Test passed (see KEMA Report 1250-15 V1) - Eurofins Product Service GmbH Reichenwalde, Germany Test passed see Report G0M-1411-4316-SEC027N-V04 see Report G0M-1411-4317-SEC027N-V06  The observed equipment had operated according to design requirements after test.     

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.2	<b>Protection against electric shock</b>	- IEC/EN 60255-5 - IEC/EN 60255-27			Tested by: - Eurofins Product Service GmbH Reichenwalde, Germany
2.2.1	Measurement of insulation resistance		for devices in a new condition  after damp heat test, 10 days	DC 500 V > 100 MΩ  DC 500 V > 10 MΩ	all circuits  all circuits
2.2.2	Protective bonding test	- IEC/EN 61140 - VDE 0140-1 protection class 1	tested acc. to IEC 61131-2 Item 12.2.2 30 A/ 2 min/ 0.1 Ω	≤ 0.1Ω	Insulation resistance > 100 MΩ  > 10 MΩ  The requirements are met ≤ 0.1 Ω all touchable ports against housing
2.3	<b>Flammability</b>	- IEC/EN 60255-1 - IEC/EN 60255-27 - VDE 0435-300			
2.3.1	Equipment temperature limits and protection against spread of fire		max. permissible continuous input values  max. permissible continuous load current of output relays	Temperature of accessible parts & enclosure < 70 °C at an ambient temperature of 40 °C	-confirmed  max. temperature rise at enclosure: Δt = 10 K No damage ; The observed equipment had operated according to design requirements after the test.



Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.3.2	Flammability of materials and components	- IEC/EN 60255-27 - VDE 0435-327 - UL508	t <sub>amb</sub> = 40 °C, full load operation  t <sub>amb</sub> = 70 °C quiescent state  Stress duration: t ≥ 8 h		No damage; no exceeding of critical temperatures for components  The observed equipment had operated according to design requirements after test.
2.4	<b>Wrong Polarity</b>	- IEC 60255-27 Wrong polarity for versions with  V <sub>N</sub> = DC: 24V, 48V  V <sub>N</sub> = DC: 60 V, 110 V, 125V, 220 V, 250V	Check if incorrect polarity of the auxiliary supply voltage may lead to the internal device fuse blowing.		No damage; no exceeding of critical temperatures for components
2.5	<b>Laser and IRED devices</b>	- IEC/EN 60825-1/-2 - VDE 0837 T1/2	Test of compliance with specified IRED class 1		confirmed by checking of manufacturer's technical data

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.6	<b>Mechanical resistance against shock and impact</b>	- IEC/EN 61010-1 - VDE 0411 Teil 1			
2.6.1	Rigidity test	- IEC/EN 61010-1 - VDE 0411 Teil 1	Test force with 30 N to any part of the enclosure which is accessible during operation		tested by - AUCOTEAM GmbH, 10407 Berlin The observed equipment had operated according to design requirements after the test.
2.6.2	Impact hammer test	- IEC/EN 61010-1 - VDE 0411 Teil 1	Stress: 3 hits with an energy of 5 J to all parts which are accessible in normal use		tested by - AUCOTEAM GmbH, 10407 Berlin The observed equipment had operated according to design requirements after the test.
2.7	<b>Protection degree provided by enclosure</b>	- IEC/EN 60529 - VDE 0470 Teil 1	modular and non-modular devices:  front side: IP54 rear side (terminals attached): IP20		tested by - Eurofins Product Service GmbH Reichenwalde, Germany  - RST Rail System Testing GmbH Hennigsdorf, Germany  - AUCOTEAM GmbH, Berlin, Germany  Test passed The observed equipment had operated according to design requirements after the test.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.8	<b>Load capacity</b>	- IEC/EN 60255-27 - VDE 0435-327			
2.8.1	Current circuits, thermal short-time ratings				
2.8.1.1	Standard inputs (protection-class current transformers)	in L1, L2, L3, N: 4 $I_N$ continuous 5 $I_N$ for 3 min 6 $I_N$ for 2 min 30 $I_N$ for 10 s 100 $I_N$ for 1 s	$I_N = 1 A, I_N = 5 A$		No damage ; The observed equipment had operated according to design requirements after test.
2.8.1.2	Ins-Input for high-sensitive earth fault detection (instrument transformers)	in L1, L2, L3, N: 4 $I_N$ continuous 5 $I_N$ for 3 min 6 $I_N$ for 2 min 30 $I_N$ for 10 s 100 $I_N$ for 1 s	$I_N = 1 A, I_N = 5 A$		Tested by: - DNV GL - Energy KEMA Laboratories, Arnhem Test passed (see KEMA Report 1250-15 V1) No damage ; The observed equipment had operated according to design requirements after test.  - Eurofins Product Service GmbH Reichenwalde, Germany Test passed see Report G0M-1411-4316-SEC027N-V04 see Report G0M-1411-4317-SEC027N-V06

