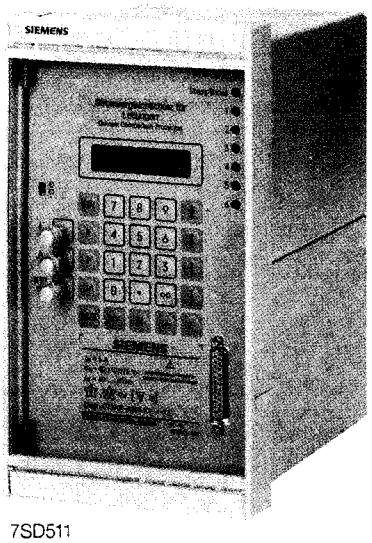
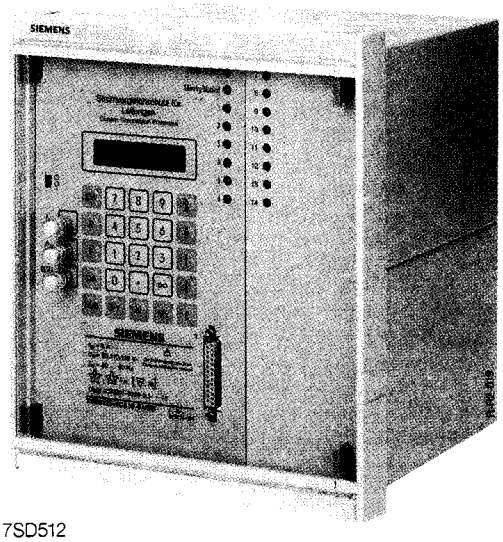
SIEMENS

Current comparison protection 7SD511/512 for overhead lines and cables



7SD511



7SD512

Fig. 1
Current comparison protection 7SD51

Application

The current comparison protection units 7SD511/512 are for fast and selective short-circuit protection of cables and overhead lines of all voltage levels. The combination of dynamic and steady-state measurement makes the current comparison protection sensitive to internal high-resistant faults and extremely stable during short-circuit through currents. Neither the treatment of the network neutrals nor the load current has an influence on the short-circuit sensitivity. The digital transmission of protection data normally occurs via fibre optics. The integrated optical interfaces facilitate a direct connection up to 15 km. In addition an isolated V.24 interface permits the connection to a powerful optoamplifier or a PCM transmission unit. The protection also includes an integrated thermal replica for monitoring the current-induced heat losses and the data transmission and an emergency overcurrent protection. In addition the 7SD512 has an automatic-reclosure function. The devices can interface with conventional switchgear systems or alternatively be integrated in the modern substation control system LSA 678.

Construction

The units are of compact design and include all components for the measured value formation and evaluation, operator panel and display field, alarm and trip outputs, binary input option, serial interfaces and auxiliary voltage DC/DC converter.

Two housing models are available. The model for flush mounting or cubicle mounting has rear connection elements. The model for surface mounting has screw terminals which are accessible from the front.

Mode of operation

The current comparison protection units 7SD51 have fully digital measurement processing from the scanning and digitisation of measured values to the trip decisions for the circuit-breakers.

Digital measurement methods largely suppress the influence of high-frequency transients, transient DC components, and differing current transformer saturation levels.

Features

- Selective short-circuit protection for cables and overhead lines,
- Overload protection with thermal characteristic,
- Digital transmission of protection data via fibre optics,
- Circuit-breaker intertripping and remote trip signal transfer,
- Marshallable binary inputs, LED's, alarm and trip relays,
- Operational current measurement,
- Fault recording,
- Commissioning aids,
- Monitoring the protection data transmission,
- Emergency overcurrent-time protection in case of loss of the data transmission,
- Integrated single and three-pole auto-reclose function for 7SD512.

Auto-reclose function

The relay 7SD512 has an auto-reclose (AR) facility. The range of functions include:

- Three-pole AR for all fault types
- Single-pole AR for single-phase faults, no reclose for multi-phase faults
- Single-pole AR for single-phase faults and three-pole AR for multi-phase faults
- Single or multi-shot AR
- Integration with external AR equipment with communication via binary (contact) inputs and outputs
- Control of the integrated AR function by an external protection scheme.

