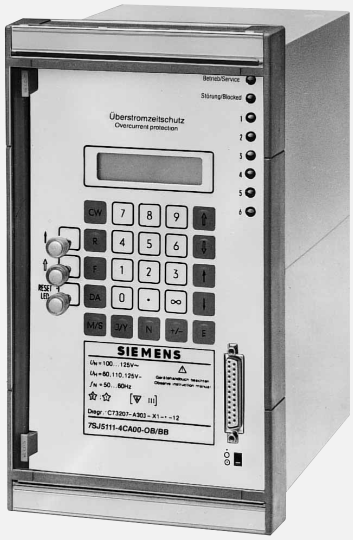
7SJ511 Numerical overcurrent–time protection relay (Version V3)



Scope of functions

49

50

50N

51

51N

50BF

Fig. 1
7SJ511 numerical overcurrent–time protection relay

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 design, the unit contains:

- All components for analog value acquisition and numeric evaluation
- Operating panel
- Indication and command outputs
- Binary inputs
- Serial interfaces for parameterization and connection to substation control and protection
- Auxiliary voltage converter.

The device can be provided in two housings. The model for panel surface mounting is equipped with terminals accessible from the front. The options for flush mounting have rear connection terminals and are available with or without glass cover.

Implemented functions/features

The following functions are available:

- Definite–time/inverse time overcurrent protection
- Definite–time/inverse time earth–fault protection
- Overload protection (with memory)
- Reverse interlocking (busbar protection scheme)
- Circuit–breaker failure protection
- Trip circuit test function
- Display of on–load measured current values
- Fault recording.

Mode of operation

With the use of a powerful micro–controller and digital analog value preparation and processing, the effect of high frequency transients and transient DC components is largely eliminated.

If definite–time characteristics are used the measuring method involves evaluation of the fundamental. If dependent time characteristics are chosen there is a choice between r.m.s value or fundamental calculation.

Serial interfaces

The device is equipped with two serial interfaces.

A PC can be connected to the front port to ease setup of the relay using DIGSI. This program, which runs under MS–WINDOWS, can also be used to evaluate up to 8 oscillographic fault records, 8 fault logs and 1 event log containing up 30 events.

The 7SJ511 can be hooked up to a substation automation system. The system interface for linking to the SINAUT LSA substation control and protection system or a protection master unit uses the protocol IEC 870–5–103 (standard of the Association of German Power Utilities, VDEW/ZVEI recommendation). The connection can be either via an 820 nm fibre optics interface or an electrical RS232C interface.

Self monitoring

Hardware and software are constantly monitored and irregularities immediately detected and signalled. In this way a very high degree of safety, reliability and availability is achieved.

7SJ511 Numerical overcurrent–time protection relay (Version V3)

Convenient setting

The menu driven HMI or connected OC is used for setting parameters. The parameters are stored in a non–volatile memory so that the setting is retained even if the supply voltage is cut off.

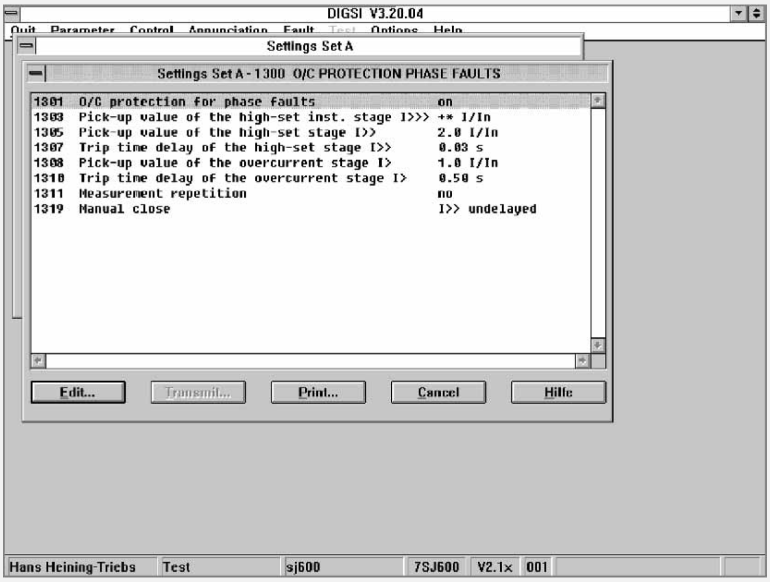


Fig. 2
Settings window using DIGSI

Oscillographic fault recording of up to 8 records (5 seconds maximum)

The "Fault recording" function is used to record the phase currents in the event of a power system fault. Either pickup, tripping or binary input can be selected to trigger waveform capture. The maximum length of a record can be programmed. The recorded traces of the phase and ground currents and pickup and drop–off of internal events can be transmitted to a PC for convenient analysis using DIGRA.

