SIEMENS

SIPROTEC 7SD60
Numerical Current Differential Protection Relay for Two Pilot-Wire Link

Protection Systems

Catalog
SIPROTEC 5.2 · 1999

C E R T I F I C A T E

DQS Deutsche Gesellschaft zur Zertifizierung von Managementsystemen mbH
Qualitäts- und Umweltgutachter

hereby certifies that the company

SIEMENS AG
Power Transmission and Distribution Group (EV)
Protection and Substation Control Systems (EV S)
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Protection Relays, Substation Control
RemoteTerminal Units, Fault Recorders

has implemented and maintains a

quality system.

A quality audit, documented in an audit report, has verified that this quality system fulfils the requirements of the following standard

DIN EN ISO 9001
August 1994 edition

This certificate is valid until	2001-09-04
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SIPROTEC 7SD60 Numerical Current Differential Protection Relay for Two Pilot-Wire Link

- Differential protection relay for overhead lines and cables
  - Current differential protection with external summation current transformer 4AM49 (87L)
  - Suitable for use for distances of 12 km max. via two pilot-wires
  - Differential protection can be combined with overcurrent release
  - Pilot-wire monitoring function
  - Bidirectional remote tripping
  - Circuit-breaker intertripping at the remote station
  - Seal-in of the TRIP command until manual reset (Lockout function)
  - Minimal current transformer requirements due to integrated saturation detector
  - Restraint against inrush / undelayed trip for high differential fault currents
- Operational measured values
  - Local and remote current
  - Differential current
  - Restraint current
- Monitoring functions
  - Hardware
  - Firmware
  - Spill current supervision
- Hardware
  - Auxiliary supply voltages 24, 48 V DC 60, 110, 125 V DC 220, 250 V DC, 115 V AC
  - Local operation by means of integrated keyboard
  - LCD display for settings and analysis
  - Housing flush-mounted housing 1/6 19" 7XP20 surface-mounted housing 1/6 19" 7XP20

Fig. 1
SIPROTEC 7SD60 Numerical current differential protection relay

- Communication
  - via personal computer and DIGSI 3 via RS232↔RS485 converter
  - with modem
  - with substation control system via IEC 60870-5-103
  - 2 kV isolated RS485 interface, bus connection possible
- Protection functions

ANSI	IEC	
87L 87T		ΔI for lines/cables, transformers
85		Intertrip, remote trip
86		Lockout function

Differential protection

Page

SIPROTEC 7SD60 Numerical Current Differential Protection Relay for Two Pilot-Wire Link

Description

Application

The 7SD60 unit is a numerical current differential protection relay, simple to set, operating in conjunction with the remote station via a two pilot-wire link.

It is connected to the primary current transformers via an external summation current transformer. The unit operates internally on the summated current taken from the secondary side of the summation current transformer. The link to the remote station is realized by means of a pair of symmetrical pilot-wires allowing distances of up to approximately 12 km. Adaptation to the pilot-wire resistance is effected by means of software within the unit. Therefore matching is not necessary.

The primary field of application of the unit is protection of short overhead lines and cables with two line ends. However, transformers and reactors may be located within the protection zone. The unit can be fitted with inrush restraint in such cases. A differential protection instantaneous tripping stage is also provided in this case. Vector group adaptation is not effected inside the unit and must, if necessary, be effected by means of a matching current transformer.

The 7SD60 can be fitted with a pilot-wire monitoring function. In addition to monitoring the pilot-wire link to the remote station, this also includes bidirectional circuit-breaker intertripping and a remote tripping command.

This unit substitutes the 7SD24 steady-state differential protection. However, direct interoperation with the 7SD24 is not possible. On replacement of a 7SD24, its external summation current transformer can be used as the input transformer for the 7SD60.

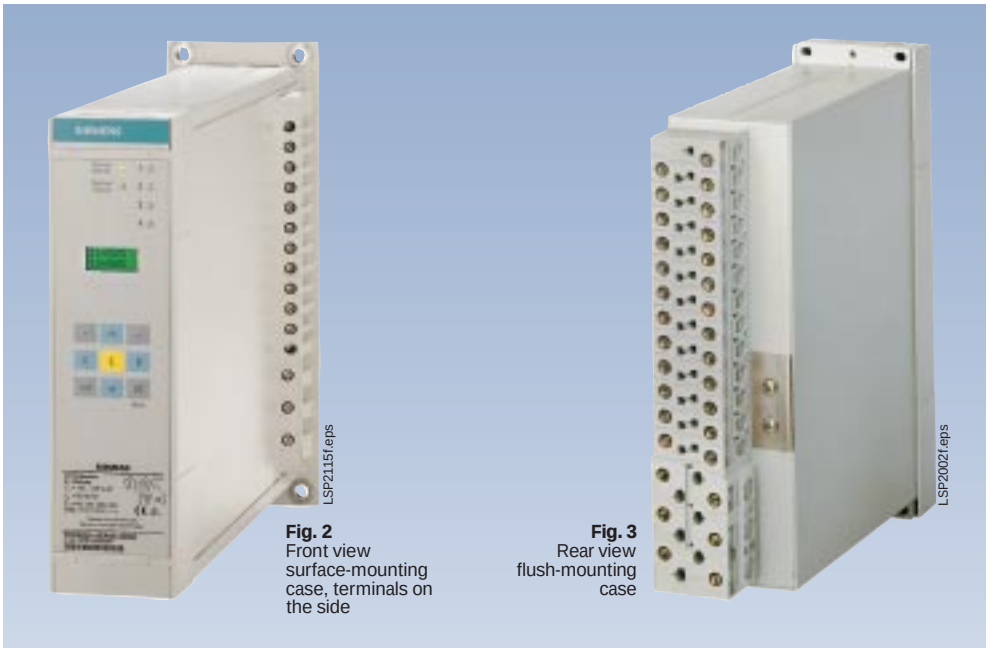


Fig. 2 Front view surface-mounting case, terminals on the side

Fig. 3 Rear view flush-mounting case

Construction

The compact 7SD60 protection relay contains all the components for:

- Measured value acquisition and evaluation
- Operation and LCD indications
- Alarm and command contacts
- Input and evaluation of binary signals
- Data transmission via the RS485 bus interface
- Auxiliary voltage supply

The primary current transformers are connected to the 4AM49 summation transformer. At the rated current value of either 1 A or 5 A this outputs a current of 20 mA which is measured by the 7SD60 unit. The summation current transformer is supplied together with the protection unit if so ordered.

The unit can be supplied in two different housings. The one for flush mounting in a panel or cubicle has connection terminals at the rear. The version for panel surface mounting is supplied with terminals accessible from the front. Alternatively the unit can be supplied with two-tier terminals arranged above and below the unit.

Functions

The following functions are integrated:

- Current differential protection with adjustable trip value $I_{Diff>}$
- Differential protection with combined trip release ($I_{Diff>}$ and I)
- Detection of current transformer saturation due to external faults.
  In consequence: Increased restraint of differential protection.
- Inrush restraint with instantaneous tripping stage
- Seal-in of the trip command until manual reset (Lockout function)
- Pilot-wire monitoring
- Circuit-breaker intertripping to the remote station
- Remote tripping command via a binary input

Improved measuring methods

By means of digital measured value processing, in particular through use of numerical fundamental frequency filters, the interference effects of DC components in the instrument transformer circuits and other transient components in the differential current is practically filtered out. By that, use of sensitive settings of the protection unit is possible, even under difficult conditions.