Disturbance recording

The digital measured values for the three-phase and earth currents are stored for a period of 100 ms before fault inception until 2.9 s after fault inception. This data can be transferred either to the coordinated substation control system LSA 678 or to a PC for analysis. This stored information will be overwritten upon occurrence of a new network fault, so that the most recent fault data is always available.

Fault reports

The 7SD511/512 provide detailed data for the analysis of protection operations, as well as for the recording of all relay operational status changes (e. g. relay blocked/ready). All these data are stored in a non-volatile memory.

- Real-time clock
  A battery back-up clock is available, which is synchronized via a digital input or the system serial interface to supply time/date information for fault reports.
- Relay operation reports
  Summarized fault data for the last three relay operations are always available. A new fault recording overwrites the oldest data.
- Service status reports
  All relay service status changes are recorded in a ring buffer. In addition, it is possible to inspect the on-line input current values (viz. three-phase currents and earth current) via the front panel LCD display.

Marshalling of command and alarm/ event relays, LED's and binary inputs

All input/output relays and indicating LED's may be functionally allocated according to the user's requirements.

Commissioning

Due to the digital signal transmission to the remote line end, commissioning effort is reduced by measurement and indication of:

- Load currents of the local and remote station,
- Transfer time of signals from one station to the other,
- Phase sequence of the local station,
- Phase allocation of the conductors between the stations.

This enables the current transformer connections, the polarity of the current transformers, phase sequence and phase allocation to be tested from the one end.

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Technical data

Input circuits	Rated current I_N		1 or 5 A
	Rated frequency f_N, can be parameterized		50 or 60 Hz
	Thermal overload capacity of current inputs,	continuous	$4 \times I_N$
		10 s	$30 \times I_N$
		1 s	$100 \times I_N$
	dynamic,	half-cycle	$250 \times I_N$
	Power consumption of current inputs	at I_N = 1 A	< 0.1 VA
		at I_N = 5 A	< 0.5 VA
Auxiliary DC voltage	Rated auxiliary voltage U_H		24, 48 V or 60, 110, 125 V or 220, 250 V
	Permissible rated auxiliary voltage ranges		19 to 56 V 48 to 144 V 176 to 288 V
	Max. perm. ripple content	at rated auxiliary voltage	≤ 12 %
	Power consumption	quiescent	approx. 9 W
		energised	approx. 10.5 W
	Stored-energy time at $U_H \geq 110$ V		≥ 50 ms
Binary inputs	Marshallable 7SD511/512		4/10
	DC operating voltage		24 to 250 V
	Current input		approx. 2.5 mA
Alarm contacts	Number of fault alarm relays 7SD511/512	not marshallable	1/1
	Number of alarm relays 7SD511/512	marshallable	4/10
	Contacts per relay		see connection diagrams
	Switching capacity Make/Break		20 W/VA
	Switching voltage		250 V AC/DC
	Permissible current		1 A
Trip contacts	Number of trip relays 7SD511/512	marshallable	2/5
	Contacts per relay		see connection diagrams
	Switching capacity Make		1000 W/VA
	Break		30 W/VA
	Switching voltage		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 LED's 7SD511/512	red	6/14
Construction of unit	Casing, dimensions		7XP20, see dimension drawings
	Weight, terminals	panel flush mounting/cubicle mounting	approx. 6.5 kg, see connection diagrams
		panel surface mounting	approx. 8 kg, 30 terminals
	Degree of protection according to DIN 40 050		IP 51
Standards, specifications	DIN VDE 0435 Part 303 and IEC 255-5 or IEC 255-6		
Climatic tests	Permissible ambient temperatures	in service	– 5 to +50°C
		in storage	–25 to +55°C
		during transport	–25 to +70°C
	Humidity class		Class F to DIN 40 040 no condensation permitted
Mechanical stress test acc. to DIN 40046	In service		10 to 60 Hz: 0.035 mm amplitude 60 to 500 Hz: 0.5 *g* acceleration
	During transport		5 to 8 Hz: 7.5 mm amplitude 8 to 500 Hz: 2 *g* acceleration

