SIPROTEC 7SJ64 multifunction protection relay with synchronization

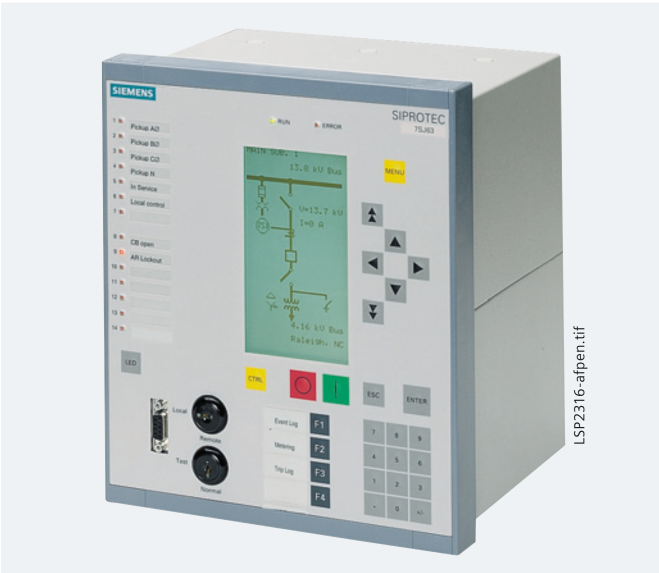

Fig. 5/87 SIPROTEC 7SJ64 multifunction protection relay

Description

The SIPROTEC 7SJ64 can be used as a protective control and monitoring relay for distribution feeders and transmission lines of any voltage in networks that are earthed (grounded), low-resistance grounded, ungrounded, or of a compensated neutral point structure. The relay is suited for networks that are radial or looped, and for lines with single or multi-terminal feeds. The SIPROTEC 7SJ64 is equipped with a synchronization function which provides the operation modes 'synchronization check' (classical) and 'synchronous/asynchronous switching' (which takes the CB mechanical delay into consideration). Motor protection comprises undercurrent monitoring, starting time supervision, restart inhibit, locked rotor, load jam protection as well as motor statistics.

The 7SJ64 is featuring the "flexible protection functions". Up to 20 protection functions can be added according to individual requirements. Thus, for example, rate-of-frequency-change protection or reverse power protection can be implemented.

The relay provides easy-to-use local control and automation functions. The number of controllable switchgear depends only on the number of available inputs and outputs. The integrated programmable logic (CFC) allows the user to implement their own functions, e.g. for the automation of switchgear (interlocking). CFC capacity is much larger compared to 7SJ63 due to extended CPU power. The user is able to generate user-defined messages as well.

The flexible communication interfaces are open for modern communication architectures with control systems.

Function overview

Protection functions

- Overcurrent protection
- Directional overcurrent protection
- Sensitive dir./non-dir. ground-fault detection
- Displacement voltage
- Intermittent ground-fault protection
- Directional intermittent ground fault protection
- High-impedance restricted ground fault
- Inrush restraint
- Motor protection
- Overload protection
- Temperature monitoring
- Under-/overvoltage protection
- Under-/overfrequency protection
- Rate-of-frequency-change protection
- Power protection (e.g. reverse, factor)
- Undervoltage-controlled reactive power protection
- Breaker failure protection
- Negative-sequence protection
- Phase-sequence monitoring
- Synchronization
- Auto-reclosure
- Fault locator
- Lockout

Control functions/programmable logic

- Flexible number of switching devices
- Position of switching elements is shown on the graphic display
- Local/remote switching via key-operated switch
- Control via keyboard, binary inputs, DIGSI 4 or SCADA system
- Extended user-defined logic with CFC (e.g. interlocking)

Monitoring functions

- Operational measured values $V, I, f, \ldots$
- Energy metering values W_p, W_q
- Circuit-breaker wear monitoring
- Slave pointer
- Trip circuit supervision
- Fuse failure monitor
- 8 oscillographic fault records
- Motor statistics

Communication interfaces

- System interface
  - IEC 60870-5-103, IEC 61850
  - PROFIBUS DP
  - DNP 3 / DNP3 TCP / MODBUS RTU
  - PROFINET
- Service interface for DIGSI 4 (modem)
- Additional interface for temperature detection (RTD-box)
- Front interface for DIGSI 4
- Time synchronization via IRIG B/DCF77

Application

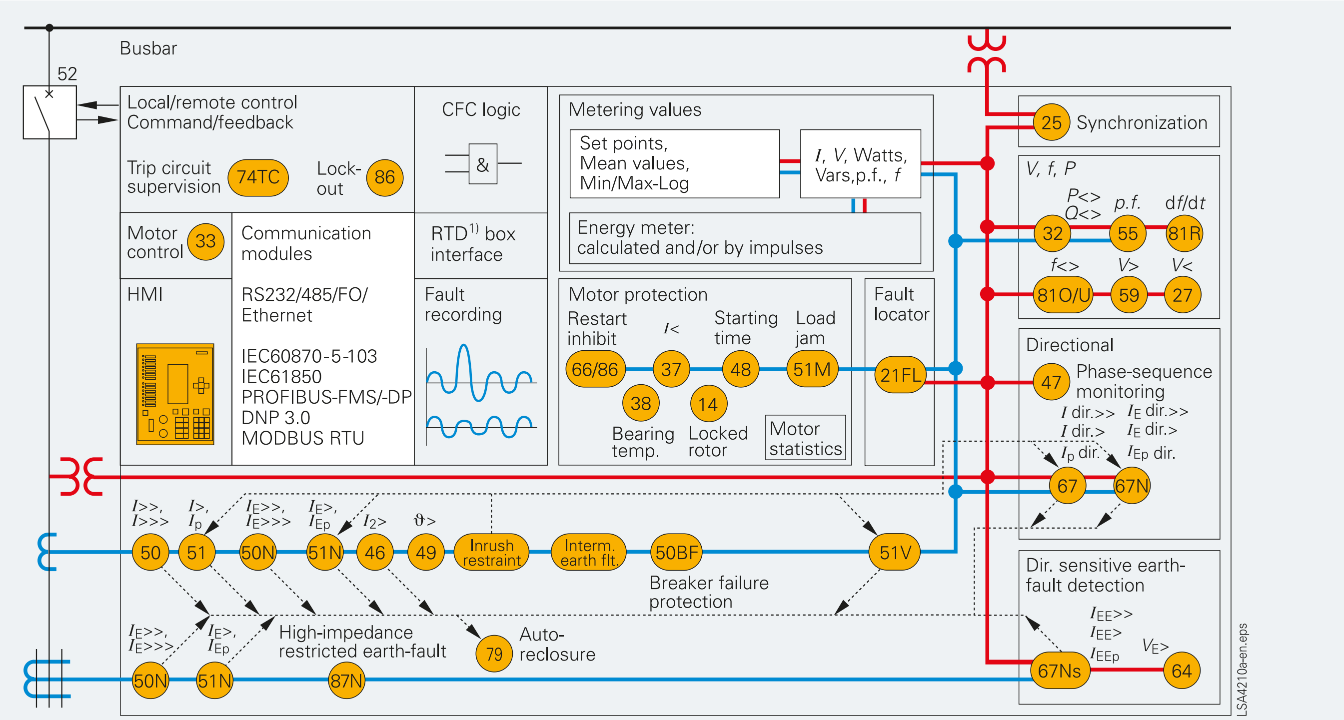

Fig. 5/88 Function diagram

Application

The SIPROTEC 7SJ64 unit is a numerical protection relay that also performs control and monitoring functions and therefore supports the user in cost-effective power system management, and ensures reliable supply of electric power to the customers. Local operation has been designed according to ergonomic criteria. A large, easy-to-read graphic display was a major design aim.

Control

The integrated control function permits control of disconnect devices (electrically operated/motorized switches) or circuit-breakers via the integrated operator panel, binary inputs, DIGSI 4 or the control and protection system (e.g. SICAM). The present status (or position) of the primary equipment can be displayed. 7SJ64 supports substations with single and duplicate busbars. The number of elements that can be controlled (usually 1 to 5) is only restricted by the number of inputs and outputs available. A full range of command processing functions is provided.

Programmable logic

The integrated logic characteristics (CFC) allow users to implement their own functions for automation of switchgear (interlocking) or a substation via a graphic user interface. Due to extended CPU power, the programmable logic capacity is much larger compared to 7SJ63. The user can also generate user-defined messages.

Line protection

The 7SJ64 units can be used for line protection of high and medium-voltage networks with grounded, low-resistance grounded, isolated or compensated neutral point.

Synchronization

In order to connect two components of a power system, the relay provides a synchronization function which verifies that switching ON does not endanger the stability of the power system.

The synchronization function provides the operation modes 'syn-chro-check' (classical) and 'synchronous/asynchronous switching' (which takes the c.-b. mechanical delay into consideration).

Motor protection

When protecting motors, the relays are suitable for asynchronous machines of all sizes.

Transformer protection

The 7SJ64 units perform all functions of backup protection supplementary to transformer differential protection. The inrush suppression effectively prevents tripping by inrush currents.

The high-impedance restricted ground-fault protection detects short-circuits and insulation faults of the transformer.

Backup protection

The relays can be used universally for backup protection.

Flexible protection functions

By configuring a connection between a standard protection logic and any measured or derived quantity, the functional scope of the relays can be easily expanded by up to 20 protection stages or protection functions.

Metering values

Extensive measured values, limit values and metered values permit improved system management.

ANSI	IEC	Protection functions
50, 50N	$I>$, $I>>$, $I>>>$ $I_E>$, $I_E>>$, $I_E>>>$	Definite-time overcurrent protection (phase/neutral)
50, 50N	$I>>>>$, $I_2>$ $I_E>>>>$	Additional definite-time overcurrent protection stages (phase/neutral) via flexible protection functions
51, 51V, 51N	I_p, I_{Ep}	Inverse overcurrent protection (phase/neutral), phase function with voltage-dependent option
67, 67N	$I_{dir}>$, $I_{dir}>>$, $I_{p\ dir}$ $I_{Edir}>$, $I_{Edir}>>$, $I_{Ep\ dir}$	Directional overcurrent protection (definite/inverse, phase/neutral), Directional comparison protection
67Ns/50Ns	$I_{EE}>$, $I_{EE}>>$, I_{EEp}	Sensitive ground-fault protection
–		Cold load pick-up (dynamic setting change)
59N/64	V_E, $V_0>$	Displacement voltage, zero-sequence voltage
–	$I_{IE}>$	Intermittent ground fault
67Ns	$I_{IE\ dir}>$	Directional intermittent ground fault protection
87N		High-impedance restricted ground-fault protection
50BF		Breaker failure protection
79M		Auto-reclosure
25		Synchronization
46	$I_2>$	Phase-balance current protection (negative-sequence protection)
47	$V_2>$, phase seq.	Unbalance-voltage protection and/or phase-sequence monitoring
49	$\vartheta>$	Thermal overload protection
48		Starting time supervision
51M		Load jam protection
14		Locked rotor protection
66/86		Restart inhibit
37	$I<$	Undercurrent monitoring
38		Temperature monitoring via external device (RTD-box), e.g. bearing temperature monitoring
27, 59	$V<$, $V>$	Undervoltage/overvoltage protection
59R	dV/dt	Rate-of-voltage-change protection
32	$P<>$, $Q<>$	Reverse-power, forward-power protection
27/Q	$Q>/V<$	Undervoltage-controlled reactive power protection
35	$\cos\varphi$	Power factor protection
81O/U	$f>$, $f<$	Overfrequency/underfrequency protection
81R	df/dt	Rate-of-frequency-change protection
21FL		Fault locator

Construction

Connection techniques and housing with many advantages

⅓, ½ and ¹⁄₁-rack sizes

These are the available housing widths of the 7SJ64 relays, referred to a 19" module frame system. This means that previous models can always be replaced. The height is a uniform 244 mm for flush-mounting housings and 266 mm for surface-mounting housings for all housing widths. All cables can be connected with or without ring lugs. Plug-in terminals are available as an option.

It is thus possible to employ prefabricated cable harnesses. In the case of surface mounting on a panel, the connection terminals are located above and below in the form of screw-type terminals. The communication interfaces are located in a sloped case at the top and bottom of the housing. The housing can also be supplied optionally with a detached operator panel (refer to Fig. 5/91), or without operator panel, in order to allow optimum operation for all types of applications.

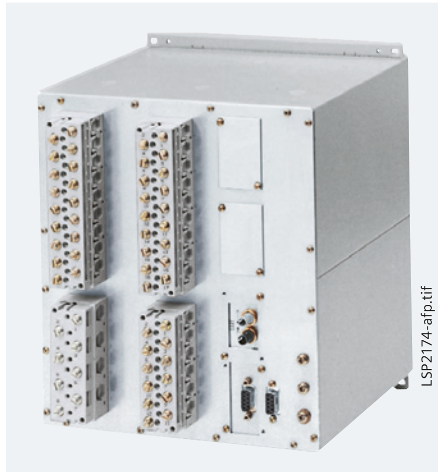

Fig. 5/89 Flush-mounting housing with screw-type terminals

Fig. 5/90 Front view of 7SJ64 with ⅓ × 19" housing

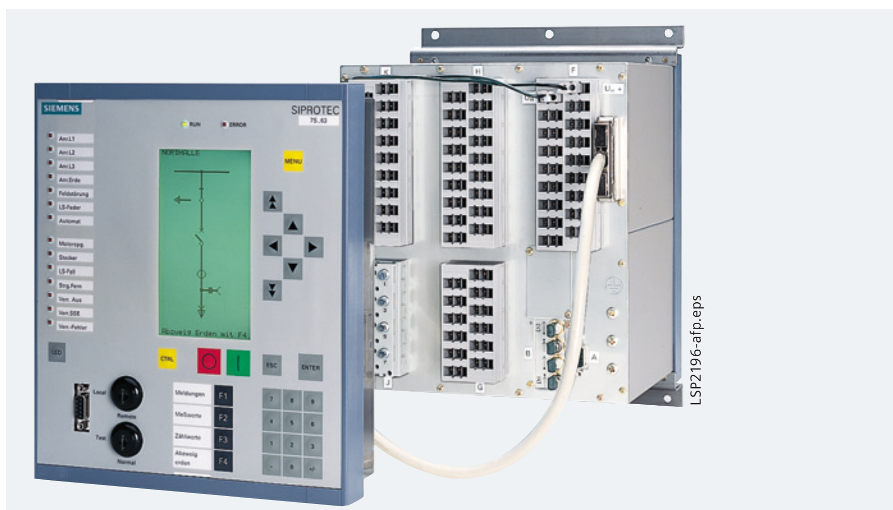

Fig. 5/91 Housing with plug-in terminals and detached operator panel

Fig. 5/92 Surface-mounting housing with screw-type terminals

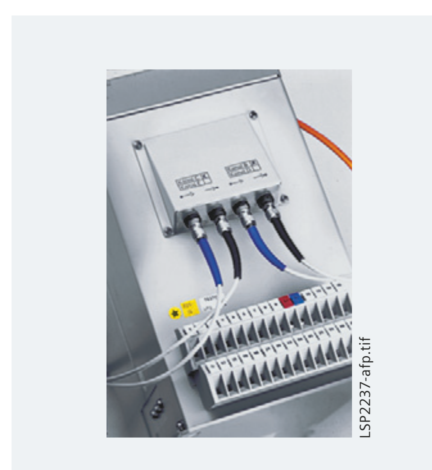

Fig. 5/93 Communication interfaces in a sloped case in a surface-mounting housing

Protection functions

Overcurrent protection (ANSI 50, 50N, 51,51V, 51N)

This function is based on the phase-selective measurement of the three phase currents and the ground current (four transformers). Three definite-time overcurrent protection elements (DMT) exist both for the phases and for the ground. The current threshold and the delay time can be set in a wide range. In addition, inverse-time overcurrent protection characteristics (IDMTL) can be activated. The inverse-time function provides – as an option – voltage-restraint or voltage-controlled operating modes.
With the "flexible protection functions", further definite-time overcurrent stages can be implemented in the 7SJ64 unit.