Digital 100 Hz filters, which operate precisely and have no negative effect on the long-term stability, are employed for detection of the inrush condition.

Continuous self-monitoring

Both the hardware and software of the unit are continuously self-monitored. High availability is thus ensured.

Event-logging with time-stamp

The 7SD60 unit makes available extensive data for analysis of faults and for supervision of the operating conditions. The messages are time-stamped and stored in various memories.

- Fault indications (fault logs)
  The last three fault logs are always available on request. All the events associated with differential protection tripping are recorded on a millisecond time resolution. Whenever a new fault operation occurs, the oldest one stored is overwritten.
- Operational indications (event logs)
  All operational indications are stored in a circular buffer.

Operational measured values

Two measured values can be displayed simultaneously on the LCD display. The following measured values are available for supervision and commissioning purposes:

- The summated current at the local relay (which is a replica of the symmetrical operating current of the line)
- The calculated summated current of the remote end
- The differential current of the line. This is the difference of the summated current of the local relay and the summated current of the remote end.
- Pilot-wire resistance (for commissioning and setting)
- The angle between the summated currents (for commissioning)
- Restraint current

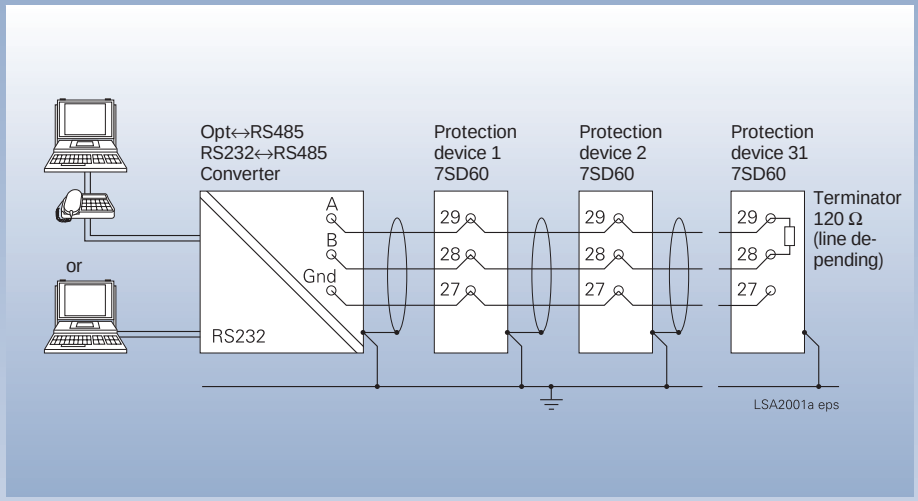


Fig. 4
Bus communication via RS485 interface

Testing aids

The protection unit facilitates testing and commissioning for the user. Numerous test functions, which can be activated either by means of the operator keys or by means of the DIGSI PC program, have been integrated in the unit. Entry of a password is required for some of the tests. The following testing aids are provided:

- Measured value display of the operational values
- Interrogation of the status of binary inputs, LEDs
- Circuit-breaker trip test
  Operation of the trip relay by means of operator keys. Previous entry of password necessary.

Freely assignable inputs and outputs

A number of messages, e.g. blocking of a function via a binary input or the TRIP command (which is assigned to a command contact) are available within the unit. Commonly used messages are preassigned, so that normally there is no need to alter the inputs and outputs.

Nonetheless, provision has been made for “OR linking” by the user of up to 10 messages to a binary input. Up to 20 messages can be simultaneously assigned to a command and alarm relay or to a LED.

Serial data transmission

As standard, the unit is fitted with an RS485 interface. This is suitable for connection to a bus and allows connection of up to 32 devices via a two-wire serial interface (use of a third core for earth is recommended). A PC is connected via this interface using an RS232<->RS485 converter, thus allowing use of the DIGSI operator program, by means of which PC-aided planning, parameter setting and evaluation can be performed. By this readout it is also possible to output the fault recordings stored by the unit on occurrence of faults.

Using a RS485<->820 nm optical converter as an accessory (7XV5650, 7XV5651), it is possible to provide an interference-free and isolated link to a central control system or a remote control system employing DIGSI, thus allowing implementation of economically viable configurations, e.g. for remote diagnostics.

The serial interface can also be set in the IEC 60870-5-103 mode (VDEW - Association of German Utilities - interface), thus allowing integration of the unit in a station control system. However, only 2 messages (ready for operation and the trip signal) and the fault recording are available. For this reason use of the 7SD502 unit is recommended in those cases in which integration in the station control system is a prime consideration.

SIPROTEC 7SD60 Numerical Current Differential Protection Relay for Two Pilot-Wire Link

Description

Easy setting

Menu-driven setting is carried out via the integrated operator panel and the LCD display. Setting by means of the DIGSI program is, however, much more user-friendly. In the latter case all the PC functions of the DIGSI standard program, which is common to all SIPROTEC units, are available. An economic version DIGSI-Light is available for the 7SD60, 7SJ60 and 7RW60 units.

Fault recording

Fault recording is carried out on tripping by the differential relay. The instantaneous value of the summated current of the local relay and of the remote relay are recorded in addition to the differential current and the restraint current.

Triggering of fault recording from the PC is also possible for test purposes.

Up to eight faults in total can be saved at any one time. The oldest of these is overwritten whenever a new fault is recorded.

Total fault memory time is 5 s.

