SIPROTEC 7SA511 distance protection relay (Version V3)

Scope of functions

Fig. 1
SIPROTEC 7SA511 distance protection relay

Application

The 7SA511 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 7SA511 can be incorporated in both conventional switchgear systems and modern LSA 678 substation control and protection systems.

Construction

With its compact construction the 7SA511 contains all the components required for current and voltage measurement for protection scheme logic, fault recording and on-line 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 100 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 7SA511 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 system interface (either isolated RS232C/V.24 or fibre-optic) 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 starcoupler.

The communication protocol used is the compatible protocol according IEC 870–5–103. 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 7SA511 with the DIGSI software is possible if a modem is connected to the FO–serial interface.

For existing systems, the Siemens-specific protocol to DIN 19 244 is still available.

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.

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Distance protection

Distance protection is the main function of the 7SA511 relay. The distinguishing features of the relay are as follows:

- Availability of multiple starting options:
  a) Overcurrent fault detection $I \gg$
  b) Voltage-dependent overcurrent fault detection $V</I>$ (option)
  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} (see Fig. 2) or the 3 x phase-to-phase voltages V_{PH-PH}.
  c) Polygonal impedance characteristic fault detection $Z<$ (option) (see Fig. 3). 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. 4). Separate settings are provided for the resistance reach R for phase-to-phase and phase-to-earth faults. Five distance zones are provided and they may be independently set in the forward or reverse direction or non-directional. Two 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.
- Seven independent time delays are provided.
- Phase-selective tripping is available for use with single-pole or single and three-pole rapid auto-reclosing schemes.
- 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.

As an option, the fault location can be provided by parallel–line mutual compensation, if the zero–current of the parallel–lines can be measured.

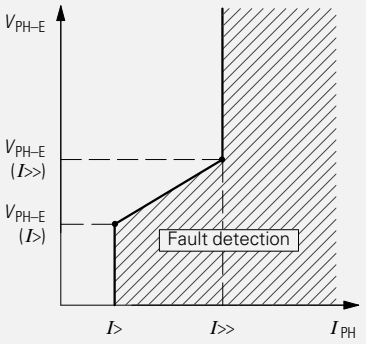

Fig. 2
Characteristic of voltage-dependent overcurrent fault detector V_{PH-E} (I_{PH})

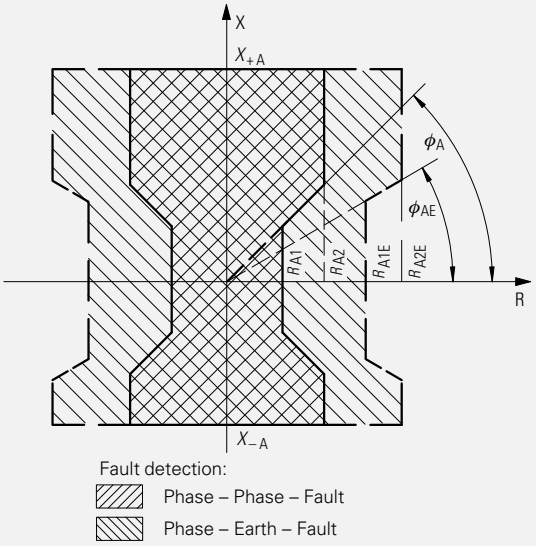

Fig. 3
Characteristic of impedance fault detector ($Z<$)

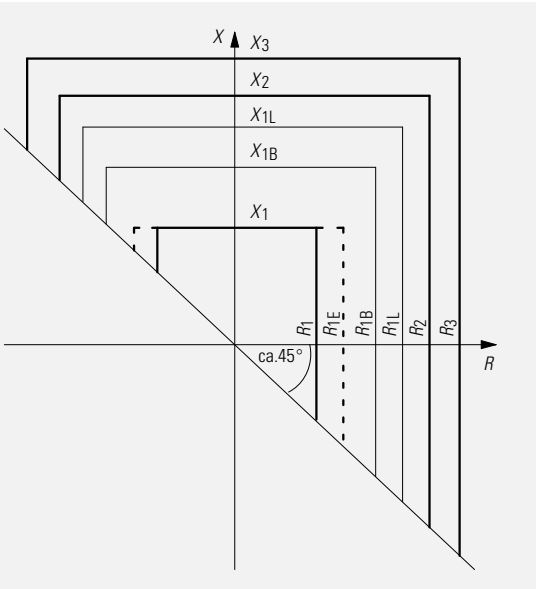

Fig. 4
Distance protection tripping characteristics

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Overcurrent-time and definite-time overcurrent protection (emergency)

