Low Voltage Products

Motor Protection Relay, SPEM
Motor Protection Relay SPEM

In designing the SPEM motor protection relay the principle aim has not only been to fully protect the motor, but also to reduce down time to a minimum.

TCM - Thermal Capacity Memory
The SPEM relay is based on microprocessor techniques with a built in logic supervising thermal behaviour of motor.

The thermal capacity memory monitors the motor current and continuously compares the data to the known thermal record of the motor, and operates when the thermal limit of the motor is exceeded.

The microprosessor based construction ensures long time stability, high accuracy and disturbance free operation.

The compact size enables installation in cramped places.

Protection
SPEM offers protection in the following ways:
• Thermal Overload Protection with complete Thermal Capacity Memory (TCM)
• Start-up Current Protection
• Under Current Protection
• Unbalance Protection
  - phase unbalance
  - phase failure
  - incorrect phase sequence
• Earth Fault Protection
• Self Supervision
• Fail Safe Operation

Applications
The SPEM relay is the ideal answer to problems requiring more versatile or accurate protection for a motor than can be offered by a standard thermal overload relay. SPEM relays can be used for protecting low voltage squirrel cage (AC) motors

Use of SPEM motor protection relay:
- helps in extending life time of motor
- helps in optimizing motor size
- helps in planning maintenance work
- protects the drive from mechanical damage

EMC-tested
Tested according to EMC-directive No: 89/336/EEC.

1) In the following cases please contact the manufacturer:
  - Frequency Converters
  - Star-Delta Starters
  - Soft Starters
  - Power Factor Correction Banks (PFC)
Thermal Overload Protection

Provides reliable protection for motor starting as well as for heavy and repeated starting.

The microprocessor is continuously calculating the thermal capacity available in the motor:

1) starting
2) overloading
3) stand still (even after tripping)

Tripping takes place, when the thermal capacity of motor is exceeded i.e. motor current is higher than $1.05 \times$ full load current $I_\theta$. Refer to the thermal tripping characteristics below.

Thermal tripping characteristics:

Without prior load (Cold curve)

Cooling time-constant = $4 \times$ the heating time-constant

With prior load $0.9 \times I_\theta$ (Hot curve)
Start-Up Current Protection

The relay trips if the thermal capacity of motor is exceeded during starting. The tripping curve is defined by the preset maximum starting time \( t \) (time). In the hot state SPEM’s TCM takes into account also the thermal history of the motor during starting.

The maximum motor starting times are available from the motor manufacturers. If the preset maximum starting time exceeds 1.7 x the real motor starting time, SPEM allows two starts in the cold state and one in the hot state.

Under Current Protection

Provides protection against a sudden loss of loads e.g.
- Dry running pumps
- Broken conveyer belts

This feature can be selected by means of switch S2 \((I \leq \text{OFF/ON})\) on the front panel of the SPEM relay (see page 6.)

After tripping, if there is less than 60 % of motor capacity available, SPEM does not allow a new start until the motor cools down (restart inhibit). In this case, a new start is possible approximately after 30 s.

Unbalance Protection

Provides protection against:
1. Phase unbalance
2. Phase failure
3. Incorrect phase sequence
Earth Fault Protection

(SPEM40_ and SPEM50_ types)

- Provides an indication of a defect in motor winding. Motor can remain in operation if necessary from process point of view.

- The maintenance of the motor can be postponed to an appropriate time.

By all means of switch S3 (I₀/ TRIP) on the front panel of SPEM, it is possible to select either tripping and signalling or only signalling in case of earth fault failure.

If only signalling is selected, there will be no tripping of the SPEM relay but the signalling contact (9-10) of the relay operates.

In case a tripping function is selected and the SPEM relay has tripped, it will be automatically reset after 200 ms when automatic reset is selected from switch S1 (Reset A/M).

Time lag 1 second for eliminating short time failures.

The tripping level for the earth fault current can be set with the potentiometer I₀ / Iₙ on the front panel of the SPEM relay.

Self Supervision

The functions of the electronic circuits are continuously supervised by means of a hardware watchdog.

In case of an internal fault, contact 9-10 closes giving an alarm and contact 11-12 remains in its position keeping the motor circuit closed, and enabling continuation of the process.