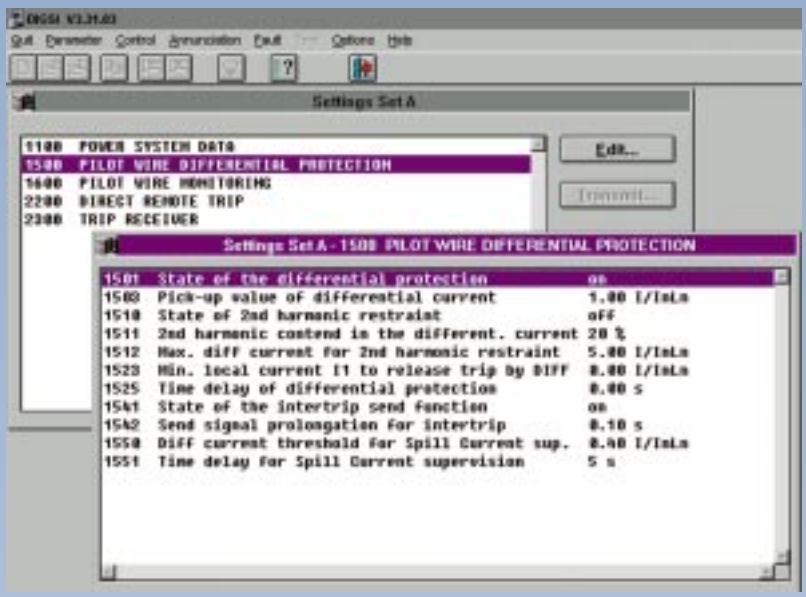


Fig. 5
PC-based setting

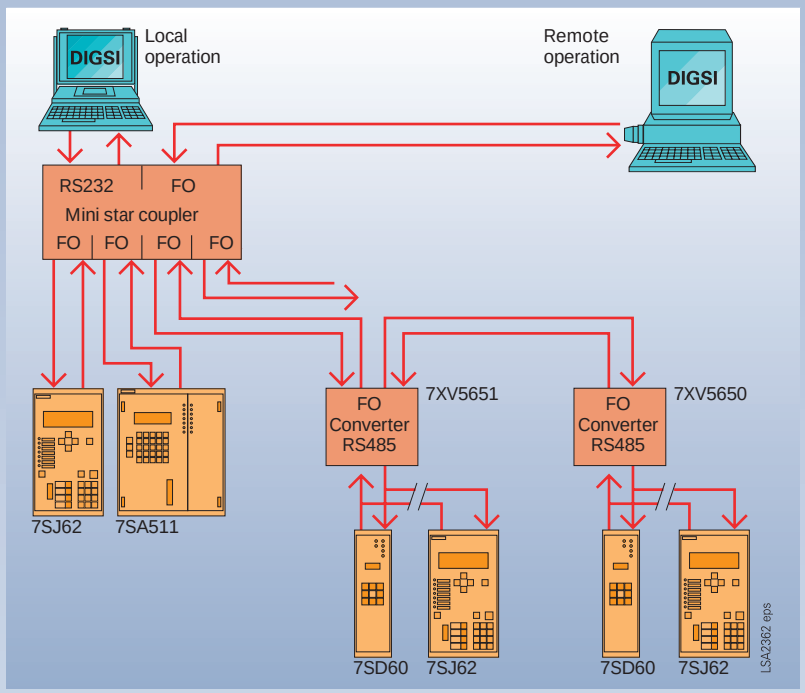


Fig. 6
Central operation via DIGSI

Mode of operation of the differential protection relay

An external summation current transformer 4AM49, which can be supplied as an accessory either in a 1 A or a 5 A version, allows connection of any secondary currents of the primary current transformers (see Fig. 7). The standard ratios of the three primary windings of the summation current transformer are IL1:IL2:IL3 = 5:3:4 (IL1:IL3:IL0=2:1:3) (see Fig. 9). In consequence the sensitivity of the tripping characteristic for single-phase faults is appreciably higher in comparison to that for two-phase and three-phase faults. Since the current on such faults is often weak, an amplification factor of 1.7 to 2.8 referred to the symmetrical response value is achieved.

Other sensitivity values can, however, be obtained by altering the connections at the summation c.t.

With a symmetrical three-phase current of 1 x I_N, the secondary current of the summation current transformer is 20 mA.

The 7SD60 measures and digitalizes the summated current I_{M1} of the local relay by means of a sensitive current input (see Fig. 9). A voltage drop occurs across a fixed-value resistor R_b installed in the unit. With a through-flowing load or a through-flowing short-circuit current, the voltage drop at both ends of the line is approximately equal but of opposite polarity, so that no current flows through the pilot-wire. On occurrence of an internal fault, different values are obtained for the voltage drop across R_b at both ends. In consequence a current I_a flows through the pilot-wire, which is measured by means of the current transformer. In conjunction with the pilot-wire resistance (available as a parameter in the unit) and the internal resistor R_a, it is possible to calculate the differential current from the measured current flowing through the pilot-wire. As soon as an adjustable value is reached, the protection relay trips the line at both ends.

Matching of the sensitivity of the unit for different values of pilot-wire resistance is effected by the firmware of the unit during parameter setting, so that time-consuming matching of the pilot-wire resistance is unnecessary.

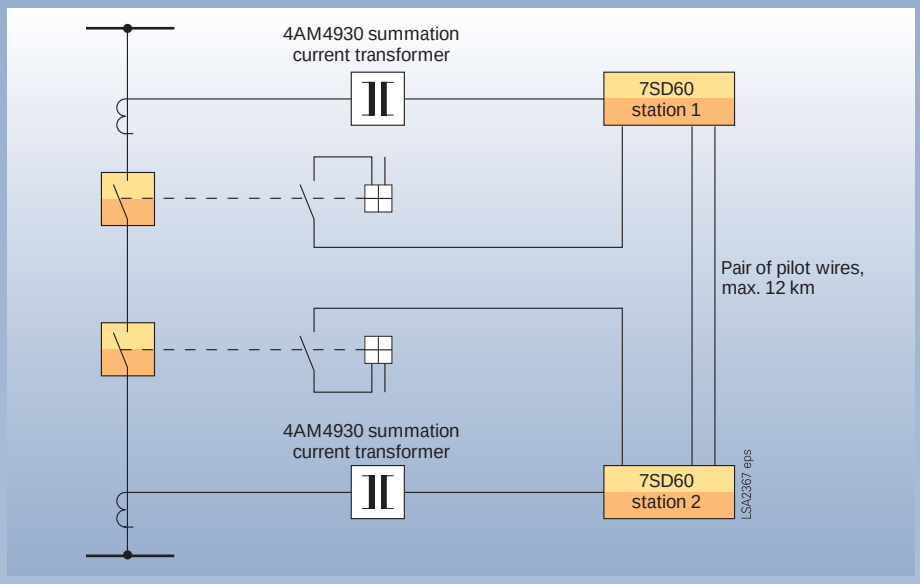
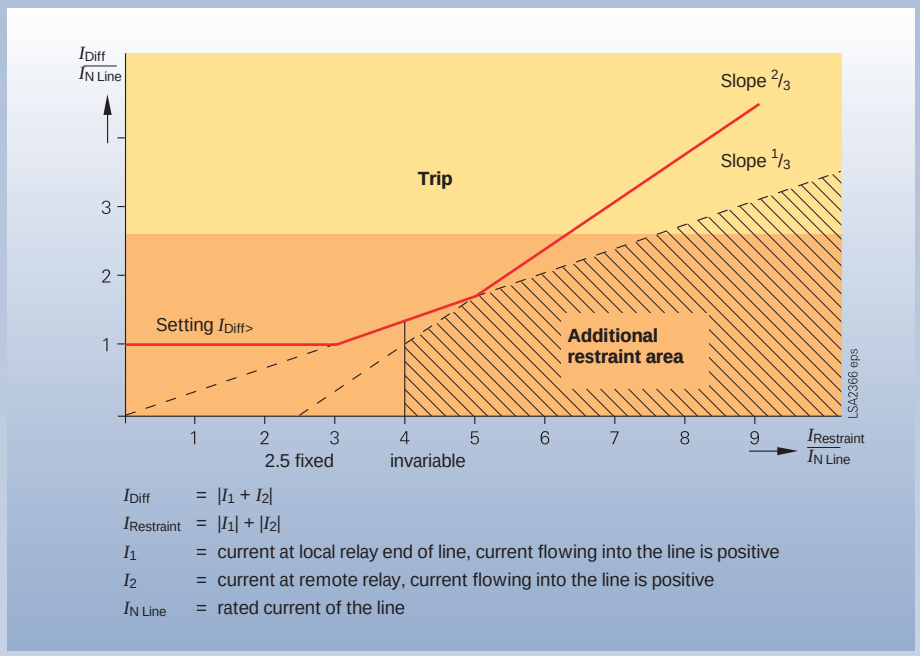


Fig. 7
7SD60 Line differential protection for operation with two pilot wires



$I_{Diff} = |I_1 + I_2|$
$I_{Restraint} = |I_1| + |I_2|$
I_1 = current at local relay end of line, current flowing into the line is positive
I_2 = current at remote relay, current flowing into the line is positive
$I_{N\,Line}$ = rated current of the line

Fig. 8
Trip characteristic of differential protection

Trip characteristic of the differential protection relay

The main function of the unit is current comparison protection. The trip characteristic is fixed and takes into account both the linear and the non-linear errors of the current transformers. It is only necessary to set the tripping value $I_{Diff>}$ (see Fig. 8), although the standard setting is suitable for most applications. It should be parameterized according to the rated current of the line; sensitive setting is possible even when the current transformer rated currents and the line rated currents differ by as much as a factor of 2. Differences in the current transformation ratios at the ends of the line must, however, be compensated for by means of external matching current transformers.

