Overcurrent Protection / 7SJ45

SIPROTEC easy 7SJ45 numerical overcurrent protection relay powered by CTs

Function overview

- Operation without auxiliary voltage via integrated CT power supply
- Standard current transformers (1 A/5 A)
- Low power consumption: 1.4 VA at $I_N$ (of the relay)
- Easy mounting due to compact housing
- Easy connection via screw-type terminals

Protection functions

- 2-stage overcurrent protection
- Definite-time and inverse-time characteristics (IEC/ANSI)
- High-current stage $I_{>>}$ or calculated ground-current stage $I_E$ or $I_{EP}$ selectable
- Trip with pulse output (DC 24 V / 0.1 Ws) or relay output (changeover contact)
- Repetition of trip during circuit-breaker failure (relays with pulse output)
- Combination with electromechanical relays is possible due to the emulation algorithm

Monitoring functions

- Hardware and software are continuously monitored during operation

Front design

- Simple setting via DIP switches (self-explaining)
- Settings can be executed without auxiliary voltage – no PC
- Integrated mechanical trip indication optionally

Additional features

- Optional version available for most adverse environmental conditions (condensation permissible)
- Flush mounting or surface (rail) mounting

Description

The SIPROTEC easy 7SJ45 is a numerical overcurrent protection relay which is primarily intended as a radial feeder or transformer protection (backup) in electrical networks. It provides definite-time and inverse-time overcurrent protection according to IEC and ANSI standards. The 7SJ45 relay does not require auxiliary voltage supply. It imports its power supply from the current transformers.

Fig. 5/1  SIPROTEC easy 7SJ45 numerical overcurrent protection relay powered by current transformers (CT)
Overcurrent Protection / 7SJ45

Application, construction

Application

The SIPROTEC easy 7SJ45 is a numerical overcurrent protection relay which is primarily intended as a radial feeder or transformer protection (backup) in electrical networks. It provides definite-time and inverse-time overcurrent protection according to IEC and ANSI standards. The convenient setting with DIP switches is self-explanatory and simple.

The 7SJ45 relay does not require auxiliary voltage supply. It imports its power supply (1.4 VA at \( I_N \), sum of all phases) from the current transformers.

Impulse output for low-energy trip release or contact output for additional auxiliary transformer are available. An optional integrated trip indication shows that a trip occurred.

<table>
<thead>
<tr>
<th>ANSI</th>
<th>IEC</th>
<th>Protection functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>&gt; &gt;</td>
<td>Instantaneous overcurrent protection</td>
</tr>
<tr>
<td>50, 51</td>
<td>&gt; I, ( I_p )</td>
<td>Overcurrent protection (phase)</td>
</tr>
<tr>
<td>50N, 51N</td>
<td>&gt; I, ( I_{SP} )</td>
<td>Overcurrent protection (ground)</td>
</tr>
</tbody>
</table>

Construction

Within its compact housing the protection relay contains all required components for:

- Measuring and processing
- Alarm and command output
- Operation and indication (without a PC)
- Optional mechanical trip indication
- Auxiliary supply from current transformers
- Maintenance not necessary

The housing dimensions of the units are such that the 7SJ45 relays can in general be installed into the existing cutouts in cubicles. Alternative constructions are available (surface mounting and flush mounting). The compact housing permits easy mounting, and a version for the most adverse environmental conditions, even with extreme humidity, is also available.

Fig. 5/2 Typical application

Fig. 5/3 Application in distribution switchgear

Fig. 5/4 Screw-type terminals
Protection functions

The overcurrent function is based on phase-selective measurement of the three phase currents.

The earth (ground) current $I_E$ (Gnd) is calculated from the three line currents $I_{L1}$ (A), $I_{L2}$ (B), and $I_{L3}$ (C).

The relay has always a normal stage for phase currents $I> (50/51)$. For the second stage, the user can choose between a high-current stage for phase currents $I>> (50)$ or a normal stage for calculated ground currents $I_E> (50N/51N)$.

The inverse-time overcurrent protection with integrating measurement method (disk emulation) emulates the behaviour of electromechanical relays.

The influence of high-frequency transients and transient DC components is largely suppressed by the implementation of numerical measured-value processing.

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Available inverse-time characteristics

<table>
<thead>
<tr>
<th>Characteristics acc. to</th>
<th>ANSI/IEEE</th>
<th>IEC 60255-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderately inverse/normal inverse</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Very inverse</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Extremely inverse</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>
Connection diagrams

Pulse output
These relays require a low-energy trip release (DC 24 V/0.1 Ws) in the circuit-breaker, and are intended for modern switchgear. In case of circuit-breaker failure, a repetition of the tripping signal is initiated.

