SIPROTEC 7SD61 differential protection relay for two line ends

Fig. 7/1 SIPROTEC 7SD61 differential protection relay

Description

The 7SD610 relay is a differential protection relay suitable for all types of applications and incorporating all those functions required for differential protection of lines, cables and transformers. Transformers and compensation coils within the differential protection zone are protected by means of integrated functions, which were previously to be found only in transformer differential protection. It is also well-suited for complex applications such as series and parallel compensation of lines and cables.

It is designed to provide differential and directional back-up protection for all voltage levels and types of networks. The relay features high speed and phase-selective short-circuit measurement. The unit is thus suitable for single-phase and three-phase fault clearance.

Digital data communication for differential current measurement is effected via fiber-optic cables, networks or pilot wires connections, so that the line ends can be quite far apart. The serial protection interface (R2R interface) of the relay can flexibly be adapted to the requirements of all existing communication media. If the communication method is changed, flexible retrofitting of communication modules to the existing configuration is possible.

Apart from the main protection function, i.e. the differential protection, the 7SD610 has a full range of configurable emergency and / or back-up protection functions such as phase and ground overcurrent protection with directional elements if voltage transformers are connected. Overload, under- and over-voltage/frequency and breaker-failure protection round off the functional scope of the 7SD610.

Function overview

Protection functions

- Differential protection for universal use with power lines and cables on all voltage levels with phase-segregated measurement (87L)
- Two line ends capability
- Suitable for transformers in protected zones (87T)
- Restricted ground-fault protection (87N) if a transformer is within the protection zone
- Well-suited for serial compensated lines
- Two independent differential stages:
  one stage for sensitive measuring for high-resistance faults and one stage for high-current faults and fast fault clearance
- Breaker-failure protection (50BF)
- Phase and ground overcurrent protection with directional element (50, 50N, 51, 51N, 67, 67N)
- Phase-selective intertripping (85)
- Overload protection (49)
- Over/undervoltage protection (59/27)
- Over/underfrequency protection (81O/U)
- Auto-reclosure single/three-pole (79)

Control functions

- Command and inputs for control of CB and disconnectors (isolators)

Monitoring functions

- Self-supervision of the relay
- Trip circuit supervision (74TC)
- 8 oscillographic fault records
- CT-secondary current supervision
- Event logging / fault logging
- Switching statistics

Front design

- User-friendly local operation
- PC front port for convenient relay setting
- Function keys and 8 LEDs for local alarm

Communication interfaces

- 1 serial protection data (R2R) interface
- Front interface for PC connection
- System interface
  – IEC 61850 Ethernet
  – IEC 60870-5-103 protocol
  – PROFIBUS DP, DNP 3 and MODBUS
- Service / modem interface (rear)
- Time synchronization via IRIG-B, DCF77 or system interface

Features

- Browser-based commissioning tool
- Direct connection to digital communication networks

Application

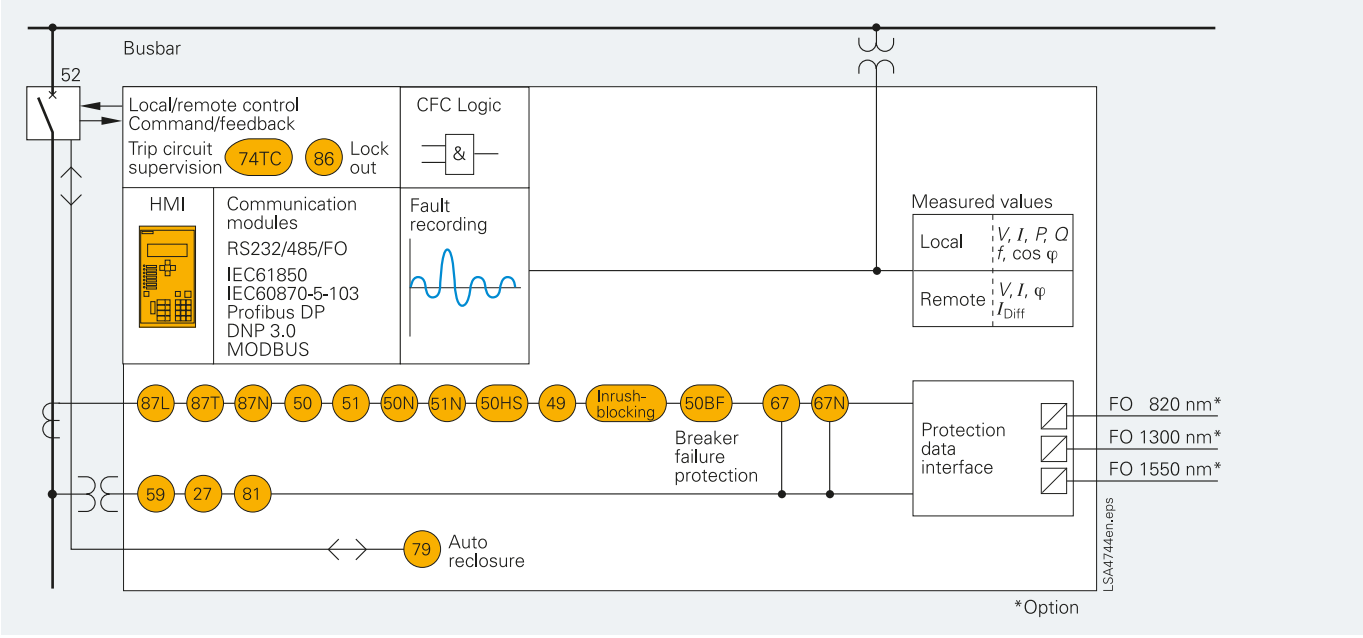

Fig. 7/2

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Application

The 7SD610 relay is a differential protection relay suitable for all types of applications and incorporating all those functions required for differential protection of lines, cables and transformers.
Transformers and compensation coils within the differential protection zone are protected by means of integrated functions, which were previously to be found only in transformer differential protection. It is also well-suited for complex applications such as series and parallel compensation of lines and cables.

It is designed to provide protection for all voltage levels and types of networks; two line ends may lie within the protection zone. The relay features very high-speed and phase-selective short-circuit measurement. The unit is thus suitable for single and three-phase fault clearance. The necessary restraint current for secure operation is calculated from the current transformer data by the differential protection unit itself.

Digital data communication for differential current measurement is effected via fiber-optic cables, digital communication networks or pilot wires, so that the line ends can be quite far apart. Thanks to special product characteristics, the relay is particularly suitable for use in conjunction with digital communication networks.

The units measure the delay time in the communication network and adaptively match their measurements accordingly. The units can be operated through pilot wires or twisted telephone pairs at typical distances of 8 km by means of special converters.

The serial communication interfaces for data transmission between the ends are replaceable by virtue of plug-in modules and can easily be adapted to multi-mode and mono-mode fiber-optic cables and to leased lines within the communication networks. Secure, selective and sensitive protection of two-end lines can now be provided by means of these relays.

ANSI	Protection functions
87L	ΔI for lines / cables
87T	ΔI for lines / cables with transformers
87N	Restricted ground-fault protection
85	Phase-selective intertrip, remote trip
86	Lockout function
50/50N 51/51N/67/67N	Overcurrent protection with directional elements
50HS	Instantaneous high-current tripping (switch-onto-fault)
79	Single or three-pole auto-reclosure with new adaptive technology
49	Overload protection
50BF	Breaker-failure protection
59/27	Overvoltage / undervoltage protection
81O/U	Overfrequency / underfrequency protection
74TC	Trip circuit supervision

Typical applications employing fiber-optic cables or communication networks

Five applications are shown in Fig. 7/3. The 7SD610 differential protection relay is connected to the current transformers and to the voltage transformers at one end of the cable, although only the currents are required for the differential protection function. The voltage connection improves, among other things, the frequency measurement and allows the measured values and the fault records to be extended. Direct connection to the other units is effected via mono-mode fiber-optic cables and is thus immune to interference.

Five different modules are available. In the case of direct connection via fiber-optic cables, data communication is effected at 512 kbit/s and the command time of the protection unit is reduced to 15 ms. Parallel compensation (for the load currents) is provided within the protection zone of the cable. By means of the integrated inrush restraint, the differential protection relay can tolerate the surge on switching-on of the cable and the compensation reactors, and thus allows sensitive settings to be used under load conditions.

7SD610 offers many features to reliably and safely handle data exchange via communication networks.

Depending on the bandwidth available a communication converter for G703-64 kbit/s or X21-64/128/512 kbit/s can be selected. For higher communication speed a communication converter with G703-E1 (2,048 kbit/s) or G703-T1 (1,554 kbit/s) is available. Furthermore the 7SD610 supports the IEEE C37.94 interface with 1/2/4 and 8 timeslots.

The connection to the communication converter is effected via a cost-effective 820 nm interface with multi-mode fiber. This communication converter converts the optical input to electrical signals in accordance to the specified telecommunication interface.

The fourth example shows the relays being connected via a twisted pilot pair. Data exchange and transmission is effected via pilot wires of a typical length of 15 km. Here a transformer is in the protected zone. In this application, 7SD610 is set like a transformer differential relay. Vector group matching and inrush restraint is provided by the relay.

