Low Voltage Products

Motor Protection Relay, SPEM

SPEM 1 GB 01-06

Motor Pr otection 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.

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[1)].

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

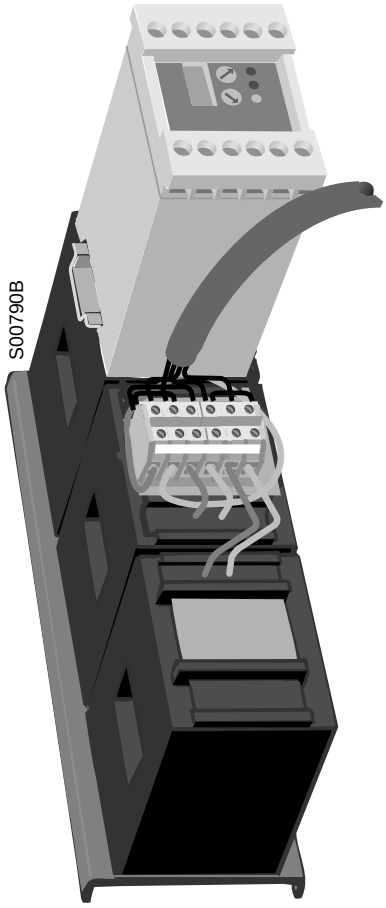
EMC-tested

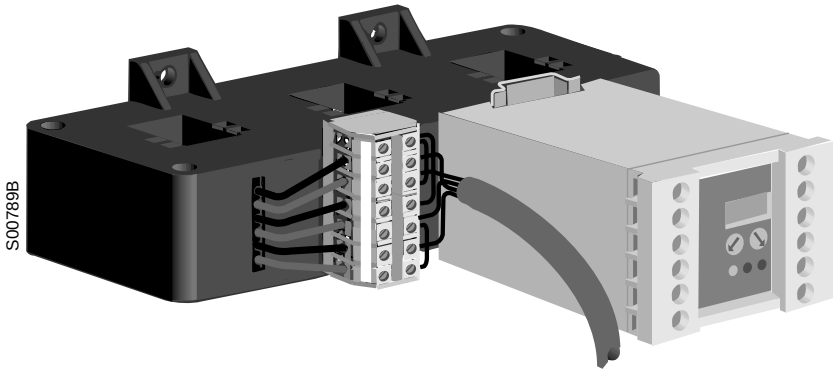
Tested according to EMC-directive
No: 89/336/EEC.

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

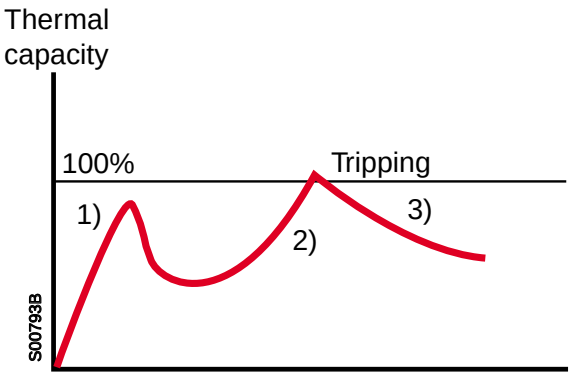


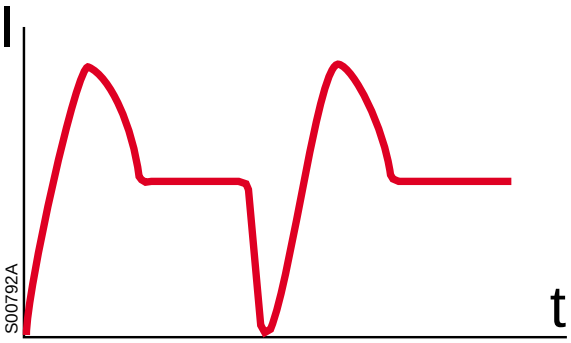


[1)] **In the following cases please contact the manufacturer:**
- **Frequency Converters**
- **Star-Delta Starters**
- **Soft Starters**
- **Power Factor Correction Banks (PFC)**

