

SIPROTEC 4 7SA522 Distance Protection Relay for Transmission Lines



Fig. 6/47 SIPROTEC 4
7SA522 distance protection relay

Description

The SIPROTEC 4 7SA522 relay provides full-scheme distance protection and incorporates all functions usually required for the protection of a power line. The relay is designed to provide fast and selective fault clearance on transmission and subtransmission cables and overhead lines with or without series capacitor compensation. The power system star point can be solid or resistance grounded (earthed), resonant-earthed via Peterson coil or isolated. The 7SA522 is suitable for single-pole and three-pole tripping applications with and without tele (pilot) protection schemes.

The 7SA522 incorporates several protective functions usually required for transmission line protection.

- High-speed tripping time
- Suitable for cables and overhead lines with or without series capacitor compensation
- Self-setting power swing detection for power swing frequencies up to 7 Hz
- Digital relay-to-relay communication for two and three terminal topologies
- Adaptive auto-reclosure (ADT)

Function overview

Protection functions

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

Control functions

- Commands f. control of CB 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

- User-friendly local operation with numeric keys
- LEDs for local alarm
- PC front port for convenient relay setting
- Function keys

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
- 2 serial protection data interfaces for tele (pilot) protection
- Rear-side service/modem interface
- Time synchronization via IRIG B or DCF77 or system interface

Hardware

- Binary inputs: 8/16/24
- Output relays: 16/24/32
- High-speed trip outputs: 5 (optional)

Application

The 7SA522 relay provides full-scheme distance protection and incorporates all functions usually required for the protection of a power line. The relay is designed to provide fast and selective fault clearance on transmission and subtransmission cables and overhead lines with or without series capacitor compensation. This contributes towards improved stability and availability of your electrical power transmission system. The power system star point can be solid or impedance grounded (earthed), resonant-earthed via Peterson coil or isolated. The 7SA522 is suitable for single and three-pole tripping applications with and without tele (pilot) protection schemes.

The effect of apparent impedances in unfaulted fault loops is eliminated by a sophisticated and improved method which uses pattern recognition with symmetrical components and load compensation. The correct phase selection is essential for selective tripping and reliable fault location.

During network power swings, an improved power swing blocking feature prevents the distance protection from unwanted tripping and optionally provides controlled tripping in the event of loss of synchronism (out of step). This function guarantees power transmission even under critical network operating 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 and interlocking change, it is possible in the majority of the 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.

Features

- High speed tripping time
- Suitable for cables and overhead lines with or without series capacitor compensation
- Self setting power swing detection for frequencies up to 7 Hz
- Digital relay-to-relay communication for two and three terminal topologies
- Adaptive auto-reclosure (ADT)

ANSI	Protection function
21/21N	Distance protection
FL	Fault locator
50N/51N	Directional earth(ground)-fault protection
67N	
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(ground)-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)

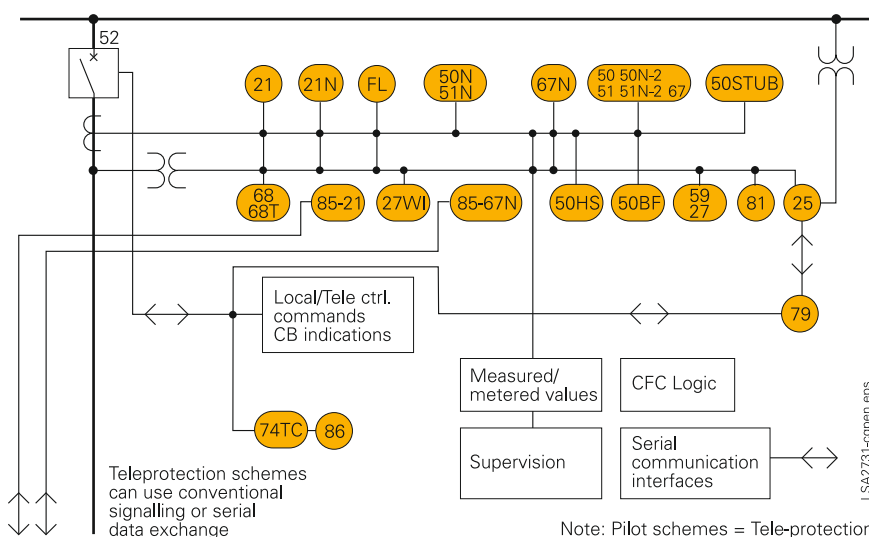


Fig. 6/48
Single-line diagram

Construction

Connection techniques and housing with many advantages

1/2 and 1/1-rack sizes

These are the available housing widths of the SIPROTEC 4 7SA522 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.



Fig. 6/49

Housing widths 1/2 x 19" and 1/1 x 19"



Fig. 6/50

Rear view with screw-type terminals and serial interfaces



Fig. 6/51

Rear view with terminal covers and wiring

Protection functions

Distance protection (ANSI 21, 21N)

The main function of the 7SA522 is a full-scheme 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 faults. The shortest tripping time is less than one cycle. Single-pole and three-pole tripping is possible. The distance protection is suitable for cables and overhead lines with or without series capacitor compensation.

Mho and quadrilateral characteristics

The 7SA522 relay provides quadrilateral as well as mho zone characteristics. Both characteristics can be used separately for phase and ground (earth) faults. Resistance ground (earth) faults can, for instance, be covered with the quadrilateral characteristic and phase faults with the mho characteristic.

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 7SA522 distance protection incorporates a well-proven, highly sophisticated phase selection algorithm. The pickup of unfaulted loops is reliably eliminated to prevent the adverse influence of currents and voltages in the fault-free loops. This phase selection algorithm achieves single-pole tripping and correct distance measurement in a wide application range.

Parallel line compensation

The influence of wrong distance measurement due to parallel lines can be compensated by feeding the neutral current of the parallel line to the relay. Parallel line compensation can be used for distance protection as well as for the fault locator.

7 distance zones

Six independent distance zones and one separate overreach zone are available. Each distance zone has dedicated time stages, partly separate for single-phase or multi-phase faults. Ground (earth) faults are detected by monitoring the neutral current $3I_0$ and the zero-sequence voltage $3V_0$.

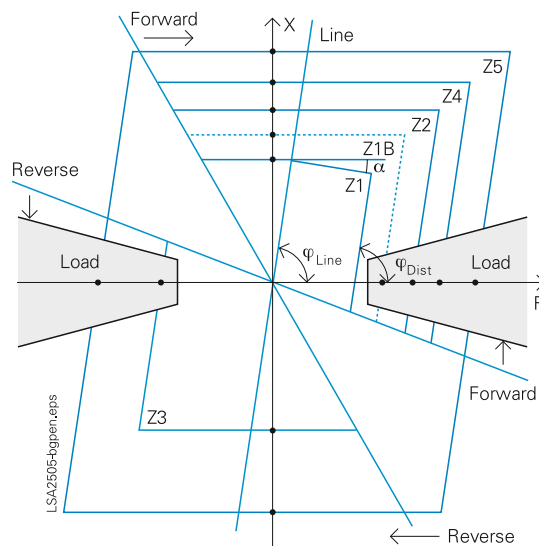


Fig. 6/52
Distance protection:
quadrilateral characteristic

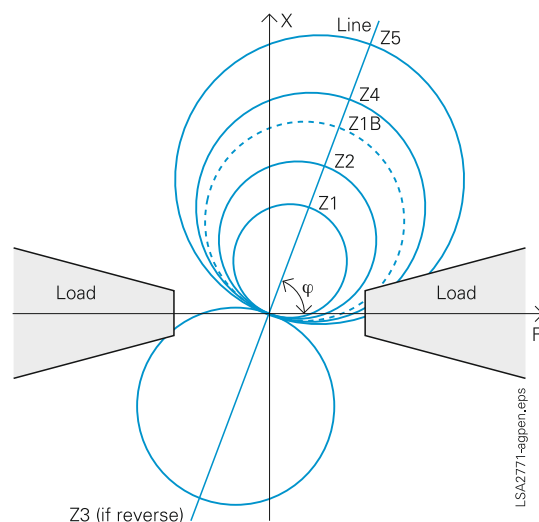


Fig. 6/53
Distance protection:
mho characteristic

The quadrilateral tripping characteristic permits separate setting of the reactance X and the resistance R . The resistance section R can be set separately for faults with and without earth involvement. This characteristic has therefore an optimal performance in case of faults with fault resistance. The distance zones can be set forward, reverse or non-directional. Sound phase polarization and voltage memory provides a dynamically unlimited directional sensitivity.

Mho

The mho tripping characteristic provides sound phase respectively memory polarization for all distance zones. The diagram shows characteristic without the expansion due to polarizing. During a forward fault the polarizing expands the mho circle towards the source so that the origin is included. This mho circle expansion guarantees safe and selective operation for all types of faults, even for close-in faults.

Protection functions

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 result is displayed in ohms, miles, kilometers or in percent of the line length. Parallel line and load current compensation is also available.

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 7SA522 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:

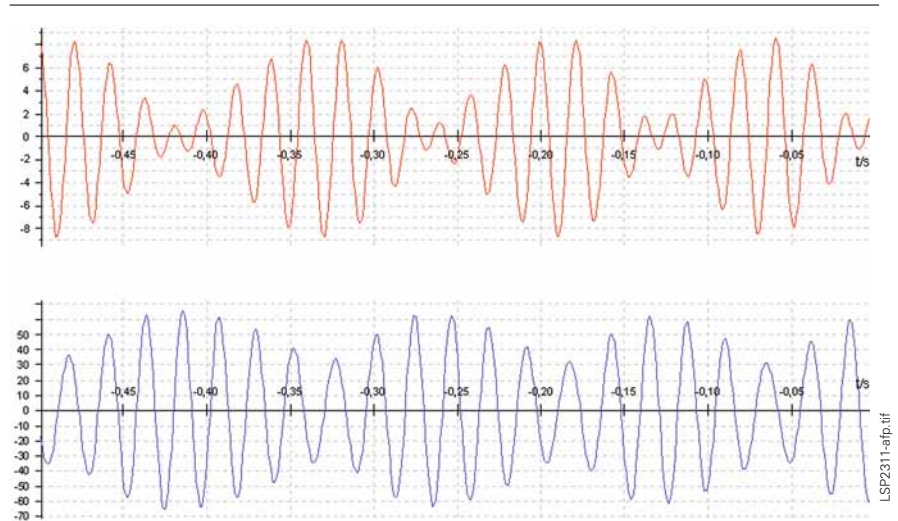


Fig. 6/54
Power swing current and voltage wave forms

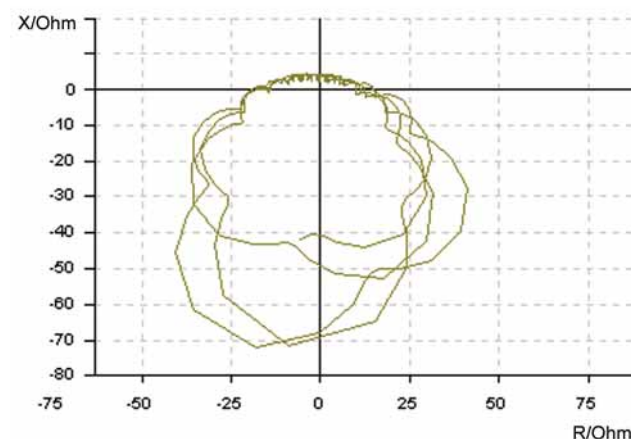


Fig. 6/55
Power swing
circle diagram

- PUTT, permissive underreaching zone transfer trip
- POTT, permissive overreaching zone transfer trip
- UNBLOCKING
- BLOCKING
- 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 as well.

7SA522 also permits the transfer of phase-selective signals. This feature is particularly advantageous as it ensures reliable single-pole tripping, if two 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 applications, if some user-specific linkages are implemented by way of the integrated CFC logic. During disturbances in the transmission receiver or on the transmission circuit, the teleprotection function can be blocked by 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. A transient blocking function (Current reversal guard) is provided 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 7SA522 relay is equipped with 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 tripping at the weak-infeed end. A phase-selective 1-pole or 3-pole trip is issued if a permissive trip signal (POTT or Unblock-ing) 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.

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

In grounded (earthed) networks, it may happen that the distance protection sensitivity is not sufficient to detect high-resistance ground (earth) faults. The 7SA522 protection relay therefore has protection functions for faults of this nature.

The ground (earth)-fault overcurrent protection can be used with 3 definite-time stages and one inverse-time stage (IDMT). A 4th definite-time stage can be applied instead of the one inverse-time stage.

Inverse-time characteristics according to IEC 60255-3 and ANSI/IEEE are provided (see "Technical data"). An additional logarithmic inverse-time characteristic is also available.

The direction decision can be determined by the neutral current and the zero-sequence voltage or by the negative-sequence components V_2 and I_2 . In addition or as an alternative to the directional determination with zero-sequence voltage, the star-point current of an grounded (earthed) power transformer may also be used for polarization. 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 for both directions (non-directional).

As an option, the 7SA522 relay can be provided with a sensitive neutral (residual) current transformer. This feature provides a measuring range for the neutral (residual) current from 5 mA to 100 A with a nominal relay current of 1 A and from 5 mA to 500 A with a nominal relay current of 5 A. Thus the ground(earth)-fault overcurrent protection can be applied with extreme sensitivity.

