SIPROTEC 4 7UM61 multifunction generator and motor protection relay

Fig. 11/1 SIPROTEC 4 7UM61 multifunction generator and motor protection relay

Description

The SIPROTEC 4 7UM61 protection relays can do more than just protect. They also offer numerous additional functions. Be it ground faults, short-circuits, overloads, overvoltage, overfrequency or underfrequency, protection relays assure continued operation of power stations. The SIPROTEC 4 7UM61 protection relay is a compact unit which has been specially developed and designed for the protection of small and medium-sized generators. They integrate all the necessary protection functions and are particularly suited for the protection of:

– Hydro and pumped-storage generators
– Co-generation stations
– Private power stations using regenerative energy sources such as wind or biogases
– Diesel generator stations
– Gas-turbine power stations
– Industrial power stations
– Conventional steam power stations.

The device can also be used for protecting synchronous and asynchronous motors.

The integrated programmable logic functions (continuous function chart CFC) offer the user high flexibility so that adjustments can easily be made to the varying power station requirements, on the basis of special system conditions.

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

Function overview

Basic version

- Stator ground-fault protection
- Sensitive ground-fault protection
- Stator overload protection
- Overcurrent-time protection (either definite-time or inverse-time)
- Definite-time overcurrent-time protection, directional
- Undervoltage and overvoltage protection
- Underfrequency and overfrequency protection
- Reverse power protection
- Overexcitation protection
- External trip coupling

Standard version

Scope of basic version plus:

- Forward-power protection
- Underexcitation protection
- Negative-sequence protection
- Breaker failure protection

Full version

Scope of standard version plus:

- Inadverdent energization protection
- 100 %-stator ground-fault protection with 3rd harmonic
- Impedance protection

Asynchronous motor

Scope of standard version plus

- Motor starting time supervision
- Restart inhibit (without underexcitation protection)

Monitoring functions

- Trip circuit supervision
- Fuse failure monitor
- Operational measured values V, I, f, ...
- Every metering value W_p, W_q
- Time metering of operation hours
- Self-supervision of relay
- 8 oscillographic fault records

Communication interfaces

- System interface
  – IEC 60870-5-103 protocol
  – PROFIBUS-DP
  – MODBUS RTU
  – DNP 3.0

Generator Protection / 7UM61

Application

Application

The 7UM6 protection relays of the SIPROTEC 4 family are compact multifunction units which have been developed for small to medium-sized power generation plants. They incorporate all the necessary protective functions and are especially suitable for the protection of:

– Hydro and pumped-storage generators
– Co-generation stations
– Private power stations using regenerative energy sources such as wind or biogases
– Power generation with diesel generators
– Gas turbine power stations
– Industrial power stations
– Conventional steam power stations.

They can also be employed for protection of motors and transformers.

The numerous other additional functions assist the user in ensuring cost-effective system management and reliable power supply. Measured values display current operating conditions. Stored status indications and fault recording provide assistance in fault diagnosis not only in the event of a disturbance in generator operation.

Combination of the units makes it possible to implement effective redundancy concepts.

Protection functions

Numerous protection functions are necessary for reliable protection of electrical machines. Their extent and combination are determined by a variety of factors, such as machine size, mode of operation, plant configuration, availability requirements, experience and design philosophy.

This results in multifunctionality, which is implemented in outstanding fashion by numerical technology.

In order to satisfy differing requirements, the combination of functions is scalable (see Table 11/1). Selection is facilitated by division into groups.

Protection functions	Abbreviation	ANSI No.	Generator			
			Basic	Standard	Full	Motor async.
Stator ground-fault protection non-directional, directional	V_0>, $3I_0$> \(V_0, $3I_0$)	59N, 64G, 67G	■	■	■	■
Sensitive ground-fault protection (also rotor ground-fault protection)	I_{EE}>	50/51GN (64R)	■	■	■	■
Stator overload protection	I^2t	49	■	■	■	■
Definite-time overcurrent protection with undervoltage seal-in	I> +V<	51	■	■	■	■
Definite-time overcurrent protection, directional	I>>, Direc.	50/51/67	■	■	■	■
Inverse-time overcurrent protection	$t = f(I)$+V<	51V	■	■	■	■
Overvoltage protection	V>	59	■	■	■	■
Undervoltage protection	V<	27	■	■	■	■
Frequency protection	f<, f>	81	■	■	■	■
Reverse-power protection	$-P$	32R	■	■	■	■
Overexcitation protection (Volt/Hertz)	V/f	24	■	■	■	
Fuse failure monitor	V_2/V_1, I_1/I_2	60FL	■	■	■	■
External trip coupling (7UM611/612)	Incoup.		2/4	2/4	2/4	2/4
Trip circuit supervision (7UM612)	T.C.S.	74TC	■	■	■	■
Forward-power protection	P>, P<	32F		■	■	■
Underexcitation protection	1/xd	40		■	■	
Negative-sequence protection	I_2>, $t = f(I_2)$	46		■	■	■
Breaker failure protection	I_{min}>	50BF		■	■	■
Inadvertent energization protection	I>, V<	50/27			■	
100 %-stator-ground-fault protection with 3rd harmonics	$V_{0(3^{rd}\ harm)}$	59TN 27TN (3^{rd} harm)			■	
Impedance protection with (I>+V<)-pickup	Z<	21			■	
Motor starting time supervision	$I_{an}{}^2t$	48			■	■
Restart inhibit for motors	I^2t	49 Rotor			■	■
External temperature monitoring through serial interface	ϑ (Thermo-box)	38	■	■	■	■
Rate-of-frequency-change protection[1)]	df/dt >	81R	■	■	■	■
Vector jump supervision (voltage)[1)]	$\Delta\varphi$ >		■	■	■	■

1) Available as an option (please refer to Order No., position 15).

Table 11/1 Scope of functions of the 7UM61

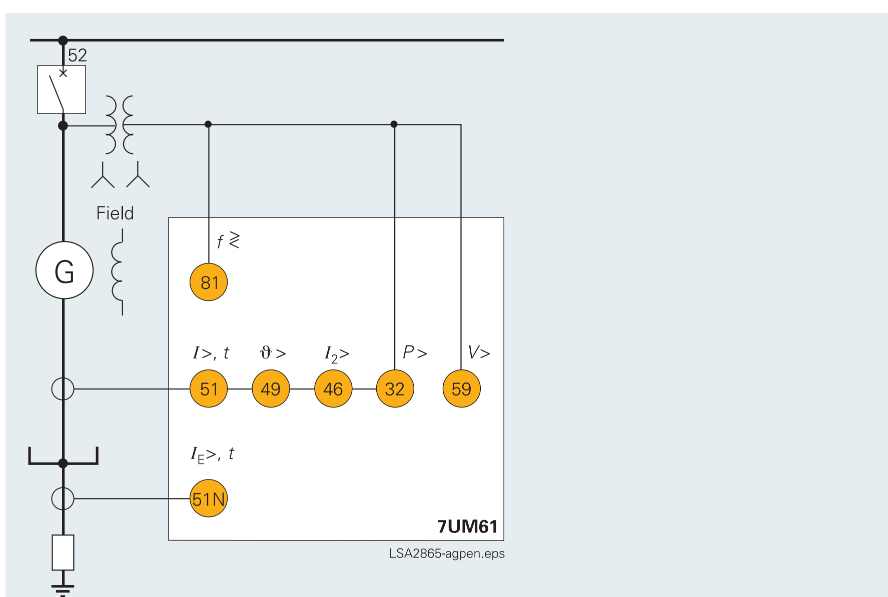

Fig. 11/2 Overview

11

Generator Basic

One application is concentrated on small generators or as backup protection for larger generators. The function mix is also an effective addition to transformer differential protection with parallel-connected transformers. The functions are also suitable for system disconnection.

Generator Standard

This function mix is recommended for generator outputs exceeding 1 MVA. It is also suitable for protection of synchronous motors. Another application is as backup protection for the larger block units.

Generator Full

Here, all protection functions are available and are recommended from generator outputs exceeding 5 MVA. Backup protection for the larger block units is also a recommended application.

Asynchronous motor

This protection function mix is recommended for motors up to 1 – 2 MW. It offers a wide frequency operating range from 11 Hz to 69 Hz. When an infeed is switched, the protection adapts to the changed voltage and frequency.

Construction

The SIPROTEC 4 units have a uniform design and a degree of functionality which represents a whole new quality in protection and control. Local operation has been designed according to ergonomic criteria. Large, easy-to-read displays were a major design aim. The DIGSI 4 operating program considerably simplifies planning and engineering and reduces commissioning times.

The 7UM611 is configured in ⅓ 19 inch, and the 7UM612 in ½ 19 inch width. This means that the units of previous models can be replaced. The height throughout all housing width increments is 243 mm.

All wires are connected directly or by means of ring-type cable lugs.

Alternatively, versions with plug-in terminals are also available. These permit the use of prefabricated cable harnesses.

In the case of panel surface mounting, the connecting terminals are in the form of screw-type terminals at top and bottom. The communication interfaces are also arranged on the same sides.

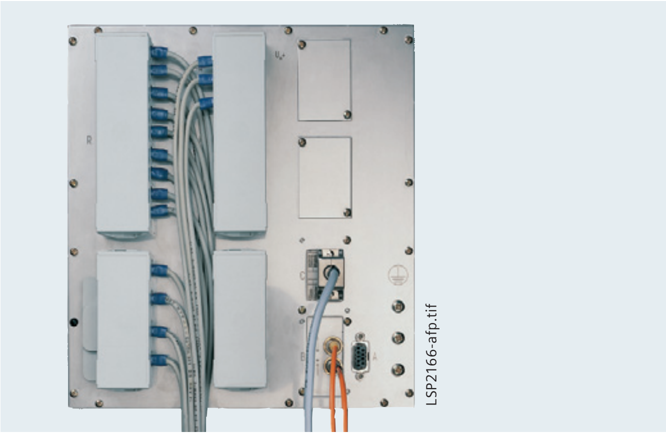

Fig. 11/3 Rear view with wiring terminal safety cover and serial interface

11

Protection functions

Definite-time overcurrent protection $I>$, $I>>$ (ANSI 50, 51, 67)

This protection function comprises the short-circuit protection for the generator and also the backup protection for upstream devices such as transformers or power system protection.

An undervoltage stage at $I>$ maintains the pickup when, during the fault, the current falls below the threshold. In the event of a voltage drop on the generator terminals, the static excitation system can no longer be sufficiently supplied. This is one reason for the decrease of the short-circuit current.

The $I>>$ stage can be implemented as high-set instantaneous trip stage. With the integrated directional function it can be applied for generators without star point CT (see Figure 11/4).

Inverse-time overcurrent protection (ANSI 51V)

This function also comprises short-circuit and backup protection and is used for power system protection with current-dependent protection devices.

IEC and ANSI characteristics can be selected (Table 11/2).

The current function can be controlled by evaluating the generator terminal voltage.

The "controlled" version releases the sensitive set current stage.

With the "restraint" version, the pickup value of the current is lowered linearly with decreasing voltage.

The fuse failure monitor prevents unwanted operation.

Stator overload protection (ANSI 49)

The task of the overload protection is to protect the stator windings of generators and motors from high, continuous overload currents. All load variations are evaluated by the mathematical model used. The thermal effect of the r.m.s. current value forms the basis of the calculation. This conforms to IEC 60255-8.
In dependency of the current the cooling time constant is automatically extended. If the ambient temperature or the temperature of the coolant are injected via PROFIBUS-DP, the model automatically adapts to the ambient conditions; otherwise a constant ambient temperature is assumed.

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Negative-sequence protection (ANSI 46)

Asymmetrical current loads in the three phases of a generator cause a temperature rise in the rotor because of the negative sequence field produced.

This protection detects an asymmetrical load in three-phase generators. It functions on the basis of symmetrical components and evaluates the negative sequence of the phase currents.
The thermal processes are taken into account in the algorithm and form the inverse characteristic. In addition, the negative sequence is evaluated by an independent stage (alarm and trip) which is supplemented by a time-delay element (see Fig. 11/5).

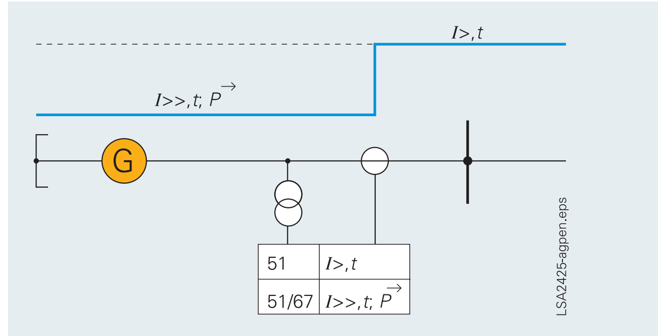

Fig. 11/4 Protection with current transformer on terminal side

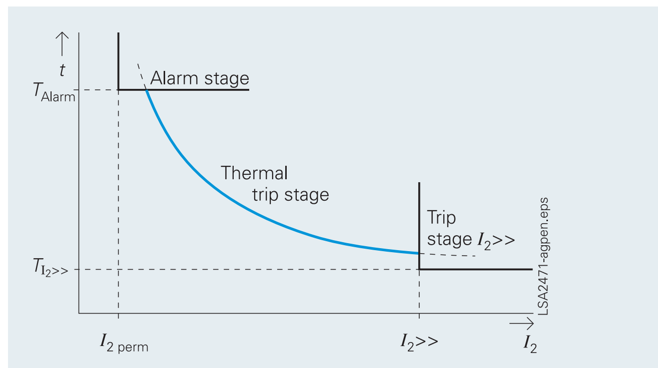

Fig. 11/5 Characteristic of negative-sequence protection

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

Table 11/2

Underexcitation protection (ANSI 40) (Loss-of-field protection)

Derived from the generator terminal voltage and current, the complex admittance is calculated and corresponds to the generator diagram scaled in per unit. This protection prevents damage due to loss of synchronism resulting from underexcitation. The protection function provides three characteristics for monitoring static and dynamic stability. In the event of exciter failure, fast response of the protection can be ensured via binary input. This input releases a timer with a short time delay.

