# DS7
# Soft starter



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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.

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Redaction:   René Wiegand

# ⚡ Danger!
# Dangerous electrical voltage!

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## 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's 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

# Contents

# Contents

Contents

# 0 About this Manual

This manual contains special information that you will need to connect a soft starter correctly and configure it to your requirements using the parameters. The details apply to the indicated hardware and software versions.
The manual describes all construction sizes of the DS7 series soft starters. Differences and special characteristics of each rating level and construction size are listed accordingly.

## 0.1 List of revisions

The following significant amendments have been introduced since previous issues:

| Publication date | Page | Subject | new | modified | deleted |
|---|---|---|---|---|---|
| 09/16 | 96 | Extended functionality | ✓ | | |
| | 44 | Actuation of resistive loads | ✓ | | |
| 09/13 | | Fully revised; firmware version V46 | ✓ | | |
| 07/12 | 145ff. | Chapter "SmartWire-DT" | ✓ | | |
| | All | Complete revision | ✓ | | |
| 11/11 | 89 | Size 2 (16 - 32 A) – Isolated relay contacts<br>Size 3 and 4 (41 - 200 A) – Isolated relay contacts | | ✓ | |
| 06/11 | All | Complete revision | ✓ | ✓ | |
| 04/11 | 56 | Configuration options of DS7 | ✓ | | |
| | 216 | Power supply dependent data (further) | ✓ | | |
| | 19 | Power values | | ✓ | |
| 07/10 | | Initial issue | | | |

## 0.2 Further manuals for this device

Further information can be found in the following manuals:

On "Soft starter"

- "Design of soft starters" - MN03902001Z-EN (previous description AWB8250-1346D)

On "SmartWire-DT"

- "SmartWire-DT The system" – MN05006002Z-EN (previous designation AWB2723-1617en)
- "SmartWire-DT module" – MN05006001Z-EN (previous designation AWB2723-1613en)
- "SmartWire-DT Gateways" – MN05013002Z-EN (previous designation AWB2723-1612en)
- "XIOC signal modules" – MN05002002Z-EN (previous designation AWB2725-1452en

➡ More information on the devices described here can be found on the Internet under:

http://www.eaton.eu/Europe/Electrical/ProductsServices/ AutomationControl/SwitchingProtectingDrivingMotors/SoftStarters/DS7/

as well as

http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/ Kundensupport/DownloadCenter/index.htm

**→ Customer support → Download Center – Documentation**

In the **Quick Search** box, enter the document name (MN03901001).

## 0.3 Sources

[1] Profile Drive Technology, PROFIdrive Technical Specification for PROFIBUS and PROFINET, Version 4.1, May 2006; Order No: 3.172

## 0.4 Target group

The content of the manual is written for engineers and electricians. A specialist knowledge of electrical engineering is needed for commissioning.

The chapter "SmartWire-DT" is intended for automation technicians and engineers. Detailed knowledge of the field bus systems used is presumed. In addition you should be familiar with the handling of the SmartWire-DT system.

## 0.5 Writing conventions

Symbols used in this manual have the following meanings:

▶ Indicates instructions to be followed.

### 0.5.1 Hazard warnings of material damages

> *NOTICE*
> Warns about the possibility of material damage.

### 0.5.2 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.

### 0.5.3 Tips

→ Indicates useful tips.

## 0.6 Abbreviations

The following abbreviations are used in this manual:

| Abbreviation | Meaning |
|---|---|
| BG | Construction size |
| DS | Default settings |
| DS7-SWD | DS7 soft starter with SmartWire-DT (abbreviated designation for devices with part no. DS7-34D…) |
| EMC | Electromagnetic compatibility |
| GND | Ground (0-V-potential) |
| LED | Light Emitting Diode (LED) |
| PDS | Power Drive System (magnet system) |
| RCD | Residual Current Device (residual current circuit-breaker) |
| SmartWire-DT | SmartWire-DT |
| TOR | Top of Ramp |
| t-Start | Ramp time for start voltage |
| t-Stop | Ramp time for voltage reduction |
| U-Start | Start voltage |
| UL | Underwriters Laboratories |
| $U_{LN}$ | Mains voltage |
| $+U_s/-U_s$ | Control voltage |

## 0.7 Mains supply voltages

The rated operating voltages stated in the following table are based on the standard values.

In ring networks (as found in Europe) the rated operating voltage at the transfer point of the power supply companies is the same as the value in the consumer networks (e.g. 230 V or 400 V).

In star networks (as found in North America), the rated operating voltage at the transfer point of the utility companies is higher than in the consumer network.
Example: 120 V → 115 V, 240 V → 230 V, 480 V → 460 V.

The wide tolerance range of the DS7 soft starters allows for voltage drops of 10% and a voltage drop of additional 4 %, as well as an excess voltage of 10 % that are permissible in consumer supply networks.

The rated mains voltage operational data is always based on mains frequencies of 50/60 Hz (50 Hz - 5 % – 60 Hz +5 %).

## 0.8 Units of measurement

Every physical dimension included in this manual uses international metric system units, otherwise known as SI (Système International d'Unités) units. For the purpose of the equipment's UL certification, some of these dimensions are accompanied by their equivalents in imperial units.

Table 1: Unit conversion examples

| Designation | US-American designation | Imperial unit | SI value | Conversion value |
|---|---|---|---|---|
| Length | inch | 1 in ('') | 25.4 mm | 0.0394 |
| Power | horsepower | 1 HP = 1.014 PS | 0.7457 kW | 1.341 |
| Moment of torque | pound-force inches | 1 lbf in | 0.113 Nm | 8.851 |
| Temperature | Fahrenheit | 1 °F ($T_F$) | -17.222 °C ($T_C$) | $T_F = T_C \times 9/5 + 32$ |
| Rotational speed | Revolutions per minute | 1 rpm | 1 $min^{-1}$ | 1 |
| Weight | pound | 1 lb | 0.4536 kg | 2.205 |
| Flow rate | cubic feed per minute | 1 cfm | 1.698 $m^3$/min | 0.5889 |

# 1 Device series DS7

## 1.1 Front View

The following two devices are used as examples of the DS7 series:

- DS7-340SX032N0-N (left) – without SmartWire-DT interface
- DS7-34DSX032N0-D (right) with SmartWire-DT interface
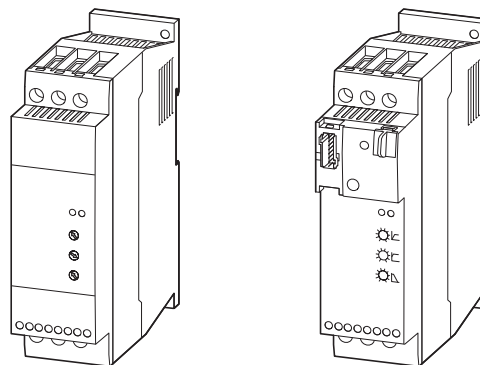


Figure 1:   Front view of DS7 soft starter
Left: Without SmartWire-DT interface
Right: With SmartWire-DT interface

## 1.2  Features

DS7 series soft starters comply with the IEC/EN 60947-4-2 product standard and are provided with the following standard features:

Table 2:   Features of the DS7 soft starters

| Feature | Instance |
|---|---|
| Compact design | ✓ |
| Adjustable start voltage | ✓ |
| Separately adjustable ramp times for start and stop | ✓ |
| Digital inputs | ✓   1 (size 1), 2 (size 2, size 3, size 4) |
| Relay output | ✓   1 (size 1), 2 (size 2, size 3, size 4) |
| Standard controller card and parameters over the entire performance range | ✓ |
| Communication | ✓   via SmartWire-DT (with types DS7-34D…-D) |

## 1.3 System overview

The following figure shows a DS7 soft starter together with (optional) accessories.
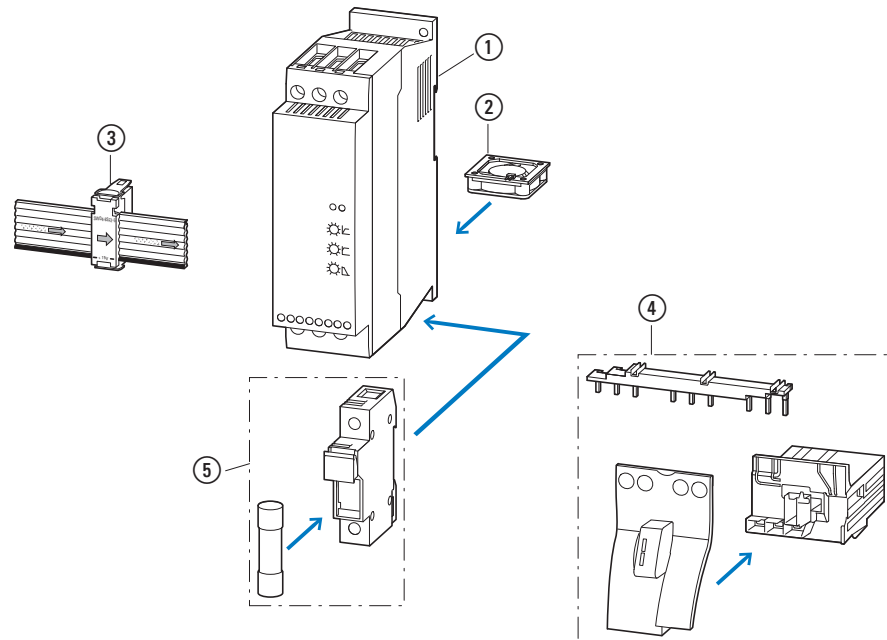


Figure 2:    System overview, DS7 soft starters

① DS7 soft starters
② Device fan (DS7-FAN-…)
③ Communication System SmartWire-DT
④ Mounting accessories
⑤ Superfast semiconductor fuse and fuse base

## 1.4 Description

### 1.4.1 DS7-340…, DS7-342…

The following drawing shows a DS7 soft starter (without SmartWire-DT) of size 2.
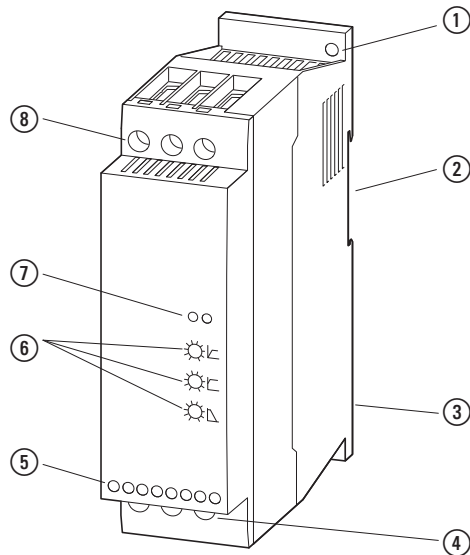


Figure 3: Description of the DS7-34…-N soft starter

① Fixing holes (screw fastening)
② Cutout for mounting on mounting rail (DIN EN 50022-35)
③ Device fan (mounting space on back)
④ Connection terminals of the power section, motor connection (2T1, 4T2, 6T3)
⑤ Control signal terminals
⑥ Potentiometer (U-Start, t-Start, t-Stop)
⑦ LEDs (RUN, error)
⑧ Connection terminals of the power section, mains voltage (1L1, 3L2, 3L3)

## 1.4.2 DS7-34D…

The following drawing shows a DS7-34D… soft starter with a SmartWire-DT connection (hereafter referred to with the abbreviation DS7-SWD) of size 2.
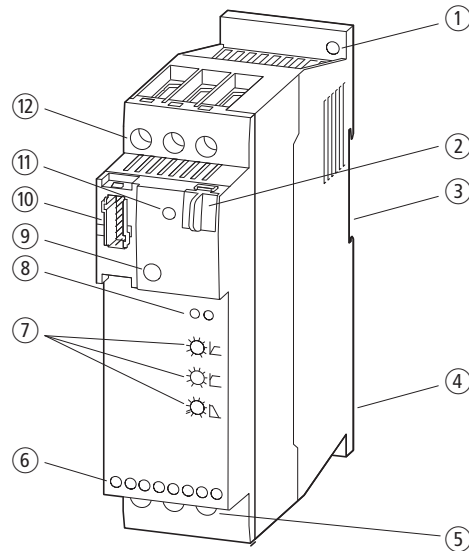


Figure 4:    Description of the DS7-34D…-D soft starter

① Fixing holes (screw fastening)
② Data interface for PKE32-COM
③ Cutout for mounting on mounting rail (DIN EN 50022-35)
④ Device fan (mounting space on rear)
⑤ Connection terminals of the power section, motor connection (2T1, 4T2, 6T3)
⑥ Control signal terminals
⑦ Potentiometer (U-Start, t-Start, t-Stop)
⑧ Light-emitting diodes (RUN, Error): DS7 diagnostic LEDs
⑨ 1-0-A switch
⑩ Connection for SmartWire-DT external device plug
⑪ LED: SmartWire-DT diagnostic LED
⑫ Connection terminals of the power section, mains voltage (1L1, 3L2, 3L3)

→ The SmartWire-DT external device plug with an adapted SmartWire-DT ribbon cable is connected to the DS7-SWD soft starter via connection ⑩.
For detailed instructions on how to use the SmartWire-DT external device plug (SWD4-8SF2-5) with the 8-pin SmartWire-DT cable, refer to the "Setting up SWD4-8SF2-5 external device plugs" section in manual MN05006002Z-EN, "SmartWire-DT - The System."

→ SmartWire-DT diagnostic LED ⑪ shows the communication status, the status of the DS7-SWD soft starter, and the switching command via the SmartWire-DT system.
For more information on the SmartWire-DT diagnostic LED, refer to → section 8.10.4, "SmartWire-DT diagnostic LEDs", page 214.

## 1.5 Key to part numbers

The soft starters of the DS7 series are assigned part numbers according to the following key to part numbers:

```
DS7 -  3  4  x  SX  yyy  N  0  - z     Explanation
```

**Instance:**
N = no option
D = SmartWire-DT

**Degree of protection:**
0 = IP00, IP20, NEMA 0

**EMC filter**
N = no filter

**Rated operational current I_e:**
Examples: 004 = 4 A
012 = 12 A
200 = 200 A

**Device version:**
SX = Standard soft starter with internal bypass relay

**Control voltage and Control signals:**
D = 24 V DC
0 = 24 V AC/DC
2 = 120/230 V AC

**Mains supply voltage:**
4 = 400 V (200 – 480 V)

**Supply phases:**
3 = three-phase incoming unit

**Soft starter series:**
Drives motor starter, Generation 7

Figure 5:    DS7 key to part numbers

## Example of key to part numbers

An example of the key to part numbers is shown below:

| DS7 - | 3 | 4 | 2 | SX | 024 | N | 0 | - N | Explanation |

**Instance:**
N = no option

**Degree of protection:**
0 = IP00, IP20, NEMA 0

**EMC filter**
N = no filter

**Rated operational current $I_e$:**
024 = 24 A

**Device version:**
SX = Standard soft starter with internal bypass relay

**Control voltage and Control signals:**
2 = 120/230 V AC

**Mains supply voltage:**
4 = 400 V (200 - 480 V)

**Supply phases:**
3 = three-phase incoming unit

**Soft starter series:**
Drives motor starter, Generation 7

## 1.6 Checking the Delivery

→ Before opening the packaging go over the nameplate on the packaging and check for whether the delivered soft starter is the same part no. as the one you ordered.

The DS7 series soft starter are carefully packed and prepared for shipment. These devices should only be shipped in their original packaging with suitable transportation materials. Please take note of the labels and instructions on the packaging, as well as of those meant for the unpacked device.

Open the packaging with adequate tools and inspect the contents immediately after receipt in order to ensure that they are complete and undamaged.

The packaging must contain the following parts:

• A soft starter from the DS7-34…-N or DS7-34…-D series
• an instructional leaflet IL (see table below).

If the delivered items are damaged, incomplete, or incorrect, please notify the responsible sales office immediately.
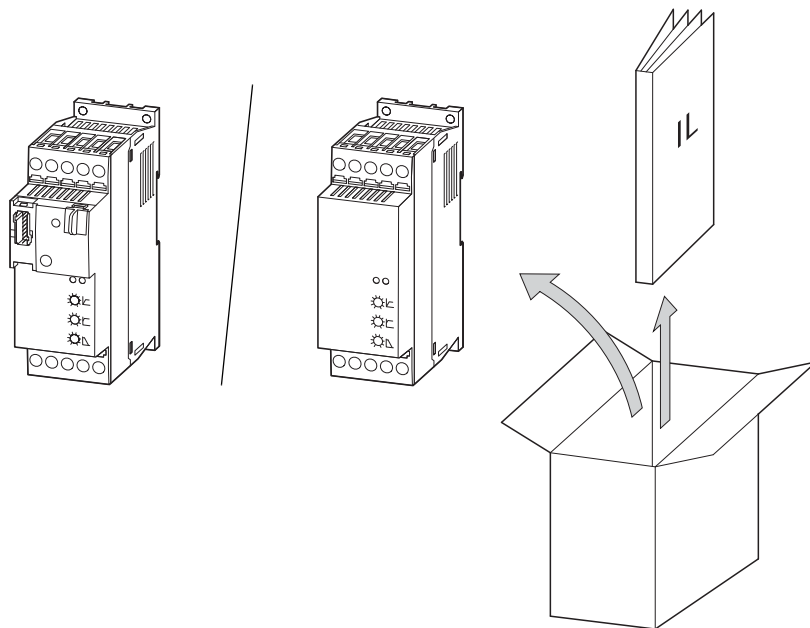


Figure 6:    Equipment supplied with DS7 soft starter

The part no. on the nameplate indicates the specific DS7 soft starter version corresponding to the unit.

In the figure below, the following letters are used to provide the following information:

- x: Control voltage $U_s$ or $U_c$
- yyy: Rated operational current $I_e$
- z: Options / characteristics
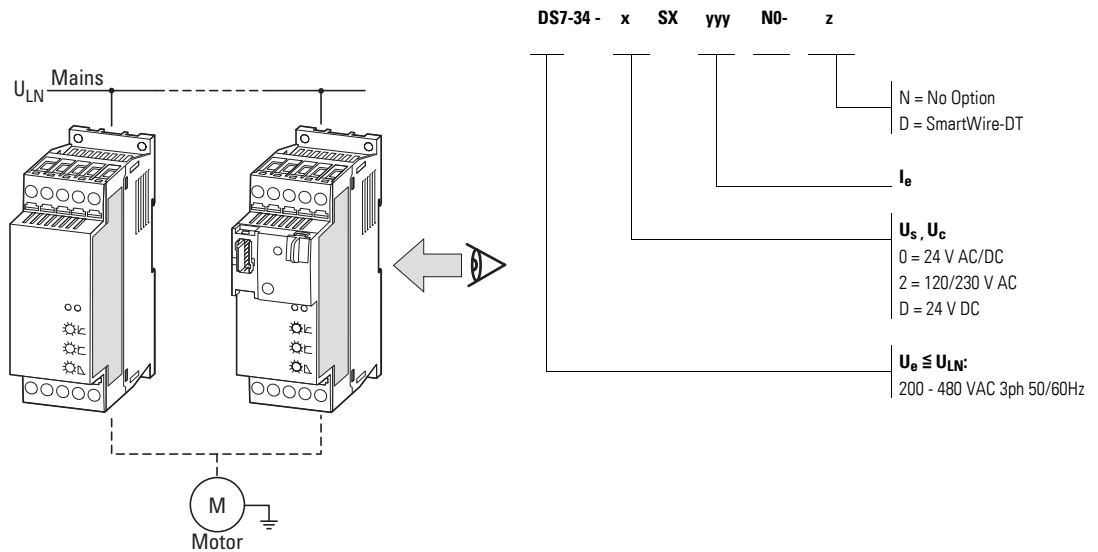


Figure 7: Nameplate and part no. position

The following table shows which instructional leaflets are meant for which DS7 soft starter sizes:

Table 3: Instruction leaflet for soft starter series DS7

| Instruction leaflet | Construction size | For device type | Rated operational current $I_e$ |
|---|---|---|---|
| IL03902003Z (previous designation AWA8250-2541) | BG1 | DS7-34…SX004… DS7-34…SX007… DS7-34…SX009… DS7-34…SX012… | 004 = 4 A 007 = 7 A 009 = 9 A 012 = 12 A |
| IL03902004Z (previous designation AWA8250-2542) | BG2 | DS7-34…SX016… DS7-34…SX024… DS7-34…SX032… | 016 = 16 A 024 = 24 A 032 = 32 A |
| IL03902005Z (previous designation AWA8250-2543) | BG3 | DS7-34…SX041… DS7-34…SX055… DS7-34…SX070… DS7-34…SX081… DS7-34…SX100… | 041 = 41 A 055 = 55 A 070 = 70 A 081 = 81 A 100 = 100 A |
| | BG4 | DS7-34…SX135… DS7-34…SX160… DS7-34…SX200… | 135 = 135 A 160 = 160 A 200 = 200 A |

## 1.7 Technical data

### 1.7.1 Assigned motor outputs

The following motor outputs can be connected if using three-phase asynchronous motors and a load suitable for soft starters.

Table 4: Assigned rated motor outputs for three-phase asynchronous motors

| Part no. | Soft starter's rated operational current | | Assigned motor output[1] at | | | | |
|---|---|---|---|---|---|---|---|
| | $I_e$ (IEC)[2] | $I_e$ (UL)[3, 4] | 230 V 50 Hz | 400 V 50 Hz | 200 V 60 Hz | 230 V 60 Hz | 460 V 60 Hz |
| | A | A | kW | kW | HP | HP | HP |
| DS7-34xSX004N0-… | 4 | 4.2 | 0.75 | 1.5 | ¾ | 1 | 2 |
| DS7-34xSX007N0-… | 7 | 7.6 | 1.5 | 3 | 2 | 2 | 5 |
| DS7-34xSX009N0-… | 9 | 9.6 | 2.2 | 4 | 2 | 3 | 5 |
| DS7-34xSX012N0-… | 12 | 14 | 3 | 5.5 | 3 | 3 | 10 |
| DS7-34xSX016N0-… | 16 | 17.5 | 4 | 7.5 | 5 | 5 | 10 |
| DS7-34xSX024N0-… | 24 | 25.3 | 5.5 | 11 | 7½ | 7½ | 15 |
| DS7-34xSX032N0-… | 32 | 34 | 7.5 | 15 | 10 | 10 | 25 |
| DS7-34xSX041N0-… | 41 | 42 | 11 | 22 | 10 | 15 | 30 |
| DS7-34xSX055N0-… | 55 | 54 | 15 | 30 | 15 | 20 | 40 |
| DS7-34xSX070N0-… | 70 | 68 | 15 | 37 | 20 | 25 | 50 |
| DS7-34xSX081N0-… | 81 | 80 | 22 | 45 | 25 | 30 | 60 |
| DS7-34xSX100N0-… | 100 | 96 | 30 | 55 | 30 | 30 | 75 |
| DS7-34xSX135N0-… | 135 | 130 | 30 | 75 | 40 | 50 | 100 |
| DS7-34xSX160N0-… | 160 | 156 | 45 | 90 | 50 | 60 | 125 |
| DS7-34xSX200N0-… | 200 | 192 | 55 | 110 | 60 | 75 | 150 |

1) Motor shaft output for normal four-pole internally and surface cooled three-phase asynchronous motors (1500 rpm at 50 Hz or 1800 rpm at 60 Hz)
2) IEC: Mains voltage = Motor voltage (at load) 230 V, 400 V
3) Reduced overload current acc. to UL 508C
4) Mains voltage 208 V / 240 V / 480 V ↔ motor voltage 200 V / 230 V / 460 V

The motor outputs listed below can be connected when using single-phase AC motors (asynchronous capacitor motors) and a load suitable for soft starters within an industrial environment:

Table 5: Assigned rated motor outputs for AC motors

| Part no. | Soft starter's rated operational current | | Assigned motor output[1] at | | | |
|---|---|---|---|---|---|---|
| | $I_e$ (IEC)[2] | $I_e$ (UL)[3], [4] | 230 V 50 Hz | 200 V 60 Hz | 208 V 60 Hz | 230 V 60 Hz |
| | A | A | kW | HP | HP | HP |
| DS7-34xSX004N0-… | 4 | 4.2 | 0.37 | ¼ | ⅓ | ⅓ |
| DS7-34xSX007N0-… | 7 | 7.6 | 0.75 | ½ | ½ | ¾ |
| DS7-34xSX009N0-… | 9 | 9.6 | 1.1 | ¾ | 1 | 1 |
| DS7-34xSX012N0-… | 12 | 14 | 1.5 | 1 | 1½ | 1½ |
| DS7-34xSX016N0-… | 16 | 17.5 | 2.2 | 2 | 2 | 2 |
| DS7-34xSX024N0-… | 24 | 25.3 | 3 | 3 | 3 | 3 |
| DS7-34xSX032N0-… | 32 | 34 | 4 | 5 | 5 | 5 |

1) Motor shaft output for normal four-pole internal and surface-cooled AC motors (1500 rpm at 50 Hz or 1800 rpm at 60 Hz)
2) IEC: Mains voltage = Motor voltage (at load) 230 V
3) Reduced overload current acc. to UL 508C
4) Mains voltage 208 V / 240 V ↔ motor voltage 200 V / 230 V

→ When using single-phase AC motors, the rated operational current will depend on the system frequency and the capacitor being used.

Example:
240 V, 50/60 Hz, 1.5/2.1 A
1300/1350 rpm, 5.0 µF CAP

## 1.7.2 General data

Table 6:   General Technical Data

| General | |
|---|---|
| Product standard | IEC/EN 60 947-4-2 |
| Approvals, certificates | CE, UL, CSA, CCC, Gost |
| Mounting position | vertical |
| Degree of protection | IP20 for the front and operator control and operating elements. IP20 on all sides in size 1 IP00 on all sides in size 2, 3, 4 |
| Busbar tag shroud | Finger- and back-of-hand proof |
| Mechanical shock resistance | 8 g/11 ms |
| Vibration resistance to EN 60721-3-2 | 2M2 |
| **Power section** | |
| Rated operating voltage | 200 - 480 V AC ±10 % |
| Mains frequency | 50/60 Hz ±5 % |
| Overload cycle to EN 60947-4-2 | AC53a: 3-5: 75-10 |
| Minimum load current | 0.5 A |
| Rated impulse withstand voltage $U_{imp}$ 1.2/50 µs | 4 kV |
| Rated insulation voltage $U_i$ | 500 V |
| Overvoltage category/pollution degree | II/2 |
| **Control section (inclusive SmartWire-DT)** | |
| Supply-/control voltage | depending on variant 24 V AC / 24 V DC (18 - 30 V ± 0 %) 120 - 230 V AC (98 - 264 V ± 0 %) |
| Mains frequency (with AC versions) | 50/60 Hz ±5 % |
| Rated impulse withstand voltage $U_{imp}$ | 2.5 kV |
| Rated insulation voltage $U_i$ | 300 V |
| Over voltage category | II |
| **Soft start functions** | |
| Ramp times | |
|     Acceleration | 1 - 30 s |
|     Lag | 0 (= free run-down), 1 - 30 s |
| Start voltage (= switch-off voltage) | 30 - 100 % |
| **Controlling and signalling** | |
| Control inputs | depending on variant 2 with size 1 4 with size 2 5 with size 3, size 4 |
| Relay | depending on variant 1 with size 1 (non-isolated) 2 with size 2, 3, 4 (potential-free) |
| LED | 2 at DS7 without SWD (DS7-340…, DS7-342…) 3 at DS7 without SWD (DS7-34D…) |

### 1.7.3 Device version

DS7 soft starters are classified in accordance with IEC 60947-4-2:2011, Table 1 (Functional possibilities of semiconductor motor control devices). The soft starters belonging to the DS7 series correspond to device version 1.
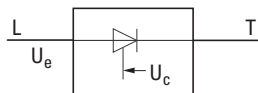


Figure 8:   Semi-conductor – Motor – Controlgear

### 1.7.4 Permissible environmental conditions

The following shows the permissible values for the ambient influences on soft starters of the DS7 series.

Table 7:   Permissible environmental conditions

| Property | Value |
|---|---|
| Installation altitude[1] | Up to 1000 m a.s.l.; higher than this up to 2000 m with a current reduction of 1 % $I_e$ per 100 m |
| Temperature | |
|    Operation | -5 to +40 °C without current reduction, up to +60 °C with a current reduction of 1 % $I_e$ per Kelvin, if the DS7-FAN-032 device fan is fitted up to +60 °C with a current reduction of 2 % $I_e$ per Kelvin without device fan |
|    Storage | -25 - +60 °C continuous |
|    Transport | -25 - +60 °C continuous |
| Climatic proofing | damp heat, cyclic, to DIN IEC Part 68 2-10 damp heat constant to DIN IEC 68 Part 2-3 |
| Permissible humidity rating | Relative air humidity 85 %, non condensing |
| Permissible pollution | Pollution degree 2 to EN 60947-1 |

1)   Higher installation altitude upon request

### 1.8 Intended use

The devices of the DS7 series

- are not devices for household use, and are designed exclusively for use in commercial applications,
- can be used in the described system configurations in the industrial environment,
- are not machines in the sense of the EC Machinery Safety Directive,
- comply in a typical drive configuration with the requirements of the EU EMC Directive, the EU Low Voltage Directive, as well as the specified standards.

The soft starters of the DS7 series are electrical apparatus for installation in the control panels of electrical systems or machines. They are designed for the soft starting of single-phase or three-phase AC motors mounted in a machine or for assembly with other machine or plant components.

If installed in machines, the soft starters must not be commissioned until it has been determined that the corresponding machines comply with the safety requirements in Machinery Directive 2006/42/EC. Standard EN 60204 must be complied with within this context. Commissioning is only permitted if the requirements of the EMC Directive (2014/30/EU) have been observed.

The soft starters of the DS7 series meet the requirements of the Low Voltage Directive 2014/35/EU and the product standard EN 60947-4-2.

The user is responsible for ensuring that the use of the relevant machines, as well as the corresponding applications, complies with all applicable EC Directives. Any other usage constitutes improper use.

> At the output of a DS7 soft starter (terminals U, V, W) you must not
>
> • connect any capacitive load (e.g. phase compensation capacitors),
> • do not connect any further soft starters (parallel connection on output side).

Observe the technical data and connection requirements. These are shown on the rating plate of the soft starter as well as in this documentation.

## 1.9 Maintenance and inspection

DS7 soft starters will be maintenance-free provided that the corresponding general rated operational data, as well as all specific technical data (→ section 1.7, "Technical data") for the relevant versions, is observed. However, please note that external factors may have an impact on the operation and lifespan of DS7 soft starters.

We therefore recommend that the devices are checked regularly and the following maintenance measures are carried out at the specified intervals.

Table 8: Maintenance measures and maintenance intervals

| Maintenance measures | Maintenance interval |
|---|---|
| Clean cooling vents (cooling slits) | please enquire |
| Check the fan function | 6 - 24 months (depending on the environment) |
| Filter in the control panel doors (see the manufacturer's specifications) | 6 - 24 months (depending on the environment) |
| Check the terminal's (control signal terminals, power terminals) tightening torques | regularly |
| Check connection terminals and all metallic surfaces for corrosion | 6 - 24 months; when stored, no more than 12 months later (depending on the environment) |
| Motor cable | According to manufacturer specifications, no later than 5 years |

DS7 soft starters are not designed in such a way as to allow for the replacement or repair of their individual components or sub-assemblies.

## 1.10 Storage

If the DS7 soft starter is stored before use, suitable ambient conditions must be ensured at the storage site:

- Storage temperature: -25 - +60 °C,
- Average relative humidity: < 85%; no condensation

## 1.11 Service and warranty

In the unlikely event that you experience a problem with your DS7 soft starter, please contact your local sales office.

When you call, have the following data ready:

- The exact part no. (see nameplate)
- the date of purchase,
- A detailed description of the problem related to the DS7 soft starter

If some of the information printed on the rating plate is not legible, please state only the data which are clearly legible.

Information concerning the guarantee can be found in the Terms and Conditions Eaton Industries GmbH.

**Hotline After Sales Service**

+49 (0) 180 5 223822 (de, en)

AfterSalesEGBonn@eaton.com

## 1.12 Disposal

The soft starters of the DS7 series can be disposed of as electronic scrap in accordance with national regulations.

## 1.13 Selection criteria

The soft starter DS7 ③ is selected on the basis of the supply voltage $U_{LN}$ of the supply network ① and the rated operational current of the assigned motor ②. The circuit type ($\Delta$ / $Y$) of the motor must be selected according to the supply voltage ①. The rated output current $I_e$ of the soft starter must be greater than/equal to the rated motor current.



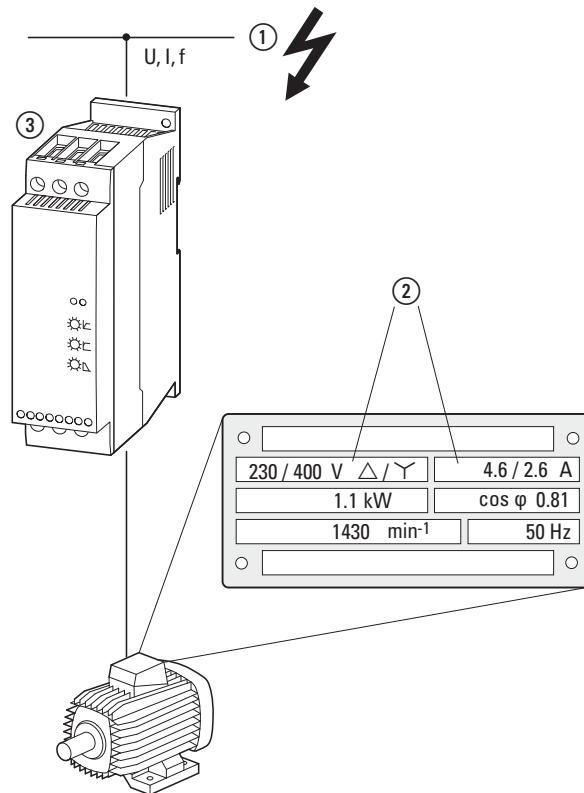| 230 / 400 V  $\triangle$ / $Y$ | 4.6 / 2.6  A |
| 1.1 kW | cos φ 0.81 |
| 1430   min⁻¹ | 50 Hz |

Figure 9:   Selection criteria

When selecting the drive, the following criteria must be taken into account:

- Type of motor (e.g. three-phase asynchronous motor)
- Mains voltage = rated operating voltage of the motor (e.g. 3 AC ~ 400 V),
- Rated motor current (recommended value, dependent on the circuit type and the power supply),
- Load torque (quadratic, linear),
- Starting torque,
- Ambient air temperature (rated value +40 °C).

➜ With heavy starting duty motors, the soft starter must be overdimensioned in terms of its overload capacity.

➜ In the case of single-phase AC motors (➜ page 20), the selection must be based on the mains voltage (= the motor's rated operating voltage) and the rated motor current for the specific line frequency.

## 1.14 Function

DS7 soft starters use phase control for controlling the voltage of the supply network smoothly from an adjustable start value up to 100 % of the rated value $U_{LN}$. This voltage control enables the inrush current of a three-phase asynchronous motor to be limited and its starting torque to be considerably reduced. This enables a smooth and jerk-free increase in torque, adjusted to the load behavior of the machine.
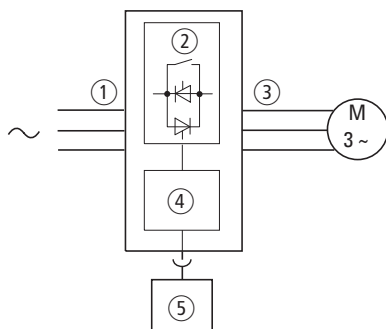


Figure 10: Function chart

(1) Mains supply voltage $U_{LN}$ 3 × 200 V bis 3 × 480 V

(2) Antiparallel thyristors in two phases with bypass contact for controlling the motor voltage

(3) Output voltage $U_2$: three-phase, from an adjustable start voltage to 100% mains voltage with the use of a ramp function at a constant line frequency
Output current $I_{2N}$: 4 - 200 A at a maximum ambient air temperature of +40 °C
Rated motor shaft output $P_2$: 1.5 - 110 kW with 400 or 3 - 150 HP with 480 V

(4) Controller card for controlling the power section
This is used to initiate control commands and set the parameters.

(5) SmartWire-DT interface (optional) for configuring parameters and for control and monitoring

➜ The following limitations apply to single-phase AC motors:

(1) $U_{LN}$: 1 x 200 - 240 V
(3) Output current $I_{2N}$: 4 - 32 A
Rated motor shaft output $P_2$ with 230 V: 0.37 - 4 kW or 1/3 - 5 HP

**Example of a current and torque curve for motor starts with a soft starter**
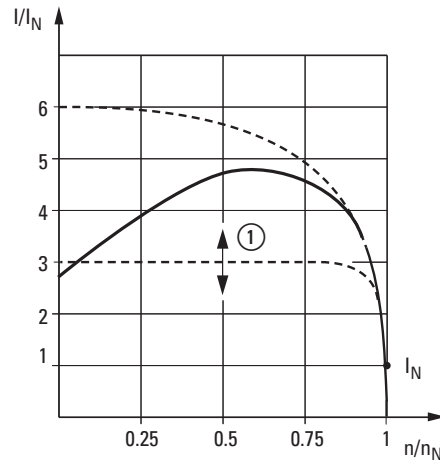


Figure 11: Reduced current rise

$I_N$ = Rated operational current at the operating point
$n_N$ = Rated speed at the operating point
① = adjustable current limitation

When used together with a PKE motor-protective circuit-breaker and a SmartWire-DT connection, size 1 and size 2 DS7-34D…-D soft starters can also be used to start motors with current limiting ①.
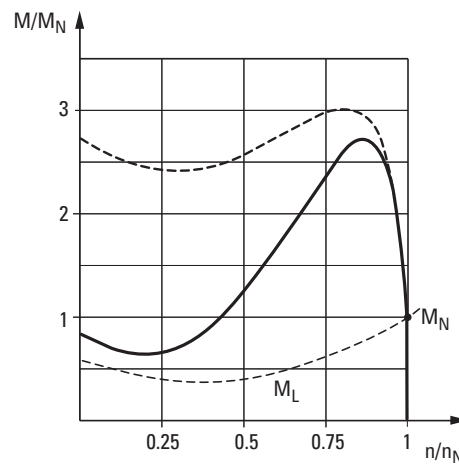


Figure 12: Reduced torque curve

$n_N$ = Rated speed at the operating point
$M_N$ = Rated-load torque of the motor during operation
$M_L$ = Load torque at the motor shaft
$M_L < M_N$ at motor start
$M_L \leqq M_N$ in continuous operation

The mechanical apparatus of a drive unit controlled with a DS7 soft starter are therefore accelerated very smoothly. This has a positive effect on the lifespan, operating behavior and operating processes, and prevents any adverse effects such as

• Impacting of cog edges in the gearbox
• Pressure surge in pipe systems,
• Slipping of V belts or
• Jitter with conveyor systems.

The generalized phase control of the supply voltage is implemented on the DS7 soft starter by means of anti-parallel thyristors which are bridged for continuous operation by so-called bypass contacts (TOR signal) after a time controlled voltage change (t-Start) has elapsed.

The transition resistance of these bypass contacts is considerably lower than the transition resistance of the power semiconductors. This reduces the heat dissipation in the soft starter and extends the lifespan of the power semiconductors.
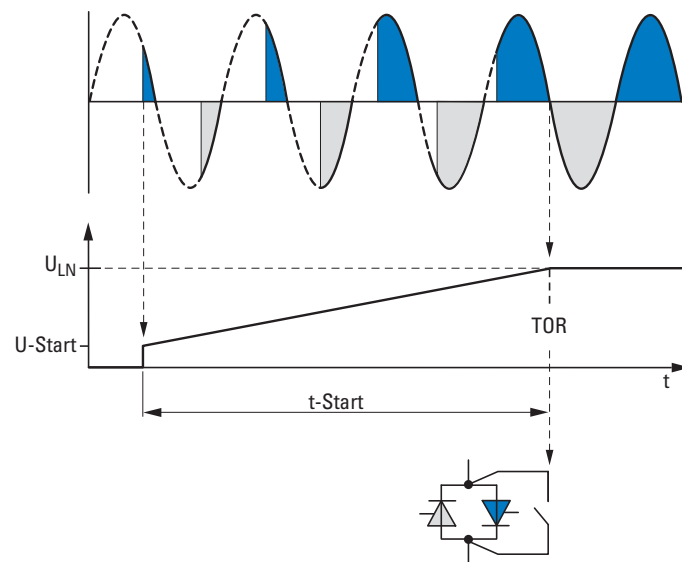


Figure 13: Generalized phase control of the supply voltage

$U_{LN}$ = mains supply voltage
U-Start = start voltage
t-Start = Ramp time of the voltage change at start
TOR (Top of Ramp) = Signals the end of the set "t-Start" ramp time
(output voltage $U_2$ = mains supply voltage $U_{LN}$).
Afterwards the internal bypass contacts are closed.

As well as the time-controlled startup of a motor, the DS7 soft starter also enables a time-controlled reduction of the motor voltage and thus a controlled stopping of the motor. This type of stop function is primarily used for pumps in order to prevent pressure waves (water impact).
Jerky movements and therefore the wear on drive chains and drive belts as well as bearings and gears can be reduced.
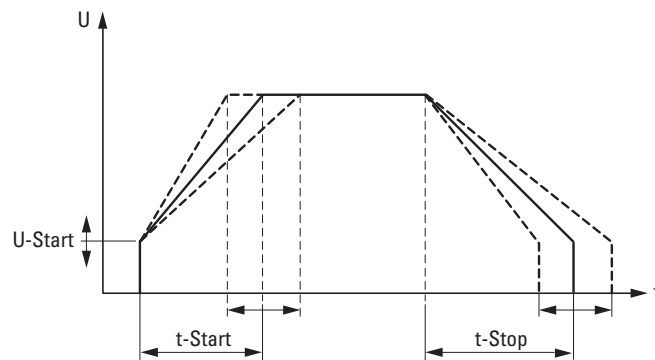


Figure 14: Time-based control of motor voltage with a soft starter

→ The acceleration time of a drive with a soft starter always depends on the load and the breakaway torques. The required breakaway torque can be set via the start voltage (U-Start). The ramp time (t-Start) for a linear voltage change should be as short as possible. The ramp time for the deceleration (t-Stop) must be greater than the load-dependent uncontrolled deceleration time of the machine.

For the power semiconductors in the soft starter, the controlled deceleration presents a similar load as the startup: If, for example, the deceleration ramp is activated on a soft starter with a maximum of 10 permissible starts per hour, the number of permissible starts is reduced to 5 per hour (plus 5 stops within this hour).

The output voltage of the soft starter determines the torque of the motor. At machine startup it must therefore be ensured that the selected starting voltage (U-Start) is not too low. Otherwise this may cause the motor to overheat excessively before it starts up.
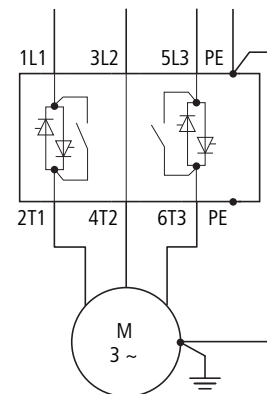
The soft starters of the DS7 device series are two-phase controlled and are available in two variants in the power section (for size 1 and 2 or size 3 and 4).
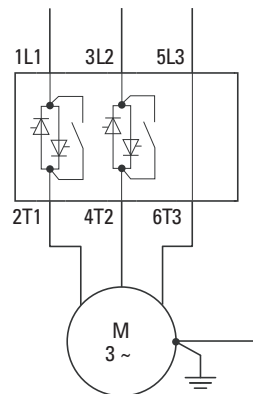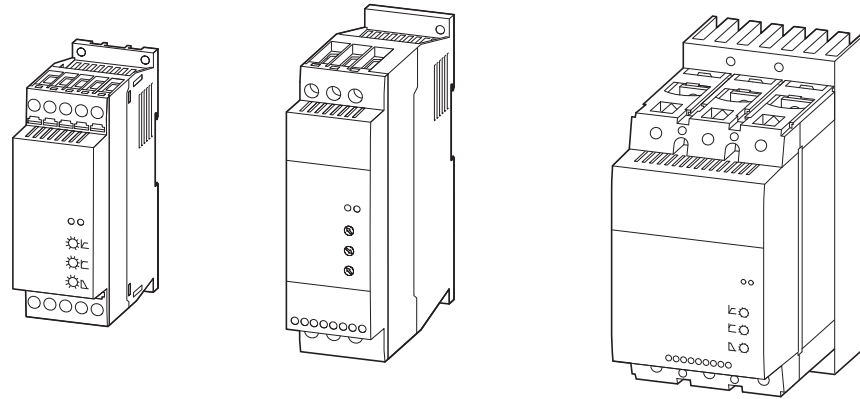


Size 1 (4 to 12 A)            Size 2 (16 to 32 A)                Size 3 and 4 (41 to 200 A)

Figure 15: Designs and variants in the power section

→ In the case of conventional two-phase controlled soft starters, the physical conditions involved in their operation lead to DC components that in turn result in an elliptical rotating field being produced. This causes the motor to start up unevenly and the acceleration time is unnecessarily extended.

The asymmetrical thyristor trigger control that was developed and patented by Eaton (Moeller) for phase control (PCT/EP00/12938, 19.12.2000) prevents DC components and ensures optimum startup behavior. This control is integrated in the DS7 soft starters and is active during the start (t-Start) and stop ramp (t-Stop).

Figure 16: Current behaviour in the uncontrolled phase
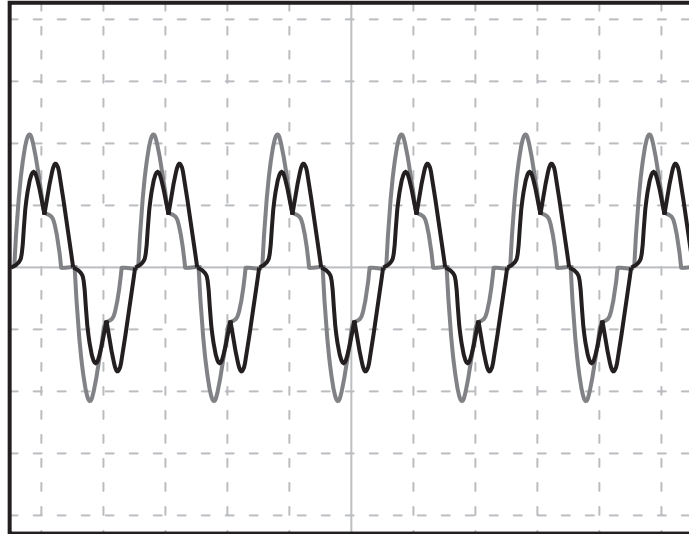
Conventional method:

▨ Symmetrical control with high DC components

New process from Eaton (Moeller):

▮ Asymmetrical control without DC components

→ With single-phase connected three-phase motors with capacitors (Steinmetz circuit), system conditions always cause an elliptical rotating field which cannot be completely compensated by the asymmetrical trigger control.

# 2 Engineering

## 2.1 Selection of devices

The DS7 soft starters can be designed for standard motors in standard applications (such as pumps, fans, conveyor belts etc.) according to the technical data provided in the Appendix.

A more specific design is required for drives with a high starting torque or high inertia. The following information must be known for correct device selection:

- the overload cycle of the machine,
- The start-up time for DOL starting or for star/delta starting,
- the maximum starting current,
- the load cycle,
- the load that the motor is required to drive.

The values of the moments of inertia must also be known for a more precise design. These values enable you to select the most suitable soft starter. The relevant procedure is described in the manual MN03902001Z-EN ("Design of soft soft starters") and applies generally to all Eaton soft starters. The necessary key data of the DS7 soft starter series that is also required for this design (rated operational current, overload capacity, root mean square current at nominal switching frequency) is provided in the Appendix in the technical data.

Connecting to a higher-level PLC through SmartWire-DT requires soft starters with part no. DS7-34D…-**D**… (hereafter referred to as "DS7-SWD"). These soft starters can be controlled and monitored via SmartWire-DT, and their parameters can be configured via SmartWire-DT as well.

> In connection with a motor-protective circuit-breaker (PKE), current can be monitored and additional protective functions can be activated via SmartWire-DT(➜ chapter 8, "SmartWire-DT").

> The devices in the DS7-34D…-D series can **only** be used in conjunction with the SmartWire-DT connection. They cannot be run via control signal terminals.
> By setting the 1-0-A switch to position 1, the corresponding motor can be started directly in manual mode (➜ chapter 8, "SmartWire-DT").

## 2.2 EMC compliance

EMC = **E**lectro**m**agnetic **C**ompatibility

The IEC EN 60947-4-2 product standards allows for the limit value classes and measurement methods of the IEC/CISPR11 or EN 55011 standard.

No other measures are required on the DS7 soft starter for the limitation of interference emission in accordance with EN 55011 limit value class A (industrial environment).

The devices of the DS7-340…(24 V AC/DC version) series furthermore meet the requirements of limit value class B (public environment) without any other measures required.

| **Note** |
|---|
| This is a Class A product. In a domestic environment, this device may cause radio interference, in which case the user may be required to take adequate measures. |

Figure 17: Note in accordance with DIN EN 60947-1 (VDE 0660-100): 2011-10 EN 60947-1: 2007 + A1: 2011, paragraph 5.3

## 2.3 Network configurations

DS7 soft starters can be used without restriction in the following network configurations:

- networks with a earthed or non-earthed center point,
- networks with an isolated star point (IT networks),
- networks with an earthed phase conductor.

## 2.4 Power connection

The power section should be protected according to the connection form used.

Cable and device protection on the supply side:

- Input AC… via standard fuses for cable protection or via motor-protective circuit-breaker.
- Fuses in UL compliant systems must be UL-approved.
- The rated operating voltages of the fuses must be suitable for the local mains voltage.
- No fuses are required on the motor side.

The following figure shows the basic connection of motor and power section.
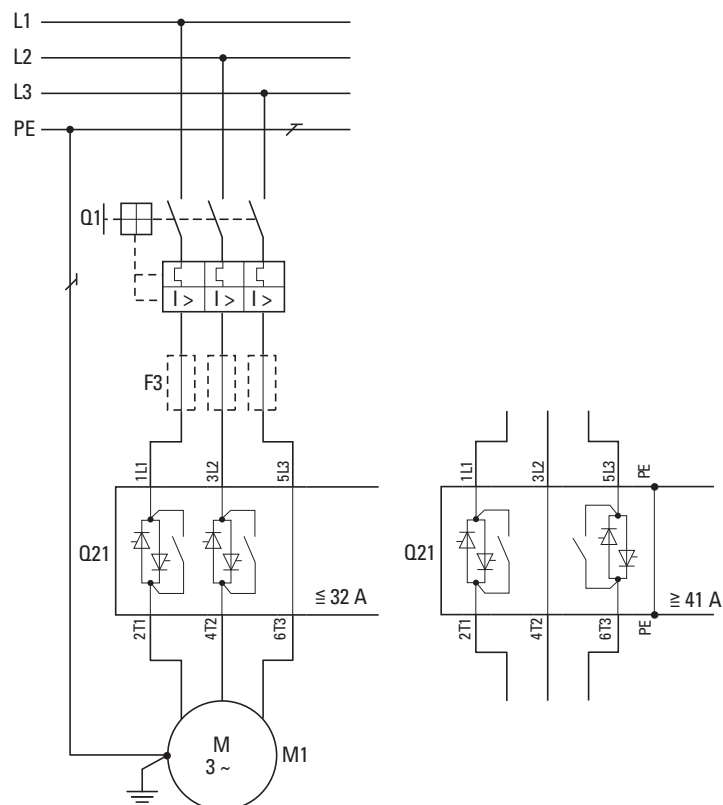


Figure 18: Connecting the power section and motor
F3 = optional semiconductor fuse
Q1 = Cable protection + motor protection
Q21 = Soft starter
M1 = Motor

At the output of the soft starter (terminals 2T1, 4T2, 6T3) you must not

- Connect any capacitive load (e.g. phase compensation capacitors),
- Connect several soft starters in parallel,
- Feed a mains voltage or a voltage from a variable frequency drive or other voltage source.

## 2.5 emergency switching off

DS7 soft starters fall under safety category B as defined in standard EN 954-1. In other words, certain faults may remain undetected (thyristor failure caused by overvoltage ➔ permanently conductive).

If the machine has more stringent requirements in accordance with EN ISO 14121-1 "Safety of machines", additional (external) measures must be implemented in accordance with this standard.

## 2.6 Protection

The devices are protected with fuse devices shown in the Appendix (➔ page 221). Different fuse devices are used depending on the type of coordination required.

### 2.6.1 Type 1 coordination

The protective switches or circuit-breakers stated are used for cable protection and motor protection. The DS7 soft starter may be damaged in the event of a short-circuit at the output terminals (motor connection 2T1, 4T2, 6T3).

### 2.6.2 Type 2 coordination

In addition to the safety devices for type 1 coordination, superfast semiconductor fuses are required for type 2 coordination. These fuses will protect the thyristors in the DS7 soft starter from damage in the event of a short-circuit on the output terminals (2T1, 4T2, 6T3 motor connections).

> *NOTICE*
> Semiconductor fuses cannot ensure a cable protection function!

The semiconductor fuses must be mounted externally on DS7 soft starters. The assigned fuse types are listed in the Appendix on page 221.

> *NOTICE*
> Protection against overvoltages in the supply network cannot be provided with superfast fuses!

## 2.7 Residual current circuit-breaker (RCD)

Residual current circuit-breakers – also referred to as RCDs (residual current devices) and ground fault circuit interrupters (GFCIs) – protect people and livestock from the presence (not the production!) of impermissibly high touch voltages. They prevent dangerous and fatal injuries caused by electrical accidents and also serve as fire prevention.

Size 1 and 2 soft starters of the DS7 series have no connection to the earth potential (PE). In size 3 and 4, the DS7 soft starters have an exposed heat sink which must be connected with the earth potential (PE).

When using a DS7 soft starter, there is no leakage current at the motor feeder. Standard residual current circuit breakers (RCD part no. A) up to 30 mA can be used.
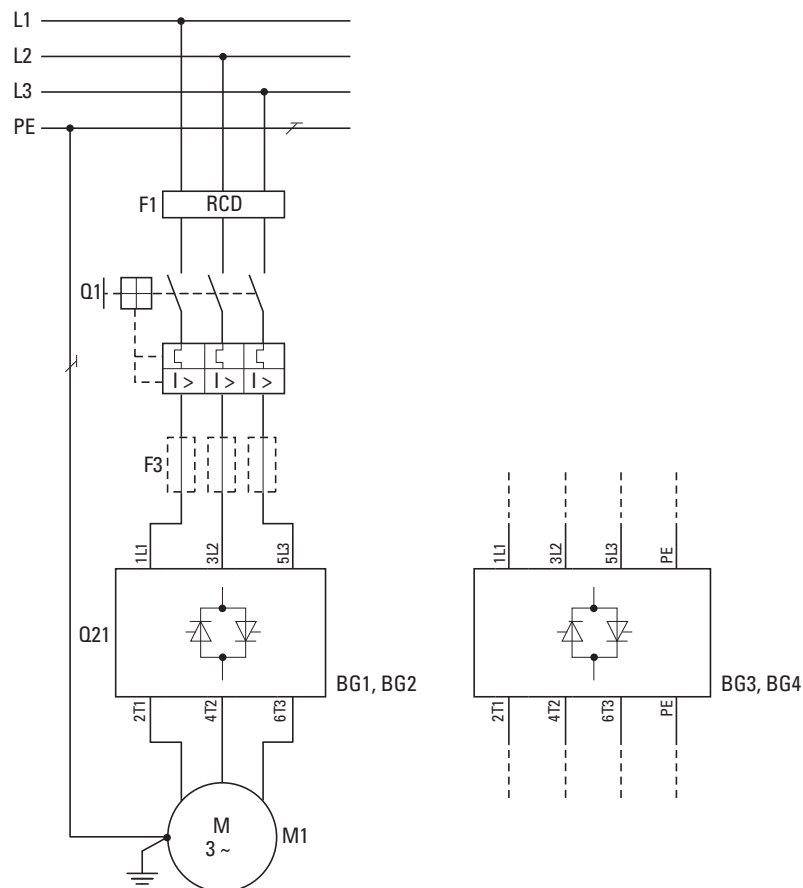


Figure 19: Motor feeder with RCD

F1 = Residual current circuit breaker (RCD)
F3 = optional semiconductor fuse
Q1 = Cable protection + motor protection
Q21 = Soft starter
M1 = Motor

## 2.8 motor protection

The motor protection protects the three-phase asynchronous motor from thermal overload due to a mechanical overload or the failure of the motor cooling (fan) or the failure of a connection cable.

There are two basic ways of protecting the three-phase asynchronous motor from overload during operation: By

- monitoring of current consumption (motor-protective circuit-breaker, overload relay or bimetal relay),
- direct temperature monitoring in the motor winding (PTC, thermistor).
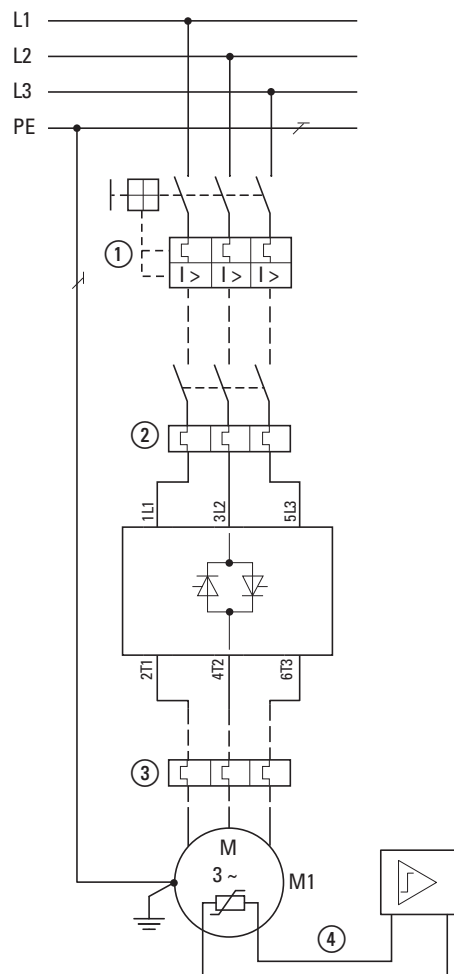


Figure 20:  Possible motor protection variants

① Motor-protective circuit-breaker (PKZ, PKE, NZM) - disconnection with manual release
② Overload relay (ZB, ZEB) – here in combination with a contactor
③ Overload relay (ZB, ZEB) for indication of the thermal overload – can alternatively (①, ②) also be arranged on the mains side
④ Thermistor, PTC or semiconductor contactor protection in the motor winding with external signalling relay (EMT)

➜ The combination of the motor protection variants ①, ② or ③ with the temperature monitoring variant ④ is also called full motor protection.

➜ After a motor protective device has tripped, the soft starter and the protective device cannot be switched on again until it has cooled down. The reset depends on the temperature.

## 2.9 DS7-SWD and PKE motor-protective circuit-breakers

DS7-SWD soft starters can also provide the following functions when used together with a PKE motor-protective circuit-breaker:

*   Protecting the DS7 soft starter against overload
*   adjustable current limitation,
*   ZMR overload relay function (in the event of an overload, the DS7 soft starter will switch off the load, instead of the PKE motor-protective circuit-breaker doing so)
*   Currents readable via SmartWire-DT
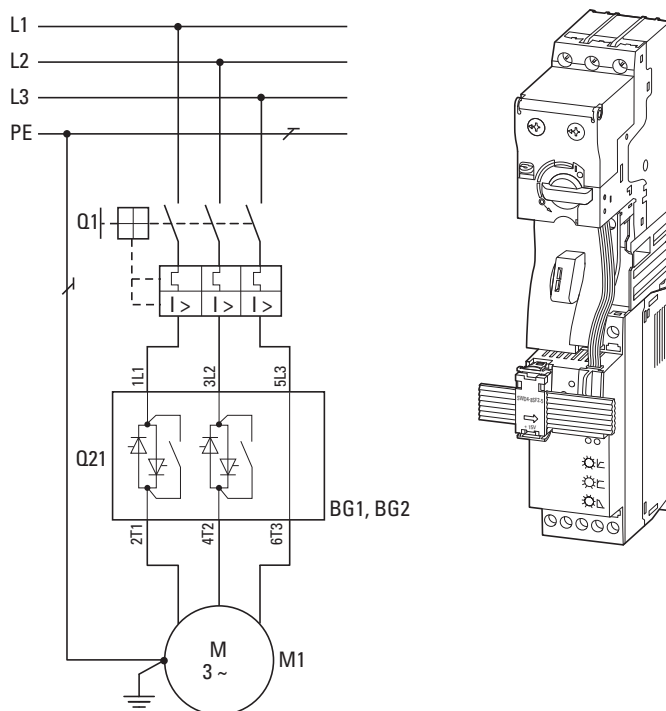


Figure 21:  Motor-starter combination: DS7-SWD and PKE

➜ Only PKE trip blocks (PKE-XTUWA-32, PKE-XTUA-…) should be used for motor protection in combination with DS7 soft starters. PKE trip block PKE-XTUCP-… for system protection must not be used in combination with a soft starter DS7! In combination with SmartWire-DT this can cause false tripping.

