SIPROTEC 4 7SA6
Distance Protection Relay for all Voltage Levels

Fig. 6/1
SIPROTEC 4
7SA6 distance protection relay

Description

The SIPROTEC 4 7SA6 distance protection relay is a universal device for protection, control and automation on the basis of the SIPROTEC 4 system. Its high level of flexibility makes it suitable to be implemented at all voltage levels. With this relay you are ideally equipped for the future: it offers security of investment and also saves on operating costs.

– High-speed tripping time
– Impedance setting range allows very small settings for the protection of very short lines
– Self-setting detection for power swing frequencies up to 7 Hz
– Current transformer saturation detector prevents non-selective tripping by distance protection in the event of CT saturation.
– Phase-segregated teleprotection for improved selectivity and availability
– Digital relay-to-relay communication by means of an integrated serial protection data interface
– Adaptive auto-reclosure (ADT)

Function overview

Protection functions

- Non-switched distance protection with 6 measuring systems (21/21N)
- High resistance earth-fault protection for single and three-pole tripping (50N, 51N, 67N)
- Earth-fault detection in isolated and resonant-earthed networks
- Tele (pilot) protection (85)
- Fault locator (FL)
- Power-swing detection/tripping (68/68T)
- Phase overcurrent protection (50/51/67)
- Switch-onto-fault protection (50HS)
- STUB bus overcurrent protection (50STUB)
- Overvoltage/undervoltage protection (59/27)
- Over/underfrequency protection (81O/U)
- Auto-reclosure (79)
- Synchro-check (25)
- Breaker failure protection (50BF)
- Thermal overload protection (49)

Control function

- Commands f. ctrl. of CBs and isolators

Monitoring functions

- Trip circuit supervision (74TC)
- Self-supervision of the relay
- Measured-value supervision
- Event logging/fault logging
- Oscillographic fault recording
- Switching statistics

Front design

- Easy operation w. numeric keys
- Function keys
- LEDs for local alarm
- PC front port for convenient relay setting

Communication interfaces

- Front interface for connecting a PC
- System interface for connecting to a control system via various protocols
  – IEC 61850 Ethernet
  – IEC 60870-5-103 protocol
  – PROFIBUS-FMS/-DP
  – DNP 3.0
- 1 serial protection data interface for teleprotection
- Rear-side service/modem interface
- Time synchronization via
  – IRIG-B or DCF 77 or
  – system interface

Application

The distance protection relay 7SA6 is non-switched incorporating all the additional functions for protection of overhead lines and cables at all voltage levels from 5 to 765 kV.

All methods of neutral point connection (resonant earthing, isolated, solid or low-resistance earthing) are reliably dealt with. The unit can issue single or three-pole TRIP commands as well as CLOSE commands. Consequently both single-pole, three-pole and multiple auto-reclosure is possible.

Teleprotection functions as well as earth-fault protection and sensitive earth-fault detection are included. Power swings are detected reliably and non-selective tripping is prevented. The unit operates reliably and selectively even under the most difficult network conditions.

Cost-effective power system management

The SIPROTEC 4 units are numerical relays which also provide control and monitoring functions and therefore support the user in view of a cost-effective power system management. The security and reliability of power supply is increased as a result of minimizing the use of hardware.

The local operation has been designed according to ergonomic criteria. Large, easy-to-read backlit displays are provided.

The SIPROTEC 4 units have a uniform design and a degree of functionality which represents a benchmark-level of performance in protection and control. If the requirements for protection, control or interlocking change, it is possible in the majority of cases to implement such changes by means of parameterization using DIGSI 4 without having to change the hardware. The use of powerful microcontrollers and the application of digital measured-value conditioning and processing largely suppresses the influence of higher-frequency transients, harmonics and DC components.

ANSI	Protection functions
21/21N	Distance protection
FL	Fault locator
50N/51N 67N	Directional earth-fault protection
50/51/67	Backup overcurrent protection
50 STUB	STUB-bus overcurrent stage
68/68T	Power swing detection/tripping
85/21	Teleprotection for distance protection
27WI	Weak-infeed protection
85/67N	Teleprotection for earth-fault protection
50HS	Switch-onto-fault protection
50BF	Breaker-failure protection
59/27	Overvoltage/undervoltage protection
81O/U	Over/underfrequency protection
25	Synchro-check
79	Auto-reclosure
74TC	Trip circuit supervision
86	Lockout (CLOSE command interlocking)
49	Thermal overload protection
I_{EE}	Sensitive earth-fault detection

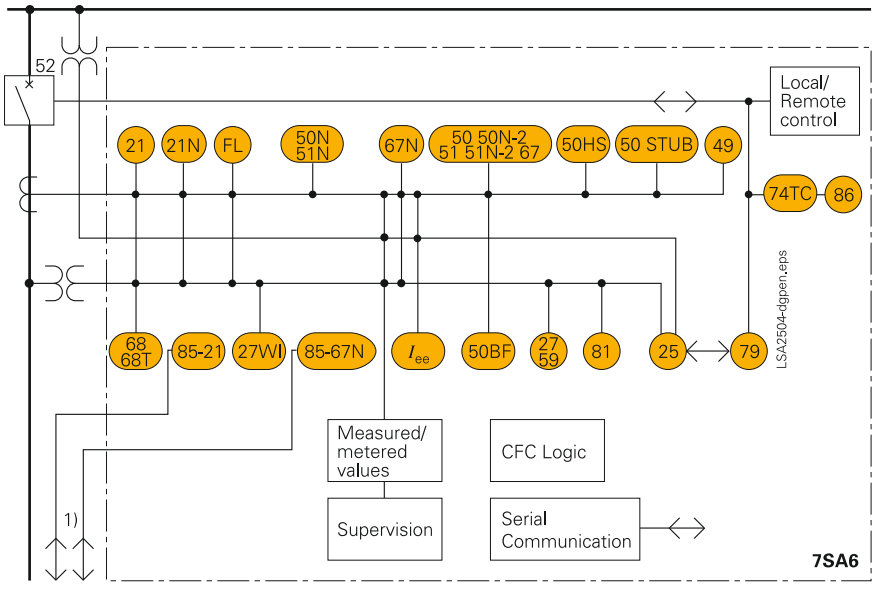


Fig. 6/2 Function diagram

1) Teleprotection schemes can use conventional signaling or serial data exchange

Construction

Connection techniques and housing with many advantages

1/3, 1/2, 2/3, and 1/1-rack sizes:
These are the available housing widths of the 7SA6 relays, referred to a 19" module frame system. This means that previous models can always be replaced. The height is a uniform 245 mm for flush-mounting housings and 266 mm for surface-mounting housings for all housing widths. All cables can be connected with or without ring lugs. Plug-in terminals are available as an option. It is thus possible to employ prefabricated cable harnesses. In the case of surface mounting on a panel, the connection terminals are located above and below in the form of screw-type terminals. The communication interfaces are located in a sloped case at the top and bottom of the housing. The housing can also be supplied optionally with a detached operator panel (refer to Fig. 6/5), in order to allow optimum operation for all types of applications.

Fig. 6/3
Flush-mounting housing with screw-type terminals

Fig. 6/4
Rear view of flush-mounting housing with covered connection terminals and wirings

Fig. 6/5 Flush-mounting housing with plug-in terminals and detached operator panel

Fig. 6/6
Surface-mounting housing with screw-type terminals

Fig. 6/7
Com munication interfaces in a sloped case in a surface-mounting housing

Protection functions

Distance protection (ANSI 21, 21N)

The main function of the 7SA6 is a non-switched distance protection. By parallel calculation and monitoring of all six impedance loops, a high degree of sensitivity and selectivity is achieved for all types of fault. The shortest tripping time is less than one cycle. All methods of neutral-point connection (resonant earthing, isolated, solid or low-resistance earthing) are reliably dealt with. Single-pole and three-pole tripping is possible. Overhead lines can be equipped with or without series capacitor compensation.

Four pickup methods

The following pickup methods can be employed alternatively:

- Overcurrent pickup *I*>>
- Voltage-dependent overcurrent pickup *V*/*I*
- Voltage-dependent and phase angle-dependent overcurrent pickup *V*/*I*/*φ*
- Impedance pickup *Z*<

Load zone

The pickup mode with quadrilateral impedance pickup (*Z*<) is fitted with a variable load zone. In order to guarantee a reliable discrimination between load operation and short-circuit (especially on long high loaded lines), the relay is equipped with a selectable load encroachment characteristic. Impedances within this load encroachment characteristic prevent the distance zones from unwanted tripping.

Absolute phase-selectivity

The 7SA6 distance protection incorporates a well-proven, highly sophisticated phase selection algorithm. The pickup of unfaulted phases is reliably eliminated. This phase selection algorithm achieves single-pole tripping and correct distance measurement in a wide application range. Interference to distance measurement caused by parallel lines can be compensated by taking the earth current of the parallel system into account.

This parallel line compensation can be taken into account both for distance measurement and for fault locating.

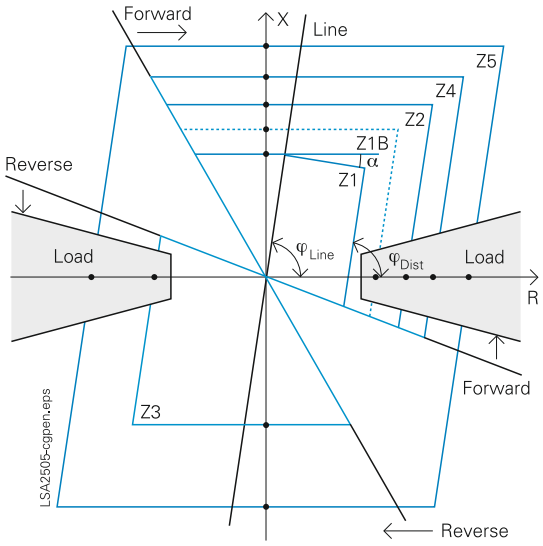


Fig. 6/8
Impedance fault detection *Z*< with quadrilateral characteristic

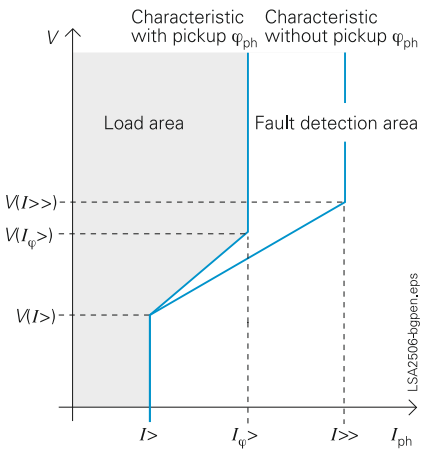


Fig. 6/9
Voltage and angle-dependent overcurrent fault detection *V* / *I* / *φ*

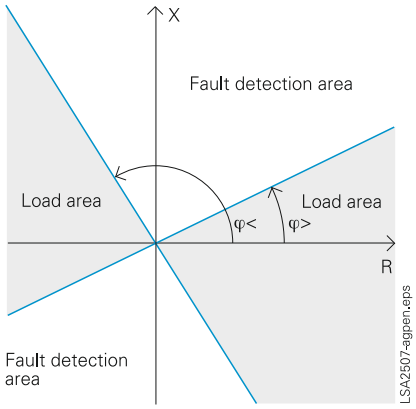


Fig. 6/10
Angle pickup for the *V* / *I* / *φ* fault detection

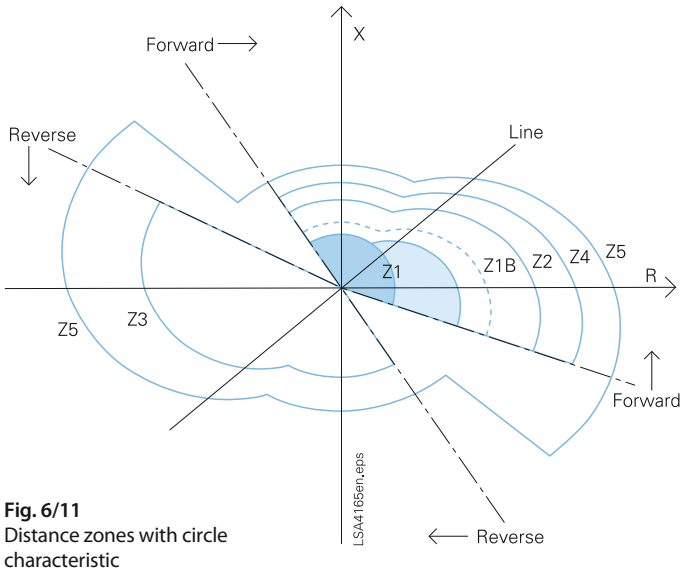


Fig. 6/11
Distance zones with circle characteristic

Protection functions

Seven distance zones
Six independant distance zones and one separate overreach zone are available. Each distance zone has dedicated time stages, partially separate for single-phase and three-phase faults. Earth faults are detected by monitoring the earth current $3I_0$ and the zero-sequence voltage $3V_0$. The quadrilateral tripping characteristic allows use of separate settings for the X and the R directions. Different R settings can be employed for earth and phase faults. This characteristic offers advantages in the case of faults with fault resistance. For applications to medium-voltage cables with low line angles, it may be advantageous to select the distance zones with the optional circle characteristic.
All the distance protection zones can be set to forward, reverse or non-directional.

Optimum direction detection
Use of voltages, which are not involved with the short-circuit loop, and of voltage memories for determination of the fault direction ensure that the results are always reliable.

Elimination of interference signals
Digital filters render the unit immune to interference signals contained in the measured values. In particular, the influence of DC components, capacitive voltage transformers and frequency changes is considerably reduced. A special measuring method is employed in order to assure protection selectivity during saturation of the current transformers.

Measuring voltage monitoring
Tripping of the distance protection is blocked automatically in the event of failure of the measuring voltage, thus preventing spurious tripping.
The measuring voltage is monitored by the integrated fuse failure monitor. Distance protection is blocked if either the fuse failure monitor or the auxiliary contact of the voltage transformer protection switch operates and in this case the EMERGENCY definite-time overcurrent protection can be activated.

Fault locator

The integrated fault locator calculates the fault impedance and the distance-to-fault. The results are displayed in ohms, kilometers (miles) and in percent of the line length. Parallel line compensation and load current compensation for high-resistance faults is also available.

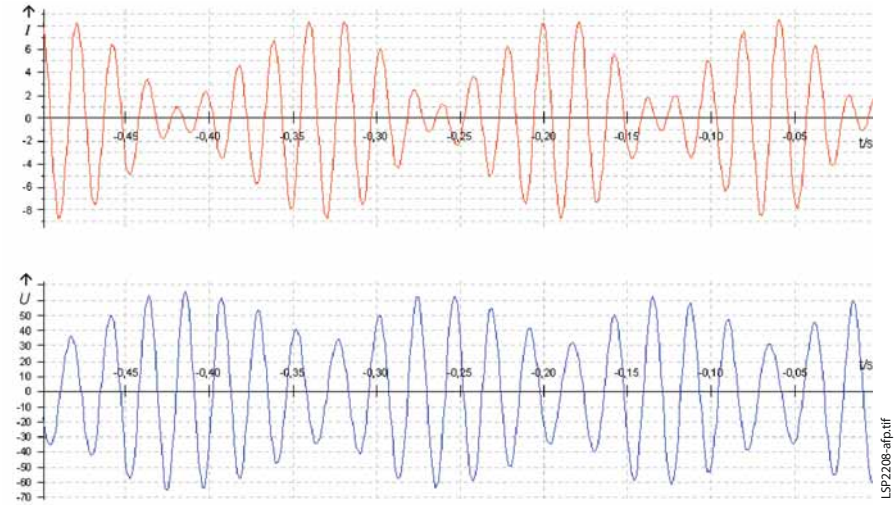


Fig. 6/12 Power swing current and voltage wave forms

Power swing detection (ANSI 68, 68T)

Dynamic transient reactions, for instance short-circuits, load fluctuations, auto-reclosures or switching operations can cause power swings in the transmission network. During power swings, large currents along with small voltages can cause unwanted tripping of distance protection relays. To avoid uncontrolled tripping of the distance protection and to achieve controlled tripping in the event of loss of synchronism, the 7SA6 relay is equipped with an efficient power swing detection function. Power swings can be detected under symmetrical load conditions as well as during single-pole auto-reclosures.

Tele (pilot) protection for distance protection (ANSI 85-21)

A teleprotection function is available for fast clearance of faults up to 100 % of the line length. The following operating modes may be selected:

- POTT
- Directional comparison pickup
- Unblocking
- PUTT acceleration with pickup
- PUTT acceleration with Z1B
- Blocking
- Pilot-wire comparison
- Reverse interlocking
- DUTT, direct underreaching zone transfer trip (together with Direct Transfer Trip function).

The carrier send and receive signals are available as binary inputs and outputs and can be freely assigned to each physical relay input or output. At least one channel is required for each direction.

Common transmission channels are power-line carrier, microwave radio and fiber-optic links. A serial protection data interface for direct connection to a digital communication network or fiber-optic link is available.

7SA6 also permits the transfer of phase-selective signals. This feature is particularly advantageous as it ensures reliable single-pole tripping, if single-pole faults occur on different lines. The transmission methods are suitable also for lines with three ends (three-terminal lines). Phase-selective transmission is also possible with multi-end application, if some user-specific linkages are implemented by way of the integrated CFC logic.

During disturbances in the signaling channel receiver or on the transmission circuit, the teleprotection function can be blocked via a binary input signal without losing the zone selectivity.

The control of the overreach zone Z1B (zone extension) can be switched over to the auto-reclosure function.

Transient blocking (current reversal guard) is provided for all the release and blocking methods in order to suppress interference signals during tripping of parallel lines.

Protection functions

Direct transfer tripping

Under certain conditions on the power system it is necessary to execute remote tripping of the circuit-breaker. The 7SA6 relay is equipped with phase-selective phase-selective "external trip inputs" that can be assigned to the received inter-trip signal for this purpose.

Weak-infeed protection: echo and/or trip (ANSI 27 WI)

To prevent delayed tripping of permissive schemes during weak or zero infeed situations, an echo function is provided.
If no fault detector is picked up at the weak-infeed end of the line, the signal received here is returned as echo to allow accelerated tripping at the strong infeed end of the line. It is also possible to initiate phase-selective tripping at the weak-infeed end. A phase-selective single-pole or three-pole trip is issued if a permissive trip signal (POTT or Unblocking) is received and if the phase-earth voltage drops correspondingly. As an option, the weak infeed logic can be equipped according to a French specification.

