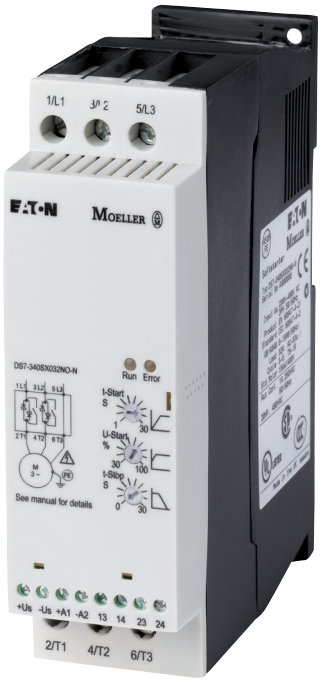
07/10 MN03901001Z-EN

User Manual

DS7
Soft Starters



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Original Operating Instructions.
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 German manual.

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Danger!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions IL (previously AWA) 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 equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does 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 interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD 384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, 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-stop devices must not cause restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.

- 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-stop 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.).

Contents

Contents

0 About This Manual

This manual provides special information required for connecting a soft starter correctly and setting its parameters to suit your requirements.
All information applies to the specified hardware and software versions. The manual describes all sizes of the DS7 soft starter series. Any differences and special features of the individual ratings and frame sizes are noted accordingly.

0.1 Additional device manuals

"Soft Starter Design" (MN03902001Z-EN, previous description AWB8250-1346GB)

0.2 Target group

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

0.3 Writing conventions

Symbols used in this manual have the following meanings:

▶ indicates actions to be taken.

CAUTION

Warns about the possibility of material damage.

WARNING

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

DANGER

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

Indicates useful tips.

For greater clarity, the name of the current chapter and the name of the current section are shown in the page header.

1 About the series

1.1 System overview

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

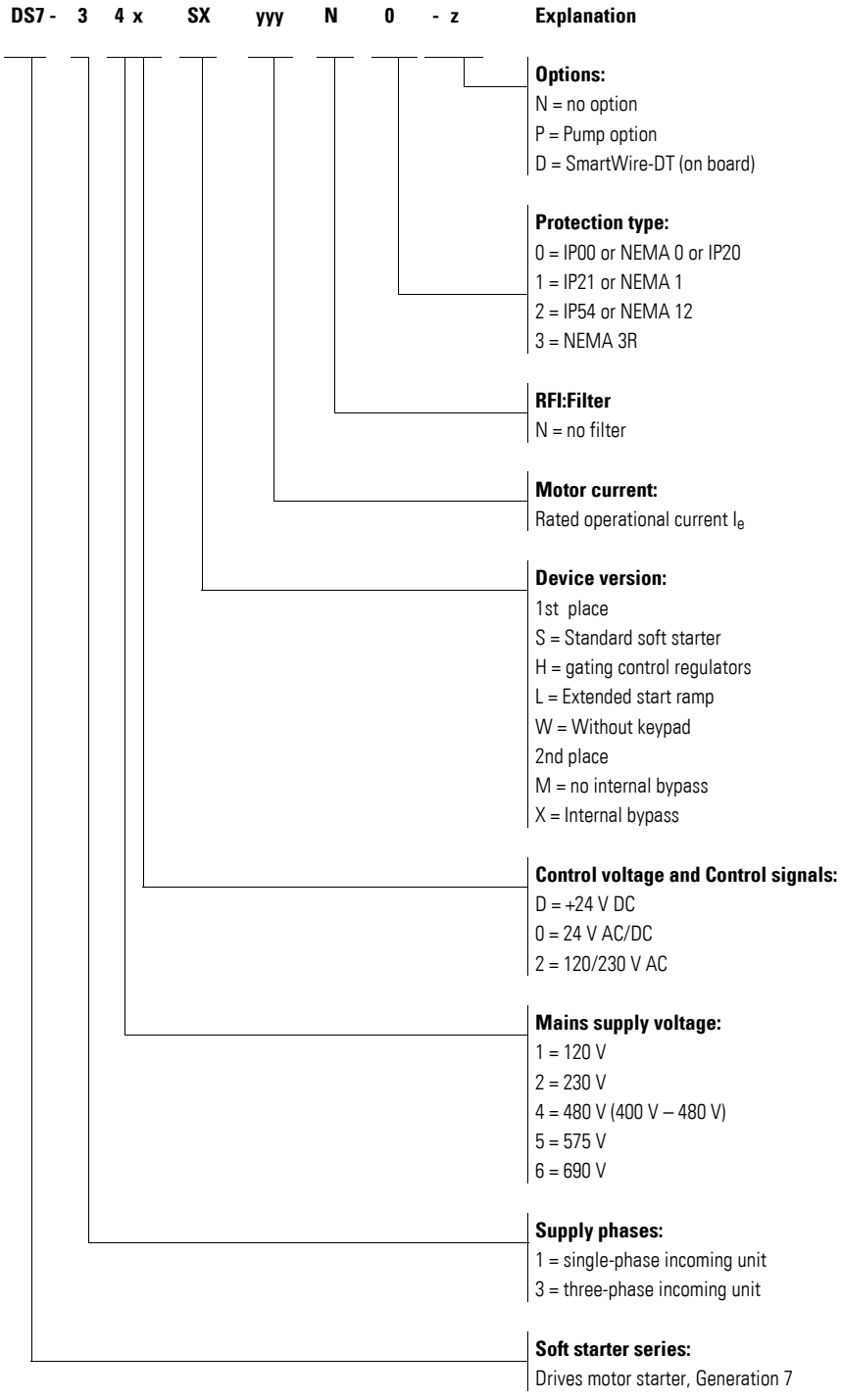
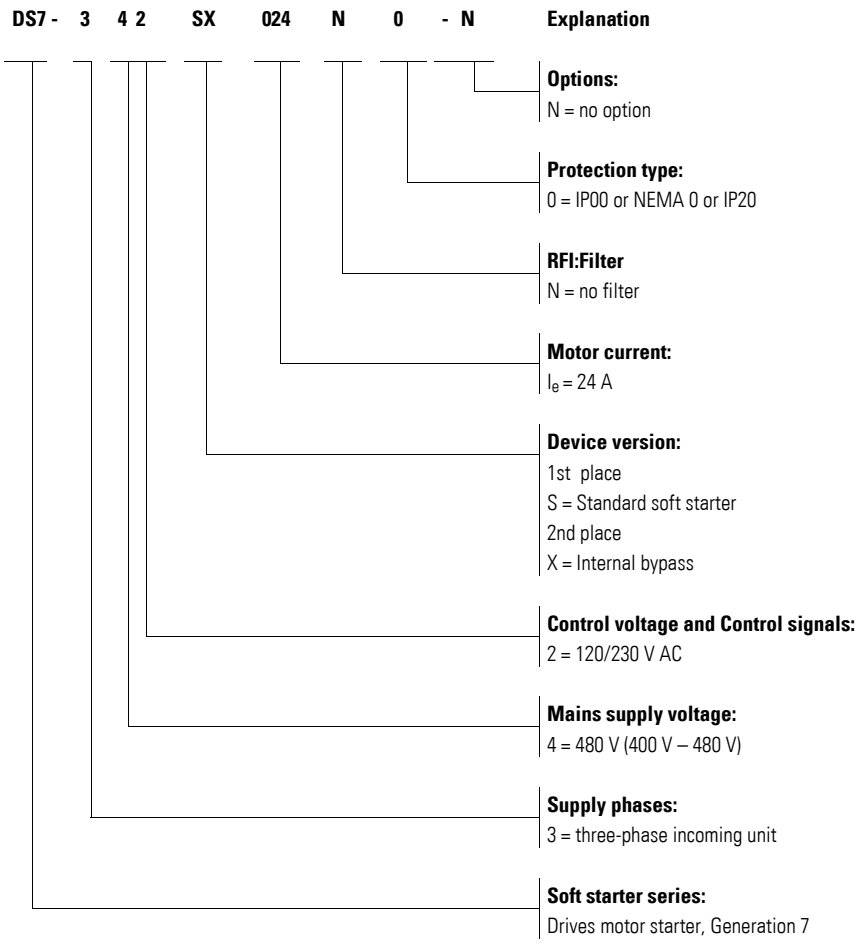


Figure 1: Key to part numbers

1.1.1 Example key to part numbers

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



1.2 Function

DS7 soft starters control the voltage of the supply network from an adjustable start value up to 100 %. This considerably reduces the starting torque of a three-phase asynchronous motor that is run on this supply system. This enables the soft starting of asynchronous motors, and the inrush current is also reduced.

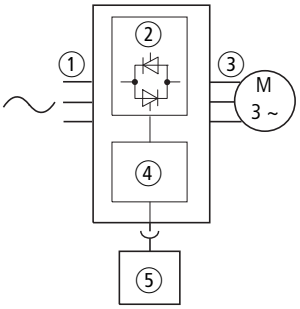


Figure 2: Functional overview

① Mains voltage U_{LN}: 3 × 200 V to 3 × 480 V
② Antiparallel thyristors in two phases with asymmetrical trigger control for controlling the motor voltage
③ Output voltage U_2: three-phase, from an adjustable start voltage through a ramp function up to 100 % supply voltage with a constant supply frequency
I_{2N}: 4 to 200 A at maximum ambient temperature of 40 °C
Motor shaft power P_2: 1.5 to 110 kW at 400 V or 3 to 150 HP at 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 device series) for modifying and storing parameters

1.3 Features of the soft starters

DS7 series soft starters are provided with the following standard features:

Table 1: Features of the soft starters

Feature	
Compact construction type	✓
Adjustable start voltage	✓
Separately adjustable ramp times for start and stop	✓
Digital inputs	✓ 1 (BG1), 2 (BG2-4)
Relay output	✓ 1 (BG1), 2 (BG2-4)
Standard controller card and parameters over the entire performance range	✓
Networkable (DS7-34D…-D)	✓ via SmartWire-DT

1.4 Front View

The following two devices are used as examples of the DS7 series: DS7-34DSX012N0-D and DS7-340SX032N0-N.

Figure 3: Front view DS7 Soft starter

1.5 Selection criteria

The soft starter is selected according to the rated motor current and the load type. The load must have a quadratic speed/torque characteristic. Loads with a linear or constant speed/torque characteristic cannot be started at full load with the DS7 soft starter (e.g. piston pumps up to the completed run-up only with bypass). The rated output current of the soft starter must always be greater than/equal to the rated motor current. With machines with heavy starting characteristics, the starter must be dimensioned accordingly higher in terms of its overload characteristics.

1.5.1 Design with different load cycles

The DS7 soft starter is designed for a standard load cycle.
When used in applications such as water pumps (centrifugal pumps), the DS7 must be selected with the assigned rated operational current. If the switch frequency, acceleration and/or starting currents are different, the design of the DS7 must take its thermal capacity into account. The Appendix (→ Page 79) provides overload curves for the different combinations of time, current and starts per hour in order for the DS7 to be selected correctly for the application.

1.5.2 Parallel connection of several motors to one soft starter

If several motors are to be operated with one soft starter, this must be designed on the basis of the sum of all rated motor currents. 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 only be supplied by a single motor, which may cause this motor to overload. 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 soft starter this can only be implemented in the SmartWire-DT version in conjunction with the networkable PKE. Alternatively, a soft starter of the DM4 series or its successor may be required.

1.5.3 Connecting motors during soft starter operation

If a motor is connected on the soft starter during operation, a soft start is not executed for this motor. The starter must then be able to supply the full starting current (approx. 6 to 8 times the rated motor current) and the current of the other motors. Otherwise, an overload will occur and the soft starter may be destroyed in the worst case.

1.5.4 Connectable motor power

The motor power stated in Table 2 can be connected when using standard motors and a normal load for soft starters.

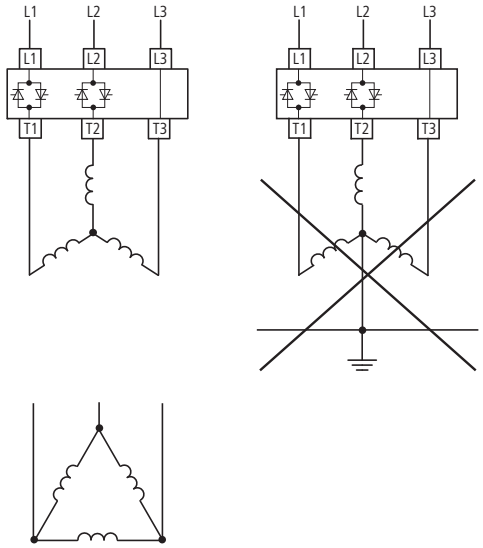


Figure 4: Permissible load connection (shown for devices up to 32 A, above this the phase L2-T2 must be connected instead of L3-T3)

Table 2: connectable motor power

Part no.	Rated operational current [A]	Motor rating in HP at 200 V [HP]	Motor rating in kW at 230 V [kW]	Motor rated operational current in HP at 230 V [HP]	Motor rating in kW at 400 V [kW]	Motor rating in HP at 480 V [HP]
DS7-34xSX004N0-…	4	0.75	0.75	0.75	1.5	2
DS7-34xSX007N0-…	7	1.5	1.5	2	3	3
DS7-34xSX009N0-…	9	2	2.2	2	4	5
DS7-34xSX012N0-…	12	3	3	5	5.5	7.5
DS7-34xSX016N0-…	16	3	4	5	7.5	10
DS7-34xSX024N0-…	24	5	5.5	7.5	11	15
DS7-34xSX032N0-…	32	10	7.5	10	15	20
DS7-34xSX041N0-…	41	10	11	15	22	30
DS7-34xSX055N0-…	55	15	15	20	30	40
DS7-34xSX070N0-…	70	20	18.5	25	37	50
DS7-34xSX081N0-…	81	25	22	30	45	60
DS7-34xSX100N0-…	100	30	30	30	55	75
DS7-34xSX135N0-…	135	40	37	50	75	100
DS7-34xSX160N0-…	160	50	45	60	90	125
DS7-34xSX200N0-…	200	60	55	75	110	150

1.5.5 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 the following table refer to the rated operation of the motor sizes (motor rating, 4-pole three-phase asynchronous motor) at an ambient temperature of +40 °C.

Table 3: Heat dissipation

Part no.		DC versions		AC versions	
	Rated operational current [A]	Heat dissipation standby [W]	Heat dissipation at rated load cycle [W]	Heat dissipation standby [W]	Heat dissipation at rated load cycle [W]
DS7-34xSX004N0-…	4	0.7	5	1.5	6
DS7-34xSX007N0-…	7	0.7	6	1.5	7
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	8
DS7-34xSX024N0-…	24	0.7	9	1.5	10
DS7-34xSX032N0-…	32	0.7	12	1.5	13
DS7-34xSX041N0-…	41	0.7	8	1.5	9
DS7-34xSX055N0-…	55	0.7	10	1.5	10
DS7-34xSX070N0-…	70	0.7	12	1.5	12
DS7-34xSX081N0-…	81	0.7	13	1.5	14
DS7-34xSX100N0-…	100	0.7	17	1.5	18
DS7-34xSX135N0-…	135	0.7	24	1.5	25
DS7-34xSX160N0-…	160	0.7	31	1.5	31
DS7-34xSX200N0-…	200	0.7	43	1.5	44

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 heat dissipation capacity.

Depending on the ramp time set and the current limitation, this current can be present for several seconds. The resulting heat dissipation must then be allowed for in the housing design.