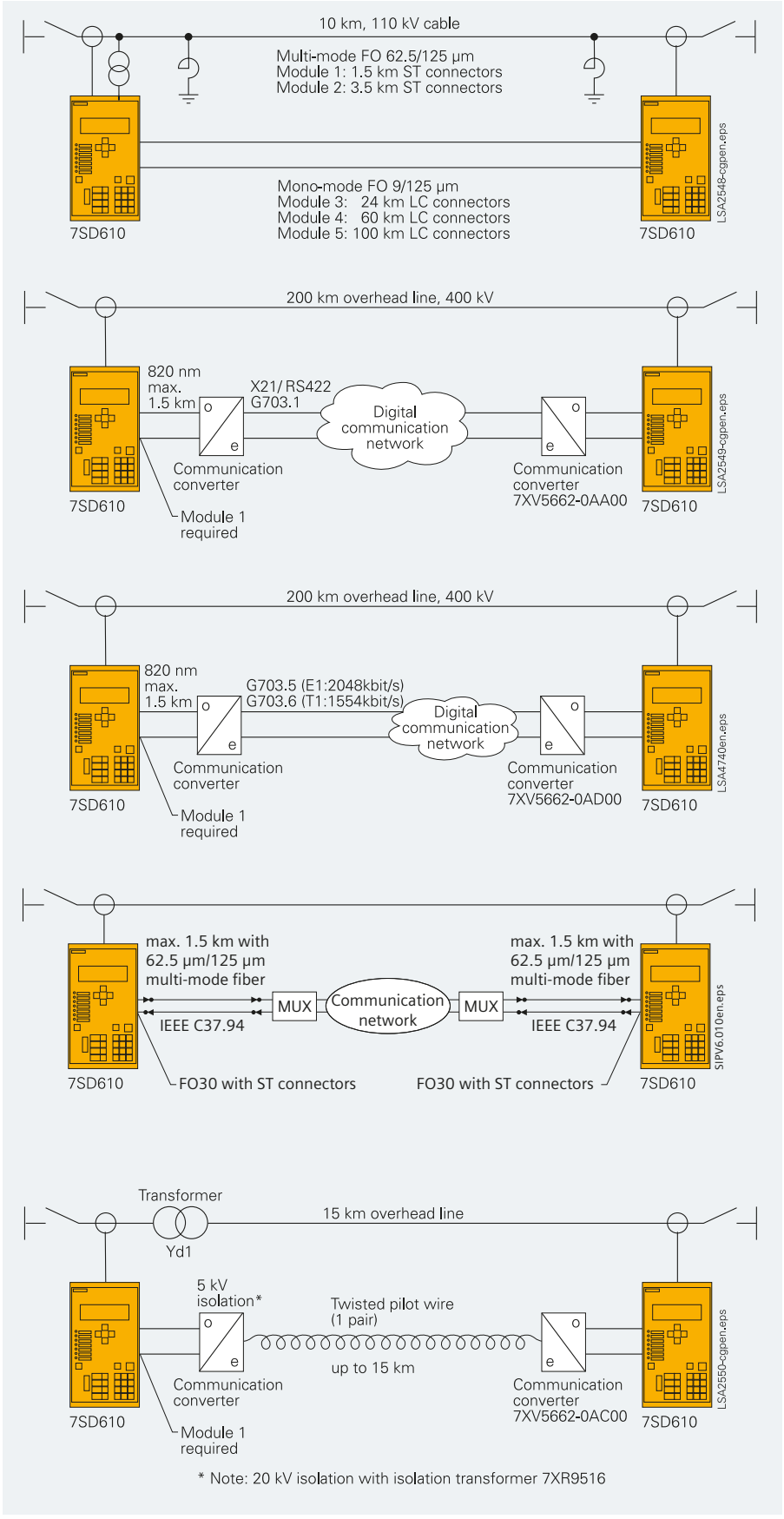

Fig. 7/3 Typical applications

Construction, protection functions

Fig. 7/4

Construction

The 7SD610 is available in a housing width of 1/3, referred to a 19" module frame system. The height is a uniform 245 mm for flush-mounting housings and 266 mm for surface-mounting housings.

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 "Dimension drawings".

Protection functions

Differential protection (ANSI 87L, 87T, 87N)

The differential protection function has the following features:

- Measurements are performed separately for each phase; thus the trip sensitivity is independent of the fault type.
- An adaptive measurement method with high sensitivity for differential fault currents below the rated current offers the detection of highly resistive faults. This trip element uses special filters, which offer high security even with high level DC components in the short-circuit current. The trip time of this stage is about 35 ms, the pickup value is about 10 % of the rated current.
- A high-set differential trip stage which clears differential fault currents higher than the rated current within 15 ms offers fast tripping time and high-speed fault clearance time. A high-speed charging comparison method is employed for this function.
- When a long line or cable is switched on at one end, transient peaks of the charge current load the line. To avoid a higher setting of the sensitive differential trip stage, this setpoint may be increased for a settable time. This offers greater sensitivity under normal load conditions.
- A special feature of the unit is parameterization of the current transformer data. The unit automatically calculates the necessary restraint current by means of the previously entered current transformer error. The unit thus adaptively matches the working point on the tripping characteristic so that it is no longer necessary for the user to enter characteristic settings.
- Different current-transformer ratios may be employed at the ends of the line. A mismatch of 1: 8 is permissible.
- Differential protection tripping can be guarded with overcurrent pickup. In this case, pickup of the protection relay is initiated only on simultaneous presence of differential current and overcurrent.
- Easy to set tripping characteristic. Because the relay works adaptively, only the set-point $I_{Diff}>$ (sensitive stage) and $I_{Diff}>>$ (high-set current differential stage) must be set according to the charge current of the line/cable.
- Differential and restraint current are monitored continuously during normal operation and are displayed as operational measured values.
- High stability during external faults even with different current transformers saturation level. For an external fault, only 5 ms of saturation-free time are necessary to guarantee the stability of the differential protection.
- Single-phase short-circuits within the protection zone can be cleared using a time delay, whereas multi-phase faults are cleared instantaneously. Because of this function, the unit is optimally suited for applications in inductively compensated networks, where differential current can occur as a result of charge transfer phenomena on occurrence of a single-phase ground fault within the protection zone, thus resulting in undesired tripping by the differential protection relay. Undesired tripping of the differential protection can be suppressed by making use of the provision for introduction of a time delay on occurrence of single-phase faults.
- With transformers or compensation coils in the protection zone, the sensitive response threshold $I_{Diff}>$ can be blocked by an inrush detection function. Like in transformer differential protection, it works with the second harmonic of the measured current compared with the fundamental component. Blocking is cancelled when an adjustable threshold value of the short-circuit current is reached, so that very high current faults are switched off instantaneously.
- In the case of transformers within the protection zone, vector group adaptation and matching of different current transformer ratios is carried out within the unit. The interference zero current, which flows through the grounded winding, is eliminated from the differential current measurement. The 7SD610 thus behaves like a transformer differential relay whose ends, however, can be quite far apart.
- A more sensitive protection for transformers within the protection zone is given by measurement of the star-point current on an grounded winding. Therefore the I_E current measurement input has to be used.
  If the sum of the phase currents of a winding is compared with the measured star-point current, a sensitive ground-current differential protection (REF) can be implemented. 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.

Characteristics of differential protection communciation through the remote relay interfaces

The 7SD610 is ideally adapted for application in communication networks.

The data required for measurement of differential currents and numerous other variables are exchanged between the protection units in the form of synchronous serial telegrams employing the full duplex mode. The telegrams are secured using 32-bit check-sums so that transmission errors in a communication network are detected immediately. Moreover, each telegram carries a time stamp accurate to a microsecond, thus allowing measurement and monitoring of the continuous transmission delay times.

- Data communication is immune to electromagnetic interference, since fiber-optic cables are employed in the critical region, e.g. in the relay house or relay room.
- Monitoring of each individual incoming telegram and of overall communication between the units, no need of supplementary equipment. The check sum (correctness of the telegram contents), the address of the neighboring unit and the transmission delay time of the telegram are monitored.
- Unambiguous identification of each unit is ensured by assignment of a settable communication address within a differential protection topology. Only those units mutually known to each other can cooperate. Incorrect interconnection of the communication links results in blocking of the protection system.
- Detection of telegrams, which are reflected back to the transmitting unit within the communication network.
- Detection of path switching in a communication network. Automatic restraint of the protection function until measurement of the parameters of the new communication link has been completed.
- Continuous measurement of the transmission delay time to the remote line end. Taking into account the delay time in differential current measurement and compensation thereof, including monitoring of a settable maximum permissible delay time of 30 ms.
- Generation of alarm signals on disturbed communication links. Statistical values for the percentage availability of the communication links per minute and per hour are available as operational measured values.
- With a GPS high-precision 1-s pulse from a GPS receiver the relays can be syncronized with an absolute, exact time at each line end. In this way, the delay in the receive and transmit path can be measured exactly. With this optional feature the relay can used in communication networks where this delay times are quite different.

Phase-selective intertrip and remote trip/indications

Normally the differential current is calculated for each line end nearly at the same time. This leads to fast and uniform tripping times. Under weak infeed conditions, especially when the differential function is combined with an overcurrent pickup, a phase-selective intertrip offers a tripping of both line ends.

- 7SD610 has 4 intertrip signals which are transmitted in high-speed mode (20 ms) to the other terminals. These intertrip signals can also be initiated and transmitted by an external relay via binary inputs. In cases where these signals are not employed for breaker intertripping, other alternative information can be rapidly transmitted to the remote end of the line.

