SIEMENS

Protection Systems

SIPROTEC Compact
Protection Devices 7SJ80, 7SJ81, 7SK80, 7RW80, 7SD80
Feeder Automation 7SC80

Catalog SIP 3.01 · V1.0

Answers for infrastructure.

SIEMENS

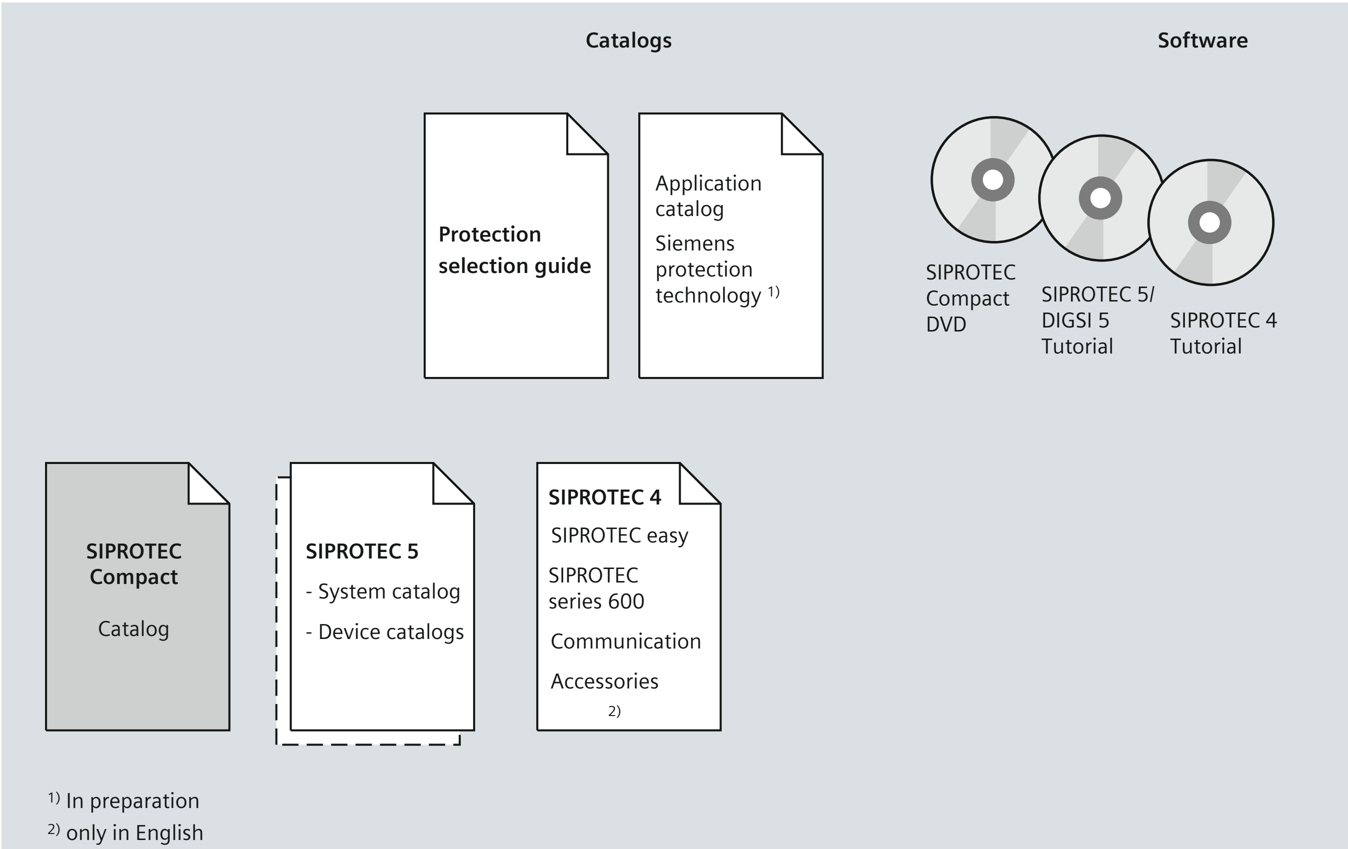


Fig. 1/1 Overview of Siemens protection catalogs

Protection selection guide

The selection guide offers an overview of the device series of the Siemens protection devices, and a device selection table.

SIPROTEC application catalog

This catalog gives an overview of the features for the complete Siemens protection system family, and describes typical protection applications and communication solutions. Furthermore, it contains practical configuring aids for, e.g., instrument transformer layouts.

SIPROTEC Compact catalog

The complete SIPROTEC compact catalog describes the features of the SIPROTEC Compact series and presents the available devices and their application possibilities.

SIPROTEC 5 catalogs

The system catalog describes the features of the SIPROTEC 5 system. The SIPROTEC 5 device catalogs describe device-specific features such as scope of functions, hardware and application.

SIPROTEC 4, SIPROTEC series 600, SIPROTEC easy, communication and accessories

This catalog describes the features of the device series SIPROTEC 4, SIPROTEC series 600 and SIPROTEC easy, as well as their devices. In further chapters, the accessories of the complete SIPRROTEC family for communication, auxiliary relays and test equipment are described.

Contents

SIPROTEC Compact Protection Devices 7SJ80, 7SJ81, 7SK80, 7RW80, 7SD80, Feeder Automation 7SC80

Catalog SIP 3.01 · V1.0

ISO 9001
ISO 14001
DNV
Certified Company

OHSAS 18001
DNV
Certified Company

The products and systems described in this catalog are manufactured and sold according to a certified management system (acc.to ISO 9001, ISO 14001 and BS OHSAS 18001).
DNV Certificate No.: 92113-2011-AHSO-GER-TGA and certificate No.: 87028-2010-AHSO-GER-TGA.

Editorial

We are pleased to have the opportunity to introduce our new SIPROTEC Compact catalog to you.

The SIPROTEC Compact series has been especially conceived for the requirements of the medium-voltage and industrial sector, but it can of course also be used for other applications such as high-voltage switchgear, for example.

The outstanding feature of the SIPROTEC Compact series is the compact design offering, at the same time, a high functional density and user friendliness. In the development of the SIPROTEC Compact series we have integrated our experience from more than 100 years of protection systems, the proven functions of SIPROTEC 4, and many customer suggestions.

The Compact series fits perfectly into the SIPROTEC concept, and can be combined with other devices of this system as required.

With SIPROTEC we are offering you an open and future-proof system family to solve the requirements of modern power supply systems.

At the beginning, please orientate yourself by means of a short overview of the complete SIPROTEC family, and then discover the system features of the SIPROTEC Compact series.

Please convince yourself of the performance of SIPROTEC Compact series, and develop the possible solutions for your requirements.

SIPROTEC – safe, reliable and efficient.

Yours sincerely,

Ingo Erkens

General Manager
Infrastructure & Cities Sector
Smart Grid Division
Energy Automation

Fig. 1/2 SIPROTEC Compact front

Fig. 1/3 Application in medium voltage

Solutions for today's and future power supply systems – for more than 100 years

SIPROTEC has established itself on the energy market for decades as a powerful and complete system family of numerical protection relays and bay controllers from Siemens.

SIPROTEC protection relays from Siemens can be consistently used throughout all applications in medium and high voltage. With SIPROTEC, operators have their systems firmly and safely under control, and have the basis to implement cost-efficient solutions for all duties in modern, intelligent and "smart" grids. Users can combine the units of the different SIPROTEC device series at will for solving manifold duties – because SIPROTEC stands for continuity, openness and future-proof design.

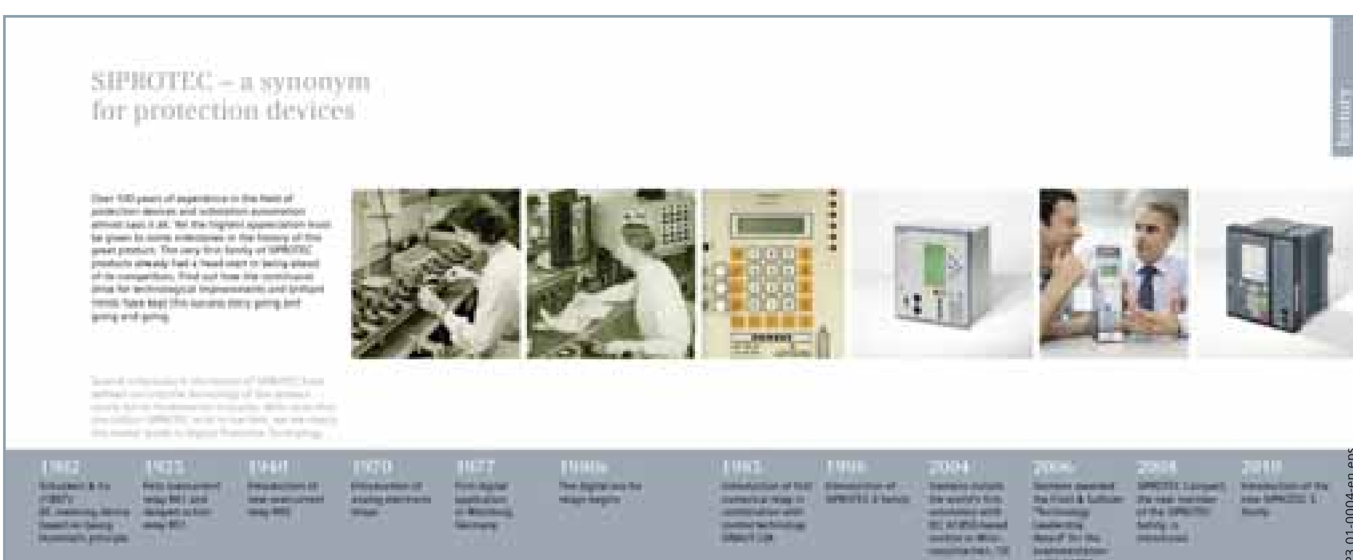
As the innovation driver and trendsetter in the field of protection systems for 100 years, Siemens helps system operators to design their grids in an intelligent, ecological, reliable and efficient way, and to operate them economically. As a pioneer, Siemens has decisively influenced the development of numerical protection systems (Fig. 1/5). The first application went into operation in Würzburg, Germany, in 1977. Consistent integration of protection and control functions for all SIPROTEC devices was the innovation step in the 90ies. After release of the communication standard IEC 61850 in the year 2004, Siemens was the first manufacturer worldwide to put a system with this communication standard into operation.


LSP3.01-0003.eps

Fig. 1/4 SIPROTEC family

How can system operators benefit from this experience?

- Proven and complete applications
- Easy integration into your system
- Highest quality of hardware and software
- Excellent operator friendliness of devices and tools
- Easy data exchange between applications
- Extraordinary consistency between product and system-engineering
- Reduced complexity by easy operation
- Siemens as a reliable, worldwide operating partner.



LSP3.01-0004-en.eps

Fig. 1/5 SIPROTEC – Pioneer over generations

SIPROTEC device series

SIPROTEC easy

SIPROTEC easy are CT power supplied, numerical overcurrent-time protection relays, which can be used as line and transformer protection (back-up protection) in electrical power supply systems with single-ended supply. They offer definite-time and inverse-time overcurrent protection functions according to IEC and ANSI. The comfortable operation via DIP switch is self-explanatory and simple.

- Two-stage overcurrent-time protection
- Saving the auxiliary power supply by operation via integrated current transformer supply
- Cost-efficient due to the use of instrument transformers with low ratings
- Tripping via pulse output (24 V DC / 0.1 Ws) or tripping relay output
- Simple, self-explanatory parameterization and operation via DIP switch directly at the device
- Easy installation due to compact assembly on DIN rail.

Fig. 1/6 SIPROTEC easy

SIPROTEC Compact (series 600)

The devices of the SIPROTEC Compact series (series 600) are compact, numerical protection devices for application in medium-voltage or industrial power supply systems. The corresponding device types are available for the different applications such as overcurrent-time protection, line differential protection, transient earth-fault relay or busbar protection.

- Space-saving due to compact design
- Reliable process connections by means of solid terminal blocks
- Effective fault evaluation by means of integrated fault recording and SIGRA 4
- Communication interface
- Operable and evaluable via DIGSI 4
- Different device types available for directional and non-directional applications.

Fig. 1/7 SIPROTEC Compact (series 600)

SIPROTEC Compact –
Maximum protection – minimum space

Reliable and flexible protection for energy distribution and industrial systems with minimum space requirements. The devices of the SIPROTEC Compact family offer an extensive variety of functions in a compact and thus space-saving 1/6 x 19" housing. The devices can be used as main protection in medium-voltage applications or as back-up protection in high-voltage systems.

SIPROTEC Compact provides suitable devices for many applications in energy distribution, such as the protection of feeders, lines or motors. Moreover, it also performs tasks such as system decoupling, load shedding, load restoration, as well as voltage and frequency protection.

The SIPROTEC Compact series is based on millions of operational experience with SIPROTEC 4 and a further-developed, compact hardware, in which many customer suggestions were integrated. This offers maximum reliability combined with excellent functionality and flexibility.

- Simple installation by means of pluggable current and voltage terminal blocks
- Thresholds adjustable via software (3 stages guarantee a safe and reliable recording of input signals)
- Easy adjustment of secondary current transformer values (1 A/5 A) to primary transformers via DIGSI 4
- Quick operations at the device by means of 9 freely programmable function keys
- Clear overview with six-line display
- Easy service due to buffer battery replaceable at the front side
- Use of standard cables via USB port at the front
- Integration in the communication network by means of two further communication interfaces
- High availability due to integrated redundancy (electrical or visual) for IEC 61850 communication
- Reduction of wiring between devices by means of cross-communication via Ethernet (IEC 61850 GOOSE)
- Time synchronization to the millisecond via Ethernet with SNTP for targeted fault evaluation
- Adjustable to the protection requirements by means of "flexible protection functions"
- Comfortable engineering and evaluation via DIGSI 4.

Fig. 1/8 SIPROTEC Compact

Fig. 1/9 SIPROTEC Compact – rear view

Fig. 1/10 Feeder automation relay 7SC80

1

SIPROTEC 4 – the proven, reliable and future-proof protection for all applications

SIPROTEC 4 represents a worldwide successful and proven device series with more than 1 million devices in field use.

Due to the homogenous system platform, the unique engineering program DIGSI 4 and the great field experience, the SIPROTEC 4 device family has gained the highest appreciation of users all over the world. Today, SIPROTEC 4 is considered the standard for numerical protection systems in all fields of application.

SIPROTEC 4 provides suitable devices for all applications from power generation and transmission up to distribution and industrial systems.

SIPROTEC 4 is a milestone in protection systems. The SIPROTEC 4 device series implements the integration of protection, control, measuring and automation functions optimally in one device. In many fields of application, all tasks of the secondary systems can be performed with one single device. The open and future-proof concept of SIPROTEC 4 has been ensured for the entire device series with the implementation of IEC 61850.

- Proven protection functions guarantee the safety of the systems operator's equipment and employees
- Comfortable engineering and evaluation via DIGSI 4
- Simple creation of automation solutions by means of the integrated CFC
- Targeted and easy operation of devices and software thanks to user-friendly design
- Powerful communication components guarantee safe and effective solutions
- Maximum experience worldwide in the use of SIPROTEC 4 and in the implementation of IEC 61850 projects
- Future-proof due to exchangeable communication interfaces and integrated CFC.

Fig. 1/11 SIPROTEC 4

Fig. 1/12 SIPROTEC 4 – rear view

Fig. 1/13 SIPROTEC 4 application in power stations

SIPROTEC 5 – the new benchmark for protection, automation and monitoring of transmission grids

The SIPROTEC 5 series is based on the long field experience of the SIPROTEC device series, and has been especially designed for the new requirements of modern high-voltage systems. For this purpose, SIPROTEC 5 is equipped with extensive functionalities and device types. With the holistic and consistent engineering tool DIGSI 5, a solution has also been provided for the increasingly complex processes, from the design via the engineering phase up to the test and operation phase.

Thanks to the high modularity of hardware and software, the functionality and hardware of the devices can be tailored to the requested application and adjusted to the continuously changing requirements throughout the entire life cycle.

Besides the reliable and selective protection and the complete automation function, SIPROTEC 5 offers an extensive database for operation and monitoring of modern power supply systems. Synchrophasors (PMU), power quality data and extensive operational equipment data are part of the scope of supply.

- Powerful protection functions guarantee the safety of the system operator's equipment and employees
- Individually configurable devices save money on initial investment as well as storage of spare parts, maintenance, expansion and adjustment of your equipment
- Clear and easy-to-use of devices and software thanks to user-friendly design
- Increase of reliability and quality of the engineering process
- High reliability due to consequent implementation of safety and security
- Powerful communication components guarantee safe and effective solutions
- Full compatibility between IEC 61850 Editions 1 and 2
- Efficient operating concepts by flexible engineering of IEC 61850 Edition 2
- Comprehensive database for monitoring of modern power grids
- Optimal smart automation platform for transmission grids based on integrated synchrophasor measurement units (PMU) and power quality functions.

Fig. 1/14 SIPROTEC 5 – modular hardware

Fig. 1/15 SIPROTEC 5 – modular process connection

Fig. 1/16 Application in a high-voltage power system

Introduction – SIPROTEC Compact

1

■ basic
● optional
– not available
1) In preparation

ANSI	Functions	Abbr.	Line differential protection	Overcurrent and feeder protection/ feeder automation			Generator and motor protection	Voltage and frequency protection
			SIPROTEC Compact					
			7SD80	7SJ80	7SJ81	7SC80 1)	7SK80	7RW80
	Protection functions for 3-pole tripping	3-pole	■	■	■	■	■	■
14	Locked rotor protection	$I>$ + $V<$	–	–	–	–	■	–
FL	Fault locator	FL	–	●	–	●	–	–
24	Overexcitation protection	V/f	–	–	–	–	–	●
25	Synchrocheck, synchronizing function	Sync	–	●	–	–	–	●
27	Undervoltage protection	$V<$	●	●	–	●	●	■
32	Directional power supervision	$P>$, $P<$	–	●	–	●	●	–
37	Undercurrent, underpower	$I<$, $P<$	–	■	■	–	■	–
38	Temperature supervision	$\Theta>$	–	–	–	–	■	–
46	Unbalanced-load protection	$I2>$	–	■	■	■	■	–
47	Phase-sequence-voltage supervision	LA, LB, LC	–	●	–	–	●	■
48	Start-time supervision	I^2_{start}	–	–	–	–	■	–
49	Thermal overload protection	θ, I^2t	■	■	■	–	■	–
50	Definite time-overcurrent protection	$I>$	■	■	■	■	■	–
50Ns	Sensitive ground-current protection	$I_{Ns}>$	–	●	●	–	●	–
50L	Load-jam protection	$I>_L$	–	–	–	–	■	–
50BF	Circuit-breaker failure protection	CBFP	■	■	■	■	■	–
51	Inverse time-overcurrent protection	I_P	■	■	■	■ 1)	■	–
55	Power factor	cos φ	–	●	–	●	●	–
59	Overvoltage protection	$V>$	●	●	–	●	●	■
59R, 27R	Rate-of-voltage-change protection	dV/dt	–	–	–	–	–	■
66	Restart inhibit	I^2t	–	–	–	–	■	–
67	Directional overcurrent protection	$I>, \angle (V,I)$	●	●	–	●	●	–
67Ns	Sensitive ground-fault detection for systems with resonant or isolated neutral	$I_N>, \angle (V,I)$	–	●	–	–	●	–
68	Power-swing blocking	$\Delta Z/\Delta t$	–	–	–	–	–	–
74TC	Trip-circuit supervision	TCS	■	■	■	–	■	■
79	Automatic reclosing	AR	●	●	–	–	–	–
81	Frequency protection	$f<$, $f>$	●	●	–	●	●	■
	Vector-jump protection	$\Delta\varphi_U>$	–	–	–	–	–	●
81LR	Load restoration	LR	–	–	–	–	–	●
85	Teleprotection		■	–	–	–	–	–
86	Lockout		■	■	■	–	■	■
87	Differential protection	ΔI	■	–	–	–	–	–
87N	Differential ground-fault protection	ΔI_N	■	●	–	–	–	–
	Further functions							
	Measured values		■	■	■	■	■	■
	Switching-statistic counters		■	■	■	■	■	■
	Logic editor		■	■	■	■	■	■
	Inrush-current detection		■	■	■	■	■	–
	External trip initiation		■	■	■	■	■	■
	Control		■	■	■	■	■	■
	Fault recording of analog and binary signals		■	■	■	■	■	■
	Monitoring and supervision		■	■	■	■	■	■
	Protection interface, serial		■	–	–	–	–	–
	No. Setting groups		4	4	4	4	4	4
	Battery charger/-monitor		–	–	–	● 1)	–	–

Table 1/1 SIPROTEC Compact relay selection table

System features

Field devices in energy distribution systems and in industrial applications must cover the most varying tasks, and yet be adjustable easily and at short notice. These tasks comprise, for example:

- Protection of different operational equipment such as lines, cables, motors and busbars
- Decoupling and disconnecting of parts of the power supply system
- Load shedding and load restoration
- Voltage and frequency protection
- Local or remote control of circuit-breakers
- Acquisition and recording of measured values and events
- Communication with neighboring devices or the control center.

Fig. 1/17 shows exemplary how the most different tasks can be easily and safely solved with the matching SIPROTEC Compact devices.

Operation

During the development of SIPROTEC Compact, special value was placed not only on a powerful functionality, but also on simple and intuitive operation by the operating personnel. Freely assignable LEDs and a six-line display guarantee an unambiguous and clear indication of the process states.

In conjunction with up to 9 function keys and the control keys for the operational equipment, the operating personnel can react quickly and safely to every situation. This ensures a high operational reliability even under stress situations, thus reducing the training effort considerably.
Please refer also to page 1/14.

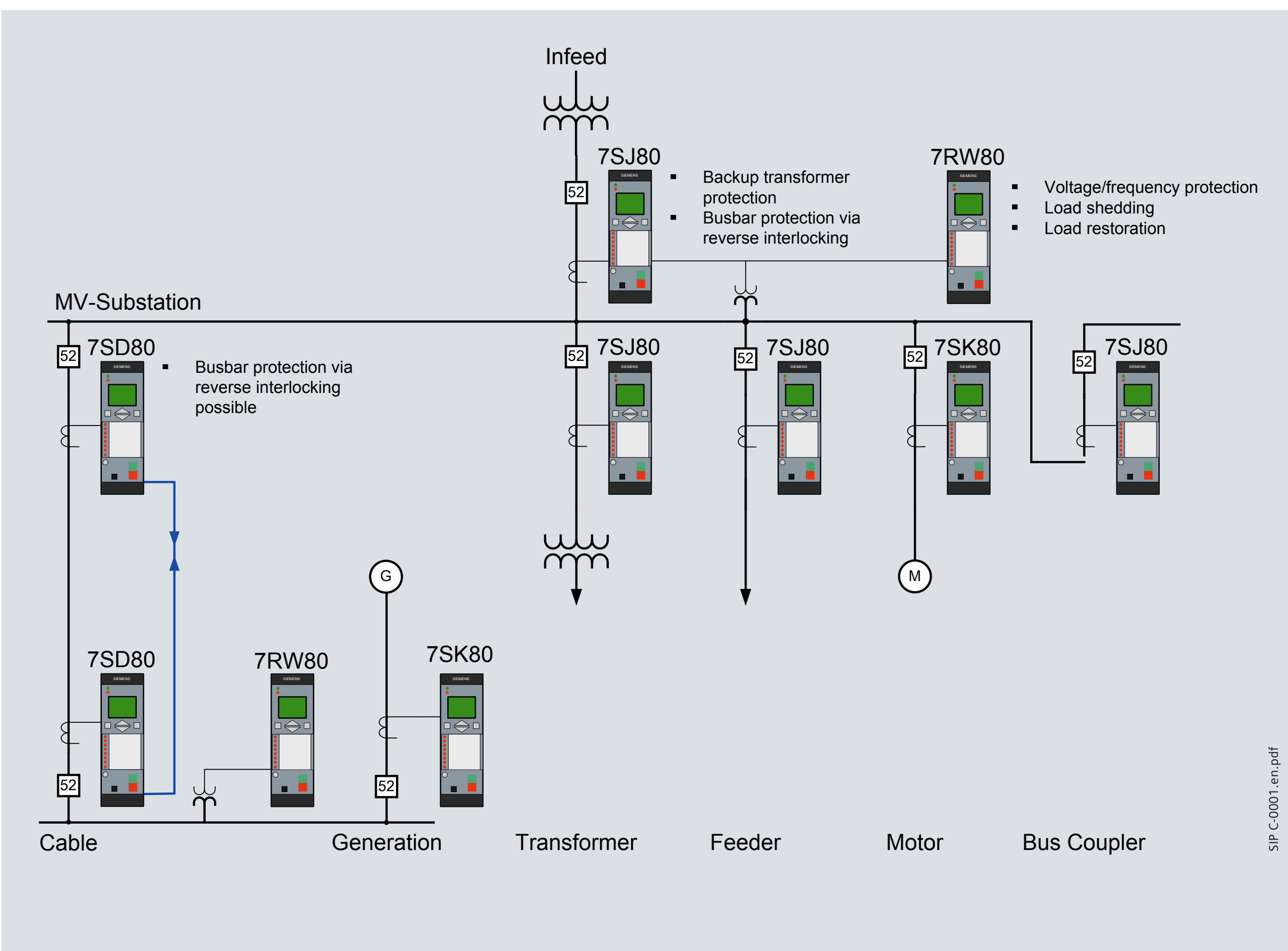


Fig. 1/17 Fields of application in a typical MV system

The Feeder Automation device 7SC80 is designed for decentralized feeder automation applications. This solution allows a very fast localization and isolation of the fault and restoration of non affected sections of the line. It is called FISR (Fault Location, Isolation, and Service Restoration)

Fig. 1/18 shows an example of a typical ring main application with overhead lines and 5 sections.

Every section is protected and automated by the 7SC80 Feeder Automation device.

The decentralized solution with 7SC80 benefits:

- Detect feeder faults
- Determine the fault location (between 2 switches/reclosers)
- Isolate the faulted section of the feeder (between 2 feeder switches/reclosers)
- Restore service to "healthy" portions of the feeder.

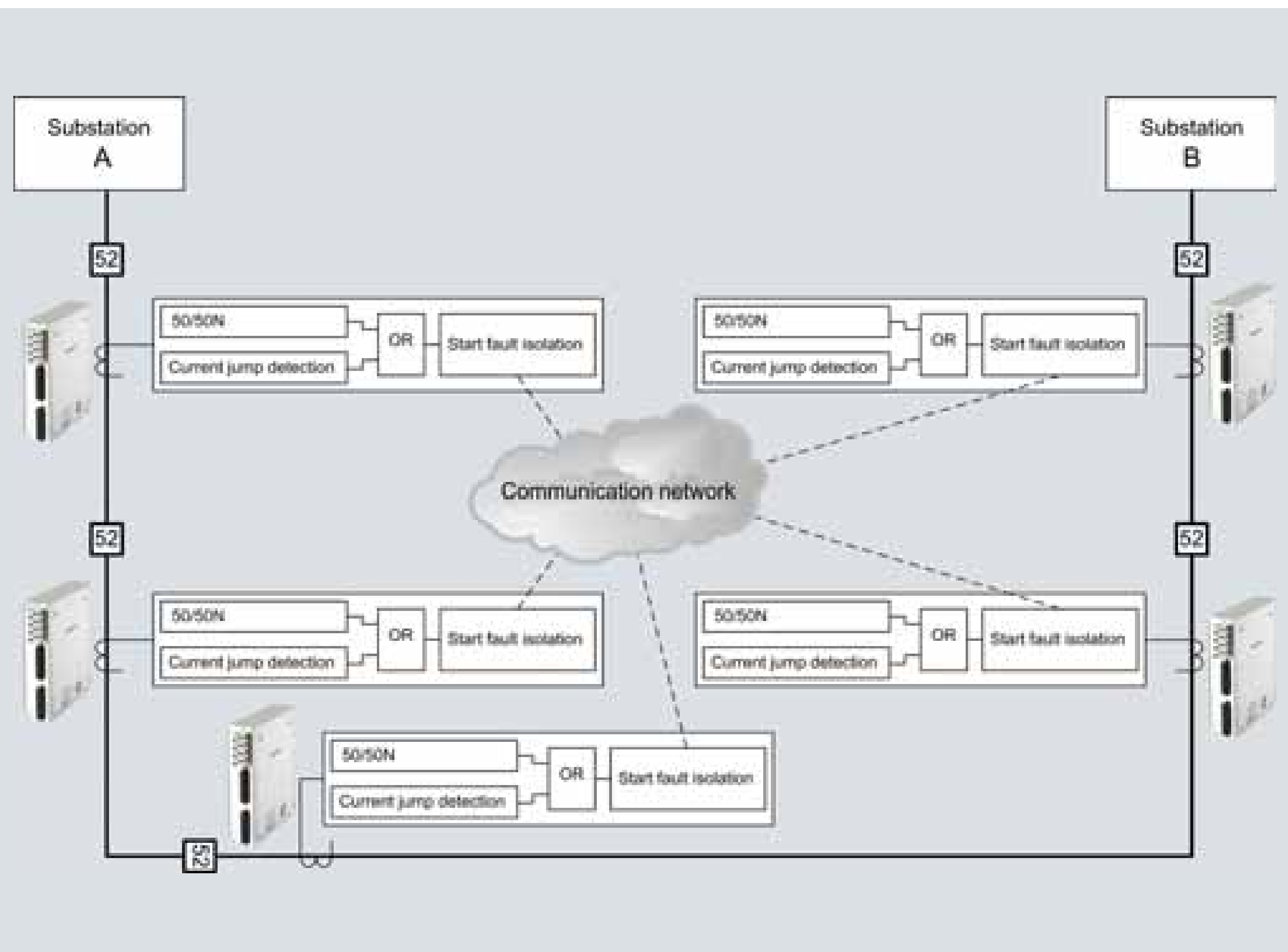


Fig. 1/18 Fields of application with feeder automation controller 7SC80

Introduction – SIPROTEC Compact

Operation

Local operation

All operations and information can be executed via an integrated user interface:

2 operation LEDs

In an illuminated 6-line LC display, process and device information can be indicated as text in different lists.

4 navigation keys

8 freely programmable LEDs serve for indication of process or device information. The LEDs can be labeled user-specifically. The LED reset key resets the LEDs.

9 freely configurable function keys support the user in performing frequent operations quickly and comfortably.

Numerical operation keys

USB user interface (type B) for modern and fast communication with the operating software DIGSI.

Keys “O” and “I” for direct control of operational equipment.

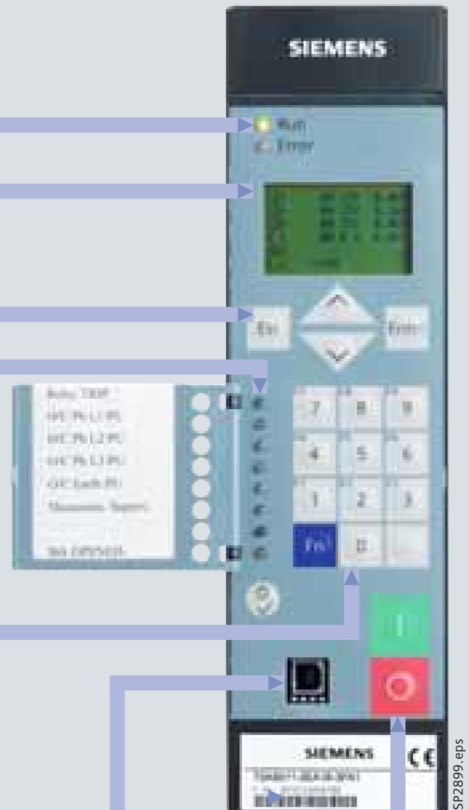


Fig. 1/19
SIPROTEC Compact with open board

Battery cover accessible from outside.

Fig. 1/20
SIPROTEC Compact with closed board and open battery cover

Connection techniques and housing with many advantages

The relay housing is 1/6 of a 19" rack and makes replacement of predecessors model very easy. The height is 244 mm (9.61").

Pluggable current and voltage terminals allow for pre-wiring and simplify the exchange of devices in the case of support. CT shorting is done in the removable current terminal block. It is thus not possible to open-circuit a secondary current transformer.

All binary inputs are independent and the pick-up thresholds are settable using software settings (3 stages). The relay current transformer taps (1 A / 5 A) are new software settings. Up to 9 function keys can be programmed for predefined menu entries, switching sequences, etc. The assigned function of the function keys can be shown in the display of the relay.

If a conventional (inductive) set of primary voltage transformers is not available in the feeder, the phase-to-ground voltages can be measured directly through a set of capacitor cones in the medium-voltage switchgear. In this case, the functions directional overcurrent protection, ground (ANSI 67N), voltage protection (ANSI 27/59) and frequency protection (ANSI 81O/U) are available. With overcurrent protection 7SJ81 there is also a device for low-power current transformer applications.

Current terminals – ring-type lugs	
Connection	W_{max} = 9.5 mm
Ring-type lugs	*d1* = 5.0 mm
Wire size	2.0 – 5.2 mm² (AWG 14 – 10)
Current terminals – single cables	
Cable cross-section	2.0 – 5.2 mm² (AWG 14 – 10)
Conductor sleeve with plastic sleeve	L = 10 mm (0.39 in) or L = 12 mm (0.47 in)
Stripping length (when used without conductor sleeve)	15 mm (0.59 in) Only solid copper wires may be used.
Voltage terminals – single cables	
Cable cross-section	0.5 – 2.0 mm² (AWG 20 – 14)
Conductor sleeve with plastic sleeve	L = 10 mm (0.39 in) or L = 12 mm (0.47 in)
Stripping length (when used without conductor sleeve)	12 mm (0.347 in) Only solid copper wires may be used.

Table 1/2 Wiring specifications for process connection

Fig. 1/21 7SK80, 7SJ80, 7SD80 rear view

Fig. 1/22 Voltage terminal block

Fig. 1/23 Current terminal block

Fig. 1/24 7SJ81 rear view

Fig. 1/25 7RW80 rear view

Fig. 1/26 Front view, surface-mounting housing

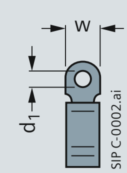


Fig. 1/27 Ring-type lug

Control and automation functions

Control

In addition to the protection functions, SIPROTEC Compact units also support all control and monitoring functions that are required for operating medium-voltage or high-voltage substations. The status of primary equipment or auxiliary devices can be obtained from auxiliary contacts and communicated to the unit via binary inputs. Therefore it is possible to detect and indicate both the OPEN and CLOSED position or a fault or intermediate circuit-breaker or auxiliary contact position.

The switchgear or circuit-breaker can be controlled via:

– integrated operator panel

– binary inputs

– substation control and protection system

– DIGSI 4.

Automation/user-defined logic

With integrated logic, the user can create, through a graphic interface (CFC), specific functions for the automation of a switchgear or a substation. Functions are activated using function keys, a binary input or through the communication interface.

Switching authority

Switching authority is determined by set parameters or through communications to the relay. If a source is set to "LOCAL", only local switching operations are possible. The following sequence for switching authority is available: "LOCAL"; DIGSI PC program, "REMOTE". There is thus no need to have a separate Local/Remote switch wired to the breaker coils and relay. The local/remote selection can be done using a function key on the front of the relay.

Command processing

This relay is designed to be easily integrated into a SCADA or control system. Security features are standard and all the functionality of command processing is offered. This includes the processing of single and double commands with or without feedback, sophisticated monitoring of the control hardware and software, checking of the external process, control actions using functions such as runtime monitoring and automatic command termination after output. Here are some typical applications:

- Single and double commands using 1, 1 plus 1 common or 2 trip contacts
- User-definable bay interlocks
- Operating sequences combining several switching operations, such as control of circuit-breakers, disconnectors and grounding switches
- Triggering of switching operations, indications or alarms by combination with existing information.

Assignment of feedback to command

The positions of the circuit-breaker or switching devices and transformer taps are acquired through feedback. These indication inputs are logically assigned to the corresponding command outputs. The unit can therefore distinguish whether the indication change is a result of switching operation or whether it is an undesired spontaneous change of state.

Chatter disable

The chatter disable feature evaluates whether, in a set period of time, the number of status changes of indication input exceeds a specified number. If exceeded, the indication input is blocked for a certain period, so that the event list will not record excessive operations.

Indication filtering and delay

Binary indications can be filtered or delayed. Filtering serves to suppress brief changes in potential at the indication input. The indication is passed on only if the indication voltage is still present after a set period of time. In the event of an indication delay, there is a delay for a preset time. The information is passed on only if the indication voltage is still present after this time.

Indication derivation

User-definable indications can be derived from individual or a group of indications. These grouped indications are of great value to the user that need to minimize the number of indications sent to the system or SCADA interface.

DIGSI 4, an operating software for all SIPROTEC protection devices

The PC operating program DIGSI 4 is the user interface to the SIPROTEC devices, regardless of their version. It is designed with a modern, intuitive user interface.

With DIGSI 4, SIPROTEC devices are configured and evaluated – it is the tailored program for industrial and energy distribution systems.

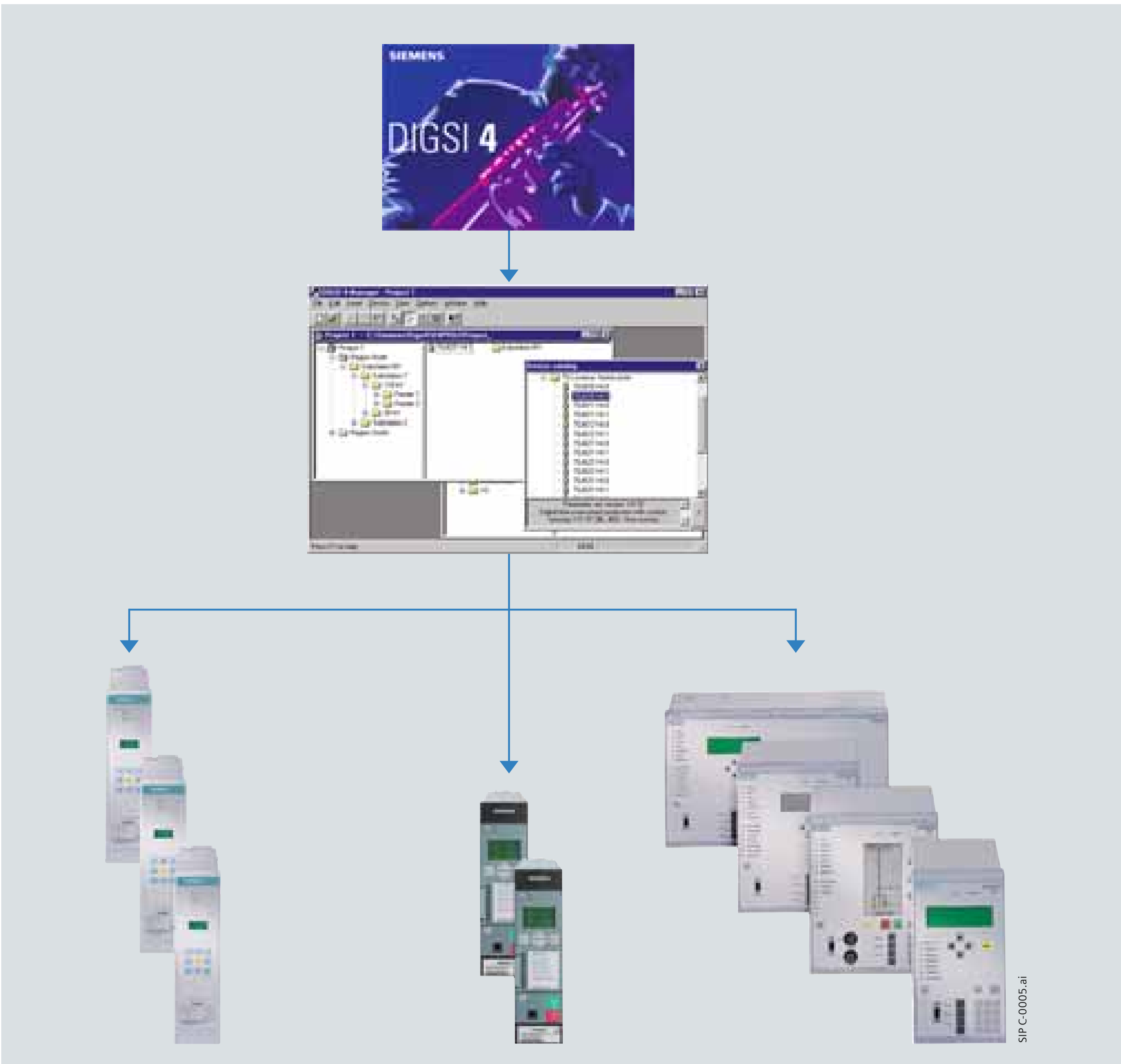


Fig. 1/28 DIGSI 4 operating program

Simple protection setting

From the numerous protection functions it is possible to easily select only those which are really required (see Fig. 1/29). This increases the clearness of the other menus.

Device setting with primary or secondary values

The settings can be entered and displayed as primary or secondary values. Switching over between primary and secondary values is done with one mouse click in the tool bar (see Fig. 1/29).

Assignment matrix

The DIGSI 4 matrix shows the user the complete configuration of the device at a glance (Fig. 1/30). For example, the assignment of the LEDs, the binary inputs and the output relays is displayed in one image. With one click, the assignment can be changed.

IEC 61850 system configurator

The IEC 61850 system configurator, which is started out of the system manager, is used to determine the IEC 61850 network structure as well as the extent of data exchange between the participants of a IEC 61850 station. To do this, subnets are added in the "network" working area – if required –, available participants are assigned to the subnets, and addressing is defined. The "assignment" working area is used to link data objects between the participants, e.g., the starting message of the *V* / inverse-time overcurrent protection *I* > function of feeder 1, which is transferred to the incoming supply in order to prompt the reverse interlocking of the V/inverse-time overcurrent protection *I* >> function there (see Fig. 1/31).

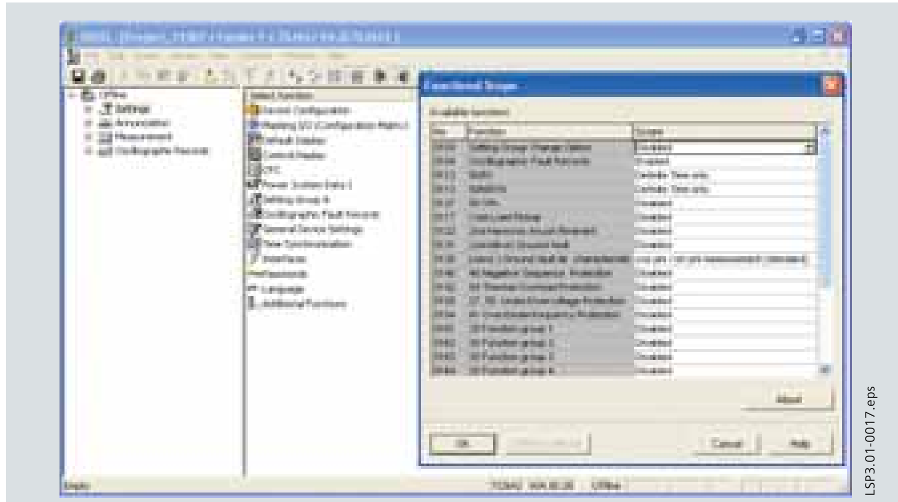


Fig. 1/29 DIGSI 4, main menu, selection of protection functions

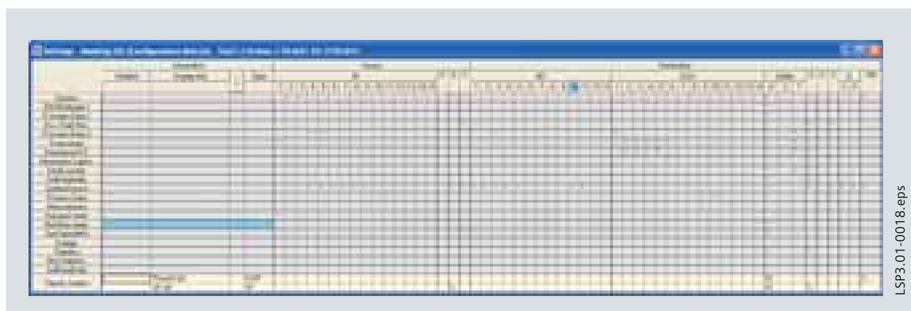


Fig. 1/30 DIGSI 4, assignment matrix

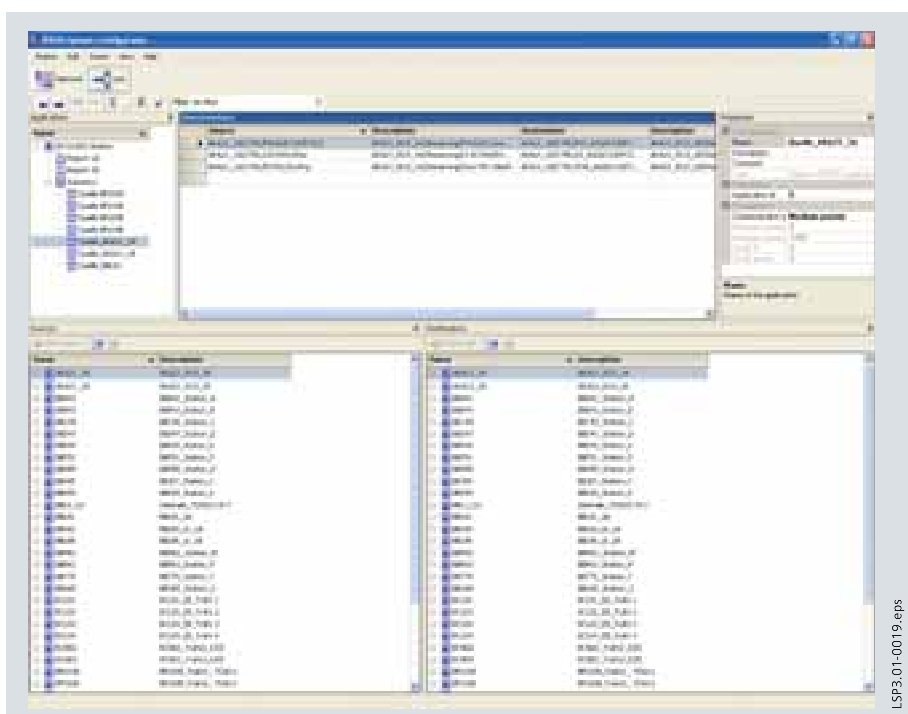


Fig. 1/31 DIGSI 4, IEC 61850 system configurator

CFC: Projecting the logic instead of programming

With the CFC (continuous function chart), it is possible to link and derive information without software knowledge by simply drawing technical processes, interlocks and operating sequences.

Logical elements such as AND, OR, timers, etc., as well as limit value requests of measured values are available (Fig. 1/32).

Commissioning

Special attention has been paid to commissioning. All binary inputs and outputs can be set and read out in targeted way. Thus, a very simple wiring test is possible. Messages can be sent to the serial interface deliberately for test purposes.

SIGRA 4, powerful analysis of all protection fault records

It is of crucial importance after a line fault that the fault is quickly and fully analyzed so that the proper measures can be immediately derived from the evaluation of the cause. As a result, the original line condition can be quickly restored and the downtime reduced to an absolute minimum. It is possible with SIGRA 4 to display records from digital protection units and fault recorders in various views and measure them, as required, depending on the relevant task.

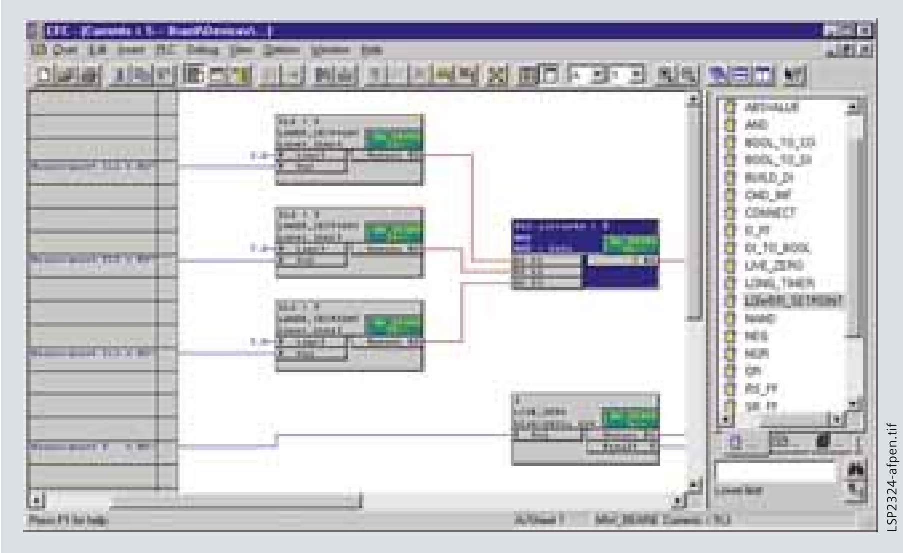


Fig. 1/32 CFC plan

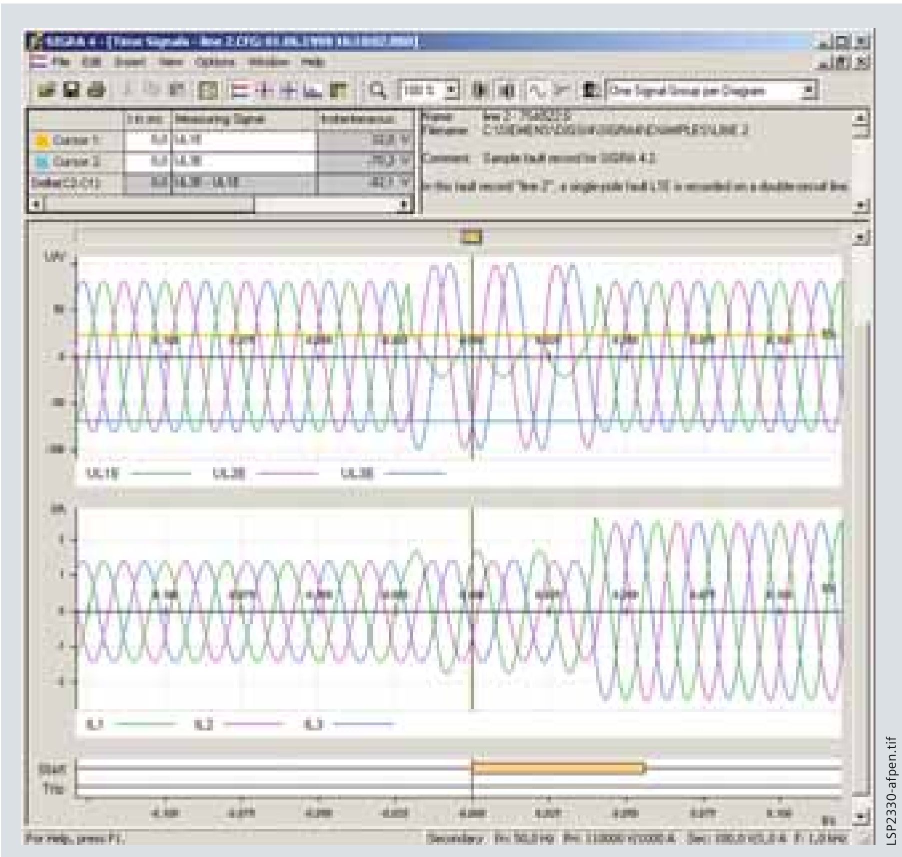


Fig. 1/33 Typical time-signal representation

1

Communication

As regards communication, the devices offer high flexibility for the connection to industrial and energy automation standards. The concept of the communication modules running the protocols enables exchangeability and retrofittability. Thus, the devices can also be perfectly adjusted to a changing communication infrastructure in the future, e.g., when Ethernet networks will be increasingly used in the utilities sector in the years to come.

USB interface

There is an USB interface on the front of the relay. All the relay functions can be set using a PC and DIGSI 4 protection operation program. Commissioning tools and fault analysis are built into the DIGSI program and are used through this interface.

Interfaces

A number of communication modules suitable for various applications can be fitted at the bottom of the housing. The modules can be easily replaced by the user. The interface modules support the following applications:

- **System/service interface**
Communication with a central control system takes place through this interface. Radial or ring type station bus topologies can be configured depending on the chosen interface. Furthermore, the units can exchange data through this interface via Ethernet and the IEC 61850 protocol and can also be accessed using DIGSI. Alternatively, up to 2 external temperature detection devices with max. 12 metering sensors can be connected to the system/service interface.
- **Ethernet interface**
The Ethernet interface has been designed for quick access to several protection devices via DIGSI. In the case of the motor protection 7SK80, it is possible to connect max. 2 external temperature detection devices with max. 12 metering sensors to the Ethernet interface. As for the line differential protection, the optical interface is located at this interface.

System interface protocols (retrofittable)

- **IEC 61850 protocol**
The IEC 61850 protocol based on Ethernet is standardized as worldwide standard for protection and control systems in the utilities sector. Via this protocol it is possible to exchange information also directly between feeder units, so that simple masterless systems for feeder and switchgear interlocking can be set up. Furthermore, the devices can be accessed with DIGSI via the Ethernet bus.
- **IEC 60870-5-103**
The IEC 60870-5-103 protocol is an international standard for the transmission of protective data and fault recordings. All messages from the unit and also control commands can be transferred by means of published, Siemens-specific extensions to the protocol.
Optionally, a redundant IEC 60870-5-103 module is available. This redundant module allows to read and change individual parameters.
- **PROFIBUS-DP protocol**
PROFIBUS-DP is a widespread protocol in industrial automation. Through PROFIBUS-DP, SIPROTEC units make their information available to a SIMATIC controller or receive commands from a central SIMATIC controller or PLC. Measured values can also be transferred to a PLC master.
- **MODBUS RTU protocol**
This simple, serial protocol is mainly used in industry and by power utilities, and is supported by a number of relay manufacturers. SIPROTEC units function as MODBUS slaves, making their information available to a master or receiving information from it. A time-stamped event list is available.
- **DNP 3.0 protocol**
Power utilities use the serial DNP 3.0 (Distributed Network Protocol) for the station and network control levels. SIPROTEC units function as DNP slaves, supplying their information to a master system or receiving information from it.

System solutions

IEC 60870

Devices with IEC 60870-5-103 interfaces can be connected to SICAM in parallel via the RS485 bus or radially via optical fiber. Via this interface, the system is open for connection of devices from other manufacturers.

Due to the standardized interfaces, SIPROTEC devices can also be integrated into systems from other manufacturers, or into a SIMATIC system. Electrical RS485 or optical interfaces are available. Optoelectronic converters enable the optimal selection of transmission physics. Thus, cubicle-internal wiring with the RS485 bus, as well as interference-free optical connection to the master can be implemented at low cost.