1.5.6 Permissible environmental conditions

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

Table 4: Permissible environmental conditions

Property	Value
Protection type	IP20
Installation altitude	Up to 1000 m a.s.l.; higher than this up to 2000 m with a current reduction of 1 % per 100 m
Temperature	
Operation	-5 up to +40 °C without reduction, up to +60 °C with a reduction of 2 % per degree Kelvin
Storage	-25 up to +60 °C continuous
Transport	-25 up to +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

1.6 Intended use

The soft starters of the DS7 series are electrical apparatus for installation in the switch cabinets of electrical systems or machines. They are designed as components for the soft starting of standard three-phase asynchronous motors (normal AC induction motor) for installation in a machine or for assembly with other components of a machine or system.

When installing in machines, the soft starters must not be commissioned until it is determined that the machine complies with the safety requirements of the Machinery Safety Directive 89/392/EC; the EN 60204 standard must also be observed here. Commissioning is only permitted if the requirements of the EMC Directive (89/336/EC) have been observed.

The soft starters of the DS7 series meet the requirements of the Low Voltage Directive 73/23/EC; they likewise comply with the product standard EN 60947-4-2.

At the output of a DS7 soft starter (terminals U, V, W) you must not

- connect any capacitive load (e.g. phase compensation capacitors),
- connect several soft starters with each other on the output side.

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

The devices of the DS7 series

- are not devices for household use, and are designed exclusively for use in commercial applications,
- are not machines in the sense of the EC Machinery Safety Directive,
- can be used in the described system configurations in the industrial environment,
- 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 user of the equipment is responsible for ensuring that the machine use complies with the relevant EU Directives. Any other usage constitutes improper use.

1.7 Storage, transport and disposal

The DS7 soft starter is carefully packed and prepared for shipment. It must only be transported in the original packaging with suitable means of transport (see weight specifications in the Appendix under Dimensions). Observe all printed labels and instructions on the packaging. This also applies to the unpacked equipment.

On delivery please check whether

- there is any external damage to the packaging,
- the specifications on the delivery note match those of your order.

Then open the packaging with a suitable tool or check whether

- parts have been damaged during transport,
- the device matches the part no. ordered,
- the installation instructions are provided with the device.

In the event of damage, incomplete or incorrect delivery, please notify the responsible sales office immediately.

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

2 Engineering

2.1 Selection of devices

The DS7 soft starters can be designed for standard applications according to the technical specifications provided in the Appendix for standard motors.

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

- the overload cycle of the machine,
- The startup time for DOL starting or for star/delta starting,
- the maximum starting current,
- the load cycle as well as
- 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 "Soft Starter Design" (MN03902001Z-EN; previous description AWB8250-1346GB) 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.

2.2 EMC measures

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

The European standard EN 60947-4-2 refers to the limit classes described in the EN 55011 standard.

No other measures are required 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.

2.3 Network configuration

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

- networks with a grounded or ungrounded star point,
- networks with an isolated star point (IT networks),
- networks with a grounded phase conductor.

2.4 Power connection

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

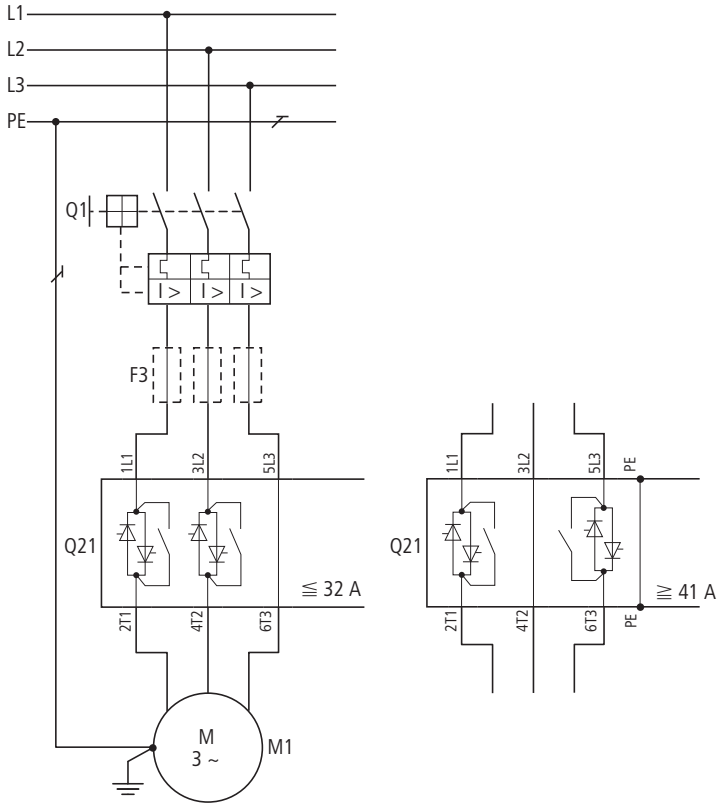


Figure 5: Power section and Motor connection

① Q1 = Line protection + motor protection
② F3 = optional semiconductor fuse
③ Q21 = Soft starter
④ 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 in a supply voltage.

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 motor protective circuit breaker
- Fuses in UL compliant systems must be UL-approved.
- The rated voltages of the fuses must be suitable for the local supply voltage.
- No fuses are required on the motor side.

2.5 Emergency switching off

The soft starters of the DS7 series comply with safety category B in accordance with EN 954-1. This means that some faults can remain undetected (e.g. thyristor failed through overvoltage = permanently conductive). If the machine has more stringent requirements in accordance with EN 1050 "Safety of machines", additional (external) measures must be implemented in accordance with this standard.

2.6 Protective element

The devices are protected with fuse devices shown in the Appendix (→ Page 87). 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 soft starter may be damaged in the event of a short-circuit.

2.6.2 Type 2 coordination

As well as the protective devices for type 1 coordination, superfast semiconductor fuses are also required. These protect the soft starter from damage in the event of a short-circuit. The semiconductor fuses do not however provide any cable protective functions!

The semiconductor fuses must be mounted externally on DS7 soft starters. The correct types are listed in the Appendix in page 87 .

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

2.7 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 start-ups 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 87

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 switch cabinets and machines,
- installation in the cable duct,
- a maximum ambient temperature of +40 °C,
- normal switching frequency.

The fuses and cable cross-sections depend on the rating of the soft starter and the start cycle (switching frequency, overcurrent).

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

2.8 Motor connection

The soft starters of the DS7 series are intended for use with three-phase asynchronous motors. It is also possible to connect

- pole-changing three-phase motors (Dahlander motors) as well as
- rotor-fed three-phase motors (slipring rotors).

With these motors, both the application (i.e. machine) and the motor itself must permit this. With pole-changing motors, the soft starter must first be disabled before the windings are changed over.

Full motor protection to VDE requirements is achieved with the use of an overcurrent relay and a temperature monitoring device.
PTC thermistors or thermostats with PTC characteristics are best suited for temperature monitoring.

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 is not too low. Otherwise this may cause the motor to overheat excessively before it starts up.

Three-phase motors with different circuit types can be operated. The circuit types depend on the rating of the motor concerned.

In a 3 × 400 V supply network, motors are operated.

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

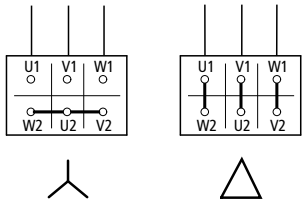


Figure 6: Possible motor circuit types:
Star connection and delta connection

A standard connection produces a clockwise rotating field. The clockwise rotation of the motor shaft is achieved by connecting the terminals of the motor and soft starter as follows:

Table 5: Connection of DS7 and motor

Net	Input DS7	Output DS7	Motor
L1	1L1	2T1	U1
L2	3L2	4T2	V1
L3	5L3	6T3	W1

The rotation direction of the motor can be reversed by changing over two phases on the motor, by

- permanently changing the connection,
- using a reversing starting combination or
- using an electronic reversing contactor.

When reversing the rotation direction, the output of the soft starter must be disabled before the reverse switching is carried out.

The rotating field direction at the input is always the same as that at the output.

2.8.1 Long motor supply cables

DS7 soft starters can also be used with long motor cables (i.e. > 100 m). However, the voltage drop on the cable must be taken into account and a larger cross-section must be laid if necessary.

2.9 Connection types

2.9.1 General enable/immediate stop without ramp function (e.g with emergency-stop)

When controlling a DS7 soft starter via terminals, a stop can be implemented without a ramp function by using a soft stop ramp time of zero. Alternatively, with DS7 devices ≧ 41 A this can be achieved by disconnecting the EN (Enable) signal.

If the DS7 soft starter, on the other hand, is controlled via a SmartWire-DT interface, this stop can be executed via the control word, irrespective of the ramp time set and device size.

In certain fault situations, the DS7 soft starter also carries out a stop without a ramp function, even when controlled via the terminals.

This is described in the chapter "Diagnostics" (→ Page 71).

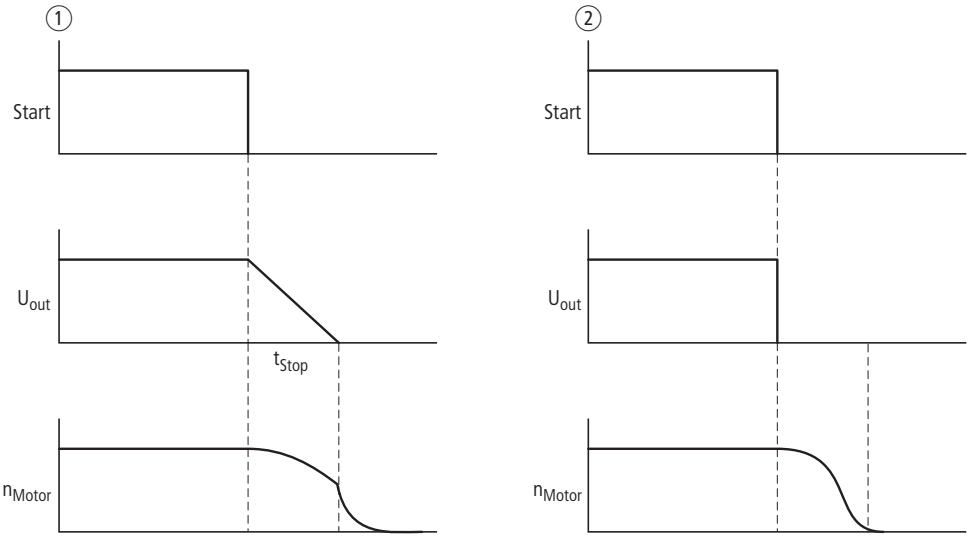


Figure 7: Emergency switching off with and without soft stop

① Terminal stop (t-Stop > 0 s)

② Stop with Enable (with sizes 1 and 2, i.e. with devices up to 32 A, only with control via SmartWire-DT) or via terminal with t-Stop = 0 s

2.9.2 Changing start commands

If the start command drops out during operation (ramp or top-of-ramp), the DS7 soft starter runs down from the current ramp value with the soft stop ramp. If during the soft stop ramp the start command is activated again, the soft stop is aborted and a soft start is carried out from the current value of the output voltage.

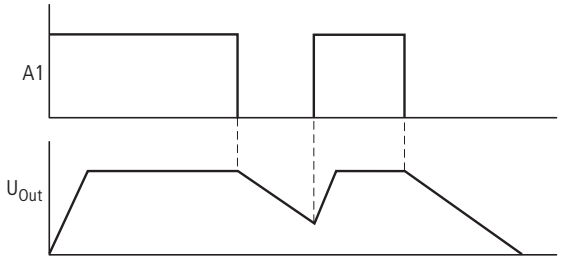


Figure 8: Changing start commands

2.9.3 Including the overload relay in the control system

We recommend the use of an external overload relay instead of a motor-protective circuit-breaker with an integrated overload relay. Only in this way can it be ensured that in the event of an overload the soft starter can be brought to a controlled stop.

WARNING

Overvoltages that can destroy the semiconductors in the soft starter may be present when the power cables are opened directly (emergency-stop during ramp operation).

Overload protection can be included in two ways:

- The overload relay's signalling contacts are incorporated in the On/Off circuit. In the event of a fault, the soft starter decelerates for the set ramp time and stops.
- The signal contacts of the overload relay are evaluated in a higher-level controller. The control word is assigned accordingly via the SmartWire-DT connection in order to switch off the output of the soft starter (Enable signal) immediately in the event of a fault. The soft starter switches off but the mains contactor remains on. In order to switch this off as well, the Stop state must be detected and the contactor de-energized separately. This is only possible with a SmartWire-DT version of the DS7 soft starter!

2.9.4 Standard connection

In standard operation, the DS7 soft starter is connected in the motor feeder. For mains isolation to EN 60947-1, subclause 7.1.6 or when working on the motor, DIN/EN 60204-1 / VDE 0113 Part 1, subclause 5.3 stipulates the mandatory use of a central switching device (contactor or main switch) with an isolation function. No contactors are required to operate individual motor feeders.