The distance protection 7SA511 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. 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
- 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-on-to-fault protection

Through the use of a binary input representing manual closing of the line circuit-breaker the 7SA511 can initiate a switch-on-to-fault function. The function may be set to initiate immediate tripping from zone Z1B or from the fault detection elements.

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

In networks with no star-point earthing, 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 7SA511 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.

Automatic-reclose function (option)

The 7SA511 can be ordered with an auto-reclose (AR) facility.
The range of functions include:

- 3-pole RAR/DAR for all fault types (DAR: delayed AR–cycle)
- 1-pole RAR for single-phase faults, no reclose for multiple-phase faults
- 1-pole RAR for single-phase faults, 3-pole RAR/DAR for multiple-phase faults
- 1-pole RAR for single-phase and for 2-phase faults without involvement of earth, and 3-pole RAR/DAR for other faults
- Multi-shot DAR
- Integration with external AR equipment with communication via binary (contact) inputs and outputs
- Control of the 7SA511 AR function by an external protection scheme
- AR blocking for faults in the cable section of mixed routes (cable and overhead line).

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 7SA511 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 blocked for the duration of the power swing
- Tripping
  Tripping may be initiated following the detection of a power swing outside the defined stability limits.

Synchronism check (option)

Where two network sections are switched in by control command or following a 3-pole RAR, it must be ensured that both network sections are mutually synchronous. For this purpose, the distance protection relay 7SA511 features a synchronism check function. After verification of network synchronism, the function enables the CLOSE command. Alternatively, reclosing can also be verified after a check for dead state of the busbar or cable.

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 (option)

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.

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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. If the IEC870–5–103 protocol is used, 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). 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 7SA511 is equipped with 5 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 7SA511 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
- 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, single and three-pole operation
- Auto-reclose test facility, single and three-pole operation
- Measurement of the respective content of the active and reactive component of the earth current during an earth fault.

Non-volatile storage of operational records

The 7SA511 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 (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
  For each pole of a circuit-breaker it is possible to record the progressive total of tripping and opening operations as well as the summation of the breaking current.
- 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.

By coupling in from outside via binary inputs, phase-selective remote tripping can take place with and without automatic reclosing.

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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 c.t. circuits, continuous	4 x I_N
		for 10 s	30 x I_N
		for 1 s	100 x I_N
	Dynamic overload		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 1 A (isolated network option)		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. 16 W
		energized	Approx. 26 W
	Max. operating time after auxiliary voltage drop		≥ 50 ms at V_{aux} ≥ 110 V
Binary inputs	Number of inputs		10 (marshallable)
	Voltage range		24 to 250 V DC, adjustable in 4 ranges
	Current input		Approx. 1.7 mA
Indication contacts	Number of relays		11 (marshallable)
		with 1CO contact each	6
		with 1NO contact each	5
	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 NO contacts each	5 (marshallable)
	Switching capacity	make	1 000 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	14
Serial interfaces	Operator interface		On the front panel, not isolated, suitable for connection of a PC
	Baud rate		1 200 to 19 200 Bd
	System interface		Control system interface, isolated, suitable for coupling to a central unit
	Baud rate		1 200 to 19 200 Bd
	Electrical connection		Similar to V.24/V.28 to CCITT or RS232C to EIA, 2kV isolated, cable with 2 core pairs, with individual and common screening e.g. LIYCY–CY/2 x 2 x 0.25 mm^2
	Insulation	transmission distance	Max. 1 km
		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 fibre)
		transmission distance	Max. 1.5 km
Construction	Housing, dimensions		7XP20, see dimension drawings
	Weight	panel flush mounting/cubicle mounting	Approx. 9.5 kg
		panel surface mounting	Approx. 11 kg
	Degree of protection according to EN 60 529	housing	IP 51
		terminals	IP 21