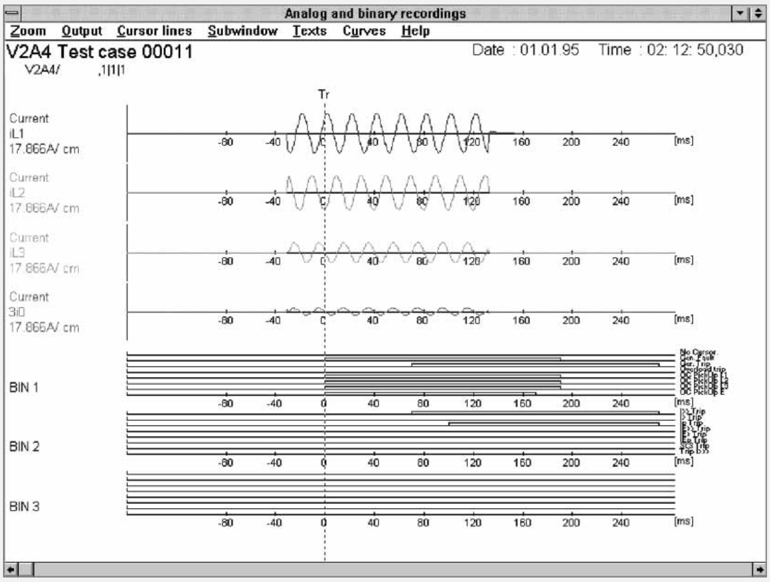


Fig. 3
Analog and binary traces

7SJ511 Numerical overcurrent–time protection relay (Version V3)

Overcurrent–time protection

IEC curves

The function is based on phase–selective measurement of the three phase currents and the earth current. Either definite–time or inverse–time maximum current time protection can be used. In addition to the overcurrent stage there is a high current state both for the phases ($I>$, $I>>$) and for the earth ($I_E>$, $I_E>>$).

The high current stage always has definite–time characteristics:

If the 11th place of the order number is 0 (country–specific presettings: German/ English), the following tripping characteristics can be selected (to BS 142, or IEC 255–4):

- normal inverse (Fig. 4)

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

- very inverse (Fig. 5)

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

- extremly inverse (Fig. 6)

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

t	tripping time
t_p	time multiplier 0 – 10 s
I	fault current
I_p	current setting 0.1 – 4 I_N

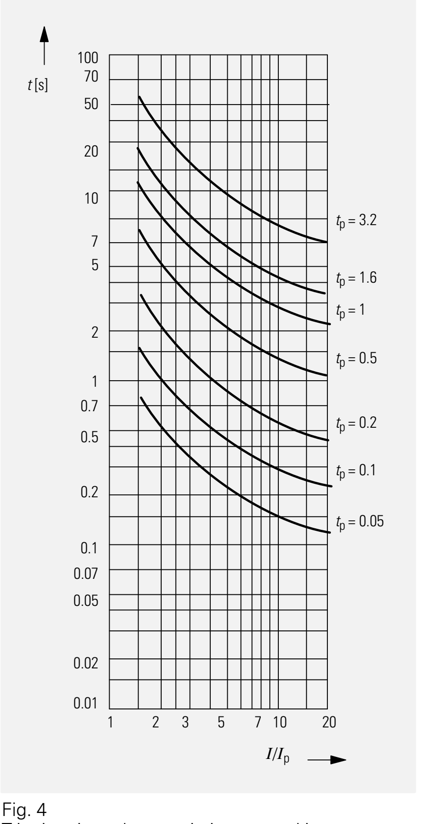


Fig. 4
Tripping time characteristics, normal inverse (IEC 255–4)

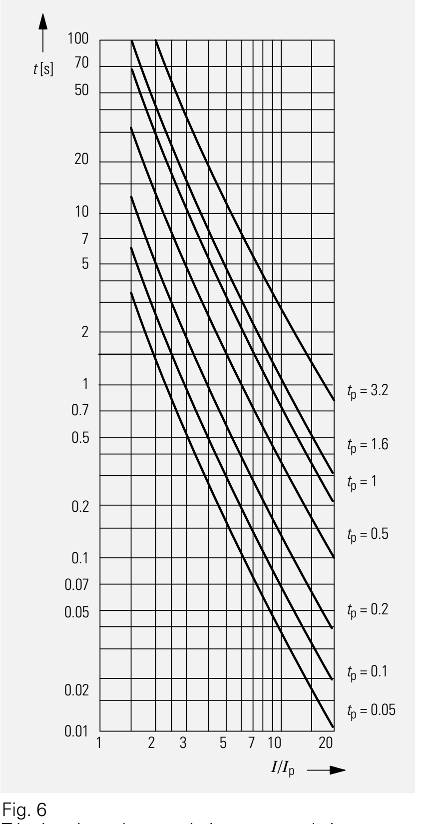


Fig. 6
Tripping time characteristics, extremely inverse (IEC 255–4)