2.9.5 Connection without soft stop ramp

2.9.5.1 Construction size 1 (up to 12 A)

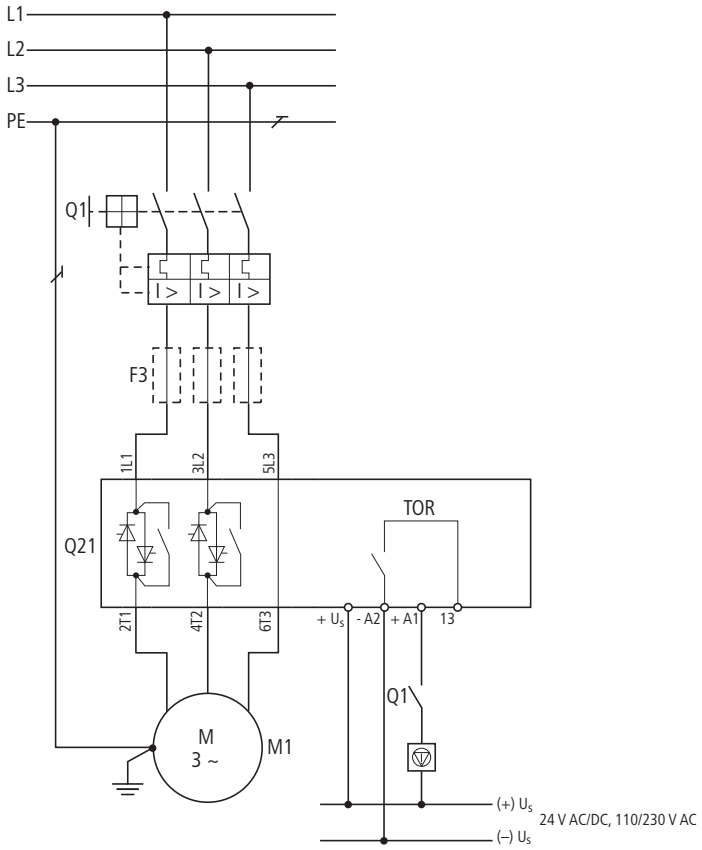


Figure 9: Standard connection without soft stop

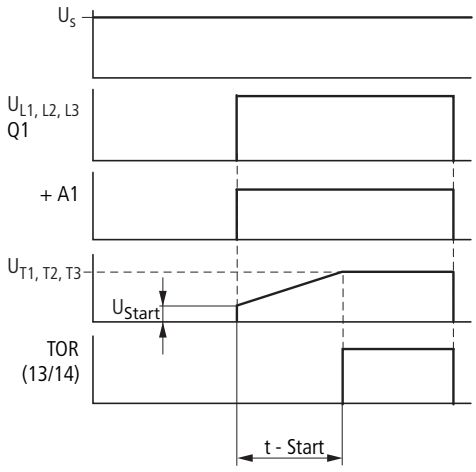


Figure 10: Logic sequence without soft stop

2.9.5.2 Construction size 2 (16 A to 32 A)

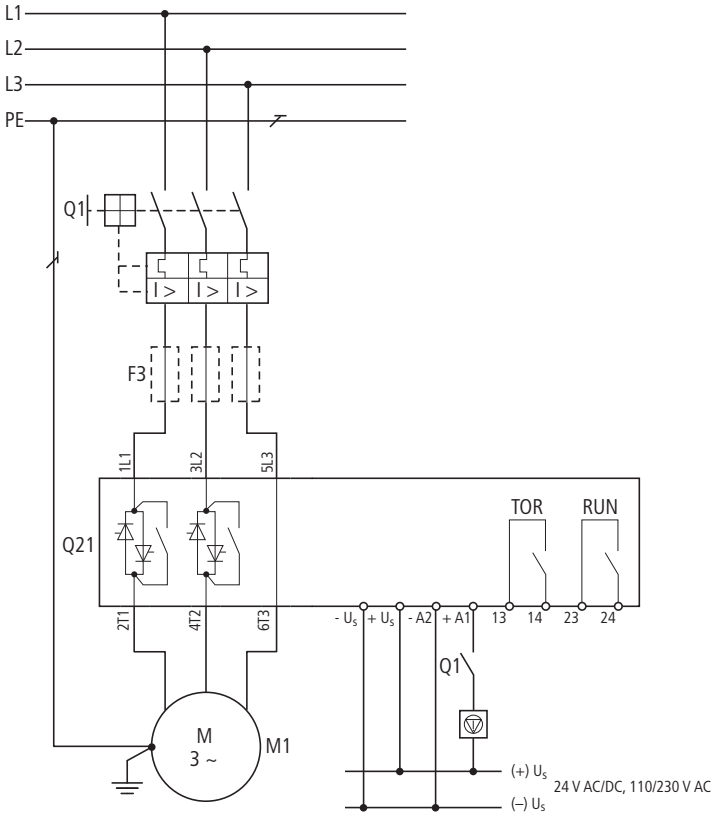


Figure 11: Standard connection without soft stop

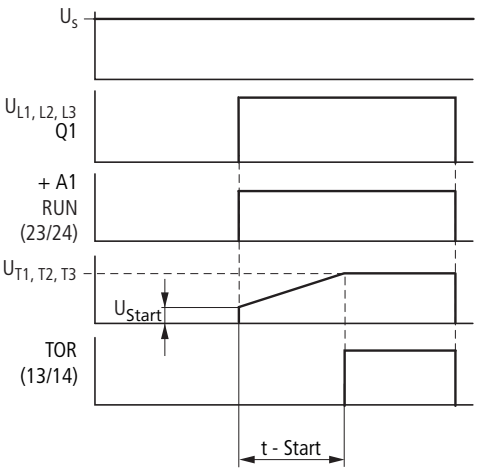


Figure 12: Logic sequence without soft stop

2.9.5.3 Construction size 3 + 4 (41 A to 200 A)

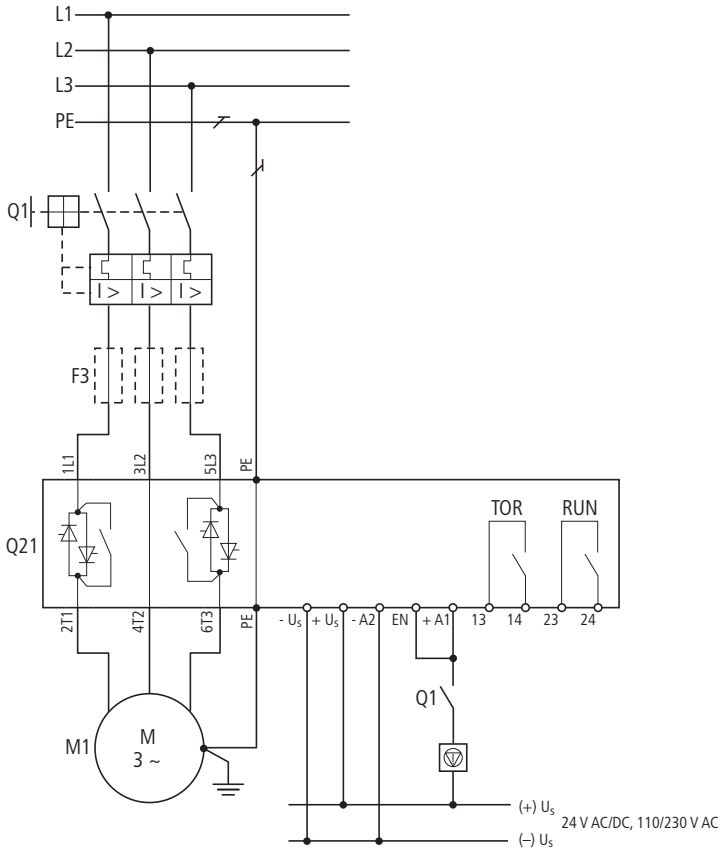


Figure 13: Standard connection without soft stop

① Q1 = Line protection
② F3 = Semiconductor fuse for type 2 coordination, in addition to Q1 (optional)
③ Q21 = Soft starter
④ M1 = Motor

