Electronic motor starter EMS2...

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Original operating manual
The German-language edition of this document is the original operating manual.

Translation of the original operating manual
All editions of this document other than those in German language are translations of the original operating manual.

1. Edition 2019, publication date 10/19
2. Edition 2023, publication date 06/23
3. Edition 2023, publication date 07/23
See revision protocol in the "About this manual" chapter.

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Redaction: René Wiegand, Ruth-Maria Walrafen

Danger!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally retriggered.
- Verify isolation from the supply.
- Ground and short-circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (IL) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalizing. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O connection so that a cable or wire breakage on the signal side does not result in undefined states in the automation device.
- Ensure a reliable electrical isolation of the low voltage for the 24 V supply. Only use power supply units complying with IEC 60364-4-41 or HD 384.4.41 S2 (VDE 0100 part 410).
- Deviations of the mains voltage from the nominal value must not exceed the tolerance limits given in the technical data, otherwise this may cause malfunction and dangerous operation.
- Emergency-Stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency switching off devices must not cause restart.
- Built-in devices for enclosures or cabinets must only be run and operated in an installed state, desk-top devices or portable devices only when the housing is closed.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency switching off devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks, etc.).
- During operation, and depending on their degree of protection, variable frequency drives may have live, uninsulated, moving, and/or rotating parts, as well as hot surfaces.
- The impermissible removal of the required cover, improper installation or incorrect operation of the motor or variable frequency drive can cause the failure of the device and serious injury and/or material damage.
- Comply with all applicable national accident prevention regulations (e.g. BGV A3) when working with energized variable frequency drives.
- The electrical installation must be carried out in accordance with the relevant regulations (e.g. with regard to cable cross sections, fuses, PE).
- All transport, installation, commissioning and maintenance work must only be carried out by trained personnel (observe IEC 60364, HD 384 or DIN VDE 0100 and national accident prevention regulations).
- If applicable, systems in which variable frequency drives are installed must be equipped with additional monitoring and protective devices in accordance with the applicable safety regulations, e.g., the German Equipment and Product Safety Act, accident prevention regulations, etc. Making changes to the variable frequency drives by using the operating software is allowed.
- Keep all covers and doors closed during operation.
- When designing the machine, the user must incorporate mechanisms and measures that limit the consequences of a drive controller malfunction or failure (an increase in motor speed or the motor sudden stop) so as to prevent hazards to people and property, e.g.:
  - Additional stand-alone devices for monitoring parameters that are relevant to safety (speed, travel, end positions, etc.)
  - Electrical and non-electrical safety devices (interlocks or mechanical locks) for mechanisms that protect the entire system
  - Due to the possibility of there being capacitors that are still holding a charge, do not touch live device parts or terminals immediately after disconnecting the variable frequency drives from the supply voltage. Heed the corresponding labels on the variable frequency drives

Content

0 About This Manual

This manual applies to electronic motor starters in the EMS2 device series. The manual describes the different product versions of the EMS2 device series, their installation and operation, as well as their use to protect motors in potentially explosive (Ex e increased safety) areas.

As we do not know your application in detail, the application information and examples provided in this document are incomplete and serve only to provide you guidance, as an operator of safety-related control technology, in the implementation of safety standards and directives. The information and examples in this document make no claim to be complete nor are they legally binding.
For more detailed information, refer to the prevailing standards and directives that are applicable to your application.

0.1 List of revisions

The following significant amendments have been introduced since previous issues:

Publication date	Page	Keyword	new	modified	deleted
07/23	6	Safety directives		✓	
06/23	6	Safety directives		✓	
	13	Motor starter with safety function…		✓	
	24	Layout of devices with adapter…		✓	
	26	FLA for UL is added	✓		
	39	Status messages		✓	
	41	Status messages		✓	
10/19		First edition	–	–	–

0.2 Target group

This manual is intended for qualified personnel installing, operating, and maintaining EMS2 electronic motor starters.

CAUTION

Installation requires a qualified electrician

0.3 Additional documents

For further information, see the following documentation:

- Manual MN120008EN, "Electronic motor starter EMS2 with SWD"
- Instruction Leaflet IL034064ZU, "EMS2"
- Instruction Leaflet IL034089ZU, „EMS2 – Safety"

0.4 Abbreviations and symbols

The following abbreviations are used in this manual:

Table 1: Abbreviations used

Abbreviation	Meaning
DO	Direct Online
DOS	Direct Online Safety
EMS	Electronic Motor Starter
LED	Light-Emitting Diode
MSFS	Motor Starter Feeder System
PLC	Programmable Logic Controller
RO	Reverse Online
ROS	Reverse Online Safety
ROSF	Reverse Online Safety Fuse

The symbols used in this manual have the following meanings:

▶ indicates actions to be taken.

0.4.1 Risk of material damage

WARNING

Warns about the possibility of material damage.

0.4.2 Hazard warnings of personal injury

CAUTION

Warns of the possibility of hazardous situations that may possibly cause slight injury.

WARNING

Warns of the possibility of hazardous situations that could result in serious injury or even death.

DANGER

Warns of hazardous situations that result in serious injury or death.

0.4.3 Tips

Indicates useful tips.

1 General information – EMS2 electronic motor starter

1.1 Standards

In addition to the standards in accordance with EN 60079 / VDE 165-1, separate standards for the corresponding types of protection apply to the protection of motors in potentially explosive atmospheres.

Motors with type of protection for potentially explosive areas, "increased safety"

The standard EN 60079-7 requires additional measures in the case of motors with the type of protection for potentially explosive areas, "increased safety".

These measures ensure, with a high degree of certainty, that impermissible high temperatures, sparks and electric arcs are prevented on motors where these would not usually occur during normal operation.
The motor protection devices for this, which themselves are not located in a potentially explosive area, must be certified by an accredited admission office.

Motors in potentially explosive dust-air mixtures

For motors in potentially explosive dust-air mixtures, the standard EN 60079-14 specifies additional measures.

Directive 2014/34/EC (ATEX) on the approximation of the laws of the Member States concerning devices and protective systems intended for use in potentially explosive areas has been in force since 20.04.2016.

Area of application

In circuits in potentially dust-explosive areas of zones 21 and 22, it must be guaranteed that the equipment connected to this circuit complies with category 2D or 3D or is certified as such.

This is a product for environment A (industry). The device can cause unwanted radio interference if used in Class B environments (household). In this case, the user may be obligated to take the necessary precautionary measures.

1.2 Safety directives

1. The device executes a function diagnosis when the drive is switched on or is in the switched on state. In addition, an authorized electrician or a skilled worker who is well acquainted with the relevant standards can conduct the "Motor overload protection" safety function test.
   For this test, the drive must be operated withright or left rotation (forward or reverse running), and the current flow in a conductor is interrupted (e.g. by removing the fuse in the L1 or L3 phase). The EMS2 then switches off the drive within 1.5 to 2 s. The LEDs for right or left rotation go out, and the ERR-LED and the reply output are set.
2. The device is an associated item of equipment.
   Do not install the device in potentially explosive areas. When installing and operating associated equipment, the applicable safety directives must be observed.
3. When using devices with 230 V AC control, always use the same phase for the control supply voltage and the control inputs.
4. If you use the "Automatic RESET" mode, the drive is switched on again after the cooling time has expired - if a control signal is still present. The cooling time is 20 minutes. For applications in the Ex-protection area, automatic restart is not permitted.
5. For safety technical data, please refer to this document and certificates (EC type examination certificate and other approvals if appropriate).
6. Electronic motor starters are not allowed to operate with variable frequency drives.
7. For emergency stop applications, the machine must be prevented from restarting automatically by a higher-level control system.
8. Secure the electronic motor starter EMS2 during safety-related applications with an access protection.

1.3 EMS2 device overview

EMS2 series electronic motor starters serve to switch and protect three-phase asynchronous motors.

Depending on the version, the following functions are available:

- Direct Online starter (DO = Direct Online)
- Reversing starter (RO = Reverse Online)
- Motor protection
  - Overload protection
  - Phase failure
  - Phase imbalance
- Category 3 controlled stop
  PL e DIN EN ISO 13849, SIL 3 IEC 61508

The compact devices contain the required interlocks which are necessary for the specified functions in order to reduce the wiring.

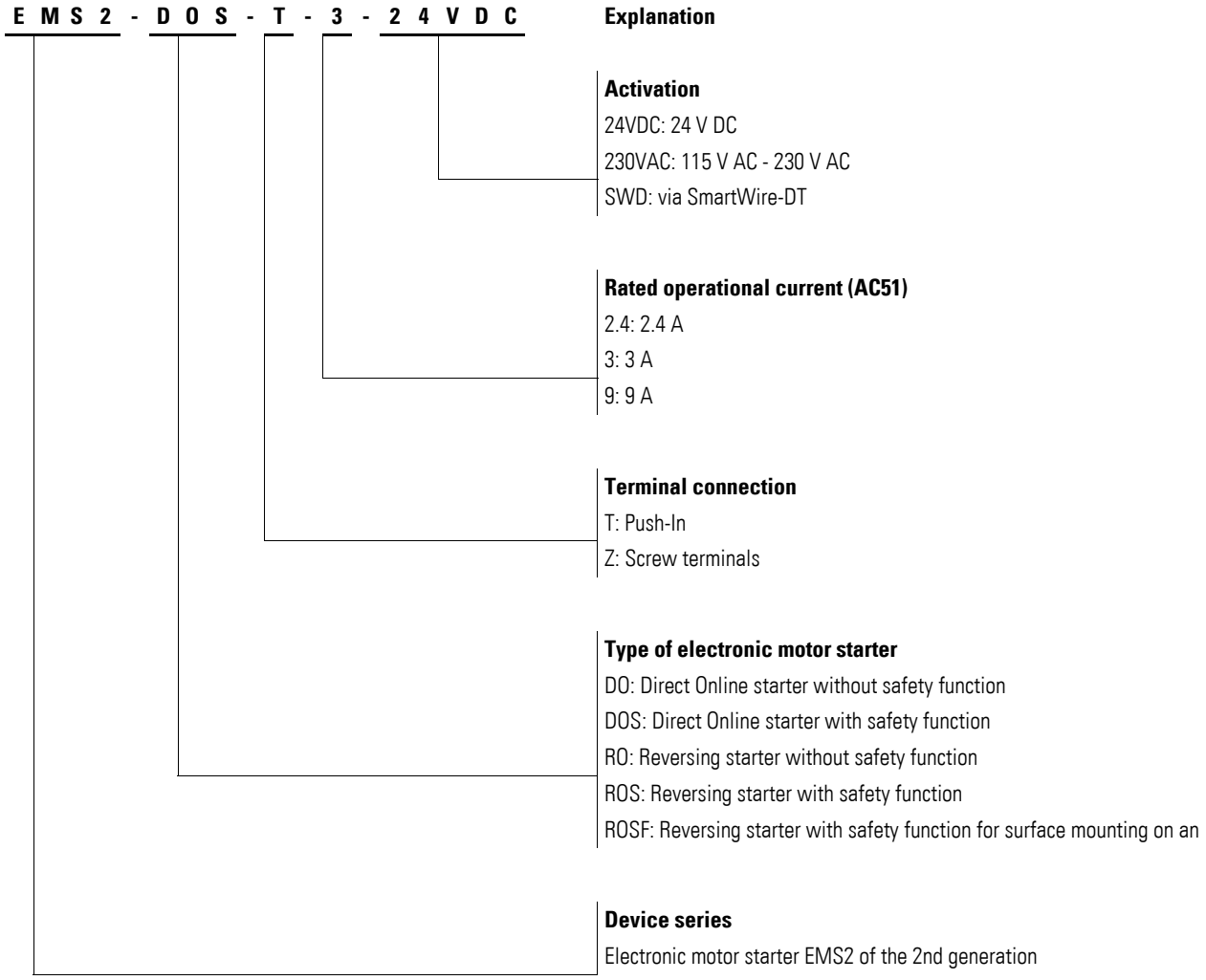
Notes on the application range

Do not operate single-phase motors in conjunction with an EMS2 electronic motor starter.