Relay output
These relays can be applied with all conventional switchgear. A transformer that provides the trip circuit energy, must be connected in the current transformer circuit.

Fig. 5/7 Connection of 3 CTs with pulse output

Fig. 5/8 Connection diagram 7SJ45 with impulse output

Fig. 5/9 Connection of 3 CTs with trigger transformer and relay output

Fig. 5/10 Connection diagram 7SJ45 with relay output
## General unit data

### Analog input
- System frequency \( f_N \): 50 or 60 Hz (selectable)

### Current transformer inputs
- Rated current, normal ground current \( I_N \): 1 or 5 A
- Power consumption at \( I_N = 1 / 5 \) A: approx. 1.4 VA at \( I_N \) (relay)
- Thermal (r.m.s.): 50 \( \cdot I_N \) for 1 s, 15 \( \cdot I_N \) for 10 s, 2 \( \cdot I_N \) continuous
- Dynamic (peak): 100 \( \cdot I_N \) for half a cycle, 10 \( \cdot P_10, 0.25 \) VA or according to the requirements and required tripping power

## Output relays

### Pulse output (7SJ45XX-0*)
- Number: 1 pulse output
- DC 24 V / 0.1 Ws

### Relay output (7SJ45XX-1*)
- Number: 1 changeover output
- Make: 1000 W/VA
- Break: 30 VA
- 40 W resistive
- 25 VA at L/R ≤ 50 ms
- Rated contact voltage: ≤ DC 250 V or ≤ AC 240 V
- Permissible current per contact: 5 A continuous, 30 A for 0.5 s (inrush current)

## Unit design

### Housing
- Flush mounting DIN 43700/IEC 61554
- Adaptable for rail mounting (recommended for local mounting only)
- Dimensions (WxHxD) in mm: 78.5 x 147 x 205.8 (incl. transparent cover and terminal blocks)
- Weight (mass) approx.: 1.5 kg

### Protection of personnel
- Front: IP 51
- Rear: IP 20
- Protection of personnel: IP1X

### UL-listing
- Listed under “69CA”.

## Electrical tests

### Specifications
- Standards: IEC 60255 (product standards), ANSI C37.90.0/1/2; UL508

### Insulation tests
- Standards: IEC 60255-5
- Voltage test (routine test): 2.5 kV (r.m.s.), 50 Hz, 1 min
- All circuits except for pulse output-ground
- Voltage test (type test) across open command contacts
- Impulse voltage test (type test) all circuits, class III

### EMC tests for interference immunity: type test
- Standards: IEC 60525-5, IEC 60255-22, EN 50263 (product standards)
- EN 50082-2 (generic standard)
- EN 61000-6-2 IEC 61000-4 (basic standards)

#### High-frequency test
- IEC 60255-22-1, class III
- 2.5 kV (peak); 1 MHz; \( \tau = 15 \) ms; \( R_l = 200 \) Q; 400 surges/s; duration ≥ 2 s

#### Electrostatic discharge
- IEC 60255-22-2, class III
- 4 kV 6/50 ns; 5 kHz; burst duration = 15 ms; repetition rate 300 ms; both polarities; \( R_l = 50 \) Q; duration 1 min

#### Irradiation with radio-frequency field, amplitude-modulated
- IEC 60255-22-3 and IEC 61000-4-3, class III
- 10 V/m; 80 to 1000 MHz; 80%; 1 kHz; AM

#### Radiation with radio-frequency field, pulse-modulated
- IEC 61000-4-3/ENV 50204, class III
- 10 V/m; 1890 MHz; repetition frequency 200 Hz; duty cycle 50%

#### Fast transient interference/bursts
- IEC 60255-22-4 and IEC 61000-4-4, class IV
- Impulse: 1.25/50 µs
- Circuit groups to ground: 2 kV; 42 W, 0.5 µF
- Across circuit groups: 1 kV; 42 W, 0.5 µF

#### Measuring inputs, binary outputs
- IEC 61000-4-5 installation, class III
- Impulse: 1.2/50 µs
- Circuit groups to ground: 2 kV; 42 W, 0.5 µF
- Across circuit groups: 1 kV; 42 W, 0.5 µF

#### Power frequency magnetic field
- IEC 60255-6
- 30 A/m continuous; 300 A/m for 5 s; 50 Hz
- 0.5 mT; 50 Hz

#### Radiated electromagnetic interference
- ANSI/IEEE C37.90.2
- 35 V/m; 25 to 1000 MHz

#### Oscillatory surge withstand capability
- ANSI/IEEE C37.90.1
- Not across open contacts
- 2.5 to 3 kV (peak); 1 to 1.5 MHz damped wave; 50 shots per s; duration ≥ 2 s; \( R_l = 150 \) Q to 200 Q
- 4 to 5 kV; 10150 ns; 50 and 120 surges per ≥ 2 s; both polarities; duration ≥ 2 s; \( R_l = 80 \) Q