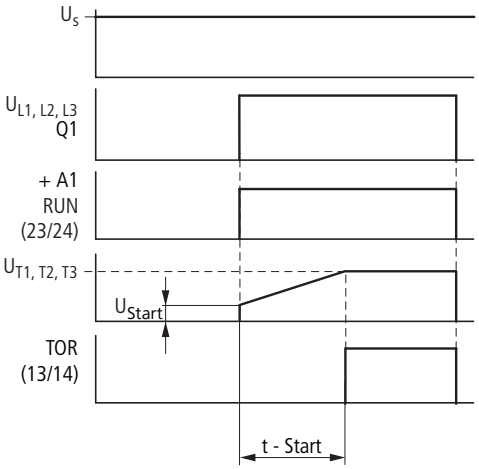


Figure 14: Logic sequence without soft stop

2.9.6 Connection with soft stop ramp

2.9.6.1 Construction size 1 (up to 12 A)

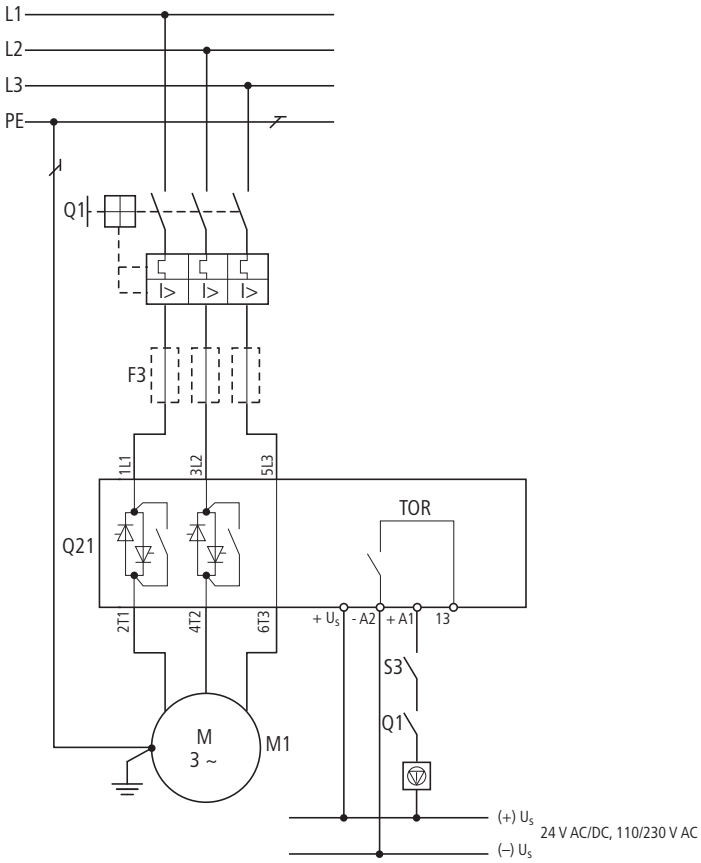


Figure 15: Standard connection with Soft stop

S3: Start/stop

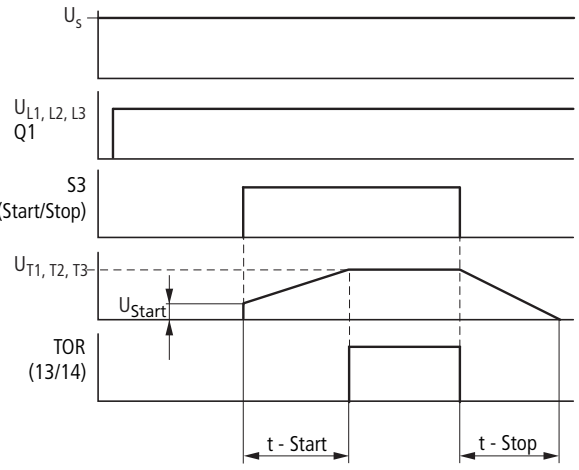


Figure 16: Logic sequence with soft stop

2.9.6.2 Construction size 2 (16 A to 32 A)

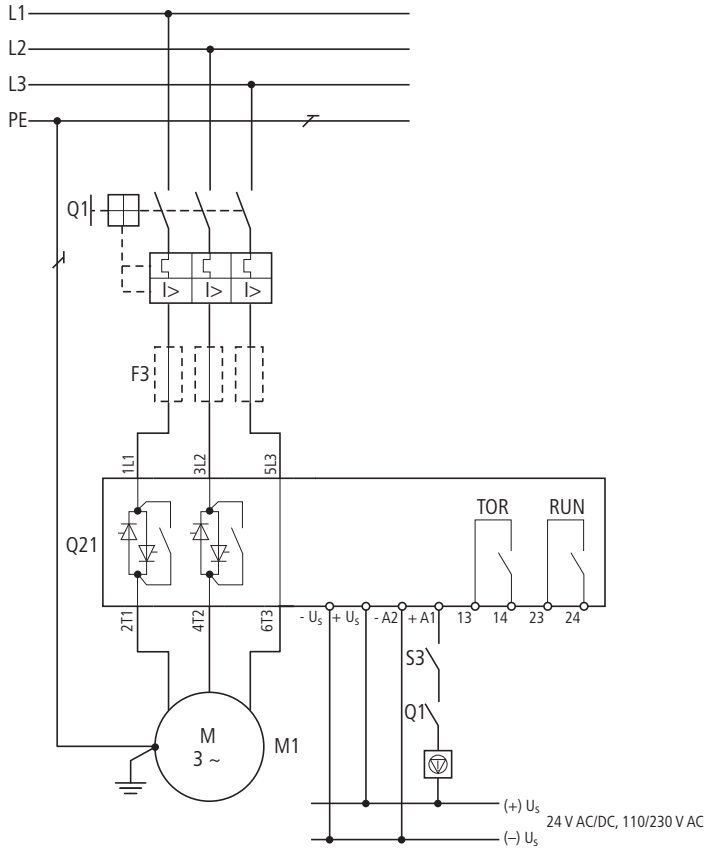


Figure 17: Standard connection with Soft stop

S3: Start/stop

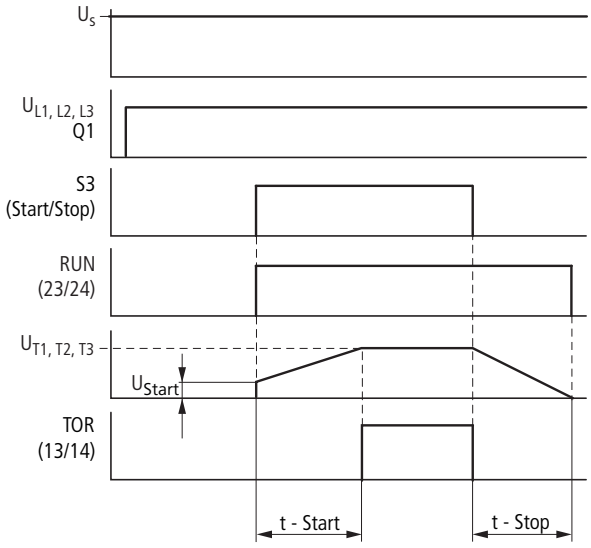


Figure 18: Logic sequence with soft stop

2.9.6.3 Construction size 3 + 4 (41 A to 200 A)

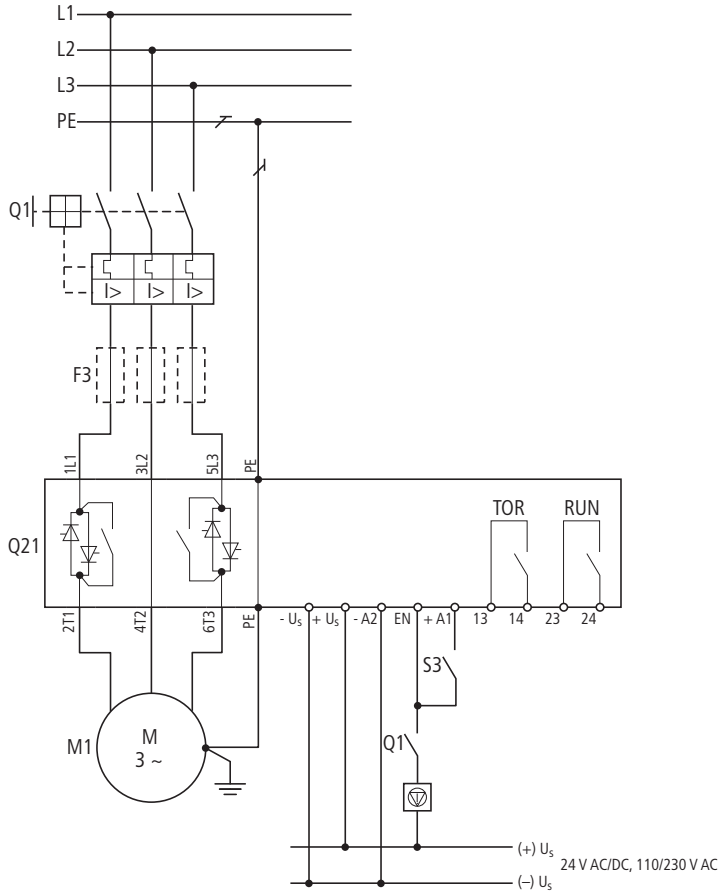


Figure 19: Standard connection with Soft stop

S3: Start/stop

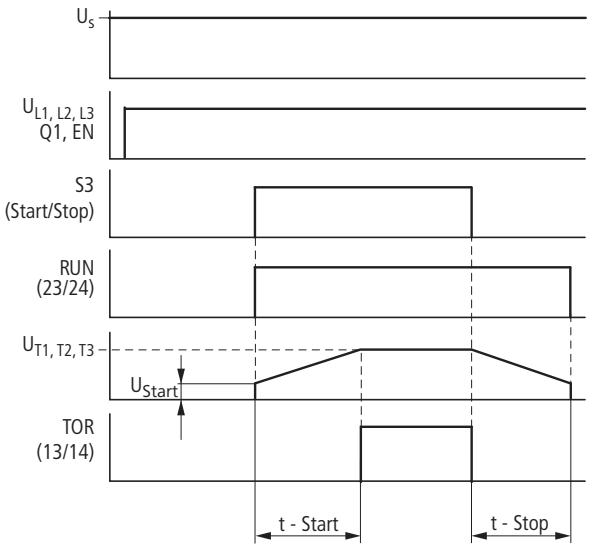


Figure 20: Logic sequence with soft stop

2.9.7 Standard connection with upstream mains contactor and soft stop ramp

2.9.7.1 Construction size 1 (up to 12 A)

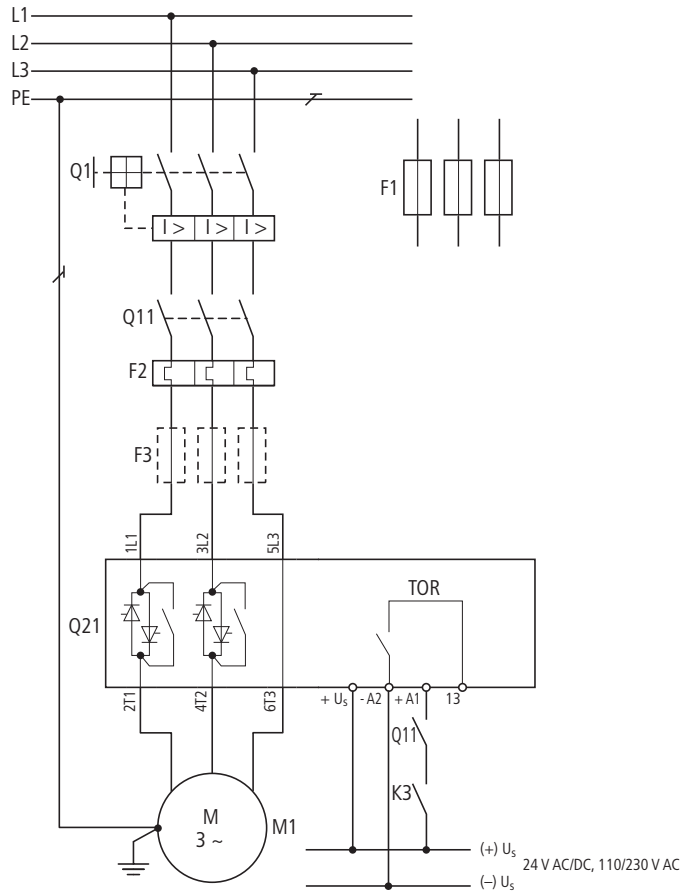


Figure 21: Standard connection with mains contactor

Q11: Mains On/Off; K3: Start/Stop

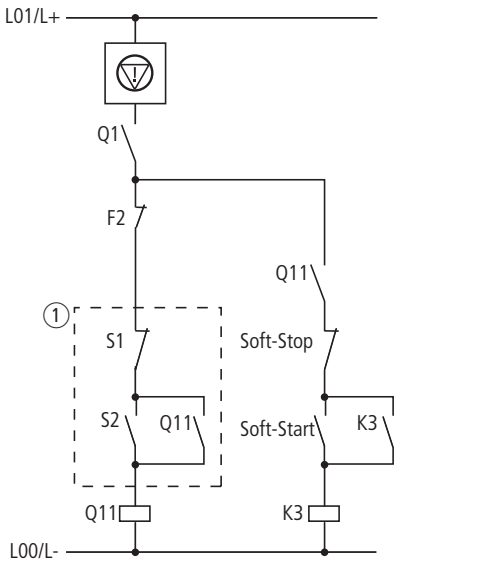


Figure 22: Control section with mains contactor

① optional - only if a stop without soft stop is required

2.9.7.2 Construction size 2 (16 A to 32 A)

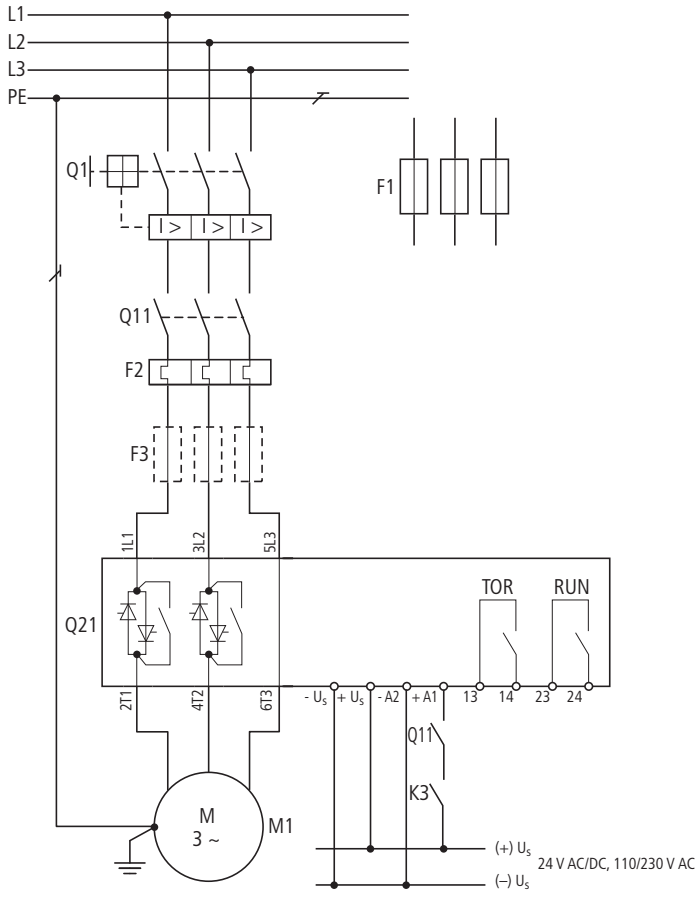


Figure 23: Standard connection with mains contactor

Q11: Mains On/Off
K3: Start/stop

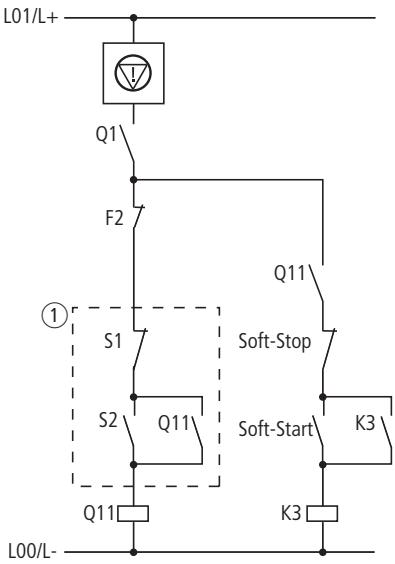


Figure 24: Control section with mains contactor

① optional - only if a stop without soft stop is required

2.9.7.3 Construction size 3 + 4 (41 A to 200 A)

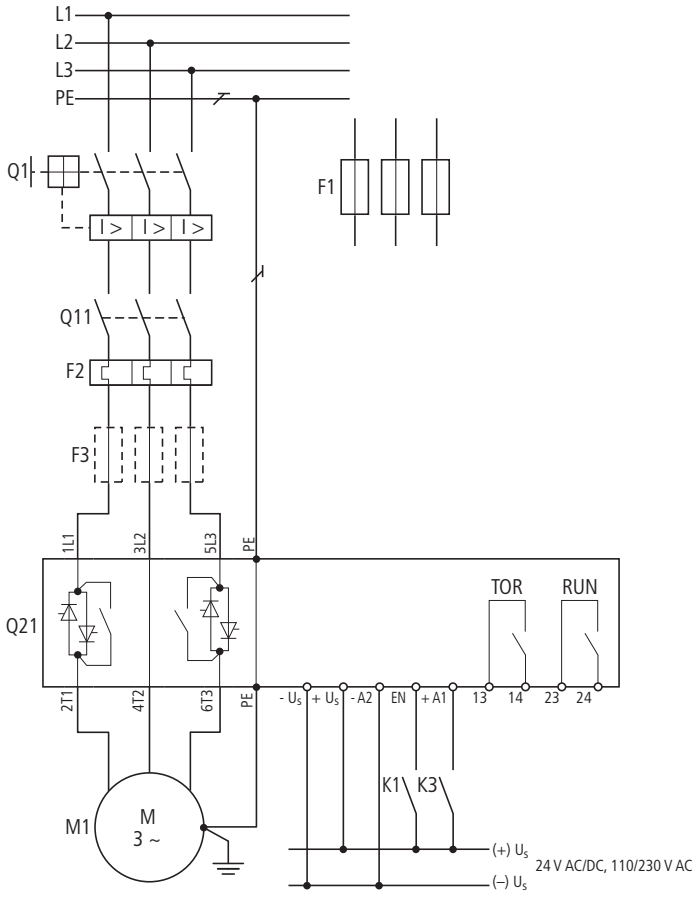


Figure 25: Standard connection with mains contactor

Q11: Mains On/Off
K3: Start/stop

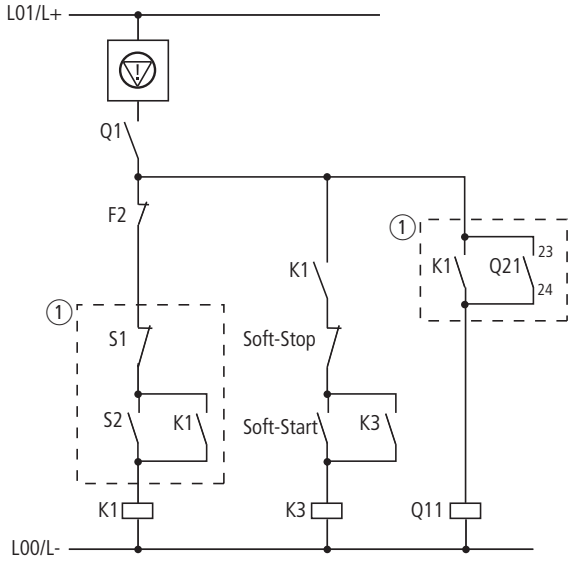


Figure 26: Control section with mains contactor

① optional - only if a stop without soft stop is required

2.9.8 Rotation direction reversal with soft stop ramp

2.9.8.1 Construction size 1 (up to 12 A)

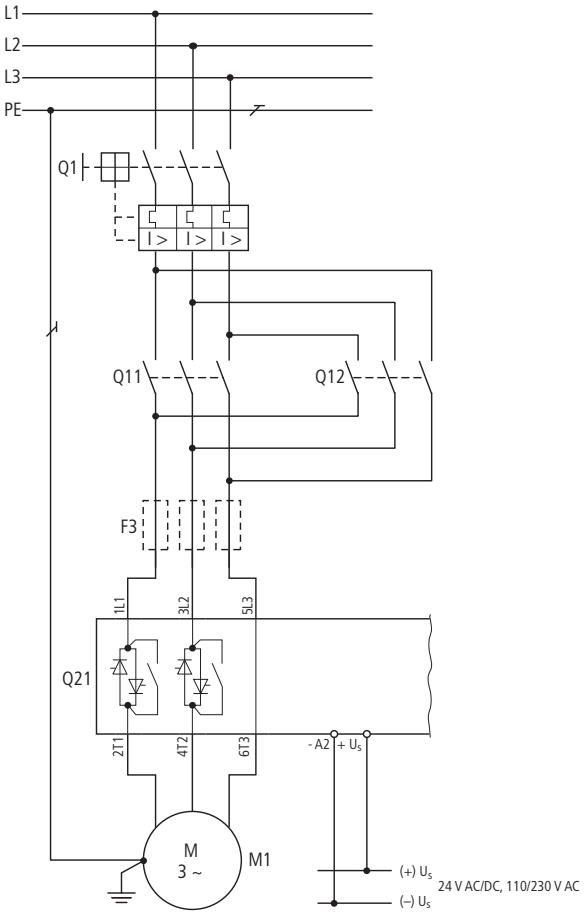


Figure 27: Rotation direction reversal with ramp

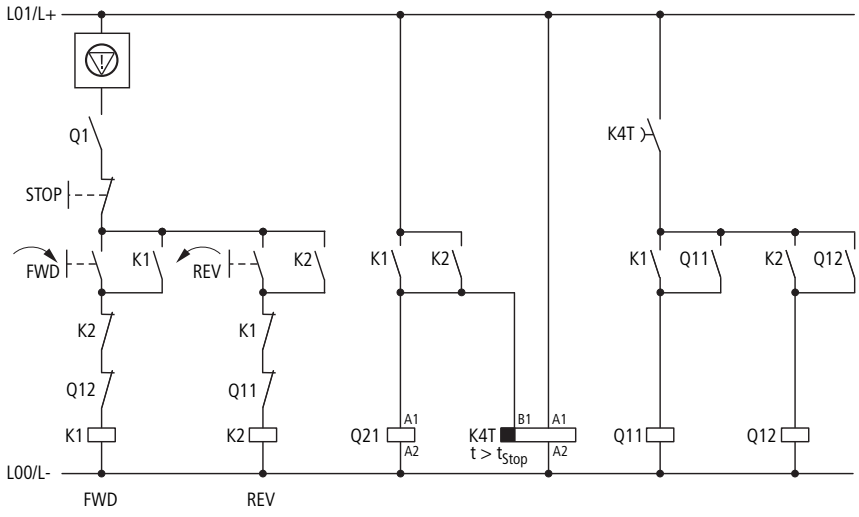


Figure 28: Control section Bidirectional operation
K4T: Simulated RUN signal

2.9.8.2 Construction size 2 (16 A to 32 A)

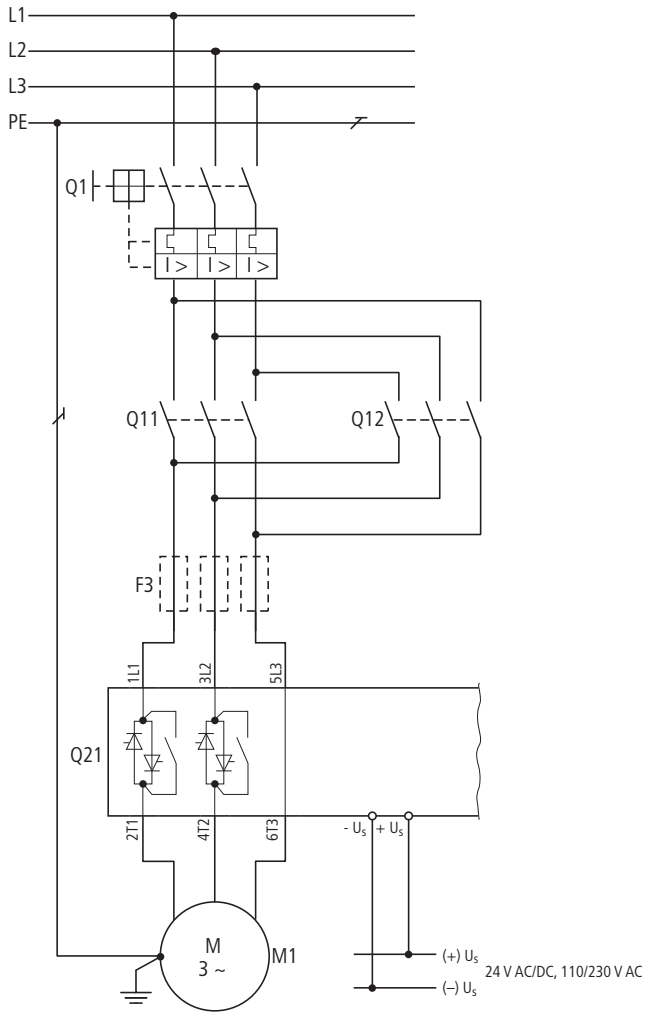


Figure 29: Rotation direction reversal with ramp

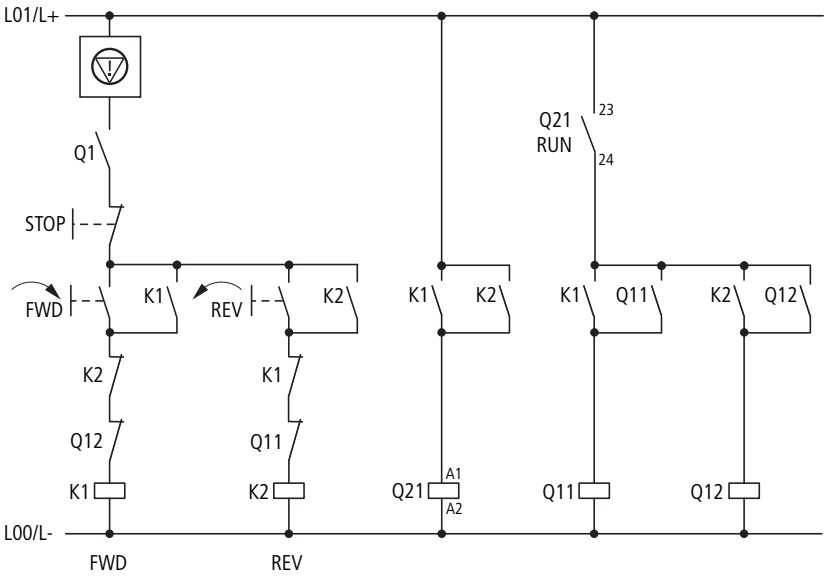


Figure 30: Control section Bidirectional operation

2.9.8.3 Construction size 3 + 4 (41 A to 200 A)

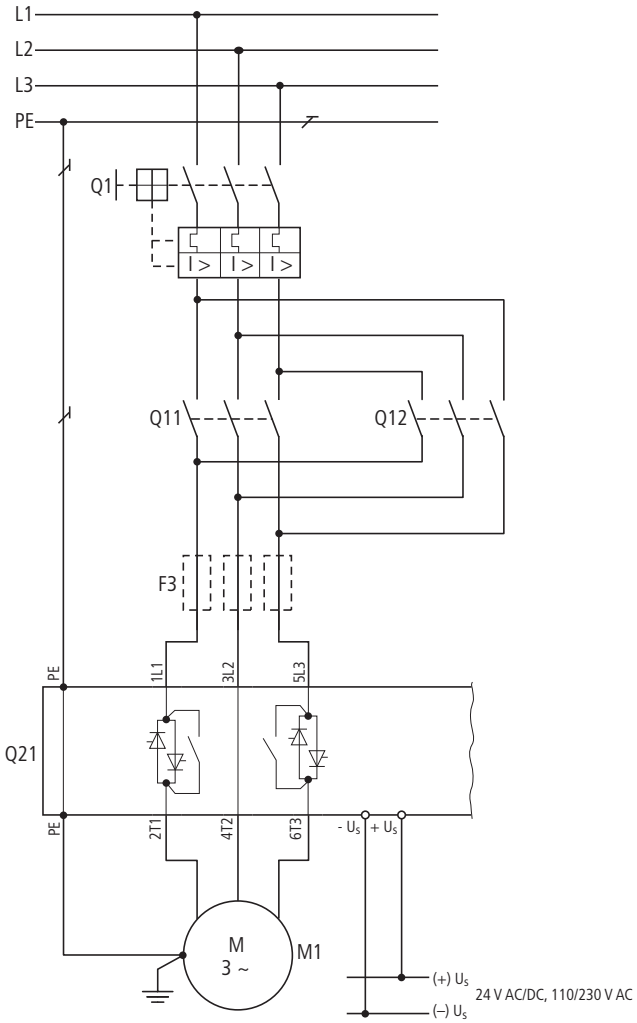


Figure 31: Rotation direction reversal with ramp

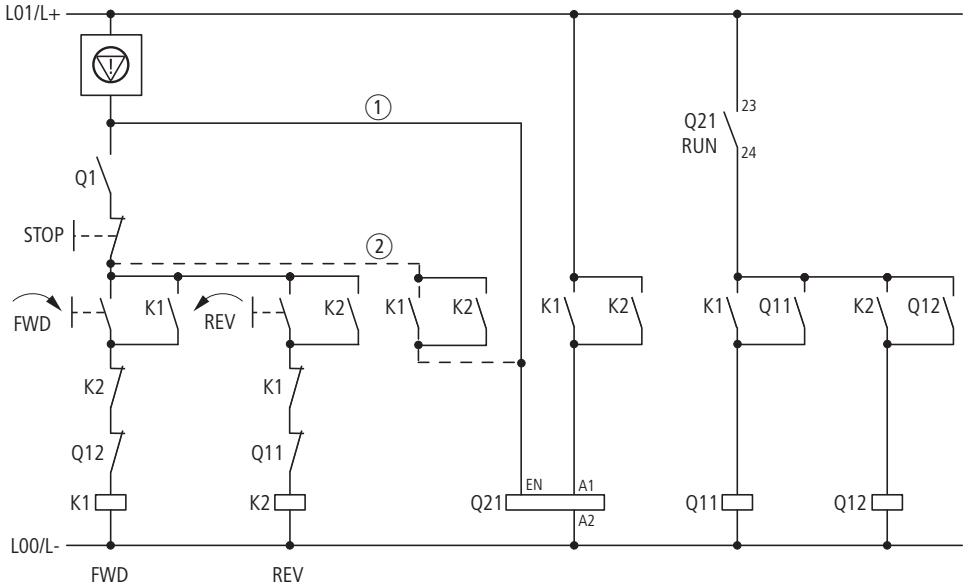


