

Test Report

Test Report No. : TS0618-001

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Subject:

Type test Transformer Differential Protection SIPROTEC 5 - V07.80 / Edition 08

The tests were performed by:

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The tests were performed for:

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This test report consists of 222 pages.

Tested equipment Multifunction Protection Relays SIPROTEC 5

Product group: Transformer Differential Protection
7UT82, 7UT85, 7UT86, 7UT87

Firmware V07.80

Tests are according to: IEC/EN 60255 series, VDE 0435
Further standards s. specific tests

Performed tests: Properties at reference conditions

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
Division Energy Management
Digital Grid

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

Date: 2018-06-15

Tested by: Holzauer



Reviewed by: Schneider

Signature

Signature

Scope of protocol

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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, e.g., 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, but with 16 2-colored LEDs

The on-site operation panels of the extension modules can be selected from 4 variants:

- With 16 1-colored LEDs and 2 key switches
- With 16 1-colored LEDs
- With 8 push-buttons and 8 1-colored LEDs
- Without display elements

The base module always contains 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 1st extension module in the 2nd device row always contains 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

Range of validity**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 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 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

Range of validity

SIPROTEC 5 devices

All type tests were performed at various combinations of all modules of the SIPROTEC 5 platform. As a result the following devices were covered:

7UT82	
Short description	Differential protection for two-winding transformers for all voltage levels
Main protection function	1 differential protection function (standard transformer) with additional stabilization; up to 2 restricted ground-fault protection functions
Usable measuring points	Two 1-phase current measuring points Two 3-phase current measuring points
Inputs and outputs Hardware flexibility	One predefined standard variable with 8 current transformers, 7 binary inputs, 6 binary outputs
Width of housing	1/3 x 19 inches

7UT85	
Short description	Differential protection for two-winding transformers for all voltage levels
Main protection function	1 differential protection function (standard or auto transformer) with additional stabilization; up to 2 restricted ground-fault protection functions
Usable measuring points	Five 3-phase current measuring points Three 1-phase current measuring points Three 3-phase voltage measuring points Three 1-phase voltage measuring points
Inputs and outputs Hardware flexibility	2 predefined standard variants with 8 current transformers, 7 to 19 binary inputs, 7 to 23 binary outputs Flexible adaptable and expandable I/O quantity structure of the modular SIPROTEC 5 module
Width of housing	1/3 x 19 inches to 1/1 x 19 inches

7UT86	
Short description	Differential protection for three-winding transformers for all voltage levels
Main protection function	1 differential protection function (standard) with additional stabilization; up to 3 restricted ground-fault protection functions For auto transformer applications 2 differential protection functions can be processed in an auto transformer function group.
Usable measuring points	Six 3-phase current measuring points Four 1-phase current measuring points Four 3-phase voltage measuring points Four 1-phase voltage measuring points
Inputs and outputs Hardware flexibility	2 predefined standard variants with 12 current transformers, 4 voltage transformers, 11 to 23 binary inputs, 19 to 34 binary outputs Flexible adaptable and expandable I/O quantity structure of the modular SIPROTEC 5 module
Width of housing	1/2 x 19 inches to 1/1 x 19 inches

Range of validity

7UT87	
Short description	Differential protection for multi-winding transformers for all voltage levels
Main protection function	Up to 2 differential protection functions with additional stabilization (in different transformer function groups); up to 5 restricted ground-fault protection functions. For auto transformer applications 2 differential protection functions can be processed in an auto transformer function group
Usable measuring points	Nine 3-phase current measuring points Five 1-phase current measuring points Five 3-phase voltage measuring points Five 1-phase voltage measuring points
Inputs and outputs Hardware flexibility	2 predefined standard variants with 20 current transformers, 4 voltage transformers, 15 to 27 binary inputs, 22 to 38 binary outputs Flexible adaptable and expandable I/O quantity structure of the modular SIPROTEC 5 module
Width of housing	2/3 x 19 inches to 1/1 x 19 inches

Range of validity

SIPROTEC 5, functional description of power supply, CPU, IO boards and plug-in modules

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

SIPROTEC 5

Functional description of boards for modular devices

Board name	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 nd row of devices, (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
CP300	Processor (CPU) Board, mounted into the front cover of the 1/3 19-inch size housing, different variants for the available device designs
IO201	Input Output Board, 4 current inputs, 8 binary inputs, 6 binary outputs, reduced assembled variant of IO202
IO202	Input Output Board, 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 Board, 8 current measuring inputs, 4 binary inputs, 4 binary outputs, mounted in 1/6 19-inch size housing
IO204	Input Output Board, 10 binary inputs, 4 binary outputs, 4 power relays for controlling 2 motors, mounted in 1/6 19-inch size housing
IO205	Input Output Board, 12 binary inputs, 16 binary outputs, mounted in 1/6 19-inch size housing
IO206	Input Output Board, 6 binary inputs, 7 binary outputs, mounted in 1/6 19-inch size housing, reduced assembled variant of IO205
IO207	Input Output Board, 16 binary inputs, 8 binary outputs, mounted in 1/6 19-inch size housing
IO208	Input Output Board, 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 Board, 8 binary inputs, 4 High Speed Outputs, mounted in 1/6 19-inch size housing
IO210	Input Output Board, 4 current measuring inputs, 3 voltage measuring inputs, 7 binary outputs, 4 high-speed measuring-transducer inputs for current or voltage, mounted in 1/6 19-inch size housing
IO211	Input Output Board, 8 voltage measuring inputs, 8 binary inputs, mounted in 1/6 or 1/3 19-inch size housing
IO212	Input Output Board, 8 high-speed measuring-transducer inputs for current or voltage, 8 binary inputs, mounted in 1/6 19-inch size housing
IO214	Input Output Board, 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 Board, 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 Board, 48 binary inputs, mounted in 1/6 19-inch size housing
IO231	Input Output Board, 24 binary inputs, 24 binary outputs, mounted in 1/6 19-inch

Range of validity

Board name	Functional description
	size housing
IO233	Input Board, 48 binary inputs (a fixed pickup threshold value of DC 105 V applies), mounted in 1/6 19-inch size housing
PB201	Process-Bus Module, 7 LC Duplex interfaces of which one is a service port, mounted in 1/6 19-inch size housing

Functional description of boards for non-modular devices

Board name	Functional description
PS101	Power Supply Board (DC: 24 V/48 V or DC: 60 V to 125 V or DC: 110 V to 250 V and AC: 100 V to 230 V), including 3 binary inputs, 2 binary outputs and one status life contact
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	Temperature module, 12 resistance temperature detectors
CP100	Processor (CPU) Board, mounted into the front cover of the device

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

USART-xx ¹ -y ² EL	Serial communication module, electrical connection
USART-xx ¹ -y ² FO	Serial communication module, optical connection
USART-xx ¹ -y ² LDFO	Serial communication module for long distances, optical connection
ETH-xx ¹ -2EL	Ethernet module, electrical connection
ETH-xx ¹ -2FO	Ethernet module, optical connection
ANAI-CA-4EL	Measuring-transducer module
ARC-CD-3FO ³	Arc Protection module

Valid for all firmware and DIGSI versions.

¹ xx: two letters, unique code for the module in the product code of the device

² y: 1 = 1 channel;
2 = 2 channels

³ Not available for Busbar Protection and Fault Recorder

Scope of editions

Edition	Date	Modifications or supplements compared to the former edition
01	2012-11-23	First edition, Software V02.00
02	2013-12-20	Revision and extended at Software V04.00
03	2014-07-18	Revision and extended at Software V05.00
04	2014-12-12	Revision and extended at Software V06.00
05	2015-12-18	Revision and extended at Software V07.00
06	2016-07-22	Revision and extended at Software V07.30
07	2017-07-21	Revision and extended at Software V07.50
08	2018-06-15	Revision and extended at Software V07.80

Subcontracting**Testing laboratory****Marking**

Technical information; Technical Data

Technical Information; Description:

Manual			Edition
1. SIPROTEC 5 Protection Devices Product Information	Part No.	C53000-B5000-C001-G	German
		C53000-B5040-C001-G	English
2. SIPROTEC 5 Hardware Manual	Part No.	C53000-G5000-C002-D	German
		C53000-G5040-C002-D	English
3. SIPROTEC 5 Operating Manual	Part No.	C53000-G5000-C003-9	German
		C53000-G5040-C003-9	English
4. SIPROTEC 5 Transformer Differential Protection 7UT82, 7UT85, 7UT86, 7UT87 Manual	Part No.	C53000-G5000-C016-9	German
		C53000-G5040-C016-9	English

For the Technical Data see the description (Technical Information).

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Summary**1 Properties at reference conditions****1.1 General****1.1.1 Standards**

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

1.1.2 Time specifications and measurements

If not otherwise declared, all specifications/results of pickup/tripping/reset times refer to the output of signals via fast output relays (Type F).

BO = Binary output

Binary outputs:

Number and data acc. to the order variant, see also general diagrams of devices

1.1.3 Relay operating times

Switching time (OOT)

OOT (Output Operating Time): additional delay of the output medium used

Type S = standard relay

OOT:

Closing time: typical: 8 ms; maximum: 10 ms;

Opening time: typical: 2 ms; maximum: 5 ms;

Type F = fast relay

OOT:

Closing time: typical: 4 ms; maximum: 5 ms;

Opening time: typical: 2 ms; maximum: 5 ms;

Type HS = High-Speed Relay

OOT:

Closing time: typical: 0,2 ms; maximum: 0,2 ms;

Opening time: typical: 9 ms; maximum: 9 ms;

Summary

1.2 87T Transformer Differential Protection

1.2.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.2.2 General Test conditions

f_{rated} : 50 Hz, 60 Hz

I_{rated} : 1 A, 5 A

1.2.3 I-DIFF

1.2.3.1 Operate Curve

1.2.3.1.1 I-DIFF Threshold

Test condition: $0.05 \leq I/I_{ratedObj} \leq 2.00$

Permissive tolerance/Limiting values: $|d| \leq 2\%$ of setting value

Test results/Remarks: $|d| < 2\%$

1.2.3.1.2 I-DIFF Slope 1

Test condition: 0.00 to 0.80

Test results/Remarks: confirmed

1.2.3.1.3 I-DIFF Intersection 1 I_{rest}

Test condition: $0.00 \leq I/I_{ratedObj} \leq 5.00$

Test results/Remarks: confirmed

1.2.3.1.4 I-DIFF Slope 2

Test condition: 0.25 to 0.95

Test results/Remarks: confirmed

1.2.3.1.5 I-DIFF Intersection 2 I_{rest}

Test condition: $1.00 \leq I/I_{ratedObj} \leq 20.00$

Test results/Remarks: confirmed

1.2.3.2 Starting Detection

1.2.3.2.1 Threshold Startup Detection

Test condition: $0.1 \leq I/I_{ratedObj} \leq 2.0$

Permissive tolerance/Limiting values: $|d| \leq 2\%$ of setting value

Test results/Remarks: $|d| < 2\%$

Summary

1.2.3.2.2 Factor Increasing Char.

Test condition: 1.0 to 5.0

Test results/Remarks: confirmed

1.2.3.2.3 Max. perm. Start Time

Test condition: 0.1 s \leq T \leq 180.0 sPermissive tolerance/Limiting values: $|d| \leq 1\%$ of setting value or 10 msTest results/Remarks: $|d| < 1\%$ of setting value or 10 ms**1.2.3.3 DC offset Detection**

1.2.3.3.1 Factor Increasing Char. DC

Test condition: 1.0 to 5.0

Test results/Remarks: confirmed

Summary**1.2.3.4 Inrush Blocking**1.2.3.4.1 2nd harmonic content

Test condition: 10 % to 45 %

Test results/Remarks: confirmed

1.2.3.4.2 Crossblock Time 2nd har.

Test condition: 0.00 s £ T £ 200.00 s

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % of setting value or 10 ms

1.2.3.5 Overexcit. Blocking1.2.3.5.1 3rd harmonic content

Test condition: 10 % to 80 %

Test results/Remarks: confirmed

1.2.3.5.2 Crossblock Time 3rd har.

Test condition: 0.00 s £ T £ 200.00 s

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % of setting value or 10 ms

1.2.3.5.3 5th harmonic content

Test condition: 10 % to 80 %

Test results/Remarks: confirmed

1.2.3.5.4 Crossblock Time 5th har.

Test condition: 0.00 s £ T £ 200.00 s

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % of setting value or 10 ms

1.2.3.6 Ext. Fault Detection

1.2.3.6.1 Threshold of add-on stabiliz.

Test condition: 1.00 £ I/I_{ratedObj} £ 20.00

Permissive tolerance/Limiting values: |d| £ 2 % of setting value

Test results/Remarks: |d| < 2 %

1.2.3.6.2 Time of add-on stabiliz.

Test condition: 0.00 s £ T £ 5.00 s, ∞

Summary

Permissive tolerance/Limiting values: $|d| \leq 1\%$ of setting value or 10 ms

Test results/Remarks: $|d| < 1\%$ of setting value or 10 ms

1.2.3.6.3 Cross-blk Time of add-on stabiliz.

Test condition: 0.00 s $\leq T \leq 2.00$ s, ∞

Permissive tolerance/Limiting values: $|d| \leq 1\%$ of setting value or 10 ms

Test results/Remarks: $|d| < 1\%$ of setting value or 10 ms

1.2.3.7 Dropout Ratio

Test condition: see item 1.2.3.1.1

Permissive tolerance/Limiting values: r approx. 0.70

Test results/Remarks: 0.68 $\leq r \leq 0.72$

Summary

1.2.3.8 Operating Times

Test condition:	see item 1.2.3.1.1
Test values:	$I/I_{rated} = 1, I/I_{rated} = 2$
Permissive tolerance/Limiting values:	t approx. 23 ms + OOT at 50 Hz 20 ms + OOT at 60 Hz
Test results/Remarks:	t approx. <23 ms + OOT at 50 Hz <20 ms + OOT at 60 Hz

1.2.3.9 Dropout Times

Test condition:	see item 1.2.3.1.1
Test values:	see item 1.2.3.8
Permissive tolerance/Limiting values:	t approx. 29 ms + OOT at 50 Hz 26 ms + OOT at 60 Hz
Test results/Remarks:	t approx. <29 ms + OOT at 50 Hz <26 ms + OOT at 60 Hz

1.2.4 I-DIFF Fast

1.2.4.1 Threshold

Test condition:	$0.5 \leq I/I_{ratedObj} \leq 35.0$
Permissive tolerance/Limiting values:	$ d \leq 2\%$ of setting value
Test results/Remarks:	$ d < 2\%$

1.2.4.2 Dropout Ratio

Test condition:	see item 1.2.4.1
Permissive tolerance/Limiting values:	r approx. 0.70
Test results/Remarks:	$0.68 \leq r \leq 0.72$

1.2.4.3 Operating Times

Test condition:	see item 1.2.4.1
Test values:	$I/I_{rated} = 1, I/I_{rated} = 2$
Permissive tolerance/Limiting values:	t approx. 8 ms + OOT at 50 Hz 8 ms + OOT at 60 Hz
Test results/Remarks:	t approx. <8 ms + OOT at 50 Hz <8 ms + OOT at 60 Hz

Summary

1.2.4.4 Dropout Times

Test condition:	see item 1.2.4.1
Test values:	see item 1.2.4.3
Permissive tolerance/Limiting values:	t approx. 29 ms + OOT at 50 Hz 26 ms + OOT at 60 Hz
Test results/Remarks:	t approx. <29 ms + OOT at 50 Hz <26 ms + OOT at 60 Hz

1.2.4.5 Time Delays

Test condition:	added to the inherent operating times
Test values:	0.00 s ≤ T _D ≤ 60.00 s
Permissive tolerance/Limiting values:	d ≤ 1 % of setting value or 10 ms
Test results/Remarks:	d < 1 % of setting value or 10 ms

1.2.5 I-DIFF Unrestraint

1.2.5.1 Threshold

Test condition:	0.5 ≤ I/I _{ratedObj} ≤ 35.0
Permissive tolerance/Limiting values:	d ≤ 2 % of setting value
Test results/Remarks:	d < 2 %

1.2.5.2 Dropout Ratio

Test condition:	see item 1.2.5.1
Permissive tolerance/Limiting values:	r approx. 0.70
Test results/Remarks:	0.68 ≤ r ≤ 0.72

1.2.5.3 Operating Times

Test condition:	see item 1.2.5.1
Test values:	I/I _{rated} = 1, I/I _{rated} = 2
Permissive tolerance/Limiting values:	t approx. 8 ms + OOT at 50 Hz 8 ms + OOT at 60 Hz
Test results/Remarks:	t approx. < 8 ms + OOT at 50 Hz < 8 ms + OOT at 60 Hz

Summary

1.2.5.4 Dropout Times

Test condition:	see item 1.2.5.1
Test values:	see item 1.2.5.3
Permissive tolerance/Limiting values:	t approx. 29 ms + OOT at 50 Hz 26 ms + OOT at 60 Hz
Test results/Remarks:	t approx. < 29 ms + OOT at 50 Hz < 26 ms + OOT at 60 Hz

1.2.5.5 Time Delays

Test condition:	added to the inherent operating times
Test values:	0.00 s ≤ T _D ≤ 60.00 s
Permissive tolerance/Limiting values:	d ≤ 1 % of setting value or 10 ms
Test results/Remarks:	d < 1 % of setting value or 10 ms

1.2.6 Frequency Operating Range

Frequency manual update:	10 Hz to 80 Hz
Test results/Remarks:	confirmed

Summary

1.3 87N Restricted Earth Fault Protection ($I_{REF>}$)

1.3.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.3.2 Pickup value ($I_{REF>}$)

Test condition: $0.05 \times I_{REF>} / I_{rated} / r_{Obj} \times 2.00$

Test values: $0.05 \times I_{REF>} / I_{rated} / r_{Obj} \times 2.00$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: $|d| \leq 2 \% \text{ of setting value at } I < 5 I_{rated}$

Test results/Remarks: $|d| < 2 \% \text{ of setting value at } I < 5 I_{rated}$

1.3.3 Pickup times ($I_{REF>}$)

1.3.3.1 1.5 x setting value ($I_{REF>}$)

Test condition: IEC/EN 60255-1

Test values: $1.5 \times \text{setting value } I_{REF>}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: t approx.
33 ms + OOT at $f_{rated} = 50 \text{ Hz}$
32 ms + OOT at $f_{rated} = 60 \text{ Hz}$

Test results/Remarks: t
< 33 ms + OOT at $f_{rated} = 50 \text{ Hz}$
< 32 ms + OOT at $f_{rated} = 60 \text{ Hz}$

1.3.3.2 2.5 x setting value ($I_{REF>}$)

Test condition: see item 1.3.3.1

Test values: $2.5 \times \text{setting value } I_{REF>}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: t approx.
27 ms + OOT at $f_{rated} = 50 \text{ Hz}$
26 ms + OOT at $f_{rated} = 60 \text{ Hz}$

Test results/Remarks: t
< 27 ms + OOT at $f_{rated} = 50 \text{ Hz}$
< 26 ms + OOT at $f_{rated} = 60 \text{ Hz}$

1.3.3.3 Dropout times

Test condition: see item 1.3.3.1

Test values: see item 1.3.3.1

Permissive tolerance/Limiting values: t approx.
80 ms at $f_{rated} = 50 \text{ Hz}$
67 ms at $f_{rated} = 60 \text{ Hz}$

Summary

Test results/Remarks: t
< 80 ms at $f_{\text{rated}} = 50$ Hz
< 67 ms at $f_{\text{rated}} = 60$ Hz

1.3.3.4 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s $\leq T_D \leq 60.00$ s, ∞

Permissive tolerance/Limiting values: $|d| \leq 1\%$ of setting value or 10 ms

Test results/Remarks: $|d| < 1\%$ of setting value or 10 ms

1.3.3.5 Dropout ratio (I_{REF})

Test condition: see item 1.3.3.1

Test values: see item 1.3.3.1

Permissive tolerance/Limiting values: r approx. 0.70

Test results/Remarks: 0.68 $\leq r \leq 0.72$

Summary

1.4 87M Motor Differential Protection

1.4.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.4.2 General test conditions

f_{rated} : 50 Hz, 60 Hz

I_{rated} : 1 A, 5 A

1.4.3 I-DIFF

1.4.3.1 Operate Curve

1.4.3.1.1 I-DIFF Threshold

Test condition: $0.05 \leq I/I_{ratedObj} \leq 2.00$

Permissive tolerance/Limiting values: $\pm 2\%$ of setting value

Test results/Remarks: $< 2\%$ of setting value

1.4.3.1.2 I-DIFF Slope 1

Test condition: 0.00 to 0.80

Test results/Remarks: confirmed

1.4.3.1.3 I-DIFF Intersection 1 Irest

Test condition: $0.00 \leq I/I_{ratedObj} \leq 5.00$

Test results/Remarks: confirmed

1.4.3.1.4 I-DIFF Slope 2

Test condition: 0.25 to 0.95

Test results/Remarks: confirmed

1.4.3.1.5 I-DIFF Intersection 2 Irest

Test condition: $1.00 \leq I/I_{ratedObj} \leq 20.00$

Test results/Remarks: confirmed

1.4.3.2 Starting Detection

1.4.3.2.1 Threshold Startup Detection

Test condition: $0.1 \leq I/I_{ratedObj} \leq 2.0$

Permissive tolerance/Limiting values: $\pm 2\%$ of setting value

Test results/Remarks: $\leq 2\%$ of setting value

Summary

1.4.3.2.2 Factor Increasing Char.

Test condition: 1.0 to 5.0

Test results/Remarks: confirmed

1.4.3.2.3 Max. perm. Start Time

Test condition: 0.1 s £ T £ 180.0 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: < 1 % of setting value or < 10 ms

1.4.3.3 DC offset Detection

1.4.3.3.1 Factor Increasing Char. DC

Test condition: 1.0 to 5.0

Test results/Remarks: confirmed

Summary

1.4.3.4 Ext. Fault Detection

1.4.3.4.1 Threshold of add-on stabiliz.

Test condition: 1.00 $\leq I/I_{ratedObj} \leq$ 20.00

Permissive tolerance/Limiting values: ± 2 % of setting value

Test results/Remarks: < 2 % of setting value

1.4.3.4.2 Time of add-on stabiliz.

Test condition: 0.00 s $\leq T \leq$ 5.00 s, ∞

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: < 1 % of setting value or < 10 ms

1.4.3.4.3 Cross-blk time of add-on stabiliz.

Test condition: 0.00 s $\leq T \leq$ 2.00 s, ∞

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: < 1 % of setting value or < 10 ms

1.4.3.5 Dropout Ratio

Test condition: see item 1.4.3.1.1

Permissive tolerance/Limiting values: $r = 0.70$

Test results/Remarks: 0.68 $\leq r \leq$ 0.72

1.4.3.6 Operating Times

Test condition: see item 1.4.3.1.1

Test values: $I/I_{rated} = 1, I/I_{rated} = 2$

Permissive tolerance/Limiting values: ≤ 23 ms + OOT at 50 Hz
 ≤ 20 ms + OOT at 60 Hz

Test results/Remarks: < 23 ms + OOT at 50 Hz
 < 20 ms + OOT at 60 Hz

1.4.3.7 Dropout Times

Test condition: see item 1.4.3.1.1

Test values: see item 1.4.3.6

Permissive tolerance/Limiting values: ≤ 29 ms + OOT at 50 Hz
 ≤ 26 ms + OOT at 60 Hz

Test results/Remarks: < 29 ms + OOT at 50 Hz
 < 26 ms + OOT at 60 Hz

Summary**1.4.4 I-DIFF Fast****1.4.4.1 Threshold**Test condition: $0.5 \times I_{ratedObj} \leq 35.0$ Permissive tolerance/Limiting values: $\pm 2\%$ of setting valueTest results/Remarks: $< 2\%$ of setting value**1.4.4.2 Dropout Ratio**

Test condition: see item 1.4.4.1

Permissive tolerance/Limiting values: $r = 0.70$ Test results/Remarks: $0.68 \leq r \leq 0.72$

Summary

1.4.4.3 Operating Times

Test condition:	see item 1.4.4.1
Test values:	$I/I_{rated} = 1, I/I_{rated} = 2$
Permissive tolerance/Limiting values:	$\leq 8 \text{ ms} + \text{OOT at 50 Hz}$ $\leq 8 \text{ ms} + \text{OOT at 60 Hz}$
Test results/Remarks:	$< 8 \text{ ms} + \text{OOT at 50 Hz}$ $< 8 \text{ ms} + \text{OOT at 60 Hz}$

1.4.4.4 Dropout Times

Test condition:	see item 1.4.4.1
Test values:	see item 1.4.4.3
Permissive tolerance/Limiting values:	$\leq 29 \text{ ms} + \text{OOT at 50 Hz}$ $\leq 26 \text{ ms} + \text{OOT at 60 Hz}$
Test results/Remarks:	$< 29 \text{ ms} + \text{OOT at 50 Hz}$ $< 26 \text{ ms} + \text{OOT at 60 Hz}$

1.4.4.5 Time Delays

Test condition:	added to the inherent operating times
Test values:	$0.00 \text{ s} \leq T_D \leq 60.00 \text{ s}$
Permissive tolerance/Limiting values:	$\pm 1 \%$ of setting value or 10 ms
Test results/Remarks:	$< 1 \%$ of setting value or $< 10 \text{ ms}$

1.4.5 I-DIFF Unrestraint

1.4.5.1 Threshold

Test condition:	$0.5 \leq I/I_{ratedObj} \leq 35.0$
Permissive tolerance/Limiting values:	$\pm 2 \%$ of setting value
Test results/Remarks:	$< 2 \%$ of setting value

1.4.5.2 Dropout Ratio

Test condition:	see item 1.4.5.1
Permissive tolerance/Limiting values:	$r = 0.70$
Test results/Remarks:	$0.68 \leq r \leq 0.72$

1.4.5.3 Operating Times

Test condition:	see item 1.4.5.1
Test values:	$I/I_{rated} = 1, I/I_{rated} = 2$

Summary

Permissive tolerance/Limiting values: $\leq 8 \text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 8 \text{ ms} + \text{OOT}$ at 60 Hz

Test results/Remarks: $< 8 \text{ ms} + \text{OOT}$ at 50 Hz
 $< 8 \text{ ms} + \text{OOT}$ at 60 Hz

1.4.5.4 Dropout Times

Test condition: see item 1.4.5.1

Test values: see item 1.4.5.3

Permissive tolerance/Limiting values: $\leq 29 \text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 26 \text{ ms} + \text{OOT}$ at 60 Hz

Test results/Remarks: $< 29 \text{ ms} + \text{OOT}$ at 50 Hz
 $< 26 \text{ ms} + \text{OOT}$ at 60 Hz

1.4.5.5 Time Delays

Test condition: added to the inherent operating times

Test values: $0.00 \text{ s} \leq T_D \leq 60.00 \text{ s}$

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: $< 1 \%$ of setting value or $< 10 \text{ ms}$

1.4.6 Frequency Operating Range

Frequency manual update: 10 Hz to 80 Hz

Test results/Remarks: confirmed

Summary

1.5 87G Generator Differential Protection

1.5.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.5.2 General test conditions

f_{rated} : 50 Hz, 60 Hz

I_{rated} : 1 A, 5 A

1.5.3 I-DIFF

1.5.3.1 Operate Curve

1.5.3.1.1 I-DIFF Threshold

Test condition: 0.05 £ $I/I_{ratedObj}$ £ 2.00

Permissive tolerance/Limiting values: ±2 % of setting value

Test results/Remarks: ≤ 2 % of setting value

1.5.3.1.2 I-DIFF Slope 1

Test condition: 0.00 to 0.80

Test results/Remarks: confirmed

1.5.3.1.3 I-DIFF Intersection 1 Irest

Test condition: 0.00 £ $I/I_{ratedObj}$ £ 5.00

Test results/Remarks: confirmed

1.5.3.1.4 I-DIFF Slope 2

Test condition: 0.25 to 0.95

Test results/Remarks: confirmed

1.5.3.1.5 I-DIFF Intersection 2 Irest

Test condition: 1.00 £ $I/I_{ratedObj}$ £ 20.00

Test results/Remarks: confirmed

1.5.3.2 Starting Detection

1.5.3.2.1 Threshold Startup Detection

Test condition: 0.1 £ $I/I_{ratedObj}$ £ 2.0

Permissive tolerance/Limiting values: ±2 % of setting value

Test results/Remarks: ≤ 2 % of setting value

Summary

1.5.3.2.2 Factor Increasing Char.

Test condition: 1.0 to 5.0

Test results/Remarks: confirmed

1.5.3.2.3 Max. perm. Start Time

Test condition: 0.1 s £ T £ 180.0 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.5.3.3 DC offset Detection

1.5.3.3.1 Factor Increasing Char. DC

Test condition: 1.0 to 5.0

Test results/Remarks: confirmed

Summary

1.5.3.4 Ext. Fault Detection

1.5.3.4.1 Threshold of add-on stabiliz.

Test condition: 1.00 $\leq I/I_{ratedObj} \leq$ 20.00

Permissive tolerance/Limiting values: ± 2 % of setting value

Test results/Remarks: ≤ 2 % of setting value

1.5.3.4.2 Time of add-on stabiliz.

Test condition: 0.00 s $\leq T \leq$ 5.00 s, ∞

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.5.3.4.3 Cross-blk time of add-on stabiliz.

