Relays for Various Protection Applications

SIPROTEC 4 7VK61
Breaker Management Relay

25 79 59 27 86 — 50BF 74TC

Fig. 10/1
SIPROTEC 4 7VK61 breaker management relay

Description

The SIPROTEC 4 breaker management relay 7VK61 is a highly flexible auto-reclosure, synchro-check and circuit-breaker failure protection unit.

This unit is used for the single and three-pole auto-reclosure of a circuit-breaker, after this circuit-breaker has tripped due to a fault. The synchro-check function ensures that the two circuits being reconnected by closing the circuit-breaker are within a defined safe operating state before the CLOSE command is issued.
The 7VK61 is also applicable as circuit-breaker failure protection. A breaker failure occurs when the circuit-breaker fails to correctly open and clear the fault after single or three-pole trip commands have been issued by the protection. It is then necessary to trip the relevant busbar zone (section) to ensure fault clearance.
Together with the above-mentioned protection functions, the following additional functions of the 7VK61 can be applied: end-fault protection, pole-discrepancy protection, overvoltage protection and undervoltage protection. As a member of the numerical SIPROTEC 4 relay family, it also provides control and monitoring functions and therefore supports the user with regard to a cost-effective power system management.

Function overview

Protection functions

- Single and/or three-pole auto-reclosure
- Synchro-check with live/dead line/bus measurement
- Closing under asynchronous conditions (consideration of CB operating time)
- Circuit-breaker failure protection with two stages (single and three-pole with/without current)
- End-fault protection
- Pole-discrepancy protection
- Overvoltage/undervoltage protection

Control function

- Commands f. ctrl. of CB and isolators

Monitoring functions

- Operational measured values
- Self-supervision of the relay
- Event buffer and fault protocols
- Oscillographic fault recording
- Monitoring of CB auxiliary contacts
- Switching statistics

Features

- All functions can be used separately
- Initiation/start by phase-segregated or 3-pole trip commands
- Auto-reclosure for max. 8 reclose cycles
- Evolving/sequential trip recognition
- Auto-reclosure with ADT, DLC, RDT
- Synchro-check with ΔV, $\Delta\varphi$, Δf measurement
- Breaker failure protection with highly secure 2-out-of-4 current check detectors
- Breaker failure protection with short reset time and negligible overshoot time

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
- Rear-side service/modem interface
- Time synchronization via
  – IRIG-B or DCF77 or system interface

Application

The 7VK61 provides highly flexible breaker management. It applies to single-breaker, ring-bus, and 1½ breaker installations. The auto-reclosure, synchronism-check, breaker failure protection and voltage protection functions can be used separately or combined. Therefore the current and voltage transformer connection can be selected according to the required application.

The auto-reclosure function closes the circuit-breaker after this circuit-breaker has tripped due to a fault. The check-synchronism function ensures that the two circuits being reconnected by closing the circuit-breaker are within a defined safe operating state before the CLOSE command is issued.

The numerical 7VK61 relay provides rapid backup fault clearance in case the circuit-breaker nearest to the fault fails to respond to a TRIP command. It is suitable for power systems of all voltage levels with single and/or three-pole circuit-breaker operation. The initiation signal can be issued from any protection or supervision equipment. Information from the circuit-breaker auxiliary contact is only required for the breaker failure protection during faults which produce little or no fault current flow, for instance due to a trip from the power transformer Buchholz protection.

Cost-effective power system management

The SIPROTEC 4 units are numerical relays which also provide control and monitoring functions and therefore support the user with regard to a cost-effective power system management. The security and reliability of the 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 cases to implement such changes by means of parameterization using DIGSI 4 without having to change the hardware.
The use of powerful microcontrollers and the application of digital measured-value conditioning and processing largely suppresses the influence of higher-frequency transients, harmonics and DC components.

ANSI	
50BF	Breaker-failure protection
59/27	Overvoltage/undervoltage protection
25	Synchro-check
79	Auto-reclosure
74TC	Trip circuit supervision
86	Lockout (CLOSE command interlocking)

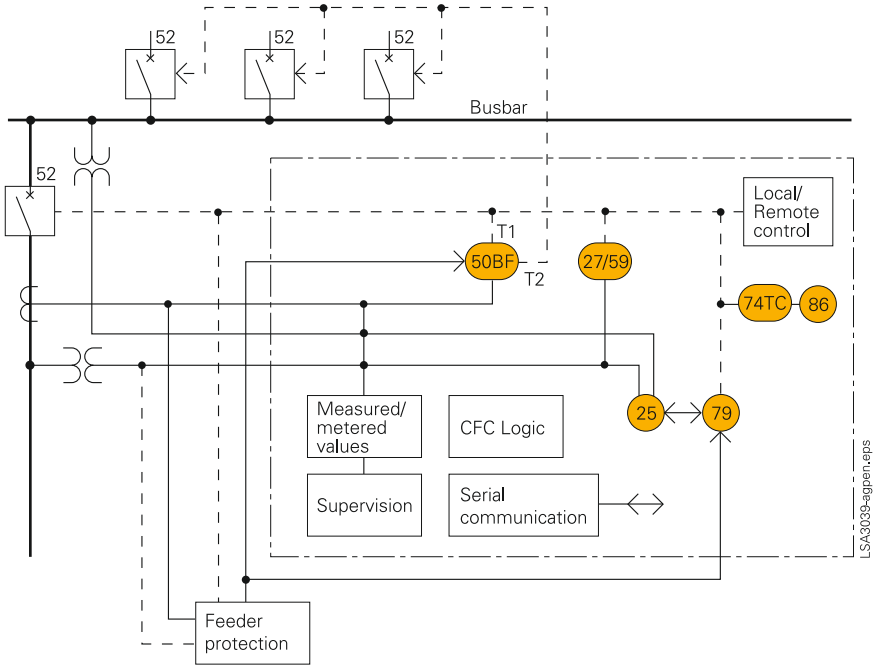

Fig. 10/2 Application and function diagram

Construction

Connection technique and housing with many advantages

1/3 and 1/2-rack sizes are available as housing widths of the SIPROTEC 4 7VK61 relays, referred to a 19" modular frame system. This means that previous models can always be replaced. The height is a uniform 255 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.

In the case of surface mounting on a panel, the connection terminals are located above and below the housing 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. 10/3
Flush-mounting housing with screw-type terminals

Fig. 10/4
Rear view of flush-mounting housing with covered connection terminals and wirings

Fig. 10/5
Surface-mounting housing with screw-type terminals, example 7SA63

Fig. 10/6
Communication interfaces in a sloped case in a surface-mounting housing

Protection functions

Auto-reclosure (ANSI 79)

The 7VK61 relay is equipped with an auto-reclose function (AR). Usually the auto-reclosure interacts with the feeder protection via binary inputs and outputs.

The function includes several operating modes:

- 3-pole auto-reclosure for all types of faults; different dead times are available depending on the type of fault
- 1-pole auto-reclosure for 1-phase faults, no reclosing for multi-phase faults
- 1-pole auto-reclosure for 1-phase and 3-pole auto-reclosing for multi-phase faults
- Multiple-shot auto-reclosure
- 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).

The 7VK61 allows the line-side voltages to be evaluated. A number of voltage-dependent supplementary functions are thus available:

- ADT
  The adaptive dead time is employed only if auto-reclosure at the remote station was successful (reduction of stress on equipment).
- DLC
  By means of dead-line check, reclosure is effected only when the line is deenergized (prevention of asynchronous breaker closure in case that the synchronism check can not be used).
- RDT
  Reduced dead time is employed in conjunction with auto-reclosure where no teleprotection method is employed: when faults within the zone extension of a distance feeder protection 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, that the fault has been cleared by the protection on the faulted downstream feeder and that reclosure with reduced dead time may take place.

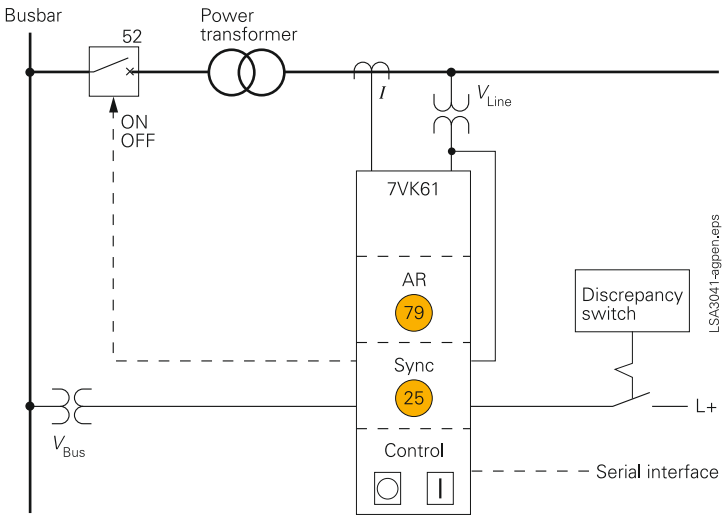

Fig. 10/7 Auto-reclosure and synchro-check with voltage measurement across a power transformer

Synchronism check (ANSI 25)

Where two network sections are switched in by control command or following a 3-pole auto-reclosure, it must be ensured that both network sections are mutually synchronous. For this purpose, a synchronism-check function is provided. After verification of the network synchronism, the function releases the CLOSE command. Consideration of the duration of the CB operating time before issuing the CLOSE command (especially important under asynchronous conditions and when several circuit-breakers with different operating times are to be operated by one single relay).

In addition, reclosing can be enabled for different criteria, e.g., when the busbar or line are not carrying a voltage (dead line or dead bus).

Breaker failure protection (ANSI 50BF)

The 7VK61 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 settable time delay has expired, a retrip command or the busbar trip command will be generated. The breaker failure protection will usually be initiated by external feeder protection relays via binary input signals. Trip signals from the internal auto-reclosure logic or from the voltage protection can start the breaker failure protection as well.

Overvoltage protection, undervoltage protection (ANSI 59, 27)

The 7VK61 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 (not in conjunction with syncho-check) or be derived from the phase voltages.
- 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 7VK61 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.

Protection functions

End-fault protection

When the circuit-breaker is open, the area located between the current transformer and the circuit-breaker can be optimally protected by means of the end-fault protection. In the event of a fault, an independently settable time delay is started after a valid initiation has been received and the circuit-breaker auxiliary contacts indicate an open circuit-breaker position, with current still flowing (see Fig. 10/8). Depending on the mounting position of the current transformer, instantaneous tripping of the busbar section or intertripping of the circuit-breaker at the opposite end occurs.

Pole-discrepancy protection

This function ensures that any one or two poles of a circuit-breaker do not remain open for longer than an independently settable time (i.e. unsymmetrical conditions). This time stage is initiated when current (above the set value) is flowing in any 1 or 2 phases, but not in all 3 phases. Additionally, the circuit-breaker auxiliary contacts (if connected) are interrogated and must show the same condition as the current measurement. Should this time delay expire, then a three-pole trip command is issued. This function is normally used when single-pole auto-reclosing is applied.

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. The trip circuit supervision function requires one or two independent potential-free binary inputs per trip circuit. To make existing (non potential-free) binary inputs potential-free, external optocoupler modules can be applied.

Lockout (ANSI 86)

Under certain operating conditions, it is advisable to block CLOSE commands after a final TRIP command of the relay has been issued. Only a manual 'Reset' command unblocks the CLOSE command. The 7VK61 is equipped with such an interlocking logic.

Monitoring functions

The 7VK61 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 all voltages are connected, the relay will detect secondary voltage interruptions by means of the integrated fuse failure monitor. Immediate alarm and blocking of the synchronism check and dead line check is provided for all types of secondary voltage failures. Additional measurement supervision functions are

- Symmetry of voltages and currents (in case of appropriate transformer connection)
- Broken-conductor supervision (if current transformers are connected)
- Summation of currents and voltages (in case of appropriate transformer connection)
- Phase-sequence supervision (if three voltage transformers are connected)

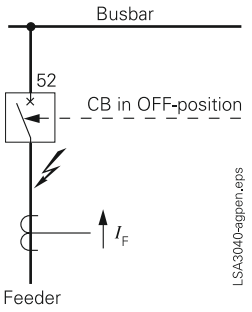

Fig. 10/8
End-fault between circuit-breaker and current transformer

Communication

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

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

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

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

7VK61 units are always fitted with a rear-side hardwired service interface, optionally as RS232 or RS485. In addition to the front-side operator interface, a PC can be connected here either directly or via a modem.

Time synchronization interface

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

Reliable bus architecture

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

Retrofitting: Modules for every type of communication

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

IEC 61850 protocol

The Ethernet-based IEC 61850 protocol is the worldwide standard for protection and control systems used by power supply corporations. Siemens was the first manufacturer to support this Standard. By means of this protocol, information can also be exchanged directly between bay units so as to set up simple masterless systems for bay and system interlocking. Access to the units via the Ethernet bus is also be possible with DIGSI.