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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 (low–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 High–voltage test (routine test), only d.c. voltage supply input Impulse voltage test (type test), all circuits, class III		2 kV (rms), 50 Hz 2.8 kV DC 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) EN 50082–2 (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 Electrostatic discharge IEC 255–22–2, class III and IEC 1000–4–2, class III Radio–frequency electromagnetic field, non–modulated report IEC 255–22–3, class III Radio–frequency electromagnetic field, amplitude modulated IEC 1000–4–3, class III Radio–frequency electromagnetic field, puls modulated ENV 50204, class III Fast transients IEC 255–22–4 class III, IEC 1000–4–4 class IV Conducted disturbances induced by radio–frequency fields, amplitude modulated IEC 1000–4–6, class III Power frequency magnetic field IEC 1000–4–8, class IV IEC 255–6		2.5 kV (peak), 1 MHz, τ = 15 μs, 400 shots/s, duration 2 s 4/6 kV contact discharge, 8 kV air discharge, both polarities, 150 pF, R_i = 330 Ω 10 V/m, 27 to 500 MHz 10 V/m, 80 to 1 000 MHz, AM 80 %, 1 kHz, 10 V/m, 900 MHz, repetition frequency 200 Hz, duty cycle 50 % 2 kV, 5/50 ns, 5 kHz, burst length = 15 ms, repetition rate 300 ms, both polarities, R_i = 50 Ω, duration 1 min 10 V, 150 kHz to 80 MHz, AM 80 %, 1 kHz, 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 Interference field strength CISPR 11, EN 55011 and VDE 0875 part 11		150 kHz to 30 MHz, class B 30 to 1 000 MHz, class A
Climatic stress tests	permissible ambient temperature permissible humidity	during service during storage during transport	–5 to +55 °C –25 to +55 °C –25 to +70 °C 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 during transport	10 to 60 Hz, 0,035 mm amplitude 60 to 150 Hz, 0,5 *g* acceleration 5 to 8 Hz, 7,5 mm amplitude 8 to 150 Hz, 2 *g* acceleration

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Technical data (continued)

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 ($I\gg$)			
	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 tolerance		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} ($I\gg$)		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} ($I\gg$)		1 V	40 to 130 V
	Distance measurement			
	Characteristic			Polygonal
	Distance zones			5, 2 as zone extensions 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 tolerance 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			7 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
	Parallel line mutual compensation			
	$\frac{X_M}{X_L}$, $\frac{R_M}{R_L}$		0.01	–7 to 7
	Directional determination			
	for all failure types			with externally generated short-circuit tripping currents and voltage memory
	Directional sensitivity			Dynamically unlimited
	Operating times			
	Minimum trip contact			23 ms
	Reset time			Approx. 30 ms
	Tolerances			Measurement tolerances according to VDE 0435, Part 303 for sinusoidal quantities
	for 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.

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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
	Parallel line compensation		Selectable; option
	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 ≥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 $I_{PH}\gg/I_N$	0.01	0.5 to 9.99
	Timers $t_I>$, $t_{IE}>$, $t_I\gg$	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		Tripping via fault detection Tripping via zone extension (POTT/PUTT)
	Comparison		Signal comparison Directional comparison Unblocking with zone extension Unblocking with tripping Blocking
	Pilot wire protection		–
	Reverse interlock		–
Earth-fault detection (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 1 000 mA
	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

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Technical data (continued)

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_{Off}		1 %	50 to 100 %
	Current warn stage I_{Alarm}/ $k\,I_N$		0.01	0.1 to 4
	Tripping time characteristic			$t = \tau \cdot I_n \dfrac{I^2 - I_{pre}^2}{I^2 - (k\,I_N)^2}$
	Reset conditions			
	Θ/Θ_{Off}			Approx. 0.99
	Θ/Θ_{Alarm}			Approx. 0.99
	I/I_{Alarm}			Approx. 0.99
	Tolerances			Class 10 % to IEC 255–8
Auto-reclose	Auto-reclose operation counter			Up to 10
	Modes			only 1-pole, only 3-pole, 1 or 3-pole
	Active times for RAR and DAR cycle	Step	0.01 s	0.01 to 320 s
	Dead times in RAR cycle		0.01 s	0.01 to 320 s
	Dead times in DAR cycle		0.01 s	0.01 to 1 800 s
	Reclaim times		0.01 s	0.5 to 320 s
	Close command duration		0.01 s	0.01 to 32 s
Synchronism check	Modes for connecting			
	Line dead/busbar live			$V_1</V_2>$
	Line live/busbar dead			$V_1>/V_2<$
	Synchronism			$V_1>/V_2>$
	Permissible voltage difference ΔV	Step	1 V	1 to 50 V
	Permissible frequency difference Δf		0.01 Hz	0.01 to 1 Hz
	Permissible angle difference $\Delta\varphi$		1°	1 to 60°
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 sampling values per network period
	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 7SA511 distance protection relay (Version V3)

