Transformer Differential Protection

Page

8

SIPROTEC 4 7UT6 Differential Protection Relay for Transformers, Generators, Motors and Busbars

Fig. 8/1 SIPROTEC 4
7UT6 differential protection relay for transformers, generators, motors and busbars

Description

The SIPROTEC 7UT6 differential protection relays are used for fast and selective fault clearing of short-circuits in transformers of all voltage levels and also in rotating electric machines like motors and generators, for short lines and busbars.

The protection relay can be parameterized for use with three-phase and single-phase transformers.

The specific application can be chosen by parameterization. In this way an optimal adaptation of the relay to the protected object can be achieved.

In addition to the differential function, a backup overcurrent protection for 1 winding/star point is integrated in the relay. Optionally, a low or high-impedance restricted earth-fault protection, a negative-sequence protection and a breaker failure protection can be used. 7UT613 and 7UT633 feature 4 voltage inputs. With this option an overvoltage and undervoltage protection is available as well as frequency protection, reverse / forward power protection, fuse failure monitor and overexcitation protection. With external temperature monitoring boxes (thermo-boxes) temperatures can be measured and monitored in the relay. Therefore, complete thermal monitoring of a transformer is possible, e.g. hot-spot calculation of the oil temperature.

7UT613 and 7UT63x only feature full coverage of applications without external relays by the option of multiple protection functions e.g. overcurrent protection is available for each winding or measurement location of a transformer. Other functions are available twice: earth-fault differential protection, breaker failure protection and overload protection. Furthermore, up to 12 user-defined (flexible) protection functions may be activated by the customer with the choice of measured voltages, currents, power and frequency as input variables.

The relays provide easy-to-use local control and automation functions.
The integrated programmable logic (CFC) allows the users to implement their own functions, e.g. for the automation of switchgear (interlocking). User-defined messages can be generated as well.
The flexible communication interfaces are open for modem communication architectures with control system.

Function overview

- Differential protection for 2- up to 5-winding transformers (3-/1-phase)
- Differential protection for motors and generators
- Differential protection for short 2 up to 5 terminal lines
- Differential protection for busbars up to 12 feeders (phase-segregated or with summation CT)

Protection functions

- Differential protection with phase-segregated measurement
- Sensitive measuring for low-fault currents
- Fast tripping for high-fault currents
- Restraint against inrush of transformer
- Phase /earth overcurrent protection
- Overload protection with or without temperature measurement
- Negative-sequence protection
- Breaker failure protection
- Low/high-impedance restricted earth fault (REF)
- Voltage protection functions (7UT613/633)

Control functions

- Commands for control of circuit-breakers and isolators
- 7UT63x: Graphic display shows position of switching elements, local/remote switching by key-operated switch
- Control via keyboard, binary inputs, DIGSI 4 or SCADA system
- User-defined logic with CFC

Monitoring functions

- Self-supervision of the relay
- Trip circuit supervision
- Oscillographic fault recording
- Permanent differential and restraint current measurement, extensive scope of operational values

Communication interfaces

- PC front port for setting with DIGSI 4
- System interface
  IEC 61850 Ethernet
  IEC 60870-5-103 protocol,
  PROFIBUS-FMS/-DP,
  MODBUS or DNP 3.0
- Service interface for DIGSI 4 (modem)/ temperature monitoring (thermo-box)
- Time synchronization via IRIG-B/DCF 77

Application

The numerical protection relays 7UT6 are primarily applied as differential protection on

– transformers
  7UT612: 2 windings
  7UT613/633: 2 up to 3 windings
  7UT635: 2 up to 5 windings,
– generators
– motors
– short line sections
– small busbars
– parallel and series reactors.

The user selects the type of object that is to be protected by setting during configuration of the relay. Subsequently, only those parameters that are relevant for this particular protected object need to be set. This concept, whereby only those parameters relevant to a particular protected object need to be set, substantially contributed to a simplification of the setting procedure. Only a few parameters must be set. Therefore the new 7UT6 relays also make use of and extend this concept. Apart from the protected plant objects defined in the 7UT6, a further differential protection function allows the protection of

– single busbars with up to 12 feeders.

The well-proven differential measuring algorithm of the 7UT51 relay is also used in the new relays, so that a similar response with regard to short-circuit detection, tripping time saturation detection and inrush restraint is achieved.

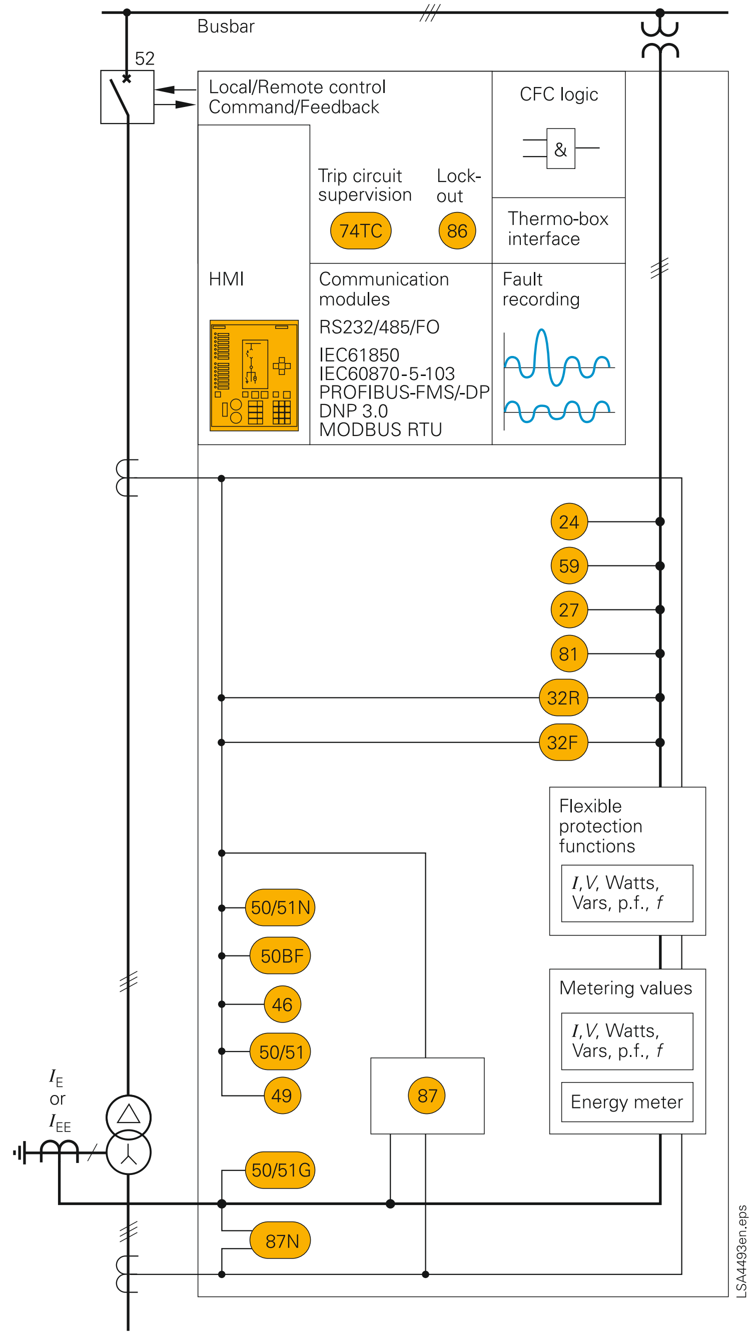

Fig. 8/2 Function diagram

8

Application

Protection functions	ANSI No.	7UT612	7UT613/33	7UT635	Three-phase transformer	Single-phase transformer	Auto-transformer	Generator/ Motor	Busbar, 3-phase	Busbar, 1-phase
Differential protection	87T/G/M/L	1	1	1	X	X	X	X	X	X
Earth-fault differential protection	87 N	1	2	2	X	X	X*)	X	–	–
Overcurrent-time protection, phases	50/51	1	3	3	X	X	X	X	X	–
Overcurrent-time protection $3I_0$	50/51N	1	3	3	X	–	X	X	X	–
Overcurrent-time protection, earth	50/51G	1	2	2	X	X	X	X	X	X
Overcurrent-time protection, single-phase		1	1	1	X	X	X	X	X	X
Negative-sequence protection	46	1	1	1	X	–	X	X	X	–
Overload protection IEC 60255-8	49	1	2	2	X	X	X	X	X	–
Overload protection IEC 60354	49	1	2	2	X	X	X	X	X	–
Overexcitation protection *) V/Hz	24	–	1	–	X	X	X	X	X	X
Overvoltage protection *) V>	59	–	1	–	X	X	X	X	–	–
Undervoltage protection *) V<	27	–	1	–	X	X	X	X	–	–
Frequency protection *) f>, f<	81	–	1	–	X	X	X	X	–	–
Reverse power protection *) -P	32R	–	1	–	X	X	X	X	–	–
Forward power protection*) P>, P<	32F	–	1	–	X	X	X	X	–	–
Fuse failure protection	60FL	–	1	–	X	X	X	X	–	–
Breaker failure protection	50 BF	1	2	2	X	X	X	X	X	–
External temperature monitoring (thermo-box)	38	X	X	X	X	X	X	X	X	X
Lockout	86	X	X	X	X	X	X	X	X	X
Measured-value supervision		X	X	X	X	X	X	X	X	X
Trip circuit supervision	74 TC	X	X	X	X	X	X	X	X	X
Direct coupling 1		X	X	X	X	X	X	X	X	X
Direct coupling 2		X	X	X	X	X	X	X	X	X
Operational measured values		X	X	X	X	X	X	X	X	X
Flexible protection functions	27, 32, 47, 50, 55, 59, 81	–	12	12	X	X	X	X	X	X

X Function applicable
– Function not applicable in this application
*) Only 7UT613/63x

Construction

The 7UT6 is available in three housing widths referred to a 19" module frame system. The height is 243 mm.

– 1/3 (7UT612),
– 1/2 (7UT613),
– 1/1 (7UT633/635) of 19"

All cables can be connected with or without cable ring lugs. Plug-in terminals are available as an option, it is thus possible to employ prefabricated cable harnesses. In the case of surface mounting on a panel, the connection terminals are located above and below in the form of screw-type terminals. The communication interfaces are located on the same sides of the housing. For dimensions please refer to the dimension drawings (part 15).

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Fig. 8/3
Rear view with screw-type terminals

Protection functions

Differential protection for transformers (ANSI 87T)

When the 7UT6 is employed as fast and selective short-circuit protection for transformers the following properties apply:

- Tripping characteristic according to Fig. 8/4 with normal sensitive I_{DIFF}> and high-set trip stage I_{DIFF}>>
- Vector group and ratio adaptation
- Depending on the treatment of the transformer neutral point, zero-sequence current conditioning can be set with or without consideration of the neutral current. With the 7UT6, the star-point current at the star-point CT can be measured and considered in the vector group treatment, which increases sensitivity by one third for single-phase faults.
- Fast clearance of heavy internal transformer faults with high-set differential element I_{DIFF}>>.
- Restrain of inrush current with 2nd harmonic. Cross-block function that can be limited in time or switched off.
- Restrain against overfluxing with a choice of 3rd or 5th harmonic stabilization is only active up to a settable value for the fundamental component of the differential current.
- Additional restrain for an external fault with current transformer saturation (patented CT-saturation detector from 7UT51).
- Insensitivity to DC current and current transformer errors due to the freely programmable tripping characteristic and fundamental filtering.
- The differential protection function can be blocked externally by means of a binary input.

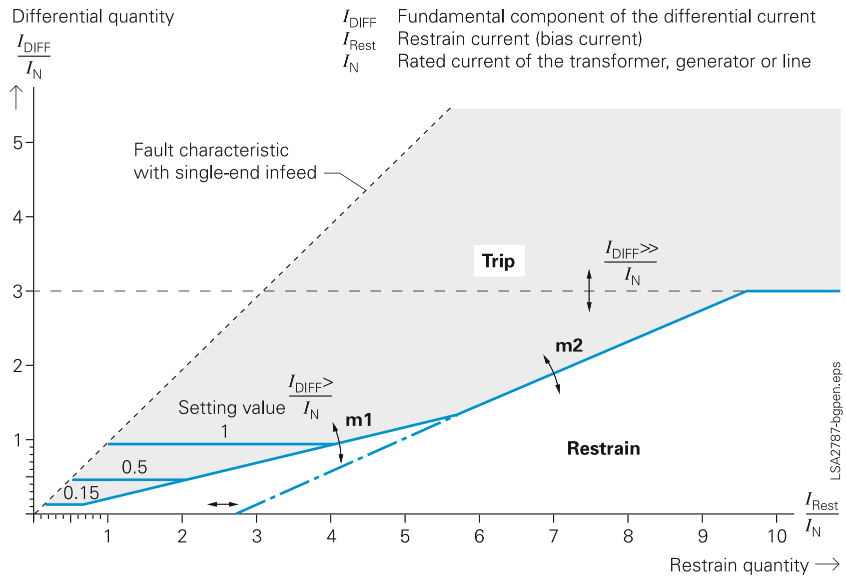

Fig. 8/4
Tripping characteristic with preset transformer parameters for three-phase faults

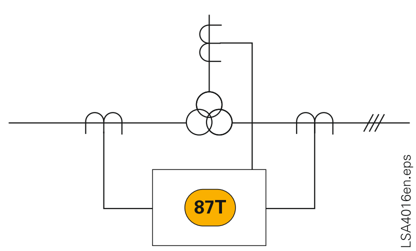

Fig. 8/5
3-winding transformers (1 or 3-phase)

Protection functions

Sensitive protection by measurement of star-point current (see Fig. 8/6) (ANSI 87N/87GD)

Apart from the current inputs for detection of the phase currents on the sides of the protected object, the 7UT6 also contains normal sensitivity I_E and high sensitivity I_{EE} current measuring inputs. Measurement of the star-point current of an earthed winding via the normal sensitivity measuring input, and consideration of this current by the differential protection, increases the sensitivity during internal single-phase faults by 33 %. If the sum of the phase currents of a winding is compared with the star-point current measured with the normal sensitivity input I_E, a sensitive earth current differential protection can be implemented (REF).

This function is substantially more sensitive than the differential protection during faults to earth in a winding, detecting fault currents as small as 10 % of the transformer rated current.

Furthermore, this relay contains a high-impedance differential protection input. The sum of the phase currents is compared with the star-point current. A voltage-dependent resistor (varistor) is applied in shunt (see Fig. 8/6). Via the sensitive current measuring input I_{EE}, the voltage across the varistor is measured; in the milli-amp range via the external resistor. The varistor and the resistor are mounted externally. An earth fault results in a voltage across the varistor that is larger than the voltage resulting from normal current transformer errors. A prerequisite is the application of accurate current transformers of the class 5P (TPY) which exhibit a small measuring error in the operational and overcurrent range. These current transformers may not be the same as used for the differential protection, as the varistor may cause rapid saturation of this current transformers.

Both high-impedance and low-impedance REF are each available twice (option) for transformers with two earthed windings. Thus separate REF relays are not required.

Differential protection for single-phase busbars (see Fig. 8/7) (ANSI 87L)

The short-circuit protection is characterized by the large number of current measuring inputs. The scope of busbar protection ranges from a few bays e.g. in conjunction with one and a half circuit-breaker applications, to large stations having up to more than 50 feeders. In particular in smaller stations, the busbar protection arrangements are too expensive. With the 7UT6 relays the current inputs may also be used to achieve a cost-effective busbar protection system for up to 12 feeders (Fig. 8/7). This busbar protection functions as a phase-selective protection with 1 or 5 A current transformers, whereby the protected phase is connected. All three phases can therefore be protected by applying three relays. Furthermore a single-phase protection can be implemented by connecting the three-phase currents via a summation transformer. The summation transformer connection has a rated current of 100 mA.

The selectivity of the protection can be improved by monitoring the current magnitude in all feeders, and only releasing the differential protection trip command when the overcurrent condition is also met. The security measures to prevent maloperation resulting from failures in the current transformer secondary circuits can be improved in this manner. This overcurrent release may also be used to implement a breaker failure protection. Should the release signal not reset within a settable time, this indicates that a breaker failure condition is present, as the short-circuit was not switched off by the bay circuit-breaker. After expiry of the time delay the circuit-breakers of the infeeds to the busbar may be tripped.

Differential protection for generators and motors (see Fig. 8/8) (ANSI 87G/M)

Equal conditions apply for generators, motors and series reactors. The protected zone is limited by the sets of current transfomers at each side of the protected object.

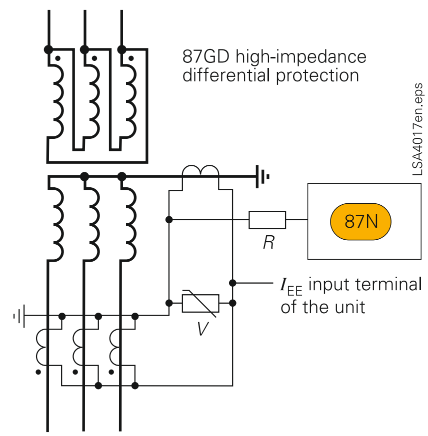

Fig. 8/6
High-impedance differential protection

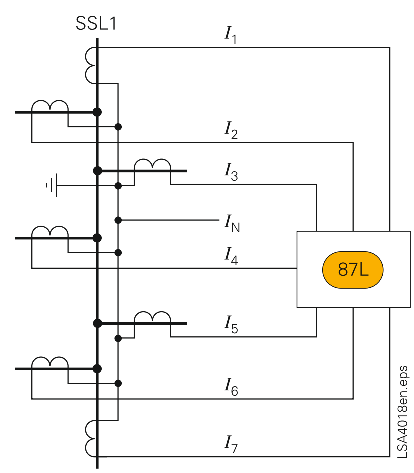

Fig. 8/7
Simple busbar protection with phase-selective configuration
7UT612: 7 feeders
7UT613/633: 9 feeders
7UT635: 12 feeders

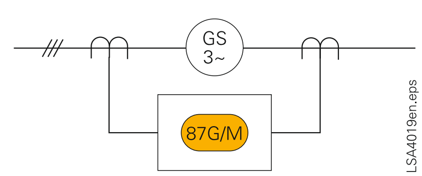

Fig. 8/8
Generator/motor differential protection

8

Protection functions

Backup protection functions

Overcurrent-time protection (ANSI 50, 50N, 51, 51N)

Backup protection on the transformer is achieved with a two-stage overcurrent protection for the phase currents and $3I_0$ for the calculated neutral current. This function may be configured for one of the sides or measurement locations of the protected object. The high-set stage is implemented as a definite-time stage, whereas the normal stage may have a definite-time or inverse-time characteristic. Optionally, IEC or ANSI characteristics may be selected for the inverse stage. The overcurrent protection $3I_0$ uses the calculated zero-sequence current of the configured side or measurement location.
Multiple availability: 3 times (option)

Overcurrent-time protection for earth (ANSI 50/51G)

The 7UT6 feature a separate 2-stage overcurrent-time protection for the earth. As an option, an inverse-time characteristic according to IEC or ANSI is available. In this way, it is possible to protect e.g. a resistor in the transformer star point against thermal overload, in the event of a single-phase short-circuit not being cleared within the time permitted by the thermal rating.
Multiple availability: 3 times (option)

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

Furthermore a negative-sequence protection may be defined for one of the sides or measurement locations. This provides sensitive overcurrent protection in the event of asymmetrical faults in the transformer. The set pickup threshold may be smaller than the rated current.

