SIPROTEC Compact 7SD80 Line Differential Protection

V4.7

Technical Data

Extract from manual E50417-G1140-C474-A2, chapter 4

Energy Automation

SIEMENS

NOTE

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

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Preface

Purpose of the Manual

This manual describes the functions, operation, installation, and commissioning of devices 7SD80. In particular, one will find:

- Information regarding the configuration of the scope of the device and a description of the device functions and settings → Chapter 2;
- Instructions for Installation and Commissioning → Chapter 3;
- Compilation of the Technical Data → Chapter 4;
- As well as a compilation of the most significant data for advanced users → Appendix.

General information with regard to design, configuration, and operation of SIPROTEC 4 devices are set out in the SIPROTEC 4 System Description */1/ SIPROTEC 4 System Description*.

Target Audience

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

Scope

This manual applies to: SIPROTEC 4 Line Differential Protection 7SD80; Firmware-Version V4.7.

Indication of Conformity

CE	This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage Directive 2006/95 EC). This conformity is proved by tests conducted by Siemens AG in accordance with the Council Directive in agreement with the generic standards EN 61000-6-2 and EN 61000-6-4 for EMC directive, and with the standard EN 60255-27 for the low-voltage directive. The device has been designed and produced for industrial use. The product conforms with the international standards of the series IEC 60255 and the German standard VDE 0435.

Additional Standards IEEE Std C37.90 (see Chapter 4 "Technical Data")

This product is UL-certified according to the Technical Data. file E194016

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Additional Support

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

Support

Our Customer Support Center provides a 24-hour service.

Phone:	+49 (180) 524-7000
Fax:	+49 (180) 524-2471
E-Mail:	*support.energy@siemens.com*

Training Courses

Inquiries regarding individual training courses should be addressed to our Training Center:

Siemens AG
Siemens Power Academy TD

Humboldtstraße 59
90459 Nürnberg
Germany

Phone:	+49 (911) 433-7415
Fax:	+49 (911) 433-7929
E-Mail:	*poweracademy@siemens.com*
Internet:	*www.siemens.com/poweracademy*

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 particular 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.

Typographic and Symbol Conventions

The following text formats are used when literal information from the device or to the device appear in the text flow:

`Parameter Names`

Designators of configuration or function parameters which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are marked in bold letters in monospace type style. The same applies to titles of menus.

`1234A`

Parameter addresses have the same character style as parameter names. Parameter addresses contain the suffix **`A`** in the overview tables if the parameter can only be set in DIGSI via the option **Display additional settings**.

`Parameter Options`

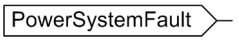
Possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are additionally written in italics. The same applies to the options of the menus.

Indications

Designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

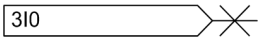
Deviations may be permitted in drawings and tables when the type of designator can be obviously derived from the illustration.

The following symbols are used in drawings:

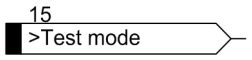


Device-internal logical input signal

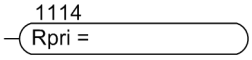
Device-internal logical output signal



Internal input signal of an analog quantity

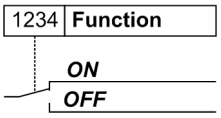


External binary input signal with number (binary input, input indication)



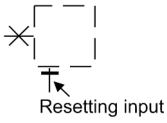
External binary output signal with number (example of a value indication)

External binary output signal with number (device indication) used as input signal

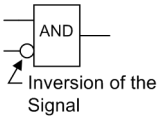


Example of a parameter switch designated **FUNCTION** with address 1234 and the possible settings ***ON*** and ***OFF***

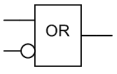
Besides these, graphical symbols are used in accordance with IEC 60617-12 and IEC 60617-13 or similar. Some of the most frequently used are listed below:



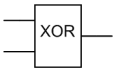
Analog input variable



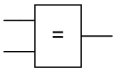
AND-gate operation of input values



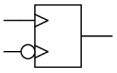
OR-gate operation of input values



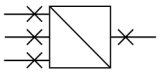
Exclusive OR gate (antivalence): output is active, if only **one** of the inputs is active



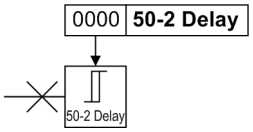
Coincidence gate: output is active, if **both** inputs are active or inactive at the same time



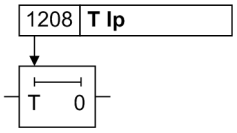
Dynamic inputs (edge-triggered) above with positive, below with negative edge



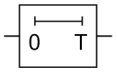
Formation of one analog output signal from a number of analog input signals



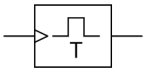
Limit stage with setting address and parameter designator (name)



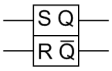
Timer (pickup delay T, example adjustable) with setting address and parameter designator (name)



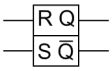
Timer (dropout delay T, example non-adjustable)



Dynamic triggered pulse timer T (monoflop)



Static memory (SR flipflop) with setting input (S), resetting input (R), output (Q) and inverted output ($\overline{Q}$), setting input dominant



Static memory (RS-flipflop) with setting input (S), resetting input (R), output (Q) and inverted output ($\overline{Q}$), resetting input dominant

Open Source Software

The product contains, among other things, Open Source Software developed by third parties. The Open Source Software used in the product and the license agreements concerning this software can be found in the Readme_OSS. These Open Source Software files are protected by copyright. Your compliance with those license conditions will entitle you to use the Open Source Software as foreseen in the relevant license. In the event of conflicts between Siemens license conditions and the Open Source Software license conditions, the Open Source Software conditions shall prevail with respect to the Open Source Software portions of the software. The Open Source Software is licensed royalty-free. Insofar as the applicable Open Source Software License Conditions provide for it you can order the source code of the Open Source Software from your Siemens sales contact - against payment of the shipping and handling charges - for a period of at least 3 years since purchase of the Product. We are liable for the Product including the Open Source Software contained in it pursuant to the license conditions applicable to the Product. Any liability for the Open Source Software beyond the program flow intended for the Product is explicitly excluded. Furthermore any liability for defects resulting from modifications to the Open Source Software by you or third parties is excluded. We do not provide any technical support for the Product if it has been modified.

4 Technical Data

This chapter provides the technical data of the device SIPROTEC 7SD80 and its individual functions, including the limit values that may not be exceeded under any circumstances. The electrical and functional data for the maximum functional scope are followed by the mechanical specifications with dimensioned drawings.

4.1 General Device Data

4.1.1 Analog Inputs

Current Inputs

Nominal Frequency	f_{Nom}	50 Hz or 60 Hz	(adjustable)
Operating range frequency (not dependent on the nominal frequency)		25 Hz to 70 Hz	
Nominal current	I_{Nom}	1 A or 5 A	
Ground current, sensitive	I_{Ns}	≤ 1.6· I_{Nom} linear range [1]	
Burden per phase and ground path - at I_{Nom} = 1 A - at I_N = 5 A -for sensitive ground fault detection at 1 A - for sensitive ground fault detection at 5 A		 ≤ 0.05 VA ≤ 0.3 VA ≤ 0.05 VA ≤ 0.3 VA	
Load capacity current path - thermal (rms) - dynamic (peak value)		 500 A for 1 s 150 A for 10 s 20 A continuous 1250 A (half-cycle)	
Load capacity input for sensitive ground fault detection I_{Ns} [1]			
- thermal (rms) - dynamic (peak value)		300 A for 1 s 100 A for 10 s 15 A continuous 750 A (half-cycle)	
[1] only in models with input for sensitive ground fault detection (see ordering data in the Appendix)			

Voltage inputs

Nominal voltage		34 V – 225 V (adjustable) for connection of phase-to-ground voltages 34 V – 200 V (adjustable) for connection of phase-to-phase voltages
Measuring Range		0 V to 200 V
Burden	at 100 V	approx. 0.005 VA
Overload capacity in the voltage path		
– thermal (rms)		230 V continuous

4.1.2 Auxiliary Voltage

DC Voltage

Voltage supply via an integrated converter		
Nominal auxiliary DC voltage V_{Aux}	DC 24 V to 48 V	DC 60 V to 250 V
Permissible voltage ranges	DC 19 V to 60 V	DC 48 V to 300 V
Overvoltage category, IEC 60255-27	III	
AC ripple voltage peak to peak, IEC 60255-11	15 % of auxiliary voltage	

Power input	Quiescent	Energized
7SD80	approx. 5 W	approx 12 W

Bridging time for failure/short-circuits, IEC 60255-11	≥ 50 ms at V ≥ 110 V
	≥ 10 ms at V < 110 V

AC Voltage

Voltage supply via an integrated converter		
Nominal auxiliary AC voltage V_{Aux}	AC 115 V	AC 230 V
Permissible voltage ranges	AC 92 V to 132 V	AC 184 V to 265 V
Overvoltage category, IEC 60255-27	III	

Power input (at AC 115 V/230 V)	< 15 VA
Bridging time for failure/short-circuit	≥ 10 ms at V = 115 V/230 V

4.1.3 Binary Inputs and Outputs

Binary Inputs

Variant	Quantity	
7SD80	3, 5, 7 (configurable) depending on ordering code	
Range of rated direct voltage	24 V to 250 V	
Current input, energized (independent of the control voltage)	approx. 0.4 mA	
Pickup time Response time binary output after trigger signal from binary input	approx. 3 ms approx. 9 ms	
Dropout time Response time binary output after trigger signal from binary input	approx. 4 ms approx. 5 ms	
Secured switching thresholds	(adjustable)	
For rated voltages	DC 24 V to 125 V	V high > DC 19 V V low < DC 10 V
For rated voltages	DC 110 V to 250 V	V high > DC 88 V V low < DC 44 V
For rated voltages	DC 220 V and 250 V	V high > DC 176 V V low < DC 88 V
Maximum admissible voltage	DC 300 V	
Input interference suppression	220 V induced above 220 nF at a recovery time between two switching operations ≥ 60 ms	

Binary Output

Signal/command relay, alarm relay		
Quantity and data	depending on the order variant (configurable)	
Order variant	NO contact	Changeover contact
7SD80	5, 8 depending on ordering code	2 (+ 1 life contact not configurable)
Switching capability MAKE	1000 W / 1000 VA	
Switching capability BREAK	40 W or 30 VA at L/R ≤ 40 ms	
Switching voltage AC and DC	250 V	
Permissible current per contact (continuous)	5 A	
Permissible current per contact (close and hold)	30 A for 1 s (NO contact)	

Interference suppression capacitor at the relay outputs 2.2 nF, 250 V, ceramic	Frequency	Impedance
	50 Hz	$1.4 \cdot 10^6\ \Omega \pm 20\ \%$
	60 Hz	$1.2 \cdot 10^6\ \Omega \pm 20\ \%$

4.1.4 Communication Interfaces

Protection Data Interfaces

See Section 4.2 “Protection Data Interfaces”

Operator Interface

Terminal	Front side, non-isolated, USB type B socket for connecting a personal computer Operation from DIGSI V4.82 via USB 2.0 full speed
Operation	with DIGSI
Transmission speed	up to 12 MBit/s max.
Bridgeable distance	5 m

Port B

IEC 60870-5-103 single	
RS232/RS485/FO depending on the order variant	Isolated interface for data transfer to a control center
RS232	
Terminal	Back case bottom, mounting location "B", 9- pin DSUB socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	min. 1,200 Bd, max. 115,000 Bd; factory setting 9,600 Bd
Bridgeable distance	15 m
RS485	
Terminal	Back case bottom, mounting location "B", 9- pin DSUB socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	min. 1,200 Bd, max. 115,000 Bd; factory setting 9,600 Bd
Bridgeable distance	max. 1 km
Fiber optic cable (FO)	
FO connector type	ST connector
Terminal	Back case bottom, mounting location "B"
Optical wavelength	λ = 820 nm
Laser Class 1 according to EN 60825-1/-2	When using glass fiber 50 µm/125 µm or glass fiber 62.5 µm/125 µm
Permissible optical signal attenuation	max. 8 dB, with glass fiber 62.5/125 µm
Bridgeable distance	max. 1.5 km
Character idle state	Configurable; factory setting “Light off”