Overvoltage protection, undervoltage protection (ANSI 59, 27)

A voltage rise can occur on long lines that are operating at no-load or that are only lightly loaded. The 7SA6 contains a number of overvoltage measuring elements. Each measuring element is of two-stage design. The following measuring elements are available:

- Phase-to-earth overvoltage
- Phase-to-phase overvoltage
- Zero-sequence overvoltage
  The zero-sequence voltage can be connected to the 4th voltage input or be derived from the phase voltages.
- Positive-sequence overvoltage of the local end or calculated for the remote end of the line (compounding)
- Negative-sequence overvoltage

Tripping by the overvoltage measuring elements can be effected either at the local circuit-breaker or at the remote station by means of a transmitted signal.

The 7SA6 is fitted, in addition, with three two-stage undervoltage measuring elements:

- Phase-to-earth undervoltage
- Phase-to-phase undervoltage
- Positive-sequence undervoltage

The undervoltage measuring elements can be blocked by means of a minimum current criterion and by means of binary inputs.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for overfrequency and underfrequency protection. 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 (45 to 55, 55 to 65 Hz). There are four elements (selectable as overfrequency or underfrequency) and each element can be delayed separately.

Directional earth-fault protection for high-resistance faults (ANSI 50N, 51N, 67N)

In an earthed network it may happen that the distance protection´s sensitivity is not sufficient to detect high-resistance earth faults. The 7SA6 protection relay therefore offers protection functions for faults of this nature.

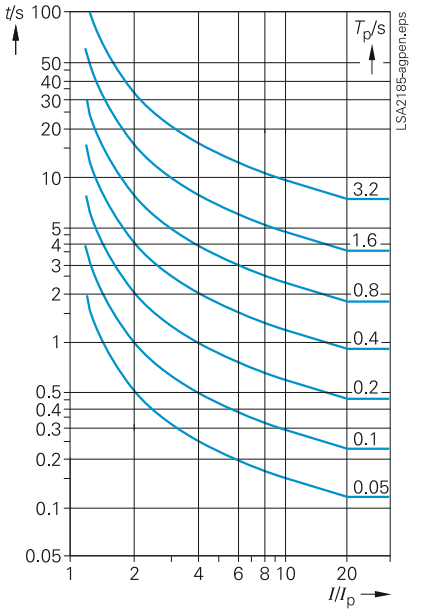
The earth-fault protection can be used with three definite-time stages and one inverse-time stage (IDMT).

Inverse-time characteristics according to IEC 60255-3 and ANSI/IEEE are provided (see "Technical data"). A 4th definite-time stage can be applied instead of the 1st inverse-time stage.

An additional logarithmic inverse-time characteristic is also available.

The direction decision is determined by the earth current and the zero-sequence voltage or by the negative-sequence components V_2 and I_2. In addition or as an alternative, the direction can be determined with the earth current of an earthed power transformer and the zero-sequence voltage. Dual polarization applications can therefore be fulfilled. Alternatively, the direction can be determined by evaluation of zero-sequence power. Each overcurrent stage can be set in forward or reverse direction or in both directions (non-directional).

The function is equipped with special digital filter algorithms, providing the elimination of higher harmonics. This feature is particularly important for small zero-sequence fault currents which usually have a high content of 3rd and 5th harmonic.



$$t = \frac{0.14}{\left(I / I_p\right)^{0.02} - 1} T_p$$

Fig. 6/13 Normal inverse

Fig. 6/14
Transient earth-fault relay 7SN60

Protection functions

Inrush stabilization and instantaneous switch-onto-fault tripping can be activated separately for each stage as well.

Different operating modes can be selected. The earth-fault protection is suitable for three-phase and, optionally, for single-phase tripping by means of a sophisticated phase selector. It may be blocked during the dead time of single-pole auto-reclose cycles or during pickup of the distance protection.

Tele (pilot) protection for directional earth-fault protection (ANSI 85-67N)

The directional earth-fault protection can be combined with the available signaling methods:

- Directional comparison
- BLOCKING
- UNBLOCKING

The transient blocking function (current reversal guard) is also provided in order to suppress interference signals during tripping of parallel lines.

The pilot functions for distance protection and for earth-fault protection can use the same signaling channel or two separate and redundant channels.

Backup overcurrent protection (ANSI 50, 50N, 51, 51N, 67)

The 7SA6 provides a backup overcurrent protection. Two definite-time stages and one inverse-time stage (IDMTL) are available, separately for phase currents and for the earth current. The application can be extended to a directional overcurrent protection (ANSI 67) by taking into account the decision of the available direction detection elements. Two operating modes are selectable. The function can run in parallel to the distance protection or only during failure of the voltage in the VT secondary circuit (emergency operation).

The secondary voltage failure can be detected by the integrated fuse failure monitor or via a binary input from a VT miniature circuit-breaker (VT m.c.b. trip).

Inverse-time characteristics according to IEC 60255-3 and ANSI/IEEE are provided (see "Technical data").

Instantaneous high-speed switch-onto-fault overcurrent protection (ANSI 50HS)

Instantaneous tripping is required when energizing a faulty line. In the event of large fault currents, the high-speed switch-onto-fault overcurrent stage can initiate very fast three-pole tripping.

With smaller fault currents, instantaneous tripping after switch-onto-fault is also possible with the overreach distance zone Z1B or with pickup.

The switch-onto-fault initiation can be detected via the binary input "manual close" or automatically via measurement.

Earth-fault detection in systems with a star-point that is not effectively earthed

In systems with an isolated or resonant earthed (grounded) star-point, single-phase earth faults can be detected. The following functions are integrated for this purpose:

- Detection of an earth fault by monitoring of the displacement voltage
- Determination of the faulted phase by measurement of the phase-to-earth voltage
- Determination of the earth-fault direction by highly accurate measurement of the active and reactive power components in the residual earth fault current.
- Alarm or trip output can be selected in the event of an earth-fault in the forward direction.
- Operation measurement of the active and reactive component in the residual earth current during an earth-fault.

Earth-fault direction detection can also be effected on the basis of the transient earth-fault principle by interfacing with the additional unit 7SN60 (see Fig. 6/14). Procedures for logging, time stamping and event recording for the network control system are standardized by the 7SA6.

Breaker failure protection (ANSI 50BF)

The 7SA6 relay incorporates a two-stage breaker failure protection to detect failures of tripping command execution, for example, due to a defective circuit-breaker. The current detection logic is phase-selective and can therefore also be used in single-pole tripping schemes. If the fault current is not interrupted after a settable time delay has expired, a retrip command or a busbar trip command will be generated. The breaker failure protection can be initiated by all integrated protection functions, as well as by external devices via binary input signals.

STUB bus overcurrent protection (ANSI 50(N)-STUB)

The STUB bus overcurrent protection is a separate definite-time overcurrent stage. It can be activated via a binary input signaling that the line isolator (disconnector) is open.

Separate settings are available for phase and earth faults.

Auto-reclosure (ANSI 79)

The 7SA6 relay is equipped with an auto-reclosure function (AR). The function includes several operating modes:

- 3-pole auto-reclosure for all types of faults; different dead times are available depending on the type of fault
- 1-pole auto-reclosure for 1-phase faults, no reclosing for multi-phase faults
- 1-pole auto-reclosure for 1-phase faults and for 2-phase faults without earth, no reclosing for multi-phase faults
- 1-pole auto-reclosure for 1-phase and 3-pole auto-reclosure for multi-phase faults
- 1-pole auto-reclosure for 1-phase faults and 2-phase faults without earth and 3-pole auto-reclosure for multi-phase faults
- Multiple-shot auto-reclosure
- Interaction with an external device for auto-reclosure via binary inputs and outputs
- Control of the internal AR function by external protection
- Interaction with the internal or an external synchro-check
- Monitoring of the circuit-breaker auxiliary contacts

In addition to the above-mentioned operating modes, several other operating principles can be employed by means of the integrated programmable logic (CFC).

Protection functions

Auto-reclosure (cont'd) (ANSI 79)

Integration of auto-reclosure in the feeder protection allows evaluation of the line-side voltages. A number of voltage-dependent supplementary functions are thus available:

- DLC
  By means of dead-line check, reclosure is effected only when the line is deenergized (prevention of asynchronous breaker closure).
- ADT
  The adaptive dead time is employed only if auto-reclosure at the remote station was successful (reduction of stress on equipment).
- RDT
  Reduced dead time is employed in conjunction with auto-reclosure where no teleprotection method is employed:
  When faults within the zone extension but external to the protected line are switched off for rapid auto-reclosure (RAR), the RDT function decides on the basis of measurement of the return voltage from the remote station which has not tripped whether or not to reduce the dead time.

Synchronism check (ANSI 25)

Where two network sections are switched in by control command or following a 3-pole auto-reclosure, it must be ensured that both network sections are mutually synchronous. For this purpose a synchro-check function is provided. After verification of the network synchronism, the function releases the CLOSE command. Alternatively, reclosing can be enabled for different criteria, e.g. checking that the busbar or line is not carrying a voltage (dead line or dead bus).

Fuse failure monitoring and other supervision functions

The 7SA6 relay provides comprehensive supervision functions covering both hardware and software. Furthermore, the measured values are continuously checked for plausibility. Therefore the current and voltage transformers are also included in this supervision system.

If any measured voltage is not present due to short-circuit or open circuit in the voltage transformer secondary circuit, the distance protection would respond with an unwanted trip due to this loss of voltage.

This secondary voltage interruption can be detected by means of the integrated fuse failure monitor. Immediate blocking of distance protection and switching to the backup-emergency overcurrent protection is provided for all types of secondary voltage failures.

Additional measurement supervision functions are

- Symmetry of voltages and currents
- Broken-conductor supervision
- Summation of currents and voltages
- Phase-sequence supervision.

Directional power protection

The 7SA6 has a function for detecting the power direction by measuring the phase angle of the positive-sequence system's power. Fig. 6/15 shows an application example displaying negative active power. An indication is issued in the case when the measured angle φ (S1) of the positive-sequence system power is within the P - Q - level sector. This sector is between angles φ A and φ B. Via CFC the output signal of the directional monitoring can be linked to the "Direct Transfer Trip (DTT)" function and thus, as reverse power protection, initiate tripping of the CB.

Fig. 6/16 shows another application displaying capacitive reactive power. In the case of overvoltage being detected due to long lines under no-load conditions it is possible to select the lines where capacitive reactive power is measured.

Trip circuit supervision (ANSI 74TC)

One or two binary inputs for each circuit-breaker pole can be used for monitoring the circuit-breaker trip coils including the connecting cables. An alarm signal is issued whenever the circuit is interrupted.

Lockout (ANSI 86)

Under certain operating conditions it is advisable to block CLOSE commands after a TRIP command of the relay has been issued. Only a manual "RESET" command unblocks the CLOSE command. The 7SA6 is equipped with such an interlocking logic.

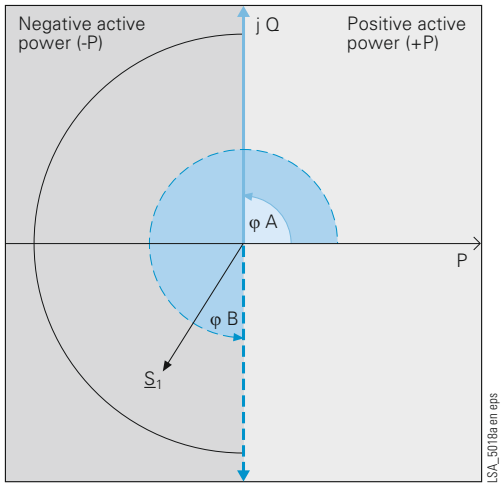


Fig. 6/15 Monitoring of active power direction

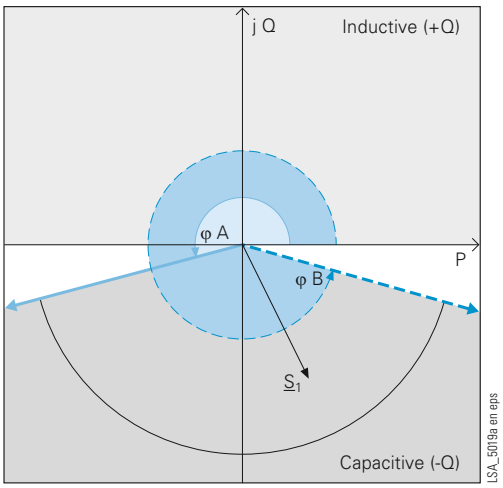


Fig. 6/16 Monitoring of reactive power

Thermal overload protection (ANSI 49)

For thermal protection of cables and transformers an overload protection with an early-warning stage is provided. The thermal replica can be generated with the maximum or mean value of the respective overtemperatures in the three phases, or with the overtemperature corresponding to the maximum phase current.

The tripping time characteristics are exponential functions according to IEC 60255-8 and they take account of heat loss due to the load current and the accompanying drop in temperature of the cooling medium. The previous load is therefore taken into account in the tripping time with overload. A settable alarm stage can output a current or temperature-dependent indication before the tripping point is reached.

Protection functions

BCD-coded output of fault location

The fault location calculated by the unit can be output for remote indication in BCD code. The output of the fault location is made in percent of the set line length with 3 decimal digits.

Analog output 0 to 20 mA

Some measured values can be output as analog values (0 to 20 mA). On a plug-in module (Fig. 6/21) two analog channels are made available. Up to two plug-in modules can be installed in the 7SA6. As an option, 2, 4 or no analog channels are available (please refer to the selection and ordering data). The measured values available for output are listed in the technical data.

Commissioning and fault event analyzing

Special attention has been paid to commissioning. All binary inputs and outputs can be displayed and activated directly. This can simplify the wiring check significantly for the user. The operational and fault events and the fault records are clearly arranged. For applications with serial protection data interface, all currents, voltages and phases are available via communication link at each local unit, displayed at the front of the unit with DIGSI 4 or with WEB Monitor[1]. A common time tagging facilitates the comparison of events and fault records.

WEB Monitor - Internet technology simplifies visualization

In addition to the universal DIGSI 4 operating program, the relay contains a WEB server that can be accessed via a telecommunication link using a browser (e.g. Internet Explorer). The advantage of this solution is to operate the unit with standard software tools and at the same time make use of the Intranet/Internet infrastructure. Apart from numeric values, graphical displays in particular provide clear information and a high degree of operating reliability. Of course, it is also possible to call up detailed measured value displays and annunciation buffers. By emulation of the integrated unit operation on the PC it is also possible to adjust selected settings for commissioning purposes.

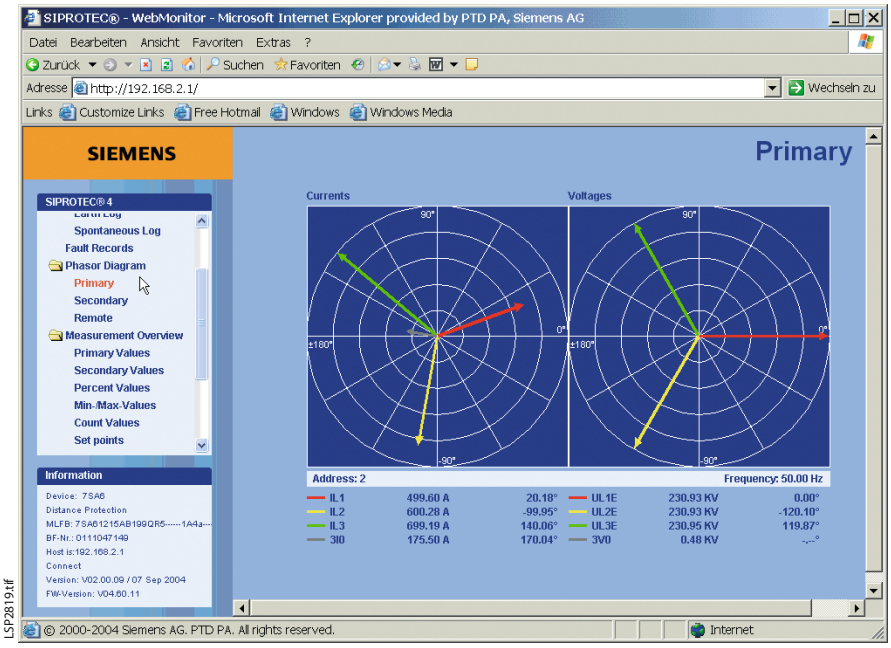


Fig. 6/17 Web Monitor: Supported commissioning by phasor diagram

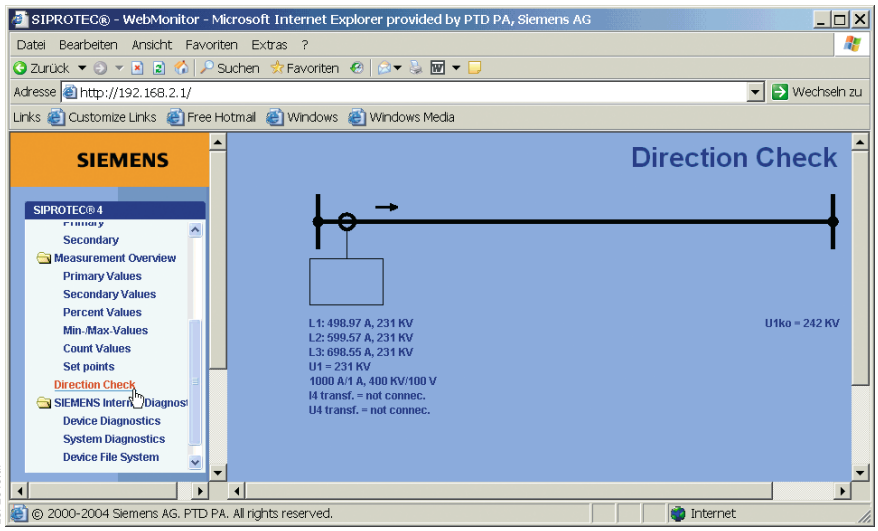


Fig. 6/18 Web Monitor: Display of the protection direction

Communication

With respect to communication, particular emphasis is placed on the customer requirements in energy automation:

- Every data item is time-stamped at the source, i.e. where it originates.
- Already during the process of communication, information is assigned to the cause thereof (e.g. assignment of the indication "circuit-breaker TRIP" to the corresponding command).
- The communication system automatically handles the transfer of large data blocks (e.g. fault recordings or parameter data files). The user has access to these features without any additional programming effort.
- For the safe execution of a control command the corresponding data telegram is initially acknowledged by the unit which will execute the command. After the release and execution of the command a feedback signal is generated. At every stage of the control command execution particular conditions are checked. If these are not satisfied, command execution may be terminated in a controlled manner.