Breaker failure protection (ANSI 50BF)

If a faulted portion of the electrical circuit is not disconnected upon issuing of a trip command, another command can be initiated using the breaker failure protection which operates the circuit-breaker, e.g., of an upstream (higher-level) protection relay.
Multiple availability: 2 times (option)

Overexcitation protection Volt/Hertz (ANSI 24) (7UT613/633 only)

The overexcitation protection serves for detection of an unpermissible high induction (proportional to V/f) in generators or transformers, which leads to a 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.

Trip circuit supervision (ANSI 74TC)

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

Lockout (ANSI 86)

All binary outputs (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.

External trip coupling

For recording and processing of external trip information via binary inputs. They are provided for information from the Buchholz relay or specific commands and act like a protective function. Each input initiates a fault event and can be individually delayed by a timer.

Undervoltage protection (ANSI 27) (7UT613/633 only)

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) (7UT613/633 only)

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) (7UT613/633 only)

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.

Protection functions

Reverse-power protection (ANSI 32R) (7UT613/633 only)

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) (7UT613/633 only)

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.

Flexible protection functions (7UT613/63x only)

For customer-specific solutions up to 12 flexible protection functions are available and can be parameterized. Voltages, currents, power and frequency from all measurement locations can be chosen as inputs. Each protection function has a settable threshold, delay time, blocking input and can be configured as a 1-phase or 3-phase unit.

Monitoring functions

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

The measuring circuits, analog-digital conversion, power supply voltages, battery, 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. (7UT613/633 only)

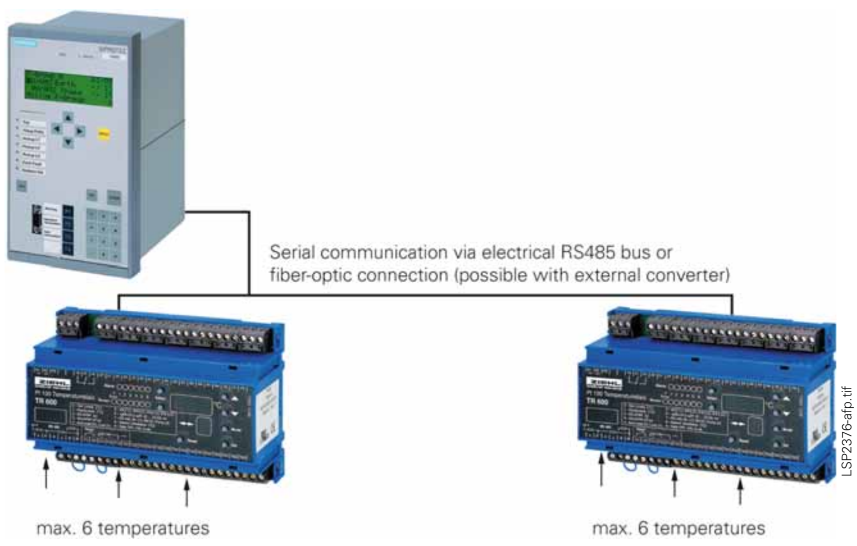

Fig. 8/9
Temperature measurement and monitoring with external thermo-boxes

Thermal monitoring of transformers

The importance of reducing the costs of transmitting and distributing energy by optimizing the system load has resulted in the increased importance of monitoring the thermal condition of transformers. This monitoring is one of the tasks of the monitoring systems, designed for medium and large transformers. Overload protection based on a simple thermal model, and using only the measured current for evaluation, has been integrated in differential protection systems for a number of years.

The ability of the 7UT6 to monitor the thermal condition can be improved by serial connection of a temperature monitoring box (also called thermo-box or RTD-box) (Fig. 8/9). The temperature of up to 12 measuring points (connection of 2 boxes) can be registered. The type of sensor (Pt100, Ni100, Ni120) can be selected individually for each measuring point. Two alarm stages are derived for each measuring point when the corresponding set threshold is exceeded.

Alternatively to the conventional overload protection, the relay can also provide a hot-spot calculation according to IEC 60345. The hot-spot calculation is carried out separately for each leg of the transformer and takes the different cooling modes of the transformer into consideration.

The oil temperature must be registered via the thermo-box for the implementation of this function. An alarm warning stage and final alarm stage is issued when the maximum hot-spot temperature of the three legs exceeds the threshold value.

For each transformer leg a relative rate of ageing, based on the ageing at 98 °C is indicated as a measured value. This value can be used to determine the thermal condition and the current thermal reserve of each transformer leg. Based on this rate of ageing, a remaining thermal reserve is indicated in % for the hottest spot before the alarm warning and final alarm stage is reached.

8

Protection functions

Measured values

The operational measured values and statistic value registering in the 7UT6, apart from the registration of phase currents and voltages (7UT613/633 only) as primary and secondary values, comprises the following:

- Currents 3-phase I_{L1}, I_{L2}, I_{L3}, I_1, I_2, $3I_0$ for each side and measurement location
- Currents 1-phase I_1 to I_{12} for each feeder and further inputs I_{x1} to I_{x4}
- Voltages 3-phase V_{L1}, V_{L2}, V_{L3}, V_{L1L2}, V_{L2L3}, V_{L3L1}, V_1, V_2, V_0 and 1-phase V_{EN}, V_4
- Phase angles of all 3-phase/ 1-phase currents and voltages
- Power Watts, Vars, *VA*/*P*, *Q*, *S* (*P*, *Q*: total and phase selective)
- Power factor (cos φ),
- Frequency
- Energy ± kWh, ± kVarh, forward and reverse power flow
- Min./max. and mean values of $V_{PH\text{-}PH}$, V_{PHE}, V_E, V_0, V_1, V_2, I_{PH}, I_1, I_2, $3I_0$, I_{DIFF}, $I_{RESTRAINT}$, *S*, *P*, *Q*, cos φ, *f*
- Operating hours counter
- Registration of the interrupted currents and counter for protection trip commands
- Mean operating temperature of overload function
- Measured temperatures of external thermo-boxes
- Differential and restraint currents of differential protection and REF

Metered values

For internal metering, the unit can calculate an energy metered value from the measured current and voltage values.

The 7UT6 relays may be integrated into monitoring systems by means of the diverse communication options available in the relays. An example for this is the connection to the SITRAM transformer monitoring system with PROFIBUS-DP interface.

Commissioning and operating aids

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

All measured currents and voltages (7UT613/633 only) of the transformer can be indicated as primary or secondary values. The differential protection bases its pickup thresholds on the rated currents of the transformer. The referred differential and stabilising (restraint) currents are available as measured values per phase. If a thermo-box is connected, registered temperature values may also be displayed. To check the connection of the relay to the primary current and voltage transformers, a commissioning measurement is provided.

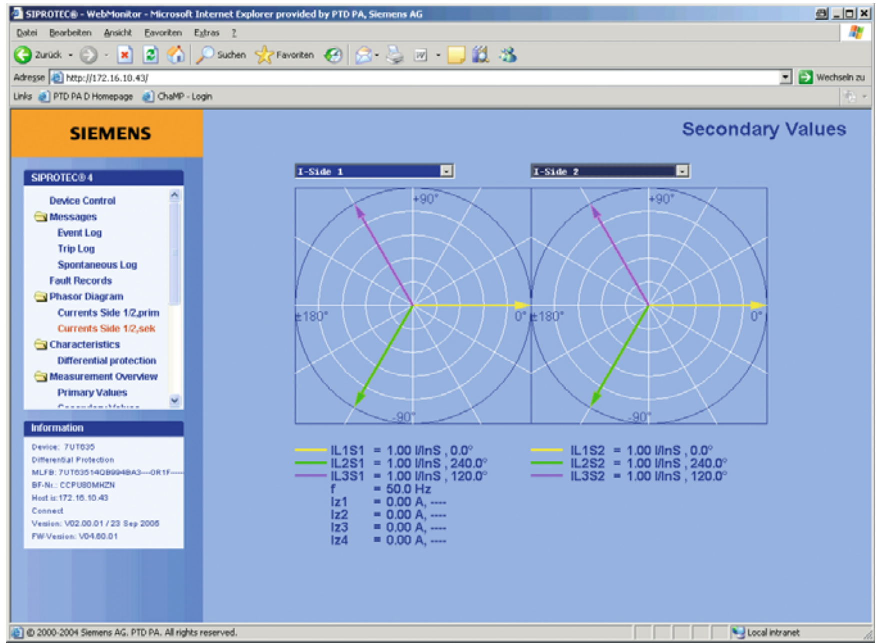

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Fig. 8/10
Commissioning via a standard Web browser: Phasor diagram

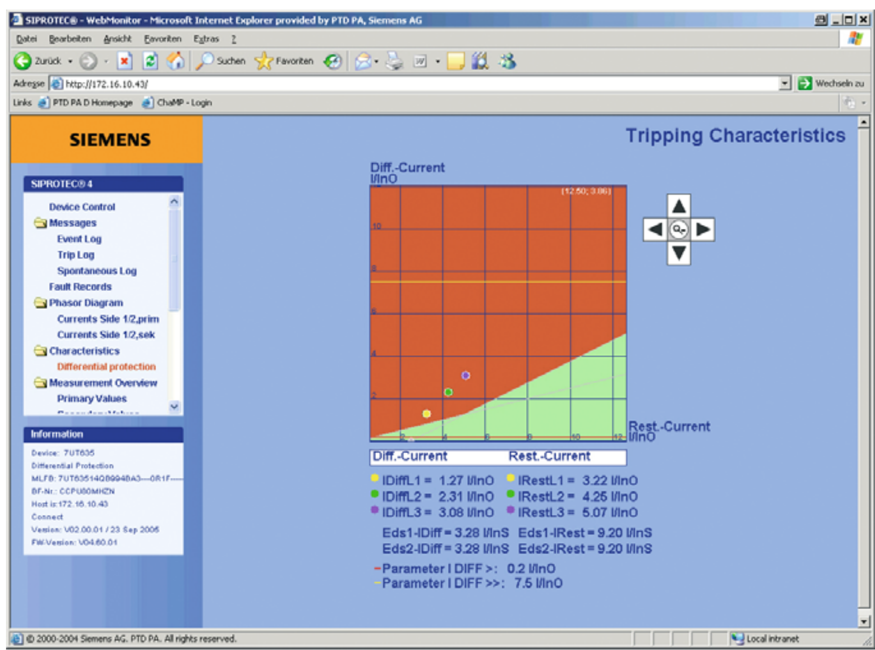

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Fig. 8/11
Commissioning via a standard Web browser: Operating characteristic

Protection functions

This measurement function works with only 5 to 10 % of the transformer rated current and indicates the current and the angle between the currents and voltages (if voltages applied). Termination errors between the primary current transfomers and input transformers of the relay are easily detected in this manner.

The operating state of the protection may therefore be checked online at any time. The fault records of the relay contain the phase and earth currents as well as the calculated differential and restraint currents. The fault records of the 7UT613/633 relays also contain voltages.

Browser-based commissioning aid

The 7UT6 provides a commissioning and test program which runs under a standard internet browser and is therefore independent of the configuration software provided by the manufacturer.

For example, the correct vector group of the transformer may be checked. These values may be displayed graphically as vector diagrams.

The stability check in the operating characteristic is available as well as event log and trip log messages. Remote control can be used if the local front panel cannot be accessed.

■ Control and automation functions

Control

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

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

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

The switchgear or circuit-breaker can be controlled via:

– integrated operator panel
– binary inputs
– substation control and protection system
– DIGSI 4

Command processing

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

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

Automation / user-defined logic

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

Switching authority

Switching authority is determined according to parameters, communication or by key-operated switch (when available).

If a source is set to “LOCAL”, only local switching operations are possible. The following sequence of switching authority is laid down: “LOCAL”; DIGSI PC program, “REMOTE”

Every switching operation and change of breaker position is kept in the status indication memory. The switch command source, switching device, cause (i.e. spontaneous change or command) and result of a switching operation are retained.

Assignment of feedback to command

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

Chatter disable

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

Filter time

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

Indication filtering and delay

Indications can be filtered or delayed.

Filtering serves to suppress brief changes in potential at the indication input. The indication is passed on only if the indication voltage is still present after a set period of time. In the event of indication delay, there is a wait for a preset time. The information is passed on only if the indication voltage is still present after this time.

Indication derivation

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

Transmission lockout

A data transmission lockout can be activated, so as to prevent transfer of information to the control center during work on a circuit bay.

Test operation

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

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. Of particular advantage is the use of the DIGSI 4 operating program during commissioning.

Rear-mounted interfaces

Two communication modules located on the rear of the unit incorporate optional equipment complements and readily permit retrofitting. They assure the ability to comply with the requirements of different communication interfaces.

The interfaces make provision for the following applications:

- Service interface (Port C/Port D[1)])
  In the RS485 version, several protection units can be centrally operated with DIGSI 4. On connection of a modem, remote control is possible. Via this interface communication with thermo-boxes is executed.
- System interface (Port B)
  This interface is used to carry out communication with a control or protection and control system and supports a variety of communication protocols and interface designs, depending on the module connected.

Commissioning aid via a standard Web browser

In the case of the 7UT6, a PC with a standard browser can be connected to the local PC interface or to the service interface (refer to "Commissioning program"). The relays include a small Web server and send their HTML-pages to the browser via an established dial-up network connection.

Retrofitting: Modules for every type of communication

Communication modules for retrofitting are available for the entire SIPROTEC 4 unit range. These ensure that, where different communication interfaces (electrical or optical) and protocols (IEC 61850 Ethernet, IEC 60870-5-103, PROFIBUS-FMS/-DP, MODBUS RTU, DNP 3.0, DIGSI, etc.) are required, such demands can be met.

Safe bus architecture

- RS485 bus
  With this data transmission via copper conductors electromagnetic fault influences are largely eliminated by the use of twisted-pair conductor. Upon failure of a unit, the remaining system continues to operate without any disturbances.
- Fiber-optic double ring circuit
  The fiber-optic double ring circuit is immune to electromagnetic interference. Upon failure of a section between two units, the communication system continues to operate without disturbance.

It is generally impossible to communicate with a unit that has failed. If a unit were to fail, there is no effect on the communication with the rest of the system.

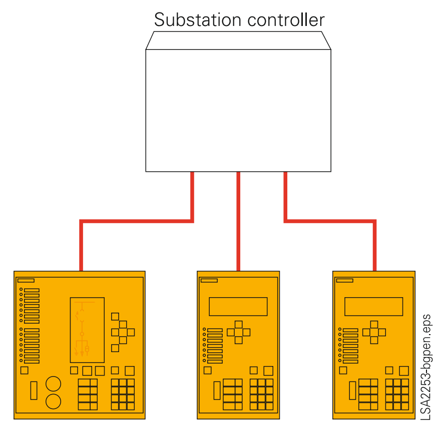


Fig. 8/12
IEC 60870-5-103 star-type RS232 copper conductor connection or fiber-optic connection

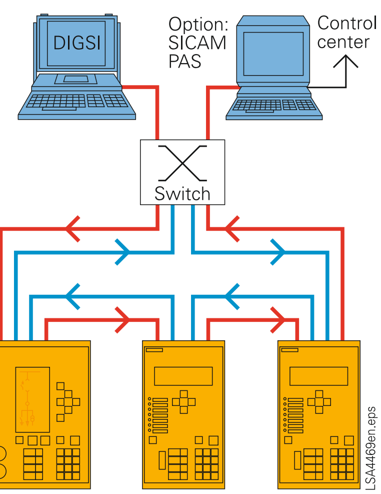


Fig. 8/13
Bus structure for station bus with Ethernet und IEC 61850, fiber-optic ring

1) Only for 7UT613/633/635

Communication

IEC 61850 Ethernet

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

IEC 60870-5-103

IEC 60870-5-103 is an internationally standardized protocol for the efficient communication in the protected area.
IEC 60870-5-103 is supported by a number of protection device manufacturers and is used worldwide.

PROFIBUS-DP

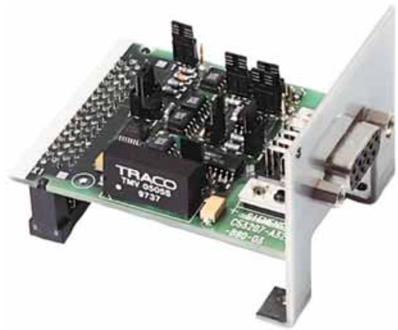
PROFIBUS-DP is an industry-recognized standard for communications and is supported by a number of PLC and protection device manufacturers.

MODBUS RTU

MODBUS RTU is an industry-recognized standard for communications and is supported by a number of PLC and protection device manufacturers.

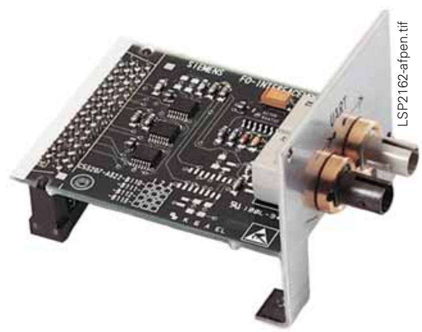
DNP 3.0

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.



LSP2163-afpen.tif

Fig. 8/14
RS232/RS485 electrical communication module



LSP2162-afpen.tif

Fig. 8/15
820 nm fiber-optic communication module

LSP2164-afpen.tif

Fig. 8/16
PROFIBUS communication module, optical double-ring

LSP3.01-0021.tif

Fig. 8/17
Optical Ethernet communication module for IEC 61850 with integrated Ethernet switch

Communication

System solutions for protection and station control

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

Units featuring IEC 60870-5-103 interfaces can be connected to SICAM in parallel via the RS485 bus or radially by fiber-optic link. Through this interface, the system is open for the connection of units of other manufacturers (see Fig. 8/12).

Because of the standardized interfaces, SIPROTEC units can also be integrated into systems of other manufacturers or in SIMATIC. Electrical RS485 or optical interfaces are available. The optimum physical data transfer medium can be chosen thanks to opto-electrical converters. Thus, the RS485 bus allows low-cost wiring in the cubicles and an interference-free optical connection to the master can be established.

For IEC 61850, an interoperable system solution is offered with SICAM PAS. Via the 100 Mbits/s Ethernet bus, the units are linked with PAS electrically or optically to the station PC. The interface is standardized, thus also enabling direct connection of units of other manufacturers to the Ethernet bus. With IEC 61850, however, the units can also be used in other manufacturers' systems (see Fig. 8/13).