IEC 60870-5-103 protocol

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

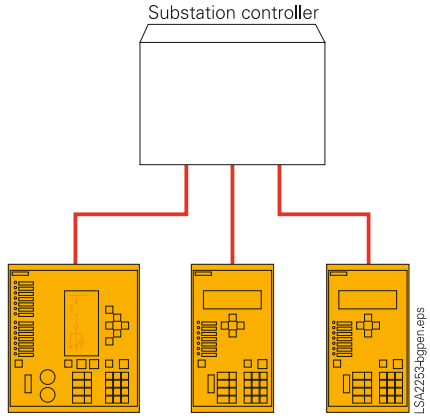

Fig. 10/9
IEC 60870-5-103 star-type RS232 copper conductor connection or fiber-optic connection

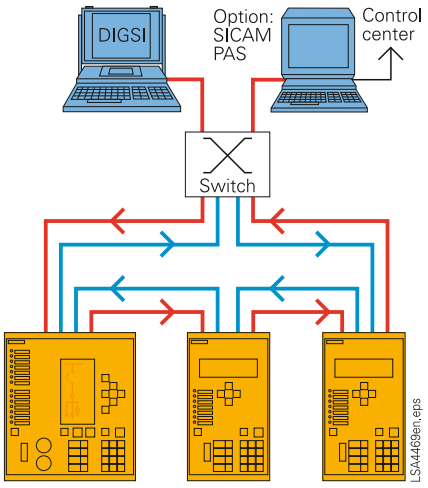

Fig. 10/10
Bus structure for station bus with Ethernet and IEC 61850 with fiber-optic ring

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Communication

PROFIBUS-DP

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

DNP 3.0

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

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. 10/14).

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 can also be used via the same station bus.

Fig. 10/11 820 nm fiber-optic communication module

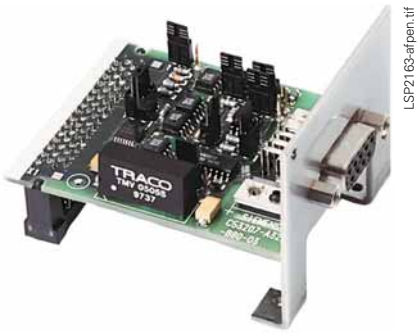


Fig. 10/12 RS232/RS485 electrical communication module

Fig. 10/13 Fiber-optic Ethernet communication module for IEC 61850 with integrated Ethernet switch

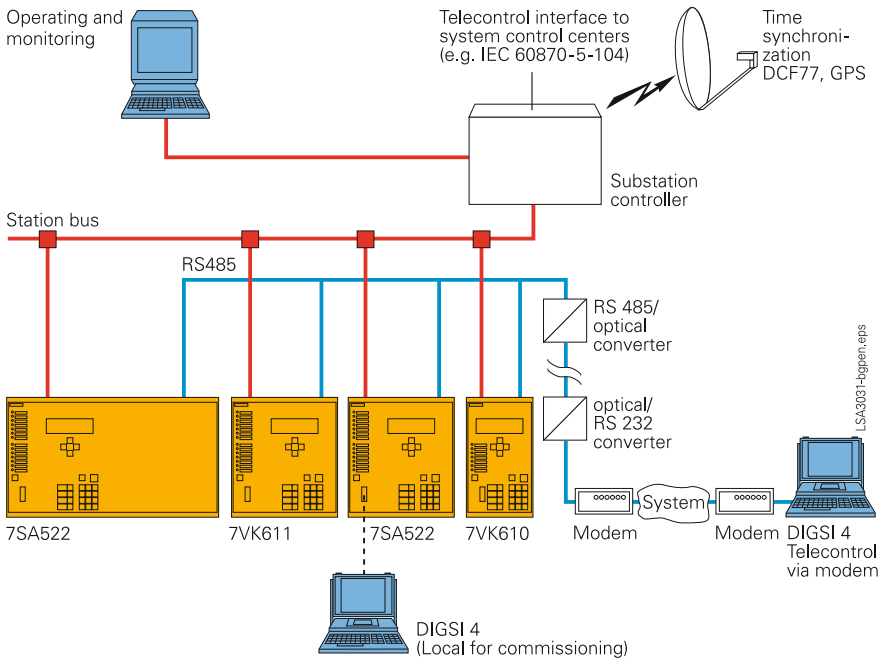


Fig. 10/14 Communication

Typical connection

Connection for current and voltage transformers

With the transformer connection as shown in Fig. 10/15, it is possible to use the complete scope of functions of 7VK61, i.e. breaker failure protection, synchronism check with 3-phase dead line check (with or without auto-reclosure), complete measured value monitoring, voltage protection, and the complete range of operational measured values.

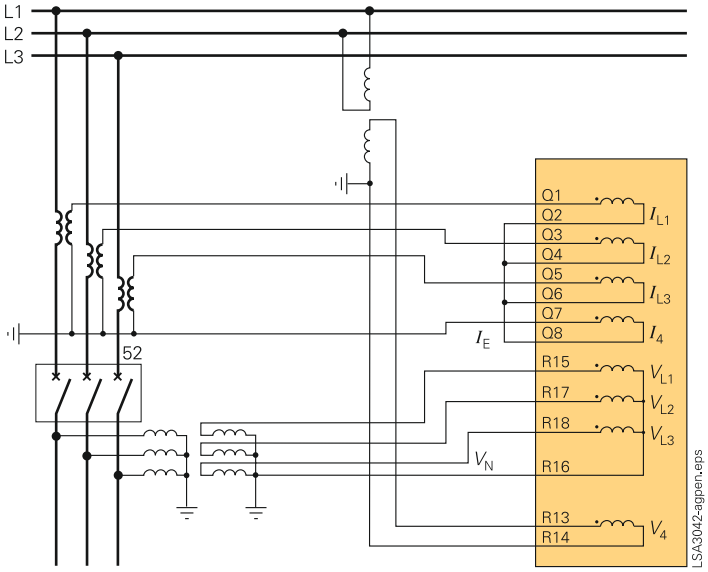


Fig. 10/15
Complete connection of all current and voltage transformers

Alternative: Connection for current transformers only

The connection for current transformers only provides breaker failure protection and current operational measured values.

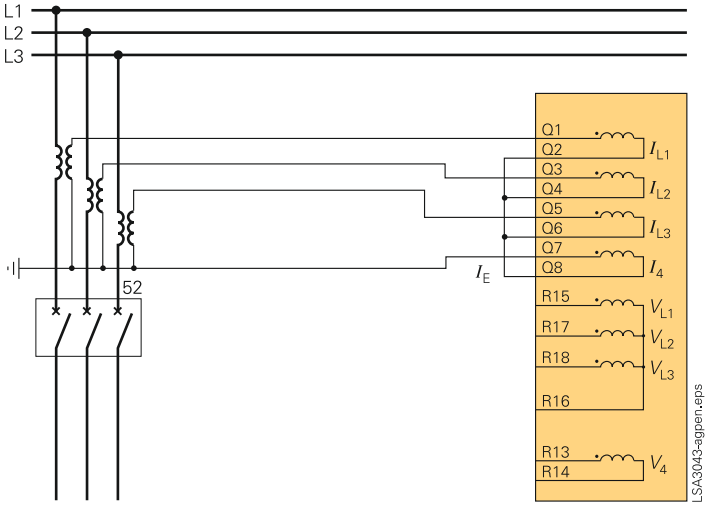


Fig. 10/16
Typical current transformer connection for breaker failure protection

Typical connection

Alternative: Connection for two voltage transformers

In case of a connection for two voltage transformers, synchro-check and two operational measured voltages, and additionally synchro-check measured values are applicable. Dead line check is performed for the connected line voltage only.

Note: Please connect the two voltages always to the terminals R15/R16 and R13/R14 with the appropriate polarity. The setting address 106 “Voltage transformer” must then be set to “single-phase”. The terminals R17 and R18 must not be connected.

The connection of the voltage V_{L1-L2} as shown in Fig. 10/17 is just an example: any other of the shown combinations is possible for synchronization.

The two voltage transformer connection can also be combined with the current transformer connection according to Fig. 10/16.

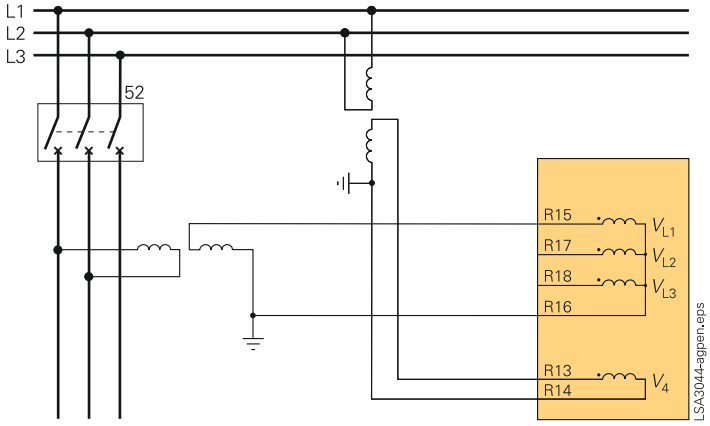


Fig. 10/17
Typical voltage transformer connection for synchro-check with single voltage dead line check

Technical data

General unit data

Analog inputs

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

Auxiliary voltage

Rated voltages	24, 48 V DC 60, 125 V DC 110, 250 V DC and 115, 230 V AC (50/60 Hz)
Permissible tolerance	-20 % to +20 %
Superimposed AC voltage (peak-to-peak)	≤ 15 %
Power consumption	
Quiescent	Approx. 5 W
Energized	Approx. 8 W to 14 W, depending on design
Bridging time during failure of the auxiliary voltage	
For V_{aux} = 48 V and V_{aux} ≥ 110 V	≥ 50 ms
For V_{aux} = 24 V and V_{aux} = 60 V	≥ 20 ms

Binary inputs

Quantity	
7VK610	7
7VK611	20
Rated voltage range	24 to 250 V, bipolar
Pickup threshold	19 or 88 V or 176 V DC, bipolar
Functions are freely assignable	
Minimum pickup voltage Ranges are settable by means of jumpers for each binary input	19 or 88 V or 176 V DC, bipolar (3 operating ranges)
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

1) Can be set via jumpers.

Output contacts

"Unit ready" contact (live status contact)	1 NC/NO contact[1)]
Command/indication relay	
Quantity	
7VK610	5 NO contacts,
7VK611	14 NO contacts, 4 NC/NO contacts[1)]
NO/NC contact	
Switching capacity	
Make	1000 W / VA
Break, contacts	30 VA
Break, contacts (for resistive load)	40 W
Break, contacts (for τ = L/R ≤ 50 ms)	25 VA
Switching voltage	250 V
Permissible total current	30 A for 0.5 seconds 5 A continuous
Operating time, approx.	
NO contact	8 ms
NO/NC contact (selectable)	8 ms
Fast NO contact	5 ms

LEDs

Quantity	
RUN (green)	1
ERROR (red)	1
LED (red), function can be assigned	
7VK610	7
7VK611	14

Unit design

Housing	7XP20
Dimensions	Refer to part 15 for dimension drawings
Degree of protection acc. to EN 60529	
Surface-mounting housing	IP 51
Flush-mounting housing	
Front	IP 51
Rear	IP 50
For the terminals	IP 20 with terminal cover put on
Weight	
Flush-mounting housing	
1/3 x 19"	5 kg
1/2 x 19"	6 kg
Surface-mounting housing	
1/3 x 19"	9.5 kg
1/2 x 19"	11 kg

Technical data

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)
Service/modem interface for DIGSI 4 / modem / service	
Isolated RS232/RS485	9-pin subminiature connector (SUB-D)
Dielectric test	500 V / 50 Hz
Distance for RS232	Max. 15 m
Distance for RS485	Max. 1000 m
System interface	
	IEC 61850 Ethernet IEC 60870-5-103 protocol PROFIBUS-FMS PROFIBUS-DP DNP 3.0
Isolated RS232/RS485	9-pin subminiature connector (SUB-D)
Baud rate	4800 to 38400 baud
Dielectric test	500 V / 50 Hz
Distance for RS232	Max. 15 m
Distance for RS485	Max. 1000 m
PROFIBUS RS485	
Dielectric test	500 V / 50 Hz
Baud rate	Max. 12 Mbaud
Distance	1000 m at 93.75 kbaud; 100 m at 12 Mbaud
PROFIBUS fiber-optic	
Only for flush-mounting housing	ST connector
For surface-mounting housing	Optical interface with OLM[1)]
Baud rate	Max. 1.5 Mbaud
Optical wavelength	λ = 820 nm
Permissible attenuation	Max. 8 dB for glass-fiber 62.5/125 µm
Distance	500 kB/s 1.6 km 1500 kB/s 530 m

Electrical tests	
Specifications	
Standards	IEC 60255 (product standards) IEEE C37.90.0/.1/.2 VDE 0435 For further standards see "Individual tests"
Insulation tests	
Standards	IEC 60255-5 and 60870-2-1
Voltage test (100 % test)	
All circuits except for auxiliary supply, binary inputs, communication and time synchronization interfaces	2.5 kV (r.m.s.), 50 Hz
Auxiliary voltage and binary inputs (100 % test)	3.5 kV DC
RS485/RS232 rear side communication interfaces and time synchronization interface (100 % test)	500 V (r.m.s.), 50 Hz
Impulse voltage test (type test)	
All circuits except for communication interfaces and time synchronization interface, class III	5 kV (peak); 1.2/50 µs; 0.5 J, 3 positive and 3 negative impulses in intervals of 5 s
***EMC tests for noise immunity;** type tests*	
Standards	IEC 60255-6; IEC 60255-22 (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 Part 303, class III	2.5 kV (peak); 1 MHz; τ = 15 µs; 400 surges per s; test duration 2 s; R_i = 200 Ω
Electrostatic discharge IEC 60255-22-2 class IV and EN 61000-4-2, class IV	8 kV contact discharge; 15 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
Irradiation with HF field, IEC 60255-22-3 class III IEC 61000-4-3, class III	10 V/m; 80 to 1000 MHz; 80 % AM; 1 kHz 10 V/m; 1.4 to 2 GHz; 80 % AM; 1 kHz
Irradiation with HF field, IEC 60255-22-31, IEC 61000-4-3	Class III, 10 V/m
Amplitude-modulated	80; 160; 450; 900 MHz; 80 % AM 1kHz; duration >10 s
Pulse-modulated	900 MHz, 50 % PM, repetition frequency 200 Hz
Fast transient disturbance/bursts IEC 60255-22-4 and IEC 61000-4-4, class IV	4 kV; 5/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; test duration 1 min

