Generator Protection

Page

SIPROTEC 4 7UM61
Multifunction Generator and Motor Protection Relay ***11**/3*

SIPROTEC 4 7UM62
Multifunction Generator, Motor and Transformer Protection Relay ***11**/33*

SIPROTEC 7UW50 Tripping Matrix ***11**/69*

SIPROTEC 7RW600
Numerical Voltage, Frequency and Overexcitation Protection Relay ***11**/71*

SIPROTEC 7VE6 Multifunction Paralleling Device ***11**/81*

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 earth 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 earth-fault protection
- Sensitive earth-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 earth-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 $V, I, f, \ldots$
- 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

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 earth-fault protection non-directional, directional	$V_0>$, $3I_0>$ $\angle(V_0, 3I_0)$	59N, 64G 67G	X	X	X	X
Sensitive earth-fault protection (also rotor earth-fault protection)	$I_{EE}>$	50/51GN (64R)	X	X	X	X
Stator overload protection	I^2t	49	X	X	X	X
Definite-time overcurrent protection with undervoltage seal-in	$I> +V<$	51	X	X	X	X
Definite-time overcurrent protection, directional	$I>>$, Direc.	50/51/67	X	X	X	X
Inverse-time overcurrent protection	$t = f(I)+V<$	51V	X	X	X	X
Overvoltage protection	$V>$	59	X	X	X	X
Undervoltage protection	$V<$	27	X	X	X	X
Frequency protection	$f<$, $f>$	81	X	X	X	X
Reverse-power protection	$-P$	32R	X	X	X	X
Overexcitation protection (Volt/Hertz)	V/f	24	X	X	X	
Fuse failure monitor	V_2/V_1, I_1/I_2	60FL	X	X	X	X
External trip coupling (7UM611/612)	Incoup.		2/4	2/4	2/4	2/4
Trip circuit supervision (7UM612)	T.C.S.	74TC	X	X	X	X
Forward-power protection	$P>$, $P<$	32F		X	X	X
Underexcitation protection	1/xd	40		X	X	
Negative-sequence protection	$I_2>$, $t = f(I_2)$	46		X	X	X
Breaker failure protection	$I_{min}>$	50BF		X	X	X
Inadvertent energization protection	$I>$, $V<$	50/27			X	
100 %-stator-earth-fault protection with 3rd harmonics	$V_{0(3^{rd}\ harm)}$	59TN 27TN (3rd h.)			X	
Impedance protection with ($I>+V<$)-pickup	$Z<$	21			X	
Motor starting time supervision	$I_{an}{}^2t$	48			X	X
Restart inhibit for motors	I^2t	49 Rotor			X	X
External temperature monitoring through serial interface	ϑ (Thermo-box)	38	X	X	X	X
Rate-of-frequency-change protection[1)]	$df/dt >$	81R	X	X	X	X
Vector jump supervision (voltage)[1)]	$\Delta\varphi >$		X	X	X	X

Table 11/1 Scope of functions of the 7UM61

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.

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

Application

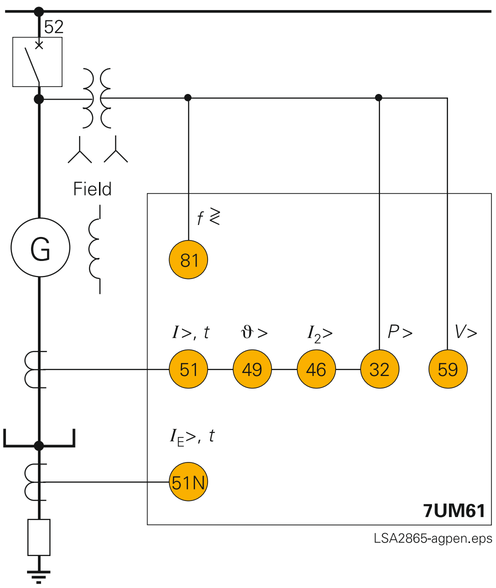


Fig. 11/2

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 1/3 19 inch, and the 7UM612 in 1/2 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.

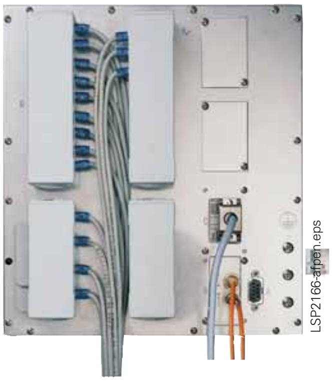


Fig. 11/3
Rear view with wiring terminal safety cover and serial interface

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.

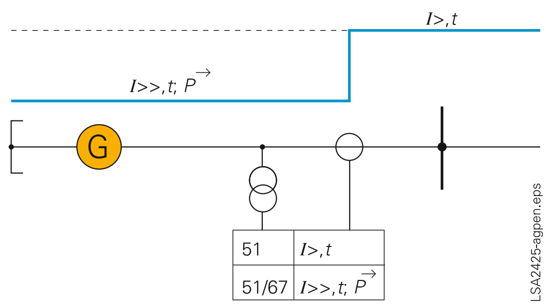


Fig. 11/4
Protection with current transformer on terminal side

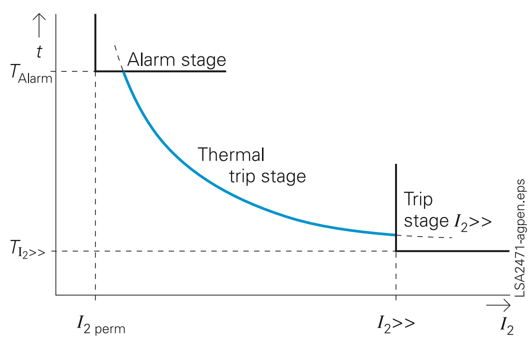


Fig. 11/5
Characteristic of negative-sequence protection

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.

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 Figure 11/5).

Available inverse-time characteristic

Characteristics	ANSI / IEEE	IEC 60255-3
Inverse	•	•
Moderately inverse	•	
Very inverse	•	•
Extremely inverse	•	•
Definite inverse	•	

Table 11/2

11

Protection functions

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 shutdown (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.

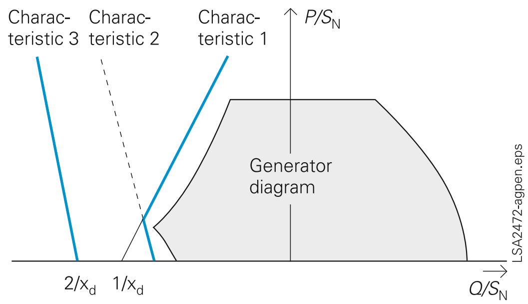


Fig. 11/6
Characteristic of underexcitation protection

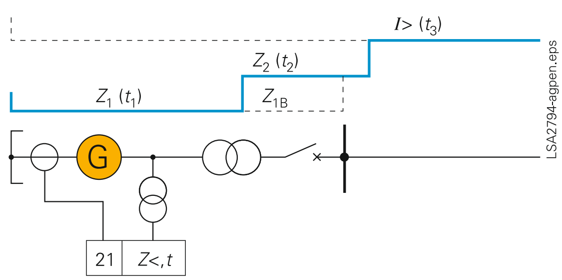


Fig. 11/7
Grading of impedance protection

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 undervoltage 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.

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-earth 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 earth-faults. This function is implemented in two stages.

Protection functions

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 underfrequency 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.

11

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

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

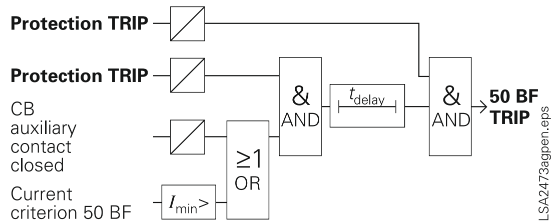


Fig. 11/8
Logic diagram of breaker failure protection

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-earth 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 earth-current measurement. This input should be connected to a core-balance current transformer. The fault direction is deduced from the displacement voltage and earth 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 earth-fault protection concepts can be implemented with this function (see Figs. 11/17 to 11/21).

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

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

Alternatively, this input is also suitable as rotor earth-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 earth current is flowing, a rotor earth fault has occurred. Measuring-circuit monitoring is provided for this application (see Figure 11/20).

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

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 earth 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).

Protection functions

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.

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.

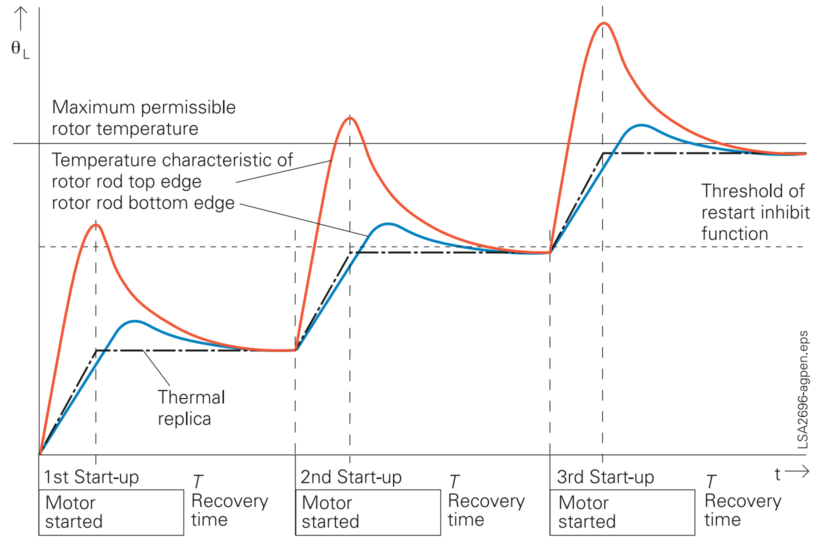


Fig. 11/9 Temperature characteristic at rotor and thermal replica of the rotor (multiple start-ups)

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).

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.

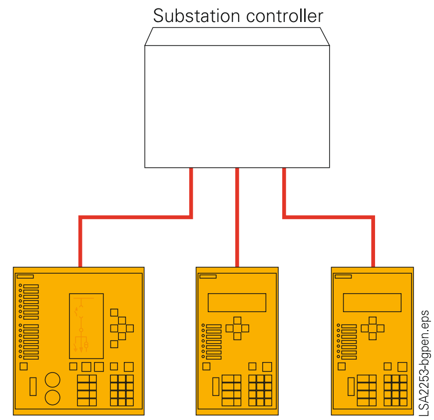


Fig. 11/10
IEC 60870-5-103 star-type RS232 copper conductor connection or fiber-optic connection

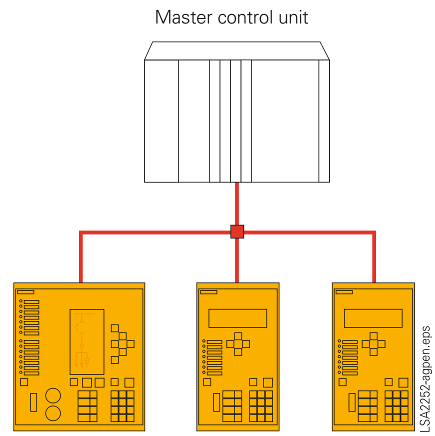


Fig. 11/11
PROFIBUS: RS485 copper conductors

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 (cyclic testing).

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

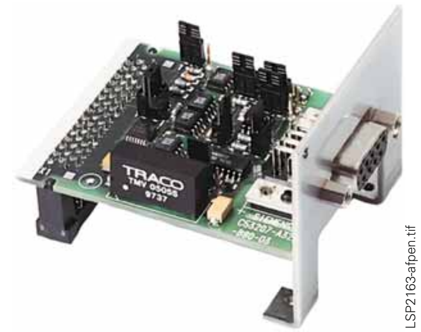


Fig. 11/12
RS232/RS485
Electrical communication module

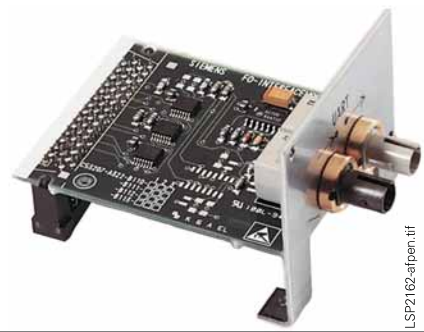


Fig. 11/13
820 nm fiber-optic
communication module

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

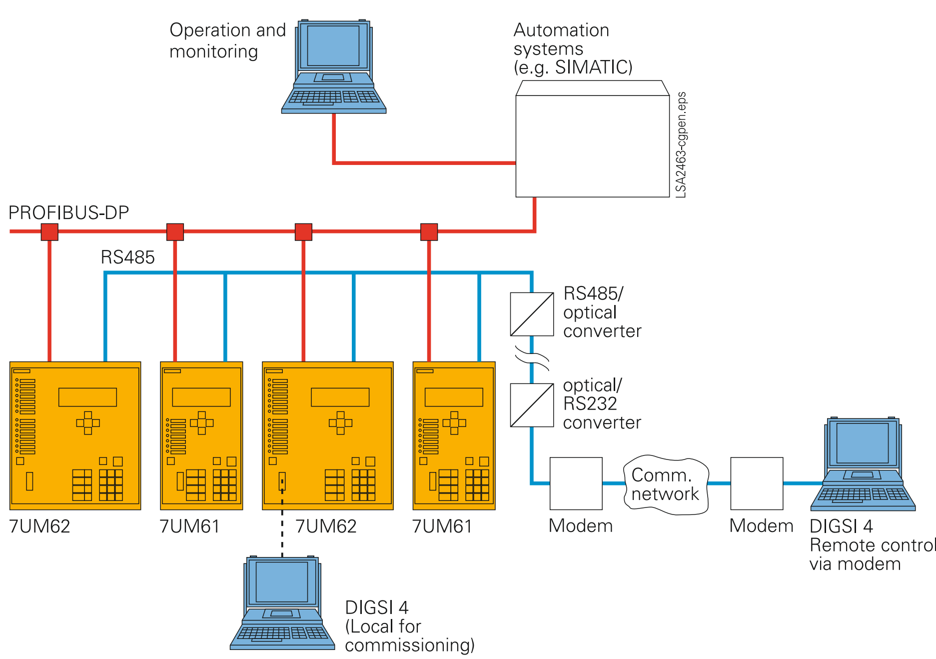


Fig. 11/15
System solution: Communication

11

Typical connections

Direct generator - busbar connection

Fig. 11/16 illustrates the recommended standard connection if several generators supply one busbar. Phase-to-earth faults are disconnected by employing the directional earth-fault criterion. The earth-fault current is driven through the cables of the system. If this is not sufficient, an earthing transformer connected to the busbar supplies the necessary current (maximum approximately 10 A) and permits a protection range of up to 90 %. The earth-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 earth-fault criterion during starting operations until synchronization is achieved.

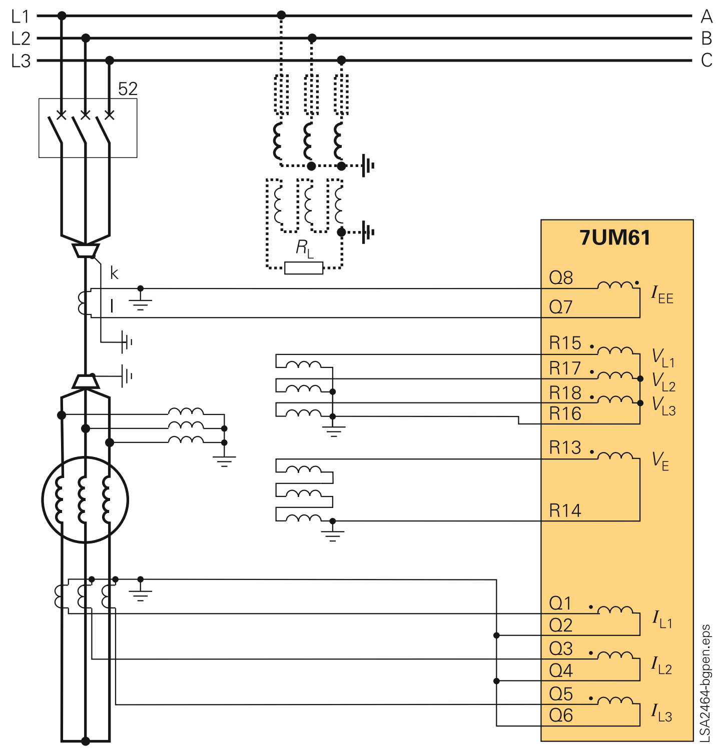


Fig. 11/16

Direct generator - busbar connection with low-resistance earthing

If the generator neutral point has low-resistance earthing, 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 earth-fault detection, the earth-current input should be looped into the common return conductor of the two current transformer sets (differential connection). The current transformers must be earthed 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.

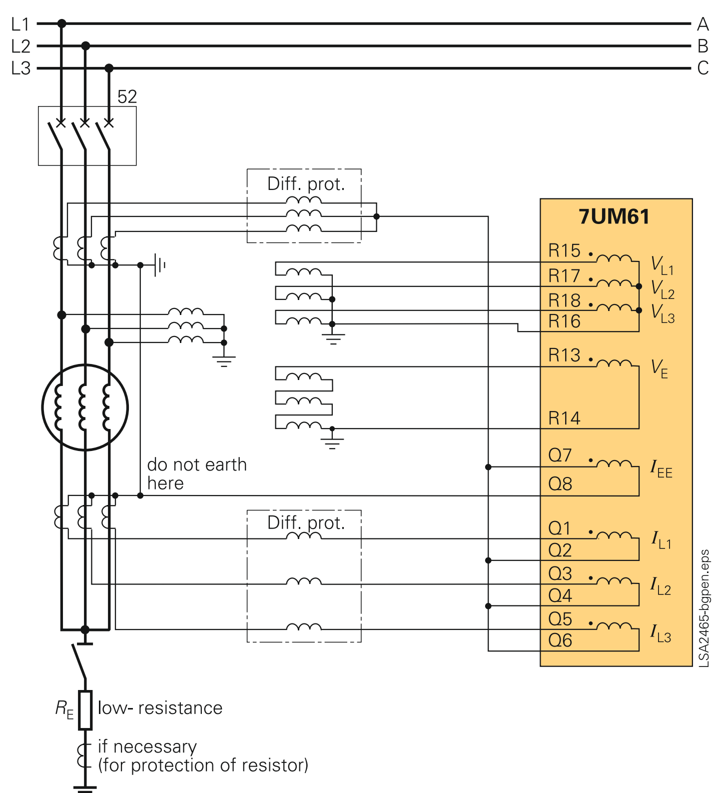


Fig. 11/17

11

Typical connections

Direct generator - busbar connection with high-resistance generator neutral earthing

With this system configuration, selective earth-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 earthing 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 earthed via the resistor.

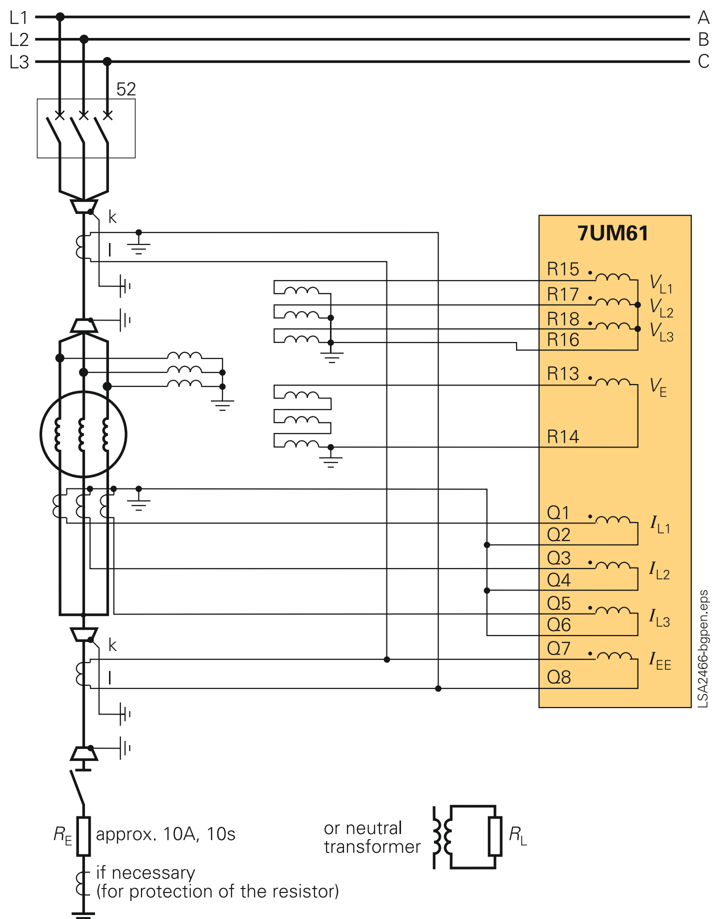


Fig. 11/18

Unit connection with isolated star point

This configuration of unit connection is a variant to be recommended (see Figure 11/19). Earth-fault detection is effected by means of the displacement voltage. In order to prevent unwanted operation in the event of earth 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 earthing transformer should be employed. The available measuring winding can be used for the purpose of voltage measurement.

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

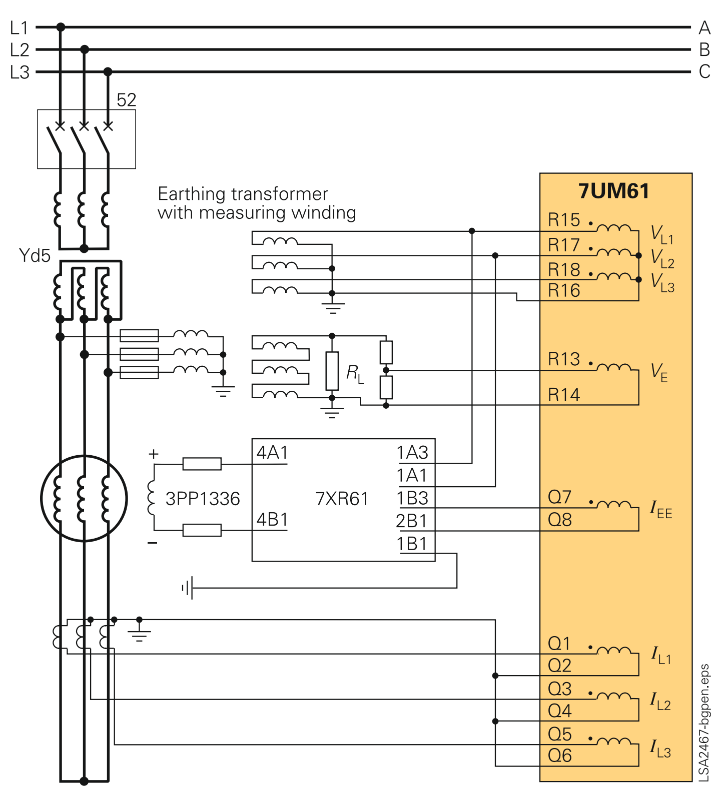


Fig. 11/19

11

Typical connections

Unit connection with neutral transformer

With this system configuration, disturbance voltage reduction and damping in the event of earth faults in the generator area are effected by a load resistor connected to generator neutral point. The maximum earth-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.

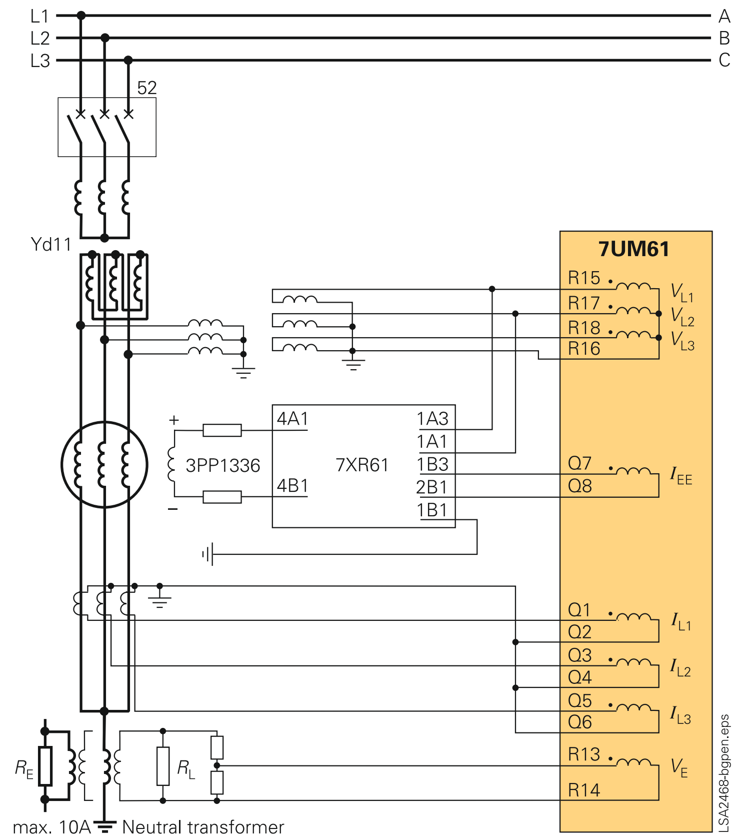


Fig. 11/20

Connection with low-voltage generators

As is generally known, the low-voltage system is solidly earthed, so that the generator neutral point is connected to earth (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.

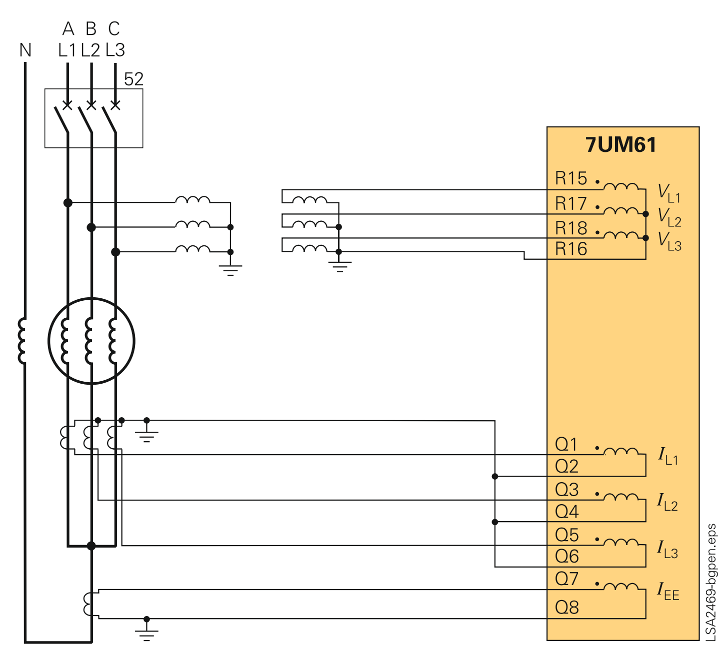


Fig. 11/21

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 earth-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 advantageous. For the detection of temperatures, 2 thermo-boxes (temperature monitoring boxes) can be connected via a serial interface.

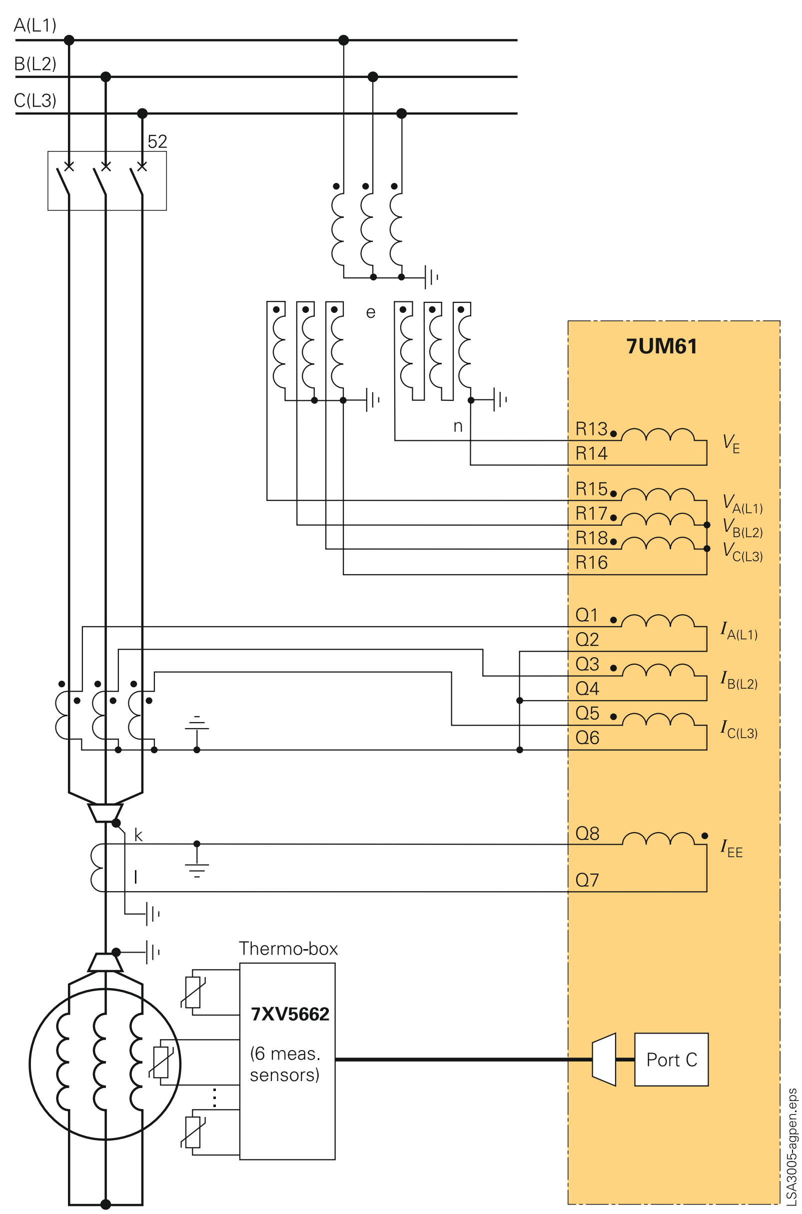


Fig. 11/22

11

Typical connections

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-earth voltages can be slightly asymmetrical. If this is disturbing, the neutral point (R16) can be connected to earth 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 earthing transformer).

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 earthing.

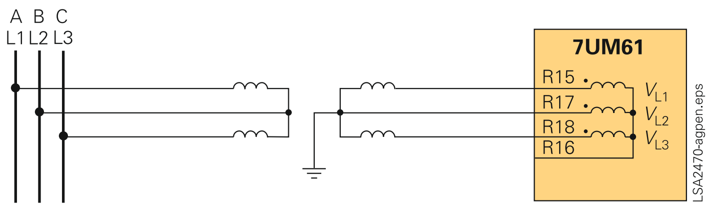


Fig. 11/23

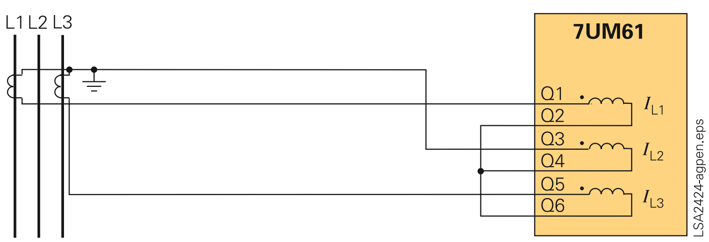


Fig. 11/24

Technical data

Hardware

Analog inputs	
Rated frequency	50 or 60 Hz
Rated current I_N	1 or 5 A
Earth 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 earth 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)
Earth 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	24 to 48 V DC 60 to 125 V DC 110 to 250 V DC and 115 V/230 V AC 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	10 to 19 V DC or 44 to 88 V DC 88 to 176 V DC[1)]
Maximum permissible voltage	300 V DC
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 15
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 (1/3 x 19″) 7UM612 (1/2 x 19″) Surface mounting housing 7UM611 (1/3 x 19″) 7UM612 (1/2 x 19″)	 Approx. 5.5 kg Approx. 7 kg Approx. 7.5 kg Approx. 12 kg

Technical data

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 Test voltage Distance for RS232 Distance for RS485	9-pin subminiature connector 500 V / 50 Hz Max. 15 m Max. 1000 m
Fiber-optic cable Optical wavelength Permissible path attenuation Bridgeable distance	Integrated ST-connector λ = 820 nm Max. 8 dB for glass-fiber 62.5/125 µm Max. 1.5 km
System interface IEC 60870-5-103 protocol, PROFIBUS-DP, MODBUS RTU	
Isolated RS232/RS485 Baud rate Test voltage Distance for RS232 Distance for RS485	9-pin subminiature connector 4800 to 115200 baud 500 V / 50 Hz Max. 15 m Max. 1000 m
PROFIBUS RS485 Test voltage Baud rate Distance	 500 V / 50 Hz Max. 12 Mbaud 1000 m at 93.75 kBaud; 100 m at 12 Mbaud
PROFIBUS fiber-optic Only for flush-mounting housing For surface-mounting housing Baud rate Optical wavelength Permissible path attenuation Distance	 ST connector Optical interface with OLM[1)] Max. 1.5 Mbaud λ = 820 nm Max. 8 dB for glass-fiber 62.5/125 µm 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	3.5 kV DC
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

11

Technical data

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 50081-1 (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

Technical data

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 $I/(k\, I_N)>1.25$

11

Technical data

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	$\|\Delta Z/Z\| \leq 5$ % 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

Technical data

Overvoltage protection *(ANSI 59)*	
Setting ranges	
Overvoltage pickup $V>$, $V>>$ (maximum phase-to-phase voltage or phase-to-earth-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 earth-fault protection, non-directional, directional *(ANSI 59N, 64G, 67G)*	
Setting ranges	
Displacement voltage $V_0>$	5 to 125 V (steps 0.1 V)
Earth 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
Earth current	1 % of set value or 0.5 mA
Time delays T	1 % or 10 ms

Sensitive earth-fault protection *(ANSI 50/51GN, 64R)*	
Setting ranges	
Earth 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	
Earth current pickup	1 % of set value or 0.5 mA
Time delays T	1 % or 10 ms

100 % stator earth-fault protection with 3 harmonics *(ANSI 59TN, 27TN (3 H.))*	
Setting ranges	
Displacement voltage $V_{0\,(3^{rd}\,harm.)}>$, $V_{0\,(3^{rd}\,harm.)}<$	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 $V_{0\,(3^{rd}\,harm.)}<$	Approx. 1.4
Overvoltage stage $V_{0\,(3^{rd}\,harm.)}>$	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 +df/dt >; - df/dt	4
Pickup value df/dt	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 df/dt	Approx. 200 ms
Drop-off times df/dt	Approx. 200 ms
Drop-off ratio df/dt	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

11

Technical data

Operational measured values	
Description	Primary; secondary or per unit (%)
Currents Tolerance	I_{L1}; I_{L2}; I_{L3}; I_{EE}; I_1; I_2 0.2 % of measured values or ± 10 mA ± 1 digit
Voltages Tolerance	V_{L1}; V_{L2}; V_{L3}; V_E; V_{L12}; V_{L23}; V_{L31}; V_1; V_2 0.2 % of measured values or ± 0.2 V ± 1 digit
Impedance Tolerance	R, X 1 %
Power Tolerance	S; P; Q 1 % of measured values or ± 0.25 % S_N
Phase angle Tolerance	φ <0.1 °
Power factor Tolerance	cos φ (p.f.) 1 % ± 1 digit
Frequency Tolerance	f 10 mHz at (V> 0.5 V_N; 40 Hz < f < 65 Hz)
Overexcitation Tolerance	V/f; 1 %
Thermal measurement Tolerance	Θ_{L1}; Θ_{L2}, Θ_{L3}, Θ_{I2}, $\Theta_{V/f}$, 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 Positive sequence current Active power Reactive power Frequency Displacement voltage (3rd harmonics)	 V_1 I_1 P Q f $V_{E(3^{rd}\ harm.)}$
Energy metering	
Meter of 4 quadrants Tolerance	W_{P+}; W_{P-}; W_{Q+}; W_{Q-} 1 %
Fault records	
Number of fault records	Max. 8 fault records
Instantaneous values Storage time Sampling interval Channels	Max. 5 s Depending on the actual frequency (e. g. 1.25 ms at 50 Hz; 1.04 ms at 60 Hz)) v_{L1}, v_{L2}, v_{L3}, v_E; i_{L1}, i_{L2}, i_{L3}, i_{EE}
R.m.s. values Storage period Sampling interval Channels	 Max. 80 s Fixed (20 ms at 50 Hz; 16.67 ms at 60 Hz) 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 89/336/EEC) and electrical equipment designed for use within certain voltage limits (Council Directive 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 1/3 19", 7 BI, 11 BO, 1 live status contact	1
Housing 1/2 19", 15 BI, 19 BO, 1 live status contact	2

Current transformer I	
1 A[1]	1
5 A[1]	5

Rated auxiliary voltage (power supply, indication voltage)	
24 to 48 V DC, threshold binary input 19 V[3]	2
60 to 125 V DC[2], threshold binary input 19 V[3]	4
110 to 220 V DC[2], 115 to 230 V AC, 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	
Generator Basic	A
Generator Standard	B
Generator Full	C
Motor, asynchronous	F

Additional functions	
Without	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.