Figure 32: Control section Bidirectional operation
① with Soft stop; ② without Soft stop

2.9.9 Bypass connection

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

2.9.10 Pump connection – single direction of rotation

When operating pumps, one of the most frequent requirements is to be able to run emergency operations with the bypass contactor. A service switch is used to select between soft starter operation and DOL starter operation via a bypass contactor. In the latter setting the soft starter is fully bypassed. But because the output circuit must not be opened during operation. The interlocks ensure that a switchover is only possible after a stop.

Unlike simple bypass operation, the bypass contactor in this case must be designed to utilization category AC-3. The recommended mains contactor shown in the Appendix (→ Page 87) can be used as a contactor.

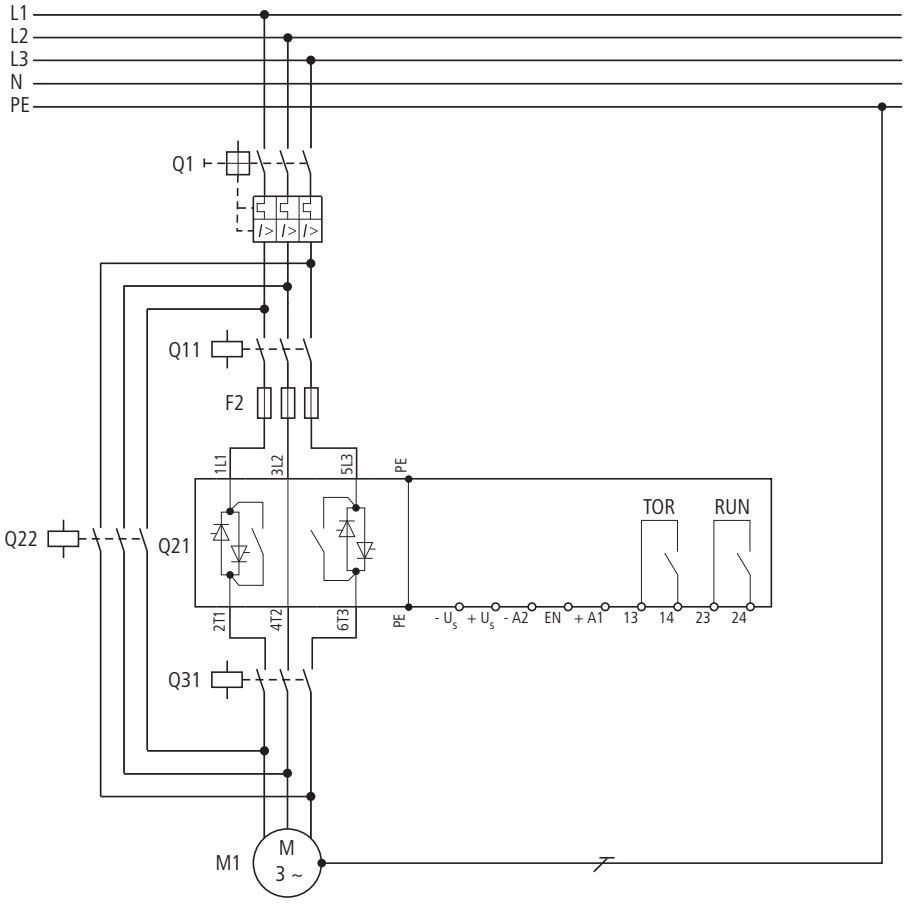


Figure 33: Power section with bypass emergency operation – pump operation
Q1 =Cable protection; Q11 = mains contactor; Q21 = Soft starter; Q31 = Secondary contactor; Q22 = Bypass contactor/Emergency operation protection; F2 = semiconductor fuse for type 2 coordination, in addition to Q1; M1 = Motor

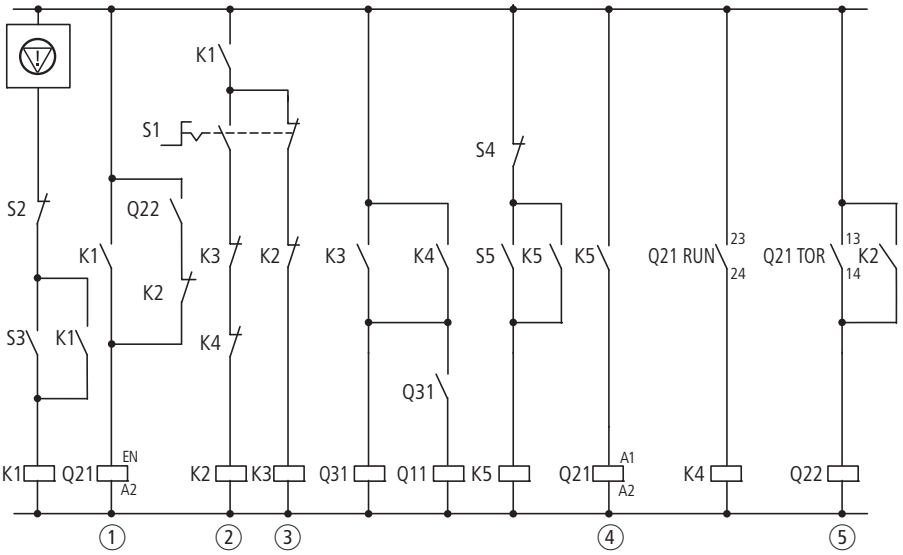


Figure 34: Actuation with bypass emergency operation – pump operation (≧ 16 A)

① Enable
② Automatic
③ Manual/bypass operation
④ Soft start/Soft stop
⑤ Bypass contactor

2.9.11 Delta connection

An “In-Delta” connection is not possible with DS7-34… series soft starters.

2.10 Starting several motors sequentially with a soft starter

When starting several motors one after the other using a soft starter, keep to the following changeover sequence:

▶1.Start using soft starter
▶2.Switch on bypass contactor
▶3.Block soft starter
▶4.Switch soft starter output to the next motor
▶5.Restart

When starting several motors with one soft starter the thermal load of the soft starter (start 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.

2.10.1 Power section (Construction size 3 + 4, 41 A to 200 A)

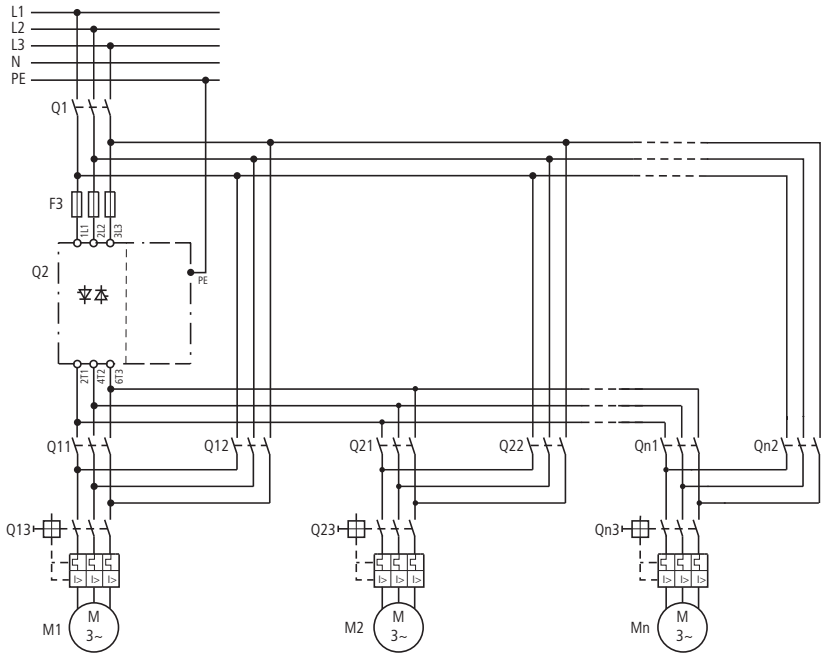


Figure 35: Power section, motor cascade

Q1 = Line protection
Q2 = Soft starters
Qn1 = Motor contactor n of soft starter
Qn2 = Supply bypass contactor for motor n
F3 = Semiconductor fuse for type “2” coordination, in addition to Q1
Mn = Motor n

2.10.1.1 Actuation (Construction size 3 + 4, 41 A to 200 A)

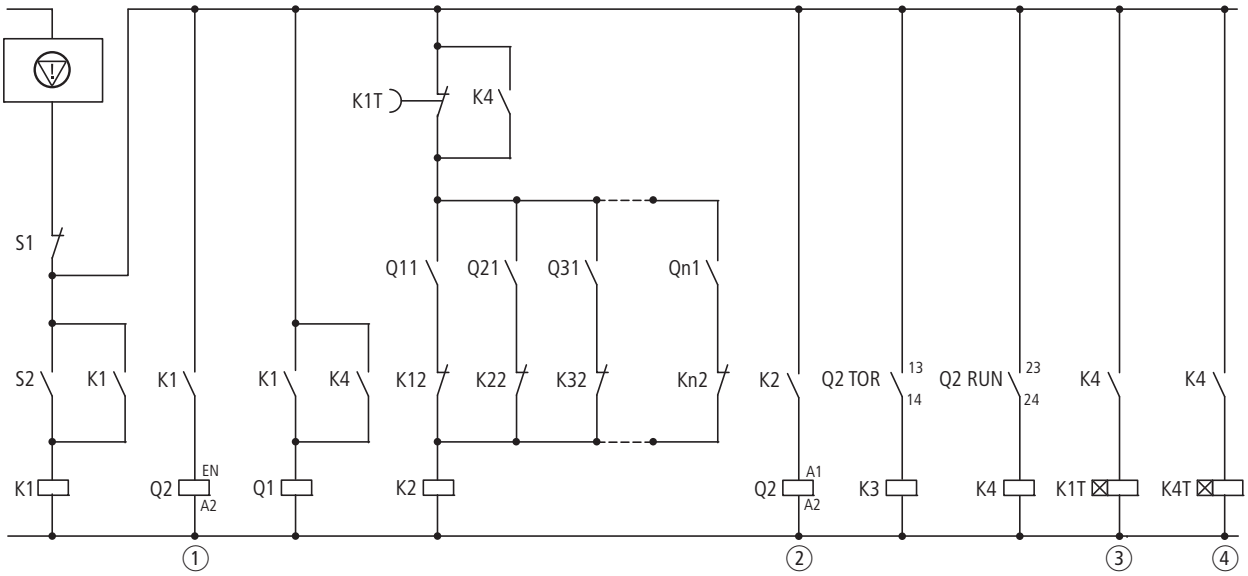


Figure 36: Actuation, motor cascade, part 1 (≧ 16 A)

① Enable
② Soft start/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.