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

Technical data

EMC tests for noise immunity; *type tests (cont'd)*	
High-energy surge voltages (SURGE), IEC 61000-4-5 installation class III	Impulse: 1.2/50 µs
Auxiliary supply	Common (longitudinal) mode: 2 kV; 12 Ω; 9 µF Differential (transversal) mode:1 kV; 2 Ω; 18 µF
Measurement inputs, binary inputs, binary output relays	Common (longitudinal) mode: 2 kV; 42 Ω; 0.5 µF Differential (transversal) 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
Magnetic field with power frequency IEC 61000-4-8, class IV; IEC 60255-6	30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz
Oscillatory surge withstand capability, IEEE C37.90.1	2.5 kV (peak); 1 MHz; τ = 50 µs; 400 surges per second, duration 2 s, R_i = 200 Ω
Fast transient surge withstand capability, IEEE C37.90.1	4 kV; 5/50 ns; 5 kHz burst length = 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; duration 1 min
Radiated electromagnetic interference IEEE C37.90.2	35 V/m; 25 to 1000 MHz,
Damped oscillation IEC 60694, IEC 61000-4-12	2.5 kV (peak value); polarity alternating 100 kHz; 1 MHz; 10 and 50 MHz; R_i = 200 Ω
EMC tests for interference emission; *type tests*	
Standard	EN 61000-6-3 (generic standard)
Conducted interference voltage on 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	
During operation	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 10 to 60 Hz: ± 0.075 mm amplitude; 60 to 150 Hz: 1 *g* acceleration, frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Half-sinusoidal Acceleration 5 *g*, duration 11 ms, 3 shocks on each of the 3 axes in both directions
Seismic vibration IEC 60255-21-3, class 1 IEC 60068-3-3	Sinusoidal 1 to 8 Hz: ± 3.5 mm amplitude (horizontal axis) 1 to 8 Hz: ± 1.5 mm amplitude (vertical axis) 8 to 35 Hz: 1 *g* acceleration (horizontal axis) 8 to 35 Hz: 0.5 *g* acceleration (vertical axis) Frequency sweep 1 octave/min 1 cycle in 3 orthogonal axes
During transport	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 5 to 8 Hz: ± 7.5 mm amplitude; 8 to 150 Hz: 2 *g* acceleration, frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Semi-sinusoidal Acceleration 15 *g*, duration 11 ms, 3 shocks on each of the 3 axes in both directions
Continuous shock IEC 60255-21-2, class 1 IEC 60068-2-29	Semi-sinusoidal Acceleration 10 *g*, duration 16 ms, 1000 shocks on each of the 3 axes in both directions

Climatic stress tests	
Standard	IEC 60255-6
Temperatures	
Type-tested acc. to IEC 60068-2-1 and -2, test Bd, for 16 h	-25 °C to +85 °C / -13 °F to +185 °F
Temporarily permissible operating temperature, tested for 96 h (Legibility of display may be impaired above +55 °C / +131 °F)	-20 °C to +70 °C / -4 °F to +158 °F
Recommended permanent operating temperature acc. to IEC 60255-6	-5 °C to +55 °C / +23 °F to +131 °F
– Limiting temperature during permanent storage	-25 °C to +55 °C / -13 °F to 131 °F
– Limiting temperature during transport	-25 °C to +70 °C / -13 °F to +158 °F
Humidity	
Permissible humidity stress: It is recommended to arrange the units in such a way that they are not exposed to direct sunlight or pronounced temperature changes that could cause condensation.	Annual average on ≤ 75 % relative humidity; on 56 days per year up to 93 % relative humidity; condensation is not permitted.

Technical data

Functions	
Auto-reclosure *(ANSI 79)*	
Number of auto-reclosures	Up to 8
Operating mode	Only 1-pole; only 3-pole, 1- or 3-pole
Operating modes with line voltage check	DLC – dead-line check ADT – adaptive dead time RDT – reduced dead time
Dead times $T_{1\text{-ph}}$, $T_{3\text{-ph}}$, T_{Seq}	0 to 1800 s (step 0.01 s) or deactivated
Action times	0.01 to 300 s (step 0.01 s) or deactivated
Reclaim times	0.5 to 300 s (step 0.01 s)
Start-signal monitoring time	0.01 to 300 s (steps 0.01 s)
Additional functions	Synchro-check request 3-phase intertripping InterCLOSE command to the remote end Check of CB ready state Blocking with manual CLOSE
Voltage limit values for DLC, ADT, RDT	
Healthy line voltage $_{PH-E}$	30 to 90 V (steps 1 V)
Dead line voltage $_{PH-E}$	2 to 70 V (steps 1 V)
Tolerances	
Time stages	1 % of setting value or 10 ms
Voltage limit values	≤ 3 % of setting value or 1 V
Synchro-check *(ANSI 25)*	
Initiate options	Auto-reclosure; Manual CLOSE control Control commands
Operating modes	
With auto-reclosure	Synchro-check Line dead/busbar live Line live/busbar dead Line and busbar dead Bypassing
For manual closure and control commands	As for auto-reclosure
Permissible voltage difference	1 to 60 V (step 0.1 V)
Permissible frequency difference	0.03 to 2 Hz (step 0.01 Hz)
Permissible angle difference	2 to 80 ° (step 1°)
Max. duration of synchronization	0.01 to 600 s (steps 0.01 s) or deactivated
Release delay with synchronous networks	0 to 30 s (steps 0.01 s)
Minimum measuring time	Approx. 80 ms
Tolerances	
Time stages	1 % of setting value or 10 ms
Voltage limit values	≤ 2 % of setting value or 1 V

Breaker failure protection *(ANSI 50BF)*	
Number of stages	2
Pickup of current element	0.05 to 20 A $_{(1A)}$ / 0.25 to 100 A $_{(5A)}$ (step 0.01 A)
Time delays $T1_{1phase}$, $T1_{3phase}$, $T2$	0 to 30 s (steps 0.01 s) or deactivated
Dropout (overshoot) time, internal	≤ 15 ms, typical; 25 ms, max.
End-fault protection	For fault between open CB and CT, with intertrip to the remote line end
Pole discrepancy supervision	Initiation if not all CB poles are closed or open
Monitoring time	0 to 30 s (steps 0.01 s) or deactivated
Tolerances	
Current limit value	≤ 5 % of setting value or 1 % I_{nom}
Time stages	1 % of setting value or 10 ms
Voltage protection *(ANSI 59, 27)*	
Operating modes	Local tripping and/or carrier trip for remote end
Overvoltage protection	
Pickup values V_{PH-E}>>, V_{PH-E}> (phase-earth overvoltage)	1 to 170 V (step 0.1 V)
Pickup values V_{PH-PH}>>, V_{PH-PH}> (phase-phase overvoltage)	2 to 220 V (step 0.1 V)
Pickup values $3V_0$>>, $3V_0$> ($3V_0$ can be measured via V4 transformers or calculated by the relay) (zero-sequence overvoltage)	1 to 220 V (step 0.1 V)
Pickup values V_1>>, V_1> (positive-sequence overvoltage)	2 to 220 V (step 0.1 V)
Pickup values V_2>>, V_2> (negative-sequence overvoltage)	2 to 220 V (step 0.1 V)
Reset ratio (settable)	0.5 to 0.98 (step 0.01)
Undervoltage protection	
Pickup values V_{PH-E}<<, V_{PH-E}< (phase-earth undervoltage)	1 to 100 V (step 0.1 V)
Pickup values V_{PH-PH}<<, V_{PH-PH}< (phase-phase undervoltage)	1 to 170 V (step 0.1 V)
Pickup values V_1<<, V_1< (positive-sequence undervoltage)	1 to 100 V (step 0.1 V)
Blocking of undervoltage protection stages	Minimum current; binary input
Reset ratio (settable)	1.01 to 1.20 (step 0.01)
Time delays	
Time delay for all stages	0 to 100 s (step 0.01 s) or deactivated
Command / pickup time	Approx. 34 ms at f_{nom} = 50 Hz Approx. 30 ms at f_{nom} = 60 Hz
Tolerances	
Voltage limit values	≤ 3 % of setting value or 1 V
Time stages	1 % of setting value or 10 ms
Trip circuit supervision *(ANSI 74TC)*	
Number of supervisable trip circuits	Up to 3
Number of required binary inputs per trip circuit	1 or 2
Indication relay	1 to 30 s (steps 1 s)

Technical data

Additional functions

Operational measured values

Representation	Primary, secondary and percentage referred to rated value
Currents	3 x I_{Phase} ; $3I_0$; I_1; I_2
Tolerances	Typ. 0.3 % of indicated measured value or 0.5 % I_{nom}
Voltages	3 x $V_{Phase-Earth}$; 3 x $V_{Phase-Phase}$; $3V_0$, V_1, V_2, V_{SYNC}, V_{en}
Tolerances	Typ. 0.25 % of indicated measured value or 0.01 % V_{nom}
Power with direction indication	*P, Q, S*
Tolerances	
P: for $\lvert\cos\varphi\rvert$ = 0.7 to 1 and V/V_{nom}, I/I_{nom} = 50 to 120 %	Typical ≤ 1%
Q: for $\lvert\sin\varphi\rvert$ = 0.7 to 1 and V/V_{nom} , I/I_{nom} = 50 to 120 %	Typical ≤ 1%
S: for V/V_{nom}, I/I_{nom} = 50 to 120 %	Typical ≤ 1%
Frequency	*f*
Tolerance	≤ 10 mHz
Power factor	PF
Tolerance for $\lvert\cos\varphi\rvert$ = 0.7 to 1	Typical ≤ 0.02

Energy meters

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

Oscillographic fault recording

Analog channels	3 x I_{Phase}, $3I_0$ 3 x V_{Phase}, $3V_0$, V_{SYNC}, V_{en}
Max. number of available recordings	8, backed-up by battery if auxiliary voltage supply fails
Sampling intervals	20 samplings per cycle
Total storage time	> 15 s
Binary channels	Pickup and trip information; number and contents can be freely configured by the user
Max. number of displayed binary channels	40

Control

Number of switching units	Depends on the number of binary / indication inputs and indication / command outputs
Control commands	Single command / double command 1, 1 plus 1 common or 2 pole
Feed back	CLOSE, TRIP, intermediate position
Interlocking	Freely configurable
Local control	Control via menu, function keys, control keys (if available)
Remote control	Control protection, DIGSI, pilot wires

Further additional functions

Measured value supervision	Current sum Current symmetry Voltage sum Voltage symmetry Phase sequence Fuse failure monitor
Indications	Power direction
Operational indications	Buffer size 200
System disturbance indication	Storage of indications 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 phases TRIP/CLOSE per phase
Dead time for CB TRIP / CLOSE cycle	0 to 30 s (steps 0.01 s)
Commissioning support	Operational measured values, CB test, status display of binary inputs, setting of output relays, generation of indications for testing serial interfaces
Phase rotation adjustment	Clockwise or anti-clockwise

CE conformity

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

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

This device is designed and produced for industrial use.

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

Selection and ordering data

Description	Order No.	Order code
7VK61 breaker management relay	7VK61☐☐ – ☐☐☐☐☐ – 4Y☐0	☐☐☐
Housing, binary inputs (BI) and outputs (BO)		
Housing 1/3 19", 7 BI, 6 BO incl. 1 live-status contact,	0	
Housing 1/2 19", 20 BI, 19 BO incl. 1 live-status contact	1	
Measuring inputs (4 x V, 4 x I)		
I_{ph} = 1 A, I_e = 1 A (min. = 0.05 A)[1]	1	
I_{ph} = 5 A, I_e = 5 A (min. = 0.25 A)[1]	5	
Rated auxiliary voltage (power supply, threshold of binary inputs)		
24 to 48 V DC, binary input threshold 19 V[3]	2	
60 to 125 V DC[2], binary input threshold 19 V[3]	4	
110 to 250 V DC[2], 115 to 230 V AC, binary input threshold 88 V[3]	5	
220 to 250 V DC[2], 115 to 230 V AC, binary input threshold 176 V[3]	6	
Unit version		
For panel flush mounting	A	
For panel surface mounting	E	
Region-specific default settings/language settings and functions versions		
Region DE, language: German, selectable	A	
Region World, language: English, selectable	B	
Region US, language:US-English, selectable	C	
Region FR, language: French, selectable	D	
Region World, language: Spanish, selectable	E	
Region World, language: Italian, selectable	F	
Port B system interface		
Empty	0	
IEC 60870-5-103 protocol, electrical RS232	1	
IEC 60870-5-103 protocol, electrical RS485	2	
IEC 60870-5-103 protocol, optical 820 nm, ST connector	3	
PROFIBUS-FMS Slave, electrical RS485	4	
PROFIBUS-FMS Slave, optical, double ring, ST connector[4]	6	
PROFIBUS-DP Slave, RS485	9	L 0 A
PROFIBUS-DP Slave, optical 820 nm , double ring, ST connector[4]	9	L 0 B
DNP 3.0, RS485	9	L 0 G
DNP 3.0, optical 820 nm, ST connector[4]	9	L 0 H
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector	9	L 0 R
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector[5]	9	L 0 S
Port C service interface		
DIGSI 4/modem, electrical RS232	1	
DIGSI 4/modem, electrical RS485	2	

Functions

Breaker failure protection 1-/3-pole or 3-pole only	Auto-reclosure 1-/3-pole or 3-pole only and synchro-check	Over/Undervoltage protection	
■			C
■		■	D
	■		N
	■	■	P
■	■		Q
■	■	■	R

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

2) Transition between the 3 auxiliary ranges can be selected by means of jumpers.