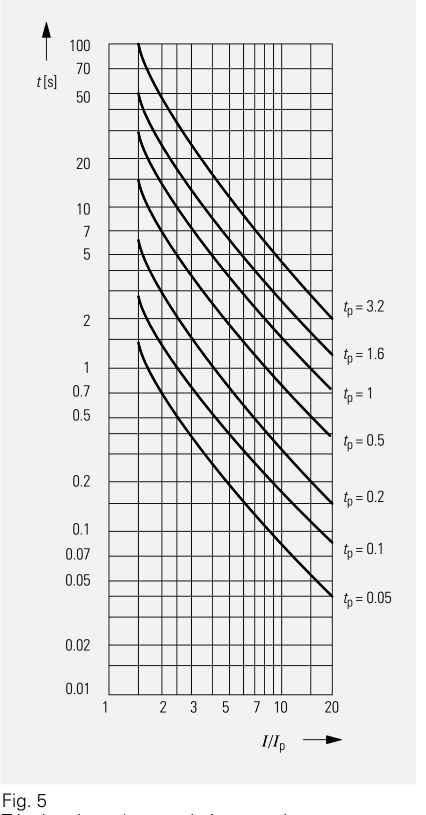


Fig. 5
Tripping time characteristics, very inverse (IEC 255–4)

7SJ511 Numerical overcurrent–time protection relay (Version V3)

US Curves

The following inverse–time characteristics have been adapted to the requirements of the US market.
The US–version has a "1" in the 11th place of the order number.

$$t = \left(\frac{A}{(I/I_p)^N - 1} + B \right) \cdot D$$

t tripping time
I_p current setting
A, B, N parameters

- I–Squared–T Curve (Fig. 7)

$$t = \frac{50.7\ D + 10.14}{(I/I_p)^2}$$

t tripping time
I_p current setting
D time dial setting

Curve type	A	B	N
Inverse	8.9341	0.17966	2.0938
Short inverse	0.2663	0.03393	1.2969
Long inverse	5.6143	2.18592	1.0000
Moderately inverse	0.054196	0.09328	0.0200

Very inverse	19.138	0.48258	2.0000
Extremely inverse	28.2785	0.12173	2.0000
Definite inverse	0.4797	0.21359	1.5625

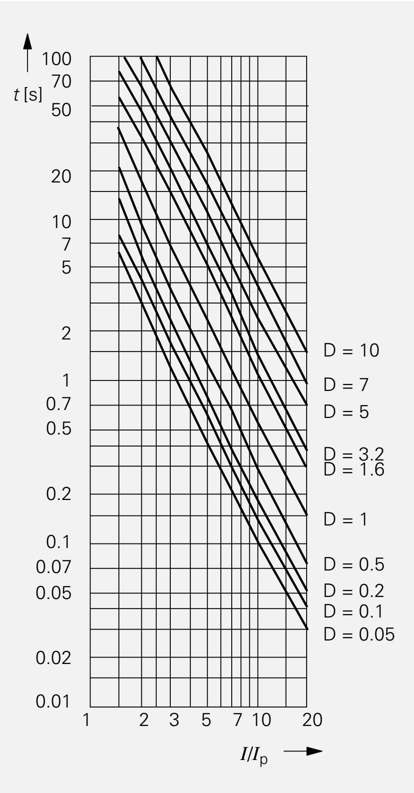


Fig. 7
Tripping time characteristic, I–squared–T curve

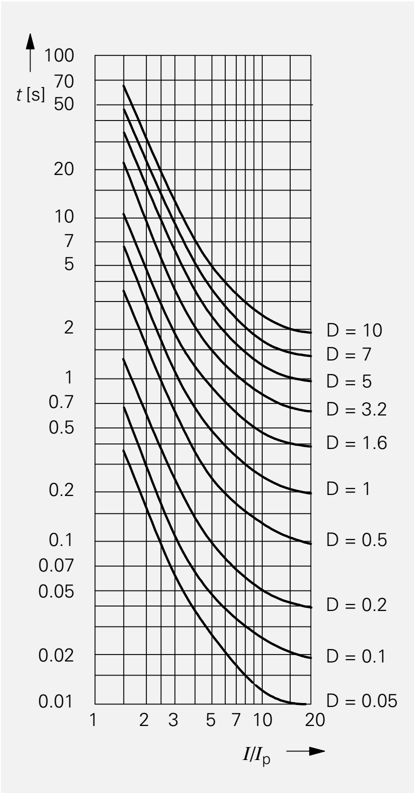


Fig. 8
Tripping time characteristic, inverse

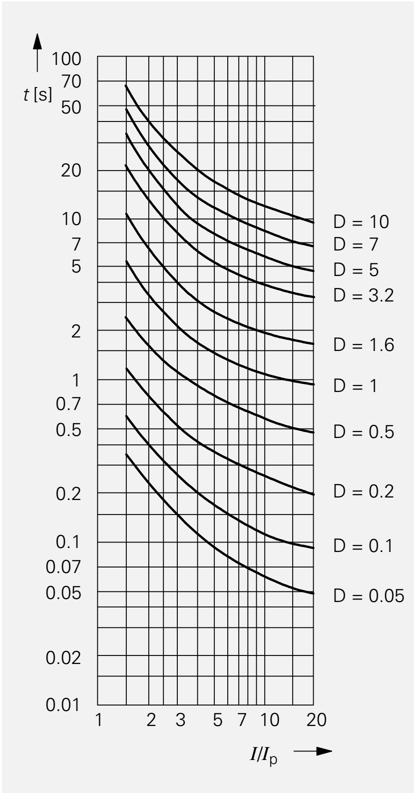


Fig. 9
Tripping time characteristic, moderately inverse

7SJ511 Numerical overcurrent–time protection relay (Version V3)