In this case, a PKE motor-protective circuit-breaker is connected to the DS7-SWD soft starter with the PKE32-COM communication cable via the PKE-XTUA-… trip block. Data will be exchanged between the data interfaces of the PKE trip block.

If the DS7-SWD soft starter is connected to a SmartWire-DT network, the DS7-SWD soft starter will transmit the data for the PKE trip block (currents) to a higher-level main controller (PLC).

## 2.10 Cables, contactors, line filters

The cables used must meet the requirements of locally applicable regulations at the site of installation.

Large dimensioned cables and contactors are required when frequent startups and high starting currents are expected. The load capacity limits of the contactors are listed in the relevant documentation. The appropriate assignment of mains contactor for the selected starting cycle of the soft starters is provided in appendix under page 223.

The fuses and cable cross-sections to be selected for the incoming and outgoing cables are also listed there.

The specifications in the Appendix refer to:

- use in control panels and machines,
- installation in the cable duct,
- a maximum ambient air temperature of +40 °C,
- normal starting frequency.

The fuses and conductor cross-sections depend on the rated operational current of the motor as well as the start cycle (operating frequency, overcurrent).

No line filters or chokes are needed.

→ In applications with an overdimensioned soft starter, the minimum connectable terminal capacity of the soft starter must be taken into account and the motor must be wired if necessary with a larger conductor cross-section.

→ When selecting the cable cross-section, take into account the voltage drop under load.
Compliance to further standards is the responsibility of the user.

## 2.11 Motor connection

DS7 soft starters enable the operation of different variants of three-phase asynchronous motors:

- Standard three-phase asynchronous motor,
- Pole-changing motors (Dahlander motors),
- Sliping rotor motors,
- External rotor motors (fan motors, roller drives),

Within this context, a "standard motor" refers to a four-pole, internally cooled or surface-cooled three-phase asynchronous motor with a speed of 1500 rpm at 50 Hz or 1800 rpm at 60 Hz.

### 2.11.1 Connection configurations (star/delta configuration)

A three-phase asynchronous motor can be connected to the DS7 soft starter in a star or delta circuit – depending on the mains voltage. This type of setup uses a standard connection configuration, also referred to as outside-the-delta wiring (with three connection cables).

**Star connection**
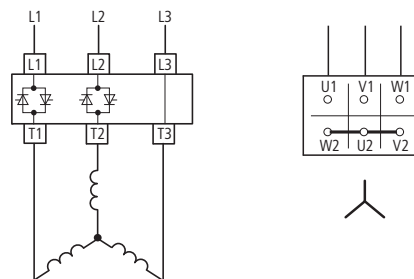
**Delta circuit**
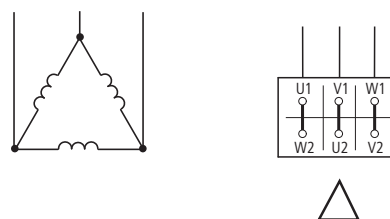
Figure 22: Permissible motor connection circuits
(shown for devices up to 32 A, furthermore, phase L2-T2 is connected through instead of L3-T3)

In a 3 × 400 V supply system, the following motors are generally operated:

- up to approx. 4 kW motor output can be switched in a star connection (230/**400 V**),
- over 4 kW motor output in a delta circuit (**400**/690 V).

Do not connect three-phase motors with starpoint-earthing (star circuit) or motors with a neutral conductor connection to DS7 soft starters (see fig. 23), as one phase is always connected directly to mains voltage and will heat up the motor excessively.
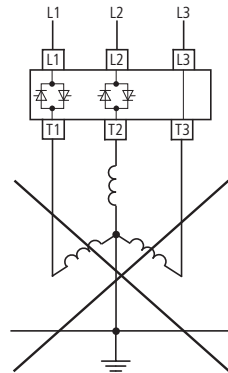
Figure 23: Not permissible neutral point earthing

## 2.11.2 Connection and phase sequence

The clockwise rotation of the motor shaft is achieved by connecting in phase sequence (clockwise rotating field with ascending numerical order of phases and ascending alphabetical order of terminal designations). The operating direction of the motor shaft is reversed by swapping round two connection phases.
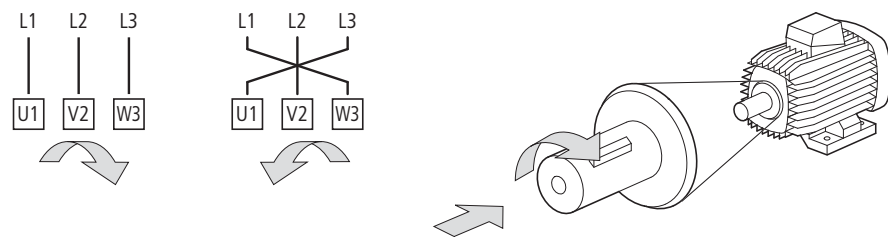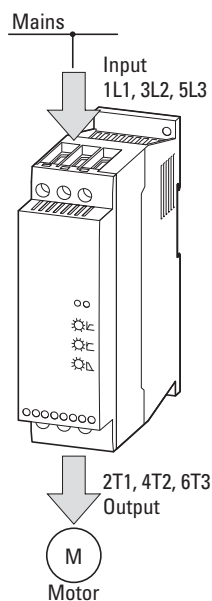


Figure 24: Operating direction with view on motor shaft



Figure 25: Connection and direction in which power flows in DS7 soft starters

For clockwise rotation, connect the motor and the DS7 soft starter to each other as follows:

Table 9:     Connection of Soft starters and motor

| Supply system (Mains) | Soft starter input (Input) | Soft starter output (Output) | Motor (Motor) |
|---|---|---|---|
| L1 | 1L1 | 2T1 | U1 |
| L2 | 3L2 | 4T2 | V1 |
| L3 | 5L3 | 6T3 | W1 |
| PE (polyethylene) | in size 3 and size 4 only: PE, ⏚ | in size 3 and size 4 only: PE, ⏚ | PE, ⏚ |

The motor's direction of rotation can be reversed with the DS7 soft starter if the soft starter is used together with a reversing contactor combination.

When reversing the operating direction, the output of the soft starter must be disabled before the reverse switching is carried out. The rotating field direction at the input will always match the rotating field direction at the soft starter's output (➔ chapter 7, "Connection examples").

## 2.11.3 Delta connection

➔ Using inside-the-delta wiring, also referred to as a six-wire connection (soft starter thyristors in series with the individual motor windings and with six connection cables), is not permissible when using a two-phase controlled DS7 soft starter!

### 2.11.4 Actuation of resistive loads

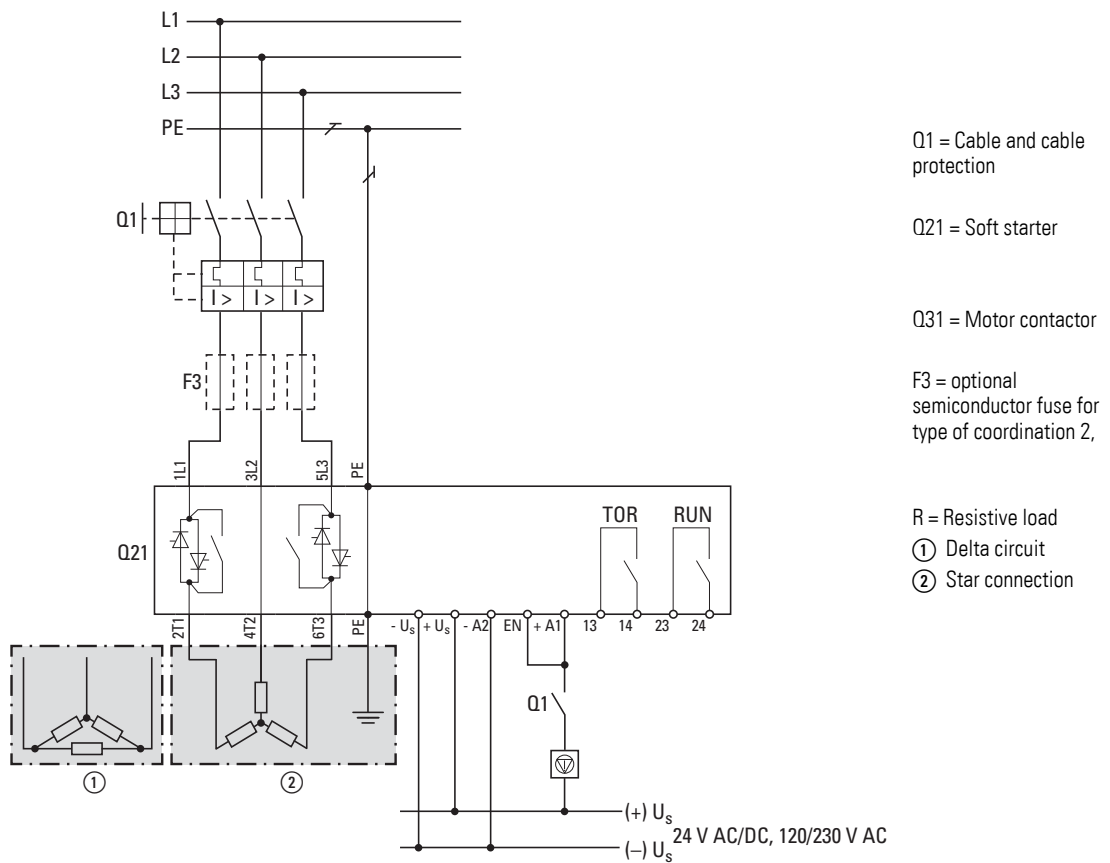DS7 soft starters can also be used to drive resistive loads (example: electrical heating elements).



Q1 = Cable and cable protection

Q21 = Soft starter

Q31 = Motor contactor

F3 = optional semiconductor fuse for type of coordination 2,

R = Resistive load
① Delta circuit
② Star connection

Figure 26: Connecting resistive loads in a wye or delta circuit

→ Do not use the soft starters to drive solidly grounded wye circuit resistive loads, as a phase will be connected directly to the mains voltage in this case!
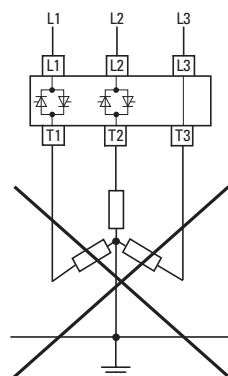


Figure 27: Impermissible connection for resistive loads

### 2.11.5 Connection of AC motors

AC motors can also be operated with the DS7 soft starters series. Only the version of the three-phase asynchronous motor with a capacitor (Steinmetz circuit) is considered suitable for industrial use.

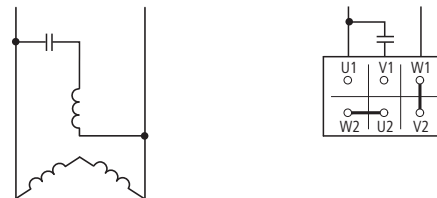**Delta circuit**
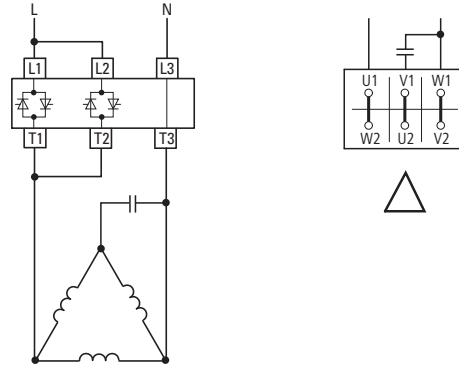
**Star connection**
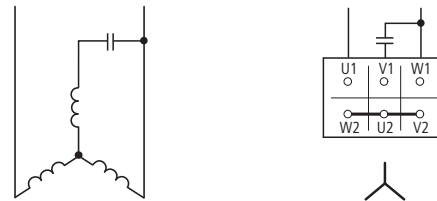
**Semi star circuit**

Figure 28: Permissible motor connection circuits when connecting to a single-phase AC supply system

In practice, single-phase motors up to an output of around 2.2 kW (230 V) are used. In the Steinmetz circuit, metal paper capacitors (450 V) with around 60 to 80 µF per kilowatt motor output are required (DIN 48501).

When connected to a single-phase AC supply, they form an auxiliary phase with a phase shift of around 90°. Compared to the required phase shift of 120° this causes an elliptical rotating field. As a result, the starting torque ($M_A$) is reduced to around 30 % of the rated-load torque ($M_N$). If a higher starting torque is required (90 - 100 %), additional starting capacitors must be used which are only switched for the startup phase, in parallel to the operation capacitor. During operation, the torque is around 70 % of the normal motor output.

→ In practical applications, three-phase asynchronous motors with capacitors (Steinmetz circuit) are only started with a soft starter on the single-phase AC supply if the load requires a reduced starting torque (such as with continuous flow machines, pumps or fans).

→ The operating direction determines the connection (L1 or N) of the auxiliary line with the capacitor.

### 2.11.6 Long motor supply cables

DS7 soft starters set no limit on the length of the motor cable.

→ When dimensioning the cable, the voltage drop caused by the cable length to the motor must be taken into account.

In practical applications, motor cable lengths up to approx. 100 m can be connected without any additional measures. Larger cable cross sections may be necessary above this length. From around 300 m upward, a detailed engineering (cable cross-section, overdimensioning of the soft starter etc.) is advisable.

### 2.11.7 Parallel motor connection

Several motors can be connected in parallel at the output of the DS7 soft starter. This does not, however, allow the behavior of the individual motors to be controlled. It must be taken into account that an even run-up of all motors cannot be ensured. If motors are mechanically interconnected, the load distribution is also uncertain. In this case, the entire drive torque may possibly only be supplied by a single motor, which may cause this motor to be overloaded. In this type of application, soft starters should be used for each single motor and the motors should be started with a current limiting function. With a DS7-SWD... soft starter this can only be implemented in conjunction with the networkable PKE motor-protective circuit-breaker. Alternatively, a soft starter of the DM4 series or its successor may be required.
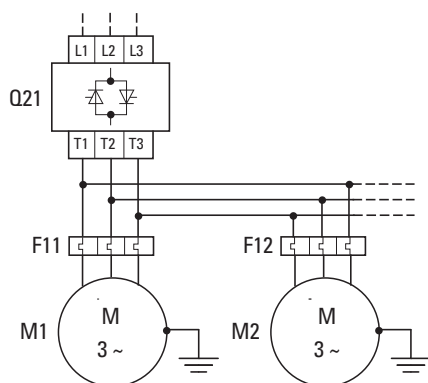


Figure 29: Parallel connection of multiple motors to a soft starter (variant 1)

→ The total current consumption of all connected motors must not exceed the rated operational current $I_e$ of the soft starter.
The overdimensioning of the soft starter is recommended if the individual motors have high starting currents.

→ Each motor must be protected from overcurrent and thermal overload (using overload relays and/or thermistor protection).

Motors with considerably different motor outputs (e.g. 1.5 kW and 11 kW) should not be connected in parallel to the output of a soft starter. Reason: Starting problems may occur in the motor with the lower output since this cannot provide the required torque.
It is therefore advisable to only use motors with similar ratings (maximum deviation: one rating size).

→ Motor-protective circuit-breakers (Q11, Q12) can also be used here instead of the overload relays (F11, F12).
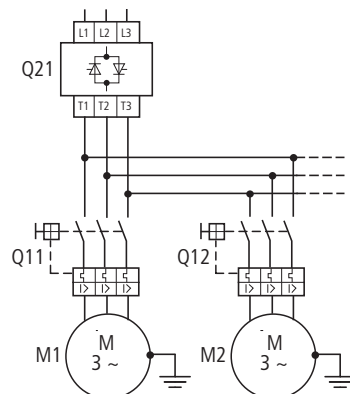


Figure 30: Parallel operation of multiple motors on a soft starter (variant 2)

→ The last connected motor must not be switched off in operation since the resulting voltage peaks may cause damage to the electronic components in the soft starter and thus to its failure.

## 2.11.8 Connecting motors

If motors are connected in parallel and an additional motor is connected to the soft starter's output during ongoing operation, the soft starter will not carry out a soft start for the new motor. However, the soft starter must be able to deliver the entire inrush current (approx. 6 to 8 times the rated motor current) and the current for the remaining motors. Otherwise, an overload will occur and the soft starter may be destroyed in the worst case.

## 2.11.9 Cascade circuit

The DS7 soft starters can be used to start several motors in sequence.
This requires the observance of a specific switching sequence (→ section 7,
"Connection examples").

→ When starting several motors with one soft starter the thermal
load of the soft starter (starting frequency, current load) must be
taken into account.
If the starts occur closely in succession, the soft starter must be
dimensioned larger (i.e. the soft starter must be designed with
an accordingly higher load cycle).

## 2.11.10 Motors with power factor correction capacitor

If capacitors are to be used for power factor correction and thus to improve
the power factor, they must be connected to the mains side of the soft
starter.

The following Figure 31 shows on the right a safe arrangement.
During the startup and stop phase (generalized phase control), the power
factor correction capacitors are disconnected. After the start time (t-Start)
elapses, they are connected via the TOR signal of the soft starter and the
capacitor contactor Q12, which disconnect them at the beginning of the stop
time (t-Stop).
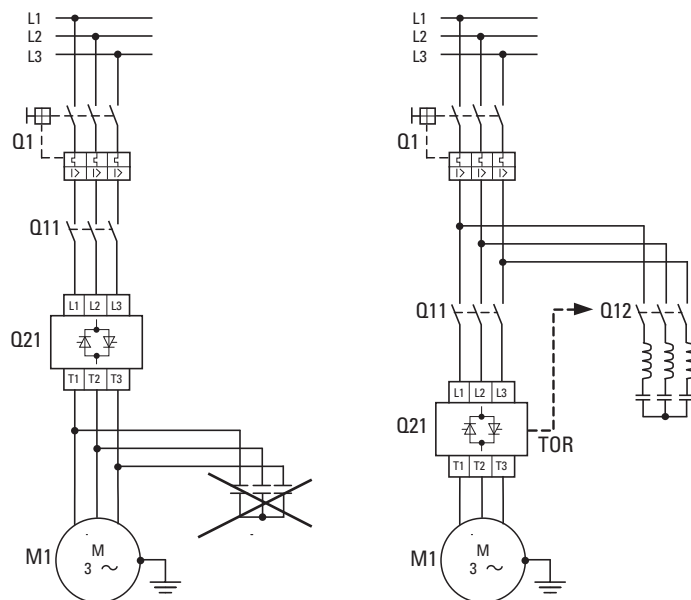


Figure 31: Reactive current compensated motor
Left: impermissible connection;
Right: permissible connection

→ In networks with electronically controlled consumers (e.g. soft
starters), the compensation devices must always be connected
with a series inductance.

> ⚠ **CAUTION**
>
> The output of a soft starter must not be connected to any capacitive loads (capacitors)!
> This would damage the soft starter.

## 2.11.11 Bypass circuit

→ Devices of the DS7-34… series are already equipped with integrated bypass contacts.
An external bypass is therefore not required.

## 2.11.12 Bypass circuit for emergency operation

In pump applications there is a frequent requirement for the bypass contactor to provide facility for emergency operation. A service switch is used to select between soft starter operation and DOL starter operation via a bypass contactor (Q22). This is used to fully isolate the soft starter. In this case, it is important that the output circuit is not opened during operation. An interlock ensures that a switchover is only possible after a stop.
The electrical and/or mechanical interlocking of contactors Q22 and Q31 ensures a safe operating state.

→ Unlike simple bypass operation (parallel contact with the thyristors in continuous operation), the bypass contactor must be designed here in accordance with utilization category AC-3 since it must be able to start the motor directly. For a suitable contactor, the contactor recommended in the Appendix (→ page 223) can be used.

Q1 = Cable protection

Q11 = Mains contactor

Q21 = Soft starter

Q22 = Bypass contactor/
Emergency operation
protection

Q31 = Motor contactor

F3 = Semiconductor fuse for
type 2 coordination, in
addition to Q1

M1 = Motor
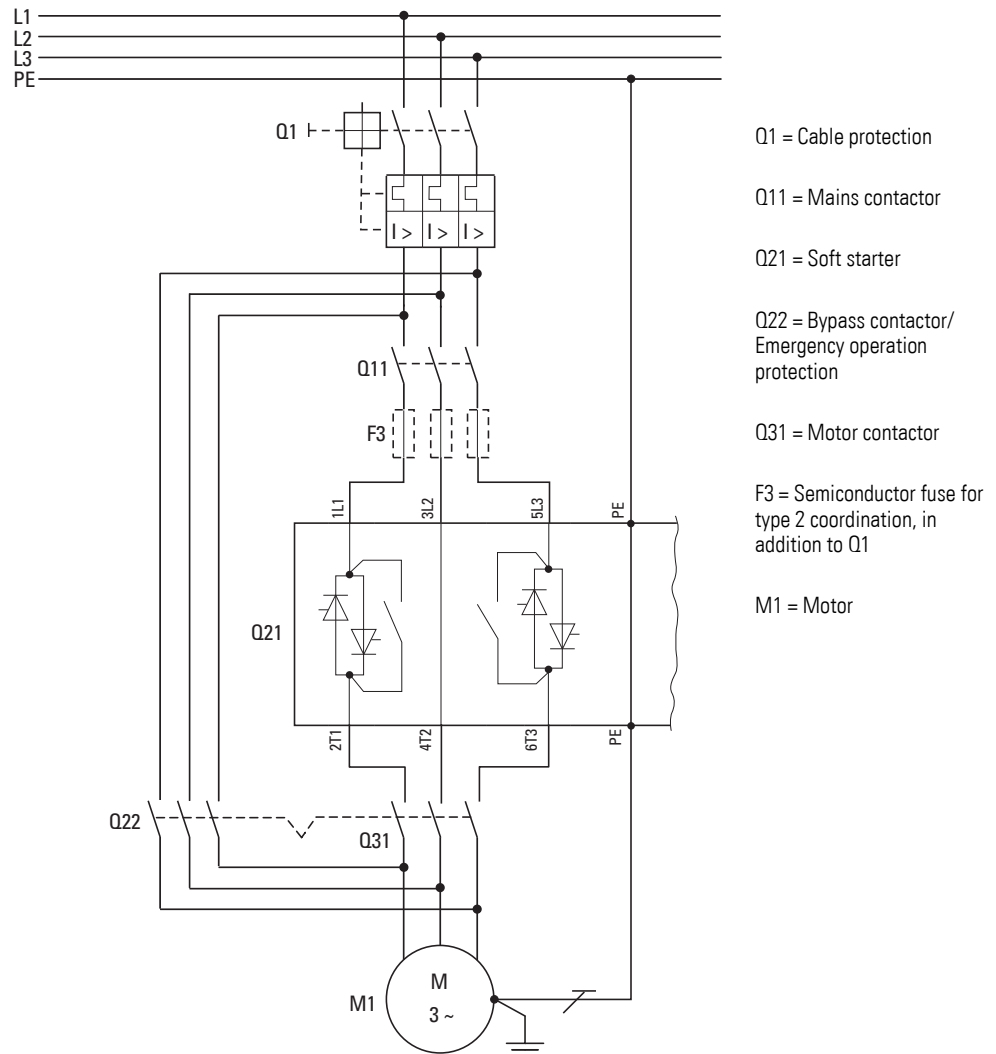
Figure 32: Power section – example: DS7 ≅ 41 A with bypass emergency operation

## 2.11.13 Repair and maintenance switch

Repair and maintenance switches disconnect all the poles (all the phases) in the connection cable to a motor. This prevents voltage from being applied and the motor from being started by accident during repair and maintenance work.

The DS7 soft starter has a two-phase circuit with semiconductor elements in the power section, one phase is always connected through directly.

> **DANGER**
>
> In both the disabled and stop states of the soft starter when the mains voltage is present (terminals 1L1, 3L2, 5L3), there is also a dangerous voltage present at the output terminals (2T1, 4T2, 6T3) and therefore also on the motor cables and connection terminals of the motor (U, V, W)!
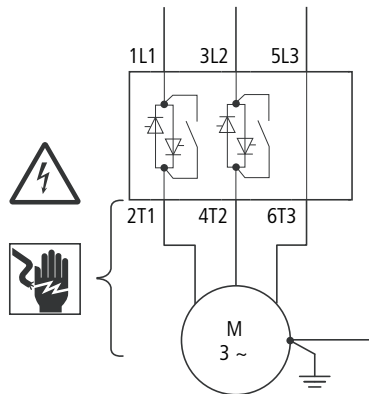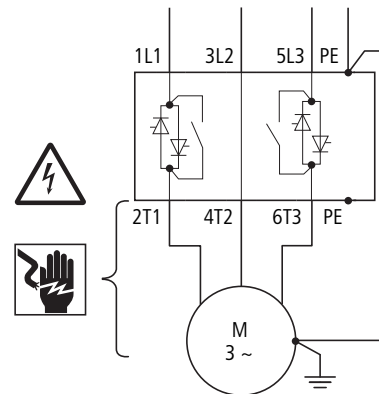
Size 1 and 2 (4 - 32 A)                    Size 3 and 4 (41 – 200 A)

Figure 33:  Dangerous voltage

Because of this, all the poles (all three phases) in two-phase controlled soft starters should always be disconnected from mains voltage in the stop state – with a contactor connected in series on the mains side, for example.

If a control system does not provide this potential isolation, it is advisable to connect the motor through a repair or maintenance switch.
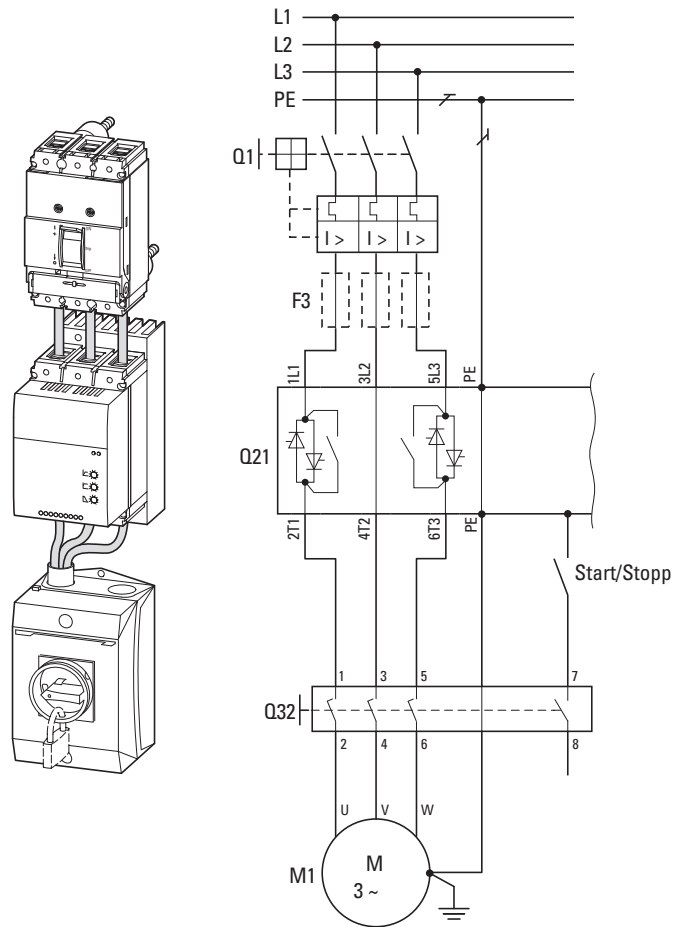
Figure 34: Connecting example of the DS7 soft starter (FS3, FS4) with a
maintenance/manual override switch for the safe isolation for motor connection

## 2.12 Loading conditions

DS7 soft starters are designed for a standard duty cycle as defined for AC-53a in product standard IEC/EN 60947-2-1. This means:

3-fold overcurrent for 5 seconds with a duty factor of 75 % and 10 starts per hour. For example: 4A: AC-53a: 3-5: 75-10

With applications such as water pumps (circulating pumps) the DS7 soft starter with the assigned rated operational current can be selected. When different operating frequencies, acceleration and/or starting currents are involved, the thermal capacity of the DS7 soft starter must be taken into account in the design.

> The appendix (→ page 219) contains overload curves for various time, current, and starts-per-hour combinations that can be used to select the right DS7 soft starter for your application.

## 2.12.1 Overload capability (load to AC-53a)

The table below shows the overload capability of the soft starter in accordance with the product standard IEC/EN 60 947-4-2. It shows:

X = Value of basic overcurrent in multiples of the rated device current
$T_x$ = Duration of the overcurrent X in seconds
F = Duty factor within the load cycle in %
S = Number of permissible starts per hour

| | Overcurrent X [×] | Overcurrent time $T_x$ [s] | Duty factor F [%] | Starts per hour S |
|---|---|---|---|---|
| DS7-34… | 3 | 5 | 75 | 10 |

## 2.12.2 Conversion of the overload capability to lower overcurrents

The stated cycle can be converted for lower overcurrents, but not for higher! The following formula is used to calculate the new time:

$$T_{xnew} = \frac{X^2 \times T_x}{X^2_{new}}$$

$T_{xnew}$ = New permissible time for the new overcurrent $X_{new}$

$X_{new}$ = Required overcurrent (must be less than the stated values)

**Example**

For X = 3, $T_x$ = 5 s: With a reduced overcurrent (X = 2.5) a new permissible overcurrent duration $T_{xnew}$ of 7.2 seconds is calculated.

$$T_{xnew} = \frac{3^2 \times 5\,s}{2.5^2} = 7.2\,s$$

> The parameters X x $I_e$, T and the number of starts allow any number of combinations of this load cycle with the same thermal load.

### 2.12.3 Different overload current

If load cycles or start frequencies are different, the following graphs can be used for reading the possible time current combination.

The example shown here is a 30 kW motor (400 V, 55 A) with an assigned DS7-34xSX055… soft starter (55 A, rated operational current = motor current). The maximum starting current of 165 A ($I_{LRP}$) can be achieved for 5 s at 10 starts per hour (overload factor X = 3).

**55A: AC-53a: 3 -5 : 75 - 10**

- S
- F [%]
- $T_x$ [s]
- X
- $I_e$ [A]
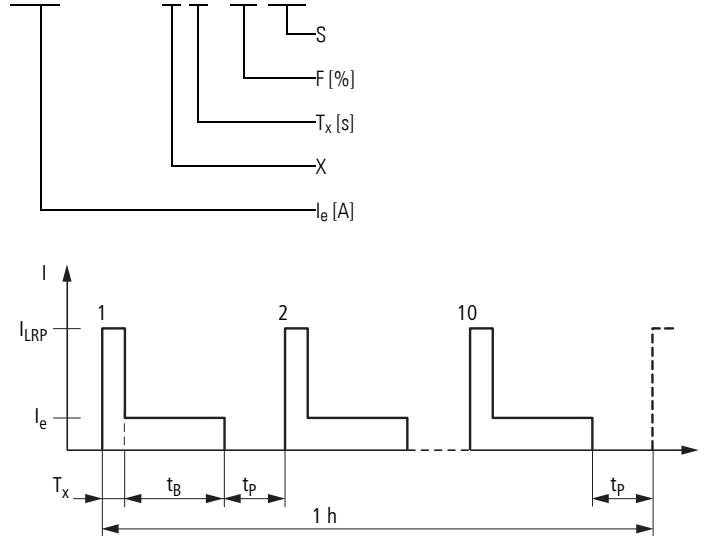


$F = 10/h$, $\quad$ 1 h = 3600 s $\quad \rightarrow \quad T_x + t_B + t_P = 360$ s

$$F = \frac{T_x + t_B}{T_x + t_B + t_P} \times 100\% \quad I$$

$$\frac{5\,s + 265\,s}{5\,s + 265\,s + 90\,s} \times 100\% = 75\%$$

$$X = \frac{I_{LRP}}{I_e} \quad \rightarrow \quad I_{LRP} = X \times I_e = 3 \times 55\,A = 165\,A$$

The prospective locked rotor current $I_{LRP}$ is the motor current that occurs when the rated operating voltage is applied and the rotor is locked ($I_{LRP} = X \times I_e$).
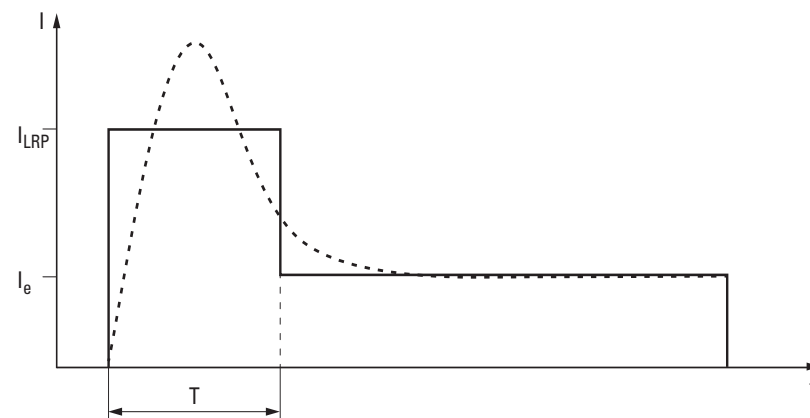


Figure 35: Real (dashed) and normalized load current
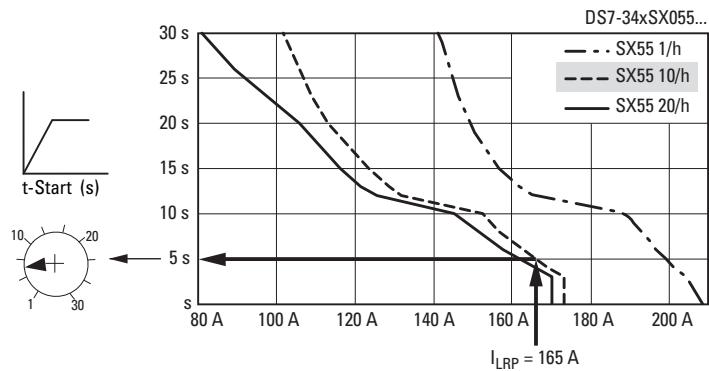
Figure 36: Overload current X = 3 with DS7-34xSX055… soft starter

If a higher overload current (e.g. X ~ 5) is required, the start conditions stated here require a DS7-34xSX100… (100 A) soft starter. The $I_{LRP}$ value here is 300 A for 5 s at 10 starts per hour. The required X ~ 5 (5 x 55 A = 275 A) is thus fulfilled (X ~ 5.4).
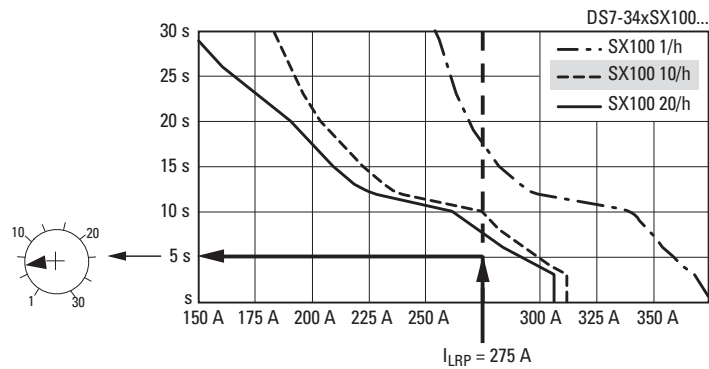


Figure 37: Overload current X = 5 with DS7-34xSX100… soft starter

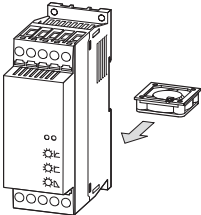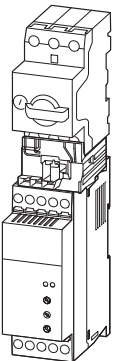At X = 5 ($I_{LRP}$ = 275 A) the larger DS7-34xSX100… soft starter also allows
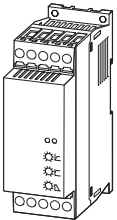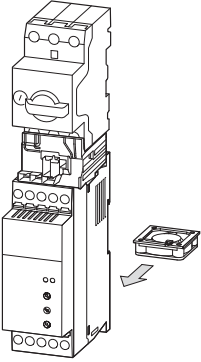
- 10 Starts per hour S with max. 10 s ($T_X$),
- 20 Starts per hour with max. 7 s ($T_X$).

## 2.12.4 Configuration options of DS7

Table 10:   Configuration options

| | Special feature | Configuration | Current | Starts per hour | Applicable graph |
|---|---|---|---|---|---|
| Stand-alone setup **without** internal fan | Standard setup | DS7 | Rated operating current $I_e$ stated on the device applies. | 10 | The graph applicable to this load cycle (10 starts per hour) applies. → Example I. (page 58) |
| Stand-alone setup of sizes 1 and 2 **with** internal fan | Increased number of startups | DS7 (to 32 A) + DS7-FAN-032 (fan) | Rated operating current $I_e$ stated on the device applies. | 40 | The graph applicable to this load cycle (10 starts per hour) applies. The number of starts per hour must be multiplied by the factor 4, i.e. 1, 10, 20 → 4, 40, 80 → Example II. (page 58) |
| Assembly with xStart components **without** fan | Derating required | DS7 (to 32 A) + PKZM0-XDM12 or PKZM0-XM32DE, PKZ/PKE DILM12-XMCP/T or ZB…12/ZB32… | The next lower rated operating current $I_e$. applies. | 10 | The valid graph for the corresponding next smaller device type applies.[2] → Example III. (page 58) |
| Assembly with xStart components **with** fan | No derating required | DS7 (to 32 A) + PKZM0-XDM12 or PKZM0-XM32DE, PKZ/PKE DILM12-XMCP/T or ZB…12/ZB32… + DS7-FAN-032 (fan) | The rated operational current $I_e$ stated on the device applies. | 10 | The graph applicable to this load cycle (10 starts per hour) applies. → Example IV. (page 58) |
| | • Increased number of startups  • Derating required | DS7 (to 32 A) + PKZM0-XDM12 or PKZM0-XM32DE, PKZ/PKE DILM12-XMCP/T or ZB…12/ZB32… + DS7-FAN-032 (fan) | The next lower rated operating current $I_e$. applies. | 40 | The valid graph for the corresponding next smaller device type applies.[2] The number of starts per hour must be multiplied by the factor 4, i.e. 1, 10, 20 → 4, 40, 80 → Example V. (page 58) |

## 2.13 Design with different load cycles

The DS7 soft starter is designed for a standard load cycle in accordance with AC-53a of the IEC/EN 60947-2-1 product standard. This means:

3-fold overcurrent for 5 seconds with a duty factor of 75 % and 10 starts per hour. For example: 4A: AC-53a: 3-5: 75-10

With applications such as water pumps (circulating pumps) the DS7 soft starter with the assigned rated operational current can be selected. When different operating frequencies, acceleration and/or starting currents are involved, the thermal capacity of the DS7 soft starter must be taken into account in the design.

➜ The appendix (➜ page 219) contains overload curves for various time, current, and starts-per-hour combinations that can be used to select the right DS7 soft starter for your application.

## 2.14 Overtemperature (Derating)

All rated operational data of the DS7 soft starter is based on a maximum ambient air temperature of +40 °C. The maximum permissible ambient air temperature is +60 °C. Higher ambient air temperatures (> +40 °C) require a reduced rated operational current $I_e$:

- 2 percent per degree Kelvin for a stand-alone setup
- 1 percent per kelvin for stand-alone setups with a dedicated DS7-FAN-… device fan

**Example**

Ambient air temperature $\vartheta$ = +50 °C → 10 K abnormal temperature rise

Soft starter DS7-34xSX032… → $I_e$ = 32 A

- Without a fan: 2 %, 10 K → 20 % $I_e$ = 6.4 A,
  $I_e$ (reduced) = 32 A - 6.4 A = 25.6 A

- With a fan: 1 %, 10 K → 10 % $I_e$ = 3.2 A,
  $I_e$ (reduced) = 32 A - 3.2 A = 28.8 A

In combination with the xStart components, further reductions are necessary since the cooling air flow is impeded. The load cycle must then be recalculated (➜ section 2.15, "Example of other load cycles").
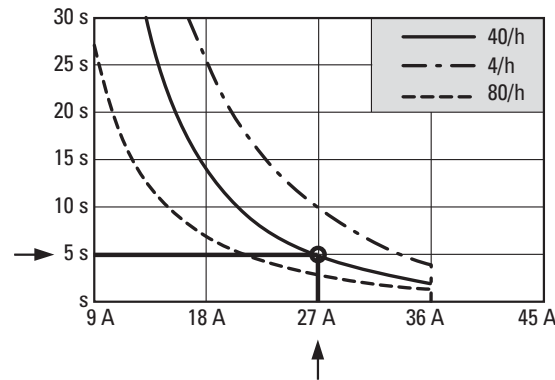
## 2.15 Example of other load cycles

**Soft starter DS7-34xSX009…: 9 A AC-53a: 3-5: 75-10**

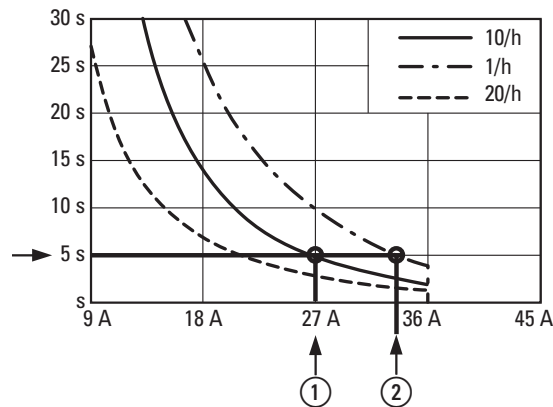**I. Stand-alone setup without device fan**
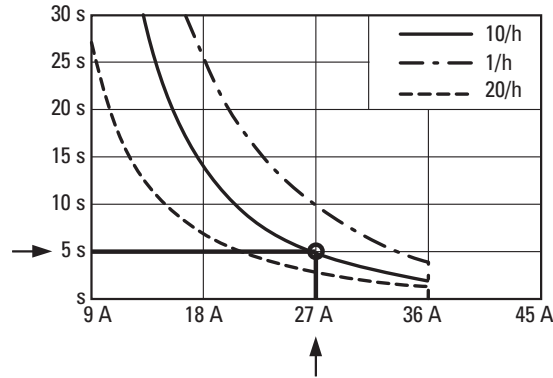


**II. Stand-alone setup with DS7-FAN-032 device fan**



**III. Combination of xStart components without device fan**

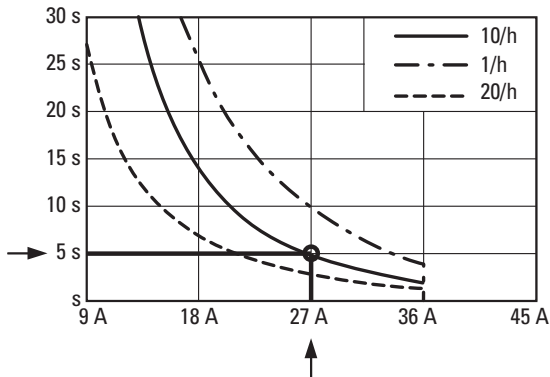The overload curve of the DS7-34xSX007 soft starter applies to DS7-34xSX009….



① At Tx = 5 s the permissible overcurrent factor here is reduced to around X = 2.2 (IRLP = 20 A).

② $I_{RLP}$ = 27 A: At $T_x$ = 5 s and X = 3 one start per hour is permissible here.

### IV: Combination of xStart components with DS7-FAN-032 device fan

In this case, the standard values can be achieved (compare with I).



### V. Combination of xStart components with DS7-FAN-032 device fan and higher starting frequencies

If higher starting frequencies are required, the overload curves of the DS7-34xSX007 soft starter apply.
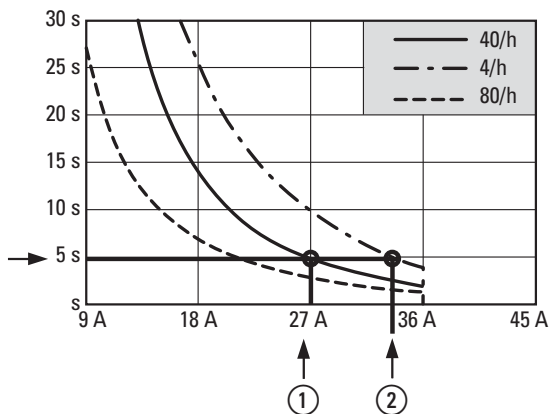


①At $T_x$ = 5 s the permissible overcurrent factor is reduced to around X = 2.2 ($I_{RLP}$ = 20 A) at a maximum of 40 starts per hour.

②$I_{RLP}$ = 27 A: At $T_x$ = 5 s and X = 3 a maximum of four starts per hour are permissible here.

> The overload curves of the individual DS7 soft starter variants are listed in the Appendix on page 219.

# 3 Installation

## 3.1 Introduction

This chapter provides a description of the mounting and the electrical connection for the soft starter DS7.

➡ While installing and/or mounting the soft starter, cover all ventilation slots in order to ensure that no foreign bodies can enter the device.

➡ Perform all installation work with the specified tools and without the use of excessive force.

➡ The DS7 soft starters must only be mounted on a non-combustible base.

Following are a series of installation examples designed to cover the entire DS7 series. The relevant mounting instructions are provided in the following instructional leaflets:

- IL03902003Z: For size 1 devices (4 – 12 A device current)
- IL03902004Z: For size 2 devices (16 – 32 A device current)
- IL03902005Z: For size 3 and 4 devices (41 - 200 A device current)

## 3.2 Mounting positions

The maximum permissible angle of inclination for all soft starters of the DS7 is 30°.
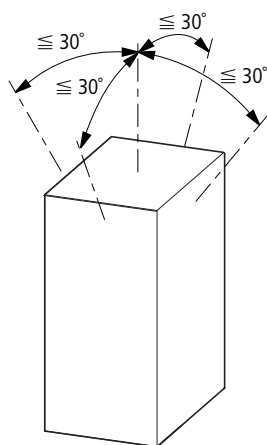


Figure 38: Vertical mounting position

➡ A mounting that is turned by 180° (stood on its head) is not permissible!

## **3.3 Flush mounting in control panel**

The mounting should take into account the weight and dimensions of the soft starter. If necessary the appropriate technical resources (lifting cart or crane for large weights) and tools must be used. Improper handling or use of the wrong tools may cause damage to the soft starter.

The Soft starter DS7 is only designed for use as built-in device.

Take sufficient counter measures in the case of:

• Contaminated cooling air, such as dust, fluff, grease:
  This can cause short-circuits on the cards
  (counter measures: installation of filters, separate ventilation circuit).
• Aggressive gases:
  These can corrode circuit-board conductors
  (counter measures: flush mounting of filters, separate ventilation circuit).
• Contaminated filters:
  These can cause overheating (counter measure: regular cleaning).

To prevent overheating, observe the following points:

• Ensure the free flow of the cooling air both to and from the device.
• No devices that produce considerable amounts of heat in the proximity of the soft starter.
• Observe the mounting clearance above and below the soft starter as the temperature of the cooling air will otherwise reach impermissible values and the soft starter will switch off.
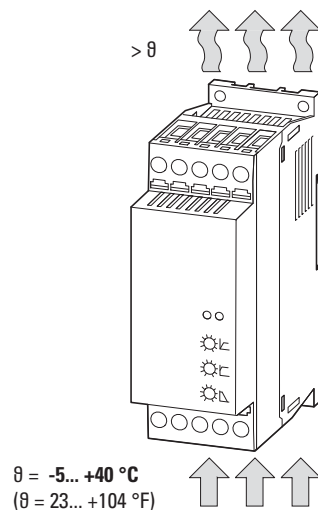


Figure 39: Cooling air supply

→ The supplied cooling air must have a temperature between -5 and +40 °C. A derating is required for higher temperatures (up to +60 .maximum):
  • 2 percent of the rated operational current $I_e$ per Kelvin (K) temperature rise from +40 °C
  • 1 percent of rated operational current $I_e$ per kelvin (K) of temperature rise after +40 °C with device fan (DS7-FAN-…)

## 3.3.1 Increased cooling

Cooling air circulation on the DS7 soft starter can be improved by using an optional DS7-FAN-… device fan

This makes the following possible:

• Operation at higher ambient air temperatures
• A compact setup and directly combining the unit with other components
• A higher number of starts per hour

→ DS7-FAN-… device fans are temperature-controlled, always run during ramp times (t-Start, t-Stop), and will continue running until the heat sink cools down again. The fan is then automatically switched off.

→ It is advisable to install device fan DS7-FAN-… before installing soft starter DS7 in the basic device.
This helps prevent additional steps for removal and changes in the installation.

⚠ **DANGER**

The device fan must only be mounted in a de-energized state.

The choice of device fan is based on the rated operational current (yyy) for the corresponding size.

Table 11: Device fans for the various rated operational currents

| Rated operational current (yyy) | Construction size | Device fan (type) | Arrangement |
|---|---|---|---|
| 004 - 012 | BG1 | DS7-FAN-032 | Flush mounting |
| 016 - 032 | BG2 | DS7-FAN-032 | Flush mounting |
| 041 - 100 | BG3 | DS7-FAN-100 | Substructure |
| 135 - 200 | BG4 | DS7-FAN-200 | Substructure |

→ For technical data for DS7-FAN… device fans, refer to → Section 9.5.4, "Device fans", page 227 and page 232.

### 3.3.1.1 DS7-FAN-032 device fan

The optional DS7-FAN-032 device can be fitted on the rear of the soft starter sizes 1 and 2 (i.e. devices up to 32 A).
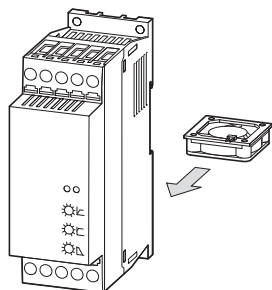


Figure 40:  Fitting the fan (basic principle)

To do this, open the mounting space in the enclosure. Carefully break out the blanking plate with a flat screwdriver (see Fig. 41):

▶ Break the four thin plastic webs [1].
▶ Lever out [2] blanking plate [3].

> *NOTICE*
> Do not break through or discard blanking plate!
> It is reinserted for fastening after the device fan is fitted.
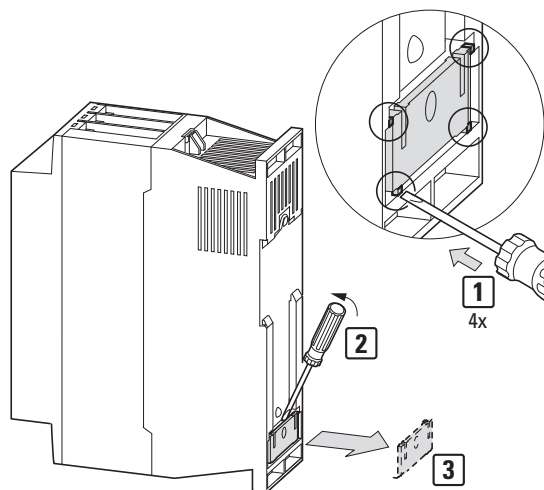


Figure 41:  Step 1: Break out blanking plate
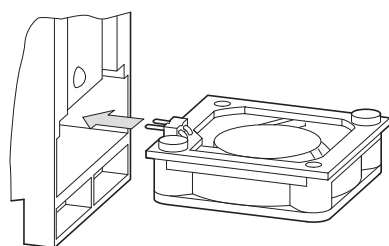


Figure 42:  Step 2: Slide in the DS7-FAN-032 fan
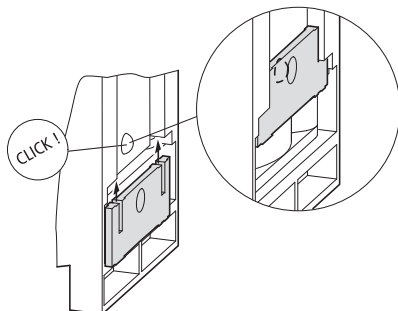
Figure 43: Step 3: Fastening the fan with the strap.

---

*NOTICE*

When inserting the device fan, make sure not to damage the fan's plug connections (pins) or connection cables.

---

To mount the DS7-FAN-032 device fan, place it on the bottom edge of the housing (plug connectors at the top left) and fully insert without the use of force. Then re-insert the previously removed blanking plate [3] (Fig. 41) from below until the round fixing point snaps into position (CLICK, Fig. 43).

To remove the device fan, lift up the blanking plate from the top (at the fixing point) using a flat screwdriver and slide out downwards. Then remove the device fan.

---

**CAUTION**

Do not damage the connection cables and plug contacts when removing the fan.

---

### 3.3.1.2 Device fan DS7-FAN-100 / DS7-FAN-200

The optional DS7-FAN-100 and DS7-FAN-200 fans are mounted on the back of the DS7 soft starter. They are fastened onto the heat sink using four screws.
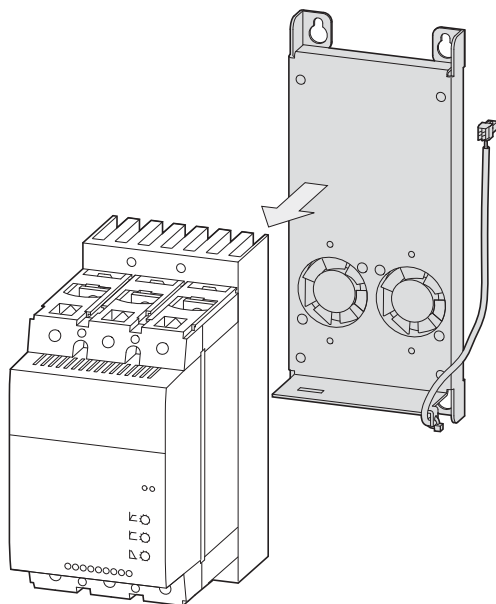


Figure 44: Fitting the fan (basic principle)
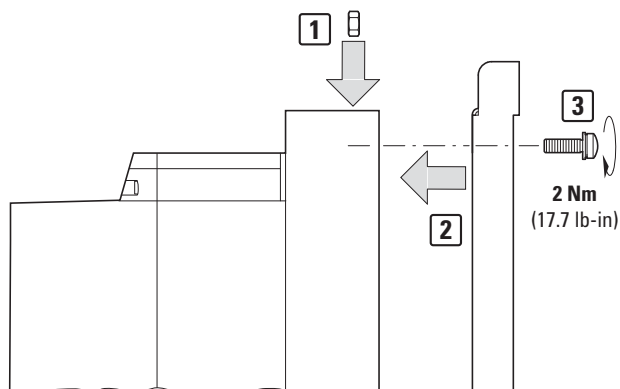


Figure 45: Mounting the DS7-FAN100/DS7-FAN200

▶ Insert the nuts into the corresponding cutouts in the cooling fins [1].
▶ Place the DS7-FAN-100 / DS7-FAN-200 fan on top of the heat sink's bottom [2].
▶ Secure the fan with the screws [3].
  The maximum tightening torque is 2 Nm.

The required nuts and screws are included with the fan.

The power connection for the device fan is connected on the soft starter's bottom (right-hand side, above motor connection terminal 6T3). In order to do so, you will first have to break out the cover for the plug connection that is found on the housing.

▶ Carefully insert a standard screwdriver (size 2.5 × 0.4 mm) into the opening to the left of the square cover [1] (to a depth of about 3 mm).
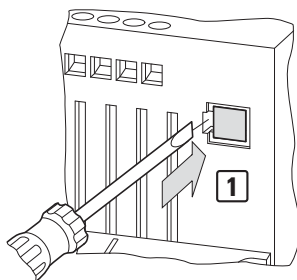


Figure 46: Insert standard screwdriver into opening.

▶ Pry out the cover [2].
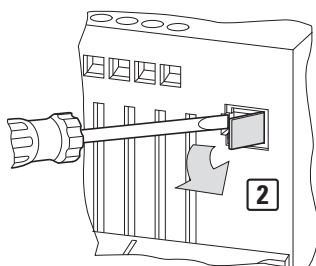


Figure 47: Loosen cover

▶ Remove the released blanking plate [3].
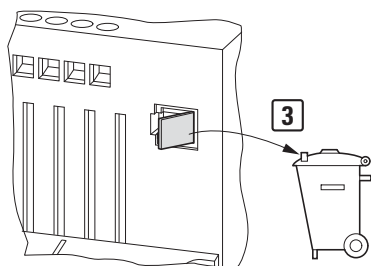


Figure 48: Remove the cover

➡ The blanking plate can not be refitted.
If you remove the device fan, make sure to cover the plug connection with a suitable material (by masking it with electrical tape, for example).

▶ Insert the device fan's plug connection into the connection opening you just opened [4] until the lower securing point locks into place with a click.
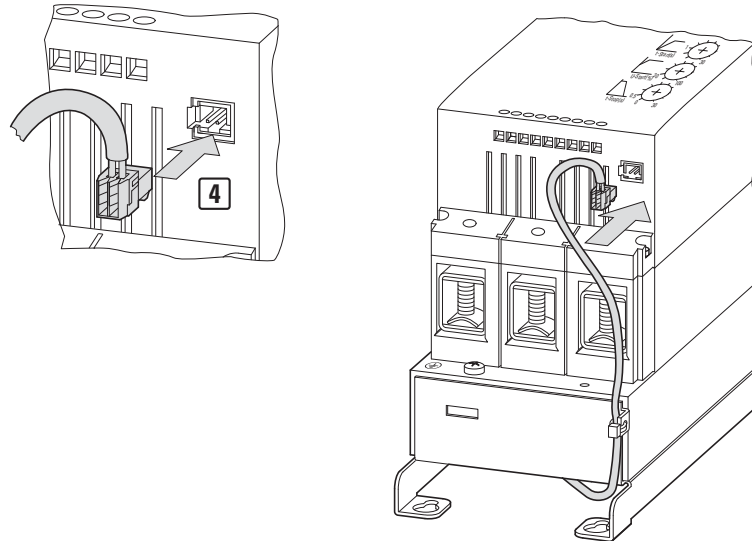
Figure 49: Plugging in the fan connection

---

*NOTICE*

When inserting the device fan, make sure not to damage the fan's plug connections (pins) or connection cables.

---

→ The device fan is temperature-controlled, always runs during ramp times (t-Start, t-Stop), and will continue to run until the heat sink cools down again. The fan is then automatically switched off.

## 3.3.2 Mounting instructions (BG 1 and BG 2)

### 3.3.2.1 Free surrounding areas

→ An installation clearance of 25 mm must be maintained in front of size 1 and size 2 (up to 32 A) DS7 soft starters. A top and bottom clearance of 75 mm each is required. If the clearances are smaller, derating will be necessary or it will be necessary to use the optional DS7-FAN-032 fan.
All sizes can be mounted directly next to each other.
Side clearance is not required to other devices that do not themselves require clearance at the sides.
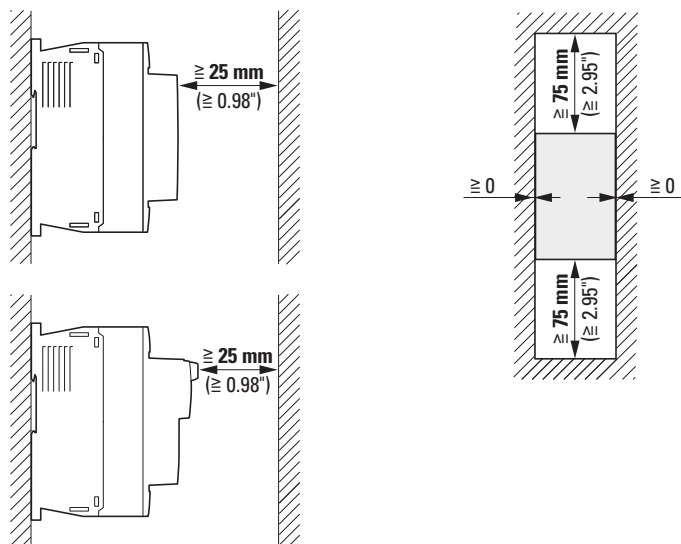


Figure 50: Installation clearances for devices up to 32 A
Top: Devices without SmartWire-DT; bottom: Devices with SmartWire-DT

→ If the point if installation is subject to continuous vibration or shocks, design measures must be taken for dampening, such as through the use of vibration dampers.

