Description

Application

The 7SA510 distance protection relay provides fast, reliable and selective clearance of faults on overhead lines and cables, being fed from one or multiple points. The network can be radial, ring or meshed. The system star point may be isolated, resonance-earthed (e g. Peterson coil), solidly earthed or low-resistance earthed.

The relay incorporates all functions normally required for distance protection and can also be applied as a time-graded back-up protection for all types of differential protection schemes.

The 7SA510 can be incorporated in both conventional switchgear systems and modern LSA 678 substation control systems.

Fig. 1
SIPROTEC 7SA510
distance protection relay

Construction

With its compact construction the 7SA510 contains all the components required for current and voltage measurement for protection scheme logic, fault recording and online measurements, operator panel with display field, event/alarm and command outputs, binary (contact) inputs, serial interfaces and power supply with DC/DC converter.

The relay can be supplied in three case variations. The version for surface mounting is supplied with 60 two-tier terminals accessible from the front. The versions for flush mounting or cubicle mounting have rear connection terminals and are available with or without glass cover.

Mode of operation

All data processing within the 7SA510 is digital, from the measurement of voltages and currents to the tripping decision logic. The application of digital measurement to a large degree suppresses the influence of switching currents, transient DC current components, high-frequency transients and harmonics.

Serial interfaces

The relay is fitted with two serial interfaces.

The operator interface on the front panel is suitable for the connection of a PC. The operating and analysis software DIGSI, running under WINDOWS, is available as an option to enable user-friendly parameter setting, analysis of fault data and records, and commissioning.

The fibre-optic system interface is available for connection to the Siemens SINAUT LSA 678 substation control system, to a central data acquisition system, to the data concentrator DAKON or to a star coupler (see Fig. 4).

The communication protocol used is the compatible protocol according to IEC 870-5-103 (VDEW). The serial information interface has been certified by the research institute for high-voltage and high-current technology (FGH) and declared to be in conformity with the IEC 870-5-103 standard.

Remote operation of the distance protection relay 7SA510 with the DIGSI software is possible if a modem is connected to the FO-serial interface.

Settings

All settings can be input by means of the integrated operator and display field panel, or a PC. All parameters are identified in clear text. The settings are stored in a non-volatile memory, so that they cannot be lost even during interruption of the supply voltage.

All parameters are reliably stored in EEPROMs and are thus independent of the state of charge of the memory battery.

Self-monitoring

Hardware and software components are monitored continuously and any irregularities are immediately detected and alarmed. As a result, the security, availability and reliability of the relay are significantly improved.

Description

Distance protection

Distance protection is the main function of the 7SA510 relay. The distinguishing features of the relay are as follows:

- Availability of multiple starting options:
  a) Overcurrent fault detection I>>, phase selective
  b) Voltage-dependent overcurrent fault detection V</I> (option), phase selective. The measured voltages, depending on the selected settings and the earth-fault detection, may be 3 x phase-to-earth V_{PH-E} , depending on the phase current I_{PH} or the 3 x phase-to-phase voltages V_{PH-PH} .
  c) Polygonal impedance characteristic fault detection Z< (option) (see Fig. 2). Either the impedances of the 3 x phase-to-phase loops or 3 x phase-to-earth loops are calculated depending on the earth-fault detection. The effect of apparent impedances in unfaulted phases during earth faults is eliminated by a compensation method.
- Earth faults are detected by earth current I_E detection and/or residual voltage V_E measurement.
- Polygonal tripping characteristics with separate settings for reactance X and resistance reach R (see Fig. 3). Separate settings are provided for the resistance reach R for phase-to-phase and phase-to-earth faults. Four distance zones are provided and they may be independently set in the forward or reverse direction or non-directional. One of the zones may also be used for zone extension schemes. In addition, a directional and a non-directional back-up time stage is available.
- Directional measurement using sound phase polarization and voltage memory for unlimited sensitivity.
- Six independent time delays are provided.
- Automatic blocking of the distance protection function is provided following detection of a V.T. failure to prevent incorrect distance measurement.

Fault locator

Fault location is provided through calculation of the fault impedance. The distance-to-fault may be output in ohms, kilometers or percentage of the line length.

Definite-time overcurrent protection (emergency)

The distance protection 7SA510 can be used as a two-stage definite-time overcurrent protection. This protective function can only be automatically activated if the measuring voltage fails resulting from short-circuit or fault in the V.T. circuit, or if the V.T. m.c.b. trips.

Universal teleprotection interface

For fast selective clearance of faults over the complete line a comprehensive teleprotection facility is provided. The following schemes may be selected:

- Intertrip via fault detection
- Intertrip via zone extension Z1B
- Signal comparison with zone extension Z1B
- Unblocking with directional fault detection
- Directional comparison with directional detection
- Unblocking with zone extension Z1B
- Blocking with zone extension Z1B
- Pilot wire protection
- Reverse interlock function

An echo function for zero or weak infeed, and a current reversal block function for comparison or blocking are integrated.

Switch-onto-fault protection

Through the use of a binary input representing manual closing of the line circuit-breaker the 7SA510 can initiate a switch-onto-fault function. The function may be set to initiate immediate tripping from zone Z1B or from the fault detection elements.