Test condition: 0.00 s $\leq T \leq$ 2.00 s, ∞

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.5.3.5 Dropout Ratio

Test condition: see item 1.5.3.1.1

Permissive tolerance/Limiting values: $r = 0.70$

Test results/Remarks: 0.68 $\leq r \leq$ 0.72

1.5.3.6 Operating Times

Test condition: see item 1.5.3.1.1

Test values: $I/I_{rated} = 1, I/I_{rated} = 2$

Permissive tolerance/Limiting values: ≤ 23 ms + OOT at 50 Hz
 ≤ 20 ms + OOT at 60 Hz

Test results/Remarks: ≤ 23 ms + OOT at 50 Hz
 ≤ 20 ms + OOT at 60 Hz

1.5.3.7 Dropout Times

Test condition: see item 1.5.3.1.1

Test values: see item 1.5.3.6

Permissive tolerance/Limiting values: ≤ 29 ms + OOT at 50 Hz
 ≤ 26 ms + OOT at 60 Hz

Test results/Remarks: < 29 ms + OOT at 50 Hz
 < 26 ms + OOT at 60 Hz

Summary**1.5.4 I-DIFF Fast****1.5.4.1 Threshold**Test condition: $0.5 \leq I/I_{ratedObj} \leq 35.0$ Permissive tolerance/Limiting values: $\pm 2\%$ of setting valueTest results/Remarks: $\leq 2\%$ of setting value**1.5.4.2 Dropout Ratio**

Test condition: see item 1.5.4.1

Permissive tolerance/Limiting values: $r = 0.70$ Test results/Remarks: $0.68 \leq r \leq 0.72$

Summary

1.5.4.3 Operating Times

Test condition:	see item 1.5.4.1
Test values:	$I/I_{rated} = 1, I/I_{rated} = 2$
Permissive tolerance/Limiting values:	$\leq 8 \text{ ms} + \text{OOT at } 50 \text{ Hz}$ $\leq 8 \text{ ms} + \text{OOT at } 60 \text{ Hz}$
Test results/Remarks:	$\leq 8 \text{ ms} + \text{OOT at } 50 \text{ Hz}$ $\leq 8 \text{ ms} + \text{OOT at } 60 \text{ Hz}$

1.5.4.4 Dropout Times

Test condition:	see item 1.5.4.1
Test values:	see item 1.5.4.3
Permissive tolerance/Limiting values:	$\leq 29 \text{ ms} + \text{OOT at } 50 \text{ Hz}$ $\leq 26 \text{ ms} + \text{OOT at } 60 \text{ Hz}$
Test results/Remarks:	$\leq 29 \text{ ms} + \text{OOT at } 50 \text{ Hz}$ $\leq 26 \text{ ms} + \text{OOT at } 60 \text{ Hz}$

1.5.4.5 Time Delays

Test condition:	added to the inherent operating times
Test values:	$0.00 \text{ s} \leq T_D \leq 60.00 \text{ s}$
Permissive tolerance/Limiting values:	$\pm 1 \%$ of setting value or 10 ms
Test results/Remarks:	$\leq 1 \%$ of setting value or $\leq 10 \text{ ms}$

1.5.5 I-DIFF Unrestraint

1.5.5.1 Threshold

Test condition:	$0.5 \leq I/I_{ratedObj} \leq 35.0$
Permissive tolerance/Limiting values:	$\pm 2 \%$ of setting value
Test results/Remarks:	$\leq 2 \%$ of setting value

1.5.5.2 Dropout Ratio

Test condition:	see item 1.5.5.1
Permissive tolerance/Limiting values:	$r = 0.70$
Test results/Remarks:	$0.68 \leq r \leq 0.72$

1.5.5.3 Operating Times

Test condition:	see item 1.5.5.1
-----------------	------------------

Summary

Test values:	$I/I_{rated} = 1, I/I_{rated} = 2$
Permissive tolerance/Limiting values:	$\leq 8 \text{ ms} + \text{OOT at } 50 \text{ Hz}$ $\leq 8 \text{ ms} + \text{OOT at } 60 \text{ Hz}$
Test results/Remarks:	$\leq 8 \text{ ms} + \text{OOT at } 50 \text{ Hz}$ $\leq 8 \text{ ms} + \text{OOT at } 60 \text{ Hz}$

1.5.5.4 Dropout Times

Test condition:	see item 1.5.5.1
Test values:	see item 1.5.5.3
Permissive tolerance/Limiting values:	$\leq 29 \text{ ms} + \text{OOT at } 50 \text{ Hz}$ $\leq 26 \text{ ms} + \text{OOT at } 60 \text{ Hz}$
Test results/Remarks:	$\leq 29 \text{ ms} + \text{OOT at } 50 \text{ Hz}$ $\leq 26 \text{ ms} + \text{OOT at } 60 \text{ Hz}$

1.5.5.5 Time Delays

Test condition:	added to the inherent operating times
Test values:	$0.00 \text{ s} \leq T_D \leq 60.00 \text{ s}$
Permissive tolerance/Limiting values:	$\pm 1 \%$ of setting value or 10 ms
Test results/Remarks:	$\leq 1 \%$ of setting value or $\leq 10 \text{ ms}$

1.5.6 Frequency Operating Range

Frequency manual update:	10 Hz to 80 Hz
Test results/Remarks:	confirmed

Summary

1.6 87L Line Differential Protection

1.6.1 Specifications

- VDE 0435
- IEC/EN 60255-1, Item 7, Annex A, B
- Time measurements done with fast relays

1.6.2 Tripping threshold Idiff stage

1.6.2.1 Pickup values

Test condition:	fault L-N , $f_{rated}= 50 \text{ Hz}, 60 \text{ Hz}$ $0.100 I_{rated} \leq I_{ph} < 20.000 I_{rated}$
Test values:	$0.100 \text{ A} \leq I_{ph} < 0.000 \text{ A}$ for $I_{rated} = 1 \text{ A}$ $0.500 \text{ A} \leq I_{ph} < 0.000 \text{ A}$ for $I_{rated} = 5 \text{ A}$
Permissive tolerance/Limiting values:	deviation d of set point value d 5 % of setting value for up to 3 line ends d 10 % of setting value for up to 6 line ends or d 1 % of I_{rated} for each line end
Test results/Remarks:	d 5 % or $< 1 \% I_{rated}$ for 2 line ends

1.6.2.2 Dropout ratio

Test condition:	see item 1.6.2.1
Test values:	see item 1.6.2.1
Permissive tolerance/Limiting values:	$r = 0.5$ if process monitor indicates circuit breaker close $r = 0.8$ if process monitor indicates circuit breaker open
Test results/Remarks:	r approx. 0.5 if process monitor indicates circuit breaker close r approx. 0.8 if process monitor indicates circuit breaker open depending on measuring tolerances

1.6.2.3 Pickup times

Test condition:	fault L-N, $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}, I_{rated} = 1 \text{ A}$ Topology = 2...6 ends, 3 in ring (3R) Transmission rate 64 kbit/s, 128 kbit/s, 512 kbit/s, 2048 kbit/s 100 shots per topology, frequency, transmission rate
Test values:	$I_{fault} = 1 \text{ A}, I_{ph} = 0.300 \text{ A}$ $t_{min}/t_{typ}/t_{max}$ in ms
Permissive tolerance/Limiting values:	up to 40 ms for 2 ends, 3 in ring with 512 kbit/s, 2048 kbit/s up to 41 ms for 3 ends with 512 kbit/s, 2048 kbit/s up to 42 ms for 4 ends with 512 kbit/s, 2048 kbit/s up to 43 ms for 5 ends with 512 kbit/s, 2048 kbit/s up to 45 ms for 6 ends with 512 kbit/s, 2048 kbit/s

Summary

Test results/Remarks:

Topology	Frequency	2048 kbit/s	512 kbit/s	128 kbit/s	64 kbit/s
2	50	28/31/34	28/31/39	31/36/42	36/47/58
2	60	26/28/32	25/28/32	27/34/39	33/44/58
3R	50	28/31/35			
3R	60	26/29/33			
3	50	28/32/35			
3	60	26/29/33			
4	50	29/32/36			
4	60	27/31/35			
5	50	30/33/38			
5	60	27/32/36			
6	50	30/35/40			
6	60	28/32/37	31/36/42	38/47/66	53/74/124

$t_{min}/t_{typ}/t_{max}$ in ms, e.g. for 2048 kBit/s: 28/31/34

Summary

1.6.2.4 Dropout times

Test condition: see item 1.6.2.3

Test values: see item 1.6.2.3

Permissive tolerance/Limiting values: up to 50 ms

Test results/Remarks:	Topology	Frequency	2048 kbit/s	512 kbit/s	128 kbit/s	64 kbit/s
	2	50	27/28/29	28/31/39	36/38/41	45/48/52
	2	60	28/28/29	27/30/35	27/35/40	35/45/62
	3R	50	27/28/30			
	3R	60	27/28/30			
	3	50	26/28/29			
	3	60	26/28/30			
	4	50	26/28/33			
	4	60	25/28/31			
	5	50	26/30/36			
	5	60	25/27/33			
	6	50	29/32/36			
	6	60	24/29/34	28/34/40	35/46/70	50/72/107

$t_{min}/t_{typ}/t_{max}$ in ms, e.g. for 2048 kBit/s: 27/28/29

1.6.2.5 Delay times

Test condition: 0.00 s $\leq T_{diff}$ \leq 60.00 s
0.00 s $\leq T_{310}$ \leq 0.50 s

Test values: 0.00 s $\leq T_{diff}$ \leq 60.00 s
0.00 s $\leq T_{310}$ \leq 0.50 s

Permissive tolerance/Limiting values: |d| 1 % of setting value
or
|d| \leq 10 ms

Test results/Remarks: |d| < 1 % of setting value or < 10ms

1.6.3 Tripping threshold Idiff fast stage

1.6.3.1 Pickup values

Test condition: fault L-N, $f_{rated} = 50$ Hz, 60 Hz
0.800 I_{rated} $\leq I_{ph}$ \leq 100.000 I_{rated}

Test values: 0.800 A $\leq I_{ph}$ \leq 7.000 A for $I_{rated} = 1$ A
4.000 A $\leq I_{ph}$ \leq 8.000 A for $I_{rated} = 5$ A

Permissive tolerance/Limiting values: deviation d of set point value
|d| 5 % of setting value for up to 3 line ends
|d| 10 % of setting value for up to 6 line ends
or
|d| 1 % of I_{rated} for each line end

Test results/Remarks: |d| 5 % of setting value or < 1 % I_{rated} for 2 line ends

1.6.3.2 Dropout ratio

Test condition: see item 1.6.3.1

Test values: see item 1.6.3.1

Summary

Permissive tolerance/Limiting values:

r = 0.5 if process monitor indicates circuit breaker close
r = 0.7 if process monitor indicates circuit breaker open

Test results/Remarks:

r approx. 0.5 if process monitor indicates circuit breaker close
r approx. 0.7 if process monitor indicates circuit breaker open
depending on measuring tolerances

Summary

1.6.3.3 Pickup times

Test condition: fault L-N, $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}, I_{rated} = 1 \text{ A}$
Topology = 2...6 ends, 3 in ring (3R)
Transmission rate 64 kbit/s, 128 kbit/s, 512 kbit/s, 2048 kbit/s
100 shots per topology, frequency, transmission rate

Test values: $I_{fault} = 2 \text{ A}, I_{ph} > = 1.000 \text{ A}$
 $t_{min}/t_{typ}/t_{max}$ in ms

Permissive tolerance/Limiting values: up to 22 ms for 2 ends, 3 in ring with 512 kbit/s, 2048 kbit/s
up to 25 ms for 3 ends with 512 kbit/s, 2048 kbit/s
up to 27 ms for 4 ends with 512 kbit/s, 2048 kbit/s
up to 29 ms for 5 ends with 512 kbit/s, 2048 kbit/s
up to 31 ms for 6 ends with 512 kbit/s, 2048 kbit/s

Test results/Remarks:

Topology	Frequency	2048 kbit/s	512 kbit/s	128 kbit/s	64 kbit/s
2	50	12/15/18	12/15/18	13/17/21	17/24/33
2	60	11/14/17	12/15/18	12/17/21	17/24/31
3R	50	13/16/19			
3R	60	13/16/19	14/17/20	15/19/23	20/26/33
3	50	14/17/20	15/18/22	15/21/30	21/33/52
3	60	13/17/20			
4	50	14/17/21			
4	60	14/18/22			
5	50	13/18/23			
5	60	14/18/24			
6	50	13/20/25			
6	60	14/19/26			

$t_{min}/t_{typ}/t_{max}$ in ms, e.g. for 2048 kBit/s: 12/15/18

1.6.3.4 Dropout times

Test condition: see item 1.6.3.3

Test values: see item 1.6.3.3

Permissive tolerance/Limiting values: up to 50 ms

Test results/Remarks:

Topology	Frequency	2048 kbit/s	512 kbit/s	128 kbit/s	64 kbit/s
2	50	29/35/41	33/36/40	35/38/41	39/45/54
2	60	29/35/40	34/37/39	35/38/44	39/46/52
3R	50	30/36/40			
3R	60	29/35/40	33/36/39	34/38/42	38/45/57
3	50	30/36/41	33/36/42	34/39/45	39/50/66
3	60	29/36/41			
4	50	30/37/42			
4	60	29/37/42			
5	50	24/37/43			
5	60	23/37/46			
6	50	23/38/45			
6	60	23/38/45			

$t_{min}/t_{typ}/t_{max}$ in ms, e.g. for 2048 kBit/s: 29/35/41

1.6.4 Tripping threshold Idiff fast 2 stage

1.6.4.1 Pickup values

Test condition: fault L-N, $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $0.500 I_{rated} \leq I_{ph} < 100.000 I_{rated}$

Summary

Test values: 0.500 A \leq I_{ph} < 7.000 A for I_{rated} = 1 A
4.000 A \leq I_{ph} < 8.000 A for I_{rated} = 5 A

Permissive tolerance/Limiting values: deviation d of set point value
|d| 5 % of setting value for up to 3 line ends
|d| 10 % of setting value for up to 6 line ends
or
|d| 1 % of I_{rated} for each line end

Test results/Remarks: |d| 5 % of setting value or < 1 % I_{rated} for 2 line ends

1.6.4.2 Dropout ratio

Test condition: see item 1.6.3.1

Test values: see item 1.6.3.1

Permissive tolerance/Limiting values: r = 0.5 if process monitor indicates circuit breaker close
r = 0.7 if process monitor indicates circuit breaker open

Test results/Remarks: r approx. 0.5 if process monitor indicates circuit breaker close
r approx. 0.7 if process monitor indicates circuit breaker open
depending on measuring tolerances

1.6.4.3 Pickup times

Test condition: fault L-N, f_{rated} = 50 Hz, 60 Hz, I_{rated} = 1 A
Topology = 2...6 ends, 3 in ring (3R)
Transmission rate 64 kbit/s, 128 kbit/s, 512 kbit/s, 2048 kbit/s
100 shots per topology, frequency, transmission rate

Test values: I_{fault} = 2 A, I_{ph} > = 1.000 A
t_{min}/t_{typ}/t_{max} in ms

Permissive tolerance/Limiting values: up to 22 ms for 2 ends, 3 in ring with 512 kbit/s, 2048 kbit/s
up to 25 ms for 3 ends with 512 kbit/s, 2048 kbit/s
up to 27 ms for 4 ends with 512 kbit/s, 2048 kbit/s
up to 29 ms for 5 ends with 512 kbit/s, 2048 kbit/s
up to 31 ms for 6 ends with 512 kbit/s, 2048 kbit/s

Test results/Remarks:

Topology	Frequency	2048 kbit/s	512 kbit/s	128 kbit/s	64 kbit/s
2	50	14/16/18	14/16/18	13/15/18	13/15/18
2	60	13/15/18	13/15/18	13/15/18	13/15/18
3R	50	13/16/19			
3R	60	13/16/19	14/17/20	15/19/23	20/26/33
3	50	14/17/20	15/18/22	15/21/30	21/33/52
3	60	13/17/20			
4	50	14/17/21			
4	60	14/18/22			
5	50	13/18/23			
5	60	14/18/24			
6	50	13/20/25			
6	60	14/19/26			

t_{min}/t_{typ}/t_{max} in ms, e.g. for 2048 kBit/s: 14/16/18

1.6.4.4 Dropout times

Test condition: see item 1.6.3.3

Summary

Test values: see item 1.6.3.3

Permissive tolerance/Limiting values: up to 50 ms

Test results/Remarks:	Topology	Frequency	2048 kbit/s	512 kbit/s	128 kbit/s	64 kbit/s
	2	50	27/29/31	27/29/31	26/28/31	26/28/30
	2	60	26/28/31	26/28/30	26/28/31	26/28/31
	3R	50	30/36/40			
	3R	60	29/35/40	33/36/39	34/38/42	38/45/57
	3	50	30/36/41	33/36/42	34/39/45	39/50/66
	3	60	29/36/41			
	4	50	30/37/42			
	4	60	29/37/42			
	5	50	24/37/43			
	5	60	23/37/46			
	6	50	23/38/45			
	6	60	23/38/45			

$t_{min}/t_{typ}/t_{max}$ in ms, e.g. for 2048 kBit/s: 27/29/31

Summary**1.6.5 Auto-stabilization**

Test condition	fault L-N, L-L-L 1.00 ϵ CT error changeover ϵ 10.00 0.50 % ϵ CT error A ϵ 50 % 0.50 % ϵ CT error B ϵ 50 %
Test values:	CT error changeover = 1 CT error A = 0.5 %, 5 %, 15 % Charging-Current compensation CT error B = 0.5 %, 5 %, 15 %
Permissive tolerance/Limiting values:	funct. acc. to manual
Test results/Remarks:	function correct

1.6.6 Transformer inside protection range

Test condition	fault L-N, L-L-L , $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Test values:	Voltage vector group Current vector group Residual current elimination
Permissive tolerance/Limiting values:	funct. acc. to manual
Test results/Remarks:	function correct

1.6.7 Charging-Current compensation

Test condition	fault L-N, $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$ 1 ϵ Ic-stabilization / Ic-rated ϵ 4 0.1 km ϵ Total line length ϵ 1000 km
Test values:	1 ϵ Ic-stabilization / Ic-rated ϵ 4 0.1 km ϵ Total line length ϵ 1000 km
Permissive tolerance/Limiting values:	funct. acc. to manual
Test results/Remarks:	function correct

Summary

1.7 Stub Protection

1.7.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.7.2 Tripping threshold S-DIFF stage

1.7.2.1 Threshold values

Test condition:	fault L-N , $f_{rated}= 50 \text{ Hz}, 60 \text{ Hz}$ $0.100 I_{rated} \leq I_{ph} < 20.000 I_{rated}$
Test values:	$0.100 \text{ A} \leq I_{ph} < 04.000 \text{ A}$ for $I_{rated} = 1 \text{ A}$ $0.500 \text{ A} \leq I_{ph} < 04.000 \text{ A}$ for $I_{rated} = 5 \text{ A}$
Permissive tolerance/Limiting values:	deviation d of set point value $ d \leq 5 \% \text{ of setting value or } \leq 1 \% \text{ of } I_{rated}$
Test results/Remarks:	$ d < 5 \% \text{ or } < 1 \% \text{ of } I_{rated}$

1.7.2.2 Operating times

Test condition:	fault L-N , $f_{rated}= 50 \text{ Hz}, 60 \text{ Hz}, I_{rated} = 1 \text{ A}$
Test values:	$I_{fault} = 1 \text{ A}, I_{ph} > = 0.300 \text{ A}$ t in ms
Permissive tolerance/Limiting values:	appr. 29 ms + OOT at $f_{rated} = 50 \text{ Hz}$ appr. 26 ms + OOT at $f_{rated} = 60 \text{ Hz}$
Test results/Remarks:	$t_{min} 26 \text{ ms} + \text{OOT}, t_{typ} 28 \text{ ms} + \text{OOT}$ at $f_{rated} = 50 \text{ Hz}$ $t_{min} 23 \text{ ms} + \text{OOT}, t_{typ} 25 \text{ ms} + \text{OOT}$ at $f_{rated} = 60 \text{ Hz}$

1.7.2.3 Dropout times

Test condition:	see item 1.7.2.2
Test values:	see item 1.7.2.2
Permissive tolerance/Limiting values:	34 ms to 50 ms
Test results/Remarks:	34 ms $\leq t \leq$ 49 ms

1.7.2.4 Delay times

Test condition:	0.00 s $\leq T \leq$ 60.00 s
Test values:	0.00 s $\leq T \leq$ 60.00 s
Permissive tolerance/Limiting values:	$ d \leq 1 \% \text{ of setting value or } \leq 10 \text{ ms}$
Test results/Remarks:	$ d < 1 \% \text{ or } < 10 \text{ ms}$

Summary

1.7.3 Tripping threshold S-DIFF fast stage

1.7.3.1 Threshold values

Test condition: fault L-N , $f_{rated}= 50 \text{ Hz}$, 60 Hz
 $0.800 I_{rated} \leq I_{ph} < 100.000 I_{rated}$

Test values: $0.800 \text{ A} \leq I_{ph} < 09.000 \text{ A}$ for $I_{rated} = 1 \text{ A}$
 $4.000 \text{ A} \leq I_{ph} < 10.000 \text{ A}$ for $I_{rated} = 5 \text{ A}$

Permissive tolerance/Limiting values: deviation d of set point value
 $|d| \leq 5 \%$ of setting value or $\leq 1 \%$ of I_{rated}

Test results/Remarks: $|d| < 5 \%$ or $< 1 \%$ of I_{rated}

1.7.3.2 Tripping times

Test condition: fault L-N , $f_{rated}= 50 \text{ Hz}$, 60 Hz , $I_{rated} = 1 \text{ A}$

Test values: $I_{ph} = 1.000 \text{ A}$
t in ms

Permissive tolerance/Limiting values: appr. 12 ms + OOT

Test results/Remarks: $t_{min} 8 \text{ ms} + \text{OOT}$, $t_{typ} 11 \text{ ms} + \text{OOT}$

1.7.3.3 Dropout times

Test condition: see item 1.7.3.2

Test values: see item 1.7.3.2

Permissive tolerance/Limiting values: 34 ms to 50 ms

Test results/Remarks: 34 ms $\leq t \leq$ 49 ms

1.7.4 Tripping threshold S-DIFF fast 2 stage

1.7.4.1 Threshold values

Test condition: fault L-N , $f_{rated}= 50 \text{ Hz}$, 60 Hz
 $0.800 I_{rated} \leq I_{ph} < 100.000 I_{rated}$

Test values: $0.800 \text{ A} \leq I_{ph} < 09.000 \text{ A}$ for $I_{rated} = 1 \text{ A}$
 $4.000 \text{ A} \leq I_{ph} < 10.000 \text{ A}$ for $I_{rated} = 5 \text{ A}$

Permissive tolerance/Limiting values: deviation d of set point value
 $|d| \leq 5 \%$ of setting value or $\leq 1 \%$ of I_{rated}

Test results/Remarks: $|d| < 5 \%$ or $< 1 \%$ of I_{rated}

Summary**1.7.4.2 Tripping times**

Test condition: fault L-N , $f_{\text{rated}} = 50 \text{ Hz}, 60 \text{ Hz}$, $I_{\text{rated}} = 1 \text{ A}$

Test values: $I_{\text{ph}} > 1.000 \text{ A}$
 t in ms

Permissive tolerance/Limiting values: appr. 12 ms + OOT

Test results/Remarks: $t_{\text{min}} 8 \text{ ms} + \text{OOT}$, $t_{\text{typ}} 11 \text{ ms} + \text{OOT}$

1.7.4.3 Dropout times

Test condition: see item 1.7.3.2

Test values: see item 1.7.3.2

Permissive tolerance/Limiting values: 34 ms to 50 ms

Test results/Remarks: 34 ms £ t £ 49 ms

Summary

1.8 67N Ground-Fault Protection for High-Resistance Ground Faults in Grounded Systems

1.8.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC60255-151

1.8.2 Definite time overcurrent stages (3I0-definite time)

1.8.2.1 Pickup values

Test condition:	3I0 calculated, 3I0 measured
	0.030 A £ 3I0 £ 100.000 A for 3I0 ($I_{N-rated} = 1 A$)
	0.150 A £ 3I0 £ 500.000 A for 3I0 ($I_{N-rated} = 5 A$)
	0.003 A £ 3I0 £ 100.000 A for 3I0 ($I_{Nsens-rated} = 1 A + I_{L-rated} = 1 A$)
	0.003 A £ 3I0 £ 500.000 A for 3I0 ($I_{Nsens-rated} = 1 A + I_{L-rated} = 5 A$)
	0.015 A £ 3I0 £ 100.000 A for 3I0 ($I_{Nsens-rated} = 5 A + I_{L-rated} = 1 A$)
	0.015 A £ 3I0 £ 500.000 A for 3I0 ($I_{Nsens-rated} = 5 A + I_{L-rated} = 5 A$)

Permissive tolerance/Limiting values:	a) $ d \leq 1\%$ of setting value or $1\% I_{rated}$ for I-prot.
	b) $ d \leq 1\%$ of setting value or $0.5\% I_{rated}$ for I-sens.

Test results/Remarks:	a) $ d \leq 1\%$ or $1\% I_{rated}$
	b) $ d \leq 1\%$ or $0.5\% I_{rated}$

1.8.2.2 Dropout ratio

Test condition:	see item 1.8.2.1
Permissive tolerance/Limiting values:	r approx. 0.95 threshold
Test results/Remarks:	r approx. 0.95 threshold

1.8.2.3 Pickup times

Test condition:	see item 1.8.2.1
Permissive tolerance/Limiting values:	a) fundam. comp. over 1 cycle filter: approx. 25 ms + OOT b) fundam. comp. over 2 cycle filter: approx. 30 ms + OOT c) extension of pickup time with power transformer inrush-current detection: approx. 10 ms
Test results/Remarks:	a) approx. 25 ms + OOT b) approx. 25 ms + OOT c) approx. 10 ms

1.8.2.4 Dropout times

Test condition:	see item 1.8.2.1
Permissive tolerance/Limiting values:	a) fundam. comp. over 1 cycle filter: approx. 20 ms + OOT b) fundam. comp. over 2 cycle filter: approx. 40 ms + OOT
Test results/Remarks:	a) approx. 30 ms + OOT b) approx. 40 ms + OOT

1.8.2.5 Time delays

Test condition:	added to the inherent operating times
Test values:	0.000 s £ T £ 60.000 s

Summary

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % of setting value or 10 ms

1.8.2.6 Direction of directional stage

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.8.3 Overcurrent Protection, 3I0 Inverse time overcurrent stage (inverse time)

1.8.3.1 Pickup

Test condition: see item 1.8.2.1

Permissive tolerance/Limiting values: a) |d| £ 1 % of setting value or 1 % I_{rated} for I-prot.
b) |d| £ 1 % of setting value or 0.5 % I_{rated} for I-sens.

Test results/Remarks: a) |d| £ 1 % or 1 % I_{rated}
b) |d| £ 1 % or 0.5 % I_{rated}

1.8.3.2 Dropout ratio

Test condition: see item 1.8.2.1

Permissive tolerance/Limiting values: a) disk emulation
b) instantaneous

Test results/Remarks: confirmed

1.8.3.3 Pickup times

Test condition: see item 1.8.2.1

Test values: pickup time for $2 \leq I/I\text{-threshold value} \leq 20$

Permissive tolerance/Limiting values: 5 % of set point value or
+2 % current tolerance or
30 ms

Test results/Remarks: confirmed

1.8.3.4 Dropout times - instantaneous

Test condition: see item 1.8.2.1

Permissive tolerance/Limiting values: t approx. 20 ms + OOT

Test results/Remarks: t approx. 20 ms + OOT

1.8.3.5 Dropout times – disk emulation

Test condition: see item 1.8.2.1

Test values: dropout time for I/I-threshold value ≤ 0.90

Summary

Permissive tolerance/Limiting values: 5 % of set point value or
+2 % current tolerance or
30 ms

Test results/Remarks: confirmed

1.8.3.6 Tripping time characteristics

Test values: tripping times t

Permissive tolerance/Limiting values: |d| £ 5 % ± 15 ms for 2 £ I/I_p £ 20
|d| £ 5 % ± 15 ms for 2 £ 3I0/I_p £ 20

1.8.3.6.1 IEC normal inverse (type A)

Test results/Remarks: confirmed

1.8.3.6.2 IEC very inverse (type B)

Test results/Remarks: confirmed

1.8.3.6.3 IEC extremely inverse (type C)

Test results/Remarks: confirmed

1.8.3.6.4 IEC long-time inverse

Test results/Remarks: confirmed

1.8.3.6.5 ANSI long-time inverse

Test results/Remarks: confirmed

1.8.3.6.6 ANSI short-time inverse

Test results/Remarks: confirmed

1.8.3.6.7 ANSI extremely inverse (type C)

Test results/Remarks: confirmed

1.8.3.6.8 ANSI very inverse

Test results/Remarks: confirmed

1.8.3.6.9 ANSI normal inverse

Test results/Remarks: confirmed

1.8.3.6.10 ANSI moderately inverse

Test results/Remarks: confirmed

1.8.3.6.11 ANSI definite inverse

Test results/Remarks: confirmed

1.8.3.7 Dropout characteristics

Test values: dropout times

Permissive tolerance/Limiting values: |d| £ 5 % ± 30 ms for 0.05 £ I/I_p £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I0/I_p £ 0.90

1.8.3.7.1 IEC normal inverse (type A)

Test results/Remarks: confirmed

1.8.3.7.2 IEC very inverse (type B)

Test results/Remarks: confirmed

Summary

1.8.3.7.3 IEC extremely inverse (type C)		
Test results/Remarks:	confirmed	
1.8.3.7.4 IEC long-time inverse		
Test results/Remarks:	confirmed	
1.8.3.7.5 ANSI long-time inverse		
Test results/Remarks:	confirmed	
1.8.3.7.6 ANSI short-time inverse		
Test results/Remarks:	confirmed	
1.8.3.7.7 ANSI extremely inverse (type C)		
Test results/Remarks:	confirmed	
1.8.3.7.8 ANSI very inverse		
Test results/Remarks:	confirmed	
1.8.3.7.9 ANSI normal inverse		
Test results/Remarks:	confirmed	
1.8.3.7.10 ANSI moderately inverse		
Test results/Remarks:	confirmed	
1.8.3.7.11 ANSI definite inverse		
Test results/Remarks:	confirmed	
1.8.3.8 Direction of directional stage		
Permissive tolerance/Limiting values:	function according to manual	
Test results/Remarks:	function correct	
1.8.4 3I0 logarithmic inverse		
1.8.4.1 Pickup		
Test condition:	threshold: see item 1.8.2.1	
	threshold-value multiplier: 1.00 £ tm £ 4.00	
	time dial: 0.05 s £ Td £ 15.00 s	
Permissive tolerance/Limiting values:	a) d £ 1 % of setting value or 1 % I _{rated} for I-prot. b) d £ 1 % of setting value or 0.5 % I _{rated} for I-sens.	
Test results/Remarks:	a) d £ 1 % or 1 % I _{rated} b) d £ 1 % or 0.5 % I _{rated}	
1.8.4.2 Dropout ratio		
Permissive tolerance/Limiting values:	a) disk emulation b) instantaneous	
Test results/Remarks:	confirmed	
1.8.4.3 Pickup times		
Test values:	pickup time for 2 ≤ I/I-threshold value ≤ 20	

Summary

Permissive tolerance/Limiting values: 5 % of set point value or
+2 % current tolerance or
30 ms

Test results/Remarks: confirmed

1.8.4.4 Dropout times

Permissive tolerance/Limiting values: t approx. 20 ms + OOT

Test results/Remarks: t approx. 20 ms + OOT

1.8.4.5 Tripping time characteristics

Test values: tripping times t

Permissive tolerance/Limiting values: |d| £ 3 % ± 10 ms

Test results/Remarks: confirmed

1.8.4.6 Dropout characteristics

Test values: dropout times

Permissive tolerance/Limiting values: |d| £ 5 % ± 30 ms for 0.05 £ I/I_P £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I₀/I_P £ 0.90

Test results/Remarks: confirmed

1.8.4.7 Direction of directional stage

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.8.5 3I0 S_r inverse

1.8.5.1 Pickup

Test condition: threshold: see item 1.8.2.1
threshold-value multiplier: 1.00 £ tm £ 4.00
ref. for S_r-characteristic: 1.00 VA £ S_{ref} £ 100.00 VA for I_{rated} = 1 A
5.00 VA £ S_{ref} £ 500.00 VA for I_{rated} = 5 A

Permissive tolerance/Limiting values: a) |d| £ 1 % of setting value or 1 % I_{rated} for I-prot.
b) |d| £ 1 % of setting value or 0.5 % I_{rated} for I-sens.

Test results/Remarks: a) |d| £ 1 % or 1 % I_{rated}
b) |d| £ 1 % or 0.5 % I_{rated}

1.8.5.2 Dropout ratio

Permissive tolerance/Limiting values: a) disk emulation
b) instantaneous

Test results/Remarks: confirmed

Summary

1.8.5.3 Pickup times

Test values: pickup time for $2 \leq I/I$ -threshold value ≤ 20

Permissive tolerance/Limiting values: 5 % of set point value or
+2 % current tolerance or
30 ms

Test results/Remarks: confirmed

1.8.5.4 Dropout times

Permissive tolerance/Limiting values: t approx. 20 ms + OOT

Test results/Remarks: t approx. 20 ms + OOT

1.8.5.5 Tripping time characteristics

Test values: tripping times t

Permissive tolerance/Limiting values: |d| $\leq 3\% \pm 10$ ms

Test results/Remarks: confirmed

1.8.5.6 Dropout characteristics

Test values: dropout times

Permissive tolerance/Limiting values: |d| $\leq 5\% \pm 30$ ms for $0.05 \leq I/I_P \leq 0.90$
|d| $\leq 5\% \pm 30$ ms for $0.05 \leq 3I_0/I_P \leq 0.90$

Test results/Remarks: confirmed

1.8.5.7 Direction of directional stage

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.8.6 3I0 V0 inverse

1.8.6.1 Pickup

Test condition: a) 3I0 calculated
Threshold:
0.030 A $\leq 3I_0 \leq 35.00$ A for 3I0 ($I_{N-rated} = 1$ A)
0.150 A $\leq 3I_0 \leq 175.000$ A for 3I0 ($I_{N-rated} = 5$ A)

b) V0 calculated, V0 measured
Threshold:
0.30 V $\leq V_0 \leq 200.000$ V
V0min for V0-characteristic: 0 V $\leq V_{0min} \leq 200.00$ V

Permissive tolerance/Limiting values: a) |d| $\leq 1\%$ of setting value or 1 % I_{rated} for I-prot.
b) |d| $\leq 1\%$ of setting value or or 1 % V_{rated}

Test results/Remarks: a) |d| $\leq 1\%$ or 1 % I_{rated}
b) |d| $\leq 1\%$ or 0.5 % I_{rated}

Summary

1.8.6.2 Dropout ratio

Permissive tolerance/Limiting values: a) 0.95 threshold
b) 0.95 threshold or (threshold – 150mV)

Test results/Remarks: confirmed

1.8.6.3 Pickup times

Test values: see 1.8.6.1

Permissive tolerance/Limiting values: 5 % of set point value or
+2 % current tolerance or
30 ms

Test results/Remarks: confirmed

1.8.6.4 Dropout times

Permissive tolerance/Limiting values: t approx. 20 ms + OOT

Test results/Remarks: t approx. 20 ms + OOT

1.8.6.5 Tripping time characteristics

Test values: tripping times t

Permissive tolerance/Limiting values: |d| £ 3 % ± 20 ms

Test results/Remarks: confirmed

1.8.6.6 Dropout characteristics

Test values: dropout times

Permissive tolerance/Limiting values: |d| £ 5 % ± 30 ms
|d| £ 5 % ± 30 ms

Test results/Remarks: confirmed

1.8.6.7 Direction of directional stage

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.8.7 Directional determination

1.8.7.1 Release threshold of zero voltage V0

Test condition: fault L-N
0.150 V £ V0 £ 34.000 V

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 1 V

Test results/Remarks: confirmed

Summary

1.8.7.2 Release threshold of neutral point current IY

Test condition: fault L-N
 0.030 A \leq IY \leq 10.000 A for $I_{rated} = 1$ A
 0.150 A \leq IY \leq 50.000 A for $I_{rated} = 5$ A

Permissive tolerance/Limiting values: $|d| \leq 1\%$ of setting value or $1\% I_{rated}$

Test results/Remarks: confirmed

1.8.7.3 Release threshold of negative sequence current I2

Test condition: fault L-N
 0.030 A \leq I2 \leq 10.000 A for $I_{rated} = 1$ A
 0.150 A \leq I2 \leq 50.000 A for $I_{rated} = 5$ A

Permissive tolerance/Limiting values: $|d| \leq 1\%$ of setting value or $1\% I_{rated}$

Test results/Remarks: confirmed

1.8.7.4 Release threshold of negative sequence voltage V2

Test condition: fault L-N
 0.150 V \leq V2 \leq 20.000 V

Permissive tolerance/Limiting values: $|d| \leq 1\%$ of setting value or $1\% I_{rated}$

Test results/Remarks: confirmed

1.8.7.5 Release angle

Test condition: fault L-N
 0° \leq α \leq 360°
 0° \leq β \leq 360°

Test values: directional limits, stationary

Permissive tolerance/Limiting values: $\alpha, \beta \pm 1.5^\circ$

Test results/Remarks: confirmed

1.8.8 Processing of functions

1.8.8.1 Phase selector

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.8.8.2 Blocking

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.8.8.3 Inrush restraint

Test condition: 10% \leq 2.HARMON.BLOCK \leq 45%
 0.50 $I_{rated} \leq$ I-RUSH-MAX \leq 25.00 I_{rated}

Summary

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.8.8.4 Switch-onto-fault

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

Summary

1.9 Directional Intermittent Ground Fault Protection

1.9.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.9.2 Pickup values

Test condition: 0.030 I_{rated} £ 3I₀ > £ 35.000 I_{rated} for protection CT
0.001 I_{rated} £ 3I₀ > £ 1.600 I_{rated} for instrument CT

Test values: I_{rated} = 1A, f_{rated} = 50 Hz; I_{rated} = 5A, f_{rated} = 60 Hz:
0.030 I_{rated} £ 3I₀ > £ 35.000 I_{rated} for protection CT
0.001 I_{rated} £ 3I₀ > £ 1.600 I_{rated} for instrument CT

Permissive tolerance/Limiting values: For protection CT:
±1 % of setting value or 0.005 I_{rated}
For instrument CT:
±1 % of setting value or 0.0001 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.005 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.0001 I_{rated}

1.9.3 Dropout ratio

Test condition: see item 1.9.2

Test values: 0.95

Permissive tolerance/Limiting values: For protection CT:
±1 % of dropout value or 0.02 I_{rated}
For instrument CT:
±1 % of dropout value or 0.0006 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of dropout value or £ 0.02 I_{rated}
For instrument CT:
£ 1 % of dropout value or £ 0.0006 I_{rated}

1.9.4 Pickup times

Test condition: see item 1.9.2

Test values: 1.2 * threshold
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: £ 30 ms + OOT at f_{rated} = 50 Hz
£ 23 ms + OOT at f_{rated} = 60 Hz

Test results/Remarks: £ 30 ms + OOT at f_{rated} = 50 Hz
£ 23 ms + OOT at f_{rated} = 60 Hz

