



SIPROTEC 5

V8.01 and higher

Overcurrent Protection 7SJ82/7SJ85

Technical Data

Extract from manual C53000-G5040-C017-B, chapter 12

Smart Infrastructure

SIEMENS

**NOTE**

For your own safety, observe the warnings and safety instructions contained in this document, if available.

Disclaimer of Liability

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

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Preface

Purpose of the Manual

This manual describes the protection, automation, control, and monitoring functions of the SIPROTEC 5 devices.

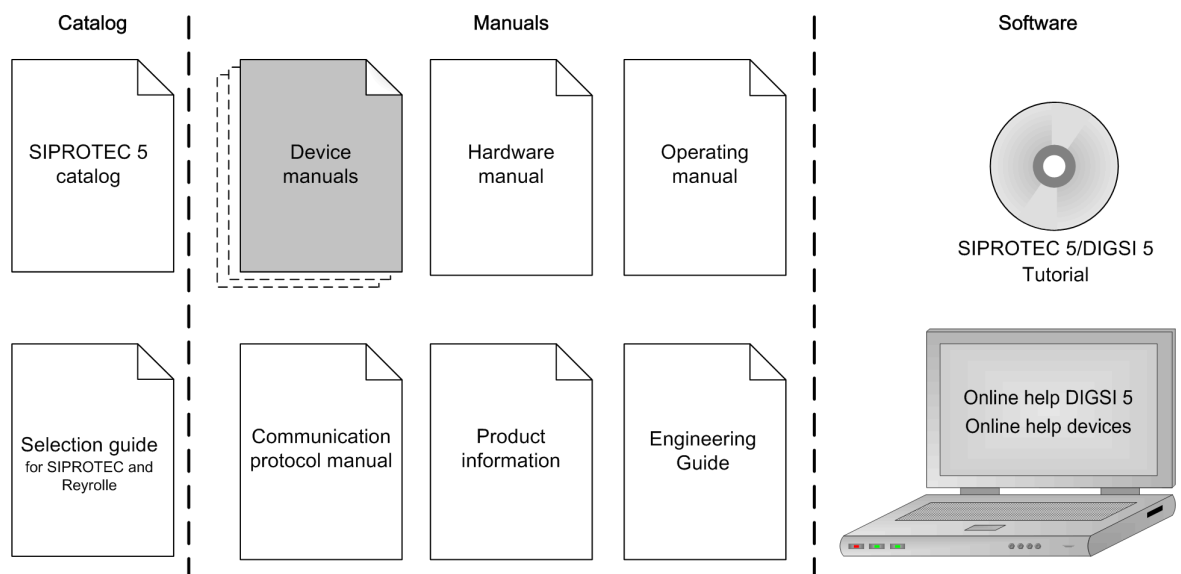
Target Audience

Protection system engineers, commissioning engineers, persons entrusted with the setting, testing and maintenance of automation, selective protection and control equipment, and operational crew in electrical installations and power plants.

Scope

This manual applies to the SIPROTEC 5 device family.

Further Documentation



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- **Device manuals**
Each Device manual describes the functions and applications of a specific SIPROTEC 5 device. The printed manual and the online help for the device have the same informational structure.
- **Hardware manual**
The Hardware manual describes the hardware building blocks and device combinations of the SIPROTEC 5 device family.
- **Operating manual**
The Operating manual describes the basic principles and procedures for operating and assembling the devices of the SIPROTEC 5 range.

- **Communication protocol manual**
The Communication protocol manual contains a description of the protocols for communication within the SIPROTEC 5 device family and to higher-level network control centers.
- **Product information**
The Product information includes general information about device installation, technical data, limiting values for input and output modules, and conditions when preparing for operation. This document is provided with each SIPROTEC 5 device.
- **Engineering Guide**
The Engineering Guide describes the essential steps when engineering with DIGSI 5. In addition, the Engineering Guide shows you how to load a planned configuration to a SIPROTEC 5 device and update the functionality of the SIPROTEC 5 device.
- **DIGSI 5 online help**
The DIGSI 5 online help contains a help package for DIGSI 5 and CFC.
The help package for DIGSI 5 includes a description of the basic operation of software, the DIGSI principles and editors. The help package for CFC includes an introduction to CFC programming, basic examples of working with CFC, and a reference chapter with all the CFC blocks available for the SIPROTEC 5 range.
- **SIPROTEC 5/DIGSI 5 Tutorial**
The tutorial on the DVD contains brief information about important product features, more detailed information about the individual technical areas, as well as operating sequences with tasks based on practical operation and a brief explanation.
- **SIPROTEC 5 catalog**
The SIPROTEC 5 catalog describes the system features and the devices of SIPROTEC 5.
- **Selection guide for SIPROTEC and Reyrolle**
The selection guide offers an overview of the device series of the Siemens protection devices, and a device selection table.

Indication of Conformity



This product complies with the directive of the Council of the European Communities on harmonization of the laws of the Member States concerning electromagnetic compatibility (EMC Directive 2014/30/EU), restriction on usage of hazardous substances in electrical and electronic equipment (RoHS Directive 2011/65/EU), and electrical equipment for use within specified voltage limits (Low Voltage Directive 2014/35/EU).

This conformity has been proved by tests performed according to the Council Directive in accordance with the product standard EN 60255-26 (for EMC directive), the standard EN 50581 (for RoHS directive), and with the product standard EN 60255-27 (for Low Voltage Directive) by Siemens.

The device is designed and manufactured for application in an industrial environment.

The product conforms with the international standards of IEC 60255 and the German standard VDE 0435.

Standards

IEEE Std C 37.90

The technical data of the product is approved in accordance with UL.

For more information about the UL database, see ul.com

You can find the product with the **UL File Number E194016**.



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Additional Support

For questions about the system, contact your Siemens sales partner.

Customer Support Center

Our Customer Support Center provides a 24-hour service.

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Customer Support Center
Humboldtstrasse 59
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Inquiries regarding individual training courses should be addressed to our Training Center:

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Notes on Safety

This document is not a complete index of all safety measures required for operation of the equipment (module or device). However, it comprises important information that must be followed for personal safety, as well as to avoid material damage. Information is highlighted and illustrated as follows according to the degree of danger:



DANGER

DANGER means that death or severe injury **will** result if the measures specified are not taken.

- ✧ Comply with all instructions, in order to avoid death or severe injuries.



WARNING

WARNING means that death or severe injury **may** result if the measures specified are not taken.

- ✧ Comply with all instructions, in order to avoid death or severe injuries.



CAUTION

CAUTION means that medium-severe or slight injuries **can** occur if the specified measures are not taken.

- ✧ Comply with all instructions, in order to avoid moderate or minor injuries.
-

NOTICE

NOTICE means that property damage **can** result if the measures specified are not taken.

- ✧ Comply with all instructions, in order to avoid property damage.



NOTE

Important information about the product, product handling or a certain section of the documentation which must be given attention.

Qualified Electrical Engineering Personnel

Only qualified electrical engineering personnel may commission and operate the equipment (module, device) described in this document. Qualified electrical engineering personnel in the sense of this manual are people who can demonstrate technical qualifications as electrical technicians. These persons may commission, isolate, ground and label devices, systems and circuits according to the standards of safety engineering.

Proper Use

The equipment (device, module) may be used only for such applications as set out in the catalogs and the technical description, and only in combination with third-party equipment recommended and approved by Siemens.

Problem-free and safe operation of the product depends on the following:

- Proper transport
- Proper storage, setup and installation
- Proper operation and maintenance

When electrical equipment is operated, hazardous voltages are inevitably present in certain parts. If proper action is not taken, death, severe injury or property damage can result:

- The equipment must be grounded at the grounding terminal before any connections are made.
- All circuit components connected to the power supply may be subject to dangerous voltage.
- Hazardous voltages may be present in equipment even after the supply voltage has been disconnected (capacitors can still be charged).
- Operation of equipment with exposed current-transformer circuits is prohibited. Before disconnecting the equipment, ensure that the current-transformer circuits are short-circuited.
- The limiting values stated in the document must not be exceeded. This must also be considered during testing and commissioning.

Used Symbols on Device

No.	Symbol	Description
1	---	Direct current, IEC 60417, 5031
2	~	Alternating current, IEC 60417, 5032
3	⎓	Direct and alternating current, IEC 60417, 5033
4	⏏	Earth (ground) terminal, IEC 60417, 5017
5	⏏	Protective conductor terminal, IEC 60417, 5019

No.	Symbol	Description
6		Caution, risk of electric shock
7		Caution, risk of danger, ISO 7000, 0434
8		Protective Insulation, IEC 60417, 5172, Safety Class II devices
9		Guideline 2002/96/EC for electrical and electronic devices
10		Guideline for the Eurasian Market

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12.1 General Device Data

12.1.1 Analog Inputs

Current Inputs

All current, voltage, and power data are specified as RMS values.			
Rated frequency f_{rated}	50 Hz, 60 Hz		
Protection-class current transformers	Rated current I_{rated}	Measuring range of the modular devices	Measuring range of the non-modular devices
	5 A 1 A	0 A to 500 A 0 A to 100 A	0 A to 250 A 0 A to 50 A
Instrument transformers	5 A 1 A	0 A to 8 A 0 A to 1.6 A	0 A to 8 A 0 A to 1.6 A
Burden for rated current	Approx. 0.1 VA		
Thermal rating (protection and instrument transformers)	20 A continuously		
	25 A for 3 min		
	30 A for 2 min		
	150 A for 10 s		
	500 A for 1 s		
Dynamic load-carrying capacity	1250 A one half wave		

GIS Low-Power Current Input (via Module IO240)

All current, voltage, and power data are specified as RMS values.	
Rated frequency f_{rated}	50 Hz 60 Hz
Rated current I_{rated} - 50 Hz	Min. 13 mV Max. 332 mV
Rated current I_{rated} - 60 Hz	Min. 15.4 mV Max. 386 mV
Measuring range	$50 \cdot I_{rated}$ (Protection channel) $1.6 \cdot I_{rated}$ (Metering channel)
Power consumption per current circuit at rated current	Max. 40 mVA Burden = 9.5 kΩ
Thermal rating	Max. input voltage = 20 V
Accuracy	Class 5TPE (Protection channel) Class 0.2S (Metering channel)

Voltage Input

All current, voltage, and power data are specified as RMS values.		
Rated frequency f_{rated}	50 Hz, 60 Hz	
Input and output modules	IO102, IO202, IO208, IO211, IO214	IO215
Measuring range	0 V to 200 V	0 V to 7.07 V
Burden	< 0.1 VA	< 0.01 VA
Thermal rating	230 V continuously	20 V continuously

GIS Low-Power Voltage Input (via Module IO240)

All current, voltage, and power data are specified as RMS values.	
Rated frequency f_{rated}	50 Hz 60 Hz
Rated voltage V_{rated} - 50 Hz	Min. 0.25 mA Max. 2.00 mA
Rated voltage V_{rated} - 60 Hz	Min. 0.30 mA Max. 2.20 mA
Measuring range	$2 \cdot V_{\text{rated}}$
Power consumption per current circuit at rated current	Max. 1 mVA Burden = 50 Ω
Thermal rating	Max. input current = 4.4 mA
Accuracy	Class 0.1

Measuring-Transducer Inputs (via Module ANAI-CA-4EL)

Insulation class	SELV (Safety Extra Low Voltage) (according to IEC 60255-27)
Connector type	8-pin terminal spring
Differential current input channels	4
Measuring range	DC -25.6 mA to +25.6 mA
Fault	< 0.5 % of the measuring range
Input impedance	140 Ω
Conversion principle	Delta-sigma (16 bit)
Permissible potential difference between channels	DC 20 V
Galvanic separation from ground/housing	DC 700 V
Permissible overload	DC 100 mA continuously
Measured-value repetition	200 ms

Inputs for Optical Sensors for Arc Protection (via Module ARC-CD-3FO)

Connector type	AVAGO AFBR-4526Z
Number of transceivers	3
Fiber type	Plastic Optical Fiber (POF) 1 mm
Receiver	
Maximum	-10 dBm $\pm$ 2 dBm
Minimum	-40 dBm $\pm$ 2 dBm
Spectrum	400 nm to 1100 nm
Attenuation	In the case of plastic optical fibers, you can expect a path attenuation of 0.2 dB/m. Additional attenuation comes from the plug and sensor head.
Optical budget ⁴³	Minimal 25 dB
Analog sampling rate	16 kHz
ADC type	10-bit successive approximation
Transmitter	
Type	LED
Wavelength	λ = 650 nm

⁴³ All values in combination with sensors approved by Siemens.

Transmitter power	Minimum 0 dBm Maximum 2 dBm
Numerical aperture	0.5 ⁴⁴
Signal rate connection test	1 pulse per second
Pulse duration connection test	11 µs

High-Speed Measuring-Transducer Inputs, Voltage/Current (via IO210, IO212)



NOTE

Current and voltage must not be connected at the same time to one measuring-transducer input. Instead, only connect either current or voltage. For EMC reasons, do not connect a line to an unused input (current or voltage).

Use shielded cables.

Table 12-1 High-Speed Measuring-Transducer Inputs, Voltage

Differential voltage input channels	IO210: 4 ⁴⁵ IO212: 8 ⁴⁶
Measuring range	DC -10 V to +10 V
Fault	< 0.5 % of the measuring range
Input impedance	48 kΩ
Max. permissible voltage with respect to ground on the measuring inputs	300 V
Permissible overload	DC 20 V continuously DC 60 V continuously (IO210 MT3 terminal point C9)

Table 12-2 High-Speed Measuring-Transducer Inputs, Current

Differential current input channels	IO210: 4 ⁴⁷ IO212: 8 ⁴⁸
Measuring range	DC -20 mA to +20 mA
Fault	< 0.5 % of the measuring range
Input impedance, current	12 Ω
Permissible potential difference between channels	DC 3.5 kV
Galvanic separation with respect to ground/housing	DC 3.5 kV
Permissible current overload	DC 100 mA continuously

Table 12-3 Common Data for the Fast Measuring-Transducer Inputs, Voltage/Current

Conversion principle	Delta-sigma (16 bit)
Insulation test voltage between the channels	DC 3.5 kV

⁴⁴ Numerical aperture (NA = sin θ (launch angle))

⁴⁵ The IO210 has 4 high-speed measuring-transducer inputs. They can be used either as a voltage or current input.

⁴⁶ The IO212 has 8 high-speed measuring-transducer inputs. They can be used either as a voltage or current input.

⁴⁷ The IO210 has 4 high-speed measuring-transducer inputs. They can be used either as a voltage or current input.

⁴⁸ The IO212 has 8 high-speed measuring-transducer inputs. They can be used either as a voltage or current input.

Insulation test voltage with respect to ground/housing	DC 3.5 kV
Measured-value repetition	62.5 μ s
Insulation class IO210	ELV (Extra Low Voltage) (as per IEC 60255-27)
Insulation class IO212	SELV (as per IEC 60255-27)

Temperature Inputs

Settings	Value	Note
Insulation class	PELV (Protective Extra Low Voltage) (acc. to IEC 60255-27)	–
Measurement mode	- Pt 100 Ω - Ni 100 Ω - Ni 120 Ω 3-wire connection, shielded cables	–
Connector type	16-pin, 17-pin terminal spring	–
Temperature measuring range	-65 °C to +710 °C	For PT100
	-50 °C to +250 °C	For NI100
	-50 °C to +250 °C	For NI120

Temperature Inputs (via Module IO240)

Settings	Value
Sensor Type	PT100 (Class F 0.3 EN 60751) 4-wire shielded cable connection
Measurement range	-50 °C to +150 °C Shot circuit and broken-wire detection
Accuracy	± 1 °C

LPIT Digital Input (via Module IO240)

Shield Cover Input	
Sensor type	Dry contact input
Measurement type	Output voltage of 1 mA current injection @ max. DC 5 V

12.1.2 Supply Voltage

Integrated Power Supply		
For modular devices, the following modules contain a power supply: PS201 – Power supply of the base module and of the 1st device row PS203 – Power supply of the 2nd device row PS204 – Redundant power supply CB202 – Plug-in module assembly with integrated power supply, for example, to accommodate communication modules		
Permissible voltage ranges (PS201, PS203, PS204, CB202)	DC 19 V to DC 60 V	DC 48 V to DC 300 V AC 80 V to AC 265 V, 50 Hz/60 Hz
Auxiliary rated voltage V_H (PS201, PS203, PS204, CB202)	DC 24 V/DC 48 V	DC 60 V/DC 110 V/DC 125 V/DC 220 V/ DC 250 V or AC 100 V/AC 115 V/AC 230 V, 50 Hz/60 Hz

Integrated Power Supply			
Permissible voltage ranges (PS101) Only for non-modular devices	DC 19 V to DC 60 V	DC 48 V to 150 V	DC 88 V to DC 300 V AC 80 V to AC 265 V, 50 Hz/60 Hz
Auxiliary rated voltage V _H (PS101) Only for non-modular devices	DC 24 V/DC 48 V	DC 60 V/DC 110 V/ DC 125 V	DC 110 V/ DC 125 V/ DC 220 V/DC 250 V or AC 100 V/AC 115 V/ AC 230 V, 50 Hz/60 Hz
Superimposed alternating voltage, peak-to-peak, IEC 60255-11, IEC 61000-4-17	≤ 15 % of the DC auxiliary rated voltage (applies only to direct voltage)		
Inrush current	≤ 18 A		
Recommended external protection	Miniature circuit breaker 6 A, characteristic C according to IEC 60898		
Internal fuse			
–	DC 24 V to DC 48 V	DC 60 V to DC 125 V	DC 24 V to DC 48 V AC 100 V to AC 230 V
PS101 Only for non-modular devices	4 A inert, AC 250 V, DC 150 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	2 A time-lag, AC 250 V, DC 300 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	
PS201, PS203, CB202 (to device version xA)	4 A inert, AC 250 V, DC 150 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	2 A time-lag, AC 250 V, DC 300 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	
PS201, PS203, PS204, CB202 (Device version xB and higher)	4 A inert, AC 250 V, DC 150 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	3.15 A time-lag, AC 250 V, DC 300 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	
Power consumption (life relay active)			
–	DC	AC 230 V/50 Hz	AC 115 V/50 Hz
1/3 module, non-modular Without plug-in modules	7 W	16 VA	12.5 VA
1/3 base module, modular Without plug-in modules	13 W	55 VA	40 VA
1/6 expansion module	3 W	6 VA	6 VA
1/6 plug-in module assembly without plug-in modules (modules CB202)	3.5 W	14 VA	7 VA
Plug-in module for base module or plug-in module assembly (for example, communication module)	< 5 W	< 6 VA	< 6 VA

Integrated Power Supply	
Stored-energy time for auxiliary voltage outage or short circuit, modular devices IEC 61000-4-11 IEC 61000-4-29	For $V \geq \text{DC } 24 \text{ V} \geq 50 \text{ ms}$ For $V \geq \text{DC } 110 \text{ V} \geq 50 \text{ ms}$ For $V \geq \text{AC } 115 \text{ V} \geq 50 \text{ ms}$
Stored-energy time for auxiliary voltage outage or short circuit, non-modular devices IEC 61000-4-11 IEC 61000-4-29	For $V \geq \text{DC } 24 \text{ V} \geq 20 \text{ ms}$ For $V \geq \text{DC } 60 \text{ V} \geq 50 \text{ ms}$ For $V \geq \text{AC } 115 \text{ V} \geq 200 \text{ ms}$

12.1.3 Binary Inputs

Standard Binary Input

Rated voltage range	DC 24 V to 250 V The binary inputs of SIPROTEC 5 are bipolar, with the exception of the binary inputs on the modules IO230, IO231, and IO233.	
Current consumption, excited	Approx. DC 0.6 mA to 2.5 mA (independent of the control voltage)	
Power consumption, max.	0.6 W	
Pickup time	Approx. 3 ms	
Dropout time ⁴⁹	Capacitive load (supply-line capacitance)	Dropout time
	< 5 nF	< 4 ms
	< 10 nF	< 6 ms
	< 50 nF	< 10 ms
	< 220 nF	< 35 ms
Control voltage for all modules with binary inputs, except module IO233	Adapt the binary-input threshold to be set in the device to the control voltage.	
	Range 1 for 24 V, 48 V, and 60 V Control voltage	$V_{\text{low}} \leq \text{DC } 10 \text{ V}$ $V_{\text{high}} \geq \text{DC } 19 \text{ V}$
	Range 2 for 110 V and 125 V Control voltage	$V_{\text{low}} \leq \text{DC } 44 \text{ V}$ $V_{\text{high}} \geq \text{DC } 88 \text{ V}$
	Range 3 for 220 V and 250 V Control voltage	$V_{\text{low}} \leq \text{DC } 88 \text{ V}$ $V_{\text{high}} \geq \text{DC } 176 \text{ V}$
Control voltage for binary inputs of the IO233 module	Range for 125 V Control voltage	$V_{\text{low}} \leq \text{DC } 85 \text{ V}$ $V_{\text{high}} \geq \text{DC } 105 \text{ V}$
Maximum permitted voltage	DC 300 V	
The binary inputs contain interference suppression capacitors. To ensure EMC immunity, use the terminals shown in the terminal diagrams/connection diagrams to connect the binary inputs to the common potential.		

Special Binary Input with Maximized Robustness against Electrical Disturbances and Failures (IO216)

Rated voltage range	DC 220 V The special binary inputs of the SIPROTEC 5 with maximized robustness against electrical disturbances and failures are bipolar and available only on the module IO216.
Input impedance	50 kΩ to 60 kΩ

⁴⁹ For time-critical applications with low-active signals, consider the specified dropout times. If necessary, provide for active discharge of the binary input (for example, a resistor in parallel to the binary input or using a change-over contact).

Rejection pulse charge	> 200 μC	
Current consumption, excited	Approx. DC 1.2 mA to 2.0 mA (additionally to the current consumption of the input impedance)	
Power consumption, max.	1.5 W at DC 242 V	
Pickup time	Approx. 3 ms	
Dropout time ⁵⁰	Capacitive load (supply-line capacitance)	Dropout time
	< 5 nF	< 3 ms
	< 10 nF	< 4 ms
	< 50 nF	< 5 ms
	< 220 nF	< 10 ms
Control voltage for the module IO216	Range for 220 V control voltage	
	Threshold pickup	158 V to 170 V
	Threshold dropout	132 V to 154 V
Maximum permitted voltage	DC 300 V	
The binary inputs contain interference suppression capacitors. To ensure EMC immunity, use the terminals shown in the terminal diagrams/connection diagrams to connect the binary inputs to the common potential.		

12.1.4 Relay Outputs

Standard Relay (Type S)

Making capacity	Max. 1000 W (L/R = 40 ms) Max. 3600 VA (power factor ≤ 0.35 , 50 Hz to 60 Hz)
Breaking capacity	Max. 30 W (L/R = 40 ms) Max. 360 VA (power factor ≤ 0.35 , 50 Hz to 60 Hz)
AC and DC contact voltage	250 V
Permissible current per contact (continuous)	5 A
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact)
Short-time current across closed contact	250 A for 30 ms
Total permissible current for contacts connected to common potential	5 A
Switching time OOT (Output Operating Time) Additional delay of the output medium used	Make time: typical: 8 ms; maximum: 10 ms Break time: typical: 2 ms; maximum: 5 ms
Max. rated data of the output contacts in accordance with UL certification	DC 24 V, 5 A, General Purpose DC 48 V, 0.8 A, General Purpose DC 240 V, 0.1 A, General Purpose AC 240 V, 5 A, General Purpose AC 120 V, 1/6 hp AC 250 V, 1/2 hp B300 R300
Interference suppression capacitors across the contacts	4.7 nF, $\pm 20\%$, AC 250 V

⁵⁰ For time-critical applications with low-active signals, consider the specified dropout times. If necessary, provide for active discharge of the binary input (for example, a resistor in parallel to the binary input or using a change-over contact).

Fast Relay (Type F)

Making capacity	Max. 1000 W (L/R = 40 ms) Max. 3600 VA (power factor ≤ 0.35 , 50 Hz to 60 Hz)
Breaking capacity	Max. 30 W (L/R = 40 ms) Max. 360 VA (power factor ≤ 0.35 , 50 Hz to 60 Hz)
AC and DC contact voltage	250 V
Permissible current per contact (continuous)	5 A
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact)
Short-time current across closed contact	250 A for 30 ms
Total permissible current for contacts connected to common potential	5 A
Switching time OOT (Output Operating Time) Additional delay of the output medium used	Make time: typical: 4 ms; maximum: 5 ms Break time: typical: 2 ms; maximum: 5 ms
Rated data of the output contacts in accordance with UL certification	DC 24 V, 5 A, General Purpose DC 48 V, 0.8 A, General Purpose DC 240 V, 0.1 A, General Purpose AC 120 V, 5 A, General Purpose AC 250 V, 5 A, General Purpose AC 250 V, 0.5 hp B300 R300
Interference suppression capacitors across the contacts	4.7 nF, $\pm 20\%$, AC 250 V
Supervision	2-channel activation with cyclic testing (only for make contact)

High-Speed Relay with Semiconductor Acceleration (Type HS)

Making capacity	Max. 2500 W (L/R = 40 ms) Max. 3600 VA (power factor ≤ 0.35 , 50 Hz to 60 Hz)
Breaking capacity	Max. 2500 W (L/R = 40 ms) Max. 360 VA (power factor ≤ 0.35 , 50 Hz to 60 Hz)
Contact voltage	AC 200 V, DC 250 V
Permissible current per contact (continuous)	5 A (according to UL certification) 10 A (no UL certification; AWG 14 / 2.5-mm ² (0.0039-in ²) copper conductors necessary)
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact)
Short-time current across closed contact	250 A for 30 ms
Switching time OOT (Output Operating Time) Additional delay of the output medium used	Make time, typical: 0.2 ms; maximum: 0.2 ms Break time, typical: 9 ms; maximum: 9 ms
Rated data of the output contacts in accordance with UL certification	B150 Q300

Power Relay (for Direct Control of Motor Switches)

Switching power for permanent and periodic operation			
250 V/4.0 A 220 V/4.5 A 110 V/5.0 A 60 V/5.0 A 48 V/5.0 A 24 V/5.0 A	1000 W 1000 W 550 W 300 W 240 W 120 W	In order to prevent any damage, the external protection circuit must switch off the motor in case the rotor is blocked.	
Turn on switching power for 30 s, recovery time until switching on again is 15 minutes. For short-term switching operations, an impulse/pause ratio of 3 % must be considered.			
100 V/9.0 A 60 V/10.0 A 48 V/10.0 A 24 V/10.0 A	1000 W 600 W 480 W 240 W		Continuous and inching operation is not permitted. In order to prevent any damage, the external protection circuit must switch off the motor in case the rotor is blocked.
AC and DC contact voltage			
250 V			
Permissible continuous current per contact			
5 A			
Permissible current per contact (switching on and holding)			
30 A for 1 s			
Short-time current across closed contact			
250 A for 30 ms			
Total permissible current for contacts connected to common potential			
5 A			
Switching time OOT (Output Operating Time) Additional delay of the output medium used			
≤ 16 ms			
Rated data of the output contacts in accordance with UL certification			
DC 300 V, 4.5 A - 30 s ON, 15 min OFF DC 250 V, 1 hp motor - 30 s ON, 15 min OFF DC 110 V, 3/4 hp motor - 30 s ON, 15 min OFF DC 60 V, 10 A, 1/2 hp motor - 30 s ON, 15 min OFF DC 48 V, 10 A, 1/3 hp motor - 30 s ON, 15 min OFF DC 24 V, 10 A, 1/6 hp motor - 30 s ON, 15 min OFF			
Interference suppression capacitors across the contacts			
4.7 nF, ± 20 %, AC 250 V			
The power relays operate in interlocked mode, that is, only one relay of each switching pair picks up at a time thereby avoiding a power-supply short circuit.			

12.1.5 Design Data**Masses**

	Device Size Weight of the Modular Devices				
Type of construction	1/3	1/2	2/3	5/6	1/1
Flush-mounting device	4.4 kg	7.2 kg	9.9 kg	12.7 kg	15.5 kg
Surface-mounted device with integrated on-site operation panel	7.4 kg	11.7 kg	15.9 kg	20.2 kg	24.5 kg
Surface-mounted device with detached on-site operation panel	4.7 kg	7.8 kg	10.8 kg	13.9 kg	17.0 kg

	Size	Weight
Detached on-site operation panel	1/3	1.9 kg
Detached on-site operation panel	1/6	1.1 kg

	Device Size Weight of the Non-Modular Devices 7xx81, 7xx82
Type of construction	1/3
Flush-mounting device	3.6 kg
Bracket for non-modular surface-mounted variant	1.9 kg

Dimensions of the Base and 1/3 Modules

Type of Construction (Maximum Dimensions)	Width over all x Height over all x Depth (incl. Current Terminal), Width and Depth Each Rounded up to the Next Full mm (in Inches)
Flush-mounting device	150 mm x 266 mm x 229 mm (5.91 x 10.47 x 9.02)
Surface-mounted device with integrated on-site operation panel	150 mm x 314 mm x 337 mm (5.91 x 12.36 x 13.27)
Surface-mounted device with detached on-site operation panel	150 mm x 314 mm x 230 mm (5.91 x 12.36 x 9.06)

Dimensions of the Device Rows

Type of Construction (Maximum Dimensions)	Width over all x Height over all x Depth (incl. Current Terminal), Width and Depth Each Rounded up to the Next Full mm (in Inches)				
Type of construction	1/3	1/2	2/3	5/6	1/1
Flush-mounting device	150 mm x 266 mm x 229 mm (5.91 x 10.47 x 9.02)	225 mm x 266 mm x 229 mm (8.86 x 10.47 x 9.02)	300 mm x 266 mm x 229 mm (11.81 x 10.47 x 9.02)	375 mm x 266 mm x 229 mm (14.76 x 10.47 x 9.02)	450 mm x 266 mm x 229 mm (17.72 x 10.47 x 9.02)
Surface-mounted device with integrated on-site operation panel	150 mm x 314 mm x 337 mm (5.91 x 12.36 x 13.27)	225 mm x 314 mm x 337 mm (8.86 x 12.36 x 13.27)	300 mm x 314 mm x 337 mm (11.81 x 12.36 x 13.27)	375 mm x 314 mm x 337 mm (14.76 x 12.36 x 13.27)	450 mm x 314 mm x 337 mm (17.72 x 12.36 x 13.27)
Surface-mounted device with detached on-site operation panel	150 mm x 314 mm x 230 mm (5.91 x 12.36 x 9.06)	225 mm x 314 mm x 230 mm (8.86 x 12.36 x 9.06)	300 mm x 314 mm x 230 mm (11.81 x 12.36 x 9.06)	375 mm x 314 mm x 230 mm (14.76 x 12.36 x 9.06)	450 mm x 314 mm x 230 mm (17.72 x 12.36 x 9.06)

Expansion Module Dimensions

Type of Construction (Maximum Dimensions)	Width x Height x Depth, Width and Depth Each Rounded up to the Next Full mm (in Inches)
Flush-mounting device	75 mm x 266 mm x 229 mm (2.95 x 10.47 x 9.02)
Surface-mounted device with integrated on-site operation panel	75 mm x 314 mm x 337 mm (2.95 x 12.36 x 13.27)
Surface-mounted device with detached on-site operation panel	75 mm x 314 mm x 230 mm (2.95 x 12.36 x 9.06)

Plug-In Module Dimensions

Type of Construction (Maximum Dimensions)	Width x Height x Depth (in Inches)
USART-Ax-xEL, ETH-Bx-xEL	61 mm x 45 mm x 120.5 mm (2.4 x 1.77 x 4.74)
USART-Ax-xFO, ETH-Bx-xFO (without protection cover)	61 mm x 45 mm x 132.5 mm (2.4 x 1.77 x 5.22)
ANAI-CA-4EL	61 mm x 45 mm x 119.5 mm (2.4 x 1.77 x 4.7)
ARC-CD-3FO	61 mm x 45 mm x 120.5 mm (2.4 x 1.77 x 4.74)

Minimum Bending Radii of the Connecting Cables Between the On-Site Operation Panel and the Base Module

Fiber-optic cable	R = 50 mm Pay attention to the length of the cable protection sleeve, which you must also include in calculations.
D-Sub cable	R = 50 mm (minimum bending radius)

Degree of Protection According to IEC 60529

For equipment in the surface-mounted housing	IP54 ⁵¹ for front
For equipment in the flush-mounting housing	IP54 ⁵¹ for front
For operator protection (back side)	IP2x for current terminal (installed) IP2x for voltage terminal (installed)
Degree of pollution, IEC 60255-27	2
Maximum operating altitude above sea level	2000 m (6561.68 ft)

UL Note

Type 1 if mounted into a door or front cover of an enclosure. When expanding the device with the 2nd device row, then they must be mounted completely inside an enclosure.

Tightening Torques for Terminal Screws

Type of Line	Current Terminal	Voltage Terminal with Spring-Loaded Terminals	Voltage Terminal with Screw Connection
Stranded wires with ring-type lug	2.7 Nm	No ring-type lug	No ring-type lug
Stranded wires with boot-lace ferrules or pin-type lugs	2.7 Nm	1.0 Nm	0.6 Nm
Solid conductor, bare (2 mm ²)	2.0 Nm	1.0 Nm	—
Bare stranded wire	Not permitted	1 Nm	0.6 Nm

**NOTE**

For current and voltage terminals, the maximum speed of the tool must not exceed 640 rpm.

⁵¹ The provided plug-in label must be used for expansion modules with LEDs.



NOTE

Use copper cables only.

Torques for Other Screw Types

Screw Type	Torque
M4 x 20	1.2 Nm
M4 x 8	1.2 Nm
M2.5 x 6	0.39 Nm
Countersunk screw, M2.5 x 6	0.39 Nm
Countersunk screw, M2.5 x 8	0.39 Nm
Collar screw, M4 x 20	0.7 Nm

12.2 Protection Interface and Protection Topology

Setting Values

Mode	On Off	
PPS Synchronization	Telegr. and PPS Telegr. or PPS PPS synchronization off	
Blocking of the unbalanced runtimes	Yes No	
Maximum signal runtime threshold	0.1 ms to 30.0 ms	Increments of 0.1 ms
Maximum runtime difference	0.000 ms to 3.000 ms	Increments of 0.001 ms
Failure indication after	0.05 s to 2.00 s	Increments of 0.01 s
Transm. fail. alarm after	0.0 s to 6.0 s	Increments of 0.1 s
Max. error rate/h	0.000 % to 100.000 %	Increments of 0.001 %
Max. error rate/min	0.000 % to 100.000 %	Increments of 0.001 %
PPS failure indication after	0.5 s to 60.0 s	Increments of 0.1 s

Transmission Rate

Direct connection:	
Transmission rate	2048 kbit/s
Connection via communication networks:	
Supported network interfaces	G703.1 with 64 kbit/s
	G703-T1 with 1.455 Mbit/s
	G703-E1 with 2.048 Mbit/s
	X.21 with 64 kbit/s or 128 kbit/s or 512 kbit/s
	Pilot wires with 128 kbit/s
Transmission rate	64 kbit/s at G703.1
	1.455 Mbit/s at G703-T1
	2.048 Mbit/s at G703-E1
	512 kbit/s or 128 kbit/s or 64 kbit/s at X.21
	128 kbit/s for pilot wires

Transmission Times

Priority 1:		
Response time, total approx.		
For 2 ends	Minimum	8 ms
	Typical	10 ms
For 3 ends	Minimum	10 ms
	Typical	14 ms
For 6 ends	Minimum	15 ms
	Typical	18 ms
Dropout times, total approx.		
For 2 ends	Typical	20 ms
For 3 ends	Typical	20 ms
For 6 ends	Typical	26 ms

Priority 2:		
Response time, total approx.		
For 2 ends	Minimum	9 ms
	Typical	16 ms
For 3 ends	Minimum	12 ms
	Typical	18 ms
For 6 ends	Minimum	17 ms
	Typical	23 ms
Dropout times, total approx.		
For 2 ends	Typical	24 ms
For 3 ends	Typical	25 ms
For 6 ends	Typical	32 ms
Priority 3⁵²		
Response time, total approx.		
For 2 ends	Minimum	
	Typical	100 ms
For 3 ends	Minimum	
	Typical	150 ms
For 6 ends	Minimum	
	Typical	200 ms
Dropout times, total approx.		
For 2 ends	Typical	100 ms
For 3 ends	Typical	150 ms
For 6 ends	Typical	200 ms

⁵² Times cannot be determined because the signals are transmitted in fragments.