In some cases this can be realized by the summation current transformer.

SIPROTEC 7SD60 Numerical Current Differential Protection Relay for Two Pilot-Wire Link

Functions

Overcurrent release / differential current monitoring

The differential protection function can be combined with an additional overcurrent release. To this end the criteria „overcurrent“ and „differential current“ are linked logically so that a TRIP command is given out by the differential function only when a differential current and an overcurrent coexist. By this means it is often possible to avoid malfunctioning due to pilot-wire short-circuit or wire-break of a connection between a current transformer and the summation current transformer. For this purpose the 7SD60 is fitted with an additional differential current monitoring function, which can effectively block the differential protection after a delay of some seconds on reaching of an adjustable value of differential current in conjunction with simultaneous operational current I_{M1} within the load range.

Saturation detector

Improved stability on single-ended saturation of the primary current transformers is ensured by means of an integrated saturation detector. It provides additional stability during external faults. 5 ms are enough time to measure an external fault due to a high restraint and small differential current. Indication is done within the additional restraint area (see Fig. 8). If - due to c.t. saturation - the differential current flows into the trip area, the differential trip is blocked for a certain time. Transient saturation of current transformers caused by transposed DC components in the short-circuit current can thus be recognized. As a result the requirements on the current transformers are reduced so that they are only required to conduct the steady-state through-flowing short-circuit current without saturation.

Pilot-wire link / pilot-wire monitoring

The link to the remote station comprises a symmetrical pair of wires (e.g. telephone lines). The maximum permissible distance between two stations is approximately 12 km. 4AM9513 isolation units can be employed for potential isolation against interference induced by longitudinal voltages where the pilot-wires run parallel to power cables over long distances.

Since the pilot-wires form an integral part of the differential protection, these are normally monitored continuously. This function is available as an option. To achieve this, 2 kHz pulses with a defined pulse-width ratio are transmitted to the remote relay via the pilot-wires. Detection of a fault in the pilot-wire link results in blocking of the differential protection.

Circuit-breaker intertripping / remote tripping

Normally tripping is effected at both stations as a result of current comparison. Tripping at one end only can occur when an overcurrent release is used or with short-circuit currents only slightly above the tripping value. Circuit-breaker intertripping can be parameterized in the unit with integral pilot-wire monitor, so that definite tripping at both ends of the line is assured.

In addition, it is possible by means of a binary input to output a remote tripping command for both directions. The command transmission time is approximately 80 ms.

Lockout of the TRIP command with manual reset

The TRIP command can be locked-out after tripping. In particular, in the case of transformers within the protection zone, reclosure of the line is normally effected only after the cause of the fault has been ascertained by the user. Manual reset is possible either via the operator panel (with password) or via a binary input. As a result premature reclosure of the circuit-breaker is prevented. The logic state of the TRIP command remains stored even during failure of the auxiliary supply voltage so that it is still present on restoration of the auxiliary supply voltage.

Inrush restraint / instantaneous tripping stage

Where transformers or reactors are located within the protection zone, inrush restraint can be supplied as an option. This inrush restraint evaluates the second harmonic of the differential current, which is typical for inrush phenomena. If the second harmonic value of the differential current referred to the fundamental frequency exceeds a preset value, tripping by the differential protection is blocked. In the case of high-current internal faults, whose amplitude exceeds the inrush current peak, tripping can be carried out instantaneously.

Vector group adaptation is not effected inside the unit and must, where necessary, be brought about by means of an external matching transformer scheme.

Connection examples

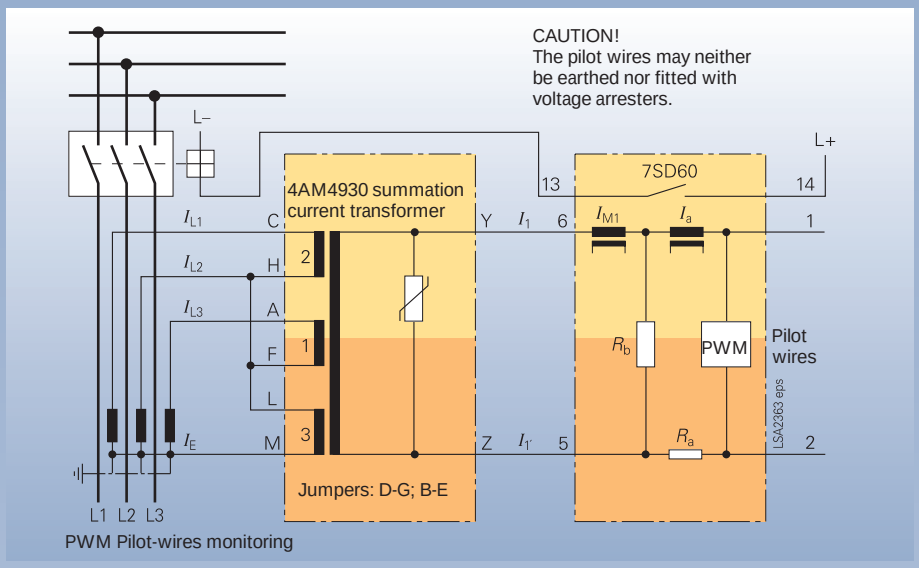


Fig. 9
Standard connection L1-L3-E, suitable for all type of networks

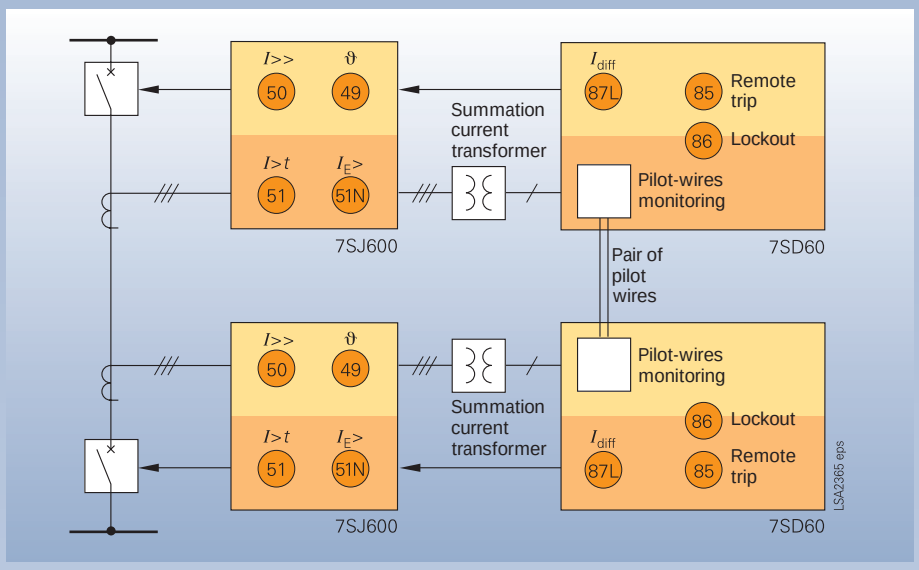


Fig. 10
Protection configuration with main (7SD60) and backup overcurrent (7SJ60) protection