IEC 61850

An interoperable system solution is offered for IEC 61850 together with SICAM. Via the 100 MBit/s Ethernet bus, the devices are connected electrically or optically to the station PC with SICAM. The interface is standardized, thus enabling the direct connection of devices from other manufacturers to the Ethernet bus.

With IEC 61850, the devices can also be installed in systems of other manufacturers.

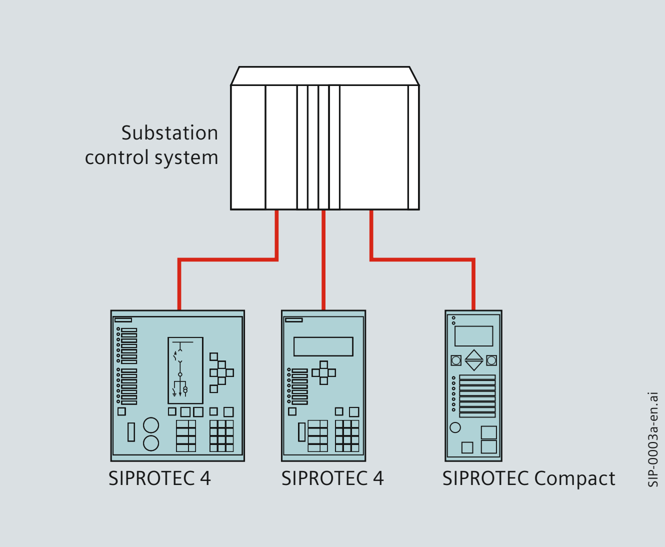


Fig. 1/34 IEC 60870-5-103: Radial fiber-optic connection

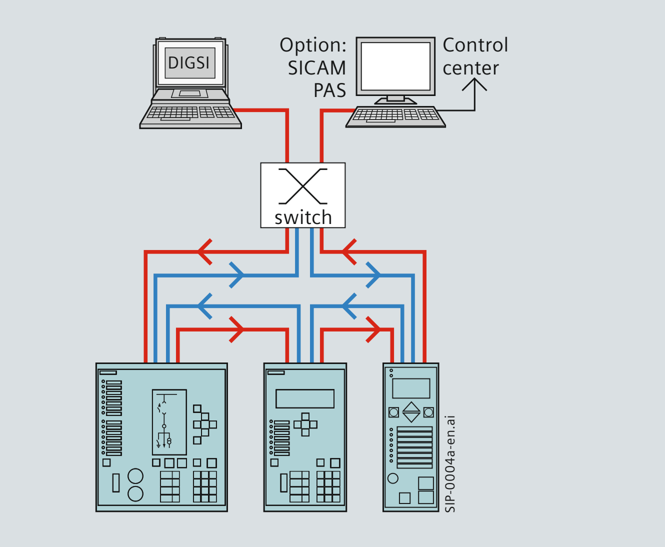


Fig. 1/35 Bus structure for station bus with Ethernet and IEC 61850, fiber-optic ring

Fig. 1/36 Optical Ethernet communication module for IEC 61850

System solution (continued)

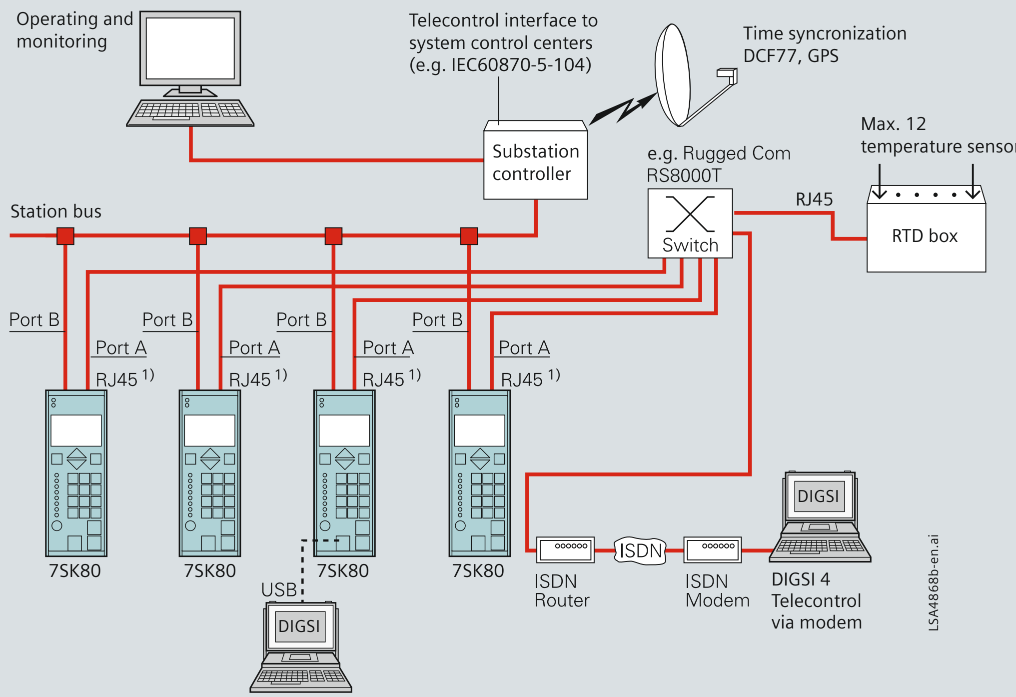


Fig. 1/37 System solution/communication

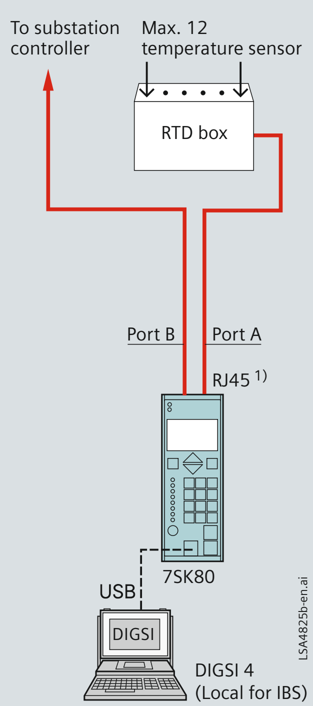


Fig. 1/38 Connection of an RTD box to 7SK80 using Ethernet interface

1) On 7SK80, the RJ45 interface at port A can be used for connection of a thermo-box. On 7SD80, port A is reserved for the optical interface.

Overcurrent Protection 7SJ80
SIPROTEC Compact

SIEMENS

Overcurrent Protection 7SJ80

You will find a detailed overview of the technical data (extract of the manual) under:
http://www.siemens.com/siprotec

Description

The SIPROTEC Compact 7SJ80 relays can be used for line/feeder protection of high and medium-voltage networks with grounded, low-resistance grounded, isolated or a compensated neutral point. The relays have all the required functions to be applied as a backup relay to a transformer differential relay.

The SIPROTEC Compact 7SJ80 features "flexible protection functions". Up to 20 additional protection functions can be created by the user. For example, a rate of change of frequency function or a reverse power function can be created. The relay provides circuit-breaker control, additional primary switching devices (grounding switches, transfer switches and isolating switches) can also be controlled from the relay. Automation or PLC logic functionality is also implemented in the relay.

The integrated programmable logic (CFC) allows the user to add own functions, e.g. for the automation of switchgear (including: interlocking, transfer and load shedding schemes). The user is also allowed to generate user-defined messages. The communication module is independent from the protection. It can easily be exchanged or upgraded to future communication protocols.

Fig. 2/1 7SJ80 front view, housing

Fig. 2/2 7SJ80 rear view

Highlights

- Pluggable current and voltage terminals
- Binary input thresholds settable using DIGSI (3 stages)
- Secondary current transformer values (1 A / 5 A) settable using DIGSI
- 9 programmable function keys
- 6-line display
- Buffer battery exchangeable from the front
- USB front port
- 2 additional communication ports
- IEC 61850 with integrated redundancy (electrical or optical)
- Relay-to-relay communication through Ethernet with IEC 61850 GOOSE
- Millisecond-accurate time synchronization through Ethernet with SNTP.

Overcurrent Protection 7SJ80

Function overview

Protection functions	IEC	ANSI No.
Instantaneous and definite time-overcurrent protection (phase/neutral)	$I>$, $I>>$, $I>>>$, $I_E>$, $I_E>>$, $I_E>>>$; I_p, I_{Ep}	50, 50N; 51, 51N
Directional time-overcurrent protection	$I_{dir}>$, $I_{dir}>>$, $I_{p\ dir}$	67
Ground-fault protection	$I_{E\ dir}>$, $I_{E\ dir}>>$, $I_{Ep\ dir}$	67N 1)
Directional/non-directional sensitive ground-fault detection	$I_{EE}>$, $I_{EE}>>$, I_{EEp}	67Ns 1), 50Ns
Displacement voltage, zero-sequence voltage	V_E, $V_0>$	59N 1)
High-impedance restricted ground-fault protection		87N
Inrush restraint		
Undercurrent monitoring	$I<$	37
Thermal overload protection	$\vartheta>$	49
Undervoltage/overvoltage protection	$V<$, $V>$	27/59
Overfrequency/underfrequency protection	$f<$, $f>$	81O/U
Breaker failure protection		50BF
Phase-balance current protection (negative-sequence protection)	$I_2>$	46
Unbalance-voltage protection and/or phase-sequence monitoring	$V_2>$, phase sequence	47
Synch-check		25
Auto-reclosure		79
Fault locator		21FL 1)
Lockout		86
Forward-power, reverse-power protection	$P<>$, $Q<>$	32 1)
Power factor	$\cos \varphi$	55 1)
Rate-of-frequency-change protection	df/dt	81R

Table 2/1 Function overview

Control functions/programmable logic

- Commands for the ctrl. of CB, disconnect switches (isolators/isolating switches)
- Control through keyboard, binary inputs, DIGSI 4 or SCADA system
- User-defined PLC logic with CFC (e.g. interlocking).

Monitoring functions

- Operational measured values V, I, f
- Energy metering values W_p, W_q
- Circuit-breaker wear monitoring
- Minimum and maximum values
- Trip circuit supervision (74TC)
- Fuse failure monitor
- 8 oscillographic fault records.

Communication interfaces

- System/service interface
  – IEC 61850
  – IEC 60870-5-103
  – PROFIBUS-DP
  – DNP 3.0
  – MODBUS RTU
- Ethernet interface for DIGSI 4
- USB front interface for DIGSI 4.

Hardware

- 4 current transformers
- 0/3 voltage transformers
- 3/7 binary inputs (thresholds configurable using software)
- 5/8 binary outputs (2 changeover/Form C contacts)
- 1 live-status contact
- Pluggable current and voltage terminals.

1) Not available if function package 'Q' (synch-check, ANSI 25) is selected.

The SIPROTEC Compact 7SJ80 unit is a numerical protection relay that can perform control and monitoring functions and therefore provide the user with a cost-effective platform for power system management, that ensures reliable supply of electrical power to the customers. The ergonomic design makes control easy from the relay front panel. A large, easy-to-read display was a key design factor.

Control

The integrated control function permits control of disconnect devices, grounding switches or circuit-breakers through the integrated operator panel, binary inputs, DIGSI 4 or the control or automation system (e.g. SICAM)

Programmable logic

The integrated logic characteristics (CFC) allow the user to add own functions for automation of switchgear (e.g. interlocking) or switching sequence. The user can also generate user-defined messages. This functionality can form the base to create extremely flexible transfer schemes.

Operational measured value

Extensive measured values (e.g. I, V), metered values (e.g.W_p,W_q) and limit values (e.g. for voltage, frequency) provide improved system management.

Operational indication

Event logs, trip logs, fault records and statistics documents are stored in the relay to provide the user or operator with all the key data required to operate modern substations.

Line protection

The 7SJ80 units can be used for line protection of high and medium-voltage networks with grounded, low-resistance grounded, isolated or a compensated neutral point.

Transformer protection

The relay provides all the functions for backup protection for transformer differential protection. The inrush suppression effectively prevents unwanted trips that can be caused by inrush currents. The high-impedance restricted ground-fault protection detects short-circuits and insulation faults on the transformer.

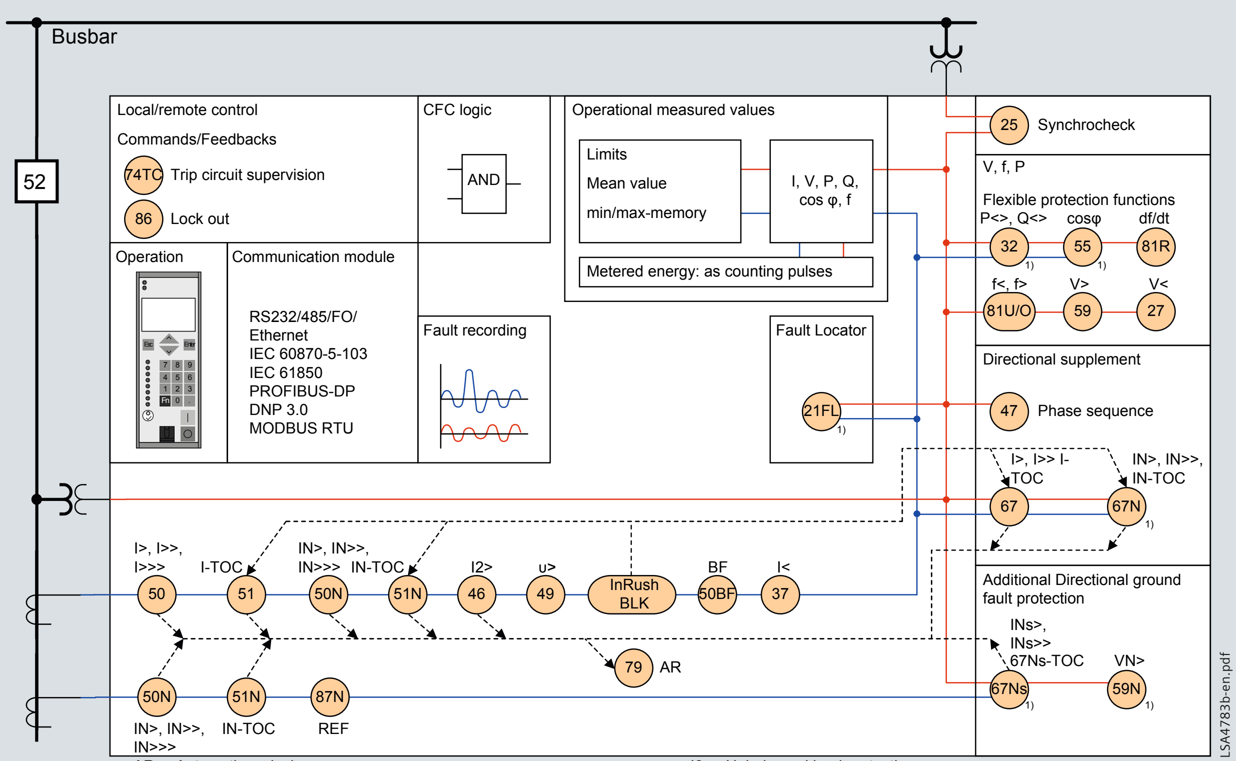
Backup protection

As a backup protection the 7SJ80 devices are universally applicable.

Switchgear cubicles for high/medium voltage

All units are designed specifically to meet the requirements of high/medium-voltage applications. In general, no separate measuring instruments (e.g., for current, voltage, frequency, ...) or additional control components are necessary.

2



AR	Automatic reclosing	I2>	Unbalanced load protection
BF	Breaker Failure Protection	ϑ>	Thermal overload protection
REF	High-impedance ground fault differential protection	I<	Undercurrent monitoring

1) Not available if function package 'Q' (synch-check, ANSI 25) is selected.

Fig. 2/3 Function diagram

2

Protection functions

Time-overcurrent protection (ANSI 50, 50N, 51, 51N)

This function is based on the phase selective measurement of the three phase currents and the ground current (four transformers). Three definite-time overcurrent protection elements (DMT) are available both for the phase and the ground elements. The current threshold and the delay time can be set in a wide range.

Inverse-time overcurrent protection characteristics (IDMTL) can also be selected and activated.

Reset characteristics

Time coordination with electromechanical relays are made easy with the inclusion of the reset characteristics according to ANSI C37.112 and IEC 60255-3 / BS 142 standards. When using the reset characteristic (disk emulation), the reset process is initiated after the fault current has disappeared. This reset process corresponds to the reverse movement of the Ferraris disk of an electromechanical relay (disk emulation).

Available inverse-time characteristics

Characteristics acc. to	IEC 60255-3	ANSI/IEEE
Inverse	•	•
Short inverse		•
Long inverse	•	•
Moderately inverse		•
Very inverse	•	•
Extremely inverse	•	•

Table 2/2 Available inverse-time characteristics

Inrush restraint

If second harmonic content is detected during the energization of a transformer, the pickup of stages I>, I_p, I>$_{dir}$ and $I_{p\ dir}$ is blocked.

Dynamic settings group switching

In addition to the static parameter changeover, the pickup thresholds and the tripping times for the directional and non-directional time-overcurrent protection functions can be changed over dynamically. As changeover criterion, the circuit-breaker position, the prepared auto-reclosure, or a binary input can be selected.

Directional comparison protection (cross-coupling)

It is used for selective instantaneous tripping of sections fed from two sources, i.e. without the disadvantage of time delays of the set characteristic. The directional comparison protection is suitable if the distances between the protection zones are not significant and pilot wires are available for signal transmission. In addition to the directional comparison protection, the directional coordinated time-overcurrent protection is used for complete selective backup protection.

Directional time-overcurrent protection (ANSI 67, 67N)

Directional phase and ground protection are separate functions. They operate in parallel to the non-directional overcurrent elements. Their pickup values and delay times can be set separately. Definite-time and inverse-time characteristics are offered. The tripping characteristic can be rotated by ± 180 degrees.

By making use of the voltage memory, the directionality can be determined reliably even for close-in (local) faults. If the primary switching device closes onto a fault and the voltage is too low to determine direction, the direction is determined using voltage from the memorized voltage. If no voltages are stored in the memory, tripping will be according to the set characteristic.

For ground protection, users can choose whether the direction is to be calculated using the zero-sequence or negative-sequence system quantities (selectable). If the zero-sequence voltage tends to be very low due to the zero-sequence impedance it will be better to use the negative-sequence quantities.

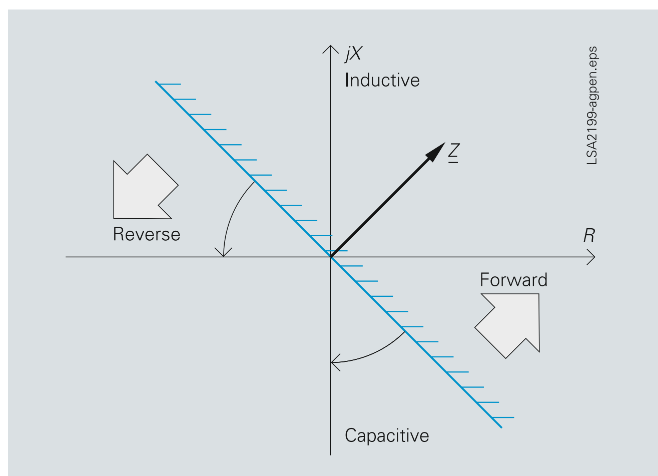


Fig. 2/4 Directional characteristics of the directional time-overcurrent protection

(Sensitive) directional ground-fault detection (ANSI 59N/64, 67Ns, 67N)

For isolated-neutral and compensated networks, the direction of power flow in the zero sequence is calculated from the zero-sequence current I_0 and zero-sequence voltage V_0. For networks with an isolated neutral, the reactive current component is evaluated; for compensated networks, the active current component or residual resistive current is evaluated. For special network conditions, e.g. high-resistance grounded networks with ohmic-capacitive ground-fault current or low-resistance grounded networks with ohmic-inductive current, the tripping characteristics can be rotated approximately ± 45 degrees (see Fig.2/5).

Two modes of ground-fault direction detection can be implemented: tripping or “signalling only mode”.

(Sensitive) directional ground-fault detection (ANSI 59N/64, 67Ns, 67N) (contin.)

It has the following functions:

- TRIP via the displacement voltage V_E
- Two instantaneous elements or one instantaneous plus one user-defined characteristic
- Each element can be set to forward, reverse or non-directional
- The function can also be operated in the insensitive mode as an additional short-circuit protection.

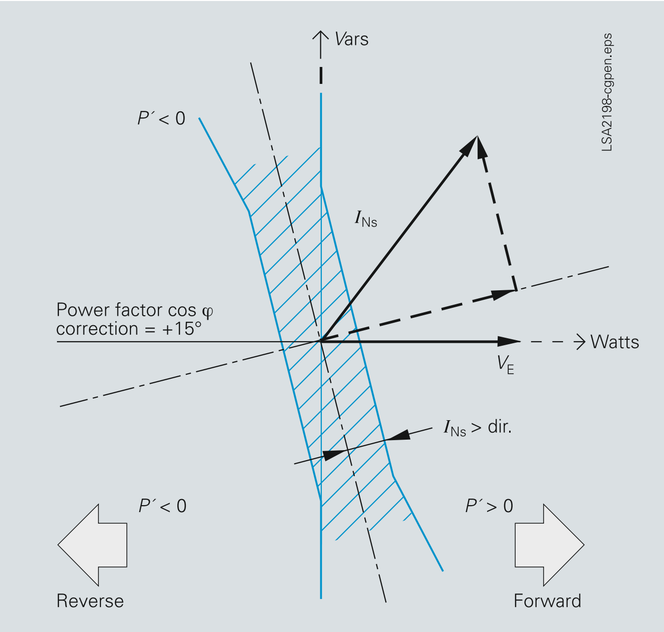


Fig. 2/5 Directional determination using cosine measurements for compensated networks

(Sensitive) ground-fault detection (ANSI 50Ns, 51Ns / 50N, 51N)

For high-resistance grounded networks, a sensitive input transformer is connected to a phase-balance neutral current transformer (also called core-balance CT). The function can also be operated in the normal mode as an additional short-circuit protection for neutral or residual ground protection.

Phase-balance current protection (ANSI 46) (Negative-sequence protection)

By measuring current on the high side of the transformer, the two-element phase-balance current/negative-sequence protection detects high-resistance phase-to-phase faults and phase-to-ground faults on the low side of a transformer (e.g. Dy 5). This function provides backup protection for high-resistance faults through the transformer.

Breaker failure protection (ANSI 50BF)

If a faulted portion of the electrical circuit is not disconnected when a trip command is issued to a circuit-breaker, another trip command can be initiated using the breaker failure protection which trips the circuit-breaker of an upstream feeder. Breaker failure is detected if, after a trip command is issued and the current keeps on flowing into the faulted circuit. It is also possible to make use of the circuit-breaker position contacts (52a or 52b) for indication as opposed to the current flowing through the circuit-breaker.

High-impedance restricted ground-fault protection (ANSI 87N)

The high-impedance measurement principle is a simple and sensitive method to detect ground faults, especially on transformers. It can also be used on motors, generators and reactors when they are operated on a grounded network.

When applying the high-impedance measurement principle, all current transformers in the protected area are connected in parallel and operated through one common resistor of relatively high *R*.

The voltage is measured across this resistor (see Fig. 2/6). The voltage is measured by detecting the current through the (external) resistor *R* at the sensitive current measurement input I_{EE}. The varistor *V* serves to limit the voltage in the event of an internal fault. It limits the high instantaneous voltage spikes that can occur at current transformer saturation.

At the same time, this results to smooth the voltage without any noteworthy reduction of the average value. If no faults have occurred and in the event of external or through faults, the system is at equilibrium, and the voltage through the resistor is approximately zero. In the event of internal faults, an imbalance occurs which leads to a voltage and a current flowing through the resistor *R*.

The same type of current transformers must be used and must at least offer a separate core for the high-impedance restricted ground-fault protection. They must have the same transformation ratio and approximately an identical knee-point voltage. They should also have only minimal measuring errors.

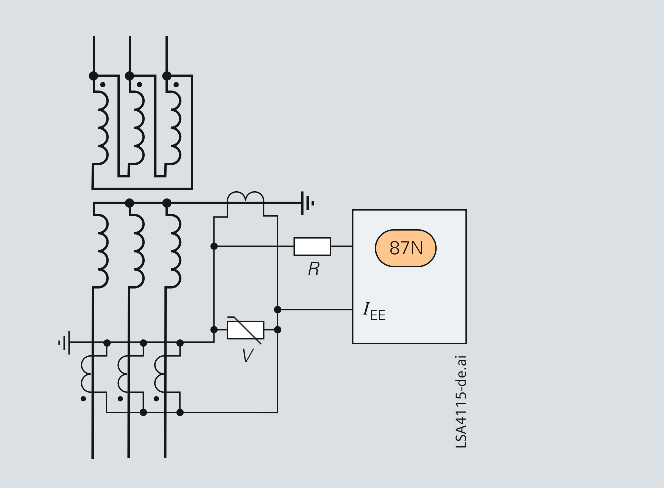


Fig. 2/6 High-impedance restricted ground-fault protection

Auto-reclosure (ANSI 79)

Multiple re-close cycles can be set by the user and lockout will occur if a fault is present after the last re-close cycle.

The following functions are available:

- 3-pole ARC for all types of faults
- Separate settings for phase and ground faults
- Multiple ARC, one rapid auto-reclosure (RAR) and up to nine delayed auto-reclosures (DAR)
- Initiation of the ARC is dependant on the trip command selected (e.g. I_2>, I>>, I_p, I_{dir}>)
- The ARC function can be blocked by activating a binary input
- The ARC can be initiated from external or by the PLC logic (CFC)
- The directional and non-directional elements can either be blocked or operated non-delayed depending on the auto-reclosure cycle
- If the ARC is not ready it is possible to perform a dynamic setting change of the directional and non-directional overcurrent elements.

Flexible protection functions

The 7SJ80 enables the user to easily add up to 20 additional protection functions. Parameter definitions are used to link standard protection logic with any chosen characteristic quantity (measured or calculated quantity). The standard logic consists of the usual protection elements such as the pickup set point, the set delay time, the TRIP command, a block function, etc. The mode of operation for current, voltage, power and power factor quantities can be three-phase or single-phase. Almost all quantities can be operated with ascending or descending pickup stages (e.g. under and overvoltage). All stages operate with protection priority.

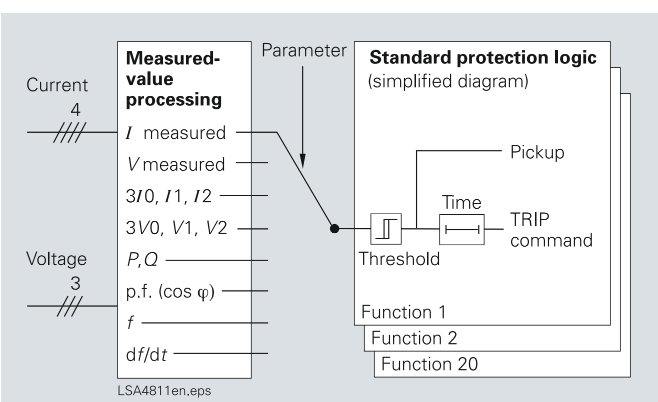


Fig. 2/7 Flexible protection functions

Protection functions/stages available are based on the available measured analog quantities:

Function	ANSI
I>, I_E>	50, 50N
V<, V>, V_E>	27, 59, 59N
$3I_0$>, I_1>, I_2>, I_2/I_1>, $3V_0$>, V_1> <, V_2 > <	50N, 46, 59N, 47
P> <, Q> <	32
cos φ	55
f > <	81O, 81U
df/dt > <	81R

Table 2/3 Available flexible protection functions

For example, the following can be implemented:

- Reverse power protection (ANSI 32R)
- Rate-of-frequency-change protection (ANSI 81R)

Synch-check (ANSI 25)

When closing a circuit-breaker, the units can check whether two separate networks are synchronized. Voltage-, frequency- and phase-angle-differences are checked to determine whether synchronous conditions exist.

Trip circuit supervision (ANSI 74TC)

One or two binary inputs can be used for monitoring the circuit-breaker trip coil including its incoming cables. An alarm signal is generated whenever the circuit is interrupted.

Lockout (ANSI 86)

All binary output statuses can be memorized. The LED reset key is used to reset the lockout state. The lockout state is also stored in the event of supply voltage failure. Reclosure can only occur after the lockout state is reset.

Thermal overload protection (ANSI 49)

To protect cables and transformers, an overload protection function with an integrated warning/alarm element for temperature and current can be used. The temperature is calculated using a thermal homogeneous body model (per IEC 60255-8), it considers the energy entering the equipment and the energy losses. The calculated temperature is constantly adjusted according to the calculated losses. The function considers loading history and fluctuations in load.

Settable dropout delay times

If the relays are used in conjunction with electromechanical relays, in networks with intermittent faults, the long dropout times of the electromechanical relay (several hundred milliseconds) can lead to problems in terms of time coordination/grading. Proper time coordination/grading is only possible if the dropout or reset time is approximately the same. This is why the parameter for dropout or reset times can be defined for certain functions, such as time-overcurrent protection, ground short-circuit and phase-balance current protection.

Undercurrent monitoring (ANSI 37)

A sudden drop in current, which can occur due to a reduced load, is detected with this function. This may be due to shaft that breaks, no-load operation of pumps or fan failure.

Overvoltage protection (ANSI 59)

The two-element overvoltage protection detects unwanted network and machine overvoltage conditions. The function can operate either with phase-to-phase, phase-to-ground, positive phase-sequence or negative phase-sequence voltage. Three-phase and single-phase connections are possible.

Undervoltage protection (ANSI 27)

The two-element undervoltage protection provides protection against dangerous voltage drops (especially for electric machines). Applications include the isolation of generators or motors from the network to avoid undesired operating conditions and a possible loss of stability. Proper operating conditions of electrical machines are best evaluated with the positive-sequence quantities. The protection function is active over a wide frequency range (45 to 55, 55 to 65 Hz). Even when falling below this frequency range the function continues to work, however, with decrease accuracy. The function can operate either with phase-to-phase, phase-to-ground or positive phase-sequence voltage, and can be monitored with a current criterion. Three-phase and single-phase connections are possible.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for overfrequency and underfrequency protection. Electric machines and parts of the system are protected from unwanted frequency deviations. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting. Frequency protection can be used over a wide frequency range (40 to 60 (for 50 Hz), 50 to 70 (for 60 Hz)). There are four elements (individually set as overfrequency, underfrequency or OFF) and each element can be delayed separately. Blocking of the frequency protection can be performed by activating a binary input or by using an undervoltage element.

Fault locator (ANSI 21FL)

The integrated fault locator calculates the fault impedance and the distance to fault. The results are displayed in Ω, kilometers (miles) and in percent of the line length.

Customized functions (ANSI 51V, 55 etc.)

Additional functions, which are not time critical, can be implemented using the CFC measured values. Typical functions include reverse power, voltage controlled overcurrent, phase angle detection, and zero-sequence voltage detection.

Further functions

Measured values

The r.m.s. values are calculated from the acquired current and voltage along with the power factor, frequency, active and reactive power. The following functions are available for measured value processing:

- Currents I_{L1}, I_{L2}, I_{L3}, I_N, I_{EE}
- Voltages V_{L1}, V_{L2}, V_{L3}, V_{12}, V_{23}, V_{31}
- Symmetrical components I_1, I_2, $3I_0$; V_1, V_2, $3V_0$
- Power Watts, Vars, VA/P, Q, S (P, Q: total and phase selective)
- Power factor cos φ (total and phase selective)
- Frequency
- Energy ± kWh, ± kVarh, forward and reverse power flow
- Mean as well as minimum and maximum current and voltage values
- Operating hours counter
- Mean operating temperature of the overload function
- Limit value monitoring
  Limit values can be monitored using programmable logic in the CFC. Commands can be derived from this limit value indication.
- Zero suppression
  In a certain range of very low measured values, the value is set to zero to suppress interference.

Metered values

For internal metering, the unit can calculate an energy metered value from the measured current and voltage values. If an external meter with a metering pulse output is available, the 7SJ80 can obtain and process metering pulses through an indication input. The metered values can be displayed and passed on to a control center as an accumulated value with reset. A distinction is made between forward, reverse, active and reactive energy.

Circuit-breaker wear monitoring/ circuit-breaker remaining service life

Methods for determining circuit-breaker contact wear or the remaining service life of a circuit-breaker (CB) allow CB maintenance intervals to be aligned to their actual degree of wear. The benefit lies in reduced maintenance costs.

There is no exact mathematical method to calculate the wear or the remaining service life of a circuit-breaker that takes arc-chamber's physical conditions into account when the CB opens.

This is why various methods of determining CB wear have evolved which reflect the different operator philosophies. To do justice to these, the relay offers several methods:

- ΣI
- ΣI^x, with x = 1..3
- $\Sigma i^2 t$.

The devices also offer a new method for determining the remaining service life:

- Two-point method

The CB manufacturers double-logarithmic switching cycle diagram (see Fig. 2/8) and the breaking current at the time of contact opening serve as the basis for this method. After CB opening, the two-point method calculates the remaining number of possible switching cycles. Two points P1 and P2 only have to be set on the device. These are specified in the CB's technical data.

All of these methods are phase-selective and a limit value can be set in order to obtain an alarm if the actual value falls below or exceeds the limit value during determination of the remaining service life.

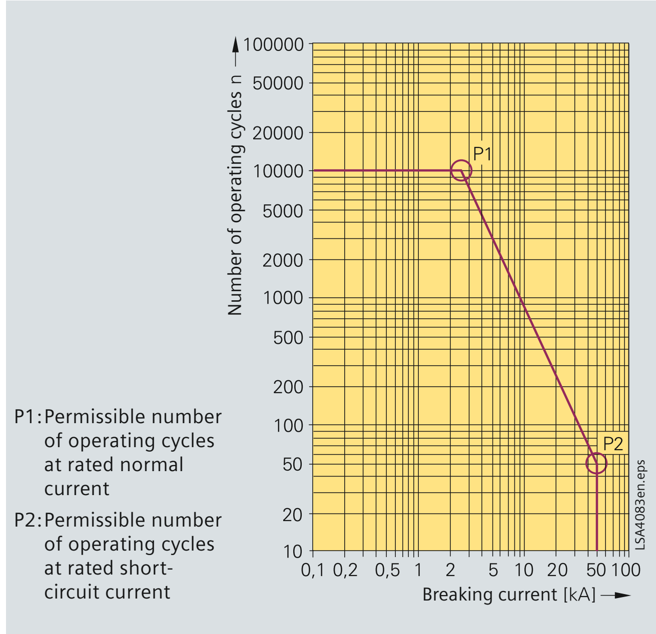


Fig. 2/8 Permissible number of operating cycles as a function of breaking current

Commissioning

Commissioning could not be easier and is supported by DIGSI 4. The status of the binary inputs can be read individually and the state of the binary outputs can be set individually. The operation of switching elements (circuit-breakers, disconnect devices) can be checked using the switching functions of the relay. The analog measured values are represented as wide-ranging operational measured values. To prevent transmission of information to the control center during maintenance, the communications can be disabled to prevent unnecessary data from being transmitted. During commissioning, all indications with test tag for test purposes can be connected to a control and protection system.

Test operation

During commissioning, all indications with test tag can be passed to a control system for test purposes.

Radial systems

General hints:
The relay at the far end (D) from the infeed has the shortest tripping time. Relays further upstream have to be time-graded against downstream relays in steps of about 0.3 s.

Earth-fault detection in isolated or compensated systems

In isolated or compensated systems, an occurred earth fault can be easily found by means of sensitive directional earth-fault detection.

1) Auto-reclosure (ANSI 79) only with overhead lines

2) Unbalanced load protection (ANSI 46) as backup protection against asymmetrical faults

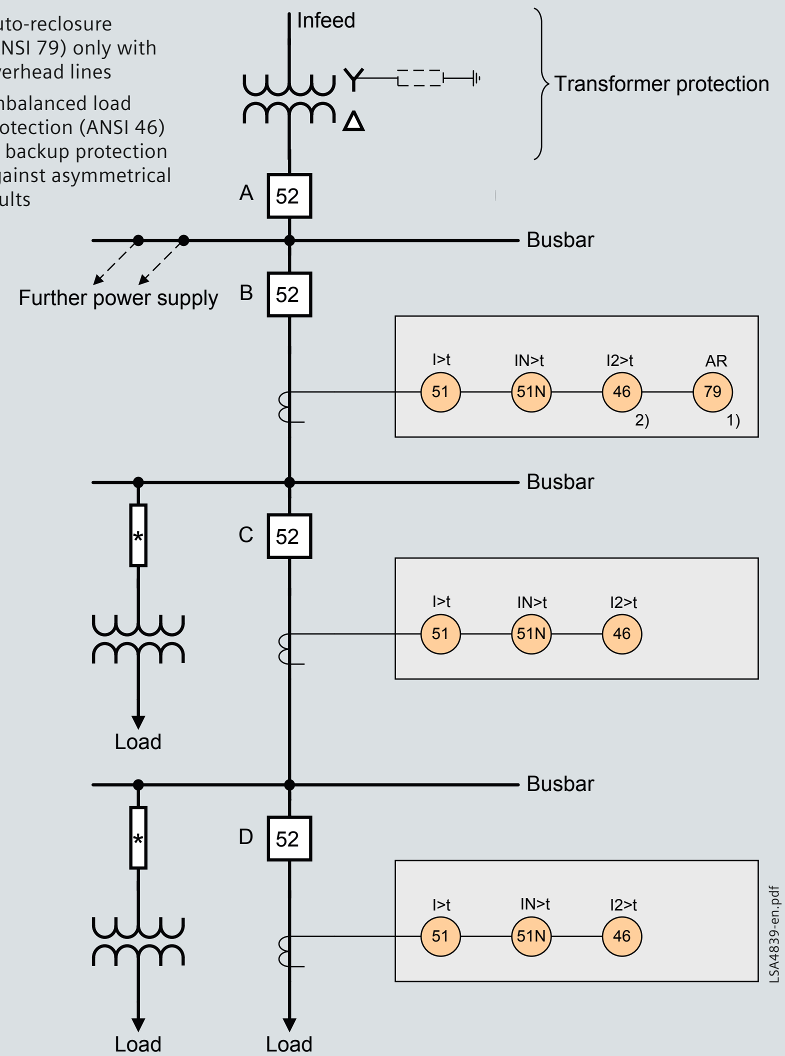


Fig. 2/9 Protection concept with overcurrent-time protection

1) The sensitive current measurement of the earth current should be made by a zero-sequence current transformer

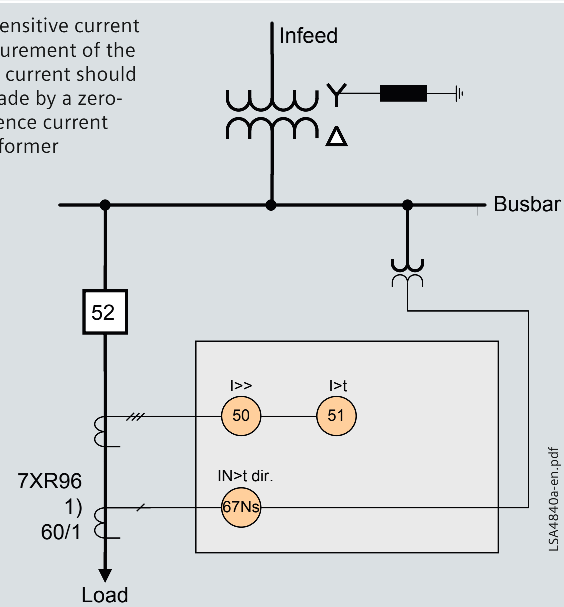


Fig. 2/10 Protection concept for directional earth-fault detection

Ring-main cable

With the directional comparison protection, 100% of the line can be protected via instantaneous tripping in case of infeed from two sources (ring-main cable).

For lines with infeed from two sources, no selectivity can be achieved with a simple definite-time overcurrent protection. Therefore, the directional definite-time overcurrent protection must be used. A non-directional definite-time overcurrent protection is enough only in the corresponding busbar feeders. The grading is done from the other end respectively.

Advantage: 100% protection of the line via instantaneous tripping, and easy setting.

Disadvantage: Tripping times increase towards the infeed.

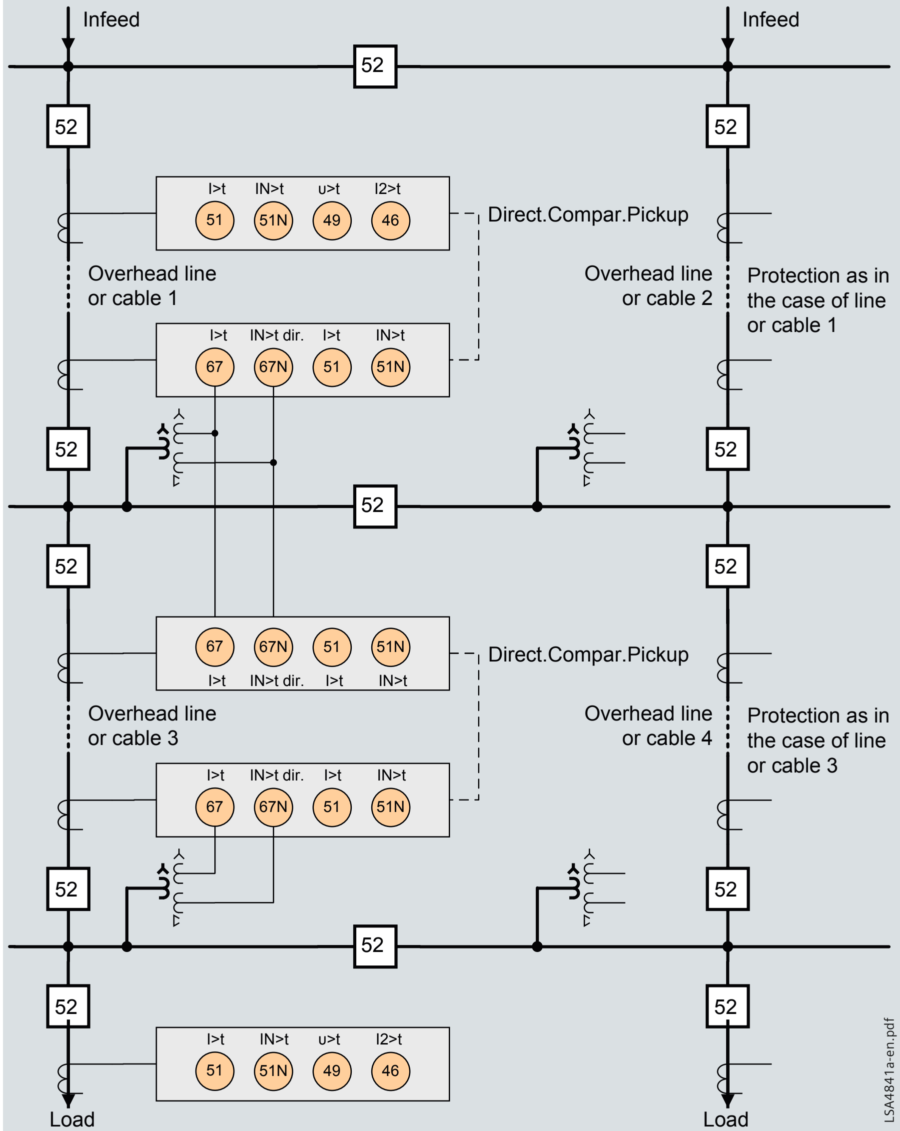


Fig. 2/11 Protection concept of ring power systems

Busbar protection by overcurrent relays with reverse interlocking

Applicable to distribution busbars without substantial (< 0.25 x I_N) backfeed from the outgoing feeders.

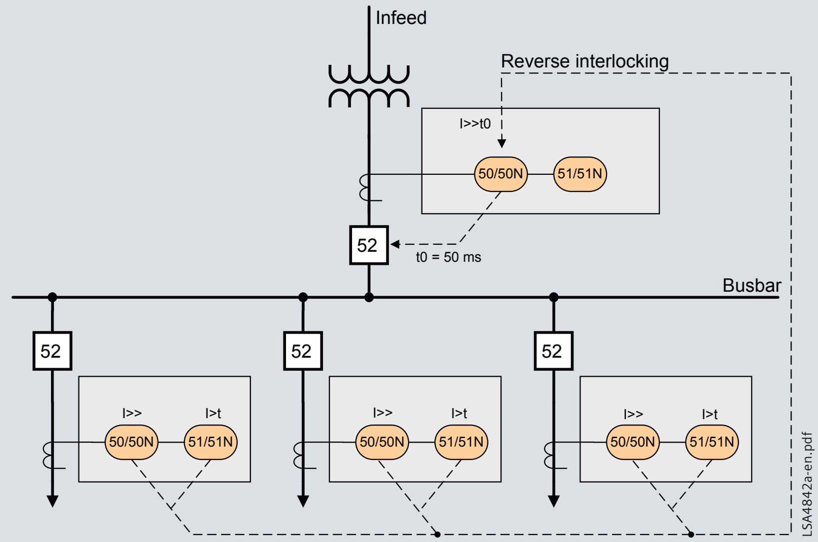


Fig. 2/12 Busbar protection via overcurrent relays with reverse interlocking

Line feeder with load shedding

In unstable power systems (e.g. solitary systems, emergency power supply in hospitals), it may be necessary to isolate selected consumers from the power system in order to protect the overall system. The overcurrent-time protection functions are effective only in the case of a short-circuit.

Overloading of the generator can be measured as a frequency or voltage drop.

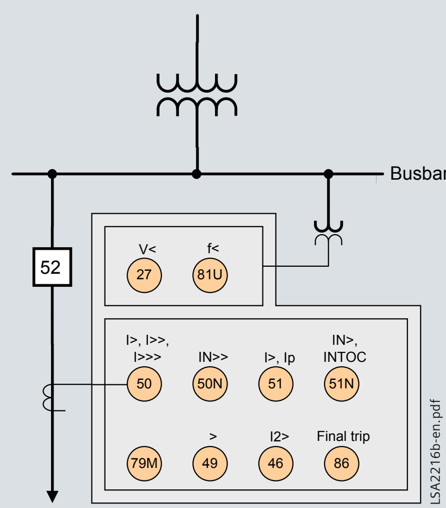


Fig. 2/13 Line feeder with load shedding

Auto-reclosure

The auto-reclosure function (AR) has starting and blocking options. In the opposite example, the application of the blocking of the high-current stages is represented according to the reclosing cycles. The overcurrent-time protection is graded (stages I, I_p) according to the grading plan. If an auto-reclosure function is installed in the incoming supply of a feeder, first of all the complete feeder is tripped instantaneously in case of fault. Arc faults will be extinguished independently of the fault location. Other protection relays or fuses do not trip (fuse saving scheme). After successful auto-reclosure, all consumers are supplied with energy again. If there is a permanent fault, further reclosing cycles will be performed. Depending on the setting of the AR, the instantaneous tripping stage in the infeed is blocked in the first, second or third cycle, i.e., now the grading is effective according to the grading plan. Depending on the fault location, overcurrent relays with faster grading, fuses, or the relay in the infeed will trip. Only the part of the feeder with the permanent fault will be shut down definitively.

Reverse power protection with parallel infeeds

If a busbar is supplied by two parallel infeeds and there is a fault in one of the infeeds, the affected busbar shall be selectively shut down, so that supply to the busbar is still possible through the remaining infeed. To do this, directional devices are required, which detect a short circuit from the busbar towards the infeed. In this context, the directional time-overcurrent protection is normally adjusted over the load current. Low-current faults cannot be shut down by this protection. The reverse power protection can be adjusted far below rated power, and is thus also able to detect reverse power in case of low-current faults far below the load current. The reverse power protection is implemented through the "flexible protection functions".

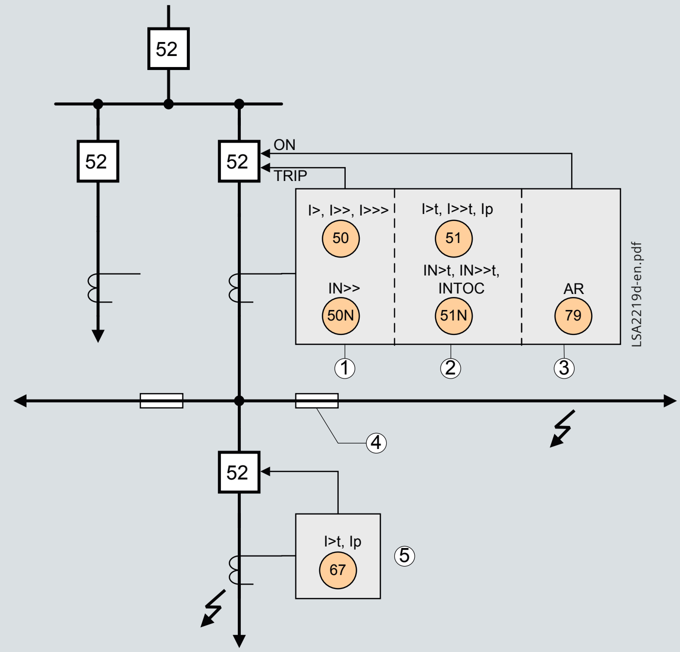


Fig. 2/14 Auto-reclosure

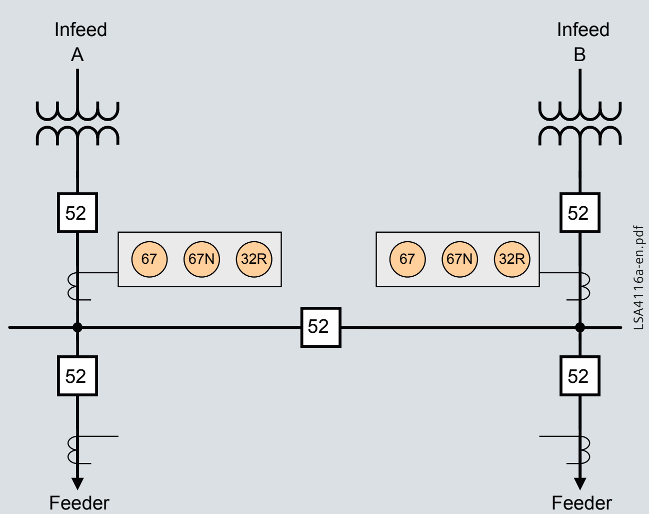


Fig. 2/15 Reverse power protection with parallel infeeds

Synchrocheck

Where two system sections are interconnected, the synchrocheck determines whether the connection is permissible without danger to the stability of the power system. In the example, load is supplied from a generator to a busbar through a transformer. The vector group of the transformer can be considered by means of a programmable angle adjustment, so that no external adjustment elements are necessary. Synchrocheck can be used for auto-reclosure, as well as for control functions (local or remote).

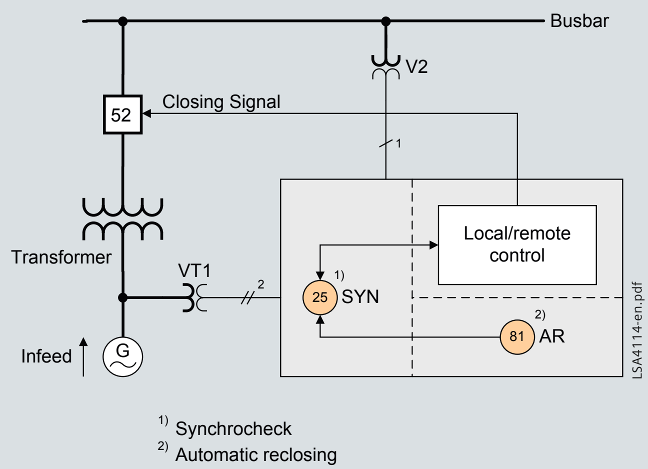


Fig. 2/16 Measurement of busbar and feeder voltage for synchronization

Protection of a transformer

The high-current stage enables a current grading, the overcurrent stages work as backup protection to subordinate protection devices, and the overload function protects the transformer from thermal overload. Low-current, single-phase faults on the low-voltage side, which are reproduced in the opposite system on the high-voltage side, can be detected with the unbalanced load protection. The available inrush blocking prevents pickup caused by the inrush currents of the transformer.