1.9.5 Dropout times

Test condition: see item 1.9.2

Permissive tolerance/Limiting values: £ 25 ms + OOT at f_{rated} = 50 Hz
£ 22 ms + OOT at f_{rated} = 60 Hz

Summary

Test results/Remarks: £ 25 ms + OOT at $f_{rated} = 50$ Hz
£ 22 ms + OOT at $f_{rated} = 60$ Hz

1.9.6 Pickup extension time

Test condition: see item 1.9.2
Test values: 0.00 s £ T £ 10.00 s
Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms
Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.9.7 Sum of extended pickup times

Test condition: see item 1.9.2
Test values: 0.00 s £ T £ 100.00 s
Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms
Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.9.8 Reset time

Test condition: see item 1.9.2
Test values: 1.00 s £ T £ 600.00 s
Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms
Test results/Remarks: £ 1 % of setting value or £ 10 ms

Summary

1.10 Non-Directional Intermittent-Ground-Fault-Protection

1.10.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC60255-151

1.10.2 Intermittent ground fault protection stage

1.10.2.1 Pickup values 3I0>

Test condition:	Fundamental components, RMS values $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Test values:	$0.030 I_{rated} \leq 3I0 < 35.000 I_{rated}$ for protection CT $0.001 I_{rated} \leq 3I0 < 1.600 I_{rated}$ for instrument CT
Permissive tolerance/Limiting values:	For protection CT: $\pm 1 \%$ of setting value or $0.005 I_{rated}$ For instrument CT: $\pm 1 \%$ of setting value or $0.0001 I_{rated}$
Test results/Remarks:	For protection CT: $\leq 1 \%$ of setting value or $\leq 0.005 I_{rated}$ For instrument CT: $\leq 1 \%$ of setting value or $\leq 0.0001 I_{rated}$

1.10.2.2 Dropout ratio

Test condition:	see item 1.10.2.1
Test values:	0.95
Permissive tolerance/Limiting values:	$\pm 1 \%$ of dropout value
Test results/Remarks:	$\leq 1 \%$ of dropout value

1.10.2.3 Pickup time

Test condition:	see item 1.10.2.1
Test values:	$2 * \text{threshold}$ $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Permissive tolerance/Limiting values:	$\leq 25 \text{ ms} + \text{OOT}$ at 50 Hz $\leq 23 \text{ ms} + \text{OOT}$ at 60 Hz
Test results/Remarks:	$\leq 25 \text{ ms} + \text{OOT}$ at 50 Hz $\leq 23 \text{ ms} + \text{OOT}$ at 60 Hz

1.10.2.4 Dropout times

Test condition:	see item 1.10.2.1
Permissive tolerance/Limiting values:	$\leq 25 \text{ ms} + \text{OOT}$ at 50 Hz $\leq 22 \text{ ms} + \text{OOT}$ at 60 Hz
Test results/Remarks:	$\leq 25 \text{ ms} + \text{OOT}$ at 50 Hz $\leq 22 \text{ ms} + \text{OOT}$ at 60 Hz

Summary**1.10.2.5 Pickup extension time**

Test condition:	see item 1.10.2.1
Test values:	0.00 s £ T £ 10.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.10.2.6 Sum of extended pickup times

Test condition:	see item 1.10.2.1
Test values:	0.00 s £ T £ 100.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.10.2.7 Reset time

Test condition:	see item 1.10.2.1
Test values:	0.00 s £ T £ 600.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

Summary

1.11 67Ns Directional Sensitive Ground Fault Protection

1.11.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.11.2 3I0 stage

1.11.2.1 Pickup values

Test condition:	Fundamental components, RMS values 0.030 I _{rated} £ 3I0> £ 35.000 I _{rated} for protection CT 0.001 I _{rated} £ 3I0> £ 35.000 I _{rated} for instrument CT
Test values:	f _{rated} = 50 Hz, 60 Hz 0.030 I _{rated} £ 3I0> £ 35.000 I _{rated} for protection CT 0.001 I _{rated} £ 3I0> £ 35.000 I _{rated} for instrument CT
Permissive tolerance/Limiting values:	For protection CT: ±1 % of setting value or 0.01 I _{rated} For instrument CT: ±1 % of setting value or 0.001 I _{rated}
Test results/Remarks:	For protection CT: ≤ 1 % of setting value or ≤ 0.01 I _{rated} For instrument CT: ≤ 1 % of setting value or ≤ 0.001 I _{rated}

1.11.2.2 Dropout ratio

Test condition:	see item 1.11.2.1
Test values:	0.95
Permissive tolerance/Limiting values:	±2 % of dropout value
Test results/Remarks:	≤ 2 % of dropout value

1.11.2.3 Pickup times

Test condition:	see item 1.11.2.1
Test values:	2*threshold f _{rated} = 50 Hz, 60 Hz
Permissive tolerance/Limiting values:	≤ 25 ms + OOT at f _{rated} = 50 Hz ≤ 23 ms + OOT at f _{rated} = 60 Hz
Test results/Remarks:	≤ 25 ms + OOT at f _{rated} = 50 Hz ≤ 23 ms + OOT at f _{rated} = 60 Hz

1.11.2.4 Dropout times

Test condition:	see item 1.11.2.1
Permissive tolerance/Limiting values:	≤ 25 ms + OOT
Test results/Remarks:	≤ 25 ms + OOT

Summary

1.11.2.5 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s £ T £ 100.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.11.3 3I0 with cos φ- or sin φ-measurement stage

1.11.3.1 Pickup values 3I0

Test condition: Fundamental components, RMS values
0.030 I_{rated} £ 3I0 > £ 35.000 I_{rated} for protection CT
0.001 I_{rated} £ 3I0 > £ 35.000 I_{rated} for instrument CT

Test values: f_{rated} = 50 Hz, 60 Hz
0.030 I_{rated} £ 3I0 > £ 35.000 I_{rated} for protection CT
0.001 I_{rated} £ 3I0 > £ 35.000 I_{rated} for instrument CT

Permissive tolerance/Limiting values: For protection CT:
±1 % of setting value or 0.01 I_{rated}
For instrument CT:
±1 % of setting value or 0.001 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.01 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.001 I_{rated}

1.11.3.2 Pickup values V0

Test condition: f_{rated} = 50 Hz, 60 Hz
0.300 V £ V0 > £ 200.000 V

Test values: 0.300 V £ V0 > £ 200.000 V

Permissive tolerance/Limiting values: ±1 % of setting value or 0.05 V

Test results/Remarks: £ 1 % of setting value or £ 0.05 V

1.11.3.3 Angle correction φ

Test condition: -45° £ φ £ 45°

Test values: -45° £ φ £ 45°

Permissive tolerance/Limiting values: ±1° at 3I0 > 5 mA, V0 ≥ 0.6 V

Test results/Remarks: £ 1° at 3I0 > 5 mA, V0 ≥ 0.6 V

1.11.3.4 Dropout ratio

Test condition: see item 1.11.3.1 and 1.11.3.2

Test values: 0.95

Permissive tolerance/Limiting values: ±2 % of dropout value

Summary

Test results/Remarks: £ 2 % of dropout value

1.11.3.5 Pickup times

Test condition: see item 1.11.3.1 and 1.11.3.2

Test values: 2*threshold
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: $\leq 32 \text{ ms} + \text{OOT}$ at $f_{rated} = 50 \text{ Hz}$
 $\leq 29 \text{ ms} + \text{OOT}$ at $f_{rated} = 60 \text{ Hz}$

Test results/Remarks: £ 32 ms + OOT at $f_{rated} = 50 \text{ Hz}$
£ 29 ms + OOT at $f_{rated} = 60 \text{ Hz}$

1.11.3.6 Dropout times

Test condition: see item 1.11.3.1 and 1.11.3.2

Permissive tolerance/Limiting values: $\leq 32 \text{ ms} + \text{OOT}$

Test results/Remarks: £ 32 ms + OOT

1.11.3.7 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.11.4 3I0 with ϕ (V,I)-measurement stage

1.11.4.1 Pickup values 3I0

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Fundamental components, RMS values
0.030 I_{rated} £ 3I0 > £ 35.000 I_{rated} for protection CT
0.001 I_{rated} £ 3I0 > £ 35.000 I_{rated} for instrument CT

Test values: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
0.030 I_{rated} £ 3I0 > £ 35.000 I_{rated} for protection CT
0.001 I_{rated} £ 3I0 > £ 35.000 I_{rated} for instrument CT

Permissive tolerance/Limiting values: For protection CT:
 $\pm 1 \%$ of setting value or 0.01 I_{rated}
For instrument CT:
 $\pm 1 \%$ of setting value or 0.001 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.01 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.001 I_{rated}

1.11.4.2 Pickup values V0

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
0.300 V £ V0 > £ 200.000 V

Summary

Test values:	0.300 V ≤ V ₀ < 200.000 V
Permissive tolerance/Limiting values:	±1 % of setting value or 0.05 V
Test results/Remarks:	≤ 1 % of setting value or ≤ 0.05 V

1.11.4.3 Rotation angle of the reference voltage

Test condition:	-180° ≤ φ ≤ 180°
Test values:	-180° ≤ φ ≤ 180°
Permissive tolerance/Limiting values:	±3° at 3I ₀ ≤ 2 mA, V ₀ ≥ 0.6 V ±2° at 2 mA < 3I ₀ < 10 mA, V ₀ ≥ 0.6 V ±1° at 3I ₀ ≥ 10 mA, V ₀ ≥ 0.6 V
Test results/Remarks:	≤ 3° at 3I ₀ ≤ 2 mA, V ₀ ≥ 0.6 V ≤ 2° at 2 mA < 3I ₀ < 10 mA, V ₀ ≥ 0.6 V ≤ 1° at 3I ₀ ≥ 10 mA, V ₀ ≥ 0.6 V

1.11.4.4 Dropout ratio

Test condition:	see item 1.11.4.1 and 1.11.4.2
Test values:	0.95
Permissive tolerance/Limiting values:	±0.5% of dropout value or 0.015 I _{rated}
Test results/Remarks:	≤ 0.5% of dropout value or ≤ 0.015 I _{rated}

1.11.4.5 Pickup times

Test condition:	see item 1.11.4.1 and 1.11.4.2
Test values:	1.2*threshold f _{rated} = 50 Hz, 60 Hz
Permissive tolerance/Limiting values:	≤ 23 ms + OOT at f _{rated} = 50 Hz ≤ 21 ms + OOT at f _{rated} = 60 Hz
Test results/Remarks:	≤ 23 ms + OOT at f _{rated} = 50 Hz ≤ 21 ms + OOT at f _{rated} = 60 Hz

1.11.4.6 Dropout times

Test condition:	see item 1.11.4.1 and 1.11.4.2
Permissive tolerance/Limiting values:	≤ 21 ms + OOT at f _{rated} = 50 Hz ≤ 20 ms + OOT at f _{rated} = 60 Hz
Test results/Remarks:	≤ 21 ms + OOT at f _{rated} = 50 Hz ≤ 20 ms + OOT at f _{rated} = 60 Hz

Summary

1.11.4.7 Time delays

Test condition: see item 1.11.4.1 and 1.11.4.2
1.2*threshold

Test values: 0.00 s £ T £ 100.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.11.5 Overvoltage protection stage V0>

1.11.5.1 Pickup values

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Fundamental components, RMS values
0.300 V £ V0> £ 200.000 V

Test values: 0.300 V £ V0> £ 200.000 V

Permissive tolerance/Limiting values: ±0.5 % of setting value or 0.05 V

Test results/Remarks: £ 0.5 % of setting value or £ 0.05 V

1.11.5.2 Dropout ratio

Test condition: 0.90 £ r £ 0.99

Test values: ±1 % of dropout value

Test results/Remarks: £ 1 % of dropout value

1.11.5.3 Pickup times

Test condition: see item 1.11.5.1

Test values: 1.2*threshold
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: RMS values, standard filter:
≤ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$
≤ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$
Fundamental components, filter over 2 cycles:
≤ 45 ms + OOT at $f_{rated} = 50 \text{ Hz}$
≤ 39 ms + OOT at $f_{rated} = 60 \text{ Hz}$

Test results/Remarks: RMS values, standard filter:
£ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$
£ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$
Fundamental components, filter over 2 cycles:
£ 45 ms + OOT at $f_{rated} = 50 \text{ Hz}$
£ 39 ms + OOT at $f_{rated} = 60 \text{ Hz}$

1.11.5.4 Dropout times

Test condition: see item 1.11.5.1

Permissive tolerance/Limiting values: RMS values, standard filter:
≤ 21 ms + OOT

Summary

Fundamental components, filter over 2 cycles:
≤ 30 ms + OOT

Test results/Remarks:

RMS values, standard filter:
£ 21 ms + OOT
Fundamental components, filter over 2 cycles:
£ 30 ms + OOT

1.11.5.5 Time delays

Test condition:

added to the inherent operating times

Test values:

0.00 s £ T £ 100.00 s

Permissive tolerance/Limiting values:

±1 % of setting value or 10 ms

Test results/Remarks:

£ 1 % of setting value or £ 10 ms

1.11.6 Transient ground fault protection stage

1.11.6.1 Pickup values 3I0

Test condition:

$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Fundamental components, RMS values
0.030 $I_{rated} \text{ } \text{ } 3I0 > \text{ } \text{ } 35.000 I_{rated}$ for protection CT
0.001 $I_{rated} \text{ } \text{ } 3I0 > \text{ } \text{ } 35.000 I_{rated}$ for instrument CT

Test values:

$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
0.030 $I_{rated} \text{ } \text{ } 3I0 > \text{ } \text{ } 35.000 I_{rated}$ for protection CT
0.001 $I_{rated} \text{ } \text{ } 3I0 > \text{ } \text{ } 35.000 I_{rated}$ for instrument CT

Permissive tolerance/Limiting values:

For protection CT:
±1 % of setting value or 0.01 I_{rated}
For instrument CT:
±1 % of setting value or 0.001 I_{rated}

Test results/Remarks:

For protection CT:
£ 1 % of setting value or £ 0.01 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.001 I_{rated}

1.11.6.2 Pickup values V0

Test condition:

$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
0.300 V £ V0 > £ 200.000 V

Test values:

0.300 V £ V0 > £ 200.000 V

Permissive tolerance/Limiting values:

±1 % of setting value or 0.05 V

Test results/Remarks:

£ 1 % of setting value or £ 0.05 V

1.11.6.3 Pickup times

Test condition:

see item 1.11.6.1 and 1.11.6.2

Test values:

2*threshold
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values:

≤ 60 ms + OOT at $f_{rated} = 50 \text{ Hz}$
≤ 55 ms + OOT at $f_{rated} = 60 \text{ Hz}$

Summary

Test results/Remarks: £ 60 ms + OOT at $f_{rated} = 50$ Hz
£ 55 ms + OOT at $f_{rated} = 60$ Hz

1.11.6.4 Dropout times

Test condition: see item 1.11.6.1 and 1.11.6.2

Permissive tolerance/Limiting values: ≤ 20 ms + OOT at $f_{rated} = 50$ Hz
 ≤ 15 ms + OOT at $f_{rated} = 60$ Hz

Test results/Remarks: £ 20 ms + OOT at $f_{rated} = 50$ Hz
£ 15 ms + OOT at $f_{rated} = 60$ Hz

1.11.6.5 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.11.7 Y0-with G0 or B0-measurement stage

1.11.7.1 Pickup values 3I0>

Test condition: Fundamental components, RMS values
0.030 I_{rated} £ 3I0> £ 35.000 I_{rated} for protection CT
0.001 I_{rated} £ 3I0> £ 35.000 I_{rated} for instrument CT

Test values: $f_{rated} = 50$ Hz, 60 Hz
0.030 I_{rated} £ 3I0> £ 35.000 I_{rated} for protection CT
0.001 I_{rated} £ 3I0> £ 35.000 I_{rated} for instrument CT

Permissive tolerance/Limiting values: For protection CT:
 ± 1 % of setting value or 0.01 I_{rated}
For instrument CT:
 ± 1 % of setting value or 0.001 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.01 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.001 I_{rated}

1.11.7.2 Pickup values V0>

Test condition: 0.300 V £V0> £ 200.000V

Test values: 0.300 V £V0> £ 200.000V

Permissive tolerance/Limiting values: ± 1 % of setting value or 0.05 V

Test results/remarks: £ 1 % of setting value or £ 0.05 V

1.11.7.3 Angle correction φ

Test condition: -45° £ φ £ 45°

Test values: -45° £ φ £ 45°

Summary

Permissive tolerance/Limiting values: $\pm 1^\circ$ at $3I_0 > 5 \text{ mA}$, $V_0 \geq 0.6 \text{ V}$
 Test results/Remarks: $\pm 1^\circ$ at $3I_0 > 5 \text{ mA}$, $V_0 \geq 0.6 \text{ V}$

1.11.7.4 Pickup time

Test condition: see item 1.11.7.1
 Test values: $2 \times \text{threshold}$
 $f_{\text{rated}} = 50 \text{ Hz}, 60 \text{ Hz}$
 Permissive tolerance/Limiting values: $\leq 32 \text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 29 \text{ ms} + \text{OOT}$ at 60 Hz
 Test results/Remarks: $\pm 32 \text{ ms} + \text{OOT}$ at 50 Hz
 $\pm 29 \text{ ms} + \text{OOT}$ at 60 Hz

1.11.7.5 Dropout times

Test condition: see item 1.11.7.1
 Permissive tolerance/Limiting values: $\leq 32 \text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 27 \text{ ms} + \text{OOT}$ at 60 Hz
 Test results/Remarks: $\pm 32 \text{ ms} + \text{OOT}$ at 50 Hz
 $\pm 27 \text{ ms} + \text{OOT}$ at 60 Hz

1.11.7.6 Time delays

Test condition: added to the inherent operating times
 Test values: $0.00 \text{ s} \pm 60.00 \text{ s}$
 Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms
 Test results/Remarks: $\pm 1 \%$ of setting value or $\pm 10 \text{ ms}$

1.11.7.7 Polarized G0/B0 threshold

Test condition: 0.10 mS \pm Y0 \pm 100.00 mS
 Test values: 0.10 mS \pm Y0 \pm 100.00 mS
 Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 0.05 mS ($I_{\text{rated}}=1\text{A}/1.6\text{A}$) or 0.25 mS ($I_{\text{rated}}=5\text{A}/8\text{A}$)
 Test results/Remarks: $\pm 1 \%$ of setting value or $\pm 0.05 \text{ mS}$ ($I_{\text{rated}}=1\text{A}/1.6\text{A}$) or $\pm 0.25 \text{ mS}$ ($I_{\text{rated}}=5\text{A}/8\text{A}$)

1.11.8 Admittance protection stage Y0>

1.11.8.1 Pickup values Y0>

Test condition: Fundamental components, RMS values
 0.10 mS \pm Y0> \pm 100.00 mS
 Test values: $f_{\text{rated}} = 50 \text{ Hz}, 60 \text{ Hz}$
 Permissive tolerance/Limiting values: For protection CT:
 $\pm 1 \%$ of setting value or $0.01 I_{\text{rated}}$
 For instrument CT:
 $\pm 1 \%$ of setting value or $0.001 I_{\text{rated}}$

Summary

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.01 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.001 I_{rated}

1.11.8.2 Threshold values V0>

Test condition: 0.300 V £V0> £ 200.000V
Test values: 0.300 V £V0> £ 200.000V
Permissive tolerance/Limiting values: ±1 % of setting value or 0.5 V
Test results/remarks: £ 1 % of setting value or £ 0.5 V

1.11.8.3 Pickup time

Test condition: see item 1.11.8.1
Test values: 2*threshold
f_{rated} = 50 Hz, 60 Hz
Permissive tolerance/Limiting values: ≤ 32 ms + OOT at 50 Hz
≤ 29 ms + OOT at 60 Hz
Test results/Remarks: £ 32 ms + OOT at 50 Hz
£ 29 ms + OOT at 60 Hz

1.11.8.4 Dropout times

Test condition: see item 1.11.8.1
Permissive tolerance/Limiting values: ≤ 32 ms + OOT
Test results/Remarks: £ 32 ms + OOT

1.11.8.5 Time delays

Test condition: added to the inherent operating times
Test values: 0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms
Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.11.9 Pulse-pattern detection stage

1.11.9.1 Threshold values V0>

Test condition: 0.300 V £V0> £ 200.000V
Test values: 0.300 V £V0> £ 200.000V
Permissive tolerance/Limiting values: ±1 % of setting value or 0.05 V
Test results/remarks: £ 1 % of setting value or £ 0.05 V

1.11.9.2 Threshold values 3I0>

Summary

Test condition:	0.030 I _{rated} £ 3I0> £ 35.000 I _{rated} for protection CT 0.001 I _{rated} £ 3I0> £ 35.000 I _{rated} for instrument CT
Test values:	f _{rated} = 50 Hz, 60 Hz 0.030 I _{rated} £ 3I0> £ 35.000 I _{rated} for protection CT 0.001 I _{rated} £ 3I0> £ 35.000 I _{rated} for instrument CT
Permissive tolerance/Limiting values:	For protection CT: ±1 % of setting value or 0.005 I _{rated} For instrument CT: ±1 % of setting value or 0.0001 I _{rated}
Test results/Remarks:	For protection CT: £ 1 % of setting value or £ 0.005 I _{rated} For instrument CT: £ 1 % of setting value or £ 0.0001 I _{rated}

1.11.9.3 Pickup time

Test condition:	Pulse-on duration=1s, Pulse-off duration=1.5s, Max.tolera.pulse-on or off=0.15s ¹
Test values:	see item 1.11.9.1 and 1.11.9.2 f _{rated} = 50 Hz, 60 Hz
Permissive tolerance/Limiting values:	≤ 2.5 s + 0.3 s + OOT
Test results/Remarks:	£ 2.5 s + 0.3 s + OOT

1.11.9.4 Dropout times

Test condition:	see item 1.11.9.1
Permissive tolerance/Limiting values:	≤ 32 ms + OOT
Test results/Remarks:	£ 32 ms + OOT

1.11.10 Directional stage with phasor measurement of a harmonic

1.11.10.1 Threshold values V0>

Test condition:	0.300 V £V0> £ 200.000V
Test values:	0.300 V £V0> £ 200.000V
Permissive tolerance/Limiting values:	±1 % of setting value or 0.05 V
Test results/remarks:	£ 1 % of setting value or £ 0.05 V

1.11.10.2 Threshold values 3I0> harmonic

¹ After the first valid pulse is detected, the function picks up. For a typical Pulse-on/off duration setting of e.g. 1.0/1.5 s, a typical Max.tolera.pulse-on or off setting of e.g. 0.15s, the inherent pickup time is approx. 1s+1.5s+2*0.15s+OOT.

Summary

Test condition:	0.030 I _{rated} £ 3I0 > £ 35.000 I _{rated} for protection CT 0.001 I _{rated} £ 3I0 > £ 35.000 I _{rated} for instrument CT
Test values:	f _{rated} = 50 Hz, 60 Hz 0.030 I _{rated} £ 3I0 > £ 35.000 I _{rated} for protection CT 0.001 I _{rated} £ 3I0 > £ 35.000 I _{rated} for instrument CT
Permissive tolerance/Limiting values:	For protection CT: ±1 % of setting value or 0.005 I _{rated} For instrument CT: ±1 % of setting value or 0.0001 I _{rated}
Test results/Remarks:	For protection CT: £ 1 % of setting value or £ 0.005 I _{rated} For instrument CT: £ 1 % of setting value or £ 0.0001 I _{rated}

1.11.10.3 Pickup time

Test condition:	see item 1.11.10.1 and 1.12.4.1
Test values:	1.2*threshold f _{rated} = 50 Hz, 60 Hz
Permissive tolerance/Limiting values:	≤ 70 ms + OOT at 50 Hz ≤ 60 ms + OOT at 60 Hz
Test results/Remarks:	£ 70 ms + OOT at 50 Hz £ 60 ms + OOT at 60 Hz

1.11.10.4 Dropout times

Test condition:	see item 1.11.10.1 and 1.12.4.1
Permissive tolerance/Limiting values:	≤ 30 ms + OOT at 50 Hz ≤ 20 ms + OOT at 60 Hz
Test results/Remarks:	£ 30 ms + OOT at 50 Hz £ 20 ms + OOT at 60 Hz

1.11.10.5 Dropout ratio 3I0 harmonic

Test condition:	see item 1.12.4.1
Test values:	0.10 £ r £ 0.95
Permissive tolerance/Limiting values:	For protection CT: ±1 % of dropout value or 0.015 I _{rated} For instrument CT: ±1 % of dropout value or 0.0005 I _{rated}
Test results/Remarks:	For protection CT: £ 1 % of dropout value or £ 0.015 I _{rated} For instrument CT: £ 1 % of dropout value or £ 0.0005 I _{rated}

1.11.10.6 Time delays

Test condition:	added to the inherent operating times
Test values:	0.00 s £ T £ 60.00 s

SummaryPermissive tolerance/Limiting values: ± 1 % of setting value or 10 msTest results/Remarks: ± 1 % of setting value or ± 10 ms

Summary

1.12 51Ns Sensitive Ground Fault Protection

1.12.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.12.2 3I0

1.12.2.1 Pickup values

Test condition:	0.030 I _{rated} £ 3I0 > £ 35.000 I _{rated} for protection CT 0.001 I _{rated} £ 3I0 > £ 35.000 I _{rated} for instrument CT
Test values:	f _{rated} = 50 Hz, 60 Hz 0.030 I _{rated} £ 3I0 > £ 35.000 I _{rated} for protection CT 0.001 I _{rated} £ 3I0 > £ 35.000 I _{rated} for instrument CT
Permissive tolerance/Limiting values:	For protection CT: ±1 % of setting value or 0.005 I _{rated} For instrument CT: ±1 % of setting value or 0.0001 I _{rated}
Test results/Remarks:	For protection CT: £ 1 % of setting value or £ 0.005 I _{rated} For instrument CT: £ 1 % of setting value or £ 0.0001 I _{rated}

1.12.2.2 Dropout ratio

Test condition:	see item 1.12.2.1
Test values:	0.95
Permissive tolerance/Limiting values:	±1 % of dropout value
Test results/Remarks:	£ 1 % of dropout value

1.12.2.3 Pickup times

Test condition:	see item 1.12.2.1
Test values:	2*threshold f _{rated} = 50 Hz, 60 Hz
Permissive tolerance/Limiting values:	£ 25 ms + OOT at f _{rated} = 50 Hz £ 23 ms + OOT at f _{rated} = 60 Hz
Test results/Remarks:	£ 25 ms + OOT at f _{rated} = 50 Hz £ 23 ms + OOT at f _{rated} = 60 Hz

1.12.2.4 Dropout times

Test condition:	see item 1.12.2.1
Permissive tolerance/Limiting values:	£ 25 ms + OOT at f _{rated} = 50 Hz £ 22 ms + OOT at f _{rated} = 60 Hz
Test results/Remarks:	£ 25 ms + OOT at f _{rated} = 50 Hz £ 22 ms + OOT at f _{rated} = 60 Hz

Summary

1.12.2.5 Time delays

Test condition:	added to the inherent operating times
Test values:	0.00 s £ T £ 100.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.12.3 Admittance protection stage Y0>

1.12.3.1 Pickup values Y0>

Test condition:	Fundamental components, RMS values 0.10 mS £ Y0> £ 100.00 mS
Test values:	$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Permissive tolerance/Limiting values:	For protection CT: ±1 % of setting value or $0.01 I_{rated}$ For instrument CT: ±1 % of setting value or $0.001 I_{rated}$
Test results/Remarks:	For protection CT: £ 1 % of setting value or £ $0.01 I_{rated}$ For instrument CT: £ 1 % of setting value or £ $0.001 I_{rated}$

1.12.3.2 Threshold values V0>

Test condition:	0.300 V £V0> £ 200.000V
Test values:	0.300 V £V0> £ 200.000V
Permissive tolerance/Limiting values:	±1 % of setting value or 0.5 V
Test results/remarks:	£ 1 % of setting value or £ 0.5 V

1.12.3.3 Pickup time

Test condition:	see item 1.12.3.1
Test values:	$2 \cdot \text{threshold}$ $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Permissive tolerance/Limiting values:	£ 32 ms + OOT at 50 Hz £ 29 ms + OOT at 60 Hz
Test results/Remarks:	£ 32 ms + OOT at 50 Hz £ 29 ms + OOT at 60 Hz

1.12.3.4 Dropout times

Test condition:	see item 1.12.3.1
Permissive tolerance/Limiting values:	£ 32 ms + OOT
Test results/Remarks:	£ 32 ms + OOT

Summary

1.12.3.5 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.12.4 Non-Directional 3I0 Harmonic Stage

1.12.4.1 Threshold value 3I0> harmonic

Test condition: 0.030 I_{rated} £ 3I0 harmonic £ 35.000 I_{rated} for protection CT

0.001 I_{rated} £ 3I0 harmonic £ 35.000 I_{rated} for instrument CT

Test values: 3rd, 5th and 7th 3I0 harmonic current related to f_{rated} = 50 Hz, 60 Hz

0.030 I_{rated} £ 3I0 harmonic £ 35.000 I_{rated} for protection CT

0.001 I_{rated} £ 3I0 harmonic £ 35.000 I_{rated} for instrument CT

Permissive tolerance/Limiting values: For protection CT:
±1 % of setting value or 0.005 I_{rated}
For instrument CT:
±1 % of setting value or 0.0001 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.005 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.0001 I_{rated}

1.12.4.2 Pickup time

Test condition: see item 1.12.4.1 and Stabilization counter = 4

Test values: 1.2*threshold
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: £ 70 ms + OOT at 50 Hz
£ 60 ms + OOT at 60 Hz

Test results/Remarks: £ 70 ms + OOT at 50 Hz
£ 60 ms + OOT at 60 Hz

1.12.4.3 Dropout times

Test condition: see item 1.12.4.2

Permissive tolerance/Limiting values: £ 40 ms + OOT at 50 Hz
£ 30 ms + OOT at 60 Hz

Test results/Remarks: £ 40 ms + OOT at 50 Hz
£ 30 ms + OOT at 60 Hz

1.12.4.4 Dropout ratio 3I0 harmonic

Test condition: see item 1.12.4.1

Summary

Test values: 3I0 harmonic current related to 0.10 £ 3I0 harm.dropout ratio £ 0.95

Permissive tolerance/Limiting values: For protection CT:
 $\pm 1\%$ of dropout value or $0.015 I_{rated}$
For instrument CT:
 $\pm 1\%$ of dropout value or $0.0005 I_{rated}$

Test results/Remarks: For protection CT:
£ 1 % of dropout value or £ 0.015 I_{rated}
For instrument CT:
£ 1 % of dropout value or £ 0.0005 I_{rated}

1.12.4.5 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s £ T> £ 60.00 s

Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

Summary

1.13 21 Distance Protection

1.13.1 Specifications

- VDE 0435
- IEC/EN 60255-1, Item 7, Annex A, B

1.13.2 Pickup values phase-fault-detection

1.13.2.1 Current

Test condition: 0.030 I_{rated} £ I_{ph} £ 35 I_{rated}

Test values: 0.05 I_{rated} £ I_{ph} £ 10.00 I_{rated}

Permissive tolerance/Limiting values: |d| £ 5 % of setting value

Test results/Remarks: |d| £ 1.0 % or 1 % I_{rated}

1.13.2.2 Voltage

Test condition: 0.500 V £ V_{ph-gnd} £ 70.00 V
1.000 V £ V_{ph-ph} £ 130.0 V

Test values: 5.00 V £ V_{ph-gnd} £ 50.00 V
8.00 V £ V_{ph-ph} £ 80.0 V

Permissive tolerance/Limiting values: |d| £ 5 % of setting value

Test results/Remarks: |d| < 5 % or 0.5 V

1.13.3 Dropout ratio

Test condition: see item 1.13.2

Test values: see item 1.13.2

Permissive tolerance/Limiting values: r approx. 0.95

Test results/Remarks: r approx. 0.95

1.13.4 Pickup values ground-fault detection

Test condition: - 3I_{0,3V0} calculated
- 3I_{0,3V0} measured

Test values: fault L-N, f_{rated}= 50 Hz, 60 Hz

Residual (ground) current:

Test condition: 0.030 I_{rated} £ 3I₀> £ 10.00 I_{rated}

Test values: 3I₀> = (0.05 , 0.1 , 0.5 , 1 , 10) I_{rated}

Permissive tolerance/Limiting values: |d| £ 5 % of setting value

Test results/Remarks: |d| £ 1.0 % or 1 % I_{rated}

Displacement voltage

Summary

Test condition: 0.300 V \leq V0 < 35.000 V

Test values: V0 > /3V0 = 0.3 V to 35 V

Permissive tolerance/Limiting values: |d| \leq 5 % of setting value

Test results/Remarks: |d| \leq 1.0 % or 0.1 % V_{rated}

1.13.5 Loop selection for double faults

Test condition:

- grounded systems
- isolated systems
- resonant-grounded

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

Summary

1.13.6 Distance measurement

1.13.6.1 Balance-points for polygonal characteristic

Test condition: parameters:
 - Zone Z1: $X1 = R1E = 2R1 = 2.5 W, \alpha(Z1) = 30^\circ$
 - Zone Z2: $X2 = 0.5 R2E = R2 = 5.0 W, \alpha(Z2) = 20^\circ$
 - Zone Z3: $X3 = R3E = R3 = 10.0 W, \alpha(Z3) = n/a$
 - Zone Z4: $X4 = R4E = R4 = 12.0 W, \alpha(Z4) = 15^\circ$

Test values: $I = 1.5 I_{rated}$; Fault L-N,L-L,L-L-L ; Angle $\varphi(V,I)$ in range 0...360° with steps of 5°

Permissive tolerance/Limiting values: X: $|d| \leq 5\%$ of setting value for 30° $\leq \text{PHI}(V,I) \leq 90^\circ$
 R: $|d| \leq 5\%$ of setting value for 0° $\leq \text{PHI}(V,I) \leq 60^\circ$

Test results/Remarks: X, R:
 - Zone Z1: $|d| \leq 3\%$
 - Zone Z2: $|d| \leq 3\%$
 - Zone Z3: $|d| \leq 3\%$
 - Zone Z4: $|d| \leq 3\%$

1.13.6.2 Balance-points for MHO characteristic

Test condition: parameters:
 - Zone Z1: $Z1 = 2.5 W$
 - Zone Z2: $Z2 = 5.0 W$
 - Zone Z3: $Z3 = 10.0 W$
 - Zone Z4: $Z4 = 12.0 W$