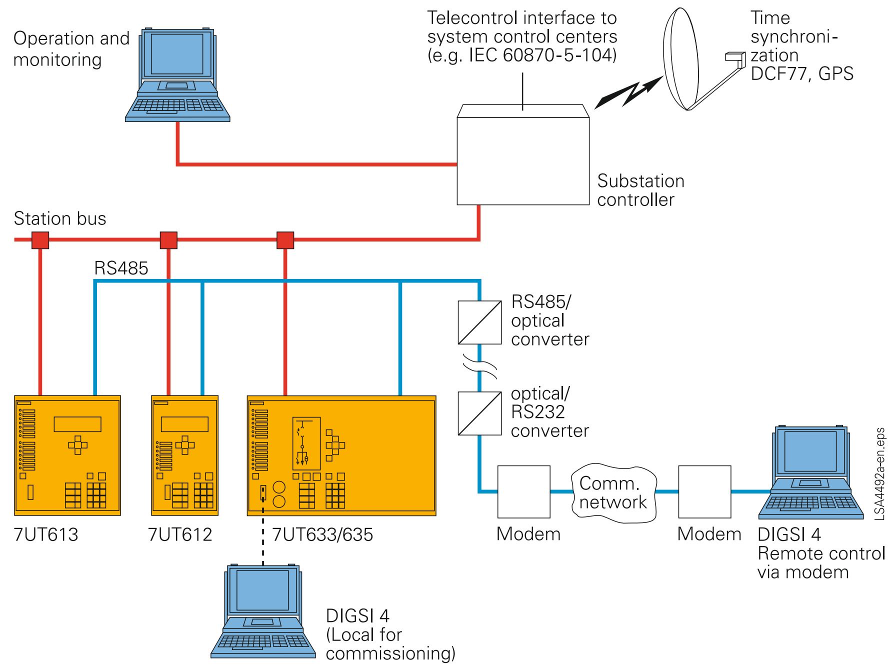


Fig. 8/18
System solution: Communications

8

Typical connections

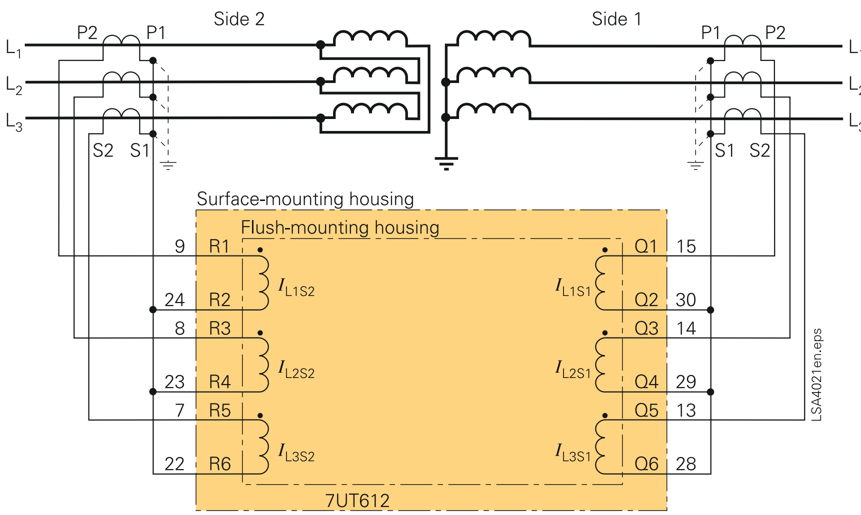


Fig. 8/19
Standard connection to a transformer without neutral current measurement

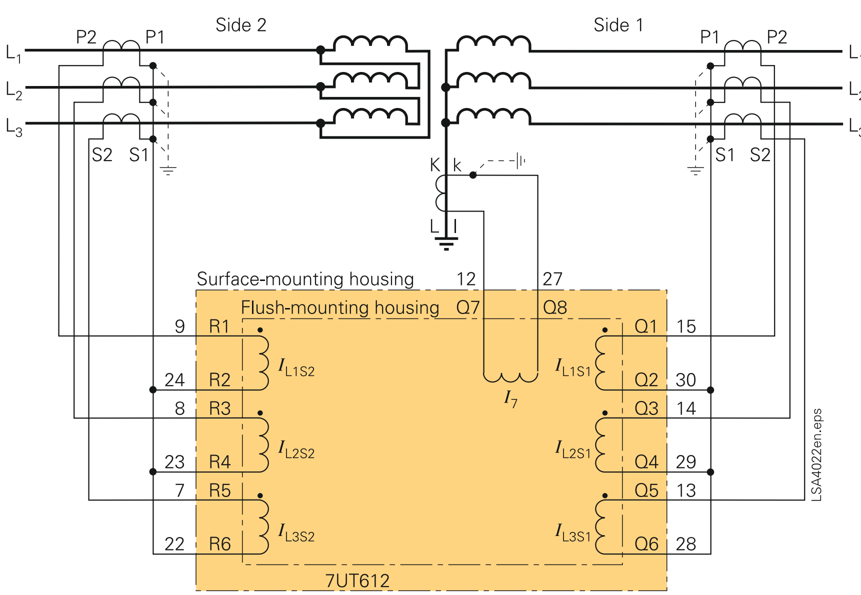


Fig. 8/20
Connection to a transformer with neutral current measurement

Typical connections

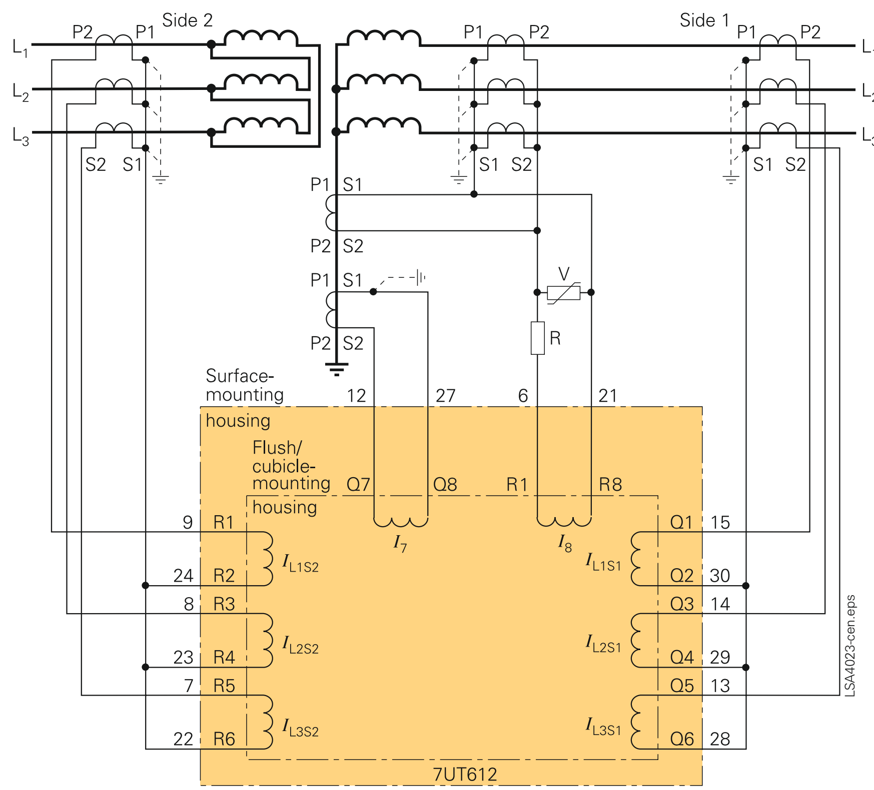


Fig. 8/21
Connection of transformer differential protection with high impedance REF (I_8) and neutral current measurement at I_7

Typical connections

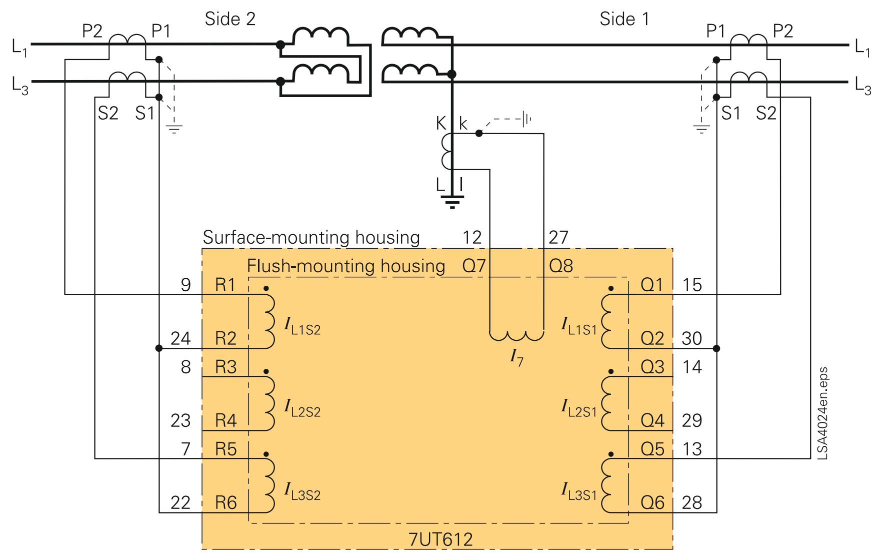


Fig. 8/22
Connection example to a single-phase power transformer with current transformer between starpoint and earthing point

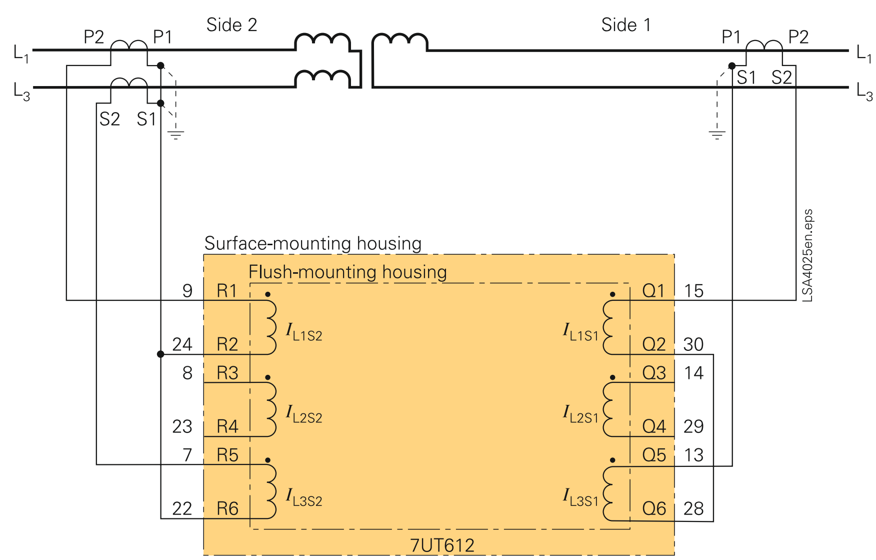


Fig. 8/23
Connection example to a single-phase power transformer with only one current transformer (right side)

Typical connections

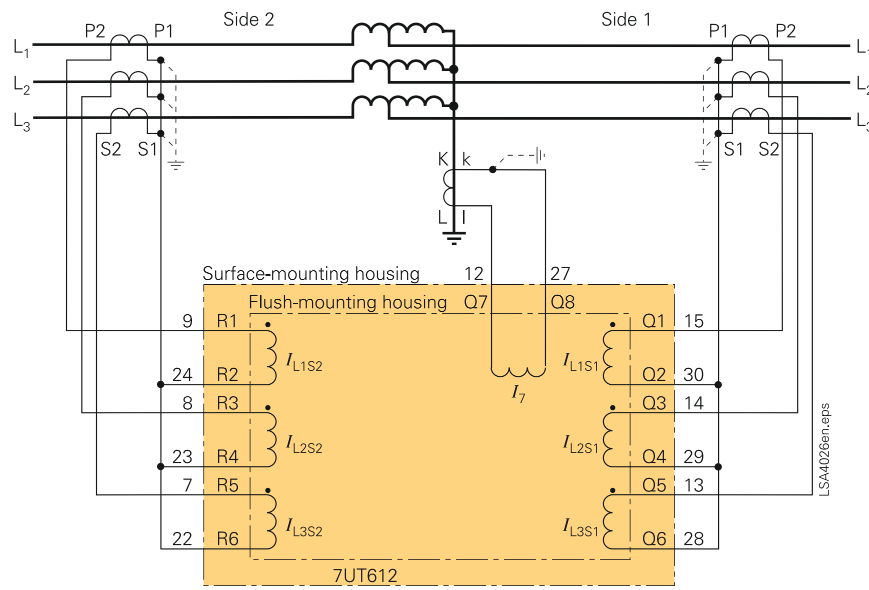


Fig. 8/24
Connection to a three-phase auto-transformer with current transformer between starpoint and earthing point

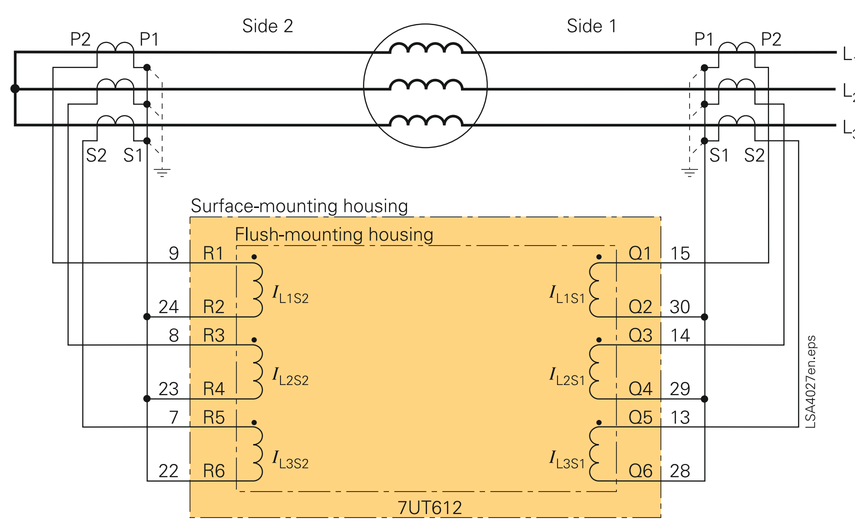


Fig. 8/25
Generator or motor protection

Typical connections

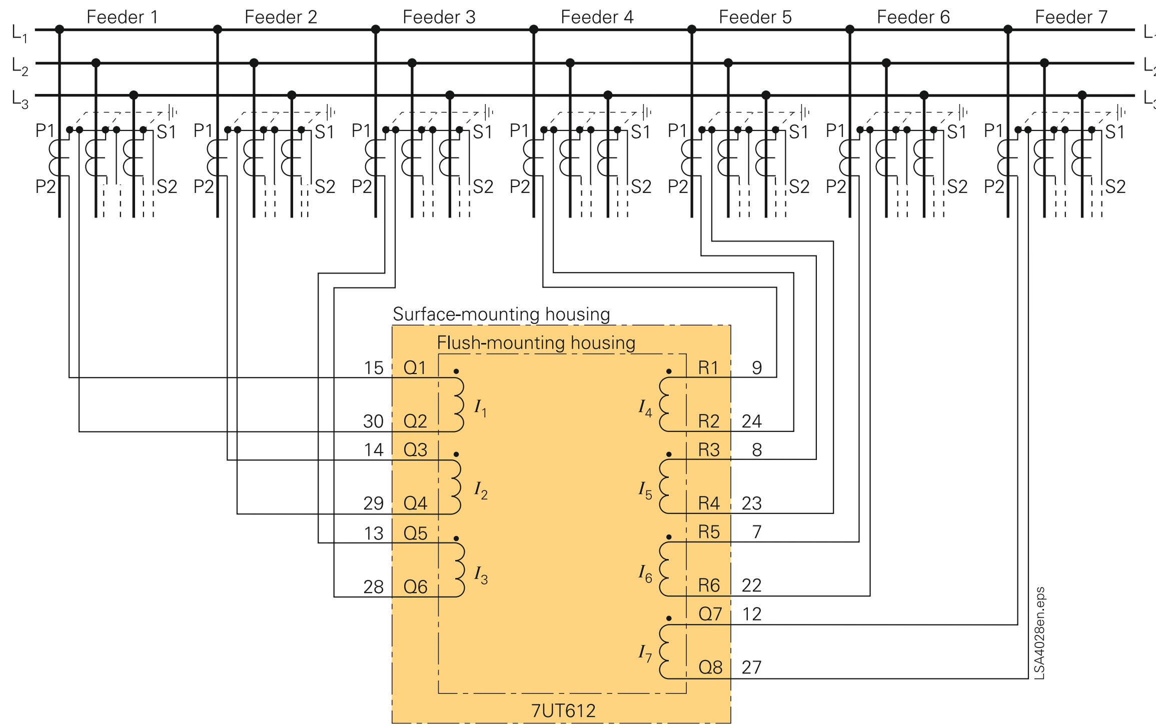


Fig. 8/26
Connection 7UT612 as single-phase busbar protection for 7 feeders, illustrated for phase L1

8

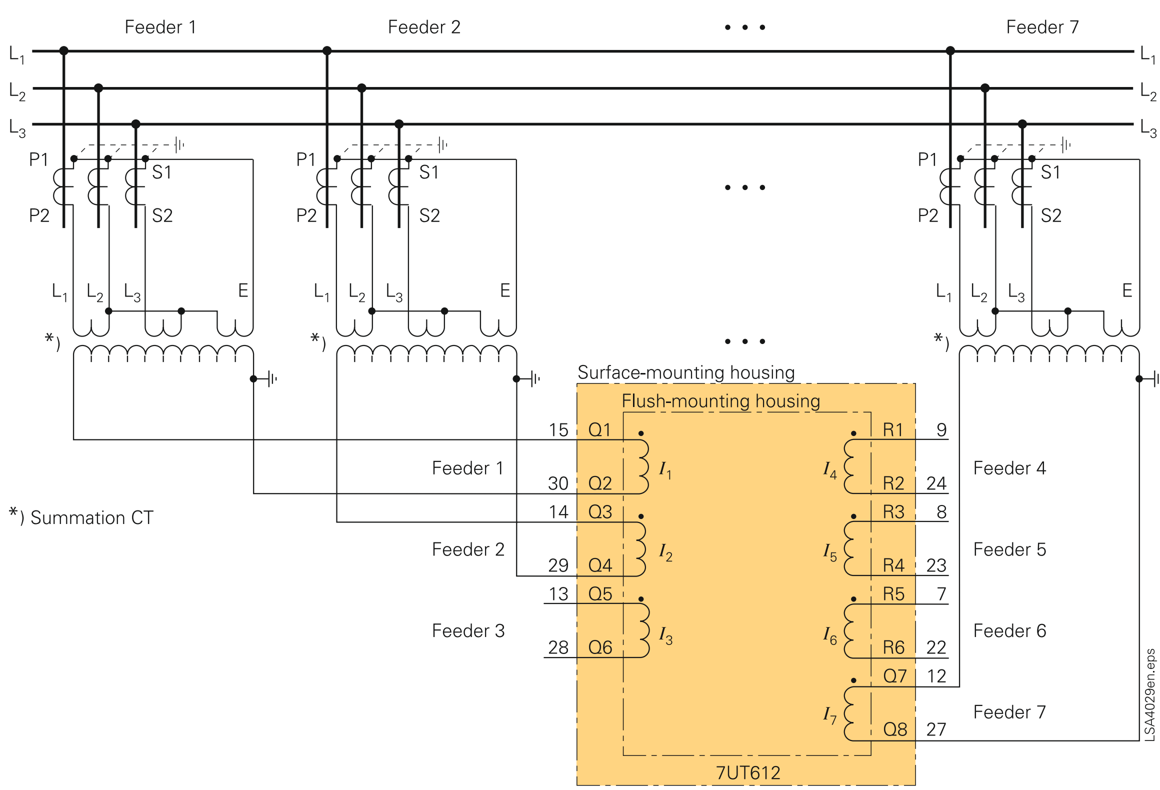


Fig. 8/27
Connection 7UT612 as busbar protection for feeders, connected via external summation current transformers (SCT) – partial illustration for feeders 1, 2 and 7