Selection and ordering data

Distance protection relay			Order No. **7SA511** □ – □□ **A** □□ – □□□□
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**
Functions/language			
V3 with IEC 870–5–103 protocol, overload protection and with synchrocheck (option)			
Operator language German			**6**
Operator language English			**7**
Fault detection			
With overcurrent ($I\gg$)			**1**
With impedance ($Z<$)/Overcurrent ($I\gg$)/Voltage-dependent overcurrent ($V<$, $I>$), settable option			**2**
With voltage-dependent overcurrent ($V<$, $I>$)/Overcurrent ($I\gg$), settable option			**3**
Options A			
Without wattmetric earth-fault detection	without FLPC		**0**
With wattmetric earth-fault detection	without FLPC		**1**
Without wattmetric earth-fault detection	with FLPC		**2**
Serial system interface			
Without			**A**
Isolated, V.24/RS232C			**B**
Integrated fibre–optic interface			**C**
Options B			
Without AR	without parameter changeover facility,	without synchronism check	**A**
With AR, 3-pole	without parameter changeover facility,	with synchronism check	**B**
With AR, 1 and 3-pole	without parameter changeover facility,	with synchronism check	**C**
Without AR	with parameter changeover facility,	with synchronism check	**E**
With AR, 3-pole	with parameter changeover facility,	with synchronism check	**F**
With AR, 1 and 3-pole	with parameter changeover facility,	with synchronism check	**G**
Options C			
Without power swing	without earth-fault protection for earthed networks		**0**
With power swing[1)]	without earth-fault protection for earthed networks		**1**
Without power swing	with earth-fault protection for earthed networks		**2**
With power swing[1)]	with earth-fault protection for earthed networks		**3**

FLPC – Fault location with parallel line mutual compensation

AR – Auto-reclose

Operation 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 2.2.11:	Abzweigschutz SIPROTEC 7SA511 (Version V3)	**E50001–K5712–A211–A2**
	Handbuch:	Abzweigschutz SIPROTEC 7SA511 (Version V3)	**C53000–G1100–C98–3**
English:	Catalog LSA 2.2.11:	SIPROTEC 7SA511 distance protection relay (Version V3)	**E50001–K5712–A211–A2–7600**
	Manual:	SIPROTEC 7SA511 distance protection relay (Version V3)	**C53000–G1176–C98–3**

1) Only available with impedance starting (Z<). Mark "**2**" in the 12th digit of the Order No.

SIPROTEC 7SA511 distance protection relay (Version V3)

Function scope of special device versions

Special device versions can be supplied for specific applications. The following functions are available in all versions:

Fault location, thermal overload protection, load values, overcurrent–time and definite time overcurrent protection, 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.

All equipment variants can be used in earthed and in compensated/isolated networks. In accordance with the functional scope of the individual equipment variants, the main applications are stated in the following table.

Functions	Versions				
	Basic version	Medium voltage		High voltage	
		Isolated, compensated, earthed network	Earthed network	Isolated/ compensated network	Earthed network
Distance protection with 3 + 2 zones, 7 time steps	+	+	+	+	+
Direction detection with voltage or sound phase polarization	+	+	+	+	+
Overcurrent starting	+	+	+	+	+
V/*I* starting	–	+	+	+	+
Impedance starting	–	–	–	+	+
Fault location	+	+	+	+	+
Parallel–line mutual compensation for fault location	–	–	–	+	+
Power swing	–	–	–	+	+
Teleprotection interface	+	+	+	+	+
Emergency definite time overcurrent protection for measuring voltage failure	+	+	+	+	+
Thermal overload	+	+	+	+	+
Earth–fault detection in non-earthed network	–	+	–	–	–
Back–up earth-fault protection (earthed network)	–	–	+	–	+
Reclosing, 3-pole	–	+	+	+	+
Reclosing, 1/3-pole	–	–	–	–	+
Synchronism check	–	+	+	+	+
Protection for switch–on–to–fault	+	+	+	+	+
Fault recording	+	+	+	+	+
Parameter changeover facility	–	+	+	+	+
Transient earth–fault detection	o	o	o	o	o
Fault location output, analog/BCD	o	o	o	o	o