Test values: $I = 1.5 I_{rated}$; fault L-N,L-L,L-L-L ; Angle $\varphi(U,I)$ in range 0...360° with steps of 5°

Test results/Remarks: Zone Z1: $|d| \leq 3\%$
 Zone Z2: $|d| \leq 3\%$
 Zone Z3: $|d| \leq 3\%$
 Zone Z4: $|d| \leq 3\%$

1.13.6.3 Balance-points for circular characteristic

Test condition: parameters:
 - Zone Z1: $Z1 = 2.5 W$
 - Zone Z2: $Z2 = 5.0 W$
 - Zone Z3: $Z3 = 10.0 W$
 - Zone Z4: $Z4 = 12.0 W$

Test values: $I = 1.5 I_{rated}$; fault L-N,L-L,L-L-L ; Angle $\varphi(U,I)$ in range 0...360° with steps of 5°

Permissive tolerance/Limiting values: X: $|d| \leq 5\%$ of setting value for 30° $\leq \text{PHI}(V,I) \leq 90^\circ$
 R: $|d| \leq 5\%$ of setting value for 0° $\leq \text{PHI}(V,I) \leq 60^\circ$

Test results/Remarks: Zone Z1: $|d| \leq 3\%$
 Zone Z2: $|d| \leq 3\%$
 Zone Z3: $|d| \leq 3\%$
 Zone Z4: $|d| \leq 3\%$

1.13.7 Directional measurement

Test condition: fault L-N,L-L,L-L-L,

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

Summary

1.13.8 Time stages of distance zones

1.13.8.1 Shortest trip time Z-Pickup

Test condition:	fault L-N,L-L,L-L-L fault angle 90° SIR 1
Permissive tolerance/Limiting values:	- f _{rated} = 50 Hz: t _{min} 17/12 ms (fast relay/high speed relay) - f _{rated} = 60 Hz: t _{min} 15/10 ms (fast relay/high speed relay)
Test results/Remarks:	- f _{rated} = 50 Hz: t _{min} 14 ms (fast relay) - f _{rated} = 60 Hz: t _{min} 13 ms (fast relay)

1.13.8.2 Shortest trip time I-Pickup

Test condition:	fault L-N,L-L,L-L-L fault angle 90° SIR 1
Permissive tolerance/Limiting values:	- f _{rated} = 50 Hz: t _{min} 17/12 ms (fast relay/high speed relay) - f _{rated} = 60 Hz: t _{min} 15/10 ms (fast relay/high speed relay)
Test results/Remarks:	- f _{rated} = 50 Hz: t _{min} 13 ms (fast relay) - f _{rated} = 60 Hz: t _{min} 12 ms (fast relay)

1.13.8.3 Shortest trip time V/I-Pickup

Test condition:	fault L-N,L-L,L-L-L fault angle 90° SIR 1
Permissive tolerance/Limiting values:	- f _{rated} = 50 Hz: t _{min} 17/12 ms (fast relay/high speed relay) - f _{rated} = 60 Hz: t _{min} 15/10 ms (fast relay/high speed relay)
Test results/Remarks:	- f _{rated} = 50 Hz: t _{min} 14 ms (fast relay) - f _{rated} = 60 Hz: t _{min} 13 ms (fast relay)

1.13.8.4 Shortest trip time V//φ -Pickup

Test condition:	fault L-N,L-L,L-L-L fault angle 90° SIR 1
Permissive tolerance/Limiting values:	- f _{rated} = 50 Hz: t _{min} 17/12 ms (fast relay/high speed relay) - f _{rated} = 60 Hz: t _{min} 15/10 ms (fast relay/high speed relay)
Test results/Remarks:	- f _{rated} = 50 Hz: t _{min} 13 ms (fast relay) - f _{rated} = 60 Hz: t _{min} 12 ms (fast relay)

1.13.8.5 Dropout times

Test condition:	fault L-N,L-L,L-L-L
Test results/Remarks:	t _{avg} = 30 ms

1.13.8.6 Tolerances of time stages

Test condition:	time stages: T1 _{1pol} ; T2 _{1pol} ; T3 _{1pol} ; T4 _{1pol} T1 _{>1pol} ; T2 _{>1pol} ; T3 _{>1pol} ; T4 _{>1pol}
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Summary

Test values: 0.00 s £ T £ 60.00 s; ¥

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| £ 1 % or 10 ms

1.13.8.7 Zone directions

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.13.9 Dynamical performance

1.13.9.1 Influence of SIR and Xk

Test condition: Zone 1
Angle $\varphi_{line} = 85^\circ$
TAU_{source} = 100 ms
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Tests for polygonal characteristics, MHO and circular characteristics

Test values: - Fault L-N,L-L,L-L-L
- Phase angle $\varphi(k)$ of fault at switching-on point varied in range of 0° to 90° in steps of 30° ; without loaded current
- 4 test angles for each SIR value
- all test for each kind of fault
- $XI = 10 \text{ W}$

1.13.9.2 Operate times

Test condition: - Fault L-N:
0.5 £ SIR £ 60 , in 17 Steps
- Fault L-L:
1 £ SIR £ 100 , in 18 Steps
- Fault L-L-L:
1 £ SIR £ 120 , in 20 Steps

Test values: - $Xk/XI = 0.0$ to 1.1 , Steps £ 0.05 with 5 repetitions at times of identical shots

Test results/Remarks: Charts and tables with constant operate times available on request for L-N/L-L/L-L-L: SIR £ 50/90/80:

$f_{rated} = 50 \text{ Hz}:$	
0.00 £ Xk/XI £ 0.35	14 ms £ t £ 24 ms (fast relay)
0.40 £ Xk/XI £ 0.65	17 ms £ t £ 24 ms (fast relay)
0.75 £ Xk/XI £ 0.95	27 ms £ t £ 38 ms (fast relay)
1.01 £ Xk/XI £ 1.10	$t = T2$; Overreach < 1 % (fast relay)
$f_{rated} = 60 \text{ Hz}:$	
0.00 £ Xk/XI £ 0.35	13 ms £ t £ 24 ms (fast relay)
0.40 £ Xk/XI £ 0.65	16 ms £ t £ 24 ms (fast relay)
0.75 £ Xk/XI £ 0.95	27 ms £ t £ 38 ms (fast relay)
1.01 £ Xk/XI £ 1.10	$t = T2$; Overreach < 1 % (fast relay)

1.13.10 Processing of functions

1.13.10.1 Residual compensation

Test condition: Configurable separately for each zone:
-0.33 £ Kr £ +11.00 and -0.33 £ Kx £ +11.00
or
0.000 £ $K0$ £ +11.000 and -180.00° £ $PHI(K0)$ £ +180.00°

Permissive tolerance/Limiting values: function according to manual

Summary

Test results/Remarks: function correct

1.13.10.2 Emergency operation

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

Summary

1.14 Impedance Protection

1.14.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.14.2 Pickup values

1.14.2.1 Current

Test condition: 0.030 I_{rated} £ I_{ph} £ 35.000 I_{rated}

Test values: 0.05 I_{rated} £ I_{ph} £ 10.00 I_{rated}

Permissive tolerance/Limiting values: |d| £ 5 % of setting value

Test results/Remarks: |d| £ 1.0 % or 1 % I_{rated}

1.14.2.2 Voltage

Test condition: 0.500 V £ V_{ph-gnd} £ 70.00 V
1.000 V £ V_{ph-ph} £ 130.0 V

Test values: 5.00 V £ V_{ph-gnd} £ 50.00 V
8.00 V £ V_{ph-ph} £ 80.0 V

Permissive tolerance/Limiting values: |d| £ 5 % of setting value

Test results/Remarks: |d| < 5 % or 0.5 V

1.14.3 Dropout ratio

Test condition: 0.030 I_{rated} £ I_{ph} £ 35.000 I_{rated}

Test values: 0.05 I_{rated} £ I_{ph} £ 10.00 I_{rated}

Permissive tolerance/Limiting values: r approx. 0.95

Test results/Remarks: r approx. 0.95

1.14.4 Distance measurement

1.14.4.1 Polygonal characteristic

Test condition: parameters:
 - Zone Z1: X1 = 2.5 W
 - Zone Z2: X2 = 5.0 W
 - Zone Z3: X3 = 10.0 W
 - Zone Z4: X4 = 12.0 W

Test values: I = 1.5 I_{rated}; Fault L-N, L-L, L-L-L ; Angle φ(V,I) in range 0...360° with steps of 5°

Permissive tolerance/Limiting values: X: |d| £ 5 % of setting value for 30° £ PHI(V,I) £ 90°
 R: |d| £ 5 % of setting value for 0° £ PHI(V,I) £ 60°

Test results/Remarks: X, R:
 - Zone Z1: |d| < 3 %
 - Zone Z2: |d| < 3 %
 - Zone Z3: |d| < 3 %
 - Zone Z4: |d| < 3 %

Summary

1.14.5 Directional measurement

Test condition: fault L-N,L-L,L-L-L,
 Permissive tolerance/Limiting values: function according to manual
 Test results/Remarks: function correct

1.14.6 Time stages of distance zones

1.14.6.1 Pickup times

Test condition: fault L-N,L-L,L-L-L
 fault angle 90°
 SIR 1
 measured with fast relay
 Permissive tolerance/Limiting values: t_{min} approx. 40/35 ms (fast relay/high speed relay)
 Test results/Remarks:

	50 Hz	60 Hz
t_{min} =	25.9 ms	21.8 ms
$t_{average}$ =	32.3 ms	27.4 ms
t_{max} =	37.4 ms	30.5 ms

1.14.6.2 Dropout times

Test condition: fault L-N,L-L,L-L-L
 Permissive tolerance/Limiting values: t approx. 20 ms
 Test results/Remarks:

t_{min} =	13.6 ms
$t_{average}$ =	18.2 ms
t_{max} =	23.4 ms

1.14.6.3 Tolerances of time stages

Test condition: time stages:
 $T1_{1pol}; T2_{1pol}; T3_{1pol}; T4_{1pol}$
 $T1_{>1pol}; T2_{>1pol}; T3_{>1pol}; T4_{>1pol}$
 Test values: 0.00 s £ T £ 60.00 s; ¥
 Permissive tolerance/Limiting values: $|d|$ £ 1 % of setting value or 10 ms
 Test results/Remarks: $|d|$ < 1 % or 10 ms

1.14.6.4 Zone directions

Permissive tolerance/Limiting values: function according to manual
 Test results/Remarks: function correct

Summary**1.16 External Trip Initiation****1.16.1 Pickup times**

Test condition: with initiation via binary input signal

Test values: $f_{rated}=50$ Hz, 60 Hz

Permissive tolerance/Limiting values: t approx. 5 ms + OOT

Test results/Remarks: t < 5 ms + OOT

1.16.2 Dropout times

Test condition: with initiation via binary input signal

Test values: $f_{rated}=50$ Hz, 60 Hz

Permissive tolerance/Limiting values: t approx. 3 ms + OOT

Test results/Remarks: t < 3 ms + OOT

1.16.3 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s to 60.00 s

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: < 1 % of setting value or 10 ms

Summary

1.17 50/51 Overcurrent Protection, Phases

1.17.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.17.2 Overcurrent Protection, phases with definite time overcurrent stages (definite time)

1.17.2.1 Pickup values

Test condition: 0.030 I_{rated} £ threshold value £ 35.000 I_{rated}
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Method of measurement = fundamental components of phases:

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or $0.005 I_{rated}$

Test results/Remarks: $\leq 1 \%$ of setting value or $\leq 0.005 I_{rated}$

Method of measurement = RMS value of phases, no filter applied:

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1 \%$ of setting value or $0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\pm 3 \%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\pm 4 \%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1 \%$ of setting value or $\leq 0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\leq 3 \%$ of setting value or $\leq 0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\leq 4 \%$ of setting value or $\leq 0.02 I_{rated}$

Method of measurement = RMS value of phases,

with filter for the compensation of the amplitude attenuation due to the anti-aliasing:

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1 \%$ of setting value or $0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\pm 2 \%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\pm 3 \%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1 \%$ of setting value or $\leq 0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\leq 2 \%$ of setting value or $\leq 0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\leq 3 \%$ of setting value or $\leq 0.02 I_{rated}$

Method of measurement = RMS value of phases,

with filter for the gain of harmonics (including compensation of the amplitude attenuation)¹

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1.5 \%$ of setting value or $0.01 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\pm 3 \%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\pm 4 \%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1.5 \%$ of setting value or $\leq 0.01 I_{rated}$ ²
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\leq 3 \%$ of setting value or $\leq 0.02 I_{rated}$ ³
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\leq 4 \%$ of setting value or $\leq 0.02 I_{rated}$ ³

1.17.2.2 Dropout ratio

Test condition: see item 1.17.2.1

¹ In case that the filter response exactly matches the user defined gain factor

² In case that the user-defined gain factor is set below 3. The tolerance is amplified if the gain factor is larger

³ In case that the user-defined gain factor is set below 7. The tolerance is amplified if the gain factor is larger

Summary

Test values: 0.90 £ r £ 0.99

Permissive tolerance/Limiting values: ±1 % of dropout value

Test results/Remarks: ≤ 1 % of dropout value

1.17.2.3 Pickup times

Test condition: see item 1.17.2.1

Test values: 1.2*threshold

Permissive tolerance/Limiting values: ≤ 25 ms + OOT at 50 Hz
≤ 22 ms + OOT at 60 Hz

Test results/Remarks: ≤ 25 ms + OOT at 50 Hz
≤ 22 ms + OOT at 60 Hz

1.17.2.4 Dropout times

Test condition: see item 1.17.2.1

Permissive tolerance/Limiting values: ≤ 20 ms + OOT

Test results/Remarks: ≤ 20 ms + OOT

1.17.2.5 Time delay

Test condition: see item 1.17.2.1
1.2*threshold

Test values: 0.00 s £ T £ 100.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 30 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 30 ms

1.17.3 Overcurrent Protection, phases with inverse time overcurrent stage (inverse time)

1.17.3.1 Pickup values

Test condition: 0.030 I_{rated} £ threshold value £ 35.000 I_{rated}
f_{rated} = 50 Hz, 60 Hz

Method of measurement = fundamental components of phases:

Permissive tolerance/Limiting values: ±1 % of setting value or 0.005 I_{rated}

Test results/Remarks: ≤ 1 % of setting value or ≤ 0.005 I_{rated}

Method of measurement = RMS value of phases, no filter applied:

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: ≤ 1 % of setting value or ≤ 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ≤ 3 % of setting value or ≤ 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ≤ 4 % of setting value or ≤ 0.02 I_{rated}

Summary

Method of measurement = RMS value of phases.

with filter for the compensation of the amplitude attenuation due to the anti-aliasing:

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1\%$ of setting value or $0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\pm 2\%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\pm 3\%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1\%$ of setting value or $\leq 0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\leq 2\%$ of setting value or $\leq 0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\leq 3\%$ of setting value or $\leq 0.02 I_{rated}$

Method of measurement = RMS value of phases.

with filter for the gain of harmonics (including compensation of the amplitude attenuation)¹

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1.5\%$ of setting value or $0.01 I_{rated}$
up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\pm 3\%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\pm 4\%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1.5\%$ of setting value or $\leq 0.01 I_{rated}$ ²
up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\leq 3\%$ of setting value or $\leq 0.02 I_{rated}$ ³
up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\leq 4\%$ of setting value or $\leq 0.02 I_{rated}$ ³

1.17.3.2 Dropout ratio

Test condition: see item 1.17.3.1

Instantaneous

Test values: 1.05 * threshold value
0.95 * pickup value

Disk emulation

Test values: 0.90 * threshold value

Permissive tolerance/Limiting values: $\pm 1\%$ of dropout value

Test results/Remarks: $\leq 1\%$ of dropout value

1.17.3.3 Pickup times

Test condition: see item 1.17.3.1
1.2*threshold

Permissive tolerance/Limiting values: $\leq 25\text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 22\text{ ms} + \text{OOT}$ at 60 Hz

Test results/Remarks: $\leq 25\text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 22\text{ ms} + \text{OOT}$ at 60 Hz

1.17.3.4 Dropout times

Test condition: see item 1.17.3.1

Permissive tolerance/Limiting values: $\leq 20\text{ ms} + \text{OOT}$

¹ In case that the filter response exactly matches the user defined gain factor

² In case that the user-defined gain factor is set below 3. The tolerance is amplified if the gain factor is larger

³ In case that the user-defined gain factor is set below 7. The tolerance is amplified if the gain factor is larger

Summary

Test results/Remarks:	≤ 20 ms + OOT
1.17.3.5 Tripping time characteristics	
Test condition:	see item 1.17.3.1 1.2*threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of the reference value + 2 % of current tolerance) or 30 ms
1.17.3.5.1 IEC normal inverse (type A)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.2 IEC very inverse (type B)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.3 IEC extremely inverse (type C)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.4 IEC long-time inverse (type B)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.5 ANSI long-time inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.6 ANSI short-time inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.7 ANSI extremely inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.8 ANSI very inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.9 ANSI normal inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.10 ANSI moderately inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.5.11 ANSI definite inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.17.3.6 Dropout characteristics	
Test condition:	see item 1.17.3.1
Disk emulation:	0.8*threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of the reference value + 2 % of current tolerance) or 30 ms
1.17.3.6.1 IEC normal inverse (type A)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms

Summary

- 1.17.3.6.2 IEC very inverse (type B)
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.3 IEC extremely inverse (type C)
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.4 IEC long-time inverse (type B)
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.5 ANSI long-time inverse
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.6 ANSI short-time inverse
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.7 ANSI extremely inverse
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.8 ANSI very inverse
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.9 ANSI normal inverse
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.10 ANSI moderately inverse
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$
- 1.17.3.6.11 ANSI definite inverse
Test results/Remarks: $\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance}) \text{ or } \leq 30 \text{ ms}$

1.17.4 Overcurrent Protection, phases with user-defined characteristic¹

1.17.4.1 Pickup

Test condition: $0.030 I_{rated} \leq \text{threshold value} \leq 35.000 I_{rated}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Method of measurement = fundamental components of phases:

Permissive tolerance/Limiting values: $\pm 1 \% \text{ of setting value or } 0.005 I_{rated}$

Test results/Remarks: $\leq 1 \% \text{ of setting value or } \leq 0.005 I_{rated}$

Method of measurement = RMS value of phases, no filter applied :

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1 \% \text{ of setting value or } 0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\pm 3 \% \text{ of setting value or } 0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\pm 4 \% \text{ of setting value or } 0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1 \% \text{ of setting value or } \leq 0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\leq 3 \% \text{ of setting value or } \leq 0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\leq 4 \% \text{ of setting value or } \leq 0.02 I_{rated}$

Method of measurement = RMS value of phases.

with filter for the compensation of the amplitude attenuation due to the anti-aliasing:

¹ Not available for Busbar Protection

Summary

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1\%$ of setting value or $0.005 I_{rated}$
 up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\pm 2\%$ of setting value or $0.02 I_{rated}$
 up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\pm 3\%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1\%$ of setting value or $\leq 0.005 I_{rated}$
 up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\leq 2\%$ of setting value or $\leq 0.02 I_{rated}$
 up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\leq 3\%$ of setting value or $\leq 0.02 I_{rated}$

Method of measurement = RMS value of phases.

with filter for the gain of harmonics (including compensation of the amplitude attenuation¹

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1.5\%$ of setting value or $0.01 I_{rated}$
 up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\pm 3\%$ of setting value or $0.02 I_{rated}$
 up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\pm 4\%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1.5\%$ of setting value or $\leq 0.01 I_{rated}$ ²
 up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\leq 3\%$ of setting value or $\leq 0.02 I_{rated}$ ³
 up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\leq 4\%$ of setting value or $\leq 0.02 I_{rated}$ ³

1.17.4.2 Dropout ratio

Test condition: see item 1.17.4.1

Instantaneous

Test values: 1.05 * threshold value
0.95 * pickup value

Disk emulation

Test values: 0.90 * threshold value

Permissive tolerance/Limiting values: $\pm 1\%$ of dropout value

Test results/Remarks: $\leq 1\%$ of dropout value

1.17.4.3 Pickup times

Test condition: see item 1.17.4.1
1.2*threshold

Permissive tolerance/Limiting values: $\leq 25\text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 22\text{ ms} + \text{OOT}$ at 60 Hz

Test results/Remarks: $\leq 25\text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 22\text{ ms} + \text{OOT}$ at 60 Hz

1.17.4.4 Dropout times

Test condition: see item 1.17.4.1

Permissive tolerance/Limiting values: $\leq 25\text{ ms} + \text{OOT}$

Test results/Remarks: $\leq 25\text{ ms} + \text{OOT}$

¹ In case that the filter response exactly matches the user defined gain factor

² In case that the user-defined gain factor is set below 3. The tolerance is amplified if the gain factor is larger

³ In case that the user-defined gain factor is set below 7. The tolerance is amplified if the gain factor is larger

Summary**1.17.4.5 Tripping time characteristics**

Test condition:	see item 1.17.4.1 1.2*threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of the reference value + 2 % of current tolerance) or 30 ms
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms

1.17.4.6 Dropout characteristics

Test condition:	see item 1.17.4.1
Disk emulation:	0.8*threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of the reference value + 2 % of current tolerance) or 30 ms
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms

Summary

1.18 50N/51N Overcurrent Protection, Ground

1.18.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.18.2 Overcurrent Protection, ground with definite time overcurrent stages (definite time)

1.18.2.1 Pickup values

Test condition: 0.010 I_{rated} £ threshold value £ 35.000 I_{rated} for protection CT
0.001 A £ threshold value £ 1.600 A for instrument CT (Current range: 1.6A)
0.002 A £ threshold value £ 8.000 A for instrument CT (Current range: 8A)
 $f_{rated} = 50$ Hz, 60 Hz

Method of measurement = fundamental components of phases and 3I0:

Permissive tolerance/Limiting values: For protection CT:
±1 % of setting value or 0.005 I_{rated}
For instrument CT:
±1 % of setting value or 0.0005 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.005 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.0005 I_{rated}

Method of measurement = RMS value of phases and 3I0:

Permissive tolerance/Limiting values: For protection CT:
up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, $f_{rated} = 50$ Hz: ±3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, $f_{rated} = 60$ Hz: ±4 % of setting value or 0.02 I_{rated}
For instrument CT:
up to 30th harmonic: ±1 % of setting value or 0.0005 I_{rated}
up to 50th harmonic, $f_{rated} = 50$ Hz: ±3 % of setting value or 0.001 I_{rated}
up to 50th harmonic, $f_{rated} = 60$ Hz: ±4 % of setting value or 0.001 I_{rated}

Test results/Remarks: For protection CT:
up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}
up to 50th harmonic, $f_{rated} = 50$ Hz: £ 3 % of setting value or £ 0.02 I_{rated}
up to 50th harmonic, $f_{rated} = 60$ Hz: £ 4 % of setting value or £ 0.02 I_{rated}
For instrument CT:
up to 30th harmonic: £ 1 % of setting value or £ 0.0005 I_{rated}
up to 50th harmonic, $f_{rated} = 50$ Hz: £ 3 % of setting value or £ 0.001 I_{rated}
up to 50th harmonic, $f_{rated} = 60$ Hz: £ 4 % of setting value or £ 0.001 I_{rated}

1.18.2.2 Dropout ratio

Test condition: see item 1.18.2.1

Test values: For protection CT:
95 % of Threshold value or 0.015 I_{rated} or 50% of threshold value (for secondary current threshold £ 0.030 I_{rated})
For instrument CT:
95 % of Threshold value or 0.0005 I_{rated} or 50% of threshold value (for secondary current threshold £ 0.001 I_{rated})

Permissive tolerance/Limiting values: For protection CT:
±1 % of dropout value or 0.005 I_{rated}
For instrument CT:
±1 % of dropout value or 0.0005 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of dropout value or £ 0.005 I_{rated}
For instrument CT:
£ 1 % of dropout value or £ 0.0005 I_{rated}

1.18.2.3 Pickup times

Test condition: see item 1.18.2.1

Test values: 1.2*threshold
 $f_{rated} = 50$ Hz, 60 Hz

Summary

Permissive tolerance/Limiting values: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

Test results/Remarks: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

1.18.2.4 Dropout times

Test condition: see item 1.18.2.1

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

1.18.2.5 Time delay

Test condition: see item 1.18.2.1
1.2*threshold

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 30 ms

Test results/Remarks: £ 1 % of setting value or £ 30 ms

1.18.3 Overcurrent Protection, ground with inverse time overcurrent stage (inverse time)

1.18.3.1 Pickup values

Test condition: 0.010 I_{rated} £ threshold value £ 35.000 I_{rated} for protection CT
0.001 A £ threshold value £ 1.600 A for instrument CT (Current range: 1.6A)
0.002 A £ threshold value £ 8.000 A for instrument CT (Current range: 8A)
f_{rated} = 50 Hz, 60 Hz

Method of measurement = fundamental components of phases and 3I0:

Permissive tolerance/Limiting values: For protection CT:
±1 % of setting value or 0.005 I_{rated}
For instrument CT:
±1 % of setting value or 0.0005 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.005 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.0005 I_{rated}

Method of measurement = RMS value of phases and 3I0:

Permissive tolerance/Limiting values: For protection CT:
up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.02 I_{rated}
For instrument CT:
up to 30th harmonic: ±1 % of setting value or 0.0005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.001 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.001 I_{rated}

Test results/Remarks: For protection CT:
up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.02 I_{rated}
For instrument CT:
up to 30th harmonic: £ 1 % of setting value or 0.0005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.001 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.001 I_{rated}

1.18.3.2 Dropout ratio

Test condition: see item 1.18.3.1

Instantaneous:
Test values: For protection CT:
95 % of pickup value or 0.015 I_{rated} or 50% of pickup value (for secondary current threshold £ 0.030 I_{rated})
For instrument CT:

Summary

95 % of pickup value or $0.0005 I_{rated}$ or 50% of pickup value (for secondary current threshold $\leq 0.001 I_{rated}$)

Disk emulation

Test values:

90% of pickup value

Permissive tolerance/Limiting values:

For protection CT:
 $\pm 1\%$ of dropout value or $0.005 I_{rated}$
For instrument CT:
 $\pm 1\%$ of dropout value or $0.0005 I_{rated}$

Test results/Remarks:

For protection CT:
 $\leq 1\%$ of dropout value or $\leq 0.005 I_{rated}$
For instrument CT:
 $\leq 1\%$ of dropout value or $\leq 0.0005 I_{rated}$

1.18.3.3 Pickup times

Test condition:

see item 1.18.3.1

Test value:

$1.2 \times \text{threshold}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values:

$\leq 25 \text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 22 \text{ ms} + \text{OOT}$ at 60 Hz

Test results/Remarks:

$\leq 25 \text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 22 \text{ ms} + \text{OOT}$ at 60 Hz

1.18.3.4 Dropout times

Test condition:

see item 1.18.3.1

Permissive tolerance/Limiting values:

$\leq 20 \text{ ms} + \text{OOT}$

Test results/Remarks:

$\leq 20 \text{ ms} + \text{OOT}$

1.18.3.5 Tripping time characteristics

Test condition:

see item 1.18.3.1
 $1.2 \times \text{threshold}$

Test values:

Time dial: 0.05 $\leq T \leq 15.00$

Permissive tolerance/Limiting values:

$\pm (5\% \text{ of the reference value} + 2\% \text{ of current tolerance})$ or 30 ms

1.18.3.5.1 IEC normal inverse (type A)

Test results/Remarks:

$\leq (5\% \text{ of the reference value} + 2\% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$

1.18.3.5.2 IEC very inverse (type B)

Test results/Remarks:

$\leq (5\% \text{ of the reference value} + 2\% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$

1.18.3.5.3 IEC extremely inverse (type C)

Test results/Remarks:

$\leq (5\% \text{ of the reference value} + 2\% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$

1.18.3.5.4 IEC long-time inverse (type B)

Test results/Remarks:

$\leq (5\% \text{ of the reference value} + 2\% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$

1.18.3.5.5 ANSI long-time inverse

Test results/Remarks:

$\leq (5\% \text{ of the reference value} + 2\% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$

1.18.3.5.6 ANSI short-time inverse

Test results/Remarks:

$\leq (5\% \text{ of the reference value} + 2\% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$

1.18.3.5.7 ANSI extremely inverse

Test results/Remarks:

$\leq (5\% \text{ of the reference value} + 2\% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$

Summary

1.18.3.5.8 ANSI very inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.5.9 ANSI normal inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.5.10 ANSI moderately inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.5.11 ANSI definite inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6 Dropout characteristics	
Test condition:	see item 1.18.3.1 Disk emulation: 0.8*threshold
Test values:	I/I threshold value £ 0.90
Permissive tolerance/Limiting values:	±(5 % of the reference value + 2 % of current tolerance) or 30 ms
1.18.3.6.1 IEC normal inverse (type A)	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.2 IEC very inverse (type B)	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.3 IEC extremely inverse (type C)	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.4 IEC long-time inverse (type B)	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.5 ANSI long-time inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.6 ANSI short-time inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.7 ANSI extremely inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.8 ANSI very inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.9 ANSI normal inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.10 ANSI moderately inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms
1.18.3.6.11 ANSI definite inverse	
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.18.4 Overcurrent Protection, ground with user-defined characteristic¹

1.18.4.1 Pickup

Test condition: 0.010 I_{rated} £ threshold value £ 35.000 I_{rated} for protection CT
0.001 A £ threshold value £ 1.600 A for instrument CT (Current range: 1.6A)
0.002 A £ threshold value £ 8.000 A for instrument CT (Current range: 8A)
f_{rated} = 50 Hz, 60 Hz

Method of measurement = fundamental components of phases and 3I0:

Permissive tolerance/Limiting values: For protection CT:
±1 % of setting value or 0.005 I_{rated}
For instrument CT:
±1 % of setting value or 0.0005 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of setting value or £ 0.005 I_{rated}
For instrument CT:
£ 1 % of setting value or £ 0.0005 I_{rated}

Method of measurement = RMS value of phases and 3I0:

Permissive tolerance/Limiting values: For protection CT:
up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.02 I_{rated}
For instrument CT:
up to 30th harmonic: ±1 % of setting value or 0.0005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.001 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.001 I_{rated}

Test results/Remarks: For protection CT:
up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.02 I_{rated}
For instrument CT:
up to 30th harmonic: £ 1 % of setting value or £ 0.0005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.001 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.001 I_{rated}

1.18.4.2 Dropout ratio

Test condition: see item 1.18.4.1

Instantaneous:
Test values: For protection CT:
95 % of pickup value or 0.015 I_{rated} or 50% of pickup value (for secondary current threshold £ 0.030 I_{rated})
For instrument CT:
95 % of pickup value or 0.0005 I_{rated} or 50% of pickup value (for secondary current threshold £ 0.001 I_{rated})

Disk emulation
Test values: 90% of pickup value

Permissive tolerance/Limiting values: For protection CT:
±1 % of dropout value or 0.005 I_{rated}
For instrument CT:
±1 % of dropout value or 0.0005 I_{rated}

Test results/Remarks: For protection CT:
£ 1 % of dropout value or £ 0.005 I_{rated}
For instrument CT:
£ 1 % of dropout value or £ 0.0005 I_{rated}

1.18.4.3 Pickup times

Test condition: see item 1.18.4.1

Test value: 1.2*threshold
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

¹ Not available for Busbar Protection

Summary

Test results/Remarks: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

1.18.4.4 Dropout times

Test condition: see item 1.18.4.1
Permissive tolerance/Limiting values: £ 25 ms + OOT
Test results/Remarks: £ 25 ms + OOT

1.18.4.5 Tripping time characteristics

Test condition: see item 1.18.4.1
1.2*threshold
Test values: Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values: $\pm(5\%$ of the reference value + 2 % of current tolerance) or 30 ms
Test results/Remarks: £ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms

1.18.4.6 Dropout characteristics

Test condition: see item 1.18.4.1
Disk emulation: 0.8*threshold
Test values: I/I threshold value £ 0.90
Permissive tolerance/Limiting values: $\pm(5\%$ of the reference value + 2 % of current tolerance) or 30 ms
Test results/Remarks: £ (5 % of the reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.19 50/51 Overcurrent Protection 1-phase

1.19.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.19.2 Overcurrent protection, 1-phase with definite time-overcurrent stage

1.19.2.1 Pickup values

Test condition: 0.030 I_{rated} $\leq I < 35.000 I_{rated}$ for protection CT
0.001 I_{rated} $\leq I < 1.600 I_{rated}$ for instrument CT

Test values: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
0.030 I_{rated} $\leq I < 35.000 I_{rated}$ for protection CT

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or $0.005 I_{rated}$

Test results/Remarks: $\leq 1 \%$ of setting value or $\leq 0.005 I_{rated}$

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1 \%$ of setting value or $0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\pm 3 \%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\pm 4 \%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1 \%$ of setting value or $\leq 0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\leq 3 \%$ of setting value or $\leq 0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\leq 4 \%$ of setting value or $\leq 0.02 I_{rated}$

1.19.2.2 Dropout ratios

Test condition: see item 1.19.2.1

Test values: 0.95

Permissive tolerance/Limiting values: $\pm 1 \%$ of dropout value

Test results/Remarks: $\leq 1 \%$ of dropout value

1.19.2.3 Pickup times

Test condition: see item 1.19.2.1

Test values: $2 \times \text{threshold}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: $\leq 15 \text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 14 \text{ ms} + \text{OOT}$ at 60 Hz

Test results/Remarks: $\leq 15 \text{ ms} + \text{OOT}$ at 50 Hz
 $\leq 14 \text{ ms} + \text{OOT}$ at 60 Hz

1.19.2.4 Dropout times

Test condition: see item 1.19.2.1

Summary

Permissive tolerance/Limiting values: $\leq 20 \text{ ms} + \text{OOT}$
 Test results/Remarks: $\leq 20 \text{ ms} + \text{OOT}$

1.19.2.5 Time delays

Test condition: added to the inherent operating times
 Test values: $0.000 \text{ s} \leq T \leq 60.000 \text{ s}$
 Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms
 Test results/Remarks: $\leq 1 \%$ of setting value or $\leq 10 \text{ ms}$

1.19.3 Overcurrent Protection, 1-ph with inverse-time overcurrent stage

1.19.3.1 Pickup values

Test condition: $0.030 I_{\text{rated}} \leq I < 35.000 I_{\text{rated}}$ for protection CT
 $0.001 I_{\text{rated}} \leq I < 1.600 I_{\text{rated}}$ for instrument CT
 Test values: $f_{\text{rated}} = 50 \text{ Hz}, 60 \text{ Hz}$
 $0.030 I_{\text{rated}} \leq I < 35.000 I_{\text{rated}}$ for protection CT