Typical connections

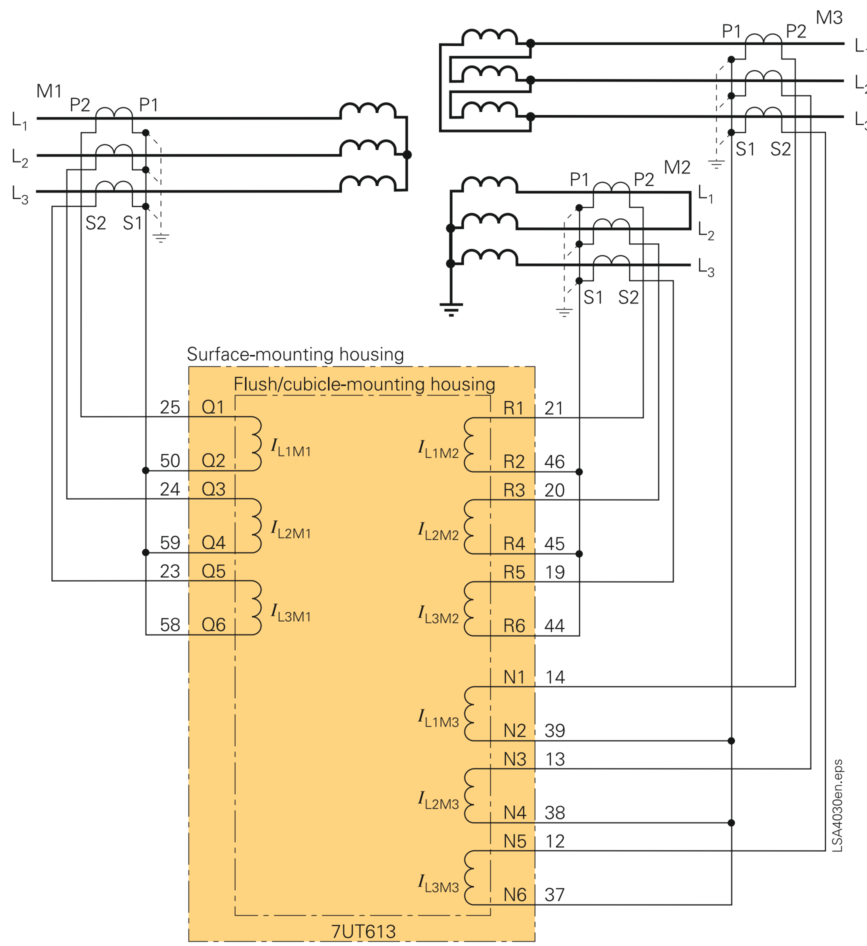


Fig. 8/28
Connection example 7UT613 for a three-winding power transformer

8

Typical connections

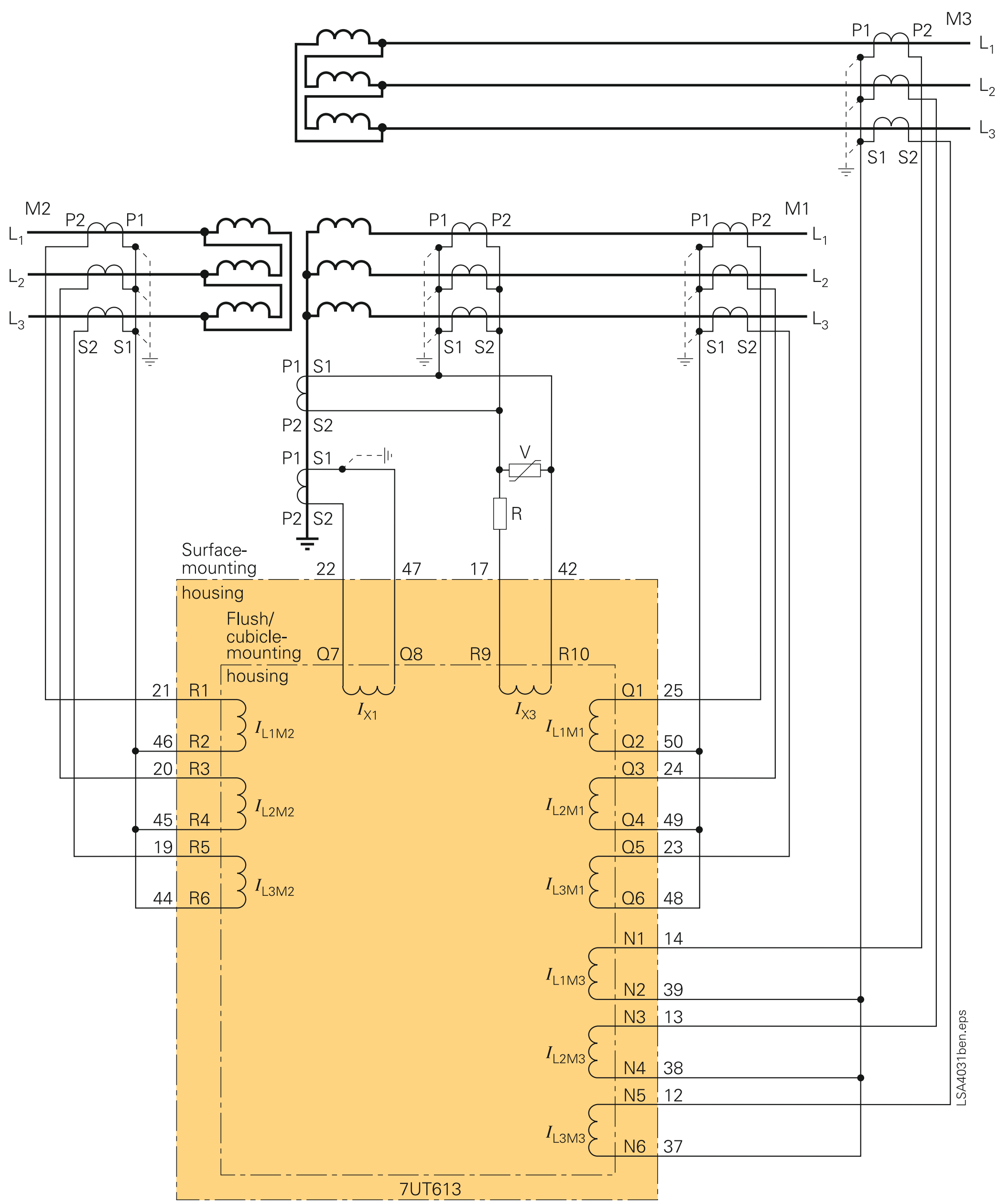


Fig. 8/29

Connection example 7UT613 for a three-winding power transformer with current transformers between starpoint and earthing point, additional connection for high-impedance protection; I_{X3} connected as high-sensitivity input

Typical connections

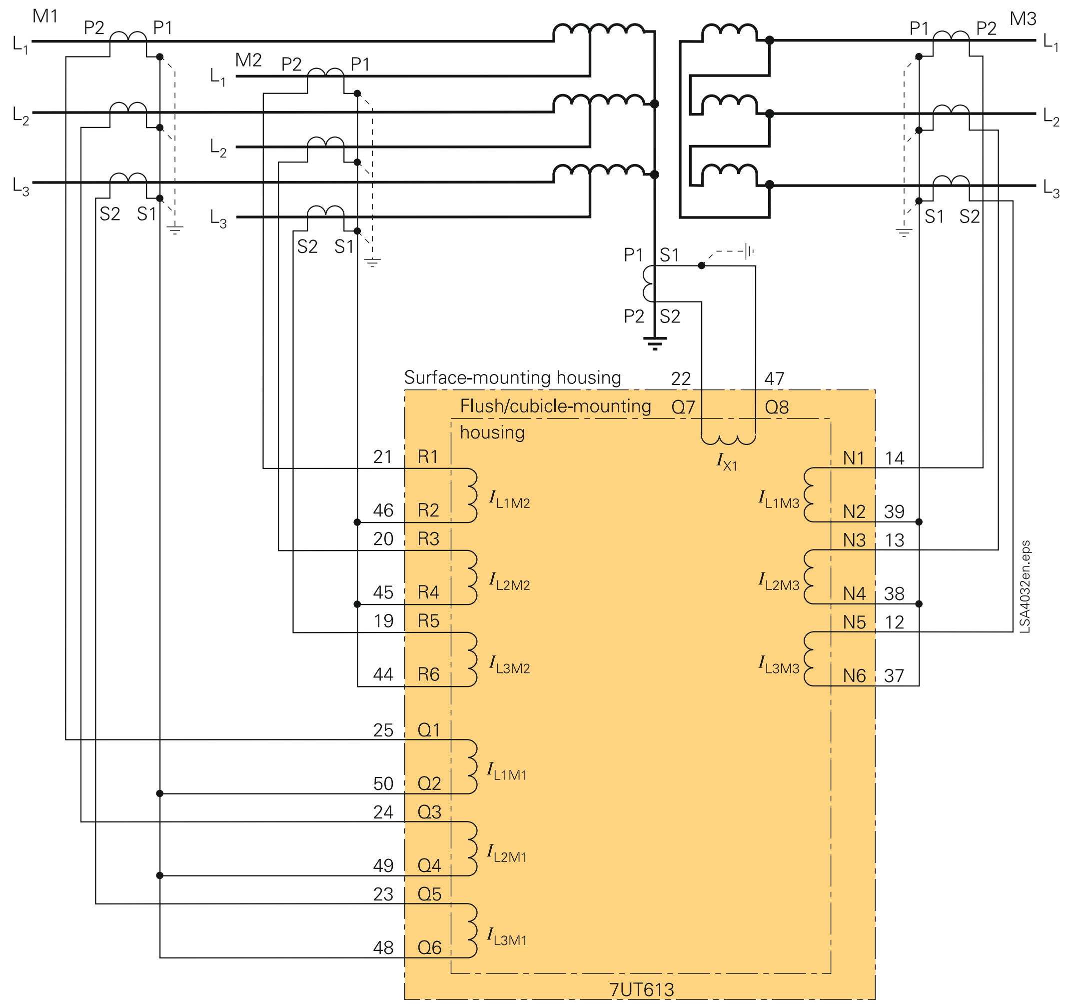


Fig. 8/30
Connection example 7UT613 for a three-phase auto-transformer with three-winding and current transformer between starpoint and earthing point

Typical connections

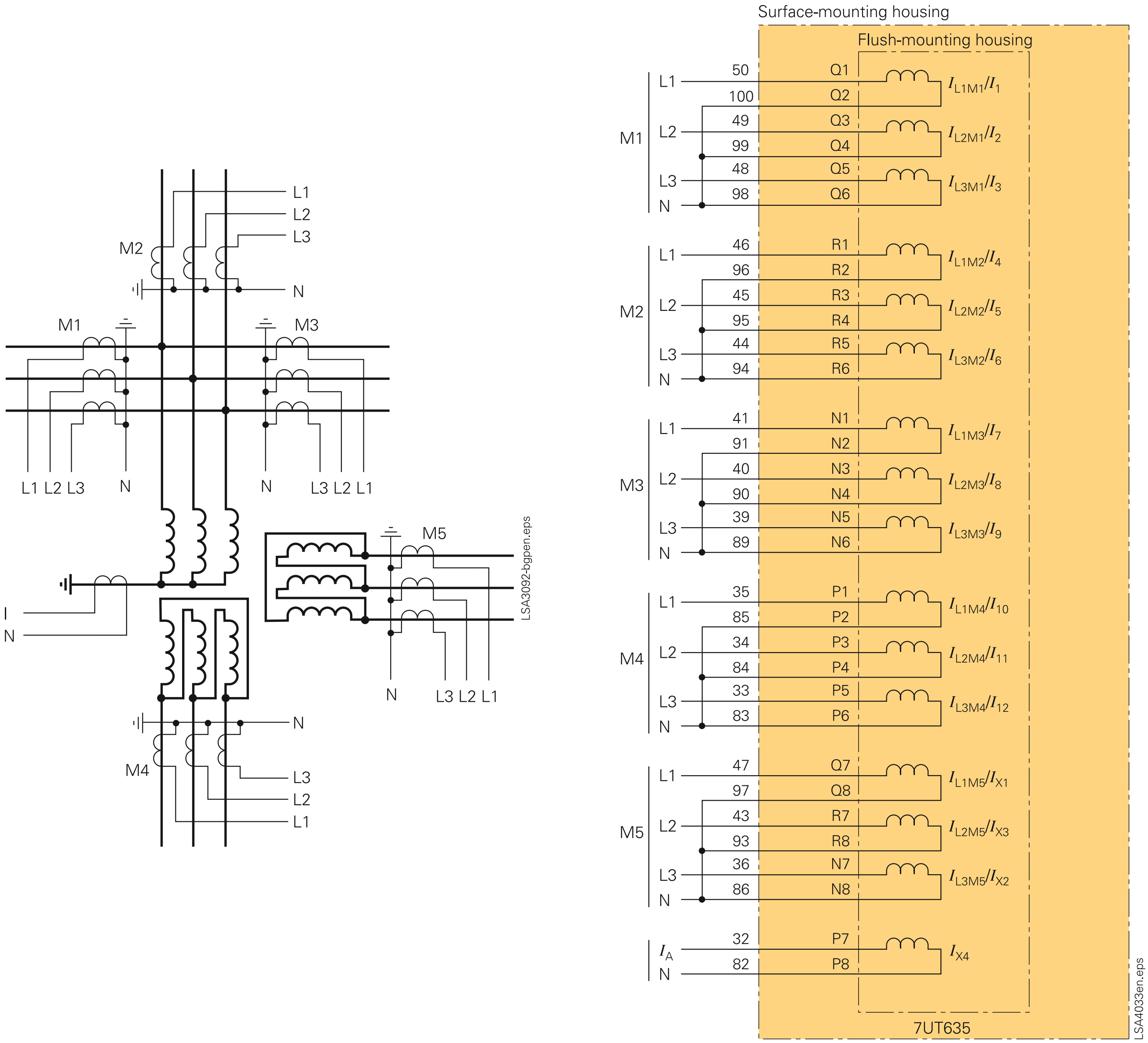


Fig. 8/31
Connection example 7UT635 for a three-winding power transformer with 5 measurement locations (3-phase) and neutral current measurement

8

Typical connections

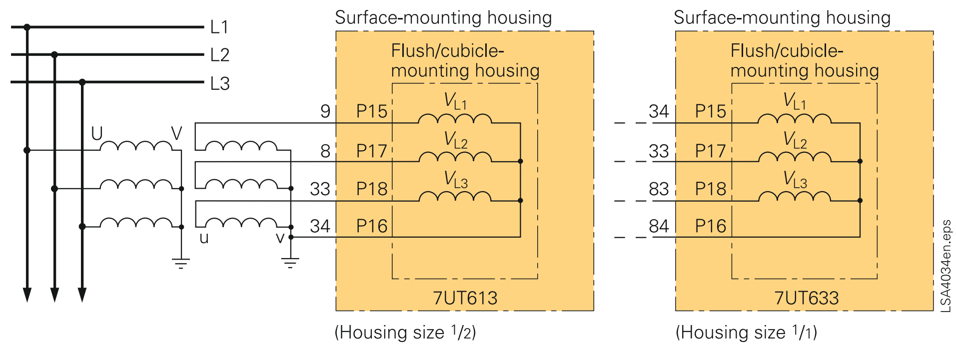


Fig. 8/32
Voltage transformer connection to 3 star-connected voltage transformers (7UT613 and 7UT633 only)

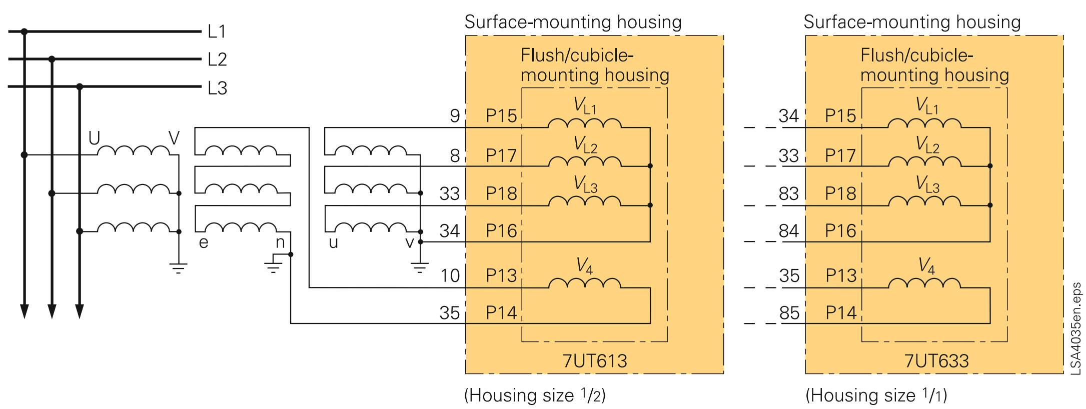


Fig. 8/33
Voltage transformer connection to 3 star-connected voltage transformers with additional delta winding (e-n-winding) (7UT613 and 7UT633 only)

Technical data

General unit data

Analog inputs

Rated frequency	50 or 60 Hz (selectable)			
Rated current	0.1 or 1 or 5 A (selectable by jumper, 0.1 A)			
Power consumption	7UT			
In CT circuits	612	613	633	635
with I_N = 1 A; in VA approx.	0.02	0.05	0.05	0.05
with I_N = 5 A; in VA approx.	0.2	0.3	0.3	0.3
with I_N = 0.1 A; in VA approx.	0.001	0.001	0.001	0.001
sensitive input; in VA approx.	0.05	0.05	0.05	0.05
Overload capacity	I_N			
In CT circuits				
Thermal (r.m.s.)	100 I_N for 1 s 30 I_N for 10 s 4 I_N continuous			
Dynamic (peak value)	250 I_N (half cycle)			
In CT circuits for highly sensitive input I_{EE}				
Thermal	300 A for 1 s 100 A for 10 s 15 A continuous			
Dynamic	750 A (half cycle)			
Rated voltage (7UT613/633 only)	80 to 125 V			
Power consumption per phase at 100 V	≤ 0.1 VA			
Overload capacity				
Thermal (r.m.s.)	230 V continuous			