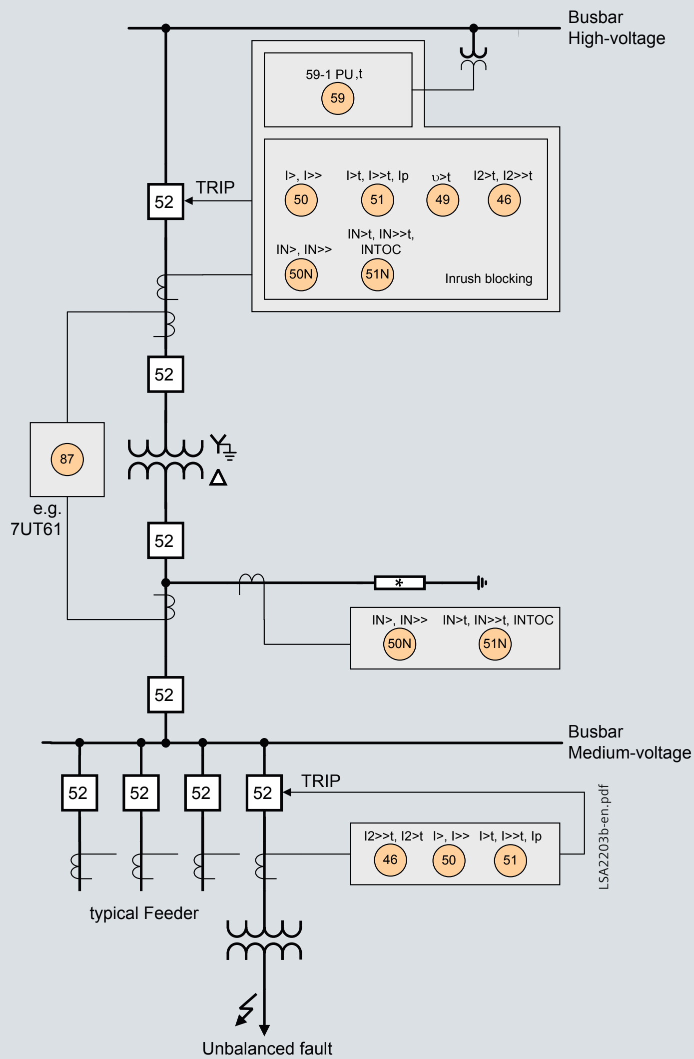


Fig. 2/17 Typical protection concept for a transformer

Selection and ordering data

Product description	Order No.	Short code
	12345 6 7 - 8 9 10 11 12 - 13 14 15 16 +	
	7SJ80□□-□□□□□-□□□□+□□□	
Housing, binary inputs and outputs (4 x I)		
Housing 1/6 19", 3 BI, 5 BO [1], 1 live status contact	1	
Housing 1/6 19", 7 BI, 8 BO [1], 1 live status contact	2	
Housing 1/6 19", 3 x V, 3 BI, 5 BO [1], 1 live status contact	3	
Housing 1/6 19", 3 x V, 7 BI, 8 BO [1], 1 live status contact	4	
Measuring inputs, default settings		
I_{ph} = 1 A/5 A, I_e = 1 A/5 A	1	
I_{ph} = 1 A/5 A, I_{ee} (sensitive) = 0.001 to 1.6 A/0.005 to 8 A	2	
Rated auxiliary voltage		
24 V to 48 V DC	1	
60 V to 250 V DC; 115 V AC; 230 V AC	5	
Unit version		
Surface mounting housing, screw-type terminals	B	
Flush mounting housing, screw-type terminals	E	
Region-specific default and language settings		
Region DE, IEC, language German [2], standard front	A	
Region World, IEC/ANSI, language English [2], standard front	B	
Region US, ANSI, language US-English [2], US front	C	
Region FR, IEC/ANSI, language French [2], standard front	D	
Region World, IEC/ANSI, language Spanish [2], standard front	E	
Region World, IEC/ANSI, language Italian [2], standard front	F	
Region RUS, IEC/ANSI, language Russian [2], standard front	G	
Region CHN, IEC/ANSI, language Chinese [3], Chinese front	K	
Port B (at bottom of device)		
No port	0	
IEC 60870-5-103 or DIGSI 4/modem, electrical RS232	1	
IEC 60870-5-103 or DIGSI 4/modem, electrical RS485	2	
IEC 60870-5-103 or DIGSI 4/modem, optical 820 nm, ST connector	3	
Further protocols see supplement L	9	L 0 □
PROFIBUS DP slave, electrical RS485		A
PROFIBUS DP slave, optical, double ring, ST connector		B
MODBUS, electrical RS485		D
MODBUS, optical 820 nm, ST connector		E
DNP 3.0, electrical RS485		G
DNP 3.0, optical 820 nm, ST connector		H
IEC 60870-5-103, redundant, electrical RS485, RJ45 connector		P
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector		R
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector		S
Port A (at bottom of device)		
No port	0	
With Ethernet interface (DIGSI, not IEC 61850), RJ45 connector	6	
Measuring / fault recording		
With fault recording	1	
With fault recording, average values, min/max values	3	

Positions 13–16: see next page

1) 2 changeover/Form C
2) Language selectable
3) Language not changeable

You will find a detailed overview of the technical data (extract of the manual) under: http://www.siemens.com/siprotec

ANSI No.	Product description	Order No. 14 15 16
	Basic version	F A [3)]
50/51	Time-overcurrent protection phase $I>$, $I>>$, $I>>>$, I_p	
50N/51N	Time-overcurrent protection ground $I_E>$, $I_E>>$, $I_E>>>$, I_{Ep}	
50N(s)/51N(s)[1)]	Sensitive ground fault protection $I_{EE}>$, $I_{EE}>>$, I_{EEp}	
87N[2)]	High impedance REF	
49	Overload protection	
74TC	Trip circuit supervision	
50BF	Circuit breaker failure protection	
46	Negative sequence / unbalanced load protection	
37	Undercurrent monitoring	
86	Lockout	
	Parameter changeover	
	Monitoring functions	
	Control of circuit-breaker	
	Flexible protection functions (current parameters)	
	Inrush restraint	
	Basic version + directional ground-fault detection + voltage protection + frequency protection	F B [4)]
67	Directional overcurrent protection phase, $I_E>$, $I_E>>$, I_{Ep}	
67N(s)[1)]	Directional sensitive ground fault protection, $I_{EE}>$, $I_{EE}>>$, I_{EEp}	
64/59N	Displacement voltage	
27/59	Under-/overvoltage	
81U/O	Under-/overfrequency, $f<$, $f>$	
47	Phase rotation	
32/55/81R	Flexible protection functions (current and voltage parameters)	
	Protective function for voltage, power, power factor, frequency change	
	Basic version + directional ground-fault detection + directional element phase + voltage protection + frequency protection	F C [4)]
67	Directional overcurrent protection phase, $I>$, $I>>$, I_p	
67N	Directional overcurrent protection ground, $I_E>$, $I_E>>$, I_{Ep}	
67N(s)[1)]	Directional sensitive ground fault protection, $I_{EE}>$, $I_{EE}>>$, I_{EEp}	
64/59N	Displacement voltage	
27/59	Under-/overvoltage	
81U/O	Under-/overfrequency, $f<$, $f>$	
47	Phase rotation	
32/55/81R	Flexible protection functions (current and voltage parameters)	
	Protective function for voltage, power, power factor, frequency change	
	Basic version + directional element phase + voltage protection + frequency protection + synch-check	F Q [5)]
67	Directional overcurrent protection phase, $I>$, $I>>$, I_p	
27/59	Under-/overvoltage	
81U/O	Under-/overfrequency, $f<$,$f>$	
47	Phase rotation	
25	Synch-check	
81R	Flexible protection functions (current and voltage parameters)	
	Protective function for voltage, frequency change	
	ARC / Fault locator	
	Without	0
79	With auto-reclose	1
21FL	With fault locator [4)]	2
79/21FL	With auto-reclose, with fault locator [4)]	3

1) Depending on the ground current input the function will be either sensitive (I_{EE}) or non-sensitive (I_E).

2) 87N (REF) only with sensitive ground current input (position **7** = **2**).

3) Only with position 6 = **1** or **2**

4) Only with position 6 = **3** or **4**

5) Only with position 6 = **3** or **4** and position 16 = **0** or **1**

Connection diagrams

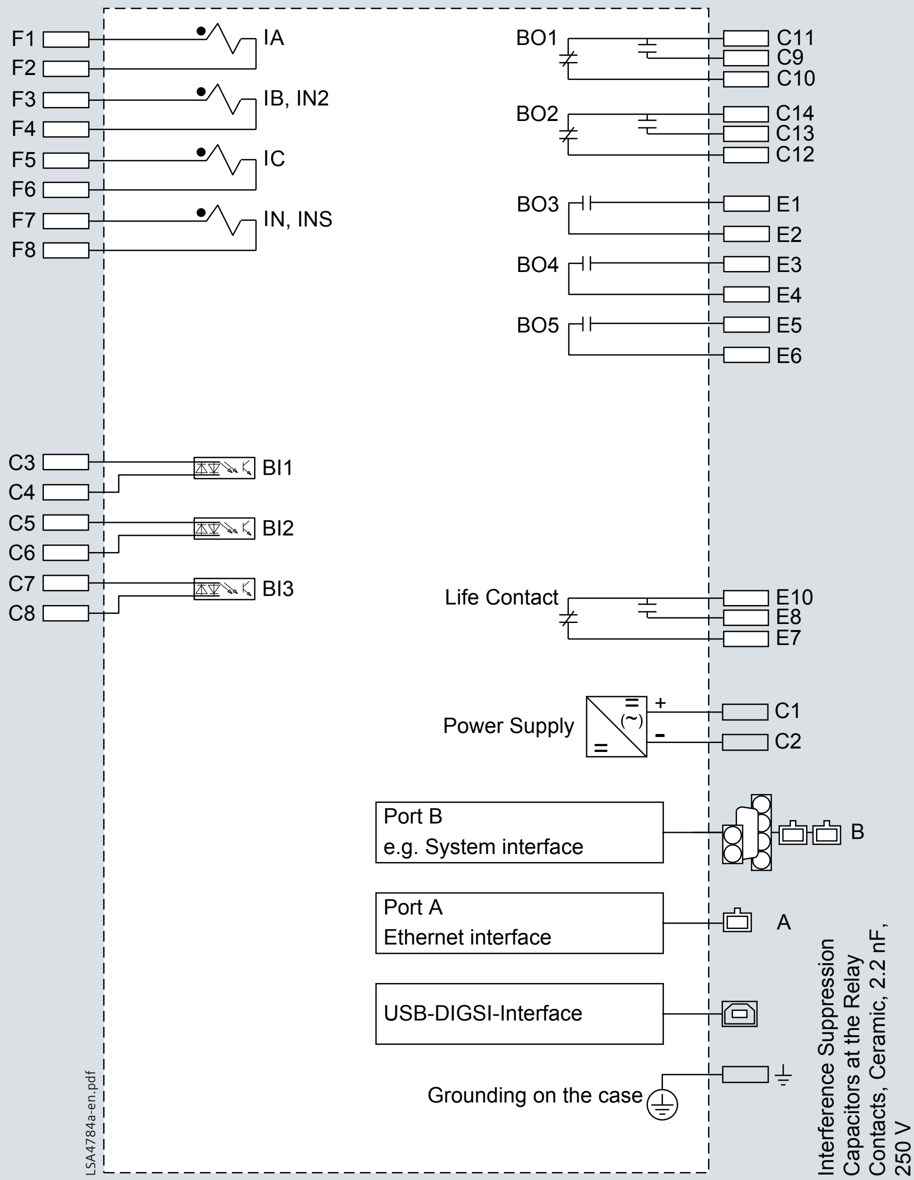


Fig. 2/18 Multifunction protection 7SJ801

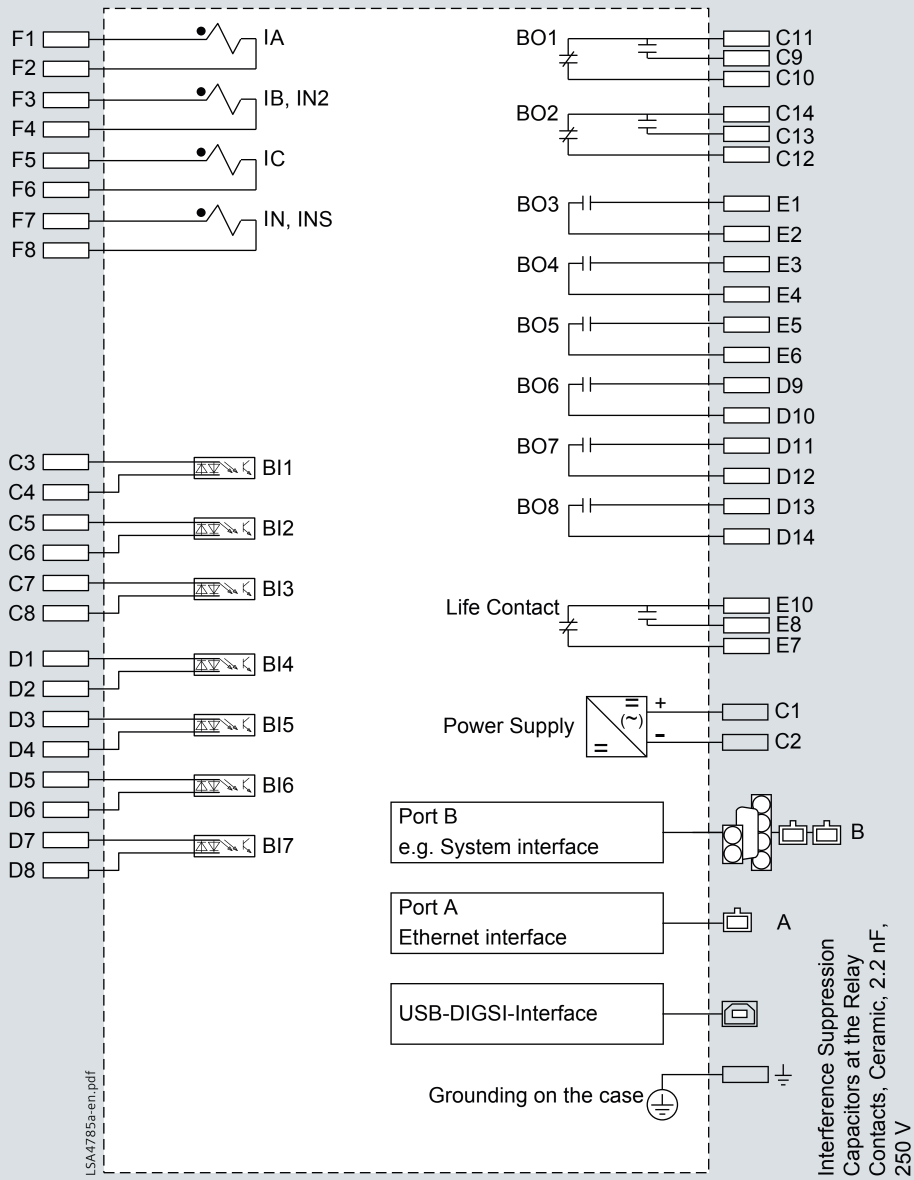


Fig. 2/19 Multifunction protection 7SJ802

Connection diagrams

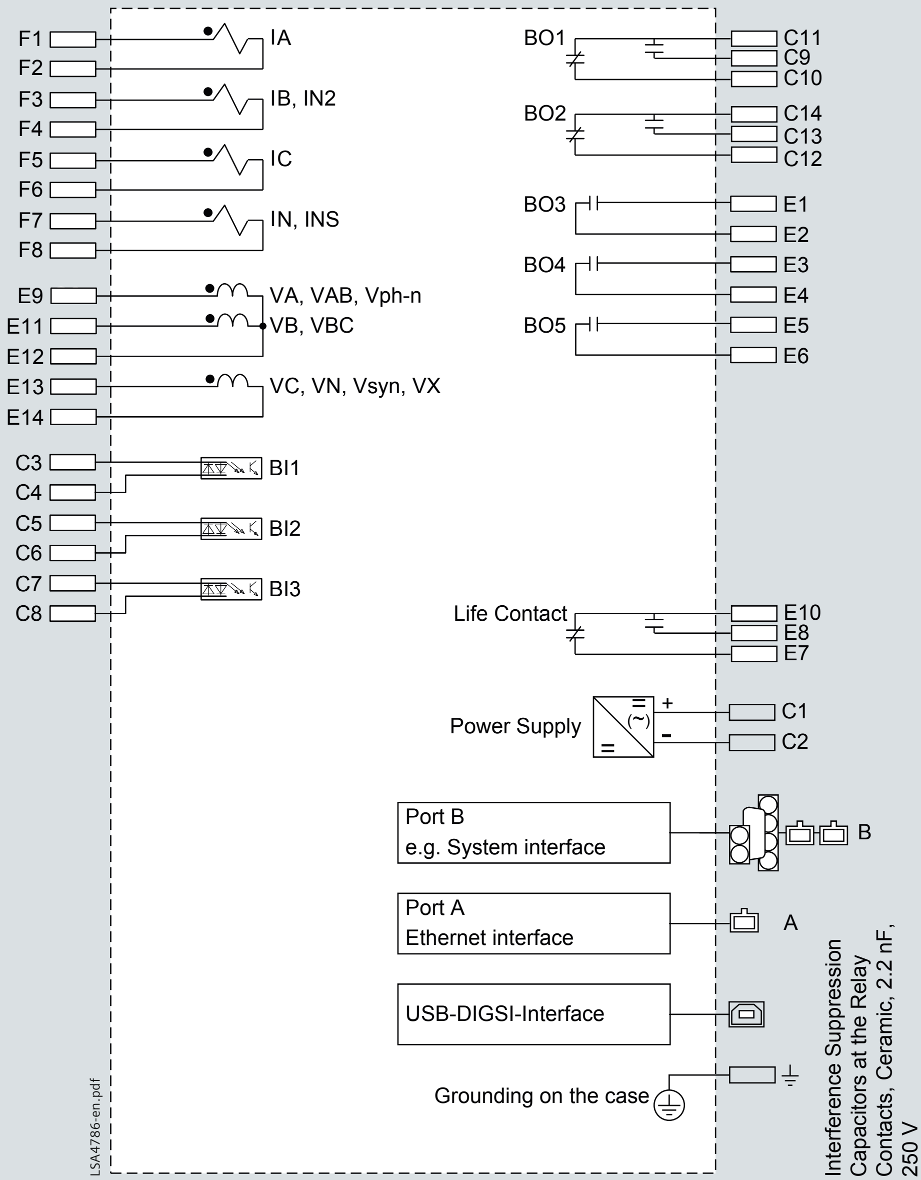


Fig. 2/20 Multifunction protection 7SJ803

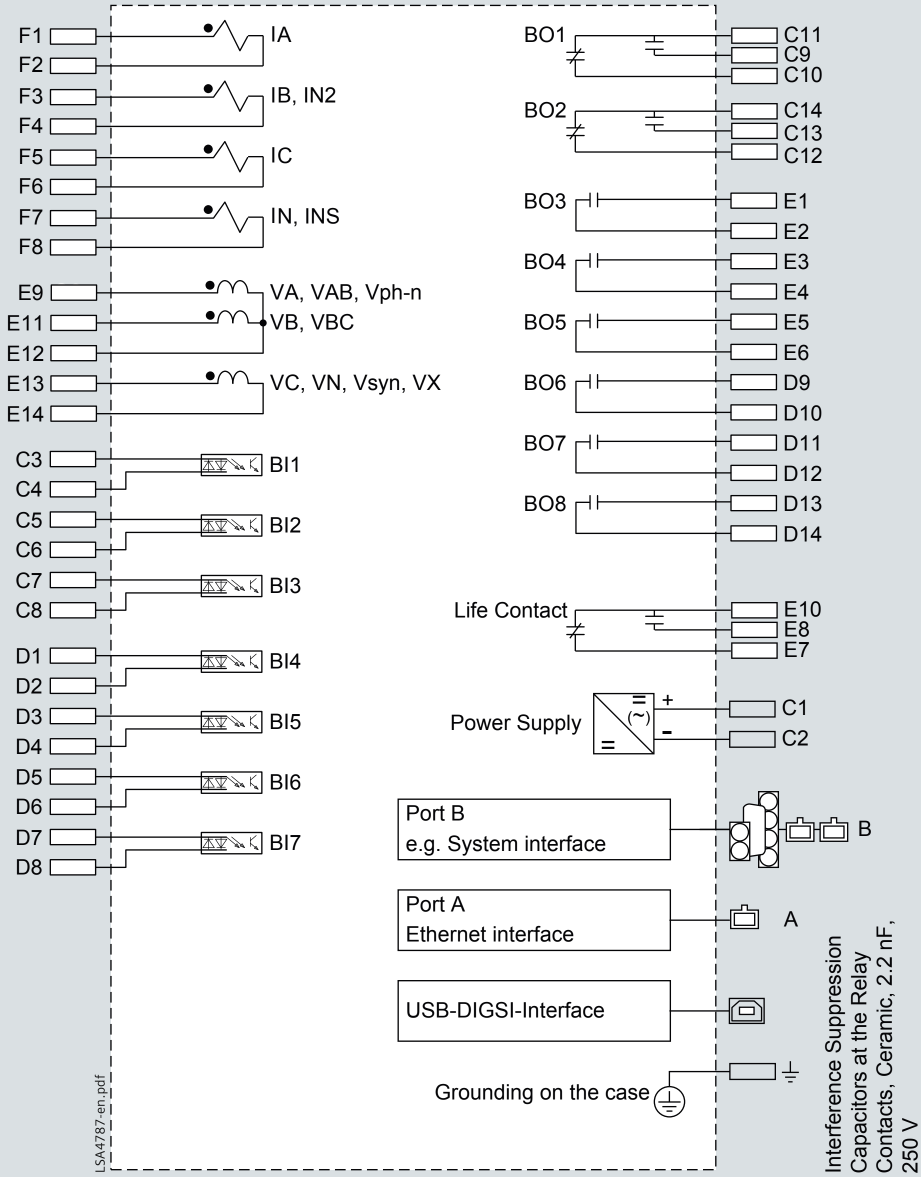


Fig. 2/21 Multifunction protection 7SJ804

Connection examples

Connection of current and voltage transformers

Standard connection

For grounded networks, the ground current is obtained from the phase currents by the residual current circuit.

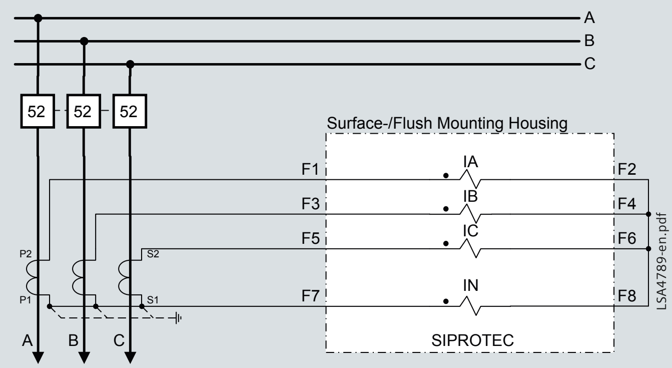


Fig. 2/22 Residual current circuit without directional element

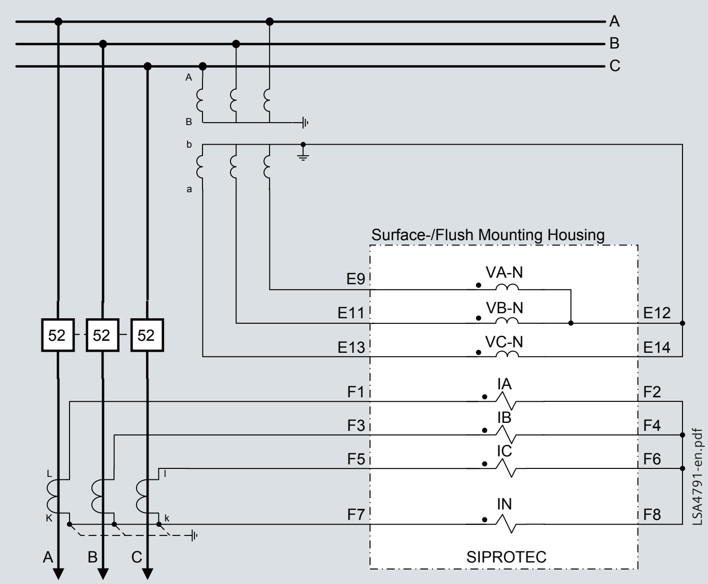


Fig. 2/23 Residual current circuit with directional element

For power systems with small earth currents, e.g. isolated or compensated systems, the earth current is measured by a zero-sequence current transformer.

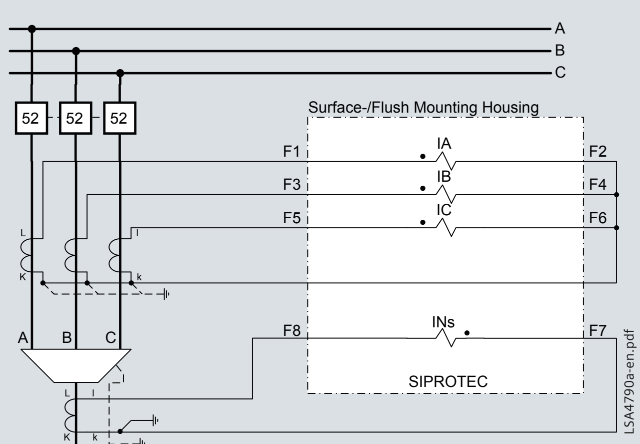


Fig. 2/24 Sensitive ground current detection without directional element

Connection for compensated networks

The figure shows the connection of two phase-to-ground voltages and the V_E voltage of the broken delta winding and a phase-balance neutral current transformer for the ground current. This connection maintains maximum precision for directional ground-fault detection and must be used in compensated networks.

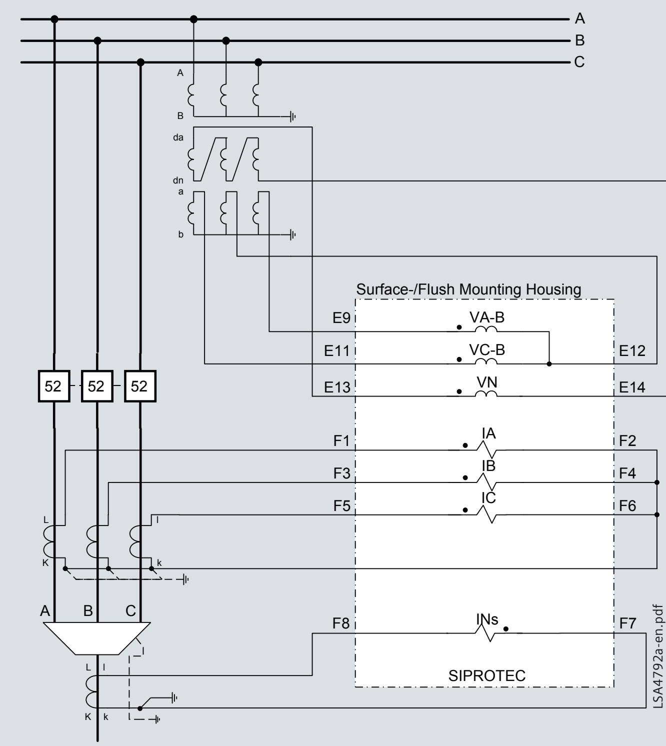


Fig. 2/25 Sensitive directional ground-fault detection with directional element for phases

Sensitive directional ground-fault detection.

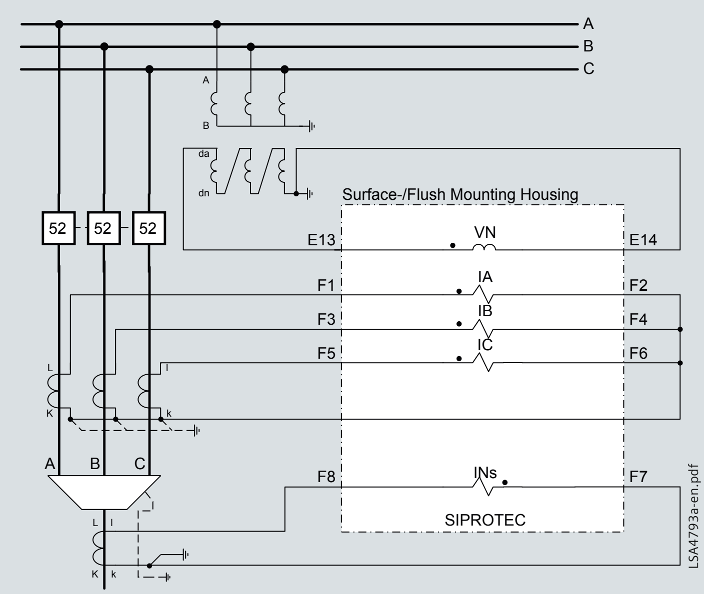


Fig. 2/26 Sensitive directional ground-fault detection

Connection examples

2

Connection for the synch-check function

If no directional earth-fault protection is used, connection can be done with just two phase current transformers. For the directional phase short-circuit protection, the phase-to-phase voltages acquired with two primary transformers are sufficient.

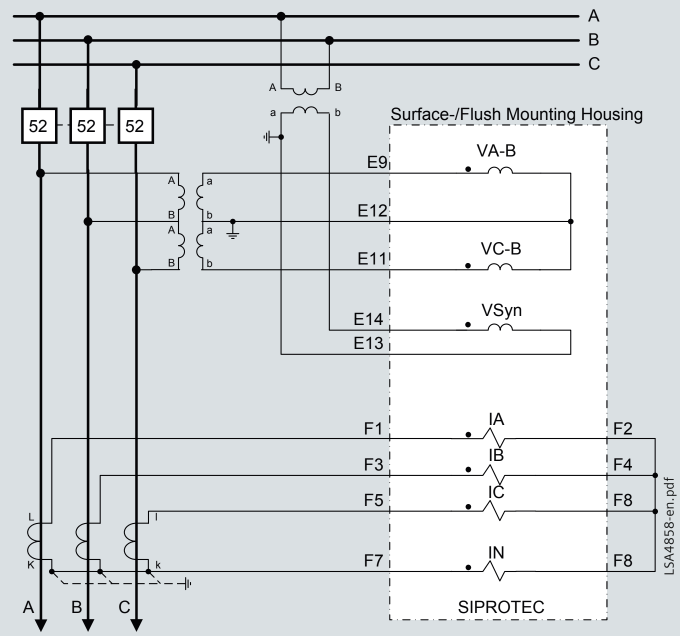


Fig. 2/27 Measuring of the busbar voltage and the outgoing feeder voltage for synchronization

Overview of connection types

Type of network	Function	Current connection	Voltage connection
(Low-resistance) grounded networks	Time-overcurrent protection phase/ground non-directional	Residual circuit, with 3 phase-current transformers required, phase-balance neutral current transformers possible	–
(Low-resistance) grounded networks	Sensitive ground-fault protection	Phase-balance neutral current transformers required	–
Isolated or compensated networks	Time-overcurrent protection phases non-directional	Residual circuit, with 3 or 2 phase-current transformers possible	–
(Low-resistance) grounded networks	Time-overcurrent protection phases directional	Residual circuit, with 3 phase-current transformers possible	Phase-to-ground connection or phase-to-phase connection
Isolated or compensated networks	Time-overcurrent protection phases directional	Residual circuit, with 3 or 2 phase-current transformers possible	Phase-to-ground connection or phase-to-phase connection
(Low-resistance) grounded networks	Time-overcurrent protection ground directional	Residual circuit, with 3 phase-current transformers required, phase-balance neutral current transformers possible	Phase-to-ground connection required
Isolated networks	Sensitive ground-fault protection	Residual circuit, if ground current > 0.05 I_N on secondary side, otherwise phase-balance neutral current transformers required	3 times phase-to-ground connection or phase-to-ground connection with broken delta winding
Compensated networks	Sensitive ground-fault protection cos φ measurement	Phase-balance neutral current transformers required	3 times phase-to-ground connection or phase-to-ground connection with broken delta winding

Table 2/4 Overview of connection types

Overcurrent Protection 7SJ81 for Low-Power Current Transformer Applications SIPROTEC Compact

SIEMENS

Overcurrent Protection 7SJ81

for Low-Power Current Transformer Applications

You will find a detailed overview of the technical data (extract of the manual) under:
http://www.siemens.com/siprotec

Description

The SIPROTEC Compact 7SJ81 provides 4 low-power current transformer inputs. With the same low-power current transformer (LPCT) a wide range of primary rated line currents can be covered. Objects with rated currents in the range from 50 A to 5000 A can be protected when using low-power current transformers with a transmission ratio of 50 A / 22.5 mV. Any other low-power current transformer with a different transmission ratio can be combined with 7SJ81 (transmission ratio settable by software).

Please refer to page 3/4 for a list of available low-power current transformers from TRENCH.

The SIPROTEC Compact 7SJ81 relays can be used for line/feeder protection of high and medium-voltage networks with grounded, low-resistance grounded, isolated or a compensated neutral point. The relays have all the functionality to be applied as a backup relay to a transformer differential relay.

The SIPROTEC Compact 7SJ81 offers highest reliability at major functionality by the synergy of reliable algorithms with newly developed hardware. The reliability is proven by the experience in the field of almost 1,000,000 SIPROTEC devices.

The relay provides numerous functions to respond flexibly to the system requirements and to deploy the invested capital economically. Examples for this are: exchangeable interfaces, flexible protection functions and the integrated automation level (CFC). Freely assignable LEDs and a six-line display ensure a unique and clear display of the process states.
In combination with up to 9 function keys, the operating personnel can react quickly and safely in any situation. This guarantees a high operational reliability.

Highlights

- Removable voltage terminal blocks
- Binary input thresholds settable using DIGSI (3 stages)
- 9 programmable function keys
- 6-line display
- Buffer battery exchangeable from the front
- USB front port
- 2 additional communication ports
- IEC 61850 with integrated redundancy (electrical or optical)
- Relay-to-relay communication through Ethernet with IEC 61850 GOOSE
- Millisecond-accurate time synchronization through Ethernet with SNTP.

Fig. 3/1 7SJ81 front view

Fig. 3/2 7SJ81 rear view

Protection functions	IEC	ANSI
Time-overcurrent protection	I>, I>>, I>>>, I_E>, I_E>>, I_E>>>; I_p, I_{Ep}	50, 50N; 51, 51N
Sensitive ground fault protection	I_{EE}>, I_{EE}>>, I_{EEp}	50N(s), 51N(s)
Inrush restraint		
Undercurrent monitoring	I<	37
Overload protection	ϑ>	49
Breaker failure protection		50BF
Phase unbalance or negative-sequence protection	I_2>, I_2>>, I_{2p}	46
Lockout		86

Table 3/1 Function overview

Control functions/programmable logic

- Commands for the ctrl. of CB, disconnect switches (isolators/isolating switches)
- Control through keyboard, binary inputs, DIGSI 4 or SCADA system
- User-defined PLC logic with CFC (e.g. interlocking).

Monitoring functions

- Operational measured values I, f
- Circuit-breaker wear monitoring
- Minimum and maximum values
- Trip circuit supervision (74TC)
- 8 oscillographic fault records.

Communication interfaces

- System/service interface
  - IEC 61850
  - IEC 60870-5-103
  - PROFIBUS-DP
  - DNP 3.0
  - MODBUS RTU
- Ethernet interface for DIGSI 4
- USB front interface for DIGSI 4.

Hardware

- 4 current transformers
- 3/7 binary inputs (thresholds configurable using software)
- 5/8 binary outputs (2 changeover/Form C contacts)
- 1 live-status contact
- Pluggable voltage terminals.

Available low-power current transformers (LPCT) from TRENCH:

Order No.	Description	Drawing number
16 100 005	LPCT 25-A (D120) with CAT.5 cable and RJ45 connector	3-16100000
16 110 005	LPCT 25-B (D108) with CAT.5 cable and RJ45 connector	3-16110000
16 120 005	LPCT 25-C (D300) with CAT.5 cable and RJ45 connector	3-16120000
16 130 005	LPCT 25-D (D55) with CAT.5 cable and RJ45 connector	3-16130000
16 140 005	LPCT K-60 (D120) with CAT.5 cable and RJ45 connector	3-16140000
16 150 005	LPCT 25-E (oval) with CAT.5 cable and RJ45 connector	3-16150003

Table 3/2 Available low-power current transformers (LPCT) from TRENCH

CAT.5 cable length:	Standard 6.5 m
Transmission ratio:	LPCT 25-A (B, C, D, E): 50 A/22.5 mV
	LPCT K-60: 60 A/7.07 V
Contact partner:	Rolf.Fluri@siemens.com

Trench Switzerland AG, Lehenmattstraße 353, CH-4028 Basel

The SIPROTEC Compact 7SJ81 unit is a numerical protection relay that can perform control and monitoring functions and therefore provides the user with a cost-effective platform for power system management, that ensures reliable supply of electrical power to the customers. The ergonomic design makes control easy from the relay front panel. A large, easy-to-read display was a key design factor.

Control

The integrated control function permits control of disconnect devices, grounding switches or circuit-breakers through the integrated operator panel, binary inputs, DIGSI 4 or the control or automation system (e.g. SICAM).

Programmable logic

The integrated logic characteristics (CFC) allow the user to add own functions for automation of switchgear (e.g. interlocking) or switching sequence. The user can also generate user-defined messages. This functionality can form the base to create extremely flexible transfer schemes.

Operational measured values

Extensive measured values (e.g. I, V), metered values (e.g.W_p,W_q) and limit values (e.g. for voltage, frequency) provide improved system management.

Operational indications

Event logs, trip logs, fault records and statistics documents are stored in the relay to provide the user or operator with all the key data required to operate modern substations.

Line protection

The 7SJ81 units can be used for line protection of high and medium-voltage networks with grounded, low-resistance grounded, isolated or a compensated neutral point.

Transformer protection

The relay provides all the functions for backup protection for transformer differential protection. The inrush suppression effectively prevents unwanted trips that can be caused by inrush currents.

Backup protection

The 7SJ81 can be used as a backup protection for a wide range of applications.

Switchgear cubicles for high/medium voltage

All units are designed specifically to meet the requirements of medium-voltage applications. In general, no separate measuring instruments (e.g., for current, voltage, frequency, ...) or additional control components are necessary in the cubicles.

3

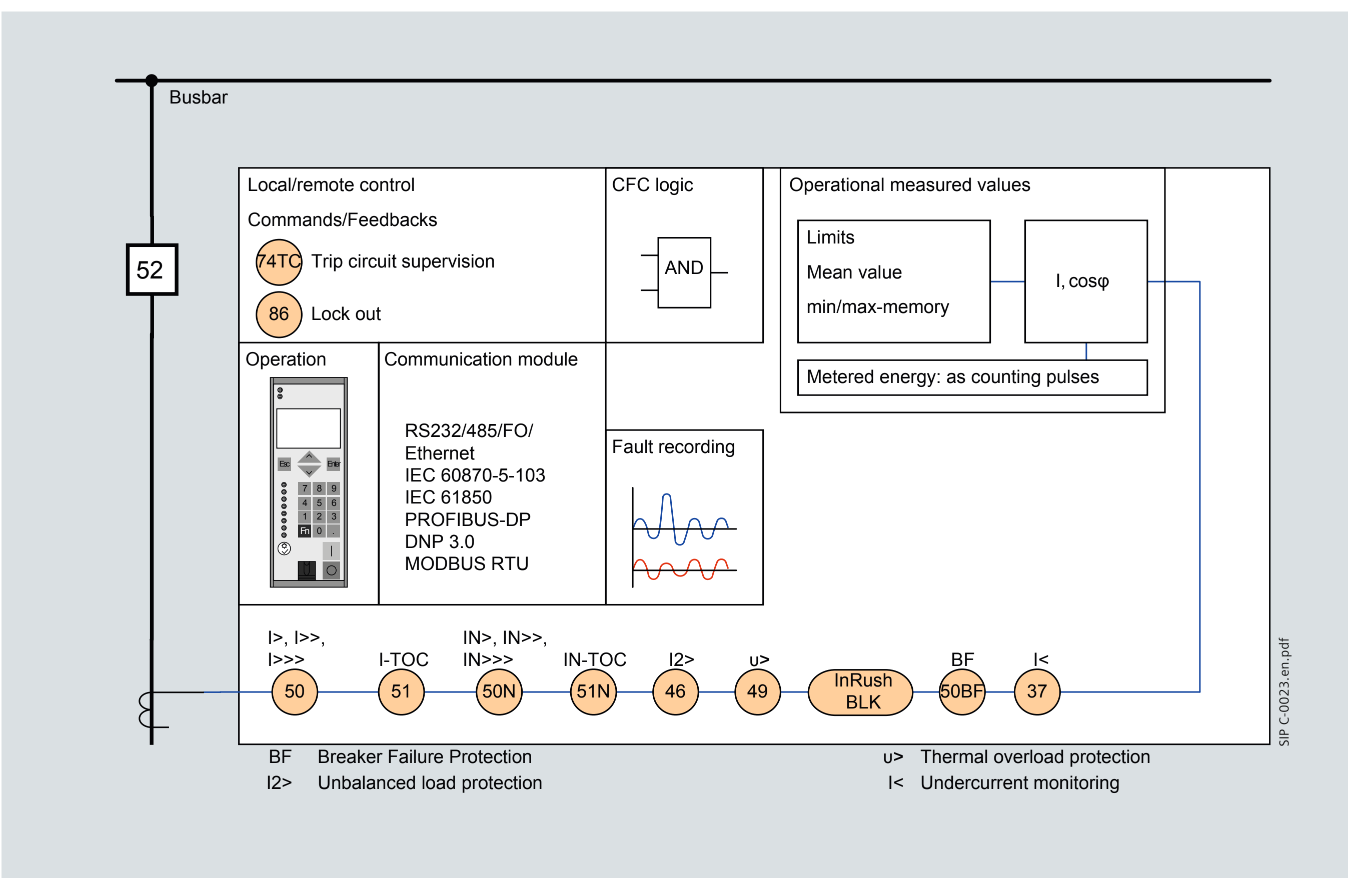


Fig. 3/3 Function diagram

Protection functions

Time-overcurrent protection (ANSI 50, 50N, 51, 51N)

This function is based on the phase-selective measurement of the three phase currents and the ground current (four transformers). Three definite-time overcurrent protection elements (DMT) are available both for the phase and the ground elements. The current threshold and the delay time can be set in a wide range.

Inverse-time overcurrent protection characteristics (IDMTL) can also be selected and activated.

Reset characteristics

Time coordination with electromechanical relays is made easy with the inclusion of the reset characteristics according to ANSI C37.112 and IEC 60255-3 / BS 142 standards. When using the reset characteristic (disk emulation), the reset process is initiated after the fault current has disappeared. This reset process corresponds to the reverse movement of the Ferraris disk of an electromechanical relay (disk emulation).

Available inverse-time characteristics

Characteristics acc. to	IEC 60255-3	ANSI / IEEE
Inverse	•	•
Short inverse		•
Long inverse	•	•
Moderately inverse		•
Very inverse	•	•
Extremely inverse	•	•

Table 3/3 Available inverse-time characteristics

Inrush restraint

If second harmonic content is detected during the energization of a transformer, the pickup of stages $I>$, I_p, $I_{>dir}$ and $I_{p\ dir}$ is blocked.

Dynamic settings group switching

In addition to the static parameter changeover, the pickup thresholds and the tripping times for the directional and non-directional time-overcurrent protection functions can be changed over dynamically. As changeover criterion, the circuit-breaker position, the prepared auto-reclosure, or a binary input can be selected.

(Sensitive) ground-fault detection (ANSI 50Ns, 51Ns / 50N, 51N)

For high-resistance grounded networks, a sensitive input transformer is connected to a phase-balance neutral current transformer (also called core-balance CT). The function can also be operated in the normal mode as an additional short-circuit protection for neutral or residual ground protection.

Phase-balance current protection (ANSI 46) (Negative-sequence protection)

By measuring current on the high side of the transformer, the two-element phase-balance current/negative-sequence protection detects high-resistance phase-to-phase faults and phase-to-ground faults on the low side of a transformer Dy 5. This function provides backup protection for high-resistance faults through the transformer.

Breaker failure protection (ANSI 50BF)

If a faulted portion of the electrical circuit is not disconnected when a trip command is issued to a circuit-breaker, another trip command can be initiated using the breaker failure protection which trips the circuit-breaker of an upstream feeder. Breaker failure is detected if, after a trip command is issued and the current keeps on flowing into the faulted circuit. It is also possible to make use of the circuit-breaker position contacts (52a or 52b) for indication as opposed to the current flowing through the circuit-breaker.

Flexible protection functions

The 7SJ81 enables the user to easily add up to 20 additional protection functions. Parameter definitions are used to link standard protection logic with any chosen characteristic quantity (measured or calculated quantity). The standard logic consists of the usual protection elements such as the pickup set point, the set delay time, the TRIP command, a block function, etc. The mode of operation for current quantities can be three-phase or phase-selective. Almost all quantities can be operated with ascending or descending pickup stages (e.g. under and overvoltage). All stages operate with protection priority or speed.

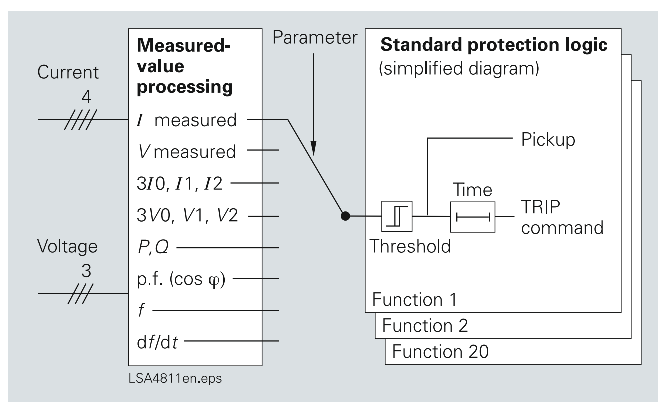


Fig. 3/4 Flexible protection functions

Protection functions/stages available are based on the available measured analog quantities:

Function	ANSI
$I>$, $I_E>$	50, 50N

Table 3/4 Available flexible protection functions

Trip circuit supervision (ANSI 74TC)

One or two binary inputs can be used for monitoring the circuit-breaker trip coil including its incoming cables. An alarm signal is generated whenever the circuit is interrupted.

Lockout (ANSI 86)

All binary output statuses can be memorized. The LED reset key is used to reset the lockout state. The lockout state is also stored in the event of supply voltage failure. Reclosure can only occur after the lockout state is reset.

Thermal overload protection (ANSI 49)

To protect cables and transformers, an overload protection function with an integrated warning / alarm element for temperature and current can be used. The temperature is calculated using a thermal homogeneous body model (per IEC 60255-8), it considers the energy entering the equipment and the energy losses. The calculated temperature is constantly adjusted according to the calculated losses. The function considers loading history and fluctuations in load.

Settable dropout delay times

If the relays are used in conjunction with electromechanical relays, in networks with intermittent faults, the long dropout times of the electromechanical relay (several hundred milliseconds) can lead to problems in terms of time coordination / grading. Proper time coordination / grading is only possible if the dropout or reset time is approximately the same. This is why the parameter for dropout or reset times can be defined for certain functions, such as time-overcurrent protection, ground short-circuit and phase-balance current protection.

Undercurrent monitoring (ANSI 37)

A sudden drop in current, which can occur due to a reduced load, is detected with this function. This may be due to shaft that breaks, no-load operation of pumps or fan failure.

Further functions

Measured values

The following functions are available for measured value processing:

- Currents I_{L1}, I_{L2}, I_{L3}, I_E, I_{EE}
- Symmetrical components I_1, I_2, $3I_0$; V_1, V_2, $3V_0$
- Mean as well as minimum and maximum current values
- Operating hours counter
- Mean operating temperature of the overload function
- Limit value monitoring
  Limit values can be monitored using programmable logic in the CFC. Commands can be derived from this limit value indication.
- Zero suppression
  In a certain range of very low measured values, the value is set to zero to suppress interference.

Metered values

If an external meter with a metering pulse output is available, the 7SJ81 can obtain and process metering pulses through an indication input. The metered values can be displayed and passed on to a control center as an accumulated value with reset. A distinction is made between forward, reverse, active and reactive energy.

3

Circuit-breaker wear monitoring/ circuit-breaker remaining service life

Methods for determining circuit-breaker contact wear or the remaining service life of a circuit-breaker (CB) allow CB maintenance intervals to be aligned to their actual degree of wear. The benefit lies in reduced maintenance costs.

There is no exact mathematical method to calculate the wear or the remaining service life of a circuit-breaker that takes arc-chamber's physical conditions into account when the CB opens.

This is why various methods of determining CB wear have evolved which reflect the different operator philosophies. To do justice to these, the relay offers several methods:

- ΣI
- ΣI^x, with x = 1..3
- $\Sigma i^2 t$.

The devices also offer a new method for determining the remaining service life:

- Two-point method.

The CB manufacturers double-logarithmic switching cycle diagram (see Fig. 3/5) and the breaking current at the time of contact opening serve as the basis for this method. After CB opening, the two-point method calculates the remaining number of possible switching cycles. Two points P1 and P2 only have to be set on the device. These are specified in the CB's technical data.

All of these methods are phase-selective and a limit value can be set in order to obtain an alarm if the actual value falls below or exceeds the limit value during determination of the remaining service life.

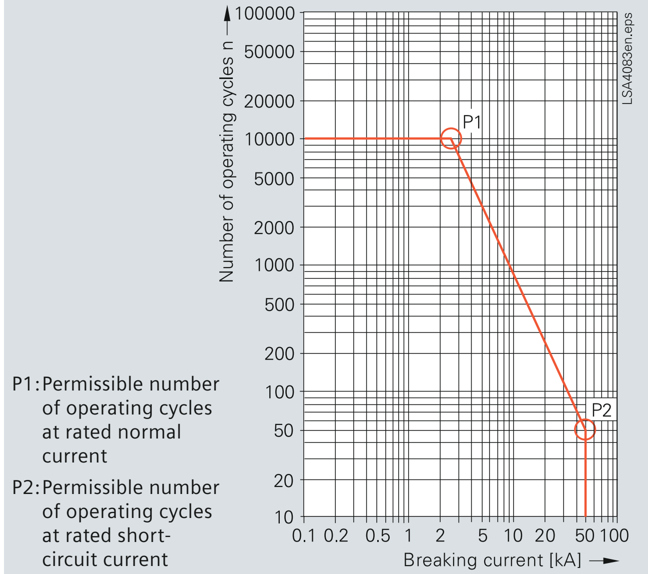


Fig. 3/5 Permissible number of operating cycles as a function of breaking current

Commissioning

Commissioning could not be easier and is supported by DIGSI 4. The status of the binary inputs can be read individually and the state of the binary outputs can be set individually. The operation of switching elements (circuit-breakers, disconnect devices) can be checked using the switching functions of the relay. The analog measured values are represented as wide-ranging operational measured values. To prevent transmission of information to the control center during maintenance, the communications can be disabled to prevent unnecessary data from being transmitted. During commissioning, all indications with test tag for test purposes can be connected to a control and protection system.

Test operation

During commissioning, all indications with test tag can be passed to a control system for test purposes.

Radial systems

General hints:
The relay at the far end (D) from the infeed has the shortest tripping time. Relays further upstream have to be time-graded against downstream relays in steps of about 0.3 s.

Busbar protection by overcurrent relays with reverse interlocking

Applicable to distribution busbars without substantial (< 0.25 x I_N) backfeed from the outgoing feeders.

1) Unbalanced load protection (ANSI 46) as backup protection against asymmetrical faults

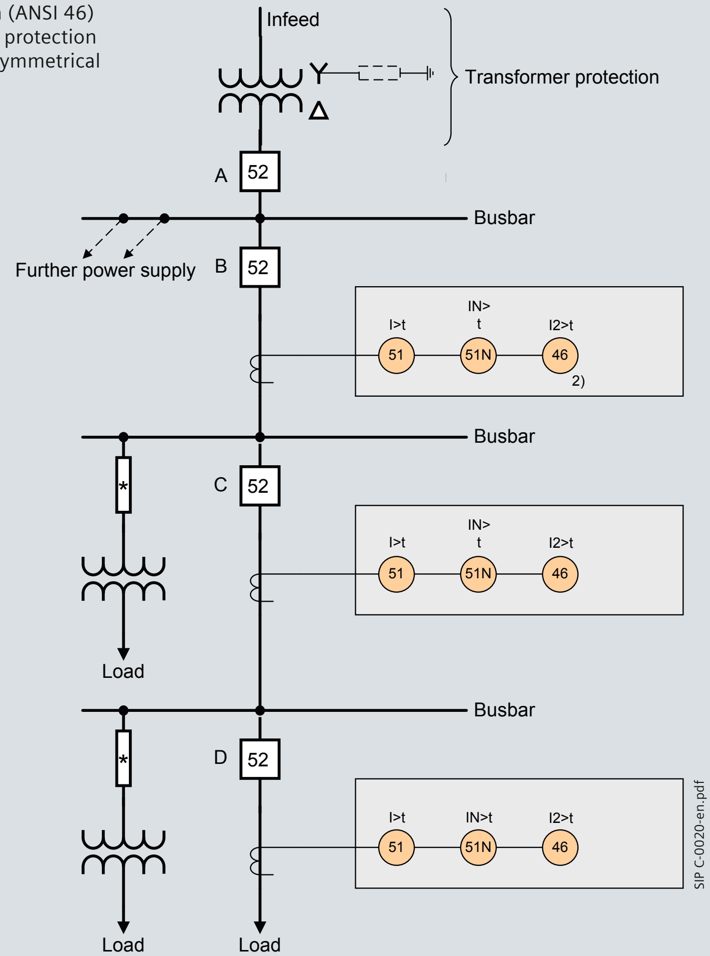


Fig. 3/6 Protection concept with overcurrent-time protection

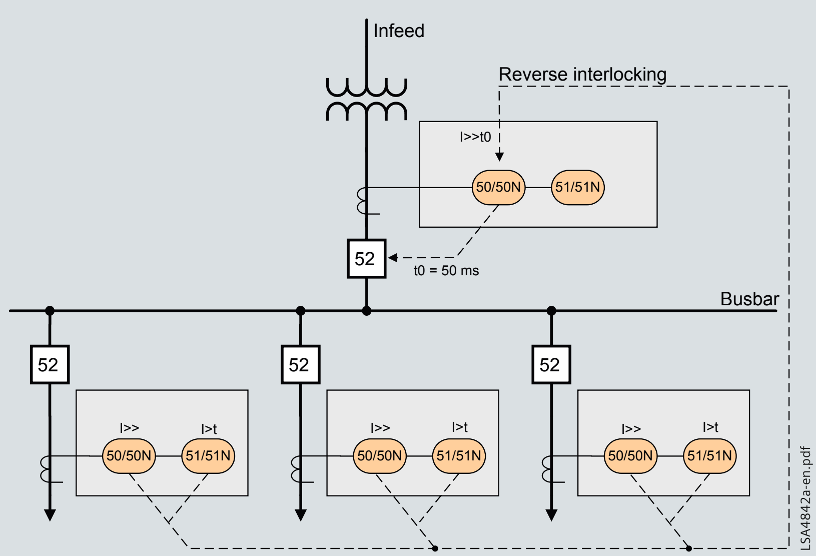


Fig. 3/7 Busbar protection with reverse interlocking

Protection of a transformer

The high-current stage enables a current grading, the overcurrent stages work as backup protection to subordinate protection devices, and the overload function protects the transformer from thermal overload. Low-current, single-phase faults on the low-voltage side, which are reproduced in the opposite system on the high-voltage side, can be detected with the unbalanced load protection. The available inrush blocking prevents pickup caused by the inrush currents of the transformer.