## 3.3.2.2 Fitting on mounting plate

The DS7 soft starters are screwed onto the switch cabinet wall (mounting plate). The control signal terminals and the operator control and display elements must face the front. The screw fixing is completed with at least two diagonally arranged flat head screws. The use of washers and split washers is recommended.
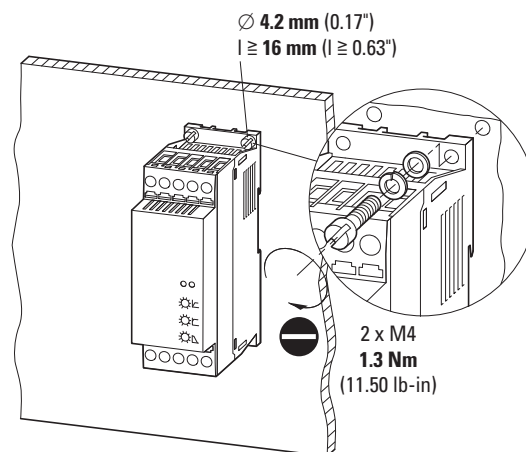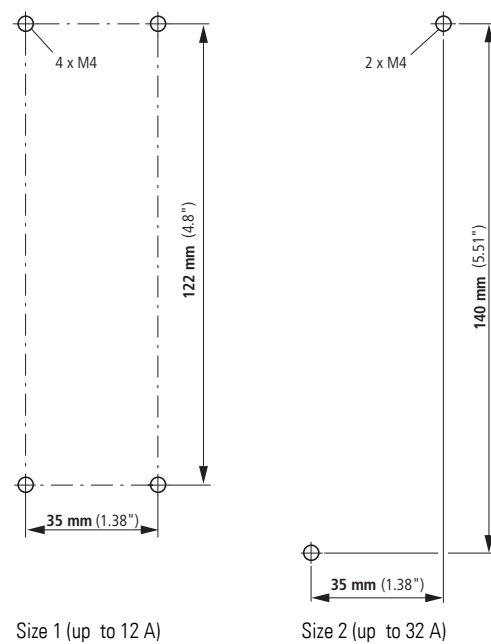


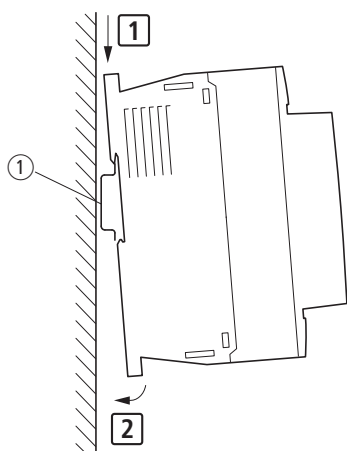Figure 51: Screw fixing on mounting plate (example using size 1)



Size 1 (up to 12 A)    Size 2 (up to 32 A)

Figure 52: Drilling dimensions

### 3.3.2.3 Surface mounting on mounting rail



Place the DS7 soft starter onto the mounting rail from above [1], push down [2] and let it snap into position.

Removing it requires using a little force from above:
In order to remove the soft starter, pull the lower housing edge forward and lift the soft starter upwards and off the mounting rail.
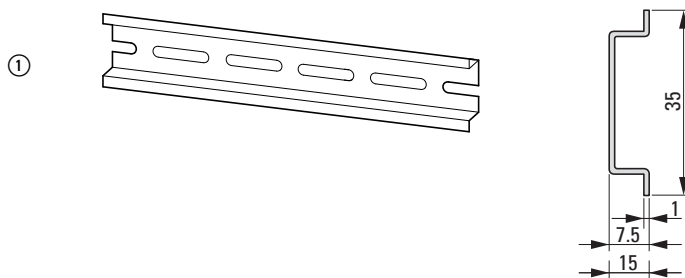
Figure 53: Fixing to the mounting rail



Figure 54: Mounting rail conforming with IEC/EN 60715

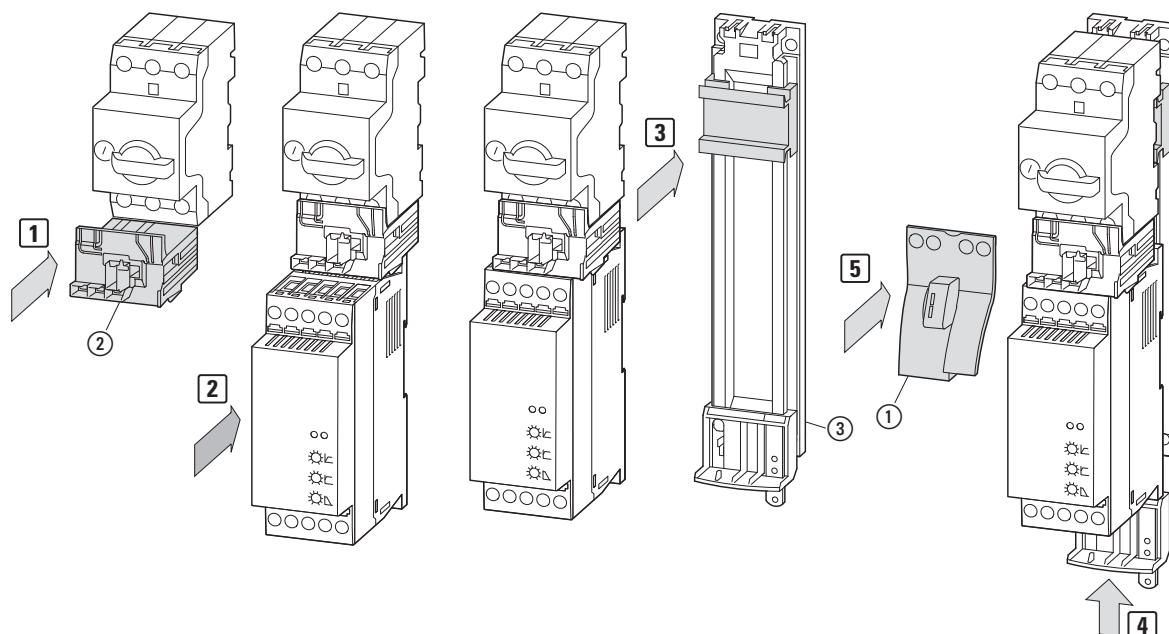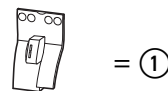## 3.3.2.4 Size 1: Surface mounting with PKZ or PKE



Figure 55: Mounting of size 1 devices (up to 12 A)

The size 1 DS7 soft starter (up to 12 A) can be connected directly to a PKZ or PKE motor-protective circuit-breaker. This electronic motor-starter combination can be mounted directly on a mounting plate, a mounting rail or on busbar adapter. Accessories required:

- PKZM0-XDM12 wiring kit for connecting a DS7 soft starter directly to a PKZ or PKE motor-protective circuit-breaker
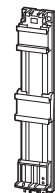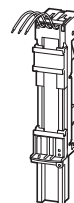
$= \text{\textcircled{1}}$

$= \text{\textcircled{2}}$

- optional, variant 1:
  PKZM0-XC45L top-hat rail adapter

$= \text{\textcircled{3}}$

- optional, variant 2:
  BBA0L-25 busbar adapter

$= \text{\textcircled{3}}$

### 3.3.2.5 Size 2: Surface mounting with PKZ or PKE

This is implemented in the same way as the surface mounting for size 1 and the required accessories:
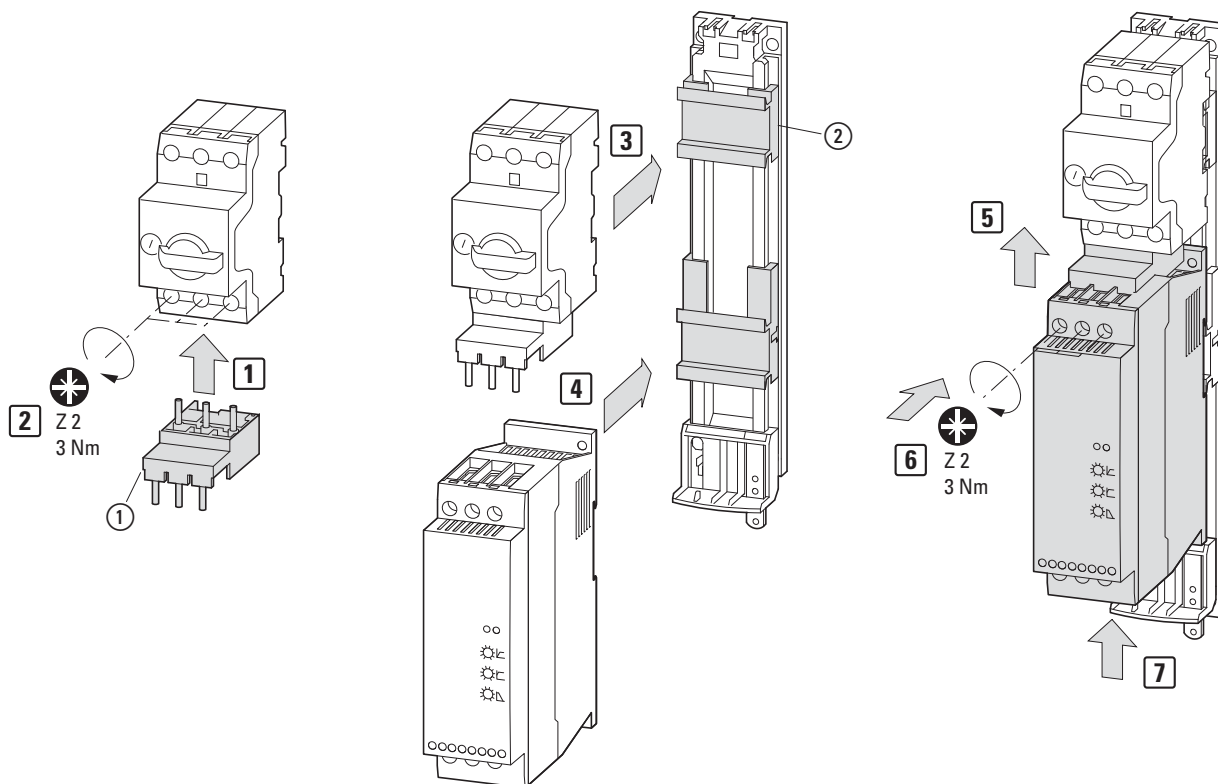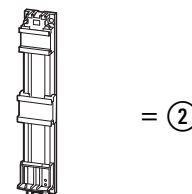


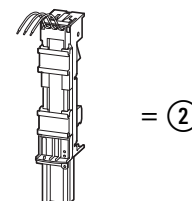Figure 56: Mounting of size 2 devices (up to 32 A)

- PKZM0-XM32DE electric contact module for connecting a DS7 soft starter directly to a PKZ or PKE motor-protective circuit-breaker = ①

- optional, variant 1: PKZM0-XC45L/2 top-hat rail adapter = ②

- optional, variant 2: BBA0L-32 busbar adapter = ②

### 3.3.3 Mounting instructions (size 3 and 4)

### 3.3.3.1 Free surrounding areas

With sizes 3 and 4 (41 to 200 A), a mounting clearance of 5 mm to the front of the DS7 soft starter must be maintained. A top and bottom clearance of 75 mm each is required.

If the clearances are smaller, derating will be necessary or it will be necessary to install an optional DS7-FAN-100 (for size 3) or DS7-FAN-200 (for size 4) device fan.

When combined with the NZM1 or NZM2 motor-protective circuit-breaker and the NZM1/2-AB spacers, the minimum clearance ① between the DS7 soft starter and the NZM motor-protective circuit-breaker is:

- ≧ 25 mm at NZM1 (BG 3),
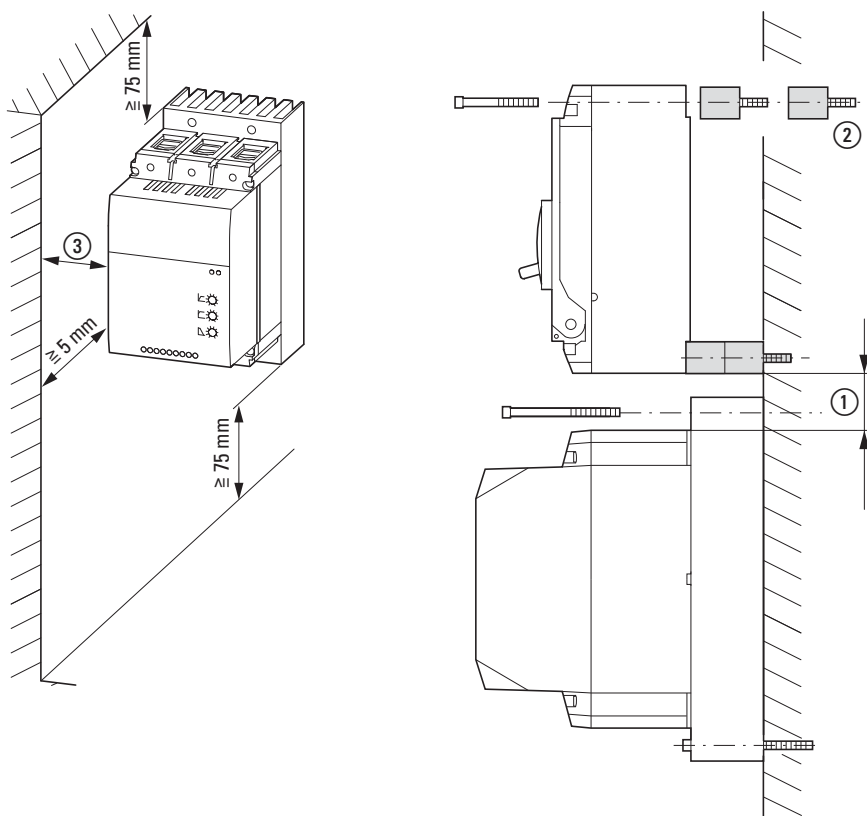- ≧ 35 mm at NZM2 (BG 4).

Figure 57: Mounting NZM + DS7 for sizes 3 and 4 (from 41 A)

The spacers ② are fitted underneath the NZM motor-protective circuit-breakers and allow the required thermal air circulation for the heat sink of the soft starter.

➜ The spacers are not supplied with the DS7 soft starter.

The following are required:

- for NZM1 (DS7 devices up to 100 A):
  4 = 1 x NZM1/2-XAB plus 2 M4 x 50 screws,
- for NZM2 (DS7 devices up to 200 A):
  16 = 4 x NZM1/2-XAB plus 4 M4 x 85/20 screws.

Side clearance ③ is not required to other devices that do not themselves require clearance at the sides. A side clearance of 5 mm is required in combination, for example, with an NZM2 motor-protective circuit-breaker.
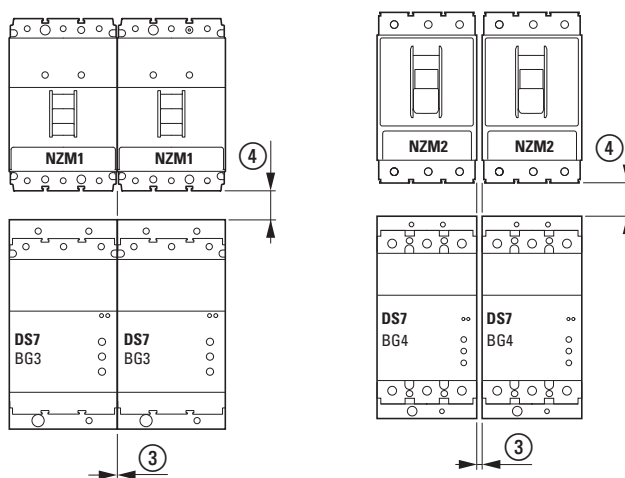


Figure 58: Side clearances in conjunction with NZM motor-protective circuit-breakers

③ DS7 + NZM1: ≧ 0                    ③ DS7 + NZM2: ≧ 5 mm (≧ 0.197")
④ ≧ 25 mm (0.98")                    ④ ≧ 35 mm (3.38")

### 3.3.3.2 Fitting on mounting plate

The DS7 soft starters in sizes 3 and 4 must be screw fastened vertically on a heat conductive non-combustible mounting plate. The control signal terminals and the operating and indication elements must face the front. The screw fixing is completed with at least two diagonally arranged flat head screws. The use of washers and split washers is recommended.

Size 3 (up to 100 A)
① = 22.5 mm
② = 161 mm

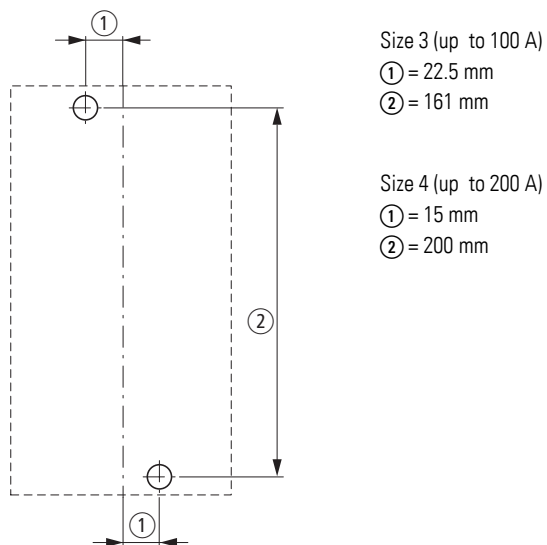Size 4 (up to 200 A)
① = 15 mm
② = 200 mm

Figure 59: Drilling dimensions

➡ The drilling dimensions will be different when using optional device fan DS7-FAN-100 or DS7-FAN-200.
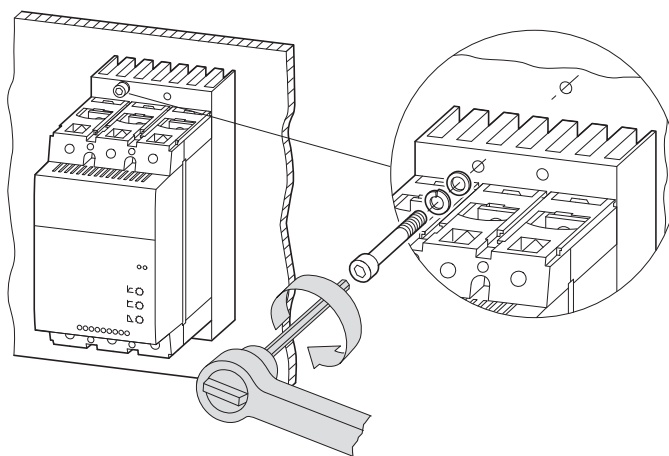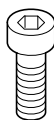Refer to the dimension drawings on page 232.



Figure 60: Fitting on mounting plate, DS7 soft starter (sizes 3 and 4)

| Part no. | | mm | inch | Nm | lb-in |
|---|---|---|---|---|---|
| DS7-34…SX041N0<br>DS7-34…SX055N0<br>DS7-34…SX070N0<br>DS7-34…SX081N0<br>DS7-34…SX100N0 | 2 x M5 x ≥ 55 | 4 | 0.16 | 9 | 80 |
| DS7-34…SX135N0<br>DS7-34…SX160N0<br>DS7-34…SX200N0 | 2 x M6 x ≥ 65 | 5 | 0.2 | 14 | 123 |

## 3.4 Electrical Installation

> ⚠️ **DANGER – DANGER OF ELECTRICAL SHOCK!**
>
> Carry out wiring work only after the Soft starter has been correctly mounted and secured.
> Carry out wiring work only if the unit is de-energized.

> *WARNING – FIRE HAZARD!*
>
> Only use cables, circuit-breakers, and contactors that feature the indicated permissible nominal current value.

> *NOTICE*
>
> The devices contain components that are sensitive to electrostatic charges. Before undertaking work near the terminals, personnel must discharge themselves (i.e. by touching a PE fixing screw or another grounded metal surface in the control panel).

> ⚠️ **DANGER**
>
> The power section of the soft starter contains semiconductor components. These do not have any isolation between the supply and the load. Small leakage currents are always therefore present.An upstream disconnector must therefore be switched off before working on the soft starter or motor.
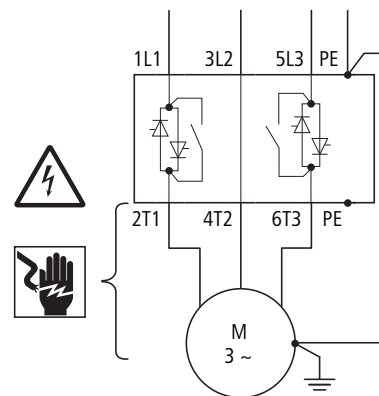
> ⚠️ **DANGER**
>
> Before connecting the DS7 soft starter's power terminals to voltage for the first time, the control voltage needs to be applied in order to ensure that the internal bypass contacts will open. This is necessary in order to prevent the motor from starting unintentionally.
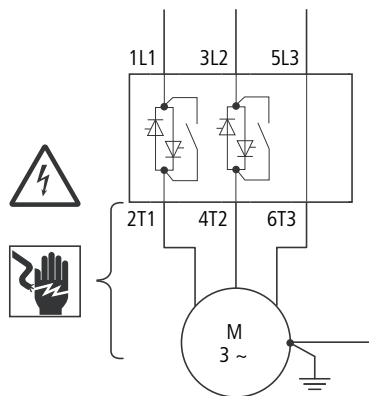


Size 1 and 2 (4 to 32 A)    Size 3 and 4 (41 to 200 A)

## 3.4.1 Connection to power section
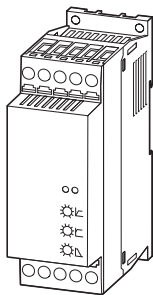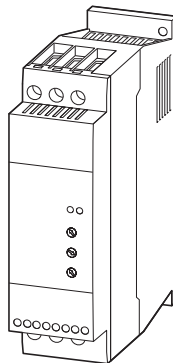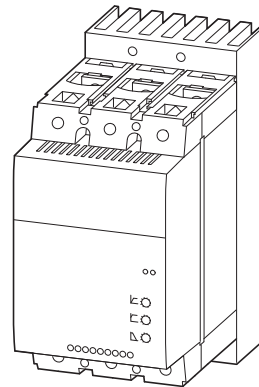
| **Size 1 (4 – 12 A)** | **Size 2 (16 – 32 A)** | **Size 3 a. 4 (41 – 200 A)** |
|---|---|---|
| L1 → 1/L1 | L1 → 1/L1 | L1 → 1/L1 |
| L2 → 3/L2 | L2 → 3/L2 | L2 → 3/L2 |
| L3 → 5/L3 | L3 → 5/L3 | L3 → 5/L3 |
| | | PE → PE ⏚ |



| | | |
|---|---|---|
| 2/T1 → U | 2/T1 → U | 2/T1 → U |
| 4/T2 → V | 4/T2 → V | 4/T2 → V |
| 6/T3 → W | 6/T3 → W | 6/T3 → W |
| | | PE → PE ⏚ |



For frame size 1, the motor connection can optionally be implemented with a DILM12-XMCP/T motor outgoer plug.



Figure 61:  Pluggable motor connection for size 1

Table 12: Terminal capacities for size 1 and 2

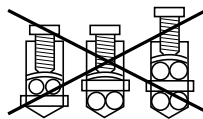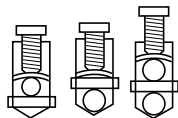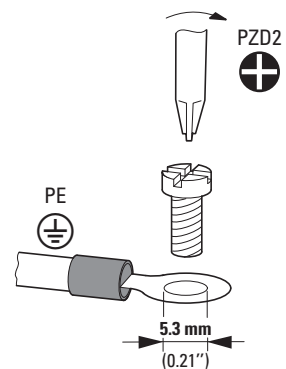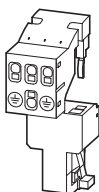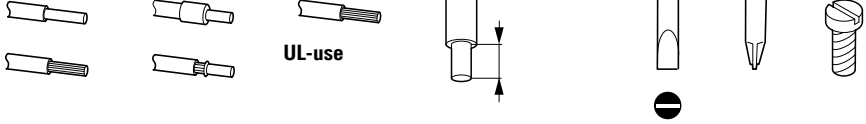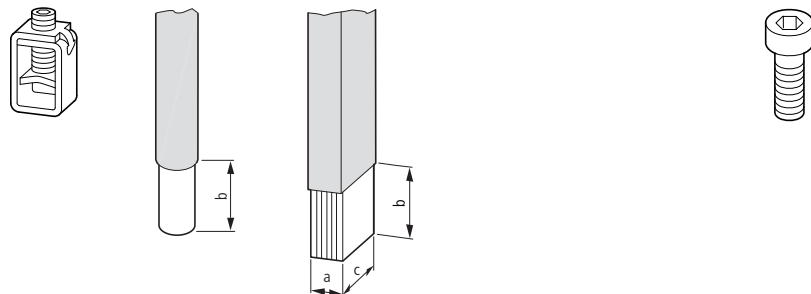| Part no. | mm$^2$ | mm$^2$ | AWG | mm | inch | | | Nm | lb-in |
|---|---|---|---|---|---|---|---|---|---|
| **Size 1** | 0.75 - 4 | 0.75 - 2.5 | 18 - 10 | 10 | 0.39 | 1 x 6 | PZ2 | 1.2 | 10.62 |
| DS7…004…<br>DS7…007…<br>DS7…009…<br>DS7…012… | 2 x 0.75 - 3.5 | 2 x 0.75 - 2.5 | 2 x 21 - 20 | 10 | 0.39 | 1 x 6 | PZ2 | 1.2 | 10.62 |
| **?Frame size 2** | 0.75 - 16 | 0.75 - 16 | 18 - 6 | 10 | 0.39 | 1 x 6 | PZ2 | 3.2 | 28.32 |
| DS7…016…<br>DS7…024…<br>DS7…032… | 2 x 0.75 - 10 | 2 x 0.75 - 10 | | 10 | 0.39 | 1 x 6 | PZ2 | 3.2 | 28.32 |

Table 13: Terminal capacities for size 3 and 4
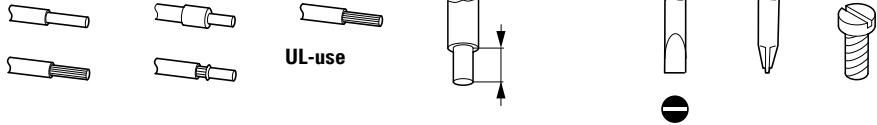
| Part no. | IEC | | | UL-use | | | mm | inch | Nm | lb-in |
|---|---|---|---|---|---|---|---|---|---|---|
| | a [mm] | b [mm] | c [mm] | a [inch] | b [inch] | c [inch] | | | | |
| **Frame size 3**<br><br>DS7…041…<br>DS7…055…<br>DS7…070…<br>DS7…081…<br>DS7…100… | 10 - 70 mm$^2$<br>2 x 6 - 25 mm$^2$<br>2 - 9 x 9 x 0.8 mm | | | AWG12-2/0<br><br>2 - 9 x 0.35 x 0.03 inch | | | | | | |
| | 1.6 - 7.2 | 16.5 | 9 | 0.06 - 0.28 | 0.65 | 0.35 | 4 | 0.16 | 9 | 80 |
| **Frame size 4**<br><br>DS7…135…<br>DS7…160…<br>DS7…200… | 4 - 185 mm$^2$<br>2 x 4 - 70 mm$^2$<br>2 x 9 x 0.8 mm - 10 x 16 x 0.8 mm | | | AWG12 - 350 MCM<br>2 x 0.35 x 0.03 inch<br>10 x 0.63 x 0.03 inch | | | | | | |
| | 1.6 - 8 | 22 | 9 -16 | 0.006 - 0.31 | 0.87 | 0.35 - 0.63 | 5 | 0.2 | 14 | 123 |

## 3.4.2 Connection in control section

Table 14:   Terminal capacity control section

| Part no. | mm² | mm² | AWG UL-use | mm | inch | | | Nm | lb-in |
|---|---|---|---|---|---|---|---|---|---|
| **Size 1** | 0.75 - 4 | 0.75 - 2.5 | 18 - 10 | 10 | 0.39 | 1 x 6 | PZ2 | 1.2 | 10.62 |
| DS7…004… DS7…007… DS7…009… DS7…012… | 2 x 0.75 - 3.5 | 2 x 0.75 - 2.5 | 2 x 21 - 20 | 10 | 0.39 | 1 x 6 | PZ2 | 1.2 | 10.62 |
| **Frame size 2** | 0.5 - 2.5 | 0.5 - 1.5 | 21 - 16 | 6 | 0.24 | 0.6 x 3.5 | PZ2 | 0.4 | 3.54 |
| DS7…016… DS7…024… DS7…032… | 2 x 0.5 - 1.0 | 2 x 0.5 - 0.75 | 2 x 21 - 20 | 6 | 0.24 | 0.6 x 3.5 | | 0.4 | 3.54 |
| **Frame size 3** | 0.5 - 2.5 | 0.5 - 1.5 | 21 - 16 | 6 | 0.24 | 0.6 x 3.5 | PZ2 | 0.4 | 3.54 |
| DS7…041… DS7…055… DS7…070… DS7…081… DS7…100… | 2 x 0.5 - 1.0 | 2 x 0.5 - 0.75 | 2 x 21 - 20 | 6 | 0.24 | 0.6 x 3.5 | | 0.4 | 3.54 |
| **Frame size 4** | 0.5 - 2.5 | 0.5 - 1.5 | 21 - 16 | 6 | 0.24 | 0.6 x 3.5 | PZ2 | 0.4 | 3.54 |
| DS7…135… DS7…160… DS7…200… | 2 x 0.5 - 1.0 | 2 x 0.5 - 0.75 | 2 x 21 - 20 | 6 | 0.24 | 0.6 x 3.5 | | 0.4 | 3.54 |
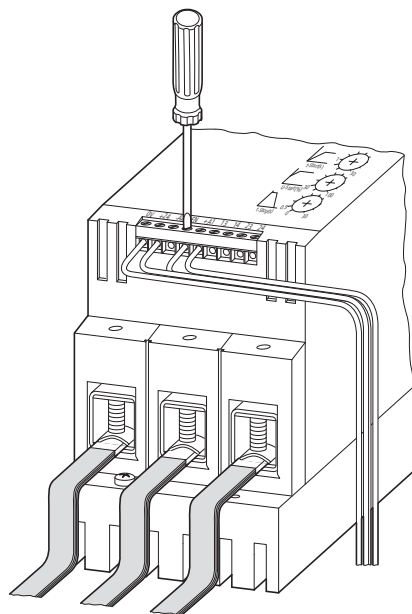


Figure 62:  Example for size 3 and 4

→ Unlike with variable frequency drives, the screen earth kit of the motor cables is not required.

→ Lay the control cables ② spatially separated from the power cables ① and if possible only cross at right angles.
This particularly applies to 24 V control voltages. The control cables do not have to be shielded.



Figure 63: Laying control cables

① Power cable L1, L2, L3, U, V, W
② Control cables: $+U_s$, $-U_s$, +A1, -A2, EN, 13, 14, 23, 24

### 3.4.3 Connection to SmartWire-DT

Connect the SWD external device plug with the adapted SmartWire-DT ribbon cable.



SWD4-100LF8-24
SWD4-3LF8-24-2S
SWD4-5LF8-24-2S
SWD4-10LF8-24-2S
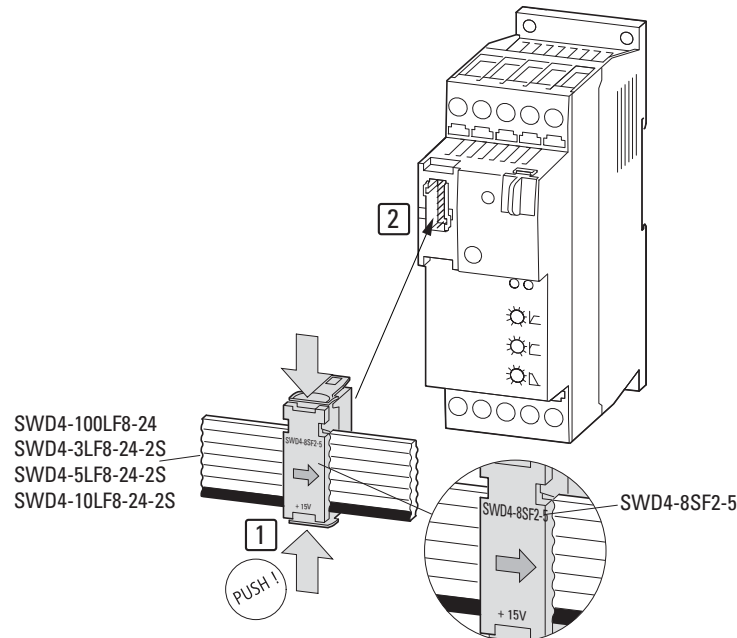
SWD4-8SF2-5

Figure 64:  Connecting the SmartWire-DT external device plug with the adapted ribbon cable

> *NOTICE*
>
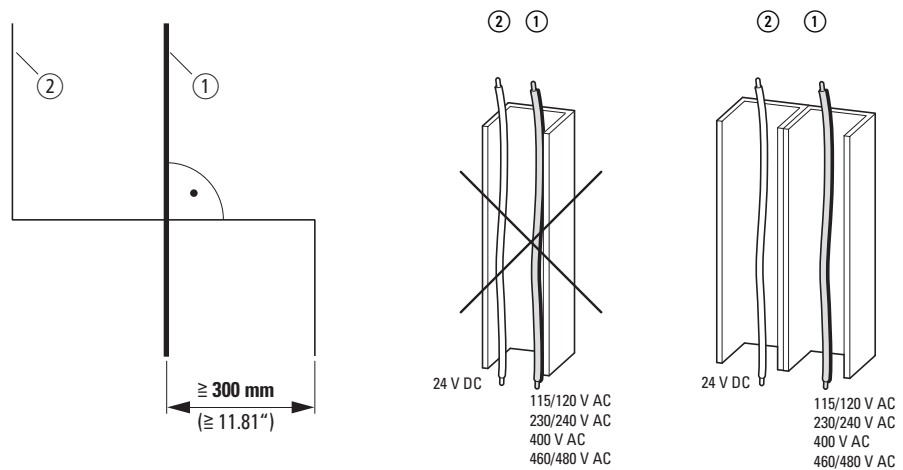> Do not install or remove the SWD4-8SF2-5 SmartWire-DT external device plug without switching off the supply and control voltages first.

### 3.4.3.1 PKE32-COM communication cable

To connect a PKE motor-protective circuit-breaker (sizes 1 and 2 only) with a PKE-XTU(W)A-… trip block to a DS7-SWD soft starter (size 1 or size 2), you will need a PKE32-COM communications cable. This cable will serve as a communication link between the DS7-SWD soft starter and the PKE-XTU(W)A-… PKE trip block. Data will be exchanged via the PKE trip block's data interface and the data interface on the DS7-SWD soft starter.
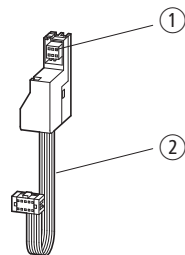


Figure 65:  PKE32-COM communication cable

① Connector for PKE-XTU(W)A-… trip block
② Data cable with connector for soft starter DS7-SWD

In order to connect a PKE motor-protective circuit-breaker with a PKE32-COM communication cable, the following additional installation steps for the DS7-SWD soft starter are required on top of the standard installation procedure (→ figures 55 and 56):

▶ Remove the empty module on the PKE basic device.
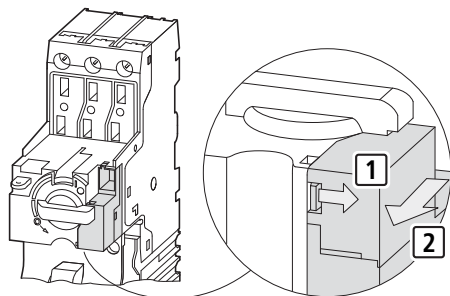


▶ Connect the PKE32-COM communication cable to the PKE basic device.
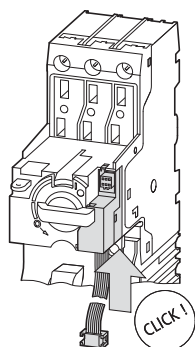


▶ Install the PKE trip block for motor protection: PKE-XTUWA-32 or PKE-XTUA-…
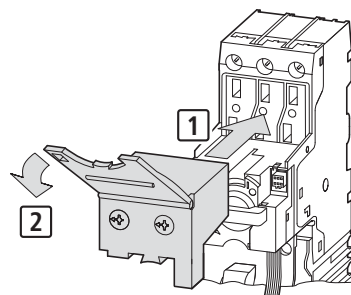


→  PKE trip block PKE-XTUCP-… for system protection must not be used in combination with a soft starter DS7!

▶ Remove the communication interface cover on the DS7-SWD soft starter (please lift the cover!) and connect the PKE32-COM communication cable.
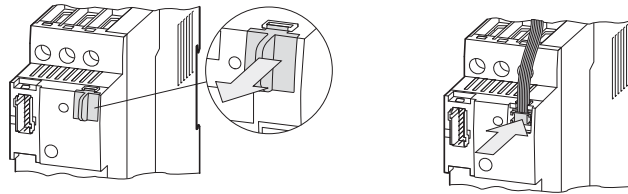
▶ Put the communication interface cover back in place.

### 3.4.4 Functions of control signal terminals

This section describes the functions of the control signal terminals.

Table 15: Function of control signal terminals

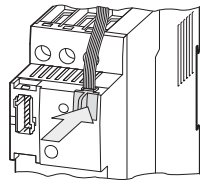| Connection terminal | Construction size | | | | Description |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| +U$_s$ | ✓ | ✓ | ✓ | ✓ | Regulator supply voltage (positive pole)<br>• DS7-340…:<br>  +24 V DC, +10 %/-15 %, 150 mA<br>  24 V AC, +10 %/-15 %, 150 mA, 50/60 Hz<br>• DS7-342…:<br>  120 - 230 V AC, +10 %/-15 %, 100 mA at 230 V, 50/60 Hz |
| -U$_s$ | | ✓ | ✓ | ✓ | Reference potential (0 V) for +U$_s$ |
| +A1 | ✓ | ✓ | ✓ | ✓ | Control input start/stop (positive pole)<br>Same voltage level as +U$_s$<br>Low level: 0 - 3 V;<br>High level: 4.6 – +U$_s$<br>Current drain:<br>DS7-340…: 1.6 mA at 24 V<br>DS7-342…: 4 mA at 230 V |
| -A2 | ✓ | ✓ | ✓ | ✓ | Reference potential (0 V) per +A1<br>In the case of size 1, reference potential for relay contact 13 (TOR) and +U$_s$ as well |
| EN | | | ✓ | ✓ | Control input, controller enable (enable, positive pole)<br>EN must be actuated before +A1.<br>If the t-Stop function is used, EN should not be disconnected until after the RUN signal has been deactivated.<br>If EN is deactivated in RUN mode, the drive will execute an uncontrolled stop. |
| 13 | (✓) | ✓ | ✓ | ✓ | Relay contact, N/O TOR (Top-of-Ramp)<br>230 V AC, 1 A, AC 11<br><br>**Notice!**<br>In the case of size 1, the type (AC/DC) and magnitude (24 V/230 V) of the voltage being switched (TOR: 13/-A2) must be identical to those of the control voltage: +U$_s$ = +A1 = 13, reference potential -A2 |
| 14 | | ✓ | ✓ | ✓ | Common contact of TOR relay contact (control signal terminal 13) |
| 23 | | ✓ | ✓ | ✓ | Relay contact, N/O RUN (RUN signal)/READY<br>230 V AC, 1 A, AC 11 |
| 24 | | ✓ | ✓ | ✓ | Common contact of RUN/READY (control signal terminal 23) |

### 3.4.5 Control section power supply

The control section in the DS7 soft starter can be powered with the following voltages using terminals $+U_s/-U_s$ (sizes 2, 3, and 4) or $+U_s/-A2$ (size 1):

- 24 V DC/AC at DS7-34**0**…
- 120 - 230 V AC at DS7-34**2**…
- 24 V DC at DS7-34**D**…

DS7-34D…-D soft starters can be powered directly through the SmartWire-DT ribbon cable.

→ At a high load on the PSU supplying the SWD (many modules, signaling lamps, soft starters) soft starter DS7 can also be supplied with control voltage through control signal terminals $U_s$ or further SmartWire-DT PSUs (gateway EU5C-SWD-PF…). If power is fed through control signal terminals $U_s$ the 24 V connection on the SWD gateway must be switched off.

→ Ensure that the regulator supply voltage and the control signals always have the same potential and are supplied from the same voltage source.

> *NOTICE*
>
> In size 1 devices, connection terminals $+U_s$, +A1, and 13 (via the TOR contact) have a common reference potential (-A2). The switched voltage (TOR) and the control voltages ($+U_s$, +A1) **must** be the same here!

### 3.4.6 Internal device voltages

The DS7 soft starters do not provide any internal voltage.

### 3.4.7 Ground control voltage

All control signal terminals of the DS7 soft starter are galvanically isolated from the power section. Connecting the control voltage on the DS7 soft starter to earth is not necessary.

→ If control voltage earthing requirements must be complied with (e.g., Safety of machinery - Electrical equipment of machines, EN 60204) earthing must be implemented at the power supply source (control transformer, power supply unit).

### 3.4.8 Relay contacts

The soft starters of the DS7 series are provided with one or two relays with an N/O contact depending on the current range. The relays are galvanically isolated from the power section.

Table 16: Relay contacts

| Relays (Control signal terminal) | Designation | Function |
|---|---|---|
| 13/14 or -A2/13 | **TOR** | Top-of-ramp: Signals operation with full voltage on the motor (top of start ramp reached; set time t-Start elapsed). |
| 23/24 | **RUN/READY** | Operating signal during ramp time (t-Start, t-Stop), as well as during continuous operation (= TOR)<br><br>Default setting: **RUN**<br><br>**Note:**<br>This relay is only installed in devices of sizes 2, 3 and 4. |

In applications in which the relay contacts (TOR, RUN / READY) control external contactors, the contactor coil must be connected in order to increase interference immunity:

- for AC voltage with an RC filter,
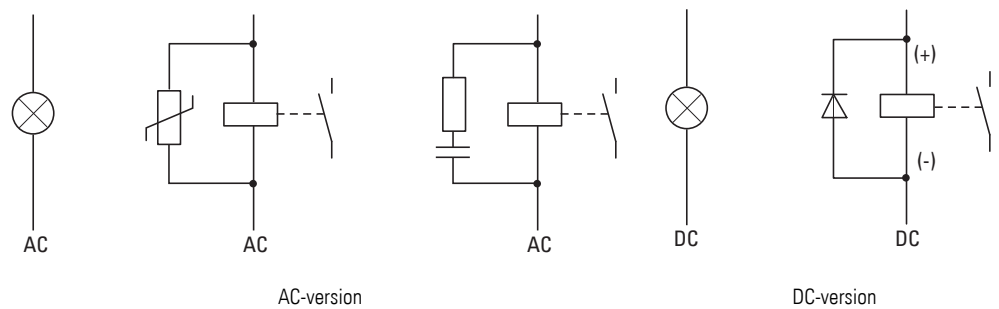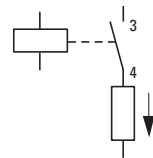- for DC voltage with free-wheel diode.



Figure 66: Relay contacts with permissible load and recommended connection

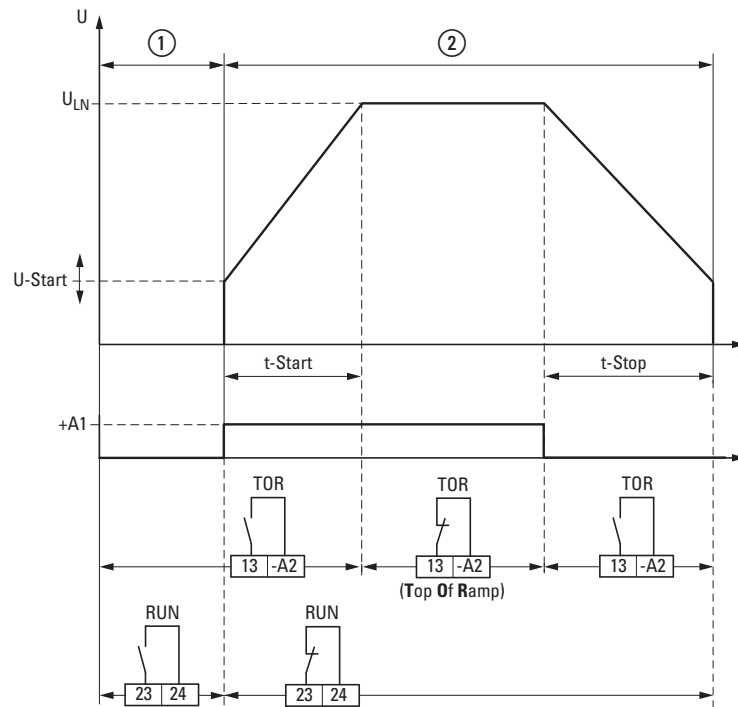The illustration below shows the operating points for the Run signals at relay contacts TOR (13/14) and RUN (23/24).

Figure 67: Relay contact positions (example: size 2 DS7)
① Ready for operation
② operation

Soft starters DS7 of the size 1 (up to 12 A) have no RUN / READY relay.
The TOR relay in this size has different terminal designations and has the same reference potential (-A2) as the control voltage.



Figure 68: TOR relay in size 1 devices

The RUN relay (control signal terminal 23/24 sizes 2, 3 and 4 only) closes together with the start command at control signal terminal +A1. The start ramp (t-Start) is enabled around 100 ms later. This makes it possible to switch an optional mains contactor on and off via the RUN relay. If there is no voltage present at the power section by this time of 100 ms, the DS7 soft starter switches off with the "phase failure" fault signal.

The TOR relay (control signal terminals 13/14, or 13/-A2 in the case of size 1) will be switched on after the set t-Start time elapses (the contact will close). The TOR contact will open again (the relay will be de-energized) if the start command on control signal terminal +A1 is turned off or if the DS7 soft starter detects a fault.

## 3.4.9 Relay contacts - connection examples

**Size 1 (4 - 12 A) – Non-isolated relay contact**
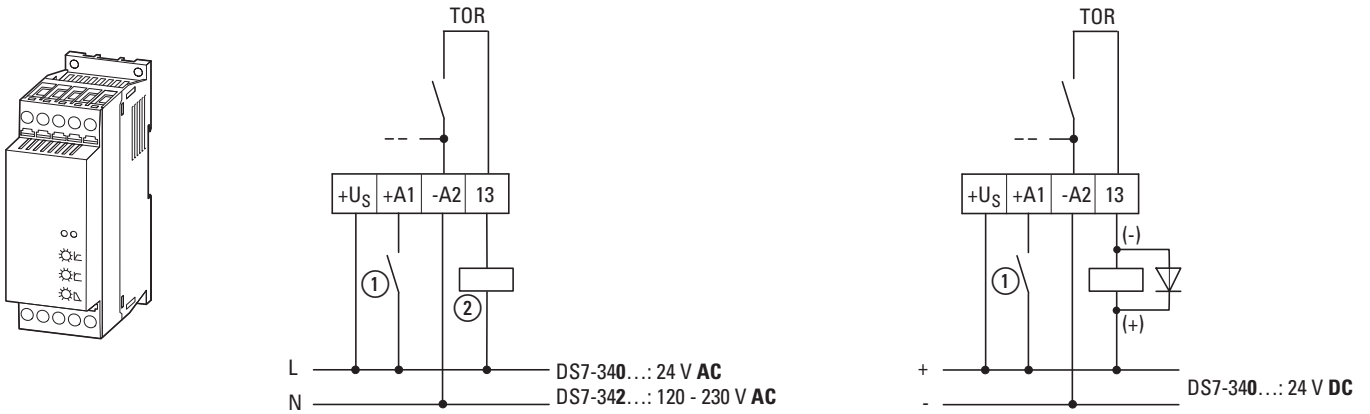


**Size 2 (16 - 32 A) – Isolated relay contacts**
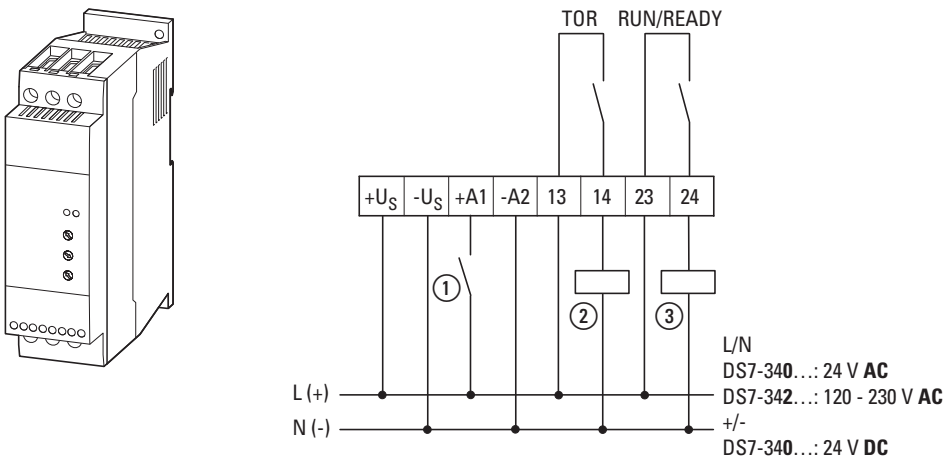


**Size 3 and 4 (41 - 200 A) – Isolated relay contacts**
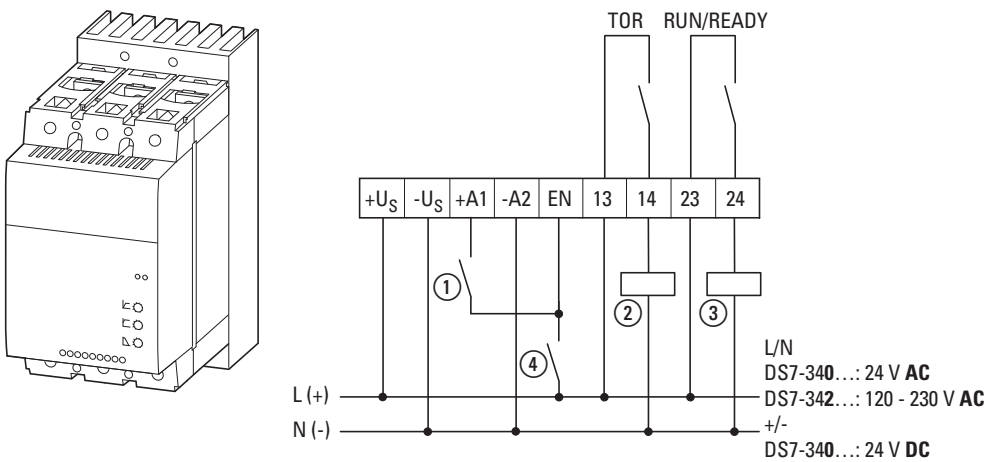


① Start/Stop signal  
② Operating signal Top-of-Ramp  
③ Operating signal RUN or READY  
④ Controller enable (EN = Enable)

## 3.5 Block diagrams

The number and arrangement of the control terminals in the individual sizes vary according to the power.

### Size 1 (4 – 12 A)
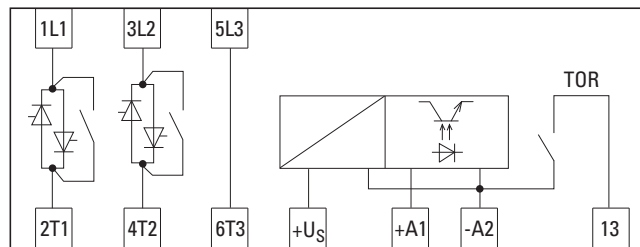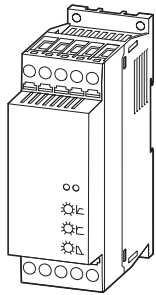
### Size 2 (16 – 32 A)
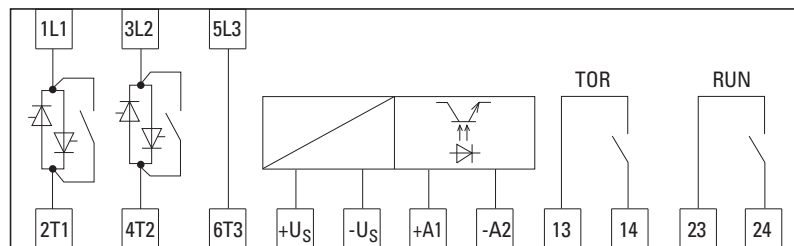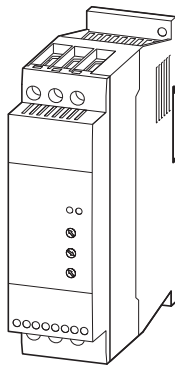
### Size 3 and 4 (41 – 200 A)
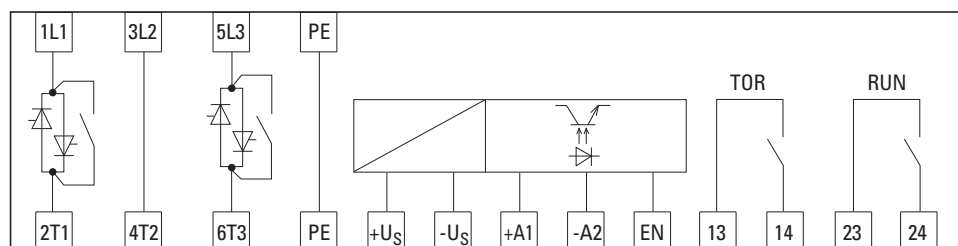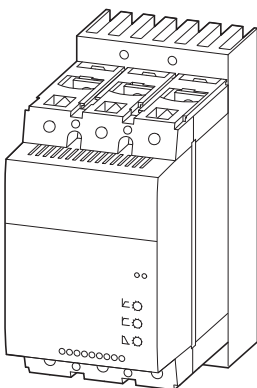
Figure 69: Block diagrams

## 3.6 Insulation test

The soft starters of the DS7 series are tested, delivered and require no additional testing.

> ⚠️ **CAUTION**
>
> On the control signal and the connection terminals of the soft starter, no leakage resistance tests are to be performed with an insulation tester.

If insulation testing is required in the power circuit of the motor feeder, you must consider the following measures.

- **Checking the motor cable insulation**
  Disconnect the motor cable from the connection terminals 2/T1, 4/T2 and 6/T3 from the soft starter and from the motor (U, V, W). The insulation resistance of the motor cable between the individual phase conductors and between each phase conductor and the protective conductor can be measured. The insulation resistance must be greater than 1 MΩ.

- **Checking the mains cable insulation**
  Disconnect the mains cable from the mains power supply and from the connection terminals 1/L1, 3/L2 and 5/L3 of the soft starter. The insulation resistance of the mains cable between the individual phase conductors and between each phase conductor and the protective conductor can be measured. The insulation resistance must be greater than 1 MΩ.

- **Checking the motor insulation**
  Disconnect the motor cable from the motor (U, V, W) and open the bridge circuits (star or delta) in the motor terminal box. The insulation resistance can then be measured between the individual motor windings. The measurement voltage must at least match the rated operating voltage of the motor but is not to exceed 1000 V.
  The insulation resistance must be greater than 1 MΩ.

➡️ Consider the notes from the motor manufacturer in testing the insulation resistance.

# 4 Operation

## 4.1 Checklist for commissioning

Before commissioning the DS7 soft starter, make sure to check the following (using the check list):

| No. | Activity | Note |
|---|---|---|
| 1 | Installation and wiring completed as specified in the relevant instructional leaflets (→ table 3, page 18) and this manual. | |
| 2 | All wiring and line section leftovers, as well as all the tools used, have been removed from the soft starter's and the drive motor's proximity. | |
| 3 | All terminals in the power section and in the control section were tightened with the specified torque. | |
| 4 | The lines connected to the output terminals of the soft starter (2/T1, 4/T2, 6/T3) are not short-circuited and are not connected to ground (PE). | |
| 5 | The heat sink (in size 3 and 4 soft starters) is properly earthed (PE). | |
| 6 | All electrical connections and switchgears in the power section were implemented properly and were designed in line with the corresponding requirements. | |
| 7 | Each single phase of the supply voltage (L1, L2, L3) is protected with a fuse. | |
| 8 | Soft starter and motor are adapted to the mains voltage (i.e. the rated operational data on the nameplate and the "star" and "delta" connection have been checked). | |
| 9 | The quality and volume of cooling air are in line with the environmental conditions required for the soft starter and the motor. | |
| 10 | All connected control cables comply with the corresponding stop conditions (e.g., switch in OFF position). | |
| 12 | The effective direction of a coupled machine will allow the motor to start. | |
| 13 | All emergency switching off functions and safety functions are in an appropriate condition. | |

| No. | Activity | Note |
|-----|----------|------|
| 14 | **DS7-SWD**<br>When the unit is connected to SmartWire-DT, the control voltage must be switched on (SWD LED lit green) and the card address must be set on the SmartWire-DT system | |
| 15 | **DS7-SWD**<br>Control voltage $U_s$, $U_c$ must match the relevant voltage specifications for the DS7 soft starter (see nameplate specifications). | |
| 16 | **DS7-SWD**<br>The SmartWire-DT address for the DS7-SWD soft starter will be assigned automatically by the gateway when the configuration button is pressed. | |

> ⚠ **DANGER**
>
> Hazardous voltage!
> The safety instructions on pages I and II must be followed.

## 4.2 Commissioning

The factory settings for DS7-34… soft starters are configured in such a way as to allow a suitably rated 4-pole standard motor to be run in typical soft starter applications without the need for any additional adjustments.

---

*NOTICE*

Make sure that there is no danger in starting the motor. Disconnect the driven machine if there is a danger in an incorrect operating state.

---

*NOTICE*

Before switching on the soft starter, check whether the permissible ambient conditions have not been exceeded and that there is no moisture inside the device. Storing the soft starter in a cool place for example may cause moisture to occur. If moisture has penetrated the device, ensure that it is completely dried.

---

*NOTICE*

The electrical installation and commissioning must only be carried out by suitably qualified personnel.
The user is responsible for ensuring suitable earthing and cable protection for the incoming unit in accordance with local and national regulations.
The motor must be protected from overloads!

---

In addition, soft starters belonging to the DS7-34D… series also feature a 1-0-A switch that can be used to manually switch the soft starter on and off.

The 1-0-A switch's positions have the following functions:

• 1: DS7-SWD = ON
• 0: DS7-SWD = OFF
• A: Control via SmartWire-DT (PNU 928.0) or via control signal terminals / potentiometers

The 1-0-A switch can be used for starting and stopping the motor only if soft starter DS7-34D… is supplied with 24 V DC through the SmartWire-DT ribbon cable or the control signal terminals $U_s$.

## 4.3 Extended functionality

This extended functionality is only available on DS7-340… and DS7-342… models.

**Scope of extended functionality**

- Relay 23 can be reprogrammed from RUN to READY.
- An input-side check of the phase sequence can be enabled.

**Setting the potentiometers**

To activate the extended functionality, set the potentiometers as follows:

- **t-Start**: Max: 30 s
- **U-Start**: Max: 100 %
- **t-Stop**: About 65 % (do not select the maximum or the minimum value)

If the potentiometers are set to settings other than the ones shown above, the DS7 soft starter will keep its configuration, i.e., the relay function and phase sequence detection function will keep behaving the same way as the last time before the device was switched off.

**Configure**

When the control section's power supply is activated, there will be a two-second configuration period, provided that the potentiometers have been set to the correct settings. During this configuration period, the green LED and the red LED will show a solid light. If no adjustments are made during these two seconds, the DS7 soft starter will keep its previous configuration.

**Changing the relay functionality from RUN to READY and vice versa**

▶ Change the value for **t-Start** from Max to Min and then back from Min to Max within the configuration period (2 seconds).
  • After this, the **green** LED will flash for 1 second with a frequency of 8 Hz if the **RUN** functionality has been activated (default).
  • On the other hand, the **red** LED will flash for 1 second with a frequency of 8 Hz if the **READY** functionality has been activated instead (Extended).

**Enabling/disabling the phase sequence check**

▶ Change the value for **U-Start** from Max to Min and then back from Min to Max within the configuration period (2 seconds).
  • After this, the **green** LED will flash for 1 second with a frequency of 8 Hz if the phase sequence error detection function has been disabled (default).
  • On the other hand, the **red** LED will flash for 1 second with a frequency of 8 Hz if the phase sequence error detection function has been enabled instead (Extended).

**Causes of fault**

If the configuration process fails, both the green and the red LED will flash for 1 second.