IEC 60870-5-103 redundant, RS485	
Isolated interface for data transfer to a control center	
Terminal	Back case bottom, mounting location "B", RJ45 socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	min. 2,400 Bd, max. 57,600 Bd; factory setting 19,200 Bd
Bridgeable distance	max. 1 km
Profibus RS485 (DP)	
Terminal	Back case bottom, mounting location "B", 9- pin DSUB socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	Up to 1.5 MBd
Bridgeable distance	1 000 m (3 300 ft) at ≤ 93.75 kBd 500 m (1 600 ft) at ≤ 187.5 kBd 200 m (660 ft) at ≤ 1.5 MBd
Profibus FO (DP)	
FO connector type	ST connector Double ring
Terminal	Back case bottom, mounting location "B"
Transmission speed	bis 1.5 MBd
Recommended:	> 500 kBd with normal casing
Optical wavelength	λ = 820 nm
Laser Class 1 according to EN 60825-1/-2	When using glass fiber 50/125 µm or glass fiber 62.5/125 µm
Permissible optical signal attenuation	max. 8 dB, with glass fiber 62.5/125 µm
Bridgeable distance	max. 1.5 km
DNP3.0 /MODBUS RS485	
Terminal	Back case bottom, mounting location "B", 9- pin DSUB socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	up to 19,200 Bd
Bridgeable distance	max. 1 km
DNP3.0 /MODBUS FO	
FO connector type	ST connector transmitter/receiver
Terminal	Back case bottom, mounting location "B"
Transmission speed	up to 19,200 Bd
Optical wavelength	λ = 820 nm
Laser Class 1 according to EN 60825-1/-2	When using glass fiber 50 µm/125 µm or glass fiber 62.5/125 µm
Permissible optical signal attenuation	max. 8 dB, with glass fiber 62.5/125 µm
Bridgeable distance	max. 1.5 km
Ethernet electrical (EN 100) for DIGSI, IEC61850	
Terminal	Back case bottom, mounting location "B", 2 x RJ45 socket 100BaseT according to IEEE802.3

Test voltage (with regard to the socket) (PELV)	500 V; 50 Hz
Transmission speed	100 MBit/s
Bridgeable distance	20 m
Ethernet optical (EN 100) for DIGSI, IEC61850	
Terminal	Back case bottom, mounting location "B", Duplex-LC, 100BaseF according to IEEE802.3
Transmission speed	100 MBit/s
Optical wavelength	1300 nm
Bridgeable distance	max. 2 km (1.24 mi)

4.1.5 Electrical Tests

Standards

Standards:	IEC 60255 IEEE Std C37.90, see individual functions VDE 0435 for more standards see also individual functions

Insulation Tests

Normen:	IEC 60255-27 and IEC 60870-2-1
High voltage test (routine test). All circuits except power supply, binary inputs, communication interfaces and CU protection data interface	2.5 kV, 50 Hz
High voltage test (routine test). Auxiliary voltage and binary inputs	DC 3.5 kV
High voltage test (routine test): isolated communication interfaces (A and B)	500 V, 50 Hz
Voltage test (routine test) CU protection data interface[1)]	DC 70 V
Impulse voltage test (type test), all processor circuits against each other and against the grounding terminal (except communication interface and CU protection data interface) category III	5 kV (peak value); 1.2 µs/50 µs; 0.5 J; 3 positive and 3 negative impulses at intervals of 1 s
Impulse voltage test (type test), all processor circuits against the internal electronics (except communication interface and CU protection data interface)	6 kV (peak value); 1.2 µs/50 µs; 0.5 J; 3 positive and 3 negative impulses at intervals of 1 s
Impulse voltage test (type test), all processor circuits against the CU protection data interface [2)]	6 kV (peak value); 1.2 µs/50 µs; 0.5 J; 3 positive and 3 negative impulses at intervals of 1 s
Voltage test (type test) only CU protection data interface against all processor circuits[2)]	DC 3.5 kV
Voltage test (type test) only CU protection data interface against protective grounding terminal [3)]	1.9 kV, 50 Hz
[1)] Protection circuits through surge arresters on the primary side [2)] (type test) not against protective conductor and internal electronic components. Protection circuits through surge arresters on the primary side [3)] Voltage test without surge arresters (only type test), see also Section 3.1 Mounting and Connections	

EMC Tests for Immunity (Type Tests)

Standards:		IEC 60255-6 and -22, (product standards) IEC/EN 61000-6-2 VDE 0435 For more standards, see the individual tests
1 MHz test, class III IEC 60255-22-1, IEC 61000-4-18, IEEE C37.90.1		2.5 kV (Peak); 1 MHz; τ = 15 µs; 400 Surges per s; Test duration 2 s; R_i = 200 Ω
Electrostatic discharge, class IV IEC 60255-22-2, IEC 61000-4-2		8 kV contact discharge; 15 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
Irradiation with HF field, amplitude-modulated, class III IEC 60255-22-3, IEC 61000-4-3		10 V/m; 80 MHz to 1 GHz; 1.4 GHz to 2.7 GHz 80 % AM; 1 kHz
Fast transient disturbances/burst, class IV IEC 60255-22-4, IEC 61000-4-4, IEEE C37.90.1		4 kV; 5 ns/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; test duration 1 min
High-energy surge voltages installation classIII IEC 60255-22-5, IEC 61000-4-5		Impuls: 1.2 µs/50 µs
	Auxiliary voltage	common mode: 4 kV; 12 Ω; 9 µF diff. mode: 1 kV; 2 Ω; 18 µF
	Measuring inputs and relay outputs	common mode: 4 kV; 42 Ω; 0.5 µF diff. mode: 1 kV; 42 Ω; 0.5 µF
	Binary inputs	common mode: 4 kV; 42 Ω; 0.5 µF diff. mode: 1 kV; 42 Ω; gas-filled tube
	CU protection interface, unscreened, a and b	common mode: 4 kV; 42 Ω; gas-filled tube
	CU protection interface, screened	common mode: 4 kV; 2 Ω; coupling into shield
Line-conducted high frequency, amplitude-modulated, class III IEC 60255-22-6, IEC 61000-4-6		10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Power system frequency magnetic field IEC 61000-4-8, Klasse IV;		30 A/m continuous; 300 A/m for 3 s;
Radiated electromagnetic interference IEEE Std C37.90.2		20 V/m; 80 MHz to 1 GHz; 80 % AM; 1 kHz 35 V/m; 80 MHz to 1GHz; 100 % pulse 1 Hz rep. rate 50% duty cycle
Damped oscillations IEC 61000-4-18		2.5 kV (peak); 100 kHz; 40 pulses per s; test duration 2 s; Ri = 200 Ω

EMC Tests for Noise Emission Test (Type Test)

Standard:	IEC/EN 61000-6-4
Radio noise voltage to lines, only auxiliary voltage IEC-CISPR 11	150 kHz to 30 MHz Limit Class A
Interference field strength IEC-CISPR 11	30 MHz to 1000 MHz Limit Class A

4.1.6 Mechanical Stress Tests

Vibration and Shock Stress during Stationary Operation

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class 2; IEC 60068-2-6	Sinusoidal 10 Hz to 60 Hz: ±0,075 mm amplitude; 60 Hz to 150 Hz: 1g acceleration frequency sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, Class 1; IEC 60068-2-27	Semi-sinusoidal 5 g acceleration, duration 11 ms, each 3 shocks in both directions of the 3 axes
Seismic Vibration IEC 60255-21-3, Class 2; IEC 60068-3-3	Sinusoidal 1 Hz to 8 Hz: ±7,5 mm amplitude (horizontal axis) 1 Hz to 8 Hz: ±3,5 mm amplitude (vertical axis) 8 Hz to 35 Hz: 2 g Beschleunigung (horizontal axis) 8 Hz to 35 Hz: 1 g Beschleunigung (vertical axis) Frequency sweep 1 octave/min 1 cycle in 3 orthogonal axes

Vibration and Shock Stress during Transport

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class 2; IEC 60068-2-6	Sinusoidal 5 Hz to 8 Hz: ±7,5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration Frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, Class 1; IEC 60068-2-27	Semi-sinusoidal 15 g acceleration , duration 11 ms, each 3 shocks (in both directions of the 3 axes)
Continuous Shock IEC 60255-21-2, Class 1; IEC 60068-2-29	Semi-sinusoidal 10 g acceleration , duration 16 ms, each 1000 shocks (in both directions of the 3 axes)

4.1.7 Climatic Stress Tests

Temperatures

Standards:	IEC 60255-6
Type test (in acc. with IEC 60068-2-1 and -2, Test Bd for 16 h)	–25 °C to +85 °C or –13 °F to +185 °F
Permissible temporary operating temperature (tested for 96 h)	–20 °C to +70 °C or –4 °F to +158 °F (clearness of the display may be impaired from +55 °C or +131 °F)
Recommended for permanent operation (in acc. with IEC 60255-6)	–5 °C to +55 °C or +23 °F to +131 °F
Limit temperatures for storage	–25 °C to +55 °C or –13 °F to +131 °F
Limit temperatures for transport	–25 °C to +70 °C or –13 °F to +158 °F
Storage and transport with factory packaging	

Humidity

Permissible humidity	Mean value per year ≤ 75 % relative humidity; on 56 days of the year up to 93 % relative humidity; condensation must be avoided!
Siemens recommends that all devices be installed such that they are not exposed to direct sunlight, nor subject to large fluctuations in temperature that may cause condensation to occur.	

4.1.8 Service Conditions

The protective device is designed for use in an industrial environment and an electrical utility environment. Proper installation procedures should be followed to ensure electromagnetic compatibility (EMC).

In addition, the following is recommended:

- All contacts and relays that operate in the same cubicle, cabinet, or relay panel as the numerical protective device should, as a rule, be equipped with suitable surge suppression components.
- For substations with operating voltages of 100 kV and above, all external cables should be shielded with a conductive shield grounded at both ends. For substations with lower operating voltages, no special measures are normally required.
- Do not withdraw or insert individual modules or boards while the protective device is energized. In withdrawn condition, some components are electrostatically endangered; during handling the ESD standards (for **E**lectrostatic **S**ensitive **D**evices) must be observed. They are not endangered when inserted into the case.

4.1.9 Design

Case	7XP20
Dimensions	see dimensional drawings, Section *4.19 Dimensions*

Device	Case	Size	Weight
7SD80**-*B	for panel surface mounting	$^1/_6$	4.5 kg
7SD80**-*E	for panel flush mounting	$^1/_6$	4 kg

Protection type acc. to IEC 60529	
for equipment in the surface-mounting case	IP 50
for equipment in flush mounting case	Front IP 51 Rear IP 50
for operator protection	IP 2x for current terminal IP 1x for voltage terminal
Degree of pollution, IEC 60255-27	2

4.1.10 UL Certification Conditions

Output Relays	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	1/3 hp
	AC 250 V	1/2 hp
	B300, R300	
Voltage Inputs	Input voltage range	300 V

Battery	Servicing of the circuitry involving the batteries and replacement of the lithium batteries shall be done by a trained technician. Replace Battery with VARTA or Panasonic Cat. Nos. CR 1/2 AA or BR 1/2 AA only. Use of another Battery may present a risk of fire or explosion. See manual for safety instructions. Caution: The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100 °C (212 °F) or incinerate. Dispose of used battery promptly. Keep away from children.	
Climatic Stress Tests	Surrounding air temperature	tsurr: max. 70 °C (158 °F), normal operation
Design	Field Wires of Control Circuits shall be separated from other circuits with respect to the end use requirements!	
	Type 1 if mounted into a door or front cover of an enclosure.	

4.2 Protection Interfaces and Connections

Differential Protection

Number of devices for one protected object (=number of ends delimited by the current transformer)	2

Protection Interfaces

Connection optical fiber	Port "A"
Connection electrical	Voltage terminal "D1" and "D2"
Connection modules for protection data interface, depending on the order variant:	

Optical protection data interface:	
Maximum distance monomode fiber	24 km (14.91 miles)
Maximum distance multimode fiber[1)]	4 km (2.49 miles)
Protocol	Full duplex
Connector type	Duplex-LC-Stecker, SFF (IEC 61754-20 Standard)
Maximum baudrate	512 kBit/s
Transmission rate	min. -15 dBm_{avg} max. -8 dBm_{avg}
Receiver sensitivity (maximum)	-31 dBm_{avg}
Optical wavelength	1310 nm
Optical budget	16.0 dB
Laser Class 1 according to EN 60825-1/-2	Using monomode fiber 9 µm/125 µm
Range	You should assume a path attenuation of 0.5 dB/km (0.8 dB/miles) for monomode and multimode fiber. For multimode fiber you must additionally take the product of the bandwidth lengths into consideration.
[1)] When using multimode fiber, a monomode patch cable is used on the sending side; a multimode patch cable is used on the receiving side (mode conditioning patch cable).	