12.3 Date and Time Synchronization

Date format	DD.MM.YYYY (Europe)
	MM/DD/YYYY (USA)
	YYYY-MM-DD (China)
Time source 1, time source 2	None
	IRIG-B 002(003)
	IRIG-B 006(007)
	IRIG-B 005(004) with extension according to IEEE C37.118-2005
	DCF77
	PI (protection interface) ⁵³
	SNTP
	IEC 60870-5-103
	DNP3
	IEEE 1588
Time zone 1, time zone 2	T104
	Local
	UTC
Failure indication after	0 s to 3600 s
Time zone and daylight saving time	Manually setting the time zones
Time zone offset with respect to GMT	-720 min to 840 min
Switching over to daylight saving time	Active
	Inactive
Beginning of daylight saving time	Input: day and time
End of daylight saving time	Input: day and time
Offset daylight saving time	0 min to 120 min [steps of 15]

⁵³ If provided

12.4 Analog-Units Function Group

20-mA Unit Ether. 7XV5674-0KK00-1AA1

Max. number of connected 20-mA units	4
Max. number of channels per 20-mA unit	12

20-mA Unit Serial 7XV5674-0KK30-1AA1 (RS485) and 7XV5674-0KK40-1AA1 (Fiberglass)

Max. number of connected 20-mA units	4
Max. number of channels per 20-mA unit	12

RTD Unit (Ziehl TR1200) 7XV5662-6AD10

Max. number of connected RTD units	4
Max. number of sensors per RTD unit	12
Sensor type	Pt 100 to EN 60751; connection of Ni 100 and Ni 120 sensors possible. The measured values must be converted in the evaluation unit.

RTD Unit (Ziehl TR1200 IP) 7XV5662-8AD10

Max. number of connected RTD units	4
Max. number of sensors per RTD unit	12
Sensor type	Pt 100 to EN 60751; connection of Ni 100 and Ni 120 sensors possible. The measured values must be converted in the evaluation unit.

Temperature Measured Values

Unit of measurement for temperature	°C or °F, adjustable
Pt 100	-199 °C to 800 °C (-326 °F to 1472 °F)
Ni 100	-54 °C to 278 °C (-65 °F to 532 °F)
Ni 120	-52 °C to 263 °C (-62 °F to 505 °F)
Resolution	1 °C or 1 °F
Tolerance	±0.5 % of the measured value ±1 K

12.5 Overcurrent Protection, Phases

12.5.1 Stage with Definite-Time Characteristic Curve

Setting Value for the Function Block Filter

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value ⁵⁴	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.90 to 0.99	Increments of 0.01
Operate delay		0.00 s to 100.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s
Pickup delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT ⁵⁵ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

⁵⁴ If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 I_{rated,sec}.

⁵⁵ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	2 % of the setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation ⁵⁶) (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ⁵⁷
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3% of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ⁵⁸
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ⁵⁹
Time delays	1 % of the setting value or 10 ms

⁵⁶ In case that the filter response exactly matches the user-defined gain factors

⁵⁷ In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.

⁵⁸ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

⁵⁹ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %
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12.5.2 Stage with Inverse-Time Characteristic Curve**Setting Value for the Function Block Filter**

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.00 to 15.00	Increments of 0.01
Pickup delay		0.00 s to 60.00 s	Increments of 0.01 s
Minimum time of the curve		0.00 s to 1.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

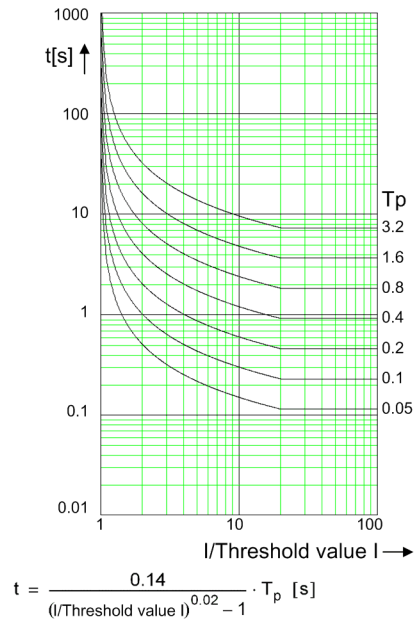
Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

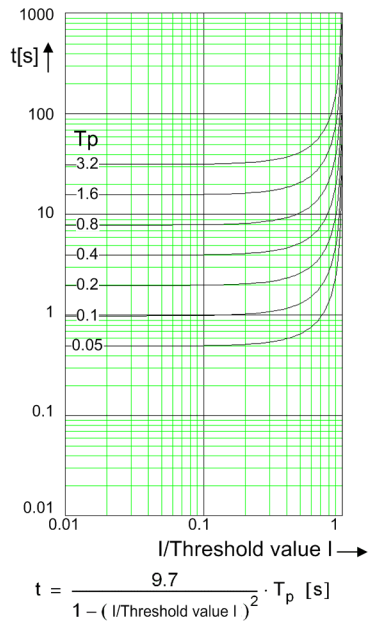
Operate Curves and Dropout-Time Characteristic Curves according to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
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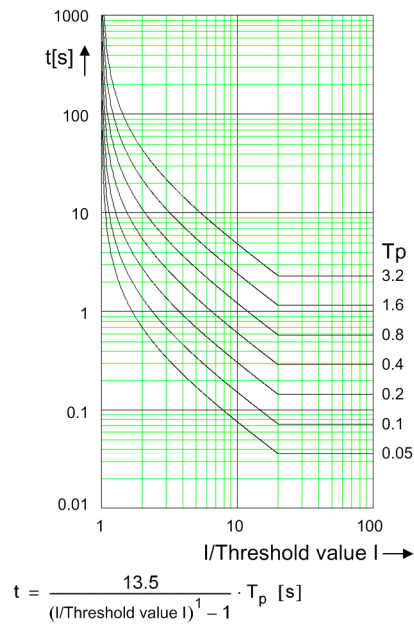
NORMAL INVERSE: Type A



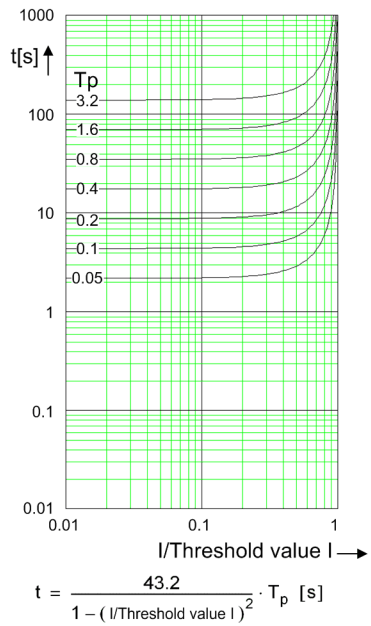
RESET NORMAL INVERSE: Type A



VERY INVERSE: Type B



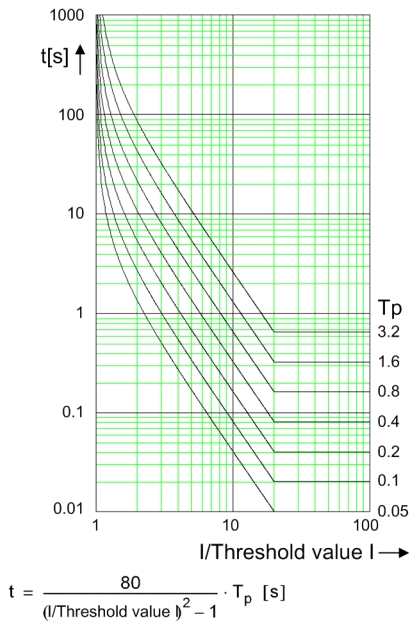
RESET VERY INVERSE: Type B



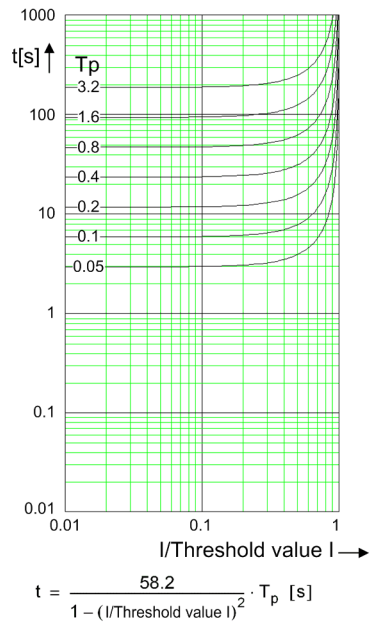
[dwocpk11-080213-01.tif, 1, en_US]

Figure 12-1 Operate Curves and Dropout-Time Characteristic Curves According to IEC

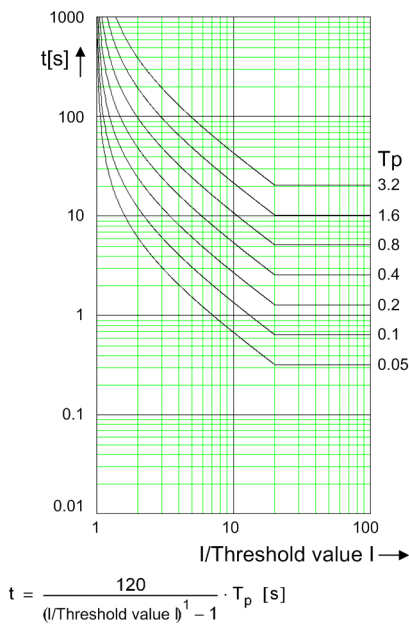
EXTREMELY INVERSE: Type C



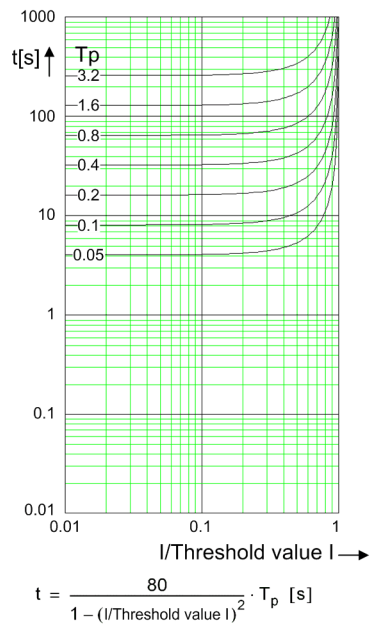
RESET EXTREMELY INVERSE: Type C



LONG-TIME INVERSE: Type B



RESET LONG-TIME INVERSE: Type B

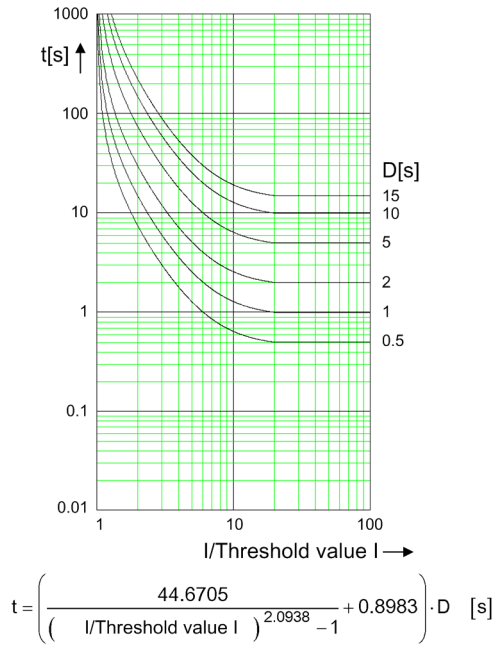


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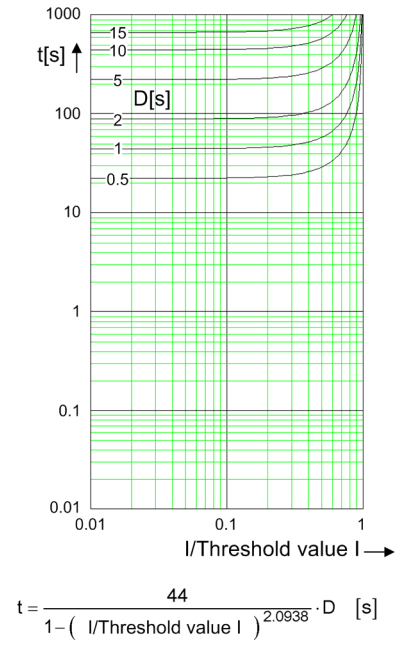
Figure 12-2 Operate Curves and Dropout-Time Characteristic Curves According to IEC

Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

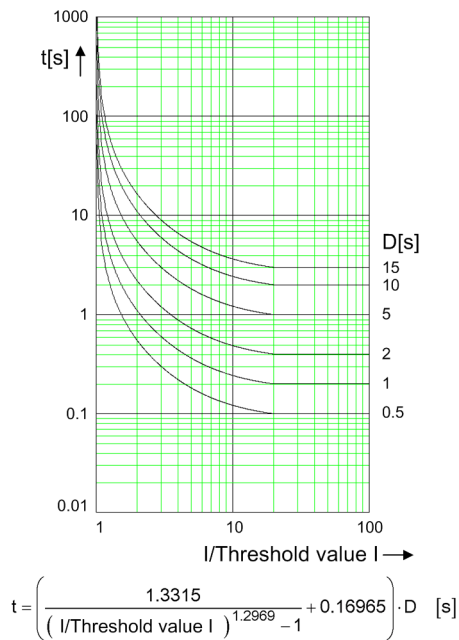
Inverse: Type C



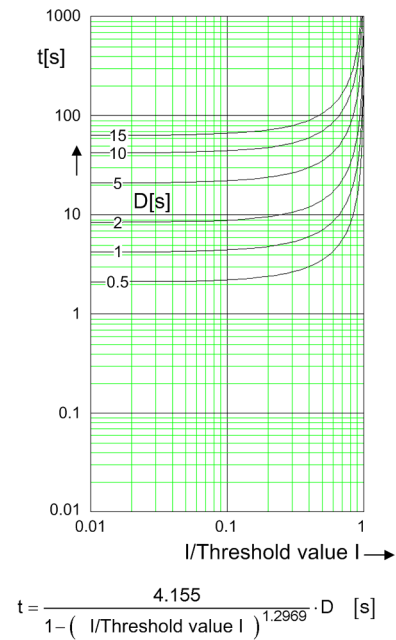
RESET INVERSE: Type C



SHORT INVERSE



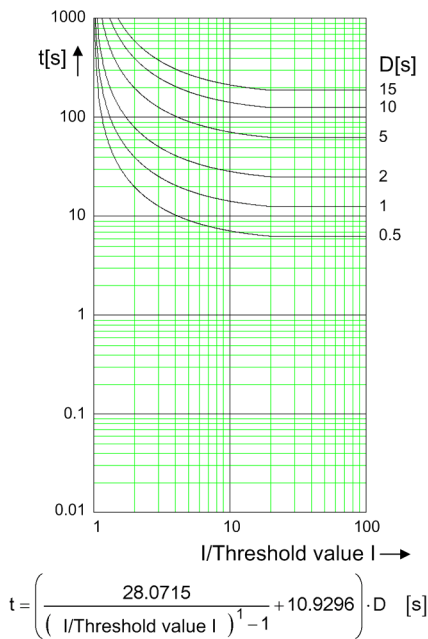
RESET SHORT INVERSE



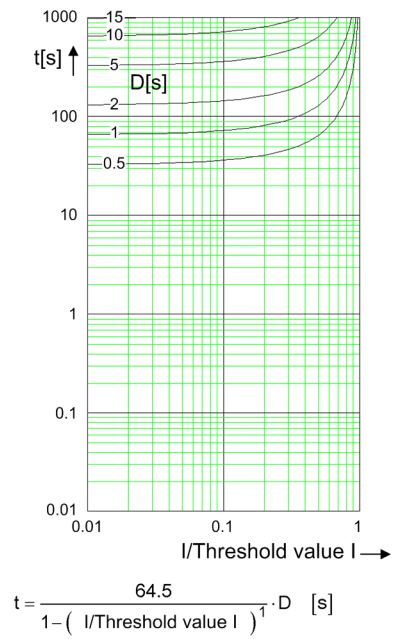
[dwocpka1-080213-01.tif, 2, en_US]

Figure 12-3 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

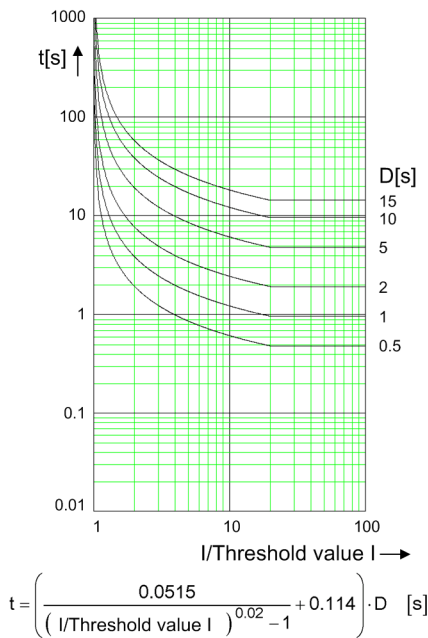
LONG INVERSE



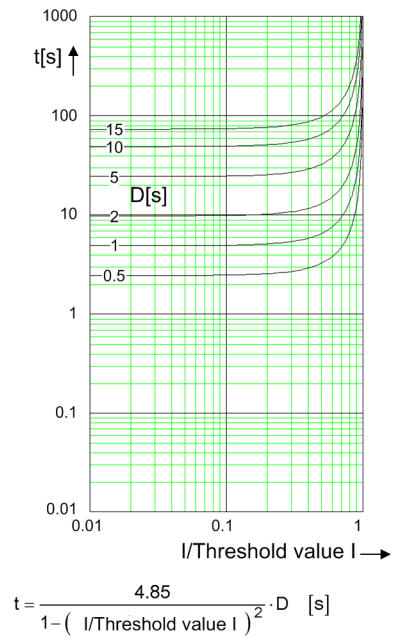
RESET LONG INVERSE



MODERATELY INVERSE



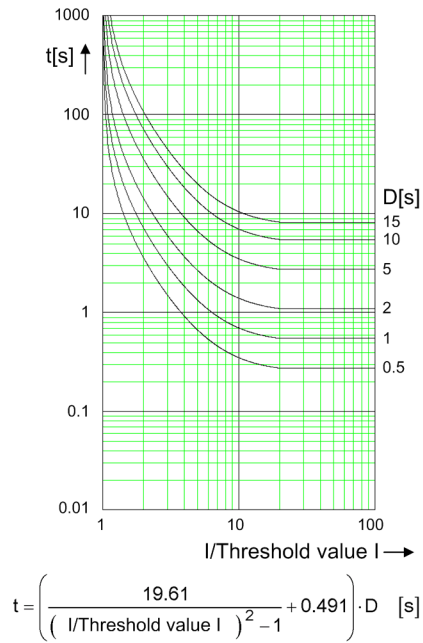
RESET MODERATELY INVERSE



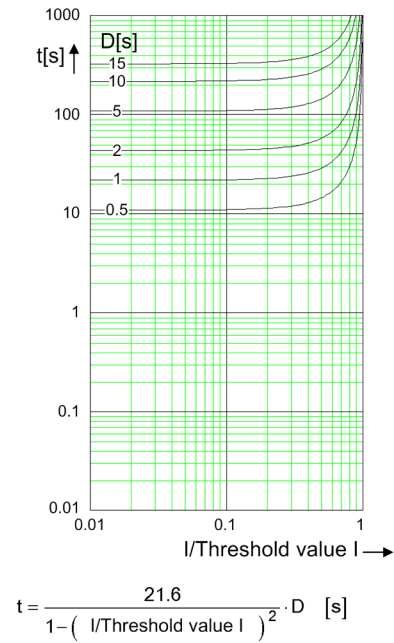
[dwocpka2-080213-01.tif, 2, en_US]

Figure 12-4 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

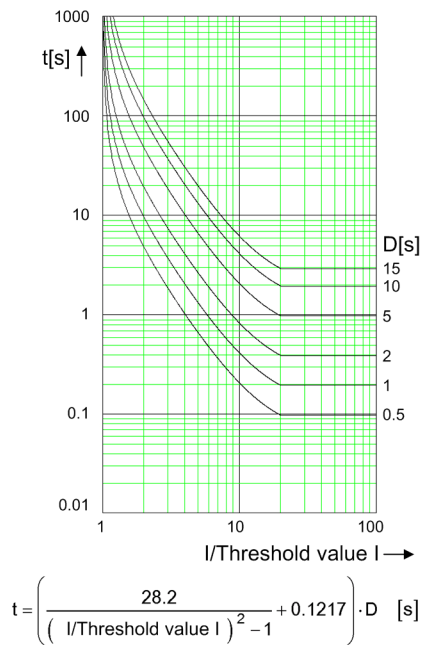
VERY INVERSE



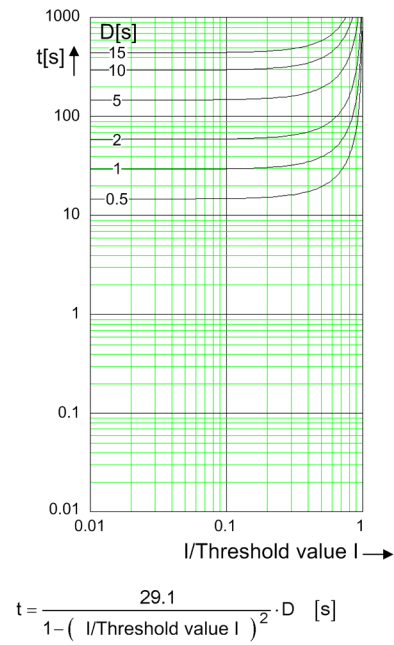
RESET VERY INVERSE



EXTREMELY INVERSE

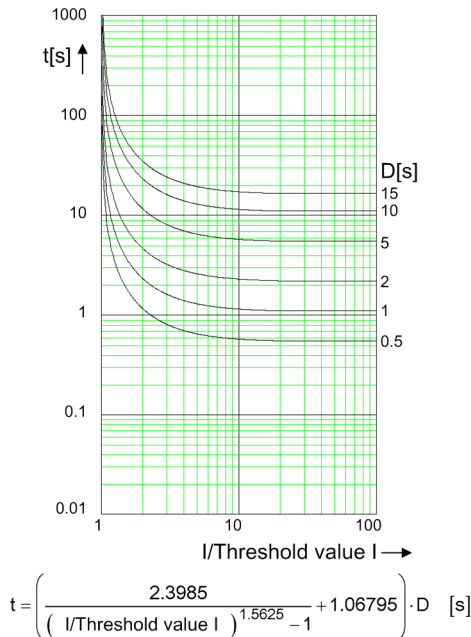
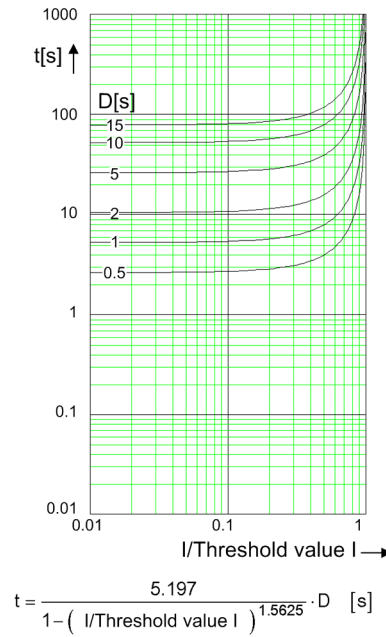


RESET EXTREMELY INVERSE



[dwocpka3-080213-01.tif, 2, en_US]

Figure 12-5 Tripping Characteristic Curves and Dropout Characteristic Curves According to ANSI/IEEE

DEFINITE INVERSE

RESET DEFINITE INVERSE


Note: IGnd threshold stands for ground fault instead of the I threshold.

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Figure 12-6 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)

Up to 50th harmonic, $f_{rated} = 50$ Hz	2 % of the setting value or 10 mA ($I_{rated} = 1$ A) or 50 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Up to 50th harmonic, $f_{rated} = 60$ Hz	3 % of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation ⁶⁰ (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA ($I_{rated} = 1$ A) or 50 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %) ⁶¹
Up to 50th harmonic, $f_{rated} = 50$ Hz	3% of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %) ⁶²
Up to 50th harmonic, $f_{rated} = 60$ Hz	4 % of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %) ⁶³
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %
---	-------

12.5.3 Stage with User-Defined Characteristic Curve

Setting Value for the Function Block Filter

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A

⁶⁰ In case that the filter response exactly matches the user-defined gain factors

⁶¹ In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.

⁶² In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

⁶³ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

Absolute pickup value	1 A @ 50 and 100 I _{rated}	0.000 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.00 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.000 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.000 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 20.00 p.u.	Increments of 0.01 p.u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p.u. to 0.95 p.u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of $1.1 \cdot \text{threshold value}$ or 95 % of the absolute pickup value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 75 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 2.5 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. $< 0.90 \cdot \text{threshold value}$

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)

Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	2 % of the setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation ⁶⁴ (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ⁶⁵
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3% of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ⁶⁶
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ⁶⁷
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
---	-------

Operate Curves and Dropout-Time Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
---	---------------

⁶⁴ In case that the filter response exactly matches the user-defined gain factors

⁶⁵ In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.

⁶⁶ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

⁶⁷ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

12.6 Voltage-Dependent Overcurrent Protection, Phases

Setting Values for All Stage Types

Method of measurement		Fundamental component RMS value	–
Overcurrent threshold value	For $I_{rated} = 1 \text{ A}$	0.030 A to 35.000 A	Increments of 0.001 A
	For $I_{rated} = 5 \text{ A}$	0.15 A to 175.00 A	Increments of 0.01 A
Time delay		0.10 s to 60.00 s	Increments of 0.01 s

Setting Values for Inverse-Time Overcurrent Protection Stages

Method of measurement		Fundamental component RMS value	–
Dropout ratio of undervoltage ⁶⁸		1.01 to 1.20	Increments of 0.01
Undervoltage threshold value ⁶⁸		0.300 V to 175.000 V	Increments of 0.001 V
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01

Setting Values for Definite-Time Overcurrent Protection Stages

Seal-in voltage	0.300 V to 175.000 V	Increments of 0.001 V
Phase-to-phase voltage	0.300 V to 175.000 V	Increments of 0.001 V
Negative-sequence voltage V2	0.300 V to 200.000 V	Increments of 0.001 V
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Duration of V-seal-in time	0.10 s to 60.00 s	Increments of 0.01 s

Dropout for Inverse-Time Overcurrent Protection Stages

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	
Current	95 % of $1.1 \cdot \text{threshold value}$
Voltage ⁶⁸	105 % of threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1 \text{ A}$) or 75 mA sec. ($I_{rated} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1 \text{ A}$) or 2.5 mA sec. ($I_{rated} = 5 \text{ A}$)
Voltage transformer ⁶⁸	150 mV sec.

Reset of the Integration Timer for Inverse-Time Overcurrent Protection Stages

Instantaneous	With dropout
Disk emulation	Approx. $< 0.90 \cdot \text{threshold value}$

⁶⁸ The value is for the inverse-time overcurrent voltage-released stage.

Dropout for Definite-Time Overcurrent Protection Stages

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1 \text{ A}$) or 75 mA sec. ($I_{rated} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1 \text{ A}$) or 2.5 mA sec. ($I_{rated} = 5 \text{ A}$)
Voltage transformer	150 mV sec.

Operate Curves and Dropout Characteristic Curves According to IEC

Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
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The operate curves and dropout characteristic curves according to IEC can be found in the chapter Technical Data under Inverse-Time Overcurrent Protection.

Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

The operate curves and dropout characteristic curves according to IEC can be found in the chapter Technical Data under Inverse-Time Overcurrent Protection.

Times for Definite-Time Overcurrent Protection Stages

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT ⁶⁹ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{rated} = 1 \text{ A}$) or 25 mA ($I_{rated} = 5 \text{ A}$), ($f_{rated} \pm 10 \%$)
Currents, method of measurement = RMS value (33 % part of harmonic in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{rated} = 1 \text{ A}$) or 25 mA ($I_{rated} = 5 \text{ A}$), ($f_{rated} \pm 10 \%$)

⁶⁹ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Voltage	0.5 % of the setting value or 0.05 V
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
---	-------

12.7 Overcurrent Protection, Ground

12.7.1 Stage with Definite-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value ⁷⁰	1 A @ 50 and 100 I _{rated}	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.05 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.002 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.90 to 0.99	Increments of 0.01
Time delay		0.00 s to 60.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT ⁷¹ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$	Slightly expanded tolerances
$1.1 f_{rated} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

⁷⁰ If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under $0.1 I_{rated,sec}$.

⁷¹ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

Tolerances

3I ₀ measured via I ⁴⁷² , method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{rated} = 1$ A) or 25 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
3I ₀ measured via I ⁴⁷³ , method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{rated} = 1$ A) or 25 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Up to 50th harmonic, $f_{rated} = 50$ Hz	3 % of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Up to 50th harmonic, $f_{rated} = 60$ Hz	4 % of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %
---	-------

12.7.2 Stage with Inverse-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value ⁷⁴	1 A @ 50 and 100 I _{rated}	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.05 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.002 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.00 to 15.00	Increments of 0.01
Minimum time of the curve		0.00 s to 1.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1$ A) or 75 mA sec. ($I_{rated} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1$ A) or 2.5 mA sec. ($I_{rated} = 5$ A)

⁷² Slightly expanded tolerances will occur during the calculation of 3I₀, maximum factor of 2

⁷³ Slightly expanded tolerances will occur during the calculation of 3I₀, maximum factor of 2

⁷⁴ If you have selected the **method of measurement = RMS value**, do not set the threshold value under 0.1 $I_{rated, sec}$.