Fail Safe Operation

In case of loss of external auxiliary voltage, the motor protection relay trips and can be taken into operation after reconnection of the auxiliary voltage.

After reconnection of auxiliary voltage supply, the SPEM considers the situation as 75 % of the thermal capacity of motor would have been used.

Every time when the auxiliary voltage will be connected, contact 9-10 closes for a short period of time (10 ms) giving an “OK” signal e.g. to PLC.
Presetting

**t₆**
Adjustability from 2 s to 30 s. Information from motor manufactures.

**Switches S1...S8**

**S1**
**Automatic or manual resetting**
The SPEM is always automatically reset, when tripping takes place caused by thermal overload or start-up current protection. Otherwise either manual or automatic resetting.

Manual resetting by operating S1 from manual position to automatic position and back to manual position.

**S2**
**Undercurrent protection OFF/ON**
Whether underload protection is required or not.

**S3**
**Alarm/trip from earth fault**
Selection of alarm or tripping and alarm.

**S4...S8**
**Full load current (Iᵣ) preset.**
Operation of dipswitches to ON-position by moving to the right.

Selectable from 60 % up to 122 % with accuracy of +/− 1 %.

Steps are:
- 60 % (fixed)
- 32 %
- 16 %

**Earth fault**
(SPEM 40_ and SPEM 50_types). Adjustability from 20 % to 60 % of rated zero sequence (SPEM 40_) or residual (SPEM 50_) current. See table on the page 8.

**Setting of full load current preset in percentage (Iᵣ %) and adjustment of current transformers.**

The functions (except earth fault protection) are based on full load current, which is the maximum allowed continuous on load current of the motor. The presets, in percent, can be calculated from the following formula:

\[ I_{\theta} % = \frac{I_{\theta}}{I_{CT}} \times 100 \% \]

- \( I_{\theta} % \) = full load current preset in percentage
- \( I_{\theta} \) = maximum allowed continuous on load current = full load current
- \( I_{CT} \) = rated primary current of current transformer

**Example:**
ABB motor M2BA 315 SMC 4B3

\( P_n = 160 \text{ kW}, I_n = 282 \text{ A}, 400 \text{ V} \) used with 5 % overload allowed by the manufacturer

Full load current: \( I_{\theta} = 282 \text{ A} \times 1.05 = 296 \text{ A} \)

SPEM type selected from the table on page 9, SPEM40 B310 (with earth fault protection) setting value:

\[ I_{\theta} = \frac{296 \text{ A}}{310 \text{ A}} \times 100 \% = 95 \% \]

Select switches S8 and S4. Fixed 60% no need to select.

\((60 + 32 +2) % = 94 \% < 95 \%\)

The \( t_6 \) time for the motor: M2BA 315 SMC 4B3 is 15 s (information from motor manufacturer).
**Front panel indicators**

**Failure indications:**
When there is a failure, the relay trips and the yellow “OK” LED goes out and the correspondent red LED failure indication shows.

Indicates when relay permits starting (steady yellow light).

**Tripping caused by:**

**Thermal overload, start-up current**
- Steady red light on the middle LED
- Always automatically reset
- The “tripped” indication cancels when the motor is restarted

**Phase unbalance**
- Irregular red flash of the middle LED
- Automatic or manual reset
- The “tripped” indication cancels when the motor is restarted

**Under current**
- Steady red flash of the middle LED
- Automatic or manual reset
- The “tripped” indication cancels when the motor is restarted

**Earth fault**
- Steady red light on the lower LED
- Automatic or manual reset
- The earth fault indication cancels when the motor is restarted or if the fault disappears.