## EMC tests for interference emission: type test
- Standard: IEC CISPR 22
- Interference field strength
- IEC CISPR 22
- EN 50081–1* (generic)
- 30 to 1000 MHz, class B
## Technical data

### Mechanical stress tests

**Vibration, shock stress and seismic vibration**

<table>
<thead>
<tr>
<th>During operation</th>
<th>Standards</th>
<th>IEC 60255-21 and IEC 60068-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration</td>
<td>IEC 60255-21-1, class II</td>
<td>Sinusoidal 10 to 60 Hz ± 0.75 mm amplitude; 60 to 150 Hz: 1 g acceleration. Frequency sweep 1 octave/min 20 cycles in 3 perpendicular axes</td>
</tr>
<tr>
<td>Shock IEC 60225-21-2; class I</td>
<td>Semi-sinusoidal 5 g acceleration, duration 11 ms, each 3 shocks in both directions of the 3 axes</td>
<td></td>
</tr>
<tr>
<td>Seismic vibration</td>
<td>IEC 60255-21-3; class I</td>
<td>Sinusoidal 1 to 8 Hz: ± 4.0 mm amplitude (horizontal vector); 1 to 8 Hz: ± 2.0 mm amplitude (vertical vector); 8 to 35 Hz: 1 g acceleration (horizontal vector); 8 to 35 Hz: 0.5 g acceleration (vertical vector); Frequency sweep 1 octave/min 1 cycle in 3 perpendicular axes</td>
</tr>
<tr>
<td>During transport (flush mounting)</td>
<td>Standards</td>
<td>IEC 60255-21 and IEC 60068-2</td>
</tr>
<tr>
<td>Vibration</td>
<td>IEC 60255-21-1, class II</td>
<td>Sinusoidal 5 Hz to 8 Hz: ± 7.5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration. Frequency sweep 1 octave/min 20 cycles in 3 perpendicular axes</td>
</tr>
<tr>
<td>Shock IEC 60225-21-2, class 1</td>
<td>Semi-sinusoidal 15 g acceleration, duration 11 ms, each 3 shocks in both directions of the 3 axes</td>
<td></td>
</tr>
<tr>
<td>Continuous shock</td>
<td>IEC 60255-21-2, class 1</td>
<td>Semi-sinusoidal 10 g acceleration, duration 16 ms, each 1000 shocks in both directions of the 3 axes</td>
</tr>
</tbody>
</table>

### Climatic stress tests

**Temperatures**

<table>
<thead>
<tr>
<th>Temperatures during service</th>
<th>–20 °C to +70 °C / –4 °F to +158 °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible temperature during storage</td>
<td>–20 °C to +55 °C / –4 °F to +131 °F</td>
</tr>
<tr>
<td>Permissible temperature during transport</td>
<td>–25 °C to +55 °C / –13 °F to +131 °F</td>
</tr>
</tbody>
</table>

**Humidity**

- **Permissible humidity class (standard)**: Annual mean value ≤ 75 % relative humidity; on 30 days per year up to 95 % relative humidity; condensation not permissible.
- **Permissible humidity class (condensation proof)**: Condensation is permissible according to IEC 60654-1, class III.

### Functions

#### Overcurrent protection

**Definite time (DT O/C ANSI 50/51)**

<table>
<thead>
<tr>
<th>Setting range / steps</th>
<th>Current pickup (I_p) (phases)</th>
<th>2 (I_n) to 20 (I_n) or deactivated, step 0.5 (I_n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-phase supply: see note*</td>
<td>0.5 (I_n) to 6.2 (I_n) or deactivated, step 0.1 (I_n)</td>
</tr>
<tr>
<td></td>
<td>3-phase supply: see note*</td>
<td>0.5 (I_n) to 6.2 (I_n) or deactivated, step 0.1 (I_n)</td>
</tr>
<tr>
<td></td>
<td>Delay times (T&gt;T_p)</td>
<td>0 to 1575 ms, step 25 ms</td>
</tr>
<tr>
<td></td>
<td>Delay times (D) (ANSI)</td>
<td>0 to 6300 ms, step 100 ms</td>
</tr>
</tbody>
</table>