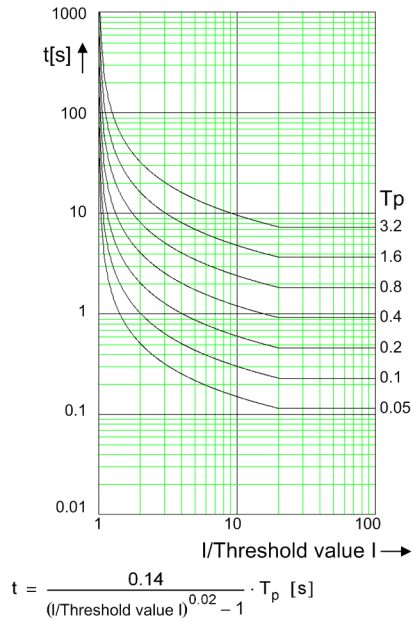
Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. $< 0.90 \cdot \text{threshold value}$

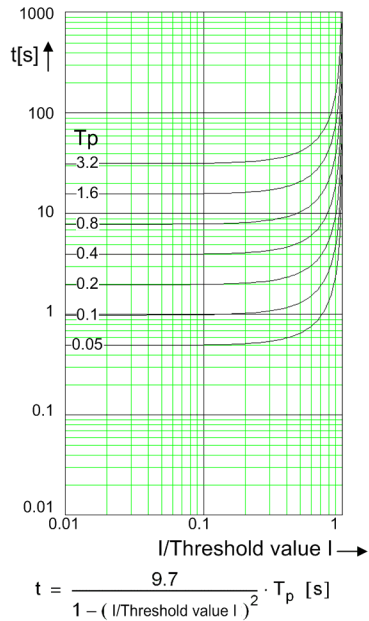
Operate Curves and Dropout Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
--	---------------

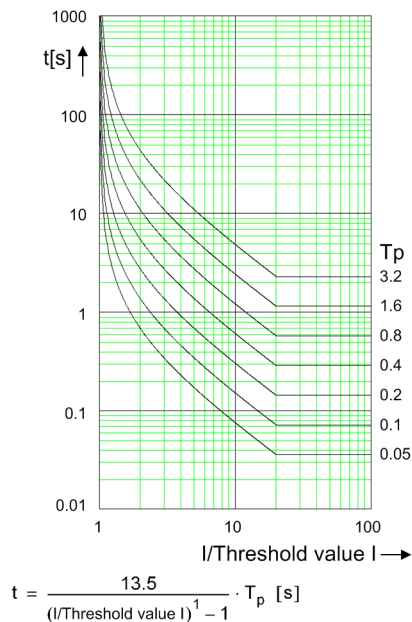
NORMAL INVERSE: Type A



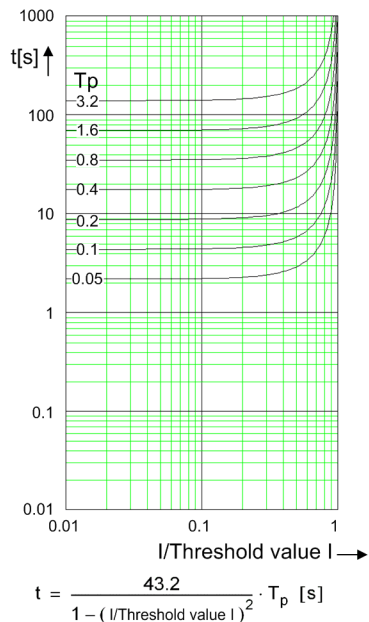
RESET NORMAL INVERSE: Type A



VERY INVERSE: Type B



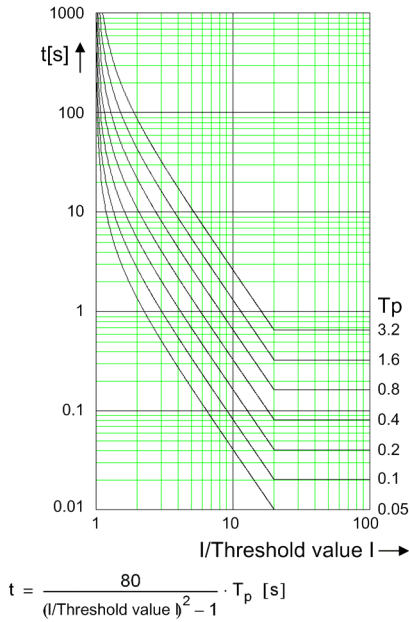
RESET VERY INVERSE: Type B



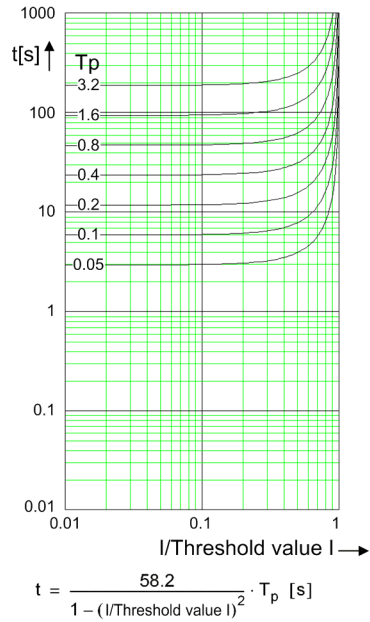
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Figure 12-7 Operate Curves and Dropout Characteristic Curves According to IEC

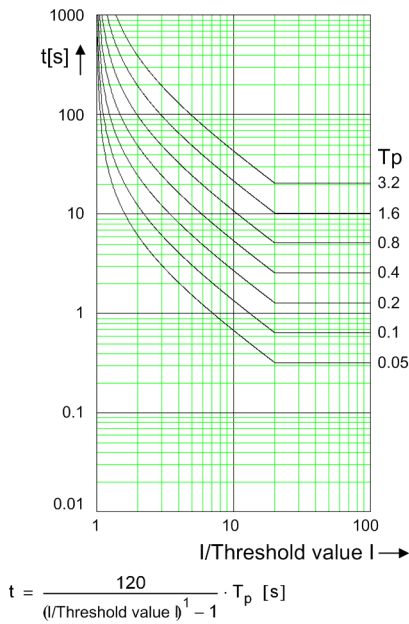
EXTREMELY INVERSE: Type C



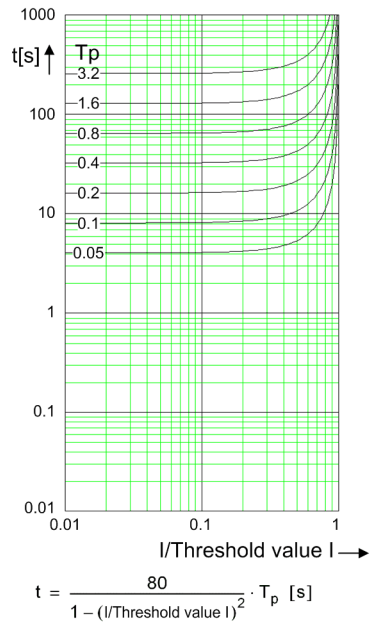
RESET EXTREMELY INVERSE: Type C



LONG-TIME INVERSE: Type B



RESET LONG-TIME INVERSE: Type B

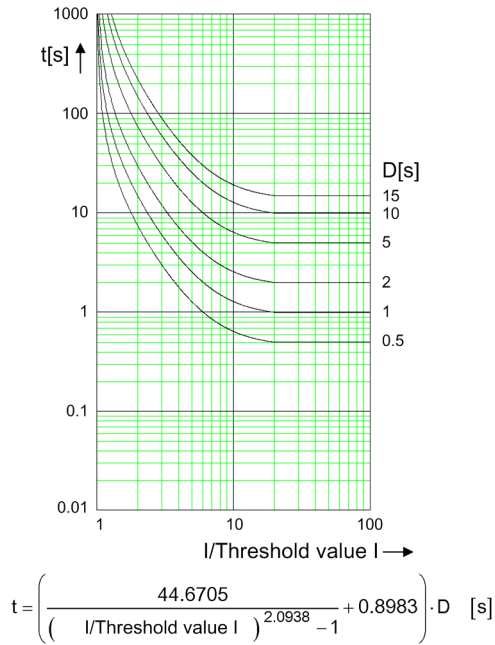


[dwocpki2-080213-01.tif, 1, en_US]

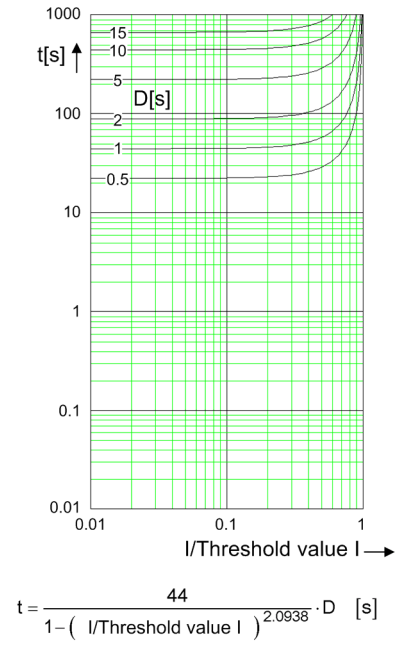
Figure 12-8 Operate Curves and Dropout Characteristic Curves According to IEC

Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

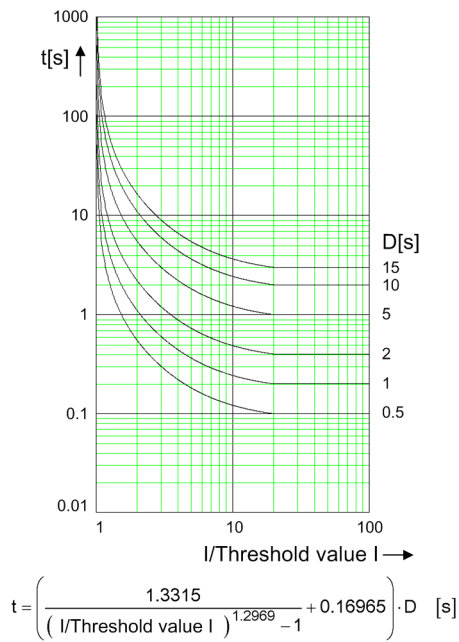
Inverse: Type C



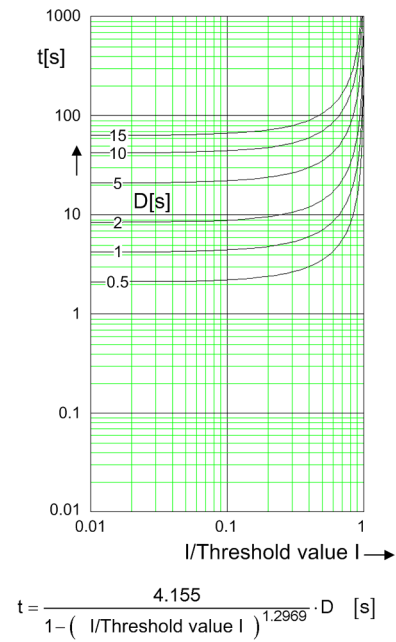
RESET INVERSE: Type C



SHORT INVERSE



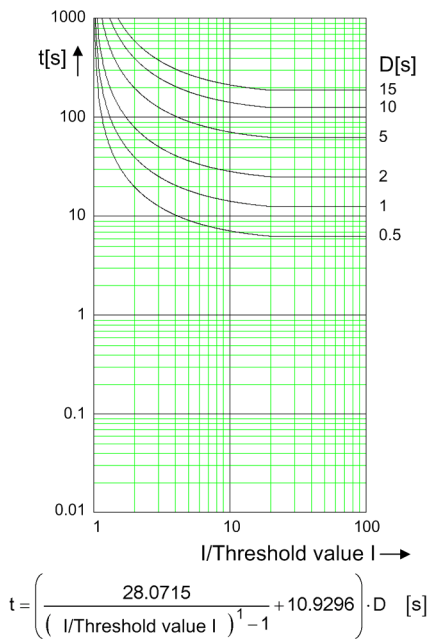
RESET SHORT INVERSE



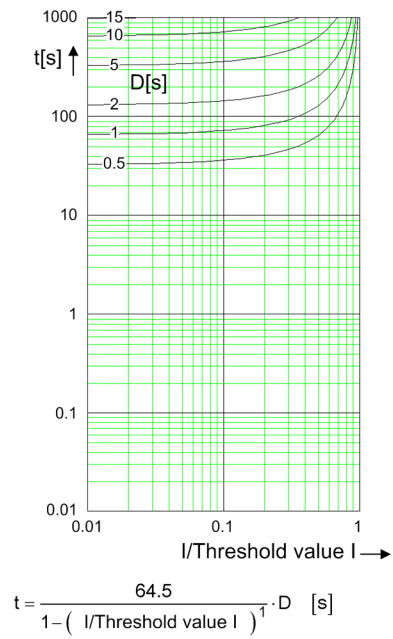
[dwocpka1-080213-01.tif, 2, en_US]

Figure 12-9 Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

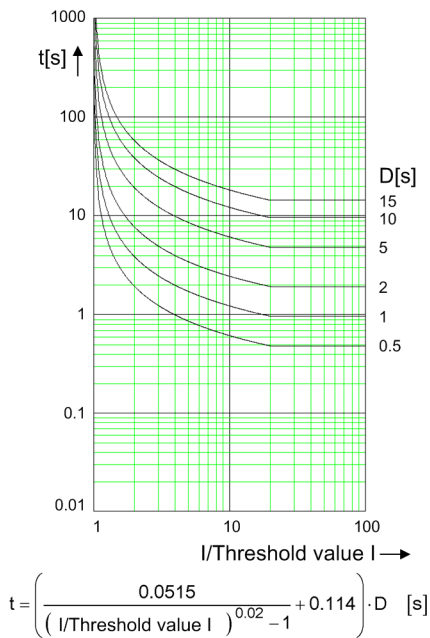
LONG INVERSE



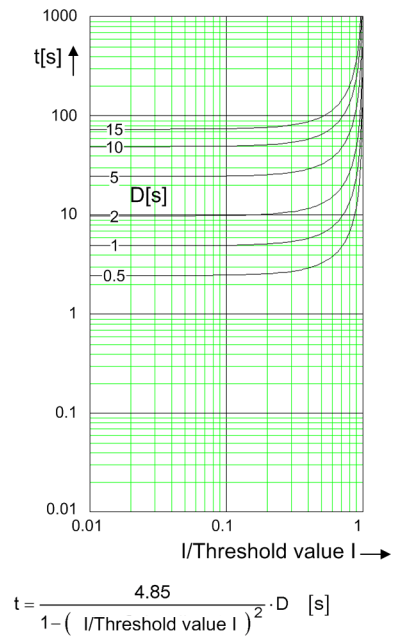
RESET LONG INVERSE



MODERATELY INVERSE



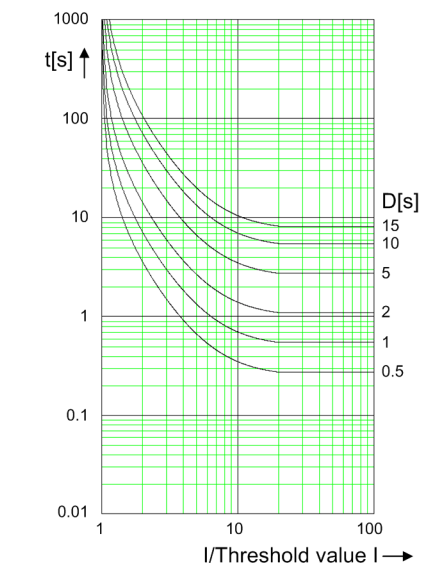
RESET MODERATELY INVERSE



[dwocpka2-080213-01.tif, 2, en_US]

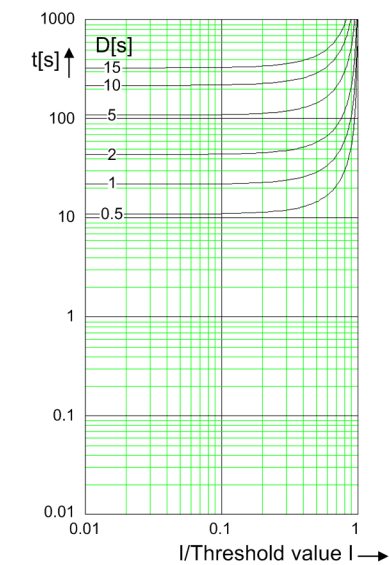
Figure 12-10 Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

VERY INVERSE



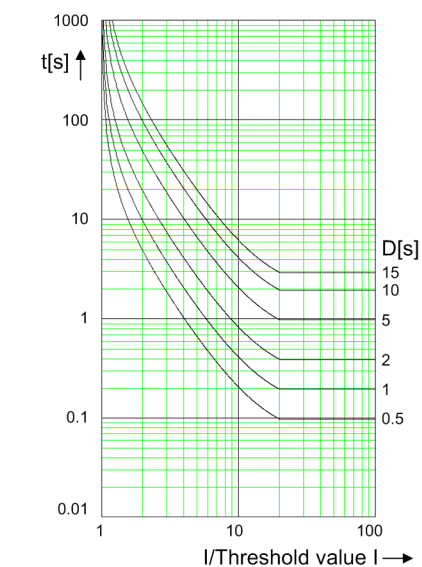
$$t = \left(\frac{19.61}{\left(\frac{I}{\text{Threshold value } I} \right)^2 - 1} + 0.491 \right) \cdot D \quad [\text{s}]$$

RESET VERY INVERSE



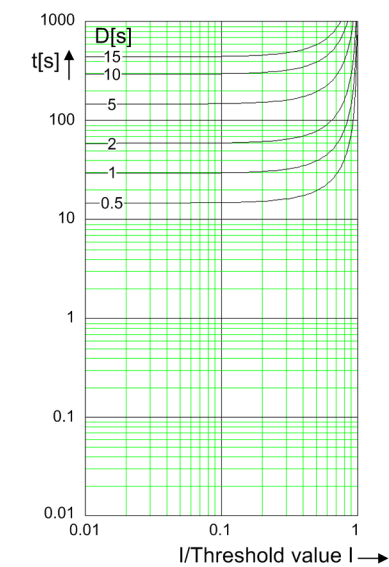
$$t = \frac{21.6}{1 - \left(\frac{I}{\text{Threshold value } I} \right)^2} \cdot D \quad [\text{s}]$$

EXTREMELY INVERSE



$$t = \left(\frac{28.2}{\left(\frac{I}{\text{Threshold value } I} \right)^2 - 1} + 0.1217 \right) \cdot D \quad [\text{s}]$$

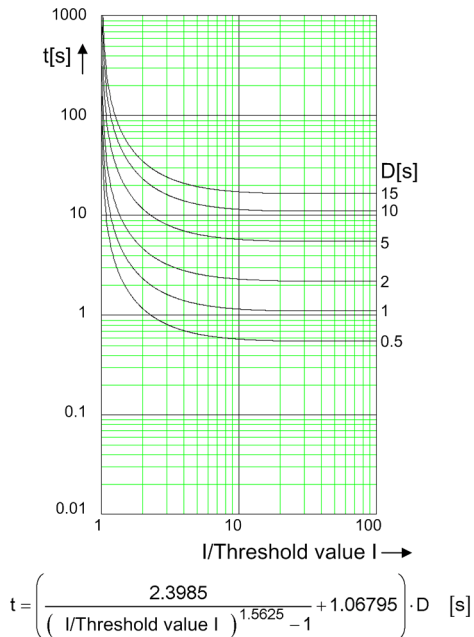
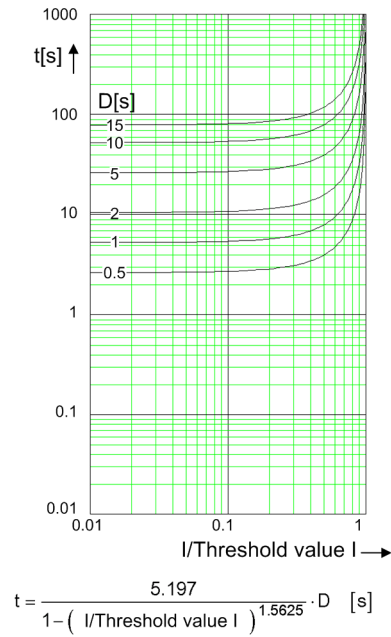
RESET EXTREMELY INVERSE



$$t = \frac{29.1}{1 - \left(\frac{I}{\text{Threshold value } I} \right)^2} \cdot D \quad [\text{s}]$$

[dwocpka3-080213-01.tif, 2, en_US]

Figure 12-11 Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

DEFINITE INVERSE**RESET DEFINITE INVERSE**

Note: IGnd threshold stands for ground fault instead of the I threshold.

[dwocpka4-080213-01.tif, 2, en_US]

Figure 12-12 Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

3I0 measured via I_4^{75} , method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
3I0 measured via I_4^{76} , method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)

⁷⁵ Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2

⁷⁶ Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2

Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for $2 \leq I/\text{threshold value } I \leq 0.90$	5 % of the reference (calculated) value +2 % current tolerance or 30 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %
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12.7.3 Stage with User-Defined Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 I _{rated}	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.05 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.002 A to 8.000 A	Increments of 0.001 A
Absolute pickup value	1 A @ 50 and 100 I _{rated}	0.000 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.00 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.000 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.000 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 20.00 p. u.	Increments of 0.01 p.u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p.u. to 0.95 p. u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of $1.1 \cdot \text{threshold value}$ or 95 % of the absolute pickup value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1$ A) or 75 mA sec. ($I_{\text{rated}} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1$ A) or 2.5 mA sec. ($I_{\text{rated}} = 5$ A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. $< 0.90 \cdot \text{threshold value}$

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

3I0 measured via I4 ⁷⁷ , method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
3I0 measured via I4 ⁷⁸ , method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	$< 5 \%$
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Operate Curves and Dropout-Time Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
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⁷⁷ Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2

⁷⁸ Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2

12.8 Directional Overcurrent Protection, Phases

12.8.1 Stage with Definite-Time Characteristic Curve

Setting Values

Rotation angle of the reference voltage		-180° to +180°	Increments of 1°
Directional mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value ⁷⁹	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.90 to 0.99	Increments of 0.01
Time delay		0.00 s to 60.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Direction Determination

Type	With healthy voltages With voltage memory 2 s
Forward range	V _{ref,rot} ±88°
Dropout differential forward/reverse range	1°
Directional sensitivity	Unlimited for 1 and 2-phase short circuits Dynamically unlimited, stationary for 3-phase short circuits Approx. 13 V phase-to-phase

⁷⁹ If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 I_{rated,sec}.

Times

Operate time with time delay = 0 ms	Approx. 37 ms + OOT ⁸⁰ at 50 Hz Approx. 31 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Time delay	1 % of the setting value or 10 ms
Direction-determination angle error	1 °

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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12.8.2 Stage with Inverse-Time Characteristic Curve**Setting Values**

Rotation angle of the reference voltage	-180° to +180°	Increments of 1°
Directional mode	Forward Backward	–
Method of measurement	Fundamental component RMS value	–

⁸⁰ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Threshold value ⁸¹	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	—
Time multiplier		0.00 to 15.00	Increments of 0.01
Minimum time of the curve		0.00 s to 1.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Operate Curves and Dropout-Time Characteristic Curves according to IEC

Normal inverse: type A	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-1
Very inverse: type B	
Extremely inverse: type C	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-2
Long-time inverse: type B	

Operate Curves and Dropout-Time Characteristic Curves according to ANSI/IEEE

Inverse: type C	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-3
Short inverse	
Long inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-4
Moderately inverse	
Very inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-5
Extremely inverse	
Definite inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-6

Direction Determination

Type	With healthy voltages With voltage memory 2 s
Forward range	V _{ref,rot} ±88°

⁸¹ If you have selected the **method of measurement = RMS value**, do not set the threshold value under 0.1 I_{rated,sec}.

Dropout differential forward/reverse range	1°
Directional sensitivity	Unlimited for 1 and 2-phase short circuits Dynamically unlimited, stationary for 3-phase short circuits Approx. 13 V phase-to-phase

Times

Operate time with time delay = 0 ms	Approx. 37 ms + OOT ⁸² at 50 Hz Approx. 31 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Operate time for $2 \leq I/\text{threshold value} I \leq 20$	5 % of the reference (calculated) value +2 % current tolerance or 10 ms
Dropout time for $I/\text{threshold value} I \leq 0.90$	5 % of the reference (calculated) value +2 % current tolerance or 10 ms
Direction-determination angle error	1°

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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⁸² OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

12.8.3 Stage with User-Defined Characteristic Curve

Setting Values

Rotation angle of the reference voltage		-180° to +180°	Increments of 1°
Directional mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value ⁸³	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate characteristic curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 66.67 p.u.	Increments of 0.01 p.u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p.u. to 0.95 p.u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Direction Determination

Type	With healthy voltages With voltage memory 2 s
Forward range	V _{ref,rot} ±88°

⁸³ If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 I_{rated,sec}.

Dropout differential forward/reverse range	1°
Directional sensitivity	Unlimited for 1-phase and 2-phase short circuits Dynamically unlimited, stationary for 3-phase short circuits Approx. 13 V phase-to-phase

Times

Operate time with time delay = 0 ms	Approx. 37 ms + OOT ⁸⁴ at 50 Hz Approx. 31 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Operate time for $2 \leq I/\text{threshold value} \leq 20$	5 % of the reference (calculated) value +2 % current tolerance or 10 ms
Dropout time for $I/\text{threshold value} \leq 0.90$	5 % of the reference (calculated) value +2 % current tolerance or 10 ms
Direction-determination angle error	1°

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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⁸⁴ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

12.9 Directional Overcurrent Protection, Ground

12.9.1 Stage with Definite-Time Characteristic Curve

Setting Values for the Function Direction Determination

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode	Forward Reverse	–
Method of measurement	Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A Increments of 0.001 A
Dropout ratio	0.90 to 0.99	Increments of 0.01
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential ($= | \text{pickup value} - \text{dropout value} |$) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 75 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 2.5 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Time delays	1 % of the setting value or 10 ms
Direction-determination angle error	1°

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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12.9.2 Stage with Inverse-Time Characteristic Curve**Setting Values for the Function Direction Determination**

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Type of characteristic curve		Characteristic curves according to IEC and ANSI	

Dropout	Disk emulation Instantaneous	–
Time multiplier	0.00 to 15.00	Increments of 0.01
Minimum time of the curve	0.00 s to 1.00 s	Increments of 0.01 s
Additional time delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential ($= | \text{pickup value} - \text{dropout value} |$) of the following 2 criteria applies:

Dropout	95 % of $1.1 \cdot \text{threshold value}$
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 75 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 2.5 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. $< 0.90 \cdot \text{threshold value}$

Operate Curves and Dropout-Time Characteristic Curves according to IEC

Normal inverse: type A	Refer to the respective figure of the technical data for the non-dir-OC-ground function 12.7.2 Stage with Inverse-Time Characteristic Curve
Very inverse: type B	
Extremely inverse: type C	
Long-time inverse: type B	

Operate Curves and Dropout-Time Characteristic Curves according to ANSI/IEEE

Inverse: type C	Refer to the respective figure of the technical data for the non-dir-OC-ground function 12.7.2 Stage with Inverse-Time Characteristic Curve
Short inverse	
Long inverse	
Moderately inverse	
Very inverse	
Extremely inverse	
Definite inverse	

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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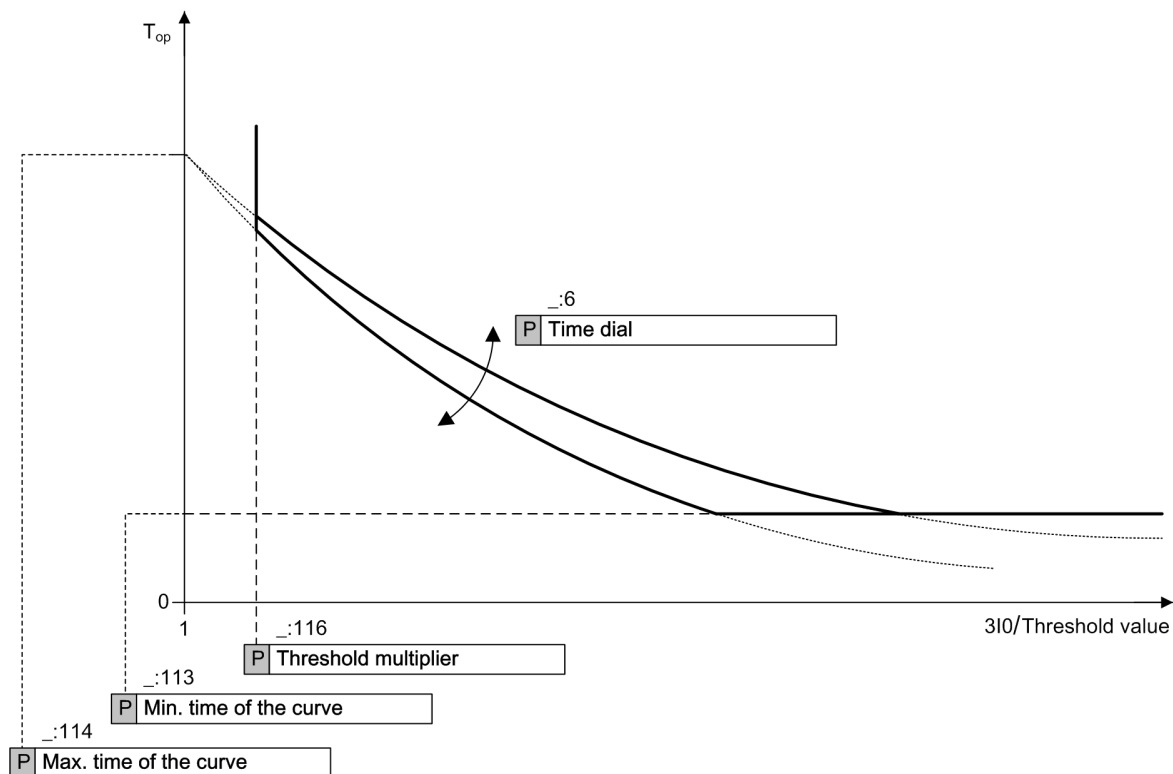
12.9.3 Stage with Inverse-Time Overcurrent Protection with Logarithmic-Inverse Characteristic Curve**Setting Values for the Function Direction Determination**

Method for direction determination	Zero sequence Negative sequence	—
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode	Forward Reverse	—
Method of measurement	Fundamental component RMS value	—

Threshold value	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Characteristic curve: see Figure 12-13			
Threshold value multiplier		1.00 to 4.00	Increments of 0.01
Time multiplier		0.000 s to 60.000 s	Increments of 0.001 s
Minimum time of the characteristic curve		0.000 s to 60.000 s	Increments of 0.001 s
Maximum time of the characteristic curve		0.000 s to 60.000 s	Increments of 0.001 s
Additional time delay		0.000 s to 60.000 s	Increments of 0.001 s



[dwloginv-300913, 3, en_US]

Figure 12-13 Operate Curve of Logarithmic Inverse-Time Characteristic

Dropout

The greater dropout differential ($= | \text{pickup value} - \text{dropout value} |$) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 75 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 2.5 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Inverse-time operate time to logarithmic inverse-time characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Inverse-time dropout time to logarithmic inverse-time characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Thresholds

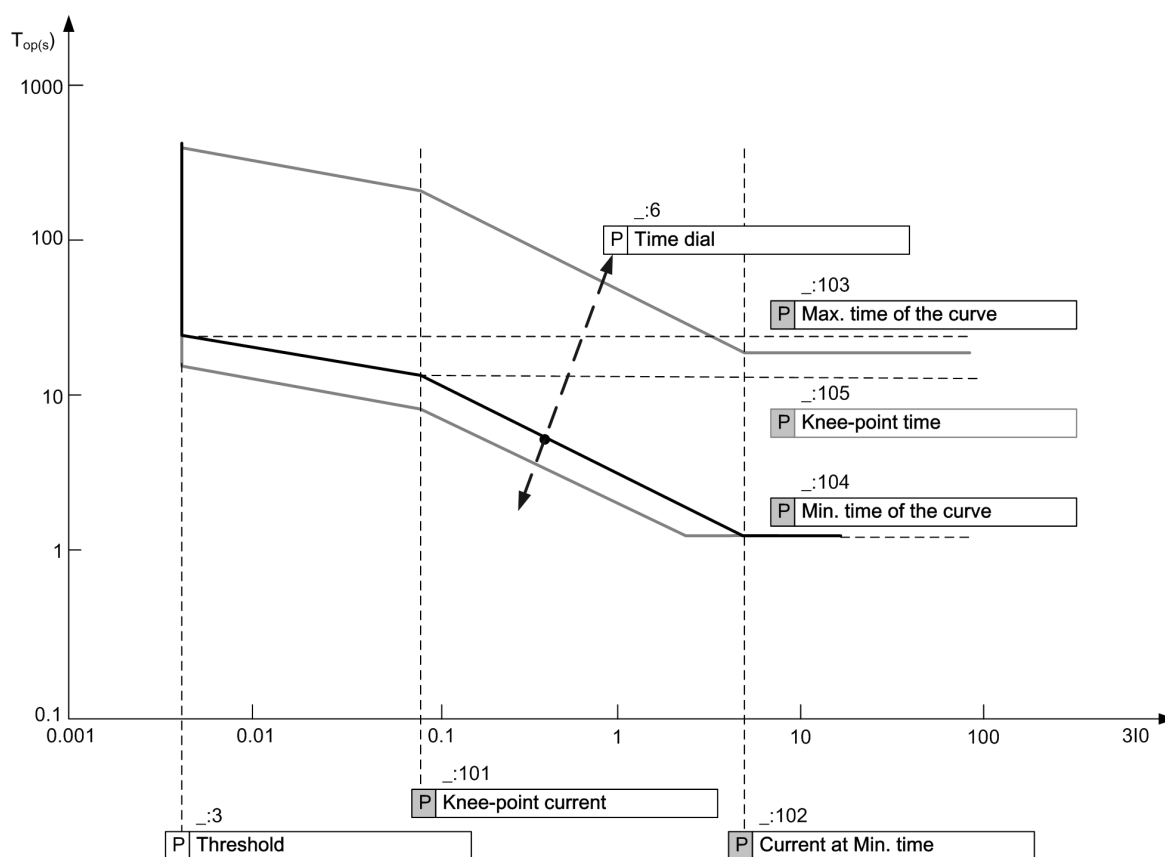
Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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12.9.4 Stage with Knee-Point Characteristic Curve**Setting Values for the Function Direction Determination**

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Characteristic curve: see Figure 12-14			
Minimum time of the characteristic curve		0.00 s to 30.00 s	Increments of 0.01 s
Knee-point time of the curve		0.00 s to 100.00 s	Increments of 0.01 s
Maximum time of the characteristic curve		0.00 s to 200.00 s	Increments of 0.01 s
Knee-point value		0.030 A to 35.000 A	Increments of 0.001 A
Current at minimum time of the curve		0.030 A to 35.000 A	Increments of 0.001 A
Time multiplier		0.05 to 1.50	Increments of 0.01



[dwdrlolnkn-171013, 1, en_US]

Figure 12-14 Operate Curve of the Logarithmic Inverse Time with Knee-Point Characteristic (In the Example of **Threshold = 0.004 A**)

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1 \text{ A}$) or 75 mA sec. ($I_{rated} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1 \text{ A}$) or 2.5 mA sec. ($I_{rated} = 5 \text{ A}$)

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{rated} = 1 \text{ A}$) or 25 mA ($I_{rated} = 5 \text{ A}$)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{rated} = 1 \text{ A}$) or 25 mA ($I_{rated} = 5 \text{ A}$), ($f_{rated} \pm 10 \%$)
Up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{rated} = 1 \text{ A}$) or 100 mA ($I_{rated} = 5 \text{ A}$), ($f_{rated} \pm 10 \%$)
Up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{rated} = 1 \text{ A}$) or 100 mA ($I_{rated} = 5 \text{ A}$), ($f_{rated} \pm 10 \%$)
Inverse-time operate time to logarithmic inverse time with knee-point characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Inverse-time dropout time to logarithmic inverse time with knee-point characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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12.9.5 Stage with User-Defined Characteristic Curve

Setting Values for the Function Direction Determination

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode	Forward Reverse	–
Method of measurement	Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 35.000 A Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A Increments of 0.001 A
Dropout	Disk emulation Instantaneous	–
Time multiplier	0.05 to 15.00	Increments of 0.01
X values of the operate curve	1.00 p. u. to 66.67 p. u.	Increments of 0.01 p. u.
Y values of the operate curve	0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve	2 to 30	Increments of 1
X values of the dropout characteristic curve	0.05 p. u. to 0.95 p. u.	Increments of 0.01 p. u.
Y values of the dropout characteristic curve	0.00 s to 999.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of $1.1 \cdot \text{threshold value}$
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 75 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 2.5 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. $< 0.90 \cdot \text{threshold value}$

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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12.10 Inrush-Current Detection

Setting Values

Operat.-range limit I _{max}	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Content 2nd harmonic		10 % to 45 %	Increments of 1 %
Duration of the crossblock function		0.03 s to 200.00 s	Increments of 0.01 s

Times

Operating times	Approx. 29 ms
-----------------	---------------

Pickup

Harmonic: I _{2nd harm} /I _{1st harm}	Setting value or at least I _{1st harm} = 10 mA sec. and I _{2nd harm} = 10 mA sec. (I _{rated} = 1 A) I _{1st harm} = 50 mA sec. and I _{2nd harm} = 50 mA sec. (I _{rated} = 5 A)
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Dropout

The greater dropout differential (= | **pickup threshold** - **dropout threshold** |) of the following criteria is used:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for the overcurrent protection and a dropout ratio of 105 % applies for the undercurrent protection.	
Minimum absolute dropout differential	
Protection-class current transformers	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument transformers	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)
Harmonic: I _{2nd harm} /I _{1st harm}	0.75 or I _{2nd harm} = 5 mA sec. (I _{rated} = 1 A) or I _{2nd harm} = 25 mA sec. (I _{rated} = 5 A)

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Current measurement $I_{\max}$	1 % of the setting value or 5 mA
Harmonic: $I_{2\text{nd harm}}/I_{1\text{st harm}}$	1 % of the setting value
Time delays	1 % of the setting value or 10 ms

12.11 2nd Harmonic Detection Ground

Setting Values

Measured value	IN measured 3I0 calculated	
2nd harmonic content	10 % to 45 %	Increments of 1 %

Times

Operating times	Approx. 29 ms
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Pickup

Harmonic: $I_{2nd\ harm}/I_{1st\ harm}$	Setting value or at least $I_{1st\ harm} = 10\ \text{mA sec. and}$ $I_{2nd\ harm} = 10\ \text{mA sec. (} I_{rated} = 1\ \text{A)}$ $I_{1st\ harm} = 50\ \text{mA sec. and}$ $I_{2nd\ harm} = 50\ \text{mA sec. (} I_{rated} = 5\ \text{A)}$
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Dropout

The greater dropout differential (= | **pickup threshold** - **dropout threshold** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for the overcurrent protection and a dropout ratio of 105 % applies for the undercurrent protection.	
Minimum absolute dropout differential	
Protection-class current transformers	15 mA sec. ($I_{rated} = 1\ \text{A}$) or 75 mA sec. ($I_{rated} = 5\ \text{A}$)
Instrument transformers	0.5 mA sec. ($I_{rated} = 1\ \text{A}$) or 2.5 mA sec. ($I_{rated} = 5\ \text{A}$)
Harmonics: $I_{2nd\ harm}/I_{1st\ harm}$	0.75 or $I_{2nd\ harm} = 5\ \text{mA sec. (} I_{rated} = 1\ \text{A)}$ or $I_{2nd\ harm} = 25\ \text{mA sec. (} I_{rated} = 5\ \text{A)}$

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ \text{Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90\ \text{Hz}$	Slightly expanded tolerances
$f < 10\ \text{Hz}$ $f > 90\ \text{Hz}$	Inactive

Tolerances

Harmonics: $I_{2nd\ harm}/I_{1st\ harm}$	1 % of the setting value for setting values $I_{2nd\ harm}/I_{1st\ harm}$
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12.12 Arc Protection

Setting Values

Threshold I>	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Threshold 3I0>>	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
External trip initiation		no current light	
Operating mode		light only current and light	
Sensor		point sensor line sensor custom	
Threshold light		-28.00 dB to 0.00 dB	Increments of 0.01
Channel		Possible settings, application-dependent	

Dropout

The larger dropout differential (= | **pickup threshold** - **dropout threshold** |) of the following 2 criteria is used:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 90 % applies to the current threshold values.	
Minimum absolute dropout differential	
Protection-class current transformers	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument transformers	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Shortest operate time Operating mode = light only	Approx. 2.6 ms + OOT ⁸⁵
Shortest operate time Operating mode = Current and light	Approx. 4.0 ms + OOT at 50 Hz Approx. 3.8 ms + OOT at 60 Hz

⁸⁵ OOT (Output Operating Time): Additional delay of the output medium used, for example, 5 ms with fast relay, see chapter [12.1.4 Relay Outputs](#)

12.13 Instantaneous High-Current Tripping

Setting Values

Threshold value	1 A @ 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 50 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.50 to 0.90	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time for current > 2 · √2 · threshold value	Approx. 8 ms + OOT ⁸⁶
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Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Response tolerance, current	5 % of setting value or 10 mA at I _{rated} = 1 A 5 % of setting value or 50 mA at I _{rated} = 5 A
Time delays	1 % of the setting value or 10 ms

⁸⁶ OOT (Output Operating Time) Additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

12.14 Instantaneous Tripping at Switch onto Fault

Setting Values

Tripping delay	0.00 s to 60.00 s	Increments of 0.01 s
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Tolerances

Times	< 1 % of the setting value or 10 ms
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12.15 Overcurrent Protection, 1-Phase

12.15.1 Stage with Definite-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value ⁸⁷	1 A @ 50 and 100 I _{rated}	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.05 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.002 A to 8.000 A	Increments of 0.001 A
Dropout ratio (fixed)		0.95	–
Time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 15 ms + OOT ⁸⁸ at 50 Hz Approx. 14 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT at 50 Hz Approx. 17 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$	Slightly expanded tolerances
$1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

⁸⁷ If you have selected the **method of measurement = RMS value**, do not set the threshold value under $0.1 I_{\text{rated,sec}}$.