11

Accessories

Description	Order No.
DIGSI 4 Software for configuration and operation of Siemens protection units running under MS Windows 2000/XP Profesional 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 earth-fault protection	7XR6100-0CA00
	Short code
Series resistor for rotor earth-fault protection (group: 013002)	3PP1336-0DZ K2Y
Resistor for stator earth-fault protection (voltage divider, 5 : 1) (group 013001)	3PP1336-1CZ K2Y
Temperature monitoring box (thermo-box)	
24 to 60 V AC/DC	7XV5662-2AD10
90 to 240 V AC/DC	7XV5662-5AD10
Manual for 7UM61	
English	C53000-G1176-C127-2

Accessories

Fig. 11/25 Mounting rail for 19" rack

Fig. 11/26
2-pin connector

Fig. 11/27
3-pin connector

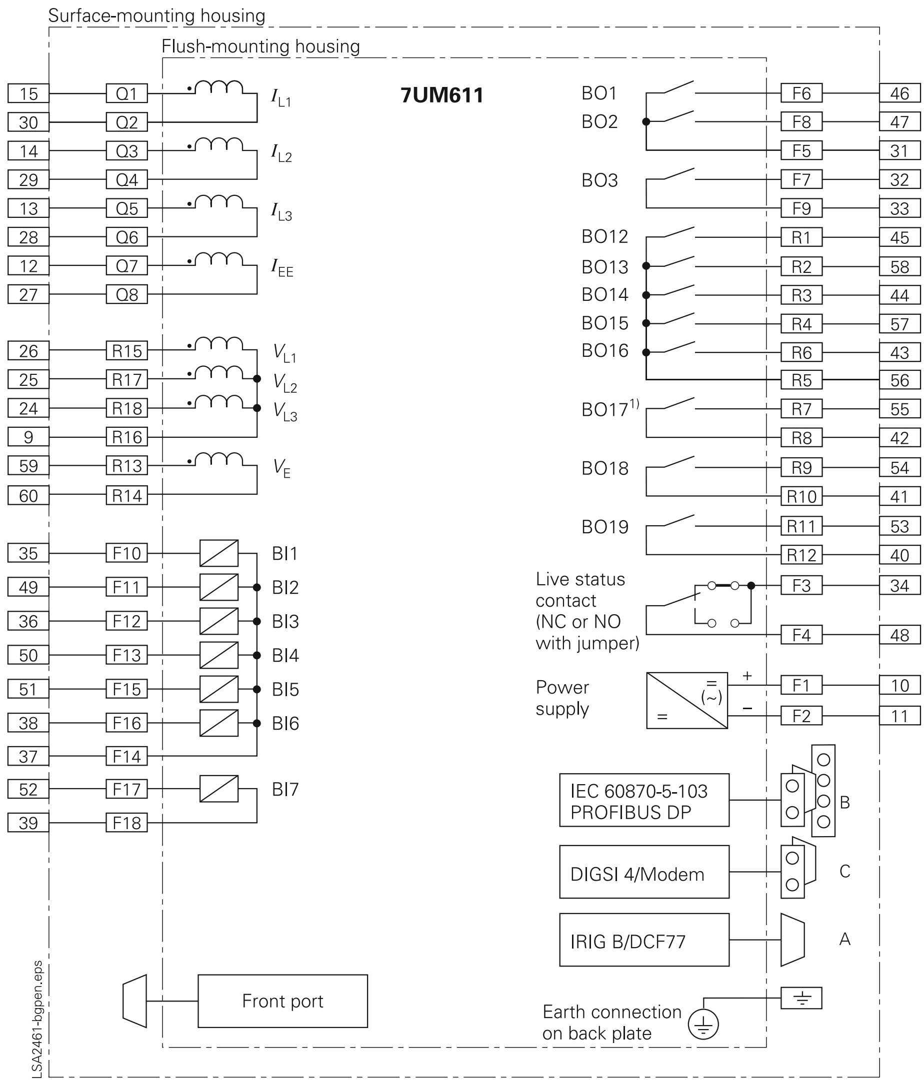
Fig. 11/28
Short-circuit link for current terminals

Fig. 11/29
Short-circuit link for voltage terminals/indications terminals

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 1 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)]	
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.

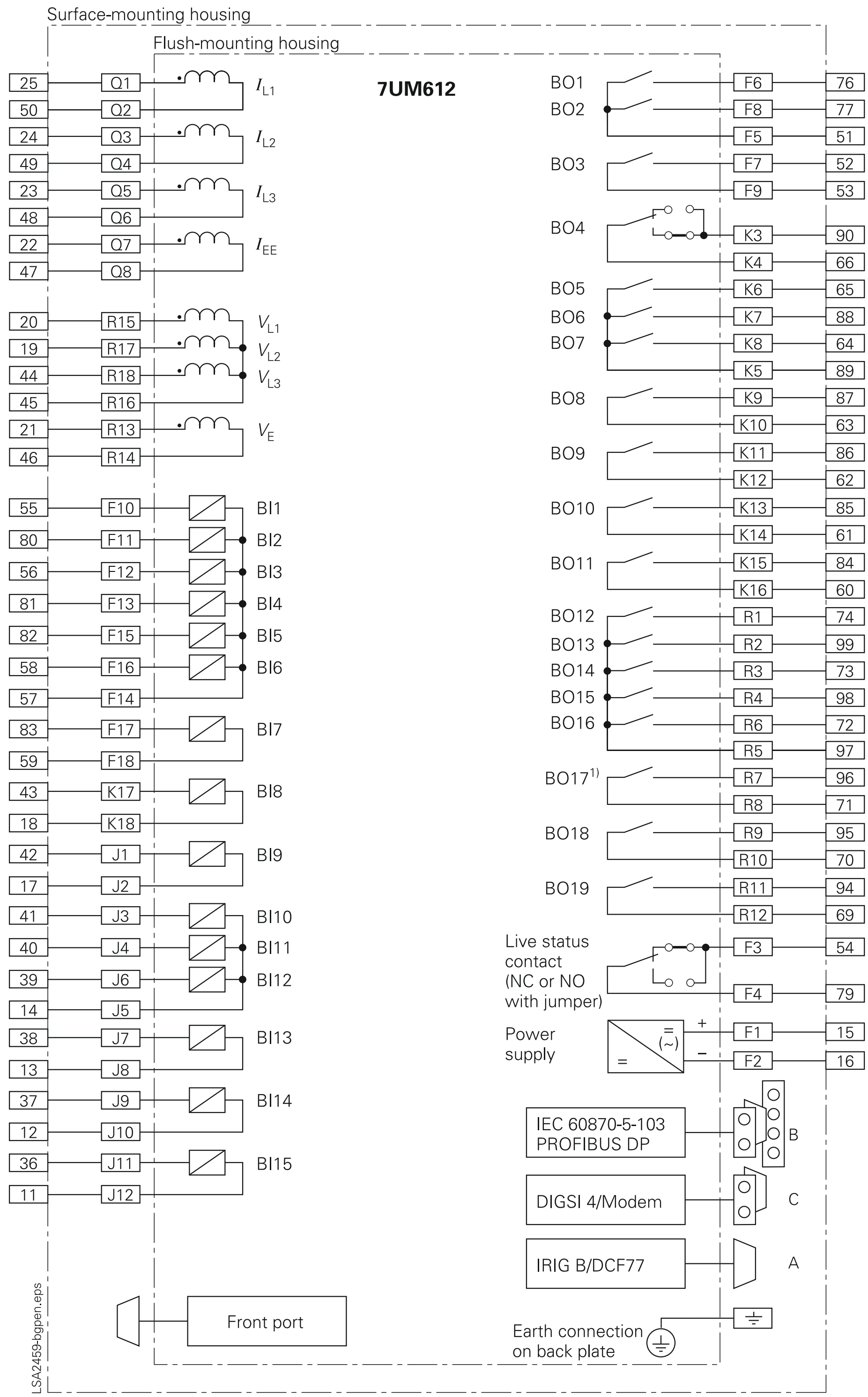
Connection diagram, IEC



1) NO or NC with jumper possible.

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

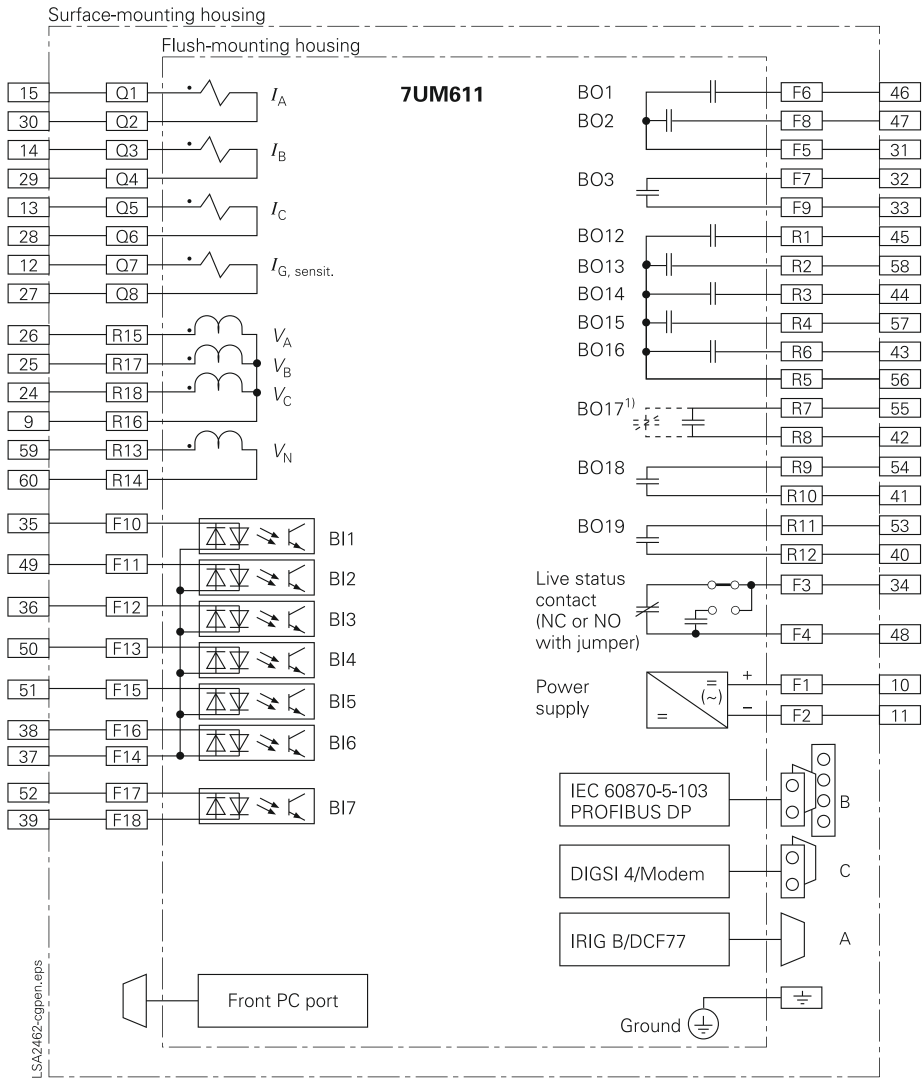
Connection diagram, IEC



1) NO or NC with jumper possible.

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

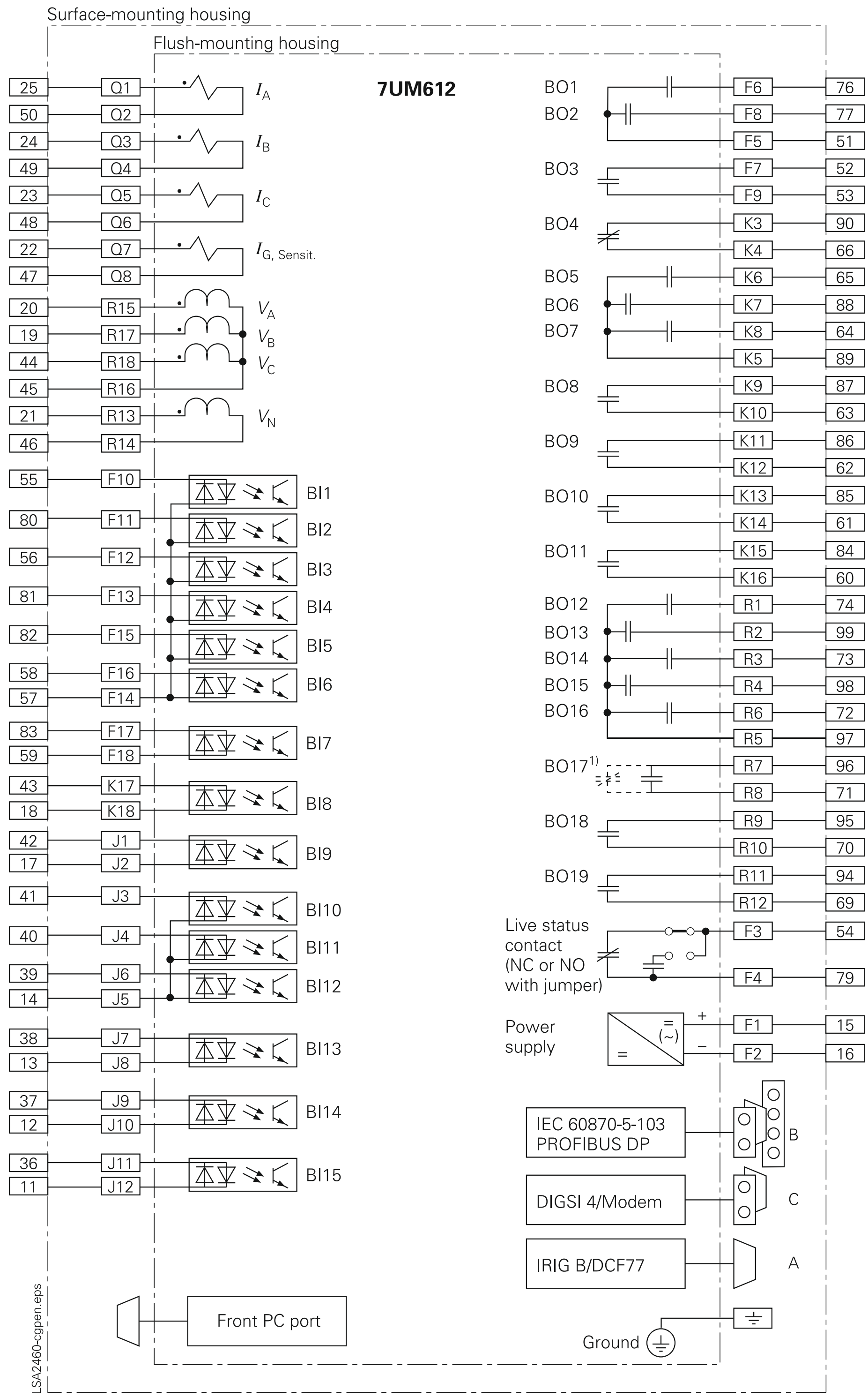
Connection diagram, ANSI



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)

SIPROTEC 4 7UM62
Multifunction Generator, Motor and Transformer Protection Relay

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Fig. 11/34 SIPROTEC 4 7UM62 multifunction protection relay for generators, motors and transformers

Description

The SIPROTEC 4 7UM62 protection relays can do more than just protect. They also offer numerous additional functions. Be it earth faults, short-circuits, overloads, overvoltage, overfrequency or underfrequency asynchronous conditions, protection relays assure continued operation of power stations. The SIPROTEC 4 7UM62 protection relay is a compact unit which has been specially developed and designed for the protection of small, medium-sized and large 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 SIPROTEC 4 7UM62 includes all necessary protection functions for large synchronous and asynchronous motors and for transformers.

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.

The following basic functions are available for all versions:

Current differential protection for generators, motors and transformers, stator earth-fault protection, sensitive earth-fault protection, stator overload protection, overcurrent- time protection (either definite time or inverse time), definite-time overcurrent protection with directionality, undervoltage and overvoltage protection, underfrequency and overfrequency protection, overexcitation and underexcitation protection, external trip coupling, forward-power and reverse-power protection, negative-sequence protection, breaker failure protection, rotor earth-faults protection (f_n, R-measuring), motor starting time supervision and restart inhibit for motors.

Function overview

Standard version

Scope of basic version plus:

- Inadvertent energization protection
- 100 %-stator earth-fault protection with 3rd harmonic
- Impedance protection

Full version

Scope of standard version plus:

- DC voltage protection
- Overcurrent protection during start-ups
- Earth-current differential protection
- Out-of-step protection

Additional version

Available for each version:

- Sensitive rotor earth-fault protection (1-3 Hz method)
- Stator earth-fault protection with 20 Hz voltage
- Rate-of-frequency-change protection
- Vector jump supervision

Monitoring function

- Trip circuit supervision
- Fuse failure monitor
- Operational measured values V, I, f, …
- Energy metering values W_p, W_q
- Time metering of operating hours
- Self-supervision of relay
- 8 oscillographic fault records

Communication interfaces

- System interface
  - IEC 61850 protocol
  - IEC 60870-5-103 protocol
  - PROFIBUS-DP
  - MODBUS RTU
  - DNP 3.0

Hardware

- Analog inputs
- 8 current transformers
- 4 voltage transformers
- 7/15 binary inputs
- 12/20 output relays

Front design

- User-friendly local operation
- 7/14 LEDs for local alarm
- Function keys
- Graphic display with 7UM623

Application

The 7UM6 protection relays of the SIPROTEC 4 family are compact multi-function 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 11/3). Selection is facilitated by division into five groups.

Generator Basic

One application concentrates on small and medium generators for which differential protection is required. The function mix is also suitable as backup protection. Protection of synchronous motors is a further application.

Generator Standard

In the case of medium-size generators (10 to 100 MVA) in a unit connection, this scope of functions offers all necessary protection functions. Besides inadvertent energization protection, it also includes powerful backup protection for the transformer or the power system. The scope of protection is also suitable for units in the second protection group.

Generator Full

Here, all protection functions are available and the main application focuses on large block units (more than 100 MVA). The function mix includes all necessary protection functions for the generator as well as backup protection for the block transformer including the power system. Additional functions such as protection during start-up for generators with starting converters are also included.

The scope of functions can be used for the second protection group, and functions that are not used, can be masked out.

Asynchronous motor

Besides differential protection, this function package includes all protection functions needed to protect large asynchronous motors (more than 1 MVA). Stator and bearing temperatures are measured by a separate thermo-box and are transmitted serially to the protection unit for evaluation.

Transformer

This scope of functions not only includes differential and overcurrent protection, but also a number of protection functions that permit monitoring of voltage and frequency stress, for instance. The reverse-power protection can be used for energy recovery monitoring of parallel-connected transformers.

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 7UM623 is equipped with a graphic display thus providing and depicting more information especially in industrial applications. The DIGSI 4 operating program considerably simplifies planning and engineering and reduces commissioning times.

The 7UM621 and 7UM623 are configured in 1/2 19 inches 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.

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Fig. 11/35
Rear view with wiring terminal safety cover and serial interface

Protection functions

Protection functions	Abbre-viation	ANSI No.	Gene-rator Basic	Gene-rator Standard	Gene-rator Full	Motor Asyn-chronous	Trans-former
Current differential protection	ΔI	87G/87T/87M	X	X	X	X	X
Stator earth-fault protection non-directional, directional	V_0>, $3I_0$> \(V_0, $3I_0$)	59N, 64G 67G	X	X	X	X	X
Sensitive earth-fault protection (also rotor earth-fault protection)	I_{EE}>	50/51GN (64R)	X	X	X	X	X
Sensitive earth-fault prot. B (e.g. shaft current prot.)	I_{EE-B}> I_{EE-B}<	51GN	X	X	X	X	X
Stator overload protection	I^2t	49	X	X	X	X	X
Definite-time overcurrent prot. with undervolt. seal-in	I> +V<	51	X	X	X	X	X
Definite-time overcurrent protection, directional	I>>, Direc.	50/51/67	X	X	X	X	X
Inverse-time overcurrent protection	$t = f(I)$+V<	51V	X	X	X	X	X
Overvoltage protection	V>	59	X	X	X	X	X
Undervoltage protection	V<, $t = f$(V)	27	X	X	X	X	X
Frequency protection	f<, f>	81	X	X	X	X	X
Reverse-power protection	$-P$	32R	X	X	X	X	X
Overexcitation protection (Volt/Hertz)	V/f	24	X	X	X	X	X
Fuse failure monitor	V_2/V_1, I_2/I_1	60FL	X	X	X	X	X
External trip coupling	Incoup.		4	4	4	4	4
Trip circuit supervision	T.C.S.	74TC	X	X	X	X	X
Forward-power protection	P>, P<	32F	X	X	X	X	X
Underexcitation protection (loss-of-field protection)	1/xd	40	X	X	X		
Negative-sequence protection	I_2>, $t = f(I_2)$	46	X	X	X	X	
Breaker failure protection	I_{min}>	50BF	X	X	X	X	X
Motor starting time supervision	$I_{start}^2 t$	48	X	X	X	X	
Restart inhibit for motors	I^2t	66, 49 Rotor	X	X	X	X	
Rotor earth-fault protection (f_n, R-measuring)	R<	64R (f_n)	X	X	X		
Inadvertent energization protection	I>, V<	50/27		X	X		
100 % stator earth-fault protection with 3rd harmonics	$V_{0(3rd\ harm.)}$	59TN, 27TN 3rd h		X	X		
Impedance protection with (I>+V<) pickup	Z<	21		X	X		
Interturn protection	$U_{Interturn}$>	59N(IT)		X	X		
DC voltage / DC current time protection	V_{dc} > I_{dc} >	59N (DC) 51N (DC)			X		
Overcurrent protection during startup (for gas turbines)	I>	51			X		
Earth-current differential protection	ΔI_e	87GN/TN	X[1)]	X[1)]	X	X[1)]	X[1)]
Out-of-step protection	$\Delta Z/\Delta t$	78			X		
Rotor earth-fault protection (1-3 Hz square wave voltage)	R_{REF}<	64R (1–3 Hz)	X[1)]	X[1)]	X[1)]		
100 % stator earth-fault protection with 20 Hz voltage	R_{SEF}<	64G (100 %)	X[1)]	X[1)]	X[1)]		
Rate-of-frequency-change protection	df/dt >	81R	X[1)]	X[1)]	X[1)]	X[1)]	X[1)]
Vector jump supervision (voltage)	$\Delta\varphi$ >		X[1)]	X[1)]	X[1)]	X[1)]	X[1)]
Threshold supervision			X	X	X	X	X
Supervision of phase rotation	A, B, C	47	X	X	X	X	X
Undercurrent via CFC	I <	37	X	X	X	X	X
External temperature monitoring via serial interface	ϑ (Thermo-box)	38	X	X	X	X	X

Table 11/3 Scope of functions of the 7UM62

1) Optional for all function groups.

Protection functions

Current differential protection (ANSI 87G, 87M, 87T)

This function provides undelayed short-circuit protection for generators, motors and transformers, and is based on the current differential protection principle (Kirchhoff's current law).

The differential and restraint (stabilization) current are calculated on the basis of the phase currents. Optimized digital filters reliably attenuate disturbances such as aperiodic component and harmonics. The high resolution of measured quantities permits recording of low differential currents (10 % of I_N) and thus a very high sensitivity.

An adjustable restraint characteristic permits optimum adaptation to the conditions of the protected object. Software is used to correct the possible mismatch of the current transformers and the phase angle rotation through the transformer (vector group). Thanks to harmonic analysis of the differential current, inrush (second harmonic) and overexcitation (fifth harmonic) are reliably detected, and unwanted operation of the differential protection is prevented. The current of internal short-circuits is reliably measured by a fast measuring stage (I_{Diff}>>), which operates with two mutually complementary measuring processes. An external short-circuit with transformer saturation is picked up by a saturation detector with time and status monitoring. It becomes active when the differential current (I_{Diff}) moves out of the add-on restraint area.

If a motor is connected, this is detected by monitoring the restraint current and the restraint characteristic is briefly raised. This prevents false tripping in the event of unequal current transmission by the current transformers.

Figure 11/36 shows the restraint characteristic and various areas.

Earth-current differential protection (ANSI 87GN, 87TN)

The earth-current differential protection permits high sensitivity to single-pole faults. The zero currents are compared. On the one hand, the zero-sequence current is calculated on the basis of the phase currents and on the other hand, the earth current is measured directly at the star-point current transformer.

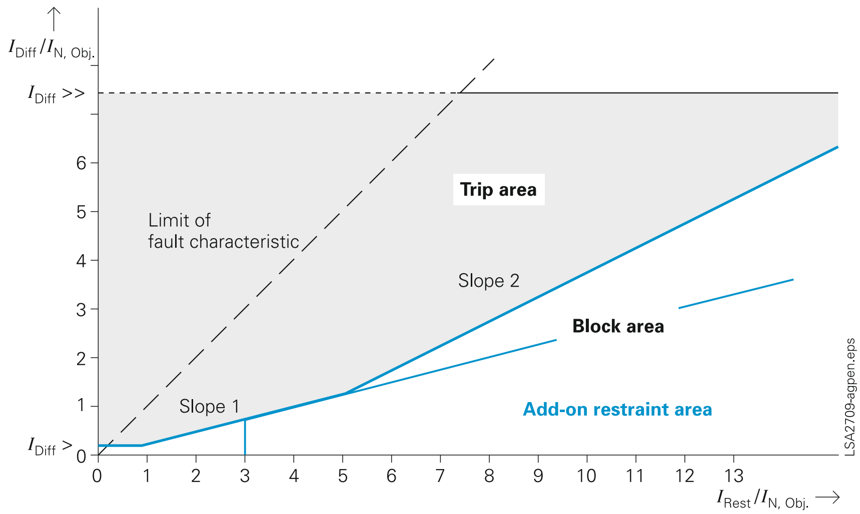

Fig. 11/36 Restraint characteristic of current differential protection

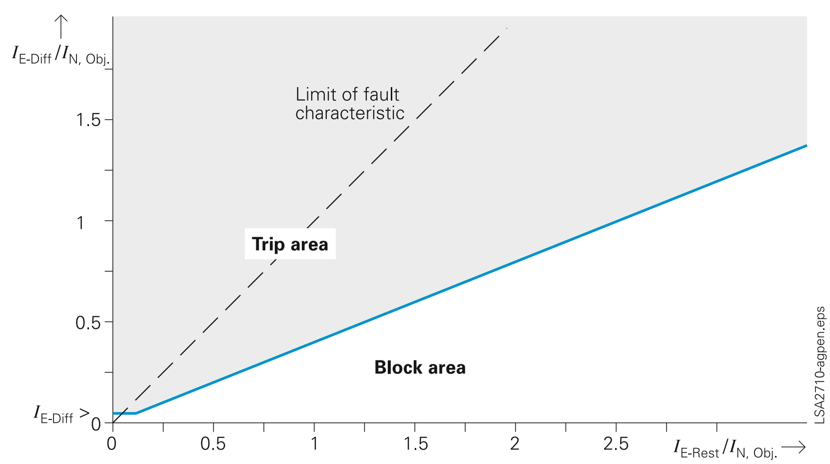

Fig. 11/37 Restraint characteristic of earth-current differential protection

The differential and restraint quantity is generated and fitted into the restraint characteristic (see Fig. 11/37).

DC components in particular are suppressed by means of specially dimensioned filters. A number of monitoring processes avoid unwanted operation in the event of external short-circuits. In the case of a sensitive setting, multiple measurement ensures the necessary reliability.

However, attention must be drawn to the fact that the sensitivity limits are determined by the current transformers.

The protection function is only used on generators when the neutral point is earthed with a low impedance. In the case of transformers, it is connected on the neutral side. Low impedance or solid earthing is also required.

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 drops 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 used as backup protection on the transformer high-voltage side. With the information of the directional element, impedance protection can be controlled via the CFC.

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 11/4).

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.

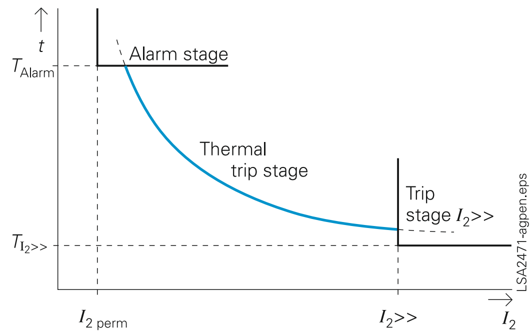

Fig. 11/38 Characteristic of negative-sequence protection

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 a mathematical model. 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 a transducer (TD2) or PROFIBUS-DP, the model automatically adapts to the ambient conditions; otherwise a constant ambient temperature is assumed.

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 Figure 11/38). In the case of motors, the protection function is also used to monitor a phase failure.

Available inverse-time characteristics

Characteristics	ANSI	IEC 60255-3
Inverse	•	•
Moderately inverse	•	
Very inverse	•	•
Extremely inverse	•	•
Definite inverse	•	

Table 11/4

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

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. Via a transducer, the excitation voltage (see Figure 11/52) can be injected and, in the event of failure, a swift reaction of the protection function can be achieved by timer changeover.

The straight-line characteristics allow the protection to be optimally adapted to the generator diagram (see Figure 11/39). 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.

Protection functions

Reverse-power protection (ANSI 32R)

The reverse-power protection monitors the direction of active power flow and picks up when the mechanical energy fails. This function can be used for operational shutdown (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 power system 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 exceeding of a limit value, while another stage monitors falling below another limit value. The power is calculated using the positive-sequence component of current and voltage. The function can be used to shut down idling motors.

Impedance protection (ANSI 21)

This fast short-circuit protection protects the generator and the unit 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 the “open” position the impedance measuring range can be extended (see Figure 11/40).

The overcurrent pickup element with undervoltage seal-in ensures a reliable pickup and the loop selection logic ensures a reliable detection of the faulty loop. With this logic it is possible to perform correct measurement via the unit transformer.

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-earth 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 earth 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 underfrequency 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 eight 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.