The units offer a high degree of flexibility by supporting different standards for connection to industrial and power automation systems. By means of the communication modules, on which the protocols run, exchange and retrofit is possible. Therefore, the units will also in future allow for optimal adaptation to changing communication infrastructure such as the application of Ethernet networks which are already widely applied in the power supply sector.

Local PC interface

The serial RS232 PC interface accessible from the front of the unit permits quick access to all parameters and fault event data. The use of the DIGSI 4 operating program is particularly advantageous during commissioning.

Service/modem interface

7SA6 units are always fitted with a rear-side hardwired service interface, optionally as RS232 or RS485. In addition to the front-side operator interface, a PC can be connected here either directly or via a modem.

Time synchronization interface

The time synchronization interface is a standard feature in all units. The supported formats are IRIG-B and DCF77.

Reliable bus architecture

- RS485 bus
  With this data transmission via copper conductors, electromagnetic fault influences are largely eliminated by the use of twisted-pair conductors. Upon failure of a unit, the remaining system continues to operate without any problem.
- Fiber-optic double ring circuit
  The fiber-optic double ring circuit is immune to electromagnetic interference. Upon failure of a section between two units, the communication system continues to operate without disturbance. It is usually impossible to communicate with a unit that has failed. Should a unit fail, there is no effect on the communication with the rest of the system.

Retrofitting: Modules for every type of communication

Communication modules for retrofitting are available for the entire SIPROTEC 4 unit range. These ensure that, where different communication protocols (IEC 61850, IEC 60870-5-103, PROFIBUS, DNP, etc.) are required, such demands can be met. For fiber-optic communication, no external converter is required for SIPROTEC 4.

IEC 61850 protocol

The Ethernet-based IEC 61850 protocol is the worldwide standard for protection and control systems used by power supply corporations. Siemens was the first manufacturer to support this standard. By means of this protocol, information can also be exchanged directly between bay units so as to set up simple masterless systems for bay and system interlocking. Access to the units via the Ethernet but is also possible with DIGSI. It is also possible to retrieve operating and fault records as well as fault recordings via a browser. This Web monitor will also provide a few items of unit-specific information in browser windows.

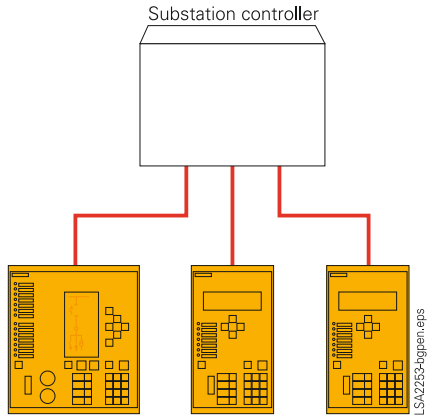


Fig. 6/19
IEC 60870-5-103 star-type RS232 copper conductor connection or fiber-optic connection

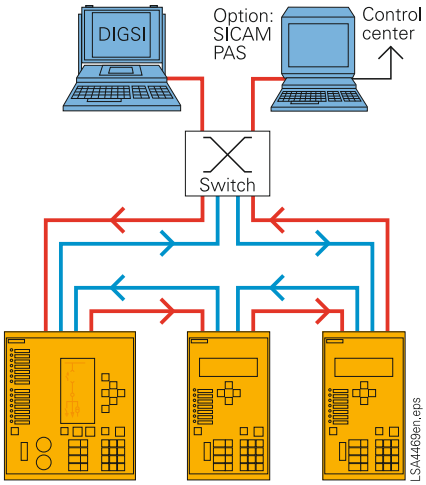


Fig. 6/20
Bus structure for station bus with Ethernet and IEC 61850

Communication

IEC 60870-5-103 protocol

IEC 60870-5-103 is an internationally standardized protocol for efficient communication with protection relays. IEC 60870-5-103 is supported by a number of protection device manufacturers and is used worldwide. Supplements for control functions are defined in the manufacturer-specific part of this standard.

PROFIBUS-DP

PROFIBUS-DP is an industrial communications standard and is supported by a number of PLC and protection device manufacturers.

DNP 3.0

DNP 3.0 (Distributed Network Protocol, Version 3) is an internationally recognized protection and bay unit communication protocol. SIPROTEC 4 units are Level 1 and Level 2 compatible.

Analog outputs 0 to 20 mA

2 or 4 analog output interfaces for transmission of measured or fault location values are available for the 7SA6. Two analog output interfaces are provided in an analog output module. Up to two analog output modules can be inserted per unit.

Fig. 6/21
820 nm fiber-optic communication module

Fig. 6/22
Fiber-optic Ethernet communication module for IEC 61850 with integrated Ethernet switch

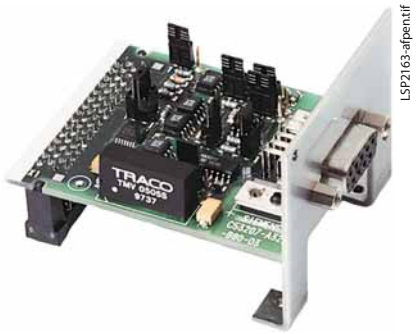


Fig. 6/23
RS232/RS485 electrical communication module

Fig. 6/24
Output module 0 to 20 mA, 2 channels

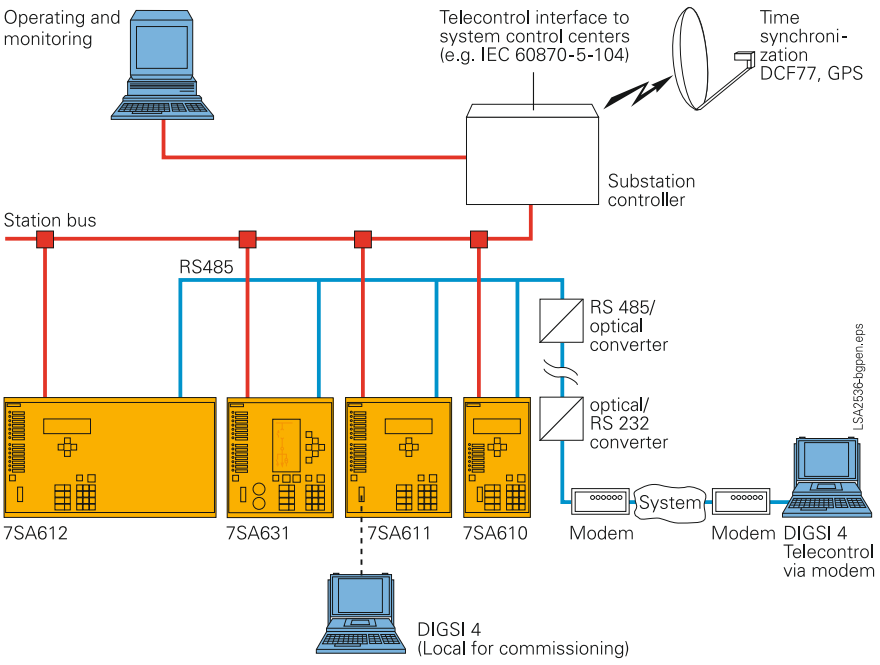


Fig. 6/25
Communication

Communication

System solutions for protection and station control

Together with the SICAM power automation system, SIPROTEC 4 can be used with PROFIBUS-FMS. Over the low-cost electrical RS485 bus, or interference-free via the optical double ring, the units exchange information with the control system. Units equipped with IEC 60870-5-103 interfaces can be connected to SICAM in parallel via the RS485 bus or connected in star by fiber-optic link. Through this interface, the system is open for the connection of units of other manufacturers (see Fig. 6/25).

Because of the standardized interfaces, SIPROTEC units can also be integrated into systems of other manufacturers or in SIMATIC. Electrical RS485 or optical interfaces are available. The optimum physical data transfer medium can be chosen thanks to opto-electrical converters. Thus, the RS485 bus allows low-cost wiring in the cubicles and an interference-free optical connection to the master can be established.

For IEC 61850, an interoperable system solution is offered with SICAM PAS. Via the 100 Mbits/s Ethernet bus, the units are linked with PAS electrically or optically to the station PC. The interface is standardized, thus also enabling direct connection of units of other manufacturers to the Ethernet bus. With IEC 61850, however, the units can also be used in other manufacturers' systems. Units with an IEC 60870-5-103 interface are connected with PAS via the Ethernet station bus by means of serial/Ethernet converters. DIGSI and the Web monitor can also be used via the same station bus.

Serial protection data interface

The tele (pilot) protection schemes can be implemented using digital serial communication. The 7SA6 is capable of remote relay communication via direct links or multiplexed digital communication networks. The serial protection data interface has the following features:

- Fast phase-selective teleprotection signaling for distance protection, optionally with POTT or PUTT schemes
- Signaling for directional earth-fault protection – directional comparison for high resistance faults in solidly earthed systems
- Echo-function
- Two and three-terminal line applications can be implemented without additional logic
- Interclose command transfer with the auto-reclosure "Adaptive dead time" (ADT) mode
- 28 remote signals for fast transfer of binary signals
- Flexible utilisation of the communication channels by means of the programmable CFC logic
- Display of the operational measured values of the opposite terminal(s) with phase-angle information relative to a common reference vector
- Clock synchronization: the clock in only one of the relays must be synchronized from an external so called "Absolute Master" when using the serial protection data interface. This relay will then synchronize the clock of the other (or the two other relays in 3 terminal applications) via the protection data interface.
- 7SA522 and 7SA6 can be combined via the protection data interface.

The communication possibilities are identical to those for the line differential protection relays 7SD5 and 7SD610. The following options are available:

- FO5[1], OMA1[2] module: Optical 820 nm, 2 ST connectors, FO cable length up to 1.5 km for link to communication networks via communication converters or for direct FO cable connection
- FO6[1], OMA2[2] module: Optical 820 nm, 2 ST connectors, FO cable length up to 3.5 km, for direct connection via multi-mode FO cable
- FO17[1]: For direct connection up to 25 km[3], 1300 nm, for mono-mode fiber 9/125 µm, LC-Duplex connector
- FO18[1]: For direct connection up to 60 km[3] 1300 nm, for mono-mode fiber 9/125 µm, LC-Duplex connector
- FO19[1]: For direct connection up to 100 km[3] 1550 nm, for mono-mode fiber 9/125 µm, LC-Duplex connector
- FO30[1]: For transmission with the IEEE C37.94 standard.

The link to a multiplexed communication network is made by separate communication converters (7XV5662). These have a fiber-optic interface with 820 nm and ST connectors to the protection relay. The link to the communication network is optionally an electrical X21 or a G703.1 interface. If the connection to the multiplexor supports IEEE C37.94, a direct fibre optic connection to the relay is possible using the FO30 module.

For operation via copper wire communication (pilot wires), a modern communication converter for copper cables is available. This operates with both the two-wire and three-wire copper connections which were used by conventional differential protection systems before. The communication converter for copper cables is designed for 5 kV insulation voltage. An additional 20 kV isolation transformer can extend the field of applications of this technique into ranges with higher insulation voltage requirements. With SIPROTEC 4 and the communication converter for copper cables a digital follow-up technique is available for two-wire protection systems (typical 15 km) and all three-wire protection systems using existing copper communication links.

Communication data:

- Supported network interfaces G703.1 with 64 kBit/s; X21/RS422 with 64 or 128 or 512 kBit/s; IEEE C37.94
- Max. channel delay time 0.1 ms to 30 ms (in steps of 0.1 ms)
- Protocol HDLC
- 32-bit CRC-check according to CCITT and ITU
- Each protection relay possesses a unique relay address
- Continuous communication link supervision: Individual faulty data telegrams do not constitute an immediate danger, if they occur only sporadically. The statistical availability, per minute and hour, of the serial protection data interface can be displayed.

Figure 6/26 shows four applications for the serial protection data interface on a two-terminal line.

1) For flush-mounting housing.

2) For surface-mounting housing.

3) For surface-mounting housing the internal fiber-optic module OMA1 will be delivered together with an external repeater.

Communication

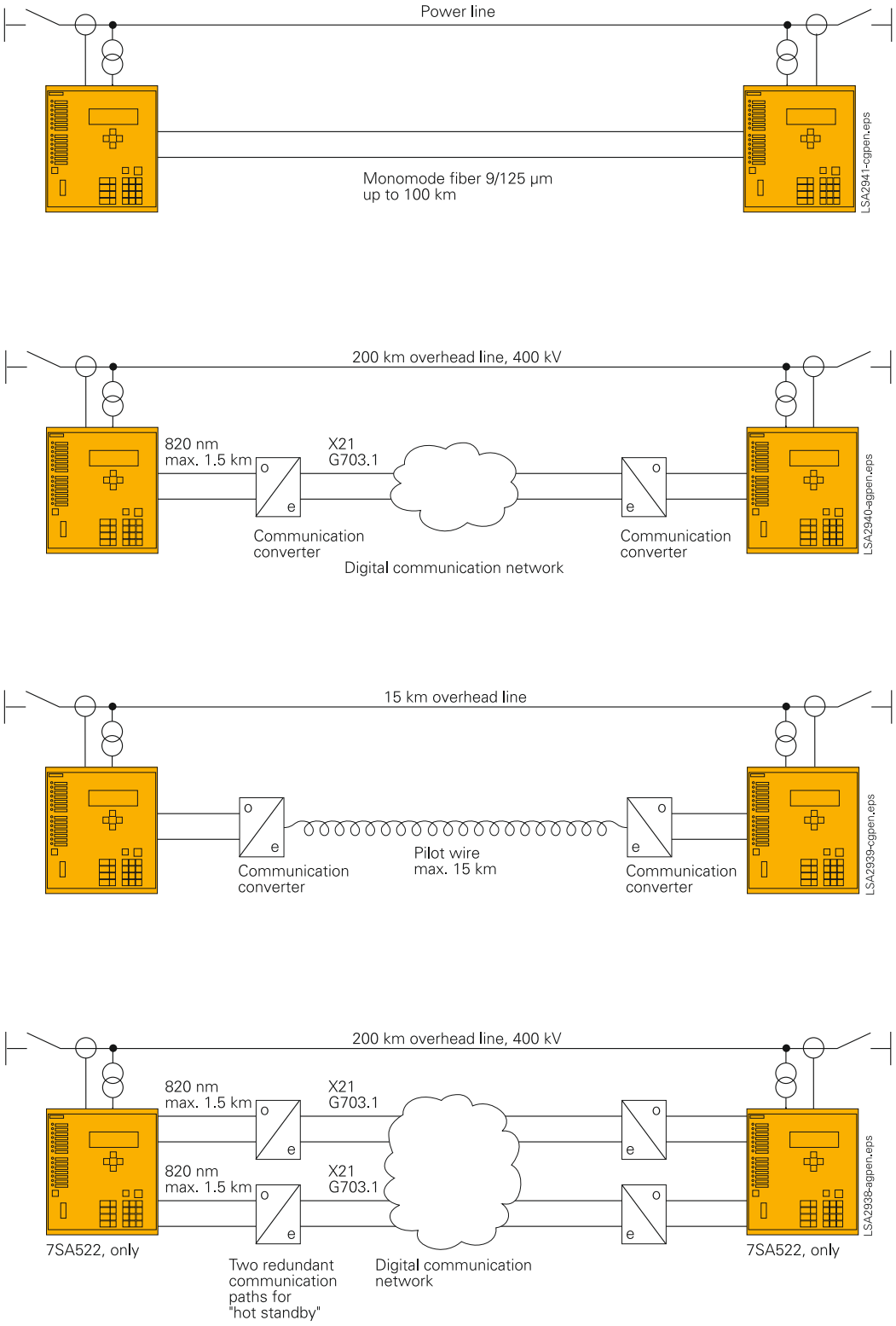


Fig. 6/26
Communication topologies for the serial protection data interface on a two-terminal line

Communication

Three-terminal lines can also be protected with a tele (pilot) protection scheme by using SIPROTEC 4 distance protection relays. The communication topology may then be a ring or a chain topology, see Fig. 6/27. In a ring topology a loss of one data connection is tolerated by the system. The topology is re-routed to become a chain topology within less than 100 ms. To reduce communication links and to save money for communications, a chain topology may be generally applied.