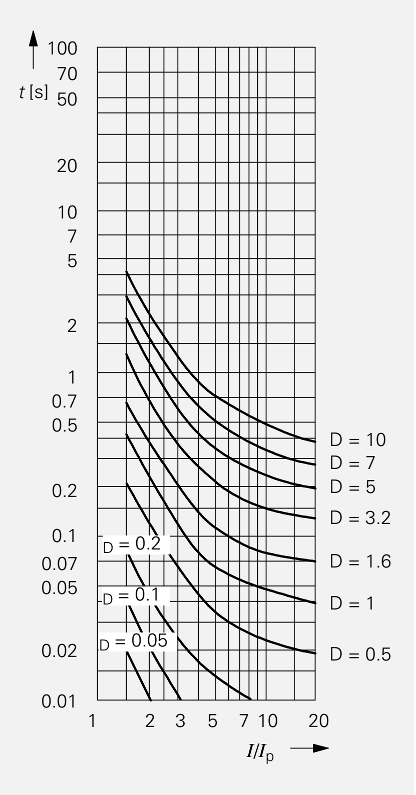


Fig. 10
Tripping time characteristic, short inverse

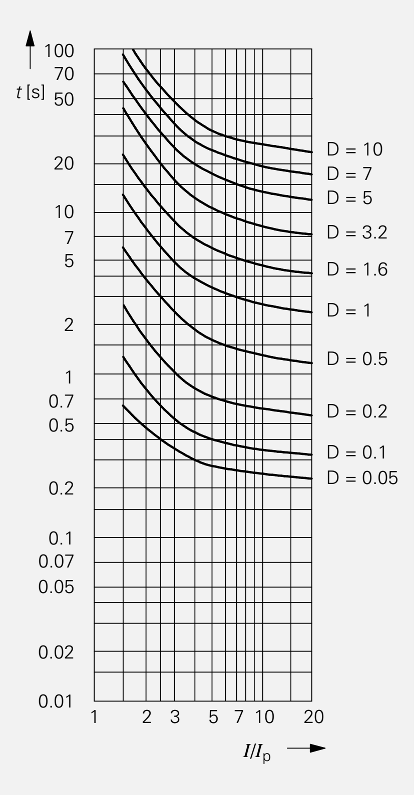


Fig. 12
Tripping time characteristic, long inverse

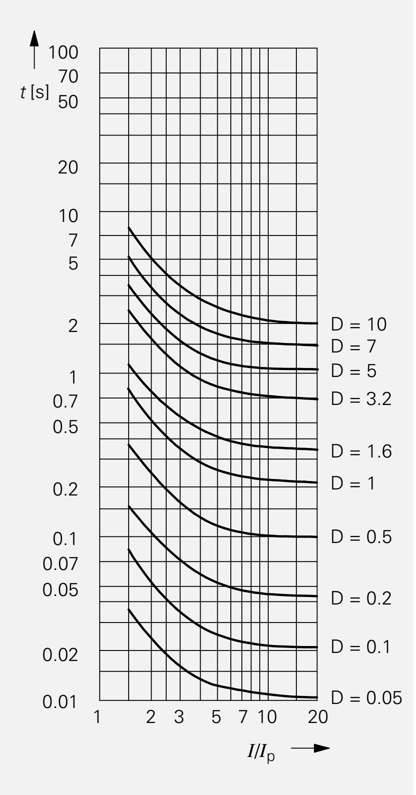


Fig. 14
Tripping time characteristic, definite inverse

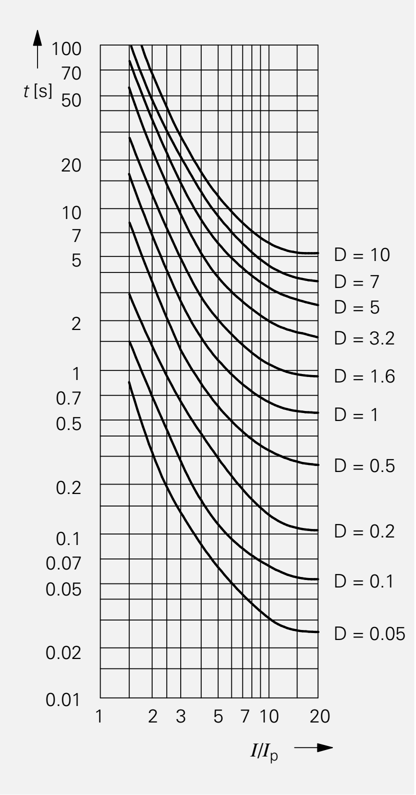


Fig. 11
Tripping time characteristic, very inverse

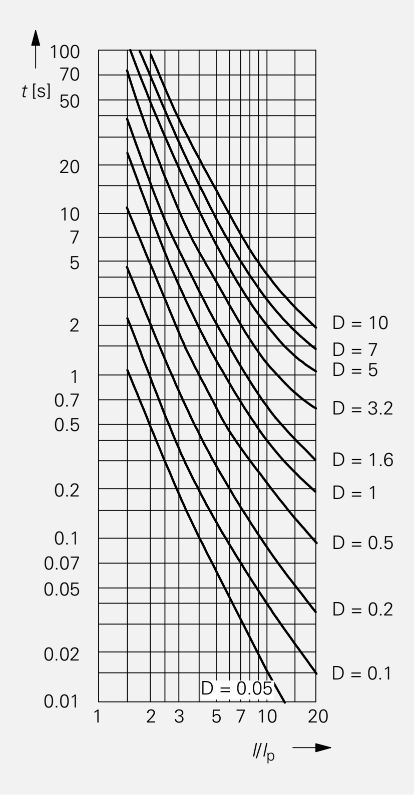


Fig. 13
Tripping time characteristic, extremely inverse

7SJ511 Numerical overcurrent–time protection relay (Version V3)

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.