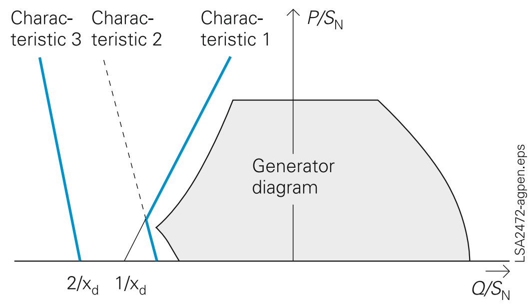

Fig. 11/39
Characteristic of underexcitation protection

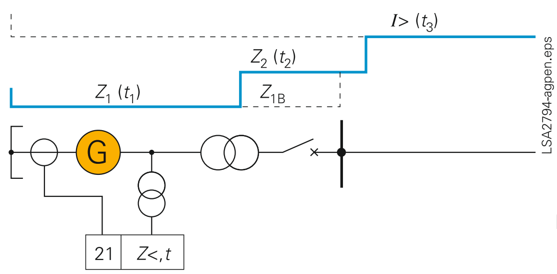

Fig. 11/40

Protection functions

90 % stator earth-fault protection, non-directional, directional (ANSI 59N, 64G, 67G)

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

For the selective earth-fault detection, the direction of the flowing earth 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-earth 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 earth-current measurement. This input should be connected to a core-balance current transformer. The fault direction is deduced from the displacement voltage and earth 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 earth-fault protection concepts can be implemented with this function (see Figures 11/51 to 11/54).

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

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

Alternatively, this input is also suitable as rotor earth-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 earth current is flowing, a rotor earth fault has occurred. Measuring circuit monitoring is provided for this application (see Figure 11/56).

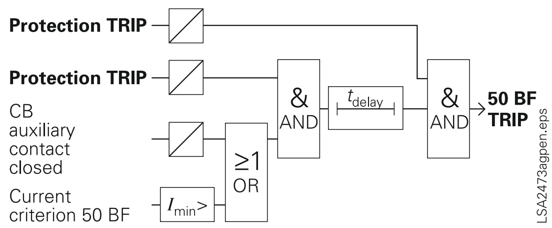

Fig. 11/41
Logic diagram of breaker failure protection

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

Owing to the creative design, the generator produces a 3rd harmonic that forms a zero phase-sequence 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 earth fault in the vicinity of the neutral point, there is a change in the amplitude of the 3rd harmonic voltage (dropping in the neutral point and rising at the terminals).

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

The picked-up threshold of the voltage stage is restrained by the active power. This increases sensitivity at low load.

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 11/41).

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.

Rotor earth-fault protection (ANSI 64R)

This protection function can be realized in three ways with the 7UM62. The simplest form is the method of rotor-current measurement (see sensitive earth-current measurement).

Resistance measurement at system-frequency voltage

The second form is rotor earth resistance measurement with voltage at system frequency (see Fig. 11/56). This protection measures the voltage injected and the flowing rotor earth current. Taking into account the complex impedance from the coupling device (7XR61), the rotor earth resistance is calculated by way of a mathematical model. By means of this method, the disturbing influence of the rotor earth capacitance is eliminated, and sensitivity is increased. Fault resistance values up to 30 kΩ can be measured if the excitation voltage is without disturbances. Thus, a two-stage protection function, which features a warning and a tripping stage, can be realized. An additionally implemented undercurrent stage monitors the rotor circuit for open circuit and issues an alarm.

Protection functions

Resistance measurement with a square wave voltage of 1 to 3 Hz

A higher sensitivity is required for larger generators. On the one hand, the disturbing influence of the rotor earth capacitance must be eliminated more effectively and, on the other hand, the noise ratio with respect to the harmonics (e.g. sixth harmonic) of the excitation equipment must be increased. Injecting a low-frequency square wave voltage into the rotor circuit has proven itself excellently here (see Figure 11/57).

The square wave voltage injected through the controlling unit 7XT71 leads to permanent recharging of the rotor earth capacitance. By way of a shunt in the controlling unit, the flowing earth current is measured and is injected into the protection unit (measurement input). In the absence of a fault ($R_E \approx \infty$), the rotor earth current after charging of the earth capacitance is close to zero. In the event of an earth fault, the fault resistance including the coupling resistance (7XR6004), and also the injecting voltage, defines the stationary current. The current square wave voltage and the frequency are measured via the second input (control input). Fault resistance values up to 80 kΩ can be measured by this measurement principle. The rotor earth circuit is monitored for discontinuities by evaluation of the current during the polarity reversals.

100% stator earth-fault protection with 20 Hz injection (ANSI 64 G (100%))

Injecting a 20 Hz voltage to detect earth faults even at the neutral point of generators has proven to be a safe and reliable method. Contrary to the third harmonic criterion (see page 11/8), it is independent of the generator's characteristics and the mode of operation. Measurement is also possible during system standstill (Fig. 11/55).

This protection function is designed so as to detect both earth faults in the entire generator (genuine 100 %) and all electrically connected system components.

The protection unit measures the injected 20 Hz voltage and the flowing 20 Hz current. The disturbing variables, for example stator earth capacitance, are eliminated by way of a mathematical model, and the ohmic fault resistance is determined.

On the one hand, this ensures high sensitivity and, on the other hand, it permits use of generators with large earth capacitance values, e.g. large hydroelectric generators.

Phase-angle errors through the earthing or neutral transformer are measured during commissioning and are corrected in the algorithm.

The protection function has a warning and tripping stage. The measurement circuit is also monitored and failure of the 20 Hz generator is measured.

Independent of earth resistance calculation, the protection function additionally evaluates the amount of the r.m.s. current value.

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.

DC voltage time protection/DC current time protection (ANSI 59N (DC) 51N (DC))

Hydroelectric generators or gas turbines are started by way of frequency starting converters. An earth fault in the intermediate circuit of the frequency starting converter causes DC voltage displacement and thus a direct current. As the neutral or earthing transformers have a lower ohmic resistance than the voltage transformers, the largest part of the direct current flows through them, thus posing a risk of destruction from thermal overloading.

As shown in Fig. 11/55, the direct current is measured by means of a shunt transformer (measuring transducer) connected directly to the shunt. Voltages or currents are fed to the 7UM62 depending on the version of the measuring transducer. The measurement algorithm filters out the DC component and takes the threshold value decision. The protection function is active as from 0 Hz.

If the measuring transducer transmits a voltage for protection, the connection must be interference-free and must be kept short.

The implemented function can also be used for special applications. Thus, the r.m.s. value can be evaluated for the quantity applied at the input over a wide frequency range.

Overcurrent protection during start-up (ANSI 51)

Gas turbines are started by means of frequency starting converters. Overcurrent protection during start-up measures short-circuits in the lower frequency level (as from about 5 Hz) and is designed as independent overcurrent-time protection. The pickup value is set below the rated current. The function is only active during start-up. If frequencies are higher than 10 Hz, sampling frequency correction takes effect and the further short-circuit protection functions are active.

Out-of-step protection (ANSI 78)

This protection function serves to measure power swings in the system. If generators feed to a system short-circuit for too long, low frequency transient phenomena (active power swings) between the system and the generator may occur after fault clearing. If the center of power swing is in the area of the block unit, the "active power surges" lead to unpermissible mechanical stressing of the generator and the turbine.

As the currents and voltages are symmetrical, the positive-sequence impedance is calculated on the basis of their positive-sequence components and the impedance trajectory is evaluated. Symmetry is also monitored by evaluation of the negative-phase-sequence current. Two characteristics in the R/X diagram describe the active range (generator, unit transformer or power system) of the out-of-step protection. The associated counters are incremented depending on the range of the characteristic in which the impedance vector enters or departs. Tripping occurs when the set counter value is reached.

Protection functions

The counters are automatically reset if power swing no longer occurs after a set time. By means of an adjustable pulse, every power swing can be signaled. Expansion of the characteristic in the R direction defines the power swing angle that can be measured. An angle of 120 ° is practicable. The characteristic can be tilted over an adjustable angle to adapt to the conditions prevailing when several parallel generators feed into the system.

Inverse undervoltage protection (ANSI 27)

Motors tend to fall out of step when their torque is less than the breakdown torque. This, in turn, depends on the voltage. On the one hand, it is desirable to keep the motors connected to the system for as long as possible while, on the other hand, the torque should not fall below the breakdown level. This protection task is realized by inverse undervoltage protection. The inverse characteristic is started if the voltage is less than the pickup threshold V_p<. The tripping time is inversely proportional to the voltage dip (see equation). The protection function uses the positive-sequence voltage, for the protection decision.

$$t_{TRIP} = \frac{I}{I - \frac{V}{V_p}} \cdot T_M$$

t_{TRIP} Tripping time

V Voltage

V_p Pickup value

T_M Time multiplier

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.

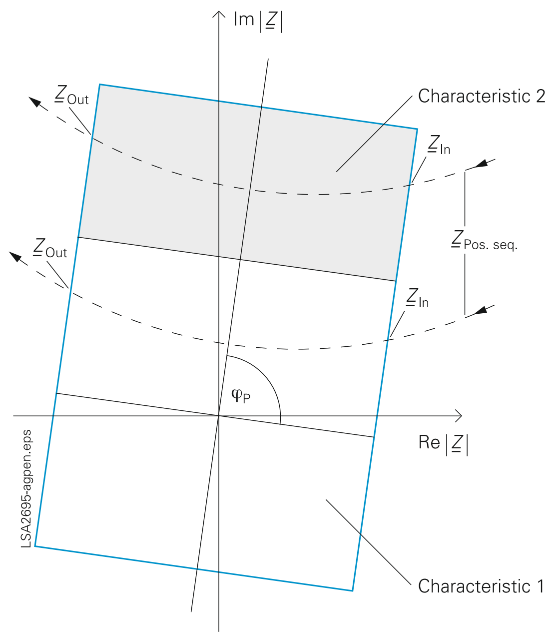

Fig. 11/42
Ranges of the characteristic and possible oscillation profiles.

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.

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.

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. 11/43 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 canceled 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.

Sensitive earth-fault protection B (ANSI 51 GN)

The I_{EE-B} sensitive earth-fault protection feature of 7UM62 provides greater flexibility and can be used for the following applications:

- Any kind of earth-fault current supervision to detect earth faults (fundamental and 3rd harmonics)
- Protection against load resistances
- Shaft current protection in order to detect shaft currents of the generator shaft and prevent that bearings take damage.

Protection functions

The sensitive earth-current protection $I_{EE\text{-}B}$ uses either the hardware input I_{EE1} or I_{EE2}. These inputs are designed in a way that allows them to cut off currents greater than 1.6 A (thermal limit, see technical data). This has to be considered for the applications or for the selection of the current transformers.

The shaft current protection function is of particular interest in conjunction with hydro-electric generators. Due to their construction, the hydroelectric generators have relatively long shafts. A number of factors such as friction, magnetic fields of the generators and others can build up a voltage across the shaft which then acts as voltage source (electro-motive force-emf). This inducted voltage of approx. 10 to 30 V is dependent on the load, the system and the machine.

If the oil film covering a bearing is too thin, breakdown can occur. Due to the low resistance (shaft, bearing and earthing), high currents may flow that destroy the bearing. Past experience has shown that currents greater than 1 A are critical for the bearings. As different bearings can be affected, the current entering the shaft is detected by means of a special transformer (folding transformer).

Interturn protection (ANSI 59N (IT))

The interturn fault protection detects faults between turns within a generator winding (phase). This situation may involve relatively high circulating currents that flow in the short-circuited turns and damage the winding and the stator. The protection function is characterized by a high sensitivity.

The displacement voltage is measured at the open delta winding by means of 3 two-phase isolated voltage transformers. So as to be insensitive towards earth faults, the isolated voltage transformer star point has to be connected to the generator star point by means of a high-voltage cable. The voltage transformer star point must not be earthed since this implies that the generator star point, too, would be earthed with the consequence that each fault would lead to a single-pole earth fault.

In the event of an interturn fault, the voltage in the affected phase will be reduced causing a displacement voltage that is detected at the broken delta winding. The sensitivity is limited rather by the winding asymmetries than by the protection unit.

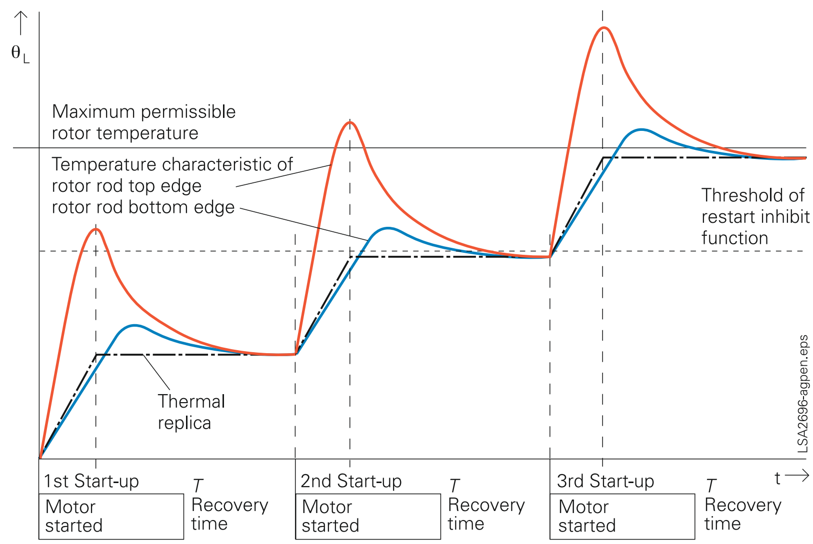

Fig. 11/43 Temperature characteristic at rotor and thermal replica of the rotor (multiple start-ups)

An FIR filter determines the fundamental component of the voltage based an the scanned displacement voltage. Selecting an appropriate window function has the effect that the sensitivity towards higher-frequency oscillations is improved and the disturbing influence of the third harmonic is eliminated while achieving the required measurement sensitivity.

External trip coupling

For recording and processing of external trip information, there are 4 binary inputs. They are provided for information from the Buchholz relay or generator-specific commands and act like a protection 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

At the rear of the unit there is one fixed interface and two communication modules which 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 (fixed)

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. Furthermore, the units can exchange data through this interface via Ethernet and IEC 61850 protocol and can also be operated by DIGSI.

IEC 61850 protocol

The Ethernet-based IEC 61850 protocol is the worldwide standard for protection and control systems used by power supply corporations. Siemens is of 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 will also be possible with DIGSI.

IEC 60870-5-103

IEC 60870-5-103 is an internationally standardized protocol for communication in the protected area.

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 system (EN 50170).

PROFIBUS is supported internationally by several hundred manufacturers.

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).

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.

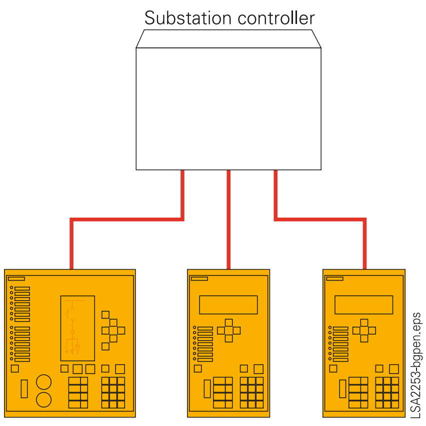

Fig. 11/44
IEC 60870-5-103 star-type RS232 copper conductor connection or fiber-optic connection

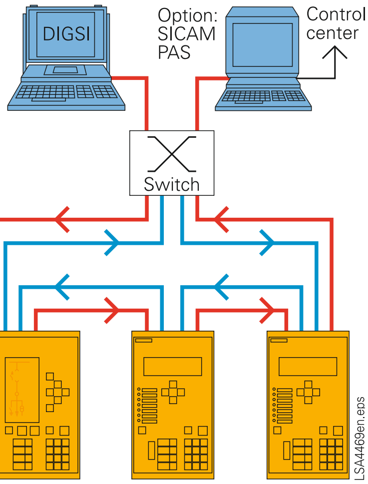

Fig. 11/45
Bus structure for station bus with Ethernet and IEC 61850, fiber-optic ring

11

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 (cyclic testing).

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

For IEC 61850, an interoperable system solution is offered with SICAM PAS. Via the 100 Mbit/s Ethernet bus, the unit 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. 11/45).

Analog output 0 to 20 mA

Alternatively to the serial interfaces up to two analog output modules (4 channels) can be installed in the 7UM62.
Several operational measured values (I_1, I_2, V, P, Q, f, PF ($\cos\varphi$), Θ_{stator}, Θ_{rotor}) can be selected and transmitted via the 0 to 20 mA interfaces.

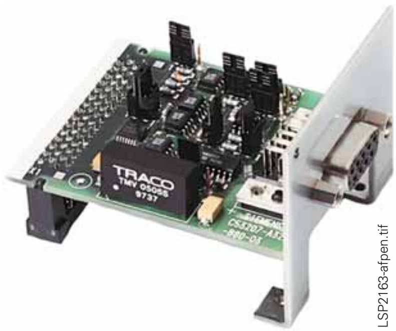

Fig. 11/46
RS232/RS485 electrical communication module

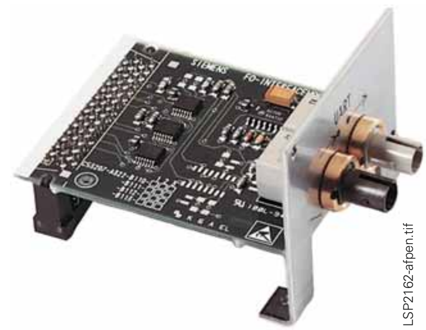

Fig. 11/47
820 nm fiber-optic communication module

Fig. 11/48
PROFIBUS communication module, optical, double-ring

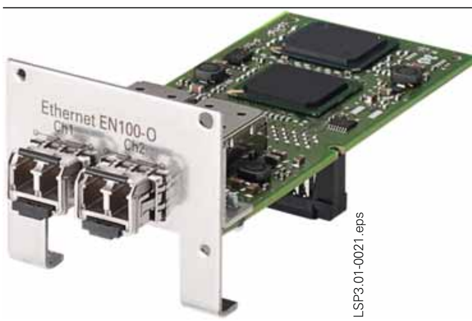

Fig. 11/49
Optical Ethernet communication module for IEC 61850 with integrated Ethernet switch

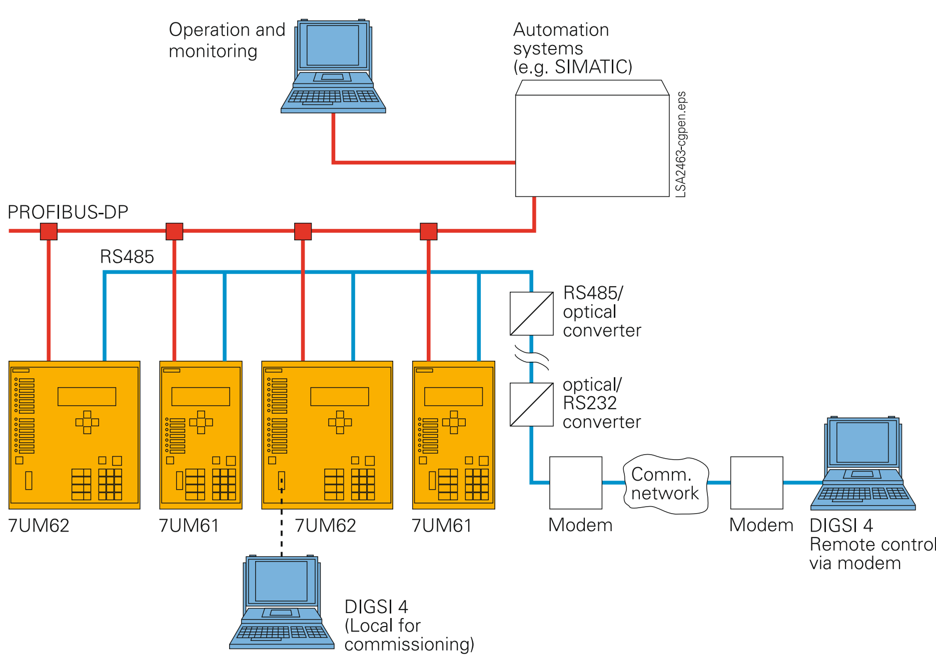

Fig. 11/50 System solution: Communications

Typical connections

Direct generator - busbar connection

Figure 11/51 illustrates the recommended standard connection when several generators supply one busbar. Phase-to-earth faults are disconnected by employing the directional earth-fault criterion. The earth-fault current is driven through the cables of the system.
If this is not sufficient, an earthing transformer connected to the busbar supplies the necessary current (maximum approximately 10 A) and permits a protection range of up to 90 %. The earth-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 earth-fault criterion during starting operations until synchronization is achieved.

Differential protection embraces protection of the generator and of the outgoing cable. The permissible cable length and the current transformer design (permissible load) are mutually dependent. Recalculation is advisable for lengths of more than 100 m.

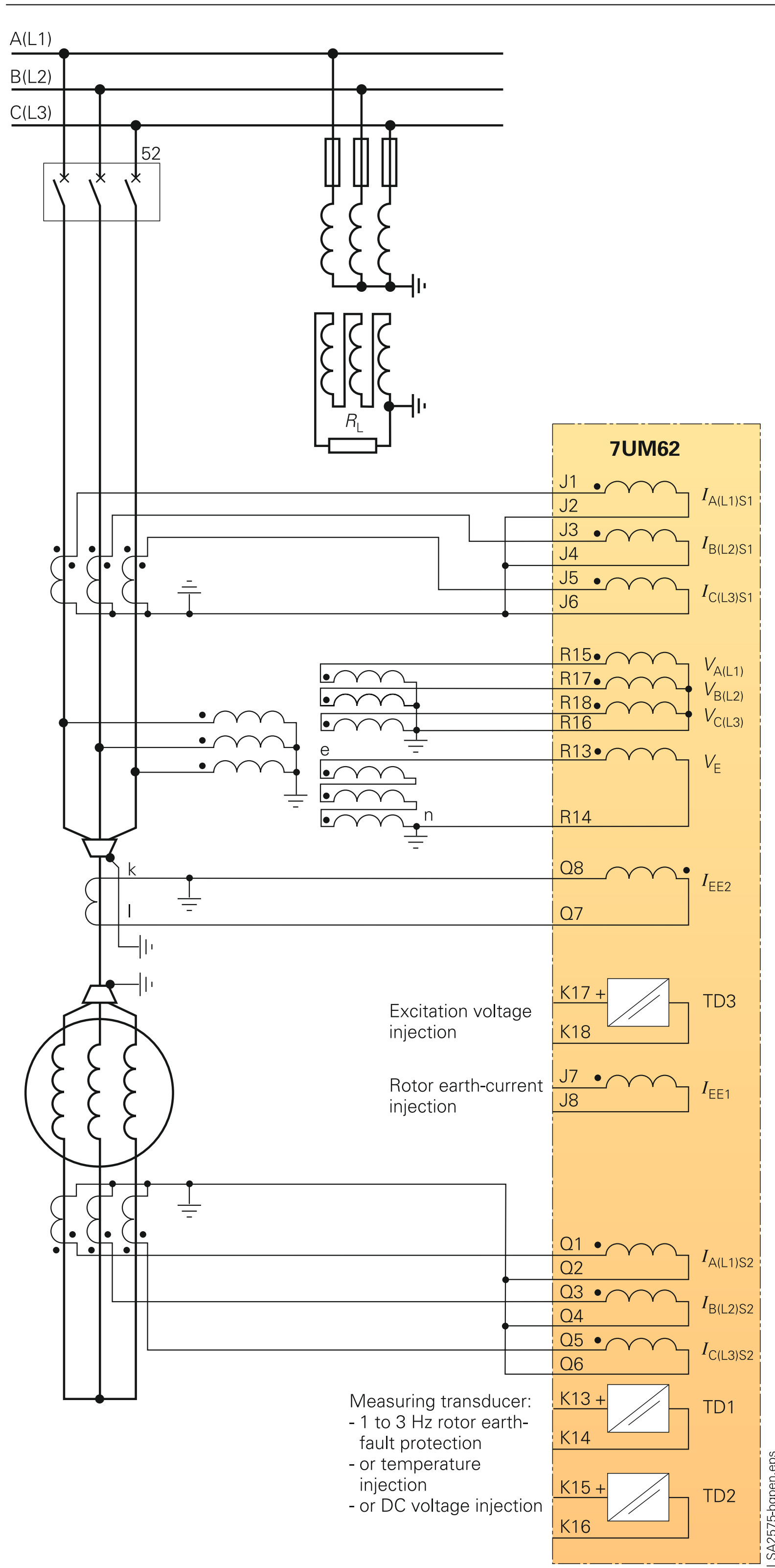

Fig. 11/51

11

Typical connections

Direct generator - busbar connection with low-resistance earthing

If the generator neutral point has low-resistance earthing, the connection illustrated in Fig. 11/52 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 earth-fault detection, the earth-current input should be looped into the common return conductor of the two current transformer sets (differential connection). The current transformers must be earthed at only one point. The displacement voltage V_E is utilized as an additional enabling criterion.

Balanced current transformers (calibration of windings) 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.

Earth-current differential protection can be used as an alternative (not illustrated).

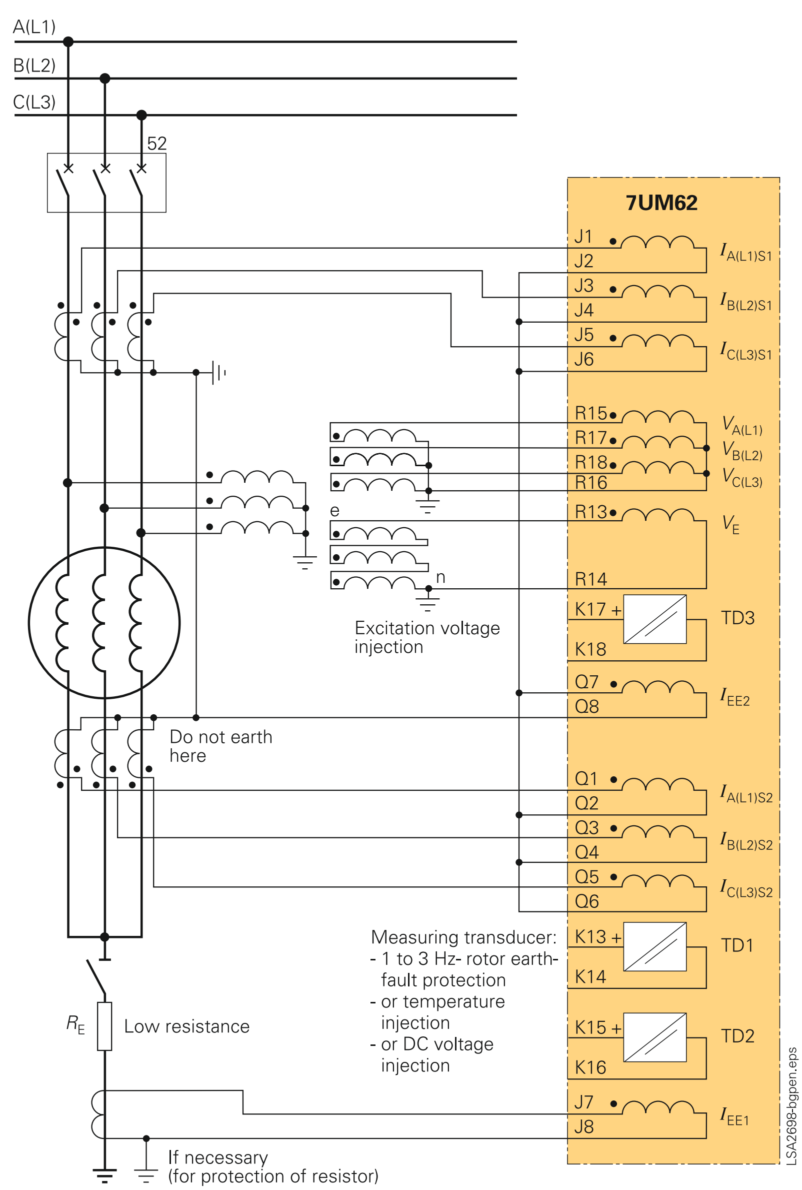

Fig. 11/52

Typical connections

Unit connection with isolated star point

This configuration of unit connection is a variant to be recommended (see Fig. 11/53). Earth-fault detection is effected by means of the displacement voltage. In order to prevent unwanted operation in the event of earth 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 earthing transformer should be employed. The available measuring winding can be used for the purpose of voltage measurement.

In the application example, differential protection is intended for the generator. The unit transformer is protected by its own differential relay (e.g. 7UT612).

As indicated in the figure, additional protection functions are available for the other inputs. They are used on larger generator/transformer units (see also Figures 11/56 and 11/58).

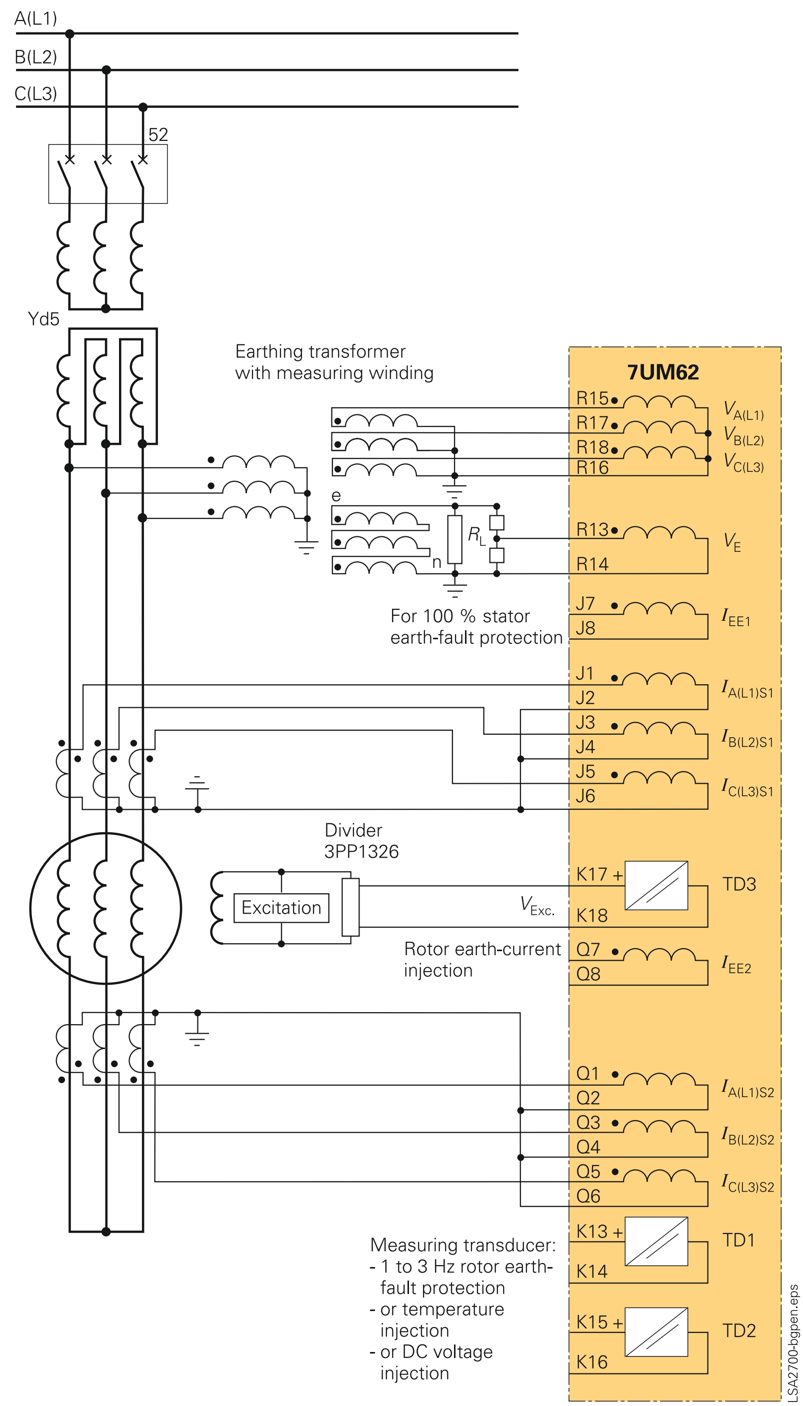

Fig. 11/53

Typical connections

Unit connection with neutral transformer

With this system configuration, disturbance voltage reduction and damping in the event of earth faults in the generator area are effected by a load resistor connected to the generator neutral point.

The maximum earth-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 below

$$\left(\frac{V_{Gen}}{\sqrt{3}} \Big/ 500\,\mathrm{V}\right)$$

The higher secondary voltage can be reduced by means of a voltage divider.

Electrically, the circuit is identical to the configuration in Fig. 11/53.

In the application opposite, the differential protection is designed as an overall function and embraces the generator and unit transformer. The protection function carries out vector group adaptation as well as other adaptations.