Reset characteristics

For easier time coordination with electromechanical relays, reset characteristics according to ANSI C37.112 and IEC 60255-3 / BS 142 standards are applied.

When using the reset characteristic (disk emulation), a reset process is initiated after the fault current has disappeared. This reset process corresponds to the reverse movement of the Ferraris disk of an electromechanical relay (thus: disk emulation).

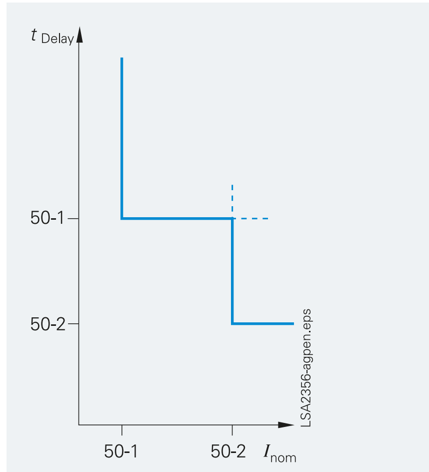

Fig. 5/94 Definite-time overcurrent protection

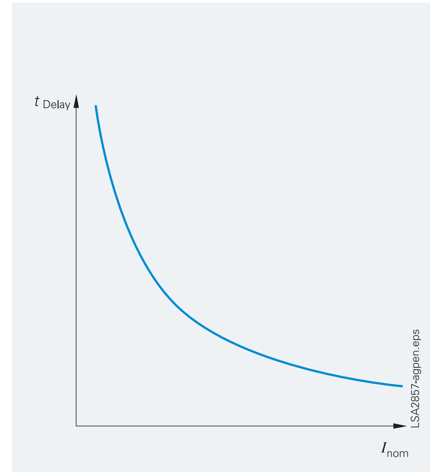

Fig. 5/95 Inverse-time overcurrent protection

Available inverse-time characteristics		
Characteristics acc. to	*ANSI/IEEE*	*IEC 60255-3*
Inverse	•	•
Short inverse	•	
Long inverse	•	•
Moderately inverse	•	
Very inverse	•	•
Extremely inverse	•	•
Definite inverse	•	

User-definable characteristics

Instead of the predefined time characteristics according to ANSI, tripping characteristics can be defined by the user for phase and ground units separately. Up to 20 current / time value pairs may be programmed. They are set as pairs of numbers or graphically in DIGSI 4.

Inrush restraint

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

Cold load pickup/dynamic setting change

For directional and nondirectional overcurrent protection functions the initiation thresholds and tripping times can be switched via binary inputs or by time control.

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Directional overcurrent protection (ANSI 67, 67N)

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

By means of voltage memory, directionality can be determined reliably even for close-in (local) faults. If the switching device closes onto a fault and the voltage is too low to determine direction, directionality (directional decision) is made with voltage from the voltage memory. If no voltage exists in the memory, tripping occurs according to the coordination schedule.

For ground protection, users can choose whether the direction is to be determined via zero-sequence system or negative-sequence system quantities (selectable).
Using negative-sequence variables can be advantageous in cases where the zero voltage tends to be very low due to unfavorable zero-sequence impedances.

Directional comparison protection (cross-coupling)

It is used for selective protection of sections fed from two sources with instantaneous tripping, i.e. without the disadvantage of time coordination. The directional comparison protection is suitable if the distances between the protection stations are not significant and pilot wires are available for signal transmission. In addition to the directional comparison protection, the directional coordinated overcurrent protection is used for complete selective backup protection. If operated in a closed-circuit connection, an interruption of the transmission line is detected.

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

For isolated-neutral and compensated networks, the direction of power flow in the zero sequence is calculated from the zero-sequence current I_0 and zero-sequence voltage V_0. For networks with an isolated neutral, the reactive current component is evaluated; for compensated networks, the active current component or residual resistive current is evaluated.

For special network conditions, e.g. high-resistance grounded networks with ohmic-capacitive ground-fault current or low-resistance grounded networks with ohmic-inductive current, the tripping characteristics can be rotated approximately ± 45 degrees.

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

It has the following functions:

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

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

For high-resistance grounded networks, a sensitive input transformer is connected to a phase-balance neutral current transformer (also called core-balance CT).

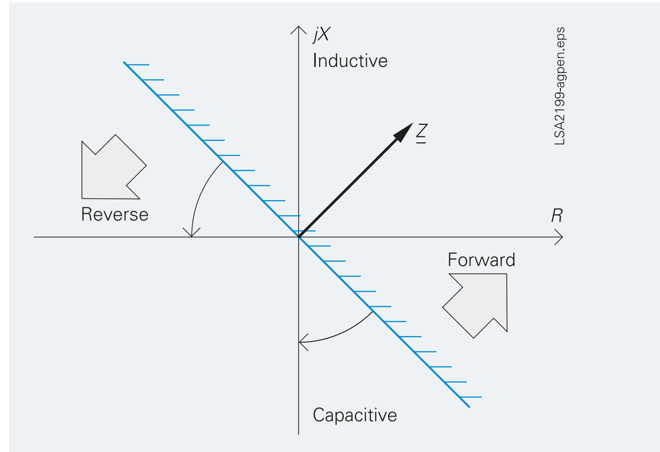


Fig. 5/96 Directional characteristic of the directional overcurrent protection

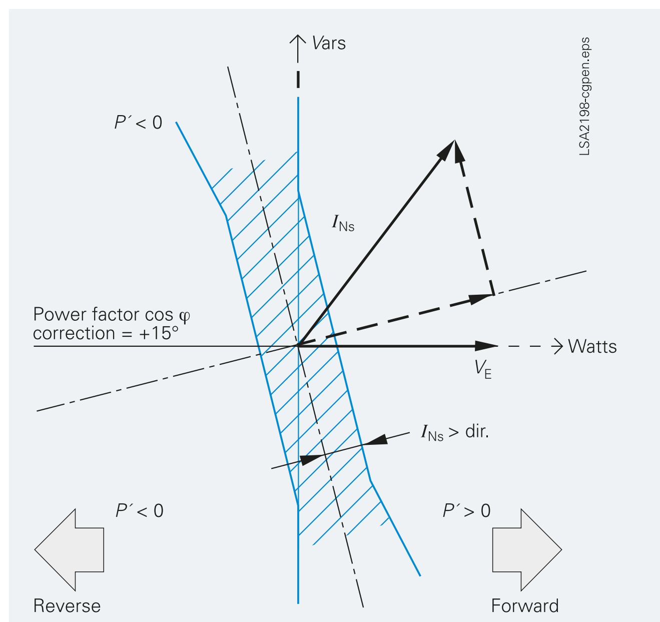


Fig. 5/97 Directional determination using cosine measurements for compensated networks

The function can also be operated in the insensitive mode, as an additional short-circuit protection.

Intermittent ground-fault protection

Intermittent (re-striking) faults occur due to insulation weaknesses in cables or as a result of water penetrating cable joints. Such faults either simply cease at some stage or develop into lasting short-circuits. During intermittent activity, however, star-point resistors in networks that are impedance-grounded may undergo thermal overloading. The normal ground-fault protection cannot reliably detect and interrupt the current pulses, some of which can be very brief.

The selectivity required with intermittent ground faults is achieved by summating the duration of the individual pulses and by triggering when a (settable) summed time is reached. The response threshold I_{IE}> evaluates the r.m.s. value, referred to one systems period.

Directional intermittent ground fault protection (ANSI 67Ns)

The directional intermittent ground fault protection has to detect intermittent ground faults in resonant grounded cable systems selectively. Intermittent ground faults in resonant grounded cable systems are usually characterized by the following properties:

- A very short high-current ground current pulse (up to several hundred amperes) with a duration of under 1 ms
- They are self-extinguishing and re-ignite within one halfperiod up to several periods, depending on the power system conditions and the fault characteristic.
- Over longer periods (many seconds to minutes), they can develop into static faults.

Such intermittent ground faults are frequently caused by weak insulation, e.g. due to decreased water resistance of old cables. Ground fault functions based on fundamental component measured values are primarily designed to detect static ground faults and do not always behave correctly in case of intermittent ground faults. The function described here evaluates specifically the ground current pulses and puts them into relation with the zero-sequence voltage to determine the direction.

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

In line protection, the two-element phase-balance current/ negative-sequence protection permits detection on the high side of high-resistance phase-to-phase faults and phase-to-ground faults that are on the low side of a transformer (e.g. with the switch group Dy 5). This provides backup protection for high-resistance faults beyond the transformer.

Breaker failure protection (ANSI 50BF)

If a faulted portion of the electrical circuit is not disconnected upon issuance of a trip command, another command can be initiated using the breaker failure protection which operates the circuit-breaker, e.g. of an upstream (higher-level) protection relay. Breaker failure is detected if, after a trip command, current is still flowing in the faulted circuit. As an option, it is possible to make use of the circuit-breaker position indication.

Auto-reclosures (ANSI 79)

Multiple reclosures can be defined by the user and lockout will occur if a fault is present after the last reclosure. The following functions are possible:

- 3-pole ARC for all types of faults
- Separate settings for phase and ground faults
- Multiple ARC, one rapid auto-reclosure (RAR) and up to nine delayed auto-reclosures (DAR)
- Starting of the ARC depends on the trip command selection (e.g. 46, 50, 51, 67)
- Blocking option of the ARC via binary inputs
- ARC can be initiated externally or via CFC
- The directional and non-directional elements can either be blocked or operated non-delayed depending on the auto-reclosure cycle
- Dynamic setting change of the directional and non-directional elements can be activated depending on the ready AR
- The AR CLOSE command can be given synchronous by use of the synchronization function.

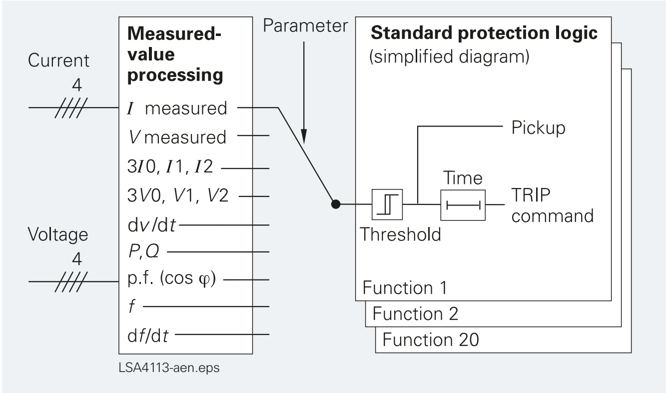


Fig. 5/98 Flexible protection functions

Flexible protection functions

The 7SJ64 units enable the user to easily add on up to 20 protective functions. To this end, parameter definitions are used to link a standard protection logic with any chosen characteristic quantity (measured or derived quantity) (Fig. 5/98). The standard logic consists of the usual protection elements such as the pickup message, the parameter-definable delay time, the TRIP command, a blocking possibility, etc. The mode of operation for current, voltage, power and power factor quantities can be three-phase or single-phase. Almost all quantities can be operated as greater than or less than stages. All stages operate with protection priority.

Protection stages/functions attainable on the basis of the available characteristic quantities:

Function	*ANSI No.*
$I>$, $I_E>$	50, 50N
$V<$, $V>$, $V_E>$, dV/dt	27, 59, 59R, 64
$3I_0>$, $I_1>$, $I_2>$, I_2/I_1, $3V_0>$, $V_1><$, $V_2><$	50N, 46, 59N, 47
$P><$, $Q><$	32
cos φ (p.f.)><	55
$f><$	81O, 81U
df/dt><	81R

For example, the following can be implemented:

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

Undervoltage-controlled reactive power protection (ANSI 27/Q)

The undervoltage-controlled reactive power protection protects the system for mains decoupling purposes. To prevent a voltage collapse in energy systems, the generating side, e.g. a generator, must be equipped with voltage and frequency protection devices. An undervoltage-controlled reactive power protection is required at the supply system connection point. It detects critical power system situations and ensures that the power generation facility is disconnected from the mains. Furthermore, it ensures that reconnection only takes place under stable power system conditions. The associated criteria can be parameterized.

5

Synchronization (ANSI 25)

- In case of switching ON the circuit-breaker, the units can check whether the two subnetworks are synchronized (classic synchro-check). Furthermore, the synchronizing function may operate in the "Synchronous/asynchronous switching" mode. The unit then distinguishes between synchronous and asynchronous networks:
  In synchronous networks, frequency differences between the two subnetworks are almost non-existant. In this case, the circuit-breaker operating time does not need to be considered. Under asynchronous condition, however, this difference is markedly larger and the time window for switching is shorter. In this case, it is recommended to consider the operating time of the circuit- breaker.

The command is automatically pre-dated by the duration of the operating time of the circuit-breaker, thus ensuring that the contacts of the CB close at exactly the right time.

Up to 4 sets of parameters for the synchronizing function can be stored in the unit. This is an important feature when several circuit-breakers with different operating times are to be operated by one single relay.

Thermal overload protection (ANSI 49)

For protecting cables and transformers, an overload protection with an integrated pre-warning element for temperature and current can be applied. The temperature is calculated using a thermal homogeneous-body model (according to IEC 60255-8), which takes account both of the energy entering the equipment and the energy losses. The calculated temperature is constantly adjusted accordingly. Thus, account is taken of the previous load and the load fluctuations.

For thermal protection of motors (especially the stator), a further time constant can be set so that the thermal ratios can be detected correctly while the motor is rotating and when it is stopped. The ambient temperature or the temperature of the coolant can be detected serially via an external temperature monitoring box (resistance-temperature detector box, also called RTD- box). The thermal replica of the overload function is automatically adapted to the ambient conditions. If there is no RTD-box it is assumed that the ambient temperatures are constant.

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

The high-impedance measurement principle is an uncomplicated and sensitive method for detecting ground faults, especially on transformers. It can also be applied to motors, generators and reactors when these are operated on an grounded network.

When the high-impedance measurement principle is applied, all current transformers in the protected area are connected in parallel and operated on one common resistor of relatively high R whose voltage is measured (see Fig. 5/99). In the case of 7SJ6 units, the voltage is measured by detecting the current through the (external) resistor R at the sensitive current measurement input I_{EE}.

The varistor V serves to limit the voltage in the event of an internal fault. It cuts off the high momentary voltage spikes occurring at transformer saturation. At the same time, this results in smoothing of the voltage without any noteworthy reduction of the average value. If no faults have occurred and in the event of external faults, the system is at equilibrium, and the voltage through the resistor is approximately zero. In the event of internal faults, an imbalance occurs which leads to a voltage and a current flow through the resistor R.

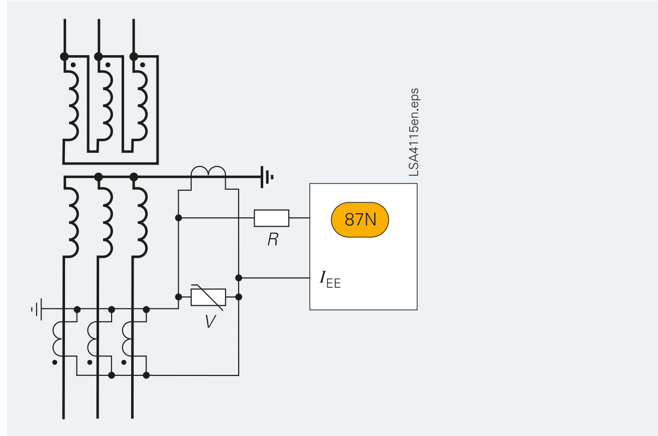


Fig. 5/99 High-impedance restricted ground-fault protection

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

Settable dropout delay times

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

■ Motor protection

Restart inhibit (ANSI 66/86)

If a motor is started up too many times in succession, the rotor can be subject to thermal overload, especially the upper edges of the bars. The rotor temperature is calculated from the stator current. The reclosing lockout only permits start-up of the motor if the rotor has sufficient thermal reserves for a complete start-up (see Fig. 5/100).