Thermal Overload Protection

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



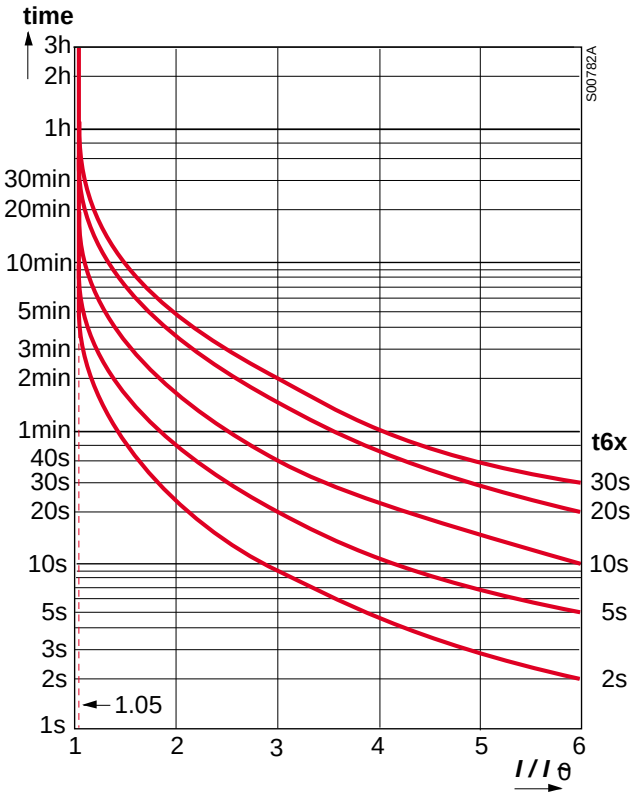


The microprocessor is continuously calculating the thermal capacity available in the motor:

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

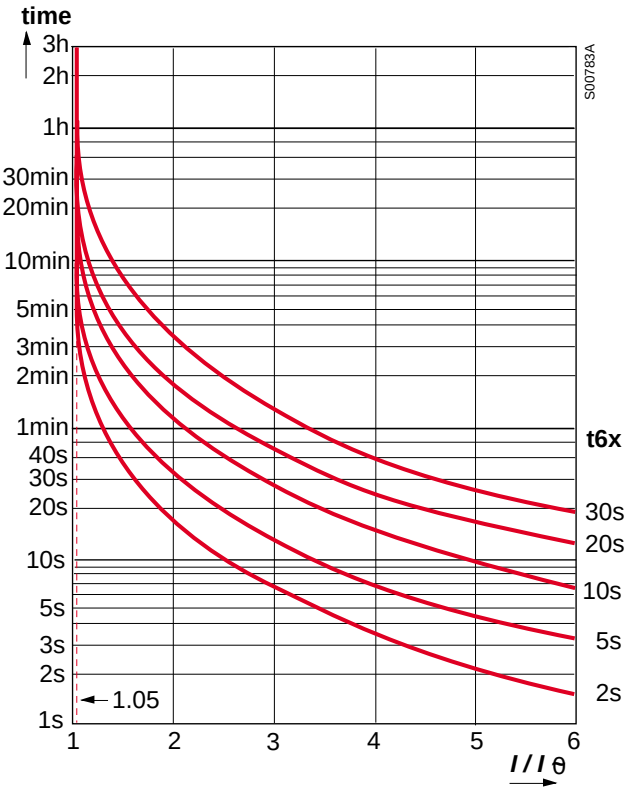
Tripping takes place, when the thermal capacity of motor is exceeded i.e. motor current is higher than 1.05 x full load current I_θ. Refer to the thermal tripping characteristics below.

