SIEMENS

**Division Energy Management**
**Digital Grid**

# Test Report

**Test Report No. :** **TS0817-005**

**Date of issue :** **2017-09-21**

**Subject:**

**Type test Numerical Line Protection SIPROTEC 5 - V07.50 / Edition 12**

**The tests were performed by:**

SIEMENS AG
Development
EM DG PRO D
Wernerwerkdamm 5
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**The tests were performed for:**

SIEMENS AG
Products
EM DG PRO LM
Humboldtstr. 59
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This test report consists of 152 pages.

| | |
|---|---|
| **Tested equipment** | **Multifunction Protection Relays SIPROTEC 5**<br><br>**Product group: Numerical Line Protection**<br>7SA84, 7SA86, 7SA87, 7SD84, 7SD86, 7SD87, 7SJ86, 7SL86, 7SL87, 7VK87, 7SA82, 7SD82, 7SL82<br><br>**Firmware V07.50** |
| **Tests are according to:** | **IEC/EN 60255, VDE 0435, IEC/ EN 60870-2-1, UL 508, IEC/EN 60255-25/26, IEC/EN 61000-6-2, IEC/EN 61000-6-4, IEEE Std C37.90.1/2** |
| **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 D**
**13629 Berlin (Siemensstadt)**

**Date:** **2017-09-21**

**Tested by: Ryzek**

Signature

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**Reviewed by: Rochow**

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:

| Model of Protective Relay | | Trip Detection | Quantity structure |
|---|---|---|---|
| 7SA82 | Distance Protection | 3 pole trip | I/Os not extendable |
| 7SD82 | Differential Protection | 3 pole trip | I/Os not extendable |
| 7SL82 | Line Protection | 3 pole trip | I/Os not extendable |
| 7SA84 | Distance Protection | 3 pole trip | I/Os not extendable |
| 7SD84 | Differential Protection | 3 pole trip | I/Os not extendable |
| 7SA86 | Distance Protection | 3-pole trip | I/Os fully modular |
| 7SD86 | Differential Protection | 3-pole trip | I/Os fully modular |
| 7SL86 | Line Protection | 3-pole trip | I/Os fully modular |
| 7SJ86 | Over Current Protection | 3-pole trip | I/Os fully modular |
| 7SA87 | Distance Protection | 1 and 3 pole trip | I/Os fully modular |
| 7SD87 | Differential Protection | 1 and 3 pole trip | I/Os fully modular |
| 7SL87 | Line Protection | 1 and 3 pole trip | I/Os fully modular |
| 7VK87 | Breaker Management Device | 1 and 3 pole trip | I/Os fully modular |

## 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 2nd 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 |
| CP200/CP300 | Processor (CPU) Board, mounted into the front cover of the 1/3 19-inch size housing, different variants for the aviable 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 size housing |
| IO233 | Input Board, 48 binary inputs (a fixed pickup threshold value of DC 105 V |

## Range of validity

| | |
|---|---|
| | 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 | 2012-02-17 | First edition, Software V01.00 |
| 02 | 2012-04-20 | Revision and extended at Software V01.11 |
| 03 | 2012-12-03 | Revision and extended at Software V02.00 |
| 04 | 2013-04-09 | Revision and extended at Software V03.00 |
| 05 | 2013-12-20 | Revision and extended at Software V04.00 |
| 06 | 2014-07-18 | Revision and extended at Software V05.00 |
| 07 | 2014-12-19 | Revision and extended at Software V06.00 |
| 08 | 2015-04-25 | Extended at Software V06.04 |
| 09 | 2015-12-18 | Revision and extended at Software V07.00 |
| 10 | 2016-07-18 | Revision and extended at Software V07.30 |
| 11 | 2017-02-28 | Revision and extended at Software V07.34 |
| 12 | 2017-09-21 | Revision and extended at Software V07.50 |

## Subcontracting

| Testing laboratory | Marking |
| --- | --- |

## Technical information; Technical Data

**Technical Information; Description:**

| | Manual | | | Edition |
|---|---|---|---|---|
| 1. | SIPROTEC 5<br>Protection Devices<br>Product Information | Part No. | C53000-B5000-C001-B<br>C53000-B5040-C001-B | German<br>English |
| 2. | SIPROTEC 5<br>Hardware<br>Manual | Part No. | C53000-G5000-C002-A<br>C53000-G5040-C002-A | German<br>English |
| 3. | SIPROTEC 5<br>Operating<br>Manual | Part No. | C53000-G5000-C003-6<br>C53000-G5040-C003-6 | German<br>English |
| 4. | SIPROTEC 5<br>Distance Protection, Line Differential Protection and Overcurrent Protection for 3-Pole Tripping 7SA82, 7SD82, 7SL82,7SA84, 7SD84, 7SA86, 7SD86, 7SL86, 7SJ86<br>Manual | Part No. | C53000-G5000-C010-7<br>C53000-G5040-C010-7 | German<br>English |
| 5. | SIPROTEC 5<br>Distance Protection, Line Differential Protection and Breaker Management for 1-Pole and 3-Pole Tripping 7SA87, 7SD87, 7SL87, 7VK87<br>Manual | Part No. | C53000-G5000-C011-7<br>C53000-G5040-C011-7 | German<br>English |
| 6. | SIPROTEC 5<br>Distance Protection, Line Differential Protection and Breaker Management for 1-Pole and 3-Pole Tripping 7SA87, 7SD87, 7SL87, 7VK87<br>Manual | Part No. | C53000-G5000-C011-9<br>C53000-G5040-C011-9 | German<br>English |

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

## Summary

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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 measurings

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 87L Line Differential Protection

### 1.2.1 Specifications

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

### 1.2.2 Tripping threshold Idiff stage

#### 1.2.2.1 Pickup values

Test condition: fault L-N , $f_{rated}$= 50 Hz, 60 Hz
0.100 $I_{rated}$ £ Iph> £ 20.000 $I_{rated}$

Test values: 0.100 A £ Iph> £ 04.000 A for $I_{rated}$ = 1 A
0.500 A £ Iph> £ 04.000 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 % or <1 % $I_{rated}$ for 2 line ends

#### 1.2.2.2 Dropout ratio

Test condition: see item 1.2.2.1

Test values: see item 1.2.2.1

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

#### 1.2.2.3 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: $I_{fault}$ = 1 A, Iph> = 0.300 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

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

### 1.2.2.4 Dropout times

Test condition: see item 1.2.2.3

Test values: see item 1.2.2.3

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

### 1.2.2.5 Delay times

Test condition: 0.00 s £ $T_{Idiff}$ £ 60.00 s
0.00 s £ $T_{3I0}$ £ 0.50 s

Test values: 0.00 s £ $T_{Idiff}$ £ 60.00 s
0.00 s £ $T_{3I0}$ £ 0.50 s

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

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

### 1.2.3 Tripping threshold Idiff fast stage

### 1.2.3.1 Pickup values

Test condition: fault L-N , $f_{rated}$= 50 Hz, 60 Hz
0.800 $I_{rated}$ £ Iph> £ 100.000 $I_{rated}$

Test values: 0.800 A £ Iph> £ 7.000 A for $I_{rated}$ = 1 A
4.000 A £ Iph> £ 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

### 1.2.3.2 Dropout ratio

Test condition: see item 1.2.3.1

Test values: see item 1.2.3.1

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

## Summary

### 1.2.3.3 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, Iph> = 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 | 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

### 1.2.3.4 Dropout times

Test condition: see item 1.2.3.3

Test values: see item 1.2.3.3

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

### 1.2.4 Tripping threshold Idiff fast 2 stage

### 1.2.4.1 Pickup values

Test condition: fault L-N , $f_{rated}$= 50 Hz, 60 Hz
0.500 $I_{rated}$ £ Iph> £ 100.000 $I_{rated}$

Test values:
0.500 A £ Iph> £ 7.000 A for $I_{rated}$ = 1 A
4.000 A £ Iph> £ 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

## Summary

### 1.2.4.2 Dropout ratio

Test condition: see item 1.2.3.1

Test values: see item 1.2.3.1

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

### 1.2.4.3 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, Iph> = 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 | 13/15/16 |
| 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

### 1.2.4.4 Dropout times

Test condition: see item 1.2.3.3

Test values: see item 1.2.3.3

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

### 1.2.5 Auto-stabilization

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

### 1.2.6 Transformer inside protection range

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

### 1.2.7 Charging-Current compensation

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

## Summary

### 1.3 Stub Protection

#### 1.3.1 Specifications

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

#### 1.3.2 Tripping threshold S-DIFF stage

##### 1.3.2.1 Threshold values

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

##### 1.3.2.2 Operating times

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

##### 1.3.2.3 Dropout times

| | |
|---|---|
| Test condition: | see item 1.3.2.2 |
| Test values: | see item 1.3.2.2 |
| Permissive tolerance/Limiting values: | 34 ms to 50 ms |
| Test results/Remarks: | 34 ms £ t £ 49 ms |

##### 1.3.2.4 Delay times

| | |
|---|---|
| Test condition: | 0.00 s £ T £ 60.00 s |
| 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 < 10ms |

#### 1.3.3 Tripping threshold S-DIFF fast stage

##### 1.3.3.1 Threshold values

| | |
|---|---|
| Test condition: | fault L-N , $f_{rated}$= 50 Hz, 60 Hz<br>0.800 $I_{rated}$ £ $I_{ph>}$ £ 100.000 $I_{rated}$ |
| Test values: | 0.800 A £ $I_{ph>}$ £ 09.000 A for $I_{rated}$ = 1 A<br>4.000 A £ $I_{ph>}$ £ 10.000 A for $I_{rated}$ = 5 A |
| Permissive tolerance/Limiting values: | deviation d of set point value<br>\|d\| £ 5 % of setting value or £ 1 % of $I_{rated}$ |
| Test results/Remarks: | \|d\| < 5 % or <1 % of $I_{rated}$ |

## Summary

**1.3.3.2 Tripping times**

| | |
|---|---|
| Test condition: | fault L-N , $f_{rated}$= 50 Hz, 60 Hz, $I_{rated}$ = 1 A |
| Test values: | $I_{ph}$> = 1.000 A<br>t in ms |
| Permissive tolerance/Limiting values: | appr. 12 ms + OOT |
| Test results/Remarks: | $t_{min}$ 8 ms + OOT, $t_{typ}$ 11 ms + OOT |

**1.3.3.3 Dropout times**

| | |
|---|---|
| Test condition: | see item 1.3.3.2 |
| Test values: | see item 1.3.3.2 |
| Permissive tolerance/Limiting values: | 34 ms to 50 ms |
| Test results/Remarks: | 34 ms £ t £ 49 ms |

**1.3.4 Tripping threshold S-DIFF fast 2 stage**

**1.3.4.1 Threshold values**

| | |
|---|---|
| Test condition: | fault L-N , $f_{rated}$= 50 Hz, 60 Hz<br>0.800 $I_{rated}$ £ $I_{ph>}$ £ 100.000 $I_{rated}$ |
| Test values: | 0.800 A £ $I_{ph>}$ £ 09.000 A for $I_{rated}$ = 1 A<br>4.000 A £ $I_{ph>}$ £ 10.000 A for $I_{rated}$ = 5 A |
| Permissive tolerance/Limiting values: | deviation d of set point value<br>\|d\| £ 5 % of setting value or £ 1 % of $I_{rated}$ |
| Test results/Remarks: | \|d\| < 5 % or < 1 % of $I_{rated}$ |

**1.3.4.2 Tripping times**

| | |
|---|---|
| Test condition: | fault L-N , $f_{rated}$= 50 Hz, 60 Hz, $I_{rated}$ = 1 A |
| Test values: | $I_{ph}$> = 1.000 A<br>t in ms |
| Permissive tolerance/Limiting values: | appr. 12 ms + OOT |
| Test results/Remarks: | $t_{min}$ 8 ms + OOT, $t_{typ}$ 11 ms + OOT |

**1.3.4.3 Dropout times**

| | |
|---|---|
| Test condition: | see item 1.3.3.2 |
| Test values: | see item 1.3.3.2 |
| Permissive tolerance/Limiting values: | 34 ms to 50 ms |
| Test results/Remarks: | 34 ms £ t £ 49 ms |

## Summary

### 1.4 21 Distance Protection Reactance Method

#### 1.4.1 Specifications

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

#### 1.4.2 Minimum current threshold

##### 1.4.2.1 Phase current threshold

| | |
|---|---|
| Test condition: | fault L-N, $f_{rated}$= 50 Hz, 60 Hz<br>0.03 $I_{rated}$ £ Iph £ 4.00 $I_{rated}$ |
| Test values: | 0.10 $I_{rated}$ £ Iph £ 4.00 $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| £ 0.5 % |

##### 1.4.2.2 Earth current threshold

| | |
|---|---|
| Test condition: | fault L-N, $f_{rated}$= 50 Hz, 60 Hz<br>0.03 $I_{rated}$ £ Iph £ 4.00 $I_{rated}$ |
| Test values: | 0.10 $I_{rated}$ £ Iph £ 4.00 $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| £ 0.5 % |

#### 1.4.3 Pickup values phase-fault-detection

##### 1.4.3.1 Current

| | |
|---|---|
| Test condition: | fault L-L, $f_{rated}$= 50 Hz, 60 Hz<br>0.03 $I_{rated}$ £ Iph £ 35.00 $I_{rated}$ |
| Test values: | 1.00 $I_{rated}$ £ Iph £ 4.00 $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| £ 0.5 % |

##### 1.4.3.2 Voltage

| | |
|---|---|
| Test condition: | fault L-L, $f_{rated}$= 50 Hz, 60 Hz<br>0.500 V £ Vph-gnd £ 70.00 V<br>1.000 V £ Vph-ph £ 130.0 V |
| Test values: | 5.00 V £ Vph-gnd £ 50.00 V<br>8.00 V £ Vph-ph £ 80.0 V |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| < 0.5 % |

#### 1.4.4 Pickup values ground-fault detection

##### 1.4.4.1 Residual (ground) current

| | |
|---|---|
| Test condition: | - 3I0,3V0 calculated<br>- 3I0,3V0 measured<br>fault L-N, $f_{rated}$= 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ 3I0> £ 35.00 $I_{rated}$ |
| Test values: | 3I0> = (0.1 , 4 , 10) $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| £ 0.5 % |

##### 1.4.4.2 Displacement voltage

| | |
|---|---|
| Test condition: | - 3I0,3V0 calculated<br>- 3I0,3V0 measured<br>fault L-N, $f_{rated}$= 50 Hz, 60 Hz<br>0.300 V £ V0> £ 35.000 V |
| Test values: | V0> /3V0 = 0.3 V to 35 V |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| £ 0.5 % |

## Summary

### 1.4.5 Loop selection for double faults

Test condition: - grounded systems

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

### 1.4.6 Distance measurement

#### 1.4.6.1 Balance-points for polygonal characteristic

Test condition: parameters:

- Line Angle = 60°, DeltaDistAngle = α
- Zone Z1: X1 = R1E = 2R1 = 2.5 W, α(Z1) = 30°
- Zone Z2: X2 = 0.5 R2E = R2 = 5.0 W, α(Z2) = 20°
- Zone Z3: X3 = R3E = R3 = 10.0 W, α(Z3) = 10°
- Zone Z4: X4 = R4E = R4 = 12.0 W, α(Z4) = 15°

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 %

#### 1.4.6.2 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-L,L-L-L ; Angle φ(U,I) in range 0...360° with steps of 5°

Test results/Remarks:
Zone Z1: |d| £ 3 %
Zone Z2: |d| £ 3 %
Zone Z3: |d| £ 3 %
Zone Z4: |d| £ 3 %

### 1.4.7 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

### 1.4.8 Time stages of distance zones

#### 1.4.8.1 Shortest trip

Test condition:
fault L-N,L-L,L-L-L
fault angle 90°
SIR 1

Permissive tolerance/Limiting values:
- $f_{rated}$ = 50 Hz: $t_{op.min}$ approx. 17/12 ms (fast relay/high speed relay)
- $f_{rated}$ = 60 Hz: $t_{op.min}$ approx. 15/10 ms (fast relay/high speed relay)

Test results/Remarks:
- $f_{rated}$ = 50 Hz: $t_{op.min}$ approx. 13.8 ms (fast relay)
- $f_{rated}$ = 60 Hz: $t_{op.min}$ approx. 13.5 ms (fast relay)

#### 1.4.8.2 Dropout times

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

Permissive tolerance/Limiting values: t approx. 30 ms

Test results/Remarks: t approx. 20 ms

#### 1.4.8.3 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; ¥

## Summary

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

Test results/Remarks: |d| £ 0.5 % or 5 ms

### 1.4.8.4 Zone directions

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

### 1.4.9 Dynamical performance

### 1.4.9.1 Influence of SIR and Xk

Test condition:
Zone 1
Angle $\varphi_{line}$ = 85°
TAUsource = 100 ms
$f_{rated}$ = 50 Hz, 60 Hz
Tests for polygonal and MHO characteristics

Test values:
- Fault L-N,L-L,L-L-L
- Phase angle φ(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
- Xl = 10 W

### 1.4.9.2 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/Xl = 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 Hz:

| | |
|---|---|
| 0.00 £ Xk/Xl £ 0.35 | 13.8 ms £ $t_{op}$ £ 18.9 ms (fast relay) |
| 0.40 £ Xk/Xl £ 0.65 | 16.4 ms £ $t_{op}$ £ 20.7 ms (fast relay) |
| 0.75 £ Xk/Xl £ 0.95 | 18.2 ms £ $t_{op}$ £ 35.6 ms (fast relay) |
| 1.01 £ Xk/Xl £ 1.10 | $t_{op}$ = T2 ; Overreach < 1 % (fast relay) |

$f_{rated}$ = 60 Hz:

| | |
|---|---|
| 0.00 £ Xk/Xl £ 0.35 | 13.5 ms £ $t_{op}$ £ 18.5 ms (fast relay) |
| 0.40 £ Xk/Xl £ 0.65 | 15.9 ms £ $t_{op}$ £ 19.5 ms (fast relay) |
| 0.75 £ Xk/Xl £ 0.95 | 17.0 ms £ $t_{op}$ £ 32.2 ms (fast relay) |
| 1.01 £ Xk/Xl £ 1.10 | $t_{op}$ = T2 ; Overreach < 1 % (fast relay) |

### 1.4.10 Processing of functions

### 1.4.10.1 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

Test results/Remarks: function correct

### 1.4.10.2 Emergency operation

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

## Summary

### 1.5 21 Distance Protection

#### 1.5.1 Specifications

- VDE 0435
- IEC/EN 60255-1, Item 7, Annex A, B
- IEC60255-121

#### 1.5.2 Pickup values phase-fault-detection

##### 1.5.2.1 Current

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ Iph £ 35 $I_{rated}$ |
| Test values: | 0.05 $I_{rated}$ £ Iph £ 10.00 $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| £ 1.0 % or 1 % $I_{rated}$ |

##### 1.5.2.2 Voltage

| | |
|---|---|
| Test condition: | 0.500 V £ Vph-gnd £ 70.00 V<br>1.000 V £ Vph-ph £ 130.0 V |
| Test values: | 5.00 V £ Vph-gnd £ 50.00 V<br>8.00 V £ Vph-ph £ 80.0 V |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| < 5 % or 0.5 V |

#### 1.5.3 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.5.2 |
| Test values: | see item 1.5.2 |
| Permissive tolerance/Limiting values: | r approx. 0.95 |
| Test results/Remarks: | r approx. 0.95 |

#### 1.5.4 Pickup values ground-fault detection

| | |
|---|---|
| Test condition: | - 3I0,3V0 calculated<br>- 3I0,3V0 measured |
| Test values: | fault L-N, $f_{rated}$= 50 Hz, 60 Hz |
| <u>Residual (ground) current:</u> | |
| 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 % $I_{rated}$ |
| <u>Displacement voltage</u> | |
| Test condition: | 0.300 V £ V0> £ 35.000 V |
| Test values: | V0> /3V0 = 0.3 V to 35 V |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| £ 1.0 % or 0.1 % $V_{rated}$ |

#### 1.5.5 Loop selection for double faults

| | |
|---|---|
| Test condition: | - grounded systems<br>- isolated systems<br>- resonant-grounded |
| Permissive tolerance/Limiting values: | function according to manual |
| Test results/Remarks: | function correct |