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### SPEM function chart

<table>
<thead>
<tr>
<th>PROTECTION</th>
<th>PRESETTING</th>
<th>INDICATION</th>
<th>FUNCTION Tripping</th>
<th>Alarm</th>
<th>RESETTING</th>
<th>Automatic</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THERMAL OVERLOAD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>- overload</td>
<td>$I_{n}$, %</td>
<td>S4..S8</td>
<td>Steady light</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- start-up current</td>
<td>$I_t$ / s</td>
<td>Upper</td>
<td>Middle LED</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>potentiom.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UNDER CURRENT</strong></td>
<td>OFF/ON</td>
<td>S2, S4..S8</td>
<td>Steady flash</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UNBALANCE</strong></td>
<td>$I_{n}$, %</td>
<td>(S4..S8)</td>
<td>Irregular flash</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- phase interrupt</td>
<td></td>
<td></td>
<td>Middle LED</td>
<td></td>
<td></td>
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<td></td>
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<td>- single phase</td>
<td></td>
<td></td>
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<td></td>
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<td>- incorrect phase</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EARTH FAULT</strong></td>
<td>$I_{n}$ / $I_n$</td>
<td>Lower</td>
<td>Steady light</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Alarm / Trip</td>
<td>potentiom.</td>
<td>Lower LED</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>S3</td>
<td>S3</td>
<td></td>
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<tr>
<td><strong>SELF SUPERVISION</strong></td>
<td>-</td>
<td>-</td>
<td>Self resetting</td>
<td>-</td>
<td></td>
<td>Self</td>
<td></td>
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<tr>
<td>Internal fault</td>
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<td>-</td>
<td></td>
<td></td>
<td></td>
<td>resetting</td>
<td></td>
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<tr>
<td><strong>FAIL SAFE</strong></td>
<td>-</td>
<td>-</td>
<td>Upper “OK” OFF</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OPERATION</td>
<td>-</td>
<td>-</td>
<td>LED</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failure of auxiliary voltage</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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When the relay is reset (manually or automatically), the “OK” LED lights again. Failure indications go out, when the motor is restarted.
**Motor Protection Relay SPEM**

**Technical Data**

### Thermal overload unit
- Setting of full load current $I_\theta$
- Resolution of full load setting: 2 %
- Setting of maximum stall time at 6 times $I_\theta$: 2...30 s
- Cooling time constant at zero current (standstill): 4 x heating time constant

### Undercurrent unit
- Operating value: 12...55 % of $I_\theta$
- Operating time: 10 s
- Resetting time: 1 s

### Undercurrent unit
- Setting of full load current $I_\theta$
- Resolution of full load setting: 2 %
- Setting of maximum stall time at 6 times $I_\theta$: 2...30 s
- Cooling time constant at zero current (standstill): 4 x heating time constant

### Phase unbalance unit
- Basic sensitivity, fully stabilized to phase current levels between $I_n$ and 4 x $I_n$, typical value: 30 %
- Operating time at pickup level: 30 s
- Operating time at full unbalance: 6 s
- Resetting time: 1 s

### Earth fault unit
- Zero-sequence / residual current setting $I_0$
- Operating time: 1 s
- Resetting time: 0.2 s

### Auxiliary power supply $U_{aux}$
- Supply voltage on standard relay:
  - SPEM_B_: 220...240 V AC
  - SPEM_C_: 110...120 V AC
- Power consumption: 3 VA

### Output contact ratings
- Rated voltage, make and break: 230 V AC
- Make and carry for 1 s: 30 A
- Continuous load: 5 A
- Breaking capacity: 5 A

### Environmental conditions
- Specified ambient service temperature: -10°...+55° C
- Transport and storage temperature range: -40°...+70° C

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*Type designation key*

<table>
<thead>
<tr>
<th>SPEM</th>
<th>4</th>
<th>0</th>
<th>B</th>
<th>1</th>
<th>0</th>
<th>5</th>
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</table>

#### Nom. current with CT

<table>
<thead>
<tr>
<th>$I_n$</th>
<th>$I_n$ - range</th>
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<tbody>
<tr>
<td>0 6 0</td>
<td>60 A</td>
</tr>
<tr>
<td>1 0 5</td>
<td>105 A</td>
</tr>
<tr>
<td>1 8 5</td>
<td>185 A</td>
</tr>
<tr>
<td>3 1 0</td>
<td>310 A</td>
</tr>
<tr>
<td>4 0 0</td>
<td>400 A</td>
</tr>
<tr>
<td>5 0 0</td>
<td>500 A</td>
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#### Aux. supply

<table>
<thead>
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<th>$U_{aux}$</th>
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</thead>
<tbody>
<tr>
<td>B: 220...240 V</td>
</tr>
<tr>
<td>C: 110...120 V</td>
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</table>

#### Earth fault protection

<table>
<thead>
<tr>
<th>Type</th>
<th>Protection Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>No earth fault protection</td>
</tr>
<tr>
<td>4</td>
<td>Zero-sequence earth fault protection (by measuring only the phase currents)</td>
</tr>
<tr>
<td>5</td>
<td>Earth fault protection by using the residual current transformer</td>
</tr>
</tbody>
</table>

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1) In types SPEM 40_ and SPEM 50_.
2) Rated residual current in types SPEM 50_ is 1 A (with continuous withstand capability 2A and thermal withstand for 1 second 40 A).
Motor Protection Relay SPEM

**Ordering Information**

The connection cable between SPEM and current transformer can be shortened but not made longer. Cable length approx. 75 cm.