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or $0.005 I_{\text{rated}}$
 Test results/Remarks: $\leq 1 \%$ of setting value or $\leq 0.005 I_{\text{rated}}$

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1 \%$ of setting value or $0.005 I_{\text{rated}}$
 up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$: $\pm 3 \%$ of setting value or $0.02 I_{\text{rated}}$
 up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$: $\pm 4 \%$ of setting value or $0.02 I_{\text{rated}}$
 Test results/Remarks: up to 30th harmonic: $\leq 1 \%$ of setting value or $\leq 0.005 I_{\text{rated}}$
 up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$: $\leq 3 \%$ of setting value or $\leq 0.02 I_{\text{rated}}$
 up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$: $\leq 4 \%$ of setting value or $\leq 0.02 I_{\text{rated}}$

1.19.3.2 Dropout ratios

Test condition: see item 1.19.3.1
 Instantaneous
 Test values: $1.05 \cdot \text{threshold value}$
 $0.95 \cdot \text{pickup value}$
 Disk emulation
 Test values: $0.90 \cdot \text{threshold value}$
 Permissive tolerance/Limiting values: $\pm 1 \%$ of dropout value
 Test results/Remarks: $\leq 1 \%$ of dropout value

Summary

1.19.3.3 Pickup times

Test values:	pickup time for $2 \leq I/I$ -threshold value ≤ 20 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Permissive tolerance/Limiting values:	£ 25 ms + OOT at 50 Hz £ 22 ms + OOT at 60 Hz
Test results/Remarks:	£ 25 ms + OOT at 50 Hz £ 22 ms + OOT at 60 Hz

1.19.3.4 Dropout times

Instantaneous:

Permissive tolerance/Limiting values:	£ 20 ms + OOT
Test results/Remarks:	£ 20 ms + OOT

Disk emulation

Test values:	dropout time for I/I -threshold value ≤ 0.90
Permissive tolerance/Limiting values:	$\pm(5 \% \text{ of reference value} + 2 \% \text{ of current tolerance})$ or 30 ms
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.19.3.5 Tripping time characteristics

Test condition:	see item 1.19.3.1 1.2*threshold
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Test values:	Time dial: 0.05 £ T £ 15.00
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Permissive tolerance/Limiting values:	$\pm(5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance})$ or 30 ms
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1.19.3.5.1 IEC normal inverse (type A)

Test results/Remarks:	$\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$
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1.19.3.5.2 IEC very inverse (type B)

Test results/Remarks:	$\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$
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1.19.3.5.3 IEC extremely inverse (type C)

Test results/Remarks:	$\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$
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1.19.3.5.4 IEC long-time inverse (type B)

Test results/Remarks:	$\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$
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1.19.3.5.5 ANSI long-time inverse

Test results/Remarks:	$\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$
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1.19.3.5.6 ANSI short-time inverse

Test results/Remarks:	$\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$
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1.19.3.5.7 ANSI extremely inverse

Test results/Remarks:	$\leq (5 \% \text{ of the reference value} + 2 \% \text{ of current tolerance})$ or $\leq 30 \text{ ms}$
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Summary

1.19.3.5.8 ANSI very inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.5.9 ANSI normal inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.5.10 ANSI moderately inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.5.11 ANSI definite inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6 Dropout characteristics	
Test condition:	see item 1.19.3.1
Disk emulation:	0.8*threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of the reference value + 2 % of current tolerance) or 30 ms
1.19.3.6.1 IEC normal inverse (type A)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.2 IEC very inverse (type B)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.3 IEC extremely inverse (type C)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.4 IEC long-time inverse (type B)	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.5 ANSI long-time inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.6 ANSI short-time inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.7 ANSI extremely inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.8 ANSI very inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.9 ANSI normal inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.10 ANSI moderately inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms
1.19.3.6.11 ANSI definite inverse	
Test results/Remarks:	≤ (5 % of the reference value + 2 % of current tolerance) or ≤ 30 ms

Summary

1.19.4 Overcurrent Protection, 1-ph with user-defined characteristic curve stage

1.19.4.1 Pickup

Test condition: 0.030 I_{rated} $I > I$ > £ 35.000 I_{rated} for protection CT
0.001 I_{rated} $I > I$ > £ 1.600 I_{rated} for instrument CT

Test values: $f_{rated} = 50$ Hz, 60 Hz
0.030 I_{rated} $I > I$ > £ 35.000 I_{rated} for protection CT

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: ± 1 % of setting value or 0.005 I_{rated}

Test results/Remarks: £ 1 % of setting value or 0.005 I_{rated}

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: ± 1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, $f_{rated} = 50$ Hz: ± 3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, $f_{rated} = 60$ Hz: ± 4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}
up to 50th harmonic, $f_{rated} = 50$ Hz: £ 3 % of setting value or £ 0.02 I_{rated}
up to 50th harmonic, $f_{rated} = 60$ Hz: £ 4 % of setting value or £ 0.02 I_{rated}

1.19.4.2 Dropout ratios

Test condition: see item 1.19.4.1

Instantaneous

Test values: 1.05 * threshold value
0.95 * pickup value

Disk emulation

Test values: 0.90 * threshold value

Permissive tolerance/Limiting values: ± 1 % of dropout value

Test results/Remarks: ≤ 1 % of dropout value

1.19.4.3 Pickup times

Test values: pickup time for $2 \leq I/I$ -threshold value ≤ 20
 $f_{rated} = 50$ Hz, 60 Hz

Permissive tolerance/Limiting values: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

Test results/Remarks: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

1.19.4.4 Dropout times

Instantaneous:

Permissive tolerance/Limiting values: £ 20 ms + OOT

Summary

Test results/Remarks: £ 20 ms + OOT

Disk emulation

Test values: dropout time for I/I-threshold value ≤ 0.90

Permissive tolerance/Limiting values: $\pm(5\%$ of reference value + 2 % of current tolerance) or 30 ms

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.19.5 Overcurrent Protection, 1-phase with fast stage

1.19.5.1 Pickup

Test condition: $0.030 I_{rated} \leq I < 35.000 I_{rated}$ for protection CT
 $0.001 I_{rated} \leq I < 1.600 I_{rated}$ for instrument CT

Test values: $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$
 $0.030 I_{rated} \leq I < 35.000 I_{rated}$ for protection CT
 $0.001 I_{rated} \leq I < 1.600 I_{rated}$ for instrument CT

Permissive tolerance/Limiting values: $\pm 5\%$ of setting value or $0.01 I_{rated}$

Test results/Remarks: £ 5 % of setting value or £ $0.01 I_{rated}$

1.19.5.2 Dropout ratio

Test condition: see item 1.19.5.1

Test values: $0.90 \leq r \leq 0.99$

Permissive tolerance/Limiting values: $\pm 1\%$ of dropout value

Test results/Remarks: $\leq 1\%$ of dropout value

1.19.5.3 Pickup times

Test condition: see item 1.19.5.1

Test values: $2 \times \text{threshold}$
 $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$

Permissive tolerance/Limiting values: $\leq 8\text{ ms} + \text{OOT}$

Test results/Remarks: $\leq 8\text{ ms} + \text{OOT}$

1.19.5.4 Dropout times

Test condition: see item 1.19.5.1

Permissive tolerance/Limiting values: $\leq 25\text{ ms} + \text{OOT}$

Test results/Remarks: $\leq 25\text{ ms} + \text{OOT}$

Summary

1.19.5.5 Time delays

Test condition: added to inherent operating times

Test values: 0.00 s ≤ T ≤ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.19.6 Overcurrent Protection, 1-ph with Logarithmic-Inverse overcurrent stage

1.19.6.1 Pickup values

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: 0.010 I_{rated} ≤ I ≤ 35.000 I_{rated} for protection CT
0.001 I_{rated} ≤ I ≤ 1.600 I_{rated} for instrument CT

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: For protection CT:
±1 % of setting value or 0.005 I_{rated}
For instrument CT:
±1 % of setting value or 0.0005 I_{rated}

Test results/Remarks: For protection CT:
≤ 1 % of setting value or ≤ 0.005 I_{rated}
For instrument CT:
≤ 1 % of setting value or ≤ 0.0005 I_{rated}

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: ±3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: ±4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: ≤ 1 % of setting value or ≤ 0.005 I_{rated}
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: ≤ 3 % of setting value or ≤ 0.02 I_{rated}
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: ≤ 4 % of setting value or ≤ 0.02 I_{rated}

1.19.6.2 Dropout ratios

Test condition: see item 1.19.6.1

Test values: 1.05 * threshold value
0.95 * pickup value

Permissive tolerance/Limiting values: For protection CT:
±1 % of dropout value or 0.015 I_{rated}
For instrument CT:
±1 % of dropout value or 0.0005 I_{rated}

Test results/Remarks: For protection CT:
≤ 1 % of dropout value or ≤ 0.015 I_{rated}
For instrument CT:
≤ 1 % of dropout value or ≤ 0.0005 I_{rated}

1.19.6.3 Pickup times

Test condition: see item 1.19.6.1

Summary

Test values:	2 * threshold
Permissive tolerance/Limiting values:	£ 30 ms + OOT at 50 Hz £ 25 ms + OOT at 60 Hz
Test results/Remarks:	£ 30 ms + OOT at 50 Hz £ 25 ms + OOT at 60 Hz

1.19.6.4 Dropout times

Test condition:	see item 1.19.6.1
Permissive tolerance/Limiting values:	£ 25 ms + OOT at 50 Hz £ 20 ms + OOT at 60 Hz
Test results/Remarks:	£ 25 ms + OOT at 50 Hz £ 20 ms + OOT at 60 Hz

1.19.6.5 Tripping time characteristics

Test condition:	added to the inherent operating times
Test values:	Time dial: 0.00 s £ T £ 60.00 s Minimum time of the curve: 0.00 s £ T £ 60.00 s Maximum time of the curve: 0.00 s £ T £ 60.00 s Additional time delay: 0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±(5 % of the reference value + 2 % of current tolerance) or 30 ms
Test results/Remarks:	£ (5 % of the reference value + 2 % of current tolerance) or 30 ms

Summary

1.20 51V Voltage-dependent Overcurrent-Protection

1.20.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-127

1.20.2 Voltage-released stage

1.20.2.1 Pickup values I_>

Test condition: 0.030 I_{rated} £ threshold value £ 35.000 I_{rated}

Test values: f_{rated} = 50 Hz, 60 Hz
0.030 I_{rated} £ threshold value £ 35.000 I_{rated}

Method of measurement = fundamental components of phases

Permissive tolerance/Limiting values: ±1 % of setting value or 0.005 I_{rated}

Test results/Remarks: £ 1 % of setting value or £ 0.005 I_{rated}

Method of measurement = RMS value of phases

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.02 I_{rated}

1.20.2.2 Dropout ratio

Test condition: see item 1.20.2.1

Instantaneous:

Test values: 1.05 * threshold value
0.95 * pickup value

Disk emulation:

Test values: 0.90 * threshold value

Permissive tolerance/Limiting values: ±1 % of dropout value

Test results/Remarks: £ 1 % of dropout value

1.20.2.3 Pickup values V_{ph-ph}<

Test condition: 0.300 V £ threshold value £ 175.000V

Test values: 0.300 V £ threshold value £ 175.000V

Permissive tolerance/Limiting values: ±0.5 % of setting value or 0.05 V

Test results/remarks: £ 0.5 % of setting value or £ 0.05 V

Summary

1.20.2.4 Pickup time

Test condition: see item 1.20.2.1

Test values: 1.2 * threshold
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

Test results/Remarks: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

1.20.2.5 Dropout times

Test condition: see item 1.20.2.1

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

1.20.2.6 Tripping time characteristics

Test condition: see item 1.20.2.1

1.2 * threshold

Test values: Time dial: 0.05 £ T £ 15.00

Permissive tolerance/Limiting values: ±(5 % of reference value + 2 % of current tolerance) or 30 ms

1.20.2.6.1 IEC normal inverse (type A)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.2 IEC very inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.3 IEC extremely inverse (type C)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.4 IEC long-time inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.5 ANSI long-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.6 ANSI short-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.7 ANSI extremely inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.8 ANSI very inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.9 ANSI normal inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.20.2.6.10 ANSI moderately inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.6.11 ANSI definite inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7 Dropout characteristics

Test condition: see item 1.20.2.1

Disk emulation: 0.8 * threshold

Test values: Time dial: 0.05 £ T £ 15.00

Permissive tolerance/Limiting values: ±(5 % of reference value + 2 % of current tolerance) or 30 ms

1.20.2.7.1 IEC normal inverse (type A)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.2 IEC very inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.3 IEC extremely inverse (type C)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.4 IEC long-time inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.5 ANSI long-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.6 ANSI short-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.7 ANSI extremely inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.8 ANSI very inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.9 ANSI normal inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.10 ANSI moderately inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.2.7.11 ANSI definite inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.3 Voltage-dependent stage

1.20.3.1 Pickup values I_p

Test condition: 0.030 I_{rated} £ threshold value £ 35.000 I_{rated}

Test values: f_{rated} = 50 Hz, 60 Hz
0.030 I_{rated} £ threshold value £ 35.000 I_{rated}

Summary

Method of measurement = fundamental components of phases

Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or $0.005 I_{rated}$

Test results/Remarks: $\pm 1\%$ of setting value or $\pm 0.005 I_{rated}$

Method of measurement = RMS value of phases

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1\%$ of setting value or $0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\pm 3\%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\pm 4\%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\pm 1\%$ of setting value or $\pm 0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50\text{ Hz}$: $\pm 3\%$ of setting value or $\pm 0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60\text{ Hz}$: $\pm 4\%$ of setting value or $\pm 0.02 I_{rated}$

1.20.3.2 Dropout ratio

Test condition: see item 1.20.3.1

Instantaneous:

Test values: $1.05 \times$ threshold value
 $0.95 \times$ pickup value

Disk emulation:

Test values: $0.90 \times$ threshold value

Permissive tolerance/Limiting values: $\pm 1\%$ of dropout value

Test results/Remarks: $\pm 1\%$ of dropout value

1.20.3.3 Pickup time

Test condition: see item 1.20.3.1

Test values: $1.2 \times$ threshold
 $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$

Permissive tolerance/Limiting values: $\pm 25\text{ ms} + \text{OOT}$ at 50 Hz
 $\pm 22\text{ ms} + \text{OOT}$ at 60 Hz

Test results/Remarks: $\pm 25\text{ ms} + \text{OOT}$ at 50 Hz
 $\pm 22\text{ ms} + \text{OOT}$ at 60 Hz

1.20.3.4 Dropout times

Test condition: see item 1.20.3.1

Permissive tolerance/Limiting values: $\pm 20\text{ ms} + \text{OOT}$

Test results/Remarks: $\pm 20\text{ ms} + \text{OOT}$

1.20.3.5 Tripping time characteristics

Test condition: see item 1.20.3.1
 $1.2 \times$ threshold

Summary

Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of reference value + 2 % of current tolerance) or 30 ms
1.20.3.5.1 IEC normal inverse (type A)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.2 IEC very inverse (type B)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.3 IEC extremely inverse (type C)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.4 IEC long-time inverse (type B)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.5 ANSI long-time inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.6 ANSI short-time inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.7 ANSI extremely inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.8 ANSI very inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.9 ANSI normal inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.10 ANSI moderately inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.5.11 ANSI definite inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.6 Dropout characteristics	
Test condition:	see item 1.20.3.1
Disk emulation:	0.8 * threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of reference value + 2 % of current tolerance) or 30 ms
1.20.3.6.1 IEC normal inverse (type A)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.6.2 IEC very inverse (type B)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.20.3.6.3 IEC extremely inverse (type C)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.20.3.6.4 IEC long-time inverse (type B)
Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.3.6.5 ANSI long-time inverse
Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.3.6.6 ANSI short-time inverse
Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.3.6.7 ANSI extremely inverse
Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.3.6.8 ANSI very inverse
Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.3.6.9 ANSI normal inverse
Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.3.6.10 ANSI moderately inverse
Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.3.6.11 ANSI definite inverse
Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.20.4 Undervoltage seal-in stage

1.20.4.1 Pickup values I>

Test condition: 0.030 I_{rated} £ threshold value £ 35.000 I_{rated}

Test values: f_{rated} = 50 Hz, 60 Hz
0.030 I_{rated} £ threshold value £ 35.000 I_{rated}

Method of measurement = fundamental components of phases

Permissive tolerance/Limiting values: ±1 % of setting value or 0.005 I_{rated}

Test results/Remarks: £ 1 % of setting value or £ 0.005 I_{rated}

Method of measurement = RMS value of phases

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.02 I_{rated}

1.20.4.2 Dropout ratio

Test condition: see item 1.20.4.1

Test values: 0.90 £ r £ 0.99

Permissive tolerance/Limiting values: ±1 % of dropout value

Test results/Remarks: £ 1 % of dropout value

Summary

1.20.4.3 Pickup values V-seal-in

Test condition:	0.300 V £ threshold value £ 175.000V
Test values:	0.300 V £ threshold value £ 175.000V
Permissive tolerance/Limiting values:	±0.5 % of setting value or 0.05 V
Test results/remarks:	£ 0.5 % of setting value or £ 0.05 V

1.20.4.4 Dropout ratio of V-seal-in

Test condition:	0.300 V £ threshold value £ 175.000V
Test values:	1.01 £ r £ 1.20
Permissive tolerance/Limiting values:	±1 % of dropout value
Test results/Remarks:	£ 1 % of dropout value

1.20.4.5 Pickup times

Test condition:	see item 1.20.4.1
Test values:	1.2 * threshold $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Permissive tolerance/Limiting values:	£ 30 ms + OOT at 50 Hz £ 25 ms + OOT at 60 Hz
Test results/Remarks:	£ 30 ms + OOT at 50 Hz £ 25 ms + OOT at 60 Hz

1.20.4.6 Dropout times

Test condition:	see item 1.20.4.1
Permissive tolerance/Limiting values:	£ 20 ms + OOT
Test results/Remarks:	£ 20 ms + OOT

1.20.4.7 Operate delays

Test condition:	I_{rated} value
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.20.4.8 Duration of V-seal-in time

Test condition:	I_{rated} value
Test values:	0.10 s £ T £ 60.00 s

Summary

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: ± 1 % of setting value or ± 10 ms

1.20.5 Undervoltage Seal-in and voltage released stage

1.20.5.1 Pickup values I>

Test condition: 0.030 I_{rated} \pm threshold value ± 35.000 I_{rated}

Test values: f_{rated} = 50 Hz, 60 Hz
0.030 I_{rated} \pm threshold value ± 35.000 I_{rated}

Method of measurement = fundamental components of phases

Permissive tolerance/Limiting values: ± 1 % of setting value or 0.005 I_{rated}

Test results/Remarks: ± 1 % of setting value or ± 0.005 I_{rated}

Method of measurement = RMS value of phases

Permissive tolerance/Limiting values: up to 30th harmonic: ± 1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ± 3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ± 4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: ± 1 % of setting value or ± 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ± 3 % of setting value or ± 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ± 4 % of setting value or ± 0.02 I_{rated}

1.20.5.2 Pickup values V2

Test condition: 0.300 V \pm threshold value ± 200.000 V

Test values: 0.300 V \pm threshold value ± 200.000 V

Permissive tolerance/Limiting values: ± 0.5 % of setting value or 0.05 V

Test results/remarks: ± 0.5 % of setting value or ± 0.05 V

1.20.5.3 Dropout ratio of I>, V2

Test condition: 0.030 I_{rated} \pm threshold value ± 35.000 I_{rated}
0.300 V \pm threshold value ± 200.000 V

Test values: 0.90 \pm r ± 0.99

Permissive tolerance/Limiting values: ± 1 % of dropout value

Test results/Remarks: ± 1 % of dropout value

1.20.5.4 Pickup values of Vph-ph<, V-seal-in

Test condition: 0.300 V \pm threshold value ± 175.000 V

Test values: 0.300 V \pm threshold value ± 175.000 V

Permissive tolerance/Limiting values: ± 0.5 % of setting value or 0.05 V

Test results/remarks: ± 0.5 % of setting value or ± 0.05 V

Summary

1.20.5.5 Dropout ratio of V-seal-in

Test condition: 0.300 V £ threshold value £ 175.000V

Test values: 1.01 £ r £ 1.20

Permissive tolerance/Limiting values: ±1 % of dropout value

Test results/Remarks: £ 1 % of dropout value

1.20.5.6 Pickup time

Test condition: see item 1.20.5.1

Test values: 1.2 * threshold
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: £ 30 ms + OOT at 50 Hz
£ 25 ms + OOT at 60 Hz

Test results/Remarks: £ 30 ms + OOT at 50 Hz
£ 25 ms + OOT at 60 Hz

1.20.5.7 Dropout times

Test condition: see item 1.20.5.1

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

1.20.5.8 Operate delays

Test condition: I_{rated} value

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.20.5.9 Duration of V-seal-in time

Test condition: I_{rated} value

Test values: 0.10 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

Summary

1.21 67 Directional Overcurrent Protection, Phases

1.21.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.21.2 Directional overcurrent protection, phases with definite time overcurrent stages (definite time)

1.21.2.1 Pickup values

Test condition: $0.030 I_{rated}$ £ threshold value £ $35.000 I_{rated}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or $0.005 I_{rated}$

Test results/Remarks: £ 1% of setting value or £ $0.005 I_{rated}$

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1 \%$ of setting value or $0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\pm 3 \%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\pm 4 \%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: £ 1% of setting value or £ $0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: £ 3% of setting value or £ $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: £ 4% of setting value or £ $0.02 I_{rated}$

1.21.2.2 Dropout ratio

Test condition: see item 1.21.2.1

Test values: $0.90 I_{rated}$ £ r £ $0.99 I_{rated}$

Permissive tolerance/Limiting values: $\pm 1 \%$ of dropout value

Test results/Remarks: £ 1% of dropout value

1.21.2.3 Pickup times

Test condition: $I/I_{rated} = 2$

Test values: $1.2 \times \text{threshold}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: £ $25 \text{ ms} + \text{OOT}$ at 50 Hz
£ $22 \text{ ms} + \text{OOT}$ at 60 Hz

Test results/Remarks: £ $25 \text{ ms} + \text{OOT}$ at 50 Hz
£ $22 \text{ ms} + \text{OOT}$ at 60 Hz

1.21.2.4 Dropout times

Test condition: see item 1.21.2.1

Permissive tolerance/Limiting values: £ $20 \text{ ms} + \text{OOT}$

Test results/Remarks: £ $20 \text{ ms} + \text{OOT}$

Summary

1.21.2.5 Time delay

Test condition: see item 1.21.2.1
1.2 * threshold

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.21.3 Directional overcurrent protection, phases with inverse time overcurrent stage (inverse time)

1.21.3.1 Pickup values

Test condition: 0.030 I_{rated} £ threshold value £ 35.000 I_{rated}
f_{rated} = 50 Hz, 60 Hz

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: ±1 % of setting value or 0.005 I_{rated}

Test results/Remarks: £ 1 % of setting value or £ 0.005 I_{rated}

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}
up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.02 I_{rated}
up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.02 I_{rated}

1.21.3.2 Dropout ratio

Test condition: see item 1.21.3.1

Instantaneous

Test values: 1.05 * threshold value
0.95 * pickup value

Disk emulation

Test values: 0.90 * threshold value

Permissive tolerance/Limiting values: ±1 % of dropout value

Test results/Remarks: £ 1 % of dropout value

1.21.3.3 Pickup times

Test condition: see item 1.21.3.1

Test values: 1.2 * threshold
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

Summary

Test results/Remarks: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

1.21.3.4 Dropout times

Test condition: see item 1.21.3.1

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

1.21.3.5 Tripping time characteristics

Test condition: see item 1.21.3.1
1.2 * threshold

Test values: Time dial: 0.05 £ T £ 15.00

Permissive tolerance/Limiting values: ±(5 % of reference value + 2 % of current tolerance) or 30 ms

1.21.3.5.1 IEC normal inverse (type A)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.2 IEC very inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.3 IEC extremely inverse (type C)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.4 IEC long-time inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.5 ANSI long-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.6 ANSI short-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.7 ANSI extremely inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.8 ANSI very inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.9 ANSI normal inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.10 ANSI moderately inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.5.11 ANSI definite inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.21.3.6 Dropout characteristics

Test condition: see item 1.21.3.1

Summary

Disk emulation:	0.8 * threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of reference value + 2 % of current tolerance) or 30 ms
1.21.3.6.1 IEC normal inverse (type A) Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.2 IEC very inverse (type B) Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.3 IEC extremely inverse (type C) Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.4 IEC long-time inverse (type B) Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.5 ANSI long-time inverse Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.6 ANSI short-time inverse Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.7 ANSI extremely inverse Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.8 ANSI very inverse Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.9 ANSI normal inverse Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.10 ANSI moderately inverse Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.21.3.6.11 ANSI definite inverse Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.21.4 Overcurrent protection, phases with user-defined characteristic

1.21.4.1 Pickup

Test condition: 0.030 I_{rated} £ threshold value £ 35.000 I_{rated}
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or $0.005 I_{rated}$

Test results/Remarks: £ 1 % of setting value or £ 0.005 I_{rated}

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1 \%$ of setting value or $0.005 I_{rated}$
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: $\pm 3 \%$ of setting value or $0.02 I_{rated}$
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: $\pm 4 \%$ of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}
up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: £ 3 % of setting value or £ 0.02 I_{rated}
up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: £ 4 % of setting value or £ 0.02 I_{rated}

1.21.4.2 Dropout ratio

Test condition: see item 1.21.4.1

Instantaneous

Test values: 1.05 * threshold value
0.95 * pickup value

Disk emulation

Test values: 0.90 * threshold value

Permissive tolerance/Limiting values: $\pm 1 \%$ of dropout value

Test results/Remarks: £ 1% of dropout value

1.21.4.3 Pickup times

Test condition: see item 1.21.4.1

Test values: 1.2*threshold
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

Test results/Remarks: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

1.21.4.4 Dropout times

Test condition: see item 1.21.4.1

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 25 ms + OOT

Summary**1.21.4.5 Tripping time characteristics**

Test condition:	see item 1.21.4.1 1.2 * threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of reference value + 2 % of current tolerance) or 10 ms
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 10 ms

1.21.4.6 Dropout characteristics

Test condition:	see item 1.21.4.1
Disk emulation:	0.8 * threshold
Test values:	Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±(5 % of reference value + 2 % of current tolerance) or 10 ms
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 10 ms

1.21.5 Directional determination

Test condition:	$0.030 I_{rated}$ £ threshold value £ $35.000 I_{rated}$ $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Test values:	-180° £ φ £ 180°
Permissive tolerance/Limiting values:	±1°
Test results/Remarks:	£ 1°

Summary

1.22 67 Directional Overcurrent Protection, Ground

1.22.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.22.2 Overcurrent Protection, 3I0 with definite time overcurrent stages (definite time)

1.22.2.1 Pickup values

Test condition: 0.030 I_{rated} £ 3I0 > £ 35.000 I_{rated}

Test values: f_{rated} = 50 Hz, 60 Hz
0.030 I_{rated} £ 3I0 > £ 20.000 I_{rated}

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: ±1 % of setting value or 0.005 I_{rated}

Test results/Remarks: £ 1 % of setting value or £ 0.005 I_{rated}

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}

up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.02 I_{rated}

up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}

up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.02 I_{rated}

up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.02 I_{rated}

1.22.2.2 Dropout ratio

Test condition: see item 1.22.2.1

Test values: 0.90 £ r £ 0.99

Permissive tolerance/Limiting values: ±1 % of dropout value

Test results/Remarks: £ 1 % of dropout value

1.22.2.3 Pickup times

Test condition: see item 1.22.2.1

Test values: I/I_{rated} = 2
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: £ 30 ms + OOT at 50 Hz
£ 25 ms + OOT at 60 Hz

Test results/Remarks: £ 30 ms + OOT at 50 Hz
£ 25 ms + OOT at 60 Hz

Summary

1.22.2.4 Dropout times

Test condition: see item 1.22.2.1
 Permissive tolerance/Limiting values: £ 20 ms + OOT
 Test results/Remarks: £ 20 ms + OOT

1.22.2.5 Time delays

Test condition: added to the inherent operating times
 Test values: 0.00 s £ T £ 60.00 s
 Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms
 Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.22.3 Overcurrent Protection, 3I0 with inverse time overcurrent stage (inverse time)

1.22.3.1 Pickup values

Test condition: $0.030 I_{rated} \leq 3I0 < 35.000 I_{rated}$
 Test values: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $0.030 I_{rated} \leq 3I0 < 20.000 I_{rated}$

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: ±1 % of setting value or $0.005 I_{rated}$
 Test results/Remarks: £ 1 % of setting value or £ $0.005 I_{rated}$

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or $0.005 I_{rated}$
 up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: ±3 % of setting value or $0.02 I_{rated}$
 up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: ±4 % of setting value or $0.02 I_{rated}$
 Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ $0.005 I_{rated}$
 up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: £ 3 % of setting value or £ $0.02 I_{rated}$
 up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: £ 4 % of setting value or £ $0.02 I_{rated}$

1.22.3.2 Dropout ratio

Test condition: see item 1.22.3.1
 Instantaneous
 Test values: $1.05 \cdot \text{threshold value}$
 $0.95 \cdot \text{pickup value}$
 Disk emulation

Summary

Test values: 0.90 * threshold value
 Permissive tolerance/Limiting values: ±1 % of dropout value
 Test results/Remarks: ≤ 1% of dropout value

1.22.3.3 Pickup times

Test condition: $I/I_{rated} = 2$
 Test values: pickup time for $2 \leq 3I/I$ -threshold value ≤ 20
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 Permissive tolerance/Limiting values: ±(5 % of reference value + 2 % of current tolerance) or 30 ms
 Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.22.3.4 Dropout times

Test condition: see item 1.22.3.1
Instantaneous
 Permissive tolerance/Limiting values: £ 20 ms + OOT
 Test results/Remarks: £ 20 ms + OOT
Disk emulation
 Permissive tolerance/Limiting values: ±(5 % of reference value + 2 % of current tolerance) or 30 ms
 Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.22.3.5 Tripping time characteristics

Test condition: see item 1.22.3.1
 1.2 * threshold
 Test values: Time dial: 0.05 £ T £ 15.00
 Permissive tolerance/Limiting values: ±(5 % of reference value + 2 % of current tolerance) or 30 ms

1.22.3.5.1 IEC normal inverse (type A)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.22.3.5.2 IEC very inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.22.3.5.3 IEC extremely inverse (type C)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.22.3.5.4 IEC long-time inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.22.3.5.5 ANSI long-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.22.3.5.6 ANSI short-time inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.5.7 ANSI extremely inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.5.8 ANSI very inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.5.9 ANSI normal inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.5.10 ANSI moderately inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.5.11 ANSI definite inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6 Dropout characteristics	
Test condition:	see item 1.22.3.1
Test values:	dropout times
Permissive tolerance/Limiting values:	±(5 % of reference value + 2 % of current tolerance) or 30 ms
1.22.3.6.1 IEC normal inverse (type A)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.2 IEC very inverse (type B)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.3 IEC extremely inverse (type C)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.4 IEC long-time inverse (type B)	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.5 ANSI long-time inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.6 ANSI short-time inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.7 ANSI extremely inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.8 ANSI very inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.9 ANSI normal inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms
1.22.3.6.10 ANSI moderately inverse	
Test results/Remarks:	£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.22.3.6.11 ANSI definite inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.22.4 Overcurrent Protection, 3I0 with user-defined characteristic

1.22.4.1 Pickup

Test condition: 0.030 I_{rated} £ 3I0 > £ 35.000 I_{rated}

Test values: f_{rated} = 50 Hz, 60 Hz
0.030 I_{rated} £ 3I0 > £ 18.000 I_{rated}

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: ±1 % of setting value or 0.005 I_{rated}

Test results/Remarks: £ 1 % of setting value or £ 0.005 I_{rated}

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or 0.005 I_{rated}

up to 50th harmonic, f_{rated} = 50 Hz: ±3 % of setting value or 0.02 I_{rated}

up to 50th harmonic, f_{rated} = 60 Hz: ±4 % of setting value or 0.02 I_{rated}

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ 0.005 I_{rated}

up to 50th harmonic, f_{rated} = 50 Hz: £ 3 % of setting value or £ 0.02 I_{rated}

up to 50th harmonic, f_{rated} = 60 Hz: £ 4 % of setting value or £ 0.02 I_{rated}

1.22.4.2 Dropout ratio

Test condition: see item 1.22.4.1

Instantaneous

Test values: 1.05 * threshold value
0.95 * pickup value

Disk emulation

Test values: 0.90 * threshold value

Permissive tolerance/Limiting values: ±1 % of dropout value

Test results/Remarks: ≤ 1 % of dropout value

1.22.4.3 Pickup times

Test condition: see item 1.22.4.1

Test values: pickup time for 2 ≤ I_p/I-threshold value ≤ 20
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: ±(5 % of reference value + 2 % of current tolerance) or 30 ms

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.22.4.4 Dropout times

Test condition: see item 1.22.4.1

Instantaneous:

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

Disk emulation

Permissive tolerance/Limiting values: ±(5 % of reference value + 2 % of current tolerance) or 30 ms

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.22.5 Overcurrent Protection, Logarithmic inverse curve stage (inverse time)

1.22.5.1 Pickup values

Test condition: $0.030 I_{rated} \leq I < 310 > \leq 35.000 I_{rated}$

Test values: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $0.030 I_{rated} \leq I < 310 > \leq 20.000 I_{rated}$

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: ±1 % of setting value or $0.005 I_{rated}$

Test results/Remarks: £ 1 % of setting value or £ $0.005 I_{rated}$

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or $0.005 I_{rated}$

up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: ±3 % of setting value or $0.02 I_{rated}$

up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: ±4 % of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ $0.005 I_{rated}$

up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: £ 3 % of setting value or £ $0.02 I_{rated}$

up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: £ 4 % of setting value or £ $0.02 I_{rated}$

1.22.5.2 Dropout ratio

Test condition: see item 1.22.5.1

Test values: $1.05 \cdot \text{threshold value}$
 $0.95 \cdot \text{pickup value}$

Permissive tolerance/Limiting values: ±1 % of dropout value

Test results/Remarks: ≤ 1 % of dropout value

Summary

1.22.5.3 Pickup times

Test condition: see item 1.22.5.1

Test values: $3I_0/I_{rated} = 2$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: £ 35 ms + OOT at 50 Hz
£ 32 ms + OOT at 60 Hz