## Summary

### 1.5.6 Distance measurement

#### 1.5.6.1 Balance-points for polygonal characteristic

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

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 %

#### 1.5.6.2 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 φ(U,I) in range 0...360° with steps of 5°

Test results/Remarks:
Zone Z1: |d| £ 3 %
Zone Z2: |d| £ 3 %
Zone Z3: |d| £ 3 %
Zone Z4: |d| £ 3 %

#### 1.5.6.3 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 φ(U,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:
Zone Z1: |d| £ 3 %
Zone Z2: |d| £ 3 %
Zone Z3: |d| £ 3 %
Zone Z4: |d| £ 3 %

### 1.5.7 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

### 1.5.8 Time stages of distance zones

#### 1.5.8.1 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)

#### 1.5.8.2 Shortest trip time I-Pickup

Test condition:
fault L-N,L-L,L-L-L
fault angle 90°
SIR 1

## Summary

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)

### 1.5.8.3 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)

### 1.5.8.4 Shortest trip time V/I/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)

### 1.5.8.5 Dropout times

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

Test results/Remarks:
$t_{avg}$ = 30 ms

### 1.5.8.6 Tolerances of time stages

Test condition:
time stages:
$T1_{1pol}$; $T2_{1pol}$; $T3_{1pol}$; $T4_{1pol}$
$T1_{>1pol}$; $T2_{>1pol}$; $T3_{>1pol}$; $T4_{>1pol}$

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

### 1.5.8.7 Zone directions

Permissive tolerance/Limiting values:
function according to manual

Test results/Remarks:
function correct

### 1.5.9 Dynamical performance

### 1.5.9.1 Influence of SIR and Xk

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

Test values:
- Fault L-N,L-L,L-L-L
- Phase angle φ(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
- Xl = 10 W

## Summary

### 1.5.9.2 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/Xl = 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 Hz:

| | |
|---|---|
| 0.00 £ Xk/Xl £ 0.35 | 14 ms £ t £ 24 ms (fast relay) |
| 0.40 £ Xk/Xl £ 0.65 | 17 ms £ t £ 24 ms (fast relay) |
| 0.75 £ Xk/Xl £ 0.95 | 27 ms £ t £ 38 ms (fast relay) |
| 1.01 £ Xk/Xl £ 1.10 | t = T2 ; Overreach < 1 % (fast relay) |

$f_{rated}$ = 60 Hz:

| | |
|---|---|
| 0.00 £ Xk/Xl £ 0.35 | 13 ms £ t £ 24 ms (fast relay) |
| 0.40 £ Xk/Xl £ 0.65 | 16 ms £ t £ 24 ms (fast relay) |
| 0.75 £ Xk/Xl £ 0.95 | 27 ms £ t £ 38 ms (fast relay) |
| 1.01 £ Xk/Xl £ 1.10 | t = T2 ; Overreach < 1 % (fast relay) |

### 1.5.10 Processing of functions

### 1.5.10.1 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

Test results/Remarks: function correct

### 1.5.10.2 Emergency operation

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

## Summary

### 1.6 68 Power Swing Blocking

#### 1.6.1 Power swing detection

##### 1.6.1.1 With Z< fault detection (Polygon)

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

##### 1.6.1.2 With MHO characteristic

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

#### 1.6.2 Power swing programs

##### 1.6.2.1 Block all zones

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

##### 1.6.2.2 Block polygone zone

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

##### 1.6.2.3 Block MHO zone

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

## Summary

### 1.7 Fault Locator

#### 1.7.1 Specifications

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

#### 1.7.2 Distance-to-fault measuring (FOR)

| | |
|---|---|
| Test condition: | Measuring tolerances for sinusoidal values and fault duration > 25 ms |
| Permissive tolerance/Limiting values: | £ 2.0 % of fault location (without intermediate infeed) |
| Test results/Remarks: | < 2.0 % |

#### 1.7.3 Start-to-measure command

| | |
|---|---|
| Test condition: | - by trip signal<br>- by drop-off of pickup |
| Permissive tolerance/Limiting values: | function according to manual |
| Test results/Remarks: | function correct |

## Summary

### 1.8 85-21 Teleprotection With Distance Protection

#### 1.8.1 Permissive underreach transfer trip schemes (PUTT schemes, conventional)

##### 1.8.1.1 PUTT with zone Z1B

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 and 3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

##### 1.8.1.2 PUTT with pickup

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 and 3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.8.2 Permissive overreach transfer trip schemes (POTT schemes, conventional)

##### 1.8.2.1 POTT with zone Z1B

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 and 3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

##### 1.8.2.2 Directional comparison

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 and 3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

##### 1.8.2.3 Z1B unblock

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 and 3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

##### 1.8.2.4 Z1B blocking

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 and 3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.8.3 Echo function

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.8.4 Transient blocking

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.8.5 Reverse Interlocking

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

## Summary

### 1.9 67N Ground-Fault Protection for High-Resistance Ground Faults in Grounded Systems

#### 1.9.1 Specifications

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

#### 1.9.2 Definite time overcurrent stages (3I0-definite time)

##### 1.9.2.1 Pickup values

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

##### 1.9.2.2 Dropout ratio

Test condition: see item 1.9.2.1

Permissive tolerance/Limiting values: r approx. 0.95 threshold

Test results/Remarks: r approx. 0.95 threshold

##### 1.9.2.3 Pickup times

Test condition: see item 1.9.2.1

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

##### 1.9.2.4 Dropout times

Test condition: see item 1.9.2.1

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

##### 1.9.2.5 Time delays

Test condition: added to the inherent operating times

Test values: 0.000 s £ T £ 60.000 s

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

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

##### 1.9.2.6 Direction of directional stage

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

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

##### 1.9.3.1 Pickup

Test condition: see item 1.9.2.1

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.

## Summary

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

**1.9.3.2 Dropout ratio**

Test condition: see item 1.9.2.1

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

Test results/Remarks: confirmed

**1.9.3.3 Pickup times**

Test condition: see item 1.9.2.1

Test values: pickup time for 2 ≤ 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

**1.9.3.4 Dropout times - instantaneous**

Test condition: see item 1.9.2.1

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

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

**1.9.3.5 Dropout times – disk emulation**

Test condition: see item 1.9.2.1

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

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

Test results/Remarks: confirmed

**1.9.3.6 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

**1.9.3.6.1 IEC normal inverse (type A)**
Test results/Remarks: confirmed

**1.9.3.6.2 IEC very inverse (type B)**
Test results/Remarks: confirmed

**1.9.3.6.3 IEC extremely inverse (type C)**
Test results/Remarks: confirmed

**1.9.3.6.4 IEC long-time inverse**
Test results/Remarks: confirmed

**1.9.3.6.5 ANSI long-time inverse**
Test results/Remarks: confirmed

**1.9.3.6.6 ANSI short-time inverse**
Test results/Remarks: confirmed

**1.9.3.6.7 ANSI extremely inverse (type C)**
Test results/Remarks: confirmed

**1.9.3.6.8 ANSI very inverse**
Test results/Remarks: confirmed

**1.9.3.6.9 ANSI normal inverse**
Test results/Remarks: confirmed

**1.9.3.6.10 ANSI moderately inverse**
Test results/Remarks: confirmed

## Summary

**1.9.3.6.11 ANSI definite inverse**
Test results/Remarks: confirmed

**1.9.3.7 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

**1.9.3.7.1 IEC normal inverse (type A)**
Test results/Remarks: confirmed

**1.9.3.7.2 IEC very inverse (type B)**
Test results/Remarks: confirmed

**1.9.3.7.3 IEC extremely inverse (type C)**
Test results/Remarks: confirmed

**1.9.3.7.4 IEC long-time inverse**
Test results/Remarks: confirmed

**1.9.3.7.5 ANSI long-time inverse**
Test results/Remarks: confirmed

**1.9.3.7.6 ANSI short-time inverse**
Test results/Remarks: confirmed

**1.9.3.7.7 ANSI extremely inverse (type C)**
Test results/Remarks: confirmed

**1.9.3.7.8 ANSI very inverse**
Test results/Remarks: confirmed

**1.9.3.7.9 ANSI normal inverse**
Test results/Remarks: confirmed

**1.9.3.7.10 ANSI moderately inverse**
Test results/Remarks: confirmed

**1.9.3.7.11 ANSI definite inverse**
Test results/Remarks: confirmed

**1.9.3.8 Direction of directional stage**

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

**1.9.4 3I0 logarithmic inverse**

**1.9.4.1 Pickup**

Test condition: threshold: see item 1.9.2.1

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 % $I_{rated}$

**1.9.4.2 Dropout ratio**

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

Test results/Remarks: confirmed

**1.9.4.3 Pickup times**

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

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

## Summary

Test results/Remarks: confirmed

**1.9.4.4 Dropout times**

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

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

**1.9.4.5 Tripping time characteristics**

Test values: tripping times t

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

Test results/Remarks: confirmed

**1.9.4.6 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

**1.9.4.7 Direction of directional stage**

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

**1.9.5 3I0 $S_r$ inverse**

**1.9.5.1 Pickup**

Test condition: treshold: see item 1.9.2.1

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 % $I_{rated}$

**1.9.5.2 Dropout ratio**

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

Test results/Remarks: confirmed

**1.9.5.3 Pickup times**

Test values: pickup time for 2 ≤ 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

**1.9.5.4 Dropout times**

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

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

**1.9.5.5 Tripping time characteristics**

Test values: tripping times t

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

Test results/Remarks: confirmed

**1.9.5.6 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

## Summary

Test results/Remarks: confirmed

**1.9.5.7 Direction of directional stage**

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

**1.9.6 3I0 $V_0$ inverse**

**1.9.6.1 Pickup**

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

b) V0 calculated, V0 measured
Threshold:
0.30 V £ V0 £ 200.000 V
V0min for $V_0$-characteristic: 0 V £ V0min £ 200.00 V

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

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

**1.9.6.2 Dropout ratio**

Permissive tolerance/Limiting values: a) 0.95 threshold

b) 0.95 threshold or (threshold – 150mV)

Test results/Remarks: confirmed

**1.9.6.3 Pickup times**

Test values: see 1.9.6.1

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

Test results/Remarks: confirmed

**1.9.6.4 Dropout times**

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

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

**1.9.6.5 Tripping time characteristics**

Test values: tripping times t

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

Test results/Remarks: confirmed

**1.9.6.6 Dropout characteristics**

Test values: dropout times

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

Test results/Remarks: confirmed

**1.9.6.7 Direction of directional stage**

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

**1.9.7 Directional determination**

**1.9.7.1 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

**1.9.7.2 Release threshold of neutral point current IY**

| | |
|---|---|
| Test condition: | fault L-N<br>0.030 A £ IY £ 10.000 A for $I_{rated}$ = 1 A<br>0.150 A £ IY £ 50.000 A for $I_{rated}$ = 5 A |
| Permissive tolerance/Limiting values: | \|d\| £ 1% of setting value or 1 % $I_{rated}$ |
| Test results/Remarks: | confirmed |

**1.9.7.3 Release threshold of negative sequence current I2**

| | |
|---|---|
| Test condition: | fault L-N<br>0.030 A £ I2 £ 10.000 A for $I_{rated}$ = 1 A<br>0.150 A £ I2 £ 50.000 A for $I_{rated}$ = 5 A |
| Permissive tolerance/Limiting values: | \|d\| £ 1% of setting value or 1 % $I_{rated}$ |
| Test results/Remarks: | confirmed |

**1.9.7.4 Release threshold of negative sequence voltage V2**

| | |
|---|---|
| Test condition: | fault L-N<br>0.150 V £ V2 £ 20.000 V |
| Permissive tolerance/Limiting values: | \|d\| £ 1% of setting value or 1 % $I_{rated}$ |
| Test results/Remarks: | confirmed |

**1.9.7.5 Release angle**

| | |
|---|---|
| Test condition: | fault L-N<br>0° £ α £ 360°<br>0° £ β £ 360° |
| Test values: | directional limits, stationary |
| Permissive tolerance/Limiting values: | α, β ± 1.5° |
| Test results/Remarks: | confirmed |

**1.9.8 Processing of functions**

**1.9.8.1 Phase selector**

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

**1.9.8.2 Blocking**

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

**1.9.8.3 Inrush restraint**

| | |
|---|---|
| Test condition: | 10 % £ 2.HARMON.BLOCK £ 45 %<br>0.50 $I_{rated}$ £ I-RUSH-MAX £ 25.00 $I_{rated}$ |
| Permissive tolerance/Limiting values: | function according to manual |
| Test results/Remarks: | function correct |

**1.9.8.4 Switch-onto-fault**

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

## Summary

### 1.10 85-67N Teleprotection with Ground Fault Protection

#### 1.10.1 Directional comparison pickup

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 line ends<br>3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.10.2 Directional comparison unblocking

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 line ends<br>3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.10.3 Directional comparison blocking

| | |
|---|---|
| Test condition: | 2 - 6 line ends |
| Test values: | 2 line ends<br>3 line ends |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.10.4 Echo function

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.10.5 Transient blocking

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

## Summary

### 1.11 Impedance Protection

#### 1.11.1 Specifications

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

#### 1.11.2 Pickup values

##### 1.11.2.1 Current

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ Iph £ 35.000 $I_{rated}$ |
| Test values: | 0.05 $I_{rated}$ £ Iph £ 10.00 $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| £ 1.0 % or 1 % $I_{rated}$ |

##### 1.11.2.2 Voltage

| | |
|---|---|
| Test condition: | 0.500 V £ Vph-gnd £ 70.00 V<br>1.000 V £ Vph-ph £ 130.0 V |
| Test values: | 5.00 V £ Vph-gnd £ 50.00 V<br>8.00 V £ Vph-ph £ 80.0 V |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| < 5 % or 0.5 V |

#### 1.11.3 Dropout ratio

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ Iph £ 35.000 $I_{rated}$ |
| Test values: | 0.05 $I_{rated}$ £ Iph £ 10.00 $I_{rated}$ |
| Permissive tolerance/Limiting values: | r approx. 0.95 |
| Test results/Remarks: | r approx. 0.95 |

#### 1.11.4 Distance measurement

##### 1.11.4.1 Polygonal characteristic

| | |
|---|---|
| Test condition: | parameters:<br>- Zone Z1: X1 = 2.5 W<br>- Zone Z2: X2 = 5.0 W<br>- Zone Z3: X3 = 10.0 W<br>- 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°<br>R: \|d\| £ 5 % of setting value for 0° £ PHI(V,I) £ 60° |
| Test results/Remarks: | X, R:<br>- Zone Z1: \|d\| < 3 %<br>- Zone Z2: \|d\| < 3 %<br>- Zone Z3: \|d\| < 3 %<br>- Zone Z4: \|d\| < 3 % |

#### 1.11.5 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 |

#### 1.11.6 Time stages of distance zones

##### 1.11.6.1 Pickup times

| | |
|---|---|
| Test condition: | fault L-N,L-L,L-L-L<br>fault angle 90°<br>SIR 1<br>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<br>$t_{min}$ = 25.9 ms 21.8 ms |

## Summary

| | | |
|---|---|---|
| $t_{average}$ = | 32.3 ms | 27.4 ms |
| $t_{max}$ = | 37.4 ms | 30.5 ms |

### 1.11.6.2 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 |

### 1.11.6.3 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

### 1.11.6.4 Zone directions

Permissive tolerance/Limiting values: function according to manual

Test results/Remarks: function correct

## Summary

### 1.12 External Trip Initiation

#### 1.12.1 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 |

#### 1.12.2 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 |

#### 1.12.3 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

## 1.13 50/51 Overcurrent Protection, Phases

### 1.13.1 Specifications

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

### 1.13.2 Overcurrent Protection, phases with definite time overcurrent stages (definite time)

#### 1.13.2.1 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 $I_{rated}$

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: 1 % of setting value or 0.005 $I_{rated}$
up to 50th harmonic, $f_{rated}$ = 50 Hz: 2 % of setting value or 0.02 $I_{rated}$
up to 50th harmonic, $f_{rated}$ = 60 Hz: 3 % 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: 2 % of setting value or 0.02 $I_{rated}$
up to 50th harmonic, $f_{rated}$ = 60 Hz: 3 % of setting value or 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: 1.5 % of setting value or 0.01 $I_{rated}$
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: 1.5 % of setting value or 0.01 $I_{rated}$[2]
up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$[3]
up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$[3]

#### 1.13.2.2 Dropout ratio

Test condition: see item 1.13.2.1

Test values: 0.90 £ r £ 0.99

Permissive tolerance/Limiting values: 1 % of dropout value

Test results/Remarks: 1 % of dropout value

#### 1.13.2.3 Pickup times

Test condition: see item 1.13.2.1

Test values: 1.2*threshold

Permissive tolerance/Limiting values:
t approx.
25 ms + OOT at 50 Hz
22 ms + OOT at 60 Hz

Test results/Remarks:
t approx.
25 ms + OOT at 50 Hz
22 ms + OOT at 60 Hz

[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

**1.13.2.4 Dropout times**

| | |
|---|---|
| Test condition: | see item 1.13.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

**1.13.2.5 Time delay**

| | |
|---|---|
| Test condition: | see item 1.13.2.1<br>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 |

**1.13.3 Overcurrent Protection, phases with inverse time overcurrent stage (inverse time)**

**1.13.3.1 Pickup values**

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ threshold value £ 35.000 $I_{rated}$<br>$f_{rated}$ = 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 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>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 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 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: 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 2 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 3 % of setting value or 0.02 $I_{rated}$ |
| Test results/Remarks: | up to 30th harmonic: 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 2 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 3 % of setting value or 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: 1.5 % of setting value or 0.01 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$ |
| Test results/Remarks: | up to 30th harmonic: 1.5 % of setting value or 0.01 $I_{rated}$[2]<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$[3]<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$[3] |

**1.13.3.2 Dropout ratio**

| | |
|---|---|
| Test condition: | see item 1.13.3.1 |
| Instantaneous: | |
| Test values: | 1.05 * threshold value<br>0.95 * pickup value |
| Disk emulation | |
| Test values: | 0.90 * threshold value |

[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

Permissive tolerance/Limiting values: 1 % of dropout value

Test results/Remarks: 1% of dropout value

**1.13.3.3 Pickup times**

Test condition: see item 1.13.3.1
1.2*threshold

Permissive tolerance/Limiting values: t approx.
25 ms + OOT at 50 Hz
22 ms + OOT at 60 Hz

Test results/Remarks: t approx.
25 ms + OOT at 50 Hz
22 ms + OOT at 60 Hz

**1.13.3.4 Dropout times**

Test condition: see item 1.13.3.1

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

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

**1.13.3.5 Tripping time characteristics**

Test condition: see item 1.13.3.1
1.2*threshold

Test values: Time dial: 0.05 £ T £ 15.00

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

**1.13.3.5.1 IEC normal inverse (type A)**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.5.2 IEC very inverse (type B)**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.5.3 IEC extremely inverse (type C)**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

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

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

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

**1.13.3.5.7 ANSI extremely inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.5.8 ANSI very inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.5.9 ANSI normal inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.5.10 ANSI moderately inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.5.11 ANSI definite inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.6 Dropout characteristics**

Test condition: see item 1.13.3.1
Disk emulation: 0.8*threshold

Test values: Time dial: 0.05 £ T £ 15.00

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

**1.13.3.6.1 IEC normal inverse (type A)**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

## Summary

**1.13.3.6.2 IEC very inverse (type B)**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.6.3 IEC extremely inverse (type C)**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

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

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

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

**1.13.3.6.7 ANSI extremely inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.6.8 ANSI very inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.6.9 ANSI normal inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.6.10 ANSI moderately inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.3.6.11 ANSI definite inverse**
Test results/Remarks: 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms

**1.13.4 Overcurrent Protection, phases with user-defined characteristic[1]**

**1.13.4.1 Pickup**

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 $I_{rated}$

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: 1 % of setting value or 0.005 $I_{rated}$
up to 50th harmonic, $f_{rated}$ = 50 Hz: 2 % of setting value or 0.02 $I_{rated}$
up to 50th harmonic, $f_{rated}$ = 60 Hz: 3 % 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: 2 % of setting value or 0.02 $I_{rated}$
up to 50th harmonic, $f_{rated}$ = 60 Hz: 3 % of setting value or 0.02 $I_{rated}$

Method of measurement = RMS value of phases,

with filter for the gain of harmonics (including compensation of the amplitude attenuation[2]

Permissive tolerance/Limiting values:
up to 30th harmonic: 1.5 % of setting value or 0.01 $I_{rated}$
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: 1.5 % of setting value or 0.01 $I_{rated}$[3]
up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$[1]
up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$[1]

