## SIPROTEC 4 7UT6 differential protection relay for transformers, generators, motors and busbars


**Fig. 8/1** SIPROTEC 7UT6 differential protection relay for ransformers, generators, motors and busbar

### 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 ground-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: ground-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 /ground overcurrent protection
- Overload protection with or without temperature measurement
- Negative-sequence protection
- Breaker failure protection
- Low/high-impedance restricted ground 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 DP,
  MODBUS or DNP 3
- Service interface for DIGSI 4 (modem)/ temperature monitoring (thermo-box)
- Time synchronization via IRIG-B/DCF 77

## Application

### 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.

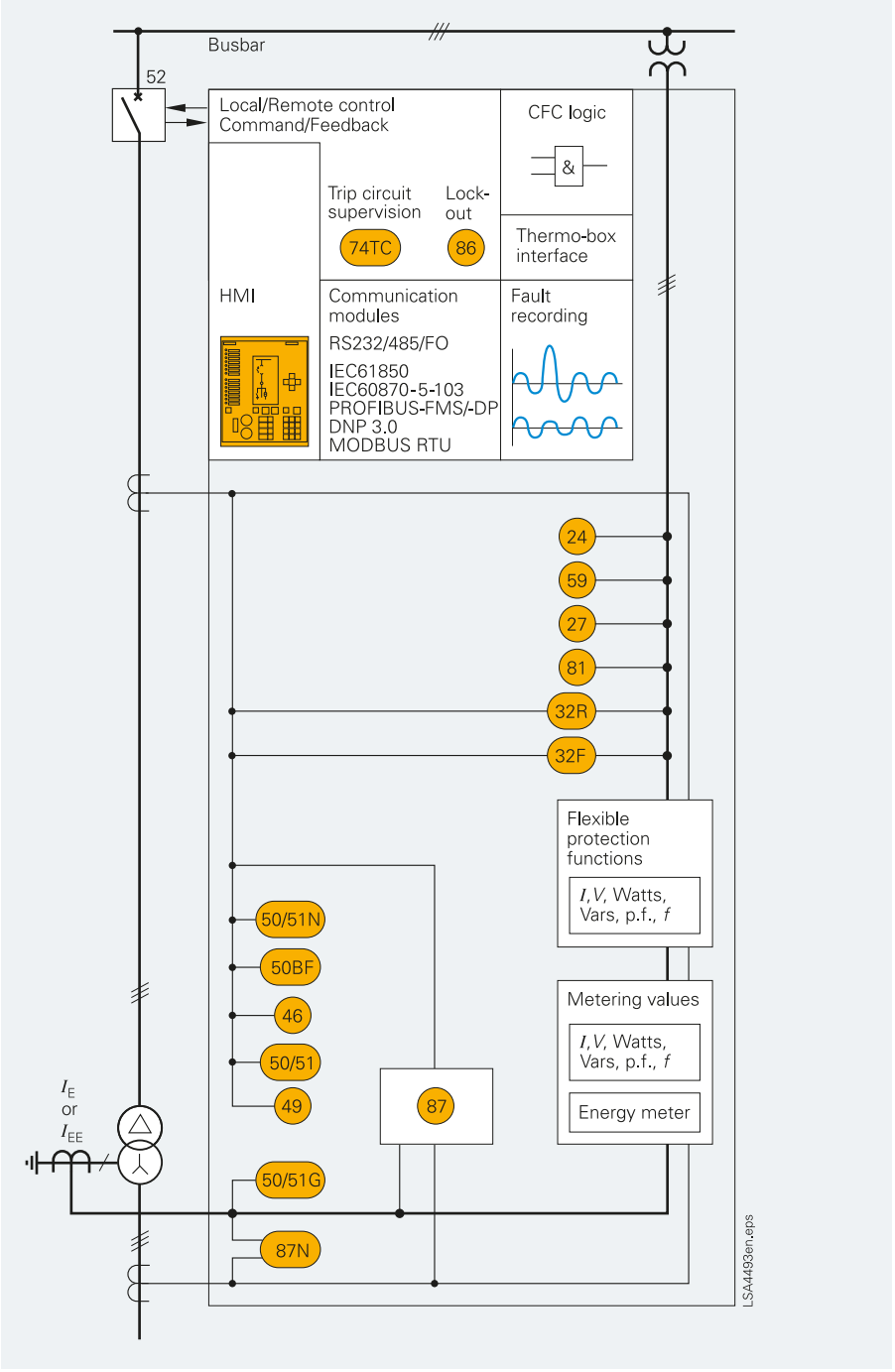



**Fig. 8/2** Function diagram

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

■ 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.

– ⅓ (7UT612),
– ½ (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 14).


**Fig. 8/3** Rear view flush-mountig housing

## 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.

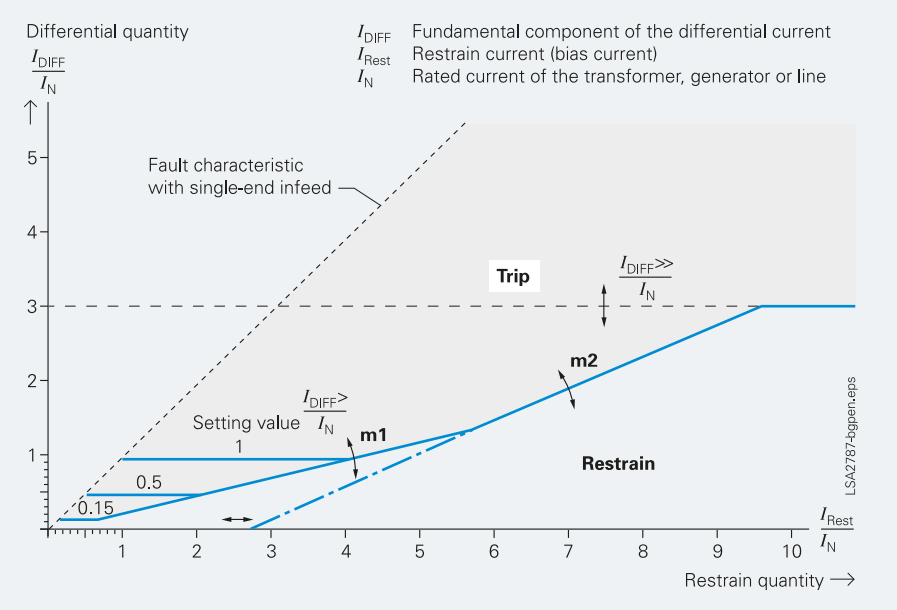



**Fig. 8/4** Tripping characteristic with preset transformer parameters for three-phase faults

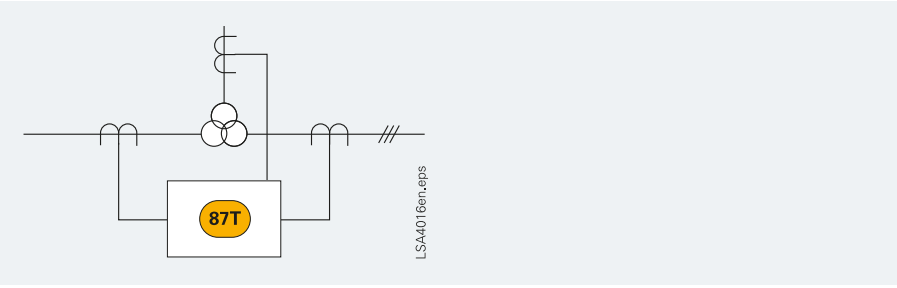



**Fig. 8/5** 3-winding transformers (1 or 3-phase)

**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 grounded 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 ground current differential protection can be implemented (REF).

This function is substantially more sensitive than the differential protection during faults to ground 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 ground 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 grounded windings. Thus separate REF relays are not required.

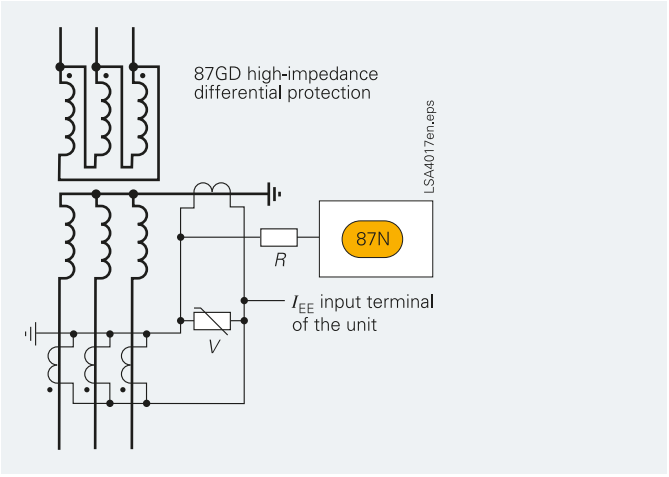



**Fig. 8/6** High-impedance differential protection

**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.

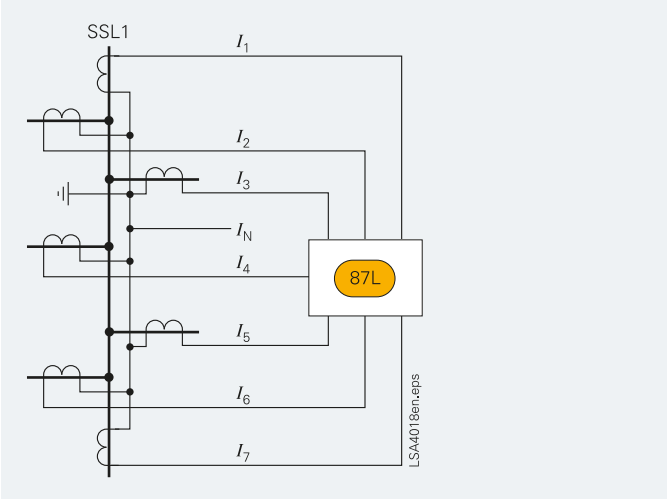



**Fig. 8/7** Simple busbar protection with phase-selective configuration
7UT612: 7 feeders; 7UT613/633: 9 feeders;
7UT635: 12 feeders

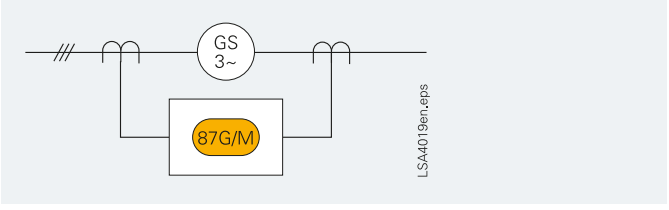



**Fig. 8/8** Generator/motor differential protection

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.

## 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 ground (ANSI 50/51G)**

The 7UT6 feature a separate 2-stage overcurrent-time protection for the ground. 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-ground voltages (for low-voltage generators) can be evaluated. The measuring results of the line-to-line voltages are independent of the neutral point displacement caused by ground faults.
This function is implemented in two stages.