Possible reasons for this include:

- The functionality was not configured fast enough
  (i.e., within the 2-second configuration period).
- The configuration steps were not carried out with the required precision.
- t-Start and U-Start were adjusted simultaneously.

## 4.4 Potentiometer settings

The soft starters can be adjusted as necessary for the application at hand by using the three potentiometers, which are labeled **U-Start**, **t-Start**, and **t-Stop** respectively. Aside from these potentiometer settings, no additional settings or prompts are required in order to run the soft starters.

When using DS7-SWD soft starters, these potentiometer settings can be adjusted by means of parameters.

→ section 8.9, "Programming" explains how to configure the DS7-SWD soft starter's parameters.
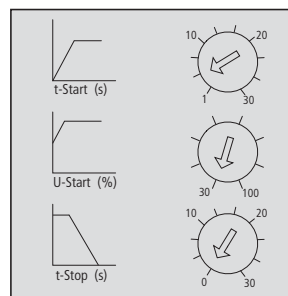


Figure 70:  Potentiometer layout

Table 17: Potentiometer settings in the default settings

| Potentiometer | Value | Function | DS | PNU Index | DS |
|---|---|---|---|---|---|
| **U-Start** | 30 - 100 % | Start voltage at which the ramp function is started | 30 % | 11 | 4915 |
| **t-Start** | 1 - 30 s | Time in which the voltage is increased from the value U-Start to 100 % with a linear time ramp | 5 s | 111 | 50 |
| **t-Stop** | 0 - 30 s | Time in which the voltage is reduced from 100 % to the value U-Start with a linear time ramp | 0 s | 114 | 0 |

## 4.4.1 How the potentiometers work



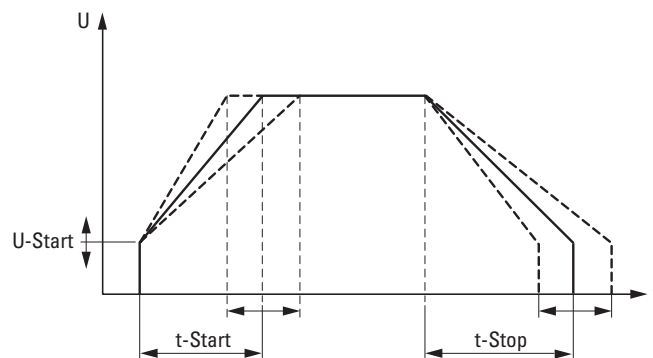Figure 71:  Time-based control of motor voltage with a soft starter

### 4.4.1.1 U-Start

The start voltage U-start determines the torque of the motor.
Low values produce soft starting and a higher thermal load of the motor.
If the voltage is too low, the motor may not start immediately. In this case,
the voltage should be set higher in order to avoid any unnecessary heating of
the motor.

The motor's torque is proportional to the square of the start voltage.
Because of this, voltages lower than 30 % of mains voltage $U_{LN}$ are not
recommended. This value corresponds to around 10 % of the starting torque
of a motor in direct mains operation. When using a star-delta configuration,
the motor will start with approximately 30 % of the starting torque.

➔ Set start voltage U-Start to a voltage that is high enough to
cause the motor to rotate immediately with the start command.
This will prevent unnecessary motor heating.

### 4.4.1.2 t-Start

The t-Start starting time is used to set the time in which the motor voltage
will be increased from a starting value of U-Start to 100 % $U_{LN}$, therefore
accelerating the motor smoothly. If this starting time is too long, the motor
and the soft starter will be subjected to high temperature loads. This can
cause the safety devices to trip. Because of this, the shortest possible
starting time should be selected.

➔ Depending on the load and duty cycle, more starts per hour may
be possible when using shorter start times. Conversely, longer
start times will mean fewer starts per hour.

The ramp times should always be configured in a way that makes sense for
the specific machine application at hand.

Examples:

• With conveyor belts select a time so that the transported goods do not
topple.
• With belt drives, the time should be selected so that the belts do not
slip.

Some drives (e.g. a motor in idle operation or unloaded drives) reach the
rated speed already at the beginning or during the soft start ramp. In this
case, the t-Start setting must be reduced in such a way that any unnecessary
motor heating will be avoided.

➔ Excessively short start times may lead to the internal relay being
overloaded.

### 4.4.1.3 t-Stop

In the industry, the t-Stop stop ramp is used predominantly for applications involving pumps, conveyor belts, and belt drives. For example, it can be used to prevent goods being conveyed from toppling over (e.g., bottles on a conveyor belt), V-belts from slipping, and water impact caused by valves being closed from occurring.

With all other applications, the parameter t-Stop can also be set to zero in order to prevent any unnecessary temperature rise in the motor.

A soft stop ramp has the same temperature characteristics as a start. It also therefore causes the heating of the soft starter and motor, and must be taken into account when determining the starting frequency. The stop ramp terminates at a set value of U-Start. A correct setting will cause the minimum torque to be generated at which the motor still turns. At lower voltages (torques), the machine remains at standstill due to losses or friction.

The stop ramp is activated when the start command is turned off (low signal on control signal terminal +A1). The drive then moves with the set stop time (t-Stop) to the value of the start voltage (U-Start). When this is reached, the soft starter switches off the output. If the motor still is still turning, it will perform an uncontrolled stop from this point. The soft stop time is default set to 0 s, in other words the motor performs an uncontrolled stop.
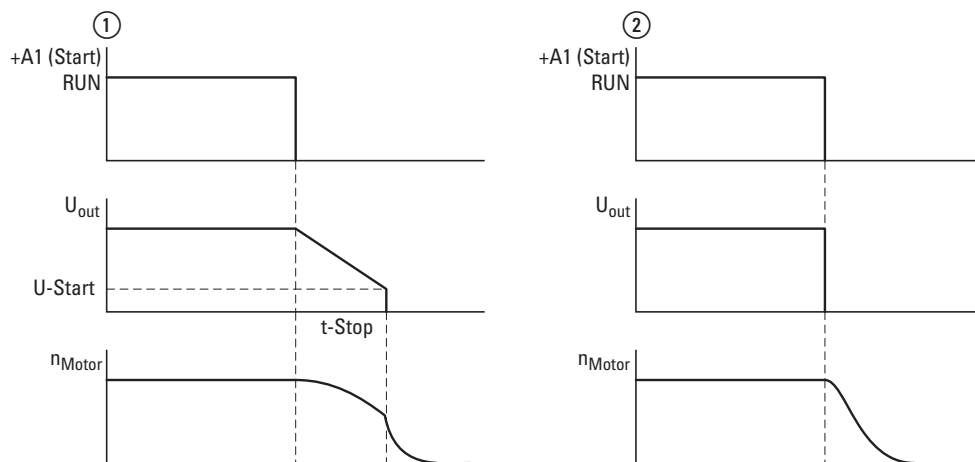


Figure 72: Operation with ① and without ② soft stop
① With stop ramp (+A1 = OFF, t-Stop > 0)
② Without stop ramp (+A1 0 OFF, t-Stop = 0 s) or via control signal terminal EN (in the case of sizes 3 and 4) or via SmartWire-DT with t-Stop = 0

→ In the case of size 3 and 4 ($I_e \geqq 41$ A) devices, the stop command without a ramp function can also be achieved by turning off the EN (Enable) control signal.

→ In the case of devices with SmartWire-DT, the stop command can also be activated, with or without a soft stop, via SmartWire-DT.
For more information, see → chapter 8, "SmartWire-DT".

If the start command (+A1) is activated again while the stop ramp is active (t-Stop time active), the soft stop will be aborted and a soft start will be carried out starting from the latest output voltage and start ramp (t-Start) values.
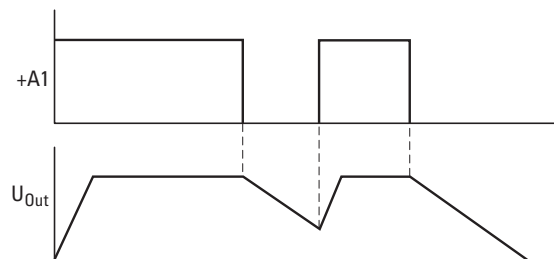


Figure 73: Changing start signal +A1

→ In the case of size 3 and size 4 devices without SmartWire-DT, the EN (Enable) signal must remain on without change.
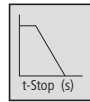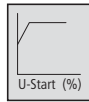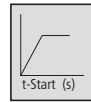For devices with SmartWire-DT → chapter 8, "SmartWire-DT".

*NOTICE*
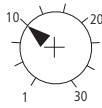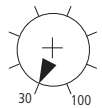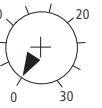Excessively short ramp times may lead to the relay being overloaded!
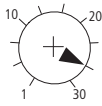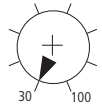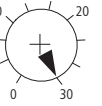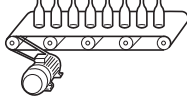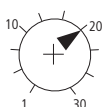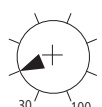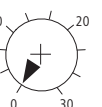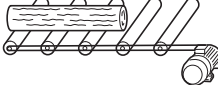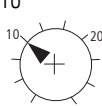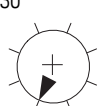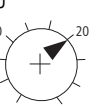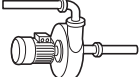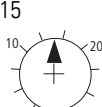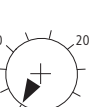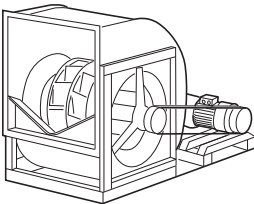
## 4.4.2 Examples

The diagrams below show various settings that have proven to be effective for standard applications in real-life environments:

| t-Start [s] | U-Start [%] | t-Stop [s] | Application example | |
|---|---|---|---|---|
| ~10 | ~30 | 0 | | J → 0<br>Low flywheel mass |
| ~25 | ~30 | ~30 | | Conveyor belt with loose belt |
| ~20 | ~40 | 0 | | Roller conveyers |
| ~10 | ~30 | ~20 | | Centrifugal pump |
| ~15 | ~40 | 0 | | Fan general (building) with belt drive |

| t-Start [s] | U-Start [%] | t-Stop [s] | Application example | |
|---|---|---|---|---|
| ~18 | ~40 | 0 | | J → ∞<br>High flywheel mass<br>→ Soft starter DS7 should have a higher output than the assigned motor. |
| ~15 | ~50 | 0 | | Tunnel fan<br>Axial fan<br>→ Soft starter DS7 should have a higher output than the assigned motor. |
| ~10 | ~60 | 0 | | Bulk conveyor<br>Escalator |
| ~10 | ~60 | 0 | | Mixers<br>Agitators<br>→ Soft starter DS7 should have a higher output than the assigned motor. |
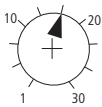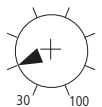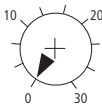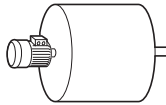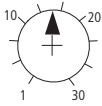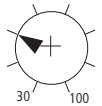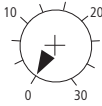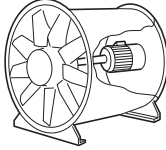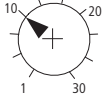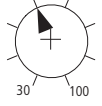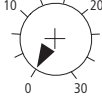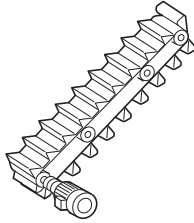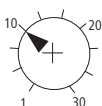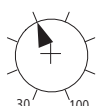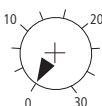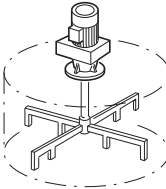
Figure 74: Recommended settings per application

→ When using DS7-SWD soft starters, these settings can be adjusted using parameters (PNU) (→ section 8.9.5.2, "Acyclic DS7 soft starter data", page 186.

## 4.5 Commissioning instructions

| No. | Occupation |
|-----|-----------|
| 1 | Set the potentiometer or the U-Start parameter as per the recommendation in the table above or, as a general setting, turn t-Start to approximately 50 % (15 s) and t-Stop to its minimum value (0 = coasting). |
| 2 | Starting<br>After a maximum time of one second, the motor should start to turn, otherwise deactivate the start signal (or on devices from 41 A the Enable signal) immediately.<br><br>If the motor has turned, proceed with point 3.<br><br>If the motor has not started, increase U-Start by around 10 % (to around 40 %).<br>Wait a minute for cooling and repeat step 1. |
| 3 | Optimizing t-Start: The motor should accelerate evenly from standstill to rated speed at rated load. When it has reached rated speed, the set ramp time should have completed ($U_2 = U_{LN}$, = TOR). |
| 4 | Repeat the start process. After every start, wait around five minutes in order to allow the unit to cool down. |
| 5 | Run-up optimization<br><br>• If the drive accelerates faster than the set ramp time (t-Start), shorten this as much as this application allows.<br>• If the application requires more time for the acceleration than the set ramp time, increase the value of t-Start – unless the load cycle of the soft starter is exceeded.<br>• If the acceleration time is longer than the limits set in step 4 or 5, let the soft starter cool down for 5 minutes, increase the ramp time and proceed with step 4. |
| 6 | If a stop ramp is needed, the time set (t-Stop) should be longer than the machine's coasting time in order for the stop ramp to have an effect. As a soft stop produces a current increase, observe the thermal output capacity (load cycle) of the soft starter (number of starts per hour). Within this context, the stop ramp must be considered equivalent to a start in terms of thermal characteristics. |

→ If the required settings for an application exceed the permissible load cycle of the soft starter, a larger device must be selected accordingly.

→ The soft starter heats up at the start. In order to avoid overheating, make sure to adhere to the required cool-down times without fail. If there will be frequent starts during normal operation, the soft starter may have to be oversized under certain circumstances and/or optional fan DS7-FAN… may have to be used.
For more information, refer to the "Technical data" appendix. Additional information including application and sizing examples is found in manual MN03902001Z-EN, "Sizing Soft Starters."

## 4.6 Start the motor

The motor accelerates at the set values when the start command (high signal) is applied at control terminal +A1. In the case of frame sizes 3 and 4, the EN signal must be present before +A1. The actual acceleration time can differ from the set values, depending on the load. After the start is completed, the soft starter switches to the operating phase.

## 4.7 Operation

Switching on the motor side is permissible for a safety disconnection (emergency switching off).

> **DANGER**
>
> On no account must you open the device if the supply voltage is switched on. Danger to life!

> **DANGER**
>
> Soft starters are electrical apparatus for use in power installations in industrial applications. During operation hazardous live parts and hot surfaces are present on the soft starter. These present a risk of serious injury!

> **DANGER**
>
> The impermissible removal of the required cover, improper installation or incorrect operation of the motor or soft starter can cause the failure of the device and serious injury and/or material damage.

> **DANGER**
>
> If the device displays an error message, this must be examined carefully. If a hardware fault is indicated, it is possible that not all phases of the soft starter have disconnected. Before working on the device or motor, they must be securely isolated beforehand from the mains supply without fail (e.g. switch off circuit-breaker).

> → If the drive is not isolated from the supply when stationary (mains contactor, main switch), it may start up accidentally in the event of a malfunction. Even if the motor is stationary, the terminals are still energized (leakage current across the thyristors, uncontrolled phase)

> **DANGER**
>
> One phase to the motor is internally bridged, which means that a supply phase is still directly present at the motor even when it is switched off. Danger in the event of contact!
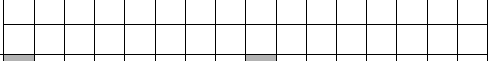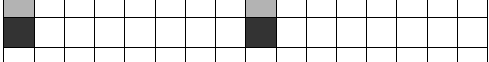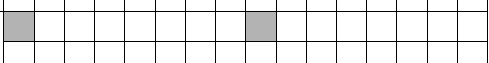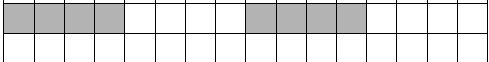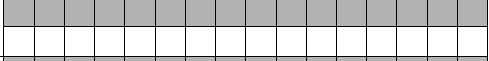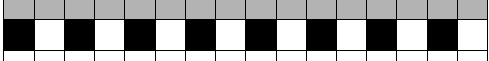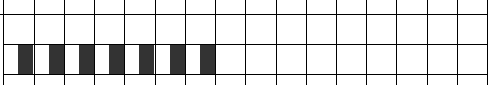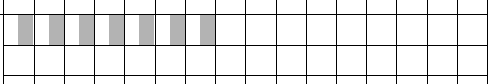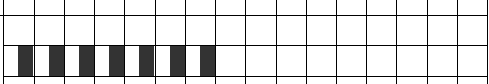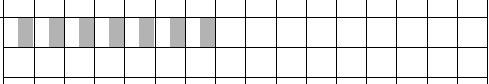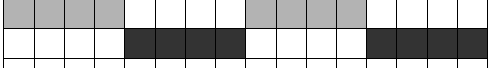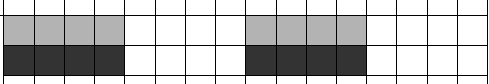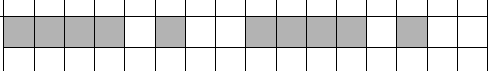
## 4.8 LED indicators

The RUN and Error LEDs are used to indicate the DS7 soft starter's operating state.

The shades of gray below have the following meanings in the following table:

◻ = Green RUN LED

◼ = Red Error LED

| Status signal | View |
|---|---|
| **Operation** | |
| Initialization | (green LED flashing, red LED flashing alternately) |
| Off – No supply voltage | (both LEDs off) |
| Supply voltage without enable (EN), only in frame sizes 3 and 4 and all sizes in the case of DS7-34D…-D soft starters | (green and red LED on, brief) |
| Supply voltage and enable (EN), only in frame sizes 3 and 4 and all sizes in the case of DS7-34D…-D BG4 soft starters  Ramp (t-Start or t-Stop) | (green LED on, brief) / (green LED on) |
| TOR (continuous operation) | (green LED on continuously) |
| Current limitation | (green LED on, red LED flashing) |
| Configuration mode activated | (green LED on, red LED on) |
| Relays 23 and 24 configured as READY | (red LED flashing) |
| Relays 23 and 24 configured as RUN | (green LED flashing) |
| Phase sequence check enabled | (red LED flashing) |
| Phase sequence check disabled | (green LED flashing) |
| **Warning** | |
| Overtemperature after operation (A1 switched off) | (green LED on, red LED flashing pattern) |
| A1 start command without Enable (EN); only in sizes 3 and 4 | (green LED on, red LED flashing) |
| SmartWire-DT operation, potentiometer may be inoperative (DS7-34D… only) | (green LED flashing) |

| Status signal | View |
|---|---|
| **Error** | |
| Over/under temperature heat sink | |
| Thyristor is defective | |
| Phase failure | |
| Bypass is defective | |
| Supply voltage faulty | |
| Potentiometer configuration is faulty | |
| Phase sequence error | |

Figure 75: LED signals

➜ The following operating signals and error messages show additional LED indicator modes.

➜ When control voltage $U_s$ is switched on, the DS7 soft starter starts an initialization routine. During this phase, both LEDs (RUN, Error) may light up simultaneously for a short time.
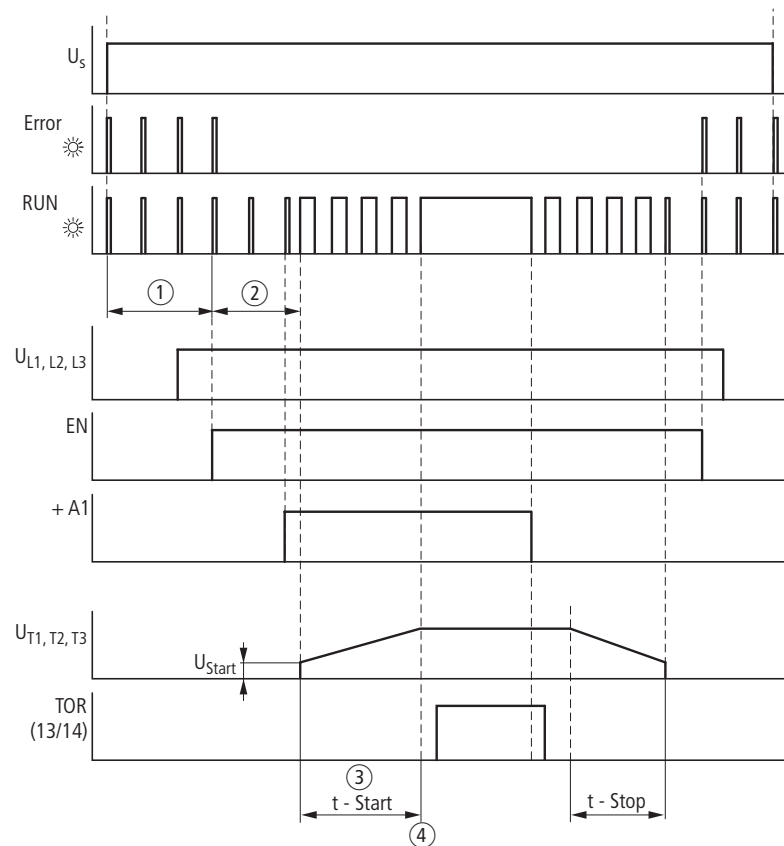
Figure 76: Actuation signals and LEDs

① Initialization
② Ready for operation
③ Acceleration phase
④ Top of ramp reached (TOR signal)

→ The top of the ramp, TOR (i.e., after the t-Start time has elapsed), and the actual motor acceleration can have different durations. The actual acceleration time will depend on the load and the motor, and even with the same identical t-Start setting may result in different times if the loads change.

## 4.8.1 Operating state signals

The DS7 soft starter's operating states are indicated on the basic device by means of two LEDs (RUN, Error):

- RUN = Operating signal (green)
- Error = fault message (red)
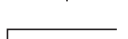
This document uses the following symbols in order to represent the operating states:

○   off – The LED is not lit up

☀   on – LED lit

◐   flashing – indication with different flash frequencies

Table 18: LEDs during operation

| | LED status indication | | Relay contact | | | |
|---|---|---|---|---|---|---|
| | RUN (green) | Error (red) | TOR | TOR | RUN | READY |
| | | | 13/-A2 (size 1) | 13/14 (size 2, size 3, size 4) | 23/24 (size 2, size 3, size 4) | 23/24 (size 2, size 3, size 4) |
| $U_S$ = 0 No control voltage (+$U_S$/-$U_S$) | ○ | ○ | open | open | open | open |
| $U_S$ Control voltage "On" | ◐ (1s) | ○ | open | open | open | open |
| Only in sizes 3 and 4 Control voltage $U_S$ on, without EN enable signal | ◐ (1s) | ◐ (1s) | | open | open | open |
| Only in sizes 3 and 4 Control voltage $U_S$ on and EN enable signal | ◐ (1s) | ○ | | open | open | open |
| Ramp (t-Start, t-Stop) | ◐ (1s) | ○ | open | open | closed | closed |
| TOR Continuous operation | ☀ | ○ | closed | closed | closed | closed |

## 4.8.2 Signals in DS7-34D…-D

In conjunction with SmartWire-DT, the RUN and Error LEDs are used to output the following signals in devices belonging to series DS7-34D…-D (in addition to → section 4.8.1, "Operating state signals"):

Table 19: LED signals in DS7-34D…-D

| | LED status indication | | Relay contact | | |
|---|---|---|---|---|---|
| | RUN (green) | Error (red) | TOR | TOR | RUN |
| | | | 13/-A2 (size 1) | 13/14 (size 2, size 3, size 4) | 23/24 (size 2, size 3, size 4) |
| No control voltage via SmartWire-DT connection | ◯ | ◯ | ⟋ | ⟋ | ⟋ |
| Control voltage U_s via SmartWire-DT connection, without enable or start command (both LEDs flashing at the same time) | ◐ | ◐ | ⟋ | ⟋ | ⟋ |
| Control via SmartWire-DT connection (operating signal for t-Start, TOR, t-Stop) | ◐ | ◯ | ⟍ | ⟍ | ⟍ |
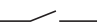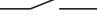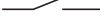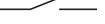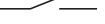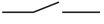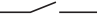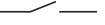
→ The states indicated by the SmartWire-DT diagnostic LED are described in → chapter 8, "SmartWire-DT".

## 4.8.3 Messages in the event of faults

Fault messages will always cause the TOR and RUN / READY relays to be switched off.

Table 20: LED during fault scenario

| | LED indicators | | Relay contacts | | |
|---|---|---|---|---|---|
| | **RUN (green)** | **Error (red)** | **TOR** | **TOR** | **RUN/READY** |
| | | | 13/-A2 (size 1) | 13/14 (size 2, size 3, size 4) | 23/24 (size 2, size 3, size 4) |
| **Alarm messages** | | | | | |
| Overtemperature after STOP (before new start command) | ◑ | ◑ | ─╱── | | |
| Start without Enable (EN) (only with size 3 and 4) | ◑ | ◑ | | ─╱── | ─╱── |
| **Error Messages** | | | | | |
| Temperature error The heat sink temperature is outside of the permissible limit values. | ☼ | ☼ | ─╱── | ─╱── | ─╱── |
| Thyristor fault Failure of one or several thyristors in the power section | ○ | ☼ | ─╱── | ─╱── | ─╱── |
| Phase failure Phase fault in the mains voltage (L1, L2, L3) | ○ | ◑ | ─╱── | ─╱── | ─╱── |
| Bypass fault (Relay contact faulty) | ◑ | ☼ | ─╱── | ─╱── | ─╱── |
| Fault in the control voltage (U$_S$) | ◑ | ◑ | ─╱── | ─╱── | ─╱── |

## 4.8.4 Error messages

The following events are detected as faults and cause the soft starter to switch off. All events are signaled with the Error LED. The RUN and TOR relays will then be switched off (OFF).
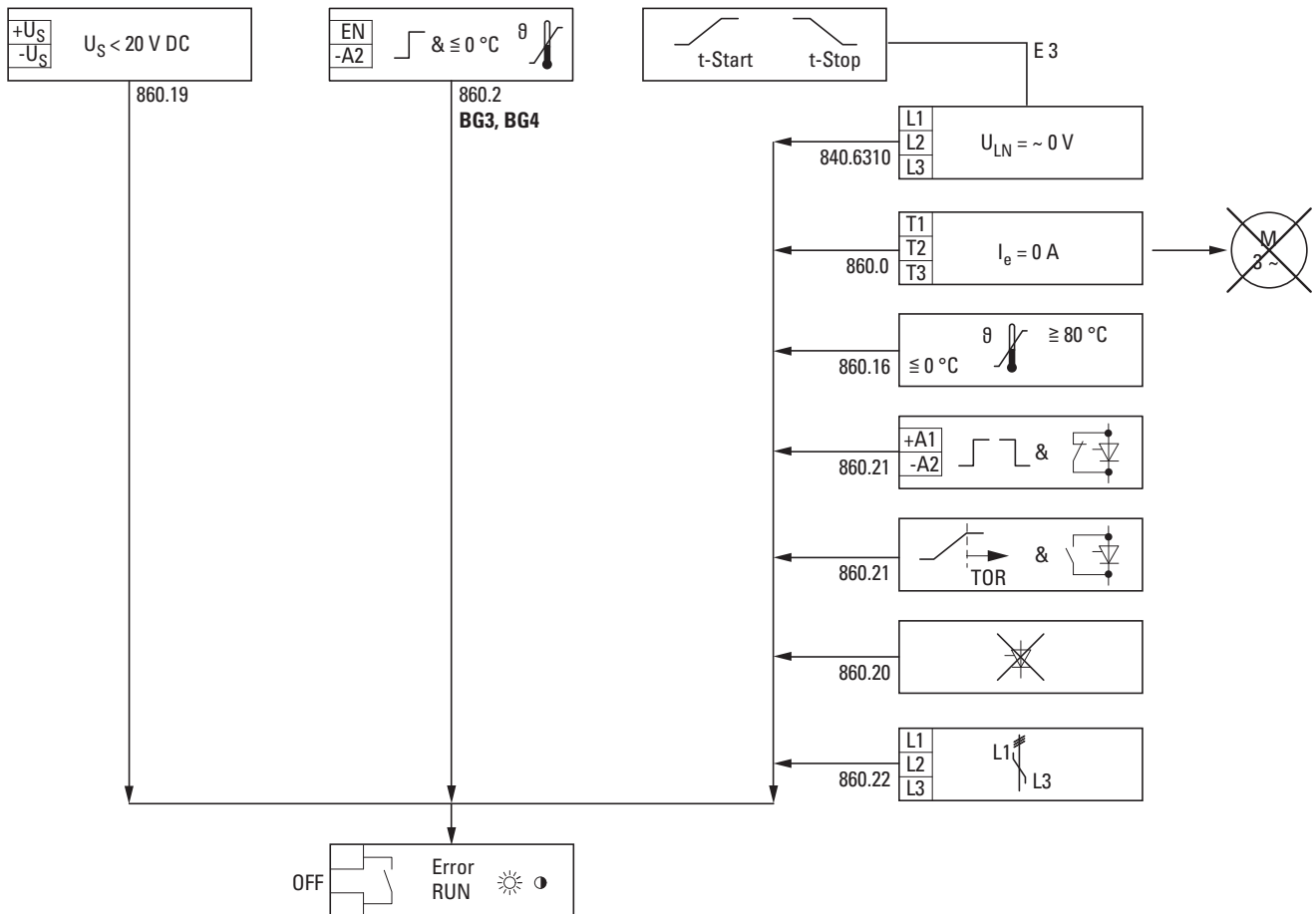


Figure 77: Error messages

In the case of DS7-34D…-D devices, error messages will be transmitted individually and with additional information via the SWD connection (➔ chapter 8, "SmartWire-DT").

### 4.8.4.1 Error messages on start

Start (ramp) indicates the phase during which +A1 (and EN in sizes 3 and 4) is activated and ramp time t-Start is active. This operating state is identical to the phase in which, during continuous operation (TOR), control input +A1 is switched off and delay ramp t-Stop ($\geqq$ 1) is active. The following error messages may be issued in this operating state (start):

Table 21: Error messages on start

| Message (PNU) | Errors | Possible causes | Remedy |
|---|---|---|---|
| Phase fault (840.6310) | One phase missing on the mains side | Fuse fault | Change fuse |
| | | Wiring defective | Control Wiring |
| Zero current detection (860.0) | $I_e$ = 0 A No power flow or current has fallen below the thyristors' holding current (~ 0.5 A) | A motor is not connected or the motor cable is broken | Check connection to T1, T2, T3 |
| Heat sink overtemperature/ undertemperature (860.16) | Heat sink temperature $\leqq$ 0 °C or $\geqq$ +80 °C | Device still overheated from last start/stop | Wait for cool-down time to elapse; use fan (DS7-FAN-032) if necessary |
| | | Excessively high control cabinet temperature; fan filter soiled | Monitor the temperature in the control panel |
| | | Undertemperature; ambient air temperature is too cold | Heat up the room or control panel and monitor the temperature |
| Bypass contact not opening (860.21) | • Bypass will not switch or respond • Bypass contact still closed when a start command is sent to +A1 • Bypass contact does not open when +A1 is switched off | Overload | Replace device; check dimensioning |
| | | Short-circuit in soft starter output | Check motor feeder |
| Bypass contact does not close at TOR (860.21) | The bypass contact is not closed after ramp time t-Start (= TOR) elapses | • Internal fault in soft starter • Defective control section or relay | Replace device |
| Thyristor is defective (860.20) | • Fuse fault • Unbalanced phase currents (> 30 %) • Different voltage magnitude between input (L1, L2, L3) and output (T1, T2, T3) during operation (TOR) | Soft starter was overloaded during last stop Thyristor destroyed | Replace device; check dimensioning |
| | | Lightning | Exchange device; install lightning protection in the installation |
| Supply voltage faulty (860.19) | Excessively low voltage for regulator supply ($U_S$ < 20 VDC) | Overload of the external power supply unit | Check dimensioning and overload of the power supply unit |
| | | Supply voltage not available | Check control signals for switching the supply voltage; install interlocks for start command if necessary |
| No release (EN) (860.2) – only sizes 3 and 4 | An enable signal is not sent when EN is activated | Heat sink temperature $\leqq$ 0 °C | Heat up the room or control panel and monitor the temperature |
| Phase sequence error (860.22) | Incorrect phase sequence | The power supply phases are connected in the wrong sequence. | Swap the phases |

## 4.8.4.2 Error messages during operation

Error messages during operation are signaled with the Error and RUN LEDs. The RUN and TOR relays are switched off when this happens (OFF).

The following error messages may be issued during operation (RUN, TOR):

Table 22: Error messages during operation

| Message (PNU) | Errors | Possible causes | Remedy |
|---|---|---|---|
| Heat sink overtemperature/ undertemperature (860.16) | Heat sink temperature $\leqq 0$ °C or $\geqq +80$ °C | Device still overheated from last start/stop | Wait for cool-down time to elapse; use fan (DS7-FAN-032) if necessary |
| | | Excessively high control cabinet temperature; fan filter soiled | Monitor the temperature in the control panel |
| | | Undertemperature; ambient air temperature is too cold | Heat up the room or control panel and monitor the temperature |
| Specifications for connection to supply voltage faulty (860.19) | Excessively low voltage for regulator supply ($U_S < 20$ V DC) | Overload of the external power supply unit | Check dimensioning and overload of the power supply unit |
| | | Supply voltage not available | Check control signals for switching the supply voltage; install interlocks for start command if necessary |

Phase faults can only be detected while the start ramp (t-Start) is active. Once the start ramp is no longer active (TOR), it will no longer be possible to detect a phase failure.

→ The mains frequency is not monitored during operation. This makes it possible to ensure reliable operating behavior even under adverse conditions, such as those that are prevalent when there is an unstable generator (mains supply voltage). Proper operation can only be ensured within the permissible limits of 50/60 Hz ± 5 %.

# 5 Diagnostics

→ The housing of the DS7 soft starter does not have to be opened for diagnostics and fault detection tasks. The design of the soft starter does not allow for it to be opened, and this may cause lasting damage to the housing.
All possible fault causes can be determined by means of the relevant indicators (LEDs, relays) or by taking measurements at the connection terminals.
DS7-34D…-D soft starters can also be diagnosed using SmartWire-DT (by reading the corresponding parameters).

## 5.1 Fault retrieval

The following information provides help in fault detection and troubleshooting. Some possible faults are described below.

### 5.1.1 Motor not starting

Possible causes:

- Start signal (+A1) not present.
- Enable signal (EN) not present (only with size 3 and 4).
- No start or enable signal via SmartWire-DT (DS7-SWD only).
- Mains voltage ($U_{LN}$) not present.
- Regulator supply voltage ($U_S$) not present.
- Ramp time (t-Start) too long.
- Start voltage (U-Start) too low.
- DS7 diagnostics LED (Error) lights up.

### 5.1.2 Motor stops immediately after start completed

Possible causes:

- Switch off due to error message (Error), e.g. phase fault or frequency fault.
- Start signal (+A1) and/or enable signal (EN, only size 3 and 4) were deactivated.
- The connection, or signal transmission, via SmartWire-DT is faulty or has been interrupted (DS7-SWD only).

### 5.1.3 Motor running unevenly

Possible causes:

- Motor output/motor current too low (<< 1.5 kW at 400 V)
- too low centrifugal masses or no load on motor.
- oscillating loads.
- Slipping V-belts (check the load and the belt tension).

### 5.1.4 Motor consuming too much current

Possible causes:

- motor overload.
- Ramp time (t-Start) too long.
- start voltage too low (U-Start).
- start voltage too high (U-Start).

### 5.1.5 Connected motor overheating

Possible causes:

- Ramp time (t-Start) too long.
- too many starts in succession.
- start voltage too high (U-Start).
- Heavy starting duty with this motor rating not or only not sufficiently allowed for when selected.

## 5.2 Acknowledgment of error messages

Potential fault sources can be determined by checking the indications and flashing frequencies of the RUN and Error LEDs and using tables 18 to 21. Once the source of a fault has been fixed or eliminated, a restart can be carried out.

Certain error messages can be acknowledged during operation if

- The control signal on terminal +A1 is switched off and then back on
- The corresponding bits are set again if SmartWire-DT-based control is being used

# 6 Parameterization

## 6.1 Operating principles

The soft starter is controlled as follows:

• Via control signal terminals in the case of DS7-340… and DS7-342… soft starters
• Via SmartWire-DT in the case of DS7-34D…-D soft starters

By configuring the appropriate parameters (in DS7-34D…-D units) or adjusting the potentiometers on the front, DS7 soft starters can be adjusted as necessary for the application at hand. All setting values are stored in parameters.

→ The connection examples shown in the following chapter are based on the standard versions of soft starter DS7.
Additional functions of the communications-capable versions of the DS7 soft starters (DS7-34D…-D) are described in
→ chapter 8, "SmartWire-DT".

## 6.2 Default settings of the basic device

The soft starters of the DS7 series are factory set so that no settings are required for standard applications.

The most important default settings are listed below.

Table 23: DS7 soft starter default settings

| Terminal, function | Default settings |
| --- | --- |
| +A1 | Start/stop |
| EN (only sizes 3 and 4) | Controller enable |
| Ramp times | t-Start: ~5 s<br>t-Stop: 0 s |
| Start voltage | ~30 % |
| Relay K1 | TOR (Top-of-Ramp) |
| Relay K2 (for devices from 16 A) | RUN = operating signal |

# 7 Connection examples

## 7.1 Size 1 (4 – 12 A)

### 7.1.1 Connection without soft stop ramp
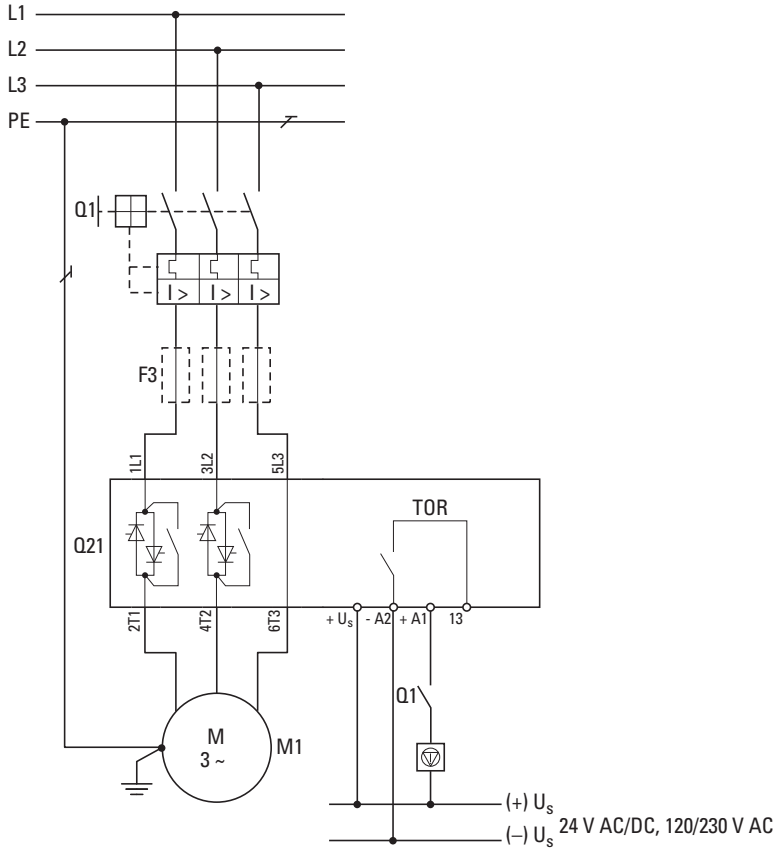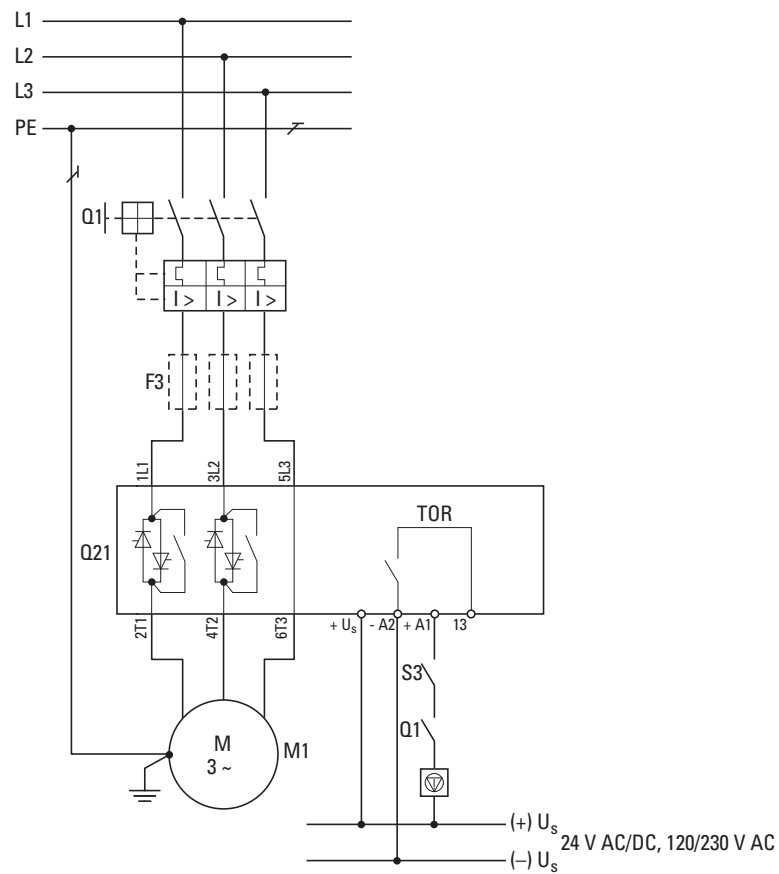


**Direct motor start**

Q1 = Cable and motor protection

Start enable (+A1) uncontrolled stop of the motor on deactivation

F3 = optional semiconductor fuse for type of coordination 2

Figure 78:     Standard connection without soft stop



Figure 79:     Flow diagram - without soft stop

## 7.1.2 Connection with soft stop ramp



**Start/stop operation**

Q1 = Cable and motor protection

Start enable (+A1) uncontrolled stop of the motor on deactivation

F3 = optional semiconductor fuse for type of coordination 2

S3: Start/stop

Figure 80:  Standard connection with Soft stop
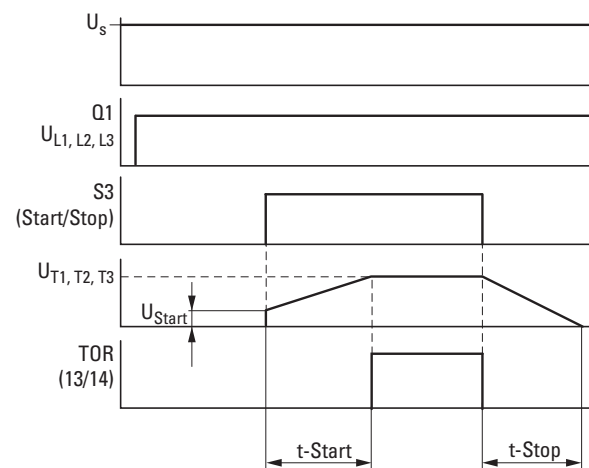


Figure 81:  Flow diagram – with soft stop

### 7.1.3 Standard connection with upstream mains contactor and soft stop ramp



Q1, F1 = Cable and motor protection

Q11 = Mains contactor

F2 = motor protection

F3 = Optional semiconductor fuse for type 2 coordination, in addition to Q1 or F1

Setting: t-Stop > 0
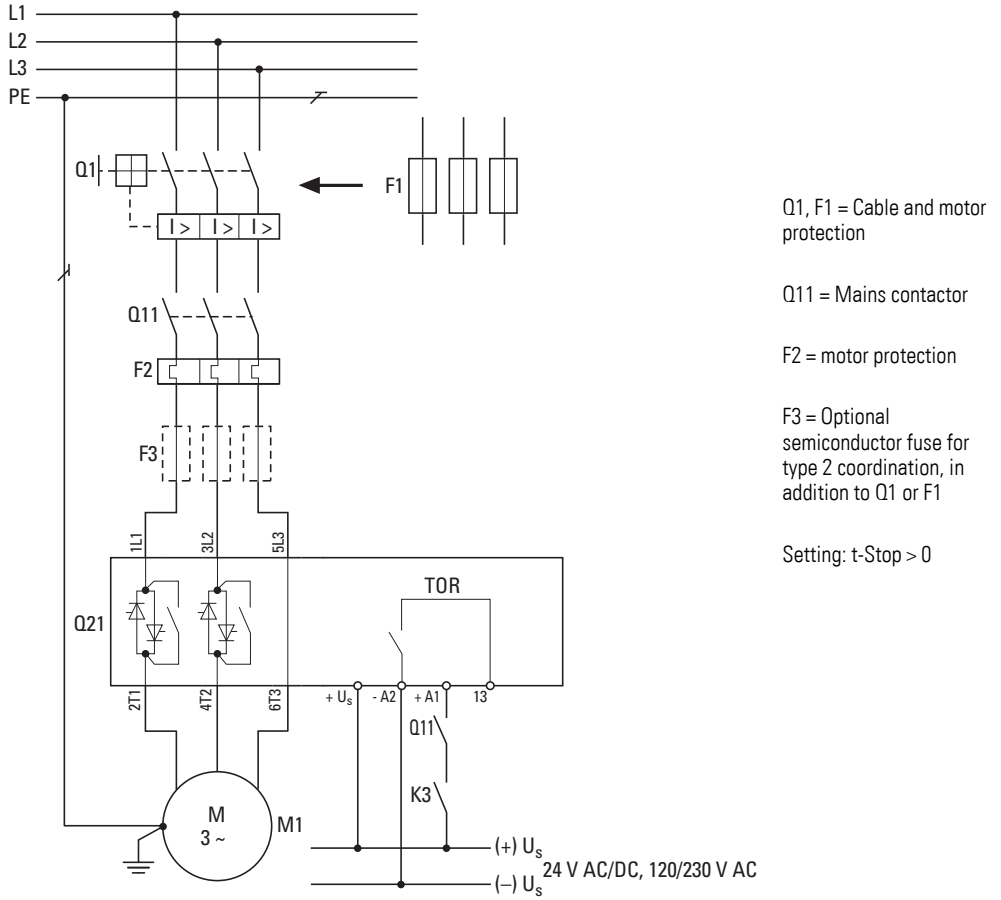
Figure 82:     Standard connection with mains contactor



① Control section for the mains contactor Q11

During operation, the deactivation via S1 causes an uncontrolled stop of the motor.
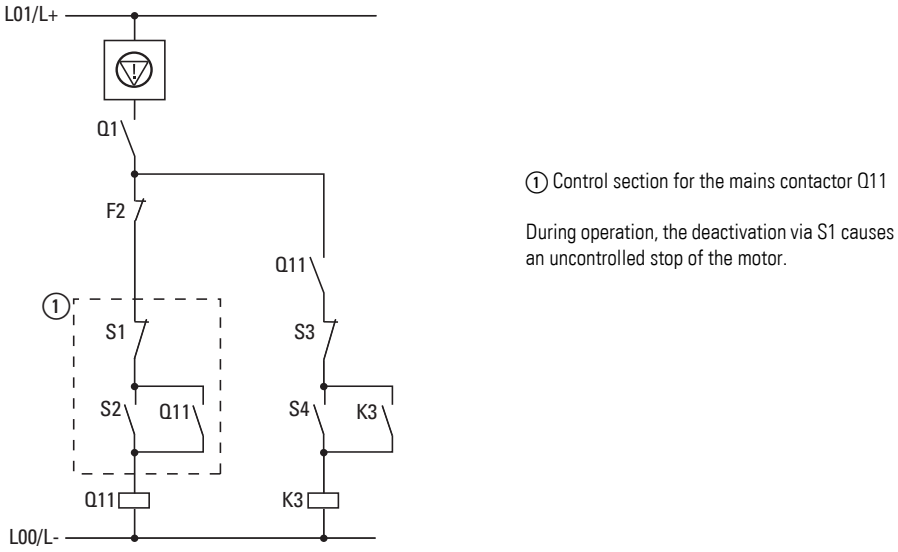
Figure 83:     Control section with mains contactor

## 7.1.4 Simple change of rotation



Q1 = Cable and motor protection

Q21 = Soft starter

Q31 = Reversing contactor

M1 = Motor
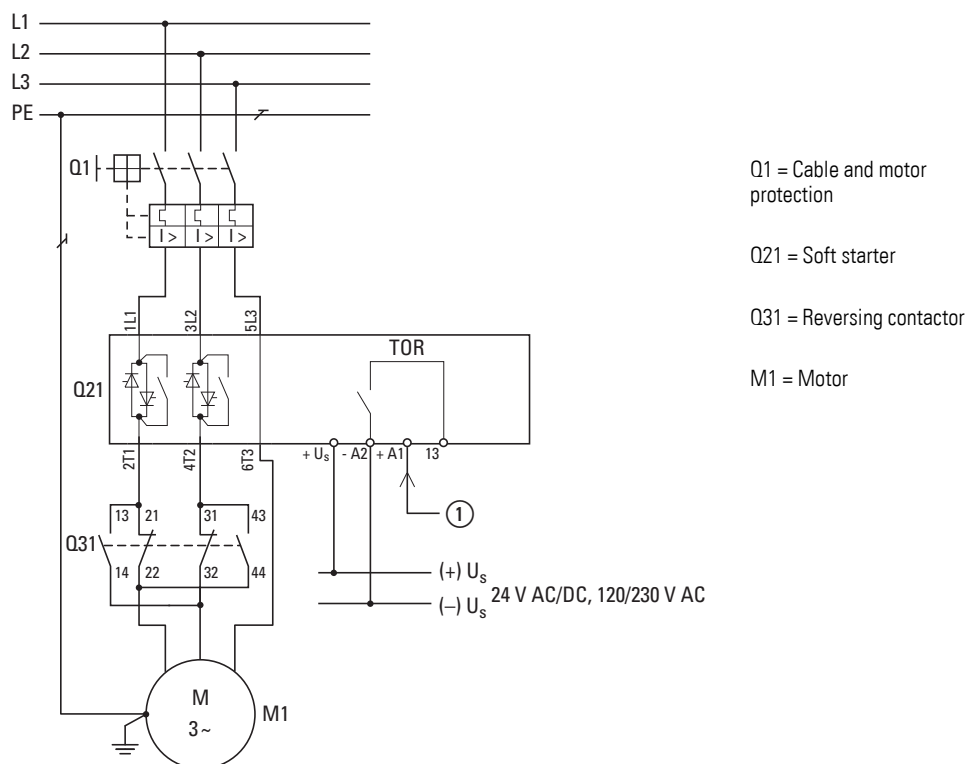
Figure 84:     Change of rotation

Example for accessories required:

S3 = M22-WRK… selector switch with three switch positions
Q31 = DILA-22(…) contactor + DILA… auxiliary contact module

When in the R position (FWD), S3 will use contact 23/24 to apply the enable signal ① to the DS7 soft starter (+A1 control signal terminal). The rotation is reversed with S3 via the zero position (off) to position L (REV).
The contactor Q31 is activated and switches the enable signal ① via the auxiliary contact 53/54 to the DS7 soft starter (control terminal +A1).



S3 = Rotation direction selection switch with three contactor states

L = REV (anticlockwise rotating field)
0 = Off
R = FWD (clockwise rotating field)
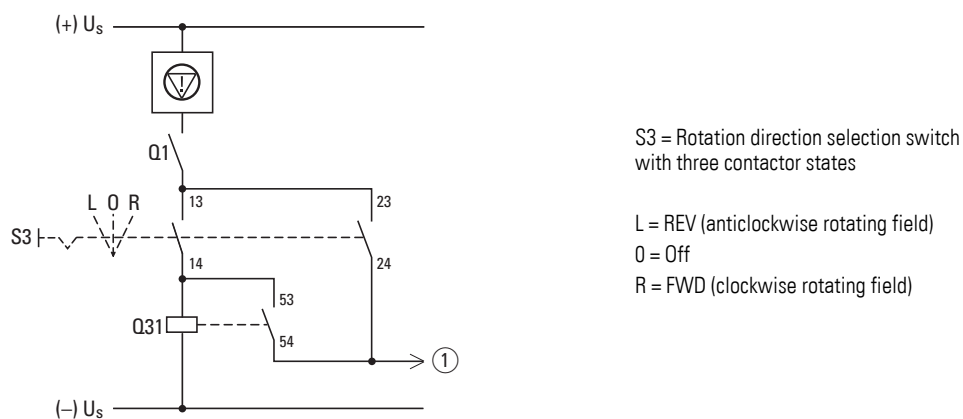
Figure 85:     Actuation of reversing contactor

## 7.1.5 Rotation direction reversal with soft stop ramp

Q1 = Cable and motor
protection

Q11 = mains contactor FWD
(clockwise rotating field)

Q12 = mains contactor REV
(anticlockwise rotating field)

F3 = optional semiconductor
fuse for type 2 coordination in
addition to Q1
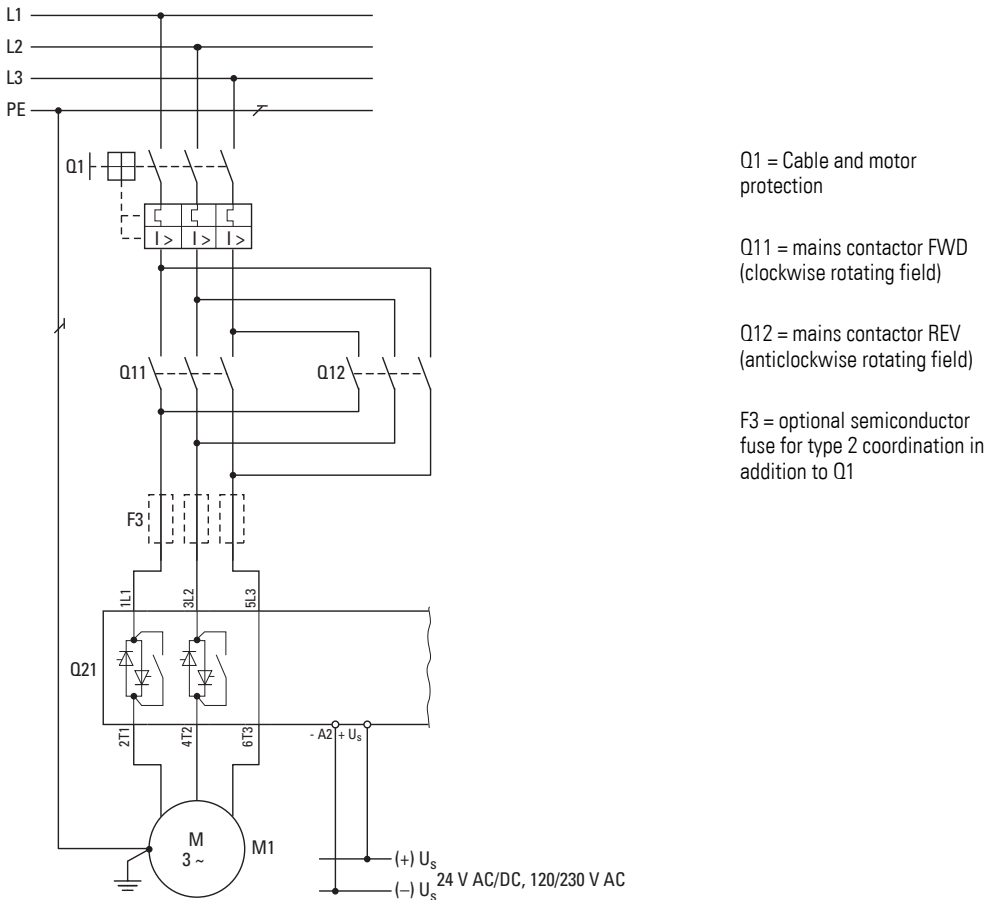
Figure 86:     Rotation direction reversal with ramp

K4T: Simulated RUN
signal -
K2T is an off-delayed
timing relay (type ETR2)
and simulates here the
RUN signal. The reset
time must be greater
than the stop time (t-
Stop) set on the soft
starter. Switching to the
other operating
direction is only
possible after the value
set here has elapsed.
The soft stop is also
active here after an
emergency-stop
command.
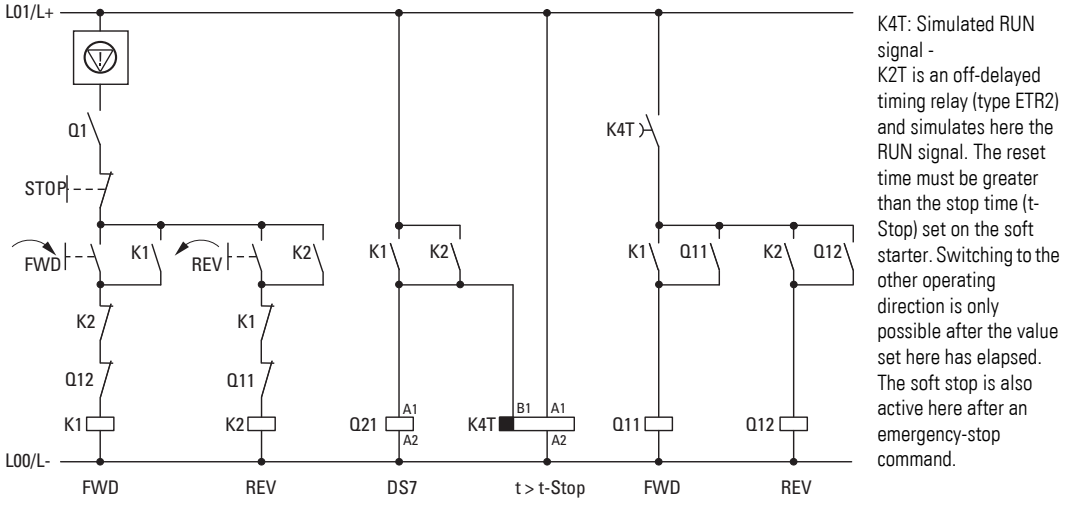
Figure 87:     Control section Bidirectional operation

➡ The control voltages (+U$_S$) of the DS7 soft starter and the contactor
control must have the same potential: 24 V DC/AC or 120/230 V AC

### 7.1.6 Reversing the direction of rotation with MSC-R



Q1 = Cable protection

Q11 = mains contactor FWD
(clockwise rotating field)

Q12 = mains contactor REV
(anticlockwise rotating field)

MSC-R… = reversing motor starter
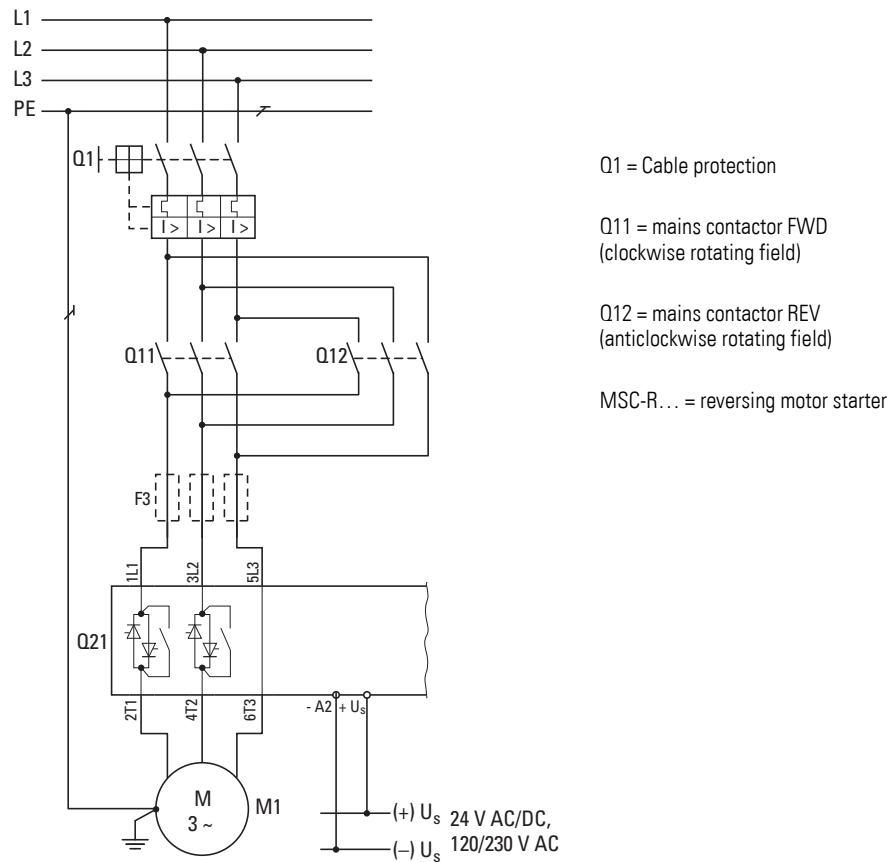
Figure 88: Rotation direction reversal without ramp



① Assembled control station

② Reversing starter

③ Standard auxiliary contact
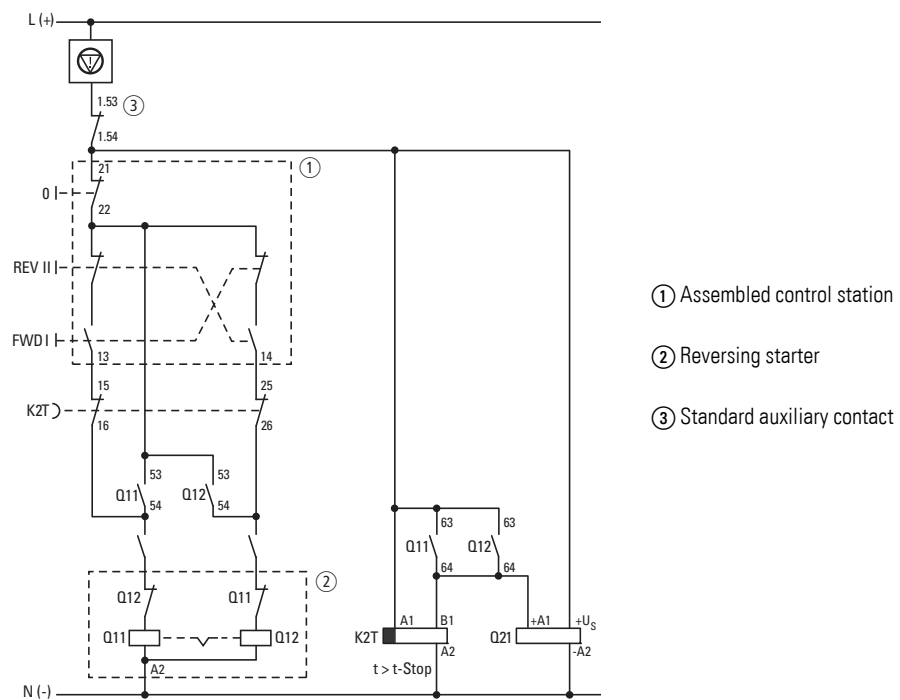
Figure 89: Control section bidirectional operation with ramp

➡ The control voltages (+U$_S$) of the DS7 soft starter and the contactor control must have the same potential: 24 V DC/AC or 120/230 V AC
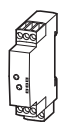
Q1, Q11, Q12 = MSC-R motor starter combination is a compact device with electrical and mechanical interlocking. The NHI-E-10-PKZ0 auxiliary contact ③ is added to Q1 for cable and motor protection.
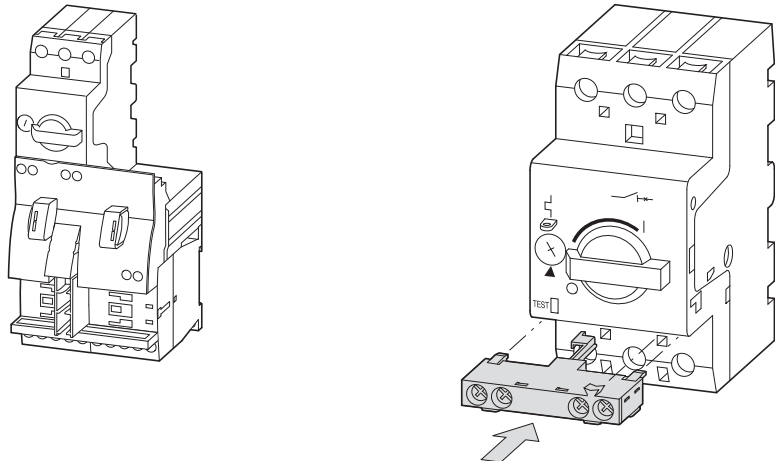


② Reversing starter MSC-R…

③ Standard auxiliary contact (grey) NHI-E-10-PKZ0

Two DILA-XHI20 auxiliary contact modules are added to the reversing contactors Q11 and Q12. The 53/54 NO contact is used for the self-maintaining of Q11 and Q12; NO contact 63/64 actuates the timing relay K2T and the soft starter Q21. The pushbutton actuators 0, I, II as a complete device (M22-I3-M1) for surface mounting ① enable the rotation direction change.