Only devices with safety function (DOS, ROS, ROSF) may be used in potentially explosive Ex e increased safety (ATEX) areas.

1.4 Type code

The type designation of an EMS2 electronic motor starter is made up of the following type code (comprising five groups):



2 Motor starters

2.1 Construction

The following drawing shows the designations for the EMS2 electronic motor starter, intended for installation on a top-hat rail.

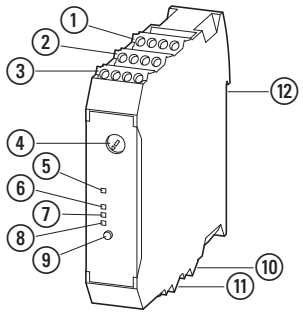


Figure 1: Designations on EMS2 – when installed on a top-hat rail

① Terminals for control voltage U_S and ON/R/L
② Reset (and reference point of the control inputs for motor starters with safety function)
③ Relay output
④ Setting dial for motor protection
⑤ LED **PWR** (green)
⑥ LED **ERR** (red)
⑦ LED **L** (yellow) – for reversing starters
⑧ LED **R** (yellow) – for reversing starters or LED **ON** (yellow) – for direct starters
⑨ Set/reset button
⑩ Terminals for input voltage
⑪ Terminals for output voltage
⑫ Top-hat rail fitting

2.2 Motor starter without safety function (DO, RO)

The devices described in this Section must not be operated in potentially explosive Ex e increased safety (ATEX) areas.

Table 2: DO (DOL starter) and RO (reversing starter) versions

Type	Minimum current	Rated operational current I_e		Control voltage U_S		Terminals	
		AC51 EN 60947-4-3	AC53a EN 60947-4-2	24 V DC	115 V AC - 230 V AC	Push-In	Screws
DOL starters							
EMS2-DO-T-2.4-24VDC	0.18 A	2.4 A	2.4 A	✓	–	✓	–
EMS2-DO-T-9-24VDC	1.5 A	9 A	6.5 A	✓	–	✓	–
EMS2-DO-Z-2,4-24VDC	0.18 A	2.4 A	2.4 A	✓	–	–	✓
EMS2-DO-Z-9-24VDC	1.5 A	9 A	6.5 A	✓	–	–	✓
EMS2-DO-Z-2,4-230VAC	0.18 A	2.4 A	2.4 A	–	✓	–	✓
EMS2-DO-Z-9-230VAC	1.5 A	9 A	6.5 A	–	✓	–	✓
Reversing starters							
EMS2-RO-T-2,4-24VDC	0.18 A	2.4 A	2.4 A	✓		✓	–
EMS2-RO-T-9-24VDC	1.5 A	9 A	6.5 A	✓	–	✓	–
EMS2-RO-Z-2,4-24VDC	0.18 A	2.4 A	2.4 A	✓	–	–	✓
EMS2-RO-Z-9-24VDC	1.5 A	9 A	6.5 A	✓	–	–	✓
EMS2-RO-Z-2,4-230VAC	0.18 A	2.4 A	2.4 A	–	✓	–	✓
EMS2-RO-Z-9-230VAC	1.5 A	9 A	6.5 A	–	✓	–	✓

Notes

→ Note that the permissible continuous current for devices with a rated operational current I_e of 9 A depends on the type of mounting and the ambient temperature, → section 2.5, "Layout of devices with I_e = 9 A", page 17.

→ Currents under the minimum current specified in table 2 will not be detected by the motor protection. The motor must not be operated under this value.
The motor starter itself also works if the current is under this minimum value. This state is displayed by the flashing of both LEDs **PWR** and **ERR**. The relay output also signals an alarm.

2.2.1 Block diagrams

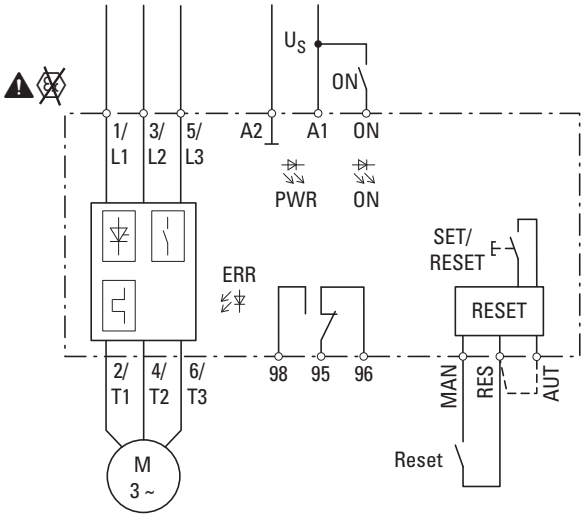


Figure 2: Block diagram direct starter

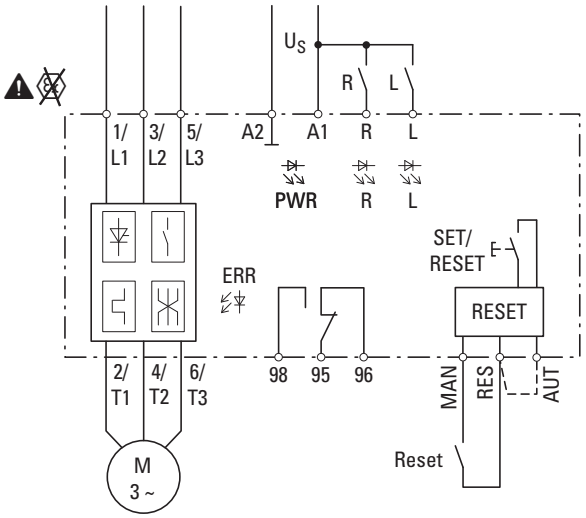


Figure 3: Block diagram reversing starter

2.2.2 Terminal assignment

Table 3: Terminal assignment

Terminal	Function
1L1	three-phase incoming unit
3L2	three-phase incoming unit
5L3	three-phase incoming unit
2T1	three-phase motor connection
4T2	three-phase motor connection
6T3	three-phase motor connection
A1	control voltage connection
A2	control voltage connection A2 is simultaneously the reference point for the control inputs ON as well as L and R
ON	Motor startup (with DOL starters) Reference point is terminal A2
L	Motor startup in counterclockwise rotation (for reversing starters) Reference point is terminal A2
R	Motor startup: clockwise rotation (for reversing starters) Reference point is terminal A2
95	Relay output for fault messages
96	Relay output for fault messages
98	Relay output for fault messages
RES / MAN	Input for manual resetting of error messages
RES / AUT	Input for automatic resetting of error messages

2.3 Motor starter with safety function (DOS, ROS)

The devices described in this Section must not be operated in potentially explosive Ex e increased safety (ATEX) areas.
Motors in the Ex-Area can be controlled.

Table 4: DOS (DOL starter) and ROS (reversing starter) versions

Type	Minimum current	Rated operational current I_e		Control voltage U_S		Terminals	
		AC51 EN 60947-4-3	AC53a EN 60947-4-2	24 V DC	115 V AC - 230 V AC	Push-in	Screws
DOL starter							
EMS2-DOS-T-3-24VDC	0.18 A	3 A	3 A	✓	–	✓	–
EMS2-DOS-T-9-24VDC	1.5 A	9 A	7 A	✓	–	✓	–
EMS2-DOS-Z-3-24VDC	0.18 A	3 A	3 A	✓	–	–	✓
EMS2-DOS-Z-9-24VDC	1.5 A	9 A	7 A	✓	–	–	✓
Reversing starters							
EMS2-ROS-T-3-24VDC	0.18 A	3 A	3 A	✓	–	✓	–
EMS2-ROS-T-9-24VDC	1.5 A	9 A	7 A	✓	–	✓	–
EMS2-ROS-Z-3-24VDC	0.18 A	3 A	3 A	✓	–	–	✓
EMS2-ROS-Z-9-24VDC	1.5 A	9 A	7 A	✓	–	–	✓

Notes

→ Note that the permissible continuous current for devices with a rated operational current I_e of 9 A depends on the type of mounting and the ambient temperature, → section 2.5, “Layout of devices with I_e = 9 A”, page 17

→ Currents under the minimum current specified in the table 4 will not be detected by the motor protection.
It is therefore not permissible to operate the motor under this value – especially in applications which fall under the remit of the ATEX guideline.
The motor starter itself will also work even though the current is under the minimum value. This is indicated by both **PWR** and **ERR** LEDs flashing.
The relay output also signals an alarm.
Observe the minimum permissible load current in safety-related applications.

2.3.1 Block diagrams

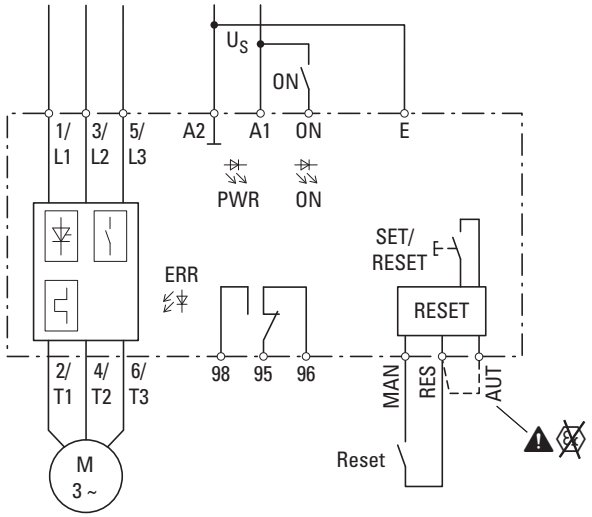


Figure 4: Block diagram of DOL starter with safety function

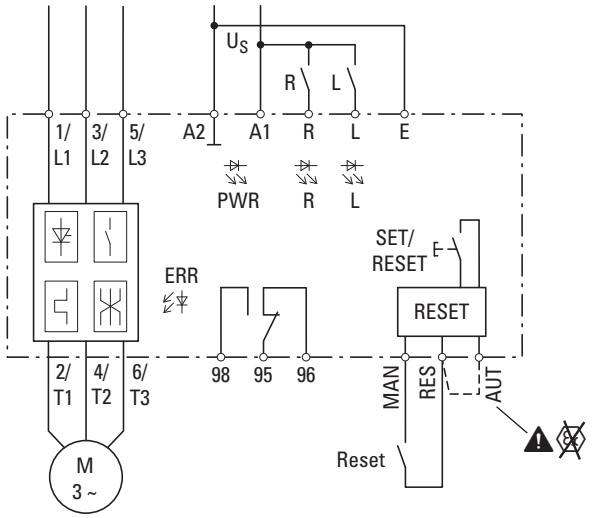


Figure 5: Block diagram of DOL starter with safety function

Notes

The block diagrams in Figures 4 and 5 serve merely to represent the general functions.
The actual wiring depends on the application case (→ chapter 5, "Application examples", page 33).

The voltages supplying the motor starter on terminals A1 and A2 and the voltage which activates terminals ON or R and L do not need to originate from the same source.
Reference point for activation is terminal E.