The function is equipped with special digital filter algorithms, providing the elimination of higher harmonics. This feature is particularly important for low zero-sequence fault currents which usually have a high content of 3rd and 5th harmonics. Inrush stabilization and instantaneous switch-onto-fault trip can be activated separately for each stage as well.

Different operating modes can be selected. The ground(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 ground(earth)-fault protection (ANSI 85-67N)

The directional ground(earth)-fault overcurrent protection can be combined with one of the following teleprotection schemes:

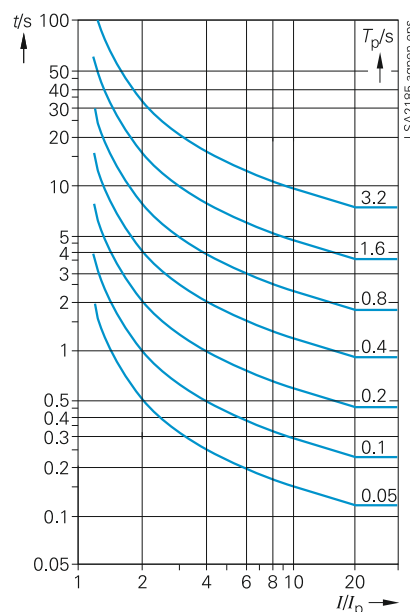
- Directional comparison
- BLOCKING
- UNBLOCKING

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 ground(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 7SA522 provides a backup overcurrent protection. Two definite-time stages and one inverse-time stage (IDMTL) are available, separately for phase currents and for the neutral (residual) current.



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

Fig. 6/56 Normal inverse

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").

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

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

Settings are available for phase and ground(earth)-faults.

Protection functions

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

Instantaneous tripping is possible when energizing a faulty line. In the event of large fault currents, the high-speed switch-onto-fault overcurrent stage can initiate very fast 3-pole tripping.

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

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

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 7SA522 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 7SA522 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 over-frequency 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.

Breaker failure protection (ANSI 50BF)

The 7SA522 relay incorporates a two-stage circuit-breaker failure protection to detect failures of tripping command execution, for example due to a defective circuit-breaker. The current detection logic is phase-segregated and can therefore also be used in single-pole tripping schemes.

If the fault current is not interrupted after a time delay has expired, a retrip command or the 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.

Auto-reclosure (ANSI 79)

The 7SA522 relay is equipped with an auto-reclose function (AR). The function includes several operating modes:

- 3-pole auto-reclosure for all types of faults; different dead times are available depending 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-reclosing for multi-phase faults
- 1-pole auto-reclosure for 1-phase faults and 2-phase faults without earth and 3-pole auto-reclosure for other faults
- Multiple-shot auto-reclosure
- Interaction with an external device for auto-reclosure via binary inputs and outputs
- Control of the integrated 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).

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 tele-protection 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, it must be ensured that both network sections are mutually synchronous. For this purpose, a synchronism-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).

Protection functions

Fuse failure monitoring and other supervision functions

The 7SA522 relay provides comprehensive monitoring 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 monitoring 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 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 7SA522 has a function for detecting the power direction by measuring the phase angle of the positive-sequence system's power. Fig. 6/57 shows an application example displaying negative active power. An indication is issued in the case when the measured angle φ (S_1) of the positive-sequence system power is within the P - Q - level sector. This sector is between angles φA and φB .

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.6/58 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.

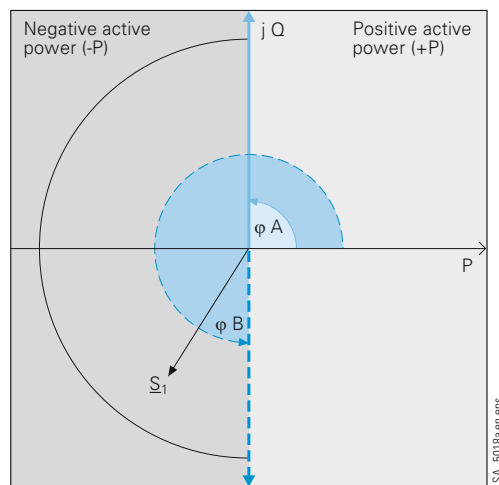


Fig. 6/57 Monitoring of active power direction

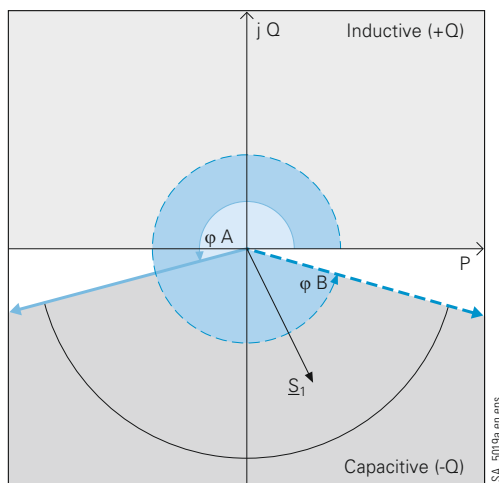


Fig. 6/58 Monitoring of reactive power

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 7SA522 is equipped with such an interlocking logic.

Protection functions

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.

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.

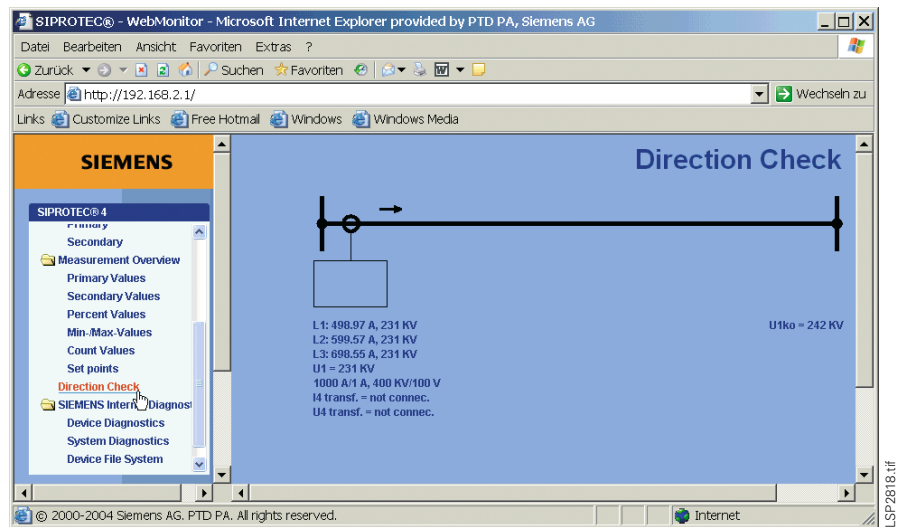


Fig. 6/59 Web Monitor: Display of the protection direction

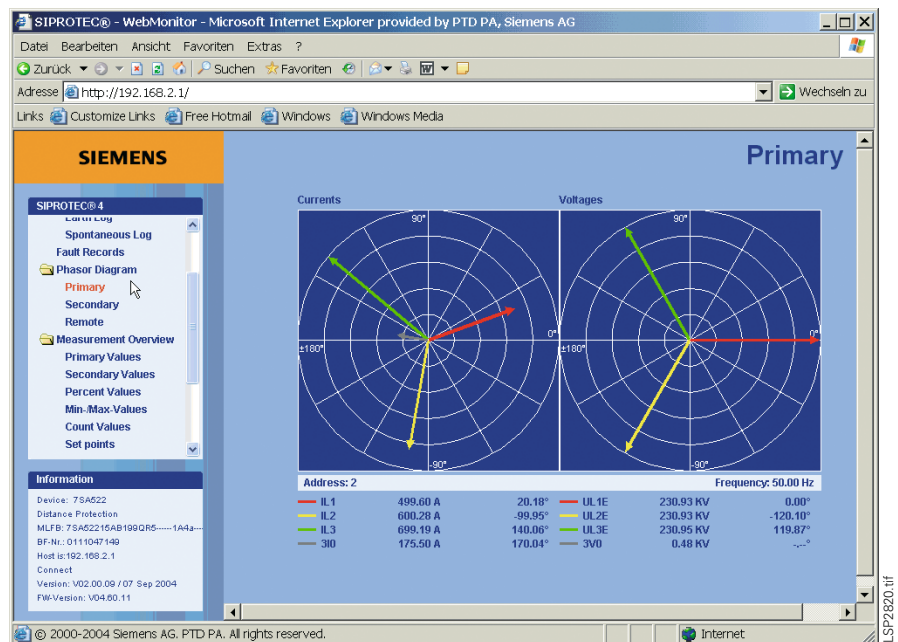


Fig. 6/60 Web monitor: Supported commissioning by phasor diagram

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.
- 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 device 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

By means of the RS 485/RS 232 interface, it is possible to efficiently operate a number of protection units centrally via DIGSI 4. Remote operation is possible on connection of a modem. This offers the advantage of rapid fault clarification, especially in the case of unmanned power plants. With the optical version, centralized operation can be implemented by means of a star coupler.

Time synchronization

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 problems.
- 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 the 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.

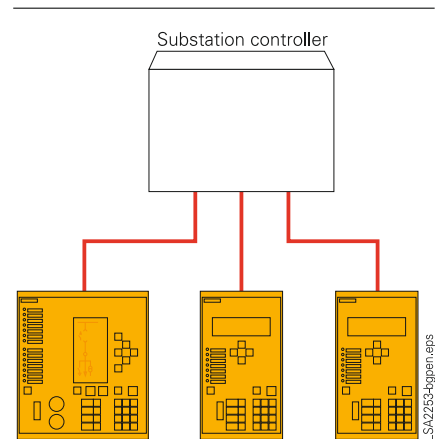


Fig. 6/61
IEC 60870-5-103 star type RS232 copper conductor connection or fiber-optic connection

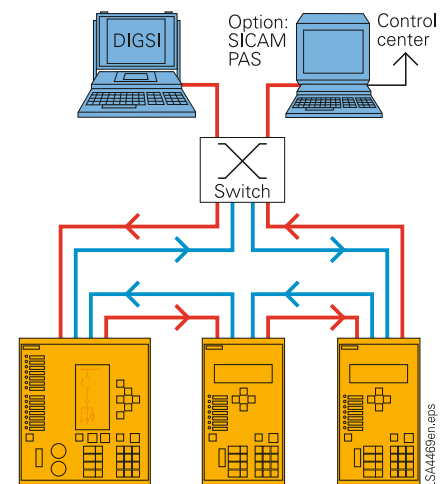


Fig. 6/62
Bus structure for station bus with Ethernet and IEC 61850

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 relay 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 communication standard and is supported by a number of PLC and protection relay 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.

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. 6/67).

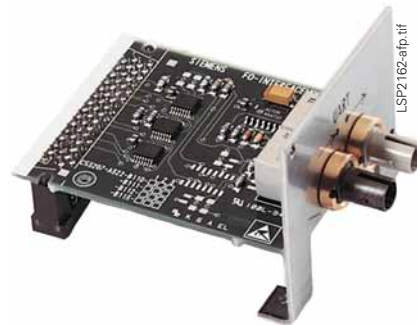


Fig. 6/63
820 nm fiber-optic communication module

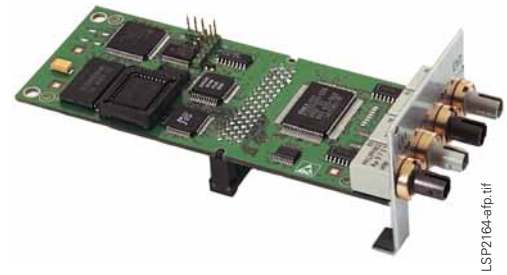


Fig. 6/64
PROFIBUS fiber-optic double ring communication module

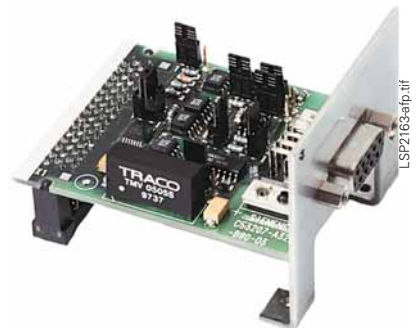


Fig. 6/65
RS232/RS485 electrical communication module



Fig. 6/66
Fiber-optic Ethernet communication module for IEC 61850 with integrated Ethernet switch