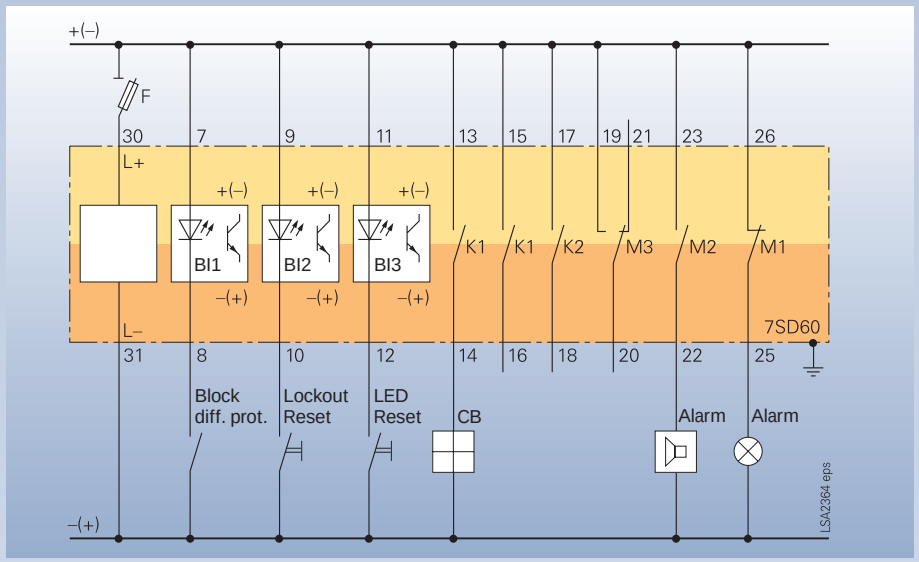


Fig. 11
Typical circuit for auxiliary voltage supply

SIPROTEC 7SD60 Numerical Current Differential Protection Relay for Two Pilot-Wire Link

Technical data

Input circuits	Rated current I_N	20 mA without summation current transformer 1 or 5 A with summation current transformer
	Rated frequency f_N	50/60 Hz parameterizable
	Thermal overload capability current path	
	continuous	2 x I_N
	for 10s	30 x I_N
	for 1s	100 x I_N
Auxiliary voltage	Auxiliary voltage via integrated DC/DC converter	
	Rated auxiliary DC voltage/permissible variations	24/48 V DC /19 to 58 V DC 60/110/125 V DC /48 to 150 V DC 220/250 V DC /176 to 300 V DC
	Superimposed AC voltage V_{aux} Peak-to-peak	≤ 12 % at rated voltage ≤ 6 % at limits of admissible voltage
	Power consumption	
	Quiescent	Approx. 2 W
	Energized	Approx. 4 W
	Bridging time during failure/ short-circuit of auxiliary voltage	≥ 50 ms (at V_{aux} ≥ 100 V AC/DC) ≥ 20 ms (at V_{aux} ≥ 24 V DC)
	Rated auxiliary voltage AC V_{aux} /permissible variations	115 V AC / 88 to 133 V AC
Command contacts	Number of relays	2 (marshallable)
	Contacts per relay	2 NO or 1 NO
	Switching capacity	
	Make	1000 W/VA
	Break	30 W/VA
	Switching voltage	250 V
	Permissible current	
	Continuous	5 A
	For 0.5 s	30 A
Signal contacts	Number of relays	3 (2 marshallable)
	Contacts per relay	1 CO
	Switching capacity	
	Make	1000 W/VA
	Break	30 W/VA
	Switching voltage	250 V AC/DC
	Permissible current	5 A
Binary inputs	Number	3 (marshallable)
	Operation voltage	24 to 250 V DC
	Current consumption, energized,	Approx. 2.5 mA independent of operating voltage
	Pick-up threshold, reconnectable	by solder bridges
	Rated aux. voltages 24/48/60 V DC	
	$V_{pick-up}$	≥ 17 V DC
	$V_{drop-off}$	< 8 V DC
	Rated aux. voltages 110/125/220/250 V DC	
	$V_{pick-up}$	≥ 74 V DC
	$V_{drop-off}$	< 45 V DC
Serial interface (Isolated)	Standard	RS485
	Test voltage	2.8 kV DC for 1 min
	Connections	Via wire to housing terminals, 2 data transmission lines, 1 earthing cable for connection to an RS485↔RS232 converter, cables have to be shielded, screen has to be earthed Setting at supply: 9600 baud
	Transmission speed	min. 1200 baud; max.19200 baud
Construction	Housing 7XP20	For dimensions, see dimension drawings
	Dimensions	see Fig. 13
	Weight	
	With housing for surface mounting	approx. 4.5 kg
	With housing for surface mounting/cubicle mounting	approx. 4 kg
	Degree of protection acc. to EN 60529	
	Housing	IP 51
	Terminals	IP 21

CE-conformity, standards	This product is in conformity with the directives of the Council of the European Communities on the approximation of the laws of the Member States relating to the electromagnetic compatibility (EMC Council Directive 89/336/EEC) and concerning electrical equipment for use within specified voltage limits (low-voltage directive 73/23/EEC). The product conforms with the international standard IEC 60255 and the national standard DIN 57 435 Part 303 (corresponding to VDE 0435 Part 303). The unit has been developped and manufactured for use in industrial areas in accordance with the EMC standard.	Conformity is proved by tests performed by Siemens AG in line with article 10 of the Council Directives in accordance with the generic standards EN 50081 and EN 50082 for the EMC directive and standard EN 60255-6 for the low-voltage directive.
Insulation tests	Standards	IEC 60255-5 ANSI/IEEE C37.90.0
	Voltage test (routine test) All circuits except DC supply and RS485 Only DC voltage supply and RS485	 2 kV (rms), 50 Hz 2.8 kV DC
	Impulse voltage test (type test) All circuits, class III	5 kV (peak), 1.2/50 µs, 0.5 J; 3 positive and 3 negative shots at intervals of 5 s
	Test crosswise: Measurement circuits, pilot wire connections, power supply, binary inputs, class III, (no tests cross-wise over open contacts, RS458 interface terminals)	
EMC-tests; Immunity (type tests)	Standards	IEC 60255-6; IEC 60255-22 (international product standard) EN 50082-2 (generic standard) VDE 0435 Part 303 (German product standard)
	High-frequency test IEC 60255-22-1, VDE 0435 Part 303; class III	2.5 kV (peak); 1 MHz; τ = 15 ms; 400 shots/s; duration 2 s
	Electrostatic discharge IEC 60255-22-2, EN 61000-4-2; class III	4/6 kV contact discharge; 8 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
	Radio-frequency electromagnetic field, non-modulated report IEC 60255-22-3 class III	10 V/m 27 to 500 MHz
	Radio-frequency electromagnetic field, amplitude-modulated IEC 61000-4-3; class III	10 V/m 80 to 1000 MHz; AM 80 %; 1 kHz
	Radio-frequency electromagnetic field, pulse-modulated IEC 61000-4-3/ENV 50204; class III	10 V/m, 900 MHz; repetition rate 200 Hz, duty cycle 50 %
	Fast transients/bursts IEC 60255-22-3, IEC 61000-4-4, class IV	2 kV; 5/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; duration 1 min
	Conducted disturbances induced by radio-frequency fields, amplitude-modulated IEC 61000-4-6, class III	10 V; 150 kHz to 80 MHz; AM 80 %; 1 kHz
	Power frequency magnetic field IEC 61000-4-8; class IV; EN 60255-6	30 A/m; 50 Hz, continuous 300 A/m for 3 s; 50 Hz; 0.5 mT , 50 Hz
	Oscillatory surge withstand capability ANSI/IEEE C37.90.1 (common mode)	2.5 to 3 kV (peak), 1 MHz to 1.5 MHz decaying oscillation; 50 shots per s; duration 2 s; R_i = 150 Ω to 200 Ω
	Fast transient surge withstand capability ANSI/IEEE C37.90.1 (common mode)	4 to 5 kV; 10/150 ns; 50 shots per s both polarities; duration 2 s; R_i = 80 Ω
	Radiated electromagnetic interference ANSI/IEEE C37.90.2	10 to 20 V/m; 25 to 1000 MHz; amplitude and pulse modulated
	High-frequency test Document 17C (SEC) 102	2.5 kV (peak, alternating polarity) 100 kHz, 1 MHz, 10 and 50 MHz, decaying oscillation; R_i = 50 Ω
EMC-tests; emission (type tests)	Standard	EN 50081- (generic standard)
	Conducted interference voltage, auxiliary voltage only, EN 55022, VDE 0878 Part 22 CISPR 22, limit value class B	150 kHz to 30 MHz
	Interference field strength EN 55011, VDE 0875 Part 11, IEC CISPR 11, limit value class A	30 to 1000 MHz