The straight-line characteristics allow the protection of the generator diagram to be optimally adapted (see Fig. 11/6). The per-unit-presentation of the diagram allows the setting values to be directly read out.

The positive-sequence systems of current and voltage are used to calculate the admittance. This ensures that the protection always operates correctly even with asymmetrical network conditions.

If the voltage deviates from the rated voltage, the admittance calculation has the advantage that the characteristics move in the same direction as the generator diagram.

Reverse-power protection (ANSI 32R)

The reverse-power protection monitors the direction of active power flow and picks up when the mechanical energy fails because then the drive power is taken from the network. This function can be used for operational shut-down (sequential tripping) of the generator but also prevents damage to the steam turbines. The reverse power is calculated from the positive-sequence systems of current and voltage. Asymmetrical network faults therefore do not cause reduced measuring accuracy. The position of the emergency trip valve is injected as binary information and is used to switch between two trip command delays. When applied for motor protection, the sign (±) of the active power can be reversed via parameters.

Forward-power protection (ANSI 32F)

Monitoring of the active power produced by a generator can be useful for starting up and shutting down generators. One stage monitors threshold beyond one limit value while another stage monitors threshold below another limit value. The power is calculated using the positive-sequence component of current and voltage.

Impedance protection (ANSI 21)

This fast short-circuit protection protects the generator, the generator transformer and is a backup protection for the power system. This protection has two settable impedance stages; in addition, the first stage can be switched over via binary input. With the circuit-breaker in "open" position (see Fig. 11/7) the impedance measuring range can be extended. The overcurrent pickup element with under-voltage seal-in ensures a reliable pickup and the loop selection logic a reliable detection of the faulty loop. With this logic it is possible to perform a correct measurement via the unit transformer.

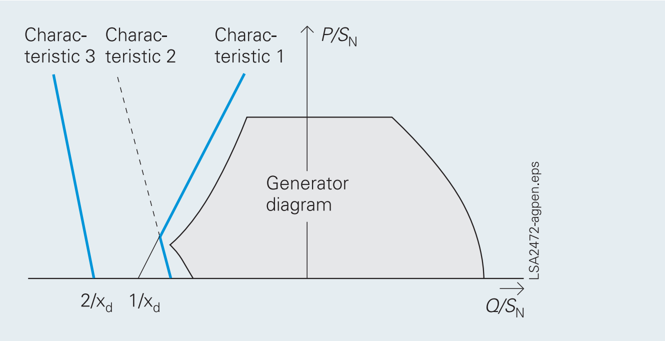

Fig. 11/6 Characteristic of underexcitation protection

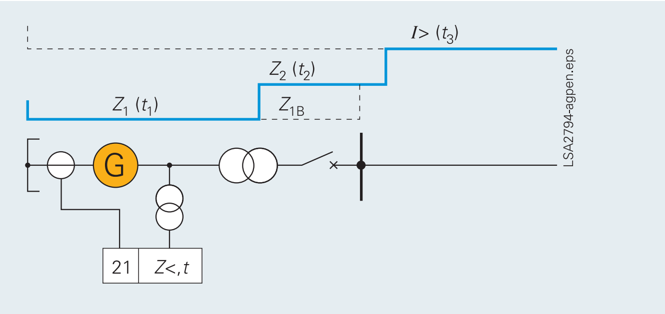

Fig. 11/7 Grading of impedance protection

Undervoltage protection (ANSI 27)

The undervoltage protection evaluates the positive-sequence components of the voltages and compares them with the threshold values. There are two stages available.

The undervoltage function is used for asynchronous motors and pumped-storage stations and prevents the voltage-related instability of such machines.

The function can also be used for monitoring purposes.

Overvoltage protection (ANSI 59)

This protection prevents insulation faults that result when the voltage is too high.

Either the maximum line-to-line voltages or the phase-to-ground voltages (for low-voltage generators) can be evaluated. The measuring results of the line-to-line voltages are independent of the neutral point displacement caused by ground-faults. This function is implemented in two stages.

Frequency protection (ANSI 81)

The frequency protection prevents impermissible stress of the equipment (e.g. turbine) in case of under or overfrequency. It also serves as a monitoring and control element.

The function has four stages; the stages can be implemented either as under-frequency or overfrequency protection. Each stage can be delayed separately.

Even in the event of voltage distortion, the frequency measuring algorithm reliably identifies the fundamental waves and determines the frequency extremely precisely. Frequency measurement can be blocked by using an undervoltage stage.

Overexcitation protection Volt/Hertz (ANSI 24)

The overexcitation protection serves for detection of an unpermissible high induction (proportional to V/f) in generators or transformers, which leads to thermal overloading. This may occur when starting up, shutting down under full load, with weak systems or under isolated operation. The inverse characteristic can be set via seven points derived from the manufacturer data.

In addition, a definite-time alarm stage and an instantaneous stage can be used.

For calculation of the V/f ratio, frequency and also the highest of the three line-to-line voltages are used. The frequency range that can be monitored comprises 11 to 69 Hz.

Stator ground-fault protection, non-directional, directional (ANSI 59N, 64G, 67G)

Ground faults manifest themselves in generators that are operated in isolation by the occurrence of a displacement voltage. In case of unit connections, the displacement voltage is an adequate, selective criterion for protection.

For the selective ground-fault detection, the direction of the flowing ground current has to be evaluated too, if there is a direct connection between generator and busbar.

The protection relay measures the displacement voltage at a VT located at the transformer star point or at the broken delta-winding of a VT. As an option, it is also possible to calculate the zero-sequence voltage from the phase-to-ground voltages. Depending on the load resistor selection, 90 to 95 % of the stator winding of a generator can be protected.

A sensitive current input is available for ground-current measurement. This input should be connected to a core-balance current transformer. The fault direction is deduced from the displacement voltage and ground current. The directional characteristic (straight line) can be easily adapted to the system conditions. Effective protection for direct connection of a generator to a busbar can therefore be established. During start-up, it is possible to switch over from the directional to the displacement voltage measurement via an externally injected signal.

Depending on the protection setting, various ground-fault protection concepts can be implemented with this function (see Figs. 11/17 to 11/21).

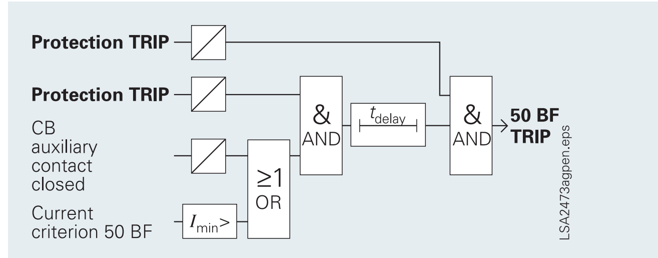

Fig. 11/8 Logic diagram of breaker failure protection

Sensitive ground-fault protection (ANSI 50/51GN, 64R)

The sensitive ground-current input can also be used as separate ground-fault protection. It is of two-stage form. Secondary ground currents of 2 mA or higher can be reliably handled.

Alternatively, this input is also suitable as rotor ground-fault protection. A voltage with rated frequency (50 or 60 Hz) is connected in the rotor circuit via the interface unit 7XR61. If a higher ground current is flowing, a rotor ground fault has occurred. Measuring-circuit monitoring is provided for this application (see Figure 11/20).

100 % stator ground-fault protection with 3rd harmonic (ANSI 59TN, 27TN (3rd H.))

Owing to the design, the generator produces a 3rd harmonic that forms a zero system. It is verifiable by the protection on a broken delta winding or on the neutral transformer. The magnitude of the voltage amplitude depends on the generator and its operation.

In the event of an ground fault in the vicinity of the neutral point, there is a voltage displacement in the 3rd harmonic (dropping in the neutral point and rising at the terminals).

Depending on the connection, the protection must be set in either undervoltage or overvoltage form. It can also be delayed. So as to avoid overfunction, the active power and the positive-sequence voltage act as enabling criteria.

The final protection setting can be made only by way of a primary test with the generator.

Breaker failure protection (ANSI 50BF)

In the event of scheduled downtimes or a fault in the generator, the generator can remain on line if the circuit-breaker is defective and could suffer substantial damage.

Breaker failure protection evaluates a minimum current and the circuit-breaker auxiliary contact. It can be started by internal protective tripping or externally via binary input. Two-channel activation avoids overfunction (see Figure 11/8).

Inadvertent energization protection (ANSI 50, 27)

This protection has the function of limiting the damage of the generator in the event of an unintentional switch-on of the circuit-breaker, whether the generator is standing still or rotating without being excited or synchronized. If the power system voltage is connected, the generator starts as an asynchronous machine with a large slip and this leads to excessively high currents in the rotor.

A logic circuit consisting of sensitive current measurement for each phase, measured value detector, time control and blocking as of a minimum voltage, leads to an instantaneous trip command. If the fuse failure monitor responds, this function is ineffective.

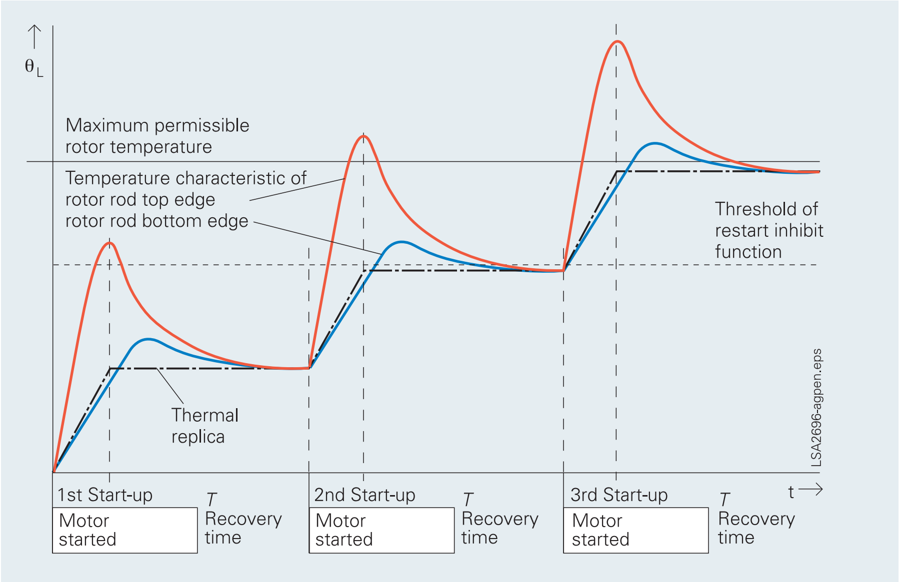

Fig. 11/9 Temperature characteristic at rotor and thermal replica of the rotor (multiple start-ups)

Starting time supervision (motor protection only) (ANSI 48)

Starting time supervision protects the motor against long unwanted start-ups, which might occur as a result of excessive load torque or excessive voltage drops within the motor, or if the rotor is locked.

The tripping time is dependent on the square of the start-up current and the set start-up time (Inverse Characteristic). It adapts itself to the start-up with reduced voltage. The tripping time is determined in accordance with the following formula:

$$t_{\text{Trip}} = \left(\frac{I_{\text{start}}}{I_{\text{rms}}}\right)^2 \cdot t_{\text{start max}}$$

t_{Trip} Tripping time

I_{start} Permissible start-up current

$t_{\text{start max}}$ Permissible start-up time

I_{rms} Measured r.m.s. current value

Calculation is not started until the current I_{rms} is higher than an adjustable response value (e.g. 2 $I_{\text{N, MOTOR}}$).

If the permissible locked-rotor time is less than the permissible start-up time (motors with a thermally critical rotor), a binary signal is set to detect a locked rotor by means of a tachometer generator. This binary signal releases the set locked-rotor time, and tripping occurs after it has elapsed.

Restart inhibit for motors (ANSI 66, 49Rotor)

When cold or at operating temperature, motors may only be connected a certain number of times in succession. The start-up current causes heat development in the rotor which is monitored by the restart inhibit function.

Contrary to classical counting methods, in the restart inhibit function the heat and cooling phenomena in the rotor are simulated by a thermal replica. The rotor temperature is determined on the basis of the stator currents. Restart inhibit permits restart of the motor only if the rotor has enough thermal reserve for a completely new start. Fig. 11/9 illustrates the thermal profile for a permissible triple start out of the cold state. If the thermal reserve is too low, the restart inhibit function issues a blocking signal with which the motor starting circuit can be blocked. The blockage is cancelled again after cooling down and the thermal value has dropped below the pickup threshold.