[1] Not available for Busbar Protection
[2] In case that the filter response exactly matches the user defined gain factor
[3] In case that the user-defined gain factor is set below 3. The tolerance is amplified if the gain factor is larger

## Summary

**1.13.4.2 Dropout ratio**

| | |
|---|---|
| Test condition: | see item 1.13.4.1 |
| Instantaneous: | |
| Test values: | 1.05 * threshold value<br>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 |

**1.13.4.3 Pickup times**

| | |
|---|---|
| Test condition: | see item 1.13.4.1<br>1.2*threshold |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>25 ms + OOT at 60 Hz |

**1.13.4.4 Dropout times**

| | |
|---|---|
| Test condition: | see item 1.13.4.1 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT |
| Test results/Remarks: | t approx.<br>25 ms + OOT |

**1.13.4.5 Tripping time characteristics**

| | |
|---|---|
| Test condition: | see item 1.13.4.1<br>1.2*threshold |
| Test values: | Time dial: 0.05 £ T £ 15.00 |
| Permissive tolerance/Limiting values: | 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms |
| Test results/Remarks: | 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms |

**1.13.4.6 Dropout characteristics**

| | |
|---|---|
| Test condition: | see item 1.13.4.1<br>Disk emulation: 0.8*threshold |
| Test values: | Time dial: 0.05 £ T £ 15.00 |
| Permissive tolerance/Limiting values: | 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms |
| Test results/Remarks: | 5 % of the reference (calculated) value + 2 % of current tolerance or 30 ms |

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

## Summary

## 1.14 50/51 Overcurrent Protection 1-phase

### 1.14.1 Specifications

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

### 1.14.2 Overcurrent protection, 1-phase with definite time-overcurrent stage

#### 1.14.2.1 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ I> £ 1.600 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ for CT protection |
| Method of measurement = fundamental components: | |
| 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 $I_{rated}$ |
| Method of measurement = RMS value: | |
| Permissive tolerance/Limiting values: | up to 30$^{th}$ hamonics: \|d\| £ 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: \|d\| £ 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: \|d\| £ 4 % of setting value or 0.02 $I_{rated}$ |
| Test results/Remarks: | up to 30$^{th}$ hamonics: \|d\| £ 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: \|d\| £ 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: \|d\| £ 4 % of setting value or 0.02 $I_{rated}$ |

#### 1.14.2.2 Dropout ratios

| | |
|---|---|
| Test condition: | see item 1.14.2.1 |
| Test values: | see item 1.14.2.1 |
| Permissive tolerance/Limiting values: | 0.95 (fixed) |
| Test results/Remarks: | 0.95 (fixed) |

#### 1.14.2.3 Pickup times

| | |
|---|---|
| Test condition: | see item 1.14.2.1 |
| Test values: | $I/I_{rated/r}$ = 2<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | t approx.<br>15 ms + OOT at 50 Hz<br>14 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>15 ms + OOT at 50 Hz<br>14 ms + OOT at 60 Hz |

#### 1.14.2.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.14.2.1 |
| Test values: | see item 1.14.2.1 |
| Permissive tolerance/Limiting values: | t approx. 20 ms + OOT |
| Test results/Remarks: | t approx. 20 ms + OOT |

#### 1.14.2.5 Time delays

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.000 s £ T £ 60.000 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % of setting value or 10 ms |

## Summary

### 1.14.3 Overcurrent Protection,1-ph with inverse-time overcurrent stage

#### 1.14.3.1 Pickup values

Test condition: 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ for CT protection
0.001 $I_{rated}$ £ I> £ 1.600 $I_{rated}$ for CT sensitive
Time dial:
0.05 £ T £ 15.00

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

Method of measurement = fundamental components:

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 $I_{rated}$

Method of measurement = RMS value:

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

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

#### 1.14.3.2 Dropout ratios

Test condition: see item 1.14.3.1

Test values: see item 1.14.3.1

Instantaneous:

Permissive tolerance/Limiting values: approx. 1.05 * threshold value
approx. 0.95 * pickup value

Test results/Remarks: approx. 1.05 * threshold value
approx. 0.95 * pickup value

Disk emulation

Permissive tolerance/Limiting values: approx. 0.90 * threshold value

Test results/Remarks: approx. 0.90 * threshold value

#### 1.14.3.3 Pickup times

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

Permissive tolerance/Limiting values: t approx.
25 ms + OOT at 50 Hz
22 ms + OOT at 60 Hz

Test results/Remarks: t approx.
25 ms + OOT at 50 Hz
22 ms + OOT at 60 Hz

#### 1.14.3.4 Dropout times

Instantaneous:

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

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

Disk emulation

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

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

Test results/Remarks: 5 % of set point value or
+2 % current tolerance or
30 ms

## Summary

**1.14.3.5 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

**1.14.3.5.1 IEC normal inverse (type A)**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.2 IEC very inverse (type B)**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.3 IEC extremely inverse (type C)**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.4 IEC long-time inverse (type B)**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.5 ANSI long-time inverse**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.6 ANSI short-time inverse**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.7 ANSI extremely inverse**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.8 ANSI very inverse**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.9 ANSI normal inverse**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.10 ANSI moderately inverse**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.5.11 ANSI definite inverse**
Test results/Remarks: |d| £ 5 % ± 15 ms for 2 £ $I/I_P$ £ 20
|d| £ 5 % ± 15 ms for 2 £ $3I0/I_P$ £ 20

**1.14.3.6 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

**1.14.3.6.1 IEC normal inverse (type A)**
Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ $I/I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ $3I0/I_P$ £ 0.90

**1.14.3.6.2 IEC very inverse (type B)**
Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ $I/I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ $3I0/I_P$ £ 0.90

**1.14.3.6.3 IEC extremely inverse (type C)**
Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ $I/I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ $3I0/I_P$ £ 0.90

**1.14.3.6.4 IEC long-time inverse (type B)**
Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ $I/I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ $3I0/I_P$ £ 0.90

## Summary

**1.14.3.6.5 ANSI long-time inverse**

Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ I/$I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I0/$I_P$ £ 0.90

**1.14.3.6.6 ANSI short-time inverse**

Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ I/$I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I0/$I_P$ £ 0.90

**1.14.3.6.7 ANSI extremely inverse**

Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ I/$I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I0/$I_P$ £ 0.90

**1.14.3.6.8 ANSI very inverse**

Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ I/$I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I0/$I_P$ £ 0.90

**1.14.3.6.9 ANSI normal inverse**

Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ I/$I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I0/$I_P$ £ 0.90

**1.14.3.6.10 ANSI moderately inverse**

Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ I/$I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I0/$I_P$ £ 0.90

**1.14.3.6.11 ANSI definite inverse**

Test results/Remarks: |d| £ 5 % ± 30 ms for 0.05 £ I/$I_P$ £ 0.90
|d| £ 5 % ± 30 ms for 0.05 £ 3I0/$I_P$ £ 0.90

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

#### 1.14.4.1 Pickup

Test condition: 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ for CT protection
0.001 $I_{rated}$ £ I> £ 1.600 $I_{rated}$ for CT sensitive
Time dial:
0.05 £ T £ 15.00

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

Method of measurement = fundamental components:

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 0.005 $I_{rated}$

Test results/Remarks: |d| < 1 % or 0.5 % $I_{rated}$

Method of measurement = RMS value:

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

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

#### 1.14.4.2 Dropout ratios

Test condition: see item 1.14.4.1

Test values: see item 1.14.4.1

Instantaneous:

Permissive tolerance/Limiting values: approx. 1.05 * threshold value
approx. 0.95 * pickup value

Test results/Remarks: approx. 1.05 * threshold value
approx. 0.95 * pickup value

Disk emulation

Permissive tolerance/Limiting values: approx. 0.90 * threshold value

Test results/Remarks: approx. 0.90 * threshold value

## Summary

**1.14.4.3 Pickup times**

| | |
|---|---|
| Test values: | pickup time for 2 ≤ I/I-threshold value ≤ 20 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |

**1.14.4.4 Dropout times**

Instantaneous:

| | |
|---|---|
| Permissive tolerance/Limiting values: | t approx. 20 ms + OOT |
| Test results/Remarks: | t approx. 20 ms + OOT |

Disk emulation

| | |
|---|---|
| Test values: | dropout time for I/I-threshold value ≤ 0.90 |
| Permissive tolerance/Limiting values: | 5 % of set point value or<br>+2 % current tolerance or<br>30 ms |
| Test results/Remarks: | 5 % of set point value or<br>+2 % current tolerance or<br>30 ms |

**1.14.5 Overcurrent Protection, 1-phase with fast stage**

**1.14.5.1 Pickup**

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ I> £ 1.600 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ I> £ 1.600 $I_{rated}$ for CT sensitive |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value or 0.01 $I_{rated}$ |
| Test results/Remarks: | \|d\| £ 5 % or 0.01 $I_{rated}$ |

**1.14.5.2 Dropout ratio**

| | |
|---|---|
| Test values: | r = settable dropout ratio |
| Permissive tolerance/Limiting values: | 0.90 £ r £ 0.99 |
| Test results/Remarks: | confirmed |

**1.14.5.3 Pickup times**

| | |
|---|---|
| Test values: | $I/I_{rated/r}$ = 2<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | t approx.<br>8 ms + OOT at 50 Hz / 60 Hz |
| Test results/Remarks: | t approx.<br>8 ms + OOT at 50 Hz / 60 Hz |

**1.14.5.4 Dropout times**

| | |
|---|---|
| Test condition: | see item 1.14.5.1 |
| Test values: | see item 1.14.5.1 |
| Permissive tolerance/Limiting values: | t approx. 25 ms + OOT |
| Test results/Remarks: | t approx. 25 ms + OOT |

## Summary

**1.14.5.5 Time delays**

| | |
|---|---|
| Test condition: | added to 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 |

## Summary

### 1.15 67 Directional Overcurrent Protection, Phases

#### 1.15.1 Specifications

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

#### 1.15.2 Directional overcurrent protection, phases with definite time overcurrent stages (definite time)

#### 1.15.2.1 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ threshold value £ 35.000 $I_{rated}$<br>$f_{rated}$ = 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 30$^{th}$ hamonics: 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$ |
| Test results/Remarks: | up to 30$^{th}$ hamonics: 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$ |

#### 1.15.2.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.15.2.1 |
| Test values: | 0.90 £ r £ 0.99 |
| Permissive tolerance/Limiting values: | 1 % of dropout value |
| Test results/Remarks: | 1 % of dropout value |

#### 1.15.2.3 Pickup times

| | |
|---|---|
| Test condition: | see item 1.15.2.1<br>1.2*threshold |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |

#### 1.15.2.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.15.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

#### 1.15.2.5 Time delay

| | |
|---|---|
| Test condition: | see item 1.15.2.1<br>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 |

## Summary

### 1.15.3 Directional overcurrent protection, phases with inverse time overcurrent stage (inverse time)

#### 1.15.3.1 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ threshold value £ 35.000 $I_{rated}$<br>$f_{rated}$ = 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 30$^{th}$ hamonics: 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$ |
| Test results/Remarks: | up to 30$^{th}$ hamonics: 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$ |

#### 1.15.3.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.15.3.1 |
| Instantaneous: | |
| Test values: | 1.05 * threshold value<br>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 |

#### 1.15.3.3 Pickup times

| | |
|---|---|
| Test condition: | see item 1.15.3.1<br>1.2*threshold |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>25 ms + OOT at 60 Hz |

#### 1.15.3.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.15.3.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

#### 1.15.3.5 Tripping time characteristics

| | |
|---|---|
| Test condition: | see item 1.15.3.1<br>1.2*threshold |
| Test values: | Time dial: 0.05 £ T £ 15.00 |
| Permissive tolerance/Limiting values: | 5 % of setting value or + 2 % of current tolerance or 10 ms |

##### 1.15.3.5.1 IEC normal inverse (type A)

| | |
|---|---|
| Test results/Remarks: | 5 % of setting value or ± 2 % of current tolerance or 30 ms |

##### 1.15.3.5.2 IEC very inverse (type B)

| | |
|---|---|
| Test results/Remarks: | 5 % of setting value or ± 2 % of current tolerance or 30 ms |

##### 1.15.3.5.3 IEC extremely inverse (type C)

| | |
|---|---|
| Test results/Remarks: | 5 % of setting value or ± 2 % of current tolerance or 30 ms |

##### 1.15.3.5.4 IEC long-time inverse (type B)

| | |
|---|---|
| Test results/Remarks: | 5 % of setting value or ± 2 % of current tolerance or 30 ms |

## Summary

**1.15.3.5.5 ANSI long-time inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.5.6 ANSI short-time inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.5.7 ANSI extremely inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.5.8 ANSI very inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.5.9 ANSI normal inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.5.10 ANSI moderately inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.5.11 ANSI definite inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6 Dropout characteristics**

Test condition: see item 1.15.3.1

Disk emulation: 0.8*threshold

Test values: Time dial: 0.05 £ T £ 15.00

Permissive tolerance/Limiting values: 5 % of setting value or + 2 % of current tolerance or 10 ms

**1.15.3.6.1 IEC normal inverse (type A)**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.2 IEC very inverse (type B)**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.3 IEC extremely inverse (type C)**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.4 IEC long-time inverse (type B)**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.5 ANSI long-time inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.6 ANSI short-time inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.7 ANSI extremely inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.8 ANSI very inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.9 ANSI normal inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.10 ANSI moderately inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

**1.15.3.6.11 ANSI definite inverse**
Test results/Remarks: 5 % of setting value or ± 2 % of current tolerance or 30 ms

## Summary

### 1.15.4 Overcurrent protection, phases with user-defined characteristic

#### 1.15.4.1 Pickup

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ threshold value £ 35.000 $I_{rated}$<br>$f_{rated}$ = 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 30$^{th}$ hamonics: 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$ |
| Test results/Remarks: | up to 30$^{th}$ hamonics: 1 % of setting value or 0.005 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 50 Hz: 3 % of setting value or 0.02 $I_{rated}$<br>up to 50th harmonic, $f_{rated}$ = 60 Hz: 4 % of setting value or 0.02 $I_{rated}$ |

#### 1.15.4.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.15.4.1 |
| Instantaneous: | |
| Test values: | 1.05 * threshold value<br>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 |

#### 1.15.4.3 Pickup times

| | |
|---|---|
| Test condition: | see item 1.15.4.1<br>1.2*threshold |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>25 ms + OOT at 60 Hz |

#### 1.15.4.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.15.4.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>25 ms + OOT |

#### 1.15.4.5 Tripping time characteristics

| | |
|---|---|
| Test condition: | see item 1.15.4.1<br>1.2*threshold |
| Test values: | Time dial: 0.05 £ T £ 15.00 |
| Permissive tolerance/Limiting values: | 5 % of setting value or + 2 % of current tolerance or 10 ms |
| Test results/Remarks: | 5 % of setting value or ± 2 % of current tolerance or 10 ms |

#### 1.15.4.6 Dropout characteristics

| | |
|---|---|
| Test condition: | see item 1.15.4.1 |
| Disk emulation: | 0.8*threshold |
| Test values: | Time dial: 0.05 £ T £ 15.00 |
| Permissive tolerance/Limiting values: | 5 % of setting value or + 2 % of current tolerance or 10 ms |
| Test results/Remarks: | 5 % of setting value or ± 2 % of current tolerance or 10 ms |

## Summary

### 1.15.5 Directional determination

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ threshold value £ 35.000 $I_{rated}$<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Test values: | -180°£ φ £ 180° |
| Permissive tolerance/Limiting values: | 1° |
| Test results/Remarks: | 4° |

## Summary

### 1.16 50 High-Speed Instantaneous Overcurrent Protection

#### 1.16.1 Specifications

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

#### 1.16.2 General test conditions

| | |
|---|---|
| $f_{rated}$ | 50 Hz, 60 Hz |

#### 1.16.3 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ |
| Test values: | 0.100 $I_{rated}$ £ I> £ 5.000 $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value or 0.010 $I_{rated}$ |
| Test results/Remarks: | \|d\| < 5 % of setting value or 0.010 $I_{rated}$ |

#### 1.16.4 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.16.2 |
| Test values: | r = settable dropout ratio<br>0.50 £ r £ 0.90 |
| Permissive tolerance/Limiting values: | \|d\| £ 5 % of setting value |
| Test results/Remarks: | \|d\| < 5 % of setting value |

#### 1.16.5 Pickup times

| | |
|---|---|
| Test condition: | current > 2√2 of threshold value |
| Test values: | t in ms |
| Permissive tolerance/Limiting values: | t £ 8 ms + OOT |
| Test results/Remarks: | t < 8 ms + OOT |

#### 1.16.6 Dropout times

| | |
|---|---|
| Test condition: | current change from > 2√2 to 0 of threshold value |
| Test values: | t in ms |
| Test results/Remarks: | t approx. 30 ms + OOT |

## Summary

### 1.17 46 Directional Negative-Sequence Protection with definite-time characteristic

#### 1.17.1 Specifications

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

#### 1.17.2 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 35.00 $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 2 % of setting value or 10 mA |
| Test results/Remarks: | \|d\| < 2 % or 0.8 % absolute |

#### 1.17.3 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.17.2 |
| Permissive tolerance/Limiting values: | r approx. 0.95 |
| Test results/Remarks: | 0.93 £ r £ 0.97 |

#### 1.17.4 Pickup times

| | |
|---|---|
| Test condition: | see item 1.17.2 |
| Permissive tolerance/Limiting values: | t approx. 40 ms + OOT |
| Test results/Remarks: | t < 40 ms + OOT |

#### 1.17.5 Dropout times

| | |
|---|---|
| Permissive tolerance/Limiting values: | t approx. 40 ms + OOT |
| Test results/Remarks: | t < 39 ms + OOT |

#### 1.17.6 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 % or 10 ms |

#### 1.17.7 Directional determination

##### 1.17.7.1 Angle forward α

| | |
|---|---|
| Test condition: | 0° £ α £ 360° |
| Test values: | various settings |
| Permissive tolerance/Limiting values: | \|d\| £ 1° |
| Test results/Remarks: | \|d\| < 1° |

##### 1.17.7.2 Angle reverse β

| | |
|---|---|
| Test condition: | 0° £ β £ 360° |
| Test values: | various settings |
| Permissive tolerance/Limiting values: | \|d\| £ 1° |
| Test results/Remarks: | \|d\| < 1° |

##### 1.17.7.3 Min. neg.-seq. voltage V2

| | |
|---|---|
| Test condition: | 0.15 V £ $V_2$ £ 34.0 V |
| Test values: | various settings |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % |
| Test results/Remarks: | \|d\| < 1 % |

## Summary

### 1.17.7.4 Minimum negative sequence current I2

| | |
|---|---|
| Test condition: | 0.030 A £ $I_2$ £ 10.000 $I_{rated}$ |
| Test values: | various settings |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % |
| Test results/Remarks: | \|d\| < 1 % |

## Summary

### 1.18 37 Undercurrent Protection with 3-phase

#### 1.18.1 Specifications

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

#### 1.18.2 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ |
| Test values: | $f_{rated}$ = 50 Hz, 60Hz<br>0.030 $I_{rated}$ £ I> £ 20.000 $I_{rated}$ |
| Method of measurement = fundamental components: | |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 0.005 $I_{rated}$ |
| Test results/Remarks: | \|d\| £ 2 % of setting value or 0.005 $I_{rated}$ |
| Method of measurement = RMS value: | |
| Permissive tolerance/Limiting values: | up to 30$^{th}$ hamonics: \|d\| £ 1 % of setting value or 0.005 $I_{rated}$ |
| Test results/Remarks: | up to 30$^{th}$ hamonics: \|d\| £ 2 % of setting value or 0.005 $I_{rated}$ |

#### 1.18.3 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.18.2 |
| Test values: | see item 1.18.2 |
| Permissive tolerance/Limiting values: | 1.05 (fixed) |
| Test results/Remarks: | 1.05 (fixed) |

#### 1.18.4 Pickup times

| | |
|---|---|
| Test condition: | see item 1.18.2 |
| Test values: | I/ $I_{rated}$ = 1 ; I/ $I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |

#### 1.18.5 Dropout times

| | |
|---|---|
| Test condition: | see item 1.18.2 |
| Test values: | see item 1.18.2 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |

#### 1.18.6 Time delays

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.000 s £ T £ 60.000 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| £ 1 % of setting value or 10 ms |