Technical data (continued)

Vibration and shock stress during operation	Standards	IEC 60255-21; IEC 60068-2
	Vibration IEC 60255-21-1, class I IEC 60068-2-6	sinusoidal 10 to 60 Hz; ± 0.035 mm amplitude; 60 to 150 Hz; 0,5 *g* acceleration; sweep rate 1 octave/min; 20 cycles in 3 orthogonal axes
	Shock IEC 60255-21-2, class I	half sine 5 *g* acceleration, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
	Seismic vibration IEC 60255-21-3, class I IEC 60068-2-6	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) sweep rate 1 octave/min 1 cycles in 3 orthogonal axes
during transport	Standards	IEC 60255-21; IEC 60068-2
	Vibration IEC 60255-21-1, class II IEC 60068-2-6	sinusoidal 5 Hz to 8 Hz: ±7.5 mm amplitude 8 Hz to 150 Hz: 2 *g* acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
	Shock IEC 60255-21-2, class I IEC 60068-2-27	half sine acceleration 15 *g*, duration 11 ms, 3 shocks shocks in each direction of 3 orthogonal axes
	Continuous shock IEC 60255-21-2, class I IEC 60068-2-29	half sine acceleration 10 *g*, duration 16 ms, 1000 shocks in each direction of 3 orthogonal axes
Climatic stress EN 60255-6 IEC 60255-6 DIN VDE 0435 Part 303	Recommended temperature	-5 to +55 °C (>55 °C/131 °F decreased display contrast)
	Limit temperature during sevice during storage during transport (Storage and transport with standard works packing!)	 -20 to +70 °C -25 to +55 °C -25 to +70 °C
	Humidity during service We recommend arrange the in such a way that they are kept from direct sun and from changes in temperature that might reduce condensation.	mean value per year ≤75 % relative humidity, on 30 days a year up to 95 % relative humidity, condensation not permissible!
Line differential protection All current values refer to the symmetrical current using standard connection.	Setting ranges Current threshold I_1 (release by local station current) Differential current Delay time t	 $I/I_{N\,Line}$: 0 to 1.5 (step 0.01) $I/I_{N\,Line}$: 0.5 to 2.5 (step 0.01) 0 to 60 s (step 0.01 s)
	Restraint by 2nd harmonic (see Fig. 8) $2f_N/f_N$ Reset ratio	 10 to 80 % approx. 0.7 – response value ($I_{Restraint}$ = 0)
	Inherent delays TRIP time for two-ended supply at 4 x set value Release time	 approx. 20 to 28 ms without restraint by 2nd harmonic approx. 32 to 42 ms with restraint by 2nd harmonic approx. 35 ms
	Tolerances at preset values under reference conditions Local station current threshold Differential current	 ± 3 % of setpoint, min. 0.02 x I_N ± 5 % of setpoint, min. 0.02 x I_N
	Influence parameters Auxiliary supply voltage $0.8 \le V_{aux}/V_{auxN} \le$ x 1.15 Temperature in range 0 °C ≤ Θ_{amb} ≤ 40 °C Frequency in range $0.9 \le f/f_N \le 1.1$	 ≤ 1 % ≤ 1 %/10 K ≤ 4 %
	Pilot wires Number	 2 Symmetric telephone pairs are recommended with loop resistance 73 Ω/km and capacitance 60 nF/km
	Core-to-core asymmetry at 800 Hz	max. 10^{-3}
	Maximum loop resistance	1200 Ω
	Permissible induced longitudinal voltages on direct connection of the pilot wires for connection via isolating transformer	 ≤ 1.2 kV, however, max. 60 % of the test voltage of the pilot wires ≥ 1.2 kV, however, max. 60 % of the test voltage of the pilot wires and max. 60 % of the test voltage of the isolating transformers
	Pilot-wire monitoring and intertripping (optional) Monitoring signal	 2000 Hz, pulse-code modulation
	Alarm signal delay	1 to 60 s (step 1 s)
	Inherent delay time of intertripping	approx. 65 ms
	Extension of the intertripping signal	0 to 5 s (step 0.01 s)

Remote trip
Tripping of the remote end circuit-breaker for units with pilot-wire monitoring only

Setting ranges		
Prolongation time for transmission to remote station		0 to 60 s (step 0.01 s)
Delay time for reception from the remote station		0 to 60 s (step 0.01 s)
Prolongation time for reception from the remote station		0 to 60 s (step 0.01 s)
Tolerances		
Delay time / release delay		1 % and 10 ms respectively
Inherent delay		
Transmission time without delay		approx. 80 ms

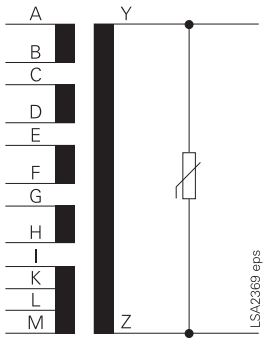
Lockout function

Lockout-seal-in of trip command	for differential protection and remote trip until reset
Lockout reset	by means of binary input and/or local operator panel/DIGSI

Additional functions

Operational measured values		
Operational currents		I_1, I_2, I_{Diff}, $I_{Restraint}$,
Measurement range		0 to 240 % I_N
Tolerance (I_1)		3 % of rated value or of measured value
Fault event recording		Storage of the events relating to the last 8 faults
Time-tagging		
Resolution for operational events		1 s
for fault events		1 ms
Fault recording (max. 8 faults)		
Storage time (from response or trip command)		total of 5 s max., pre- and posttrigger time settable
Maximum length per recording	T_{max}	0.30 to 5.00 s (step 0.01 s)
Pre-event time	T_{pre}	0.05 to 0.50 s (step 0.01 s)
Post-event time	T_{post}	0.05 to 0.50 s (step 0.01 s)
Time resolution at 50 Hz		1 instantaneous value per 1.66 ms
Time resolution at 60 Hz		1 instantaneous value per 1.38 ms
Circuit-breaker test		Using test circuit

4AM4930 summation current transformer



Power consumption in the circuit with standard connection L1-L3-E (Fig. 9) referred to the through-flowing rated current (7SD600 unit in operation).