As the fan provides no forced cooling when the motor is off, it cools down more slowly. Depending on the operating state, the protection function controls the cooling time constant. A value below a minimum current is an effective changeover criterion.

System disconnection

Take the case of in-plant generators feeding directly into a system. The incoming line is generally the legal entity boundary between the system owner and the in-plant generator. If the incoming line fails as the result of auto-reclosure, for instance, a voltage or frequency deviation may occur depending on the power balance at the feeding generator. Asynchronous conditions may arise in the event of connection, which may lead to damage on the generator or the gearing between the generator and the turbine. Besides the classic criteria such as voltage and frequency, the following two criteria are also applied (vector jump, rate-of-frequency-change protection).

Rate-of-frequency-change protection (ANSI 81)

The frequency difference is determined on the basis of the calculated frequency over a time interval. It corresponds to the momentary rate-of-frequency change. The function is designed so that it reacts to both positive and negative rate-of-frequency changes. Exceeding of the permissible rate-of-frequency change is monitored constantly. Release of the relevant direction depends on whether the actual frequency is above or below the rated frequency. In total, four stages are available, and can be used optionally.

Protection functions

Vector jump

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

External trip coupling

For recording and processing of external trip information, there are 2 (for 7UM611) or 4 (for 7UM612) binary inputs. They are provided for information from the Buchholz relay or generator-specific commands and act like a protective function. Each input initiates a fault event and can be individually delayed by a timer.

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.

Phase rotation reversal

If the relay is used in a pumped-storage power plant, matching to the prevailing rotary field is possible via a binary input (generator/motor operation via phase rotation reversal).

2 pre-definable parameter groups

In the protection, the setting values can be stored in two data sets. In addition to the standard parameter group, the second group is provided for certain operating conditions (pumped-storage power stations). It can be activated via binary input, local control or DIGSI 4.

Lockout (ANSI 86)

All binary outputs (alarm or trip relays) 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.

Fuse failure and other monitoring

The relay comprises high-performance monitoring for the hardware and software.

The measuring circuits, analog-digital conversion, power supply voltages, memories and software sequence (watch-dog) are all monitored.

The fuse failure function detects failure of the measuring voltage due to short-circuit or open circuit of the wiring or VT and avoids overfunction of the undervoltage elements in the protection functions.

The positive and negative-sequence system (voltage and current) are evaluated.

Filter time

All binary inputs can be subjected to a filter time (indication suppression).

Communication

With respect to communication, particular emphasis has been placed on high levels of flexibility, data integrity and utilization of standards common in energy automation. The design of the communication modules permits interchangeability on the one hand, and on the other hand provides openness for future standards (for example, Industrial Ethernet).

Local PC interface

The 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 during commissioning is particularly advantageous.

Rear-mounted interfaces

Two communication modules on the rear of the unit incorporate optional equipment complements and permit retrofitting. They assure the ability to comply with the requirements of different communication interfaces (electrical or optical) and protocols (IEC 60870, PROFIBUS, DIGSI).

The interfaces make provision for the following applications:

Service interface

In the RS485 version, several protection units can be centrally operated with DIGSI 4. By using a modem, remote control is possible. This provides advantages in fault clearance, in particular in unmanned substations.

System interface

This is used to communicate with a control or protection and control system and supports, depending on the module connected, a variety of communication protocols and interface designs.

IEC 60870-5-103

IEC 60870-5-103 is an internationally standardized protocol for communication with protection relays.

IEC 60870-5-103 is supported by a number of protection unit manufacturers and is used worldwide.

The generator protection functions are stored in the manufacturer-specific, published part of the protocol.

PROFIBUS-DP

PROFIBUS is an internationally standardized communication protocol (EN 50170). PROFIBUS is supported internationally by several hundred manufacturers and has to date been used in more than 1,000,000 applications all over the world.

With the PROFIBUS-DP, the protection can be directly connected to a SIMATIC S5/S7. The transferred data are fault data, measured values and information from or to the logic (CFC).

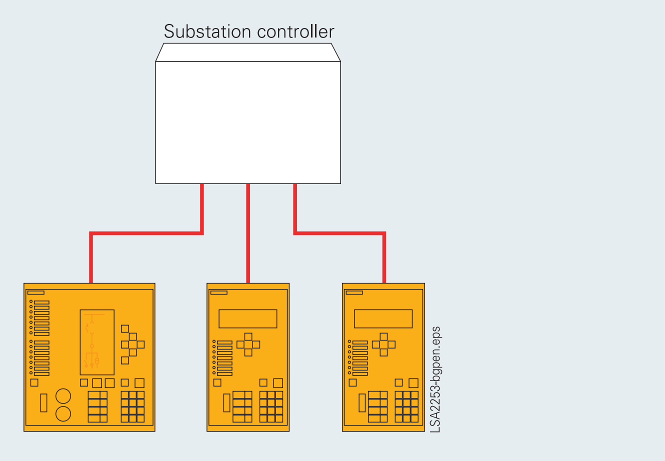

Fig. 11/10 IEC 60870-5-103 star-type RS232 copper conductor connection or fiber-optic connection

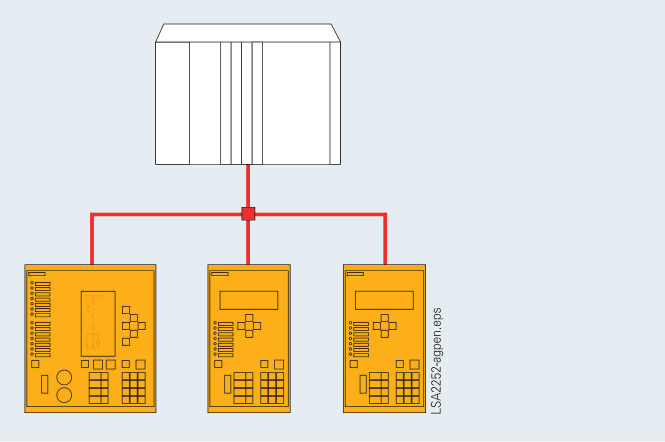

Fig. 11/11 PROFIBUS: RS485 copper conductors

MODBUS RTU

MODBUS is also a widely utilized communication standard and is used in numerous automation solutions.

DNP 3.0

DNP 3.0 (Distributed Network Protocol version 3) is a messaging-based communication protocol. The SIPROTEC 4 units are fully Level 1 and Level 2 compliant with DNP 3.0. DNP 3.0 is supported by a number of protection device manufacturers.

Safe bus architecture

- RS485 bus
  With this data transmission via copper conductors, electromagnetic interference influences are largely eliminated by the use of twisted-pair conductor. Upon failure of a unit, the remaining system continues to operate without any faults.
- 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.

Communication

System solution

SIPROTEC 4 is tailor-made for use in SIMATIC-based automation systems.

Via the PROFIBUS-DP, indications (pickup and tripping) and all relevant operational measured values are transmitted from the protection unit.

Via modem and service interface, the protection engineer has access to the protection devices at all times. This permits remote maintenance and diagnosis.

Parallel to this, local communication is possible, for example, during a major inspection.

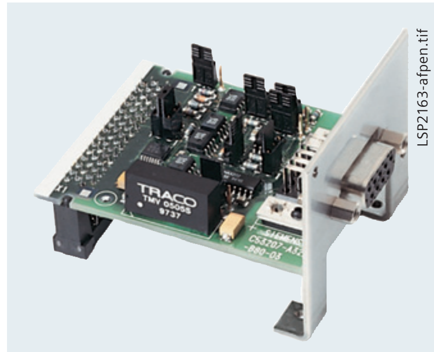

Fig. 11/12 RS232/RS485 Electrical communication module

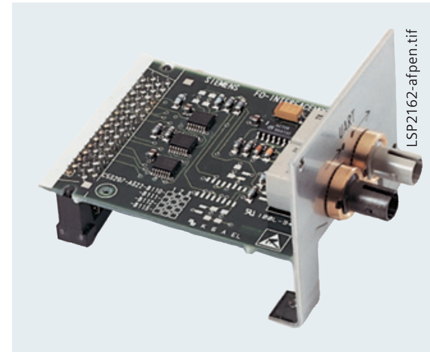

Fig. 11/13 820 nm fiber-optic communication module

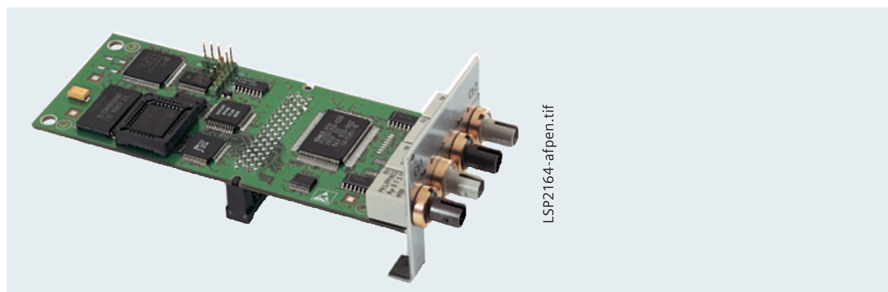

Fig. 11/14 PROFIBUS communication module, optical, double-ring

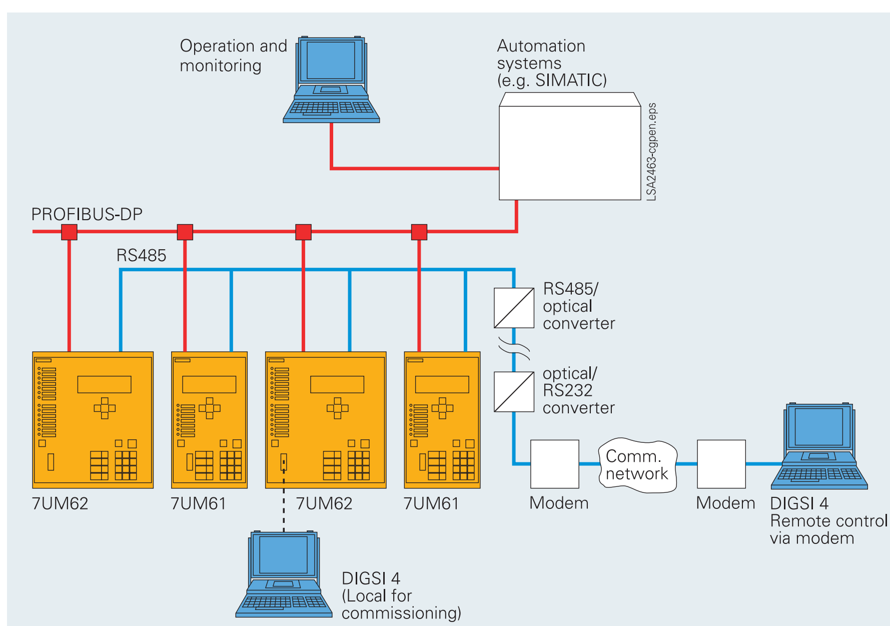

Fig. 11/15 System solution: Communication

Typical connections

Direct generator – busbar connection

Fig. 11/16 illustrates the recommended standard connection if several generators supply one busbar. Phase-to-ground faults are disconnected by employing the directional ground-fault criterion. The ground-fault current is driven through the cables of the system. If this is not sufficient, an grounding transformer connected to the busbar supplies the necessary current (maximum approximately 10 A) and permits a protection range of up to 90 %. The ground-fault current should be detected by means of core-balance current transformers in order to achieve the necessary sensitivity. The displacement voltage can be used as ground-fault criterion during starting operations until synchronization is achieved.

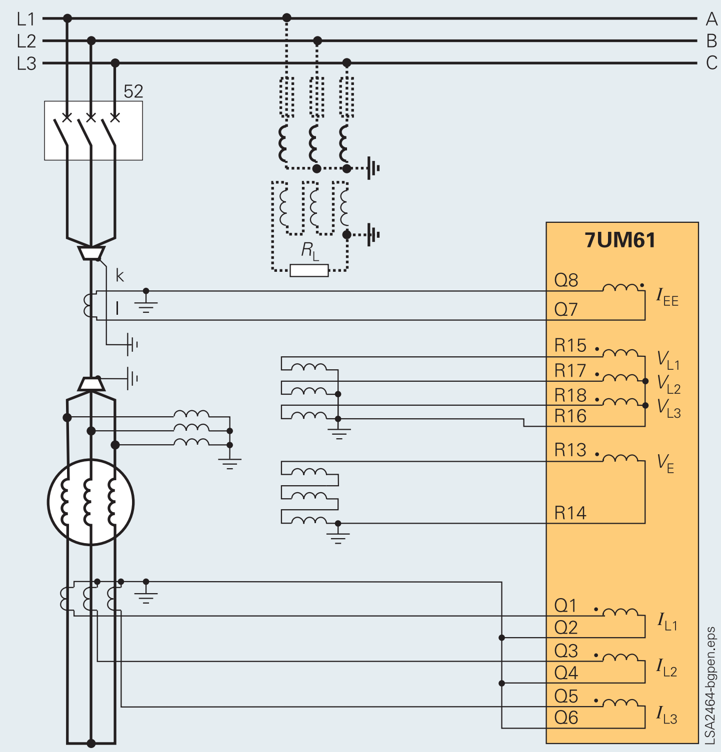

Fig. 11/16

Direct generator – busbar connection with low-resistance grounding

If the generator neutral point has low-resistance grounding, the connection illustrated in Fig. 11/17 is recommended. In the case of several generators, the resistance must be connected to only one generator, in order to prevent circulating currents (3rd harmonic).