3) The binary input thresholds are selectable in 3 steps by means of jumpers.

4) Optical interfaces are not available with surface mounting housings (position 9 = E). Please order the version with RS485 interface and a separate electrical/optical converter.

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

Accessories

Description	Order No.
DIGSI 4	
Software for configuration and operation of Siemens protection units running under MS Windows 2000/XP Professional Edition device templates, Comtrade Viewer, electronic manual included as well as "Getting started" manual on paper, connecting cables (copper)	
Basis Full version with license for 10 computers, on CD-ROM (authorization by serial number)	*7XS5400-0AA00*
Professional DIGSI 4 Basis and additionally SIGRA 4 (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation)	*7XS5402-0AA00*
SIGRA 4	
(generally contained in DIGSI Professional, but can be ordered additionally) Software for graphic visualization, analysis and evaluation of fault records. Can also be used for fault records of devices of other manufacturers (Comtrade format). Running under MS Windows 2000/XP Professional Edition Incl. templates, electronic manual with license for 10 PCs. Authorization by serial number. On CD-ROM.	*7XS5410-0AA00*
Connecting cable (copper)	
Cable between PC/notebook (9-pin connector) and protection unit (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)	*7XV5100-4*
Voltage transformer miniature circuit-breaker	
Rated current 1.6 A; thermal overload release 1.6 A; overcurrent trip 6 A	*3RV1611-1AG14*
Manual for 7VK61	
For the latest version please visit	*www.siemens.com/siprotec*

Fig. 10/18 Mounting rail for 19" rack

Fig. 10/19
2-pin connector

Fig. 10/20
3-pin connector

Fig. 10/21
Short-circuit link for current contacts

Fig. 10/22
Short-circuit link for voltage contacts/ indications contacts

Description		Order No.	Size of package	Supplier	Fig.
Connector	2-pin	*C73334-A1-C35-1*	1	Siemens	10/19
	3-pin	*C73334-A1-C36-1*	1	Siemens	10/20
Crimp connector	CI2 0.5 to 1 mm²	*0-827039-1*	4000	AMP [1]	
		0-827396-1	1	AMP [1]	
	CI2 1 to 2.5 mm²	*0-827040-1*	4000	AMP [1]	
		0-827397-1	1	AMP [1]	
	Type III+ 0.75 to 1.5 mm²	*0-163083-7*	4000	AMP [1]	
		0-163084-2	1	AMP [1]	
Crimping tool	For type III+ and matching female	*0-539635-1*	1	AMP [1]	
		0-539668-2		AMP [1]	
	for CI2 and matching female	*0-734372-1*	1	AMP [1]	
		1-734387-1		AMP [1]	
19" mounting rail		*C73165-A63-D200-1*	1	Siemens	10/18
Short-circuit links	For current terminals	*C73334-A1-C33-1*	1	Siemens	10/21
	For other terminals	*C73334-A1-C34-1*	1	Siemens	10/22
Safety cover for terminals	large	*C73334-A1-C31-1*	1	Siemens	10/4
	small	*C73334-A1-C32-1*	1	Siemens	10/4

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

Connection diagram

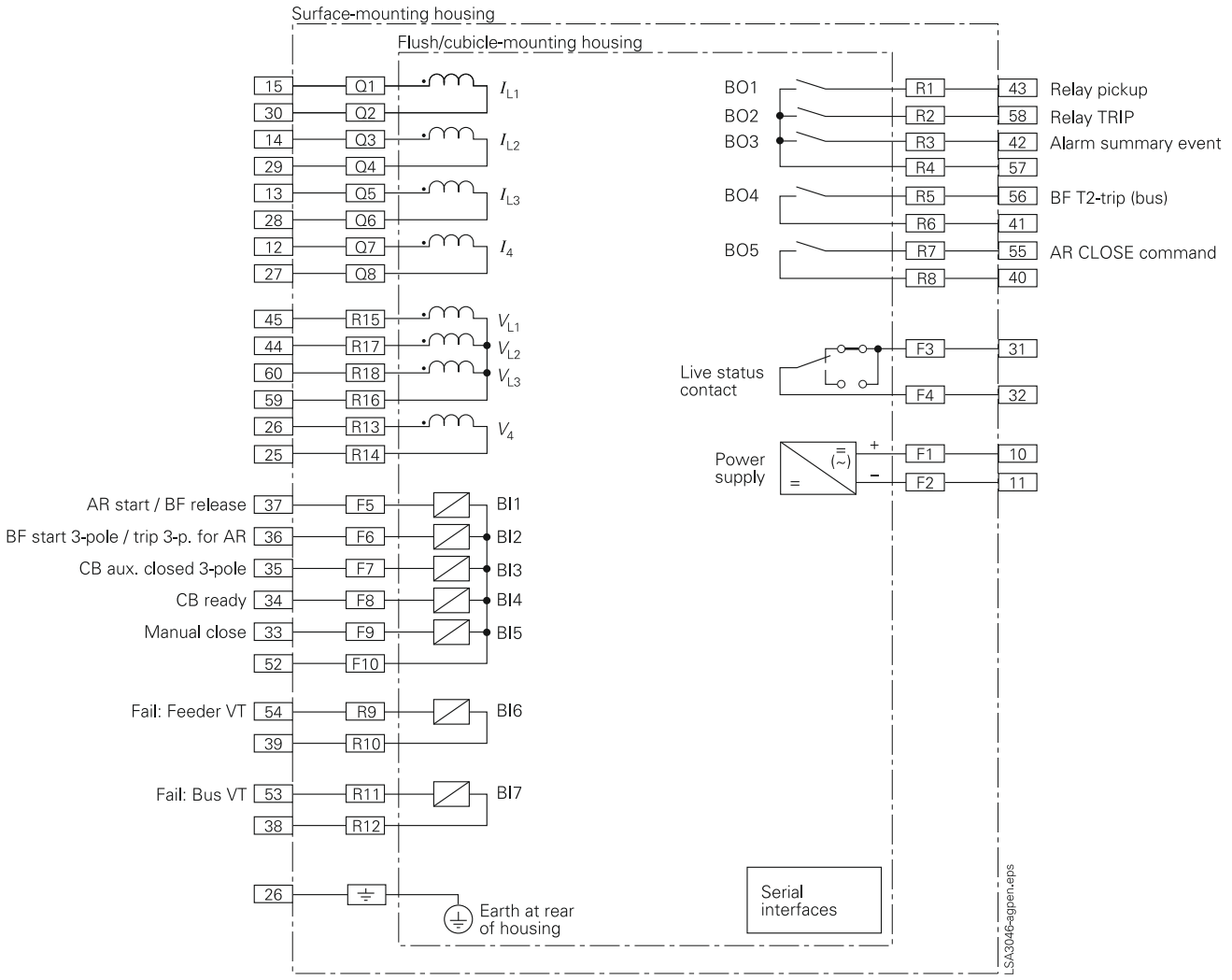


Fig. 10/23
Connection diagram 7VK610, 1/3 x 19" housing

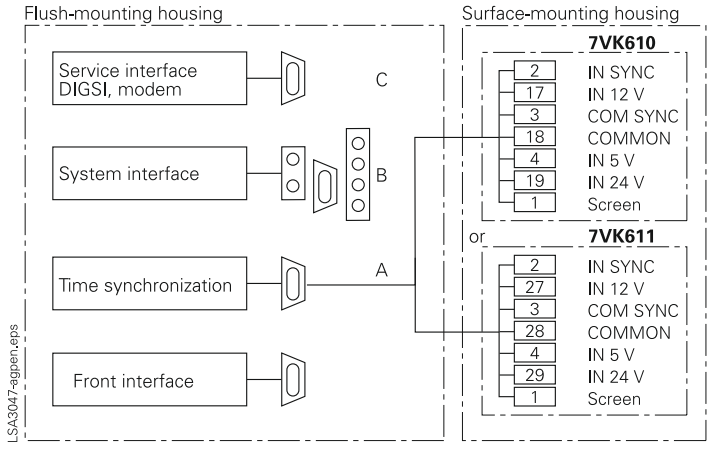


Fig. 10/24
Serial interfaces

Connection diagram

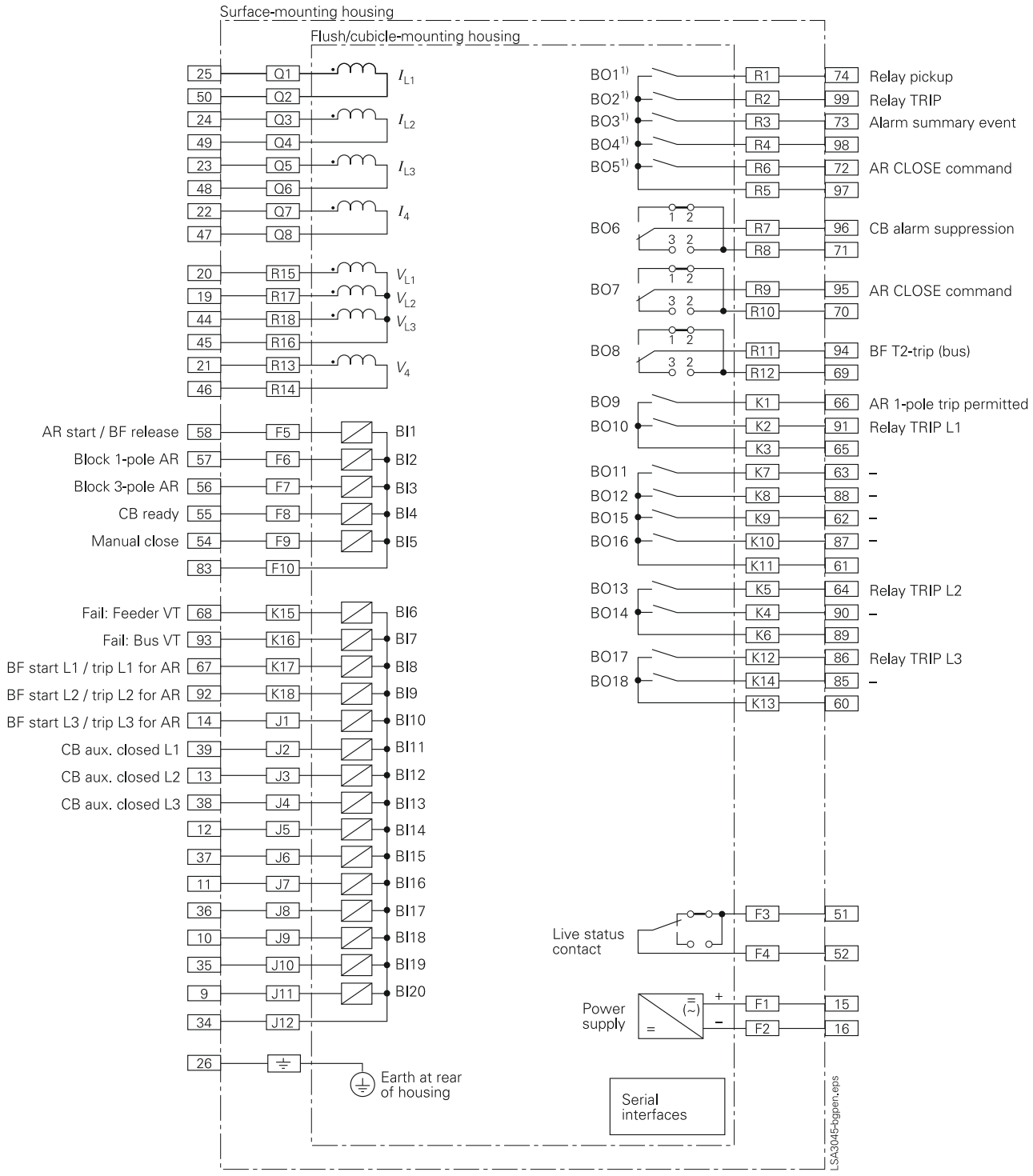


Fig. 10/25
Connection diagram 7VK611, 1/2 x 19" housing

1) Fast relay

SIPROTEC 7SV600
Numerical Circuit-Breaker Failure Protection Relay

Fig. 10/26
SIPROTEC 7SV600
numerical circuit- breaker
failure protection relay

Description

The SIPROTEC 7SV600 is a numerical relay used for circuit-breaker failure protection. A failure occurs when the circuit-breaker fails to correctly open and clear the fault after single or three-pole trip commands have been issued by the protection unit. It is then necessary to trip the relevant busbar zone (section) to ensure fault clearance.

Generally, the monitoring of the current is sufficient as the criterion for the indication that the circuit-breaker has successfully cleared the fault ("current condition"). However, under certain fault conditions (e.g. overvoltage), little or no current may flow, making the measurement of current unreliable for indication of the circuit-breaker status ("no current condition"). The 7SV600 operates correctly for both these conditions. The relay is suitable for use at all voltage levels and in all applications. The current transformers can either be of the closed iron core or linear type. The relay can be incorporated in conventional switchgear systems and modem substation control systems e.g. SICAM.