Test results/Remarks: £ 30 ms + OOT at 50 Hz
£ 25 ms + OOT at 60 Hz

1.22.5.4 Dropout times

Test condition: see item 1.22.5.1

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

1.22.5.5 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±5 % of setting value or 15 ms

Test results/Remarks: £ 5 % of setting value or £ 15 ms

1.22.6 Overcurrent Protection, The logarithmic inverse time characteristic with knee point

1.22.6.1 Pickup values

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $0.030 I_{rated} \leq 3I_0 < 35.000 I_{rated}$

Test values: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $0.030 I_{rated} \leq 3I_0 < 20.000 I_{rated}$

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: ±1 % of setting value or $0.005 I_{rated}$

Test results/Remarks: £ 1 % of setting value or £ $0.005 I_{rated}$

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: ±1 % of setting value or $0.005 I_{rated}$

up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: ±3 % of setting value or $0.02 I_{rated}$

up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$: ±4 % of setting value or $0.02 I_{rated}$

Test results/Remarks: up to 30th harmonic: £ 1 % of setting value or £ $0.005 I_{rated}$

up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$: £ 3 % of setting value or £ $0.02 I_{rated}$

Summary

up to 50th harmonic, $f_{rated} = 60$ Hz: £ 4 % of setting value or £ 0.02 I_{rated}

1.22.6.2 Dropout ratio

Test condition: see item 1.22.6.1
 Test values: 0.95 * threshold value
 Permissive tolerance/Limiting values: ±1 % of dropout value
 Test results/Remarks: ≤ 1 % of dropout value

1.22.6.3 Pickup times

Test condition: see item 1.22.6.1
 Test values: $3I_0/I_{rated} = 2$
 $f_{rated} = 50$ Hz, 60 Hz
 Permissive tolerance/Limiting values: £ 35 ms + OOT at 50 Hz
 £ 32 ms + OOT at 60 Hz
 Test results/Remarks: £ 30 ms + OOT at 50 Hz
 £ 25 ms + OOT at 60 Hz

1.22.6.4 Dropout times

Test condition: see item 1.22.6.1
 Permissive tolerance/Limiting values: £ 20 ms + OOT
 Test results/Remarks: £ 20 ms + OOT

1.22.6.5 Time delays

Test condition: added to the inherent operating times
 Test values: 0.00 s £ T £ 100.00 s
 Permissive tolerance/Limiting values: ±5 % of setting value or 15 ms
 Test results/Remarks: £ 5 % of setting value or £ 15 ms

1.22.7 Directional determination

1.22.7.1 Rotation angle of reference voltage

Test condition: -180° £ Phi £ 180°
 Test values: -180° £ Phi £ 180°
 Permissive tolerance/Limiting values: ±1°
 Test results/Remarks: £ 1°

1.22.7.2 Min. voltage V0 or V2

Test condition: 0.15 V £ V0/V2 £ 20.00 V

Summary

Test values: 0.15 V £ V0/V2 £ 20.00 V

Permissive tolerance/Limiting values: $\pm 1\%$

Test results/Remarks: £ 1 %

1.22.7.3 Forward section +/-

Test condition: 0° £ Phi £ 90°

Test values: 0° £ Phi £ 90°

Permissive tolerance/Limiting values: $\pm 1^\circ$

Test results/Remarks: £ 1°

Summary

1.23 46 Negative-Sequence Protection

1.23.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.23.2 46 Negative-Sequence protection with definite time overcurrent stage

1.23.2.1 Pickup values

1.23.2.1.1 Reference value: rated current

Test condition:	5.0 % $\leq I_2/I_{ref}$ ≤ 999.9 %
Test values:	5.0 % $\leq I_2/I_{ref}$ ≤ 999.9 %
Permissive tolerance/Limiting values:	± 2 % of setting value or 0.8 % absolute
Test results/Remarks:	≤ 2 % of setting value or ≤ 0.8 % absolute

1.23.2.1.2 Reference value: pos. seq. current

Test condition:	5.0 % $\leq I_2/I_{ref}$ ≤ 999.9 %
Test values:	5.0 % $\leq I_2/I_{ref}$ ≤ 999.9 %
Permissive tolerance/Limiting values:	± 2 % of setting value or 4 % absolute
Test results/Remarks:	≤ 2 % of setting value or ≤ 4 % absolute

1.23.2.2 Dropout ratio

Test condition:	see item 1.23.2.1
Test values:	0.90 $\leq r$ ≤ 0.99
Permissive tolerance/Limiting values:	± 1 % of dropout value
Test results/Remarks:	≤ 1 % of dropout value

1.23.2.3 Pickup times

Test condition:	see item 1.23.2.1
Test values:	1.2 * threshold value $f_{rated} = 50$ Hz, 60 Hz
Permissive tolerance/Limiting values:	≤ 40 ms + OOT at 50 Hz ≤ 35 ms + OOT at 60 Hz
Test results/Remarks:	≤ 40 ms + OOT at 50 Hz ≤ 35 ms + OOT at 60 Hz

1.23.2.4 Dropout times

Test condition:	see item 1.23.2.1
Permissive tolerance/Limiting values:	≤ 35 ms + OOT

Summary

Test results/Remarks: £ 35 ms + OOT

1.23.2.5 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s £ T> £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.23.3 46 Negative-Sequence protection with inverse time overcurrent stage

1.23.3.1 Pickup values

1.23.3.1.1 Reference value: rated current

Test condition: 5.0 % £ I₂/I_{ref} £ 999.9 %

Test values: 5.0 % £ I₂/I_{ref} £ 999.9 %

Permissive tolerance/Limiting values: ±2 % of setting value or 0.8 % absolute

Test results/Remarks: £ 2 % of setting value or £ 0.8 % absolute

1.23.3.1.2 Reference value: pos. seq. current

Test condition: 5.0 % £ I₂/I_{ref} £ 999.9 %

Test values: 5.0 % £ I₂/I_{ref} £ 999.9 %

Permissive tolerance/Limiting values: ±2 % of setting value or 4 % absolute

Test results/Remarks: £ 2 % of setting value or £ 4 % absolute

1.23.3.2 Pickup times

Test condition: see item 1.23.3.1

Test values: 1.2 * threshold value
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: £ 40 ms + OOT at 50 Hz

£ 35 ms + OOT at 60 Hz

Test results/Remarks: £ 40 ms + OOT at 50 Hz

£ 35 ms + OOT at 60 Hz

1.23.3.3 Dropout times

Test condition: see item 1.23.3.1

Permissive tolerance/Limiting values: £ 35 ms + OOT

Test results/Remarks: £ 35 ms + OOT

Summary

1.23.3.4 Tripping time characteristics

Test condition: see item 1.23.3.1

Test values: Time dial: 0.05 £ T £ 15.00

Permissive tolerance/Limiting values: $\pm(5\% \text{ of reference value} + 2\% \text{ of current tolerance})$ or 30 ms

1.23.3.4.1 IEC normal inverse (type A)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.2 IEC very inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.3 IEC extremely inverse (type C)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.4 IEC long-time inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.5 ANSI long-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.6 ANSI short-time inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.7 ANSI extremely inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.8 ANSI very inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.9 ANSI normal inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.10 ANSI moderately inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.4.11 ANSI definite inverse

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5 Dropout characteristics

Test condition: see item 1.23.3.1

Disk emulation: 0.8*threshold

Test values: Time dial: 0.05 £ T £ 15.00

Permissive tolerance/Limiting values: $\pm(5\% \text{ of reference value or } + 2\% \text{ of current tolerance})$ or 30 ms

1.23.3.5.1 IEC normal inverse (type A)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.2 IEC very inverse (type B)

Test results/Remarks: £ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

Summary**1.23.3.5.3 IEC extremely inverse (type C)**

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.4 IEC long-time inverse (type B)

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.5 ANSI long-time inverse

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.6 ANSI short-time inverse

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.7 ANSI extremely inverse

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.8 ANSI very inverse

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.9 ANSI normal inverse

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.10 ANSI moderately inverse

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

1.23.3.5.11 ANSI definite inverse

Test results/Remarks:

£ (5 % of reference value + 2 % of current tolerance) or £ 30 ms

Summary

1.24 37 Undercurrent Protection with 3-phase

1.24.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.24.2 Pickup values

Test condition: $0.030 I_{rated} \leq I < 35.000 I_{rated}$

Test values: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $0.030 I_{rated} \leq I < 20.000 I_{rated}$

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: $\pm 1 \% \text{ of setting value or } 0.005 I_{rated}$

Test results/Remarks: $\leq 1 \% \text{ of setting value or } \leq 0.005 I_{rated}$

Method of measurement = RMS value:

Permissive tolerance/Limiting values: up to 30th harmonic: $\pm 1 \% \text{ of setting value or } 0.005 I_{rated}$

Test results/Remarks: up to 30th harmonic: $\leq 1 \% \text{ of setting value or } \leq 0.005 I_{rated}$

1.24.3 Dropout ratio

Test condition: see item 1.24.2

Test values: 1.05

Permissive tolerance/Limiting values: $\pm 1 \% \text{ of dropout value}$

Test results/Remarks: $\leq 1 \% \text{ of dropout value}$

1.24.4 Pickup times

Test condition: see item 1.24.2

Test values: $I / I_{rated} = 2$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: $\leq 25 \text{ ms} + \text{OOT at } 50 \text{ Hz}$
 $\leq 22 \text{ ms} + \text{OOT at } 60 \text{ Hz}$

Test results/Remarks: $\leq 25 \text{ ms} + \text{OOT at } 50 \text{ Hz}$
 $\leq 22 \text{ ms} + \text{OOT at } 60 \text{ Hz}$

1.24.5 Dropout times

Test condition: see item 1.24.2

Permissive tolerance/Limiting values: $\leq 25 \text{ ms} + \text{OOT at } 50 \text{ Hz}$
 $\leq 22 \text{ ms} + \text{OOT at } 60 \text{ Hz}$

Test results/Remarks: $\leq 25 \text{ ms} + \text{OOT at } 50 \text{ Hz}$
 $\leq 22 \text{ ms} + \text{OOT at } 60 \text{ Hz}$

Summary**1.24.6 Time delays**

Test condition:	added to the inherent operating times
Test values:	0.000 s £ T £ 60.000 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

Summary**1.25 24 Overexcitation Protection****1.25.1 Specifications**

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.25.2 General Test conditions

f_{rated} : 50 Hz, 60 Hz

V_{rated} : 100 V

1.25.3 Definite Time**1.25.3.1 V/f Threshold**

Test condition: 1.00 \leq V/f \leq 1.40

Permissive tolerance/Limiting values: $|d| \leq 2\%$ of setting value

Test results/Remarks: $|d| < 2\%$

1.25.3.2 Dropout ratio

Test condition: see item 1.25.3.1

Test values: see item 1.25.3.1

Permissive tolerance/Limiting values: 0.98

Test results/Remarks: 0.96 $\leq r \leq$ 0.99

1.25.3.3 Pickup Times

Test condition: see item 1.25.3.1

Test values: 1.00 \leq V/f \leq 1.40

Permissive tolerance/Limiting values: ≤ 33 ms + OOT at 50 Hz
 ≤ 30 ms + OOT at 60 Hz

Test results/Remarks: ≤ 33 ms + OOT at 50 Hz
 ≤ 30 ms + OOT at 60 Hz

1.25.3.4 Dropout times

Test condition: see item 1.25.3.1

Test values: 1.00 \leq V/f \leq 1.40

Permissive tolerance/Limiting values: ≤ 10 ms + OOT at 50 Hz
 ≤ 10 ms + OOT at 60 Hz

Test results/Remarks: ≤ 10 ms + OOT at 50 Hz
 ≤ 10 ms + OOT at 60 Hz

Summary

1.25.3.5 Time delays

Test condition: added to the inherent operating times

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % of setting value or 10 ms

1.25.4 Thermal Characteristic

1.25.4.1 V/f Threshold

Test condition: 1.00 £ V/f £ 1.20

Permissive tolerance/Limiting values: |d| £ 2 % of setting value

Test results/Remarks: |d| < 2 %

1.25.4.2 Dropout ratio

Test condition: see item 1.25.4.1

Test values: see item 1.25.4.1

Permissive tolerance/Limiting values: 0.98

Test results/Remarks: 0.96 £ r £ 0.99

1.25.4.3 Pickup Times

Test condition: see item 1.25.4.1

Test values: 1.00 £ V/f £ 1.20

Permissive tolerance/Limiting values: ≤ 33 ms + OOT at 50 Hz
≤ 30 ms + OOT at 60 Hz

Test results/Remarks: ≤ 33 ms + OOT at 50 Hz
≤ 30 ms + OOT at 60 Hz

1.25.4.4 Dropout times

Test condition: see item 1.25.4.1

Test values: 1.00 £ V/f £ 1.20

Permissive tolerance/Limiting values: ≤ 10 ms + OOT at 50 Hz
≤ 10 ms + OOT at 60 Hz

Test results/Remarks: ≤ 10 ms + OOT at 50 Hz
≤ 10 ms + OOT at 60 Hz

1.25.4.5 Cooling time therm. replica

Test condition: added to the inherent operating times

Summary

Test values:	0 s £ T £ 100000 s
Permissive tolerance/Limiting values:	d £ 1 % of setting value or 10 ms
Test results/Remarks:	d < 1 % of setting value or 10 ms

1.25.4.6 Operate curve

Test condition:	1.00 p.u. £ V/f £ 10.00 p.u. 0 s £ t £ 100000 s
Test values:	1.00 p.u. £ V/f] £ 10.00 p.u. 0 s £ t £ 100000 s
Permissive tolerance/Limiting values:	d £ 5 % in relation to V/f, ± 600ms
Test results/Remarks:	d < 5 % in relation to V/f, ± 600ms

1.25.5 Frequency Operating Range

Frequency manual update:	10 Hz to 80 Hz
Test results/Remarks:	confirmed

Summary

1.26 46 Unbalanced-Load Protection

1.26.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.26.2 Thermal characteristics

1.26.3 Max. continuously perm. I2

Test condition:	3 % £ I2 £ 30 %
Test values:	3 % £ I2 £ 30 %
Permissive tolerance/Limiting values:	d £ 3 % of setting value or 3 mA at I _{rated} = 1 A or 15 mA at I _{rated} = 5 A
Test results/Remarks:	d £ 3 % of setting value or 3 mA at I _{rated} = 1 A or 15 mA at I _{rated} = 5 A

1.26.4 Unbalanced load factor K

Test condition:	1.0 s £ K £ 100.0 s
Test values:	various settings
Test results/Remarks:	function correct

1.26.5 Cooling time thermal replica T_{Cool down}

Test condition:	0 s £ T _{Cool down} £ 50000 s
Test values:	various settings
Test results/Remarks:	function correct

1.26.6 Time delays

Test condition:	added to the inherent operating times
Test values:	0.00 s £ T > £ 60.00 s or ∞
Permissive tolerance/Limiting values:	d £ 1 % of setting value or 10 ms
Test results/Remarks:	d < 1 % or 10 ms

Summary

1.27 50 High-Speed Instantaneous Overcurrent Protection

1.27.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-151

1.27.2 General test conditions

f_{rated} 50 Hz, 60 Hz

1.27.3 Pickup values

Test condition: $0.030 I_{rated} \leq I < 35.000 I_{rated}$

Test values: $0.100 I_{rated} \leq I < 5.000 I_{rated}$

Permissive tolerance/Limiting values: $|d| \leq 5\%$ of setting value or $0.010 I_{rated}$

Test results/Remarks: $|d| < 5\%$ of setting value or $0.010 I_{rated}$

1.27.4 Dropout ratio

Test condition: see item 1.27.2

Test values: $r =$ settable dropout ratio
 $0.50 \leq r \leq 0.90$

Permissive tolerance/Limiting values: $|d| \leq 5\%$ of setting value

Test results/Remarks: $|d| < 5\%$ of setting value

1.27.5 Pickup times

Test condition: current $> 2\sqrt{2}$ of threshold value

Test values: t in ms

Permissive tolerance/Limiting values: t ≤ 8 ms + OOT

Test results/Remarks: t < 8 ms + OOT

1.27.6 Dropout times

Test condition: current change from $> 2\sqrt{2}$ to 0 of threshold value

Test values: t in ms

Test results/Remarks: t approx. 30 ms + OOT

Summary

1.28 47/59 Overvoltage Protection

1.28.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-127

1.28.2 3ph Voltage ph-to-gnd, ph-to-ph V with definite time overvoltage stage

1.28.2.1 Pickup values

Test condition:	Fundamental components, RMS values $f_{rated} = 50 \text{ Hz}, 60\text{Hz}$
Test values:	0.300 V £ threshold value £ 340.000 V
Permissive tolerance/Limiting values:	in the range $f_{rated} \pm 10 \%$ $\pm 0.5 \%$ of setting value or 0.05 V
Test results/Remarks:	in the range $f_{rated} \pm 10 \%$ £ 0.5 % of setting value or £ 0.05 V

1.28.2.2 Dropout ratio

Test condition:	See item 1.28.2.1
Test values:	0.90 £ r £ 0.99
Permissive tolerance/Limiting values:	$\pm 0.5 \%$ of dropout value or 0.05 V
Test results/Remarks:	£ 0.5 % of dropout value or £ 0.05 V

1.28.2.3 Pickup times

Test condition	See item 1.28.2.1
Test values:	1.2 * threshold $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Permissive tolerance/Limiting values:	£ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$ £ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$
Test results/Remarks:	£ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$ £ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$

1.28.2.4 Dropout times

Test condition:	See item 1.28.2.1
Permissive tolerance/Limiting values:	£ 20 ms + OOT
Test results/Remarks:	£ 20 ms + OOT

1.28.2.5 Time delays

Test condition:	See item 1.28.2.1
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	$\pm 1 \%$ of setting value or 10 ms

Summary

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.28.3 3ph Voltage ph-to-gnd, ph-to-ph V with inverse time overvoltage stage

1.28.3.1 Pickup values

Test condition: Fundamental components, RMS values
 $f_{rated} = 50 \text{ Hz}, 60\text{Hz}$

Test values: 0.300 V £ pickup value £ 340.000 V

Permissive tolerance/Limiting values: in the range $f_{rated} \pm 10 \%$
 $\pm 0.5 \%$ of setting value or 0.05 V

Test results/Remarks: in the range $f_{rated} \pm 10 \%$
£ 0.5 % of setting value or £ 0.05 V

1.28.3.2 Dropout ratio

Test condition See item 1.28.3.1

Test values: 0.95

Permissive tolerance/Limiting values: $\pm 0.5 \%$ of dropout value or 0.05 V

Test results/Remarks: £ 0.5 % of dropout value or £ 0.05 V

1.28.3.3 Pickup times

Test condition See item 1.28.3.1

Test values: 1.2*pickup value
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: £ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$
£ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$

Test results/Remarks: £ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$
£ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$

1.28.3.4 Dropout times

Test condition: See item 1.28.3.1
Reset time is set 0 s

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

1.28.3.5 Definite time delays

Test condition: See item 1.28.3.1

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

Summary

1.28.3.6 Reset time

Test condition:	See item 1.28.3.1
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.28.3.7 Inverse time characteristic

Test condition:	See item 1.28.3.1
Test values:	Charact.constant k: 0.00 £ k £ 300.00 Charact.constant α: 0.010 £ α £ 5.000 Charact.constant c: 0.000 £ c £ 5.000 Time dial: 0.05 £ T £ 15.00
Permissive tolerance/Limiting values:	±5 % of the setting value or 30 ms
Test results/Remarks:	£ 5 % of the setting value or £ 30 ms

1.28.4 Positive sequence V1

1.28.4.1 Pickup values

Test condition:	$f_{rated} = 50 \text{ Hz}, 60\text{Hz}$
Test values:	0.300 V £ threshold value £ 200.000 V
Permissive tolerance/Limiting values:	in the range $f_{rated} \pm 10 \%$ ±0.5 % of setting value or 0.05 V
Test results/Remarks:	in the range $f_{rated} \pm 10 \%$ £ 0.5 % of setting value or £ 0.05 V

1.28.4.2 Dropout ratio

Test condition:	See item 1.28.4.1
Test values:	0.90 £ r £ 0.99
Permissive tolerance/Limiting values:	±0.5 % of dropout value or 0.05 V
Test results/Remarks:	£ 0.5 % of dropout value or £ 0.05 V

1.28.4.3 Pickup times

Test condition	See item 1.28.4.1
Test values:	1.2 * threshold $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Permissive tolerance/Limiting values:	£ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$ £ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$
Test results/Remarks:	£ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$ £ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$

Summary

1.28.4.4 Dropout times

Test condition	See item 1.28.4.1
Permissive tolerance/Limiting values:	£ 20 ms + OOT
Test results/Remarks:	£ 20 ms + OOT

1.28.4.5 Time delays

Test condition:	See item 1.28.4.1
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.28.5 Zero Sequence, Residual Voltage V0

1.28.5.1 Pickup values

Test condition:	RMS values, fundamental components, fundamental components over 2 cycles
Test values:	0.300 V £ threshold value £ 340.000 V
Permissive tolerance/Limiting values:	in the range $f_{rated} \pm 10\%$ ±0.5 % of setting value or 0.05 V
Test results/Remarks:	in the range $f_{rated} \pm 10\%$ £ 0.5 % of setting value or £ 0.05 V

1.28.5.2 Dropout ratio

Test condition:	See item 1.28.5.1
Test values:	0.90 £ r £ 0.99
Permissive tolerance/Limiting values:	±0.5 % of dropout value or 0.05 V
Test results/Remarks:	£ 0.5 % of dropout value or £ 0.05 V

1.28.5.3 Pickup times (Filter = RMS value, Standard Filter)

Test condition	See item 1.28.5.1
Test values:	1.2 * threshold $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$
Permissive tolerance/Limiting values:	£ 25 ms + OOT at $f_{rated} = 50\text{ Hz}$ £ 22 ms + OOT at $f_{rated} = 60\text{ Hz}$
Test results/Remarks:	£ 25 ms + OOT at $f_{rated} = 50\text{ Hz}$ £ 22 ms + OOT at $f_{rated} = 60\text{ Hz}$

1.28.5.4 Dropout times (Filter = RMS value, Standard Filter)

Test condition	See item 1.28.5.1
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Summary

Permissive tolerance/Limiting values: £ 20 ms + OOT at $f_{rated} = 50$ Hz
£ 16.6 ms + OOT at $f_{rated} = 60$ Hz

Test results/Remarks: £ 20 ms + OOT at $f_{rated} = 50$ Hz
£ 16.6 ms + OOT at $f_{rated} = 60$ Hz

1.28.5.5 Pickup times (Filter = over 2 cycles)

Test condition See item 1.28.5.1

Test values: 1.2 * threshold
 $f_{rated} = 50$ Hz, 60 Hz

Permissive tolerance/Limiting values: £ 45 ms + OOT at $f_{rated} = 50$ Hz
£ 39 ms + OOT at $f_{rated} = 60$ Hz

Test results/Remarks: £ 45 ms + OOT at $f_{rated} = 50$ Hz
£ 39 ms + OOT at $f_{rated} = 60$ Hz

1.28.5.6 Dropout times (Filter = over 2 cycles)

Test condition See item 1.28.5.1

Permissive tolerance/Limiting values: £ 31.06 ms + OOT at $f_{rated} = 50$ Hz
£ 27.06 ms + OOT at $f_{rated} = 60$ Hz

Test results/Remarks: £ 31.06 ms + OOT at $f_{rated} = 50$ Hz
£ 27.06 ms + OOT at $f_{rated} = 60$ Hz

1.28.5.7 Time delays

Test condition: See item 1.28.5.1

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.28.6 Any Voltage Vx

1.28.6.1 Pickup values

Test condition: Fundamental components, RMS values

$f_{rated} = 50$ Hz, 60Hz

Test values: 0.300 V £ threshold value £ 340.000 V

Permissive tolerance/Limiting values: in the range $f_{rated} \pm 10$ %
±0.5 % of setting value or 0.05 V

Test results/Remarks: in the range $f_{rated} \pm 10$ %
£ 0.5 % of setting value or £ 0.05 V

1.28.6.2 Dropout ratio

Test condition: See item 1.28.6.1

Test values: 0.90 £ r £ 0.99

Summary

Permissive tolerance/Limiting values: $\pm 0.5\%$ of dropout value or 0.05 V
Test results/Remarks: $\pm 0.5\%$ of dropout value or ± 0.05 V

1.28.6.3 Pickup times

Test condition: See item 1.28.6.1
Test values: 1.2 * threshold
 $f_{rated} = 50$ Hz, 60 Hz
Permissive tolerance/Limiting values: ± 25 ms + OOT at $f_{rated} = 50$ Hz
 ± 22 ms + OOT at $f_{rated} = 60$ Hz
Test results/Remarks: ± 25 ms + OOT at $f_{rated} = 50$ Hz
 ± 22 ms + OOT at $f_{rated} = 60$ Hz

1.28.6.4 Dropout times

Test condition: See item 1.28.6.1
Permissive tolerance/Limiting values: ± 20 ms + OOT
Test results/Remarks: ± 20 ms + OOT

1.28.6.5 Time delays

Test condition: See item 1.28.6.1
Test values: 0.00 s \pm T ± 60.00 s
Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or 10 ms
Test results/Remarks: $\pm 1\%$ of setting value or ± 10 ms

1.28.7 Negative sequence V2

1.28.7.1 Pickup values

Test condition: $f_{rated} = 50$ Hz, 60Hz
Test values: 0.300 V \pm threshold value ± 200.000 V
Permissive tolerance/Limiting values: in the range $f_{rated} \pm 10\%$
 $\pm 0.5\%$ of setting value or 0.05 V
Test results/Remarks: in the range $f_{rated} \pm 10\%$
 $\pm 0.5\%$ of setting value or ± 0.05 V

1.28.7.2 Dropout ratio

Test condition: See item 1.28.7.1
Test values: 0.90 \pm r ± 0.99
Permissive tolerance/Limiting values: $\pm 0.5\%$ of dropout value or 0.05 V
Test results/Remarks: $\pm 0.5\%$ of dropout value or ± 0.05 V

Summary

1.28.7.3 Pickup times

Test condition	See item 1.28.7.1
Test values:	1.2 * threshold $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Permissive tolerance/Limiting values:	Measuring window length 1 cycle: £ 55 ms + OOT Measuring window length 10 cycles: £ 210 ms + OOT (depends on the measuring window length) at $f_{rated} = 50 \text{ Hz}$ Measuring window length 1 cycle: £ 48 ms + OOT Measuring window length 10 cycles: £ 190 ms + OOT (depends on the measuring window length) at $f_{rated} = 60 \text{ Hz}$
Test results/Remarks:	Measuring window length 1 cycle: £ 55 ms + OOT Measuring window length 10 cycles: £ 210 ms + OOT (depends on the measuring window length) at $f_{rated} = 50 \text{ Hz}$ Measuring window length 1 cycle: £ 48 ms + OOT Measuring window length 10 cycles: £ 190 ms + OOT (depends on the measuring window length) at $f_{rated} = 60 \text{ Hz}$

1.28.7.4 Dropout times

Test condition	See item 1.28.7.1
Permissive tolerance/Limiting values:	Measuring window length 1 cycle: £ 20 ms + OOT Measuring window length 10 cycles: £ 70 ms + OOT (depends on the measuring window length)
Test results/Remarks:	Measuring window length 1 cycle: £ 20 ms + OOT Measuring window length 10 cycles: £ 70 ms + OOT (depends on the measuring window length)

1.28.7.5 Time delays

Test condition:	See item 1.28.7.1
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.28.8 Ratio of negative-sequence to positive-sequence, V2/V1

1.28.8.1 Pickup values

Test condition:	$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Test values:	0.5% £ threshold value £ 100%
Permissive tolerance/Limiting values:	in the range $f_{rated} \pm 10 \%$ ±0.5 % of setting value or 0.05 V
Test results/Remarks:	in the range $f_{rated} \pm 10 \%$ £ 0.5 % of setting value or £ 0.05 V

Summary

1.28.8.2 Dropout ratio

Test condition: See item 1.28.8.1

Test values: 0.90 ≤ r ≤ 0.99

Permissive tolerance/Limiting values: ±0.5 % of dropout value or 0.05 V

Test results/Remarks: ≤ 0.5 % of dropout value or ≤ 0.05 V

1.28.8.3 Pickup times

Test condition: See item 1.28.8.1

Test values: 1.2 * threshold
f_{rated} = 50 Hz, 60 Hz

Permissive tolerance/Limiting values: Measuring window length 1 cycle: ≤ 55 ms + OOT
Measuring window length 10 cycles: ≤ 210 ms + OOT
(depends on the measuring window length) at f_{rated} = 50 Hz

Measuring window length 1 cycle: ≤ 48 ms + OOT
Measuring window length 10 cycles: ≤ 190 ms + OOT
(depends on the measuring window length) at f_{rated} = 60 Hz

Test results/Remarks: Measuring window length 1 cycle: ≤ 55 ms + OOT
Measuring window length 10 cycles: ≤ 210 ms + OOT
(depends on the measuring window length) at f_{rated} = 50 Hz

Measuring window length 1 cycle: ≤ 48 ms + OOT
Measuring window length 10 cycles: ≤ 190 ms + OOT
(depends on the measuring window length) at f_{rated} = 60 Hz

1.28.8.4 Dropout times

Test condition: See item 1.28.8.1

Permissive tolerance/Limiting values: Measuring window length 1 cycle: ≤ 22 ms + OOT
Measuring window length 10 cycles: ≤ 55 ms + OOT
(depends on the measuring window length) at f_{rated} = 50 Hz

Measuring window length 1 cycle: ≤ 18 ms + OOT
Measuring window length 10 cycles: ≤ 45 ms + OOT
(depends on the measuring window length) at f_{rated} = 60 Hz

Test results/Remarks: Measuring window length 1 cycle: ≤ 22 ms + OOT
Measuring window length 10 cycles: ≤ 55 ms + OOT
(depends on the measuring window length) at f_{rated} = 50 Hz

Measuring window length 1 cycle: ≤ 18 ms + OOT
Measuring window length 10 cycles: ≤ 45 ms + OOT
(depends on the measuring window length) at f_{rated} = 60 Hz

1.28.8.5 Time delays

Test condition: See item 1.28.8.1

Test values: 0.00 s ≤ T ≤ 60.00 s

SummaryPermissive tolerance/Limiting values: ± 1 % of setting value or 10 msTest results/Remarks: ± 1 % of setting value or ± 10 ms

Summary

1.29 27 Undervoltage Protection

1.29.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-127

1.29.2 3ph Voltage ph-to-gnd, ph-to-ph with definite time undervoltage stages

1.29.2.1 Pickup values

Test condition: fundamental components, RMS values
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: 0.300 V £ threshold value £ 175.000 V

Permissive tolerance/Limiting values: in the range $f_{rated} \pm 10 \%$
 $\pm 0.5 \%$ of setting value or 0.05 V

Test results/Remarks: in the range $f_{rated} \pm 10 \%$
£ 0.5 % of setting value or £ 0.05 V

1.29.2.2 Dropout ratio

Test condition: see item 1.29.2.1

Test values: 1.01 £ r £ 1.20

Permissive tolerance/Limiting values: $\pm 0.5 \%$ of dropout value or 0.05 V

Test results/Remarks: £ 0.5 % of dropout value or £ 0.05 V

1.29.2.3 Pickup times

Test condition: see item 1.29.2.1

Test values: 0.8* threshold value
no pickup delay
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: $\leq 25 \text{ ms} + \text{OOT}$ at $f_{rated} = 50 \text{ Hz}$
 $\leq 22 \text{ ms} + \text{OOT}$ at $f_{rated} = 60 \text{ Hz}$

Test results/Remarks: £ 25 ms + OOT at $f_{rated} = 50 \text{ Hz}$
£ 22 ms + OOT at $f_{rated} = 60 \text{ Hz}$

1.29.2.4 Pickup delay

Test condition: see item 1.29.2.1
0.8* pickup value

Permissive tolerance/Limiting values: $\leq 40 \text{ ms}$

Test results/Remarks: £ 40 ms

1.29.2.5 Dropout times

Test condition: see item 1.29.2.1

Summary

Permissive tolerance/Limiting values: $\leq 20 \text{ ms} + \text{OOT}$

Test results/Remarks: $\leq 20 \text{ ms} + \text{OOT}$

1.29.2.6 Time delays

Test condition: see item 1.29.2.1

Test values: 0.00 s \leq T \leq 60.00 s

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: $\leq 1 \%$ of setting value or $\leq 10 \text{ ms}$

1.29.3 3ph Voltage ph-to-gnd, ph-to-ph with inverse time undervoltage stages

1.29.3.1 Pickup values

Test condition: fundamental components, RMS values
 $f_{\text{rated}} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: 0.300 V \leq threshold value $\leq 175.000 \text{ V}$

Permissive tolerance/Limiting values: in the range $f_{\text{rated}} \pm 10 \%$
 $\pm 0.5 \%$ of setting value or 0.05 V

Test results/Remarks: in the range $f_{\text{rated}} \pm 10 \%$
 $\leq 0.5 \%$ of setting value or $\leq 0.05 \text{ V}$

1.29.3.2 Dropout ratio

Test condition: see item 1.29.3.1

Test values: 1.05

Permissive tolerance/Limiting values: $\pm 0.5 \%$ of dropout value or 0.05 V

Test results/Remarks: $\leq 0.5 \%$ of dropout value or $\leq 0.05 \text{ V}$

1.29.3.3 Pickup times

Test condition: see item 1.29.3.1

Test values: 0.8* threshold value
no pickup delay
 $f_{\text{rated}} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: $\leq 25 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 50 \text{ Hz}$
 $\leq 22 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 60 \text{ Hz}$

Test results/Remarks: $\leq 25 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 50 \text{ Hz}$
 $\leq 22 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 60 \text{ Hz}$

1.29.3.4 Pickup delay

Test condition: see item 1.29.3.1
0.8* pickup value

Permissive tolerance/Limiting values: $\leq 40 \text{ ms}$

Summary

Test results/Remarks: £ 40 ms

1.29.3.5 Dropout times

Test condition: see item 1.29.3.1
with no reset time

Permissive tolerance/Limiting values: ≤ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