For selective ground-fault detection, the ground-current input should be looped into the common return conductor of the two current transformer sets (differential connection). The current transformers must be grounded at only one point. The displacement voltage V_E is utilized as an additional enabling criterion.

Balanced current transformers are desirable with this form of connection. In the case of higher generator power (for example, I_N approximately 2000 A), current transformers with a secondary rated current of 5 A are recommended.

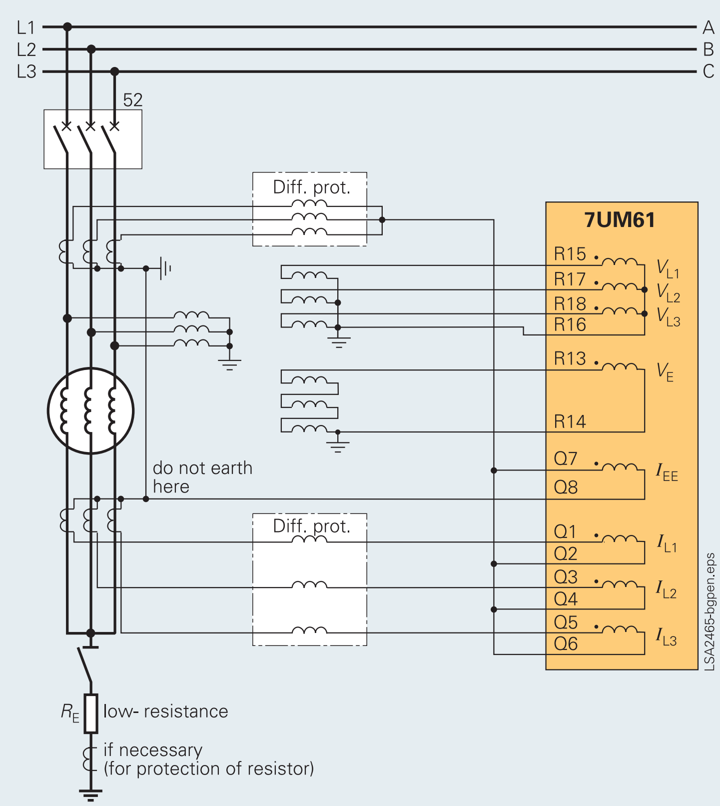

Fig. 11/17

11

Direct generator – busbar connection with high-resistance generator neutral grounding

With this system configuration, selective ground-fault detection is implemented on the basis of the lower fault currents through the differential connection of core-balance current transformers (see Figure 11/18). Secondary-side grounding must be effected at only one core-balance current transformer. The displacement voltage is to be utilized additionally as enable criterion.

The load resistor takes the form either of primary or of secondary resistor with neutral transformer. In the case of several generators connected to the busbar, again only one generator will be grounded via the resistor.

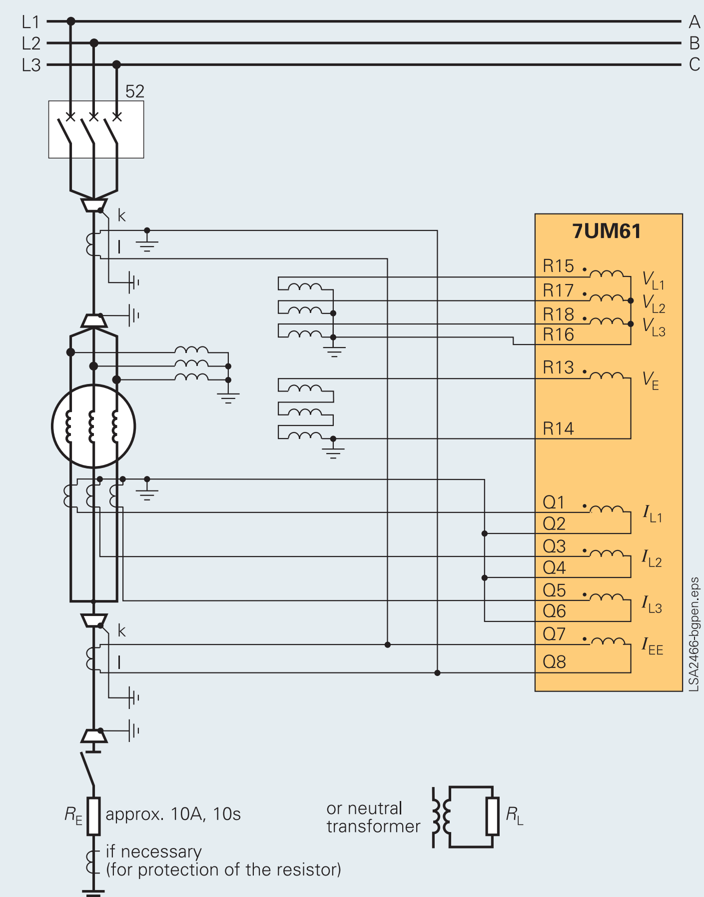

Fig. 11/18

Unit connection with isolated star point

This configuration of unit connection is a variant to be recommended (see Figure 11/19). Ground-fault detection is effected by means of the displacement voltage. In order to prevent unwanted operation in the event of ground faults in the system, a load resistor must be provided at the broken delta winding. Depending on the plant (or substation), a voltage transformer with a high power (VA) may in fact be sufficient. If not, an grounding transformer should be employed. The available measuring winding can be used for the purpose of voltage measurement.

Rotor ground-fault protection can be implemented with the unassigned ground-fault current input. The 7XR61 coupling unit must be used for this purpose.

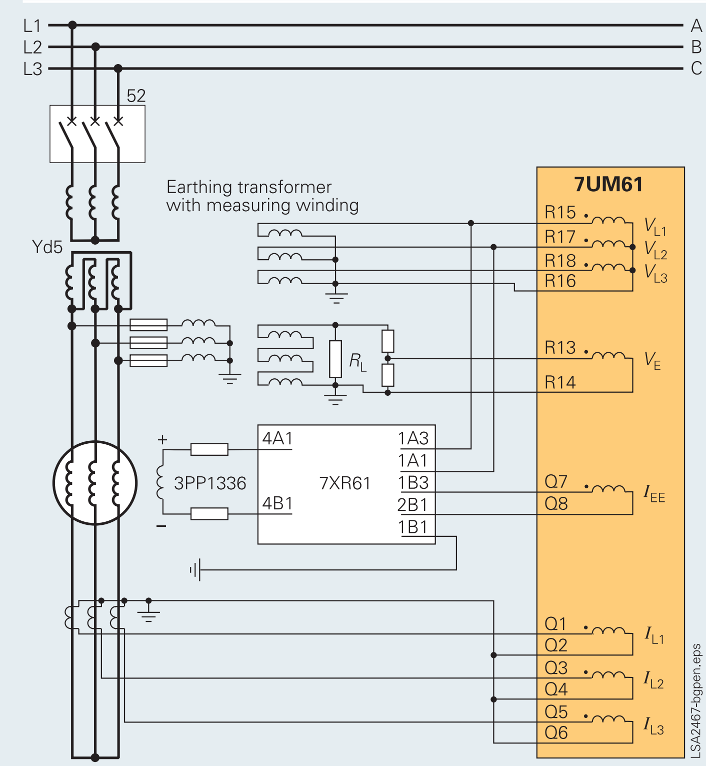

Fig. 11/19

11

Unit connection with neutral transformer

With this system configuration, disturbance voltage reduction and damping in the event of ground faults in the generator area are effected by a load resistor connected to generator neutral point. The maximum ground-fault current is limited to approximately 10 A. Configuration can take the form of a primary or secondary resistor with neutral transformer. In order to avoid low secondary resistance, the transformation ratio of the neutral transformer should be low. The higher secondary voltage can be reduced by means of a voltage divider.

Electrically, the circuit is identical to the configuration in Figure 11/19.

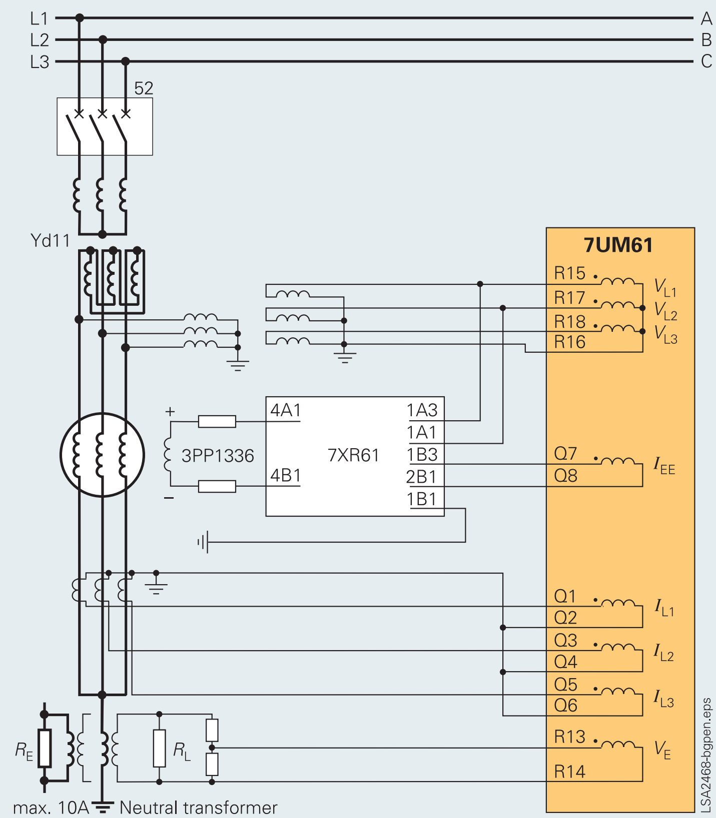

Fig. 11/20

Connection with low-voltage generators

As is generally known, the low-voltage system is solidly grounded, so that the generator neutral point is connected to ground (see Figure 11/21). With this configuration, there is the risk that, as a result of the 3rd harmonics forming a zero phase-sequence system, circulating currents will flow via the N-conductor. This must be limited by the generator or system configuration (reactor).

Otherwise, connection corresponds to the customary standard. In the case of residual current transformer design, it has to be ensured that the thermal current limit (1 s) of the I_{EE} input is restricted to 300 A.

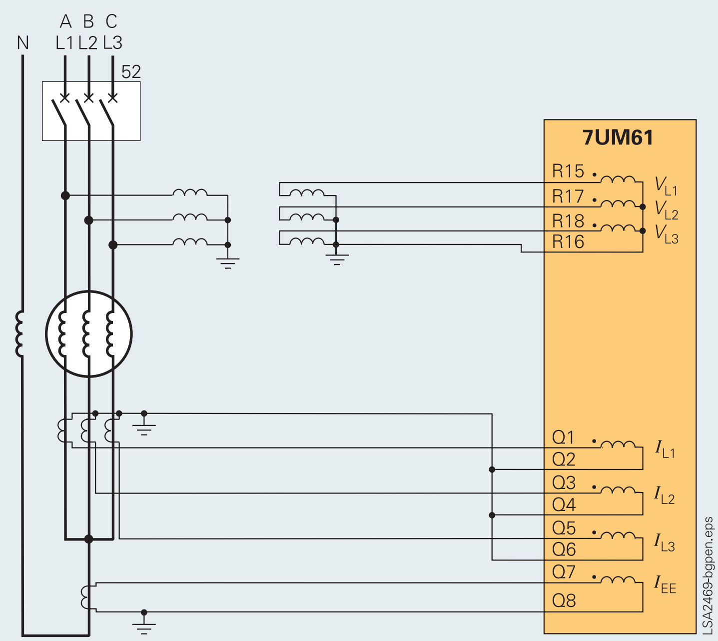

Fig. 11/21

11

Typical connections

Connection of an asynchronous motor

The figure shows the standard connection of motors of medium capacity (500 kW to <(1-2) MW). In addition to the short-circuit protection, an ground-fault protection (V_E; I_E inputs) is available.

As the busbar voltage is being monitored, starting of the motor is prevented if the voltage is too low or – in case of failure of infeed – the motor circuit-breaker is opened. Here, the wide range of frequency is advantangeous. For the detection of temperatures, 2 thermo-boxes (temperature monitoring boxes) can be connected via a serial interface.