2.3.2 Example of a reversing starter

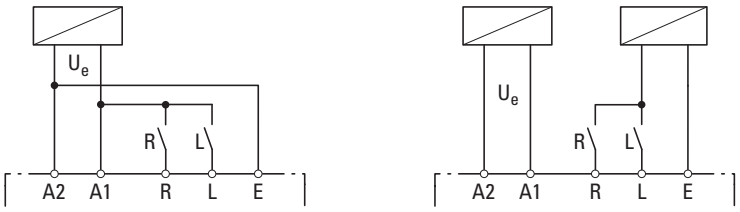


Figure 6: Mutual (left) and separate (right) voltage sources for supply and control inputs

2.3.3 Terminal assignment

Table 5: Terminal assignment

Terminal	Function
1L1	three-phase incoming unit
3L2	three-phase incoming unit
5L3	three-phase incoming unit
2T1	three-phase motor connection
4T2	three-phase motor connection
6T3	three-phase motor connection
A1	control voltage connection
A2	control voltage connection
ON	Motor startup (with DOL starters) Reference point is terminal A2
L	Motor startup in counterclockwise rotation (for reversing starters) Reference point is terminal E
R	Motor startup in counterclockwise rotation (for reversing starters) Reference point is terminal E
E	Reference point for control inputs L, R and ON
95	Relay output for fault messages
96	Relay output for fault messages
98	Relay output for fault messages
RES / MAN	Input for manual resetting of error messages
RES / AUT	Input for automatic resetting of error messages

2.4 Mounting

Devices in the EMS2-**DO**-…, EMS2-**DOS**-…, EMS2-**RO**-… and EMS2-**ROS**-… series are designed for mounting on a 35-mm-top-hat rail.

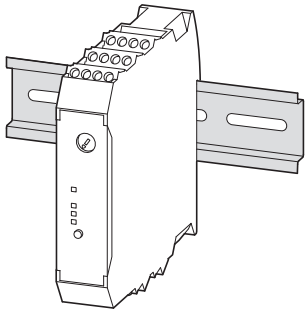


Figure 7: Mounting on top-hat rail

Notes

Note that the direct linking of devices with a rated operational current I_e of 9 A can lead to a reduction in performance (derating) under some circumstances.

EMS-XBR-… (→ section 9.1.1, "Three-phase current connector", page 53) three-phase current connectors can be used to connect the supply terminals 1L1, 3L2 and 5L3 of up to 5 devices in a row.

2.5 Layout of devices with I_e = 9 A

When using devices with a rated operational current I_e of 9 A, note that the permissible thermal continuous current I_L depends on the type of mounting and the ambient temperature. See diagram below.

Moreover, the maximum permissible current of 56 A must not be exceeded, even in startup.

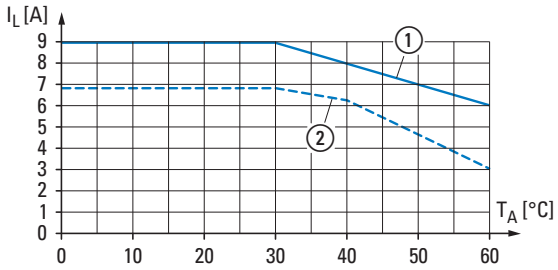


Figure 8: Thermal continuous current I_L according to ambient temperature

① When mounting the devices with a minimum distance of 20 mm
② With devices in a row

The maximum current during startup of the motor is derived by multiplying the motor rated current with the "startup factor", which with standard asynchronous motors is usually between 6 and 10.

Contact the motor manufacturer to establish the actual value.

EMS2 devices with a rated operational current I_e of 2.4 A or 3 A can be operated at temperatures up to 60 °C without restriction.

Example

A motor with the values shown below is to be operated with an EMS2 electronic motor starter.

Motor:

Power:	P_{Mot} = 2.2 kW
Rated operational current I_e at 400 V:	I_{Mot} = 4.7 A
Startup factor I_{max} / I_{Mot}:	8.5

Control panel temperature: 55 °C

Questions:

- Is operation possible?
- How should the motor starter be mounted?

Checks:

Step 1:

Check to see if the motor starter is suitable for the maximum current (56 A).

I_{max} = I_{Mot} x startup factor = 4.7 A x 8.5 = 39.95 A < 56 A

Step 2:

Which motor current is permissible at an ambient temperature of 55 °C? (→ Figure 8, page 17)

- in a row: 4 A < 4.7 A → not permissible!
- at a distance of 20 mm: 6.5 A > 4.7 A → permissible!

Conclusion:

The EMS2 motor starter can be used for this application, but must be mounted with a distance of at least 20 mm between the devices.

3 Plug-in motor starter ROSF for mounting on an adapter

Plug-in motor starters of the EMS2 series are available exclusively as reversing starters with a safety function (EMS2-**ROSF**-…).

→ The motor starters described in this Section must not be operated in potentially explosive Exe increased safety (ATEX) areas.
Only motors in Ex areas may be controlled.

Table 6: ROSF (plug-in reversing starter with safety function) versions

Type	Minimum current	Rated operational current I_e		Control voltage U_S		Terminals	
		AC51 EN 60947-4-3	AC53a EN 60947-4-2	24 V DC	115 V AC - 230 V AC	Push-In	Screws
EMS2-ROSF-Z-3-24VDC	0.18 A	3 A	3 A	✓	–	–	✓
EMS2-ROSF-Z-9-24VDC	1.5 A	9 A	7 A	✓	–	–	✓

Notes

→ Note that the permissible continuous current for devices with a rated operational current I_e of 9 A depends on the type of mounting and the ambient temperature.
See following Sections.

→ Currents under the minimum current specified in the table 6 will not be detected by the motor protection. It is therefore not permissible to operate the motor under this value.

The motor starter itself also works if the current is under this minimum value. This state is displayed by the flashing of both LEDs **PWR** and **ERR**. The relay output also signals an alarm.

WARNING

The plug-in motor starters are usually used in conjunction with busbar adapters, where several starters have a mutual external short-circuit protective element. To protect the individual motor starters, these contain an internal fuse for each phase.
These fuses are accessible by opening a flap on the left side of the device.
The fuses must only be replaced with the device not plugged in (disconnected from the power supply).

The fuses that must be used are listed in → section 9.2, “Fuses”, page 55.

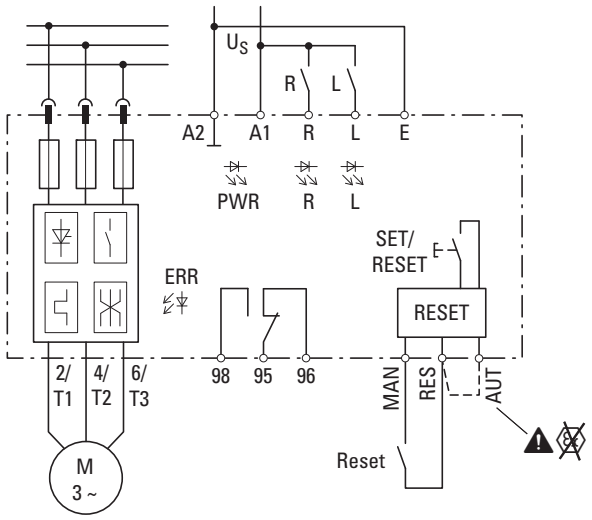


Figure 9: Block diagram

Block diagram 9 serves merely to show the general functions. The actual wiring depends on the application case,
→ chapter 5, "Application examples", page 33.

The voltages supplying the motor starter on terminals A1 and A2 and the voltage which activates terminals R and L do not need to originate from the same source.
Reference point for activation is terminal E.

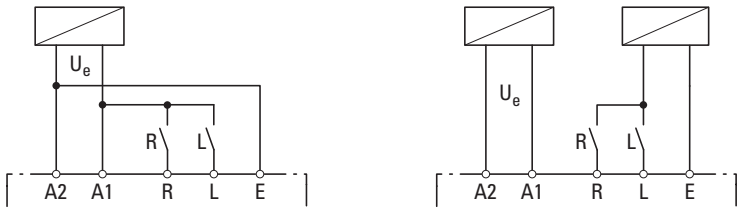


Figure 10:Mutual (left) and separate (right) voltage sources for supply and control inputs

Table 7: Terminal assignment

Terminal	Function
1L1	three-phase incoming unit
3L2	three-phase incoming unit
5L3	three-phase incoming unit
2T1	three-phase motor connection
4T2	three-phase motor connection
6T3	three-phase motor connection
A1	control voltage connection
A2	control voltage connection A2 is simultaneously the reference point for the control inputs ON as well as L and R
ON	Motor startup (with DOL starters) Reference point is terminal A2
L	Motor startup in counterclockwise rotation (for reversing starters) Reference point is terminal A2
R	Motor startup in counterclockwise rotation (for reversing starters) Reference point is terminal A2
95	Relay output for fault messages
96	Relay output for fault messages
98	Relay output for fault messages
RES / MAN	Input for manual resetting of error messages
RES / AUT	Input for automatic resetting of error messages

3.1 Mounting

The EMS2 system includes two types of adapters:

- Top-hat rail adapter EMS2-XTH

  The motor starter is supplied via terminals on the adapter. The adapter is mounted on a top-hat rail and the starter is inserted into the adapter.

- Busbar adapter
  - Classic EMS2-XBB60

  Power to the busbar adapters is supplied by a busbar which runs along the back. It is not necessary to supply the individual starters.

In addition, EMS2-ROSF motor starters are compatible with the Motor Starter Feeder System (MSFS).

→ Note that a direct linking of devices with a rated operational current I_e of 9 A can lead to a reduction in performance (derating) under some circumstances.

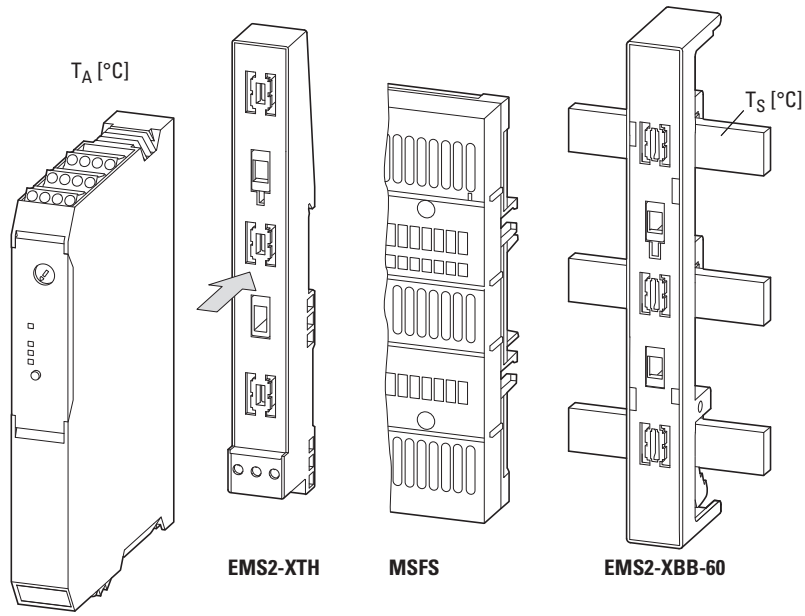


Figure 11:Mounting on adapters

3.2 Layout of devices with adapter EMS2-XTH

When using EMS2-ROSF devices with a rated operational current I_e of 9 A in (AC51) conjunction with the adapter EMS2-XTH, note that the permissible thermal continuous current depends on the type of mounting and the ambient temperature. See diagram below.

Moreover, the maximum permissible current must not be exceeded, even in startup.

→ It is not permitted to use the motor starters described in this Section in potentially explosive areas (ATEX).
Only motors in potentially explosive areas may be controlled.

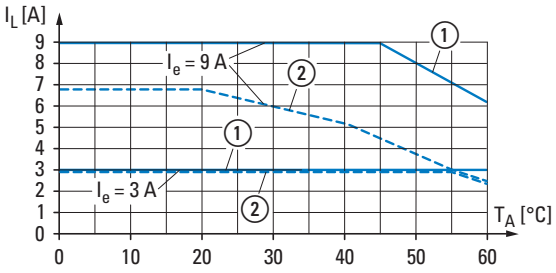


Figure 12: Thermal continuous current I_L depending on the ambient temperature
① When mounting the devices with a minimum distance of 20 mm
② For directly linked devices

The maximum current during start-up of the motor is derived by multiplying the motor rated current with the "startup factor", which with standard asynchronous motors is usually between 6 and 10.
Contact the motor manufacturer to establish the actual value.