Auxiliary voltage

Rated voltage	24 to 48 V DC 60 to 125 V DC 110 to 250 V DC and 115 V AC (50/60 Hz), 230 V AC			
Permissible tolerance	-20 to +20 %			
Superimposed AC voltage (peak-to-peak)	≤ 15 %			
Power consumption (DC/AC)	7UT			
	612	613	633	635
Quiescent; in W approx.	5	6/12	6/12	6/12
Energized; in W approx. depending on design	7	12/19	20/28	20/28
Bridging time during failure of the auxiliary voltage				
V_{aux} ≥ 110 V	≥ 50 ms			

Binary inputs

Functions are freely assignable				
Quantity marshallable	7UT			
	612	613	633	635
	3	5	21	29
Rated voltage range	24 to 250 V, bipolar			
Minimum pickup threshold	19 or 88 V DC (bipolar)			
Ranges are settable by means of jumpers for each binary input				
Maximum permissible voltage	300 V DC			
Current consumption, energized	Approx. 1.8 mA			

Output relay

Command / indication / alarm relay				
Quantity	7UT			
each with 1 NO contact	612	613	633	635
(marshallable)	4	8	24	24
1 alarm contact, with 1 NO or NC contact (not marshallable)				
Switching capacity				
Make	1000 W / VA			
Break	30 VA			
Break (with resistive load)	40 W			
Break (with L/R ≤ 50 ms)	25 W			
Switching voltage	250 V			
Permissible total current	30 A for 0.5 seconds 5 A continuous			
Operating time, approx.				
NO contact	8 ms			
NO/NC contact (selectable)	8 ms			
Fast NO contact	5 ms			
High-speed*) NO trip outputs	< 1 ms			

LEDs

Quantity	7UT			
	612	613	633	635
RUN (green)	1	1	1	1
ERROR (red)	1	1	1	1
LED (red), function can be assigned	7	14	14	14

Unit design

Housing 7XP20	For dimensions please refer to dimension drawings part 15			
Degree of protection acc. to IEC 60529				
For the device				
in surface-mounting housing	IP 51			
in flush-mounting housing				
front	IP 51			
rear	IP 50			
For personal safety	IP 2x with closed protection cover			
Housing	7UT			
	612	613	633	635
Size, referred to 19” frame	1/3	1/2	1/1	1/1
Weight, in kg				
Flush-mounting housing	5.1	8.7	13.8	14.5
Surface-mounting housing	9.6	13.5	22.0	22.7

Serial interfaces

Operating interface 1 for DIGSI 4 or browser

Connection	Front side, non-isolated, RS232, 9-pin subminiature connector (SUB-D)
Transmission rate in kbaud Setting as supplied: 38.4 kbaud, parity 8E1	7UT612: 4.8 to 38.4 kbaud 7UT613/633/635: 4.8 to 115 kbaud
Distance, max.	15 m

Time synchronization DCF77 / IRIG-B signal / IRIG-B000

Connection	Rear side, 9-pin subminiature connector (SUB-D) (terminals with surface-mounting housing)
Voltage levels	5, 12 or 24 V (optional)

Service interface (operating interface 2) for DIGSI 4 / modem / service

Isolated RS232/RS485/FO	9-pin subminiature connector (SUB-D)
Dielectric test	500 V / 50 Hz
Distance for RS232	Max. 15 m / 49.2 ft
Distance for RS485	Max. 1000 m / 3300 ft
Distance for FO	1.5 km (1 mile)

*) With high-speed contacts all operating times are reduced by 4.5 ms.

8

Technical data

System interface	
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 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 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 62.5/125µm
Distance	Max. 800 m/0.5 mile
IEC 60870-5-103	
Isolated RS232/RS485/FO	9-pin subminiature connector (SUB-D)
Baud rate	4800 to 19200 baud
Dielectric test	500 V/50 Hz
Distance for RS232	Max. 15 m
Distance for RS485	Max. 1000 m
For fiber-optic cable	
Connector type	ST connector
Optical wavelength	λ = 820 nm
Permissible attenuation	Max. 8 dB, for glass-fiber 62.5/125 µm
Distance	Max. 1.5 km
PROFIBUS RS485 (-FMS/-DP)	
Connector type	9-pin subminiature connector (SUB-D)
Baud rate	Max. 1.5 Mbaud
Dielectric test	500 V / 50 Hz
Distance	Max. 1000 m (3300 ft) at ≤ 93.75 kbaud
PROFIBUS fiber optic (-FMS/-DP)	
Only for flush-mounting housing	ST connector
For surface-mounting housing	Optical interface with OLM[1)]
Baud rate	Max. 1.5 Mbaud
Optical wavelength	λ = 820 nm
Permissible attenuation	Max. 8 dB, for glass-fiber 62.5/125 µm
Distance	500 kbaud 1.6 km (0.99 miles) 1500 kbaud 530 m (0.33 miles)
DNP 3.0 RS485 / MODBUS RS485	
Connector type	9-pin subminiatur connector (SUB-D)
Baud rate	Max. 19200 baud
Dielectric test	500 V / 50 Hz
Distance	Max. 1000 m (3300 ft)
DNP 3.0 Optical/MODBUS FO	
Connector type	ST connector
Optical wavelength	λ = 820 nm
Permissible attenuation	Max. 8 dB, for glass-fiber 62.5/125 µm
Distance	1.5 km (1 mile)

1) Conversion with external OLM
For fiber-optic interface please complete Order No. at 11th position with 4 (FMS RS485) or 9 (DP RS485) and Order code L0A 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
Insulation tests	
Standards	IEC 60255-5 and 60870-2-1
Voltage test (100 % test)	
All circuits except for auxiliary supply, binary inputs and communication interfaces	2.5 kV (r.m.s.), 50 Hz / 60 Hz
Auxiliary voltage and binary inputs (100 % test)	3.5 kV DC
RS485/RS232 rear side communication interfaces and time synchronization interface (100 % test)	500 V (r.m.s.), 50 Hz / 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 interference immunity	
Standards	IEC 60255-6, 60255-22 (product standards) EN 6100-6-2 (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); 1 MHz; τ = 15 ms; 400 surges per s; test duration 2 s; R_i = 200 Ω
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, frequency sweep, IEC 60255-22-3, IEC 61000-4-3 class III	10 V/m; 80 to 1000 MHz; 80 % AM; 1 kHZ
Irradiation with RF field, amplitude-modulated, single frequencies, IEC 60255-22-3, IEC 61000-4-3, class III	10 V/m; 80, 160, 450, 900 MHz, 80 % AM; duration > 10 s
Irradiation with RF field, pulse-modulated, single frequencies, IEC 60255-22-3, IEC 61000-4-3/ ENV 50204, class III	10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 % PM
Fast transients interference, bursts IEC 60255-22-4 and IEC 61000-4-4, class IV	4 kV; 5/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities; R_i = 50; 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: 2kV; 12 Ω, 9 µF Differential (transversal) mode: 1kV; 2 Ω, 18 µF
Analog inputs, binary inputs, binary outputs	Common (longitude) mode: 2kV; 42 Ω, 0.5 µF Differential (transversal) mode: 1kV; 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

Technical data

Electrical tests (cont'd)	
EMC tests for interference immunity (cont'd)	
Magnetic field with power frequency IEC 61000-4-8, IEC 60255-6 class IV	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 kV (peak); 1 MHz; τ = 15 µs; Damped wave; 400 surges per second; duration 2 s; R_i = 200 Ω
Fast transient surge withstand capability, ANSI/IEEE C37.90.1	4 kV; 5/50 ns; 5 kHz; burst 15 ms; repetition rate 300 ms; both polarities; duration 1 min.; R_i = 80 Ω
Damped oscillations IEC 60894, IEC 61000-4-12	2.5 kV (peak value), polarity alternating 100 kHz, 1 MHz, 10 MHz and 50 MHz, R_i = 200 Ω
EMC tests for interference emission (type test)	
Standard	EN 50081-* (generic standard)
Conducted interference, only auxiliary supply IEC-CISPR 22	150 kHz to 30 MHz Limit class B
Radio interference field strenght 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
Vibration IEC 60255-21-1, class 2 IEC 60255-2-6	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 of the 3 axes
Continuous shock IEC 60255-21-2, class 1 IEC 60068-2-29	Half-sinusoidal acceleration 10 *g*, duration 16 ms, 1000 shocks on each of the 3 axes in both directions

Climatic stress tests	
Temperatures	
Type-tested acc. to IEC 60068-2-1 and -2, test Bd, for 16 h	-25 °C to +85 °C / -13 °F to +185 °F
Temporarily permissible operating temperature, tested for 96 h	-20 °C to +70 °C / -4 °F to +158 °F
Recommended permanent operating temperature acc. to IEC 60255-6 (Legibility of display may be impaired above +55 °C / +131 °F)	-5 °C to +55 °C / +25 °F to +131 °F
– Limiting temperature during permanent storage	-25 °C to +55 °C / -13 °F to +131 °F
– Limiting temperature during transport	-25 °C to +70 °C / -13 °F to +158 °F
Humidity	
Permissible humidity 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.	Yearly average ≤ 75 % relative humidity; on 56 days in the year up to 93 % relative humidity; condensation not permitted

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 (“Low voltage” 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).

Further applicable standards: ANSI/IEEE C37.90.0 and C37.90.1.

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”.

Technical data

Functions			
Differential protection			
General			
Pickup values			
Differential current $I_{DIFF} > / I_{Nobj}$	0.05 to 2.00	(steps 0.01)	
High-current stage $I_{DIFF} >> / I_{Nobj}$	0.5 to 35.0 or deactivated	(steps 0.1) (stage ineffective)	
Pickup on switch-on (factor of $I_{DIFF} >$)	1.0 to 2.0	(steps 0.1)	
Add-on stabilization on external fault ($I_{STAB} >$ set value) $I_{add\text{-}on} / I_{Nobj}$ action time	2.00 to 15.00 2 to 250 cycles or deactivated	(steps 0.01) (steps 1 cycle) (effective until dropoff)	
Tolerances (at preset parameters) $I_{DIFF} >$ stage and characteristic $I_{DIFF} >>$ stage	 5 % of set value 5 % of set value		
Time delays			
Delay of $I_{DIFF} >$ stage $T_{I\text{-}DIFF>}$	0.00 to 60.00 s or deactivated	(steps 0.01 s) (no trip)	
Delay of $I_{DIFF} >>$ stage $T_{I\text{-}DIFF>>}$	0.00 to 60.00 s or deactivated	(steps 0.01 s) (no trip)	
Time tolerance	1 % of set value or 10 ms		
The set times are pure delay times			
Transformers			
Harmonic stabilization			
Inrush restraint ratio (2^{nd} harmonic) I_{2fN}/I_{fN}	10 to 80 %	(steps 1 %)	
Stabilization ratio further (n-th) harmonic (optional 3^{rd} or 5^{th}) I_{nfN}/I_{fN}	10 to 80 %	(steps 1 %)	
Crossblock function max. action time for crossblock	Can be activated / deactivated 2 to 1000 AC cycles (steps 1 cycle) or 0 (crossblock deactivated) or deactivated (active until dropout)		
Operating times			
Pickup time/dropout time with single-side infeed			
Pickup time (in ms) at frequency	50 Hz	60 Hz	
7UT 612			
$I_{DIFF} >$, min.	38	35	
$I_{DIFF} >>$, min.	19	17	
Dropout time (in ms), approx.	35	30	
7UT 613/63x			
$I_{DIFF} >$, min.	30	27	
$I_{DIFF} >>$, min.	11	11	
Dropout time (in ms), approx.	54	46	
Dropout ratio, approx.	0.7		
Current matching for transformers			
Vector group adaptation	0 to 11 (x 30 °) (steps 1)		
Star-point conditioning	Earthed or non-earthed (for each winding)		

Generators, motors, reactors			
Operating times			
Pickup time/dropout time with single-side infeed			
Pickup time (in ms) at frequency	50 Hz	60 Hz	
7UT 612			
$I_{DIFF} >$, min.	38	35	
$I_{DIFF} >>$, min.	19	17	
Dropout time (in ms), approx.	35	30	
7UT 613/63x			
$I_{DIFF} >$, min.	30	27	
$I_{DIFF} >>$, min.	11	11	
Dropout time (in ms), approx.	54	46	
Dropout ratio, approx.	0.7		
Busbars, short lines			
Differential current monitor			
Steady-state differential current monitoring $I_{DIFF\ mon}/I_{Nobj}$	0.15 to 0.80	(steps 0.01)	
Delay of blocking with differential current monitoring $T_{DIFF\ mon}$	1 to 10 s	(steps 1 s)	
Feeder current guard			
Trip release I_{guard}/I_{Nobj} by feeder current guard	0.20 to 2.00 or 0 (always released)	(steps 0.01)	
Operating times			
Pickup time/dropout time with single-side infeed			
Pickup time (in ms) at frequency	50 Hz	60 Hz	
7UT 612			
$I_{DIFF} >$, min.	25	25	
$I_{DIFF} >>$, min.	19	17	
Dropout time (in ms), approx.	30	30	
7UT 613/63x			
$I_{DIFF} >$, min.	11	11	
$I_{DIFF} >>$, min.	11	11	
Dropout time (in ms), approx.	54	46	
Dropout ratio, approx.	0.7		

Technical data

Restricted earth-fault protection

Multiple availability	2 times (option)
Settings	
Differential current $I_{REF} > / I_{Nobj}$	0.05 to 2.00 (steps 0.01)
Limit angle φ_{REF}	110 ° (fixed)
Time delay T_{REF}	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
The set times are pure delay times	
Operating times	

Pickup time (in ms) at frequency	50 Hz	60 Hz
7UT 612		
At 1.5 · setting value I_{REF} >, approx.	40	38
At 2.5 · setting value I_{REF} >, approx.	37	32
Dropout time (in ms), approx.	40	40
7UT 613/63x		
At 1.5 · setting value I_{REF} >, approx.	35	30
At 2.5 · setting value I_{REF} >, approx.	33	29
Dropout time (in ms), approx.	26	23
Dropout ratio, approx.	0.7	

Overcurrent-time protection for phase and residual currents

Multiple availability		3 times (option)
Characteristics		
Definite-time stages (DT)		I_{Ph} >>, $3I_0$ >>, I_{Ph} >, $3I_0$ >
Inverse-time stages (IT)		I_P, $3I_{0P}$
Acc. to IEC		Inverse, very inverse, extremely inverse, long-time inverse
Acc. to ANSI		Inverse, moderately inverse, very inverse, extremely inverse, definite inverse, short inverse, long inverse Alternatively, user-specified trip and reset characteristics
Reset characteristics (IT)		Acc. to ANSI with disk emulation
Current stages		
High-current stages	I_{Ph} >>	0.10 to 35.00 A [1] (steps 0.01 A) or deactivated (stage ineffective)
	T_{IPh} >>	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
	$3I_0$ >>	0.05 to 35.00 A [1] (steps 0.01 A) or deactivated (stage ineffective)
	T_{3I0} >>	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
Definite-time stages	I_{Ph} >	0.10 to 35.00 A [1] (steps 0.01 A) or deactivated (stage ineffective)
	T_{IPh}	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
	$3I_0$ >	0.05 to 35.00 A [1] (steps 0.01 A) or deactivated (stage ineffective)
	T_{3I0} >	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
Inverse-time stages	I_P	0.10 to 4.00 A [1] (steps 0.01 A)
Acc. to IEC	T_{IP}	0.05 to 3.20 s (steps 0.01 s) or deactivated (no trip)
	$3I_{0P}$	0.05 to 4.00 A [1] (steps 0.01 A)
	T_{3I0P}	0.05 to 3.20 s (steps 0.01 s) or deactivated (no trip)
Inverse-time stages	I_P	0.10 to 4.00 A [1] (steps 0.01 A)
Acc. to ANSI	D_{IP}	0.50 to 15.00 s (steps 0.01 s) or deactivated (no trip)
	$3I_{0P}$	0.05 to 4.00 A [1] (steps 0.01 A)
	D_{3I0P}	0.50 to 15.00 s (steps 0.01 s) or deactivated (no trip)

Current stages (cont'd)

Tolerances		
Definite time	Currents Times	3 % of set value or 1 % of rated current 1 % of set value or 10 ms
Inverse time	Currents	Pickup at $1.05 \leq I/I_P \leq 1.15$; or $1.05 \leq I/3I_{0P} \leq 1.15$
Acc. to IEC	Times	5 % ± 15 ms at f_N = 50/60 Hz for $2 \leq I/I_P \leq 20$ and $T_{IP}/s \geq 1$; or $2 \leq I/3I_{0P} \leq 20$ and $T_{3I0P}/s \geq 1$
Acc. to ANSI	Times	5 % ± 15 ms at f_N = 50/60 Hz for $2 \leq I/I_P \leq 20$ and $D_{IP}/s \geq 1$; or $2 \leq I/3I_{0P} \leq 20$ and $D_{3I0P}/s \geq 1$

The set definite times are pure delay times.

Operating times of the definite-time stages

Pickup time/dropout time phase current stages

Pickup time (in ms) at frequency	50 Hz	60 Hz
7UT612		
Without inrush restraint, min.	20	18
With inrush restraint, min.	40	35
Dropout time (in ms), approx.	30	30
7UT613/6x		
Without inrush restraint, min.	11	11
With inrush restraint, min.	33	29
Dropout time (in ms), approx.	35	35

Pickup time/dropout time residual current stages

Pickup time (in ms) at frequency	50 Hz	60 Hz
7UT 612		
Without inrush restraint, min.	40	35
With inrush restraint, min.	40	35
Dropout time (in ms), approx.	30	30
7UT613/6x		
Without inrush restraint, min.	21	19
With inrush restraint, min.	31	29
Dropout time (in ms), approx.	45	43

Dropout ratios

Current stages	Approx. 0.95 for $I/I_N \geq 0.5$

Inrush blocking

Inrush blocking ratio (2nd harmonic) I_{2fN}/I_{fN}	10 to 45 % (steps 1 %)
Lower operation limit	I > 0.2 A [1]
Max. current for blocking	0.30 to 25.00 A [1] (steps 0.01 A)
Crossblock function between phases max. action time for crossblock	Can be activated/deactivated 0.00 to 180 s (steps 0.01 A)

1) Secondary values based on I_N = 1 A;
for I_N = 5 A they must be multiplied by 5.