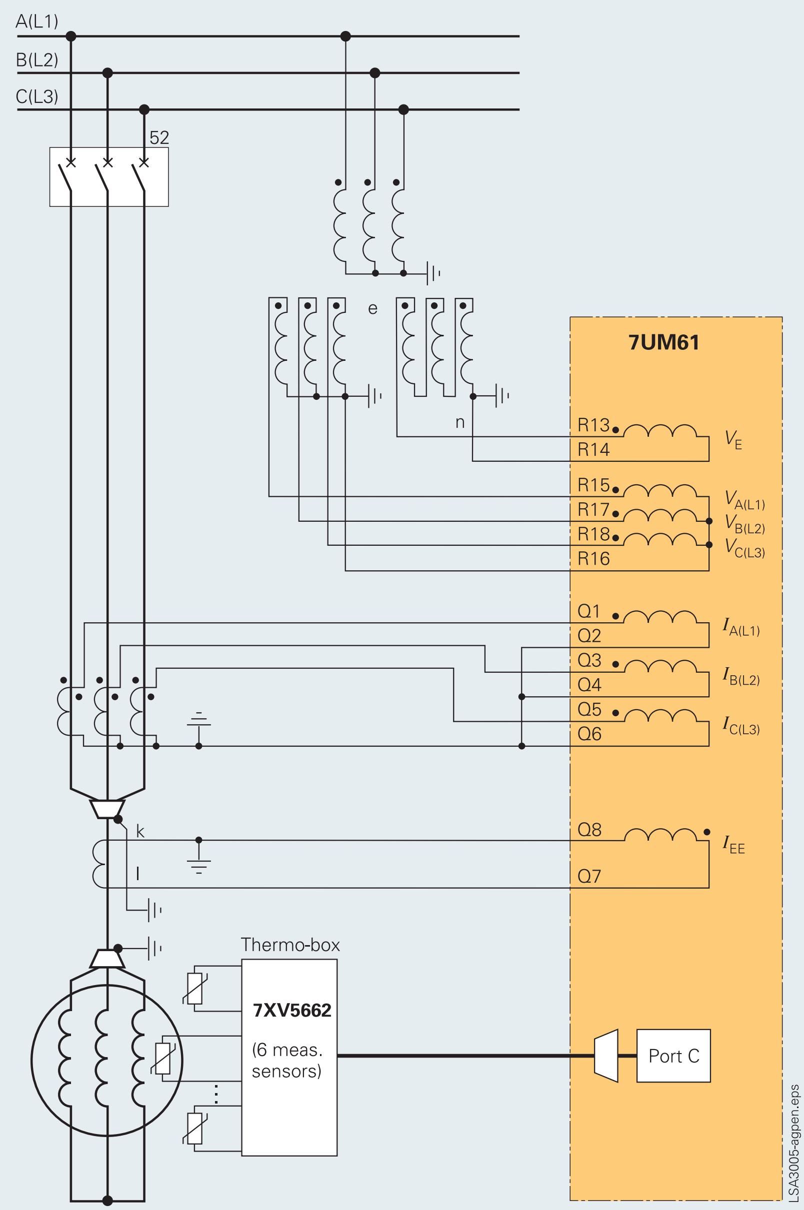

Fig. 11/22

Voltage transformer in open delta connection (V-connection)

Protection can also be implemented on voltage transformers in open delta connection. Figure 11/23 shows the connection involved. If necessary, the operational measured values for the phase-to-ground voltages can be slightly asymmetrical. If this is disturbing, the neutral point (R16) can be connected to ground via a capacitor.

In the case of open delta connection, it is not possible to calculate the displacement voltage from the secondary voltages. It must be passed to the protection relay along a different path (for example, voltage transformer at the generator neutral point or from the grounding transformer).

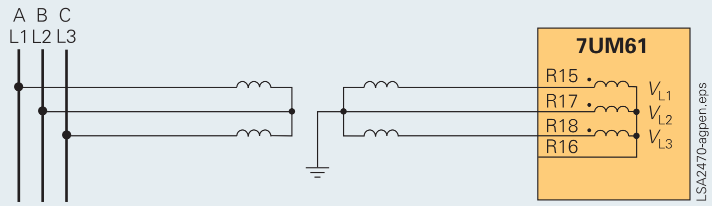

Fig. 11/23

Connection with two current transformers

This configuration is to be found in older systems with insulated or high-resistance star point. This connection is illustrated in Fig. 11/24. In the protection unit, the secondary currents are represented correctly and, in addition, the positive and the negative-sequence system are correctly calculated. Limits of application occur in the case of low-resistance and solid grounding.

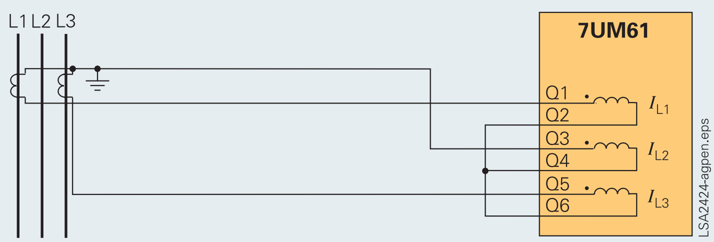

Fig. 11/24

Technical data

Hardware	
Analog inputs	
Rated frequency	50 or 60 Hz
Rated current I_N	1 or 5 A
Ground current, sensitive I_{Emax}	1.6 A
Rated voltage V_N	100 to 125 V
Power consumption With I_N = 1 A With I_N = 5 A For sensitive ground current Voltage inputs (with 100 V)	 Approx. 0.05 VA Approx. 0.3 VA Approx. 0.05 VA Approx. 0.3 VA
Capability in CT circuits Thermal (r.m.s. values) Dynamic (peak)	 100 I_N for 1 s 30 I_N for 10 s 4 I_N continuous 250 I_N (one half cycle)
Ground current, sensitive Dynamic (peak)	300 A for 1 s 100 A for 10 s 15 A continuous 750 A (one half cycle)
Capability in voltage paths	230 V continuous
Auxiliary voltage	
Rated auxiliary voltage	DC 24 to 48 V DC 60 to 125 V DC 110 to 250 V and AC 115 V/230 V with 50/60 Hz
Permitted tolerance	–20 to +20 %
Superimposed (peak-to-peak)	≤ 15 %
Power consumption During normal operation 7UM611 7UM612 During pickup with all inputs and outputs activated 7UM611 7UM612	 Approx. 4 W Approx. 4.5 W Approx. 9.5 W Approx. 12.5 W
Bridging time during auxiliary voltage failure at V_{aux} = 48 V and V_{aux} ≥ 110 V at V_{aux} = 24 V and V_{aux} = 60 V	 ≥ 50 ms ≥ 20 ms
Binary inputs	
Number 7UM611 7UM612	 7 15
3 pickup thresholds Range is selectable with jumpers	DC 10 to 19 V or DC 44 to 88 V 88 to 176 V DC[1)]
Maximum permissible voltage	DC 300 V
Current consumption, energized	Approx. 1.8 mA

1) Not valid for the CPU board.

Output relays	
Number 7UM611 7UM612	 12 (1 NO, 1 optional as NC, via jumper) 20 (1 NO, 2 optional as NC, via jumper)
Switching capacity Make Break Break (for resistive load) Break (for L/R ≤ 50 ms)	 1000 W/VA 30 VA 40 W 25 VA
Switching voltage	250 V
Permissible current	5 A continuous 30 A for 0.5 seconds
LEDs	
Number RUN (green) ERROR (red)	 1 1
Assignable LED (red) 7UM611 7UM612	 7 14
Unit design	
7XP20 housing	For dimensions see dimension drawings, part 14
Degree of protection acc. to EN 60529 For surface-mounting housing For flush-mounting housing Front Rear For the terminals	 IP 51 IP 51 IP 50 IP 2x with terminal cover put on
Weight Flush-mounting housing 7UM611 (⅓ x 19") 7UM612 (½ x 19") Surface-mounting housing 7UM611 (⅓ x 19") 7UM612 (½ x 19")	 Approx. 5.5 kg Approx. 7 kg Approx. 7.5 kg Approx. 12 kg

Serial interfaces	
Operating interface for DIGSI 4	
Connection	Non-isolated, RS232, front panel; 9-pin subminiature connector
Baud rate	4800 to 115200 baud
Time synchronization IRIG-B/DCF 77 signal (Format IRIG-B000)	
Connection	9-pin subminiature connector, terminal with surface-mounting housing
Voltage levels	Selectable 5 V or 12 V or 24 V
Service/modem interface for DIGSI 4/modem/service	
Isolated RS232/RS485	9-pin subminiature connector
Test voltage	500 V / 50 Hz
Distance for RS232	Max. 15 m
Distance for RS485	Max. 1000 m
Fiber-optic cable	Integrated ST-connector
Optical wavelength	λ = 820 nm
Permissible path attenuation	Max. 8 dB for glass-fiber 62.5/125 µm
Bridgeable distance	Max. 1.5 km
System interface IEC 60870-5-103 protocol, PROFIBUS-DP, MODBUS RTU	
Isolated RS232/RS485	9-pin subminiature connector
Baud rate	4800 to 115200 baud
Test voltage	500 V / 50 Hz
Distance for RS232	Max. 15 m
Distance for RS485	Max. 1000 m
PROFIBUS RS485	
Test voltage	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 path attenuation	Max. 8 dB for glass-fiber 62.5/125 µm
Distance	1.6 km (500 kB/s) 530 m (1500 kB/s)

1) Conversion with external OLM
For fiber-optic interface please complete order number at 11th position with **4** (FMS RS485) or **9** and Order code **L0A** (DP RS485) and additionally order:
For single ring: SIEMENS OLM 6GK1502-3AB10
For double ring: SIEMENS OLM 6GK1502-4AB10

Electrical tests	
Specifications	
Standards	IEC 60255 (product standards) ANSI/IEEE C37.90.0/.1/.2 UL 508 DIN 57435, part 303 For further standards see below.
Insulation tests	
Standards	IEC 60255-5
Voltage test (100 % test) All circuits except for auxiliary supply, binary inputs communication and time synchronization interfaces	2.5 kV (r.m.s.), 50/60 Hz
Voltage test (100 % test) Auxiliary voltage and binary inputs	DC 3.5 kV
Voltage test (100 % test) RS485/RS232 rear side communication interfaces and time synchronization interface	500 V (r.m.s. value), 50/60 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 at intervals of 5 s
EMC tests for noise immunity; type test	
Standards	IEC 60255-6, IEC 60255-22 (product standards) EN 50082-2 (generic standard) 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 pulses per s; duration 2 s
Electrostatic discharge IEC 60255-22-2, class IV EN 61000-4-2, class IV	8 kV contact discharge; 15 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
Irradiation with RF field, non-modulated IEC 60255-22-3 (report), class III	10 V/m; 27 to 500 MHz
Irradiation with RF field, amplitude-modulated IEC 61000-4-3, class III	10 V/m; 80 to 1000 MHz; 80 % AM; 1 kHz
Irradiation with RF field, pulse-modulated, IEC 61000-4-3/ENV 50204, class III	10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %
Fast transient interference bursts IEC 60255-22-4, 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

EMC tests for noise immunity; type tests	
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 and relay outputs	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 ANSI/IEEE C37.90.1	2.5 to 3 kV (peak); 1 to 1.5 MHz damped wave; 50 surges per second; 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 second; both polarities; Duration 2 s ; R_i = 80 Ω
Radiated electromagnetic interference ANSI/IEEE C37.90.2	35 V/m; 25 to 1000 MHz
Damped oscillations IEC 60894, 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 50 081-* (technical generic standard)
Conducted interference voltage on lines only auxiliary supply IEC-CISPR 22	150 kHz to 30 MHz Limit class B
Interference field strength IEC-CISPR 22	30 to 1000 MHz Limit class B

Mechanical stress tests	
Vibration, shock stress and seismic vibration	
During operation	
Standards	IEC 60255-21 and IEC 60068
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 each in both directions of the 3 axes
Seismic vibration IEC 60255-21-2, class 1 IEC 60068-3-3	Sinusoidal 1 to 8 Hz: ± 3.5 mm amplitude (horizontal axis) 1 to 8 Hz: ± 1.5 mm amplitude (vertical axis) 8 to 35 Hz: 1 g acceleration (horizontal axis) 8 to 35 Hz: 0.5 g acceleration (vertical axis) Frequency sweep 1 octave/min 1 cycle in 3 orthogonal axes
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	Half-sinusoidal Acceleration 15 g, duration 11 ms, 3 shocks each in both directions 3 axes
Continuous shock IEC 60255-21-2, class 1 IEC 60068-2-29	Half-sinusoidal Acceleration 10 g, duration 16 ms, 1000 shocks in both directions of the 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	–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 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 ≤ 75 % relative humidity; on 56 days a year up to 93 % relative humidity; condensation is not permitted

Functions	
General	
Frequency range	11 to 69 Hz
Definite-time overcurrent protection, directional (ANSI 50, 51, 67)	
Setting ranges	
Overcurrent $I>$, $I>>$	0.1 to 8 A (steps 0.01 A); 5 times at I_N = 5 A
Time delay T	0 to 60 s (steps 0.01 s) or indefinite
Undervoltage seal-in $V<$	10 to 125 V (steps 0.1 V)
Seal-in time of $V<$	0.1 to 60 s (steps 0.01 s)
Angle of the directional element (at $I>$)	– 90 ° to + 90 ° (steps 1 °)
Times	
Pickup time $I>$, $I>>$	
At 2 times of set value	Approx. 35 ms
At 10 times of set value	Approx. 25 ms
Drop-off time $I>$, $I>>$	Approx. 50 ms
Drop-off ratio	$I>$: 0.95; $I>>$: 0.9 to 0.99 (steps 0.01)
Drop-off ratio $V<$	Approx. 1.05
Tolerances	
Current pickup (starting) $I>$, $I>>$	1 % of set value or 10/50 mA
Undervoltage seal-in $V<$	1 % of set value or 0.5 V
Angle of the directional element	1 °
Time delays	1 % or 10 ms