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.8.2	Voltage circuits	230 V continuous IO102, IO202, IO208, IO211, IO214  20 V continuous IO215	230 V continuous  20 V continuous		Tested by: - DNV GL - Energy KEMA Laboratories, Arnhem Test passed (see KEMA Report 1250-15 V1) - Eurofins Product Service GmbH Reichenwalde, Germany Test passed see Report G0M-1411-4316-SEC027N-V04 see Report G0M-1411-4317-SEC027N-V06  No damage ; The observed equipment had operated according to design requirements after test.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.8.3	Output relays, contact performance  (Standard Relay: Type S, Fast Relay: Type F, High-Speed Relay with Semiconductor Acceleration: Type HS)	- IEC/EN 61810-1 - VDE 0435-201  - IEC/EN 60255-1 - VDE 0435-300  - IEEE Std C37.90	mechanical endurance unloaded min. 10 000 cycles  switching capacity make 1000 W/VA @ L/R = 40 ms for Type S and F  break 30 W/VA @ L/R = 40 ms for Type S and F  make/break 2500 W/VA @ L/R = 40 ms for Type HS  switching voltage AC/DC 250 V for Type S and F AC 200 V, DC 250 V for Type HS  permissible current continuous: 5A		tested: >12 000 cycles  No damage ; The observed equipment had operated according to design requirements after test.  Tested by: - DNV GL - Energy KEMA Laboratories, Arnhem Test passed (see KEMA Report 1250-15 V1)  - Eurofins Product Service GmbH Reichenwalde, Germany Test passed see Report G0M-1411-4316-SEC027N-V04 see Report G0M-1411-4317-SEC027N-V06  -Siemens AG, Berlin, Germany Type Test Laboratory see Report TS0717-006

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
		- IEC 60947-5-1	<p>Short-time capacity</p> <p>make and carry</p> <p>30 A for:</p> <p>0.2 s ON</p> <p>15 s OFF</p> <p>number of operations</p> <p>≥ 2000</p> <p>Short-time current across closed contact</p> <p>250 A for 30 ms</p> <p>3 operations with an interval of 10 s</p>		<p>Tested by:</p> <p>- DNV GL - Energy</p> <p>KEMA Laboratories, Arnhem</p> <p>Test passed (see KEMA Report 1250-15 V1)</p> <p>- Eurofins Product Service GmbH</p> <p>Reichenwalde, Germany</p> <p>Test passed</p> <p>see Report G0M-1411-4316-SEC027N-V04</p> <p>see Report G0M-1411-4317-SEC027N-V06</p> <p>No damage ;</p> <p>The observed equipment had operated according to design requirements after test.</p> <p>No damage ;</p> <p>The observed equipment had operated according to design requirements after test.</p>

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.8.4	Power relays (for Direct Control of Motor Switches)	- IEC/EN 61810-1 - VDE 0435-201 - IEC/EN 60255-1 - VDE 0435-300 - IEEE Std C37.90 - IEEE Std C37.90 - IEC/EN 61810-1 - VDE 0435-201 - IEC 60947-5-1	switching capacity make –break 250 V 1000 W 220 V 1000 W 110 V 1000 W 60 V 600 W 48 V 480 W 24 V 240 W switching voltage AC/DC 250 V max. ON time 30 s recovery time before switching on again: 15 min Short-time capacity make and carry 30 A for: 0.2 s ON 15 s OFF number of operations ≥ 2000 make and carry 30 A for 1 s number of operations at least 1 Short-time current across closed contact 250 A for 30 ms 3 operations with an interval of 10 s		No damage ; The observed equipment had operated according to design requirements after test. No damage ; The observed equipment had operated according to design requirements after test. No damage ; The observed equipment had operated according to design requirements after test.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
2.8.5	Binary Inputs	- IEC/EN 60255-1	DC: 60 V DC: 150 V DC: 300 V continuous	Range 1 Range 2 Range 3	No damage ; The observed equipment had operated according to design requirements after test.
2.9	<b>Surge current withstand test</b>	- IEC 60255-1 - IEC/EN 60255-27 - VDE 0435-327	Surge current impulse, 1 cycle with		
2.9.1	Standard inputs (protection-class current transformers)	in L1, L2, L3, N: $\hat{I} = 250 I_N$ (half cycle)	$I_N = 5 \text{ A}$		1250 A for 20 ms (one cycle)  No damage ; The observed equipment had operated according to design requirements after test.
2.9.2	Ins-Input for high-sensitive earth fault detection (instrument transformers)	in L1, L2, L3, N: $\hat{I} = 250 I_N$ (half cycle)	$I_N = 5 \text{ A}$		1250 A for 20 ms (one cycle)  No damage ; The observed equipment had operated according to design requirements after test.



Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
<p><b>3</b></p> <p>3.1</p> <p>3.1.1</p>	<p><b>Environmental Tests</b></p> <p><b>Temperature and climatic stress during operation</b></p> <p>Cold</p>	<p>- IEC 60255-1 - IEC/EN 60255-27 - VDE 0435-327</p> <p>tests according IEC 60068 and IEC 60255-1</p> <p>Note: During the boot up phase of the devices a crypto processor on the CPU modules CP100 &amp; CP200 is active (internal security check). This crypto processor is only specified for a temperature range from -25 °C to 85 °C. Due to this fact a boot up of the devices from -40 °C is not possible (the crypto processor blocks the boot up phase because of its internal security function). It is only possible to decrease the ambient temperature to -40°C after the boot up phase. It is also not possible to switch off and switch on the device during the test at an ambient temperature of 85 °C. The crypto processor prevents again the boot up of the devices because its internal chip temperature exceeds the specified temperature range of 85°C.</p> <p>- IEC/EN 60068-2-1 Test Ad</p> <p>- IEC/EN 60068-2-1 Test Ad</p>	<p>device start up at ϑ = -25 °C and hold temperature for t = 96 h</p> <p>temperature decreased during operation to ϑ = -40 °C for t = 16 h</p>		<p>tested by: RST Rail System Testing GmbH 16761 Hennigsdorf (Germany) See Report No. P50-15-0191 See Report No. P50-15-0376 See Report No. P50-16-0239 See Report No. P50-17-0239</p> <p>No damage ; The observed equipment had operated according to design requirements after test.</p> <p>No damage ; The observed equipment had operated according to design requirements after test.</p>

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
3.1.2	Dry heat	- IEC/EN 60068-2-2 Test Bd	$\vartheta = +70\text{ °C}$ $t = 96\text{ h}$  $\vartheta = +85\text{ °C}$ $t = 16\text{ h}$		No damage ; The observed equipment had operated according to design requirements after test.
3.1.3	Slow temperature change	- IEC/EN 60068-2-14 Test Nb	$\vartheta_{\min} = -25\text{ °C}$ $\vartheta_{\max} = +75\text{ °C}$ $t_{\max} = t_{\min} = 10\text{ h to }14\text{ h}$ $\text{tramp} = 20\text{ K/h}$ $\geq 5\text{ cycles}$		No damage ; The observed equipment had operated according to design requirements after test.
3.1.4	Damp heat; steady state	- IEC/EN 60068-2-78, Test Cab	$\vartheta = +40\text{ °C}$ $\text{Frel.} = 93\text{ \%}$ $\text{test duration}$ $t = 56\text{ days}$		No damage ; The observed equipment had operated according to design requirements after test.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
3.1.5	Damp heat; cyclic (12+12-hour cycle)	- IEC/EN 60255-1 - IEC/EN 60068-2-30, Test Db	lower test temperature: 25 °C ± 3 °C, relative humidity: 97 % - 2 %, +3 %  upper test temperature: 55 °C ± 2 °C, relative humidity: 93 % ± 3 %  temperature change: each 3 h (0.17 K/min)  test duration: t = 6 d (6 cycles each 24 h)		No damage ; The observed equipment had operated according to design requirements after test.
3.2	<b>Temperature and climatic stress during storage and transport</b>	- IEC 60255-1 - IEC/EN 60255-27 - VDE 0435-327  tests according IEC 60068			tested by: RST Rail System Testing GmbH 16761 Hennigsdorf (Germany) See Report No. P50-15-0191 See Report No. P50-15-0376 See Report No. P50-16-0239 See Report No. P50-17-0239
3.2.1	Cold	- IEC/EN 60068-2-1 Test Ad	ϑ = -40 °C t = 96 h		No damage ; The observed equipment had operated according to design requirements after test.
3.2.2	Dry heat	- IEC/EN 60068-2-2 Test Bd	ϑ = +70 °C t = 96 h		No damage ; The equipment was seen to operate according to design requirements after test

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
3.2.3	Fast temperature change	- IEC/EN 60068-2-14 Prüfung/Test Nb	θ <sub>min</sub> = -25 °C θ <sub>max</sub> = +70 °C t <sub>max</sub> = t <sub>min</sub> = 2 h tramp ≤ 10 s 60 cycles		tested by AUCOTEAM GmbH, 10407 Berlin The observed equipment had operated according to design requirements after test.
3.3	<b>Industrial atmosphere</b>	Device not in operation	Concentration selected acc. to		tested by AUCOTEAM GmbH, 10407 Berlin
3.3.1	Gas test, selective	- IEC/EN 60068-2-42 Test Kc  - IEC/EN 60068-2-43 Test Kd	- DIN 40046 V T36 (Test Kx) 25 ppm SO <sub>2</sub> ; t = 10 d  - DIN 40046 V T37 (Test Ky) 10 ppm – 15 ppm H <sub>2</sub> S; t = 10 d		Report no.: PB7827.01/10  The equipment was seen to operate according to design requirements
3.3.2	Mixed gas test	- IEC/EN 60068-2-60, Method 4	IEC 60068-2-60, Methode/Method 4 SO <sub>2</sub> : 0.2 ppm NO <sub>2</sub> : 0.2 ppm H <sub>2</sub> S: 0.01 ppm Cl <sub>2</sub> : 0.01 ppm T = 10 d		Report no.: PB7827.02/10  The equipment was seen to operate according to design requirements
3.4	<b>Mechanical dynamic stress tests</b>	Tests were carried out on devices in housings for panel flush mounting and surface mounting 1/6 up to 1/1 of 19 inch			tested by AUCOTEAM GmbH, 10407 Berlin and RST Rail System Testing GmbH 16761 Hennigsdorf