\+ Function included
– Function not included
o Function possible with add-on

SIPROTEC 7SA511 distance protection relay (Version V3)

Selection and ordering data for the special device versions

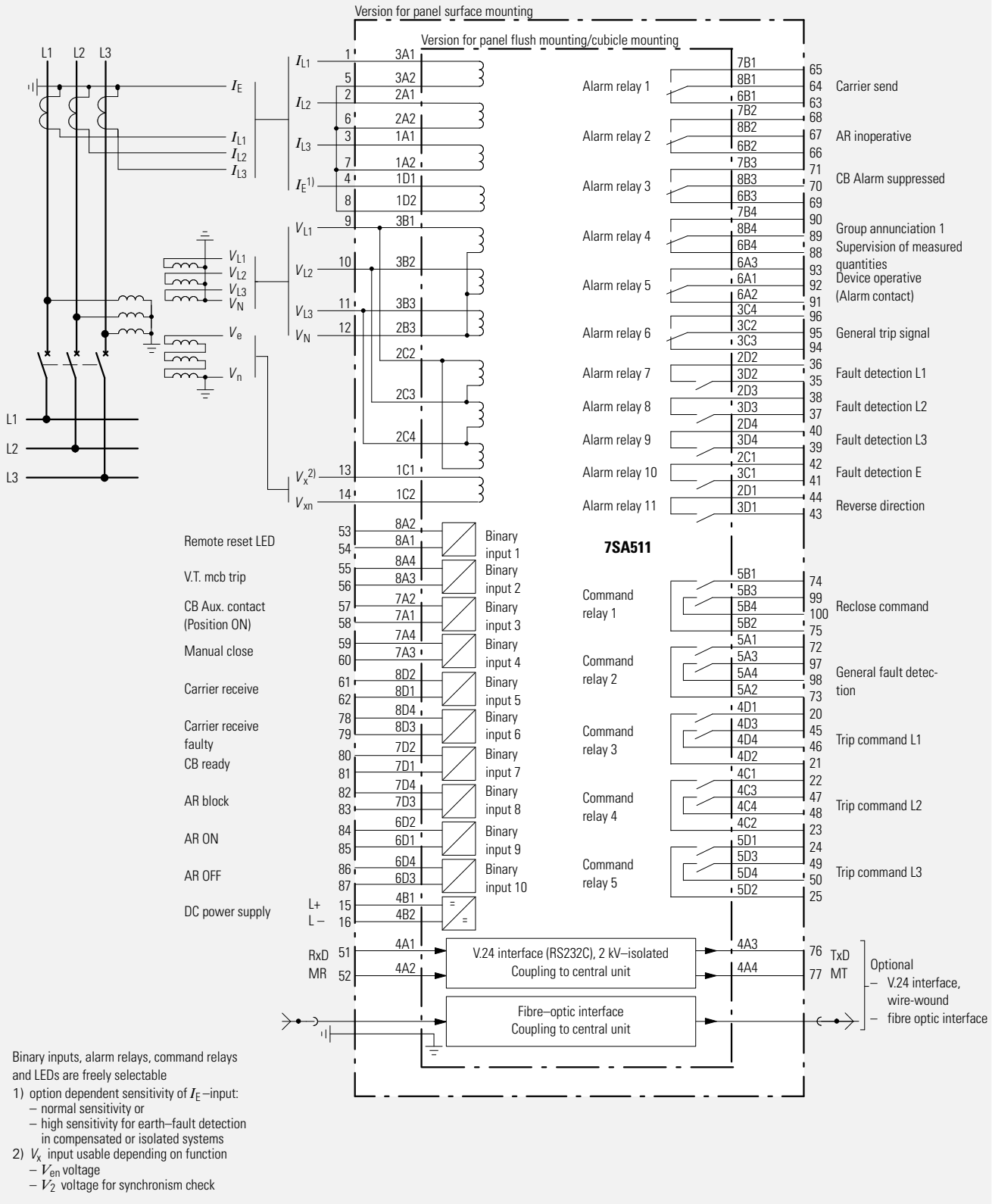
Distance protection relay		Order No. 7SA511 □ – □ □ A □ □ – □ □ □ □
Rated current at 50/60 Hz		
1 A		1
5 A		5
Rated auxiliary voltage		
24, 48 V DC		2
60, 110, 125 V DC		4
220, 250 V DC		5
Construction		
For panel surface mounting		B
For panel flush mounting/cubicle mounting		C
For panel flush mounting/cubicle mounting without glass cover		E
Language		
Operating language German		6
Operating language English		7
Special device versions		
Basic version		1 0 A 0
Medium–voltage version:	isolated, compensated, earthed network (sensitive current transducer for I_E)	3 1 F 0
	earthed network	3 0 F 2
High–voltage version:	isolated, compensated network	2 2 F 1
	earthed network	2 2 G 3
Serial interface		
Without		A
Isolated, V.24/RS232C		B
Integrated fibre–optic interface		C