Example

A motor with the values shown below is to be operated with an EMS2 electronic motor starter.

Motor:

Power:	P_{Mot} = 2.2 kW
Rated operational current I_e at 400 V:	I_{Mot} = 4.7 A
Startup factor I_{max} / I_{Mot}:	8.5
Control panel temperature:	55 °C

Questions:

- Is operation possible?
- How should the motor starter be mounted?

Checks:

Step 1:

Check to see if the motor starter is suitable for the maximum current (56 A).

I_{max} = I_{Mot} x startup factor = 4,7 A x 8.5 = 39.95 A < 56 A

Step 2:

Which motor current is permissible at an ambient temperature of 55 °C? (→ Figure 12)

- directly linked: 3 A < 4.7 A → not permissible!
- at a 20 mm distance: 6.7 A > 4.7 A → permissible!

Conclusion:

The motor starter EMS2 can be used for this application; it must, however, be mounted with at least 20 mm distance between the next device.

3.2.1 Layout of devices with adapter EMS2-XBB or MSFS

When using EMS2-ROSF devices with a rated operational current I_e of 9 A or 3 A in conjunction with an EMS2-XBB or MSFS adapter, note that the permissible thermal continuous current depends on the type of mounting, the ambient temperature T_A and the temperature T_S of the busbar. See diagram below.

Moreover, the maximum permissible current must not be exceeded, even in startup. It is not permitted to use the devices described in this Section in potentially explosive areas (ATEX). Motors in the Ex-Area can be controlled.

The maximum current during startup of the motor is derived by multiplying the motor nominal current with the "startup factor", which with standard asynchronous motors is usually between 6 and 10.

Contact the motor manufacturer to establish the actual value.

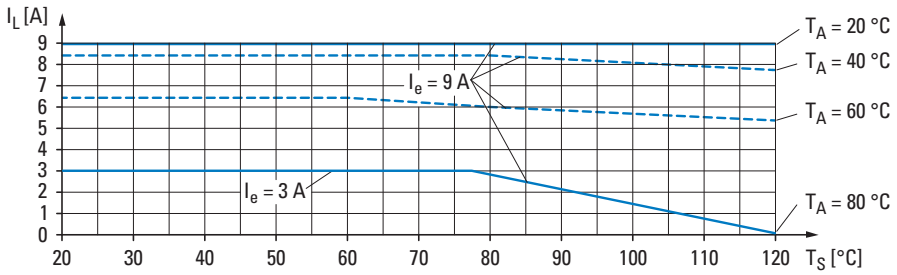


Figure 13: Derating curve for devices with I_e = 9 A which are mounted at a minimum distance of 20 mm (at least one free slot between the starters)

T_S = temperature of the busbar

T_A = ambient temperature in the control panel

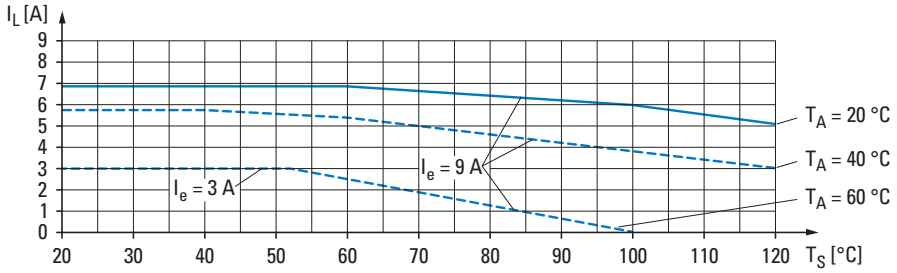


Figure 14: Derating curve for directly linked devices with I_e = 9 A

T_S = temperature of the current busbar

T_A = ambient temperature in the control panel

4 Short-circuit / motor protection

4.1 Short-circuit protection

The protective elements on the network side of the EMS2 electronic motor starter are permissible as short-circuit protection according to table 8 below. Local standards regarding the cable protection must also be taken into consideration.

4.1.1 Use in IEC environment

EMS2 electronic motor starters can be used in IEC environments according to the following table.

Table 8: Fuse protection in IEC environment

Device type	Maximum short-circuit current I_q at the mounting location	Max. permissible supply voltage	Type of coordination
16A gG	50 kA	500 V	1
30A CCMR30	50 kA	500 V	1
FAZ-B16/3	2.5 kA	400 V	1
PKM0-4	50 kA	415 V	1
PKM0-6.3	15 kA	415 V	1
Fuse 16 A FF / gR (10 x 38 mm)	10 kA	500 V	2
Fuse 20 A FF / gR (10 x 38 mm)	5 kA	400 V	2
Fuse 30 A CC (10 x 38 mm)	30 kA	480 V	1

4.1.2 Use in UL environment

EMS2 electronic motor starters are suitable for use

- in a circuit with maximum 480 V and a symmetrical short-circuit current of maximum 5 kA;
- in a circuit with maximum 480 V and a symmetrical short-circuit current of maximum 100 kA, provided they are protected with a 30-A fuse, type J or CC or equivalent;
- in a "group installation" in a circuit with maximum 480 V and a symmetrical short-circuit current of maximum 5 kA;
- in a "group installation", suitable for use in a circuit with a maximum of 480 V and a symmetrical short-circuit current of maximum 100 kA, provided they are protected with a 30-A fuse (type J or CC or equivalent);

Table 9: Fuse protection in UL environment ("group installation")

Device type	SCCR	Max. permissible supply voltage	Type of coordination
20A RK5	5 kA	480 V	1
30A CC	100 kA	480 V	1

WARNING

For use with a "low voltage, limited energy, isolated power supply" use copper cables approved to at least 75 °C.
The device is designed for use with a "low voltage, limited energy, isolated power supply".

	EMS2-DO(RO)…-2,4-…	EMS2-DOS(ROS)…-3-…	EMS2-DO(RO)..-9-…	EMS2-DOS(ROS)..-9-…
FLA Motor starter	2,4 A (500 V AC)	3 A (480 V AC)	6,5 A (500 V AC)	7,6 A (480 V AC)
FLA General Use	–	3 A (480 V AC)	–	9 A (480 V AC)

4.2 Motor protection

Themotor protection prevents the connected motor from heating up too much if the actual motor current is greater than the specified rated current (i. e. $I > I_n$). The time up until tripping depends on the current and the trip class.

Devices with a rated operational current I_e of 2.4 A or 3 A are in trip class 10.

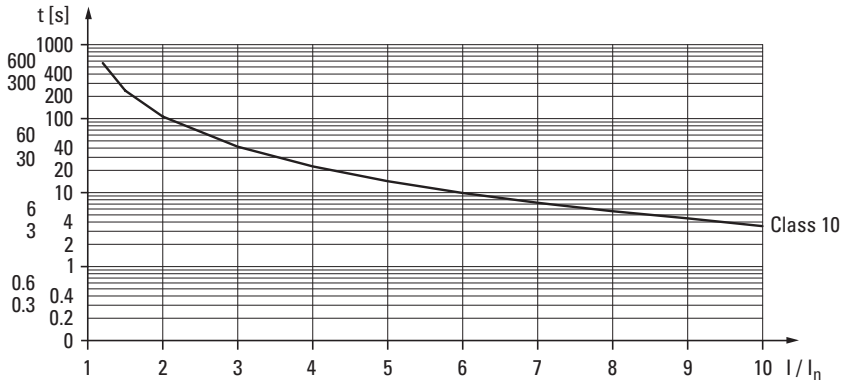


Figure 15: Tripping characteristics class 10

t = tripping time

I = actual motor current

I_n = setting of the motor protection on the EMS2 device

Devices with a rated operational current I_e of 9 A have the tripping class 10A.

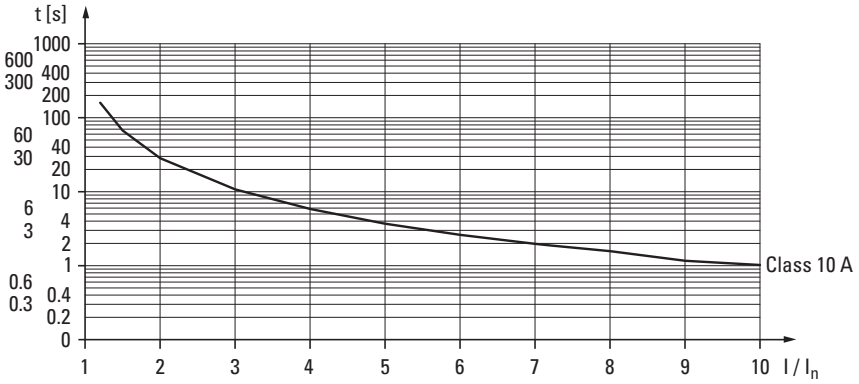


Figure 16: Tripping characteristics class 10A

t = tripping time

I = actual motor current

I_n = setting of the motor protection on the device EMS2

WARNING

Below the minimum device current, the motor on the EMS2 motor starter is ineffective.

→ The setting for the motor protection can only be changed in parameterization mode.
The position of the potentiometer on the front of the EMS2 is not an indicator of the actual set value.
In the delivery state, it is set to the lowest value.
See also → section 4.2.3, "Conditions when setting the motor protection", page 29.

4.2.1 Symmetry detection

The motor currents are measured at phases L1 and L3 and monitored for symmetry.

If the motor currents deviate by more than ≥ 33 %, the motor shuts down within 2 minutes.

If the motor currents deviate by more than ≥ 67 %, (e.g., phase failure), the motor shuts down within 2 seconds.

The deviation can be calculated using the following formulas.

$|I_{max}| > I_{nenn}$ → deviation = $(I_{max} - I_{min})/I_{max}$

$|I_{max}| < I_{nenn}$ → deviation = $(I_{max} - I_{min})/I_{nenn}$

→ In the event of high clock rates, the motor protection function may trip due to the increased switch-on currents

4.2.2 Motor with brake

If a motor with brake (connection in the motor terminal board) is connected, the 400 V AC brake must be linked to the 2/T1 and 6/T3 terminals.

A 230 V AC brake must be connected to the 4/T2 terminals and the star point of the motor.

WARNING

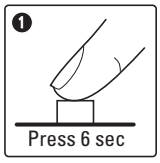
Increase motor current monitoring to the nominal brake current. This should be set accordingly on the hybrid motor starter.

4.2.3 Conditions when setting the motor protection

Ensure that the following conditions are met when setting the motor protection or when displaying the set value:

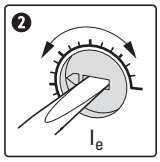
- The device is supplied with voltage.
- There are no errors.
- There is no start signal on the terminals ON, L or R.

4.2.4 Setting of the motor protection



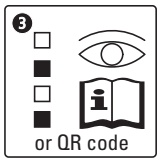
Activating parameterization mode

▶ Press the RESET button for at least 6 seconds.
→ The green **PWR** LED flashes once.



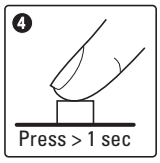
Setting the motor rated current

▶ Turn the potentiometer to the desired value.



Checking the value on the LEDs

▶ Compare the set value with that which is displayed on the LEDs (→ table 10, page 30).



Leaving parameterization mode

▶ Press the RESET button.

4.2.5 Displaying the set value

▶ Press the RESET button for between 2 seconds and 6 seconds.
→ The four LEDs (**PWR**, **ERR**, **L**, **R/ON**) will display the set value for a period of 3 seconds (for the coding, see table 10 below. 0 = off, 1 = on).