## Summary

## 1.19 51V Voltage-dependent Overcurrent-Protection

### 1.19.1 Specifications

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

### 1.19.2 Voltage-released stage

#### 1.19.2.1 Pickup values I>

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ threshold value £ 35.000 $I_{rated}$ |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ threshold value £ 18.000 $I_{rated}$ |

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

#### 1.19.2.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.19.2.1 |
| Instantaneous: | |
| Test values: | 1.05 * threshold value<br>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 |

#### 1.19.2.3 Pickup values Vph-ph<

| | |
|---|---|
| Test condition: | 0.300 V £ threshold value £ 175.000V |
| Test values: | 0.300 V £ threshold value £ 175.000V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>0.5 % of setting value or 0.05 V |
| Test results/remarks: | in the range $f_{rated}$ ±10 %<br>0.5 % of setting value or 0.05 V |

#### 1.19.2.4 Pickup time

| | |
|---|---|
| Test condition: | see item 1.19.2.1 |
| Test values: | 1.2*threshold |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |

#### 1.19.2.5 Dropout times

| | |
|---|---|
| Test condition: | see item 1.19.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

## Summary

**1.19.2.6 Tripping time characteristics**

| | |
|---|---|
| Test condition: | see item 1.19.2.1 |
| | 1.2*threshold |
| Test values: | Time dial: 0.05 £ T £ 15.00 |
| Permissive tolerance/Limiting values: | 5 % of setting value or + 2 % of current tolerance or 30 ms |

**1.19.2.6.1 IEC normal inverse (type A)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.6.2 IEC very inverse (type B)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.6.3 IEC extremely inverse (type C)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

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

**1.19.2.6.5 ANSI long-time inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.6.6 ANSI short-time inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.6.7 ANSI extremely inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.6.8 ANSI very inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.6.9 ANSI normal inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.6.10 ANSI moderately inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.6.11 ANSI definite inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.7 Dropout characteristics**

| | |
|---|---|
| Test condition: | see item 1.19.2.1 |
| Disk emulation: | 0.8*threshold |
| Test values: | Time dial: 0.05 £ T £ 15.00 |
| Permissive tolerance/Limiting values: | 5 % of setting value or + 2 % of current tolerance or 30 ms |

**1.19.2.7.1 IEC normal inverse (type A)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.7.2 IEC very inverse (type B)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.7.3 IEC extremely inverse (type C)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

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

**1.19.2.7.5 ANSI long-time inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.7.6 ANSI short-time inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.7.7 ANSI extremely inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.7.8 ANSI very inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.7.9 ANSI normal inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

## Summary

**1.19.2.7.10 ANSI moderately inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.2.7.11 ANSI definite inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

### 1.19.3 Voltage-dependent.Stage

### 1.19.3.1 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 £ 18.000 $I_{rated}$

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 hamonics: 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 30$^{th}$ hamonics: 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 $I_{rated}$

### 1.19.3.2 Dropout ratio

Test condition: see item 1.19.3.1

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

### 1.19.3.3 Pickup time

Test condition: see item 1.19.3.1

Test values: 1.2*threshold

Permissive tolerance/Limiting values: t approx.
25 ms + OOT at 50 Hz
22 ms + OOT at 60 Hz

Test results/Remarks: t approx.
25 ms + OOT at 50 Hz
22 ms + OOT at 60 Hz

### 1.19.3.4 Dropout times

Test condition: see item 1.19.3.1

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

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

### 1.19.3.5 Tripping time characteristics

Test condition: see item 1.19.3.1
1.2*threshold

Test values: Time dial: 0.05 £ T £ 15.00

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

**1.19.3.5.1 IEC normal inverse (type A)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

## Summary

**1.19.3.5.2 IEC very inverse (type B)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.5.3 IEC extremely inverse (type C)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

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

**1.19.3.5.5 ANSI long-time inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.5.6 ANSI short-time inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.5.7 ANSI extremely inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.5.8 ANSI very inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.5.9 ANSI normal inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.5.10 ANSI moderately inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.5.11 ANSI definite inverse**
Test results/Remarks: 5 % of setting value or + 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 setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.1 IEC normal inverse (type A)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.2 IEC very inverse (type B)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.3 IEC extremely inverse (type C)**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

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

**1.19.3.6.5 ANSI long-time inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.6 ANSI short-time inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.7 ANSI extremely inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.8 ANSI very inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.9 ANSI normal inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.10 ANSI moderately inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.3.6.11 ANSI definite inverse**
Test results/Remarks: 5 % of setting value or + 2 % of current tolerance or 30 ms

**1.19.4 Undervoltage seal-in stage**

**1.19.4.1 Pickup values I>**

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

## Summary

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 hamonics: 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 hamonics: 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 ratio

Test condition: see item 1.19.4.1

Test values: 0.90 £ r £ 0.99

Permissive tolerance/Limiting values: 1 % of dropout value

Test results/Remarks: 1 % of dropout value

### 1.19.4.3 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: 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

### 1.19.4.4 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

### 1.19.4.5 Pickup times

Test condition: see item 1.19.4.1

Test values: 1.2*threshold

Permissive tolerance/Limiting values: t approx.
30 ms + OOT at 50 Hz
25 ms + OOT at 60 Hz

Test results/Remarks: t approx.
30 ms + OOT at 50 Hz
25 ms + OOT at 60 Hz

### 1.19.4.6 Dropout times

Test condition: see item 1.19.4.1

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

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

### 1.19.4.7 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

## Summary

**1.19.4.8 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

**1.19.5 Undervoltage Seal-in and voltage released stage**

**1.19.5.1 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 hamonics: 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 hamonics: 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 $I_{rated}$

**1.19.5.2 Pickup values V2**

Test condition: 0.300 V £ threshold value £ 200.000V

Test values: 0.300 V £ threshold value £ 200.000V

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

**1.19.5.3 Dropout ratio**

Test condition: 0.030 $I_{rated}$ £ threshold value £ 35.000 $I_{rated}$
0.300 V £ threshold value £ 200.000V

Test values: 0.90 £ r £ 0.99

Permissive tolerance/Limiting values: 1 % of dropout value

Test results/Remarks: 1 % of dropout value

**1.19.5.4 Pickup values Vph-ph<, 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: 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

**1.19.5.5 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

**1.19.5.6 Pickup time**

Test condition: see item 1.19.5.1

Test values: 1.2*threshold

## Summary

Permissive tolerance/Limiting values: t approx.
30 ms + OOT at 50 Hz
25 ms + OOT at 60 Hz

Test results/Remarks: t approx.
30 ms + OOT at 50 Hz
25 ms + OOT at 60 Hz

### 1.19.5.7 Dropout times

Test condition: see item 1.19.5.1

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

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

### 1.19.5.8 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

### 1.19.5.9 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

## 1.20 47/59 Overvoltage Protection

### 1.20.1 Specifications

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

### 1.20.2 3ph Voltage ph-to-gnd, ph-to-ph V with definite time overvoltage stage

#### 1.20.2.1 Pickup values

| | |
|---|---|
| Test condition: | Fundamental components, RMS values<br>$f_{rated}$ = 50 Hz, 60Hz<br>0.300 V £ threshold value £ 340.000 V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |

#### 1.20.2.2 Dropout ratio

| | |
|---|---|
| Test condition: | See item 1.20.2.1 |
| Test values: | r = setable dropout ratio<br>0.90 £ r £ 0.99 |
| Permissive tolerance/Limiting values: | \|d\| £ 0.5 % of dropout value or 0.05 V |
| Test results/Remarks: | \|d\| £ 0.5 % of dropout value or 0.05 V |

#### 1.20.2.3 Pickup times

| | |
|---|---|
| Test condition | See item 1.20.2.1<br>1.2* threshold value |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.20.2.4 Dropout times

| | |
|---|---|
| Test condition: | See item 1.20.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

#### 1.20.2.5 Time delays

| | |
|---|---|
| Test condition: | See item 1.20.2.1 |
| 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 |

### 1.20.3 3ph Voltage ph-to-gnd, ph-to-ph V with inverse time overvoltage stage

#### 1.20.3.1 Pickup values

| | |
|---|---|
| Test condition: | Fundamental components, RMS values<br>$f_{rated}$ = 50 Hz, 60Hz<br>0.300 V £ pickup value £ 340.000 V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |

#### 1.20.3.2 Dropout ratio

| | |
|---|---|
| Test condition | See item 1.20.3.1 |

## Summary

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

### 1.20.3.3 Pickup times

Test condition: See item 1.20.3.1
1.2* pickup value

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

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

### 1.20.3.4 Dropout times

Test condition: See item 1.20.3.1
Reset time is set 0 s

Permissive tolerance/Limiting values: Approx.
20 ms + OOT

Test results/Remarks: Approx.
20 ms + OOT

### 1.20.3.5 Definite time delays

Test condition: See item 1.20.3.1

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

### 1.20.3.6 Reset time

Test condition: See item 1.20.3.1

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

### 1.20.3.7 Inverse time characteristic

Test condition: See item 1.20.3.1

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: |d| £ 5 % of the setting value or 30 ms

Test results/Remarks: |d| £ 5 % of the setting value or 30 ms

### 1.20.4 Positive sequence V1

### 1.20.4.1 Pickup values

Test condition: $f_{rated}$ = 50 Hz, 60Hz
0.300 V £ threshold value £ 200.000 V

Permissive tolerance/Limiting values: in the range $f_{rated}$ ±10 %
|d| £ 0.5 % of setting value or 0.05 V

Test results/Remarks: in the range $f_{rated}$ ±10 %
|d| £ 0.5 % of setting value or 0.05 V

### 1.20.4.2 Dropout ratio

Test condition: See item 1.20.4.1

Test values: r = setable dropout ratio
0.90 £ r £ 0.99

Permissive tolerance/Limiting values: |d| £ 0.5 % of dropout value or 0.05 V

Test results/Remarks: |d| £ 0.5 % of dropout value or 0.05 V

## Summary

**1.20.4.3 Pickup times**

| | |
|---|---|
| Test condition | See item 1.20.4.1<br>1.2* threshold value |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |

**1.20.4.4 Dropout times**

| | |
|---|---|
| Test condition | See item 1.20.4.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

**1.20.4.5 Time delays**

| | |
|---|---|
| Test condition: | See item 1.20.4.1 |
| 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 |

**1.20.5 Zero Sequence, Residual Voltage V0**

**1.20.5.1 Pickup values**

| | |
|---|---|
| Test condition: | RMS values, fundamental components, fundamental components over 2 cycles<br>0.300 V £ threshold value £ 340.000 V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |

**1.20.5.2 Dropout ratio**

| | |
|---|---|
| Test condition: | See item 1.20.5.1 |
| Test values: | r = setable dropout ratio<br>0.90 £ r £ 0.99 |
| Permissive tolerance/Limiting values: | \|d\| £ 0.5 % of dropout value or 0.05 V |
| Test results/Remarks: | \|d\| £ 0.5 % of dropout value or 0.05 V |

**1.20.5.3 Pickup times (Filter = RMS value, Standard Filter)**

| | |
|---|---|
| Test condition | See item 1.20.5.1<br>1.2* threshold value |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |

**1.20.5.4 Dropout times (Filter = RMS value, Standard Filter)**

| | |
|---|---|
| Test condition | See item 1.20.5.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT at $f_{rated}$ = 50 Hz<br>16.6 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>20 ms + OOT at $f_{rated}$ = 50 Hz<br>16.6 ms + OOT at $f_{rated}$ = 60 Hz |

## Summary

**1.20.5.5 Pickup times (Filter = over 2 cycles)**

| | |
|---|---|
| Test condition | See item 1.20.5.1<br>1.2* threshold value |
| Permissive tolerance/Limiting values: | t approx.<br>45 ms + OOT at $f_{rated}$ = 50 Hz<br>39 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>45 ms + OOT at $f_{rated}$ = 50 Hz<br>39 ms + OOT at $f_{rated}$ = 60 Hz |

**1.20.5.6 Dropout times (Filter = over 2 cycles)**

| | |
|---|---|
| Test condition | See item 1.20.5.1 |
| Permissive tolerance/Limiting values: | t approx.<br>31.06 ms + OOT at $f_{rated}$ = 50 Hz<br>27.06 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>31.06 ms + OOT at $f_{rated}$ = 50 Hz<br>27.06 ms + OOT at $f_{rated}$ = 60 Hz |

**1.20.5.7 Time delays**

| | |
|---|---|
| Test condition: | See item 1.20.5.1 |
| 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 |

**1.20.6 Any Voltage Vx**

**1.20.6.1 Pickup values**

| | |
|---|---|
| Test condition: | Fundamental components, RMS values<br>$f_{rated}$ = 50 Hz, 60Hz<br>0.300 V £ threshold value £ 340.000 V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |

**1.20.6.2 Dropout ratio**

| | |
|---|---|
| Test condition: | See item 1.20.6.1 |
| Test values: | r = setable dropout ratio<br>0.90 £ r £ 0.99 |
| 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 |

**1.20.6.3 Pickup times**

| | |
|---|---|
| Test condition | See item 1.20.6.1<br>1.2* threshold value |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |

**1.20.6.4 Dropout times**

| | |
|---|---|
| Test condition: | See item 1.20.6.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

## Summary

**1.20.6.5 Time delays**

| | |
|---|---|
| Test condition: | See item 1.20.6.1 |
| 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 |

**1.20.7 Negative sequence V2**

**1.20.7.1 Pickup values**

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>0.300 V £ threshold value £ 200.000 V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |

**1.20.7.2 Dropout ratio**

| | |
|---|---|
| Test condition: | See item 1.20.7.1 |
| Test values: | r = setable dropout ratio<br>0.90 £ r £ 0.99 |
| Permissive tolerance/Limiting values: | \|d\| £ 0.5 % of dropout value or 0.05 V |
| Test results/Remarks: | \|d\| £ 0.5 % of dropout value or 0.05 V |

**1.20.7.3 Pickup times**

| | |
|---|---|
| Test condition | See item 1.20.7.1<br>1.2* threshold value |
| Permissive tolerance/Limiting values: | t approx.<br>Measuring window length 1 cycle: 55ms + OOT<br>Measuring window length 10 cycles: 210ms + OOT<br>(depends on the measuring window length) at $f_{rated}$ = 50 Hz<br>Measuring window length 1 cycle: 48ms + OOT<br>Measuring window length 10 cycles: 190ms + OOT<br>(depends on the measuring window length) at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>Measuring window length 1 cycle: 55ms + OOT<br>Measuring window length 10 cycles: 210ms + OOT<br>(depends on the measuring window length) at $f_{rated}$ = 50 Hz<br>Measuring window length 1 cycle: 48ms + OOT<br>Measuring window length 10 cycles: 190ms + OOT<br>(depends on the measuring window length) at $f_{rated}$ = 60 Hz |

**1.20.7.4 Dropout times**

| | |
|---|---|
| Test condition | See item 1.20.7.1 |
| Permissive tolerance/Limiting values: | t approx.<br>Measuring window length 1 cycle: 20ms + OOT<br>Measuring window length 10 cycles: 70ms + OOT<br>(depends on the measuring window length) |
| Test results/Remarks: | t approx.<br>Measuring window length 1 cycle: 20ms + OOT<br>Measuring window length 10 cycles: 70ms + OOT<br>(depends on the measuring window length) |

**1.20.7.5 Time delays**

| | |
|---|---|
| Test condition: | See item 1.20.7.1 |

## 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 % of setting value or 10 ms

### 1.20.8 Ratio of negative-sequence to positive-sequence, V2/V1

#### 1.20.8.1 Pickup values

Test condition: $f_{rated}$ = 50 Hz, 60Hz
0.5% £ threshold value £ 100%

Permissive tolerance/Limiting values: in the range $f_{rated}$ ±10 %
|d| £ 0.5 % of setting value or 0.05 V

Test results/Remarks: in the range $f_{rated}$ ±10 %
|d| £ 0.5 % of setting value or 0.05 V

#### 1.20.8.2 Dropout ratio

Test condition: See item 1.20.8.1

Test values: r = setable dropout ratio
0.90 £ r £ 0.99

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

#### 1.20.8.3 Pickup times

Test condition: See item 1.20.8.1
1.2* threshold value

Permissive tolerance/Limiting values: t approx.

Measuring window length 1 cycle: 55ms + OOT
Measuring window length 10 cycles: 210ms + OOT
(depends on the measuring window length) at $f_{rated}$ = 50 Hz

Measuring window length 1 cycle: 48ms + OOT
Measuring window length 10 cycles: 190ms + OOT
(depends on the measuring window length) at $f_{rated}$ = 60 Hz

Test results/Remarks: t approx.

Measuring window length 1 cycle: 55ms + OOT
Measuring window length 10 cycles: 210ms + OOT
(depends on the measuring window length) at $f_{rated}$ = 50 Hz

Measuring window length 1 cycle: 48ms + OOT
Measuring window length 10 cycles: 190ms + OOT
(depends on the measuring window length) at $f_{rated}$ = 60 Hz

#### 1.20.8.4 Dropout times

Test condition: See item 1.20.8.1

Permissive tolerance/Limiting values: t approx.

Measuring window length 1 cycle: 22ms + OOT
Measuring window length 10 cycles: 55ms + OOT
(depends on the measuring window length) at $f_{rated}$ = 50 Hz

Measuring window length 1 cycle: 18ms + OOT
Measuring window length 10 cycles: 45ms + OOT
(depends on the measuring window length) at $f_{rated}$ = 60 Hz

Test results/Remarks: t approx.