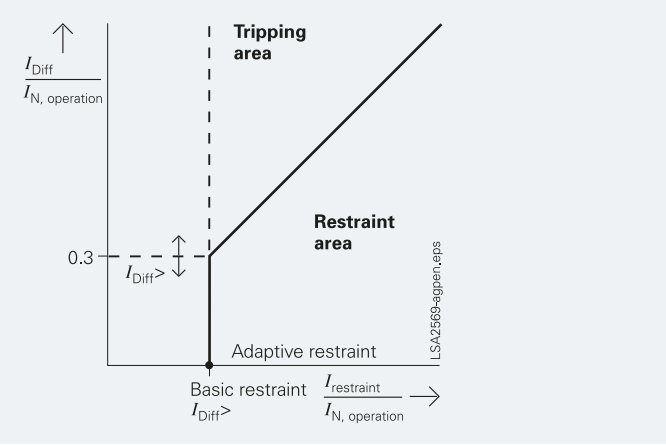

Fig. 7/5 Tripping characteristic

- In addition, four high-speed remote commands are available, which can be introduced either via a binary input or by means of an internal event and then rapidly communicated to the other end.
- Provided that the circuit-breaker auxiliary contacts are wired to binary inputs at the line ends, the switching status of the circuit-breakers is indicated and evaluated at the remote ends of the line. Otherwise the switching status is derived from the measured current.

Possible modes of operation of the differential protection section

Special modes of operation such as the “Commissioning mode” and “Test operation” are advantageous for commissioning and servicing the units.

- In general, an alarm indication is generated on interruption of the communication links and an attempt is made to re-establish the communication link. The units operate in the emergency mode, provided that these have been parameterized.
- The complete configuration can also be used in a testing mode. The local end is in an operating mode, which, for example, allows the pickup values to be tested. The current values received from the remote end of the line are set to zero, so as to achieve defined test conditions. The remote-end unit ignores the differential currents, which occur as a result of testing, and blocks differential protection and breaker intertripping. It may optionally operate in the backup protection mode.
- Differential protection is activated in the commissioning mode. However, test currents injected at one end of the line and which generate a differential current do not lead to output of a TRIP command by the differential protection or to breaker intertripping. All those indications that would actually occur in conjunction with a genuine short-circuit are generated and displayed. TRIP commands can be issued by the backup protection.

Protection functions

Thermal overload protection (ANSI 49)

A built-in overload protection with a current and thermal alarm stage is provided for thermal protection of cables and transformers.

The trip time characteristics are exponential functions according to IEC 60255-8. The preload is considered in the trip times for overloads.

An adjustable alarm stage can initiate an alarm before tripping is initiated.

Overcurrent protection (ANSI 50, 50N, 51, 51N, 67, 67N)

The 7SD610 provides a three-stage overcurrent protection. Two definite-time stages and one inverse-time stage (IDMT) are available, separately for phase currents and for the ground current. Two operating modes (backup, emergency) are selectable. Two stages e.g. can run in backup mode, whereas the third stage is configured for emergency operation, e.g. during interruption of the protection communication and/or failure of the voltage in the VT secondary circuit. The secondary voltage failure can be detected by the integrated fuse failure monitor or via a binary input from a VT miniature circuit-breaker (VT m.c.b. trip).

The following ANSI/IEC inverse-time characteristics are available:

- Inverse
- Short inverse
- Long inverse
- Moderately inverse
- Very inverse
- Extremely inverse
- Definite inverse

If VTs are connected, separate stages with directional measurement are available, two definite-time and two inverse-time stages (each for phase and ground). Using the forward pickup indication as a signal to the remote end, a 100 % protection coverage of the line can be operated in parallel to the differential protection.

Instantaneous high-speed switch-onto-fault overcurrent protection (ANSI 50HS)

Instantaneous tripping is possible when energizing a faulty line. On large fault currents, the high-speed switch-onto-fault overcurrent stage can initiate very fast three-pole tripping.

Circuit-breaker closure onto a faulty line is also possible provided that the circuit-breaker auxiliary contacts of the remote end are connected and monitored. If an overcurrent arises on closing of the circuit-breaker at one end of a line (while the other end is energized) the measured current can only be due to a short-circuit. In this case, the energizing line end is tripped instantaneously.

In the case of circuit-breaker closure, the auto-reclosure is blocked at both ends of the line to prevent a further unsuccessful closure onto a short-circuit. If circuit-breaker intertripping to the remote end is activated, intertripping is also blocked.

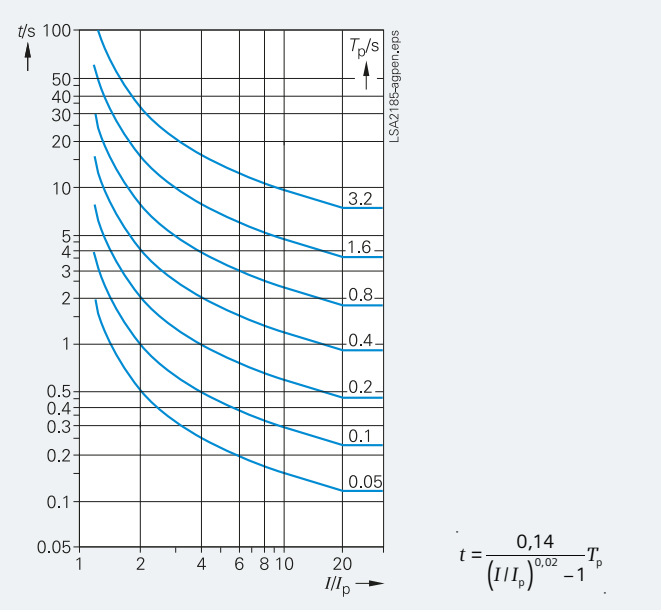

Fig. 7/6 Inverse

Auto-reclosure (ANSI 79)

The 7SD610 relay is equipped with an auto-reclose function (AR). The function includes several operating modes:

- 3-pole auto-reclosure for all types of faults; different dead times are available depending the type of fault
- 1-pole auto-reclosure for 1-phase faults, no reclosing for multi-phase faults
- 1-pole auto-reclosure for 1-phase faults and for 2-phase faults without ground, no reclosing for multi-phase faults
- 1-pole auto-reclosure for 1-phase and 3-pole auto-reclosing for multi-phase faults
- 1-pole auto-reclosure for 1-phase faults and 2-phase faults without ground and 3-pole auto-reclosure for other faults
- Multiple-shot auto-reclosure
- Interaction with an external device for auto-reclosure via binary inputs and outputs
- Control of the integrated AR function by external protection
- Adaptive auto-reclosure. Only one line end is closed after the dead time. If the fault persists this line end is switched off. Otherwise the other line ends are closed via a command over the communication links. This avoids stress when heavy fault currents are fed from all line ends again.
- Interaction with an external synchro-check
- Monitoring of the circuit-breaker auxiliary contacts

In addition to the above-mentioned operating modes, several other operating principles can be employed by means of the integrated programmable logic (CFC).

Integration of auto-reclosure in the feeder protection allows evaluation of the line-side voltages. A number of voltage-dependent supplementary functions are thus available:

- DLC
  By means of dead-line check, reclosure is effected only when the line is deenergized (prevention of asynchronous breaker closure).
- ADT
  The adaptive dead time is employed only if auto-reclosure at the remote station was successful (reduction of stress on equipment).
- RDT
  Reduced dead time is employed in conjunction with auto-reclosure where no tele-protection method is employed: When faults within the zone extension, but external to the protected line, are switched off for rapid auto-reclosure (RAR), the RDT function decides on the basis of measurement of the return voltage from the remote station which has not tripped whether or not to reduce the dead time.

Breaker failure protection (ANSI 50BF)

The 7SD610 relay incorporates a two-stage breaker failure protection to detect the failure of tripping command execution, for example, due to a defective circuit-breaker. The current detection logic is phase-segregated and can therefore also be used in single-pole tripping schemes. If the fault current is not interrupted after a settable time delay has expired, a retrip command or a busbar trip command is generated. The breaker failure protection can be initiated by all integrated protection functions as well as by external devices via binary input signals.

Overvoltage protection, undervoltage protection (ANSI 59, 27)

A voltage rise can occur on long lines that are operating at no-load or are only lightly loaded. The 7SD610 contains a number of overvoltage measuring elements. Each measuring element is of two-stage design. The following measuring elements are available:

- Phase-to-ground overvoltage
- Phase-to-phase overvoltage
- Zero-sequence overvoltage
- The zero-sequence voltage can be connected to the 4^{th} voltage input or be derived from the phase voltages.
- Positive-sequence overvoltage of the local end or calculated for the remote end of the line (compounding).
- Negative-sequence overvoltage

Tripping by the overvoltage measuring elements can be effected either at the local circuit-breaker or at the remote station by means of a transmitted signal.

The 7SD610 is fitted, in addition, with three two-stage under-voltage measuring elements:

- Phase-to-ground undervoltage
- Phase-to-phase undervoltage
- Positive-sequence undervoltage

The undervoltage measuring elements can be blocked by means of a minimum current criterion and by means of binary inputs.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for overfrequency and underfrequency protection. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting. Frequency protection can be used over a wide frequency range (45 to 55, 55 to 65 Hz). There are four elements (selectable as overfrequency or underfrequency) and each element can be delayed separately.

Protection functions

Monitoring and supervision functions

The 7SD610 relay provides comprehensive monitoring functions covering both hardware and software. Furthermore, the measured values are continuously checked for plausibility. Therefore the current and voltage transformers are also included in this monitoring system.

Current transformer / Monitoring functions

A broken wire between the CTs and relay inputs under load may lead to malopera- tion of a differential relay if the load current exceeds the differential setpoint. The 7SD610 provides fast broken wire supervision which immediatelly blocks all line ends if a broken wire condition is measured by a local relay. This avoids maloperation due to broken wire condition. Only the phase where the broken wire is detected is blocked. The other phases remain under differential operation.

Fuse failure monitoring

If any measured voltage is not present due to short-circuit or open circuit in the voltage transformer secondary circuit this can lead to a failure or a being missing measuring of the directional overcurrent protection. This secondary voltage interruption can be detected by means of the integrated fuse failure monitor. Immediate blocking of the directional steps of the overcurrent protection is started automatically.