Inverse-time overcurrent protection (ANSI 51V)	
Setting ranges	
Pickup overcurrent I_P	0.1 to 4 A (steps 0.01 A); 5 times at I_N = 5 A
Time multiplier IEC-characteristics T	0.05 to 3.2 s (steps 0.01 s) or indefinite
Time multiplier ANSI-characteristics D	0.5 to 15 (steps 0.01) or indefinite
Undervoltage release $V<$	10 to 125 V (steps 0.1 V)
Trip characteristics	
IEC	Normal inverse; very inverse; extremely inverse
ANSI	Inverse; moderately inverse; very inverse; extremely inverse; definite inverse
Pickup threshold	Approx. 1.1 I_P
Drop-off threshold	Approx. 1.05 I_P for $I_P/I_N \geq 0.3$
Tolerances	
Pickup threshold I_P	1 % of set value 10/50 mA
Pickup threshold $V<$	1 % of set value or 0.5 V
Time for $2 \leq I/I_P \leq 20$	5 % of nominal value + 1 % current tolerance or 40 ms
Stator overload protection, thermal (ANSI 49)	
Setting ranges	
Factor k according to IEC 60255-8	0.5 to 2.5 (steps 0.01)
Time constant	30 to 32000 s (steps 1 s)
Time delay factor at standstill	1 to 10 (steps 0.01)
Alarm overtemperature $\Theta_{Alarm}/\Theta_{Trip}$	70 to 100 % related to the trip temperature (steps 1 %)
Overcurrent alarm stage I_{Alarm}	0.1 to 4 A (steps 0.01 A); 5 times at I_N = 5 A
Temperature at I_N	40 to 200 °C (steps 1 °C) or 104 to 392 °F (steps 1 °F)
Scaling temperature of cooling medium	40 to 300 °C (steps 1 °C) or 104 to 572 °F (steps 1 °F)
Reset time at emergency start	20 to 150000 s (steps 1 s)
Drop-off ratio	
Θ/Θ_{Trip}	Drop-off with Θ_{Alarm}
Θ/Θ_{Alarm}	Approx. 0.99
I/I_{Alarm}	Approx. 0.95
Tolerances	
Regarding k x I_P	2 % or 10/50 mA; class 2 % according to IEC 60255-8
Regarding trip time	3 % or 1 s: class 3 % according to IEC 60255-8 for $I/(k\ I_N)>1.25$

Negative-sequence protection (ANSI 46)	
Setting ranges	
Permissible negative sequence I_2 perm. $/I_N$	3 to 30 % (steps 1 %)
Definite time trip stage $I_2>>/I_N$	10 to 100 % (steps 1 %)
Time delays T_{Alarm}; $T_{I2>>}$	0 to 60 s (steps 0.01 s) or indefinite
Negative-sequence factor k	2 to 40 s (steps 0.1 s)
Cooling down time $T_{Cooling}$	0 to 50000 s (steps 1 s)
Times	
Pickup time (definite stage)	Approx. 50 ms
Drop-off time (definite stage)	Approx. 50 ms
Drop-off ratios I_2 perm.; I_2 >>	Approx. 0.95
Drop-off ratio thermal stage	Drop-off at fall below of I_2 perm.
Tolerances	
Pickup values I_2 perm.; I_2 >>	3 % of set value or 0.3 % negative sequence
Time delays	1 % or 10 ms
Thermal characteristic Time for $2 \leq I_2/I_2$ perm. ≤ 20	5 % of nominal value +1 % current tolerance or 600 ms

Underexcitation protection (ANSI 40)	
Setting ranges	
Conductance thresholds 1/xd characteristic (3 characteristics)	0.25 to 3.0 (steps 0.01)
Inclination angle α_1, α_2, α_3	50 to 120 ° (steps 1 °)
Time delay T	0 to 50 s (steps 0.01 s) or indefinite
Times	
Stator criterion 1/xd characteristic; α	Approx. 60 ms
Undervoltage blocking	Approx. 50 ms
Drop-off ratio	
Stator criterion 1/xd characteristic; α	Approx. 0.95
Undervoltage blocking	Approx. 1.1
Tolerances	
Stator criterion 1/xd characteristic	3 % of set value
Stator criterion α	1 ° electrical
Undervoltage blocking	1 % or 0.5 V
Time delays T	1 % or 10 ms

Reverse-power protection (ANSI 32R)	
Setting ranges	
Reverse power $P_{Rev.>}/S_N$	–0.5 to –30 % (steps 0.01 %)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Times	
Pickup time	Approx. 360 ms (50 Hz); Approx. 300 ms (60 Hz)
Drop-off time	Approx. 360 ms (50 Hz); Approx. 300 ms (60 Hz)
Drop-off ratio $P_{Rev.>}$	Approx. 0.6
Tolerances	
Reverse power $P_{Rev.>}$	0.25 % S_N ± 3 % set value
Time delays T	1 % or 10 ms

Forward-power protection (ANSI 32F)	
Setting ranges	
Forward power $P_{Forw.<}/S_N$	0.5 to 120 % (steps 0.1 %)
Forward power $P_{Forw.>}/S_N$	1 to 120 % (steps 0.1 %)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Times	
Pickup time (accurate measuring)	Approx. 360 ms (50 Hz); Approx. 300 ms (60 Hz)
Pickup time (fast measuring)	Approx. 60 ms (50 Hz); Approx. 50 ms (60 Hz)
Drop-off time (accurate measuring)	Approx. 360 ms (50 Hz); Approx. 300 ms (60 Hz)
Drop-off time (fast measuring)	Approx. 60 ms (50 Hz); Approx. 50 ms (60 Hz)
Drop-off ratio $P_{Forw.<}$	1.1 or 0.5 % of S_N
Drop-off ratio $P_{Forw.>}$	Approx. 0.9 or –0.5 % of S_N
Tolerances	
Active power $P_{Forw.<}$, $P_{Forw.>}$	0.25 % S_N ± 3 % of set value at $Q < 0.5\ S_N$ at accurate measuring 0.5 % S_N ± 3 % of set value at $Q < 0.5\ S_N$ at fast measuring
Time delays T	1 % or 10 ms

Impedance protection (ANSI 21)	
Setting ranges	
Overcurrent pickup $I>$	0.1 to 4 A (steps 0.01 A); 5 times at I_N = 5A
Undervoltage seal-in $V<$	10 to 125 V (steps 0.1V)
Impedance Z1 (related to I_N =1 A)	0.05 to 130 Ω (steps 0.01 Ω)
Impedance Z1B (related to I_N =1 A)	0.05 to 65 Ω (steps 0.01 Ω)
Impedance Z2 (related to I_N =1 A)	0.05 to 65 Ω (steps 0.01 Ω)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Times	
Shortest tripping time	Approx. 40 ms
Drop-off time	Approx. 50 ms
Drop-off ratio	
Overcurrent pickup $I>$	Approx. 0.95
Undervoltage seal-in $V<$	Approx. 1.05
Tolerances	
Overcurrent pickup $I>$	1 % of set value. 10/50 mA
Undervoltage seal-in $V<$	1 % of set value. or 0.5 V
Impedance measuring Z1, Z2	$\lvert\Delta Z/Z\rvert \leq 5$ % for 30 ° $\leq \varphi_K \leq$ 90 °
Time delays T	1 % or 10 ms

Undervoltage protection (ANSI 27)	
Setting range	
Undervoltage pickup $V<$, $V<<$ (positive sequence as phase-to-phase values)	10 to 125 V (steps 0.1 V)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Times	
Pickup time $V<$, $V<<$	Approx. 50 ms
Drop-off time $V<$, $V<<$	Approx. 50 ms
Drop-off ratio $V<$, $V<<$	1.01 to 1.1 (steps 0.01)
Tolerances	
Voltage limit values	1 % of set value or 0.5 V
Time delays T	1 % or 10 ms

Overvoltage protection (ANSI 59)	
Setting ranges	
Overvoltage pickup V>, V>> (maximum phase-to-phase voltage or phase-to-ground-voltage)	30 to 170 V (steps 0.1 V)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Time	
Pickup times V>, V>>	Approx. 50 ms
Drop-off times V>, V>>	Approx. 50 ms
Drop-off ratio V>, V>>	0.9 to 0.99 (steps 0.01)
Tolerances	
Voltage limit value	1 % of set value 0.5 V
Time delays T	1 % or 10 ms

Frequency protection (ANSI 81)	
Setting ranges	
Steps; selectable f>, f<	4
Pickup values f>, f<	40 to 65 Hz (steps 0.01 Hz)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Undervoltage blocking V_1<	10 to 125 V (steps 0.1 V)
Times	
Pickup times f>, f<	Approx. 100 ms
Drop-off times f>, f<	Approx. 100 ms
Drop-off difference Δf	Approx. 20 mHz
Drop-off ratio V_1<	Approx. 1.05
Tolerances	
Frequency	10 mHz (at V> 0.5 V_N)
Undervoltage blocking	1 % of set value or 0.5 V
Time delays T	1 % or 10 ms

Overexcitation protection (Volt/Hertz) (ANSI 24)	
Setting ranges	
Pickup threshold alarm stage	1 to 1.2 (steps 0.01)
Pickup threshold V/f>>-stage	1 to 1.4 (steps 0.01)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Characteristic values of V/f	1.1/1.15/1.2/1.25/1.3/1.35/1.4
and assigned times $t(V/f)$	0 to 20000 s (steps 1 s)
Cooling down time $T_{Cooling}$	0 to 20000 s (steps 1 s)
Times (Alarm and V/f>>-stage)	
Pickup times at 1.1 of set value	Approx. 60 ms
Drop-off times	Approx. 60 ms
Drop-off ratio (alarm, trip)	0.95
Tolerances	
V/f-pickup	3 % of set value
Time delays T	1 % or 10 ms
Thermal characteristic (time)	5 % rated to V/f or 600 ms

90 % stator ground-fault protection, non-directional, directional (ANSI 59N, 64G, 67G)	
Setting ranges	
Displacement voltage V_0 >	5 to 125 V (steps 0.1 V)
Ground current $3I_0$>	2 to 1000 mA (steps 1 mA)
Angle of direction element	0 to 360 ° (steps 1 °)
Time delays T	0 to 60 s (steps 0,01 s) or indefinite
Times	
Pickup times V_0>, $3I_0$>	Approx. 50 ms
Drop-off times V_0>/ $3I_0$>	Approx. 50 ms
Drop-off ratio V_0>, $3I_0$>	0.7
Drop-off difference angle	10 ° directed to power system
Tolerances	
Displacement voltage	1 % of set value or 0.5 V
Ground current	1 % of set value or 0.5 mA
Time delays T	1 % or 10 ms

Sensitive ground-fault protection (ANSI 50/51GN, 64R)	
Setting ranges	
Ground current pickup I_{EE}>, I_{EE}>>	2 to 1000 mA (steps 1 mA)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Measuring circuit supervision I_{EE}<	1.5 to 50 mA (steps 0.1 mA)
Times	
Pickup times	Approx. 50 ms
Drop-off times	Approx. 50 ms
Measuring circuit supervision	Approx. 50 ms
Drop-off ratio I_{EE}>, I_{EE}>>	0.95 or 1 mA
Drop-off ratio measuring circuit supervision I_{EE}<	Approx. 1.1 or 1 mA
Tolerances	
Ground current pickup	1 % of set value or 0.5 mA
Time delays T	1 % or 10 ms

100 % stator ground-fault protection with 3rd harmonics (ANSI 59TN, 27TN (3rd H.))	
Setting ranges	
Displacement voltage $V_{0\,(3rd\,harm.)}$>, $V_{0\,(3rd\,harm.)}$<	0.2 to 40 V (steps 0.1 V)
Time delay T	0 to 60 s (steps 0.01 s) or indefinite
Active-power release	10 to 100 % (steps 1 %) or indefinite
Positive-sequence voltage release	50 to 125 V (steps 0.1 V) or indefinite
Times	
Pickup time	Approx. 80 ms
Drop-off time	Approx. 80 ms
Drop-off ratio	
Undervoltage stage $V_{0\,(3rd\,harm.)}$<	Approx. 1.4
Overvoltage stage $V_{0\,(3rd\,harm.)}$>	Approx. 0.6
Active-power release	Approx. 0.9
Positive-sequence voltage release	Approx. 0.95
Tolerances	
Displacement voltage	3 % of set value or 0.1 V
Time delay T	1 % or 10 ms

Technical data

Breaker failure protection (ANSI 50BF)	
Setting ranges	
Current thresholds I>BF	0.04 to 1 A (steps 0.01 A)
Time delay BF-T	0.06 to 60 s (steps 0.01 s) or indefinite
Time	
Pickup time	Approx. 50 ms
Drop-off time	Approx. 50 ms
Tolerances	
Current threshold I>BF/I_N	1 % of set value or 10/50 mA
Time delay T	1 % or 10 ms