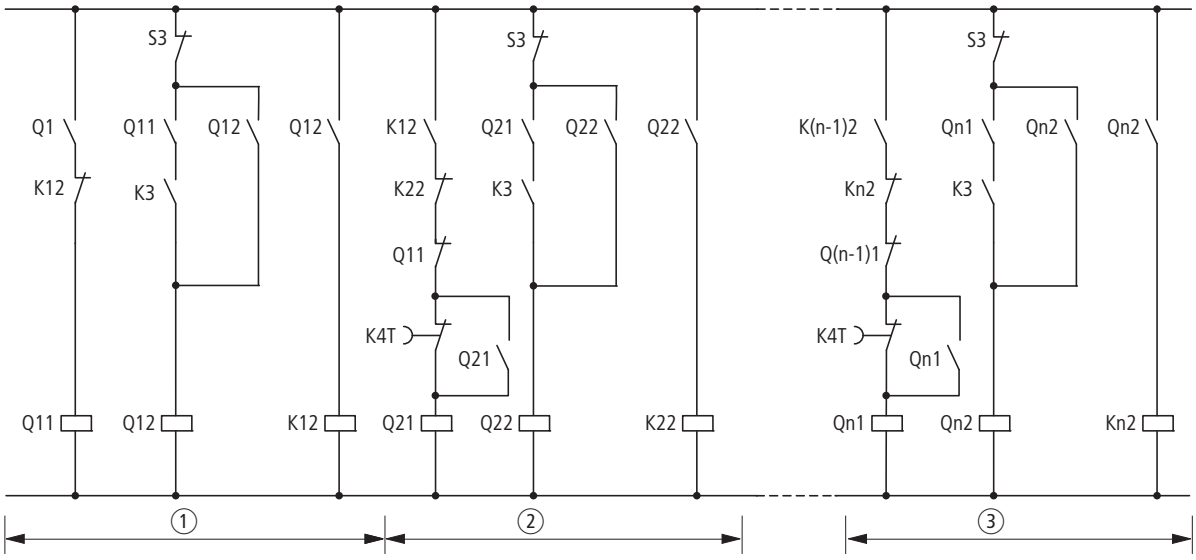


Figure 37: Actuation, motor cascade, part 2

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.

2.11 Pole-changing motors/Dahlander motors

The DS7 soft starter is connected in the feeder cable before pole-changing. The start command must be present after a circuit is selected and a start command for the pole changing was set. All pole changes are only executed at standstill.

Operation via the SmartWire-DT interface is advantageous since this allows the downloading of different parameter sets. In this way, an optimum adaption to the motor or the application is possible. The actuation is similar to a cascade control apart from the fact that only the other winding is switched and not the next motor.

2.12 Parallel switching of motors on one soft starter

You can also use soft starters to start several motors connected in parallel. This does not, however, allow the behavior of the individual motors to be controlled. Each motor is to be fitted with suitable overload protection.

→ The current consumption of all connected motors must not exceed the rated operational current I_e of the soft starter!

→ You must, however, protect each motor with thermistors and/or overload relays!

If motors with large rating differences (e.g. with 1.5 kW and 11 kW) are connected in parallel to the output of a soft starter, problems may occur during the start: In certain circumstances the motor with the lower motor power may not provide the required torque. This is due to the relatively high resistive load in the stator of the smaller motor. In this case it requires a higher voltage than the higher rated motor during the start.

2.13 Connecting the controller section

2.13.1 Regulator supply voltage (rated control voltage U_S)

The regulator supply voltage U_S is fed externally via terminals +Us/-Us (16 – 200 A) and A2 (4 – 12 A). Depending on the device version, 24 V AC/DC or 110 - 230 V AC must be connected.

DS7 soft starters with a SmartWire-DT connection can also be supplied via the SmartWire-DT cable; an additional connection to +Us is unnecessary.

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

2.13.2 Internal device voltages

The DS7 soft starters do not provide any internal voltage.

2.13.3 Grounding the 0 V potential

All control signal terminals of the DS7 soft starter are galvanically isolated from the power section. Grounding is not required.

2.13.4 Relay contacts

The soft starters of the DS7-340… series are provided with one or two relays with an N/O contact depending on the current range. The signal assignment can be programmed via SmartWire-DT, otherwise this is pre-programmed with the standard assignment. The relay is galvanically isolated from the soft starter.

Table 6: Relay contacts

Terminal	Standard function	Configuration	Meaning	Load carrying capacity
13	TOR	Input K1	N/O	250 V AC, 1 A, AC-1 or 24 V AC/DC, 1 A, AC-1 (devices up to 12 A at 24V supply voltage)
14 or –A2 with devices up to 12 A		Output K1		
With devices from 16 A additionally:				
23	RUN	Input K2	N/O	250 V AC, 1 A, AC-1
24		Output K2		

If you connect external contactors to a relay contact, you can increase interference immunity by

- connecting in AC circuits the contactor coil parallel with an RC filter,
- by connecting in DC circuits the contactor coil in parallel with a freewheel diode.

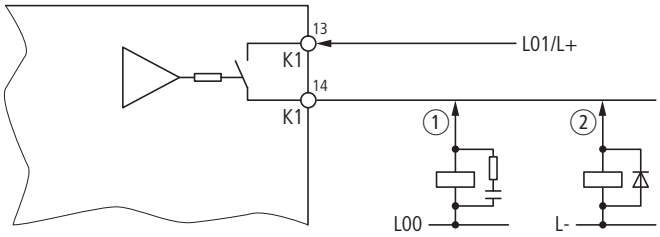


Figure 38: Relay connection

① Suppressor circuit with AC control voltage
② Suppressor circuit with DC control voltage

The RUN relay closes together with the start command; the ramp starts 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, the DS7 soft starter switches off with the "phase failure" fault message.

3 Parameter setting

3.1 Operating principles

You can adapt the soft starter to your application by setting appropriate parameters. The possible settings are defined in parameters.

The devices are assigned parameters either via the potentiometers on the front of the device, or with DS7 soft starters of SmartWire-DT version, via the interface.

Only the standard versions (DS7-340… and DS7-342…) are described below.
The DS7-34D… communication-enabled version is described in a separate document.

3.2 Factory 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 following tables shows the most important settings.

Table 7: Factory settings DS7

terminal, function	Factory setting
1A	Start/stop
Ramp times	t-Start: ~5 s t-Stop: 0 s
Start voltage	30 %
Relay K1	Top of Ramp
Relay K2 (for devices from 16 A)	RUN

3.3 Parameterization of DS7-340… and DS7-342…

The DS7-340… and DS7-342… soft starters are adapted to the application using the three potentiometers **t-Start**, **U-Start** and **t-Stop**. No other settings or entries are required apart from these potentiometer settings.

3.3.1 Start data

Table 8: Start data, potentiometer settings

Potentiometer	Parameter numbers	Value	Function	Factory setting
U-Start	U-StartPoti	30 – 92 %	Start voltage at which the ramp function is started	30 %
t-Start	t-StartPoti	1 – 30 s	Time in which the voltage **U-Start** is increased to 100 % by means of a linear voltage ramp	5 s
t-Stop	t-StopPoti	0 – 30 s	• Time in which the voltage 100 % is reduced to **U-Start** by means of a linear voltage ramp	0 s

The start voltage 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 ramp times likewise determine the startup behavior.
The longer the ramp times, the greater the thermal load on the motors. The ramp times set should therefore only be long enough to meet the requirements of the machine (example: with conveyor belts: select a time so that the transported goods do not topple; with belt drives: select a time so that the belts do not slip).

Some drives already reach the rated speed during the soft start ramp. In this case, it is not necessary to continue running a voltage ramp. The setting **t-Start** should then be adjusted to prevent unnecessary temperature rise.

During the ramps the DS7 soft starter uses a special process (“asymmetrical trigger control”) in order to suppress the otherwise normal imbalances in current or torque characteristics for two-phase controlled soft starters. In this way, DS7 soft starters can ensure the smooth running characteristics of a three-phase controlled soft starter.

Any combination of start and stop time is possible.

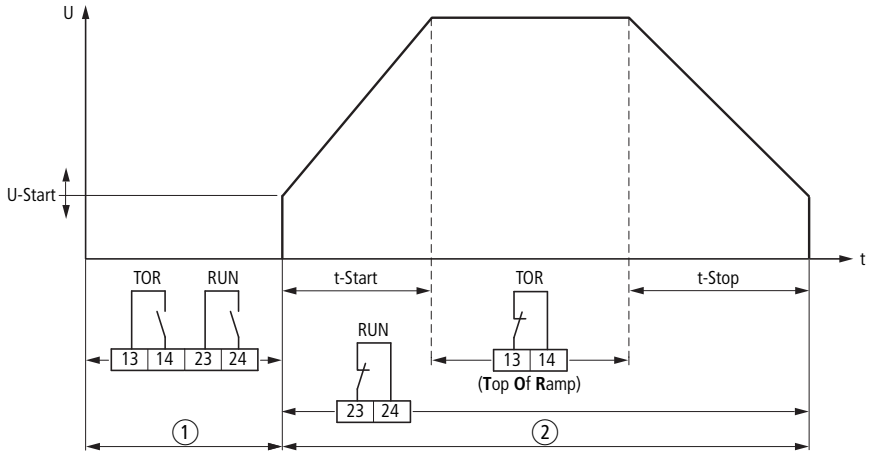


Figure 39: Relationship between relay and ramp

① Current consumption at 35 mA

② Current consumption 65 mA operation:
With construction size 1 the RUN relay is omitted; the terminal 14 is replaced by –A2

The potentiometers have the following effects:

3.3.1.1 t-Start

The start time **t-Start** defines the actual function of the soft starter. The motor voltage is increased in the set time from the start value **U-Start** to 100 %, thus accelerating the motor smoothly. If the time is too long, the motor and soft starter will be subject to higher temperature loads. This can cause the protective devices to trip. As short a time as possible should be selected: ideally a time between 2 and 5 seconds. With shorter start times, more starts per hour are also possible than is stated in the load cycle. Longer times mean accordingly fewer starts.

3.3.1.2 U-Start

The start voltage **U-Start** has a direct effect on the initial torque of the motor. As this increases quadratically, values lower than 30 % are not useful (corresponds to 9 % of the starting torque of the motor in mains operation; a star-delta circuit supplies 30 %). The start voltage of the motor should be high enough for the motor to start turning immediately at the start in order to prevent any unnecessary temperature rise.

3.3.1.3 t-Stop

A stop ramp is useful for pumps and conveyor belts in order, for example, to prevent the toppling of transported goods (e.g. bottles on a conveyor belt) or water hammer caused by valves shutting. 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 causes therefore the heating of the soft starter and motor and must be taken into account when determining the starting frequency.

The stop ramp is ended at the potentiometer setting of **U-Start**.
A correct setting will cause the minimum torque to be generated at which the motor still turns. With lower voltages (torques), the machine will remain at a standstill due to losses or friction.

3.3.2 Relay outputs

Table 9: Relay outputs, function

Relays	Designation	Value	Function
K1	K1-Pointer	TOR	Top-of-ramp: indicates operation with full voltage on the motor (top of start ramp reached).
K2	K2-Pointer	RUN	This relay is closed while the soft starter is in operation. The soft starter can be operating within a ramp or in the TOR state (relay only provided with devices > 12 A).

The relays are at the following terminals:

Table 10: Relay outputs, terminal assignments

Current range	K1	Default Function	K2	Default Function
to 12 A	13/-A2	TOR	–	–
16 – 32 A	13/14	TOR	23/24	RUN
41 – 200 A	13/14	TOR	23/24	RUN

4 Mounting/Installation

4.1 Scope of supply

On receiving the soft starter, check whether the delivery is complete and correct. Contact your responsible sales office if anything is missing or faulty.

Equipment supplied:

- a type DS7-34… device,
- an instructional leaflet IL (previous description AWA)
  - IL03902003Z (previous description instructional leaflet 8250-2541): for devices in construction size 1 (to 12 A device current)
  - IL03902004Z (previous description instructional leaflet 8250-2542): for devices in construction size 2 (to 32 A device current)
  - IL03902005Z (previous description instructional leaflet 8250-2543): for devices in construction size 3 or 4 (to 200 A device current)

4.2 Installation in switch cabinet

The mounting should take into account the weight and dimensions of the soft starter. For this use the necessary technical equipment (lifting trolley or crane for large loads) and tools.

Improper handling or use of the wrong tools may cause damage to the soft starter.

Soft starters are only designed for use as built-in devices.

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: installation 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.
- Do not install any 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.

A mounting clearance of 25 mm must be ensured at the front of DS7 series soft starters.
With devices up to 32 A a clearance of 75 mm is required above and below the device. With higher currents, 55 mm is sufficient to achieve the specified load cycle.
With smaller clearances, derating is necessary or the optional fan can be used.
All types can be mounted directly next to each other.
Additional clearances must be observed when mounting together with the NZM circuit-breaker!

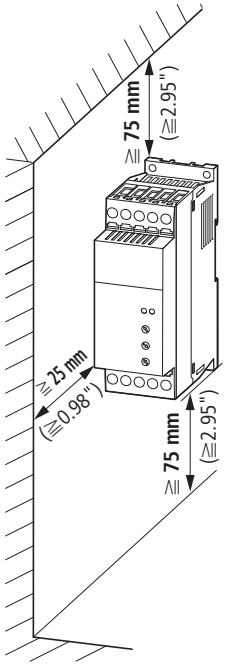


Figure 40: Installation free areas to 32 A

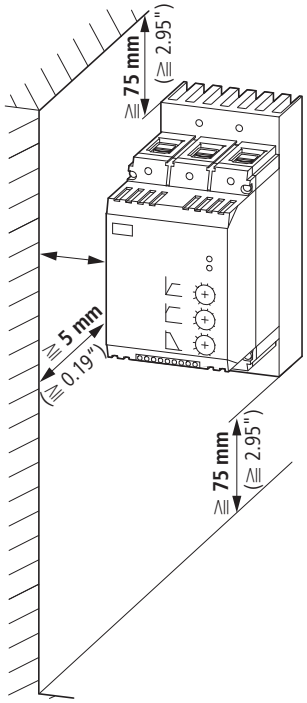


Figure 41: Installation free areas from 41 A

When using a soft starter in a location that is continuously subject to vibration or shock the use of vibration dampers should be considered.

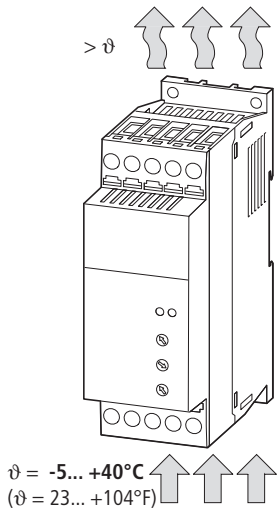


Figure 42: Cooling air supply

The supplied cooling air must have a temperature between -5 and +40 °C. A derating is required for higher temperatures.

4.2.1 Possible mounting positions

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

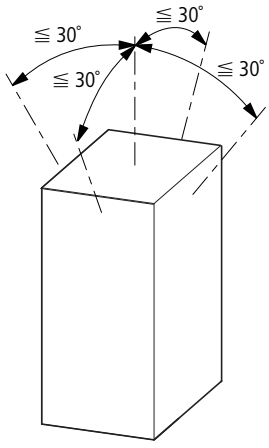


Figure 43: Mounting position

The soft starters are screwed onto the switch cabinet wall (mounting plate). The control signal terminals here point to the front.