**Supply voltage 230 V 50...60 Hz.**

Current transformer included.

<table>
<thead>
<tr>
<th>Rated current $I_n$ [A]</th>
<th>Rated current range $l_n$ [A]</th>
<th>Max. setting of $I_n$ [%]</th>
<th>Earth fault protection</th>
<th>Type</th>
<th>Order number</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>4.5...63</td>
<td>106</td>
<td>-</td>
<td>SPEM30B060 1SCA022388R3120</td>
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<tr>
<td>105</td>
<td>63...111</td>
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<td>SPEM30B105 1SCA022388R5090</td>
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<tr>
<td>185</td>
<td>111...186</td>
<td>102</td>
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<td>SPEM30B185 1SCA022388R5170</td>
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<tr>
<td>310</td>
<td>186...310</td>
<td>100</td>
<td>-</td>
<td>SPEM30B310 1SCA022388R5250</td>
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</tr>
<tr>
<td>400</td>
<td>240...400</td>
<td>100</td>
<td>-</td>
<td>SPEM30B400 1SCA022388R5330</td>
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<tr>
<td>500</td>
<td>300...500</td>
<td>100</td>
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<td>SPEM30B500 1SCA022388R5410</td>
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<tr>
<td>60</td>
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<td>111...186</td>
<td>102</td>
<td>185</td>
<td>SPEM40B185 1SCA022388R6310</td>
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<tr>
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<td>186...310</td>
<td>100</td>
<td>310</td>
<td>SPEM40B310 1SCA022388R6490</td>
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<tr>
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<td>SPEM40B400 1SCA022388R6570</td>
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<tr>
<td>500</td>
<td>300...500</td>
<td>100</td>
<td>500</td>
<td>SPEM40B500 1SCA022388R6650</td>
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</table>

**Supply voltage 110 V 50...60 Hz.**

Current transformer included.

<table>
<thead>
<tr>
<th>Rated current $I_n$ [A]</th>
<th>Rated current range $l_n$ [A]</th>
<th>Max. setting of $I_n$ [%]</th>
<th>Earth fault protection</th>
<th>Type</th>
<th>Order number</th>
</tr>
</thead>
<tbody>
<tr>
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<td>105</td>
<td>63...111</td>
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<td>SPEM50C105 1SCA022388R7460</td>
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<td>185</td>
<td>111...186</td>
<td>102</td>
<td>185</td>
<td>SPEM50C185 1SCA022388R7540</td>
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<tr>
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<td>240...400</td>
<td>100</td>
<td>400</td>
<td>SPEM50C400 1SCA022388R7710</td>
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<td>300...500</td>
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<td>SPEM50C500 1SCA022388R7890</td>
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<td>4.5...63</td>
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<td>SPEM50C060 1SCA022388R8000</td>
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<td>500</td>
<td>SPEM50C500 1SCA022388R8510</td>
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</table>
Primary windings for lower rated currents

Only for types SPEM_060

<table>
<thead>
<tr>
<th>Current range $I_n$ [A]</th>
<th>Turns around current transformer [turns]</th>
<th>Max. setting of $I_n$ [%]</th>
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<tbody>
<tr>
<td>4.5...7.5</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>7.2...12.0</td>
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<td>100</td>
</tr>
<tr>
<td>12.0...20.0</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>18.0...36.0</td>
<td>2</td>
<td>120</td>
</tr>
<tr>
<td>36.0...63.6</td>
<td>1</td>
<td>106</td>
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</tbody>
</table>

Motor Protection Relay SPEM
Connection Diagrams
Motor Protection Relay SPEM
Connection Diagrams

Direct on line starters

Connection diagram with a separate residual current transformer
Motor Protection Relay SPEM
Dimension Drawings

The technical data and dimensions are valid at the time of printing. We reserve the right to subsequent alterations.