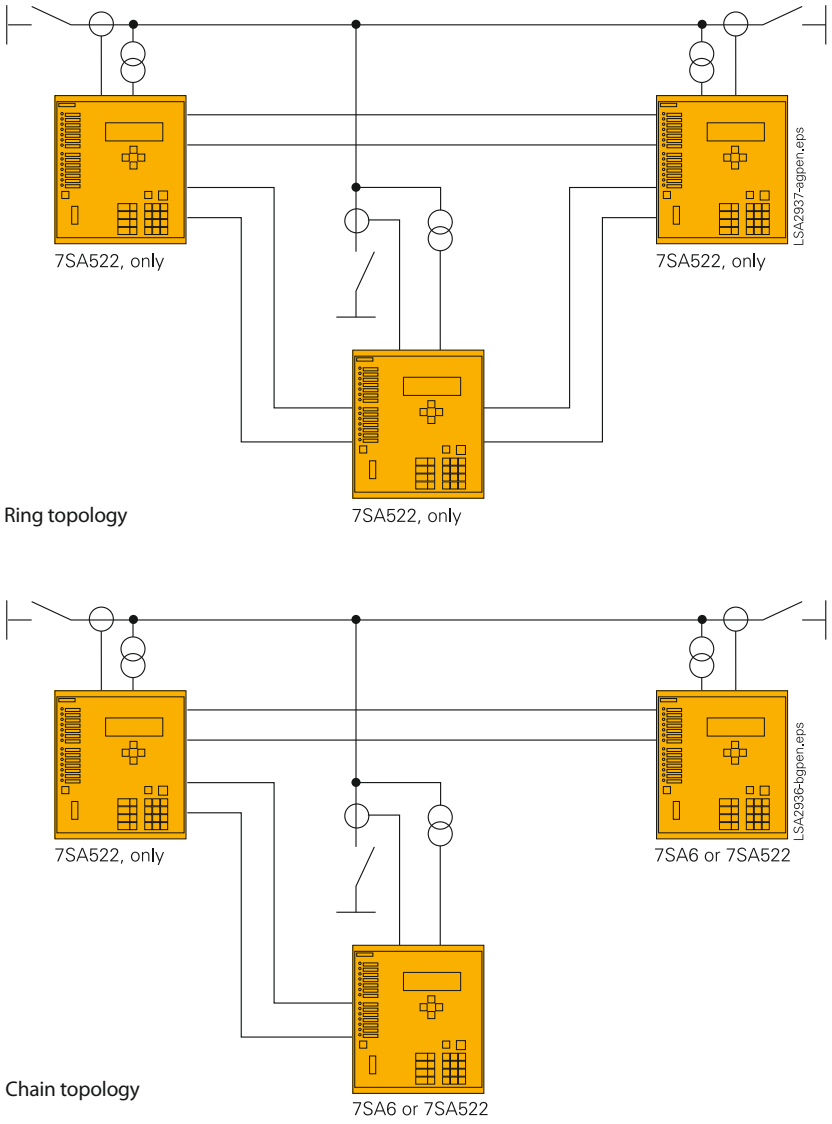


Fig. 6/27 Ring or chain communication topology

Typical connection

Connection for current and voltage transformers

3 phase current transformers with neutral point in the line direction, I_4 connected as summation current transformer (=$3I_0$): Holmgreen circuit

3 voltage transformers, without connection of the broken (open) delta winding on the line side; the $3V_0$ voltage is derived internally.

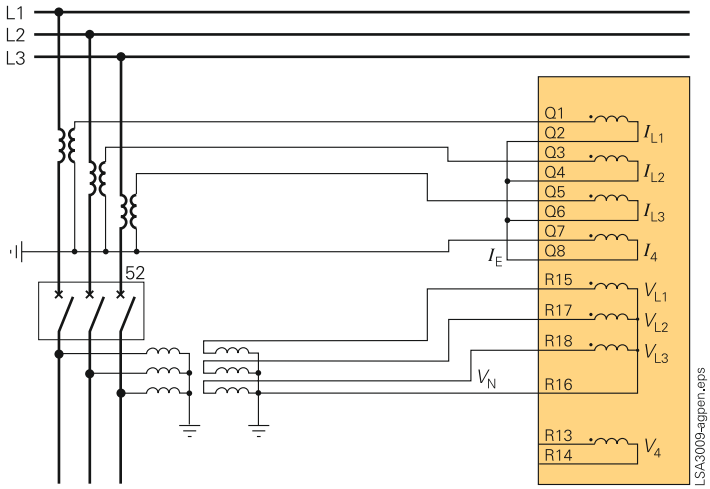


Fig. 6/28 Example of connection for current and voltage transformers

Alternative current measurement

The 3 phase current transformers are connected in the usual manner. The neutral point is in line direction. I_4 is connected to a separate neutral core-balance CT, thus permitting a high sensitive $3I_0$ measurement.

Note: Terminal Q7 of the I_4 transformer must be connected to the terminal of the core balance CT pointing in the same direction as the neutral point of the phase current transformers (in this case in line direction). The voltage connection is effected in accordance with Fig. 6/28, 6/32 or 6/33.

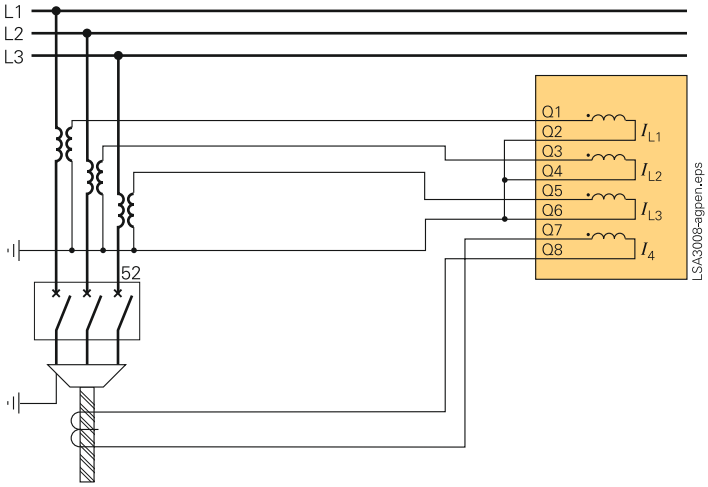


Fig. 6/29 Alternative connection of current transformers for sensitive earth-current measuring with core-balance current transformers

Typical connection

Alternative current connection

3 phase current transformers with neutral point in the line direction, I_4 connected to a current transformer in the neutral point of an earthed transformer for directional earth-fault protection. The voltage connection is effected in accordance with Fig. 6/28, 6/32 or 6/33.

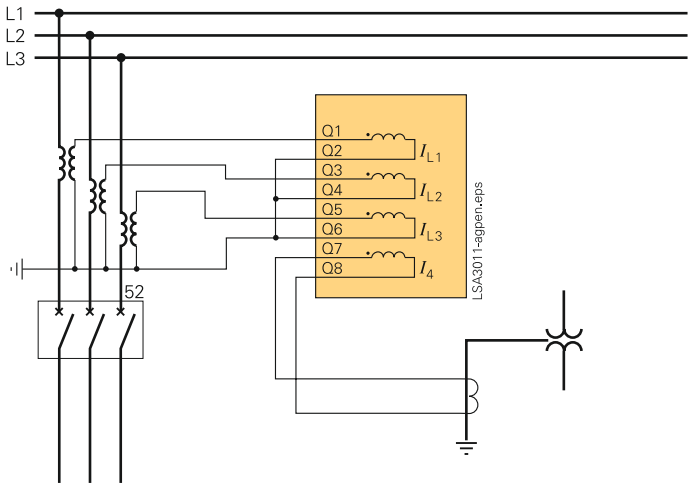


Fig. 6/30 Alternative connection of current transformers for measuring neutral current of an earthed power transformer

Alternative current connection

3 phase current transformers with neutral point in the line direction, I_4 connected to summation current of the parallel line for parallel line compensation on overhead lines. The voltage connection is effected in accordance with Fig. 6/28, 6/32 or 6/33.

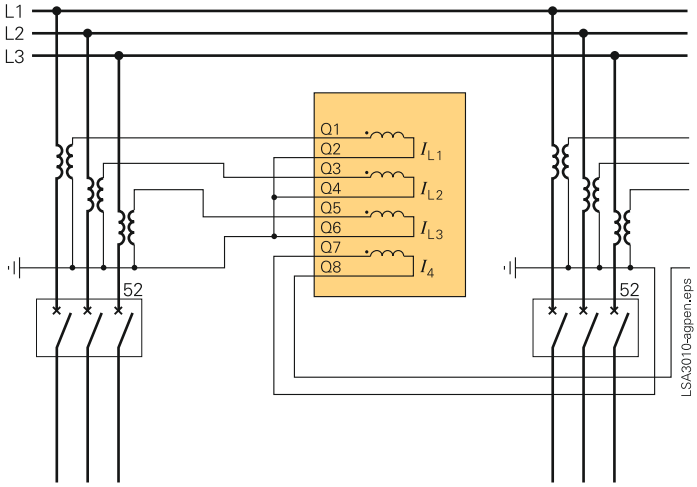


Fig. 6/31 Alternative connection of current transformers for measuring the earth current of a parallel line

Typical connection

Alternative voltage connection

3 phase voltage transformers, V_4 connected to broken (open) delta winding (V_{en}) for additional summation voltage monitoring and earth-fault directional protection. The current connection is effected in accordance with Fig. 6/28, 6/29, 6/30 and 6/31.

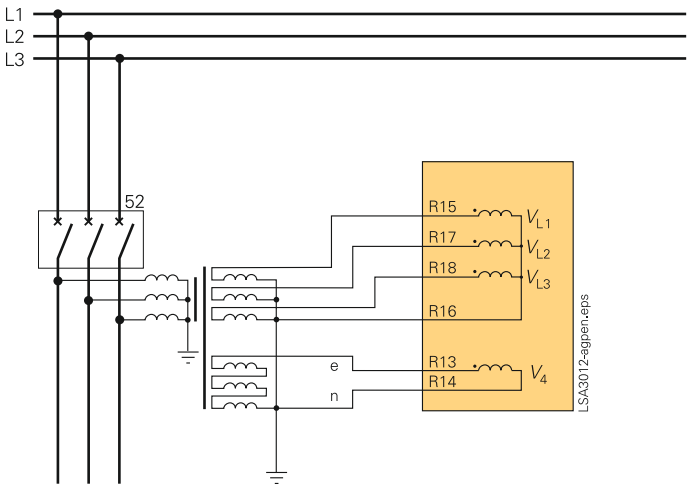


Fig. 6/32 Alternative connection of voltage transformers for measuring the displacement voltage (e-n voltage)

Alternative voltage connection

3 phase voltage transformers, V_4 connected to busbar voltage transformer for synchro-check.

Note: Any phase-to-phase or phase-to-earth voltage may be employed as the busbar voltage. Parameterization is carried out on the unit. The current connection is effected in accordance with Fig. 6/28, 6/29, 6/30 and 6/31.

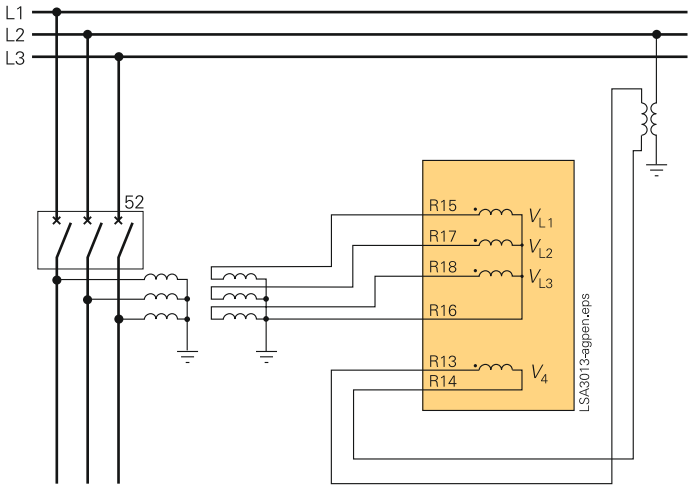


Fig. 6/33 Alternative connection of voltage transformers for measuring the busbar voltage

Technical data

General unit data

Analog inputs

Rated frequency	50 or 60 Hz (selectable)
Rated current I_{nom}	1 or 5 A (selectable)
Rated voltage V_{nom}	80 to 125 V (selectable)
Power consumption	
With I_{nom} = 1 A	Approx. 0.05 VA
With I_{nom} = 5 A	Approx. 0.30 VA
For $I_{E,}$ sensitive with 1 A	Approx. 0.05 VA
Voltage inputs	≤ 0.10 VA
Overload capacity of current circuit (r.m.s.)	
Thermal	500 A for 1 s 150 A for 10 s 20 A continuous
Dynamic (peak value)	1250 A (half cycle)
Earth current	
Sensitive	300 A for 1 s 100 A for 10 s 15 A continuous
Dynamic (peak value)	750 A (half cycle)
Thermal overload capacity of voltage circuit	230 V continuous

Auxiliary voltage

Rated voltages	24 to 48 V DC 60 to 125 V DC 110 to 250 V DC and 115 to 230 V AC (50/60 Hz)
Permissible tolerance	-20 % to +20 %
Superimposed AC voltage (peak-to-peak)	≤ 15 %
Power consumption	
Quiescent	Approx. 5 W
Energized	Approx. 12 W to 18 W, depending on design
Bridging time during failure of the auxiliary voltage	
For V_{aux} = 48 V and V_{aux} ≥ 110 V	≥ 50 ms
For V_{aux} = 24 V and V_{aux} = 60 V	≥ 20 ms

Binary inputs

Quantity	
7SA610*-*A/E/J	5
7SA610*-*B/F/K	7
7SA6*1*-*A/E/J	13
7SA6*1*-*B/F/K	20
7SA6*2*-*A/E/J	21
7SA6*2*-*B/F/K	29
7SA6*2*-*C/G/L	33
Rated voltage range	24 to 250 V, bipolar
Pickup threshold	17 or 73 or 154 V DC, bipolar
Functions are freely assignable	
Pickup/reset voltage thresholds Ranges are settable by means of jumpers for each binary input	19 V DC/10 V DC or 88 V DC/44 V DC, or 176 V DC/88 V DC bipolar (3 nominal ranges 17/73/154 V DC)
Maximum permissible voltage	300 V DC
Current consumption, energized	Approx. 1.8 mA
Input impulse suppression	220 nF coupling capacitance at 220 V with a recovery time >60 ms

Output contacts

"Unit ready" contact (live status contact)	1 NC/NO contact[1]
Command/indication relay	
Quantity	
7SA610*-*A/E/J	5 NO contacts, 3 NC/NO contact[1]
7SA610*-*B/F/K	5 NO contacts,
7SA6*1*-*A/E/J	12 NO contacts, 4 NC/NO contacts[1]
7SA6*1*-*B/F/K	8 NO contacts, 4 power relays[2]
7SA6*2*-*A/E/J	19 NO contacts, 5 NC/NO contacts[1]
7SA6*2*-*B/F/K	26 NO contacts, 6 NC/NO contacts[1]
7SA6*2*-*C/G/L	11 NO contacts, 8 power relays[2]
NO/NC contact	
Switching capacity	
Make	1000 W / VA
Break, high-speed trip outputs	1000 W / VA
Break, contacts	30 VA
Break, contacts (for resistive load)	40 W
Break, contacts (for τ = L/R ≤ 50 ms)	25 VA
Switching voltage	250 V
Permissible total current	30 A for 0.5 seconds 5 A continuous
Operating time, approx.	
NO contact	8 ms
NO/NC contact (selectable)	8 ms
Fast NO contact	5 ms
High-speed NO trip outputs	< 1 ms
Power relay for direct control of disconnector actuator motors	
Switching capacity	
Make for 48 to 250 V	1000 W/ VA
Break for 48 to 250 V	1000 W/ VA
Make for 24 V	500 W/ VA
Break for 24 V	500 W/ VA
Switching voltage	250 V
Permissible total current	30 A for 0.5 seconds 5 A continuous
Max. operating time	30 s
Permissible relative operating time	1 %

LEDs

	Quantity
RUN (green)	1
ERROR (red)	1
LED (red), function can be assigned	
7SA610	7
7SA6*1/2/3	14

1) Can be set via jumpers.

2) Each pair of power relays is mechanically interlocked to prevent simultaneous closing.

Technical data

Unit design		
Housing		7XP20
Dimensions		Refer to part 15 f. dimension drawings
Degree of protection acc. to EN 60529		
Surface-mounting housing		IP 51
Flush-mounting housing		
Front		IP 51
Rear		IP 50
For the terminals		IP 20 with terminal cover put on
Weight		
Flush-mounting housing	1/3 x 19"	4 kg
	1/2 x 19"	6 kg
	2/3 x 19"	8 kg
	1/1 x 19"	10 kg
Surface-mounting housing	1/3 x 19"	6 kg
	1/2 x 19"	11 kg
	1/1 x 19"	19 kg

Serial interfaces	
Operating interface for DIGSI 4 *(front of unit)*	
Connection	Non-isolated, RS232, 9-pin subminiature connector (SUB-D)
Baud rate	4800 to 115200 baud setting as supplied: 38400 baud; parity 8E1
Time synchronization	
DCF77/ IRIG-B signal (format IRIG-B000)	
Connection	9-pin subminiature connector (SUB-D) (terminal with surface-mounting housing)
Voltage levels	5 V, 12 V or 24 V (optional)
Service/modem interface for DIGSI 4 / modem / service	
Isolated RS232/RS485	9-pin subminiature connector (SUB-D)
Dielectric test	500 V / 50 Hz
Distance for RS232	Max. 15 m
Distance for RS485	Max. 1000 m
System interface	
	IEC 61850 Ethernet IEC 60870-5-103 protocol PROFIBUS-FMS PROFIBUS-DP DNP 3.0
Isolated RS232/RS485	9-pin subminiature connector (SUB-D)
Baud rate	4800 to 38400 baud
Dielectric test	500 V / 50 Hz
Distance for RS232	Max. 15 m
Distance for RS485	Max. 1000 m
PROFIBUS RS485	
Dielectric test	500 V / 50 Hz
Baud rate	Max. 12 Mbaud
Distance	1 km at 93.75 kBd; 100 m at 12 MBd
PROFIBUS fiber-optic	
Only for flush-mounting housing	ST connector
For surface-mounting housing	Optical interface with OLM[4)]
Baud rate	Max. 1.5 Mbaud
Optical wavelength	λ = 820 nm
Permissible attenuation	Max. 8 dB for 62.5/125 µm fiber
Distance	500 kbit/s 1.6 km 1500 kbit/s 530 m
Protection data interface	
Quantity	1
FO5[1)], OMA1[2)]: Fiber-optic interface with clock recovery for direct connection up to 1.5 km or for connection to a communication converter, 820 nm	For multi-mode fiber 62.5/125 µm, ST connectors Permissible fiber attenuation 8 dB
FO6[1)], OMA2[2)]: Fiber-optic interface for direct connection up to 3.5 km, 820 nm	For multi-mode fiber 62.5/125 µm, ST connectors Permissible fiber attenuation 16 dB
FO30[1)]: for direct fibre-optic connection to a multiplexor using IEEE C37.94 standard	For multi-mode fiber 62.5/125 µm, ST connectors Permissible fiber attenuation 8 dB
FO17[1)]: for direct connection up to 24 km[3)], 1300 nm	For mono-mode fiber 9/125 µm, LC-Duplex connector Permissible fiber attenuation 13 dB
FO18[1)]: for direct connection up to 60 km[3)], 1300 nm	For mono-mode fiber 9/125 µm, LC-Duplex connector Permissible fiber attenuation 29 dB
FO19[1)]: for direct connection up to 100 km[3)], 1550 nm	For mono-mode fiber 9/125 µm, LC-Duplex connector Permissible fiber attenuation 29 dB
Relay communication equipment	
External communication converter 7XV5662-0AA00 with X21/RS422 or G703.1 interface	
External communication converter for linking the optical 820 nm interface of the unit (FO5/OMA1 option with clock recovery) to the X21/RS422/G703.1 interface of the communication network	Electrical X21/RS422 or G703.1 interface settable by jumper Baud rate settable by jumper
FO interface with 820 nm with clock recovery	Max. 1.5 km with 62.5/125 µm multi- mode fiber to protection relay
Electrical X21/RS422 interface	64/128/512 kbit (settable by jumper) max. 800 m, 15-pin connector to the communication network
Electrical G703.1 interface	64 kbit/s max. 800 m, screw-type terminal to the communication network
External communication converter 7XV5662-0AC00 for pilot wires	
External communication converter for linking the optical 820 nm interface of the unit (FO5/OMA1 option with clock recovery) to pilot wires.	Typical distance: 15 km max.
FO interface for 820 nm with clock recovery	Max. 1.5 km with 62.5/125 µm multi-mode fiber to protection relay, 128 kbit
Electrical interface to pilot wires	5 kV-isolated

1) For flush-mounting housing.