**Frequency protection (ANSI 81) (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.

### 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.

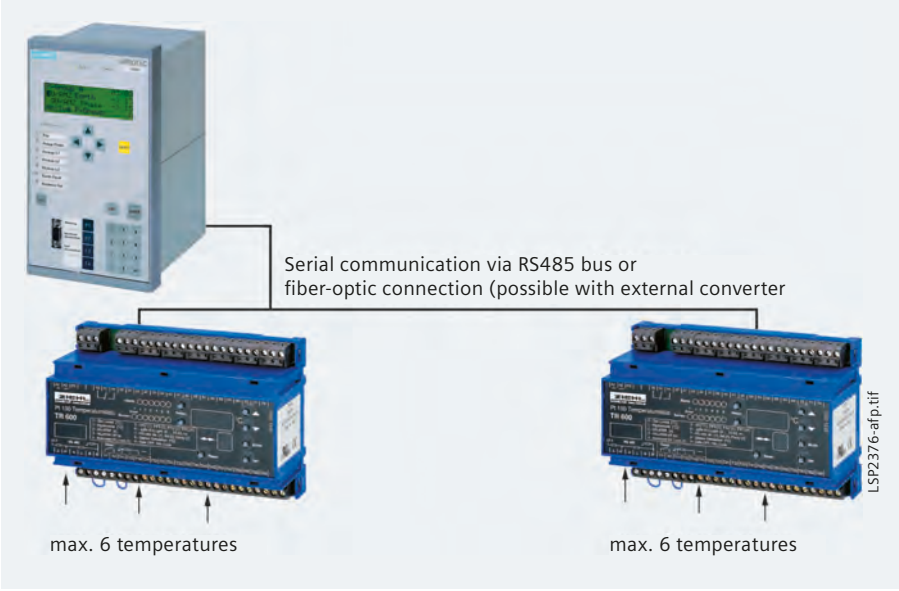



**Fig. 8/9** Temperature measurement and monitoring with external thermo-boxes

### 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)

### 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.

## 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 $\varphi$),
- Frequency
- Energy + kWh, + kVarh, forward and reverse power flow
- Min./max. and mean values of $V_{PH-PH}$, $V_{PHE}$, $V_E$, $V_0$, $V_1$, $V_2$, $I_{PH}$, $I_1$, $I_2$, $3I_0$, $I_{DIFF}$, $I_{RESTRAINT}$, $S$, $P$, $Q$, cos $\varphi$, $f$
- 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

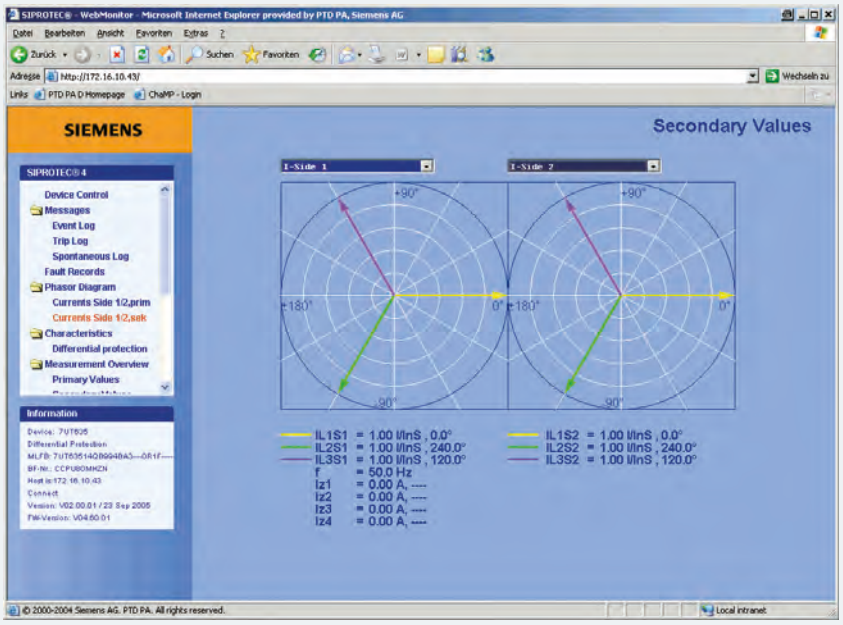



**Fig. 8/10** Commissioning via a standard Web browser: Phasor diagram

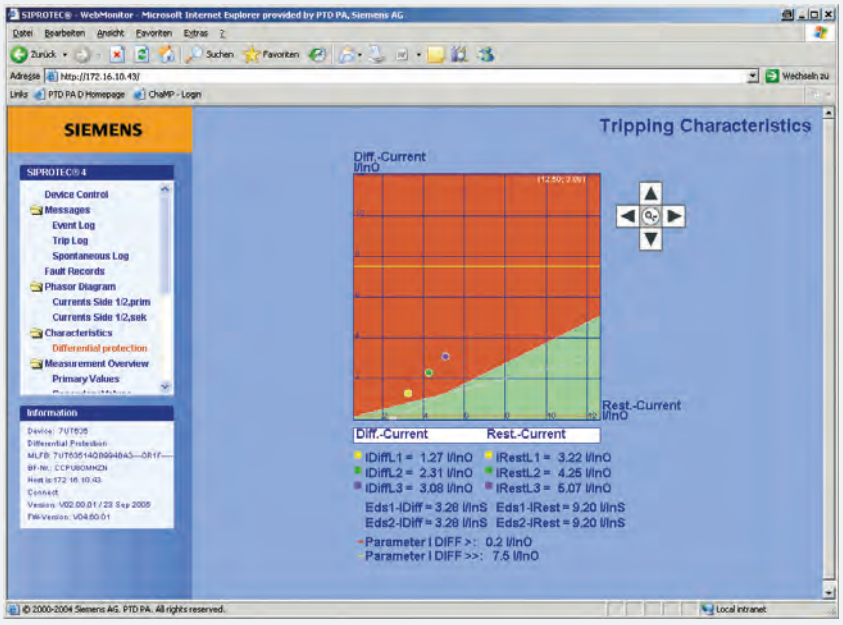



**Fig. 8/11** Commissioning via a standard Web browser:Operating characteristic

### 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.

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 ground 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 grounding 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)
  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 DP, MODBUS RTU, DNP 3, DIGSI, etc.) are required, such demands can be met.

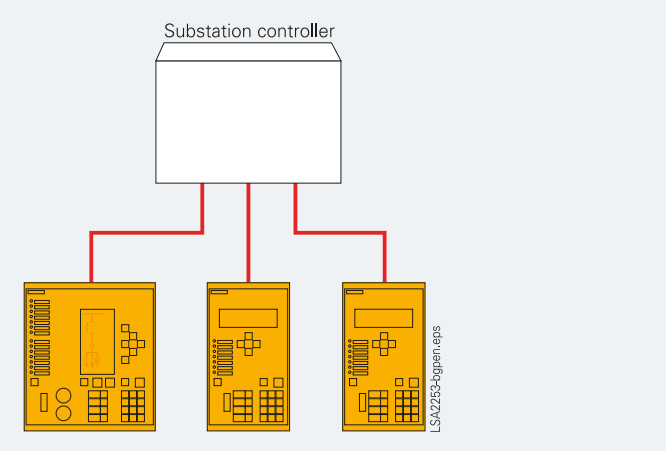



**Fig. 8/12** IEC 60870-5-103 star-type RS232 copper conductor connection or fiber-optic connection

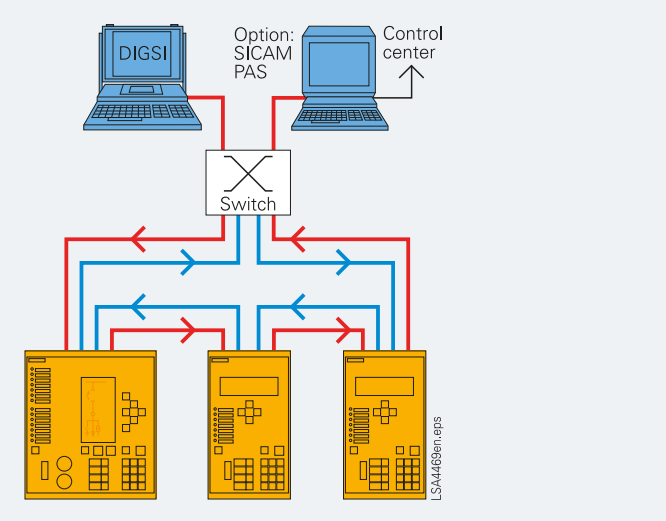



**Fig. 8/13** Bus structure for station buswith Ethernet und IEC 61850, fiber-optic ring

### 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.

### 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.

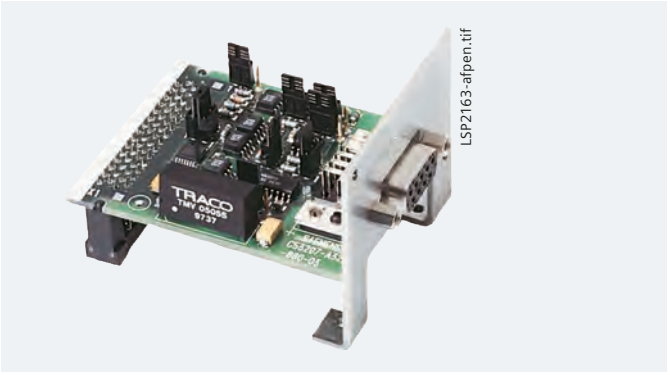



**Fig. 8/14** RS232 / RS485 electrical communication module

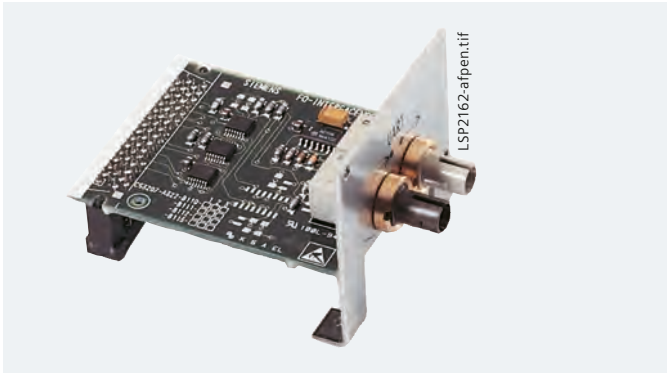



**Fig. 8/15** 820 nm fiber-optic communication module

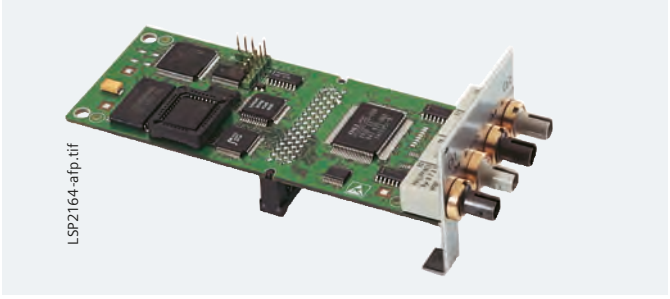



**Fig. 8/16** PROFIBUS communication module, optical double-ring

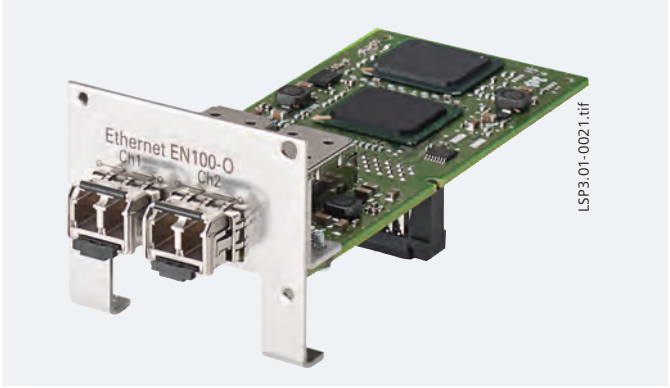



**Fig. 8/17** Optical Ethernet communication module for IEC 61850 with integrated Ethernet switch

8

## Communication

### System solutions for protection and station control

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

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

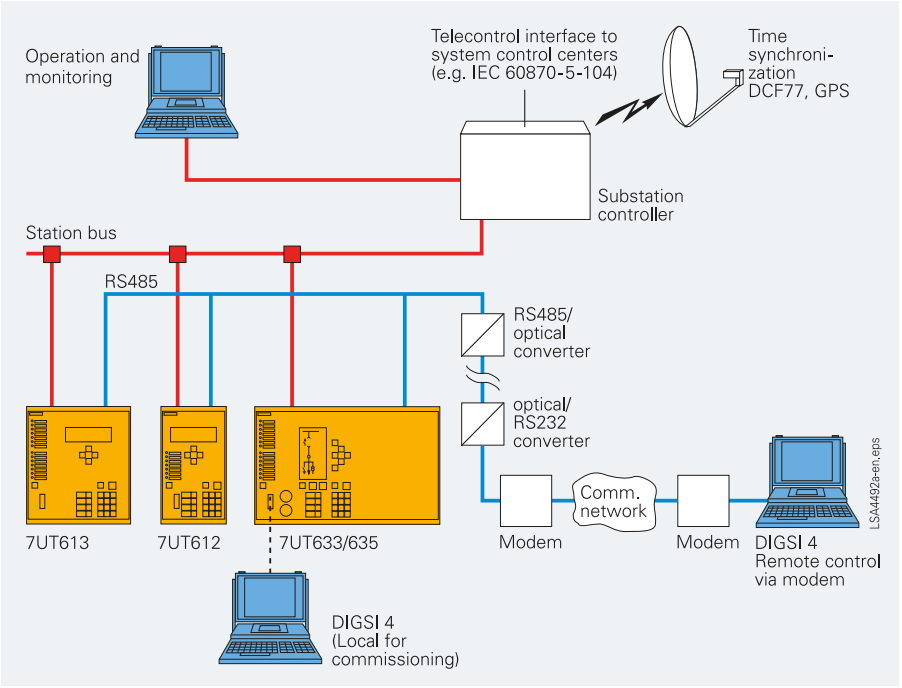



**Fig. 8/18** System solution: Communications

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).