Table 10: Settings of the motor protection

Code				Setting I_n		
PWR	**ERR**	**L**	**R**	**I_e = 2.4 A (EMS2-….-2.4…)**	**I_e = 3 A (EMS2-….-3…)**	**I_e = 9 A (EMS2-….-9…)**
PWR	**ERR**	**–**	**ON**	**A**	**A**	**A**
0	0	0	0	0.18	0.18	1.5
0	0	0	1	0.25	0.3	1.0
0	0	1	0	0.41	0.44	2.5
0	0	1	1	0.56	0.6	3.0
0	1	0	0	0.71	0.68	3.5
0	1	0	1	0.87	0.88	4.0
0	1	1	0	1.02	1.0	4.5
0	1	1	1	1.117	1.1	5.0
1	0	0	0	1.33	1.2	5.5
1	0	0	1	1.48	1.5	6.0
1	0	1	0	1.63	1.6	6.5
1	0	1	1	1.79	1.9	7.0
1	1	0	0	1.94	2.1	7.5
1	1	0	1	2.09	2.4	8.0
1	1	1	0	2.25	2.7	8.5
1	1	1	1	2.4	3.0	9.0

4.2.6 Tripping and reset

Tripping

In the case of tripping,

- the motor starter switches off,
- the output relay switches
  (connection between terminals 95 and 98 instead of
  between terminals 95 and 96)
- the LED **ERR** flashes,
- and one of the LEDs **L**, **R** or **ON**
  lights up (depending on the previously driven operating direction).

Reset

EMS2 series motor starters have a "thermal memory", which means that a reset after the motor protection has tripped is possible only once a waiting period (cooling-down time) has passed.

After the waiting period has passed, the **L**, **R** or **ON** LED which had previously lit up permanently prior to the error flashes (see also → section 6.3, "Resetting after an error message", page 42).

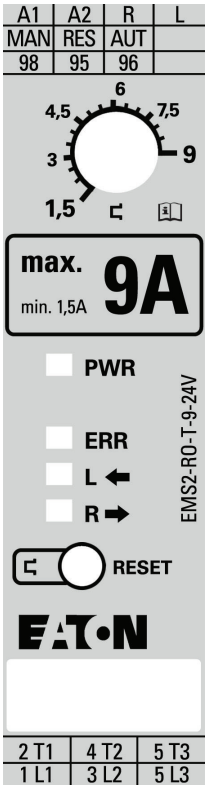


Figure 17:Front view

5 Application examples

One of the reasons why EMS2 electronic motor starters achieve such a high lifespan is that the power to the contacts that are located in the device can be disconnected. This is done by the triggering of semiconductors and relays by the internal electronics. For this function to be active, the motor starter needs to constantly be supplied with control voltage to terminals A1 and A2.

There are, however, application cases (for example, when the actuation is carried out via a PLC) in which the supply voltage on the terminals A1 and A2 is turned off in order to achieve a safe state after a controlled stop.

CAUTION

Since the control supply voltage or the control voltage of the hybrid motor starter is disconnected via a single channel, this type of installation according to SIL 3 (Cat. 3, Cat. 4) is permitted, only if error prevention for cross circuits according to EN ISO 13849 is permitted.
This is the case, for example, if the hybrid motor starter and the safety relay are installed in the same switch cabinet.
If such error prevention is not permitted, the control supply voltage must be disconnected via two channels or two positions (→ section 5.1, "Single-channel controlled stop application (cat. 3, SIL 3, PL e) with error prevention", page 34, → section 5.2, "Reversing starter 24 V DC with safety function (dual-channel) (cat. 3, SIL 3, PL e)", page 36).

5.1 Single-channel controlled stop application (cat. 3, SIL 3, PL e) with error prevention

With a higher-level safety relay combination within a closed control cabinet (→ figure 18, → figure 19).

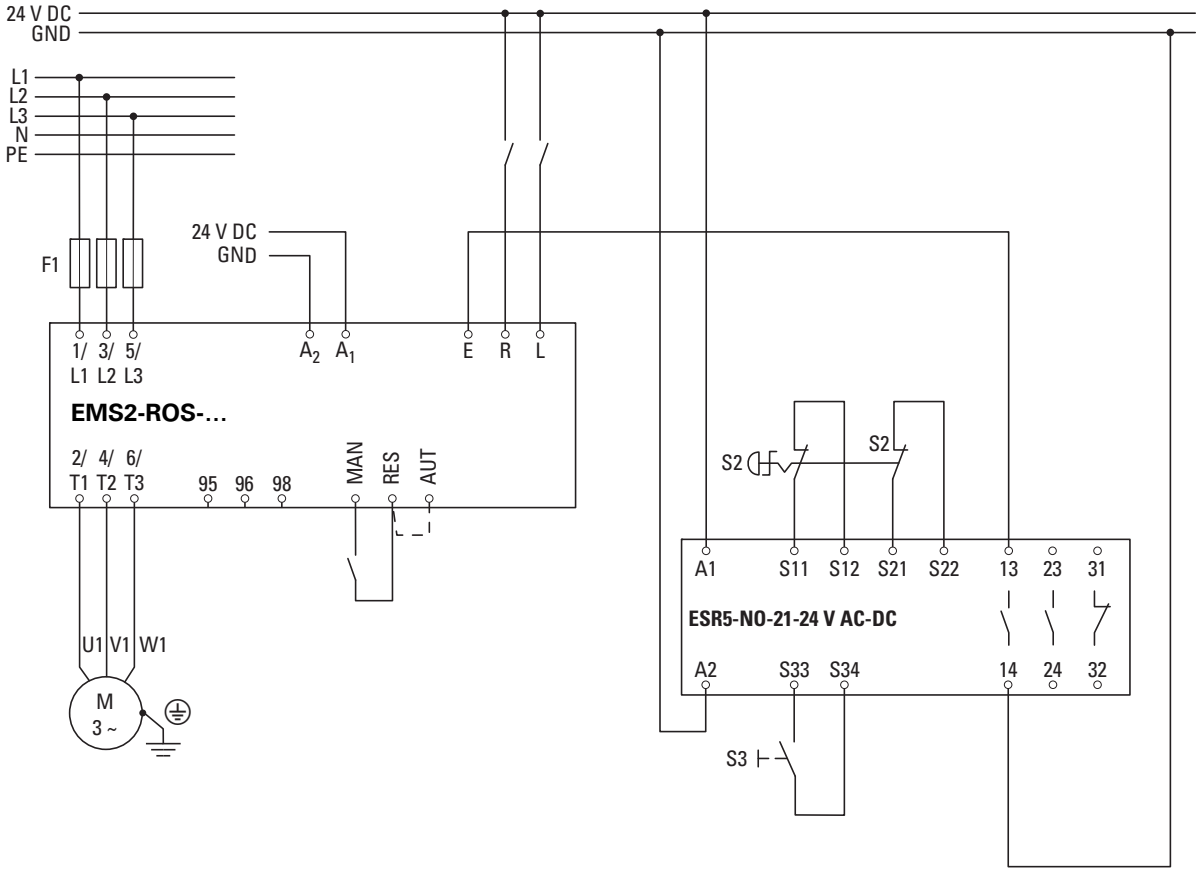


Figure 18: Single-channel controlled stop application with error prevention (disconnect "Ground E")

Motor starter EMS2-ROS… is used in conjunction with an ESR5-series safety relay. The mutual reference point of the control inputs (terminal E) is switched via the safety relay.
The preset for the control commands for the operating direction takes place directly at 24 V DC on the **L** or **R** terminal.

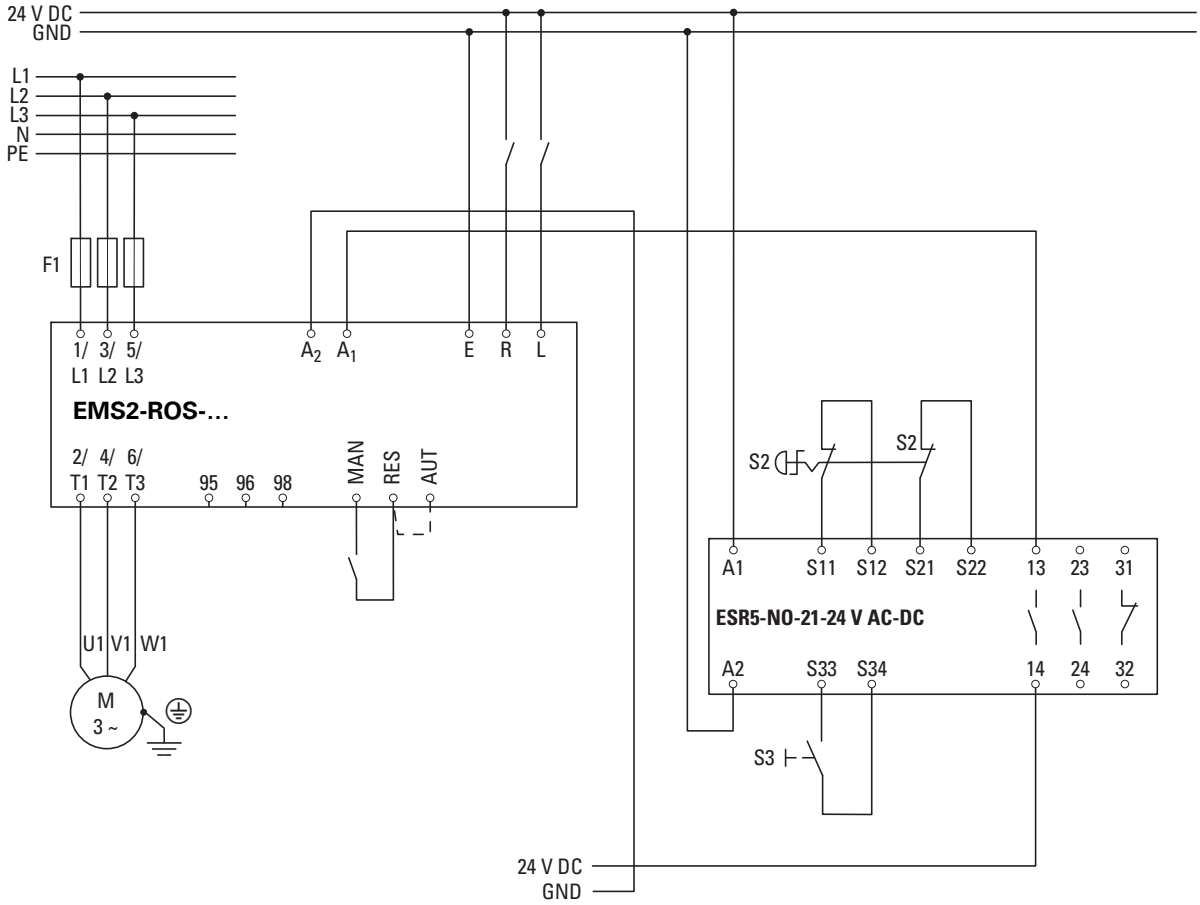


Figure 19: Single-channel controlled stop application with safety relay with error prevention (disconnect U_S)

Motor starter EMS2-ROS… is used in conjunction with an ESR5-series safety relay. The preset for the control commands for the operating direction takes place directly at 24 V DC on the **L** or **R** terminal. In contrast to the previous example, in the case of a controlled stop, the supply voltage on the terminals A1 and A2 is switched off by the safety relay.

Please also refer to Page 33 for more information about the lifespan of devices.

→ Motor starter and safety relay should be located in the same control panel.

5.2 Reversing starter 24 V DC with safety function (dual-channel) (cat. 3, SIL 3, PL e)

Consider these two examples.