2) For surface-mounting housing.

3) For surface-mounting housing the internal fiber-optic module (OMA1) will be delivered together with an external repeater.

4) Conversion with external OLM
For fiber-optic interface please complete order number at 11th position with 4 (FMS RS485) or 9 and Order Code L0A (DP RS485) or 9 and Order Code L0G (DNP 3.0) and additionally a suitable external repeater.

Technical data

Electrical tests

Specifications

Standards	IEC 60255 (product standards) IEEE Std C37.90.0/.1/.2; UL 508 VDE 0435 Further standards see "Individual functions"

Insulation tests

Standards	IEC 60255–5 and 60870-2-1
High-voltage test (routine test)	
All circuits except for power supply, binary inputs, high-speed outputs, communication and time synchronization interfaces	2.5 kV (r.m.s.), 50 Hz
Auxiliary voltage, binary inputs and high-speed outputs (routine test)	3.5 kV DC
only isolated communication interfaces and time synchronization interface (routine test)	500 V (r.m.s.), 50 Hz
Impulse voltage test (type test)	
All circuits except for communication interfaces and time synchronization interface, class III	5 kV (peak); 1.2/50 µs; 0.5 Ws, 3 positive and 3 negative impulses in intervals of 5 s

EMC tests for noise immunity; type tests

Standards	IEC 60255-6/-22 (product standard) EN 61000-6-2 (generic standard), VDE 0435 part 301 DIN VDE 0435-110
High-frequency test IEC 60255-22-1 class III and VDE 0435 Section 303, class III	2.5 kV (peak); 1 MHz; τ = 15 µs; 400 surges per s; test duration 2 s, R_i = 200 Ω
Electrostatic discharge IEC 60255-22-2 class IV and IEC 61000-4-2, class IV	8 kV contact discharge; 15 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
Irradiation with HF field, frequency sweep IEC 60255-22-3 (report) class III IEC 61000-4-3, class III	10 V/m; 80 to 1000 MHz: 80 % AM; 1 kHz 10 V/m; 800 to 960 MHz: 80 % AM; 1 kHz 10 V/m; 1.4 to 2 GHz: 80 % AM; 1 kHz
Irradiation with HF field, single frequencies IEC 60255-22-31, IEC 61000-4-3, class III amplitude/pulse modulated	10 V/m; 80, 160, 450. 900 MHz; 80 % AM; 1 kHz; duty cycle > 10 s 900 MHz; 50 % PM, repetition frequency 200 Hz
Fast transient disturbance/bursts IEC 60255-22-4 and IEC 61000-4-4, class IV	4 kV; 5/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; test duration 1 min
High-energy surge voltages (SURGE), IEC 61000-4-5 installation class III Auxiliary supply	Impulse: 1.2/50 µs Common mode: 2 kV; 12 Ω; 9 µF Differential mode:1 kV; 2 Ω; 18 µF
Analog measurement inputs, binary inputs, relays output	Common mode: 2 kV; 42 Ω; 0.5 µF Differential mode: 1 kV; 42 Ω; 0.5 µF
Line-conducted HF, amplitude-modulated, IEC 61000-4-6, class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Power system frequency magnetic field IEC 61000-4-8, class IV; IEC 60255-6	30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz
Oscillatory surge withstand capability, IEEE Std C37.90.1	2.5 kV (peak); 1 MHz τ = 50 µs; 400 surges per second, test duration 2 s, R_i = 200 Ω
Fast transient surge withstand capability, IEEE Std C37.90.1	4 kV; 5/50 ns; 5 kHz; burst length = 15 ms repition rate 300 ms, ; both polarities; test duration 1 min; R_i = 50 Ω
Radiated electromagnetic interference IEEE Std C37.90.2	35 V/m; 25 to 1000 MHz, amplitude and pulse-modulated
Damped oscillations IEC 60694, IEC 61000-4-12	2.5 kV (peak value); polarity alternating 100 kHz; 1 MHz; 10 and 50 MHz; R_i = 200 Ω

EMC tests for noise emission; type test

Standard	EN 61000-6-3 (generic standard)
Radio noise voltage to lines, only auxiliary voltage IEC-CISPR 22	150 kHz to 30 MHz Limit class B
Radio interference field strength IEC-CISPR 22	30 to 1000 MHz Limit class B
Harmonic currents on the network lead at 230 V AC, IEC 61000-3-2	Class A limits are observed
Voltage fluctuations and flicker on the network incoming feeder at 230 V AC, IEC 61000-3-3	Limits are observed

Mechanical stress test

Vibration, shock stress and seismic vibration

<u>During operation</u>	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 10 to 60 Hz: ± 0.075 mm amplitude; 60 to 150 Hz: 1 *g* acceleration frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Semi-sinusoidal Acceleration 5 *g*, duration 11 ms, 3 shocks on each of the 3 axes in both directions
Seismic vibration IEC 60255-21-2, class 1 IEC 60068-3-3	Sinusoidal 1 to 8 Hz: ± 3.5 mm amplitude (horizontal axis) 1 to 8 Hz: ± 1.5 mm amplitude (vertical axis) 8 to 35 Hz: 1 *g* acceleration (horizontal axis) 8 to 35 Hz: 0.5 *g* acceleration (vertical axis) Frequency sweep 1 octave/min 1 cycle in 3 orthogonal axes
<u>During transport</u>	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 5 to 8 Hz: ± 7.5 mm amplitude; 8 to 150 Hz: 2 *g* acceleration Frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Semi-sinusoidal Acceleration 15 *g*, duration 11 ms, 3 shocks on each of the 3 axes in both directions
Continuous shock IEC 60255-21-2, class 1 IEC 60068-2-29	Semi-sinusoidal Acceleration 10 *g*, duration 16 ms, 1000 shocks on each of the 3 axes in both directions

Technical data

Climatic stress tests	
Standard	IEC 60255-6
Temperatures	
Type-tested acc. to IEC 60068-2-1 and -2, test Bd	-25 °C to +85 °C / -13 °F to +185 °F
Temporarily permissible operating temperature, tested for 96 h (Legibility of display may be impaired above +55 °C / +131 °F)	-20 °C to +70 °C / -4 °F to +158 °F
Recommended permanent operating temperature acc. to IEC 60255-6	-5 °C to +55 °C / +23 °F to +131 °F
– Limiting temperature during permanent storage	-25 °C to +55 °C / -13 °F to 131 °F
– Limiting temperature during transport	-25 °C to +70 °C / -13 °F to +158 °F
Humidity	
Permissible humidity stress: It is recommended to arrange the units in such a way that they are not exposed to direct sunlight or pronounced temperature changes that could cause condensation.	Annual average on ≤ 75 % relative humidity; on 56 days per year up to 93 % relative humidity; condensation is not permitted.

Functions	
Distance protection *(ANSI 21, 21N)*	
Types of pickup	Overcurrent pickup ($I>$); Voltage-dependent overcurrent pickup ($V< / I>$); Voltage-dependent and phase angle-dependent overcurrent pickup ($V< / I> / \varphi>$); Impedance pickup ($Z<$)
Types of tripping	Three-pole for all types of faults; Single-pole for single-phase faults / otherwise three-pole; Single-pole for single-phase faults and two-pole phase-to-phase faults / otherwise three-pole
Characteristic	Quadrilateral or circle
Distance protection zones	7, 1 of which as controlled zone All zones can be set to forward, reverse, non-directional or inactive
Timer stages for tripping delay	7 for multi-phase faults 3 for single-phase faults
Setting range	0 to 30 s or deactivated (steps 0.01 s)
Zone setting X (for distance zones and Z< starting)	0.050 to 600 Ω (1A) / 0.01 to 120 Ω (5A) (step 0.001 Ω)
Resistance setting (for quadrilateral distance zones and Z< starting)	
Phase-to-phase faults and phase-to-earth faults	0.05 to 600 Ω (1A) / 0.01 to 120 Ω (5A) (step 0.001 Ω)
Line angle	10 ° to 89 °
Inclination angle for quadrilateral characteristic	30° to 90° (step 1°)
Zone setting Z_r (for circle characteristic)	0.050 to 600 Ω(1 A)/0.010 to 120 Ω(5 A) (step 0.001 Ω)
Threshold angle α for increased resistance tolerance (circle charac.)	10 to 90 ° (step 1°)
Overcurrent pickup $I>>$ (for $I>>$, $V</I>$, $V</I>/\varphi>$)	0.25 to 10 A (1A) / 1.25 to 50 A (5A) (step 0.01 A)
Minimum current pickup $I>$ (for $V</I>$, $V</I>/\varphi>$ and $Z<$)	0.05 to 4 A (1A) / 0.25 to 20 A (5A) (step 0.01 A)
Minimum current pickup $I_\varphi>$ (for $V</I>/\varphi>$)	0.1 to 8 A (1A) / 0.5 to 40 A (5A) (step 0.01 A)
Undervoltage pickup (for $V</I>$ and $V</I>/\varphi>$)	
$V_{PH\text{-}e}<$	20 to 70 V (step 1 V)
$V_{PH\text{-}PH}<$	40 to 130 V (step 1 V)
Load angle pickup (for $V</I>/\varphi>$)	
Load angle φ	30 ° to 80 °
Load angle φ	90 ° to 120 °
Load zone (for $Z<$)	Impedances within the load zone do not cause pickup in pickup mode Z<; Load zones for phase-to-phase and phase-to-earth faults can be set separately
Load angle	20 ° to 60 °
Resistance	0.1 to 600 Ω (1A) / 0.02 to 120 Ω (5A)
Earth-fault detection	
Earth current $3I_0>$	0.05 to 4 A (1A) / 0.25 A to 20 A (5A) (step 0.01 A)
Zero-sequence voltage $3V_0>$	
for earthed networks	1 to 100 V (step 1 V) or deactivated
for resonant-earthed networks	10 to 200 V (step 1 V) or deactivated
Earth impedance matching	
Parameter formats	R_E/R_L and X_E/X_L or k_0 and φ (k_0)
Separately settable for	Distance protection zone Z1 and higher distance zones (Z1B, Z2 to Z6)
R_E/R_L and X_E/X_L	-0.33 to +7.00 (step 0.01)
k_0 and φ (k_0)	0 to 4 (step 0.01) and - 135 ° to 135 ° (step 0.01 °)
Parallel line matching	For parallel compensation
R_M/R_L and X_M/X_L	0 to 8 (step 0.01)
Phase preference on double earth-faults in resonant-earthed / non-earthed networks	Phase preference or no preference (selectable)
Direction decision for all types of faults	With fault-free voltages and/or voltage memory
Direction sensitivity	Dynamically unlimited

Technical data

Times	
Shortest trip time (measured at the fast relay; refer to the terminal connection diagram)	Approx. 17 ms for f_N = 50 Hz Approx. 15 ms for f_N = 60 Hz
Shortest trip time (measured at the high-speed trip outputs)	Approx. 12 ms at 50 Hz Approx. 10 ms at 60 Hz
Reset time	Approx. 30 ms
Tolerances	For sinusoidal measured variables
Response values (in conformity with DIN 57435, Part 303)	
V and I	≤ 5 % of setting value
Angle (φ)	≤ 3 °
Impedances (in conformity with DIN 57435, Part 303)	$\left\|\frac{\Delta X}{X}\right\| \le 5\ \%$ for 30 ° ≤ φ_{SC} ≤ 90 ° $\left\|\frac{\Delta R}{R}\right\| \le 5\ \%$ for 0 ° ≤ φ_{SC} ≤ 60 °
Time stages	1 % of setting value or 10 ms
Fault locator	
Output of the distance to fault	X, R (secondary) in Ω X, R (primary) in Ω Distance in kilometers or in % of line length
Start of calculation	With trip, with reset of pickup, with binary input
Reactance per unit length	0.005 to 6.5 Ω/km$_{(1A)}$ / 0.001 to 1.3 Ω/km$_{(5A)}$ (step 0.001 Ω/km)
Tolerance	For sinusoidal quantities ≤ 2.5 % line length for 30 ° ≤ φ_{SC} ≤ 90 ° and V_{SC}/V_{nom} > 0.1
BCD-coded output of fault location	
Indicated value	Fault location in % of the line length
Output signals	Max. 10: d[1 %], d[2 %], d[4 %], d[8 %], d[10 %], d[20 %], d[40 %], d[80 %], d[100 %], d[release]
Indication range	0 % to 195 %
Tele (pilot) protection for distance protection *(ANSI 85-21)*	
Modes of operation	PUTT (Z1B acceleration); DUTT; PUTT (acceleration with pickup); POTT; Directional comparison; Reverse interlocking Pilot-wire comparison; Unblocking; Blocking
Additional functions	Echo function (refer to weak-infeed function) Transient blocking for schemes with measuring range extension
Transmission and reception signals	Phase-selective signals available for maximum selectivity with single-pole tripping; signals for 2- and 3-end-lines

Weak-infeed protection *(ANSI 27-WI)*	
Operating modes with carrier (signal) reception and no fault detection	Echo Echo and trip with undervoltage
Undervoltage phase-earth	2 to 70 V (step 1 V)
Time delay	0 to 30 s (step 0.01 s)
Echo impulse	0 to 30 s (step 0.01 s)
Tolerances	
Voltage threshold	≤ 5 % of setting value or 0.5 V
Timer	1 % of setting value or 10 ms
Direct transfer trip (DTT)	
Direct phase-selective tripping via binary input	Alternatively with or without auto-reclosure
Trip time delay	0 to 30 s (step 0.01 s)
Timer tolerance	1 % of setting value or 10 ms
Power swing detection *(ANSI 68, 68T)*	
Power swing detection principle	Measurement of the rate of change of the impedance vector and monitoring of the vector path
Max. detectable power swing frequency	Approx. 7 Hz
Operating modes	Power swing blocking and/or power swing tripping for out-of-step conditions
Power swing blocking programs	All zones blocked; Z1/Z1B blocked; Z2 to Z6 blocked; Z1, Z1B, Z2 blocked
Detection of faults during power swing blocking	Reset of power swing blocking for all types of faults
Backup overcurrent protection *(ANSI 50 (N), 51 (N), 67)*	
Operating modes	Active only with loss of VT secondary circuit or always active
Characteristic	2 definite-time stages / 1 inverse-time stage, 1 definite-time Stub-protection stage
Instantaneous trip after switch-onto-fault	Selectable for every stage
Definite-time stage *(ANSI 50, 50N)*	
Phase current pickup I_{PH}>>	0.1 to 25 A $_{(1A)}$ / 0.5 to 125 A $_{(5A)}$ (step 0.01 A)
Earth current pickup $3I_0$>>	0.05 to 25 A $_{(1A)}$ / 0.25 to 125 A $_{(5A)}$ (step 0.01 A)
Phase current pickup I_{PH}>	0.1 to 25 A $_{(1A)}$ / 0.5 to 125 A $_{(5A)}$ (step 0.01 A)
Earth current pickup $3I_0$>	0.05 to 25 A $_{(1A)}$ / 0.25 to 125 A $_{(5A)}$ (step 0.01 A)
Time delay	0 to 30 s (step 0.01 s) or deactivated
Tolerances	
Current pickup	≤ 3 % of setting value or 1 % I_N
Delay times	1 % of setting value or 10 ms
Operating time	Approx. 25 ms