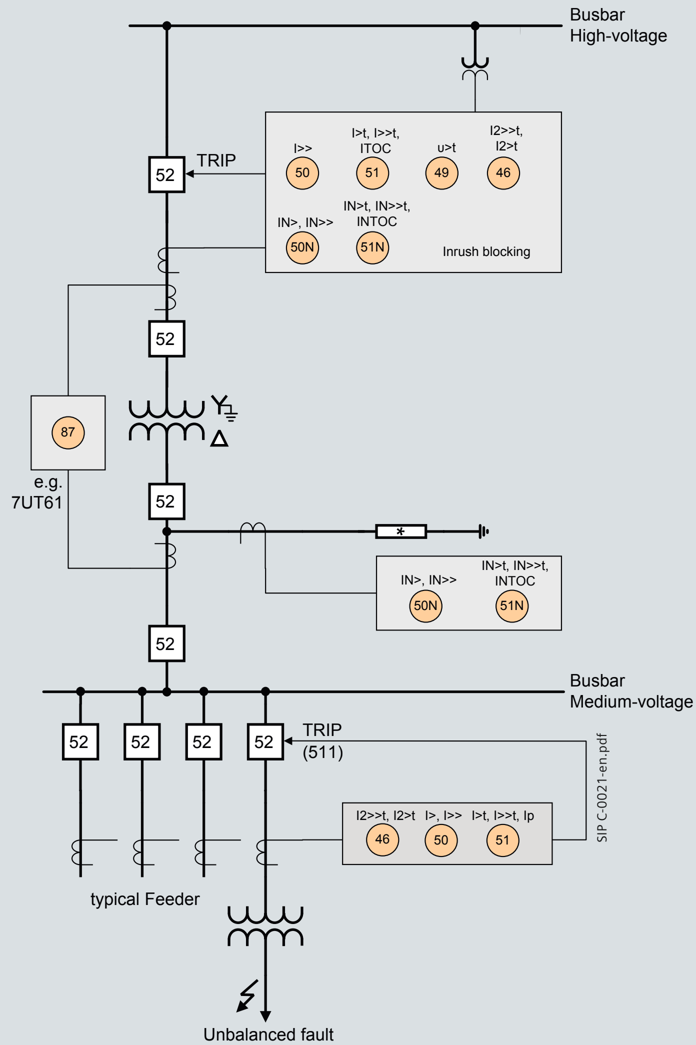


Fig. 3/8 Typical protection concept for a transformer

Description	Order No.	Short code
	12345 6 7 8 9 10 11 12 13 14 15 16	
	7SJ81□3-□□□□□-□□□0-□□□	
Overcurrent protection relay for low-power current transformer		
4 x low-power current transformer input		
Housing, binary inputs and outputs (4 x *I*)		
Housing 1/6 19"; 3 BI, 5 BO [1], 1 live status contact	1	
Housing 1/6 19"; 7 BI, 8 BO [1], 1 live status contact	2	
Auxiliary voltage		
60 V to 250 V DC; 115 V AC; 230 V AC	5	
Unit version		
Flush mounting housing, screw-type terminal	E	
Region-specific default- and language settings		
Region World, IEC/ANSI, language English, standard front	B	
Port B (at bottom of device, rear)		
No port	0	
IEC 60870-5-103 or DIGSI 4/modem, electrical RS232	1	
IEC 60870-5-103 or DIGSI 4/modem, electrical RS485	2	
IEC 60870-5-103 or DIGSI 4/modem, optical 820 nm, ST connector	3	
Further protocols see supplement L	9	L 0 □
PROFIBUS DP slave, electrical RS485	9	A
PROFIBUS DP slave, optical, double ring, ST connector	9	B
MODBUS, electrical RS485	9	D
MODBUS, optical 820 nm, ST connector	9	E
DNP 3.0, electrical RS485	9	G
DNP 3.0, optical 820 nm, ST connector	9	H
IEC 60870-5-103, redundant, electrical RS485, RJ45 connector	9	P
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector	9	R
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector	9	S
Port A (at bottom of device, in front)		
No Port	0	
With Ethernet interface (DIGSI, not IEC 61850), RJ45 connector	6	
Measuring/fault recording		
With fault recording, average values, min/max values	3	
Functionality		
50/51 Time-overcurrent protection phase: $I>$, $I>>$, $I>>>$, I_p **50N/51N** Time-overcurrent protection ground $I_E>$, $I_E>>$, $I_E>>>$, I_{Ep} **50N(s)/51N(s)** [2] Sensitive ground fault protection $I_{EE}>$, $I_{EE}>>$, I_{EEp} **49** Overload protection **74TC** Trip circuit supervision **50BF** Circuit-breaker failure protection **46** Negative-sequence protection **37** Undercurrent monitoring **86** Lockout Parameter changeover Monitoring functions Control of circuit-breaker Flexible protection functions (current parameters) Inrush restraint	F A	

1) 2 changeover/Form C

2) Depending on the connected low-power ground current transformer the function will be either sensitive (I_{Ns}) or non-sensitive (I_N)

You will find a detailed overview of the technical data (extract of the manual) under: http://www.siemens.com/siprotec

for Low-Power Current Transformer Applications – Connection diagrams

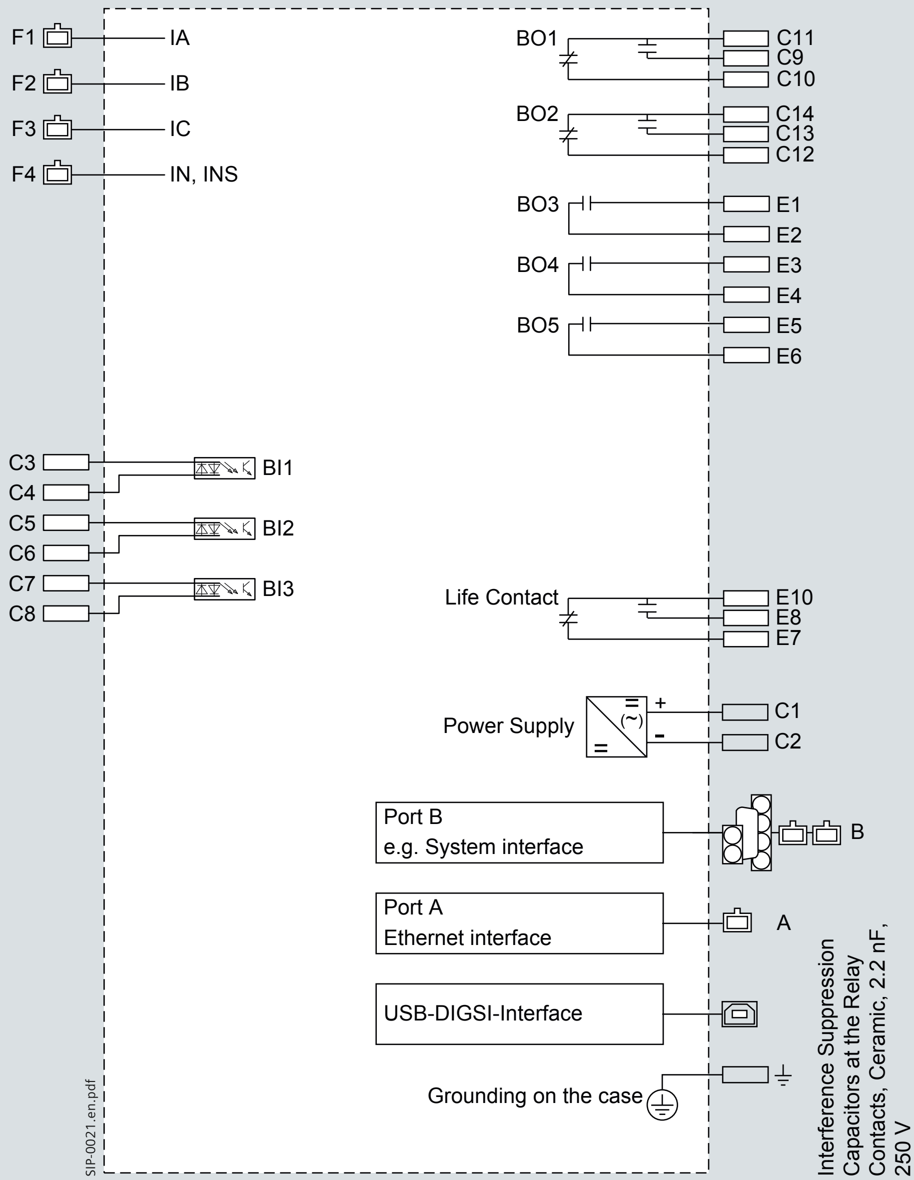


Fig. 3/9 Connection diagram for 7SJ81

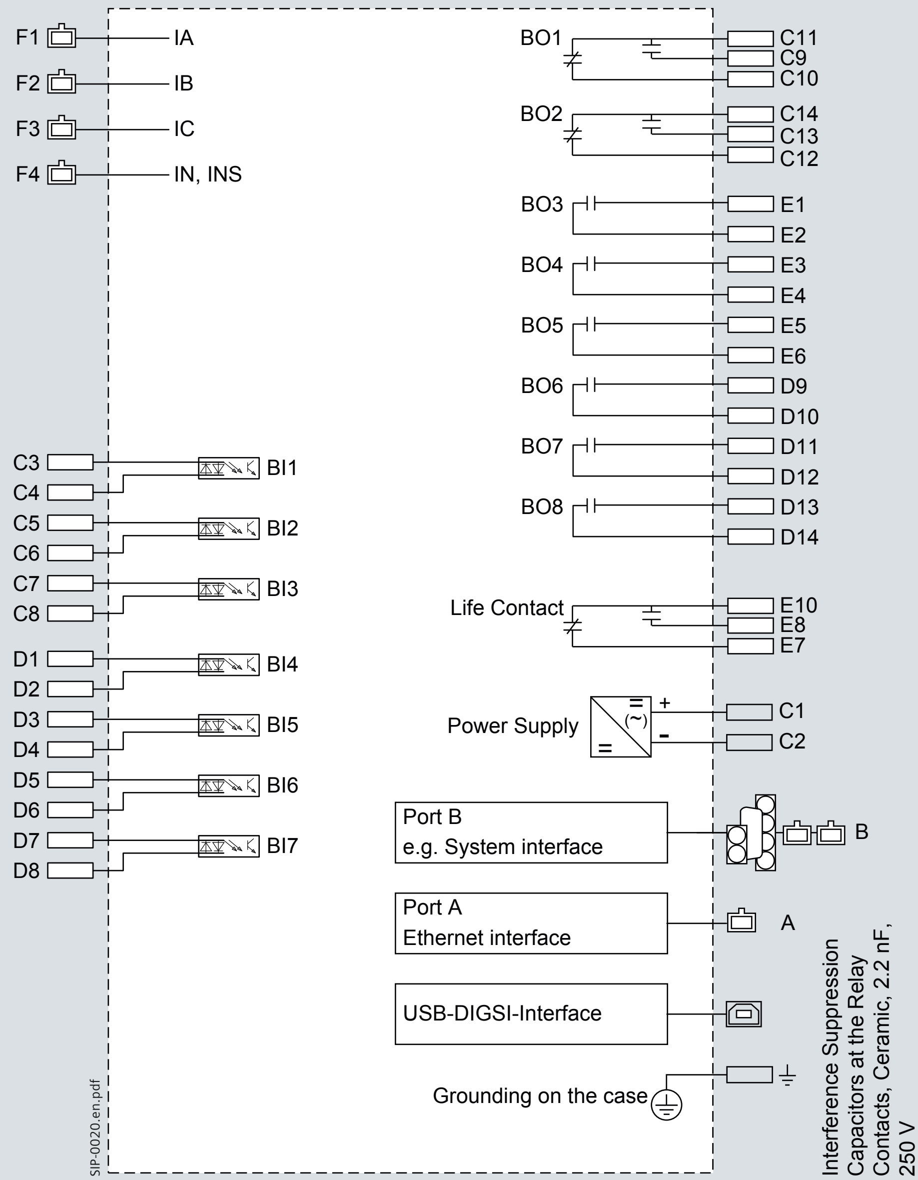


Fig. 3/10 Connection diagram for 7SJ812

Standard connection capabilities

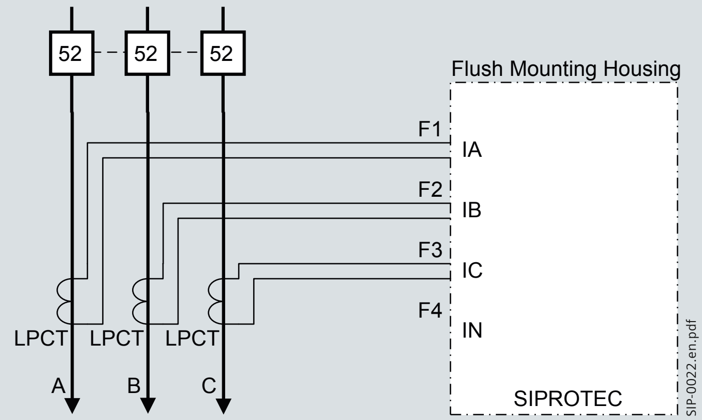


Fig. 3/11 Standard connection for 7SJ81

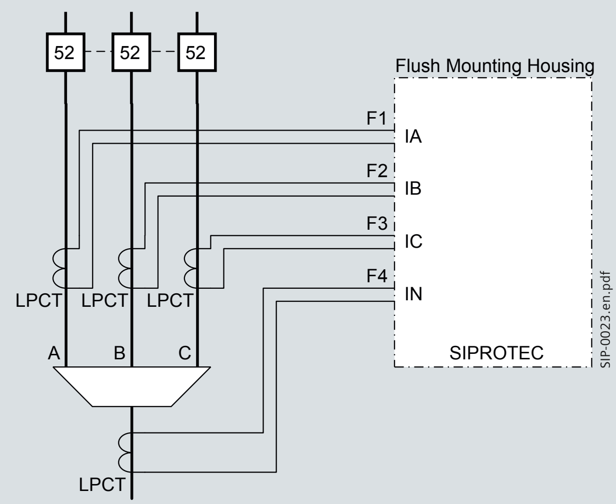


Fig. 3/12 Connection of 3 current transformers and ground current for 7SJ81

Generator and Motor Protection 7SK80
SIPROTEC Compact

SIEMENS

Generator and Motor Protection 7SK80

You will find a detailed overview of the technical data (extract of the manual) under:
http://www.siemens.com/siprotec

Description

The SIPROTEC Compact 7SK80 is a multi-functional motor protection relay. It is designed for protection of asynchronous motors of all sizes. The relays have all the required functions to be applied as a backup relay to a transformer differential relay.

The SIPROTEC Compact 7SK80 features "flexible protection functions". Up to 20 additional protection functions can be created by the user. For example, a rate-of-change of frequency function or a reverse-power function can be created. The relay provides circuit-breaker control, additional primary switching devices (grounding switches, transfer switches and isolating switches) can also be controlled from the relay. Automation or PLC logic functionality is also implemented in the relay.

The integrated programmable logic (CFC) allows the user to add own functions, e.g. for the automation of switchgear (including: interlocking, transfer and load shedding schemes). The user is also allowed to generate user-defined messages. The communication module is independent from the protection. It can easily be exchanged or upgraded to future communication protocols.

Highlights

- Pluggable current and voltage terminals
- Binary input thresholds settable using DIGSI (3 stages)
- Secondary current transformer values (1 A/5 A) settable using DIGSI
- 9 programmable function keys
- 6-line display
- Buffer battery exchangeable from the front
- USB front port
- 2 additional communication ports
- IEC 61850 with integrated redundancy (electrical or optical)
- Relay-to-relay communication through Ethernet with IEC 61850 GOOSE
- Millisecond-accurate time synchronization through Ethernet with SNTP.

Fig. 4/1 7SK80 front view

Fig. 4/2 7SK80 rear view

4

Function overview

Protection functions	IEC	ANSI
Instantaneous and definite time-overcurrent protection (phase/neutral)	$I>$, $I>>$, $I>>>$, $I_E>$, $I_E>>$, $I_E>>>$; I_p, I_{Ep}	50, 50N; 51, 51N
Directional time-overcurrent protection, ground	$I_{E\ dir}>$, $I_{E\ dir}>>$, $I_{Ep\ dir}$	67N
Directional overcurrent protection, ground (definite/inverse)	$I_{EE}>$, $I_{EE}>>$, I_{EEp}	67Ns, 50Ns
Displacement voltage, zero-sequence voltage	V_E, $V_0>$	59N
Undercurrent monitoring	$I<$	37
Temperature monitoring		38
Thermal overload protection	$\vartheta>$	49
Load jam protection		51M
Locked rotor protection		14
Restart inhibit		66/86
Undervoltage/overvoltage protection	$V<$, $V>$	27/59
Forward-power, reverse-power protection	$P<>$, $Q<>$	32
Power factor	$\cos \varphi$	55
Overfrequency/underfrequency protection	$f<$, $f>$	81O/U
Breaker failure protection		50BF
Phase-balance current protection (negative-sequence protection)	$I_2>$	46
Unbalance-voltage protection and/or phase-sequence monitoring	$V_2>$, phase sequence	47
Start-time supervision		48
Lockout		86
Rate-of-frequency-change protection	df/dt	81R

Table 4/1 Function overview

Control functions/programmable logic

- Commands for the ctrl. of CB, disconnect switches (isolators/isolating switches)
- Control through keyboard, binary inputs, DIGSI 4 or SCADA system
- User-defined PLC logic with CFC (e.g. interlocking).

Monitoring functions

- Operational measured values V, I, f
- Energy metering values W_p, W_q
- Circuit-breaker wear monitoring
- Minimum and maximum values
- Trip circuit supervision
- Fuse failure monitor
- 8 oscillographic fault records
- Motor statistics.

Communication interfaces

- System/service interface
  - IEC 61850
  - IEC 60870-5-103
  - PROFIBUS-DP
  - DNP 3.0
  - MODBUS RTU
- Ethernet interface for DIGSI 4, RTD box
- USB front interface for DIGSI 4.

Hardware

- 4 current transformers
- 0/3 voltage transformers
- 3/7 binary inputs (thresholds configurable using software)
- 5/8 binary outputs (2 changeover)
- 0/5 RTD inputs
- 1 live-status contact
- Pluggable current and voltage terminals.

The SIPROTEC Compact 7SK80 unit is a numerical motor protection relay that can perform control and monitoring functions and therefore provide the user with a cost-effective platform for power system management, that ensures reliable supply of electrical power to the customers. The ergonomic design makes control easy from the relay front panel. A large, easy-to-read display was a key design factor.

Control

The integrated control function permits control of disconnect devices, grounding switches or circuit-breakers through the integrated operator panel, binary inputs, DIGSI 4 or the control or automation system (e.g. SICAM).

Programmable logic

The integrated logic characteristics (CFC) allow the user to add own functions for automation of switchgear (e.g. interlocking) or switching sequence. The user can also generate user-defined messages. This functionality can form the base to create extremely flexible transfer schemes.

Operational measured value

Extensive measured values (e.g. I, V), metered values (e.g.W_p,W_q) and limit values (e.g. for voltage, frequency) provide improved system management.

Operational indication

Event logs, trip logs, fault records and statistics documents are stored in the relay to provide the user or operator with all the key data required to operate modern substations.

Motor protection

The 7SK80 relay is specifically designed to protect induction-type asynchronous motors.

Line protection

The 7SK80 units can be used for line protection of high and medium-voltage networks with grounded, low-resistance grounded, isolated or a compensated neutral point.

Transformer protection

The 7SK80 relay provides all the functions for backup protection for transformer differential protection. The inrush suppression effectively prevents unwanted trips that can be caused by inrush currents.

Backup protection

As a backup protection the 7SK80 devices are universally applicable.

Switchgear cubicles for high/medium voltage

All units are designed specifically to meet the requirements of high / medium-voltage applications. In general, no separate measuring instruments (e.g., for current, voltage, frequency, ...) or additional control components are necessary.

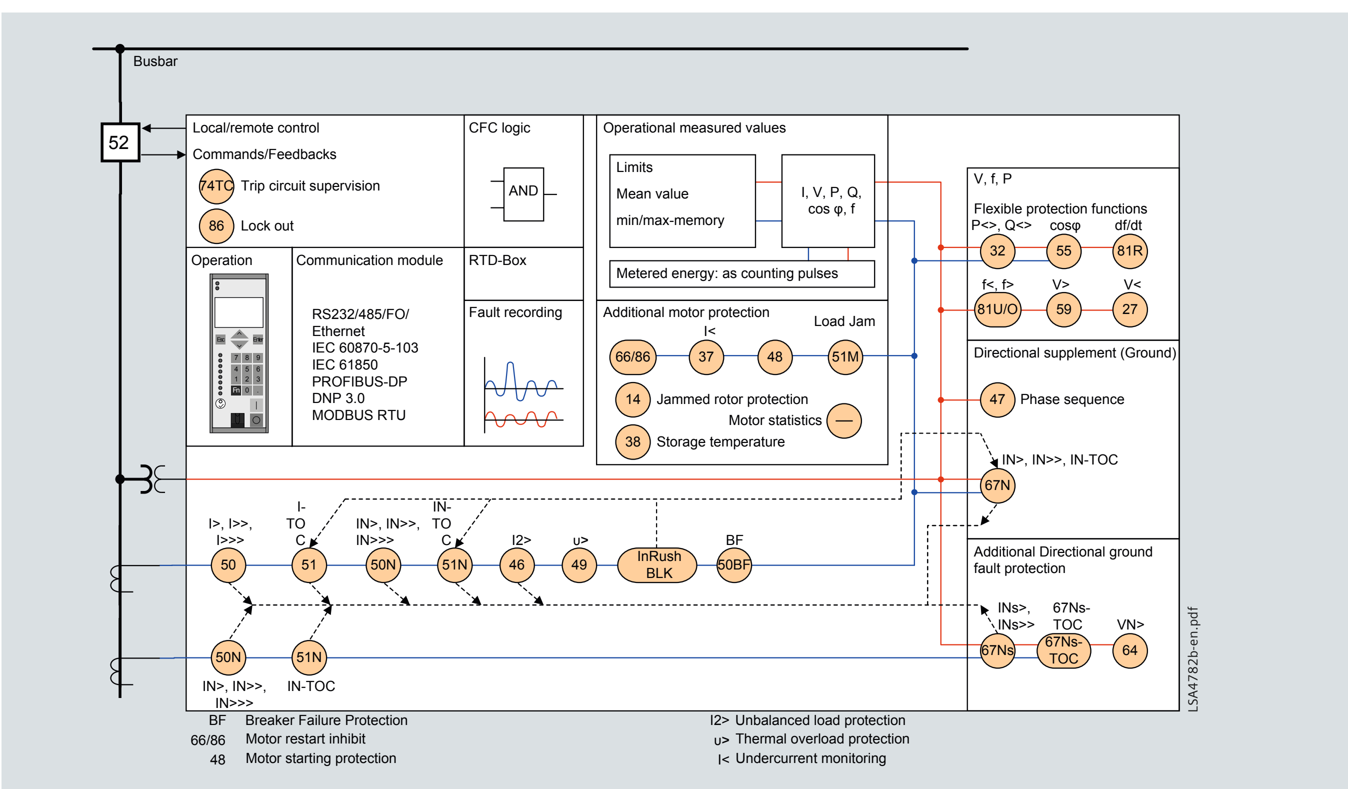


Fig. 4/3 Function diagram

Protection functions

Time-overcurrent protection (ANSI 50, 50N, 51, 51N)

This function is based on the phase selective measurement of the three phase currents and the ground current (four transformers). Three definite-time overcurrent protection elements (DMT) are available both for the phase and the ground elements. The current threshold and the delay time can be set in a wide range.

Inverse-time overcurrent protection characteristics (IDMTL) can also be selected and activated.

Reset characteristics

Time coordination with electromechanical relays are made easy with the inclusion of the reset characteristics according to ANSI C37.112 and IEC 60255-3 /BS 142 standards. When using the reset characteristic (disk emulation), the reset process is initiated after the fault current has disappeared. This reset process corresponds to the reverse movement of the Ferraris disk of an electromechanical relay (disk emulation).

Available inverse-time characteristics

Characteristics acc. to	IEC 60255-3	ANSI/IEEE
Inverse	•	•
Short inverse		•
Long inverse	•	•
Moderately inverse		•
Very inverse	•	•
Extremely inverse	•	•

Table 4/2 Available inverse-time characteristics

Inrush restraint

If second harmonic content is detected during the energization of a transformer, the pickup of stages $I>$, I_p, $I>_{dir}$ and $I_{p\ dir}$ is blocked.

Dynamic settings group switching

In addition to the static parameter changeover, the pickup thresholds and the tripping times for the directional and non-directional time-overcurrent protection functions can be changed over dynamically. As changeover criterion, the circuit-breaker position, the prepared auto-reclosure, or a binary input can be selected.

Directional overcurrent protection, ground (ANSI 67N)

Directional ground protection is a separate function. It operates in parallel to the non-directional ground overcurrent elements. Their pickup values and delay times can be set separately. Definite-time and inverse-time characteristics aroffered. The tripping characteristic can be rotated by 0 to ± 180 degrees.

For ground protection, users can choose whether the direction is to be calculated using the zero-sequence or negative-sequence system quantities (selectable). If the zero-sequence voltage tends to be very low due to the zero-sequence impedance it will be better to use the negative-sequence quantities.

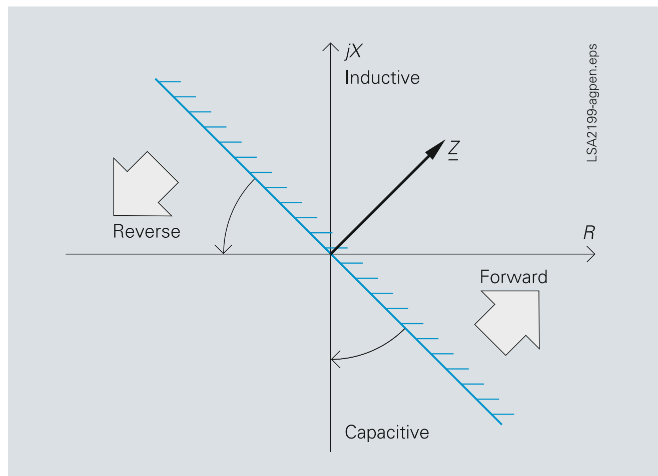


Fig. 4/4 Directional characteristic of the directional time-overcurrent protection, ground

(Sensitive) directional ground-fault detection (ANSI 59N/64, 67Ns, 67N)

For isolated-neutral and compensated networks, the direction of power flow in the zero sequence is calculated from the zero-sequence current I_0 and zero-sequence voltage V_0. For networks with an isolated neutral, the reactive current component is evaluated; for compensated networks, the active current component or residual resistive current is evaluated. For special network conditions, e.g. high-resistance grounded networks with ohmic-capacitive ground-fault current or low-resistance grounded networks with ohmic-inductive current, the tripping characteristics can be rotated approximately ± 45 degrees (see Fig. 4/5).

Two modes of ground-fault direction detection can be implemented: tripping or "signalling only mode".

It has the following functions:

- TRIP via the displacement voltage V_E
- Two instantaneous elements or one instantaneous plus one user-defined characteristic
- Each element can be set to forward, reverse or non-directional
- The function can also be operated in the insensitive mode as an additional short-circuit protection.

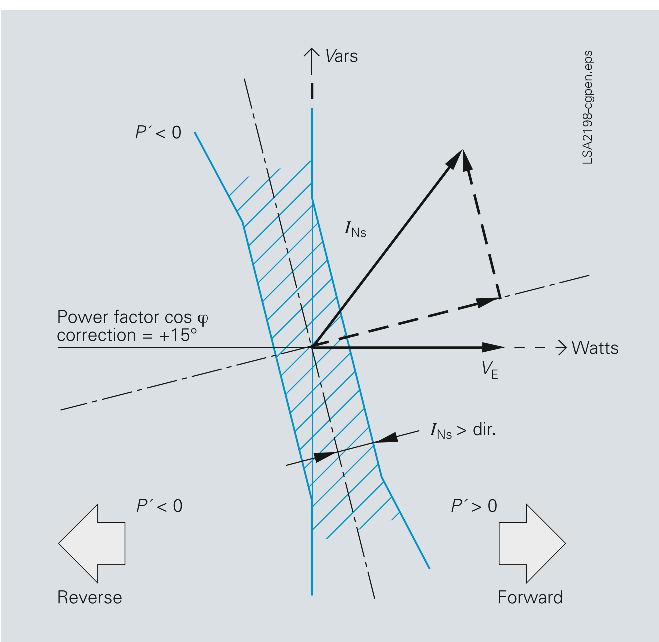


Fig. 4/5 Directional determination using cosine measurements for compensated networks

(Sensitive) ground-fault detection (ANSI 50Ns, 51Ns / 50N, 51N)

For high-resistance grounded networks, a sensitive input transformer is connected to a phase-balance neutral current transformer (also called core-balance CT). The function can also be operated in the normal mode as an additional short-circuit protection for neutral or residual ground protection.

Phase-balance current protection (ANSI 46) (Negative-sequence protection)

By measuring current on the high side of the transformer, the two-element phase-balance current/negative-sequence protection detects high-resistance phase-to-phase faults and phase-to-ground faults on the low side of a transformer (e.g. Dy 5). This function provides backup protection for high-resistance faults through the transformer.

Breaker failure protection (ANSI 50BF)

If a faulted portion of the electrical circuit is not disconnected when a trip command is issued to a circuit-breaker, another trip command can be initiated using the breaker failure protection which trips the circuit-breaker of an upstream feeder. Breaker failure is detected if, after a trip command is issued and the current keeps on flowing into the faulted circuit. It is also possible to make use of the circuit-breaker position contacts (52a or 52b) for indication as opposed to the current flowing through the circuit-breaker.

Flexible protection functions

The 7SK80 enables the user to easily add up to 20 additional protection functions. Parameter definitions are used to link standard protection logic with any chosen characteristic quantity (measured or calculated quantity). The standard logic consists of the usual protection elements such as the pickup set point, the set delay time, the TRIP command, a block function, etc. The mode of operation for current, voltage, power and power factor quantities can be three-phase or phase-selective. Almost all quantities can be operated with ascending or descending pickup stages (e.g. under and over-voltage). All stages operate with protection priority or speed.

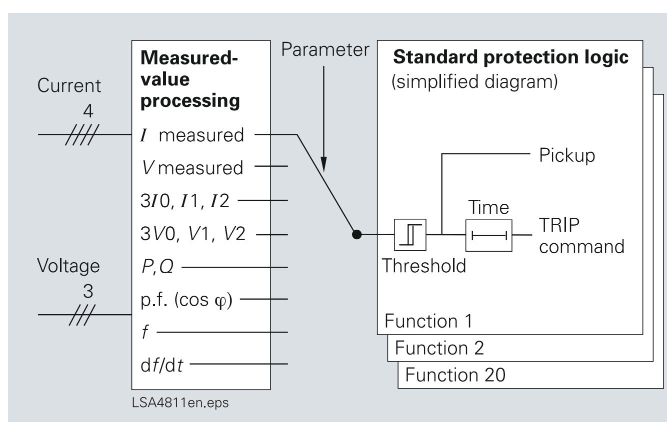


Fig. 4/6 Flexible protection functions

Protection functions/stages available are based on the available measured analog quantities:

Function	ANSI
$I>$, $I_E>$	50, 50N
$V<$, $V>$, $V_E>$	27, 59, 59N
$3I_0>$, $I_1>$, $I_2>$, $I_2/I_1>$, $3V_0>$, $V_1><$, $V_2><$	50N, 46, 59N, 47
$P><$, $Q><$	32
cos φ	55
$f><$	81O, 81U
$df/dt><$	81R

Tabelle 4/3 Available flexible protection functions

For example, the following can be implemented:

- Reverse power protection (ANSI 32R)
- Rate-of-frequency-change protection (ANSI 81R).

Trip circuit supervision (ANSI 74TC)

One or two binary inputs can be used for monitoring the circuit-breaker trip coil including its incoming cables. An alarm signal is generated whenever the circuit is interrupted.

Lockout (ANSI 86)

All binary output statuses can be memorized. The LED reset key is used to reset the lockout state. The lockout state is also stored in the event of supply voltage failure. Reclosure can only occur after the lockout state is reset.

Thermal overload protection (ANSI 49)

To protect cables and transformers, an overload protection function with an integrated warning/alarm element for temperature and current can be used. The temperature is calculated using a thermal homogeneous body model (per IEC 60255-8), it considers the energy entering the equipment and the energy losses. The calculated temperature is constantly adjusted according to the calculated losses. The function considers loading history and fluctuations in load.

Protection of motors requires an additional time constant. This is used to accurately determine the thermal heating of the stator during the running and motor stopped conditions. The ambient temperature or the temperature of the coolant can be detected either through internal RTD inputs or via an external RTD-box.The thermal replica of the overload function is automatically adapted to the ambient conditions. If neither internal RTD inputs nor an external RTD-box exist, it is assumed that the ambient temperatures are constant.

Settable dropout delay times

If the relays are used in conjunction with electromechanical relays, in networks with intermittent faults, the long dropout times of the electromechanical relay (several hundred milliseconds) can lead to problems in terms of time coordination/grading. Proper time coordination/grading is only possible if the dropout or reset time is approximately the same. This is why the parameter for dropout or reset times can be defined for certain functions, such as time-overcurrent protection, ground short-circuit and phase-balance current protection.

Motor protection

Restart inhibit (ANSI 66/86)

If a motor is subjected to many successive starts, the rotor windings or rotor bars can be heated up to a point where the electrical connections between the rotor bars and the end rings are damaged. As it is not possible to physically measure the heat of the rotor we need to determine the heat by measuring the current the rotor is drawing through the stator to excite the rotor. A thermal replica of the rotor is established using a I^2t curve. The restart inhibit will block the user from starting the motor if the relay determined that the rotor reached a temperature that will damage the rotor should a start be attempted. The relay will thus only allow a restart if the rotor has a sufficient thermal reserve to start (see Fig.).

Emergency start-up

If the relay determines that a restart of the motor is not allowed, the relay will issue a block signal to the closing command, effectively blocking any attempt to start the motor. The emergency startup will defeat this block signal if activated through a binary input. The thermal replica can also be reset to allow an emergency restart of the motor.

Temperature monitoring (ANSI 38)

Either 5 internal RTD inputs or up to 12 RTD inputs through an external RTD box can be applied for temperature detection. Example for the application with 5 internal RTD inputs: Two RTDs can be applied to each bearing (the cause of 50% of typical motor failures). The remaining RTD is used to measure the ambient temperature. Stator temperature is calculated by the current flowing through the stator windings. Alternatively up to 12 RTDs can be applied using an external RTD box connected either through RS485 on Port B or through Ethernet on Port A. The RTDs can also be used to monitor the thermal status of transformers or other pieces of primary equipment.

Starting time supervision/Locked rotor protection (ANSI 48/14)

Starting time supervision protects the motor against unwanted prolonged starts that might occur in the event of excessive load torque or excessive voltage drops within the motor, or if the rotor is locked. Rotor temperature is calculated from measured stator current. The tripping time is calculated according to the following equation:

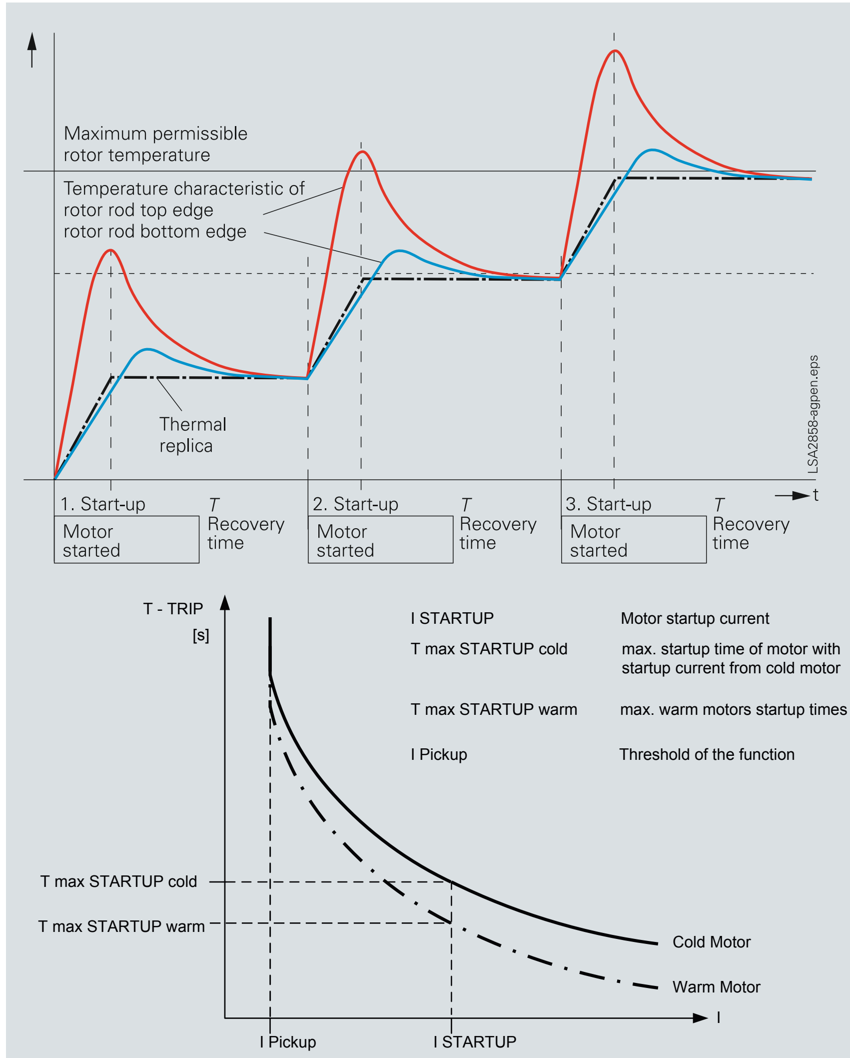


Fig. 4/7 Starting time supervision characteristics

$$t_{\text{TRIP}} \quad \frac{I_{\text{A}}{}^2}{I}\, t_{\text{Amax}}$$

t_{TRIP} = Tripping time
I_{A} = Motor starting current
t_{Amax} = Max. permissible starting time
I = Actual current flowing

Because the flow of current is the cause of the heating of the motor windings, this equation will accurately calculate the starting supervision time. The accuracy will not be affected by reduced terminal voltage that could cause a prolonged start. The trip time is an inverse current dependant characteristic (I^2t).

Block rotor can also be detected using a speed sensor connected to a binary input of the relay. If activated it will cause an instantaneous trip.

Load jam protection (ANSI 51M)

Load jam is activated when a sudden high load is applied to the motor because of mechanical failure of a pump for example. The sudden rise in current is detected by this function and can initiate an alarm or a trip. The overload function is too slow and thus not suitable.

Unbalanced load protection (ANSI 46)

The unbalanced load protection detects a phase failure or load unbalance due to system asymmetry, and protects the rotor from impermissible overheating.

Undercurrent monitoring (ANSI 37)

A sudden drop in current, which can occur due to a reduced load, is detected with this function. This may be due to shaft that breaks, no-load operation of pumps or fan failure.

Motor statistics

Essential statistical information is saved by the relay during a start. This includes the duration, current and voltage. The relay will also provide data on the number of starts, total operating time, total down time, etc. This data is saved as statistics in the relay.

Overvoltage protection (ANSI 59)

The two-element overvoltage protection detects unwanted network and machine overvoltage conditions. The function can operate either with phase-to-phase, phase-to-ground, positive phase-sequence or negative phase-sequence voltage. Three-phase and single-phase connections are possible.

Undervoltage protection (ANSI 27)

The two-element undervoltage protection provides protection against dangerous voltage drops (especially for electric machines). Applications include the isolation of generators or motors from the network to avoid undesired operating conditions and a possible loss of stability. Proper operating conditions of electrical machines are best evaluated with the positive-sequence quantities. The protection function is active over a wide frequency range (45 to 55, 55 to 65 Hz). Even when falling below this frequency range the function continues to work, however, with decrease accuracy. The function can operate either with phase-to-phase, phase-to-ground or positive phase-sequence voltage, and can be monitored with a current criterion. Three-phase and single-phase connections are possible.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for overfrequency and underfrequency protection. Electric machines and parts of the system are protected from unwanted frequency deviations. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting. Frequency protection can be used over a wide frequency range (40 to 60 (for 50 Hz), 50 to 70 (for 60 Hz)). There are four elements (individually set as overfrequency, underfrequency or OFF) and each element can be delayed separately. Blocking of the frequency protection can be performed by activating a binary input or by using an undervoltage element.

Customized functions (ANSI 51V, 55 etc.)

Additional functions, which are not time critical, can be implemented using the CFC measured values. Typical functions include reverse power, voltage controlled overcurrent, phase angle detection, and zero-sequence voltage detection.

Further functions

Measured values

The r.m.s. values are calculated from the acquired current and voltage along with the power factor, frequency, active and reactive power. The following functions are available for measured value processing:

- Currents I_{L1}, I_{L2}, I_{L3}, I_N, I_{EE}
- Voltages V_{L1}, V_{L2}, V_{L3}, V_{12}, V_{23}, V_{31}
- Symmetrical components I_1, I_2, $3I_0$; V_1, V_2, $3V_0$
- Power Watts, Vars, VA/P, Q, S (P, Q: total and phase selective)
- Power factor cos φ (total and phase selective)
- Frequency
- Energy ± kWh, ± kVarh, forward and reverse power flow
- Mean as well as minimum and maximum current and voltage values
- Operating hours counter
- Mean operating temperature of the overload function
- Limit value monitoring
  Limit values can be monitored using programmable logic in the CFC. Commands can be derived from this limit value indication
- Zero suppression
  In a certain range of very low measured values, the value is set to zero to suppress interference.

Metered values

For internal metering, the unit can calculate an energy metered value from the measured current and voltage values. If an external meter with a metering pulse output is available, the 7SK80 can obtain and process metering pulses through an indication input. The metered values can be displayed and passed on to a control center as an accumulated value with reset. A distinction is made between forward, reverse, active and reactive energy.

Circuit-breaker wear monitoring/ circuit-breaker remaining service life

Methods for determining circuit-breaker contact wear or the remaining service life of a circuit-breaker (CB) allow CB maintenance intervals to be aligned to their actual degree of wear. The benefit lies in reduced maintenance costs.

There is no exact mathematical method to calculate the wear or the remaining service life of a circuit-breaker that takes arc-chamber's physical conditions into account when the CB opens.

This is why various methods of determining CB wear have evolved which reflect the different operator philosophies. To do justice to these, the relay offers several methods:

- ΣI
- ΣI^x, with x = 1..3
- $\Sigma i^2 t$.

The devices also offer a new method for determining the remaining service life:

- Two-point method

The CB manufacturers double-logarithmic switching cycle diagram (see Fig. 4/8) and the breaking current at the time of contact opening serve as the basis for this method. After CB opening, the two-point method calculates the remaining number of possible switching cycles. Two points P1 and P2 only have to be set on the device. These are specified in the CB's technical data.

All of these methods are phase-selective and a limit value can be set in order to obtain an alarm if the actual value falls below or exceeds the limit value during determination of the remaining service life.

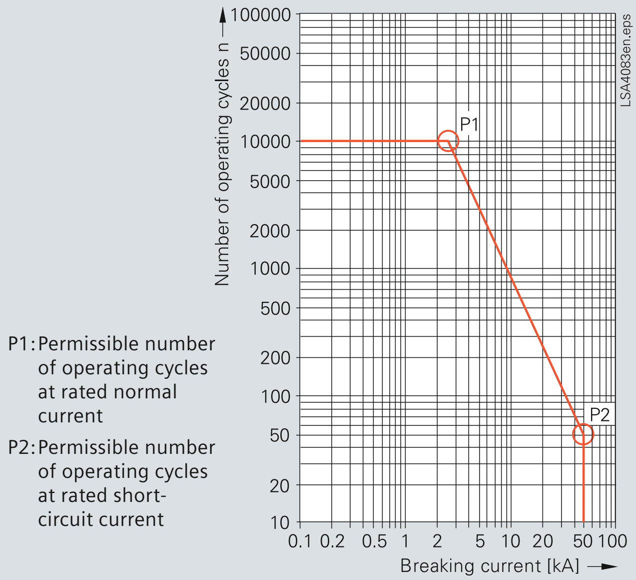


Fig. 4/8 Permissible number of operating cycles as a function of breaking current

Commissioning

Commissioning could not be easier and is supported by DIGSI 4. The status of the binary inputs can be read individually and the state of the binary outputs can be set individually. The operation of switching elements (circuit-breakers, disconnect devices) can be checked using the switching functions of the relay. The analog measured values are represented as wide-ranging operational measured values. To prevent transmission of information to the control center during maintenance, the communications can be disabled to prevent unnecessary data from being transmitted. During commissioning, all indications with test tag for test purposes can be connected to a control and protection system.

Test operation

During commissioning, all indications with test tag can be passed to a control system for test purposes.

Application examples

Radial systems

General hints:
The relay at the far end (D) from the infeed has the shortest tripping time. Relays further upstream have to be time-graded against downstream relays in steps of about 0.3 s.

1) Unbalanced load protection (ANSI 46) as backup protection against asymmetrical faults

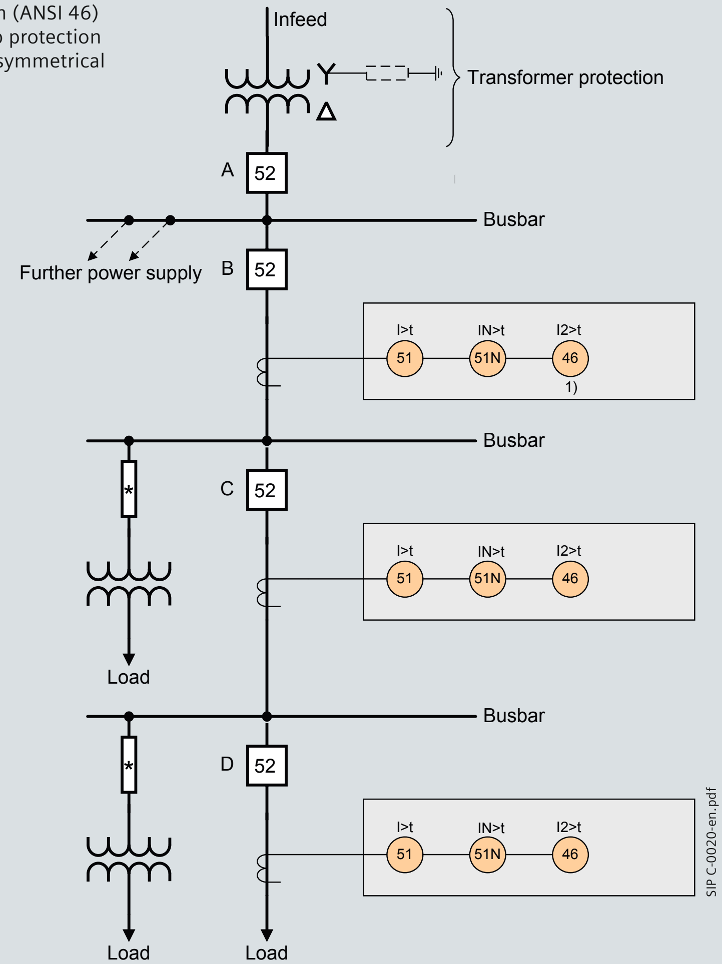


Fig. 4/9 Protection concept with overcurrent-time protection

Earth-fault detection in isolated or compensated systems

In isolated or compensated systems, an occurred earth fault can be easily found by means of sensitive directional earth-fault detection.

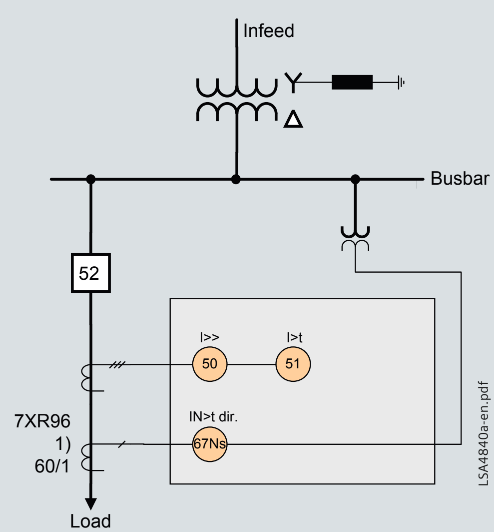


Fig. 4/10 Protection concept for directional earth-fault detection

Small and medium-sized motors < 1MW

Applicable, with effective and low-resistance infeed ($I_E \geq I_{N,\ Motor}$), to low-voltage motors and high-voltage motors with low-resistance infeed ($I_E \geq I_{N,\ Motor}$).

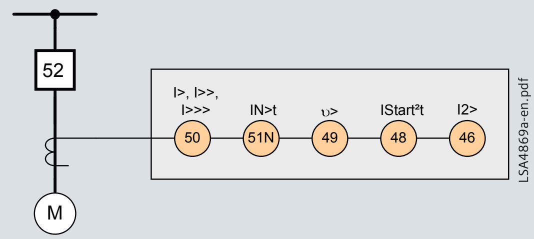


Fig. 4/11 Protection concept for small motors

High-resistance infeed

($I_E \leq I_{N,\ Motor}$)

1) Zero-sequence current transformer
2) The sensitive directional earth-fault detection (ANSI 67Ns) is only applicable with the infeed from an isolated system or a system earthed via Petersen coil.

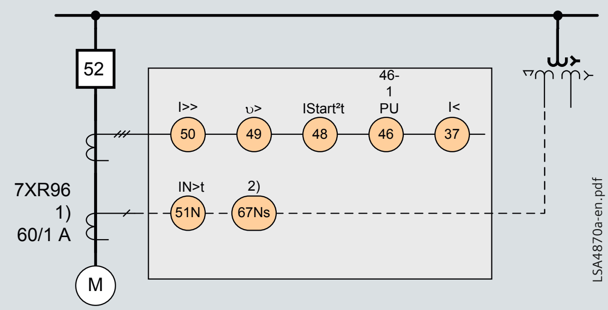


Fig. 4/12

Generators < 500 kW

If a zero-sequence current transformer is available for the sensitive earth-fault protection, the 7SK80 relay with the sensitive earth-current input should be used.

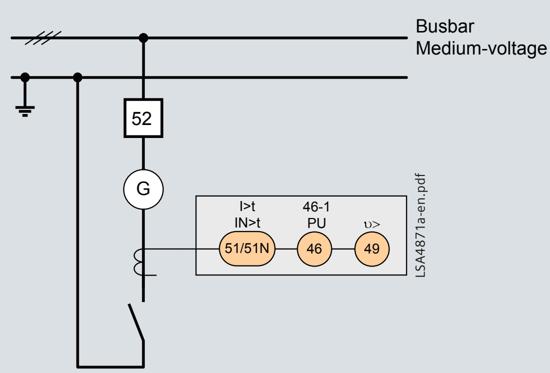


Fig. 4/13 Protection concept for smallest generators with solidly earthed neutral

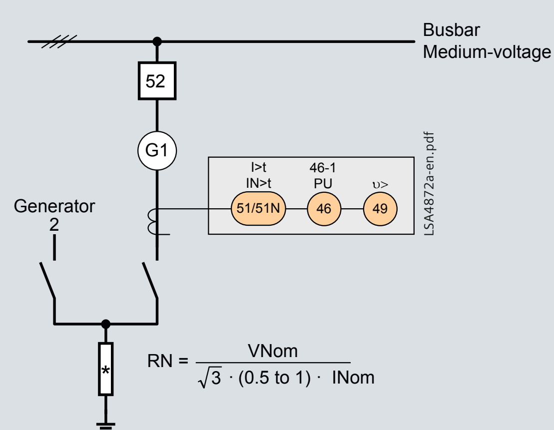


Fig. 4/14 Protection concept for smallest generators with low-resistance neutral earthing

Generators up to 1MW

Two voltage transformers in V-connection are sufficient.

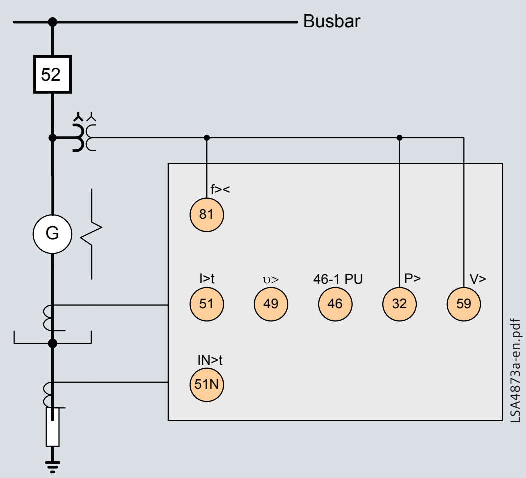


Fig. 4/15 Protection concept for small generators

4

Busbar protection by overcurrent relays with reverse interlocking

Applicable to distribution busbars without substantial (< 0.25 x I_N) backfeed from the outgoing feeders.

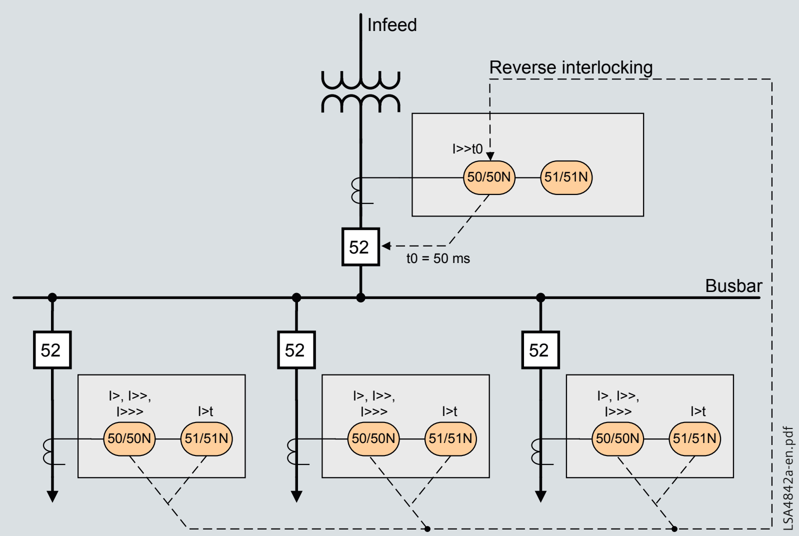


Fig. 4/16 Busbar protection with reverse interlocking

Line feeder with load shedding

In unstable power systems (e.g. solitary systems, emergency power supply in hospitals), it may be necessary to isolate selected consumers from the power system in order to protect the overall system. The overcurrent-time protection functions are effective only in the case of a short-circuit. Overloading of the generator can be measured as a frequency or voltage drop.

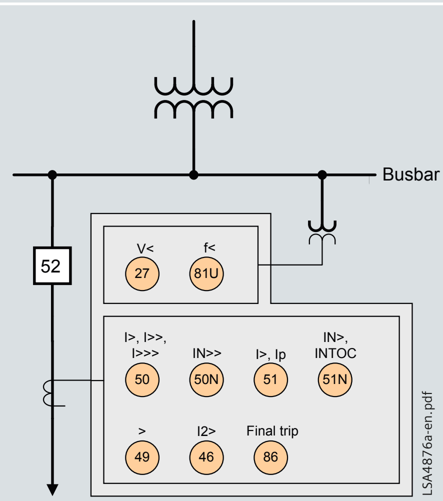


Fig. 4/17 Line feeder with load shedding

Protection of a transformer

The high-current stage enables a current grading, the overcurrent stages work as backup protection to subordinate protection devices, and the overload function protects the transformer from thermal overload. Low-current, single-phase faults on the low-voltage side, which are reproduced in the opposite system on the high-voltage side, can be detected with the unbalanced load protection. The available inrush blocking prevents pickup caused by the inrush currents of the transformer.