Technical data (continued)

Serial interfaces	Operator interface	at the front, not isolated, suitable for connection of a PC
	System interface	potential-free, suitable for coupling to a central data unit
	Protocol	DIN 19244
	Safety	Hamming distance $d = 4$
	Speed	4800, 9600 or 19200 baud
	Method	asynchronous
	Connection fibre optic	two integrated FSMA plug connectors for fibre optic connection
	optical wave length	820 nm
	permissible fibre damping	max. 8 dB with glass fibre 62.5/125 µm
	distance	max. 2 km
	Interface to far end	potential-free
	Telegram format	DIN 19244
	Safety	Hamming distance $d = 4$
	Speed	19200 baud
	Method	asynchronous
	Connection electrical	similar to V.24/V.28 acc. to CCITT or RS232C acc. to EIA, 2 kV isolated
	distance	max. 1000 m. (suitable only for coupling between 7SD511/512 and fibre optic transmission unit, e. g. PCM 30)
	Connection fibre optic 820 nm interface	two integrated FSMA plug connectors for fibre optic connection
	optical wave length	820 nm
	permissible fibre damping	max. 8 dB with glass fibre 62.5/125 µm
	distance	max. 2 km
	Connection fibre optic 1300 nm interface	two integrated FC plug connectors for fibre optic connection
	optical wave length	1300 nm
	permissible fibre damping	max. 19 dB with glass fibre 50/125 µm or 62.5/125 µm
	distance	max. 13.5 dB with glass fibre 9/125 µm max. 10 to 15 km (depends on fibre cable)
	In the models for panel flush mounting and cubicle mounting isolated supply voltages for connection of an electro-optical converter are connected to terminals	+12 V (max. 100 mA) −12 V (max. 25 mA)
Insulation tests	High-voltage test	2 kV (rms) 50 Hz; 1 min or alternatively 2.8 kV DC; 1 min
	Impulse voltage test	5 kV (peak); 1.2/50 µs; 0.5 J; 3 positive and 3 negative pulses at intervals of 5 s
Interference tests	High-frequency test (1 MHz test) IEC 255-22-1, Class III	2.5 kV (peak); 1 MHz; $\tau = 15$ µs; 400 pulses per s; duration 2 s
	Electrostatic discharges (ESD test) IEC 255-22-2, Class III	8 kV (peak); 5/30 ns; 10 positive discharges
	Radiated electromagnetic field test IEC 255-22-3 (Report), Class III	test with Walkie Talkie 68 MHz, 151 MHz, 450 MHz
	Fast transient test IEC 41 B (CO) 53 (draft), Class III	2 kV (peak); 5/50 ns; 5 kHz; 4 mJ per impulse

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Technical data (continued)