Electrical protection data interface:	
Maximum distance	16 km (9.94 miles) (for AWG 19 / 0.65 mm^2)
Maximum transmission rate	128 kBit/s
Telecommunication cable or communication cable	twin-wire, e.g. A-2Y(L)2Y-Kabel
Cable attenuation	< 40 dB (for 80 kHz)

Ranges determined during tests[1)]				
Mode	Transmission rate [kbit/s]	maximum range [km]	Attenuation [db]	Signal noise ratio (SNR) [db]
Telephone wire A-2Y(L)2Y 20x2x0.8 twisted, fully screened				
01	64	20	42	12
02	128	18	42	11
03	64	20	39	7
04	128	20	42	6
05	128	16	33	9
06	128	14	28	6
Signal line A-2Y2YB2Y 20x1x1.4 PE insulation material, single wires not twisted, fully screened				
01	64	6	10	36
02	128	6	13	21

03	64	20	23	20
04	128	6	10	30
05	128	14	18	16
06	128	20	23	9
PVC line NYY-J 16x1.5 insulation material, single wires not twisted				
01	64	8	14	11
02	128	6	14	30
03	64	16	24	19
04	128	6	11	30
05	128	12	18	13
06	128	16	24	8

[1)] A multi-wire cable of 1 km length was used to determine the maximum range. The cables were wound on cable reels. The 1 km wires were connected in series to obtain the maximum length. Twisted pair cables allow the use of several similar communication devices (e.g. 3 pairs of 7SD80) within one cable. You should use twisted pair cables to minimize possible interference. Considerable restrictions may occur due to cross-talk effects when using signal cables or underground cables (no telecommunication cables, e.g. auxiliary protection cables with high capacitance per unit length) which are used by several communication devices. The values determined here are examples. The actually possible range depends on the properties of the cable, the number of joints and splices.

To select the modes of the Cu protection interface connection, please observe the following criteria:			
	The connection must be established in the selected mode.		
	The number of message errors (per minute and/or per hour) should be as small as possible (operational measured value).		
	Mode	Signal noise ratio, S/N (the higher this value the better)	Attenuation, D (the smaller this value the better)
	01 and 02	≥ 12 db	≤ 40 dB
	03 and 04	≥ 6 db	≤ 40 dB
	05 and 06	≥ 6 db	≤ 30 dB
	(the signal noise ratio and the attenuation are operational measured values)		
It can be possible to select several modes for a cable. Due the smaller disturbance sensitivity, modes 01 and 03 are recommended. We recommend the following for the lines listed here as examples:			
	Line 1 (telephone line): Mode 03 (largest range 20 km)		
	Line 2 (signal line): Mode 06 (largest range 20 km for high transmission rates)		
	Line 3 (PVC line): Mode 03 (Range 16 km if SNR is good. The high attenuation is due to the range here)		

4.3 87 Differential Protection Phase Comparison Protection

Pickup Values

Differential current, dynamic; **87L Idyn>**	I_{Nom} = 1 A	0.20 A to 4.00 A	Increments 0.01 A
	I_{Nom} = 5 A	1.00 A to 20.00 A	
Differential current when switching onto a fault; **87L Idyn close>**	I_{Nom} = 1 A	0.20 A to 4.00 A	Increments 0.01 A
	I_{Nom} = 5 A	1.00 A to 20.00 A	
Differential current, static; **87L Isteady>**	I_{Nom} = 1 A	0.50 A to 4.00 A	Increments 0.01 A
	I_{Nom} = 5 A	2.50 A to 20.00 A	

Operating Times

The operating times depend on the communication speed. The following data require a transmission rate of 512 kbit/s.		
Pickup time with infeed at both ends approx.		15 ms to 40 ms
Trip times with infeed at both ends approx.		35 ms to 40 ms
Command time approx.		15 ms to 90 ms
Start time at 50 Hz approx.		51 ms
Frequency range		45 Hz to 55 Hz at 50 Hz 55 Hz to 65 Hz at 60 Hz 25 Hz to 45 Hz at 50 Hz 30 Hz to 55 Hz at 60 Hz if only the static element is active
Tolerances	I_{Nom} = 1 A	20 mA
	I_{Nom} = 5 A	100 mA

Time Delaytime delays

Tripping delay	**87L Trip Delay**	0.00 s to 0.10 s	Increments 0.01 s
Expiry tolerances		1 % of set value or 10 ms	
The set times are pure time delays			

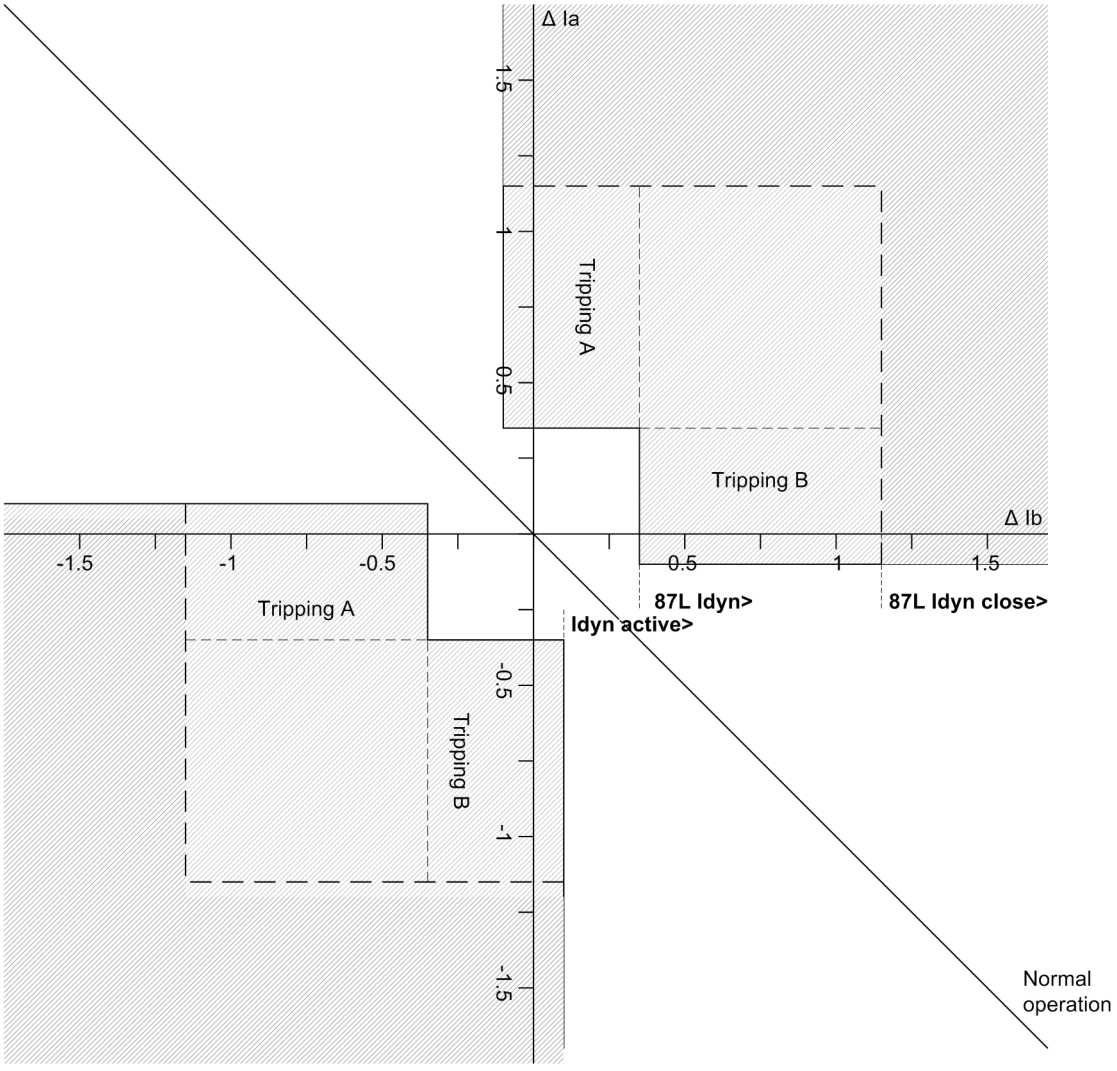
Emergency Operation

Communication failure	See section “Time Overcurrent Protection”

Frequency Operating Range

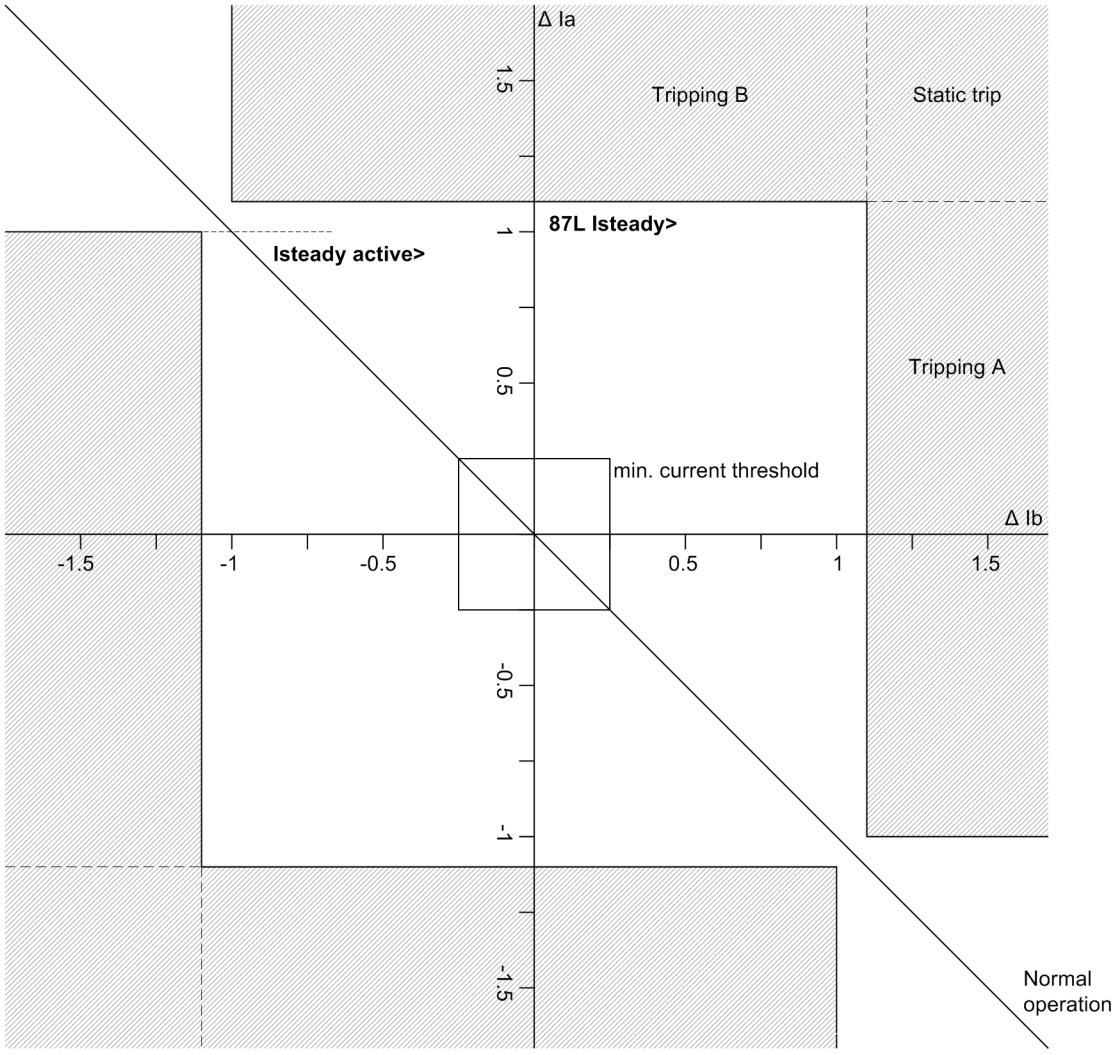
Operating Range	$0.8 \le f/f_{Nom} \le 1.2$ stable when starting machine

Pickup Characteristic



[dyn-mode-pcc-101206, 1, en_US]

Figure 4-1 Dynamic pickup characteristic



[stat-mode-pcc-101206, 1, en_US]

Figure 4-2 Static pickup characteristic

4.4 Ground Fault Differential Protection in Grounded Systems

Pickup Values

Differential current; **87N L: I-DIFF>**	I_{Nom} = 1 A	0.10 A to 20.00 A	Increments0.01 A
	I_{Nom} = 5 A	0.50 A to 100.00 A	

Operating Times

The operating times depend on the communication speed. The following data require a transmission rate of 512 kbit/s.		
Pickup/trip times of the **87N L: I-DIFF>** element at at 50 Hz or 60 Hz approx.	minimum	35 ms
	typical	37 ms
	maximum	40 ms
Dropout times of the **87N L: I-DIFF>** element approx.	minimum	30 ms
	typical	32 ms
	maximum	34 ms
Differential current		5% of setting value or 1 % I_{Nom}
Delay of the **87N L: I-DIFF>** element approx.		1 % of setting value or 10 ms
Frequency range		45 Hz to 55 Hz at 50 Hz 55 Hz to 65 Hz at 60 Hz 25 Hz to 45 Hz at 50 Hz 30 Hz to 55 Hz at 60 Hz Increased tolerances

Time Delays

Tripping delay	**87L Trip Delay**	0.00 s to 0.10 s	Increments0.01 s
Expiry tolerances		1 % of setting value or 10 ms	
The set times are pure time delays.			

