

7SA513 line protection relay (Version V3)



Fig. 1
7SA513 line protection relay

Application

The 7SA513 numerical line protection relay provides selective and fast clearance of faults on overhead lines and cables with single and multiple end in-feed in high voltage networks with any type of meshing. The neutral point can be earthed, compensated or isolated. The main function is a fast 6-system distance protection with a polygon fault detection and tripping characteristic. A fault detection program with a $V/I\phi$ characteristic is also available instead of the polygon fault detection characteristic. The unit also incorporates all functions usually required for line protection. It can also be used as backup overcurrent and distance protection for all types of differential protection equipment. The unit can be integrated both into conventional installations and into SINAUT LSA 678 substation control and protection.

Design

The compact 7SA513 line protection relay contains all the components required for analog value acquisition and evaluation, the operating and display panel, indication and command outputs, binary input options, serial interfaces and auxiliary voltage converters. The use of a powerful 32-bit signal processor combined with a 16-bit standard processor permits integration of numerous protection functions into a compact device.

Three housing versions can be supplied. The version for surface-mounting on a switchboard is fitted with double-tier terminals accessible from the front. The versions for flush-mounting in a switchboard or cubicle have connecting elements at the rear and are available with or without a glass cover.

Method of operation

All data processing within the 7SA513 line protection relay is digital, from the measurement and digitization of voltages and currents to the tripping decision logic. Computer-bound, digital measuring methods largely suppress the influence of inrush currents, transient DC components, higher frequency transients and harmonics. In the distance protection function measuring errors due to load currents and currents on the parallel line can be compensated.

Serial interfaces

The unit is equipped with 2 serial interfaces.

The operating interface on the front is suitable for connecting PCs. The DIGSI operating program running under WINDOWS, provides user-friendly settings, evaluation of fault recordings and faults, and commissioning.

The system interface is available as a fibre optics interface for connection to the SINAUT LSA 678 substation control and protection or a relay data concentrator.

The communication protocol used conforms to the recommendations of VDEW/ZVEI based on IEC 870-5-103.

The Siemens-specific protocol conforming to DIN 19 244 is still available for existing installations.

Setting

All parameters can be set by the operator using the integrated keypad and display panel or a PC. The parameters are stored in non-volatile memory so that they are retained even after the supply voltage has been switched off.

Self-monitoring

The hardware and software components are constantly monitored and any irregularities are immediately detected and signalled. This ensures a high degree of safety, reliability and availability.

Overcurrent and Distance Relays

7SA513 line protection relay (Version V3)

Distance protection

The main function of the 7SA513 line protection relay is a six-system distance protection. By parallel calculation and monitoring of all six impedance loops a high degree of sensitivity and selectivity is achieved for all types of fault. The shortest command time is less than one network cycle.

The fault detection characteristic used is the polygon impedance fault detection $Z<$ (see Fig. 2). The shape of the fault detection polygon permits optimum adaptation to the load conditions on the protected line. Starting of unfaulted loops is eliminated to prevent the adverse influence of currents and voltages in the fault free loops. Overcurrent fault detection can be activated in parallel to the polygon impedance fault detection.

As an option to the polygon impedance fault detection, voltage and angle-dependent overcurrent fault detection may also be used (see Fig. 3).

This $V/I/\varphi$ characteristic uses the phase voltages V_{ph-E} or the line voltages V_{ph-ph} depending on the phase angle φ and the phase current I_{ph} according to the selected mode of starting.

The polygon tripping characteristic permits separate setting of the reactance X and the resistance R (see Fig. 4). The reactance section R can be set separately for faults with and without earth involvement. Earth faults are detected by monitoring the earth current I_E , the negative phase sequence current I_2 and/or the displacement voltage V_E .

Five distance zones can be set forward, reverse or non-directionally, two of them as overreach zones for automatic reclosure and permissible tripping schemes. For each distance zone a time stage is available for the directional and non-directional characteristic (A total of 10 independent time stages).

Compensation for load current and parallel lines is included.

Digital filtering of the measured values makes the unit insensitive to disturbances in the measured quantities. In particular the influence of DC components, capacitive voltage transformers, series compensated lines and frequency changes are reduced.

Sound phase polarization and voltage memories provides dynamically unlimited directional sensitivity. Phase selective 1-pole or 3-pole tripping is possible when used with 1-pole or 1 and 3-pole rapid or delayed auto reclosing scheme.

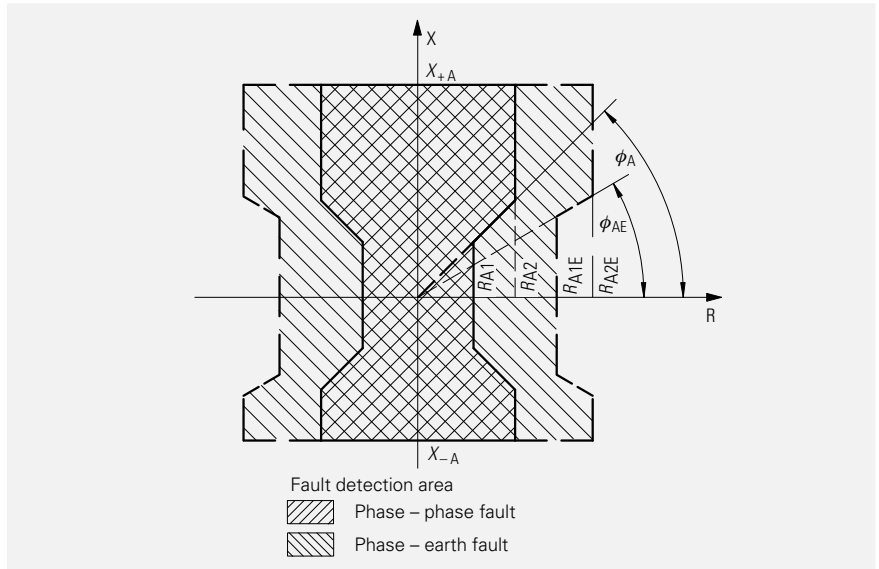


Fig. 2 Fault detection polygon for polygon impedance ($Z<$)

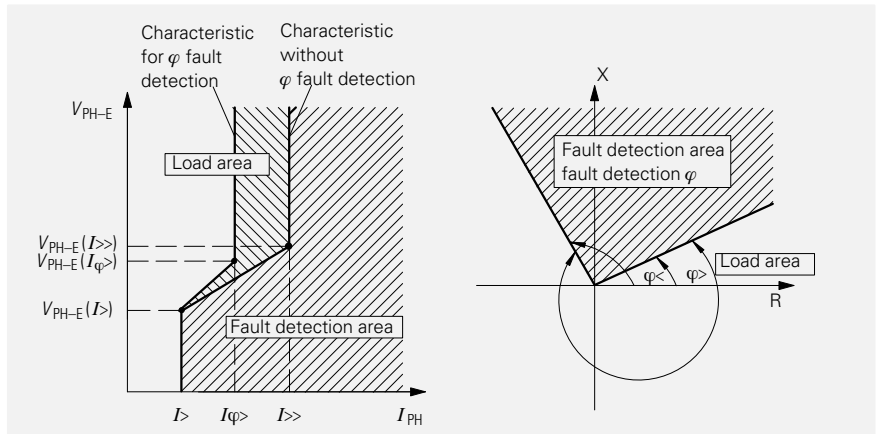


Fig. 3 Characteristics of the voltage and angle-dependent overcurrent fault detection $V/I/\varphi$