Accessories for the distance protection relay 7SA511

Transient earth fault relay		Order No. 7SN7100 – □ □ A 0 0
Rated auxiliary voltage		
100 to 110/220 V, AC, 50 Hz		0
24 V DC		1
48 V DC		2
60 V DC		3
110/125 V DC		4
220/250 V DC		5
Construction		
For panel surface mounting		B
For panel flush mounting/cubicle mounting		C

Fault location output equipment		Order No. 7SM7 □ 0 0 – □ □ □ 0 0
Device type		
Analog output unit		0
BCD output unit		1
Rated auxiliary voltage		
24 V DC		1
48 V DC		2
60 V DC		3
110/125 V DC		4
220/250 V DC		5
Construction		
For panel surface mounting		B
For panel flush mounting/cubicle mounting		C
Binary input		
For BCD output unit 7SM71:	no binary input	A
For analog output unit 7SM70:	24/48/60 V DC	A
	110/125/220 V DC	C

SIPROTEC 7SA511 distance protection relay (Version V3)



Binary inputs, alarm relays, command relays and LEDs are freely selectable

1) option dependent sensitivity of I_E–input:
   – normal sensitivity or
   – high sensitivity for earth–fault detection in compensated or isolated systems

2) V_x input usable depending on function
   – V_{en} voltage
   – V_2 voltage for synchronism check

Fig. 5
Connection diagram for distance protection relay 7SA511 (Version V3), state of development FF