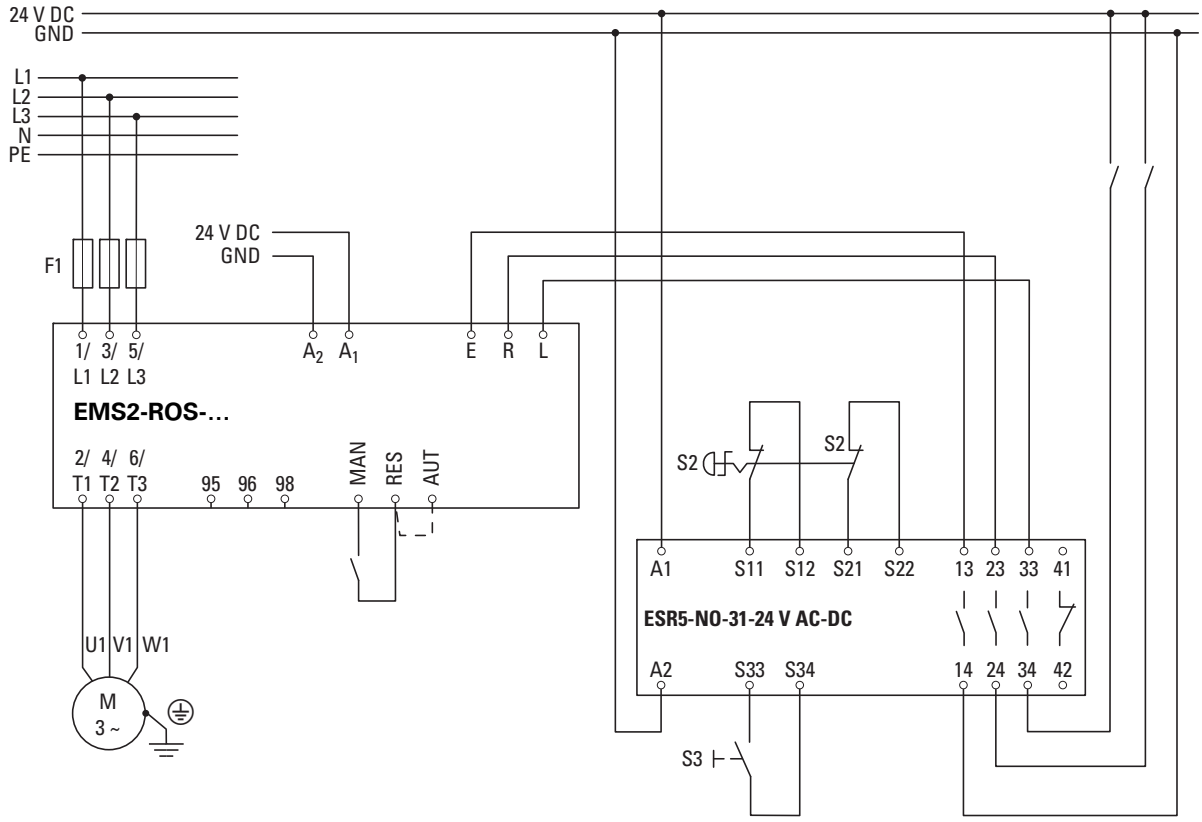


Figure 20: Reversing starter with safety function (dual-channel)

In this example (shown in Figure 20), the EMS2-ROS… motor starter is used in combination with an ESR5 series safety relay. The mutual reference point of the control inputs (terminal **E**) and the control commands **L** and **R** are switched via the safety relay. The preset for the control commands for the operating direction takes place directly at 24 V DC on the **L** or **R** terminal.

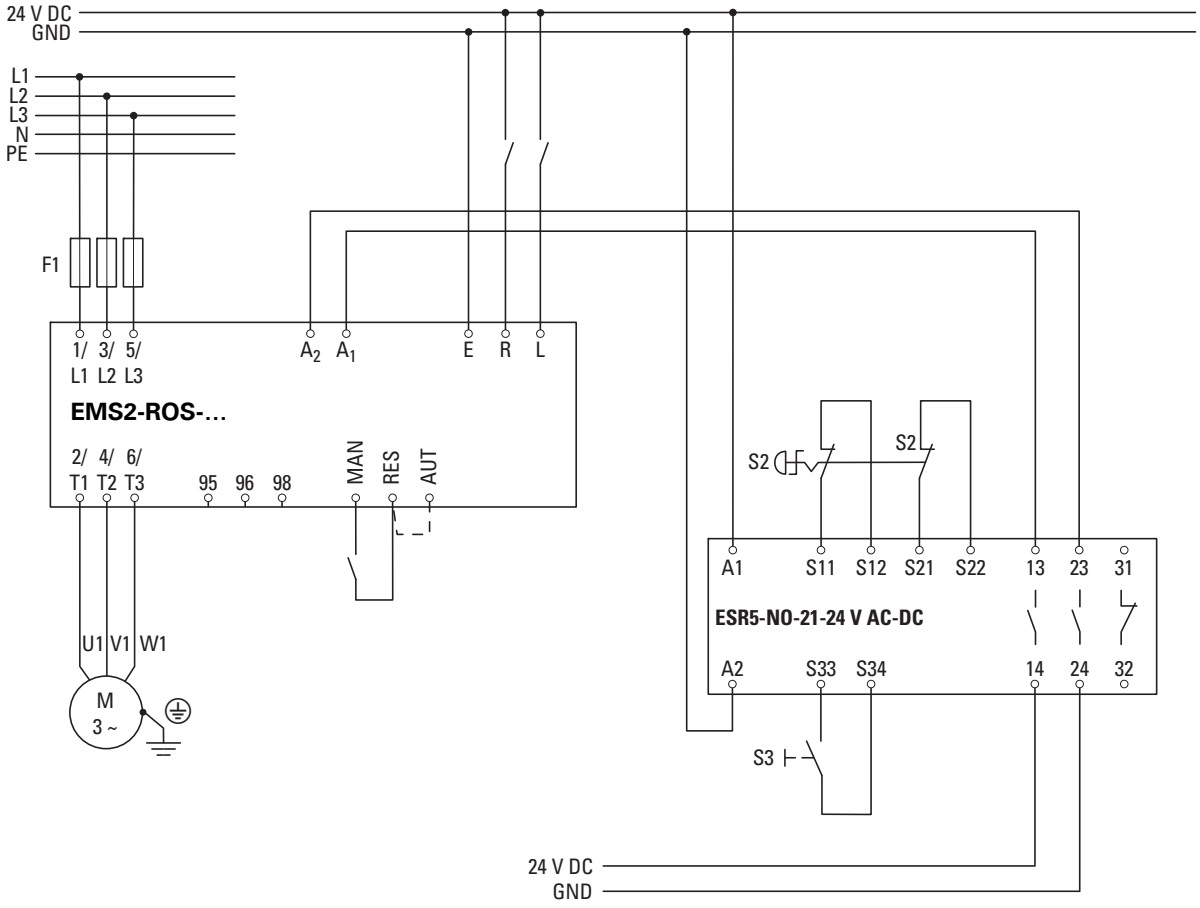


Figure 21: Reversing starter with safety function (dual-channel)

In this example (shown in figure 21), the EMS2-ROS... motor starter is used in combination with an ESR5 series safety relay. The preset for the control commands for the operating direction takes place directly at 24 V DC on the L or R terminal.

In contrast to the previous example, in the case of a controlled stop, the supply voltage on the terminals A1 and A2 is switched off by the safety relay, which causes a reduction in the lifespan of the motor starter.

Please also note the information about the lifespan of devices on Page 33.

6 Status messages

The status light emitting diodes (LEDs) (→ Figure 1, page 9) indicate the operating states.

Internal and external device faults or process errors "ERR" (e.g.: overcurrent, imbalance, phase failure) are indicated by a red LED, while a yellow LED shows clockwise or counterclockwise operation.

Internal faults cannot be acknowledged. They are stored in the device and will eventually prevent the equipment from being started at all. In case of external errors, an error acknowledgement is required to exit the safe shutdown state.

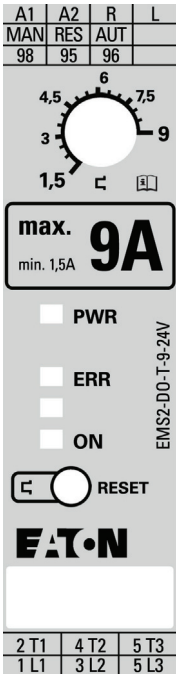
When the EMS2 detects a fault, the explosion-proof motor is switched off safely and the feedback relay is actuated. The fault can also be diagnosed using the status LEDs.

Depending on the status, an alarm is also provided via the relay output (terminals 95 / 96 / 98).

6.1 LEDs on the front of the device

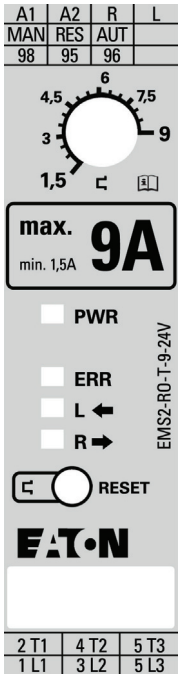
There are four LEDs on the front of the EMS2 motor starter which display the current device status.

DOL starter



PWR – green
no designation – yellow
ERR – red
no designation – yellow
ON – yellow

Reversing starter



PWR – green
no designation – yellow
ERR – red
L – yellow
R – yellow

Figure 22: LEDs on direct and reversing starters

The status LEDs in combination provide information about the device status

LED does not light up

LED lights up

LED flashes

Table 11: Status messages – combination of four LEDs

LED				Status	Description	Reset
PWR	ERR	L / (–)	R / (ON)			
				Off	No control voltage U_S present	–
				Ready for operation	Control voltage U_S present	–
				Drive switched on	Counterclockwise operation (L)	–
				Drive switched on	Clockwise operation (R or ON)	–
				Internal error	Device needs to be replaced	Not possible
				Motor protection tripped during counterclockwise operation → section 4.2, "Motor protection", page 27	Motor protection in cooling-down phase,reset not possible.	Manually after a cooling-down time of approx. 2 min; automatically after approx. 20 min with a bridge between AUT and RES
				Motor protection tripped during counterclockwise operation → section 4.2, "Motor protection", page 27	Cooling-down phase concluded, manual reset possible	Manually after a cooling-down time of approx. 2 min; automatically after approx. 20 min with a bridge between AUT and RES
				Motor protection tripped during clockwise operation → section 4.2, "Motor protection", page 27	Motor protection in cooling-down phase, Reset not possible.	Manually after a cooling-down time of approx. 2 min; automatically after approx. 20 min with a bridge between AUT and RES
				Motor protection tripped during clockwise operation → section 4.2, "Motor protection", page 27	Cooling-down phase concluded, manual reset possible	Manually after a cooling-down time of approx. 2 min; automatically after approx. 20 min with a bridge between AUT and RES
				Bad checksum	Error during system recovery. The thermal memory of the motor protection function is set to the maximum value. The error must be manually acknowledged in automatic mode.	Manual
				Asymmetrical phase current	The currents in the phases deviate from one another by more than 33%.	Manual
				Motor is stalled (counterclockwise operation)	The maximum measurable motor current is exceeded for longer than 2 s.	Manual
				Motor is stalled (clockwise operation)	The maximum measurable motor current is exceeded for longer than 2 s.	Manual
				With actuated output stage no current is measured.	Error has occurred during counterclockwise operation.	Automatic, as soon as the error has been remedied
				With actuated output stage no current is measured.	Error has occurred during clockwise operation.	Automatic, as soon as the error has been remedied

6.2 Output relay

In good working condition, the device output relay is in the off position (contact between terminals 95 and 96). When an error occurs, the relay switches (contact between the terminals 95 and 98) and remains until the error has been acknowledged (see the following Section "Resetting after an error message").

→ The output relay serves exclusively to indicate operating states. It is not part of the safety chain.

6.3 Resetting after an error message

WARNING

If an error is acknowledged and a command on the terminals **L**, **R** or **ON** is pending, the motor starter is automatically started up. In this case, use external measures (e. g. by means of an interlock) to ensure that there is no hazardous situation.