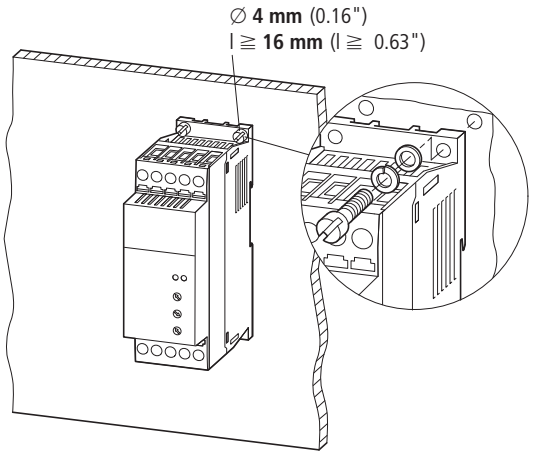


Figure 44: Mounting on the mounting plate with devices up to 32 A

Alternative:

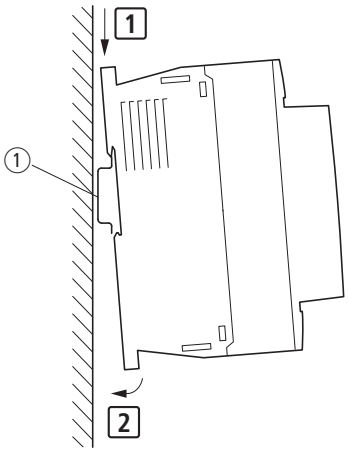


Figure 45: Mounting on the top-hat rail with devices up to 32 A

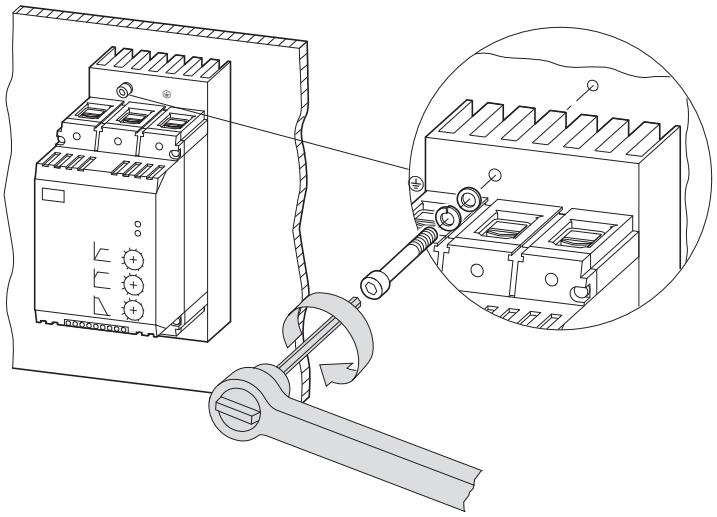


Figure 46: Mounting on the mounting plate with devices of 41 A and above

Together with an NZM:

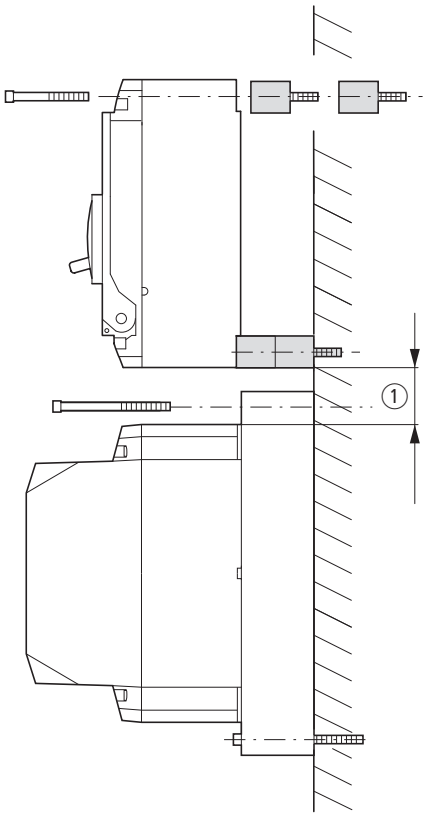


Figure 47: Mounting NZM + DS7 from 41 A and above

① Clearance of NZM to DS7 from 41 A and above,
with NZM1 ≧ 25 mm, with NZM2 ≧ 35 mm

The instructional leaflet is provided with the each soft starter.

4.3 Connections

Observe the following points for the connections.

CAUTION

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 mounting screw or another grounded metal surface in the switch cabinet).

CAUTION

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 mounting screw or another grounded metal surface in the switch cabinet).

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 of a few milliamperes are always present. An upstream disconnector must therefore be switched off before working on the starter or motor.

4.3.0.1 Connecting the motor supply cable

Lay all cables separately from the motor cable!

The conductor cross-section apply to cables 1L1, 3L2, 5L3, N, 2T1, 4T2 and 6T3. A PE connection is not required with devices up to 32 A.

4.3.0.2 Shielding motor cables

Unlike with frequency inverters, the shielding of the motor cables is not required.

4.3.0.3 Connect control cables

The cross-sections suitable for the terminals are listed in the Appendix in the section "Technical data" (→ chapter 7.4.2, page 84).

4.3.0.4 Shielding control cables

The control cables do not have to be shielded.

4.3.0.5 Installing a fan

An optional fan can be installed on the rear of the soft starter.

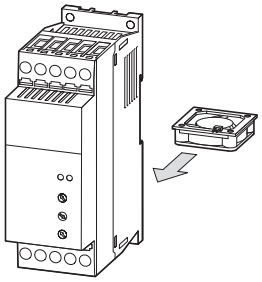


Figure 48: Mounting a fan on soft starters up to 32 A (basic principle)

For this break off the retaining strap carefully with a flat screwdriver, insert the fan and then secure it with the previously removed strap. To remove the fan carry out the same steps in reverse order.

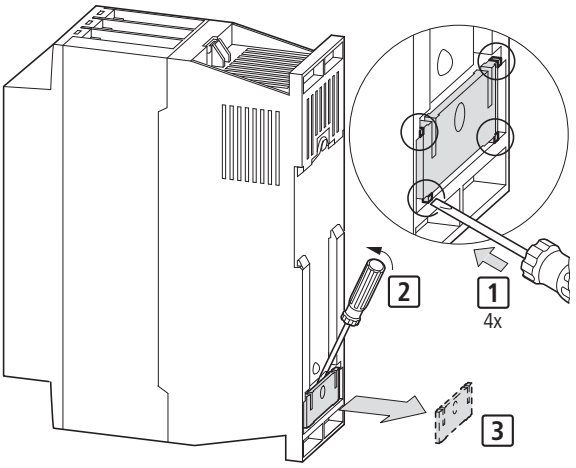


Figure 49: Step 1: break off strap

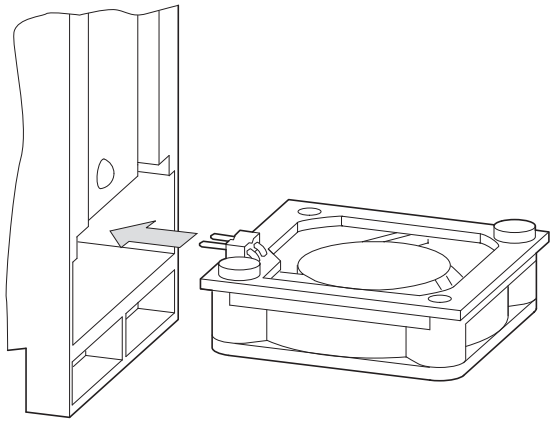


Figure 50: Step 2: insert fan

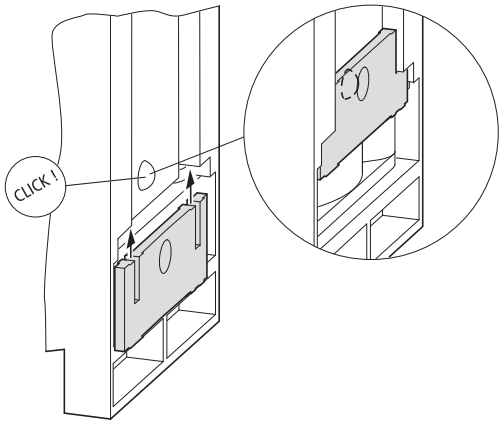


Figure 51: Step 3: secure with strap

→ The fan runs during the ramp time and continues running until the heat sink has cooled down. The fan is then automatically switched off.

4.3.0.6 Construction size 1 with the PKZ/PKE and mounting on the top-hat or busbar rail

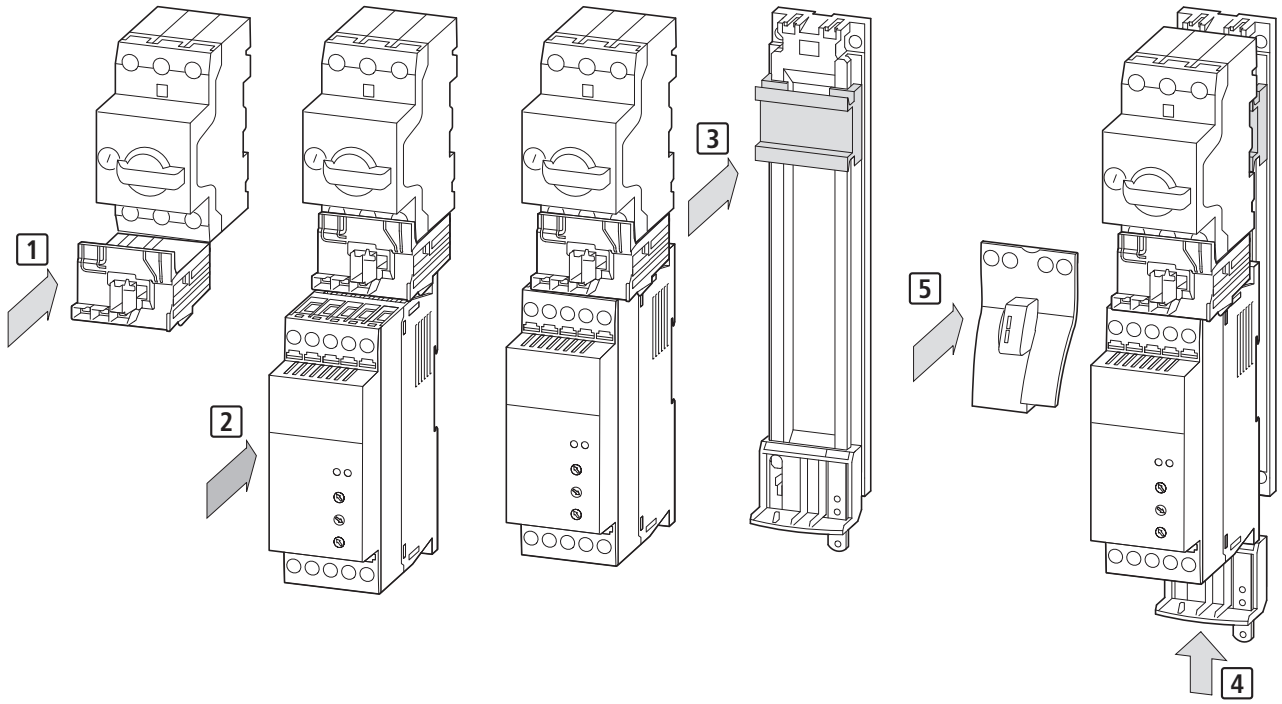


Figure 52: Mounting on the top-hat/busbar rail with devices up to 12 A

4.3.0.7 Construction size 2 with the PKZ/PKE and mounting on the top-hat or busbar rail

Mounting on the busbar adapter is carried out in the same way.

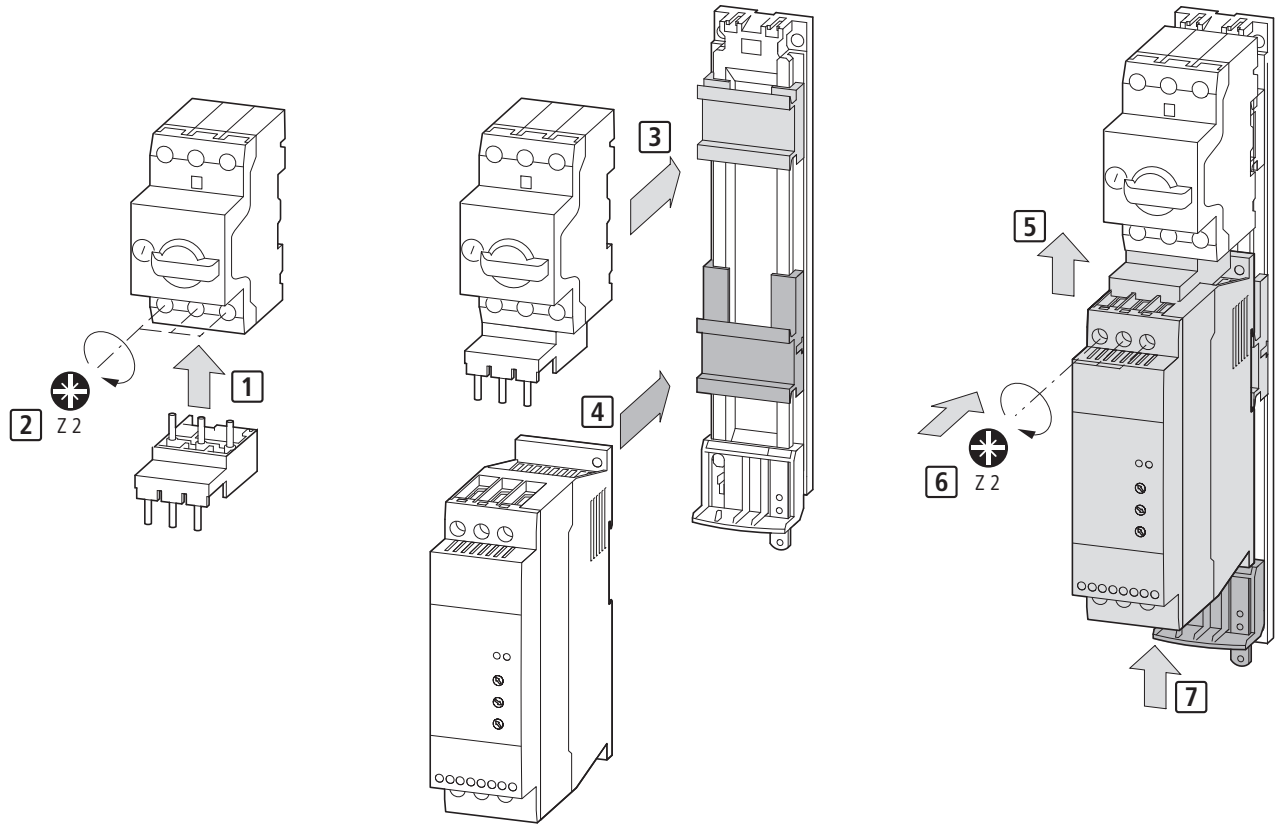


Figure 53: Mounting on the top-hat/busbar rail with devices up to 32 A

4.3.0.8 Fitting the motor plug

To wire the motor plug see installation instructions AWA2100-2690.

4.3.0.9 Fitting the overload relay

The ZB12 or ZB32 overload relay can be fitted directly to a DS7 soft starter.

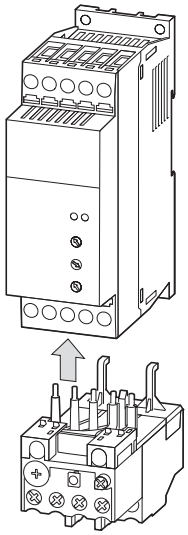


Figure 54: Mounting the overload relay with devices up to 32 A

5 Operation

5.1 Placing into operation

DS7-34… series soft starters are factory set so that you can operate a suitably rated 4-pole standard motor in a typical soft starter application without any additional settings required.

CAUTION

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.

CAUTION

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

→ Voltage breakdown tests must not be carried out on parts of the soft starter.
A suitable measuring instrument (with an internal resistance of at least 10 Ω per 1 V) must be used for measuring signal voltages.