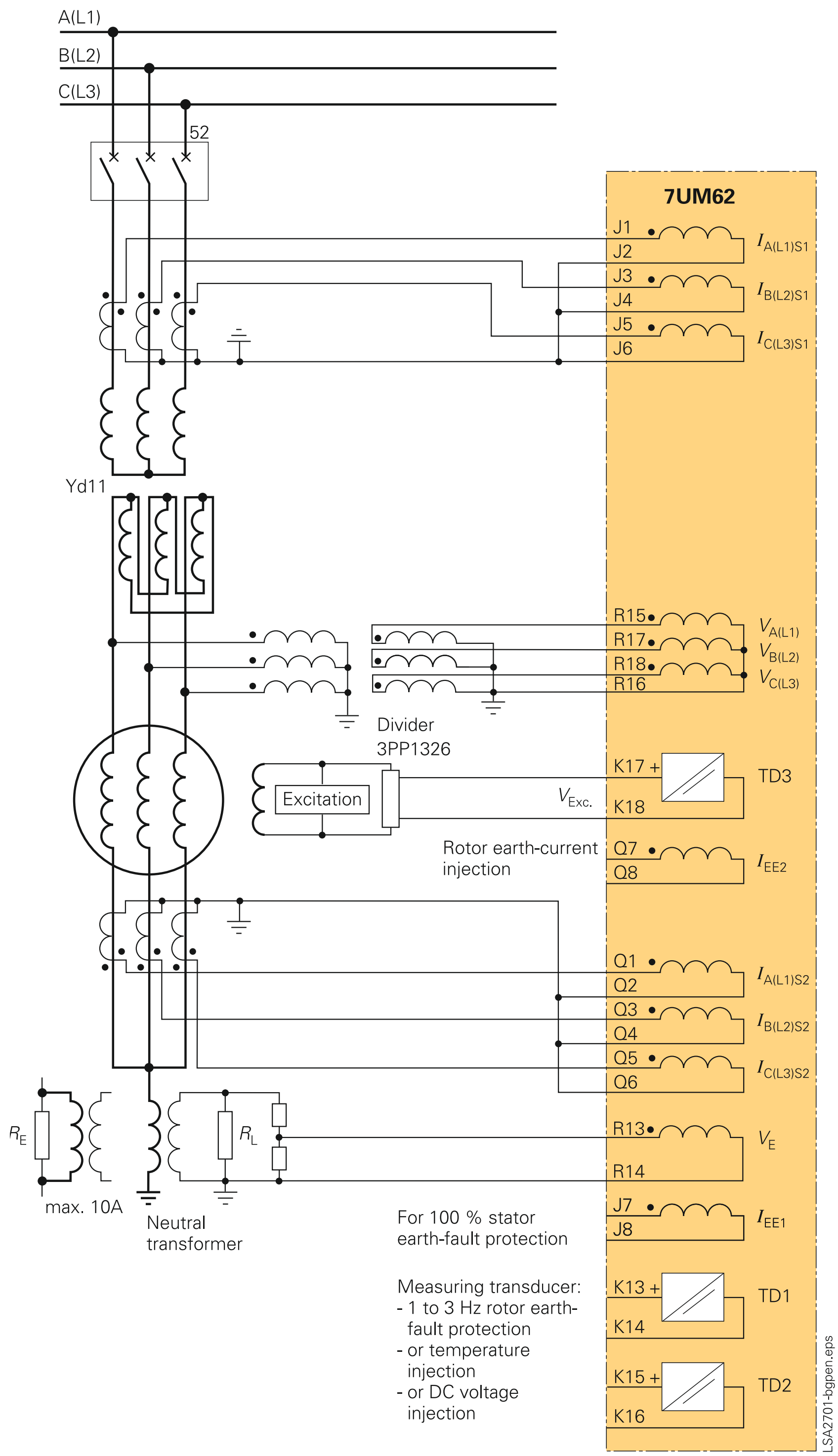

Fig. 11/54

11

Typical connections

Voltage transformer in open delta connection (V-connection)

Protection can also be implemented on voltage transformers in open delta connection (Fig. 11/55). If necessary, the operational measured values for the phase-to-earth voltages can be slightly asymmetrical. If this is disturbing, the neutral point (R16) can be connected to earth 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 earthing transformer).

100 % stator earth-fault protection, earth-fault protection during start-up

Fig. 11/56 illustrates the interfacing of 100 % stator earth-fault protection with voltage injection of 20 Hz, as meant for the example of the neutral transformer. The same interfacing connection also applies to the broken delta winding of the earthing transformer.

The 20 Hz generator can be connected both to the DC voltage and also to a powerful voltage transformer (>100 VA). The load of the current transformer 4NC1225 should not exceed 0.5 Ω.

The 7XT33, 7XT34 and load resistance connection must be established with a low resistance ($R_{Connection} < R_L$). If large distances are covered, the devices are accommodated in the earthing cubicle.

Connection of the DC voltage protection function (TD 1) is shown for systems with a starting converter. Depending on the device selection, the 7KG6 boosts the measured signal at the shunt to 10 V or 20 mA.

The TD 1 input can be jumpered to the relevant signal.

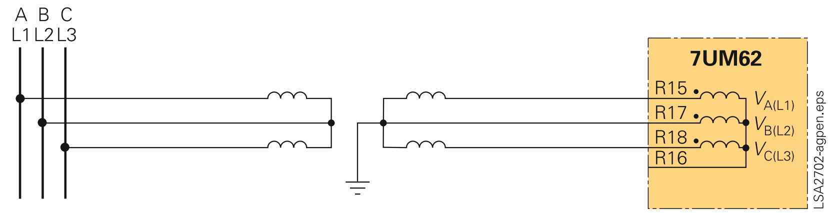

Fig. 11/55

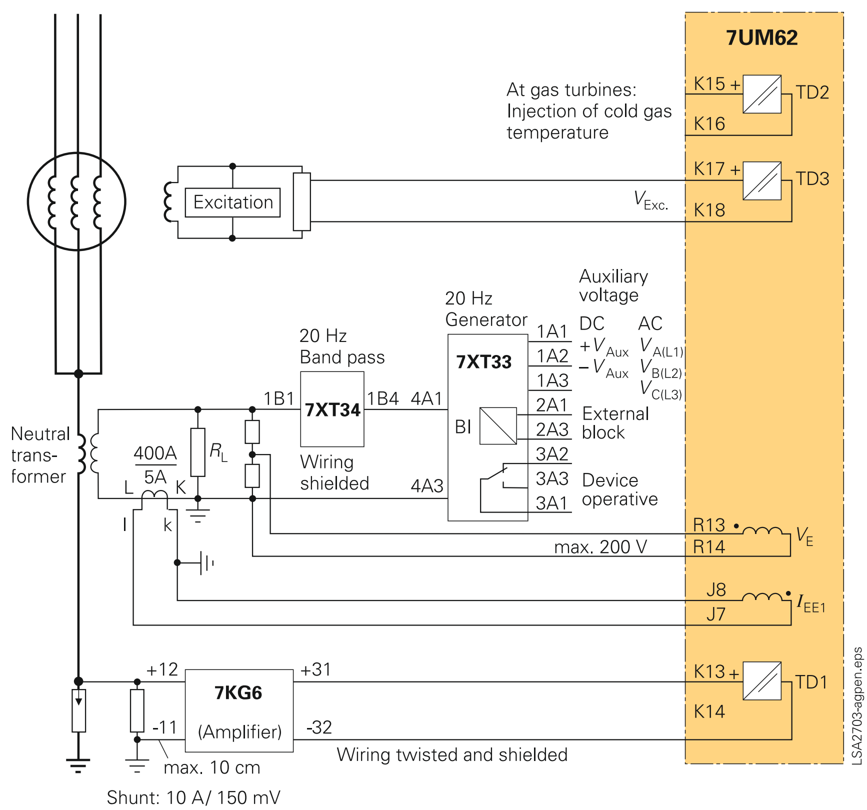

Fig. 11/56

11

Typical connections

Rotor earth-fault protection with voltage injection at rated frequency

Fig. 11/57 shows the connection of rotor earth-fault protection to a generator with static excitation. If only the rotor current is evaluated, there is no need for voltage connection to the relay.

Earth must be connected to the earthing brush. The external resistors 3PP1336 must be added to the coupling device 7XR61 if the circulating current can exceed 0.2 A as the result of excitation (sixth harmonic). This is the case as from a rated excitation voltage of >150 V, under worst-case conditions.

Rotor earth-fault protection with a square wave voltage of 1 to 3 Hz

The measuring transducers TD1 and TD2 are used for this application. The controlling unit 7XT71 generates a square wave voltage of about ± 50 V at the output. The frequency can be jumpered and depends on the rotor earth capacitance. Voltage polarity reversal is measured via the control input and the flowing circular current is measured via the measurement input. Earth must be connected to the earthing brush.

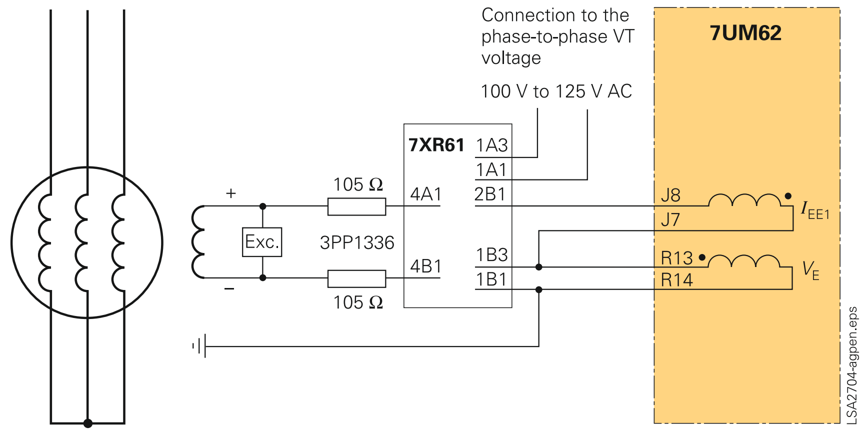

Fig. 11/57

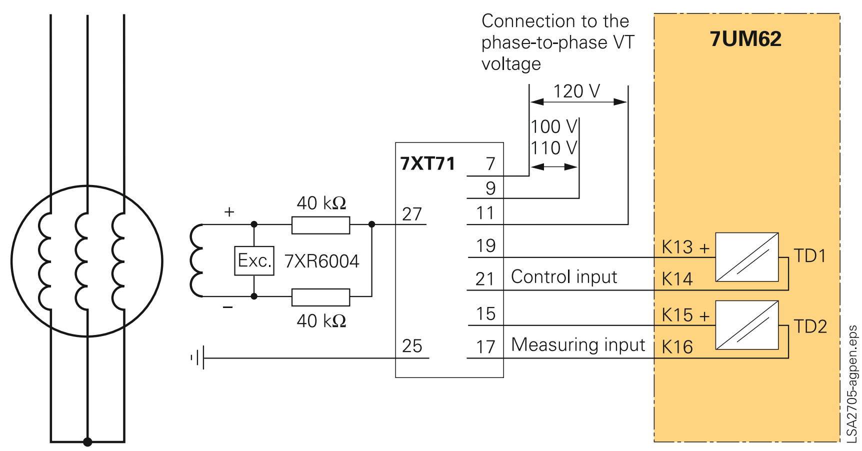

Fig. 11/58

11

Typical connections

Protection of an asynchronous motor

Fig. 11/59 shows a typical connection of the protection function to a large asynchronous motor. Differential protection embraces the motor including the cable. Recalculation of the permissible current transformer burden is advisable for lengths of more than 100 m.

The voltage for voltage and displacement voltage monitoring is generally tapped off the busbar. If several motors are connected to the busbar, earth faults can be detected with the directional earth-fault protection and selective tripping is possible. A core balance current transformer is used to detect the earth current. The chosen pickup value must be slightly higher if there are several cables in parallel.

The necessary shutdown of the motor in the event of idling can be realized with active power monitoring.

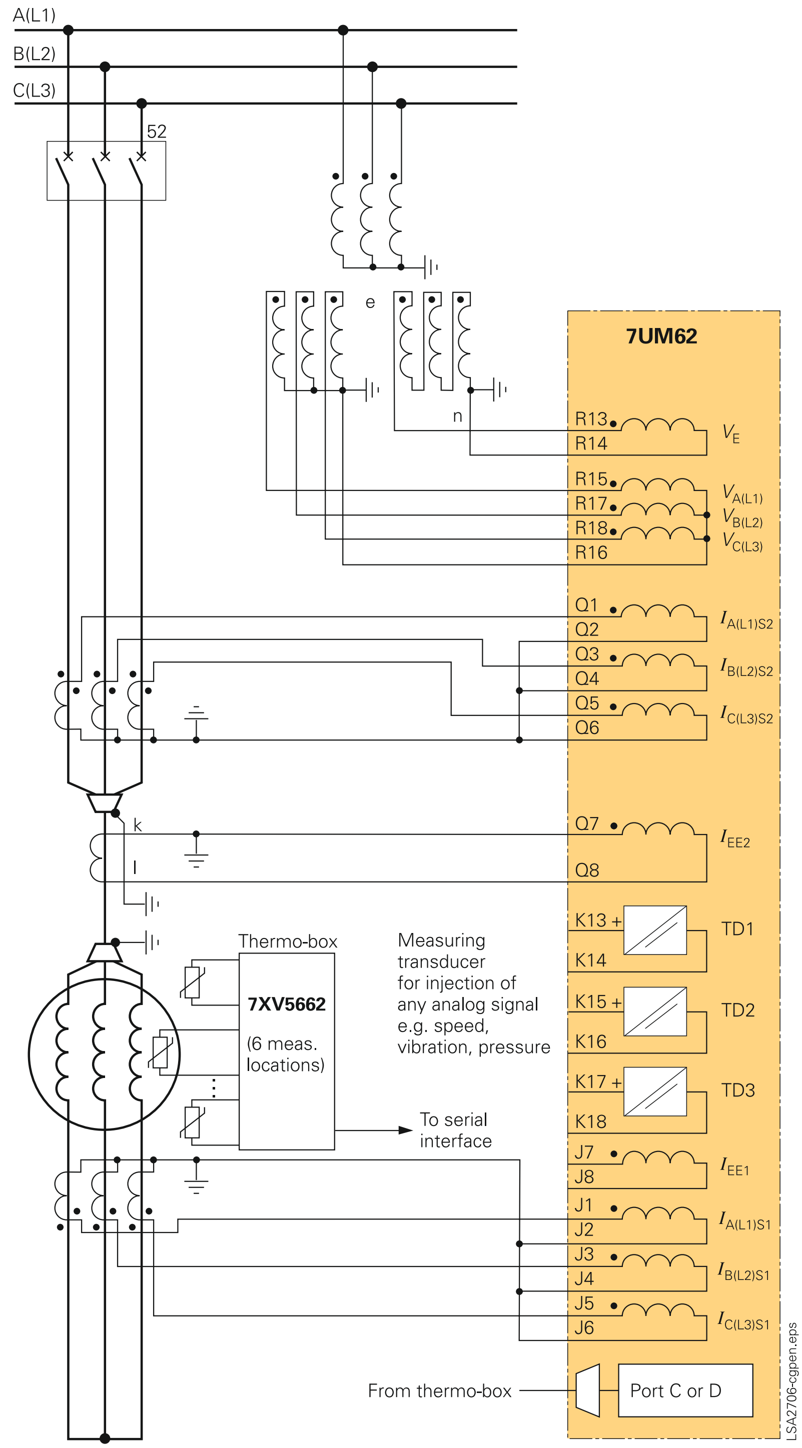

Fig. 11/59

Typical connections

Use of selected analog inputs

Several protection functions take recourse to the same analog inputs, thus ruling out certain functions depending on the application. One input may only be used by one protection function. A different combination can be used by the unit belonging to Protection Group 2, for example.

Multiple use refers to the sensitive earth-current inputs and the displacement voltage input (see Table 11/5).

The same applies to the measuring transducers (Table 11/6).

Current transformer requirements

The requirements imposed on the current transformer are determined by the differential protection function. The instantaneous trip stage (I_{Diff}>>) reliably masters (via the instantaneous algorithm) any high-current internal short-circuits.

The external short-circuit determines the requirements imposed on the current transformer as a result of the DC component. The non-saturated period of a flowing short-circuit current should be at least 5 ms. Table 11/7 shows the design recommendations.
IEC 60044-1 and 60044-6 were taken into account. The necessary equations are shown for converting the requirements into the knee-point voltages. The customary practice which presently applies should also be used to determine the rated primary current of the current transformer rated current. It should be greater than or equal to the rated current of the protected object.

	I_{EE1}	I_{EE2}	V_E
Sensitive earth-fault protection	X[1)]	X[1)]	
Directional stator earth-fault protection		X	X
Rotor earth-fault protection (f_n, R-measuring)	X		X
100 % stator earth-fault protection with 20 Hz voltage	X		X
Earth-current differential protection	X[1)]	X[1)]	

1) optional (either I_{EE1} or I_{EE2})

Table 11/5: Multiple use of analog inputs

	TD1	TD2	TD3
Injection of excitation voltage			X
DC voltage time/DC current time protection	X		
Injection of a temperature		X	
Rotor earth-fault protection (1 to 3 Hz)	X	X	
Processing of analog values via CFC	X	X	X

Table 11/6: Multiple use of measuring transducers

Symmetrical short-circuit limiting factor

Required actual accuracy limiting factor	Resulting rated accuracy limiting factor
$K'_{ssc} = K_{td} \cdot \frac{I_{pssc}}{I_{pn}}$	$K_{ssc} = \frac{R'_b + R_{Ct}}{R_{BN} + R_{Ct}} \cdot K'_{ssc}$

Current transformer requirements

	Transformer	Generator
Transient dimensioning factor K_{td}	≥ 4 $\tau_N \leq 100$ ms	$>$ (4 to 5) $\tau_N > 100$ ms
Symmetrical short-circuit current I_{pssc}	$\approx \frac{1}{v_{sc}} \cdot I_{pn,Tr}$	$\approx \frac{1}{x''_d} \cdot I_{pn,G}$
Example	$v_{sc} = 0.1$ $K'_{ssc} > 40$	$x''_d = 0.12$ $K'_{ssc} >$ (34 to 42)
Note: Identical transformers have to be employed	Rated power ≥ 10 or 15 VA Example: Network transformer 10P10: (10 or 15) VA (I_{sn} = 1 or 5 A)	Note: Secondary winding resistance Example: $I_{N,G}$ approx. 1000 to 2000 A 5P15: 15 VA (I_{sn} = 1 or 5 A) $I_{N,G}$ > 5 000 A 5P20: 30 VA (I_{sn} = 1 or 5 A)

Knee-point voltage

IEC	British Standard	ANSI
$V = K_{ssc}(R_{ct} + R_b)I_{sn}$	$V = \frac{(R_{ct} + R_b)I_{sn}}{1.3} K_{ssc}$	$V = 20 \cdot I_{sn} \cdot (R_{ct} + R_b) \cdot \frac{K_{ssc}}{20}$ I_{sn} = 5 A (typical value)

K_{td}	Rated transient dimensioning factor	R_{ct}	Secondary winding resistance
I_{pssc}	Primary symmetrical short-circuit current	v_{sc}	Short-circuit voltage (impedance voltage)
I_{pn}	Rated primary current (transformer)	x''_d	Subtransient reactance
R'_b	Connected burden	I_{sn}	Rated secondary current (transformer)
R_b	Rated resistive burden	τ_N	Network time constant

Table 11/7: Recommendations for dimensioning

Technical data

Hardware	
Analog input	
Rated frequency	50 or 60 Hz
Rated current I_N	1 or 5 A
Earth current, sensitive I_{Emax}	1.6 A
Rated voltage V_N (at 100 V)	100 to 125 V
Measuring transducer	- 10 to + 10 V (R_i = 1 MΩ) or - 20 to + 20 mA (R_i = 10 Ω)
Power consumption With I_N = 1 A With I_N = 5 A For sensitive earth 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)	 100 I_N for 1 s 30 I_N for 10 s 4 I_N continuous
Dynamic (peak)	250 I_N (one half cycle)
Earth current, sensitive	300 A for 1 s 100 A for 10 s 15 A continuous
Dynamic (peak)	750 A (one half cycle)
Capability in voltage paths	230 V continuous
Capability of measuring transducer As voltage input As current input	 60 V continuous 100 mA continuous
Auxiliary voltage	
Rated auxiliary voltage	24 to 48 V DC 60 to 125 V DC 110 to 250 V DC and 115 V/230 V AC with 50/60 Hz
Permitted tolerance	–20 to +20 %
Superimposed (peak-to-peak)	≤ 15 %
Power consumption During normal operation 7UM621 7UM622 7UM623 During pickup with all inputs and outputs activated 7UM621 7UM622 7UM623	 Approx. 5.3 W Approx. 5.5 W Approx. 8.1 W Approx. 12 W Approx. 15 W Approx. 14.5 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 7UM621, 7UM623 7UM622	 7 15
3 pickup thresholds Range is selectable with jumpers	10 to 19 V DC or 44 to 88 V DC 88 to 176 V DC
Maximum permissible voltage	300 V DC
Current consumption, energized	Approx. 1.8 mA

Output relays	
Number 7UM621 7UM622	 12 (1 NO; 4 optional as NC, via jumper) 21 (1 NO; 5 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
LED	
Number RUN (green) ERROR (red)	 1 1
Assignable LED (red)	14
Unit design	
7XP20 housing	For dimensions see dimension drawings, part 15
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 7UM621/7UM623 (1/2 x 19") 7UM622 (1/1 x 19") Surface-mounting housing 7UM621/7UM623 (1/2 x 19") 7UM622 (1/1 x 19")	 Approx. 7 kg Approx. 9.5 kg Approx. 12 kg Approx. 15 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 case
Voltage levels	Selectable 5 V, 12 V or 24 V
Service/modem interface (Port C) for DIGSI 4 / modem / service	
Isolated RS232/RS485 Test voltage Distance for RS232 Distance for RS485	9-pin subminiature connector 500 V / 50 Hz Max. 15 m Max. 1000 m

Technical data

System interface (Port B) ***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)
Analog output module (electrical)	2 ports with 0 to 20 mA
System interface (Port B) ***IEC 61850***	
Ethernet, electrical (EN 100) for IEC 61850 and DIGSI	
Connection	
for flush-mounting case	Rear panel, mounting location "B", two RJ45 connector, 100 Mbit/s acc. to IEEE802.3
for surface-mounting case	At bottom part of the housing
Test voltage	500 V; 50 Hz
Transmission speed	100 Mbits/s
Distance	20 m/66 ft
Ethernet, optical (EN 100) for IEC 61850 and DIGSI	
Connection	
for flush-mounting case	Rear panel, mounting location "B", LC connector receiver/transmitter
for panel surface-mounting case	Not available
Optical wavelength	λ = 1350 nm
Transmission speed	100 Mbits/s
Laser class 1 acc. to EN 60825-1/-2	Glass fiber 50/125 µm or glass fiber 62/125µm
Permissible path attenuation	Max. 5 dB for glass fiber 62.5/125 µm
Distance	Max. 800 m/0.5 mile

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	3.5 kV DC
Voltage test (100 % test) only isolated 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 DIN 57435 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
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

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

Technical data

EMC tests for interference emission; type tests	
Standard	EN 50081-1 (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	
<u>During operation</u>	
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
<u>During transport</u>	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 5 to 8 Hz: ±7.5 mm amplitude; 8 to 150 Hz: 2 *g* acceleration Frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	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 test	
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 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 $I>$, $I>>$	0.05 to 20 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 or 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

11

Technical data

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 stand still	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)
Limit current I_{Limit}	0.5 to 8 A (steps 0.01), 5 times at I_N = 5 A
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_N	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 200 % (steps 1 %)
Time delays T_{Alarm}; $T_{I2>>}$	0 to 60 s (steps 0.01 s) or indefinite
Negative-sequence factor K	1 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	5 % of set point + 1 % current tolerance
Time for $2 \leq I_2/I_{2\ perm.} \leq 20$	or 600 ms

Underexcitation protection (ANSI 40)

Setting ranges	
Conductance thresholds 1/xd characteristic (3 characteristics)	0.20 to 3.0 (steps 0.01)
Inclination angle $\alpha_1, \alpha_2, \alpha_3$	50 to 120 ° (steps 1 °)
Time delay T	0 to 50 s (steps 0.01 s) or indefinite
Undervoltage blocking $V<$	10 to 125 V (steps 0.1 V)
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

Technical data

Impedance protection *(ANSI 21)*

Setting ranges	
Overcurrent pickup $I>$	0.1 to 20 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 or 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 (definite-time and inverse-time function) *(ANSI 27)*

Setting range	
Undervoltage pickup $V<$, $V<<$, $V_p<$ (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
Time multiplier T_M	0.1 to 5 s (steps 0.01 s)
Times	
Pickup time $V<$, $V<<$	Approx. 50 ms
Drop-off time $V<$, $V<<$	Approx. 50 ms
Drop-off ratio $V<$, $V<<$, $V_p<$	1.01 or 0.5 V
Tolerances	
Voltage limit values	1 % of set value or 0.5 V
Time delays T	1 % or 10 ms
Inverse-time characteristic	1 % of measured value of voltage

Overvoltage protection *(ANSI 59)*

Setting ranges	
Overvoltage pickup $V>$, $V>>$ (maximum phase-to-phase voltage or phase-to-earth-voltage)	30 to 170 V (steps 0.1 V)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Times	
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	3 stages 0 to 100 s, 1 stage up to 600 s
Undervoltage blocking $V_1<$	(steps 0.01 s) 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	1.05/1.1/1.15/1.2/1.25/1.3/1.35/1.4
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 earth-fault protection, non-directional, directional *(ANSI 59N, 64G, 67G)*

Setting ranges	
Displacement voltage $V_0>$	2 to 125 V (steps 0.1 V)
Earth 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 $V_0>$, $3I_0>$	0.95
Drop-off difference angle	10 ° directed to power system
Tolerances	
Displacement voltage	1 % of set value or 0.5 V
Earth current	1 % of set value or 0.5 mA
Time delays T	1 % or 10 ms

Technical data

Sensitive earth-fault protection *(ANSI 50/51GN, 64R)*	
Setting ranges	
Earth 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. 2 s
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	
Earth current pickup	1 % of set value or 0.5 mA
Time delays T	1 % or 10 ms

100 % stator earth-fault protection with 3rd harmonic *(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

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
Times	
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

Current differential protection *(ANSI 87G, 87M, 87T)*	
Setting ranges	
Differential current $I_D>I_N$	0.05 to 2 (steps 0.01)
High-current stage $I_D>>I_N$	0.8 to 12 (steps 0.1)
Inrush stabilization ratio I_{2fN}/I_N	10 to 80 (steps 1 %)
Harmonic stabilization ratio I_{nfN}/I_N (n=3rd or 4th or 5th harmonics)	10 to 80 (steps 1 %)
Additional trip time delay T	0 to 60 s (steps 0.01 s) or indefinite
Times	
Pickup time ($I_D \geq$ 1.5 setting value I_D >)	Approx. 35 ms
Pickup time ($I_D \geq$ 1.5 setting value I_D>>)	Approx. 20 ms
Drop-off time	Approx. 35 ms
Drop-off ratio	Approx. 0.7
Tolerances	
Pickup characteristic	3 % of set value or 0.01 I/I_N
Inrush stabilization	3 % of set value or 0.01 I/I_N
Additional time delays	1 % or 10 ms

Earth-current differential protection *(ANSI 87GN, 87TN)*	
Setting ranges	
Differential current I_{E-D} >/I_N	0.01 to 1 (steps 0.01)
Additional trip time delay	0 to 60 s (steps 0.01 s) or indefinite
Times	
Pickup time ($I_{E-D} \geq$ 1.5 setting value I_{E-D} >)	Approx. 50 ms
Drop-off time	Approx. 50 ms
Drop-off ratio	Approx. 0.7
Tolerances	
Pickup characteristic	3 % of set value
Additional time delay	1 % or 10 ms

Technical data

Rotor earth-fault protection with f_N (ANSI 64R) (f_N)	
Setting ranges	
Alarm stage $R_{E, Alarm}$ <	3 to 30 kΩ (steps 1 kΩ)
Trip stage $R_{E, Trip}$ <	1.0 to 5 kΩ (steps 0.1 kΩ)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Correction angle	- 15 ° to + 15 ° (steps 1 °)
Times	
Pickup time	≤ 80 ms
Drop-off time	≤ 80 ms
Drop-off ratio	Approx. 1.25
Tolerances	
Trip stage $R_{E, Trip}$ <,	Approx. 5 % of set value
Alarm stage $R_{E, Alarm}$ <	Approx. 10 % of set value
Time delays T	1 % or 10 ms
Permissible rotor earth capacitance	0.15 to 3 µF

Sensitive rotor fault protection with 1 to 3 Hz (ANSI 64R) (1 to 3 Hz)	
Setting ranges	
Alarm stage $R_{E,Alarm}$ <	5 to 80 kΩ (steps 1 kΩ)
Trip stage $R_{E, Trip}$ <	1 to 10 kΩ (steps 1 kΩ)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Pickup value of meas. circuit supervision Q_C<	0.01 to 1 mAs (steps 0.01 mAs)
Times	
Pickup time	Approx. 1 to 1.5 s (depends on frequency of 7XT71)
Drop-off time	Approx. 1 to 1.5 s
Drop-off ratio R_E	Approx 1.25
Drop-off ratio Q_C <	1.2 or 0.01 mAs
Tolerances	
Trip stage ($R_{E,Trip}$ <; Alarm stage $R_{E, Alarm}$<)	Approx. 5 % or 0.5 kΩ at 0.15 µF ≤ C_E < 1µF Approx. 10 % or 0.5 kΩ at 1 µF ≤ C_E < 3 µF
Time delays T	1 % or 10 ms
Permissible rotor earth-capacitance	0.15 to 3 µF

100 % stator earth-fault protection with 20 Hz (ANSI 64G) (100 %)	
Setting ranges	
Alarm stage R_{SEF} <	20 to 500 Ω (steps 1 Ω)
Trip stage R_{SEF} <<	10 to 300 Ω (steps 1 Ω)
Earth current stage I_{SEF} >	0.02 to 1.5 A (steps 0.01 A)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Supervision of 20 Hz generator	
$V_{20\,Hz}$	0.3 to 15 V (steps 0.1 V)
$I_{20\,Hz}$	5 to 40 mA (steps 1 mA)
Correction angle	- 60 ° to + 60 ° (steps 1 °)
Times	
Pickup times R_{SEF}<, R_{SEF}<<	≤ 1.3 s
Pickup time I_{SEF}>	≤ 250 ms
Drop-off times R_{SEF}<, R_{SEF}<<	≤ 0.8 s
Drop-off time I_{SEF}>	≤ 120 ms
Drop-off ratio	Approx. 1.2 to 1.7
Tolerances	
Resistance (R_{SEF})	ca. 5 % or 2 Ω
Earth current stage (I_{SEF} >)	3 % or 3 mA
Time delays T	1 % or 10 ms

Out-of-step protection (ANSI 78)	
Setting ranges	
Positive sequence current pickup I_1>	0.2 to 4 I_1/I_N (steps 0.1 I_1/I_N)
Negative-sequence current pickup I_2<	0.05 to 1 I_2/I_N (steps 0.01 I_2/I_N)
Impedances Z_a to Z_d (based on I_N =1 A)	0.05 to 130 Ω (steps 0.01 Ω)
Inclination angle of polygon φ_P	60 to 90 ° (steps 1 °)
Number of out-of-step periods characteristic 1	1 to 10
Number of out-of-step periods characteristic 2	1 to 20
Holding time of pickup t_H	0.2 to 60 s (steps 0.01 s)
Holding time for out-of-step annunciation	0.02 to 0.15 s (steps 0.01 s)
Times	
Typical trip time	Depending from the out-of-step frequency
Tolerances	
Impedance measurement	$\lvert\Delta Z/Z\rvert$ ≤ 5 % for 30 ° ≤ φ_{SC} ≤ 90 ° or 10 mΩ
Time delays T	1 % to 10 ms

DC voltage time / DC current time protection (ANSI 59N (DC) ; 51N (DC))	
Setting ranges	
Voltage pickup V = >,<	0.1 to 8.5 V (steps 0.1 V)
Current pickup I = >, <	0.2 to 17 mA (steps 0.1 mA)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Times	
Pickup time (operational condition 1)	Approx. 60 ms
Pickup time (operational condition 0)	Approx. 200 ms
Drop-off time	Approx. 60 ms or 200 ms
Drop-off ratio	0.9 or 1.1
Tolerances	
Voltage	1 % of set value, or 0.1 V
Current	1 % of set value, or 0.1 mA
Time delays T	1 % or 10 ms

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

11

Technical data

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

Sensitive earth-fault protection B (ANSI 51GN)	
Setting ranges	
Earth current $I_{EE\text{-}B}$>,	0.3 to 1000 mA (steps 0.1 A)
Earth current $I_{EE\text{-}B}$<,	0.3 to 500 mA (steps 0.1 mA)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Measuring method	- Fundamental, - 3rd harmonic - 1^{rst} and 3rd harmonics
Times	
Pick-up times	Approx. 50 ms
Drop-off times	Approx. 50 ms
Drop-off ratio $I_{EE\text{-}B}$>	0.90 or 0.15 mA
Drop-off ratio $I_{EE\text{-}B}$<	1.1 or 0.15 mA
Tolerances	
Earth current	1 % of set value or 0.1 mA
Time delays T	1 % of set value or 10 ms

Interturn protection (ANSI 59N(IT))	
Setting ranges	
Displacement voltage $V_{Interturn}$>	0.3 to 130 V (steps 0.1 V)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Times	
Pick-up times $V_{Interturn}$>	Approx. 60 ms
Drop-off times $V_{Interturn}$>	Approx. 60 ms
Drop-off ratio $V_{Interturn}$>	0.5 to 0.95 adjustable
Tolerances	
Displacement voltage	1 % of set value or 0.5 V
Time delays T	1 % of set value 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)
Sensors types	Pt100; Ni 100, Ni 120

External trip coupling	
Number of external trip couplings	4

Threshold supervision	
Setting ranges	
Threshold of measured values MV_1 > to MV_{10}<	-200 % to +200 % (steps 1 %)
Assignable measured values	P, active power Q, reactive power change of active power ΔP Voltage V_{L1}, V_{L2}, V_{L3}, V_E, V_0, V_1, V_2, V_{E3h} Current $3I_0$, I_1, I_2, I_{EE1}, I_{EE2} Power angle φ Power factor cos φ Value at TD1
Times	
Pick-up times	Approx. 20 - 40 ms
Drop-off times	Approx. 20 - 40 ms
Drop-off to pick-up ratio	
Threshold MV_x>	0.95
Threshold MV_x<	1.05

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

Technical data

Operational measured values

Description	Primary; secondary or per unit (%)
Currents	$I_{L1,S1}$; $I_{L2,S1}$; $I_{L3,S1}$; $I_{L1,S2}$; $I_{L2,S2}$; $I_{L3,S2}$; I_{EE1}; I_{EE2}; I_1; I_2; I_{20Hz}
Tolerance	0.2 % of measurement values or ± 10 mA ± 1 digit
Differential protection currents	I_{DiffL1}; I_{DiffL2}; I_{DiffL3}; I_{RestL1}; I_{RestL2}; I_{RestL3};
Tolerances	0.1 % of measured or ± 10 mA ± 1 digit
Phase angles of currents	$\varphi I_{L1,S1}$; $\varphi I_{L2,S1}$; $\varphi I_{L3,S1}$; $\varphi I_{L1,S2}$; $\varphi I_{L2,S2}$; $\varphi I_{L3,S2}$;
Tolerances	< 0.5 °
Voltages	V_{L1}; V_{L2}; V_{L3}; V_E; V_{L12}; V_{L23}; V_{L31}; V_1; V_2; $V_{20\,Hz}$
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}, $\Theta_{V/f}$, sensors
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 %

Analog outputs (optional)

Number	max. 4 (depending on variant)
Possible measured values	I_1, I_2, I_{EE1}, I_{EE2}, V_1, V_0, V_{03h}, $\|P\|$, $\|Q\|$, $\|S\|$, $\|\cos\varphi\|$ f, V/f, φ, $\Theta_S/\Theta_{S\,Trip}$, $\Theta_{Rotor}/\Theta_{Rotor\,Trip}$, $R_{E,\,REF}$; $R_{E,\,REF\ 1\text{-}3Hz}$; $R_{E\,SEF}$
Range	0 to 22.5 mA
Minimum threshold (limit of validity)	0 to 5 mA (steps 0.1 mA)
Maximum threshold	22 mA (fixed)
Configurable reference value 20 mA	10 to 1000 % (steps 0.1 %)

Fault records

Number of fault records	Max. 8 fault records
Instantaneous values	
Storage time	Max. 5 s
Sampling interval	Depending on the actual frequency (e. g. 1.25 ms at 50 Hz; 1.04 ms at 60 Hz)
Channels	v_{L1}, v_{L2}, v_{L3}, v_E; $i_{L1,S1}$; $i_{L2,S1}$; $i_{L3,S1}$; i_{EE1}; $i_{L1,S2}$; $i_{L2,S2}$; $i_{L3,S2}$; i_{EE2}; TD1; TD2; TD3
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_{EE1}, I_{EE2}, P, Q, φ, R, X, 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 89/336/EEC) and electrical equipment designed for use within certain voltage limits (Council Directive 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
7UM62 multifunction generator, motor and transformer protection relay	*7UM62□□-□□□□□-□□□0*	*□□□*
Housing, binary inputs and outputs		
Housing 1/2 19", 7 BI, 12 BO, 1 live status contact	*1*	
Housing 1/1 19", 15 BI, 20 BO, 1 live status contact	*2*	
Graphic display, 1/2 19'', 7BI, 12 BO, 1 live status contact	*3*	
Current transformer I		
1 A[1)], I_{EE} (sensitive)	*1*	
5 A[1)], I_{EE} (sensitive)	*5*	
Rated auxiliary voltage (power supply, indication voltage)		
24 to 48 V DC, threshold binary input 19 V[3)]	*2*	
60 to 125 V DC[2)], threshold binary input 19 V[3)]	*4*	
110 to 220 V DC[2)], 115 V/230 V AC, threshold binary input 88 V[3)]	*5*	
220 to 250 V DC, 115 V/230 V AC, threshold binary input 176 V	*6*	
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*	
Port B (System interface)		
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*	
Analog output 2 x 0 to 20 mA	*7*	
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*
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connectors	*9*	*L 0 R*
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector[4)]	*9*	*L 0 S*
Only Port C (Service Interface)		
DIGSI 4 / modem, electrical RS232	*1*	
DIGSI 4 / modem, temperature monitoring box, electrical RS485	*2*	
Port C (Service interface) and Port D (Additional Interface)	*9*	*M □ □*
Port C (Service Interface)		
DIGSI 4 / modem, electrical RS232		*1*
DIGSI 4 / modem, temperature monitoring box, electrical RS485		*2*
Port D (Additional Interface)		
Temperature monitoring box, optical 820 nm, ST connector		*A*
Temperature monitoring box, electrical RS485		*F*
Analog outputs 2 x 0 to 20 mA		*K*

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) Not available with position 9 = "*B*"

* Not with position 9 = *B*; if 9 = "*B*", please order 7UM62 unit with RS485 port and separate fiber-optic converters.