I_N		in phase (approx. VA) L1	L2	L3
1 A	Single-phase	2.2	1.3	1.7
	Symmetrical three-phase	0.6	0.2	0.35
5 A	Single-phase	3.5	1.5	2.2
	Symmetrical three-phase	0.7	0.2	0.5

	Connections	4AM4930-7DB I_N = 1 A	4AM4930-6DB I_N = 5 A
C.t. rated current			
Number of turns			
Primary windings	A to B	5	1
	C to D	10	2
	E to F	15	3
	G to H	30	6
	I to K	30	6
	K to L	30	6
	L to M	60	12
Secondary windings	Y to Z	1736	1736
Thermal rating			
Continuous current in Amperes	A to B	4.5	20
	C to D	4.5	20
	E to F	4.5	20
	G to H	4.5	20
	I to K	1.2	6.5
	K to L	1.2	6.5
	L to M	1.2	6.5
	Y to Z	0.2	0.2
Secondary rated current with standard connection (see Fig. 9) and symmetrical 3-phase current	Y to Z	20 mA	20 mA

Requirements for the current transformers (c.t.)

$$k_{alf1} \text{ and } k_{alf2} \geq \frac{I_{K,\,max}}{I_{N,\,c.t.}},\quad \frac{3}{4} \leq \frac{k_{alf1}}{k_{alf2}} \leq \frac{4}{3}$$

k_{alf1} accuracy limiting factor side 1
k_{alf2} accuracy limiting factor side 2
$I_{K,\,max}$ through-flowing short-circuit current, max.
$I_{N,\,c.t.}$ primary transformer current

SIPROTEC 7SD60 Numerical Current Differential Protection Relay for Two Pilot-Wire Link

Selection and ordering data

Designation	Order No.:
Numerical current comparison protection for two pilot-wire link	**7SD600□-□□A□ 0-□ DA0**
Rated current; rated frequency	
20 mA; 50/60 Hz (without external summation current transformer)	**0**
1 A 50/60 Hz; with external summation c.t. 4AM4930-7DB	**1**
5 A 50/60 Hz; with external summation c.t. 4AM4930-6DB	**5**
Auxiliary voltage supply	
24, 48 V DC	**2**
60, 110, 125 V DC	**4**
220/250 V DC/115 V AC, 50/60 Hz	**5**
Mechanical design	
in housing for panel surface-mounting with terminals at the side	**B**
with terminals on top and bottom	**D**
in housing for panel flush-mounting or cubicle-mounting	**E**
Operating language	
English – alternatively either German or Spanish can be selected	**0**
Functional scope	
Differential protection	**0**
Differential protection, inrush restraint	**1**
Differential protection, pilot-wire monitoring, remote trip	**2**
Differential protection, pilot-wire monitoring, remote trip, inrush restraint	**3**

Accessories

Copper connection cable between PC (9-pin female connector) and converter/protection unit	**7XV5100-2**
RS232 - RS485 converter with connection cable 2.5 m, PC adapter	
with plug-in power supply unit 230 V AC	**7XV5700-0AA00**
with plug-in power supply unit 110 V AC	**7XV5700-1AA00**
Fully-duplex converter fiber-optic RS485 auxiliary supply voltage 24 to 250 V DC and 250 V AC	
Single optical interface	**7XV5650-0AA00**
Double optical interface (cascadable)	**7XV5651-0AA00**
DIGSI operating program for protection unit (stage 1) Parameterizing and operation software (without DIGRA) protection unit Requires MS-WINDOWS V3.1, WINDOWS 95 or WINDOWS NT 4.0	
English	**7XS5120-1AA0**
German	**7XS5120-0AA0**
DIGRA graphical evaluation program for visualization of fault recordings in conjunction with DIGSI Requires: MS-WINDOWS V3.1, WINDOWS 95 or WINDOWS NT 4.0 and DIGSI	
German	**7XS5130-0AA0**
English	**7XS5130-1AA0**
Summation current transformer	
1 A, 50/60 Hz, for 7SD600	**4AM4930-7DB**
5 A, 50/60 Hz, for 7SD600	**4AM4930-6DB**
Manual 7SD60	
English	**E50417-G1176-C069-A1**
German	**E50417-G1100-C069-A1**
Catalog SIPROTEC 5.2 · 1999	
English	**E50001--K4405-A121-A1-7600**
German	**E50001--K4405-A121-A1**