Technical data

***Inverse-time stage** (ANSI 51, 51N)*	
Phase current pickup I_P	0.1 to 4 A (1A) / 0.5 to 20 A (5A) (step 0.01 A)
Earth current pickup $3I_{0P}$	0.05 to 4 A (1A) / 0.25 to 20 A (5A) (step 0.01 A)
Tripping time characteristics acc. to IEC 60255-3	Normal inverse; very inverse; extremely inverse; long time inverse
Tripping time characteristics acc. to ANSI/IEEE (not for DE region, see selection and ordering data 10th position)	Inverse; short inverse; long inverse; moderately inverse; very inverse; extremely inverse; definite inverse
Time multiplier for IEC charac. T	T_p = 0.05 to 3 s (step 0.01 s)
Time multiplier for ANSI charac. D	D_{IP} = 0.5 to 15 s (step 0.01 s)
Pickup threshold	Approx. 1.1 I/I_p (ANSI: I/I_p = M)
Reset threshold	Approx. 1.05 x I/I_p (ANSI: I/I_p = M)
Tolerances	
Operating time for 2 ≤ I/I_p ≤ 20	≤ 5 % of setpoint ± 15 ms
***Directional earth-fault overcurrent protection for high-resistance faults in systems with earthed star point** (ANSI 50N, 51N, 67N)*	
Characteristic	3 definite-time stages / 1 inverse-time stage or 4 definite-time stages or 3 definite-time stages / 1 $V_{0inv.}$ stage
Phase selector	Permits 1-pole tripping for single-phase faults or 3-pole tripping for multi-phase faults selectable for every stage
Inrush restraint	Selectable for every stage
Instantaneous trip after switch-onto-fault	Selectable for every stage
Influence of harmonics	
Stages 1 and 2 (I>>> and I>>)	3rd and higher harmonics are completely suppressed by digital filtering
Stages 3 and 4 (I> and inverse 4th stage)	2nd and higher harmonics are completely suppressed by digital filtering
***Definite-time stage** (ANSI 50N)*	
Pickup value $3I_0$>>>	0.5 to 25 A (1A) / 2.5 to 125 A (5A) (step 0.01 A)
Pickup value $3I_0$>>	0.2 to 25 A (1A) / 1 to 125 A (5A) (step 0.01 A)
Pickup value $3I_0$>	0.05 to 25 A (1A) / 0.25 to 125 A (5A) (step 0.01 A) Neutral (residual) current transformer with normal sensitivity (refer to ordering data, position 7); 0.003 to 25 A (1A) / 0.015 to 125 A (5A) (step 0.001 A) Neutral (residual) current transformer with high sensitivity (refer to ordering data, position 7)
Pickup value $3I_0$, 4th stage	0.05 to 25 A (1A) / 0.25 to 125 A (5A) (step 0.01 A) Neutral (residual) current transformer with normal sensitivity (refer to ordering data, position 7); 0.003 to 25 A (1A) / 0.015 to 125 A (5A) (step 0.001 A) Neutral (residual) current transformer with high sensitivity (refer to ordering data, position 7)
Time delay for definite-time stages	0 to 30 s (step 0.01 s) or deactivated
Tolerances	
Current pickup	≤ 3 % of setting value or 1 % I_{nom}
Delay times	1 % of setting value or 10 ms
Command / pickup times $3I_0$>>> and $3I_0$>>	Approx. 30 ms
Command / pickup times $3I_0$> and $3I_0$, 4th stage	Approx. 40 ms
***Inverse-time stage** (ANSI 51N)*	
Earth-current pickup $3I_{0P}$	0.05 to 4 A (1A) / 0.25 to 20 A (5A) (step 0.01 A) Neutral (residual) current transformer with normal sensitivity (refer to ordering data, position 7) 0.003 to 4 A (1A) / 0.015 to 20 A (5A) (step 0.001 A) Neutral (residual) current transformer with high sensitivity (refer to ordering data, position 7)
Tripping characteristics acc. to IEC 60255-3	Normal inverse; very inverse; extremely inverse; long time
ANSI/IEEE tripping characteristic (not for region DE, see selection and ordering data, position 10)	Inverse; short inverse; long inverse; moderately inverse; very inverse; extremely inverse; definite inverse
Inverse logarithmic tripping characteristics (not for regions DE and US, see selection and ordering data, position 10)	$t = T_{3I0Pmax} - T_{3I0P} \ln \frac{3I0}{3I0_p}$
Pickup threshold	1.1 to 4.0 x I/I_p (step 0.1 s)
Time multiplier for IEC charac. T	T_p = 0.05 to 3 s (step 0.01 s)
Time multiplier for ANSI charac. D	D_{I0P} = 0.5 to 15 s (step 0.01 s)
Pickup threshold	Approx. 1.1 I/I_p (ANSI: I/I_p = M)
Inverse logarithmic pickup threshold	1.1 to 4.0 x I/I_{0P} (step 0.1)
Reset threshold	Approx. 1.05 I/I_{0P} (ANSI: I/I_p = M)
Tolerance	
Operating time for 2 ≤ I/I_p ≤ 20	≤ 5 % of setpoint ± 15 ms
Zero-sequence voltage protection V_	
Tripping characteristic	$t = \frac{2\ s}{\frac{V_0}{4} - V_{0inv\ min}}$
Zero-sequence power-dependent stage	
Compensated zero-sequence power	$S_r = 3I_0 \cdot 3V_0 \cdot \cos(\varphi - \varphi_{comp.})$
***Direction decision** (ANSI 67N)*	
Measured signals for direction decision	$3I_0$ and $3V_0$ or $3I_0$ and $3V_0$ and I_Y (star point current of an earthed power transformer) or $3I_2$ and $3V_2$ (negative-sequence system) or zero-sequence power S_r or automatic selection of zero-sequence or negative-sequence quantities dependent on the magnitude of the component voltages
Min. zero-sequence voltage $3V_0$	0.5 to 10 V (step 0.1 V)
Min. current I_Y (of earthed transformers)	0.05 to 1 A (1A) / 0.25 to 5 A (5A) (step 0.01 A)
Min. negative-sequence voltage $3V_2$	0.5 to 10 V (step 0.1 V)
Min. negative-sequence current $3I_2$	0.05 to 1 A (1A) / 0.25 to 5 A (5A) (step 0.01 A)

Technical data

Inrush current blocking, capable of being activated for each stage	
Component of the 2nd harmonic	10 to 45 % of the fundamental (step 1 %)
Max. current, which cancels inrush current blocking	0.5 to 25 A (1A) / 2.5 to 125 A (5A) (step 0.01 A)
Tele (pilot) protection	
For directional earth-fault protection *(ANSI 85-67N)*	
Operating modes	Directional comparison, blocking, unblocking
Additional functions	Echo (see function "weak infeed"); transient blocking for schemes with parallel lines
Send and receive signals	Suitable for 2 and 3 end-lines
Instantaneous high-speed switch-onto-fault overcurrent protection *(ANSI 50HS)*	
Operating mode	Active only after CB closing; instantaneous trip after pickup
Pickup current I>>>	1 to 25 A (1A) / 5 to 125 A (5A) (step 0.01 A)
Reset ratio	Approx. 0.90
Tolerances	
Current starting	≤ 3 % of setting value or 1 % I_N
Shortest tripping time	
With reference to fast relays	Approx. 12 ms
With high-speed trip to outputs	Approx. 8 ms
Voltage protection *(ANSI 59, 27)*	
Operating modes	Local tripping and/or carrier trip for remote end
Overvoltage protection	
Pickup values V_{PH-E}>>, V_{PH-E}> (phase-earth overvoltage)	1 to 170 V (step 0.1 V)
Pickup values V_{PH-PH}>>, V_{PH-PH}> (phase-phase overvoltage)	2 to 220 V (step 0.1 V)
Pickup values $3V_0$>>, $3V_0$> ($3V_0$ can be measured via V4 transformers or calculated by the relay) (zero-sequence overvoltage)	1 to 220 V (step 0.1 V)
Pickup values V_1>>, V_1> (positive-sequence overvoltage)	2 to 220 V (step 0.1 V)
Measured voltage	Local positive-sequence voltage or calculated remote positive-sequence voltage (compounding)
Pickup values V_2>>, V_2> (negative-sequence overvoltage)	2 to 220 V (step 0.1 V)
Reset ratio (settable)	0.5 to 0.98 (step 0.01)
Undervoltage protection	
Pickup values V_{PH-E}<<, V_{PH-E}< (phase-earth undervoltage)	1 to 100 V (step 0.1 V)
Pickup values V_{PH-PH}<<, V_{PH-PH}< (phase-phase undervoltage)	1 to 170 V (step 0.1 V)
Pickup values V_1<<, V_1< (positive-sequence undervoltage)	1 to 100 V (step 0.1 V)
Blocking of undervoltage prot. stages	Minimum current; binary input
Reset ratio (settable)	1.01 to 1.20 (step 0.01)

Time delays	
Time delay for all stages	0 to 100 s (step 0.01 s) or deactivated
Command / pickup time	Approx. 30 ms
Command/pickup time for $3V_0$ stages	Approx. 30 ms or 65 ms (settable)
Tolerances	
Voltage limit values	≤ 3 % of setting value or 1 V
Time stages	1 % of setting value or 10 ms
Frequency protection *(ANSI 81)*	
Number of frequency elements	4
Setting range	45.5 to 54.5 Hz (in steps of 0.01) at f_{nom} = 50 Hz 55.5 to 64.5 Hz (in steps of 0.01) at f_{nom} = 60 Hz
Delay times	0 to 600 s or ∞ (in steps of 0.01 s)
Operating voltage range	6 to 230 V (phase-to-earth)
Pickup times	Approx. 80 ms
Dropout times	Approx. 80 ms
Hysteresis	Approx. 20 mHz
Dropout condition	Voltage = 0 V and current = 0 A
Tolerances	
Frequency	15 mHz for V_{PH-PH}: 50 to 230 V
Delay times	1 % of the setting value or 10 ms
Thermal overload protection *(ANSI 49)*	
Factor k acc. to IEC 60255-8	0.1 to 4 (steps 0.01)
Time constant τ	1 to 999.9 min (steps 0.1 min)
Thermal alarm stage $\Theta_{Alarm}/\Theta_{Trip}$	50 to 100 % referred to tripping temperature (steps 1 %)
Current-based alarm stage I_{Alarm}	0.1 to 4 A (1A) / 0.5 to 20 A (5A) (steps 0.01 A)
Calculating mode for overtemperature	Θ_{max}, Θ_{mean}, Θ with I_{max}
Pickup time characteristic	$t = \tau \ln \frac{I^2 - I_{pre}^2}{I^2 - (k\, I_{nom})^2}$
Reset ratio	
Θ/Θ_{Alarm}	Approx. 0.99
Θ/Θ_{Trip}	Approx. 0.99
I/ I_{Alarm}	Approx. 0.97
Overload measured values	Θ/Θ_{Trip} L1; Θ/Θ_{Trip} L2; Θ/Θ_{Trip} L3; Θ/Θ_{Trip}
Tolerances	Class 10 % acc. to IEC 60255-8
Breaker failure protection *(ANSI 50BF)*	
Number of stages	2
Pickup of current element	0.05 to 20 A (1A) / 0.25 to 100 A (5A) (step 0.01 A)
Time delays $T1_{1phase}$, $T1_{3phase}$, $T2$	0 to 30 s (steps 0.01 s) or deactivated
Additional functions	End-fault protection CB pole discrepancy monitoring
Drop-off (overshoot) time, internal	≤ 15 ms, typical; 25 ms, max.
Tolerances	
Current limit value	≤ 5 % of setting value or 1 % I_{nom}
Time stages	1 % of setting value or 10 ms

Technical data

Auto-reclosure *(ANSI 79)*	
Number of auto-reclosures	Up to 8
Operating mode	Only 1-pole; only 3-pole, 1 or 3-pole
Operating modes with line voltage check	DLC – dead-line check ADT – adaptive dead time RDT – reduced dead time
Dead times $T_{1\text{-PH}}$, $T_{3\text{-PH}}$, T_{Seq}	0 to 1800 s (step 0.01 s) or deactivated
Action times	0.01 to 300 s (step 0.01 s) or deactivated
Reclaim times	0.5 to 300 s (step 0.01 s)
Start-signal monitoring time	0.01 to 300 s (step 0.01 s)
Additional functions	Synchro-check request 3-phase intertripping InterCLOSE command to the remote end Check of CB ready state Blocking with manual CLOSE
Voltage limit values for DLC, ADT, RDT	
Healthy line voltage $_{PH-E}$	30 to 90 V (step 1 V)
Dead line voltage $_{PH-E}$	2 to 70 V (step 1 V)
Tolerances	
Time stages	1 % of setting value or 10 ms
Voltage limit values	≤ 3 % of setting value or 1 V
Synchro-check *(ANSI 25)*	
Initiate options	Auto-reclosure; Manual CLOSE control Control commands
Operating modes	
With auto-reclosure	Synchro-check Line dead/busbar live Line live/busbar dead Line and busbar dead Bypassing
For manual closure and control commands	As for auto-reclosure
Permissible voltage difference	1 to 60 V (step 0.1 V)
Permissible frequency difference	0.03 to 2 Hz (step 0.01 Hz)
Permissible angle difference	2 to 80 ° (step 1°)
Max. duration of synchronization	0.01 to 600 s (step 0.01 s) or deactivated
Release delay with synchronous networks	0 to 30 s (step 0.01 s)
Minimum measuring time	Approx. 80 ms
Tolerances	
Time stages	1 % of setting value or 10 ms
Voltage limit values	≤ 2 % of setting value or 1 V
Earth-fault detection for compensated / isolated networks	
Zero-sequence voltage $3V_0$	1 to 150 V (step 1 V)
Phase selection with phase voltages $V<$ and $V>$	10 to 100 V (step 1 V)
Directional determination	Active / reactive power measurements
Minimum current for directional determination	3 to 1000 mA (steps 1 mA)
Angle correction for core-balance CT	0 to 5 ° at 2 operating points (step 0.1 °)
Operating modes	Only indication; indication and trip
Delay times	0 to 320 s (step 0.01 s)
Pickup time	Approx. 50 ms
Earth-fault measured values	Active and reactive component of earth-fault current I_{EEac}, I_{EEreac}
Tolerances	
Voltage limit values	≤ 5 % of setting value or 1 V
Current limit values	≤ 10 % of setting value
Time stages	1 % of setting value or 10 ms
Trip circuit supervision *(ANSI 74TC)*	
Number of supervisable trip circuits	Up to 3
Number of required binary inputs per trip circuit	1 or 2
Indication relay	1 to 30 s (step 1 s)

Additional functions	
Operational measured values	
Representation	Primary, secondary and percentage referred to rated value
Currents	3 x I_{Phase} ; $3I_0$; $I_{E\ sensitve}$; I_1; I_2; I_Y; $3I_{0PAR}$
Tolerances	Typ. 0.3 % of indicated measured value or 0.5 % I_{nom}
Voltages	3 x $V_{Phase\text{-}Earth}$; 3 x $V_{Phase\text{-}Phase}$; $3V_0$, V_1, V_2, V_{SYNC}, V_{en}
Tolerances	Typ. 0.25 % of indicated measured value or 0.01 % V_{nom}
Power with direction indication	*P, Q, S*
Tolerances	
P: for $\lvert\cos\varphi\rvert$ = 0.7 to 1 and V/V_{nom}, I/I_{nom} = 50 to 120 %	Typical ≤ 1%
Q: for $\lvert\sin\varphi\rvert$ = 0.7 to 1 and V/V_{nom} , I/I_{nom} = 50 to 120 %	Typical ≤ 1%
S: for V/V_{nom}, I/I_{nom} = 50 to 120 %	Typical ≤ 1%
Frequency	*f*
Tolerance	≤ 10 mHz
Power factor	p.f. ($\cos\varphi$)
Tolerance for $\lvert\cos\varphi\rvert$ = 0.7 to 1	Typical ≤ 0.02
Load impedances with directional indication	3 x $R_{Phase\text{-}Earth}$, $X_{Phase\text{-}Earth}$ 3 x $R_{Phase\text{-}Phase}$, $X_{Phase\text{-}Phase}$
Earth-fault measured values	Active and reactive component of earth-fault current I_{EEac}, I_{EEreac}
Overload measured values	Θ/Θ_{Trip} L1; Θ/Θ_{Trip} L2; Θ/Θ_{Trip} L3; Θ/Θ_{Trip}
Long-term mean values	
Interval for derivation of mean value	15 min / 1 min; 15 min / 3 min; 15 min / 15 min
Synchronization instant	Every ¼ hour; every ½ hour; every hour
Values	3 x I_{Phase}; I_1; *P*; *P*+; *P*-; *Q*; *Q*+; *Q*-; *S*

Technical data

Minimum/maximum memory	
Indication	Measured values with date and time
Resetting	Cyclically Via binary input Via the keyboard Via serial interface
Values	
Min./max. of measured values	3 x I_{Phase}; I_1; 3 x $V_{Phase-Earth}$; 3 x $V_{Phase-to-phase}$; $3V_0$; V_1; P+; P-; Q+; Q-; S; f; power factor (+); power factor (–)
Min./max. of mean values	3 x $I_{Phase;}$ I_1; P; Q; S
Energy meters	
Four-quadrant meters	W_{P+}; W_{P-}; W_{Q+}; W_{Q-}
Tolerance for $\lvert\cos\varphi\rvert > 0.7$ and $V > 50$ % V_{nom} and $I > 50$ % I_{nom}	5 %
Analog measured value output *0 to 20 mA*	
Number of analog channels	2 per plug-in module Alternatively 1 or 2 or no plug-in module (Refer to ordering data, position 11 and Order code for position 12)
Indication range	0 to 22 mA
Selectable measured values	Fault location [%]; fault location [km]; V_{L23} [%]; I_{L2} [%]; $\lvert P\rvert$ [%]; $\lvert Q\rvert$ [%]; breaking current $I_{max\text{-}primary}$
Max. burden	350 Ω
Oscillographic fault recording	
Analog channels	3 x I_{Phase}, $3I_0$, $3I_{0\ PAR}$ 3 x V_{Phase}, $3V_0$, V_{SYNC}, V_{en}
Max. number of available recordings	8, backed-up by battery if auxiliary voltage supply fails
Sampling intervals	20 samplings per cycle
Total storage time	> 15 s
Binary channels	Pickup and trip information; number and contents can be freely configured by the user
Max. number of displayed binary channels	100
Control	
Number of switching units	Depends on the number of binary / indication inputs and indication / command outputs
Control commands	Single command / double command 1, 1 plus 1 common or 2 pole
Feed back	CLOSE, TRIP, intermediate position
Interlocking	Freely configurable
Local control	Control via menu, function keys, control keys (if available)
Remote control	Control protection, DIGSI, pilot wires

Further additional functions	
Measured value supervision	Current sum Current symmetry Voltage sum Voltage symmetry Phase sequence Fuse failure monitor Power direction
Indications	
Operational indications	Buffer size 200
System disturbance indication	Storage of indications of the last 8 faults, buffer size 600
Earth-fault indication	Storage of indications of the last 8 faults, buffer size 200
Switching statistics	Number of breaking operations per CB pole Sum of breaking current per phase Breaking current of last trip operation Max. breaking current per phase
Circuit-breaker test	TRIP/CLOSE cycle, 3 phases TRIP/CLOSE per phase
Dead time for CB TRIP / CLOSE cycle	0 to 30 s (steps 0.01 s)
Commissioning support	Operational measured values, c.-b. test, status display of binary inputs, setting of output relays, generation of indications for testing serial interfaces
Phase rotation adjustment	Clockwise or anti-clockwise

CE conformity

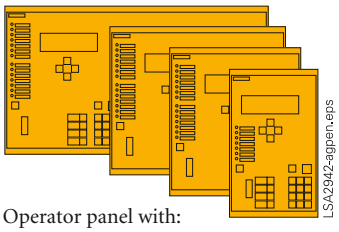
This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 89/336/EEC) and concerning electrical equipment for use within specified voltage limits (Low-voltage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

This conformity is proved by tests conducted by Siemens AG in accordance with Article 10 of the Council Directive in agreement with the generic standards EN 61000-6-2 and EN 61000-6-4 for the EMC directive and with the standard EN 60255-6 for the low-voltage directive.