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
3.4.1	Vibration response test, sinusoidal; stationary use	- IEC/EN 60068-2-6 Test Fc - IEC/EN 60255-21-1 Class 2	Frequency range: - 10 Hz to 150 Hz  Stress level: - 10 Hz to 58 Hz; ± 0.075 mm amplitude  - 58 Hz to 150 Hz; 10 m/s <sup>2</sup> acceleration  - 1 octave/minute  Test time: - 20 cycles in the three main axes of device		The observed equipment had operated according to design requirements during and after test.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
3.4.2	Vibration endurance test, sinusoidal; transport stress	- IEC/EN 60068-2-6 Test Fc - IEC/EN 60255-21-1 Class 2 <sup>a)</sup>	<p>Frequency range: - 5 Hz to 150 Hz</p> <p>Stress level:</p> <p>- 5 Hz to 8 Hz; ±7.5 mm amplitude</p> <p>- 8 Hz to 150 Hz; 20 m/s<sup>2</sup> acceleration</p> <p>- 1 octave/minute</p> <p>Test time: - 20 /cycles in the three main axes of device</p>		<p>The observed equipment had operated according to design requirements during and after test.</p> <p>a) The non-modular devices in the surface mounting frame meets only class 1.</p>

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
3.4.3	Seismic stress; stationary use	- IEC/EN 60068-2-57 - IEC/EN 60068-3-3 Test Fc - IEC/EN 60255-21-3 Class 2	Frequency range: - 3 Hz to 35 Hz <sup>a)</sup> Stress level: - sinusoidal - 3 Hz to 8 Hz <sup>a)</sup> ± 8 mm amplitude horizontal axes ± 4 mm amplitude vertical axis - 8 Hz to 35 Hz 20 m/s <sup>2</sup> acceleration horizontal axes - 10 m/s <sup>2</sup> acceleration vertical axis  - 1 octave/minute  - 1 cycle in the three main axes of device		The observed equipment had operated according to design requirements during and after test.  a) For technical reasons the frequency range has been raised at the lower frequency from 1 Hz to 3 Hz
3.4.4	Shock response test; use                      stationary	- IEC/EN 60068-2-27 Test Ea - IEC/EN 60255-21-2 Class 1	3 shocks at a time per main axis and direction 50 m/s <sup>2</sup> , 11 ms half sinusoidal		The observed equipment had operated according to design requirements during and after test.
3.4.5	Shock withstand test; stress                      transport	- IEC/EN 60068-2-27 Test Ea - IEC/EN 60255-21-2 Class 1	3 shocks at a time per main axis and direction 150 m/s <sup>2</sup> , 11 ms half sinusoidal		The observed equipment had operated according to design requirements after test.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
3.4.6	Bump test (continuous shock); transport stress	- IEC/EN 60068-2-27 Test Eb - IEC/EN 60255-21-2 Class 1	1000 shocks at a time  per main axis and direction 100 m/s <sup>2</sup> , 16 ms half sinusoidal		The observed equipment had operated according to design requirements after test.



Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
<p><b>4</b></p> <p>4.1</p> <p>4.1.1</p>	<p><b>Electromagnetic compatibility (EMC)</b></p> <p><b>Immunity tests</b></p> <p>1 MHz burst disturbance test</p>	<ul style="list-style-type: none"> <li>- IEC/EN 60255-1</li> <li>- VDE 0435-300</li> <li>- IEC/EN 60255-26</li> <li>- (IEC/EN 60255-22)</li> <li>- (IEC/EN 60255-25)</li> <li>- IEC 61850-3</li> <li>- IEC/EN 61000-3-2</li> <li>- IEC/EN 61000-3-3</li> <li>- IEC/EN 61000-6-2</li> <li>- IEC/EN 61000-6-5</li> <li>- IEC/EN 60255-26</li> <li>- IEC 61000-4-18</li> <li>- (IEC/EN 60255-22-1)</li> </ul>	<p>Device in operation mode; Measuring quantities 5 % lower/higher than measured pickup values</p> <p>Amplitude:</p> <ul style="list-style-type: none"> <li>- common mode 2.5 kV (peak value)</li> <li>- differential mode 2.5 kV (peak value)</li> </ul> <p>f = 1 MHz, R<sub>i</sub> = 200 Ω repetition rate: 400 Hz test duration ≥ 60 s</p>	<p>Acceptance criteria acc. to IEC/EN 61000-6-2 (A, B, C) and IEC/EN 60255-26, table 23</p> <p>criterion B</p>	<p>The direct coupling of the disturbances is the preferred method for process connection lines. According to the standards, shielded cables were tested with the coupling clamp in common mode test only.</p> <p>tested by</p> <ul style="list-style-type: none"> <li>- PRO EMV GmbH, 15344 Strausberg</li> <li>- Eurofins Product Service GmbH, 15526 Reichenwalde</li> </ul> <p>No maloperation The observed equipment had operated according to design requirements.</p>