Thermal tripping characteristics:



Without prior load (Cold curve)

Cooling time-constant = 4 x the heating time-constant

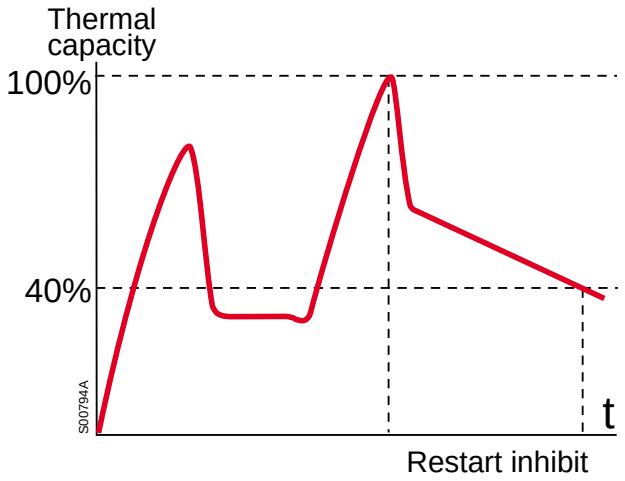


With prior load 0.9 x I_θ (Hot curve)

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_6 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.

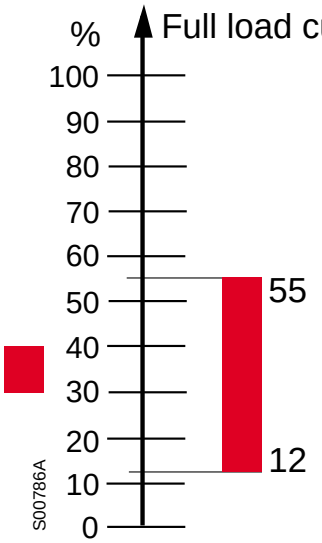


Under Current Protection

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

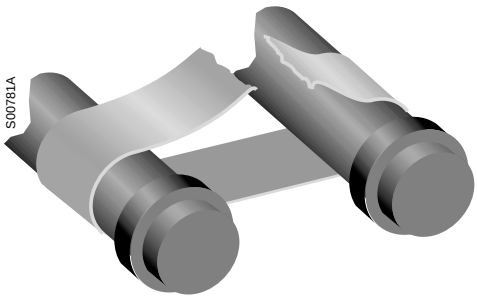
This feature can be selected by means of switch S2 (I ≤ OFF/ON) on the front panel of the SPEM relay (see page 6.)

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.



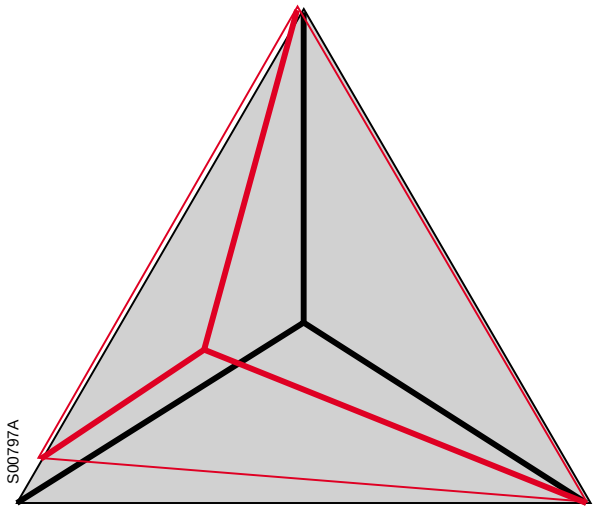
Typical off load current for large and medium sized motors.

Tripping is activated if the current stays between 12...55% of full load current (I_θ) longer than 10 s.

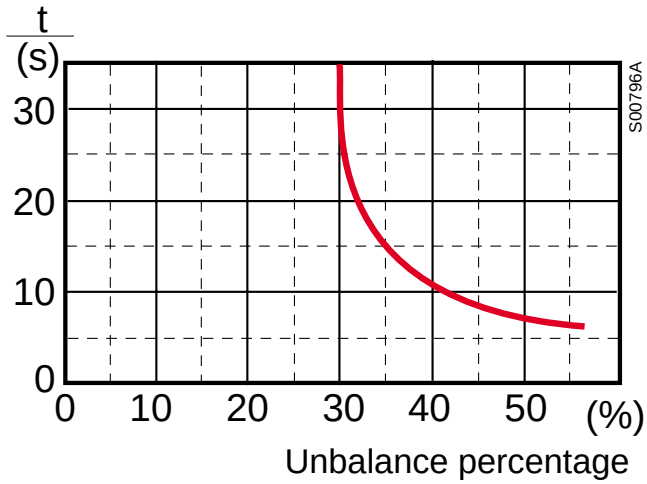


Unbalance Protection

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



In case of complete phase failure or incorrect phase sequence, the tripping time is 6 s. Otherwise according to the curve shown.