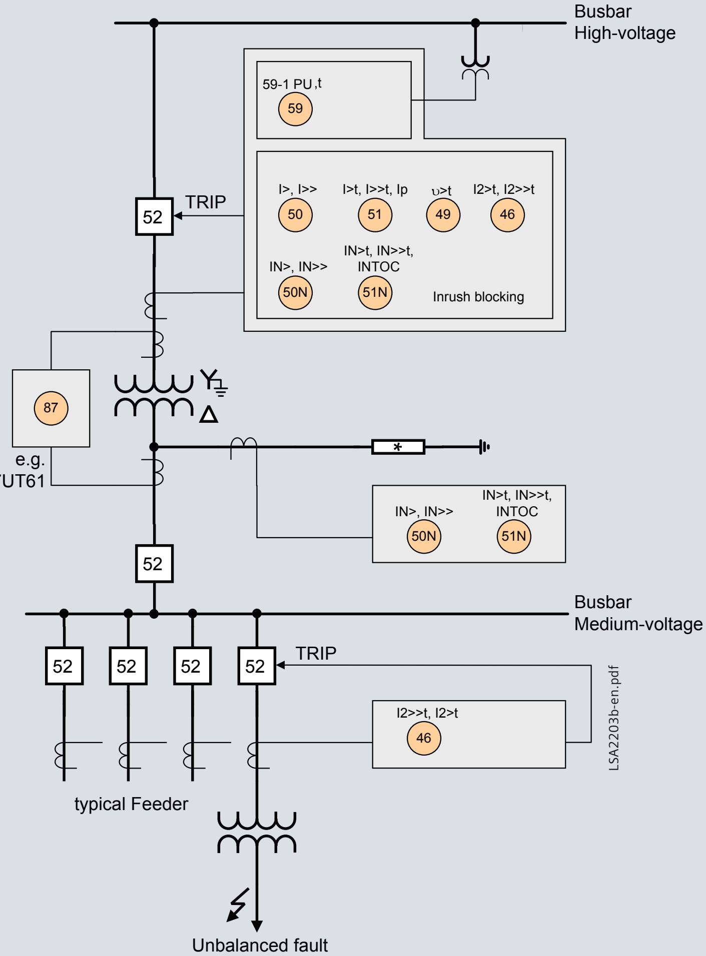


Fig. 4/18 Typical protection concept for a transformer

Motor protection

For short-circuit protection, the stages I>> and I_E>> are available, for example. Sudden load variations in running operation are acquired by the I_{load}> function. For isolated systems, the sensitive earth-fault detection (I_{EE}>>, V_0>) can be used. The stator is protected against thermal overload by s, the rotor by I_2>, start-time supervision and restart inhibit. A locked rotor is detected via a binary input, and shut down as fast as required. The restart inhibit can be deactivated by an "emergency start".

The undervoltage function prevents a start when the voltage is too low; the overvoltage function prevents insulation damages.

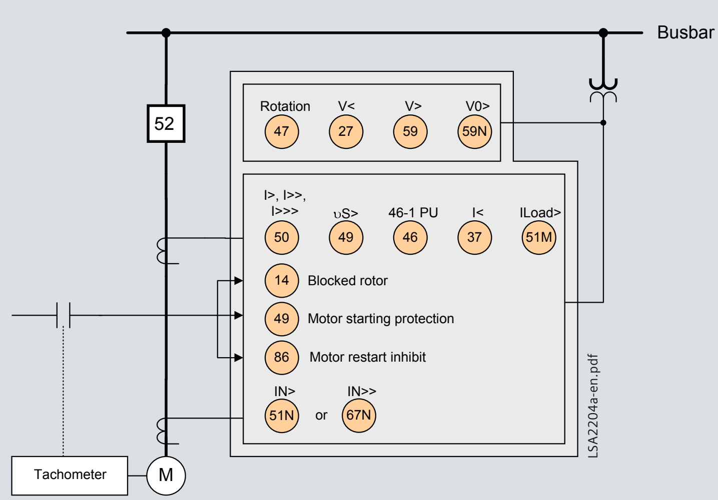


Fig. 4/19 Typical protection concept for an asynchronous high-voltage motor

Selection and ordering data

Product description	Order No.	Short code
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 7SK80□□-□□□□□-□□□□+□□□	
Housing, binary inputs and outputs (4 x *I*)		
Housing 1/6 19"; 3 BI, 5 BO [1], 1 live status contact	1	
Housing 1/6 19"; 7 BI, 8 BO [1], 1 live status contact	2	
Housing 1/6 19"; 3 x *V*, 3 BI, 5 BO [1], 1 live status contact	3	
Housing 1/6 19"; 3 x *V*, 7 BI, 8 BO [1], 1 live status contact	4	
Housing 1/6 19"; 3 BI, 5 BO [1], 1 live status contact, 5 RTD inputs	5	
Housing 1/6 19"; 3 x *V*, 3 BI, 5 BO [1], 1 live status contact, 5 RTD inputs	6	
Measuring inputs, default settings *I*		
I_{ph} = 1 A / 5 A, I_e = 1 A / 5 A	1	
I_{ph} = 1 A / 5 A, I_{ee} (sensitive) = 0.001 to 1.6 A / 0.005 to 8 A	2	
Rated auxiliary voltage		
24 V to 48 V	1	
60 V to 250 V DC; 115 V AC; 230 V AC	5	
Unit version		
Surface mounting housing, screw-type terminal	B	
Flush mounting housing, screw-type terminal	E	
Region-specific default- and language settings		
Region DE, IEC, language German [2], standard front	A	
Region World, IEC/ANSI, language English [2], standard front	B	
Region US, ANSI, language US-English [2], US front	C	
Region FR, IEC/ANSI, language French [2], standard front	D	
Region World, IEC/ANSI, language Spanish [2], standard front	E	
Region World, IEC/ANSI, language Italian [2], standard front	F	
Region RUS, IEC/ANSI, language Russian [2], standard front	G	
Region CHN, IEC/ANSI, language Chinese [3], Chinese front	K	
Port B (at bottom of device)		
No port	0	
IEC 60870-5-103 or DIGSI 4/modem, electrical RS232	1	
IEC 60870-5-103 DIGSI 4/modem or RTD-box, electrical RS485	2	
IEC 60870-5-103 DIGSI 4/modem or RTD-box, optical 820 nm, ST connector	3	
Further protocols see supplement L	9	L 0 □
PROFIBUS DP slave, electrical RS485	9	A
PROFIBUS DP slave, optical, double ring, ST connector	9	B
MODBUS, electrical RS485	9	D
MODBUS, optical 820 nm, ST connector	9	E
DNP 3.0, electrical RS485	9	G
DNP 3.0, optical 820 nm, ST connector	9	H
IEC 60870-5-103, redundant, electrical RS485, RJ45 connector	9	P
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector	9	R
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector	9	S
Port A (at bottom of device)		
No port	0	
With Ethernet interface (DIGSI, RTD-box, not IEC 61850), RJ45 connector	6	
Measuring / fault recording		
With fault recording	1	
With fault recording, average values, min/max values	3	

see next page

1) 2 changeover/Form C. 2) Language selectable 3) Language not changeable

You will find a detailed overview of the technical data (extract of the manual) under: http://www.siemens.com/siprotec

ANSI No.	Product description	Order No. 14 15 16
Motor protection device		**H D 0** [2]
	Basic version (contained in all options)	
50/51	Time-overcurrent protection phase $I>$, $I>>$, $I>>>$, I_p	
50N/51N	Time-overcurrent protection ground $I_E>$, $I_E>>$, $I_E>>>$, I_{Ep}	
50N(s)/51N(s) [1]	Sensitive ground fault protection $I_{EE}>$, $I_{EE}>>$, I_{EEp}	
49	Overload protection	
74TC	Trip circuit supervision	
50BF	Circuit breaker failure protection	
46	Negative sequence / unbalanced load protection	
86	Lockout	
48	Starting time supervision	
37	Undercurrent monitoring	
66/86	Restart inhibit	
14	Locked rotor protection	
51M	Load jam protection	
	Motor statistics	
	Parameter changeover	
	Monitoring functions	
	Control of circuit-breaker	
	Flexible protection functions (current parameters)	
	Inrush restraint	
	Basic version included	**H E 0** [3]
67N	Directional overcurrent protection ground, $I_E>$, $I_E>>$, I_{Ep}	
67N(s) [1]	Directional sensitive ground fault protection, $I_{EE}>$, $I_{EE}>>$, I_{EEp}	
64/59N	Displacement voltage	
27/59	Under-/overvoltage	
81 U/O	Under-/overfrequency, $f<$, $f>$	
47	Phase rotation	
32/55/81R	Flexible protection functions (current and voltage parameters)	
	Protection function for voltage, power, power factor, frequency change	

1) Depending on the ground current input the function will be either sensitive (I_{EE}) or non-sensitive (I_E).

2) Only with position 6 = **1, 2** or **5**

3) Only with position 6 = **3, 4** or **6**

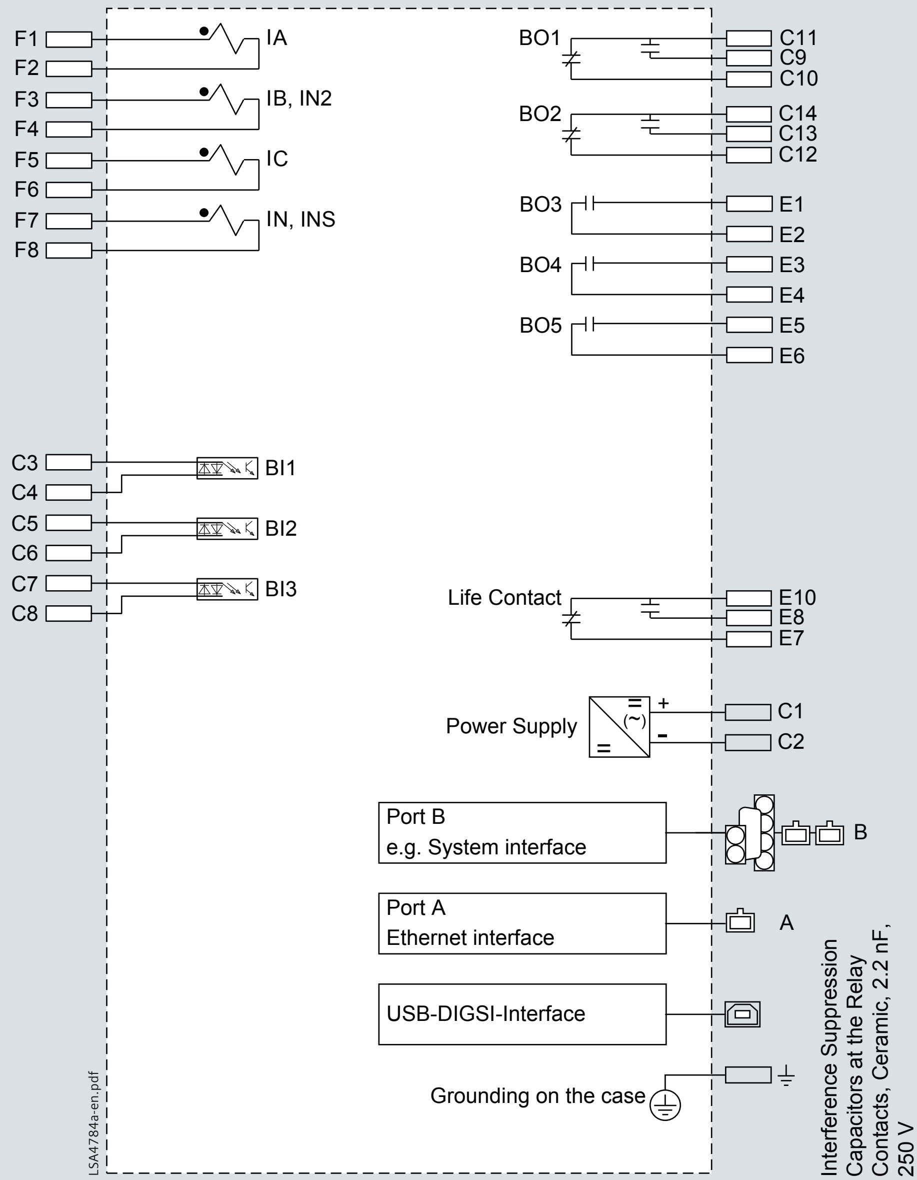


Fig. 4/20 Motor protection 7SK801

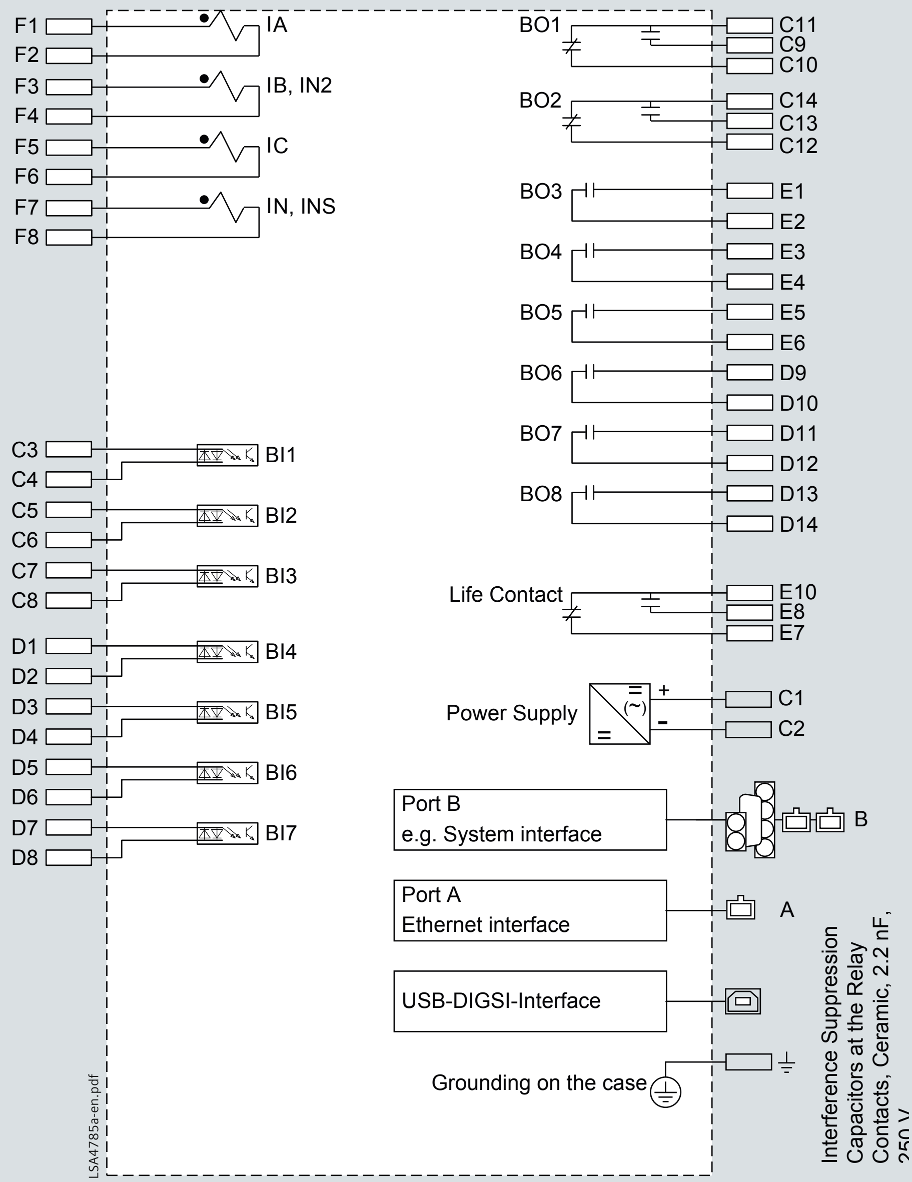


Fig. 4/21 Motor protection 7SK802

4

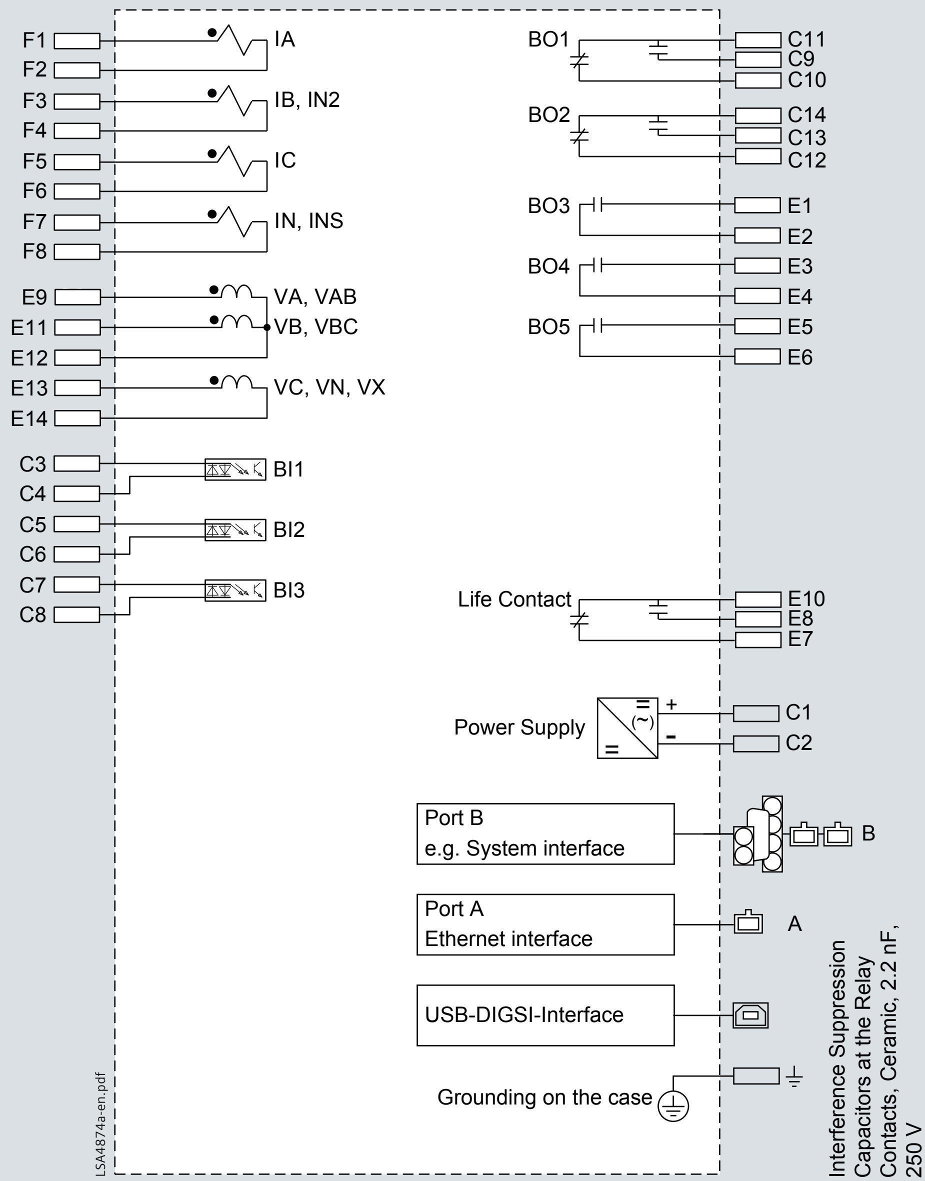


Fig. 4/22 Motor protection 7SK803

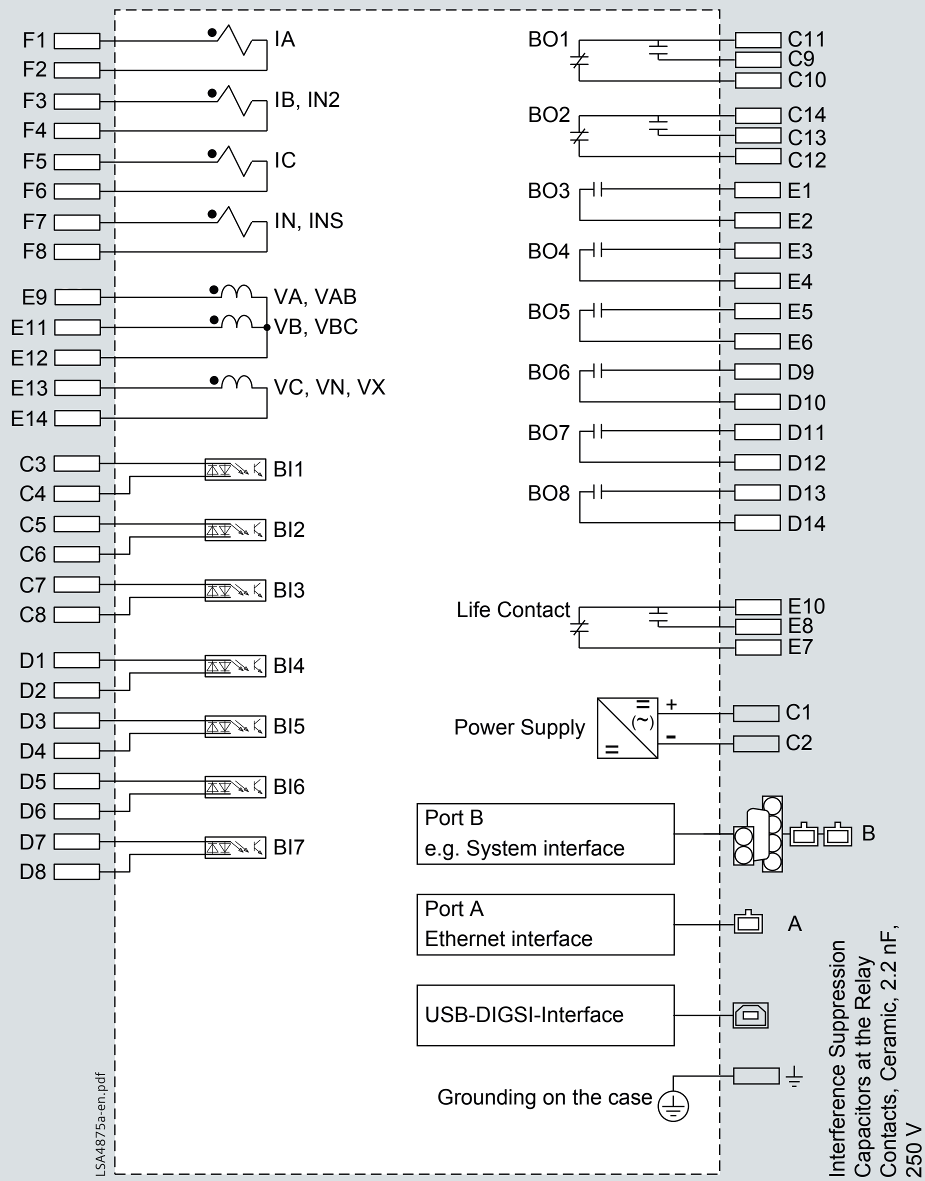


Fig. 4/23 Motor protection 7SK804

Connection diagrams

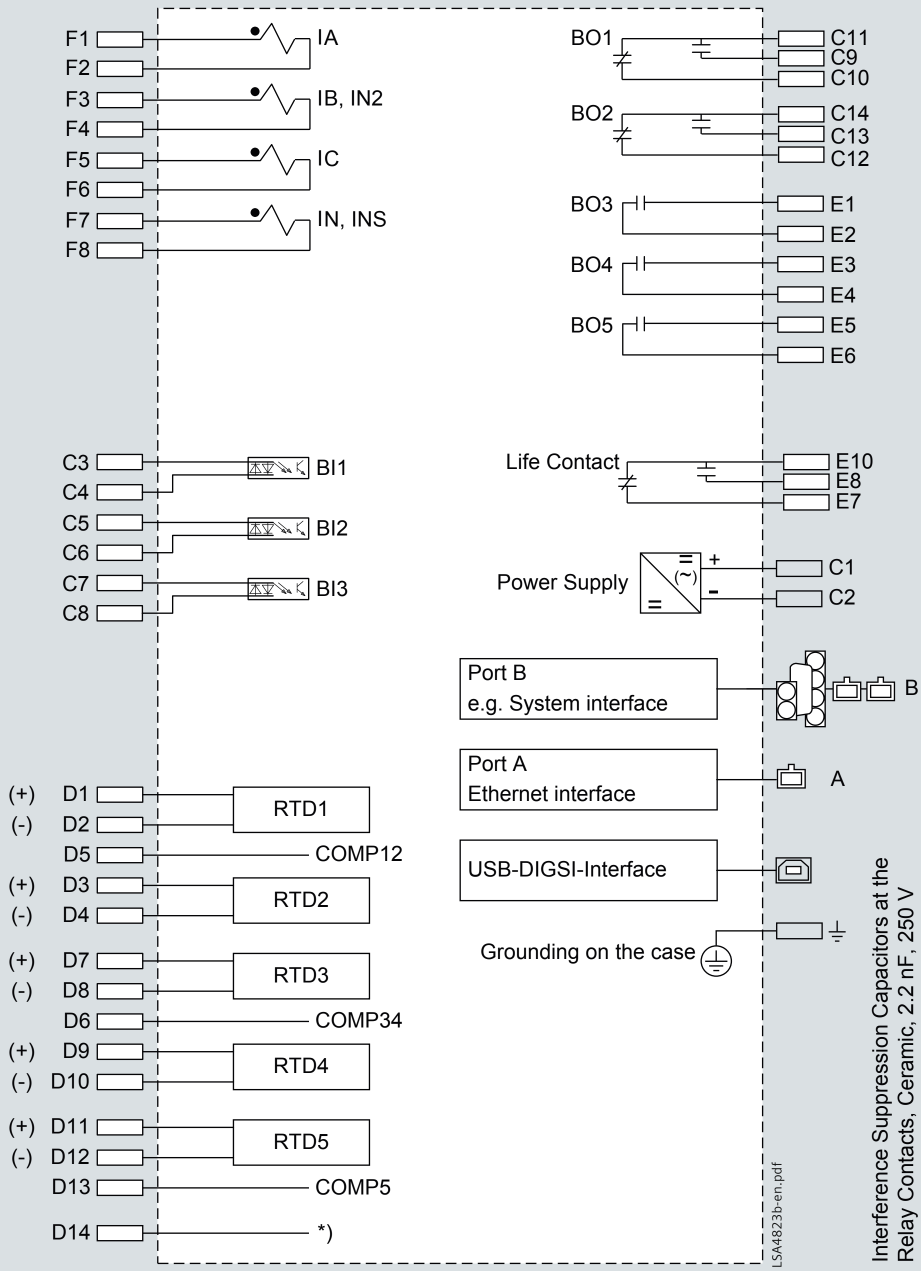


Fig. 4/24 Motor protection 7SK805

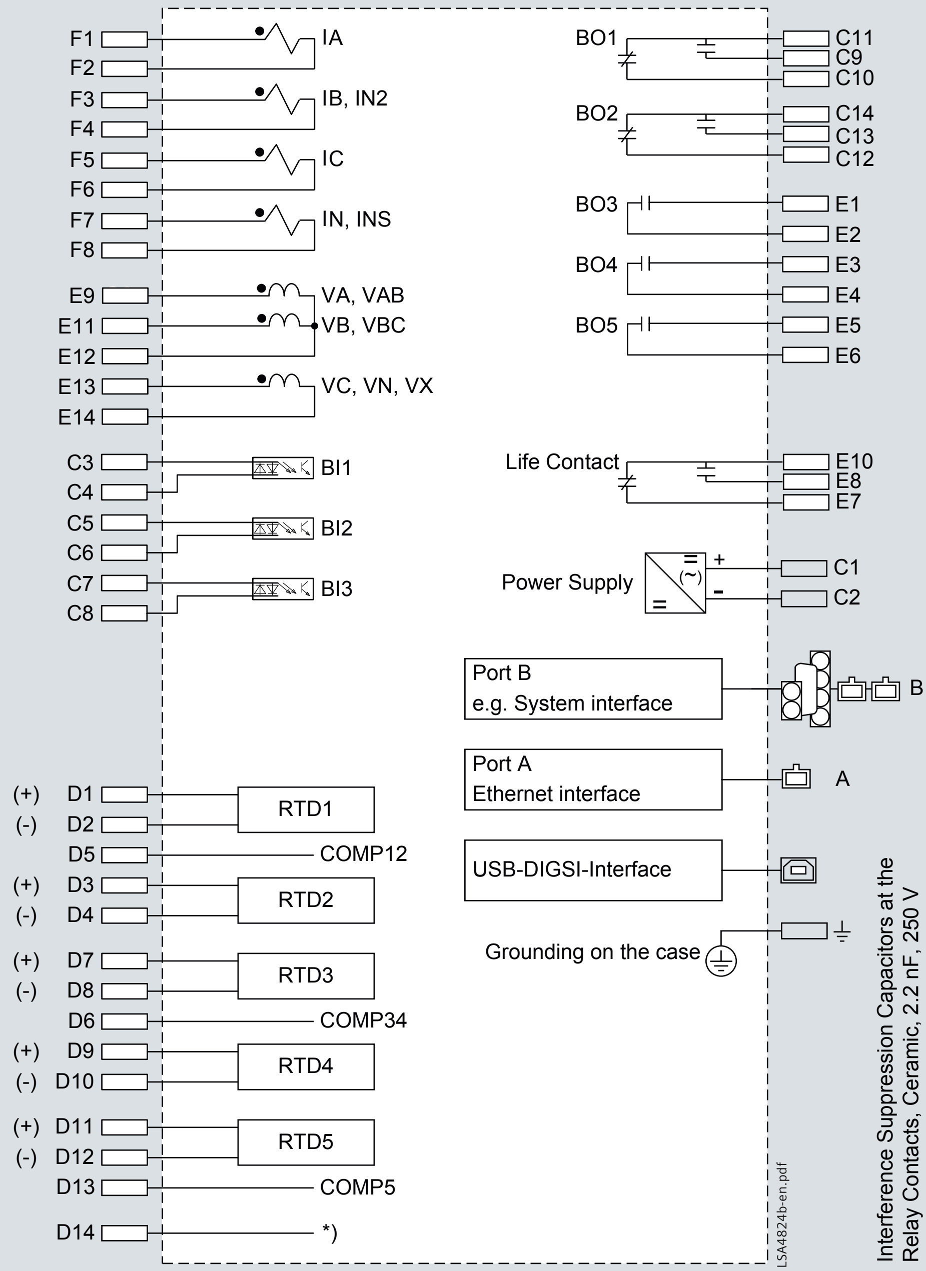


Fig. 4/25 Motor protection 7SK806

4

Connection of current and voltage transformers

Standard connection

For grounded networks, the ground current is obtained from the phase currents by the residual current circuit.

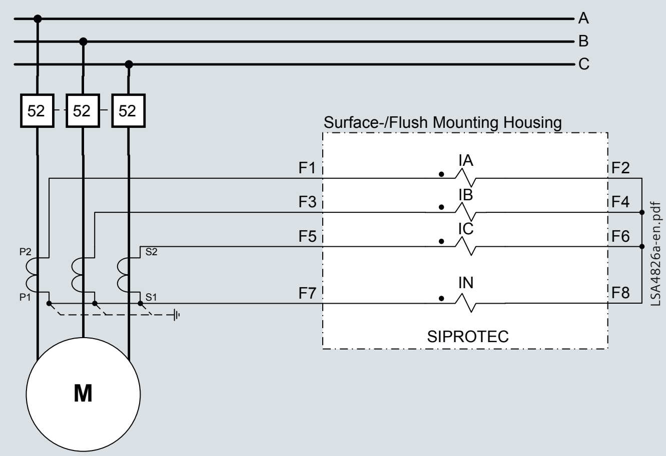


Fig. 4/26 Residual current circuit without directional element

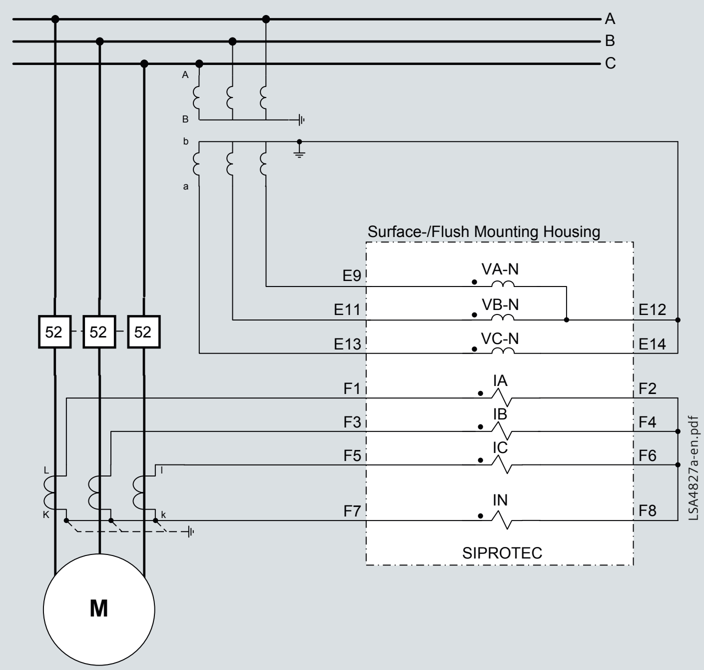


Fig. 4/27 Residual current circuit with directional element for ground (non directional element for phases)

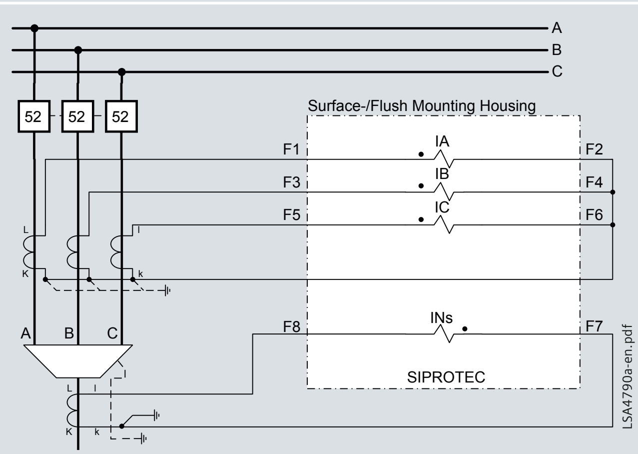


Fig. 4/28 Current transformer connections on three current transformers, earth current of additional summation current transformer

Connection for compensated networks

The figure shows the connection of two phase-to-ground voltages and the V_E voltage of the broken delta winding and a phase-balance neutral current transformer for the ground current. This connection maintains maximum precision for directional ground-fault detection and must be used in compensated networks.

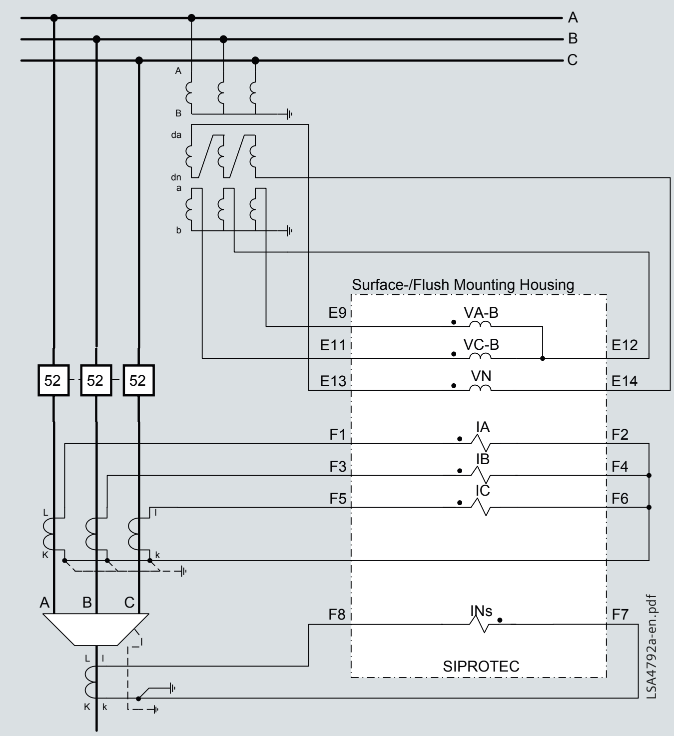


Fig. 4/29 Sensitive directional ground-fault detection (non directional element for phases)

Sensitive directional ground-fault detection.

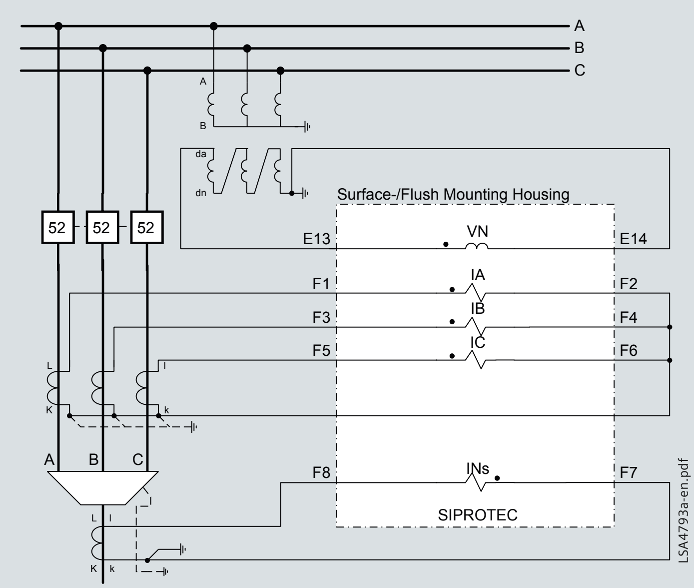


Fig. 4/30 Sensitive directional ground-fault detection

Connection for all types of power systems

The illustration shows the connection of three current transformers and two voltage transformers in V-connection.

A directional earth-fault protection is not possible, as the displacement voltage cannot be calculated.

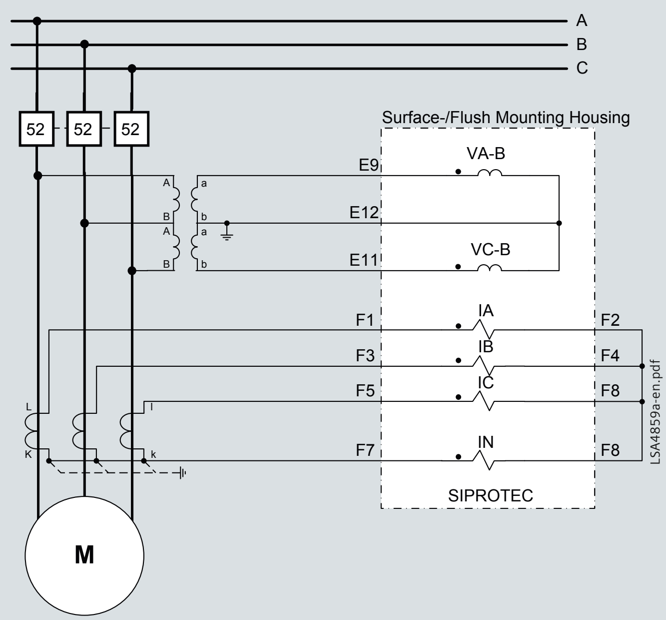


Fig. 4/31 Residual circuit with voltage functions (non directional element for phase)

Overview of connection types

Type of network	Function	Current connection	Voltage connection
(Low-resistance) grounded networks	Time-overcurrent protection phase/ground non-directional	Residual circuit, with 3 phase-current transformers required, phase-balance neutral current transformers possible	–
(Low-resistance) grounded networks	Sensitive ground-fault protection	Phase-balance neutral current transformers required	–
Isolated or compensated networks	Time-overcurrent protection phases non-directional	Residual circuit, with 3 or 2 phase-current transformers possible	–
(Low-resistance) grounded networks	Time-overcurrent protection phases directional	Residual circuit, with 3 phase-current transformers possible	Phase-to-ground connection or phase-to-phase connection
Isolated or compensated networks	Time-overcurrent protection phases directional	Residual circuit, with 3 or 2 phase-current transformers possible	Phase-to-ground connection or phase-to-phase connection
(Low-resistance) grounded networks	Time-overcurrent protection ground directional	Residual circuit, with 3 phase-current transformers required, phase-balance neutral current transformers possible	Phase-to-ground connection required
Isolated networks	Sensitive ground-fault protection	Residual circuit, if ground current > 0.05 I_N on secondary side, otherwise phase-balance neutral current transformers required	3 times phase-to-ground connection or phase-to-ground connection with broken delta winding
Compensated networks	Sensitive ground-fault protection cos φ measurement	Phase-balance neutral current transformers required	3 times phase-to-ground connection or phase-to-ground connection with broken delta winding

Table 4/4 Overview of connection types

Voltage and Frequency Protection 7RW80
SIPROTEC Compact

SIEMENS

Voltage and Frequency Protection 7RW80

You will find a detailed overview of the technical data (extract of the manual) under:
http://www.siemens.com/siprotec

Description

The SIPROTEC Compact 7RW80 is a numerical, multi-function relay for connection to voltage transformers. It can be used in distribution systems, on transformers and for electrical machines. If the SIPROTEC Compact 7RW80 detects any deviation from the permitted voltage, frequency or overexcitation values, it will respond according to the values set. The relay can also be applied for the purposes of system decoupling and for load shedding if ever there is a risk of a system collapse as a result of inadmissibly large frequency drops. An integrated load restoration function allows the re-establishment of the power system after recovery of the system frequency.

The SIPROTEC Compact 7RW80 features "flexible protection functions". Up to 20 additional protection functions can be created by the user. For example, a rate of change of frequency function or a reverse power function can be created. The relay provides circuit-breaker control, additional primary switching devices (grounding switches, transfer switches and isolating switches) can also be controlled from the relay. Automation or PLC logic functionality is also implemented in the relay.

The integrated programmable logic (CFC) allows the user to add own functions, e.g. for the automation of switchgear (including: interlocking, transfer and load shedding schemes). The user is also allowed to generate user-defined messages. The communication module is independent from the protection. It can easily be exchanged or upgraded to future communication protocols.

Highlights

- Pluggable current and voltage terminals
- Binary input thresholds settable using DIGSI (3 stages)
- 9 programmable function keys
- 6-line display
- Buffer battery exchangeable from the front
- USB front port
- 2 additional communication ports
- IEC 61850 with integrated redundancy (electrical or optical)
- Relay-to-relay communication through Ethernet with IEC 61850 GOOSE
- Millisecond-accurate time synchronization through Ethernet with SNTP.

Fig. 5/1 7RW80 front view

Fig. 5/2 7RW80 rear view

5

Voltage and Frequency Protection 7RW80

Function overview

Protection functions	IEC	ANSI
Undervoltage/overvoltage protection	$V<$, $V>$	27/59
Displacement voltage, zero-sequence voltage	V_E, $V_0>$	59N [1)]
Overfrequency/underfrequency protection	$f<$, $f>$	81O/U
Load restoration		
Jump of voltage vector	$\Delta\varphi>$	
Overexcitation protection	V/f	24
Unbalance-voltage protection and/or phase-sequence monitoring	$V_2>$, phase sequence	47
Synch-check		25
Rate-of-frequency-change protection	df/dt	81R
Rate-of-voltage-change protection	dV/dt	
Trip circuit supervision		74TC
Lockout		86

Table 5/1 Function overview

5

Control functions/programmable logic

- Commands for the ctrl. of CB, disconnect switches (isolators/isolating switches)
- Control through keyboard, binary inputs, DIGSI 4 or SCADA system
- User-defined PLC logic with CFC (e.g. interlocking).

Monitoring functions

- Operational measured values *V*, *f*
- Minimum and maximum values
- Trip circuit supervision
- Fuse failure monitor
- 8 oscillographic fault records.

Communication interfaces

- System/service interface
  – IEC 61850
  – IEC 60870-5-103
  – PROFIBUS-DP
  – DNP 3.0
  – MODBUS RTU
- Ethernet interface for DIGSI 4
- USB front interface for DIGSI 4.

Hardware

- 3 voltage transformers
- 3/7 binary inputs (thresholds configurable using software)
- 5/8 binary outputs (2 changeover)
- 1 live-status contact
- Pluggable terminal blocks.

1) Not available if function package “Q” or “E” (synch-check) is selected.

The SIPROTEC Compact 7RW80 unit is a numerical protection relay that can perform control and monitoring functions and therefore provide the user with a cost-effective platform for power system management, that ensures reliable supply of electrical power to the customers. The ergonomic design makes control easy from the relay front panel. A large, easy-to-read display was a key design factor.

Control

The integrated control function permits control of disconnect devices, grounding switches or circuit-breakers through the integrated operator panel, binary inputs, DIGSI 4 or the control or automation system (e.g. SICAM)

Programmable logic

The integrated logic characteristics (CFC) allow the user to add own functions for automation of switchgear (e.g. inter-locking) or switching sequence. The user can also generate user-defined messages. This functionality can form the base to create extremely flexible transfer schemes.

Operational measured value

Extensive measured values (e.g. I, V), metered values (e.g.W_p,W_q) and limit values (e.g. for voltage, frequency) provide improved system management.

Operational indication

Event logs, trip logs, fault records and statistics documents are stored in the relay to provide the user or operator with all the key data required to operate modern substations.

Line protection

For the enhancement of the feeder protection the 7RW80 provides several stages for voltage and frequency protection.

Generator and transformer protection

Through implemented voltage, frequency and overexcitation protection the 7RW80 can be used for generators and trans-formers in case of defective voltage or frequency control, full load rejection or operation in islanding generation systems.

System decoupling and load shedding

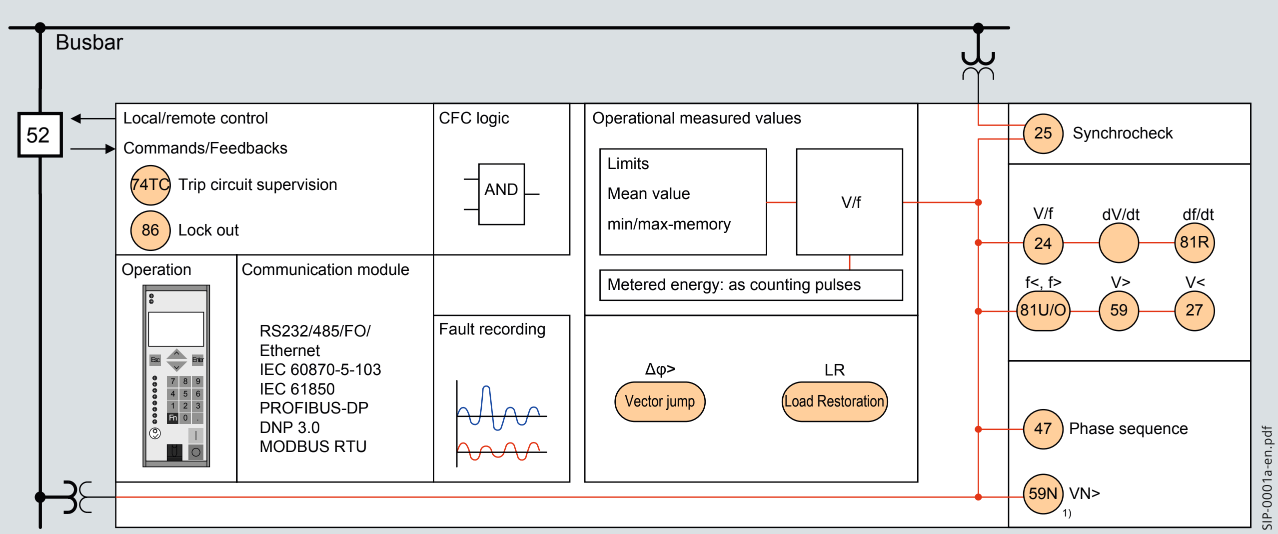
For system decoupling and load shedding the 7RW80 provides voltage, frequency, rate-of-frequency-change and rate-of-voltage-change protection.

Load restoration

For power system recovery, frequency protection and load restoration are available in 7RW80.

Switchgear cubicles for high/medium voltage

All units are designed specifically to meet the requirements of high / medium-voltage applications. In general, no separa-te measuring instruments (e.g., for current, voltage, frequen-cy, ...) or additional control components are necessary.



1) Not available if function package “Q” (synch-check) is selected.

Fig. 5/3 Function diagram

Protection functions

Undervoltage protection (ANSI 27)

The two-element undervoltage protection provides protection against dangerous voltage drops (especially for electric machines). Applications include the isolation of generators or motors from the network to avoid undesired operating conditions and a possible loss of stability. Proper operating conditions of electrical machines are best evaluated with the positive-sequence quantities. The protection function is active over a wide frequency range of 25 to 70 Hz. The function can operate either with phase-to-phase, phase-to-ground or positive phase-sequence voltage. Three-phase and single-phase connections are possible. In addition a user definable curve with up to 20 value pairs is available.

Overvoltage protection (ANSI 59)

The two-element overvoltage protection detects unwanted network and machine overvoltage conditions. The function can operate either with phase-to-phase, phase-to-ground, positive phase-sequence or negative phase-sequence voltage. Three-phase and single-phase connections are possible. In addition, a user definable curve with up to 20 value pairs is available.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for overfrequency and underfrequency protection. Electric machines and parts of the system are protected from unwanted frequency deviations. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting. Frequency protection can be used over a wide frequency range of 25 to 70 Hz. There are four elements (individually set as overfrequency, underfrequency or OFF) and each element can be delayed separately. Blocking of the frequency protection can be performed by activating a binary input or by using an undervoltage element.

Load restoration

The load restoration function provides an automatic reconnection of power system parts when the system frequency has recovered after load shedding. Four load restoration stages are available. They can be switched on and off separately. If the frequency conditions allow the assumption of sufficient generation resources, the load restoration function will consecutively reconnect small load parts at specified time intervals.

Overexcitation protection (ANSI 24)

The overexcitation protection serves for detection of an unpermissible high induction (proportional to *V/f*) in generators or transformers, which leads to thermal overloading. This may occur when starting up, shutting down under full load, with weak systems or under isolated operation. The inverse characteristic can be set via eight points derived from the manufacturer data. In addition, a definite-time alarm stage and an instantaneous stage can be used. For calculation of the *V/f* ratio, frequency and also the highest of the three line-to-line voltages are used. The frequency range that can be monitored comprises 25 to 70 Hz.

Jump of voltage vector

Monitoring the phase angle in the voltage is a criterion for identifying an interrupted infeed. If the incoming line should fail, the abrupt current discontinuity leads to a phase angle jump in the voltage. This is measured by means of a delta process. The command for opening the generator or coupler circuit-breaker will be issued if the set threshold is exceeded.

Flexible protection functions

The 7RW80 enables the user to easily add up to 20 additional protection functions. Parameter definitions are used to link standard protection logic with any chosen characteristic quantity (measured or calculated quantity). The standard logic consists of the usual protection elements such as the pickup set point, the set delay time, the TRIP command, a block function, etc.

The mode of operation for voltage quantities can be three-phase or single-phase. Almost all quantities can be operated with ascending or descending pickup stages (e.g. under and overvoltage). All stages operate with protection priority or speed.

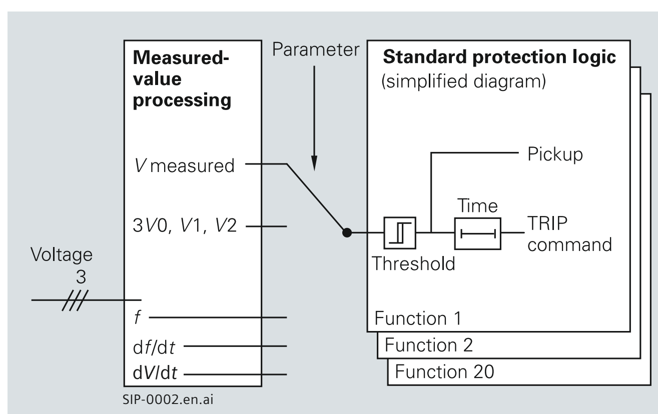


Fig. 5/4 Flexible protection functions

Protection functions/stages available are based on the available measured analog quantities:

Function	ANSI
$V<$, $V>$, $V_E>$	27, 59, 59N
$3V_0>$, $V_1><$, $V_2><$	59N, 47
$f><$	81O, 81U
$df/dt><$	81R
dV/dt	

Table 5/2 Available flexible protection functions

For example, the following can be implemented:

- Rate-of-frequency-change protection (ANSI 81R)
- Rate-of-voltage-change protection.

Synch-check (ANSI 25)

When closing a circuit-breaker, the units can check whether two separate networks are synchronized. Voltage, frequency and phase-angle-differences are checked to determine whether synchronous conditions exist.

Lockout (ANSI 86)

All binary output statuses can be memorized. The LED reset key is used to reset the lockout state. The lockout state is also stored in the event of supply voltage failure. Reclosure can only occur after the lockout state is reset.

Trip circuit supervision (ANSI 74TC)

One or two binary inputs can be used for monitoring the circuit-breaker trip coil including its incoming cables. An alarm signal is generated whenever the circuit is interrupted.

Customized functions

Additional functions can be implemented using CFC or flexible protection functions.

Further functions

Measured values

The r.m.s. values are calculated from the acquired voltages along with the frequency. The following functions are available for measured value processing:

- Voltages V_{L1}, V_{L2}, V_{L3}, V_{L1L2}, V_{L2L3}, V_{L3L1}
- Symmetrical components V_1, V_2, V_0
- Frequency
- Mean as well as minimum and maximum voltage values
- Operating hours counter
- Limit value monitoring
  Limit values can be monitored using programmable logic in the CFC. Commands can be derived from this limit value indication
- Zero suppression
  In a certain range of very low measured values, the value is set to zero to suppress interference.

Commissioning

Commissioning could not be easier and is supported by DIGSI 4. The status of the binary inputs can be read individually and the state of the binary outputs can be set individually. The operation of switching elements (circuit-breakers, disconnect devices) can be checked using the switching functions of the relay. The analog measured values are represented as wide-ranging operational measured values. To prevent transmission of information to the control center during maintenance, the communications can be disabled to prevent unnecessary data from being transmitted. During commissioning, all indications with test tag for test purposes can be connected to a control and protection system.

Test operation

During commissioning, all indications with test tag can be passed to a control system for test purposes.

Line feeder with load shedding

In unstable power systems (e.g. solitary systems, emergency power supply in hospitals), it may be necessary to isolate selected consumers from the power system in order to protect the overall system.

The overcurrent-time protection functions are effective only in the case of a short-circuit.

Overloading of the generator can be measured as a frequency or voltage drop.

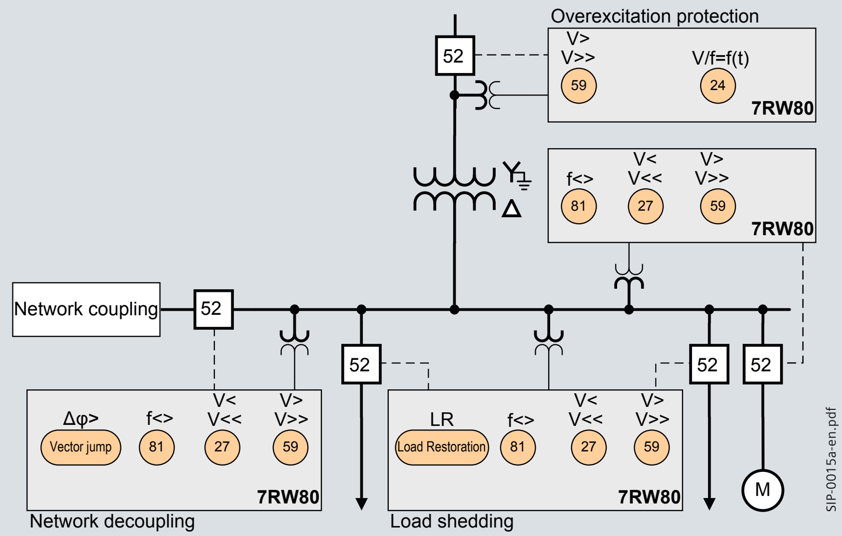


Fig. 5/5 Application example 7RW80

Load shedding with rate-of-frequency-change protection

From the measured frequency, the frequency difference is determined over a time interval. It corresponds to the momentary frequency change.