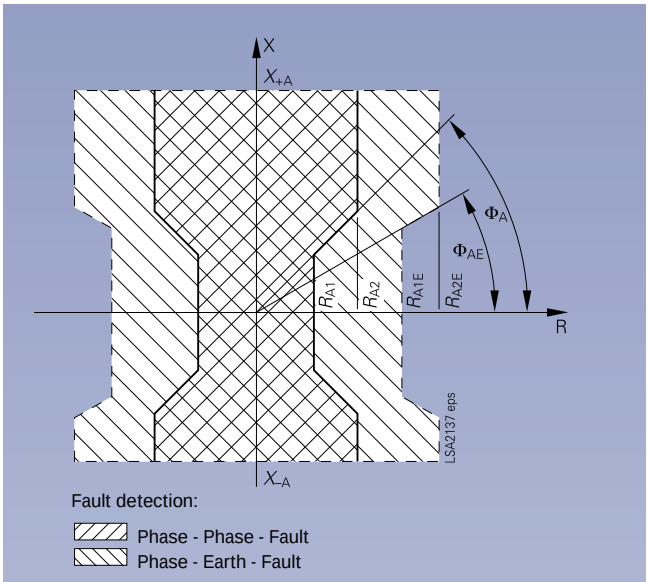

Fig. 2
Characteristic of impedance fault detector (Z<)

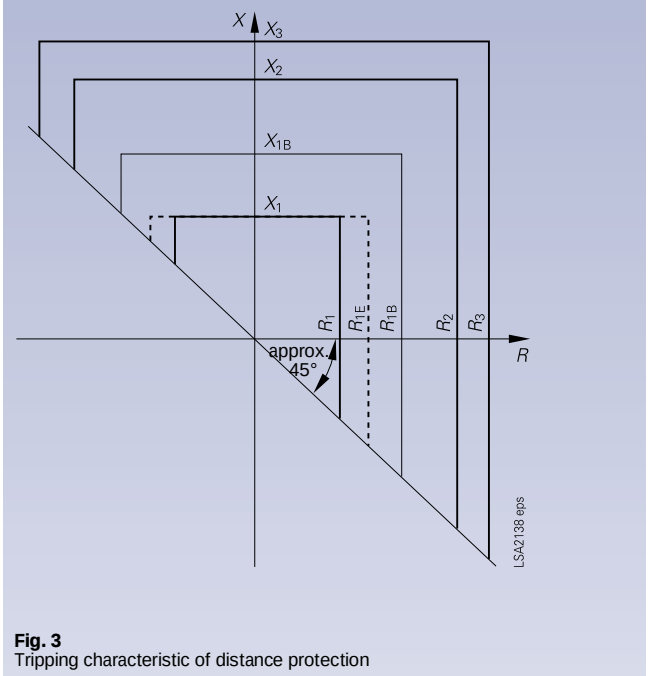

Fig. 3
Tripping characteristic of distance protection

Earth-fault detection in non-earthed networks (option)

In networks with compensated or isolated star point, single phase-to-ground earth-fault detection is provided. The following functions are included:

- Detection of an earth fault by monitoring the residual displacement voltage V_E.
- Determination of the faulted phase through measurement of the phase-to-earth voltages.
- Determination of the direction of the earth fault through precise measurement of the active and reactive components of the residual current (I_E).
- Annunciation or tripping in the event of an earth fault in forward direction.
- Measurement of the respective content of the active and reactive component of the earth current during an earth fault.

Sensitive earth-fault protection in earthed networks (option)

In earthed networks which are subject to extreme high-resistance earth faults, it is possible for the fault impedance to lie outside of the distance protection impedance characteristic. The 7SA510 may include the following optional functions for high-resistance earth-fault protection:

- Directional earth-fault protection with emergency and back-up definite-time overcurrent protection function
- Earth-fault overcurrent protection function with inverse-time characteristic
- The directional earth-fault function may be extended to become a directional comparison scheme with the use of interstation signalling and comparison logic.

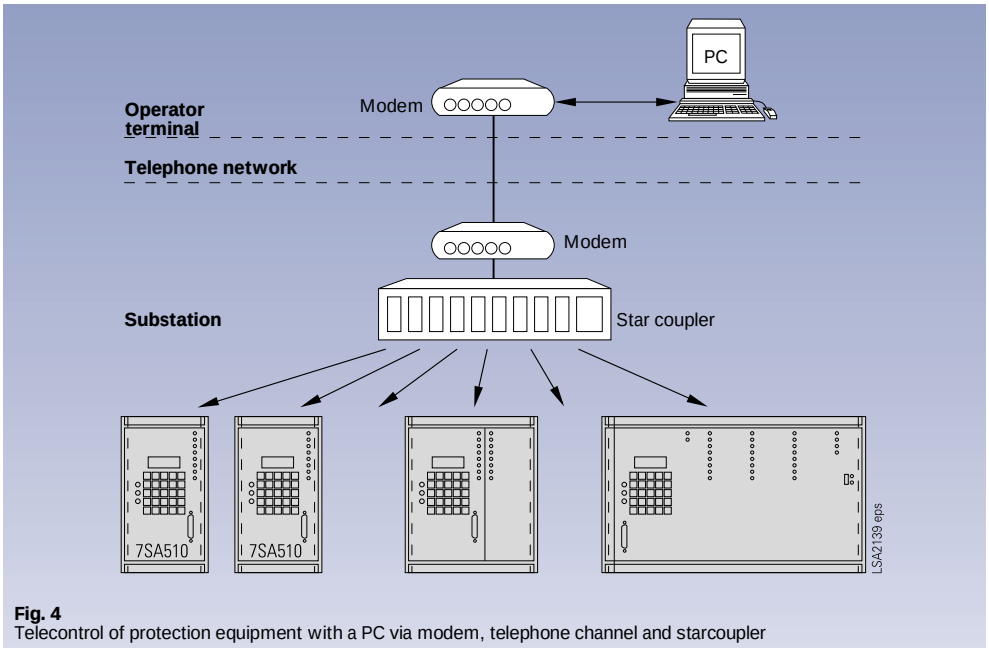

Fig. 4
Telecontrol of protection equipment with a PC via modem, telephone channel and starcoupler

Power swing (option)

Power swings can give rise to high equalization currents and small voltages. Small voltages, with simultaneous high currents, mean small impedances, which can lead to tripping of the distance protection. In order to avoid uncontrolled tripping by the distance protection and specific tripping in the event of synchronism loss, the 7SA510 distance protection relay features an additional power swing function option.

The following reaction to power swings can be set:

- Blocking
  The distance protection tripping function may be blokked for the duration of the power swing
- Tripping
  Tripping may be initiated following the detection of a power swing outside the defined stability limits.