The time-lag of the unbalance / singlephasing unit.

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 (I_0 / 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 I_0 / I_n 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.

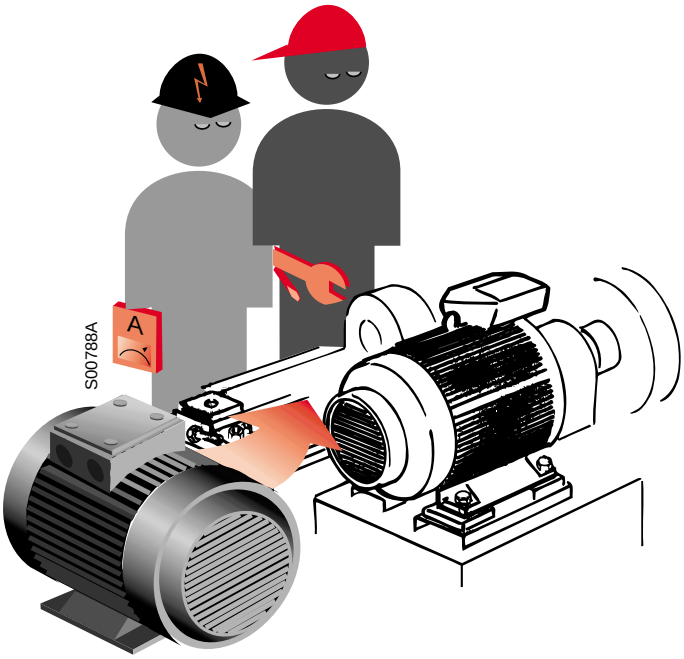
In case of an internal fault, contact 9-10 closes giving an alarm and contact 11-12 remains in its position keeping the motor circuit closed, and enabling continuation of the process.

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.

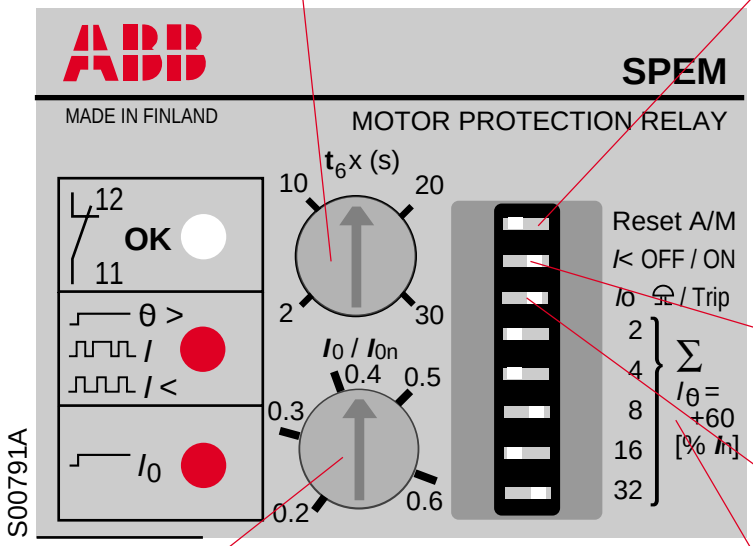
Every time when the auxiliary voltage will be connected, contact 9 -10 closes for a short period of time (10 ms) giving an “OK” signal e.g. to PLC.



Presetting

t_6 time

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



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.

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 (I_q) 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)	8 %
32 %	4 %
16 %	2 %

Setting of full load current preset in percentage (I_θ %) and adjustement 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_θ % = full load current preset in percentage
I_θ = maximum allowed continous on load current = full load current
I_{CT} = rated primary current of current transformer

Example:

ABB motor M2BA 315 SMC 4B3

P_n = 160 kW, I_n = 282 A, 400 V used with 5 % overload allowed by the manufacturer

Full load current: I_θ = 282 A x 1.05 = 296 A

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

$$I_\theta = \frac{296\ A}{310\ A} \times 100\,\% = 95\,\%$$

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).

