SIEMENS

Digital overcurrent-time protection relay 7SJ511

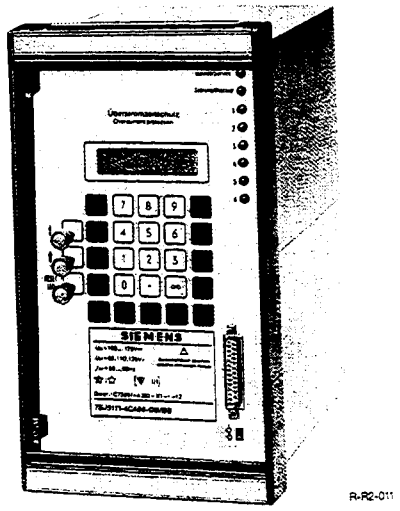

Fig. 1
Digital overcurrent-time protection relay 7SJ511

Application

The 7SJ511 is used as a definite-time or inverse definite minimum time/(IDMT) overcurrent protection in medium-voltage distribution systems with single-end infeed. It is also used as back-up for differential protection schemes applied to lines, transformers and generators.

Construction

Within its compact construction, the device contains all the components required for:

- Capture and evaluation of measureands
- Operator panel with display field
- Event/alarm and command outputs
- Binary input options
- Serial interfaces
- Power supply converter.

The device can be supplied in two case variations. The variant for flush mounting or mounting in a cubicle has rear connection terminals. The model for surface mounting is supplied with two-tier terminals accessible from the front.

Implemented functions/features

The following functions are available:

- Definite-time/IDMT overcurrent protection
- Reverse interlocking (busbar protection scheme)
- Circuit-breaker failure protection
- Trip circuit test function
- Earth-fault protection
- Display of on-load measured current values
- Disturbance recording.

Mode of operation

With the application of a powerful microprocessor and filtering and processing of digital values, the influence of high frequency transients, DC current components and differing CT saturation can be suppressed to a large degree.

Serial interfaces

The relay includes two serial interfaces.

The operator interface is provided on the front panel of the relay for connection of an AT compatible PC (utilising an operator program). This allows convenient parameter setting, transfer and evaluation of fault operation details for the last three faults and the current wave forms stored during the last fault and relay commissioning.

The system interface is optionally available as an isolated V.24 interface or as a fibre optic interface for connection to either the substation control system LSA 678 or to a central protection unit.

Settings

All setting parameters can be input via the integrated operator panel and display field, or via a PC under user control. The settings are stored in a non-volatile memory, so they are secure even during interruption of the supply voltage.

Self monitoring

All important hardware and software components are monitored continuousiy. Any irregularities in the hardware or program sequence are immediately detected and alarmed. As a result, the security, reliability and availability of the protection relay are significantly improved.

Overcurrent-time protection

This function is based on a phase-selective measurement of the three-phase currents and the earth current. According to the specific requirement, either the definite-time or the IDMT overcurrent protection mode can be selected. Both the definite-time and the IDMT overcurrent protection modes have two levels of operation, i. e. apart from the overcurrent level ($I>$), a high-set element ($I\gg$) is also provided. In both the definite-time and the IDMT overcurrent protection modes, the high-set element has a definite-time overcurrent characteristic.

Apart from the selection of the tripping time characteristics, the overcurrent values for phase currents and earth currents have to be set. For the definite-time overcurrent characteristic, the tripping time referring to the current threshold value is input directly. In the case of the IDMT overcurrent function, the tripping time t is optionally calculated according to the following three tripping time characteristics (according to BS 142 or IEC 255-4):

normal inverse NI (Fig. 2)

$$t = \frac{0.14}{(I/I_p)^{0.02} - 1} \cdot t_p$$

very inverse VI (Fig. 3)

$$t = \frac{13.5}{I/I_p - 1} \cdot t_p$$

extremely inverse EI (Fig. 4)