Thermal overload protection

For thermal protection of cables an overload protection with an early warning stage is provided. The thermal replica can be formed with the maximum or mean value of the respective excess temperatures in the three phases, or with the temperature rise from the respective maximum phase current.

The tripping time characteristics are exponential functions to IEC 255-8 and they take account of heat loss due to the load current and the accompanying drop in temperature of the cooling medium. The previous load is therefore taken into account in the tripping time on overload. A settable alarm stage can output a current or temperature-dependent indication before the tripping point is reached.

Selectable parameter changeover setting groups

Through binary (contact) inputs or via the relay setting facilities (front panel or serial interface) it is possible to change between four sets of previously stored parameter settings. This allows the rapid modification of relay settings to match configuration changes in the protected network.

Parameter set changeover is also possible via the compatible IEC 870-5-103 interface.

Fault recording

The digitized measured values of phase currents, earth current, phase voltages and residual earth voltage, together with several binary channels, are stored with parameterizable pre-trigger and post fault time. Storage of recorded fault data is battery-buffered and therefore remains available even after an interruption of the auxiliary power supply. Fault recording can be transmitted to a PC and to the SINAUT LSA substation control system for evaluation. Parallel operation of PC and substation control system is possible. Up to 8 fault records can be stored. The data memory is organized as a ring buffer store with a maximum length of 5 s at f_N = 50 Hz or 4.2 s at f_N = 60 Hz.

The oldest fault records are overwritten with the newest data. A fault record can also be started via a binary input or - especially as an aid in commissioning - via an integrated control panel or PC. The respective record duration can then be parameterized.

Function allocation for command and alarm relays, LEDs and binary inputs

The 7SA510 is equipped with 2 heavy-duty output relays. They can be linked with the commands for the above-mentioned protective functions and with all other signal outputs or binary signals.

For user-specific output and display of signals, alarm relays and LEDs may be allocated as desired. Individual signals can be grouped. The stored LED indications are protected from supply voltage failure.

All binary inputs can likewise be allocated as desired.

Measurement and test functions

The 7SA510 provides a large number of test and measurement functions, including the following:

- Measurement of the (in-service) impedance of six impedance loops and indication of direction, reactance and resistance
- Monitoring of the phase sequence

Description

Measurement and test functions (continued)

- In-service measurement I_{L1}, I_{L2}, I_{L3}
- In-service measurement V_{L1-L2}, V_{L2-L3}, V_{L3-L1}, V_{L1}, V_{L2}, V_{L3}
- Active and reactive power measurement
- Frequency measurement
- Trip circuit test facility, three-pole operation
- Measurement of the respective content of the active and reactive component of the earth current during an earth fault in compensated or isolated networks.

Non-volatile storage of operational records

The 7SA510 provides all the data necessary to analyze the operational performance of the relay following a network fault. The following recording functions are all secure from interruption of the auxiliary power supply.

- Real-time clock
  A standardized, battery-backed, real-time clock is available which may be synchronized via a binary input or via the system serial interface. The clock time can be set via PC and IEC 870-5-103 interface. All events are recorded with a date and time tag.
- Fault indications
  The operational records (e.g. fault type, distance-to-fault etc.) for the last three fault operations are available via the integrated control panel. The last four operational records are available at the PC interface via DIGSI.
- Operational indications
  All signals not associated directly with the fault are stored in the operational indication buffer.
- Earth-fault protocol (compensated/isolated networks)
  Relays with the optional isolated/compensated network earth-fault detection function store record and fault details in a separate memory block.
- Tripping statistics
  The progressive total of tripping and opening operations as well as the summation of the breaking currents is stored.
- Automatic data display
  An operation mode may be selected in which two (normal service) measured values are continuously updated on the integrated LCD display. Following a fault operation two (previously selected) stored fault information values are displayed.

User-definable binary inputs and time stages, external tripping

There are four binary inputs available for recording of binary signals, e.g. signals from other protective devices. These inputs are stored in the operational indications buffer and can be passed to alarm relays, LEDs and the SINAUT LSA substation control and protection.

The relay is also equipped with two parameterizable time stages. The start and reset signals can be marshalled to binary inputs; the timing period can be marshalled to alarm relays and LEDs.

Pickup and reset delay can be set across a broad range. External use of additional time relays for special switching requirements will in future be dispensed with.

Technical data

Input circuits

Rated current I_N			1 or 5 A
Rated voltage V_N			80 to 125 V AC
Rated frequency f_N			50 or 60 Hz
Thermal overload capability	in v.t. circuits, continuous		140 V AC
	in phase c.t. circuits, continuous		4 x I_N
		for 10 s	30 x I_N
		for 1 s	100 x I_N
	in earth c.t. circuit, continuous		15 A
		for 10 s	150 A
		for 1 s	300 A
Dynamic overload, impulse for a half cycle			250 x I_N
Burden	v.t. circuits		Approx. 0.1 VA
	c.t. circuits	at I_N = 1 A	Approx. 0.05 VA
		at I_N = 5 A	Approx. 0.2 VA
	Residual current input		Approx. 0.05 VA

Voltage supply
via integrated DC/DC converter

Rated auxiliary voltage V_{aux}		24, 48 V DC 60, 110, 125 V DC 220, 250 V DC
Permissible tolerance		-20 to +15 %
Permissible max. ripple (pk-pk)		≤12 %
Power consumption	quiescent	Approx. 9 W
	energized	Approx. 13 W
Max. operating time after auxiliary voltage drop		≥50 ms at V_{aux} ≥110 V

Binary inputs

Number of inputs		4 (marshallable)
Voltage range		24 to 250 V DC, adjustable in 4 ranges
Current input		Approx. 1.7 mA

Indication contacts

Number of relays	with 1 changeover contact each	5 (marshallable)
Switching capacity make/break		20 W/VA
Switching voltage		Max. 250 V AC/DC
Permissible current	continuous	1 A