8

Technical data

Overcurrent-time protection for earth current

Multiple availability		3 times (option)
Characteristics		
Definite-time stages (DT)		$I_E >>$, $I_E >$
Inverse-time stages (IT)		I_{EP}
Acc. to IEC		Inverse, very inverse, extremely inverse, long-time inverse
Acc. to ANSI		Inverse, moderately inverse, very inverse, extremely inverse, definite inverse, short inverse, long inverse
		Alternatively, user-specified trip and reset characteristics
Reset characteristics (IT)		Acc. to ANSI with disk emulation
Current stages		
High-current stage	$I_E >>$	0.05 to 35.00 A [1] (steps 0.01 A) or deactivated (stage ineffective)
	$T_{IE} >>$	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
Definite-time stage	$I_E >$	0.05 to 35.00 A [1] (steps 0.01 A) or deactivated (stage ineffective)
	$T_{IE} >$	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
Inverse-time stages	I_{EP}	0.05 to 4.00 A [1] (steps 0.01 A)
Acc. to IEC	T_{IEP}	0.05 to 3.20 s (steps 0.01 s) or deactivated (no trip)
Inverse-time stages	I_{EP}	0.05 to 4.00 A [1] (steps 0.01 A)
Acc. to ANSI	D_{IEP}	0.50 to 15.00 s (steps 0.01 s) or deactivated (no trip)
Tolerances		
Definite time	Currents	3 % of set value or 1 % of rated current
	Times	1 % of set value or 10 ms
Inverse time	Currents	Pickup at $1.05 \leq I/I_{EP} \leq 1.15$
Acc. to IEC	Times	5 % ± 15 ms at f_N = 50/60 Hz for $2 \leq I/I_{EP} \leq 20$ and T_{IEP}/s ≥ 1
Acc. to ANSI	Times	5 % ± 15 ms at f_N = 50/60 Hz for $2 \leq I/I_{EP} \leq 20$ and D_{IEP}/s ≥ 1

The set definite times are pure delay times.

Operating times of the definite-time stages

Pickup time/dropout time

Pickup time (in ms) at frequency	50 Hz	60 Hz
7UT 612		
Without inrush restraint, min.	20	18
With inrush restraint, min.	40	35
Dropout time (in ms), approx.	30	30
7UT613/63x		
Without inrush restraint, min.	11	11
With inrush restraint, min.	33	29
Dropout time (in ms), approx.	35	35

Dropout ratios		
Current stages		Approx. 0.95 for $I/I_N \geq 0.5$
Inrush blocking		
Inrush blocking ratio (2nd harmonic)	I_{2fN}/I_{fN}	10 to 45 % (steps 1 %)
Lower operation limit		$I > 0.2$ A [1]
Max. current for blocking		0.30 to 25.00 A [1] (steps 0.01 A)

1) Secondary values based on I_N = 1 A; for I_N = 5 A they must be multiplied by 5.

Dynamic cold-load pickup for overcurrent-time protection

Time control		
Start criterion		Binary input from circuit-breaker auxiliary contact or current criterion (of the assigned side)
CB open time	$T_{CB\ open}$	0 to 21600 s (= 6 h) (steps 1 s)
Active time	$T_{Active\ time}$	1 to 21600 s (= 6 h) (steps 1 s)
Accelerated dropout time	$T_{Stop\ time}$	1 to 600 s (= 10 min) (steps 1 s) or deactivated (no accelerated dropout)
Setting ranges and changeover values		
Dynamic parameters of current pickup and delay times or time multipliers		Setting ranges and steps are the same as for the functions to be influenced

Single-phase overcurrent-time protection

Current stages		
High-current stage	$I >>$	0.05 to 35.00 A [1] (steps 0.01 A) 0.003 to 1.500 A [2] (steps 0.001 A) or deactivated (stage ineffective)
	$T_T >>$	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
Definite-time stage	$I >$	0.05 to 35.00 A [1] (steps 0.01 A) 0.003 to 1.500 A [2] (steps 0.001 A) or deactivated (stage ineffective)
	$T_I >$	0.00 to 60.00 s (steps 0.01 s) or deactivated (no trip)
Tolerances	Currents	3 % of set value or 1 % of rated current at I_N = 1 A or 5 A; 5 % of set value or 3 % of rated current at I_N = 0.1 A
	Times	1 % of set value or 10 ms

The set definite times are pure delay times.

Operating times

Pickup time/dropout time

Pickup time (in ms) at frequency	50 Hz	60 Hz
7UT612		
Minimum	20	18
Dropout time (in ms), approx.	30	27
7UT613/63x		
Minimum	14	13
Dropout time (in ms), approx.	25	22

Dropout ratios

Current stages	Approx. 0.95 for $I/I_N \geq 0.5$

2) Secondary values for high-sensitivity current input I_8, independent of rated current.

8

Technical data

Unbalanced load protection (Negative-sequence protection)

Characteristics

Definite-time stages	(DT)	$I_2 >>, I_2 >$
Inverse-time stages Acc. to IEC	(IT)	I_{2P} Inverse, very inverse, extremely inverse
Acc. to ANSI		Inverse, moderately inverse, very inverse, extremely inverse
Reset characteristics	(IT)	Acc. to ANSI with disk emulation
Operating range		0.1 to 4 A [1)]

Current stages

High-current stage	$I_2 >>$ $T_{I2} >>$	0.10 to 3.00 A [1)] 0.00 to 60.00 s or deactivated (no trip)	(steps 0.01 A) (steps 0.01 s)
Definite-time stage	$I_2 >$ $T_{I2} >$	0.10 to 3.00 A [1)] 0.00 to 60.00 s or deactivated (no trip)	(steps 0.01 A) (steps 0.01 s)
Inverse-time stages Acc. to IEC	I_{2P} T_{I2P}	0.10 to 2.00 A [1)] 0.05 to 3.20 s or deactivated (no trip)	(steps 0.01 A) (steps 0.01 s)
Inverse-time stages Acc. to ANSI	I_{2P} D_{I2P}	0.10 to 2.00 A [1)] 0.50 to 15.00 s or deactivated (no trip)	(steps 0.01 A) (steps 0.01 s)

Tolerances Definite-time	Currents Times	3 % of set value or 1 % of rated current 1 % of set value or 10 ms
Inverse time Acc. to IEC	Currents Times	Pickup at $1.05 \leq I/I_{EP} \leq 1.15$ 5 % ± 15 ms at f_N = 50/60 Hz for $2 \leq I/I_{EP} \leq 20$ and $T_{IEP}/s \geq 1$
Acc. to ANSI	Times	5 % ± 15 ms at f_N = 50/60 Hz for $2 \leq I/I_{EP} \leq 20$ and $D_{IEP}/s \geq 1$

The set definite times are pure delay times.

Operating times of the definite-time stages

Pickup time/dropout time

Pickup time (in ms) at frequency	50 Hz	60 Hz
7UT612		
Minimum	50	45
Dropout time (in ms), approx.	30	30
7UT613/63x		
Minimum	41	34
Dropout time (in ms), approx.	23	20

Dropout ratios

Current stages	Approx. 0.95 for $I_2/I_N \geq 0.5$

Thermal overload protection

Overload protection using a thermal replica

Multiple availability	2 times (option)

Setting ranges

Factor k acc. IEC 60255-8		0.10 to 4.00	(steps 0.01)
Time constant	τ	1.0 to 999.9 min	(steps 0.1 min)
Cooling down factor at motor stand-still (for motors)	$K\tau$-factor	1.0 to 10.0	(steps 0.1)
Thermal alarm stage	$\Theta_{alarm}/\Theta_{trip}$	50 to 100 % referred to trip temperature rise	(steps 1 %)
Current-based alarm stage	I_{alarm}	0.10 to 4.00 A [1)]	(steps 0.01 A)
Start-up recognition (for motors)	$I_{start\text{-}up}$	0.60 to 10.00 A [1)] or deactivated (no start-up recognition)	(steps 0.01 A)
Emergency start run-on time (for motors)	$T_{run\text{-}on}$	10 to 15000 s	(steps 1 s)

Overload protection using a thermal replica (cont'd)

Tripping characteristics

Tripping characteristic for $I/(k \cdot I_N) \leq 8$

$$t = \tau \cdot \ln \frac{\left(\frac{I}{k \cdot I_N}\right)^2 - \left(\frac{I_{pre}}{k \cdot I_N}\right)^2}{\left(\frac{I}{k \cdot I_N}\right)^2 - 1}$$

t	Tripping time
τ	Heating-up time constant
I	Actual load current
I_{pre}	Preload current
k	Setting factor IEC 60255-8
I_N	Rated current of the protected object

Dropout ratios

Θ/Θ_{trip}	Dropout at Θ_{alarm}
Θ/Θ_{alarm}	Approx. 0.99
I/I_{alarm}	Approx. 0.97

Tolerances
(with one 3-phase measuring location)

Referring to $k \cdot I_N$	3 % or 10 mA [1)]; class 3 % acc. IEC 60255-8
Referring to tripping time	3 % or 1 s at f_N = 50/60 Hz for $I/(k \cdot I_N) > 1.25$

Frequency influence referring to $k \cdot I_N$

In the range $0.9 \leq f/f_N \leq 1.1$	1 % at f_N = 50/60 Hz

Hot-spot calculation and determination of the ageing rate

Thermo-box
(temperature monitoring box)

Number of measuring points	From 1 thermo-box (up to 6 temperature sensors) or from 2 thermo-boxes (up to 12 temperature sensors)
For hot spot calculation *one* temperature sensor must be connected.	

Cooling

Cooling method	ON (oil natural) OF (oil forced) OD (oil directed)	
Oil exponent Y	1.6 to 2.0	(steps 0.1)
Hot spot to top-oil gradient H_{gr}	22 to 29	(steps 1)

Annunciation thresholds

Warning temperature hot spot	98 to 140 °C 208 to 284 °F	(steps 1 °C) (steps 1 °F)
Alarm temperature hot spot	98 to 140 °C 208 to 284 °F	(steps 1 °C) (steps 1 °F)
Warning ageing rate	0.125 to 128.000	(steps 0.001)
Alarm ageing rate	0.125 to 128.000	(steps 0.001)

1) Secondary values based on I_N = 1 A;
for I_N = 5 A they must be multiplied by 5.

Technical data

Thermo-boxes for overload protection	
Thermo-boxes (connectable)	1 or 2
Number of temperature sensors per thermo-box	Max. 6
Measuring type	Pt 100 Ω or Ni 100 Ω or Ni 120 Ω
Annuciation thresholds	
For each measuring point:	
Warning temperature (stage 1)	-50 to 250 °C (steps 1 °C) -58 to 482 °F (steps 1 °F) or deactivated (no warning)
Alarm temperature (stage 2)	-50 to 250 °C (steps 1 °C) -58 to 482 °F (steps 1 °F) or deactivated (no alarm)

Breaker failure protection	
Multiple availability	2 times (option)
Setting ranges	
Current flow monitoring	0.04 to 1.00 A [1)] (steps 0.01 A) for the respective side
Dropoff to pickup ratio	Approx. 0.9 for $I \geq 0.25$ A [1)]
Pickup tolerance	5 % of set value or 0.01 A [1)]
Breaker status monitoring	Binary input for CB auxiliary contact
Starting conditions	
For breaker failure protection	Internal trip External trip (via binary input)
Times	
Pickup time	Approx. 2 ms (7UT613/63x) and approx. 3 ms (7UT612) with measured quantities present; Approx. 20 ms after switch-on of measured quantities, f_N = 50/60 Hz
Reset time (incl. output relay), approx.	50 Hz / 60 Hz
7UT612	30 ms / 30 ms
7UT613/63x	25 ms / 25 ms
Delay times for all stages	0.00 to 60.00 s; deactivated (steps 0.01 s)
Time tolerance	1 % of setting value or 10 ms

Overexitation protection (Volt / Hertz) (7UT613 / 633 only)		
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 deactivated	
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 (in ms) (alarm and V/f>>-stage)	50 Hz	60 Hz
Pickup times at 1.1 of set value, approx.	36	31
Drop-off times, approx.	28	23
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	

1) Secondary values based on I_N = 1 A;
for I_N = 5 A they must be multiplied by 5.

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

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

Technical data

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
External trip commands	
Binary inputs	
Number of binary inputs for direct tripping	2
Operating time	Approx. 12.5 ms min. Approx. 25 ms typical
Dropout time	Approx. 25 ms
Delay time	0.00 to 60.00 s (steps 0.01 s)
Expiration tolerance	1 % of set value or 10 ms
The set definite times are pure delay times.	
Transformer annunciations	
External annunciations	Buchholz warning Buchholz tank Buchholz tripping
Measured quantities supervision	
Current symmetry (for each measurement location)	$\|I_{min}\| / \|I_{max}\|$ < BAL. FAKT. I if I_{max} / I_N > BAL. I LIMIT / I_N
BAL. FAKT. I	0.10 to 0.90 (steps 0.01)
BAL. I LIMIT	0.10 to 1.00 A [1] (steps 0.01 A)
Voltage symmetry (if voltages applied)	$\|V_{min}\| / \|V_{max}\|$ < BAL. FAKT. if $\|V_{max}\|$ > BALANCE V-LIMIT
Voltage sum (if voltages applied)	$\|\underline{V}_{L1}+\underline{V}_{L2}+\underline{V}_{L3}$- kV · $\underline{V}_{EN}\|$ > 25 V
Current phase sequence	$\underline{I}_{L1}$ before $\underline{I}_{L2}$ before $\underline{I}_{L3}$ (clockwise) or $\underline{I}_{L1}$ before $\underline{I}_{L3}$ before $\underline{I}_{L2}$ (counter-clockwise) if $\|\underline{I}_{L1}\|, \|\underline{I}_{L2}\|, \|\underline{I}_{L3}\| > 0.5\ I_N$
Voltage phase sequence (if voltages applied)	$\underline{V}_{L1}$ before $\underline{V}_{L2}$ before $\underline{V}_{L3}$ (clockwise) or $\underline{V}_{L1}$ before $\underline{V}_{L3}$ before $\underline{V}_{L2}$ (counter-clock) if $\|\underline{V}_{L1}\|, \|\underline{V}_{L2}\|, \|\underline{V}_{L3}\| > 40\ V/\sqrt{3}$
Broken wire	Unexpected instantaneous current value and current interruption or missing zero crossing
Fuse failure monitor	
	detects failure of the measured voltage

Trip circuit supervision	
Trip circuits	
Number of supervised trip circuits	1
Operation of each trip circuit	With 1 binary input or with 2 binary inputs
Flexible protection functions (ANSI 27, 32, 47, 50, 55, 59,81)	
N°. of selectable stages	12
Operating modes / measuring quantities	Measurement location or side selectable
3-phase	$I, I_1, I_2, 3I_0, V, V_1, V_2, V_0, P, Q, \cos\varphi$
1-phase	$I, I_E, I_{E\ sens.}, V, P, Q, \cos\varphi$
Without fixed phase relation	f, binary input
Pickup when	Exceeding or falling below threshold value
Setting ranges	
Current $I, I_1, I_2, 3I_0, I_E$	0.05 to 35 A (steps of 0.01 A)
Sens. earth curr. $I_{E\ sens.}$	0.001 to 1.5 A (steps of 0.001 A)
Voltages V, V_1, V_2, V_0	1 to 170 V (steps of 0.1 V)
Displacement voltage V_E	1 to 200 V (steps of 0.1 V)
Power P, Q	1.6 to 3000 W (steps of 0.1 W)
Power P, Q (side)	0.01 to 17 P/S_N, Q/S_N, (steps of 0.01)
Power factor ($\cos\varphi$)	- 0.99 to + 0.99 (steps of 0.01)
Frequency f_N = 50/60 Hz	10 to 66 Hz (steps of 0.01 Hz)
Pickup delay time	0 to 60 s (steps of 0.01 s)
Trip delay time	0 to 3600 s (steps of 0.01 s)
Dropout delay time	0 to 60 s (steps of 0.01 s)
Times	On request (see Manual)
Dropout times	On request (see Manual)
Tolerances	On request (see Manual)
Additional functions	
Operational measured values	
– Operational measured values of currents, 3-phase for each side and measurement location	I_{L1}; I_{L2}; I_{L3} in A primary and secondary and % of I_N
Tolerance at I_N = 1 or 5 A	1 % of measured value or 1 % of I_N
Tolerance at I_N = 0.1 A	2 % of measured value or 2 % of I_N
– Operational measured values of currents, 3-phase for each side and measurement location	$3I_0$; I_1; I_2 in A primary and secondary and % of I_N
Tolerance	2 % of measured value or 2 % of I_N
– Operational measured values of currents	
1-phase for each measurement location	in A primary and secondary and % of I_N
Tolerance at I_N = 1 or 5 A	1 % of measured value or 1 % of I_N
Tolerance at I_N = 0.1 A	2 % of measured value or 2 % of I_N
For high-sensitivity inputs	in A primary and secondary
Tolerance	1 % of measured value or 2 mA

	Feeder	Further	High-sensitivity
7UT612	I_1 to I_7	I_7 to I_8	I_8
7UT613	I_1 to I_9	I_{x1} to I_{x3}	I_{x3}
7UT633	I_1 to I_9	I_{x1} to I_{x3}	I_{x3}
7UT635	I_1 to I_{12}	I_{x1} to I_{x4}	I_{x3}, I_{x4}

– Phase angles of currents, 3-phase for each measurement location	φ (I_{L1}); φ (I_{L2}); φ (I_{L3}) in °, referred to φ (I_{L1})
Tolerance	1 ° at rated current

8

Technical data

Operational measured values (cont'd)	
– Phase angles of currents, 7UT612 7UT613 7UT633 7UT635	 φ (I_1) to φ (I_8) φ (I_1) to φ (I_9), φ (I_{x1}) to φ (I_{x3}) φ (I_1) to φ (I_9), φ (I_{x1}) to φ (I_{x4}) φ (I_1) to φ (I_{12}), φ (I_{x1}) to φ (I_{x4})
1-phase for each measurement location Tolerance	in °, referred to φ (I_1) 1 ° at rated current
– Operational measured values of voltages (7UT613/633 only)	in kV primary and V secondary and % of V_N
3-phase (if voltage applied) Tolerance Tolerance 1-phase (if voltage applied) Tolerance	V_{L1-E}, V_{L2-E}, V_{L3-E}, V_{L1-L2}, V_{L2-L3}, V_{L3-L1}, 0.2 % of measured value or ± 0.2 V V_1, V_2, V_0, 0.4 % of measured value or ± 0.4 V V_{EN} or V_4 0.2 % of measured value or ± 0.2 V
– Phase angles of voltages (7UT613/633 only, if voltages applied) Tolerance	φ (V_{L1-E}), φ (V_{L2-E}), φ (V_{L3-E}), φ (V_4), φ (V_{EN}) 1 ° at rated voltage
– Operational measured values of frequency Range Tolerance	f in Hz and % of f_N 10 to 75 Hz 1 % within range f_N ± 10 % and $I \geq I_N$
– Operational measured values of power	