$$t = \frac{80}{(I/I_p)^2 - 1} \cdot t_p$$

t tripping time
t_p time multiplier
I fault current
I_p current setting

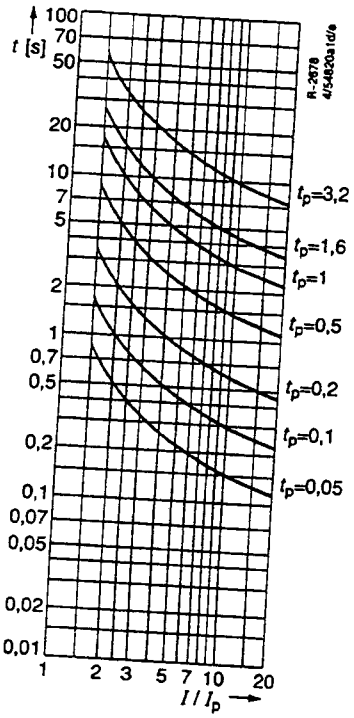

Fig. 2
Tripping time characteristics, normal inverse

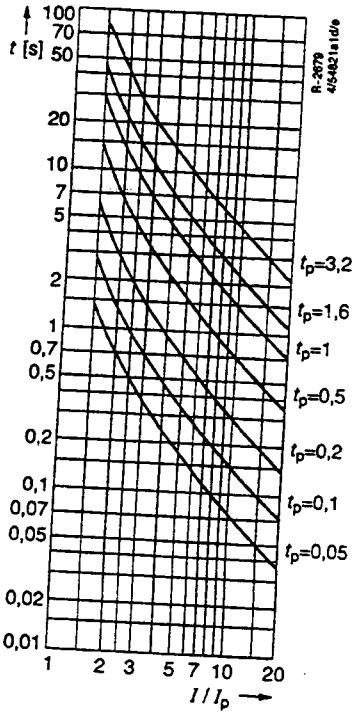

Fig. 3
Tripping time characteristics, very inverse

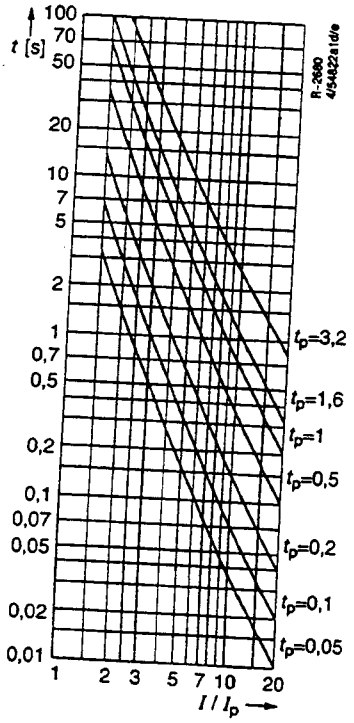

Fig. 4
Tripping time characteristics, extremely inverse

Fast busbar protection using reverse interlocking scheme

Blocking of the $I \gg$ stage is possible via a binary input. A setting parameter determines whether the input circuit operates in the "normally open" (i. e. energise to block) or the "normally closed" (i. e. energise to release) mode. Thus, the digital overcurrent protection 7SJ511 can be used as a fast busbar protection in star connected networks or in open ring networks, (ring open at one location), using the reverse interlock principle. This can be used in medium-voltage systems, in power station auxiliary supply networks, etc., in which cases a transformer feeds from a higher-voltage system onto a busbar with several outgoing feeders. "Reverse interlocking" means that the overcurrent time protection can trip within a short time which is independent of the grading time, if it is not blocked by the pick-up of the next downstream overcurrent time relay. Therefore, the protection which is closest to the fault will always trip within the short time, as it can not be blocked by a relay behind the fault location.

The trip time includes the waiting time which is necessary to determine whether blocking should occur or not. In case of an outgoing feeder circuit-breaker failure, the back-up time which is graded over the feeders becomes effective.

Circuit-breaker failure protection

After the issue of a trip command by the relay or upon the excitation of a digital input by an external protection, the breaker failure current check function is initiated.

If current is still detected after the set time (e. g. in the case of a breaker failure), an alarm relay or a command relay (for breaker failure tripping) is energised.

Circuit-breaker trip circuit test function

The integrity of the circuit-breaker trip circuit can be tested via an operator initiated trip command. This test can be initiated via the front panel keyboard or operator serial interface, but only after input of a code word.

Earth-fault protection

For protection against high-resistance earth-faults in earthed networks, it is possible to monitor the earth current via an independent fourth input current transformer. As for the phase current protection, a choice may be made between the definite time and the IDMT overcurrent characteristics, both having definite time high-set overcurrent characteristic.

Fault reports

The 7SJ511 provides detailed data for the analysis of protection operations, as well as 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
  Summarised 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. 3-phase currents and earth current) via the front panel LCD display.

Disturbance recording

The digital measured values for the 3-phase and earth currents are stored for a period of 100 ms before fault inception until 1.4 seconds after fault inception. This data can be transferred either to the co-ordinated 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.

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.