Measuring window length 1 cycle: 22ms + OOT
Measuring window length 10 cycles: 55ms + OOT
(depends on the measuring window length) at $f_{rated}$ = 50 Hz

## Summary

Measuring window length 1 cycle: 18ms + OOT
Measuring window length 10 cycles: 45ms + OOT
(depends on the measuring window length) at $f_{rated}$ = 60 Hz

**1.20.8.5 Time delays**

| | |
|---|---|
| Test condition: | See item 1.20.8.1 |
| 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 |

## Summary

## 1.21 27 Undervoltage Protection

### 1.21.1 Specifications

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

### 1.21.2 3ph Voltage ph-to-gnd, ph-to-ph define time with definite time undervoltage stages

#### 1.21.2.1 Pickup values

| | |
|---|---|
| Test condition: | fundamental components, RMS values<br>0.300 V £ threshold value £ 175.000 V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |

#### 1.21.2.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.21.2.1 |
| Test values: | r = setable dropout ratio<br>1.01 £ r £ 1.20 |
| Permissive tolerance/Limiting values: | \|d\| £ 0.5 % of dropout value or 0.05 V |
| Test results/Remarks: | \|d\| £ 0.5 % of dropout value or 0.05 V |

#### 1.21.2.3 Pickup times

| | |
|---|---|
| Test condition | see item 1.21.2.1<br>0.8* threshold value<br>no pickup delay |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.21.2.4 Pickup delay

| | |
|---|---|
| Test condition | see item 1.21.2.1<br>0.8* pickup value |
| Permissive tolerance/Limiting values: | t approx.<br>40 ms |
| Test results/Remarks: | t approx.<br>40 ms |

#### 1.21.2.5 Dropout times

| | |
|---|---|
| Test condition: | see item 1.21.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

#### 1.21.2.6 Time delays

| | |
|---|---|
| Test condition: | see item 1.21.2.1 |
| 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 |

### 1.21.3 3ph Voltage ph-to-gnd, ph-to-ph with inverse time undervoltage stages

#### 1.21.3.1 Pickup values

| | |
|---|---|
| Test condition: | fundamental components, RMS values<br>0.300 V £ threshold value £ 175.000 V |

## Summary

Permissive tolerance/Limiting values: in the range $f_{rated}$ ±10 %
|d| £ 0.5 % of setting value or 0.05 V

Test results/Remarks: in the range $f_{rated}$ ±10 %
|d| £ 0.5 % of setting value or 0.05 V

### 1.21.3.2 Dropout ratio

Test condition: see item 1.21.3.1

Test values: 1.05

Permissive tolerance/Limiting values: |d| £ 0.5 % of dropout value or 0.05 V

Test results/Remarks: |d| £ 0.5 % of dropout value or 0.05 V

### 1.21.3.3 Pickup times

Test condition: see item 1.21.3.1
0.8* pickup value
no pickup delay

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

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

### 1.21.3.4 Pickup delay

Test condition: see item 1.21.3.1
0.8* pickup value

Permissive tolerance/Limiting values: t approx.
40 ms

Test results/Remarks: t approx.
40 ms

### 1.21.3.5 Dropout times

Test condition: see item 1.21.3.1
with no reset time

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

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

### 1.21.3.6 Inverse time characteristics

Test condition: see item 1.21.3.1
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

### 1.21.3.7 Definite Time delays

Test condition: see item 1.21.3.1

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

### 1.21.3.8 Reset Time

Test condition: see item 1.21.3.1

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

## Summary

### 1.21.4 Positive-Sequence Voltage V1

#### 1.21.4.1 Pickup values

| | |
|---|---|
| Test condition: | fundamental components, RMS values<br>0.300 V £ threshold value £ 200.000 V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |

#### 1.21.4.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.21.4.1 |
| Test values: | r = setable dropout ratio<br>1.01 £ r £ 1.20 |
| Permissive tolerance/Limiting values: | \|d\| £ 0.5 % of dropout value or 0.05 V |
| Test results/Remarks: | \|d\| £ 0.5 % of dropout value or 0.05 V |

#### 1.21.4.3 Pickup times

| | |
|---|---|
| Test condition | see item 1.21.4.1<br>0.8* threshold value |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.21.4.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.21.4.1 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT |
| Test results/Remarks: | t approx.<br>20 ms + OOT |

#### 1.21.4.5 Time delays

| | |
|---|---|
| Test condition: | see item 1.21.4.1 |
| 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 |

### 1.21.5 Any Voltage Vx

#### 1.21.5.1 Pickup values

| | |
|---|---|
| Test condition: | fundamental components, RMS values<br>0.300 V £ threshold value £ 200.000 V |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>\|d\| £ 0.5 % of setting value or 0.05 V |

#### 1.21.5.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.21.5.1 |
| Test values: | r = setable dropout ratio<br>1.01 £ r £ 1.20 |
| Permissive tolerance/Limiting values: | \|d\| £ 0.5 % of dropout value or 0.05 V |
| Test results/Remarks: | \|d\| £ 0.5 % of dropout value or 0.05 V |

#### 1.21.5.3 Pickup times

| | |
|---|---|
| Test condition | see item 1.21.5.1<br>0.8* threshold value |

## Summary

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

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

### 1.21.5.4 Dropout times

Test condition: see item 1.21.5.1

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

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

### 1.21.5.5 Time delays

Test condition: see item 1.21.5.1

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

## Summary

### 1.22 51Ns Sensitive Ground Fault Protection

#### 1.22.1 Specifications

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

#### 1.22.2 3I0

##### 1.22.2.1 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % of setting value or 0.5% of $I_{rated}$<br>For CT sensitive:<br>\|d\| £ 1 % of setting value or 0.01% of $I_{rated}$ |
| Test results/Remarks: | For CT protection:<br>\|d\| £ 1 % of setting value or 0.5% of $I_{rated}$<br>For CT sensitive:<br>\|d\| £ 1 % of setting value or 0.01% of $I_{rated}$ |

##### 1.22.2.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.22.2.1 |
| Test values: | see item 1.22.2.1 |
| Permissive tolerance/Limiting values: | 0.95 (fixed) |
| Test results/Remarks: | 0.95 (fixed) |

##### 1.22.2.3 Pickup times

| | |
|---|---|
| Test condition: | see item 1.22.2.1 |
| Test values: | $I/I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>23 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>23 ms + OOT at $f_{rated}$ = 60 Hz |

##### 1.22.2.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.22.2.1 |
| Test values: | see item 1.22.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |

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

## Summary

### 1.22.3 Admittance protection stage Y0>

#### 1.22.3.1 Pickup values Y0>

| | |
|---|---|
| Test condition: | Fundamental components, RMS values<br>0.10 mS £ Y0> £ 100.00 mS |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % of setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % of setting value or 0.1% of $I_{rated}$ |
| Test results/Remarks: | For CT protection:<br>\|d\| £ 1 % of setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % of setting value or 0.1% of $I_{rated}$ |

#### 1.22.3.2 Threshold values V0>

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

#### 1.22.3.3 Pickup time

| | |
|---|---|
| Test condition: | see item 1.22.3.1 |
| Test values: | $I/I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT at 50 Hz<br>29 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>32 ms + OOT at 50 Hz<br>29 ms + OOT at 60 Hz |

#### 1.22.3.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.22.3.1 |
| Test values: | see item 1.22.3.1 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT |
| Test results/Remarks: | t approx.<br>32 ms + OOT |

#### 1.22.3.5 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 % from setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % or 10 ms |

## Summary

### 1.23 67Ns Directional Sensitive Ground Fault Protection

#### 1.23.1 Specifications

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

#### 1.23.2 3I0 stage

##### 1.23.2.1 Pickup values

| | |
|---|---|
| Test condition: | Fundamental components, RMS values<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % from setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.1% of $I_{rated}$ |
| Test results/Remarks: | \|d\| < 1 % |

##### 1.23.2.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.23.2.1 |
| Test values: | see item 1.23.2.1 |
| Permissive tolerance/Limiting values: | approx. 0.95 |
| Test results/Remarks: | 0.93…0.97 |

##### 1.23.2.3 Pickup times

| | |
|---|---|
| Test condition: | see item 1.23.2.1 |
| Test values: | $I/I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>23 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>23 ms + OOT at $f_{rated}$ = 60 Hz |

##### 1.23.2.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.23.2.1 |
| Test values: | see item 1.23.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT |
| Test results/Remarks: | t approx.<br>25 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: | \|d\| £ 1 % from setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % or 10 ms |

## Summary

### 1.23.3 3I0 with cos φ- or sin φ-measurement stage

#### 1.23.3.1 Pickup values 3I0

| | |
|---|---|
| Test condition: | Fundamental components, RMS values<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection[1] |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % from setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.1% of $I_{rated}$ |
| Test results/Remarks: | \|d\| < 1 % |

#### 1.23.3.2 Pickup values V0

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.300 V £ V0> £ 200.000 V |
| Test values: | 0.300 V £ V0> £ 200.000 V |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % from setting value or 0.05 V |
| Test results/Remarks: | \|d\| < 1 % or 0.05 V |

#### 1.23.3.3 Angle correction φ

| | |
|---|---|
| Test condition: | -45° £ φ £ 45° |
| Test values: | -45° £ φ £ 45° |
| Permissive tolerance/Limiting values: | \|d\| £ 1° at 3I0 > 5 mA, V0> = 0.6 V |
| Test results/Remarks: | \|d\| < 1° at 3I0 > 5 mA, V0> = 0.6 V |

#### 1.23.3.4 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.23.3.1 and 1.23.3.2 |
| Test values: | see item 1.23.3.1 and 1.23.3.2 |
| Permissive tolerance/Limiting values: | approx. 0.95 |
| Test results/Remarks: | 0.93…0.97 |

#### 1.23.3.5 Pickup times

| | |
|---|---|
| Test condition: | see item 1.23.3.1 and 1.23.3.2 |
| Test values: | $I/I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT at $f_{rated}$ = 50 Hz<br>29 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>32 ms + OOT at $f_{rated}$ = 50 Hz<br>29 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.23.3.6 Dropout times

| | |
|---|---|
| Test condition: | see item 1.23.3.1 and 1.23.3.2 |
| Test values: | see item 1.23.3.1 and 1.23.3.2 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT |
| Test results/Remarks: | t approx.<br>32 ms + OOT |

#### 1.23.3.7 Time delays

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.00 s £ T> £ 60.00 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % from setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % or 10 ms |

## Summary

### 1.23.4 3I0 with φ (V,I)-measurement stage

#### 1.23.4.1 Pickup values 3I0

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60 Hz<br>Fundamental components, RMS values<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % from setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.1% of $I_{rated}$ |
| Test results/Remarks: | \|d\| < 1 % |

#### 1.23.4.2 Pickup values V0

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.300 V £ V0> £ 200.000 V |
| Test values: | 0.300 V £ V0> £ 200.000 V |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % from setting value or 0.05 V |
| Test results/Remarks: | \|d\| < 1 % or 0.05 V |

#### 1.23.4.3 Rotation angle of the reference voltage

| | |
|---|---|
| Test condition: | -180° £ φ £ 180° |
| Test values: | -180° £ φ £ 180° |
| Permissive tolerance/Limiting values: | \|d\| £ 1° at 3I0 > 5 mA, V0 ≥ 0.6 V |
| Test results/Remarks: | \|d\| £ 3° at 3I0 £ 2 mA, V0 ≥ 0.6 V<br>\|d\| £ 2° at 2 mA < 3I0 < 10 mA, V0 ≥ 0.6 V<br>\|d\| £ 1° at 3I0 ≥ 10 mA, V0 ≥ 0.6 V |

#### 1.23.4.4 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.23.4.1 and 1.23.4.2 |
| Test values: | see item 1.23.4.1 and 1.23.4.2 |
| Permissive tolerance/Limiting values: | 0.5% of dropout value or 15mA |
| Test results/Remarks: | 0.5% of dropout value or 15mA |

#### 1.23.4.5 Pickup times

| | |
|---|---|
| Test condition: | see item 1.23.4.1 and 1.23.4.2 |
| Test values: | 1.2*threshold |
| Permissive tolerance/Limiting values: | t approx.<br>23 ms + OOT at $f_{rated}$ = 50 Hz<br>21 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>23 ms + OOT at $f_{rated}$ = 50 Hz<br>21 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.23.4.6 Dropout times

| | |
|---|---|
| Test condition: | see item 1.23.4.1 and 1.23.4.2 |
| Permissive tolerance/Limiting values: | t approx.<br>21 ms + OOT at $f_{rated}$ = 50 Hz<br>20 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>21 ms + OOT at $f_{rated}$ = 50 Hz<br>20 ms + OOT at $f_{rated}$ = 60 Hz |

## Summary

**1.23.4.7 Time delays**

| | |
|---|---|
| Test condition: | see item 1.23.4.1 and 1.23.4.2<br>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 |

**1.23.5 Overvoltage protection stage V0>**

**1.23.5.1 Pickup values**

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60 Hz<br>Fundamental components, RMS values<br>0.300 V £ V0> £ 200.000 V |
| Test values: | 0.300 V £ V0> £ 200.000 V |
| Permissive tolerance/Limiting values: | \|d\| £ 0.5 % from setting value or 0.05 V |
| Test results/Remarks: | \|d\| < 0.5 % or 0.05 V |

**1.23.5.2 Dropout ratio**

| | |
|---|---|
| Test condition: | r = setable dropout ratio<br>0.90 £ r £ 0.99 |
| Test values: | 0.90 £ r £ 0.99 |
| Test results/Remarks: | 0.90 £ r £ 0.99 |

**1.23.5.3 Pickup times**

| | |
|---|---|
| Test condition: | see item 1.23.5.1 |
| Test values: | see item 1.23.5.1 |
| Permissive tolerance/Limiting values: | t approx.<br>RMS values, standard filter:<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz<br>Fundamental components, filter over 2 cycles:<br>45 ms + OOT at $f_{rated}$ = 50 Hz<br>39 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>RMS values, standard filter:<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz<br>Fundamental components, filter over 2 cycles:<br>45 ms + OOT at $f_{rated}$ = 50 Hz<br>39 ms + OOT at $f_{rated}$ = 60 Hz |

**1.23.5.4 Dropout times**

| | |
|---|---|
| Test condition: | see item 1.23.5.1 |
| Test values: | see item 1.23.5.1 |
| Permissive tolerance/Limiting values: | t approx.<br>RMS values, standard filter:<br>21 ms + OOT<br>Fundamental components, filter over 2 cycles:<br>30 ms + OOT |
| Test results/Remarks: | t approx.<br>RMS values, standard filter:<br>21 ms + OOT<br>Fundamental components, filter over 2 cycles:<br>30 ms + OOT |

**1.23.5.5 Time delays**

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.00 s £ T> £ 60.00 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % from setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % or 10 ms |

## Summary

### 1.23.6 Transient ground fault protection stage

#### 1.23.6.1 Pickup values 3I0

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60 Hz<br>Fundamental components, RMS values<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % from setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.1% of $I_{rated}$ |
| Test results/Remarks: | For CT protection:<br>\|d\| £ 1 % from setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.1% of $I_{rated}$ |

#### 1.23.6.2 Pickup values V0

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.300 V £ V0> £ 200.000 V |
| Test values: | 0.300 V £ V0> £ 200.000 V |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % from setting value or 0.05 V |
| Test results/Remarks: | \|d\| £ 1 % from setting value or 0.05 V |

#### 1.23.6.3 Pickup times

| | |
|---|---|
| Test condition: | see item 1.23.6.1 and 1.23.6.2 |
| Test values: | $I/I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>60 ms + OOT at $f_{rated}$ = 50 Hz<br>55 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>60 ms + OOT at $f_{rated}$ = 50 Hz<br>55 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.23.6.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.23.6.1 and 1.23.6.2 |
| Test values: | see item 1.23.6.1 and 1.23.6.2 |
| Permissive tolerance/Limiting values: | t approx.<br>20 ms + OOT at $f_{rated}$ = 50 Hz<br>15 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>20 ms + OOT at $f_{rated}$ = 50 Hz<br>15 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.23.6.5 Time delays

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.00 s £ T> £ 60.00 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % from setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % or 10 ms |

## Summary

### 1.23.7 Y0-with G0 or B0-measurement stage

#### 1.23.7.1 Pickup values 3I0>

| | |
|---|---|
| Test condition: | Fundamental components, RMS values<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % from setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.1% of $I_{rated}$ |
| Test results/Remarks: | For CT protection:<br>\|d\| £ 1 % from setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.1% of $I_{rated}$ |

#### 1.23.7.2 Pickup values V0>

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

#### 1.23.7.3 Angle correction φ

| | |
|---|---|
| Test condition: | -45° £ φ £ 45° |
| Test values: | -45° £ φ £ 45° |
| Permissive tolerance/Limiting values: | \|d\| £ 1° at 3I0 > 5 mA, V0> = 0.6 V |
| Test results/Remarks: | \|d\| £ 1° at 3I0 > 5 mA, V0> = 0.6 V |

#### 1.23.7.4 Pickup time

| | |
|---|---|
| Test condition: | see item 1.23.7.1 |
| Test values: | $I/I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT at 50 Hz<br>29 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>32 ms + OOT at 50 Hz<br>29 ms + OOT at 60 Hz |

#### 1.23.7.5 Dropout times

| | |
|---|---|
| Test condition: | see item 1.23.7.1 |
| Test values: | see item 1.23.7.1 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT at 50 Hz<br>27 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>32 ms + OOT at 50 Hz<br>27 ms + OOT at 60 Hz |

#### 1.23.7.6 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 % from setting value or 10 ms |
| Test results/Remarks: | \|d\| £ 1 % from setting value or 10 ms |

## Summary

**1.23.7.7 Polarized G0/B0 threshold**

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

**1.23.8 Admittance protection stage Y0>**

**1.23.8.1 Pickup values Y0>**

| | |
|---|---|
| Test condition: | Fundamental components, RMS values<br>0.10 mS £ Y0> £ 100.00 mS |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % of setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % of setting value or 0.1% of $I_{rated}$ |
| Test results/Remarks: | For CT protection:<br>\|d\| £ 1 % of setting value or 1% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % of setting value or 0.1% of $I_{rated}$ |

**1.23.8.2 Threshold values V0>**

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

**1.23.8.3 Pickup time**

| | |
|---|---|
| Test condition: | see item 1.23.8.1 |
| Test values: | $I/I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT at 50 Hz<br>29 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>32 ms + OOT at 50 Hz<br>29 ms + OOT at 60 Hz |

**1.23.8.4 Dropout times**

| | |
|---|---|
| Test condition: | see item 1.23.8.1 |
| Test values: | see item 1.23.8.1 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT |
| Test results/Remarks: | t approx.<br>32 ms + OOT |

**1.23.8.5 Time delays**

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.00 s £ T> £ 60.00 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % from setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % or 10 ms |

**1.23.9 pulse-pattern detection stage**

**1.23.9.1 Threshold values V0>**

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

## Summary

### 1.23.9.2 Threshold values 3I0>

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % from setting value or 0.5% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.01% of $I_{rated}$ |
| Test results/Remarks: | For CT protection:<br>\|d\| £ 1 % from setting value or 0.5% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % from setting value or 0.01% of $I_{rated}$ |

### 1.23.9.3 Pickup time

| | |
|---|---|
| Test condition: | Pulse-on duration=1s, Pulse-off duratiom=1.5s, Max.tolera.pulse-on or off=0.15s[1] |
| Test values: | see item 1.23.9.1 and 1.23.9.2 |
| Permissive tolerance/Limiting values: | t approx.<br>2.5s + 0.3s + OOT |
| Test results/Remarks: | t approx.<br>2.5s + 0.3s + OOT |

### 1.23.9.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.23.9.1 |
| Test values: | see item 1.23.9.1 |
| Permissive tolerance/Limiting values: | t approx.<br>32 ms + OOT |
| Test results/Remarks: | t approx.<br>32 ms + OOT |

### 1.23.10 Directional stage with phasor measurement of a harmonic

### 1.23.10.1 Threshold values V0>

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

### 1.23.10.2 Threshold values 3I0> harmonic

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT protection<br>0.001 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT sensitive |
| Permissive tolerance/Limiting values: | For CT protection:<br>\|d\| £ 1 % of setting value or 0.5% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % of setting value or 0.01% of $I_{rated}$ |
| Test results/Remarks: | For CT protection:<br>\|d\| £ 1 % of setting value or 0.5% of $I_{rated}$<br>For CT measurement:<br>\|d\| £ 1 % of setting value or 0.01% of $I_{rated}$ |

### 1.23.10.3 Pickup time

| | |
|---|---|
| Test condition: | see item 1.23.10.1 and 1.23.10.2 |
| Test values: | 1.2*Threshold |

[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

Permissive tolerance/Limiting values: t approx.
70 ms + OOT at 50 Hz
60 ms + OOT at 60 Hz

Test results/Remarks: t approx.
70 ms + OOT at 50 Hz
60 ms + OOT at 60 Hz

### 1.23.10.4 Dropout times

Test condition: see item 1.23.10.1 and 1.23.10.2

Test values: see item 1.23.10.1 and 1.23.10.2

Permissive tolerance/Limiting values: t approx.
30 ms + OOT at 50 Hz
20 ms + OOT at 60 Hz

Test results/Remarks: t approx.
30 ms + OOT at 50 Hz
20 ms + OOT at 60 Hz

### 1.23.10.5 Dropout ratio 3I0 harmonic

Test condition: see item 1.23.10.2

Test values: see item 1.23.10.2

Permissive tolerance/Limiting values: For CT protection:
|d| £ 1 % of dropout value or 1.5% of $I_{rated}$
For CT measurement:
|d| £ 1 % of dropout value or 0.05% of $I_{rated}$

Test results/Remarks: For CT protection:
|d| £ 1 % of dropout value or 1.5% of $I_{rated}$
For CT measurement:
|d| £ 1 % of dropout value or 0.05% of $I_{rated}$

### 1.23.10.6 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 % from setting value or 10 ms

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

## Summary

### 1.24 Non-Directional Intermittent-Ground-Fault-Protection

#### 1.24.1 Specifications

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

#### 1.24.2 Intermittent ground fault protection stage

##### 1.24.2.1 Pickup values 3I0>

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

##### 1.24.2.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.24.2.1 |
| Test values: | see item 1.24.2.1 |
| Permissive tolerance/Limiting values: | approx. 0.95 |
| Test results/Remarks: | approx. 0.95 |

##### 1.24.2.3 Pickup time

| | |
|---|---|
| Test condition: | see item 1.24.2.1 |
| Test values: | $I/I_{rated}$ = 2 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>23 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>23 ms + OOT at 60 Hz |

##### 1.24.2.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.24.2.1 |
| Test values: | see item 1.24.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |

##### 1.24.2.5 Pickup extension time

| | |
|---|---|
| Test condition: | 0.00 s £ T £ 10.00 s |
| Test values: | 0.00 s £ T £ 10.00 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| £ 1 % of setting value or 10 ms |

## Summary

**1.24.2.6 Sum of extended pickup times**

| | |
|---|---|
| Test condition: | 0.00 s £ T £ 100.00 s |
| Test values: | 0.00 s £ T £ 100.00 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| £ 1 % of setting value or 10 ms |

**1.24.2.7 Reset time**

| | |
|---|---|
| Test condition: | 0.00 s £ T £ 600.00 s |
| Test values: | 0.00 s £ T £ 600.00 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| £ 1 % of setting value or 10 ms |