Dimension drawings in mm

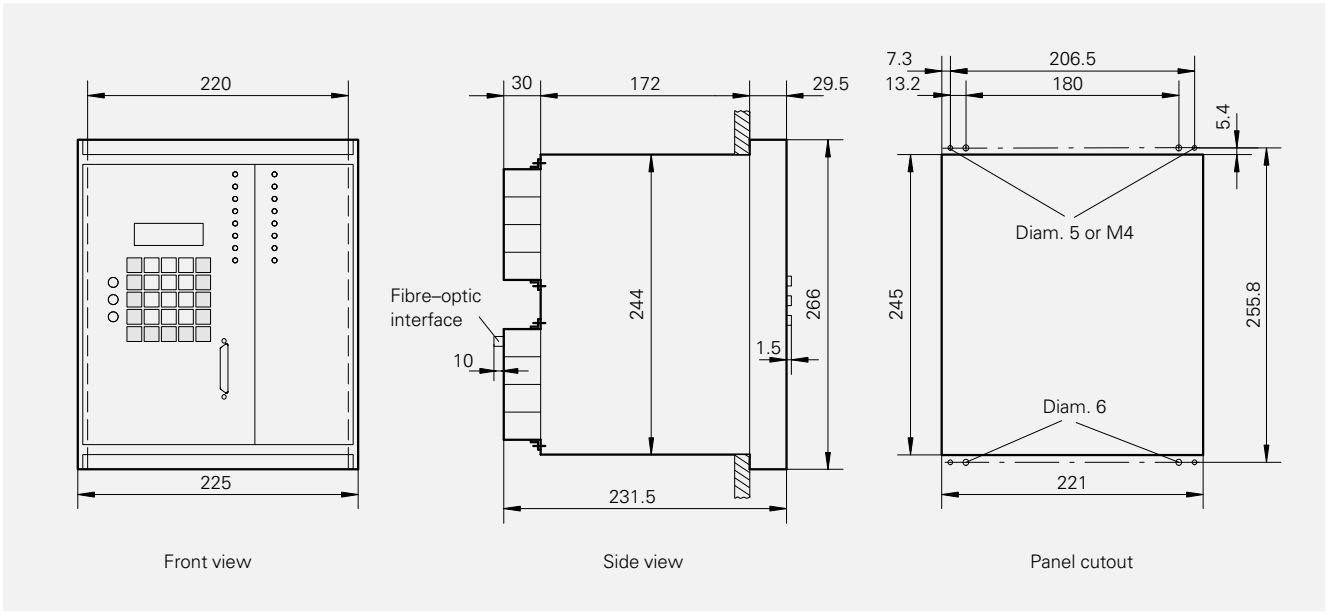


Fig. 6
7SA511 (Version V3) with housing 7XP2040–2 (for panel flush mounting/cubicle mounting)

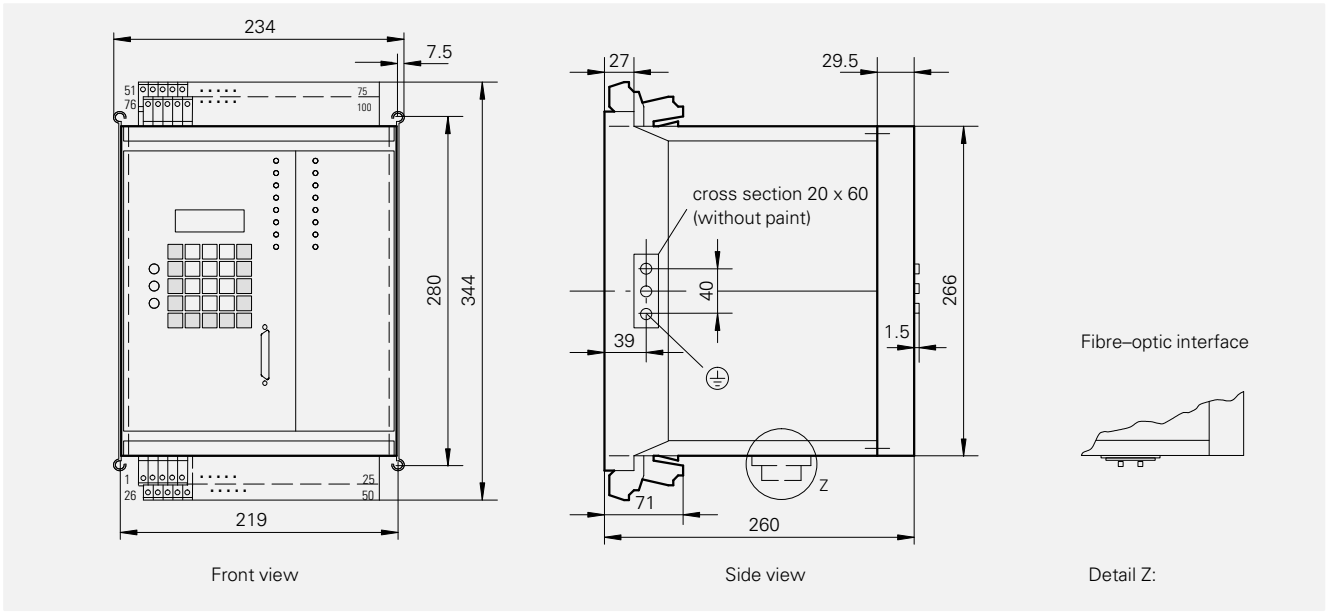


Fig. 7
7SA511 (Version V3) with housing 7XP2040–1 (for panel surface mounting)

Conditions of Sale and Delivery • Export Regulations • Trademarks • Dimensions

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