① Contact sequence
M22-I3-M1 assembled control station
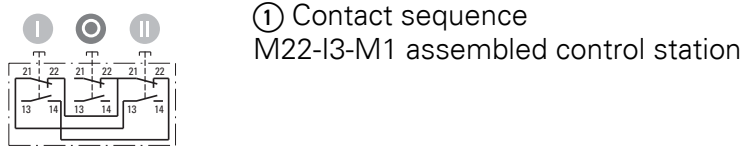
K4T is an off-delayed timing relay (part no. ETR2) and simulates here the RUN signal. The reset time must be greater than the stop time (t-Stop) set on the DS7 soft starter. Switching to the other operating direction is only possible after the value set here has elapsed. The soft stop is also active here after an emergency-stop command.



A1-A2
B1  t > t-Stop
15-16 / 25-26
Power LED (grün)
Relais LED (gelb)
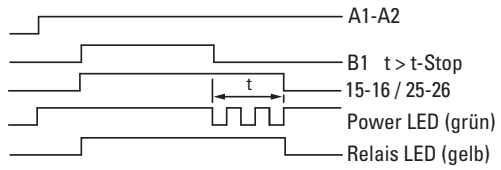
### 7.1.7 Connection for ac motor



Figure 90:    AC motor in Steinmetz circuit
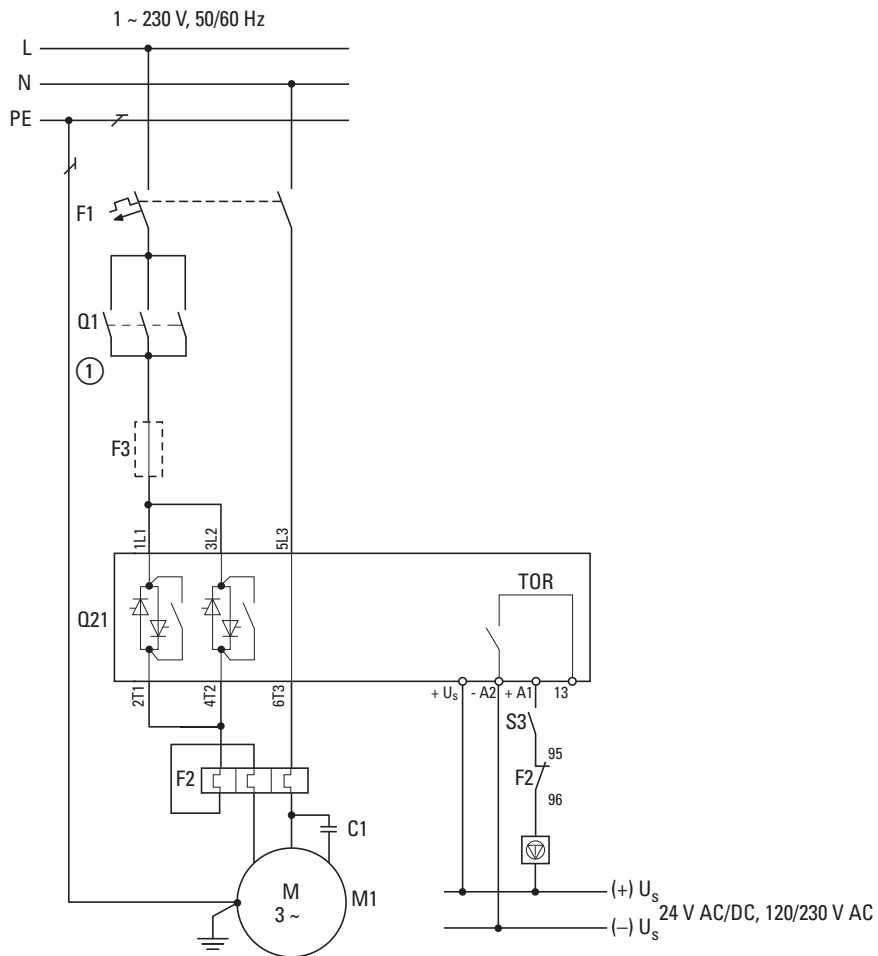
C1 = Startup and operating capacitor

F1 = Cable and short-circuit protective device (FA2-B…/1N)

F2 = Overload relay

F3 = optional semiconductor fuse for type 2 coordination, in addition to F1

Q1 = mains contactor (optional) (example for ①: DILM7 + DILM12-XP1)

Q21 = Soft starter

S3 = Start/stop-switch

## 7.2 Size 2 (16 – 32 A)

### 7.2.1 Connection without soft stop ramp
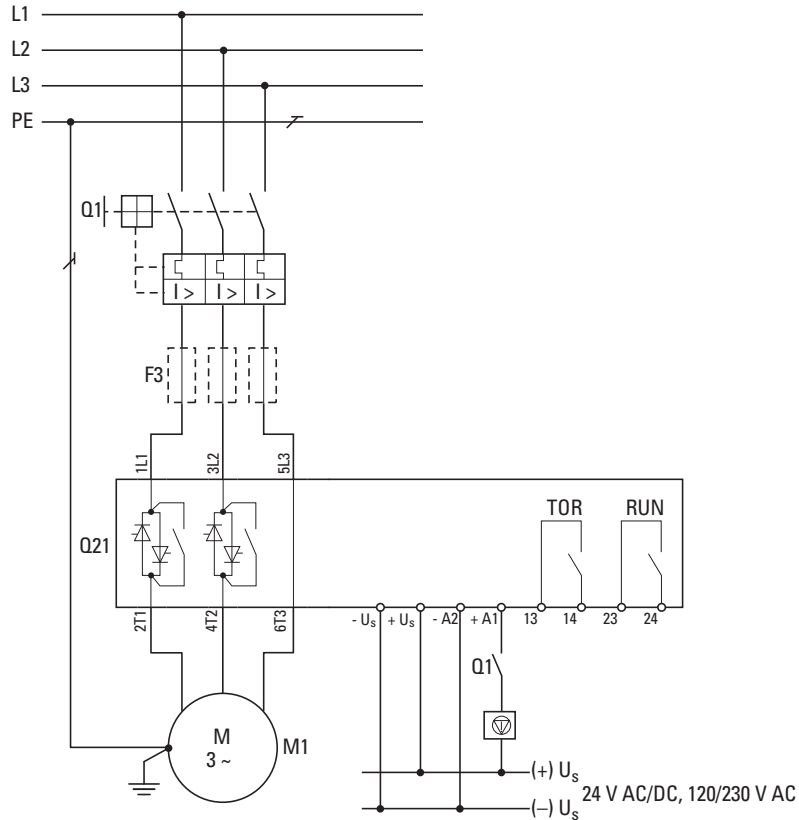
**Direct motor start**

Q1 = Cable and motor protection

Start enable (+A1) uncontrolled stop of the motor on deactivation

F3 = optional semiconductor fuse for type of coordination 2

Figure 91: Standard connection without soft stop
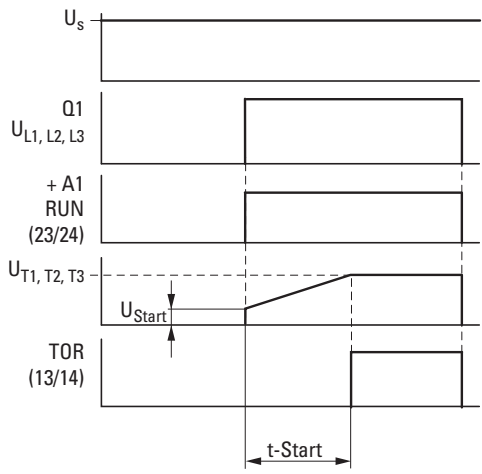
Figure 92: Flow diagram – without soft stop

### 7.2.2 Connection with soft stop ramp
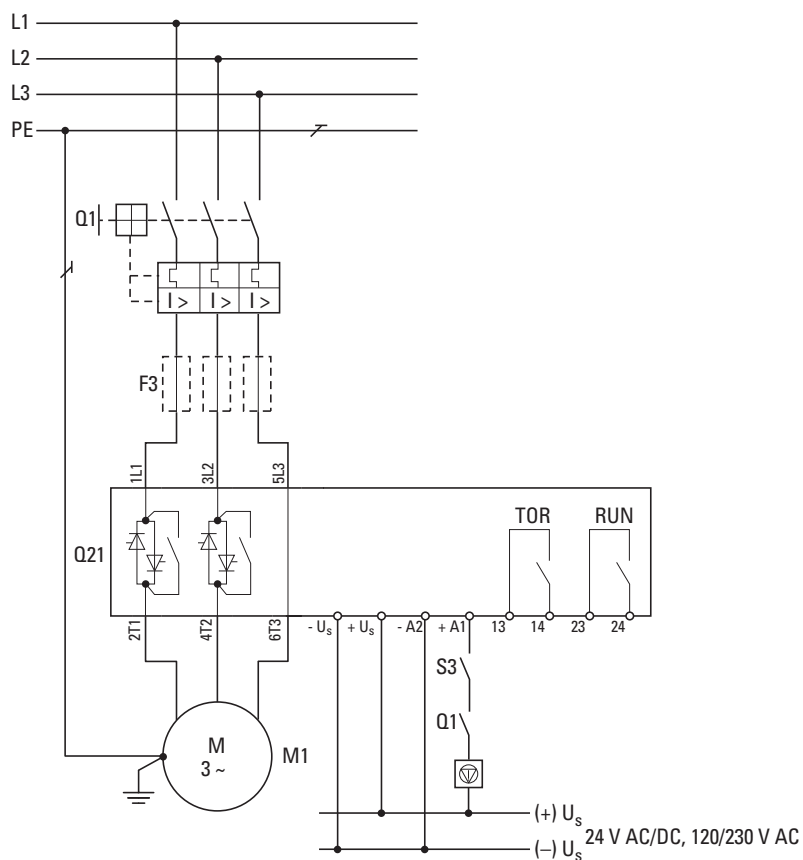


**Start/stop operation**

Q1 = Cable and motor protection

Start enable (+A1) uncontrolled stop of the motor on deactivation

F3 = optional semiconductor fuse for type of coordination 2

S3: Start/stop

Figure 93:    Standard connection with soft stop
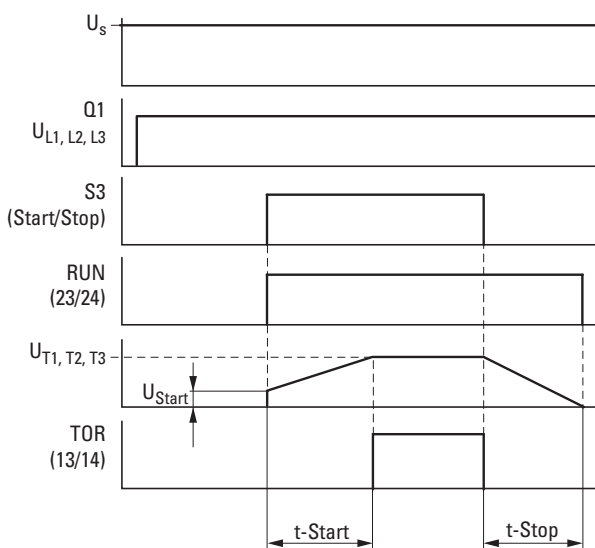


Figure 94:    Flow diagram – with soft stop

### 7.2.3 Standard connection with upstream mains contactor and soft stop ramp
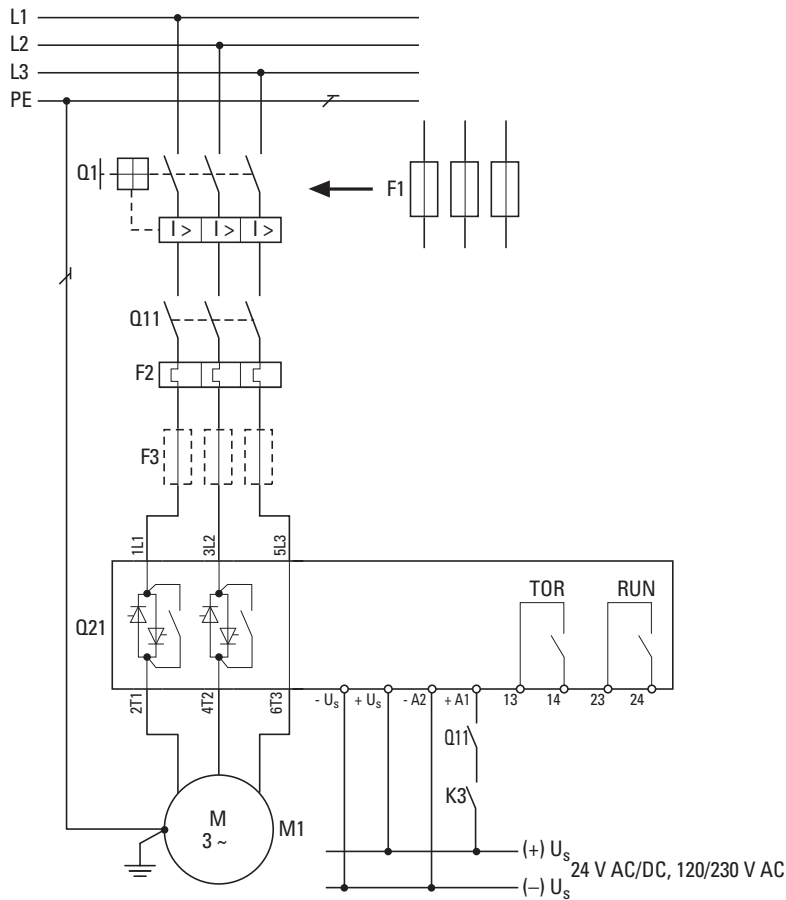
**Start/stop operation**

Q1, F1 = Cable and motor protection

Q11 = Mains contactor

F2 = motor protection

F3 = Optional semiconductor fuse for type 2 coordination , in addition to Q1 or F1

Setting: t-Stop > 0

Figure 95:    Standard connection with soft stop
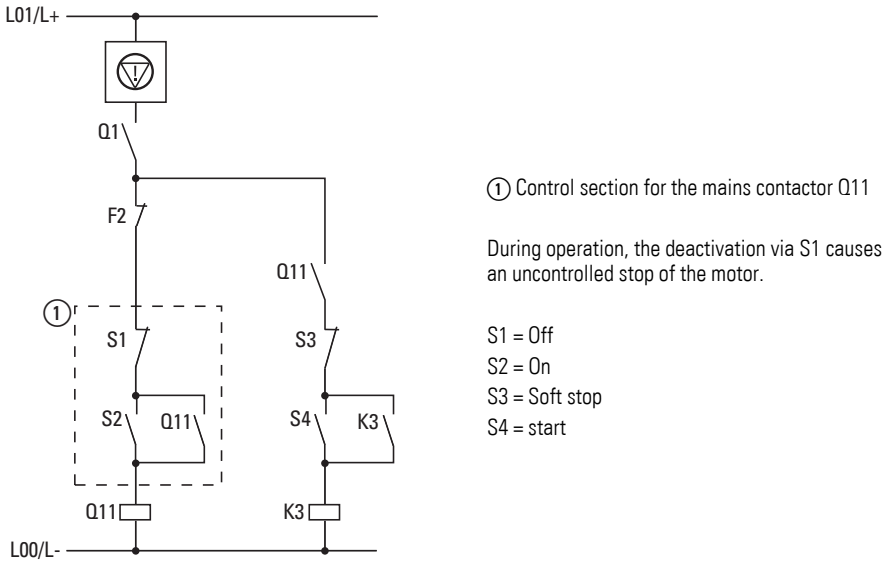
① Control section for the mains contactor Q11

During operation, the deactivation via S1 causes an uncontrolled stop of the motor.

S1 = Off
S2 = On
S3 = Soft stop
S4 = start

Figure 96:    Control section with mains contactor

### 7.2.4 Rotation direction reversal with soft stop ramp
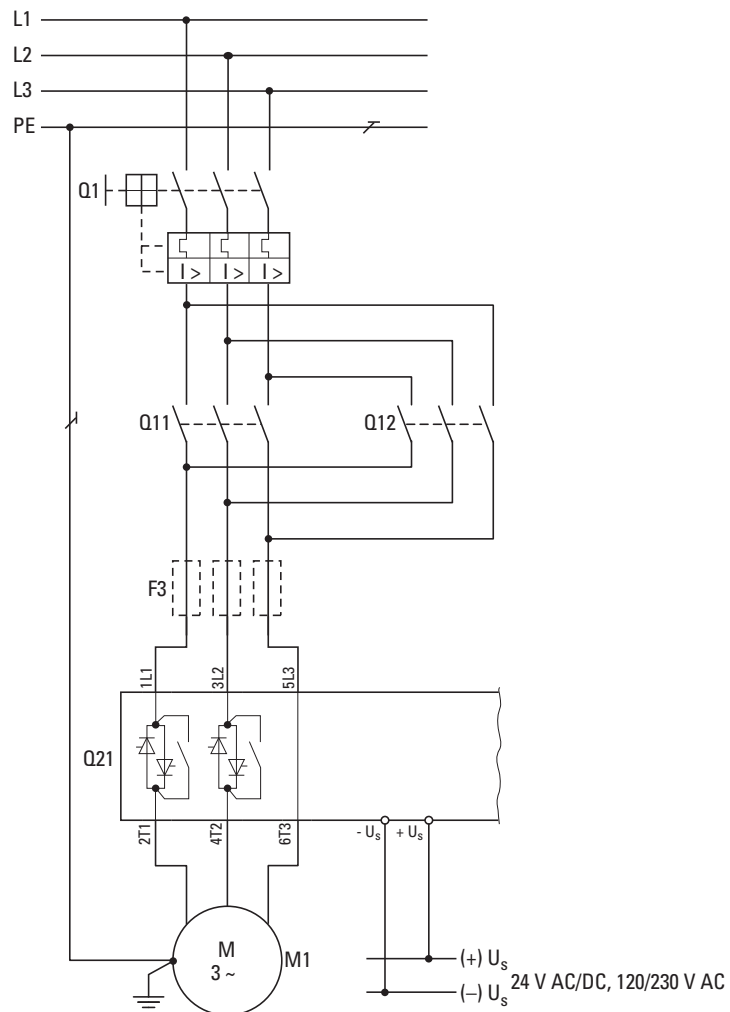


Figure 97:    Rotation direction reversal with ramp

Q1 = Cable and motor protection

Q11 = mains contactor FWD (clockwise rotating field)

Q12 = mains contactor REV (anticlockwise rotating field)

F3 = optional semiconductor fuse for type 2 coordination in addition to Q1
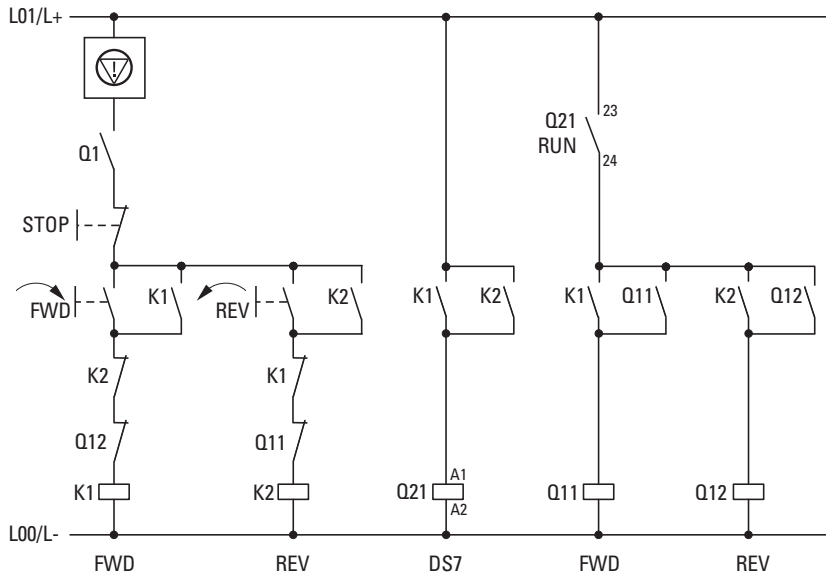
Figure 98: Control section bidirectional operation

The RUN relay (Q21:23/24) only enables the rotation direction change (phase change) after the soft stop time (t-Stop) has elapsed.

The soft stop is also active here after an emergency-stop command.

## 7.3 Size 3 and 4 (41 – 200 A)

### 7.3.1 Connection without soft start ramp
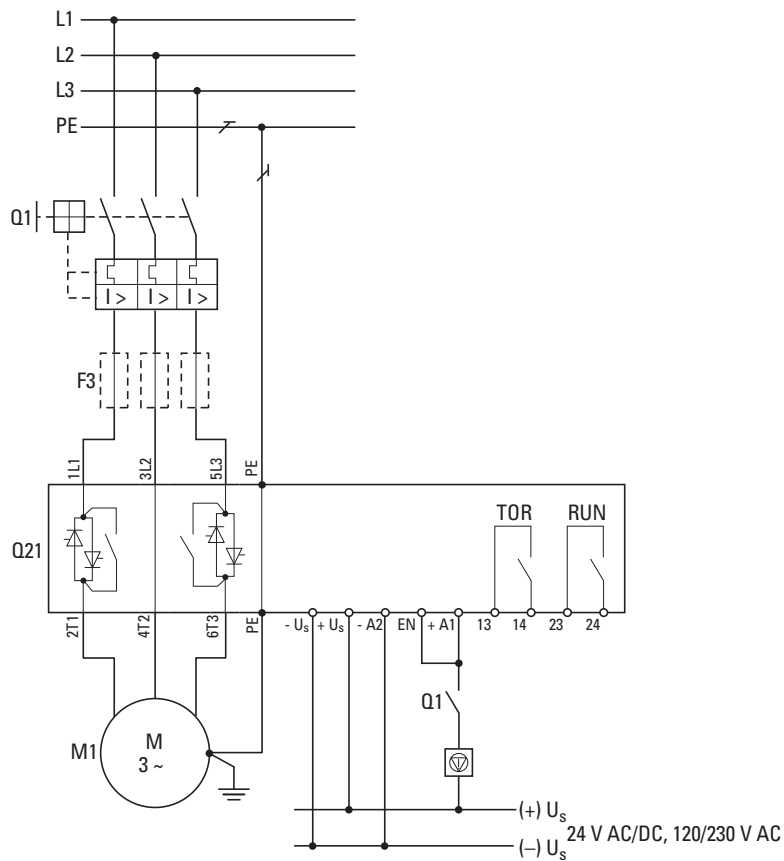


**Direct motor start**

Q1 = Cable and motor protection

Q21 = Soft starter

Start enable (+A1) uncontrolled stop of the motor on deactivation

F3 = optional semiconductor fuse for type of coordination 2

M1 = Motor

Figure 99:    Standard connection without soft stop
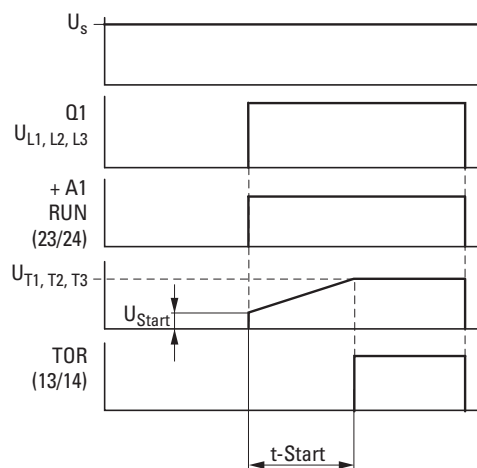


Figure 100:  Flow diagram – without soft stop

## 7.3.2 Connection with soft start ramp
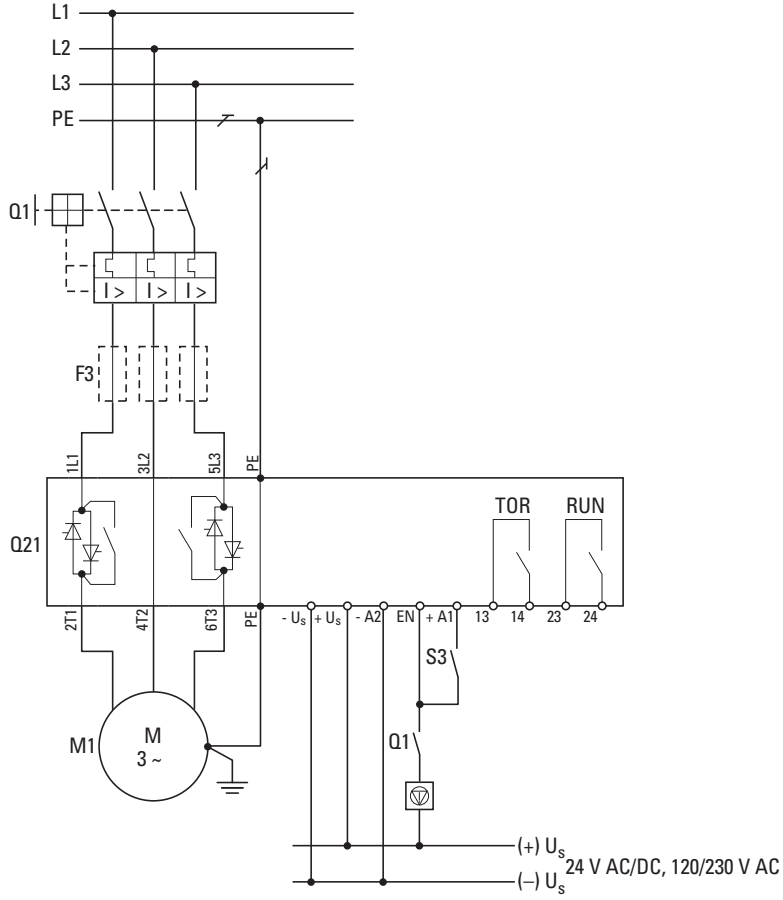


**Start/stop operation**

Q1 = Cable and motor protection

Start enable (+A1) uncontrolled stop of the motor on deactivation

F3 = optional semiconductor fuse for type of coordination 2

S3: Start/stop

Figure 101:   Standard connection with Soft stop
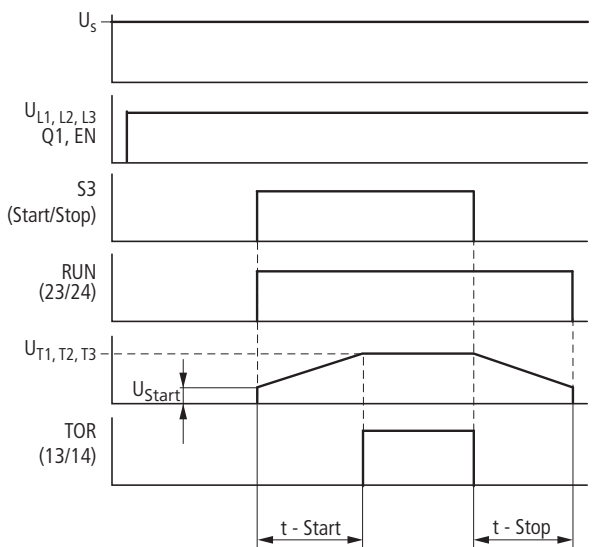


Figure 102:   Flow diagram – with soft stop

### 7.3.3 Standard connection with upstream mains contactor and soft stop ramp



Q1; F1: cable protection

F2: motor protection

F3 = optional semi-conductor fuse for type 2 coordination in addition to (optional) Q1

K1: Controller enable

K3: Start/stop

Q11: Mains On/Off

Q21: Soft starters
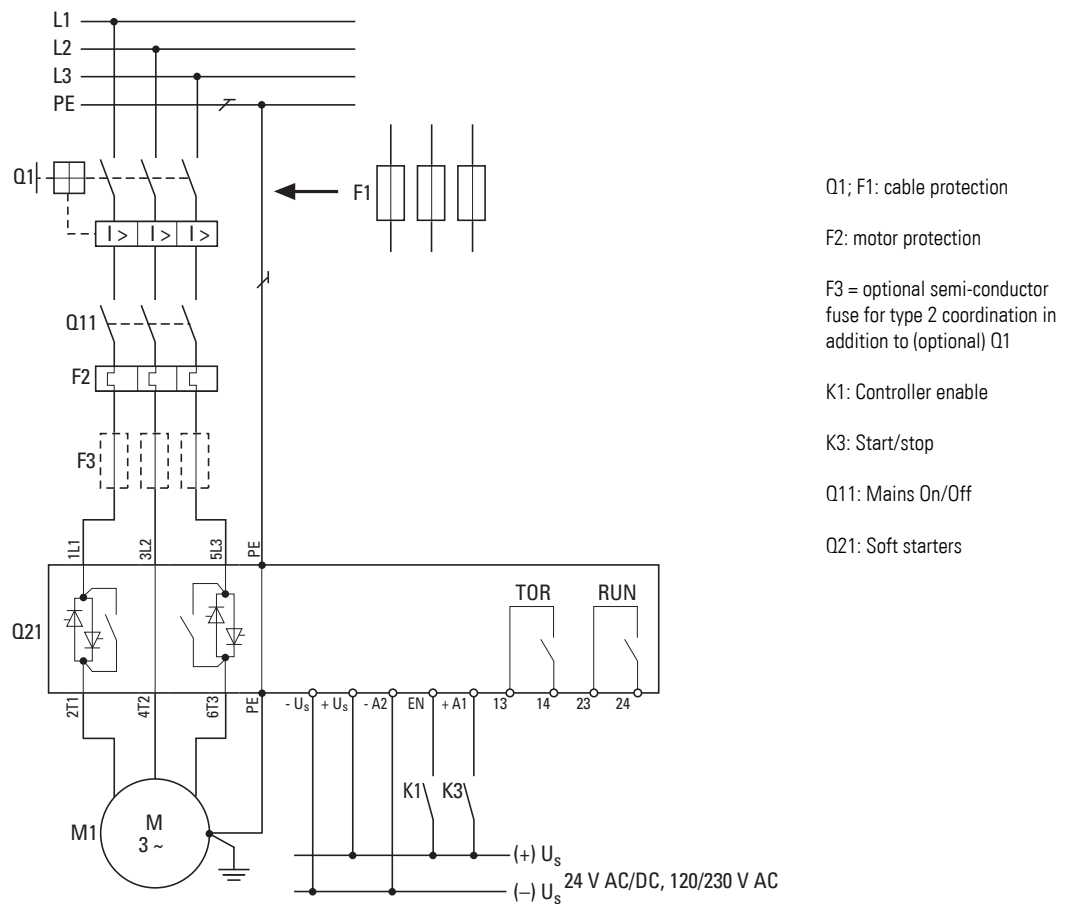
Figure 103: Standard connection with mains contactor



① Control section for the mains contactor Q11

During operation, the deactivation via S1 causes an uncontrolled stop of the motor.
The RUN relay (Q21:23/24) monitors the switching operation (no undefined operating state).

S1 = Off
S2 = On
S3 = Soft stop
S4 = start
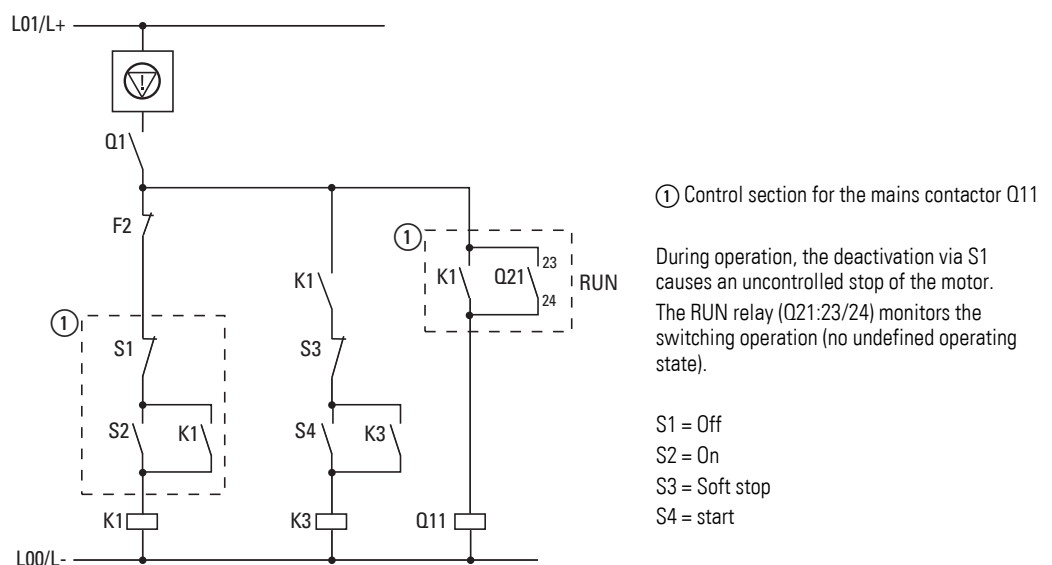
Figure 104: Control section with mains contactor

## 7.3.4 Rotation direction reversal with soft stop ramp
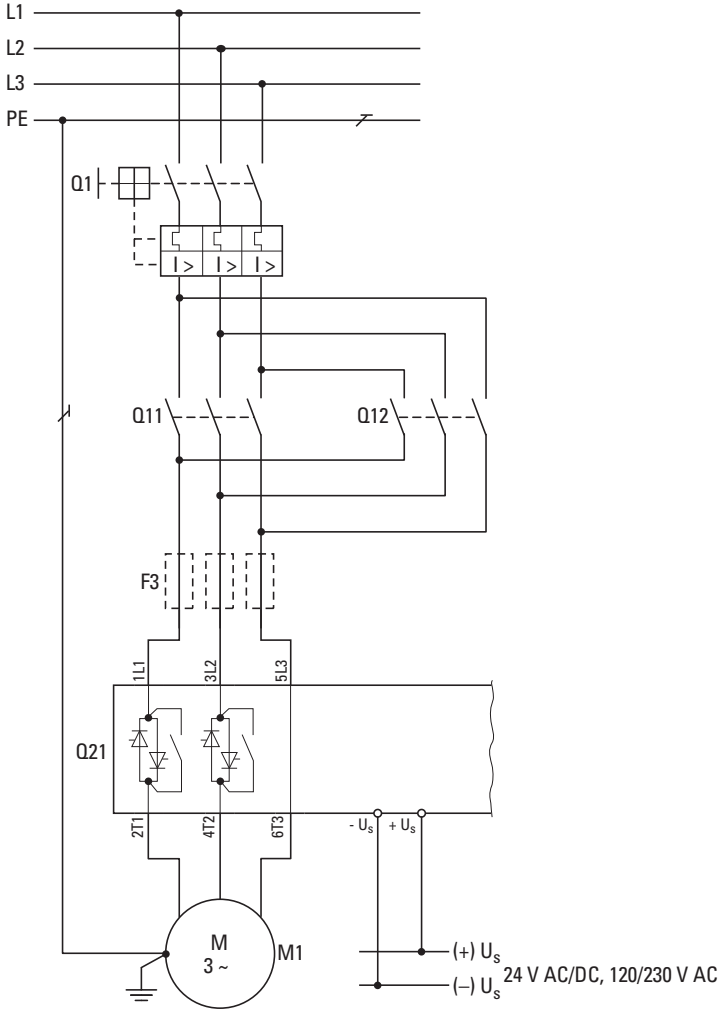


Q1 = Cable and motor protection

Q11 = mains contactor FWD (clockwise rotating field)

Q12 = mains contactor REV (anticlockwise rotating field)

F3 - Optional semiconductor fuse for type 2 coordination, in addition to Q1

Figure 105:  Rotation direction reversal with ramp
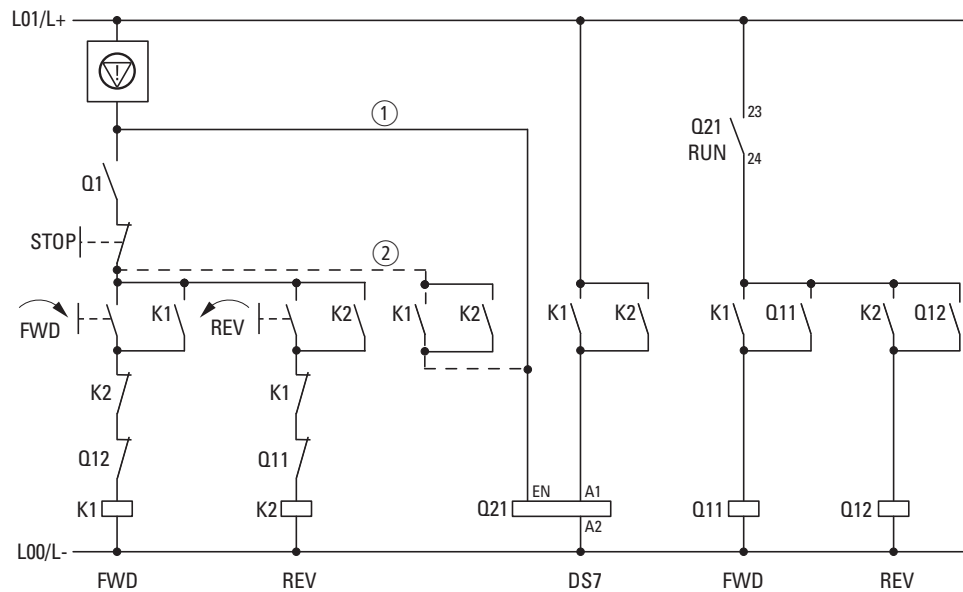
Figure 106: Control section bidirectional operation

Terminal models:

① with Soft stop

② without Soft stop

The RUN relay (Q21:23/24) only enables the rotation direction change (phase change) after the soft stop time (t-Stop) has elapsed.

The soft stop is also active here after an emergency-stop command.

## 7.3.5 Compact motor starter with maintenance switch
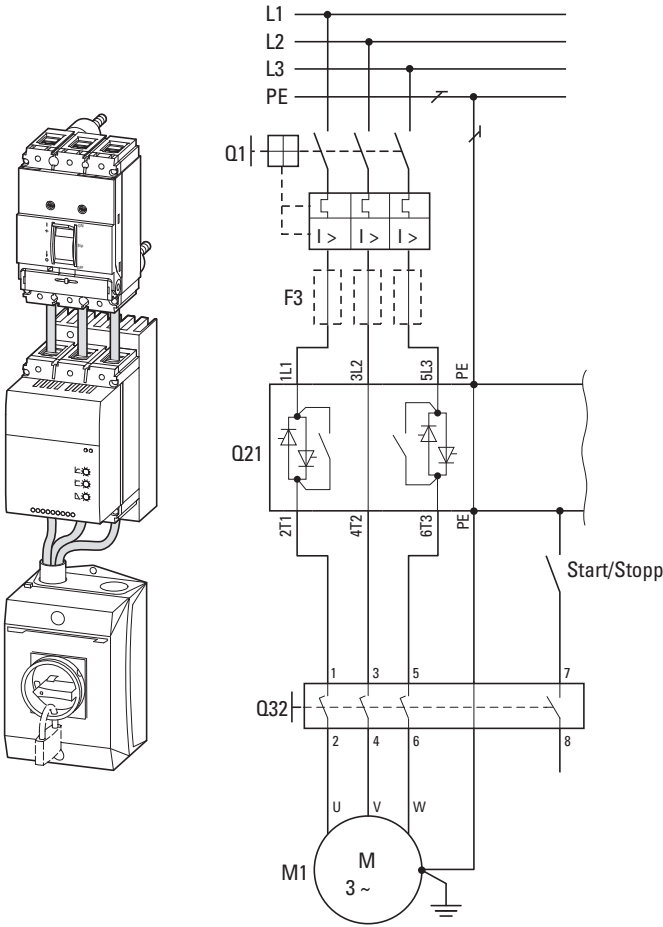


**DS7 soft starter, NZM circuit-breaker and P3 maintenance switch**

Q1 = Cable and motor protection

Q21 = DS7 soft starter

Q32 = Maintenance switch (local)

F3 = optional semiconductor fuse for type 2 coordination (in addition to Q1)

M1 = Three-phase motor

Figure 107: Motor starter with repair/maintenance switch

### 7.3.6 DS7 soft starter and NZM circuit-breaker with emergency-stop function to IEC/EN 60204 and VDE 0113 Part 1



3 AC, 230 V:
NZM1-XUHIV208-240AC
NZM2/3-XUHIV209-240AC
3 AC, 400 V:
NZM1-XUHIV380-440AC
NZM2/3-XUHIV380-440AC

⊙ = EMERGENCY SWITCHING OFF

Q1 = Cable and motor protection
(NZM1, NZM2)

Q21 = DS7 soft starter

M1 = Motor

F3 = superfast semiconductor fuse, optional
for type 2 coordination (in addition to Q1)

① control circuit terminal

② Undervoltage release with early-make
auxiliary contact

Figure 108:  Soft starter with emergency-stop function

## 7.3.7 Bypass circuit for emergency operation

→ Devices of the DS7-34… series are equipped with integrated bypass contacts. External bypass contacts are therefore not required for standard operation.

In pump applications the bypass circuit is often required to provide emergency operation capability. A service switch (key switch) is used to select the bypass circuit between soft starter operation and DOL starter operation. This is used to fully isolate the soft starter.

In this case, it is important that the output circuit is not opened during operation. The interlocks in the controller ensure that a switchover is only possible after a stop.

→ Unlike the simple bypass operation, in this case the bypass contactor must be designed in accordance with utilization category AC-3. For a suitable contactor, see our recommended mains contactor in the Appendix (→ page 221).
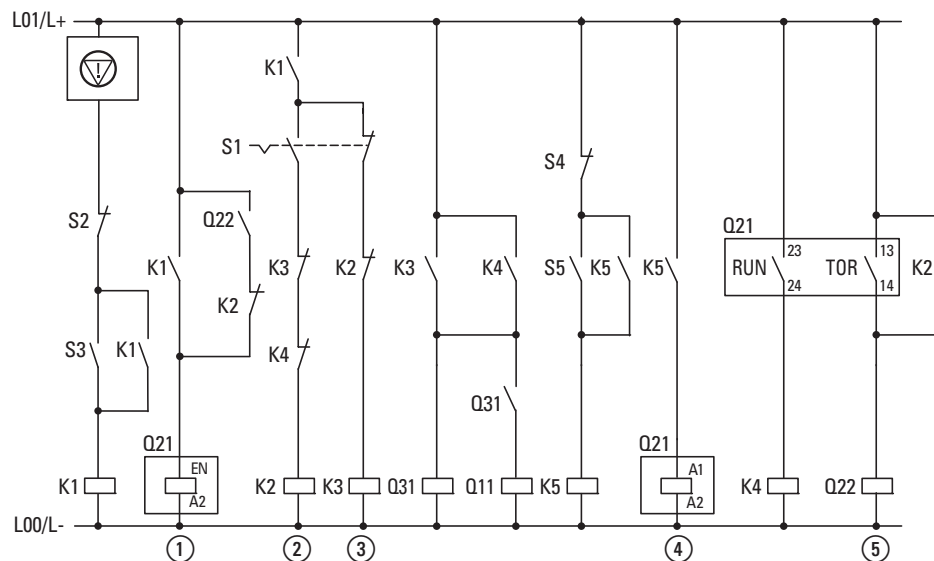
Figure 109: Actuation with bypass emergency operation – pump operation

① Enable
② Automatic operation (soft starter)
③ Manual/bypass operation
④ Soft starter/Soft stop
⑤ Bypass contactor

S1 = Operating mode selector switches
S2 = Off
S3 = On
S4 = Stop (Soft starter)
S5 = Start (Soft starter)

The electrical and/or mechanical interlocking of contactors Q22 and Q31 ensures safe operating states.

# 7 Connection examples

## 7.3 Size 3 and 4 (41 − 200 A)



Q1 = Cable and motor protection

Q11 = Mains contactor

Q21 = Soft starter

Q31 = Motor contactor

Q22 = Bypass contactor/Emergency operation protection

F2 = superfast semiconductor fuse for type of coordination 2 (optional), in addition to Q1

M1 = Motor
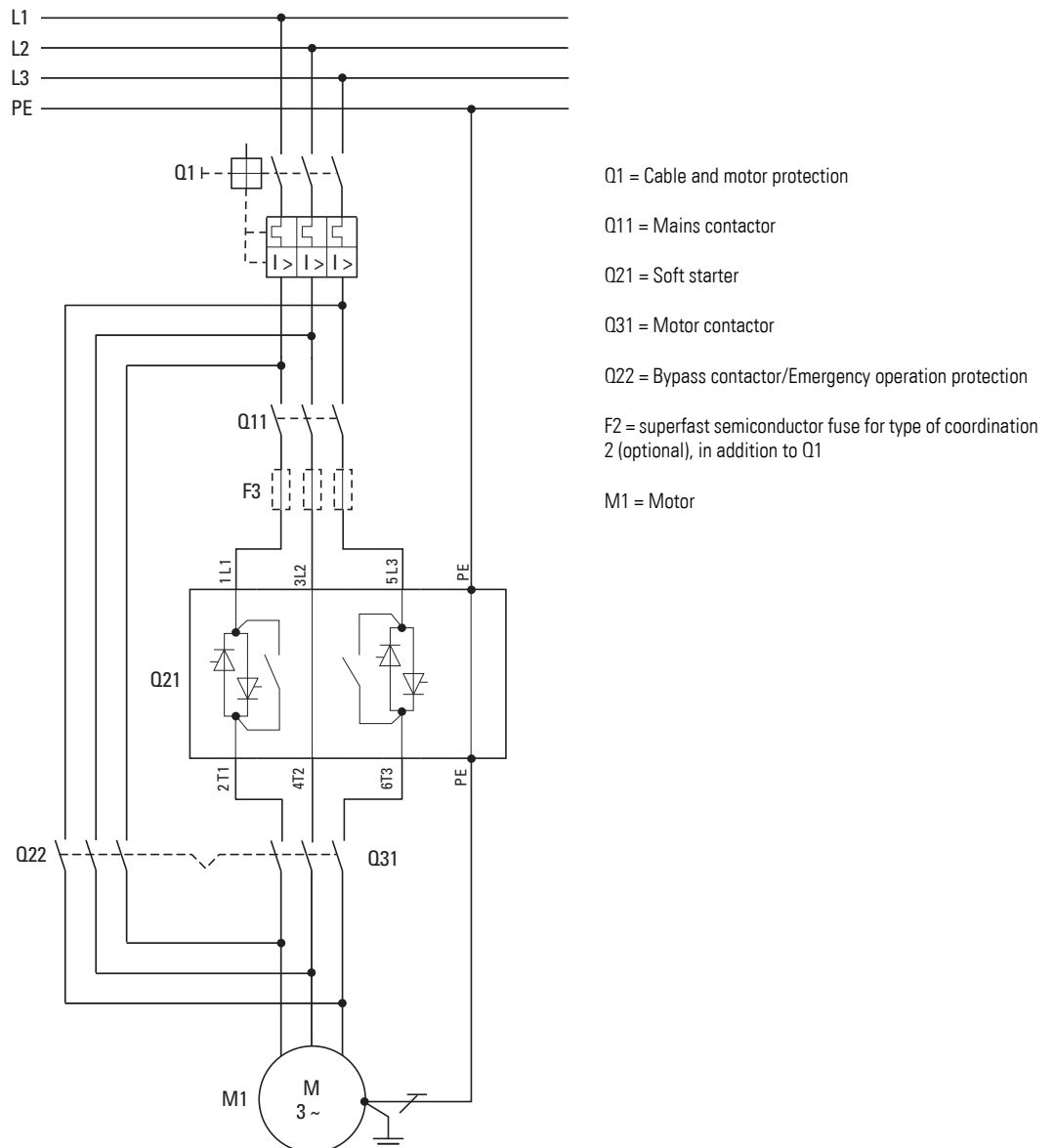
Figure 110: Power section with bypass emergency operation – (pump operation)

→ The control system shown here can also be used for the DS7 soft starters in size 2 (16 - 32 A).

### 7.3.8 Starting several motors sequentially with a soft starter

If you will be starting several motors one after the other with a single soft starter, make sure to follow the changeover sequence below:

▶1. Start using soft starter
▶2. Switch on bypass contactor Qn2 via TOR
▶3. Disable soft starter
▶4. Switch soft starter output with Qn1 to the next motor
▶5. Restart

➜ When starting several motors with one soft starter the thermal load of the soft starter (starting frequency, current load) must be taken into account.
If the starts occur closely in succession, the soft starter must be dimensioned larger (i.e. the soft starter must be designed with an accordingly higher load cycle).

➜ Due to the thermal design of the DS7 soft starters, we recommend the use of an (optional) fan when using a DS7 series device for starting several motors.

# 7 Connection examples

## 7.3 Size 3 and 4 (41 − 200 A)
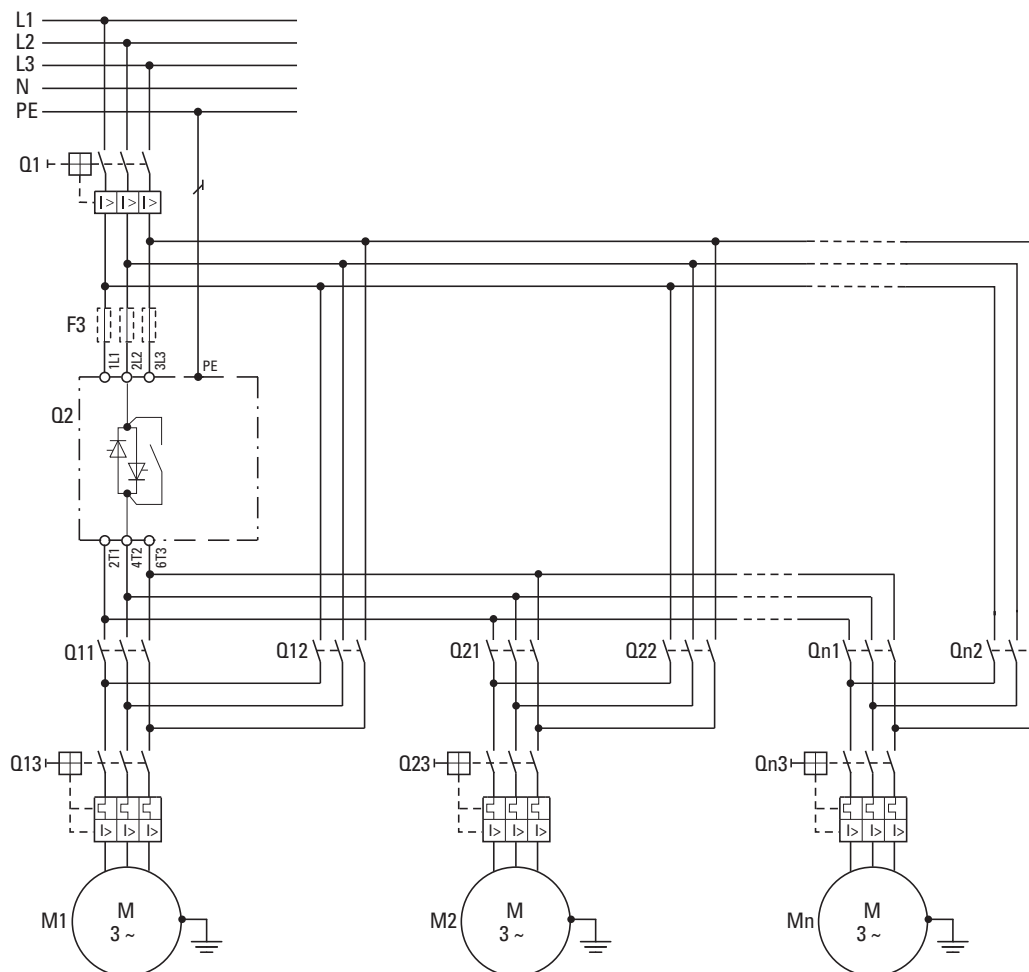


Figure 111: Power section, motor cascade

F3 = Superfast semiconductor fuse for type 2 coordination, in addition to Q1 (optional)
Q1 = cable protection through circuit-breaker or fuse (F1)
Q2 = Soft starter DS7
Qn1 = Contactor (1, 2, n)
Qn2 = Supply bypass contactor for motor (1, 2, n)
Qn3 = Motor protection (motor-protective circuit-breaker
or current transformer-operated overload relay)
Mn = Motor (1, 2, n)

→ The control system shown here can also be used for the DS7 soft starters in size 2 (16 to 32 A).

→ The "thermal motor protection" (Q13, Q23, Qn3) can also be ensured with current transformer-operated overload relays (see → section 2.11.7, "Parallel motor connection", page 46).
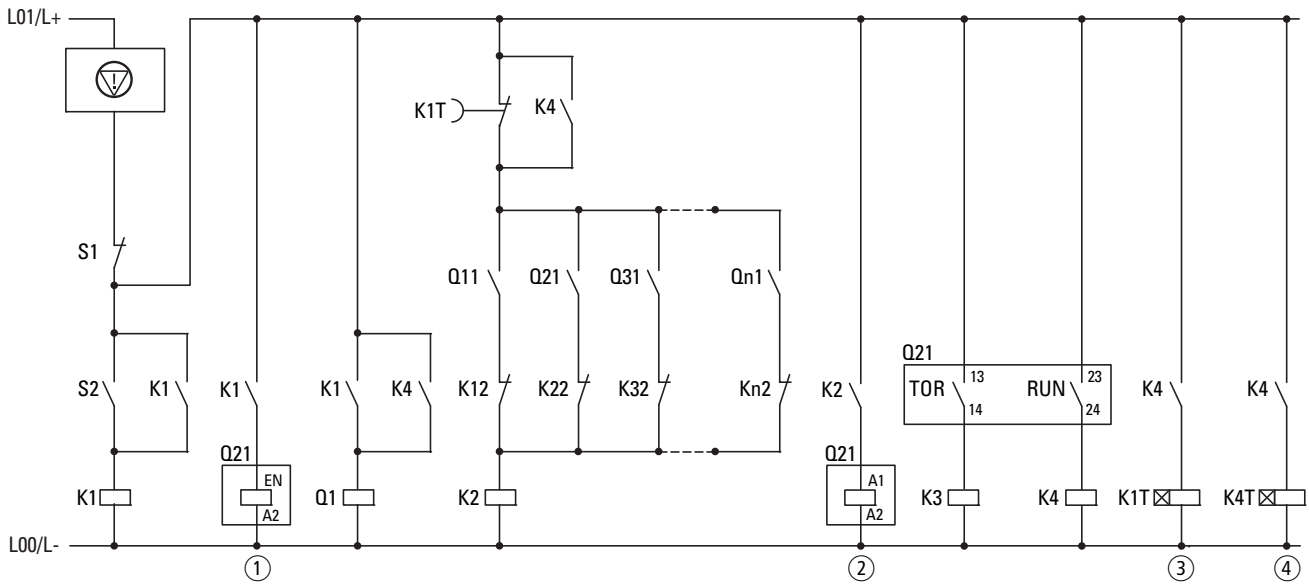
Figure 112: Actuation, motor cascade, part 1

① Enable

② Soft starter/Soft stop

③ Starting frequency monitoring.
   Set the timing relay so that the soft starter is not thermally overloaded.
   The appropriate time relates to the admissible operating frequency of the selected soft starter.
   Otherwise select the soft starter so that the required times are achievable.

④ Set the timing relay to 2 s off-delay. This ensures that the next motor branch is not connected when a soft starter is running.
N/C contact S1 switches all motors off at the same time.
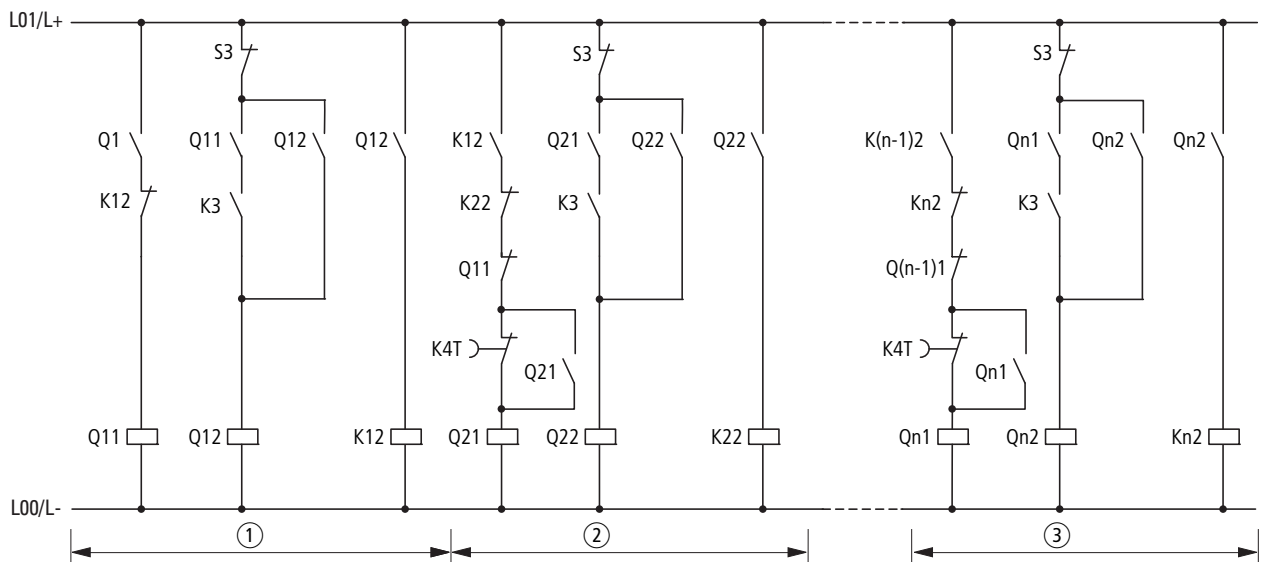


Figure 113: Actuation, motor cascade, part 2

① Motor 1

② Motor 2

③ Motor n

The N/C contact S3 is required if motors also have to be switched off individually.