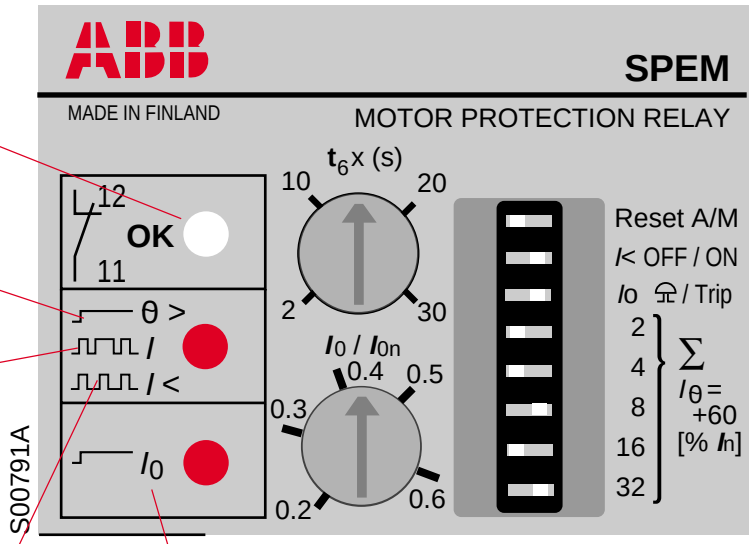
Front panel indicators

Failure indications:

When there is a failure, the relay trips and the yellow “OK” LED goes out and the correspondant red LED failure indication shows.

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

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 re started or if the fault disappears.

SPEM function chart

PROTECTION	PRESETTING		INDICATION		FUNCTION Tripping	FUNCTION Alarm	RESETTING Automatic	RESETTING Manual
THERMAL OVERLOAD - overload - start-up current	$I_θ$ % t_6 / s	S4..S8 Upper potentiom.	Steady light	Middle LED	x	x	x	-
UNDER CURRENT	OFF/ON $I_θ$ %	S2 (S4...S8)	Steady flash	Middle LED	x	x	x	x
UNBALANCE - phase interrupt - single phase - incorrect phase sequence	$I_θ$ %	(S4...S8)	Irregular flash	Middle LED	x	x	x	x
EARTH FAULT	I_0 / I_n % Alarm Trip	Lower potentiom. S3 S3	Steady light	Lower LED	 - x	 x x	 - x	 x x
SELF SUPERVISION Internal fault	-	-	-	-	-	x	Self resetting	Self resetting
FAIL SAFE OPERATION Failure of auxiliary voltage	-	-	“OK” OFF	Upper LED	x	-	-	-

Motor Protection Relay SPEM
Technical Data

Thermal overload unit

Setting of full load current I_θ	see table on the next page
Resolution of full load setting	2 %
Setting of maximum stall time at 6 times I_n, t_6x	2...30 s
Cooling time constant at zero current (standstill)	4 x heating time constant

Undercurrent unit

Operating value	12...55 % of I_θ
Operating time	10 s
Resetting time	1 s

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 [1)]

Zero-sequence / residual [2)] current setting I_0	0.2...0.6 x I_{0n}
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
(operation range 0.85 x U_{min} ...1.10 x U_{max})	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 AC

Environmental conditions

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

[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).

Type designation key

SPEM 4 0 B 1 0 5

Nom. current with CT

			I_n	I_n - range
0	**6**	**0**	60 A	4,5...63 A
1	**0**	**5**	105 A	63...111 A
1	**8**	**5**	185 A	111...186 A
3	**1**	**0**	310 A	186...310 A
4	**0**	**0**	400 A	240...400 A
5	**0**	**0**	500 A	300...500 A

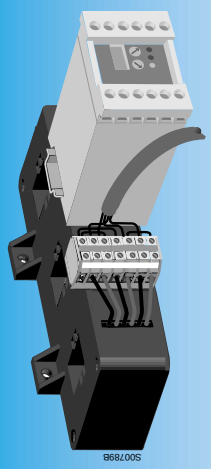
Aux. supply

	U_{aux}
B	220...240 V
C	110...120 V

Earth fault protection

3	No earth fault protection
4	Zero-sequence earth fault protection (by measuring only the phase currents)
5	Earth fault protection by using the residual current transformer.