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Technical data

Input circuits	Rated current I_N	1 A or 5 A
	Rated frequency f_N	50 Hz or 60 Hz
	Thermal overload capability in current path	
	continuous	$4 \times I_N$
	10 s	$10 \times I_N$
	1 s	$100 \times I_N$
	Dynamic overload capability (half cycle)	$250 \times I_N$
	Burden	
	of current inputs at $I_N = 1$ A	approx. 0.1 VA
	at $I_N = 5$ A	approx. 0.2 VA
Voltage supply via integrated DC/DC converter	Rated auxiliary voltage U_H/permissible tolerance	24, 48 V DC or / 19 to 56 V DC 60, 110, 125 V DC or / 48 to 144 V DC 220, 250 V DC or /176 to 288 V DC
	Max. ripple at rated voltage	≤ 12 %
	Power consumption, quiescent	approx. 5 W
	energised	approx. 10 W
	Max. bridging time during loss of voltage supply	≥ 50 ms at $U_H \geq 110$ V DC
Binary inputs	Number	2 (marshallable)
	Voltage range	24 to 250 V DC
	Current consumption independent of operating voltage	approx. 2.5 mA
Alarm/event contacts	Number of relays, each having 1 c/o contact	5 (marshallable)
	Switching capacity make/break	20 W/VA
	Switching voltage	250 V AC/DC
	Permissible current, continuous	1 A
Command contacts	Number of relays, each having 2 NO contacts	2 (marshallable)
	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 indication green	1
	Blocked indication red	1
	Marshallable LED's red	6
Serial interfaces	Operator interface	not isolated
	Connection	on front panel, 25-pole subminiature plug ISO 2110 for the connection of a PC
	Potential free system interface	isolated
	Standard	similar to V.24/V.28 according to EIA, DIN 19 244
	Baud rate	9600 Bd max. 19200 Bd, min. 4800 Bd
	Hamming distance	d = 4
	Electrical protocol	according to CCIT or RS 232
	distance	max. 1 km
	Fibre optic protocol	Integrated FSMA connectors for fibre optic connection
	Optical wavelength	820 nm
	Permissible attenuation	max. 8 dB with glassfibre 62.5/125 µm
	Distance	max. 2 km

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Technical data

Construction of unit	Case, dimensions Weight Degree of protection according to DIN 40 050	 flush mounting/cubicle mounting surface mounting	7XP20, see dimension drawings approx. 9.5 kg approx. 11 kg IP51
Standards	DIN VDE 0435, Part 303 and IEC255-5 or IEC255-6		
Insulation tests	High voltage test Impulse voltage test		2 kV (rms), 50 Hz; 1 min or alternatively 2.8 kV DC; 1 min 5 kV (peak); 1.2/50 µs; 0.5 J; 3 positive and 3 negative shots at intervals of 5 s
Disturbance tests	High frequency test (1 MHz test) IEC255-22-1, Class III Electrostatic discharge (ESD test) IEC255-22-2, Class III Electromagnetic fields (Radiated electr. magn. field test) IEC255-22-3 (Report), Class III Fast transient test IEC41B (CO)53 (draft), Class III		2.5 kV (peak); 1 MHz; τ = 15 µs; 400 shots per second; duration 2 s 8 kV (peak); 5/30 ns; 10 positive discharges Frequency 27 MHz to 500 MHz; 10 V/m 2 kV (peak); 5/50 ns; 5 kHz, 4 mJ per impulse; 1 min per polarity
Radio interference	DIN VDE 0871, limit class B		
Climatic conditions	Permissible ambient temperature Humidity rating	in service during storage during transport	– 5°C to +55°C –25°C to +55°C –25°C to +70°C Code letter F to DIN 40 040, condensation not permissible
Mechanical stress tests according to DIN 40 046	Permissible mechanical stress	in service during transport	10 Hz to 60 Hz: 0.035 mm amplitude 60 Hz to 500 Hz: 0.5 g acceleration 5 Hz to 8 Hz: 7.5 mm amplitude 8 Hz to 500 Hz: 2 g acceleration
Setting ranges **Definite-time overcurrent protection**	Overcurrent High set current Delay times Tolerances Current pick-up value Time Reset time	phase $I>$ earth $I_E>$ phase $I\gg$ earth $I_E\gg$	I/I_N = 0.1 to 25 I/I_N = 0.1 to 25 I/I_N = 0.1 to 25 I/I_N = 0.1 to 25 0 to 60 s or infinity ± 5 % of set value ± 1 % or ± 10 ms approx. 30 ms
IDMT overcurrent protection	Overcurrent High set current Time multiplier t_p Pick-up value Characteristics according to IEC255-4, paragraph 3.5.2 or BS142 Linear current range Tolerances Pick-up value Time	phase $I>$ earth $I_E>$ phase $I\gg$ (DMT) earth $I_E\gg$ (DMT)	I_p/I_N = 0.1 to 4 I_p/I_N = 0.1 to 4 I/I_N = 0.1 to 25 I/I_N = 0.1 to 25 0.05 bis 3.2 s 1.1 × I_p normal inverse, very inverse, extremely inverse 25 × I_N ± 5 % ≤ 5 % for 2 ≤ ($I/I_p>$) ≤ 20 and t_p = 1
Disturbance recording	Measured values Starts recording on Recording duration		i_{L1}, i_{L2}, i_{L3}, i_E Trip, fault detection, binary input –100 ms to 1400 ms
Additional functions	On-line display of Currents Current range Tolerance Frequency range		 I_{L1}, I_{L2}, I_{L3}, I_E 0 to 240 % × I_N ≤ 2 % of corresponding rated value f