## Summary

## 1.25 Directional Intermittent Ground Fault Protection

### 1.25.1 Specifications

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

### 1.25.2 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT type: protection<br>0.001 $I_{rated}$ £ 3I0> £ 1.600 $I_{rated}$ for CT type: sensitive |
| Test values: | $I_{rated}$=1A, $f_{rated}$ = 50 Hz:<br>0.030 $I_{rated}$ £ 3I0> £ 35.000 $I_{rated}$ for CT type: protection<br>0.001 $I_{rated}$ £ 3I0> £ 1.600 $I_{rated}$ for CT type: sensitive<br><br>$I_{rated}$=5A, $f_{rated}$ = 60 Hz:<br>0.030 $I_{rated}$ £ 3I0> £ 20.000 $I_{rated}$ for CT type: 4* protection<br>0.001 $I_{rated}$ £ 3I0> £ 1.600 $I_{rated}$ for CT type: sensitive |
| Permissive tolerance/Limiting values: | For CT protection:<br>£ 1 % of setting value or 0.5% of $I_{rated}$<br>For CT sensitive:<br>£ 1 % of setting value or 0.01% of $I_{rated}$ |
| Test results/Remarks: | For CT protection:<br>£ 1 % of setting value or 0.5% of $I_{rated}$<br>For CT sensitive:<br>£ 1 % of setting value or 0.01% of $I_{rated}$ |

### 1.25.3 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.25.2 |
| Test values: | see item 1.25.2 |
| Permissive tolerance/Limiting values: | approx. 0.95 |
| Test results/Remarks: | For CT protection:<br>£ 1 % of setting value or 2% of $I_{rated}$<br>For CT sensitive:<br>£ 1 % of setting value or 0.06% of $I_{rated}$ |

### 1.25.4 Pickup times

| | |
|---|---|
| Test condition: | see item 1.25.2 |
| Test values: | $I/I_{rated}$ = 1.2 |
| Permissive tolerance/Limiting values: | t approx.<br>30 ms + OOT at $f_{rated}$ = 50 Hz<br>23 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | 30 ms + OOT at $f_{rated}$ = 50 Hz<br>23 ms + OOT at $f_{rated}$ = 60 Hz |

### 1.25.5 Dropout times

| | |
|---|---|
| Test condition: | see item 1.25.2 |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | 25 ms + OOT at $f_{rated}$ = 50 Hz<br>22 ms + OOT at $f_{rated}$ = 60 Hz |

### 1.25.6 Pickup extension time

| | |
|---|---|
| Test condition: | see item 1.25.2 |
| 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 |

## Summary

**1.25.7 Sum of extended pickup times**

| | |
|---|---|
| Test condition: | see item 1.25.2 |
| 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 |

**1.25.8 Reset time**

| | |
|---|---|
| Test condition: | see item 1.25.2 |
| 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

### 1.26 87N Restricted Earth Fault Protection ($I_{REF>}$)

#### 1.26.1 Specifications

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

#### 1.26.2 Pickup value ($I_{REF>}$)

| | |
|---|---|
| Test condition: | 0.05 £ $I_{REF>}/I_{rated/r\ Obj}$ £ 2.00 |
| Test values: | 0.05 £ $I_{REF>}/I_{rated/r\ Obj}$ £ 2.00<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | \|d\| £ 2 % of setting value at I < 5 $I_{rated}$ |
| Test results/Remarks: | \|d\| < 2 % of setting value at I < 5 $I_{rated}$ |

#### 1.26.3 Pickup times ($I_{REF>}$)

##### 1.26.3.1 1.5 x setting value ($I_{REF>}$)

| | |
|---|---|
| Test condition: | IEC/EN 60255-1 |
| Test values: | 1.5 x setting value $I_{REF>}$<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | t approx.<br>33 ms + OOT at $f_{rated}$ = 50 Hz<br>32 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t<br>< 33 ms + OOT at $f_{rated}$ = 50 Hz<br>< 32 ms + OOT at $f_{rated}$ = 60 Hz |

##### 1.26.3.2 2.5 x setting value ($I_{REF>}$)

| | |
|---|---|
| Test condition: | see item 1.26.3.1 |
| Test values: | 2.5 x setting value $I_{REF>}$<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | t approx.<br>27 ms + OOT at $f_{rated}$ = 50 Hz<br>26 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t<br>< 27 ms + OOT at $f_{rated}$ = 50 Hz<br>< 26 ms + OOT at $f_{rated}$ = 60 Hz |

##### 1.26.3.3 Dropout times

| | |
|---|---|
| Test condition: | see item 1.26.3.1 |
| Test values: | see item 1.26.3.1 |
| Permissive tolerance/Limiting values: | t approx.<br>80 ms at $f_{rated}$ = 50 Hz<br>67 ms at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t<br>< 80 ms at $f_{rated}$ = 50 Hz<br>< 67 ms at $f_{rated}$ = 60 Hz |

##### 1.26.3.4 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 |

##### 1.26.3.5 Dropout ratio ($I_{REF>}$)

| | |
|---|---|
| Test condition: | see item 1.26.3.1 |
| Test values: | see item 1.26.3.1 |
| Permissive tolerance/Limiting values: | r approx. 0.70 |
| Test results/Remarks: | 0.68 £ r £ 0.72 |

## Summary

### 1.27 Inrush-Current Detection

#### 1.27.1 Specifications

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

#### 1.27.2 General test conditions

| | |
|---|---|
| $f_{rated}$ | 50 Hz, 60 Hz |

#### 1.27.3 Operating-range limit Imax

| | |
|---|---|
| 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 $I_{rated}$ |

#### 1.27.4 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 |

#### 1.27.5 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 |

#### 1.27.6 Pickup times

| | |
|---|---|
| Permissive tolerance/Limiting values: | approx. 29 ms + OOT |
| Test results/Remarks: | approx. 29 ms + OOT |

#### 1.27.7 Dropout ratios

#### 1.27.7.1 Current measurement Imax

| | |
|---|---|
| Test condition: | r = 0.95 or 0.015 A at $I_{rated}$ = 1 A<br>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 |

#### 1.27.7.2 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

### 1.28 Jump Detection

#### 1.28.1 Current jump detection [1]

##### 1.28.1.1 Pickup values

| | |
|---|---|
| Test condition: | L-N, 3I0<br>$f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ |
| Permissive tolerance/Limiting values: | \|d\| £ 3 % of setting value or 0.01 $I_{rated}$ |
| Test results/Remarks: | \|d\| £ 3 % of setting value or 0.01 $I_{rated}$ |

##### 1.28.1.2 Pickup times

| | |
|---|---|
| Test condition: | see item 1.28.1.1 |
| Test values: | see item 1.28.1.1 |
| Permissive tolerance/Limiting values: | t approx.<br>8 ms + OOT |
| Test results/Remarks: | t approx.<br>8 ms + OOT |

#### 1.28.2 Voltage jump detection

##### 1.28.2.1 Pickup values

| | |
|---|---|
| Test condition: | L-N, L-L, V0<br>$f_{rated}$ = 50 Hz, 60 Hz<br>0.30V £ V> £ 340.000 V |
| Permissive tolerance/Limiting values: | \|d\| £ 2 % of setting value or 0.1 V |
| Test results/Remarks: | \|d\| £ 2 % of setting value or 0.1 V |

##### 1.28.2.2 Pickup times

| | |
|---|---|
| Test condition: | see item 1.28.2.1 |
| Test values: | see item 1.28.2.1 |
| Permissive tolerance/Limiting values: | t approx.<br>8 ms + OOT |
| Test results/Remarks: | t approx.<br>8 ms + OOT |

[1] Not applicable for Busbar Protection

## Summary

### 1.29 50BF Circuit BreakerFailure Protection

#### 1.29.1 Pickup values

| | |
|---|---|
| $f_{rated}$ | 50 Hz, 60 Hz |
| $I_{rated}$ | 1A, 5A |
| $3I0_{criterion}$ | Plausibility check / Direct release |
| $I2_{criterion}$ | Plausibility check / Direct release |

#### 1.29.2 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ 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 % $I_{rated}$ |

#### 1.29.3 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 % $I_{rated}$ |

#### 1.29.4 Pickup times

| | |
|---|---|
| Test condition: | Pickup time |
| Permissive tolerance/Limiting values: | £ 10 ms |
| Test results/Remarks: | < 10 ms |

#### 1.29.5 Dropout times

##### 1.29.5.1 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] |

##### 1.29.5.2 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] |

#### 1.29.6 Time delays

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.000 s to 60.000 s |
| Permissive tolerance/Limiting values: | £ 1 % of setting value or 10 ms |
| Test results/Remarks: | < 1 % of setting value or 10 ms |

#### 1.29.7 Operation with CB auxiliary contact

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | function correct |

#### 1.29.8 Standard Characteristic Curve

##### 1.29.8.1 Threshold $I_{diff}$

| | |
|---|---|
| Test condition: | 0.20 to 4.00 I/Irated obj |
| Permissive tolerance/Limiting values: | £ 5 % of setting value or 50 mA |
| Test results/Remarks: | < 5 % of setting value or 50 mA |

[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

### 1.29.9 Frequency Operating Range

| | |
|---|---|
| Test condition: $f_{rated}$ -10% < f < $f_{rated}$ +5% | According to specified tolerances |
| Test results/Remarks: | confirmed |
| Test condition: 10 Hz < f < $f_{rated}$ -10%<br>$f_{rated}$ +5% < f < 80 Hz | Slightly expanded tolerances |
| Test results/Remarks: | confirmed |
| Test condition: f < 10 Hz, f > 80 Hz | Active |
| Test results/Remarks: | confirmed |

## Summary

### 1.30 Circuit Breaker Restrike Protection

#### 1.30.1 Pickup values

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz<br>0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ |
| Permissive tolerance/Limiting values: | £1 % of setting value or 0.5 % $I_{rated}$ |
| Test results/Remarks: | £1 % of setting value or 0.5 % $I_{rated}$ |

#### 1.30.2 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.29.1 |
| Test value: | 95% of threshold value |
| Permissive tolerance/Limiting values: | £1 % of setting value or 0.5 % $I_{rated}$ |
| Test results/Remarks: | £1 % of setting value or 0.5 % $I_{rated}$ |

#### 1.30.3 Pickup times

| | |
|---|---|
| Test condition: | see item 1.29.1<br>1.2*threshold |
| Permissive tolerance/Limiting values: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>25 ms + OOT at 50 Hz<br>22 ms + OOT at 60 Hz |

#### 1.30.4 Dropout times

| | |
|---|---|
| Test condition: | see item 1.29.1<br>1.2*threshold |
| Permissive tolerance/Limiting values: | 20 ms + OOT |
| Test results/Remarks: | 20 ms + OOT |

#### 1.30.5 Time delay T1 for 3-pole retrip

| | |
|---|---|
| Test condition: | see item 1.29.1<br>1.2*threshold |
| 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 |

#### 1.30.6 Time delay T2 for 3-pole trip

| | |
|---|---|
| Test condition: | see item 1.29.1<br>1.2*threshold |
| 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 |

#### 1.30.7 Time delay for minimum operate

| | |
|---|---|
| Test condition: | see item 1.29.1<br>1.2*threshold |
| 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

**1.30.8 Time delay for dropout**

| | |
|---|---|
| Test condition: | see item 1.29.1<br>1.2*threshold |
| Test values: | 0.00 s to 60.00 s |
| Permissive tolerance/Limiting values: | £ 1 % of setting value or 35 ms |
| Test results/Remarks: | £ 1 % of setting value or 35 ms |

**1.30.9 Position recognition delay**

| | |
|---|---|
| Test condition: | see item 1.29.1<br>1.2*threshold |
| 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 |

**1.30.10 Monitoring duration**

| | |
|---|---|
| Test condition: | see item 1.29.1<br>1.2*threshold |
| 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

### 1.31 25 Synchronization Function

#### 1.31.1 Specifications

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

#### 1.31.2 Tolerances

##### 1.31.2.1 Tolerances of the voltage settings

Permissive tolerance/Limiting values: 2 % of setting value or 1 V

Test results/Remarks: £ 2 % or £ 1 V

##### 1.31.2.2 Voltage difference V2>V1; V2<V1

Permissive tolerance/Limiting values: 1 V

Test results/Remarks: £ 0,15 V

##### 1.31.2.3 Frequency difference f2>f1; f2<f1

Permissive tolerance/Limiting values: 1 mHz

Test results/Remarks: £ 1mHz

##### 1.31.2.4 Angular difference α2>α1; α2<α1

Permissive tolerance/Limiting values: 1 °

Test results/Remarks: £ 0,2 °

##### 1.31.2.5 Tolerance of all time settings

Permissive tolerance/Limiting values: 10 ms

Test results/Remarks: £ 10 ms

##### 1.31.2.6 Max. phase displacement angle

Permissive tolerance/Limiting values: 5 ° for Δf ≤ 1 Hz
10 ° for Δf > 1 Hz

Test results/Remarks: ≤ 5 ° for Δf ≤ 1 Hz
≤ 10 ° for Δf > 1 Hz

#### 1.31.3 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
- 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

## Summary

### 1.32 Balancing Command for Synchronization Function

#### 1.32.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255- 8

#### 1.32.2 Balancing Voltage v2

##### 1.32.2.1 TV pulse min

| | |
|---|---|
| Test values: | 0.01 s £ TV pulse min £ 1.00 s |
| Permissive tolerance/Limiting values: | 10 ms |
| Test results/Remarks: | 10 ms |

##### 1.32.2.2 TV pulse max

| | |
|---|---|
| Test values: | 0.01 s £ TV pulse max £ 60.00 s |
| Permissive tolerance/Limiting values: | 10 ms |
| Test results/Remarks: | 10 ms |

##### 1.32.2.3 T position impulse ( Calculated impulse length for voltage control)

| | |
|---|---|
| Test values: | 0.100 V £ dV per second £ 50.000 V<br>-5.000 V £ dV £ 5.000 V |
| Permissive tolerance/Limiting values: | 1 % of calculated impulse or 10 ms |
| Test results/Remarks: | 1 % of calculated impulse or 10 ms |

##### 1.32.2.4 T pause V

| | |
|---|---|
| Test values: | 0.10 s £ Tpause V £ 60.00 s |
| Permissive tolerance/Limiting values: | 10 ms |
| Test results/Remarks: | 10 ms |

#### 1.32.3 Balancing Frequency f2

##### 1.32.3.1 T f pulse min

| | |
|---|---|
| Test values: | 0.01 s £ Tf pulse min £ 1.00 s |
| Permissive tolerance/Limiting values: | 10 ms |
| Test results/Remarks: | 10 ms |

##### 1.32.3.2 T f pulse max

| | |
|---|---|
| Test values: | 0.01 s £ Tf pulse max £ 60.00 s |
| Permissive tolerance/Limiting values: | 10 ms |
| Test results/Remarks: | 10 ms |

##### 1.32.3.3 T position impulse ( Calculated impulse length for frequency control)

| | |
|---|---|
| Test values: | 0.05 Hz/s £ df/dt of the controller £ 5.00 Hz/s<br>-1.00 Hz £ df £ 1.00 Hz |
| Permissive tolerance/Limiting values: | 1 % of calculated impulse or 10 ms |
| Test results/Remarks: | 1 % of calculated impulse or 10 ms |

##### 1.32.3.4 T pause f

| | |
|---|---|
| Test values: | 0.10 s £ T pause f £ 60.00 s |
| Permissive tolerance/Limiting values: | 10 ms |
| Test results/Remarks: | 10 ms |

## Summary

### 1.33 79 Automatic Reclosing Function

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

## Summary

## 1.34 81 Frequency Protection

### 1.34.1 Specifications

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

### 1.34.2 Pickup values f<, f>

| | |
|---|---|
| Test condition: | 40.00 Hz £ f> £ 70.00 Hz<br>Method A: Angle difference method<br>Method B : Filtering method |
| Test values: | A: $f_{rated}$ - 0.2 Hz < f < $f_{rated}$ + 0.2 Hz<br>B: $f_{rated}$ - 3.0 Hz < f < $f_{rated}$ + 3.0 Hz |
| Permissive tolerance/Limiting values: | A: \|d\| £ 5 mHz at V = $V_{rated}$<br>B: \|d\| £ 10 mHz at V = $V_{rated}$ |
| Test results/Remarks: | A: \|d\| < 5 mHz at V = $V_{rated}$<br>B: \|d\| < 10 mHz at V = $V_{rated}$ |

### 1.34.3 Dropout ratio Δf

| | |
|---|---|
| Test condition: | 20 mHz to 2000 mHz |
| Permissive tolerance/Limiting values: | \|d\| £ 5 mHz at V = $V_{rated}$ |
| Test results/Remarks: | \|d\| < 5 mHz at V = $V_{rated}$ |

#### 1.34.3.1 Pickup times f<, f>

| | |
|---|---|
| Permissive tolerance/Limiting values: | Method A:<br>t approx.<br>70 ms + OOT at $f_{rated}$ = 50 Hz<br>60 ms + OOT at $f_{rated}$ = 60 Hz<br><br>Method B:<br>t approx.<br>75 ms + OOT at $f_{rated}$ = 50 Hz<br>75 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | Method A:<br>t<br>< 70 ms + OOT at $f_{rated}$ = 50 Hz<br>< 60 ms + OOT at $f_{rated}$ = 60 Hz<br><br>Method B:<br>t<br>< 75 ms + OOT at $f_{rated}$ = 50 Hz<br>< 75 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.34.3.2 Dropout times f<, f>

| | |
|---|---|
| Test values: | dropout by I, V -> 0 |
| Permissive tolerance/Limiting values: | 60 ms £ t £ 80 ms |
| Test results/Remarks: | 60 ms < t < 80 ms |

#### 1.34.3.3 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 % or 10 ms |

## Summary

### 1.35 81R Rate of Frequency Change

#### 1.35.1 Specifications

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

#### 1.35.2 df/dt falling

##### 1.35.2.1 Pickup values

| | |
|---|---|
| Test condition: | $0.9 \le f/f_{rated} \le 1.1$ |
| Test values: | 0.10 Hz/s ≤ df/dt ≤ 20.00 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<br>Measuring window > 3 periods < 3 %; < 0.06 Hz/s |

##### 1.35.2.2 Dropout differential

| | |
|---|---|
| Test condition: | $0.9 \le f/f_{rated} \le 1.1$ |
| Test values: | 0.02 Hz/s≤ Dropout differential ≤ 0.99 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<br>Measuring window > 3 periods < 3 %; < 0.06 Hz/s |

##### 1.35.2.3 Pickup times

| | |
|---|---|
| Test condition: | 0.10 Hz/s ≤ df/dt ≤ 20.00 Hz/s |
| Test results/Remarks: | Approx.165 ms to 225 ms (depends on measuring window length) |

##### 1.35.2.4 Dropout times

| | |
|---|---|
| Test condition: | 0.10 Hz/s ≤ df/dt ≤ 20.00 Hz/s |
| Test results/Remarks: | Approx.165 ms to 225 ms (depends on measuring window length) |

##### 1.35.2.5 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 |

#### 1.35.3 df/dt rising

##### 1.35.3.1 Pickup values

| | |
|---|---|
| Test condition: | $0.9 \le f/f_{rated} \le 1.1$ |
| Test values: | 0.10 Hz/s ≤ df/dt ≤ 20.00 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<br>Measuring window > 3 periods < 3 %; < 0.06 Hz/s |

##### 1.35.3.2 Dropout differential

| | |
|---|---|
| Test condition: | $0.9 \le f/f_{rated} \le 1.1$ |
| Test values: | 0.02 Hz/s≤ Dropout differential ≤ 0.99 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<br>Measuring window > 3 periods < 3 %; < 0.06 Hz/s |

##### 1.35.3.3 Pickup times

| | |
|---|---|
| Test condition: | 0.10 Hz/s ≤ df/dt ≤ 20.00 Hz/s |
| Test results/Remarks: | Approx.165 ms to 225 ms (depends on measuring window length) |

## Summary

**1.35.3.4 Dropout times**

| | |
|---|---|
| Test condition: | 0.10 Hz/s ≤ df/dt ≤ 20.00 Hz/s |
| Test results/Remarks: | Approx.165 ms to 225 ms (depends on measuring window length) |