Emergency start-up

This function disables the reclosing lockout via a binary input by storing the state of the thermal replica as long as the binary input is active. It is also possible to reset the thermal replica to zero.

Temperature monitoring (ANSI 38)

Up to two temperature monitoring boxes with a total of 12 measuring sensors can be used for temperature monitoring and detection by the protection relay. The thermal status of motors, generators and transformers can be monitored with this device. Additionally, the temperature of the bearings of rotating machines are monitored for limit value violation. The temperatures are being measured with the help of temperature detectors at various locations of the device to be protected. This data is transmitted to the protection relay via one or two temperature monitoring boxes (see "Accessories", page 5/197).

Starting time supervision (ANSI 48/14)

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

for $I > I_{MOTOR\ START}$

$$t = \left(\frac{I_A}{I}\right)^2 \cdot T_A$$

I = Actual current flowing

$I_{MOTOR\ START}$ = Pickup current to detect a motor start

t = Tripping time

I_A = Rated motor starting current

T_A = Tripping time at rated motor starting current (2 times, for warm and cold motor)

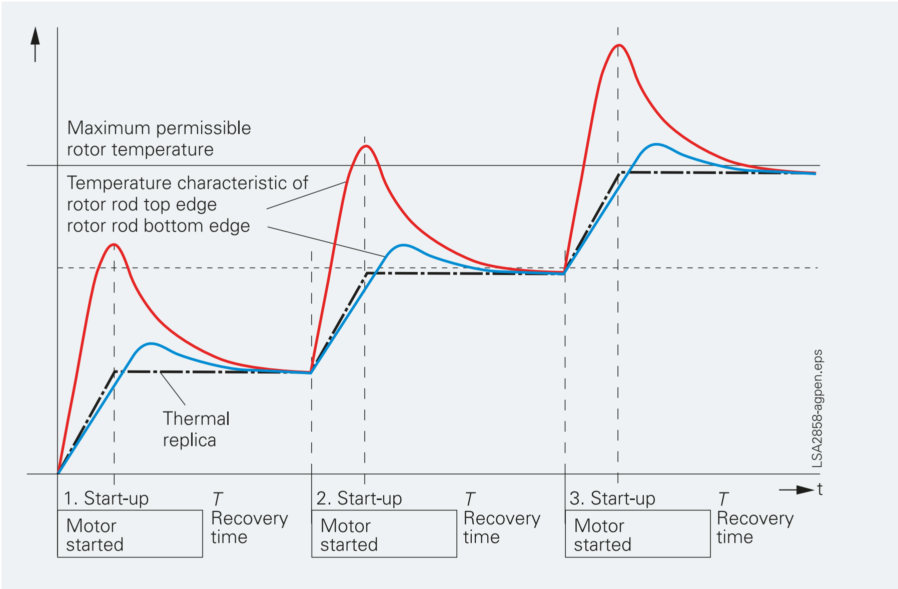


Fig. 5/100

The characteristic (equation) can be adapted optimally to the state of the motor by applying different tripping times T_A in dependence of either cold or warm motor state. For differentiation of the motor state the thermal model of the rotor is applied.

If the trip time is rated according to the above formula, even a prolonged start-up and reduced voltage (and reduced start-up current) will be evaluated correctly. The tripping time is inverse (current dependent).

A binary signal is set by a speed sensor to detect a blocked rotor. An instantaneous tripping is effected.

Load jam protection (ANSI 51M)

Sudden high loads can cause slowing down and blocking of the motor and mechanical damages. The rise of current due to a load jam is being monitored by this function (alarm and tripping).

The overload protection function is too slow and therefore not suitable under these circumstances.

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

The negative-sequence / phase-balance current protection detects a phase failure or load unbalance due to network asymmetry and protects the rotor from impermissible temperature rise.

Undercurrent monitoring (ANSI 37)

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

Motor statistics

Essential information on start-up of the motor (duration, current, voltage) and general information on number of starts, total operating time, total down time, etc. are saved as statistics in the device.

■ Voltage protection

Overvoltage protection (ANSI 59)

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

Undervoltage protection (ANSI 27)

The two-element undervoltage protection provides protection against dangerous voltage drops (especially for electric machines). Applications include the isolation of generators or motors from the network to avoid undesired operating states and a possible loss of stability. Proper operating conditions of electrical machines are best evaluated with the positive-sequence quantities. The protection function is active over a wide frequency range (45 to 55, 55 to 65 Hz)[1)]. Even when falling below this frequency range the function continues to work, however, with a greater tolerance band.

The function can operate either with phase-to-phase, phase-to-ground or positive phase-sequence voltage, and can be monitored with a current criterion.
Three-phase and single-phase connections are possible.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for over-frequency and under-frequency protection. Electric machines and parts of the system are protected from unwanted speed deviations. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting. Frequency protection can be used over a wide frequency range (40 to 60, 50 to

1) The 45 to 55, 55 to 65 Hz range is available for f_N = 50/60 Hz.

70 Hz)[1]. There are four elements (selectable as overfrequency or underfrequency) and each element can be delayed separately. Blocking of the frequency protection can be performed if using a binary input or by using an undervoltage element.

Fault locator (ANSI 21FL)

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

Circuit-breaker wear monitoring

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

There is no mathematically exact method of calculating the wear or the remaining service life of circuit-breakers that takes into account the arc-chamber's physical conditions when the CB opens. This is why various methods of determining CB wear have evolved which reflect the different operator philosophies. To do justice to these, the devices offer several methods:

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

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

- Two-point method

The CB manufacturers double-logarithmic switching cycle diagram (see Fig. 5/101) and the breaking current at the time of contact opening serve as the basis for this method. After CB opening, the two-point method calculates the number of still possible switching cycles. To this end, the two points P1 and P2 only have to be set on the device. These are specified in the CB's technical data. All of these methods are phase-selective and a limit value can be set in order to obtain an alarm if the actual value falls below or exceeds the limit value during determination of the remaining service life.

Commissioning

Commissioning could hardly be easier and is fully supported by DIGSI 4. The status of the binary inputs can be read individually and the state of the binary outputs can be set individually. The operation of switching elements (circuit-breakers, disconnect devices) can be checked using the switching functions of the bay controller. The analog measured values are represented as wide-ranging operational measured values. To prevent transmission of information to the control center during maintenance, the bay controller communications can be disabled to prevent unnecessary data from being transmitted. During commissioning, all indications with test marking for test purposes can be connected to a control and protection system.

Test operation

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

1) The 40 to 60, 50 to 70 Hz range is available for f_N = 50/60 Hz.

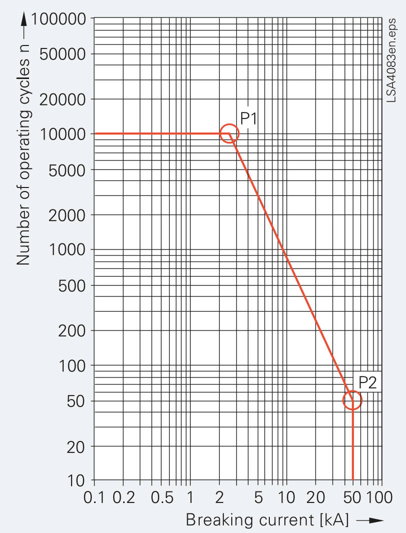


Fig. 5/101 CB switching cycle diagram

Functions

Control and automatic functions

Control

In addition to the protection functions, the SIPROTEC 4 units also support all control and monitoring functions that are required for operating medium-voltage or high-voltage substations.

The main application is reliable control of switching and other processes.

The status of primary equipment or auxiliary devices can be obtained from auxiliary contacts and communicated to the 7SJ64 via binary inputs. Therefore it is possible to detect and indicate both the OPEN and CLOSED position or a fault or intermediate circuit-breaker or auxiliary contact position.

The switchgear or circuit-breaker can be controlled via:
– integrated operator panel
– binary inputs
– substation control and protection system
– DIGSI 4

Automation / user-defined logic

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

Switching authority

Switching authority is determined according to parameters, communication or by key-operated switch (when available). If a source is set to “LOCAL”, only local switching operations are possible. The following sequence of switching authority is laid down: “LOCAL”; DIGSI PC program, “REMOTE”.

Key-operated switch

7SJ64 units are fitted with key-operated switch function for local/remote changeover and changeover between interlocked switching and test operation.

Command processing

All the functionality of command processing is offered. This includes the processing of single and double commands with or without feedback, sophisticated monitoring of the control hardware and software, checking of the external process, control actions using functions such as runtime monitoring and automatic command termination after output. Here are some typical applications:

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

Motor control

The SIPROTEC 7SJ64 with high performance relays is well-suited for direct activation of the circuit-breaker, disconnector and grounding switch operating mechanisms in automated substations.

Interlocking of the individual switching devices takes place with the aid of programmable logic. Additional auxiliary relays can be eliminated. This results in less wiring and engineering effort.

Assignment of feedback to command

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

Chatter disable

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

Indication filtering and delay

Binary indications can be filtered or delayed.

Filtering serves to suppress brief changes in potential at the indication input. The

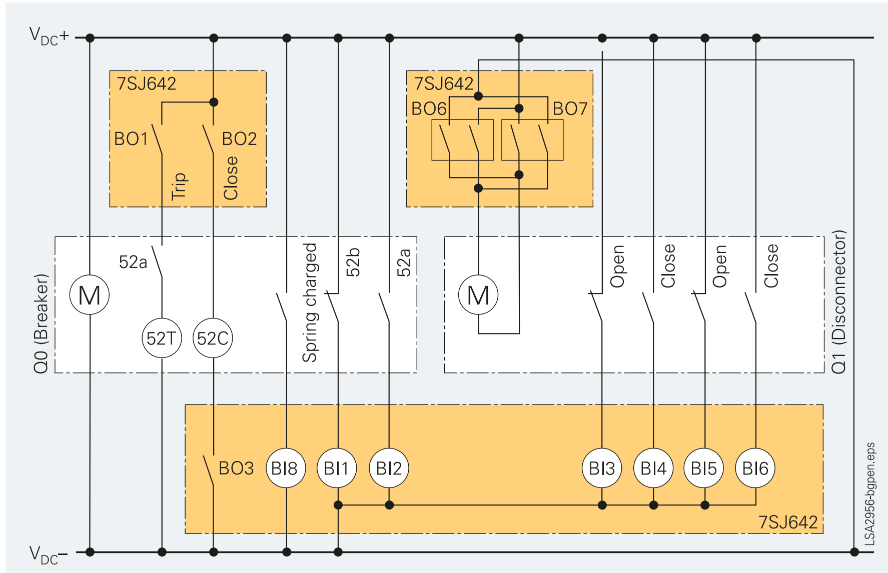


Fig. 5/102 Typical wiring for 7SJ642 motor direct control (simplified representation without fuses). Binary output BO6 and BO7 are interlocked so that only one set of contacts are closed at a time.

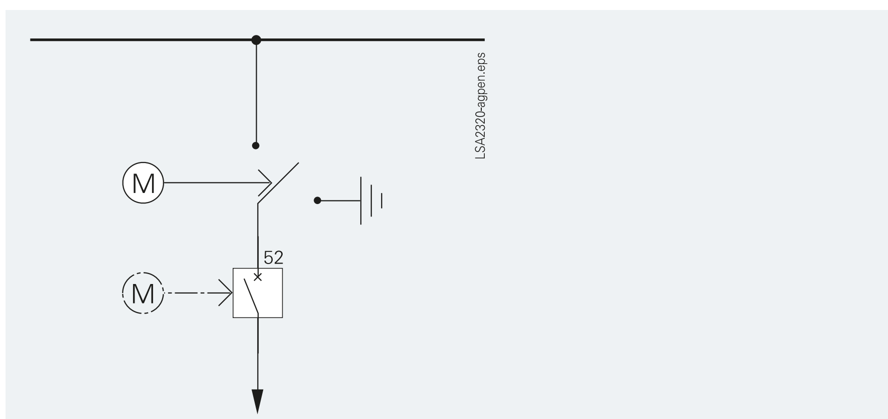


Fig. 5/103 Example: Single busbar with circuit-breaker and motor-controlled three-position switch

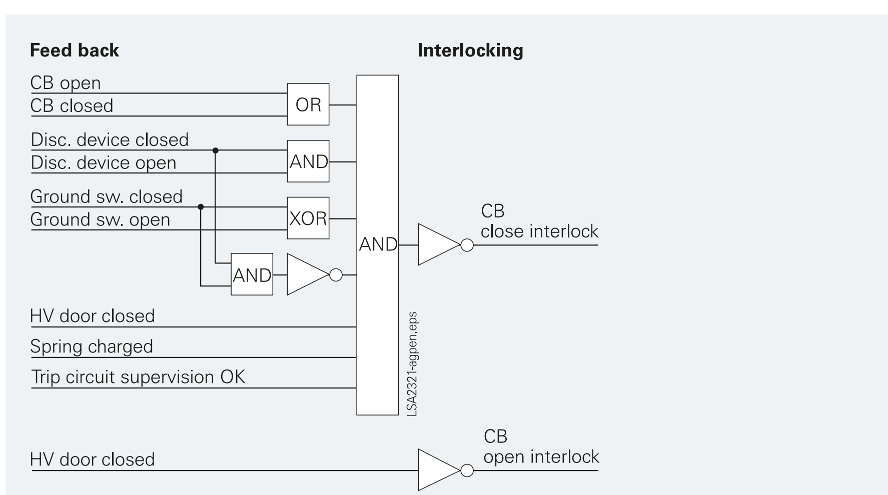


Fig. 5/104 Example: Circuit-breaker interlocking indication is passed on only if the indication voltage is still present after a set period of time.

In the event of indication delay, there is a wait for a preset time. The information is passed on only if the indication voltage is still present after this time.

Indication derivation

A further indication (or a command) can be derived from an existing indication. Group indications can also be formed. The volume of information to the system interface can thus be reduced and restricted to the most important signals.

Measured values

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

- Currents I_{L1}, I_{L2}, I_{L3}, I_E, I_{EE} (67Ns)
- Voltages V_{L1}, V_{L2}, V_{L3}, V_{L1L2}, V_{L2L3}, V_{L3L1}, V_{syn}
- Symmetrical components I_1, I_2, $3I_0$; V_1, V_2, V_0
- Power Watts, Vars, VA/P, Q, S (P, Q: total and phase selective)
- Power factor (cos φ), (total and phase selective)
- Frequency
- Energy ± kWh, ± kVarh, forward and reverse power flow
- Mean as well as minimum and maximum current and voltage values
- Operating hours counter
- Mean operating temperature of overload function
- Limit value monitoring
  Limit values are monitored using programmable logic in the CFC. Commands can be derived from this limit value indication.
- Zero suppression
  In a certain range of very low measured values, the value is set to zero to suppress interference.

Metered values

For internal metering, the unit can calculate an energy metered value from the measured current and voltage values. If an external meter with a metering pulse output is available, the SIPROTEC 4 unit can obtain and process metering pulses via an indication input.

The metered values can be displayed and passed on to a control center as an accumulation with reset. A distinction is made between forward, reverse, active and reactive energy.

Switchgear cubicles for high/medium voltage

All units are designed specifically to meet the requirements of high/medium-voltage applications.

In general, no separate measuring instruments (e.g. for current, voltage, frequency measuring transducer ...) or additional control components are necessary.