Circuit diagram

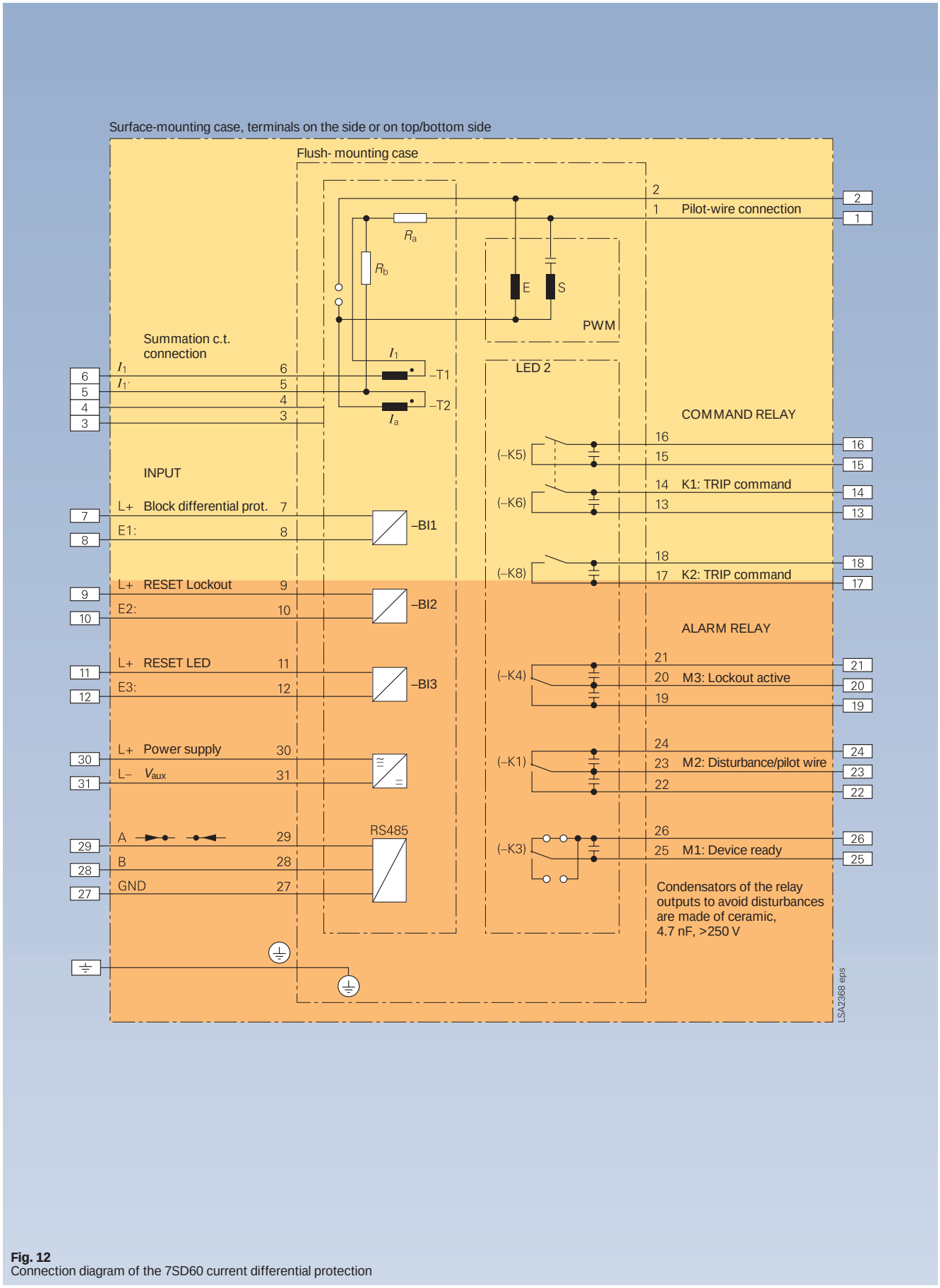


Fig. 12
Connection diagram of the 7SD60 current differential protection

Dimension drawings

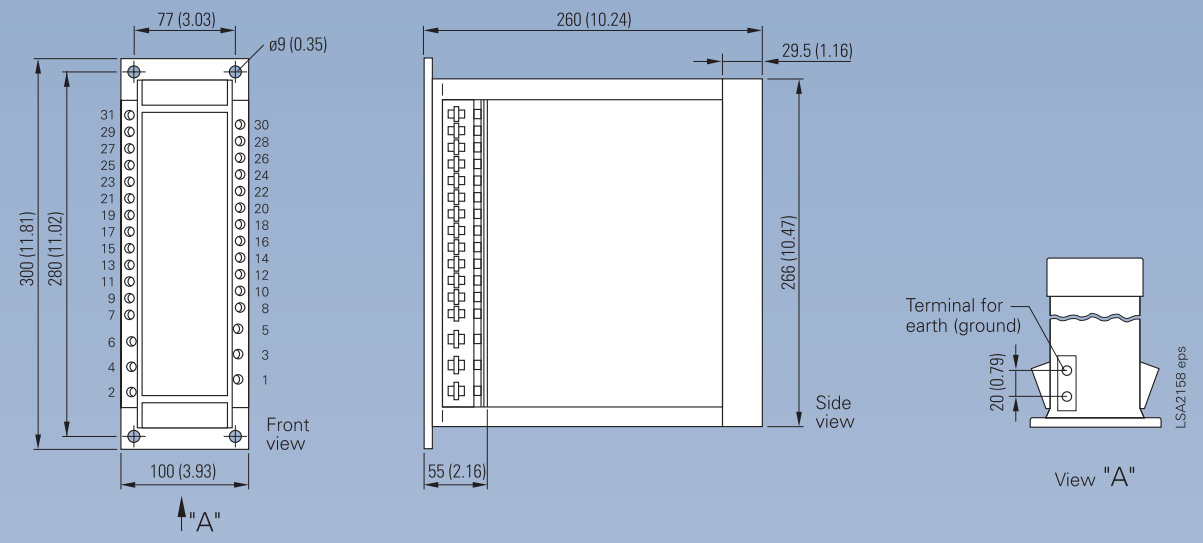


Fig. 13
7SD60 with 7XP20 housing
for panel surface-mounting,
terminals on the side

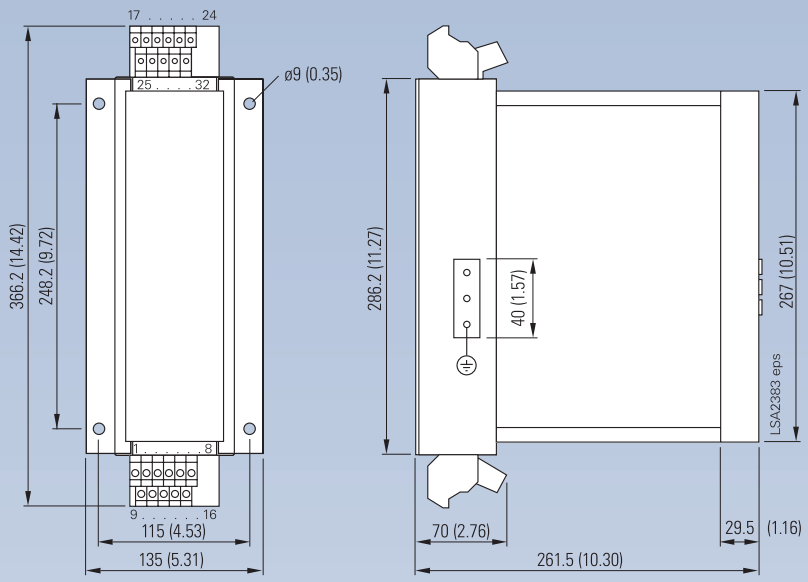


Fig. 14
7SD60 with 7XP20 housing
for panel surface-mounting
terminals on top and bottom

Dimensions are indicated in mm;
values stated in brackets are inches

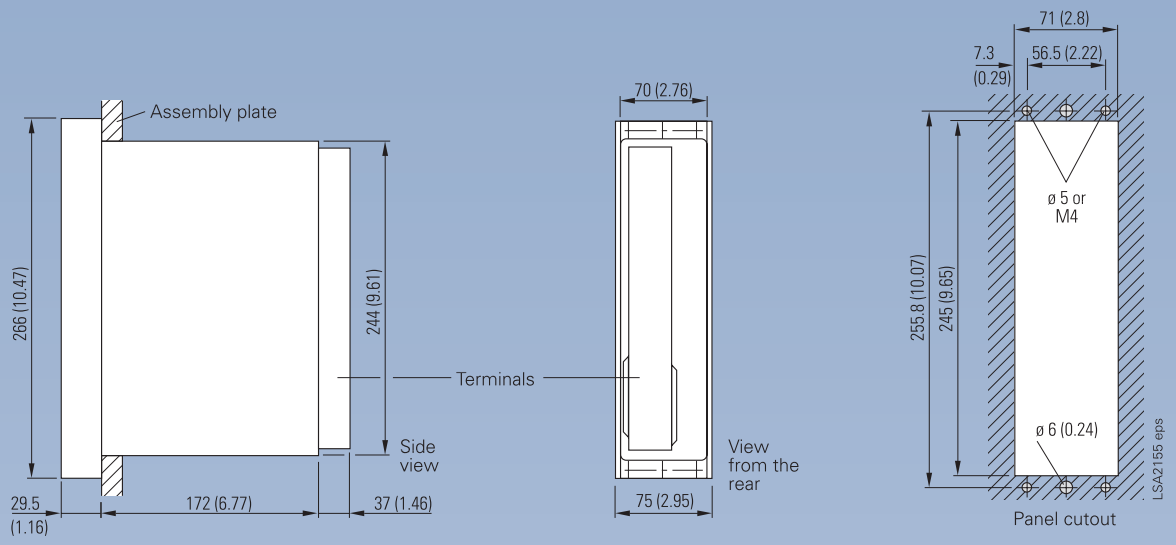
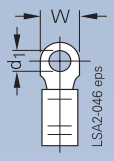


Fig. 15
7SD60 with 7XP20 housing
for panel flush-mounting / cubicle-mounting
terminals on the rear

Terminals

		Wire size	Fittings (small items)	Order No. (manufacturer)	Order No. (Siemens)
	**Voltage contacts 7 to 31**				
	Ring-cabel lugs	Crimp springs contacts[1] from Weidmüller			
	d_1 = 4 mm (0.2 in)	0.5 to 1 mm ^{2}	3000 units	162 552	W73073-A2502-C1
	$W_{max.}$ = 9 mm (0.36 in)	1.5 to 2.5 mm^2	2500 units	162 550	W73073-A2503-C1
	Wire size 1 to 2.6 mm^2 (AWG 16 to 14)				

1) for panel flush-mounting only

Dimensions are indicated in mm;
values stated in brackets are inches

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