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.1.2	Electrostatic discharge (ESD) test	- IEC/EN 60255-26 - IEC/EN 61000-4-2 - (IEC/EN 60255-22-2)	contact discharge modular devices - front: 2 kV, 4 kV, 6 kV, 8 kV - rear: 2 kV, 4 kV, 6 kV, 8 kV  contact discharge non-modular devices - front: 2 kV, 4 kV, 6 kV, 8 kV - rear: 2 kV, 4 kV, 6 kV  air discharge modular and non-modular devices 2 kV, 4 kV, 6 kV, 8 kV, 12 kV, 15 kV  both polarities C = 150 pF, Ri = 330 Ω	criterion B	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.
4.1.3	Radiated electromagnetic field disturbance test				
4.1.3.1	RF-field, amplitude modulated Frequency sweep test (IEC)	- IEC/EN 60255-26 - IEC/EN 61000-4-3 - (IEC/EN 60255-22-3)	80 MHz to 1 GHz, 20 V/m (rms, unmodulated) 80 % AM; 1 kHz  1 GHz to 6 GHz, 10 V/m (rms, unmodulated) 80 % AM; 1 kHz  frequency steps 1% dwell time 2 s each frequency step	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde  No maloperation The observed equipment had operated according to design requirements.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.1.3.2	RF-field, amplitude modulated Spot frequency test (IEC)	- IEC/EN 60255-26 - IEC/EN 61000-4-3 - (IEC/EN 60255-22-3)	80 MHz, 160 MHz, 380 MHz, 450 MHz, 900 MHz 20 V/m (rms, unmodulated) 80 % AM; 1 kHz; t = 10 s  1850 MHz, 2150 MHz 10 V/m (Effektivwert, unmoduliert) (rms, unmodulated) 80 % AM; 1 kHz; t = 10 s	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.
4.1.3.3	RF-field, amplitude modulated Frequency sweep test (IEEE)	- IEEE Std C37.90.2	80 MHz to 1 GHz 20 V/m (rms, unmodulated) 80 % AM; 1KHz frequency steps 1% dwell time 2 s each frequency step	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.
4.1.3.4	RF-field, amplitude modulated Spot frequency test (IEEE)	- IEEE Std C37.90.2	80 MHz, 160 MHz, 450 MHz, 900 MHz, 20 V/m (rms, unmodulated) 80 % AM; 1 kHz; t = 10 s	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.
4.1.3.5	RF-field, pulse modulated Spot frequency test (IEEE)	- IEEE Std C37.90.2	900 MHz 35 V/m duty cycle 50 % repetition rate 200 Hz t = 10 s	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.1.3.6	RF-field, pulse modulated keying test (IEEE)	- IEEE Std C37.90.2	80 MHz to 1 GHz 35 V/m duty cycle 50 % repetition rate 1 Hz frequency step 1 % dwell time 2 s each frequency step	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.
4.1.4	Electrical fast transient disturbance test (EFT)	- IEC/EN 60255-26 - IEC/EN 61000-4-4 - (IEC/EN 60255-22-4)  common and differential mode	amplitude; repetition frequency: - power supply 4 kV; 5 kHz - all other inputs and outputs 4 kV; 5 kHz - earth 4 kV; 5 kHz wave shape 5 ns/50 ns Ri = 50 Ω burst length 15 ms burst period 300 ms duration ≥ 5 min (tested at exemplary selected circuits) both polarities	criterion B	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.1.5	Surge immunity test	- IEC/EN 60255-26 - IEC/EN 61000-4-5 - (IEC/EN 60255-22-5)  wave shape 1.2 μs/50 μs  5 positive and 5 negative shots at intervals of 1 min.	power supply - common mode 4 kV; 12 Ω; 9 μF - differential mode 1 kV; 2 Ω; 18 μF binary inputs and measuring inputs - common mode 4 kV; 42 Ω; 0.5 μF - differential mode 2 kV; 42 Ω; varistor/arrestor binary output - common mode 4 kV; 42 Ω; 0.5 μF - differential mode 2 kV; 42 Ω; 0.5 μF	criterion B	tested by - PRO EMV GmbH 15344 Strausberg Germany  - Eurofins Product Service GmbH 15526 Reichenwalde Germany  No maloperation The observed equipment had operated according to design requirements.
4.1.6	Oscillatory Surge Withstand Capability Test (IEEE)	- IEEE Std C37.90.1	Amplitude: - common mode 2.5 kV (peak value) - differential mode 2.5 kV (peak value) f = 1 MHz, τ = 15 ms, Ri = 200 Ω repetition frequency 400 Hz duration ≥ 60 s	criterion B	No maloperation The observed equipment had operated according to design requirements.
4.1.7	Fast Transient Surge Withstand Capability Test (IEEE)	- IEEE Std C37.90.1	common and differential mode 4 kV wave shape 5 ns/50 ns Ri = 50 Ω burst length 15 ms burst period 300 ms duration ≥ 1 min both polarities	criterion B	No maloperation The observed equipment had operated according to design requirements.