Heavy-duty contacts

Number of relays	with 2 N/O contacts each	2 (marshallable)
Switching capacity	make	1000 W/VA
	break	30 W/VA
Switching voltage		Max. 250 V AC/DC
Permissible current	continuous	5 A
	0.5 s	30 A

LED displays

Ready for operation	green	1
Fault indication	red	1
Marshallable LEDs	red	6

Serial interfaces

Operator interface		On the front panel, not isolated, suitable for connection of a PC
Baud rate		1200 to 19200 Bd
System interface		Control system interface for coupling to a central unit
Baud rate		1200 to 19200 Bd
Connection	fibre-optic connection	Integrated FSMA connector for fibre-optic connection
	optical wavelength	820 nm
	permissible line attenuation	Max. 8 dB (for 62.5/125 µm F.O.)
	transmission distance	Max. 1.5 km

Construction

Housing, dimensions			7XP20, see dimension drawings
Weight	panel flush mounting/cubicle mounting		Approx. 5.4 kg
	panel surface mounting		Approx. 8.7 kg
Degree of protection according to EN 60 529		housing	IP 51
		terminals	IP 21

Technical data (continued)

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 to the use of electrical equipment within defined voltage ranges (lovv-voltage directive 73/23/EEC). The product conforms with the international standard IEC 255 and the national standard DIN 57 435 part 303 (corresponding to VDE 0435 part 303). The relay is designed for use in an industrial environment, for installation in standard relay rooms and compartments so that with proper installation electro-magnetic compatibility (EMC) is ensured.		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 89/336/EEC and with standard EN 60255-6 for the low-voltage directive.
Insulation tests IEC 255-5, DIN 57 435 part 303	High-voltage test (routine test), except d.c. voltage supply input		2 kV (rms) 50 Hz
	High-voltage test (routine test), only d.c. voltage supply input		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
EMC-tests; immunity (type test) Standards: IEC 255-6, IEC255-22 (international product standard) EN50082-2 (generic standard) VDE 0435 part 303 (German product standard)	High-frequency test with 1 MHz interference IEC 255-22-1, class III and VDE 0435 part 303, class III		2.5 kV (peak), 1 MHz, τ = 15 µs, 400 shots/s, duration 2 s
	Electrostatic discharge IEC 255-22-2,class III and IEC 1000-4-2, class III		4/6 kV contact discharge, 8 kV air discharge, both polarities, 150pF, R_i =330 Ω
	Radio-frequency electromagnetic field, non-modulated report IEC 255-22-3, class III		10 V/m, 27 to 500 MHz
	Radio-frequency electromagnetic field, amplitude modulated IEC 1000-4-3, class III		10 V/m, 80 to 1000 MHz, AM 80 %, 1 kHz,
	Radio frequency electromagnetic field, puls modulated ENV 50204, class III		10 V/m, 900 MHz, repetition frequency 200 Hz, duty cycle 50 %
	Fast transients IEC 255-22-4 class III, IEC 1000-4-4 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 1000-4-6, class III		10 V, 150 kHz to 80 MHz, AM 80 %, 1 kHz,
	Power frequency magnetic field IEC 1000-4-8, class IV IEC 255-6		30 A/m, continuous, 300 A/m for 3 s, 50 Hz 0.5 mT; 50 Hz
EMC-tests; emission (type test) Standard: EN 50081-*(European generic standard)	Conducted interference voltage, auxiliary voltage CISPR 22, EN 55022 and VDE 0878 part 22		150 kHz to 30 MHz, class B
	Interference field strength CISPR 11, EN 55011 and VDE 0875 part 11		30 to 1000 MHz, class A
Climatic stress tests	permissible ambient temperature	during service during storage during transport	-5 to +55 °C -25 to +55 °C -25 to +70 °C
	permissible humidity		mean value per year ≤ 75 % relative humidity, on 30 days per year up to 95 % relative humidity, condensation not permissible
Mechanical stress tests IEC 255-21-1, IEC 68-2	permissible mechanical stress	during service	10 to 60 Hz, 0.035 mm amplitude 60 to 150 Hz, 0.5 *g* acceleration
		during transport	5 to 8 Hz, 7.5 mm amplitude 8 to 150 Hz, 2 *g* acceleration

Distance protection

Setting ranges			
Earth-fault detection			
Earth current I_E/I_N	Step	0.01	0.25 to 1
Displacement voltage			
$V_E >$ (= $\sqrt{3}$ V_0, earthed network)		1 V	2 to 100 V
$V_E >$ (= $\sqrt{3}$ V_0, isolated network)		1 V	10 to 100 V
Overcurrent fault detection ($I>>$)			
Overcurrent I_{PH}/I_N		0.01	0.1 to 4
Impedance fault detection ($Z<$)			
Characteristic			Polygonal
Forward reach $X+$		0.01 Ω	0.1 to 200 Ω[1]
Reverse reach $X-$		0.01 Ω	0.1 to 200 Ω[1]
Resistance reach R		0.01 Ω	0.1 to 200 Ω[1]
Threshold angle between load and short-circuit range		0.1°	30 to 80°
Minimum current I_{PH}/I_N		0. 01	0.1 to 4
Voltage-dependent overcurrent fault detection ($V<I>$)			
Phase-to-earth voltage V_{PH-E} ($I>$)		1 V	20 to 70 V
Phase-to-earth voltage V_{PH-E} ($I>>$)		1 V	20 to 70 V
Phase-to-phase voltage V_{PH-PH} ($I>$)		1 V	40 to 130 V
Phase-to-phase voltage V_{PH-PH} ($I>>$)		1 V	40 to 130 V
Distance measurement			
Characteristic			Polygonal
Distance zones			4; 1 as zone extension and all zones may be set in the forward, reverse or in both directions (non-directional)
Reactance reach X		0.01 Ω	0.05 to 130 Ω[1]
Resistance reach R			
for phase-to-phase faults		0.01 Ω	0.05 to 65 Ω[1]
for phase-to-earth faults		0.01 Ω	0.05 to 130 Ω[1]
Time stages			6 for multi-phase faults 3 for single-phase faults
Timer range		0.01 s	0 to 32 s or infinite
Residual compensation			
$\frac{X_E}{X_L}, \frac{R_E}{R_L}$		0.01	-7 to 7
Directional determination			
for all failure types			with sound phase polarization and voltage memory
Directional sensitivity			Dynamically unlimited
Operating times			
Minimum trip time			23 ms
Reset time			Approx. 30 ms
Tolerances			Measurement tolerances according to VDE 0435, Part 303 for sinusoidal quantities
for polygonal impedance fault detection			$\frac{\Delta X}{X} \leq 5\ \%$ for $30° \leq \varphi \leq 90°$ $\frac{\Delta R}{R} \leq 10\ \%$ for $0° \leq \varphi \leq 60°$
for distance measurement			$\frac{\Delta X}{X} \leq 5\ \%$ for $30° \leq \varphi \leq 90°$ $\frac{\Delta R}{R} \leq 5\ \%$ for $0° \leq \varphi \leq 60°$
for amplitude measurement			+5 %
Timer accuracy			+1 % of set value or 10 ms