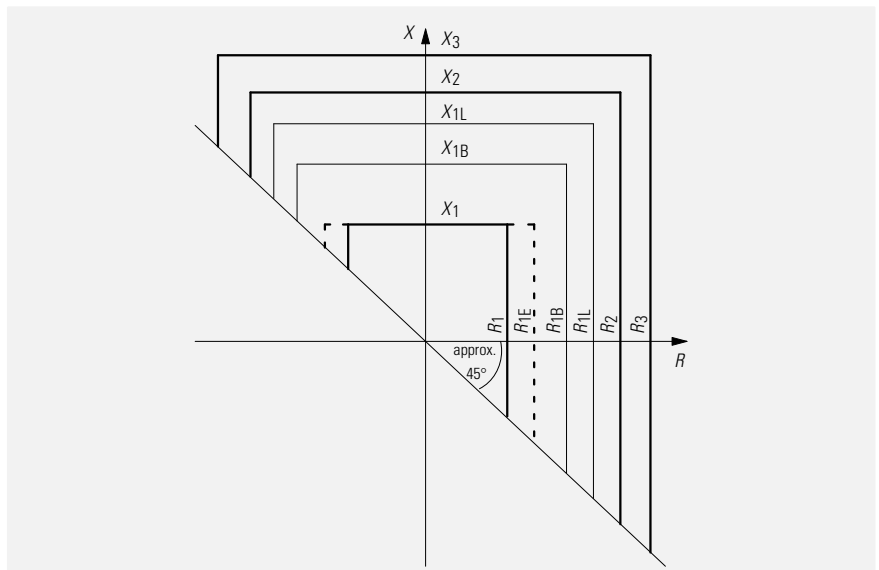


Fig. 4 Tripping characteristics of the distance protection

7SA513 line protection relay (Version V3)

Distance protection (continued)

Following the loss of V.T. voltage inputs, the distance protection can be blocked automatically to prevent incorrect operation.

The distance protection has an instantaneous tripping level $I \gg \gg$. If this level is exceeded tripping is immediate. This level can be used on very long lines if a large short-circuit current is expected from close in faults while the short-circuit current for reverse faults will definitely be reduced to a level below the setting value. The function can be deactivated (default setting).

Fault location

The fault location function calculates the fault impedance and the distance-to-fault. The result can be displayed in ohms, kilometers or percent of the line length. Parallel line and load current compensation is also available for fault location function.

Signal transmission

For fast selective clearance of faults up to 100 % of the line length a signal transmission function is available. The following modes may be selected:

- Permissible underreach transfer trip with fault detection
- Zone acceleration with Z1B
- Permissible overreach with overreach zone Z1B
- Direction comparison with directional fault detection
- Unblocking mode with overreach zone Z1B
- Unblocking mode with directional fault detection
- Blocking mode
- Overreach zone comparison via pilot wires
- Reverse interlocking.

The transient blocking function is provided with overreaching schemes to transient or current reversals resulting from the clearance of short circuits on parallel lines.

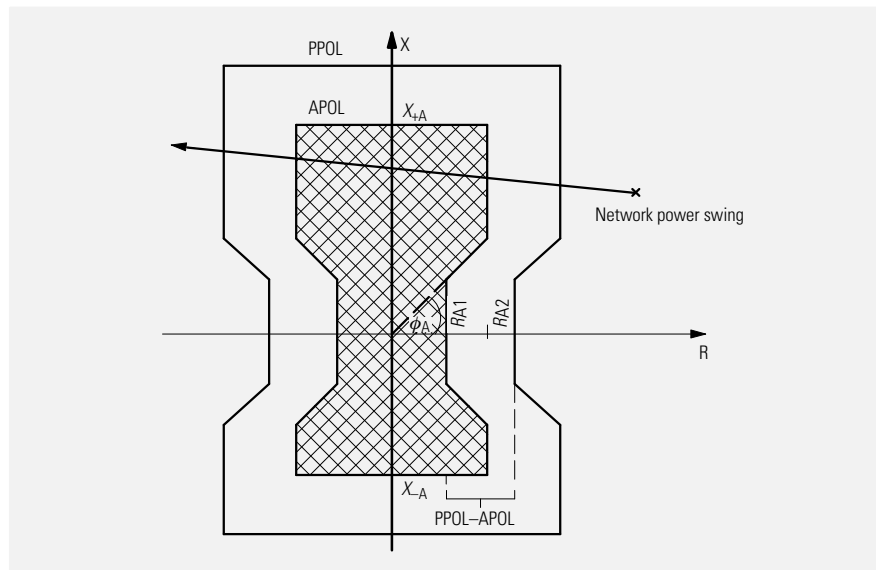


Fig. 5
Polygon for power swing detection

Network power swings

During network power swings large currents can occur along with small voltages. Small voltages and large currents imply small impedances which can cause distance protection tripping. To avoid uncontrolled tripping by the distance protection and to achieve controlled tripping in the event of loss of synchronism (pole slip), a power swing supplement is available for the 7SA513 line protection relay.

The following operating modes for network power swings can be set:

- Power swing blocking to prevent the distance protection from tripping
- Power swing tripping for controlled tripping in the event of unstable power swings (out-of-step protection).

Weak infeed protection

To prevent delayed tripping of permissible schemes during weak or zero infeed situations, an echo function is provided. If no fault detector picks up at one end of the line, the signal received here is returned as echo to allow accelerated tripping at the other end of the line.

It is also possible to initiate tripping during a weak infeed. At the end of the line where the fault detector does not pick up, a phase selective 1-pole or 3-pole trip is issued if a corresponding drop in the P_{HE} voltage is present.

Overcurrent protection as a backup function and emergency function during measured voltage failure

The 7SA513 line protection relay includes overcurrent protection. It can be used as a backup function and as an emergency function in the event of a short-circuit or interruption in the voltage transformer circuit or if the circuit-breaker of the voltage transformer trips. The settings for the emergency function may differ from those of the backup protection function. The overcurrent protection can be set as two-stage definite-time overcurrent protection or as inverse-time overcurrent protection.

Switch-on-to-fault protection

Instantaneous tripping is possible when energizing a short-circuited line. Initiation of the binary input "Manual Close" will, depending on the setting, result in instantaneous tripping in Z1, Z1B or fault detection.

On definite, large current faults the high current instantaneous stage can initiate very fast 3-pole tripping even if the binary input "Manual Close" is not initiated.