Additional measurement supervision functions are

- Symmetry of voltages and currents
- Summation of currents and voltages

Trip circuit supervision (ANSI 74TC)

One or two binary inputs for each circuit- breaker pole can be used for monitoring the circuit-breaker trip coils including the connecting cables. An alarm signal is issued whenever the circuit is interrupted.

Lockout (ANSI 86)

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

Local measured values

The measured values are calculated from the measured current and voltage signals along with the power factor (cos φ), the frequency, the active and reactive power. Measured values are displayed as primary or secondary values or in percent of the specific line rated current and voltage. The relay uses a 20 bit high-resolution AD converter and the analog inputs are factory-calibrated, so a high accuracy is reached.

The following values are available for measured-value processing:

- Currents 3 x I_{Phase}, $3I_0$, I_E, $I_{E\ sensitive}$
- Voltages 3 x $V_{Phase\text{-}Ground}$, 3 x $V_{Phase\text{-}Phase}$,
- $3V_0$, V_{en},
- Symmetrical components I_1, I_2, V_1, V_2
- Real power P (Watt), reactive power
- Q (Var), apparent power S (VA)
- Power factor PF (= cos φ)
- Frequency f
- Differential and restraint current per phase
- Availability of the data connection to the remote line ends per minute and per hour
- Regarding delay time measuring with the GPS-version the absolute time for transmit and receive path is displayed separately.

Limit value monitoring: Limit values are monitored by means of the CFC. Commands can be derived from these limit value indications.

Measured values at remote line ends

Every two seconds the currents and voltages are freezed at the same time at all line ends and transmitted via the communication link. At a local line end, currents and voltages are thus available with their amount and phases (angle) locally and remotely. This allows checking the whole configuration under load conditions. In addition, the differential and restraint currents are also displayed. Important communication measurements, such as delay time or faulty telegrams per minute/hour are also available as measurements. These measured values can be processed with the help of the CFC logic editor.

Commissioning

Special attention has been paid to commissioning. All binary inputs and outputs can be displayed and activated directly. This can simplify the wiring check significantly for the user. The operational and fault events and the fault records are clearly arranged.

Furthermore, all currents and optional voltages and phases are available via communication link at the local relay and are displayed in the relay, with DIGSI 4 or with the Web Monitor.

The operational and fault events and fault records from all line ends share a common time tagging which allows to compare events registered in the different line ends on a common time base.

WEB Monitor – Internet technology simplifies visualization

In addition to the universal DIGSI 4 operating program, the relay contains a WEB server that can be accessed via a telecommunication link using a browser (e.g. Internet Explorer). The advantage of this solution is to operate the unit with standard software tools and at the same time make use of the Intranet/Internet infrastructure. This program shows the protection topology and comprehensive measurements from local and remote line ends. Local and remote measurements are shown as phasors and the breaker positions of each line end are depicted. It is possible to check the correct connection of the current transformers or the correct vector group of a transformer.

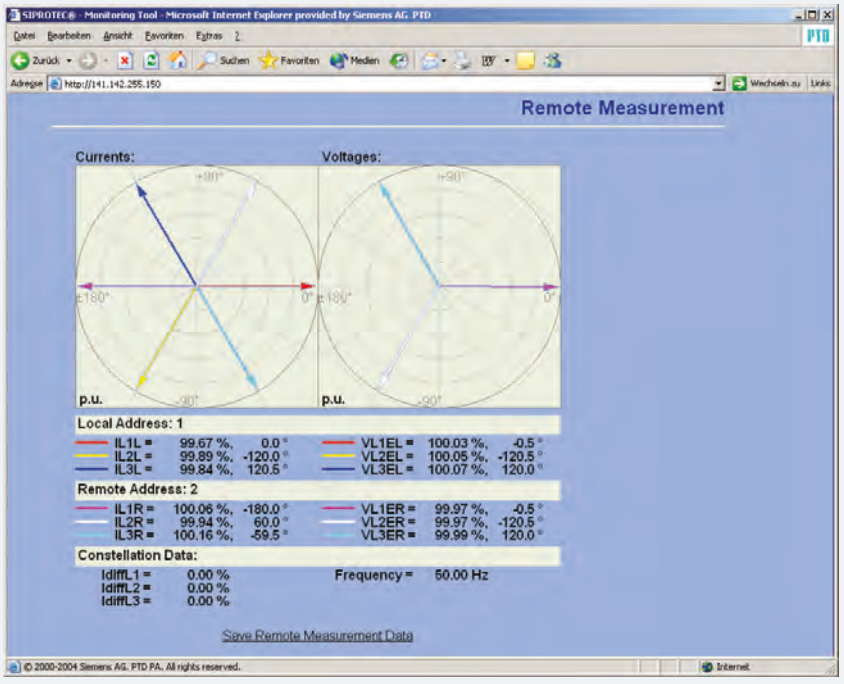

Fig. 7/7 Browser-aided commissioning: Phasor diagram

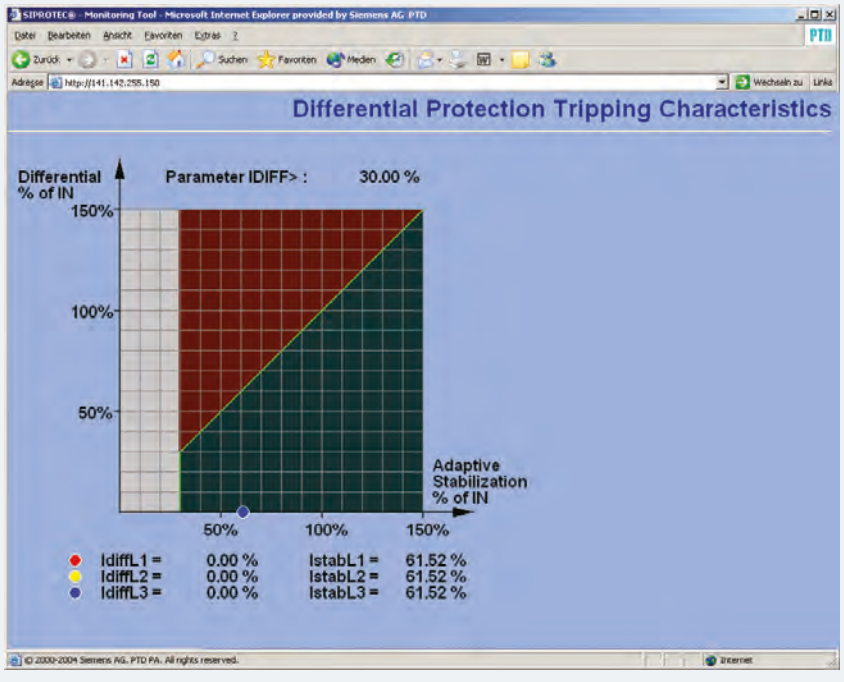

Fig. 7/8 Browser-aided commissioning: Differential protection tripping characteristic

Stability can be checked by using the operating characteristic as well as the calculated differential and restraint values in the browser windows.

Event log and trip log messages are also available. Remote control can be used, if the local front panel cannot be accessed.

Functions

■ 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.

With respect to communication, particular emphasis has been placed on high flexibility, data security and use of customary standards in the field of energy automation. The concept of the communication modules allows interchangeability on the one hand, and, on the other hand, is open for future standards.

Local PC interface

The PC interface provided on the front panel on the unit allows the parameters, status and fault event data to be rapidly accessed by means of the DIGSI 4 operating program. Use of this program is particularly advantageous during testing and commissioning.

Rear-mounted interfaces

The service and system communication interfaces are located at the rear of the unit. In addition, the 7SD610 is provided with a protection interface. The interface complement is variable and retrofitting is possible without any difficulty. These interfaces ensure that the requirements for different communication interfaces (electrical and optical) and protocols can be met.

The interfaces are designed for the following applications:

Service / modem interface

By means of the RS485 interface, it is possible to efficiently operate a number of protection units centrally via DIGSI 4. Remote operation is possible on connection of a modem. This offers the advantage of rapid fault clarification, especially in the case of unmanned power plants.

In the case of the 7SD610, a PC with a standard browser can be connected to the service interface (refer to "Commissioning program").

System interface

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 7SD610, 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 sends its 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, DNP 3.0, MODBUS, DIGSI, etc.) are required, such demands can be met.

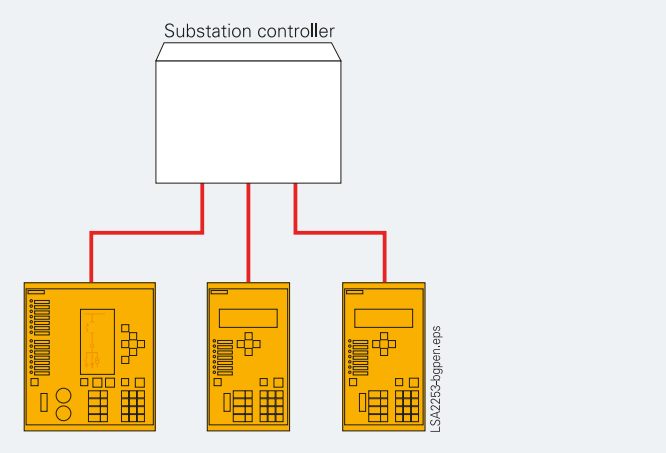

Fig. 7/9 IEC 60870-5-103 star-type RS232 copper conductor connection or fiber-optic connection

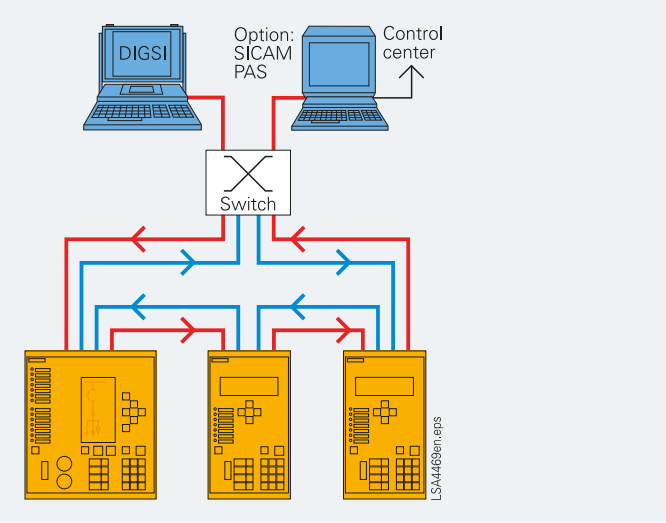

Fig. 7/10 Bus structure for station bus with Ethernet and IEC 61850

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.

