

## SIPROTEC 7SA513 Distance Protection Relay for Transmission Lines



Fig. 6/81  
SIPROTEC 7SA513 distance protection relay

### Description

The 7SA513 numerical distance protection relay provides selective and fast clearance of faults on overhead lines and cables with single and multiple end infeed in high and extra high voltage networks with any type of meshing. The neutral point can be earthed, compensated or isolated. The main function is a fast non-switched distance protection with a polygon fault detection and tripping characteristic.

A fault detection program with a  $V/I/\varphi$  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 distance protection for all types of differential protection equipment. The unit can be integrated both into conventional installations and into SICAM substation control and protection systems.

The serial system interface protocol used conforms to IEC 60870-5-103.

### Function overview

#### Protection functions

- Non-switched distance protection with 6 measurement systems
- Fault locator
- Sensitive earth-fault protection for high-resistance earth faults in earthed networks
- Backup overcurrent-time protection
- Overvoltage protection
- Auto-reclosure
- Teleprotection (pilot protection)
- Synchro-check
- Breaker failure protection
- Power swing blocking/tripping
- Switch-onto-fault protection
- Weak-infeed protection

#### Features

- Tripping time 18 ms at 50 Hz
- Adaptive measurement algorithms with reliable fault loop selection
- Dynamically unlimited directional sensitivity
- Suitable for lines with series capacitors
- Compensation for the influence of a parallel line in case of earth faults
- Non-volatile storage of events

#### Monitoring functions

- Self-supervision of the relay
- Measured-value supervision
- Event logging
- Fault logging
- Oscillographic fault records

#### Front design

- User-friendly local operation
- 30 LEDs for local alarm
- PC front port for convenient relay setting

#### Communication interfaces

- Front interface for connecting a PC
- System interface for connecting to a control system via IEC 60870-5-103 or DIN 19244 protocol

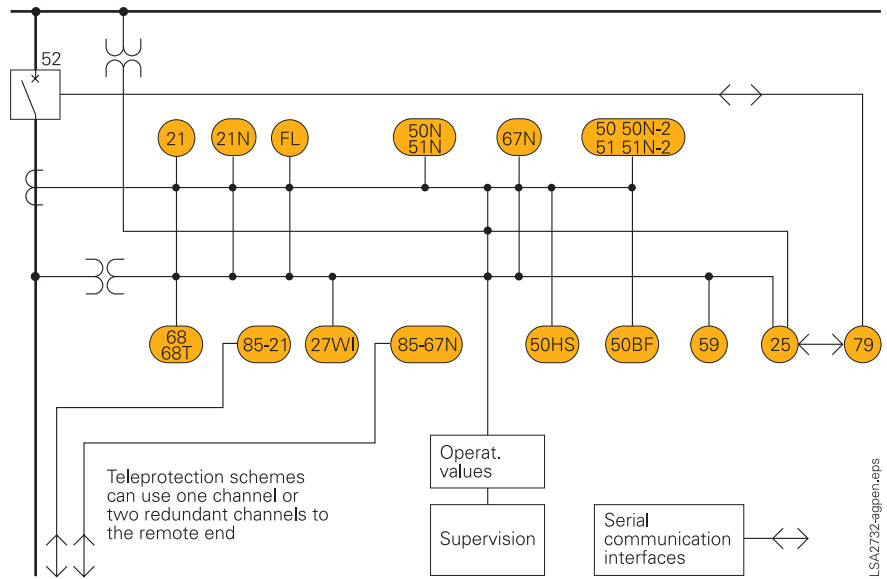
#### Hardware

- Analog inputs:
  - 5 current transformers
  - 7 voltage transformers
- Binary inputs: 16/24
- Binary outputs: 22/33

**Application**

The 7SA513 numerical distance protection relay provides selective and fast clearance of faults on overhead lines and cables with single and multiple end infeed in high-voltage networks with any type of meshing. The neutral point can be earthed, compensated or isolated. The main function is a fast non-switched distance protection with a polygon fault detection and tripping characteristic. A fault detection program with a  $V/I/\varphi$  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 SICAM substation control and protection systems.

ANSI	Protection functions
(21) (21N)	Distance protection
(FL)	Fault locator
(50N) (51N)	Directional earth-(ground) fault overcurrent protection
(67N)	Directional earth-(ground) fault overcurrent protection
(50) (51)	Backup overcurrent-time protection
(68) (68T)	Power swing detection/tripping
(85) (21)	Teleprotection for distance protection
(27WI)	Weak-infeed protection
(85) (67N)	Teleprotection for earth-fault protection
(50HS)	Switch-onto-fault protection
(50BF)	Breaker failure protection
(59)	Overvoltage protection
(25)	Synchro-check
(79)	Auto-reclosure



**Fig. 6/82** Function diagram

**Construction**

The compact 7SA513 distance 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 panel surface mounting is fitted with double-tier terminals accessible from the front. The versions for panel flush mounting or cubicle mounting have connecting elements at the rear and are available with or without a glass cover.