Overcurrent and Distance Relays

7SA513 line protection relay (Version V3)

Automatic reclosure

The 7SA513 relay is equipped with automatic reclosure (ARC). The range of functions includes:

- 3-pole RAR/DAR¹⁾ for all types of faults
- 1-pole RAR for 1-phase faults, no reclose for polyphase faults
- 1-pole RAR for 1-phase and 2-phase faults without earth, no reclose for poly-phase faults
- 1-pole RAR for 1-phase and 3-pole RAR/DAR for poly-phase faults
- 1-pole RAR for 1-phase and 2-phase faults without earth and 3-pole RAR/DAR for other faults
- Multiple-shot DAR
- Interaction with an external device for automatic reclosure via binary inputs and outputs
- Control of the integrated ARC function by external protection
- ARC blocking for faults on the cable portion of mixed cable/overhead lines
- Interaction with an internal or external synchro check
- Monitoring of the circuit-breaker auxiliary contacts.

High resistance earth-fault protection in an earthed network

In earthed networks where high resistance earth faults can occur, the fault detection of the distance protection may not be sensitive enough. The 7SA513 line protection relay has protection functions for high-resistance earth faults of this nature. Only one of these functions can be active at any one time:

- Directional or non-directional earth fault protection with definite-time overcurrent characteristic
- Directional or non-directional earth fault protection with inverse-time overcurrent characteristic
- Directional or non-directional earth fault protection with voltage-dependent characteristic (V_0 inverse characteristic).

To implement a directional comparison scheme, the directional earth-fault function can be supplemented with a signal transmission logic.

Earth-fault direction detection is performed with residual current and residual voltage. In addition or as an alternative to the residual voltage, the start point current (I_Y) of an earthed transformer may be used for polarization of the directional earth-fault function. A phase selector permits single pole tripping by the earth-fault protection in the event of single phase earth-faults in conjunction with uni-polar automatic reclosing.

Synchronism check

When connecting two network sections by control command or following a 3-pole auto-reclosure, it must be ensured that the two network sections are in synchronism. For this purpose a synchronism check function is provided. After verification of network synchronism, the function enables the CLOSE command. Alternatively reclosure can be enabled after a checking that the busbar or line is not carrying a voltage (dead line or dead bus).

Overvoltage protection

On very long EHV lines that carry no or light load impermissible overvoltages can occur due to the Ferranti effect. For protection against these overvoltages the 7SA513 line protection relay contains a two stage overvoltage protection. Compounding can be set for the $V>$ stage that calculates the voltages at the remote end of the line. Tripping can be performed at the local circuit-breaker or at the remote end of the line by transmission of an intertripping signal.

Circuit-breaker failure protection

The 7SA513 line protection incorporates a single stage circuit-breaker failure protection function to detect failure of trip commands, for example due to a defective circuit-breaker. The current detection logic is phase selective and can therefore also be used in single pole tripping schemes. If the fault current has not been interrupted after a set time delay has elapsed, the busbar trip command is generated.

Parameter set switchover

It is possible to switch between four different parameter sets via the binary inputs, the integrated operating panel or the serial operating interface. In this way it is possible to adapt the protection relay settings if the network configuration has been changed by switching actions.

Parameter set switchover is also possible via the compatible VDEW/ZVEI interface protocol.

1) RAR – Rapid auto-reclosure
DAR – Delayed auto-reclosure
ARC – Automatic reclosure

Fault value recording

The digitized measured values of the phase currents, earth currents, phase voltages as well as displacement voltage and several binary channels are stored with a set pre- and post fault time. The fault value recording can be transferred to a PC and the SINAUT LSA 678 substation control and protection for evaluation. Parallel use of a PC and the substation control and protection is possible. If the VDEW/ZVEI interface is used, up to 8 fault value recordings can be stored. The data memory is a ring buffer with a maximum length of 10 s (at $f_N = 50$ Hz). The oldest fault value recording is overwritten by the latest data. Fault value recording can be started via a binary input or, as an aid to commissioning, via the integrated operator panel or PC. The recording duration can then be parameterized.

The fault value recording memory is protected against failure of the supply voltage.

Marshaled command and alarm relays, LEDs, binary inputs

The device is equipped with several command relays with trip duty contacts. They can be assigned both to the commands of the integrated protection functions as well as to all other alarm outputs or binary signals.

Alarm relays and LEDs can be freely assigned for user-specific output and display of alarms and events. Several single indications can be grouped together to form a group indication. The retentive LED displays are protected against failure of the supply voltage. All binary inputs can also be freely marshalled.

Measuring and test functions

Numerous measuring and test functions are integrated in the 7SA513 line protection for commissioning and operational measurement:

- Measurement of the in-service impedance of all 6 loops and display of direction, reactance and resistance
- Monitoring of the phase sequence
- In-service measurement
 - $I_{ph1}, I_{ph2}, I_{ph3}$
- In-service measurement
 - $V_{ph1-ph2},$
 $V_{ph2-ph3},$
 $V_{ph3-ph1},$
 $V_{ph1}, V_{ph2}, V_{ph3}$
- Active and reactive power measurement (W and VAR)
- Frequency measurement
- Trip circuit test with circuit-breaker, 1 and 3-pole
- Test ARC, 1 and 3-pole.

7SA513 line protection relay (Version V3)

Non-volatile storage of operational records

The 7SA513 unit provides detailed data for the analysis of faults and for checking states during operation. All the event memories listed below are backed up against failure of the supply voltage.

- **Time**
As a standard a battery backed up clock is available which can be synchronized via a binary input. The clock can be set via the PC and VDEW/ZVEI interface. The time and date are assigned to all events.
- **Fault records**
The events of the last 3 network faults can be retrieved at any time via the integrated operator panels. The events of the last 8 network faults are available via the PC interface.
- **Operational events**
All events that are not immediately associated by the fault are stored in the operational event memory.
- **Tripping statistics**
For each pole of the circuit-breaker the trip and close cycles as well as the disconnected current are summated separately.
- **Automatic display on the LCD**
An operating mode can be activated in which up to 2 operational measured values are display in the integrated LCD. When a fault occurs the display automatically indicates 2 selected items of fault information.

User-definable binary inputs and time delays, external trip signals

To register binary signals that could for instance be generated by other protection devices, 4 binary inputs are provided. They are stored in the operational event buffer and can be signalled via alarm relays, LEDs and SINAUT LSA substation control.

The unit is also equipped with 2 settable time stages. The start and reset signals can be marshalled to binary inputs, the time stage output to alarm relays and LEDs. A wide range of pick-up and drop-off times can be set. In future the use of external time relays for special applications will no longer be necessary.

Phase selective remote tripping with and without automatic reclosure can be achieved by coupling external signals via binary input.