Current comparison protection	Setting ranges Steady-state trip limit I_{STAT}/I_N Dynamic trip limit I_{DYN}/I_N Dynamic trip limit $I_{DYN\ SWITCH\text{-}IN}/I_N$ Times Operating time (two-side infeed) at I = 4 × setting value I_{DYN} at I = 10 × setting value I_{DYN} Additional delay of trip signal Min. trip signal time Reset value I/I_N Tolerance of trip characteristic (steady-state, single-side infeed) Frequency range f_N = 50 Hz f_N = 60 Hz	 0.5 to 4 (in steps of 0.01) 0.2 to 1 (in steps of 0.01) 0.2 to 4 (in steps of 0.01) approx. 23 to 33 ms approx. 16 to 26 ms 0 to 0.05 s (in steps of 0.01 s) 0.05 to 1 s (in steps of 0.01 s) approx. 0.05 ± 5 % of specified value 45 to 55 Hz 55 to 65 Hz
Overload protection	Setting ranges Factor k acc. to IEC 255.8 in steps of 0.01 Time constant τ in steps of 0.1 min Temperature alarm stage $\Theta_{alarm}/\Theta_{trip}$ trip temperature Current alarm stage I_{alarm} Trip time characteristic Reset ratios Tolerances	 1 to 5 1 to 999.9 min 50 to 100 % $I_{alarm} \geq I_{max} = k \cdot I_N$ $t = \tau \lg \frac{I^2 - I^2_{pre}}{I^2 - (k \cdot I_N)^2}$ Θ/Θ_{alarm} approx. 0.99 Θ/Θ_{trip} approx. 0.99 I/I_{alarm} approx. 0.99 Class 10 % acc. to IEC
Setting ranges **Definite-time overcurrent protection**	Overcurrent phase $I>$ or earth $I_E>$ High set current phase $I\gg$ or earth $I_E\gg$ Delay times Tolerances Current pick-up value Time Reset time	I/I_N = 0.1 to 15 or 0.1 to 4 respectively I/I_N = 0.1 to 15 or 0.1 to 10 respectively 0 to 60 s or infinity ± 5 % of set value ± 1 % or ± 10 ms approx. 30 ms
IDMT overcurrent protection	Overcurrent phase $I>$ or earth $I_E>$ High set current phase $I\gg$ (DMT) or earth $I_E\gg$ (DMT) Time multiplier t_p Pick-up value Characteristics according to IEC 255-4, paragraph 3.5.2 or BS 142 Linear current range Tolerances Pick-up value Time	I_p/I_N = 0.1 to 4 I/I_N = 0.1 to 15 or 0.1 to 10 respectively 0.05 to 3.2 s 1.1 × I_p normal inverse, very inverse, extremely inverse 20 × I_N ± 5 % ≤ 5 % for 2 ≤ $(I/I_p>)$ ≤ 20 and t_p = 1
Load monitoring	Operational currents Measurement range Tolerance Overload protection values Conductor temperature Measurement range Tolerance	I_{L1}; I_{L2}; I_{L3}; I_E 0 to 240 % I_N ≤ 2 % of rated value Θ/Θ_{trip} calculated 0 to 240 % ≤ 3 % referred to Θ_{trip}
Fault event recording	Fault events	storage of the last three fault events
Fault recording	Phase currents (instantaneous values) Storage time/storage depth Resolution of instantaneous values Holding time Starts recording on	i_{L1}; i_{L2}; i_{L3}; i_E max. −100 to 2900 ms at f_N = 50 Hz max. −83 to 2416 ms at f_N = 60 Hz 1.25 ms at f_N = 50 Hz 1.04 ms at f_N = 60 Hz until next fault trip, test operation, binary input

Selection and ordering data

Current comparison protection	Order No. 7SD51 □□ - □□ A □□ - □□A0
without auto-reclose function (AR)	1
with single and three-pole auto-reclose function (AR)	2
Rated current for AC 50/60 Hz	
1 A	1
5 A	5
Auxiliary voltage supply	
24 V, 48 V DC	2
60 V, 110 V, 125 V DC	4
220 V, 250 V DC	5
Construction	
for panel surface mounting	B
for panel flush mounting/cubicle mounting	C
Software version for 7SD511	
V1 without real-time clock	0
V2 with real-time clock	1
Software version for 7SD512	
V2 with real-time clock	1
Real-time clock	
without	0
with	1
Serial interface to far end	
isolated, hard-wired V.24	0
integrated fibre optic interface 820 nm	1
1300 nm	2
Serial interface	
without	A
integrated fibre optic interface 820 nm	C