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 ans 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.

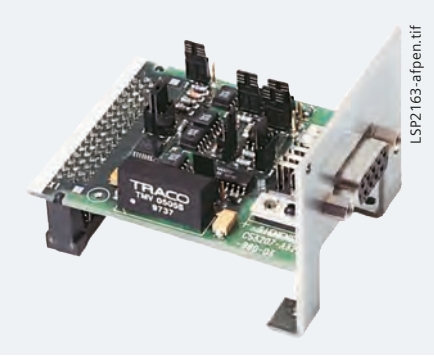

Fig. 7/11 RS232/RS485 electrical communication module

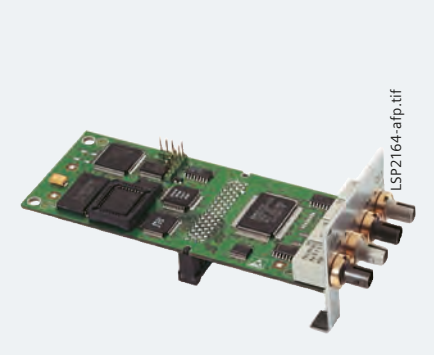

Fig. 7/12 PROFIBUS fiber-optic double ring communication module

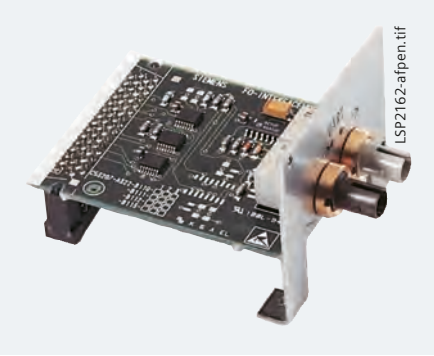

Fig. 7/13 820 nm fiber-optic communication module

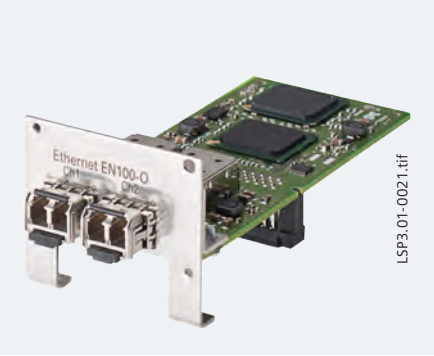

Fig. 7/14 Fiber-optic Ethernet communication module for IEC 61850 with integrated Ethernet switch

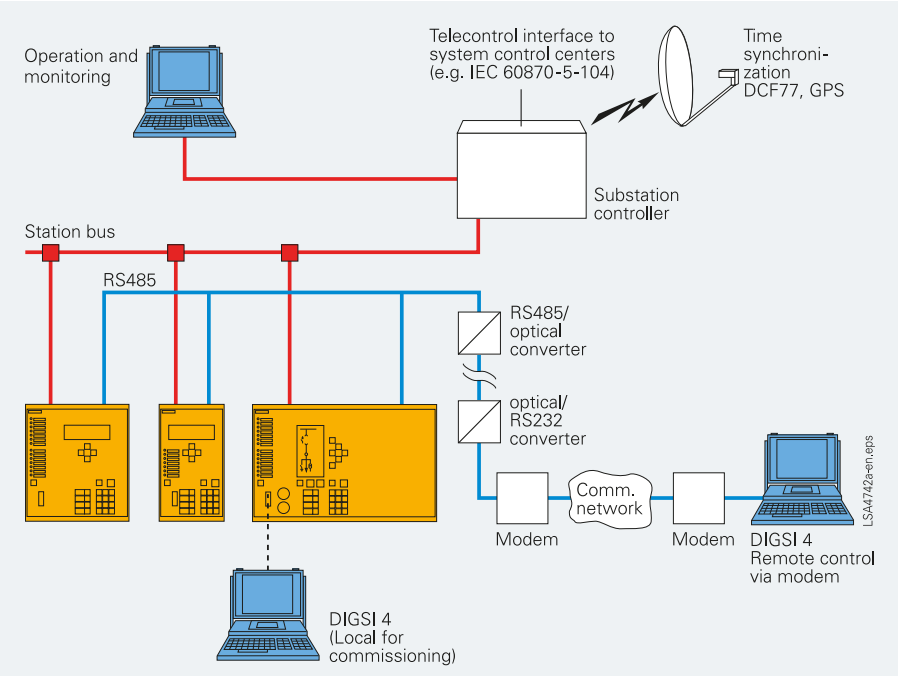

Fig. 7/15 System solution: Communications

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. 7/9).

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. 7/10).

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

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

Serial protection interface (R2R interface)

The 7SD610 provides one protection interface to cover two line end applications.

In addition to the differential protection function, other protection functions can use this interface to increase selectivity and sensitivity as well as covering advanced applications.

- Fast phase-selective teleprotection signaling using the directional stages of the overcurrent protection with POTT or PUTT schemes
- Two terminal line applications can be implemented without additional logic
- Interclose command transfer with the auto-reclosure "Adaptive dead time" (ADT) mode
- 4 remote signals for fast transfer of binary signals
- Flexible utilization of the communication channels by means of the programmable CFC logic

The protection interfaces have different options to cover new and existing communication infrastructures.

- FO5[1], OMA1[2] module:
  820 nm fiber-optic interface with clock recovery/ST connectors for direct connection with multi-mode FO cable up to 1.5 km for the connection to a communication converter.
- FO6[1], OMA2[2] module:
  820 nm fiber-optic interface/ST connectors for direct connection up to 3.5 km with multi-mode FO cable.

New fiber-optic interfaces, series FO1x

FO17[1]:
For direct connection up to 24 km[3], 1300 nm, for mono-mode fiber 9/125 µm, LC-Duplex connector

FO18[1]:
For direct connection up to 60 km[3], 1300 nm, for mono-mode fiber 9/125 µm, LC-Duplex connector

FO19[1]:
For direct connection up to 100 km[3], 1550 nm, for mono-mode fiber 9/125 µm, LC-Duplex connector

FO30:
820 nm fiber-optic interface/ST connectors for direct connection up to 1.5 km and for connections to a IEEE C37.94 multiplexer interface.

The link to a multiplexed communication network is made by separate communication converters (7XV5662). These have a fiber-optic interface with 820 nm and 2 ST connectors to the protection relay. The link to the communication network is optionally an electrical X21/G703-64 kbit/s or G703-E1/-T1 interface. Furthermore the IEEE C37.94 interface is supported by the FO30 module.

For operation via copper wire communication (pilot wires or twisted telephone pair), a modern communication converter for copper cables is available. This operates with both the two-wire and three-wire copper connections which were used by conventional differential protection systems before. The communication converter for copper cables is designed for 5 kV insulation voltage. An additional 20 kV isolation transformer can extend the field of applications of this technique into ranges with higher insulation voltage requirements. The connection via FO cable to the relay is interference-free. With SIPROTEC 4 and the communication converter for copper cables a digital follow-up technique is available for two-wire protection systems (up to 8 km) and all three-wire protection systems using existing copper communication links.

Different communication converters are listed under "Accessories".

Communication data:

- 32-bit CRC-check according to CCITT and ITU
- Each protection relay possesses a unique relay address
- Continuous communication link supervision: Individual faulty data telegrams do not constitute an immediate danger, if they occur only sporadically. The statistical availability, per minute and hour, of the serial protection interface can be displayed.
- Supported network interfaces X21/RS422 with 64 or 128 or 512 kbit/s; or G703-64 kbit/s and G703-E1 (2,048 kbit/s) or G703-T1 (1,554 kbit/s) or IEEE C37.94.
- Max. channel delay time 0.1 ms to 30 ms (in steps of 0.1 ms)
- Protocol HDLC

1) For flush-mounting housing.

2) For surface-mounting housing.

3) For surface-mounting housing the internal FO module OMA1 will be delivered together with an external repeater.