Overcurrent and Distance Relays

7SA513 line protection relay (Version V3)

Technical data

Input circuits	<p>Rated current I_N Rated voltage V_N Rated frequency f_N Thermal overload capacity in V.T. circuits, continuous in C.T. circuits, continuous for 1 s Maximum dynamic overload Power consumption, voltage inputs at $I_N = 1$ A current inputs at $I_N = 5$ A</p>	<p>1 or 5 A 80 to 125 V AC 50 or 60 Hz 140 V AC $4 \times I_N$ $100 \times I_N$ $250 \times I_N$ approx. 0.5 VA approx. 0.1 VA approx. 0.2 VA</p>
Power supply via integrated converter	<p>Rated auxiliary voltage V_{aux} (working range) Permitted tolerance of the rated auxiliary voltage V_{aux} Max. ripple at V_{auxnom} Power consumption, quiescent energized Max. bridging time during auxiliary voltage failure</p>	<p>48, 60 V DC 110, 125 V DC 220, 250 V DC -20 to +15% $\leq 12\%$ approx. 15 W approx. 40 W ≥ 50 ms at $V_{aux} \geq 110$ V</p>
Input/output modules	Quantity	2 or 3
Binary inputs	<p>Number per input/output module Voltage range, can be set with jumpers Current consumption</p>	<p>8 (marshallable) 24, 60 V DC 110, 125 V DC 220, 250 V DC approx. 3 mA</p>
Alarm contacts	<p>Number of relays per input/output module each with 1 change-over contact Switching capacity of the standard relays make/break Permissible current for standard relays, continuous Switching voltage for standard relays Switching power of the Reed relays make/break Permissible current for Reed relays, continuous Switching voltage for Reed relays Permissible load circuit capacitance for Reed relays</p>	<p>9 standard relays or 6 standard relays and 1 Reed relay; all relays can be marshalled 20 W/VA 1 A 250 V AC/DC 15 W/VA 0.3 A 220 V AC/DC max. 5 nF</p>
Command contacts	<p>Number of relays per input/output module with 2 NO contacts each Switching power make break Switching voltage Permissible current continuous 0.5 s</p>	<p>2 (marshallable) 1 000 W/VA 30 W/VA 250 V AC/DC 5 A 30 A</p>
LED displays	<p>Ready green Faulty red Converter healthy green Marshallable displays per input/output module red</p>	<p>1 1 3 8</p>
Serial interfaces	<p>Operating interface Baud rate System interface Baud rate Fibre-optic connection Optical wavelength Permissible line attenuation Distance</p>	<p>On the front, not isolated, suitable for connecting a personal computer 1 200 to 19 200 bd isolated, suitable for linking to a central unit 1 200 to 19 200 bd Integrated FSMA plug connector for FO connection with ceramic connector 820 nm up to 8 dB per glass fibre 62.5/125 μm up to 2 km</p>

7SA513 line protection relay (Version V3)

Technical data (continued)

Mechanical design	Housing, dimensions Degree of protection to EN 60529	Housing Terminals 7XP20, see dimension drawing IP 51 IP 21
CE conformity, regulations	The product meets the stipulations of the guideline of the council of the European Committees for harmonization of the legal requirements of the member states on electro-magnetic compatibility (EMC guideline 89/336/EEC). The product conforms with the international standard of the IEC 255 series and the German national standard DIN VDE 57 435/Part 303. The unit has been developed and manufactured for use in industrial areas in accordance with the EMC standard. The unit has not been designed for use in living quarters as defined in standard EN 50081.	This conformity is the result of a test that was performed by Siemens AG in accordance with article 10 of the guideline and the EN 50081-2 and EN 50082-2 basic specifications.
Insulation tests IEC 255-5, DIN VDE 0435 Part 303	Voltage test (100% test), all circuits except for auxiliary voltage Voltage test (100% test), only auxiliary voltage Surge voltage test (type test), all circuits, Class III	2 kV (RMS value), 50 Hz 2.8 kV DC 5 kV (peak value), 1.2/50 μ s, 0.5 J, 3 positive and 3 negative surges at intervals of 5 s
EMC tests for noise immunity (type tests Standards: IEC 255-22 (product standard) EN 50082-2 (basic specification) DIN VDE 0435 Part 303	High frequency test IEC 255-22-1, Class III and DIN VDE 0435 Part 303, Class III Static discharge test IEC 255-22-2, Class III and EN 61000-4-2, Class III Irradiation with high frequency field, unmodulated, IEC 255-22-3 (report), Class III Irradiation with high frequency field, amplitude-modulated ENV 50140, Class III Irradiation with high frequency field, pulse-modulated ENV 5014/ENV 50204, Class III Rapid burst IEC 255-22-4 and EN 61000-4-4, Class III Line-bound high frequency, amplitude-modulated ENV 50141, Class III Magnetic field with power system frequency EN 61000-4-8, Class IV	2.5 kV (peak value), 1 MHz, $\tau = 15 \mu$ s, 400 pulses per s, test duration 2 s 4 kV/6 kV contact discharge, 8 kV air discharge, both polarities, 150 pF, $R_f=330 \Omega$ 10 V/m, 27 to 500 MHz 10 V/m, 80 to 1000 MHz, 80 %, 1 kHz, AM 10 V/m, 900 MHz, repetition rate 2000 Hz, ED 50 % 2 kV, 5/50 ns, 5 kHz, burst length = 15 ms, repetition rate 300 ms, both polarities, $R_f=50 \Omega$, test duration 1 min 10 V, 150 kHz to 80 MHz, 80 %, 1 kHz, AM 30 A/m, continuous, 300 A/m for 3 s, 50 Hz
EMC tests for interference emission (type tests) Standards: EN 50081-2 (basic specifications)	Radio interference voltages, only auxiliary voltage CISPR 11, EN 55011, limit value A and DIN VDE 0875 Part 11, limit value A Radio interference field strength CISPR 11, EN 55011, limit value A and DIN VDE 0875 Part 11, limit value A	150 kHz to 30 MHz 30 to 1000 MHz
Climatic stress	Permissible ambient temperature Humidity stress	during operation during storage during transport -5 to +55 °C -25 to +55 °C -25 to +70 °C Average annual relative humidity ≤ 75 %, on 30 days in the year up to 95 % relative humidity, condensation not permissible
Mechanical test stress IEC 255-21-1, IEC 68-2	Permissible mechanical stress	during operation 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
Distance protection	Setting ranges Earth fault detection Earth current I_E/I_N in steps of 0.01 Displacement voltage $V_E > (= \sqrt{3} \times V_0, \text{ earthed networks})$ 1 V $V_E > (= \sqrt{3} \times V_0, \text{ unearthed networks})$ 1 V Impedance start (Z<) Characteristic Range forward X+ 0.01 Ω Range backward X- 0.01 Ω Resistance tolerance 0.01 Ω Limit angle between load and short-circuit range 0.1° Minimum current $I_{ph>} / I_N$ 0.01 Overcurrent $I_{ph>>} / I_N$ 0.01	0.1 to 1 2 to 100 V 10 to 100 V polygon 0.1 to 200 Ω^1 0.1 to 200 Ω^1 0.1 to 200 Ω^1 30 to 80° 0.1 to 4 1 to 20

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

Overcurrent and Distance Relays

7SA513 line protection relay (Version V3)

Technical data (continued)