1.29.3.6 Inverse time characteristics

Test condition: see item 1.29.3.1
0.8*pickup value

Test values: Charact.constant k: 0.00 £ k £ 300.00
Charact.constant α: 0.010 £ α £ 5.000
Charact.constant c: 0.000 £ c £ 5.000
Time dial: 0.05 £ T £ 15.00

Permissive tolerance/Limiting values: ±5 % of setting value or 30 ms

Test results/Remarks: £ 5 % of setting value or £ 30 ms

1.29.3.7 Definite Time delays

Test condition: see item 1.29.3.1

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.29.3.8 Reset Time

Test condition: see item 1.29.3.1

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.29.4 Positive-Sequence Voltage V1

1.29.4.1 Pickup values

Test condition: fundamental components, RMS values
f_{rated} = 50 Hz, 60 Hz

Test values: 0.300 V £ threshold value £ 200.000 V

Permissive tolerance/Limiting values: in the range f_{rated} ±10 %
±0.5 % of setting value or 0.05 V

Test results/Remarks: in the range f_{rated} ±10 %
£ 0.5 % of setting value or £ 0.05 V

Summary

1.29.4.2 Dropout ratio

Test condition:	see item 1.29.4.1
Test values:	1.01 \leq r \leq 1.20
Permissive tolerance/Limiting values:	± 0.5 % of dropout value or 0.05 V
Test results/Remarks:	≤ 0.5 % of dropout value or ≤ 0.05 V

1.29.4.3 Pickup times

Test condition	see item 1.29.4.1
Test values:	0.8* threshold value $f_{rated} = 50$ Hz, 60 Hz
Permissive tolerance/Limiting values:	≤ 25 ms + OOT at $f_{rated} = 50$ Hz ≤ 22 ms + OOT at $f_{rated} = 60$ Hz
Test results/Remarks:	≤ 25 ms + OOT at $f_{rated} = 50$ Hz ≤ 22 ms + OOT at $f_{rated} = 60$ Hz

1.29.4.4 Dropout times

Test condition:	see item 1.29.4.1
Permissive tolerance/Limiting values:	≤ 20 ms + OOT
Test results/Remarks:	≤ 20 ms + OOT

1.29.4.5 Time delays

Test condition:	see item 1.29.4.1
Test values:	0.00 s \leq T \leq 60.00 s
Permissive tolerance/Limiting values:	± 1 % of setting value or 10 ms
Test results/Remarks:	≤ 1 % of setting value or ≤ 10 ms

1.29.5 Any Voltage Vx

1.29.5.1 Pickup values

Test condition:	fundamental components, RMS values $f_{rated} = 50$ Hz, 60 Hz
Test values:	0.300 V \leq threshold value ≤ 200.000 V
Permissive tolerance/Limiting values:	in the range $f_{rated} \pm 10$ % ± 0.5 % of setting value or 0.05 V
Test results/Remarks:	in the range $f_{rated} \pm 10$ % ≤ 0.5 % of setting value or ≤ 0.05 V

1.29.5.2 Dropout ratio

Test condition:	see item 1.29.5.1
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Summary

Test values:	1.01 $\leq r \leq$ 1.20
Permissive tolerance/Limiting values:	± 0.5 % of dropout value or 0.05 V
Test results/Remarks:	≤ 0.5 % of dropout value or ≤ 0.05 V

1.29.5.3 Pickup times

Test condition	see item 1.29.5.1
Test values:	0.8* threshold value $f_{rated} = 50$ Hz, 60 Hz
Permissive tolerance/Limiting values:	≤ 25 ms + OOT at $f_{rated} = 50$ Hz ≤ 22 ms + OOT at $f_{rated} = 60$ Hz
Test results/Remarks:	≤ 25 ms + OOT at $f_{rated} = 50$ Hz ≤ 22 ms + OOT at $f_{rated} = 60$ Hz

1.29.5.4 Dropout times

Test condition:	see item 1.29.5.1
Permissive tolerance/Limiting values:	≤ 20 ms + OOT
Test results/Remarks:	≤ 20 ms + OOT

1.29.5.5 Time delays

Test condition:	see item 1.29.5.1
Test values:	0.00 s $\leq T \leq$ 60.00 s
Permissive tolerance/Limiting values:	± 1 % of setting value or 10 ms
Test results/Remarks:	≤ 1 % of setting value or ≤ 10 ms

Summary

1.30 27 Undervoltage-controlled Reactive Power Protection

1.30.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-127

1.30.2 Protection stage

1.30.2.1 Pickup values $V<$

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: $3.000 \text{ V} \leq V < \leq 175.000 \text{ V}$

Permissive tolerance/Limiting values: $\pm 0.5 \%$ of set point value or 0.05 V

Test results/Remarks: $\leq 0.5 \%$ of set point value or $\leq 0.05 \text{ V}$

1.30.2.2 V dropout ratio

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $r = \text{dropout ratio}$

Test values: $r = 1.05$

Permissive tolerance/Limiting values: $\pm 0.5 \%$ of dropout value or 0.05 V

Test results/Remarks: $\leq 0.5 \%$ of dropout value or $\leq 0.05 \text{ V}$

1.30.2.3 Pickup values $I1>$

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: $0.030 I_{rated} \leq I1 > \leq 10.000 I_{rated}$

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or $0.005 I_{rated}$

Test results/Remarks: $\leq 1 \%$ of setting value or $\leq 0.005 I_{rated}$

1.30.2.4 Dropout ratio release current

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $r = \text{dropout ratio}$

Test values: $r = 0.95$

Permissive tolerance/Limiting values: $\pm 1 \%$ of dropout value

Test results/Remarks: $\leq 1 \%$ of dropout value

1.30.2.5 Pickup values $Q<$

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: $1.0\% \leq Q < \leq 200.0\%$

Permissive tolerance/Limiting values: $\pm 0.005 S_{rated}$ or 3% of setting value

Summary

Test results/Remarks: $\leq 0.005 S_{rated}$ Or $\leq 3 \%$ of setting value

1.30.2.6 Q dropout ratio

Test condition: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
 $r = \text{dropout ratio}$

Test values: $r = 0.95$

Permissive tolerance/Limiting values: $\pm 3 \%$ of dropout value

Test results/Remarks: $\leq 3 \%$ of dropout value

1.30.2.7 Pickup time

Test condition: see item 1.30.2.1, 1.30.2.3, 1.30.2.5

Test values: $0.8 * \text{threshold value}$

$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: $\leq 55 \text{ ms} + \text{OOT}$ at $f_{rated} = 50 \text{ Hz}$
 $\leq 45 \text{ ms} + \text{OOT}$ at $f_{rated} = 60 \text{ Hz}$

Test results/Remarks: $\leq 55 \text{ ms} + \text{OOT}$ at $f_{rated} = 50 \text{ Hz}$
 $\leq 45 \text{ ms} + \text{OOT}$ at $f_{rated} = 60 \text{ Hz}$

1.30.2.8 Dropout times

Test condition: see item 1.30.2.1, 1.30.2.3, 1.30.2.5

Permissive tolerance/Limiting values: $\leq 55 \text{ ms} + \text{OOT}$ at $f_{rated} = 50 \text{ Hz}$
 $\leq 45 \text{ ms} + \text{OOT}$ at $f_{rated} = 60 \text{ Hz}$

Test results/Remarks: $\leq 55 \text{ ms} + \text{OOT}$ at $f_{rated} = 50 \text{ Hz}$
 $\leq 45 \text{ ms} + \text{OOT}$ at $f_{rated} = 60 \text{ Hz}$

1.30.2.9 Time delays

Test condition: added to the inherent operating times

Test values: $0.00 \text{ s} \leq T \leq 60.00 \text{ s}$

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: $\leq 1 \%$ of setting value or $\leq 10 \text{ ms}$

1.30.2.10 Operate delay generator CB

Test condition: added to the inherent operating times

Test values: $0.00 \text{ s} \leq T \leq 60.00 \text{ s}$

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: $\leq 1 \%$ of setting value or $\leq 10 \text{ ms}$

Summary

1.30.2.11 Operate delay grid CB

Test condition:	added to the inherent operating times
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.30.3 Recloser stage

1.30.3.1 V> reclosure threshold

Test condition:	$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Test values:	3.000 V £ V> £ 340.000 V
Permissive tolerance/Limiting values:	±0.5 % of set point value or 0.05V
Test results/Remarks:	£ 0.5 % of set point value or £ 0.05V

1.30.3.2 V dropout ratio

Test condition:	$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$ $r = \text{dropout ratio}$
Test values:	$r = 0.95$
Permissive tolerance/Limiting values:	±0.5 % of dropout value or 0.05 V
Test results/Remarks:	£ 0.5 % of dropout value or £ 0.05 V

1.30.3.3 f-difference positive

Test condition:	$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Test values:	0.01 Hz to 5.00 Hz
Permissive tolerance/Limiting values:	±10 mHz
Test results/Remarks:	£ 10 mHz

1.30.3.4 f-difference negative

Test condition:	$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Test values:	-5.00 Hz to -0.01 Hz
Permissive tolerance/Limiting values:	±10 mHz
Test results/Remarks:	£ 10 mHz

1.30.3.5 I> release threshold

Test condition:	$f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
Test values:	$0.030 I_{rated} \text{ £ } I > \text{ £ } 10.000 I_{rated}$

Summary

Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or $0.005 I_{rated}$

Test results/Remarks: $\pm 1\%$ of setting value or $\pm 0.005 I_{rated}$

1.30.3.6 Dropout ratio release current

Test condition: $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$
 $r = \text{dropout ratio}$

Test values: $r = 0.95$

Permissive tolerance/Limiting values: $\pm 1\%$ of dropout value

Test results/Remarks: $\pm 1\%$ of dropout value

1.30.3.7 Time delay

Test condition: $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$

Test values: $0.00\text{ s} \leq T \leq 3600.00\text{ s}$

Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or 10 ms

Test results/Remarks: $\pm 1\%$ of setting value or $\pm 10\text{ ms}$

Summary**1.32 Fault Locator****1.32.1 Specifications**

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.32.2 Distance-to-fault measuring (FOR)

Test condition: Measuring tolerances for sinusoidal values and fault duration > 25 ms

Permissive tolerance/Limiting values: $\pm 2.0\%$ of fault location (without intermediate infeed)

Test results/Remarks: < 2.0 %

1.32.3 Start-to-measure command

Test condition: - by trip signal
- by drop-off of pickup

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

Summary

1.33 81 Frequency Protection

1.33.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.33.2 Pickup values $f<$, $f>$

Test condition:	40.00 Hz $\leq f >$ \leq 70.00 Hz Method A: Angle difference method Method B : Filtering method
Test values:	A: $f_{rated} - 0.2 \text{ Hz} < f < f_{rated} + 0.2 \text{ Hz}$ B: $f_{rated} - 3.0 \text{ Hz} < f < f_{rated} + 3.0 \text{ Hz}$
Permissive tolerance/Limiting values:	A: $ d \leq 5 \text{ mHz}$ at $V = V_{rated}$ B: $ d \leq 10 \text{ mHz}$ at $V = V_{rated}$
Test results/Remarks:	A: $ d < 5 \text{ mHz}$ at $V = V_{rated}$ B: $ d < 10 \text{ mHz}$ at $V = V_{rated}$

1.33.3 Dropout ratio Δf

Test condition:	20 mHz to 2000 mHz
Permissive tolerance/Limiting values:	$ d \leq 5 \text{ mHz}$ at $V = V_{rated}$
Test results/Remarks:	$ d < 5 \text{ mHz}$ at $V = V_{rated}$

1.33.3.1 Pickup times $f<$, $f>$

Permissive tolerance/Limiting values:	Method A: t approx. 70 ms + OOT at $f_{rated} = 50 \text{ Hz}$ 60 ms + OOT at $f_{rated} = 60 \text{ Hz}$ Method B: t approx. 75 ms + OOT at $f_{rated} = 50 \text{ Hz}$ 75 ms + OOT at $f_{rated} = 60 \text{ Hz}$
Test results/Remarks:	Method A: t < 70 ms + OOT at $f_{rated} = 50 \text{ Hz}$ < 60 ms + OOT at $f_{rated} = 60 \text{ Hz}$ Method B: t < 75 ms + OOT at $f_{rated} = 50 \text{ Hz}$ < 75 ms + OOT at $f_{rated} = 60 \text{ Hz}$

1.33.3.2 Dropout times $f<$, $f>$

Test values:	dropout by I, $V \rightarrow 0$
Permissive tolerance/Limiting values:	60 ms $\leq t \leq$ 80 ms
Test results/Remarks:	60 ms < t < 80 ms

Summary**1.33.3.3 Time delays**

Test condition:	added to the inherent operating times
Test values:	0.00 s \leq T \leq 60.00 s
Permissive tolerance/Limiting values:	$ d \leq 1\%$ of setting value or 10 ms
Test results/Remarks:	$ d < 1\%$ or 10 ms

Summary

1.34 81R Rate of Frequency Change

1.34.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.34.2 df/dt falling

1.34.2.1 Pickup values

Test condition:	$0.9 \leq f/f_{rated} \leq 1.1$
Test values:	$0.10 \text{ Hz/s} \leq df/dt \leq 20.00 \text{ Hz/s}$
Permissive tolerance/Limiting values:	< 5 % of set point value or 0.1 Hz/s
Test results/Remarks:	Measuring window ≤ 3 periods < 5 %; < 0.06 Hz/s Measuring window > 3 periods < 3 %; < 0.06 Hz/s

1.34.2.2 Dropout differential

Test condition:	$0.9 \leq f/f_{rated} \leq 1.1$
Test values:	$0.02 \text{ Hz/s} \leq \text{Dropout differential} \leq 0.99 \text{ Hz/s}$
Permissive tolerance/Limiting values:	< 5 % of Dropout value or 0.1 Hz/s
Test results/Remarks:	Measuring window ≤ 3 periods < 5 %; < 0.06 Hz/s Measuring window > 3 periods < 3 %; < 0.06 Hz/s

1.34.2.3 Pickup times

Test condition:	$0.10 \text{ Hz/s} \leq df/dt \leq 20.00 \text{ Hz/s}$
Test results/Remarks:	Approx.165 ms to 225 ms (depends on measuring window length)

1.34.2.4 Dropout times

Test condition:	$0.10 \text{ Hz/s} \leq df/dt \leq 20.00 \text{ Hz/s}$
Test results/Remarks:	Approx.165 ms to 225 ms (depends on measuring window length)

1.34.2.5 Time delays

Test condition:	Added to the inherent operating times
Test values:	0.00 s to 60.00 s
Permissive tolerance/Limiting values:	± 1 % of setting value or 10 ms
Test results/Remarks:	≤ 1 % or ≤ 10 ms

Summary**1.34.3 df/dt rising****1.34.3.1 Pickup values**

Test condition:	$0.9 \leq f/f_{\text{rated}} \leq 1.1$
Test values:	$0.10 \text{ Hz/s} \leq df/dt \leq 20.00 \text{ Hz/s}$
Permissive tolerance/Limiting values:	< 5 % of set point value or 0,1 Hz/s
Test results/Remarks:	Measuring window ≤ 3 periods < 5 %; < 0.06 Hz/s Measuring window > 3 periods < 3 %; < 0.06 Hz/s

1.34.3.2 Dropout differential

Test condition:	$0.9 \leq f/f_{\text{rated}} \leq 1.1$
Test values:	$0.02 \text{ Hz/s} \leq \text{Dropout differential} \leq 0.99 \text{ Hz/s}$
Permissive tolerance/Limiting values:	< 5 % of Dropout value or 0.1 Hz/s
Test results/Remarks:	Measuring window ≤ 3 periods < 5 %; < 0.06 Hz/s Measuring window > 3 periods < 3 %; < 0.06 Hz/s

1.34.3.3 Pickup times

Test condition:	$0.10 \text{ Hz/s} \leq df/dt \leq 20.00 \text{ Hz/s}$
Test results/Remarks:	Approx.165 ms to 225 ms (depends on measuring window length)

1.34.3.4 Dropout times

Test condition:	$0.10 \text{ Hz/s} \leq df/dt \leq 20.00 \text{ Hz/s}$
Test results/Remarks:	Approx.165 ms to 225 ms (depends on measuring window length)

1.34.3.5 Time delays

Test condition:	Added to the inherent operating times
Test values:	0.00 s to 60.00 s
Permissive tolerance/Limiting values:	± 1 % of setting value or 10 ms
Test results/Remarks:	≤ 1 % or ≤ 10 ms

Summary

1.35 49 Thermal Overload Protection 3phases

1.35.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-149

Test condition/Test values: calculation method = O/L-calculation
 - Modus Q-max = Q max
 - Modus Q-I_{max} = Q of I_{max}

Permissive tolerance/Limiting values: k = Factor according to IEC 60255-149 or VDE 0435 T3011

1.35.2 Pickup threshold $k \cdot I_N$

Test condition: $k = I_{max}/I_{rated}$
 0.10 ≤ k ≤ 4.00

Test values: k = 0.10, 1.00, 4.00

No filter applied

Permissive tolerance/Limiting values: Up to 30th harmonic: ±2 % or 0.01 I_{rated}, 2 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 50 Hz: ±4 % or 0.02 I_{rated}, 4 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 60 Hz: ±5 % or 0.025 I_{rated}, 5 % class acc. to IEC60255-149

Test results/Remarks: Up to 30th harmonic: ≤ 2 % or 0.01 I_{rated}, 2 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 50 Hz: ≤ 4 % or 0.02 I_{rated}, 4 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 60 Hz: ≤ 5 % or 0.025 I_{rated}, 5 % class acc. to IEC60255-149

With the filter for the compensation of the amplitude attenuation due to the anti-aliasing

Permissive tolerance/Limiting values: Up to 30th harmonic: ±2 % or 0.01 I_{rated}, 2 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 50 Hz: ±3 % or 0.02 I_{rated}, 4 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 60 Hz: ±4 % or 0.02 I_{rated}, 5 % class acc. to IEC60255-149

Test results/Remarks: Up to 30th harmonic: ≤ 2 % or 0.01 I_{rated}, 2 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 50 Hz: ≤ 3 % or 0.02 I_{rated}, 4 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 60 Hz: ≤ 4 % or 0.02 I_{rated}, 5 % class acc. to IEC60255-149

With filter for the gain of harmonics including compensation of the amplitude attenuation¹

Permissive tolerance/Limiting values: Up to 30th harmonic: ±2 % or 0.01 I_{rated}, 2 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 50 Hz: ±4 % or 0.02 I_{rated}, 4 % class acc. to IEC60255-149
 Up to 50th harmonic, f_{rated} = 60 Hz: ±5 % or 0.025 I_{rated}, 5 % class acc. to IEC60255-149

Test results/Remarks: Up to 30th harmonic: ≤ 2 % or 0.01 I_{rated}, 2 % class acc. to IEC60255-149²
 Up to 50th harmonic, f_{rated} = 50 Hz: ≤ 4 % or 0.02 I_{rated}, 4 % class acc. to IEC60255-149³
 Up to 50th harmonic, f_{rated} = 60 Hz: ≤ 5 % or 0.025 I_{rated}, 5 % class acc. to IEC60255-149⁴

¹ In case that the filter response exactly matches the user defined gain factor

² In case that the user-defined gain factor is set below 3. The tolerance is amplified if the gain factor is larger

³ In case that the user-defined gain factor is set below 7. The tolerance is amplified if the gain factor is larger

⁴ In case that the user-defined gain factor is set below 7. The tolerance is amplified if the gain factor is larger

Summary

1.35.3 Thermal warning stage

Test condition: 50 % £ Q-warn £ 100 %
 Test values: Q-warn = 50 %, 63 %, 90 %, 100 %
 Test results/Remarks: function correct

1.35.4 Current warning stage

Test condition: 0.03 I_{rated} £ I_{warn} £ 35.00 I_{rated}
 Test results/Remarks: function correct

1.35.5 Dropout ratio

Test condition: dropout threshold ratio
 50 % £ r £ 99 %
 Test results/Remarks: function correct

1.35.6 Tripping time characteristics

1.35.6.1 Parameter k, t

Test condition: $k = I_{max}/I_{rated}$ (IEC 60255-149)
 t = Time constant
 Test values: tripping times t
 Permissive tolerance/Limiting values: ±3 % or 1 s
 3 % class acc. to IEC 60255-149 for $I/(k * I_{rated}) > 1.25$
 Test results/Remarks: £ 3 % or £ 1 s
 3 % class acc. to IEC 60255-149 for $I/(k * I_{rated}) > 1.25$

1.35.6.2 Range of k, t

Test condition: 0.10 £ k £ 4.00
 30 s £ t £ 60000 s
 Test values: fault L-N, Modus Q-max
 Permissive tolerance/Limiting values: $t = t \ln\{ ((I/k I_{rated})^2 - (I_{pre}/k I_{rated})^2) / ((I/k I_{rated})^2 - 1) \}$ for $I/(k * I_{rated})$ £ 8
 Test results/Remarks: $t = t \ln\{ ((I/k I_{rated})^2 - (I_{pre}/k I_{rated})^2) / ((I/k I_{rated})^2 - 1) \}$ for $I/(k * I_{rated})$ £ 8

1.35.6.3 With and without preload

Test condition: with and without preload
 Test values: a) k = 0.1; t = (300, 500) min; I = 0.7 A
 b) k = 1.1; t = (20, 100) min; I = 2.5 A
 c) k = 4.0; t = (1, 5) min; I = 5.0 A
 d) k = 1.0; t = (1, 3, 10) min; I = 1.0 A

Summary**1.35.6.4 Range $I/(k \cdot I_{rated}) \geq 8$**

Test condition:	range $I/(k \cdot I_{rated}) \geq 8$
Test values:	a) $k = 1.0$: $I/(k \cdot I_{rated}) = 8, 10, 12$ b) $k = 0.1$: $I/(k \cdot I_{rated}) = 8, 10, 50$
Permissive tolerance/Limiting values:	$t[\geq 8] = \text{const} = t[8]$ $t[8] = t$ according to formula for $I/(k \cdot I_{rated}) = 8$
Test results/Remarks:	function correct

Summary

1.36 49 Thermal Overload Protection 1phase

1.36.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

Test condition/Test values: calculation method = O/L-calcul
 - Modus Q-max = Q max
 - Modus Q-I_{max} = Q of I_{max}

Permissive tolerance/Limiting values: k = Factor according to IEC 60255-8 or VDE 0435 T3011

1.36.2 Pickup threshold $k \cdot I_N$

Test condition: $k = I_{max}/I_{rated}$
 0.10 £ k £ 4.00

Test values: k = 0.10, 1.00, 4.00

Permissive tolerance/Limiting values: ±2 % or 10 mA at I_{rated} = 1A
 ±2 % or 50 mA at I_{rated} = 5A
 class 2 % acc. to IEC 255-8

Test results/Remarks: ≤ 2 %

1.36.3 Thermal time constant

Test condition: 30 s £ t_{th} £ 60 000 s

Test values: t_{th} = 30 s, 100 s, 60 000 s

Test results/Remarks: function correct

1.36.4 Thermal warning stage

Test condition: Q-warn/Q-trip
 50 % £ Q-warn £ 100 %

Test values: Q-warn = 50 %, 70 %, 90 %, 100 %

Test results/Remarks: function correct

1.36.5 Current warning stage

Test condition: 0.03 I_{rated} £ I_{warn} £ 35.00 I_{rated}

Test values: I_{warn} = 0.03 A, 0.5 A, 5 A, 10 A

Test results/Remarks: function correct

1.36.6 Maximum thermal current

Test condition: 0.03 I_{rated} £ I_{max thermal} £ 10.00 I_{rated}

Test values: I_{max thermal} = 1.1 A, 2.5 A, 10 A

Test results/Remarks: function correct

Summary

1.36.7 Dropout ratio

Test condition: dropout threshold operate ratio
50 % £ r £ 99 %

Test values: r = 50 %, 70 %, 90 %, 99 %

Test results/Remarks: function correct

1.36.8 Tripping time characteristics

Test condition: $k = I_{max}/I_{rated}$ (IRC 255-8)
0.10 £ k £ 4.00

t = Time constant
30 s £ t £ 60 000 s

with and without preload

Test values: tripping times t
Fault L-N, Modus Q-max

k = 0.1, 1, 4; t = 100 s
k = 1; t = 30 s, 100 s, 60 000 s

Permissive tolerance/Limiting values: ±3 % or 1 s
class 3 % acc. to IEC 255-8 for $I/(k * I_{rated}) > 1.25$
 $t = t \ln\{ ((I/k I_{rated})^2 - (I_{pre}/k I_{rated})^2) / ((I/k I_{rated})^2 - 1) \}$ for $I/(k * I_{rated})$ £ 8

Test results/Remarks: £ 3 % or £ 1 s
class 3 % acc. to IEC 255-8 for $I/(k * I_{rated}) > 1.25$
 $t = t \ln\{ ((I/k I_{rated})^2 - (I_{pre}/k I_{rated})^2) / ((I/k I_{rated})^2 - 1) \}$ for $I/(k * I_{rated})$ £ 8

Summary

1.37 Thermoboxes for Temperature Detection

1.37.1 Specifications

- IEC/EN 60255-1

1.37.2 Connection

- Ethernet: TR1200 IP

- RS 485: TR1200

1.37.3 Temperature detectors

Test condition: Connectable Thermoboxes 4

Test values: Number of Thermoboxes per type 4

Test results/Remarks: numbers correct

1.37.4 Number of temperature sensors per thermobox

Test condition: Max. 12

Test values: Max. 12

Test results/Remarks: numbers correct

1.37.5 Thresholds for Indication stage 1

Test condition: -50 °C to 250 °C
-58 °F to 482 °F

Test values: -50 °C to 250 °C
-58 °F to 482 °F

Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or ± 1 °C or ± 2 °F

Test results/Remarks: $< 1\%$ of setting value or ± 1 °C or ± 2 °F

1.37.6 Thresholds for Indication stage 2

Test condition: -50 °C to 250 °C
-58 °F to 482 °F

Test values: -50 °C to 250 °C
-58 °F to 482 °F

Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or ± 1 °C or ± 2 °F

Test results/Remarks: $< 1\%$ of setting value or ± 1 °C or ± 2 °F

1.37.7 Dropout ratio

Test condition: 3 °C or 6 °F

Test values: 3 °C or 6 °F

Summary

Test results/Remarks: Function correct

1.37.8 Time delays

Test condition: Added to the Inherent Operating Times

Test values: 0.00 s to 60.00 s or ∞

Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or 10 ms

Test results/Remarks: $< 1\%$ of setting value or 10 ms

Summary**1.38 Temperature Supervision****1.38.1 Pickup values**

Test condition:	-50 °C to 250 °C -58 °F to 482 °F
Permissive tolerance/Limiting values:	±0.5 % of the setting value or ±1 °C or ±2 °F
Test results/Remarks:	≤ 0.5 % of the setting value or ≤ 1 °C or ≤ 2 °F

1.38.2 Dropout ratio

Test condition:	-50 °C to 250 °C -58 °F to 482 °F
Permissive tolerance/Limiting values:	3 °C or 6 °F
Test results/Remarks:	3 °C or 6 °F

1.38.3 Time delays

Permissive tolerance/Limiting values:	0.00 s to 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	≤ 1 % of setting value or ≤ 10 ms

Summary

1.39 49H HotSpot Calculation

1.39.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC 60076-7
- IEEE C57.91:2011

1.39.2 General Test Conditions

f_{rated} : 50 Hz, 60 Hz

I_{rated} : 1 A, 5 A

1.39.3 General

1.39.3.1 HST Warning Threshold

Test condition: 80 °C to 140 °C

176 °F to 284 °F

Permissive tolerance/Limiting values: $|d| \pm 0.5 \%$ of measured value or ± 1 K

Test results/Remarks: $|d| < 0.5 \%$

1.39.3.2 HST Alarm Threshold

Test condition: 80 °C to 140 °C

176 °F to 284 °F

Permissive tolerance/Limiting values: $|d| \pm 0.5 \%$ of measured value or ± 1 K

Test results/Remarks: $|d| < 0.5 \%$

1.39.3.3 Operating Times

Test condition: see item 1.39.3.1 and 1.39.3.2

Test results/Remarks: Due to long process of HotSpot calculation the operating time is depend on oil-temperature and load increasing

1.39.3.4 Emergency Start Time Delay

Test condition: added to the inherent operating times

Test values: 0 s $\leq T \leq$ 15000 s

Permissive tolerance/Limiting values: $|d| \leq 1 \%$ of setting value or 10 ms

Test results/Remarks: $|d| < 1 \%$ of setting value or 10 ms

Summary

1.1 50BF Circuit Breaker Failure Protection

1.1.1 General test conditions

f_{rated}	50 Hz, 60 Hz
I_{rated}	1 A, 5 A
3I0 criterion	Plausibility check / Direct release
I2 criterion	Plausibility check / Direct release

1.1.2 Pickup values

Test condition:	$0.030 I_{rated} \leq I < 35.000 I_{rated}$
Permissive tolerance/Limiting values:	2 % of setting value or 1 % I_{rated}
Test results/Remarks:	2 % of setting value or 1 % I_{rated}

1.1.3 Dropout ratio

Test condition:	approx. 0.95
Permissive tolerance/Limiting values:	2 % of setting value or 1 % I_{rated}
Test results/Remarks:	2 % of setting value or 1 % I_{rated}

1.1.4 Pickup times

Test condition:	Pickup time
Permissive tolerance/Limiting values:	≤ 10 ms
Test results/Remarks:	< 10 ms

1.1.5 Dropout times

1.1.5.1 Dropout time via the current-flow criterion

Test condition:	dropout time via the current-flow criterion
Permissive tolerance/Limiting values:	≤ 15 ms typical
Test results/Remarks:	≤ 15 ms ¹

1.1.5.2 Dropout time, via circuit-breaker auxiliary contact criterion

Test condition:	dropout time, via circuit-breaker auxiliary contact criterion
Permissive tolerance/Limiting values:	≤ 5 ms
Test results/Remarks:	≤ 5 ms ¹

¹ The dropout time is the time required by the CBFP function to detect that the CB is open. The time for switching a contact is not included

Summary**1.1.6 Time delays**

Test condition: added to the inherent operating times

Test values: 0.000 s to 60.000 s

Permissive tolerance/Limiting values: $\pm 1\%$ of setting value or 10 ms

Test results/Remarks: $\pm 1\%$ of setting value or 10 ms

1.1.7 Operation with CB auxiliary contact

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: function correct

Summary

1.2 Circuit Breaker Restrike Protection

1.2.1 Pickup values

Test condition: 0.030 I_{rated} £ $I > £ 35.000 I_{rated}$

Test values: $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$
0.030 I_{rated} £ $I > £ 35.000 I_{rated}$

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 0.005 I_{rated}

Test results/Remarks: £ 1 % of setting value or £ 0.005 I_{rated}

1.2.2 Dropout ratio

Test condition: see item 1.2.1

Test value: 0.95

Permissive tolerance/Limiting values: $\pm 1 \%$ of dropout value or 0.005 I_{rated}

Test results/Remarks: £ 1 % of dropout value or £ 0.005 I_{rated}

1.2.3 Pickup times

Test condition: see item 1.2.1

Test values: 1.2 * threshold value
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Permissive tolerance/Limiting values: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

Test results/Remarks: £ 25 ms + OOT at 50 Hz
£ 22 ms + OOT at 60 Hz

1.2.4 Dropout times

Test condition: see item 1.2.1

Permissive tolerance/Limiting values: £ 20 ms + OOT

Test results/Remarks: £ 20 ms + OOT

1.2.5 Time delay T1 for 3-pole retrip

Test condition: see item 1.2.1
1.2 * threshold value

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: £ 1 % of setting value or £ 10 ms

1.2.6 Time delay T2 for 3-pole trip

Test condition: see item 1.2.1
1.2 * threshold value

Summary

Test values:	0.05 s to 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.2.7 Time delay for minimum operate

Test condition:	see item 1.2.1 1.2 * threshold value
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.2.8 Time delay for dropout

Test condition:	see item 1.2.1 1.2 * threshold value
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 35 ms
Test results/Remarks:	£ 1 % of setting value or £ 35 ms

1.2.9 Position recognition delay

Test condition:	see item 1.2.1 1.2 * threshold
Test values:	0.00 s £ T £ 60.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

1.2.10 Monitoring duration

Test condition:	see item 1.2.1 1.2 * threshold value
Test values:	1.00 s to 600.00 s
Permissive tolerance/Limiting values:	±1 % of setting value or 10 ms
Test results/Remarks:	£ 1 % of setting value or £ 10 ms

Summary

1.3 Arc Protection

1.3.1 General test conditions

f_{rated} 50 Hz, 60 Hz

I_{rated} 1 A

1.3.2 Light only

1.3.2.1 Pickup time

Test condition: 100 measurements
Pickup of stage measured with high-speed-relais

Test results/Remarks: $t_{max} = 3.6$ ms
 $t_{min} = 2.6$ ms
 $t_{average} = 3.0$ ms

1.3.2.2 Dropout time

Test condition: 100 measurements
Pickup of stage measured with high-speed-relais

Test results/Remarks: $t_{max} = 27.3$ ms
 $t_{min} = 26.7$ ms
 $t_{average} = 27.3$ ms

1.3.3 Light and current

1.3.3.1 Threshold $I>$

Test condition: 1pol-fault, 3pol-fault
 $0.03 \text{ } \epsilon \ I/I_{ratedObj} \text{ } \epsilon \ 10.00$

Permissive tolerance/Limiting values: no operate below threshold, measurement accuracy not considered

Test results/Remarks: confirmed

1.3.3.2 Threshold $3I0>$

Test condition: 1pol-fault, I_N calculated, I_N measured
 $0.03 \text{ } \epsilon \ I/I_{ratedObj} \text{ } \epsilon \ 10.00$

Permissive tolerance/Limiting values: no operate below threshold, measurement accuracy not considered

Test results/Remarks: confirmed

1.3.3.3 Dropout ratio $I>$

Test condition: 1pol-fault, 3pol-fault
 $0.03 \text{ } \epsilon \ I/I_{ratedObj} \text{ } \epsilon \ 10.00$

Permissive tolerance/Limiting values: approx. 0.90

Test results/Remarks: 0.80 – 0.95

1.3.3.4 Dropout ratio $3I0>$

Test condition: 1pol-fault
 $0.03 \text{ } \epsilon \ I/I_{ratedObj} \text{ } \epsilon \ 10.00$

Summary

Permissive tolerance/Limiting values: approx. 0.90

Test results/Remarks: 0.80 – 0.95

1.3.3.5 Pickup time

Test condition: 100 measurements per fault type and frequency
fault inception angle 10x(0°, 18°, 36°...162°)
Current jump from 1A to 10A at default threshold
Pickup of stage measured with high-speed-relais