⁸⁸ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{rated} = 1$ A) or 25 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{rated} = 1$ A) or 25 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Up to 50th harmonic, $f_{rated} = 50$ Hz	3 % of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Up to 50th harmonic, $f_{rated} = 60$ Hz	4 % of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %
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12.15.2 Stage with Inverse-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value ⁸⁹	1 A @ 50 and 100 Irated	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.05 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.002 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of $1.1 \cdot \text{threshold value}$
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1$ A) or 75 mA sec. ($I_{rated} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1$ A) or 2.5 mA sec. ($I_{rated} = 5$ A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. $< 0.90 \cdot \text{threshold value}$

⁸⁹ If you have selected the **method of measurement = RMS value**, do not set the threshold value under $0.1 I_{rated, sec.}$

Operate Curves and Dropout Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
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The operate curves and dropout characteristic curves according to IEC can be found in the Technical Data chapter under Inverse-Time Overcurrent Protection.

Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

The operate curves and dropout characteristic curves according to ANSI/IEEE can be found in the Technical Data chapter under Inverse-Time Overcurrent Protection.

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms

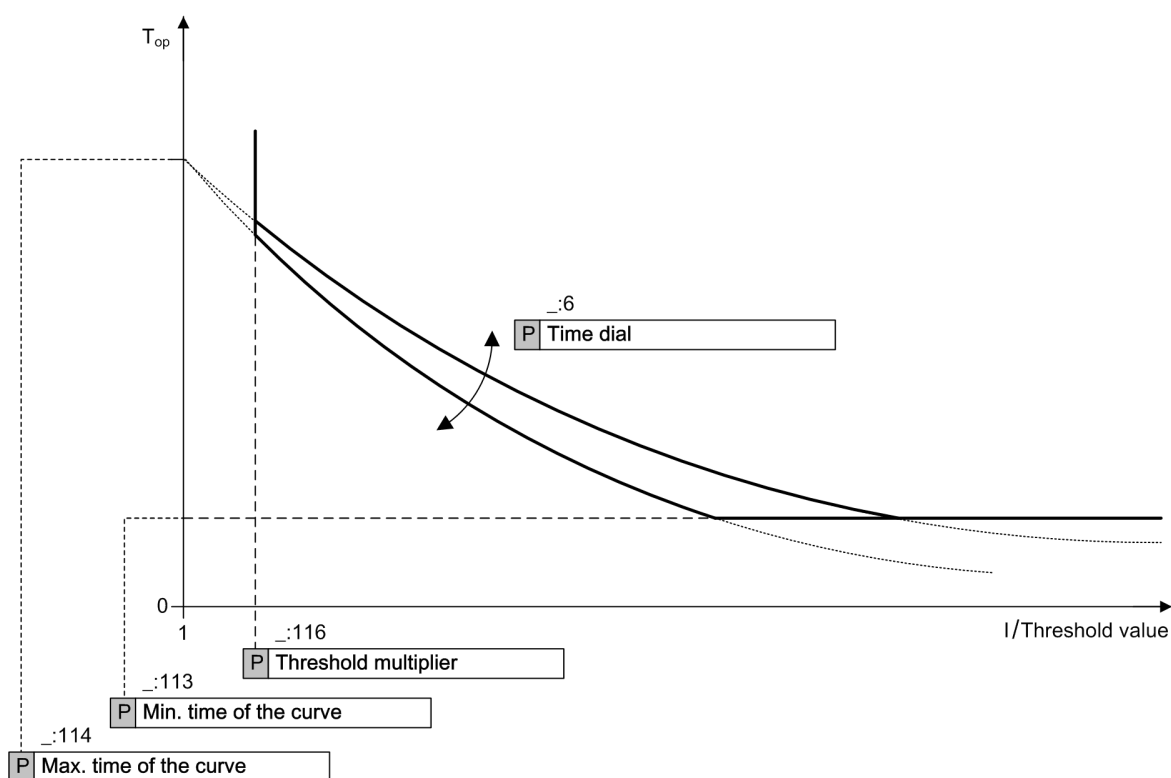
Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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12.15.3 Stage with Inverse-Time Overcurrent Protection with Logarithmic-Inverse Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.050 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.002 A to 8.000 A	Increments of 0.001 A
Characteristic curve: see Figure 12-15			
Threshold value multiplier		1.00 to 4.00	Increments of 0.01
Time dial		0.000 s to 60.000 s	Increments of 0.001 s
Minimum time of the characteristic curve		0.000 s to 60.000 s	Increments of 0.001 s
Maximum time of the characteristic curve		0.000 s to 60.000 s	Increments of 0.001 s
Additional time delay		0.000 s to 60.000 s	Increments of 0.001 s



[dw_ocp 1phase logarithmic, 1, en_US]

Figure 12-15 Operate Curve of Logarithmic Inverse-Time Characteristic

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1 \text{ A}$) or 75 mA sec. ($I_{rated} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1 \text{ A}$) or 2.5 mA sec. ($I_{rated} = 5 \text{ A}$)

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$	Slightly expanded tolerances
$1.1 f_{rated} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{rated} = 1 \text{ A}$) or 25 mA ($I_{rated} = 5 \text{ A}$)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{rated} = 1 \text{ A}$) or 25 mA ($I_{rated} = 5 \text{ A}$), ($f_{rated} \pm 10 \%$)
Up to 50th harmonic, $f_{rated} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{rated} = 1 \text{ A}$) or 100 mA ($I_{rated} = 5 \text{ A}$), ($f_{rated} \pm 10 \%$)
Up to 50th harmonic, $f_{rated} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{rated} = 1 \text{ A}$) or 100 mA ($I_{rated} = 5 \text{ A}$), ($f_{rated} \pm 10 \%$)
Inverse-time operate time to logarithmic inverse-time characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Inverse-time dropout time to logarithmic inverse-time characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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12.15.4 Stage with User-Defined Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 I _{rated}	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.05 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.002 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 66.67 p. u.	Increments of 0.01 p.u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p.u. to 0.95 p. u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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Operate Curves and Dropout-Time Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
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12.16 Overcurrent Protection, 1-Phase (Fast Stage)

Setting Values

Threshold value	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio (fixed)		0.90 to 0.99	Increments of 0.01
Time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 8 ms + OOT ⁹⁰
Dropout time	Approx. 25 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Pickup tolerance, current	5 % of the setting value or 10 mA (I _{rated} = 1 A) or 50 mA (I _{rated} = 5 A)
Time delays	1 % of the setting value or 10 ms

⁹⁰ OOT (Output Operating Time): additional time delay of the output medium used, for example, 5 ms with fast relay

12.17 Positive-Sequence Overcurrent Protection

12.17.1 Stage with Definite-Time Characteristic Curve

Setting Values for Protection Stage

Threshold value	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Operate delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT ⁹¹ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Current	1 % of the setting value or 5 mA (I _{rated} = 1 A) or 25 mA (I _{rated} = 5 A), (f _{rated} ± 10 %)
Time delays	1 % of the setting value or 10 ms

⁹¹ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

12.17.2 Stage with Inverse-Time Characteristic Curve

Setting Values for Protection Stage

Threshold	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Reset		instantaneous disk emulation	—
Time dial		0.00 to 15.00	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Operate and Dropout Characteristic Curves

You can select from the following operate and dropout characteristic curves:

Table 12-4 Standard Characteristic Curves according to IEC

Normal inverse: type A	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-1
Very inverse: type B	
Extremely inverse: type C	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-2
Long-time inverse: type B	

Table 12-5 Standard Characteristic Curves according to ANSI

Inverse: type C	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-3
Short inverse	
Long inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-4
Moderately inverse	
Very inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-5
Extremely inverse	
Definite inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-6

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT ⁹² at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Current	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

⁹² OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

12.18 Non-Directional Intermittent Ground-Fault Protection

Setting Values

Threshold value 3I0> interm.	For current transformer type protection and I _{rated} = 1 A		0.030 A to 35.000 A	Increments of 0.001 A
	For current transformer type protection and I _{rated} = 5 A		0.15 A to 175.00 A	Increments of 0.01 A
	For I _N transformer type sensitive and I _{N-rated} = 1 A	For I _{ph-rated} = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I _N transformer type sensitive and I _{N-rated} = 5 A	For I _{ph-rated} = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Number of pickups until intermittent ground fault			2 to 10	Increments of 1
Pickup extension time			0.00 s to 10.00 s	Increments of 0.01 s
Sum of extended pickup times			0.00 s to 100.00 s	Increments of 0.01 s
Reset time			1.00 s to 600.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT ⁹³ at 50 Hz Approx. 23 ms + OOT at 60 Hz
Dropout time	Approx. 25 ms + OOT at 50 Hz Approx. 22 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

⁹³ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Tolerances

Currents	-3I ₀ via protection-class current transformers: 1 % of setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$)
	-3I ₀ via sensitive current transformer: 1 % of setting value or 0.1 mA ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.5 mA ($I_{\text{rated}} = 8 \text{ A}$)
Times	1 % of the setting value or $\pm 10 \text{ ms}$

12.19 Directional Intermittent Ground-Fault Protection

Setting Values

Threshold value 3I0>	For current transformer type protection and I _{rated} = 1 A		0.030 A to 35.000 A	Increments of 0.001 A
	For current transformer type protection and I _{rated} = 5 A		0.15 A to 175.00 A	Increments of 0.01 A
	For I _N transformer type sensitive and I _{N-rated} = 1 A	For I _{ph-rated} = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I _N transformer type sensitive and I _{N-rated} = 5 A	For I _{ph-rated} = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Number of pulses until intermittent ground fault		2 to 10	Increments of 1	
Pickup extension time		0.00 s to 10.00 s	Increments of 0.01 s	
Sum of extended pickup times		0.00 s to 100.00 s	Increments of 0.01 s	
Reset time		1.00 s to 600.00 s	Increments of 0.01 s	
Number of pulses for operate		2 to 100	Increments of 1	

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Pickup time	Approx. 30 ms + OOT ⁹⁴ at 50 Hz Approx. 23 ms + OOT at 60 Hz
Dropout time	Approx. 25 ms + OOT at 50 Hz Approx. 22 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

⁹⁴ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Tolerances

Currents	3I0 via protection-class current transformers: 1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$)
	3I0 via sensitive current transformer: 1 % of the setting value or 0.1 mA ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.5 mA ($I_{\text{rated}} = 8 \text{ A}$)
Times	1 % of the setting value or $\pm 10 \text{ ms}$

12.20 Sensitive Ground-Fault Detection

12.20.1 General

Setting Values

Decay time V0			0.03 s to 0.20 s	Increments of 0.01 s
Dropout delay			0.00 s to 60.00 s	Increments of 0.01 s
Core balance current transformer current 1	Protection-class current transformers	For $I_{ph-rated} = 1\text{ A}$	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph-rated} = 5\text{ A}$	0.15 A to 175.00 A	Increments of 0.01 A
Core balance current transformer current 2	For I_N transformer type sensitive and $I_{N-rated} = 1\text{ A}$	For $I_{ph-rated} = 1\text{ A}$	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph-rated} = 5\text{ A}$	0.001 A to 175.000 A	Increments of 0.001 A
	For I_N transformer type sensitive and $I_{N-rated} = 5\text{ A}$	For $I_{ph-rated} = 1\text{ A}$	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph-rated} = 5\text{ A}$	0.005 A to 175.000 A	Increments of 0.001 A
Core balance current transformer angle correction F1			0.0° to 5.0°	Increments of 0.1°
Core balance current transformer angle correction F2				

Times

Pickup times	Approx. 25 ms + OOT ⁹⁵ at 50 Hz Approx. 23 ms + OOT at 60 Hz
Dropout times	Approx. 25 ms + OOT at 50 Hz Approx. 22 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90\text{ Hz}$	Slightly expanded tolerances ⁹⁶
$f < 10\text{ Hz}$ $f > 90\text{ Hz}$	Active with less sensitivity ⁹⁷

Tolerances

Currents	-310 via sensitive current transformer: 1 % of the setting value or 0.1 mA ($I_{rated} = 1.6\text{ A}$) or 0.5 mA ($I_{rated} = 8\text{ A}$, $f_{rated} \pm 10\%$)
	-310 via protection-class current transformers: 1 % of the setting value or 5 mA ($I_{rated} = 1\text{ A}$) or 25 mA ($I_{rated} = 5\text{ A}$, $f_{rated} \pm 10\%$)
Voltages	1 % of the setting value or 0.05 V

⁹⁵ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

⁹⁶ Transient ground-fault stage is inactive

⁹⁷ Transient ground-fault stage is inactive

Times	1 % of the setting value or ± 10 ms
Direction-calculation angle error ⁹⁸	$\leq 1^\circ$ at $3I_0 > 5$ mA, $V_0 = 0.6$ V $\leq 2^\circ$ at $3I_0 \leq 5$ mA, $V_0 = 0.6$ V

12.20.2 Directional $3I_0$ Stage with $\cos \varphi$ or $\sin \varphi$ Measurement

Setting Values

Direction method of measurement			$\cos \varphi$ $\sin \varphi$	–
Threshold value 3I0> Minimum directional 3I0> for direction determination	Protection-class current trans-formers	For I _{ph-rated} = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I _N transformer type sensitive and I _{N-rated} = 1 A	For I _{ph-rated} = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I _N transformer type sensitive and I _{N-rated} = 5 A	For I _{ph-rated} = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Threshold value V0>			0.300 V to 200.000 V	Increments of 0.001 V
Time delay of the direction determination			0.00 s to 60.00 s	Increments of 0.01 s
α1 constraint of the direction range			1° to 15°	Increments of 1°
α2 constraint of the direction range				
Angle correction φ			-45° to 45°	Increments of 1°
Tripping delay			0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1$ A) or 75 mA sec. ($I_{rated} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1$ A) or 2.5 mA sec. ($I_{rated} = 5$ A)
Voltage transformer	150 mV sec.

⁹⁸ Not applicable to [12.20.4 Directional \$3I_0\$ Stage with \$\varphi\(V_0, 3I_0\)\$ Measurement](#)

Times

Operate time with time delay = 0 ms	Approx. 32 ms + OOT ⁹⁹ at 50 Hz Approx. 29 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 32 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

12.20.3 Directional Transient Ground-Fault Stage

Setting Values

3I0> threshold value 3I0> threshold for operate	Protection-class current transformers	For I _{ph-rated} = 1 A	0.000 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.00 A to 175.00 A	Increments of 0.01 A
	Sensitive current transformer for I _N	I _{N-rated} = 1 A	0.000 A to 1.600 A	Increments of 0.001 A
		I _{N-rated} = 5 A	0.000 A to 8.000 A	Increments of 0.001 A
Threshold value V0>			0.300 V to 200.000 V	Increments of 0.001 V
Maximum operational V0			0.300 V to 200.000 V	Increments of 0.001 V
Dropout delay			0.00 s to 60.00 s	Increments of 0.01 s
Tripping delay			0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1\text{ A}$) or 75 mA sec. ($I_{rated} = 5\text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1\text{ A}$) or 2.5 mA sec. ($I_{rated} = 5\text{ A}$)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 115 ms + OOT ¹⁰⁰ at 50 Hz Approx. 112 ms + OOT at 60 Hz
Dropout time	Approx. 20 ms + OOT at 50 Hz Approx. 15 ms + OOT at 60 Hz

⁹⁹ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

¹⁰⁰ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

12.20.4 Directional 3I0 Stage with $\phi(V0,3I0)$ Measurement

Setting Values

Threshold value 3I0>	Protection-class current transformers	For I _{ph-rated} = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I _N transformer type sensitive and I _{N-rated} = 1 A	For I _{ph-rated} = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I _N transformer type sensitive and I _{N-rated} = 5 A	For I _{ph-rated} = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Min. V0> for direction determination			0.300 V to 200.000 V	Increments of 0.001 V
Time delay of the direction determination			0.00 s to 60.00 s	Increments of 0.01 s
Rotation angle of the reference voltage			-180° to 180°	Increments of 1°
Forward range +/-			0° to 180°	Increments of 1°
Tripping delay			0.00 s to 100.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1\text{ A}$) or 75 mA sec. ($I_{rated} = 5\text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1\text{ A}$) or 2.5 mA sec. ($I_{rated} = 5\text{ A}$)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 23 ms + OOT ¹⁰¹ at 50 Hz Approx. 21 ms + OOT at 60 Hz
Extension of operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 21 ms + OOT at 50 Hz Approx. 20 ms + OOT at 60 Hz

Tolerances

Direction-calculation angle error	$\leq 1^\circ$ at $3I0 \geq 10\text{ mA}$, $V0 = 0.6\text{ V}$ $\leq 2^\circ$ at $2\text{ mA} < 3I0 < 10\text{ mA}$, $V0 = 0.6\text{ V}$ $\leq 3^\circ$ at $3I0 \leq 2\text{ mA}$, $V0 = 0.6\text{ V}$
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¹⁰¹ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

12.20.5 Directional Y0 Stage with G0 or B0 Measurement (Admittance)

Setting Values

Direction method of measurement			B0 G0	–
Release Threshold value 3I0>	Protection-class current transformers	For I _{ph-rated} = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I _N transformer type sensitive and I _{N-rated} = 1 A	For I _{ph-rated} = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I _N transformer type sensitive and I _{N-rated} = 5 A	For I _{ph-rated} = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Threshold value V0>			0.300 V to 200.000 V	Increments of 0.001 V
Threshold value Y0>			0.10 mS to 100.00 mS	Increments of 0.01 mS
Time delay of direction determination			0.00 s to 60.00 s	Increments of 0.01 s
α1 constraint of direction range α2 constraint of direction range			1° to 15°	Increments of 1°
Angle correction φ			-45° to 45°	Increments of 1°
Tripping delay			0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1\text{ A}$) or 75 mA sec. ($I_{rated} = 5\text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1\text{ A}$) or 2.5 mA sec. ($I_{rated} = 5\text{ A}$)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 32 ms + OOT ¹⁰² at 50 Hz Approx. 29 ms + OOT at 60 Hz
Extension of operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 32 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

¹⁰² OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

Tolerances

Admittance	1 % of the setting value or 0.05 mS ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.25 mS ($I_{\text{rated}} = 8 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
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12.20.6 Directional Stage with Phasor Measurement of a Harmonic

Setting Values

Min. 3I ₀ > of the selected harmonic phasor	Protection-class current transformers	For $I_{\text{ph-rated}} = 1 \text{ A}$	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{\text{ph-rated}} = 5 \text{ A}$	0.15 A to 175.00 A	Increments of 0.01 A
	For I_{N} transformer type sensitive and $I_{\text{N-rated}} = 1 \text{ A}$	For $I_{\text{ph-rated}} = 1 \text{ A}$	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{\text{ph-rated}} = 5 \text{ A}$	0.001 A to 175.000 A	Increments of 0.001 A
	For I_{N} transformer type sensitive and $I_{\text{N-rated}} = 5 \text{ A}$	For $I_{\text{ph-rated}} = 1 \text{ A}$	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{\text{ph-rated}} = 5 \text{ A}$	0.005 A to 175.000 A	Increments of 0.001 A
Dropout ratio of the direction determination in terms of the zero-sequence harmonic current			0.10 to 0.95	Increments of 0.01
Threshold value V0>			0.300 V to 200.000 V	Increments of 0.001 V
Time delay of the direction determination			0.00 s to 60.00 s	Increments of 0.01 s
Extension of the direction result			0.00 s to 60.00 s	Increments of 0.01 s
Forward range +/-			0° to 90°	Increments of 1°
Tripping delay			0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 75 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 2.5 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 70 ms + OOT ¹⁰³ at 50 Hz Approx. 60 ms + OOT at 60 Hz
Dropout time	Approx. 30 ms + OOT at 50 Hz Approx. 20 ms + OOT at 60 Hz

¹⁰³ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

Tolerances

Zero-sequence harmonic current 3I _{0harm} .	-3I _{0harm} . via sensitive current transformer: 1 % of the setting value or 0.1 mA ($I_{rated} = 1.6 \text{ A}$) or 0.5 mA ($I_{rated} = 8 \text{ A}$, $f_{rated} \pm 10 \%$)
	-3I _{0harm} . via protection-class current transformers: 1 % of the setting value or 5 mA ($I_{rated} = 1 \text{ A}$) or 25 mA ($I_{rated} = 5 \text{ A}$, $f_{rated} \pm 10 \%$)
V ₀ fundamental-component value	1 % of the setting value or 0.05 V
Direction-calculation angle error of the 3rd, 5th, or 7th harmonic phasor	$\leq 1^\circ$ at 3I _{0harm} . > 5 mA $\leq 2^\circ$ at 3I _{0harm} . $\leq 5 \text{ mA}$

12.20.7 Non-Directional V₀ Stage with Zero-Sequence Voltage/Residual Voltage

Setting Values

Threshold value ¹⁰⁴	0.300 V to 200.000 V	Increments of 0.001 V
Time delay	0.00 s to 100.00 s	Increments of 0.01 s
Pickup delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01
V < faulty ph-gnd vltg.	0.300 V to 200.000 V	Increments of 0.001 V
V > healthy ph-gnd. vltg.	0.300 V to 200.000 V	Increments of 0.001 V

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms	
Standard filter, true RMS	Approx. 25 ms + OOT ¹⁰⁵ at 50 Hz Approx. 22 ms + OOT at 60 Hz
2 cycle filters	Approx. 45 ms + OOT at 50 Hz Approx. 39 ms + OOT at 60 Hz
Dropout time	
Standard filter, true RMS	Approx. 20 ms + OOT at 50 Hz Approx. 16.6 ms + OOT at 60 Hz
2 cycle filters	Approx. 31.06 ms + OOT at 50 Hz Approx. 27.06 ms + OOT at 60 Hz

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

¹⁰⁴ If you have selected the **method of measurement = RMS value**, do not set the threshold value under 10 V.

¹⁰⁵ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

12.20.8 Non-Directional 3I0 Stage

Setting Values

Method of Measurement			Fundamental component RMS value	
Threshold value 3I0>	Protection-class current transformers	For I _{ph-rated} = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For transformer type I-sensitive and I _{N-rated} = 1 A	For I _{ph-rated} = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For transformer type I-sensitive and I _{N-rated} = 5 A	For I _{ph-rated} = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Pickup delay			0.00 s to 60.00 s	Increments of 0.01 s
Tripping delay			0.00 s to 100.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1\text{ A}$) or 75 mA sec. ($I_{rated} = 5\text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1\text{ A}$) or 2.5 mA sec. ($I_{rated} = 5\text{ A}$)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT ¹⁰⁶ at 50 Hz Approx. 23 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 25 ms + OOT at 50 Hz Approx. 22 ms + OOT at 60 Hz

12.20.9 Non-Directional Y0 Stage

Setting Values

V0> threshold value	0.300 V to 200.000 V	Increments of 0.001 V
Threshold Y0>	0.10 mS to 100.00 mS	Increments of 0.01 mS

¹⁰⁶ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

Pickup delay	0.00 s to 60.00 s	Increments of 0.01 s
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 32 ms + OOT ¹⁰⁷ at 50 Hz Approx. 29 ms + OOT at 60 Hz
Extension of operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 32 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

Current Operating Range

Minimum 3I0 threshold for Y0 calculation	Protection-class current transformers	30 mA sec. ($I_{rated} = 1\text{ A}$)
		150 mA sec. ($I_{rated} = 5\text{ A}$)
	Sensitive current transformer	1 mA sec. ($I_{rated} = 1\text{ A}$)
		5 mA sec. ($I_{rated} = 5\text{ A}$)

Tolerances

Admittance	1 % of the setting value or 0.05 mS ($I_{rated} = 1.6\text{ A}$) or 0.25 mS ($I_{rated} = 8\text{ A}$), ($f_{rated} \pm 10\%$)
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12.20.10 Non-Directional 3I0 Harmonic Stage

Setting Values

3I0 harm. threshold	Protection-class current transformers	For $I_{ph-rated} = 1\text{ A}$	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph-rated} = 5\text{ A}$	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type sensitive and $I_{N-rated} = 1\text{ A}$	For $I_{ph-rated} = 1\text{ A}$	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph-rated} = 5\text{ A}$	0.001 A to 175.000 A	Increments of 0.001 A
	For I_N transformer type sensitive and $I_{N-rated} = 5\text{ A}$	For $I_{ph-rated} = 1\text{ A}$	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph-rated} = 5\text{ A}$	0.005 A to 175.000 A	Increments of 0.001 A
3I0 harm. dropout ratio			0.10 to 0.95	Increments of 0.01
Pickup extension time			0.00 s to 60.00 s	Increments of 0.01 s
Operate delay			0.00 s to 60.00 s	Increments of 0.01 s
Stabilization counter			1 to 10	Increments of 1

¹⁰⁷ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 75 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 2.5 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)

Times

Operate time with time delay = 0 ms and stabilization counter = 4	Approx. 70 ms + OOT ¹⁰⁸ at 50 Hz Approx. 60 ms + OOT at 60 Hz
Dropout time	Approx. 40 ms + OOT at 50 Hz Approx. 30 ms + OOT at 60 Hz

Tolerances

Zero-sequence harmonic current 3I0harm.	-3I0harm. via sensitive current transformer: 1 % of the setting value or 0.1 mA ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.5 mA ($I_{\text{rated}} = 8 \text{ A}$, $f_{\text{rated}} \pm 10 \%$)
	-3I0harm. via protection-class current transformers: 1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$, $f_{\text{rated}} \pm 10 \%$)

12.20.11 Pulse-Pattern Detection Stage

Setting Values

V0> threshold value			0.300 V to 200.000 V	Increments of 0.001 V
3I0> threshold value	Protection-class current trans- formers	For I _{ph-rated} = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I _N transformer type sensitive and I _{N-rated} = 1 A	For I _{ph-rated} = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I _N transformer type sensitive and I _{N-rated} = 5 A	For I _{ph-rated} = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For I _{ph-rated} = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
3I0 delta pulse off-on			2 % to 50%	Increments of 1 %
Pulse-on duration			0.20 s to 10.00 s	Increments of 0.01 s
Pulse-off duration				

¹⁰⁸ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

No. of pulses for operate Monitoring time(in pulses)	2 to 100	Increments of 1
Max.tolera.pulse-on or off	0.02 s to 2.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1$ A) or 75 mA sec. ($I_{rated} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1$ A) or 2.5 mA sec. ($I_{rated} = 5$ A)
Voltage transformer	150 mV sec.

Times

Operate delay = 0 ms	Approx. 2.5 s + 0.3 s + OOT ¹⁰⁹ at 50 Hz and 60 Hz ¹¹⁰
Dropout time	Approx. 32 ms + OOT at 50 Hz and 60 Hz

12.20.12 Intermittent Ground-Fault Blocking Stage**Setting Values**

Threshold	For current transformer type protection and $I_{rated} = 1$ A	0.030 A to 35.000 A	Increments of 0.001 A
	For current transformer type protection and $I_{rated} = 5$ A	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type sensitive and $I_{N-rated} = 1$ A	0.001 A to 1.600 A	Increments of 0.001 A
	For I_N transformer type sensitive and $I_{N-rated} = 5$ A	0.005 A to 8.000 A	Increments of 0.001 A
No.of pulses for interm.GF		2 to 50	Increments of 1
Reset time		1.00 s to 600.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

¹⁰⁹ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

¹¹⁰ After the first valid pulse is detected, the function picks up. For the typical settings 1.00 s of Pulse-on duration, 1.50 s of Pulse-off duration, and 0.15 s of Max.tolera.pulse-on or off, the inherent pickup time is approx. 1 s + 1.5 s + 2 · 0.15 s + OOT

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1 \text{ A}$) or 75 mA sec. ($I_{rated} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1 \text{ A}$) or 2.5 mA sec. ($I_{rated} = 5 \text{ A}$)

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$	Slightly expanded tolerances
$1.1 f_{rated} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active with reduced sensitivity

Tolerances

Currents	3I0 via protection-class current transformers: 1 % of the setting value or 5 mA ($I_{rated} = 1 \text{ A}$) or 25 mA ($I_{rated} = 5 \text{ A}$)
	3I0 via sensitive current transformer: 1 % of the setting value or 0.2 mA ($I_{rated} = 1.6 \text{ A}$) or 1 mA ($I_{rated} = 8 \text{ A}$)
Times	1 % of the setting value or $\pm 10 \text{ ms}$

12.21 Undercurrent Protection

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value I_k	1 A @ 100 I_{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 100 I_{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I_{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I_{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Pickup delay		0.00 s to 60.00 s	Increments of 0.01 s
Operate delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1$ A) or 75 mA sec. ($I_{rated} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1$ A) or 2.5 mA sec. ($I_{rated} = 5$ A)

Times

Operate time	Approx. 25 ms + OOT ¹¹¹ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Dropout time	Approx. 25 ms + OOT at 50 Hz Approx. 22 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

¹¹¹ OOT (Output Operating Time): additional delay of the output medium used, for example, 5 ms with fast relays, see chapter Relay Outputs

Tolerances

Currents, method of measurement = fundamental component	1 % of setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value (33 % portion harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Time delays	1 % of the setting value or 10 ms

12.22 Negative-Sequence Protection

12.22.1 Stage with Definite-Time Characteristic Curve

Setting Values

Reference value for I_2 (I_{ref})		Rated object current $I_{rated, obj}$ Positive-sequence current I_1	
Pickup value		5.0 % to 999.9 % I_2/I_{ref}	Increments of 0.1
Dropout ratio		0.40 to 0.99	Increments of 0.01
Time delay		0.00 s to 60.00 s	Increments of 0.01 s
Release current (minimum current release)	1 A @ 50 and 100 Irated	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Maximum phase current (maximum current limiting)	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

- Dropout differential derived from the parameter **Dropout ratio**
- Dropout differential of 0.5 % of the object rated current

Times

Pickup time	Approx. 40 ms + OOT ¹¹² at 50 Hz
	Approx. 35 ms + OOT at 60 Hz
Dropout time	Approx. 35 ms + OOT

Current Operating Range

Current range	At least one phase current $\geq$ setting value $I_{release}$
	All phase currents $\leq$ setting value $I_{ph, max}$

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$	Slightly expanded tolerances
$1.1 f_{rated} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

¹¹² OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

Tolerances

Pickup value	
$I_2/I_{\text{rated, obj}}$	Approx. 1% of the setting value or 0.3% of the absolute value
I_2/I_1	Approx. 1 % of the setting value or 0.5 % of the absolute value ($I_1 > 50 \text{ mA}$ ($I_{\text{rated}} = 1 \text{ A}$) or 250 mA ($I_{\text{rated}} = 5 \text{ A}$))
Time delays	1 % of the setting value or 10 ms

12.22.2 Stage with Inverse-Time Characteristic Curve

Setting Values

Reference value for I_2 (I_{ref})	Rated object current $I_{\text{rated,obj.}}$ Positive-sequence current I_1	
Pickup value	5.0 % to 999.9 % I_2/I_{ref}	Increments of 0.1
Dropout	Disk emulation Instantaneous	
Time multiplier	0.05 to 15.00	Increments of 0.01
Release current (minimum current release)	1 A @ 50 and 100 Irated	0.030 A to 10.000 A Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A Increments of 0.001 A
Maximum phase current (maximum current limiting)	1 A @ 50 and 100 Irated	0.030 A to 35.000 A Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A Increments of 0.001 A

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

- Dropout of 95 % of $1.1 \cdot \text{threshold value}$
- Dropout differential of 0.5 % of the object rated current

Times

Pickup time	Approx. 40 ms + OOT ¹¹³ at 50 Hz
	Approx. 35 ms + OOT at 60 Hz
Dropout time	Approx. 35 ms + OOT

Dropout Ratio

Disk emulation	Approx. 0.90 · threshold value
Instantaneous	Approx. 1.05 · threshold value Approx. 0.95 · pickup value

¹¹³ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

Operate and Dropout Characteristic Curves

You can select from the following operate and dropout characteristic curves:

Table 12-6 Standard Characteristic Curves to IEC

Normal inverse: type A	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-1 See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-2
Very inverse: type B	
Extremely inverse: type C	
Long-time inverse: type B	

Table 12-7 Standard Characteristic Curves to ANSI

Inverse: type C	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-3
Short inverse	
Long inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-4
Moderately inverse	
Very inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-5
Extremely inverse	
Definite inverse	See chapter 12.5.2 Stage with Inverse-Time Characteristic Curve, Figure 12-6

Extension of the Operating Time

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
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Current Operating Range

Current range	At least one phase current $\geq$ setting value I_{release}
	All phase currents $\leq$ setting value $I_{\text{ph, max}}$

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Reference value = rated current	
Pickup value	Approx. 1 % of the setting value or 0.3 % of the absolute value
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the setting value or + 2 % of the current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the setting value or + 2 % of the current tolerance or 30 ms
Reference value = pos. seq. current	
Pickup value	Approx. 1 % of the setting value or 0.5 % of the absolute value ($I_1 > 50 \text{ mA}$ ($I_{\text{rated}} = 1 \text{ A}$) or 250 mA ($I_{\text{rated}} = 5 \text{ A}$))

Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms

12.23 Directional Negative-Sequence Protection with Definite-Time Delay

Setting Values

Directional mode	Forward, backward, non-directional	
Stabilization with phase currents	0 % to 30 %	Increments of 1 %
Threshold value (pickup value) at $I_{N-rated} = 1 \text{ A}$	0.030 A to 35.000 A	Increments of 0.001 A
Threshold value (pickup value) at $I_{N-rated} = 5 \text{ A}$	0.15 A to 175.00 A	Increments of 0.01 A
Extension time of the blocking after a 1-pole pause	0.00 s to 60.00 s	Increments of 0.01 s

Setting Values for Direction Determination

Minimum negative-sequence system voltage V2	0.150 V to 20.000 V	Increments of 0.001 V
Minimum negative-sequence system current I2	For $I_{rated} = 1 \text{ A}$	0.030 A to 10.000 A
	For $I_{rated} = 5 \text{ A}$	0.15 A to 50.00 A
Upper limit angle forward, β	0° to 360°	Increments of 1°
Lower limit angle forward, α	0° to 360°	Increments of 1°

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

- Dropout differential derived from the parameter **Dropout ratio**
- Dropout differential of 0.5 % of the object rated current

Times

Operate time with time delay = 0 ms	Approx. 40 ms + OOT ¹¹⁴ at 50 Hz Approx. 40 ms + OOT at 60 Hz
Dropout time	Approx. 39 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Threshold values:	
Negative-sequence voltage V2	1 % of the setting value or 0.05 V
Negative-sequence current I2	2 % of the setting value or 10 mA at $I_{rated} = 1 \text{ A}$
	1 % of the setting value or 50 mA at $I_{rated} = 5 \text{ A}$
Times:	
Independent time delays	1 % of the setting value or 10 ms

¹¹⁴ OOT (Output Operating Time) Additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

Limit angle in determining the direction	1°
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12.24 Thermal Overload Protection, 3-Phase – Advanced

Setting Value for the Function Block Filter

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values/Increments for the Protection Stage

Threshold current warning	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Threshold thermal warn.		50 % to 100 %	Increments of 1 %
Dropout threshold operate		50 % to 99 %	Increments of 1 %
Emerg. start T overtravel		0 s to 15 000 s	Increments of 10 s
K-factor acc. to IEC 60225-149		0.10 to 4.00	Increments of 0.01
Thermal time constant		10 s to 60 000 s	Increments of 1 s
Cooling time constant		10 s to 60 000 s	Increments of 1 s
Imax thermal	1 A @ 50 and 100 Irated	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Imin cooling	1 A @ 50 and 100 Irated	0.000 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.00 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.000 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.000 A to 8.000 A	Increments of 0.001 A
Temperature rise at Irated		40 K to 200 K	Increments of 1 K
Default temperature		-55°C to 55°C	Increments of 1°C
Minimal temperature		-55°C to 40°C	Increments of 1°C

Dropout Ratios

Tripping threshold (fixed at 100 %)	Dropout if value drops below operate indication dropout threshold
Thermal warning threshold	About 0.99 of the setting value
Current warning threshold	About 0.95 of the setting value

Frequency Range of the Input Signals

The function captures input signals up to the 50th harmonic.