Communication

Communication possibilities between relays

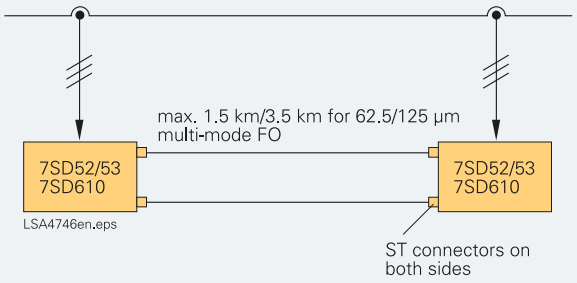

Fig. 7/16 Direct optical link up to 1.5 km/3.5 km, 820nm

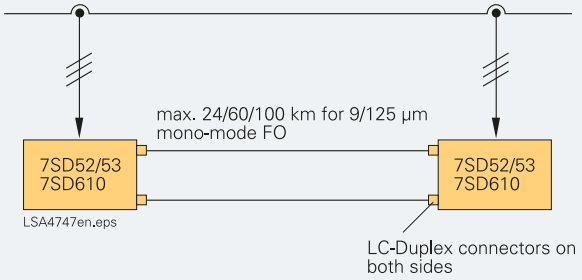

Fig. 7/17 Direct optical link up to 25/60 km with 1300 nm or up to 100 km with 1550 nm

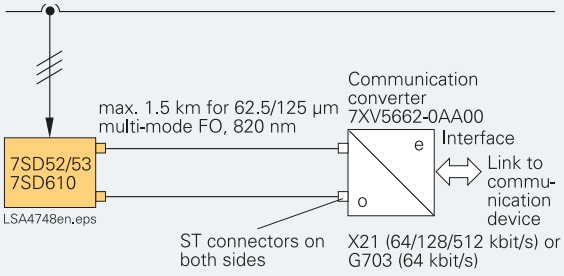

Fig. 7/18 Connection to a communication network CC-XG

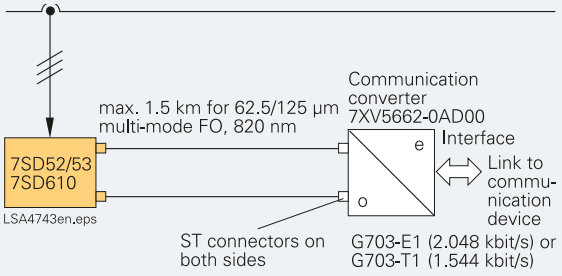

Fig. 7/19 Connection to a communication network CC-2M

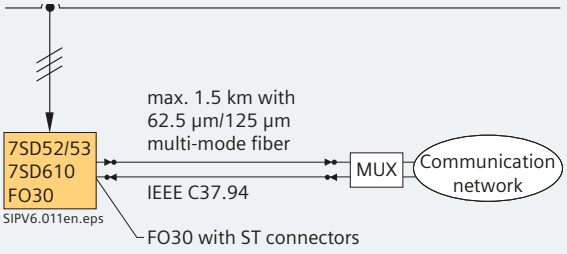

Fig. 7/20 Connection to a communication network via IEEE C37.94

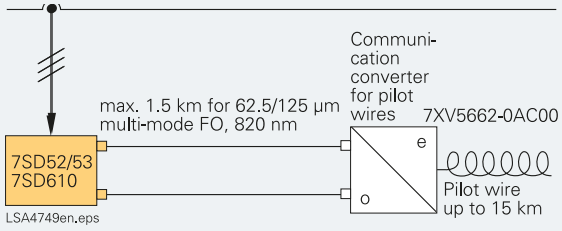

Fig. 7/21 Connection to a pilot wire

Typical connection

Connection of current and voltage transformers

A typical connection is to the phase CT. The residual current at the I_E input is formed by summation of the phase currents. This ensures optimum supervision functions for the current.

Optionally, voltages are measured by means of voltage transformers and are fed to the unit as a phase-to-ground voltage. The zero voltage is derived from the summation voltage by calculation performed in the unit.

As a matter of fact, the 7SD610 unit does not require any voltage transformers for operation of the differential protection.

Alternative current measurement

3 phase current transformers with neutral point in the line direction, I_4 connected to a current transformer in the neutral point of a grounded (earthed) transformer for restricted ground-fault protection (REF) or directional ground (earth)-fault protection.

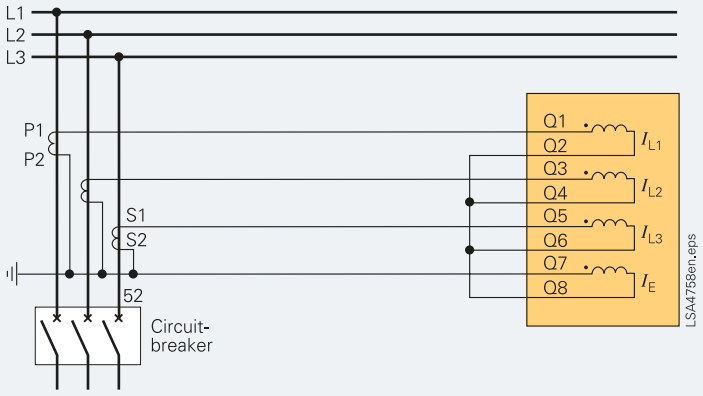

Fig. 7/22 Typical connection to current transformers

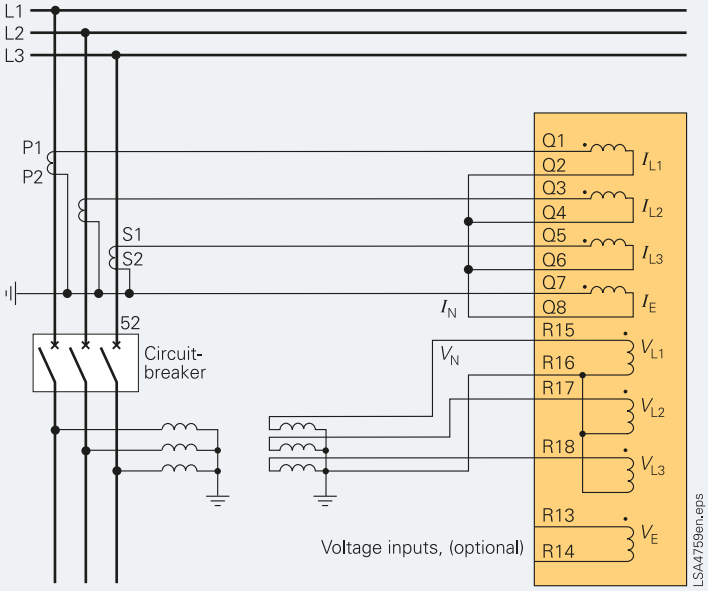

Fig. 7/23 Typical connection to current transformers with optional voltage inputs

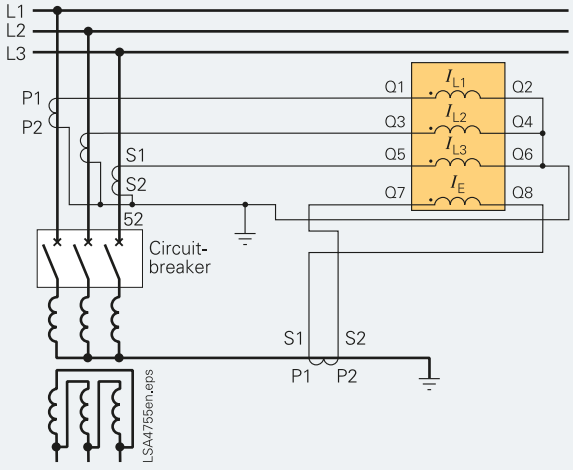

Fig. 7/24 Connection for transformer with restricted ground-fault protection (REF)

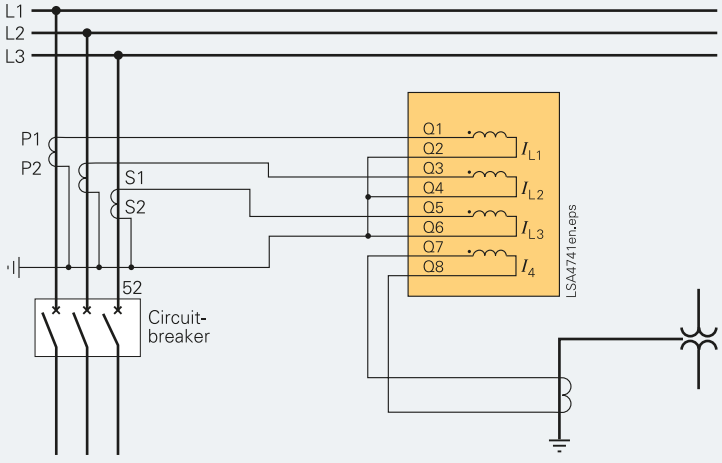

Fig. 7/25 Alternative connection of current transformers for measuring neutral current of a grounded (earthed) power transformer

Technical data

General unit data	
Analog inputs	
Rated frequency	50 or 60 Hz (selectable)
Rated current I_N	1 or 5 A (selectable)
Rated voltage V_N	80 to 125 V (selectable)
Power consumption	
in CT circuits with I_N = 1 A	Approx. 0.05 VA
with I_N = 5 A	Approx. 0.3 VA
in VT circuits	Approx. 0.1 VA
Thermal overload capacity	I_N
in CT circuits (for I_N = 5 A)	100 A for 1 s 30 I_N for 10 s 4 I_N continuous
Dynamic (peak value)	250 I_N (half sine)
In VT circuits for highly sensitive ground-fault protection	300 A for 1 s 100 A for 10 s 15 A continuous
in VT circuits	230 V per phase continuous
Auxiliary voltage	
Rated voltages Ranges are settable by means of jumpers	DC 24 to 48 V DC 60 to 125 V [1] DC 110 to 250 V [1] and AC 115 V (50/60 Hz)[1]
Permissible tolerance	-20 % to +20 %
Superimposed AC voltage (peak-to-peak)	≤ 15 %
Power consumption	
Under normal operating conditions	Approx. 8 W
During pickup with all inputs and outputs activated	Approx. 18 W
Bridging time during failure of the auxiliary voltage	
V_{aux} ≥ 110 V	≥ 50 ms
Binary inputs	
Number	7 (marshallable)
Rated voltage range Pickup threshold	24 to 250 V, bipolar 17 or 73 V (selectable)
Functions are freely assignable	
Minimum pickup threshold Ranges are settable by means of jumpers for each binary input	DC 17 or 73 V, bipolar
Maximum permissible voltage	DC 300 V
Current consumption, energized	Approx. 1.8 mA
Output relay	
Command / indication relay	
Number	5 (marshallable) 1 alarm contact (not marshallable)
Switching capacity	1000 W/VA
Make	30 VA
Break	40 W
Break (with resistive load)	25 W
Break (with L/R ≤ 50 ms)	250 V
Switching voltage	30 A for 0.5 seconds
Permissible total current	5 A continuous
LEDs	
Number	
RUN (green)	1
ERROR (red)	1
LED (red), function can be assigned	7