**1.35.3.5 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

## 1.36 Underfrequency Load Shedding Protection

### 1.36.1 Specifications

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

### 1.36.2 General function block

#### 1.36.2.1 Minimum Voltage

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60 Hz. |
| Test values: | 0.300 p.u. £ threshold value £ 0.900 p.u. |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>0.5 % of setting value or 0.05 V |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>0.5 % of setting value or 0.05 V |

#### 1.36.2.2 Phi (power criterion)

| | |
|---|---|
| Test condition: | see item 1.36.2.1 |
| Test values: | -30°£ threshold value £ 30° |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>1° |
| Test results/remarks: | in the range $f_{rated}$ ±10 %<br>1° |

Min.current(power crit.)

| | |
|---|---|
| Test condition: | see item 1.36.2.1 |
| Test values: | 0.020 p.u. £ threshold value £ 0.200 p.u. |
| Permissive tolerance/Limiting values: | in the range $f_{rated}$ ±10 %<br>1 % of setting value or 0.005 $I_{rated}$ |
| Test results/Remarks: | in the range $f_{rated}$ ±10 %<br>1 % of setting value or 0.005 $I_{rated}$ |

#### 1.36.2.3 Df/dt-rising blk. threshold

| | |
|---|---|
| Test condition: | 0.9 ≤ $f/f_{rated}$ ≤ 1.1 |
| Test values: | 0.10 Hz/s ≤ threshold value ≤ 20.00 Hz/s |
| Permissive tolerance/Limiting values: | 5 % of setting value or 0.1 Hz/s |
| Test results/Remarks: | Measuring window ≤ 3 periods, 5 % of setting value or 0.06 Hz/s<br>Measuring window > 3 periods, 3 % of setting value or 0.06 Hz/s |

#### 1.36.2.4 Df/dt-falling blk. threshold

| | |
|---|---|
| Test condition: | 0.9 ≤ $f/f_{rated}$ ≤ 1.1 |
| Test values: | 0.10 Hz/s ≤ threshold value ≤ 20.00 Hz/s |
| Permissive tolerance/Limiting values: | 5 % of setting value or 0.1 Hz/s |
| Test results/Remarks: | Measuring window ≤ 3 periods, 5 % of setting value or 0.06 Hz/s<br>Measuring window > 3 periods, 3 % of setting value or 0.06 Hz/s |

#### 1.36.2.5 Df/df dropout differential

| | |
|---|---|
| Test condition: | 0.9 ≤ $f/f_{rated}$ ≤ 1.1 |
| Test values: | 0.02 Hz/s≤ Dropout differential ≤ 0.99 Hz/s |
| Permissive tolerance/Limiting values: | 5 % of Dropout value or 0.1 Hz/s |
| Test results/Remarks: | Measuring window ≤ 3 periods,5 % of setting value or 0.06 Hz/s<br>Measuring window > 3 periods,3 % of setting value or 0.06 Hz/s |

### 1.36.3 Underfrequency Protection stage

#### 1.36.3.1 Pickup values

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60 Hz<br>f< stabilization counter = 6 |

## Summary

Test values: $f_{rated}$ - 10.0 Hz < f < $f_{rated}$ + 10.0 Hz

Permissive tolerance/Limiting values: 5 mHz at V = $V_{rated}$

Test results/Remarks: 5 mHz at V = $V_{rated}$

### 1.36.3.2 Frequency dropout differential

Test condition: see item 1.36.3.1

Test values: 20 mHz to 2000 mHz

Permissive tolerance/Limiting values: 5 mHz at V = $V_{rated}$ ($f_{rated}$ - 10.0 Hz < f < $f_{rated}$ + 10.0 Hz)

Test results/Remarks: 5 mHz at V = $V_{rated}$ ($f_{rated}$ - 10.0 Hz < f < $f_{rated}$ + 10.0 Hz)

### 1.36.3.3 Pickup times

Test condition: see item 1.36.3.1

Test values: 1.2*threshold

Permissive tolerance/Limiting values: 85 ms + OOT at 50 Hz
80 ms + OOT at 60 Hz

Test results/Remarks: 85 ms + OOT at 50 Hz
80 ms + OOT at 60 Hz

### 1.36.3.4 Dropout times

Test condition: see item 1.36.3.1

Permissive tolerance/Limiting values: 80 ms + OOT at 50 Hz
75 ms + OOT at 60 Hz

Test results/Remarks: 80 ms + OOT at 50 Hz
75 ms + OOT at 60 Hz

### 1.36.3.5 Operate delay

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 10ms

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

## Summary

### 1.37 78 Out-of-Step Protection

#### 1.37.1 Specifications

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

#### 1.37.2 Power-swing frequency

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

#### 1.37.3 Number of acceptable swings

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

#### 1.37.4 Maximum negative sequence current

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

#### 1.37.5 Characteristic

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

#### 1.37.6 Times

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

## Summary

### 1.38 32 General Power Protection 3-phases

#### 1.38.1 Specifications

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

#### 1.38.2 Pickup values

| | |
|---|---|
| Test condition: | -200.0 % to +200.0 % |
| Test values: | -200.0 % to +200.0 % |
| Permissive tolerance/Limiting values: | \|d\| £ 0.5 % $S_{n/r}$ ± 3 % of setting value |
| Test results/Remarks: | \|d\| < 0.5 % $S_{n/r}$ ± 3 % of setting value |

#### 1.38.3 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 |

#### 1.38.4 Dropout ratio

| | |
|---|---|
| Test condition: | 0.90 to 0.99 at >stage<br>1.01 to 1.10 at <stage |
| Test values: | 0.90 to 0.99 at >stage<br>1.01 to 1.10 at <stage |
| Permissive tolerance/Limiting values: | function according to manual |
| Test results/Remarks: | function correct |

#### 1.38.5 Pickup times

| | |
|---|---|
| Permissive tolerance/Limiting values: | t approx.<br>55 ms + OOT at $f_{rated}$ = 50 Hz<br>45 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t<br>< 55 ms + OOT at $f_{rated}$ = 50 Hz<br>< 45 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.38.6 Dropout times

| | |
|---|---|
| Permissive tolerance/Limiting values: | t approx.<br>55 ms + OOT at $f_{rated}$ = 50 Hz<br>45 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t<br>< 55 ms + OOT at $f_{rated}$ = 50 Hz<br>< 45 ms + OOT at $f_{rated}$ = 60 Hz |

#### 1.38.7 Time delays

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

## Summary

## 1.39 27 Undervoltage-controlled Reactive Power Protection

### 1.39.1 Specifications

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

### 1.39.2 Protection stage

#### 1.39.2.1 Pickup values V<

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>3.000 V £ V< £ 175.000 V |
| Test values: | 3.000 V £ V< £ 175.000 V |
| Permissive tolerance/Limiting values: | < 0.5 % of set point value or 0.05 V |
| Test results/Remarks: | < 0.5 % of set point value or 0.05 V |

#### 1.39.2.2 V dropout ratio

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>r = dropout ratio |
| Test values: | r = 1.05 |
| Test results/Remarks: | 1.01 £ r £ 1.20 |

#### 1.39.2.3 Pickup values I1>

| | |
|---|---|
| Test condition: | 0.030 A £ I1> £ 10.000 $I_{rated}$ |
| Test values: | $f_{rated}$ = 50 Hz, 60Hz |
| Permissive tolerance/Limiting values: | 1 % of setting value or 0.005 $I_{rated}$ |
| Test results/remarks: | 1 % of setting value or 0.005 $I_{rated}$ |

#### 1.39.2.4 Dropout ratio release current

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>r = dropout ratio |
| Test values: | r = 0.95 |
| Test results / remarks: | 0.90 £ r £ 0.99 |

#### 1.39.2.5 Pickup values Q<

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>1.0% £ Q< £ 200.0% |
| Test values: | 1.0% £ Q< £ 200.0% |
| Permissive tolerance/Limiting values: | <0.5 % Sn/r ± 3 % of setting value |
| Test results / remarks: | <0.5 % Sn/r ± 3 % of setting value |

#### 1.39.2.6 Q dropout ratio

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>r = dropout ratio |
| Test values: | r £ 0.95 |
| Test results / remarks: | 0.90 £ r £ 0.99 |

#### 1.39.2.7 Pickup time

| | |
|---|---|
| Test condition: | see item 1.39.2.1, 1.39.2.3, 1.39.2.5 |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | t approx.<br>55 ms + OOT at $f_{rated}$ = 50 Hz<br>45 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>55 ms + OOT at $f_{rated}$ = 50 Hz<br>45 ms + OOT at $f_{rated}$ = 60 Hz |

## Summary

### 1.39.2.8 Dropout times

| | |
|---|---|
| Test condition: | see item 1.39.2.1, 1.39.2.3, 1.39.2.5 |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | t approx.<br>55 ms + OOT at $f_{rated}$ = 50 Hz<br>45 ms + OOT at $f_{rated}$ = 60 Hz |
| Test results/Remarks: | t approx.<br>55 ms + OOT at $f_{rated}$ = 50 Hz<br>45 ms + OOT at $f_{rated}$ = 60 Hz |

### 1.39.2.9 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 |

### 1.39.2.10 Operate delay generator CB

| | |
|---|---|
| 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 |

### 1.39.2.11 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: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| £ 1 % of setting value or 10 ms |

### 1.39.3 Recloser stage

### 1.39.3.1 V> reclosure threshold

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>3.000 V £ V> £ 340.000 V |
| 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 |

### 1.39.3.2 V dropout ratio

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>r = dropout ratio |
| Test values: | r = 0.95 |
| Test results / remarks: | 0.90 £ r £ 0.99 |

### 1.39.3.3 f-difference positive

| | |
|---|---|
| Test condition: | 0.01 Hz to 5.00 Hz |
| Test values: | 0.01 Hz to 5.00 Hz |
| Permissive tolerance/Limiting values: | 10 mHz |
| Test results/Remarks: | 10 mHz |

### 1.39.3.4 f-difference negative

| | |
|---|---|
| Test condition: | -5.00 Hz to -0.01 Hz |
| Test values: | -5.00 Hz to -0.01 Hz |
| Permissive tolerance/Limiting values: | 10 mHz |
| Test results/Remarks: | 10 mHz |

## Summary

**1.39.3.5 I> release threshold**

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 10.000 $I_{rated}$ |
| Test values: | $f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | 1 % of setting value or 0.005 $I_{rated}$ |
| Test results/Remarks: | 1 % of setting value or 0.005 $I_{rated}$ |

**1.39.3.6 Dropout ratio release current**

| | |
|---|---|
| Test condition: | $f_{rated}$ = 50 Hz, 60Hz<br>r = dropout ratio |
| Test values: | r = 0.95 |
| Test results/Remarks: | 0.90 £ r £ 0.99 |

**1.39.3.7 Time delay**

| | |
|---|---|
| Test condition: | 0.00 s £ T £ 3600.00 s |
| Test values: | 0.00 s £ T £ 3600.00 s |
| Permissive tolerance/Limiting values: | £1% of setting value or 10 ms |
| Test results/Remarks: | £1% of setting value or 10 ms |

## Summary

### 1.40 49 Thermal Overload Protection 3phases

#### 1.40.1 Specifications

- VDE 0435
- IEC/EN 60255-1, item 7, Annex A, B
- IEC/EN 60255-8

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 60255-8 or VDE 0435 T3011

#### 1.40.2 Pickup threshold k * $I_N$

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 IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 50 Hz, 4% or 0.02 $I_{rated,}$ 4% class acc. to IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 60 Hz, 5% or 0.025 $I_{rated,}$ 5% class acc. to IEC60255-8

Test results/Remarks:
Up to 30th harmonic, 2% or 0.01 $I_{rated,}$ 2% class acc. to IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 50 Hz, 4% or 0.02 $I_{rated,}$ 4% class acc. to IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 60 Hz, 5% or 0.025 $I_{rated,}$ 5% class acc. to IEC60255-8

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 IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 50 Hz, 3% or 0.02 $I_{rated,}$ 4% class acc. to IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 60 Hz, 4% or 0.02 $I_{rated,}$ 5% class acc. to IEC60255-8

Test results/Remarks:
Up to 30th harmonic, 2% or 0.01 $I_{rated,}$ 2% class acc. to IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 50 Hz, 3% or 0.02 $I_{rated,}$ 4% class acc. to IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 60 Hz, 4% or 0.02 $I_{rated,}$ 5% class acc. to IEC60255-8

With filter for the gain of harmonics including compensation of the amplitude attenuation[1]

Permissive tolerance/Limiting values:
Up to 30th harmonic, 2% or 0.01 $I_{rated,}$ 2% class acc. to IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 50 Hz, 4% or 0.02 $I_{rated,}$ 4% class acc. to IEC60255-8
Up to 50th harmonic, $f_{rated}$ = 60 Hz, 5% or 0.025 $I_{rated,}$ 5% class acc. to IEC60255-8

Test results/Remarks:
Up to 30th harmonic, 2% or 0.01 $I_{rated,}$ 2% class acc. to IEC60255-8 [2]
Up to 50th harmonic, $f_{rated}$ = 50 Hz, 4% or 0.02 $I_{rated,}$ 4% class acc. to IEC60255-8[3]
Up to 50th harmonic, $f_{rated}$ = 60 Hz, 5% or 0.025 $I_{rated,}$ 5% class acc. to IEC60255-8[4]

#### 1.40.3 Thermal warning stage

Test condition: 50 % £ Q-warn £ 100 %

Test values: Q-warn = 50 %, 63 %, 90 %, 100 %

Test results/Remarks: function correct

#### 1.40.4 Current warning stage

Test condition: 0.03 $I_{rated}$ £ $I_{warn}$ £ 35.00 $I_{rated}$

Test results/Remarks: function correct

#### 1.40.5 Dropout ratio

Test condition: dropout threshold ratio
50 % £ r £ 99 %

Test results/Remarks: function correct

[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

### 1.40.6 Tripping time characteristics

#### 1.40.6.1 Parameter k, t

| | |
|---|---|
| Test condition: | $k = I_{max}/I_{rated}$ (IEC 60255-8)<br>t = Time constant |
| Test values: | tripping times t |
| Permissive tolerance/Limiting values: | \|d\| £ 3 % or 1 s<br>3 % class acc. to IEC 60255-8 for $I/(k * I_{rated}) > 1.25$ |

#### 1.40.6.2 Range of k, t

| | |
|---|---|
| Test condition: | 0.10 £ k £ 4.00<br>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 $I/(k* I_{rated}) £ 8$ |

#### 1.40.6.3 With and without preload

| | |
|---|---|
| Test condition: | with and without preload |
| Test values: | a) k = 0.1; t = (300, 500) min; I = 0.7 A<br>b) k = 1.1; t = (20, 100) min; I = 2.5 A<br>c) k = 4.0; t = (1, 5) min; I = 5.0 A<br>d) k = 1.0; t = (1, 3, 10) min; I = 1.0 A |

#### 1.40.6.4 Range $I/(k*I_{rated}) ≥ 8$

| | |
|---|---|
| Test condition: | range $I/(k*I_{rated}) ≥ 8$ |
| Test values: | a) k = 1.0: $I/(k*I_{rated}) = 8, 10, 12$<br>b) k = 0.1: $I/(k*I_{rated}) = 8, 10, 50$ |
| Permissive tolerance/Limiting values: | t[≥ 8] = const = t[8]<br>t[8] = t according to formula for $I/(k*I_{rated}) = 8$ |
| Test results/Remarks: | function correct |

## Summary

### 1.41 49 Thermal Overload Protection 1phase

#### 1.41.1 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

#### 1.41.2 Pickup threshold k * $I_N$

Test condition: $k = I_{max}/I_{rated}$
$0.10 \leq k \leq 4.00$

Test values: k = 0.10, 1.00, 4.00

Permissive tolerance/Limiting values: |d| £ 2% or 10mA at $I_{rated}$ = 1A
|d| £ 2% or 50mA at $I_{rated}$ = 5A
class 2% acc. to IEC 255-8

Test results/Remarks: |d| < 2 %

#### 1.41.3 Thermal time constant

Test condition: $30s \leq t_{th} \leq 60000s$

Test values: $t_{th}$ = 30s, 100s, 60000s

Test results/Remarks: function correct

#### 1.41.4 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

#### 1.41.5 Current warning stage

Test condition: $0.03\ I_{rated} \leq I_{warn} \leq 35.00\ I_{rated}$

Test values: $I_{warn}$ = 0.03A, 0.5A, 5A, 10A

Test results/Remarks: function correct

#### 1.41.6 Maximum thermal current

Test condition: $0.03\ I_{rated} \leq I_{max\ thermal} \leq 10.00\ I_{rated}$

Test values: $I_{max\ thermal}$ = 1.1A, 2.5A, 10A

Test results/Remarks: function correct

#### 1.41.7 Dropout ratio

Test condition: dropout threshold operate ratio
50% £ r £ 99%

Test values: r = 50%, 70%, 90%, 99%

Test results/Remarks: function correct

## Summary

### 1.41.8 Tripping time characteristics

| | |
|---|---|
| Test condition: | $k = I_{max}/I_{rated}$ (IRC 255-8)<br>0.10 £ k £ 4.00<br><br>t = Time constant<br>30 s £ t £ 60000 s<br><br>with and without preload |
| Test values: | tripping times t<br>Fault L-N, Modus Q-max<br><br>k = 0.1, 1, 4; t = 100s<br>k = 1; t = 30s, 100s, 60000s |
| Permissive tolerance/Limiting values: | \|d\| £ 3 % or 1s<br>class 3 % acc. to IEC 255-8 for $I/(k * I_{rated}) > 1.25$<br><br>$t = t\ ln\{ ((I/k\ I_{rated})^2-(I_{pre}/k\ I_{rated})^2)) / ((I/k\ I_{rated})^2-1)) \}$ for $I/(k* I_{rated})$ £ 8 |
| Test results/Remarks: | function correct<br>\|d\| < 2% or 0.2s |

## Summary

## 1.42 Arc Protection

### 1.42.1 General test conditions

$f_{rated}$ 50 Hz, 60 Hz

$I_{rated}$ 1 A

### 1.42.2 Light only

#### 1.42.2.1 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

#### 1.42.2.2 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

### 1.42.3 Light and current

#### 1.42.3.1 Threshold I>

Test condition: 1pol-fault, 3pol-fault
0.03 £ $I/I_{ratedObj}$ £ 10.00

Permissive tolerance/Limiting values: no operate below threshold, measurement accuracy not considered

Test results/Remarks: confirmed

#### 1.42.3.2 Threshold 3I0>

Test condition: 1pol-fault, IN calculated, IN measured
0.03 £ $I/I_{ratedObj}$ £ 10.00

Permissive tolerance/Limiting values: no operate below threshold, measurement accuracy not considered

Test results/Remarks: confirmed

#### 1.42.3.3 Dropout ratio I>

Test condition: 1pol-fault, 3pol-fault
0.03 £ $I/I_{ratedObj}$ £ 10.00

Permissive tolerance/Limiting values: approx. 0.90

Test results/Remarks: 0.80 – 0.95

#### 1.42.3.4 Dropout ratio 3I0>

Test condition: 1pol-fault
0.03 £ $I/I_{ratedObj}$ £ 10.00

Permissive tolerance/Limiting values: approx. 0.90

Test results/Remarks: 0.80 – 0.95

#### 1.42.3.5 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 |

## Summary

### 1.42.3.6 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 |

### 1.42.4 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

### 1.43 Tripping on Weak Infeed (French Specification)

#### 1.43.1 General test conditions

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

$f_{rated}$ 50 Hz

$I_{rated}$ 1 A

#### 1.43.2 Pickup values

#### 1.43.2.1 Vph-g<factor

Test condition: 0.10 £ $V_{ph\text{-}g<factor}$ £ 1

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: confirmed

#### 1.43.2.2 Undervoltage

Test condition: 0.30 V £ $V_{ph\text{-}gnd}$ £ 50 V

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

Test results/Remarks: |d| £ 5 % of setting value or 0.1 V

#### 1.43.2.3 3I0> threshold

Test condition: 0.20 A £ 3I0 £ 1 A

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

Test results/Remarks: |d| £ 3 % of setting value or 0.01 $I_{rated}$

#### 1.43.2.4 Time constant Tau

Test condition: 1 s £ Tau £ 60 s

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: confirmed

#### 1.43.3 Pickup times

Test condition: 10 measurements with receive signal
Voltage jump from $V_n$ to 0 at default threshold
Pickup of stage measured with fast-relais

Test results/Remarks: 1pol, 50Hz
$t_{max}$ = 31.4 ms
$t_{min}$ = 18.4 ms
$t_{average}$ = 25.1 ms