Tolerances

No filter applied (33 % harmonics, in relation to the fundamental component)		
With reference to $k \cdot I_{rated}$	Up to 30th harmonic	2 % or 10 mA ($I_{rated} = 1$ A) or 50 mA ($I_{rated} = 5$ A), 2 % class acc. to IEC 60255-149
	Up to 50th harmonic, $f_{rated} = 50$ Hz	4 % or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), 4 % class acc. to IEC 60255-149
	Up to 50th harmonic, $f_{rated} = 60$ Hz	5 % or 25 mA ($I_{rated} = 1$ A) or 125 mA ($I_{rated} = 5$ A), 5 % class acc. to IEC 60255-149
With the filter for compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)		
With reference to $k \cdot I_{rated}$	Up to 30th harmonic	2 % or 10 mA ($I_{rated} = 1$ A) or 50 mA ($I_{rated} = 5$ A), 2 % class acc. to IEC 60255-149
	Up to 50th harmonic, $f_{rated} = 50$ Hz	3 % or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), 3 % class acc. to IEC 60255-149
	Up to 50th harmonic, $f_{rated} = 60$ Hz	4 % or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), 4 % class acc. to IEC 60255-149
With the filter for gain of harmonics including compensation of the amplitude attenuation¹¹⁵ (33 % harmonics, in relation to the fundamental component)		
With reference to $k \cdot I_{rated}$	Up to 30th harmonic	2 % or 10 mA ($I_{rated} = 1$ A) or 50 mA ($I_{rated} = 5$ A), 2 % class acc. to IEC 60255-149 ¹¹⁶
	Up to 50th harmonic, $f_{rated} = 50$ Hz	4 % or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), 4 % class acc. to IEC 60255-149 ¹¹⁷
	Up to 50th harmonic, $f_{rated} = 60$ Hz	5 % or 25 mA ($I_{rated} = 1$ A) or 125 mA ($I_{rated} = 5$ A), 5 % class acc. to IEC 60255-149 ¹¹⁷
With reference to the operate time	Up to 30th harmonic	3 % or 1 s for $I/(k \cdot I_{rated}) > 1.25$, 3 % class acc. to IEC 60255-149

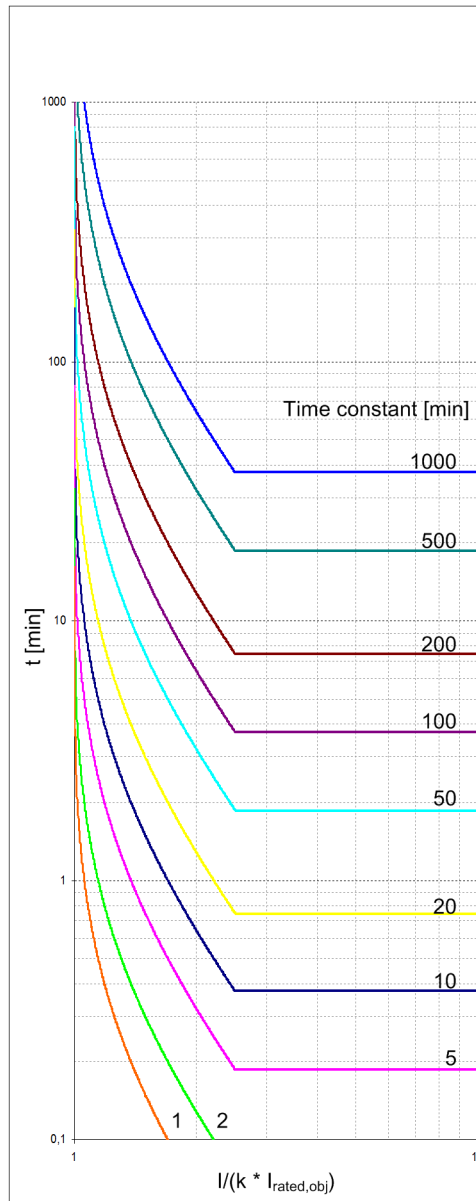
¹¹⁵ In case that the filter response exactly matches the user-defined gain factor.

¹¹⁶ In case that the user-defined gain factor is set below 3. The tolerance is increased if the gain factor is larger.

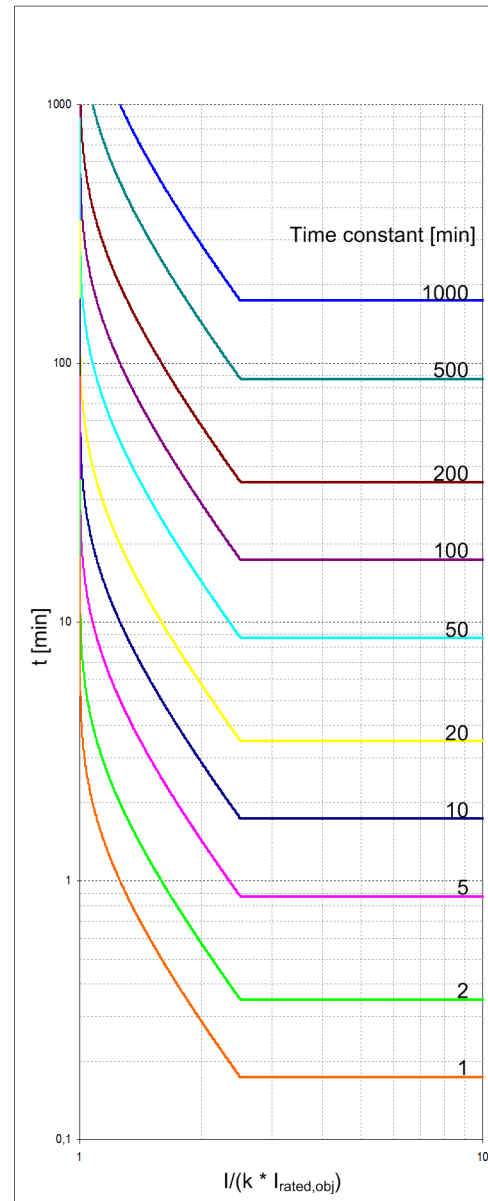
¹¹⁷ In case that the user-defined gain factor is set below 7. The tolerance is increased if the gain factor is larger.

Operate Curve

Operate curve	$t = \tau_{th} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{rated,obj.}} \right)^2 - \left(\frac{I_{preload}}{k \cdot I_{rated,obj.}} \right)^2}{\left(\frac{I}{k \cdot I_{rated,obj.}} \right)^2 - 1}$	
Where	t	Operate time
	τ_{th}	Time constant
	I	Current load current
	$I_{preload}$	Preload current
	k	Setting factor according to VDE 0435 part 3011 or IEC 60255-149 (K factor)
	$I_{rated, obj}$	Rated current of the protected object


 With 80 % preload and with $I_{\max, \text{therm}} = 2.5 * k * I_{\text{rated}}$

$$t = \tau_{\text{th}} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{\text{rated,obj}}} \right)^2 - \left(\frac{I_{\text{preload}}}{k \cdot I_{\text{rated,obj}}} \right)^2}{\left(\frac{I}{k \cdot I_{\text{rated,obj}}} \right)^2 - 1} \quad [\text{min}]$$


 Without preload and with $I_{\max, \text{therm}} = 2.5 * k * I_{\text{rated}}$

$$t = \tau_{\text{th}} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{\text{rated,obj}}} \right)^2}{\left(\frac{I}{k \cdot I_{\text{rated,obj}}} \right)^2 - 1} \quad [\text{min}]$$

[dwausike-100611-01.tif, 1, en_US]

Figure 12-16 Operate Curve of Overload Protection

12.25 Thermal Overload Protection, User-Defined Characteristic Curve

Setting Values

Threshold current warning	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Threshold thermal warn.		50 % to 100 %	Increments of 1 %
Dropout threshold operate		50 % to 99 %	Increments of 1 %
Emerg. start T overtravel		0 s to 15 000 s	Increments of 10 s
I _{max} thermal	1 A @ 50 and 100 I _{rated}	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
I _{min} cooling	1 A @ 50 and 100 I _{rated}	0.000 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.00 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.000 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.000 A to 8.000 A	Increments of 0.001 A
Curve based on preload		1 % to 100 %	Increments of 1 %
Number of value pairs for the operate curve		2 to 30	Increments of 1
X values of the operate curve		1.10 p.u. to 20.00 p. u.	Increments of 0.0 p.u.
Y values of the operate curve		1.00 s to 20 000.00 s	Increments of 0.01 s

Dropout Ratios

Tripping threshold (fixed at 100 %)	Dropout if value drops below operate indication dropout threshold
Thermal warning threshold	About 0.99 of the setting value
Current warning threshold	About 0.95 of the setting value

Frequency Range of the Input Signals

The function captures input signals up to the 50th harmonic.

Tolerances

With reference to $k \cdot I_{\text{rated}}$	For $I_{\text{rated}} = 1 \text{ A}$	2 % or 10 mA, class 2 % acc. to IEC 60255-149
	For $I_{\text{rated}} = 5 \text{ A}$	2 % or 50 mA, class 2 % acc. to IEC 60255-149
With reference to operate time		3 % or 1 s, class 3 % acc. to IEC 60255-149 for $I/(k \cdot I_{\text{rated}}) > 1.25$

12.26 Thermal Overload Protection, 1-Phase

Setting Values/Increments for the Protection Stage

Threshold current warning	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Threshold thermal warn.		50 % to 100 %	Increments of 1 %
Dropout threshold operate		50 % to 99 %	Increments of 1 %
K-factor acc. to IEC 60225-149		0.10 to 4.00	Increments of 0.01
Thermal time constant		10 s to 60 000 s	Increments of 1 s
I _{max} thermal	1 A @ 50 and 100 I _{rated}	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Temperature rise at I _{rated}		40 K to 200 K	Increments of 1 K
Default temperature		-55°C to 55°C	Increments of 1°C
Minimal temperature		-55°C to 40°C	Increments of 1°C

Dropout Ratios

Tripping threshold (fixed at 100 %)	Dropout if value drops below operate indication dropout threshold
Thermal warning threshold	About 0.99 of the setting value
Current warning threshold	About 0.95 of the setting value

Frequency Range of the Input Signals

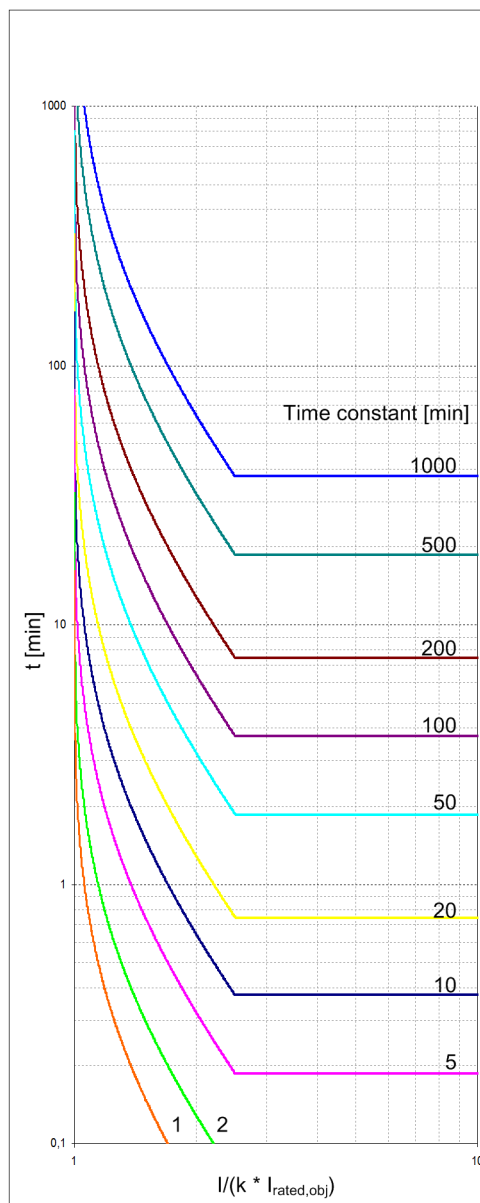
The function captures input signals up to the 50th harmonic.

Tolerances

With reference to $k \cdot I_{\text{rated}}$	Up to 30th harmonic	2 % or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), 2 % class acc. to IEC 60255-149
	Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	4 % or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), 4 % class acc. to IEC 60255-149
	Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	5 % or 25 mA ($I_{\text{rated}} = 1 \text{ A}$) or 125 mA ($I_{\text{rated}} = 5 \text{ A}$), 5 % class acc. to IEC 60255-149
With reference to the operate time	Up to 30th harmonic	3 % or 1 s for $I/(k \cdot I_{\text{rated}}) > 1.25$, 3 % class acc. to IEC 60255-149

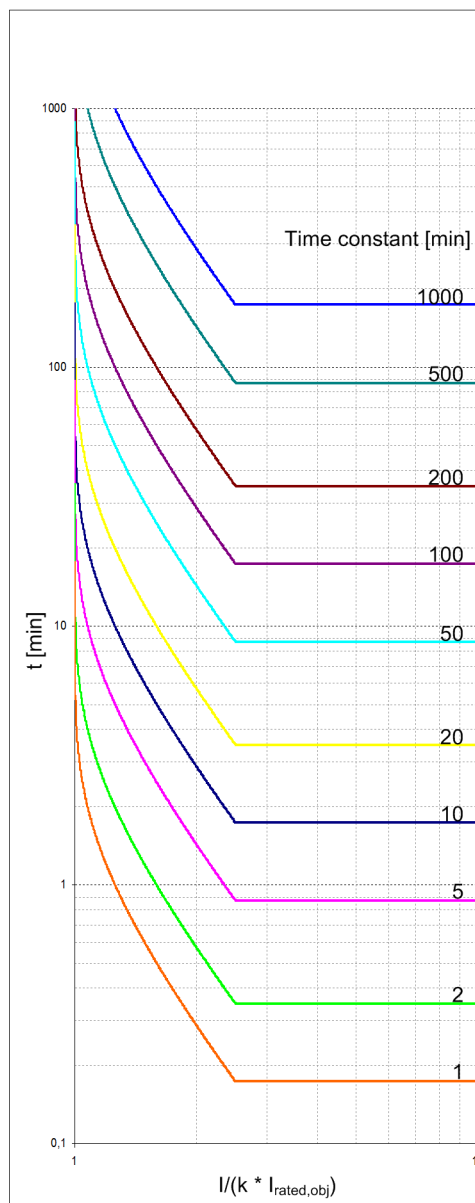
Operate Curve

Operate curve	$t = \tau_{th} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{rated,obj.}}\right)^2 - \left(\frac{I_{preload}}{k \cdot I_{rated,obj.}}\right)^2}{\left(\frac{I}{k \cdot I_{rated,obj.}}\right)^2 - 1}$	
Where	t	Operate time
	τ_{th}	Time constant
	I	Current load current
	$I_{preload}$	Preload current
	k	Setting factor according to VDE 0435 part 3011 or IEC 60255-8 (K factor)
	$I_{rated, obj}$	Rated current of the protected object



With 80 % preload and with $I_{\max, \text{therm}} = 2.5 \cdot k \cdot I_{\text{rated}}$

$$t = \tau_{\text{th}} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{\text{rated}, \text{obj}}} \right)^2 - \left(\frac{I_{\text{preload}}}{k \cdot I_{\text{rated}, \text{obj}}} \right)^2}{\left(\frac{I}{k \cdot I_{\text{rated}, \text{obj}}} \right)^2 - 1} \quad [\text{min}]$$



Without preload and with $I_{\max, \text{therm}} = 2.5 \cdot k \cdot I_{\text{rated}}$

$$t = \tau_{\text{th}} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{\text{rated}, \text{obj}}} \right)^2}{\left(\frac{I}{k \cdot I_{\text{rated}, \text{obj}}} \right)^2 - 1} \quad [\text{min}]$$

[dwausike-100611-01.tif, 1, en_US]

Figure 12-17 Operate Curve of Overload Protection

12.27 Unbalanced-Load Protection

Setting Values

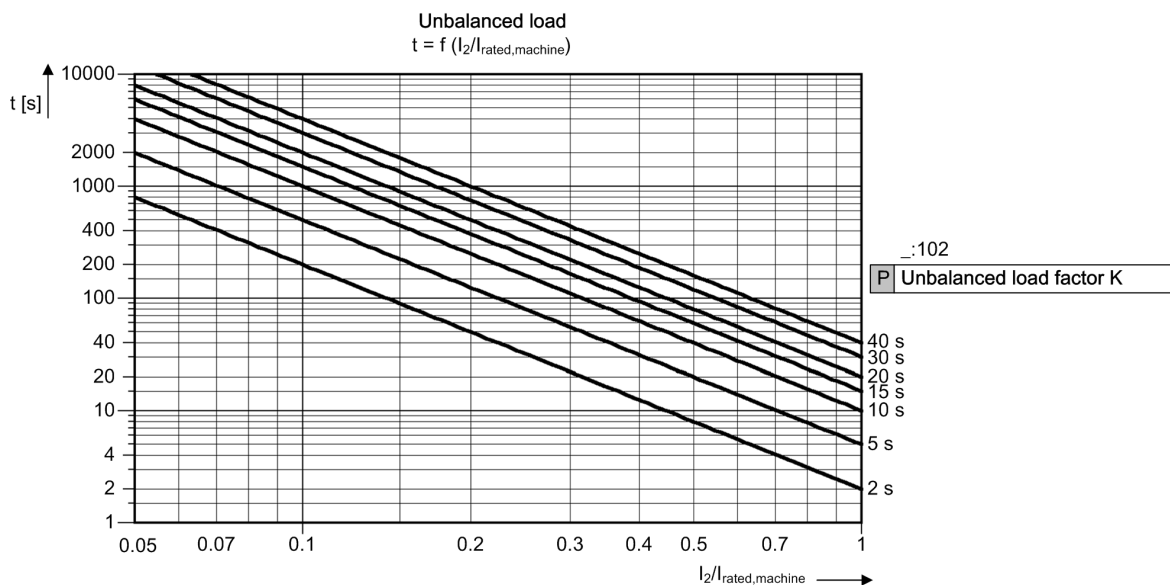
Maximum continuously perm. I ₂	3.0 % to 30.0 % I ₂ /I _{rated,machine}	Increments of 0.1 %
Unbalanced load factor K	1.0 s to 100.0 s	Increments of 0.1 s
Warning delay	0.0 s to 60.0 s; ∞	Increments of 0.1 s
Cooling time thermal replica	0 s to 50 000 s	Increments of 1 s

Dropout

$I_{2perm} \cdot I_{rated,machine} \leq 10 \text{ mA}$	Dropout value = $0.5 \cdot I_{2perm} \cdot I_{rated,machine}$
$10 \text{ mA} < I_{2perm} \cdot I_{rated,machine} \leq 100 \text{ mA}$	Dropout value = $I_{2perm} \cdot I_{rated,machine} - 5 \text{ mA}$
$I_{2perm} \cdot I_{rated,machine} > 100 \text{ mA}$	Dropout value = $0.95 \cdot I_{2perm} \cdot I_{rated,machine}$

Operate Characteristics

Characteristic of the thermal replica	$t_{I2perm} = \frac{K}{(I_2/I_{rated,machine})^2}$	
Where:	t _{I2perm}	Permissible application time of the negative-sequence current
	K	Unbalanced load factor K
	I ₂ /I _{rated,machine}	Unbalanced load (negative-sequence current/rated current of the machine)



[dwunbaop-300913, 1, en_US]

Figure 12-18 Thermal Characteristic for Unbalanced Load Protection

Times

Pickup time of the warning stage	Approx. 60 ms + OOT ¹¹⁸ at 50 Hz Approx. 50 ms + OOT at 60 Hz
Dropout time	Approx. 50 ms or better

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Negative-sequence current I_2	The value can be any of the following: • $\leq 1\%$ of the setting value • 3 mA at $I_{\text{rated}} = 1 \text{ A}$ • 15 mA at $I_{\text{rated}} = 5 \text{ A}$
Warning delay	1 % of the setting value or 10 ms
Time for $I_2/I_{2\text{perm}} \leq 10$	< (5 % of the reference value + 2 % of the current tolerance) or 100 ms

Influencing Variables for the Thresholds

Harmonics	
– Up to 10 % 3rd harmonic	$\leq 1 \%$
– Up to 10 % 5th harmonic	$\leq 1 \%$

¹¹⁸ OOT (Output Operating Time): additional delay of the output medium used, for example, 5 ms with fast relays

12.28 Overcurrent Protection for Capacitor Banks

12.28.1 Stage with Definite-Time Characteristic Curve

Setting Value for the Function Block Filter

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value ¹¹⁹	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.90 to 0.99	Increments of 0.01
Operate delay		0.00 s to 100.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s
Pickup delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1\text{ A}$) or 75 mA sec. ($I_{rated} = 5\text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1\text{ A}$) or 2.5 mA sec. ($I_{rated} = 5\text{ A}$)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT ¹²⁰ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

¹¹⁹ If you have selected the **method of measurement = RMS value**, do not set the threshold value under $0.1 I_{rated,sec}$.

¹²⁰ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	2 % of the setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation) ¹²¹ (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ¹²²
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3% of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ¹²³
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ¹²⁴
Time delays	1 % of the setting value or 10 ms

¹²¹ In case that the filter response exactly matches the user-defined gain factors

¹²² In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.

¹²³ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

¹²⁴ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %
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12.28.2 Stage with Inverse-Time Characteristic Curve**Setting Value for the Function Block Filter**

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.00 to 15.00	Increments of 0.01
Pickup delay		0.00 s to 60.00 s	Increments of 0.01 s
Minimum time of the curve		0.00 s to 1.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

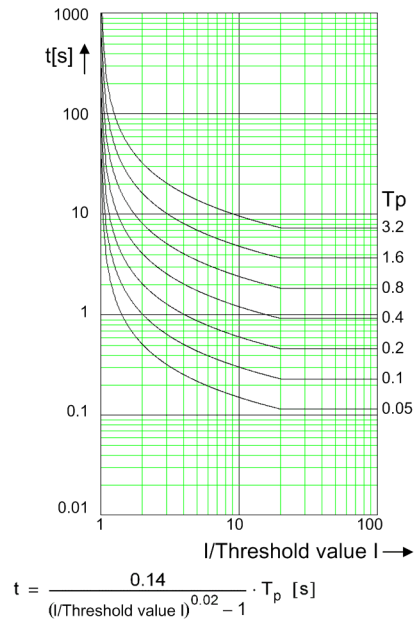
Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

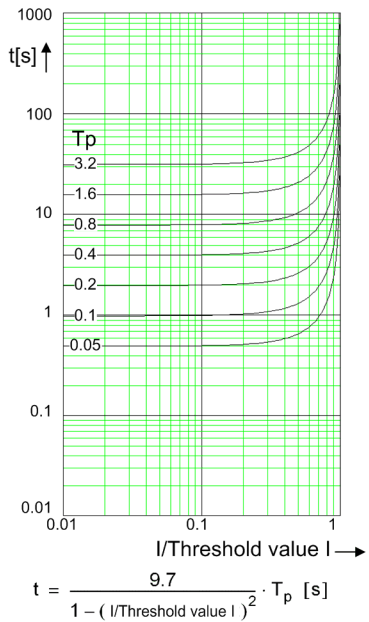
Operate Curves and Dropout-Time Characteristic Curves according to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
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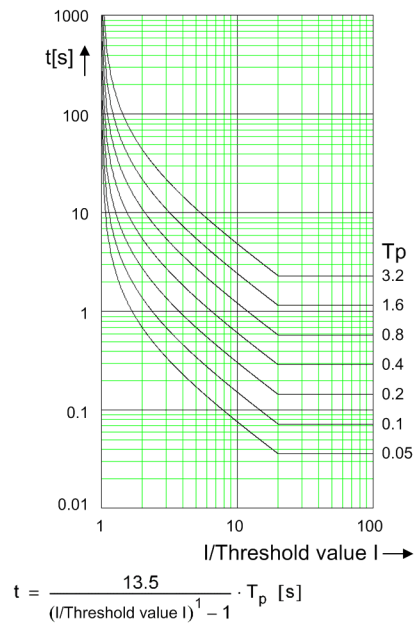
NORMAL INVERSE: Type A



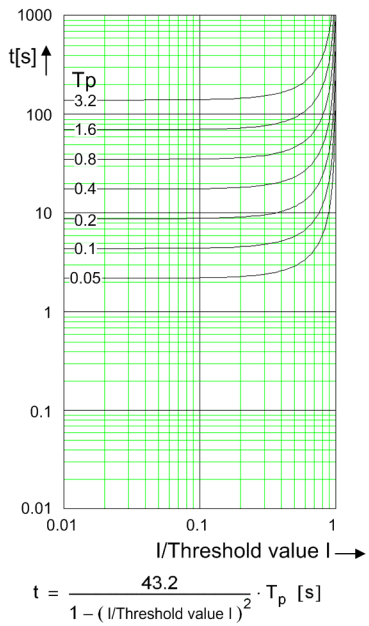
RESET NORMAL INVERSE: Type A



VERY INVERSE: Type B



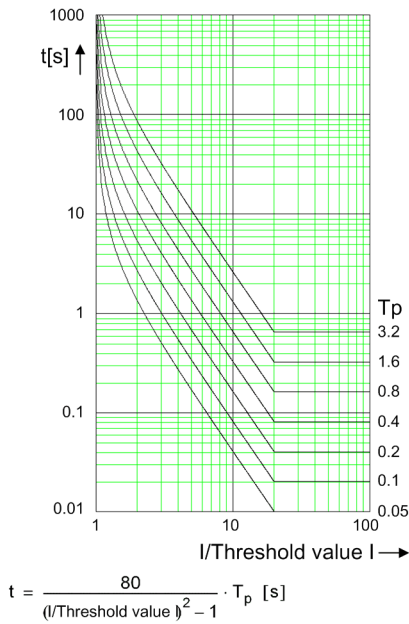
RESET VERY INVERSE: Type B



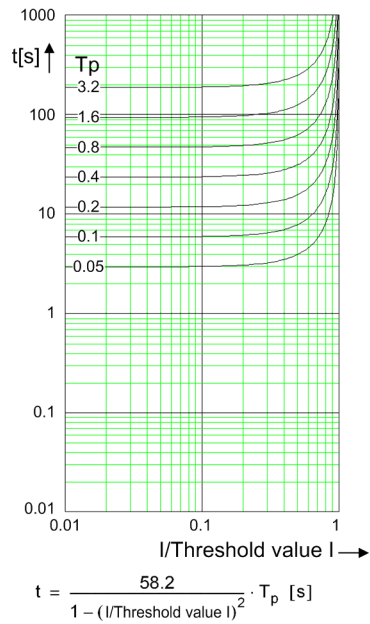
[dwocpk11-080213-01.tif, 1, en_US]

Figure 12-19 Operate Curves and Dropout-Time Characteristic Curves According to IEC

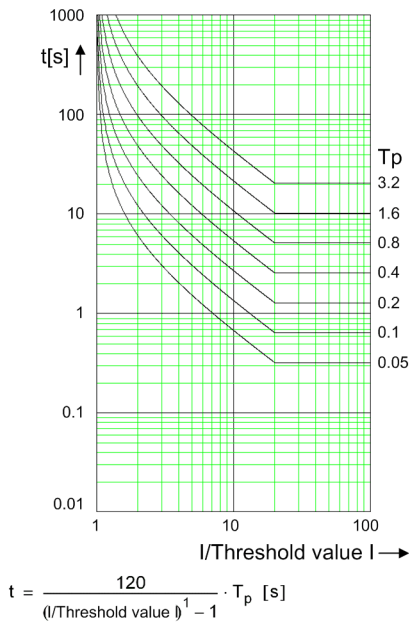
EXTREMELY INVERSE: Type C



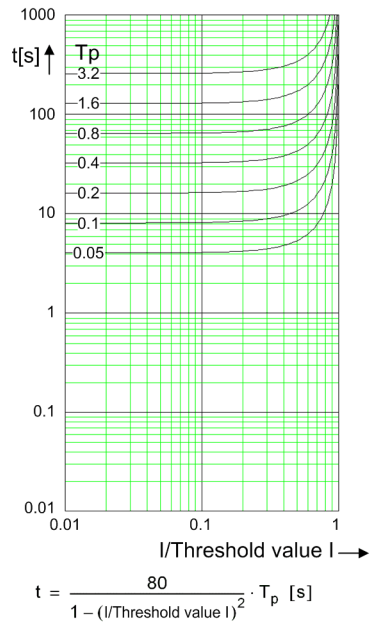
RESET EXTREMELY INVERSE: Type C



LONG-TIME INVERSE: Type B



RESET LONG-TIME INVERSE: Type B

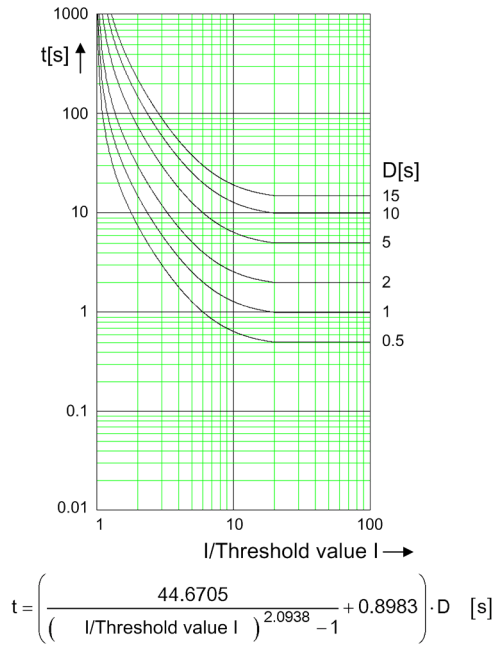


[dwocpki2-080213-01.tif, 1, en_US]

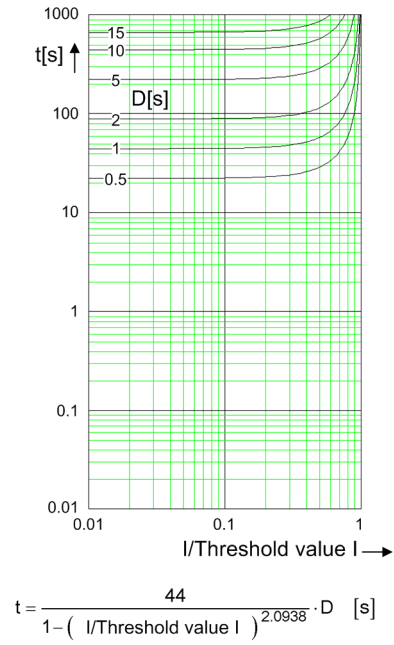
Figure 12-20 Operate Curves and Dropout-Time Characteristic Curves According to IEC

Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

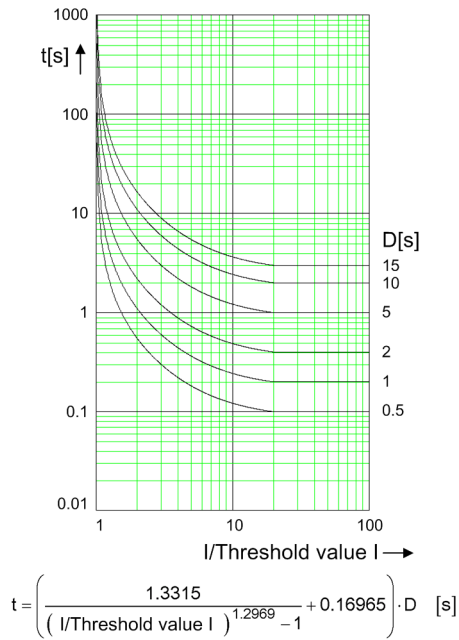
Inverse: Type C



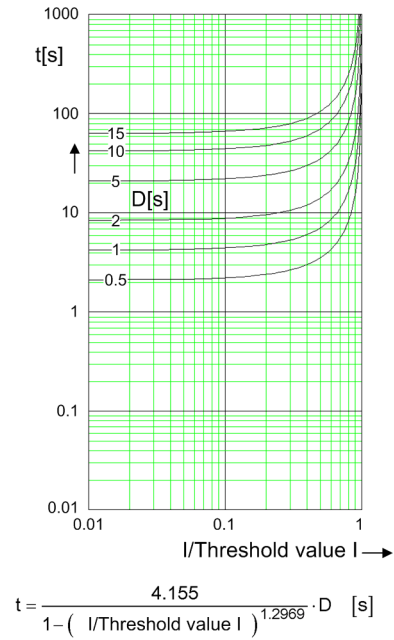
RESET INVERSE: Type C



SHORT INVERSE



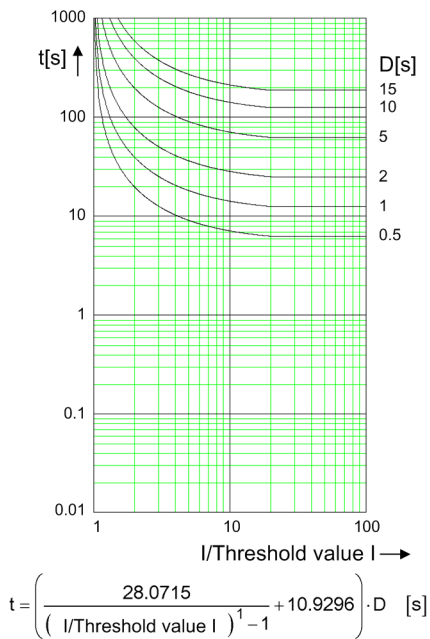
RESET SHORT INVERSE



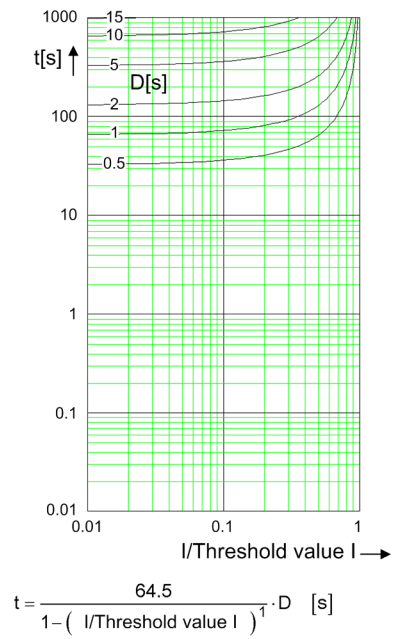
[dwocpka1-080213-01.tif, 2, en_US]