1) Impedance settings referred to I_N = 1 A; at I_N = 5 A these values are 5 times the secondary values.

Technical data (continued)

Fault locator	Distance to fault			Secondary Ω, primary Ω, Km or % of line length
	Start signal			Trip output, fault detector reset or binary input
	Reactance per unit length	Step	0.001 Ω/km	0.01 to 5 Ω/km
	Measurement tolerance (according to VDE 0435, Part 303 for sinusoidal quantities)			≤ 2.5 % line length for 30° ≤ φ_k ≤ 90° and $V_K/V_N \geq 0.1$ without intermediate infeed
Power swing (devices with impedance starting *Z*<)	Power swing detection principle			Measurement of the rate of change of impedance
	Modes			Power swing blocking Power swing tripping
	Differences between power swing polygon and fault detector	Step	0.01 Ω	0.1 to 50 Ω
	Rate of change (impedance)		1 Ω/s	0 to 200 Ω/s
	Operating time		0.01 s	0.01 to 32 s or until end of power swing
Definite-time o/c emergency mode	Automatic initiation on recognition of measuring voltage failure or v.t.m.c.b. trip			
	Setting ranges			
	Overcurrent $I_{PH}>/I_N$	Step	0.01	0.1 to 4
	Earth current $I_E>/I_N$		0.01	0.1 to 4
	High set o/c $I_{PH}>>/I_N$		0.01	0.5 to 9.99
	Timers $t_I>$, $t_{IE}>$, $t_I>>$		0.01 s	0 to 32 s or infinite
	Measurement tolerance (according to VDE 0435, Part 303 for sinusoidal quantities)			±5 %
Universal teleprotection interface	Modes			
	Tripping			PUTT via fault detection PUTT/POTT via zone extension
	Comparison			Signal comparison Directional comparison Unblocking with zone extension Unblocking with fault detection Blocking
	Pilot wire protection			–
	Reverse interlocking			–
Earth-fault detection (compensated/isolated networks)	Earth-fault detection using residual displacement voltage $V_E > (= \sqrt{3}\, V_0)$	Step	1 V	10 to 100 V
	Faulted phase detection			
	$V_{PH-E}<$ (faulted phase)		1 V	10 to 100 V
	$V_{PH-E}>$ (unfaulted phase)		1 V	10 to 100 V
	Measurement tolerance (according to VDE 0435, Part 303 for sinusoidal quantities)			≤ 5 % of set value
	Directional determination			
	Measuring principle			Active/reactive power measurement
	Earth-fault current $I_E>$ (active/reactive *I*),		1 mA	3 to 1000 m A
	cable type c.t. angle error correction		0.1°	0 to 5° in 2 operating points
	Measurement tolerance (according to VDE 0435, Part 303 for sinusoidal quantities)			≤ 10 % of set value
Sensitive earth-fault protection (high-resistance faults in earthed networks)	Directional earth-fault protection with back-up definite-time non-directional overcurrent function			
	Earth-current fault detection $I_E>/I_N$	Step	0.01	0.1 to 4
	Residual displacement voltage $V_E> (= \sqrt{3}\, V_0)$		0.1 V	1 to 10 V
	Directional determination			with I_E and V_E
	Carrier signalling			Directional comparison
	Operating times			
	Shortest tripping time			Approx. 30 ms
	Current reversal guard time			Approx. 30 ms
	Tripping time delay		0.01 s	0 to 32 s or ineffective
	Timer tolerance			≤1 % of set value or 10 ms
	Undirectional earth-fault protection with inverse time characteristic			
	Characteristics according to IEC 255-3, or BS142			Normal inverse Very inverse, Extremely inverse
	Pick-up value $I_E > I_N$		0.01	0.1 to 4
	Time multiplier t_{IE}		0.01 s	0 to 32 s
	Tolerances			
	Current pick-up			5 to 15 % of set value
	Operating time			≤ 5 % ± 15 ms for 2 ≤ ($I/I_E>$) ≤ 20 and 1 s ≤ t_{IE} ≤ 30 s

Thermal overload protection

Setting ranges			
Factor k to IEC 255-8	Step	0.01	0.1 to 4
Time constant τ		0.1 min	1 to 999.9 min
Evaluation of thermal replica			Θ_{max} , Θ_{mean} , Θ with I_{max}
Temperature warning stage Θ_{Alarm} /Θ_{Trip}		1 %	50 to 100 %
Current warning stage I_{Alarm} /k I_N		0.01	0.1 to 4
Tripping time characteristic			$t = \tau \cdot \ln \frac{I^2 - I_{pre}^2}{I^2 - (k\, I_N)^2}$
Reset conditions			
Θ/Θ_{Trip}			Approx. 0.99
Θ/Θ_{Alarm}			Approx. 0.99
I/I_{Alarm}			Approx. 0.99
Tolerances			Class 10 % to IEC 255-8