Cont'd on next page

Selection and ordering data

Description	Order No.
7UM62 multifunction generator, motor and transformer protection	*7UM62□□-□□□□□-□□□0*
Measuring functions	
Without extended measuring functions	*0*
Min./max. values, energy metering	*3*
Functions	
Generator Basic	*A*
Generator Standard	*B*
Generator Full	*C*
Asynchronous Motor	*F*
Transformer	*H*
Functions (additional functions)	
Without	*A*
Sensitive rotor earth-fault protection and 100 % stator earth-fault protection	*B*
Restricted earth-fault protection	*C*
Network decoupling (d*f*/d*t* and vector jump)	*E*
All additional functions	*G*

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*
Professional + IEC 61850 Complete version DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation) + IEC 61850 system configurator	*7XS5403-0AA00*
IEC 61850 System configurator Software for configuration of stations with IEC 61850 communication under DIGSI, running under MS Windows 2000 or XP Professional Edition Optional package for DIGSI 4 Basis or Professional License for 10 PCs. Authorization by serial number. On CD-ROM	*7XS5460-0AA00*
SIGRA 4 (generally contained in DIGSI Professional, but can be ordered additionally) Software for graphic visualization, analysis and evaluation of fault records. Can also be used for fault records of devices of other manufacturers (Comtrade format). Running under MS Windows 95/98/ME/NT/2000/XP Professional. Incl. templates, electronic manual with license for 10 PCs. Authorization by serial number. On CD-ROM.	*7XS5410-0AA00*

1) For more detailed information on the functions see Table 11/3.

Accessories

Description	Order No.
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*
Cable between thermo-box and relay	
- length 5 m / 5.5 yd	*7XV5103-7AA05*
- length 25 m / 27.3 yd	*7XV5103-7AA25*
- length 50 m / 54.7 yd	*7XV5103-7AA50*
Coupling device for rotor earth-fault protection	*7XR6100-0CA00*
	Short code
Series resistor for rotor earth-fault protection (group: 013002)	*3PP1336-0DZ K2Y*
Resistor for underexcitation protection (voltage divider, 20:1) (group: 012009)	*3PP1326-0BZ K2Y*
Resistor for stator earth-fault protection (voltage divider, 5:1) (group 013001)	*3PP1336-1CZ K2Y*
20 Hz generator	*7XT3300-0CA00*
20 Hz band pass filter	*7XT3400-0CA00*
Current transformer (400 A /5 A, 5 VA)	*4NC5225-2CE20*
Controlling unit f. rotor earth-fault protection (0.5 to 4 Hz)	*7XT7100-0EA00*
Resistor for 1 to 3 Hz rotor earth-fault protection	*7XR6004-0CA00*
Temperature monitoring box (thermo-box)	
24 to 60 V AC/DC	*7XV5662-2AD10*
90 to 240 V AC/DC	*7XV5662-5AD10*

Fig. 11/60 Mounting rail for 19" rack

Fig. 11/61
2-pin connector

Fig. 11/62
3-pin connector

Fig. 11/63
Short-circuit link for current terminals

Fig. 11/64
Short-circuit link for voltage terminals/ indications terminals

Description		Order No.	Size of package	Supplier	Fig.
Connector	2-pin	*C73334-A1-C35-1*	1	Siemens	11/61
	3-pin	*C73334-A1-C36-1*	1	Siemens	11/62
Crimp connector	CI2 0.5 to 1 mm^2	*0-827039-1*	4000	AMP [1]	
		0-827396-1	1	AMP [1]	
	CI2 1 to 2.5 mm^2	*0-827040-1*	4000	AMP [1]	
		0-827397-1	1	AMP [1]	
	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]	
Mounting rail		*C73165-A63-D200-1*	1	Siemens	11/60
Short-circuit links	For current terminals	*C73334-A1-C33-1*	1	Siemens	11/63
	For other terminals	*C73334-A1-C34-1*	1	Siemens	11/64
Safety cover for terminals	Large	*C73334-A1-C31-1*	1	Siemens	11/35
	Small	*C73334-A1-C32-1*	1	Siemens	11/35

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

Connection diagram, IEC

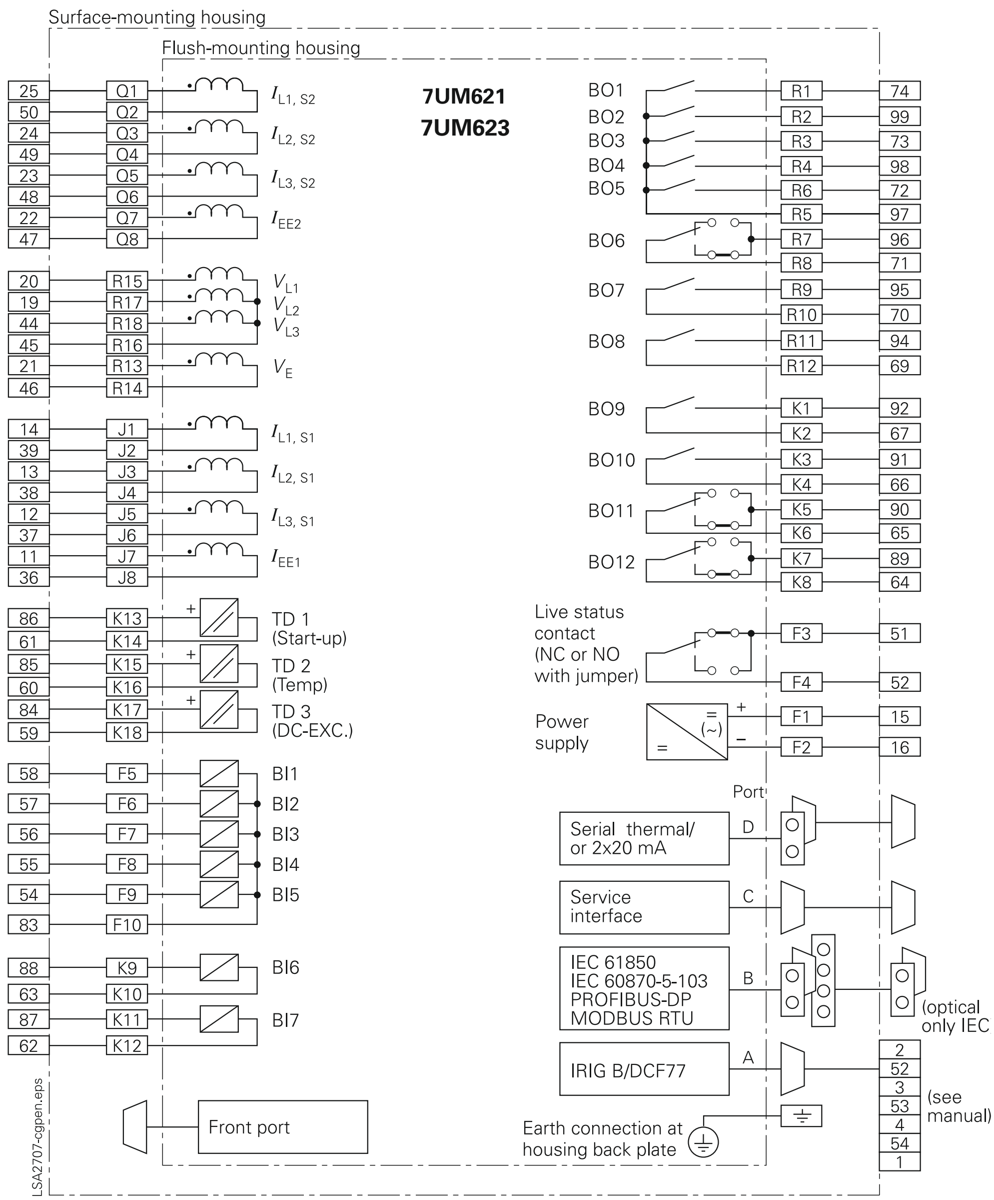

Fig. 11/65

7UM621 and 7UM623 connection diagram (IEC standard)

Connection diagram, IEC

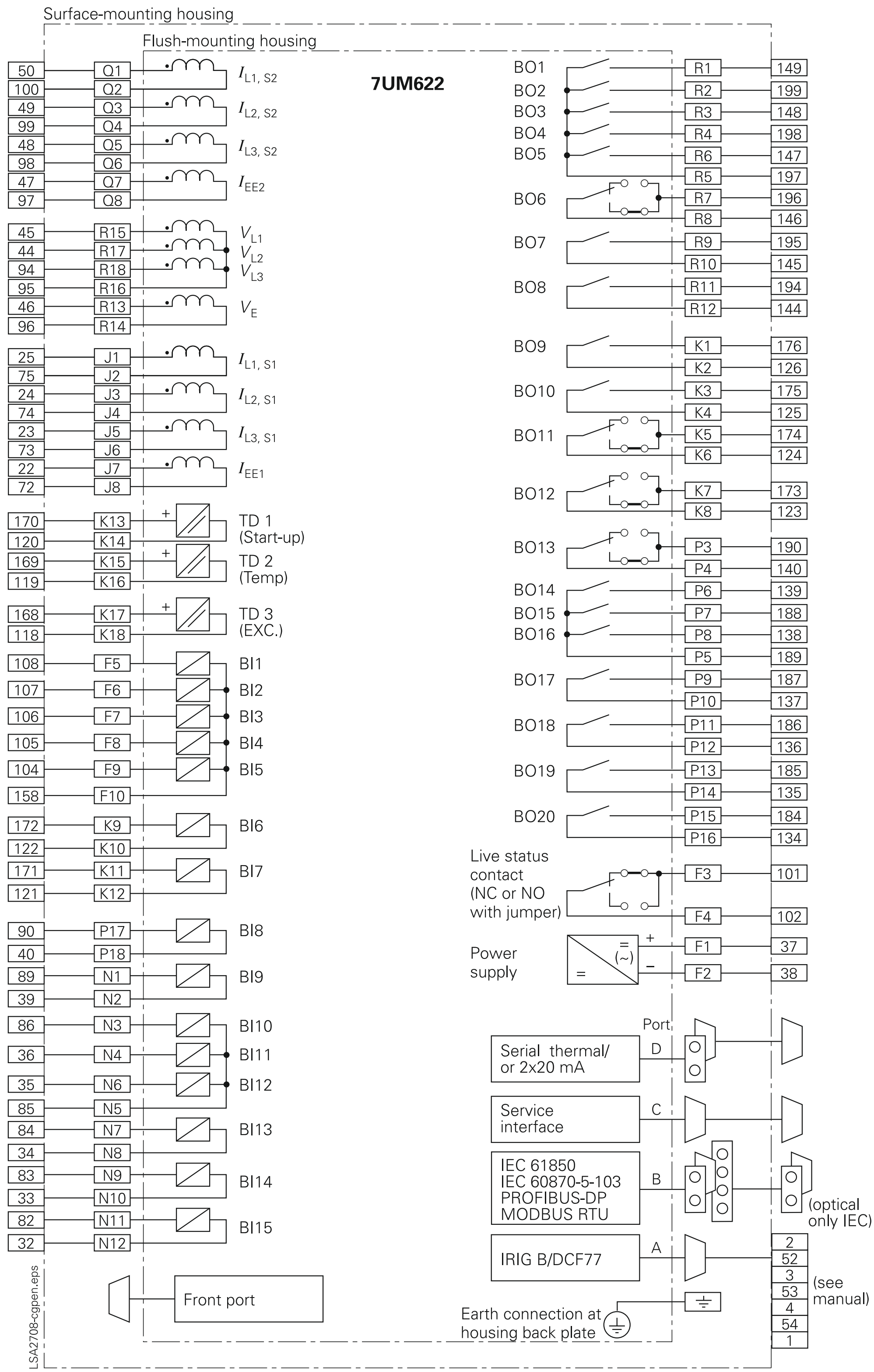

Fig. 11/66

7UM622 connection diagram (IEC standard)

Connection diagram, ANSI

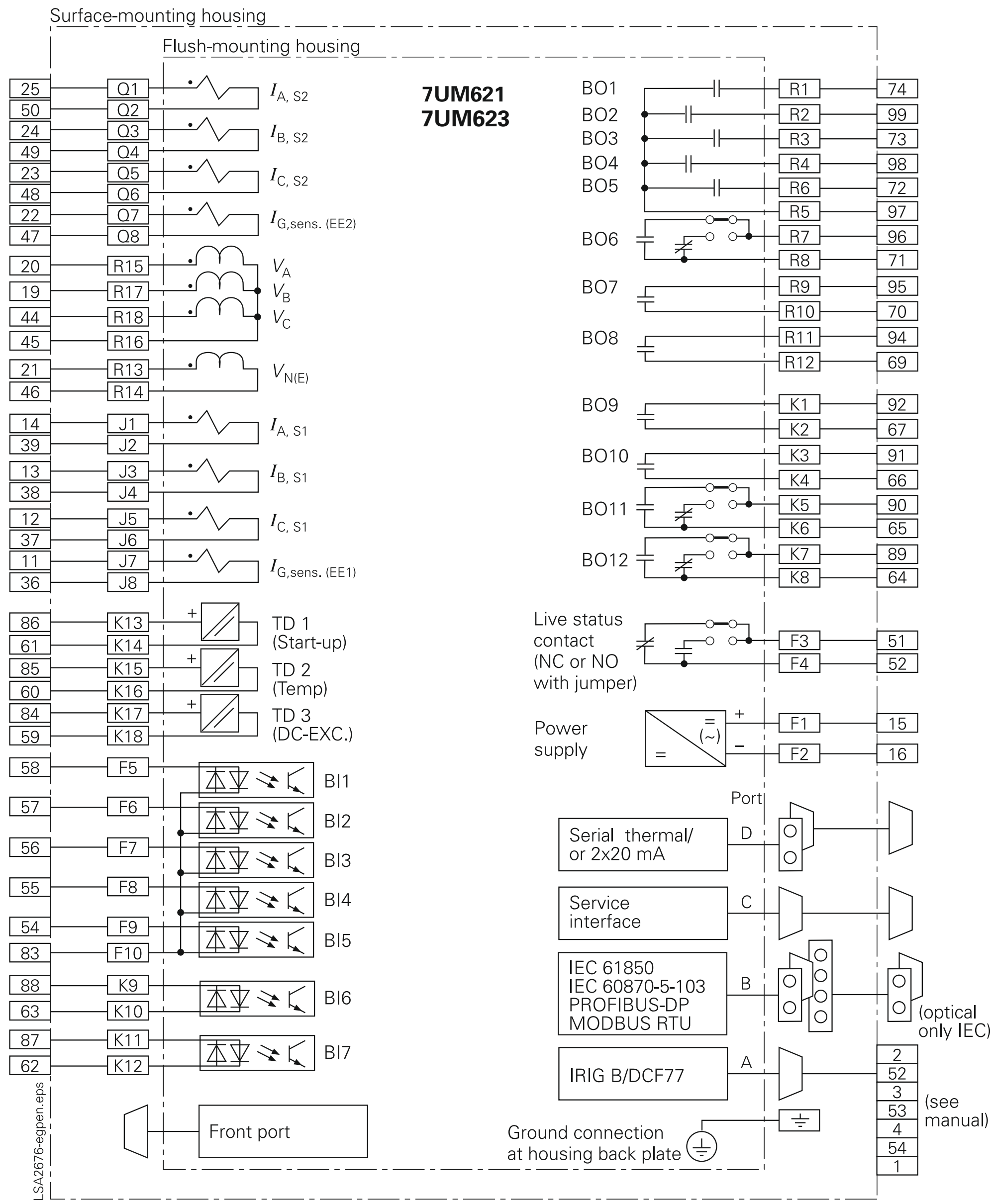

Fig. 11/67

7UM621 and 7UM623 connection diagram (ANSI standard)

Connection diagram, ANSI

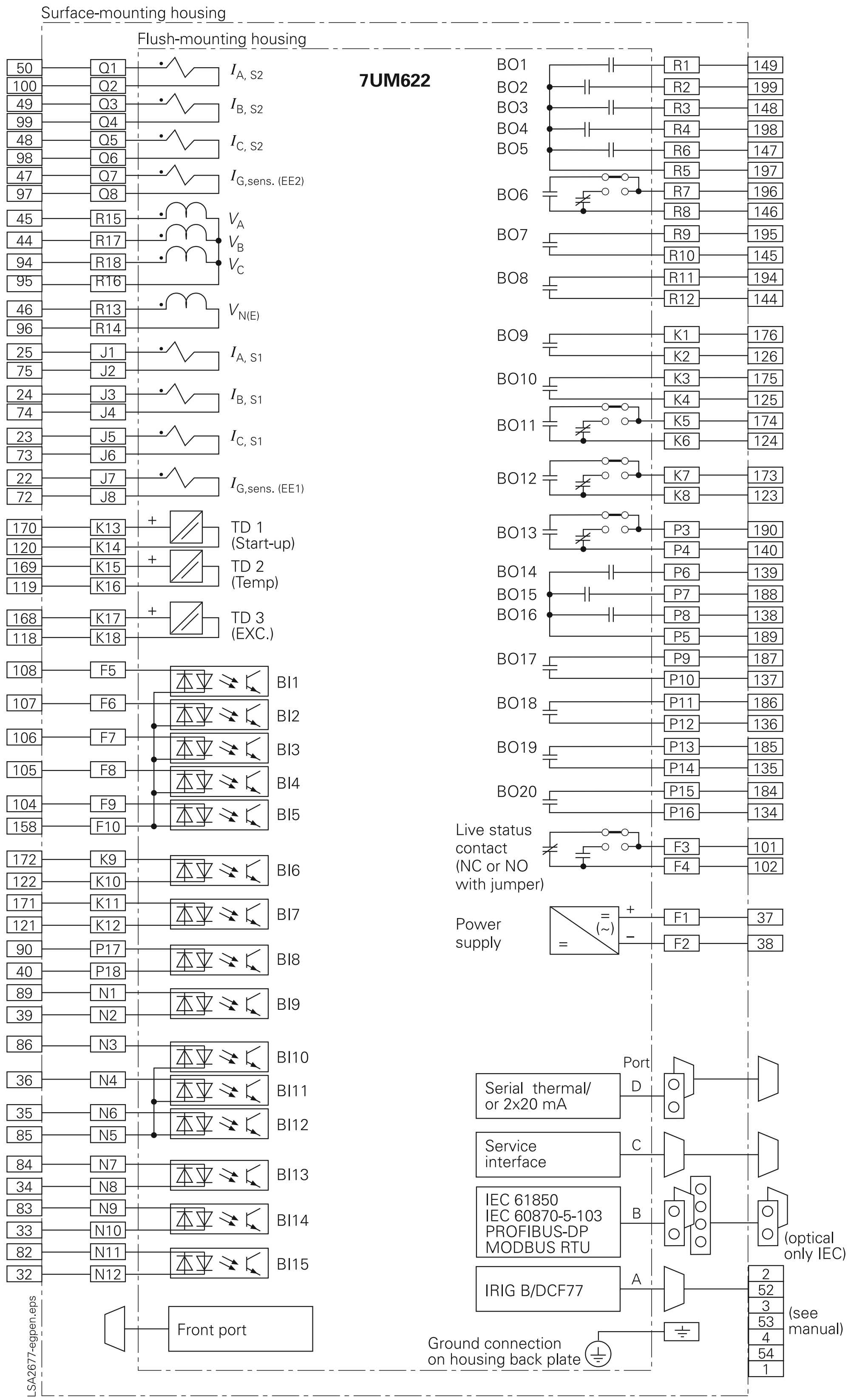

Fig. 11/68

7UM622 connection diagram (ANSI standard)

SIPROTEC 7UW50 Tripping Matrix

Fig. 11/69 SIPROTEC 7UW50 tripping matrix

Function overview

Functions

- Hardware tripping matrix
- 28 inputs
- 10 outputs
- One LED is assigned to each input and output

Features

- Easy marshalling of trip signals via diode plugs
- Plexiglass cover prevents unauthorized marshalling

Description

The tripping matrix 7UW50 is a component of the Siemens numerical generator protection system. The tripping matrix provides a transparent, easily programmable facility for combining output commands of the trip outputs of individual protection devices with plant items such as the circuit-breakers, de-excitation etc. The matrix was developed for marshalling tripping commands of large power stations.

With its help, the tripping schematic can be temporarily changed, e.g., on the basis of a generator circuit-breaker revision. If the software matrix incorporated in each generator protection unit is used for marshalling the tripping commands, the marshalling in the protection units must be changed for this purpose.

Selection and ordering data

Description	Order No.
7UW50 tripping matrix	*7UW5000-□□A00*
Rated auxiliary voltage	
60 V, 110 V, 125 V DC	*4*
220 V, 250 V DC	*5*
Unit design	
For panel surface mounting	*B*
For panel flush mounting or cubicle mounting	*C*

SIPROTEC 7RW600
Numerical Voltage, Frequency and Overexcitation Protection Relay

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Fig. 11/70 SIPROTEC 7RW600 voltage, frequency and overexcitation protection relay

Description

The SIPROTEC 7RW600 is a numerical multifunction protection relay for connection to voltage transformers. It can be used in distribution systems, on transformers and for electrical machines. If the SIPROTEC 7RW600 detects any deviation from the permitted voltage, frequency or overexcitation values, it will respond according to the values set. The SIPROTEC 7RW600 can be used for the purposes of system decoupling and for load shedding if ever there is a risk of a system collapse as a result of inadmissibly large frequency drops. Voltage and frequency thresholds can also be monitored.

The SIPROTEC 7RW600 voltage, frequency and overexcitation relay can be used to protect generators and transformers in the event of defective voltage control, of defective frequency control, or of full load rejection, or furthermore islanding generation systems.

This device is intended as a supplement to Siemens substation systems and for use in individual applications. It has two voltage inputs (V; V_x) to which a variety of functions have been assigned. While input V serves all of the implemented functions, input V_x is exclusively dedicated to the voltage protection functions. The scope of functions can be selected from three ordering options.

Function overview

Line protection

- Voltage protection
- Frequency protection

Generator protection

- Voltage protection
- Frequency protection
- Overexcitation protection

Transformer protection

- Voltage protection
- Overexcitation protection

Power system decoupling

- Voltage protection
- Frequency protection

Load shedding

- Frequency protection
- Rate-of-frequency-change protection

Status measured values

Monitoring functions

- Hardware
- Software
- Event logging
- Fault recording
- Continuous self-monitoring

Hardware

- Auxiliary voltages:
  – 24, 48 V DC
  – 60, 110, 125 V DC
  – 220, 250 V DC, 115 V AC
- Local operation
- LCD for setting and analysis
- Housing for
  – Flush-mounting 1/6 19-inch 7XP20;
  – Surface-mounting 1/6 19-inch 7XP20

Communication ports

- Personal computer
- Via RS485 – RS232 converter
- Via modem
- SCADA
  – IEC 60870-5-103 protocol
- Bus-capable

Application

The SIPROTEC 7RW600 is a numerical multifunction protection relay for connection to voltage transformers. It can be used in distribution systems, on transformers and for electrical machines.
If the SIPROTEC 7RW600 detects any deviation from the permitted voltage, frequency or overexcitation values, it will respond according to the values set. The SIPROTEC 7RW600 can be used for the purposes of system decoupling and for load shedding if ever there is a risk of a system collapse as a result of inadmissibly large frequency drops. Voltage and frequency thresholds can also be monitored.

The SIPROTEC 7RW600 voltage, frequency and overexcitation relay can be used to protect generators and transformers in the event of defective voltage control, of defective frequency control, or of full load rejection, or furthermore islanding generation systems.

Applications

ANSI	IEC	Protection functions
(27)	$V<, t; t = f(V<)$	Undervoltage protection
(59)(59N)	$V>>, t; V>, t$	Overvoltage protection
(81)(81R)	$f>; f<; \left\|-\frac{df}{dt}\right\|>; +\frac{df}{dt}$	Frequency protection, rate-of-frequency-change protection
(24)	$\frac{V}{f}>, t; \frac{V}{f} = f(t)$	Overexcitation protection

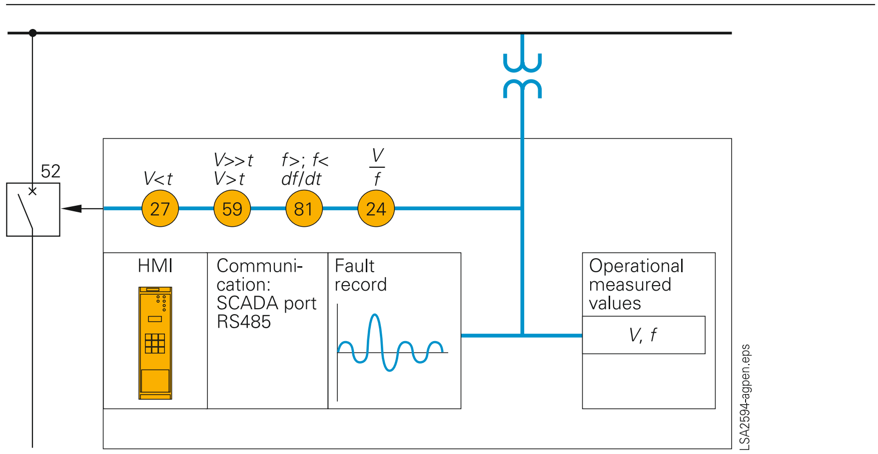

Fig. 11/71 Function diagram

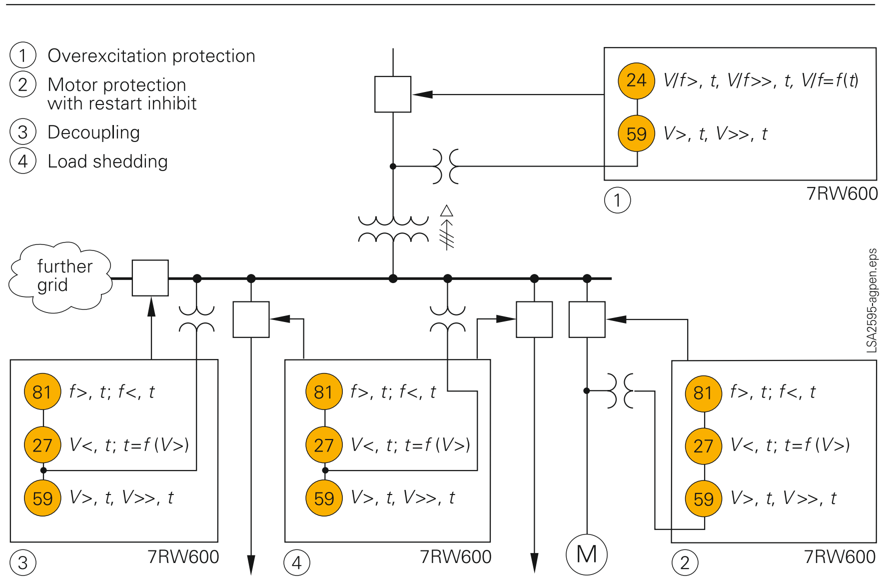

Fig. 11/72

11

Construction

The SIPROTEC 7RW600 relay contains, in a compact form, all the components needed for:

- Acquisition and evaluation of measured values
- Operation and display
- Output of messages, signals and commands
- Input and evaluation of binary signals
- Data transmission (RS485) and
- Auxiliary voltage supply.

The SIPROTEC 7RW600 receives AC voltages from the primary voltage transformer. The secondary rated voltage range, 100 to 125 V, is adapted internally on the device.

There are two device variants available:

- The first version, for panel flush mounting or cubicle mounting, has its terminals accessible from the rear.
- The second version for panel surface mounting, has its terminals accessible from the front.

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Fig. 11/73
Rear view of surface-mounting case

Protection functions

Overvoltage protection

The overvoltage protection has the function of detecting inadmissible overvoltages in power systems and electrical machines and, in such event, it initiates system decoupling or shuts down the generators.

Two voltage measuring inputs (V, V_x) are provided on the unit. These must be connected to two phase-to-phase voltages. The input voltages are processed separately in two two-stage protective functions. From these, two principle connection variants are derived.

Fig. 11/76, Fig. 11/77, and Fig. 11/78, on page 11/75, show the following connection examples:

Fig. 11/76:
Separated connection, used for overvoltage protection and earth-fault detection

Fig. 11/77:
Two-phase connection to a voltage transformer

Fig. 11/78:
Alternative V connection

Undervoltage protection

The main function of the undervoltage protection is protecting electrical machines (e.g. pumped-storage power generators and motors) against the consequences of dangerous voltage drops. It separates the machines from the power system and thus avoids inadmissible operating states and the possible risk of stability loss. This is a necessary criterion in system decoupling.

To ensure that the protection functions in a physically correct manner, when used in conjunction with electrical machines, the positive-sequence system must be evaluated.

The protection function can be blocked, via a binary input, causing a drop in energizing power. The auxiliary contact of the circuit-breaker can be used for this purpose with the circuit-breaker open. Alternatively, undervoltage acquisition can be activated on a conductor-separated basis ($V<, V_x<$).

Additionally, it is possible to use an inverse-time undervoltage protection function for motor protection. The tripping time depends in the undervoltage drop. A time grading is possible.

Frequency protection

The frequency protection can be used to protect against overfrequency or against underfrequency. It protects electrical machines and plants/substations against adverse effects in the event of deviations in the rated speed (e.g. vibration, heating, etc.), detects and records frequency fluctuations in the power system, and disconnects certain loads according to the thresholds set. It can also be used for the purposes of system decoupling, and thus improves the availability of in-plant power generation.