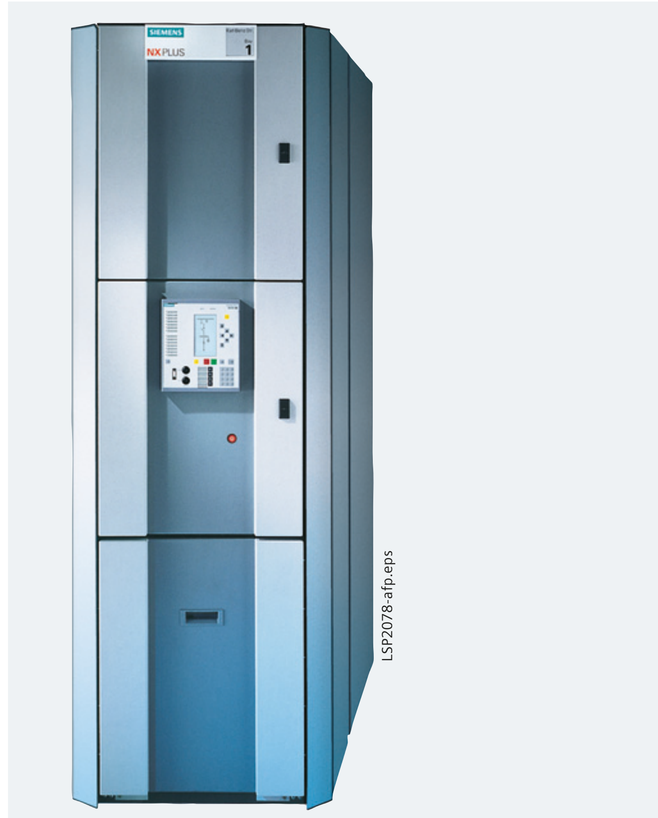


Fig. 5/105 NX PLUS panel (gas-insulated)

Communication

In terms of communication, the units offer substantial flexibility in the context of connection to industrial and power automation standards. Communication can be extended or added on thanks to modules for retrofitting on which the common protocols run. Therefore, also in the future it will be possible to optimally integrate units into the changing communication infrastructure, for example in Ethernet networks (which will also be used increasingly in the power supply sector in the years to come).

Serial front interface

There is a serial RS232 interface on the front of all the units. All of the unit's functions can be set on a PC by means of the DIGSI 4 protection operation program. Commissioning tools and fault analysis are also built into the program and are available through this interface.

Rear-mounted interfaces[1)]

A number of communication modules suitable for various applications can be fitted in the rear of the flush-mounting housing. In the flush-mounting housing, the modules can be easily replaced by the user.
The interface modules support the following applications:

- Time synchronization interface
  All units feature a permanently integrated electrical time synchronization interface. It can be used to feed timing telegrams in IRIG-B or DCF77 format into the units via time synchronization receivers.
- System interface
  Communication with a central control system takes place through this interface. Radial or ring type station bus topologies can be configured depending on the chosen interface. Furthermore, the units can exchange data through this interface via Ethernet and IEC 61850 protocol and can also be operated by DIGSI.
- Service interface
  The service interface was conceived for remote access to a number of protection units via DIGSI. It can be an electrical RS232/RS485 interface. For special applications, a maximum of two temperature monitoring boxes (RTD-box) can be connected to this interface as an alternative.
- Additional interface
  Up to 2 RTD-boxes can be connected via this interface.

System interface protocols (retrofittable)

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 possible with DIGSI. It is also possible to retrieve operating and fault messages and fault recordings via a browser. This Web monitor also provides a few items of unit-specific information in browser windows.

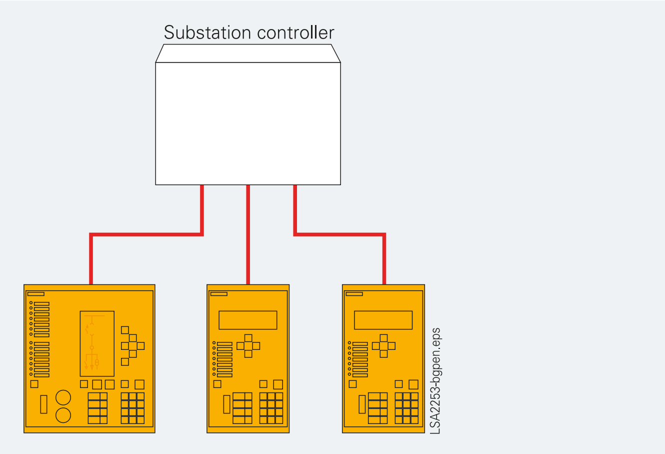


Fig. 5/106 IEC 60870-5-103: Radial fiber-optic connection

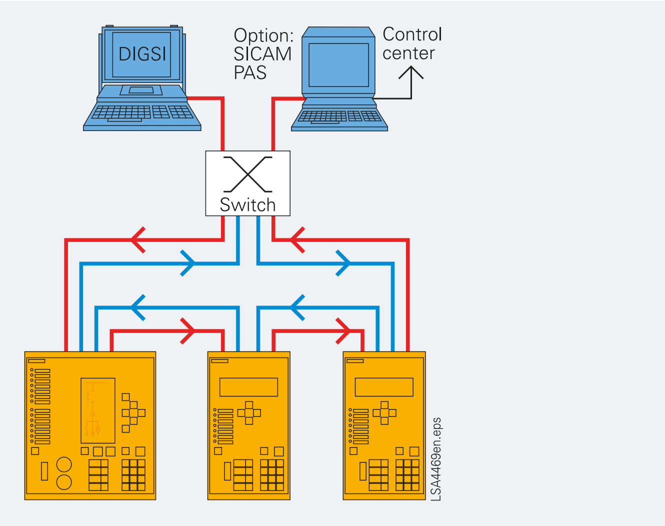


Fig. 5/107 Bus structure for station bus with Ethernet and IEC 61850, fiber-optic ring

IEC 60870-5-103 protocol

The IEC 60870-5-103 protocol is an international standard for the transmission of protective data and fault recordings. All messages from the unit and also control commands can be transferred by means of published, Siemens-specific extensions to the protocol.

Redundant solutions are also possible. Optionally it is possible to read out and alter individual parameters (only possible with the redundant module).

PROFIBUS DP protocol

PROFIBUS DP is the most widespread protocol in industrial automation. Via PROFIBUS DP, SIPROTEC units make their information available to a SIMATIC controller or, in the control direction, receive commands from a central SIMATIC. Measured values can also be transferred.

1) For units in panel surface-mounting housings please refer to note on page 5/193.

Communication

MODBUS RTU protocol

This uncomplicated, serial protocol is mainly used in industry and by power supply corporations, and is supported by a number of unit manufacturers. SIPROTEC units function as MODBUS slaves, making their information available to a master or receiving information from it. A time-stamped event list is available.

PROFINET

PROFINET is the ethernet-based successor of PROFIBUS DP and is supported in the variant PROFINET IO. The protocol which is used in industry together with the SIMATIC systems control is realized on the optical and electrical Plus ethernet modules which are delivered since November 2012. All network redundancy procedures which are available for the ethernet modules, such as RSTP, PRP or HSR, are also available for PROFINET. The time synchronization is made via SNTP. The network monitoring is possible via SNMP V2 where special MIB files exist for PROFINET. The LLDP protocol of the device also supports the monitoring of the network topology. Single-point indications, double-point indications, measured and metered values can be transmitted cyclically in the monitoring direction via the protocol and can be selected by the user with DIGSI 4. Important events are also transmitted spontaneously via configurable process alarms. Switching commands can be executed by the system control via the device in the controlling direction. The PROFINET implementation is certified. The device also supports the IEC 61850 protocol as a server on the same ethernet module in addition to the PROFINET protocol. Client server connections are possible for the intercommunication between devices, e.g. for transmitting fault records and GOOSE messages.

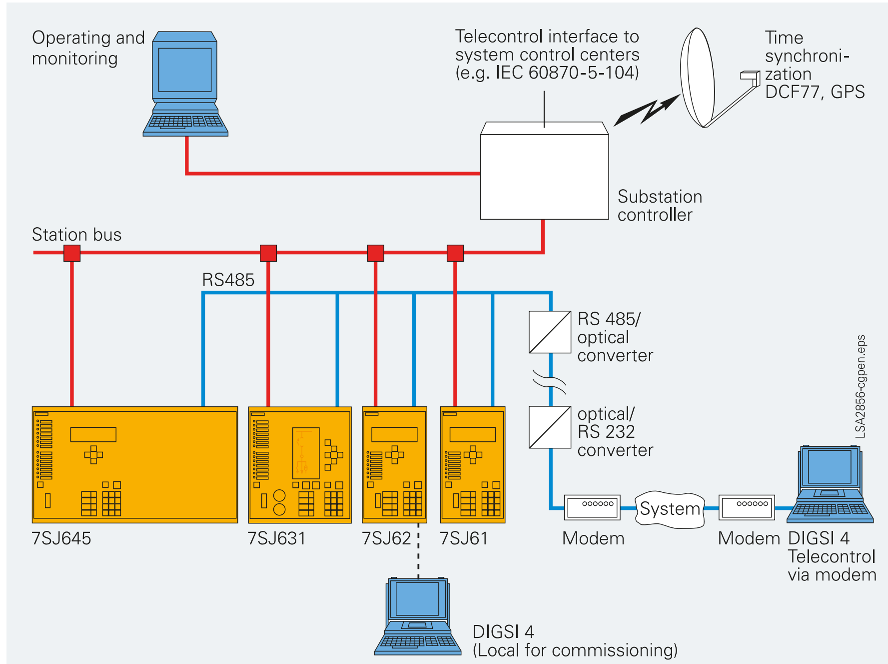


Fig. 5/108 System solution/communication

Fig. 5/109 Optical Ethernet communication module for IEC 61850 with integrated Ethernet-switch

DNP 3.0 protocol

Power utilities use the serial DNP 3.0 (Distributed Network Protocol) for the station and network control levels. SIPROTEC units function as DNP slaves, supplying their information to a master system or receiving information from it.

DNP3 TCP

The ethernet-based TCP variant of the DNP3 protocol is supported with the electrical and optical ethernet module. Two DNP3 TCP clients are supported. Redundant ring structures can be realized for DNP3 TCP with the help of the integrated switch in the module. For instance, a redundant optical ethernet ring can be constructed. Single-point indications, double-point indications, measured and metered values can be confi gured with DIGSI 4 and are transmitted to the DNPi client. Switching commands can be executed in the controlling direction. Fault records of the device are stored in the binary Comtrade format and can be retrieved via the DNP3 file transfer. The time synchronization is performed via the DNP3 TCP client or SNTP. The device can also be integrated into a network monitoring system via the SNMP V2 protocol. Parallel to the DNP3 TCP protocol the IEC 61850 protocol (the device works as a server) and the GOOSE messages of the IEC 61850 are available for the intercommunication between devices.

System solutions for protection and station control

Together with the SICAM power automation system, SIPROTEC 4 can be used with PROFIBUS DP. Over the low-cost electrical RS485 bus, or interference-free via the optical double ring, the units exchange information with the control system.

Units featuring IEC 60870-5-103 interfaces can be connected to SICAM in parallel via the RS485 bus or radially by fiber-optic link.

Through this interface, the system is open for the connection of units of other manufacturers (see Fig. 5/106).

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 (see Fig. 5/107).

Typical connections

Connection of current and voltage transformers

Standard connection

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

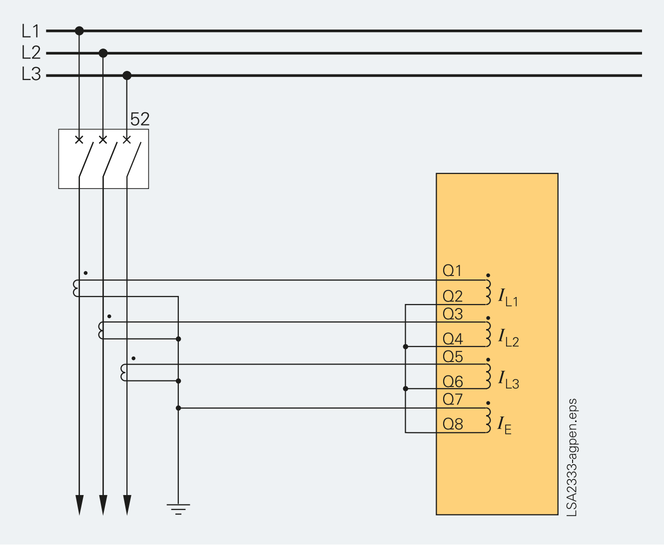


Fig. 5/110 Residual current circuit without directional element

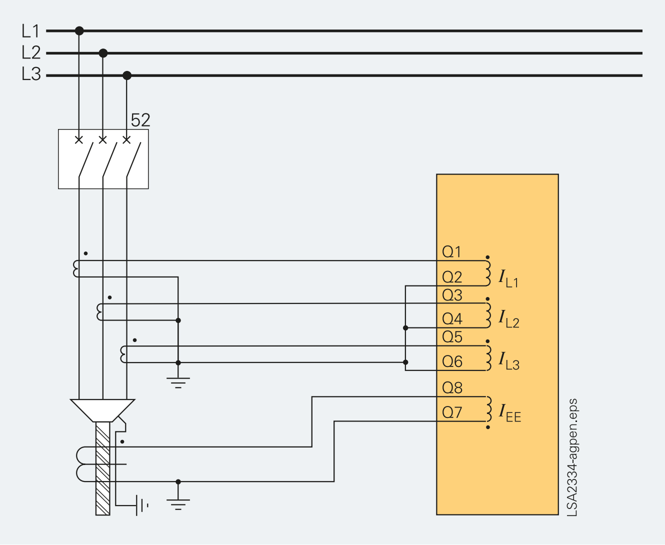


Fig. 5/111 Sensitive ground current detection without directional element

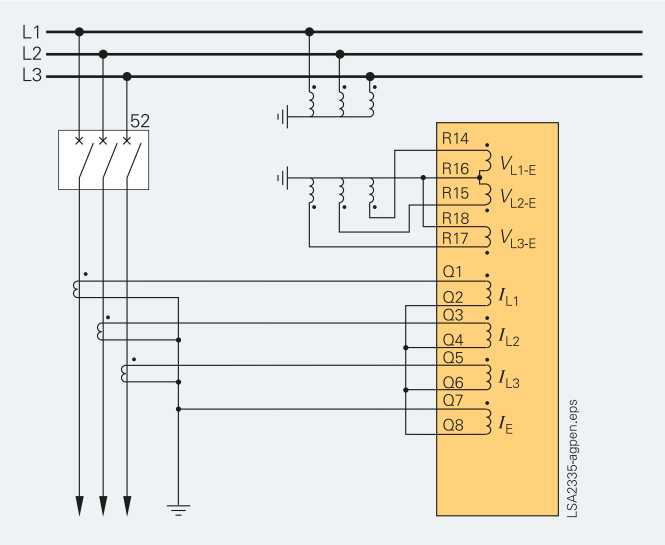


Fig. 5/112 Residual current circuit with directional element

5

Typical connections

Connection for compensated networks

The figure shows the connection of two phase-to-ground voltages and the V_E voltage of the open delta winding and a phase-ground neutral current transformer for the ground current. This connection maintains maximum precision for directional ground-fault detection and must be used in compensated networks.
Fig. 5/113 shows sensitive directional ground-fault detection.

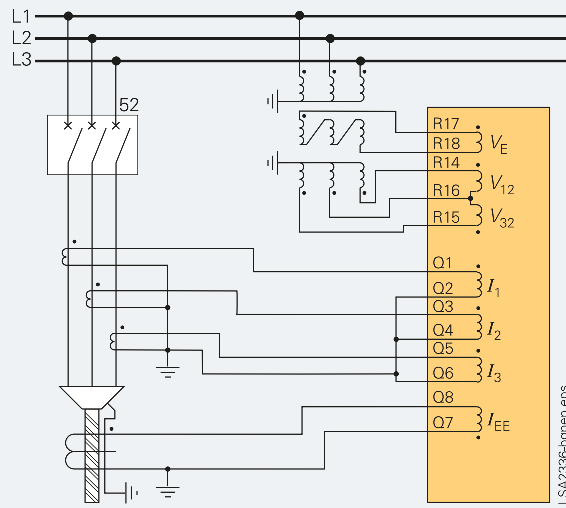


Fig. 5/113 Sensitive directional ground-fault detection with directional element for phases

Connection for isolated-neutral or compensated networks only

If directional ground-fault protection is not used, the connection can be made with only two phase current transformers. Directional phase short-circuit protection can be achieved by using only two primary transformers.