This device is designed and produced for industrial use.

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

Selection and ordering data



Operator panel with:
- 4-line backlit display,
- function keys,
- numerical keys,
- PC interface

Description	Order No.
7SA61 distance protection relay for all voltage levels	7SA61☐☐-☐☐☐☐☐-☐☐☐☐

see pages 6/32 to 6/35

Housing, number of LEDs

Housing width 1/3 19", 7 LEDs	0
Housing width 1/2 19", 14 LEDs	1
Housing width 1/1 19", 14 LEDs	2
Housing width 2/3 19", 14 LEDs	3

Measuring input (4 x V, 4 x I)

I_{PH} = 1 A[1], I_e = 1 A (min. = 0.05 A)	1
I_{PH} = 1 A[1], I_e = sensitive (min. = 0.003 A)	2
I_{PH} = 5 A[1], I_e = 5 A (min. = 0.25 A)	5
I_{PH} = 5 A[1], I_e = sensitive (min. = 0.003 A)	6

Rated auxiliary voltage (power supply, binary inputs)

24 to 48 V DC, binary input threshold 17 V[3]	2
60 to 125 V DC[2], binary input threshold 17 V[3]	4
110 to 250 V DC[2], 115 to 230 V AC, binary input threshold 73 V[3]	5

Binary/ indication inputs	Indication/ command outputs incl. live status contact	Fast relay[4]	High-speed trip output	Power relay[5]	Flush-mounting housing/ screw-type terminals	Flush-mounting housing/ plug-in terminals	Surface-mounting housing/ screw-type terminals	
For 7SA610								
5	4	5			■			A
5	4	5					■	E
5	4	5				■		J
7	6				■			B
7	6						■	F
7	6					■		K
For 7SA611								
13	5	12			■			A
13	5	12					■	E
13	5	12				■		J
13	4	8	5		■			M
13	4	8	5				■	N
13	4	8	5			■		P
20	9			4	■			B
20	9			4			■	F
20	9			4		■		K
For 7SA612								
21	13	12			■			A
21	13	12					■	E
21	13	12				■		J
21	12	8	5		■			M
21	12	8	5				■	P
21	12	8	5			■		R
29	21	12			■			B
29	21	12					■	F
29	21	12				■		K
29	20	8	5		■			N
29	20	8	5				■	Q
29	20	8	5			■		S
33	12			8	■			C
33	12			8			■	G
33	12			8		■		L
For 7SA613								
21	13	12			■			A
21	12	8	5		■			M

1) Rated current can be selected by means of jumpers.

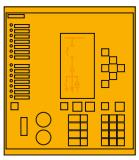
2) Transition between the two auxiliary voltage ranges can be selected by means of jumpers.

3) The binary input thresholds are selectable in three stages by means of jumpers, exception: versions with power relays have some binary inputs with only two binary input thresholds.

4) Fast relays are identified in the terminal connection diagram.

5) Power relay for direct control of disconnector actuator motors. Each pair of contacts is mechanically interlocked to prevent simultaneous closure.

Selection and ordering data



Operator panel with:
- backlit graphic display for single-line diagram
- control keys,
- key-operated switches,
- function keys,
- numerical keys,
- PC interface

Description	Order No.
7SA63 distance protection relay for all voltage levels	*7SA63□□-□□□□□□-□□□□*

see pages 6/32 to 6/35

Housing, number of LEDs

Housing width 1/2 19", 14 LEDs	*1*
Housing width 1/1 19", 14 LEDs	*2*

Measuring input (4 x V, 4 x I)

I_{PH} = 1 A[1], I_e = 1 A (min. = 0.05 A)	*1*
I_{PH} = 1 A[1], I_e = sensitive (min. = 0.003 A)	*2*
I_{PH} = 5 A[1], I_e = 5 A (min. = 0.25 A)	*5*
I_{PH} = 5 A[1], I_e = sensitive (min. = 0.003 A)	*6*

Rated auxiliary voltage (power supply, binary inputs)

24 to 48 V DC, binary input threshold 17 V[3]	*2*
60 to 125 V DC[2], binary input threshold 17 V[3]	*4*
110 to 250 V DC[2], 115 to 230 V AC, binary input threshold 73 V[3]	*5*

Binary/ indication-inputs	Indication/ command outputs incl. live status contact	Fast relay[4]	High-speed trip outputs	Power relay[5]	Flush-mounting housing/ screw-type terminals	Flush-mounting housing/ plug-in terminals	Surface-mounting housing/ screw-type terminals	
For 7SA631								
13	5	12			■			*A*
13	5	12					■	*E*
13	5	12				■		*J*
13	4	8	5		■			*M*
13	4	8	5				■	*N*
13	4	8	5			■		*P*
20	9			4	■			*B*
20	9			4			■	*F*
20	9			4		■		*K*
For 7SA632								
21	13	12			■			*A*
21	13	12					■	*E*
21	13	12				■		*J*
21	12	8	5		■			*M*
21	12	8	5				■	*P*
21	12	8	5			■		*R*
29	21	12			■			*B*
29	21	12					■	*F*
29	21	12				■		*K*
29	20	8	5		■			*N*
29	20	8	5				■	*Q*
29	20	8	5			■		*S*
33	12			8	■			*C*
33	12			8			■	*G*
33	12			8		■		*L*

1) Rated current can be selected by means of jumpers.

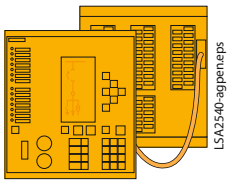
2) Transition between the two auxiliary voltage ranges can be selected by means of jumpers.

3) The binary input thresholds are selectable in three stages by means of jumpers, exception: versions with power relays have some binary inputs with only two binary inputs thresholds.

4) Fast relays are identified in the terminal connection diagram.

5) Power relay for direct control of disconnector actuator motors. Each pair of contacts is mechanically interlocked to prevent simultaneous closure.

Selection and ordering data



Units with
detached operator panel with
- backlit graphic display
- control keys
- key-operated switches
- function keys
- numerical keys
- PC interface

Description	Order No.
7SA64 distance protection relay for all voltage levels	*7SA64*□□-□□□□□□-□□□□

see pages 6/32 to 6/35

Housing, number of LEDs

Housing width 1/2 19", 14 LEDs	*1*
Housing width 1/1 19", 14 LEDs	*2*

Measuring input (4 x V, 4 x I)

I_{PH} = 1 A[1], I_e = 1 A (min. = 0.05 A)	*1*
I_{PH} = 1 A[1], I_e = sensitive (min. = 0.003 A)	*2*
I_{PH} = 5 A[1], I_e = 5 A (min. = 0.25 A)	*5*
I_{PH} = 5 A[1], I_e = sensitive (min. = 0.003 A)	*6*

Rated auxiliary voltage (power supply, binary inputs)

24 to 48 V DC, binary input threshold 17 V[3]	*2*
60 to 125 V DC[2], binary input threshold 17 V[3]	*4*
110 to 250 V DC[2], 115 to 230 V AC, binary input threshold 73 V[3]	*5*

Binary/ indication-inputs	Indication/ command outputs incl. live status contact	Fast relay[4]	High-speed trip outputs	Power relay[5]	Flush-mounting housing/ screw-type terminals	Flush-mounting housing/ plug-in terminals	
For 7SA641							
13	5	12			■		*A*
13	5	12				■	*J*
13	4	8	5		■		*M*
13	4	8	5			■	*P*
20	9			4	■		*B*
20	9			4		■	*K*
For 7SA642							
21	13	12			■		*A*
21	13	12				■	*J*
21	12	8	5		■		*M*
21	12	8	5			■	*R*
29	21	12			■		*B*
29	21	12				■	*K*
29	20	8	5		■		*N*
29	20	8	5			■	*S*
33	12			8	■		*C*
33	12			8		■	*L*

1) Rated current can be selected by means of jumpers.

2) Transition between the two auxiliary voltage ranges can be selected by means of jumpers.

3) The binary input thresholds are selectable in three stages by means of jumpers, exception: versions with power relays have some binary inputs with only two binary inputs thresholds.

4) Fast relays are identified in the terminal connection diagram.

5) Power relay for direct control of disconnector actuator motors.
Each pair of contacts is mechanically interlocked to prevent simultaneous closure.

Selection and ordering data

Description	Order No.	Order code
7SA6 distance protection relay for all voltage levels	*7SA6*□□-□□□□□-□□□□	□□□
Region-specific default settings / language settings		
Region DE, language: German	*A*	
Region World, language: English (GB)	*B*	
Region US, language: English (US)	*C*	
Region FR, French	*D*	
Region World, Spanish	*E*	
Region World, Italian	*F*	
Region World, language: Russian	*G*	
Region World, language: Polish	*H*	
Port B		
Empty	*0*	
System interface, IEC 60870-5-103 protocol, electrical RS232	*1*	
System interface, IEC 60870-5-103 protocol, electrical RS485	*2*	
System interface, IEC 60870-5-103 protocol, optical 820 nm, ST connector	*3*	
System interface, PROFIBUS-FMS Slave[2], electrical RS485	*4*	
System interface, PROFIBUS-FMS Slave[2], optical[3], double ring[3], ST connector	*6*	
2 analog outputs, each 0.....20 mA	*7*	
System interface, PROFIBUS-DP, electrical RS485	*9*	*L 0 A*
System interface, PROFIBUS-DP, optical 820 nm, double ring[3], ST connector	*9*	*L 0 B*
System interface, DNP 3.0, electrical RS485	*9*	*L 0 G*
System interface, DNP 3.0, optical 820 nm, ST connector[3]	*9*	*L 0 H*
System interface, IEC 61850, 100 Mbit/s Ethernet, electrical, duplicate, RJ45 plug connectors	*9*	*L 0 R*
System interface, IEC 61850, 100 Mbit/s Ethernet, optical, double, LC connector[4]	*9*	*L 0 S*

see pages 6/33 to 6/35

1) Definitions for region-specific default settings and functions:

Region DE: preset to $f = 50$ Hz and line length in km, only IEC inverse characteristic can be selected, directional earth (ground) fault protection: no logarithmic inverse characteristic, no direction decision with zero-sequence power S_r; distance protection can be selected with quadrilateral or circle characteristic.

Region US: preset to $f = 60$ Hz and line length in miles, ANSI inverse characteristic only, directional earth (ground) fault protection: no logarithmic inverse characteristic, no direction decision with zero-sequence power S_r, no U_0 inverse characteristic.

Region World: preset to $f = 50$ Hz and line length in km, directional earth (ground) fault protection: no direction decision with zero-sequence power S_r, no U_0 inverse characteristic.

Region FR: preset to f = 50 Hz and line length in km, directional earth (ground) fault protection: no U_0 inverse characteristic, no logarithmic inverse characteristic, weak infeed logic selectable between French specification and world specification.

2) For SICAM energy automation systems.

3) Optical double ring interfaces are not available with surface mounting housings.

4) For surface mounting housing applications please order the relay with electrical Ethernet interface and use a separate fiber-optic switch.

Selection and ordering data

Description	Order No.	Order code
7SA6 distance protection relay for all voltage levels	7SA6□□-□□□□□-□□□□	□□□
Port C and port D		
Port C: DIGSI/modem, electrical RS232, Port D: empty		1
Port C: DIGSI/modem, electrical RS485, Port D: empty		2
Port C and Port D installed		9
Port C		
DIGSI/modem, electrical RS232		1
DIGSI/modem, electrical RS485		2
Port D		
Protection data interface: optical 820 nm, two ST connectors, FO cable length up to 1.5 km For direct connection via multi-mode FO cable or communication networks [1]		A
Protection data interface: optical 820 nm, two ST connectors, FO cable length up to 3.5 km For direct connection via multi-mode FO cable		B
Two analog outputs, each 0...20 mA		K
Protection data interface: optical 1300 nm, LC-Duplex connector FO cable length up to 24 km for direct connection via mono-mode FO cable[2]		G
Protection data interface: optical 1300 nm, LC-Duplex connector FO cable length up to 60 km for direct connection via mono-mode FO cable[2)3)]		H
Protection data interface: optical 1550 nm, LC-Duplex connector FO cable length up to 100 km for direct connection via mono-mode FO cable[2)4)]		J
FO30 optical 820 nm, 2-ST-connector, length of optical fibre up to 1.5 km for multimode fibre, for communication networks with IEEEC37.94 interface or direct optical fibre connection (not available for surface mounted housing)		S

see pages 6/34 and 6/35

1) For suitable communication converters 7XV5662 (optical to G703.1/X21/RS422 or optical to pilot wire) see "Accessories".

2) For surface -mounting housing applications an internal fiber-optic module 820 nm will be delivered in combination with an external repeater.

3) For distances less than 25 km, two optical attenuators 7XV5107-0AA00 are required to avoid optical saturation of the receiver element.

4) For distances less than 50 km, two optical attenuators 7XV5107-0AA00 are required to avoid optical saturation of the receiver element.

Selection and ordering data

Description				Order No.
7SA6 distance protection relay for all voltage levels				*7SA6*□□□-□□□□□-□□□□
Functions 1				
Trip mode	Thermal overload protection (ANSI 49)	BCD-coded output for fault location		
3-pole				*0*
3-pole		■		*1*
3-pole	■			*2*
3-pole	■	■		*3*
1/3-pole				*4*
1/3-pole		■		*5*
1/3-pole	■			*6*
1/3-pole	■	■		*7*
Functions 2				
Distance protection pickup (ANSI 21, 21N)		Power swing detection (ANSI 68, 68T)	Parallel line compensation	
I>				*A*
V< / *I*>				*B*
Quadrilateral (*Z*<)				*C*
Quadrilateral (*Z*<), *V*< / *I*> / φ				*D*
Quadrilateral (*Z*<)		■		*F*
Quadrilateral (*Z*<), *V*< / *I*> / φ		■		*G*
V< / *I*>			■ 1)	*J*
Quadrilateral (*Z*<)			■ 1)	*K*
Quadrilateral (*Z*<), *V*< / *I*> / φ			■ 1)	*L*
Quadrilateral (*Z*<)		■	■ 1)	*N*
Quadrilateral (*Z*<), *V*< / *I*> / φ		■	■ 1)	*P*
Functions 3				
Auto-reclosure (ANSI 79)	Synchro-check (ANSI 25)	Breaker failure protection (ANSI 50BF)	Over/undervoltage protection *V*>, *V*< (ANSI 27, 59) Over/underfrequency protection (ANSI 81)	
				A
			■	*B*
		■		*C*
		■	■	*D*
	■			*E*
	■		■	*F*
	■	■		*G*
	■	■	■	*H*
■				*J*
■			■	*K*
■		■		*L*
■		■	■	*M*
■	■			*N*
■	■		■	*P*
■	■	■		*Q*
■	■	■	■	*R*
Functions 4				
Directional earth-fault protection, earthed networks (ANSI 50N, 51N, 67N)	Earth-fault detection compensated/ isolated networks	Measured values extended Min, max, mean		
				0
		■		*1*
	■ 2)			*2*
	■ 2)	■		*3*
■				*4*
■		■		*5*
■	■ 2)			*6*
■	■ 2)	■		*7*

1) Only with position 7 of Order No. = *1* or *5*.

2) Only with position 7 of Order No. = *2* or *6*.

Selection and ordering data

Description: *7SA6 distance protection relay for all voltage levels*

Order No.: *7SA6□□□-□□□□□□-□□□□*

Preferential types

Functions 1

Trip mode, 3-pole	Trip mode 1 or 3-pole	Pickup I>	Pickup V <,I>	Z < (quadrilateral) V<,I>,φ	Power swing detection	Parallel line compensation	Auto-reclosure	Synchro-check	Breaker failure protection	Voltage protection Frequency protection	Earth-fault protection directional for earthed networks	Earth-fault directional for compensated isolated networks	Overload protection	Measured values, extended, min. max. mean	Order No.
Basic version															
■		■								■					*1 A B 0*
■		■								■				■	*1 A B 1*
Medium voltage, cables															
■		■	■						■	■	■	■[1]	■		*3 B D 6*
■		■	■						■	■	■	■[1]	■	■	*3 B D 7*
Medium voltage, overhead lines															
■		■	■				■		■	■	■	■[1]	■		*3 B M 6*
■		■	■				■		■	■	■	■[1]	■	■	*3 B M 7*
High voltage, cables															
■		■	■	■	■			■	■	■	■		■		*3 G H 4*
■		■	■	■	■			■	■	■	■		■	■	*3 G H 5*
High voltage, overhead lines															
■	■	■	■	■	■	■[2]	■	■	■	■	■		■		*7 P R 4*
■	■	■	■	■	■	■[2]	■	■	■	■	■		■	■	*7 P R 5*

1) Only with position 7 of Order No. = *2* or *6*.

2) Only with position 7 of Order No. = *1* or *5*.