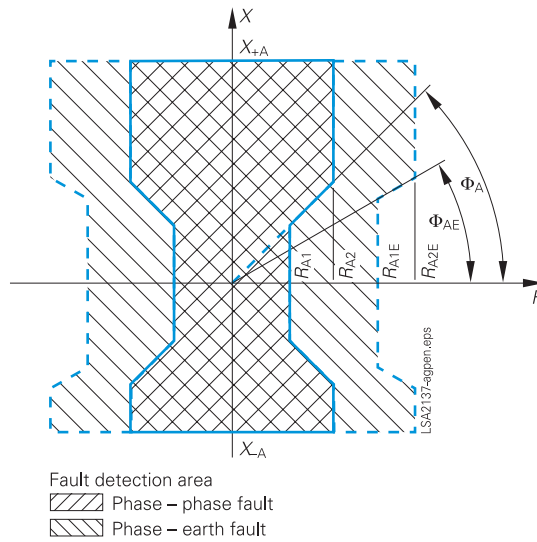
**Protection functions**

*Distance protection*

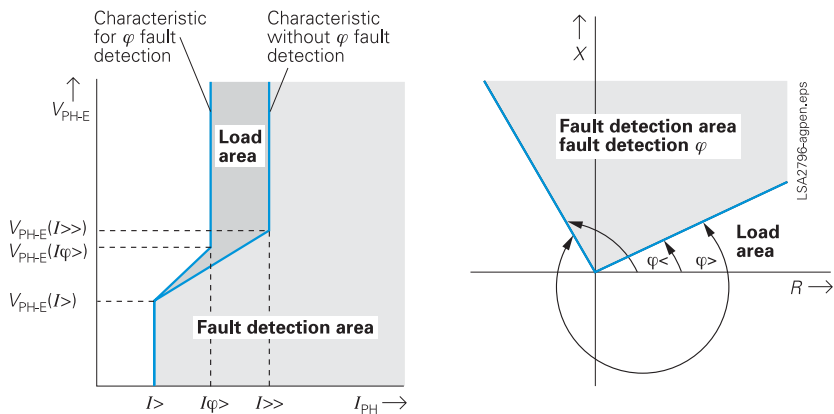
The main function of the 7SA513 protection relay is a non-switched distance protection. By parallel calculation and monitoring of all six impedance loops a high degree of sensitivity and selectivity is achieved for all types of fault. The shortest command time is less than one network cycle.

The fault detection characteristic used is the polygon impedance fault detection  $Z<$ . 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.

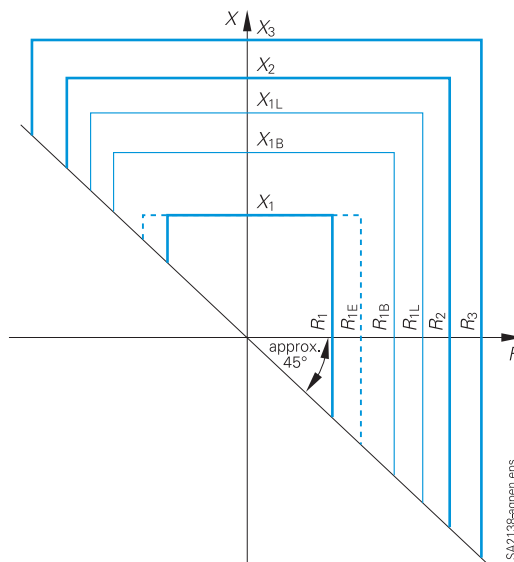
As an option to the polygon impedance fault detection, voltage and angle-dependent overcurrent fault detection may also be used. This  $V/I/\varphi$  characteristic uses the phase voltages  $V_{ph-E}$  or the line voltages  $V_{ph-ph}$  depending on the phase angle  $\varphi$  and the phase current  $I_{ph}$  according to the selected mode of starting.



**Fig. 6/83** Fault detection polygon for polygon impedance ( $Z<$ )



**Fig. 6/84** Characteristics of the voltage and angle-dependent overcurrent fault detection  $V/I/\varphi$



**Fig. 6/85** Tripping characteristics of the distance protection

## Protection functions

### Distance protection (continued)

The polygon tripping characteristic permits separate setting of the reactance  $X$  and the resistance  $R$ . The resistance 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-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 auto-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 values. In particular the influence of DC components, capacitive voltage transformers, series compensated lines and frequency changes is reduced.

Sound phase polarization and voltage memories provide 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-reclosure scheme.

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

### Fault locator

The fault locator 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 are also available.

### Tele (pilot) protection for distance protection

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

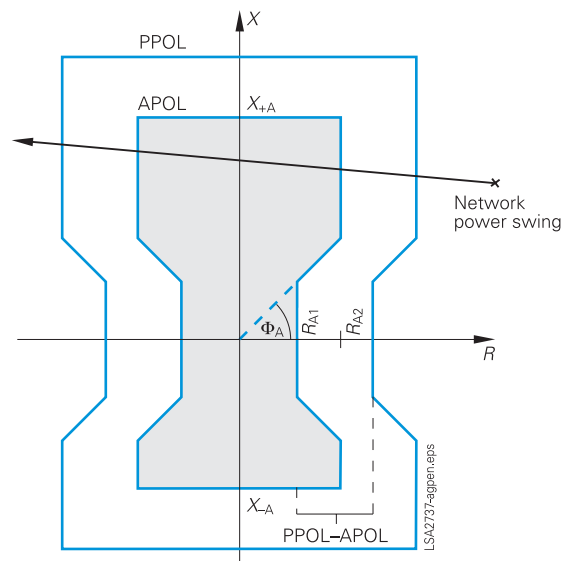


Fig. 6/86  
Polygon for power swing detection

- 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 operate with transient or current reversals resulting from the clearance of short circuits on parallel lines.

### Power swing detection

During network power swings, large currents can occur along with small voltages. Small voltages and large currents imply small impedances which can cause unwanted tripping of distance protection relays. 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 detection function is available for the 7SA513 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 – echo and/or trip

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 at the weak-infeed end. 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 phase-earth voltage is present.

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

The 7SA513 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 secondary circuit or if the circuit-breaker of the voltage transformer (VT mcb) 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.

## Protection functions

### Switch-onto-fault protection

Instantaneous tripping is required when energizing a faulty line. Initiation of the binary input “Manual Close” will, depending on the setting, result in instantaneous tripping in Z1, Z1B or with 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.

### Auto-reclosure

The 7SA513 relay is equipped with auto-reclosure (AR). The range of functions includes:

- 3-pole RAR/DAR<sup>1)</sup> for all types of faults
- 1-pole RAR for 1-phase faults, no reclosing for multi-phase faults
- 1-pole RAR for 1-phase and 2-phase faults without earth, no reclose for multi-phase faults
- 1-pole RAR for 1-phase and 3-pole RAR/DAR for multi-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 auto-reclosure via binary inputs and outputs
- Control of the integrated AR function by external protection
- AR 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 protection relay has protection functions for high-resistance earth faults of this nature. Only one of these functions can be active at 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 star point current ( $I_N$ ) 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 1-pole auto-reclosing.