Motor Protection Relay SPEM
Ordering Information



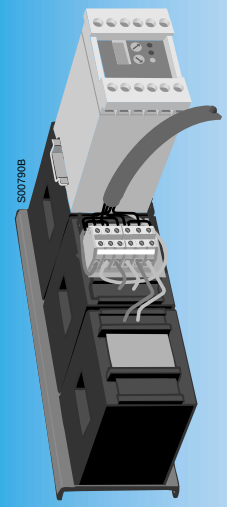
Motor Protection Relays SPEM

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

Supply voltage 230 V 50...60 Hz.

Current transformer included.

Rated current I_n [A]	Rated current range I_n [A]	Max. setting of I_θ / [%]	Earth fault protection Rated zero sequence current $I_{\theta n}$ [A]	Earth fault protection Rated residual current $I_{\theta n}$ [A]	Type	Order number
60	4.5…63	106	-	-	SPEM30B060	1SCA022388R3210
105	63…111	106	-	-	SPEM30B105	1SCA022388R5090
185	111…186	102	-	-	SPEM30B185	1SCA022388R5170
310	186…310	100	-	-	SPEM30B310	1SCA022388R5250
400	240…400	100	-	-	SPEM30B400	1SCA022388R5330
500	300…500	100	-	-	SPEM30B500	1SCA022388R5410
60	4.5…63	106	60	-	SPEM40B060	1SCA022388R6140
105	63…111	106	105	-	SPEM40B105	1SCA022388R6220
185	111…186	102	185	-	SPEM40B185	1SCA022388R6310
310	186…310	100	310	-	SPEM40B310	1SCA022388R6490
400	240…400	100	400	-	SPEM40B400	1SCA022388R6570
500	300…500	100	500	-	SPEM40B500	1SCA022388R6650
60	4.5…63	106	-	1	SPEM50B060	1SCA022388R6730
105	63…111	106	-	1	SPEM50B105	1SCA022388R6810
185	111…186	102	-	1	SPEM50B185	1SCA022388R6900
310	186…310	100	-	1	SPEM50B310	1SCA022388R7030
400	240…400	100	-	1	SPEM50B400	1SCA022388R7110
500	300…500	100	-	1	SPEM50B500	1SCA022388R7200



Supply voltage 110 V 50...60 Hz.

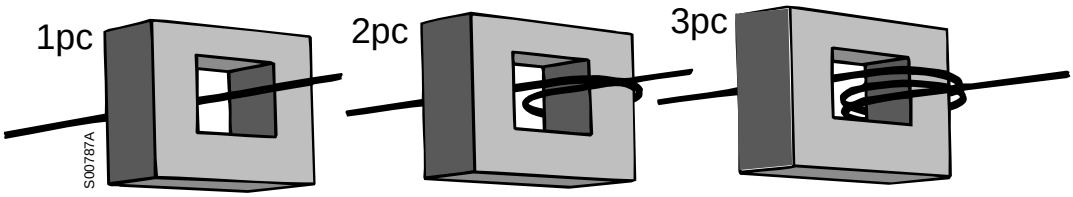
Current transformer included.

Rated current I_n [A]	Rated current range I_n [A]	Max. setting of I_θ / [%]	Earth fault protection Rated zero sequence current $I_{\theta n}$ [A]	Earth fault protection Rated residual current $I_{\theta n}$ [A]	Type	Order number
60	4.5…63	106	-	-	SPEM30C060	1SCA022388R5500
105	63…111	106	-	-	SPEM30C105	1SCA022388R5680
185	111…186	102	-	-	SPEM30C185	1SCA022388R5760
310	186…310	100	-	-	SPEM30C310	1SCA022388R5840
400	240…400	100	-	-	SPEM30C400	1SCA022388R5920
500	300…500	100	-	-	SPEM30C500	1SCA022388R6060
60	4.5…63	106	60	-	SPEM40C060	1SCA022388R7380
105	63…111	106	105	-	SPEM40C105	1SCA022388R7460
185	111…186	102	185	-	SPEM40C185	1SCA022388R7540
310	186…310	100	310	-	SPEM40C310	1SCA022388R7620
400	240…400	100	400	-	SPEM40C400	1SCA022388R7710
500	300…500	100	500	-	SPEM40C500	1SCA022388R7890
60	4.5…63	106	-	1	SPEM50C060	1SCA022388R7970
105	63…111	106	-	1	SPEM50C105	1SCA022388R8010
185	111…186	102	-	1	SPEM50C185	1SCA022388R8190
310	186…310	100	-	1	SPEM50C310	1SCA022388R8270
400	240…400	100	-	1	SPEM50C400	1SCA022388R8350
500	300…500	100	-	1	SPEM50C500	1SCA022388R8430