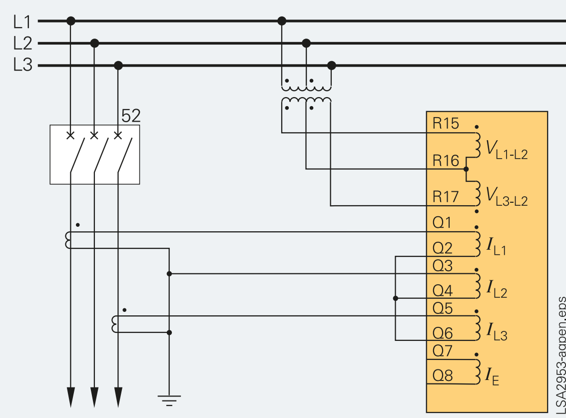


Fig. 5/114 Isolated-neutral or compensated networks

Connection for the synchronization function

The 3-phase system is connected as reference voltage, i. e. the outgoing voltages as well as a single-phase voltage, in this case a busbar voltage, that has to be synchronized.

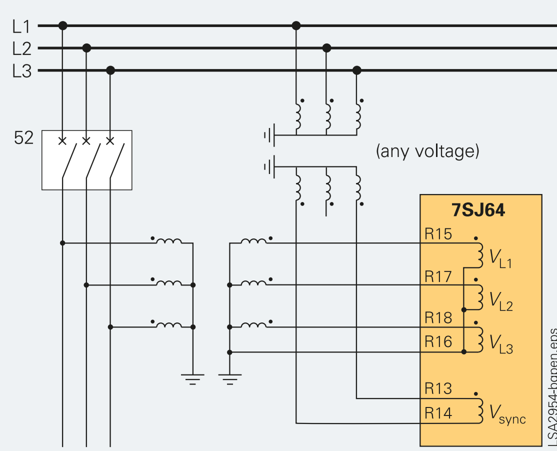


Fig. 5/115 Measuring of the busbar voltage and the outgoing feeder voltage for synchronization

5

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

Typical applications

■ Application examples

Synchronization function

When two subnetworks must be interconnected, the synchronization function monitors whether the subnetworks are synchronous and can be connected without risk of losing stability.

As shown in Fig. 5/116, load is being fed from a generator to a busbar via a transformer. It is assumed that the frequency difference of the 2 subnetworks is such that the device determines asynchronous system conditions.

The voltages of the busbar and the feeder should be the same when the contacts are made; to ensure this condition the synchronism function must run in the "synchronous/asynchronous switching" mode. In this mode, the operating time of the CB can be set within the relay. Differences between angle and frequency can then be calculated by the relay while taking into account the operating time of the CB. From these differences, the unit derives the exact time for issuing the CLOSE command under asynchronous conditions. When the contacts close, the voltages will be in phase.

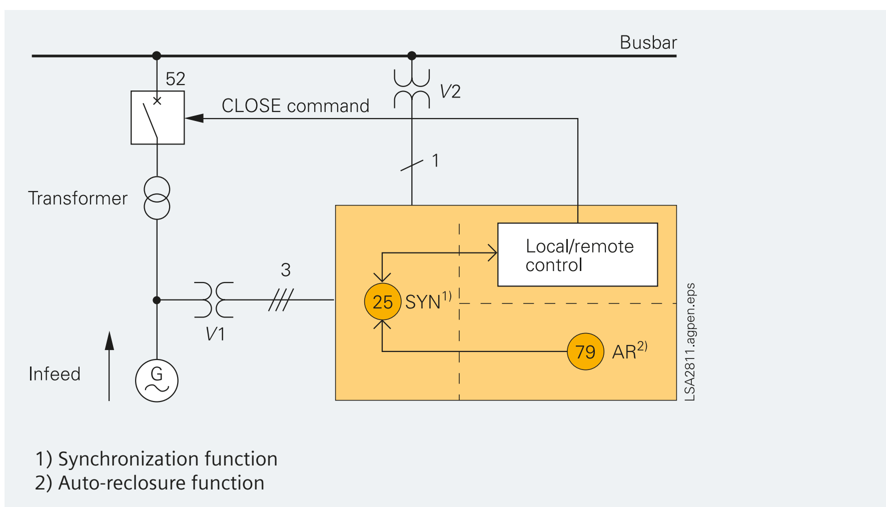


Fig. 5/116 Measuring of busbar and feeder voltages for synchronization

The vector group of the transformer can be considered by setting parameters. Thus no external circuits for vector group adaptation are required.

This synchronism function can be applied in conjunction with the auto-reclosure function as well as with the control function CLOSE commands (local/remote).

Connection of circuit-breaker

Undervoltage releases

Undervoltage releases are used for automatic tripping of high-voltage motors.

Example:
DC supply voltage of control system fails and manual electric tripping is no longer possible.

Automatic tripping takes place when voltage across the coil drops below the trip limit. In Figure 5/172, tripping occurs due to failure of DC supply voltage, by automatic opening of the live status contact upon failure of the protection unit or by short-circuiting the trip coil in event of a network fault.

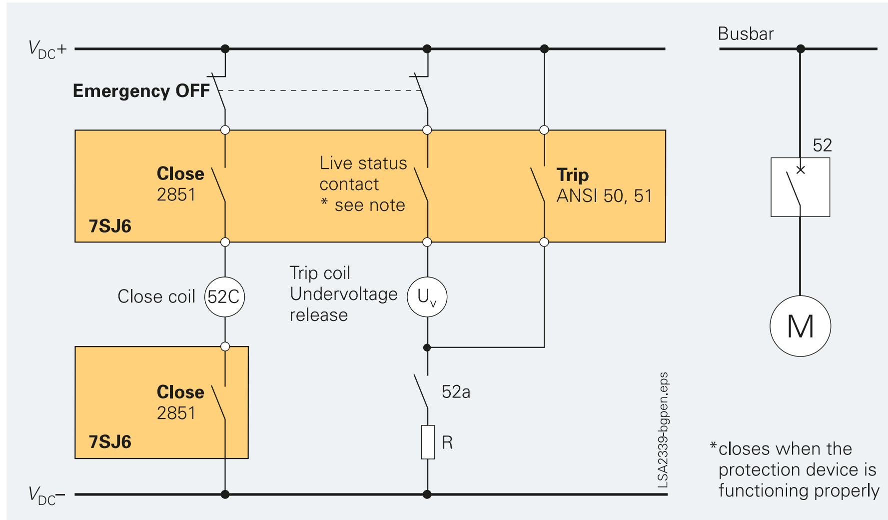


Fig. 5/117 Undervoltage release with make contact 50, 51

In Fig. 5/118 tripping is by failure of auxiliary voltage and by interruption of tripping circuit in the event of network failure. Upon failure of the protection unit, the tripping circuit is also interrupted, since contact held by internal logic drops back into open position.

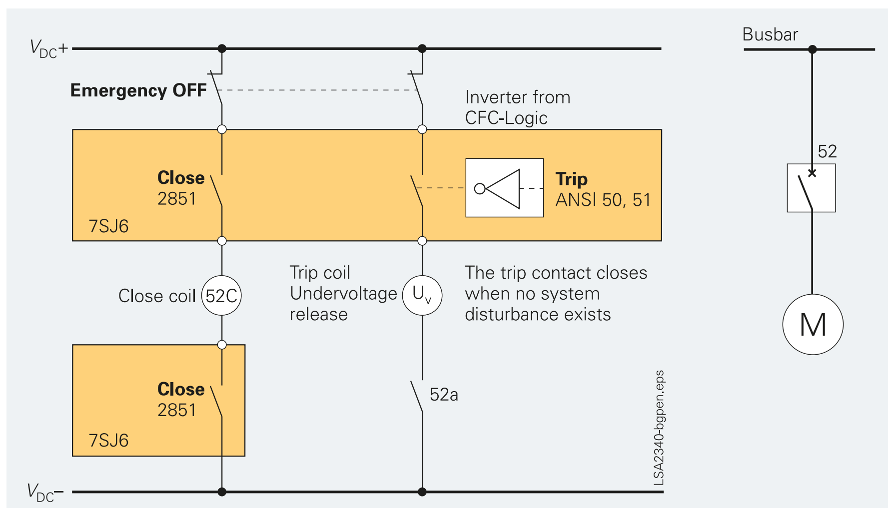


Fig. 5/118 Undervoltage release with locking contact (trip signal 50 is inverted)

Trip circuit supervision (ANSI 74TC)

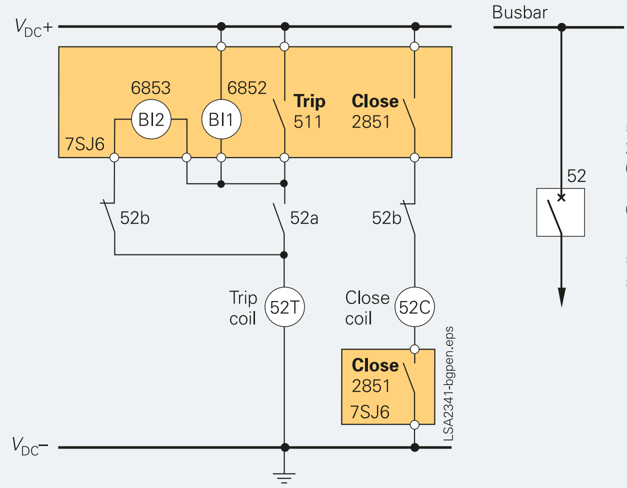
One or two binary inputs can be used for monitoring the circuit-breaker trip coil including its incoming cables. An alarm signal occurs whenever the circuit is interrupted.

Lockout (ANSI 86)

All binary outputs can be stored like LEDs and reset using the LED reset key. The lockout state is also stored in the event of supply voltage failure. Reclosure can only occur after the lockout state is reset.

Reverse-power protection for dual supply (ANSI 32R)

If power is fed to a busbar through two parallel infeeds, then in the event of any fault on one of the infeeds it should be selectively interrupted. This ensures a continued supply to the busbar through the remaining infeed. For this purpose, directional devices are needed which detect a short-circuit current or a power flow from the busbar in the direction of the infeed. The directional overcurrent protection is usually set via the load current. It cannot be used to deactivate low-current faults. Reverse-power protection can be set far below the rated power. This ensures that it also detects power feedback into the line in the event of low-current faults with levels far below the load current. Reverse-power protection is performed via the “flexible protection functions” of the 7SJ64.



Protection indications

511* General trip
2851* CB close command
6852* Trip circuit supervision: Trip relay
6853* Trip circuit supervision: CB aux

52a open, when CB is open
52b open, when CB is closed
BI Binary input

TRIP contact	Breaker	BI1	BI2
open	closed	H	L
open	open	H	H
closed	closed	L	L
closed	open	L	H

Fig. 5/119 Trip circuit supervision with 2 binary inputs

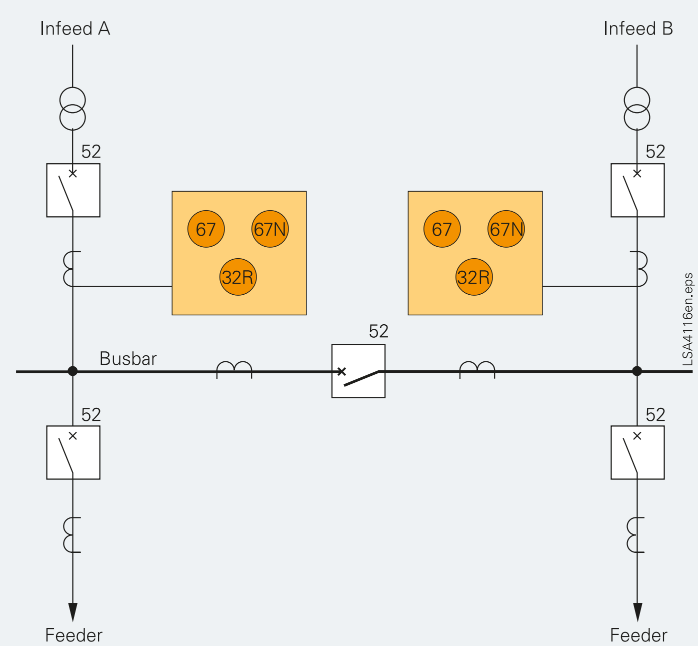


Fig. 5/120 Reverse-power protection for dual supply

5

Technical data

General unit data	
Measuring circuits	
System frequency	50 / 60 Hz (settable)
Current transformer	
Rated current I_{nom}	1 or 5 A (settable)
Option: sensitive ground-fault CT	I_{EE} < 1.6 A
Power consumption	
at I_{nom} = 1 A	Approx. 0.05 VA per phase
at I_{nom} = 5 A	Approx. 0.3 VA per phase
for sensitive ground-fault CT at 1 A	Approx. 0.05 VA
Overload capability	
Thermal (effective)	500 A for 1 s 150 A for 10 s 20 A continuous
Dynamic (impulse current)	250 x I_{nom} (half cycle)
Overload capability if equipped with sensitive ground-fault CT	
Thermal (effective)	300 A for 1 s 100 A for 10 s 15 A continuous
Dynamic (impulse current)	750 A (half cycle)
Voltage transformer	
Rated voltage V_{nom}	100 V to 225 V
Measuring range	0 V to 200 V
Power consumption at V_{nom} = 100 V	< 0.3 VA per phase
Overload capability in voltage path (phase-neutral voltage)	
Thermal (effective)	230 V continuous

Auxiliary voltage (via integrated converter)

Rated auxiliary voltage V_{aux}	DC	24 / 48 V	60 / 125 V	110 / 250 V	
Permissible tolerance	DC	19 – 58 V	48 – 150 V	88 – 300 V	
Ripple voltage, peak-to-peak		≤ 12 % of rated auxiliary voltage			
Power consumption		7SJ640	7SJ641 7SJ642	7SJ645	7SJ647
Quiescent	Approx.	5 W	5.5 W	6.5 W	7.5 W
Energized	Approx.	9 W	12.5 W	15 W	21 W
Backup time during loss/short-circuit of auxiliary direct voltage		≥ 50 ms at V > DC 110 V ≥ 20 ms at V > DC 24 V			
Rated auxiliary voltage V_{aux}	AC	115 V / 230 V			
Permissible tolerance	AC	92 – 32 V / 184 – 265 V			
Power consumption		7SJ640	7SJ641 7SJ642	7SJ645	7SJ647
Quiescent	Approx.	7 W	9 W	12 W	16 W
Energized	Approx.	12 W	19 W	23 W	33 W
Backup time during loss/short-circuit of auxiliary alternating voltage		≥ 200 ms			

Binary outputs/command outputs

Type	7SJ640	7SJ641	7SJ642	7SJ645	7SJ647
Number (marshallable)	7	15	20	33	48
Voltage range	DC 24 – 250 V				
Pickup threshold modifiable by plug-in jumpers					
Pickup threshold DC	DC 19 V		DC 88 V		
For rated control voltage DC	DC 24/48/60/110/ 125 V		DC 110/125/220/250 V		
Power consumption energized	0.9 mA (independent of operating voltage) for BI 8…19 / 21…32; 1.8 mA for BI 1…7 / 20/33…48				