The acknowledging (reset) of an error can be carried out in various ways. The options depend on the nature of the error (→ table 11, page 41).

- **Automatic** reset
- **Manual** reset
  - via the button on the front of the device
  - via a contact
  - via a PLC (only with devices with U_S = 24 V DC)

6.3.1 Automatic reset

When a phase or a motor that is not connected fail, or in the case of an operation beneath the minimum current I_{min}, the EMS2 electronic motor starter is automatically reset as soon as the error has been remedied.

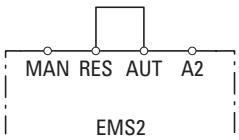


Figure 23: Circuit for an automatic reset

To reset automatically after a message from the motor protector, the terminals RES and AUT must be bridged. The automatic reset takes place after approx. 20 minutes of cooling-down time.

It is possible to reset the device using a manual command during this period of time. The condition for this is that the cooling-down time for a manual reset (approx. 2 minutes) has passed. (One of the **L**, **R** or **ON** LEDs is flashing).

→ Automatic reset of the EMS2 electronic motor starter is **not** permitted in potentially explosive Ex e increased safety areas.

6.3.2 Manual reset

After remedying the error, the error message can be reset manually.
In the case of a message from the motor protection, note that the error message can be reset only after the cooling-down time has passed.
The **L**, **R** or **ON** LED lights up permanently during the cooling-down time.

After the cooling-down time, the permanent light changes to flashing, meaning a reset is now possible.

For a reset, the EMS2 motor starter requires a signal with a rising edge on the MAN terminal with a duration of less than 2 seconds.

- If the signal is longer or the reset button on the front of the device is pressed for longer, the device remains in error mode and the set motor current is displayed.
- If the signal lasts for longer than 6 seconds, the device switches to programming mode (→ section 4.2.4, "Setting of the motor protection").

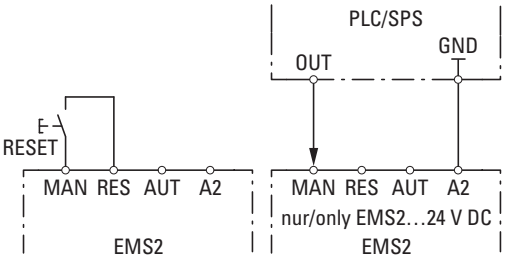


Figure 24: Circuit for a manual reset
left: via external button; right: via PLC

If the message is to be reset by an external button, this must be connected between the RES and MAN terminals.

Only for devices with a control voltage U_S of 24 V DC

A reset can also be carried out with a 24-V signal from an external PLC.
To do so, the output of the PLC needs to be connected to the MAN terminal.
The reference point for the PLC output voltage must be connected with terminal A2.

WARNING

It is not possible to perform a reset via a PLC for devices with a control voltage of 230 V AC.
In this case, connecting the PLC to terminal A2 could destroy the PLC.

→ The error is not reset when the reset signal is applied; it is reset when it is withdrawn (falling edge).

7 Technical data

Size/feature	EMS2-…-24VDC	EMS2-…-230VAC
Standards	**For EMS2-D(R)O-… devices without safety function:** IEC/EN 60947-1 IEC/EN 60947-4-2 **For EMS2-D(R)OS(F)-… devices with safety function:** IEC/EN 60947-1 IEC/EN 60947-4-2 IEC 61508 ISO 13849	**For EMS2-D(R)O-… devices without safety function:** IEC/EN 60947-1 IEC/EN 60947-4-2
Ambient conditions and mounting		
Ambient temperature during operation	For devices **without** safety function: -25°C - +70°C Condensation not permissible – prevent with suitable measures! Observe derating! For devices **with** safety function: -25 °C - +55 °C (without derating for single device) -25 °C - +70 °C (with derating) Condensation not permissible – prevent with suitable measures! Observe derating!	-25 °C - +70 °C Condensation not permissible – prevent with suitable measures! Observe derating!
Storage temperature, permissible	-40°C - + 80°C	-40°C - + 80°C
Degree of protection	IP20	IP20
Degree of pollution	2	2
Dimensions	→ section 8, “Dimensions”, page 51	→ section 8, “Dimensions”, page 51
Mounting	on 35-mm top-hat rail according to IEC/EN 60715	on 35-mm top-hat rail according to IEC/EN 60715
Mounting position	Vertical, motor feeder on bottom	Vertical, motor feeder on bottom
EMC	Emitted interference is cable related: EN 55011, class A Emitted interference is radiated: EN 61000-6-3, class A This is a product for environment A. In a domestic environment, this device may cause radio interference, in which case the user may be required to take adequate measures.	Emitted interference is cable related: EN 55011, class A Emitted interference is radiated: EN 61000-6-3, class A This is a product for environment A. In a domestic environment, this device may cause radio interference, in which case the user may be required to take adequate measures.

Size/feature	EMS2-…-24VDC	EMS2-…-230VAC
Connections		
Cross-section - control cables	**EMS2-D(R)O-T-…**: Push in terminals 0.2 mm² - 2.5 mm² AWG 24 - 14 **EMS2-D(R)O-Z-…**: Screw terminals 0.14 mm² - 2.5 mm² AWG 24 - 14	Screw terminals 0.14 mm² - 2.5 mm² AWG 26 - 14
Cross-section - power cables	**EMS2-D(R)O-T-…**: Push in terminals 0.2 mm² - 2.5 mm² AWG 24 - 14 **EMS2-D(R)O-Z-…**: Screw terminals 0.2 mm² - 2.5 mm² AWG 24 - 14	Screw terminals 0.2 mm² - 2.5 mm² AWG 24 - 14
Tightening torque	EMS2-D(R)O(S)-**Z**-…: 0,5 Nm - 0,6 Nm (5 lb-in - 7 lb-in) EMS2-D(R)O(S)-**T**-…: –	0.5 Nm - 0.6 Nm (5 lb-in - 7 lb-in)
Stripping length	EMS2-D(R)O-**T**-…: 10 mm (0.39") EMS2-D(R)O-**Z-…**: 8 mm (0.31")	8 mm (0.31")
Supply of the device / the control inputs		
Overvoltage category	III	III
Supply		
Rated control voltage U_S	24 V DC	230 V AC
Range of the control supply voltage	19.2 V DC - 30 V DC	85 V AC - 253 V AC
Rated control current I_S	40 mA	4 mA
Protection against overvoltage	Yes	Yes
Protection against polarity reversal	Yes	No
Control inputs		
Rated actuating voltage U_C	24 V DC	230 V AC
Rated actuating current I_C	5 mA For devices **with** safety function: EMS2-D(R)O**S**-…-…-24VDC: 10 mA	7 mA
Switching threshold	LOW < 9.6 V DC HIGH > 19.2 V DC	LOW < 44 V AC HIGH > 85 V AC
Protection against polarity reversal	Yes	No
Typical break time	< 30 ms	< 70 ms

Size/feature	EMS2-…-24VDC	EMS2-…-230VAC
Relay output		
Changeover contact	Potential-free changeover contact	Potential free changeover contact
Terminals	Terminal 95: Root Terminal 96: N/C Terminal 98: N/O	Terminal 95: Root Terminal 96: N/C Terminal 98: N/O
Switching capacity according to IEC 60947-S-1	2 A (25 V, DC13)	3 A (230 V, AC15)
Power circuit		
Rated operational voltage U_e	500 V AC, 50/60 Hz	500 V AC, 50/60 Hz
Operational voltage	42 V AC - 550 V AC	42 V AC - 550 V AC
Rated operational current AC51	EMS2-…-**2,4**-24VDC: 2.4 A EMS2-…-**3**-24VDC: 3 A EMS2-…-**9**-24VDC: 9 A	EMS2-…-Z-**2,4**-230VAC: 2.4 A EMS2-…-Z-**9**-230VAC: 9 A
Rated operational current AC53a	EMS2-…-**2,4**-24VDC: 2.4 A EMS2-…-**9**-24VDC: 6.5 A For devices **with** safety function: EMS2-…**S**(F)-…-**3**-24VDC: 3 A EMS2-…**S**(F)-…-**9**-24VDC: 7 A	EMS2-…-Z-**2,4**-230VAC: 2.4 A EMS2-…-Z-**9**-230VAC: 6.5 A
Permissible load current range	For devices **without** safety function: EMS2-…-**2,4**-24VDC: 0.18 A - 2.4 A EMS2-…-**9**-24VDC: 1.5 A - 9 A For devices **with** safety function: EMS2-D(R)O**S**-…-**3**-24VDC: 0.15 A - 33 A EMS2-D(R)O**S**-…-**9**-24VDC: 1.2 A - 60 A	EMS2-…-Z-**2,4**-230VAC: 0.18 A - 2.4 A EMS2-…-Z-**9**-230VAC: 1.5 A - 9 A
Motor protection tripping characteristics (IEC 60947-4-2)	**EMS2-…-2.4-24VDC**: Class 10 **EMS2-…-3-24VDC**: Class 10 **EMS2-…-9-24VDC**: Class 10A	Class10A
Heat dissipation	For devices **without** safety function: EMS2-D(R)O-…-**2,4**-24VDC: 1.1 W - 3.3 W EMS2-D(R)O…-**9**-24VDC: 1.1 W - 14.6 W For devices **with** safety function: EMS2-D(R)O**S**-…-**3**-24VDC: 1.5 W - 3 W EMS2-D(R)O**S**-…-**9**-24VDC: 1.5 W - 13 W For Plug-in motor starters **EMS2-ROSF-…** for mounting on an adapter: EMS2-**ROSF**-Z-**3**-24VDC: 1,5 W - 4 W EMS2-**ROSF**-Z-**9**-24VDC: 1,5 W - 14 W	EMS2-…-Z-**2,4**-230VAC: 2.6 W - 4.7 W EMS2-…-Z-**9**-230VAC: 2.6 W -16.1 W
Rated operational voltage U_e	500 V AC, 50/60 Hz	500 V AC, 50/60 Hz
Range of operational voltage	42 V AC - 550 V AC	42 V AC - 550 V AC
Rated operational current AC51	3 A	9 A
Rated operational current AC53a	3 A	7 A
Permissible load current range	0.18 A - 3 A	1.5 A - 9 A

Size/feature	EMS2-…-24VDC	EMS2-…-230VAC
Motor protection tripping characteristics (IEC 60947-4-2)	Class 10	Class 10A
Heat dissipation min / max	0.88 W / 4.1 W	0.88 W / 7 W
Cooling-off time with auto reset after triggering	20 min	20 min
Protection against overvoltage	Yes	Yes
Allocated protective element on the network side	→ section 4.1, "Short-circuit protection", page 25	→ section 4.1, "Short-circuit protection", page 25
Use in UL environment	→ section 4.1.2, "Use in UL environment", page 26	→ section 4.1.2, "Use in UL environment", page 26
Insulation properties		
Rated insulation voltage	500 V	500 V
Rated impulse voltage / insulation	6 kV	4 kV
Insulation properties between the actuating voltage, control supply voltage and auxiliary circuit to the main circuit	Operational voltage ≤ 300 V AC (e. g. 230 / 400V AC, 277 / 480 V AC): Safe isolation according to IEC/EN 60947-1 and EN 50178 checks for devices with safety Operational voltage 300 V AC - 500 V AC: Basic isolation according to IEC/EN 60947-1 Safe isolation according to EN 50178	Operational voltage ≤ 300 V AC (e. g. 230 / 400V AC, 277 / 480 V AC): Safe isolation according to IEC/EN 60947-1 and EN 50178 checks for devices with safety Operational voltage 300 V AC - 500 V AC: Basic isolation according to IEC/EN 60947-1 Safe isolation according to EN 50178
Insulation properties between actuating voltage and control supply voltage to auxiliary circuits	Safe isolation according to IEC/EN 60947-1 and EN 50178	Safe isolation according to IEC/EN 60947-1 and EN 50178
Degree of pollution	2	2
Additional information for devices with safety function, i.e. EMS2-D(R)OS(F)-…-24VDC		
System conditions		
Database for failure rates	SN 29500	–
System type (made up of subsystems)	Type B	–
Applied standard	IEC 61508	–
Beta factor	2 %	–
Safe switch off		
HFT (hardware fault tolerance)	1	
Ambient temperature	40 °C - 60 °C	–
MTTF (Mean Time to Failure)	64 years at 40 °C ambient temperature	–
$MTTF_D$ (Mean Time to Failure Dangerous)	175 years at 40 °C ambient temperature	–
Shutdown time	200 ms	–
λ_{sd} – failure rate of detectable safe failures (sd = safe, detectable)	0 FIT	–
λ_{su} – failure rate of undetectable safe failures (su = safe, undetectable)	1134 FIT at 40°C ambient temperature	–
λ_{dd} – failure rate of detectable dangerous failures (dd = dangerous, detectable)	647 FIT at 40 °C ambient temperature	–
λ_{du} – failure rate of undetectable dangerous failures (du = dangerous, undetectable)	4.2 FIT at 40 °C ambient temperature	–
SFF (Safe Failure Fraction)	99.8 % at 40 °C ambient temperature	–
DC (Diagnostic Coverage)	99.4 % at 40 °C ambient temperature	–