Inadvertent energizing protection (ANSI 50, 27)	
Setting ranges	
Current pickup I>>>	0.1 to 20 A (steps 0.1 A); 5 times at I_N= 5 A
Voltage release V_1<	10 to 125 V (steps 1 V)
Time delay	0 to 60 s (steps 0.01 s) or indefinite
Drop-off time	0 to 60 s (steps 0.01 s) or indefinite
Times	
Reaction time	Approx. 25 ms
Drop-off time	Approx. 35 ms
Drop-off ratio I>>>	Approx. 0.8
Drop-off ratio V_1<	Approx. 1.05
Tolerances	
Current pickup	5 % of set value or 20/100 mA
Undervoltage seal-in V_1<	1 % of set value or 0.5 V
Time delay T	1 % or 10 ms

External trip coupling	
Number of external trip couplings	2 for 7UM611 4 for 7UM612

Trip circuit supervision (ANSI 74TC)	
Number of supervised trip circuits (only 7UM612)	1

Starting time supervision for motors (ANSI 48)	
Setting ranges	
Motor starting current $I_{Start\ max}$ /I_N	1.0 to 16 (steps 0.01)
Starting current pickup $I_{Start,\ pickup.}$ /I_N	0.6 to 10 (steps 0.01)
Permissible starting time $T_{Start\ max}$	1.0 to 180 s (steps 0.1 s)
Permissible locked rotor time $T_{Blocking}$	0.5 to 120 s (steps 0.1 s) or indefinite
Times	Depending on the settings
Drop-off ratio	Approx. 0.95
Tolerances	
Current threshold	1 % of set value, or 1 % of I_N
Time delays T	5 % or 30 ms

Restart inhibit for motors (ANSI 66, 49 Rotor)	
Setting ranges	
Motor starting current $I_{Start\ max}$ /I_N	3.0 to 10.0 (steps 0.01)
Permissible starting time $T_{Start\ max}$	3.0 to 120.0 s (steps 0.1 s)
Rotor temperature equalization time $T_{Equali.}$	0 to 60.0 min (steps 0,1 min)
Minimum restart inhibit time $T_{Restart,\ min}$	0.2 to 120.0 min (steps 0.1 min)
Permissible number of warm starts n_W	1 to 4
Difference between warm and cold starts n_K-n_W	1 to 2
Extensions of time constants (running and stop)	1.0 to 100.0
Tolerances	
Time delays T	1 % or 0.1 ms

Rate-of-frequency-change protection (ANSI 81R)	
Setting ranges	
Steps, selectable +d*f*/d*t* >; -d*f*/d*t*	4
Pickup value d*f*/d*t*	0.2 to 10 Hz/s (steps 0.1 Hz/s);
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Undervoltage blocking V_1<	10 to 125 V (steps 0.1 V)
Times	
Pickup times d*f*/d*t*	Approx. 200 ms
Drop-off times d*f*/d*t*	Approx. 200 ms
Drop-off ratio d*f*/d*t*	Approx. 0.95 or 0.1 Hz/s
Drop-off ratio V<	Approx. 1.05
Tolerances	
Rate-of-frequency change	Approx. 0.1 Hz/s at V> 0.5 V_N
Undervoltage blocking	1 % of set value or 0.5 V
Time delays T	1 % or 10 ms

Vector jump supervision (voltage)	
Setting ranges	
Stage $\Delta\varphi$	0.5 ° to 15 ° (steps 0.1 °)
Time delay T	0 to 60 s (steps 0.01 s) or indefinite
Undervoltage blocking V_1<	10 to 125 V (steps 0.1 V)
Tolerances	
Vector jump	0.3 ° at V> 0.5 V_N
Undervoltage blocking	1 % of set value or 0.5 V
Time delay T	1 % or 10 ms

Incoupling of temperature via serial interface (thermo-box) (ANSI 38)	
Number of measuring sensors	6 or 12
Temperature thresholds	40 to 250 °C or 100 to 480 °F (steps 1 °C or 1 °F)
Sensor types	Pt100; Ni 100, Ni 120

Operational measured values	
Description	Primary; secondary or per unit (%)
Currents	I_{L1}; I_{L2}; I_{L3}; I_{EE}; I_1; I_2
Tolerance	0.2 % of measured values or ± 10 mA ± 1 digit
Voltages	V_{L1}; V_{L2}; V_{L3}; V_E; V_{L12}; V_{L23}; V_{L31}; V_1; V_2
Tolerance	0.2 % of measured values or ± 0.2 V ± 1 digit
Impedance	R, X
Tolerance	1 %
Power	S; P; Q
Tolerance	1 % of measured values or ± 0.25 % S_N
Phase angle	φ
Tolerance	<0.1 °
Power factor	cos φ (p.f.)
Tolerance	1 % ± 1 digit
Frequency	f
Tolerance	10 mHz at (V> 0.5 V_N; 40 Hz < f < 65 Hz)
Overexcitation	V/f;
Tolerance	1 %
Thermal measurement	Θ_{L1}; Θ_{L2}, Θ_{L3}, Θ_{I2}, $\Theta_{V/f}$,
Tolerance	5 %
Min./max.memory	
Memory	Measured values with date and time
Reset manual	Via binary input Via key pad Via communication
Values	
Positive sequence voltage	V_1
Positive sequence current	I_1
Active power	P
Reactive power	Q
Frequency	f
Displacement voltage (3rd harmonics)	$V_{E(3rd\ harm.)}$
Energy metering	
Meter of 4 quadrants	W_{P+}; W_{P-}; W_{Q+}; W_{Q-}
Tolerance	1 %
Fault records	
Number of fault records	Max. 8 fault records
Instantaneous values	Max. 5 s
Storage time	Depending on the actual frequency
Sampling interval	(e. g. 1.25 ms at 50 Hz; 1.04 ms at 60 Hz)
Channels	v_{L1}, v_{L2}, v_{L3}, v_E; i_{L1}, i_{L2}, i_{L3}, i_{EE}
R.m.s. values	
Storage period	Max. 80 s
Sampling interval	Fixed (20 ms at 50 Hz; 16.67 ms at 60 Hz)
Channels	V_1, V_E, I_1, I_2, I_{EE}, P, Q, φ, f-f_n

Additional functions	
Fault event logging	Storage of events of the last 8 faults Puffer length max. 600 indications Time solution 1 ms
Operational indications	Max. 200 indications Time solution 1 ms
Elapsed-hour meter	Up to 6 decimal digits (criterion: current threshold)
Switching statistics	Number of breaker operation Phase-summated tripping current

CE conformity

This product is in conformity with the Directives of the European Communities on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EEC previous 89/336/EEC) and electrical equipment designed for use within certain voltage limits (Council Directive 2006/95/EEC previous 73/23/EEC).

This unit conforms to the international standard IEC 60255, and the German standard DIN 57435/Part 303 (corresponding to VDE 0435/ Part 303).

The unit has been developed and manufactured for application in an industrial environment according to the EMC standards.

This conformity is the result of a test that was performed by Siemens AG in accordance with Article 10 of the Council Directive complying with the generic standards EN 50081-2 and EN 50082-2 for the EMC Directive and standard EN 60255-6 for the "low-voltage Directive".

Selection and ordering data

Description	Order No.	Order code
7UM61 multifunction generator and motor protection relay	7UM61□□-□□□□□-□□□0-□□□	
Housing, binary inputs and outputs		
Housing ⅓ 19", 7 BI, 11 BO, 1 live status contact	1	
Housing ½ 19", 15 BI, 19 BO, 1 live status contact	2	
Current transformer I_N		
1 A 1)	1	
5 A 1)	5	
Rated auxiliary voltage (power supply, indication voltage)		
DC 24 to 48 V, threshold binary input 19 V 3)	2	
DC 60 to 125 V 2), threshold binary input 19 V 3)	4	
DC 110 to 220 V 2), AC 115 to 230 V, threshold binary input 88 V 3)	5	
Unit version		
For panel surface-mounting, 2 tier screw-type terminals top/bottom	B	
For panel flush-mounting, plug-in terminals (2-/3- pin connector)	D	
Flush-mounting housing, screw-type terminal (direct connection, ring-type cable lugs)	E	
Region-specific default setting/function and language settings		
Region DE, 50 Hz, IEC characteristics, language: German, (language can be selected)	A	
Region World, 50/60 Hz, IEC/ANSI characteristics, language: English (UK), (language can be selected)	B	
Region US, 60 Hz, ANSI characteristics, language: English (US), (language can be selected)	C	
System interface (rear of units)		
No system interface	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-DP slave, electrical RS485	9	L 0 A
PROFIBUS-DP slave, optical 820 nm, double ring, ST connector*	9	L 0 B
MODBUS, electrical RS485	9	L 0 D
MODBUS, optical 820 nm, ST connector*	9	L 0 E
DNP 3.0, electrical RS485	9	L 0 G
DNP 3.0, optical 820 nm, ST connector*	9	L 0 H
DIGSI 4/modem interface (rear of unit)		
No interface	0	
DIGSI 4, electrical RS232	1	
DIGSI 4, temperature monitoring box, electrical RS485	2	
DIGSI 4, temperature monitoring box, optical 820 nm, ST connector	3	
Measuring functions		
Without	0	
Min./max. values, energy metering	3	
Functions 4)		
Generator Basic	A	
Generator Standard	B	
Generator Full	C	
Motor, asynchronous	F	
Additional functions 4)		
Without A	A	
Network decoupling (d*f*/d*t* and vector jump)	E	

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 in stages by means of jumpers.

4) For more detailed information on the functions see Table 11/1 on page 11/4.

* Not with position 9 = **B**; if 9 = "**B**", please order 7UM61 unit with RS485 port and separate fiber-optic converters.

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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 (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 Cable between PC / notebook (9-pin connector) and protection unit (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)	**7XV5100-4**
	Coupling device for rotor ground-fault protection	**7XR6100-0CA00**
		Short code
	Series resistor for rotor ground-fault protection (group: 013002)	**3PP1336-0DZ K2Y**
	Resistor for stator ground-fault protection (voltage divider, 5 : 1) (group 013001)	**3PP1336-1CZ K2Y**
	Temperature monitoring box (thermo-box)	
	AC/DC 24 to 60 V	**7XV5662-2AD10**
	AC/DC 90 to 240 V	**7XV5662-5AD10**
	Manual for 7UM61	
	English	**C53000-G1176-C127-2**

Selection and ordering data

Accessories

Fig. 11/25 Mounting rail for 19" rack

Fig. 11/26
2-pin connector

Fig. 11/27
3-pin connector

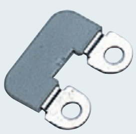
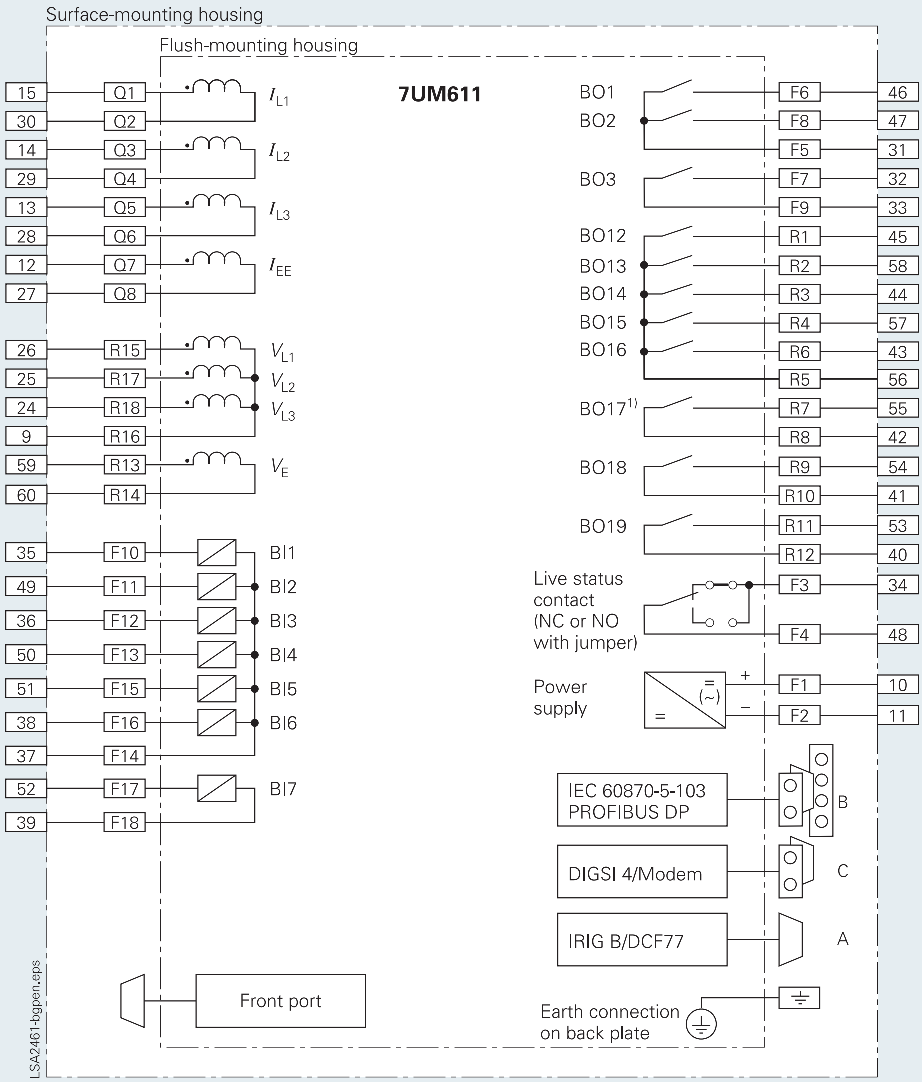