Primary windings for lower rated currents

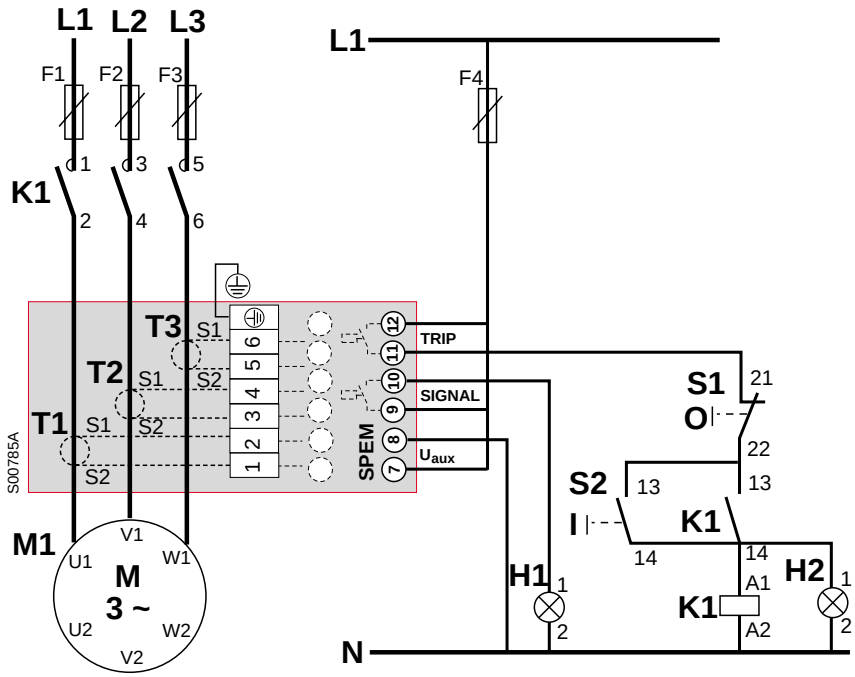
Only for types SPEM_060

Current range I_n [A]	Turns around current transformer [turns]	Max. setting of I_θ / [%]
4.5...7.5	8	100
7.2...12.0	5	100
12.0...20.0	3	100
18.0...36.0	2	120
36.0...63.6	1	106