Binary outputs/command outputs

Type	7SJ640	7SJ641	7SJ642	7SJ645	7SJ647
Command/indication relay	5	13	8	11	21
Contacts per command/ indication relay	1 NO / form A				
Live status contact	1 NO / NC (jumper) / form A / B				
Switching capacity					
Make	1000 W / VA				
Break	30 W / VA / 40 W resistive / 25 W at L/R ≤ 50 ms				
Switching voltage	≤ DC 250 V				
Permissible current	5 A continuous, 30 A for 0.5 s making current, 2000 switching cycles				

Power relay (for motor control)

Type	7SJ640 7SJ641	7SJ642	7SJ645	7SJ647
Number	0	2 (4)	4 (8)	4 (8)
Number of contacts/relay		2 NO / form A		
Switching capacity				
Make	1000 W / VA at 48 V … 250 V / 500 W at 24 V			
Break	1000 W / VA at 48 V … 250 V / 500 W at 24 V			
Switching voltage	≤ DC 250 V			
Permissible current	5 A continuous, 30 A for 0.5 s			

Electrical tests	
Specification	
Standards	IEC 60255 ANSI C37.90, C37.90.1, C37.90.2, UL508
Insulation tests	
Standards	IEC 60255-5; ANSI/IEEE C37.90.0
Voltage test (100 % test) all circuits except for auxiliary voltage and RS485/RS232 and time synchronization	2.5 kV (r.m.s. value), 50/60 Hz
Auxiliary voltage	DC 3.5 kV
Communication ports and time synchronization	AC 500 V
Impulse voltage test (type test) all circuits, except communication ports and time synchronization, class III	5 kV (peak value); 1.2/50 µs; 0.5 J 3 positive and 3 negative impulses at intervals of 5 s
EMC tests for interference immunity; type tests	
Standards	IEC 60255-6; IEC 60255-22 (product standard) EN 50082-2 (generic specification) DIN 57435 Part 303
High-frequency test IEC 60255-22-1, class III and VDE 0435 Part 303, class III	2.5 kV (peak value); 1 MHz; τ =15 ms; 400 surges per s; test duration 2 s
Electrostatic discharge IEC 60255-22-2 class IV and EN 61000-4-2, class IV	8 kV contact discharge; 15 kV air gap 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; AM 80 %; 1 kHz
Irradiation with radio-frequency field, pulse-modulated IEC 61000-4-3/ENV 50204; class III	10 V/m, 900 MHz; repetition rate 200 Hz, on duration 50 %
Fast transient interference/burst IEC 60255-22-4 and IEC 61000-4-4, class IV	4 kV; 5/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; test duration 1 min
High-energy surge voltages (Surge) IEC 61000-4-5; class III	
Auxiliary voltage	From circuit to circuit: 2 kV; 12 Ω; 9 µF across contacts: 1 kV; 2 Ω ;18 µF
Binary inputs/outputs	From circuit to circuit: 2 kV; 42 Ω; 0.5 µF across contacts: 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; AM 80 %; 1 kHz
Power frequency magnetic field IEC 61000-4-8, class IV IEC 60255-6	30 A/m; 50 Hz, continuous 300 A/m; 50 Hz, 3 s 0.5 mT, 50 Hz
Oscillatory surge withstand capability ANSI/IEEE C37.90.1	2.5 to 3 kV (peak value), 1 to 1.5 MHz damped wave; 50 surges per s; duration 2 s, R_i = 150 to 200 Ω
Fast transient surge withstand capability ANSI/IEEE C37.90.1	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	35 V/m; 25 to 1000 MHz; amplitude and pulse-modulated
Damped wave 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 50081-* (generic specification)
Conducted interferences only auxiliary voltage IEC/CISPR 22	150 kHz to 30 MHz Limit class B
Radio interference field strength IEC/CISPR 11	30 to 1000 MHz Limit class B
Units with a detached operator panel must be installed in a metal cubicle to maintain limit class B	

Mechanical stress tests	
Vibration, shock stress and seismic vibration	
<u>During operation</u>	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 10 to 60 Hz; ± 0.075 mm amplitude; 60 to 150 Hz; 1 *g* acceleration frequency sweep 1 octave/min 20 cycles in 3 perpendicular axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Semi-sinusoidal Acceleration 5 *g*, duration 11 ms; 3 shocks in both directions of 3 axes
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 perpendicular axes
<u>During transportation</u>	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 5 to 8 Hz: ± 7.5 mm amplitude; 8 to 150 Hz; 2 *g* acceleration, frequency sweep 1 octave/min 20 cycles in 3 perpendicular axes
Shock IEC 60255-21-2, Class 1 IEC 60068-2-27	Semi-sinusoidal Acceleration 15 *g*, duration 11 ms 3 shocks in both directions of 3 axes
Continuous shock IEC 60255-21-2, class 1 IEC 60068-2-29	Semi-sinusoidal Acceleration 10 *g*, duration 16 ms 1000 shocks in both directions of 3 axes

Climatic stress tests			
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	-20 °C to +70 °C / -4 °F to +158 °F		
Recommended permanent operating temperature acc. to IEC 60255-6 (Legibility of display may be impaired above +55 °C / +131 °F)	-5 °C to +55 °C / +25 °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 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 75 % relative humidity; on 56 days a year up to 95 % relative humidity; condensation not permissible!		
Unit design			
Type	7SJ640 7SJ642	7SJ641	7SJ645 7SJ647
Housing	7XP20		
Dimensions	See dimension drawings, part 14 of this catalog		
Weight in kg	Housing width 1/3	Housing width 1/2	Housing width 1/1
Surface-mounting housing	8	11	15
Flush-mounting housing	5	6	10
Housing for detached operator operator panel	–	8	12
Detached operator panel	–	2.5	2.5
Degree of protection acc. to EN 60529			
Surface-mounting housing	IP 51		
Flush-mounting housing	Front: IP 51, rear: IP 20;		
Operator safety	IP 2x with cover		

Futher information can be found in the current manual at: www.siemens.com/siprotec

Description	Order No.
7SJ64 multifunction protection relay with synchronization	7SJ64□□-□□□□□-□□□□
Housing, binary inputs and outputs	
Housing ⅓ 19", 7 BI, 5 BO, 1 live status contact, text display 4 x 20 character (only for 7SJ640) 9th position only with: **B, D, E**	0
Housing ½ 19", 15 BI, 13 BO (1 NO/NC or 1a/b contact), 1 live status contact, graphic display	1
Housing ½ 19", 20 BI, 8 BO, 2 power relays (4 contacts), 1 live status contact, graphic display	2
Housing 1/1 19", 33 BI, 11 BO, 4 power relays (8 contacts), 1 live status contact, graphic display	5
Housing 1/1 19", 48 BI, 21 BO, 4 power relays (8 contacts), 1 live status contact, graphic display	7
Measuring inputs (4 x V, 4 x I)	
I_{ph} = 1 A[1)], I_e = 1 A[1)] (min. = 0.05 A) Position 15 only with **A, C, E, G**	1
I_{ph} = 1 A[1)], I_e = sensitive (min. = 0.001 A) Position 15 only with **B, D, F, H**	2
I_{ph} = 5 A[1)], I_e = 5 A[1)] (min. = 0.25 A) Position 15 only with **A, C, E, G**	5
I_{ph} = 5 A[1)], I_e = sensitive (min. = 0.001 A) Position 15 only with **B, D, F, H**	6
I_{ph} = 5 A[1)], I_e = 1 A[1)] (min. = 0.05 A) Position 15 only with **A, C, E,G**	7
Rated auxiliary voltage (power supply, binary inputs)	
DC 24 to 48 V, threshold binary input DC 19 V [3)]	2
DC 60 to 125 V [2)], threshold binary input DC19 V [3)]	4
DC 110 to 250 V [2)], AC 115 to 230 V, threshold binary input DC 88 V [3)]	5
Unit version	
Surface-mounting housing, plug-in terminals, detached operator panel, panel mounting in low-voltage housing	A
Surface-mounting housing, 2-tier terminals on top/bottom	B
Surface-mounting housing, screw-type terminals (direct connection/ring-type cable lugs), detached operator panel, panel mounting in low-voltage housing	C
Flush-mounting housing, plug-in terminals (2/3 pin connector)	D
Flush-mounting housing, screw-type terminals (direct connection/ring-type cable lugs)	E
Surface-mounting housing, screw-type terminals (direct connection/ring-type cable lugs), without operator panel, panel mounting in low-voltage housingg	F
Surface-mounting housing, plug-in terminals, without operator panel, panel mounting in low-voltage housing	G
Region-specific default settings / function versions and language settings	
Region DE, 50 Hz, IEC, language: German (language selectable)	A
Region World, 50/60 Hz, IEC/ANSI, language: English (GB) (language selectable)	B
Region US, 60 Hz, ANSI, language: English (US) (language selectable)	C
Region FR, 50/60 Hz, IEC/ANSI, language: French (language selectable)	D
Region World, 50/60 Hz, IEC/ANSI, language: Spanish (language selectable)	E
Region IT, 50/60 Hz, IEC/ANSI, language: Italian (language selectable)	F
Region RU, 50/60 Hz, IEC/ANSI, language: Russian(language can be changed)	G

See next page

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

Selection and ordering data

Description	Order No.	Order code
7SJ64 multifunction protection relay with synchronization	7SJ64□□-□□□□□-□□□□-□□□□	
System interface (on rear of unit, Port B)		
No system interface	0	
IEC 60870-5-103 protocol, RS232	1	
IEC 60870-5-103 protocol, RS485	2	
IEC 60870-5-103 protocol, 820 nm fiber, ST connector	3	
PROFIBUS DP Slave, RS485	9	L 0 A
PROFIBUS DP Slave, 820 nm wavelength, double ring, ST connector 1)	9	L 0 B
MODBUS, RS485	9	L 0 D
MODBUS, 820 nm wavelength, ST connector 2)	9	L 0 E
DNP 3.0, RS485	9	L 0 G
DNP 3.0, 820 nm wavelength, ST connector 2)	9	L 0 H
IEC 60870-5-103 protocol, redundant, RS485, RJ45 connector 2)	9	L 0 P
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector (EN 100)	9	L 0 R
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector (EN 100) 2)	9	L 0 S
DNP3 TCP + IEC 61850, 100Mbit Eth, electrical, double, RJ45 connector 4)	9	L 2 R
DNP3 TCP + IEC 61850, 100Mbit Eth, optical, double, LC connector 4)	9	L 2 S
PROFINET + IEC 61850, 100Mbit Eth, electrical, double, RJ45 connector 4)	9	L 3 R
PROFINET + IEC 61850, 100Mbit Eth, optical, double, LC connector 4)	9	L 3 S
Only Port C (service interface)		
DIGSI 4/modem, electrical RS232	1	
DIGSI 4/modem/RTD-box 3), electrical RS485	2	
Port C and D (service and additional interface)	9	M□□
Port C (service interface)		
DIGSI 4/modem, electrical RS232		1
DIGSI 4/modem/RTD-box 3), electrical RS485		2
PortD(additional interface)		
RTD-box 3), 820 nm fiber, ST connector 5)		A
RTD-box 3), electrical RS485		F
Measuring/fault recording		
Fault recording	1	
Slave pointer,mean values, min/max values, fault recording	3	

See following pages

1) Not with position 9 = "**B**"; if 9 = "**B**", please order 7SJ6 unit with RS485 port and separate fiber-optic converters.
For single ring, please order converter 6GK1502-2CB10, not available with position 9 = "**B**".
For double ring, please order converter 6GK1502-3CB10, not available with position 9 = "**B**".
The converter requires a AC 24 V power supply (e.g. power supply 7XV5810-0BA00).

2) Not available with position 9 = "B".

3) Temperature monitoring box 7XV5662-□AD10, refer to "Accessories".

4) Available with V4.9

5) When using the temperature monitoring box at an optical interface, the additional RS485 fiber-optic converter 7XV5650-0□A00 is required.

Description			Order No. / Order code
7SJ64 multifunction protection relay with synchronization			7SJ64□□-□□□□□-□□□□-□□□□
Designation	ANSI No.	Description	
Basic version		Control	
	50/51	Overcurrent protection $I>$, $I>>$, $I>>>$, I_p	
	50N/51N	Ground-fault protection $I_E>$, $I_E>>$, $I_E>>>$, I_{Ep}	
	50N/51N	Insensitive ground-fault protection through IEE function: $I_{EE}>$, $I_{EE}>>$, I_{EEp} 1)	
	50/50N	Flexible protection functions (index quantities derived from current): Additional time-overcurrent protection stages $I_2>$, $I>>>>$, $I_E>>>>$	
	51 V	Voltage-dependent inverse-time overcurrent protection	
	49	Overload protection (with 2 time constants)	
	46	Phase balance current protection (negative-sequence protection)	
	37	Undercurrent monitoring	
	47	Phase sequence	
	59N/64	Displacement voltage	
	50BF	Breaker failure protection	
	74TC	Trip circuit supervision	
		4 setting groups, cold-load pickup, Inrush blocking	
	86	Lockout	F A
■ *V, P, f*	27/59	Under-/overvoltage	
	81O/U	Under-/overfrequency	
	27/Q	Undervoltage-controlled reactive power protection 3)	
	27/47/59(N)	Flexible protection (index quantities derived from	
	32/55/81R	current and voltages): Voltage, power, p.f., rate-of-frequency-change protection	F E
■ IEF *V, P, f*	27/59	Under-/overvoltage	
	81O/U	Under-/overfrequency	
	27/Q	Undervoltage-controlled reactive power protection 3)	
	27/47/59(N)	Flexible protection (index quantities derived from	
	32/55/81R	current and voltages): Voltage, power, p.f., rate-of-frequency-change protection Intermittent ground fault	P E
■ Dir	67/67N	Direction determination for overcurrent, phases and ground	F C
■ Dir *V, P, f*	67/67N	Direction determination for overcurrent, phases and ground	
	27/59	Under-/overvoltage	
	81O/U	Under-/overfrequency	
	27/Q	Undervoltage-controlled reactive power protection 3)	
	27/47/59(N)	Flexible protection (index quantities derived from	
	32/55/81R	current and voltages): Voltage, power, p.f., rate-of-frequency-change protection	F G
■ Dir V,P,f IEF	67/67N	Direction determination for overcurrent, phases and ground Intermittent ground fault protection	
	27/59	Under-/overvoltage	
	81U/O	Under-/overfrequency	
	27/Q	Undervoltage-controlled reactive power protection 3)	
	27/47/59(N)	Flexible protection functions (quantities derived from current & voltages)	
	32/55/81R	Voltage-/power-/p.f.-/rate of freq. change-protection Intermittent ground-fault	P G
■ Dir IEF	67/67N	Direction determination for overcurrent, phases and ground Intermittent ground fault	P C
Sens.ground-f.det. Motor	67/67N	Direction determination for overcurrent, phases and ground	
Dir V,P,f REF	67Ns	Directional sensitive ground-fault detection	
■	67Ns	Directional intermittent ground fault protection 3)	
	87N	High-impedance restricted ground fault	F D 2)

Continued on next page

■ Basic version included

V, P, f = Voltage, power, frequency protection

Dir = Directional overcurrent protection

IEF = Intermittent ground fault

1) Only with insensitive ground-current transformer when position 7 = **1**, **5**, **7**.

2) For isolated/compensated networks only with sensitive ground-current transformer when position 7 = **2**, **6**.