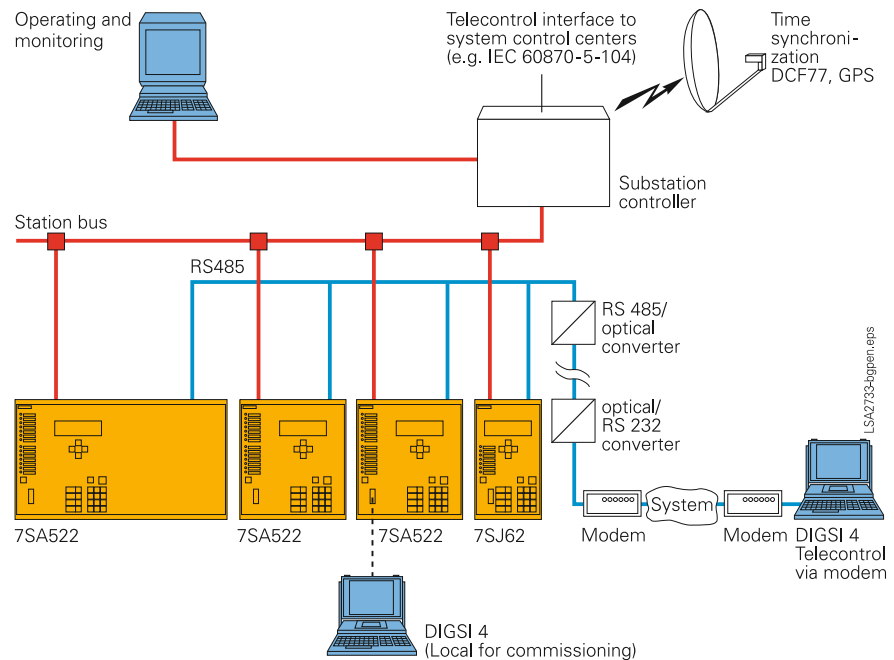


Fig. 6/67 Communication

Communication

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 7SA522 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 ground(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
- Redundant communication path switchover is possible with the 7SA522 when 2 serial protection data interfaces are installed

- 28 remote signals for fast transfer of binary signals
- Flexible utilization 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:

- FO5¹⁾, OMA1²⁾ 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
- FO6¹⁾, OMA2²⁾ module: Optical 820 nm, 2 ST connectors, FO cable length up to 3.5 km, for direct connection via multi-mode FO cable
- FO17¹⁾: for direct connection up to 24 km³⁾, 1300 nm, for mono-mode fiber 9/125 μm, LC-Duplex connector
- FO18¹⁾: for direct connection up to 60 km³⁾, 1300 nm, for mono-mode fiber 9/125 μm, LC-Duplex connector
- FO19¹⁾: for direct connection up to 100 km³⁾, 1550 nm, for mono-mode fiber 9/125 μm, LC-Duplex connector
- FO30¹⁾: 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 2 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 6/68 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

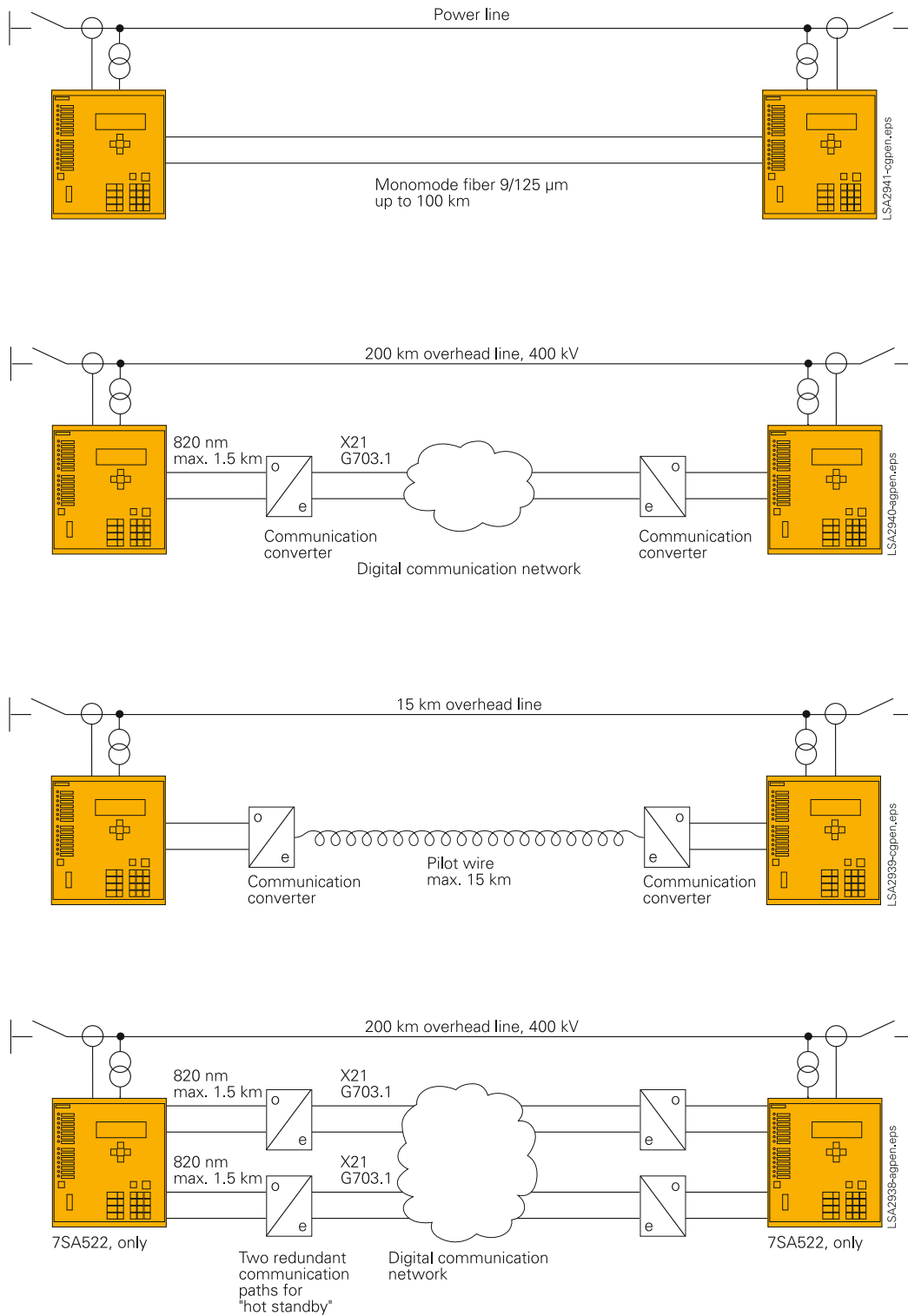


Fig. 6/68
Communication topologies for the serial protection data interface on a two-terminal line

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. 6/69. 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 money for communications, a chain topology may be generally applied.

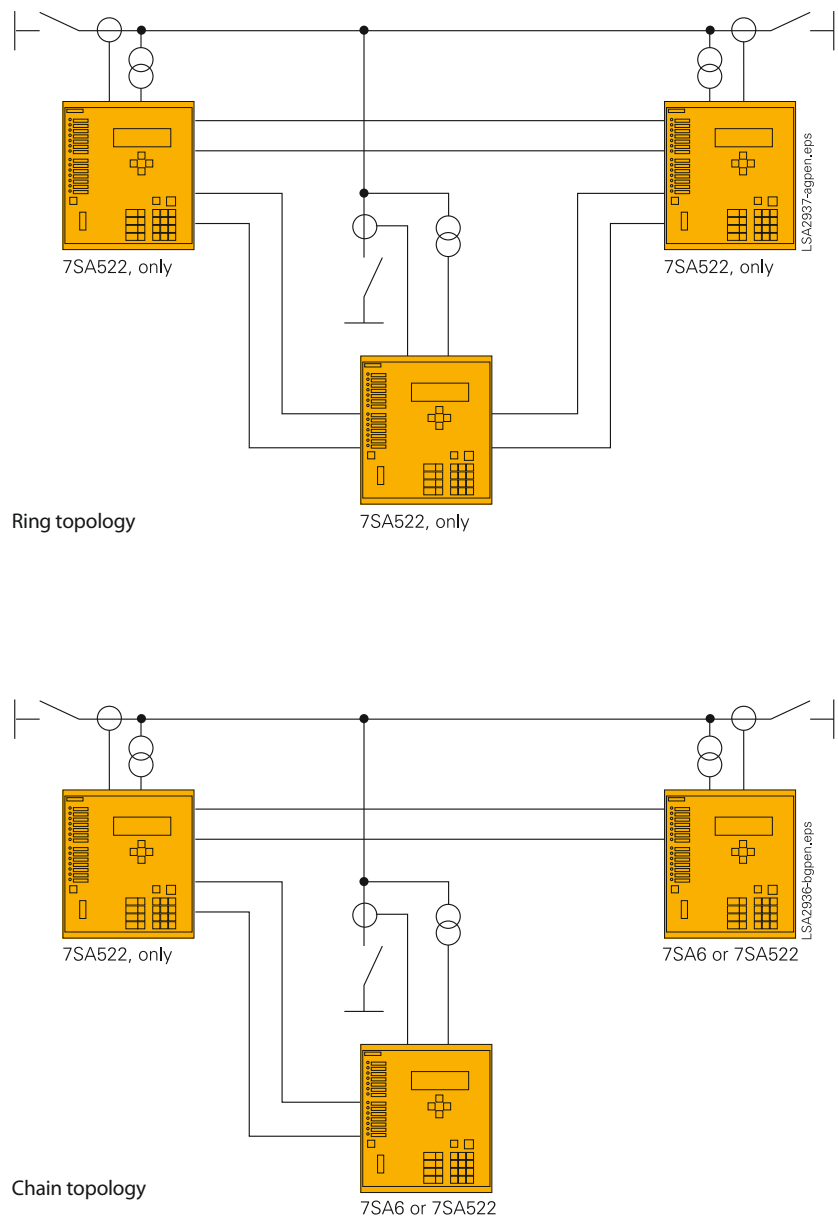


Fig. 6/69
Ring or chain communication topology

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.

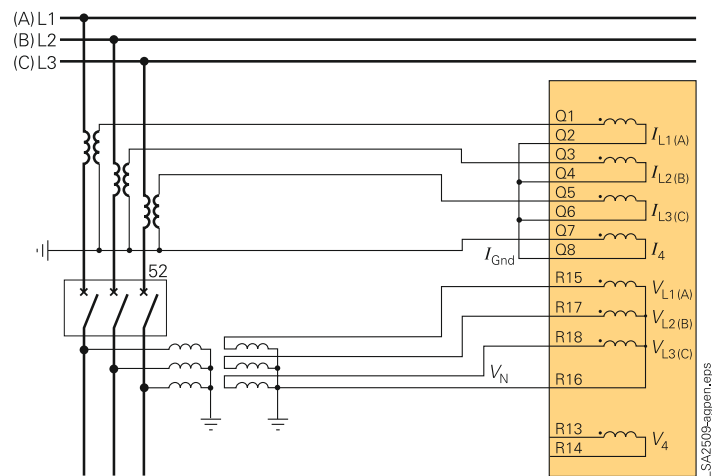


Fig. 6/70 Example of connection for current and voltage transformers

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. 6/70, 6/74 or 6/75.

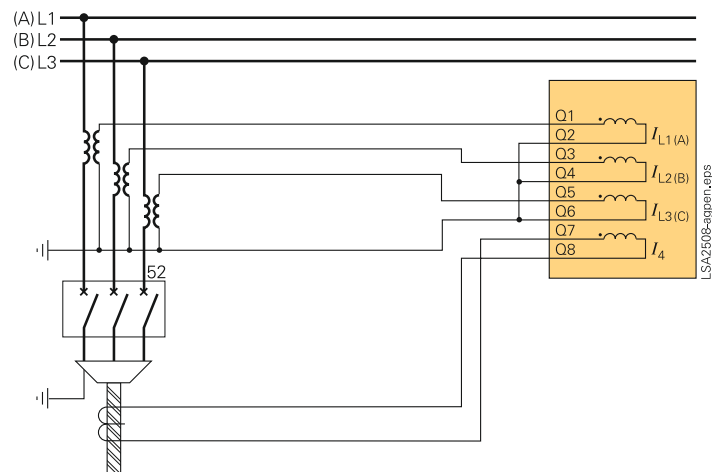


Fig. 6/71 Alternative connection of current transformers for sensitive ground(earth)-current measuring with core-balance current transformers

Alternative current connection

Alternative current connection

Siemens SIP · Edition No. 6

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 ground(earth)-fault directional protection. The current connection is effected in accordance with Fig. 6/70, 6/71, 6/72 and 6/73.

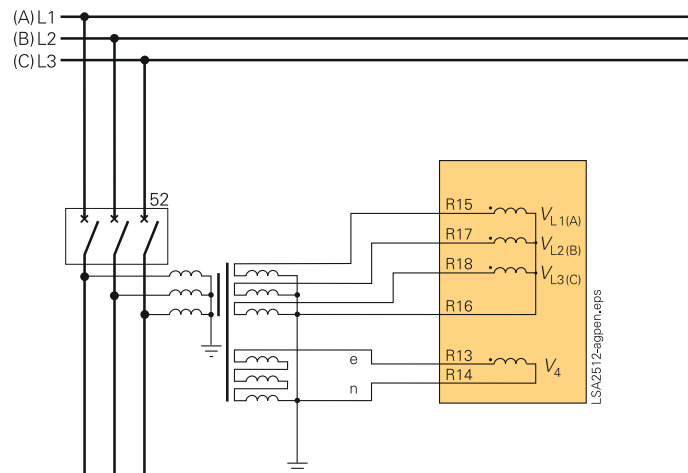


Fig. 6/74 Alternative connection of voltage transformers for measuring the displacement voltage (e-n voltage)

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-ground(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. 6/70, 6/71, 6/72 and 6/73.