Emergency Operation

Communication failure	See section “Time Overcurrent Protection”

Frequency Operating Range

Operating Range	$0.8 \le f/f_{Nom} \le 1.2$ stable at machine startup (f = 0 to f_{Nom})

Standard Precision of Operational Measured Values

The standard accuracy of the operational measured values of the ground fault differential protection of ± 0.5 % of the rated operational current is ensured up to a transformer error adjustment of 2:1.

4.5 Ground Fault Differential Protection in Resonant-grounded / Isolated Systems

Pickup Values

Differential current; **87N L: IN(s)>**	I_{Nom} = 1 A	0.003 A to 1.000 A	Increments 0.001 A

Operating Times

The operating times depend on the communication speed. The following data require a transmission rate of 512 kbit/s.		
Pickup/trip times of the **87N L: IN(s)>** element at 50 Hz or 60 Hz approx.	minimum	24 ms to 29 ms
Dropout times of the **87N L: I-DIFF>** element approx.	minimum	35 ms to 50 ms
Minimum current for direction determination		5% of setting value or 1 % I_{Nom}
Delay of the **87N L: I-DIFF>** element approx.		1 % of setting value or 10 ms
Frequency range		45 Hz to 55 Hz at 50 Hz 55 Hz to 65 Hz at 60 Hz 25 Hz to 45 Hz at 50 Hz 30 Hz to 55 Hz at 60 Hz Increased tolerances

Time Delays

Tripping delay	**87N L:Trip-Delay**	0.00 s to 320 s	Increments 0.01 s
Expiry tolerances		1 % of setting value or 10 ms	
The set times are pure time delays.			

Frequency Operating Range

Operating Range	$0.8 \le f/f_{Nom} \le 1.2$ stable at machine start-up (f = 0 to f_{Nom})

4.6 Breaker Intertrip and Remote Tripping- Direct Local Trip

Breaker Intertrip and Remote Tripping

Transfer trip of the opposite end for single-end tripping	can be switched on/off

External Direct Trip

Operating time, total	approx. 6 ms	
Trip time delay **Trip Time DELAY**	minimum	14 ms
	typical	17 ms
	maximum	20 ms
Dropout times	minimum	25 ms
	typical	27 ms
	maximum	29 ms
Expiry tolerances	1 % of setting value or 10 ms	
The set times are pure time delays		

Remote Trip

Tripping of the remote ends by a command injected via binary inputs The command times depend on the communication speed. The following data require a transmission rate of 512 kbit/s for the optical fiber protection interface.			
Operating times, total approx.	minimum		10 ms
	typical		13 ms
	maximum		15 ms
Dropout times	minimum		26 ms
	typical		27 ms
	maximum		29 ms
Tripping delay	**85 DT: TD-BI**	0.00 s to 30.00 s	Increments 0.01 s
Trip time prolongation	**85 DT:T-PROL BI**	0.00 s to 30.00 s	Increments 0.01 s
Expiry tolerances		1 % of setting value or 10 ms	
The set times are pure time delays			

4.7 Time Overcurrent Protection

Operating Modes

As emergency overcurrent protection or backup overcurrent protection	
Emergency Overcurrent Protection	Effective when the differential protection system is blocked (e.g. because of a failure of the device communication)
Backup overcurrent protection	operates independent of any events

Characteristic Curves

Definite dime stages (definite)	50-B2, 50N-B2, 50-B1, 50N-B1, 50-3, 50N-3, 67-B2, 67N-B2, 67-B1, 67N-B1 ($I_{Ph}>$, $3I_0>$, $I_{Ph}>>$, $3I_0>>$, $I_{Ph}>>>$, $3I_0>>>$, $I_{Ph}>_{dir}$, $3I_0>_{dir}$, $I_{Ph}>>_{dir}$, $3I_0>>_{dir}$)
Inverse time elements	51-B, 51N-B, 67-TOC, 67N-TOC (I_P, $3I_{0P}$; I_{Pdir}, $3I_{0Pdir}$); a characteristic curve according to *Figure 4-3* to *Figure 4-5* can be selected

High-Set Current Elements

Pickup value **50-B1 PICKUP** (phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Pickup value **50N-B1 PICKUP** (ground)	for I_{Nom} = 1 A	0.05 A to 25.00 A or ∞ (ineffective)	Increments0.01 A
	for I_{Nom} = 5 A	0.25 A to 125.00 A or ∞ (ineffective)	
Pickup value **67-B1 PICKUP** (directional phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Delays (directional phases)	**67-B1 DELAY**	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
	67N-B1 DELAY	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Delay **50-B1 DELAY** (phases)		0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Delay **50N-B1 DELAY** (ground)		0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Dropout ratio		approx. 0.93 for $I/I_{Nom} \geq 0.5$	
Pickup times		minimum	30 ms
		typical	32 ms
		maximum	35 ms
Dropout times		minimum	33 ms
		typical	35 ms
		maximum	38 ms
Tolerances	Currents	3 % of setting value or 1 % Nennstrom	
	Times	1 % of setting value or 10 ms	
The set times are pure time delays			

Overcurrent Elements

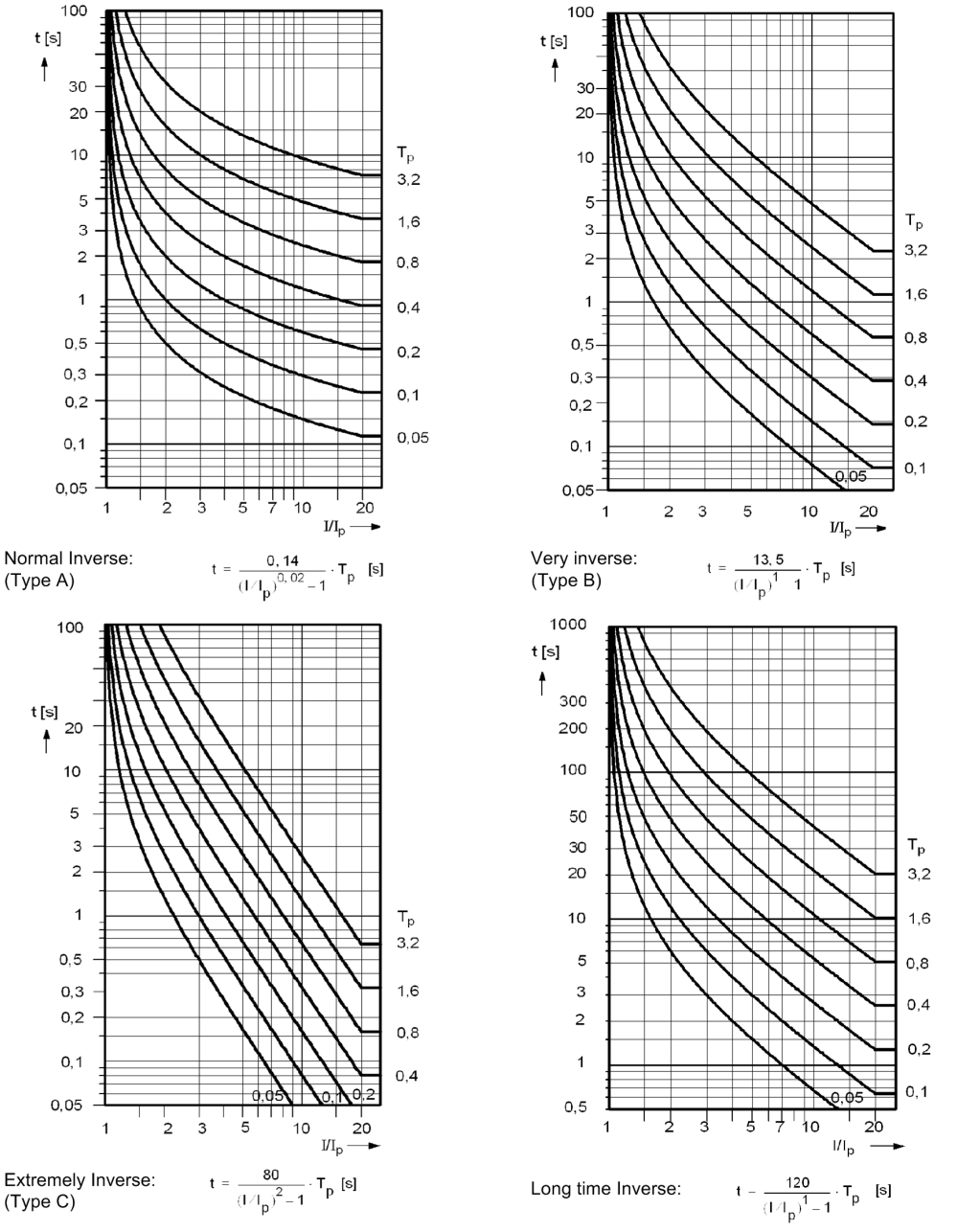
Pickup value **50-B2 PICKUP** (phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Pickup value **50N-B2 PICKUP** (ground)	for I_{Nom} = 1 A	0.05 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 125.00 A or ∞ (ineffective)	
Delays	**50-B2 DELAY**	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
	50N-B2 DELAY	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Pickup value **50-3 PICKUP** (phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Pickup value **50N-3 PICKUP** (ground)	for I_{Nom} = 1 A	0.05 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 125.00 A or ∞ (ineffective)	
Delays	**50-3 DELAY**	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
	50N-3 DELAY	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Pickup value **67-B2 PICKUP** directional phases	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Pickup value **67N-B2 PICKUP** directional ground	for I_{Nom} = 1 A	0.05 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 125.00 A or ∞ (ineffective)	
Delays (directional phases)	**67-B2 DELAY**	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
	67N-B2 PICKUP	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Dropout ratio		approx. 0.93 for $I/I_{Nom} \geq 0.5$	
Pickup times		approx. 30 ms	
Dropout times		approx. 30 ms	
Tolerances	Currents	3 % of setting value or 1 % nominal current	
	Times	1 % of setting value or 10 ms	
The set times are pure time delays			

Inverse Time Current Elements (IEC)

Pickup value **51-B PICKUP** (phases)	for I_{Nom} = 1 A	0.10 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A or ∞ (ineffective)	
Pickup value **51N-B PICKUP** (ground)	for I_{Nom} = 1 A	0.05 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A or ∞ (ineffective)	
Time multipliers	**51-B TD IEC** (phases)	0.05 s to 3.00 s or ∞ (ineffective)	Increments 0.01 s
	51N-B TD IEC (ground)	0.05 s to 3.00 s or ∞ (ineffective)	Increments 0.01 s
Additional time delays	**51-B AddT-DELAY** (phases)	0.00 s to 30.00 s	Increments 0.01 s
	51N-B AddT-delay (ground)	0.00 s to 30.00 s	Increments 0.01 s
Tolerances			
Pickup, dropout thresholds I_P, $3I_{0P}$		3 % of setting value or 1 % nominal current	
Pickup time $2 \le I/I_P \le 20$ and $T_{IP} \ge 1$ s Pickup time $2 \le I/3I_{0P} \le 20$ and $T_{3I0P} \ge 1$ s		5 % of setting value ± 15 ms 5 % of setting value ± 15 ms	
defined times		1 % of setting value or 10 ms	
Pickup value **67-TOC PICKUP** directional phases	for I_{Nom} = 1 A	0.10 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A or ∞ (ineffective)	
Pickup value **67N-TOC PICKUP** (directional ground)	for I_{Nom} = 1 A	0.05 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A or ∞ (ineffective)	
Time multipliers (directional phases)	**67-TOC TD IEC** (phases)	0.05 s to 3.00 s or ∞ (ineffective)	Increments 0.01 s
	67N-TOC TD IEC (ground)	0.05 s to 3.00 s or ∞ (ineffective)	Increments 0.01 s
Additional time delays (directional phases)	**67-TOC AddTDel.** (phases)	0.00 s to 30.00 s	Increments 0.01 s
	67N-TOC AddTDel (ground)	0.00 s to 30.00 s	Increments 0.01 s
Tolerances (directional phases)			
Pickup, dropout thresholds I_{Pdir}, $3I_{0Pdir}$		3 % of setting value or 1 % nominal current	
Pickup time $2 \le I/I_{Pdir} \le 20$ and $T_{IPdir} \ge 1$ s Pickup time $2 \le I/3I_{0Pdir} \le 20$ and $T_{3I0Pdir} \ge 1$ s		5 % of setting value ± 15 ms 5 % of setting value ± 15 ms	
defined times		1 % of setting value or 10 ms	
Characteristics		see *Figure 4-3*	
defined times		1 % of setting value or 10 ms	

Inverse Time Elements (ANSI)