8

## Typical connections

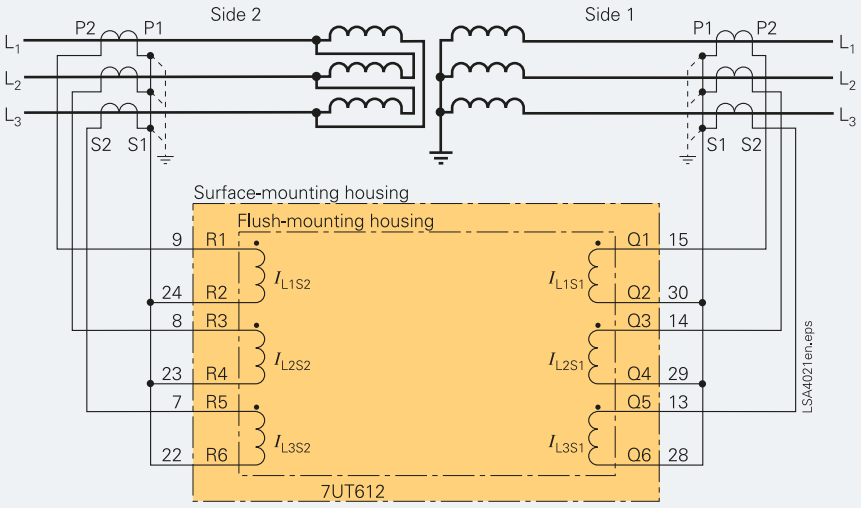



**Fig. 8/19** Standard connection to a transformer without neutral current measurement

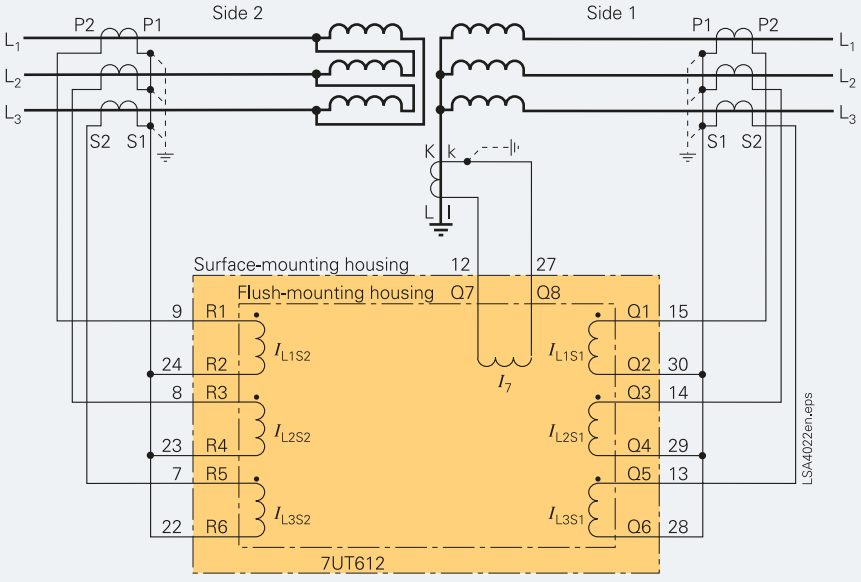



**Fig. 8/20** Connection to a transformer with neutral current measurement

8

## Typical connections

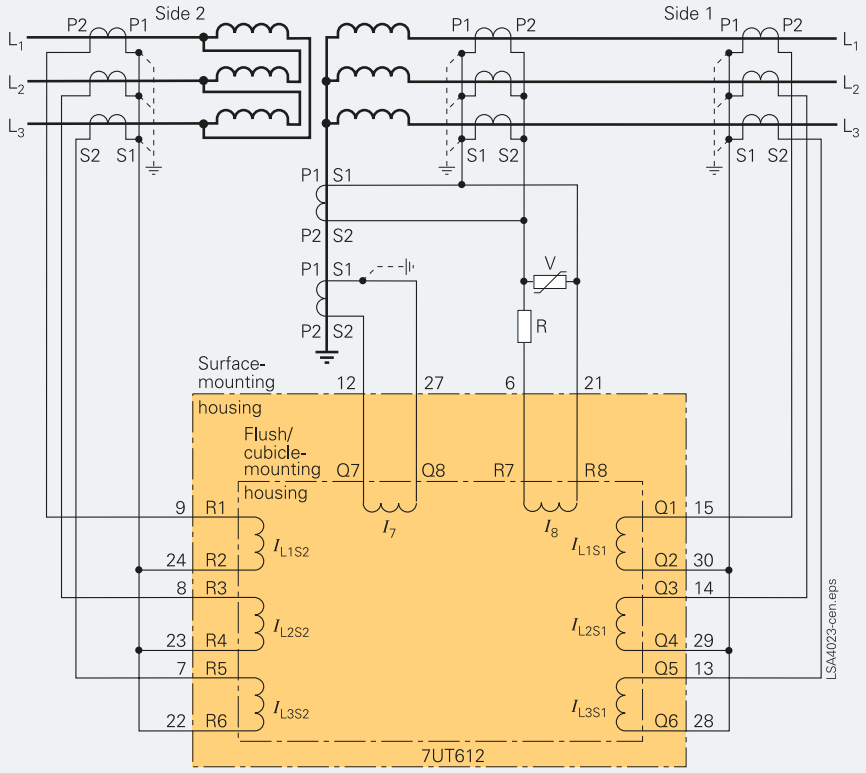



**Fig. 8/21** Connection of transformer differential protection with high impedance REF ($I_8$) and neutral current measurement at $I_7$

8

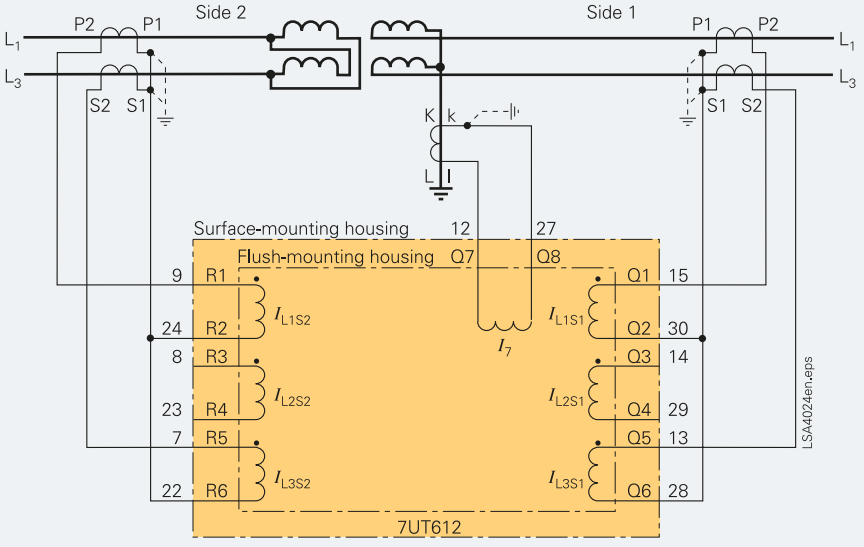



**Fig. 8/22** Connection example to a single-phase power transformer with current transformer between starpoint and grounding point

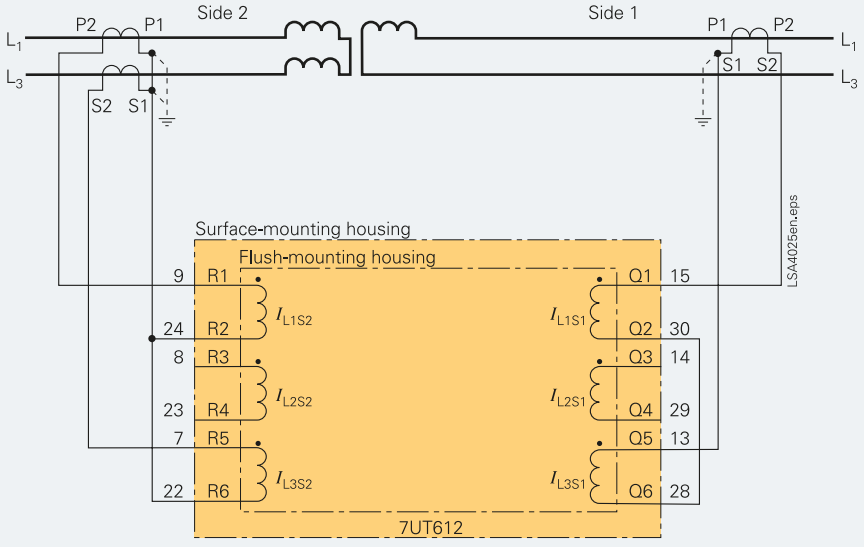



**Fig. 8/23** Connection example to a single-phase power transformer with only one current transformer (right side)

8

## Typical connections

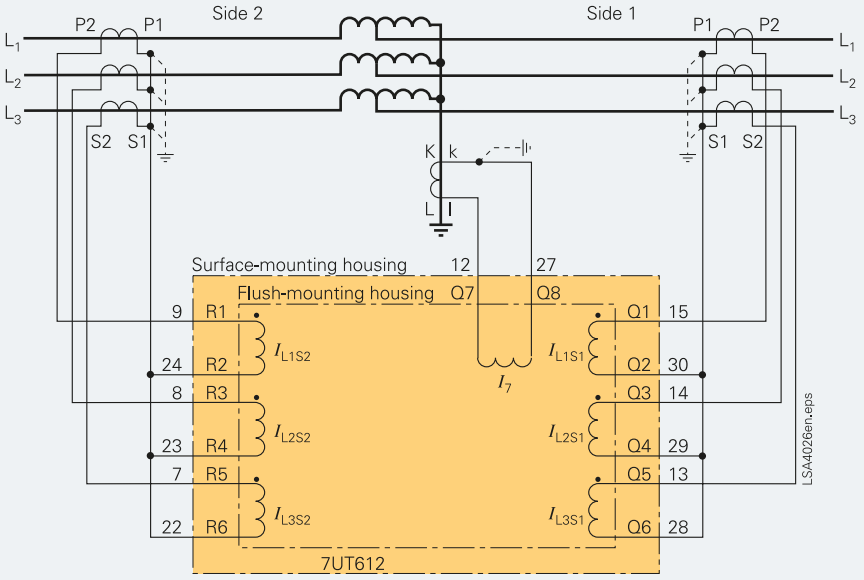



**Fig. 8/24** Connection to a three-phase auto-transformer with current transformer between starpoint and grounding point