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.1.8	Conducted disturbances induced by radio frequency fields, amplitude modulated frequency sweep test	- IEC/EN 60255-26 - IEC/EN 61000-4-6 - (IEC/EN 60255-22-6)	150 kHz to 80 MHz 10 V (rms, unmodulated) 80 % AM; 1 kHz; Ri = 150 Ω frequency steps 1% dwell time: 2 s each frequency step	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.
4.1.9	Conducted disturbances induced by radio frequency fields, amplitude modulated Spot frequency test	- IEC/EN 60255-26 - IEC/EN 61000-4-6 - (IEC/EN 60255-22-6)	27 MHz, 68 MHz 10 V (rms, unmodulated) 80 % AM; 1 kHz; t = 10 s	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.
4.1.10	Power frequency magnetic field test	- IEC/EN 60255-26 - IEC/EN 61000-4-8 - (IEC/EN 60255-22-8)	- 30 A/m continuous; 50/60 Hz 300 A/m short term; 50/60 Hz  - 0.5 mT continuous; 50/60 Hz  - 1000 A/m continuous; 50/60 Hz	criterion A	tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde No maloperation The observed equipment had operated according to design requirements.  - Deviation of measured values U and I  δ  < 5 %

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.1.11	Pulsed magnetic field test	- IEC/EN 61000-4-9  wave shape 6.4 μs/16 μs  5 positive and 5 negative shots at intervals of 10 s	- 1600 A/m	criterion B	No maloperation The observed equipment had operated according to design requirements. no influence to measurands observed
4.1.12	DC Ripple	- IEC 60255-26 - IEC 61000-4-17	V-DC = 0.8*V <sub>N</sub> , 1.20*V <sub>N</sub> with superimposed ac voltage (peak-to-peak) : 0 % to 15 % of V <sub>N</sub> f = 16.7 Hz, 50 Hz, 60 Hz, 100 Hz, 120 Hz, 300 Hz	≤15 % of rated voltage, tested at the lowest voltage and at the voltage of the voltage range V <sub>rated</sub> ± 20 %	Tested by: - DNV GL - Energy KEMA Laboratories, Arnhem -Eurofins Product Service GmbH, 15526 Reichenwalde  Test passed, no maloperation

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.1.13	Damped oscillatory wave test	- IEC/EN 61000-4-18	<p>common and differential mode 2.5 kV (peak value) both polarities 100 kHz test duration each ≥ 1 min Ri = 200 Ω</p> <p>common and differential mode 2.5 kV (peak value) both polarities 1 MHz test duration each ≥ 1 min Ri = 200 Ω</p> <p>common mode test 2 kV (peak value) both polarities 3 MHz, 10 MHz, 30 MHz test duration each ≥ 1 min Ri = 50 Ω</p>	criterion B	<p>tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde</p> <p>No maloperation The observed equipment had operated according to design requirements.</p> <p>tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde</p> <p>No maloperation The observed equipment had operated according to design requirements.</p> <p>tested by - Eurofins Product Service GmbH, 15526 Reichenwalde</p> <p>No maloperation The observed equipment had operated according to design requirements.</p>



Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.1.14	Power frequency immunity test	- IEC/EN 60255-26 - IEC/EN 61000-4-16 - (IEC/EN 60255-22-7)	Coupling to DC binary input ports - Differential mode 150 V/50 Hz via 100 Ω and 0.1 μF - common mode 300 V/50 Hz via 220 Ω and 0.47 μF binary input control voltage 24 V 48 V 60 V 125 V 250 V	criterion A    binary input threshold low low low medium high	External parallel resistor 3.9 kOhm/min. 4 W 3.9 kOhm/min. 4 W 3.9 kOhm/min. 4 W 20 kOhm/min. 4 W 47 kOhm/min. 4 W  Tested by - DNV GL - Energy KEMA Laboratories, Arnhem  Test passed, no maloperation The observed equipment had operated according to design requirements.
4.1.15	Up and down ramping of auxiliary supply voltage	- IEC 60255-26 - VDE 0435-300	DC: V <sub>N</sub> = 24 V DC: V <sub>N</sub> = 60 V  0 V → 100 % V <sub>N</sub> in 60 s 100 % V <sub>N</sub> → 0 V in 60 s		tested by -Eurofins Product Service GmbH, 15526 Reichenwalde  No maloperation The equipment had operated according to design requirements.
4.1.16	Voltage dips	IEC 60255-26 - IEC 61000-4-11 (ac voltages) - IEC 61000-4-29 (dc voltages)	40 % residual voltage, corresponds to 60 % voltage dip  70 % residual voltage, corresponds to 30 % voltage dip	for 200 ms according IEC 60255-26   for 500 ms according IEC 60255-26	tested by - PRO EMV GmbH, 15344 Strausberg The equipment had operated according to design requirements
4.1.17	Short interruptions	- IEC 60255-26 - IEC 61000-4-11 (ac voltages) - IEC 61000-4-29 (dc voltages)			tested by - PRO EMV GmbH, 15344 Strausberg The equipment had operated according to design requirements