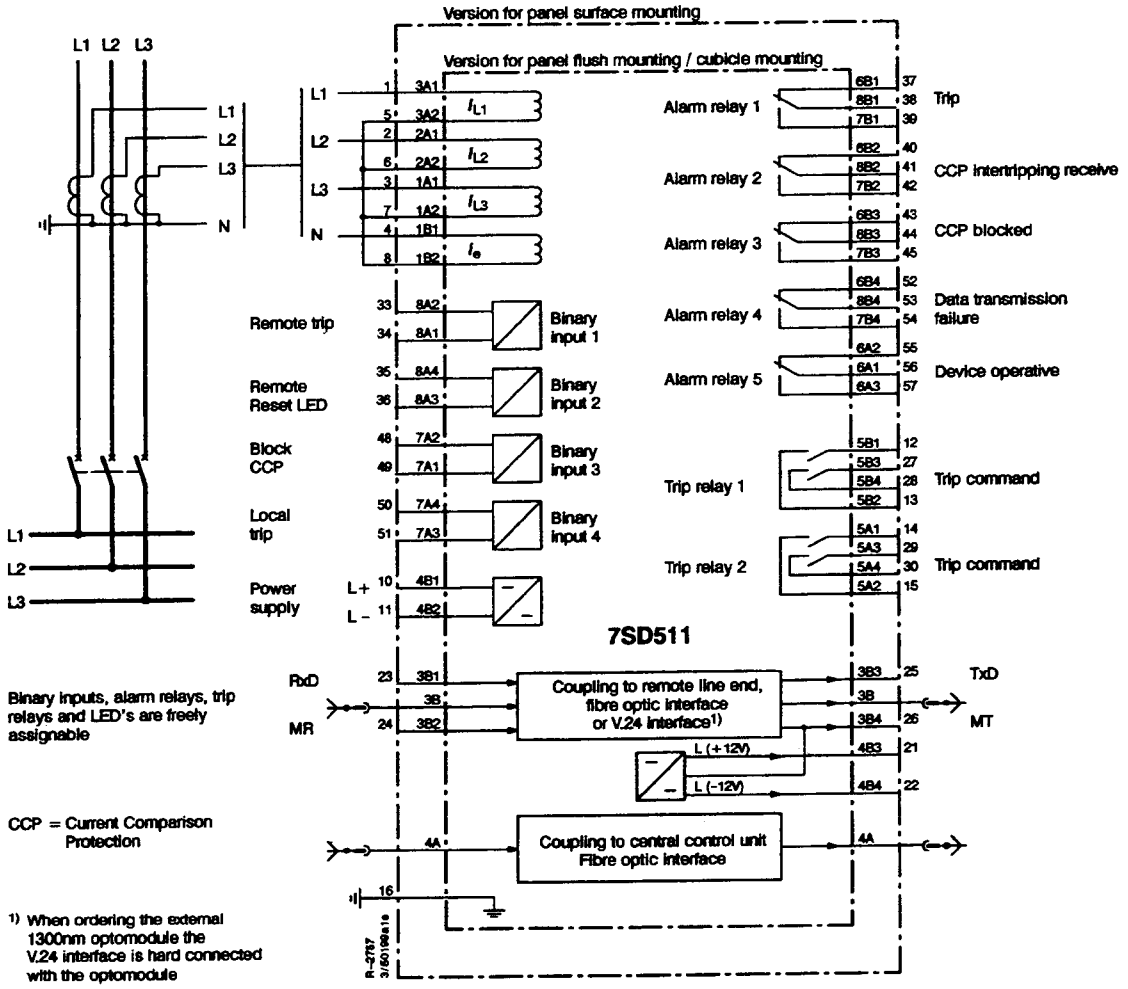

Fig. 5
Connection diagram for current comparison protection 7SD511

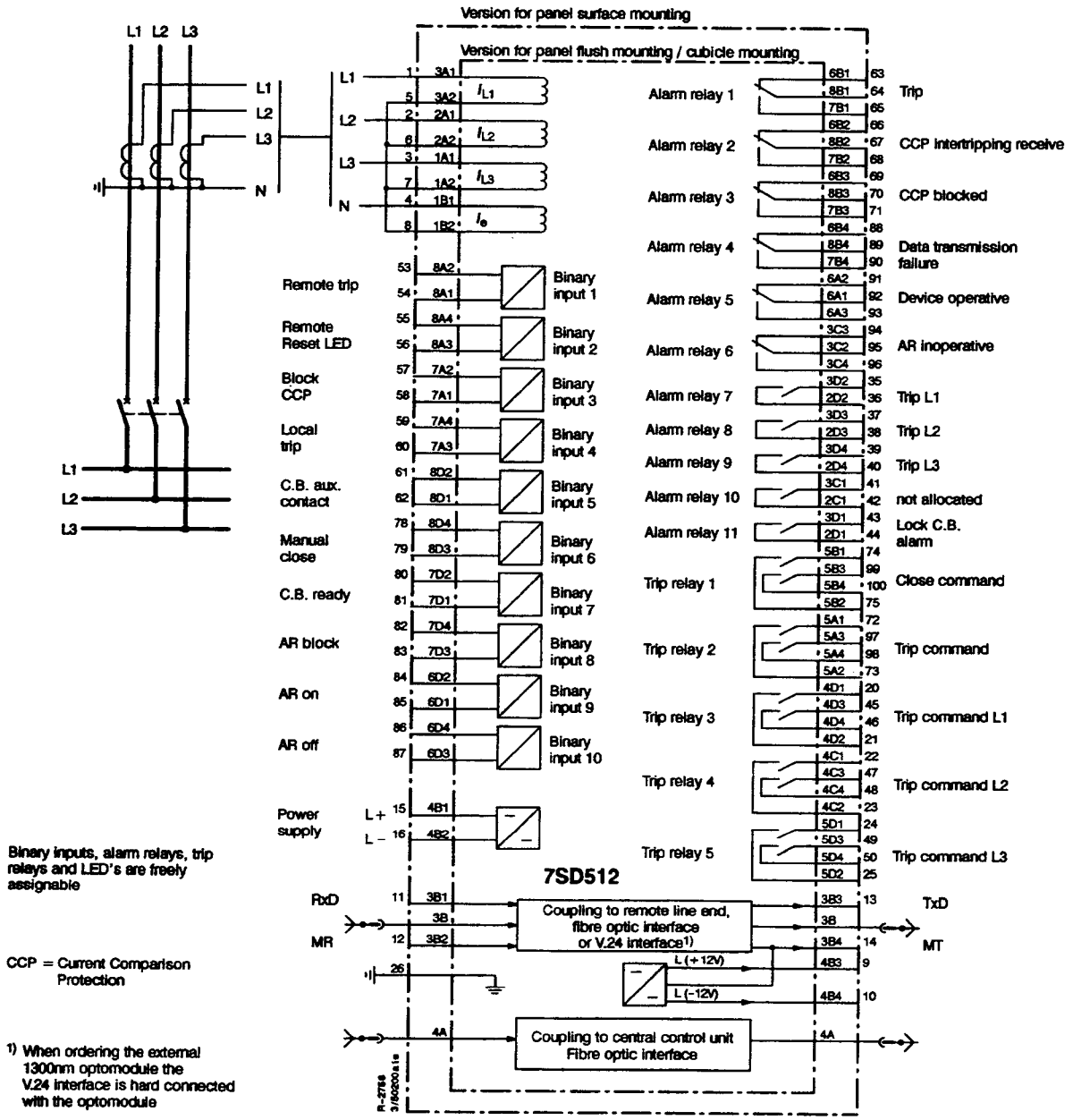

Fig. 6