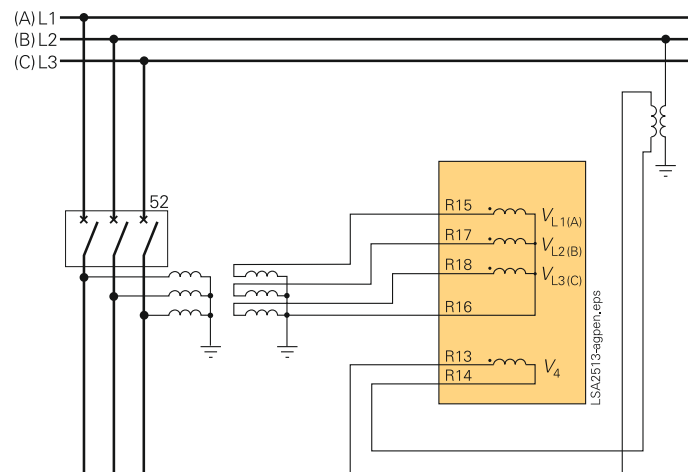


Fig. 6/75 Alternative connection of voltage transformers for measuring the busbar voltage

Technical data

General unit data

Analog input

Rated frequency	50 or 60 Hz (selectable)
Rated current I_{nom}	1 or 5 A (selectable)
Rated voltage	80 to 125 V (selectable)
Power consumption	
In CT circuits with $I_{nom} = 1$ A	Approx. 0.05 VA
In CT circuits with $I_{nom} = 5$ A	Approx. 0.30 VA
In the CT circuit for high sensitive ground(earth)-fault protection (refer to ordering code) at 1 A	Approx. 0.05 VA
In VT circuits	Approx. 0.10 VA
Thermal overload capacity	
In CT circuits	500 A for 1 s 150 A for 10 s 20 A continuous
In the CT circuit for high sensitive ground(earth)-fault protection (refer to ordering code)	300 A for 1 s 100 A for 10 s 15 A continuous
In VT circuits	230 V continuous per phase
Dynamic overload capacity	
In CT circuits	1250 A (one half cycle)
In the CT circuit for high sensitive ground(earth)-fault protection (refer to ordering code)	750 A (one half cycle)

Auxiliary voltage

Rated auxiliary voltage	24 to 48 V DC 60 to 125 V DC 110 to 250 V DC and 115 V AC with 50/60 Hz
Permissible tolerance of the rated auxiliary voltage	-20 % to +20 %
Max. superimposed AC voltage (peak-to-peak)	≤ 15 %
Power consumption	
During normal operation	Approx. 8 W
During pickup with all inputs and outputs activated	Approx. 18 W
Bridging time during auxiliary voltage failure	
$V_{aux} = 48$ V and $V_{aux} \geq 110$ V	≥ 50 ms

Binary inputs

Quantity	8 or 16 or 24 (refer to ordering code)
Functions are freely assignable	
Pickup/Reset voltage thresholds	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

Quantity	8 or 16 or 24 (refer to ordering code)
Function can be assigned	
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 $\tau = L/R \leq 50$ ms)	25 VA
Switching voltage	250 V
Permissible current	30 A for 0.5 s 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

LEDs

	Quantity
RUN (green)	1
ERROR (red)	1
Indication (red), function can be assigned	14

Unit design

Housing	7XP20
Dimension	1/2 x 19" or 1/1 x 19" Refer to ordering code, and see dimension drawings, part 15
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	
1/2 x 19"	6 kg
1/1 x 19"	10 kg
Surface-mounting housing	
1/2 x 19"	11 kg
1/1 x 19"	19 kg

Serial interfaces

Operating interface, front of unit for DIGSI 4

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)

Technical data

Service/modem interface (operating interface 2)

(refer to ordering code)	For DIGSI 4 / modem / service
Isolated RS232/RS485	9-pin subminiature connector
Dielectric test	500 V/ 50 Hz
Distance for RS232	Max. 15 m
Distance for RS485	Max. 1000 m
Fiber-optic	Integrated ST connector
Optical wavelength	$\lambda = 820$ nm
Permissible attenuation	Max. 8 dB for 62.5/125 μ m fiber
Distance max.	1.5 km

System interface

(refer to ordering code)	IEC 61850 Ethernet IEC 60870-5-103 PROFIBUS-FMS PROFIBUS-DP DNP 3.0
Isolated RS232/RS485	9-pin subminiature connector
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	1000 m at 93.75 kbaud; 100 m at 12 Mbaud
PROFIBUS fiber-optic ²⁾	
Only for flush-mounting housing	ST connector
For surface-mounting housing	Optical interface with OLM ⁴⁾
Baud rate	Max. 1.5 Mbaud
Optical wavelength	$\lambda = 820$ nm
Permissible attenuation	Max. 8 dB for 62.5/125 μ m fiber
Distance	500 kbit/s 1.6 km 1500 kbit/s 530 m

Protection data relay interfaces

Quantity	Max. 2 (refer to ordering code)
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 μ m, ST connectors
FO6 ¹⁾ , OMA2 ²⁾ : Fiber-optic interface for direct connection up to 3.5 km, 820 nm	For multi-mode fiber 62.5/125 μ m, ST connectors
FO30 ¹⁾ : for direct fibre-optic connection to a multiplexor using IEEE C37.94 standard	For multi-mode fiber 62.5/125 μ m, ST connectors
FO17 ¹⁾ : for direct connection up to 24 km ³⁾ , 1300 nm	For mono-mode fiber 9/125 μ m, LC-Duplex connector
FO18 ¹⁾ : for direct connection up to 60 km ³⁾ , 1300 nm	For mono-mode fiber 9/125 μ m, LC-Duplex connector
FO19 ¹⁾ : for direct connection up to 100 km ³⁾ , 1550 nm	For mono-mode fiber 9/125 μ m, LC-Duplex connector

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.

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 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 μ m 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 w. clock recovery) to pilot wires.	Typical distance: 15 km
FO interface for 820 nm with clock recovery	Max. 1.5 km with 62.5/125 μ m multi-mode fiber to protection relay, 128 kbit
Electrical interface to pilot wires	5 kV-isolated

Electrical tests

Specifications

Standards	IEC 60255 (product standards) IEEE Std C37.90.0/.1/.2; UL 508 VDE 0435 Further standards see "Individual functions"
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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 μ s; 0.5 Ws, 3 positive and 3 negative impulses in intervals of 5 s

Technical data

Electrical tests (cont'd)

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; $\tau = 15 \mu\text{s}$; 400 surges per s; test duration 2 s, $R_i = 200 \Omega$
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; $R_i = 330 \Omega$
Irradiation with HF field, frequency sweep IEC 60255-22-3 (report) class III	10 V/m; 80 to 1000 MHz: 80 % AM; 1 kHz 10 V/m; 800 to 960 MHz: 80 % AM; 1 kHz
IEC 61000-4-3, class III	10 V/m; 1.4 to 2 GHz: 80 % AM; 1 kHz
Irradiation with HF field, single fre- quencies 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 fre- quency 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; $R_i = 50 \Omega$; 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 capabil- ity, IEEE Std C37.90.1	2.5 kV (peak); 1 MHz $\tau = 50 \mu\text{s}$; 400 surges per second, test duration 2 s, $R_i = 200 \Omega$
Fast transient surge withstand capa- bility, IEEE Std C37.90.1	4 kV; 5/50 ns; 5 kHz; burst length = 15 ms repetition rate 300 ms; ; both polarities; test duration 1 min; $R_i = 50 \Omega$
Radiated electromagnetic interfer- ence 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 alternat- ing 100 kHz; 1 MHz; 10 and 50 MHz; $R_i = 200 \Omega$

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: $\pm 0.075 \text{ mm}$ amplitude; 60 to 150 Hz: 1 g acceleration frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes Semi-sinusoidal Acceleration 5 g, duration 11 ms, 3 shocks on each of the 3 axes in both directions
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Sinusoidal 1 to 8 Hz: $\pm 3.5 \text{ mm}$ amplitude (horizontal axis) 1 to 8 Hz: $\pm 1.5 \text{ mm}$ 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
Seismic vibration IEC 60255-21-2, class 1 IEC 60068-3-3	
<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: $\pm 7.5 \text{ mm}$ 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

Climatic stress tests

Standard	IEC 60255-6
<u>Temperatures</u>	
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 im- paired above +55 °C / +131 °F)	-20 °C to +70 °C / -4 °F to +158 °F
Recommended permanent operat- ing 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
<u>Humidity</u>	
Permissible humidity stress: It is recommended to arrange the units in such a way that they are not exposed to direct sunlight or pro- nounced temperature changes that could cause condensation.	Annual average on $\leq 75 \%$ relative hu- midity; on 56 days per year up to 93 % relative humidity; condensation is not permitted.

Technical data

Certifications

UL listing	7SA522*-A*
Models with threaded terminals	7SA522*-C* 7SA522*-D*
UL recognition	7SA522*-J*
Models with plug-in terminals	7SA522*-L* 7SA522*-M*

Functions

Distance protection (ANSI 21, 21N)

Distance protection zones	7, 1 of which as controlled zone, all zones can be set forward or/and reverse
Time stages for tripping delay	7 for multi-phase faults
Setting range 0 to 30 s or deactivated (steps 0.01 s)	3 for single-phase faults
Characteristic Selectably separately for phase and ground (earth) faults	(refer to ordering code) quadrilateral and/or MHO
Time range	0.00 to 30 s (step 0.01 s) or deactivated
Line angle φ_L	10 ° to 89 ° (step 1 °)
Inclination angle for quadrilateral characteristic	30 ° to 90 ° (step 1 °)
Quadrilateral reactance reach X	0.05 to 600 $\Omega_{(1A)}$ / 0.01 to 120 $\Omega_{(5A)}$ (step 0.001 Ω)
Quadrilateral resistance reach R for phase-to-phase faults and phase-to-ground(earth) faults	0.05 to 600 $\Omega_{(1A)}$ / 0.01 to 120 $\Omega_{(5A)}$ (step 0.001 Ω)
MHO impedance reach ZR	0.05 to 200 $\Omega_{(1A)}$ / 0.01 to 40 $\Omega_{(5A)}$ (step 0.01 Ω)
Minimum phase current I	0.05 to 4 A $_{(1A)}$ / 0.25 to 20 A $_{(5A)}$ (step 0.01 A)
Ground(earth)-fault pickup Neutral (residual) current 3 I ₀ (Ground current)	0.05 to 4 A $_{(1A)}$ / 0.25 to 20 A $_{(5A)}$ (step 0.01 A)
Zero-sequence voltage 3V ₀	1 to 100 V (step 1V) or deactivated
Zero-sequence compensation selectable input formats	R _E /R _L and X _E /X _L k ₀ and $\varphi(k_0)$
Separately selectable for zones	Z1 higher zones (Z1B, Z2 to Z5)
R _E /R _L and X _E /X _L	-0.33 to 7 (step 0.01)
k ₀ $\varphi(k_0)$	0 to 4 (step 0.001) -135 to 135 ° (steps 0.01 °)
Parallel line mutual compensation R _M /R _L and X _M /X _L	(refer to ordering code) 0.00 to 8 (step 0.01)
Load encroachment Minimum load resistance	0.10 to 600 $\Omega_{(1A)}$ / 0.02 to 120 $\Omega_{(5A)}$ (step 0.001 Ω) or deactivated
Maximum load angle	20 to 60 ° (step 1 °)
Directional decision for all types of faults	With sound phase polarization and/or voltage memory
Directional sensitivity	Dynamically unlimited

Tolerances

For sinusoidal quantities

$$\left| \frac{\Delta X}{X} \right| \leq 5 \% \text{ for } 30^\circ \leq \varphi_{SC} \leq 90^\circ$$

$$\left| \frac{\Delta R}{R} \right| \leq 5 \% \text{ for } 0^\circ \leq \varphi_{SC} \leq 60^\circ$$

$$\left| \frac{\Delta Z}{Z} \right| \leq 5 \% \text{ for } -30^\circ \leq (\varphi_{SC} - \varphi_{line}) \leq +30^\circ$$

Timer tolerance

± 1 % of set value or 10 ms

Operating times

Minimum trip time
with fast relays
Minimum trip time
with high-speed relays
Reset time

Approx. 17 ms at 50 Hz
Approx. 15 ms at 60 Hz
Approx. 12 ms at 50 Hz
Approx. 10 ms at 60 Hz
Approx. 30 ms

Fault locator

Output of the distance to fault

X, R (secondary) in Ω
X, R (primary) in Ω
Distance in kilometers or miles
Distance in % of line length

Start of calculation

With trip, with pickup reset

Reactance per unit length

0.005 to 6.5 Ω / km $_{(1A)}$ /
0.001 to 1.3 Ω / km $_{(5A)}$ or
0.005 to 10 Ω / mile $_{(1A)}$ /
0.001 to 2 Ω / mile $_{(5A)}$
(step 0.001 Ω / unit)

Tolerance

For sinusoidal quantities
≤ 2.5 % line length for
30 ° ≤ φ_{SC} ≤ 90 ° and $V_{SC}/V_N > 0.10$