Test results/Remarks:	1pol, 50 Hz	1pol, 60 Hz	3pol, 50 Hz	3pol, 60 Hz
t _{max} =	9.2 ms	9.0 ms	6.9 ms	6.9 ms
t _{min} =	4.4 ms	3.8 ms	4.0 ms	3.8 ms
t _{average} =	5.5 ms	5.8 ms	5.3 ms	5.3 ms

1.3.3.6 Dropout time

Test condition: 100 measurements
Current jump to 0 A
Pickup of stage measured with high-speed-relais

Test results/Remarks:	1pol, 50 Hz	1pol, 60 Hz	3pol, 50 Hz	3pol, 60 Hz
t _{max} =	27.3 ms	27.8 ms	27.3 ms	27.8 ms
t _{min} =	26.7 ms	26.3 ms	26.2 ms	26.2 ms
t _{average} =	27.2 ms	27.3 ms	27.2 ms	27.3 ms

1.3.4 Frequency operating range

Test condition: I_{test} = 5 I_{rated} at default threshold, f = 5 Hz - 100 Hz

Permissive tolerance/Limiting values: 10 Hz – 80 Hz

Test results/Remarks: confirmed

Summary

1.4 Power Plant Disconnection

1.4.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.4.2 Function stage

1.4.2.1 Pickup values of I>

Test condition: $0.030 I_{rated} \leq I < 35.000 I_{rated}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: $0.030 I_{rated} \leq I < 35.000 I_{rated}$

Permissive tolerance/Limiting values: $\pm 1 \% \text{ of setting value or } 0.005 I_{rated}$

Test results/Remarks: $\leq 1 \% \text{ of setting value or } \leq 0.005 I_{rated}$

1.4.2.2 Dropout ratio of I>

Test condition: $0.030 I_{rated} \leq I < 35.000 I_{rated}$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: $r = 0.95$

Permissive tolerance/Limiting values: $\pm 1 \% \text{ of dropout value or } 0.005 I_{rated}$

Test results/Remarks: $\leq 1 \% \text{ of dropout value or } \leq 0.005 I_{rated}$

1.4.2.3 Pickup values of P1>

Test condition: $50 \% \leq P1 < 100 \%$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: $50 \% \leq P1 < 100 \%$

Permissive tolerance/Limiting values: $\pm 0.5 \% S_{rated} \text{ or } \pm 3 \% \text{ of setting value when } Q < 0.5 S_{rated}$

Test results/Remarks: $\leq 0.5 \% S_{rated} \text{ or } \leq 3 \% \text{ of setting value when } Q < 0.5 S_{rated}$

1.4.2.4 Dropout ratio of P1>

Test condition: $50 \% \leq P1 < 100 \%$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Test values: $r = 0.95$

Permissive tolerance/Limiting values: $\pm 0.5 \% S_{rated} \text{ or } \pm 3 \% \text{ of setting value when } Q < 0.5 S_{rated}$

Test results/Remarks: $\leq 0.5 \% S_{rated} \text{ or } \leq 3 \% \text{ of setting value when } Q < 0.5 S_{rated}$

1.4.2.5 Pickup values of Vph-ph<

Test condition: $0.3 V \leq V_{ph-ph} < 175 V$
 $f_{rated} = 50 \text{ Hz}, 60 \text{ Hz}$

Summary

Test values: 0.3 V \leq threshold value \leq 175 V

Permissive tolerance/Limiting values: ± 0.5 % of setting value or 0.05 V

Test results/Remarks: ≤ 0.5 % of setting value or ≤ 0.05 V

1.4.2.6 Dropout ratio of V_{ph-ph<}

Test condition: 0.3 V \leq V_{ph-ph<} \leq 175 V
f_{rated} = 50 Hz, 60 Hz

Test values: r = 1.05

Permissive tolerance/Limiting values: ± 0.5 % of dropout value or 0.05 V

Test results/Remarks: ≤ 0.5 % of dropout value or ≤ 0.05 V

1.4.2.7 Pickup values of dP1<

Test condition: -100 % \leq dP1< \leq -30 %
f_{rated} = 50 Hz, 60 Hz

Test values: -100 % \leq dP1< \leq -30 %

Permissive tolerance/Limiting values: ± 0.5 % S_{rated} or ± 3 % of setting value when Q < 0.5 S_{rated}

Test results/Remarks: ≤ 0.5 % S_{rated} or ≤ 3 % of setting value when Q < 0.5 S_{rated}

1.4.2.8 Dropout ratio of dP1<

Test condition: -100 % \leq dP1< \leq -30 %
f_{rated} = 50 Hz, 60 Hz

Test values: r = 0.95

Permissive tolerance/Limiting values: ± 0.5 % S_{rated} or ± 3 % of setting value when Q < 0.5 S_{rated}

Test results/Remarks: ≤ 0.5 % S_{rated} or ≤ 3 % of setting value when Q < 0.5 S_{rated}

1.4.2.9 Pickup values of P1<

Test condition: 0 % \leq P1< \leq 60 %
f_{rated} = 50 Hz, 60 Hz

Test values: 0 % \leq P1< \leq 60 %

Permissive tolerance/Limiting values: ± 0.5 % S_{rated} or ± 3 % of setting value when Q < 0.5 S_{rated}

Test results/Remarks: ≤ 0.5 % S_{rated} or ≤ 3 % of setting value when Q < 0.5 S_{rated}

1.4.2.10 Dropout ratio of P1<

Test condition: 0 % \leq P1< \leq 60 %
f_{rated} = 50 Hz, 60 Hz

Test values: r = 1.05

Permissive tolerance/Limiting values: ± 0.5 % S_{rated} or ± 3 % of setting value when Q < 0.5 S_{rated}

Summary

Test results/Remarks: $\leq 0.5 \% S_{rated}$ or $\leq 3 \%$ of setting value when $Q < 0.5 S_{rated}$

1.4.2.11 Dropout delay

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: $\leq 1 \%$ of setting value or ≤ 10 ms

1.4.2.12 Pickup times

1.4.2.12.1 Characteristic curve = no

Permissive tolerance/Limiting values: ≤ 28 ms + OOT at 50 Hz
 ≤ 25 ms + OOT at 60 Hz

Test results/Remarks: ≤ 28 ms + OOT at 50 Hz
 ≤ 25 ms + OOT at 60 Hz

1.4.2.12.2 Characteristic curve = yes

Permissive tolerance/Limiting values: ≤ 26 ms + OOT at 50 Hz
 ≤ 24 ms + OOT at 60 Hz

Test results/Remarks: ≤ 26 ms + OOT at 50 Hz
 ≤ 24 ms + OOT at 60 Hz

1.4.2.13 Dropout times

1.4.2.13.1 Characteristic curve = no

Permissive tolerance/Limiting values: ≤ 19 ms + OOT at 50 Hz
 ≤ 18 ms + OOT at 60 Hz

Test results/Remarks: ≤ 19 ms + OOT at 50 Hz
 ≤ 18 ms + OOT at 60 Hz

1.4.2.13.2 Characteristic curve = yes

Permissive tolerance/Limiting values: ≤ 22 ms + OOT at 50 Hz
 ≤ 20 ms + OOT at 60 Hz

Test results/Remarks: ≤ 22 ms + OOT at 50 Hz
 ≤ 20 ms + OOT at 60 Hz

1.4.2.14 Operate delay

1.4.2.14.1 Characteristic curve = no

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: $\leq 1 \%$ of setting value or ≤ 10 ms

1.4.2.14.2 Characteristic curve = yes

Test values: 0.00 s £ T £ 60.00 s

Permissive tolerance/Limiting values: $\pm 1 \%$ of setting value or 10 ms

Test results/Remarks: $\leq 1 \%$ of setting value or ≤ 10 ms

Summary

1.5 Inrush-Current Detection

1.5.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.5.2 General test conditions

f_{rated} 50 Hz, 60 Hz

1.5.3 Operating-range limit I_{max}

Test condition: 0.030 I_{rated} £ I_{max} £ 35.000 I_{rated}

Test values: 0.030 I_{rated} £ I_{max} £ 35.000 I_{rated}

Permissive tolerance/Limiting values: $|d|$ £ 1 % of setting value or 0.005 I_{rated}

Test results/Remarks: $|d|$ £ 1 % of setting value or 0.005 I_{rated}

1.5.4 Content of 2nd harmonics

Test condition: 10 % £ $I/I_{2ndHarm.}$ £ 45 %

Test values: 10 % £ $I/I_{2ndHarm.}$ £ 45 %

Permissive tolerance/Limiting values: $|d|$ £ 1 % of setting value

Test results/Remarks: $|d|$ < 1 % of setting value

1.5.5 Duration of the cross-blocking

Test condition: 0.03 s £ T £ 200.00 s

Test values: 0.03 s £ T £ 200.00 s

Permissive tolerance/Limiting values: $|d|$ £ 1 % of setting value or 10 ms

Test results/Remarks: $|d|$ < 1 % of setting value or 10 ms

1.5.6 Pickup times

Permissive tolerance/Limiting values: approx. 29 ms + OOT

Test results/Remarks: approx. 29 ms + OOT

1.5.7 Dropout ratios

1.5.7.1 Current measurement I_{max}

Test condition: $r = 0.95$ or 0.015 A at $I_{rated} = 1$ A
 $r = 0.95$ or 0.075 A at $I_{rated} = 5$ A

Permissive tolerance/Limiting values: 1% of the setting value or 5mA

Test results/Remarks: 1% of the setting value or 5mA

Summary**1.5.7.2 Harmonics I2.Harm/I1.Harm**

Test condition:	r = 0.95
Permissive tolerance/Limiting values:	1% of the setting value for settings of $I_{2ndHarm}/I_{1stHarm}$ Time delays
Test results/Remarks:	1% of the setting value for settings of $I_{2ndHarm}/I_{1stHarm}$ Time delays

Summary

1.6 32 General Power Protection 3-phases

1.6.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.6.2 Pickup values

Test condition: -200.0 % to +200.0 %

Test values: -200.0 % to +200.0 %

Permissive tolerance/Limiting values: $\pm 0.5 \% S_{N/r}$ or $\pm 3 \%$ of setting value

Test results/Remarks: $\leq 0.5 \% S_{N/r}$ or $\leq 3 \%$ of setting value

1.6.3 Tilt power characteristic

Test condition: -89.0 ° to +89.0 °

Test values: -89.0 ° to +89.0 °

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.6.4 Dropout ratio

Test condition: 0.90 to 0.99 at >stage
1.01 to 1.10 at <stage

Test values: 0.90 to 0.99 at >stage
1.01 to 1.10 at <stage

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

1.6.5 Pickup times

Permissive tolerance/Limiting values: $\leq 55 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 50 \text{ Hz}$
 $\leq 45 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 60 \text{ Hz}$

Test results/Remarks: $\leq 55 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 50 \text{ Hz}$
 $\leq 45 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 60 \text{ Hz}$

1.6.6 Dropout times

Permissive tolerance/Limiting values: $\leq 55 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 50 \text{ Hz}$
 $\leq 45 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 60 \text{ Hz}$

Test results/Remarks: $\leq 55 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 50 \text{ Hz}$
 $\leq 45 \text{ ms} + \text{OOT}$ at $f_{\text{rated}} = 60 \text{ Hz}$

1.6.7 Time delays

Test condition: added to the inherent operating times

Summary

Test values:	0.00 s to 60.00 s
Permissive tolerance/Limiting values:	± 1 % of setting value or 10 ms
Test results/Remarks:	≤ 1 % of setting value or ≤ 10 ms

Summary

1.7 32R Reverse Power Protection

1.7.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.7.2 Angle correction

Test condition: -10.00 ° £ Angle correction £ 10.00 °

Test values: -10.00 ° £ Angle correction £ 10.00 °

Permissive tolerance/Limiting values: $\pm 0.15\% S_n$ or $\pm 5\%$ of setting values when $Q < 0.5S_n$

Test results/Remarks: $\leq 0.15\% S_n$ or $\leq 5\%$ of setting values when $Q < 0.5S_n$

1.7.3 Minimum voltage V1

Test condition: 0.300 V £ Minimum voltage V1 £ 60.000 V
 $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$

Test values: 0.300 V £ Minimum voltage V1 £ 60.000 V

Permissive tolerance/Limiting values: $\pm 0.5\%$ of dropout value or 0.05 V

Test results/Remarks: £ 0.5 % of dropout value or $\leq 0.05\text{ V}$

1.7.4 Threshold

Test condition: -30.00 % £ threshold value £ -0.30 %
 $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$

Test values: -30.00 % £ threshold value £ -0.30 %

Permissive tolerance/Limiting values: $\pm 0.15\% S_n$ or $\pm 5\%$ of setting values when $Q < 0.5S_n$

Test results/Remarks: $\leq 0.15\% S_n$ or $\leq 5\%$ of setting values when $Q < 0.5S_n$

1.7.5 Dropout ratio

Test condition: -30.00 % £ threshold value £ -0.30 %

Test values: 0.40 £ threshold value £ 0.99

Permissive tolerance/Limiting values: $\pm 0.15\% S_n$ or $\pm 5\%$ of setting values when $Q < 0.5S_n$

Test results/Remarks: $\leq 0.15\% S_n$ or $\leq 5\%$ of setting values when $Q < 0.5S_n$

1.7.6 Pickup time

Test condition: Threshold = -1.00 %
 $f_{rated} = 50\text{ Hz}, 60\text{ Hz}$
from 0 to 1.20 * threshold value

Permissive tolerance/Limiting values: $\leq 360\text{ ms} + \text{OOT at } 50\text{ Hz}$
 $\leq 300\text{ ms} + \text{OOT at } 60\text{ Hz}$

Summary

Test results/Remarks: ≤ 347 ms + OOT at 50 Hz
 ≤ 290 ms + OOT at 60 Hz

1.7.7 Dropout times

Test condition: Threshold = -1.00 %
 $f_{rated} = 50$ Hz, 60 Hz
from $1.20 \cdot$ Threshold value to $0.44 \cdot$ dropout value

Permissive tolerance/Limiting values: ≤ 360 ms + OOT at 50 Hz
 ≤ 300 ms + OOT at 60 Hz

Test results/Remarks: ≤ 232 ms + OOT at 50 Hz
 ≤ 184 ms + OOT at 60 Hz

1.7.8 Dropout delay

Test condition: see item 1.7.7

Test values: 0.00 s \leq T \leq 60.00 s

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.7.9 Operate delay

Test condition: See item 1.7.6

Test values: 0.00 s \leq T \leq 60.00 s

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.7.10 Operate delay stop valve

Test condition: See item 1.7.6

Test values: 0.00 s \leq T \leq 60.00 s

Permissive tolerance/Limiting values: ± 1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

Summary**1.8 Jump Detection****1.8.1 Current jump detection****1.8.1.1 Pickup values**

Test condition:	L-N, 3I0 $f_{\text{rated}} = 50 \text{ Hz}, 60 \text{ Hz}$ $0.030 I_{\text{rated}} \leq I < 35.000 I_{\text{rated}}$
Permissive tolerance/Limiting values:	$ d \leq 3 \% \text{ of setting value or } 0.01 I_{\text{rated}}$
Test results/Remarks:	$ d \leq 3 \% \text{ of setting value or } 0.01 I_{\text{rated}}$

1.8.1.2 Pickup times

Test condition:	see item 1.8.1.1
Test values:	see item 1.8.1.1
Permissive tolerance/Limiting values:	t approx. 8 ms + OOT
Test results/Remarks:	t approx. 8 ms + OOT

1.8.2 Voltage jump detection**1.8.2.1 Pickup values**

Test condition:	L-N, L-L, V0 $f_{\text{rated}} = 50 \text{ Hz}, 60 \text{ Hz}$ $0.30V \leq V < 340.000 V$
Permissive tolerance/Limiting values:	$ d \leq 2 \% \text{ of setting value or } 0.1 V$
Test results/Remarks:	$ d \leq 2 \% \text{ of setting value or } 0.1 V$

1.8.2.2 Pickup times

Test condition:	see item 1.8.2.1
Test values:	see item 1.8.2.1
Permissive tolerance/Limiting values:	t approx. 8 ms + OOT
Test results/Remarks:	t approx. 8 ms + OOT

Summary

1.9 Vector Jump Protection

1.9.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.9.2 General

1.9.2.1 Pickup values

1.9.2.1.1 Threshold V1 min

Test condition: Positive sequence voltage, set parameter Threshold V1 max = 175.000 V

Test values: 1.000 V < threshold value £ 158.200 V

Permissive tolerance/Limiting values: ±1 % of setting value or 0.05 V

Test results/Remarks: ≤ 1 % of setting value or ≤ 0.05 V

1.9.2.1.2 Threshold V1 max

Test condition: Positive sequence voltage, set parameter Threshold V1 min = 0.300 V

Test values: 1.000 V < threshold value £ 175.000 V

Permissive tolerance/Limiting values: ±1 % of setting value or 0.05 V

Test results/Remarks: ≤ 1 % of setting value or ≤ 0.05 V

1.9.2.1.3 T Block

Test condition: Change voltage or frequency from out of range to be within working range as following: Change voltage from $0.5 V_{rated}$ to V_{rated} at $f = f_{rated}$

Change voltage from $1.5 V_{rated}$ to V_{rated} at $f = f_{rated}$

Change frequency from $0.5 f_{rated}$ to f_{rated} at $V = V_{rated}$

Change frequency from $1.5 f_{rated}$ to f_{rated} at $V = V_{rated}$

Test values: 0.00 s £ T > £ 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.9.3 Stage Δφ

1.9.3.1 Pickup values

1.9.3.1.1 Threshold Δφ

Test condition: $V = V_{rated}$

Test values: $2.0^\circ < \text{threshold value } £ 30.0^\circ$

Permissive tolerance/Limiting values: ± 0.5 °

Test results/Remarks: ± 0.5 °

1.9.3.2 Pickup times

Test condition: $V = V_{rated}$

Summary

Change $\Delta\phi$ to + 12.0 ° (leading angle) or to – 12.0 ° (lagging angle), at threshold $\Delta\phi = 10.0^\circ$

Permissive tolerance/Limiting values: 44 ms to 63 ms + OOT at 50 Hz
36 ms to 53 ms + OOT at 60 Hz

Test results/Remarks: 44 ms ≤ t ≤ 63 ms + OOT at 50 Hz
36 ms ≤ t ≤ 53 ms + OOT at 60 Hz

1.9.3.3 Operate delay

Test condition: $V = V_{rated}$
Change $\Delta\phi$ to + 15.0 ° at threshold $\Delta\phi = 10.0^\circ$

Test values: 0.00 s ≤ T < 59.90 s
(the range of operate delay: 0.00 s ≤ T < 60.00 s, but the setting must less than T-reset, so test range: 0.00 s ≤ T < 59.90 s)

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.9.3.4 T Reset

Test condition: $V = V_{rated}$
Change $\Delta\phi$ to + 15.0 ° at threshold $\Delta\phi = 10.0^\circ$

Test values: 0.00 s ≤ T < 60.00 s

Permissive tolerance/Limiting values: ±1 % of setting value or 10 ms

Test results/Remarks: ≤ 1 % of setting value or ≤ 10 ms

1.9.4 Stage I1 < Release

1.9.4.1 Pickup value

1.9.4.1.1 I<Threshold

Test condition: $V = V_{rated}$

Test values: 0.030 A < threshold value ≤ 10.000 A

(the range of I<Threshold: 0.030 A ≤ Threshold value ≤ 30.000 A)

Permissive tolerance/Limiting values: ±1 % setting value or 0.010 I_{rated}

Test results/Remarks: ≤ 1 % setting value or ≤ 0.010 I_{rated}

Summary

1.10 25 Synchronization Function

1.10.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.10.2 Tolerances

1.10.2.1 Tolerances of the voltage settings

Permissive tolerance/Limiting values: 2 % of setting value or 1 V

Test results/Remarks: £ 2 % or £ 1 V

1.10.2.2 Voltage difference $V2 > V1$; $V2 < V1$

Permissive tolerance/Limiting values: 1 V

Test results/Remarks: £ 0,15 V

1.10.2.3 Frequency difference $f2 > f1$; $f2 < f1$

Permissive tolerance/Limiting values: 1 mHz

Test results/Remarks: £ 1 mHz

1.10.2.4 Angular difference $\alpha2 > \alpha1$; $\alpha2 < \alpha1$

Permissive tolerance/Limiting values: 1 °

Test results/Remarks: £ 0,2 °

1.10.2.5 Tolerance of all time settings

Permissive tolerance/Limiting values: 10 ms

Test results/Remarks: £ 10 ms

1.10.2.6 Max. phase displacement angle

Permissive tolerance/Limiting values: 5 ° for $\Delta f \leq 1$ Hz
10 ° for $\Delta f > 1$ Hz

Test results/Remarks: ≤ 5 ° for $\Delta f \leq 1$ Hz
 ≤ 10 ° for $\Delta f > 1$ Hz

1.10.3 Tested functionality

Test values: Synchronous operation mode
Asynchronous operation mode
De-energized switching
- Dead line
- Dead bus
Df/dt limitation
Low frequent oscillations
Direct closing
Function values
Error reactions
Threshold values for
- Voltages and voltage difference

Summary

- Frequency and frequency difference
- Angle difference
- Rate of frequency change
- Delay time
- Binary inputs
- Start and stop
- Selection
- Blocking
- De-energized switching
- Start synchronization by
- Control function
- Auto recloser
- Binary input
- Conditions
- Connection types Ph-Ph and Ph-Gnd
- 3ph and 1ph measuring points
- V sync. Selection by measuring point ID

Test results/Remarks:

Functionality according to manual confirmed

Summary

1.11 90V Voltage Control

1.11.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B

1.11.2 General Test conditions

f_{rated} : 50 Hz, 60 Hz

I_{rated} : 1 A, 5 A

V_{rated} : 100 V

1.11.3 Voltage Control

1.11.3.1 Target voltage

Test condition: 10.000 V $\leq V_{target} \leq$ 340.000 V

Permissive tolerance/Limiting values: $|d| \leq 0.5\%$ of setting value or 0.05 V

Test results/Remarks: $|d| < 0.5\%$ of setting value or 0.05 V

1.11.3.2 Bandwidth

Test condition: 0.2 % to 10.0 %

Test results/Remarks: confirmed

1.11.4 Line compensation LDC-Z

1.11.4.1 Target voltage rising

Test condition: 0.0 % to 20.0 %

Test results/Remarks: confirmed

1.11.4.2 Max load current

Test condition: 0.0 % to 500.0 %

Test results/Remarks: confirmed

1.11.5 Line compensation LDC-X and R

1.11.5.1 R line

Test condition: 0.0 Ω to 30.0 Ω

Test results/Remarks: confirmed

1.11.5.2 X line

Test condition: -30.0 Ω to 30.0 Ω

Test results/Remarks: confirmed

Summary

1.11.6 Limiting

1.11.6.1 V_{min} Threshold

Test condition: 10.000 V ≤ V_{min} ≤ 340.000 V

Permissive tolerance/Limiting values: |d| ≤ 0.5 % of setting value or 0.05 V

Test results/Remarks: |d| < 0.5 % of setting value or 0.05 V

1.11.6.2 V_{max} Threshold

Test condition: 10.000 V ≤ V_{max} ≤ 340.000 V

Permissive tolerance/Limiting values: |d| ≤ 0.5 % of setting value or 0.05 V

Test results/Remarks: |d| < 0.5 % of setting value or 0.05 V

1.11.6.3 V_{min} Time delay

Test condition: added to the inherent operating times

Test values: 0 s ≤ T ≤ 20 s

Permissive tolerance/Limiting values: |d| ≤ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % or 10 ms

1.11.6.4 V_{max} Time delay

Test condition: added to the inherent operating times

Test values: 0 s ≤ T ≤ 20 s

Permissive tolerance/Limiting values: |d| ≤ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % or 10 ms

1.11.7 Blockings

1.11.7.1 V < Threshold

Test condition: 10.000 V ≤ V_{min} ≤ 340.000 V

Permissive tolerance/Limiting values: |d| ≤ 0.5 % of setting value or 0.05 V

Test results/Remarks: |d| < 0.5 % of setting value or 0.05 V

1.11.7.2 I > Threshold

Test condition: 10 % ≤ I > ≤ 500 %

Test results/Remarks: confirmed

1.11.7.3 I < Threshold

Test condition: 3 % ≤ I < ≤ 100 %

Summary

Test results/Remarks: confirmed

1.11.7.4 V< Time delay

Test condition: added to the inherent operating times

Test values: 0 s £ T £ 20 s

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % or 10 ms

1.11.7.5 I> Time delay

Test condition: added to the inherent operating times

Test values: 0 s £ T £ 20 s

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % or 10 ms

1.11.7.6 I< Time delay

Test condition: added to the inherent operating times

Test values: 0 s £ T £ 20 s

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 10 ms

Test results/Remarks: |d| < 1 % or 10 ms

Summary**1.12 Supervision Functions****1.12.1 Voltage-transformer circuit breaker**

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: Function correct

1.12.2 Current-balance supervision

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: Function correct

1.12.3 Voltage-balance supervision

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: Function correct

1.12.4 Current-sum supervision

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: Function correct

1.12.5 Voltage-sum supervision

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: Function correct

1.12.6 Measuring-voltage failure (Fuse failure monitor)

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: Function correct

1.12.7 Current phase rotation supervision

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: Function correct

1.12.8 Voltage phase rotation supervision

Permissive tolerance/Limiting values: funct. acc. to manual

Test results/Remarks: Function correct

1.12.9 74TC Trip circuit supervisionTest condition: Number trip circuit: 1 to 3
Operation mode: with 1 or 2 BI

Permissive tolerance/Limiting values: funct. acc. to manual

Summary

Test results/Remarks:

Function correct

Summary

1.13 Operational Measured Values

1.13.1 Specifications

- IEC/EN 60255-1, Annex A, B

1.13.2 Currents, instrument transformers

Test condition:	Current range	< 1.6 I _{rated}
	Nominal range	1 A, 5 A
	Measuring ranges	(0.1 to 1.6) I _{rated}
	Frequency range:	
	f _{rated} = 50 Hz:	49 Hz to 51 Hz
	f _{rated} = 60 Hz:	59 Hz to 61 Hz
Test values:	I _A , I _B , I _C , 3I ₀ in A (prim), A (sec), % (of I _{rated})	
Permissible tolerance/Limiting values:	± 0.15 % of the measured value in the above mentioned ranges	
Test results/Remarks:	± 0.15 %	
Test condition:	Frequency range:	
	f _{rated} = 50 Hz:	40 Hz to 60 Hz
	f _{rated} = 60 Hz:	50 Hz to 70 Hz
Test values:	I _A , I _B , I _C , 3I ₀ in A (prim), A (sec), % (of I _{rated})	
Permissible tolerance/Limiting values:	± 0.3 % of the measured value in the above mentioned ranges	
Test results/Remarks:	± 0.3 %	

1.13.3 Currents, protection-class transformers

Test condition:	Current range	<100 I _{rated} ¹ , <50 I _{rated} ²
	Nominal range	1 A, 5 A
	Measuring ranges	0.1 to 25 A
	Frequency range:	
	f _{rated} = 50 Hz:	49 Hz to 51 Hz
	f _{rated} = 60 Hz:	59 Hz to 61 Hz
Test values:	I _A , I _B , I _C , 3I ₀ in A (prim), A (sec), % (of I _{rated})	
Permissible tolerance/Limiting values:	± 0.2 % of the measured value in the above mentioned ranges	
Test results/Remarks:	± 0.2 % of the measured value	
Test condition:	Frequency range:	
	f _{rated} = 50 Hz:	40 Hz to 60 Hz
	f _{rated} = 60 Hz:	50 Hz to 70 Hz
Test values:	I _A , I _B , I _C , 3I ₀ in A (prim), A (sec), % (of I _{rated})	

¹ for modular device only

² for non-modular device only

Summary

Permissive tolerance/Limiting values: £ 0.3 % of the measured value in the above mentioned ranges

Test results/Remarks: £ 0.3 %

1.13.4 Voltages

Test condition: Voltage Range < 200 V (sec.)

Secondary rated voltage 100 V to 125 V

Measuring Range (1.1 to 2) V_{rated}

Frequency range:

$f_{rated} = 50 \text{ Hz}$: 49 Hz to 51 Hz

$f_{rated} = 60 \text{ Hz}$: 59 Hz to 61 Hz

Test values: $V_A, V_B, V_C, V_{AB}, V_{BC}, V_{CA}$ in kV (prim), in V (sec), % of V_{rated}

Permissive tolerance/Limiting values: 0.2 % of the measured value in the above mentioned ranges

Test results/Remarks: £ 0.2 %

Test condition:

Frequency range:

$f_{rated} = 50 \text{ Hz}$: 40 Hz to 60 Hz

$f_{rated} = 60 \text{ Hz}$: 50 Hz to 70 Hz

Test values: $V_A, V_B, V_C, V_{AB}, V_{BC}, V_{CA}$ in kV (prim), in V (sec), % of V_{rated}

Permissive tolerance/Limiting values: 0.3 % of the measured value in the above mentioned ranges

Test results/Remarks: £ 0.3 %

1.13.5 Phase angle, current and voltage

Test condition: I_{rated}, V_{rated}

Frequency range:

$f_{rated} = 50 \text{ Hz}$: 47.5 Hz to 52.5 Hz

$f_{rated} = 60 \text{ Hz}$: 57.5 Hz to 62.5 Hz

(operative range 10 Hz to 80 Hz with higher tolerances)

Test values: $\varphi (I_A-I_B), \varphi (I_B-I_C), \varphi (I_C-I_A)$ in °
 $\varphi (V_A-V_B), \varphi (V_B-V_C), \varphi (V_C-V_A)$ in °

Permissive tolerance/Limiting values: Current $\leq 0.2^\circ$ at I_{rated}
Voltage $\leq 0.2^\circ$ at V_{rated}

Test results/Remarks: Current $< 0.2^\circ$ at I_{rated}
Voltage $< 0.2^\circ$ at V_{rated}

1.13.6 Power, ratings

1.13.6.1 Active Power P

Test condition: W secondary

Measuring Range: $|\cos\varphi| \geq 0.01$

Voltage Range: (0.8 to 1.2) V_{rated}

Summary

Current range:	(0.1 to 2) I _{rated}
Frequency range:	
f _{rated} = 50 Hz:	49 Hz to 51 Hz
f _{rated} = 60 Hz:	59 Hz to 61 Hz
Test values:	P, P _A , P _B , P _C in W (secondary)
Permissive tolerance/Limiting values:	£ 0.3 % of the measured value in the above mentioned ranges
Test results/Remarks:	£ 0.3 %
Test condition:	Frequency range:
	f _{rated} = 50 Hz: 40 Hz to 60 Hz
	f _{rated} = 60 Hz: 50 Hz to 70 Hz
Test values:	P, P _A , P _B , P _C in W (secondary)
Permissive tolerance/Limiting values:	£ 0.5 % of the measured value in the above mentioned ranges
Test results/Remarks:	£ 0.5 %

1.13.6.2 Reactive Power Q

Test condition:	VAr secondary
Measuring Range:	cosφ ≥ 0.984
Voltage Range:	(0.8 to 1.2) V _{rated}
Current range:	(0.1 to 2) I _{rated}
Frequency range:	
f _{rated} = 50 Hz:	49 Hz to 51 Hz
f _{rated} = 60 Hz:	59 Hz to 61 Hz
Test values:	Q, Q _A , Q _B , Q _C in VAr (secondary)
Permissive tolerance/Limiting values:	£ 1 % of the measured value in the above mentioned ranges
Test results/Remarks:	£ 1 %
Test condition:	Frequency range:
	f _{rated} = 50 Hz: 40 Hz to 60 Hz
	f _{rated} = 60 Hz: 50 Hz to 70 Hz
Test values:	Q, Q _A , Q _B , Q _C in VAr (secondary)
Permissive tolerance/Limiting values:	£ 1.5 % of the measured value in the above mentioned ranges
Test results/Remarks:	£ 1.5 %

1.13.6.3 Apparent Power S

Test condition:	VA secondary
Measuring Range:	(0.01 to 2) S _{rated}
Voltage Range:	(0.8 to 1.2) V _{rated}

Summary

Current range:	(0.1 to 2) I_{rated}
Frequency range:	
$f_{rated} = 50$ Hz:	49 Hz to 51 Hz
$f_{rated} = 60$ Hz:	59 Hz to 61 Hz
Test values:	S, S_A , S_B , SC in VA (secondary)
Permissive tolerance/Limiting values:	£ 0.3 % of the measured value in the above mentioned ranges
Test results/Remarks:	£ 0.3 %
Test condition:	Frequency range: $f_{rated} = 50$ Hz: 40 Hz to 60 Hz $f_{rated} = 60$ Hz: 50 Hz to 70 Hz
Test values:	S, S_A , S_B , SC in VA (secondary)
Permissive tolerance/Limiting values:	£ 0.5 % of the measured value in the above mentioned ranges
Test results/Remarks:	£ 0.5 %

1.13.7 Frequency

Test condition:	Frequency range	10 Hz to 80 Hz
Test values:	f in Hz and f_{rated}	
Permissive tolerance/Limiting values:	£ 20 mHz in the range $f_{rated} \pm 10$ % at V_{rated} , I_{rated}	
Test results/Remarks:	£ 10 mHz in the range $f_{rated} \pm 10$ % at V_{rated} , I_{rated} (operative range > $f_{rated} \pm 10$ % with higher tolerances)	

Summary**1.14 Interfaces****1.14.1 USB interface (front panel)**

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

1.14.2 Integrated ethernet interface (rear)

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

1.14.3 System interfaces**1.14.3.1 IEC 60870-5-103**

Test values: RS232, RS485, LWL

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

1.14.3.2 IEC 60870-5-104

Test values: LWL

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

1.14.3.3 DNP3.0

Test values: RS485, LWL

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

1.14.3.4 IEC 61850 (Edition 1 and 2)

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

1.14.4 Time synchronization

Test condition: IRIG-B, DCF77, SNTP

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

1.14.5 Protection interfaces

Test values: Transmission of status information

Summary

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

1.14.6 Phasor measurement unit (PMU)

Permissive tolerance/Limiting values: Accuracy according to IEEE C37.118.1 (class P)
Accuracy according to IEEE C37.118.1 (class M)

Test results/Remarks: Requirements for class P and M in accordance to IEEE C37.118.1 passed