### Synchro-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 synchronized. For this purpose, a synchro-check function is provided. After verification of network synchronism, the function enables the CLOSE command. Alternatively, reclosure can be enabled after 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 loads, 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.

### Breaker failure protection

The 7SA513 relay incorporates a single-stage breaker failure protection function to detect failure of tripping command execution, 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 IEC 60870-5-103 system interface protocol.

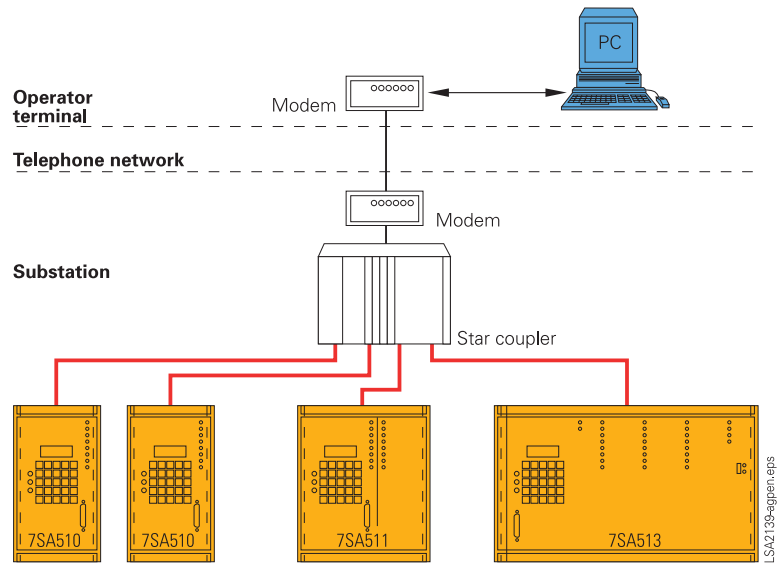
1) RAR – Rapid auto-reclosure  
DAR – Delayed auto-reclosure  
AR – Auto-reclosure.

## Communication

### Serial interfaces

The relay is equipped with two serial interfaces.

The operating interface on the front panel is suitable for connecting a Windows-capable PC. The DIGSI operating and analysis software allows easy setting, fault recording evaluation and commissioning. The system interface is an 820 nm fiber-optic interface for linking to the SICAM substation control and protection system or a protection master unit (protocol) according to IEC 60870-5-103. The operator with DIGSI can also be connected to the system interface.



**Fig. 6/87**

Telecontrol of protection equipment with a PC via modem, telephone channel and star coupler

## Technical data

General unit data	
<b>Analog inputs</b>	
Rated current $I_N$	1 or 5 A
Rated voltage $V_N$	80 to 125 V AC
Rated frequency $f_N$	50 or 60 Hz
Thermal overload capacity In V.T. circuits, continuous In C.T. circuits, continuous for 1 s	140 V AC $4 \times I_N$ $100 \times I_N$
Maximum dynamic overload	$250 \times I_N$
Power consumption Voltage inputs Current inputs at $I_N = 1$ A at $I_N = 5$ A	Approx. 0.5 VA Approx. 0.1 VA Approx. 0.5 VA
<b>Power supply (via integrated converter)</b>	
Rated auxiliary voltage $V_{aux}$ (working range)	48, 60 V DC 110, 125 V DC 220, 250 V DC
Permissible tolerance of the rated auxiliary voltage $V_{aux}$	-20 to + 15 %
Max. ripple at $V_{auxN}$	$\leq 12$ %
Power consumption Quiescent Energized	Approx. 15 W Approx. 40 W
Max. bridging time during auxiliary voltage failure	$\geq 50$ ms at $V_{aux} \geq 110$ V
<b>Input/output modules</b>	
Quantity	2 or 3
<b>Binary inputs</b>	
Number per input/output module	8 (marshallable)
Voltage range, can be set with jumpers	24, 60 V DC 110, 125 V DC 220, 250 V DC
Current consumption	Approx. 3 mA
<b>Alarm contacts</b>	
Number of relays per input/output module each with 1 changeover contact	9 standard relays or 6 standards relays and 1 Reed relay; all relays can be marshalled
Switching capacity of the standard relays make/break	20 W / VA
Permissible current for standard relays, continuous	1 A
Switching voltage for standard relays	250 V AC / DC
Switching power of the Reed relays make/break	15 W / VA
Permissible current for Reed relays, continuous	0.3 A
Switching voltage for Reed relays	220 V AC / DC
Permissible load circuit capacitance for Reed relays	Max. 5 nF

Command contacts	
Number of relays per input/output module with 2 NO contacts each	2 (marshallable)
Switching power Make Break	1000 W / VA 30 W / VA
Switching voltage permissible current Continuous 0.5 s	250 V AC/DC 5 A 30 A
<b>LEDs</b>	
Ready = green	1
Faulty = red	1
Converter healthy = green	4
Marshallable displays per input/output module = red	8

Serial interfaces	
Operating interface	On the front, not isolated, suitable for connecting a personal computer
Baud rate	1200 to 19200 baud
System interface	Isolated, suitable for linking to a central unit
Baud rate	1200 to 19200 baud
Fiber-optic connection	Integrated FSMA connector for FO connection with ceramic connector
Optical wavelength	820 nm
Permissible line attenuation	Up to 8 dB per glass fiber 62.5/125 $\mu$ m
Distance	Up to 2 km

Unit design	
Housing, dimensions	7XP20, see dimension drawings, part 16
Degree of protection to EN 60529 Housing Terminals	IP 51 IP 21

Insulation tests (IEC 60255-5, DIN VDE 0435, Part 303)	
Voltage test (100 % test), all circuits except for auxiliary voltage	2 kV (RMS value), 50 Hz
Voltage test (100 % test), only auxiliary voltage	2.8 kV DC
Surge voltage test (type test), all circuits, class III	5 kV (peak value), 1.2/50 $\mu$ s, 0.5 J, 3 positive and 3 negative surges at intervals of 5 s