Distance protection (continued)	Setting values (continued)	
	Voltage and angle-dependent overcurrent start ($V/I/\varphi$)	
	Phase-to-earth voltage V_{ph-E} ($I>$) in steps of	1 V
	Phase-to-earth voltage V_{ph-E} ($I\gg$)	1 V
	Phase-to-phase voltage V_{ph-ph} ($I>$)	1 V
	Phase-to-phase voltage V_{ph-ph} ($I\gg$)	1 V
	Minimum current $I_{ph>}/I_N$	0.01
	Overcurrent $I_{ph>}/I_N$	0.01
	Limit angle between load and short-circuit range φ	1°
	Distance measurement	
	Characteristic	polygon
	Distance zones	5, 2 of these as overreach zones and all can be set forward, backward or non-directional
	Range X	0.01 Ω
	Resistance tolerance R for phase-to-phase fault	0.01 Ω
	Resistance tolerance R for phase-to-earth fault	0.01 Ω
	Time stages	7 for multi-phase faults 3 for single-phase faults
	Ranges	0.01 s
	Earth impedance matching	
	$\frac{X_E}{X_L}, \frac{R_E}{R_L}$	0.01
	Parallel line matching	
	$\frac{X_M}{X_L}, \frac{R_M}{R_L}$	0.01
	Distance protection instantaneous tripping level $I>>>$ (non-directional)	
	Smallest setting value	$3 \times I_N$
	Greatest setting value	$20 \times I_N$
	Default	∞ (no tripping with $I>>>$ level)
	Load current compensation	
	Direction detection for all types of error	with externally generated short-circuit tripping voltages and voltage memory dynamically unlimited
	Directional sensitivity	
	Times	
	Shortest command time	
	Shortest command time (distance protection instantaneous tripping level $I>>>$)	approx. 18 ms at $f_N = 50$ Hz
	Release time after OPEN command	approx. 16.5 ms at $f_N = 60$ Hz
	after start release without OPEN command	approx. 11 ms
		approx. 25 ms
		approx. 30 ms
	Tolerances	
	Measuring tolerances to DIN VDE 0435 Part 303 (for sinusoidal measured quantities)	
	For impedance start	$\frac{\Delta X}{X} \leq 5\%$ for $30^\circ \leq \varphi_k \leq 90^\circ$
		$\frac{\Delta R}{R} \leq 10\%$ for $0^\circ \leq \varphi_k \leq 60^\circ$
	For distance measurement	$\frac{\Delta X}{X} \leq 5\%$ for $30^\circ \leq \varphi_k \leq 90^\circ$
		$\frac{\Delta R}{R} \leq 5\%$ for $0^\circ \leq \varphi_k \leq 60^\circ$
	For amplitude measurement	$\pm 5\%$
	Timer accuracy	$\leq 1\%$ of setting value or 10 ms
Instantaneous disconnection on connection to short-circuit	High current start $I_k>/I_N$	1 to 25
	Shortest command time	approx. 11 ms
Fault location	Output of the distance to fault	in Ω secondary, Ω primary, km, %
	Start signal	Trip, start release, binary input
	Setting reactance per unit in steps of 0.01 Ω /km	0.01 to 5 Ω /km
	Parallel line compensation	can be set as an option
	Load current compensation	can be set as an option
	Measuring tolerances to DIN VDE 0435 Part 303 (for sinusoidal measured quantities)	$\leq 2.5\%$ line length at $30^\circ \leq \varphi_k \leq 90^\circ$ and $V_k/V_N \geq 0.1$

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

Overcurrent and Distance Relays

7SA513 line protection relay (Version V3)

Technical data (continued)

Signal transmission	<p>Modes</p> <p>Permissible schemes</p> <p>Comparison methods</p> <p>Overreach zone comparison via pilot wire</p> <p>Reverse interlocking</p>	<p>PUR transfer trip with fault detector</p> <p>ZOne acceleration with Z1B</p> <p>POR</p> <p>Direction comparison</p> <p>Unblock with fault detector</p> <p>Unblock with Z1B</p> <p>Blocking procedure</p> <p>–</p> <p>–</p>
Power swing add-on module (for impedance start Z<)	<p>Principle of power swing protection</p> <p>Modes</p> <p>Difference power swing and fault detector polygon in steps of 0.01 Ω</p> <p>Rate of change dR/dT 1 Ω/s</p> <p>Operating time 0.01 s</p>	<p>Measurement of the rate of change of the impedance vector</p> <p>Power swing blocking</p> <p>Power swing tripping</p> <p>0.1 to 50 Ω</p> <p>0 to 200 Ω/s</p> <p>0.01 to 32 s or until the end of power swing</p>
Weak infeed protection with comparison and blocking schemes: active during signal reception without fault detection	<p>Mode</p>	<p>Echo function and/or trip</p>
Overcurrent time protection	<p>Characteristic</p> <p>Applications</p> <p>Setting range of definite time overcurrent protection</p> <p>High set Phase $I_{ph}>>I_N$ in steps of 0.01</p> <p>Earth $I_E>>I_N$ 0.01</p> <p>Overcurrent Phase $I_{ph}>I_N$ 0.01</p> <p>Earth $I_E>I_N$ 0.01</p> <p>Times $t_{I>}$, $t_{IE>}$, $t_{I>>}$ 0.01 s</p> <p>Shortest command time</p> <p>Setting range of inverse time overcurrent protection</p> <p>High set (DT) Phase $I_{ph}>>I_N$ 0.01</p> <p>Earth $I_E>>I_N$ 0.01</p> <p>Overcurrent (IDMT) Phase $I_{ph}I_N$ 0.01</p> <p>Earth $I_{EP}I_N$ 0.01</p> <p>Time multiplier t_p</p> <p>Pick-up threshold 1.1 × I_p</p> <p>Characteristic according to IEC 255–4, Section 3.5.2 or BS 142 normally, very, extremely inverse</p> <p>Measuring tolerance according to DIN VDE 0435 Part 303</p> <p>Pick-up level DT ≤ ± 5 %</p> <p>IDMT Pick-up at 1.05 < I/I_p < 1.15</p> <p>Time delay DT 1 % of setting value or 10 ms</p> <p>IDMT ≤ 5 % ± 15 ms for 2 ≤ I/I_p ≤ 20 and 1 s ≤ t_p ≤ 20 s</p>	<p>Definite-time overcurrent protection, inverse time overcurrent protection</p> <p>as backup protection function, as emergency function with automatic activation following measured voltage failure or voltage transformer mcb trip</p> <p>0.1 to 9.99</p> <p>0.1 to 4</p> <p>0.1 to 9.99</p> <p>0.1 to 4</p> <p>0 to 32 s or deactivated approx. 30 ms</p> <p>0.1 to 9.99</p> <p>0.1 to 4</p> <p>0.1 to 4</p> <p>0.1 to 4</p> <p>0.05 to 32</p> <p>1.1 × I_p</p>
Earth-fault protection for high-resistance earth faults in an earthed network	<p>Directional earth fault definite time protection with non-directional backup protection</p> <p>Pick-up with earth current $I_E>I_N$ in steps of 0.01</p> <p>Displacement voltage $V_E > (= \sqrt{3} \times V_0)$ 1 V</p> <p>Direction detection with</p> <p>Signal transmission method</p> <p>Times</p> <p>Shortest command time</p> <p>Current reversal time</p> <p>Trip delay 0.01 s</p> <p>Time tolerance</p> <p>Directional earth IDMTL protection</p> <p>Characteristics according to IEC 255–4, Section 3.5.2 or BS 142</p> <p>Pick-up value $I_E>I_N$ 0.01</p> <p>Time multiplier $t_{IE>}$ 0.01 s</p> <p>Tolerances</p> <p>Current pick-up level</p> <p>Operating times</p>	<p>0.1 to 4</p> <p>0.1 to 10 V</p> <p>with I_E and V_E and I_Y</p> <p>Direction comparison</p> <p>approx. 30 ms</p> <p>approx. 30 ms</p> <p>0 to 32 s or deactivated</p> <p>≤ 1 % of setting value or 10 ms</p> <p>Normal, very, extremely inverse</p> <p>0.1 to 4</p> <p>0 to 32 s</p> <p>Pick-up at 1.05 < I/I_{EP} < 1.15</p> <p>≤ 5 % for 2 ≤ $I/I_{E>}$ ≤ 20 and 1 s ≤ t_{IE} ≤ 20 s</p>