It is thus possible to quickly detect any major load drops in the power system, to disconnect certain consumers from the system, and to restore the system to stability. Unlike frequency protection, rate-of-frequency-change-protection already reacts before the pickup threshold of the frequency protection is reached.

The pickup value depends on the application, and follows the conditions of the power system. The rate-of-frequency-change protection function can also be used for the purposes of system decoupling.

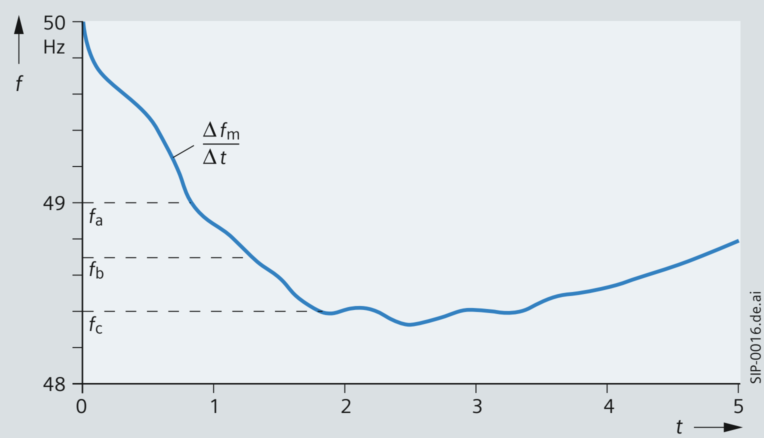
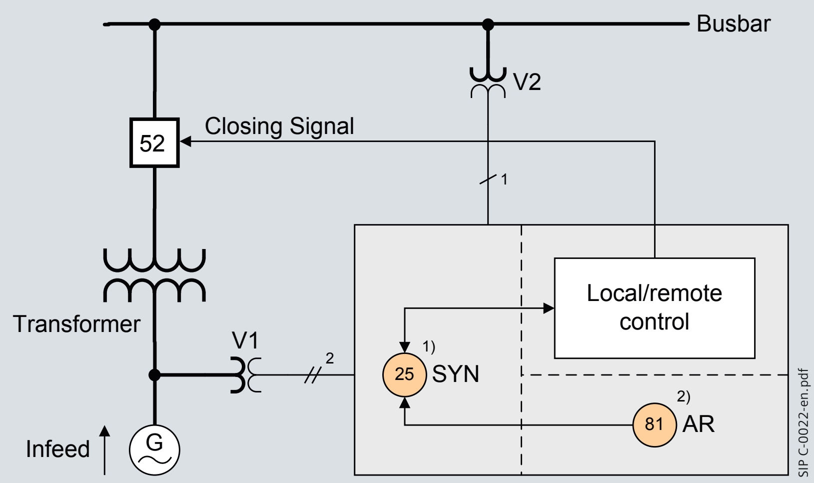


Fig. 5/6 Load shedding

Synchrocheck

Where two system sections are interconnected, the synchrocheck determines whether the connection is permissible without danger to the stability of the power system. In the example, load is supplied from a generator to a busbar through a transformer. The vector group of the transformer can be considered by means of a programmable angle adjustment, so that no external adjustment elements are necessary. Synchrocheck can be used for auto-reclosure, as well as for control functions (local or remote).



1) Synch-check
2) Auto reclosure

Fig. 5/7 Measurement of busbar and feeder voltage for synchronization

Selection and ordering data

Product description	Order No.	Short code
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	
	7RW80□0-□□□□□-□□□□+□□□	
Voltage and frequency relay		
Housing, binary inputs and outputs		
Housing 1/6 19", 3x *V*, 3 BI, 5 BO [1] , 1 live status contact	1	
Housing 1/6 19", 3x *V*, 7 BI, 8 BO [1] , 1 live status contact	2	
Rated auxiliary voltage		see next page
24 V to 48 V DC	1	
60 V to 250 V DC; 115 V AC; 230 V AC	5	
Unit version		
Surface mounting housing, screw-type terminal	B	
Flush mounting housing, screw-type terminal	E	
Region-specific default- and language settings		
Region DE, IEC, language German [2], standard front	A	
Region World, IEC/ANSI, language English [2], standard front	B	
Region US, ANSI, language US-English [2], US front	C	
Region FR, IEC/ANSI, language French [2], standard front	D	
Region World, IEC/ANSI, language Spanish [2], standard front	E	
Region World, IEC/ANSI, language Italian [2], standard front	F	
Region RUS, IEC/ANSI, language Russian [2], standard front	G	
Region CHN, IEC/ANSI, language Chinese [3], Chinese front	K	
Port B (at bottom of device, rear)		
No port	0	
IEC 60870-5-103 or DIGSI 4/modem, electrical RS232	1	
IEC 60870-5-103 or DIGSI 4/modem, electrical RS485	2	
IEC 60870-5-103 or DIGSI 4/modem, optical 820 nm, ST connector	3	
Further protocols see supplement L	9	L 0 □
PROFIBUS DP slave, electrical RS485	9	A
PROFIBUS DP slave, optical, double ring, ST connector	9	B
MODBUS, electrical RS485	9	D
MODBUS, optical 820 nm, ST connector	9	E
DNP 3.0, electrical RS485	9	G
DNP 3.0, optical 820 nm, ST connector	9	H
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector	9	R
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector	9	S
Port A (at bottom of device, front)		
No port	0	
With Ethernet interface (DIGSI, not IEC 61850), RJ45 connector	6	
Measuring / fault recording		
With fault recording, average values, min/max values	1	

1) 2 changeover/Form C.
2) Language selectable
3) Language not changeable

You will find a detailed overview of the technical data (extract of the manual) under: http://www.siemens.com/siprotec

5

ANSI No.	Product description	Order No.
		14 15 16 D □ 0
	Voltage and frequency protection	A
27/59	Under/Overvoltage	
64/59N	Displacement voltage	
81U/O	Under/Overfrequency	
47	Phase rotation	
74TC	Trip circuit supervision	
86	Lockout	
	Parameter changeover	
	Monitoring functions	
	Control of circuit-breaker	
	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change	
	Voltage, frequency protection and load restoration	B
27/59	Under/Overvoltage	
64/59N	Displacement voltage	
81U/O	Under/Overfrequency	
	Load restoration	
47	Phase rotation	
74TC	Trip circuit supervision	
86	Lockout	
	Parameter changeover	
	Monitoring functions	
	Control of circuit-breaker	
	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change	
	Voltage, frequency protection and synch-check	C
27/59	Under/Overvoltage	
81U/O	Under/Overfrequency	
25	Synch-check	
47	Phase rotation	
74TC	Trip circuit supervision	
86	Lockout	
	Parameter changeover	
	Monitoring functions	
	Control of circuit-breaker	
	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change	
	Voltage, frequency, overexcitation protection and vector jump	D
27/59	Under/Overvoltage	
64/59N	Displacement voltage	
81U/O	Under/Overfrequency	
24	Overexcitation	
	Vector jump	
47	Phase rotation	
74TC	Trip circuit supervision	
86	Lockout	
	Parameter changeover	
	Monitoring functions	
	Control of circuit-breaker	
	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change	
	Voltage, frequency, overexcitation protection and vector jump, load restoration and synch-check	E
27/59	Under/Overvoltage	
81U/O	Under/Overfrequency	
24	Overexcitation	
	Vector jump	
	Load restoration	
25	Synch-check	
47	Phase rotation	
74TC	Trip circuit supervision	
86	Lockout	
	Parameter changeover	
	Monitoring functions	
	Control of circuit-breaker	
	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change	

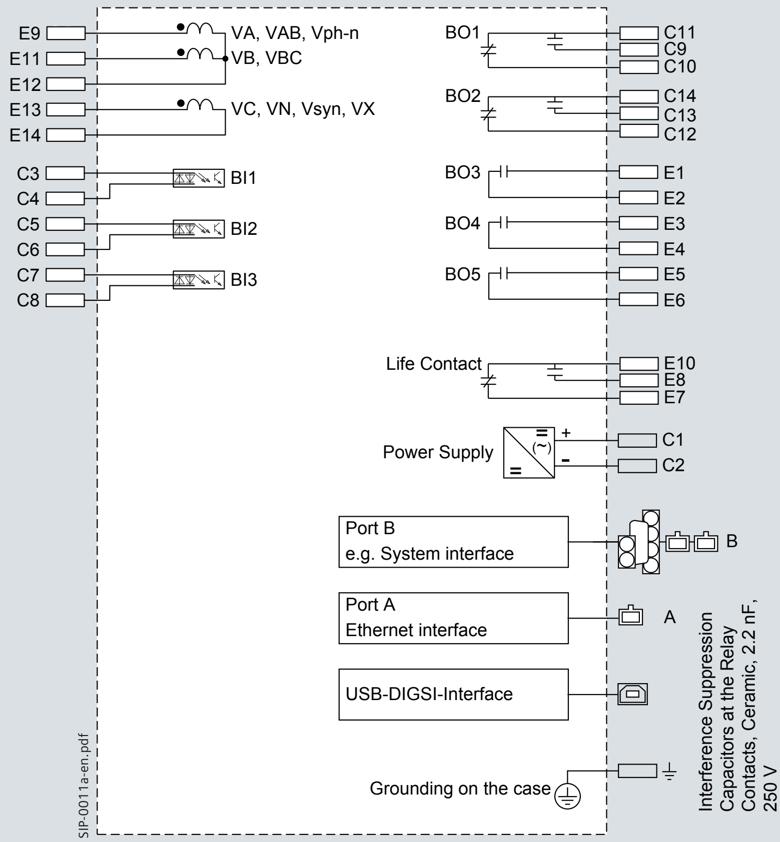


Fig. 5/8 Voltage and frequency protection 7RW801

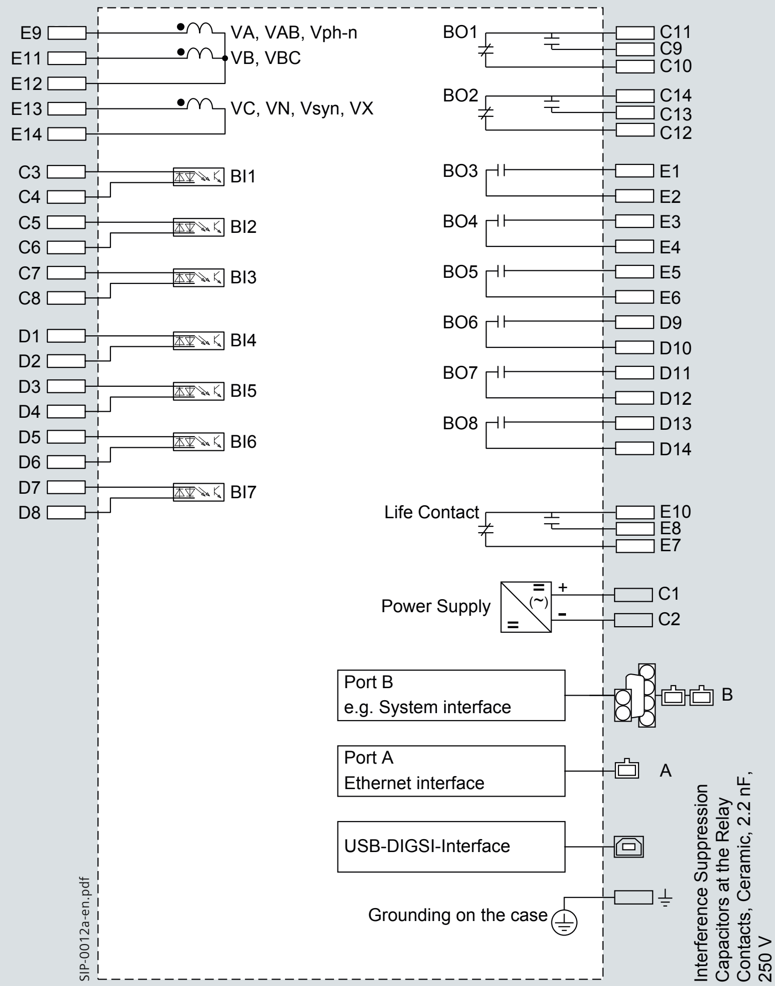


Fig. 5/9 Voltage and frequency protection 7RW802

5

Connection examples

Standard connection

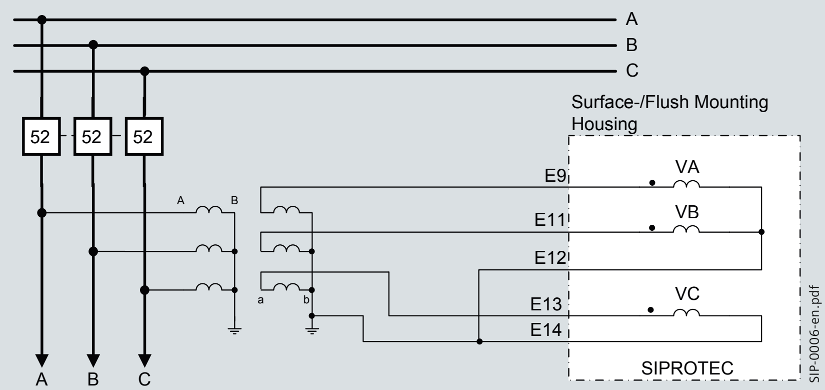


Fig. 5/10 Example for connection type "V_{AN}, V_{BN}, V_{CN}" load-side voltage connection

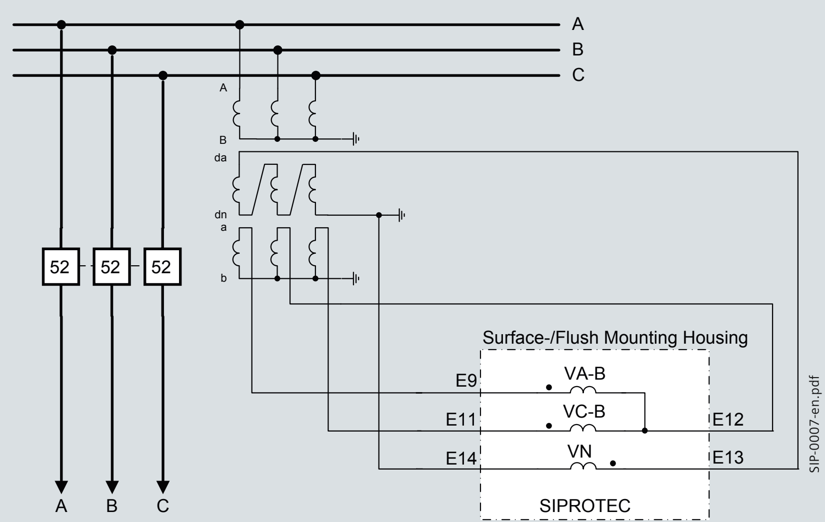


Fig. 5/11 Voltage transformer connections to two voltage transformers (phase-to-phase voltages) and broken data winding (da-dn)

Connection V_x

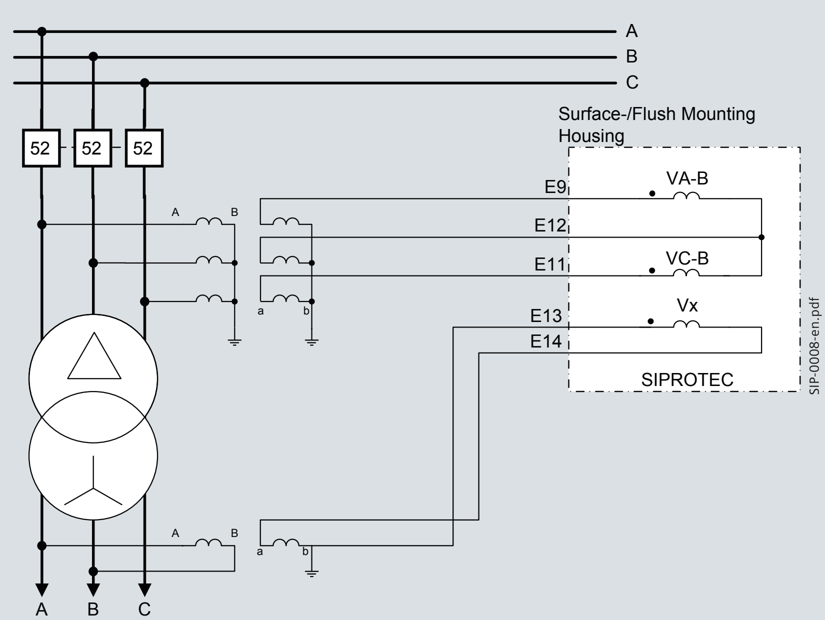


Fig. 5/12 Example for connection type "V_{AB}, V_{BC}, V_x"

Connection for synch-check

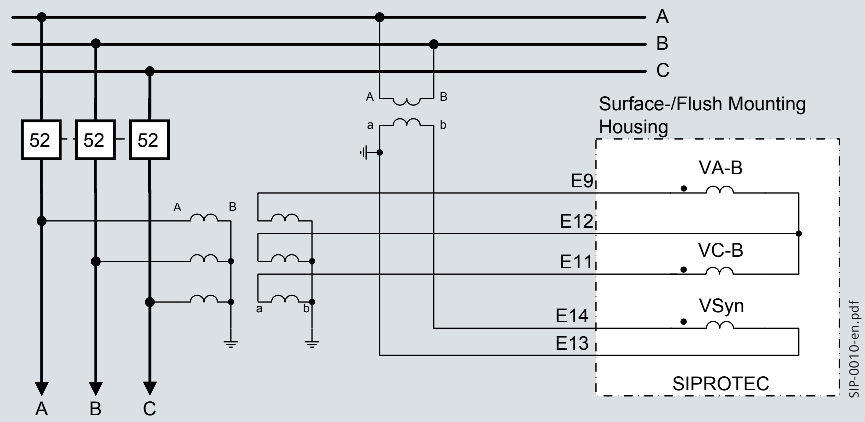


Fig. 5/13 Example for connection type "V_{AB}, V_{BC}, V_{SYN}"

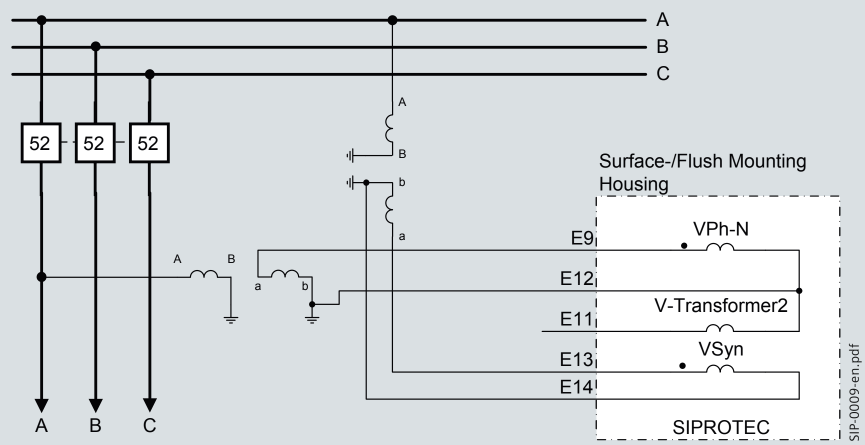


Fig. 5/14 Example for connection type "$V_{ph\text{-}n}$, V_{syn}".
The connection can be established at any one of the three phases.
The phase must be the same for $V_{ph\text{-}n}$ and V_{syn}.

Line Differential Protection 7SD80
SIPROTEC Compact

SIEMENS

Line Differential Protection 7SD80

You will find a detailed overview of the technical data (extract of the manual) under:
http://www.siemens.com/siprotec

Description

The line differential protection 7SD80 from the SIPROTEC Compact device series has been conceived for selective line protection in systems with earthed (solid, low-resistance, high-resistance), isolated or compensated neutral design.

The differential protection algorithms used are characterized by a high stability in case of external faults, low instrument transformer requirements, and simple parameterization and testing.

In the 7SD80 version with connection of voltage transformers, the integrated overcurrent-time protection can also be used as a directional two-stage overcurrent-time protection.

Each of the three overcurrent-time protection stages can be set as emergency or backup protection independently of each other. First of all, this enables the integration of the 7SD80 in a simple busbar protection system by means of reverse interlocking, and it additionally provides a directional time-overcurrent protection emergency function if the communication between the 7SD80 relays fails.

Protection interface communication

Data exchange of the differential protection function takes place by means of digital communication via integrated two-wire interface and/or an integrated fiber-optic interface.

Communication via the protection interface can further be used to send an intertripping command to the circuit-breaker at the opposite end, and to exchange at the same time up to 16 freely assignable binary signals between the 7SD80 relays.

Highlights

- Pluggable current and voltage terminals
- Binary input thresholds settable using DIGSI (3 stages)
- Secondary current transformer values (1 A/5 A) settable using DIGSI
- 9 programmable function keys
- 6-line display
- Buffer battery exchangeable from the front
- USB front port
- 2 additional communication ports
- IEC 61850 with integrated redundancy (electrical or optical)
- Relay-to-relay communication through Ethernet with IEC 61850 GOOSE
- Millisecond-accurate time synchronization through Ethernet with SNTP.

7SD80-specific features

- Two different and mutually independent differential protection algorithms for phase-to-phase faults and phase-to-earth faults
- Simple parameterization and testing of the differential protection
- The primary transformer currents can differ from each other by a factor of 4
- Low current transformer requirements for the differential protection
- Integrated interfaces for exchanging differential protection data (fiber-optic and/or two-wire copper cables)
- Integrated monitoring function of the protection interface, both in the commissioning phase and in running operation
- Addressability of the protection devices for the differential protection communication in order to detect an accidental interchange of the communication cables in case of parallel cables
- Integrated non-directional and directional time-overcurrent protection (3 stages)
- Transmission of a circuit-breaker intertripping signal and 16 further binary signals to the opposite end.

Fig. 6/1 7SD80 front view

Fig. 6/2 7SD80 rear view

6

Function overview

Protection functions	IEC	ANSI No.	Comment
Differential protection, phase	ΔI	87L	
$3I_0$ differential protection	$\Delta 3I_0$	87N L	
Ground-fault differential protection for systems with resonant or isolated neutral	ΔI_{EE}	87Ns L	Optional
Definite-time overcurrent protection with delay for phase	$I>, I>>, I>>>$	50 TD (3 stages)	
Definite-time overcurrent protection with delay for earth	$I_E>, I_E>>, I_E>>>$	50N TD (3 stages)	
Inverse time-overcurrent protection (phase)	I_P	51	
Inverse time-overcurrent protection (ground)	I_{EP}	51N	
Inrush current detection			
Breaker failure protection	LSVS	50BF	
Trip circuit supervision	AKU	74TC	
Lockout		86	
Circuit-breaker intertripping scheme		85 DT	
External trip initiation			
Undervoltage/overvoltage protection	$V<, V>$	27/59	Optional
Underfrequency/overfrequency protection	$f<, f>$	81 U/O	Optional
Directional overcurrent protection (phase)	$I>, I>>, I_P$	67 (3 stages)	Optional
Directional overcurrent protection (ground)	$I_E>, I_E>>, I_{PE}$	67N (3 stages)	Optional
Auto-reclosure (3-pole)	ARE	79	Optional
Flexible protection functions for current, voltage, power, cosφ, frequency	Flex Funk		Partly optional
Thermal overload protection	I^2t	49	
Control functions			

Table 6/1 Function overview

Control functions/programmable logic

- Commands (e.g. for the control of circuit-breakers, disconnect switches, grounding switches, etc.) through:
  – keyboard
  – binary inputs
  – DIGSI 4
  – communication interface
- User-defined PLC logic with CFC (e.g. interlocking).

Monitoring functions

- Operational measured values V, I, f
- Energy metering values W_p, W_q
- Circuit-breaker wear monitoring
- Minimum and maximum values
- Trip circuit supervision
- Fast measuring voltage failure “fuse-failure-monitor”
- 8 oscillographic fault records.

Communication interface

- System interface
  – IEC 61850
  – IEC 60870-5-103
  – MODBUS RTU
  – DNP 3.0
  – PROFIBUS-DP
- Service interface
  – USB front interface for DIGSI 4
  – RS232/RS485 (instead of the system interface)
- Protection interface
  – Fiber-optic connection and/or
  – Two-wire connection.

Hardware

- 4 current transformers
- 0/3 voltage transformers
- 3/5/7 binary inputs (thresholds configurable using software)
- 5/8 binary outputs (2 changeover)
- 1 live-status contact
- Pluggable current and voltage terminals.

The SIPROTEC Compact relay 7SD80 is a numerical line differential protection relay, which in addition to its main function, the selective protection of overhead lines and cables, also covers control and monitoring tasks.

Line protection

The 7SD80 devices are suitable as selective line protection for application in high-voltage and medium-voltage systems of all types of neutral designs (solid, low-resistance or high-resistance earthed, isolated or compensated).

Apart from the main protection function, the line differential protection, 7SD80 offers a lot of additional protection functions. These can be used in parallel as a backup protection function, or as an emergency function if the main protection function fails, and they complement the range of functions of 7SD80 for application in transmission lines.

Control

The integrated control function permits control of disconnect devices, grounding switches or circuit-breakers through the integrated operator panel, binary inputs, DIGSI 4 or the control or automation system (e.g. SICAM)

Programmable logic

The integrated logic characteristics (CFC) allow the user to add own functions for automation of switchgear (e.g. interlocking) or switching sequence. The user can also generate user-defined messages. This functionality can form the base to create extremely flexible transfer schemes.

Operational measured values

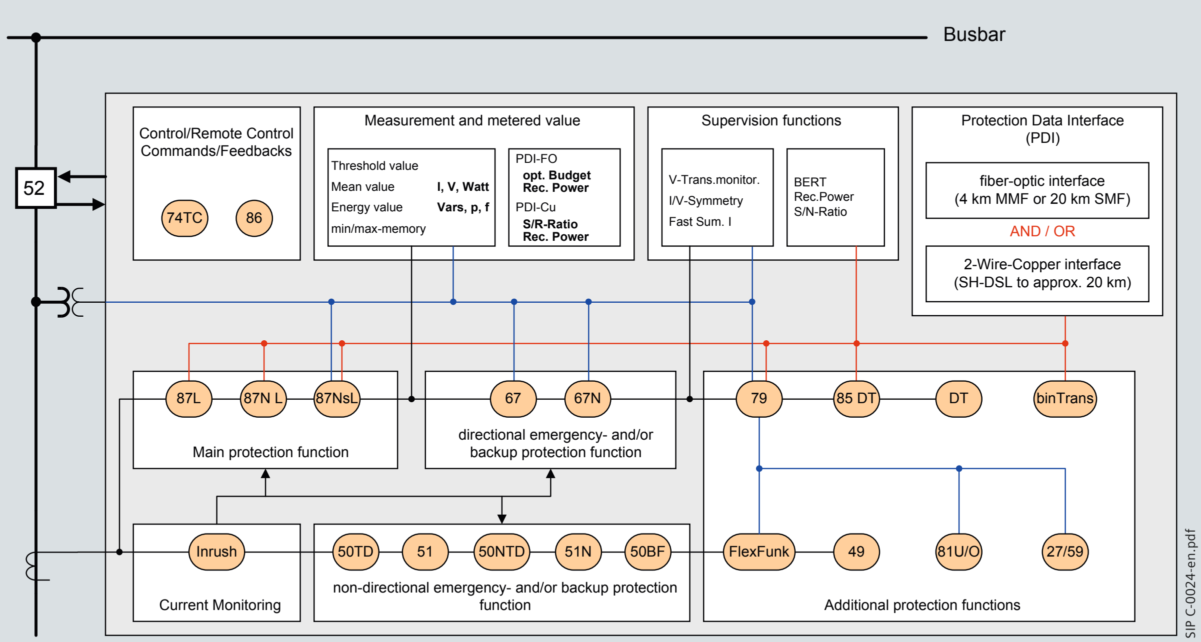
Extensive measured values (e.g. I, V), metered values (e.g. W_p, W_q) and limit values (e.g. for voltage, frequency) provide improved system management.

As for the operational measured values, a special focus was placed on the measured values critical for differential protection. So, the attenuation values and the signal-to-noise ratio of the communication connection, for example, are acquired and indicated in addition to the measurement of the quality of the telegram exchange per time unit.

Particular attention was paid to making the commissioning of the differential protection easier and safer. In this context, the amplitude and angle of the currents and of the voltages, if applicable, are displayed additionally with reference to the local measuring variable. In this way, a possible incorrect connection (polarity reversal) of the current transformers can be detected early, and eliminated.

Operational indication

Monitoring of operation is ensured and documented by storage of event logs, trip logs, fault records and statistics.



1) Not available if function package 'Q' (synch-check, ANSI 25) is selected.

Fig. 6/3 Function diagram

Protection functions

Differential protection (ANSI 87L, 87N L, 87Ns L)

The differential protection 7SD80 consists of two separately operating differential protection algorithms:

- Phase comparison protection (PCP)
- Earth-fault differential protection (EFD).

The phase comparison protection, PCP, offers a safe and robust short-circuit protection for all types of neutral treatment. Of course, this is also valid for application in systems with isolated or resonant-earthed neutral. Adaptation of the phase comparison protection according to the neutral treatment is done by setting parameters via DIGSI.

The earth-fault differential protection, EFD, operates with two different algorithms, depending on the neutral treatment in the power system to be protected.

For application in solidly, low-resistance or high-resistance earthed systems, the EFD analyzes the measured zero-sequence current. The fundamental wave of the zero-sequence current is determined by filtering. The filtered zero-sequence currents of the local side and the opposite side are added and provide the zero-sequence differential current. In addition, an adaptive stabilization is calculated. If the zero-sequence differential current exceeds the sum of the pickup value and the adaptive stabilization, there is a tripping.

For application in power systems with isolated or resonant-earthed neutrals, the connection of voltages – at least of the zero-sequence voltage – and the use of a sensitive earth-current transformer is required. From the zero-sequence current and the voltage, the apparent power of the zero-sequence system is calculated, and compared with the opposite end. Depending on the direction of the power flow, an internal or external earth fault is detected. This is only indicated, and can be shut down immediately or with a set delay.

Circuit-breaker intertripping (ANSI 85 DT)

The 7SD80 devices have an integrated circuit-breaker intertripping function for tripping the circuit-breaker at the opposite end. The circuit-breaker intertripping can be activated directly by the differential protection functions, but also through binary signals of any other external or internal protection function. The circuit-breaker intertripping can be combined with an integrated phase and/or zero-sequence current threshold, which permits to trip the circuit-breaker if there is a sufficiently high current.

Overcurrent-time protection, non-directional/directional (ANSI 50, 50N, 51, 51N, 67, 67N)

This function is based on the phase-selective measurement of the three phase currents and the earth current (4 instrument transformers).

In the 7SD80, three definite-time overcurrent protection stages are integrated for protection against phase faults, as well as for protection against earth faults. The current threshold and the delay time can be set for each stage. Furthermore, inverse-time overcurrent protection characteristics can be added.

Each of the overcurrent-time protection stages can be set as emergency or backup protection independently of each other. This enables the integration of the 7SD80 in a simple busbar protection concept by means of reverse interlocking. When voltage transformers are connected, a directional time-overcurrent protection emergency function can be activated if the protection interface communication fails.

Available inverse-time characteristics

Characteristics acc. to	IEC 60255-3	ANSI/IEEE
Inverse	•	•
Short inverse		•
Long inverse	•	•
Moderately inverse		•
Very inverse	•	•
Extremely inverse	•	•

Table 6/2 Available inverse-time characteristics

Inrush restraint

When the second harmonic is detected while energizing a transformer inside or outside of the protection zone, pickup of the differential protection stages or the overcurrent-time protection stages can be suppressed.

Breaker failure protection (ANSI 50BF)

If a faulted portion of the electrical circuit is not disconnected when a trip command is issued to a circuit-breaker, another trip command can be initiated using the breaker failure protection which trips the circuit-breaker of an upstream feeder.

Breaker failure is detected if, after a trip command is issued the current keeps on flowing into the faulted circuit. It is also possible to make use of the circuit-breaker position contacts (52a or 52b) for indication as opposed to the current flowing through the circuit-breaker.

External trip initiation

Through a binary input, an external protection device or monitoring equipment can be coupled into the signal processing of the 7SD80 to trip the local circuit-breaker.

Trip circuit supervision (ANSI 74TC)

One or two binary inputs can be used for monitoring the circuit-breaker trip coil including its incoming cables. An alarm signal is generated whenever the circuit is interrupted.

Flexible protection functions

The 7SD80 enables the user to easily add up to 20 additional protective functions. Parameter definitions are used to link standard protection logic with any chosen characteristic quantity (measured or calculated quantity). The standard logic consists of the usual protection elements such as the pickup set point, the set delay time, the TRIP command, a block function, etc. The mode of operation for current, voltage, power and power factor quantities can be three-phase or phase-selective. Almost all quantities can be operated with ascending or descending pickup stages (e.g. under and over voltage). All stages operate with protection priority or speed.

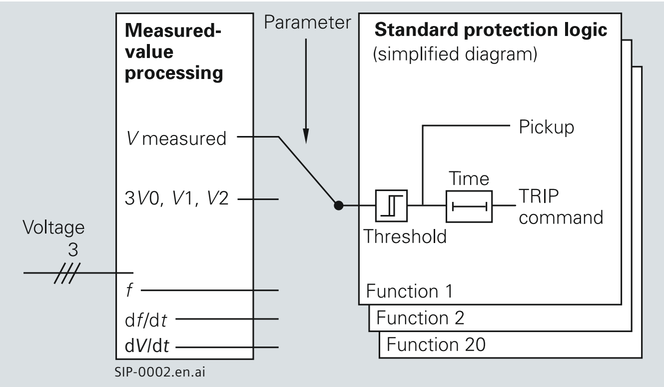


Fig. 6/4 Flexible protection functions

Lockout (ANSI 86)

All binary output statuses can be memorized. The LED reset key is used to reset the lockout state. The lockout state is also stored in the event of supply voltage failure. Reclosure can only occur after the lockout state is reset.

Thermal overload protection (ANSI 49)

To protect cables, an overload protection function with an integrated warning/alarm element for temperature and current can be used. The temperature is calculated using a thermal homogeneous body model (per IEC 60255-8), it considers the energy entering the equipment and the energy losses. The calculated temperature is constantly adjusted according to the calculated losses. The function considers loading history and fluctuations in load.

Overvoltage protection (ANSI 59)

The two-element overvoltage protection detects unwanted network and machine overvoltage conditions. The function can operate either with phase-to-phase, phase-to-ground, positive phase-sequence or negative phase-sequence voltage. Three-phase and single-phase connections are possible.

Undervoltage protection (ANSI 27)

The two-element undervoltage protection provides protection against dangerous voltage drops (especially for electric machines). Applications include the isolation of generators or motors from the network to avoid undesired operating conditions and a possible loss of stability. Proper operating conditions of electrical machines are best evaluated with the positive-sequence quantities. The protection function is active over a wide frequency range (45 to 55, 55 to 65 Hz). Even when falling below this frequency range the function continues to work, however, with decreased accuracy. The function can operate either with phase-to-phase, phase-to-ground or positive phase-sequence voltage, and can be monitored with a current criterion. Three-phase and single-phase connections are possible.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for overfrequency and underfrequency protection. Electric machines and parts of the system are protected from unwanted frequency deviations. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting. Frequency protection can be used over a wide frequency range (± 10 Hz rated frequency). There are four elements (individually set as overfrequency, underfrequency or OFF) and each element can be delayed separately. Blocking of the frequency protection can be performed by activating a binary input or by using an undervoltage element.

Customized functions (ANSI 51V, 55 etc.)

Additional functions can be implemented using CFC or flexible protection functions. Typical functions include reverse power, voltage controlled overcurrent, phase angle detection, and zero-sequence voltage detection.

Fast current monitoring and further monitoring functions

The 7SD80 incorporates comprehensive monitoring functions for hardware and software. Monitoring comprises the measuring circuits, the analog-digital conversion, the internal supply voltages, the memories and the software sequence (watchdog).

Local measured values

The r.m.s. values are calculated from the acquired current and voltage along with the power factor, frequency, active and reactive power. The following functions are available for measured value processing:

- Currents I_{L1}, I_{L2}, I_{L3}, I_N, I_{EE} (67 NS)
- Voltages V_{L1}, V_{L2}, V_{L3}, V_{12}, V_{23}, V_{31}
- Symmetrical components I_1, I_2, $3I_0$; V_1, V_2, $3V_0$
- Power Watts, Vars, VA/P, Q, S (P, Q: total and phase selective)
- Power factor cos φ (total and phase selective)
- Frequency
- Energy ± kWh, ± kVarh, forward and reverse power flow
- Operating hours counter
- Mean operating temperature of the overload function
- Limit value monitoring.

Limit values can be monitored using programmable logic in the CFC. Commands can be derived from this limit value indication.

Zero suppression:

In a certain range of very low measured values, the value is set to zero to suppress interference.

Measured values of the opposite end

Every two seconds, the currents and voltages of the other end of the line are transmitted through the communication connection, and indicated in relation to the locally measured currents and voltages. The following measured values are available:

- Amplitude of currents I_{L1}, I_{L2}, I_{L3}
- Phase angle of currents φI_{L1}, φI_{L2}, φI_{L3}
- Amplitude of voltages V_{L1}, V_{L2}, V_{L3}
- Phase angle of voltages φV_{L1}, φV_{L2}, φV_{L3}.

Measured values of communication

For the fiber-optic interface, the following measured values are available:

- Sending and receiving power of the optical communication module
- Optical damping of the fiber-optic cable
- Telegrams sent per second, minute and hour
- Sum of correct and incorrect telegrams received per second, minute and hour
- Availability of the protection interface.

For the two-wire interface, the following measured values are available:

- Damping of the copper cable
- Signal-to-noise ratio of the signal received
- Telegrams sent per second, minute and hour
- Sum of correct and incorrect telegrams received per second, minute and hour
- Availability of the protection interface.

Metered values

For internal metering, the unit can calculate an energy metered value from the measured current and voltage values. If an external meter with a metering pulse output is available, the 7SD80 can obtain and process metering pulses through an indication input. The metered values can be displayed and passed on to a control center as an accumulated value with reset. A distinction is made between forward, reverse, active and reactive energy.

Radial feeder

The protection of a radial feeder with several substations via overcurrent-time protection leads to comparably high shutdown times at the point of infeed due to the necessary time grading. The stipulated fault clearance time may therefore not be attainable.

Here, using the line differential protection 7SD80 is a simple remedy. This relay clears faults between the substations selectively and instantaneously, thus reducing the maximum fault clearance time of the radial feeder.

In the example shown, this is represented generally for the line between the infeed and substation A.

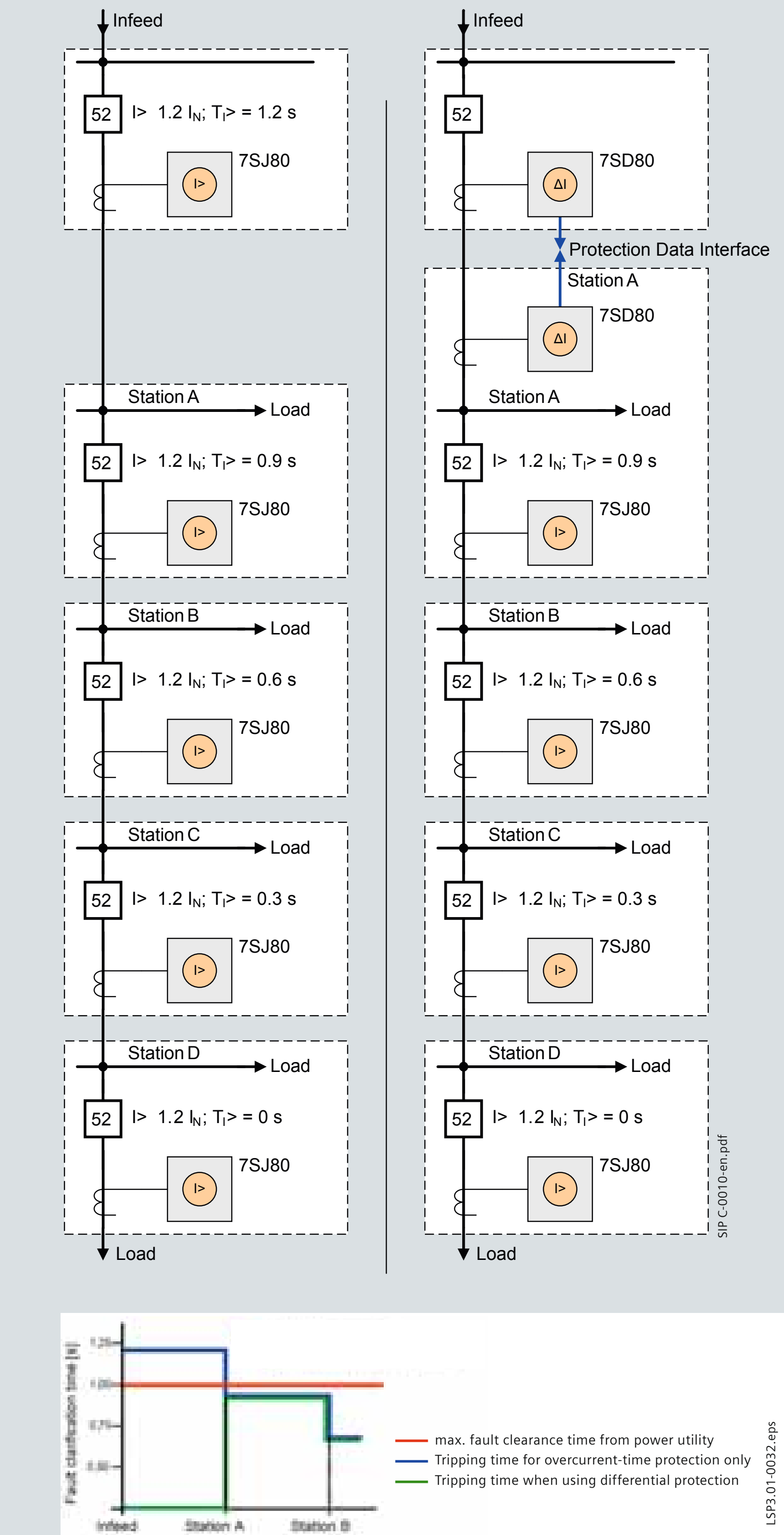


Fig. 6/5 Protection concept to reduce the shutdown times at the point of infeed of a radial feeder

Applications examples

Parallel feeder

Parallel feeders with bidirectional power flow can be ideally protected with the line differential protection 7SD80.

As a difference to the alternative concept of the direction comparison protection, 7SD80 does not require voltage transformers.

The communication connection required in each case only leads to instantaneous, strictly selective tripping when the differential protection is used

In addition, the shorter fault clearance time prevents damage to the generators at the opposite end.

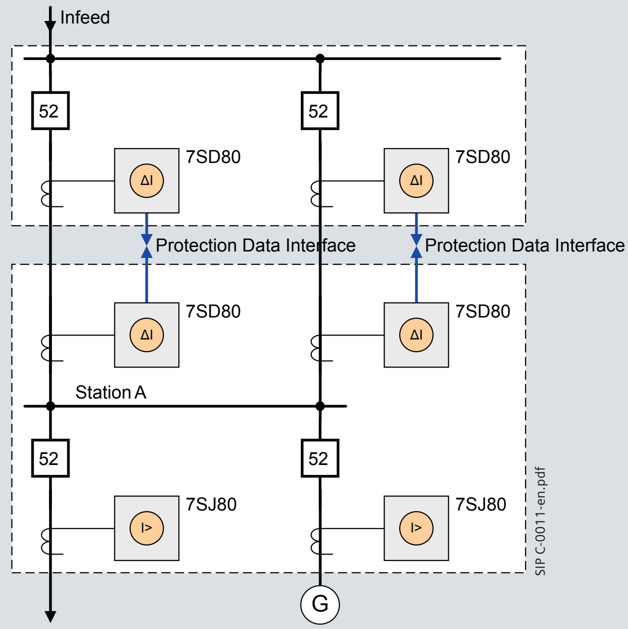


Fig. 6/6 Protection of parallel feeders via 7SD80

6

Ring feeder

The line differential protection 7SD80 is ideally suited to protect ring feeders. Faults on the connection cables/lines of the ring are cleared strictly selectively and instantaneously. For this purpose, connection of the 7SD80 devices to a current transformer is sufficient. For the main protection function of the 7SD80, voltage transformers are not necessary. Even intermediate infeeds in the substations of the ring are completely covered by this protection concept.

Common alternative protection concepts are mostly based on the use of directional time-overcurrent protection, which on the other hand also requires voltage transformers in the substations. An inverse grading of these directional definite-time overcurrent protection devices, however, leads to long fault clearance times. The use of the definite-time overcurrent relays as direction comparison protection requires – like the differential protection – a communication connection between the protection devices at the ends of the corresponding ring segment, but this does not reach the fault clearance time of the differential protection.

The definite-time overcurrent protection integrated in 7SD80 includes three stages, two thereof can also be used as directional definite-time overcurrent protection stages. The operating mode of each stage is settable. The stage can be activated permanently, or only if the differential protection function fails, e.g. if the communication connection fails. These definite-time stages allow to configure an integrated backup protection concept with the 7SD80 relays in the ring-main panels. Moreover, a busbar protection system can also be implemented in the substations by means of a reverse interlocking.

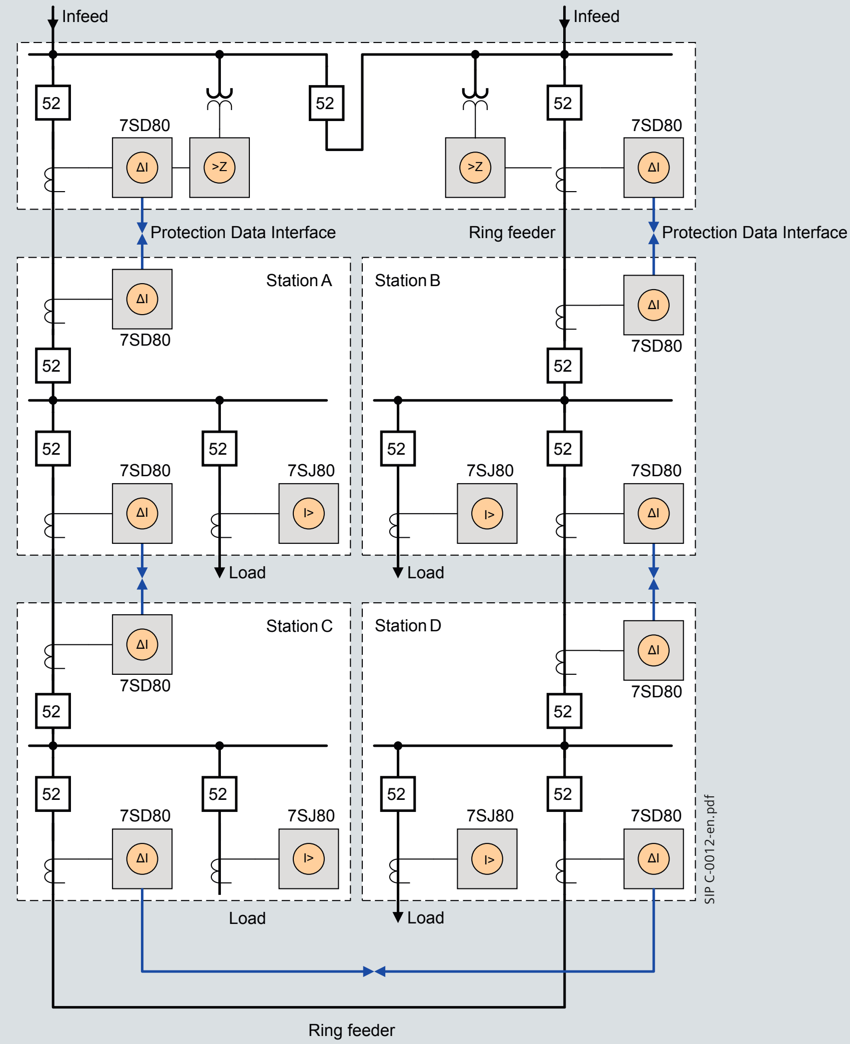


Fig. 6/7 Protection concept for ring feeders via 7SD80

6

Selection and ordering data

Product description	Order No.	Short code
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 7SD80□□-□□□□□-□□□□+□□□	
Medium voltage differential protection device		
Housing 1/6 19", binary inputs and outputs, 1 live status contact		
4 x I, 3 BI, 5 BO [1)], prot. data interface FO for mono- (24 km) and multimode (4 km), LC-duplex connector	1	
4 x I, 7 BI, 8 BO [1)], prot. data interface FO for mono- (24 km) and multimode (4 km), LC-duplex connector	2	
4 x I, 5 BI, 8 BO [1)], prot. data interface, 2 wires copper, twisted	3	
4 x I, 3 x V, 3 BI, 5 BO [1)], prot. data interface FO for mono- (24 km) and multimode (4 km), LC-duplex connector	5	
4 x I, 3 x V, 7 BI, 8 BO [1)], prot. data interface FO for mono- (24 km) and multimode (4 km), LC-duplex connector	6	
4 x I, 3 x V, 5 BI, 8 BO [1)], prot. data interface, 2 wires copper twisted	7	
Measuring inputs, default settings		
I_{ph} = 1 A/5 A, I_E = 1 A/5 A	1	
I_{ph} = 1 A/5 A, I_{EE} (sensitive) = 0.001 to 1.6 A/0.005 to 8 A	2	
Rated auxiliary voltage		
24 V to 48 V DC	1	
60 V to 250 V DC; 115 V AC; 230 V AC	5	
Unit version		
Surface mounting housing, screw-type terminal	B	
Flush mounting housing, screw-type terminal	E	
Region-specific default- and language settings		
Region DE, IEC, language German [2)], standard face plate	A	
Region World, IEC/ANSI, language English [2)], standard face plate	B	
Region US, ANSI, language US-English [2)], US face plate	C	
Port B (at bottom of device)		
No port	0	
IEC 60870-5-103 or DIGSI 4/modem or time sync. port, electrical RS232	1	
IEC 60870-5-103 or DIGSI 4/modem or time sync. port, electrical RS485	2	
IEC 60870-5-103 or DIGSI 4/modem time sync. port, optical 820 nm, ST connectors	3	
Further protocols see supplement L	9	L 0 □
PROFIBUS DP slave, electrical RS485	9	A
PROFIBUS DP slave, optical, double ring, ST connector	9	B
MODBUS, electrical RS485	9	D
MODBUS, optical 820 nm, ST connector	9	E
DNP 3.0, electrical RS485	9	G
DNP 3.0, optical 820 nm, ST connector	9	H
IEC 60870-5-103, redundant, electrical RS485, RJ45 connector	9	P
IEC 61850, 100 Mbit Ethernet, 2 electrical ports, RJ45 connector	9	R
IEC 61850, 100 Mbit Ethernet, 2 FO ports, LC-duplex connector	9	S
Port A (at bottom of device)		
No port [3)]	0	
Redundant FO protection data interface to the 2 wire copper interface Protection data interface FO for mono- (24 km) and multimode (4 km), LC-duplex connector [4)]	7	
Measuring / fault recording		
With fault recorder	1	
With fault recorder, average values, min/max values	3	

Positions 13–16: continued next page

1) Incl. 2 changeover/Form C
2) Language selectable
3) The FO interface is equipped if MLFB position 6 = **1**, **2**, **5** or **6**
4) Only if MLFB position 6 = **3** or **7**

A detailed overview of the technical data (extract of the manual) you will find under: http://www.siemens.com/siprotec

6

ANSI No.	Variants	Order No. 14	15	16
	Medium voltage differential protection device Basic version (contained in all options)	F	A	1)
87L/87N L	Line differential protection (phase comparison and $3I_O$ differential protection 1))			
	Inrush-current detection			
50 TD/51	Definite/inverse time-overcurrent protection phase $I>$, $I>>$, $I>>>$, I_p			
50N TD/51N	Definite/inverse time-overcurrent protection ground $I_E>$, $I_E>>$, $I_E>>>$, I_{Ep}			
49	Overload protection			
74TC	Trip circuit supervision			
50BF	Circuit breaker failure protection			
86	Lockout			
85 DT	Circuit-breaker intertripping function (trip of the remote circuit-breaker)			
	External trip initiation			
	Parameter changeover (parameter group change)			
	Supervision functions			
	Circuit-breaker test			
	Control of circuit-breaker			
	Flexible protection function current, voltage 2), cos φ 2), power 2), frequency 2)			
27/59	Under-/Overvoltage protection 2) $V<$, $V>$			
81 U/O	Under-/Overfrequency protection 2) $f<$, $f>$			
	Basic version included	F	B	
67	Directional definite/inverse time-overcurrent protection, phase 3) $\angle(V,I)$ $I>$, $I>>$, I_p			
67N	Directional definite/inverse time-overcurrent protection ground 3) $\angle(V,I)$ $I_E>$, $I_E>>$, I_{Ep}			
	Basic version included	F	C	
87Ns L	Ground-fault differential protection for isolated/resonance-earthed networks 3) 4)			
	Basic version included	F	E	
67	Directional definite/inverse time-overcurrent protection, phase 3) $\angle(V,I)$ $I>$, $I>>$, I_p			
67N	Directional definite/inverse time-overcurrent protection, ground 3) $\angle(V,I)$ $I_E>$, $I_E>>$, I_{Ep}			
87Ns L	Ground-fault differential protection for isolated/resonance-earthed networks 3) 4)			
	Additional functions			
	Without			0
	Transmission of 16 binary signals via the protection data interface			1
79	With automatic reclosure function (AR)			2
79	Transmission of 16 binary signals via the protection data interface and With automatic reclosure function (AR)			3

1) MLFB position 7 = **1** required (I_{ph} = 1 A / 5 A, I_E = 1 A / 5 A)

2) Function available if MLFB position 6 = **5**, **6** or **7** (voltage transformer inputs)

3) MLFB position 6 = **5**, **6** or **7** required (voltage transformer inputs)