EMC tests for noise immunity; type tests	
Standards: IEC 60255-22 (product standard) / EN 50082-2 (generic standard) / DIN VDE 0435, Part 303	
High-frequency test IEC 60255-22-1, class III and DIN VDE 0435 Part 303, class III	2.5 kV (peak value), 1 MHz, $\tau = 15$ $\mu$ s, 400 pulses per s, test duration 2 s
Electrostatic discharge IEC 60255-22-2, class III and EN 61000-4-2, class III	4 kV/6 kV contact discharge, 8 kV air discharge, both polarities, 150 pF, $R_i = 330$ $\Omega$
Irradiation with high-frequency field, unmodulated	10 V/m, 27 to 500 MHz

## Technical data

IEC 60255-22-3 (report), class III	
Irradiation with high-frequency field, amplitude-modulated ENV 50140, class III	10 V/m, 80 to 1000 MHz, 80 %, 1 kHz, AM
Irradiation with high-frequency field, pulse-modulated ENV 5014/ENV 50204, class III	10 V/m, 900 MHz, repetition rate 2000 Hz, ED 50 %
Fast transients, bursts IEC 60255-22-4 and EN 61000-4-4, class III	2 kV, 5/50 ns, 5 kHz, burst length = 15 ms, repetition rate 300 ms, both polarities, $R_i = 50 \Omega$ , test duration 1 min
Line-conducted high frequency, amplitude-modulated ENV 50141, class III	10 V, 150 kHz to 80 MHz, 80 %, 1 kHz, AM
Magnetic field with power frequency EN 61000-4-8, class IV	30 A/m, continuous, 300 A/m for 3 s, 50 Hz

## EMC tests for interference emission; type tests

Standards: EN 50081-2 (generic standard)	
Conducted interference voltages, only auxiliary voltage, CISPR 11, EN 55011, limit value A and DIN VDE 0875, Part 11, limit value A	150 kHz to 30 MHz
Radio interference field strength CISPR 11, EN 55011, limit value A and DIN VDE 0875, Part 11, limit value A	30 to 1000 MHz

## Climatic stress test

Permissible ambient temperature	
During operation	-5 to + 55 °C
During storage	-25 to + 55 °C
During transport	-25 to + 70 °C
Humidity stress	Average annual relative humidity $\leq 75$ %, on 30 days per year up to 95 % relative humidity, condensation not permissible

## Mechanical stress test

IEC 60255-21-1, IEC 60068-2	
Permissible mechanical stress	
During operation	10 to 60 Hz, 0.035 mm amplitude
During transport	60 to 500 Hz, 0.5 g acceleration 5 to 8 Hz, 7.5 mm amplitude 8 to 500 Hz, 2 g acceleration

1) Impedance settings refer to  $I_N = 1$  A;  
at  $I_N = 5$  A these values must be divided by 5.

## Functions

## Distance protection

Setting ranges	
Earth-fault detection	0.1 to 1 (in steps of 0.01)
Earth current $I_E / I_N$	
Displacement voltage $V_E > (= \sqrt{3} \times V_0, \text{ earthed networks})$ $V_E > (= \sqrt{3} \times V_0, \text{ unearthed networks})$	2 to 100 V (in steps of 1 V) 10 to 100 V (in steps of 1 V)
Impedance start ( $Z <$ )	
Characteristic	Polygon
Range forward $X+$	0.1 to 200 $\Omega^{(1)}$ (in steps of 0.01 $\Omega$ )
Range backward $X-$	0.1 to 200 $\Omega^{(1)}$ (in steps of 0.01 $\Omega$ )
Resistance $R$	0.1 to 200 $\Omega^{(1)}$ (in steps of 0.01 $\Omega$ )
Limit angle between load and short-circuit range	30 to 80 ° (in steps of 0.1 °)
Minimum current $I_{ph>} / I_N$	0.1 to 4 (in steps of 0.01)
Overcurrent $I_{ph>>} / I_N$	1 to 20 (in steps of 0.01)
Voltage and angle-dependent overcurrent start ( $V/I / \varphi$ )	
Phase-to-earth voltage $V_{ph-E} (I >)$ in steps of Phase-to-earth voltage $V_{ph-E} (I >>)$	20 to 70 V (in steps of 1 V) 20 to 70 V (in steps of 1 V)
Phase-to-phase voltage $V_{ph-ph} (I >)$ Phase-to-phase voltage $V_{ph-ph} (I >>)$	40 to 130 V (in steps of 1 V) 40 to 130 V (in steps of 1 V)
Minimum current $I_{ph>} / I_N$ Overcurrent $I_{ph>>} / I_N$	0.1 to 1 (in steps of 0.01) 0.25 to 4 (in steps of 0.01)
Limit angle between load and short-circuit range $\varphi$	30 to 60 ° or 90 to 120 °
Distance measurement	
Characteristic	Polygon
Distance zones	5, 2 of these as overreach zones and all can be set forward, backward or non-directional
Range $X$	0.05 to 130 $\Omega$ (in steps of 0.01 $\Omega$ )
Resistance $R$	
For phase-to-phase fault	0.05 to 65 $\Omega$ (in steps of 0.01 $\Omega$ )
For phase-to-earth fault	0.05 to 130 $\Omega$ (in steps of 0.01 $\Omega$ )
Time stages	7 for multi-phase faults 3 for single-phase faults
Ranges	0 to 32 s or deactivated (in steps of 0.01 s)
Earth impedance matching $\frac{X_E}{X_L}, \frac{R_E}{R_L}$	-7 to 7 (in steps of 0.01)
Parallel line matching $\frac{X_M}{X_L}, \frac{R_M}{R_L}$	-7 to 7 (in steps of 0.01)
Load current compensation	-
Direction detection for all types of faults	With sound phase polarization and voltage memory dynamically unlimited
Directional sensitivity	
Times	
Shortest command time	Approx. 18 ms at $f_N = 50$ Hz
Shortest command time	Approx. 16.5 ms at $f_N = 60$ Hz
Reset time	
After TRIP command	Approx. 25 ms
After reset without TRIP command	Approx. 30 ms