Function overview

Protection functions

- Circuit-breaker failure protection (single or three-pole with/without current)
- Independently settable delay times for operation with and without current
- Single or two-stage time delay of the busbar trip command
- Re-trip (cross trip) stage (1st stage of the 2-stage operation)
- Intertrip facility (via teleprotection interface)
- End-fault protection with intertrip
- "No current" control using the circuit-breaker auxiliary contacts

Features

- Highly sensitive current detection
- 2-out-of-4 check of the current detectors
- Short reset time, negligible overshoot time
- Can be initiated by phase-segregated or common-phase trip commands
- End-fault protection
- Assignable output relays, LEDs and binary inputs

Monitoring functions

- Monitoring of circuit-breaker auxiliary contacts
- Operational current measured values
- Self-supervision of the relay
- Event buffer
- Fault protocols
- Oscillographic fault recording

Communication interfaces

- 1 x RS485 interface
  – IEC 60870-5-103 protocol
  – DIGSI

Hardware

- Digital inputs:
  – 3 binary inputs
- Digital outputs:
  – 4 output relays

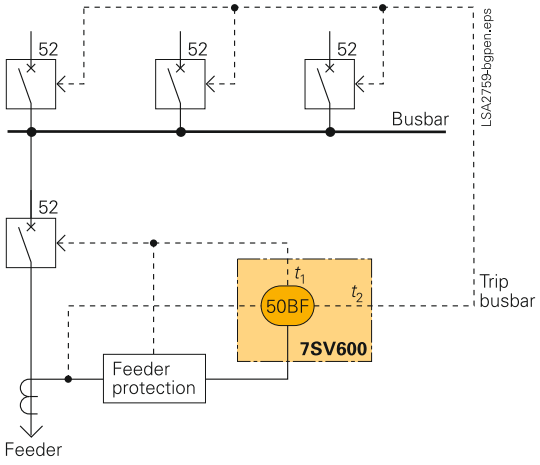
Front design

- Display for operation and measured values
- 6 LEDs for local alarm

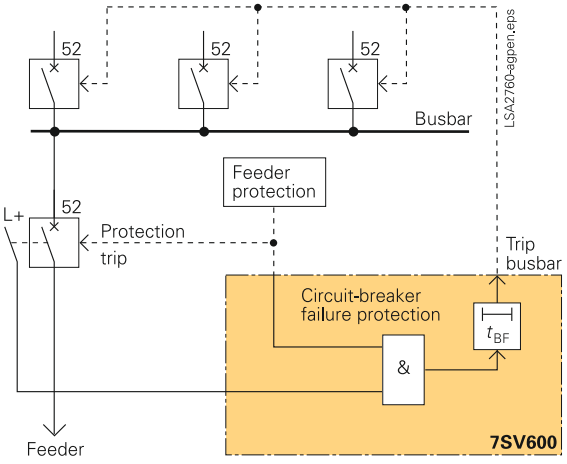
Application

The numerical circuit-breaker failure protection relay 7SV600 provides rapid backup fault clearance instruction to the associated circuit-breakers in case the circuit-breaker nearest to the fault fails to respond.

It is suitable for power systems of all voltage levels. The initiation signal can be derived from any protection or supervision equipment or, in case of manual opening, from the control discrepancy switch of the breaker. Information from the circuit-breaker auxiliary contact is required for the breaker failure protection to function during faults which produce little or no current flow (possible only with common-phase initiation).



Simplified application diagram of circuit-breaker failure protection.



Simplified application diagram of circuit-breaker failure protection by means of a circuit-breaker auxiliary contact.

Fig. 10/27 Typical applications

Construction

The relay contains all the components needed for

- Acquisition and evaluation of measured values
- Operation and display
- Output of signals and trip commands
- Input and evaluation of binary signals
- SCADA interface (RS485)
- Power supply

The rated CT currents applied to the SIPROTEC 7SV600 can be 1 or 5 A. This is selectable via a jumper inside the relay.

Three different housings are available. The flush-mounting versions have terminals accessible from the rear. The surface-mounting version has terminals accessible from the front.

Fig. 10/28
Rear view of surface-mounting housing

Protection functions

The breaker failure protection can operate single-stage or two-stage. When used as single-stage protection, the bus trip command is given to the adjacent circuit-breakers if the protected feeder breaker fails. When used as two-stage protection, the first stage can be used to repeat the trip command to the relevant feeder breaker, normally on a different trip coil, if the initial trip command from the feeder protection is not successful. The second stage will result in a bus trip to the adjacent breakers, if the command of the first stage is not successful.

The bus trip command from the breaker failure protection can be routed to all circuit-breakers linked to the same busbar (section) as the breaker that failed. It can also be transmitted to the remote end by means of a suitable communication link (e.g. PLC, radio wave, or optical fiber).

The isolator replica which is necessary in case of multiple busbar sections is not part of the 7SV600 relay.

The current level is monitored in each of the three phases against a set threshold. In addition, the zero-sequence component or the negative-sequence component of the phase currents derived by symmetrical component analysis is monitored. This ensures high security against malfunction by use of a 2-out-of-4 check of the current detectors.

The version with phase-segregated initiation enables reliable breaker failure detection even during single-pole auto-reclose cycles, provided the phase-segregated trip signals of the feeder protection are connected to the 7SV600.

If the protected circuit-breaker is not operational (e.g. air pressure failure or spring not charged), instantaneous bus trip of the adjacent circuit-breakers can be achieved following a feeder protection trip, provided the relay is informed via binary input of the breaker status (possible only for common-phase initiation).

An end-fault protection function is integrated in the 7SV600 relay. An end fault is a short-circuit located between the circuit-breaker and the current transformer set of the feeder. For this fault, current flow is detected, although the auxiliary contacts of the breaker indicate open breaker poles. A command signal is generated which can be transmitted to the remote-end breaker (possible only for common-phase initiation).

Special measures are taken to prevent malfunction of the relay. Besides the mentioned 2-out-of-4 check of the current detection elements, the trip signals of the feeder protection can be connected in a redundant manner, so that they can be checked for plausibility (possible only for common-phase initiation).

Continuous monitoring of the measured values permits rapid annunciation of any fault in the instrument transformer circuits. Continuous plausibility monitoring of the internal measured value processing circuits and monitoring of the auxiliary voltages to ensure that they remain within tolerance are obviously inherent features.

Serial data transmission

A PC can be connected to ease setup of the relay using the Windows-based program DIGSI which runs under MS-Windows.

It can also be used to evaluate up to 8 oscillographic fault records, 8 fault logs and the operational event buffer. As an option, a system interface is available.

The SIPROTEC 7SV600 transmits a subset of data via IEC 60870-5-103 protocol:

- General fault detection of the device
- General trip of the device
- Current in phase L2 [%] =
- Breaker failure trip T1 (local trip)
- Breaker failure trip T2 (busbar trip)
- Circuit-breaker defective: Trip
- Trip by end-fault protection
- Trip by monitoring current symmetry
- Breaker failure protection is active

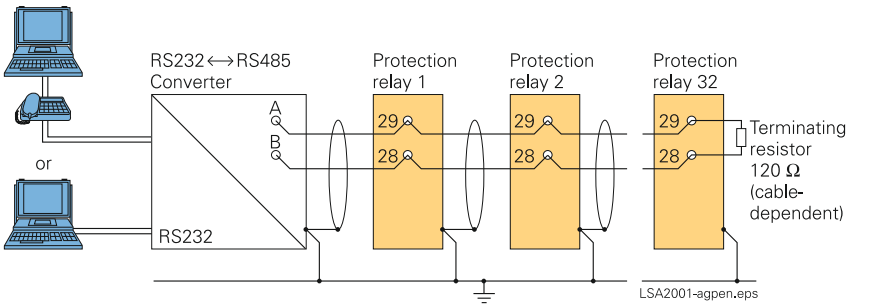


Fig. 10/29
Wiring communication RS485
For convenient wiring of the RS485 bus,
use bus cable system 7XV5103 (see part 13 of this catalog)

Connection diagrams

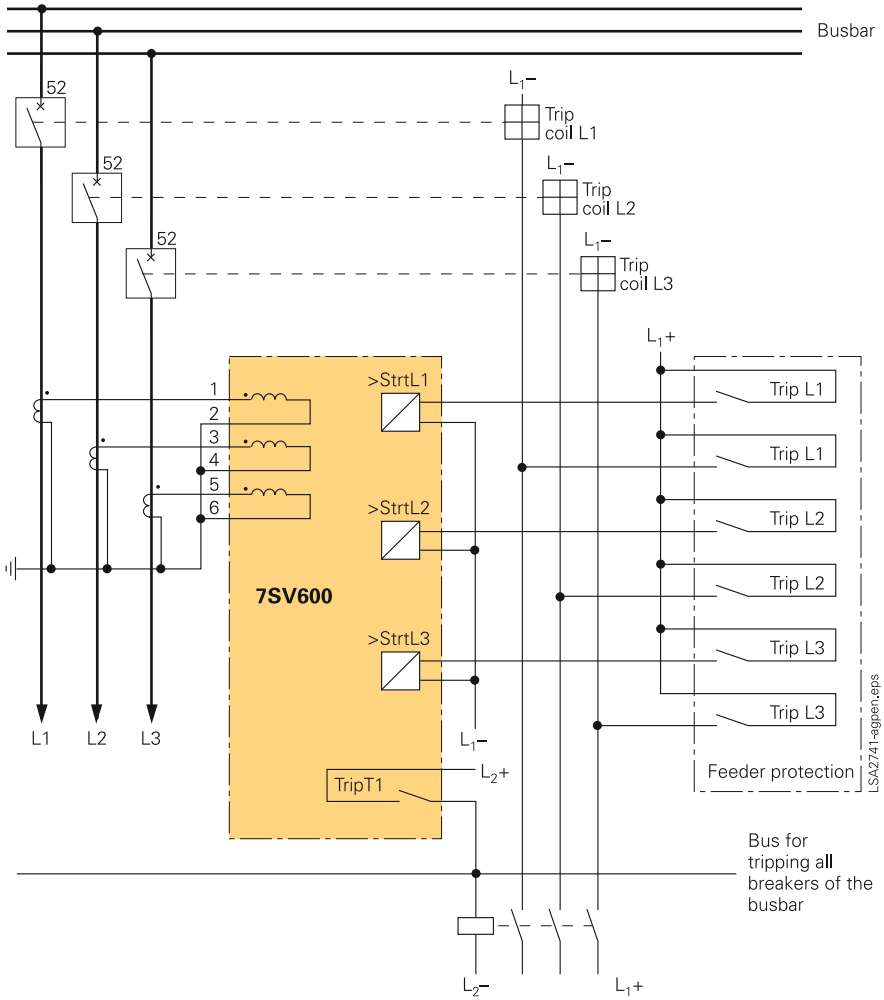


Fig. 10/30
Connection example for single-stage breaker failure protection with phase-segregated initiation

Connection diagrams

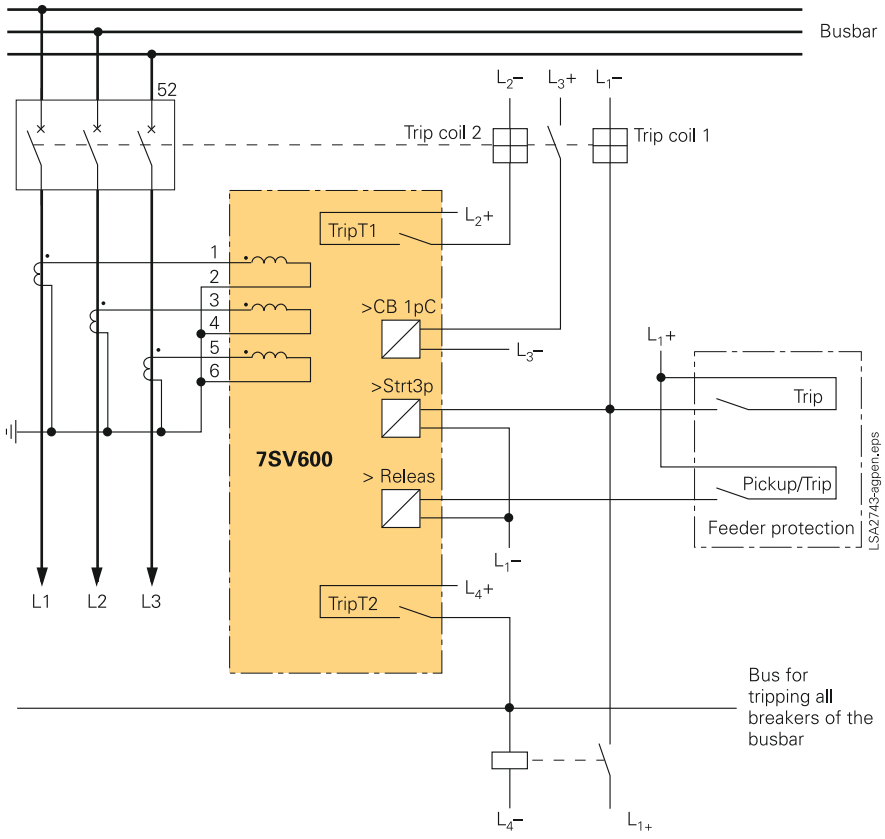


Fig. 10/31
Connection example for 2-stage breaker failure protection, common phase initiation, CB interrogation