3) available with V4.9

Overcurrent Protection / 7SJ64

Selection and ordering data

Description			Order No. / Order code
7SJ64 multifunction protection relay with synchronization			7SJ64□□-□□□□□-□□□□-□□□□
Designation	ANSI No.	Description	
Basic version		Control	
	50/51	Overcurrent protection $I>$, $I>>$, $I>>>$, I_p	
	50N/51N	Ground-fault protection $I_E>$, $I_E>>$, $I_E>>>$, I_{Ep}	
	50N/51N	Insensitive ground-fault protection via IEE function: $I_{EE}>$, $I_{EE}>>$, I_{EEp} [1)]	
	50/50N	Flexible protection functions (index quantities derived from current): Additional time-overcurrent protection stages $I_2>$, $I>>>>$, $I_E>>>>$	
	51 V	Voltage-dependent inverse-time overcurrent protection	
	49	Overload protection (with 2 time constants)	
	46	Phase balance current protection (negative-sequence protection)	
	37	Undercurrent monitoring	
	47	Phase sequence	
	59N/64	Displacement volt	
	50BF	Breaker failure protection	
	74TC	Trip circuit supervision	
		4 setting groups, cold-load pickup	
		Inrush blocking	
	86	Lockout	
Sens.ground-f.det. Motor	67Ns	Directional sensitive ground-fault detection	
Dir V,P,f REF	67Ns	Directional intermittent ground fault protection [3)]	
■	87N	High-impedance restricted ground fault	
	27/59	Under-/overvoltage	
	81O/U	Under-/overfrequency	
	27/Q	Undervoltage-controlled reactive power protection [3)]	
	27/47/59(N)	Flexible protection (index quantities derived from	
	32/55/81R	current and voltages): Voltage, power, p.f., rate-of-frequency-change protection	F F [2)]
Sens.ground-f.det. Motor IEF	67/67N	Directional sensitive ground-fault detection, phases and ground	
Dir V,P,f REF	67Ns	Directional sensitive ground-fault detection	
	67Ns	Directional intermittent ground fault protection [3)]	
■	87N	High-impedance restricted ground fault	
		Intermittent ground fault	P D [2)]
Sens.ground-f.det. Motor	67Ns	Directional sensitive ground-fault detection	
Dir V,P,f REF	67Ns	Directional intermittent ground fault protection [3)]	
■	87N	High-impedance restricted ground fault	F B [2)]
Sens.ground-f.det. Motor	67Ns	Directional sensitive ground-fault detection	
Dir V,P,f REF	67Ns	Directional intermittent ground fault protection [3)]	
■	87N	High-impedance restricted ground fault	
	48/14	Starting time supervision, locked rotor	
	66/86	Restart inhibit	
	51M	Load jam protection, motor statistics	
	27/59	Under-/overvoltage	
	81O/U	Under-/overfrequency	
	27/Q	Undervoltage-controlled reactive power protection [3)]	
	27/47/59(N)	Flexible protection (index quantities derived from	
	32/55/81R	current and voltages): Voltage, power, p.f., rate-of-frequency-change protection	H F [2)]
Sens.ground-f.det. Motor	67/67N	Direction determination for overcurrent, phases and ground	
Dir V,P,f REF	67Ns	Directional sensitive ground-fault detection	
	67Ns	Directional intermittent ground fault protection [3)]	
	87N	High-impedance restricted ground fault	
	48/14	Starting time supervision, locked rotor	
	66/86	Restart inhibit	
	51M	Load jam protection, motor statistics	
	27/59	Under-/overvoltage	
	81O/U	Under-/overfrequency	
	27/Q	Undervoltage-controlled reactive power protection [3)]	
	27/47/59(N)	Flexible protection (index quantities derived from	
	32/55/81R	current and voltages): Voltage, power, p.f., rate-of-frequency-change protection	H H [2)]

■ Basic version included

V, P, f = Voltage, power, frequency protection

Dir = Directional overcurrent protection

IEF = Intermittent ground fault

1) Only with insensitive ground-current transformer when position 7 = **1**, **5**, **7**.

2) For isolated/compensated networks only with sensitive ground-current transformer when position 7 = **2**, **6**.

3) available with V4.9

Continued on next page

Description			Order No.	Order code
7SJ64 multifunction protection relay with synchronization			7SJ64□□-□□□□□-□□□□-□□□□	
Designation	ANSI No.	Description		
Basic version		Control		
	50/51	Overcurrent protection $I>$, $I>>$, $I>>>$, I_p		
	50N/51N	Ground-fault protection $I_E>$, $I_E>>$, $I_E>>>$, I_{Ep}		
	50N/51N	Insensitive ground-fault protection via IEE function: $I_{EE}>$, $I_{EE}>>$, I_{EEp} 1)		
	50/50N	Flexible protection functions (index quantities derived from current): Additional time-overcurrent protection stages $I_2>$, $I>>>>$, $I_E>>>>$		
	51 V	Voltage-dependent inverse-time overcurrent protection		
	49	Overload protection (with 2 time constants)		
	46	Phase balance current protection (negative-sequence protection)		
	37	Undercurrent monitoring		
	47	Phase sequence		
	59N/64	Displacement voltage		
	50BF	Breaker failure protection		
	74TC	Trip circuit supervision		
		4 setting groups, cold-load pickup		
		Inrush blocking		
	86	Lockout		
Sens.ground-f.det. Motor Dir V,P,f REF ■	67/67N	Direction determination for overcurrent, phases and ground		
	67Ns	Directional sensitive ground-fault detection		
	67Ns	Directional intermittent ground fault protection 3)		
	87N	High-impedance restricted ground fault		
		Intermittent ground fault		
	48/14	Starting time supervision, locked rotor		
	66/86	Restart inhibit		
	51M	Load jam protection, motor statistics		
	27/59	Undervoltage/overvoltage		
	81O/U	Underfrequency/overfrequency		
	27/Q	Undervoltage-controlled reactive power protection 3)		
	27/47/59(N)	Flexible protection (index quantities derived from		
	32/55/81R	current and voltages): Voltage, power, p.f., rate-of-frequency-change protection	R H 2)	
■ Motor Dir *V, P, f*	67/67N	Direction determination for overcurrent, phases and ground		
	48/14	Starting time supervision, locked rotor		
	66/86	Restart inhibit		
	51M	Load jam protection, motor statistics		
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27/Q	Undervoltage-controlled reactive power protection 3)		
	27/47/59(N)	Flexible protection (index quantities derived from		
	32/55/81R	current and voltages): Voltage, power, p.f., rate-of-frequency-change protection	H G	
■ Motor	48/14	Starting time supervision, locked rotor		
	66/86	Restart inhibit		
	51M	Load jam protection, motor statistics	H A	
ARC, fault locator, synchronization				
	Without		0	
	79	With auto-reclosure	1	
	21FL	With fault locator	2	
	79, 21FL	With auto-reclosure, with fault locator	3	
	25	With synchronization	4	
	25, 79,21FL	With synchronization, auto-reclosure, fault locator	7	
ATEX100 Certification For protection of explosion-protected motors (increased-safety type of protection "e")				Z X 9 9 2)

■ Basic version included

V, P, f = Voltage, power, frequency protection

Dir = Directional overcurrent protection

1) Only with insensitive ground-current transformer when position 7 = **1**, **5**, **7**.

2) This variantmight be supplied with a previous firmware version.

3) available with V4.9

5

Selection and ordering data

5

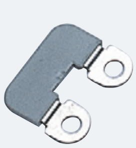
Accessories	Description	Order No.
	Temperature monitoring box	
	AC/DC 24 to 60 V	**7XV5662-2AD10**
	AC/DC 90 to 240 V	**7XV5662-5AD10**
	Varistor/VoltageArrester	
	Voltage arrester for high-impedance REF protection 125 Vrms; 600 A; 1S/S 256	**C53207-A401-D76-1**
	240 Vrms; 600 A; 1S/S 1088	**C53207-A401-D77-1**
	Connecting cable	
	Cable between PC / notebook (9-pin con.) and protection unit (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)	**7XV5100-4**
	Cable between temperature monitoring box and SIPROTEC 4 unit	
	- length 5 m / 16.4 ft	**7XV5103-7AA05**
	- length 25 m / 82 ft	**7XV5103-7AA25**
	- length 50 m / 164 ft	**7XV5103-7AA50**
	Manual for 7SJ64	
	English /German	**C53000-G1100-C147-x** 1)

1) x = please inquire for latest edition (exact Order No.).

Mounting rail

2-pin connector

3-pin connector

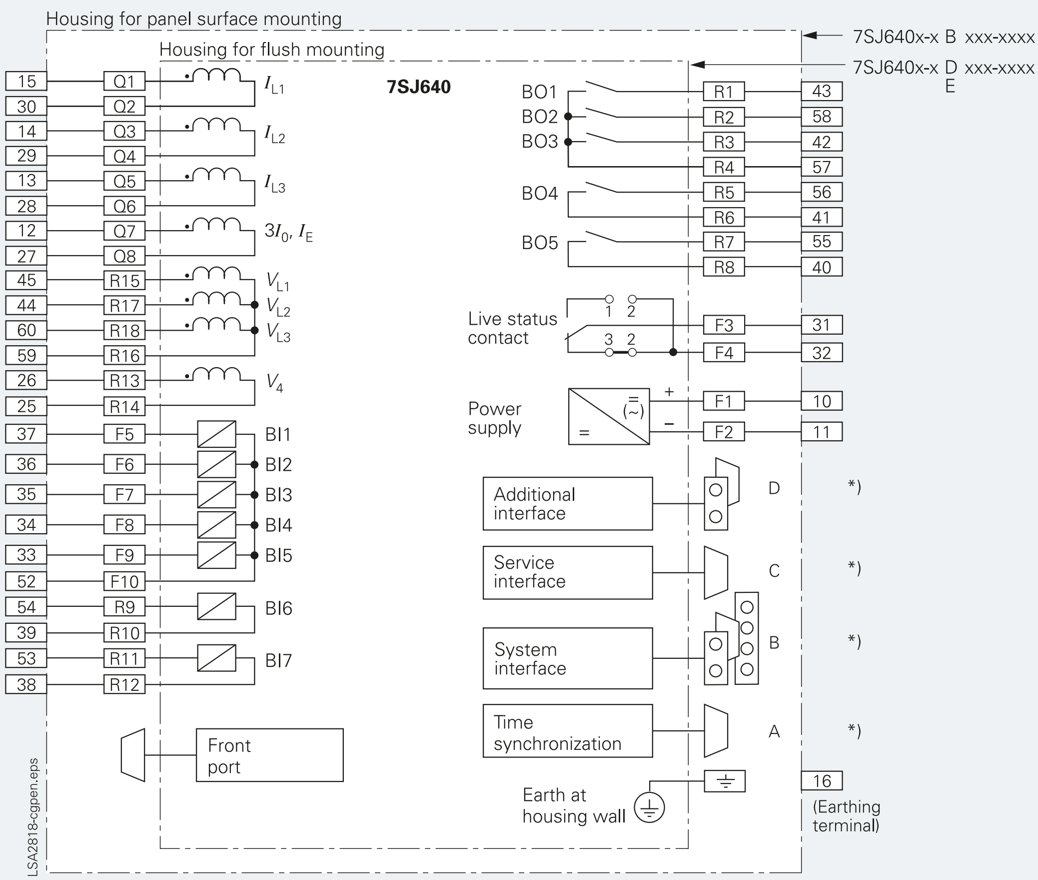


Short-circuit links for current terminals

Short-circuit links for current terminals

Description	Order No.	Size of package	Supplier
Terminal safety cover			
Voltage/current terminal 18-pole/12-pole	**C73334-A1-C31-1**	1	Siemens
Voltage/current terminal 12-pole/8-pole	**C73334-A1-C32-1**	1	Siemens
Connector 2-pin	**C73334-A1-C35-1**	1	Siemens
Connector 3-pin	**C73334-A1-C36-1**	1	Siemens
Crimp connector CI2 0.5 to 1 mm^2	**0-827039-1**	4000 taped on reel	1)
Crimp connector CI2 0.5 to 1 mm^2	**0-827396-1**	1	1)
Crimp connector: Type III+ 0.75 to 1.5 mm^2	**0-163084-2**	1	1)
Crimp connector: Type III+ 0.75 to 1.5 mm^2	**0-163083-7**	4000 taped on reel	1)
Crimping tool for Type III+	**0-539635-1**	1	1)
and matching female	**0-539668-2**	1	1)
Crimping tool for CI2	**0-734372-1**	1	1)
and matching female	**1-734387-1**	1	1)
Short-circuit links			
for current terminals	**C73334-A1-C33-1**	1	Siemens
for other terminals	**C73334-A1-C34-1**	1	Siemens
Mounting rail for 19" rack	**C73165-A63-D200-1**	1	Siemens

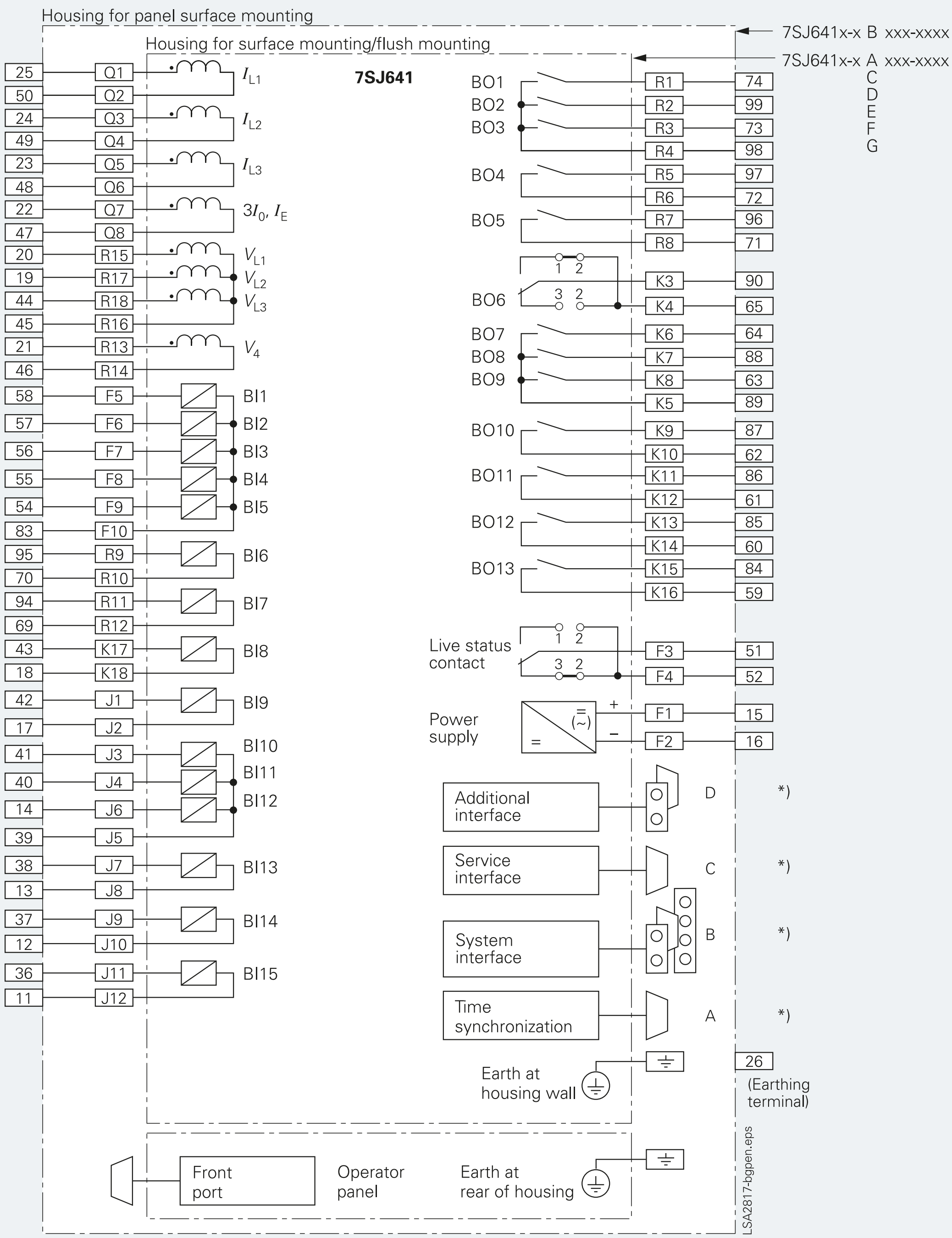
1) Your local Siemens representative can inform you on local suppliers.