# 7 Connection examples
## 7.3 Size 3 and 4 (41 − 200 A)

# 8 SmartWire-DT

## 8.1 Introduction

The SmartWire-DT connection system is an intelligent system and makes possible the reliable and easy connection of switching devices, pilot devices and I/O components with overriding bus systems. The components that are connected with the SmartWire-DT system are linked, e.g. to PROFIBUS-DP or CANopen communication networks via gateways using SmartWire-DT masters.

With the SmartWire-DT system up to 99 modules can be connected to form a network. Modules can include SmartWire-DT I/O modules or SmartWire-DT modules for contactors or pilot devices. The electrical connection is effected via a special 8-pole connecting lead and the relevant plugs.

Soft starters with part no. DS7-34**D**…-D… (abbreviated as "DS7-SWD" here) are capable of being connected to a SmartWire-DT system and to a higher-level PLC as a result. These soft starters can be controlled and monitored via SmartWire-DT, and their parameters can be configured via SmartWire-DT as well.

Depending on the specific model and field of application, DS7-SWD soft starters can be combined and operated together with an NZM circuit-breaker, a PKZ motor-protective circuit-breaker, or a PKE electronic motor-protective circuit-breaker as a safety device. In addition, it is possible to connect a PKE motor-protective circuit-breaker to SmartWire-DT via a DS7-SWD soft starter and to read its information this way as well. For this purpose, the PKE motor-protective circuit-breaker features an electronic trip block with its own communication module.

➜ This chapter uses the original English terms that appear throughout a variety of specifications (e.g., SmartWire-DT, PROFIdrive) ➜ section 8.4, "Abbreviations".

## 8.2 Profiles for DS7-SWD

Table 24: Profiles for DS7-SWD soft starters

| Profile | Name | Description |
|---|---|---|
| 1 | DS7-SWD PKE1 | PKE profile 1, start/stop bit for DS7 |
| 2 | DS7-SWD PKE2 | PKE profile 2, start/stop bit for DS7 |
| 3 | DS7-SWD PKE3 | PKE profile 3, start/stop bit for DS7 |
| 4 | DS7-SWD PKE1-8Bit | PKE profile 1, control data for the DS7 in one extra byte (command) at the end of the frame |
| 5 | DS7-SWD PKE2-8Bit | PKE profile 2, control data for the DS7 in one extra byte (command) at the end of the frame |
| 6 | DS7-SWD PKE3-8Bit | PKE profile 3, control data for the DS7 in one extra byte (command) at the end of the frame |
| 7 | DS7-SWD PKE1-PD 2x16Bit | PKE profile 1, control data for the DS7 in two extra words (one-word command, one-word analog value) at the end of the frame |
| 8 | DS7-SWD PKE2-PD 2x16Bit | PKE profile 2, control data for the DS7 in two extra words (one-word command, one-word analog value) at the end of the frame |
| 9 | DS7-SWD PKE3-PD 2x16Bit | PKE profile 3, control data for the DS7 in two extra words (one-word command, one-word analog value) at the end of the frame |
| 10 | DS7-SWD 8Bit | Control data for the DS7 in a single extra byte (command) without PKE |
| 11 | DS7-SWD PD 2x16Bit | Control data for the DS7 in two extra words (one-word command, one-word analog value) without PKE |

Acyclic data transfers to DS7-SWD soft starters are possible with all profiles as per the "Base Mode Parameter Access" profile.

## 8.3 1-0-A switch

Soft starters belonging to the DS7-SWD series feature a 1-0-A switch that can be used to manually switch the soft starter on and off.
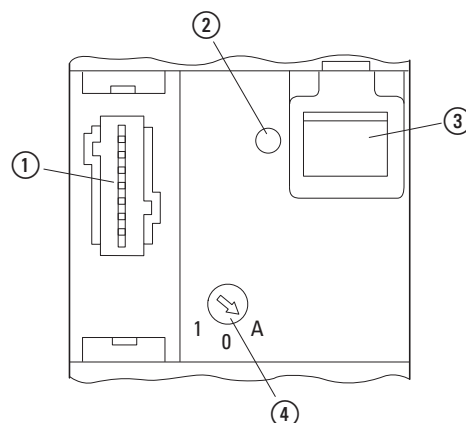


Figure 114:  Control section with mains contactor

① Connection for SmartWire-DT external device plug
② LED: SmartWire-DT diagnostic LED
③ Data interface for PKE32-COM
④ 1-0-A switch

The 1-0-A switch's positions are as follows:

- 1: DS7-SWD soft starter is switched on
- 0: DS7-SWD soft starter switched off
- A: switching command via SmartWire-DT

➡ The overload relay function (ZMR) will only be active in the 1-0-A switch's A position. The overload relay function will be disabled in positions 1 and 0.

## 8.4 Abbreviations

The following abbreviations are used throughout this chapter:

| Abbreviation | Meaning |
|---|---|
| ACKR | Acknowledge required |
| TH | Drive Object |
| EU5C-SWD-CAN | SmartWire-DT gateway for connecting to a CANopen master |
| EU5C-SWD-DP | SmartWire-DT gateway for connecting to a PROFIBUS master |
| GSD | Device master data |
| ID | Identifier |
| PDU | Protocol Data Unit |
| PLC | Programmable Logic Controller |
| PNU | Parameter Number |
| PROFIBUS | Process Field Bus |
| RFG | Ramp function generator |
| PLC(S) | programmable logic controller |
| SmartWire-DT | SmartWire-DT |

## 8.5 SmartWire-DT response time

The DS7-SWD soft starter's response time on a SmartWire-DT system is about 150 ms. When there are two stations, the response time will increase by about 50 ms; when there are 50, by about 400 ms.

## 8.6 Interoperability

### 8.6.1 Gateways

The DS7-SWD soft starter's interoperability is guaranteed with the following SmartWire-DT gateway firmware versions (and higher):

Table 25: Firmware versions of SmartWire-DT gateways

| SmartWire-DT gateway | Firmware Version |
|---|---|
| EU5C-SWD-CAN | V 1.20 |
| EU5C-SWD-DP | V 1.20 |

→ The firmware of the SmartWire-DT gateway can be updated using the SWD-Assist program. This program, as well as the required firmware versions, can be downloaded for free on the Internet at:
http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/Kundensupport/index.htm
→ **Customer support** → **Download Center – Software**

### 8.6.2 Fieldbus description files

The DS7-SWD's interoperability is guaranteed with the following versions (and later versions) of the fieldbus description files for the corresponding gateway:

Table 26: Compatible DS7-SWD fieldbus description files

| SmartWire-DT gateway | Description file |
|---|---|
| EU5C-SWD-CAN | EU5C-SWD-CAN_V120.eds |
| EU5C-SWD-DP (Intel-based CPU) | Moed14.gsd |
| EU5C-SWD-DP (Motorola-based CPU) | Moeld14.gsd |

→ These and other fieldbus description files can be found on the Internet at:
http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/Kundensupport/index.htm
→ **Customer support** → **Download Center – Software**

### 8.6.3 SWD-Assist

The SWD-Assist program provides valuable support in the engineering of your SmartWire-DT topology. SWD-Assist is software that runs under operating systems Windows 2000 (SP 4), Windows XP, Windows Vista (32-bit) or Windows 7 and relieves you of the planning work required for an SWD topology. DS7-SWD soft starters can be used in SWD-Assist version V 1.60 and higher.

➜ The SWD-Assist software is available free of charge on the
Internet at:
http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/
Kundensupport/index.htm
**➜ Customer support ➜ Download Center – Software**

## 8.7 Part numbers

The following part numbers belonging to the DS7 series of soft starters are
capable of communicating with SmartWire-DT:

Table 27: DS7 part numbers for connecting
to SmartWire-DT

| Frame size | Part no. DS7… |
|---|---|
| 1 | DS7-34DSX004N0-D |
| | DS7-34DSX007N0-D |
| | DS7-34DSX009N0-D |
| | DS7-34DSX012N0-D |
| 2 | DS7-34DSX016N0-D |
| | DS7-34DSX024N0-D |
| | DS7-34DSX032N0-D |
| 3 | DS7-34DSX041N0-D |
| | DS7-34DSX055N0-D |
| | DS7-34DSX070N0-D |
| | DS7-34DSX081N0-D |
| | DS7-34DSX100N0-D |
| 4 | DS7-34DSX135N0-D |
| | DS7-34DSX160N0-D |
| | DS7-34DSX200N0-D |

## 8.8 Replacing soft starters

If you replace a DS7-SWD soft starter in a supply system, you will have to
press the configuration button after replacing it and switching on the voltage.
This ensures that the new soft starter is assigned a network address.

> ⚠ **DANGER**
>
> Before replacing a DS7-SWD soft starter, make sure to switch
> off the voltage and the entire SmartWire-DT system.

> *NOTICE*
>
> If a DS7-SWD soft starter is replaced, the order of SmartWire-DT
> modules must not be altered.

## 8.9 Programming

### 8.9.1 Introduction

Cyclic and acyclic data as well as diagnostic data can be transferred via the SmartWire-DT system. The number of cyclic data is variable and is defined with the aid of profiles.

DS7-SWD soft starters (with or without a PKE motor-protective circuit-breaker) are designed in such a way as to match the following profiles and meet the following standards:

- PROFIdrive profile
- the PKE profiles already implemented in the PKE-SWD-032 connection,
- The standard specified by SmartWire-DT.

The appropriate profile can be selected by the user.

### 8.9.2 State diagrams

The state diagrams used below correspond to PROFIdrive profile 4.1 and are adapted in line with the relevant profiles. The grey boxes in the figures represent the current state (S = State) with the help of the input bytes. The white boxes represent the transition conditions with the help of the relevant output byte bits. Dots are used to indicate priority levels. The more dots a transition has, the higher its priority.

Process data level (PNU 928.0)

- 0 (local): Control via control signal terminals and potentiometer.
  - Sizes 1 to 4: A1 control signal terminal corresponds to the EN_Set bit.
  - Sizes 1 and 2: Since there is no EN control signal terminal, there is an automatic transition from S3 to S4.
  - Sizes 3 and 4: EN control signal terminal corresponds to the EN_Op bit.

- 1 (network): Control via SmartWire-DT.

→ If the ZMR function is active, the EN_Op bit will be overwritten with a 0 in all profiles as long as there is an overload.
More information on the ZMR function
→ section 8.9.3, "Cyclic data", page 159.

→ For the available parameter numbers (PNU), see
→ section 8.9.5, "acyclic data", page 185.

Following are the state diagrams that depend on PNU 928.0 and on the selected profile. The images indicate the following states:

DS7 soft starter state

Command to DS7 soft starter

### 8.9.2.1 Local – State diagram for sizes 1 and 2

If a size 1 or 2 DS7-SWD soft starter is used with **PNU 928.0 = 0**, the state diagram shown below will apply. The transition from S3 to S4 is automatic.
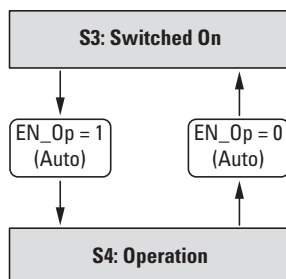


Figure 115: State diagram: Local (sizes 1 and 2)

### 8.9.2.2 Local – State diagram for sizes 3 and 4

If a size 3 or 4 DS7-SWD soft starter is used with **PNU 928.0 = 0**, the state diagram shown below will apply. The transition from S3 to S4 takes place when the EN control signal terminal is switched.
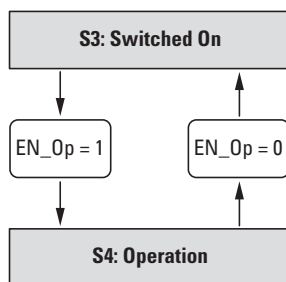


Figure 116: State diagram: Local (sizes 3 and 4)

### 8.9.2.3 Local – S4: Operation

If a DS7-SWD of any size is used with **PNU 928.0 = 0**, the state diagram shown below will apply. The transitions take place when the A1 control signal terminal is switched.
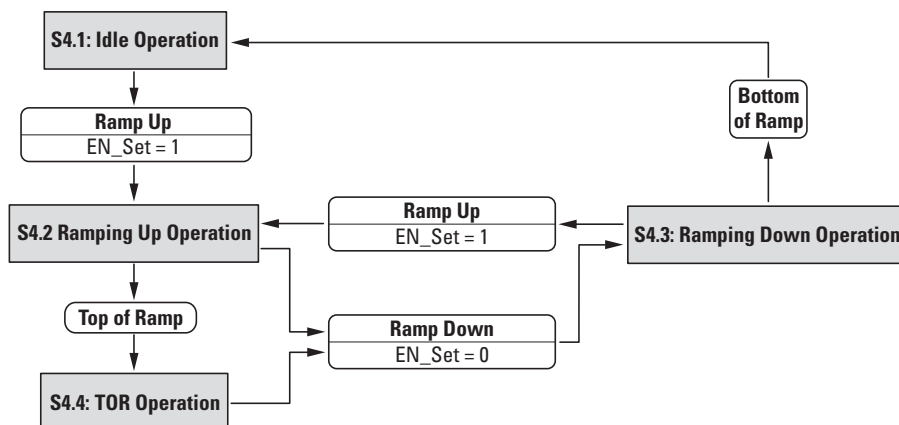


Figure 117: State diagram: Local – S4

### 8.9.2.4 Network – State diagram for profiles 1, 2, 3

If profile 1, 2 or 3 (DS7 as Contactor) is used with **PNU 928.0 = 1**, the state diagram shown below will apply. The transition from S3 to S4 is automatic.

### 8.9.2.5 Network – S4: Operation, profiles 1, 2, 3

If profile 1, 2 or 3 (DS7 as Contactor) is used with **PNU 928.0 = 1**, the state diagram shown below will apply. The transitions will take place when the state of the DS7 start/stop bit is changed.
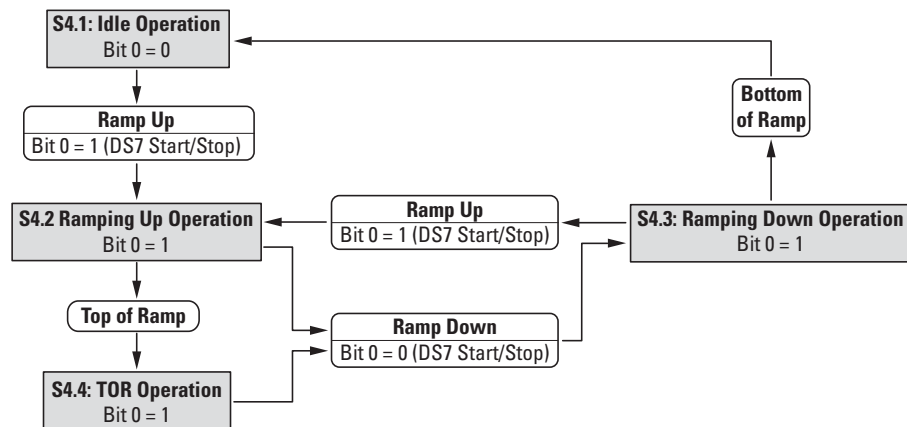


Figure 118: State diagram: Network – S4 (profiles 1, 2, 3)

### 8.9.2.6 Network – State diagram for profiles 4, 5, 6, 10

If profile 4, 5, 6, or 10 (**Short**) is used with **PNU 928.0 = 1**, the state diagram shown below will apply.
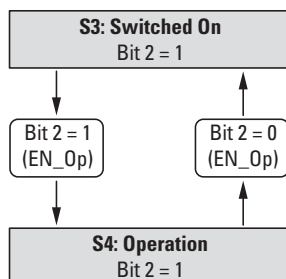


Figure 119:   State diagram: Network (profiles 4, 5, 6, 10)

### 8.9.2.7 Network – S4: Operation, profiles 4, 5, 6, 10

If profile 4, 5, 6, or 10 (**Short**) is used with **PNU 928.0 = 1**, the state diagram shown below will apply. The transitions will take place when the state of the EN_Set bit is changed.
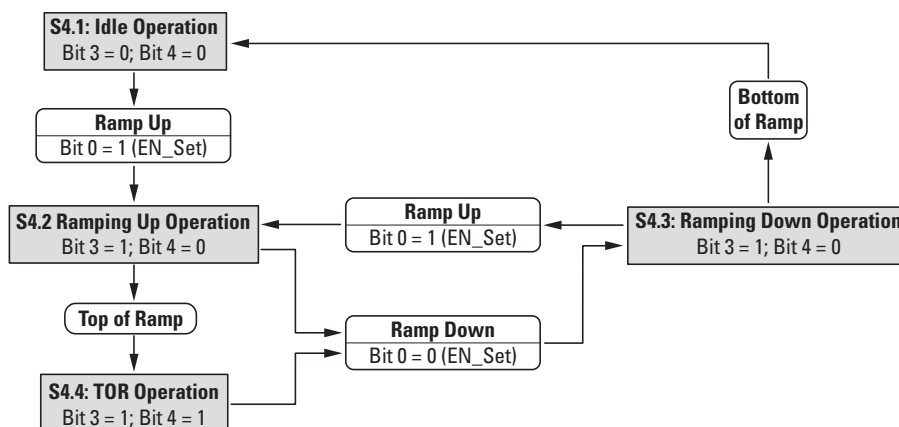


Figure 120:   State diagram: Network – S4 (profiles 4, 5, 6, 10)

### 8.9.2.8 Network – State diagram for profiles 7, 8, 9, 11

If profile 7, 8, 9, or 11 (**Long**) is used with **PNU 928.0 = 1**, the state diagram shown below will apply.

➜ In addition to the transition conditions shown below, the Ctl_PLC bit needs to be set in the output byte.

➜ For more information on the Ctl_Req and Ctl_PLC bits, see ➜ section 8.9.3, "Cyclic data".
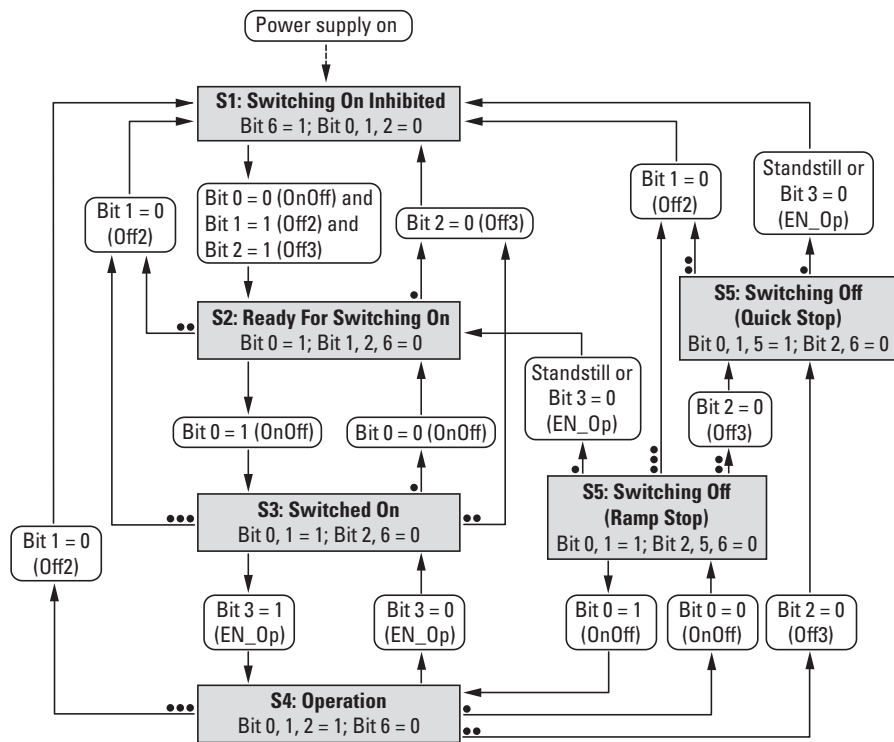


Figure 121: State diagram: Network (profiles 7, 8, 9, 11)

### 8.9.2.9 Network – S4: Operation, profiles 7, 8, 9, 11

If profile 7, 8, 9, or 11 (**Long**) is used with **PNU 928.0 = 1**, the state diagram shown below will apply. The transitions will take place when the corresponding bits' state is changed.
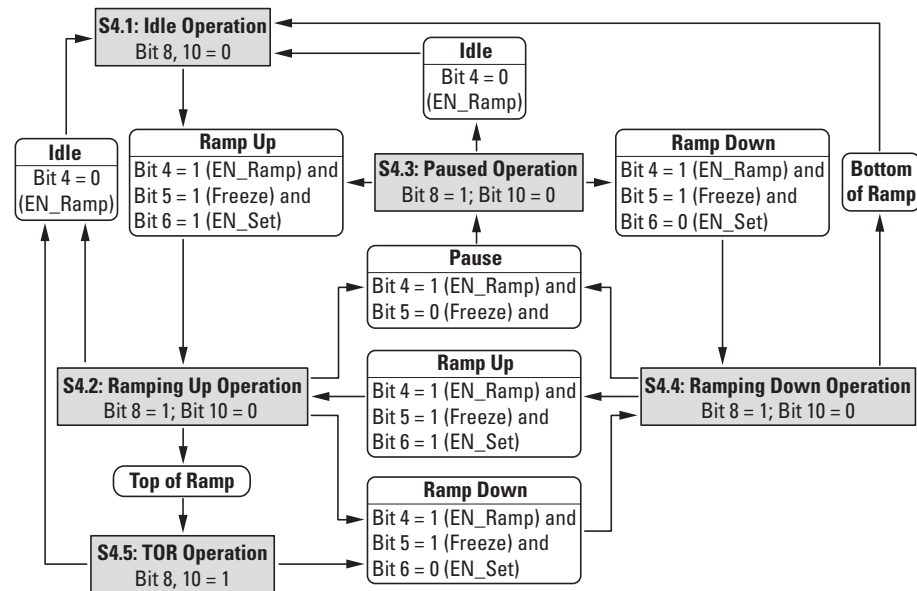


Figure 122: State diagram: Network – S4 (profiles 7, 8, 9, 11)

### 8.9.2.10 General state diagram: Profiles: 1, 2, 3

The state diagram shown below is used in profiles 1, 2 and 3 (DS7 as contactor). The transition from S3 to S4 is automatic.
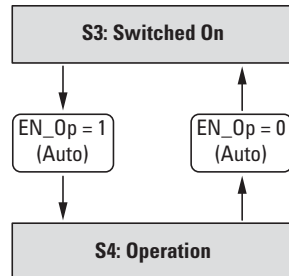


Figure 123:   General state diagram (Profiles 1, 2, 3)

### 8.9.2.11 State S4: Operation: Profiles 1, 2, 3
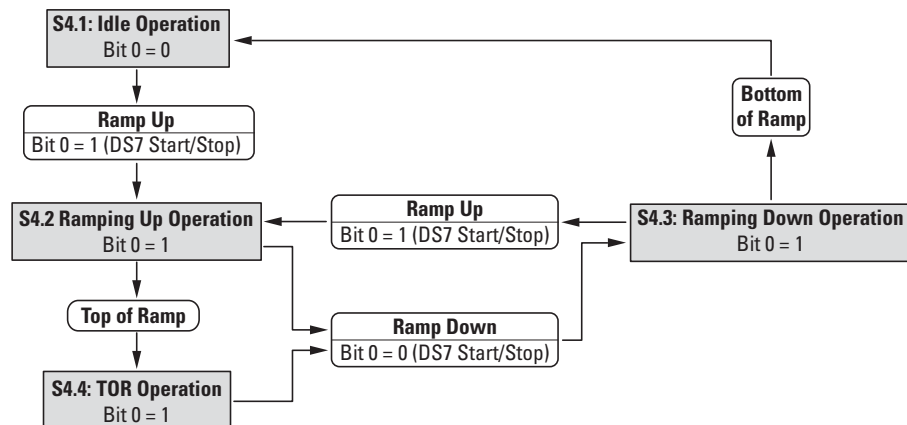


Figure 124:   S4: operation (profiles 1, 2, 3)

### 8.9.2.12 General state diagram: Profiles: 4, 5, 6, 10

The state diagram shown below is used in profiles 4, 5, 6 and 10 (Short).
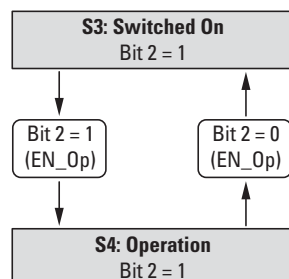


Figure 125:   General state diagram (profiles 4, 5, 6, 10)

### 8.9.2.13 State S4: Operation: Profiles 4, 5, 6, 10
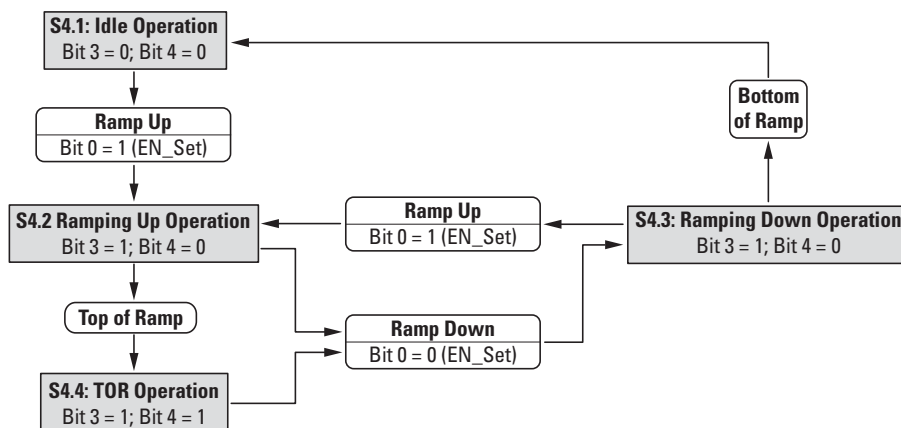


Figure 126:   S4: Operation (profile 4, 5, 6, 10)

### 8.9.2.14 General state diagram: Profiles 7, 8, 9, 11

The state diagram shown below is used in profiles 7, 8, 9, and 11 (Long).
In addition to the transition conditions shown below, the Ctl_PLC bit needs
to be set in the output byte.

For more information on the Ctl_Req and Ctl_PLC bits, see
→ section 8.9.3, "Cyclic data", page 159.
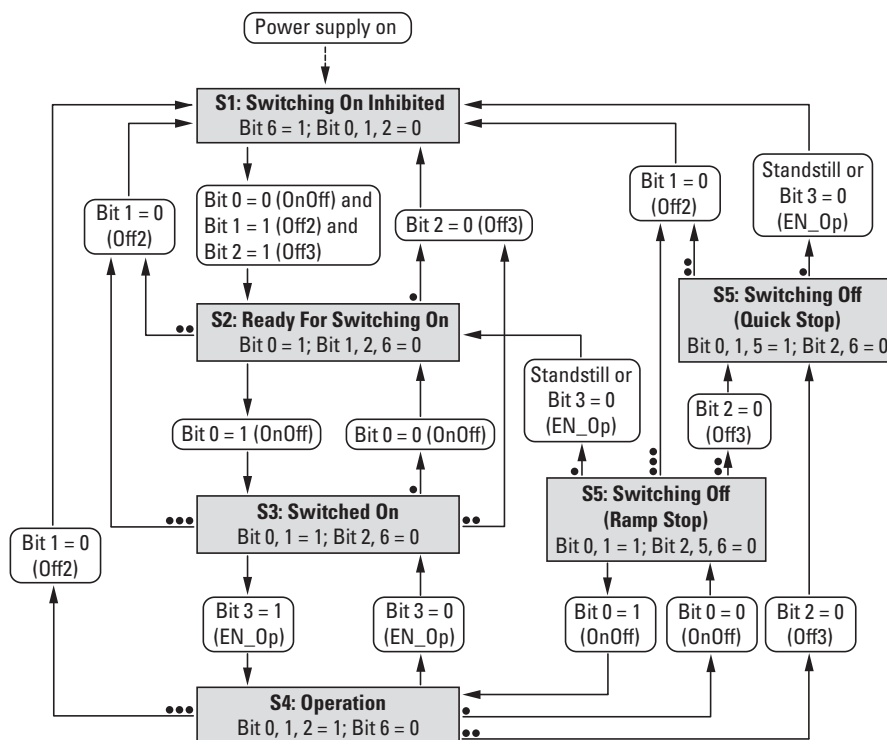
Figure 127:   General state diagram (profiles 7, 8, 9, 11)

### 8.9.2.15 State S4: Operation: Profiles 7, 8, 9, 11
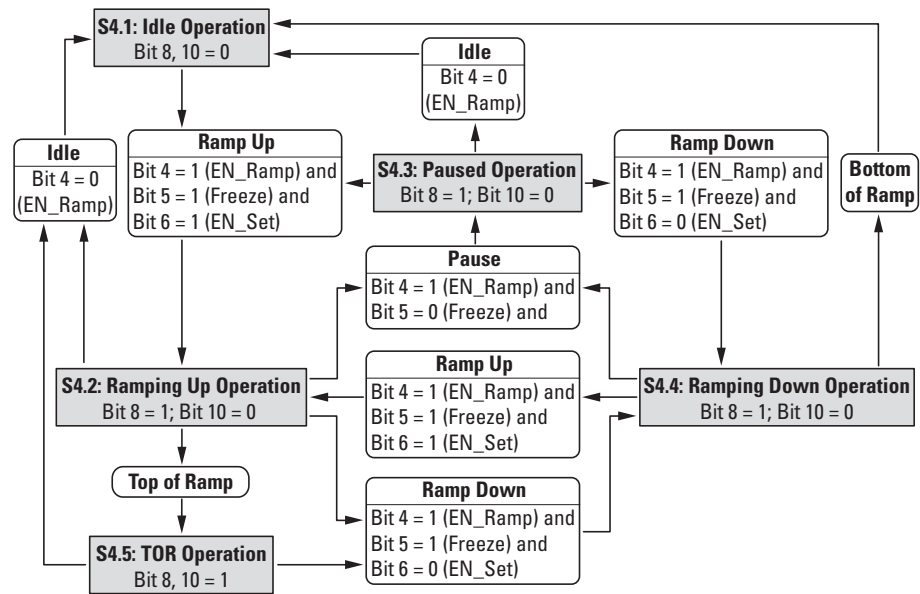


Figure 128: S4: Operation (profile 7, 8, 9, 11)

### 8.9.3 Cyclic data

#### 8.9.3.1 Introduction

The amount of cyclic input / output data (process data) for the DS7-SWD soft starter can be adjusted as necessary for the application at hand by using the various profiles. These profiles are selected in the hardware / PLC configuration program (in the SWD-Assist program, for example).

There are a total of 11 cyclic profiles available for selection. The following sections describe these profiles in detail.

Profiles 1 to 9 are designed for operating a DS7-SWD soft starter with a PKE motor-protective circuit-breaker:

- Profiles 1, 2, and 3 (DS7 as contactor): DS7-SWD PKE1 to DS7-SWD PKE3
  This group supports the operation of a DS7-SWD soft starter, which will behave like a contactor in this case. Accordingly, these profiles match the motor starter profiles for the PKE-SWD-32 motor-protective circuit-breaker.

- Profiles 4, 5, and 6 (short): DS7-SWD PKE 1-8bit to DS7-SWD PKE3-8bit
  This group complements the motor starter profiles with the I/O-link profile.
  Control and status data will be processed as per the I/O-link profile.

- Profiles 7, 8, and 9 (long): DS7-SWD PKE1-PD 2x16 bit to DS7-SWD PKE3-PD 2x16 bit
  This group complements the motor starter profiles with the PROFIdrive profile that the PROFIBUS User Organization (PNO) has defined for the cyclic exchange of data with drives. Control and status data will be processed as per the PROFIdrive profile.

Profiles 10 and 11 are designed for operating a DS7-SWD soft starter without a PKE motor-protective circuit-breaker:

- Profile 10 (Short): DS7-SWD 8 bit
- Profile 11 (Long): DS7-SWD PD 2x16 Bit = Word

Profile 11 will be set by default.

When using profiles 10 and 11, a DS7-SWD soft starter > 32 A can also be used optionally with an upstream NZM as a safety device.

Table 28: Profiles

| No. | Name | Input bytes (status) 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Σ | Output bytes (control) 0 | 1 | 2 | 3 | 4 | Σ | Bytes Σ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DS7-SWD PKE1 | DS7/ PKE | PKE | | | | | | | | 2 | DS7/ PKE | | | | | 1 | 3 |
| 2 | DS7-SWD PKE2 | DS7/ PKE | PKE | PKE | PKE | | | | | | 4 | DS7/ PKE | | | | | 1 | 5 |
| 3 | DS7-SWD PKE3 | DS7/ PKE | PKE | PKE | PKE | PKE | | | | | 5 | DS7/ PKE | | | | | 1 | 6 |
| 4 | DS7-SWD PKE1-8Bit | DS7/ PKE | PKE | DS7 | | | | | | | 2+1 | PKE | DS7 | | | | 1+1 | 5 |
| 5 | DS7-SWD PKE2-8Bit | DS7/ PKE | PKE | PKE | PKE | DS7 | | | | | 4+1 | PKE | DS7 | | | | 1+1 | 7 |
| 6 | DS7-SWD PKE3-8Bit | DS7/ PKE | PKE | PKE | PKE | PKE | DS7 | | | | 5+1 | PKE | DS7 | | | | 1+1 | 8 |
| 7 | DS7-SWD PKE1-PD 2x16Bit | DS7/ PKE | PKE | DS7 | DS7 | DS7 | DS7 | | | | 2+4 | PKE | DS7 | DS7 | DS7 | DS7 | 1+4 | 11 |
| 8 | DS7-SWD PKE2-PD 2x16Bit | DS7/ PKE | PKE | PKE | PKE | DS7 | DS7 | DS7 | DS7 | | 4+4 | PKE | DS7 | DS7 | DS7 | DS7 | 1+4 | 13 |
| 9 | DS7-SWD PKE3-PD 2x16Bit | DS7/ PKE | PKE | PKE | PKE | PKE | DS7 | DS7 | DS7 | DS7 | 5+4 | PKE | DS7 | DS7 | DS7 | DS7 | 1+4 | 14 |
| 10 | DS7-SWD 8Bit | DS7 | DS7 | | | | | | | | 1+1 | DS7 | DS7 | | | | 1+1 | 4 |
| 11 | DS7-SWD PD 2x16Bit | DS7 | DS7 | DS7 | DS7 | DS7 | | | | | 1+4 | DS7 | DS7 | DS7 | DS7 | | 4 | 9 |

→ DS7-SWD soft starters can also be operated, without a PKE motor-protective circuit-breaker, with a PKZ or an NZM as a safety device.

→ For additional information on how to connect a DS7-SWD to a PKE motor-protective circuit-breaker with a trip block, consult manual MN05006001Z-EN, "SmartWire-DT Modules."

### 8.9.3.2 Inputs (status) profiles 1, 2, 3

Profiles 1, 2, and 3 have a maximum of five input bytes and one output byte.

→ The number of cyclic input bytes can be changed with the module's different profiles (→ table 28, page 160).

Byte 0:

Status information: DS7, PKE, PKE-SWD-32

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| SUBST | PRSNT | – | DIAG | A2 | A1 | P | C |

| Data bit | Designation | Meaning |
|---|---|---|
| 0 | DS7 run | 0: Stop soft starter DS7-SWD<br>1: Run DS7-SWD soft starter |
| 1 | STAT (PKE) | 0: PKE tripped<br>1: PKE Powered up |
| 2, 3 | A1, A2 | 1-0-A switch on DS7-SWD soft starter:<br>00: not defined<br>10: Position A: Automatic<br>(commands via SmartWire-DT/terminal)<br>01: Position 0: DS7 stop<br>11: Position 1: DS7 operation |
| 4 | DIAG | Soft starter diagnostics:<br>0: no diagnostic alarm<br>1: Diagnostic alarm present |
| 5 | – | Not used |
| 6 | PRSNT | Presence of DS7-SWD soft starter:<br>0: Device not present<br>1: Device present |
| 7 | SUBST | Presence of a universal module:<br>0: Configured module present<br>1: universal module M22-SWD-NOP(C) present |

Byte 1:

Set value $I_r$, trip reasons, acknowledge signal

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| ACKR | TRIPR | TRIPR | TRIPR | $I_r$ | $I_r$ | $I_r$ | $I_r$ |

| Data bit | Designation | Meaning | Notes |
|---|---|---|---|
| 0 - 3 | $I_r$ | Set value $I_r$ | → table 29, page 164 |
| 4 - 6 | TRIPR = Trip reason | Trip reason | → table 30, page 164 |
| 7 | ACKR = Acknowledge required | ZMR manual function acknowledgement required<br>0: No acknowledgement required<br>1: Acknowledgement of overload required | → section "Overload relay function (ZMR)", page 168 |

Byte 2:

Motor current [%]

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| I-REL | I-REL | I-REL | I-REL | I-REL | I-REL | I-REL | I-REL |

| Data bit | Designation | Meaning | Notes |
|---|---|---|---|
| 0 - 7 | I-REL | Motor current [%] | → section , "Motor current [%] PKE (I_REL)", page 165 |

Byte 3:

Thermal motor image [%]

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| TH | TH | TH | TH | TH | TH | TH | TH |

| Data bit | Designation | Meaning | Notes |
|---|---|---|---|
| 0 - 7 | TH | Thermal motor image [%] | → section , "Thermal motor map on PKE (TH)", page 166 |

Byte 4:

Type of trip block, set time-lag class

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| – | – | CLASS | CLASS | CLASS | TYPE | TYPE | TYPE |

| Data bit | Designation | Meaning | | |
|---|---|---|---|---|
| 0 - 2 | TYPE | Part no. of PKE trip block | | |
| | | Value [hex] | PKE- | trip block |
| | | 0 | XTUA-1.2 | 0.3 - 1.2 A |
| | | 1 | XTUA-4 | 1.0 - 4.0 A |
| | | 2 | XTUA-12 | 3.0 - 12 A |
| | | 3 | XTUA-32 | 8.0 - 32 A |
| | | 4 | XTUWA-32 | 8.0 – 32 A (width 55 mm) |
| | | 5 | XTUWA-65 | 16.0 - 65A |
| 3 - 5 | CLASS | set PKE time lag | | |
| | | Value [hex] | time-lag class | Time |
| | | 0 | Class 5 | 146.2 s |
| | | 1 | Class 10 | 292.5 s |
| | | 2 | Class 15 | 438.7 s |
| | | 3 | Class 20 | 585.0 s |
| | | 4 | test | 0 |
| 6, 7 | – | Not used | | |

**Set rated operational current $I_r$ on PKE**

The overload release value set on the PKE basic device (adjustable with a selector switch) is reproduced by bit field Ir (input byte 1, bits 0 to 3). The value of Ir represents the overload release's absolute current value, which will depend on the selected PKE trip block. Bit field Ir has the following meaning for the different PKE trip blocks:

Table 29: Absolute value of set rated operational current on the PKE

| Ir value [hex] | Set rated operational current $I_r$ [A] on the PKE | | | | |
|---|---|---|---|---|---|
| | **PKE-XTUA-1.2** | **PKE-XTUA-4** | **PKE-XTUA-12** | **PKE-XTU(W)A-32** | **PKE-XTUA-65** |
| 0 | 0.30 | 1.00 | 3.0 | 8.0 | 16.0 |
| 1 | 0.33 | 1.10 | 3.3 | 8.8 | 17.6 |
| 2 | 0.36 | 1.20 | 3.6 | 9.7 | 19.4 |
| 3 | 0.40 | 1.30 | 4.0 | 10.5 | 21.3 |
| 4 | 0.43 | 1.42 | 4.3 | 11.5 | 23.0 |
| 5 | 0.47 | 1.55 | 4.7 | 12.5 | 24.8 |
| 6 | 0.50 | 1.70 | 5.0 | 13.5 | 26.8 |
| 7 | 0.56 | 1.90 | 5.6 | 15.0 | 30.0 |
| 8 | 0.63 | 2.10 | 6.3 | 17.0 | 33.6 |
| 9 | 0.70 | 2.40 | 7.0 | 19.0 | 37.7 |
| A | 0.77 | 2.60 | 7.7 | 20.5 | 40.9 |
| B | 0.83 | 2.80 | 8.3 | 22.0 | 44.4 |
| C | 0.90 | 3.00 | 9.0 | 24.0 | 48.1 |
| D | 1.00 | 3.30 | 10.0 | 27.0 | 53.3 |
| E | 1.10 | 3.70 | 11.0 | 29.0 | 58.6 |
| F | 1.20 | 4.00 | 12.0 | 32.0 | 65.0 |

**PKE trip reason (TRIPR)**

In the event of a malfunction or interruption of the main circuits, the reason for the interruption will be indicated by the TRIPR bit field:

Table 30: Trip reasons PKE (TRIPR)

| Value [hex] | Meaning |
|---|---|
| 0 | Not defined |
| 1 | Overload ➞ PKE motor-protective circuit-breaker has switched off |
| 2 | Short-circuit ➞ PKE motor-protective circuit-breaker has switched off |
| 3 | Phase failure/phase unbalance ➞ Switched off at 100 % of thermal motor map (TH) |
| 4 | Test position on PKE-XTUA ➞ PKE motor-protective circuit-breaker has switched off |
| 5 | Overload with activated ZMR function ➞ The DS7-SWD soft starter has switched off. The value of the thermal motor map (TH) is still greater than 100% after the unit is switched off. |
| 6 | Remote tripping |
| 7 | Not used |

Trip reasons 1, 2, 3, and 4 for the PKE motor-protective circuit-breaker have the following effects on the DS7-SWD soft starter:

- Profiles 1, 2, 3: The DS7-SWD soft starter will be stopped. After the PKE motor-protective circuit-breaker is switched back on, the soft starter can be switched back on with the DS7 start/stop 1 command.
- Profiles 4, 5, 6: The DS7-SWD soft starter will be stopped. After the PKE motor-protective circuit-breaker is switched back on, the soft starter can be reset with the FaultAck = 1 command. The soft starter will be switched on again directly depending on the position of the EN_Set and EN_Op bits.
- Profiles 7, 8, 9, 11: The DS7-SWD soft starter will stop.

After the PKE motor-protective circuit-breaker is switched back on, the fault can be reset with the FaultAck = 1 command and the soft starter can be switched back on with the relevant bits.

With the exception of trip reason "$05_{hex}$ Overload with activated ZMR function," the transmitted trip reasons will be reset if the main contacts of the PKE motor-protective circuit-breaker are closed back again and a current flow is sensed through the PKE trip block. The "$05_{hex}$ Overload with activated ZMR function" trip reason will be reset as soon as the thermal motor map (TH) falls below a value of 100 %.

The "$03_{hex}$ Phase failure/Phase unbalance" message will be set if a phase current difference of 50 % is measured between the maximum measured phase current and the relevant phase. The message will be reset as soon as the phase current difference falls below 25 %.

The "Phase failure/Phase unbalance" message will not necessarily cause the main circuits to be interrupted. In order to protect the connected motor in the event of a phase failure or phase unbalance, the tripping time in the event of an overcurrent will be reduced to 40 % of the value used when the phase load is balanced. The main circuits will be interrupted early.

The "Test" position on the PKE trip block and remote tripping via the R-TRIP output bit causes a trip if a phase current of at least 85 % of the minimum marker of the adjustable overload release on the PKE trip block flows through all three main circuits (example: for device PKE-XTUA-4 $I_r$ = 1 A $\longrightarrow$ $I_{min}$ = 0.85 x 1 A = 0.85 A).

**Motor current [%] PKE (I_REL)**

The DS7-SWD soft starter uses input byte 2 to provide the current motor current to the PKE motor-protective circuit-breaker. The motor current is represented as a relative value within a range of 0 % ($00_{hex}$) to 255 % ($FF_{hex}$). The relative value is calculated as the value of the maximum measured phase current relative to the set current value of the overload release. The accuracy of the relative current indication depends on the measured phase current relative to the PKE trip block's current range. For a sufficiently accurate measurement of the phase current, a phase current of at least 85 % of the adjustable overload release on the PKE trip block must be flowing. The maximum measuring accuracy of the transferred relative current value is 5 %.

**Thermal motor map on PKE (TH)**

Depending on the current range and the actual power flow, the PKE motor-protective circuit-breaker calculates the thermal state of the motor and provides it as a data byte. The thermal load of the motor is mapped via input byte 3. The value is displayed as a relative value in the ranges 0 % ($00_{hex}$) to 255 % ($FF_{hex}$).

The main circuits are interrupted as a result of a motor overload if the thermal motor image is 110 %. In the event of phase failure or phase unbalance, the main circuits are interrupted at a value of 100 % of the thermal motor image. In the event of a phase unbalance and trip caused by an overload, the value of the thermal motor image is raised from 100 % to 110 %.

## 8.9.3.3 Selecting a profile

The appropriate profile can be selected by the user.

- A PKE will be installed upstream of the DS7-SWD unit – motor starter compatibility:
  If only a simple start/stop command is required, any of the three PKE profiles can be chosen based on the desired PKE functionality
  (→ section 8.9.3.1, "Introduction", page 159).
- No PKE will be installed upstream of the DS7-SWD unit:
  If the control specifics need to be comparable to those characterizing terminal-based operation and the following functions are desired with enable and start/stop:
  - an error message,
  - an alarm message,
  - A TOR signal and/or a RUN signal
    any one of profiles 4, 5, or 6 – based on the desired PKE functionality – or profile 10, if there is no PKE installed upstream of the DS7-SWD unit, can be chosen
    (→ section 8.2, "Profiles for DS7-SWD", page 146 and → table 28, page 160).

- Complete control is required:
  If complete control with all options is desired or if the following functions are needed:

  - Closing lockout,
  - External current limiting function
  - Programmable response in the event of a loss of communications
  - Feedback regarding the thermal load on the DS7-SWD
    any one of profiles 7, 8, or 9 – based on the desired PKE functionality – or profile 11, if there is no PKE installed upstream of the DS7-SWD unit, can be chosen.

### 8.9.3.4 Profiles 1, 2, 3: Outputs (control)

Output byte 0 is mapped as follows on SmartWire-DT.

Table 31: Profiles 1, 2, 3: Output byte 0

| Byte | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 0 | 0 | DS7 start/stop | 0: DS7 stop<br>1: DS7 operation |
| | 1 | R_TRIP | Remote tripping PKE:<br>0: no PKE remote tripping<br>1: PKE remote tripping (rising edge: 0 → 1)<br>→ section "Remote tripping function for PKE (R_TRIP)" |
| | 2 | ZMR | DS7 ZMR on/off:<br>0: Deactivation of ZMR function<br>1: Activation of ZMR function<br>→ section "Overload relay function (ZMR)" |
| | 3 | ZMR_HA | ZMR operating mode manual/automatic of DS7:<br>0: ZMR function: Manual operating mode<br>1: ZMR function: Automatic operating mode<br>→ section "ZMR function (ZMR_HA): "Manual" mode",<br>→ section "ZMR function (ZMR_HA): "Automatic" mode" |
| | 4 - 7 | – | Not used |

➔ Faults can be acknowledged by changing the value of the DS7 Start/Stop bit from 1 to 0.

**Remote tripping function for PKE (R_TRIP)**

In a combination of motor-protective circuit-breaker PKE and soft starter DS7-SWD connected via communication connection PKE32-COM the remote tripping function does not cause the motor-protective circuit-breaker PKE to open. Instead, the "external fault" message is output at the soft starter and a response defined with parameter PNU 840.90 (External Fault) is initiated. By default the soft starter then stops. If the soft starter does not respond to the external fault, the motor-protective circuit-breaker trips.

The "Remote trip PKE basic device" command is supported by the following PKE trip block versions (and later versions).

| Part no. of PKE trip block | Version |
|----------------------------|---------|
| PKE-XTUA-1.2<br>PKE-XTUA-4<br>PKE-XTUA-12<br>PKE-XTUA-32 | 05 |
| PKE-XTUWA-32 | 01 |
| PKE-XTUA-65 | 01 |

The remote tripping function is only available in profiles 1 to 9 (profiles for operation with a PKE motor-protective circuit-breaker).

The remote tripping function is activated by output byte 0, bit 1 (R_TRIP). Soft starter DS7-SWD stops and input byte 1 bits 4 to 6 (trip indication) continually indicates a remote tripping.

**Overload relay function (ZMR)**

In the event of an overload, the ZMR overload relay function makes it possible to switch off the motor not by tripping the PKE motor-protective circuit-breaker, but by switching off the DS7-SWD soft starter instead as soon as the PKE motor-protective circuit-breaker's thermal motor model reaches a value of 110 %.

The ZMR function will only be active if the manual/automatic switch on the DS7-SWD communication module is set to A = Automatic.

If the ZMR function is deactivated by the HOST during a trip operation caused by the ZMR function, the trip operation will remain active as long as the thermal motor model is < 100 %. During this time, $5_{hex}$ will be signalled for the differential trip indication.

In the event of a malfunction in the communications between the soft starter and the motor-protective circuit-breaker, or whenever the soft starter is switched on, the ZMR function in the motor-protective circuit-breaker will be deactivated; the motor-protective circuit-breaker will trip by itself.

The function is activated with output byte 0, bit 2. Due to safety reasons, the function will only be active if it remains continuously (cyclically) enabled via the host.

→ In the event of a phase unbalance and activated ZMR function, the value of the thermal motor image is raised from 100 % to 110 % after a trip. The availability of the switched-off DS7-SWD soft starter will be restored when the value falls below 100 %.

→ The control bits for activating and deactivating the ZMR function are only found in profiles 1 to 9 (profiles for operation with PKE).

> ⚠ **DANGER**
>
> Never disconnect the communication link between the PKE-SWD-32 motor-protective circuit-breaker and the PKE trip block after an overload while the ZMR function is enabled, as this can cause the DS7-SWD soft starter to be switched on if a switch command is present.

**ZMR function (ZMR_HA): "Manual" mode**

Output byte 0, bit 3 (ZMR manual mode/automatic operation) can be used from the host to define, for the ZMR function, whether the DS7 soft starter should be automatically switched back on after an overload shutdown caused by the ZMR function once the overload (= thermal motor model in PKE motor-protective circuit-breaker < 100 %) is no longer present. If not (i.e., "manual" mode), the overload will have to be acknowledged. Input byte 1, bit 7 (ACKR) is used to indicate to the host that an acknowledgment is required. The bit is set if the PKE signals a thermal motor model ≧ 110 % and the ZMR function is in "manual" mode.

During an overload, i.e., thermal motor model ≧ 110 %, this is signalled with input byte 1, in the differential trip indication in bits 4 to 6, with a value of $5_{hex}$.

The user can use both pieces of information to determine that a trip operation caused by the ZMR function has occurred and to find out whether the thermal overload is still present.

It can be acknowledged by switching the DS7-SWD soft starter or by changing the ZMR operating mode:

- For profiles 1 to 3: By setting bit 0 (DS7 start/stop) in output byte 0 to 0 (stop)
- For profiles 4 to 6: By setting bit 0 (EN_Set) in output byte +1 (Short) to 0 (deactivate setpoint value)
- For profiles 7 to 9: By setting bit 6 (EN_Set) in output bytes 1 and 2 to 0 (do not activate setpoint value)
- Or for profiles 1 to 9: By setting bit 3 (ZMR mode) in output byte 0 to 1 (ZMR "automatic" mode) and then, optionally, setting it back to 0 ("manual"). This will reset bit 7 (ACKR) in input byte 1 – independently of the thermal motor model.
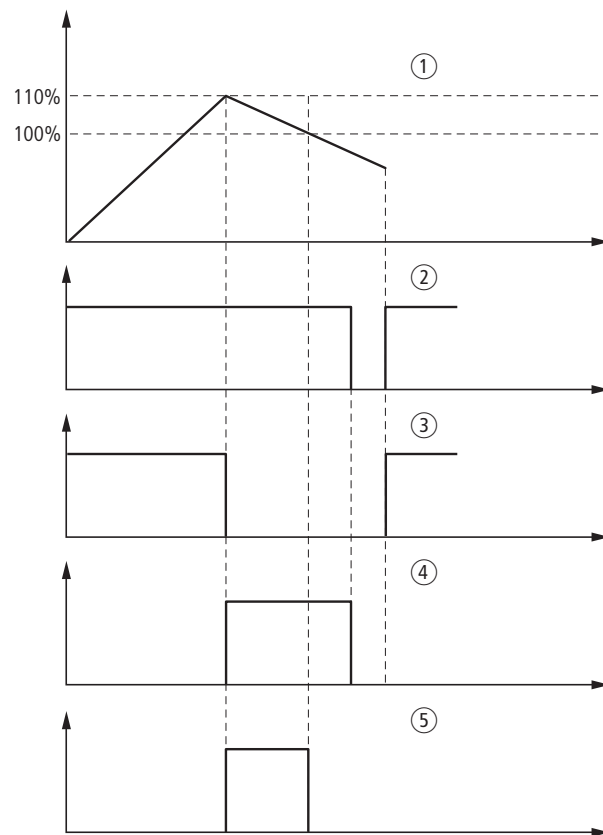
Figure 129: Acknowledgement of manual ZMR operating mode by "DS7 OFF" command

① Thermal motor image
② Switching command for soft starter DS7-SWD
③ Switching state of soft starter DS7
④ ACKR bit field status
⑤ Trip indication: Overload with activated ZMR function
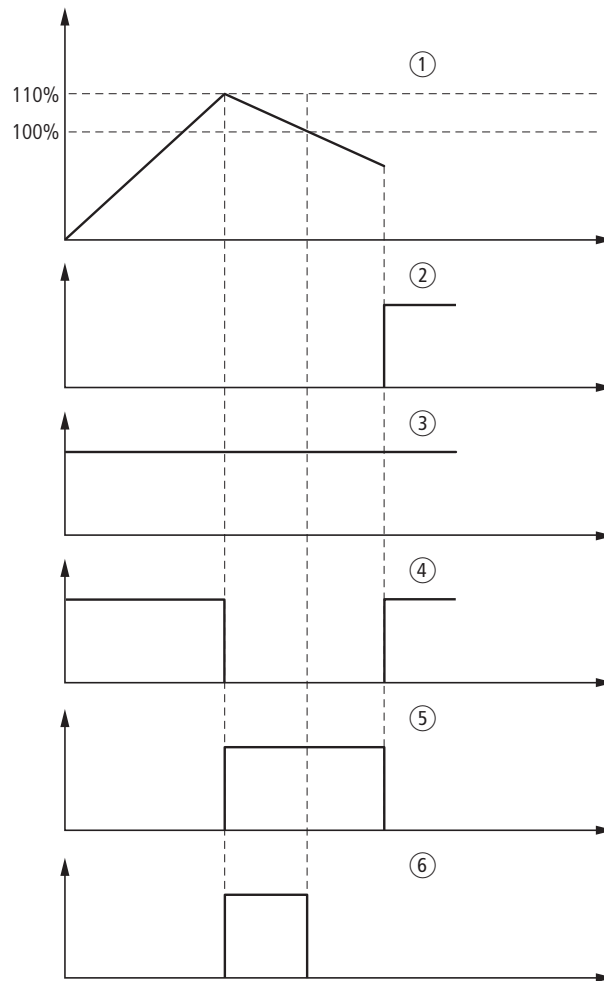
Figure 130: Acknowledgement of manual ZMR operating mode by changing the ZMR mode

① Thermal motor image
② ZMR M/A bit field status
③ Switching command for soft starter DS7-SWD
④ Switching state of soft starter DS7
⑤ ACKR bit field status
⑥ Trip indication: Overload with tripped ZMR function

> *NOTICE*
>
> The ZMR function can be deactivated only when the thermal motor image falls below the 100 % mark.

It will not be possible to switch on the soft starter until the acknowledgment bit has been reset AND the thermal motor model in the PKE motor-protective circuit-breaker is < 100 %. After this, a value of $0_{hex}$ will be signalled in the differential trip indication in bits 4 to 6 in input byte 1.

In the "manual" ZMR mode, the soft starter will be stopped when the ZMR function has been activated and the PKE signals a request for switching off the DS7-SWD.

**ZMR function (ZMR_HA): "Automatic" mode**

When in "automatic" ZMR mode, the DS7-SWD soft starter will be ready to be switched on immediately after the thermal motor image falls below the 100 % mark. "Automatic" ZMR mode is activated by setting the ZMR M/A output bit (output byte 0, bit 3).

> ⚠ **DANGER**
>
> If the switch-on command for the DS7-SWD soft starter is sent while in "automatic" ZMR mode, the motor will start up automatically after the thermal motor image falls below the 100 % mark.

The illustration below shows the switching performance of soft starter DS7-SWD on overload with the ZMR in Automatic mode.
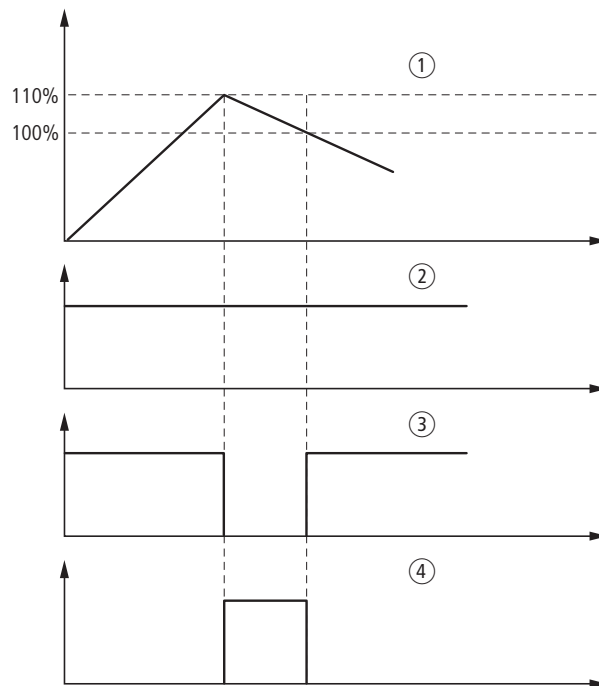


Figure 131: "Automatic" ZMR operating mode

① Thermal motor model
② Switching command for soft starter DS7-SWD
③ Switching state of soft starter DS7
④ Trip reason: Overload with activated ZMR function

Input byte 1, bit 7 (ACKR acknowledgment) is not active in automatic mode.

### 8.9.3.5 Profiles 4, 5, 6: inputs (status)

Input bytes are mapped as follows on SmartWire-DT.

Profiles 4, 5, and 6 correspond to profiles 1 to 3, but with an added status byte:

Profile 4 = Profile 1 (2 bytes) + DS7 status (1 byte)

Table 32: Profiles 4 to 6: input bytes

| Byte | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 0 | 0 | | Not used |
| | 1 - 7 | | → section 8.9.3.2, "Inputs (status) profiles 1, 2, 3", page 161 |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| +1 (Status DS7) | 0 | ERR | Error present 0: no error 1: Error |
| | 1 | WARN | Warning present: 0: no warning 1: Warning |
| | 2 | RDY | Ready, switched on: 0: not switched on 1: switched on |
| | 3 | RUN | DS7 Run, power part active: 0: Stop (power section inactive) 1: Running (power section active) |
| | 4 | TOR | Top of ramp: 0: Top of start ramp not reached 1: Top of start ramp reached |
| | 5[1] | CL | Current limit: 0: Current limit not reached 1: Current limit reached |
| | 6, 7 | – | Not used |

1) Bit 5 will only be activated if parameter 681.0 is set to 1.

## 8.9.3.6 Profiles 4, 5, 6: Outputs (control)

Output bytes 0 and 1 (Short) are mapped as follows on SmartWire-DT.