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 %

Power swing detection (ANSI 68, 68T)

Power swing detection principle

Measurement of the rate of impedance
vector change and monitoring of the
vector path

Max. detectable power swing frequency

Approx. 7 Hz

Operating modes

Power swing blocking and/or power
swing tripping (out-of-step tripping)

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

Technical data

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

Operating modes	POTT PUTT, DUTT Directional comparison: Blocking Directional comparison: Unblocking Directional comparison hybrid (POTT and echo with weak-infeed protection)
Transient blocking logic (current reversal guard)	For overreaching schemes
Send and receive signals	Suitable for 2- and 3- terminal lines, phase-segregated signals for selective single-phase tripping selectable

Direct transfer trip (DTT)

Direct phase-selective tripping via binary input	Alternatively with or without auto-reclosure
Trip time delay	0.00 to 30 s (step 0.01 s) or deactivated
Timer tolerance	± 1 % of setting value or 10 ms

Directional ground(earth)-fault overcurrent protection (ANSI 50N, 51N, 67N)

Characteristics	3 definite-time stages / 1 inverse-time stage or 4 definite-time stages
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 $I_{>>}$)	3 rd and higher harmonics are completely suppressed by digital filtering 2 nd and higher harmonics are completely suppressed by digital filtering
Stages 3 and 4 ($I_{>}$ and inverse 4 th stage)	

Definite-time stage

Pickup definite-time stage 1, $3I_0$	0.05 to 25 A _(1A) / 0.25 to 125 A _(5A) (step 0.01 A)
Pickup definite-time stage 2, $3I_0$	0.05 to 25 A _(1A) / 0.25 to 125 A _(5A) (step 0.01 A)
Pickup definite-time stage 3, $3I_0$	0.05 to 25 A _(1A) / 0.25 to 125 A _(5A) (step 0.01 A) With normal neutral (residual) current CT (refer to ordering code) 0.003 to 25 A _(1A) / 0.015 to 125 A _(5A) (step 0.01 A) With high sensitive neutral (residual) current CT (refer to ordering code)
Pickup definite-time stage 4, $3I_0$	0.05 to 4 A _(1A) / 0.25 to 20 A _(5A) (step 0.01 A) With normal neutral (residual) current CT (refer to ordering code) 0.003 to 4 A _(1A) / 0.015 to 20 A _(5A) (step 0.01 A) With high sensitive neutral (residual) current CT (refer to ordering code)
Time delay for definite-time stages	0.00 to 30 s (step 0.01 s) or deactivated
Tolerances Current starting Delay times	≤ 3 % of setting value or 1 % of I_{nom} ± 1 % of setting value or 10 ms
Pickup times Definite-time stages 1 and 2 Definite-time stages 3 and 4	Approx. 30 ms Approx. 40 ms

Inverse-time stage

Current starting inverse-time stage $3I_0$	0.05 to 4 A _(1A) / 0.25 to 20 A _(5A) (step 0.01 A) With normal neutral (residual) current CT (refer to ordering code) 0.003 to 4 A _(1A) / 0.015 to 20 A _(5A) (step 0.001 A) With high sensitive neutral (residual) current CT (refer to ordering code)
Characteristics according to IEC 60255-3	Normal inverse, very inverse, extremely inverse, long time inverse,
Time multiplier for IEC T characteristics	$T_p = 0.05$ to 3 s (step 0.01s) or deactivated
Pickup threshold	Approx. $1.1 \times I / I_p$
Reset threshold	Approx. $1.05 \times I / I_p$
Tolerances Operating time for $2 \leq I / I_p \leq 20$	≤ 5 % of setpoint ± 15 ms
Characteristics according to ANSI/IEEE	Inverse, short inverse, long inverse, moderately inverse, very inverse, extremely inverse, definite inverse
Time dial	0.50 to 15 s (step 0.01) or deactivated
Pickup threshold	Approx. $1.1 \times M$
Reset threshold	Approx. $1.05 \times M$
Tolerances Operating time for $2 \leq M \leq 20$	≤ 5 % of setpoint ± 15 ms
Characteristic according to logarithmic inverse characteristic	$t = T_{3I_{0p} \max} - T_{3I_{0p}} \ln \frac{3I_0}{3I_{0p}}$
Pickup threshold	1.1 to 4.0 $\times I / I_p$ (step 0.1)
Characteristic according to compensated zero-sequence power	$S_r = 3I_0 \cdot 3V_0 \cdot \cos(\varphi - \varphi_{comp.})$
Polarizing quantities for directional decision	$3I_0$ and $3V_0$ or $3I_0$ and $3V_0$ and I_E (grounded (earthed) power transformer) or $3I_2$ and $3V_2$ (negative sequence) 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)
Ground (earth) current I_E of grounded (earthed) power transformer	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)
2 nd harmonic ratio for inrush restraint	10 to 45 % of fundamental (step 1 %)
Maximum current, overriding inrush restraint	0.5 to 25 A _(1A) / 2.5 to 125 A _(5A) (step 0.01 A)

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

Operating modes	Directional comparison: Pickup Directional comparison: Blocking Directional comparison: Unblocking
Transient blocking logic	For schemes with parallel lines
Send and receive signals	Suitable for 2- and 3- terminal lines

Technical data

Weak-infeed protection with undervoltage (ANSI 27W1)

Operating modes with carrier (signal) reception	Echo Echo and trip with undervoltage
Undervoltage phase – ground (earth)	2 to 70 V (step 1 V)
Time delay	0.00 to 30 s (step 0.01 s)
Echo impulse	0.00 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

Backup overcurrent protection (ANSI 50N, 51N, 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

Pickup definite-time stage 1, phase current	0.1 to 25 A _(1A) / 0.5 to 125 A _(5A) (step 0.01 A)
Pickup definite-time stage 1, neutral (residual) current	0.05 to 25 A _(1A) / 0.25 to 125 A _(5A) (step 0.01 A)
Pickup definite-time stage 2, phase current	0.1 to 25 A _(1A) / 0.5 to 125 A _(5A) (step 0.01 A)
Pickup definite-time stage 2, neutral (residual) current	0.05 to 25 A _(1A) / 0.25 to 125 A _(5A) (step 0.01 A)
Time delay for definite-time stages	0.0 to 30 s (step 0.01 s) or deactivated
Tolerances	
Current starting	≤ 3 % of setting value or 1 % of I _{nom}
Delay times	± 1 % of setting value or 10 ms
Operating time	Approx. 25 ms

Inverse-time stage

Phase current starting for inverse-time stage	0.1 to 4 A _(1A) / 0.5 to 20 A _(5A) (step 0.01 A)
Neutral (residual) current starting for inverse-time stage	0.05 to 4 A _(1A) / 0.25 to 20 A _(5A) (step 0.01 A)
Characteristic according to IEC 60255-3	Normal inverse, very inverse, extremely inverse, long time inverse
Time multiplier	T _p = 0.05 to 3 s (step 0.01 s) or deactivated
Pickup threshold	Approx. 1.1 x I / I _p
Reset threshold	Approx. 1.05 x I / I _p
Tolerances	
Operating time for 2 ≤ I / I _p ≤ 20	≤ 5 % of setpoint ± 15 ms
Characteristics according to ANSI/IEEE	Inverse, short inverse, long inverse, moderately inverse, very inverse, extremely inverse, definite inverse
Time dial	D _{IP} 0.50 to 15 s (step 0.01) or deactivated
Pickup threshold	Approx. 1.1 x M (M = I/I _p)
Reset threshold	Approx. 1.05 x M
Tolerances	
Operating time for 2 ≤ M ≤ 20	≤ 5 % of setpoint ± 15 ms

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

Operating modes	Active only with open isolator position (signaled via binary input)
Characteristic	1 definite-time stage
Instantaneous trip after switch-onto-fault	Selectable
Pickup phase current	0.1 to 25 A _(1A) / 0.5 to 125 A _(5A) (step 0.01 A)
Pickup neutral (residual) current	0.05 to 25 A _(1A) / 0.25 to 125 A _(5A) (step 0.01 A)
Time delay, separate for phase and ground (earth) stage	0.00 to 30 s (step 0.01 s) or deactivated
Reset ratio	Approx. 0.95
Tolerances	
Current starting	≤ 3 % of setting value or 1 % of I _{nom}
Delay times	± 1 % of setting value or 10 ms

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

Operating mode	Active only after CB closing; instantaneous trip after pickup
Pickup current	1 to 25 A _(1A) / 5 to 125 A _(5A) (step 0.01 A)
Reset ratio	Approx. 0.95
Tolerances	
Current starting	≤ 3 % of setting value or 1 % of I _{nom}
Operating time	
With fast relays	Approx. 13 ms
With high-speed trip outputs	Approx. 8 ms

Voltage protection (ANSI 59, 27)

Operating modes	Local tripping and/or carrier trip impulse for remote end, only indication
Overvoltage protection	
Pickup values V _{PH-Gnd} >>, V _{PH-Gnd} > (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)

Technical data

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 protection stages	Minimum current; binary input stages
Reset ratio (settable)	1.01 to 1.20 (step 0.01)

Time delays

Time delay for 3 V_0 stages	0 to 100 s (step 0.01 s) or deactivated
Time delay for all other over- and undervoltage stages	0 to 30 s (steps 0.01 s) or deactivated
Command / pickup time	Approx. 30 ms
Command/pickup time for 3 V_0 stages	Approx. 30 ms or 65 ms (settable)
Tolerances	
Voltage limit values	$\leq 3\%$ of setting value or 0.5 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

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 $T_{1\text{phase}}, T_{1\text{3phase}}, T_2$	0 to 30 s (steps 0.01 s) or deactivated
Additional functions	End-fault protection CB pole discrepancy monitoring
Reset time	12 ms, typical; 25 ms max.
Tolerances	
Current limit value	$\leq 5\%$ of setting value or 1 % I_{nom}
Time stages	1 % of setting value or 10 ms

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 $T_{1-PH}, T_{3-PH}, T_{Seq}$	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	30 to 90 V (step 1 V)
Dead line	2 to 70 V (step 1 V)
Tolerances	
Time stages	1 % of setting value or 10 ms
Voltage limit values	$\leq 3\%$ of setting value or 0.5 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)
Tolerances	
Time stages	1 % of setting value or 10 ms
Voltage limit values	$\leq 2\%$ of setting value or 2 V

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)

Technical data

Additional functions

Operational measured values

Representation	Primary, secondary and percentage referred to rated value
Currents	$3 \times I_{\text{Phase}}$; $3I_0$; $I_{\text{Gnd sensitive}}$; I_1 ; I_2 ; I_Y ; $3I_{0\text{PAR}}$
Tolerances	Typical 0.3 % of indicated measured value or 0.5 % I_{nom}
Voltages	$3 \times V_{\text{Phase-Ground}}$; $3 \times V_{\text{Phase-Phase}}$; $3V_0$, V_1 , V_2 , V_{SYNC} , V_{en}
Tolerances	Typical 0.25 % of indicated measured value or 0.01 V_{nom}
Power with direction indication	P , Q , S
Tolerances	
P : for $ \cos \varphi = 0.7$ to 1 and V/V_{nom} , $I/I_{\text{nom}} = 50$ to 120 %	Typical ≤ 1 %
Q : for $ \sin \varphi = 0.7$ to 1 and V/V_{nom} , $I/I_{\text{nom}} = 50$ to 120 %	Typical ≤ 1 %
S : for V/V_{nom} , $I/I_{\text{nom}} = 50$ to 120 %	Typical ≤ 1 %
Frequency	f
Tolerance	≤ 20 mHz
Power factor	p.f. ($\cos \varphi$)
Tolerance for $ \cos \varphi = 0.7$ to 1	Typical ≤ 3 %
Load impedances with directional indication	$3 \times R_{\text{Phase-Ground}}$, $X_{\text{Phase-Ground}}$ $3 \times R_{\text{Phase-Phase}}$, $X_{\text{Phase-Phase}}$

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	$3 \times I_{\text{Phase}}$; I_1 ; P ; $P+$; $P-$; Q ; $Q+$; $Q-$; S

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	$3 \times I_{\text{Phase}}$; I_1 ; $3 \times V_{\text{Phase-Ground}}$; $3 \times V_{\text{Phase-to-phase}}$; $3V_0$; V_1 ; $P+$; $P-$; $Q+$; $Q-$; S ; f power factor (+); power factor (-)
Min./max. of mean values	$3 \times I_{\text{Phase}}$; I_1 ; P ; Q ; S

Energy meters

Four-quadrant meters	W_{P+} ; W_{P-} ; W_{Q+} ; W_{Q-}
Tolerance for $ \cos \varphi > 0.7$ and $V > 50$ % V_{nom} and $I > 50$ % I_{nom}	5 %

Oscillographic fault recording

Analog channels	$3 \times I_{\text{Phase}}$, $3I_0$, $3I_{0\text{PAR}}$ $3 \times V_{\text{Phase}}$, $3V_0$, 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
Remote control	Control protection, DIGSI, pilot wires

Further additional functions

Measurement supervision	Current sum Current symmetry Voltage sum Voltage symmetry Voltage phase sequence Fuse failure monitor Power direction
Annunciations Event logging Fault logging	Buffer size 200 Storage of signals of the last 8 faults, buffer size 600
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-phase TRIP/CLOSE cycle per phase
Setting range Dead time for c.b. TRIP/CLOSE cycle Commissioning support	0.00 to 30 s (step 0.01 s) Operational measured values, CB. test, status display of binary indication 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

Description

7SA522 distance protection relay
for transmission lines

Order No.