## Technical data

**Distance protection (continued)**

Tolerances	
Measuring tolerances to DIN VDE 0435, part 303 (for sinusoidal measured quantities)	
For impedance start	$\frac{\Delta X}{X} \leq 5\%$ for $30^\circ \leq \varphi_{sc} \leq 90^\circ$ $\frac{\Delta R}{R} \leq 10\%$ for $0^\circ \leq \varphi_{sc} \leq 60^\circ$
For distance measurement	$\frac{\Delta X}{X} \leq 5\%$ for $30^\circ \leq \varphi_{sc} \leq 90^\circ$ $\frac{\Delta R}{R} \leq 5\%$ for $0^\circ \leq \varphi_{sc} \leq 60^\circ$
For amplitude measurement	$\pm 5\%$
Timer accuracy	$\pm 1\%$ of setting value or 10 ms

**Instantaneous high-current switch-onto-fault protection**

High current start $I_{sc>} / I_N$	1 to 25
Shortest command time	Approx. 11 ms

**Fault locator**

Output of the distance to fault	In $\Omega$ secondary, $\Omega$ primary, km, %
Start of calculation	Trip, pickup reset, binary input
Setting reactance per unit in steps of 0.01 $\Omega$ /km	0.01 to 5 $\Omega$ /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 $30^\circ \leq \varphi_{sc} \leq 90^\circ$ and $V_{sc} / V_N \geq 0.1$

**Teleprotection for distance protection**

Modes	
Permissible underreach schemes	PUTT transfer trip with fault detector Zone acceleration with Z1B
Permissible overreach methods	POTT, directional comparison: Unblocking with fault detection Unblocking with Z1B Blocking
Overreach zone comparison via pilot wire	–
Reverse interlocking	–

**Power swing blocking/tripping (for impedance start Z<)**

Principle of power swing protection	Measurement of the rate of change of the impedance vector
Modes	Power swing blocking Power swing tripping
Difference power swing and fault detector polygon	0.1 to 50 $\Omega$ (in steps of 0.01 $\Omega$ )
Rate of change $dR/dT$	0 to 200 $\Omega$ /s (in steps of 1 $\Omega$ /s)
Operating time	0.01 to 32 s or until (in steps of 0.01 s) the end of power swing

**Weak-infeed protection with overreach and blocking schemes: active during signal reception without fault detection**

Mode	Echo function and/or trip
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**Overcurrent-time protection**

Characteristic	Definite-time overcurrent protection, inverse-time overcurrent protection	
Applications	As backup protection function, as emergency function with automatic activation following measured voltage failure or voltage transformer mcb trip	
Setting range of definite-time overcurrent protection		
High set	Phase $I_{ph>>} / I_N$ Earth $I_E>>} / I_N$	0.1 to 9.99 (in steps of 0.01) 0.1 to 4 (in steps of 0.01)
Overcurrent	Phase $I_{ph>} / I_N$ Earth $I_E>} / I_N$	0.1 to 9.99 (in steps of 0.01) 0.1 to 4 (in steps of 0.01)
Times $t_{>}, t_{E>}, t_{>>}$		
Shortest command time	0 to 32 s (in steps of 0.01 s) or deactivated Approx. 30 ms	
Setting range of inverse-time overcurrent protection		
High set (DT)	Phase $I_{ph>>} / I_N$ Earth $I_E>>} / I_N$	0.1 to 9.99 (in steps of 0.01) 0.1 to 4 (in steps of 0.01)
Overcurrent (IDMT)	Phase $I_{ph>} / I_N$ Earth $I_{EP} / I_N$	0.1 to 4 (in steps of 0.01) 0.1 to 4 (in steps of 0.01)
Time multiplier $t_p$	0.05 to 32	
Pickup threshold	$1.1 \times I_p$	
Characteristic according to IEC 60255-4, Section 3.5.2 or BS 142	Normal inverse, very inverse, extremely inverse	
Measuring tolerance according to DIN VDE 0435, part 303		
Pickup level	DT IDMT	$\leq \pm 5\%$ Pickup at $1.05 < I/I_p < 1.15$
Time delay	DT IDMT	1 % of setting value or 10 ms $\leq 5\% \pm 15$ ms for $2 \leq I/I_p \leq 20$ and $1 \text{ s} \leq t_p \leq 20 \text{ s}$

**Earth-fault protection for high-resistance earth faults in earthed networks**

Directional earth-fault definite-time protection with non-directional backup protection

Pickup with earth current $I_E>} / I_N$	0.1 to 4 (in steps of 0.01)
Displacement voltage $V_E> (= \sqrt{3} \times V_0)$	0.1 to 10 V (in steps of 1 V)
Direction detection	With $I_E$ and $V_E$ and $I_Y$
Teleprotection method	Direction comparison
Times	
Shortest command time	Approx. 30 ms
Current reversal time	Approx. 30 ms
Trip delay	0 to 32 s or deactivated (in steps of 0.01 s)
Time tolerance	$\leq 1\%$ of setting value or 10 ms
Directional earth IDMTL protection	
Characteristic according to IEC 60255-4, Section 3.5.2 or BS 142	Normal inverse, very inverse, extremely inverse
Pickup value $I_F>} / I_N$	0.1 to 4 (in steps of 0.01)
Time multiplier $t_{E>}$	0 to 32 s (in steps of 0.01)
Tolerances	
Current pickup level	Pickup at $1.05 < I/I_{EP} < 1.15$
Operating times	$\leq 5\%$ for $2 \leq (I/I_E>) \leq 20$ and $1 \text{ s} \leq t_{E>} \leq 20 \text{ s}$

## Technical data

## Auto-reclosure

Number of auto-reclosures	Up to 10
Program	Only 1-pole Only 3-pole 1 or 3-pole
Action times for RAR and DAR cycle	0.01 to 320 s (in steps of 0.01 s)
Dead times in the RAR cycle	0.01 to 320 s (in steps of 0.01 s)
Dead times in DAR cycles	0.01 to 1800 s (in steps of 0.01 s)
Reclaim times	0.5 to 320 s (in steps of 0.01 s)
CLOSE command duration	0.01 to 32 s (in steps of 0.01 s)