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
		modular devices	DC: V = 24 V DC: V = 48 V  DC: V = 60 V DC: V = 110 V DC: V = 125 V DC: V = 220 V DC: V = 250 V  AC: V = 100 V AC: V = 115 V AC: V = 230 V at $\phi_b=0^\circ, 90^\circ, 180^\circ, 270^\circ$	tu min. 50 ms   tu min. 50 ms   tu min. 50 ms	50 % of output relays energized, 2 communication modules activated  tu $\geq$ 50 ms tu $\leq$ 200 ms  tu $\geq$ 50 ms tu $\leq$ 150 ms tu $\leq$ 180 ms tu $\leq$ 500 ms tu $\leq$ 650 ms  tu $\leq$ 200 ms tu $\leq$ 250 ms tu $\leq$ 900 ms
		Non-modular devices	DC: V = 24 V DC: V = 48 V  DC: V = 60 V DC: V = 110 V DC: V = 125 V  DC: V = 220 V DC: V = 250 V AC: V = 100 V AC: V = 115 V AC: V = 230 V at $\phi_b=0^\circ, 90^\circ, 180^\circ, 270^\circ$	min. 20 ms  min. 50 ms  min. 200 ms	50 % of output relays energized, 2 communication modules activated  tu $\geq$ 20 ms tu $\leq$ 550 ms  tu $\geq$ 50 ms tu $\leq$ 260 ms tu $\leq$ 230 ms  tu $\leq$ 1100 ms tu $\leq$ 1500 ms  tu $\geq$ 200 ms tu $\leq$ 2500 ms

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.2	<b>Emission (Radio frequency interference, RFI)</b>	- IEC/EN 60255-26 - (IEC/EN 60255-25) - IEC/EN 61000-6-4  - IEC CISPR 11 - IEC CISPR 22  - EN 55011 - EN 55022			
4.2.1	Conducted emission at mains port	- CISPR 11 - EN 55011 Group 1 / Class A	150 kHz to 30 MHz  Test performed for device in idle and max. operated condition 1/3 up to 1/1 19 inch device DC: $V_{aux} = 24\text{ V}$ DC : $V_{aux} = 48\text{ V}$ DC : $V_{aux} = 60\text{ V}$ DC : $V_{aux} = 220\text{ V}$ AC: $V_{aux} = 230\text{ V}$		tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde  Test successfully passed
4.2.2	Conducted emission at telecommunication port	- CISPR 22 - EN 55022 Group 1 / Class A	150 kHz to 30 MHz  Test performed for device in idle and max operated condition		tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde  Test successfully passed, class A and B

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
4.2.3	Radiated Emission (30 - 1000 MHz)	- CISPR 11, - EN 55011 Group 1 / Class A	Measuring distance 3 m/10 m Test performed for device in idle and max operated condition 1/3 up to 1/1 19 inch device		tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde  Test passed
4.2.4	Radiated Emission (1 - 6 GHz)	- CISPR 22, - EN 55022 Group 1 / Class A	Measuring distance 3 m Test performed for device in idle and max operated condition 1/3 up to 1/1 19 inch device		tested by - PRO EMV GmbH, 15344 Strausberg -Eurofins Product Service GmbH, 15526 Reichenwalde  Test passed

Protocol item	Test	Test condition Operative range Specifications	Test values	Permissive Tolerance Limiting values	Test result Remarks
<p><b>5</b></p> <p>5.1</p>	<p><b>Approvals</b></p> <p><b>UL/CSA certification</b></p>	<p>- UL 508, CSA C22.2 No. 14-13 Safety for Industrial Control Equipment</p>		<p>UL File Number: E194016 Protective Relays</p>	<p>The devices are in compliance with U.S. and Canadian requirements with the values as stated in technical data.</p> <p>Report Reference for modular devices: File E194016, volume 1, section 16</p> <p>Report Reference for non-modular devices: File E194016, volume 1, section 22</p>

**Appendix A1 : List of used standards**

<b>Product standards</b>	<b>Date of issue</b>	<b>Description</b>
IEC 60255-1	2009	Measuring relays and protection equipment – Part 1: Common requirements
(IEC 60255-6)	replaced by IEC 60255-1	Measuring relays and protection equipment – Part 1: Common requirements
IEC 60870-2-1	1995	Telecontrol equipment and systems – Part 2: Operating conditions – Section 1: Power supply and electromagnetic compatibility
IEC 61010-1	2010	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
IEC 60825-1	2014	Safety of laser products - Part 1: Equipment classification and requirements
IEC 60825-2	2010	Safety of laser products - Part 2: Safety of optical fibre communication systems
IEC 61850-3	2013	Communication networks and systems in substations – Part 3: General requirements
IEEE Std C37.90	2005	IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE Std C37.90.1	2012	IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE Std C37.90.2	2004	IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
UL 508	2007, 17 <sup>th</sup> edition	Standard for Industrial Control Equipment
CSA C22.2 No. 14-13	2013	Standard for Industrial Control Equipment
<b>Generic standards</b>	<b>Date of issue</b>	<b>Description</b>
IEC 61000-3-2	2014	Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤16 A per phase)
IEC 61000-3-3	2013	Electromagnetic compatibility (EMC) –Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection
IEC 61000-6-2	2016	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards – Immunity for industrial environments
IEC 61000-6-4	2011	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards – Emission standard for industrial environments
IEC 61000-6-5	2015	Electromagnetic compatibility (EMC) - Part 6-5: Generic standards - Immunity for power station and substation environments
<b>Standards for testing</b>	<b>Date of issue</b>	<b>Description</b>
IEC 60038	2009	IEC standard voltages
IEC 60068-2-1	2007	Environmental testing – Part 2-1: Tests – Test A: Cold
IEC 60068-2-2	2007	Environmental testing. Part 2-2. Tests. Test B: Dry heat
IEC 60068-2-3	replaced by IEC 60068-2-78	Basic environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state
IEC 60068-2-6	2007	Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)
IEC 60068-2-14	2009	Environmental testing – Part 2-14: Tests – Test N: Change of temperature
IEC 60068-2-27	2008	Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock
(IEC 60068-2-29)	replaced by IEC 60068-27	Basic environmental testing procedures. Part 2 : Tests. Test Eb and guidance: Bump
IEC 60068-2-30	2005	Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)
IEC 60068-2-42	2003	Environmental testing – Part 2-42: Tests; Test Kc: Sulphur dioxide test for contacts and connections