7SA522□-□□□□□-□□□□ □□□

Current transformer

$I_{PH} = 1 \text{ A}^{1)}$, $I_{Gnd} = 1 \text{ A}$ (min. = 0.05 A) 1

$I_{PH} = 1 \text{ A}^{1)}$, $I_{Gnd} = \text{high sensitive}$ (min. = 0.003 A) 2

$I_{PH} = 5 \text{ A}^{1)}$, $I_{Gnd} = 5 \text{ A}$ (min. = 0.25 A) 5

$I_{PH} = 5 \text{ A}^{1)}$, $I_{Gnd} = \text{high sensitive}$ (min. = 0.003 A) 6

(Order code position 7 = 2 or 6 not available
with position 14 = K, M, N, Q)

Rated auxiliary voltage (power supply, binary inputs)

24 to 48 V DC, binary input threshold 17 V DC³⁾ 2

60 to 125 V DC²⁾, binary input threshold 17 V DC³⁾ 4

110 to 250 V DC²⁾, 115 V AC, binary input threshold 73 V DC³⁾ 5

220 to 250 V DC²⁾, 115 V AC, binary input threshold 154 V DC³⁾ 6

see following
pages

	Binary indication inputs	Signal/command outputs, incl. live status contact	Fast relays	High-speed trip outputs	Housing width referred to 19"	Flush-mounting housing/ screw-type terminals	Flush-mounting housing/ plug-in terminals	Surface-mounting housing/ screw-type terminals	
8	4	12	—	1/2	■				A
8	4	12	—	1/2			■		E
8	4	12	—	1/2		■			J
16	12	12	—	1/1	■				C
16	12	12	—	1/1			■		G
16	12	12	—	1/1		■			L
16	4	15	5	1/1	■				N
16	4	15	5	1/1			■		Q
16	4	15	5	1/1		■			S
24	20	12	—	1/1	■				D
24	20	12	—	1/1			■		H
24	20	12	—	1/1		■			M
24	12	15	5	1/1	■				P
24	12	15	5	1/1			■		R
24	24	3	5	1/1		■			T
22	32	12	—	1/1	■				U
24	4	18	10	1/1	■				W

Region-specific default settings/language settings (language selectable)

Region DE, language: German A

Region World, language: English (GB) B

Region US, language: English (US) C

Region FR, language: French D

Region World, language: Spanish E

Region World, language: Italian F

Region World, language: Russian G

Region World, language: Polish H

Regulation on region-specific presets and function versions:

Region DE: preset to $f = 50 \text{ Hz}$ and line length in km, only IEC,
directional ground-(earth) fault protection: no logarithmic inverse characteristic,
no direction decision with zero-sequence power S_r

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

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

Region FR: preset to $f = 50 \text{ Hz}$ and line length in km, directional ground-(earth) fault protection:
no U_0 inverse characteristic, no logarithmic inverse characteristic,
weak infed logic selectable between French specification and World specification.

- 1) Rated current can be selected by means of jumpers.
- 2) Transition between the three auxiliary voltage ranges can be selected by means of jumpers.
- 3) The binary input thresholds can be selected by means of jumpers.

Selection and ordering data

Description	Order No.	Order Code
<i>7SA522 distance protection relay for transmission lines</i>	<i>7SA522□-□□□□□-□□□□□□□□</i>	<i>□□□□</i>
<i>Port B</i>		
Empty	0	↑ see following pages ↑
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, electrical RS485 ¹⁾	4	
System interface, PROFIBUS-FMS Slave, optical, double ring, ST connector ¹⁾²⁾	6	
System interface, PROFIBUS-DP Slave, RS485	9	L 0 A
System interface, PROFIBUS-DP Slave, 820 nm optical, double ring, ST connector ²⁾	9	L 0 B
System interface, DNP 3.0, RS485	9	L 0 G
System interface, DNP 3.0, 820 nm optical, ST connector ²⁾	9	L 0 H
System interface, IEC 61850, 100 Mbit/s Ethernet, electrical, duplicate, RJ45 plug connector	9	L 0 R
System interface, IEC 61850, 100 Mbit/s Ethernet, optical, double, LC connector ⁵⁾	9	L 0 S
<i>Port C and/or Port D</i>		
Empty	0	
Port C: DIGSI/modem, electrical RS232; Port D: empty	1	
Port C: DIGSI/modem, electrical RS485; Port D: empty	2	
Port C: DIGSI/modem, optical 820 nm, ST connector; Port D: empty	3	
<i>With Port D</i>	9	M □ □
<i>Port C</i>		
Empty	0	↑ ↑
DIGSI/modem, electrical RS232	1	
DIGSI/modem, electrical RS485	2	
DIGSI/modem, optical 820 nm, ST connector	3	
<i>Port D</i>		
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 ³⁾		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
Protection data interface: optical 1300 nm, LC-Duplex connector FO cable length up to 24 km for direct connection via mono-mode FO cable ⁴⁾		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 ⁴⁾⁶⁾		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 ⁴⁾⁷⁾		J
FO30 optical 820 nm, 2-ST-connector, length of optical fibre up to 1.5 km for multimode fibre, for communication networks with IEEE C37.94 interface or direct optical fibre connection (not available for surface mounted housing)		S

1) For SICAM energy automation system.

2) Optical double ring interfaces are not available with surface-mounting housings. Please, order the version with RS485 interface and a separate electrical/ optical converter.

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

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

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

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

7) 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.	Order Code
<i>7SA522 distance protection relay for transmission lines</i>	<i>7SA522□-□□□□□-□□□□ □□□</i>	
<i>Functions 1 and Port E</i>		
Trip mode 3-pole; Port E: empty	0	see next page
Trip mode 3-pole; BCD-coded output for fault location, Port E: empty	1	
Trip mode 1 and 3-pole; Port E: empty	4	
Trip mode 1 and 3-pole; BCD-coded output for fault location, Port E: empty	5	
<i>With Port E</i>	9	N □ □
<i>Functions 1</i>		
Trip mode 3-pole	0	↑
Trip mode 3-pole; BCD-coded output for fault location	1	
Trip mode 1 and 3-pole	4	
Trip mode 1 and 3-pole; BCD-coded output for fault location	5	
<i>Port E</i>		
Protection data interface:		
FO5: Optical 820 nm, 2 ST connectors, FO cable length up to 1.5 km for communication networks ¹⁾ or direct connection via multi-mode FO cable		A
FO6: Optical 820 nm, 2 ST connectors, FO cable length up to 3.5 km for direct connection via multi-mode FO cable		B
FO17: Optical 1300 nm, LC-Duplex connector FO cable length up to 24 km for direct connection via mono-mode FO cable ²⁾		G
FO18: Optical 1300 nm, LC-Duplex connector FO cable length up to 60 km for direct connection via mono-mode FO cable ²⁾³⁾		H
FO19: 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 IEEE C37.94 interface or direct optical fibre connection (not available for surface mounted housing)		S

1) 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.

7SA522 distance protection relay
for transmission lines

7SA522□-□□□□□-□□□□ □□□

Functions 2

Distance protection characteristic (ANSI 21, 21N)	Power swing detection (ANSI 68, 68T)	Parallel line compensation	
Quadrilateral			C
Quadrilateral and/or MHO			E
Quadrilateral	■		F
Quadrilateral and/or MHO	■		H
Quadrilateral		■ ¹⁾	K
Quadrilateral and/or MHO		■ ¹⁾	M
Quadrilateral	■	■ ¹⁾	N
Quadrilateral and/or MHO	■	■ ¹⁾	Q

Functions 3

Auto-reclosure (ANSI 79)	Synchro-check (ANSI 25)	Breaker failure protection (ANSI 50BF)	Over-/undervoltage protection (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

Direction ground(earth)-fault protection, grounded (earthed) networks (ANSI 50N, 51N, 67N)	Measured values, extended Min, max, mean	
		0
	■	1
■		4
■	■	5

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

Accessories

Description	Order No.
<i>DIGSI 4</i> 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)	<i>7XS5400-0AA00</i>
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)	<i>7XS5402-0AA00</i>
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) + IEC61850 system configurator	<i>7XS5403-0AA00</i>
<i>IEC 61850 System configurator</i> 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	<i>7XS5460-0AA00</i>
<i>SIGRA 4</i> (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.	<i>7XS5410-0AA00</i>
<i>Connecting cable (copper)</i> Cable between PC/notebook (9-pin connector) and protection unit (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)	<i>7XV5100-4</i>
<i>Voltage transformer miniature circuit-breaker</i> Rated current 1.6 A; thermal overload release 1.6 A; overcurrent trip 6 A	<i>3RV1611-1AG14</i>
<i>Manual for 7SA522</i> English, V4.61 and higher	<i>C53000-G1176-C155-5</i>
<i>Opto-electric communication converters</i> Optical to X21/RS422 or G703.1 Optical to pilot wires	<i>7XV5662-0AA00</i> <i>7XV5662-0AC00</i>
<i>Additional interface modules</i> Protection data interface FO 5, OMA1, 820 nm, multi-mode FO cable, ST connector, 1.5 km Protection data interface FO 6, OMA2, 820 nm, multi-mode FO cable, ST connector, 3.5 km Protection data interface FO 17, 1300 nm, mono-mode FO cable, LC-Duplex connector, 25 km Protection data interface FO 18, 1300 nm, mono-mode FO cable, LC-Duplex connector, 60 km Protection data interface FO 19, 1550 nm, mono-mode FO cable, LC-Duplex connector, 100 km	<i>C53207-A351-D651-1</i> <i>C53207-A351-D652-1</i> <i>C53207-A322-B115-3</i> <i>C53207-A322-B116-3</i> <i>C53207-A322-B117-3</i>
<i>Optical repeaters</i> Serial repeater (2-channel), opt. 1300 nm, mono-mode FO cable, LC-Duplex connector, 25 km Serial repeater (2-channel), opt. 1300 nm, mono-mode FO cable, LC-Duplex connector, 60 km Serial repeater (2-channel), opt. 1550 nm, mono-mode FO cable, LC-Duplex connector, 100 km	<i>7XV5461-0BG00</i> <i>7XV5461-0BH00</i> <i>7XV5461-0BJ00</i>

Accessories



Fig. 6/76 Mounting rail for 19" rack

Fig. 6/77
2-pin connectorFig. 6/78
3-pin connectorFig. 6/79
Short-circuit link
for current con-
tactsFig. 6/80
Short-circuit link
for voltage con-
tacts

Description		Order No.	Size of package	Supplier	Fig.
Connector	2-pin	C73334-A1-C35-1	1	Siemens	6/77
	3-pin	C73334-A1-C36-1	1	Siemens	6/78
Crimp connector	CI2 0.5 to 1 mm ²	0-827039-1	4000	AMP ¹⁾	
		0-827396-1	1	AMP ¹⁾	
	CI2 1 to 2.5 mm ²	0-827040-1	4000	AMP ¹⁾	
		0-827397-1	1	AMP ¹⁾	
Crimping tool	Type III+ 0.75 to 1.5 mm ²	0-163083-7	4000	AMP ¹⁾	
		0-163084-2	1	AMP ¹⁾	
	For Type III+ and matching female	0-539635-1	1	AMP ¹⁾	
		0-539668-2		AMP ¹⁾	
		0-734372-1	1	AMP ¹⁾	
	For CI2 and matching female	1-734387-1		AMP ¹⁾	
19"-mounting rail		C73165-A63-D200-1	1	Siemens	6/76
Short-circuit links	For current terminals	C73334-A1-C33-1	1	Siemens	6/79
	For other terminals	C73334-A1-C34-1	1	Siemens	6/80
Safety cover for terminals	Large	C73334-A1-C31-1	1	Siemens	6/51
	Small	C73334-A1-C32-1	1	Siemens	6/51