Figure 12-21 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

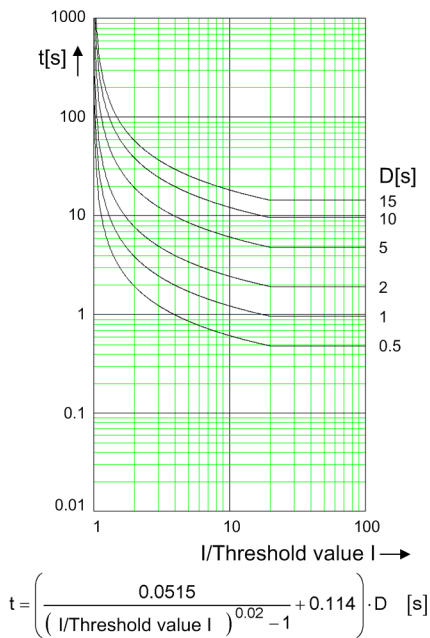
LONG INVERSE



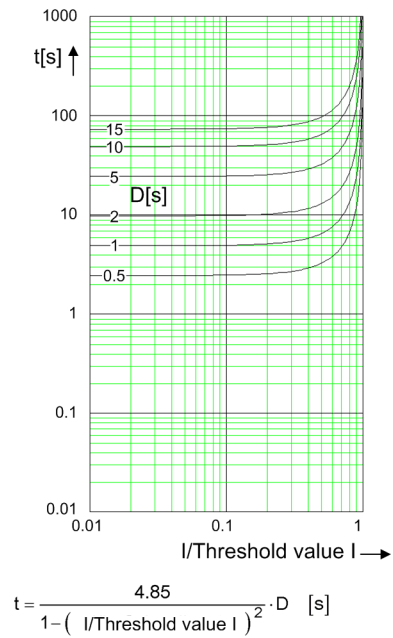
RESET LONG INVERSE



MODERATELY INVERSE



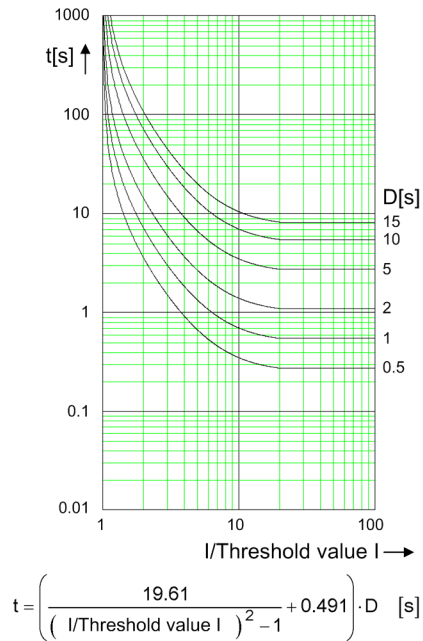
RESET MODERATELY INVERSE



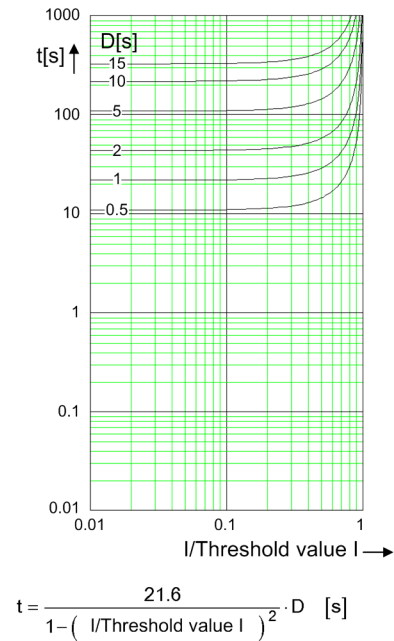
[dwocpka2-080213-01.tif, 2, en_US]

Figure 12-22 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

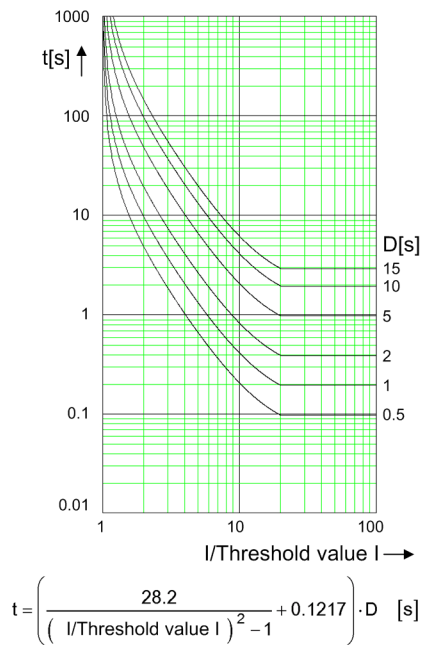
VERY INVERSE



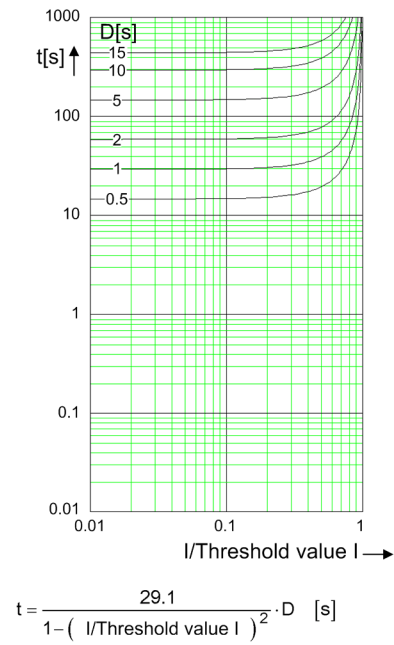
RESET VERY INVERSE



EXTREMELY INVERSE



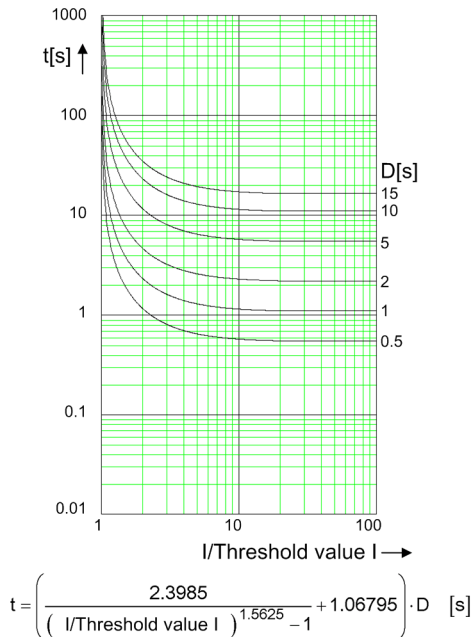
RESET EXTREMELY INVERSE



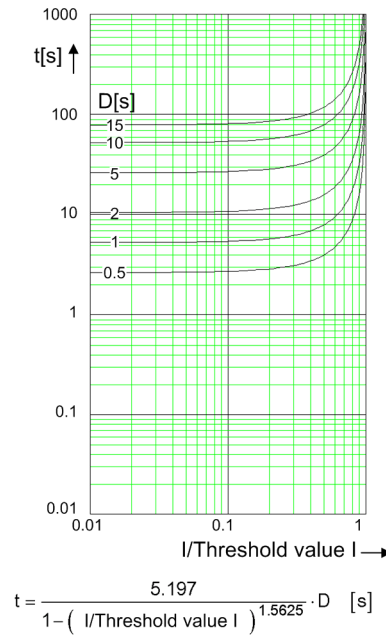
[dwocpka3-080213-01.tif, 2, en_US]

Figure 12-23 Tripping Characteristic Curves and Dropout Characteristic Curves According to ANSI/IEEE

DEFINITE INVERSE



RESET DEFINITE INVERSE



Note: IGnd threshold stands for ground fault instead of the I threshold.

[dwocpka4-080213-01.tif, 2, en_US]

Figure 12-24 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)

Up to 50th harmonic, $f_{rated} = 50$ Hz	2 % of the setting value or 10 mA ($I_{rated} = 1$ A) or 50 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Up to 50th harmonic, $f_{rated} = 60$ Hz	3 % of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation ¹²⁵ (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA ($I_{rated} = 1$ A) or 50 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %) ¹²⁶
Up to 50th harmonic, $f_{rated} = 50$ Hz	3% of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %) ¹²⁷
Up to 50th harmonic, $f_{rated} = 60$ Hz	4 % of the setting value or 20 mA ($I_{rated} = 1$ A) or 100 mA ($I_{rated} = 5$ A), ($f_{rated} \pm 10$ %) ¹²⁸
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %
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12.28.3 Stage with User-Defined Characteristic Curve

Setting Value for the Function Block Filter

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A

¹²⁵ In case that the filter response exactly matches the user-defined gain factors

¹²⁶ In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.

¹²⁷ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

¹²⁸ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

Absolute pickup value	1 A @ 50 and 100 Irated	0.000 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.00 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.000 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.000 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 20.00 p.u.	Increments of 0.01 p.u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p.u. to 0.95 p.u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** – **dropout value** |) of the following 2 criteria applies:

Dropout	95 % of $1.1 \cdot \text{threshold value}$ or 95 % of the absolute pickup value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 75 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)
Instrument current transformer	0.5 mA sec. ($I_{\text{rated}} = 1 \text{ A}$) or 2.5 mA sec. ($I_{\text{rated}} = 5 \text{ A}$)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. $< 0.90 \cdot \text{threshold value}$

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)

Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	2 % of the setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	3 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation ¹²⁹) (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ¹³⁰
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3% of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ¹³¹
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 20 mA ($I_{\text{rated}} = 1 \text{ A}$) or 100 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) ¹³²
Operate time for $2 \leq I/I$ threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100 \text{ ms}$ (with complete unbalance)	< 5 %
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Operate Curves and Dropout-Time Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
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¹²⁹ In case that the filter response exactly matches the user-defined gain factors

¹³⁰ In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.

¹³¹ In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

¹³² In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

12.29 Current-Unbalance Protection for Capacitors, 3-Phase

Setting Values for the Function

Automatic compensation		Yes No	
Time between switch off and switch on		0.00 s to 60.00 s	Increments of 0.01 s
Normalization with I_c		Yes No	
Threshold of defective C-element	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A

Setting Values (Overcurrent-Protection Stage I>)

Measured value		compensated non-compensated	
$I_{unbal.}$	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
$I_{unbal.}$	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Operate delay		0.00 s to 60.00 s	Increments of 0.01 s

Setting Values (Counter Stage)

Type of counting groups	segregated sum	
Max. no. of def. elem. phs A	1 to 1000	Increments of 1
Max. no. of def. elem. phs B	1 to 1000	Increments of 1
Max. no. of def. elem. phs C	1 to 1000	Increments of 1
Operate delay	0.00 s to 10000.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1$ A) or 75 mA sec. ($I_{rated} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1$ A) or 2.5 mA sec. ($I_{rated} = 5$ A)

Times

Operate time with time delay = 0 ms	Approx. 32 ms + OOT ¹³³ at 50 Hz Approx. 29 ms + OOT at 60 Hz
Dropout time	Approx. 32 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents I_c , $I_{\text{unbal.}}$ Protection-class current transformers	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Currents $I_{\text{unbal.}}$ Sensitive current transformer	1 % of the setting value or 0.1 mA ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.5 mA ($I_{\text{rated}} = 8 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Time delays	1 % of the setting value or 10 ms

¹³³ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

12.30 Current-Unbalance Protection for Capacitors, 1-Phase

Setting Values for the Function

Automatic compensation		Yes No	
Time between switch off and switch on		0.00 s to 60.00 s	Increments of 0.01 s
Normalization with I _c		Yes No	
Threshold of defective C-element	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A

Setting Values (Overcurrent-Protection Stage I>)

Current threshold I _{unbal.}	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.150 A to 175.000 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.005 A
Operate delay		0.00 s to 60.00 s	Increments of 0.01 s
Measured value			compensated non-compensated

Setting Values (Counter Stage)

Type of counting groups		segregated sum
Type of counting phases		segregated sum
Max. no. of def. elem. phs A	1 to 1000	Increments of 1
Max. no. of def. elem. phs B	1 to 1000	Increments of 1
Max. no. of def. elem. phs C	1 to 1000	Increments of 1
Max. no. of def. elem.	1 to 1000	Increments of 1
Operate delay	0.00 s to 10000.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 32 ms + OOT ¹³⁴ at 50 Hz Approx. 29 ms + OOT at 60 Hz
Dropout time	Approx. 32 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents I_c , $I_{\text{unbal.}}$ Protection-class current transformers	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10\%$)
Currents $I_{\text{unbal.}}$ Sensitive current transformer	1 % of the setting value or 0.1 mA ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.5 mA ($I_{\text{rated}} = 8 \text{ A}$), ($f_{\text{rated}} \pm 10\%$)
Time delays	1 % of the setting value or 10 ms

¹³⁴ OOT (Output Operating Time): additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

12.31 Voltage-Differential Protection for Capacitors

Setting Values (General Functionality)

Matching-factor setting	not phase-selective phase-selective	
Voltage matching factor k	0.5000 to 2000.0000	Increments of 0.0001

Setting Values (Protection Stage Vdiff>)

Threshold	0.005 p.u. to 1.000 p.u. ¹³⁵	Increments of 0.001 p.u.
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

Dropout ratio for sec. threshold > 3 V	95 %
Dropout differential for sec. threshold 0.3 V to 3 V	150 mV
Dropout ratio for sec. threshold 0.2 V to 0.3 V	50 %

Times

Operate time with time delay = 0 ms	Approx. 30 ms + OOT (Output Operating Time) at 50 Hz Approx. 27 ms + OOT (Output Operating Time) at 60 Hz
Dropout time	Approx. 20 ms + OOT (Output Operating Time) at 50 Hz Approx. 18 ms + OOT (Output Operating Time) at 60 Hz

Tolerances

Threshold ≥ 0.2 V	1 % of the setting value or 0.05 V (compensated)
Time delays	1 % of the setting value or 10 ms

Operating Range of the Secondary Differential Voltage

Operating Range of the secondary differential voltage	≥ 0.1 V (compensated)
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Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

¹³⁵ Minimum secondary setting threshold = 0.2 V

12.32 Differential Protection for Capacitor Banks

Setting Values

Operate curve			
Threshold value	$I/I_{\text{rated,obj}}$	0.05 to 2.00	Increments of 0.01
Slope 1		0.00 to 0.80	Increments of 0.01
Intersection 1 I _{rest}	$I/I_{\text{rated,obj}}$	0.00 to 5.00	Increments of 0.01
Slope 2		0.25 to 0.95	Increments of 0.01
Intersection 2 I _{rest}	$I/I_{\text{rated,obj}}$	1.00 to 20.00	Increments of 0.01
Startup detection			
Startup detection threshold value	$I/I_{\text{rated,obj}}$	0.1 to 2.0	Increments of 0.1
Characteristic curve increase factor		1.0 to 5.0	Increments of 0.1
Maximum starting time		0.1 s to 180.0 s	Increments of 0.1 s
DC-component detection			
Characteristic curve increase factor DC		1.0 to 5.0	Increments of 0.1
Inrush-current detection			
2nd harmonic content		10 % to 45 %	Increments of 1 %
Crossblk. time 2nd har.		0.00 s to 200.00 s or ∞	Increments of 0.01 s
Detection of external faults			
Add-on stabilization threshold value	$I/I_{\text{rated,obj}}$	1.00 to 20.00	Increments of 0.01
Add-on stabilization time		0.00 s to 5.00 s or ∞	Increments of 0.01 s
Crossblk. time additional stabilization		0.00 s to 2.00 s or ∞	Increments of 0.01 s
Operate curve		See figure Figure 12-25	

I-DIFF Fast

Threshold value	$I/I_{\text{rated,obj}}$	0.5 to 35.0	Increments of 0.1
Tripping delay		0.00 s to 60.00 s	Increments of 0.01 s

I-DIFF Unrestrained

Threshold value	$I/I_{\text{rated,obj}}$	0.5 to 35.0	Increments of 0.1
Tripping delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout Ratio

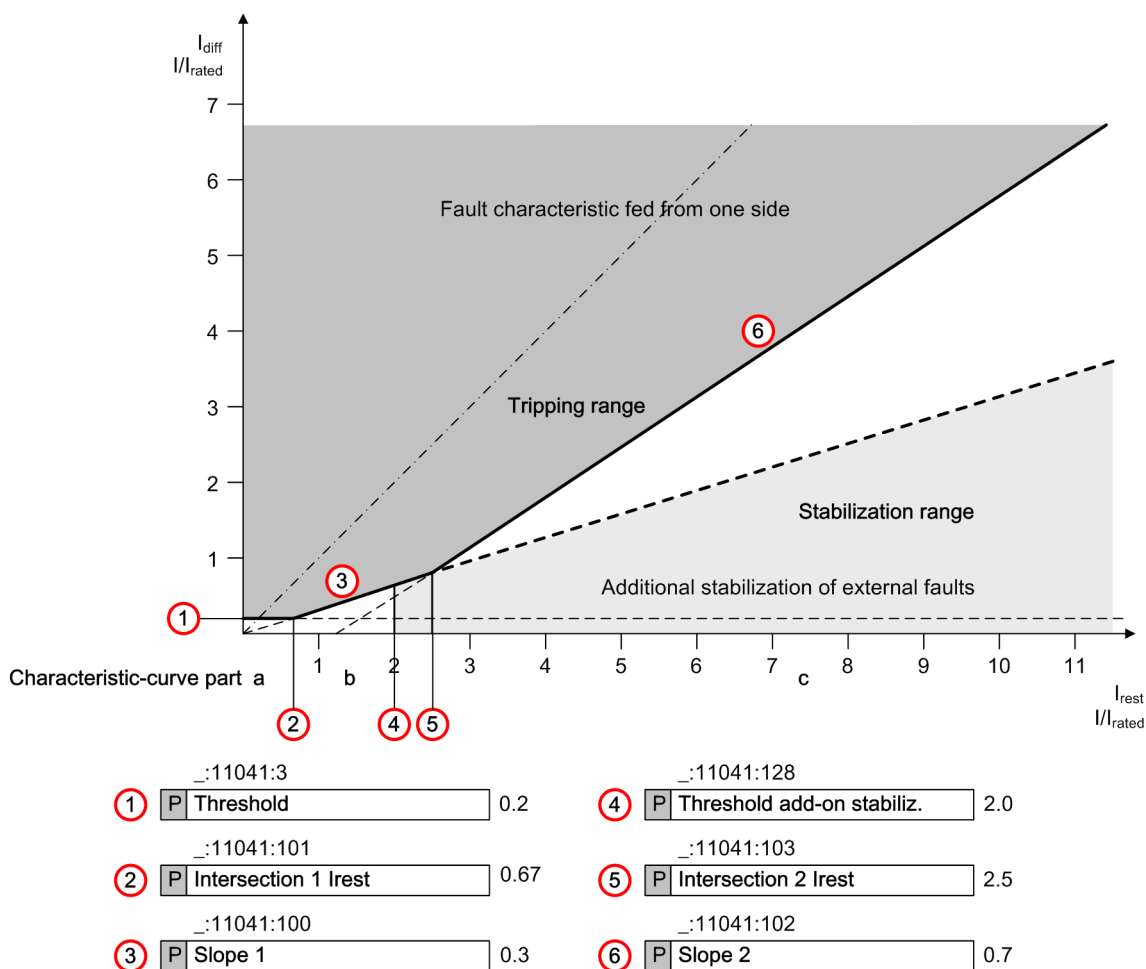
I-DIFF stage	Approx. 0.7
I-DIFF fast stage	Approx. 0.8
I-DIFF unrestrained stage	Approx. 0.7

Response Tolerance

For preset characteristic curve parameters; for 2 sides with 1 measuring point each	
I-DIFF stage and characteristic curve	2 % of the setting value
I-DIFF fast stage	2 % of the setting value

Time Delays

I-DIFF stage	0.00 s to 60.00 s	Increments of 0.01 s
I-DIFF fast stage	0.00 s to 60.00 s	Increments of 0.01 s
Timer tolerance	1 % of the setting value or 10 ms	



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Figure 12-25 Operate Curve of the Differential Protection

Operate Times

Operate times for one-sided supply		
I-DIFF stage, min	50 Hz	23 ms + OOT ¹³⁶
	60 Hz	20 ms + OOT ¹⁾
I-DIFF fast stage, min	50 Hz	8 ms + OOT ¹⁾
	60 Hz	8 ms + OOT ¹⁾
I-DIFF unrestrained stage, min	50 Hz	8 ms + OOT ¹⁾
	60 Hz	8 ms + OOT ¹⁾
Dropout time, approx.	50 Hz	29 ms
	60 Hz	26 ms

¹³⁶ Refer to protection functions, for example overcurrent protection

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

12.33 Overvoltage Protection with 3-Phase Voltage

Setting Values for the Function

Stabilization counter	0 to 10	Increments of 1
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Setting Values for Stage Type Definite-Time Overvoltage Protection

Measured value	Phase-to-phase Phase-to-ground	
Method of measurement	Fundamental component RMS value	
Pickup mode	1 out of 3 3 out of 3	
Pickup value ¹³⁷	0.300 V to 340.000 V	Increments of 0.001 V
Time delay	0.00 s to 300.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

Setting Values for Stage Type Inverse-Time Overvoltage Protection

Measured value	Phase-to-phase Phase-to-ground	
Method of measurement	Fundamental component RMS value	
Pickup mode	1 out of 3 3 out of 3	
Pickup value	0.300 V to 340.000 V	Increments of 0.001 V
Pickup factor	1.00 to 1.20	Increments of 0.01
Characteristic constant k	0.00 to 300.00	Increments of 0.01
Characteristic constant α	0.010 to 5.000	Increments of 0.001
Characteristic constant c	0.000 to 5.000	Increments of 0.001
Time multiplier	0.05 to 15.00	Increments of 0.01
Additional time delay	0.00 s to 60.00 s	Increments of 0.01 s
Reset time	0.00 s to 60.00 s	Increments of 0.01 s

Operate Curve for Stage Type Inverse-Time Overvoltage Protection

$$T_{op} = T_{inv} + T_{add}$$

Where

T_{op} Operate delay

T_{inv} Inverse-time delay

T_{add} Additional time delay (parameter **Additional time delay**)

$$T_{inv} = T_p \left(\frac{k}{\left(\frac{V}{V_{thresh}} \right)^\alpha - 1} + c \right) [s]$$

¹³⁷ If you have selected the **method of measurement = RMS value**, do not set the threshold value under 10 V.

Where

T_{inv}	Inverse-time delay
T_p	Time multiplier (parameter Time dial)
V	Measured voltage
V_{thresh}	Threshold value (parameter Threshold)
k	Curve constant k (parameter Charact. constant k)
α	Curve constant α (parameter Charact. constant α)
c	Curve constant c (parameter Charact. constant c)

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT ¹³⁸ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$	Slightly expanded tolerances
$1.1 f_{rated} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances for Stage Type Definite-Time Overvoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

Tolerances for Stage Type Inverse-Time Overvoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Operate time for $1.2 \leq V/V \text{ threshold value} \leq 20$	5 % of the setting value or 30 ms
Reset time delay	1 % of the setting value or 10 ms

¹³⁸ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

12.34 Overvoltage Protection with Zero-Sequence Voltage/Residual Voltage

Setting Values

Method of measurement	RMS value Fundamental component Fundamental component over 2 cycle filters	
Block. on measuring-voltage outage	Yes No	
Determ. ph. aff. by grd. flt.	Yes No	
Threshold value ¹³⁹	0.300 V to 340.000 V	Increments of 0.001 V
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Pickup delay	0.00 s to 320.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01
V < faulty ph-gnd vltg.	0.300 V to 200.000 V	Increments of 0.001 V
V > healthy ph-gnd. vltg.	0.300 V to 200.000 V	Increments of 0.001 V

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms	
Standard filter, true RMS, typical	Approx. 25 ms + OOT ¹⁴⁰ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Standard filter, true RMS, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
2 cycle filters, typical	Approx. 40 ms + OOT at 50 Hz Approx. 35 ms + OOT at 60 Hz
2 cycle filters, maximum	Approx. 45 ms + OOT at 50 Hz Approx. 40 ms + OOT at 60 Hz
Dropout time	
Standard filter, true RMS, typical	Approx. 20 ms + OOT at 50 Hz Approx. 17 ms + OOT at 60 Hz
Standard filter, true RMS, maximum	Approx. 25 ms + OOT at 50 Hz Approx. 20 ms + OOT at 60 Hz

¹³⁹ If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

¹⁴⁰ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

2 cycle filters, typical	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
2 cycle filters, maximum	Approx. 35 ms + OOT at 50 Hz Approx. 30 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$	Slightly expanded tolerances
$1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

12.35 Overvoltage Protection with Positive-Sequence Voltage

Setting Values

Pickup value	0.300 V to 200.000 V	Increments of 0.001 V
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT ¹⁴¹ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

¹⁴¹ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

12.36 Overvoltage Protection with Negative-Sequence Voltage

Setting Values for the Function

Measuring window	1 cycle to 10 cycles	Increments of 1 cycle
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Setting Values

Pickup value of V2	0.300 V to 200.000 V	Increments of 0.001 V
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Pickup times	55 ms to 210 ms + OOT ¹⁴² (depends on the measuring-window length) at 50 Hz 48 ms to 185 ms + OOT (depends on the measuring-window length) at 60 Hz
Dropout time	20 ms to 70 ms + OOT (depends on the measuring-window length)

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$	Slightly expanded tolerances
$1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Voltages	0.50 % of the setting value or 0.050 V
Time delays	1.00 % of the setting value or 10 ms

¹⁴² OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

12.37 Overvoltage Protection with Any Voltage

Setting Values

Measured value ¹⁴³	Measured phase-to-ground voltage V_A Measured phase-to-ground voltage V_B Measured phase-to-ground voltage V_C Measured phase-to-phase voltage V_{AB} Measured phase-to-phase voltage V_{BC} Measured phase-to-phase voltage V_{CA} Measured phase-to-phase voltage V_{AB} Measured phase-to-phase voltage V_{BC} Measured phase-to-phase voltage V_{CA} Calculated voltage V_0	
Method of measurement	Fundamental component RMS value	
Pickup value ¹⁴⁴	0.300 V to 340.000 V	Increments of 0.001 V
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT ¹⁴⁵ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

¹⁴³ If the function **Overvoltage protection with any voltage** is used in a 1-phase function group, the measured-value parameter is not visible.

¹⁴⁴ If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

¹⁴⁵ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

Tolerances

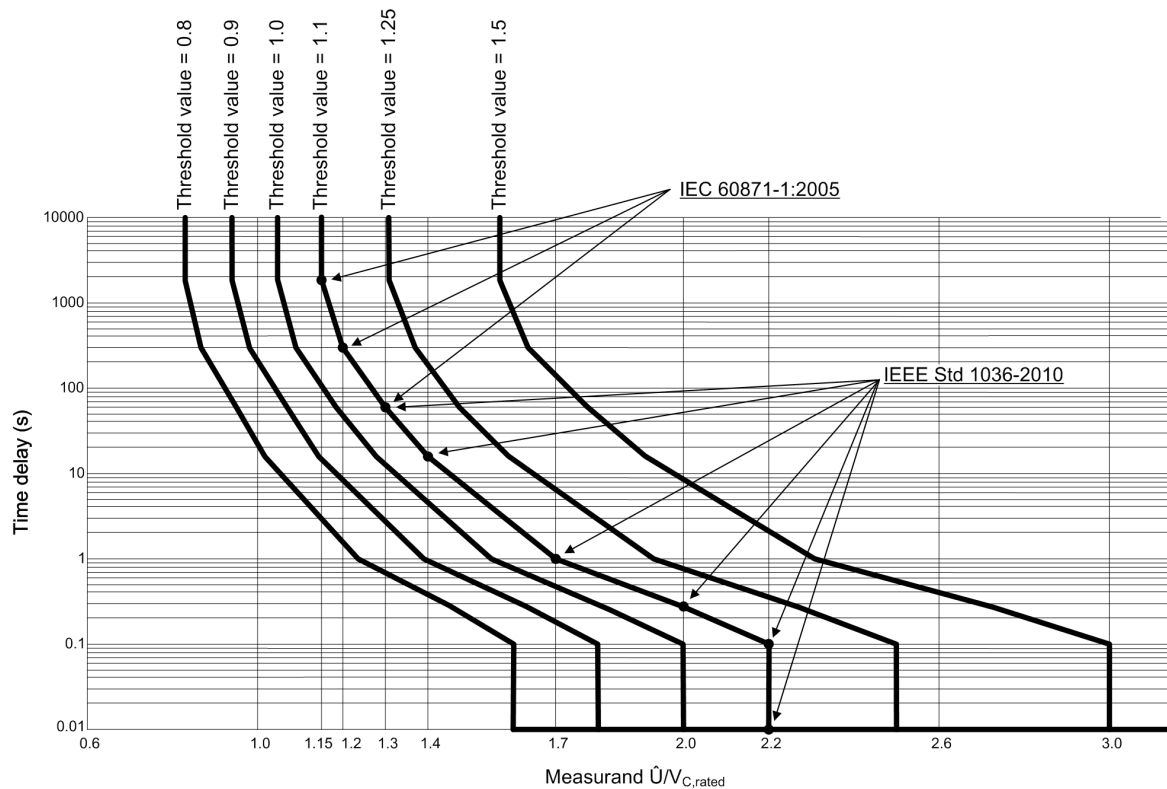
Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

12.38 Peak Overvoltage Protection for Capacitors

Setting Values

Threshold value	0.80 to 3.00 p.u.	Increments of 0.01
Inverse-time stage	0.80 to 10.00 p.u.	Increments of 0.01
Definite-time stage	0.80 to 3.00 p.u.	Increments of 0.01
Tripping delay	0.01 s to 3600.00 s	Increments of 0.01 s
Dropout delay	0.00 s to 3600.00 s	Increments of 1.00 s
Down integration time	1 min to 1500 min	Increments of 1 min
Time multiplier	0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate curve	30	Increments of 1
X values of the operate curve	1.00 p.u. to 4.00 p.u.	Increments of 0.01 p.u.
Y values of the operate curve	0.00 s to 9999.99 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve	30	Increments of 1
X values of the dropout characteristic curve	0.01 p.u. to 0.95 p.u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve	0.00 s to 9999.99 s	Increments of 0.01 s

Inverse-Time Characteristic Curve (IEC/IEEE)



[dw_pecinv-230813, 2, en_US]

Figure 12-26 Inverse-Time Characteristic Curve

The points on the characteristic curve defined in the standards result from a threshold setting of 1.1. These single points are connected via semi-logarithmic line segments.

Table 12-8 Peak Overvoltage Inverse-Time Characteristic (for Threshold Setting 1.1)

Measurand $\hat{U}/V_{c, \text{rated}}$	Time Delay	Curve Point According to
<1.15	∞ (no pickup)	Siemens definition
1.15	1800.00 s	IEC 60871-1:2005
1.2	300.00 s	IEC 60871-1:2005
1.3	60.00 s	IEC 60871-1:2005, IEEE Std 1036-2010
1.4	15.00 s	IEEE Std 1036-2010
1.7	1.00 s	IEEE Std 1036-2010
2	0.25 s	IEEE Std 1036-2010
2.2	0.1 s	IEEE Std 1036-2010
>2.2	0.01 s	IEEE Std 1036-2010

Times

Pickup time	Approx. 35 ms + OOT at 50 Hz ¹ Approx. 25 ms + OOT at 60 Hz ¹
Dropout Time	Depending on settings
¹ OOT (Output Operating Time) additional delay of the output medium used, for example, 5 ms with fast relays	

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Peak overvoltage (33 % harmonics, with reference to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 0.005 p.u. ($f_{\text{rated}} \pm 10\%$)
Up to 50th harmonic, $f_{\text{rated}} = 50 \text{ Hz}$	3 % of the setting value or 0.02 p.u. ($f_{\text{rated}} \pm 10\%$)
Up to 50th harmonic, $f_{\text{rated}} = 60 \text{ Hz}$	4 % of the setting value or 0.02 p.u. ($f_{\text{rated}} \pm 10\%$)
Time delays	
Measured value of definite-time stage	1 % of the setting value or 10 ms
Measured value of inverse-time stage and stage with user-defined characteristic curve	5 % of the setting value +1 % of the measured value or 30 ms
Down integration time	5 % of the setting value or 30 ms

12.39 Overvoltage Protection with Negative-Sequence Voltage/Positive-Sequence Voltage

Setting Values for the Function

Measuring window	1 cycle to 10 cycles	Increments of 1 cycle
Minimum voltage V1	0.300 V to 60.000 V	Increments of 0.001 V

Setting Values for Stage Types

Pickup value of V2/V1	0.50 % to 100.00 %	Increments of 0.01 %
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Pickup times	55 ms to 210 ms + OOT ¹⁴⁶ (depends on the measuring-window length) at 50 Hz 48 ms to 190 ms + OOT (depends on the measuring-window length) at 60 Hz
Dropout times	22 ms to 55 ms + OOT (depends on the measuring-window length) at 50 Hz 18 ms to 45 ms + OOT (depends on the measuring-window length) at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Voltages	0.50 % of the setting value or 0.050 V
Time delays	1.00 % of the setting value or 10 ms

¹⁴⁶ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

12.40 Undervoltage Protection with 3-Phase Voltage

Setting Values for the Function

Stabilization counter	0 to 10	Increments of 1
-----------------------	---------	-----------------

Setting Values for Stage Type Definite-Time Undervoltage Protection

Measured value	Phase-to-phase Phase-to-ground	
Method of measurement	Fundamental component RMS value	
Current-flow criterion	On Off	
Threshold value I>	1 A @ 50 and 100 Irated	0.030 A to 10.000 A Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A Increments of 0.001 A
Threshold value ¹⁴⁷	0.300 V to 175.000 V	Increments of 0.001 V
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	1.01 to 1.20	Increments of 0.01

Setting Values for Stage Type Inverse-Time Undervoltage Protection

Measured value	Phase-to-phase Phase-to-ground	
Method of measurement	Fundamental component RMS value	
Current-flow criterion	On Off	
Threshold value I>	1 A @ 50 and 100 Irated	0.030 A to 10.000 A Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A Increments of 0.001 A
Threshold	0.300 V to 175.000 V	Increments of 0.001 V
Pickup factor	0.80 to 1.00	Increments of 0.01
Characteristic constant k	0.00 to 300.00	Increments of 0.01
Characteristic constant α	0.010 to 5.000	Increments of 0.001
Characteristic constant c	0.000 to 5.000	Increments of 0.001
Time multiplier	0.05 to 15.00	Increments of 0.01
Additional time delay	0.00 s to 60.00 s	Increments of 0.01 s
Reset time	0.00 s to 60.00 s	Increments of 0.01 s

Operate Curve

$$T_{op} = T_{Inv} + T_{add}$$

Where:

T_{op} Operate delay

¹⁴⁷ If you have selected the **Method of measurement = RMS value**, do not set the threshold value under 10 V.