Accessories

Description	Order No.
DIGSI 4	
Software for configuration and operation of Siemens protection units running under MS Windows 2000/XP Professional device templates, Comtrade Viewer, electronic manual included as well as "Getting started" manual on paper, connecting cables (copper)	
Basis Full version with license for 10 computers, on CD-ROM (authorization by serial number)	*7XS5400-0AA00*
Professional DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation)	*7XS5402-0AA00*
Professional + IEC 61850 DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation) + IEC 61850 system configurator	*7XS5403-0AA00*
IEC 61850 System configurator	
Software for configuration of stations with IEC 61850 communication under DIGSI, running under MS Windows 2000 or XP Professional Edition Optional package for DIGSI 4 Basis or Professional License for 10 PCs. Authorization by serial number. On CD-ROM	*7XS5460-0AA00*
SIGRA 4	
(generally contained in DIGSI Professional, but can be ordered additionally) Software for graphic visualization, analysis and evaluation of fault records. Can also be used for fault records of devices of other manufacturers (Comtrade format). Running under MS Windows 2000/XP Professional. Incl. templates, electronic manual with license for 10 PCs. Authorization by serial number. On CD-ROM.	*7XS5410-0AA00*
Connecting cable (copper)	
Cable between PC/notebook (9-pin connector) and protection unit (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)	*7XV5100-4*
Voltage transformer miniature circuit-breaker	
Rated current 1.6 A; thermal overload release 1.6 A; overcurrent trip 6 A	*3RV1611-1AG14*
Manual for 7SA6	
English, V4.61 and higher	*C53000-G1176-C156-5*

Accessories

Description	Order No.
Opto-electric communication converters	
Optical to X21/RS422 or G703.1	*7XV5662-0AA00*
Optical to pilot wires	*7XV5662-0AC00*
Additional interface modules	
Protection data interface FO 5, OMA1, 820 nm, multi-mode FO cable, ST connector, 1.5 km	*C53207-A351-D651-1*
Protection data interface FO 6, OMA2, 820 nm, multi-mode FO cable, ST connector, 3.5 km	*C53207-A351-D652-1*
Protection data interface FO 17, 1300 nm, mono-mode FO cable, LC-Duplex connector, 24 km	*C53207-A322-B115-3*
Protection data interface FO 18, 1300 nm, mono-mode FO cable, LC-Duplex connector, 60 km	*C53207-A322-B116-3*
Protection data interface FO 19, 1550 nm, mono-mode FO cable, LC-Duplex connector, 100 km	*C53207-A322-B117-3*
Optical repeaters	
Serial repeater (2-channel), opt. 1300 nm, mono-mode FO cable, LC-Duplex connector, 24 km	*7XV5461-0BG00*
Serial repeater (2-channel), opt. 1300 nm, mono-mode FO cable, LC-Duplex connector, 60 km	*7XV5461-0BH00*
Serial repeater (2-channel), opt. 1550 nm, mono-mode FO cable, LC-Duplex connector, 100 km	*7XV5461-0BJ00*

Fig. 6/34 Mounting rail for 19" rack

Fig. 6/35
2-pin connector

Fig. 6/36
3-pin connector

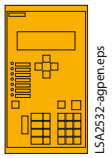
Fig. 6/37
Short-circuit link for current contacts

Fig. 6/38
Short-circuit link for voltage contacts/ indications contacts

Description		Order No.	Size of package	Supplier	Fig.
Connector	2-pin	*C73334-A1-C35-1*	1	Siemens	6/35
	3-pin	*C73334-A1-C36-1*	1	Siemens	6/36
Crimp connector	CI2 0.5 to 1 mm²	*0-827039-1*	4000	AMP [1]	
		0-827396-1	1	AMP [1]	
	CI2 1 to 2.5 mm²	*0-827040-1*	4000	AMP [1]	
		0-827397-1	1	AMP [1]	
	Type III+ 0.75 to 1.5 mm²	*0-163083-7*	4000	AMP [1]	
		0-163084-2	1	AMP [1]	
Crimping tool	For Type III+ and matching female	*0-539635-1*	1	AMP [1]	
		0-539668-2		AMP [1]	
	for CI2 and matching female	*0-734372-1*	1	AMP [1]	
		1-734387-1		AMP [1]	
19"-mounting rail		*C73165-A63-D200-1*	1	Siemens	6/34
Short-circuit links	For current terminals	*C73334-A1-C33-1*	1	Siemens	6/37
	For other terminals	*C73334-A1-C34-1*	1	Siemens	6/38
Safety cover for terminals	large	*C73334-A1-C31-1*	1	Siemens	6/4
	small	*C73334-A1-C32-1*	1	Siemens	6/4

1) Your local Siemens representative can inform you on local suppliers.

Connection diagram



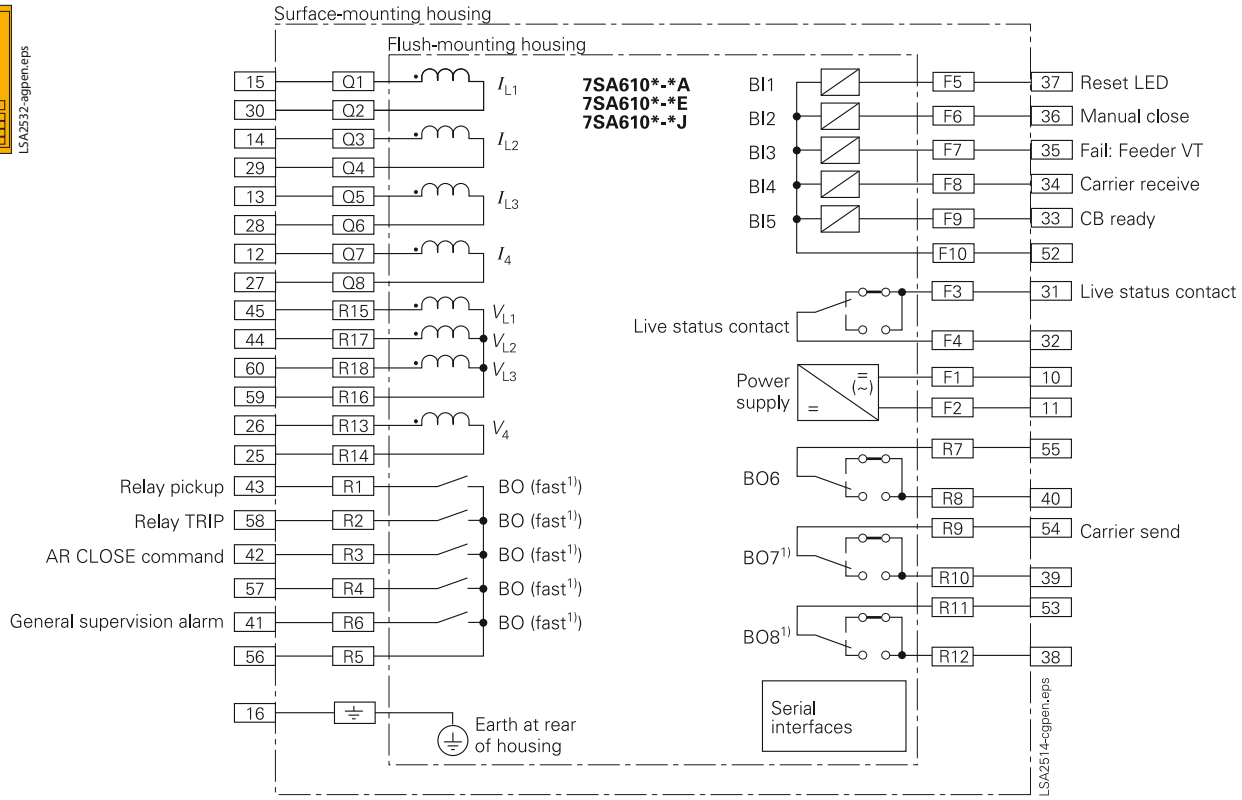


Fig. 6/39
Connection diagram

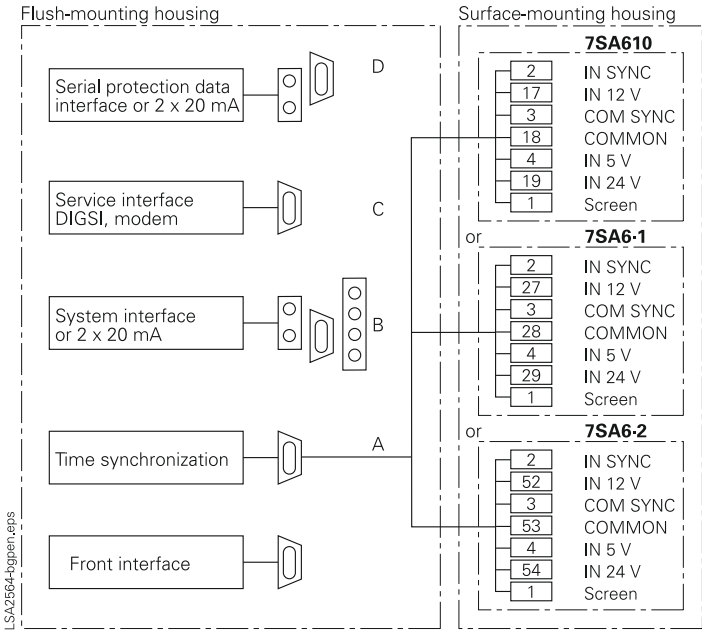


Fig. 6/40
Serial interfaces

1) Starting from unit version ..../EE.

Connection diagram

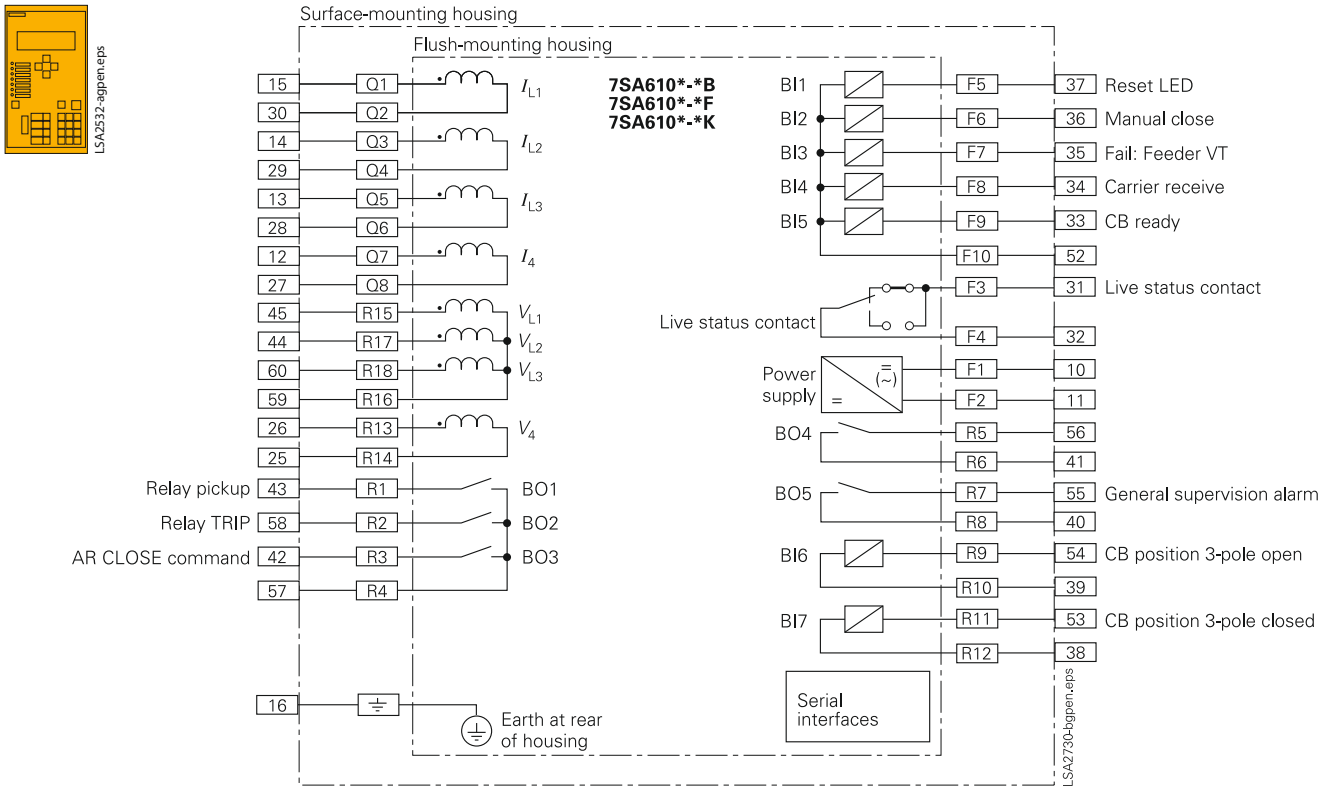


Fig. 6/41
Connection diagram

Note: For serial interfaces see Fig. 6/40.

Connection diagram

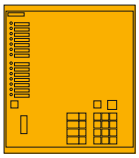


Fig. 6/42
Connection diagram

1) Starting from unit version .../EE.

2) High-speed trip outputs in versions 7SA6*1*-*M, 7SA*1*-*N, 7SA*1*-*P.
Time advantage of high-speed relays over fast relays: approx. 5 ms

3) Time advantage with fast relay approx. 3 ms.

4) Version with 3-pole tripping.

5) Version with 1/3-pole tripping.

Note: For serial interfaces see Fig. 6/40.

Connection diagram

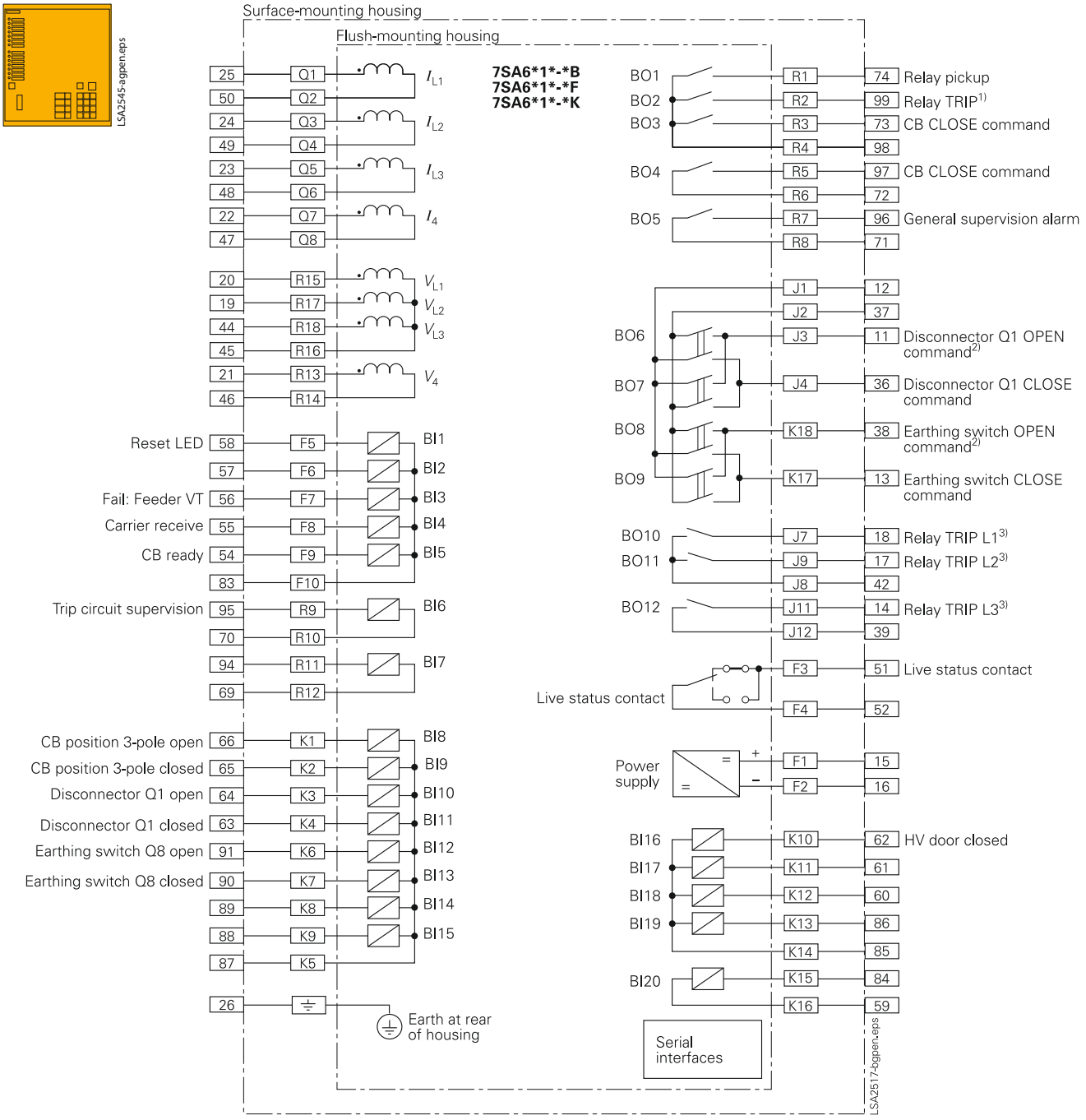
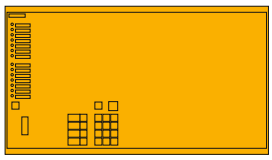


Fig. 6/43
Connection diagram

1) Version with 3-pole tripping.
2) Each pair of contacts is mechanically interlocked to prevent simultaneous closure.
3) Version with 1/3-pole tripping.
Note: For serial interfaces see Fig. 6/40.

Connection diagram



LSA2546-agpen.eps

1) 7SA613 is only available in a 2/3 x 19" flush-mounting housing.

2) Starting from unit version .../EE

3) Time advantage with fast relay approx. 3 ms.

4) High-speed trip outputs in versions 7SA6*2*-*M, 7SA6*2*-*P, 7SA6*2*-*R. Time advantage of high-speed relays over fast relays: approx. 5 ms

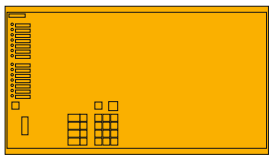
5) Version with 3-pole tripping.

6) Version with 1/3-pole tripping.

Note: For serial interfaces see Fig. 6/40.

Fig. 6/44
Connection diagram

Connection diagram



LSA2546-agpen.eps

1) Starting from unit version .../EE.

2) High-speed trip outputs in versions 7SA6*2*-*N, 7SA6*2*-*Q, 7SA6*2*-*S.

3) Time advantage with fast relay approx. 3 ms.

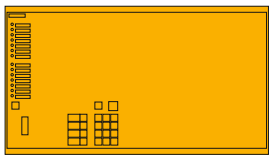
4) Version with 3-pole tripping.

5) Version with 1/3-pole tripping.
Time advantage of high-speed relays over fast relays: approx. 5 ms.

Note: For serial interfaces see Fig. 6/40.

Fig. 6/45 Connection diagram

Connection diagram



LSA2546-agpen.eps

1) Version with 3-pole tripping.

2) Each pair of contacts is mechanically interlocked to prevent simultaneous closure.

3) Version with 1/3-pole tripping.

Note: For serial interfaces see Fig. 6/40.

Fig. 6/46 Connection diagram