Fig. 11/28
Short-circuit link
for current contacts

Fig. 11/29
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	11/26
	3-pin	**C73334-A1-C36-1**	1	Siemens	11/27
Crimp connector	CI2 0.5 to 1 mm^2	**0-827039-1**	4000	AMP [1]	
		0-827396-1	1	AMP [1]	
	CI2 0.5 to 2.5 mm^2	**0-827040-1**	4000	AMP [1]	
		0-827397-1	1	AMP [1]	
	Type III+ 0.75 to 1.5 mm^2	**0-163083-7**	4000	AMP [1]	
		0-163084-2	1	AMP [1]	
Crimping tool	For type III+	**0-539635-1**	1	AMP [1]	
	and matching female	**0-539668-2**		AMP [1]	
	For CI2	**0-734372-1**	1	AMP [1]	
	and matching female	**1-734387-1**		AMP [1]	
19"-mounting rail		**C73165-A63-D200-1**	1	Siemens	11/25
Short-circuit links	For current terminals	**C73334-A1-C33-1**	1	Siemens	11/28
	For other terminals	**C73334-A1-C34-1**	1	Siemens	11/29
Safety cover for terminals	large	**C73334-A1-C31-1**	1	Siemens	11/3
	small	**C73334-A1-C32-1**	1	Siemens	11/3

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

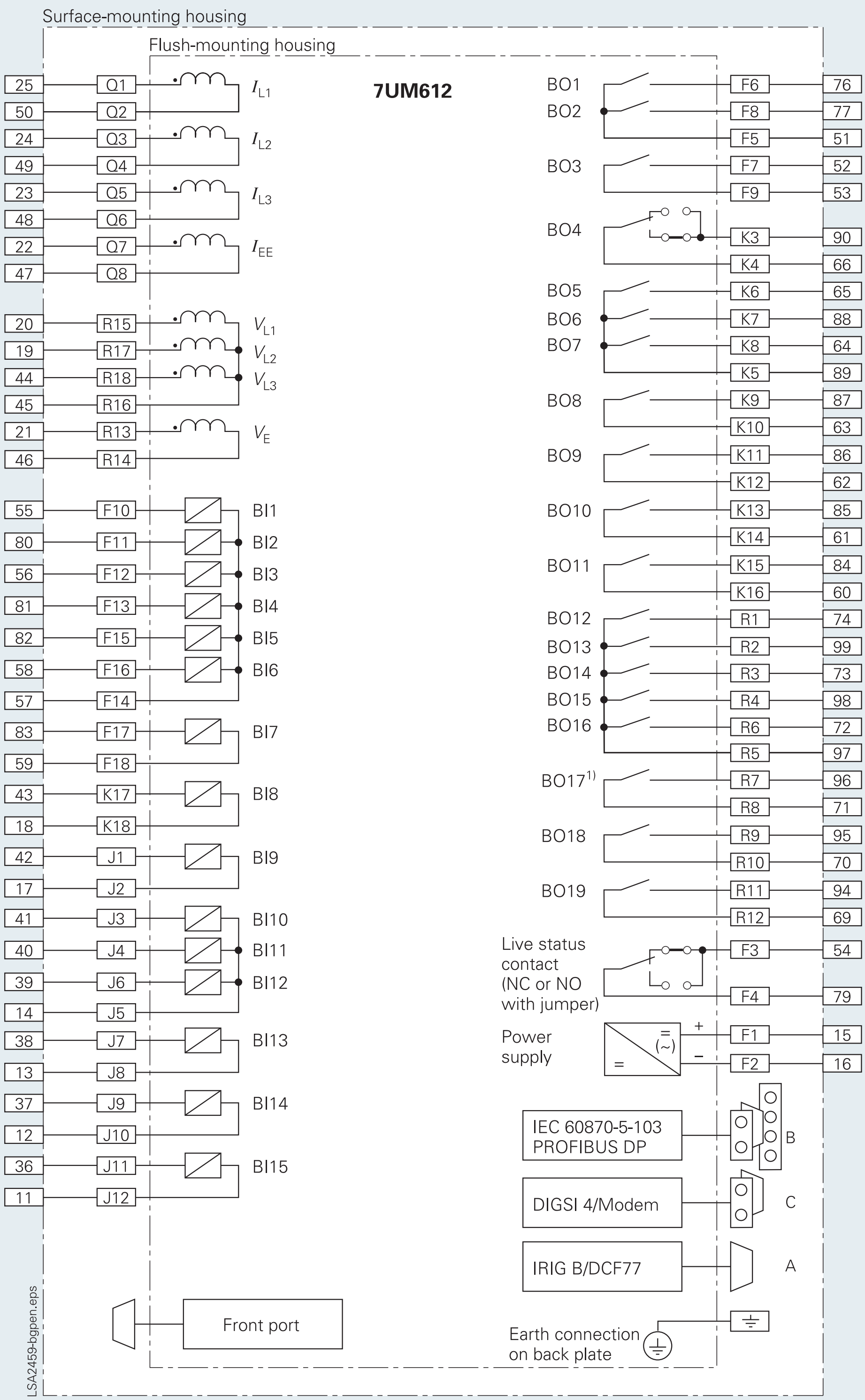


1) NO or NC with jumper possible.

Fig. 11/30 7UM611 connection diagram (IEC standard)

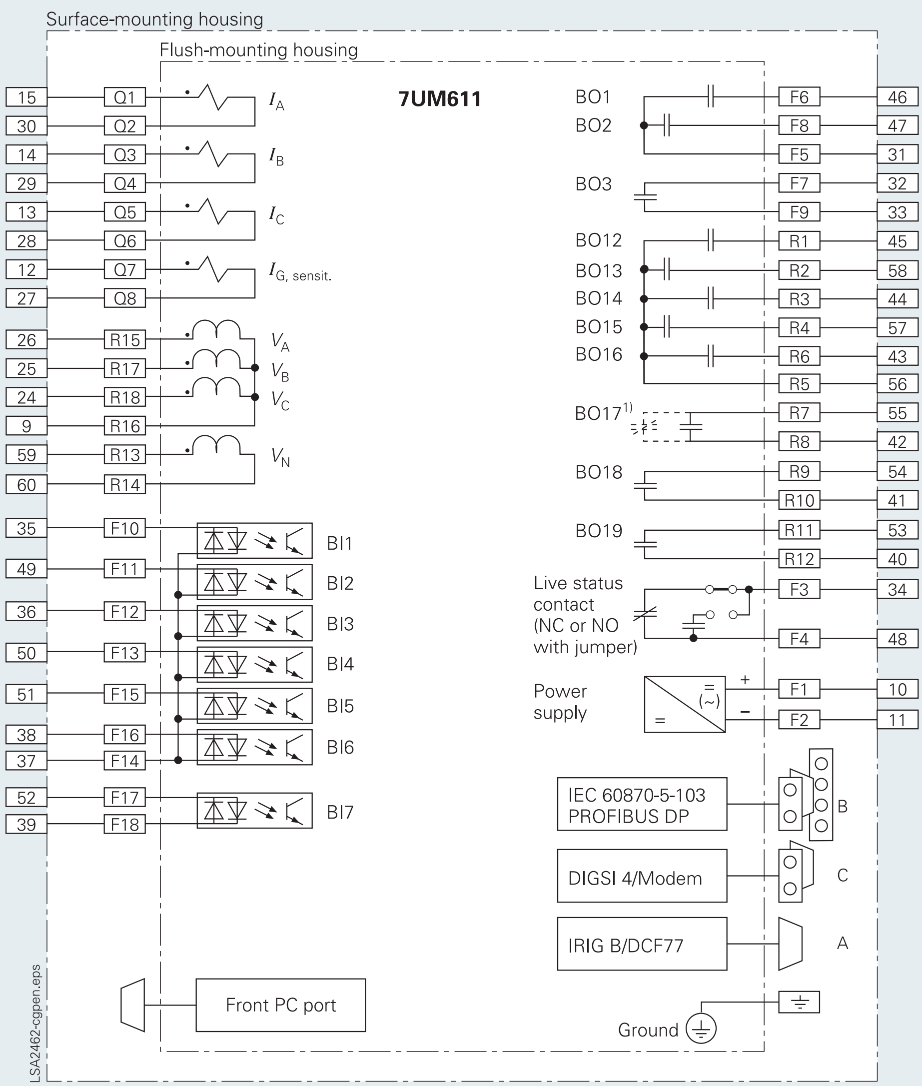
11

Connection diagram, IEC



1) NO or NC with jumper possible.

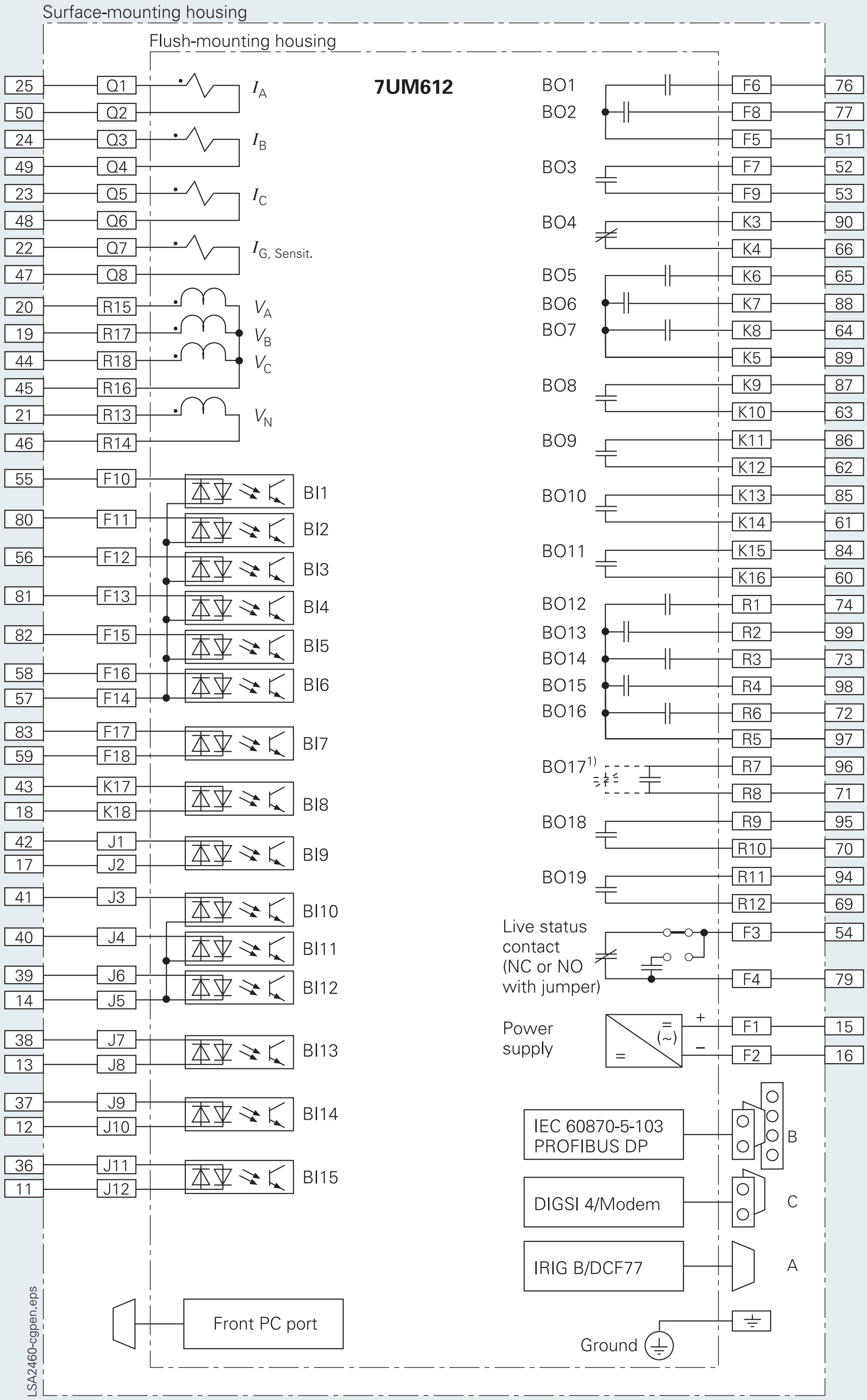
Fig. 11/31 7UM612 connection diagram (IEC standard)



1) NO or NC with jumper possible.

Fig. 11/32 7UM611 connection diagram (ANSI standard)

Connection diagram, ANSI



1) NO or NC with jumper possible.

Fig. 11/33 7UM612 connection diagram (ANSI standard)