T_{Inv} Inverse-time delay

T_{add} Additional time delay (parameter **Additional time delay**)

$$T_{Inv} = T_p \left(\frac{k}{1 - \left(\frac{V}{V_{Thresh}} \right)^\alpha} + c \right) [s]$$

[fo_UVP3ph_inverse, 2, en_US]

Where

T_{Inv} Inverse-time delay

T_p Time multiplier (parameter **Time dial**)

V Measured undervoltage

V_{Thresh} Threshold value (parameter **Threshold**)

k Curve constant k (parameter **Charact. constant k**)

α Curve constant α (parameter **Charact. constant α**)

c Curve constant c (parameter **Charact. constant c**)

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT ¹⁴⁸ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive, maintained; Dropout of the pickup induced by blocking or by increasing the measurand beyond the dropout threshold

¹⁴⁸ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

Tolerances for Stage Type Definite-Time Undervoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Currents	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$, $f_{\text{rated}} \pm 10 \%$), valid for protection-class current transformers
	1 % of the setting value or 0.1 mA ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.5 mA ($I_{\text{rated}} = 8 \text{ A}$, $f_{\text{rated}} \pm 10 \%$), valid for instrument transformers
Time delays	1 % of the setting value or 10 ms

Tolerances for Stage Type Inverse-Time Undervoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Currents	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$, $f_{\text{rated}} \pm 10 \%$), valid for protection-class current transformers
	1 % of the setting value or 0.1 mA ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.5 mA ($I_{\text{rated}} = 8 \text{ A}$, $f_{\text{rated}} \pm 10 \%$), valid for instrument transformers
Operate time for $0 < V/V_{\text{Thresh}} < 0.9$	5 % of the setting value or 30 ms
Reset time delay	1 % of the setting value or 10 ms

12.41 Undervoltage Protection with Positive-Sequence Voltage

Setting Values

Threshold value		0.300 V to 200.000 V	Increments of 0.001 V
Time delay		0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio		1.01 to 1.20	Increments of 0.01
Current-flow criterion		On Off	
Threshold value I>	1 A @ 50 and 100 Irated	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT ¹⁴⁹ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive, maintained; Dropout of the pickup induced by blocking or by increasing the measurand beyond the dropout threshold

¹⁴⁹ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Currents	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$, $f_{\text{rated}} \pm 10 \%$), valid for protection-class current transformers
	1 % of the setting value or 0.1 mA ($I_{\text{rated}} = 1.6 \text{ A}$) or 0.5 mA ($I_{\text{rated}} = 8 \text{ A}$, $f_{\text{rated}} \pm 10 \%$), valid for instrument transformers
Time delays	1 % of the setting value or 10 ms

12.42 Undervoltage Protection with Any Voltage

Setting Values

Measured value	Measured phase-to-ground voltage V_A Measured phase-to-ground voltage V_B Measured phase-to-ground voltage V_C Measured phase-to-phase voltage V_{AB} Measured phase-to-phase voltage V_{BC} Measured phase-to-phase voltage V_{CA} Calculated phase-to-phase voltage V_{AB} Calculated phase-to-phase voltage V_{BC} Calculated phase-to-phase voltage V_{CA} Calculated voltage V_0	
Method of measurement	Fundamental component RMS value	
Threshold value ¹⁵⁰	0.300 V to 340.000 V	Increments of 0.001 V
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	1.01 to 1.20	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT ¹⁵¹ at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$	Slightly expanded tolerances
$1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive, maintained; Dropout of the pickup induced by blocking or by increasing the measurand beyond the dropout threshold

¹⁵⁰ If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

¹⁵¹ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

12.43 Overfrequency Protection

Setting Values

Pickup values $f_{>}$	Angle difference method	
	40.00 Hz to 90.00 Hz	Increments of 0.01 Hz
	Filtering method	
	40.00 Hz to 70.00 Hz	Increments of 0.01 Hz
Dropout differential	20 mHz to 2 000 mHz	Increments of 10 mHz
Time delay T	0.00 s to 600.00 s	Increments of 0.01 s
Minimum voltage	3.000 V to 175.000 V	Increments of 0.001 V

Times

Pickup times $f_{>}$	Angle difference method	
	50 Hz	Approx. 70 ms + OOT ¹⁵²
	60 Hz	Approx. 60 ms + OOT
	Filtering method	
	50 Hz	Approx. 79 ms + OOT
	60 Hz	Approx. 65 ms + OOT
Dropout times $f_{>}$	60 ms to 80 ms	

Dropout

The larger dropout differential (= | **pickup value** - **dropout threshold** |) of the following 2 criteria is used:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 99.97 % applies to the overfrequency protection.	
Minimum absolute dropout differential	5 mHz

Operating Ranges

Voltage range	5 V to 230 V (phase-phase)	
Frequency range	Angle difference method	10 Hz to 90 Hz
	Filtering method	25 Hz to 80 Hz

Tolerances

Frequency $f_{>}$	
$f_{\text{rated}} - 0.20 \text{ Hz} < f < f_{\text{rated}} + 0.20 \text{ Hz}$	$\pm 5 \text{ mHz}$ at $V = V_{\text{rated}}$
$f_{\text{rated}} - 3.0 \text{ Hz} < f < f_{\text{rated}} + 3.0 \text{ Hz}$	$\pm 10 \text{ mHz}$ at $V = V_{\text{rated}}$
Time delay T($f_{>}$)	1 % of the setting value or 10 ms
Minimum voltage	1 % of the setting value or 0.5 V

¹⁵² OOT (Output Operating Time): Additional delay of the output medium used, for example, 5 ms with fast relays, see chapter [12.1.4 Relay Outputs](#)

12.44 Underfrequency Protection

Setting Values

Pickup values $f_{<}$	30.00 Hz to 70.00 Hz	Increments of 0.01 Hz
Dropout differential	20 mHz to 2 000 mHz	Increments of 10 mHz
Time delay T	0.00 s to 600.00 s	Increments of 0.01 s
Minimum voltage	3.000 V to 175.000 V	Increments of 0.001 V

Times

Pickup times $f_{<}$	Angle difference method	
	50 Hz	Approx. 70 ms + OOT ¹⁵³
	60 Hz	Approx. 60 ms + OOT
	Filtering method	
	50 Hz	Approx. 75 ms + OOT
	60 Hz	Approx. 64 ms + OOT
Dropout times $f_{<}$	60 ms to 80 ms	

Dropout

The larger dropout differential (= | **pickup value** - **dropout threshold** |) of the following 2 criteria is used:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not present, a dropout ratio of 100.03 % applies to the underfrequency protection.	
Minimum absolute dropout differential	5 mHz

Operating Ranges

Voltage range	5 V to 230 V (phase-phase)	
Frequency range	Angle difference method	10 Hz to 90 Hz
	Filtering method	25 Hz to 80 Hz

Tolerances

Frequency $f_{<}$	
$f_{\text{rated}} - 0.20 \text{ Hz} < f < f_{\text{rated}} + 0.20 \text{ Hz}$	$\pm 5 \text{ mHz at } V = V_{\text{rated}}$
$f_{\text{rated}} - 3.0 \text{ Hz} < f < f_{\text{rated}} + 3.0 \text{ Hz}$	$\pm 10 \text{ mHz at } V = V_{\text{rated}}$
Time delay T($f_{<}$)	1 % of the setting value or 10 ms
Minimum voltage	1 % of the setting value or 0.5 V

¹⁵³ OOT (Output Operating Time): Additional delay of the output medium used, for example, 5 ms with fast relays, see chapter [12.1.4 Relay Outputs](#)

12.45 Underfrequency Load Shedding

Setting Values for the Function

Minimum voltage	0.300 p.u. to 0.900 p.u.	Increments of 0.001 p.u.
Minimum current	0.020 p.u. to 0.200 p.u.	Increments of 0.001 p.u.
Power angle	-30° to 30°	Increments of 1°
Positive power direction	inv. to CT neu.pnt sett. acc. to CT neu.pnt sett.	
Threshold value for the df/dt-rising rate or df/dt-falling rate	0.1 Hz/s to 20.0 Hz/s	Increments of 0.1 Hz/s
df/dt measuring window	2 periods to 5 periods	Increments of 1 period
df/dt dropout differential	0.02 Hz/s to 0.99 Hz/s	Increments of 0.10 Hz/s
f < stabilization counter	1 to 20	Increments of 1

Setting Values for the Stage

Pickup threshold	40.00 Hz to 70.00 Hz	Increments of 0.01 Hz
Dropout differential	20 mHz to 2000 mHz	Increments of 10 mHz
Time delay	0.00 s to 60.00 s	Increments of 0.01 s

Times

Pickup times with stabilization counter = 6	Approx. 85 ms + OOT ¹⁵⁴ at 50 Hz Approx. 80 ms + OOT at 60 Hz
Dropout time	Approx. 80 ms + OOT at 50 Hz Approx. 75 ms + OOT at 60 Hz

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout	
Frequency	0.01 Hz
df/dt-rising rate and df/dt-falling rate	0.1 Hz/s
Voltage V1	105 % of the threshold value
Current I1	105 % of the threshold value at $\varphi \leq 0$ 95.23 % of the threshold value at $\varphi > 0$
Power angle	1°
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1$ A) or 75 mA sec. ($I_{rated} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1$ A) or 2.5 mA sec. ($I_{rated} = 5$ A)
Voltage transformer	150 mV sec.

Tolerances

Frequency f<	
$f_{rated} - 0.20 \text{ Hz} < f < f_{rated} + 0.20 \text{ Hz}$	$\pm 5 \text{ mHz at } V = V_{rated}$

¹⁵⁴ OOT (Output Operating Time): additional time delay of the output medium used, for example, 5 ms with fast relay

$f_{\text{rated}} - 3.0 \text{ Hz} < f < f_{\text{rated}} + 3.0 \text{ Hz}$	$\pm 10 \text{ mHz at } V = V_{\text{rated}}$
df/dt, measuring window > 3 periods	Approx. 3 % or 0.06 Hz/s
df/dt, measuring window ≤ 3 periods	Approx. 5 % or 0.06 Hz/s
Minimum voltage	0.5 % of the setting value or 0.05 V
Minimum current	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Power angle	1°
Time delays	1 % of the setting value or 10 ms

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$	Slightly expanded tolerances
$1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

12.46 Rate of Frequency Change Protection

Setting Values for the Function

Minimum voltage	3.000 V to 175.000 V	Increments of 0.001 V
Measuring window	2 periods to 5 periods	Increments of 1 period

Setting Values for Stage Types

Threshold	0.100 Hz/s to 20.000 Hz/s	Increments of 0.025 Hz/s
Dropout differential	0.02 Hz/s to 0.99 Hz/s	Increments of 0.01 Hz/s
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

Frequency	Parameterizable dropout differential
Minimum voltage	
The larger dropout differential (= pickup value - dropout threshold) of the following 2 criteria is used:	
Dropout differential derived from Dropout ratio	105 % for the Minimum voltage parameter
Minimum absolute dropout differential	150 mV secondary

Times

Pickup time	Approx. 160 ms + OOT ¹⁵⁵ to 220 ms + OOT (depends on measuring window length) at 50 Hz Approx. 140 ms + OOT to 200 ms + OOT (depends on measuring window length) at 60 Hz
Dropout time	Approx. 160 ms + OOT to 220 ms + OOT (depends on measuring window length) at 50 Hz Approx. 140 ms + OOT to 200 ms + OOT (depends on measuring window length) at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Threshold, measuring window > 3 periods	Approx. 3 % or 0.060 Hz/s
Threshold, measuring window ≤ 3 periods	Approx. 5 % or 0.060 Hz/s

¹⁵⁵ OOT (Output Operating Time): Additional delay of the output medium used, for example, 5 ms with fast relays, see chapter [12.1.4 Relay Outputs](#)

Minimum voltage	1 % of the setting value or 0.5 V
Time delays	1 % of the setting value or 10 ms

Functional Measured Value

Value	Description
df/dt	Calculated rate of frequency change

12.47 Vector-Jump Protection

Setting Values

Threshold V1 min	0.300 V to 175.000 V	Increments of 0.001 V
Threshold V1 max	0.300 V to 175.000 V	Increments of 0.001 V
Threshold $\Delta\phi$	2.0° to 30.0°	Increments of 0.1°
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s
T Reset	0.00 s to 60.00 s	Increments of 0.01 s
T Block	0.00 s to 60.00 s	Increments of 0.01 s
I < Threshold	0.030 A to 35.000 A at 1 A 0.150 A to 175.000 A at 5 A	Increments of 0.001 A

Times

Pickup times	Approx. 80 ms + OOT ¹⁵⁶ at 50 Hz Approx. 66.8 ms + OOT at 60 Hz
Dropout times	Approx. 80 ms + OOT at 50 Hz Approx. 66.8 ms + OOT at 60 Hz

Frequency Operating Range

$f_{\text{rated}} - 3 \text{ Hz} \leq f \text{ or } f_{\text{rated}} \leq f_{\text{rated}} + 3 \text{ Hz}$	According to specified tolerances
$f < f_{\text{rated}} - 3 \text{ Hz or } f > f_{\text{rated}} + 3 \text{ Hz}$	Inactive

Tolerances

Angle jump	0.5° at $V > 0.5 V_{\text{rated}}$
Voltage blocking	1 % of the setting value or 0.500 V
Undercurrent release	For $I_{\text{rated}} = 1 \text{ A}$: 1 % of the setting value or 10 mA For $I_{\text{rated}} = 5 \text{ A}$: 1 % of the setting value or 50 mA
Time delay T	1 % or 10 ms

¹⁵⁶ OOT (Output Operating Time): additional delay of the output medium used. You can find more information in chapter [12.1.4 Relay Outputs](#).

12.48 Power Protection (P,Q), 3-Phase

Setting Values

Measured value	Positive sequence power Power of phase A Power of phase B Power of phase C	
Threshold value	-200.0 % to +200.0 %	Increments of 0.1
Tilt-power characteristic	-89.0° to +89.0°	Increments of 0.1°
Dropout delay time	0.00 s to 60.00 s	Increments of 0.01 s
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	Upper stage: 0.90 to 0.99 Lower stage: 1.01 to 1.10	Increments of 0.01 Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
Minimum absolute dropout differential	0.5 % S_{rated}

Times

Pickup times	Approx. 55 ms + OOT ¹⁵⁷ at 50 Hz Approx. 45 ms + OOT at 60 Hz
Dropout times	Approx. 55 ms + OOT at 50-Hz Approx. 45 ms + OOT at 60 Hz

Tolerances

Power	0.5 % $S_{rated} \pm 3$ % of setting value (S_{rated} : rated apparent power)
Time delays	1 % of the setting value or 10 ms

Variables That Influence Pickup Values

Auxiliary DC voltage in the range $0.8 \leq V_{aux.}/V_{aux.,rated} \leq 1.15$	≤ 1 %
Frequency in the range $0.95 \leq f/f_{rated} \leq 1.05$	≤ 1 %
Harmonics	≤ 1 %
- Up to 10 % of 3rd harmonics	≤ 1 %
- Up to 10 % of 5th harmonics	≤ 1 %

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} < f < 0.9 f_{rated}$	Slightly expanded tolerances
$1.1 f_{rated} < f$	
$f \leq 10 \text{ Hz}$	Inactive

¹⁵⁷ OOT (Output Operating Time): additional delay of the output medium used, see Chapter [12.1.4 Relay Outputs](#)

12.49 Reverse-Power Protection

Setting Values

Reverse power P_{reverse} (p.u.)	-0.30 % to -30.00 %	Increments of 0.01 %
Angle correction	-10.00 ° to 10.00 °	Increments of 0.01 °
Minimum voltage V1	0.300 V to 60.000 V	Increments of 0.001 V
Tripping delay	0.00 s to 60.00 s	0.00 s to 60.00 s
Tripping delay with quick stop	0.00 s to 60.00 s	0.00 s to 60.00 s
Dropout delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.40 to 0.99	Increments of 0.01

Dropout

Reverse power P_{reverse} (p.u.)	Parameterizable dropout differential
---	--------------------------------------

Times

Pickup times	Approx. 360 ms at $f = 50$ Hz Approx. 300 ms at $f = 60$ Hz
Dropout times	Approx. 360 ms at $f = 50$ Hz Approx. 300 ms at $f = 60$ Hz

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Reverse power	0.15 % S_{rated} or 5 % of the setting value when $Q < 0.5 S_{\text{rated}}$
Time delays	1 % or 10 ms

12.50 Overexcitation Protection

Setting Values

Threshold value (Inverse-time characteristic curve pickup)	$\frac{V/V_{rated}}{f/f_{rated}}$	1.00 to 1.20	Increments of 0.01
Threshold value (Definite-time characteristic curve pickup)	$\frac{V/V_{rated}}{f/f_{rated}}$	1.00 to 1.40	Increments of 0.01
Time delay (warning delay and tripping delay)		0.00 s to 60.00 s	Increments of 0.01 s
Characteristic value pairs		2 to 30	
	Ranges of values	V/f	1.00 p.u. to 10.00 p.u.
		t	0 s to 100 000 s
Cooling time therm. replica		0 s to 100 000 s	Increments of 1 s

Functional Measured Values

Measured Value	Description
(_:2311:322) V/f	Value calculated from voltage and frequency.
(_:13591) <i>Therm. charact.</i>	Thermal tripping of the overexcitation protection. If the value reaches 100 %, tripping occurs.

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Operating Times

Operate times/dropout times		
Operate time at frequency	50 Hz	60 Hz
Minimum	33 ms + OOT ¹	30 ms + OOT ¹⁵⁸
Dropout time	10 ms + OOT ¹	10 ms + OOT ¹

Dropout Ratios

Warning, tripping (independent stage)	Approx. 0.98
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Operate Curve

Thermal replica	For default setting refer to the following characteristic curve Figure 12-27
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Tolerances

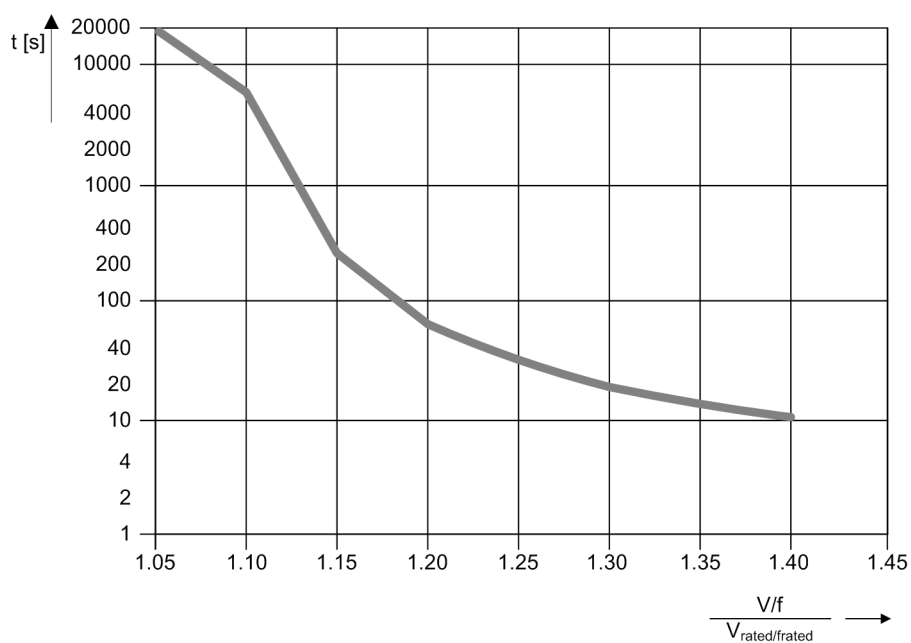
V/f pickup	2 % of the setting value
Time delays	1 % of the setting value or 10 ms (min. 1.5 periods)
Thermal replica	5 % based on $V/f \pm 600 \text{ ms}$

¹⁵⁸ Refer to protection functions, for example overcurrent protection

Voltage measurement accuracy	0.5 % of the setting value or 0.5 V in the range $f_n \pm 10\%$
Frequency measurement accuracy	1.0 % of the setting value or 1.0 Hz in the frequency range 10 Hz to 90 Hz

Influencing Quantities

Auxiliary direct voltage in the 0.8 range	$\leq 1\%$
Time delays	$\leq 0.5\%/10\text{ K}$
Thermal replica	$\leq 1\%$
Harmonics	
up to 10 % of 3rd harmonics	$\leq 1\%$
up to 10 % of 5th harmonics	$\leq 1\%$



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Figure 12-27 Operate Curve from the Thermal Replica of the Overexcitation Protection (Default Setting)

12.51 Undervoltage-Controlled Reactive-Power Protection

Setting Values

Threshold value	Power Q	1.00 % to 200.00 %	Increments of 0.01 %
	Voltage of protection stage	3.000 to 175.000	Increments of 0.001 V
	Voltage of reclosure stage	3.000 V to 340.000 V	Increments of 0.001 V
Current I_1 release threshold	1 A @ 50 and 100 I _{rated}	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Operate delay		0.00 s to 60.00 s	Increments of 0.01 s
Release time delay of reclosure stage		0.00 s to 3600.00 s	Increments of 0.01 s

Dropout Ratio

Protection stage	
Reactive-power flow Q	Approx. 0.95
Voltage	Approx. 1.02
Release current	Approx. 0.95
Reclosure stage	
Voltage	Approx. 0.98
Release current	Approx. 0.95

Times

Pickup time	Approx. 55 ms + OOT ¹⁵⁹ at 50 Hz Approx. 45 ms + OOT at 60 Hz
Dropout time	Approx. 55 ms + OOT at 50 Hz Approx. 45 ms + OOT at 60 Hz

Tolerances

Current I_1	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$)
Voltage	0.5 % of the setting value or 0.05 V
Power Q	0.5 % $S_{\text{rated}} \pm 3 \%$ of the setting value (S_{rated} : rated apparent power)
Time delays	1 % of the setting value or 10 ms
Reclosure time delay	1 % of the setting value or 10 ms

¹⁵⁹ OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

12.52 Circuit-Breaker Failure Protection

Starting Conditions

For circuit-breaker failure protection	3-pole tripping internal or external ¹⁶⁰
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Setting Values

Phase-current threshold values	1 A @ 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	1 A @ 50 I _{rated}		
	5 A @ 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	5 A @ 50 I _{rated}		
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Sensitive threshold value	1 A @ 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	1 A @ 50 I _{rated}		
	5 A @ 100 I _{rated}	0.15 A to 175.00A	Increments of 0.01 A
	5 A @ 50 I _{rated}		
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Supervision time of release signal		0.00 s to 1.00 s	Increments of 0.01 s
Time delays T1		0.000 s to 60.000 s	Increments of 0.001 s
Time delays T2		0.050 s to 60.000 s	Increments of 0.001 s
Supervision times of the binary inputs		0.05 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup threshold** - **dropout threshold** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies to the current threshold values.	
Minimum absolute dropout differential	
Protection-class current transformers	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument transformers	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Circuit-Breaker Supervision

Position supervision via circuit-breaker auxiliary contacts	
For 3-pole CB tripping	1 input each for make contact and break contact



NOTE

The circuit-breaker failure protection can also work without the circuit-breaker auxiliary contacts stated. Auxiliary contacts are required for circuit-breaker failure protection in cases where the current flow is absent or too low for tripping (for example with a transformer or a Buchholz protection).

¹⁶⁰ Via binary inputs

Times

Pickup time, in the case of an internal start	< 1 ms
Pickup time, in the case of an external start	< 5 ms
Typical dropout time	< 15 ms
Dropout time, via circuit-breaker auxiliary contact criterion ¹⁶¹	< 5 ms

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Threshold values, dropout thresholds	2 % of the setting value or 1 % of the rated current
Times	1 % of the setting value or 10 ms

¹⁶¹ The use of the transformer connection types **2ph**, **2p**, **CT + IN-sep** result in slightly expanded tolerances

12.53 Circuit-Breaker Restrike Protection

Setting Values

Threshold value	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Monitoring duration		1.00 s to 600.00 s	Increments of 0.01 s
Position recognition delay		0.00 s to 60.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s
Trip delay time		0.05 s to 60.00 s	Increments of 0.01 s
Retrip delay time		0.00 s to 60.00 s	Increments of 0.01 s
Minimum operate (trip) time		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I _{rated} = 1 A) or 75 mA sec. (I _{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I _{rated} = 1 A) or 2.5 mA sec. (I _{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT at 50 Hz Approx. 22 ms + OOT at 60 Hz
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Threshold	1 % of the setting value or 5 mA (I _{rated} = 1 A) or 25 mA (I _{rated} = 5 A)
Time delays	1 % of the setting value or 10 ms

12.54 Restricted Ground-Fault Protection

Setting Values

Threshold value ¹⁶²	0.05 A to 2.00 A	Increments of 0.01 A
Gradient	0.00 to 0.95	Increments of 0.01
Operate curve	See figure	
Pickup tolerance (for preset characteristic curve parameters; for 2 sides with 1 measuring point each)	2 %	
Tripping delay	0.00 s to 60.00 s or ∞ (no tripping)	Increments of 0.01 s
Timer tolerance	1 % of the setting value or 10 ms	

Functional Measured Values

Measured Value	Description
(_:306) I REF,operate	Operate quantity of the restricted ground-fault protection from the angle criterion and can be displayed in the fault record
(_:307) I Angle,REF	Stabilizing value (angle) of the restricted ground-fault protection from the angle criterion and can be displayed in the fault record
(_:311) I REF,Trip operate	Operate quantity of the restricted ground-fault protection when OFF; will be issued in the log
(_:312) I angle,REF operate	Stabilizing value of the restricted ground-fault protection when OFF; will be issued in the log
(_:301) I diff.	Differential current; can be displayed in the fault record
(_:302) I restr.	Restraint current; can be displayed in the fault record

Dropout Ratio

Threshold value	0.7
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Dropout

The greater dropout differential (= | **pickup value** - **dropout value** |) of the following 2 criteria applies:

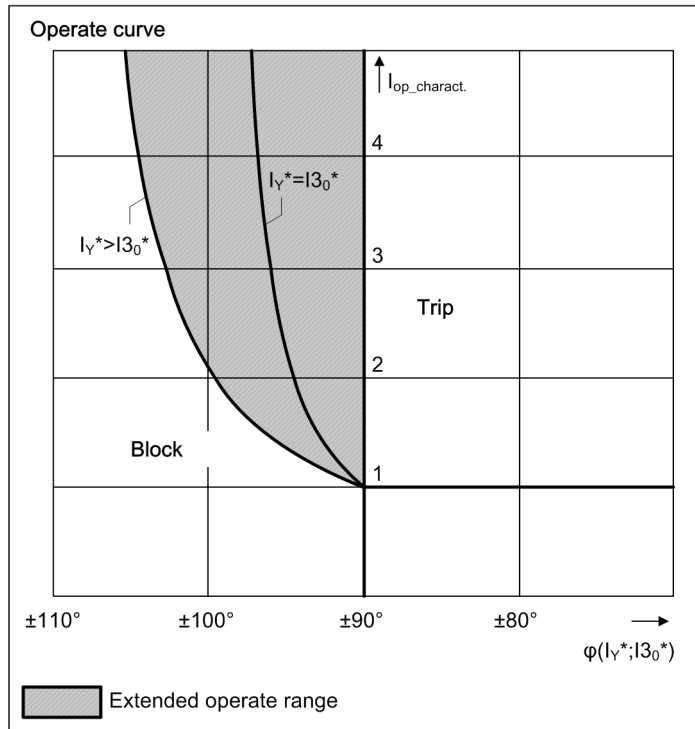
Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. ($I_{rated} = 1$ A) or 75 mA sec. ($I_{rated} = 5$ A)
Instrument current transformer	0.5 mA sec. ($I_{rated} = 1$ A) or 2.5 mA sec. ($I_{rated} = 5$ A)

Times

7UT82/7UT85/7UT86/7UT87		
Frequency	50 Hz	60 Hz
	Operate time	Operate time

¹⁶² The specified setting limit can be dynamically further limited, depending on the transformer adaptation factor, (for this refer to chapter [6.44.4 Application and Setting Notes](#)).

At 1.5 · setting value threshold value	33 ms + OOT	32 ms + OOT
At 2.5 · setting value threshold value	27 ms + OOT	26 ms + OOT
Dropout time approx.	80 ms	67 ms



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Figure 12-28 Restricted Ground-Fault Protection Operate Curve Depending on the Phase Angle between I_Y^* and $3I_{0}^*$ with Extended Operate Range.

12.55 External Trip Initiation

Setting Values

Tripping delay	0.00 s to 60.00 s	Increments of 0.01 s
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Times

Operate time with time delay = 0 ms - At initiation via binary input signal	Approx. 10 ms + OOT ¹⁶³ .
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Tolerance

Sequence tolerance for delay times	1 % of the setting value or 10 ms
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¹⁶³ OOT (Output Operating Time) additional delay of the output medium used, for example 5 ms with fast relays, see chapter [12.1.4 Relay Outputs](#)

12.56 Automatic Reclosing

Function specifications	Cyclic automatic reclosing function Automatic reclosing function with adaptive dead time (ADT) Operation with External Automatic Reclosing Function	
Number of reclosings	Max. 8, per individual settings	
Type (depending on the order variation)	1-pole, 3-pole, or 1-/3-pole	
Operating mode of the automatic reclosing function	With trip command, without action time With trip command, with action time With pickup, without action time With pickup, with action time	
Reclaim time after reclosing	0.50 s to 300.00 s	Increments of 0.01 s
Blocking time after dynamic blocking	0.5 s	-
Blocking time after manual closure	0.00 s to 300.00 s	Increments of 0.01 s
Start supervision time	0.01 s to 300.00 s	Increments of 0.01 s
Circuit-breaker supervision time	0.01 s to 300.00 s	Increments of 0.01 s
Evolving-fault detection	With trip command With Pickup	
Reaction to evolving faults	Blocks Automatic reclosing function Start, evolving fault, dead time	
Action times (separated for all cycles)	0.00 s to 300.00 s or oo (ineffective)	Increments of 0.01 s
Dead times after trip command (separated for all types and all cycles)	0.00 s to 1 800.00 s or oo (ineffective)	Increments of 0.01 s
Dead time after evolving-fault detection (separated for all cycles)	0.00 s to 1 800.00 s	Increments of 0.01 s
Synchrocheck after 3-pole dead time	None Internal External	
Transmission delay, inter close command	0.00 s to 300.00 s or oo (ineffective)	Increments of 0.01 s
Dead-line check/reduced dead time	Without Reduced dead time (VWE) Dead line checking	
Voltage supervision warning time	0.10 s to 30.00 s	Increments of 0.01 s
Limiting value for fault-free line	0.3 V to 340.0 V	Increments of 0.1 V
Limiting value for zero potential	0.3 V to 340.0 V	Increments of 0.1 V

12.57 Fault Locator

Setting Values

Reactance per unit length of the line per kilometer or per mile	
Line length for the correct output of the fault distance as a percentage of the line length	
The residual compensation factors in the setting format Kr and Kx or K0 and angle (K0)	
Consideration of the load current for 1-pole ground faults	Correction of the X value, for connection and disconnection

Fault Distance

Output of the fault distance (line length)	In Ω primary and secondary In km, miles or in percent. ¹⁶⁴
--	---

Tolerances

Measuring tolerances during sinusoidal measurands and error duration > 25 ms at 60 Hz or > 30 ms at 50 Hz	1.5 % from fault location at $V_k/V_{rated} \geq 0.01$ and one of the following scenarios: • Metal fault • Non-metallic fault for one-side infeed without load
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¹⁶⁴ The output of the fault distance in km, miles and percent presupposes a homogenous line.