## Synchro-check

Modes for connection	
Line dead/busbar dead	$V_1 < / V_2 <$
Line dead/busbar live	$V_1 < / V_2 >$
Line live/busbar dead	$V_1 > / V_2 <$
Synchronism	$V_1 > / V_2 >$
Permissible voltage difference $\Delta V$	1 to 50 V (in steps of 1 V)
Permissible frequency difference $\Delta f$	0.01 to 1 Hz (in steps of 0.01 Hz)
Permissible angle difference $\Delta \varphi$	1 to 60 ° (in steps of 1 °)

## Overvoltage protection

Function	
Voltage measurement, local	
Voltage calculation, for the opposite end (compounding)	
Voltage selection	3 x phase-to-earth voltages or 3 x phase-to-phase voltages
Pickup of the $V \gg$ level	By ANDing the phase-selective start signals or by ORing the phase-selective start signals
Setting ranges	
Voltage threshold $V > / V_N$	1 to 1.9 (in steps of 0.01)
Reset ratio $V_{res} / V >$	0.5 to 0.99 (in steps of 0.01)
Voltage threshold $V \gg / V_N$	1 to 1.9 (in steps of 0.01)
Reset ratio $V_{res} / V \gg$	0.5 to 0.99 (in steps of 0.01)
Times	
$t_{delay >}$	0 to 32 s
$t_{delay \gg}$ with circuit-breaker closed	0 to 32 s (in steps of 0.01 s)
$t_{delay \gg}$ with circuit-breaker open	0 to 32 s (in steps of 0.01 s)
Command time	Approx. 45 ms
Measuring tolerance according to DIN VDE 0435, part 303 (for sinusoidal measured quantities)	$\pm 5 \%$

## Breaker failure protection

Setting ranges	
Current start $I_{BF}/I_N$	0.1 to 4 (in steps of 0.01)
Delay time	0.05 to 1 s (in steps of 0.01 s)
Shortest reset time	Approx. 10 ms
Time tolerance	$\leq 1 \%$ of setting value or 10 ms
Measuring tolerance according to DIN VDE 0435, part 303 (for sinusoidal measured quantities)	$\pm 5 \%$

## Fault recording

Measured quantities	$i_{ph1}, i_{ph2}, i_{ph3}, i_E, V_{ph1}, V_{ph2}, V_{ph3}, V_E$
Start signal for fault recording	Trip, start, binary input, operator panel, PC
Memory management	Dynamic ring buffer
Maximum number of recordings available at one time	8
Sampling interval	20 samples per network cycle
Maximum storage time (sum of all recordings)	
At 50 Hz	10 s
At 60 Hz	8.3 s
Pre-trigger time	0.05 to 0.5 s (in steps of 0.01 s)
Post-fault time	0.05 to 0.5 s (in steps of 0.01 s)
Maximum time for one recording	0.3 to 5 s (in steps of 0.01 s)

## Additional functions

Operational measured values:	
Currents	$I_{ph1}, I_{ph2}, I_{ph3}$
Voltages	$V_{ph1-ph2}, V_{ph2-ph3}, V_{ph3-ph1}, V_{ph1}, V_{ph2}, V_{ph3}$
Power	$P/Q$
Frequency	$f$
Effective range	0 to 240 % x $I_N$ 0 to 120 % x $V_N$ 0 to 120 % x $P_N$ 96 to 104 % x $f_N$
Tolerance	$\leq 2 \%$ of the rated value

## CE conformity

The product meets the stipulations of the guideline of the Council of the European Communities for harmonization of the legal requirements of the member states on electromagnetic compatibility (EMC guide-line 89/336/EEC).

The product conforms with the international standard of the IEC 60255 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.

## Selection and ordering data

Description	Order No.
<b>7SA513 distance protection relay, version V3</b>	<b>7SA513□-□□A2□-0C□□</b>
<i>Rated current for 50/60 Hz AC</i>	
1 A	1
5 A	5
<i>Rated auxiliary voltage</i>	
48 to 60 V DC	2
110 to 125 V DC	4
220 to 250 V DC	5
<i>Unit design</i>	
For panel surface mounting	B
For panel flush mounting or cubicle flush mounting	C
For panel flush mounting or cubicle flush mounting without glass cover	E
<i>Input/output modules (EAH)<sup>1)</sup></i>	
2 EAH: 18 SR, 4 CR, 16 BI	0
3 EAH: 27 SR, 6 CR, 24 BI	1
2 EAH: 12 SR, 2 RR, 4 CR, 16 BI	2
3 EAH: 18 SR, 3 RR, 6 CR, 24 BI	3
<i>Options A</i>	
Without auto-reclosure, without synchro-check	E
With auto-reclosure 1/3-pole, without synchro-check	G
With auto-reclosure 1/3-pole, with synchro-check	H
<i>Options B</i>	
Without earth-fault backup protection for earthed networks	0
With earth-fault backup protection for earthed networks	1

1) SR Signal/Alarm relay, switching power 20 W, 1 A  
 RR Reed relay, switching power 15 W, 0.3 A  
 CR Command relay, switching power 1000 W, 5 A  
 BI Binary input, voltage range 24 to 250 V DC settable.