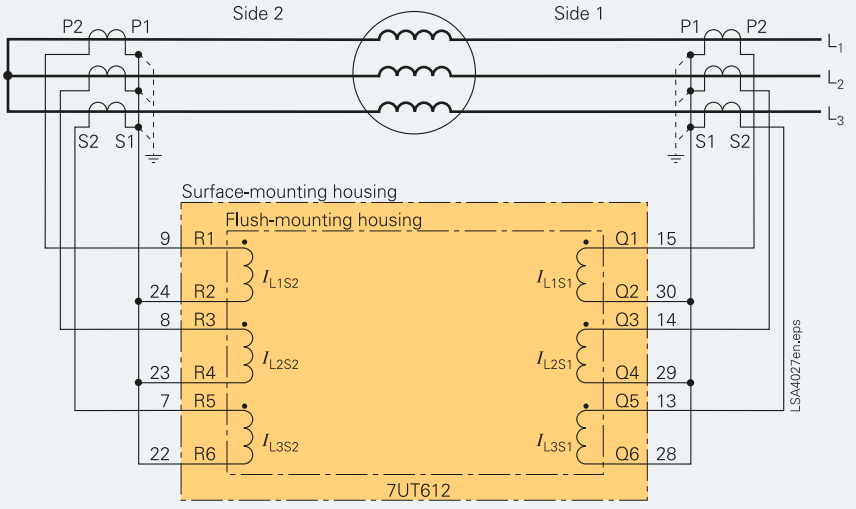



**Fig. 8/25** Generator or motor protection

8

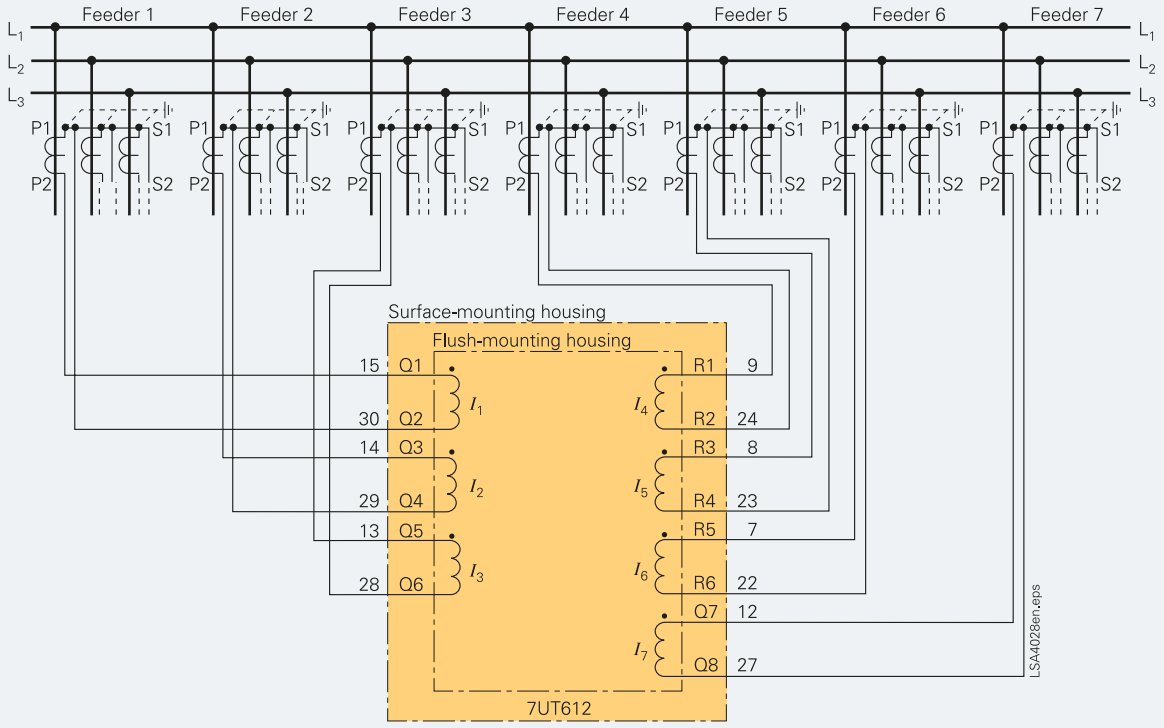



**Fig. 8/26** Connection 7UT612 as single-phase busbar protection for 7 feeders, illustrated for phase L1

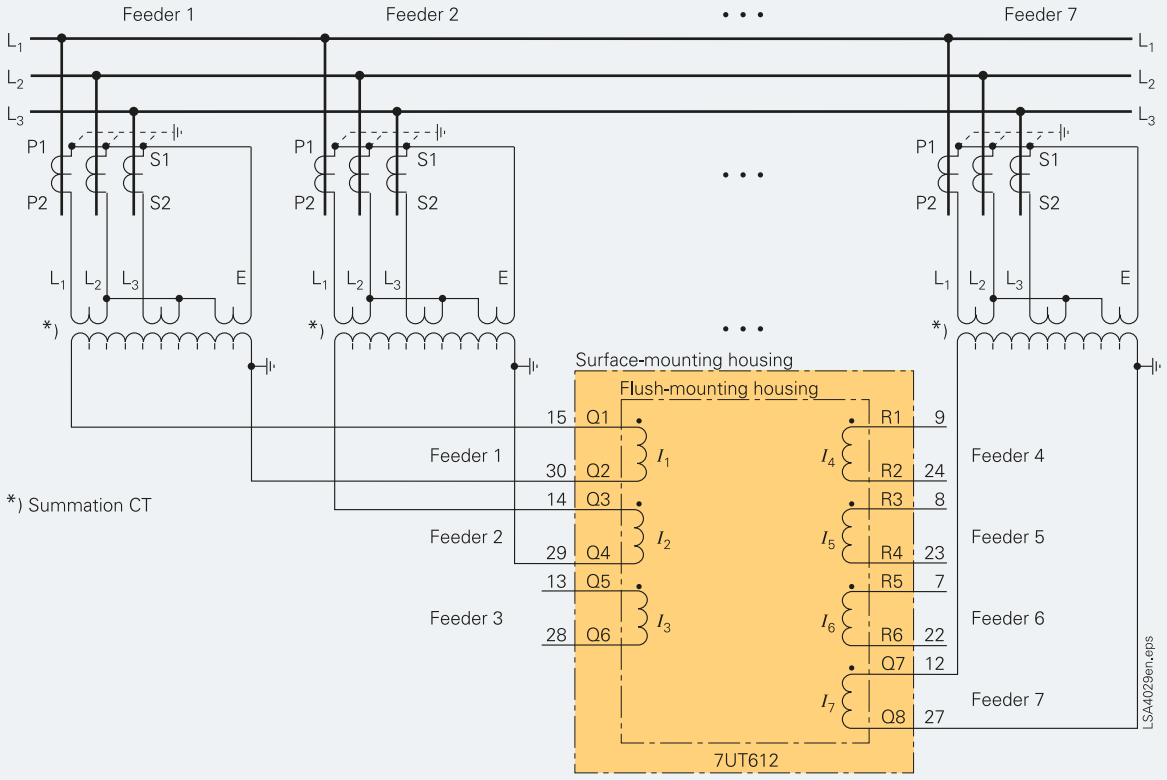



**Fig. 8/27** Connection 7UT612 as busbar protection for feeders, connected via external summation current transformers (SCT) – partial illustration for feeders 1, 2 and 7