Fault recording

Measured values			i_{L1}, i_{L2}, i_{L3}, i_E, v_{L1}, v_{L2}, v_{L3}, v_E
Starting signal			Tripping, fault detection, binary input, control panel, PC
Recording management			Dynamic ring buffer store, battery buffered
Maximum number of simultaneously available records			8
Sampling interval			20 samples per cycle
Max. recording period (sum of all records)			
at 50 Hz			5 s
at 60 Hz			4.2 s
Pre-trigger time	Step	0.01 s	0.05 to 0.5 s
Post-fault time		0.01 s	0.05 to 0.5 s
Max. period for one record		0.01 s	0.3 to 5 s

Additional functions

Operating values for	
Current	I_{L1}, I_{L2}, I_{L3}
Voltage	V_{L1-L2} , V_{L2-L3} , V_{L3-L1} , V_{L1} , V_{L2} , V_{L3}
Power	P, Q
Frequency	f
Effective range	0 to 240 % I_N , 0 to 120 % V_N , 0 to 120 % P_N , 96 to 104 % f_N
Earth current during earth faults in isolated networks	I_{ea}, I_{er}
Overload values	Θ/Θ_{trip}
Tolerance	≤ 2 % of respective rating

SIPROTEC 7SA510 Distance Protection Relay (Version V3)

Scope of functions | **Selection and ordering data**

Function scope of device versions

The following functions are available in all device versions:

Distance protection, fault locator, thermal overload protection, load values, overcurrent-time protection (emergency), operational measured values (current, voltage, active power, reactive power, frequency measurement) switching statistics with summation of interrupted currents per pole, integrated clock, battery-buffered signal memory and fault recording memory, parameter changeover facility.

All device versions can be used in earthed and in compensated/isolated networks.

Designation	Order-No.
Distance protection relay	**7SA510□ - □□A□□ - 1□D□**
Rated current at 50/60 Hz	
1 A	**1**
5 A	**5**
Rated auxiliary voltage	
24, 48 V DC	**2**
60, 110, 125 V DC	**4**
220, 250 V DC	**5**
Construction	
For panel surface mounting	**B**
For panel flush mounting/cubicle mounting	**C**
For panel flush mounting/cubicle mounting without glass cover	**E**
Relay versions	
Version 1: Operator language German, distance protection with overcurrent fault detection ($I_{>>}$), firmware V_3	**6 1**
Version 2: Operator language German, distance protection with overcurrent ($I_{>>}$) and voltage controlled overcurrent ($V_<$, $I_>$) fault detection selectable, firmware V_3	**6 3**
Version 3: Operator language English, distance protection with overcurrent fault detection ($I_{>>}$), firmware V_3	**7 1**
Version 4: Operator language English, distance protection with overcurrent ($I_{>>}$) and voltage controlled overcurrent ($V_<$, $I_>$) fault detection selectable, firmware V_3	**7 3**
Version 5: Operator language English, distance protection with impendance (Z<), voltage controlled overcurrent ($V_<$, $I_>$) and overcurrent ($I_{>>}$) fault detection, selectable, firmware V_3	**7 2**
Serial system interface	
without	**A**
with integrated fibre-optic interface	**C**
Earth-fault protection functions, power swing detection	
without	**0**
without earth-fault protection functions, with power swing blocking[1]	**1**
with sensitive earth-fault detection for compensated/isolated star point and with high-resistance earth-fault protection for solidly or low-resistance earthed star point, selectable; without power swing blocking	**2**
with sensitive earth-fault detection for compensated/isolated star point and with high-resistance earth-fault protection for solidly or low-resistance earthed star point, selectable; with power swing blocking[1]	**3**

Operating software (German and English are standard, other languages on request)

DIGSI program (suitable for all protection relays 7UM..., 7UT..., 7SJ..., 7SA..., ...)	German	**7XS5020-0AA00**
	English	**7XS5020-1AA00**
Test version:	German	**7XS5021-0AA00**
	English	**7XS5021-1AA00**
Connecting cables for protection relays (25 pin) - PC (9 pin); (other variations supplied on request)		**7XV5100-2**

Documentation

German:	Katalogblatt LSA 2.2.17:	Abzweigschutz SIPROTEC 7SA510 (Version V3)	**E50001-K5712-A271-A1**
	Handbuch:	Abzweigschutz SIPROTEC 7SA510 (Version V3)	**C53000-G1100-C113**
English:	Catalog LSA 2.2.17:	SIPROTEC 7SA510 distance protection relay (Version V3)	**E50001-K5712-A271-A1-7600**
	Manual:	SIPROTEC 75A510 distance protection relay (Version V3)	**C53000-G1176-C115**

1) The function power swing blocking (16th position 1 or 3) is only available for versions with impedance fault detection (12th position 2, version 5).