Connection diagram for current comparison protection 7SD512

Dimension drawings in mm

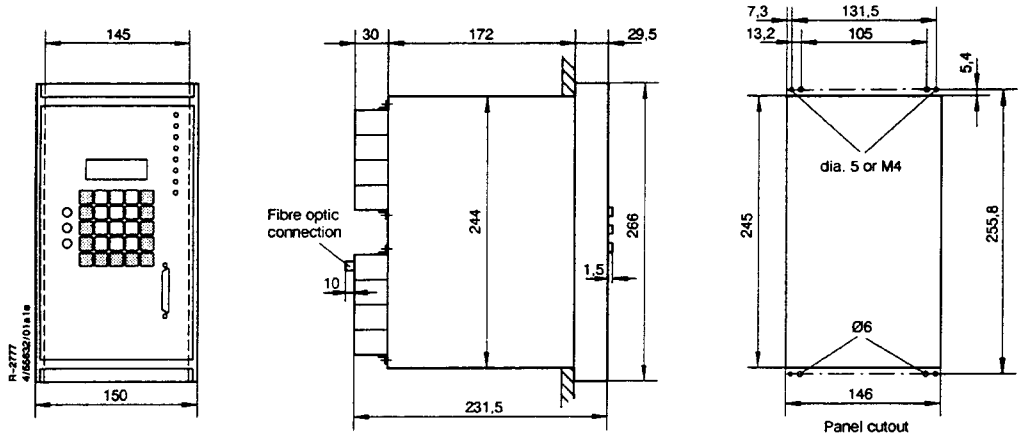

Fig. 7
7SD511 with housing 7XP2030-2 (for panel flush mounting/cubicle mounting)