Intermittend earth–fault protection with firmware V3.1

Intermittend (re–striking) faults occur due to insulation weaknesses in cables or as a result of water penetrating cable joints. Such faults either simply cease at some stage or develop into lasting short–circuits. During intermittent activity, however, starpoint resistors in networks that are impedance–earthed may undergo thermal overloading. The normal earth–fault protection cannot reliably detect and interrupt the current pulses, some of which can be very brief.

The selectivity required with intermittent earth faults is achieved by summating the durations of the individual pulses and by triggering when a (settable) summed time is reached. The response threshold I_{IE}> evaluates the rms value, referred to one systems period.

Reverse interlocking

Blocking of any stage (e.g. I>>) is possible via a binary input. Thus, the numerical overcurrent protection 7SJ511 can be used as a fast busbar protection in wye 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 supplement networks, etc., in which cases a transformer feeds from a higher–voltage system onto a busbar with several outgoing feeders.

Thermal overload protection

For the protection of cables or machines, an overload protection with a pre–warning stage for temperature and current is implemented. The temperature of the equipment to be protected is determined using a thermal homogeneous body model that contains energy input to the equipment and energy output to the environment. In this way currents that change over time and pre–loading can be taken into account (overload protection with memory).

Using a parameter, it is possible to select whether the maximum of the phase–related conductor temperature or the mean value of these is to be taken as the determining value. It is also possible to calculate the temperature from the maximum value of the conductor current.

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 energized.

Inrush stabilization

When switching on a transformer the 7SJ511 can distinguish between inrush and real short–circuits. Inrush is particularly noticeable by its relatively high second harmonic content. In the case of a short–circuit, the second harmonic content is almost non–existent. The harmonic stabilization operates independently for each of the three phases. When using inrush stabilization on one phase, it is also possible to block the remaining phases (cross block). When using inrush detection the pick–up of the high–set element stays active, and the normal overcurrent element is blocked.

Fault recording

The digitized analog values of phase currents and earth current are stored in the event of a fault. The analog values recorded can be transferred to a PC where they can be displayed, analyzed and archived using DIGSI. As an option they can be read out by the SINAUT LSA substation control and protection system.

The serial interface conforms to VDEW/ZVEI. Up to eight fault recordings can be stored. The fault recording buffer is a circulating buffer with a maximum length so that when it is full every new network fault overwrites the oldest recorded fault. A total of 5 seconds are available for the recording duration.

Indications

The 7SJ511 supplies detailed data for analyzing faults and checking states during operation. All the following indications are protected against supply voltage failure, in case there is a battery–backed clock.

- Time
  Time can be synchronized via a binary input or the serial interface. The date and time are assigned to all indications.
- Fault indications
  The indications of the faults in the device are available with a resolution of 1 ms.
- Operational indications
  All indications that do not immediately refer to a fault (e.g. operating or switching actions) are stored in the operational indication buffer (resolution 1 ms).

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.

Marshalling of command and alarm/ event relays, LEDs and binary inputs

All input/output relays and indicating LEDs may be functionally allocated according to the user's requirements. Several indications can be assigned to one output relay, LED or binary input simultaneously. In this case they are ORed.

Measuring, monitoring and testing functions

The following functions are available for commissioning, operational measurement and monitoring:

- Measuring of currents: I_{L1}, I_{L2}, I_{L3}, I_E
- Monitoring of current sum and current symmetry.
- Tripping test with circuit–breaker.

7SJ511 Numerical overcurrent–time protection relay (Version V3)

Technical data

Input circuits	Rated current I_N		1 or 5 A
	Rated frequency f_N		50 or 60 Hz
	Thermal overload capability in current path		
	continuous		4 x I_N
	1 s		100 x I_N
	Dynamic overload capability (half cycle)		250 x 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 V_{aux}/permissible ranges		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
		energized	approx. 10 W
	Max. bridging time during loss of voltage supply		≥ 50 ms at V_{aux} ≥ 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	1 000 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 LEDs	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 for data transmission to control center		isolated
	Standard		similar to V.24/V.28 (RS232C) according to EIA, DIN 19 244
	Baud rate		9 600 Bd setting as supplied; min. 4 800 Bd, max. 19 200 Bd
	Transmission reliability		hamming distance d = 4
	Connection, direct	on flush–mounted housing	at rear, 4–pole module connector
		on surface–mounted housing	at two–tier terminal at the top and bottom of the housing
			cable with 2 core pairs, with individual and common screening: e.g. LIYCY–CY/2 x 2 x o.25 mm^2
		distance	max. 1 km
		test voltage	2 kV with rated frequency for 1 min
	Connection	fibre optic cable	integrated FSMA connectors for FO connection on flush–mounted housing: at rear on surface–mounted housing: at the bottom of housing
		optical wavelength	820 nm
		permissible attenuation	max. 8 dB with glassfibre 62.5/125 µm
		distance	max. 2 km
		no character	switchable; setting as supplied ”light off“
Construction of unit	Case, dimensions		7XP20, see dimension drawings
	Weight	flush mounting/cubicle mounting	approx. 9.5 kg
		surface mounting	approx. 11 kg
	Degree of protection according to EN 60 529		IP51