#### 1.43.4 Time delays

#### 1.43.4.1 Operate delay 1-phase (TM)

Test condition: 0.0 s £ T £ 30 s

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

Test results/Remarks: confirmed

#### 1.43.4.2 Operate delay multi phases (TT)

Test condition: 0.0 s £ T £ 30 s

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

Test results/Remarks: confirmed

#### 1.43.4.3 T 3I0> extension

Test condition: 0.0 s £ T £ 30 s

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: confirmed

## Summary

**1.43.4.4 Receive extension**

| | |
|---|---|
| Test condition: | 0.0 s £ T £ 30 s |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | confirmed |

**1.43.4.5 T 3I0> alarm**

| | |
|---|---|
| Test condition: | 0.0 s £ T £ 30 s |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | confirmed |

## Summary

### 1.44 Temperature Supervision

#### 1.44.1 Pickup values

| | |
|---|---|
| Test condition: | -50 °C to 250 °C<br>-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 |

#### 1.44.2 Dropout ratio

| | |
|---|---|
| Test condition: | -50 °C to 250 °C<br>-58 °F to 482 °F |
| Permissive tolerance/Limiting values: | 3 °C or 6 °F |
| Test results/Remarks: | 3 °C or 6 °F |

#### 1.44.3 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 % or 10 ms |

## Summary

### 1.45 MAXI-L Overcurrent Protection (French Specification)

#### 1.45.1 Specifications

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

#### 1.45.2 Fast stage

##### 1.45.2.1 Threshold Iph

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ |
| Test values: | 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 0.5 % $I_{rated}$ |
| Test results/Remarks: | \|d\| < 1 % of setting value or 0.5 % $I_{rated}$ |

##### 1.45.2.2 Threshold 3I0

| | |
|---|---|
| Test condition: | 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$ |
| Test values: | 0.030 $I_{rated}$ £ I> 35.000 $I_{rated}$<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 0.5 % $I_{rated}$ |
| Test results/Remarks: | \|d\| < 1 % of setting value or 0.5 % $I_{rated}$ |

##### 1.45.2.3 Dropout ratio

| | |
|---|---|
| Test condition: | see item 1.45.2.1 |
| Test values: | r = 0.95 (fixed) |
| Permissive tolerance/Limiting values: | £ 1 % of dropout value |
| Test results/Remarks: | < 1 % of dropout value |

##### 1.45.2.4 Pickup times

Test condition: 30 measurements per fault type

Test values: $I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|---|
| $t_{max}$ | = | 30.8 ms + OOT | 25.9 ms + OOT |
| $t_{min}$ | = | 17.1 ms + OOT | 14.0 ms + OOT |
| $t_{average}$ | = | 23.9 ms + OOT | 19.5 ms + OOT |

##### 1.45.2.5 Dropout times

Test condition: 30 measurements per fault type

Test values: $I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|---|
| $t_{max}$ | = | 20.1 ms + OOT | 17.9 ms + OOT |
| $t_{min}$ | = | 6.0 ms + OOT | 5.3ms + OOT |
| $t_{average}$ | = | 12.1 ms + OOT | 10.8 ms + OOT |

##### 1.45.2.6 Operate delay Iph

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.000 s £ T £ 60.000 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % of setting value or 10 ms |

## Summary

### 1.45.2.7 Operate delay 3I0

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: confirmed

### 1.45.2.8 Operate delay manual close

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: confirmed

### 1.45.3 Normal stage

### 1.45.3.1 Pickup values

Test condition: 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$

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

Permissive tolerance/Limiting values: |d| £1 % of setting value or 0.5 % $I_{rated}$

Test results/Remarks: confirmed

### 1.45.3.2 Dropout ratio

Test condition: see item 1.45.2.1

Test values: r = 0.95 (fixed)

Permissive tolerance/Limiting values: 1 % of dropout value

Test results/Remarks: confirmed

### 1.45.3.3 Pickup times

Test condition: 30 measurements per fault type

Test values: $I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|
| $t_{max}$ = | 27.4 ms + OOT | 25.5 ms + OOT |
| $t_{min}$ = | 18.1 ms + OOT | 14.1 ms + OOT |
| $t_{average}$ = | 23.1 ms + OOT | 20.9 ms + OOT |

### 1.45.3.4 Dropout times

Test condition: 30 measurements per fault type

Test values: $I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|
| $t_{max}$ = | 17.8 ms + OOT | 16.2 ms + OOT |
| $t_{min}$ = | 7.0 ms + OOT | 5.6 ms + OOT |
| $t_{average}$ = | 12.8 ms + OOT | 11.6 ms + OOT |

### 1.45.3.5 Operate delay

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: confirmed

## Summary

## 1.46 Overload Protection for Transformers (French Specification)

### 1.46.1 Specifications

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

### 1.46.2 Pickup values

#### 1.46.2.1 Threshold IN, IP, IS, IM, IAERO

Test condition: 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$

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

Permissive tolerance/Limiting values: |d| £ 1 % of setting value or 0.5 % $I_{rated}$

Test results/Remarks: |d| < 1 % of setting value or 0.5 % $I_{rated}$

#### 1.46.2.2 Theta S

Test condition: 60 °C £ Theta £ 100 °C
140 °F £ Theta £ 212 °F

Permissive tolerance/Limiting values: |d| £ 0.5 % of setting value or 1 °C or 2 °F

Test results/Remarks: |d| < 0.5 % of setting value or 1 °C or 2 °F

#### 1.46.2.3 Theta L

Test condition: 40 °C £ Theta £ 100 °C
104 °F £ Theta £ 212 °F

Permissive tolerance/Limiting values: |d| £ 0.5 % of setting value or 1 °C or 2 °F

Test results/Remarks: |d| < 0.5 % of setting value or 1 °C or 2 °F

### 1.46.3 Dropout ratio

#### 1.46.3.1 Current

Test condition: see item 1.46.2.1

Test values: r = 0.95 (fixed)

Permissive tolerance/Limiting values: 1 % of dropout value

Test results/Remarks: confirmed

#### 1.46.3.2 Temperature

Test condition: see item 1.46.2.2

Test values: r = 0.98 (fixed)

Permissive tolerance/Limiting values: ±1 °C or ±2 °F

Test results/Remarks: confirmed

### 1.46.4 Pickup times

Test condition: 90 measurements per fault type

Test values: $I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|---|
| $t_{max}$ | = | 30.7 ms + OOT | 25.4 ms + OOT |
| $t_{min}$ | = | 17.9 ms + OOT | 14.5 ms + OOT |
| $t_{average}$ | = | 23.5 ms + OOT | 20.6 ms + OOT |

### 1.46.5 Dropout times

Test condition: 90 measurements per fault type

Test values: $I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|---|
| $t_{max}$ | = | 20.6 ms + OOT | 15.2 ms + OOT |

## Summary

| | | | |
|---|---|---|---|
| $t_{min}$ | = | 5.1 ms + OOT | 4.4 ms + OOT |
| $t_{average}$ | = | 12.0 ms + OOT | 11.5 ms + OOT |

### 1.46.6 Alarm delay

| | |
|---|---|
| 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 |

### 1.46.7 Operate delay

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0.00 s £ T £ 1800.00 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % of setting value or 10 ms |

## Summary

### 1.47 ADA Net Decoupling Overcurrent Protection (French Specification)

#### 1.47.1 Specifications

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

#### 1.47.2 Pickup values

| | |
|---|---|
| Test condition: | 0.030 A £ I> £ 35.000 A @ 1 A<br>0.15 A £ I> £ 175.00 A @ 5 A |
| Test values: | 0.030 A £ I> £ 35.000 A @ 1 A<br>0.15 A £ I> £ 175.00 A @ 5 A<br>$f_{rated}$ = 50 Hz, 60 Hz |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 0.5 % $I_{rated}$ |
| Test results/Remarks: | \|d\| < 1 % of setting value or 0.5 % $I_{rated}$ |

#### 1.47.3 Dropout ratio

| | |
|---|---|
| Test condition: | 0.90 £ r £ 0.99 |
| Test values: | r = 0.95 |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of dropout value |
| Test results/Remarks: | \|d\| < 1 % of dropout value |

#### 1.47.4 Pickup times

Test condition: 60 measurements per fault type

Test values:

$I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|---|
| $t_{max}$ | = | 30 ms + OOT | 25 ms + OOT |
| $t_{min}$ | = | 23 ms + OOT | 16 ms + OOT |
| $t_{average}$ | = | 27 ms + OOT | 20 ms + OOT |

#### 1.47.5 Dropout times

Test condition: 60 measurements per fault type

Test values:

$I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|---|
| $t_{max}$ | = | 18 ms + OOT | 17 ms + OOT |
| $t_{min}$ | = | 11 ms + OOT | 8 ms + OOT |
| $t_{average}$ | = | 15 ms + OOT | 12 ms + OOT |

#### 1.47.6 Operate delay

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0 s £ T £ 300 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % of setting value or 10 ms |

#### 1.47.7 Alarm delay

| | |
|---|---|
| Test condition: | added to the inherent operating times |
| Test values: | 0 s £ T £ 60 s |
| Permissive tolerance/Limiting values: | \|d\| £ 1 % of setting value or 10 ms |
| Test results/Remarks: | \|d\| < 1 % of setting value or 10 ms |

## Summary

## 1.48 PSL-PSC Overload Protection for Lines and Cables (French Specification)

### 1.48.1 Specifications

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

### 1.48.2 Pickup values

Test condition: 0.030 $I_{rated}$ £ I> £ 35.000 $I_{rated}$

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

Permissive tolerance/Limiting values: |d| £1 % of setting value or 0.5 % $I_{rated}$

Test results/Remarks: |d| <1 % of setting value or 0.5 % $I_{rated}$

### 1.48.3 Dropout ratio

Test condition: see item 1.48.2

Test values: r = 0.95

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

Test results/Remarks: < 1 % of dropout value

### 1.48.4 Pickup times

Test condition: 40 measurements per fault type

Test values: $I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|---|
| $t_{max}$ | = | 30.2 ms + OOT | 26.1 ms + OOT |
| $t_{min}$ | = | 18.2 ms + OOT | 15.9 ms + OOT |
| $t_{average}$ | = | 23.1 ms + OOT | 21.1 ms + OOT |

### 1.48.5 Dropout times

Test condition: 40 measurements per fault type

Test values: $I/I_{threshold}$ = 1.2
$f_{rated}$ = 50 Hz, 60 Hz

Test results:

| | | 3pol, 50Hz | 3pol, 60Hz |
|---|---|---|---|
| $t_{max}$ | = | 19.4 ms + OOT | 18.4 ms + OOT |
| $t_{min}$ | = | 6.7 ms + OOT | 7.0 ms + OOT |
| $t_{average}$ | = | 12.6 ms + OOT | 12.7 ms + OOT |

### 1.48.6 Operate delay

Test condition: added to the inherent operating times

Test values: 0.00 s £ T £ 7200.00 s

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

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

### 1.48.7 Alarm delay

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

## Summary

### 1.49 Voltage-Comparison Supervision

#### 1.49.1 Specifications

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

#### 1.49.2 Function stage

#### 1.49.2.1 Pickup times

| | |
|---|---|
| Permissive tolerance/Limiting values: | t approx.<br>5 ms + OOT at 50 Hz<br>5 ms + OOT at 60 Hz |
| Test results/Remarks: | t approx.<br>5 ms + OOT at 50 Hz<br>5 ms + OOT at 60 Hz |

## Summary

### 1.50 Supervision Functions

#### 1.50.1 Voltage-transformer circuit breaker

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.50.2 Current-balance supervision

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.50.3 Voltage-balance supervision

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.50.4 Current-sum supervision

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.50.5 Voltage-sum supervision

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.50.6 Measuring-voltage failure (Fuse failure monitor)

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.50.7 Current phase rotation supervision

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.50.8 Voltage phase rotation supervision

| | |
|---|---|
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.50.9 74TC Trip circuit supervision

| | |
|---|---|
| Test condition: | Number trip circuit: 1 to 3<br>Operation mode: with 1 or 2 BI |
| Permissive tolerance/Limiting values: | funct. acc. to manual |
| Test results/Remarks: | Function correct |

## Summary

### 1.51 Ancillary Functions

#### 1.51.1 Log buffers

##### 1.51.1.1 Operational log

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

##### 1.51.1.2 Fault log

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct. Not applicable for Fault Recorder 7KE85.

##### 1.51.1.3 Ground fault log

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct.
Not applicable for Fault Recorder 7KE85 and Busbar Protection 7SS85.

#### 1.51.2 Fault recording

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

#### 1.51.3 Date and time

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

#### 1.51.4 Setting group switching

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct. Not applicable for Fault Recorder 7KE85.

#### 1.51.5 Test functions

##### 1.51.5.1 CB tripping test

Test condition: Live tripping of CB

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct. Not applicable for Fault Recorder 7KE85.

##### 1.51.5.2 Test record

Permissive tolerance/Limiting values: Funct. acc. to manual

Test results/Remarks: Function correct

#### 1.51.6 CFC

Test condition: Funct. acc. to manual

Test results/Remarks: Function correct

## Summary

## 1.52 Operational Measured Values

### 1.52.1 Specifications

- IEC/EN 60255-1, Annex A, B

### 1.52.2 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:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>49 Hz to 51 Hz<br>59 Hz to 61 Hz |
| Test values: | $I_A$, $I_B$, $I_C$, $3I_0$ in A (prim), A (sec), % (of $I_{rated}$) | |
| Permissive tolerance/Limiting values: | £ 0.15 % of the measured value in the above mentioned ranges | |
| Test results/Remarks: | £ 0.15 % | |
| Test condition: | Frequency range:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>40 Hz to 60 Hz<br>50 Hz to 70 Hz |
| Test values: | $I_A$, $I_B$, $I_C$, $3I_0$ in A (prim), A (sec), % (of $I_{rated}$) | |
| Permissive tolerance/Limiting values: | £ 0.3 % of the measured value in the above mentioned ranges | |
| Test results/Remarks: | £ 0.3 % | |

### 1.52.3 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:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>49 Hz to 51 Hz<br>59 Hz to 61 Hz |
| Test values: | $I_A$, $I_B$, $I_C$, $3I_0$ in A (prim), A (sec), % (of $I_{rated}$) | |
| Permissive 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:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>40 Hz to 60 Hz<br>50 Hz to 70 Hz |
| Test values: | $I_A$, $I_B$, $I_C$, $3I_0$ in A (prim), A (sec), % (of $I_{rated}$) | |
| Permissive tolerance/Limiting values: | £ 0.3 % of the measured value in the above mentioned ranges | |
| Test results/Remarks: | £ 0.3 % | |

[1] for modular device only
[2] for non-modular device only

## Summary

### 1.52.4 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:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>49 Hz to 51 Hz<br>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:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>40 Hz to 60 Hz<br>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 % | |

### 1.52.5 Phase angle, current and voltage

| | | |
|---|---|---|
| Test condition: | $I_{rated}$, $V_{rated}$ | |
| | Frequency range:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>47.5 Hz to 52.5 Hz<br>57.5 Hz to 62.5 Hz |
| | (operative range 10 Hz to 80 Hz with higher tolerances) | |
| Test values: | φ ($I_A$-$I_B$), φ ($I_B$-$I_C$), φ ($I_C$-$I_A$) in °<br>φ ($V_A$-$V_B$), φ ($V_B$-$V_C$), φ ($V_C$-$V_A$) in ° | |
| Permissive tolerance/Limiting values: | Current<br>Voltage | ≤ 0.2 ° at $I_{rated}$<br>≤ 0.2 ° at $V_{rated}$ |
| Test results/Remarks: | Current<br>Voltage | < 0.2 ° at $I_{rated}$<br>< 0.2 ° at $V_{rated}$ |

### 1.52.6 Power, ratings

### 1.52.6.1 Active Power P

| | | |
|---|---|---|
| Test condition: | W secondary | |
| | Measuring Range: | \|cosφ\| ≥ 0.01 |
| | Voltage Range: | (0.8 to 1.2) $V_{rated}$ |
| | Current range: | (0.1 to 2) Irated |
| | Frequency range:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>49 Hz to 51 Hz<br>59 Hz to 61 Hz |
| Test values: | P, $P_A$, $P_B$, PC 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:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>40 Hz to 60 Hz<br>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 % | |

## Summary

### 1.52.6.2 Reactive Power Q

| | | |
|---|---|---|
| Test condition: | VAr secondary | |
| | Measuring Range: | $\|\cos\varphi\| \geq 0.984$ |
| | Voltage Range: | (0.8 to 1.2) $V_{rated}$ |
| | Current range: | (0.1 to 2) $I_{rated}$ |
| | Frequency range:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>49 Hz to 51 Hz<br>59 Hz to 61 Hz |
| Test values: | Q, $Q_A$, $Q_B$, QC in VAr (secondary) | |
| Permissive tolerance/Limiting values: | £ 1 % of the measured value in the above mentioned ranges | |
| Test results/Remarks: | £ 1 % | |
| | Frequency range:<br>$f_{rated}$ = 50 Hz: 40 Hz to 60 Hz<br>$f_{rated}$ = 60 Hz: 50 Hz to 70 Hz | |
| Test values: | Q, $Q_A$, $Q_B$, QC in VAr (secondary) | |
| Permissive tolerance/Limiting values: | £ 1.5 % of the measured value in the above mentioned ranges | |
| Test results/Remarks: | £ 1.5 % | |

### 1.52.6.3 Apparent Power S

| | | |
|---|---|---|
| Test condition: | VA secondary | |
| | Measuring Range: | (0.01 to 2) $S_{rated}$ |
| | Voltage Range: | (0.8 to 1.2) $V_{rated}$ |
| | Current range: | (0.1 to 2) $I_{rated}$ |
| | Frequency range:<br>$f_{rated}$ = 50 Hz:<br>$f_{rated}$ = 60 Hz: | <br>49 Hz to 51 Hz<br>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:<br>$f_{rated}$ = 50 Hz: 40 Hz to 60 Hz<br>$f_{rated}$ = 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 % | |

### 1.52.7 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 $f_{rated}$ ±10 % at $V_{rated}$, $I_{rated}$ | |
| Test results/Remarks: | £ 10 mHz in the range $f_{rated}$ ±10 % at $V_{rated}$, $I_{rated}$<br>(operative range > $f_{rated}$ ±10 % with higher tolerances) | |

## Summary

### 1.53 CB wear monitoring

#### 1.53.1 ∑Ix-method

No accuracies defined, because this method is a monitoring function, which contains no protection-specific task and the principles are based upon empiric determined data.

#### 1.53.2 2P-method

No accuracies defined, because this method is a monitoring function, which contains no protection-specific task and the principles are based upon empiric determined data.

#### 1.53.3 I2t-method

No accuracies defined, because this method is a monitoring function, which contains no protection-specific task and the principles are based upon empiric determined data.

#### 1.53.4 Supv.CB make time

##### 1.53.4.1 Circuit breaker closing time

| | |
|---|---|
| Test condition/Operative range: | $f_{rated}$ = 50 Hz, 60Hz<br>0.001 s £ $t_{CBcltm}$ £ 0.600 s |
| Test values: | 0.03 A £ I £ 5 A |
| Permissive tolerance/Limiting values: | $t_{CBcltm}$ £ 2 ms |
| Test results/Remarks: | $t_{CBcltm}$ < 2 ms |

## Summary

### 1.54 Interfaces

#### 1.54.1 USB interface (front panel)

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.54.2 Integrated ethernet interface (rear)

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.54.3 System interfaces

#### 1.54.3.1 IEC 60870-5-103

| | |
|---|---|
| Test values: | RS232, RS485, LWL |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.54.3.2 IEC 60870-5-104

| | |
|---|---|
| Test values: | LWL |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.54.3.3 DNP3.0

| | |
|---|---|
| Test values: | RS485, LWL |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.54.3.4 IEC 61850 (Edition 1 and 2)

| | |
|---|---|
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.54.4 Time synchronization

| | |
|---|---|
| Test condition: | IRIG-B, DCF77, SNTP |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.54.5 Protection interfaces

| | |
|---|---|
| Test values: | Transmission of status information |
| Permissive tolerance/Limiting values: | Funct. acc. to manual |
| Test results/Remarks: | Function correct |

#### 1.54.6 Phasor measurement unit (PMU)

| | |
|---|---|
| Permissive tolerance/Limiting values: | Accuracy according to IEEE C37.118.1 (class P)<br>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 |