## Accessories

Description	Order No.
<p><b>DIGSI 4</b></p> <p>Software for configuration and operation of Siemens protection units running under MS Windows (version Windows 95 and higher) device templates, Comtrade Viewer, electronic manual included as well as "Getting started" manual on paper, connecting cables (copper)</p> <p>Basis</p> <p>Full version with license for 10 computers, on CD-ROM (authorization by serial number)</p>	<a href="#">7XS5400-0AA00</a>
<p>Demo</p> <p>Demo version on CD-ROM</p>	<a href="#">7XS5401-0AA00</a>
<p>Professional</p> <p>Complete version:</p> <p>DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation)</p>	<a href="#">7XS5402-0AA00</a>
<p><b>SIGRA</b></p> <p>(generally contained in DIGSI Professional, but can be ordered additionally)</p> <p>Software for graphic visualization, analysis and evaluation of fault records. Can also be used for fault records of devices of other manufacturers (Comtrade format). Running under MS Windows 95/98/ME/NT/2000/XP Professional. Incl. templates, electronic manual with license for 10 PCs. Authorization by serial number. On CD-ROM.</p>	<a href="#">7XS5410-0AA00</a>
<p><b>Connecting cable</b></p> <p>Cable between PC/notebook (9-pin connector) and protection unit (25-pin connector)</p> <p>or</p> <p>Cable between PC/notebook (9-pin connector) and protection unit (9-pin connector)</p> <p>Adaptor 9-/25-pin for 7XV5100-4 cable for protec. unit w. 25-pin connector (cable 7XV5100-4 and adaptor contained in DIGSI 4)</p>	<p><a href="#">7XV5100-2</a></p> <p><a href="#">7XV5100-4</a></p> <p><a href="#">7XV5100-8H</a></p>
<p><b>Manual for 7SA513</b></p> <p>English</p>	<a href="#">C53000-G1176-C103</a>

Connection diagram

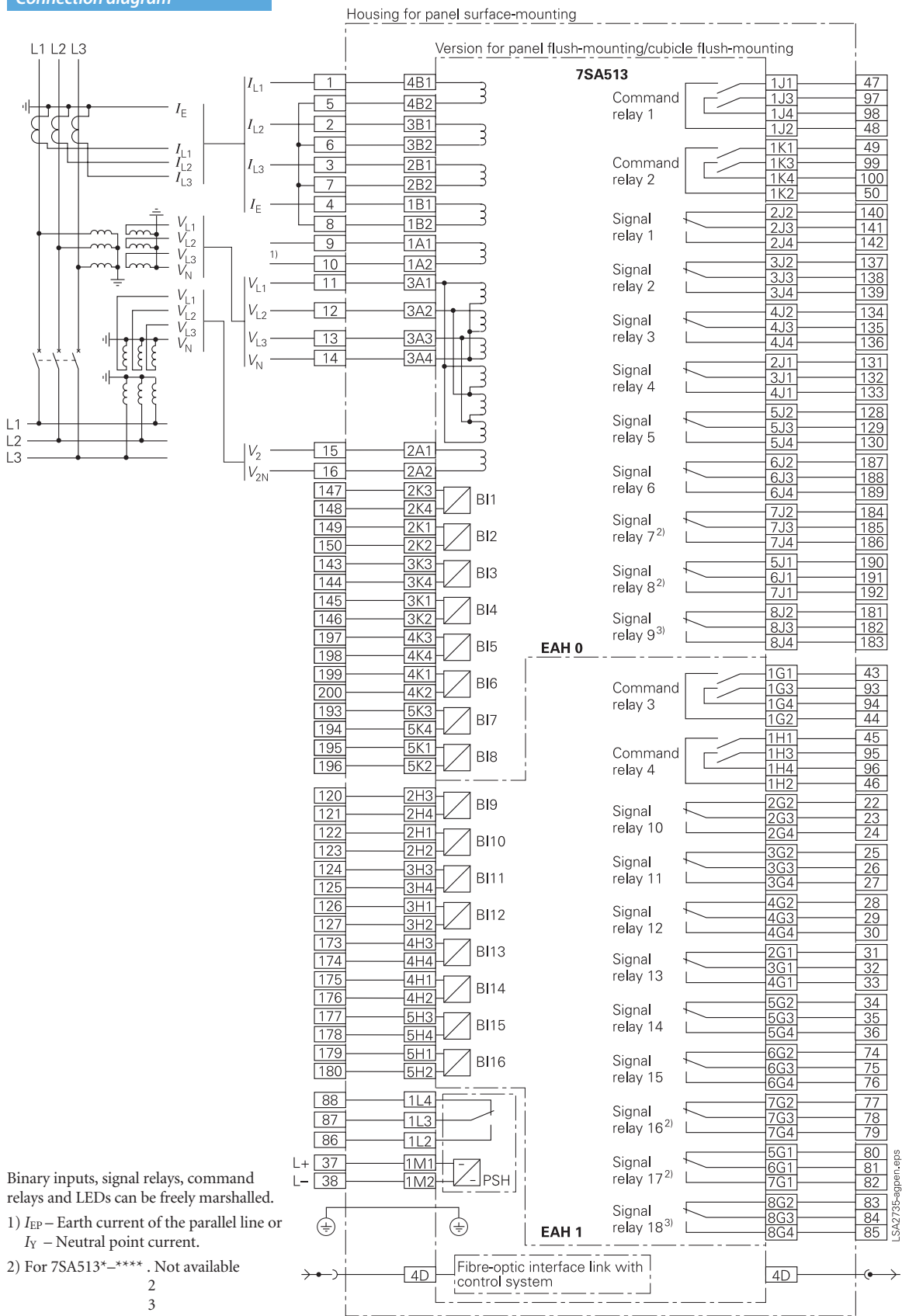


Fig. 6/88 Connection diagram for the 7SA513 distance protection relay for transmission lines, version DD, with 2 input/output modules (for 7SA513 with 3 input/output modules see Fig. 6/89)