The frequency protection function is implemented via voltage input V. From the sampled voltage, the frequency is measured by means of various filter functions. The system thus remains unaffected by harmonics, ripple control frequencies and other disturbances.

The frequency protection function operates over a wide frequency range (25-70 Hz).

It is implemented (optionally for overfrequency or for underfrequency) on a four-stage basis; each stage can be individually delayed. The frequency stages can be blocked either via the binary input or by an undervoltage stage.

Rate-of-frequency-change protection

The rate-of-frequency-change protection calculates, from the measured frequency, the gradient of frequency change df/dt. It is thus possible to detect and record any major active power overloading in the power system, to disconnect certain consumers accordingly, and to restore the system to stability. Unlike frequency protection, rate-of-frequency-change protection already reacts before the frequency threshold is undershot. To ensure effective protection settings, power system studies are recommended. The rate-of-frequency-change protection function can also be used for the purposes of system decoupling.

The rate-of-frequency-change protection function is implemented on a four-stage basis; each stage can be individually delayed. It detects and records any negative or positive frequency gradient. The measured result is generally released as soon as the rated frequency is undershot or overshot.

Rate-of-frequency-change protection can also be enabled by an underfrequency or overfrequency stage.

Protection functions

Overexcitation protection

The overexcitation protection detects and records any inadmissibly high induction

$$(B \sim \frac{V}{f})$$

in electrical equipment, e.g. generators or transformers, that may occur as a result of a voltage increase and/or frequency drop. Increased induction of this nature may lead to saturation of the iron core, excessive eddy current losses, and thus to inadmissible heating.

It is recommended to use the overexcitation protection function in power systems subject to large frequency fluctuations (e.g. systems in island configuration or with weak infeed) and for electrical block units that are separated from the system.

The overexcitation protection function calculates, from the maximum voltage (V, V_x) and the frequency, the ratio V/f. This function incorporates an independent warning and tripping stage and a curve which is dependent on and adaptable to the object to be protected and which takes due account of the object's thermal behavior. Incorrect adaptation of the voltage transformer is also corrected. The overexcitation protection function is effective over a broad frequency range (25 to 70 Hz) and voltage range (10 to 170 V).

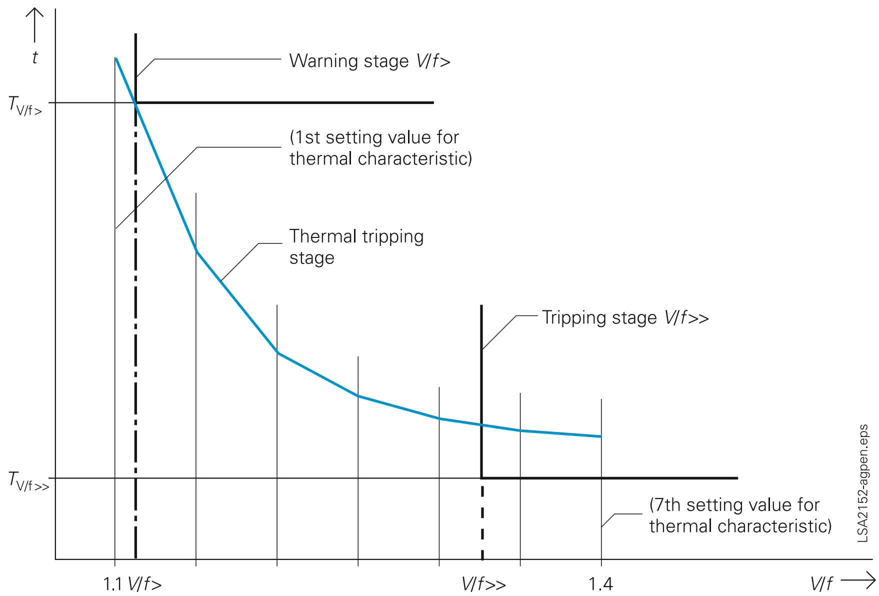

Fig. 11/74 Tripping range of overexcitation protection

Features

Serial data transmission

The SIPROTEC 7RW600 relay is fitted with an RS485 port, via which a PC can be connected, thus providing, in conjunction with the DIGSI operating and analysis program, a convenient tool for configuring and parameter setting. The DIGSI program (which runs under MS-Windows) also performs fault recording and fault evaluation. The SIPROTEC 7RW600 relay can also be linked, via the appropriate converters, either directly or over an optoelectronic connection (optical fiber) to the interface of the PC or substation control system (IEC 60870-5-103 protocol).

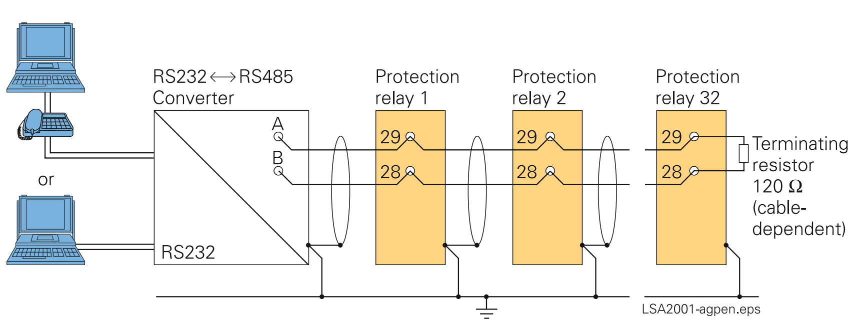

Fig. 11/75 Wiring communication
For convenient wiring of the RS485 bus,
use bus cable system 7XV5103 (see part 13 of this catalog)

Connection diagrams

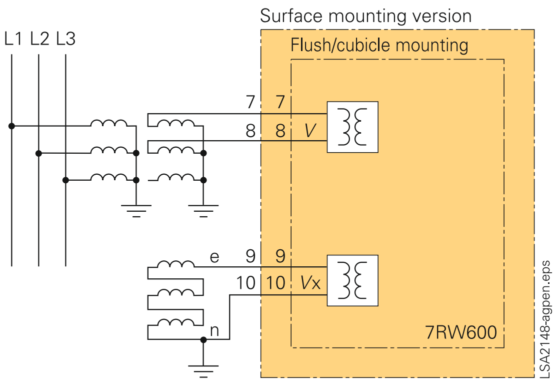

Fig. 11/76
Connection of a phase-to-phase voltage *V* and a displacement voltage *V*

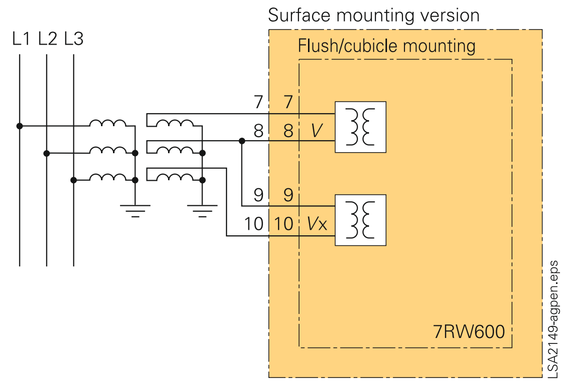

Fig. 11/77
Connection of two phase-to-phase voltages *V* to one voltage transformer set

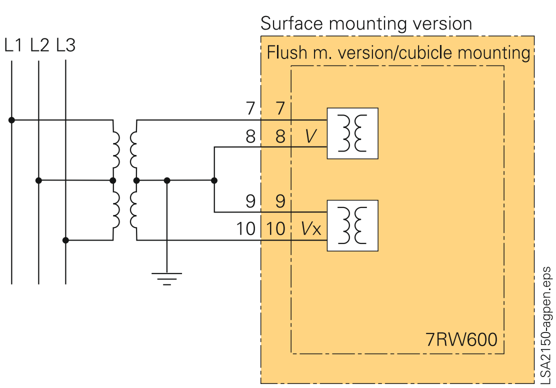

Fig. 11/78
Connection to voltage transformers in *V*-configuration

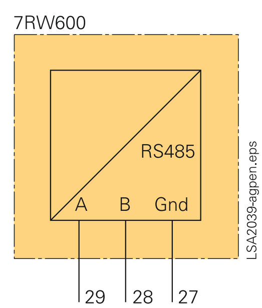

Fig. 11/79
Communication port

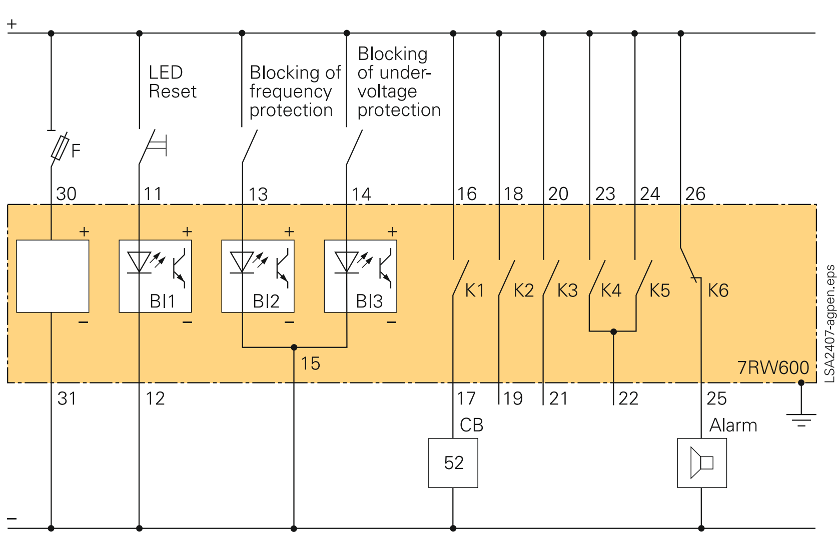

Fig. 11/80
Typical auxiliary voltage wiring

11

Technical data

Hardware	
Measuring circuits (v.t. circuits)	
Rated voltage V_N	100 to 125 V
Rated frequency f_N	50 or 60 Hz
Dynamic range	170 V
Power consumption	≤ 0.2 VA
Thermal overload capacity, continuous for ≤ 10 s	 200 V 230 V
Power supply via integrated DC/DC converter	
Rated auxiliary voltage V_{aux}	24/48 V DC 60/110/125 V DC 220/250 V DC, 115 V AC
Maximum ripple at rated voltage	≤ 12 %
Power consumption Quiescent Energized	 Approx. 2 W Approx. 4 W
Maximum bridging time following failure of auxiliary voltage	≥ 20 ms at V_{AUX} (24 V DC) ≥ 50 ms at V_{AUX} (110 V DC)
Binary inputs	
Number	3
Voltage range	24 to 250 V DC
Current consumption, independent of operating voltage	Approx. 2.5 mA
2 switching thresholds (adjustable)	17 V, 75 V
Command contacts	
Number of relays, total Number of relays with 2-channel energization	6 2
Contacts per relay (K1 to K5) Contact for relay (K6)	1 NO contact 1 NC contact or 1 NO contact (set via jumper)
Switching capacity Make Break	 1000 W/VA 30 W/VA
Switching voltage	250 V (AC/DC)
Permissible current, continuous 0.5 s	 5 A 30 A
LEDs	
Ready-to-operate (green)	1
Marshallable displays (red)	4
Fault indication (red)	1

Serial port (isolated)	
Type	RS485
Test voltage	2 kV AC for 1 min
Connections	Data cable at housing, two data wires, one frame reference for connection of a PC or similar
Transmission speed	At least 1200 baud, max. 19 200 baud
Unit design	
Case 7XP20	For dimensions, see dimension drawings, part 15
Weight Flush mounting/cubicle mounting Surface mounting	 Approx. 4 kg Approx. 4.5 kg
Degree of protection to IEC 60529/EN 60529	IP 51

Electrical test	
Specifications	
Standards	IEC 60255-5, ANSI / IEEE C37.90.0
Insulation tests	
Voltage test (routine test) All circuits except auxiliary voltage and RS485 Auxiliary voltage and RS485 only	 2.0 kV (rms), 50 Hz 2.8 kV DC
Voltage test (type test) Over open command contacts	 1.5 kV (rms), 50 Hz
Impulse withstand capability (SWC) test (type test) All circuits, class III	5 kV (peak); 1.2 / 50 µs; 0.5 J 3 positive and 3 negative impulses at intervals of 5 s
Test crosswise: Measurement circuits, pilot-wire connections, power supply, binary inputs, class III, (no tests crosswise over open contacts, RS485 interface terminals)	
EMC tests, immunity; type tests	
Standards	IEC 60255-22 (product standard) EN 50082-2 (generic standard) DIN VDE 0435, Part 303
High-frequency test IEC 60255-22-1, class III and DIN VDE 0435 Part 303, class III	2.5 kV (peak), 1 MHz, τ = 15 µs, 400 shots/s duration 2 s
Electrostatic discharge IEC 60255-22-2, class III and IEC 61000-4-2, class III	4 kV/6 kV contact discharge, 8 kV air discharge, both polarities, 150 pF, R_i = 330 Ω
Irradiation with RF field Non-modulated, IEC 60255-22-3 (report), class III Amplitude-modulated, IEC 61000-4-3, class III Pulse-modulated, IEC 6100-4-3, class III	 10 V/m, 27 to 500 MHz 10 V/m, 80 to 1000 MHz, 80 % AM, 1 kHz 10 V/m, 900 MHz, repetition frequency 200 Hz, duty cycle 50 %

Technical data

EMC tests, immunity; type tests	
Fast transients IEC 60255-22-4 and IEC 61000-4-4, class III	2 kV, 5/50 ns, 5 kHz, burst length 15 ms, repetition rate 300 ms, both polarities, R_i = 50 Ω, duration 1 min
Conducted disturbances induced by radio-frequency fields, amplitude-modulated, IEC 61000-4-6, class III	10 V, 150 kHz to 80 MHz, 80 % AM, 1 kHz
Power frequency magnetic field IEC 61000-4-8, class IV	30 A/m continuous, 50 Hz 300 A/m for 3 s, 50 Hz 0.5 mT; 50 Hz
Oscillatory surge withstand capability ANSI/IEEE C37.90.1 (common mode)	2.5 kV to 3 kV (peak), 1 MHz to 1.5 MHz, decaying oscillation, 50 shots per s, duration 2 s, R_i = 150 to 200 Ω
Fast transient surge withstand capability ANSI/IEEE C37.90.1 (common mode)	4 to 5 kV, 10/150 ns, 50 shots per s, both polarities, duration 2 s, R_i = 80 Ω
Radiated electromagnetic interference ANSI/IEEE C37.90.2	10 to 20 V/m, 25 to 1000 MHz, amplitude- and pulse-modulated
High-frequency test Document 17C (SEC) 102	2.5 kV (peak, alternating polarity), 100, 1, 10 and 50 MHz, decaying oscillation, R_i = 50 Ω
EMC tests, emission; *type tests*	
Standard	EN 50081-* (generic standard)
Conducted interference voltage, aux. voltage only CISPR 11, EN 55022, DIN VDE 0878 Part 22, limit value, class B	150 kHz to 30 MHz
Interference field strength CISPR 11, EN 55011, DIN VDE 0875 Part 11, limit value, class A	30 to 1000 MHz

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: ± 0.035 mm amplitude 60 to 150 Hz: 0.5 *g* acceleration Sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Half-sinusoidal acceleration 5 *g*, duration 11 ms 3 shocks in each direction of 3 orthogonal axes
Seismic vibration IEC 60255-21-3, class 1 IEC 60068-2-59	Sinusoidal 1 to 8 Hz: ± 4 mm amplitude (horizontal axis) 1 to 8 Hz: ± 2 mm amplitude (vertical axis) 8 to 35 Hz: 1 *g* acceleration (horizontal axis) 8 to 35 Hz: 0.5 *g* acceleration (vertical axis) Sweep rate 1 octave/min 1 cycle in 3 orthogonal axes
<u>During transport</u>	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 5 to 8 Hz: ± 7.5 mm amplitude; 8 to 150 Hz: 2 *g* acceleration Sweep rate 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 in each direction of 3 orthogonal axes
Continuous shock IEC 60255-21-2, class 1 IEC 60068-2-29	Half-sinusoidal acceleration 10 *g*, duration 16 ms, 1000 shocks in each direction of 3 orthogonal axes

Climatic stress tests	
Temperatures	
Recommended temperature during service	–5 to +55 °C (legibility may be impaired > +55 °C)
Temperature tolerances: During service During storage During transport (storage and transport in standard works packaging)	 –20 to +70 °C –25 to +55 °C –25 to +70 °C
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 30 days during the year 95 % relative humidity, condensation not permitted!

Functions	
Undervoltage protection	
Setting range V<, V_x<V_p<	20 to 120 V (in steps of 1 V)
Delay times	0 to 60 s (in steps of 0.01 s) or ∞ (i.e. non-effective)
Time multiplier for inverse characteristic Pickup time Reset time Reset ratio	 0.1 to 5 s ≤ 50 ms ≤ 50 ms 1.05
Tolerances Voltage pickup Delay times	 3 % of setting value or 1 V 1 % of setting value or 10 ms
Overvoltage protection	
Setting range V>, V>> V_x>, V_x>>	 20 to 170 V (in steps of 1 V) 10 to 170 V (in steps of 1 V)
Delay times	0 to 60 s or ∞ (in steps of 0.01 s)
Pickup time Reset time Reset ratio	≤ 50 ms ≤ 50 ms 0.95
Tolerances Voltage pickup Delay times	 3 % of setting value or 1 V < 1 % of setting value for $V > V_n$ 1 % of setting value or 10 ms

11

Technical data

Frequency protection	
Number of frequency stages $f>$ or $f<$	4
Setting range $f>$ or $f<$	40 to 68 Hz (in steps of 0.01 Hz)
Delay times	0 to 60 s or ∞ (in steps of 0.01 s)
Undervoltage blocking	20 to 100 V or ∞ (in steps of 1 V)
Pickup time $f>$, $f<$ Reset times $f>$, $f<$ Reset difference Reset ratio (undervoltage blocking)	Approx. 100 ms Approx. 100 ms Approx. 20 mHz 1.05
Tolerances Frequencies $f>$, $f<$ Undervoltage blocking Delay times	 5 mHz at $f = f_N$ and $V = V_N$ 10 mHz at $f = f_N$ 3 % of setting value or 1 V 1 % of setting value or 10 ms
Rate-of-frequency-change protection	
Number of rates-of-frequency-changing stages	4
Setting range $\frac{df}{dt}$	0.4 to 10 Hz/s or ∞ (in steps of 0.1 Hz/s)
Delay times	0 to 60 s or ∞ (in steps of 0.01 s)
Undervoltage blocking	20 to 100 V or ∞ (in steps of 1 V)
Pickup time $\frac{df}{dt}$	Approx. 200 ms
Reset ratio pickup $\frac{df}{dt}$	Approx. 0.6
Reset ratio (undervoltage blocking)	1.05
Tolerances Changes of frequencies $\frac{df}{dt}$	
In the 45 to 50 Hz range In the 54 to 60 Hz range	100 mHz/s at $f_N = 50$ Hz and $V = V_N$ 150 mHz/s at $f_N = 60$ Hz and $V = V_N$
Undervoltage blocking $V<$	3 % of setting value or 1 V
Delay times	1 % of setting value or 10 ms
Overexcitation protection	
Warning stage $\frac{V / V_N}{f / f_N}$	1 to 1.2 (in steps of 0.01)
Tripping stage $\frac{V / V_N}{f / f_N}$	1 to 1.4 (in steps of 0.01)
Delay times, warning and tripping stages Curve values V/f Associated delay times Cooling-down time	0 to 60 s, or ∞ (in steps of 0.01 s) 1.1 / 1.15 / 1.2 / 1.25 / 1.3 / 1.35 / 1.4 0 to 20000 s (in steps of 1 s) 0 to 20000 s (in steps of 1 s)
Voltage transformer adaption factor	0.5 to 2 (in steps 0.01)
Pickup response time (stage curve)	≤ 50 ms
Reset time (stage curve) Reset ratio	≤ 60 ms 0.95
Tolerances Overexcitation V/f Delay times (stage curve) Delay times (dependent curve)	 3 % of setting value 1 % of setting value or 10 ms 5 % with respect to V/f value ± 0.5 s

Fault recording	
Instantaneous value fault record Measured values Pattern Fault record duration Start signal	 V, V_x 1.00 ms (50 Hz) 0.83 ms (60 Hz) Max. 5 s Tripping, energization, binary input, PC
R.m.s. fault record Measured values Pattern Fault record duration Starting signal	 V, V_x, f-f_N 10 ms (50 Hz) 8.3 ms (60 Hz) Max. 50 s Tripping, energization, binary input, PC
Operational measured values	
Measured values	V, V_x, V_1, V/f, f
Measuring range voltage Tolerance	0 to 170 V ≤ 2 V or 5 %
Measuring range overexcitation Tolerance	0 to 2.4 ≤ 5 %
Measuring range frequency Tolerance	25 to 70 Hz ≤ 0.05 Hz or 5 MHz at $f = f_N$

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 89/336/EEC) and electrical equipment designed for use within certain voltage limits (Council Directive 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.
7RW600 numerical voltage, frequency and overexcitation protection relay	*7RW6000-□□A□0-□DA0*

Rated auxiliary voltage

24, 48 V DC	*2*
60, 110, 125 V DC	*4*
220, 250 V DC, 115 V AC	*5*

Unit design

For panel surface mounting, terminals on the side	*B*
For panel surface mounting, terminals on the top and bottom	*D*
For panel flush mounting/cubicle mounting, terminals on the rear	*E*

Languages

English	*0*
German	*1*
Spanish	*2*
French	*3*

Scope of functions

Voltage and frequency protection	*0*
Voltage, frequency and rate-of-frequency-change protection	*1*
Voltage and overexcitation protection	*2*

Accessories

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. Incl. templates, electronic manual with license for 10 PCs. Authorization by serial number. On CD-ROM.	*7XS5410-0AA00*

*Converter RS232 - RS485**

With communication cable for the SIPROTEC 7RW600 numerical voltage, frequency and overexcitation relay; length 1 m

With plug-in power supply unit 230 V AC	*7XV5700-0□□00* [1)]
With plug-in power supply unit 110 V AC	*7XV5700-1□□00* [1)]

Converter, full-duplex FO cable, RS485, with built-in power supply unit

Auxiliary voltage 24 - 250 V DC and 110 / 230 V AC	*7XV5650-0BA00*

Manual for 7RW600

English	*C53000-G1176-C117-4*

11

1) Possible versions see part 13, 7XV57 RS232-RS485 Converter

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

Connection diagrams

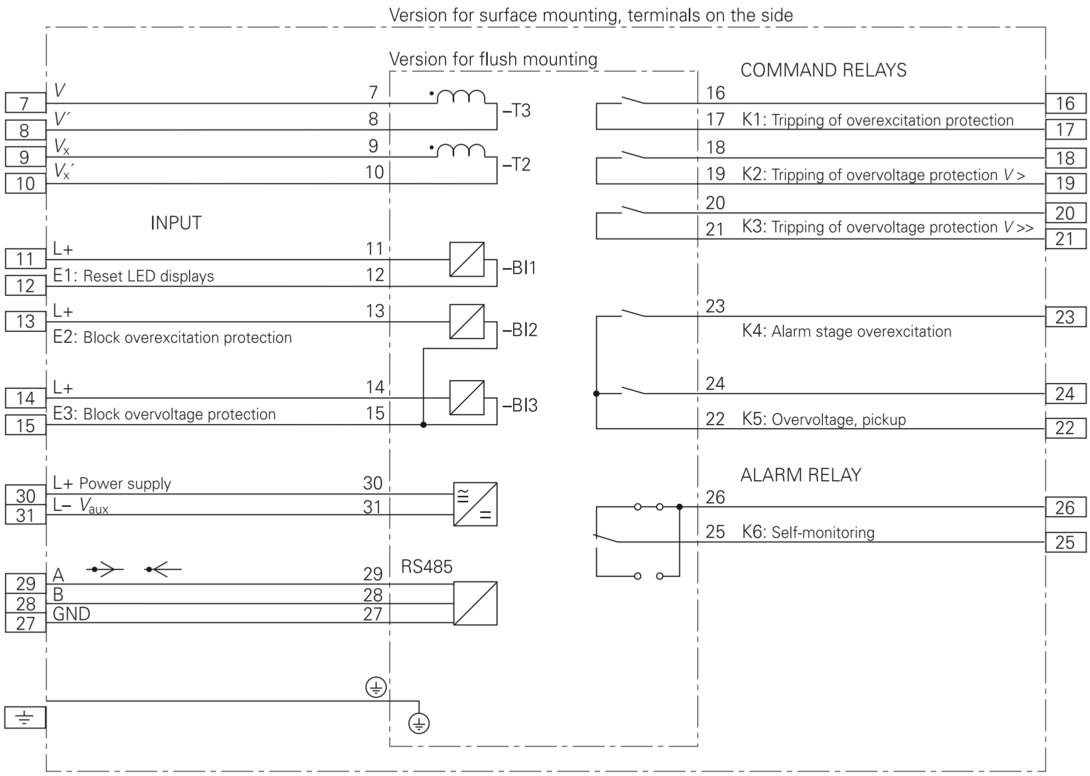

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Fig. 11/81
Connection circuit diagram of 7RW600 voltage and frequency protection with presetting of marshallable binary inputs and command contacts.
(Ordering Code: 7RW600x-xBxxx-; 7RW600x-xExxx-).

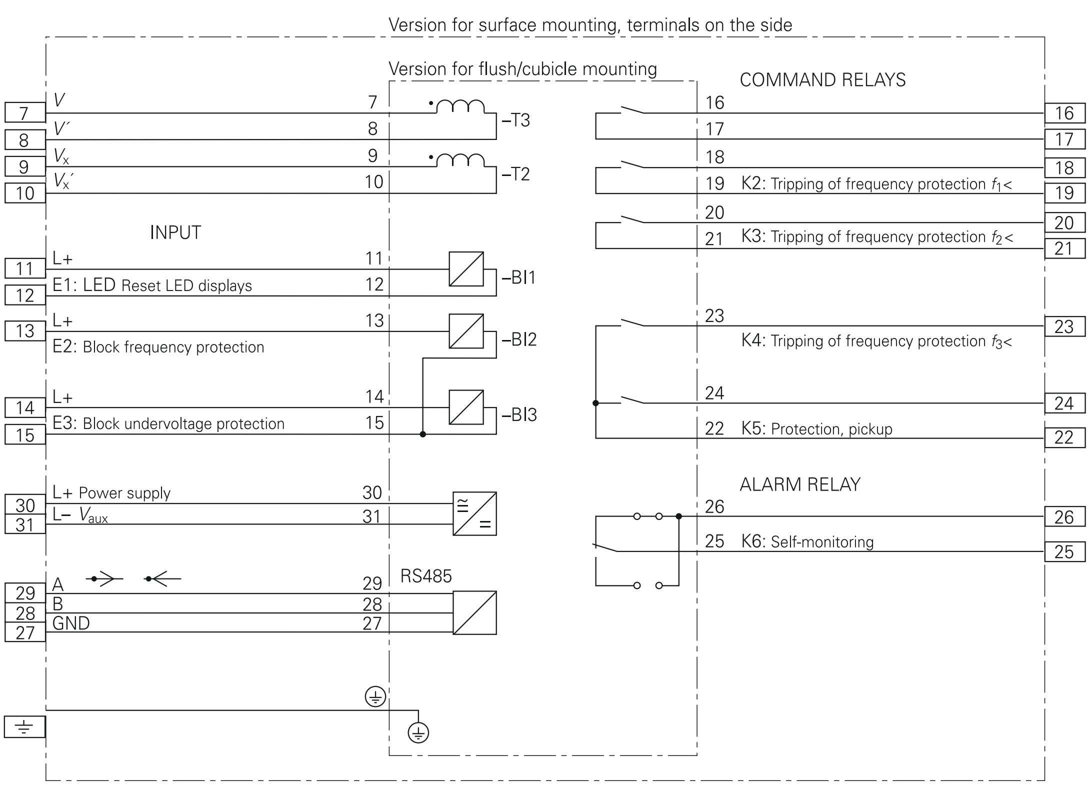

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Fig. 11/82
Connection circuit diagram of 7RW600 voltage and overexcitation protection with presetting of marshallable binary inputs and command contacts.
(Ordering Code: 7RW600x-xBxxx-; 7RW600x-xExxx-).

SIPROTEC 7VE6
Multifunction Paralleling Device

Fig. 11/83
SIPROTEC 7VE6
multifunction paralleling device

Description

The 7VE61 and 7VE63 paralleling devices of the SIPROTEC 4 family are multifunctional compact units used for paralleling power systems and generators.

Their technical design ensures highly reliable paralleling due to their 1½-channel or 2-channel measurement method and their hardware design. This is supported by numerous monitoring functions.
The units automatically detect the operating conditions. The response to these conditions depends on settings.
In "synchronous network switching" mode, the frequency difference is measured with great accuracy. If the frequency difference is almost zero for a long enough time, the networks are already synchronous and a larger making angle is permissible.

If the conditions are asynchronous, as is the case when synchronizing generators, the generator speed is automatically matched to the system frequency and the generator voltage to the system voltage. The connection is then made at the synchronous point, allowing for circuit-breaker make-time.

The 7VE61 paralleling device is a 1½-channel unit (paralleling function + synchro-check) for use with small to medium-size generators and power systems. It is more reliable than 1-channel paralleling devices. It can also be used for synchro-check, with parallel operation of three synchronization points.

For larger generators and power systems with high reliability requirements, the 2-channel 7VE63 is recommended. Two independent methods decide on the connection conditions. The unit also has the full control functions of the SIPROTEC 4 family.

Voltage and frequency functions (V>, V<, f>, f< df/dt) including voltage vector jump ($\Delta\varphi$) are optionally available for protection or network decoupling applications.

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

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

Function overview

Basic functions

- High reliability with a two-out-of-two design (1 ½ channels in 7VE61 and 2 channels in 7VE63)
- Paralleling of asynchronous voltage sources
- Balancing commands for voltage and speed (frequency)
- Paralleling of synchronous voltage sources
- Synchro-check function for manual synchronization
- Parameter blocks for use on several synchronizing points (7VE61 max. 4 and 7VE63 max. 8)

Additional functions

- Consideration of transformer vector group and tap changer
- Synchronization record (instantaneous or r.m.s. record)
- Commissioning support (CB-time measurement, test synchronization)
- Browser operation
- Full control functionality of SIPROTEC 4
- Analog outputs of operational measured values
- Functions for protection or network decoupling tasks

Protection functions (option)

- Undervoltage protection(27)
- Overvoltage protection (59)
- Frequency protection (81)
- Rate-of-frequency-change protection (81R)
- Jump of voltage vector monitoring

Monitoring functions

- Self-supervision of paralleling function
- Operational measured values
- 8 oscillographic fault records

Communication interfaces

- System interface
  – IEC 60870-5-103
  – IEC 61850 protocol
  – PROFIBUS-DP
  – MODBUS RTU and DNP 3.0
- Service interface for DIGSI 4 (modem)
- Front interface for DIGSI 4
- Time synchronization via IRIG B/ DCF77

Application

The 7VE61 and 7VE63 paralleling devices of the SIPROTEC 4 family are multifunctional compact units used for paralleling power systems and generators.

Their technical design ensures highly reliable paralleling due to their 1½-channel or 2-channel measurement method and their hardware design. This is supported by numerous monitoring functions.

The units automatically detect the operating conditions. The response to these conditions depends on settings.

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Voltage and frequency functions ($V>$, $V<$, $f>$, $f<$ $\mathrm{d}f/\mathrm{d}t$) including voltage vector jump ($\Delta\varphi$) are optionally available for protection or network decoupling applications.

Uniform design

The SIPROTEC 4 units have a uniform design and a degree of functionality which represents a whole new quality in protection and control and automation.
Local operation has been designed according to ergonomic criteria. Large, easy-to-read displays (graphic display for 7VE63) were a major design aim. The DIGSI 4 operating program considerably simplifies planning and engineering and reduces commissioning times.

Highly reliable

The 7VE6 hardware is based on 20 years of Siemens experience with numerical protection equipment. State-of-the-art technology and a high-efficiency, 32-bit microprocessor are employed. Production is subject to exacting quality standards.

Special attention has been paid to electromagnetic compatibility, and the number of electronic modules has been drastically reduced by the use of highly integrated circuits.

The software design incorporates accumulated experience and the latest technical knowledge. Object orientation and high-level language programming, combined with the continuous quality assurance system, ensure maximized software reliability.

Programmable logic

The integrated programmable logic function allows the user to implement his own functions for automation of switchgear (interlocking) via a graphic user interface. The user can also generate user-defined messages.

Adjustments can easily be made to the varying power station requirements.

Measurement method

Powerful and successful algorithms based on years of experience have been incorporated. They ensure both a high level of measurement accuracy and effective noise signal suppression. That makes for reliable paralleling even in networks with harmonics. Complementary measurement methods avoid unwanted operation.

Design

The units are available in two designs: the ½ 19" wide 7VE61 and the ½ 19" wide 7VE63. The 7VE61 features a four-line display. The 7VE63 is equipped with a graphic display for visualization of switching states. It also has a larger number of binary inputs and outputs than the 7VE61.

Communication

Flexible and powerful communication is paramount. That is why the paralleling devices have up to five serial interfaces (for details see chapter 4 "Communication"):

– Front interface for connecting a PC
– Service interface for connecting a PC (e.g. via a modem)
– System interface for connecting to a control system via IEC 60870-5-103, IEC 61850, PROFIBUS-DP, MODBUS RTU or DNP 3.0
– Interface for an analog output module (2 – 20 mA) and an input
– For time synchronization via DCF77 or IRIG B.

Operational measured values

In order to assist system management and for commissioning purposes, relevant measured values are displayed as primary and secondary values with unit and values relating to the object to be protected.

The measured values can also be transferred via the serial interfaces.