12.58 Fault Locator Plus

Setting Values

• Cb per length unit, C0 per length unit, and X per length unit of the line per kilometer or per mile • Line angle in ° • Line length for the correct output of the fault distance in km or miles and percent of the line length • The residual compensation factors in the setting format Kr and Kx or K0 and angle (K0)	
Consideration of the load current in the case of 1-phase ground faults	Correction of the X value, for connection and disconnection

Output Values

Output of the fault distance (line length), for non-homogeneous lines with indication of the line section	In km, miles, or percent
Output of the fault resistance, fault contact resistance, and fault reactance	In Ω primary and secondary

Tolerances

Measuring tolerances during sinusoidal measurands and fault duration > 25 ms at 60 Hz or > 30 ms at 50 Hz	1.5 % from fault location ¹⁶⁵ with $V_K/V_{rated} \geq 0.01$ and $I_F/I_{rated} \geq 0.1$
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¹⁶⁵ Tolerance referenced to the total line length

12.59 Temperature Supervision

Setting Values

Pickup value	-50 °C to 250 °C -58 °F to 482 °F	Increments of 1°C Increments of 1°F
Time delay	0 s to 60 s or ∞	Increments of 1 s

Dropout

Dropout differential	3 °C or 6 °F
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Tolerances

Tripping delay	±1 % of the setting value or ±10 ms
Measured temperature value	±0.5 % of the setting value or ±1 °C or ±2 °F

12.60 Current-Jump Detection

Times

Pickup time	Approx. 10 ms + OOT ¹⁶⁶ at 50 Hz Approx. 8 ms + OOT at 60 Hz
-------------	--

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Currents	3 % of setting value or 10 mA ($I_{\text{rated}} = 1 \text{ A}$) or 50 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$) for amplitude changes of sinusoidal measurands
Pulse time	1 % of the setting value or 10 ms

¹⁶⁶ OOT (Output Operating Time) additional delay of the output medium used, for example 5 ms with fast relays

12.61 Voltage-Jump Detection

Times

Pickup time	Approx. 10 ms + OOT ¹⁶⁷ at 50 Hz Approx. 8 ms + OOT at 60 Hz
-------------	--

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Inactive

Tolerances

Voltages	2 % of the setting value or 0.100 V for amplitude changes of sinusoidal measurands
Pulse time	1 % of the setting value or 10 ms

¹⁶⁷ OOT (Output Operating Time) additional delay of the output medium used, for example 5 ms with fast relays

12.62 Synchronization Function

Operating Modes

Synchrocheck
Switching synchronous systems
Switching asynchronous systems
Switching synchronous/asynchronous systems with balancing commands
De-energized switching
Direct closing command
Balancing Voltage
Balancing Frequency

Setting Values

Supervision/Delay/Pulse times:		
Max.durat. sync.process	0.00 s to 3 600.00 s or ∞ (ineffective)	Increments of 0.01 s
Supervision time de-energized switching	0.00 s to 60.00 s	Increments of 0.01 s
Closure delay	0.00 s to 60.00 s	Increments of 0.01 s
T V pulse min/T f pulse min	0.01 s to 1.00 s	Increments of 0.01 s
T V pulse max/T f pulse max	0.01 s to 60.00 s	Increments of 0.01 s
T pause V/T pause f	0.01 s to 60.00 s	Increments of 0.01 s
T close without balancing	1.00 s to 100.00 s	Increments of 0.01 s
Voltage threshold values:		
Upper voltage limit $V_{\max}$	0.300 V to 340.000 V (phase-to-phase)	Increments of 0.001 V
Lower voltage limit $V_{\min}$	0.300 V to 340.000 V (phase-to-phase)	Increments of 0.001 V
$V <$, for off-circuit conditions $V >$, for voltage present	0.300 V to 170.000 V (phase-to-phase) 0.300 V to 340.000 V (phase-to-phase)	Increments of 0.001 V Increments of 0.001 V
Differential values, changeover thresholds asynchronous/synchronous/balancing/adjusting commands:		
Voltage differences $V_2 > V_1$; $V_2 < V_1$	0.000 V to 170.000 V	Increments of 0.001 V
Frequency difference $f_2 > f_1$; $f_2 < f_1$	0.000 Hz to 2.000 Hz (synchronous) 0.000 Hz to 4.000 Hz (asynchronous)	Increments of 0.001 Hz
Angle difference $\alpha_2 > \alpha_1$; $\alpha_2 < \alpha_1$	0° to 90°	Increments of 1°
Δf threshold ASYN $\leftrightarrow$ SYN	0.010 Hz to 0.200 Hz	Increments of 0.001 Hz
Δf set point for balancing	-1.00 Hz to 1.00 Hz	Increments of 0.01 Hz
Δf for the kick pulse	-1.00 Hz to 1.00 Hz	Increments of 0.01 Hz
Adjustments of the sides:		
Angle adjustment	0.0° to 360.0°	Increments of 0.1°
Voltage adjustment	0.500 to 2.000	Increments of 0.001
Circuit breaker		
Closing time of the circuit breaker	0.01 s to 0.60 s	Increments of 0.01 s

Dropout Ratio

Min./max. operating limit	1 % of the setting value
Voltage differential	10 % of the setting value or 0.5 V
De-energized/energized	5 % of the setting value
Frequency difference	3 mHz
Angle difference	0.1°

Measured Values of the Synchronization Function

Reference voltage V1	In kV primary, in V secondary or in % V_{rated} Display always as phase-to-phase voltage 10 % to 120 % of V_{rated} • Range • Tolerance at rated frequency $\leq 1 \%$ of the measured value or 0.5 % V_{rated}
Voltage to be synchronized V2	In kV primary, in V secondary or in % V_{rated} Display always as phase-to-phase voltage 10 % to 120 % of V_{rated} • Range • Tolerance at rated frequency $\leq 1 \%$ of the measured value or 0.5 % V_{rated}
Frequency of the voltage V1f1	f1 in Hz 25 Hz $\leq f \leq$ 70 Hz • Range • Tolerance at rated frequency 1 mHz
Frequency of the voltage V1f2	f2 in Hz 25 Hz $\leq f \leq$ 70 Hz • Range • Tolerance at rated frequency 1 mHz
Voltage difference V2-V1	In kV primary, in V secondary or in % V_{rated} Display always as phase-to-phase voltage in relation to side 1 10 % to 120 % of V_{rated} • Range • Tolerance at rated frequency $\leq 1 \%$ of the measured value or 0.5 % V_{rated}
Frequency difference f2-f1	In mHz f _{rated} $\pm$ 10 % • Range • Tolerance at rated frequency 1 mHz
Angle difference $\lambda_2 - \lambda_1$	In ° -180° to +180° • Range • Tolerance at rated frequency 0.5°

Times

Measuring time, after switching on the variables	Approx. 80 ms
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Operating Range

Voltage	20 V to 340 V
Frequency	f _{rated} - 4 Hz $\leq$ f _{rated} $\leq$ f _{rated} + 4 Hz

Tolerances

Tolerances of the voltage settings	2 % of the pickup value or 1 V
Voltage difference V2>V1; V2<V1	1 V

Frequency difference $f_2 > f_1$; $f_2 < f_1$	10 mHz
Angle difference $\alpha_2 > \alpha_1$; $\alpha_2 < \alpha_1$	1°
Pulse time	1 % of the calculated impulse or 10 ms
Tolerance of all time settings	10 ms
Max. phase displacement angle	5° for $\Delta f \leq 1 \text{ Hz}$ 10° for $\Delta f > 1 \text{ Hz}$

12.63 Voltage Controller

Setting Values

General Information		
I reference for % values ¹⁶⁸	0.20 A to 100000.00 A	Increments of 0.01 A
V reference for % values ¹⁶⁹	0.20 kV to 1200.00 kV	Increments of 0.01 kV
Rated app. power transf. ¹⁷⁰	0.20 MVA to 5000.00 MVA	Increments of 0.01 MVA
Volt. cont. 2W		
Target voltage 1	10.000 V to 340.000 V	Increments of 0.001 V
Target voltage 2		
Target voltage 3		
Target voltage 4		
Volt. cont. 3W and GC		
Target voltage 1 w1	10.000 V to 340.000 V	Increments of 0.001 V
Target voltage 2 w1		
Target voltage 3 w1		
Target voltage 4 w1		
Target voltage 1 w2		
Target voltage 2 w2		
Target voltage 3 w2		
Target voltage 4 w2		
Volt. cont. 2W, 3W, and GC		
Bandwidth	0.2 % to 10.0 %	Increments of 0.1 %
T1 delay	5 s to 600 s	Increments of 1 s
T1 Inverse Min	5 s to 100 s	Increments of 1 s
T2 delay	0 s to 100 s	Increments of 1 s
Fast step down limit	0.0 % to 50.0 %	Increments of 0.1 %
Fast step down T delay	0.0 s to 10.0 s	Increments of 0.1 s
Fast step up limit	-50.0 % to 0.0 %	Increments of 0.1 %
Fast step up T delay	0.0 s to 10.0 s	Increments of 0.1 s
Function monitoring	0 min to 120 min	Increments of 1 min
Line compensation LDC-Z		
Target voltage rising	0.0 % to 20.0 %	Increments of 0.1 %
Max load current	0.0 % to 500.0 %	Increments of 0.1 %
Line compensation LDC-XandR (two-winding transformer)		
R line	0.00 Ω to 30.00 Ω	Increments of 0.01 Ω
X line	-30.00 Ω to 30.00 Ω	Increments of 0.01 Ω
Line compensation LDC-XandR		
R line	0.0 Ω to 30.0 Ω	Increments of 0.1 Ω
X line	-30.0 Ω to 30.0 Ω	Increments of 0.1 Ω
Limiting values		
Vmin threshold	10.000 V to 340.000 V	Increments of 0.001 V
Vmin time delay	0 s to 20 s	Increments of 1 s
Vmax threshold	10.000 V to 340.000 V	Increments of 0.001 V

¹⁶⁸ Only visible in the voltage-control operation without parallel operation

¹⁶⁹ Only visible in the voltage-control operation without parallel operation

¹⁷⁰ Only visible in the voltage-control operation without parallel operation

Vmax time delay	0 s to 20 s	Increments of 1 s
Blockings		
V< Threshold	10.000 V to 340.000 V	Increments of 0.001 V
V< Time delay	0 s to 20 s	Increments of 1 s
I> Threshold	10 % to 500 %	Increments of 1 %
I> Time delay	0 s to 20 s	Increments of 1 s
I< Threshold	3 % to 100 %	Increments of 1 %
I< Time delay	0 s to 20 s	Increments of 1 s
Parallel control		
Parallel-transformer id	0 to 8	Increments of 1
Maximal tap difference	1 to 9	Increments of 1
Reactive I control factor	0.01 to 100.00	Increments of 0.01
VT supervision threshold	0.5 % to 10.0 %	Increments of 0.1 %
VT supervision time delay	1 s to 600 s	Increments of 1 s
Circul. current threshold	10 % to 500 %	Increments of 1 %
Circul. current time delay	0 s to 1000 s	Increments of 1 s

Measured Values, Two-Winding Transformer

Measured Value	Description	Primary	Secondary	% Referenced to
V act.	Current, measured positive-sequence voltage (referenced to phase-to-phase)	kV	V	Target voltage of the primary system referenced to the rated voltage
ΔV act.	Voltage difference between the target voltage and the actual voltage	%	%	Voltage difference referenced to the rated voltage of the controlled winding
I load	Current measured load current (positive-sequence system)	A	A	Load current referenced to the rated value of the function
V max	Maximum positive-sequence voltage ever measured (referenced to phase-to-phase)	kV	V	Maximum voltage of the winding referenced to the rated voltage of the winding
V min	Minimum positive-sequence voltage ever measured (reference to phase-to-phase)	kV	V	Minimum voltage of the winding referenced to the rated voltage of the winding
V target	Calculated target voltage with consideration of Z compensation	kV	V	Target voltage of the winding referenced to the rated voltage of the winding
PhAng	Phase angle of the currently measured load current	°	°	-
I load Σ	Sum of the currently measured load currents. Active when line compensation is activated.	A	A	Load current referenced to the rated current of the function
I circul.	Currently measured circulating reactive current	A	A	Circulating reactive current
Vact.m	Currently measured control voltage	kV	V	Current voltage of the control referenced to the rated voltage of the function

Measured Value	Description	Primary	Secondary	% Referenced to
$\Delta V_{act\ V}$	Voltage difference	%	%	Voltage difference referenced to the rated voltage of the function
$\Delta V_{act\ C}$	Voltage difference	%	%	Voltage difference referenced to the rated voltage of the function

Measured Values for Parallel Control, Proxy

Measured Value	Description	Primary	Secondary	% Referenced to
$V_{act.}$	Actual voltage of winding	kV	V	Target voltage of the primary system referenced to the rated voltage of the function
$1/X_{trf.}$	Susceptance, internal value for GOOSE transmission	$1/\Omega$		
I_{load}	Load current	A	-	Load current referenced to the rated current of the function
$PhAng$	Phase angle of the load current relative to the voltage with a power factor of 1.0	°	°	Phase angle of the load current 100 % = 180°

Measured Values, Three-Winding Transformer

Measured Value	Description	Primary	Secondary	% Referenced to
$V_{act.w1}$	Actual voltage of winding 1	kV	V	Target voltage of the primary system referenced to the rated voltage
$V_{act.w2}$	Actual voltage of winding 2	kV	V	Target voltage of the primary system referenced to the rated voltage
$\Delta V_{act.}$	Voltage difference between the target voltage and the actual voltage	%	%	Voltage difference referenced to the rated voltage of the controlled winding
$I_{load\ w1}$	Load current of winding 1	A	A	Load current referenced to the rated current of winding 1
$I_{load\ w2}$	Load current of winding 2	A	A	Load current referenced to the rated current of winding 2
$V_{max\ 1}$	Maximum voltage of winding 1	kV	V	Maximum voltage of winding 1 referenced to the rated voltage of winding 1
$V_{max\ 2}$	Maximum voltage of winding 2	kV	V	Maximum voltage of winding 2 referenced to the rated voltage of winding 2
$V_{min\ 1}$	Minimum voltage of winding 1	kV	V	Minimum voltage of winding 1 referenced to the rated voltage of winding 1
$V_{min\ 2}$	Minimum voltage of winding 2	kV	V	Minimum voltage of winding 2 referenced to the rated voltage of winding 2

Measured Value	Description	Primary	Secondary	% Referenced to
V tar.w1	Target voltage of winding 1	kV	V	Target voltage of winding 1 referenced to the rated voltage of winding 1
V tar.w2	Target voltage of winding 2	kV	V	Target voltage of winding 2 referenced to the rated voltage of winding 2

Measured Values Grid Coupling Transformer

Measured Value	Description	Primary	Secondary	% Referenced to
Vact.w1	Actual voltage of winding 1	kV	V	Target voltage of the primary system referenced to the rated voltage
Vact.w2	Actual voltage of winding 2	kV	V	Target voltage of the primary system referenced to the rated voltage
ΔV act.	Voltage difference between the target voltage and the actual voltage	%	%	Voltage difference referenced to the rated voltage of the controlled winding
I load w1	Load current of winding 1	A	A	Load current referenced to the rated current of winding 1
I load w2	Load current of winding 2	A	A	Load current referenced to the rated current of winding 2
Vmax 1	Maximum voltage of winding 1	kV	V	Maximum voltage of winding 1 referenced to the rated voltage of winding 1
Vmax 2	Maximum voltage of winding 2	kV	V	Maximum voltage of winding 2 referenced to the rated voltage of winding 2
Vmin 1	Minimum voltage of winding 1	kV	V	Minimum voltage of winding 1 referenced to rated voltage of winding 1
Vmin 2	Minimum voltage of winding 2	kV	V	Minimum voltage of winding 2 referenced to rated voltage of winding 2
V tar.w1	Target voltage of winding 1	kV	V	Target voltage of winding 1 referenced to the rated voltage of winding 1
V tar.w2	Target voltage of winding 2	kV	V	Target voltage of winding 2 referenced to the rated voltage of winding 2

Dropout Ratio

Threshold of the voltage limit	About 0.98 of the setting value
Threshold of the current limit	About 0.95 of the setting value

12.64 Current-Balance Supervision

Setting Values

Release threshold	1 A @ 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	1 A @ 50 I _{rated}		
	5 A @ 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	5 A @ 50 I _{rated}		
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Threshold min/max		0.10 to 0.95	Increments of 0.01
Delay failure indication		0.00 s to 100.00 s	Increments of 0.01 s

Dropout Ratio

Overcurrent dropout ratio	Approx. 0.97
Undercurrent dropout ratio	Approx. 1.05

Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

12.65 Voltage-Balance Supervision

Setting Values

Release threshold	0.300 V to 170.000 V	Increments of 0.001 V
Threshold min/max	0.58 to 0.95	Increments of 0.01
Delay failure indication	0.00 s to 100.00 s	Increments of 0.01 s

Dropout Ratio

Overvoltage dropout ratio	Approx. 0.97
Undervoltage dropout ratio	Approx. 1.05

Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

12.66 Current-Sum Supervision

Setting Values

Slope factor		0.00 to 0.95	Increments of 0.01
Threshold	1 A @ 50 and 100 Irated	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A	Increments 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Delay failure indication		0.00 s to 100.00 s	Increments of 0.01 s

Dropout Ratio

Dropout ratio	Approx. 0.97
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Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

12.67 Voltage-Sum Supervision

Setting Values

Threshold	0.300 V to 170.000 V	Increments of 0.001 V
Delay failure indication	0.00 s to 100.00 s	Increments of 0.01 s

Dropout Ratio

Dropout ratio	Approx. 0.97
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Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

12.68 Current Phase-Rotation Supervision

Setting Values

Tripping delay	0.00 s to 100.00 s	Increments of 0.01 s
Phase-rotation direction	A B C A C B	

Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

12.69 Voltage Phase-Rotation Supervision

Setting Values

Tripping delay	0.00 s to 100.00 s	Increments of 0.01 s
Phase-rotation direction	A B C A C B	

Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

12.70 Voltage-Comparison Supervision

Times

Alarm times	Approx. 3 ms to 12 ms + OOT ¹⁷¹ at 50 Hz Approx. 2.5 ms to 10 ms + OOT at 60 Hz
Dropout time	20 ms

Frequency Operating Range

$10 \text{ Hz} \leq f \leq 90 \text{ Hz}$	According to specified tolerances
$f < 10 \text{ Hz}$	Inactive
$f > 90 \text{ Hz}$	

Tolerances

Pickup threshold	
Voltage	0.5 % of the setting value or 0.05 V

¹⁷¹ OOT (Output Operating Time): extra delay of the output medium used

12.71 Trip-Circuit Supervision

Setting Values

Number of monitored circuits per circuit-breaker function group	1 to 3	
Operating mode per circuit	With 1 binary input With 2 binary inputs	
Pickup and dropout time	About 1 s to 2 s	
Adjustable indication delay with 1 binary input	1.00 s to 600.00 s	Increments of 0.01 s
Adjustable indication delay with 2 binary inputs	1.00 s to 600.00 s	Increments of 0.01 s

12.72 Closing-Circuit Supervision

Setting Values

Operating mode per circuit	With 1 binary input With 2 binary inputs	
Adjustable indication delay with 1 binary input	1.00 s to 600.00 s	Increments of 0.01 s
Adjustable indication delay with 2 binary inputs	1.00 s to 30.00 s	Increments of 0.01 s

12.73 Analog Channel Supervision via Fast Current Sum

Times

Pickup times	Approx. 2 ms (faster than the fastest protection function)
Dropout time	Approx. 100 ms

Blockings

Blocked functions	All functions that process the measured values from this current measuring point (for example, differential protection).
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12.74 Measuring-Voltage Failure Detection

Setting Values

3ph.fail. - VA,VB,VC <		0.300 V to 340 000 V	Increments of 0.001 V
3ph.fail. - phs.curr.release	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
3ph.fail. - phs.curr. jump	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Asym.fail. - time delay		0.00 s to 30.00 s	Increments of 0.01 s
SO 3ph.fail. - time delay		0.00 s to 30.00 s	Increments of 0.01 s

Dropout

The larger dropout differential (= | **pickup value** - **dropout threshold** |) of the following 2 criteria is used:

Dropout differential derived from the parameter Dropout ratio	
If this parameter is not available, a dropout ratio of 95 % applies to the current threshold value and a dropout ratio of 105 % applies to the voltage threshold value.	
Minimum absolute dropout differential	150 mV sec.

Times

Pickup time	Approx. 10 ms + OOT ¹⁷² at 50 Hz Approx. 10 ms + OOT at 60 Hz
Dropout time	Approx. 20 ms + OOT

Times

Use in function group Line	
Pickup time	Approx. 10 ms + OOT ¹⁷³ at 50 Hz Approx. 9 ms + OOT at 60 Hz
Use in other function group types	
Pickup time	Approx. 20 ms + OOT ¹⁷⁴ at 50 Hz Approx. 18 ms + OOT at 60 Hz

¹⁷² OOT (Output Operating Time) Additional delay of the output medium used, see chapter [12.1.4 Relay Outputs](#)

¹⁷³ OOT (Output Operating Time) Additional delay of the output medium used, for example 5 ms with fast relays, see chapter [12.1.4 Relay Outputs](#)

¹⁷⁴ OOT (Output Operating Time) Additional delay of the output medium used, for example 5 ms with fast relays, see chapter [12.1.4 Relay Outputs](#)

Frequency Operating Range

$0.9 \leq f/f_{\text{rated}} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{\text{rated}}$ $1.1 f_{\text{rated}} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	Active

Tolerances

Currents	1 % of the setting value or 5 mA ($I_{\text{rated}} = 1 \text{ A}$) or 25 mA ($I_{\text{rated}} = 5 \text{ A}$), ($f_{\text{rated}} \pm 10 \%$)
Voltages	0.5 % of the setting value or 0.5 V
Time delays	1 % of the setting value or 10 ms

12.75 Voltage-Transformer Circuit Breaker

Setting Values

Response time	0.000 s to 0.030 s	Increments of 0.001 s
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12.76 Operational Measured Values and Statistical Values

The following applies to the tolerances of currents and voltages:

- The values apply both to the RMS values and the absolute value and phase angle of the fundamental components.
- The values were determined for pure sinusoidal signals – without harmonics.
- All measured values have an additional tolerance of 1 DIGIT.

Voltages

V_A, V_B, V_C Voltage range	V secondary < 200 V secondary
Secondary rated voltage Measuring range Frequency range	100 V to 125 V (0.1 to 2) · V_{rated} 49 Hz to 51 Hz at $f_{rated} = 50$ Hz 59 Hz to 61 Hz at $f_{rated} = 60$ Hz
Tolerance	0.2 % of the measured value in the above-mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at $f_{rated} = 50$ Hz 55 Hz to 65 Hz at $f_{rated} = 60$ Hz
Tolerance	0.3 % of the measured value in the above-mentioned measuring range
V_{AB}, V_{BC}, V_{CA} Voltage range	V secondary < 200 V
Secondary rated voltage Measuring range Frequency range	100 V to 125 V (0.1 to 2) · V_{rated} 49 Hz to 51 Hz at $f_{rated} = 50$ Hz 59 Hz to 61 Hz at $f_{rated} = 60$ Hz
Tolerance	0.2 % of the measured value in the above-mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at $f_{rated} = 50$ Hz 55 Hz to 65 Hz at $f_{rated} = 60$ Hz
Tolerance	0.3 % of the measured value in the above-mentioned measuring range

Currents, Instrument Transformers

$I_A, I_B, I_C, 3I_0$ Current range	A secondary < 1.6 I_{rated}
Rated currents Measuring range Frequency range	1 A, 5 A (0.1 to 1.6) · I_{rated} 49 Hz to 51 Hz at $f_{rated} = 50$ Hz 59 Hz to 61 Hz at $f_{rated} = 60$ Hz
Tolerance	0.1 % of the measured value in the above-mentioned measuring range

Frequency range (expanded)	45 Hz to 55 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 55 Hz to 65 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.3 % of the measured value in the above-mentioned measuring range

Currents, Protection-Class Current Transformer

$I_A, I_B, I_C, 3I_0$ Current range	A secondary < $100 I_{\text{rated}}$
Rated currents Measuring range Frequency range	1 A, 5 A (0.1 to 5) · I_{rated} 49 Hz to 51 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 59 Hz to 61 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.2 % of the measured value in the above-mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 55 Hz to 65 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.3 % of the measured value in the above-mentioned measuring range

Currents, Protection-Class Current Transformer

$I_A, I_B, I_C, 3I_0$ Current range	A secondary < $50 I_{\text{rated}}$
Rated currents Measuring range Frequency range	1 A, 5 A (0.1 to 5) · I_{rated} 49 Hz to 51 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 59 Hz to 61 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.2 % of the measured value in the above-mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 55 Hz to 65 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.3 % of the measured value in the above-mentioned measuring range

Currents, Sensitive Ground-Current Transformer

$3I_0$ Current range	A secondary < $1.6 I_{\text{rated}}$
Rated currents Measuring range Frequency range	1 A, 5 A (0.1 to 1.6) · I_{rated} 49 Hz to 51 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 59 Hz to 61 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.1 % of the measured value in the above-mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 55 Hz to 65 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.3 % of the measured value in the above-mentioned measuring range

Phase Angle

ΦV	°
Frequency range	47.5 Hz to 52.5 Hz at $f_{rated} = 50$ Hz 57.5 Hz to 62.5 Hz at $f_{rated} = 60$ Hz
Tolerance ΦV	0.2° at rated voltage
ΦI	°
Frequency range	47.5 Hz to 52.5 Hz at $f_{rated} = 50$ Hz 57.5 Hz to 62.5 Hz at $f_{rated} = 60$ Hz
Tolerance ΦI	0.2° at rated current

Power Values

Active power P	W secondary
Voltage range	$(0.8 \text{ to } 1.2) \cdot V_{rated}$
Current range	$(0.1 \text{ to } 2) \cdot I_{rated}$
Frequency range	45 Hz to 55 Hz at $f_{rated} = 50$ Hz 55 Hz to 65 Hz at $f_{rated} = 60$ Hz
Power factor	$ \cos\phi \geq 0.707$
Tolerance	0.5 % of S_{rated} in the above-mentioned measuring range
Reactive power Q	var secondary
Voltage range	$(0.8 \text{ to } 1.2) \cdot V_{rated}$
Current range	$(0.1 \text{ to } 2) \cdot I_{rated}$
Frequency range	45 Hz to 55 Hz at $f_{rated} = 50$ Hz 55 Hz to 65 Hz at $f_{rated} = 60$ Hz
Power factor	$ \cos\phi \leq 0.707$
Tolerance	0.5 % of S_{rated} in the above-mentioned measuring range
Apparent power S	VA secondary
Voltage range	$(0.8 \text{ to } 1.2) \cdot V_{rated}$
Current range	$(0.01 \text{ to } 2) \cdot I_{rated}$
Frequency range	45 Hz to 55 Hz at $f_{rated} = 50$ Hz 55 Hz to 65 Hz at $f_{rated} = 60$ Hz
Tolerance	0.5 % of S_{rated} in the above-mentioned measuring range

Power Factor

Voltage range	$(0.8 \text{ to } 1.2) \cdot V_{rated}$
Current range	$(0.1 \text{ to } 2) \cdot I_{rated}$
Frequency range	45 Hz to 55 Hz at $f_{rated} = 50$ Hz 55 Hz to 65 Hz at $f_{rated} = 60$ Hz
Tolerance	0.02 in the above-mentioned measuring range

Frequency

Frequency f	Hz
Range	$f_{\text{rated}} - 0.20 \text{ Hz} \leq f \leq f_{\text{rated}} + 0.20 \text{ Hz}$
Tolerance	$\pm 2 \text{ mHz}$ at $V = V_{\text{rated}}$ or at $I = I_{\text{rated}}$
Range	$f_{\text{rated}} - 3.00 \text{ Hz} \leq f < f_{\text{rated}} + 3.00 \text{ Hz}$
Tolerance	$\pm 5 \text{ mHz}$ at $V = V_{\text{rated}}$ or at $I = I_{\text{rated}}$
Range	25 Hz to 80 Hz; operational measured values 10 Hz to 90 Hz; functional measured values, system frequency
Tolerance	$\pm 10 \text{ mHz}$ at $V = V_{\text{rated}}$ or at $I = I_{\text{rated}}$

Statistical Values of the Device

Device operating hours	h
Range	0 to 9999999 h
Tolerance	1 h

Statistical Values of the Circuit Breaker

Op.cnt. (operation counter)	
Range	0 to 999999999
Tolerance	None
$\Sigma I \text{ Off}$ (sum of the primary currents switched off)	A, kA, MA, GA, TA, PA primary
Range	0 to 9.2×10^{15}
Operating hours	h
Range	0 to 9999999 h
Tolerance	1 h
Circuit breaker open hours	h
Range	0 to 9999999 h
Tolerance	1 h

Statistical Values of the Disconnecter

Op.cnt. (operation counter)	
Range	0 to 999999999
Tolerance	None

12.77 THD and Harmonics

Current Stage

Current range (I_a , I_b , I_c)	Instrument transformer: $< 1.6 I_{rated}$ Protection transformer: $< 100 I_{rated}$ for modular devices $< 50 I_{rated}$ for non-modular devices
Frequency range	$0.9 f_{rated}$ to $1.1 f_{rated}$
Tolerance of the THD value	0.5 % in the measured range
Tolerance of the 2nd to 20th harmonics	0.5 % in the measured range

Voltage Stage

Voltage range (V_a , V_b , V_c)	V secondary $< 200 \text{ V}$
Frequency range	$0.9 f_{rated}$ to $1.1 f_{rated}$
Tolerance of the THD value	0.5 % in the measured range
Tolerance of the 2nd to 20th harmonics	0.5 % in the measured range

12.78 Energy Values

Setting Values

Active energy W_p	kWh, MWh, GWh
Measuring range	$ \cos\phi \geq 0.01$
Voltage range	$(0.8 \text{ to } 1.2) \cdot V_{\text{rated}}$
Current range	$(0.1 \text{ to } 2) \cdot I_{\text{rated}}$
Frequency range	49 Hz to 51 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 59 Hz to 61 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.3 % of the measured value in the above mentioned measuring range
Frequency range (expanded)	40 Hz to 69 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 50 Hz to 70 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	0.5 % of the measured value in the above mentioned measuring range

Reactive energy W_q	kvarh, Mvarh, Gvarh
Measuring range	$ \cos\phi \leq 0,984$
Voltage range	$(0.8 \text{ to } 1.2) \cdot V_{\text{rated}}$
Current range	$(0.1 \text{ to } 2) \cdot I_{\text{rated}}$
Frequency range	49 Hz to 51 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 59 Hz to 61 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	1.0 % of the measured value in the above mentioned measuring range
Frequency range (expanded)	40 Hz to 69 Hz at $f_{\text{rated}} = 50 \text{ Hz}$ 50 Hz to 70 Hz at $f_{\text{rated}} = 60 \text{ Hz}$
Tolerance	1.5 % of the measured value in the above mentioned measuring range

12.79 Phasor Measurement Unit

Accuracy

IEEE Standard for Synchrophasor
Measurements

IEEE Std C37.118.1a™-2014

Data Transfer

IEEE Standard for Synchrophasor
Data transfer

IEEE Std C37.118.2™-2011

12.80 Circuit-Breaker Wear Monitoring

Setting Values

Threshold value	ΣI^x -method stage	0 to 10 000 000	Increments of 1
	2P-method stage	0 to 10 000 000	Increments of 1
	I^2t -method stage	0.00 I/I _r *s to 21 400 000.00 I/I _r *s	Increments of 0.01
CB opening time		0.001 s to 0.500 s	Increments of 0.001 s
CB break time		0.001 s to 0.600 s	Increments of 0.001 s
CB make time		0.001 s to 0.600 s	Increments of 0.001 s
Exponent for the ΣI^x method		1.0 to 3.0	Increments of 0.1
Switching cycles at I_{rated}		100 to 1 000 000	Increments of 1
Rated short-circuit breaking current I_{sc}		10 to 100 000	Increments of 1
Switching cycles at I_{sc}		1 to 1000	Increments of 1
Level of warning 1		1 % to 100 %	Increments of 1 %
Level of warning 2		1 % to 100 %	Increments of 1 %
Operating current threshold	1 A @ 50 and 100 I _{rated}	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 I _{rated}	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 I _{rated}	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 I _{rated}	0.005 A to 8.000 A	Increments of 0.001 A
Delay correction time		-0.050 s to 0.050 s	Increments of 0.001 s

Tolerances

Tolerance of the measured value make time	± 2 ms
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12.81 CFC

Typical response times and maximum number of ticks of the CFC task levels:

Task Level	Time (in ms)	Ticks for Non-Modular Devices with CP100	Ticks for Modular Devices with CP200	Ticks for Modular Devices with CP300
Fast Event-Triggered	< 1	500	500	1000
Event-Triggered	<10	12 367	12 757	14 702
Interlocking	<10	117 564 in total	121 537 in total	141 398 in total
Measurement	250			

The times describe the response time of a typical CFC chart at the respective task level. The maximum number of ticks applies to a typical load for the device based on the application template **Directional overcurrent protection, grounded system**. The maximum number can be lower in case of extensive protection applications.

The task level **Measurement** runs in cycles every 500 ms. All other task levels are event-triggered.

In order to estimate the tick consumption of a CFC chart, you can use the following formula:

$$T_{\text{Chart}} = 5 \cdot n_{\text{Inp}} + 5 \cdot n_{\text{Outp}} + T_{\text{TLev}} + \sum_i T_{\text{int}} + \sum_j T_{\text{Block}}$$

where:

- n_{Inp} Number of indications routed as input in the CFC chart
- n_{Outp} Number of indications routed as output in the CFC chart
- T_{TLev} 101 Ticks in Fast Event-Triggered level
104 Ticks in Event-Triggered level
54 Ticks in Measurement level
74 Ticks in Interlocking level
- T_{int} Number of internal connections between 2 CFC blocks in one chart
- T_{Block} Used ticks per CFC block (see [Table 12-9](#))

Table 12-9 Ticks of the Individual CFC Blocks

Element	Ticks
ABS_D	2.3
ABS_R	1.5
ACOS_R	6.9
ADD_D4	3.4
ADD_R4	3.3
ADD_XMV	6.4
ALARM	1.8
AND_SPS	1.1
AND10	2.9
APC_DEF	1.2
APC_EXE	1.0
APC_INFO	3.9
ASIN_R	1.3
ATAN_R	1.2
BLINK	1.3
BOOL_CNT	2.0
BOOL_INT	1.5

Element	Ticks
BSC_DEF	1.3
BSC_EXE	1.1
BSC_INFO	2.7
BUILD_ACD	2.9
BUILD_ACT	2.2
BUILD_BSC	1.2
BUILD_CMV	2.3
BUILD_DEL	2.1
BUILD_DPS	1.4
BUILD_ENS	1.3
BUILD_INS	0.5
BUILD_Q	0.8
BUILD_SPS	0.6
BUILD_WYE	3.2
BUILD_XMV	2.9
BUILDQ_Q	3.0
CHART_STATE	5.9
CMP_DPS	1.5
CON_ACD	0.7
CON_ACT	0.5
CONNECT	0.4
COS_R	2.5
CTD	1.8
CTU	1.6
CTUD	2.3
DINT_REAL	3.0
DINT_UINT	3.0
DIV_D	2.9
DIV_R	1.6
DIV_XMV	2.2
DPC_DEF	0.4
DPC_EXE	0.4
DPC_INFO	1.1
DPC_OUT	1.3
DPS_SPS	1.0
DRAGI_R	1.7
ENC_DEF	3.6
ENC_EXE	3.8
EQ_D	1.0
EQ_R	1.9
EXP_R	1.5
EXPT_R	2.7
F_TRGM	0.3
F_TRIG	0.3
FF_D	0.9
FF_D_MEM	1.4
FF_RS	0.7

Element	Ticks
FF_RS_MEM	1.2
FF_SR	0.8
FF_SR_MEM	1.1
GE_D	0.9
GE_R	1.1
GT_D	0.9
GT_R	1.2
HOLD_D	1.1
HOLD_R	1.0
INC_INFO	0.9
LE_D	1.1
LE_R	1.1
LIML_R	1.5
LIMU_R	1.5
LN_R	3.3
LOG_R	1.2
LOOP	1.5
LT_D	0.9
LT_R	0.9
MAX_D	0.9
MAX_R	1.4
MEMORY_D	0.9
MEMORY_R	1.1
MIN_D	0.7
MIN_R	1.3
MOD_D	1.5
MUL_D4	2.5
MUL_R4	2.7
MUL_XMV	2.8
MUX_D	1.2
MUX_R	0.9
NAND10	3.5
NE_D	0.9
NE_R	0.9
NEG	1.2
NEG_SPS	0.8
NL_LZ	3.8
NL_MV	5.6
NL_ZP	2.7
NOR10	3.2
OR_DYN	1.1
OR_SPS	1.3
OR10	2.6
R_TRGM	0.4
R_TRIG	0.4
REAL_DINT	3.0
REAL_SXMV	3.0

Element	Ticks
SIN_R	0.8
SPC_DEF	0.4
SPC_EXE	0.4
SPC_INFO	0.4
SPC_OUT	0.4
SPLIT_ACD	3.4
SPLIT_ACT	1.0
SPLIT_BSC	1.3
SPLIT_CMV	2.2
SPLIT_DEL	2.0
SPLIT_DPS	1.0
SPLIT_INS	0.5
SPLIT_Q	0.7
SPLIT_SPS	0.8
SPLIT_WYE	2.6
SPLIT_XMV	2.1
SQRT_R	0.6
SUB_D	1.3
SUB_R	1.6
SUB_XMV	2.4
SUBST_B	1.0
SUBST_BQ	1.5
SUBST_D	1.0
SUBST_R	1.0
SUBST_XQ	1.4
SXMV_REAL	3.0
TAN_R	1.1
TLONG	2.2
TOF	1.0
TON	1.1
TP	2.5
TSHORT	1.9
UINT_DINT	3.0
XOR2	2.6

12.82 Point-on-Wave Switching

You can find more information about the technical data of the **Point-on-wave switching** function in the Point-on-Wave Switching Function Manual.