Table 33: Profiles 4 to 6: Output bytes 0 and 1

| Byte | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 0 | 0 | – | Not used |
| | 1 - 7 | | See: Profiles 1, 2, 3: Output byte 0 → section 8.9.3.4, "Profiles 1, 2, 3: Outputs (control)" |
| 1 (Control DS7) | 0 | EN_Set | Enable Setpoint, DS7 Start/Stop: EN_Set enables the setpoint value and starts or stops the motor with the ramp function. 0: (deactivate setpoint value) 1: (activate setpoint value) |
| | 1 | – | Not used |
| | 2 | EN_Op | Operation released: 0: Stop (immediate disconnection of the output) 1: Operation |
| | 3 | FaultAck | Fault Acknowledge 0: Do not acknowledge current fault 1: Acknowledge current fault (rising edge: 0 → 1) |
| | 4 - 7 | – | Not used |

## 8.9.3.7 Profiles 7, 8, 9: Inputs (status)

Input bytes are mapped as follows on SmartWire-DT.

Table 34: Profiles 7, 8, 9: Input bytes

| Byte | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 0 | | | → section 8.9.3.2, "Inputs (status) profiles 1, 2, 3", page 161 |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| +2 (Long) | 0 | RSO | Ready to switch on: S2<br>0: Not ready for switching on<br>1: Ready for switching on |
| | 1 | RDY | Ready to operate; switched on: S3<br>0: not ready for operation<br>1: ready for operation |
| | 2 | EN | Operation (Enabled S4)<br>0: Stop<br>1: Operation |
| | 3 | ERR | Error present (Error)<br>0: no error<br>1: Error |
| | 4 | C_Stop | Free run-down, output de-energized (coast stop)<br>0: no free run-down<br>1: free run-down |
| | 5 | Q_Stop | Quick stop, shortest ramp<br>0: no quick stop<br>1: Quick stop |
| | 6 | SOI | Reclosing lockout (switching on inhibited: S1)<br>0: No switch-on inhibit<br>1: Switch-on inhibit |
| | 7 | WARN | Warning present:<br>0: no warning<br>1: Warning |
| | 8 | RUN | DS7 Run, power part active<br>0: Stop (power section inactive)<br>1: Running (power section active) |
| | 9 | Ctl_Req | Control requested to PLC<br>Is set if PNU 928.0 = 1.<br>0: Not ready for remote control<br>1: Ready for remote control |
| | 10 | TOR | Top of ramp:<br>0: Top of start ramp not reached<br>1: Top of start ramp reached |
| | 11[1] | CL | Current limit:<br>0: Current limit not reached<br>1: Current limit reached |
| | 12 | – | Not used |
| +2 (Long) | 0 - 15 | Utilization (Int16) | Load as a percentage (utilization %):<br>LB: Low Byte / HB: High Byte<br>0 - FFFF ≙ ±200 % / 0x4000 ≙ ±100 % |

1) Bit 11 will only be activated if parameter 681.0 is set to 1.

**Ctl_Req/Ctl_PLC**

The Ctl_Req bit (Control requested: Control via PLC requested) will be set automatically if PNU 928.0 = 1 (control via network).
After this, the application can be used to set the Ctl_PLC bit (Control by PLC) in output bytes 0 and 4. It will not be possible to use the state diagram with the control bits in output bytes 0 and 4 until this is done.

If bit Ctl_PLC = 0 when using control via the network (PNU 928.0 = 1), the DS7-SWD soft starter will switch to fail-safe mode. This will make all bytes +4 (Long) invalid (= 0). The DS7-SWD soft starter will switch to state S5 (Switching Off). After this, a quick stop or coast stop will follow; then a change to state S1.

## 8.9.3.8 current limitation

Profiles 7, 8, 9 , and 11 can be used for current limitation with the DS7-SWD soft starter.

Following is a description explaining how you can use this current limitation function on DS7-SWD units.

### Profiles 7, 8, 9

The PKE motor-protective circuit-breaker will only deliver the values of currents; the DS7-SWD soft starter will carry out the actual current limiting.

Two parameters need to be configured:

- Set the rated motor current in parameter PNU 210.0
- In parameter PNU 281.1, set the motor current to a multiple of the rated operational current

### Profile 11

Profile 11 can be used to perform an external current measurement (e.g., via an analog input to the PLC) in order to acquire values for the relevant currents. Current limiting has to be programmed in the PLC with the settings (current limits). If the set value is exceeded, the DS7-SWD soft starter can freeze the ramp with bit 5 = 0 in order to limit the current.

If the current falls below the corresponding limit, bit 5 will have to be set to 1 so that the DS7-SWD soft starter will keep running up the ramp.

> ➜ This type of current limiting is not as precise as that achieved by using a PKE motor-protective circuit-breaker connected upstream.
> However, it is usable in non-dynamic applications.

For additional information, refer to PNU 681.0 as well.

### 8.9.3.9 Profiles 7, 8, 9: Outputs (control)

Output bytes 0 and 4 are mapped as follows on SmartWire-DT.
Profiles 7, 8, and 9 correspond to profiles 1, 2, and 3, but with two added words:
Profile 4 = Profile 1 (2 bytes) + DS7 status (2 words)

Table 35: Profiles 7, 8, 9: output bytes 0 and 4

| Byte | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 0 | | | See: Profile 1 – 3: Output byte 0 ➔ section 8.9.3.4, "Profiles 1, 2, 3: Outputs (control)" |
| +2 (DS7 status) | 0 | OnOff | Switch on/off<br>0: Normal stop (with configured ramp time)<br>1: Operation |
| | 1 | Off2 | Run-down (Coast Stop: Off 2)<br>0: Coast stop (switch off output voltage)<br>1: no free run-down |
| | 2 | Off3 | Quick Stop: Off3<br>0: Quick stop (shortest ramp)<br>1: no quick stop |
| | 3 | EN_Op | Operation released<br>0: Stop<br>1: Operation |
| | 4 | EN_Ramp | Enable Ramp<br>0: Reset ramp (setpoint value = 0)<br>1: Release ramp |
| | 5 | Unfreeze | Unfreeze ramp<br>0: Freeze ramp (the ramp generator's current output value will be frozen)<br>1: Do not freeze ramp |
| | 6 | EN_Set | Enable Setpoint, DS7 Start/Stop:<br>EN_Set enables the setpoint value and starts or stops the motor with the ramp function.<br>0: Do not activate setpoint value<br>1: activate setpoint value |
| | 7 | FaultAck | Fault Acknowledge<br>0: Do not acknowledge current fault<br>1: Acknowledge current fault (rising edge: 0 → 1) |
| | 8 | – | Not used |
| | 9 | – | Not used |
| | 10 | Ctl_PLC | PLC assumes control (Control by PLC)<br>0: no control via PLC<br>1: Control via PLC |
| | 11 - 14 | – | Not used |
| | 15 | ExtFault | External Fault<br>If the bit is set, the DS7 will stop with a selected PNU 840 function.<br>The behavior is the same as if there were a change from 1 → 0 in the Enable signal, with the exception that the DS7 soft starter will switch to the Error status (input bytes n + 4: bit 3).<br>The external fault can be reset just like any other fault (with Fault acknowledge (bit 7) or by switching the supply voltage off and on).<br>0: no external fault<br>1: external fault |
| +2 (reserved) | 0 - 15 | | Not used |

## 8.9.3.10 Profile 10: Inputs (status)

Input bytes 0 and 1 (Short) are mapped as follows on SmartWire-DT.

Table 36: Profile 10: Input bytes 0 and 1

| Byte | Bit | Designation | Meaning |
|---|---|---|---|
| 0 | 0, 1 | – | Not used |
| | 2, 3 | A1, A2 | 1-0-A switch on DS7:<br>00: not defined<br>10: Position A: Automatic (commands via SmartWire-DT/control signal terminal)<br>01: Position 0: DS7 stop<br>11: Position 1: DS7 operation |
| | 4 | DIAG | 0: no diagnostic alarm<br>1: Diagnostic alarm present |
| | 5 | – | Not used |
| | 6 | PRSNT | 0: Device not present<br>1: Device present |
| | 7 | SUBST | 0: Configured module present<br>1: universal module M22-SWD-NOP(C) present |
| 1 | 0 | ERR | Error present<br>0: no error<br>1: Error |
| | 1 | WARN | Warning present:<br>0: no warning<br>1: Warning |
| | 2 | RDY | Ready to operate, switched on<br>0: not switched on<br>1: switched on |
| | 3 | RUN | DS7 running, power section active (DS7 Run, power part active):<br>0: Stop (power section inactive)<br>1: Operation (power section active) |
| | 4 | TOR | Top of ramp:<br>0: Top of start ramp not reached<br>1: Top of start ramp reached |
| | 5[1] | CL | Current limit:<br>0: Current limit not reached<br>1: Current limit reached |
| | 6, 7 | – | Not used |

1) Bit 5 will only be activated if parameter 681.0 is set to 1.

### 8.9.3.11 Profile 10: Outputs (control)

Output bytes 0 and 1 (Short) are mapped as follows on SmartWire-DT.

Table 37: Profile 10: Output bytes 0 and 1

| Byte | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 0 (Control DS7) | 0 | EN_Set | Enable Setpoint, DS7 Start/Stop: EN_Set enables the setpoint value and starts or stops the motor with the ramp function. 0: (deactivate setpoint value) 1: (activate setpoint value) |
| | 1 | – | Not used |
| | 2 | EN_Op | Operation released: 0: Stop (immediate disconnection of the output) 1: Operation |
| | 3 | FaultAck | Fault Acknowledge 0: Do not acknowledge current fault 1: Acknowledge current fault (rising edge: 0 → 1) |
| | 4 - 7 | – | Not used |
| 1 | 0 - 7 | – | Not used |

Byte 1 is only needed for internal SmartWire-DT-specific functions.

## 8.9.3.12 Profile 11: Inputs (status)

Input bytes 0 to 4 are mapped as follows on SmartWire-DT.

Table 38: Profile 11: Input bytes 0 to 4

| Byte | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 0 | 0, 1 | – | Not used |
| | 2, 3 | A1, A2 | 1-0-A switch on DS7:<br>00: not defined<br>10: Position A: Automatic (commands via SmartWire-DT/control signal terminal)<br>01: Position 0: DS7 stop<br>11: Position 1: DS7 operation |
| | 4 | DIAG | 0: no diagnostic alarm<br>1: Diagnostic alarm present |
| | 5 | – | Not used |
| | 6 | PRSNT | 0: Device not present<br>1: Device present |
| | 7 | SUBST | 0: Configured module present<br>1: universal module M22-SWD-NOP(C) present |
| 1, 2 | 0 | RSO | Ready to switch on: S2<br>0: Not ready for switching on<br>1: Ready for switching on |
| | 1 | RDY | Ready to operate; switched on: S3<br>0: not ready for operation<br>1: ready for operation |
| | 2 | EN | Enabled: S4<br>0: Stop<br>1: Operation |
| | 3 | ERR | Error present (Error)<br>0: no error<br>1: Error |
| | 4 | C_Stop | Free run-down, output de-energized (coast stop)<br>0: no free run-down<br>1: free run-down |
| | 5 | Q_Stop | Quick stop, shortest ramp<br>0: no quick stop<br>1: Quick stop |
| | 6 | SOI | Switching On Inhibit: S1<br>0: No switch-on inhibit<br>1: Switch-on inhibit |
| | 7 | WARN | Warning present:<br>0: no warning<br>1: Warning |
| | 8 | RUN | DS7 run, power part active<br>0: Stop (power section inactive)<br>1: Operation (power section active) |
| | 9 | Ctl_Req | Control requested to PLC<br>Is set if PNU 928.0 = 1.<br>0: Not ready for remote control<br>1: Ready for remote control |

| Byte | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 1, 2 | 10 | TOR | Top of ramp:<br>0: Top of start ramp not reached<br>1: Top of start ramp reached |
| | 11[1) | CL | Current limit:<br>0: Current limit not reached;<br>Voltage ramp OK<br>1: Current limit reached;<br>Voltage ramp frozen |
| | 12 | – | Not used |
| 3, 4 | 0 - 15 | Utilization (Int16) | Utilization capacity %:<br>0 - FFFF ≙ ±200 %<br>0x4000 ≙ ±100 %<br>Trip at 100 %. |

1) Bit 11 will only be activated if parameter 681.0 is set to 1.

### 8.9.3.13 Device protection for DS7-SWD soft starters (bytes 3, 4 – profile 11)

By connecting a PKE motor-protective circuit-breaker upstream of the DS7-SWD soft starter, the soft starter can be protected against overloading and excessively frequent starts. The thermal load magnitude is indicated in the cyclic data in profile 11.

When the 100 % mark (0x4000) is reached, the soft starter will trip with an "overload error" error message and will stop the motor.

### 8.9.3.14 Profile 11: outputs
### (transmitting external current values to the DS7 soft starter, firmware V48 and higher)

The current's absolute value can be transmitted in profile 11, word 1 in order to make it possible to protect the device without having to directly connect the DS7-SWD soft starter to a PKE motor-protective circuit-breaker. In order to be able to do this, the current must be measured and correctly scaled externally. The PLC will then be used to transmit an actual current value.

The value being transmitted (from 0 to 800 %) is scaled relative to the trip block's maximum value. The percentage value is scaled within the representable word range of 0x0000 to 0xFFFF and is then written to the soft starter's control data (byte 2 and byte 3).

If no current is measured, a value of 0 will be transmitted as the current value to the DS7 soft starter.

The rated operational current for the current measuring block, or the rated motor current, needs to be entered into parameter PNU 290.0. This current will be used as a reference value representing a percentage of 100 %. The one being transmitted to the DS7 soft starter will be scaled within a range of 0 to 800 % (corresponding to 0x00 to 0xFFFF): 100 % ≙ 0x2000

**Example**

Basic requirements:

- DS7 soft starter: rated motor current = 55 A
- Motor: rated motor current = 41 A
- Current measurement with measuring range of 0 - 400 A

Calculation:

- Writing to PNU 290.0 with I = 41 A
- Measured current: 82 A
- Scaling on PNU 290.0 = 41 A $\longrightarrow$ $I_{rel}$ = 82 A / 41 A $\triangleq$ 200 % $\triangleq$ 0x4000
- Value transmitted to DS7 soft starter: 0x4000

## 8.9.3.15 Profile 11: Outputs (control)

Output bytes 0 + 4 are mapped as follows on SmartWire-DT.

Table 39: Profile 11: Output bytes 0 + 4

| Word | Bit | Designation | Meaning |
|------|-----|-------------|---------|
| 0 | 0 | OnOff | Switch on/off<br>0: Normal stop (with configured ramp time)<br>1: Operation |
| | 1 | Off2 | Run-down (Coast Stop: Off 2)<br>0: Coast stop (switch off output voltage)<br>1: no free run-down |
| | 2 | Off3 | Quick Stop: Off3<br>0: Quick stop (shortest ramp)<br>1: no quick stop |
| | 3 | EN_Op | Operation released<br>0: Stop<br>1: Operation |
| | 4 | EN_Ramp | Enable Ramp<br>0: Reset ramp (setpoint value = 0)<br>1: Release ramp |
| | 5 | Un-Freeze | Freeze ramp<br>0: Freeze ramp (the ramp generator's current output value will be frozen)<br>1: Do not freeze ramp |
| | 6 | EN_Set | Enable Setpoint, DS7 Start/Stop:<br>EN_Set enables the setpoint value and starts or stops the motor with the ramp function.<br>0: Do not activate setpoint value<br>1: activate setpoint value |
| | 7 | FaultAck | Fault Acknowledge<br>0: Do not acknowledge current fault<br>1: Acknowledge current fault (rising edge: 0 → 1) |
| | 8 | – | Not used |
| | 9 | – | Not used |
| | 10 | Ctl_PLC | PLC assumes control (Control by PLC)<br>0: no control via PLC<br>1: Control via PLC |
| | 11 - 14 | – | Not used |
| | 15 | ExtFault | External Fault<br>If the bit is set, the DS7-SWD stops with a selected PNU 840 function. The behavior is the same as for a transition of the Enable signal from 1 to 0, except that soft starter DS7-SWD switches to Error state (input bytes n + 4: bit 3).<br>The external fault can be reset just like any other fault (with Fault acknowledge (bit 7) or by switching the supply voltage off and on.<br>0: no external fault<br>1: external fault |
| 1 | 0 - 15 | | Transmit values of currents from PKE motor-protective circuit-breaker to DS7 soft starter → section 8.9.3.14, "Profile 11: outputs (transmitting external current values to the DS7 soft starter, firmware V48 and higher)", page 181 |

## 8.9.4 Cyclic data via PROFIBUS-DP

➡ For information on the subject of the "transfer of cyclic data", consult manual MN05013002Z-EN, "SmartWire-DT Gateways."

## 8.9.5 acyclic data

For normal soft starter operation the acyclic data is not required. This section therefore addresses programming experts.

## 8.9.5.1 Introduction

Acylic communications are used to read and write parameters and diagnostics from and to the DS7-SWD soft starter and, optionally, the PKE motor-protective circuit-breaker; they can take place at the same time as cyclic data is being transferred. This means that acyclic communications are independent from the selected profile.

In this case, the SWD coordinator (client) communicates acyclically with the DS7-SWD soft starter (server) and, optionally, with the PKE motor-protective circuit-breaker. Communications are always initiated by the client.

➡ In order for acyclic data to be transmitted and diagnostic activities to be performed, the higher-level PLC must feature acyclic services.
The programmable EASY802-DC-SWD and EASY806-DC-SWD switchgear and controlgear do not feature acyclic services!

## 8.9.5.2 Acyclic DS7 soft starter data

The following table lists the various available parameters (PNUs). These parameters are transmitted via the parameter channel described in the following section.

| PNU Index | PNU Sub-index | Access rights | Designation | Data type | Meaning | Value range | DS | User setting |
|---|---|---|---|---|---|---|---|---|
| **Manufacturer Specific** | | | | | | | | |
| 11 | 0 | rw | U-Start | N2 | Start voltage | 30 - 100 % 4915 - 16384 | 30 % 4915 | |
| 11 | 1 | ro | U-StartPoti | N2 | Start voltage via potentiometer. If local device control (PNU 928=0), this value will overwrite PNU 11.0. | 30 - 100 % 4915 - 11468 | 4915 | |
| 12 | 0 | rw | U-StartEnd | N2 | U-start-end: The maximum ramp voltage is reproduced here as a percentage. Maximum reached: 100 % | 30 - 100 % 4915 - 16384 | 100 % 16384 | |
| 13 | 0 | rw | U-StopStart | N2 | U-stop-start: In the event of a soft stop, the voltage will fall down to the value set here; the stop ramp will start | 30 - 100 % 4915 - 16384 | 100 % 16384 | |
| 14 | 0 | rw | U-Stop | N2 | U-Stop: Minimum ramp voltage (end of soft stop), minimum reached = 0 % | 30 - 100 % 4915 - 16384 | 30 % 4915 | |
| 111 | 0 | rw | t-Start | T2 | Start time | 1 - 30 s 10 - 300 | 5 s 50 | |
| 111 | 1 | ro | t-Start-Poti | T2 | Start time via potentiometer. If local device control (PNU 928=0), this value will overwrite PNU 111.0. | 1 - 30 s 10 - 300 | – | |
| 112 | 0 | rw | TOR-Delay | D2 | Time between top of ramp and TOR bit | 150 - 400 ms 24576 - 65535 | 150 ms 24576 | |
| 113 | 0 | rw | Stop-Delay | D2 | Stop delay: Time between TOR and start of stop ramp | 150 - 400 ms 24576 - 65535 | 150 ms 24576 | |
| 114 | 0 | rw | t-Stop | T2 | Stop Time | 0 - 30 s 0 - 300 | 0 s 0 | |
| 114 | 1 | ro | t-StopPoti | T2 | Stop time via potentiometer. If local device control (PNU 928=0), this value will overwrite PNU 114.0. | 0 - 30 s 0 - 300 | – | |
| 202 | 0 | ro | Device Name | OctetString | DS7 designation | – | – | |
| 203 | 0 | ro | HW version | Unsigned16 | Hardware Version | 0 - 65535 | 0 | |
| 206 | 0 | ro | Firmware Version (DS7-SWD) | Unsigned16 | Firmware Version (DS7-SWD) | 0 - 65535 | – | |

| PNU Index | PNU Sub-index | Access rights | Designation | Data type | Meaning | Value range | DS | User setting |
|---|---|---|---|---|---|---|---|---|
| 210 | 0 | rw | $I_m$ | Unsigned16 | Rated motor current $I_m$ from nameplate:<br>X = $I_m$ x 10<br>X = Read/written value<br><br>**Example:**<br>Rated motor current: 2, 3 A<br>Value that the PLC needs to send: 23<br><br>The value is used to calculate the current limit (PNU 281.1).<br><br>It must be sent by the PLC if it is different from the DS7's rated operational current $I_e$. ($I_e$ is used as a default setting.) | 0 - 65535 | 0 | |
| 280 | 0 | ro | $I_e$ | Unsigned16 | Soft starter rated operational current $I_e$:<br>X = $I_e$ x 10<br>X = Value read here | 0 - 200 | – | |
| 281 | 1 | rw | CurrentLimit | Unsigned16 | Current limitation:<br>A current limitation can be implemented here by using a PKE. If the configured limit value is reached, the DS7-SWD will freeze the voltage ramp and set the CL bit in the SWD input byte (profiles 7, to 9, and 11). PNU 681.0 activates and deactivates the current limitation. If the PKE does not deliver any current, but PNU 681.0 = 1 and the DS7-SWD is running, the DIAG2 bit will be set and, in profiles 4 to 11, the WARN bit will be set as well.<br><br>Rated motor current $I_m$ (PNU 210.0) is used for calculating the current limitation within this context. The value is independent from the PKE motor-protective circuit-breaker and from the DS7-SWD soft starter model. | 0 - 800 %<br>65535 | 300 %<br>24576 | |
| 290 | 0 | ro<br>rw (version V48 and higher) | IeBreakerMax | Unsigned16 | Maximum current of PKE:<br>X = $I_e$Breaker x 10<br>X = Value read here<br><br>$I_e$ = 21.7 A; X = 217 | 0 - 650 | 0 | |
| 310 | 0 | ro | Profiles | Unsigned16 | Profile group being used<br>0: No selection<br>10: PROFIdrive profile (Profiles 7, 8, 9, 11)<br>11: Short profile (Profiles 4, 5, 6, 10)<br>12: Motor starter profile (Profiles 1, 2, 3) | 0 - 12 | 10 | |

| PNU Index | PNU Sub-index | Access rights | Designation | Data type | Meaning | Value range | DS | User setting |
|---|---|---|---|---|---|---|---|---|
| 362 | 0 | rw | ComLoss/Timeout | T2 | Time before automatic switch-off | 10 - 300 | 10 | |
| 514 | 1 | ro | IeBreaker | Unsigned16 | Current PKE current: Corresponds to I_REL of the cyclic input data with an expanded value range | 0 - 800 % 0 - 65535 | 0 | |
| 681 | 0 | rw | SetCurrentLimit | Unsigned8 | Used to enable PKE current limitation: 0: Current limitation deactivated 1: Current limitation activated | 0; 1 | 0 | |
| 723 | 0 | ro | OverloadStatus | Unsigned8 | Overload status: 0: No overload 1: Overload (main alarm) | 0; 1 | 0 | |
| 723 | 1 | ro | OverloadLimitStatus | Unsigned8 | Overload limit status: The overload limit status is based on PNU 823.1 0: Overload limit not reached 1: Overload limit reached → Potential impending overload fault (Early-warning) | 0; 1 | 0 | |
| 750 | 0 | ro | InputStatusA1 | Unsigned8 | Current status of control signal terminal A1: 0: Voltage unavailable 1: Voltage available | 0 - 256 | – | |
| 750 | 1 | ro | InputStatusEN | Unsigned8 | Current status of control signal terminal EN: 0: Voltage unavailable 1: Voltage available | 0 - 256 | – | |
| 751 | 0 | ro | RelaisStatusTOR | Unsigned8 | TOR relay status: 0: not activated 1: activated | 0 - 256 | 0 | |
| 751 | 1 | ro | RelaisStatusRUN | Unsigned8 | RUN relay status: 0: not activated 1: activated | 0 - 256 | 0 | |
| 820 | 0 | ro | StartCounter | Unsigned32 | Counter for the number of starts | $0 - (2^{32} - 1)$ | – | |
| 821 | 0 | ro | RunTime | T4 | Service life counter (RUN): Counts how long the DS7-SWD soft starter is switched on (RUN) | $0 - (2^{32} - 1)$ | – | |
| 821 | 2 | ro | PowerOnTime | T4 | Mains voltage counter: Counts how long mains voltage (L1, L2, L3) is applied at the DS7-SWD soft starter | $0 - (2^{32} - 1)$ | – | |
| 821 | 1 | ro | SupplyOnTime | T4 | Supply duration counter: Counts how long control voltage (24 V via terminal or SmartWire-DT) is applied | $0 - (2^{32} - 1)$ | – | |
| 822 | 0 | ro | HeatsinkTemp | Integer16 | Heat sink temperature | -255 - +255 °C -32767 - 32767 | 0 °C 0 | |

| PNU Index | PNU Sub-index | Access rights | Designation | Data type | Meaning | Value range | DS | User setting |
|---|---|---|---|---|---|---|---|---|
| 823 | 0 | ro | Overload | N2 | Current overload as a percentage: If the current current is lower/higher than the DS7-SWD's rated operational current, the value will fall/increase. If 100 %: PNU 723.0 = 1 | 0.00 - 200.00 % 0 - 32768 | 0 % 0 | |
| 823 | 1 | rw | OverloadLimit | N2 | Overload limit as a percentage: If the value for PNU 823.0 exceeds the limit value set with this parameter, PNU 723.1 will be set to 1. | 0.00 - 100.00 % 0 - 16384 | 100 % 16384 | |
| 840 | | | FaultReaction | | Fault reaction: The response to specific faults can be set in each subindex: 0: No fault response ➝ Continue operation 1: Set WARN bit ➝ Continue operation and generate a warning 2: Set DIAG and ERR bits ➝ Stop with ramp 3: Set DIAG and ERR bits ➝ Quick stop 4: Set DIAG and ERR bits ➝ Coast stop | | | |
| 840 | 0 | ro | Fire Mode | Unsigned16 | Fire Mode | 0 | 0 | |
| 840 | 4230 | rw | HeatsinkOverUnderTemp | Unsigned16 | Over/under temperature heat sink | 0 - 4 | 4 | |
| 840 | 4240 | rw | ElectronicsOverTemp | Unsigned16 | Overtemperature Electronic | 0 - 4 | 0 | |
| 840 | 4250 | rw | ThyristorOverTemp | Unsigned16 | Overtemperature, thyristor (I²t) | 0 - 4 | 4 | |
| 840 | 5110 | rw | SupplyVoltageFault | Unsigned16 | Supply voltage error | 0 - 4 | 4 | |
| 840 | 5410 | rw | ThyristorFault | Unsigned16 | Thyristor error | 0 - 4 | 4 | |
| 840 | 5460 | rw | BypassDefective | Unsigned16 | (Internal) bypass defective | 0 - 4 | 4 | |
| 840 | 6310 | rw | PhaseLoss | Unsigned16 | Phase loss A phase loss can only be detected while the ramp is active in the controlled phases. Once the unit stops or TOR is reached, the DS7-SWD soft starter will not be able to detect phase failures. When TOR is reached, the soft starter will continue running. Additional responses will depend on the motor protection equipment being used. | 0 - 4 | 4 | |
| 840 | 7500 | rw | CommunicationFault | Unsigned16 | erroneous communication | 0 - 4 | 4 | |
| 840 | 9000 | rw | ExternalFault | Unsigned16 | External fault | 0 - 4 | 4 | |

| PNU Index | PNU Sub-index | Access rights | Designation | Data type | Meaning | Value range | DS | User setting |
|---|---|---|---|---|---|---|---|---|
| 860 | 0 | ro | Warnings | Unsigned32 | Warnings<br>If bit WARN = 1 in profiles 7, 8, 9, 11, a warning is active. The warning can be read in PNU 860.0. Reading the warning will only be possible as long as the warning is active. Warning bits 16 to 24 will only be generated if the error response for the corresponding fault is (PNU 840.X) = 1. Example: PNU 860.0: Bit 20 = 1 → Thyristor fault<br><br>$2^0$: NoCurrentFeedback (generated if current limiting (PNU 681.0) is activated and the DS7-SWD soft starter has the RUN status.)<br>$2^1$: OvertempForNextStart (the heat sink is still too hot for a new start; however, continuous operation can be continued.)<br>$2^2$: StartWithoutEnable (start command active, but no EN signal present yet)<br>$2^{16}$: HeatsinkOverUnderTemp (Heat sink overtemperature/undertemperature)<br>$2^{17}$: ElectronicsOverTemp (Overtemperature Electronic)<br>$2^{18}$: ThyristorOverTemp (Overtemperature, thyristor ($I^2$t))<br>$2^{19}$: SupplyVoltageFault (Supply voltage error)<br>$2^{20}$: ThyristorFault (Thyristor error)<br>$2^{21}$: BypassDefective (Bypass is defective)<br>$2^{22}$: PhaseLoss (phase failure)<br>$2^{23}$: CommunicationFault (erroneous communication)<br>$2^{24}$: ExternalFault (external fault) | 0 - 4294967295 | | |

| PNU Index | PNU Sub-index | Access rights | Designation | Data type | Meaning | Value range | DS | User setting |
|---|---|---|---|---|---|---|---|---|
| **Profile-specific** | | | | | | | | |
| 927 | 0 | rw | ParameterAccess | Unsigned16 | Parameter level<br>Defines the parameter level. Changes are only possible if the DS7-SWD soft starter is stopped (state S1 or S2):<br>0: Local parameter access (control signal terminals and potentiometers)<br>1: Parameter access via network<br>2: Parameter access via network (except for potentiometer parameters), local access for potentiometers | 0 - 2 | 2 | |
| 928 | 0 | rw | ProcessDataAccess | Unsigned16 | Process data level:<br>Defines the process data level. Changes are only possible if the DS7-SWD soft starter is stopped (state S1 or S2):<br>0: Local control (control signal terminals and potentiometer)<br>1: Control via network<br>2: not used<br>3: not used<br>4: Control via network – automatic change to local control in the event of a loss of communications (PNU 928 = 0).<br>Switch back to network control as soon as communication is re-established.<br>5: Dual mode. EN/Start-Stop must be applied simultaneously with the interface commands. They will only be valid if both are present.<br><br>**Note:**<br>In the case of firmware version V46 and lower, the unit will switch to local control automatically only if the soft starter was correctly started after being switched on. | 0 - 5 | 4 (from version V46) | |
| 944 | 0 | ro | Fault Message Counter | Unsigned16 | Fault counter[1] | 0 - 65535 | | |
| 947 | 0 | ro | NewestFaultNumber | Unsigned16 | Fault Number<br>Fault numbers, listed chronologically | 0 - 65535 | 0 | |
| 947 | 1 | ro | | Unsigned16 | | 0 - 65535 | 0 | |
| 947 | 2 | ro | | Unsigned16 | | 0 - 65535 | 0 | |
| 947 | 3 | ro | | Unsigned16 | | 0 - 65535 | 0 | |
| 947 | 4 | ro | | Unsigned16 | | 0 - 65535 | 0 | |
| 947 | 5 | ro | | Unsigned16 | | 0 - 65535 | 0 | |
| 947 | 6 | ro | | Unsigned16 | | 0 - 65535 | 0 | |
| 947 | 7 | ro | OldestFaultNumber | Unsigned16 | | 0 - 65535 | 0 | |

| PNU Index | PNU Sub-index | Access rights | Designation | Data type | Meaning | Value range | DS | User setting |
|---|---|---|---|---|---|---|---|---|
| 950 | 0 | ro | Fault Situations | Unsigned16 | Number of faults and error messages that can be stored in the memory buffer | 8 | 8 | |
| | 1 | ro | Fault Messages | Unsigned16 | | 1 | 1 | |
| 952 | 0 | rw | FaultSituationCounter | Unsigned16 | Fault counter: Number of faults that have occurred since the last reset<br><br>**Note:**<br>A reset takes place both when the unit is switched on and when it is switched off (up to and including version V46).<br>In order to clear the fault counter, the value has to be set to 0 (in version V48 and higher). | 0 – 65535 | | |
| 962 | 0 | ro | SamplingTime | Time Difference | Scan time in ms:<br>Time required to calculate T2, T4, and D2. | $0 - (2^{32} - 1)$ | 100 | |
| 964 | 0 | ro | Manufacturer | Unsigned16 | Device identification (DriveUnitIdentification) - SWD Interface | 0 - 65535 | 265 | |
| 972 | 0 | rw | PowerOnReset | Unsigned16 | Carries out a restart:<br><br>**Notice:**<br>Modified parameters will not be saved. In order to save the parameters, PNU 977.0 must be set to 1. | 0; 1 | 0 | |
| 975 | | | Drive Object Identification | | Drive identification | | | |
| | 0 | ro | Manufacturer | Unsigned16 | | 0 - 65535 | 9 | |
| | 1 | ro | Drive Unit Type | Unsigned16 | | 0 - 65535 | 16 | |
| | 2 | ro | Version (SW) | Unsigned16 | | 0 - 65535 | 66 | |
| | 3 | ro | Firmware date (Year) | Unsigned16 | | 0 - 65535 | 221 | |
| | 4 | ro | Firmware date (day/month) | Unsigned16 | | 0 - 65535 | 83 | |
| | 5 | ro | DO Class | Unsigned16 | | 0 - 65535 | 0 | |
| | 6 | ro | DO sub class | Unsigned16 | | 0 - 65535 | 0 | |
| | 7 | ro | DO-ID | Unsigned16 | | 0 - 65535 | 0 | |
| | 8 | ro | reserved | Unsigned16 | | 0 - 65535 | 0 | |
| | 9 | ro | reserved | Unsigned16 | | 0 - 65535 | 0 | |
| | 10 | ro | Manufacturer Specific | Unsigned16 | | 0 - 65535 | 0 | |
| 976 | 0 | rw | FactorySettings | Unsigned16 | Resets all parameters to their default setting. | 0; 1 | 0 | |
| 977 | 0 | rw | SaveParameters | Unsigned16 | Stores all parameters in internal memory. | 0; 1 | 0 | |

| PNU Index | PNU Sub-index | Access rights | Designation | Data type | Meaning | Value range | DS | User setting |
|---|---|---|---|---|---|---|---|---|
| 980 | | ro | DefinedParameters | Unsigned16 | Defined parameters: List of PNUs being used without subindex. Each subindex contains a PNU. If the subindex holds a 0, the end of the list has been reached. | 0 - 65535 | – | |
| 980 | 0 | ro | U-Start | Unsigned16 | Start of list | | | |
| 980 | 1 | ro | U-StartEnd | Unsigned16 | | | | |
| 980 | 2 | ro | U-StopStart | Unsigned16 | | | | |
| 980 | … | ro | | Unsigned16 | | | | |
| 980 | n - 1 | ro | DO-Save parameter | Unsigned16 | | | | |
| 980 | n | ro | End of list | Unsigned16 | End of list | | | |

1) Every time there is a fault, the fault counter's value will be incremented by one. The corresponding information will be stored in non-volatile memory and can be used to analyze how many faults have occurred since the fault buffer was last reset. This makes it possible to compare it to the information obtained the last time the fault buffer was read in order to determine whether the messages in the fault buffer listed all faults or whether some have already been lost in the stack. As long as the difference between two read operations on the parameters is smaller than or equal to 8, all previous faults in the fault buffer will be accessible. The mechanism behind the fault buffer can result in a second or third fault appearing as a subsequent fault after a first fault: In this case, the user will only receive one single piece of information with the error bit, although there will actually be three new messages. In these cases, the fault counter can help determine which fault occurred first. DS7-SWD does not support any subsequent fault analyses.

**Fire Mode**

In normal operation each error message causes the soft starter to switch off.

If Fire mode is active, all protective functions can be disabled. In this case, the soft starter will continue to run until it is ruined. Fire mode can be activated by setting the error response to a value of "No response." Use parameter PNU 840 to do so. All the corresponding subindexes must be set to 0.

→ Fire mode can only be used when using profile 7, 8, 9, or 11. In addition, bus monitoring must be enabled.

The seven most recent faults will be stored in the device.

> ⚠ **DANGER**
>
> Having Fire mode enabled will pose a risk of serious injury, death, and property damage, as it will no longer be possible to control the soft starter and the soft starter will remain active.
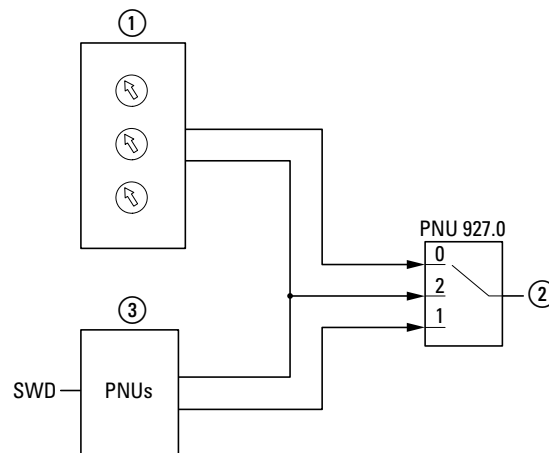
**PNU 927.0 (Parameter level)**



Figure 132: PNU 927.0

① Potentiometer
② Parameter soft starters DS7-SWD
③ acyclic data


**PNU 928.0 (process data level)**
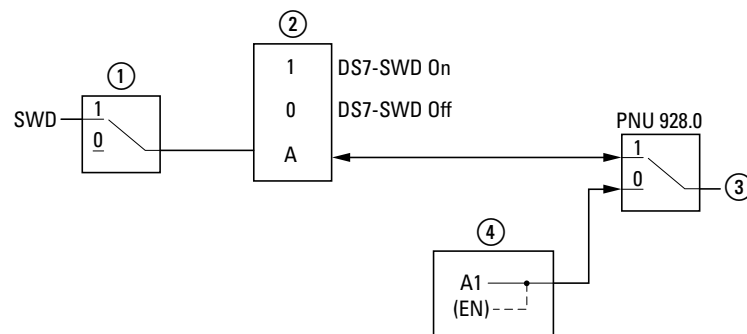


Figure 133: PNU 928.0

① Bit 10: Ctl_PLC (only applicable for 7, 8, 9, 11 profiles)
② 1-0-A switch
③ DS7-SWD soft starter process data
④ Control signal terminals

If parameter PNU 928 is set to 0 (WE1), it will be possible to control the device using the terminals (the device will then behave like a DS7 soft starter without a SmartWire-DT connection). It will continue to be possible to read data via SmartWire-DT.

➡ If the DS7-SWD soft starter is run using the control signal terminals, the SmartWire-DT system's ground must be at the same zero potential.

### 8.9.5.3 cycle time

SmartWire-DT will require a certain amount of time in order to transmit data to the DS7-SWD soft starter. Likewise, the DS7-SWD soft starter will require a certain amount of time in order to perform the corresponding commands.

Following are a couple of examples showing response times for cyclic data transfers and for the feedback signal sent back to the PLC.

**Example 1:**
**XC202… controller, PROFIBUS DP interface, 2 slaves**

| Size | Set value |
| --- | --- |
| Baud Rate | 500 kBaud at DP<br>250 kBaud at SWD |
| Start | 150 - 200 ms |
| Stop | 150 - 200 ms |
| Coast Stop | 1.5 s (complete stop) |
| External Error | 150 - 200 ms (complete stop) |

**Example 2:**
**XC202… controller, PROFIBUS DP interface, 58 slaves**

| Size | Set value |
| --- | --- |
| Baud Rate | 9.6 kBaud at DP<br>125 kBaud at SWD |
| Start | 600 ms |
| Stop | 600 ms |
| Quick Stop | 2 - 2.5 s |

In the case of PROFIBUS DP, the decisive factor for response time is the baud rate, not the number of slaves.

### 8.9.5.4 Acyclic PKE motor-protective circuit-breaker data

In addition to cyclic input and output bytes, the DS7-SWD soft starter makes it possible to read the following acyclic PKE data. The parameter channel described in the following section is not required for transmitting the data.

Table 40: Available data

| Index | Byte | Bit | Designation | Description | | |
|-------|------|-----|-------------|-------------|---|---|
| 1 | 0 | 0 - 7 | I_REL | Relative motor current PKE :<br>Set rated operational current on PKE<br>$00_{hex} - FF_{hex}$ (i. e. 0 - 255 %) | | |
| 2 | 0 | 0 - 7 | TH | PKE thermal motor map (specified as a percentage) | | |
| 3 | 0 | 0 - 2 | TYPE | Part no. of PKE trip block | | |
| | | | | Value [hex] | PKE- | trip block |
| | | | | 0 | XTUA-1.2 | 0.3 - 1.2 A |
| | | | | 1 | XTUA-4 | 1.0 - 4.0 A |
| | | | | 2 | XTUA-12 | 3.0 - 12 A |
| | | | | 3 | XTUA-32 | 8.0 - 32 A |
| | | | | 4 | XTUWA-32 | 8.0 – 32 A (width 55 mm) |
| | | | | 5 | XTUWA-65 | 16.0 - 65 A |
| | | 3 - 5 | CLASS | set PKE time lag | | |
| | | | | Value [hex] | Time-lag class | Time |
| | | | | 0 | Class 5 | 146.2 s |
| | | | | 1 | Class 10 | 292.5 s |
| | | | | 2 | Class 15 | 438.7 s |
| | | | | 3 | Class 20 | 585.0 s |
| | | | | 4 | test | |
| | | 6, 7 | – | Not used | | |

➜ For a description of acyclic communications with the PKE motor-protective circuit-breaker via PROFIBUS-DP, see ➜ section 8.9.9, "Acyclic data via PROFIBUS-DP: PKE".

## 8.9.6 Acyclic parameter channel for DS7-SWD soft starter

### 8.9.6.1 Introduction

The acyclic parameter channel is used in order to configure the parameters of the DS7-SWD soft starter; it corresponds to PROFIdrive profile.

The following sections describe the parameter channel's functions.

### 8.9.6.2 Protocol

The DS7-SWD soft starter is responsible, among other things, for mapping the protocol in such a way that SmartWire-DT will be able to use the parameter channel in a fully transparent manner. Regardless of whether data should be read or written, the first request from the coordinator will always be a write request. The parameter request will define whether the job is a read job or a write job. After the write request is transmitted (contains read or write job), a write response without data will be expected. After this, the coordinator, prompted by the higher-level PLC's application, will poll the DS7 with read requests. The DS7 will acknowledge the read requests negatively (error: state conflict) until the read response is completed and the DS7 can send a response (read job: with data / write request: without data).
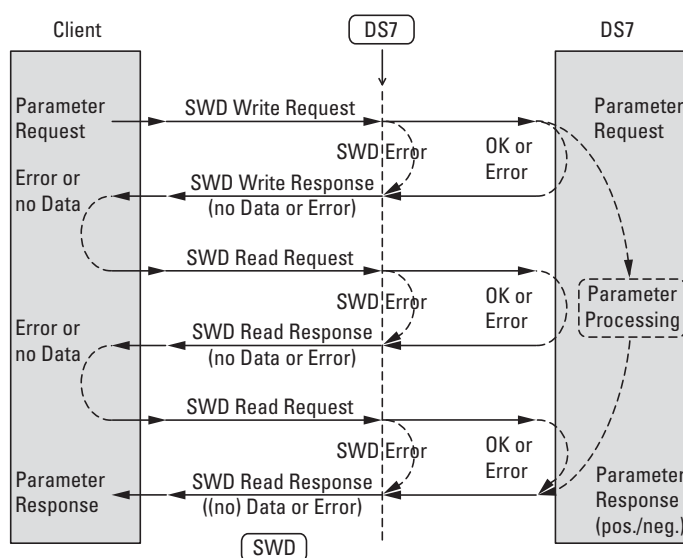


Figure 134: Acyclic parameter channel protocol

### 8.9.6.3 SmartWire-DT write request – Read job

Only individual parameter reading is supported (i.e., array and multiple parameter reading is not supported). The parameter request's frame length is set at 10 bytes.

Various objects can be transmitted in the parameter channel – these objects are identified by what is referred to as a PNU (parameter number) and a subindex. The write request includes a declaration that specifies that the job is a read job.

| Byte | Designation | Description |
|---|---|---|
| 0 | Request Reference | Request identification: Unique identification for a request/response pair for the master. The master can increment the identification number for each new request in the application. It will be echoed by the DS7-SWD soft starter after this. $01_{hex}$ - $FF_{hex}$ (i.e. $1_{dec}$ - $255_{dec}$) |
| 1 | Request ID | Request ID: The type of request is specified here. $01_{hex}$: Read request |
| 2 | DO-ID | Drive-Object-ID: $00_{hex}$ |
| 3 | No. of Paramters | Number of parameters: Only individual parameter processing is supported. $01_{hex}$ |
| 4 | Attribute | Attribute: Defines which object type should be accessed. $10_{hex}$ ($16_{dec}$): Value |
| 5 | No. of Elements | Number of elements: Address of the parameter that should be accessed PNU 0 - PNU 999: $00_{hex}$ (for subindex 0 only) PNU 0 - PNU 999 (without 202): $01_{hex}$ |
| 6, 7 | Parameter number | Parameter number (PNU): Address of the parameter that should be accessed $0000_{hex}$ - $FFFF_{hex}$ (i. e. $0_{dec}$ - $65535_{dec}$) |
| 8, 9 | Subindex | Subindex: Address of the parameter's first field element or start of the text $0000_{hex}$ - $FFFF_{hex}$ (i. e. $0_{dec}$ - $65535_{dec}$) |

➡ In this case, the number of bytes is always 10.

### 8.9.6.4 SmartWire-DT write request – Write job

Only individual parameter writing is supported (i.e., array and multiple parameter writing is not supported). The maximum parameter request frame length is set at 16 bytes. The maximum length of a writable parameter is one double word. All kinds of objects can be transmitted in the parameter channel – these objects are identified by what is referred to as a PNU (parameter number) and a subindex. The write request includes a declaration that specifies that the job is a write job.

| Byte | Designation | Description |
|------|-------------|-------------|
| 0 | Request Reference | Request identification: <br> Unique identification for a request/response pair for the master. The master can increment the identification number for each new request in the application. The DS7-SWD will then echo it. <br> $01_{hex}$ - $FF_{hex}$ (i.e. $1_{dec}$ - $255_{dec}$) |
| 1 | Request ID | Request ID: <br> The type of request is specified here. <br> $02_{hex}$: Write job |
| 2 | DO-ID | Drive-Object-ID: <br> $00_{hex}$ |
| 3 | No. of Paramters | Number of parameters: <br> Only individual parameter processing is supported. <br> $01_{hex}$ |
| 4 | Attribute | Attribute: <br> Defines which object type should be accessed. <br> $10_{hex}$ ($16_{dec}$): Value |
| 5 | No. of Elements | Number of elements: <br> Address of the parameter that should be accessed <br> PNU 0 - PNU 999: $00_{hex}$ (for subindex 0 only) <br> PNU 0 - PNU 999: $01_{hex}$ |
| 6, 7 | Parameter number | Parameter number (PNU): <br> Address of the parameter that should be accessed <br> $0000_{hex}$ - $FFFF_{hex}$ (i.e. $0_{dec}$ - $65535_{dec}$) |
| 8, 9 | Subindex | Subindex: <br> Address of the parameter's first field element or start of the text <br> $0000_{hex}$ - $FFFF_{hex}$ (i.e. $0_{dec}$ - $65535_{dec}$) |
| 10 | Format | Format: <br> $01_{hex}$ - $7C_{hex}$ ($\rightarrow$ $01_{dec}$ - $124_{dec}$) |
| 11 | No. of Values | Number of values being accessed. <br> $01_{hex}$ |
| 12 - (15) | Value | Value: Specifies the value of the parameter being accessed. <br> The length depends on the format and can be a maximum of 4 bytes. <br> $00000000_{hex}$ - $FFFFFFFF_{hex}$ (i. e. $0_{dec}$ - $4294967295_{dec}$) |

➜ In this case, the number of bytes is variable (13, 14, or 16) and will depend on the selected format.

The valid formats (byte 10) for the DS7-SWD soft starter from PROFIdrive profile are marked in the following table:

| Data type | Code (dec) | Code (hex) |
|---|---|---|
| **Standard** | | |
| Integer16 | 3 | 3 |
| Unsigned8 | 5 | 5 |
| Unsigned16 | 6 | 6 |
| Unsigned32 | 7 | 7 |
| OctetString | 10 | A_x |
| TimeDifference | 13 | D |
| **Additional** | | |
| Zero | 64 | 40 |
| Byte | 65 | 41 |
| Word | 66 | 42 |
| Double word | 67 | 43 |
| Error | 68 | 44 |
| **Profile-specific** | | |
| N2 Normalized value (16 Bit) | 113 | 71 |
| V2 Bit sequence | 115 | 73 |
| T2 Time constant (16 Bit) | 118 | 76 |
| T4 Time constant (32 Bit) | 119 | 77 |
| D2 Time constant | 120 | 78 |

## 8.9.7 Data types

There are special data types defined for PROFIdrive communications: PROFIdrive-specific and standard data types.

## 8.9.7.1 PROFIdrive specific

### TimeDifference ($13_{dec}$)

The value used by the DS7-SWD soft starter for TimeDifference is stored in the Sampling Time (PNU 962) parameter.

| Data type | Code (dec) | Code (hex) | Bytes | Value range | Resolution |
|---|---|---|---|---|---|
| TimeDifference | 13 | D | 2 | $0 \leq i \leq 4294967295$ | $2^{-31} \triangleq 0.021$ ms |

Example:

100 ms = $4971_{dec}$ = $136B_{hex}$

86400000 ms (= 1 day) = $4294967295_{dec}$ = $FFFFFFFF_{hex}$

### Normalised value: N2

N2 is a normalized value for relative scaling. N2 falls within a range of -200 % to +200 %.

| Data type | Code (dec) | Code (hex) | Bytes | Value range | Resolution |
|---|---|---|---|---|---|
| N2 Normalized value (16 Bit) | 113 | 71 | 2 | $-200\ \% \leq i \leq (200 - 2^{-14})\ \%$ | $2^{-14} \triangleq 0.0061$ % |

Conversion examples:

Without a sign bit:
$0_{dec}$ = $0x0000_{hex}$ $\triangleq$ 0 %
$1_{dec}$ = $0x0001_{hex}$ $\triangleq$ 0.0061 %
$16384_{dec}$ = $0x4000_{hex}$ $\triangleq$ 100 %
$32767_{dec}$ = $0x7FFF_{hex}$ $\triangleq$ 199.99 %

With a sign bit (bit 15):
$-1_{dec}$ = $0xFFF_{hex}$ $\triangleq$ -0.0061 %
$-16384_{dec}$ = $0xC000_{hex}$ $\triangleq$ -100 %
$-32768_{dec}$ = $0x8000_{hex}$ $\triangleq$ -200 %

For coding, the most significant bit (MSB) comes directly after the SN bit (sign bit) in the first octet.

- SN = 0: Positive numbers, including zero
- SN = 1: Negative numbers

| Octet | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit3 | Bit 2 | Bit1 |
|---|---|---|---|---|---|---|---|---|
| 1 | SN | $2^{-0}$ | $2^{-1}$ | $2^{-2}$ | $2^{-3}$ | $2^{-4}$ | $2^{-5}$ | $2^{-6}$ |
| 2 | $2^{-7}$ | $2^{-8}$ | $2^{-9}$ | $2^{-10}$ | $2^{-11}$ | $2^{-12}$ | $2^{-13}$ | $2^{-14}$ |
| 3 | $2^{-15}$ | $2^{-16}$ | $2^{-17}$ | $2^{-18}$ | $2^{-19}$ | $2^{-20}$ | $2^{-21}$ | $2^{-22}$ |
| 4 | $2^{-23}$ | $2^{-24}$ | $2^{-25}$ | $2^{-26}$ | $2^{-27}$ | $2^{-28}$ | $2^{-29}$ | $2^{-30}$ |

**Bit sequence: V2**

In this bit string, 16 variables of type BOOLEAN are represented in two octets.

Code: $115_{dec} = 73_{hex}$

| Octet | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit3 | Bit 2 | Bit1 |
|---|---|---|---|---|---|---|---|---|
| 1 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
| 2 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

**Time constant: D2**

Values of time data type D2 always refer to a specific, constant scan time $T_a$. This time Ta is the shortest scan time (defined in PNU 962) and is required here in order to evaluate D2.

The value for D2 can be calculated as follows:

$D2 = i \times T_a/16384$

| Data type | Code (dec) | Code (hex) | Byte | Value range | Resolution |
|---|---|---|---|---|---|
| D2 Time constant | 120 | 78 | 1 | $0 \leq i \leq (2 - 2^{-14}) \times T_a$ | $2^{-14} \times T_a$ |

Time constant: T2

Values of time data type T2 are always relative to a specific constant scan time $T_a$. $T_a$ is the shortest scan time (defined in PNU 962). It is required here to calculate T2.

The following formula applies: $T2 = i \times T_a$

| Data type | Code (dec) | Code (hex) | Byte | Value range | Resolution |
|---|---|---|---|---|---|
| T2 Time constant (16 Bit) | 118 | 76 | 1 | $0 \leq i \leq 32767 \times T_a$ | $T_a$ |
| T2 Time constant (32 Bit) | 119 | 77 | 2 | $0 \leq i \leq 4294967295 \times T_a$ | $T_a$ |

➡ For more detailed information on the data types, refer to the following as well: IEC 61158-5: 2003

### 8.9.7.2 SmartWire-DT write response

The DS7 soft starter will respond to a received SmartWire-DT write request with a SmartWire-DT write response.

The following SmartWire-DT write responses are possible:

*   SWD write response(+) – Without data or errors if the DS7 soft starter has understood the SmartWire-DT write request
*   SWD write request(-) – Error. If an error has occurred, the write response will contain an error. These errors are bus-specific and are explained in the corresponding sections.

> For the various possible errors, see → section 8.9.8, "Acyclic data via PROFIBUS-DP: DS7".

### 8.9.7.3 SmartWire-DT read request

After receiving a positive SmartWire-DT write response, it is possible to start polling SmartWire-DT read requests. If a write job has been transmitted previously, information regarding the write status will be requested; in the case of a read job, the data will be requested.

### 8.9.7.4 SmartWire-DT read response

The SmartWire-DT read request will be acknowledged until there is a SmartWire-DT read response.

The following SmartWire-DT read responses are possible:

*   SmartWire-DT read response(-) – Error.
    *   If there is an error related to addressing (index)
    *   The DS7-SWD soft starter cannot be reached
    *   If the response from the DS7-SWD is still pending.

*   SmartWire-DT read response(+) – Parameter channel error,
    *   If the error concerns the PROFIdrive parameter channel.

*   SmartWire-DT read response(+) – Without data,
    *   If the DS7-SWD soft starter has completed the response for a write job.

*   SWD read response(+) – with data,
    *   If the DS7-SWD soft starter has completed the response for a read job

The following sections go into the various possible SmartWire-DT read responses in greater detail.

**SmartWire-DT read response(-) – Error**

If an error has occurred, the read response will contain an error. These errors are bus-specific and are explained in the corresponding sections.

**SmartWire-DT read response(+) – Parameter channel error**

If there is an error in the parameter channel, a positive SmartWire-DT read response(+) – Parameter channel error will be generated. The error will be contained either in a write job or a read job.

| Byte | Designation | Description |
|------|-------------|-------------|
| 0 | Request Reference | Request identification: Is echoed |
| 1 | Response-ID | Response ID: $81_{hex}$: Read job(-); $82_{hex}$: Write job(-) |
| 2 | DO-ID | Drive-Object-ID: Is echoed |
| 3 | No. of Parameters | Number of Parameters: $01_{hex}$ |
| 4 | Format | Format: $44_{hex}$: Error |
| 5 | No. of Values | Number of values: $01_{hex}$ |
| 6 - 9 | Error Number | Fault Number: $00_{hex}$ - $23_{hex}$ |

The following table lists the PROFIdrive profile's parameter channel errors. The various errors that are possible when using a DS7-SWD soft starter are marked („DS7-SWD" column).

Table 41: Parameter channel errors with PROFIdrive

| Faultnumber [hex] | Designation | Description | Supplementary information | DS7-SWD |
|-------------------|-------------|-------------|---------------------------|---------|
| 00 | Invalid parameter number | Attempting to access a non-available parameter | 0 | ✓ |
| 01 | Parameter value cannot be changed | Attempting to have write access to a parameter that cannot be modified | Subindex | ✓ |
| 02 | Value below lower limit or above upper limit | Attempting to have write access with a value outside the value range | Subindex | ✓ |
| 03 | Bad subindex | Attempting to access to a non-available subindex in a string or array parameter | Subindex | ✓ |
| 04 | Not an array | Attempting to use a subindex in order to access a parameter without index | 0 | |
| 05 | Incorrect data type | Attempting to access a parameter with a value not corresponding to the parameter's data type | 0 | ✓ |
| 06 | Setting not allowed | Write access with a non-zero value not allowed | Subindex | ✓ |
| 07 | Description element cannot be modified | Attempting to have write access to a description element that cannot be modified | Subindex | |
| 08 | reserved | – | – | |
| 09 | No description data available | Attempting to access a non-available description. The value is not available. | 0 | ✓ |
| 0A | reserved | – | – | |
| 0B | No usage rights | Attempting to have write access without write permissions | 0 | ✓ |
| 0C | reserved | – | – | |

| Faultnumber [hex] | Designation | Description | Supplementary information | DS7-SWD |
|---|---|---|---|---|
| 0D | reserved | – | – | |
| 0E | reserved | – | – | |
| 0F | No text array available | Attempting to access a non-available text array | 0 | |
| 10 | reserved | – | – | |
| 11 | Request cannot be carried out due to operating status | Access is temporarily not possible | 0 | ✓ |
| 12 | reserved | – | – | |
| 13 | reserved | – | – | |
| 14 | Value not permitted | Attempting to have write access with a value that is within the value range, but that is not permitted due to other reasons (parameter with defined values) | Subindex | ✓ |
| 15 | Request too long for acyclic communication channel | The length of the current request exceeds the maximum permitted length of the acyclic communication channel. | 0 | |
| 16 | Parameter address not permissible | Not permissible or non-supported value for attribute, No. of elements, parameter number, subindex, or a combination thereof | 0 | ✓ |
| 17 | Format not permissible | Write request: Invalid format or format not permissible for this parameter | 0 | |
| 18 | No. of values are not consistent | Write request: The number of values in the parameter data does not match the number of values for the parameter address. | 0 | |
| 19 | DO does not exist | Attempting to access a non-existing drive object | 0 | ✓ |
| 20 | Parameter text element cannot be changed | Attempting to have write access to a parameter text element without write permissions | Subindex | |
| 21 | Not permissible request ID | unsupported service | | ✓ |
| 22 | Response too long for parameter manager | The length of the current response exceeds the parameter manager's parameter processing capacity | | |
| 23 | Multiple parameter access not permissible | Is not supported. | | ✓ |
| …-64 | reserved | – | | |
| 65-FF | manufacturer specific | – | | |

### SmartWire-DT read response(+) – Without data

As soon as the DS7-SWD soft starter has completed the response for a write job, it will send a SmartWire-DT read response(+) – without data.

| Byte | Designation | Description |
|---|---|---|
| 0 | Request Reference | Request identification: Is echoed |
| 1 | Response-ID | Response ID: $02_{hex}$: Write job (+) |
| 2 | DO-ID | Drive-Object-ID: Is echoed |
| 3 | No. of Parameters | Number of Parameters: $01_{hex}$ |

### SmartWire-DT read response(+) – With data (all PNUs)

As soon as the DS7-SWD soft starter has completed the response for a read job for the range PNU 0 – PNU 999 (without PNU 202), it will send a SmartWire-DT read response(+) – with data.

| Byte | Designation | Description |
|---|---|---|
| 0 | Request Reference | Request identification: Is echoed |
| 1 | Response-ID | Response ID: $01_{hex}$: Read job (+) |
| 2 | DO-ID | Drive-Object-ID: Is echoed |
| 3 | No. of Parameters | Number of Parameters: $01_{hex}$ |
| 4 | Format | Format: $01_{hex}$ – $7C_{hex}$ (i.e. $01_{dec}$ – $124_{dec}$) |
| 5 | No. of Values | Number of values: $01_{hex}$ : value |
| 6 - 9 | Value | Value: Specifies the value of the parameter being accessed. The length depends on the format and can be a maximum of 4 bytes. $00000000_{hex}$ - $FFFFFFFF_{hex}$ (i. e. $0_{dec}$ - $4294967295_{dec}$) Content of PNU 0 – PNU 999 (without PNU 202) |

### SmartWire-DT read response(+) – With data (PNU 202)

As soon as the DS7-SWD soft starter has completed the response for a PNU 202 read job, it will send a SmartWire-DT read response(+) – with data.

| Byte | Designation | Description |
|---|---|---|
| 0 | Request Reference | Request identification: Is echoed |
| 1 | Response-ID | Response ID: $01_{hex}$: Read job (+) |
| 2 | DO-ID | Drive-Object-ID: Is echoed |
| 3 | No. of Parameters | Number of Parameters: $01_{hex}$ |
| 4 | Format | Format: $0A_{hex}$ (= $10_{dec}$) |
| 5 | No. of Values | Number of values: $01_{hex}$: value |
| 6 - 25 | Value | Value: Specifies the value of the parameter being accessed. The length depends on the format and can be a maximum of 20 bytes. Content of PNU 202 |

## 8.9.8 Acyclic data via PROFIBUS-DP: DS7

### 8.9.8.1 Introduction

Acyclic communications with a slave via PROFIBUS-DP can basically be established by a Class 1 master and a Class 2 master simultaneously. This means that the DS7-SWD soft starter will need to handle acyclic requests and responses from/to both masters.