## Typical connections

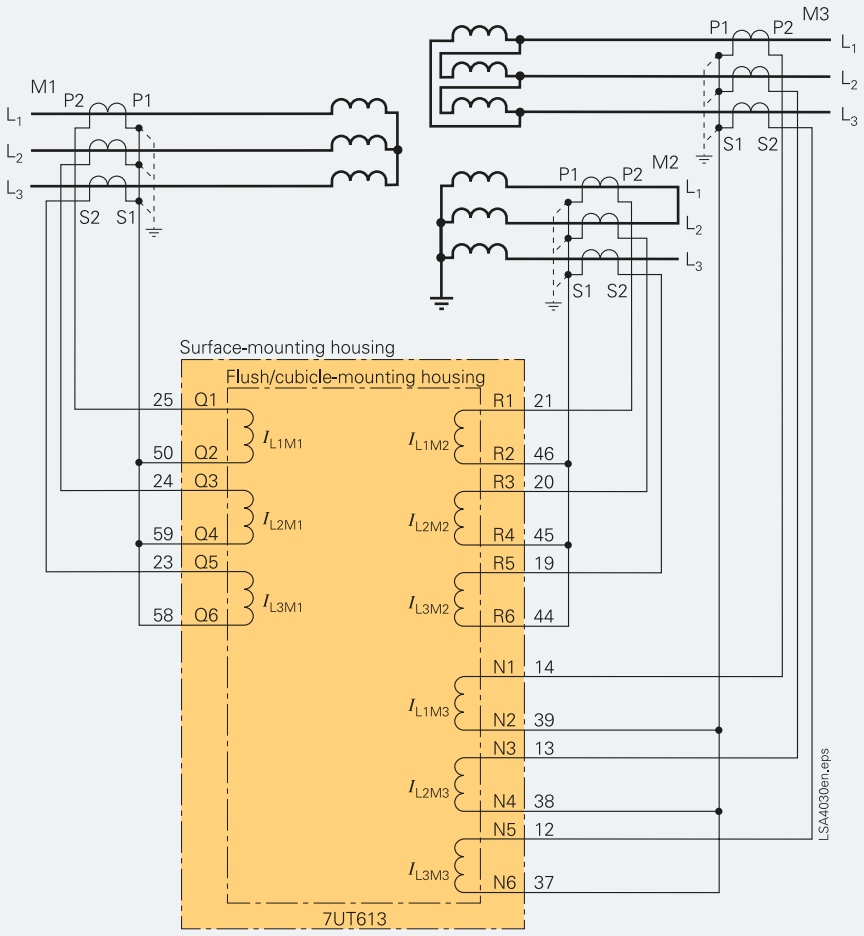



**Fig. 8/28** Connection example 7UT613 for a three-winding power transformer

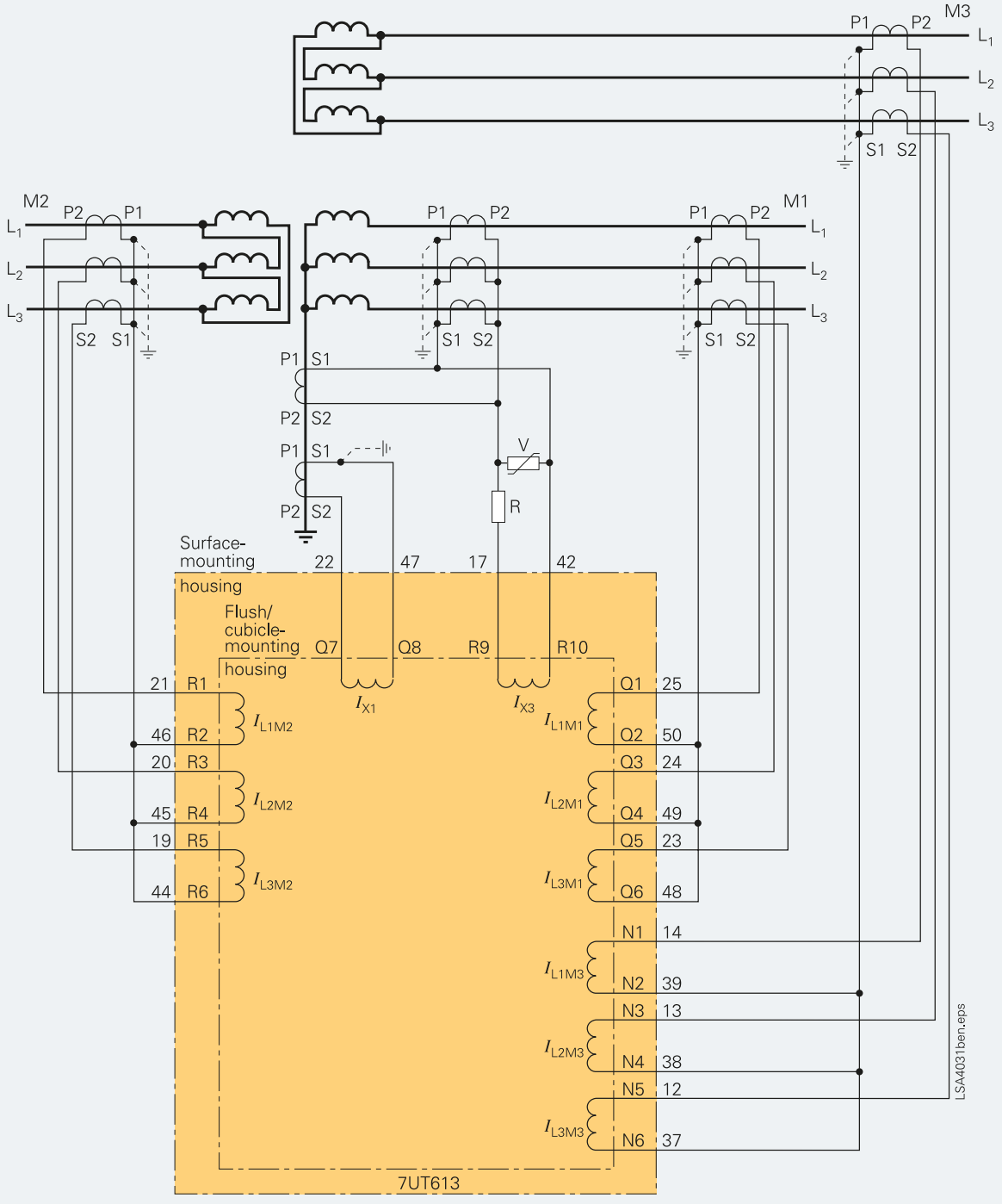



**Fig. 8/29** Connection example 7UT613 for a three-winding power transformer with current transformers between starpoint and grounding point, additional connection for high-impedance protection; $I_{X3}$ connected as high-sensitivity input

## Typical connections

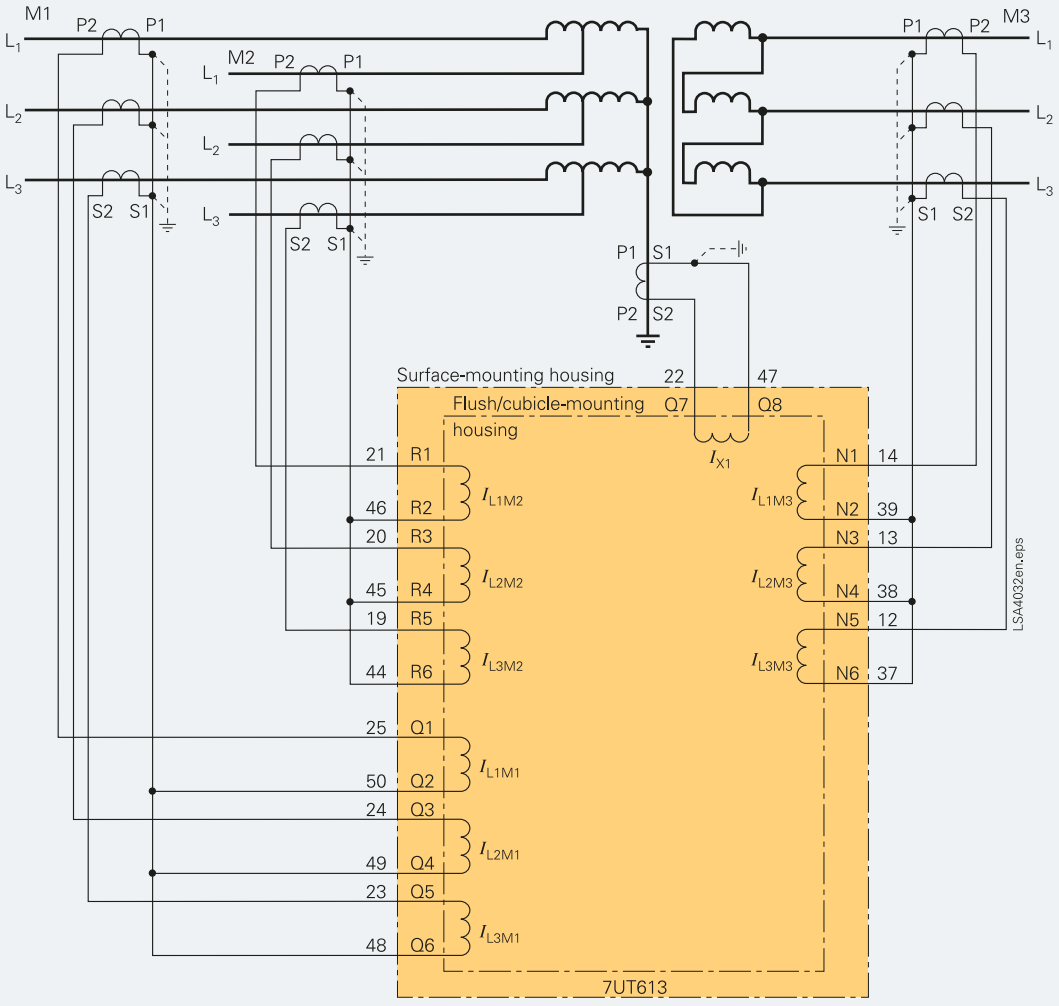
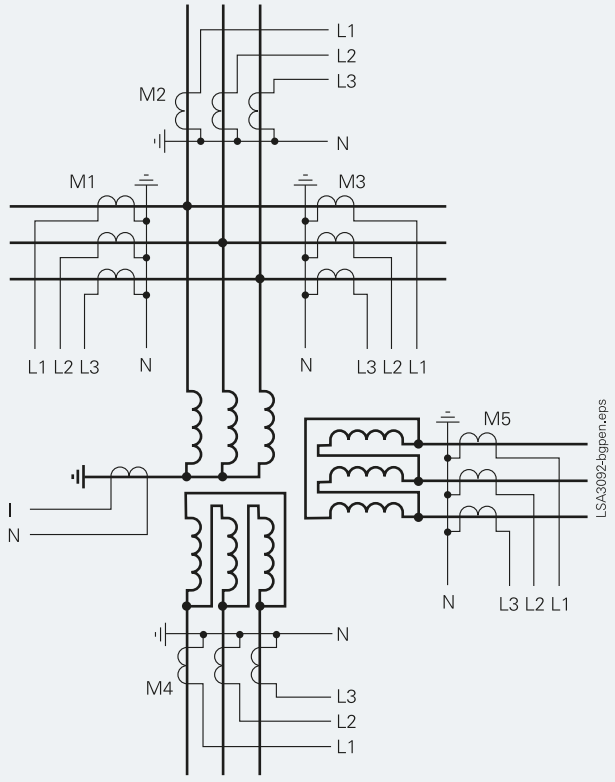



**Fig. 8/30** Connection example 7UT613 for a three-phase auto-transformer with three-winding and current transformer between starpoint and grounding point

8



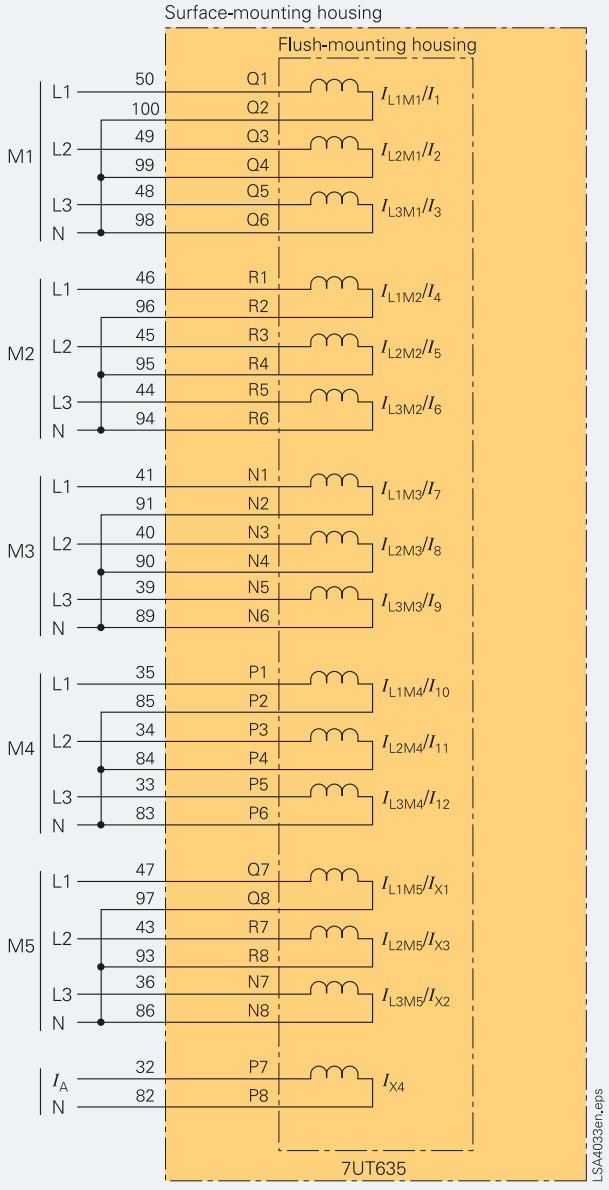




**Fig. 8/31** Connection example 7UT635 for a three-winding power transformer with 5 measurement locations (3-phase) and neutral current measurement

8

## Typical connections

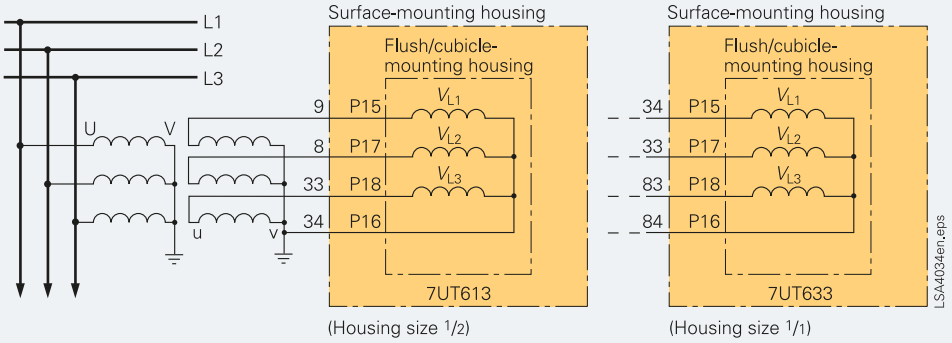



**Fig. 8/32** Voltage transformer connection to 3 star-connected voltage transformers (7UT613 and 7UT633 only)

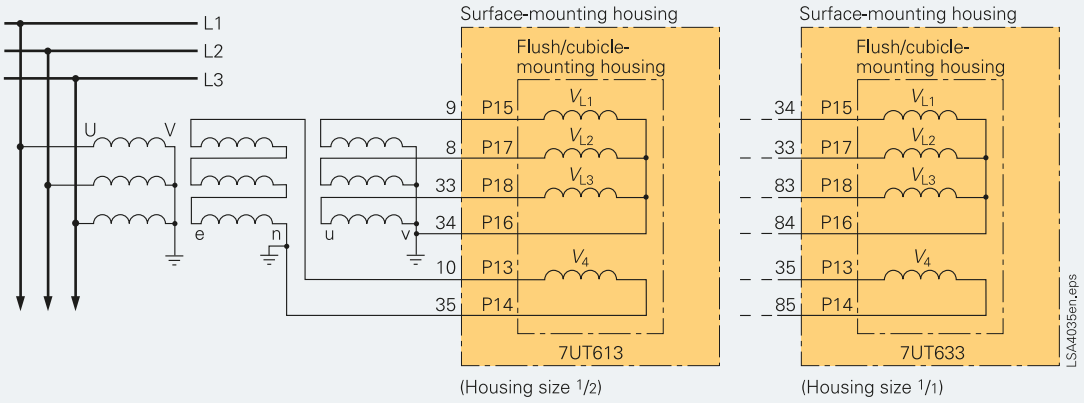



**Fig. 8/33** Voltage transformer connection to 3 star-connected voltage transformers with additional delta winding (e-n-winding) (7UT613 and 7UT633 only)