In addition, the programmable logic permits limit value scans and status indications derived therefrom.

Metered values are available in the form of energy metered values for the active and reactive energy supplied and are also provided by an elapsed-hour meter.

Application

Indications

The SIPROTEC 4 units provide detailed data for analysis of synchronization (fault events from activated protection functions) and for checking states during operation. All indications are protected against power supply failure.

- **Synchronization indications** (Fault indications) The last eight synchronizations (faults) are stored in the unit at all times. A fresh synchronization (fault) will erase the oldest one. The fault indications have a time resolution of 1 ms. They provide detailed information on history. The buffer memory is designed for a total of 600 indications.
- **Operational indications** All indications that are not directly associated with the synchronization (fault) (e.g. operating or switching actions) are stored in the status indication buffer. The time resolution is 1 ms, buffer size: 200 indications.

Fault recording at up to 10 or 100 seconds

An instantaneous value or r.m.s. value recorder is provided. The firmware permits storage of 8 fault recordings. Triggering can be effected by the synchronization function (starting or closing command), protection function (pickup or tripping), binary input, the DIGSI 4 operating program or by the control system.

The instantaneous value recording stores the voltage input values (v_a,v_b,v_c,v_d,v_e,v_f), voltage differences (v_a-v_d,v_b-v_e, v_c-v_f), and calculated r.m.s. values ΔV, Δf, $\Delta\alpha$ at 1-ms intervals (or 0.83-ms intervals for 60 Hz). The r.m.s. values are calculated every half cycle. The total duration of the fault recording is 10 seconds. If the time is exceeded, the oldest recording is overwritten.

If you want to record for a longer period for commissioning purposes (for example, to show the effect of balancing commands), r.m.s. value recording is advisable. The relevant calculated values (V_1,V_2, f_1, f_2, ΔV, Δf, $\Delta\alpha$) are recorded at half-cycle intervals. The total duration is 100 seconds.

Time synchronization

A battery-backed clock is a standard component and can be synchronized via a synchronization signal (DCF77; IRIG B via satellite receiver), binary input, system interface or SCADA (e.g. SICAM). A date and time are assigned to every indication.

Freely assignable binary inputs and outputs

Binary inputs, output relays, and LEDs can each be given separate user-specific assignments. Assignment is effected using a software matrix, which greatly simplifies the allocation of individual signals.

To ensure dual-channel redundancy, control of the CLOSE relay (relay R1 and R2) is prioritized and should not be altered. These two relays have a special, highly reliable control and monitoring logic (see Fig. 11/89).

Continuous self-monitoring

The hardware and software are continuously monitored. If abnormal conditions are detected, the unit signals immediately. In this way, a great degree of safety, reliability and availability is achieved.

Reliable battery monitoring

The battery buffers the indications and fault recordings in the event of power supply voltage failure. Its function is checked at regular intervals by the processor. If the capacity of the battery is found to be declining, an alarm indication is generated.

All setting parameters are stored in the Flash-EPROM which are not lost if the power supply or battery fails. The SIPROTEC 4 unit remains fully functional.

Functions

Functional scope of the paralleling function

The units contain numerous individually settable functions for different applications. They cover the following operating modes:

Synchro-check

In this mode, the variables ΔV, Δf, $\Delta\alpha$ are checked. If they reach set values, a release command is issued for as long as all three conditions are met, but at least for a settable time.

Switching synchronous networks

The characteristic of synchronous networks is their identical frequency ($\Delta f \approx 0$). This state is detected, and fulfillment of the ΔV and $\Delta\alpha$ conditions is checked. If the conditions remain met for a set time, the CLOSE command is issued.

Switching asynchronous networks

This state occurs in the power system and generator (open generator circuit-breaker). A check is made for fulfillment of ΔV and Δf conditions and the connection time is calculated, taking account of $\Delta\alpha$, and the circuit-breaker making time. By means of balancing commands (for voltage and frequency), the generator can automatically be put into a synchronous condition.

Switching onto dead busbars

The voltage inputs are checked here. The CLOSE command is issued depending on the set program and the result of measurement. A three-phase connection increases reliability because several voltages must fulfill the conditions (see Fig. 11/84).

The following operating states are possible:

- $V1 < V2 >$ (connection to dead busbar (side 1))
- $V1 > V2 <$ (connection to dead line (side 2))
- $V1 < V2 <$ (forced closing)

Functions

Voltage and frequency band query

Synchronization is not activated until the set limits are reached. Then the remaining parameters (see above) are checked.

Vector group adaptation

If synchronization is effected using a transformer, the unit will take account of the phase-angle rotation of the voltage phasor in accordance with the vector group entry for the transformer. On transformers with a tap changer, the tap setting can be communicated to the unit, for example, as BCD code (implemented in the 7VE63). When using the IEC 61850 communication standard, it is possible to detect tap position indications with a bay control unit (e.g. 6MD66) and to transmit these indications via GOOSE to the 7VE6 paralleling device. Deviations from the rated transformation ratio result in the appropriate voltage amplitude adaptation.

Voltage and frequency balancing

If the synchronization conditions are not fulfilled, the unit will automatically issue balancing signals. These are the appropriate up or down commands to the voltage or speed controller (frequency controller). The balancing signals are proportional to the voltage or frequency difference, which means that if the voltage or frequency difference is substantial, longer balancing commands will be output. A set pause is allowed to elapse between balancing commands to allow the state change to settle. This method ensures rapid balancing of the generator voltage or frequency to the target conditions.

If identical frequency is detected during generator-network synchronization ("motionless synchronization phasor"), a kick pulse will put the generator out of this state.

For example, if the voltage is to be adjusted using the transformer tap changer, a defined control pulse will be issued.

Several synchronizing points

Depending on the ordered scope, several synchronization points can be operated. The data for synchronization of each circuit-breaker (synchronization function group) are stored individually. In the maximum version, the 7VE63 operates up to 8 synchronization points. Selection is made either via the binary input or the serial interface. With the CFC, it is also possible to control the connection of the measured variables or commands via a master relay.

Commissioning aids

The paralleling device is designed to be commissioned without an external tester/recorder (see Fig. 11/84). For that purpose, it contains a codeword-protected commissioning section. This can be used to measure the make time automatically with the unit (internal command issue until the CB poles are closed). This process is logged by the fault recording function.

The operational measured values also include all measured values required for commissioning. The behavior of the paralleling function or the unit is also documented in detail in the operational annunciation and synchronization annunciation buffer. The connection conditions are documented in the synchronization record. Test synchronization is also permitted. All actions inside the synchronizer are taken but the two CLOSE relays are not operated (R1 and R2). This state can also be initiated via a binary input.

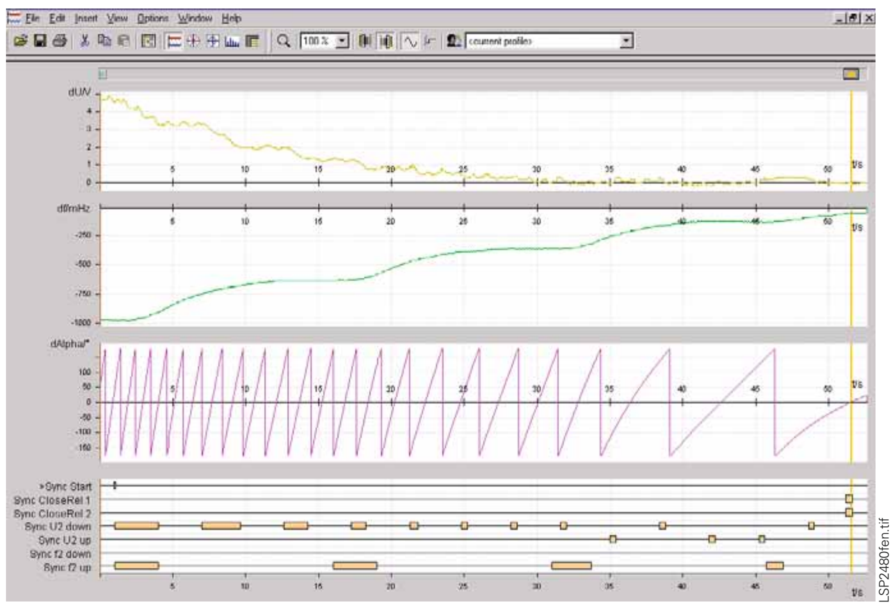


Fig. 11/84
SIGRA 4, synchronization record with balancing commands

11

Functions

Great safety and reliability due to multi-channel redundancy

Generator synchronization especially requires units in which unwanted operation can be ruled out. The paralleling device achieves this multi-channel redundancy with a two-out-of-two decision. That means that two conditions for the CLOSE command must be fulfilled. Fig. 11/85 shows the structure of the two designs.

In the 1½-channel version (7VE61), the paralleling function is the function that gives the CLOSE command. The synchro-check function acts as a release criterion with rougher monitoring limit settings. Other monitoring functions are also active at the same time (see below).

In the two-channel version (7VE63), two independent methods work in parallel. The CLOSE command is given when the two methods simultaneously decide on CLOSE. Fig. 11/86 shows the consistent implementation of dual-channel redundancy.

The measured quantities are fed to two ADCs. The second ADC processes the values rotated through 180° (e.g. $\overline{V1}$). The monitoring methods test all the transformer circuits including internal data acquisition for plausibility and they block measurement if deviations are found. The phase-sequence test detects connection errors. The measuring methods 1 and 2 include the measurement algorithms and logic functions.

In keeping with the two-channel redundancy principle, differing measurement methods are used to prevent unwanted operation due to systematic errors.

In addition, numerous methods are also active, such as closure monitoring (synchronism monitoring of both methods). Unwanted relay operation is avoided by two-channel operation of both CLOSE relays. The two measurement methods operate the transistors crossed over.

Moreover, coil operation is monitored in the background. For this purpose, transistors are activated individually and the response is fed back. Both interruptions and transistor breakdown are detected. When faults are found, the unit is blocked immediately.

The plausibility monitoring of set values (valid limits) and selection of the synchronization function groups (only one can be selected) are also supported. In the event of any deviations, messages are output and the paralleling function is blocked.

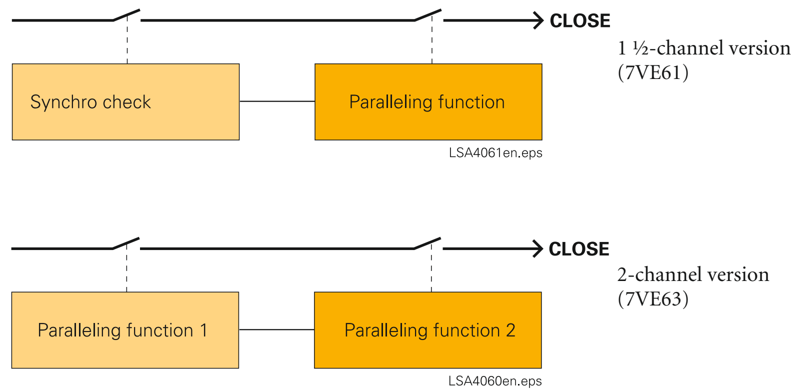


Fig. 11/86
Design of multi-channel redundancy

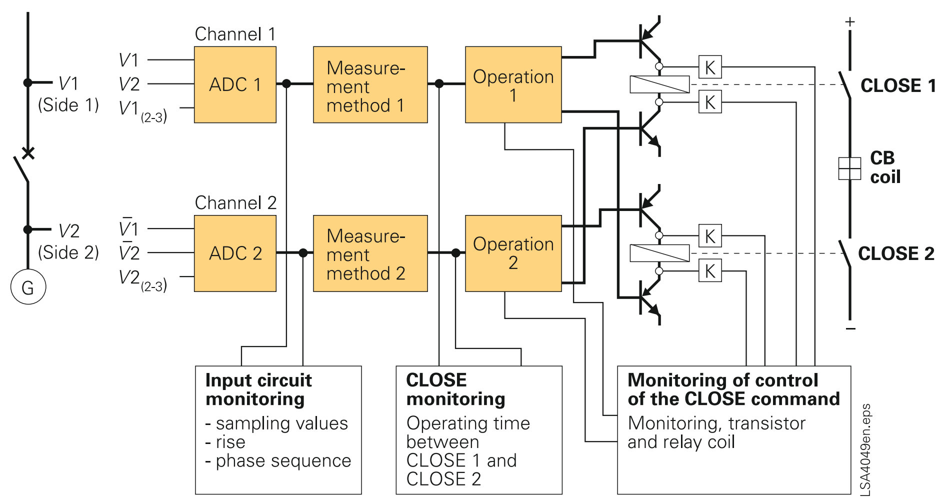


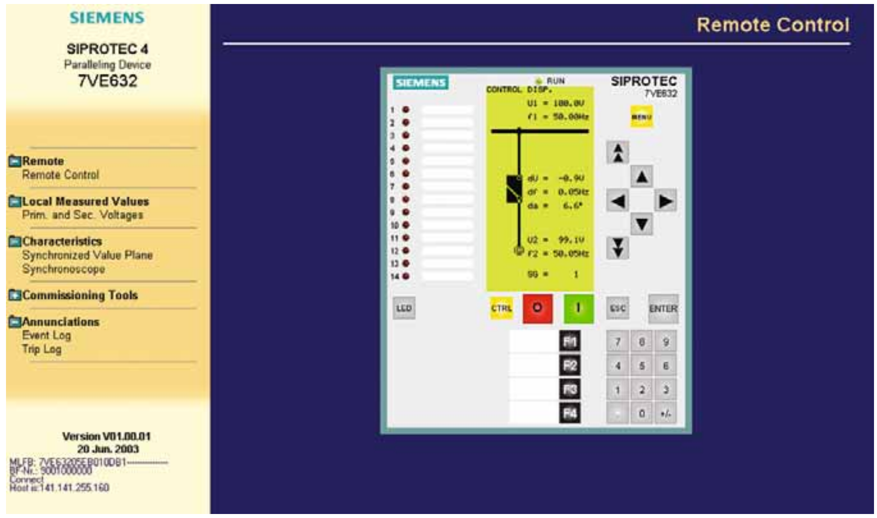
Fig. 11/85
Two-channel redundancy

11

Functions

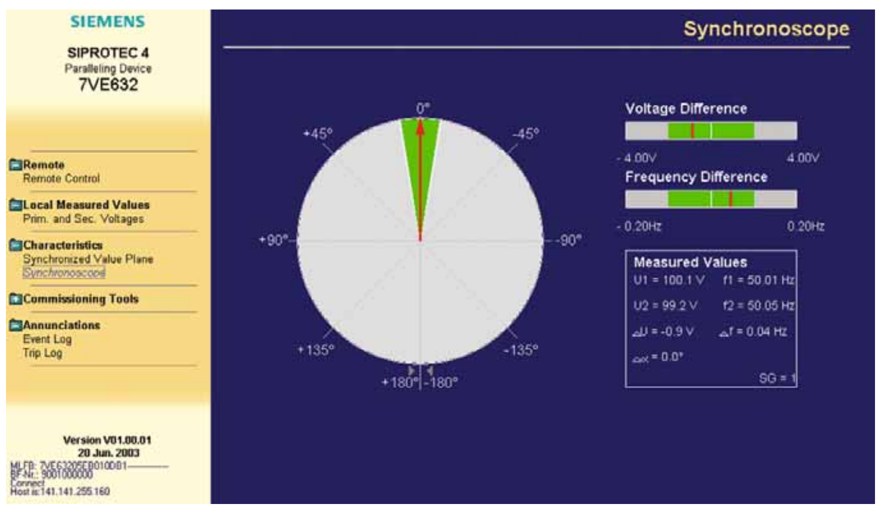
Internet technology simplifies commissioning

In addition to the universal DIGSI 4 operating program, the synchronizer contains a Web server that can be accessed via a telecommunications link using a browser (e.g. Internet Explorer). The advantage of this solution is that it is both possible to operate the unit with standard software tools and to make use of the Intranet/ Internet infrastructure. Moreover, information can be stored in the unit without any problems. In addition to numeric values, visualizations facilitate work with the unit. In particular, graphical displays provide clear information and a high degree of operating reliability. Fig. 11/88 shows an example of an overview that is familiar from conventional synchronizers. The current status of synchronization conditions is clearly visible. Of course, it is possible to call up further measured value displays and annunciation buffers. By emulation of integrated unit operation, it is also possible to adjust selected settings for commissioning purposes, (see Fig. 11/87).



LSP2481fen.tif

Fig. 11/87
Browser-based operation



LSP2482fen.tif

Fig. 11/88
Overview display of the synchronization function

11

Functions

Protection and automation functions

Basic concept

The paralleling function is not performed constantly. Therefore the measured quantities provided at the analog inputs are available for other functions. Voltage and frequency protection or limit value monitoring of these quantities are typical applications. Another possible application is network decoupling. After network disconnection, automatic resynchronization using the CFC is possible on request.
To allow for great flexibility, these functions can be assigned to the analog inputs. This is defined for the specific application.

Undervoltage protection (ANSI 27)

The protection function is implemented on two stages and evaluates the voltage at an input assigned to it. Analysis of a phase-to-phase voltage is beneficial as it avoids starting in the event of earth faults. The protection function can be used for monitoring and decoupling purposes or to prevent voltage-induced instability of generators by disconnection.

Overvoltage protection (ANSI 59)

The protection function is implemented on two stages and evaluates the voltage at an input assigned to it.
The overvoltage protection prevents impermissible stress on equipment due to excessive voltages.

Frequency protection (ANSI 81)

The protection function is implemented on four stages and evaluates the frequency of an input assigned to it. Depending on the frequency threshold setting, the function can provide overfrequency protection (setting $> f_n$) or underfrequency protection (setting $< f_n$. Each stage can be delayed separately. Stage 4 can be configured either as an overfrequency or underfrequency stage.

The application consists of frequency monitoring usually causing network disconnection in the event of any deviations. The function is suitable as a load shedding criterion.

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

This function can also be assigned to an input. 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 to react 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.

This function is used for fast load shedding or for network decoupling.

Jump of voltage vector monitoring

Smaller generating plants frequently require the vector jump function. With this criterion it is possible to detect a disconnected supply (e.g. due to the dead time during an automatic reclosure) and initiate generator disconnection. This avoids impermissible loads on the generating plant, especially the drive gearing, if reconnection to the network is asynchronous.

The vector jump function monitors the phase angle change in the voltage.

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.

Vector jump monitoring is performed again for the assigned voltage input. This function is blocked during synchronization.

Threshold monitoring

The threshold function is provided for fast monitoring and further processing in the CFC. Optional monitoring of the calculated voltage (for violation of an upper or lower threshold) at the six voltage inputs is possible. A total of three greater-than and three less-than thresholds are available. The check is made once per cycle, resulting in a minimum operating time of about 30 ms for the voltage. The times can be extended by the internal check time, if necessary (about 1 cycle).

Typical applications

Connection to three-phase voltage transformer

If three-phase voltage transformers are available, connection as shown in Fig. 11/89 is recommended. This is the standard circuit because it provides a high level of reliability for the paralleling function. The phase-sequence test is additionally active, and several voltages are checked on connection to a dead busbar. Interruption in the voltage connection does not lead to unwanted operation. Please note that side 1 (that is, V_1) is always the feed side. That is important for the direction of balancing commands.

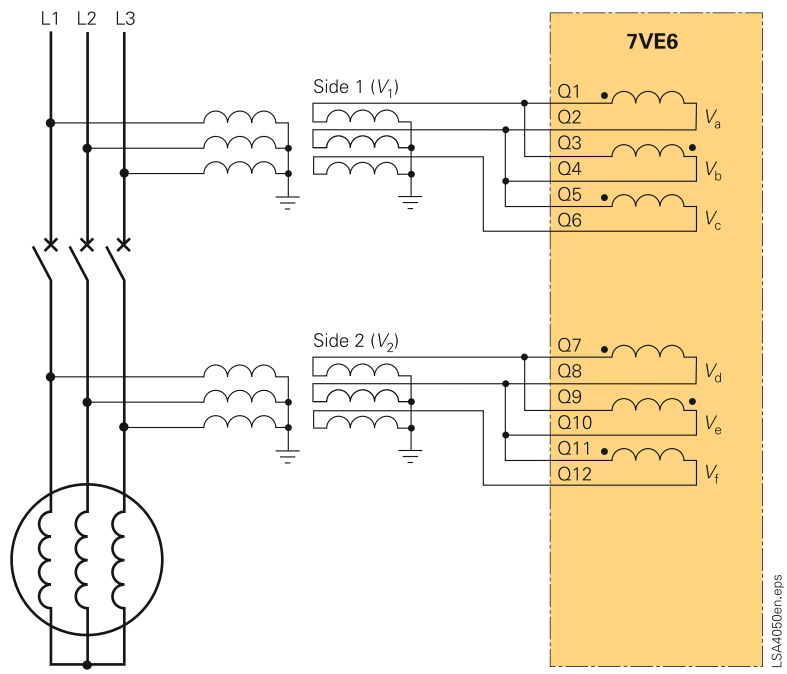


Fig. 11/89

Connection to open delta connection (V-connection) voltage transformer

Fig. 11/90 shows an alternative to Fig. 11/89 for substations in which the voltage transformers have to be V-connected. For the paralleling device, this connection is the electrical equivalent of the connection described above. It is also possible to combine the two: three one-pole isolated voltage transformers on one side and the V-connection on the other. If, additionally, a synchroscope is connected, it must be electrically isolated by means of an interposing transformer.

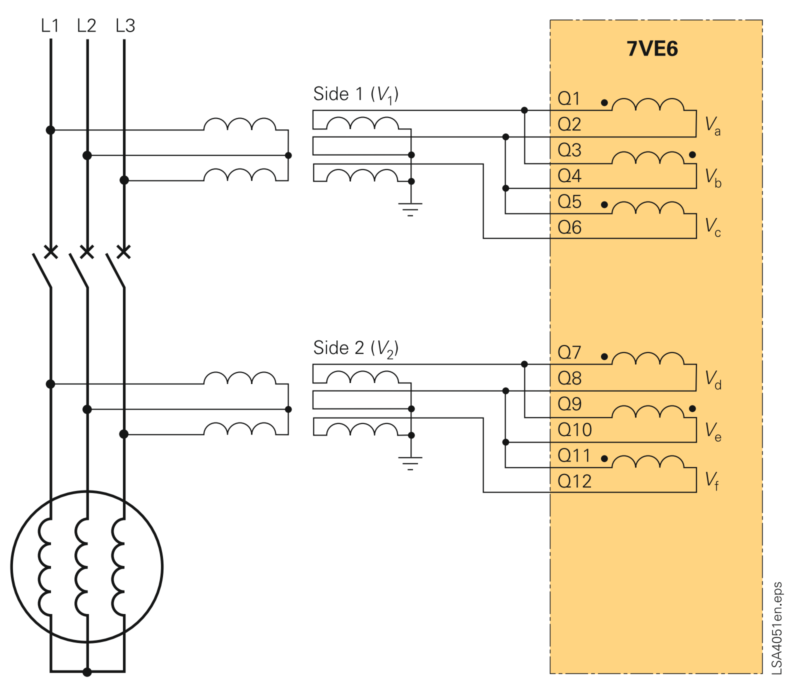


Fig. 11/90

Typical applications

Connection to unearthed voltage transformer

To save costs for the voltage transformer, two-phase isolated voltage transformers are used that are connected to the phase-to-phase voltage (see Fig. 11/91). In that case, the phase-rotation supervision is inactive and reliability restrictions when connecting to the dead busbar must be accepted.

Full two-channel redundancy is ensured.

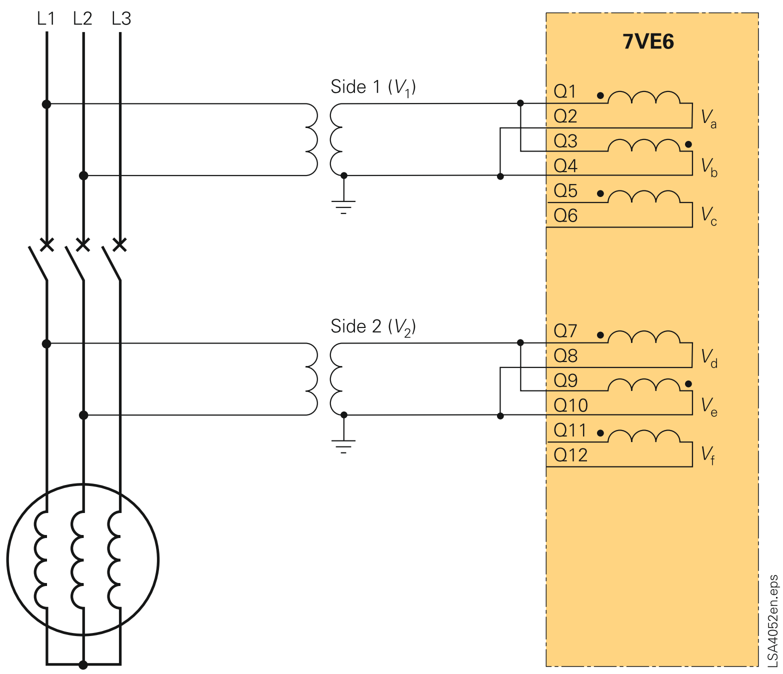


Fig. 11/91

Connection to single-phase isolated voltage transformer

As an alternative to Fig. 11/91, some substations use single-phase isolated voltage transformers (see Fig. 11/92). In this case, only a phase-to-earth voltage is available. This connection should be avoided if possible. Especially in isolated or resonant-(star point) neutral-earthed networks, an earth fault would lead to a voltage value of zero. That does not permit synchronization and the busbar is detected as dead.
If V_1 < and V_2 > connection is permitted, there is a high risk of incorrect synchronization. Furthermore, an earth fault in phase L2 leads to an angle rotation of – for instance – 30° in phase L1. This means that the device switches at a large fault angle.

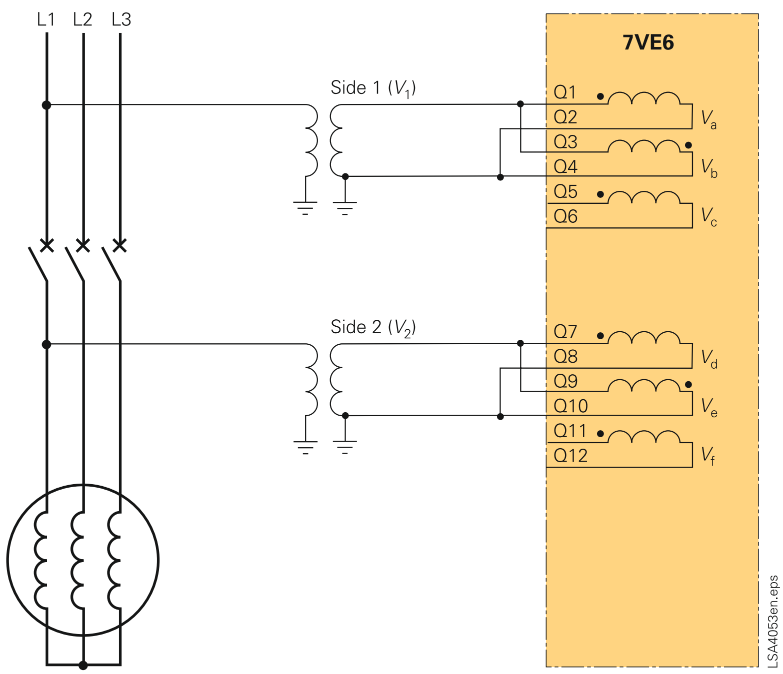


Fig. 11/92

11

Typical applications

Switching in 16.7 Hz networks for application in traction systems

The unit can also be used for synchronizing railway networks or generators. The connection has to be executed according to Fig. 11/93. No phase sequence test is available here. Two-channel redundancy is ensured.

The voltage inputs permit the application of the 16.7 Hz frequency without any difficulties.

On connection to a dead busbar, a broken wire in the external voltage transformer circuit is not detected. It is recommended to make another interrogation of a second voltage transformer.

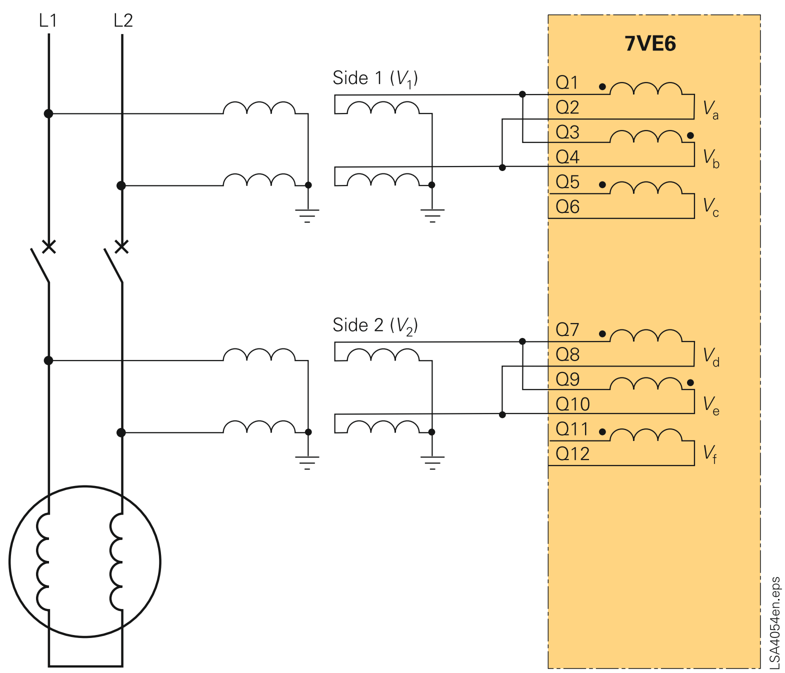


Fig. 11/93

11

Typical applications

Synchro-check for several synchronizing points

To avoid unwanted operation during manual synchronization or during connection of circuit-breakers in the network, the synchro-check function is used as an enabling criterion. It is fully compatible with all of the connections described above (see Figs. 11/89 to 11/93). With the "synchro-check" ordering option, the paralleling device also allows up to three circuit-breakers to be monitored in parallel. That saves wiring, switching and testing. In particular, that is an application for the 1½ circuit-breaker method. Moreover, on smaller generating plants one unit can be used for up to three generators, which helps reduce costs.

The connection shown in Fig. 11/94 is a single-pole version, which is acceptable for the synchro-check function.

An alternative is the connection for two switching devices (see Fig. 11/95).

The two free voltage inputs can be used for monitoring purposes.