Connection diagram

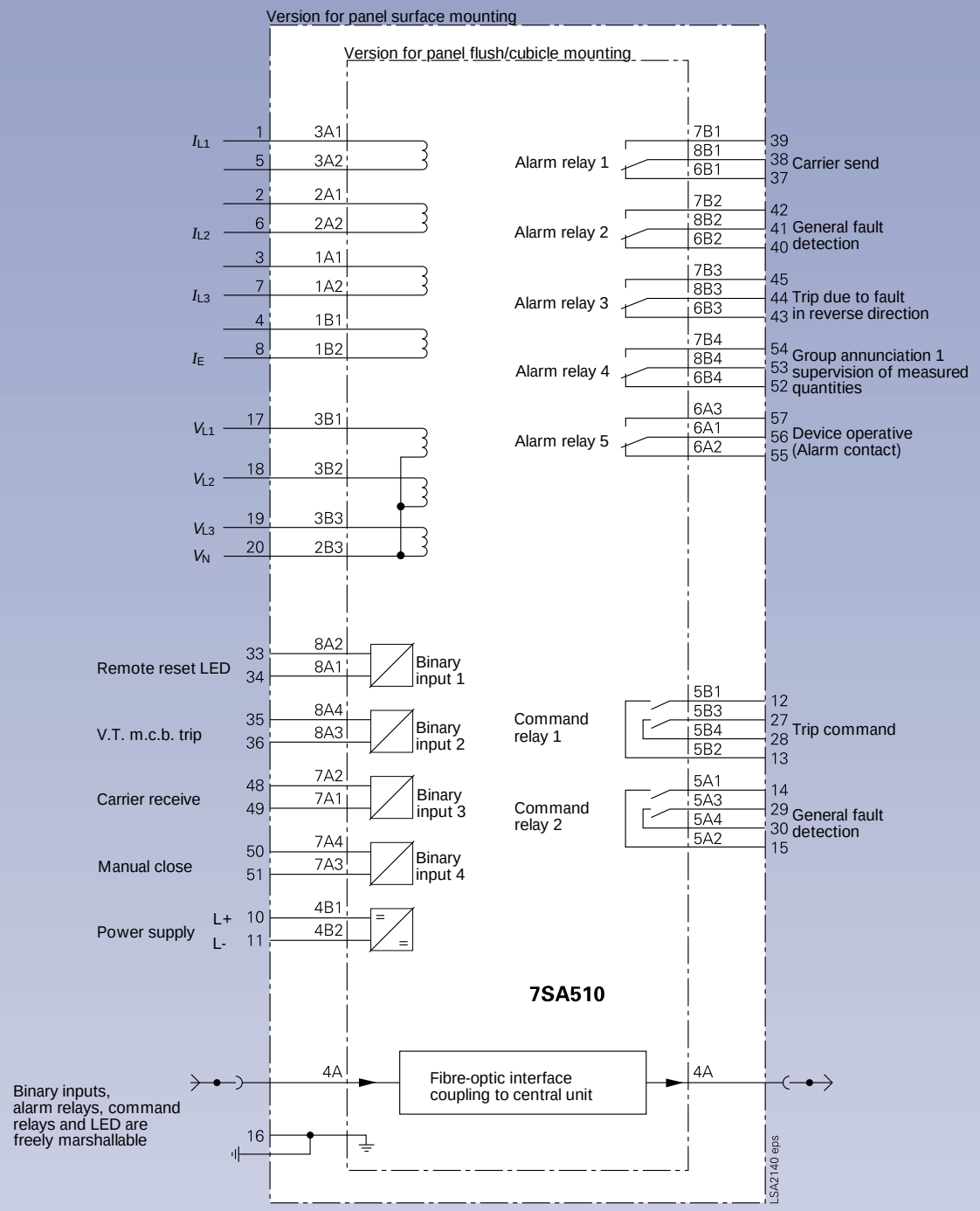

Fig. 5
Connection diagram for distance protection relay 7SA510 (version V3), state of development BB

Connection diagrams

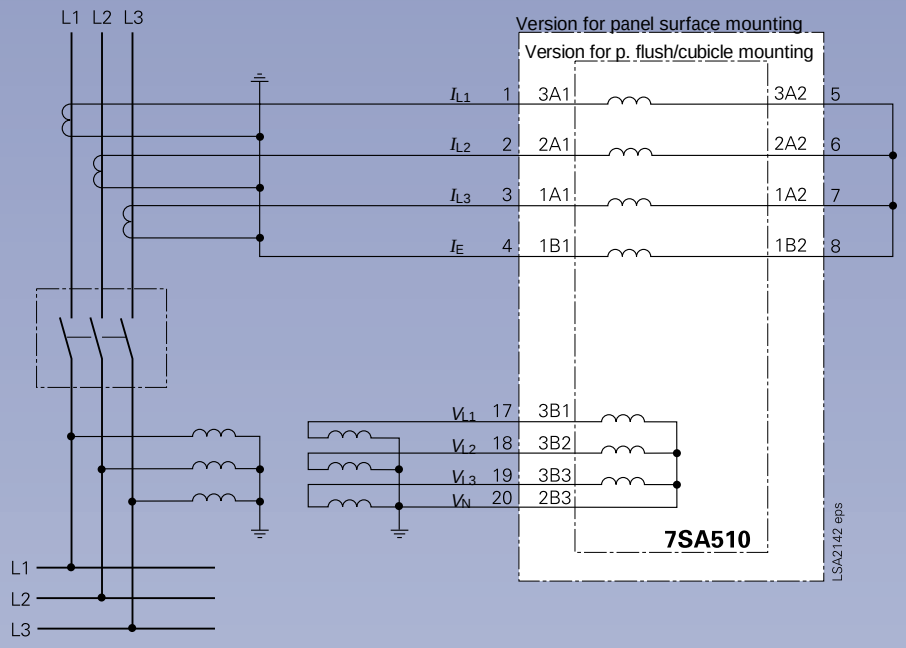

Fig. 6
Connection diagram for Holmgreen connection of current transformers for networks with any kind of star point treatment with c.t.- star point towards busbar