8

| 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<br>30 $I_N$ for 10 s<br>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<br>100 A for 10 s<br>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 | DC 24 to 48 V<br>DC 60 to 125 V<br>DC 110 to 250 V and AC 115 V (50/60 Hz), AC 230 V | | | |
| 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 $V_{aux} \geq 110$ 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 | DC 19 or 88 V (bipolar) | | | |
| Ranges are settable by means of jumpers for each binary input | | | | |
| Maximum permissible voltage | DC 300 V | | | |
| 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 w 50 ms) | 25 W | | | |
| Switching voltage | 250 V | | | |
| Permissible total current | 30 A for 0.5 seconds<br>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 14 | | | |
| 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 |

| Electrical tests | |
|---|---|
| *Specifications* | |
| Standards | IEC 60255 (Product standards)<br>ANSI/IEEE C37.90.0/.1/.2<br>UL 508 |
| *Insulation tests* | |
| Standards | EC 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) | DC 3.5 kV |
| 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 ms; 0.5 J<br>3 positive and 3 negative impulses at intervals of 5 s |

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

8

## Technical data

| Electrical tests (cont'd) | |
|---|---|
| *EMC tests for interference immunity* | |
| Standards | IEC 60255-6, 60255-22 (product standards)<br>EN 6100-6-2 (generic standard)<br>DIN 57435 / Part 303 |
| High frequency test<br>IEC 60255-22-1, class III and<br>DIN 57435 / Part 303, class III | 2.5 kV (peak); 1 MHz; τ = 15 ms;<br>400 surges per s; test duration 2 s;<br>$R_i$ = 200 Ω |
| Electrostatic discharge<br>IEC 60255-22-2 class IV<br>EN 61000-4-2, class IV | 8 kV contact discharge; 15 kV air discharge; both polarities;<br>150 pF; $R_i$ = 330 Ω |
| Irradiation with RF field,<br>frequency sweep,<br>IEC 60255-22-3,<br>IEC 61000-4-3 class III | 10 V/m; 80 to 1000 MHz;<br>80 % AM; 1 kHZ |
| Irradiation with RF field, amplitude-modulated, single frequencies,<br>IEC 60255-22-3,<br>IEC 61000-4-3, class III | 10 V/m; 80, 160, 450, 900 MHz,<br>80 % AM;<br>duration > 10 s |
| Irradiation with RF field, pulse-modulated, single frequencies,<br>IEC 60255-22-3, IEC 61000-4-3/<br>ENV 50204, class III | 10 V/m; 900 MHz; repetition frequency 200 Hz;<br>duty cycle 50 % PM |
| Fast transients interference, bursts<br>IEC 60255-22-4 and<br>IEC 61000-4-4, class IV | 4 kV; 5/50 ns; 5 kHz;<br>burst length = 15 ms;<br>repetition rate 300 ms; both polarities;<br>$R_i$ = 50 Ω; test duration 1 min |
| High-energy surge voltages (SURGE), IEC 61000-4-5,<br>installation class III | Impulse: 1.2/50 ms |
| Auxiliary supply | Common (longitudinal) mode:<br>2kV; 12 Ω, 9 µF<br>Differential (transversal) mode:<br>1kV; 2 Ω, 18 µF |
| Analog inputs, binary inputs, binary outputs | Common (longitude) mode:<br>2kV; 42 Ω, 0.5 µF<br>Differential (transversal) mode:<br>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 |
| *EMC tests for interference immunity (cont'd)* | |
| Magnetic field with power frequency<br>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;<br>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;<br>repetition rate 300 ms;<br>both polarities; duration 1 min.;<br>$R_i$ = 80 Ω |
| Damped oscillations<br>IEC 60894, IEC 61000-4-12 | 2.5 kV (peak value), polarity alternating 100 kHz, 1 MHz, 10 MHz and<br>50 MHz, $R_i$ = 200 Ω |
| *EMC tests for interference emission (type test)* | |
| Standard | EN 50081-* (generic standard) |
| Conducted interference,<br>only auxiliary supply<br>IEC-CISPR 22 | 150 kHz to 30 MHz<br>Limit class B |
| Radio interference field strenght<br>IEC-CISPR 22 | 30 to 1000 MHz<br>Limit class B |

| Mechanical stress tests | |
|---|---|
| *Vibration, shock stress and seismic vibration* | |
| During operation | |
| Standards | IEC 60255-21 and IEC 60068 |
| Vibration<br>IEC 60255-21-1, class 2<br>IEC 60068-2-6 | Sinusoidal<br>10 to 60 Hz: ± 0.075 mm amplitude; 60 to 150 Hz: 1 *g* acceleration<br>frequency sweep 1 octave/min.<br>20 cycles in 3 orthogonal axes |
| Shock<br>IEC 60255-21-2, class 1<br>IEC 60068-2-27 | Half-sinusoidal<br>acceleration 5 *g*, duration 11 ms,<br>3 shocks each in both directions of the 3 axes |
| Seismic vibration<br>IEC 60255-21-2, class 1<br>IEC 60068-3-3 | Sinusoidal<br>1 to 8 Hz: ± 3.5 mm amplitude (horizontal axis)<br>1 to 8 Hz: ± 1.5 mm amplitude (vertical axis)<br>8 to 35 Hz: 1 *g* acceleration (horizontal axis)<br>8 to 35 Hz: 0.5 *g* acceleration (vertical axis)<br>frequency sweep 1 octave/min<br>1 cycle in 3 orthogonal axes |
| During transport | |
| Standards | IEC 60255-21 and IEC 60068 |
| Vibration<br>IEC 60255-21-1, class 2<br>IEC 60255-2-6 | Sinusoidal<br>5 to 8 Hz: ± 7.5 mm amplitude;<br>8 to 150 Hz: 2 *g* acceleration<br>frequency sweep 1 octave/min<br>20 cycles in 3 orthogonal axes |
| Shock<br>IEC 60255-21-2, class 1<br>IEC 60068-2-27 | Half-sinusoidal<br>acceleration 15 *g*, duration 11 ms,<br>3 shocks each in both directions of the 3 axes |
| Continuous shock<br>IEC 60255-21-2, class 1<br>IEC 60068-2-29 | Half-sinusoidal<br>acceleration 10 *g*, duration 16 ms,<br>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<br>(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<br>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; ondensation not permitted |

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

## Selection and ordering data

| Description | Order No. | Order code |
|---|---|---|
| **7UT612 differential protection relay for transformers, generators, motors and busbars**<br>**Housing ⅓ x 19"; 3 BI, 4 BO, 1 live status contact, 7 $I$, $I_{EE}$** | **7UT612**□-□□□□□-□□ **A 0** - | □□□ |
| **Rated current** | | |
| $I_N$ = 1 A | **1** | |
| $I_N$ = 5 A | **5** | |
| **Rated auxiliary voltage (power supply, binary inputs)** | | |
| DC 24 to 48 V, binary input threshold 19 V[2)] | **2** | |
| DC 60 to 125 V[1)], binary input threshold 19 V[2)] | **4** | |
| DC 110 to 250 V[1)], AC 115/230 V, binary input threshold 88 V[2)] | **5** | |
| DC 220 to 250 V[1)], AC 115/230 V, binary input threshold 176 V[1,2,3)] | **6** | |
| **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** | |
| **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 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 Ethernet, optical, double, LC connector (EN 100)[5)] | **9** | **L 0 S** |

see next page

1) With plug-in jumper one of the 2 voltage ranges can be selected

2) For each binary input one of 2 pick-up threshold ranges can be selected with plug-in jumper

3) Ordering option 6 only for V4.6 and higher

4) Not possible with surface mounting housing (position 9 = B). For the surface mounted version, please order a device with the appropriate electrical RS485 interface and accessories as stated in A.1under „External converters“

5) Cannot be delivered in connection with 9th digit = B.

## Selection and ordering data

| Description | Order No. | Order code |
|---|---|---|
| **7UT612 differential protection relay for transformers, generators, motors and busbars** | **7UT612**□-□□□□□-□□ | **A 0** |
| **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, electrical RS485 | | **2** |
| DIGSI 4 / browser or temperature monitoring box, 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)[1] | | **4** |
| **Differential protection + basic functions** | | |
| Differential protection for transformer, generator, motor, busbar (87)<br>Overload protection for one winding (49), Lockout (86)<br>Overcurrent-time protection (50/51): $I>$, $I>>$, $I_P$ (inrush stabilization)<br>Overcurrent-time protection (50N/51N): $3I_0>$, $3I_0>>$, $3I_{0P}$ (inrush stabilization)<br>Overcurrent-time protection ground (50G/51G): $I_E>$, $I_E>>$, $I_{EP}$ (inrush stabilization) | | **A** |
| **Differential protection + basic functions + additional functions** | | |
| Restricted ground fault protection, low impedance (87N)<br>Restricted ground fault protection, high impedance (87N without resistor and varistor), O/C 1-phase<br>Trip circuit supervision (74TC), breaker failure protection (50BF), unbalanced load protection (46) | | **B** |

1) Only in connection with position 12 = 2 or 3

## Selection and ordering data

| Description | Order No. | Order code |
|---|---|---|
| **7UT613 differential protection relay for transformers, generators, motors and busbars**<br>**Housing ½ x19"; 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 | |
| | see next page | |
| **Rated auxiliary voltage (power supply, binary inputs)** | | |
| DC 24 to 48 V, binary input threshold 19 V[2)] | 2 | |
| DC 60 to 125 V[1)], binary input threshold 19 V[2)] | 4 | |
| DC 110 to 250 V[1)], AC 115/230 V, binary input threshold 88 V[2)] | 5 | |
| DC 220 to 250 V[1)], AC 115/230 V, binary input threshold 176 V[1,2)] | 6 | |
| **Unit design** | | |
| Surface mounting housing with two-tier terminals, ½ x 19", 5 BI, 8 BO, 1 live status contact | B | |
| Flush mounting housing, ½ x 19", with plug-in terminals, 5 BI, 8 BO, 1 live status contact | D | |
| Flush mounting housing with screwed terminals, ½ x 19", 5 BI, 8 BO, 1 live status contact | 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 DP Slave, electrical RS485 | 9 | L 0 A |
| PROFIBUS DP Slave, optical 820 nm, double ring, ST connector[3)] | 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 | 9 | L 0 R |
| IEC 61850, 100 Mbit Etherent, optical, ST-connector[4)] | 9 | L 0 S |

1) One of the 2 voltage ranges can be selected with plug-in jumper

2) For each binary input one of 2 pick-up threshold ranges can be selected with plug-in jumper.

3) Not possible with surface mounting housing (position 9 = B). For the surface mounted version, please order a device with the appropriate electrical RS485 interface and accessories in accordance with A.1 under „External Converters"

4) Cannot be delivered in connection with 9th digit = B.

## 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[1)] | | 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)[2)] | 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 $3I_0$ (50N/51N): $3I_0>$, $3I_0>>$, $3I_{0P}$ (inrush stabilization) | | |
| Overcurrent-time protection ground (50G/51G): $I_E>$, $I_E>>$, $I_{EP}$ (inrush stabilization) | A | |
| **Differential protection + basic functions + additional current functions** | | |
| Restricted ground-fault protection, low impedance (87N) | | |
| Restricted ground-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) In case of a connection to a RTD box 7XV5662-xAD10, a RS485-LWL converter 7XV5650-0xA00 is required.