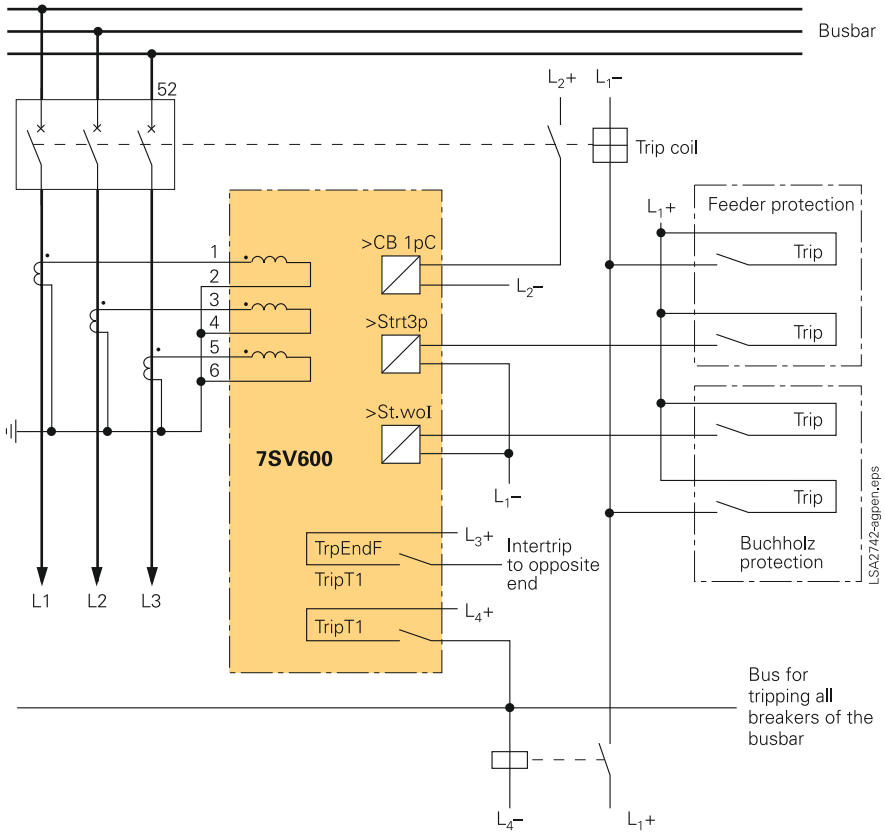


Fig. 10/32
Connection example for single-stage breaker failure protection with common phase initation and Buchholz protection, CB interrogation is imperative; additional intertrip signal to the opposite line end in case of breaker failure or end fault

Technical data

General unit data

Measuring circuits

Rated current I_N	1 to 5 A
Rated frequency f_N can be parameterized	50 or 60 Hz (selectable)
Power consumption of current inputs	
At I_N = 1 A	< 0.1 VA
At I_N = 5 A	< 0.2 VA
Overload capability current path,	
Thermal (r.m.s.)	100 x I_N for ≤ 1 s 30 x I_N for ≤ 10 s 4 x I_N continuous
Dynamic (pulse current)	250 x I_N one half cycle

Auxiliary voltage

Power supply via integrated DC/DC converter

Rated auxiliary voltage V_{Aux} DC	24 / 48 V DC 60 / 110 / 125 V DC 220 / 250 V DC
Permissible variations	19 to 58 V DC 48 to 150 V DC 176 to 300 V DC
Superimposed	
AC voltage	≤ 12 % at rated voltage
Peak-to-peak	≤ 6 % at limits of admissible voltage
Power consumption	
Quiescent	Approx. 2 W
Energized	Approx. 4 W
Bridging time during failure/short-circuit of auxiliary voltage	≥ 50 ms at V_{rated} ≥ 110 V DC ≥ 20 ms at V_{rated} ≥ 24 V DC
Rated auxiliary voltage V_{Aux}	115 V AC, 50/60 Hz 230 V AC, 50/60 Hz
Permissible variations	92 to 133 V AC 184 to 265 V AC

Heavy duty (command) contacts

Command (trip) relays, number	2 (can be marshalled)
Contacts per relays	2 NO
Switching capacity	
Make	1000 W / VA
Break	30 W / VA
Switching voltage	250 V
Permissible current	5 A continuous 30 A for 0.5 s

Signal contacts

Signal/alarm relays	2 (can be marshalled)
Contact per relays	1 CO
Switching capacity	
Make	1000 W/VA
Break	30 W/VA
Switching voltage	250 V
Permissible current	5 A

Binary inputs

Number	3 (can be marshalled)
Rated operating voltage	24 to 250 V DC
Current consumption	Approx. 2.5 mA, independent of operating voltage
Pick-up threshold	selectable by plug-in jumpers
Rated aux. voltage 24/48/60 V DC	V_{pickup} ≥ 17 V DC $V_{drop-off}$ < 8 V DC
Rated aux. voltage 110/125/220/250 V DC	V_{pickup} ≥ 74 V DC $V_{drop-off}$ < 45 V DC

Unit design

Housing	7XP20
Dimensions	Refer to part 15 for dimension drawings
Weight	
In housing for surface mounting	Approx. 4.5 kg
In housing for flush mounting	Approx. 4.0 kg
Degree of protection acc. to EN 60529	
Housing	IP 51
Terminals	IP 21

Serial interface

Isolated	
Standard	RS485
Test voltage	2.8 kV DC
Connection	Data cable on terminals, two data wires, one frame reference, for connection of a personal computer or similar; core pairs with shield, shield must be earthed; communication possible via modem
Baud rate	As delivered 9600 baud min. 1200 baud; max. 19200 baud

Electrical tests

Specifications

Standards	IEC 60255-5; ANSI/IEEE C37.90.0

Insulation tests

High voltage test (routine test) except DC voltage supply input and RS485	2 kV (r.m.s.); 50 Hz
High voltage test (routine test) only DC voltage supply input and RS485	2.8 kV DC
High voltage test (type test)	
Between open contacts of trip relays	1.5 kV (r.m.s.), 50 Hz
Between open contacts of alarm relays	1 kV (r.m.s.), 50 Hz
Impulse voltage test (type test) all circuits, class III	5 kV (peak); 1.2/50 µs; 0.5 J; 3 positive and 3 negative impulses at intervals of 5 s

Technical data

EMC tests for noise immunity; type tests

Standards: IEC 60255-6, IEC 60255-22 (product standards);
EN 50082-2 (generic standard) VDE 0435, part 303

High frequency IEC 60255-22-1, class III	2.5 kV (peak); 1 MHz; τ =15 µs; 400 shots/s; duration 2 s
Electrostatic discharge IEC 60255-22-2, class III and IEC 61000-4-2, class III	4 kV/6 kV contact discharge; 8 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
Irradiation with radio-frequency field, non-modulated; IEC 60255-22-3 (report), class III	10 V/m; 27 to 500 MHz
Irradiation with radio-frequency field, amplitude-modulated; IEC 61000-4-3, class III	10 V/m; 80 to 1000 MHz; 80 % AM; 1 kHz
Irradiation with radio-frequency field, pulse-modulated; IEC 61000-4-3/ENV 50204, class III	10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %
Fast transients/bursts IEC 60255-22-4 and IEC 61000-4-4, class III	2 kV; 5/50 ns; 5 kHz; burst length 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; duration 1 min
Line-conducted HF, amplitude-modulated IEC 61000-4-6, class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Magnetic field with power frequency IEC 61000-4-8, class IV IEC 60255-6	 30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz
Oscillatory surge withstand capability ANSI/IEEE C37.90.1 (common mode)	2.5 to 3 kV (peak); 1 to 1.5 MHz, decaying oscillation; 50 surges per s; duration 2 s; R_i = 150 Ω to 200 Ω
Fast transient surge withstand capability ANSI/IEEE C37.90.1 (common mode)	4 to 5 kV; 10/150 ns; 50 surges per s; both polarities; duration 2 s; R_i = 80 Ω
Radiated electromagnetic interference ANSI/IEEE C37.90.2	10 to 20 V/m; 25 to 1000 MHz; amplitude and pulse modulated
High frequency test document 17C (SEC) 102	2.5 kV (peak, alternating polarity); 100 kHz, 1 MHz, 10 and 50 MHz, decaying oscillation; R_i = 50 Ω

EMC tests for interference emission; type tests

Standard	EN 50081-* (generic standard)
Conducted interference voltage, aux. voltage CISPR 22, EN 55022	150 to 30 MHz Limit class B
Radio interference field strength CISPR 11, EN 55011	30 to 1000 MHz Limit class A

Mechanical stress tests

Vibration, shock stress and seismic vibration

During operation

Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class I IEC 60068-2-6	Sinusoidal 10 to 60 Hz: ± 0.035 mm amplitude; 60 to 150 Hz: 0.5 *g* acceleration Sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class I	Half-sine Acceleration 5 *g*, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
Seismic vibration IEC 60255-21-3, class I IEC 60068-3-3	Sinusoidal 1 to 8 Hz: ± 3.5 mm amplitude (horizontal axis) 1 to 8 Hz: ± 1.5 mm amplitude (vertical axis) 8 to 35 Hz: 1 *g* acceleration (horizontal axis) 8 to 35 Hz: 0.5 *g* acceleration (vertical axis) Sweep rate 1 octave/min 1 cycle in 3 orthogonal axes

During transportation

Standard	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class II IEC 60068-2-6	Sinusoidal 5 to 8 Hz: ± 7.5 mm amplitude; 8 to 150 Hz: 2 *g* acceleration Sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class I IEC 60068-2-27	Half-sine Acceleration 15 *g*, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
Continuous shock IEC 60255-21-2, class I IEC 60068-2-29	Half-sine Acceleration 10 *g*, duration 16 ms, 1000 shocks in each direction of 3 orthogonal axes

Technical data

Climatic stress tests

Temperatures

Permissible temperature during service	–20 °C to +70 °C (> 55 °C decreased display contrast)
Recommended temperature during service	–5 °C to +55 °C
Permissible temperature during storage	–25 °C to +55 °C
Permissible temperature during transport Storage and transport with standard works packaging!	–25 °C to +70 °C

Humidity

Permissible humidity We recommend that all units are installed such that they are not subjected to direct sunlight, nor to large temperature fluctuations which may give rise to condensation.	Mean value per year ≤ 75 % relative humidity; on 30 days per year 95 % relative humidity; condensation not permissible!

Service conditions

The relay is designed for use in industrial environment, for installation in standard relay rooms and compartments so that with proper installation electromagnetic compatibility (EMC) is ensured. The following should also be heeded:

- All contactors and relays which operate in the same cubicle or on the same relay panel as the digital protection equipment should, as a rule, be fitted with suitable spike quenching elements.
- All external connection leads in substations from 100 kV upwards should be shielded with a shield capable of carrying power currents and earthed at both sides. No special measures are normally necessary for substations of lower voltages.
- The shield of the RS485 cable must be earthed.
- It is not permissible to withdraw or insert individual modules under voltage. In the withdrawn condition, some components are electrostatically endangered; during handling the standards for electrostatically endangered components must be observed. The modules are not endangered when plugged in.

WARNING! The relay is not designed for use in residential, commercial or light-industrial environment as defined in EN 50081.

Functions

Breaker supervision

Current detection	
Setting range	0.05 x I_N to 4.00 x I_N (steps 0.01 x I_N)
Drop-off ratio	Approx. 0.9
Tolerance	0.01 x I_N or 5 % of set value
Initiation conditions	
Depending on ordered version	Phase-segregated initiation (single-pole trip from feeder protection) or common-phase initiation (three-pole trip from feeder protection) and common-phase initiation (three-pole trip from non-short-circuit protection)
Times	
Pickup time	Approx. 15 ms with measured quantities present Approx. 25 ms after switch-on of measured quantities
Drop-off time with sinusoidal measured quantities	≤ 10 ms
Drop-off time maximum	≤ 25 ms
Delay times for all time stages	0.00 s to 32.00 s (steps 0.01 ms) or deactivated
Delay time tolerance	1 % of set value or 10 ms
The set times are pure delay times.	

Additional functions

Operational value measurements

Operational current values	I_{L1}; I_{L2}; I_{L3}
Measurement range	0 % to 240 % I_N
Tolerance	3 % of rated value or of measured value

Steady-state measured value supervision

Current unbalance	I_{max} / I_{min} > symmetry factor as long as $I > I_{limit}$

Fault event data storage

Storage of annunciations of the last eight faults with max. 30 messages each	

Time assignment

Resolution for operational annunciations	1 s
Resolution for fault event annunciations	1 ms
Max. time deviation	0.01 %

Data storage for fault recording (max. 8 fault events)

Total storage time (fault detection or trip command = 0 ms)	Max. 5 s, selectable pre-trigger and post-fault time
Max. storage period per fault event T_{max}	0.30 to 5.00 s (steps 0.01 s)
Pre-trigger time T_{pre}	0.05 to 0.50 s (steps 0.01 s)
Post-fault time T_{post}	0.05 to 0.50 s (steps 0.01 s)
Sampling rate	1 instantaneous value per ms at 50 Hz 1 instantaneous value per 0.83 ms at 60 Hz

Selection and ordering data

Description	Order No.
7SV600 numerical circuit-breaker failure protection relay	*7SV600□-□□A00-□DA0*
Rated current; rated frequency	
1 A; 50/60 Hz	*1*
5 A; 50/60 Hz	*5*
Rated auxiliary voltage	
24, 48 V DC	*2*
60, 110, 125 V DC	*4*
220, 250 V DC / 115 V AC, 50/60 Hz	*5*
230 V AC, 50/60 Hz	*6*
Unit design	
For panel surface mounting with terminals on both sides	*B*
For panel surface mounting with terminals at top and bottom	*D*
For panel flush mounting/cubicle mounting	*E*
Options	
For common phase initiation	*0*
For common phase initiation or phase-segregated initiation	*1*

Accessories

DIGSI 4	
Software for configuration and operation of Siemens protection units running under MS Windows (version Windows 2000/XP Professional Edition) device templates, Comtrade Viewer, electronic manual included as well as "Getting started" manual on paper, connecting cables (copper)	
Basis Full version with license for 10 computers, on CD-ROM (authorization by serial number)	*7XS5400-0AA00*
Professional DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation)	*7XS5402-0AA00*

*RS232 (V.24)↔RS485 converter**	*7XV5700-□□□00*
Plug-in auxiliary power supply unit 220 V/50 Hz AC	*0*
Plug-in auxiliary power supply unit 110 V/60 Hz AC	*1*
With RS485 connecting cable for 7SJ6, 7RW6, 7SD6, 7SV6	*A*
With RS485 connecting cable with 9-pin connector for SIMEAS Q	*B*
With RS485 connecting cable with plug connector for SIMEAS T	*C*
Without RS232 connecting cable	*A*
With RS232 connecting cable 7XV5100-2 for PC/notebook, 9-pin connector (female)	*B*
With RS232 adapter, 25-pin connector (male) to 9-pin connector (female) for connection to notebook/PC	*C*

Converter full-duplex fiber-optic cable - RS485	
With power supply 24 - 250 V DC and 110/230 V AC	*7XV5650-0BA00*
Manual for 7SV600	
For the latest version please visit	*www.siemens.com/siprotec*

*) RS485 bus system up to 115 kbaud
RS485 bus cable and adaptor
7XV5103-□AA□□; see part 13.