Size/feature	EMS2-…-24VDC	EMS2-…-230VAC
PFH_D: (Probability of dangerous failure per hour)	4.2 FIT at 40 °C ambient temperature	–
PFD_{avg} (6 months / 36 months) (Average Probability of Failure on Demand)	at 40 °C ambient temperature: 6 months: 1,37907 x 10^{-5} 36 months: 8,6235 x 10^{-5}	–
Safety level according to	IEC 61508-1: to SIL 3 ISO 13849-1: to category 3 PL e	–
Motor protection		
HFT (hardware fault tolerance)	0	–
Ambient temperature	40 °C - 60 °C	–
MTTF (Mean Time to Failure)	67 years at 40 °C ambient temperature	
$MTTF_D$ (Mean Time to Failure Dangerous)	169 years at 40 °C ambient temperature	–
Shutdown time	EMS2-D(R)OS(F)-…-**3**-24VDC: according to class 10, IEC 60947 EMS2-D(R)OS(F)-…-**9**-24VDC: according to class 10A, IEC 60947	–
λ_{sd} – failure rate of detectable safe failures (sd = safe, detectable)	0 FIT	–
λ_{su} – failure rate of undetectable safe failures (su = safe, undetectable)	1027 FIT at 40 °C ambient temperature	–
λ_{dd} – failure rate of detectable dangerous failures (dd = dangerous, detectable)	670 FIT at 40 °C ambient temperature	–
λ_{du} – failure rate of undetectable dangerous failures (du = dangerous, undetectable)	5.4 FIT at 40 °C ambient temperature	–
SFF (Safe Failure Fraction)	99.7 % at 40 °C ambient temperature	–
DC (Diagnostic Coverage)	99.2 % at 40 °C ambient temperature	–
PFD_{avg} (6 months / 36 months) (Average Probability of Failure on Demand)	at 40 °C ambient temperature: 6 months: 1,97487 x 10^{-5} 36 months: 12,1362 x 10^{-5}	–
Safety level according to	IEC 61508-1: SIL 2	–

8 Dimensions

8.1 Motor starters

8.1.1 Motor starters with screw terminals for top-hat rail mounting

- EMS2-DO-Z-…
- EMS2-RO-Z-…
- EMS2-DOS-Z-…
- EMS2-ROS-Z-…

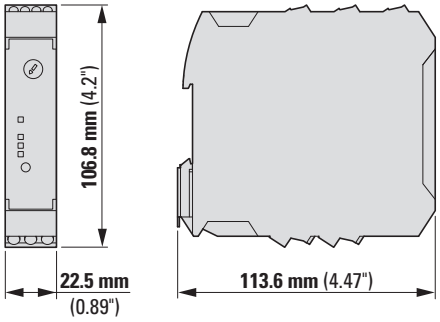


Figure 25: EMS2-DO-Z-…, EMS2-RO-Z-…, EMS2-DOS-Z-…, EMS2-ROS-Z-…

8.1.2 Motor starters with push-in terminals for top-hat rail mounting

- EMS2-DO-T-…
- EMS2-RO-T-…
- EMS2-DOS-T-…
- EMS2-ROS-T-…

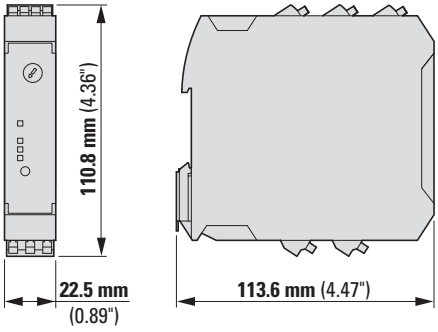


Figure 26: EMS2-DO-T-…, EMS2-RO-T-…, EMS2-DOS-T-…, EMS2-ROS-T-…

8.1.3 Plug-in motor starters

- EMS2-ROSF-…

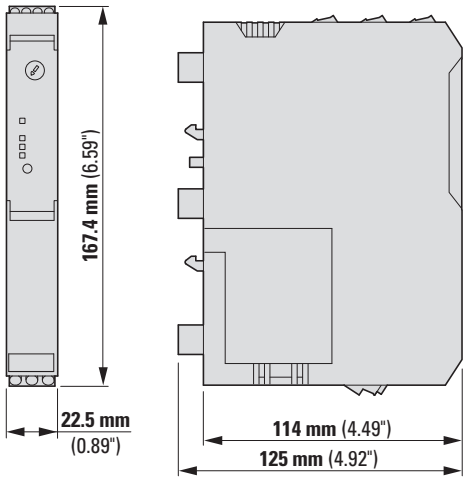


Figure 27: EMS2-ROSF-…

8.2 Adapters

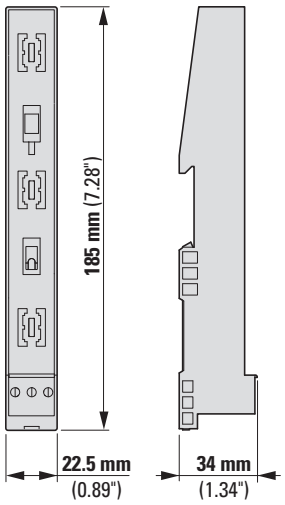


Figure 28: EMS2-XTH

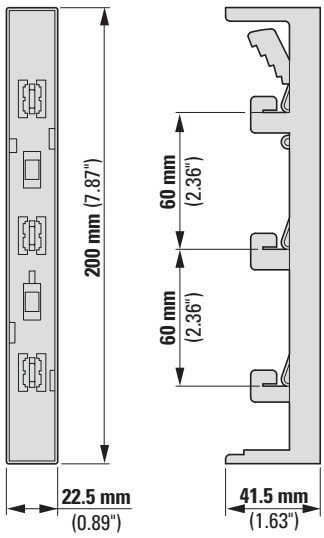


Figure 29: EMS2-XBB60

9 Accessories

9.1 Connectors

9.1.1 Three-phase current connector

The EMS2-XBR-… three-phase current connectors bridge the supply terminals (1L1 / 3L2 / 5L3) of multiple EMS2 electronic motor starters. They are available in various versions which differ, on the one hand, in the number of motor starters to be connected and, on the other hand, in the terminal technology used (screw terminals or push-in terminals) (→ table 12).

The distance of the individual terminal blocks from one another is designed so that they can also be used if the motor starters are fitted at a distance of 22.5 mm from one another. The length l of the connection cable is 3 m.

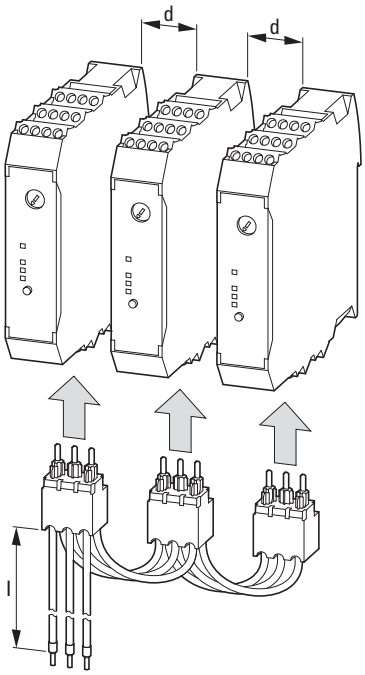


Figure 30: Three-phase current connector

Table 12: EMS2-XBR-… three-phase current connector

Type	Connection type	Length l of the connection cable	Maximum number of EMS2 motor starters to be supplied	Maximum distance d between two motor starters
EMS2-XBR-Z-2	for devices with screw terminals	3 m	2	22.5 mm
EMS2-XBR-Z-3		3 m	3	22.5 mm
EMS2-XBR-Z-4		3 m	4	22.5 mm
EMS2-XBR-Z-5		3 m	5	22.5 mm
EMS2-XBR-T-2	for devices with push-in terminals	3 m	2	22.5 mm
EMS2-XBR-T-3		3 m	3	22.5 mm
EMS2-XBR-T-4		3 m	4	22.5 mm
EMS2-XBR-T-5		3 m	5	22.5 mm

9.1.2 Control current connector

EMS-XCW-… control current connectors are used to loop control signals between several EMS2 series devices.

They are available in different versions, which differ in the number of motor starters to be connected (details → table 13).

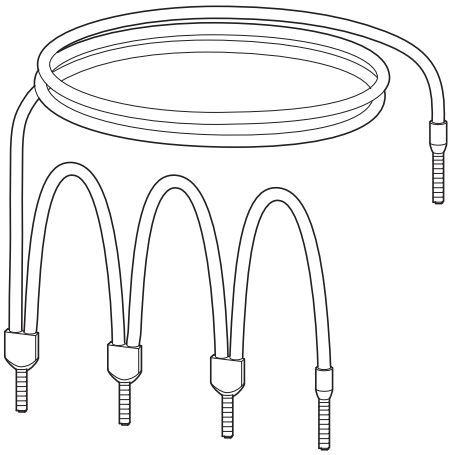


Figure 31: Control current connector EMS-XCW-…

Table 13: Control current connector EMS-XCW-…

Type	Cross-section and color	Length l of the connection cable	Maximum number of motor starters EMS2 to be supplied
EMS-XCW-2	0.75 mm², blue	2 m	2
EMS-XCW-3	0.75 mm², blue	2 m	3
EMS-XCW-4	0.75 mm², blue	2 m	4
EMS-XCW-5	0.75 mm², blue	2 m	5

9.2 Fuses

In the delivery state of the devices EMS2-**ROSF**-…, the fuses inside the device are already mounted.

If a fuse is tripped, first of all ensure that the cause for the tripping has been remedied (external short-circuit, etc.).

Only the following fuses may be used to replace the original fuses.

Table 14: Replacement fuses

Type of motor starter	Type of fuse	Dimensions	Rated data [1]
EMS2-ROSF-Z-3-24VDC	3x 10x38-16A-GR	10 x 38 mm	16A /690V (CC) / Superflink gR
EMS2-ROSF-Z-9-24VDC	3x 10x38-20A-GR	10 x 38 mm	20A /690V (CC) / Superflink gR
EMS2-ROSF-Z-9-24VDC	3x 10x38-30A-GR	10 x 38 mm	30A /690V (CC) / Superflink gR

1) We recommended using fuses manufactured by Mersen or fuses with similar characteristics

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By capitalizing on the global growth trends of electrification and digitalization, we're accelerating the planet's transition to renewable energy, helping to solve the world's most urgent power management challenges, and doing what's best for our stakeholders and all of society.

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