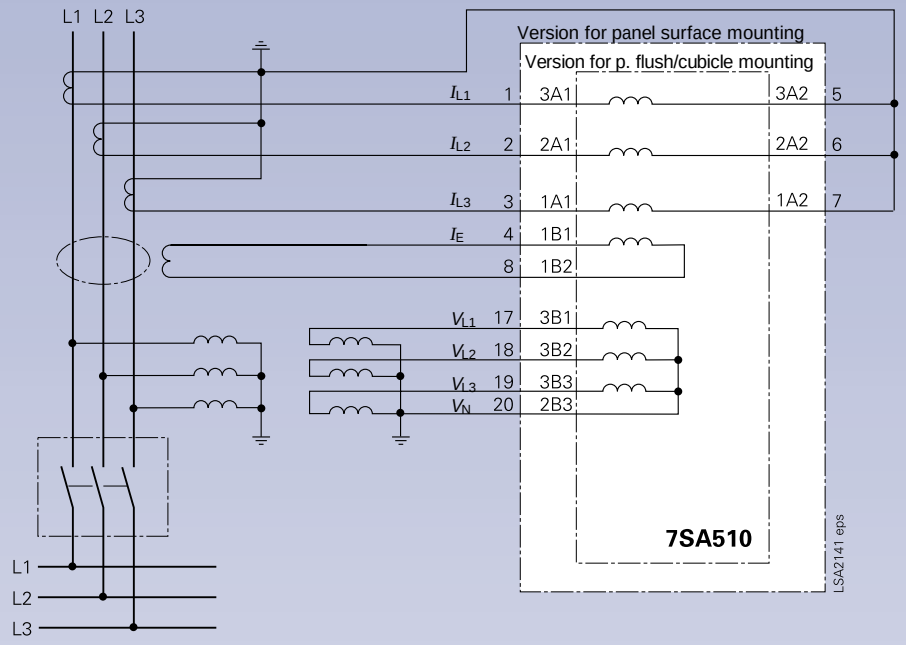

Fig. 7
Connection diagram for networks with compensated/isolated star point, I_E-connection to separate cable-type c.t., c.t.- star point towards line

Dimensions drawings (in mm)

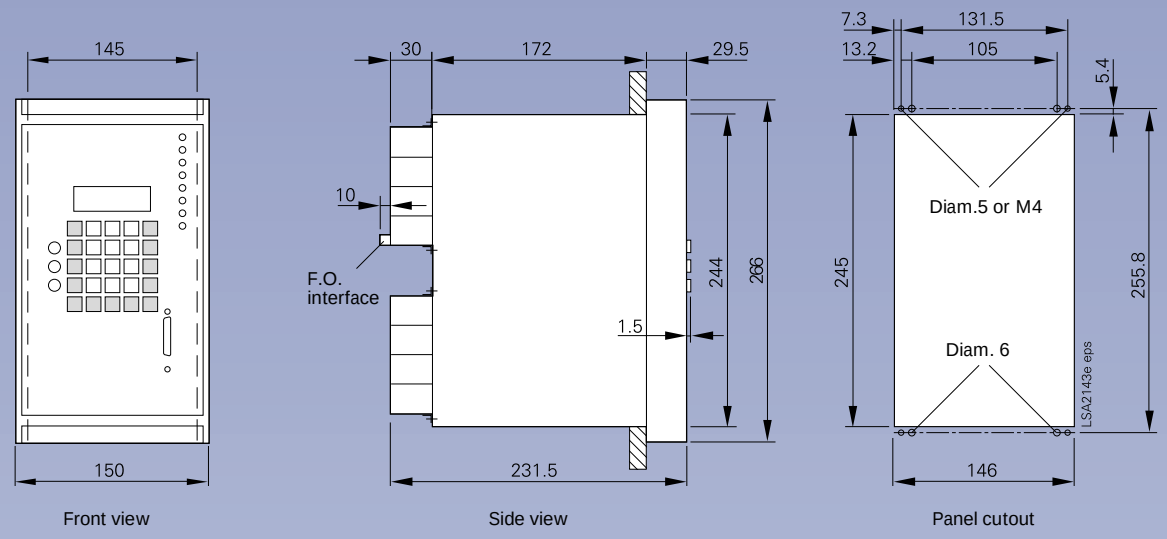

Fig. 8
SIPROTEC 7SA510 distance protection relay with 7XP2030-2 housing (for panel flush mounting or cubicle mounting)

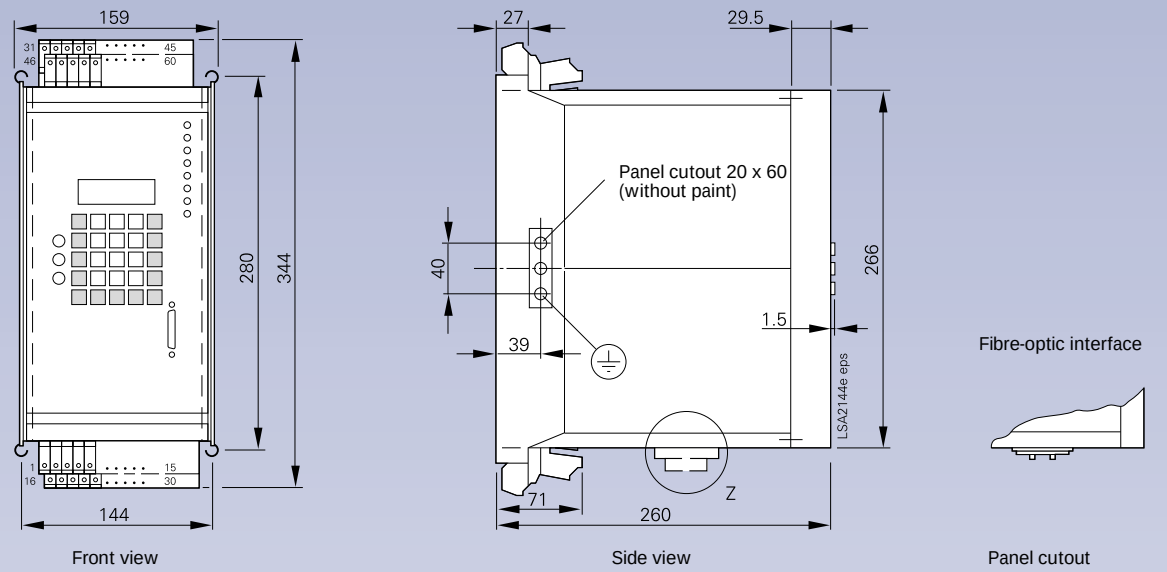

Fig. 9
SIPROTEC 7SA510 distance protection relay with 7XP2030-1 housing (for panel surface mounting)

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