*) For pinout of communication ports see part 14 of this catalog.
For the allocation of the terminals of the panel surface-mounting version refer to the manual (http://www.siemens.com/siprotec).

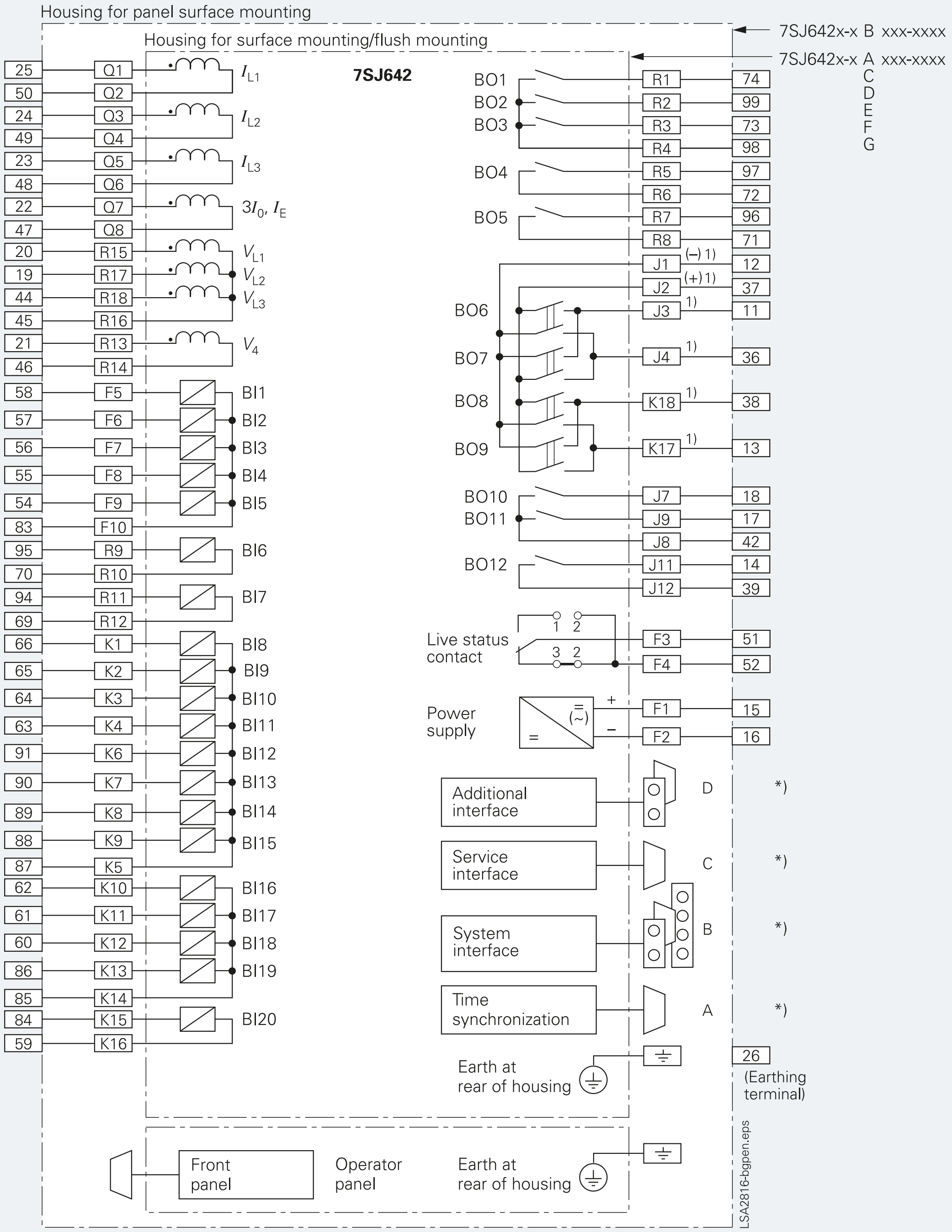
Fig. 5/121 7SJ640 connection diagram

Connection diagram



*) For pinout of communication ports see part 14 of this catalog.
For the allocation of the terminals of the panel surface-mounting version refer to the manual (http://www.siemens.com/siprotec).

Fig. 5/122 7SJ641 connection diagram

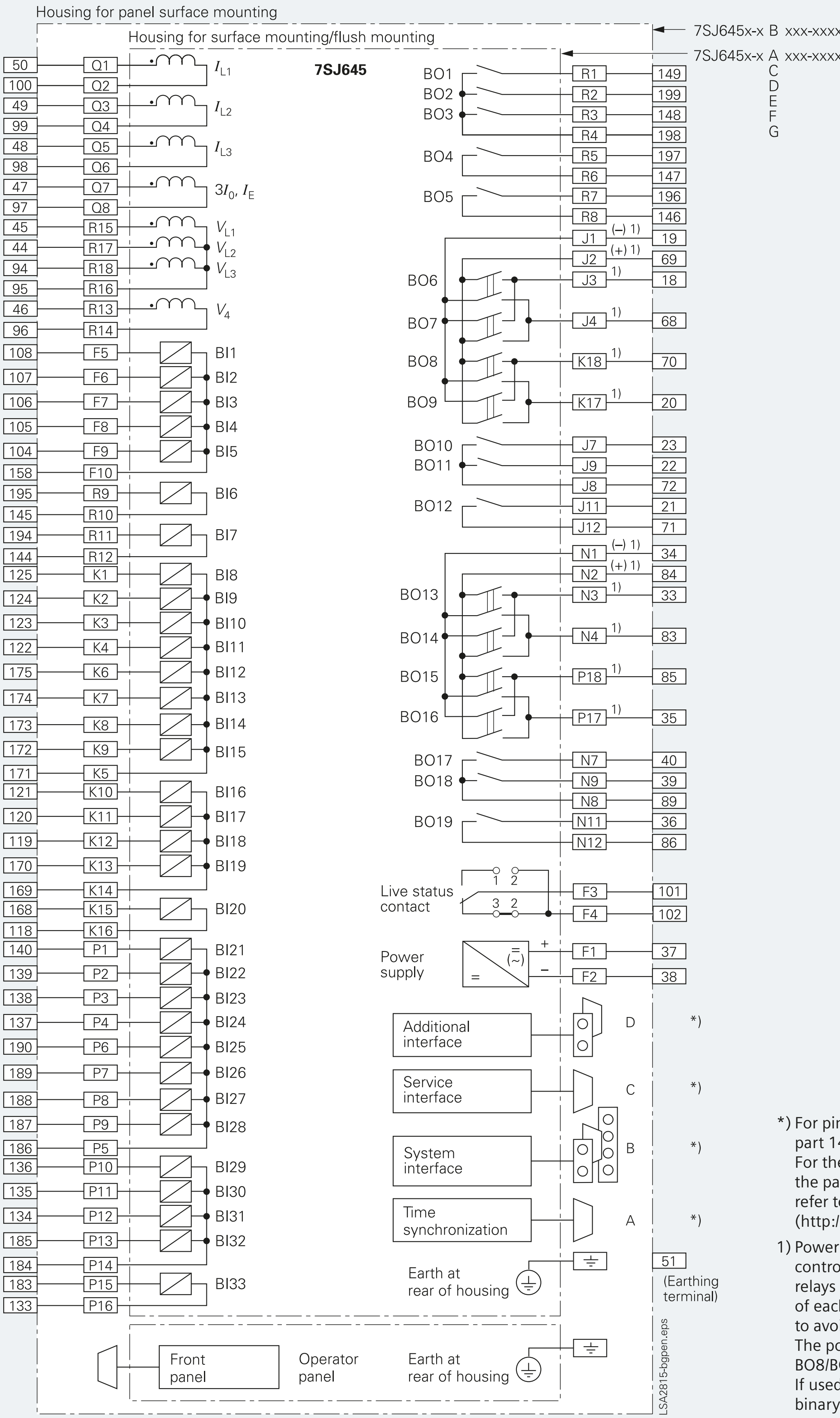


*) For pinout of communication ports see part 14 of this catalog.
For the allocation of the terminals of the panel surface-mounting version refer to the manual (http://www.siemens.com/siprotec).

1) Power relays are intended to directly control motorized switches. The power relays are interlocked so only one relay of each pair can close at a time, in order to avoid shorting out the power supply. The power relay pairs are BO6/BO7, BO8/BO9. If used for protection purposes only one binary output of a pair can be used.

Fig. 5/123 7SJ642 connection diagram

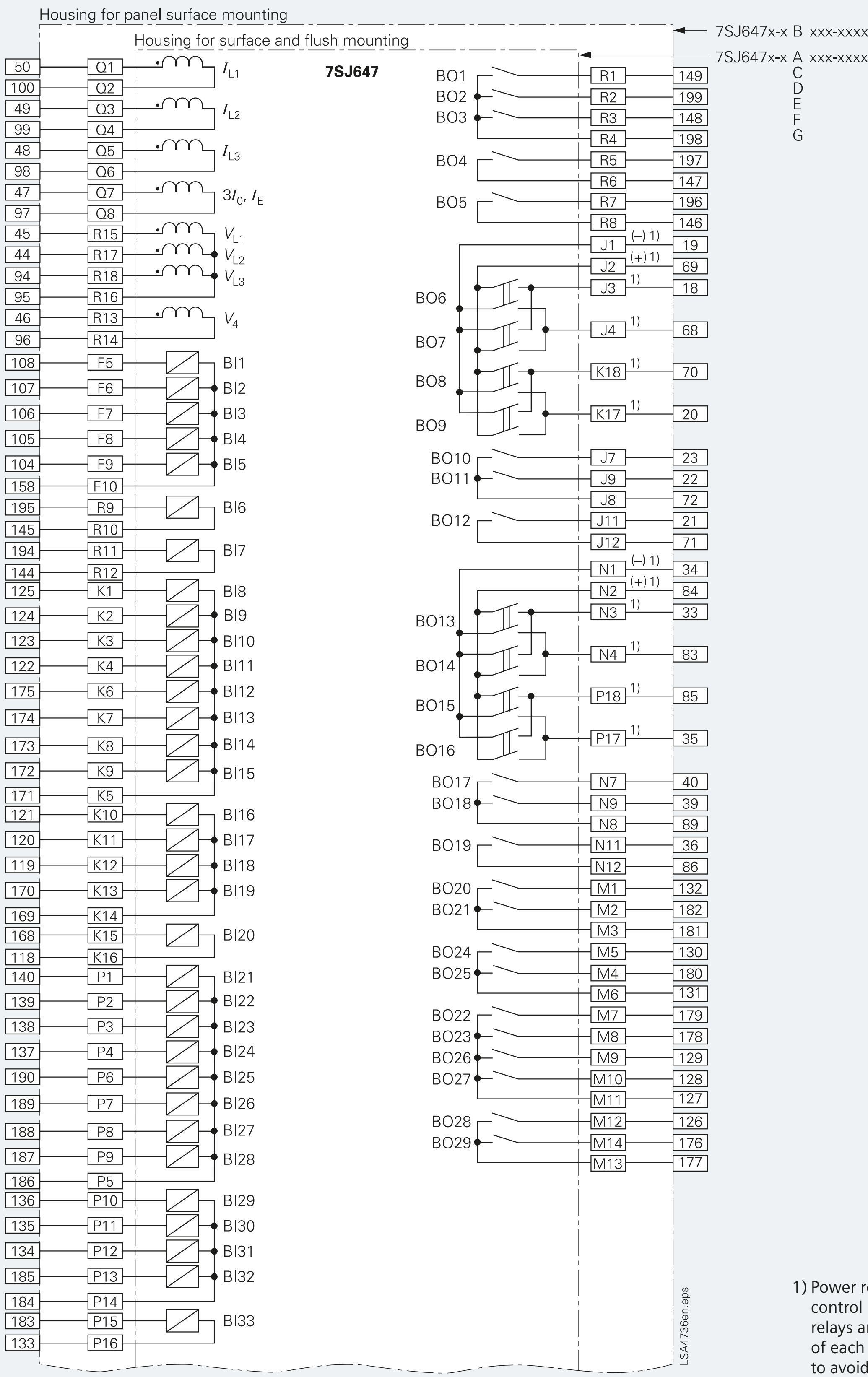
Connection diagram



*) For pinout of communication ports see part 14 of this catalog.
For the allocation of the terminals of the panel surface-mounting version refer to the manual (http://www.siemens.com/siprotec).

1) Power relays are intended to directly control motorized switches. The power relays are interlocked so only one relay of each pair can close at a time, in order to avoid shorting out the power supply. The power relay pairs are BO6/BO7, BO8/BO9, BO13/BO14, BO15/BO16. If used for protection purposes only one binary output of a pair can be used.

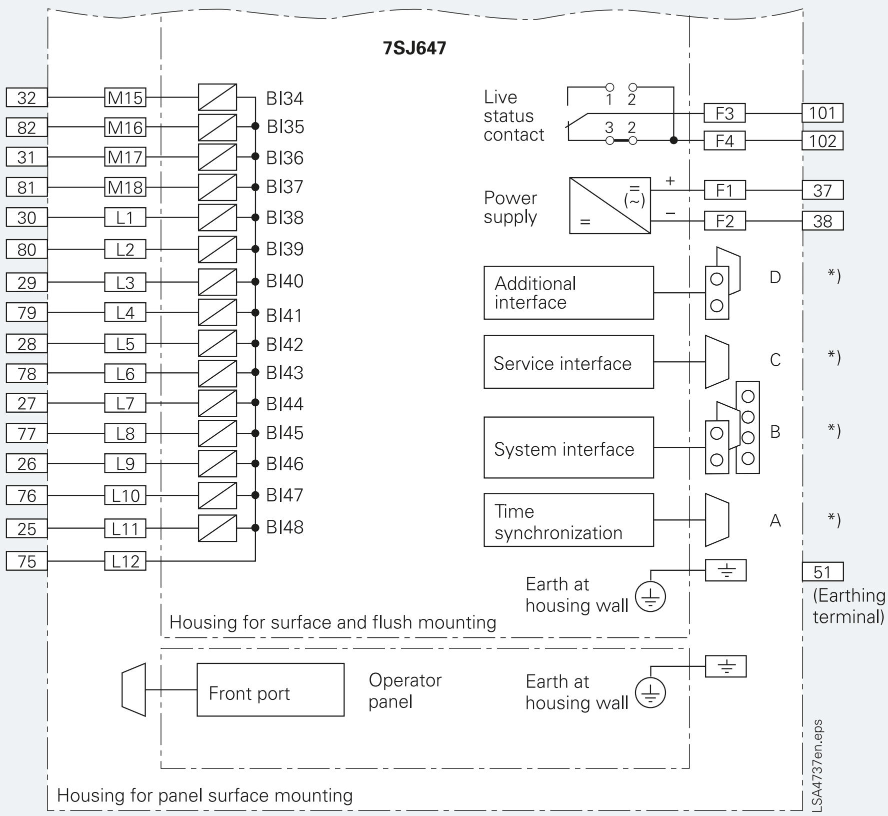
Fig. 5/124 7SJ645 connection diagram



1) Power relays are intended to directly control motorized switches. The power relays are interlocked so only one relay of each pair can close at a time, in order to avoid shorting out the power supply. The power relay pairs are BO6/BO7, BO8/BO9, BO13/BO14, BO15/BO16. If used for protection purposes only one binary output of a pair can be used.

Fig. 5/125 7SJ647 connection diagram part 1; continued on following page

Connection diagram



*) For pinout of communication ports see part 14 of this catalog.
For the allocation of the terminals of the panel surface-mounting version refer to the manual (http://www.siemens.com/siprotec).

Fig. 5/126 7SJ647 connection diagram part 2