Connection diagram

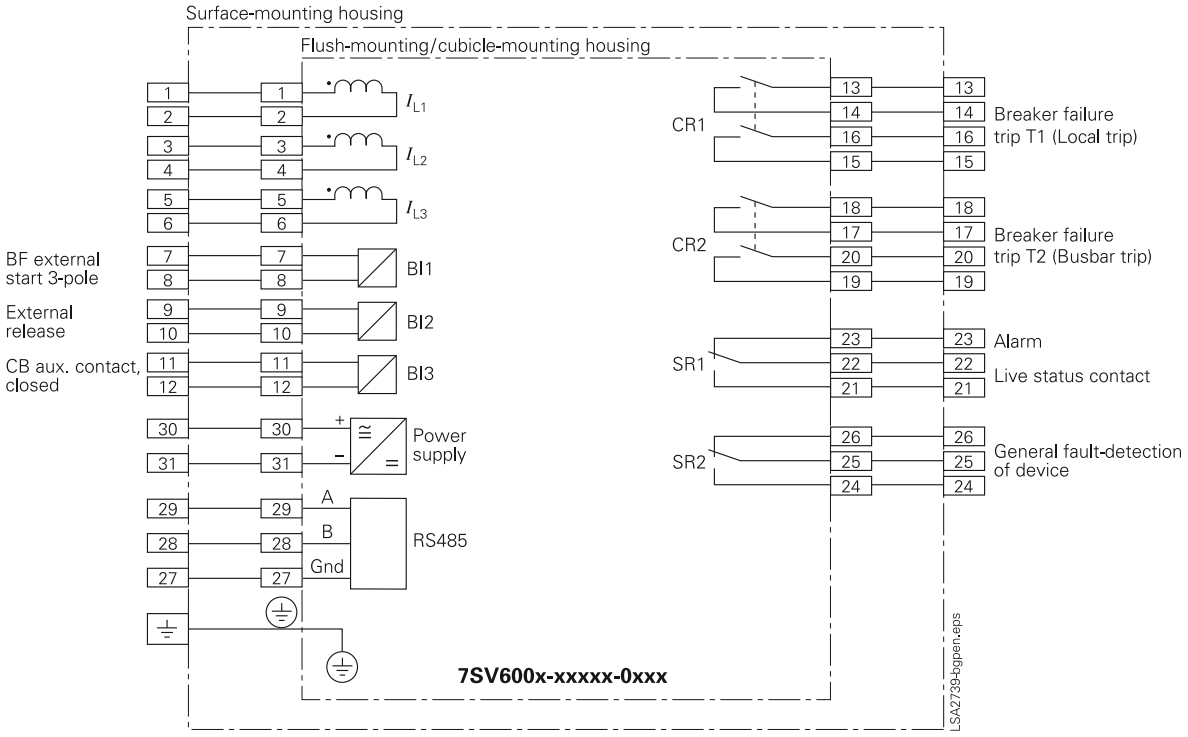


Fig. 10/33
General connection diagram of 7SV600 with presettings for common phase initiation

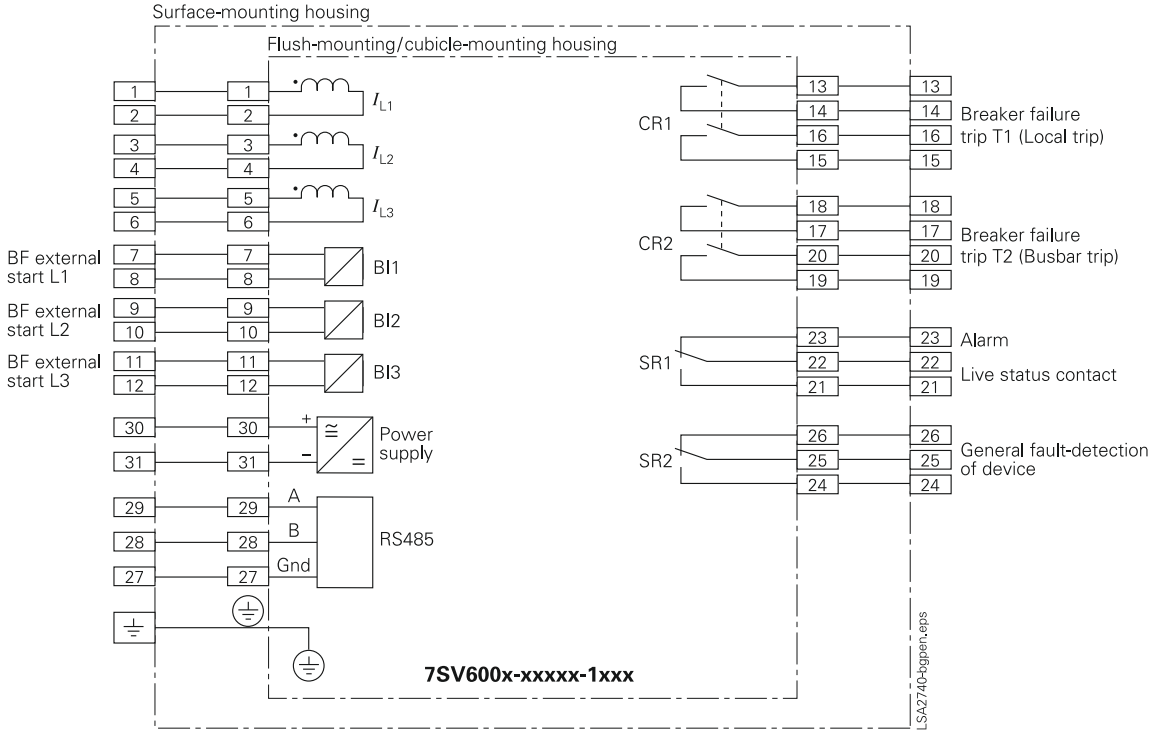


Fig. 10/34
General connection diagram of 7SV600 with presettings for phase-segregated initiation

SIPROTEC 7SN60
Transient Earth-Fault Protection Relay

Fig. 10/35
SIPROTEC 7SN60
transient earth-fault relay

Description

The highly sensitive 7SN60 transient earth-fault relay determines the direction of transient and continuous earth faults in systems with isolated neutral, in systems with high-impedance resistive earthing and in compensated systems. Continuous earth faults are indicated with a delay, either in conjunction with a transient earth fault and subsequently persisting displacement voltage, or with just the displacement voltage present.

Function overview

Protection functions

- Units for panel surface mounting or flush mounting in 7XP20 housing, with terminals on the side or terminals on the top/bottom
- Both fault directions indicated by LEDs and signaled by relays
- High pickup sensitivity due to separate detection and evaluation of total current and displacement voltage
- 1 A and 5 A rated current selectable for current transformer matching
- 16 selectable pickup thresholds for detection of transients in the current path, even with higher steady-state total currents of 10 to 300 mA
- Fixed pickup threshold of 5 V for detection of transients in the voltage path, even in the case of higher steady-state displacement voltages
- 4 selectable pickup thresholds for evaluation of the displacement voltage of 10 to 50 V
- Optional suppression of switching operations by evaluation of the displacement voltage after a switching-induced transient has occured
- Wide-range power supply for connection to 110/230 V AC systems, 60 to 250 V DC station batteries or 100 V DC voltage transformers without switchover or 24 to 60 V DC
- Binary inputs for remote reset and blocking with extremely wide input voltage range of 24 to 250 V DC
- Automatic reset of direction indications and signals after 3 or 10 s (selectable)
- Automatic reset in case of intermittent earth faults only after the last earth-fault, i.e. the correct indication and signal of the first earth fault is preserved
- Detection of the displacement voltage and earth-fault indication/signal, independent of a transient fault detection
- Signaling and indication of a continuous earth fault possible only in the forward direction
- Fault indication if sensitivity is set too high

Construction

The relay contains all the components needed for

- Acquisition and evaluation of measured values
- Operation and display
- Output of signals and trip commands
- Power supply

The rated CT currents applied to the SIPROTEC 7SN60 can be 1 or 5 A. This is selectable via a jumper inside the relay.

Three different housings are available. The flush-mounting/cubicle-mounting housings have terminals accessible from the rear. The surface-mounting housing has terminals either on the side or on the top and bottom.

Fig. 10/36 Rear view

Protection functions

Earth-fault directional determination

The highly sensitive 7SN60 transient earth-fault relay determines the direction of transient and continuous earth faults in systems with isolated neutral, in systems with high-impedance resistive earthing and in compensated systems.

Continuous earth faults are indicated with a delay, either in conjunction with a transient earth fault and subsequently persisting displacement voltage, or with just the displacement voltage present.

In the event of an earth fault, the neutral-point voltage to earth can be as high as the full-phase voltage.

The phase-to-earth capacitances of the non-earth-faulted phases are charged via the transformer inductance.

This charging process is bound up with a strong current surge (starting oscillation).

The amplitude of this current surge depends on the expands of the system and on the contact resistance values at the earth-fault location.

This current flows via the phase-to-earth capacitances of the unaffected lines to earth, enters the earth-faulted phase via the earth-fault location and flows back from there to the feeding transformer.

Thus the direction of the earth-fault induced current surge is identical to that of the short-circuit current at the same location.

At measuring point A, as a result of the transformer summation circuit, the earth current of the faulted line is not included in the measurement, as this current portion flows through the summation transformer of the relevant Holmgreen circuit and back, thereby canceling itself out.

It is the total of the capacitive earth currents from the non-faulted system which has an effect. In the diagram they are summated on the upper line. The capacitive currents of the non-faulted lines 1, 3 and 2, 4 accumulate vectorially, which explains why only three arrows instead of four are shown at the measuring point A.

With a transient earth fault, the equalizing current forming a damped oscillation of 100 to more than 1000 Hz decays after only a few periods.

The displacement voltage V_{EM} thereupon also returns to zero. In earthed systems this takes place after a number of periods (decay of the Petersen coil - earth capacitance oscillation circuit); in non-earthed systems this occurs after a very short time.

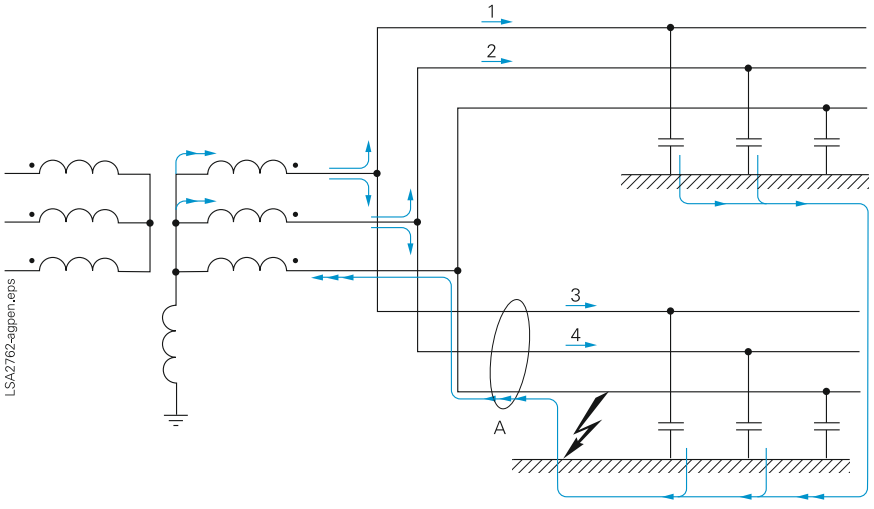


Fig. 10/37 Fault currents in the system

Protection functions

In the case of a continuous earth fault, the equalizing current in the non-earthed system changes into the mostly capacitive continuous earth current or, in compensated systems, into the relatively low residual active current.

For the directional determination, the direction of the first transient of neutral current and displacement voltage is considered.

The relay indicates the direction of the transient earth fault by LEDs (red = forward direction, yellow = reverse direction) and the relevant signaling relay pickups.

Continuous earth faults are indicated after a settable time by an LED on the relay and signaled by a signaling relay.

Detection of the fault location

If the system is of radial configuration, the red lamp immediately indicates the faulted line.

If one of the lines consists of several sections, the fault is upstream of the last red lamp.

The transient earth-fault relay can also be used without restrictions in any type of meshed systems. Transient earth-fault relays distributed at suitable points throughout the system allow detection of the earth-fault location from the directional indications.