Unit design	
Housing 7XP20	For dimensions refer to dimension drawings, part 14
Degree of protection acc. to EN 60529	
Surface-mounting housing	IP 51
Flush-mounting housing	
front	IP 51
rear	IP 50
for the terminals	IP 20 with terminal cover put on
Weight	
Flush-mounting housing 1/3 x 19"	4 kg
Surface-mounting housing 1/3 x 19"	6 kg
Electrical tests	
Specification	
Standards	EC 60255 (product standards) ANSI/IEEE C37.90.0/.1/.2 UL 508 For further standards see "Individual functions"
Insulation tests	
Standards	IEC 60255-5
Voltage test (100 % test)	
All circuits except for auxiliary supply, binary inputs and communication interfaces	2.5 kV (r.m.s.), 50 / 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 / 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 3 positive and 3 negative impulses at intervals of 5 s
EMC tests for noise immunity; type tests	
Standards	IEC 60255-6, IEC 60255-22 (product standards) (type tests) EN 50082-2 (generic standard) DIN 57435 part 303
High frequency test IEC 60255-22-1, class III and VDE 0435 part 303, class III	2.5 kV (peak); 1 MHz; τ = 15 ms; 400 surges per s; test duration 2 s
Electrostatic discharge IEC 60255-22-2, class IV EN 61000-4-2, class IV	8 kV contact discharge; 15 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
Irradiation with RF field, non-modulated IEC 60255-22-3 (report), class III	10 V/m; 27 to 500 MHz
Irradiation with RF field, amplitude-modulated IEC 61000-4-3, class III	10 V/m; 80 to 1000 MHz; 80 % AM; 1 kHz

1) For flush-mounting housing.

2) For surface-mounting housing.

3) For surface-mounting housing the internal FO module OMA1 will be delivered together with an external repeater.

Irradiation with RF field, pulse-modulated IEC 61000-4-3/ ENV 50204, class III	10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %
Fast transients, 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 Ω; test duration 1 min
High-energy surge voltages (SURGE), IEC 61000-4-5 installation, class III	Impulse: 1.2/50 µs
Auxiliary supply	Common (longitudinal) mode: 2 kV; 12 Ω; 9 µF Differential (transversal) mode: 1 kV; 2 Ω; 18 µF
Measurement inputs, binary inputs, binary output relays	Common (longitudinal) mode: 2 kV; 42 Ω; 0.5 µF Differential (transversal) mode: 1 kV; 42 Ω; 0.5 µF
Line-conducted HF, amplitude-modulated IEC 61000-4-6, class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Magnetic field with power frequency IEC 61000-4-8, class IV; IEC 60255-6	30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz
Oscillatory surge withstand capability ANSI/IEEE C37.90.1	2.5 to 3 kV (peak); 1 to 1.5 MHz damped wave; 50 surges per second, duration 2 s, R_i = 150 to 200 Ω
Fast transient surge withstand capability ANSI/IEEE C37.90.1	4 to 5 kV; 10/150 ns; 50 impulses per second; both polarities; duration 2 s; R_i = 80 Ω
Radiated electromagnetic interference ANSI/IEEE C37.90.2	35 V/m; 25 to 1000 MHz
Damped oscillation IEC 60694, IEC 61000-4-12	2.5 kV (peak value); polarity alternating 100 kHz; 1 MHz; 10 and 50 MHz; R_i = 200 Ω

EMC tests for interference emission; type tests	
Standard	EN 50081-1 (generic standard)
Conducted interference voltage on lines, only auxiliary voltage IEC-CISPR 22	150 kHz to 30 MHz
Radio interference field strength IEC-CISPR 22	Limit class B 30 to 1000 MHz Limit class B

Mechanical dynamic tests	
Vibration, shock stress and seismic vibration	
During operation	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 10 to 60 Hz: ± 0.075 mm amplitude; 60 to 150 Hz: 1 *g* acceleration frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Half-sinusoidal Acceleration 5 *g*, duration 11 ms, 3 shocks on each of the 3 axes in both directions
Seismic vibration IEC 60255-21-2, class 1 IEC 60068-3-3	Sinusoidal 1 to 8 Hz: ± 3.5 mm amplitude (horizontal axis), 1 to 8 Hz: ± 1.5 mm amplitude (vertical axis), 8 to 35 Hz: 1 *g* acceleration (horizontal axis), 8 to 35 Hz: 0.5 *g* acceleration (vertical axis), frequency sweep 1 octave/min 1 cycle in 3 orthogonal axes
During transport	
Standards	IEC 60255-21 and IEC 60068-2
Vibration IEC 60255-21-1, class 2 IEC 60068-2-6	Sinusoidal 5 to 8 Hz: ± 7.5 mm amplitude; 8 to 150 Hz: 2 *g* acceleration, Frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class 1 IEC 60068-2-27	Half-sinusoidal Acceleration 15 *g*, duration 11 ms, 3 shocks on each of the 3 axes in both directions
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 test	
Temperatures	
Type-tested acc. to IEC 60068-2-1 and -2, test Bd, for 16 h	–25 °C to +85 °C / –13 °F to +185 °F
Temporarily permissible operating temperature, tested for 96 h	–20 °C to +70 °C / –4 °F to +158 °F
Recommended permanent operating temperature acc. to IEC 60255-6 (Legibility of display may be impaired above +55 °C / +131 °C)	–5 °C to +55 °C / +25 °F to +131 °F
– Limiting temperature during permanent storage	–25 °C to +55 °C / –13 °F to +131 °F
– Limiting temperature during transport	–25 °C to +70 °C / –13 °F to +158 °F
Humidity	
Permissible humidity stress; It is recommended to arrange the units in such a way that they are not exposed to direct sunlight or pronounced temperature changes that could cause condensation.	Annual average ≤ 75 % relative humidity; on 56 days in the year up to 93 % relative humidity; moisture condensation during operation is not permitted

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

7

Selection and ordering data

Description	Order No.	Short code
7SD61 numerical line differential protection 87L SIPROTEC 4 for two-line ends, allows transformers in the protection zone	**7SD610**□-□□□□□□-□□□□-□□□	
Current transformer		
I_{ph} = 1 A[1], I_e = 1 A[1]	**1**	
I_{ph} = 1 A[1], I_e = 5 A[1]	**5**	
Auxiliary voltage		
(Power supply, BI operating voltage) DC 24 to 48 V, trigger level binary input 19 V[3]	**2**	
DC 60 to 125 V [2], trigger level binary input 19 V[3]	**4**	
DC 110 to 250 V [2], AC 115 to 230 V, trigger level binary input 88 V[3]	**5**	
DC 110 to 250 V [2], AC 115 to 230 V, trigger level binary input 176 V[3]	**6**	
Housing, number of binary inputs/outputs		
Flush-mounting housing with screw-type terminals ⅓ 19", 7 BI, 5 BO, 1 live-status contact	**B**	
Surface-mounting housing with screw-type terminals ⅓ 19", 7 BI, 5 BO, 1 live-status contact	**F**	
Flush-mounting housing with plug-in terminals, ⅓ 19", 7 BI, 5 BO , 1 live-status contact	**K**	
Region-specific default settings / function versions and language settings		
Region DE, German language (language changeable)	**A**	
Region world, English language (language changeable)	**B**	
Region US, US-English language (language changeable)	**C**	
Region world, French language (language changeable)	**D**	
Region world, Spanish language (language changeable)	**E**	
Region world, Italian language (language changeable)	**F**	
System interfaces, functions and hardware		
Without system interface	**0**	
IEC 60870-5-103 protocol, electric RS232	**1**	
IEC 60870-5-103 protocol, electric RS485	**2**	
IEC 60870-5-103 protocol, optical 820 nm, ST connector	**3**	
Further protocols see supplement L	**9**	**L 0** □
PROFIBUS DP slave, RS485		**A**
PROFIBUS DP slave, optical 820 nm, double ring, ST connector[4]		**B**
MODBUS, RS485		**D**
MODBUS, optical 820 nm, ST connector[4]		**E**
DNP 3.0, RS485		**G**
DNP 3.0, optical 820 nm, ST connector[4]		**H**
IEC 61850, 100 Mbit Ethernet electrical, double, RJ45 connector (EN 100)		**R**
IEC 61850, 100 Mbit Ethernet, with integrated switch optical, double, LC connector[5]		**S**

see next page

BI = Binary input
BO = Binary output

1) Rated current 1/5 A can be selected by means of jumpers.

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

3) Setting of the BI thresholds can be made for each binary input via jumpers in 3 steps.