7SJ511 Numerical overcurrent–time protection relay (Version V3)

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 concerning electrical equipment for use within specified voltage limits (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 standard 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 III 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 0878 part 11	150 kHz to 30 MHz class B 30 to 1 000 MHz class A
Climatic stress tests	permissible ambient temperature during service during storage during transport permissible humidity	–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 500 Hz, 0,5 *g* acceleration 5 to 8 Hz, 7,5 mm amplitude 8 to 500 Hz, 2 *g* acceleration
Overload protection	Factor *k* Time constant τ Warning temperature Θ_{Warn} Current warning stage I_{Warn}	0.1 to 4 1 to 999.9 min 50 to 100% 0.1 to 4 x I/I_N
Breaker–failure protection	Triggering threshold I> Delay time t_{SVS}	0.1 to 4 x I/I_N 0.06 to 60 s and infinity
Fault recording	Measured values Start signal Recording duration Holding time	i_{L1}, i_{L2}, i_{L3}, i_E Trip, energization, binary, input, LSA, integrated operating panel Max. 5 s Until fault–recording buffer full. New fault entries overwrite the oldest recorded faults.
Operational analog values	Currents Measuring ranges	I_{L1}, I_{L2}, I_{L3}, I_E 0 to 240 % x I_N

7SJ511 Numerical overcurrent–time protection relay (Version V3)

Technical data (continued)

Definite–time overcurrent protection	Overcurrent	phase $I>$ earth $I_E>$	I/I_N = 0.1 to 25 I/I_N = 0.1 to 25
	High set current	phase I earth I_E	I/I_N = 0.1 to 25 I/I_N = 0.1 to 25
	Delay times		0 to 60 s or infinity
	Tolerances Current pick–up value Time Reset time		 ± 5 % of set value ± 1 % or ± 10 ms approx. 30 ms
Inverse–time overcurrent protection	Overcurrent	phase I_p earth I_{Ep}	I_p/I_N = 0.1 to 4 I_p/I_N = 0.1 to 4
	High set current	phase $I \gg$ (DMT) earth $I_E \gg$ (DMT)	I/I_N = 0.1 to 25 I/I_N = 0.1 to 25
	Time multiplier t_p		0,05 to 3,2 s
	Pick–up value		1.1 x I_p
	Characteristics according to IEC255–4, paragraph 3.5.2 or BS142 (if 11th place of order number = 0)		normal inverse, very inverse, extremely inverse
	US curves (if 11th place of order number = 1)		I_p: 0.1 to 4, D: 0 to 10s
	Linear current range		25 x I_N
	Tolerances Pick–up value Time Shortest operating time201		 ± 5 % ≤ 5 % for 2 ≤ $(I/I_p>)$ ≤ 20 and t_p = 1 <30 ms

Selection and ordering data

7SJ511 numercial overcurrent–time protection relay	Order No. **7SJ511 □ – □ □ A □ □ – □ □**
Rated current at 50/60 Hz AC 1 A 5 A	 **1** **5**
Auxiliary voltage for converter 24/48 V DC 60/110/125 V DC 220/250 V DC	 **2** **4** **5**
Design structure 7XP2030–1 housing for switchboard mounting 7XP2030–2 housing for switchboard/cubicle mounting with Weidmüller terminals 7XP2030–2 housing for switchboard/cubicle mounting with Weidmüller terminals without glass cover	 **B** **C** **E**
Language: country–specific presettings German/English; 50 Hz (Europe) English; 60 Hz (USA)	 **0** **1**
Real–time clock / non–volatile alarm memory / software generation Without / without / version V 2.1x With / with / version V2.1x Without / without / version V3 With / with / version V3	 **0** **1** **2** **3**
Scope of function without intermittend earth–fault protection with intermittend earth–fault protection	 **0** **2**
Serial system interface Without With isolated RS 232C (V.24) interface (wire–connected) With integrated fibre–optic connection	 **A** **B** **C**

Operating program DIGSI (other languages on request)

DIGSI Version V3 for Windows, full version for 10 PCs and update for 3 years,	German English	**7XS5020–0AA00** **7XS5020–1AA00**
DIGSI Version V3 for Windows, demo–/testversion,	German English	**7XS5021–0AA00** **7XS5021–1AA00**