Pickup value **51-B PICKUP** (phases)	for I_{Nom} = 1 A	0.10 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A or ∞ (ineffective)	
Pickup value **51N-B PICKUP** (ground)	for I_{Nom} = 1 A	0.05 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A or ∞ (ineffective)	
Time multipliers	**51-B TD ANSI** (phases)	0.50 s to 15.00 s or ∞ (ineffective)	Increments 0.01 s
	51N-B TD ANSI (ground)	0.50 s to 15.00 s or ∞ (ineffective)	Increments 0.01 s
Additional time delays	**51-B AddT-DELAY** (phases)	0.00 s to 30.00 s	Increments 0.01 s
	51N-B AddT-delay (ground)	0.00 s to 30.00 s	Increments 0.01 s
Tolerances			
Pickup, dropout thresholds I_P, $3I_{0P}$		3 % of setting value or 1 % nominal current	
Pickup time $2 \le I/I_P \le 20$ and $D_{IP} \ge 1$ s Pickup time $2 \le I/3I_{0P} \le 20$ and $D_{3I0P} \ge 1$ s		5 % of setting value ± 15 ms 5 % of setting value ± 15 ms	
defined times		1 % of setting value or 10 ms	
Pickup value **67-TOC PICKUP** (directional phases)	for I_{Nom} = 1 A	0.10 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A or ∞ (ineffective)	
Pickup value **67N-TOC PICKUP** (directional ground)	for I_{Nom} = 1 A	0.05 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A or ∞ (ineffective)	
Time multipliers (directional phases)	**67-TOC TD ANSI** (phases)	0.50 s to 15.00 s or ∞ (ineffective)	Increments 0.01 s
	67N-TOC TD ANSI (ground)	0.50 s to 15.00 s or ∞ (ineffective)	Increments 0.01 s
Additional time delays (directional phases)	**67-TOC AddTDel.** (phases)	0.00 s to 30.00 s	Increments 0.01 s
	67N-TOC AddTDel (ground)	0.00 s to 30.00 s	Increments 0.01 s
Tolerances (directional elements)			
Pickup, dropout thresholds I_{Pdir}, $3I_{0Pdir}$		3 % of setting value or 1 % nominal current	
Pickup time $2 \le I/I_{Pdir} \le 20$ and $D_{IPdir} \ge 1$ s Pickup time $2 \le I/3I_{0Pdir} \le 20$ and $D_{3I0Pdir} \ge 1$ s		5 % of setting value ± 15 ms 5 % of setting value ± 15 ms	
Characteristics		see *Figure 4-4* and *Figure 4-5*	
defined times		1 % of setting value or 10 ms	

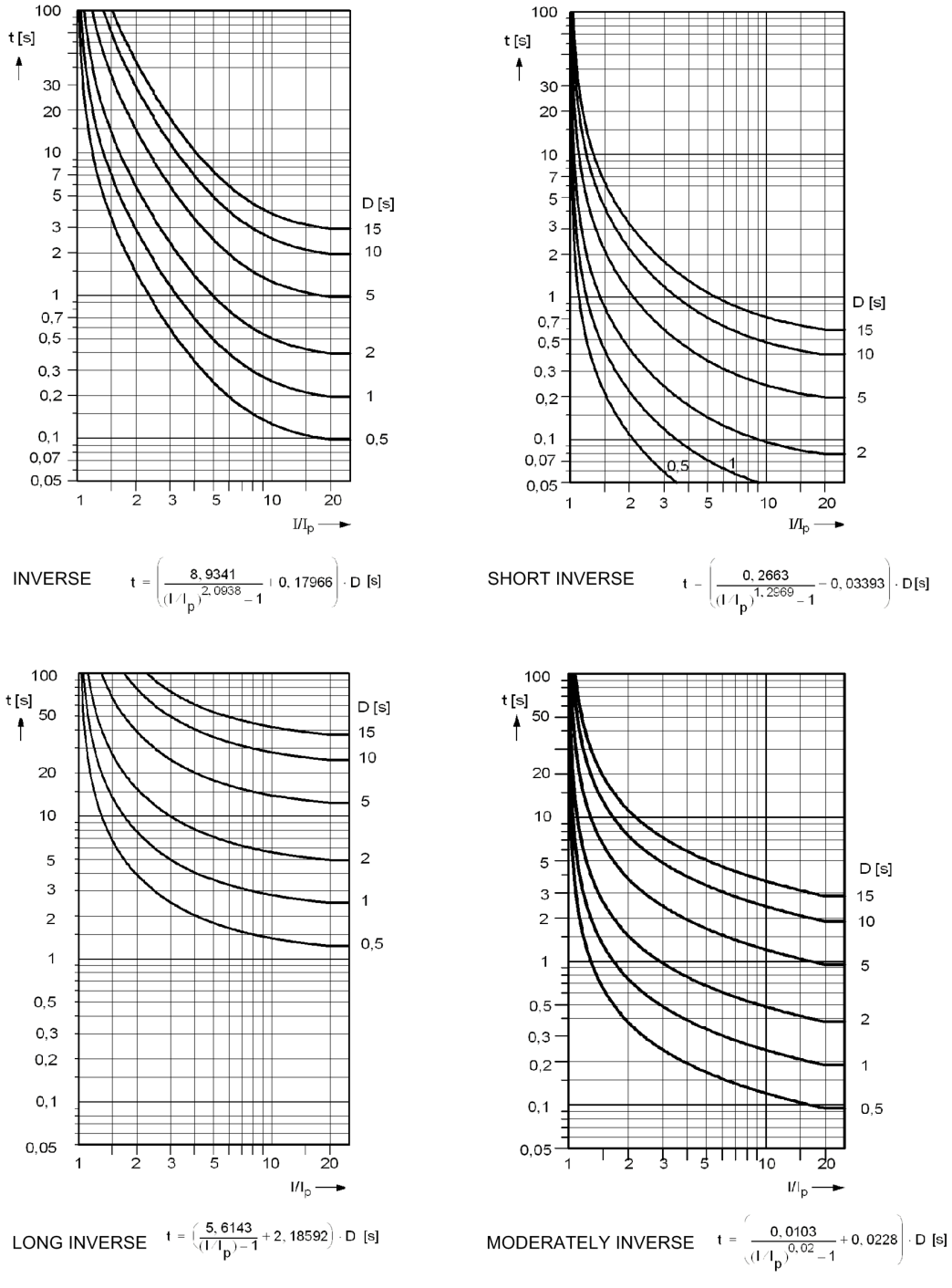


t Trip Time
T_p Setting Value of the Time Factor
I Fault current
I_p Setting value current

Note:
For earth fault read 3I0p instead of Ip
and T3I0p instead of Tp.

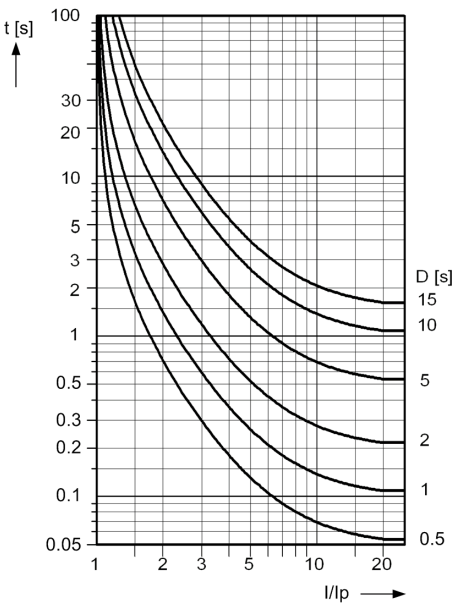
[td-kennl-amz-n-iec-oz-060802, 1, en_US]

Figure 4-3 Trip time characteristics of inverse time overcurrent elements, acc. IEC (phases and ground)

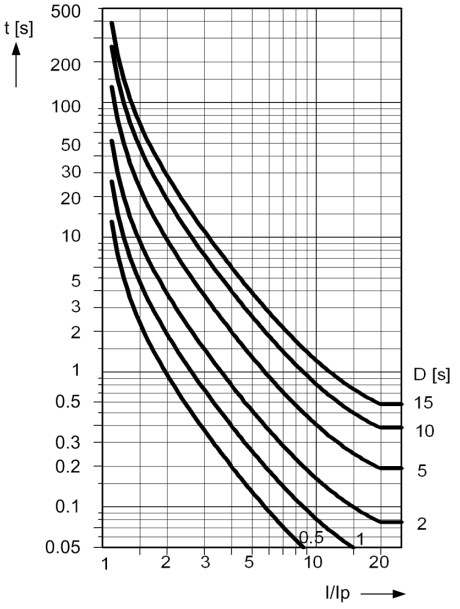


[td-kennl-amz-n-ansi-1-oz-060802, 1, en_US]

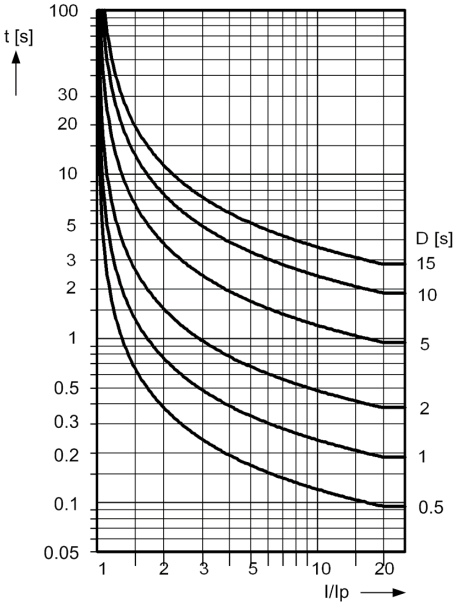
Figure 4-4 Trip time characteristics of inverse time overcurrent element, acc. ANSI/IEEE (phases and ground)



VERY INVERSE: $t = \left(\frac{3{,}922}{(I/I_p)^2 - 1} + 0{,}0982 \right) \cdot D[s]$



EXTREMELY INVERSE $t = \left(\frac{5{,}64}{(I/I_p)^2 - 1} + 0{,}02434 \right) \cdot D[s]$



DEFINITE INVERSE $t = \left(\frac{0{,}4797}{(I/I_p)^{1{,}5625} - 1} + 0{,}21359 \right) \cdot D[s]$

t Trip Time
D Setting value time multiplier
I Fault current
Ip Setting value current

Note:
For earth fault read 3I0p instead of Ip and D3I0p instead of D.

[td-kennl-amz-n-ansi-2-oz-060802, 1, en_US]

Figure 4-5 Trip time characteristics of inverse time overcurrent element, acc. ANSI/IEEE (phases and ground)

4.8 Inrush Current Restraint Breaker Intertrip and Remote Tripping

Phase Comparison Protection

Restraint ratio 2. Harmonische zur Grundschwingung I_{2fNom}/I_{fNom}		0 % to 45 %	Increments 1 %
Max. current for restraint	I_{Nom} = 1 A	1.1 A to 25.0 A	Increments 0.1 A
	I_{Nom} = 5 A	5.5 A to 125.0 A	
Crossblock function		can be switched on/off	
Max. action time for crossblock **CROSSB 2HM**		0.00 s to 60.00 s or 0 (crossblock deactivated) or ∞ (active until dropout)	Increments 0.01 s

Restricted Earth Fault Protection

Restraint ratio 2. Inrush stabilization I_{2fNom}/I_{fNom}		0 % to 45 %	Increments 1 %
Max. current for restraint	I_{Nom} = 1 A	1.1 A to 25.0 A	Increments 0.1 A
	I_{Nom} = 5 A	5.5 A to 125.0 A	
Crossblock function		zu- und abschaltbar	
Max. action time for crossblock **CROSSB 2HM**		0.00 s to 60.00 s or 0 (crossblock deactivated) or ∞ (active until dropout)	Increments 0.01 s

4.9 Circuit-Breaker Failure Protection (Optional)

Circuit Breaker Supervision

Current-flow Monitoring	for I_{Nom} = 1 A	0.05 A to 20.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 100.00 A	
Zero sequence current monitoring	for I_{Nom} = 1 A	0.05 A to 20.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 100.00 A	
Dropout ratio		approx.0.95	
Tolerance		5 % of setting value or 1 % of nominal current	
Monitoring of circuit breaker auxiliary contact position			
for three-pole tripping		binary input for CB auxiliary contact	
Note::			
e: The circuit breaker failure protection can also operate without the indicated circuit breaker auxiliary contacts, but the function range is then reduced.			
Auxiliary contacts are necessary for the circuit breaker failure protection for tripping without or with a very low current flow (e.g. Buchholz protection) and for Time Overcurrent fault protection and circuit breaker pole discrepancy supervision.			