	S	P	Q
7UT612	x	–	–
7UT613	x	x	x
7UT633	x	x	x
7UT635	x	–	–

S (apparent power)	Applied or rated voltage
P (active power)	Only if voltage applied, 7UT613/633 only
Q (reactive power)	Only if voltage applied, 7UT613/633 only, in kVA; MVA; GVA primary
– Operational measured value of power factor	cos φ (p.f.) Only if voltage applied, 7UT613/633 only
– Overexcitation Tolerance	V / f Only if voltage applied, 7UT613/633 only 2 % of measured value
– Operational measured values for thermal value	Θ_{L1}; Θ_{L2}; Θ_{L3}; Θ_{res}, referred to tripping temperature rise Θ_{trip}
– Operational measured values (Overload protection acc. to IEC 60354)	$\Theta_{thermo-box1}$ to $\Theta_{thermo-box12}$ in °C or °F relative aging rate, load reserve
– Measured values of differential protection Tolerance (with preset values)	$I_{DIFF\ L1}$; $I_{DIFF\ L2}$; $I_{DIFF\ L3}$; $I_{REST\ L1}$; $I_{REST\ L2}$; $I_{REST\ L3}$ in % of operational rated current 2 % of measured value or 2 % of I_N (50/60 Hz) 3 % of measured value or 3 % of I_N (16.7 Hz)
– Measured values of restricted earth-fault protection Tolerance (with preset values)	$I_{DIFFREF}$; $I_{RestREF}$ in % of operational rated current 2 % of measured value or 2 % of I_N (50/60 Hz) 3 % of measured value or 3 % of I_N (16.7 Hz)

8

Max. / Min. / Mean report	
Report of measured values	With date and time from all sides and measurement locations
Reset, automatic	Time of day adjustable (in minutes, 0 to 1439 min) Time frame and starting time adjustable (in days, 1 to 365 days, and ∞)
Reset, manual	Using binary input, using keypad, via communication
Min./max./mean values for current	I_{L1}, I_{L2}, I_{L3}, I_1 (positive-sequence component) I_2 (negative-sequence component), $3I_0$, $I_{DIFF\ L1}$, $I_{DIFF\ L2}$, $I_{DIFF\ L3}$, $I_{RESTR.L1}$, $I_{RESTR.L2}$, $I_{RESTR.L3}$
Min./max./mean values for voltages	V_{L1-E}, V_{L2-E}, V_{L3-E} V_1 (positive-sequence component) V_2 (negative-sequence component) V_0, V_E, V_{L1-L2}, V_{L2-L3}, V_{L3-L1}
Min./max./mean values for power	S, P, Q, cos φ, frequency
Min./max. for mean values	see above
Fault event log	
Storage of the messages of the last 8 faults	With a total of max. 200 messages
Fault recording	
Number of stored fault records	Max. 8
Storage period (start with pickup or trip)	Max. 5 s for each fault, Approx. 5 s in total

	7UT 612	613	633	635
Sampling rate at f_N = 50 Hz	600 Hz	800 Hz	800 Hz	800 Hz
Sampling rate at f_N = 60 Hz	720 Hz	960 Hz	960 Hz	960 Hz

Switching statistics	
Number of trip events caused by 7UT6	
Total of interrupted currents caused by 7UT6	Segregated for each pole, each side and each measurement location
Operating hours Criterion	Up to 7 decimal digits Excess of current threshold
Real-time clock and buffer battery	
Resolution for operational messages	1 ms
Resolution for fault messages	1 ms
Buffer battery	3 V/1 Ah, type CR 1/2 AA Self-discharging time approx. 10 years
Time synchronization	
Operating modes:	
Internal	Internal via RTC
IEC 60870-5-103	External via system interface (IEC 60870-5-103)
Time signal IRIG B	External via IRIG B
Time signal DCF77	External, via time signal DCF77
Time signal synchro-box	External, via synchro-box
Pulse via binary input	External with pulse via binary input

Selection and ordering data

Description	Order No.	Order Code
7UT612 differential protection relay for transformers, generators, motors and busbars Housing 1/3 x 19"; 3 BI, 4 BO, 1 live status contact, 7 I, I_{EE}[1)]	*7UT612□-□□□□□-□□A0*	*□□□*

Description	Code
Rated current	
I_N = 1 A	*1*
I_N = 5 A	*5*
Rated auxiliary voltage (power supply, binary inputs)	
24 to 48 V DC, binary input threshold 17 V [2)]	*2*
60 to 125 V DC [3)], binary input threshold 17 V [2)]	*4*
110 to 250 V DC, 115/230 V AC, binary input threshold 73 V [2)]	*5*
Unit design	
For panel surface mounting, two-tier terminals on top and bottom	*B*
For panel flush mounting, plug-in terminals (2/3-pole AMP connector)	*D*
For panel flush mounting, screw-type terminals, (direct wiring/ring lugs)	*E*
Region-specific default settings/function and language settings	
Region DE, 50/60 Hz, IEC/ANSI, language German; selectable	*A*
Region World, 50/60 Hz, IEC/ANSI, language English (GB); selectable	*B*
Region US, 60/50 Hz, ANSI/IEC, language English (US); selectable	*C*
Region World, 50/60 Hz, IEC/ANSI, language Spanish; selectable	*E*

Description	Code	Order Code
System interface (Port B) on rear		
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-FMS Slave, electrical RS485	*4*	
PROFIBUS-FMS Slave, optical, single loop, ST connector[4)]	*5*	
PROFIBUS-FMS Slave, optical, double loop, ST connector[4)]	*6*	
PROFIBUS-DP Slave, electrical RS485	*9*	*L 0 A*
PROFIBUS-DP Slave, optical 820 nm, double loop, ST connector[4)]	*9*	*L 0 B*
MODBUS, electrical RS485	*9*	*L 0 D*
MODBUS, optical 820 nm, ST connector[4)]	*9*	*L 0 E*
DNP 3.0, electrical RS485	*9*	*L 0 G*
DNP 3.0, optical 820 nm, ST connector[4)]	*9*	*L 0 H*
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector (EN 100)	*9*	*L 0 R*
IEC 61850, 100 Mbit Etherent, optical, double, LC connector (EN 100)[5)]	*9*	*L 0 S*

1) Sensitivity selectable normal/high.

2) The binary input thresholds are selectable in two stages by means of jumpers.

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

4) With surface-mounting housing: only RS485 interface available.

5) If position 9 = "B" (surface-mounting housing), please order relay with electrical Ethernet interface and use a separate FO switch.

See next page

8

Selection and ordering data

Description	Order No.
7UT612 differential protection relay for transformers, generators, motors and busbars	*7UT612□ - □□□□□- □□A0*
DIGSI 4/browser/modem interface (Port C) on rear/temperature monitoring box connection	
No DIGSI 4 port	*0*
DIGSI 4/browser, electrical RS232	*1*
DIGSI 4/browser or temperature monitoring box[1], electrical RS485	*2*
DIGSI 4/browser or temperature monitoring box[1], 820 nm fiber optic, ST connector	*3*
Functions	
Measured values/monitoring functions	
Basic measured values	*1*
Basic measured values, transformer monitoring functions (connection to thermo-box/hot spot acc. to IEC, overload factor)	*4*
Differential protection + basic functions	
Differential protection for transformer, generator, motor, busbar (87) Overload protection for one winding (49), Lockout (86) Overcurrent-time protection (50/51): I>, I>>, I_P (inrush stabilization) Overcurrent-time protection (50N/51N): 3I_0>, 3I_0>>, 3I_{0P} (inrush stabilization) Overcurrent-time protection earth (50G/51G): I_E>, I_E>>, I_{EP} (inrush stabilization)	*A*
Differential protection + basic functions + additional functions	
Restricted earth fault protection, low impedance (87N) Restricted earth fault protection, high impedance (87N without resistor and varistor), O/C 1-phase Trip circuit supervision (74TC), breaker failure protection (50BF), unbalanced load protection (46)	*B*

1) External temperature monitoring box required.

Selection and ordering data

Description	Order No.	Order Code
7UT613 differential protection relay for transformers, generators, motors and busbars Housing 1/2 x 19"; 5 BI, 8 BO, 1 live status contact, 11 I, I_{EE}[1)]	*7UT613□-□□□□□-□□□□ □□□*	
Rated current		
I_N = 1 A	*1*	
I_N = 5 A	*5*	
Rated auxiliary voltage (power supply, binary inputs)		
24 to 48 V DC, binary input threshold 17 V[2)]	*2*	
60 to 125 V DC[3)], binary input threshold 17 V[2)]	*4*	
110 to 250 V DC[1)], 115/230 V AC, binary input threshold 73 V[2)]	*5*	
110 to 250 V DC[1)], 115/230 V AC, binary input threshold 154 V[2)]	*6*	
Unit design		
Surface-mounting housing with two-tier terminals	*B*	
Flush-mounting housing with plug-in terminals	*D*	
Flush-mounting housing with screw-type terminals	*E*	
Region-specific default settings/language settings		
Region DE, 50/60 Hz, IEC/ANSI, language German; selectable	*A*	
Region World, 50/60 Hz, IEC/ANSI, language English (GB); selectable	*B*	
Region US, 60/50 Hz, ANSI/IEC, language English (US); selectable	*C*	
Region World, 50/60 Hz, IEC/ANSI, language French; selectable	*D*	
Region World, 50/60 Hz, IEC/ANSI, language Spanish; selectable	*E*	
System interface (Port B) on rear		
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-FMS Slave, electrical RS485	*4*	
PROFIBUS-FMS Slave, optical, single ring, ST connector[4)]	*5*	
PROFIBUS-FMS Slave, optical, double ring, ST connector[4)]	*6*	
PROFIBUS-DP Slave, electrical RS485	*9*	*L 0 A*
PROFIBUS-DP Slave, optical 820 nm, double ring, ST connector[4)]	*9*	*L 0 B*
MODBUS, electrical RS485	*9*	*L 0 D*
MODBUS, optical 820 nm, ST connector[4)]	*9*	*L 0 E*
DNP 3.0, electrical RS485	*9*	*L 0 G*
DNP 3.0, optical 820 nm, ST connector[4)]	*9*	*L 0 H*
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector (EN 100)	*9*	*L 0 R*
IEC 61850, 100 Mbit Etherent, optical, double, LC connector (EN 100)[5)]	*9*	*L 0 S*

see next page

1) Sensitivity selectable normal/high.
2) The binary input thresholds are selectable in two stages by means of jumpers.
3) Transition between the two auxiliary voltage ranges can be selected by means of jumpers.
4) With surface-mounting housing: only RS485 interface available.
5) If position 9 = "B" (surface-mounting housing), please order relay with electrical Ethernet interface and use a separate FO switch.

8

Selection and ordering data

Description	Order No.	Order Code
7UT613 differential protection relay for transformers, generators, motors and busbars	*7UT613□-□□□□□ - □□□□*	*□□□*
Port C and Port D		
Port C: DIGSI 4/modem, electrical RS232; Port D: empty	1	
Port C: DIGSI 4/modem/thermo-box, electrical RS485; Port D: empty	2	
Port C and Port D installed	9	M □□
Port C (service interface)		
DIGSI 4/modem, electrical RS232		1
DIGSI 4/modem/thermo-box, electrical RS485		2
Port D (additional interface)		
Thermo-box, optical 820 nm, ST connector		A
Thermo-box, electrical RS485		F
Measured values/monitoring functions		
Basic measured values	1	
Extended measured values, min./max. values, mean values	2	
Extended measured values, min./max., mean values, transformer monitoring functions (connection to thermo-box/hot spot, overload factor)	4	
Differential protection + basic functions		
Differential protection for transformer, generator, motor, busbar (87) Overload protection according to IEC for one side (49) Lock out (86) Overcurrent-time protection phases (50/51): $I>$, $I>>$, I_P (inrush stabilization) Overcurrent-time protection 3 I_0 (50N/51N): 3 $I_0>$, 3 $I_0>>$, 3 I_{0P} (inrush stabilization) Overcurrent-time protection earth (50G/51G): $I_E>$, $I_E>>$, I_{EP} (inrush stabilization)	A	
Differential protection + basic functions + additional current functions		
Restricted earth-fault protection, low impedance (87N) Restricted earth-fault protection, high impedance (87N without resistor and varistor), O/C 1-phase Trip circuit supervision (74TC) Unbalanced load protection (46) Breaker failure protection (50BF) High-sensitivity overcurrent-time protection/tank leakage protection (64), O/C 1-phase	B	
Additional voltage functions		
Without voltage functions	A	
With overexcitation protection and voltage/power/energy/measurement	B	
With overexcitation protection and voltage/power/energy measurement + Over/undervoltage protection (59/27) + Frequency protection (81) + Directional power protection (32R/F) + Fuse failure monitor (60FL)	C	
Additional functions (general)		
Without	0	
Multiple protection functions (50, 51, 50N/G, 87N, 50BF, 49)[1]	1	
Flexible protection functions	2	
Multiple + flexible protection functions	3	

1) Available if selected on position 14.

Selection and ordering data

Description	Order No.	Order Code
7UT63□ differential protection relay for transformers, generators, motors and busbars, graphic display	*7UT63□□-□□□□□-□□□□*	*□□□*
Housing, inputs and outputs		
Housing 1/1 x 19”, 21 BI, 24 BO, 1 live status contact 12 current inputs (11 I, I_{EE} 1)); 4 voltage inputs (1 x 3-phase + 1 x 1-phase)	3	
Housing 1/1 x 19”, 29 BI, 24 BO, 1 live status contact 16 current inputs (14 I, 2 I_{EE} 1))	5	
Rated current		
$I_N = 1$ A	1	
$I_N = 5$ A	5	
Rated auxiliary voltage (power supply, binary inputs)		
24 to 48 V DC, binary input threshold 17 V 2)	2	
60 to 125 V DC 3), binary input threshold 17 V 2)	4	
110 to 250 V DC 1), 115/230 V AC, binary input threshold 73 V 2)	5	
110 to 250 V DC 1), 115/230 V AC, binary input threshold 154 V 2)	6	
Unit design		
Surface-mounting with two-tier terminals	B	
Flush-mounting with plug-in terminals	D	
Flush-mounting with screw-type terminals	E	
Surface mounting with two-tier terminals, with 5 high-speed trip contacts	N	
Flush-mounting with plug-in terminals, with 5 high-speed trip contacts	P	
Flush-mounting with screw-type terminals, with 5 high-speed trip contacts	Q	
Region-specific default settings/language settings		
Region DE, 50/60 Hz, IEC/ANSI language German; selectable	A	
Region World, 50/60 Hz, IEC/ANSI language English (GB); selectable	B	
Region US, 60/50 Hz, ANSI/IEC language English (US); selectable	C	
Region World, 50/60 Hz, IEC/ANSI, language French; selectable	D	
Region World, 50/60 Hz, IEC/ANSI language Spanish; selectable	E	
System interface (Port B) on rear		
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-FMS Slave, electrical RS485	4	
PROFIBUS-FMS Slave, optical, single ring, ST connector 4)	5	
PROFIBUS-FMS Slave, optical, double ring, ST connector 4)	6	
PROFIBUS-DP Slave, electrical RS485	9	L 0 A
PROFIBUS-DP Slave, optical 820, double ring, ST connector 4)	9	L 0 B
MODBUS, electrical RS485	9	L 0 D
MODBUS, optical 820 nm, ST connector 4)	9	L 0 E
DNP 3.0, electrical RS485	9	L 0 G
DNP 3.0, optical 820 nm, ST connector 4)	9	L 0 H
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector (EN 100)	9	L 0 R
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector (EN 100) 5)	9	L 0 S

see next page

1) Sensitivity selectable normal/high.
2) The binary input thresholds are selectable in two stages by means of jumpers.
3) Transition between the two auxiliary voltage ranges can be selected by means of jumpers.
4) With surface-mounting housing: only RS485 interface available.
5) If position 9 = “B” (surface-mounting housing), please order relay with electrical Ethernet interface and use a separate FO switch.

Selection and ordering data

Description	Order No.	Order Code
7UT63□ differential protection relay for transformers, generators, motors and busbars, graphic display	*7UT63□□-□□□□□-□□□□*	*□□□*

Port C and Port D	
Port C: DIGSI 4/modem, electrical RS232; Port D: empty	*1*
Port C: DIGSI 4/modem/thermo-box, electrical RS485; Port D: empty	*2*
Port C and Port D installed	*9* … *M* □□

Port C (service interface)	
DIGSI 4/modem, electrical RS232	*1*
DIGSI 4/modem/thermo-box, electrical RS485	*2*

Port D (additional interface)	
Thermo-box, optical 820 nm, ST connector	*A*
Thermo-box, electrical RS485	*F*

Measured values/monitoring functions	
Basic measured values	*1*
Extended measured values, min./max. values, mean values	*2*
Extended measured values, min./max. values, mean values, transformer monitoring functions (connection to thermo-box/hot spot, overload factor)	*4*

Differential protection + basic functions	
Differential protection for transformer, generator, motor, busbar (87) Overload protection according to IEC for one side (49) Lock out (86) Overcurrent-time protection phases (50/51): $I>$, $I>>$, I_P (inrush stabilization) Overcurrent-time protection 3 I_0 (50N/51N): 3 $I_0>$, 3 $I_0>>$, 3 I_{0P} (inrush stabilization) Overcurrent-time protection earth (50G/51G): $I_E>$, $I_E>>$, I_{EP} (inrush stabilization)	*A*

Differential protection + basic functions + additional current functions	
Restricted earth-fault protection, low impedance (87N) Restricted earth-fault protection, high impedance (87N without resistor and varistor), O/C 1-phase Trip circuit supervision (74TC) Unbalanced load protection (46) Breaker failure protection (50BF) High-sensitivity overcurrent-time protection/tank leakage protection (64), O/C 1-phase	*B*

Additional voltage functions (only with 7UT633)	
Without voltage functions	*A*
With overexcitation protection and voltage/power/energy/measurement	*B*
With overexcitation protection and voltage/power/energy measurement + Over/undervoltage protection (59/27) + Frequency protection (81) + Directional power protection (32R/F) + Fuse failure monitor (6FL)	*C*

Additional functions (general)	
Without	*0*
Multiple protection functions (50, 51, 50N/G, 87N, 50BF, 49)[1]	*1*
Flexible protection functions	*2*
Multiple + flexible protection functions	*3*

1) Available if selected on position 14

Accessories

Description		Order No.
DIGSI 4		
Software for configuration and operation of Siemens protection relays running under MS Windows (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 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 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 relay (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)		7XV5100-4
Cable between thermo-box and relay		
- length 5 m / 16.4 ft		7XV5103-7AA05
- length 25 m / 82 ft		7XV5103-7AA25
- length 50 m / 164 ft		7XV5103-7AA50
Voltage transformer miniature circuit-breaker Rated current 1.6 A; Thermal overload release 1.6 A; Overcurrent trip 6 A		3RV1611-1AG14
Temperature monitoring box with 6 thermal inputs For SIPROTEC units		
With 6 temperature sensors and	24 to 60 V AC/DC	7XV5662-2AD10
RS485 interface	90 to 240 V AC/DC	7XV5662-5AD10
Manual for 7UT612 English		C53000-G1176-C148-1
Manual for 7UT6 English V4.0		C53000-G1176-C160-1
English V4.6		C53000-G1176-C160-2