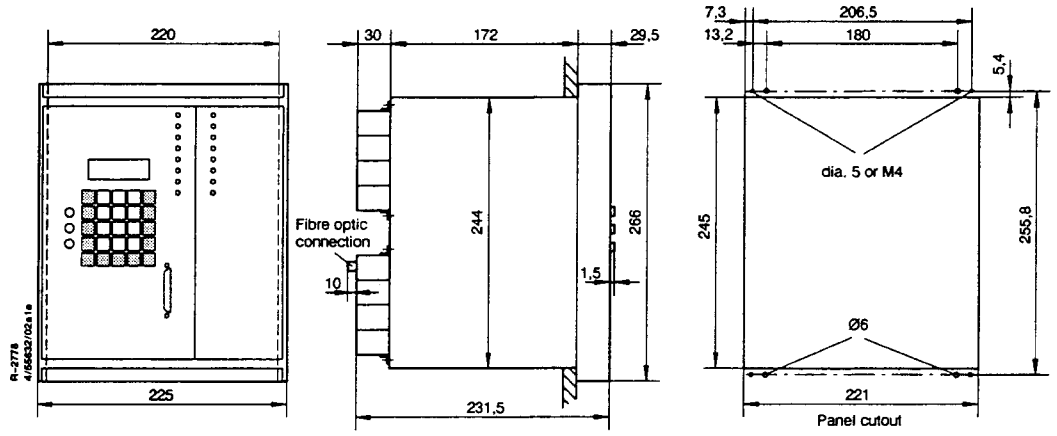

Fig. 8
7SD512 with housing 7XP2040-2 (for panel flush mounting/cubicle mounting)

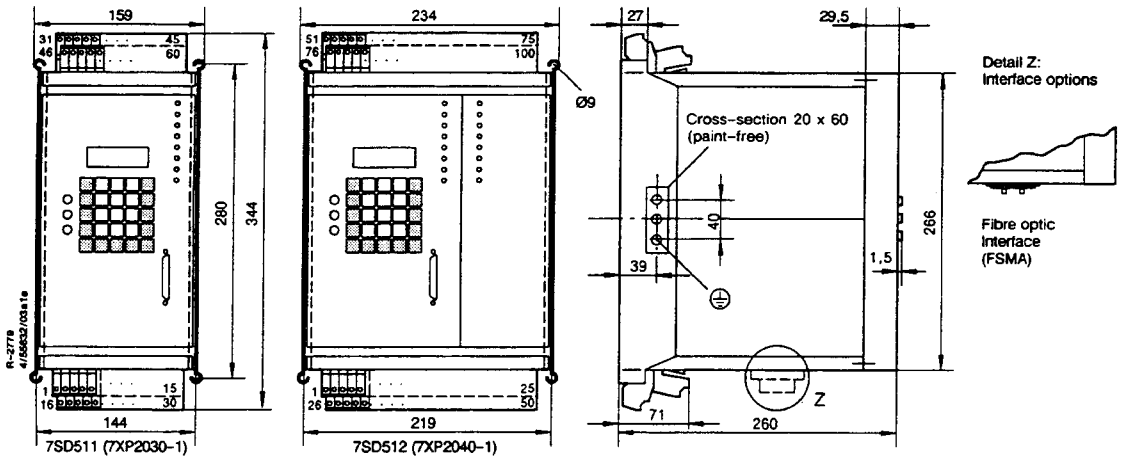

Fig. 9
7SD511/512 for panel surface mounting

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