Initiation Conditions

For circuit breaker failure protection	Internal or external 1-pole trip [1)] Internal or external 3-pole trip [1)] Internal or external 3-pole trip without current [1)]
[1)] Via binary inputs	

Times

Pickup time	approx.5 ms with measured quantities present, approx.20 ms after switch-on of measured quantities	
Drop-off time, internal (overshoot time)	≤ 15 ms at sinusoidal measured values, ≤ 25 ms maximum	
Time delays for all elements	0.00 s bis 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

End Fault Protection

With signal transmission to the opposite line end		
Time delay	0.00 s to 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

Pole Discrepancy Supervision

Initiation criterion	Not all poles are closed or open	
Monitoring time	0.00 s to 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

4.10 Thermal Overload Protection 49

Setting Ranges

Factor k according to IEC 60255-8		0.10 to 4.00	Increments 0.01
Time Constant τ_{th}		1.0 min to 999.9 min	Increments 0.1 min
Thermal Alarm $\Theta_{Alarm}/\Theta_{Trip}$		50 % to 100 % of the trip overtemperature	Increments 1 %
Current alarm element I_{Alarm}	for I_{Nom} = 1 A	0.10 A to 4.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A	

Calculation Method

Calculation method temperature rise	Maximum temperature rise of 3 phases Average of temperature rise of 3 phases Temperature rise from maximum current

Trip Characteristic

Formula for primary values:

Trip Characteristic curve for $I / (k \cdot I_{Nom}) \leq 8$

$$t = \tau_{th} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - \left(\frac{I_{pre}}{k \cdot I_{Nom}}\right)^2}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - 1}$$

with

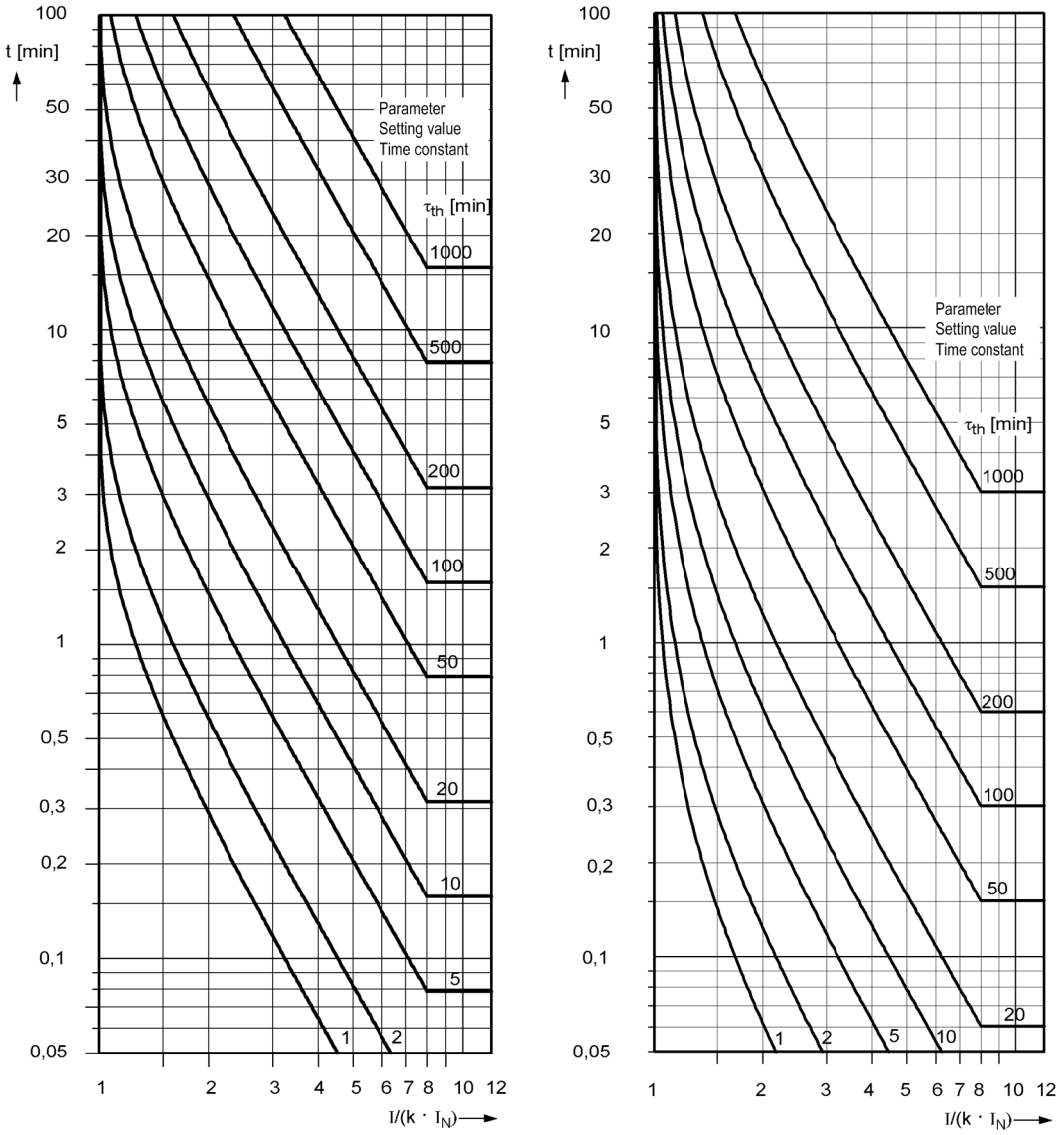
t	Trip time in minutes
τ_{th}	Heating-up time constant
In	Actual load current
I_{pre}	Preload current
k	Setting factor per IEC 60255-8
I_{Nom}	Nominal current for the protected object

Drop-off to Pick-up Ratio

Θ/Θ_{Trip}	Drops out with Θ_{Alarm}
Θ/Θ_{Alarm}	approx. 0.99
I/I_{Alarm}	approx. 0.97

Tolerances

Referring to $k \cdot I_{Nom}$	for I_N = 1 A	3 % or 15 mA, 2 % class according to IEC 60255-8
	for I_N = 5 A	3 % or 75 mA, 2 % class according to IEC 60255-8
Referring to trip time		3 % or 1 s for $I/(k \cdot I_{Nom}) > 1.25$, 3 % class according to IEC 60255-8



without pre-load:

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

with 90 % pre-load:

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

[ausloesekennlinie-ueberlast-1111203-he, 1, en_US]

Figure 4-6 Trip time curves for the thermal overload protection (49)

4.11 Voltage Protection (Optional)

Overvoltages Phase-to-Ground

Overvoltage V_{Ph}>>		1.0 V to 170.0 V; ∞	Increments 0.1 V
Delay $T_{VPh>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage V_{Ph}>		1.0 V to 170.0 V; ∞	Increments 0.1 V
Delay $T_{VPh>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Overvoltages Phase-to-Phase

Overvoltage V_{PhPh}>>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{VPhPh>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage V_{PhPh}>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{VPhPh>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Overvoltage Positive Sequence System V_1

Overvoltage V_1>>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{V1>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage V_1>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{V1>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Compounding		can be switched on/off	
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Overvoltage Negative Sequence System V_2

Overvoltage V_2>>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{V2>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage V_2>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{V2>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	

Tolerances	Voltages	3 % of setting value or 1 V
	Times	1 % of setting value or 10 ms

Overvoltage Zero Sequence System $3V_0$

Overvoltage $3V_0$>>		1.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{3V0>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage $3V_0$>		1.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{3V0>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Pickup time			
With repeated measurement		approx. 75 ms	
Without repeated measurement		approx. 40 ms	
Dropout time			
With repeated measurement		approx. 75 ms	
Without repeated measurement		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Undervoltages Phase-to-Ground

Undervoltage V_{Ph}<<		1.0 V to 100.0 V	Increments 0.1 V
Delay $T_{VPh<<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Undervoltage V_{Ph}<		1.0 V to 100.0 V	Increments 0.1 V
Delay $T_{VPh<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		1.01 to 1.20	Increments 0.01
Current criterion		can be switched on/off	
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Undervoltages Phase-to-Phase

Undervoltage V_{PhPh}<<		1.0 V to 175.0 V	Increments 0.1 V
Delay $T_{VPhPh<<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Undervoltage V_{PhPh}<		1.0 V to 175.0 V	Increments 0.1 V
Delay $T_{VPhPh<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		1.01 to 1.20	Increments 0.01
Current criterion		can be switched on/off	
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Undervoltage Positive Sequence System V_1

Undervoltage V_1<<	1.0 V to 100.0 V	Increments 0.1 V
Delay $T_{V1<<}$	0.00 s to 100.00 s; ∞	Increments 0.01 s

Undervoltage V_1<		1.0 V to 100.0 V	Increments 0.1 V
Delay $T_{V1<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		1.01 to 1.20	Increments 0.01
Current criterion		can be switched on/off	
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

4.12 Frequency Protection (Optional)

Frequency Elements

Quantity	4, depending on setting effective on f< or f>

Pickup Values

f> or f< adjustable for each element		
at f_{Nom} = 50 Hz	45.50 Hz to 54.50 Hz	Increments 0.01 Hz
at f_{Nom} = 60 Hz	55.50 Hz to 64.50 Hz	Increments 0.01 Hz

Times

Pickup times f>, f<	approx. 85 ms	
Dropout times f>, f<	approx. 30 ms	
Time delays T	0,00 s to 600,00 s	Increments 0,01 s
The set times are pure time delays. Note on drop-off times: Drop-off was enforced by current = 0 A and voltage = 0 V. Enforcing the drop-off by means of a frequency change below the drop-off threshold extends the drop-off times.		

Dropout Difference

Δf = I pickup value - dropout value I	0.02 Hz to 1 Hz

Operating Ranges

In voltage range	approx. 0.65 · V_N to 230 V (phase-to-phase)
In frequency range	25 Hz to 70 Hz

Tolerances

Frequencies f>, f< in specific range (f_{Nom} ± 10 %)	15 mHz in range V_{PhPh}: 50 V to 230 V
Time delays T(f<, f>)	1 % of setting value or 10 ms

4.13 Automatic Reclosing (Optional)

Automatic Reclosures

Number of reclosures	max. 2	
Type (depending on order variant)	3-pole	
Control	with pickup or trip command	
Action times Initiation possible without pickup and action time	0.01 s to 300.00 s; ∞	Increments 0.01 s
Dead times prior to reclosure separately for all types and all cycles	0.01 s to 1800.00 s; ∞	Increments 0.01 s
Dead times after evolving fault recognition	0.01 s to 1800.00 s	Increments 0.01 s
Blocking time after reclosure	0.50 s to 300.00 s	Increments 0.01 s
Blocking time after dynamic blocking	0.5 s	
Blocking time after manual closing	0.50 s to 300.00 s; 0	Increments 0.01 s
Start signal monitoring time	0.01 s to 300.00 s	Increments 0.01 s
Circuit breaker monitoring time	0.01 s to 300.00 s	Increments 0.01 s

4.14 Transmission of Binary Information and Commands

Remote Indications

Number of possible remote indications		16
The operating times depend on the communication speed. The following data require a transmission rate of 512 kbit/s for the optical fiber protection interface. The operating times refer to the entire signal path from entry via binary inputs until output of commands via output relays.		
Operating times, total approx.	typical	20 ms ± 5 ms
Dropout times, total approx.	typical	15 ms

4.15 Monitoring Functions

Measured Values

Current sum		$I_F = \lvert \underline{I}_A + \underline{I}_B + \underline{I}_C + k_I \cdot \underline{I}_E \rvert >$ SUM.I TRESHOLD $\cdot I_N$ + SUM.FACTORI $\cdot \Sigma \lvert I \rvert$	
- SUM.ITRESHOLD	for I_{Nom} = 1 A	0.10 A to 2.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 10.00 A	Increments 0.01 A
- SUM.FACTORI		0.00 to 0.95	Increments 0.01
Current symmetry		$\lvert I_{min} \rvert / \lvert I_{max} \rvert <$ BAL.FACTORI as long as $I_{max}/I_N >$ BAL.ILIMIT/I_N	
- BAL.FACTORI		0.10 to 0.95	Increments 0.01
- BAL.ILIMIT	for I_{Nom} = 1 A	0.10 A to 1.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 5.00 A	Increments 0.01 A
- T BAL.ILIMIT		5 s to 100 s	Increments 1 s
Broken conductor		one conductor without current, the others with current (monitoring of current transformer circuits on current step change in one phase without residual current)	
Voltage Balance		$\lvert V_{min} \rvert / \lvert V_{max} \rvert <$ SYM.FAK.V as long as $\lvert V_{max} \rvert >$ SYM.VGRENZ	
- BAL.FACTORV		0.58 to 0.95	Increments 0.01
- BAL.VLIMIT		10 V to 100 V	Increments 1 V
- T BAL.VLIMIT		5 s to 100 s	Increments 1 s
Voltage phase sequence		$\underline{V}_A$ leads $\underline{V}_B$ leads $\underline{V}_C$ as long as $\lvert \underline{V}_A \rvert$, $\lvert \underline{V}_B \rvert$, $\lvert \underline{V}_C \rvert > 40\ V/\sqrt{3}$	
non-symmetrical voltages (Fuse-Failure-Monitor)		$3 \cdot V_0 >$ FFM V> ODER $3 \cdot V_2 >$ FFM V> AND at the same time $3 \cdot I_0 <$ FFM I< AND $3 \cdot I_2 <$ FFM I<	
- FFM V>		10 V to 100 V	Increments 1 V
- FFM I<	for I_{Nom} = 1 A	0.10 A to 1.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 5.00 A	Increments 0.01 A
three-phase measuring voltage failure (Fuse-Failure-Monitor)		all V_{Ph-E} < FFM VMESS < AND at the same time all ΔI_{Ph} < FFM I_{delta} AND all $I_{Ph} > (I_{Ph}>$ (Dist.)) OR all V_{Ph-E} < FFM VMESS < AND at the same time alle $I_{Ph} < (I_{Ph}>$ (Dist.)) AND alle $I_{Ph} >$ 40 mA	
- FFM VMEAS <		2 V to 100 V	Increments 1 V