Documentation

English:	Catalog LSA 2.1.3: 7SJ511 numerical overcurrent–time protection relay (Version V3) Manual**:** 7SJ511 (V3) numerical overcurrent–time protection relay	**E50001–K5712–A131–A2–7600** **C53000–G1176–C101–1**
German:	Katalogblatt LSA 2.1.3: Digitaler Überstromzeitschutz 7SJ511 (Version V3) Handbuch**:** Digitaler Überstromzeitschutz 7SJ511 (Version V3)	**E50001–K5712–A131–A2** **C53000–G1100–C101–2**

7SJ511 Numerical overcurrent–time protection relay (Version V3)

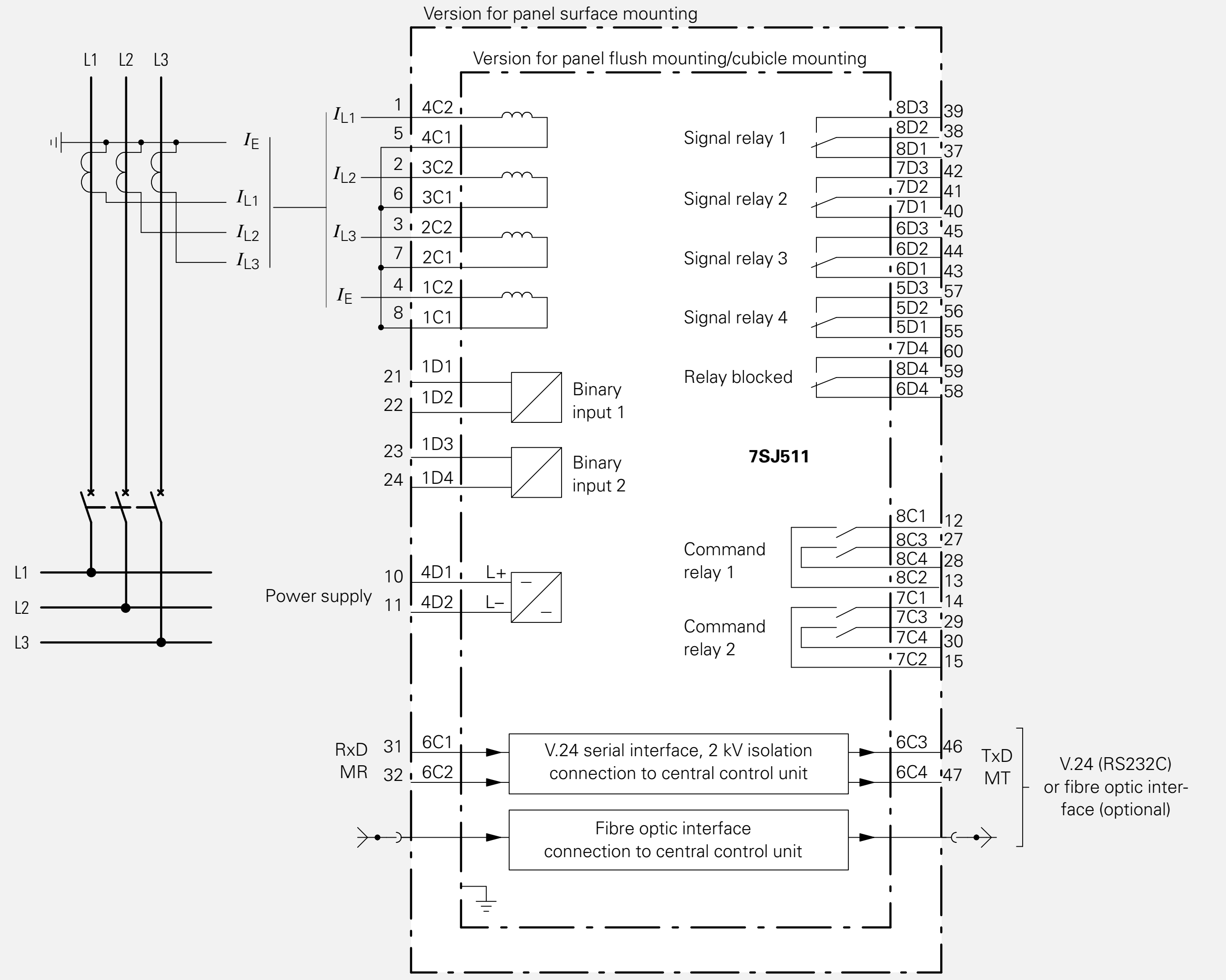


Fig. 15
Connection diagram, 7SJ511 numercial overcurrent–time protection relay

Dimension drawings in mm

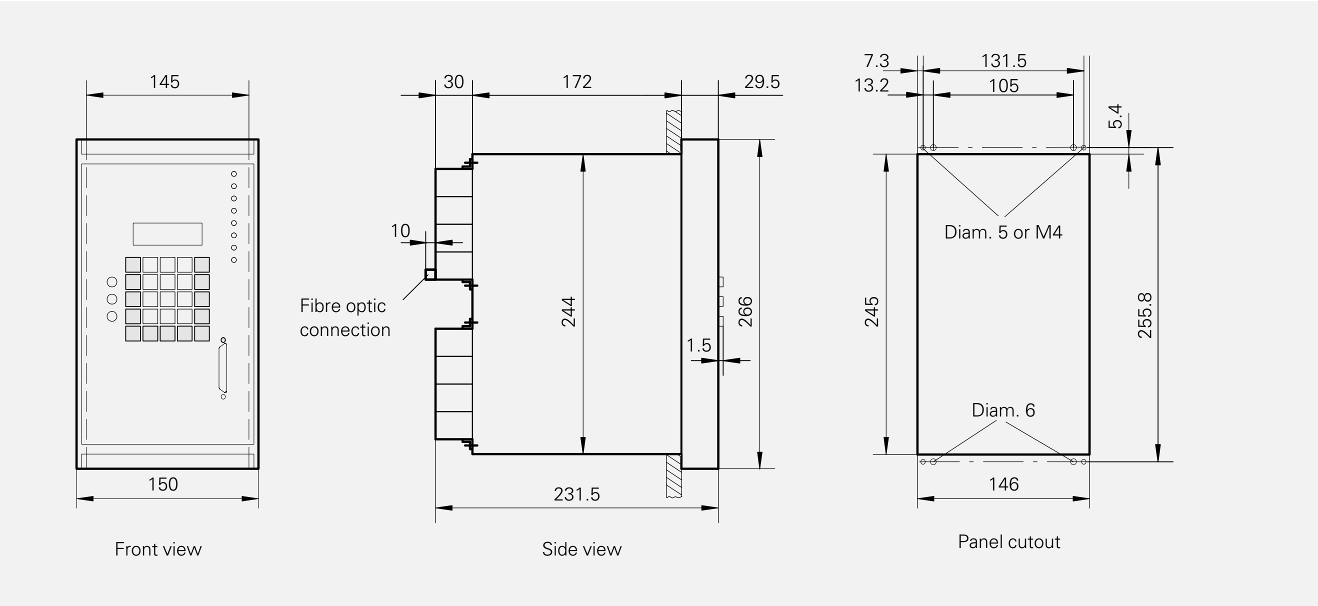


Fig. 16
7SJ511 with housing 7XP2030–2 (for panel flush mounting or cubicle mounting)

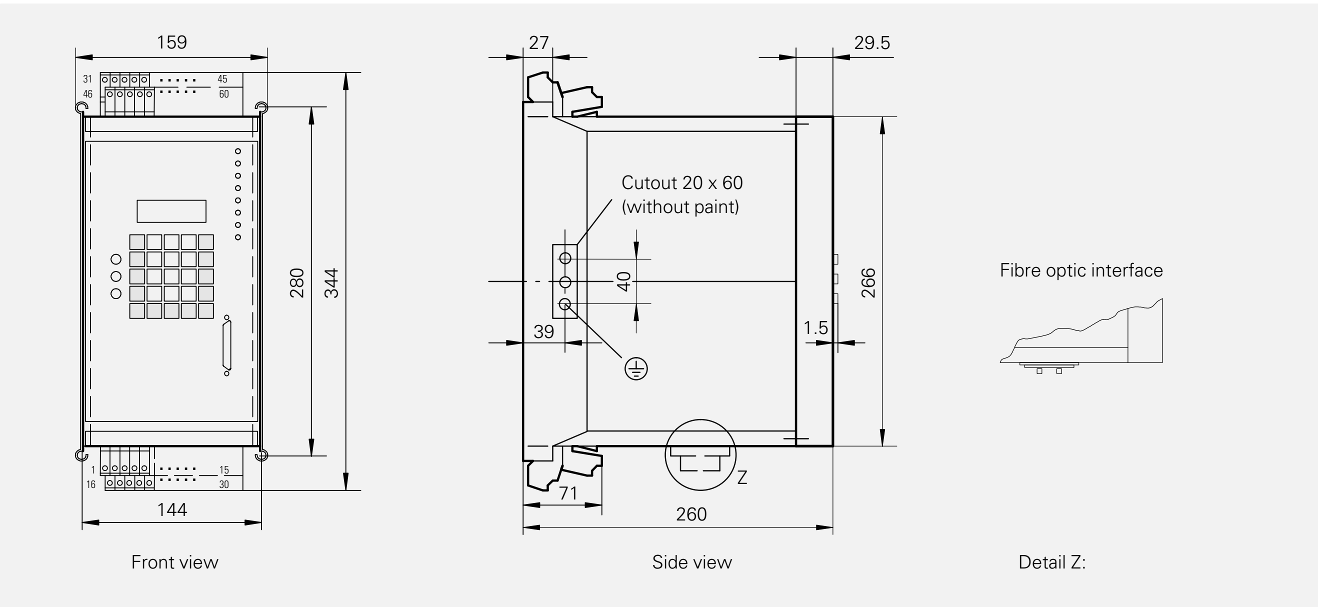


Fig. 17
7SJ511 with housing 7XP2030–1 (for panel surface mounting with two–tier terminals)

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

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General Conditions of Supply and Delivery
for Products and Services of the
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and to any other conditions agreed upon with the recipients of catalogs.

■

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The illustrations are for reference only.

We reserve the right to adjust the prices and shall charge the price applying on the date of delivery.

A 9.91 a

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Relevant are the criteria stated in the delivery note and the invoice.

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Dimensions

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http://www.ev.siemens.de

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