Overcurrent and Distance Relays

7SA513 line protection relay (Version V3)

Technical data (continued)

Automatic reclosure	Number of automatic reclosures Program Action times for RAR and DAR cycle in steps of 0.01 s Dead times in the RAR cycle 0.01 s Dead times in DAR cycles 0.01 s Reclaim times 0.01 s CLOSE command duration 0.01 s	Up to 10 Only 1-pole Only 3 -pole 1 or 3-pole 0.01 to 320 s 0.01 to 320 s 0.01 to 1800 s 0.5 to 320 s 0.01 to 32 s
Synchronism check	Modes for connection Line dead/busbar dead Line dead/busbar live Line live/busbar dead Synchronism Permissible voltage difference ΔV in steps of 1 V Permissible frequency difference Δf 0.01 Hz Permissible angle difference $\Delta\varphi$ 1°	$V_1 < /V_2 <$ $V_1 < /V_2 >$ $V_1 > /V_2 <$ $V_1 > /V_2 >$ 1 to 50 V 0.01 to 1 Hz 1 to 60°
Overvoltage protection	Function Voltage measurement, local Voltage calculation, for the opposite end (compounding) Voltage selection Pick-up of the $V_{>>}$ level Setting ranges Voltage threshold $V_{>}/V_N$ in steps of 0.01 Release ratio $V_{rel}/V_{>}$ 0.01 Voltage threshold $V_{>>}/V_N$ 0.01 Release ratio $V_{rel}/V_{>>}$ 0.01 Times $t_{V_{>}}$ $t_{V_{>>}}$ with circuit-breaker closed 0.01 $t_{V_{>>}}$ with circuit-breaker open 0.01 Command timer Measuring tolerance according to DIN VDE 0435 Part 303 (for sinusoidal measured quantities)	3 x Phase-to-earth voltages or 3 x Phase-to-phase voltages by ANDING the phase selective start signals or by ORing the phase selective start signals 1 to 1.9 0.5 to 0.99 1 to 1.9 0.5 to 0.99 0 to 32 s 0 to 32 s 0 to 32 s approx. 45 ms $\pm 5\%$
Circuit-breaker failure protection	Setting ranges Current start I_{SVS}/I_N in steps of 0.01 Delay time 0.01 s Shortest release time Time tolerance Measuring tolerance according to DIN VDE 0435 Part 303 (for sinusoidal measured quantities)	0.1 to 4 0.05 to 1 s approx. 10 ms $\leq 1\%$ of setting value or 10 ms $\pm 5\%$
Fault recording	Measured quantities Start signal for fault recording Memory management Maximum number of recordings available at one time Sampling interval Maximum storage time (sum of all recordings) at 50 Hz at 60 Hz Pre fault time in steps of 0.01 s Post fault time 0.01 s Maximum time for one recording 0.01 s	$i_{ph1}, i_{ph2}, i_{ph3}, \dot{E}, V_{ph1}, V_{ph2}, V_{ph3}, V_E$ Trip, start, binary input, operator panel, PC dynamic ring buffer 8 20 value samples per network cycle 10 s 8.3 s 0.05 to 0.5 s 0.05 to 0.5 s 0.3 to 5 s
Additional functions	Operational measured values: Currents Voltages Power Frequency Effective range Tolerance	$I_{ph1}, I_{ph2}, I_{ph3}$ $V_{ph1-ph2}, V_{ph2-ph3}, V_{ph3-ph1}, V_{ph1}, V_{ph2}, V_{ph3}$ P/Q f 0 to 240 % $\times I_N$ 0 to 120 % $\times V_N$ 0 to 120 % $\times P_N$ 96 to 104 % $\times f_N$ $\leq 2\%$ of the nominal value

7SA513 line protection relay (Version V3)

Selection and ordering data

7SA513 line protection relay	Order No. 7SA513 □ - □ □ A □ □ - 0 C □ □
Rated current at 50/60 Hz AC 1 A 5 A	↑ 1 5
Rated auxiliary voltage 48, 60 V DC 110, 125 V DC 220, 250 V DC	↑ 2 4 5
Construction for switchboard surface-mounting for switchboard flush-mounting or cubicle flush-mounting for switchboard flush-mounting or cubicle flush-mounting without glass cover	↑ B C E
Functionality V2 with impedance start, for earth networks V3 with impedance start or $V-I-\phi$ start, for earthed or compensated networks, with VDEW interface	↑ 1 2
Input/output modules (EAH) 2 EAH: 18 AR, 4 CR, 16 BI 3 EAH: 27 AR, 6 CR, 24 BI 2 EAH: 12 AR, 2 RR, 4 CR, 16 BI 3 EAH: 18 AR, 3 RR, 6 CR, 24 BI	↑ 0 1 2 3
Options A without auto-reclosure, without synchro-check with auto-reclosure 1/3-pole, without synchro-check ¹⁾ with auto-reclosure 1/3-pole, with synchro-check	↑ E G H
Options B without earth fault backup protection for earth networks ¹⁾ with earth fault backup protection for earth networks	↑ 0 1
AR Alarm relay, switching power 20 W, 1 A RR Reed relay, switching power 15 W, 0.3 A CR Command relay, switching power 1 000 W, 5 A BI Binary input, voltage range 24 to 250 V DC settable	

Documentation

Catalog LSA. 2.1.12 7SA513 line protection relay (V3)	E50001-K5712-A221-A1
Manual 7SA513 feeder protection (V2.2)	C53000-G1100-C86-2
Manual 7SA513 feeder protection (V3.1)	C53000-G1100-C103-1

1) As of functionality V3 (11th position in the order number = 2).