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

Connection diagram, IEC

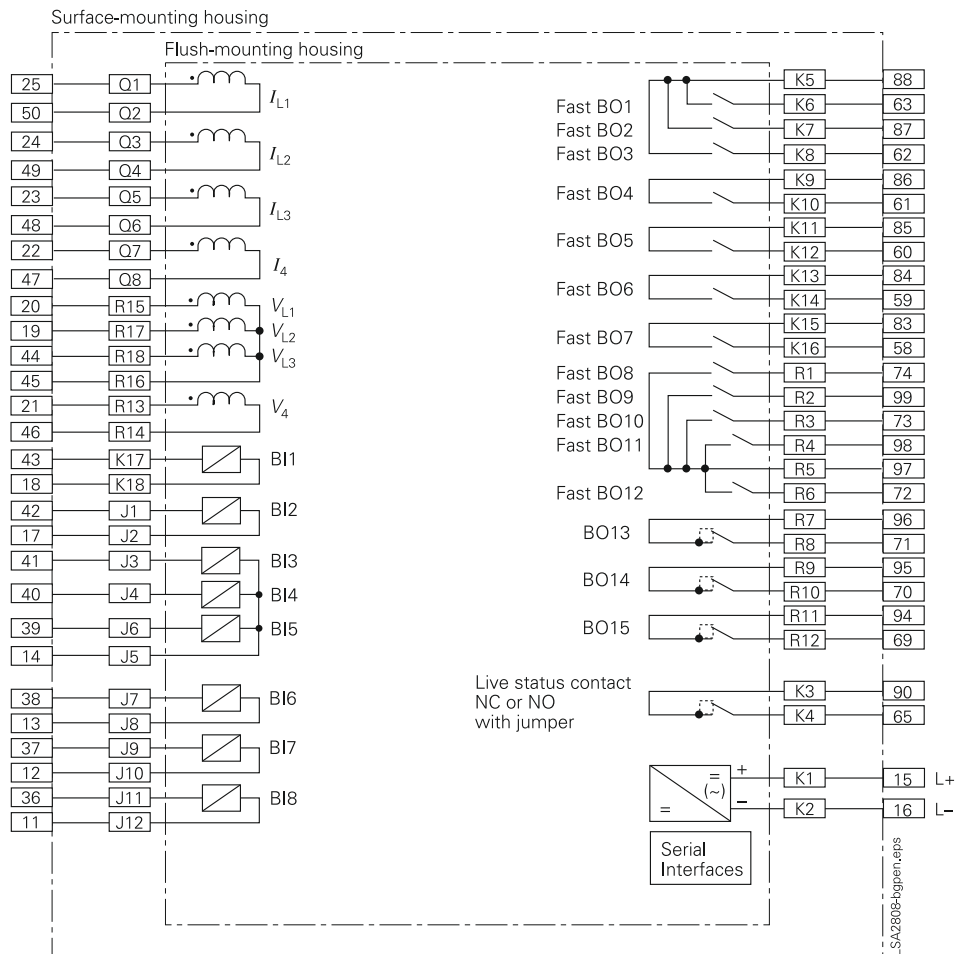


Fig. 6/81

Housing 1/2 x 19", basic version 7SA522x-xA, 7SA522x-xE and 7SA522x-xJ with 8 binary inputs and 16 binary outputs, hardware version .../FF

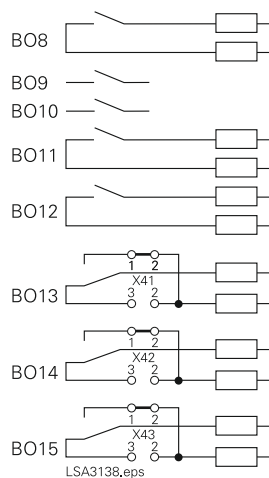


Fig. 6/81a

Additional setting by jumpers:
Separation of common circuit of BO8 to BO12 with jumpers X80, X81, X82. Switching of BO13, BO14, BO15 as NO contact or NC contact with jumpers.

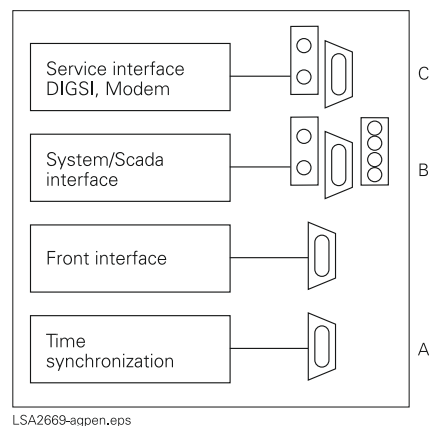
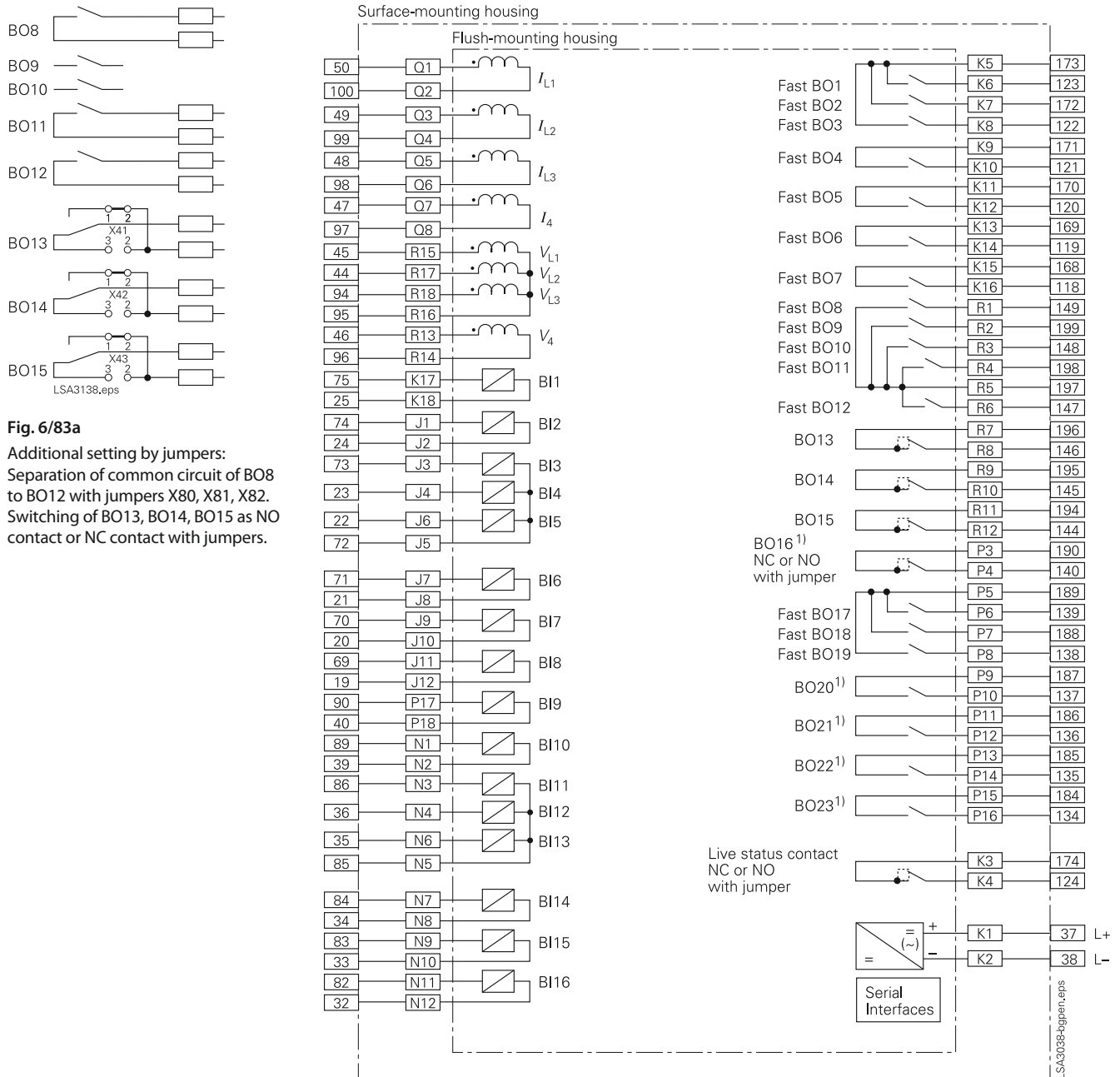


Fig. 6/82

Serial interfaces

Connection diagram, IEC



1) High-speed trip outputs in versions
7SA522x-xN, 7SA522x-xQ, 7SA522x-xS.

Note: For serial interfaces see Figure 6/82.

Connection diagram, IEC

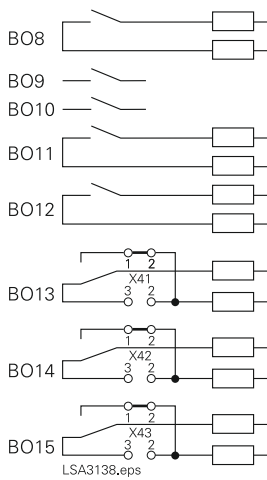


Fig. 6/84a

Additional setting by jumpers:
 Separation of common circuit of BO8 to BO12 with jumpers X80, X81, X82.
 Switching of BO13, BO14, BO15 as NO contact or NC contact with jumpers.

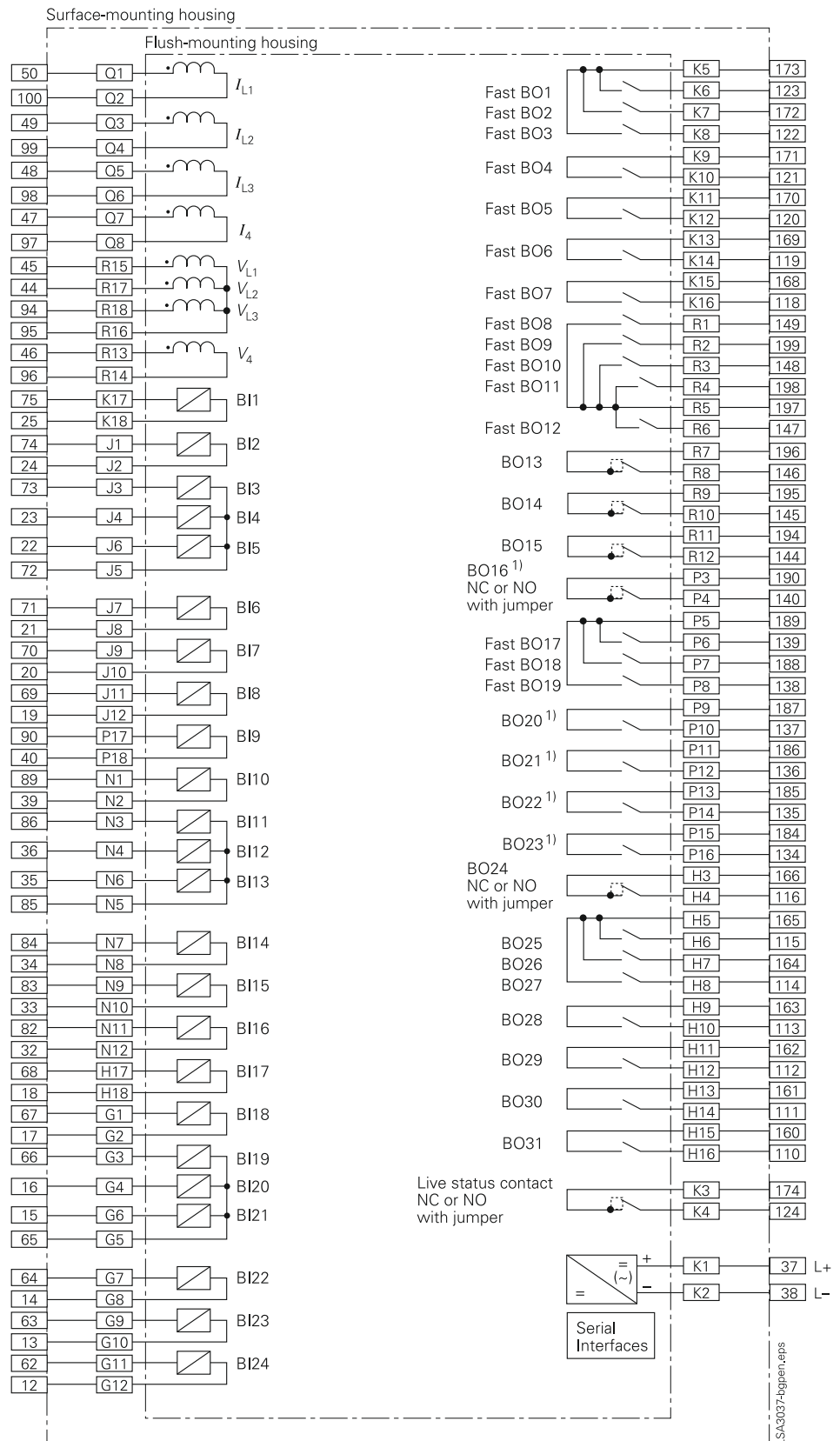


Fig. 6/84

Housing 1/1 x 19", maximum version 7SA522x-xD, 7SA522x-xH, 7SA522x-xM, 7SA522x-xP, 7SA522x-xR and 7SA522x-xT with 24 binary inputs and 32 binary outputs, hardware version .../FF

1) High-speed trip outputs in versions 7SA522x-xP, 7SA522x-xR, 7SA522x-xT.

Note: For serial interfaces see Figure 6/82.

Connection diagram, ANSI

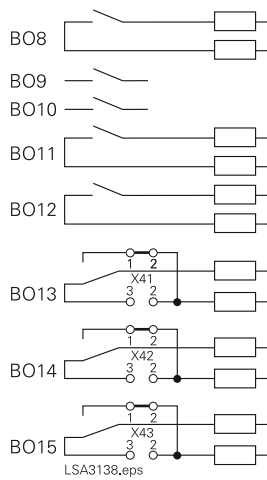


Fig. 6/85a

Additional setting by jumpers:
Separation of common circuit of BO8 to BO12 with jumpers X80, X81, X82.
Switching of BO13, BO14, BO15 as NO contact or NC contact with jumpers.