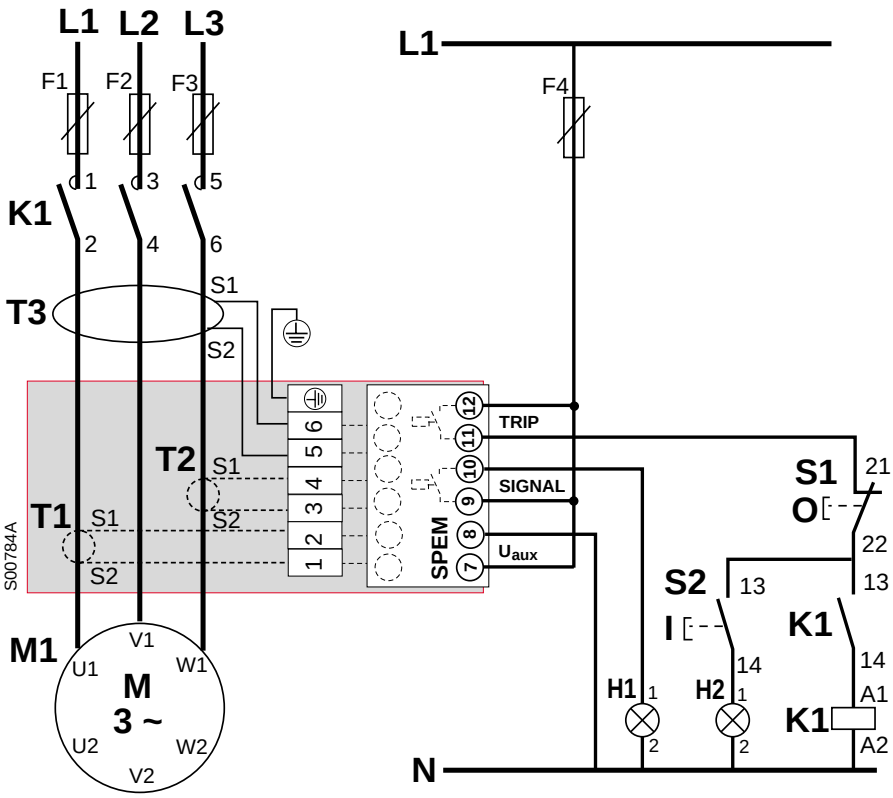


Motor Protection Relay SPEM
Connection Diagrams

Direct on line starters



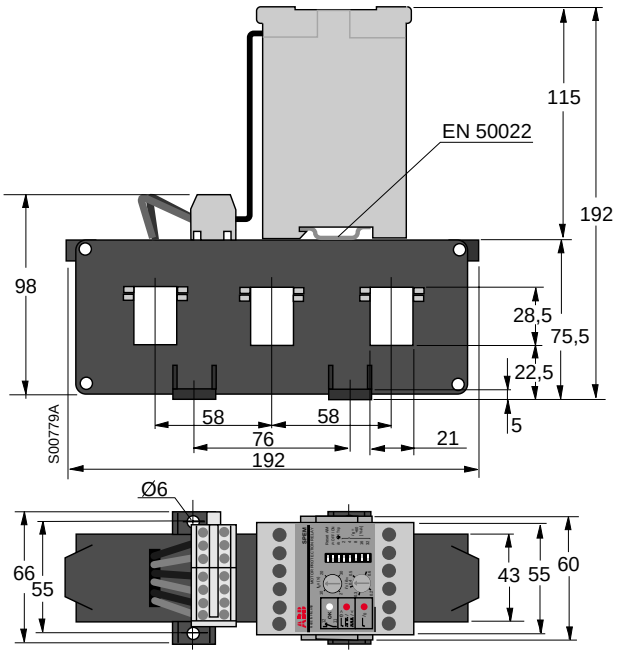
Connection diagram with a separate residual current transformer



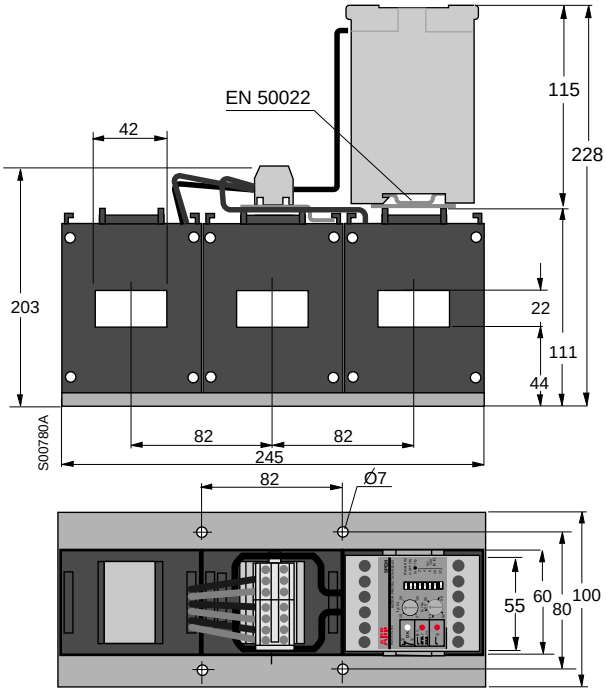
Motor Protection Relay SPEM

Dimension Drawings

SPEM_60...400



SPEM_500



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