➡ For more information on the subject of the transfer of acyclic data, consult the MN05013002Z-EN manual, "SmartWire-DT Gateways."

### 8.9.8.2 Addressing

The parameter channel is embedded as a payload data block in the acyclic PROFIBUS write/read PDUs.

The acyclic data objects of a slave are addressed via slots and indexes on the PROFIBUS. SWD maps the slot to the SWD module address. The parameter channel is always addressed with index 47.

### 8.9.8.3 protocol

Acyclic services (index-based addressing and payload data) are mapped the same way on SmartWire-DT by the PROFIBUS-DP gateway (EU5C-SWD-DP). As a result, the parameter channel can be used in a fully transparent manner by SmartWire-DT modules.

The following diagram shows the protocol between the PROFIBUS-DP master, PROFIBUS-DP gateway, and DS7-SWD soft starter.
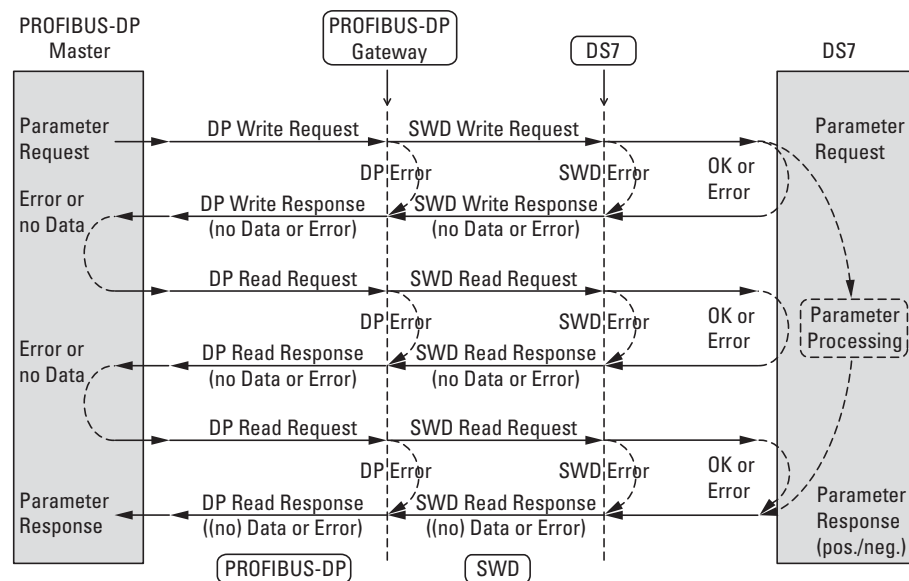


Figure 135: Acyclic PROFIBUS-DP parameter channel protocol

### 8.9.8.4 SmartWire-DT write response(-) – Error

This section shows the various possible device-specific errors that can occur during communications via the acyclic parameter channel with PROFIBUS-DP.

The following table describes the various possible errors that can be contained in the SmartWire-DT write response(-) – error.

| Error Type | Failure code | Description |
|---|---|---|
| Error_Code_1 | A1$_{hex}$ | Write error: Only reading allowed for indexes 1 – 3 (PKE motor-protective circuit-breaker). |
| Error_Code_1 | A2$_{hex}$ | DS7-SWD soft starter cannot be reached. |
| Error_Code_1 | B0$_{hex}$ | There is no valid index. |
| Error_Code_1 | B1$_{hex}$ | Parameter request block too long. |
| Error_Code_1 | B5$_{hex}$ | Parameter access temporarily not permissible due to internal processes. |

In the case of XSoft-CoDeSys, only error code 54$_{dec}$ (representing the errors listed above) can be output via function blocks XDPMV1_READ and XDPMV1_WRITE when using a PROFIBUS-DP master.

➜    For more information, see ➜ section 8.9.6, "Acyclic parameter channel for DS7-SWD soft starter", page 198.

### 8.9.8.5 SmartWire-DT read response(-) – Error

This section shows the various possible device-specific errors that can occur during communications via the acyclic parameter channel with PROFIBUS-DP.

The following table describes the various possible errors that can be contained in the SmartWire-DT read response(-) – error.

| Error Type | Failure code | Description |
|---|---|---|
| Error_Code_1 | A1$_{hex}$ | Write error: Only reading allowed for indexes 1 – 3 (PKE motor-protective circuit-breaker). |
| Error_Code_1 | A2$_{hex}$ | DS7-SWD soft starter cannot be reached. |
| Error_Code_1 | B0$_{hex}$ | There is no valid index. |
| Error_Code_1 | B5$_{hex}$ | Parameter access temporarily not permissible due to internal processes |

In the case of XSoft-CoDeSys, only error code 54dec (representing the errors listed above) can be output via function blocks XDPMV1_READ and XDPMV1_WRITE when using a PROFIBUS-DP master.

➜    For more information, see ➜ section 8.9.6, "Acyclic parameter channel for DS7-SWD soft starter", page 198.

➜    For more information on the subject of acyclic data access blocks for PROFIBUS-DP, consult manual MN05010002Z-EN, "Function Blocks for XSoft-CoDeSys."

## 8.9.9 Acyclic data via PROFIBUS-DP: PKE

### 8.9.9.1 Introduction

Acyclic communications with a slave via PROFIBUS-DP can basically be established by a Class 1 master and a Class 2 master. This means that the PKE motor-protective circuit-breaker needs to handle acyclic requests and responses from and to the masters via the DS7-SWD soft starter.

### 8.9.9.2 Addressing

The PKE motor-protective circuit-breaker provides three objects for acyclic read access. These objects are addressed with index 1, index 2, index 3; as a result, they can be separated from index 47, which is used to address the DS7-SWD soft starter's PROFIdrive objects.

### 8.9.9.3 Protocol

The DS7-SWD soft starter is used to map the protocol in such a way that it is also possible to access the PKE motor-protective circuit-breaker acyclically via SmartWire-DT.

In order to perform a read operation, the coordinator sends a read request. As a response, the requested data or an error message (as the case may be) is sent directly by the PKE motor-protective circuit-breaker via the DS7-SWD soft starter.
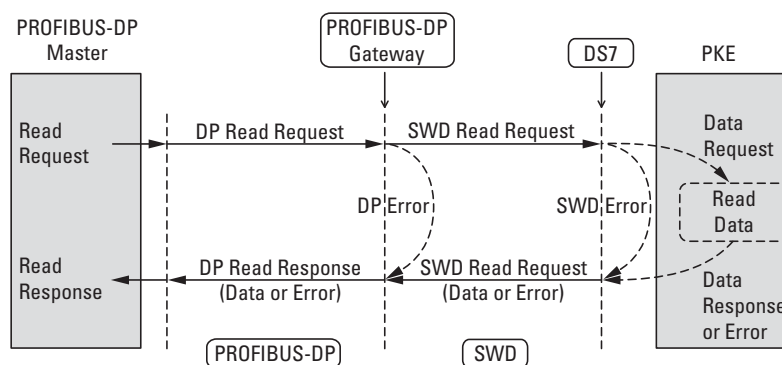


Figure 136: Protocol between PROFIBUS-DP master and PKE motor-protective circuit-breaker via DS7-SWD

➜ Further information on the subject of the "transfer of acyclic data", consult manual MN05013002Z-EN, "SmartWire-DT Gateways."

## 8.10 SmartWire-DT diagnostics

The DS7-SWD soft starter sends diagnostic messages for itself and, optionally, for the PKE motor-protective circuit-breaker.

Basically, a distinction must be drawn between:

- Basic diagnostics (basic SmartWire-DT diagnostics),
- Advanced diagnostics (advanced SmartWire-DT diagnostics) and
- PROFIdrive parameter channel diagnostics

PROFIdrive parameter channel diagnostics are shown with error messages or warnings, as applicable, in the cyclic profile with PROFIdrive (profiles 7, 8, 9, 11).

## 8.10.1 Basic SWD Diagnostics

A pending diagnostic message from the DS7-SWD soft starter will be signalled as a collective diagnostic in the cyclic profile with input byte 0, bit 4 (DIAG). A device response, if any, will be described in the advanced diagnostics.

In addition, in profiles 4 to 11, the following bits

- ERR (DS7-SWD stops)
- WARN (no response from DS7-SWD)

in the corresponding input bytes are used to show whether there are any diagnostic messages (i.e. errors or warnings).

Once you fix the fault's cause, you can acknowledge a fault (ERR) as follows:

- Profiles 1, 2, and 3: DS7 Start/Stop 1 ➝ 0
- Profiles 4 to 11: FaultAck = 1
- 1-0-A switch in position 0

Warnings (WARN) cannot be acknowledged, since they are simply messages without an ensuing response (from the DS7-SWD soft starter).

The diagnostic data that corresponds to the PROFIdrive profile can be sent at any time regardless of the profile chosen. It is provided via the acyclic services of the relevant bus system.

➡ For available diagnosis messages FaultBuffer: PNU 947 sub-index 0 to 7 ➝ section 8.9.5, "acyclic data", page 185.

### 8.10.2 Advanced SmartWire-DT diagnostics

When there is a collective diagnostic (input byte 0, bit 4 (DIAG)), the DS7-SWD soft starter will provide advanced diagnostic messages:

**Motor-protective circuit-breaker diagnostic messages (profiles 1 to 9)**

The following are the messages generated by the PKE motor-protective circuit-breaker:

Table 42: PKE motor-protective circuit-breaker diagnostic messages

| Value [hex] | Meaning | Remedy | Notes |
|---|---|---|---|
| 3 | No communication Between DS7-SWD soft starter and PKE trip block | Check whether the PKE trip block being used is a PKEXTUA-… trip block. Check the PKE32-COM connections and reconnect the device if necessary. | The DS7-SWD can continue to be used in this state. The main circuits are isolated by the PKE in the event of an overload. In these cases, an enabled overload function (ZMR) will not have any effect. |

**Soft starter diagnostic messages (profiles 1 to 11)**

The following are the messages generated by the DS7-SWD soft starter:

Table 43: DS7-SWD soft starter diagnostic messages

| Value [hex] | Meaning | Remedy | Notes |
|---|---|---|---|
| 14 | Internal communication problem in soft starter | • If the error continues, switch the supply voltage off/on<br>• Check EMC<br>• Replace soft starter | – |
| 15 | no unambiguous position of the 1-0-A switch for more than 4 seconds | Move the 1-0-A switch to one of the three defined positions. | Value $00_{hex}$ is signaled using input byte 0, bits 2 and 3. For more information, see below. |
| 19 | There is a DS7-SWD soft starter warning. | Read warning PNU 860.0 and fix the cause | Corresponds to the WARN bit in the corresponding input byte |
| 1A | There is a DS7-SWD soft starter fault. | • Read fault PNU 944 to PNU 952<br>• Fix the fault and acknowledge the error message | Corresponds to the ERR bit in the corresponding input byte |

**Diagnostic alarm $15_{hex}$**

If the 1-0-A switch does not assume a clear position for longer than 4 seconds, the DS7-SWD soft starter will be switched off and generate the following error messages:

• DIAG,
• ERR (only profiles 4 to 11),
• Diagnostic alarm $15_{hex}$ (➜ table 43).

In addition, the module's SmartWire-DT diagnostic LED will flash green (frequency: 3 Hz).

## 8.10.2.1 Advanced SmartWire-DT diagnostics via PROFIBUS

➜ For information on the subject of advanced diagnostics, consult manual MN05013002Z-EN, "SmartWire-DT Gateways".

For basic information on diagnostics via PROFIBUS-DP masters, consult manual MN05002002Z-EN, "XI/OC Signal Modules." The manual also contains explanations regarding the access of the diagnostic data of a PROFIBUS-DP slave module.

## 8.10.3 PROFIdrive diagnostics

Diagnostic data that corresponds to the PROFIdrive profile can be sent at any time regardless of the profile that has been chosen. It is provided via the acyclic parameter channel of the relevant bus system.

The ERR and WARN bits in corresponding input bytes 4 to 11 are used to show whether there are any diagnostic messages present (i.e., errors or warnings).

Faults (ERR) can be acknowledged as follows:

- Profiles 1, 2 and 3: DS7 Start/Stop 1 ➜ 0
- Profiles 4 to 11: FaultAck = 1

Warnings (WARN) cannot be acknowledged, since they are simply messages without a response (from the DS7-SWD soft starter).

➜ Available diagnostic messages (PNU 860.0 warnings and PNU 944 to PNU 952 faults)➜ section 8.9.5, "acyclic data".

### 8.10.4 SmartWire-DT diagnostic LEDs

The following table shows the information that can be determined based on the SmartWire-DT diagnostic LEDs.

Table 44: SmartWire-DT diagnostic LED indications

| Color LED | Switch command | Position 1-0-A switch | Status | Status signal |
|---|---|---|---|---|
| – | – | – | off | No power supply |
| Orange | Available | A | Continuous light | Device is operating error-free. |
| | | | flashing (3 Hz) | Diagnostics |
| Green | not available | 1 or 0 or A | Continuous light | Device is operating error-free. |
| | | | flashing (1 Hz) | • addressing process in progress<br>  • After powering on the gateway<br>  • After pressing the configuration button on the gateway<br>• Module not present in current configuration<br>• invalid type |
| | | | flashing (3 Hz) | Diagnostics |

**Switching command present**

For the orange SmartWire-DT diagnostic LED, the "switching command present" message means the following:

- Profiles 1, 2, 3:      DS7 Start/Stop = 1.
- Profiles 4, 5, 6, 10: EN_Set and EN_Op = 1.
- Profiles 7, 8, 9, 11: OnOff =1, Off2 =1, Off3 = 1, EN_Op = 1, EN_Ramp = 1, Freeze = 1, EN_Set = 1, Ctl_PLC = 1.

**Diagnostics**

If the "Diagnostics" message appears, input byte 0, bit 4 (DIAG) will be set to 1 as well. The message has the following meaning:

- Profiles 1 to 9: There is an advanced diagnostic alarm for soft starter DS7 or motor-protective circuit-breaker PKE.
- Profiles 10 and 11: There is an advanced diagnostic message for the DS7-SWD soft starter

# 9 Appendix

## 9.1 Standards

The relevant standards for the DS7 soft starters are listed below:

Table 45: Standards and EMC

| Standard type | Standard | Titles | Limit Values |
|---|---|---|---|
| Model | IEC/EN 60947-1 (EN 60529) | IP20 | |
| Interference immunity | IEC/EN 60947-4-2 | Electrostatic discharge | 8 kV air discharge<br>4 kV Contactdischarge<br>Performance criterion 2 |
| | | Electromagnetic fields<br>Frequency range 80 to 1000 MHz | 10 V/1 m<br>Performance criterion 1 |
| | | High frequency field<br>Frequency range 0.15 to 80 MHz, 80 % amplitude modulated | 140 dB (µV)<br>Performance criterion 1 |
| | | Fast transients,<br>Burst on power terminals | 2 kV/5 kHz<br>Performance criterion 2 |
| | | Burst on bus and control cables | 1 kV/5 kHz<br>Performance criterion 2 |
| | | Surge voltage test, supply cable | 2 kV phase - earth<br>1 kV phase - phase<br>Performance criterion 2 |
| | | Immunity testing for voltage dips, brief interruptions, and voltage fluctuations | DS7-340…: Performance criterion 1<br>DS7-342…: Performance criterion 2<br>DS7-34D…: Performance criterion 2 |
| Emitted interference | IEC/EN 60947-4-2 | Radio interference, housing and supply system | Class A for use in industrial environment |
| Insulation resistance | IEC/EN 60947-1 | Insulation resistance test | Appendix K |
| Permissible pollution | IEC/EN 60947-1 | Insulation of air and creepage distances | Degree of pollution 2 |
| Permissible humidity rating | IEC/EN 60947-1 | Relative humidity | 85 %, no condensation |

## 9.2 Applicable product standards and approvals

| Document type | Name |
|---|---|
| Product standard | EN/IEC 60947-4-2 |
| Approvals | • UL (UL 508)<br>• CSA (CSA C22.2 No 14-05)<br>• CCC (GB 14048.6)<br>• Gost<br>• Gost-R |
| Markings | • CE marking for LVD (Low-Voltage Directive)<br>• EMC (Electromagnetic compatibility - EMC Directive) |

### UL certification

All sizes of soft starters from the DS7 series are now UL certified:

Certificate Number    20120406-E251034
Report Reference      E251034-20110330
Issue Date            2012-APRIL-06

Learn more: www.UL.com.

## 9.3 Specific technical data

The technical data is divided up into data applicable to all devices and data applicable to specific device series and device types.

## 9.3.1 Power supply dependent data

| | | Supply voltage $U_c$ | | |
| | | 24 V AC/DC DS7-340… | 120/230 V AC DS7-342… | +24 V DS7-34D… (SmartWire-DT) |
|---|---|---|---|---|
| **General** | | | | |
| Radio interference level | | B | A group 1 | B |
| **Actuating circuit** | | | | |
| Regulator supply voltage $U_s$ | | | | |
| Voltage | V | +24 +10 % / -15 % | 120 -15 % to 230 +10 % | +24 DC − +10 %/-15 % |
| Frequency at V AC | Hz | (50/60) | 50/60 | |
| Current consumption no-load losses (without device fan) | mA | 50 | 50 | 50 |
| Current consumption operation (without device fan) | mA | 130 | 100 | 130 |
| Current consumption peak performance (close bypass contacts, without device fan) | mA | 130 | 130 | 130 |
| Fan current consumption (operation) | mA | 50 | 50 | 50 |
| Control voltage range $U_c$ | | | | |
| DC operated | V DC | 24 +10 %/-15 % | | 24 +10 %/-15 % |
| AC operated | A DC | 24 +10 %/-15 % | 120 -15% to 230 +10 % | |
| Current consumption per input (+A1, EN) | mA | 1.6 | 4 | 1.6 |
| Pick-up voltage (High signal) | | | | |
| DC operated | V DC | +17.3 - +27 | | +17.3 - +27 |
| AC operated | V AC | 17.3 - +27 | ~ 100 - 253 | |
| Drop-out voltage (Low signal) | | | | |
| DC operated | V DC | 0 - +3 | | 0 - +3 |
| AC operated | V AC | 0 - +3 | 0 - 28 | |
| Pick-up time | | | | |
| DC operated | ms | 250 | | 250 |
| AC operated | ms | 250 | 250 | |
| Drop out delay | | | | |
| DC operated | ms | 350 | | 350 |
| AC operated | ms | ~0 | 350 | |

## 9.3.2 Terminal capacity, control cables, actuating circuit

The following technical data depends on size.

| Size | Unit | Frame size 1: 4 - 12 A | Frame size 2: 16 - 32 A | Frame size 3: 41 - 100 A | Frame size 4: 135 - 200 A |
|---|---|---|---|---|---|
| **General** | | | | | |
| Dimensions (W x H x D) | mm | 45 x 130 x 95 | 45 x 150 x 118 | 93 x 175 x 139 | 108 x 215 x 178 |
| Weight | kg | 0.35 | 0.4 | 1.8 | 3.7 |
| **Terminal capacity** | | | | | |
| Cables (box terminal) | | | | | |
| Solid | mm² | 1 x (0.75 - 4) 2 x (0.75 - 2.5) | 1 x (0.75 - 16) 2 x (0.75 - 10) | 1 x (25 - 70) 2 x (6 - 25) | 1 x (4 - 185) 2 x (4 - 70) |
| Flexible with ferrule | mm² | 1 x (0.75 - 2.5) 2 x (0.75 - 2.5) | 1 x (0.75 - 16) 2 x (0.75 - 10) | | |
| Stranded | mm² | | 1 x 16 2 x 16 | 1 x (25 - 70) 2 x (6 - 25) | 1 x (4 - 185) 2 x (4 - 70) |
| Solid or stranded | AWG | 1 x (18 - 10) 2 x (18 - 10) | 1 x (14 - 8) 2 x (14 - 8) | 1 x (12 - 2/0) | 1 x (12 - 350 mcm 2 x (12 - 00) |
| Flat conductor | | | | | |
| minimum | mm | | | 2 x 9 x 0.8 | 2 x 9 x 0.8 |
| maximum | mm | | | 9 x 9 x 0.8 | 10 x 16 x 0.8 |
| Tightening torque | Nm | 1.2 | 3.2 | 9 (> 10 mm²) 6 (≦ 10 mm²) | 14 (> 10 mm²) 5 (≦ 10 mm²) |
| **Control cables** | | | | | |
| Solid | mm² | 1 x (0.75 - 4) 2 x (0.75 - 2.5) | 1 x (0.75 - 4) 2 x (0.75 - 1.5) | 1 x (0.75 - 4) 2 x (0.75 - 1.5) | 1 x (0.75 - 4) 2 x (0.75 - 1.5) |
| Flexible with ferrule | mm² | 1 x (0.75 - 2.5) 2 x (0.75 - 2.5) | 1 x (0.75 - 2.5) 2 x (0.75 - 1.5) | 1 x (0.75 - 2.5) 2 x (0.75 - 1.5) | 1 x (0.75 - 2.5) 2 x (0.75 - 1.5) |
| Stranded | mm² | | | | |
| Solid or stranded | AWG | 1 x (18 - 10) 2 x (18 - 10) | 1 x (18 - 14) 2 x (18 - 16) | 1 x (18 - 14) 2 x (18 - 16) | 1 x (18 - 14) 2 x (18 - 16) |
| Tightening torque | Nm | 1.2 | 0.6 | 0.6 | 0.6 |
| Screwdriver (flat blade) | mm | 0.6 x 3.5 | 0.6 x 3.5 | 0.6 x 3.5 | 0.6 x 3.5 |
| **Actuating circuit** | | | | | |
| Relay outputs | | | | | |
| Number | | 1 (TOR) | 2 (TOR, RUN/READY)[1] | 2 (TOR, RUN/READY)[1] | 2 (TOR, RUN/READY)[1] |
| Max. voltage range | V AC/DC | = $U_s$ | 250 | 250 | 250 |
| Max. load current | A | 1 | 1 | 1 | 1 |

1) Does not apply for soft starter DS7 with SmartWire-DT (DS7-…-D).

### 9.3.3 Heat dissipation $P_V$

The heat dissipation $P_V$ of the soft starter depends on the operating state of the connected motor.

The values in Table 46 refer to the rated operation of the motor sizes (motor rating, 4 pole three-phase asynchronous motor) at an ambient air temperature of +40 °C.

Table 46: Heat dissipation

| Part no. | Rated operational current | DC versions | | AC versions | |
|---|---|---|---|---|---|
| | | Heat dissipation in standby | Heat dissipation at rated load cycle | Heat dissipation in standby | Heat dissipation at rated load cycle |
| | A | W | W | W | W |
| DS7-34xSX004N0-… | 4 | 0.7 | 5 | 1.5 | 5 |
| DS7-34xSX007N0-… | 7 | 0.7 | 5 | 1.5 | 6 |
| DS7-34xSX009N0-… | 9 | 0.7 | 6 | 1.5 | 7 |
| DS7-34xSX012N0-… | 12 | 0.7 | 7 | 1.5 | 8 |
| DS7-34xSX016N0-… | 16 | 0.7 | 7 | 1.5 | 7 |
| DS7-34xSX024N0-… | 24 | 0.7 | 9 | 1.5 | 10 |
| DS7-34xSX032N0-… | 32 | 0.7 | 12 | 1.5 | 13 |
| DS7-34xSX041N0-… | 41 | 0.7 | 7 | 1.5 | 8 |
| DS7-34xSX055N0-… | 55 | 0.7 | 9 | 1.5 | 10 |
| DS7-34xSX070N0-… | 70 | 0.7 | 11 | 1.5 | 12 |
| DS7-34xSX081N0-… | 81 | 0.7 | 13 | 1.5 | 14 |
| DS7-34xSX100N0-… | 100 | 0.7 | 16 | 1.5 | 17 |
| DS7-34xSX135N0-… | 135 | 0.7 | 24 | 1.5 | 25 |
| DS7-34xSX160N0-… | 160 | 0.7 | 30 | 1.5 | 31 |
| DS7-34xSX200N0-… | 200 | 0.7 | 42 | 1.5 | 43 |

The start produces currents above the rated operational current.
All enclosure types in which the Soft starter is to be installed must have the required power loss capacity. Depending on the ramp time set and the current limitation, this current can be present for several seconds.
The resulting heat dissipation must in this case be allowed for in the housing design.

## 9.4 Conversion to other load cycles

### Rated operational current up to 32 A

**DS7-34xSX003…**
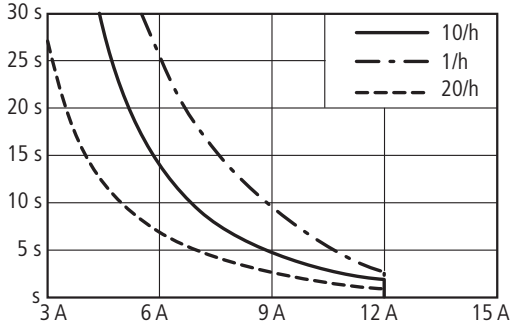
**DS7-34xSX004…**
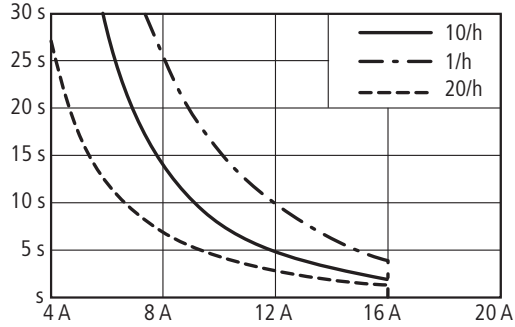
**DS7-34xSX007…**
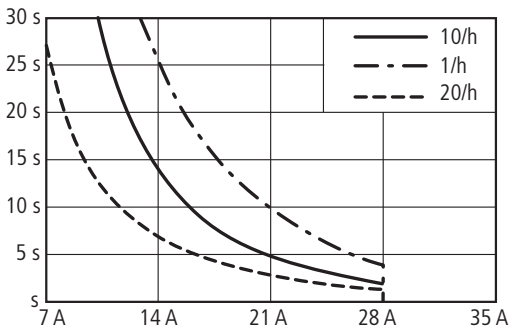
**DS7-34xSX009…**
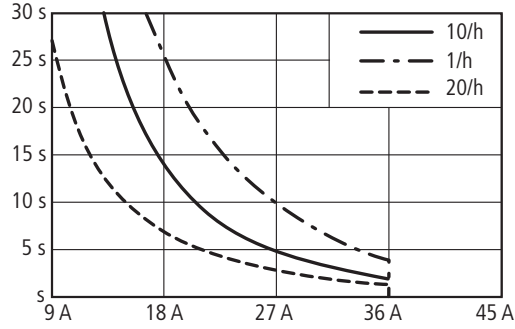
**DS7-34xSX012…**
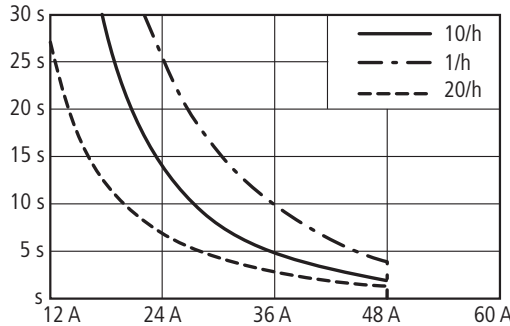
**DS7-34xSX016…**
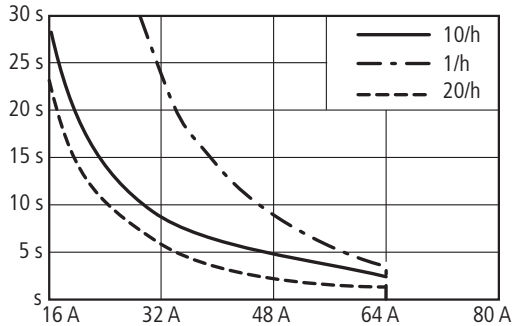
**DS7-34xSX024…**
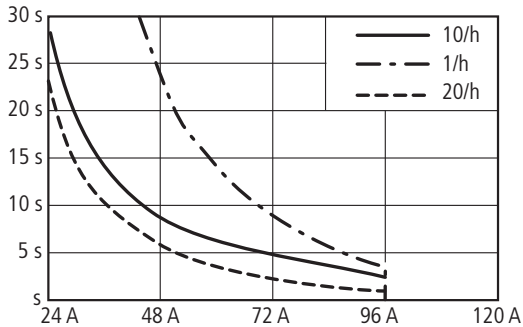
**DS7-34xSX032E…**
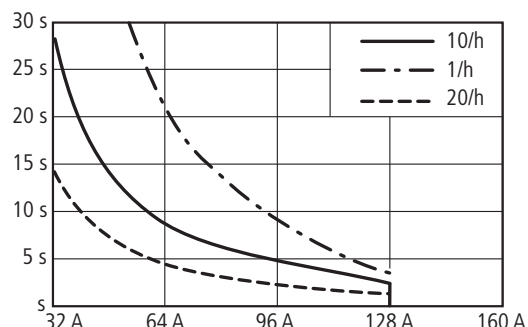
Figure 137: Current overload curves, Stand-alone setup without fan

## Rated operational current from 41 A

**DS7-34xSX041…**
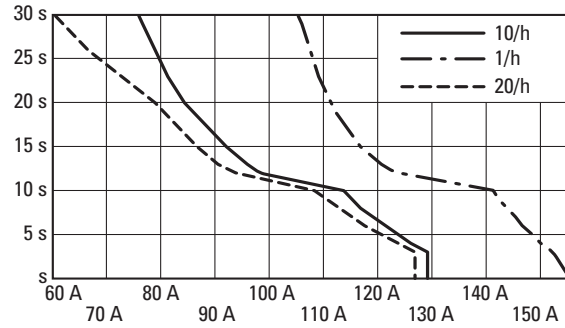
**DS7-34xSX055…**
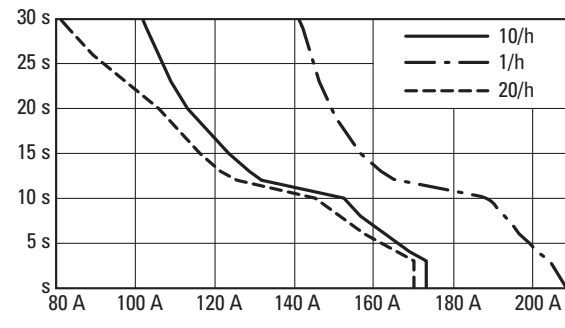
**DS7-34xSX070…**
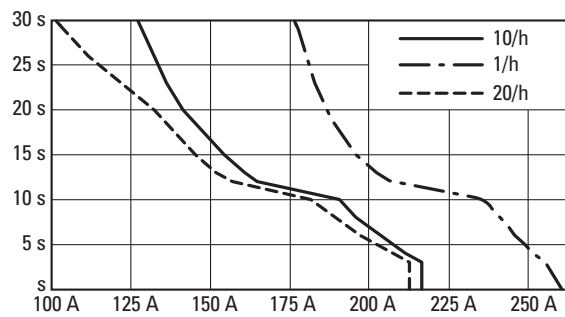
**DS7-34xSX081…**
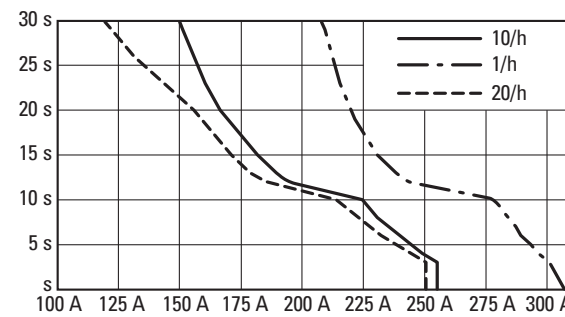
**DS7-34xSX100…**
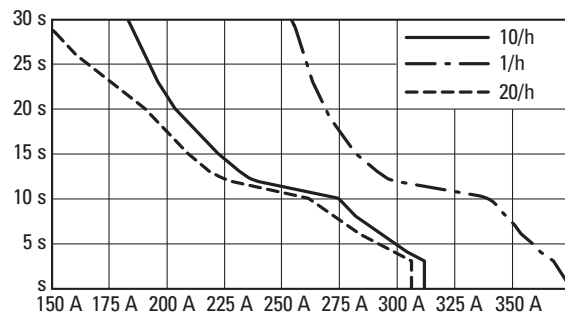
**DS7-34xSX135…**
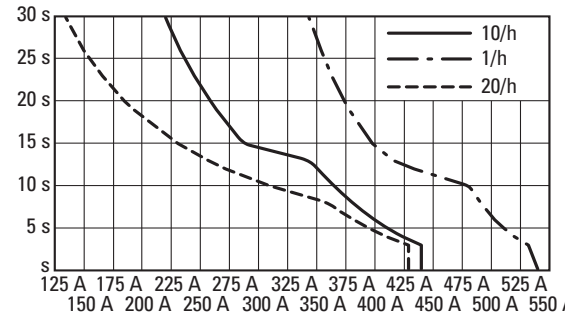
**DS7-34xSX160…**
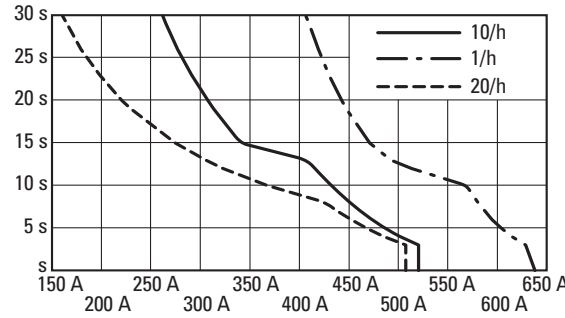
**DS7-34xSX200…**
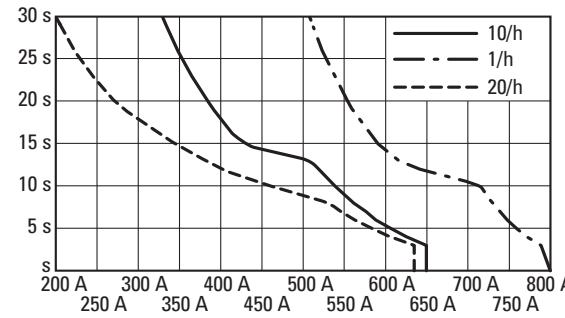
Figure 138:Current overload curves, Stand-alone setup without fan

## 9.5 accessories

### 9.5.1 Protection, short-circuit rating

Table 47:   Fuses, semiconductor fuses

| Part no. | Type "1" coordination | | Type 1 and 2 coordination | Type 2 coordination | |
|---|---|---|---|---|---|
| | Cable and motor protection ($I_q \leqq 50$ kA)[1] | Cable and motor protection ($I_q \leqq 100$ kA) | Fusing with PKE[3] | Superfast semiconductor fuses in addition to the fuses for type 1 coordination ($I_q \leqq 100$ kA) | Fuse holder for semi-conductor fuse |
| | Part no. | Part no. | Part no. | Quantity x Part no. | Quantity x Part no. |
| DS7-34xSX004N0-… | PKZM0-4 | PKZM0-4 (+ CL-PKZ0) | PKE12…-4 | 3 x 170M1359 | 3 x 170H1007 |
| DS7-34xSX007N0-… | PKZM0-10 | PKZM0-10 (+ CL-PKZ0) | PKE12…-12 | 3 x 170M1361 | 3 x 170H1007 |
| DS7-34xSX009N0-… | PKZM0-10 | PKZM0-10 (+ CL-PKZ0) | PKE12…-12 | 3 x 170M1362 | 3 x 170H1007 |
| DS7-34xSX012N0-… | PKZM0-12 | PKZM0-12 (+ CL-PKZ0)[2] | PKE12…-12 | 3 x 170M1362 | 3 x 170H1007 |
| DS7-34xSX016N0-… | PKZM0-16 | PKZM0-16 (+ CL-PKZ0)[2] | PKE32…-32 | 3 x 170M1364 | 3 x 170H1007 |
| DS7-34xSX024N0-… | PKZM0-25 | PKZM0-25 + (CL-PKZ0)[2] | PKE32…-32 | 3 x 170M1365 | 3 x 170H1007 |
| DS7-34xSX032N0-… | PKZM0-32 | PKZM0-32 + (CL-PKZ0)[2] | PKE32…-32 | 3 x 170M1366 | 3 x 170H1007 |
| DS7-34xSX041N0-… | NZMN1-M50 / PKZM4-50 | NZMN1-M50 / PKZM4-50 | – | 3 x 170M3013 | 3 x 170H3004 |
| DS7-34xSX055N0-… | NZMN1-M63 / PKZM4-58 | NZMN1-M63 / PKZM4-58 | – | 3 x 170M3013 | 3 x 170H3004 |
| DS7-34xSX070N0-… | NZMN1-M80 | NZMH1-M80 | – | 3 x 170M4008 | 3 x 170H3004 |
| DS7-34xSX081N0-… | NZMN1-M100 | NZMH1-M100 | – | 3 x 170M4008 | 3 x 170H3004 |
| DS7-34xSX100N0-… | NZMN1-M100 | NZMH1-M100 | – | 3 x 170M4008 | 3 x 170H3004 |
| DS7-34xSX135N0-… | NZMN2-M160 | NZMH2-M160 | – | 3 x 170M4010 | 3 x 170H3004 |
| DS7-34xSX160N0-… | NZMN2-M200 | NZMH2-M200 | – | 3 x 170M5008 | 3 x 170H3004 |
| DS7-34xSX200N0-…[4] | NZMN2-M200 | NZMH2-M200 | – | 3 x 170M5008 | 3 x 170H3004 |

1) Rated conditional short-circuit current lq with PKZM…; rated short-circuit breaking capacity lcu with NZM… (according to IEC/EN 60947) for 230 V/400 V and with type 1 and 2 coordination. Auto-protected range – back-up fuse is not required.

2) + CL-PKZ0 = required current limiter

3) Wiring set PKZM0-XDM required

4) For DS7-34xSX200N0-…, only the following applies: $I_q \leqq 80$ kA

The following two tables, 48 and 49, provide additional information on the high-speed semiconductor fuses.

Table 48: Superfast semiconductor fuses
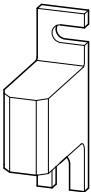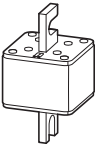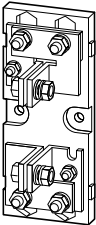
| | Part no. | Rated operational current A | max. heat dissipation P$_V$ W | Size/ fixing centres mm | Can be used for soft starters Part no. |
|---|---|---|---|---|---|
| | 170M1359 | 16 | 5.5 | 000 | DS7-34…SX004N0-… |
| | 170M1361 | 25 | 9 | 000 | DS7-34…SX007N0-… |
| | 170M1362 | 32 | 10 | 000 | DS7-34…SX009N0-… <br> DS7-34…SX012N0-… |
| | 170M1364 | 50 | 15 | 000 | DS7-34…SX016N0-… |
| | 170M1365 | 63 | 16 | 000 | DS7-34…SX024N0-… |
| | 170M1366 | 80 | 19 | 000 | DS7-34…SX032N0-… |
| | 170M3013 | 125 | 26 | S1 | DS7-34…SX041N0-… <br> DS7-34…SX055N0-… |
| | 170M4008 | 200 | 45 | S1 | DS7-34…SX070N0-… <br> DS7-34…SX081N0-… <br> DS7-34…SX100N0-… |
| | 170M4010 | 315 | 58 | S1 | DS7-34…SX135N0-… |
| | 170M5008 | 400 | 65 | S2 | DS7-34…SX160N0-… |
| | 170M6008 | 500 | 95 | S3 | DS7-34…SX200N0-… |

Table 49: Fuse bases for superfast semiconductor fuses

| | Part no. | Dimensions/ (W x H x D) mm | for size |
|---|---|---|---|
| | 170H1007 | 145 x 43 x 50 | 000 |
| | 170H3004 | 205 x 88 x 80 | S1, S2, S3 |

➔ If possible, install semiconductor fuses in the immediate vicinity of the soft starter (short connection cables).

➔ Semiconductor fuses must be installed on all three phases (L1, L2, L3).

➔ Each fuse-link requires a fuse base.

## 9.5.2 Protection, overload relay, optional mains contactor

| Part no. | Soft starter function with soft stop in case of overload | | Optional mains contactor |
|---|---|---|---|
| | Line protection[1] | Overload relays[2] | |
| DS7-34xSX004N0-… | PKM0-4 (+ CL-PKZ0)[3] | ZB12-4 | DILM7 |
| DS7-34xSX007N0-… | PKM0-10 (+ CL-PKZ0) | ZB12-10 | DILM9 |
| DS7-34xSX009N0-… | PKM0-10 (+ CL-PKZ0) | ZB12-10 | DILM9 |
| DS7-34xSX012N0-… | PKM0-12 (+ CL-PKZ0) | ZB12-12[4] | DILM12 |
| DS7-34xSX016N0-… | PKM0-16 (+ CL-PKZ0) | ZB32-16 | DILM17 |
| DS7-34xSX024N0-… | PKM0-25 (+ CL-PKZ0) | ZB32-24 | DILM25 |
| DS7-34xSX032N0-… | PKM0-32 (+ CL-PKZ0) | ZB32-32[4] | DILM32 |
| DS7-34xSX041N0-… | NZMN1-M50 / PKZM4-50 | ZB65-40 + ZB65-XEZ | DILM50 |
| DS7-34xSX055N0-… | NZMN1-M63 / PKZM4-58 | ZB65-57 + ZB65-XEZ | DILM65 |
| DS7-34xSX070N0-… | NZMN1-M80 | ZB150-70/KK | DILM80 |
| DS7-34xSX081N0-… | NZMN1-M100 | ZB150-100/KK | DILM95 |
| DS7-34xSX100N0-… | NZMN1-M100 | ZB150-100/KK | DILM115 |
| DS7-34xSX135N0-… | NZMN2-M160 | ZB150-150/KK | DILM150 |
| DS7-34xSX160N0-… | NZMN2-M200 | Z5-160/FF250 | DILM185 |
| DS7-34xSX200N0-… | NZMN2-M200 | Z5-220/FF250 | DILM225 |

1)  Used to specify the circuit-breaker required for the specified load cycle.
    For other switching cycles (operating frequency, overcurrent, overcurrent time, duty factor), this value changes and must be modified accordingly.

2)  Used to specify the circuit-breaker required for the specified load cycle.
    For other switching cycles (operating frequency, overcurrent, overcurrent time, duty factor), this value changes and must be modified accordingly.

3)  (+CL-PKZ0) = optional current limiter

4)  The ZB12 or ZB32 overload relay can be fitted directly to a DS7 soft starter.
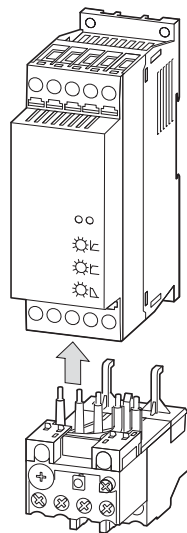


→ Further information on the overload relays is provided in the Eaton "Main Industrial Catalog 2010" (HPL0200-2010en-EN) in chapter 6 or on the Internet at:
http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/Kundensupport/index.htm
→ **Customer support** → **Catalogues** → **Industrial Switchgear 2011**

### 9.5.3 system accessories

System accessories make installation easier and increase the number of options provided by the DS7 soft starter.

➜   More information on system accessories can be found in the Eaton online catalog at:
http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/Kundensupport/index.htm

➜ **Customer support** ➜ **Catalogues** ➜ **Online Catalogue**

• **Wiring kit**

Used to connect a size 1 DS7 soft starter directly to a PKZ or PKE motor-protective circuit-breaker.
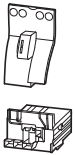
**PKZM0-XDM12** (283149) for use with:

DS7-34…SX004…
DS7-34…SX007…
DS7-34…SX009…
DS7-34…SX012…

➜ Section 3.3.2.4, "Size 1: Surface mounting with PKZ or PKE", page 72

• **Electric contact module**

Used to connect a size 2 DS7 soft starter directly to a PKZ or PKE motor-protective circuit-breaker.

**PKZM0-XM32DE** (239349) for use with:

DS7-34…SX016…
DS7-34…SX024…
DS7-34…SX032…

➜ Section 3.3.2.5, "Size 2: Surface mounting with PKZ or PKE", page 73

• **Top-hat rail adapter**

45 mm-wide adapter plate (can be grouped) designed for mechanically mounting a PKZ or PKE motor-protective circuit-breaker and a size 1 or 2 DS7 soft starter.
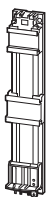
**PKZM0-XC45L** (142529) for use with:

PKZM0, PKE + DS7…004N…
PKZM0, PKE + DS7…007N…
PKZM0, PKE + DS7…009N…
PKZM0, PKE + DS7…012N…

**PKZM0-XC45L/2** (142570) for use with:

PKZM0, PKE + DS7…004N…
PKZM0, PKE + DS7…007N…
PKZM0, PKE + DS7…009N…
PKZM0, PKE + DS7…012N…
PKZM0, PKE + DS7…016N…
PKZM0, PKE + DS7…024N…
PKZM0, PKE + DS7…032N…

➜ Section 3.3.2.4, "Size 1: Surface mounting with PKZ or PKE", page 72
➜ Section 3.3.2.5, "Size 2: Surface mounting with PKZ or PKE", page 73

- **Busbar adapter**
  The 45 mm busbar adapter is suitable for connecting busbars with an interval between busbar centers of 60 mm and a bar thickness of 5 or 10 mm.
  They can be grouped and are designed for mechanically mounting a PKZ or PKE motor-protective circuit-breaker and a size 1 or 2 DS7 soft starter.
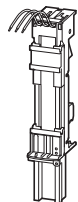
  **BBA0L-25** (142526) for use with:

  PKZM0, PKE + DS7…004N…
  PKZM0, PKE + DS7…007N…
  PKZM0, PKE + DS7…009N…
  PKZM0, PKE + DS7…012N…

  **BBA0L-25** (142527) for use with:

  PKZM0, PKE + DS7…004N…
  PKZM0, PKE + DS7…007N…
  PKZM0, PKE + DS7…009N…
  PKZM0, PKE + DS7…012N…
  PKZM0, PKE + DS7…016N…
  PKZM0, PKE + DS7…024N…
  PKZM0, PKE + DS7…032N…

  → Section 3.3.2.4, "Size 1: Surface mounting with PKZ or PKE", page 72
  → Section 3.3.2.5, "Size 2: Surface mounting with PKZ or PKE", page 73

- **Spacers**
  Spacers for NZM1 and NZM2 (when using size 3 or 4 DS7 soft starters) make it possible to quickly and cost-effectively pull up the circuit-breakers to the soft starters' connection height and to ensure uninterrupted thermal air circulation via the heat sink.
  Two spacers are required for each fixing screw; these spacers are available in sets of 4:
  NZM1: 1 x NZM1/2-XAB; NZM2: 4 x NZM1/2-XAB
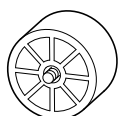
  **NZM1/2-XAB** (260203) for use with:

  NZM1(-4), PN1(-4), N(S)1(-4)
  NZM2(-4), PN2(-4), N(S)2(-4)

  → Section 3.3.3, "Mounting instructions (size 3 and 4)", page 74

- **Terminal cover (knockout)**
  Used to increase the degree of protection against contact to IP2X and to provide protection when reaching into the connection area while connecting cables in the box terminal for size 4 DS7 soft starters. If there are two conductors, the maximum cross-sectional area is 22 mm$^2$ / AWG 4.
  Cannot be combined with NZM-XSTK control circuit terminal.

  **Note:** DE6-MNT-NZM mounting kit required!
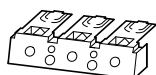
  **NZM2-XKSFA** (104640) for use with:

  NZM2, PN2, N(S)2
  DS7-34…SX135…
  DS7-34…SX160…
  DS7-34…SX200

- **Cover**
  Protection against accidental contact for size 4 DS7 soft starters when connecting cable lugs, busbars, or using tunnel terminals. When using insulated conductor material to IP1X.

  **Note:** DE6-MNT-NZM mounting kit required!
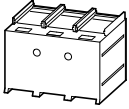
  **NZM2-XKSA** (260038**)** for use with:

  DS7-34…SX135…
  DS7-34…SX160…
  DS7-34…SX200…

- **Mounting kit**
  When using terminal covers NZM2-XKSFA and NZM2-XKSA for size 4 DS7 soft starters

  **DE6-MNT-NZM** (107323) for use with:

  DS7-34xSX135N0-x
  DS7-34xSX160N0-x
  DS7-34xSX200N0-x

  For soft starter DS7 in size 3: NZM1(-4)-XKSFA
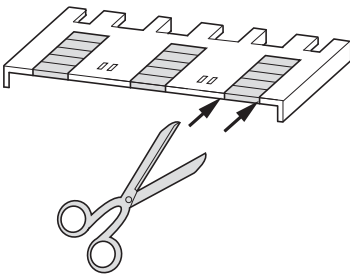
- **IP2X protection against finger contact for box terminal**
  For size 4 DS7 soft starters for box terminals; used to increase the protection against contact to IP2X. Protection when reaching into the cable connection area with the connection of cables in the box terminal. If there are two conductors, the maximum cross-sectional area is 25 mm$^2$ / AWG 4. Cannot be combined with NZM-XSTK control circuit terminal.

  **NZM2-XIPK** (266773) for use with:

  DS7-34…SX135…
  DS7-34…SX160…
  DS7-34…SX200…

- **IP2X protection against finger contact for cover**
  For size 2 DS7 soft starters and NZM2-XKSA cover

  **NZM2-XIPA** (266777) for use with:

  DS7-34…SX135…
  DS7-34…SX160…
  DS7-34…SX200…

More information on SmartWire-DT can be found in the Eaton online catalog at:
http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/Kundensupport/index.htm
**⟶ Customer support ⟶ Catalogues ⟶ Online Catalogue**

### 9.5.4 Device fans

Using a DS7-FAN-… device fan with the DS7 soft starter makes the following possible:

- Increasing the duty cycle
- Operation at higher ambient air temperatures
- Increasing the start time (t-Start)
- A higher number of starts per hour.

**DS7-FAN-032** (135553) for use with:
DS7-34…SX004…
DS7-34…SX007…
DS7-34…SX009…
DS7-34…SX012…
DS7-34…SX016…
DS7-34…SX024…
DS7-34…SX032…
**DS7-FAN-100** (169021) for use with:
DS7-34…SX041…
DS7-34…SX055…
DS7-34…SX070…
DS7-34…SX081…
DS7-34…SX100…
**DS7-FAN-200** (169022) for use with:
DS7-34…SX135…
DS7-34…SX160…
DS7-34…SX200…

### 9.5.5 SmartWire-DT
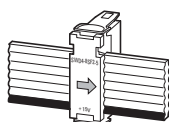
Cable, plug, tool etc.

More information on SmartWire-DT can be found in the Eaton online catalog at:

http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/Kundensupport/index.htm
→ **Customer support** → **Catalogues** → **Online Catalogue**

## 9.6 Dimensions

→ The mounting should take into account the weight and dimensions of the soft starter. For this use the necessary technical equipment and tools.
Improper handling, or using the wrong tools, may damage the soft starter!

**Size 1**

| DS7-34…SX… | Ø [mm] | Weight [kg] |
|---|---|---|
| …003… | 4 | DS7-340…: 0.3 |
| …004… | | DS7-340…: 0.3 |
| …005… | | DS7-34D…-D: 0.33 |
| …007… | | |
| …009… | | |
| …012… | | |
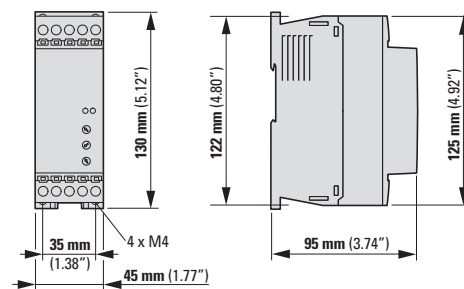


Figure 139:Dimension drawing DS7 without SWD – Size 1 (up to 12 A)
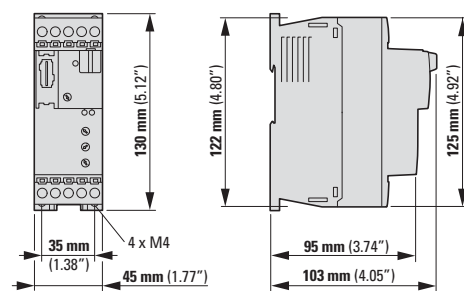


Figure 140:Dimension drawing DS7 with SWD – Size 1 (up to 12 A)

### Frame size 2

| DS7-34…SX… | Ø [mm] | Weight [kg] |
|---|---|---|
| …016… | 4 | 0.4 |
| …024… | | |
| …032… | | |
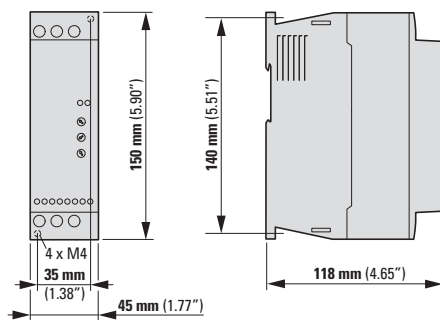


Figure 141:Dimension drawing for DS7 without SWD – Size 2 (16 - 32 A)
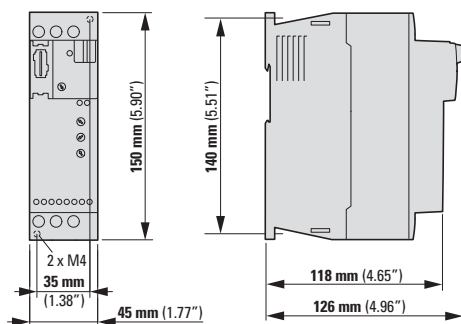


Figure 142:Dimension drawing for DS7 with SWD – Size 2 (16 - 32 A)

### Frame size 3

| DS7-34…SX… | Ø [mm] | Weight [kg] |
|---|---|---|
| …036… | 4 | 1.8 |
| …041… | | |
| …055… | | |
| …070… | | |
| …081… | | |
| …100… | | |
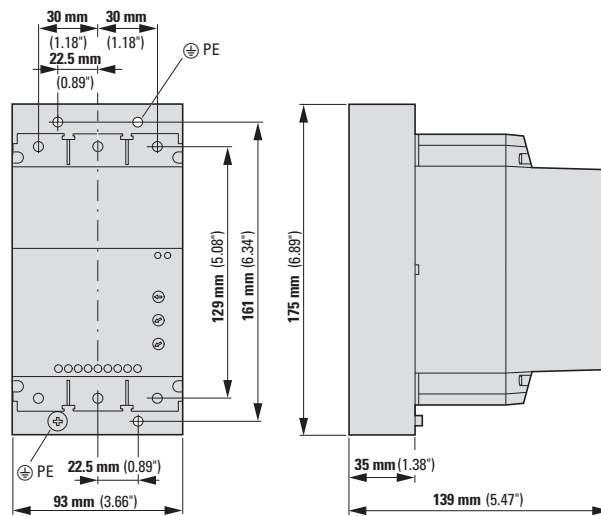


Figure 143:Dimension drawing for DS7 without SWD – Size 3 (41 - 100 A)
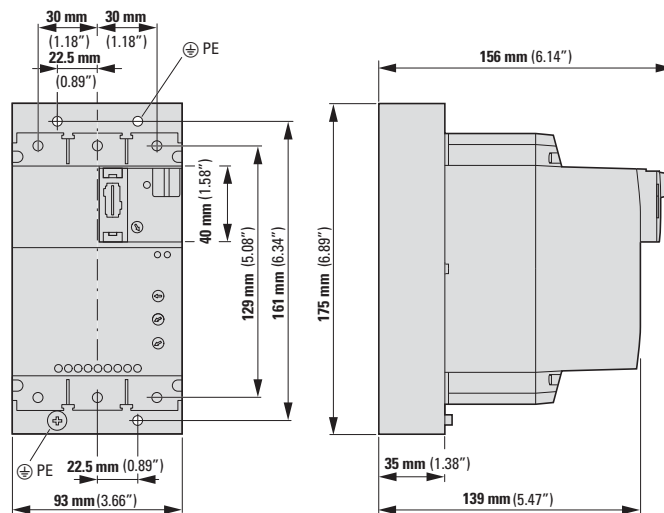


Figure 144:Dimension drawing for DS7 with SWD – Size 3 (41 - 100 A)

**Frame size 4**

| DS7-34…SX… | Ø [mm] | Weight [kg] |
|---|---|---|
| …135… | 5 | 3.4 |
| …160… | | |
| …200… | | |
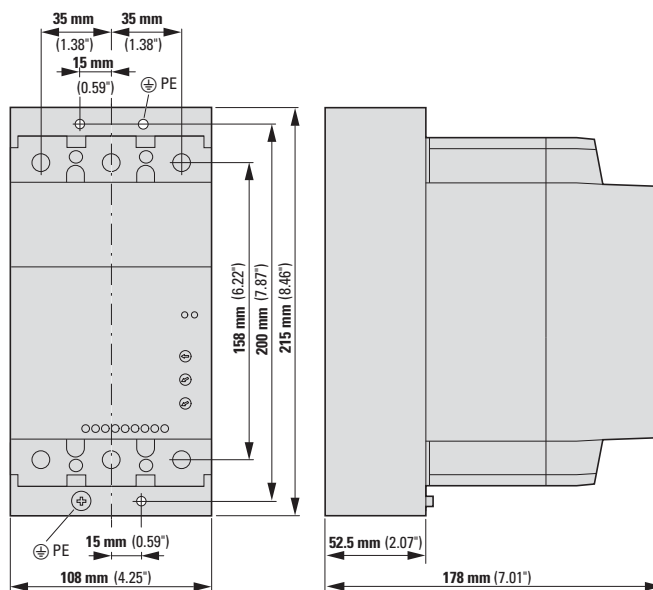


Figure 145:Dimension drawing DS7 without SWD – Size 4 (135 – 200 A)
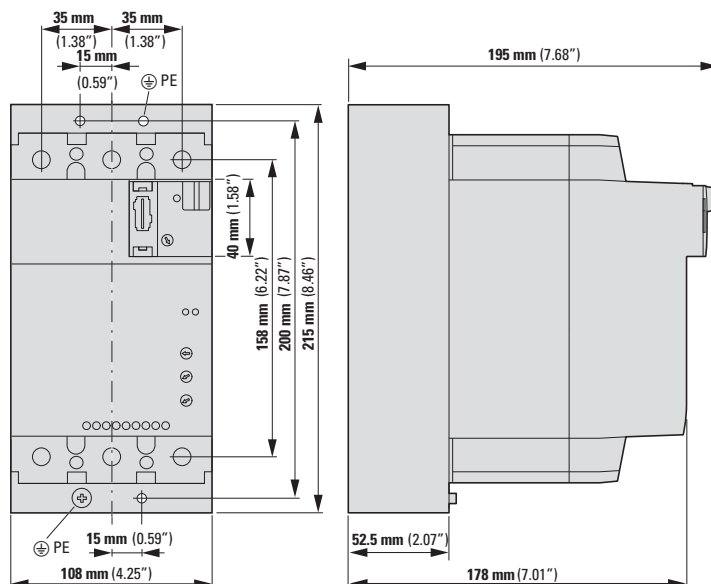


Figure 146:Dimension drawing DS7 with SWD – Size 4 (135 – 200 A)

**Device fan DS7-FAN-…**

**DS7-FAN-100**

**DS7-FAN-200**

# Index