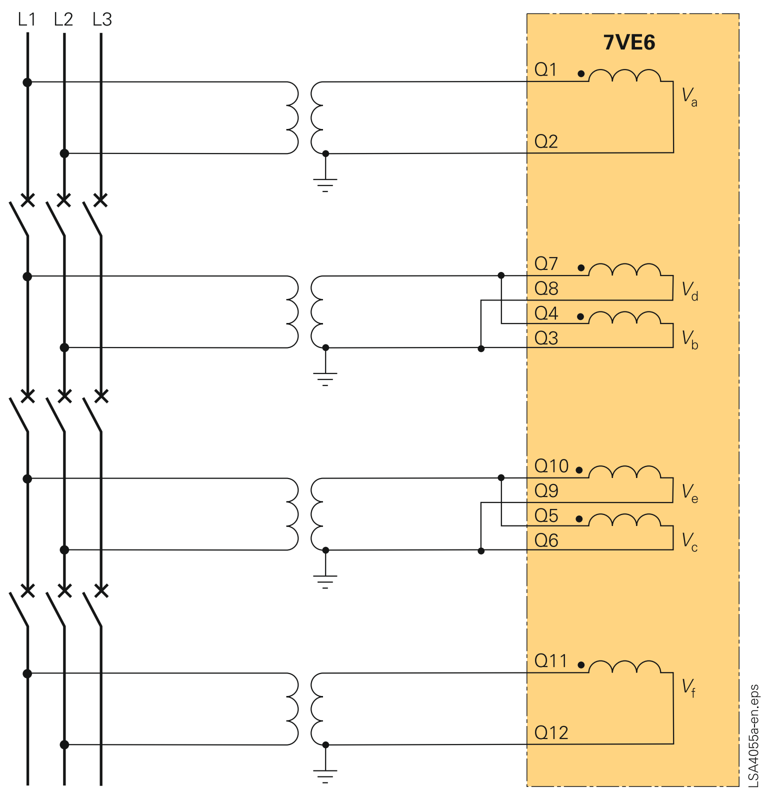


Fig. 11/94

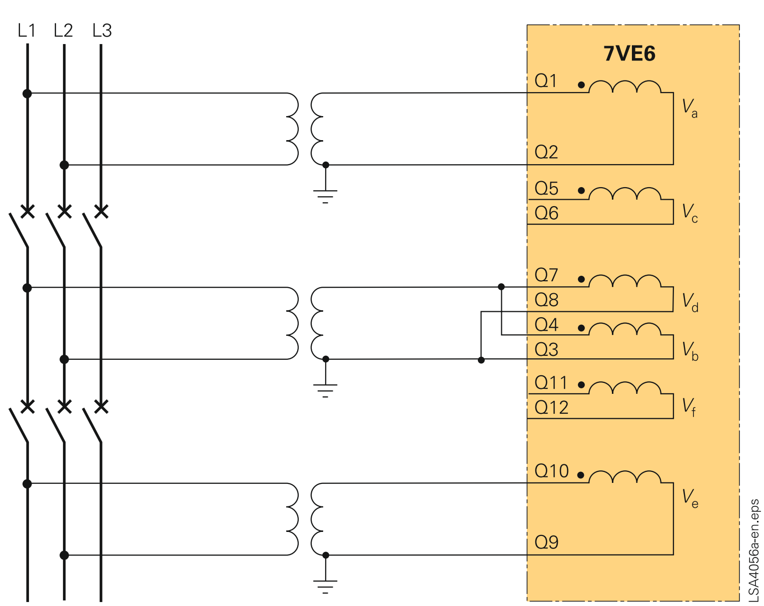


Fig. 11/95

Typical applications

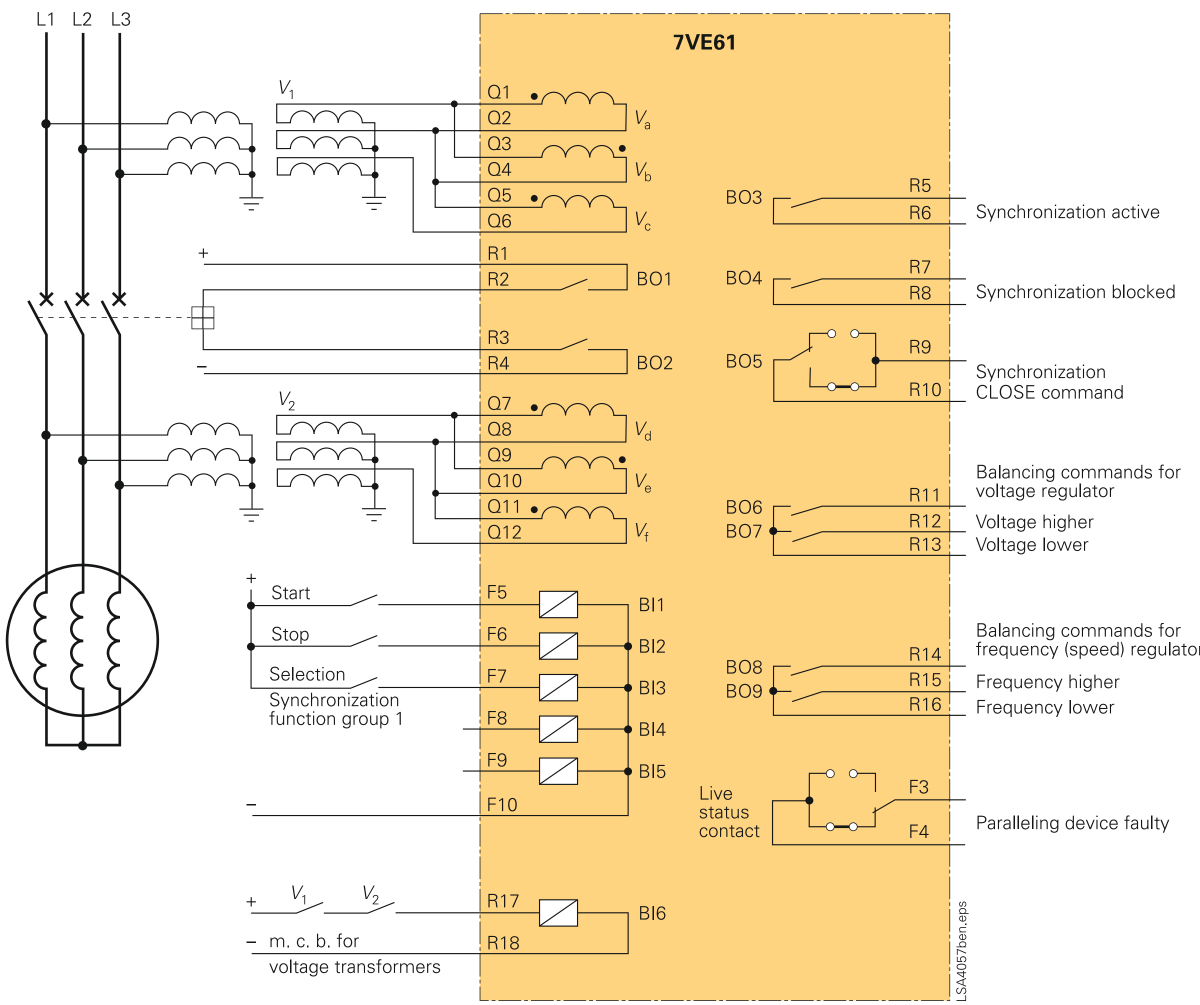


Fig. 11/96

11

Synchronization of a generator

Fig. 11/96 shows an example of the 7VE61 paralleling device connected to a medium-power generator. Where three-phase voltage transformers are available, direct connection is recommended. The synchronization point and start of synchronization is selected via the binary inputs. If cancellation is necessary, the stop input must be used.

If synchronization onto a dead busbar is permitted, the alarm contact of the voltage transformer miniature circuit-breakers (m.c.b.) must be connected to the unit.

Relays R1 and R2 are used for a CLOSE command. The other relays are used for selected indications and for the balancing commands.

The live status contact operated by the unit self-supervision function must also be wired.

Technical data

Hardware	
Analog inputs	
Rated frequency	50, 60 or 16.7 Hz
Rated voltage V_N	100 to 125 V
Power consumption Voltage inputs (at 100 V)	 Approx. 0.3 VA
Capability in voltage paths	230 V continuous
Auxiliary voltage	
Rated auxiliary voltage	24 to 48 V DC 60 to 125 V DC 110 to 250 V DC 220 to 250 V DC 115 and 230 V AC (50/60 Hz)
Permitted tolerance	-20 to +20 %
Superimposed AC voltage (peak-to-peak)	≤ 15 %
Power consumption Quiescent 7VE61 7VE63 Energized 7VE61 7VE63	 Approx. 4 W Approx. 5.5 W Approx. 9.5 W Approx. 12 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	
Quantity 7VE61 7VE63	 6 14
3 pickup thresholds Range is settable with jumpers	14 to 19 V DC, 66 to 88 V DC; 117 to 176 V DC
Maximum permissible voltage	300 V DC
Current consumption, energized	Approx. 1.8 mA
Output relays	
Quantity 7VE61 7VE62 7VE61+7VE63	 9 (each with 1 NO; 1 optional as NC, via jumper) 17 (each with 1 NO; 2 optional as NC, via jumper) 1 live status contact (NC, NO via jumper)
Switching capacity Make Break Break (for resistive load) Break (for L/R ≤ 50 ms)	 1000 W / VA 30 VA 40 W 25 W
Switching voltage	250 V
Permissible current	5 A continuous 30 A for 0.5 seconds
LEDs	
Quantity RUN (green) ERROR (red) Assignable LED (red) 7VE61 7VE63	 1 1 7 14

Unit design	
7XP20 housing	For dimensions see dimension drawings part 15
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 7VE61 (½ x 19“) 7VE63 (½ x 19“) Surface-mounting housing 7VE61 (½ x 19”) 7VE63 (½ x 19”)	 Approx. 5.2 kg Approx. 7 kg Approx. 9.2 kg Approx. 12 kg

Serial interfaces	
Operating interface for DIGSI 4	
Connection	Non-isolated, RS232, front panel; 9-pin subminiature connector (SUB-D)
Baud rate	4800 to 115,200 baud
Time synchronization IRIG-B / DCF77 signal (Format: IRIG B000)	
Connection	9-pin subminiature connector, (SUB-D), terminal with surface-mounting case
Voltage levels	Selectable 5, 12 or 24 V
Service / modem interface (Port C) for DIGSI 4 / modem / service	
Isolated RS232/RS485 Test voltage Distance for RS232 Distance for RS485	9-pin subminiature connector (SUB-D) 500 V / 50 Hz Max. 15 m Max. 1000 m
System interface (Port B) *IEC 60870-5-103 protocol, PROFIBUS-DP, MODBUS RTU, DNP 3.0)* ***and interface (Port D)***	
Isolated RS232/RS485 Baud rate Test voltage Distance for RS232 Distance for RS485	9-pin subminiature connector (SUB-D) 4800 to 115200 Baud 500 V / 50 Hz Max. 15 m Max. 1000 m
RS485: PROFIBUS-DP, MODBUS RTU, DNP 3.0 Test voltage	9-pin subminiature connector (SUB-D) 500 V / 50 Hz
Baud rate PROFIBUS-DP MODBUS RTU, DNP 3.0	 Max. 12 MBaud Max. 19200 Baud
Distance PROFIBUS-DP MODBUS RTU, DNP 3.0	 Max. 1000 m with 93.75 kBaud; Max. 100 m with 12 MBaud 1000 m
Fiber optic: IEC, PROFIBUS-DP, MODBUS RTU, DNP 3.0 PROFIBUS-DP IEC, MODBUS RTU, DNP 3.0 Baud rate PROFIBUS-DP MODBUS RTU, DNP 3.0	ST connector Double ring Point-to-point Max. 1.5 MBaud Max. 19200 Baud
Optical wavelength	λ = 820 nm
Permissible path attenuation	Max. 8 dB, for glass-fiber 62.5/125 µm
Distance	Max. 1.5 km
Analog output module (electrical)	2 ports with 0 to +20 mA

11

Technical data

System interface (Port B) ***IEC 61850***	
Ethernet, electrical (EN 100) for IEC 61850 and DIGSI	
Connection	
for flush-mounting case	Rear panel, mounting location "B", two RJ45 connector, 100 Mbit/s acc. to IEEE802.3
for surface-mounting case	At bottom part of the housing
Test voltage	500 V; 50 Hz
Transmission speed	100 Mbits/s
Distance	20 m/66 ft
Ethernet, optical (EN 100) for IEC 61850 and DIGSI	
Connection	
for flush-mounting case	Rear panel, mounting location "B", LC connector receiver/transmitter
for panel surface-mounting case	Not available
Optical wavelength	λ = 1350 nm
Transmission speed	100 Mbits/s
Laser class 1 acc. to EN 60825-1/-2	Glass fiber 50/125 µm or glass fiber 62/125 µm
Permissible path attenuation	Max. 5 dB for glass fiber 62.5/125µm
Distance	Max. 800 m/0.5 mile

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
Insulating 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	3.5 kV DC
Voltage test (100 % test) only isolated 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 DIN 57435 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
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 test)	
Standard	EN 50081-1 (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	
<u>During operation</u>	
Standards	IEC 60255-21 and IEC 60068
Vibration IEC 60255-21-1, class II 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 I IEC 60068-2-27	Half-sinusoidal Acceleration 5 *g*, duration 11 ms, 3 shocks each in both directions of the 3 axes

11

Technical data

Seismic vibration IEC 60255-21-2, class I IEC 60068-3-3	Sinusoidal 1 to 8 Hz: ± 3.5 mm amplitude (horizontal axis) 1 to 8 Hz: ± 1.5 mm amplitude (vertical axis) 8 to 35 Hz: 1 *g* acceleration (horizontal axis) 8 to 35 Hz: 0.5 *g* acceleration (vertical axis) 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 II 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 I 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 I IEC 60068-2-29	Half-sinusoidal Acceleration 10 *g*, duration 16 ms, 1000 shocks in both directions of the 3 axes

Climatic stress test	
Temperatures	
Standards	IEC 60068-2-1, IEC 60068-2-2
Recommended operating limiting temperature	–5 °C to +55 °C / +25 °F to +131 °F
Temporarily permissible operating temperature	-20 to +70 °C (Legibility of display may be impaired above +55 °C / +131 °F)
Limiting temperature during permanent storage (with supplied packing)	–25 °C to +55 °C / –13 °F to +131 °F
Limiting temperature during transport (with supplied packing)	–25 °C to +70 °C / –13 °F to +158 °F
Humidity	
Standards	IEC 60068-2-3
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	25 to 75 Hz (f_N = 50 Hz) 30 to 90 Hz (f_N = 60 Hz) 8.35 to 25 Hz (f_N = 16.7 Hz)

Paralleling function *(ANSI 25)*	
Setting ranges	
Upper voltage limit V_{max}	20 to 140 V (steps 1 V)
Lower voltage limit V_{min}	20 to 125 V (steps 1 V)
$V <$ for de-eergized status	1 to 60 V (steps 1 V)
$V >$ for energized status	20 to 140 V (steps 1 V)
Voltage difference ΔV	0 to 40 V (steps 1 V)
Frequency difference Δf	0 to 2 Hz (steps 0.01 Hz)
Angle difference $\Delta\alpha$	2 to 80° (steps 1°)
Changeover threshold asynchronous – synchronous	0.01 to 0.04 Hz (steps 0.01 Hz)
Angle correction of vector group	0 to 359° (steps 1°)
Matching voltage transformer V_1/V_2	0.5 to 2 (steps 0.01)
Circuit-breaker making time	10 to 1000 ms (steps 1 ms)
Operating time of circuit-breaker	0.01 to 10 s (steps 0.01 s)
Max. operating time after start	0.01 to 1200 s (steps 0.01 s)
Monitoring time of voltage	0 to 60 s (steps 0.1 s)
Release delay	0 to 60 s (steps 0.01 s)
Synchronous switching	0 to 60 s (steps 0.01 s)
Times	
Minimum measuring time	Approx. 80 ms (50/60 Hz) Approx. 240 ms (16.7 Hz)
Drop-off	
Drop-off ratio voltage	Approx. 0.9 ($V >$) or 1 ($V <$)
Drop-off difference frequency	20 mHz
Drop-off difference phase angle	1 °
Tolerance	
Voltage measurement	1 % of pickup value or 0.5 V
Voltage difference ΔV	1 % of pickup value or max. 0.5 V (typical < 0.2 V)
Frequency difference Δf	< 10 mHz (synchronous network) < 15 mHz (asynchronous network)
Angle difference $\Delta\alpha$	0.5° with minor slip and approx. rated frequency 3° for $\Delta f < 1$ Hz, 5° for $\Delta f > 1$ Hz
Delay times	1 % or 10 ms
Readjustment commands for synchronization	
Frequency balancing	
Minimum control pulse	10 to 1000 ms (steps 1 ms)
Maximum control pulse	1 to 32 s (steps 0.01 s)
Frequency change of controller	0.05 to 5 Hz/s (steps 0.01 Hz/s)
Setting time of controller	0 to 32 s (steps 0.01 s)
Target value for frequency balancing	-1 to 1 Hz (steps 0.01 Hz)
Kick pulse	Available
Voltage balancing	
Minimum control pulse	10 to 1000 ms (steps 1 ms)
Maximum control pulse	1 to 32 s (steps 0.01 s)
Voltage change of controller	0.1 to 50 V/s (steps 0.1 V/s)
Setting time of controller	0 to 32 s (steps 0.01 s)
Permissible overexcitation $(V/V_N)/(f/f_N)$	1 to 1.4 (steps 0.01)
Tolerances	
Minimum control pulse	1 %
Control times	Approx. 5 % or ± 20 ms
Undervoltage protection *(ANSI 27)*	
Setting range	
Undervoltage pickup $V <, V <<$	10 to 125 V (steps 0.1 V)
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Times	
Pickup times $V <, V <<$	Approx. 50 ms (150 ms at 16.7 Hz)
Drop-off times $V <, V <<$	Approx. 50 ms (150 ms at 16.7 Hz)
Drop-off ratio $V <, V <<$	1.01 to 1.10 (steps 0.01)
Tolerances	
Voltage limit values	1 % of set value or 0.5 V
Time delays T	1 % or 10 ms

Technical data

Overvoltage protection *(ANSI 59)*	
Setting ranges	
Overvoltage pickup $V>$, $V>>$	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 (150 ms at 16.7 Hz)
Drop-off times $V>$, $V>>$	Approx. 50 ms (150 ms at 16.7 Hz)
Drop-off ratio $V>$, $V>>$	0.90 to 0.99 (steps 0.01)
Tolerances	
Voltage limit values	1 % of set value or 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 $V<$	10 to 125 V (steps 0.1 V)
Times	
Pickup times $f>$, $f<$	Approx. 100 ms (300 ms at 16.7 Hz)
Drop-off times $f>$, $f<$	Approx. 100 ms (300 ms at 16.7 Hz)
Drop-off difference Δf	Approx. 20 mHz
Drop-off ratio $V<$	Approx. 1.05
Tolerances	
Frequencies	10 mHz at $f = f_N$
Undervoltage blocking	1 % of set value or 0.5 V
Time delays T	1 % or 10 ms

Rate-of-frequency-change protection *(ANSI 81R)*	
Setting ranges	
Steps, selectable $+df/dt >$; $- df/dt$	4
Pickup value df/dt	0.1 to 10 Hz/s (steps 0.1 Hz/s);
Time delays T	0 to 60 s (steps 0.01 s) or indefinite
Undervoltage blocking $V<$	10 to 125 V (steps 0.1 V)
Times	
Pickup times df/dt	Approx. 200 to 700 ms
at 16.7 Hz: times x 3	(depending on measuring duration)
Drop-off times df/dt	Approx. 200 to 700 ms
at 16.7 Hz: times x 3	(depending on measuring duration)
Drop-off ratio df/dt	0.02 at 0.99 Hz/s (settable)
Drop-off ratio $V <$	Approx. 1.05
Tolerances	
Rate-of-frequency change	Approx. 0.1 Hz/s at $V > 0.5\ V_N$
Measuring duration < 5	Approx. 5 % or 0.15 Hz/s at $V > 0.5\ V_N$
Measuring duration > 5	Approx. 3 % or 0.15 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

Jump of voltage vector monitoring	
Setting ranges	
Stage $\Delta\varphi$	2° to 30° (steps 0.1°)
Time delay T	0 to 60 s (steps 0.01 s) or indefinite
Undervoltage blocking $V<$	10 to 125 V (steps 0.1 V)
Maximum voltage	10 to 170 V (steps 0.1 V)
Times	
Pickup times $\Delta\varphi$	Approx. 75 ms (225 ms at 16.7 Hz)
Drop-off times $\Delta\varphi$	Approx. 75 ms (225 ms at 16.7 Hz)
Tolerances	
Vector jump	0.5° at $V > 0.5\ V_N$
Undervoltage blocking	1 % of set value or 0.5 V
Time delay T	1 % or 10 ms

External trip coupling	
Number of external trip couplings	4

Threshold value supervision	
Number of steps	6 (3 larger and 3 smaller)
Measured quantity	V_a, V_b, V_c, V_d, V_e, V_f
Setting ranges	2 to + 200 % (steps 1 %)
Times	
Pickup times	Approx. 50 ms (150 ms at 16.7 Hz)
Drop-off times	Approx. 50 ms (150 ms at 16.7 Hz)
Drop-off ratio	0.95
Voltage tolerance	1 % of set value or 0.5 V

Typical operational measured values	
Description	Secondary
Voltages	V_a; V_b; V_c; V_d; V_e; V_f; V_1, V_2, ΔV
Tolerance	0.2 % of measured value or ± 0.2 V ± 1 digit
Phase angle	$\Delta\alpha$
Tolerance	< 0.5°
Frequency	f_1, f_2, Δf
Tolerance	10 mHz at $f = f_N$ 15 mHz at $f = f_N \pm 10$ %

Fault records	
Number of fault records	Max. 8 fault records
Instantaneous values	
Storage time	Max. 10 s
Sampling interval	Depending on the actual frequency (e. g. 1 ms at 50 Hz; 0.83 ms at 60 Hz)
Channels	V_a, V_b, V_c, V_d, V_e, V_f, V_d-V_a, V_e-V_b, V_f-V_c, ΔV, Δf, $\Delta\alpha$
R.m.s. values	
Storage period	Max. 100 s
Sampling interval	Fixed (10 ms at 50 Hz, 8.33 ms at 60 Hz)
Channels	V_1, V_2, f_1, f_2, ΔV, Δf, $\Delta\alpha$

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
Switching statistics	Number of break operations Number of make operations

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 89/336/EEC) and electrical equipment designed for use within certain voltage limits (Council Directive 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
7VE61 multifunction paralleling unit *Housing 1/3 19", 6 BI, 9 BO, 1 live status contact*	7VE6110-□□□□□-0□□□	□□□

Auxiliary voltage (power supply, indication voltage)

Description	Order No.	Order code
24 to 48 V DC , threshold binary input 19 V	2	
60 to 125 V DC, threshold binary input 19 V	4	
110 to 250 V DC, 115 to 230 V AC, threshold binary input 88 V DC	5	
220 to 250 V DC, 115 to 230 V AC, threshold binary input 176 V DC	6	

Unit design

Description	Order No.	Order code
Surface-mounting housing, 2-tier screw-type terminals at top/bottom	B	
Flush-mounting housing, screw-type terminals (direct connection/ring-type cable lugs)	E	

Region-specific default setting/function and language settings

Description	Order No.	Order code
Region DE, 50 Hz, language German (language selectable)	A	
Region World, 50/60 Hz, language English (GB) (language selectable)	B	
Region US, 60 Hz, language English (US) (language selectable)	C	
Region World, 50/60 Hz, language Spanish (language selectable)	E	

Port B (system interface)

Description	Order No.	Order code
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	
Analog outputs 2 x 0 to 20 mA or 4 to 20 mA	7	
PROFIBUS-DP Slave, electrical RS485	9	L 0 A
PROFIBUS-DP Slave, optical 820 nm, double ring, ST connector 1)	9	L 0 B
MODBUS RTU, electrical RS485	9	L 0 D
MODBUS RTU, optical 820 nm, ST connector 1)	9	L 0 E
DNP 3.0, electrical RS485	9	L 0 G
DNP 3.0, optical 820 nm, ST connector 1)	9	L 0 H
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connectors	9	L 0 R
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector 2)	9	L 0 S

Port C (service interface)

Description	Order No.	Order code
DIGSI 4/modem, electrical RS232	1	
DIGSI 4/modem, electrical RS485	2	

Port C (service interface) and Port D (additional interface)

Port C (service interface)

Description	Order No.	Order code
DIGSI 4/modem, electrical RS232	9	M 1 □
DIGSI 4/modem, electrical RS485	9	M 2 □

Port D (additional interface)

Description	Order No.	Order code
Analog outputs 2 x 0 to 20 mA or 4 to20 mA		K

Scope of functions of the unit

Description	Order No.	Order code
Synchro-check for up to 3 synchronizing points (with dead bus/line monitoring)	A	
Paralleling function for 2 synchronizing points without balancing commands, 1½-channel, synchro-check in 2nd channel	B	
Paralleling function for 2 synchronizing points with balancing commands, 1½-channel, synchro-check in 2nd channel	C	
Paralleling function for 4 synchronizing points with balancing commands, 1½-channel, synchro-check in 2nd channel	D	

Additional functions

Description	Order No.	Order code
Without	A	
Protection and network decoupling function (voltage, frequency and rate-of-frequency-change protection, vector jump)	B	

Additional applications

Description	Order No.	Order code
Without	0	
Application for traction systems (f_n = 16.7 Hz)	1	

1) With position 9 = B (surface-mounting housing) the unit must be ordered with RS485 interface and a separate FO converter.

2) Not available with position 9 = "B"

Selection and ordering data

Description	Order No.	Order code
7VE63 multifunction paralleling unit *Housing 1/2 19", 14 BI, 17 BO,1 live status contact*	*7VE6320-□□□□□-0□□□*	*□□□*
Auxiliary voltage (power supply, indication voltage)		
24 to 48 V DC , threshold binary input 19 V DC	*2*	
60 to 125 V DC, threshold binary input 19 V DC	*4*	
110 to 250 V DC, 115 to 230 V AC, threshold binary input 88 V DC	*5*	
220 to 250 V DC, 115 to 230 V AC, threshold binary input 176 V DC	*6*	
Unit design		
Surface-mounting housing, 2-tier screw-type terminals at top/bottom	*B*	
Flush-mounting housing, screw-type terminals (direct connection/ring-type cable lugs)	*E*	
Region-specific default setting/function and language settings		
Region DE, 50 Hz, language German (language selectable)	*A*	
Region World, 50/60 Hz, language English (GB) (language selectable)	*B*	
Region US, 60 Hz, language English (US) (language selectable)	*C*	
Region World, 50/60 Hz, language Spanish (language selectable)	*E*	
Port B (system interface)		
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*	
Analog outputs 2 x 0 to 20 mA or 4 to 20 mA	*7*	
PROFIBUS-DP Slave, electrical RS485	*9*	*L 0 A*
PROFIBUS-DP Slave, optical 820 nm, double ring, ST connector [1)]	*9*	*L 0 B*
MODBUS RTU, electrical RS485	*9*	*L 0 D*
MODBUS RTU, optical 820 nm, ST connector [1)]	*9*	*L 0 E*
DNP 3.0, electrical RS485	*9*	*L 0 G*
DNP 3.0, optical 820 nm, ST connector [1)]	*9*	*L 0 H*
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connectors	*9*	*L 0 R*
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector[2)]	*9*	*L 0 S*
Port C (service interface)		
DIGSI 4/modem, electrical RS232	*1*	
DIGSI 4/modem, electrical RS485	*2*	
Port C (service interface) and Port D (additional interface)		
Port C (service interface)		
DIGSI 4/modem, electrical RS232	*9*	*M 1 □*
DIGSI 4/modem, electrical RS485	*9*	*M 2 □*
Port D (additional interface)		
Analog outputs 2 x 0 to 20 mA or 4 to 20 mA		*K*
Scope of functions of the unit		
Synchro-check for up to 3 synchronizing points (with dead bus/line monitoring)	*A*	
Paralleling function for 2 synchronizing points without balancing commands, 2-channel, independent measuring procedures	*B*	
Paralleling function for 2 synchronizing points with balancing commands, 2-channel , independent measuring procedures	*C*	
Paralleling function for 8 synchronizing points with balancing commands, 2-channel, independent measuring procedures	*D*	
Additional functions		
Without	*A*	
Protection and network decoupling function (voltage, frequency and rate-of-frequency-change protection, vector jump)	*B*	
Additional applications		
Without	*0*	
Application for traction systems (f_n = 16.7 Hz)	*1*	

1) With position 9 = *B* (surface-mounting housing) the unit must be ordered with RS485 interface and a separate FO converter.

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

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 Basis and all optional packages on CD-ROM, DIGSI 4 and DIGSI 3	*7XS5402-0AA00*
Copper 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*
Manual 7VE61 and 7VE63 Multifunction Paralleling Device	*C53000-G1176-C163-1*

Fig. 11/97
Short-circuit links for voltage contacts

Fig. 11/98
Mounting rail for 19" rack

Description		Order No.	Size of package	Supplier
Crimp connector	CI2 0.5 to 1 mm^2	*0-827039-1*	4000	AMP [1]
		0-827396-1	1	AMP [1]
	CI2 1 to 2.5 mm^2	*0-827040-1*	4000	AMP [1]
		0-827397-1	1	AMP [1]
	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
Short-circuit links	For voltage terminals	*C73334-A1-C34-1*	1	Siemens
Safety cover for terminals	large	*C73334-A1-C31-1*	1	Siemens
	small	*C73334-A1-C32-1*	1	Siemens

11

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

Connection diagram

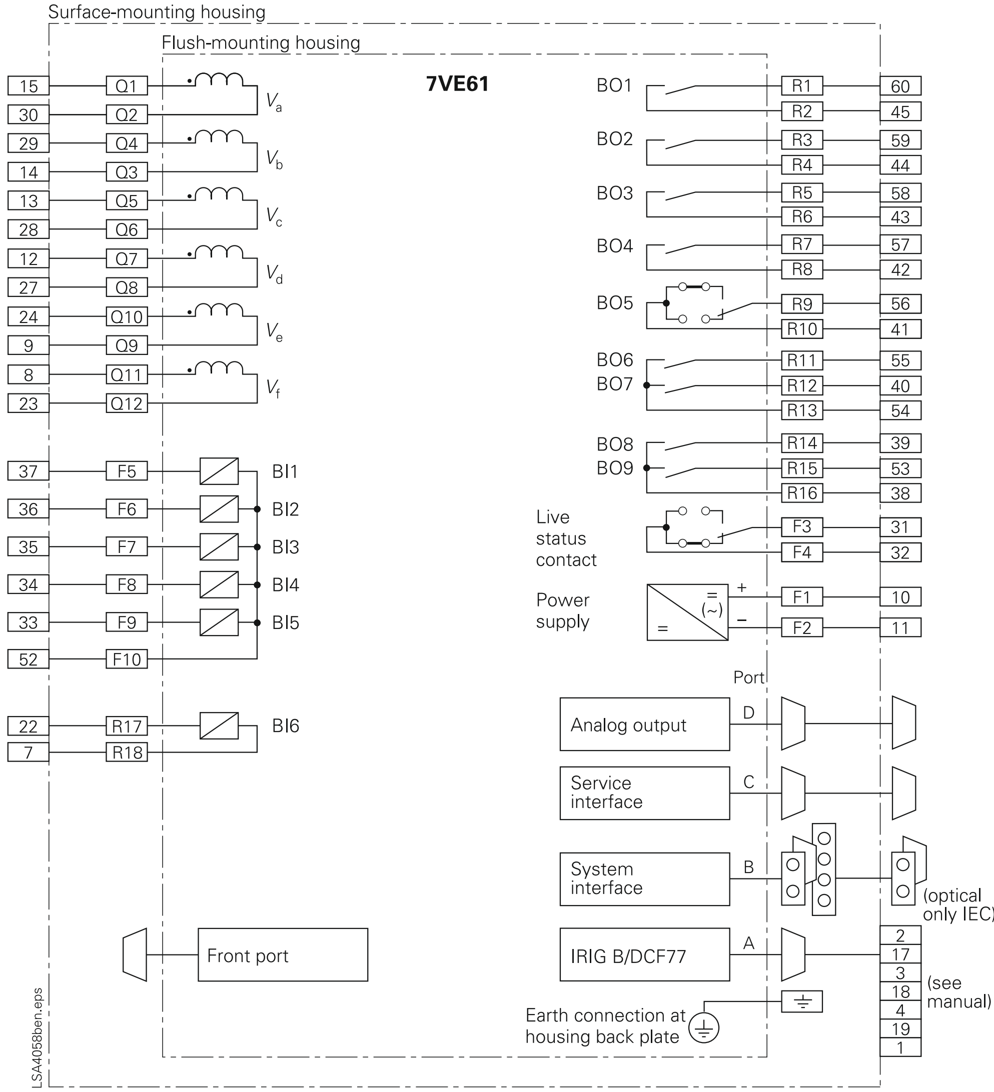


Fig. 11/99
Connection diagram

Connection diagram

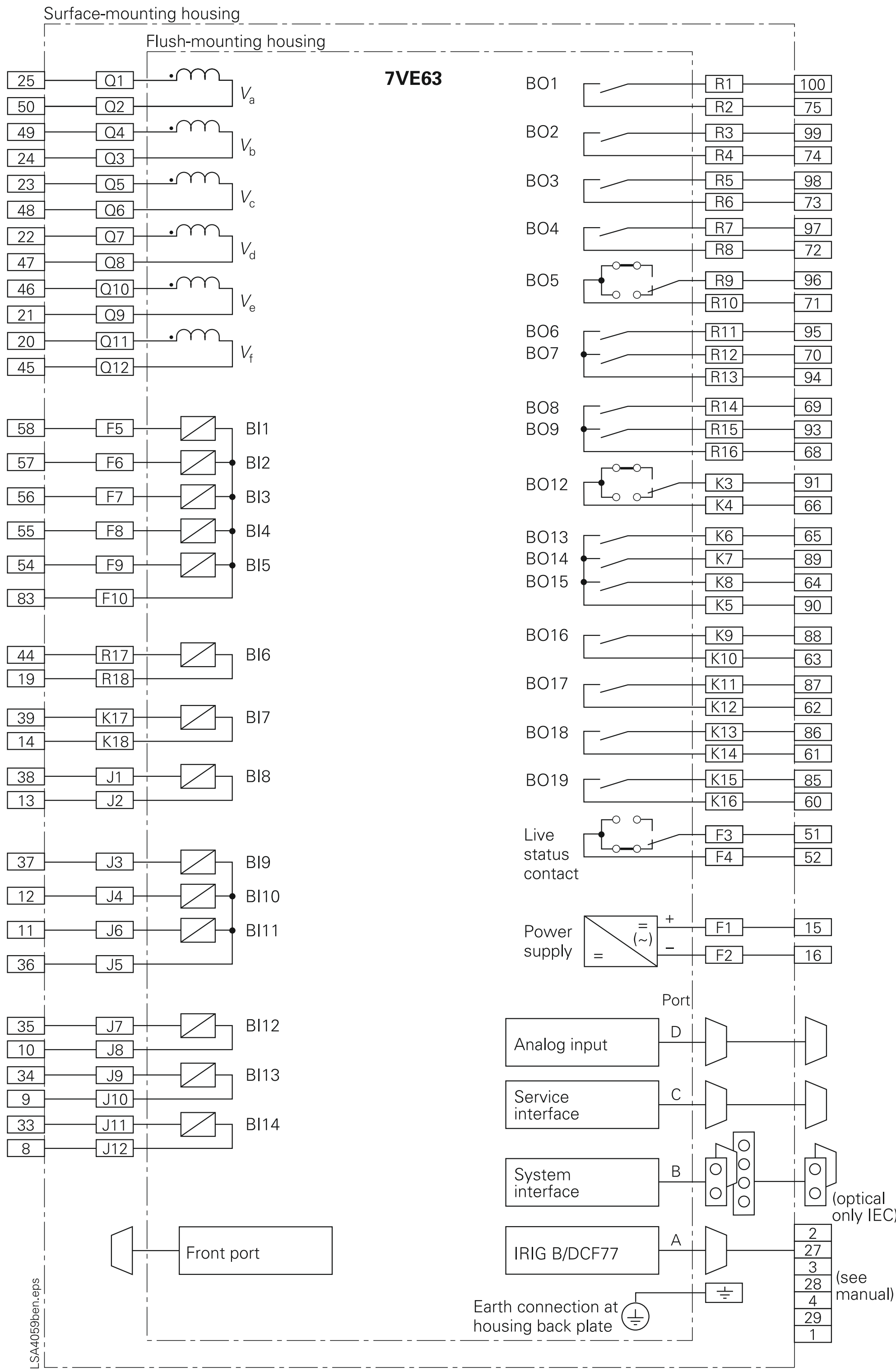


Fig. 11/100
Connection diagram