4) Not possible for surface mounting housing (Order No. pos. 9 = **F**). For the surface mounted version, please order a device with the appropriate electrical RS485 interface and an external FO-converter

5) Not possible for surface mounting housing (Order No. pos. 9 = **F**) please order the relay with electrical interface and use a separate fiber-optic switch

Selection and ordering data

Description	Order No.	Short code
7SD61 numerical line differential protection 87L SIPROTEC 4 (continued)	**7SD610**□-□□□□□□-□□□□-□□□	
DIGSI/Modem interface (on rear of device) and protection interface 1	9	M□□
DIGSI/Modem interface (on rear of device) DIGSI 4, electrical RS232		1
DIGSI 4, electrical RS485		2
Protection data interface 1		
FO5: Optical 820 nm, 2 ST-plugs, line length up to 1.5 km via multimode FO cable for communication converter or direct FO connection [1]		A
FO6: Optical 820 nm, 2 ST-plugs, line length up to 3.5 km via multimode FO cable for direct FO connection		B
FO17: Optical 1300 nm, LC-Duplex-plugs, line length up to 24 km [2] via monomode FO cable for direct FO connection [2]		G
FO18: Optical 1300 nm, LC-Duplex-plugs, line length up to 60 km via monomode FO cable for direct FO connection [2][3]		H
FO19: Optical 1550 nm, LC-Duplex-plugs, line length up to 100 km via monomode FO cable for direct FO connection [2][4]		J
FO30: Optical 820 nm, 2 ST-plugs, line length up to 1.5 km via multimode FO cable for communication networks with IEEE C37.94 interface or direct FO connection [5]		S
Functions 1		
Trip mode 3-pole only without auto reclosure	0	
Trip mode 3-pole only with auto reclosure	1	
Trip mode 1- and 3-pole without auto reclosure	2	
Trip mode 1- and 3-pole with auto reclosure	3	
Back-up functions		
with emergency or back-up overcurrent protection	B	
with emergency or back-up overcurrent and breaker failure protection	C	
with directional – emergency or back-up overcurrent protection	R	
with directional – emergency or back-up overcurrent and breaker failure protection	S	

Additional functions 1

4 Remote commands/ 24 Remote indications	Transformer expansions	Voltage-/frequence protection	Restricted earth fault (low impedance)	
				A
		■		B
	■			E
	■	■		F
■				J
■		■		K
■	■			N
■	■	■		P
■	■		■	S
■	■	■	■	T
without external GPS synchronisation of differential protection				0
with external GPS synchronisation of differential protection				1

1) Communication converter 7XV5662, see Accessories.

2) Device for surface-mounting housing (Order No. pos. 9 = **F**) will be delivered with external repeater 7XV5461-0Bx00.

3) For distances less than 25 km a set of optical attenuators 7XV5107-0AA00 must be installed to avoid saturation of the receiver element.

4) For distances less than 50 km a set of optical attenuators 7XV5107-0AA00 must be installed to avoid saturation of the receiver element.

5) Only available in flush-mounting housing (Order No. pos. 9 = **B**, **K**).

Selection and ordering data

Accessories	Description	Order No.
	Opto-electric communication converter CC-XG (connection to communication network)	
	Converter to interface to X21 or RS422 or G703-64 kbit/s synchronous communication interfaces Connection via FO cable for 62.5 / 125 µm or 50 / 120 µm and 820 nm wavelength (multi-mode FO cable) with ST connector, max. distance 1.5 km Electrical connection via X21/RS422 or G703-64 kbit/s interface	**7XV5662-0AA00**
	Opto-electric communication converter CC-2M to G703-E1/-T1 communication networks with 2,048 / 1,554 kbit/s	
	Converter to interface between optical 820 nm interface and G703-E1/-T1 interface of a communication network Connection via FO cable for 62.5/125 µm or 50/120 µm and 820 nm wavelength (multi-mode FO cable) with ST connector, max. distance 1.5 km Electrical connection via G703-E1/-T1 interface	**7XV5662-0AD00**
	Opto-electric communication converter (connection to pilot wire)	
	Converter to interface to a pilot wire or twisted telephone pair (typical 15 km length) Connection via FO cable for 62.5/125 µmor 50/120 µm and 820 nm wavelength (multi-mode FO cable) with ST connector; max. distance 1.5 km, screw-type terminals to pilot wire	**7XV5662-0AC00**
	Additional interface modules	
	Protection interface module, optical 820 nm, multi-mode FO cable, ST connector, 1.5 km	**C53207-A351-D651-1**
	Protection interface module, optical 820 nm, multi-mode FO cable, ST connector, 3.5 km	**C53207-A351-D652-1**
	Further modules	
	Protection interface module, optical 1300 nm, mono-mode FO cable, LC-Duplex connector, 24 km	**C53207-A351-D655-1**
	Protection interface module, optical 1300 nm, mono-mode FO cable, LC-Duplex connector, 60 km	**C53207-A351-D656-1**
	Protection interface module, optical 1550 nm, mono-mode FO cable, LC-Duplex connector, 100 km	**C53207-A351-D657-1**
	Protection interface module, optical 820 nm, multi-mode FO cable, ST connector, 1.5 km support of IEEE C37.94	**C53207-A351-D658-1**
	Optical repeaters	
	Serial repeater (2-channel), optical 1300 nm,mono-mode FO cable, LC-Duplex connector, 24 km	**7XV5461-0BG00**
	Serial repeater (2-channel), optical 1300 nm,mono-mode FO cable, LC-Duplex connector, 60 km	**7XV5461-0BH00**
	Serial repeater (2-channel), optical 1550 nm,mono-mode FO cable, LC-Duplex connector, 100 km	**7XV5461-0BJ00**
	Time synchronizing unit with GPS output	
	GPS 1 sec pulse and time telegram IRIG B/DCF 77	**7XV5664-0AA00**
	Isolation transformer (20 kV) for pilot wire communication	**7XR9516**
	Voltage transformer miniature circuit-breaker	
	Rated current 1.6 A; thermal overload release 1.6 A; overcurrent trip 6 A	**3RV1611-1AG14**

Selection and ordering data

Accessories	Description	Order No.
	Connecting cable (copper) Cable between PC/notebook (9-pin connector) and protection unit (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)	**7XV5100-4**
	Manual for 7SD61 V4.6 English	**C53000-G1176-C145-4**

Accessories	Description		Order No.	Size of package	Supplier	Fig.
	Connector	2-pin	**C73334-A1-C35-1**	1	Siemens	7/27
		3-pin	**C73334-A1-C36-1**	1	Siemens	7/28
	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	7/26
	Short-circuit links	For current terminals	**C73334-A1-C33-1**	1	Siemens	7/29
		For other terminals	**C73334-A1-C34-1**	1	Siemens	7/30
	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.

Fig. 7/26 Mounting rail for 19" rack

Fig. 7/27
2-pin connector

Fig. 7/28
3-pin connector

Fig. 7/29
Short-circuit link for current contacts

Fig. 7/30
Short-circuit link for voltage contacts/ indications contacts

Connection diagram

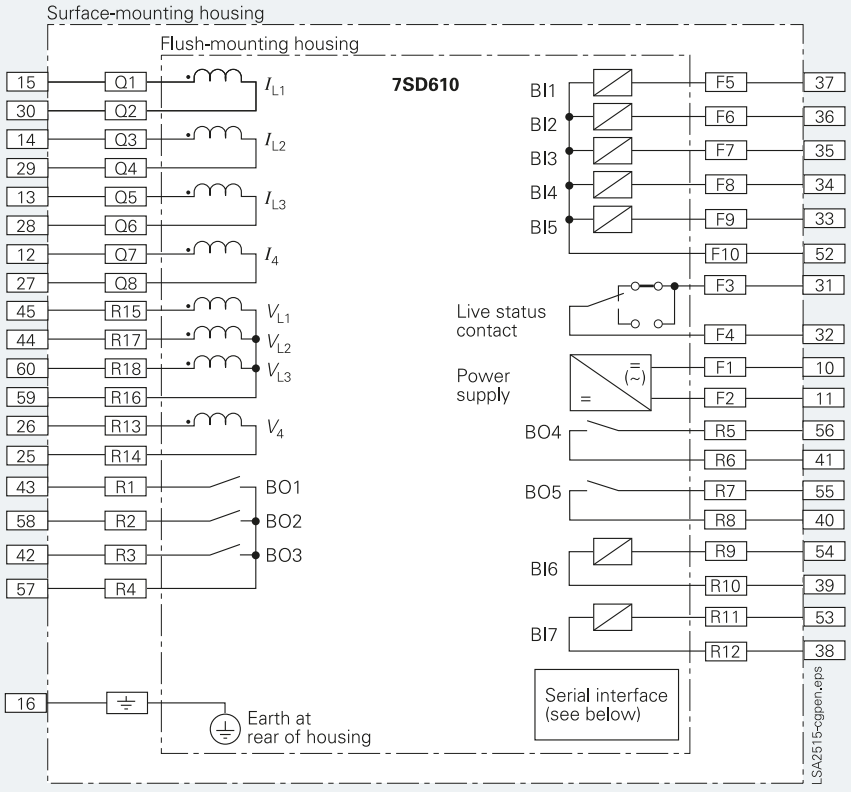

Fig. 7/31 Connection diagram

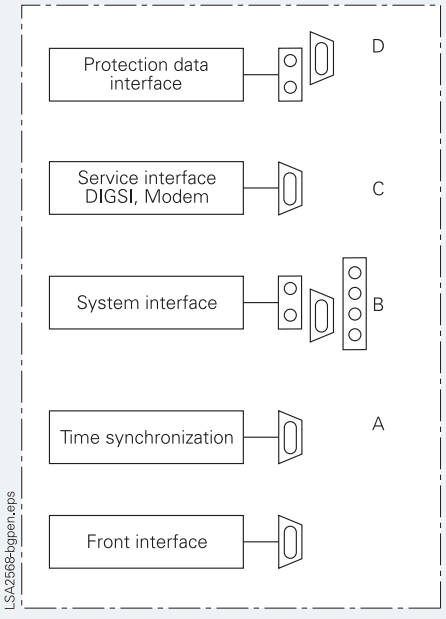

Fig. 6/32 Serial interfaces