- FFM I_{delta}	for I_{Nom} = 1 A	0.05 A to 1.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 5.00 A	Increments 0.01 A
- T V-Monitoring (waiting time for additional measured voltage failure monitoring)		0.00 s to 30.00 s	Increments 0.01 s
- T VT mcb		0 ms to 30 ms	Increments 1 ms

Trip Circuit Supervision

Number of supervised trip circuits	1 to 3	
Operation of each trip circuit	With 1 binary input or with 2 binary inputs	
Pickup and dropout time	approx. 1 to 2 s	
Settable time delay for operation with 1 binary input	1 s to 30 s	Increments 1 s

4.16 Flexible Protection Functions

Measured Values / Modes of Operation

Three-phase	I, $3I_0$, I1, I2, I2/I1, V, $3V_0$, V1, V2, dV/dt, P forward, P reverse, Q forward, Q reverse, cosφ
Single-phase	I, I_N, I_{NN},I_{N2}, V, V_N,V_x, P forward, P reverse, Q forward, Q reverse, cosφ
Without fixed phase reference	f, df/dt, binary input
Measurement method for I, V	Fundamental, r.m.s. value (true RMS), positive sequence system, negative sequence system, zero sequence system
Pickup on	exceeding threshold value or falling below threshold value

Setting Ranges / Increments

Pickup thresholds:			
Current I, I_1, I_2, $3I_0$, I_N	for I_{Nom} = 1 A	0.05 A to 40.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 200.00 A	
Relationship I_2/I_1		15 % to 100 %	Increments 1%
Sensitive ground currentI_{Ns}		0.001 A to 1.500 A	Increments 0.001 A
Voltage V, V_1, V_2, $3V_0$		2.0 V to 260.0 V	Increments 0.1 V
Displacement voltage V_0		2.0 V to 200.0 V	Increments 0.1 V
Power P, Q	for I_N = 1 A	2.0 W to 10000 W	Increments 0.1 W
	for I_N = 5 A	10 W to 50000 W	
Power facto cosφ		-0.99 to +0.99	Increments 0.01
Frequency	for f_{Nom} = 50 Hz for f_{Nom} = 60 Hz	40.0 Hz to 60.0 Hz 50.0 Hz to 70.0 Hz	Increments 0.01 Hz Increments 0.01 Hz
Frequency change df/dt		0.10 Hz/s to 20.00 Hz/s	Increments 0.01 Hz/s
Dropout ratio > element		1.01 to 3.00	Increments 0.01
Dropout ratio < element		0.70 to 0.99	Increments 0.01
Dropout difference f		0.02 Hz to 1.00 Hz	Increments 0.01 Hz
Pickup delay (standard)		0.00 s to 60.00 s	Increments 0.01 s
Pickup delay for I_2/I_1		0.00 s to 28,800.00 s	Increments 0.01 s
Command delay time		0.00 s to 3,600.00 s	Increments 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments 0.01 s

Function Limits

Power measurement three-phase	for I_{Nom} = 1 A	Positive sequence system current > 0.03 A
	for I_{Nom} = 5 A	Positive sequence system current > 0.15 A
Power measurement single-phase	for I_{Nom} = 1 A	Phase current > 0.03 A
	for I_{Nom} = 5 A	Phase current > 0.15 A

Relationship I_2/I_1 measurement	for I_{Nom} = 1 A	Positive or negative sequence system current > 0.1 A
	for I_{Nom} = 5 A	Positive or negative sequence system current > 0.5 A

Times

Pickup times:	
Current, voltage (phase quantities) for 2 times the setting value for 10 times the setting value	 approx. 30 ms approx. 20 ms
Current, voltage (symmetrical components) for 2 times the setting value for 10 times the setting value	 approx. 40 ms approx. 30 ms
Power typical maximum (small signals and threshold values)	 approx. 120 ms approx. 350 ms
Power factor	300 to 600 ms
Frequency	approx. 100 ms
Frequency change for 1.25 times the setting value	approx. 220 ms
Voltage change dV/dt for 2 times the setting value	approx. 220 ms
Binary input	approx. 20 ms
Dropout times:	
Current, voltage (phase quantities)	< 20 ms
Current, voltage (symmetrical components)	< 30 ms
Power typical maximum	 < 50 ms < 350 ms
Power factor	< 300 ms
Frequency	< 100 ms
Frequency change	< 200 ms
Binary input	< 10 ms

Tolerances

Pickup thresholds:		
Current	for I_{Nom} = 1 A	3% of setting value or 15 mA
	for I_{Nom} = 5 A	3% of setting value or 75 mA
Current (symmetrical components)	for I_{Nom} = 1 A	4% of setting value or 20 mA
	for I_{Nom} = 5 A	4% of setting value or 100 mA
Current (I_2/I_1)		4% of setting value
Voltage		3% of setting value or 0,2 V
Voltage (symmetrical components)		4% of setting value or 0,2 V
Voltage change dV/dt		5 % of setting value or 2 V/s
Power	for I_{Nom} = 1 A	3% of setting value or 0,5 W
	for I_{Nom} = 5 A	3% of setting value or 2,5 W
Power factor		3°
Frequency		15 mHz
Frequency change		5% of setting value or 0,05 Hz/s

Times	1% of setting value or 10 ms

Influencing Variables for Pickup Values

Auxiliary DC voltage in range $0.8 \leq V_{Aux}/V_{AuxNom} \leq 1,15$	1 %
Temperature in range –5 °C (23 °F) $\leq \Theta_{amb} \leq$ 55 °C (131 °F)	0.5 %/10 K
Frequency in the range of 25 Hz to 70 Hz	
Frequency in the range of $0.95 \leq f/f_{Nom} \leq 1.05$ (f_{Nom} = 50 Hz or 60 Hz)	1 %
Frequency outside range $0.95 \leq f/f_{Nom} \leq 1.05$	Increased tolerances
Harmonics - up to 10 % 3rd harmonic - up to 10 % 5th harmonic	 1 % 1 %

4.17 User-defined Functions (CFC)

Function Modules and Possible Assignments to Task Levels

Function Module	Explanation	Task Level			
		MW_BEARB	PLC1_BEARB	PLC_BEARB	SFS_BEARB
ABSVALUE	Magnitude Calculation	X	–	–	–
ADD	Addition	X	X	X	X
ALARM	Alarm	X	X	X	X
AND	AND - Gate	X	X	X	X
BLINK	Flash block	X	X	X	X
BOOL_TO_CO	Boolean to Control (conversion)	–	X	X	–
BOOL_TO_DI	Boolean to Double Point (conversion)	–	X	X	X
BOOL_TO_IC	Bool to Internal SI, Conversion	–	X	X	X
BUILD_DI	Create Double Point Annunciation	–	X	X	X
CMD_CANCEL	Cancel command	X	X	X	X
CMD_CHAIN	Switching Sequence	–	X	X	–
CMD_INF	Command Information	–	–	–	X
COMPARE	Measured value comparison	X	X	X	X
CONNECT	Connection	–	X	X	X
COUNTER	Counter	X	X	X	X
CV_GET_STATUS	Information status of the metered value, decoder	X	X	X	X
D_FF	D- Flipflop	–	X	X	X
D_FF_MEMO	Status Memory for Restart	X	X	X	X
DI_GET_STATUS	Information status double point indication, decoder	X	X	X	X
DI_SET_STATUS	Double point indication with status, encoder	X	X	X	X
DI_TO_BOOL	Double Point to Boolean (conversion)	–	X	X	X
DINT_TO_REAL	DoubleInt after real, adapter	X	X	X	X
DIST_DECODE	Double point indication with status, decoder	X	X	X	X
DIV	Division	X	X	X	X
DM_DECODE	Decode Double Point	X	X	X	X
DYN_OR	Dynamic OR	X	X	X	X
LIVE_ZERO	Live zero monitoring, nonlinear characteristic	X	–	–	–
LONG_TIMER	Timer (max.1193h)	X	X	X	X
LOOP	Feedback Loop	X	X	X	X
LOWER_SETPOINT	Lower Limit	X	–	–	–
MUL	Multiplication	X	X	X	X
MV_GET_STATUS	Information status measured value, decoder	X	X	X	X
MV_SET_STATUS	Measured value with status, encoder	X	X	X	X
NAND	NAND - Gate	X	X	X	X
NEG	Negator	X	X	X	X
NOR	NOR - Gate	X	X	X	X

OR	OR - Gate	X	X	X	X
REAL_TO_DINT	Real after DoubleInt, adapter	X	X	X	X
REAL_TO_UINT	Real after U-Int, adapter	X	X	X	X
RISE_DETECT	Rising edge detector	X	X	X	X
RS_FF	RS- Flipflop	–	X	X	X
RS_FF_MEMO	Status memory for restart	X	X	X	X
SI_GET_STATUS	Information status single point indication, decoder	X	X	X	X
SI_SET_STATUS	Single point indication with status, encoder	X	X	X	X
SQUARE_ROOT	Root Extractor	X	X	X	X
SR_FF	SR- Flipflop	–	X	X	X
SR_FF_MEMO	Status memory for restart	X	X	X	X
ST_AND	AND gate with status	X	X	X	X
ST_NOT	Negator with status	X	X	X	X
ST_OR	OR gate with status	X	X	X	X
SUB	Substraction	X	X	X	X
TIMER	Timer	–	X	X	–
TIMER_SHORT	Simple timer	–	X	X	–
UINT_TO_REAL	U-Int to real, adapter	X	X	X	X
UPPER_SETPOINT	Upper Limit	X	–	–	–
X_OR	XOR - Gate	X	X	X	X
ZERO_POINT	Zero Supression	X	–	–	–

General Limits

Description	Limit	Comments
Maximum number of all CFC charts considering all task levels	32	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.
Maximum number of all CFC charts considering one task level	16	Only Error Message (evolving fault in processing procedure)
Maximum number of all CFC inputs considering all charts	400	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.
Maximum number of inputs of one chart for each task level (number of unequal information items of the left border per task level)	400	Only fault annunciation; here the number of elements of the left border per task level is counted. Since the same information is indicated at the border several times, only unequal information is to be counted.
Maximum number of reset-resistant flipflops D_FF_MEMO, RS_FF_MEMO, SR_FF_MEMO	350	When the limit is exceeded, a fault indication is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.

Device-specific Limits

Description	Limit	Comments
Maximum number of simultaneous changes of the chart inputs per task level	50	When the limit is exceeded, an error message is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.
Maximum number of chart outputs per task level	150	

Additional Limits

Additional limits[1] for the following 4 CFC blocks:				
Task Level				
	TIMER [2] [3]	TIMER_SHORT[2] [3]	CMD_CHAIN	D_FF_MEMO
MW_BEARB				350
PLC1_BEARB	15	30	20	
PLC_BEARB				
SFS_BEARB				

[1] When the limit is exceeded, a fault indication is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.

[2] TIMER and TIMER_SHORT share the available timer resources. The relation is TIMER = 2 · system timer and TIMER_SHORT = 1 · system timer. The following condition applies for the maximum number of timers: (2 · number of TIMERs + number of TIMER_SHORTs) < 20. The LONG_TIMER is not subject to this condition.

[3] The time values for the blocks TIMER and TIMER_SHORT must not be selected shorter than the time resolution of the device of 5 ms, as the blocks will not then start with the starting pulse.

Maximum Number of TICKS in the Task Levels

Task Level	**Limit in TICKS [1]**
MW_BEARB (Measured Value Processing)	10 000
PLC1_BEARB (slow PLC Processing)	1 900
PLC_BEARB (fast PLC Processing)	200
SFS_BEARB (switchgear interlocking)	10 000

[1] When the sum of TICKS of all blocks exceeds the limits before-mentioned, an error message is output by CFC.