2) Only in connection with position 12 = 2 or 9 and Mxx (supplementary)

## 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 ⅓ x 19", 21 BI, 24 BO, 1 live status contact, 12 current inputs (11 $I$, $I_{EE}$); 4 voltage inputs (1 x 3-phase + 1 x 1-phase) | 3 | see next page |
| Housing ⅓ x 19", 29 BI, 24 BO, 1 live status contact, 16 current inputs (14 $I$, 2 $I_{EE}$) | 5 | |
| **Rated current** | | |
| $I_N$ = 1 A | 1 | |
| $I_N$ = 5 A | 5 | |
| **Rated auxiliary voltage (power supply, binary inputs)** | | |
| DC 24 to 48 V, binary input threshold 19 V[2)] | 2 | |
| DC 60 to 125 V [1)], binary input threshold 19 V[2)] | 4 | |
| DC 110 to 250 V [1)], AC 115/230 V, binary input threshold 88 V[2)] | 5 | |
| DC 220 to 250 V [1)], AC 115/230 V, binary input threshold 176 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 DP Slave, electrical RS485 | 9 | L 0 A |
| PROFIBUS DP Slave, optical 820, double ring, ST connector[3)] | 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, LC-connector[4)] | 9 | L 0 S |

1) One of the 2 voltage ranges can be selected with plug-in jumper

2) For each binary input one of 2 pick-up threshold ranges can be selected with plug-in jumper

3) Not possible with surface mounting housing (position 9 = B). For the surface mounted version, please order a device with the appropriate electrical RS485 interface and accessories in accordance with A. under „External Converters"

4) Cannot be delivered in connection with 9th digit = B.

## 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 |
| **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[1] | | 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)[2] | | 4 |
| **Differential protection + basic functions** | | |
| Differential protection for transformer, generator, motor, busbar (87)<br>Overload protection according to IEC for one side (49)<br>Lock out (86)<br>Overcurrent-time protection phases (50/51): $I>$, $I>>$, $I_P$ (inrush stabilization)<br>Overcurrent-time protection $3I_0$ (50N/51N): $3I_0>$, $3I_0>>$, $3I_{0P}$ (inrush stabilization)<br>Overcurrent-time protection ground (50G/51G): $I_E>$, $I_E>>$, $I_{EP}$ (inrush stabilization) | | A |
| **Differential protection + basic functions + additional current functions** | | |
| Restricted ground-fault protection, low impedance (87N)<br>Restricted ground-fault protection, high impedance (87N without resistor and varistor), O/C 1-phase<br>Trip circuit supervision (74TC)<br>Unbalanced load protection (46)<br>Breaker failure protection (50BF)<br>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<br>+ Over/undervoltage protection (59/27)<br>+ Frequency protection (81)<br>+ Directional power protection (32R/F)<br>+ Fuse failure monitor (6FL) | | C |
| **Additional functions (general)** | | |
| Without | | 0 |
| Multiple protection functions (50, 51, 50N/G, 87N, 50BF, 49)[3] | | 1 |
| Flexible protection functions | | 2 |
| Multiple + flexible protection functions | | 3 |

1) In case of a connection to a RTD box 7XV5662-xAD10, a RS485-LWL converter 7XV5650-0xA00 is required.

2) Only in connection with position 12 = 2 or 9 and Mxx (supplementary)

3) Available if selected on position 14.

| Accessories | Description | | Order No. |
|---|---|---|---|
| | **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 | AC/DC 24 to 60 V | **7XV5662-2AD10** |
| | RS485 interface | AC/DC 90 to 240 V | **7XV5662-5AD10** |
| | **Manual for 7UT6x** | | |
| | English V4.6 | | **C53000-G1176-C230-2** |
| | German V4.6 | | **C53000-G1100-C230-3** |
| | Turkey V4.6 | | **C53000-G115A-C230-1** |
| | **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 | 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 mm² | **0-827039-1** | 4000 | 1) | |
| | | | **0-827396-1** | 1 | 1) | |
| | | CI2 0.5 to 2.5 mm² | **0-827040-1** | 4000 | 1) | |
| | | | **0-827397-1** | 1 | 1) | |
| | | Type III+ 0.75 to 1.5 mm² | **0-163083-7** | 4000 | 1) | |
| | | | **0-163084-2** | 1 | 1) | |
| | Crimping tool | For type III+ and matching female | **0-539635-1** | 1 | 1) | |
| | | | **0-539668-2** | | 1) | |
| | | For CI2 and matching female | **0-734372-1** | 1 | 1) | |
| | | | **1-734387-1** | | 1) | |
| | 19"-mounting rail | | **C73165-A63-D200-1** | 1 | Siemens | 8/34 |
| | Short-circuit links | For current terminals | **C73334-A1-C33-1** | 1 | Siemens | 8/37 |
| | | For other terminals | **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 | |


**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/ indications contacts

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

## Connection diagram

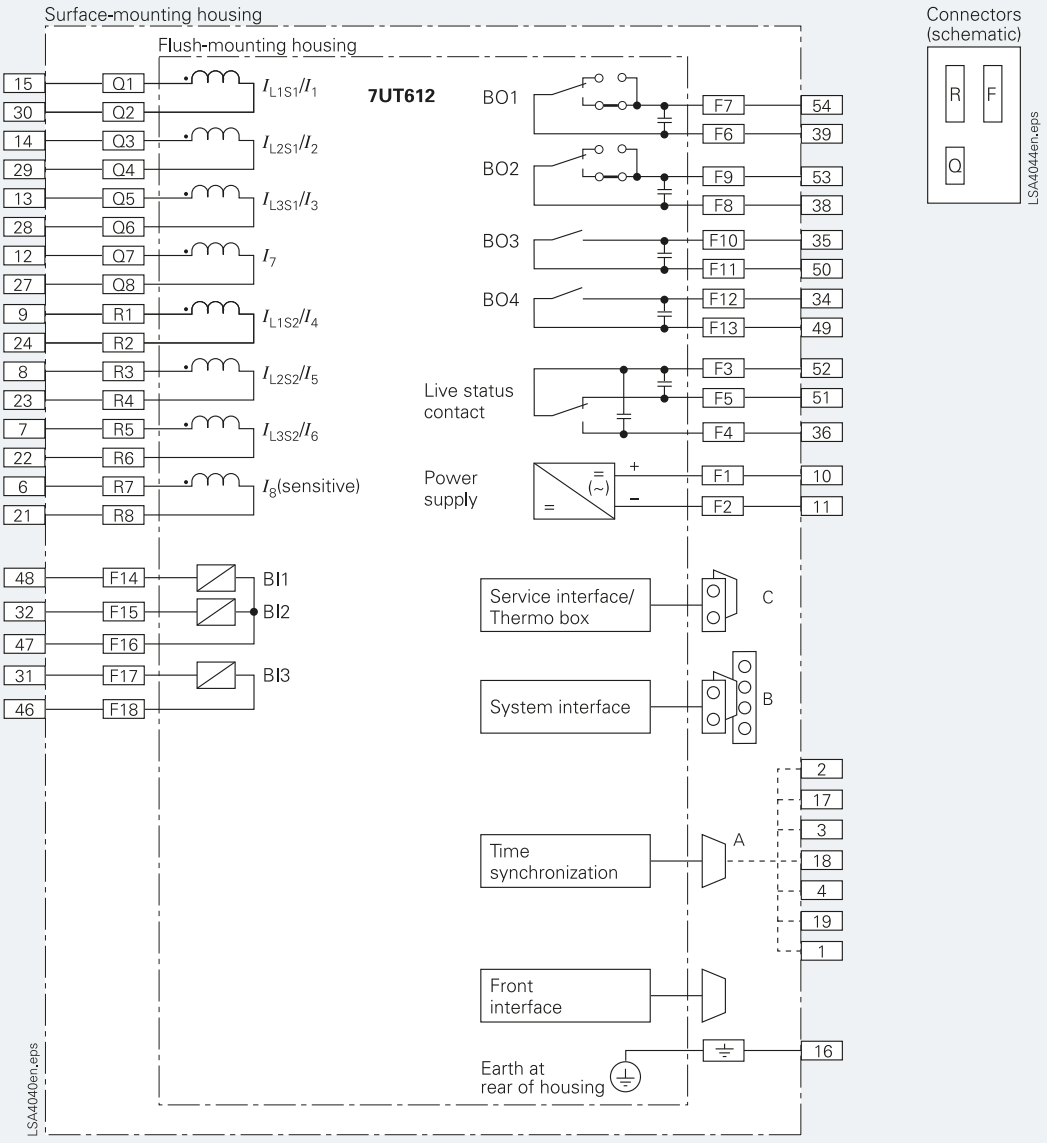



**Fig. 8/39** Connection diagram

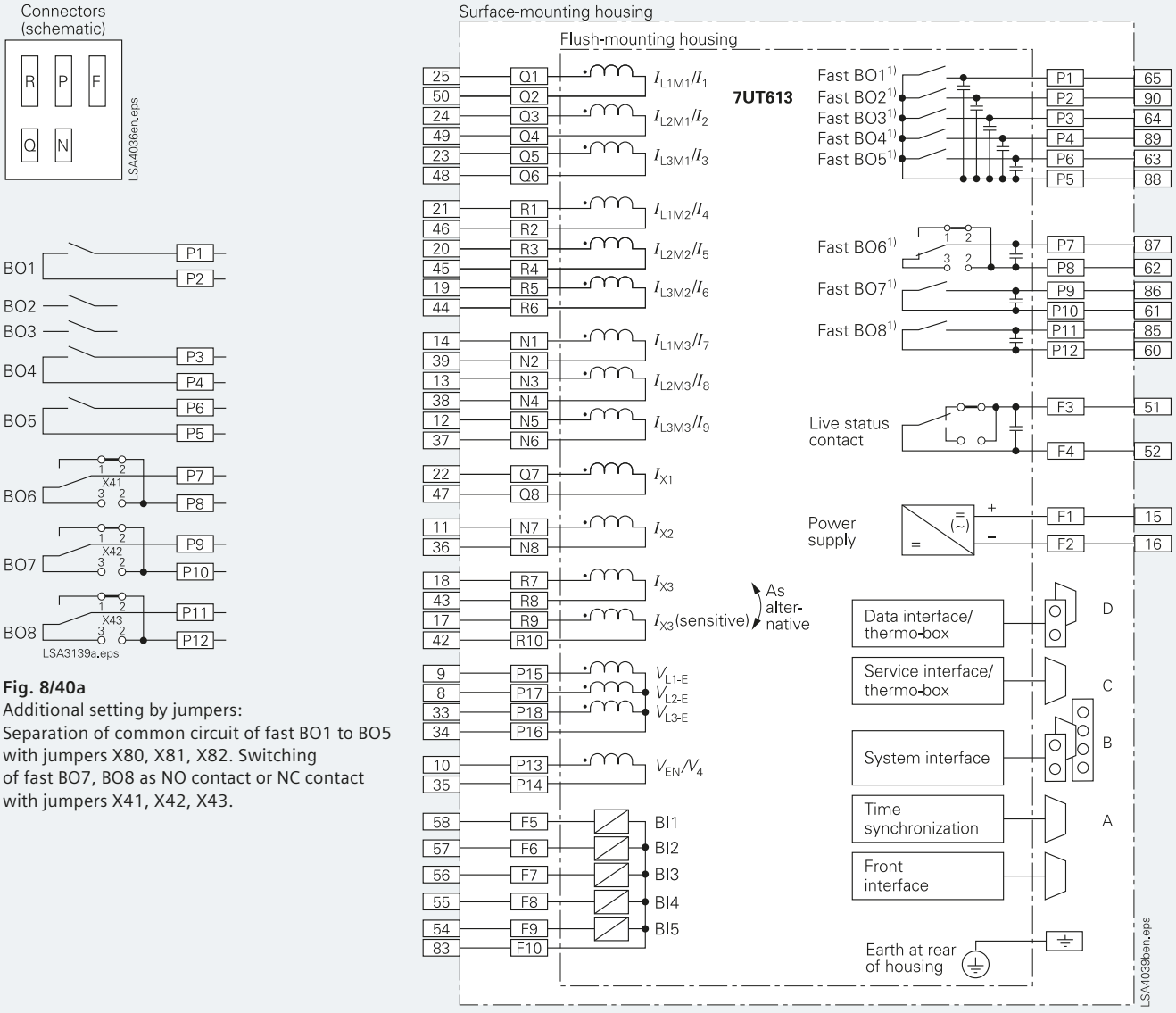



**Fig. 8/40a**
Additional setting by jumpers:
Separation of common circuit of fast BO1 to BO5 with jumpers X80, X81, X82. Switching of fast BO7, BO8 as NO contact or NC contact with jumpers X41, X42, X43.