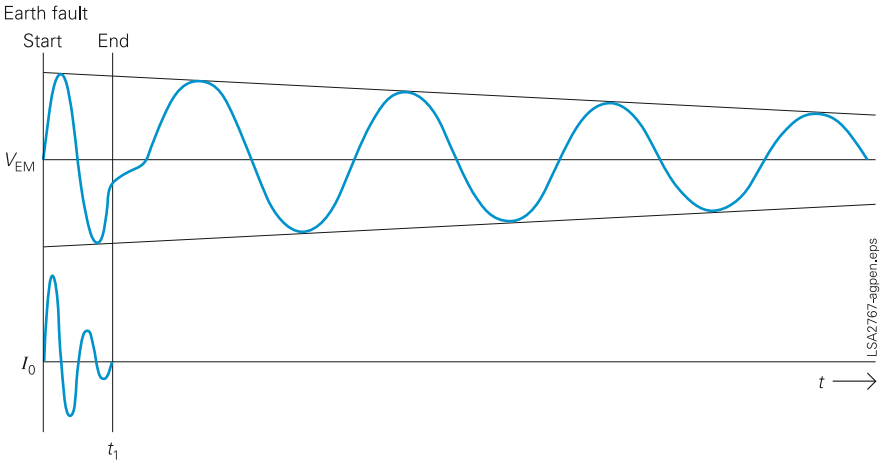


Fig. 10/38 Neutral current and displacement voltage

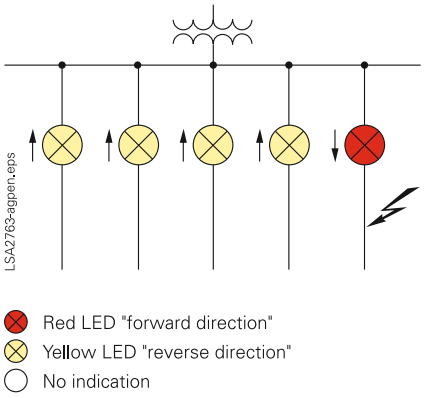


Fig. 10/39 Radial system

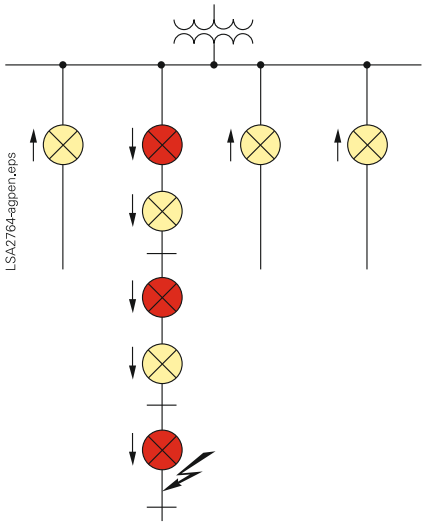


Fig. 10/40 Cascaded radial system

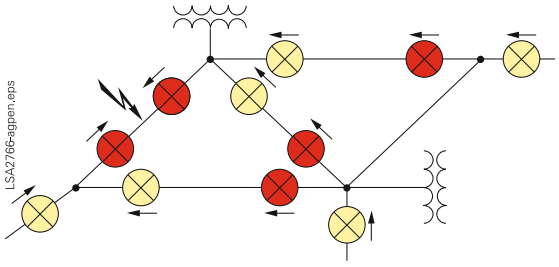


Fig. 10/41 Meshed system

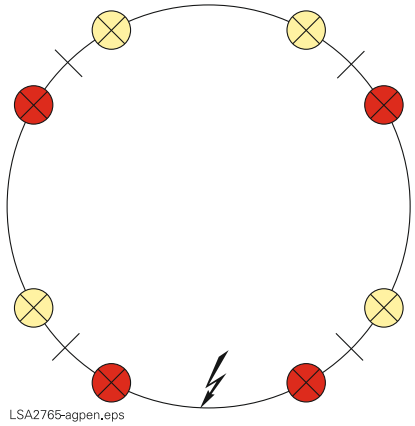


Fig. 10/42 Ring system

Typical connection

Connection of the current and voltage transformers

Figures 10/43 and 10/44 show the connection of the current and voltage transformer set in Holmgreen circuit.

In Fig. 10/43, the star point at the line-side of the CT must be connected to terminal 1 while the star point at the busbar side of the CTs must be connected to terminal 2.

The three phase voltages V_{L1}, V_{L2} and V_{L3} are connected to terminals 7, 8, 9 respectively. The earthed star point of the voltage transformer is connected to terminal 10.

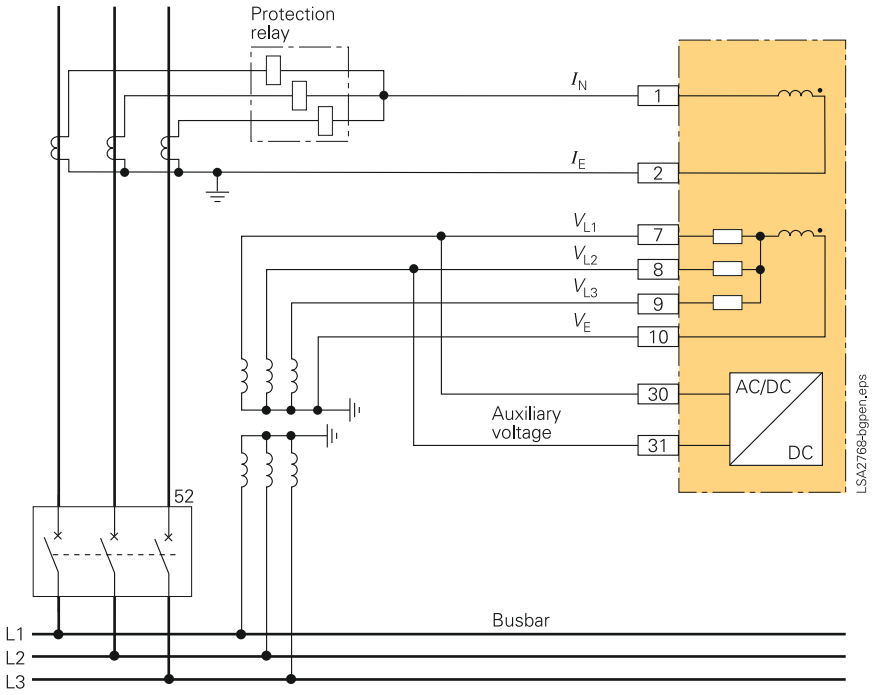


Fig. 10/43 Connection of transformers and auxiliary power supply for panel flush-mounting housing and panel surface-mounting housing (terminals on the side)

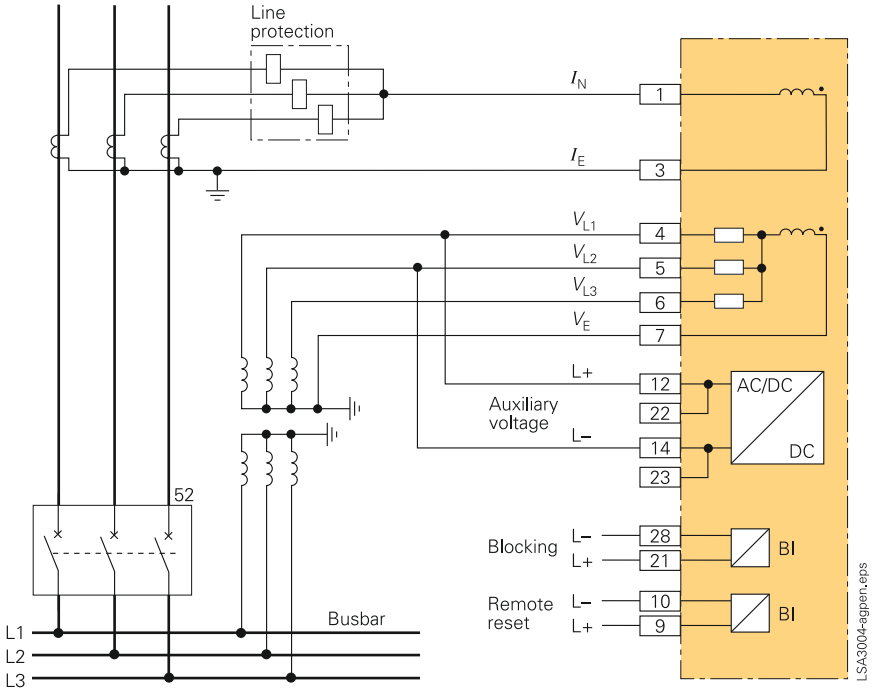


Fig. 10/44 Connection of transformers and auxiliary power supply for panel surface-mounting housing (terminals on the top/bottom)

Technical data

General unit data		
Measuring circuit		
Rated current I_0	1 or 5 A	
Input impedance Z at 50 Hz and I_N	< 0.05 Ω	
Rated voltage V_N	100/110 V AC	
Rated frequency f_N	50 Hz (16.7 Hz)	
Thermal rating		
- In voltage path, continuous	140 V AC	
- In current path, continuous	4 x I_N	
10 s	30 x I_N	
1 s (at 1 A)	100 x I_N	
1 s (at 5)	300 A	
Auxiliary voltage		
Rated auxiliary voltage V_{aux}	60 – 250 V DC and 100 – 230 V AC without switchover	
Power consumption at	Quiescent	Energized
60 V DC	3.1 W	4.5 W
110 V DC	3.0 W	4.5 W
220 V DC	3.6 W	4.6 W
250 V DC	3.7 W	4.8 W
100 V AC	2.9 VA	4.2 VA
110 V AC	3.0 VA	4.2 VA
230 V AC	4.6 VA	5.8 VA
Binary inputs		
Input voltage for blocking and remote reset input	24 - 250 V DC	
Pickup thresholds for		
– Blocking X30 pin 1-2, remote reset X31 pin 1-2	Approx. 19 V	
– Blocking X30 pin 2-3, remote reset X31 pin 2-3	Approx. 75 V	
Signaling relays		
Number of relays, forward or reverse direction	2 NO contacts	
Number of relays, continuous earth-fault signal	1 NO contact	
Number of relays, alarm	1 NC contact	
Switching capacity Make (all relays)	1000 W/VA	
Switching capacity Break (all relays)	30 W/VA	
Switching voltage	250 V AC/DC	
Permissible switching current		
Continuous	5 A	
0.5 s	30 A	
Unit design		
Housing, dimensions	SIPROTEC housing of 1/6 width Refer to part 15 for dimension drawings	
For flush mounting, terminals at the top/bottom	6 current / 25 voltage terminals	
For panel surface mounting, terminals on the side	6 current / 25 voltage terminals	
Weight	Approx. 4 kg	
Standards		
DIN VDE 0435, Part 303 and IEC 60255-5		

Selection and ordering data

Description	Order No.
7SN60 transient earth-fault protection relay	*7SN6000-☐☐A00*
In SIPROTEC housing 1/6 width Rated frequency 50 Hz	
Rated auxiliary voltage	
60 - 250 V DC and 100 - 230 V AC without switchover	*0*
24 - 48 V DC	*1*
For panel surface mounting with terminals on the side	*B*
For panel surface mounting with terminals at top/bottom part	*D*
For panel flush mounting or cubicle mounting	*E*

Connection diagram

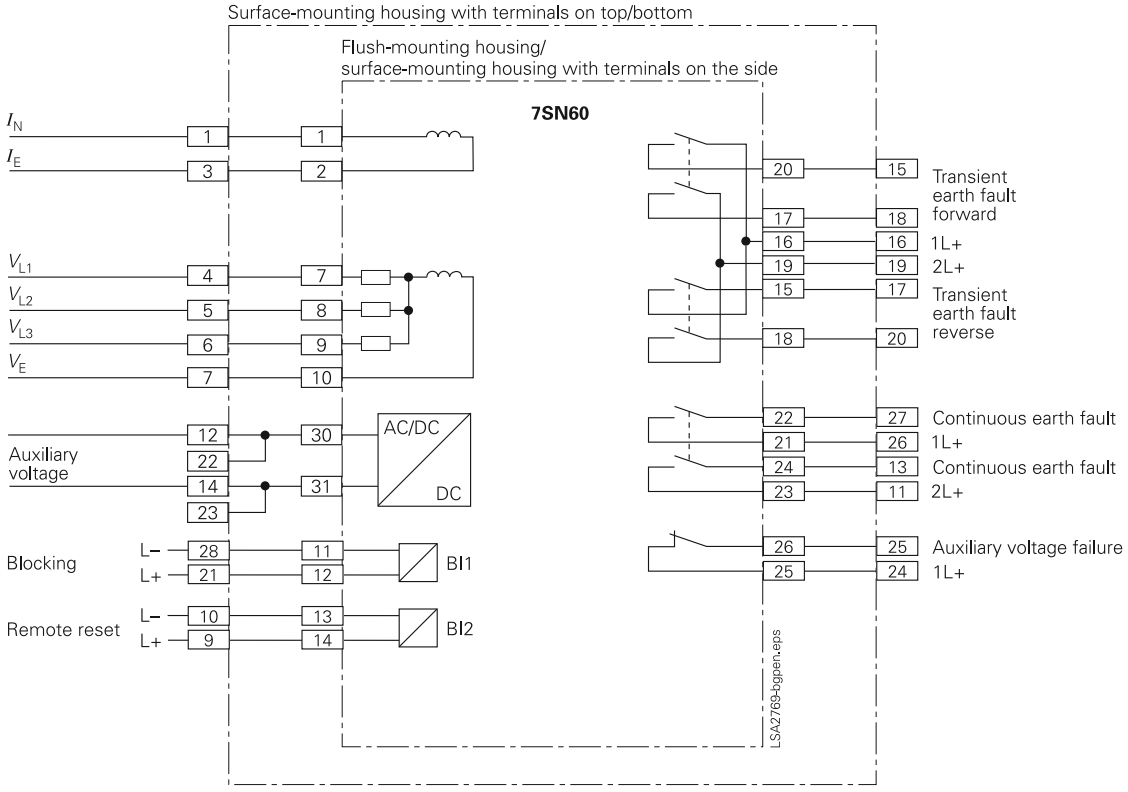


Fig. 10/45 Connection diagram