Processing Times in TICKS required by the Individual Elements

Individual Element		**Number of Ticks**
Block, basic requirement		5
Each input more than 3 inputs for generic modules		1
Connection to an input signal		6
Connection to an output signal		7
Additional for each chart		1
Operating sequence module	CMD_CHAIN	34
Flip-Flop	D_FF_MEMO	6
Loop module	LOOP	8
Decoder	DM_DECODE	8
Dynamic OR	DYN_OR	6
Addition	ADD	26
Subtraction	SUB	26
Multiplication	MUL	26
Division	DIV	54
Square root	SQUARE_ROOT	83
Timer	TIMER_SHORT	8
Timer	LONG_TIMER	11
Blinker lamp	BLINK	11
Counter	COUNTER	6
Adapter	REAL_TO_DINT	10

Individual Element		Number of Ticks
Adapter	REAL_TO_UINT	10
Alarm	ALARM	21
Vergleich	COMPARE	12
Decoder	DIST_DECODE	8

4.18 Additional Functions

Operational Measured Values

Operational Measured Values for Currents	I_A; I_B; I_C; $3I_0$; I_1; I_2; I_Y in A primary and secondary and in % $I_{NOperation}$;
Tolerance	1,5 %of measured value, or 1 % of I_N
Phasenwinkel Ströme	$\varphi(I_A\text{-}I_B)$; $\varphi(I_B\text{-}I_C)$; $\varphi(I_C\text{-}I_A)$ in °
Tolerance	1° at rated current
Betriebsmesswerte für Spannungen	$V_{A\text{-}N}$, $V_{B\text{-}N}$, $V_{C\text{-}N}$; $3V_0$, V_0, V_1, V_2, V_{1Ko} in kV primary, in V secondary or in % $V_{NOperation}/\sqrt{3}$
Tolerance	1.5 %of measured value, or 0,5 % of V_N
Betriebsmesswerte für Spannungen	V_{EN}; in V secondary
Tolerance	1.5 %of measured value, or 0,5 % of V_N
Betriebsmesswerte für Spannungen	$V_{A\text{-}B}$, $V_{B\text{-}C}$, $V_{C\text{-}A}$ in kV primary, in V secondary or in % $V_{NBetrieb}$
Tolerance	1.5 %of measured value, or 0,5 % of V_N
Phasenwinkel für Spannungen	$\varphi(V_A\text{-}V_B)$; $\varphi(V_B\text{-}V_C)$; $\varphi(V_C\text{-}V_A)$ in °
Tolerance	1 °at rated voltage
Phasenwinkel für Spannungen and Ströme	$\varphi(V_A\text{-}I_A)$; $\varphi(V_B\text{-}I_B)$; $\varphi(V_C\text{-}I_C)$ in °
Tolerance	1° at nominal voltage and nominal current
Betriebsmesswerte für Leistungen	S; P; Q (apparent, active and reactive power) in MVA; MW; Mvar primary and % S_N (operational nominal power) = $\sqrt{3} \cdot V_{Nom} \cdot I_{Nom}$
Tolerance für S	1.5 % of S_N at I/I_N and V/V_N in range 50 % to 120 %
Tolerance für P	2 % of P_N at I/I_N and V/V_N im in range 50 % to 120 % and ABS(cos φ) in range ≥ 0,7
Tolerance für Q	2 % of Q_N at I/I_N and V/V_N in range 50 % to 120 % and ABS(cos φ) in range ≤ 0,7
Betriebsmesswert Leistungsfaktor	cos φ
Tolerance	0.02
Zählwerte für Arbeit	W_p+, W_q+; W_p-; W_q- (Wirk- and Blindarbeit) in kWh (MWh or GWh) bzw. in kVARh (MVARh or GVARh)
Tolerance at Nennfrequenz	5 % für $I > 0.5\ I_N$, $V > 0.5\ V_N$ and $\lvert \cos\varphi \rvert \geq 0.707$
Betriebsmesswerte für Frequenz	f in Hz and % f_N
Bereich	10 Hz to 75 Hz
Tolerance	20 mHz in range f_N ±10 % at nominal values
Messwerte des Differentialschutzes	$I_{DIFF3I0;}$ in % $I_{NBetrieb}$ $I_{STAB3IO}$ in I/I_{NO} (nur im geerdeten Netz)
Thermische Messwerte	Θ_A/Θ_{AUS}; Θ_B/Θ_{AUS}; Θ_C/Θ_{AUS}; Θ/Θ_{AUS} bezogen auf Auslöseübertemperatur
Fernmesswerte für Ströme	I_A; I_B; I_C des fernen Endes in A primary $\varphi(I_A)$; $\varphi(I_B)$; $\varphi(I_C)$, (fern gegen lokal) in °

Remote measured values for voltages	V_A; V_B; V_C des fernen Endes in kV primary $\varphi(V_A)$; $\varphi(V_B)$; $\varphi(V_C)$, (fern gegen lokal) in °

Betriebsmeldepuffer

Kapazität	200 Einträge

Störfallprotokollierung

Kapazität	8 Störfälle mit insgesamt max. 600 Einträgen und bis zu 100 Signalen als Binärspuren (Marken)

Störwertspeicherung

max. 8 Störschriebe; durch Pufferbatterie auch at Hilfsspannungsausfall gesichert	
Speicherzeit	5 s je Störschrieb, in Summe to zu 18 s at 50 Hz (max. 15 s at 60 Hz)
Raster at 50 Hz Raster at 60 Hz	je 1 Momentanwert pro 1,0 ms je 1 Momentanwert pro 0,83 ms

Statistik (serielle Wirkschnittstelle)

Verfügbarkeit der Übertragung für Anwendungen mit Wirkschnittstelle	Verfügbarkeit in %/min und in %/h
Laufzeit der Übertragung	Auflösung 0,01 ms

Schaltstatistik

Anzahl der vom Gerät veranlassten automatischen Wiedereinschaltungen	getrennt für 1. AWE-Zyklus and alle weiteren
Summe der Ausschaltströme	getrennt je Schalterpol
Maximal abgeschalteter Strom	getrennt je Schalterpol

Echtzeitzuordnung und Pufferbatterie

Auflösung für Betriebsmeldungen	1 ms
Auflösung für Störfallmeldungen	1 ms
Pufferbatterie	Typ: 3 V/1 Ah, Typ CR 1/2 AA Selbstentladezeit ca. 10 Jahre

Inbetriebsetzungshilfen

Betriebsmesswerte Schalterprüfung

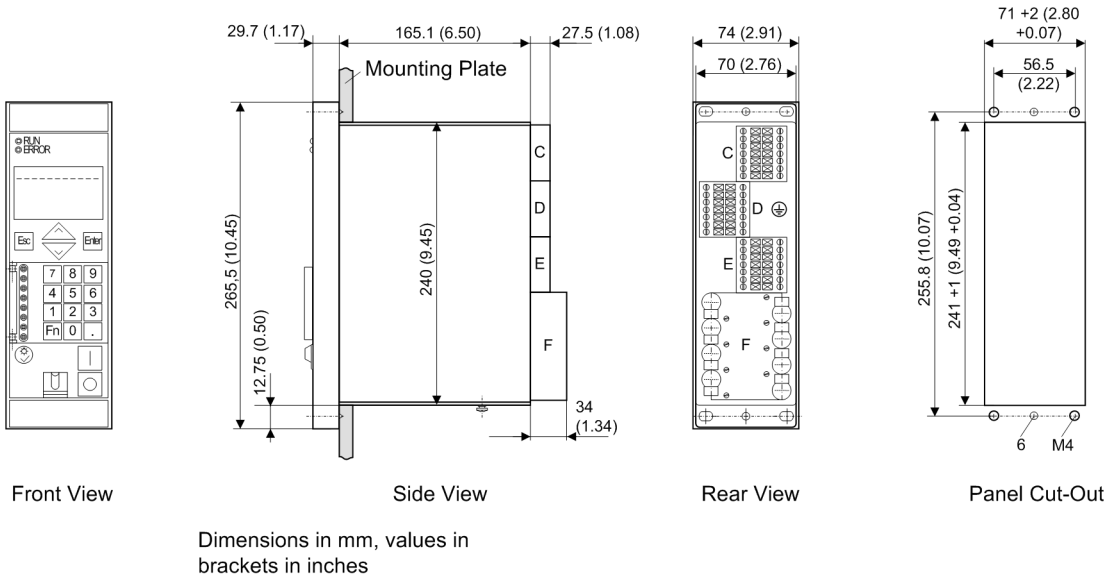
Uhr

Zeitsynchronisation		DCF 77/IRIG-B-Signal (Telegramm Format IRIG-B000) Binäreingabe Kommunikation
Betriebsarten der Uhrzeitführung		
Nr.	Betriebsart	Erläuterungen
1	**Intern**	Interne Synchronisation über RTC (Voreinstellung)
2	**IEC 60870-5-103**	Externe Synchronisation über Systemschnittstelle (IEC 60870-5-103)
3	**Zeitzeichen IRIG-B**	Externe Synchronisation über IRIG-B (Telegramm-Format IRIG-B000)

4	**Zeitzeichen DCF 77**	Externe Synchronisation über Zeitzeichen DCF 77
5	**Impuls über Binäreingang**	Externe Synchronisation mit Impuls über Binäreingang

4.19 Dimensions

4.19.1 Panel Flush Mounting and Cabinet Flush Mounting (Housing Size 1/6)



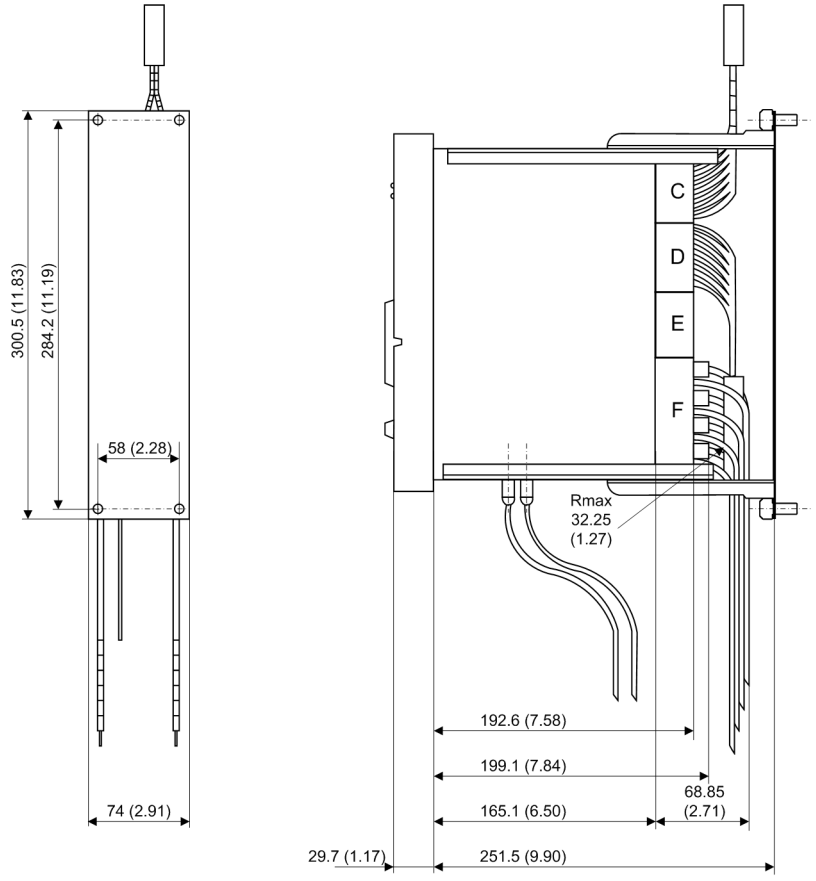
[abmess-sechstel-gehaeuse-7sx80-060606, 1, en_US]

Figure 4-7 Dimensional drawing of a 7SD80 for panel flush mounting and cabinet flush mounting (housing size $^1/_6$)

Note: A set of mounting brackets (consisting of upper and lower mounting rail) (order no. C73165-A63-D200- 1) is required for cabinet flush mounting.

Provide for sufficient space at the device bottom side or below the device to accommodate the cables of the communication modules.

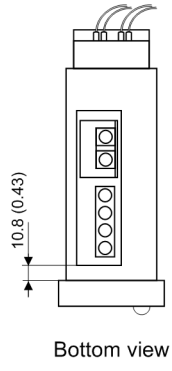
4.19.2 Panel Surface Mounting (Housing Size 1/6)



[abmess-sechstel-gehaeuse-aufbau-7sx80-060606, 1, en_US]

Figure 4-8 Dimensional drawing of a 7SD80 for panel surface mounting (housing size $^1/_6$)

4.19.3 Bottom View



[ansicht-unten-7sd80-100801, 1, en_US]

Figure 4-9 Bottom view of a 7SD80 (housing size 1/6)