Overcurrent and Distance Relays

7SA513 line protection relay (Version V3)

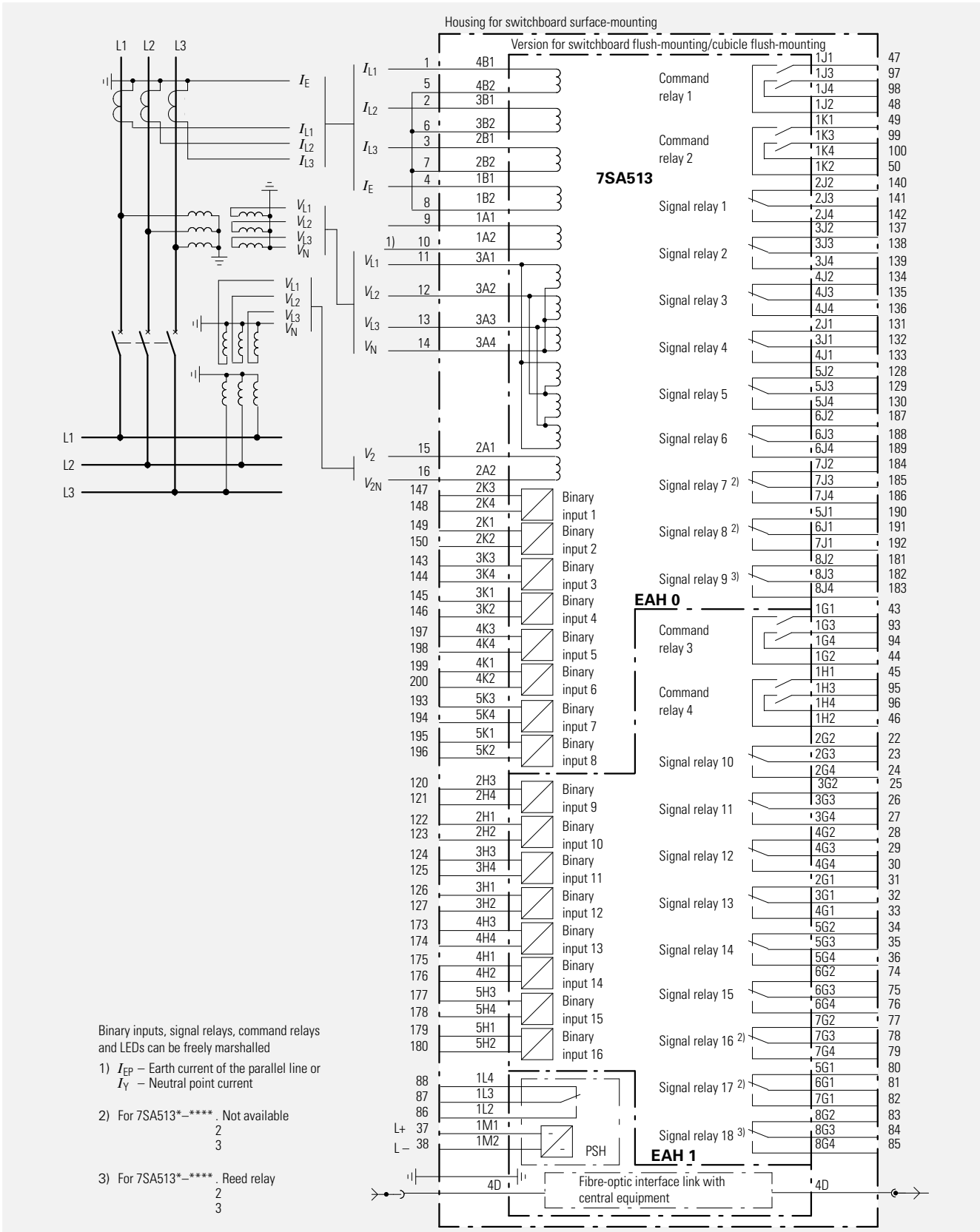


Fig. 6 Connection diagram for the 7SA513 line protection relay, version DD, with 2 input/output modules (for 7SA513 with 3 input/output modules see Fig. 7)

7SA513 line protection relay (Version V3)

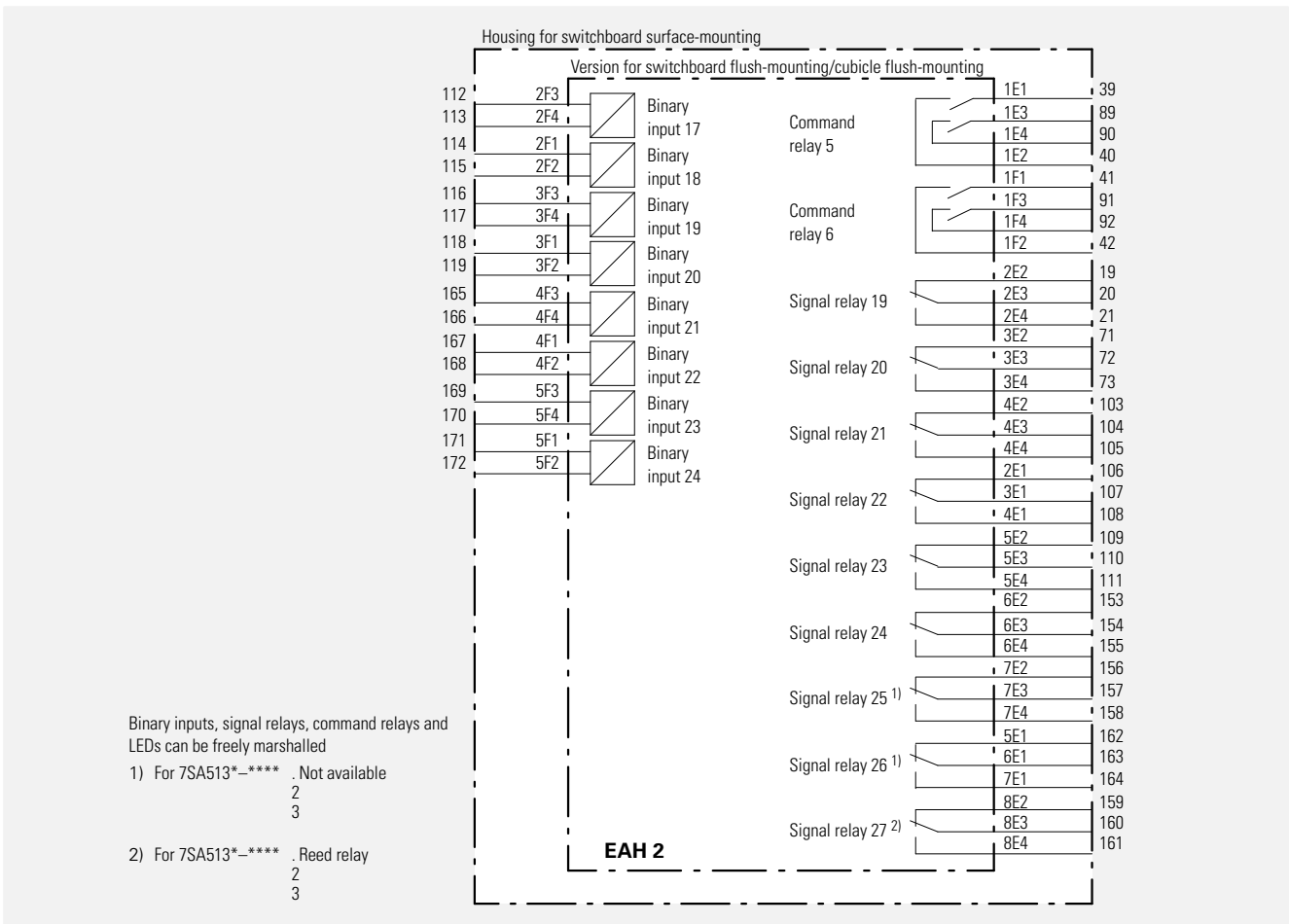


Fig. 7 (To be read together with Fig. 6)
Input/output module EAH2 in the 7SA513 line protection relay, with 3 input/output modules, version DD.