4) MLFB position 7 = **2** required (I_{ph} = 1 A / 5 A, I_{EE} (sensitive) = 0.001 to 1.6 A / 0.005 to 8 A)

Connection diagrams

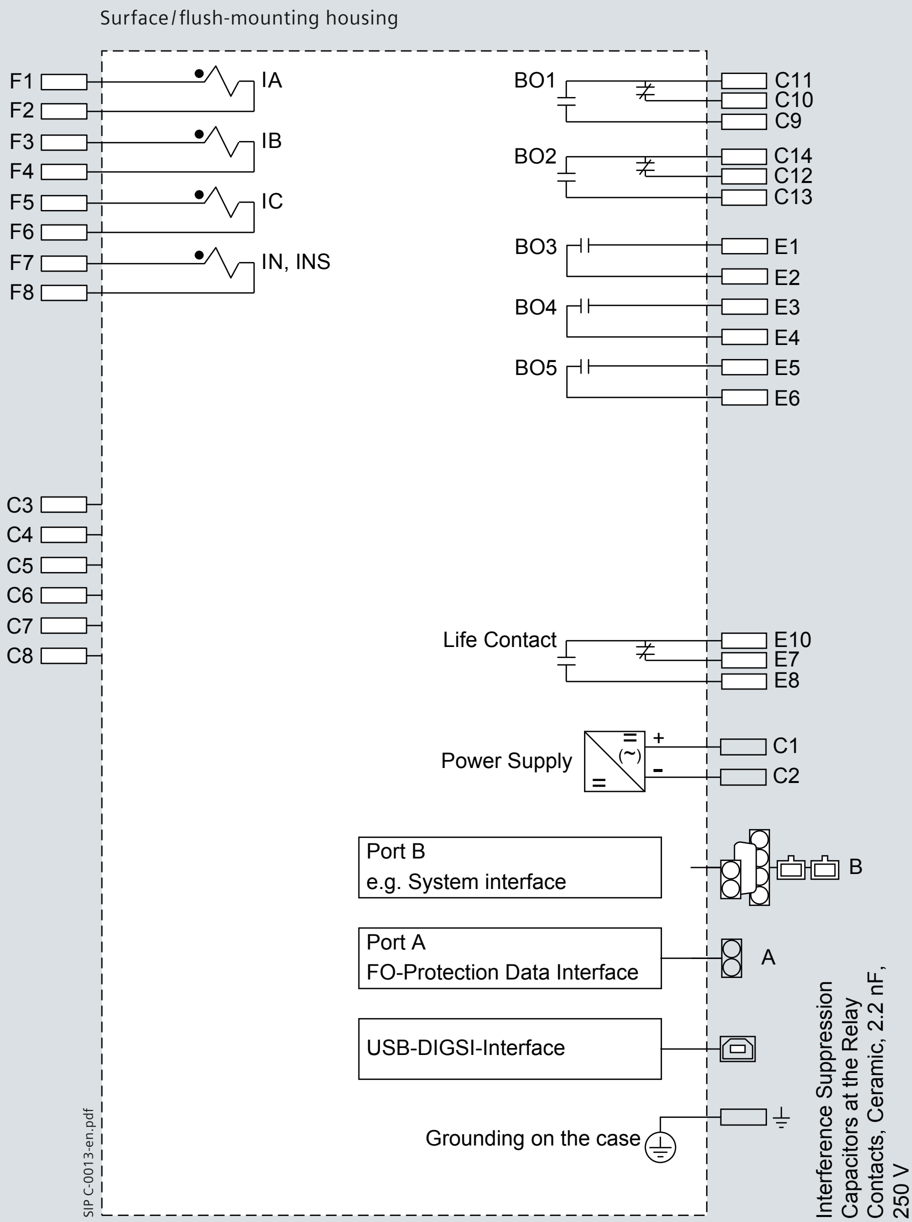


Fig. 6/8 Line differential protection 7SD801

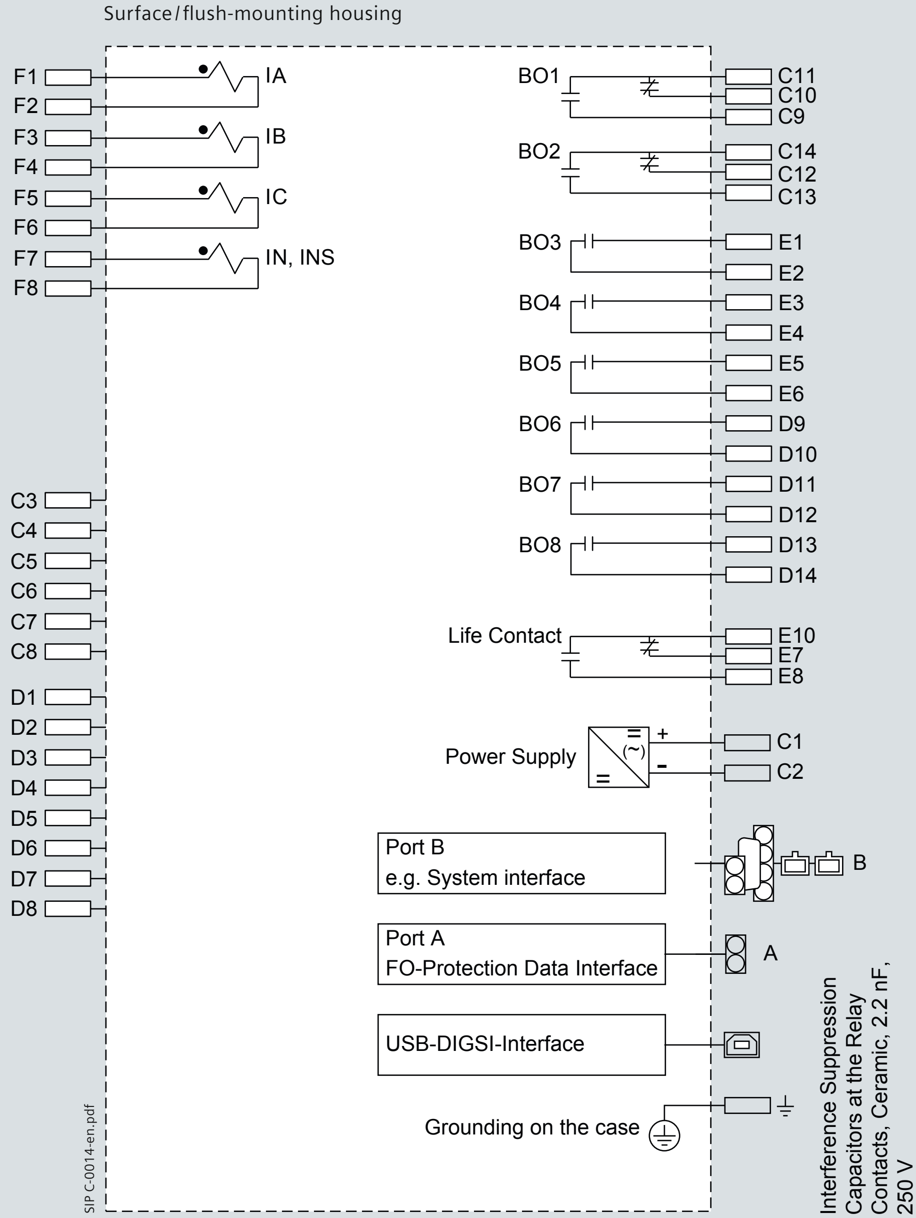


Fig. 6/9 Line differential protection 7SD802

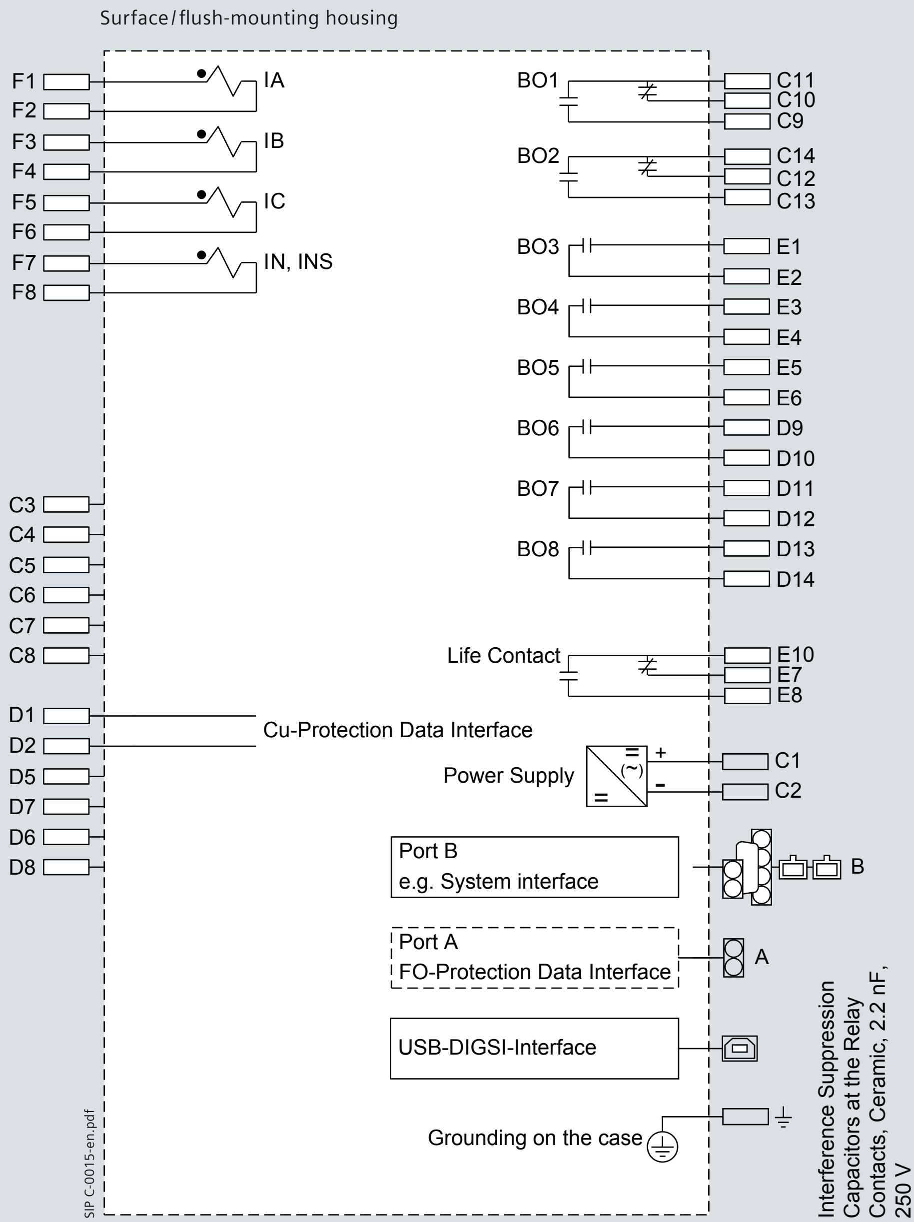


Fig. 6/10 Line differential protection 7SD803
The fiber-optic interface at port A is only available in connection with position 12 = 7

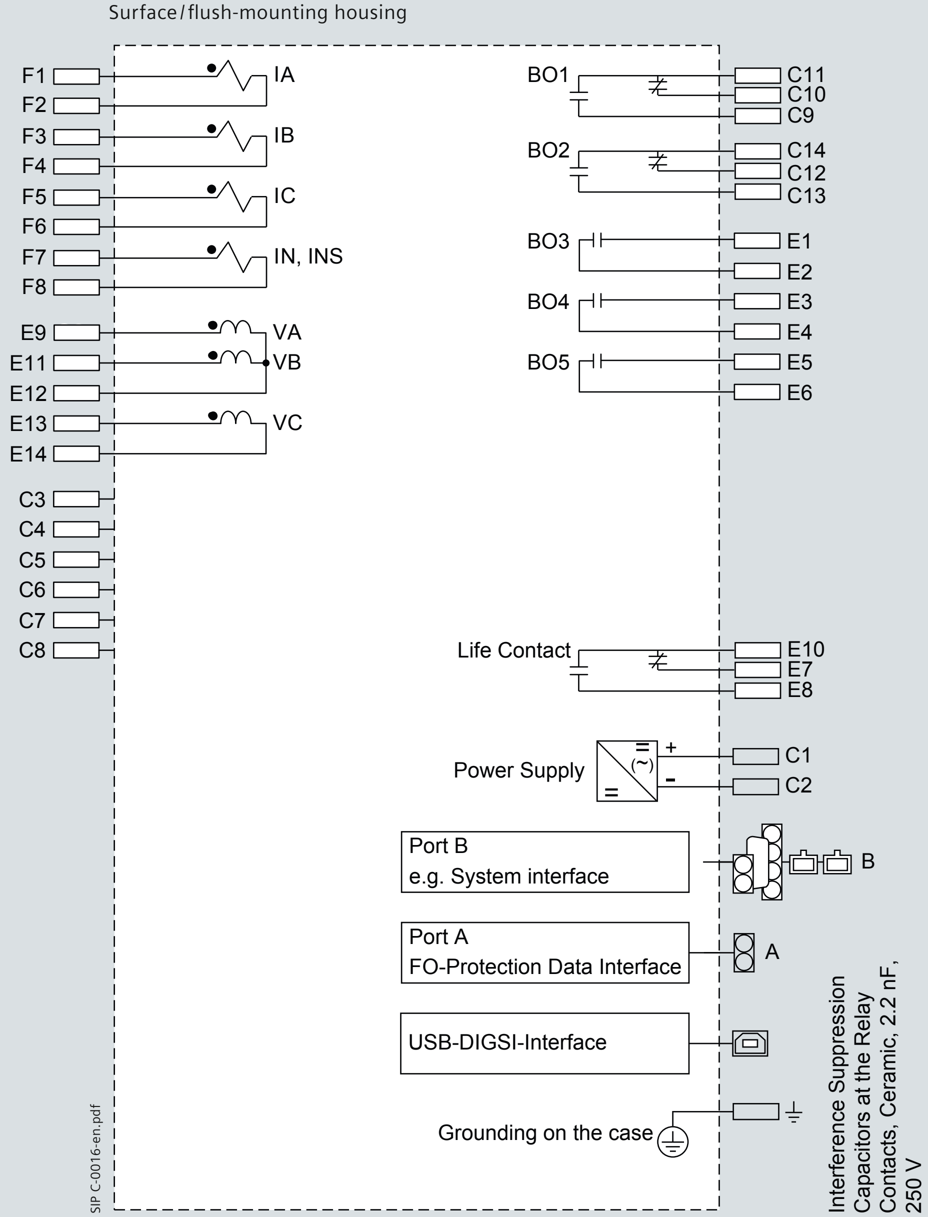


Fig. 6/11 Line differential protection 7SD805

Connection diagrams

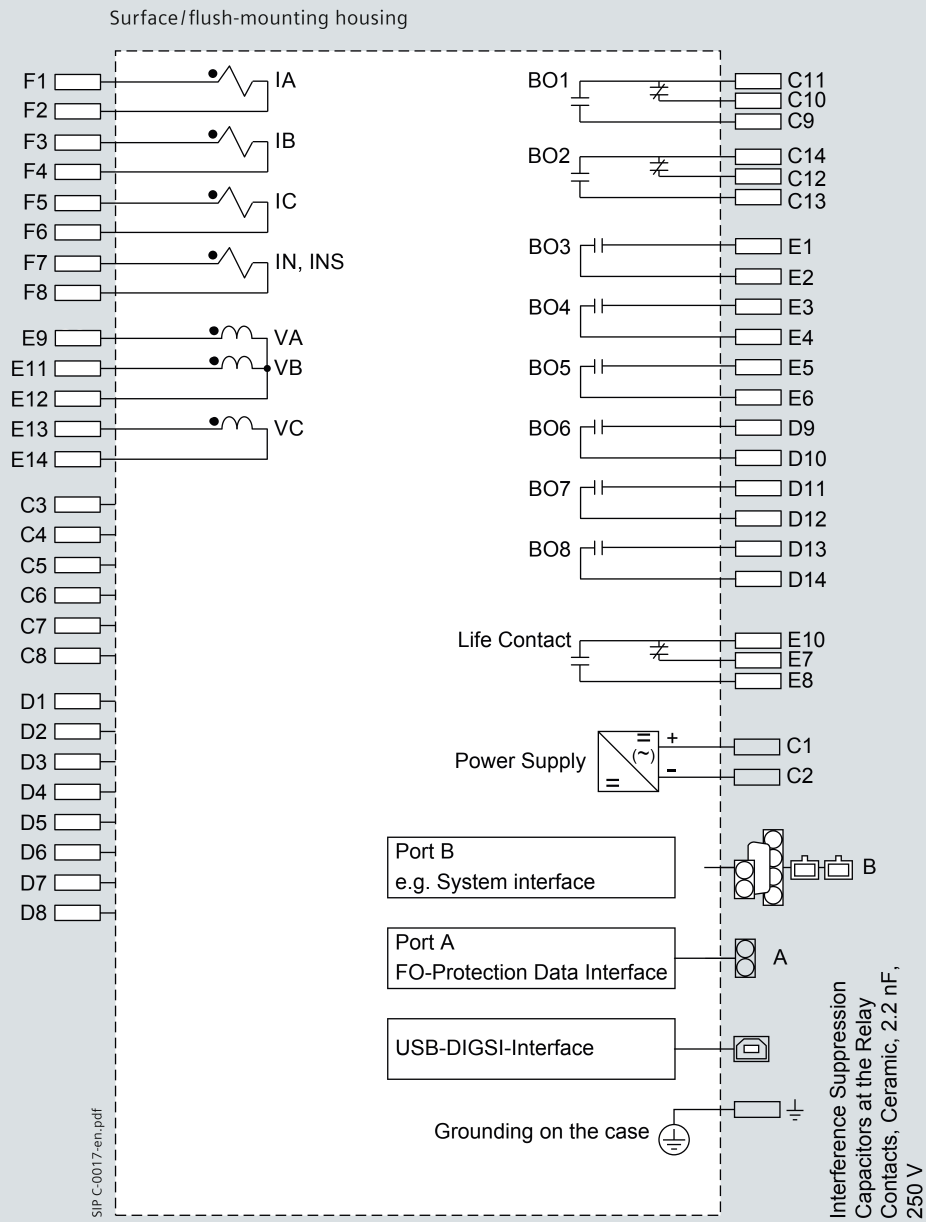


Fig. 6/12 Line differential protection 7SD806

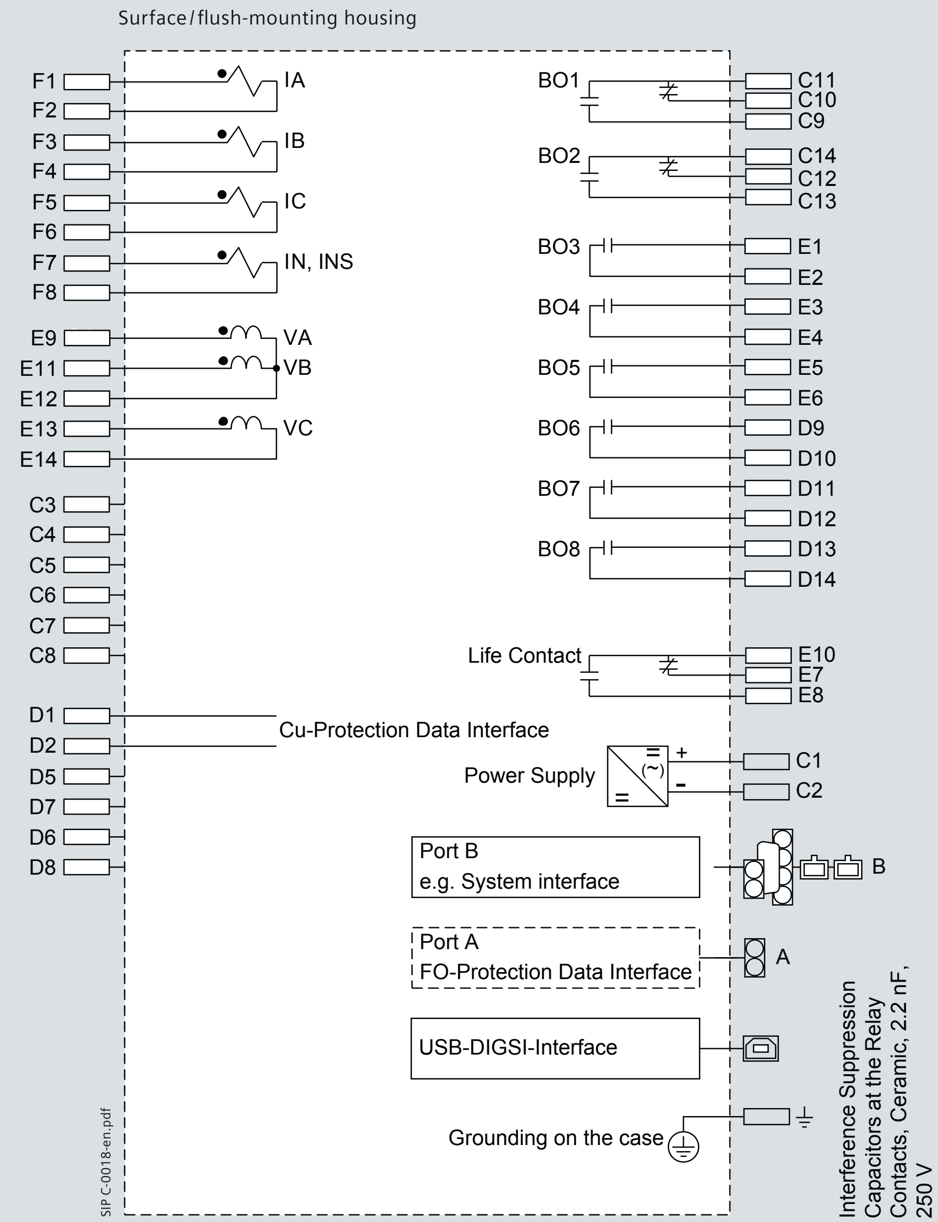


Fig. 6/13 Line differential protection 7SD807
The fiber-optic interface at port A is only available in connection with position 12 = 7

Connection examples

Current transformer connection

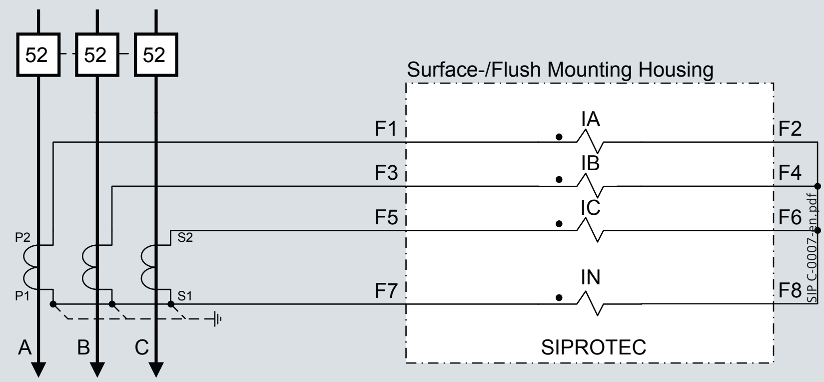


Fig. 6/14 Current transformer connections on three current transformers and neutral current (earth current) (Holmgreen circuit); normal circuit suitable for all solidly and impedance earthed systems (neutral towards line)

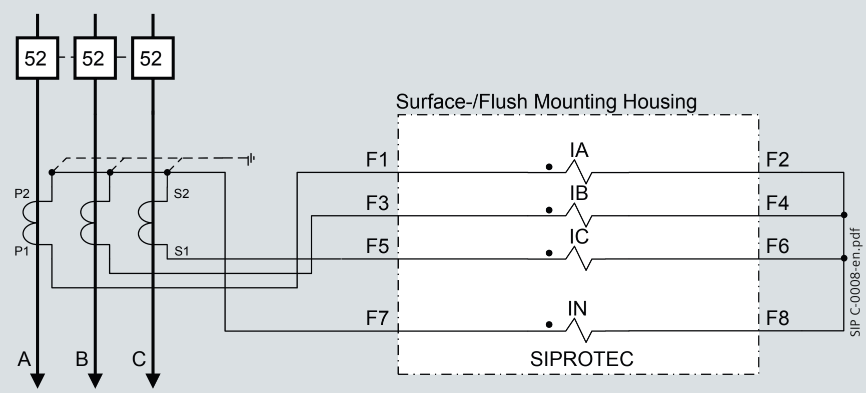


Fig. 6/15 Current transformer connections on three current transformers and neutral current (earth current) (Holmgreen circuit); normal circuit suitable for all solidly and impedance earthed systems (neutral towards busbar)

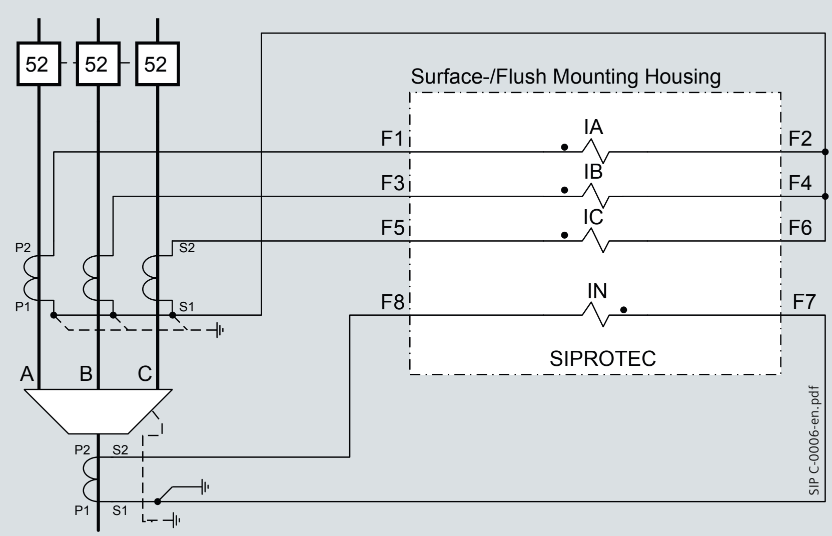


Fig. 6/16 Current transformer connections on three current transformers – earth current of additional summation current transformer, preferably for resonant-earthed and isolated systems.

Voltage transformer connection

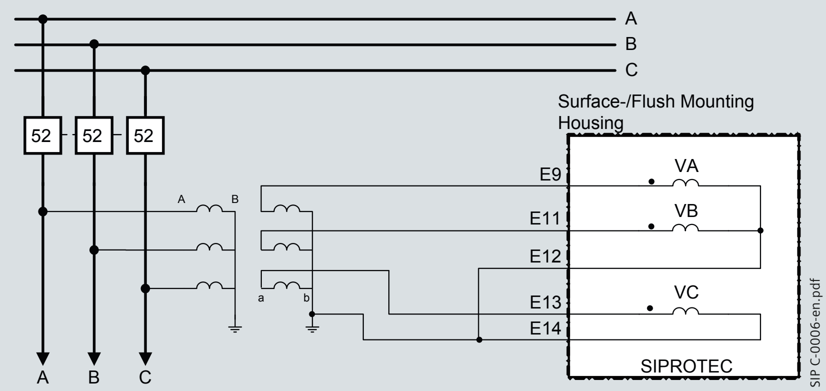


Fig. 6/17 Example for connection type "V_{1E}, V_{2E}, V_{3E}", feeder-side voltage connection

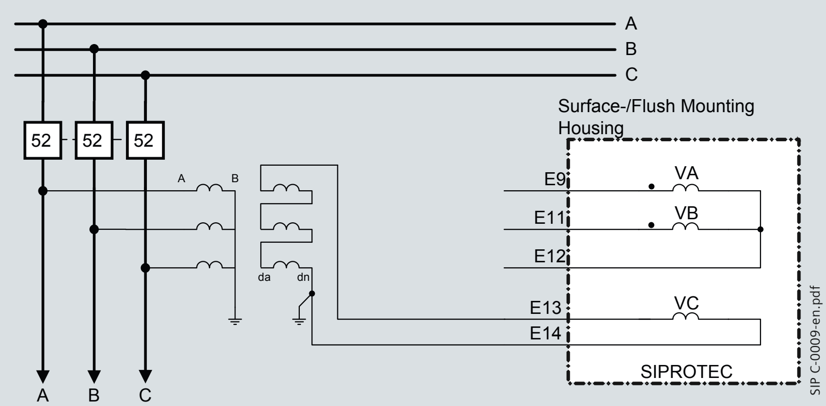


Fig. 6/18 Example for connection type "V_0 connection"

Feeder Automation Controller 7SC80
SIPROTEC Compact

SIEMENS

Feeder Automation Controller 7SC80

You will find a detailed overview of the technical data (extract of the manual) under: http://www.siemens.com/siprotec

Description

The SIPROTEC 7SC80 feeder automation controller can be used for protection and automation of medium-voltage distribution feeders with grounded or low-resistance grounded neutral point.

The 7SC80 features “flexible protection functions”. 20 additional protection functions can be created by the user. For example, a rate of change of frequency function or a reverse power function can be created. The relay provides circuit-breaker control. Additional primary switching devices (grounding switches, transfer switches and isolating switches) can also be controlled from the relay. Automation or PLC logic functionality is also implemented in the relay.

The integrated programmable logic (CFC) allows the user to add own functions, e.g. for the automation of switchgear (including: interlocking, transfer and load shedding schemes). The user is also allowed to generate user-defined messages. The communication module is independent from the protection. It can easily be exchanged or upgraded to future communication protocols.

Highlights

- Support of feeder automation applications, e.g. fault isolation and service restauration
- Designed for harsh environment
- Extended temperature range -40 °C up to 85 °C
- Open for all different communication technologies, e.g. radio, which are used for feeder automation
- Integrated battery charger and management for charging and supervision of 24 V or 48 V batteries is available
- Integrated GPS module is available for time synchronisation
- Full remote access supported for firmware and parameter updates and upgrades
- A web based HMI provides complete remote control of the device
- Low power consumption.

Fig. 7/1 7SC80 front view

Fig. 7/2 7SC80 side view

Feeder Automation Controller 7SC80

Function overview

Protection functions	IEC	ANSI No.
Overcurrent protection (phase/neutral)	$I>$, $I>>$, $I>>>$, $I_E>$, $I_E>>$, $I_E>>>$	50, 50N
Directional overcurrent protection	$I>$, $I_p<$ (V,I)	67
Sensitive ground-fault protection	$I_N>$, $<$ (V,I)	67N
Overvoltage protection, zero sequence system	V_E, $V_0>$	59N
Inrush restrained		
Undervoltage/overvoltage protection	$V<$, $V>$	27/59
Overfrequency/underfrequency protection	$f<$, $f>$	81O/U
Breaker failure protection		50BF
Phase-balance current protection (negative-sequence protection)	$I_2>$	46
Fault locator		21FL
Forward-power, reverse-power protection	$P<>$, $Q<>$	32
Power factor	$\cos \varphi$	55
Rate-of-frequency-change protection	df/dt	81R

Table 7/1 Function overview

Control functions/programmable logic

- Commands for the ctrl. of CB, disconnect switches (isolators/isolating switches)
- Control through keyboard, binary inputs, DIGSI 4 or SCADA system
- User-defined PLC logic with CFC (e.g. interlocking).

Monitoring functions

- Operational measured values V, I, f
- Energy metering values W_p, W_q
- Minimum and maximum values
- Fuse failure monitor
- 8 oscillographic fault records.

Communication interfaces

- IEC 61850 electrical and optical (single-mode distance up to 24 km)
- USB front interface for DIGSI 4.

Hardware

- 4 current transformers
- 1/4 voltage transformers
- 12 binary inputs
- 8 binary outputs
- 1 live-status contact
- Pluggable terminals.

The SIPROTEC feeder automation controller 7SC80 is a numerical protection relay that can perform control and monitoring functions and therefore provides the user with a cost-effective platform for power system management, that ensures reliable supply of electrical power to the customers.

Control

The integrated control function permits control of disconnect devices, grounding switches or circuit-breakers through the integrated operator panel, binary inputs, DIGSI 4 or the systems control (e.g. SICAM)

Programmable logic

The integrated logic characteristics (CFC) allow the user to add own functions for automation of switchgear (e.g. interlocking) or switching sequence. The user can also generate user-defined messages.

Metering values

Extensive measured values, metered values and limit values provide improved system management as well as commissioning.

Reporting

The storage of event logs, trip logs, fault records and statistics documents are stored in the relay to provide the user or operator with all the key data required to operate modern substations.

Line protection

The 7SC80 units can also be used for line protection of high and medium-voltage networks with grounded or low-resistance point.

Transformer protection

The relay provides all the functions for backup protection for transformer differential protection. The inrush suppression effectively prevents unwanted trips that can be caused by inrush currents. The high-impedance restricted ground-fault protection detects short-circuits and insulation faults on the transformer.

Switchgear cubicles for high/medium voltage

All units are designed specifically to meet the requirements of high/medium-voltage applications. In general, no separate measuring instruments (e.g., for current, voltage, frequency, ...) or additional control components are necessary. Typically the relay provides all required measurements, thus negating the use of additional metering devices like amp, volt or frequency meters. No additional control switches are required either. The relay provides 9 programmable pushbuttons and select switches.

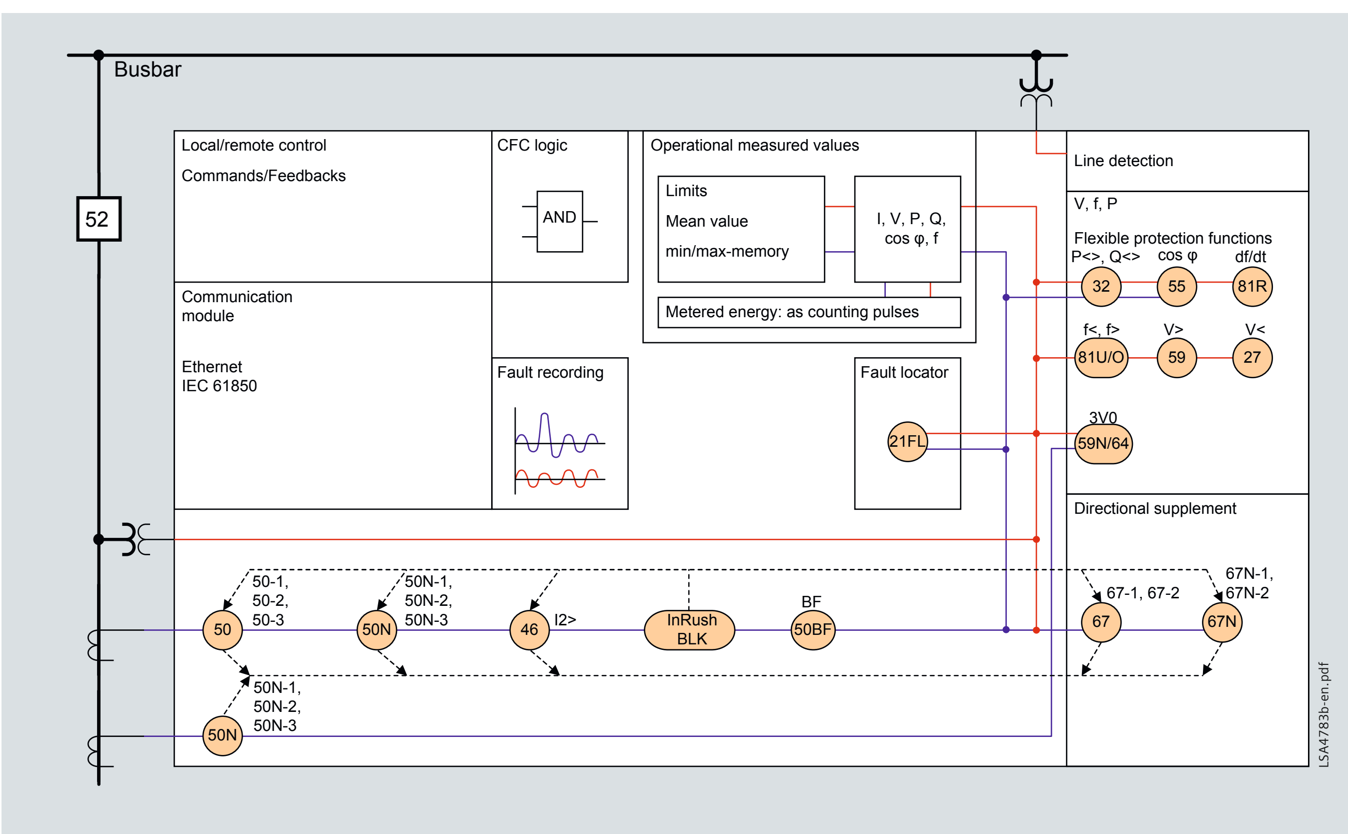


Fig. 7/3 Function diagram

Feeder Automation Controller 7SC80

Construction and hardware

Housing with many advantages

The 7SC80 has a complete other form factor than all other SIPROTEC Compact relays. It is slightly bigger (approx. 295 x 310 x 70 mm) because it has to carry some more external interfaces with regards to other compact relays. All interfaces are at the left and right hand side of the relay. A small print onto the enclosure next to the clamps describes each port in detail. All clamps are pluggable and therefore a pre-wiring and easy replacement in case of maintenance is possible. A short circuit is integrated in the pluggable CT clamp to avoid any risk of unclosed secondary CT circuits.

The first eight binary inputs and the second four binary inputs have a common ground. The threshold is fixed for 24 V and higher. The secondary values of the CTs 1 A or 5 A can be set via DIGSI.

The relay has a web-based HMI which provides 32 virtual LEDs and 9 programmable pushbuttons to configure shortcuts for menu or various applications (see Fig. 7/6).

The 7SC80 variants are always equipped with at least one single voltage input V_x. This input can be used to detect line voltage of a single phase.

In the variant with a 24/48 V DC power supply, the relay is equipped with an internal battery charger/management. The relay can control charging and draining of batteries, which are frequently used in pole mounted applications. An external battery test resistor can be connected directly to the relay. A switchable port which provides the battery voltage to an external device is also available.

An optional internal GPS module can be ordered to provide high accuracy time synchronization to each relay.

The 7SC80 relays are always equipped with either an electrical or an optical Ethernet module running under IEC 61850. The optical module is available with single mode ports to bridge distances up to 24 km, the well known integrated switch functionality is of course included.

Current terminals – single cables	
Cable cross-sections When using lugs	AWG 14-12 (2.6 mm^2 to 3.3 mm^2) AWG 14-10 (2.6 mm^2 to 6.6 mm^2)
Permissible tightening torque	2.7 Nm
Stripping length (for solid conductor)	10 mm to 11 mm (0.39 in to 0.43 in) Only solid copper wires may be used.
Process terminal connections	
Cable cross-sections	AWG 26-12 (0.2 mm^2 to 2.5 mm^2)
Permissible voltages	400 V (IEC)/300 V (UL)
Permissible currents	19 A (IEC)/15 A (UL) Only solid copper wires may be used.
Stripping length	7 mm (0.28 in)

Table 7/2 Wiring specifications for process connection

Fig. 7/4 Process terminal connections

Fig. 7/5 Current terminal

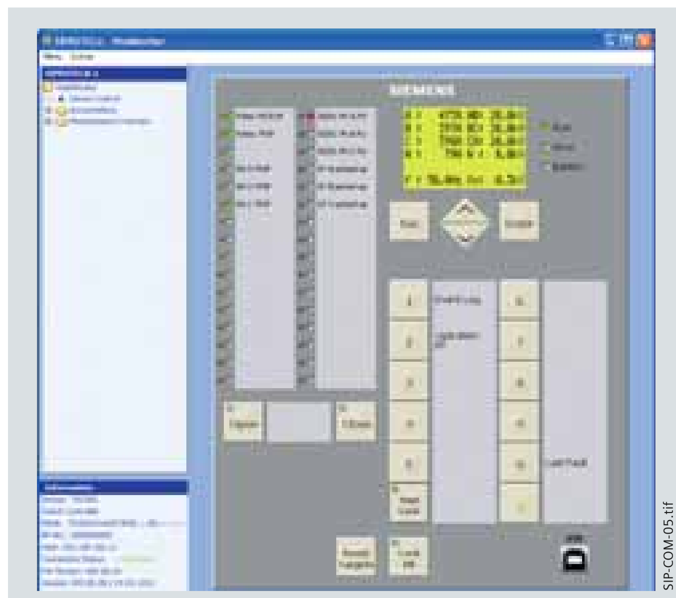


Fig. 7/6 WebMonitor

Protection functions

Overcurrent protection (ANSI 50, 50N)

This function is based on the phase-selective measurement of the three phase currents and the ground current (four transformers). Three definite-time overcurrent protection elements (DMT) are available both for the phase and the ground elements. The current threshold and the delay time can be set in a wide range.

Inrush restraint

The relay features second harmonic restraint. If second harmonic content is detected during the energization of a transformer, the pickup of non-directional and directional elements is blocked.

Dynamic setting change

The pickup thresholds and the trip times of the directional and non-directional time-overcurrent protection functions can be changed via binary inputs or by setable time control.

Directional comparison protection (cross-coupling)

It is used for selective instantaneous tripping of sections fed from two sources, i.e. without the disadvantage of time delays of the set characteristic. The directional comparison protection is suitable if the distances between the protection zones are not significant and pilot wires are available for signal transmission. In addition to the directional comparison protection, the directional coordinated time-overcurrent protection is used for complete selective backup protection.

Directional time-overcurrent protection (ANSI 67, 67N)

Directional phase and ground protection are separate functions. They operate in parallel to the non-directional overcurrent elements. Their pickup values and delay times can be set separately.

The tripping characteristic can be rotated by ± 180 degrees. By making use of the voltage memory, the directionality can be determined reliably even for close-in (local) faults. If the primary switching device closes onto a fault and the voltage is too low to determine direction, the direction is determined using voltage from the memorized voltage. If no voltages are stored in the memory, tripping will be according to the set characteristic.

For ground protection, users can choose whether the direction is to be calculated using the zero-sequence or negative-sequence system quantities (selectable). If the zero-sequence voltage tends to be very low due to the zero-sequence impedance it will be better to use the negative-sequence quantities.

Phase-balance current protection (ANSI 46) (Negative-sequence protection)

By measuring current on the high side of the transformer, the two-element phase-balance current/negative-sequence protection detects high-resistance phase-to-phase faults and phase-to-ground faults on the low side of a transformer (e.g. Dy 5 or Delta/Star 150 deg.). This function provides backup protection for high-resistance faults through the transformer.

Breaker failure protection (ANSI 50BF)

If a faulted portion of the electrical circuit is not disconnected when a trip command is issued to a circuit-breaker, another trip command can be initiated using the breaker failure protection which trips the circuit-breaker of an upstream feeder. Breaker failure is detected if, after a trip command is issued the current keeps on flowing into the faulted circuit. It is also possible to make use of the circuit-breaker position contacts (52a or 52b) for indication as opposed to the current flowing through the circuit-breaker.

Flexible protection functions

The 7SC80 enables the user to easily add up to 20 additional protection functions. Parameter definitions are used to link standard protection logic with any chosen characteristic quantity (measured or calculated quantity). The standard logic consists of the usual protection elements such as the pickup set point, the set delay time, the TRIP command, a block function, etc. The mode of operation for current, voltage, power and power factor quantities can be three-phase or single-phase. Almost all quantities can be operated with ascending or descending pickup stages (e.g. under and over voltage). All stages operate with protection priority.

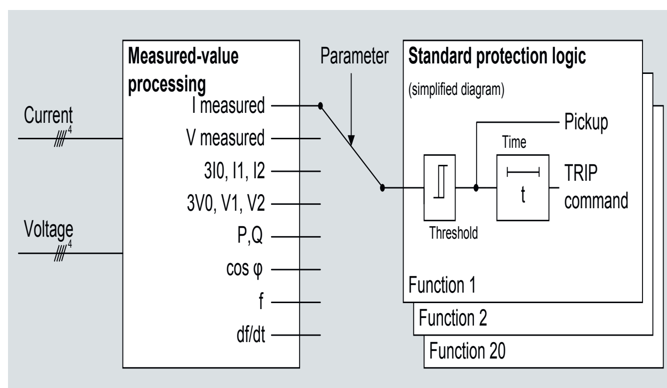


Fig. 7/7 Flexible protection functions

Protection functions/stages available are based on the available measured analog quantities:

Function	ANSI
$I>$, $I_E>$	50, 50N
$V<$, $V>$, $V_E>$	27, 59, 59N
$3I_0>$, $I_1>$, $I_2>$, $I_2/I_1>$, $3V_0>$, $V_1><$, $V_2><$	50N, 46, 59N, 47
$P><$, $Q><$	32
cos φ	55
$f><$	81O, 81U
$df/dt><$	81R

Table 7/3 Available flexible protection functions

For example, the following can be implemented:

- Reverse power protection (ANSI 32R)
- Rate-of-frequency-change protection (ANSI 81R).

7

Settable dropout delay times

If the relays are used in conjunction with electromechanical relays, in networks with intermittent faults, the long dropout times of the electromechanical relay (several hundred milliseconds) can lead to problems in terms of time coordination/grading. Proper time coordination/grading is only possible if the dropout or reset time is approximately the same. This is why the parameter for dropout or reset times can be defined for certain functions such as time-overcurrent protection, ground short-circuit and phase-balance current protection.

Overvoltage protection (ANSI 59)

The two-element overvoltage protection (possible per phase) detects unwanted network and machine overvoltage conditions. The function can operate either with phase-to-phase, phase-to-ground, positive phase-sequence or negative phase-sequence voltage.

Undervoltage protection (ANSI 27)

The two-element undervoltage protection provides protection against dangerous voltage drops (especially for electric machines). Applications include the isolation of generators or motors from the network to avoid undesired operating conditions and a possible loss of stability. Proper operating conditions of electrical machines are best evaluated with the positive-sequence quantities. The protection function is active over a wide frequency range (45 to 55, 55 to 65 Hz). Even when falling below this frequency range the function continues to work, however, with decreased accuracy. The function can operate either with phase-to-phase, phase-to-ground or positive phase-sequence voltage, and can be monitored with a current criterion. Three-phase and single-phase connections are possible.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for overfrequency and underfrequency protection. Electric machines and parts of the system are protected from unwanted frequency deviations. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting. Frequency protection can be used over a wide frequency range (40 to 60 (for 50 Hz), 50 to 70 (for 60 Hz). There are four elements (individually set as overfrequency, underfrequency or OFF) and each element can be delayed separately. Blocking of the frequency protection can be performed by activating a binary input or by using an undervoltage element.

Fault locator (ANSI 21FL)

The integrated fault locator calculates the fault impedance and the distance to fault. The results are displayed in Ω, kilometers (miles) and in percent of the line length.

Customized functions (ANSI 51V, etc.)

Additional functions, which are not time critical, can be implemented using the CFC measured values. Typical functions include reverse power, voltage controlled overcurrent, phase angle detection, and zero-sequence voltage detection.

Further functions

Measured values

The r.m.s. values are calculated from the acquired current and voltage along with the power factor, frequency, active and reactive power. The following functions are available for measured value processing:

- Currents I_{L1}, I_{L2}, I_{L3}, I_E,
- Voltages V_{L1}, V_{L2}, V_{L3}, V_{L1L2}, V_{L2L3}, V_{L3L1}, V_x
- Symmetrical components I_1, I_2, $3I_0$; V_1, V_2, V_0
- Power Watts, Vars, VA/P, Q, S (P, Q: total and phase selective)
- Power factor (cos φ), (total and phase selective)
- Frequency
- Energy ± kWh, ± kVarh, forward and reverse power flow
- Operating hours counter
- Limit value monitoring
  Limit values can be monitored using programmable logic in the CFC. Commands can be derived from this limit value indication
- Zero suppression
  In a certain range of very low measured values, the value is set to zero to suppress interference.

Metered values

For internal metering, the unit can calculate an energy metered value from the measured current and voltage values. If an external meter with a metering pulse output is available, the 7SC80 can obtain and process metering pulses through an indication input. The metered values can be displayed and passed on to a control center as an accumulated value with reset. A distinction is made between forward, reverse, active and reactive energy.

Commissioning

Commissioning could not be easier and is supported by DIGSI 4. The status of the binary inputs can be read individually and the state of the binary outputs can be set individually. The operation of switching elements (circuit-breakers, disconnect devices) can be checked using the switching functions of the relay. The analog measured values are represented as wide-ranging operational measured values. To prevent transmission of information to the control center during maintenance, the communications can be disabled to prevent unnecessary data from being transmitted. During commissioning, all indications with test tag for test purposes can be connected to a control and protection system.

Test operation

During commissioning, all indications can be passed to a control system for test purposes.

Radial systems

General hints:
The relay at the far end (D) from the infeed has the shortest tripping time. Relays further upstream have to be time-graded against downstream relays in steps of about 0.3 s.

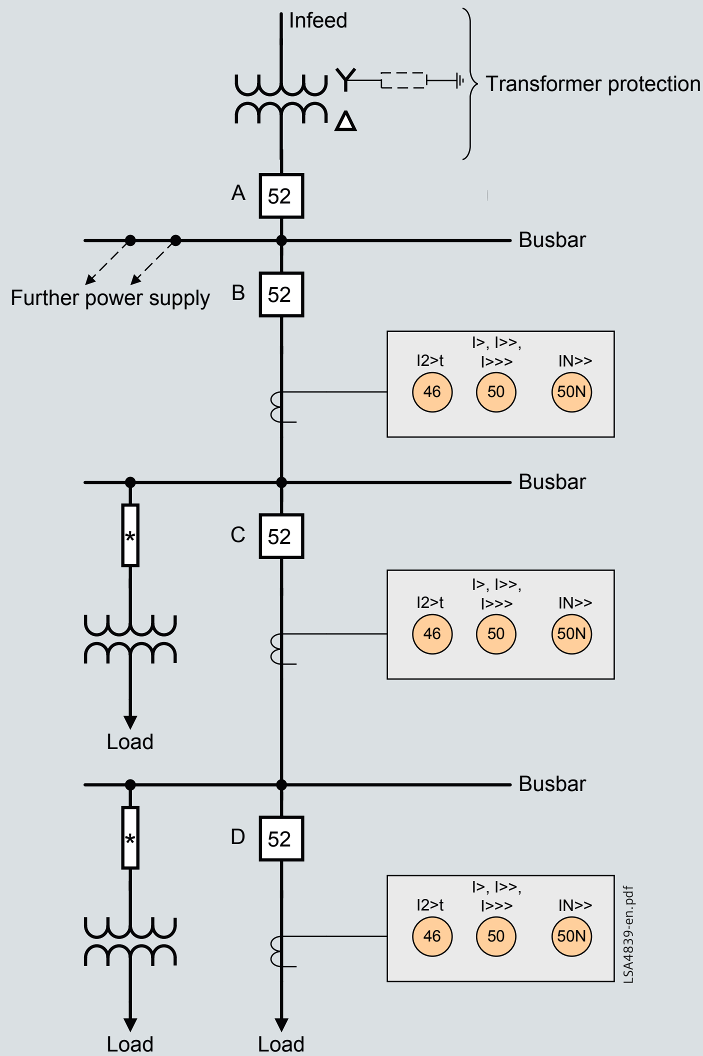


Fig. 7/8 Protection concept with overcurrent-time protection

7

Ring-main cable

With the directional comparison protection, 100% of the line can be protected via instantaneous tripping in case of infeed from two sources (ring-main cable).

For lines with infeed from two sources, no selectivity can be achieved with a simple definite-time overcurrent protection. Therefore, the directional definite-time overcurrent protection must be used. A non-directional definite-time overcurrent protection is enough only in the corresponding busbar feeders. The grading is done from the other end respectively.

Advantage: 100% protection of the line via instantaneous tripping, and easy setting.

Disadvantage: Tripping times increase towards the infeed.

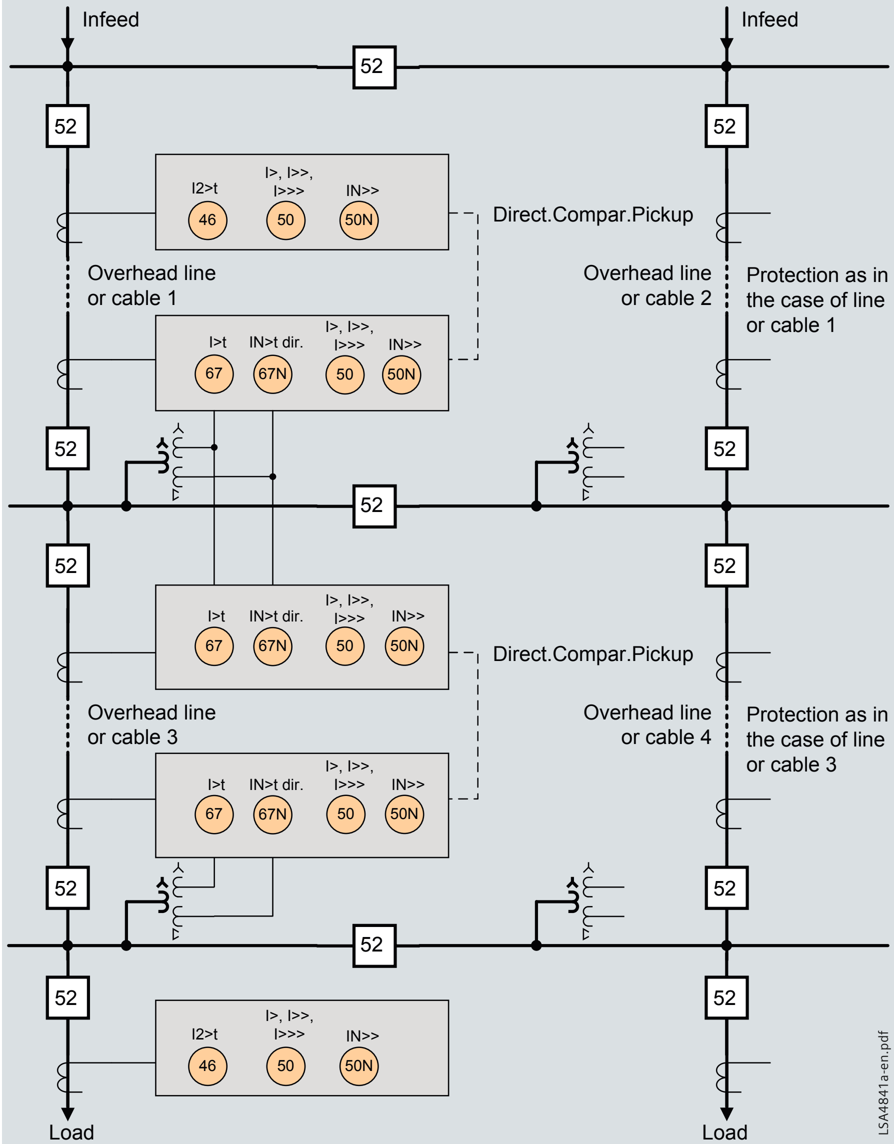


Fig. 7/9 Protection concept of ring power systems

Busbar protection by overcurrent relays with reverse interlocking

Applicable to distribution busbars without substantial (< 0.25 x I_N) backfeed from the outgoing feeders.