IEC 60068-2-43	2003	Environmental testing – Part 2-43: Tests; Test Kd: Hydrogen sulphide test for contacts and connections
IEC 60068-2-60	2015	Environmental testing – Part 2: Tests – Test Ke: Flowing mixed gas corrosion test
IEC 60068-2-78	2012	Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state
IEC 60068-3-3	1991	Environmental testing; part 3: guidance; seismic test methods for equipments
(IEC 60255-5)	replaced by IEC 60255-27	Electrical Relays – Part 5: Insulation coordination for measuring relays and protection equipment – Requirements and tests
(IEC 60255-11)	replaced by IEC 60255-26	Measuring relays and protection equipment – Part 11: Voltage dips, short interruptions, variations and ripple on auxiliary power supply port
IEC 60255-21-1	1988	Electrical relays; part 21: vibration, shock, bump and seismic tests on measuring relays and protection equipment; section one: vibration tests (sinusoidal)
IEC 60255-21-2	1988	Electrical relays; part 21: vibration, shock, bump and seismic tests on measuring relays and protection equipment; section two: shock and bump tests
IEC 60255-21-3	1993	Electrical relays; part 21: vibration, shock, bump and seismic tests on measuring relays and protection equipment; section 3: seismic tests
(IEC 60255-22-1)	replaced by IEC 60255-26	Electrical disturbance tests – 1 MHz burst immunity tests
(IEC 60255-22-2)	replaced by IEC 60255-26	Electrical disturbance tests – Electrostatic discharge tests
(IEC 60255-22-3)	replaced by IEC 60255-26	Electrical disturbance tests – Radiated electromagnetic field immunity
(IEC 60255-22-4)	replaced by IEC 60255-26	Electrical disturbance tests – Electrical fast transient/burst immunity test
(IEC 60255-22-5)	replaced by IEC 60255-26	Electrical disturbance tests – Surge immunity test
(IEC 60255-22-6)	replaced by IEC 60255-26	Immunity to conducted disturbances induced by radio frequency fields
(IEC 60255-22-7)	replaced by IEC 60255-26	Electrical relays – Part 22-7: Electrical disturbance tests for measuring relays and protection equipment – Power frequency immunity tests
(IEC 60255-25)	replaced by IEC 60255-26	Electromagnetic emission tests for measuring relays and protection equipment
IEC 60255-26	2013	Measuring relays and protection equipment – Part 26: Electromagnetic compatibility requirements (with reference to IEC 61000 and CISPR)
IEC 60255-27	2013	Measuring relays and protection equipment – Part 27: Product safety requirements
IEC 60529	2013	Degrees of protection provided by enclosures (IP code)
IEC 60947-5-1	2016	Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices
IEC 61131-2	2007	Programmable controllers – Part 2: Equipment requirements and tests
IEC 61140	2016	Protection against electric shock – Common aspects for installation and equipment
IEC 61810-1	2015	Electromechanical elementary relays – Part 1: General requirements
IEC 61000-4-2	2008	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test
IEC 61000-4-3	2010	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-4	2012	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test
IEC 61000-4-5	2014	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test
IEC 61000-4-6	2013	Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields
IEC 61000-4-8	2009	Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test
IEC 61000-4-9	2016	Electromagnetic compatibility (EMC) – Part 4-9: Testing and measurement techniques – Pulse magnetic field immunity test

IEC 61000-4-11	2004	Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests
IEC 61000-4-12	2006	Electromagnetic compatibility (EMC) - Part 4-12: Testing and measuring - Ring waves immunity test
IEC 61000-4-16	2015	Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz
IEC 61000-4-17	2009	Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on d.c. input power port immunity test
IEC 61000-4-18	2011	Electromagnetic compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test
IEC 61000-4-29	2000	Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests
CISPR 11	2015	Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement
CISPR 22	2008	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
<b>German standards</b>	<b>Date of issue</b>	<b>Description</b>
VDE 0435-201	2015	Elektromechanische Elementarrelais - Teil 201: Allgemeine Anforderungen Corresponds to IEC 61810-1
VDE 0435-300	2010	Messrelais und Schutzeinrichtungen - Teil 300: Allgemeine Anforderungen Corresponds to IEC 60255-1
VDE 0435-320	2014	Messrelais und Schutzeinrichtungen - Teil 320: Anforderungen an die elektromagnetische Verträglichkeit Corresponds to IEC 60255-26
VDE 0435-327	2014	Messrelais und Schutzeinrichtungen - Teil 327: Anforderungen an die Produktsicherheit Corresponds to IEC 60255-27