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

**Fig. 8/40** Connection diagram 7UT613

8

## Connection diagram

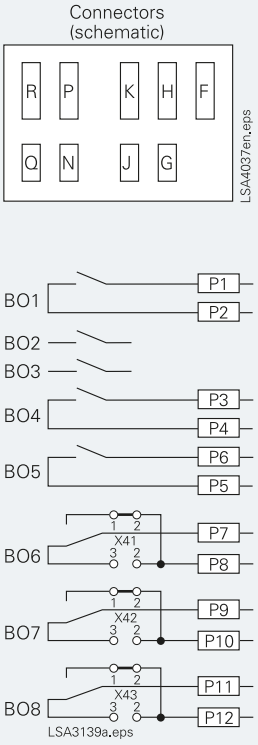
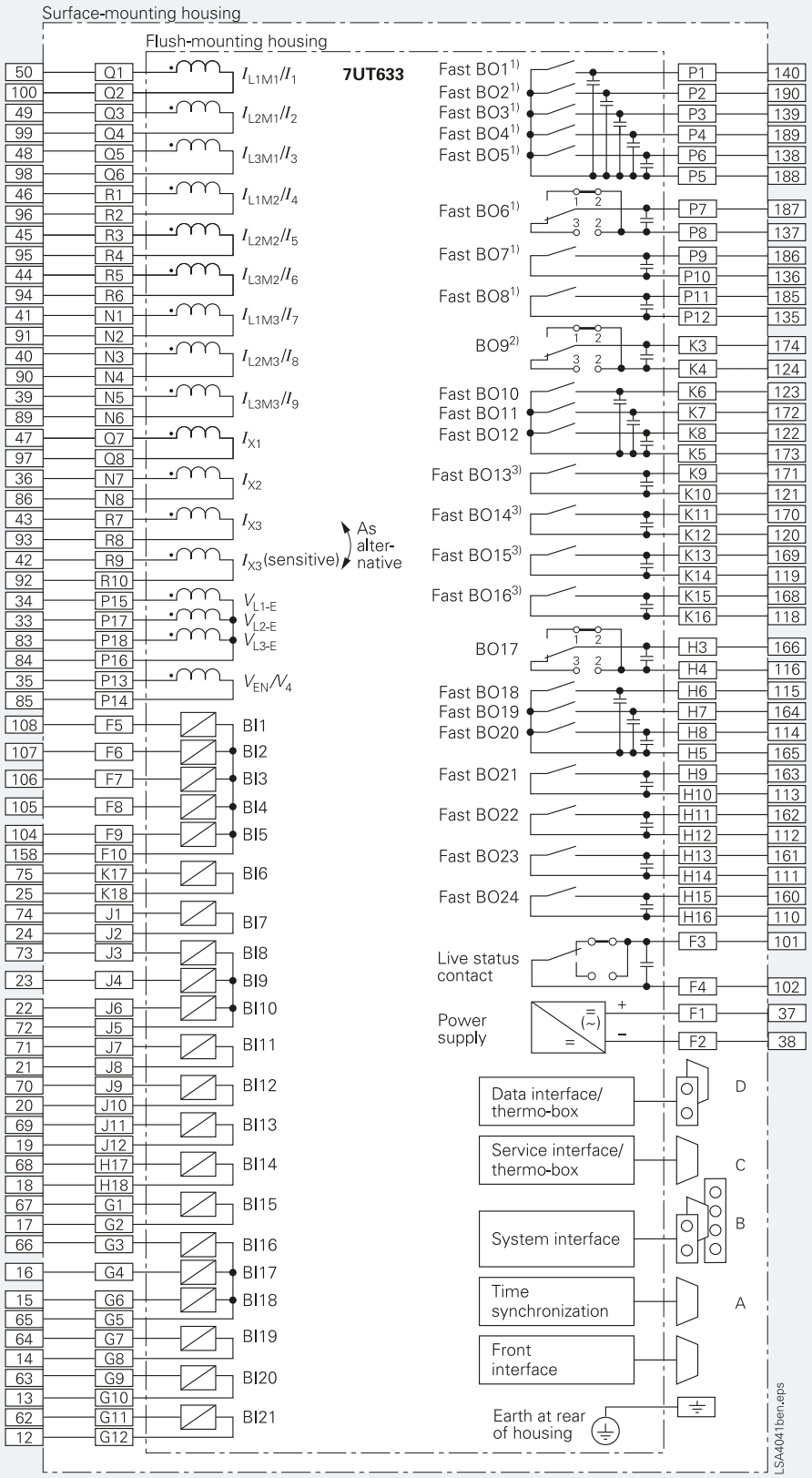
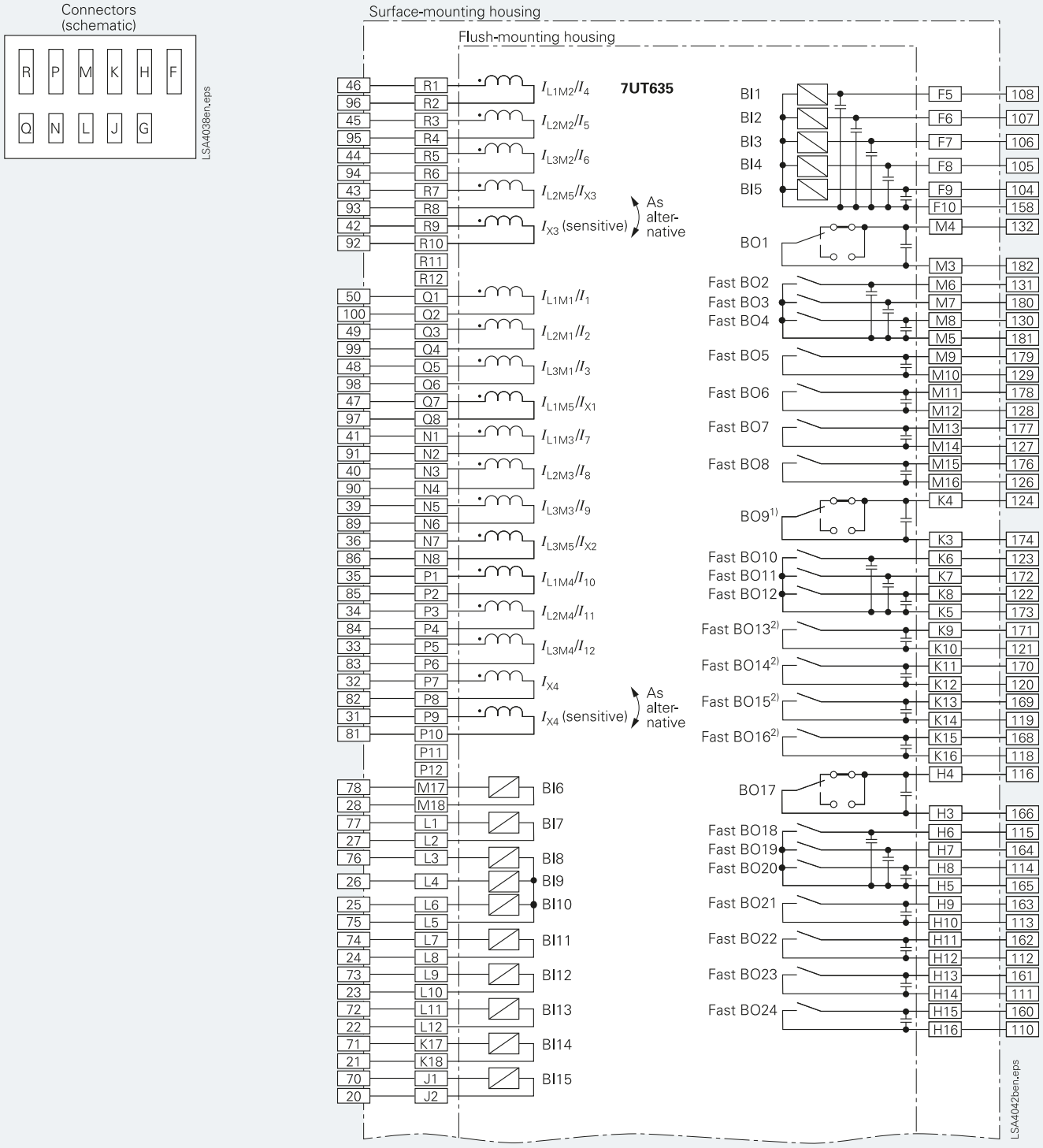



**Fig. 8/41a**
Additional setting by jumpers: Separation of common circuit of fast BO1 to BO5 with jumpers X80, X81, X82. Switching of fast BO7, BO8 as NO contact or NC contact with jumpers X41, X42, X43




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)

**Fig. 8/41** Connection diagram 7UT63




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

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

## Connection diagram

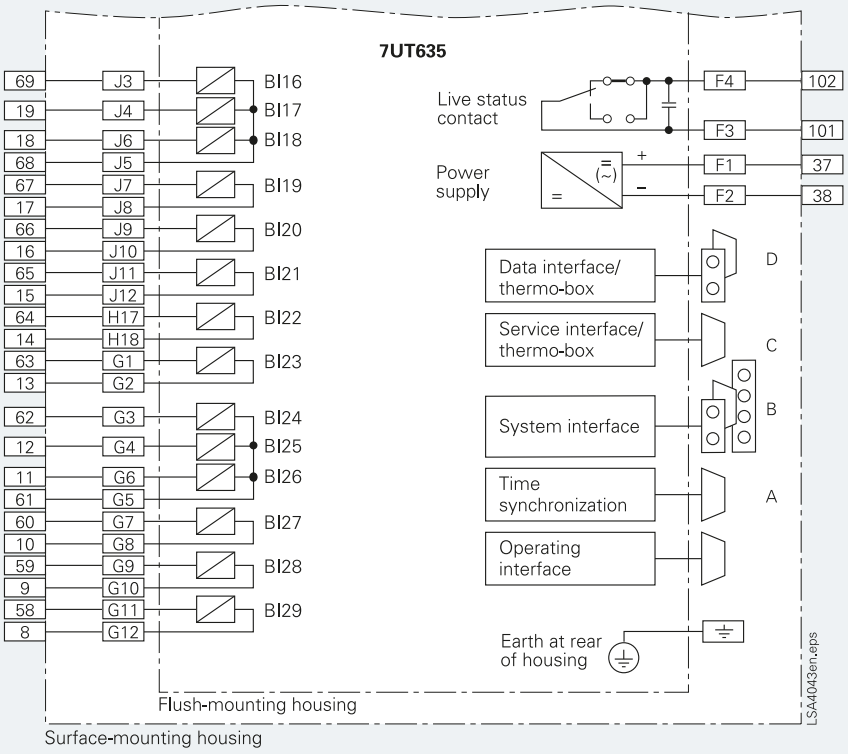



**Fig. 8/43** Connection diagram 7UT635 part 2