Overcurrent and Distance Relays

Dimension drawings in mm

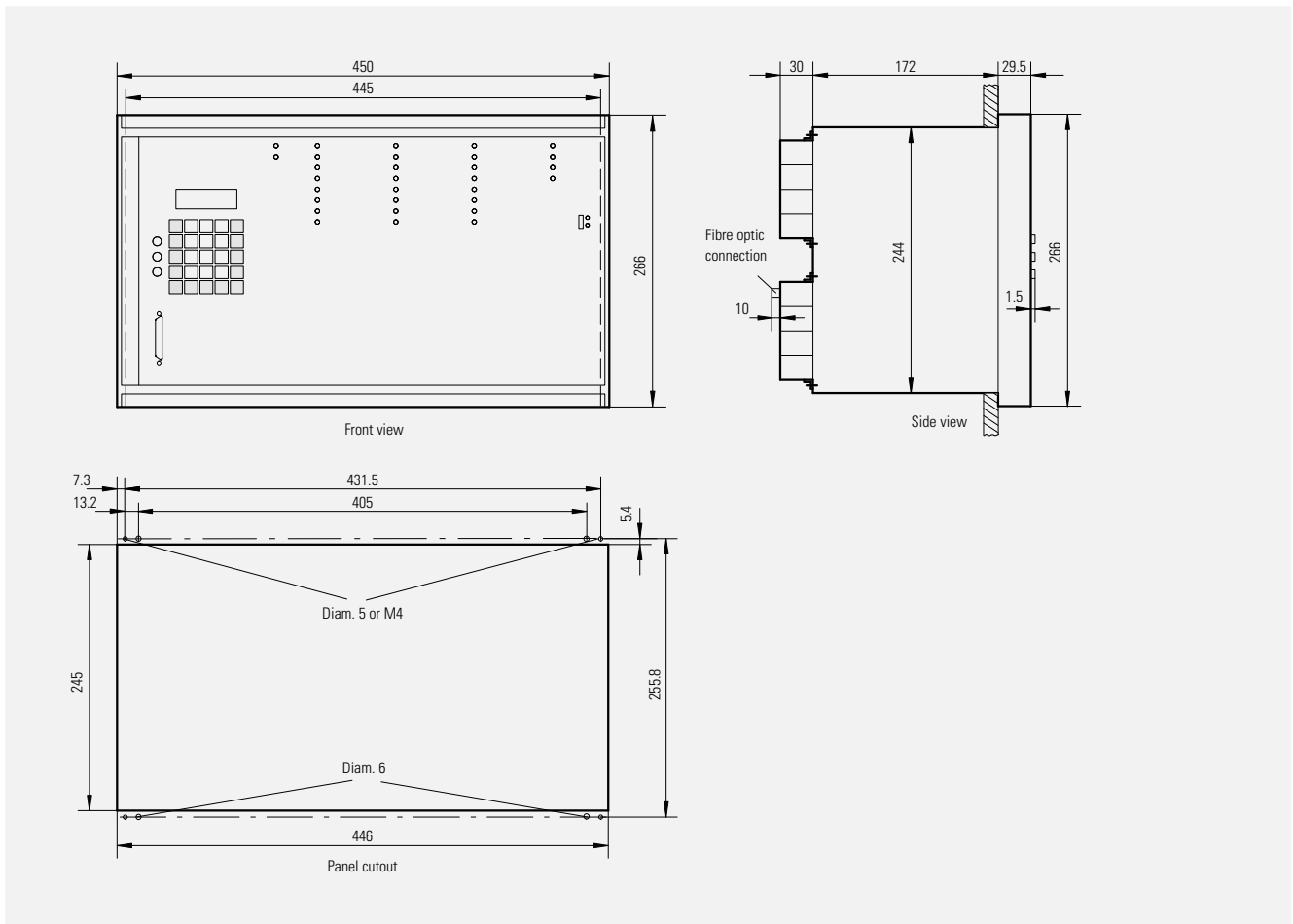


Fig. 8
7SA513 with housing 7XP2050-2 (for panel flush mounting or cubicle mounting)

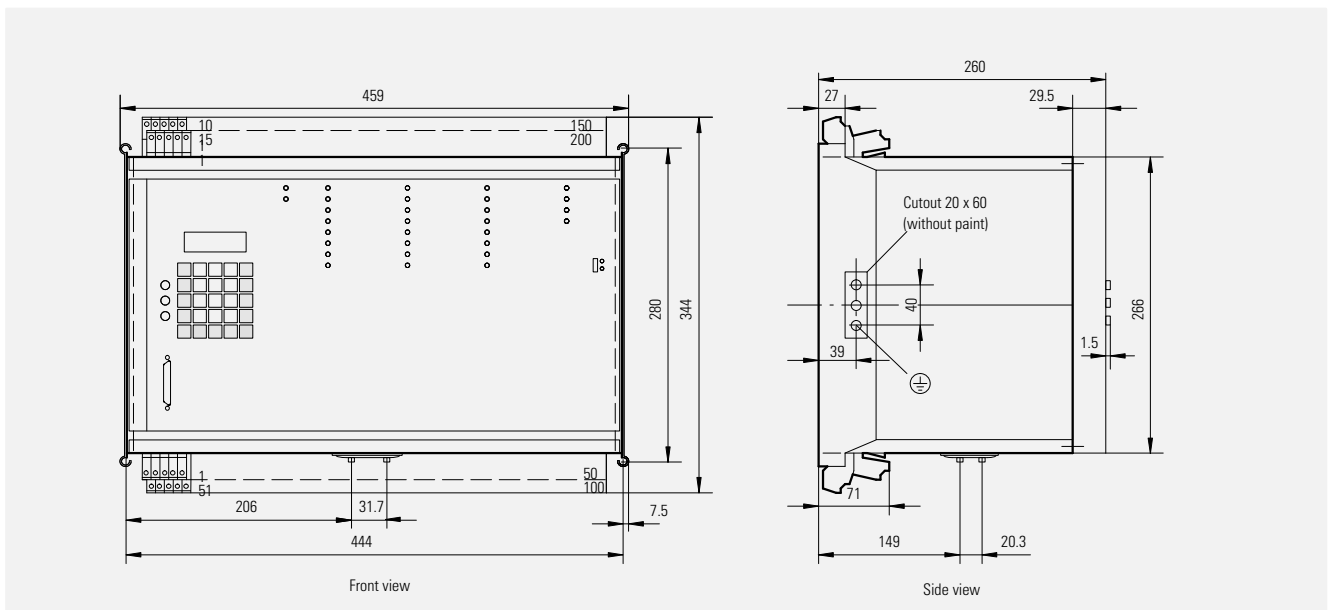


Fig. 9
7SA513 with housing 7XP2050-1 (for panel surface mounting)

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