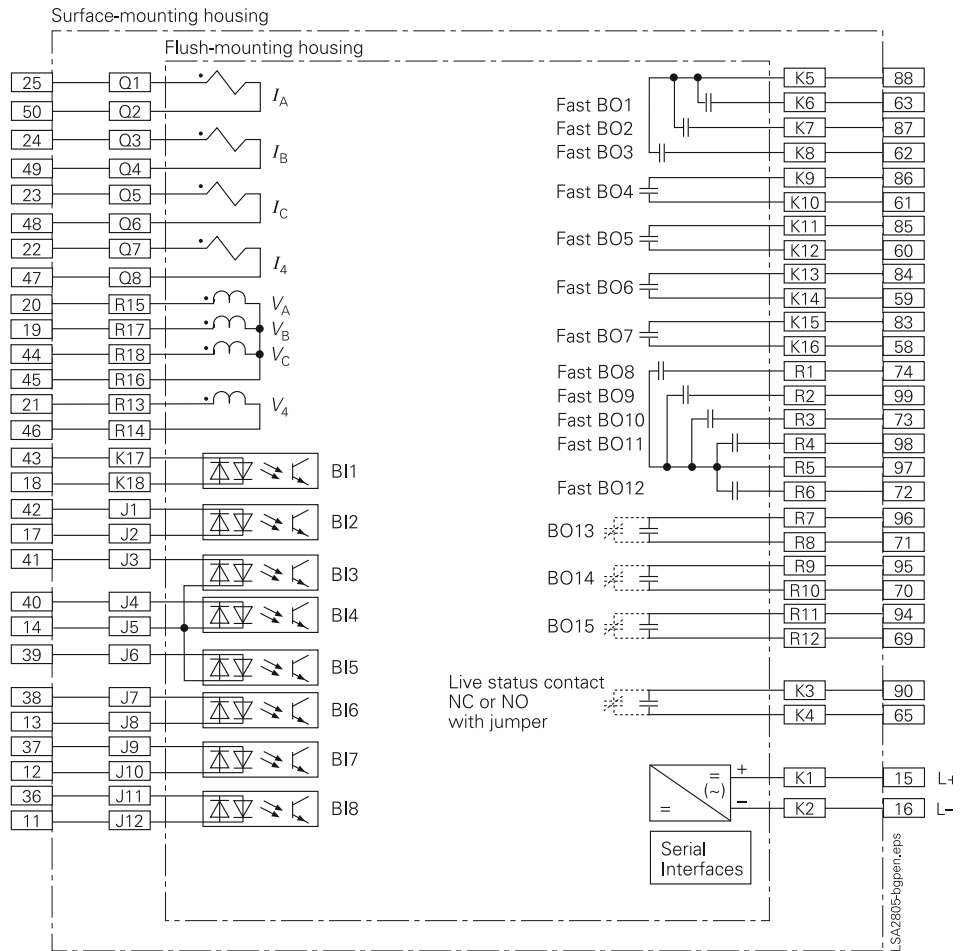


Fig. 6/85

Housing 1/2 x 19", basic version 7SA522x-xA, 7SA522x-xE and 7SA522x-xJ
with 8 binary inputs and 16 binary outputs, hardware version .../FF

Note: For serial interfaces see Figure 6/82.

Connection diagram, ANSI

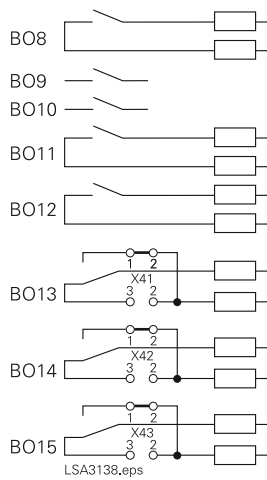


Fig. 6/86a

Additional setting by jumpers:
Separation of common circuit of BO8 to BO12 with jumpers X80, X81, X82.
Switching of BO13, BO14, BO15 as NO contact or NC contact with jumpers.

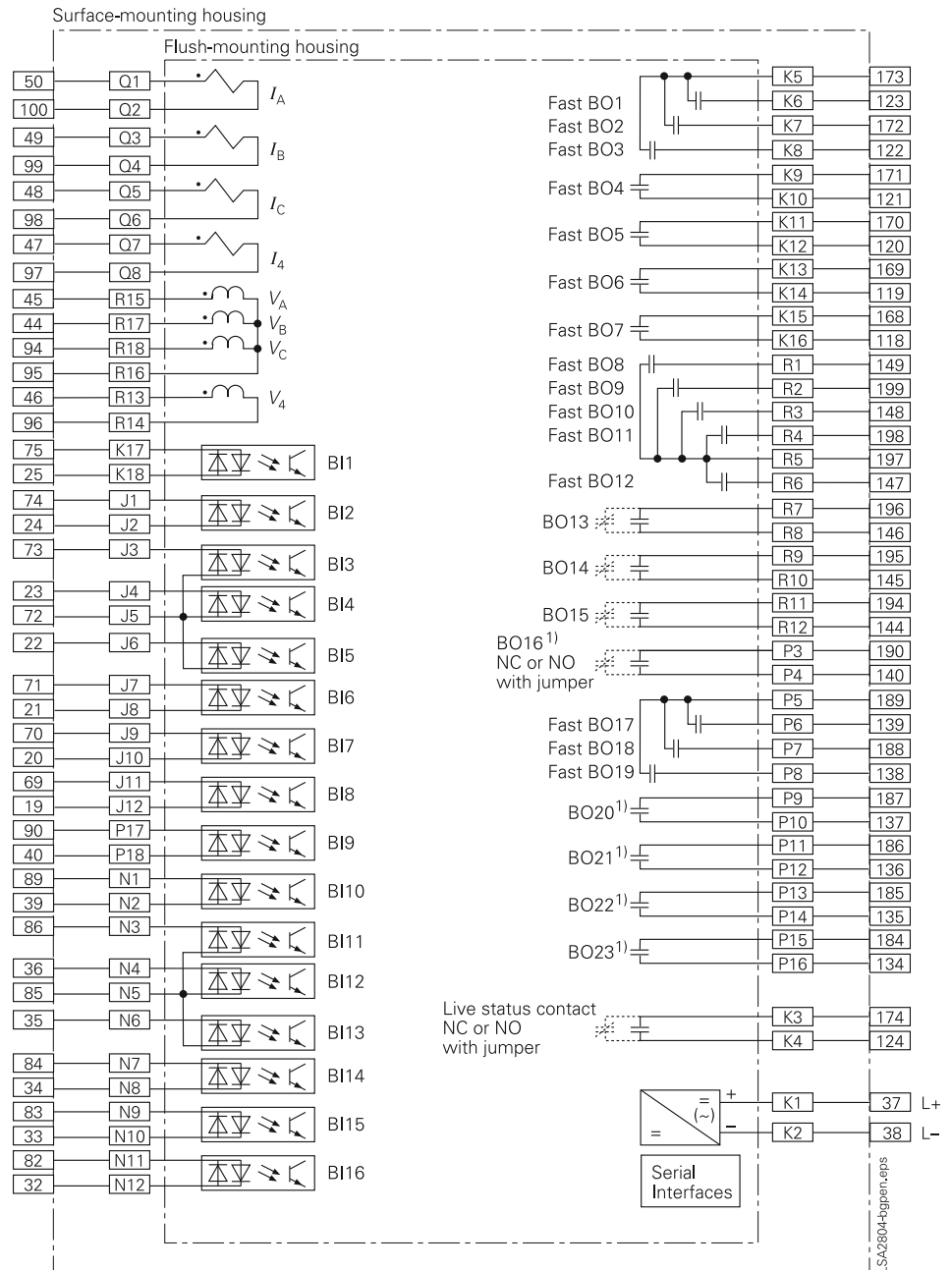


Fig. 6/86

Housing 1/1 x 19", medium version 7SA522x-xC, 7SA522x-xG, 7SA522x-xL, 7SA522x-xN, 7SA522x-xQ and 7SA522x-xS with 16 binary inputs and 24 binary outputs, hardware version .../FF

1) High-speed trip outputs in versions
7SA522x-xN, 7SA522x-xQ, 7SA522x-xS.

Note: For serial interfaces see Figure 6/82.

Connection diagram, ANSI

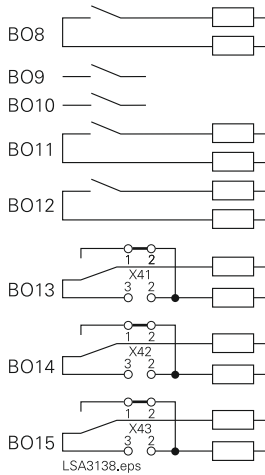


Fig. 6/87a

Additional setting by jumpers:
Separation of common circuit of BO8 to BO12 with jumpers X80, X81, X82.
Switching of BO13, BO14, BO15 as NO contact or NC contact with jumpers.

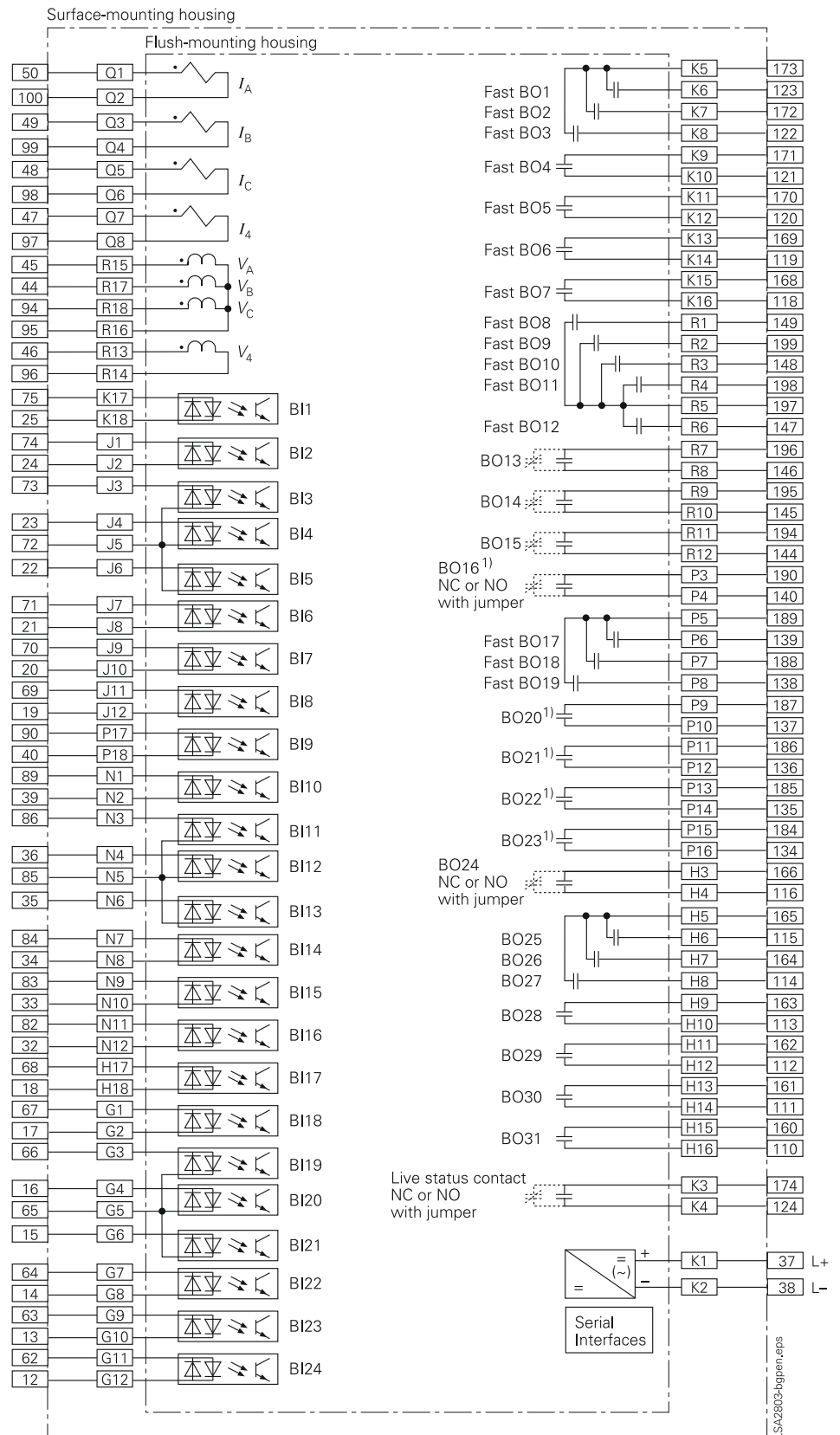


Fig. 6/87

Housing 1/1 x 19", maximum version 7SA522x-xD, 7SA522x-xH and 7SA522x-xM with 24 binary inputs and 32 binary outputs, hardware version ..FF

1) High-speed trip outputs in versions 7SA522x-xP, 7SA522x-xR, 7SA522x-xT.

Note: For serial interfaces see Figure 6/82.