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Selection and ordering data

Digital overcurrent-time protection relay 7SJ511	Order No. 7SJ511 □ - □□ A 0□ - 0□
Rated current at 50/60 Hz AC 1 A 5 A	1 5
Rated auxiliary voltage U_H for the built-in converter 24, 48 V DC 60, 110, 125 V DC 220, 250 V DC	2 4 5
Construction for panel surface mounting for panel flush mounting/cubicle mounting	B C
Real-time clock without with	0 1
Serial interface without isolated, hard-wired integrated fibre optic connection	A B C

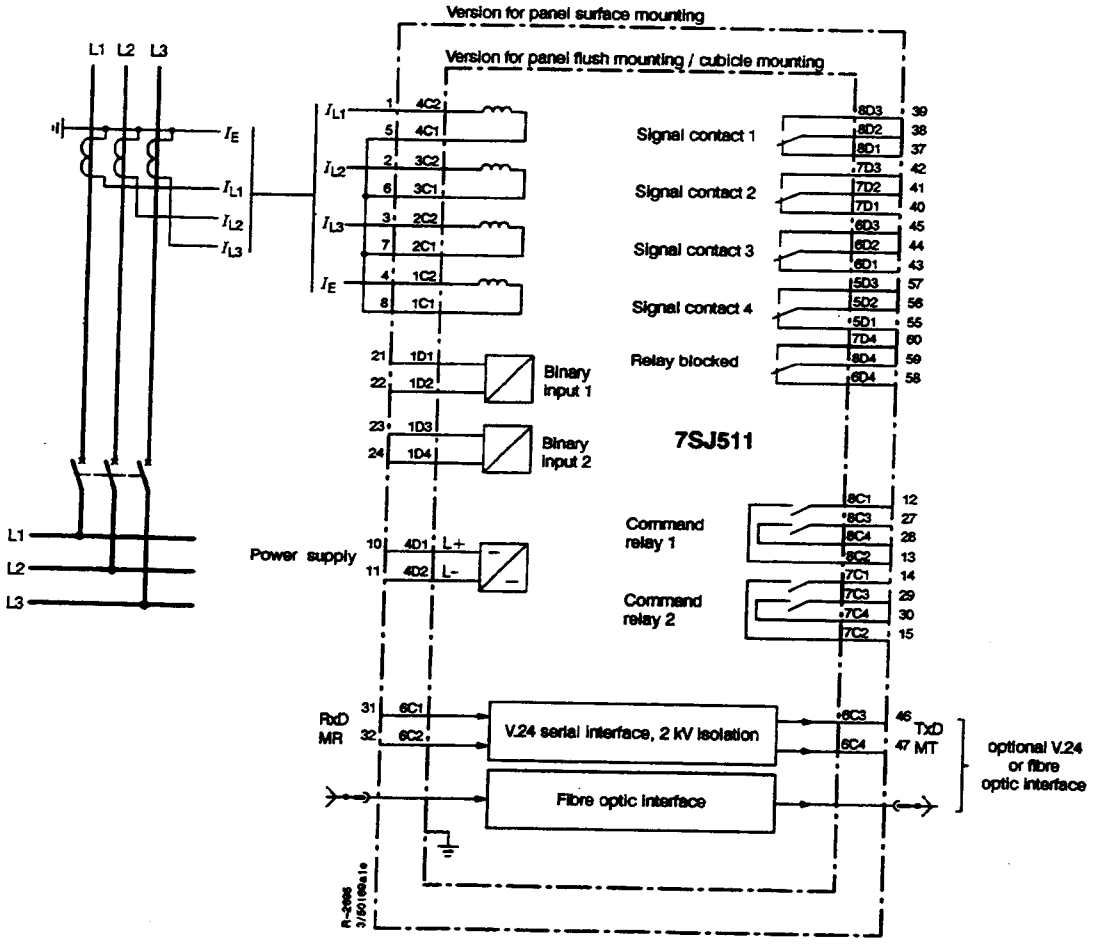

Fig. 5
Connection diagram, digital overcurrent-time protection relay 7SJ511

Dimension drawings in mm

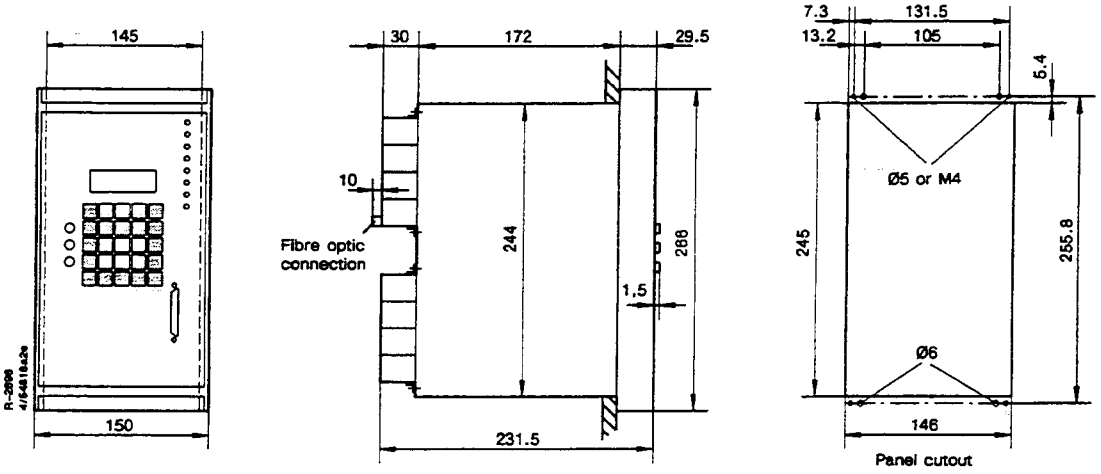

Fig. 6
7SJ511 with housing 7XP2030-2 (for panel flush mounting/cubicle mounting)

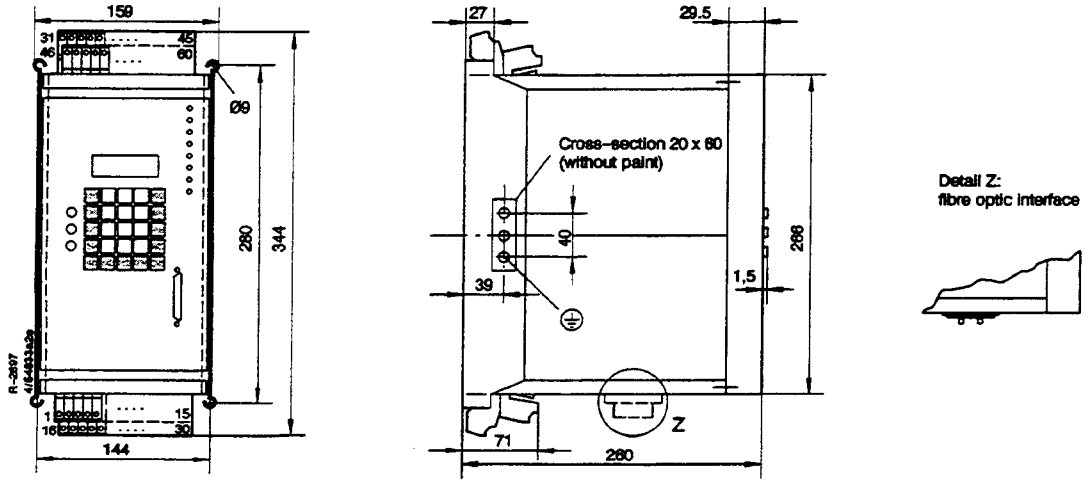

Fig. 7
7SJ511 with housing 7XP2030-1 (for panel surface mounting with two-tier terminals)

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