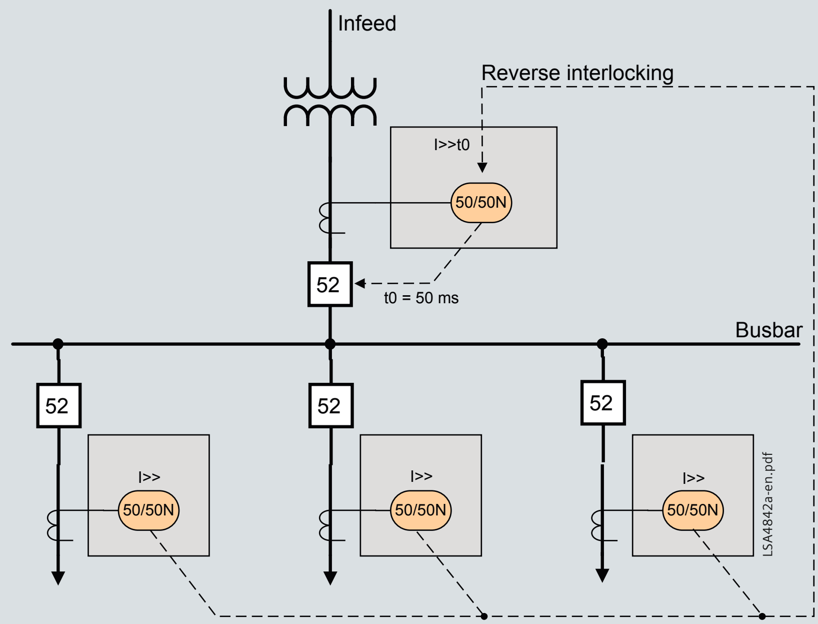


Fig. 7/10 Busbar protection with reverse interlocking

Line feeder with load shedding

In unstable power systems (e.g. solitary systems, emergency power supply in hospitals), it may be necessary to isolate selected consumers from the power system in order to protect the overall system.

The overcurrent-time protection functions are effective only in the case of a short-circuit.

Overloading of the generator can be measured as a frequency or voltage drop.

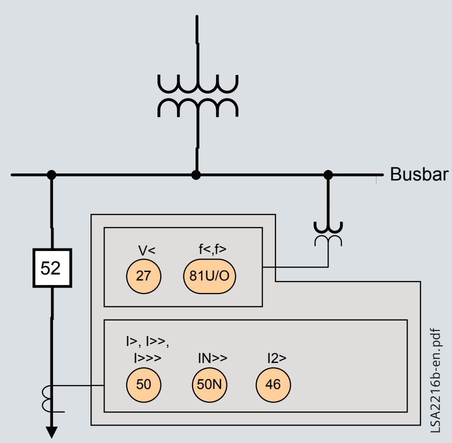


Fig. 7/11 Line feeder with load shedding

Reverse power protection with parallel infeeds

In a busbar is supplied by two parallel infeeds and there is a fault in one of the infeeds, the affected busbar shall be selectively shut down, so that supply to the busbar is still possible through the remaining infeed. To do this, directional devices are required, which detect a short circuit from the busbar towards the infeed. In this context, the directional time-overcurrent protection is normally adjusted over the load current. Low-current faults cannot be shut down by this protection. The reverse power protection can be adjusted far below rated power, and is thus also able to detect reverse power in case of low-current faults far below the load current. The reverse power protection is implemented through the "flexible protection functions".

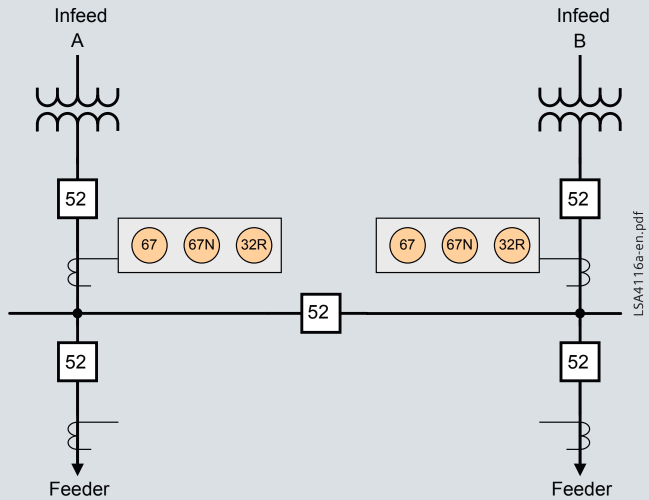


Fig. 7/12 Reverse power protection with parallel infeeds

Description	Order No.	Short code
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 7SC80□□-□□□□□-3□□□-□□□	
Feeder automation controller 1)		
Housing, binary inputs and outputs		
Housing, 12 BI, 8 BO, 1 live status contact	2 (position 6)	
Specification of CT and VT measurement inputs		
4 x CT 1 A / 5 A, 1 x 120 V AC input for line detection	2 (position 7)	
4 x CT 1 A / 5 A, 3 x PT 120 V, 1 X 120 V AC line detection	4 (position 7)	
Rated auxiliary voltage		
60 V to 250 V DC; 115 V AC; 230 V AC	1 (position 8)	
24 V / 48 V DC including battery charger / monitor	2 (position 8)	
Unit version		
Surface mounting housing	A (position 9)	
Region-specific default and language settings		
Region DE, IEC, language German	A (position 10)	
Region World, IEC / ANSI, language English	B (position 10)	
Region US, ANSI, language US-English	C (position 10)	
System interface	9 (position 11)	L □ □
100 Mbit Ethernet, electrical, double, RJ45 con. 2)	9 (position 11)	R
100 Mbit Ethernet, with integrated switch, optical, double LC connector single-mode 24 km 3)	9 (position 11)	T
Protocol for system interface		
IEC 61850		0
Additional interfaces		
No module	0 (position 12)	
GPS module	7 (position 12)	

Positions 14, 15, 16: see next page

7

1) Available Jan. 2012

2) Already contained in position 6

3) Surcharge for optical interface

You will find a detailed overview of the technical data (extract of the manual) under: http://www.siemens.com/siprotec

Selection and ordering data

ANSI No.	Product description	Order No. 14 15 16
Software packages	**Protection function packages**	F A [4]
50	Time-overcurrent protection phase: $I>$, $I>>$, $I>>>$	
50N	Time-overcurrent protection ground $I_E>$, $I_E>>$, $I_E>>>$	
50BF	Circuit-breaker failure protection	
46	Negative sequence / unbalanced load protection	
	Parameter changeover	
	Monitoring functions	
	Control of circuit breaker	
	Flexible protection functions (current parameters)	
	Under- / overfrequency	
	Inrush restraint	
	Fault recording, average values, min/max values	
67	Directional overcurrent protection phase, $I>$, $I>>$	F B [5]
67N	Directional overcurrent protection ground, $I_E>$, $I_E>>$	
64/59N	Displacement voltage	
27/59	Under- / overvoltage	
81U/O	Under- / overfrequency, $f<$, $f>$	
32/55/81R	Flexible protection functions (current and voltage parameters)	
	Protective function for voltage,	
	power, power factor, frequency change	
	No protection, pure RTU functionality	F R [6]
	Fault locator	
	Without	0
21FL	With fault locator	2 [5]

4) Only with position 7 = 2

5) Only with position 7 = 4

6) Available Q3 / 2012

You will find a detailed overview of the technical data (extract of the manual) under: http://www.siemens.com/siprotec

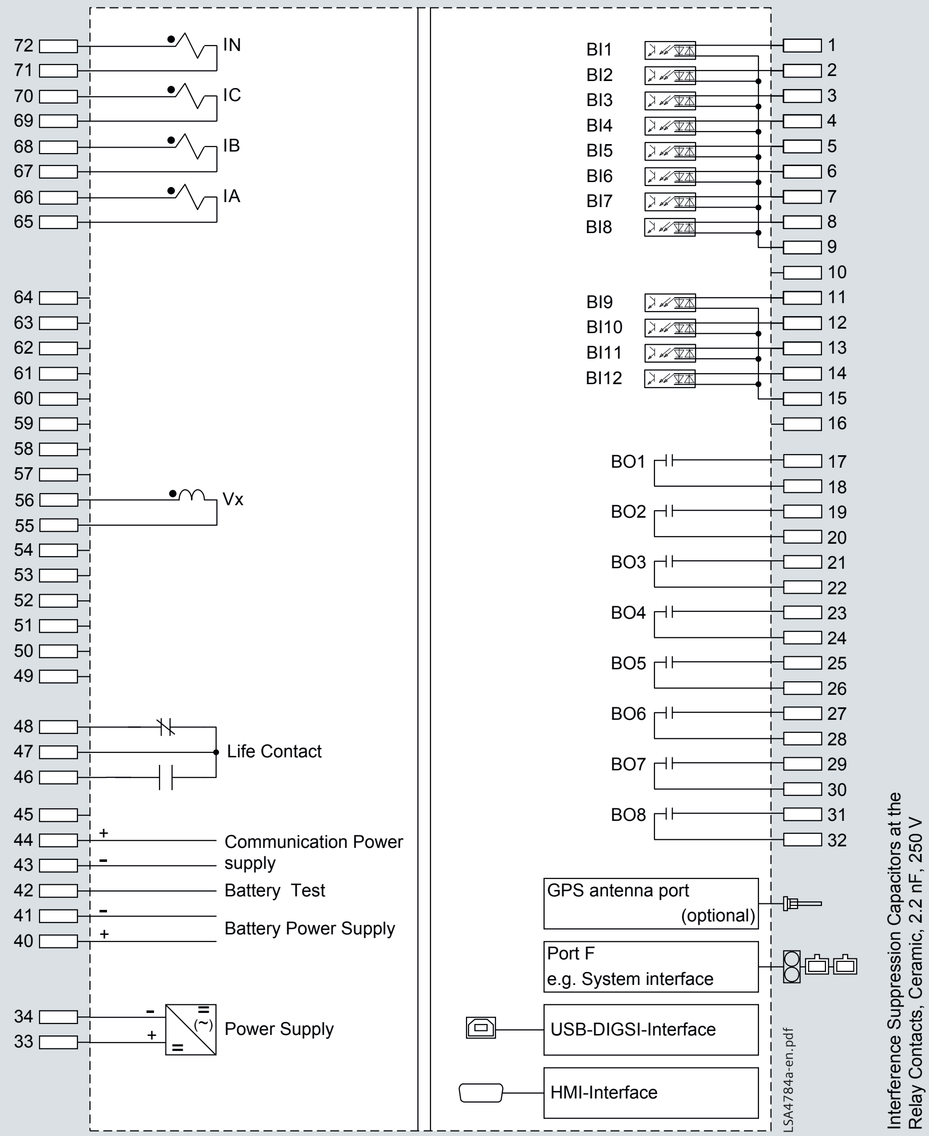


Fig. 7/13 General diagram for 7SC8022

Connection diagrams

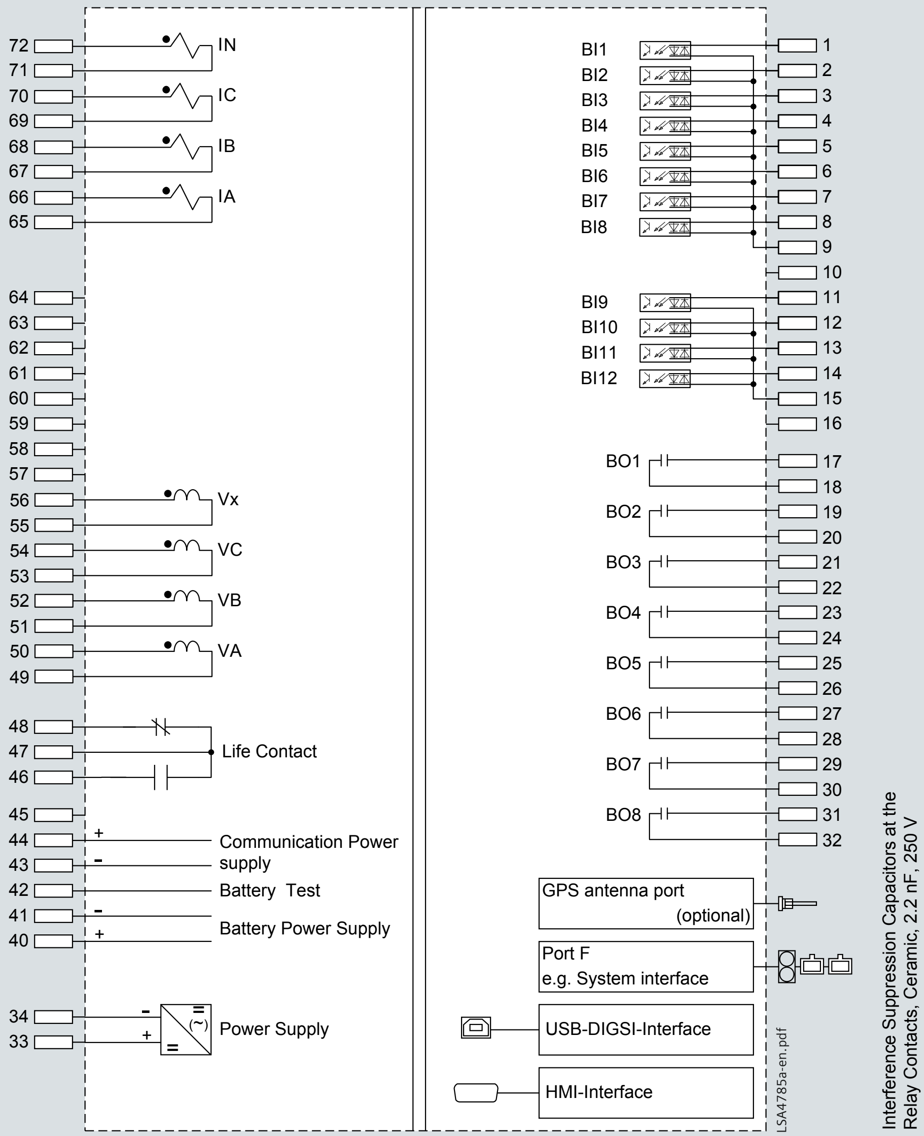


Fig. 7/14 General diagram for 7SC8024

Connection of current and voltage transformers

Standard connection

For grounded networks, the ground current is obtained from the phase currents by the residual current circuit.

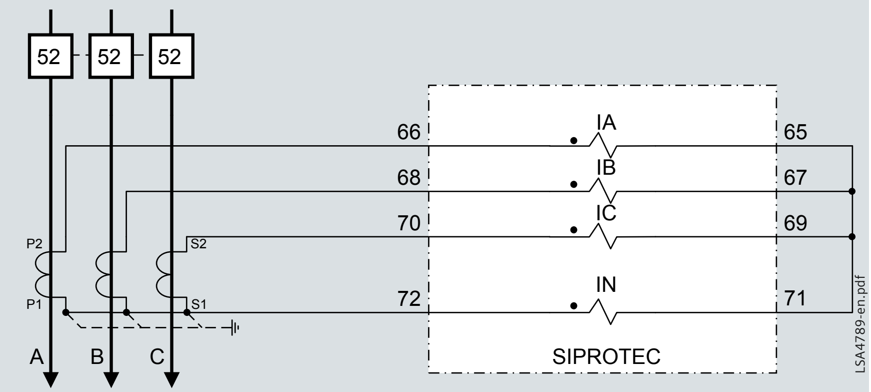


Fig. 7/15 Current transformer connections to three current transformers and neutral point current (ground current) (Holmgreen connection) – appropriate for all networks

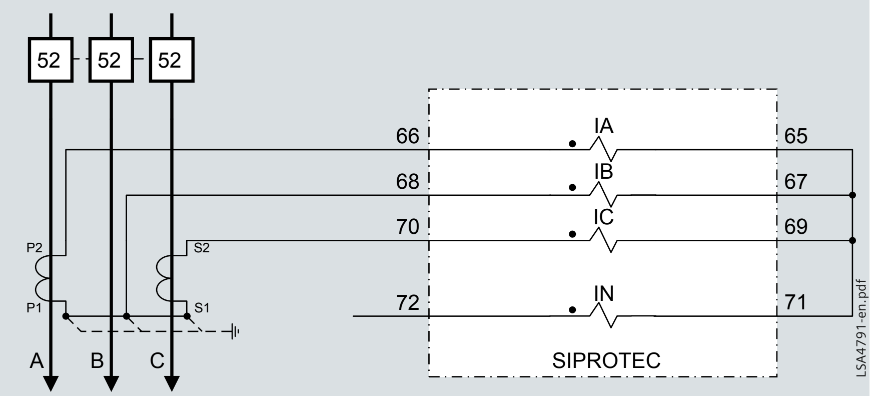


Fig. 7/16 Current transformer connections to two current transformers – only for isolated or resonant-grounded networks

Current transformer connections to three current transformers, ground current from an additional summation current transformer – preferably for effectively or low-resistance grounded networks.

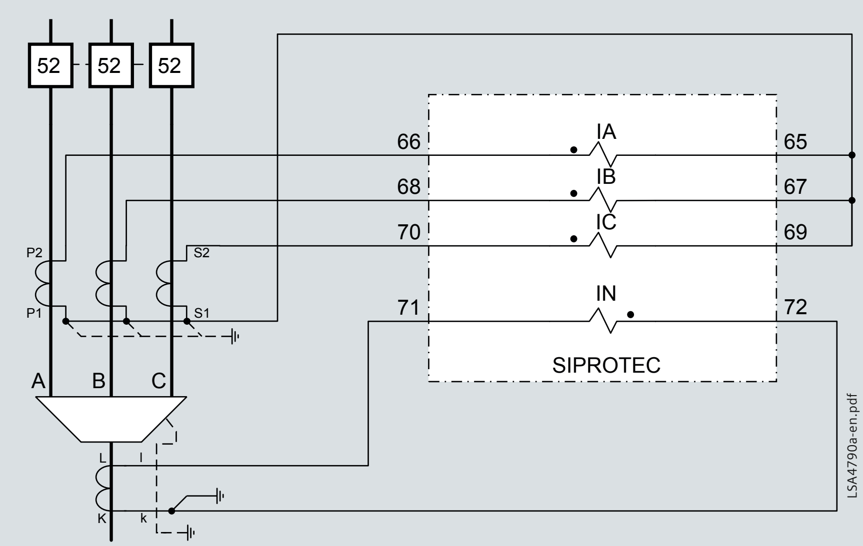


Fig. 7/17 Current transformer connections to three current transformers

Connection examples

Transformer connections to three current transformers and three voltage transformers

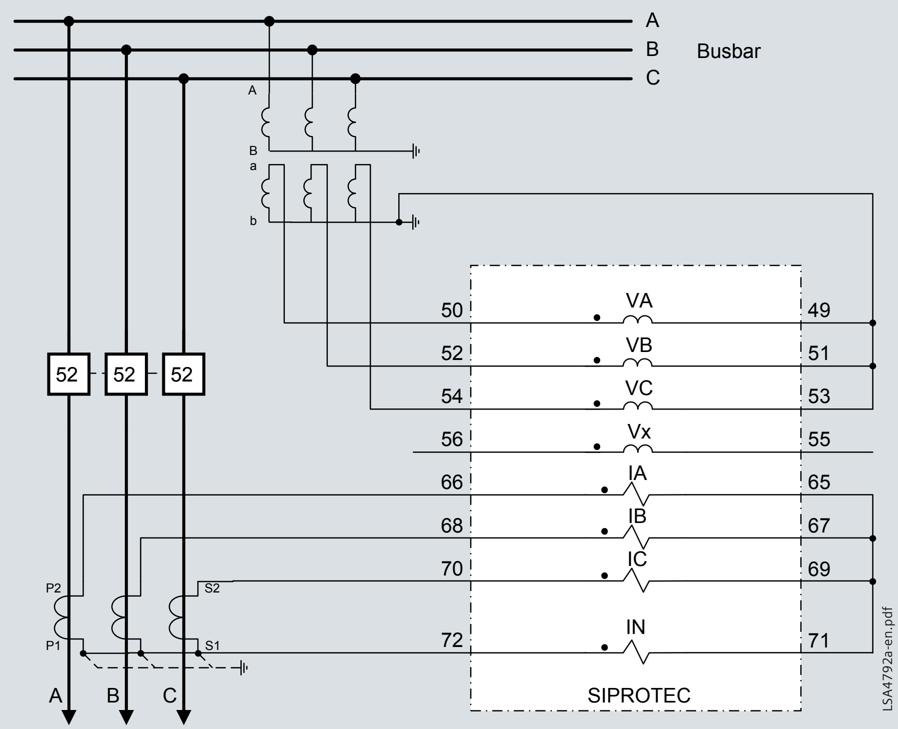


Fig. 7/18 Transformer connections to three current transformers and three voltage transformers (phase-to-ground voltages), normal circuit layout – appropriate for all networks.

Overview of connection types

Type of network	Function	Current connection	Voltage connection
(Low-resistance) grounded networks	Time-overcurrent protection phase/ground non-directional	Residual circuit, with 3 phase-current transformers required, phase-balance neutral current transformers possible	–
(Low-resistance) grounded networks	Time-overcurrent protection phases directional	Residual circuit, with 3 phase-current transformers possible	Phase-to-ground connection or phase-to-phase connection
(Low-resistance) grounded networks	Time-overcurrent protection ground directional	Residual circuit, with 3 phase-current transformers required, phase-balance neutral current transformers possible	Phase-to-ground connection required

Table 7/4 Overview of connection types

Attachment
SIPROTEC Compact

SIEMENS

SIPROTEC relay selection table

■ = Basic
● = Optional
– = not available
1) In preparation
2) Via CFC
More functions on page 8/10

	Application		Distance protection				
		Device series	SIPROTEC 4				SIPROTEC 5
ANSI	Functions	Abbr. / Type	7SA522	7SA61	7SA63	7SA64	7SA84 1)
	Protection functions for 3-pole tripping	3-pole	■	■	■	■	■
	Protection functions for 1-pole tripping	1-pole	●	●	●	●	–
14	Locked rotor protection	I> + V<	–	–	–	–	–
21	Distance protection	Z<	■	■	■	■	■
FL	Fault locator	FL	■	■	■	■	■
24	Overexcitation protection	V/f	–	–	–	–	–
25	Synchrocheck, synchronizing function	Sync	●	●	●	●	●
27	Undervoltage protection	V<	●	●	●	●	●
27TN/59TN	Stator ground fault 3rd harmonics	V0<,>(3rd Harm.)	–	–	–	–	–
32	Directional power supervision	P>, P<	■	■	■	■	●
37	Undercurrent, underpower	I< , P<	–	–	–	–	–
38	Temperature supervision	θ>	–	–	–	–	–
40	Underexcitation protection	$1/X_D$	–	–	–	–	–
46	Unbalanced-load protection	I2>	–	–	–	–	●
47	Phase-sequence-voltage supervision	LA, LB, LC	■	■	■	■	■
48	Start-time supervision	I^2_{start}	–	–	–	–	–
49	Thermal overload protection	θ, I^2t	–	■	■	■	●
50	Definite time-overcurrent protection	I>	■	■	■	■	■
50Ns	Sensitive ground-current protection	I_{Ns}>	●	●	●	●	●
50L	Load-jam protection	$I>_L$	–	–	–	–	–
50BF	Circuit-breaker failure protection	CBFP	●	●	●	●	●
51	Inverse time-overcurrent protection	I_P	■	■	■	■	■
55	Power factor	cos φ	■	■	■	■	■
59	Overvoltage protection	V>	●	●	●	●	●
59R, 27R	Rate-of-voltage-change protection	dV/dt	–	–	–	–	–
64	Sensitive ground-fault protection (machine)		–	–	–	–	–
66	Restart inhibit	I^2t	–	–	–	–	–
67	Directional overcurrent protection	I>, ∠ (V,I)	●	●	●	●	●
67Ns	Sensitive ground-fault detection for systems with resonant or isolated neutral	I_N>, ∠ (V,I)	●	●	●	●	● 1)
68	Power-swing blocking	ΔZ/Δt	●	●	●	●	●
74TC	Trip-circuit supervision	TCS	■	■	■	■	■
78	Out-of-step protection	ΔZ/Δt	●	●	●	●	●
79	Automatic reclosing	AR	●	●	●	●	●
81	Frequency protection	f<, f>	●	●	●	●	●
	Vector-jump protection	$\Delta\varphi_U$>	–	–	–	–	–
81LR	Load restoration	LR	–	–	–	–	–
85	Teleprotection		■	■	■	■	■
86	Lockout		■	■	■	■	■
87	Differential protection	ΔI	–	–	–	–	–

Table 8/1 SIPROTEC relay selection table

	Distance protection		Line differential protection							Combined line differential and distance protection	
	SIPROTEC 5		SIPROTEC 600	SIPROTEC Compact	SIPROTEC 4		SIPROTEC 5			SIPROTEC 5	
	7SA86 [1]	7SA87 [1]	7SD60	7SD80	7SD610	7SD5	7SD84 [1]	7SD86 [1]	7SD87 [1]	7SL86 [1]	7SL87 [1]
	■	■	■	■	■	■	■	■	■	■	■
	–	■	–	–	●	●	–	–	■	–	■
	–	–	–	–	–	–	–	–	–	–	–
	■	■	–	–	–	●	–	–	–	■	■
	■	■	–	–	–	●	■	■	■	■	■
	–	–	–	–	–	–	–	–	–	–	–
	●	●	–	–	–	–	●	●	●	●	●
	●	●	–	●	●	●	●	●	●	●	●
	–	–	–	–	–	–	–	–	–	–	–
	●	●	–	–	■	■	●	●	●	●	●
	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–
	●	●	–	–	–	–	●	●	●	●	●
	■	■	–	–	–	–	■	■	■	■	■
	–	–	–	–	–	–	–	–	–	–	–
	●	●	–	■	■	■	●	●	●	●	●
	■	■	●	■	■	■	■	■	■	■	■
	●	●	–	–	–	●	●	●	●	●	●
	–	–	–	–	–	–	–	–	–	–	–
	●	●	●	■	■	■	●	●	●	●	●
	■	■	–	■	■	■	■	■	■	■	■
	■	■	–	–	■	■	■	■	■	■	■
	●	●	–	●	●	●	●	●	●	●	●
	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–
	●	●	–	●	■	–	●	●	●	●	●
	● [1]	● [1]	–	–	–	●	● [1]	● [1]	● [1]	● [1]	● [1]
	●	●	–	–	–	●	–	–	–	●	●
	■	■	–	■	■	■	■	■	■	■	■
	●	●	–	–	–	●	–	–	–	●	●
	●	●	–	●	●	●	●	●	●	●	●
	●	●	–	●	●	●	●	●	●	●	●
	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–
	■	■	■	■	■	■	–	–	–	■	■
	■	■	–	■	■	■	■	■	■	■	■
	–	–	■	■	■	■	■	■	■	■	■

SIPROTEC relay selection table

■ = Basic
● = Optional
– = not available
1) In preparation
2) Via CFC
More functions on page 8/12

	Application		Overcurrent and feeder protection/ feeder automation				
		Device series	SIPROTEC easy		SIPROTEC 600		SIPROTEC Compact
ANSI	Functions	Abbr. / Type	7SJ45	7SJ46	7SJ600	7SJ602	7SJ80
	Protection functions for 3-pole tripping	3-pole	■	■	■	■	■
	Protection functions for 1-pole tripping	1-pole	–	–	–	–	–
14	Locked rotor protection	$I> + V<$	–	–	–	–	–
21	Distance protection	Z<	–	–	–	–	–
FL	Fault locator	FL	–	–	–	–	●
24	Overexcitation protection	V/f	–	–	–	–	–
25	Synchrocheck, synchronizing function	Sync	–	–	–	–	●
27	Undervoltage protection	$V<$	–	–	–	–	●
27TN/59TN	Stator ground fault 3rd harmonics	$V0<,>_{(3^{rd}\ Harm.)}$	–	–	–	–	–
32	Directional power supervision	$P>$, $P<$	–	–	–	–	●
37	Undercurrent, underpower	$I<$, $P<$	–	–	–	■	■
38	Temperature supervision	$\theta>$	–	–	–	●	–
40	Underexcitation protection	$1/X_D$	–	–	–	–	–
46	Unbalanced-load protection	$I2>$	–	–	■	■	■
47	Phase-sequence-voltage supervision	LA, LB, LC	–	–	–	–	●
48	Start-time supervision	I^2_{start}	–	–	–	–	–
49	Thermal overload protection	θ, I^2t	–	–	■	■	■
50	Definite time-overcurrent protection	$I>$	■	■	■	■	■
50Ns	Sensitive ground-current protection	$I_{Ns}>$	–	–	–	●	●
50L	Load-jam protection	$I>_L$	–	–	–		–
50BF	Circuit-breaker failure protection	CBFP	–	–	■	■	■
51	Inverse time-overcurrent protection	I_P	■	■	■	■	■
55	Power factor	$\cos\varphi$	–	–	–	–	●
59	Overvoltage protection	$V>$	–	–	–	●	●
59R, 27R	Rate-of-voltage-change protection	dV/dt	–	–	–	–	–
64	Sensitive ground-fault protection (machine)		–	–	–	–	–
66	Restart inhibit	I^2t	–	–	–	●	–
67	Directional overcurrent protection	$I>$, $\angle (V,I)$	–	–	–	–	●
67Ns	Sensitive ground-fault detection for systems with resonant or isolated neutral	$I_N>$, $\angle (V,I)$	–	–	–	●	●
68	Power-swing blocking	$\Delta Z/\Delta t$	–	–	–	–	–
74TC	Trip-circuit supervision	TCS	–	–	■	■	■
78	Out-of-step protection	$\Delta Z/\Delta t$	–	–	–	–	–
79	Automatic reclosing	AR	–	–	●	●	●
81	Frequency protection	$f<$, $f>$	–	–	–	–	●
	Vector-jump protection	$\Delta\varphi_U>$	–	–	–	–	–
81LR	Load restoration	LR	–	–	–	–	–
85	Teleprotection		–	–	–	–	–
86	Lockout		–	–	–	–	■
87	Differential protection	ΔI	–	–	–	–	–

Table 8/1 SIPROTEC relay selection table

8

	Overcurrent and feeder protection/ feeder automation							Generator and motor protection		
	SIPROTEC Compact		SIPROTEC 4				SIPROTEC 5	SIPROTEC Compact	SIPROTEC 4	
	7SJ81	7SC80 [1]	7SJ61	7SJ62	7SJ63	7SJ64	7SJ86 [1]	7SK80	7UM61	7UM62
	■	■	■	■	■	■	■	■	■	■
	–	–	–	–	–	–	–	–	–	–
	–	–	●	●	●	●	–	■	●	●
	–	–	–	–	–	–	–	–	–	●
	–	●	–	●	●	●	●	–	–	–
	–	–	–	–	–	–	–	–	●	●
	–	–	–	●	–	●	●	–	–	–
	–	●	–	●	●	●	●	●	■	■
	–	–	–	–	–	–	–	–	–	●
	–	●	–	●	–	●	●	●	●	●
	■	–	■	■	■ 2)	■	■ 2)	■	●	●
	–	–	●	●	●	●	–	■	●	●
	–	–	–	–	–	–	–	–	●	●
	■	■	■	■	■	■	■	■	●	●
	–	–	■	■	■	■	■	●	■	■
	–	–	●	●	●	●	–	■	●	●
	■	–	■	■	■	■	■	■	■	■
	■	■	■	■	■	■	■	■	■	■
	●	–	●	●	●	●	–	●	■	■
	–	–	●	●	●	●	–	■	–	–
	■	■	■	■	■	■	●	■	–	–
	■	■ 1)	■	■	■	■	■	■	■	■
	–	●	–	●	■ 2)	●	■ 2)	●	●	●
	–	●	–	●	●	●	●	●	●	●
	–	–	–	●	–	●	–	–	–	–
	–	–	–	–	–	–	–	–	■	■
	–	–	●	●	●	●	–	■	●	●
	–	●	–	●	●	●	●	●	■	■
	–	–	–	●	●	●	–	●	■	■
	–	–	–	–	–	–	–	–	–	●
	■	–	■	■	■	■	■	■	■	■
	–	–	–	–	–	–	–	–	–	●
	–	–	●	●	●	●	●	–	–	–
	–	●	–	●	●	●	●	●	■	■
	–	–	–	–	–	–	–	–	●	●
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	●	–	–	–
	■	–	■	■	■	■	■	■	■	■
	–	–	–	–	–	–	–	–	–	■

8

Attachment

SIPROTEC relay selection table

■ = Basic
● = Optional
– = not available
1) In preparation
2) Via CFC
More functions on page 8/14

Application			Transformer protection			Busbar protection	
		Device series	SIPROTEC 4			SIPROTEC 600	SIPROTEC 4
ANSI	Functions	Abbr. / Type	7UT612	7UT613	7UT63	7SS60	7SS52
	Protection functions for 3-pole tripping	3-pole	■	■	■	■	■
	Protection functions for 1-pole tripping	1-pole	–	–	–	■	–
14	Locked rotor protection	$I>$ + $V<$	–	–	–	–	–
21	Distance protection	Z<	–	–	–	–	–
FL	Fault locator	FL	–	–	–	–	–
24	Overexcitation protection	V/f	–	●	●	–	–
25	Synchrocheck, synchronizing function	Sync	–	–	–	–	–
27	Undervoltage protection	$V<$	–	●	●	–	–
27TN/59TN	Stator ground fault 3rd harmonics	$V0<,>_{(3^{rd}\ Harm.)}$	–	–	–	–	–
32	Directional power supervision	$P>$, $P<$	–	●	●	–	–
37	Undercurrent, underpower	$I<$, $P<$	–	–	–	–	–
38	Temperature supervision	$\theta>$	●	●	●	–	–
40	Underexcitation protection	$1/X_D$	–	–	–	–	–
46	Unbalanced-load protection	$I2>$	■	■	■	–	–
47	Phase-sequence-voltage supervision	LA, LB, LC	■	■	■	–	–
48	Start-time supervision	I^2_{start}	–	–	–	–	–
49	Thermal overload protection	θ, I^2t	●	●	●	–	–
50	Definite time-overcurrent protection	$I>$	■	■	■	–	●
50Ns	Sensitive ground-current protection	$I_{Ns}>$	–	–	–	–	–
50L	Load-jam protection	$I>_L$	–	–	–	–	–
50BF	Circuit-breaker failure protection	CBFP	●	●	●	–	■
51	Inverse time-overcurrent protection	I_P	●	●	●	–	●
55	Power factor	cos φ	■	■	■	–	–
59	Overvoltage protection	$V>$	–	●	●	–	–
59R, 27R	Rate-of-voltage-change protection	dV/dt	–	–	–	–	–
64	Sensitive ground-fault protection (machine)		–	–	–	–	–
66	Restart inhibit	I^2t	–	–	–	–	–
67	Directional overcurrent protection	$I>$, $\angle (V,I)$	–	–	–	–	–
67Ns	Sensitive ground-fault detection for systems with resonant or isolated neutral	$I_N>$, $\angle (V,I)$	–	–	–	–	–
68	Power-swing blocking	$\Delta Z/\Delta t$	–	–	–	–	–
74TC	Trip-circuit supervision	TCS	■	■	■	–	–
78	Out-of-step protection	$\Delta Z/\Delta t$	–	–	–	–	–
79	Automatic reclosing	AR	–	–	–	–	–
81	Frequency protection	$f<$, $f>$	–	●	●	–	–
	Vector-jump protection	$\Delta\varphi_U>$	–	–	–	–	–
81LR	Load restoration	LR	–	–	–	–	–
85	Teleprotection		–	–	–	–	–
86	Lockout		–	–	–	■	–
87	Differential protection	ΔI	■	■	■	■	■

8

	Bay controller					Breaker management		Synchro-nizing	Voltage and frequency protection	
	SIPROTEC 4			SIPROTEC 5		SIPROTEC 4	SIPROTEC 5	SIPROTEC 4	SIPROTEC 600	SIPROTEC Compact
	6MD61	6MD63	6MD66	6MD85 1)	6MD86 1)	7VK61	7VK87 1)	7VE6	7RW60	7RW80
	–	–	–	●	●	■	■	●	■	■
	–	–	–	–	–	■	■	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	●	●
	–	–	●	●	■	●	■	■	–	●
	–	–	–	●	●	●	●	●	■	■
	–	–	–	–	–	–	–	–	–	–
	–	–	–	●	●	–	●	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	■	■
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	●	●	●	●	–	–	–
	–	–	–	–	–	–	●	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	●	–	●	■	■	–	–	–
	–	–	–	●	●	●	●	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	●	●	●	●	●	■	■
	–	–	–	–	–	–	–	–	–	■
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	●	●	–	●	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	■	■	■	■	■	■	■
	–	–	–	–	–	–	–	–	–	–
	–	–	●	–	●	■	■	–	–	–
	–	–	–	●	●	–	●	●	■	■
	–	–	–	–	–	–	–	●	–	●
	–	–	–	–	–	–	–	–	–	●
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	■	■	–	–	■
	–	–	–	–	–	–	–	–	–	–

SIPROTEC relay selection table

■ = Basic ● = Optional – = not available
1) In preparation
2) Via CFC
3) = IO number of a standard variant (increased configuration available using the SIPROTEC 5 system)
4) = number of one unit 7SS60. Total number is depending on system configuration
More functions on page 8/16

Application			Distance protection					
		Device series	SIPROTEC 4				SIPROTEC 5	
ANSI	Functions	Abbr. / Type	7SA522	7SA61	7SA63	7SA64	7SA84 [1]	
87N	Differential ground-fault protection	ΔI_N	–	–	–	–	–	
	Broken-wire detection for differential protection		–	–	–	–	–	
90V	Automatic voltage control		–	–	–	–	–	
PMU	Synchrophasor measurement	PMU	–	–	–	–	● [1]	
	Further functions							
	Measured values		■	■	■	■	■	
	Switching-statistic counters		■	■	■	■	■	
	Logic editor		■	■	■	■	■	
	Inrush-current detection		–	–	–	–	■	
	External trip initiation		■	■	■	■	■	
	Control		■	■	■	■	■	
	Fault recording of analog and binary signals		■	■	■	■	■	
	Monitoring and supervision		■	■	■	■	■	
	Protection interface, serial		●	●	●	●	●	
	No. Setting groups		4	4	4	4	8	
	Battery charger/-monitor		–	–	–	–	–	

Distance protection		Line differential protection							Combined line differential and distance protection	
SIPROTEC 5		SIPROTEC 600	SIPROTEC Compact	SIPROTEC 4		SIPROTEC 5			SIPROTEC 5	
7SA86 1)	7SA87 1)	7SD60	7SD80	7SD610	7SD5	7SD84 1)	7SD86 1)	7SD87 1)	7SL86 1)	7SL87 1)
–	–	■	■	–	–	–	–	–	–	–
–	–	–	–	■	■	■	■	■	■	■
–	–	–	–	–	–	–	–	–	–	–
● 1)	● 1)	–	–	–	–	● 1)	● 1)	● 1)	● 1)	● 1)
■	■	■	■	■	■	■	■	■	■	■
■	■	–	■	■	■	■	■	■	■	■
■	■	–	■	■	■	■	■	■	■	■
■	■	●	■	■	■	■	■	■	■	■
■	■	■	■	■	■	■	■	■	■	■
■	■	–	■	■	■	■	■	■	■	■
■	■	■	■	■	■	■	■	■	■	■
■	■	■	■	■	■	■	■	■	■	■
●	●	–	■	■	■	■	■	■	■	■
8	8	–	4	4	4	8	8	8	8	8
–	–	–	–	–	–	–	–	–	–	–

SIPROTEC relay selection table

■ = Basic ● = Optional – = not available
1) In preparation
2) Via CFC
3) = IO number of a standard variant (increased configuration available using the SIPROTEC 5 system)
4) = number of one unit 7SS60. Total number is depending on system configuration
More functions on page 8/18

Application			Overcurrent and feeder protection feeder automation				
		Device series	SIPROTEC easy		SIPROTEC 600		SIPROTEC Compact
ANSI	Functions	Abbr. / Type	7SJ45	7SJ46	7SJ600	7SJ602	7SJ80
87N	Differential ground-fault protection	ΔI_N	–	–	–	●	●
	Broken-wire detection for differential protection		–	–	–	–	–
90V	Automatic voltage control		–	–	–	–	–
PMU	Synchrophasor measurement	PMU	–	–	–	–	–
	Further functions						
	Measured values		–	–	■	■	■
	Switching-statistic counters		–	–	–	–	■
	Logic editor		–	–	–	–	■
	Inrush-current detection		–	–	–	–	■
	External trip initiation		–	–	■	■	■
	Control		–	–	–	–	■
	Fault recording of analog and binary signals		–	–	■	■	■
	Monitoring and supervision		–	–	■	■	■
	Protection interface, serial		–	–	–	–	–
	No. Setting groups		1	1	1	1	4
	Battery charger/-monitor		–	–	–	–	–

	Overcurrent and feeder protection feeder automation							Generator and motor protection		
	SIPROTEC Compact		SIPROTEC 4				SIPROTEC 5	SIPROTEC Compact	SIPROTEC 4	
	7SJ81	7SC80 [1)]	7SJ61	7SJ62	7SJ63	7SJ64	7SJ86 [1)]	7SK80	7UM61	7UM62
	–	–	●	●	●	●	–	–	●	●
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	●	–	–	–
	■	■	■	■	■	■	■	■	■	■
	■	■	■	■	■	■	■	■	■	■
	■	■	■	■	■	■	■	■	■	■
	■	■	■	■	■	■	■	■	–	●
	■	■	■	■	■ 2)	■	■	■	■	■
	■	■	■	■	■	■	■	■	■	■
	■	■	■	■	■	■	■	■	–	–
	■	■	■	■	■	■	■	■	■	■
	–	–	–	–	–	–	●	–	–	–
	4	4	4	4	4	4	8	4	4	4
	–	● 1)	–	–	–	–	–	–	–	–

8

SIPROTEC relay selection table

■ = Basic ● = Optional – = not available
1) In preparation
2) Via CFC
3) = IO number of a standard variant (increased configuration available using the SIPROTEC 5 system)
4) = number of one unit 7SS60. Total number is depending on system configuration
More functions on page 8/20

Application			Transformer protection			Busbar protection	
		Device series	SIPROTEC 4			SIPROTEC 600	SIPROTEC 4
ANSI	**Functions**	Abbr. / Type	7UT612	7UT613	7UT63	7SS60	7SS52
87N	Differential ground-fault protection	ΔI_N	●	●	●	–	–
	Broken-wire detection for differential protection		■	■	■	–	–
90V	Automatic voltage control		–	–	–	–	–
PMU	Synchrophasor measurement	PMU	–	–	–	–	–
	Further functions						
	Measured values		■	■	■	■	■
	Switching-statistic counters		■	■	■	–	–
	Logic editor		■	■	■	–	■
	Inrush-current detection		■	■	■	–	–
	External trip initiation		■	■	■	–	■
	Control		■	■	■	–	–
	Fault recording of analog and binary signals		■	■	■	■	■
	Monitoring and supervision		■	■	■	■	■
	Protection interface, serial		–	–	–	–	–
	No. Setting groups		4	4	4	1	1
	Battery charger/-monitor		–	–	–	–	–

8

	Bay controller					Breaker management		Synchro-nizing	Voltage and frequency protection	
	SIPROTEC 4			SIPROTEC 5		SIPROTEC 4	SIPROTEC 5	SIPROTEC 4	SIPROTEC 600	SIPROTEC Compact
	6MD61	6MD63	6MD66	6MD85 1)	6MD86 1)	7VK61	7VK87 1)	7VE6	7RW60	7RW80
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
	–	–	–	● 1)	● 1)	–	● 1)		–	–
	●	■	■	■	■	■	■	■	■	■
	■	■	■	■	■	■	■	■	–	■
	–	■	■	■	■	■	■	■	–	■
	–	–	–	●	●	–	■	–	–	–
	–	–	–	–	–	■	■	●	●	■
	■	■	■	■	■	■	■	■	–	■
	■	■	●	■	■	■	■	■	■	■
	■	■	■	■	■	■	■	■	■	■
	–	–	–	●	●	–	●	–	–	–
	4	4	4	8	8	4	8	4	1	4
	–	–	–	–	–	–	–	–	–	–

Ordering examples and accessories

Ordering example

Position	Description	Order No.	Short code
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 7RW80 2 0-5 E C 9 6-1 D A 0+L 0 G	
6	Housing 1/6 19", 3xV, 7 BI, 8 BO[1), 1 life status contact	2	
8	Rated auxiliary voltage: DC 60 V to 250 V; AC 115 V; AC 230 V	5	
9	Unit version: Flush mounting housing, screw-type terminal	E	
10	Region US, ANSI, language US-English, US front	C	
11	Communication: System interface: DNP 3.0, electrical RS485	9	L 0 G
12	Communication: With Ethernet interface (DIGSI, not IEC 61850), RJ45 connector	6	
13	Measuring / fault recording	1	
14/15	Protection function: Voltage and frequency relay	D A	

1) 2 changeover/Form C.

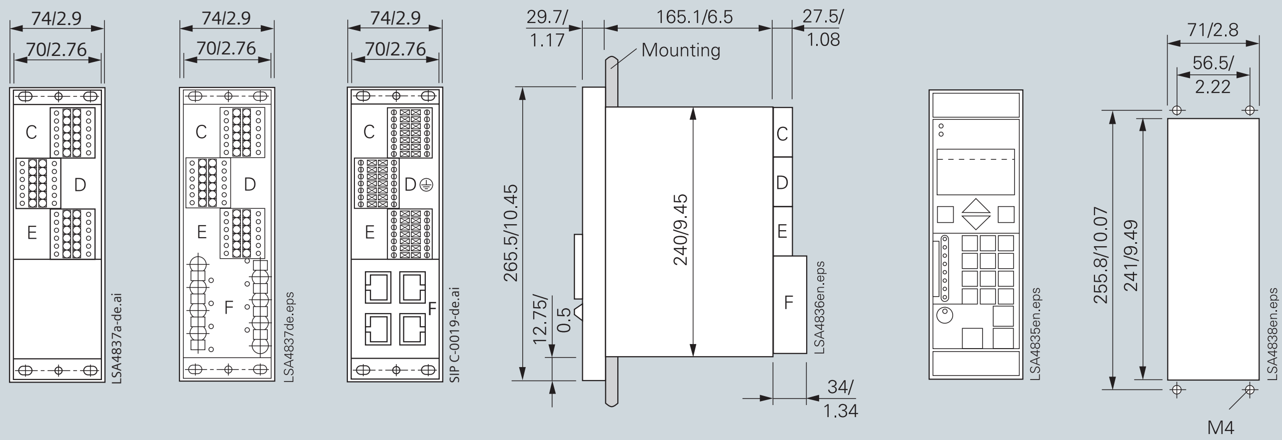
Assessories

Product description	Variants	Order No.
DIGSI 4 Software for projecting and usage of all Siemens protection devices is running under MS Windows XP prof./MS Windows Vista Home Premium, Business and Ultimate	**Basis** Basic version with license for 10 computers (authorisation by serial number)	**7XS5400-0AA00**
	Professional DIGSI 4 Basis + SIGRA (Fault record analysis) + CFC-Editor (Logic-Editor) + Display-Editor (Editor for control displays) + DIGSI 4 Remote (Remote operation) with license for 10 computers (authorisation by serial number)	**7XS5402-0AA00**
	Professional + IEC 61850 Professional version and IEC 61850 System configurator with license for 10 computers (authorisation by serical number)	**7XS5403-0AA00**
Terminals Voltage terminal block C or block E Voltage terminal block D (inverse printed) Jumper voltage block (6 pice)		 **C53207-A406-D181-1** **C53207-A406-D182-1** **C53207-A406-D194-1**
Standard USB cable (type A-type B)		available in specialist stores
Surface console	Accessories for flush-mounted variant perform an surface-mounted variant	**C53207-A356-D850-1**
Mounting bracket set for 19" frame		**C73165-A63-D200-1**

Description	Order No.
SIGRA 4 Software for graphic visualisation, analysis and evaluation of fault and measurement records is running under MS Windows XP Prof./MS Windows Vista Home Premium, Business and Ultimate / MS Windows Server 2008 R2 see product information for supported service packs of operating systems	
SIGRA 4 for DIGSI With license for 10 PCs (authorisation by serial number)	**7XS5410-0AA00**
SIGRA 4 Scientific Installation without DIGSI 4 only for university-level institutions with license for 10 PCs (authorisation by serial number)	**7XS5416-1AA00**
Stand Alone Version Installation without DIGSI 4 (authorisation by serial number)	**7XS5416-0AA00**
Trial SIGRA 4 Like SIGRA 4 Stand Alone, but only valid for 30 days (test version) (no authorisation required)	**7XS5411-1AA00**
Upgrade SIGRA 4 Trial to SIGRA 4 Stand Alone Like SIGRA 4 Stand Alone. For customers who want to unlock their trial version. With license for 10 PCs	**7XS5416-2AA00**

Attachment

Dimension drawings



Rear view
7RW80

Rear view
7SJ80, 7SK80
and 7SD80

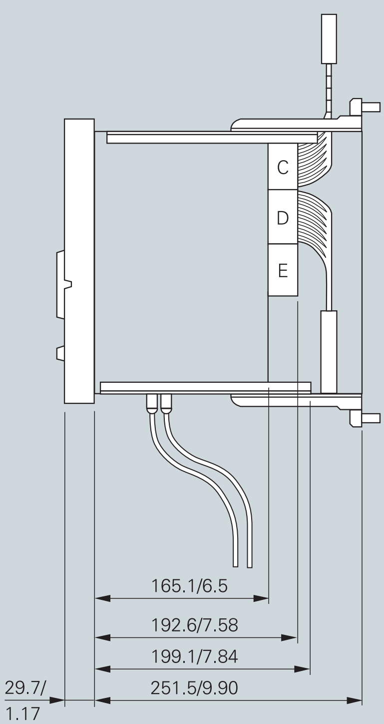
Rear view
7SJ81

Side view

Front view

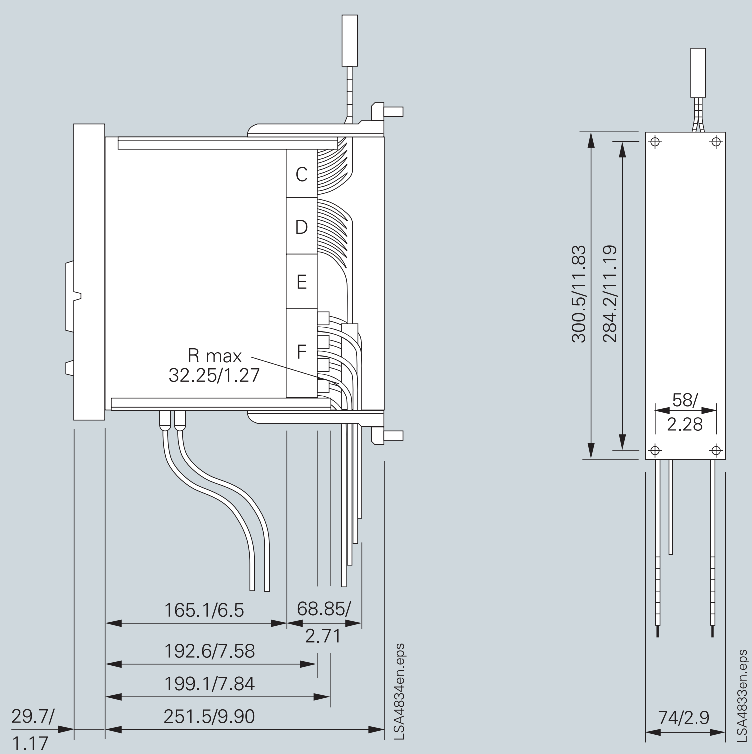
Panel cut-out

Fig. 7/1 Panel surface and cabinet flush mounting



Side view 7RW80

Fig. 7/2 7RW80 for panel surface mounting



Side view

Front view

Fig. 7/3 7SJ80, 7SK80, 7SD80 for panel surface mounting

Note: Dimensions in mm
Values in Brackets in inches

Dimension drawings 7SC80

Fig. 7/4 7SC80

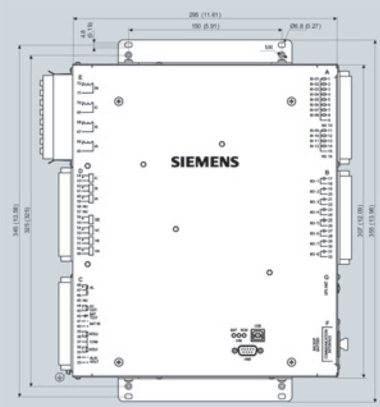


Fig. 7/5 7SC80 front dimensions

Note: Dimensions in mm
Values in Brackets in inches

Legal notice

Indication of conformity

This product conforms to the regulations of the Directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 89/336/EEC) and concerning electrical equipment for use within specified voltage limits (Low-Voltage Directive 73/23/EEC).

This conformity is the result of a test performed by Siemens AG according to Article 10 of the Directive in compliance with the basic technical standards EN 50081 and EN 50082 for the EMC Directive, and with the standard EN 60255-6 for the Low-Voltage Directive.

The device has been especially developed and manufactured for application in the industrial sector according to the EMC standard.

The product is conform with the international standard of the IEC 60255 series, and with the German standard DIN 57435/Part 303 (corresponding to VDE 0435/Part 303).

Disclaimer of liability

This document has been subjected to rigorous technical review before being published. It is revised at regular intervals, and any modifications and amendments are included in the subsequent issues. The content of this document has been compiled for information purposes only. Although Siemens AG has made best efforts to keep the document as precise and up-to-date as possible, Siemens AG shall not assume any liability for defects and damage which result through use of the information contained herein.

This content does not form part of a contract or of business relations; nor does it change these. All obligations of Siemens AG are stated in the relevant contractual agreements.

Document version: 01

Release status: 12.2011

Version of the product described: V 1.0

Copyright

Registered trademarks

Siemens AG
Infrastructure & Cities Sector
Smart Grid Division
Energy Automation
Humboldtstr. 59
90459 Nuremberg, Germany

For more information,
please contact our
Customer Support Center.
Tel.: +49 180 524 84 37
Fax: +49 180 524 24 71
(Charges depending on provider)
E-Mail: support.ic@siemens.com
www.siemens.com/siprotec

Order No. E50001-K4403-A011-A1-7600
Printed in Germany
Dispo 06200, c4bs 7442
KG 12.11 0.75 168 En
3600 / 36892 WÜ
Printed on elementary chlorine-free bleached paper.

SIEMENS