8

Accessories

Fig. 8/34 Mounting rail for 19" rack

Fig. 8/35
2-pin connector

Fig. 8/36
3-pin connector

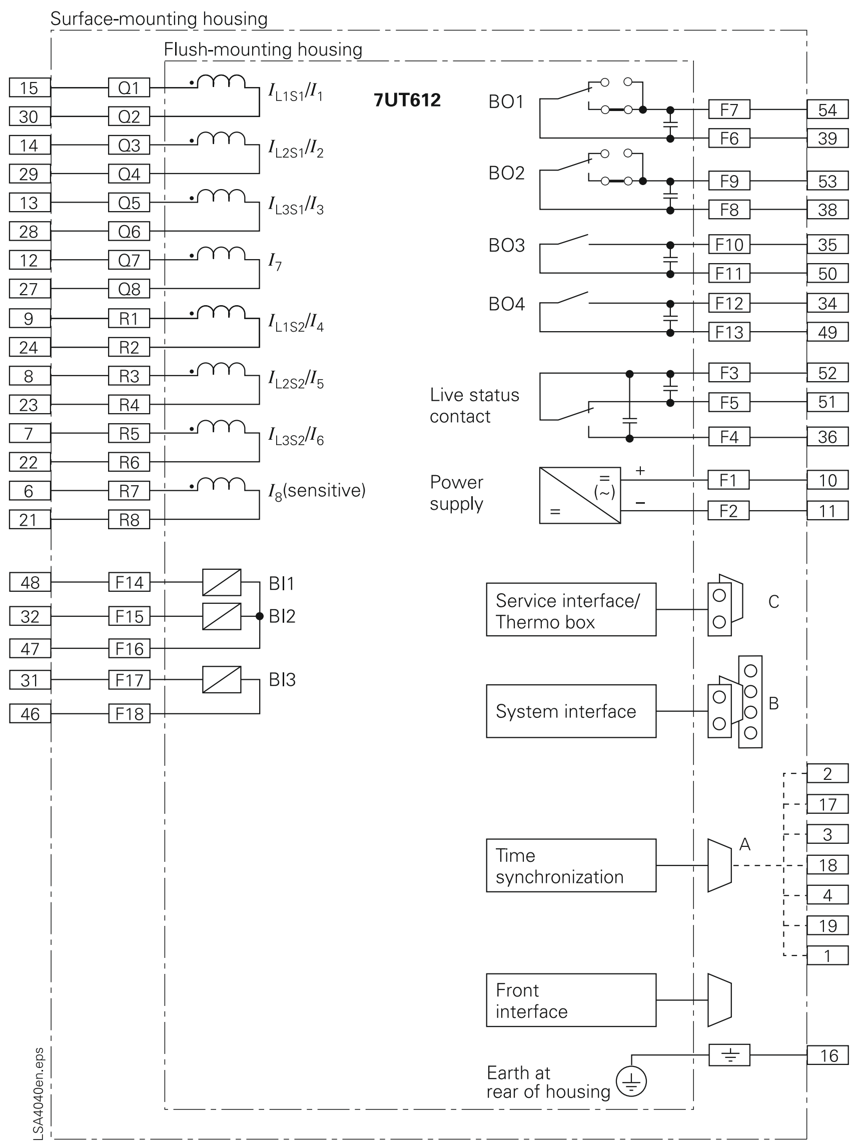
Fig. 8/37
Short-circuit link for current contacts

Fig. 8/38
Short-circuit link for voltage contacts

Description		Order No.	Size of package	Supplier	Fig.
Connector	2-pin	C73334-A1-C35-1	1	Siemens	8/35
	3-pin	C73334-A1-C36-1	1	Siemens	8/36
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	8/34
Short-circuit links	For current contacts	C73334-A1-C33-1	1	Siemens	8/37
	For voltage contacts	C73334-A1-C34-1	1	Siemens	8/38
Safety cover for terminals	large	C73334-A1-C31-1	1	Siemens	
	small	C73334-A1-C32-1	1	Siemens	

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

Connection diagram



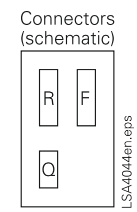
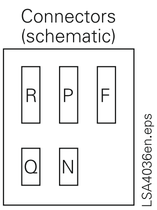


Fig. 8/39 Connection diagram

Connection diagram



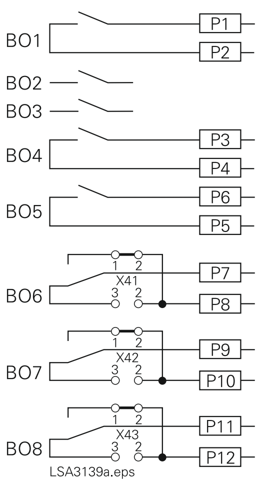


Fig. 8/40a
Additional setting by jumpers:
Separation of common circuit of fast BO1 to BO5 with jumpers X80, X81, X82. Switching of fast BO7, BO8 as NO contact or NC contact with jumpers X41, X42, X43.

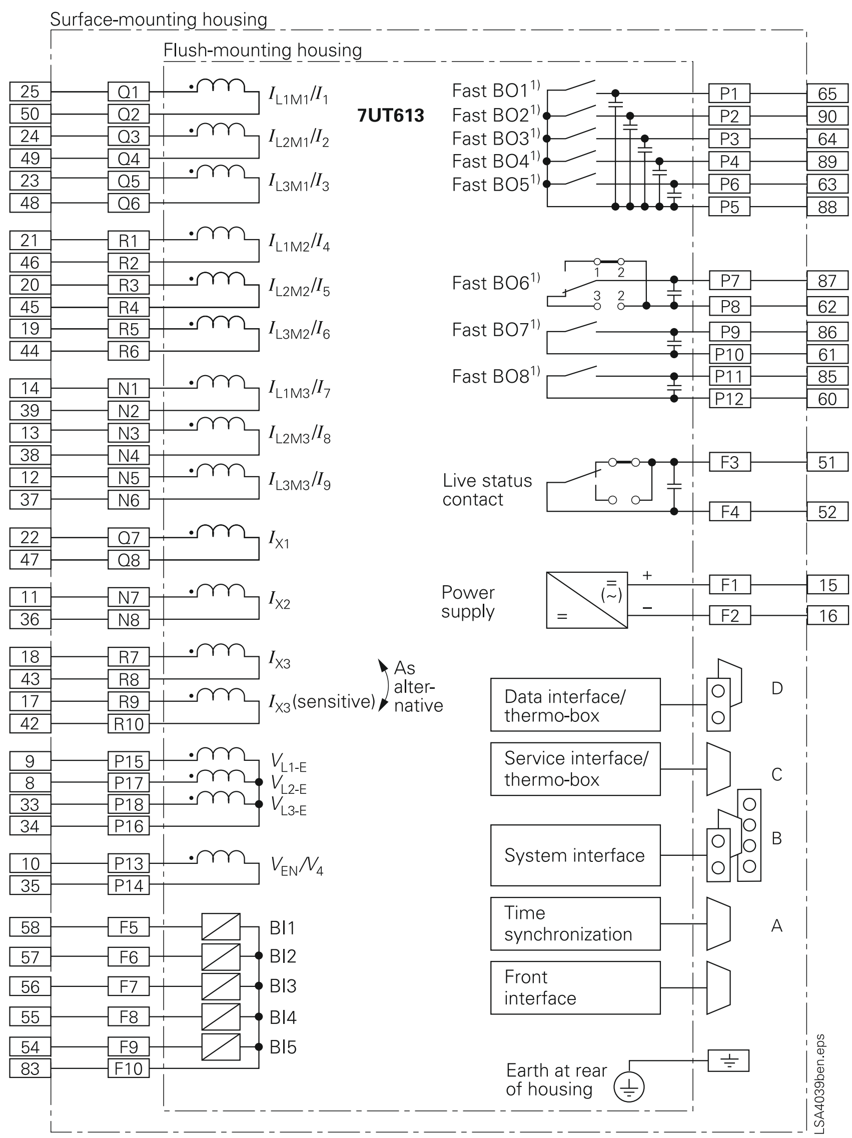
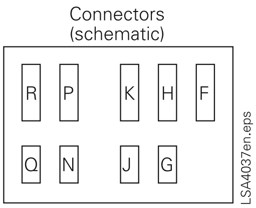


Fig. 8/40 Connection diagram 7UT613

1) Configuration of binary outputs up to hardware-version .../CC
For advanced flexibility see Fig. 8/40a.

Connection diagram



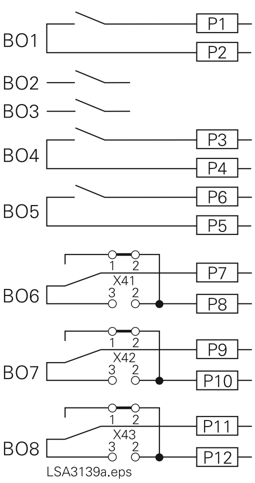


Fig. 8/41a
Additional setting by jumpers:
Separation of common circuit of fast BO1 to BO5 with jumpers X80, X81, X82. Switching of fast BO7, BO8 as NO contact or NC contact with jumpers X41, X42, X43.

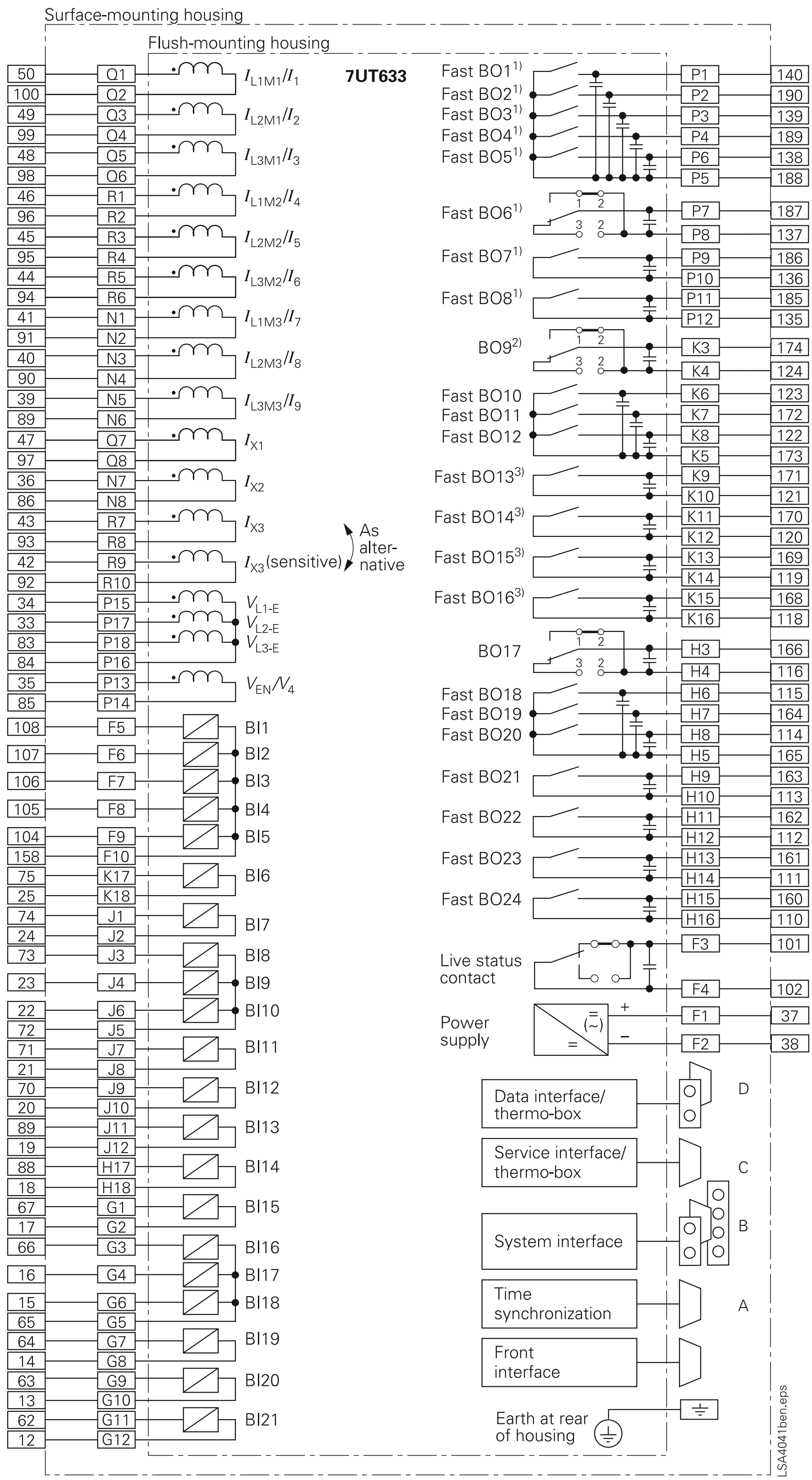


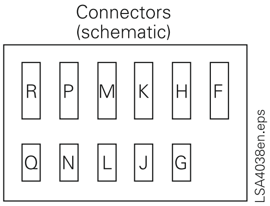
Fig. 8/41 Connection diagram 7UT63

1) Configuration of binary outputs up to hardware-version .../CC
For advanced flexibility see Fig. 8/41a.

2) High-speed contacts (option), NO only

3) High-speed contacts (option)

Connection diagram



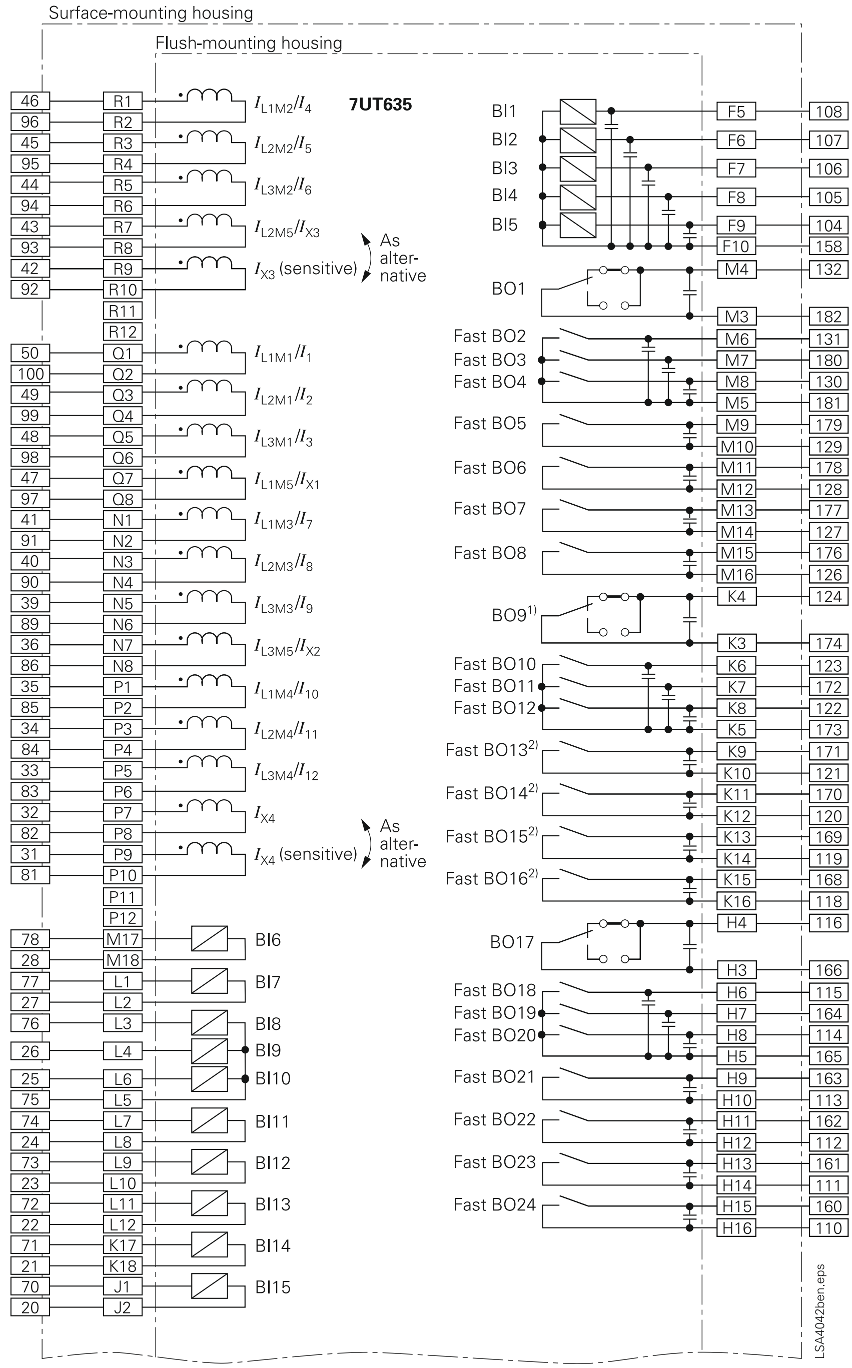


Fig. 8/42 Connection diagram 7UT635
part 1; continued on following page

1) High-speed contacts (option), NO only
2) High-speed contacts (option)

Connection diagram

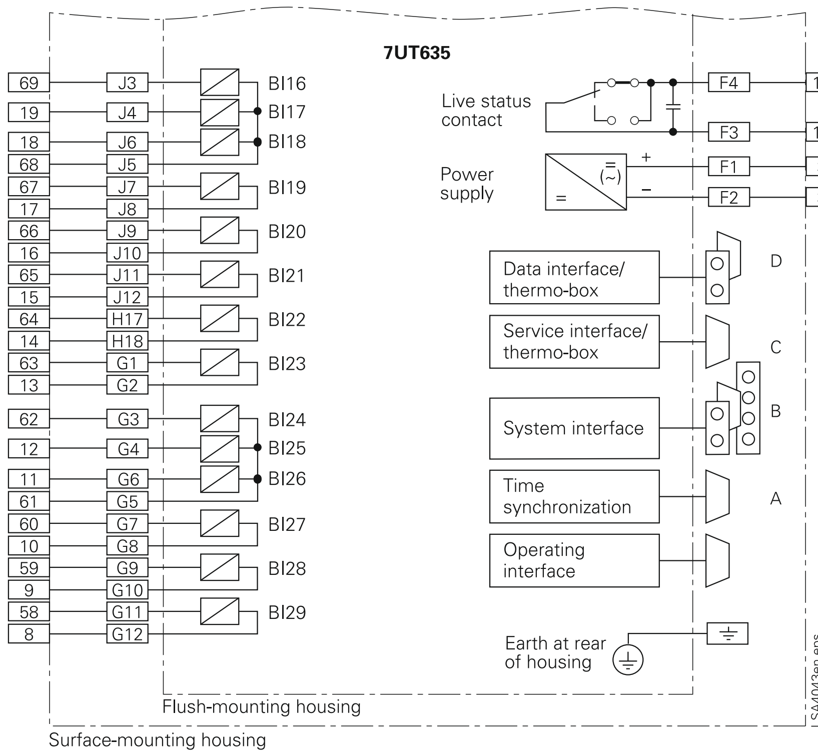


Fig. 8/43 Connection diagram 7UT635 part 2