**Inverse time (IEC or ANSI 51)**

<table>
<thead>
<tr>
<th>Setting range / steps</th>
<th>Current pickup (I_p) (phases)</th>
<th>0.5 (I_n) to 4 (I_n) or deactivated, step 0.1 (I_n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-phase supply: see note*</td>
<td>0.5 (I_n) to 4 (I_n) or deactivated, step 0.1 (I_n)</td>
</tr>
<tr>
<td></td>
<td>(ground calculated)</td>
<td>0.05 to 3.15 s, step 0.05 s</td>
</tr>
<tr>
<td></td>
<td>Delay times (T_T) (IEC)</td>
<td>0.5 to 15.00 s, step 0.25 s</td>
</tr>
</tbody>
</table>

**Trip times**

- Total time delay impulse output: approx. 32 ms
- Total time delay relay output: approx. 38 ms
- Reset ratio: approx. 0.95 (with definite time), approx. 0.91 (with inverse time)

**Tolerances**

- Definite time (DT O/C 50/51)
  - Current pickup \(I_p\) (phases)
  - 3-phase supply: see note*
  - Delay times \(T>T_p\) (IEC)
- Inverse time (IEC or ANSI 51)
  - Pickup thresholds
  - Time behavior for \(2 \times I_p < 20 \times I_n\)
- Deviation of the measured values: as a result of various interferences
  - Frequency in the range of \(0.95 < \frac{f}{f_n} < 1.05\)
  - Frequency in the range of \(0.9 < \frac{f}{f_n} < 1.1\)
  - Harmonics up to 10 % 3rd and 5th harmonic
  - DC components
  - Temperature in the range of \(-5 °C to 70 °C / 23 °F to 158 °F\)

**Overrange protection**

- Setting range / steps
- Delay times
- Trip times
- Delay times

*Note: The device allows minimum setting values of 0.5 \(I_n\) (3-phase). With single supply, operation is ensured from 0.8 \(I_n\) (7SJ45XX-0*; pulse output) or 1.3 \(I_n\) (7SJ45XX-1*; relay output) onwards (printed on the front).*
### CE conformity

This product is in conformity with the Directives of the European Communities on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EG, previous 89/336/EEC). This unit conforms to the international standard IEC 60255. The unit has been developed and manufactured for application in an industrial environment according to the EMC standards.

### Selection and ordering data

#### Description

<table>
<thead>
<tr>
<th>Description</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIPROTEC easy 7SJ45 numerical overcurrent protection relay powered by CTs</td>
<td>7SJ450-00-0AA</td>
</tr>
</tbody>
</table>

#### Current transformer $I_N$

<table>
<thead>
<tr>
<th>Value</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A</td>
<td>1</td>
</tr>
<tr>
<td>5 A</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Trip

<table>
<thead>
<tr>
<th>Feature</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse output (for further details refer to &quot;Accessories&quot;)</td>
<td>0</td>
</tr>
<tr>
<td>Relay output (for further details refer to &quot;Accessories&quot;)</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Unit design

<table>
<thead>
<tr>
<th>Design</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>For rail mounting</td>
<td>B</td>
</tr>
<tr>
<td>For panel flush mounting</td>
<td>E</td>
</tr>
</tbody>
</table>

#### Region-specific functions

<table>
<thead>
<tr>
<th>Region</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region World, 50/60 Hz; standard</td>
<td>A</td>
</tr>
<tr>
<td>Region World, 50/60 Hz; condensation-proof</td>
<td>B</td>
</tr>
</tbody>
</table>

#### IEC / ANSI

<table>
<thead>
<tr>
<th>Standard</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC</td>
<td>0</td>
</tr>
<tr>
<td>ANSI</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Indication (flag)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without</td>
<td>0</td>
</tr>
<tr>
<td>With</td>
<td>1</td>
</tr>
</tbody>
</table>

### Accessories

#### Protection relay with pulse output

<table>
<thead>
<tr>
<th>Description</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low energy trip release</td>
<td>3AX1104-2B</td>
</tr>
</tbody>
</table>

#### Protection relay with relay output

<table>
<thead>
<tr>
<th>Description</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary transformers for the trip circuit (30 VA CTs recommended)</td>
<td>4AM5065-2CB00-0AN2, 4AM5070-8AB00-0AN2</td>
</tr>
<tr>
<td>1 A</td>
<td>4AM5065-2CB00-0AN2</td>
</tr>
<tr>
<td>5 A</td>
<td>4AM5070-8AB00-0AN2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current transformer-operated trip release</td>
<td>3AX1102-2A, 3AX1102-2B</td>
</tr>
<tr>
<td>0.5 A (rated operating current)</td>
<td>3AX1102-2A</td>
</tr>
<tr>
<td>1 A (rated operating current)</td>
<td>3AX1102-2B</td>
</tr>
</tbody>
</table>