Connection diagram

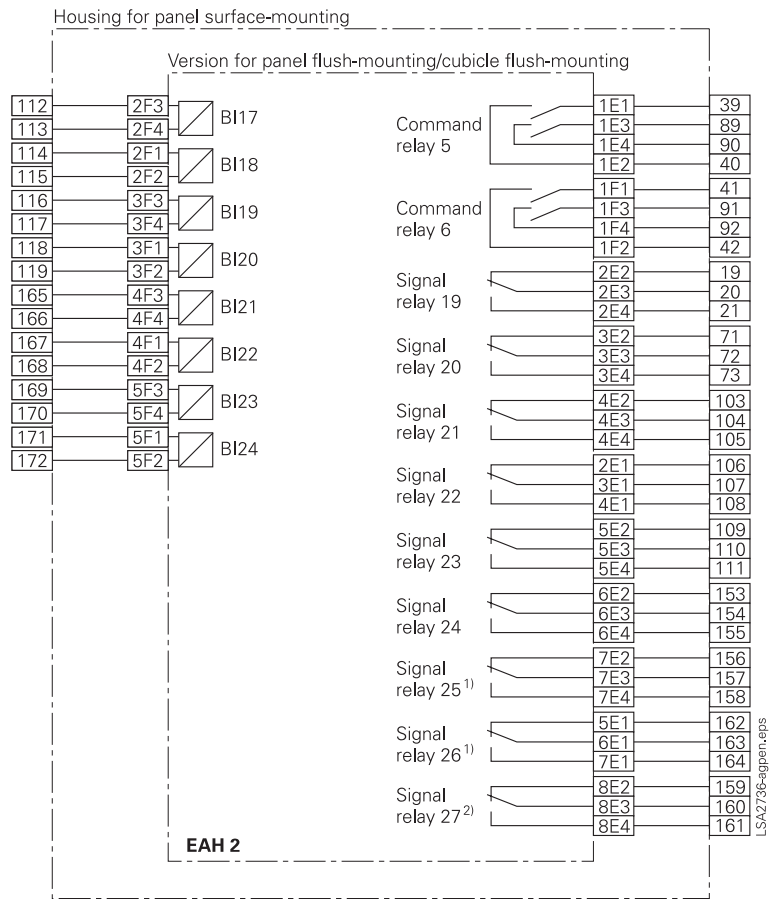


Fig. 6/89 (To be read together with Fig. 6/88)  
 Input/output module EAH2 in the 7SA513 distance protection relay  
 for transmission lines with 3 input/output modules, version DD

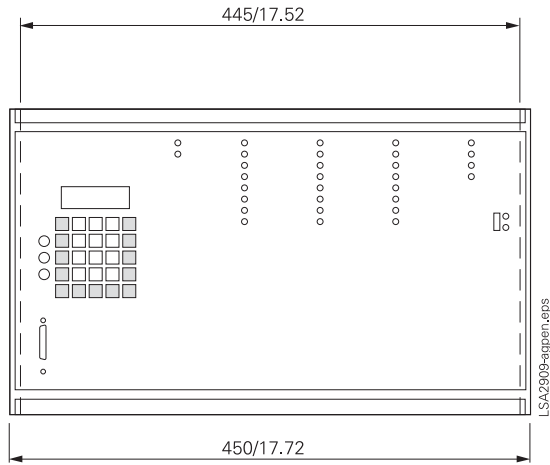
Binary inputs, signal relays, command relays and LEDs can be freely marshalled.

1) For 7SA513\*-\*\*\*\* . Not available  
 2  
 3

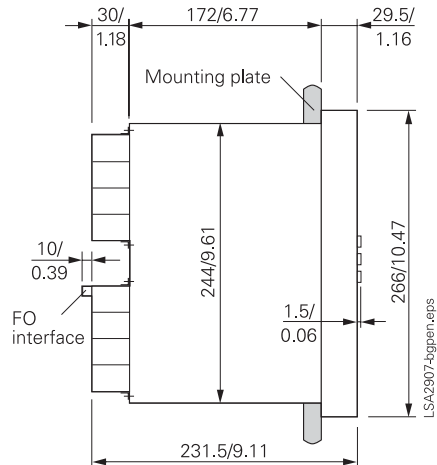
2) For 7SA513\*-\*\*\*\* . Reed relay  
 2  
 3

Dimension drawings in mm / inch

Dimension drawings for SIPROTEC 3  
1/1 x 19" housing



Front view



Side view

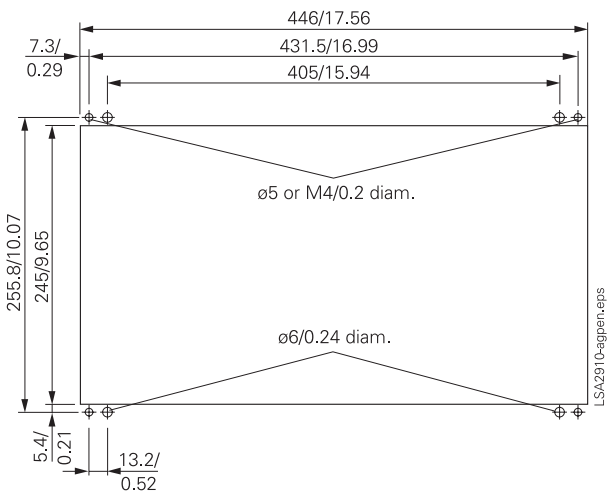


Fig. 16/33  
1/1 x 19" housing  
for panel flush mounting/cubicle mounting

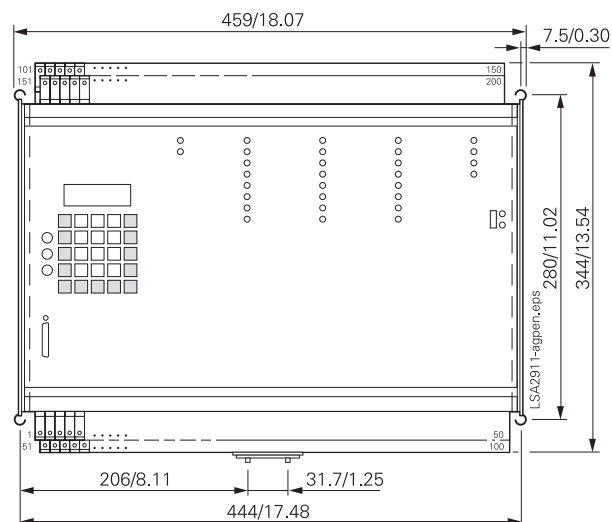


Fig. 16/34  
1/1 x 19" housing for panel surface mounting