→ Before switching on the soft starter check whether the regulator supply voltage matches the supply voltage of the DS7 soft starters (for this see the nameplate).

When changing the parameters, observe the following points:

- Never set the ramp time too long!

If the ramp time is too long, the motor will only accelerate slowly. This will cause the motor to operate with an increased current for an unnecessarily long time. In extreme cases, this can cause the device to switch off due to overtemperature.

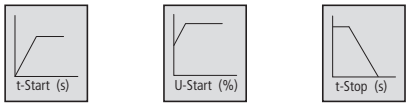
- Never set too low a start voltage!

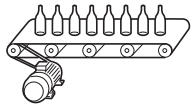
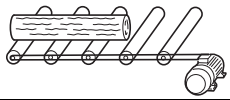
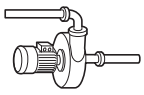
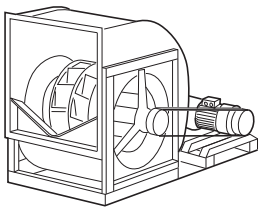
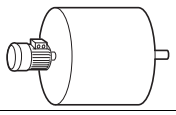
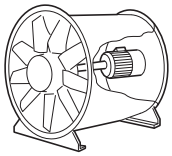
If the start voltage is set too low, the motor cannot generate sufficient torque for the acceleration. As a result the motor will only accelerate slowly or not at all. If the motor does not move or does not accelerate quickly enough, this can cause the device to switch off due to overtemperature.

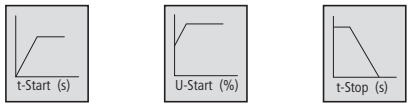
If you wish to change parameters yourself, refer to the values stated in the manual "Soft Starter Design" (MN03902001Z-EN; previous description AWB8250-1346GB).

5.2 Recommended settings

The following standard settings are recommended for an application:



t-Start (s)	U-Start (%)	t-Stop (s)		
~10	~30	0		J → 0
~25	~30	~30		
~20	~40	0		
~10	~30	~20		
~15	~40	0		
~18	~40	0		J → ∞ → DS7 > P_{Motor}
~15	~50	0		→ DS7 > P_{Motor}



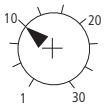
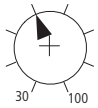
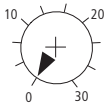
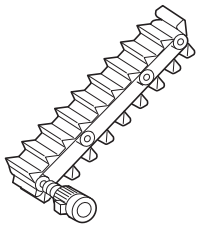
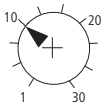
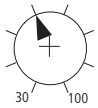
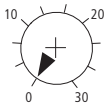
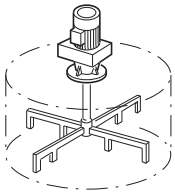
t-Start (s)	U-Start (%)	t-Stop (s)		
~10 	~60 	0 		
~10 	~60 	0 		→ DS7 > P_{Motor}

Figure 55: Recommended settings per application

5.3 Commissioning procedure

Set the parameter **U-Start** as recommended from the previous table; also set **t-Start** to maximum and **t-Stop** to minimum.

▶1.Start
Switch off the start signal (or at devices from 41 A the Enable signal) after a maximum period of 1 second. If the motor has turned, proceed with point 2. If the motor has not started, increase **U-Start** by 10 %, or if the motor has started too abruptly with the current setting, reduce **U-Start** again by 5 %.
Wait a minute for cooling and repeat step 1.

▶2.Optimize **t-Start**, set **t-Start** as recommended in the previous setting (Figure55) and allow 6 minutes for cooling.

▶3.Carry out a complete start.

▶4.If the application runs up faster than the ramp time setting, shorten this setting as much as is possible for the application.

▶5.If the application requires more time for the run-up (> 125 %) than the set ramp time, increase the value of **t-Start** – unless the load cycle of the soft starter is exceeded.
If the acceleration time is longer than the limits from step 4 or 5, let the soft starter cool down for 6 minutes, increase the ramp time and proceed with step 3.

▶6.Run-up optimization completed.

▶7.If a stop ramp is required, the set time should be set longer than the run down time of the machine in order to achieve an effect.
As a soft stop produces a current increase, observe the thermal output capacity (load cycle) of the soft starter.

A larger device must be selected if the required settings for an application cause the permissible load cycle of the soft starter to be exceeded.

5.4 Starting a motor

Applying the start command (High signal at terminal A1) will cause the motor to accelerate with the set values. The actual acceleration time can differ from the set values, depending on the load.

The soft starter heats up at the start.
To avoid overheating, the required cooling times must be observed without fail. If frequent starts are to be made in normal operation, the soft starter must be overdimensioned in certain circumstances and/or the optional fan must be used.
For this see the Appendix "Technical data" as well as the manual "Soft Starter Design" (MN03902001Z-EN; previous description AWB8250-1346GB).

5.5 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!

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 a fault 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 of fatal electric shock on contact!

After the start is completed, the soft starter switches to the operating phase.

5.6 Stop

If the stop command (low signal at terminal A1) is initiated, the soft stop is triggered. The drive then moves with the set stop time to the value of the stop voltage. 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 factory set to 0 s, in other words the motor performs an uncontrolled stop.

6 Diagnostics

The following information provides help in fault detection and troubleshooting.

DANGER

On no account should you open the device if the supply voltage is switched on. Danger of fatal injury!

6.1 Fault-finding

Some possible faults are described below:

6.1.1 Motor not starting

Possible causes:

- Start signal not present.
- Supply voltage not present.
- Regulator supply voltage not present.
- Ramp too long.
- Start voltage too low.
- Error LED lit.

6.1.2 Motor stops immediately after start completed

Possible causes:

- Disconnection due to fault, e.g. phase fault, frequency fault

6.1.3 Motor running unevenly

Possible causes:

- Motor power too small (<< 1.5 kW)
- Low flywheel masses and no load on motor

6.1.4 Motor consuming too much current

Possible causes:

- Ramp time too long
- Start voltage too low
- Start voltage too high
- Motor overload

6.1.5 Connected motor overheating

Possible causes are:

- Ramp time too long
- Too many starts in succession
- Heavy starting with this motor rating not or only not sufficiently allowed for when selected

6.2 Error messages and rectification

6.2.1 Error acknowledge

If a fault message occurs, a restart is only possible after an error acknowledge has been carried out. For this the soft start signal must be switched off. With terminal control and a standard setting, this is carried out with a Low signal on terminal A1. When the soft starter is controlled via the interface, use the "Error acknowledge" bit in the control word to carry out the reset.

If faults occur outside of the RUN state, these are reset automatically as soon as the cause of the fault is no longer present. Faults that occur in the RUN state are not automatically reset, but must be acknowledged explicitly and reset.

6.2.2 LED indicators

Depending on the situation, the LEDs have the following meaning (normal operating states):

Table 11: LED indicators

Red LED	Green LED	Function
Off	Off	Device is off.
Off	Flashing at 2 s intervals	Device ready for operation, supply OK, but no Start signal present. (Flash with 2 s pulse: 100 – 150 ms on, 1900 – 1850 ms of (= 0.5 Hz, ED = 5 – 7 %)
Off	Flashing at 0.5 s interval	Device in operation, ramp is active. (soft start or soft stop, flash with 0.5 s pulse: 0.5 s on, 0.5 s off (= 1 Hz, DF = 50 %)
Off	On	Device in operation, top of ramp reached.

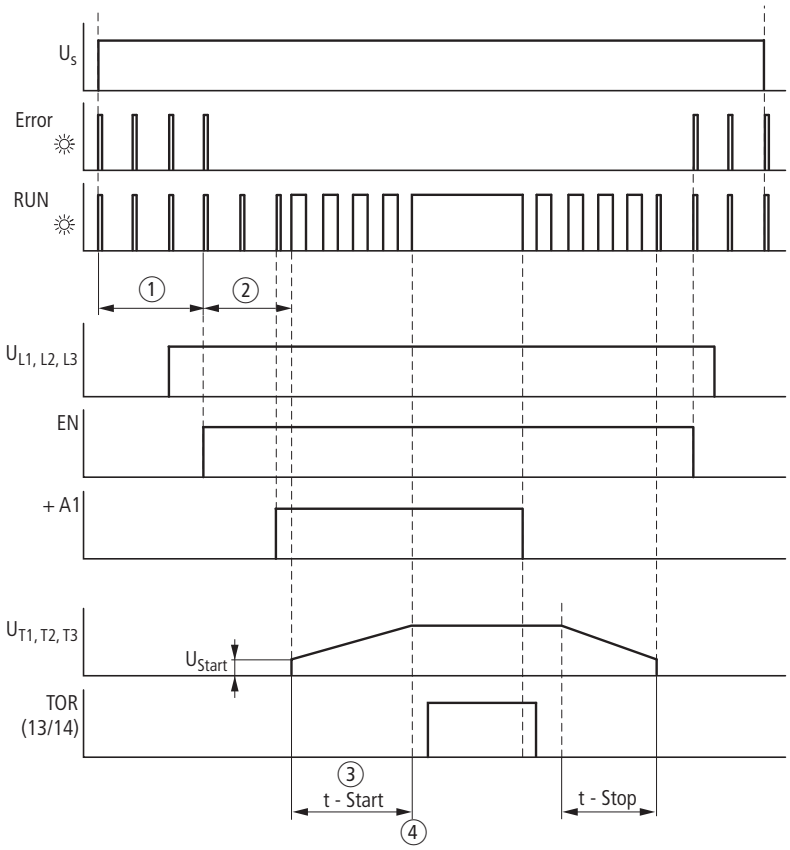


Figure 56: Actuation signals and LED

① Initialization
② Ready
③ Acceleration phase
④ Top of ramp reached, TOR signal

The top of ramp (after the **t-Start** time has elapsed) and the actual run-up of the motor can have different lengths. The actual acceleration time depends on the load and the motor, and even with the same setting of **t-Start** can lead to different times if the loads change.

6.2.3 LED indication in the event of faults

The LEDs also provide information about the device state and any detected faults.

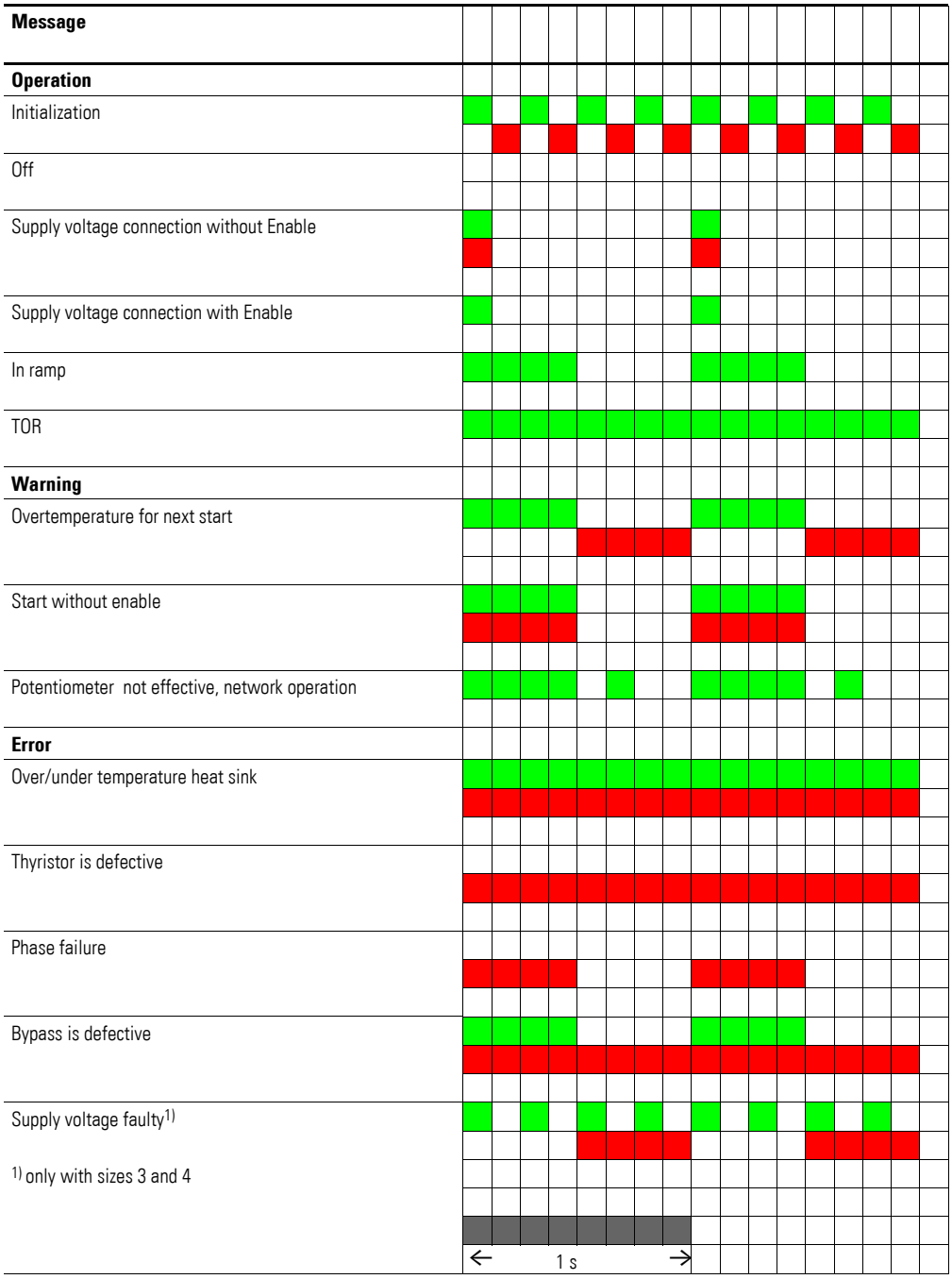


Figure 57: LED messages in the event of a fault

6.2.4 Monitoring messages

The following events are detected as faults and cause the soft starter to switch off. All events are indicated via the Error LED.

6.2.5 Fault messages on start

The following fault messages are possible at the start.

Table 12: Fault messages on start

Message	Faults	Possible causes	Remedy
Phase fault	One phase missing on the mains side	• FUSE FAULT • Wiring defective	• Change fuse • Check wiring
Over/under temperature heat sink	Heat sink too hot or environment too cold	• Device still overheated from last start/stop • Under-temperature	• Wait for cooling time, if necessary use fan option • Check heating of room or control panel
Thyristor is defective		• Device was overloaded at last stop • Lightning	• Exchange device; check dimensioning • Exchange device; install lightning protection in the installation
Bypass is defective	Bypass welded or not reacting	• Overload • Short-circuit in motor	• Exchange device; check dimensioning • Check motor
Supply voltage faulty	Too low voltage for the controller supply	• Overload of the external power supply unit • Supply voltage not available	• Check dimensioning and overload of the power supply unit • Check control signals for switching the power supply, if necessary fit interlocks for the start command

6.2.6 Fault messages during operation

The following fault messages are possible during operation.

Table 13: Fault messages during operation

Message	Faults	Possible causes	Remedy
Over/under temperature heat sink	Heat sink too hot or environment too cold	• Device still overheated from last start/stop • Control cabinet temperature too high • Under-temperature	• Wait for cooling time, if necessary use fan option • Check filter and cooling of the control panel • Heat up room or control panel

A phase fault can only be detected in a specific situation:

- Motor in ramp

After the top of ramp is reached (TOR) a phase fault can no longer be detected.

The supply frequency is not monitored in order not to prevent operation in difficult conditions (e.g. unstable generator as supply).
Proper operation can only be ensured with the permissible limits of 50/60 Hz ± 5 %.

7 Appendix

7.1 Standards

The relevant standards for the DS7 soft starters are listed below:

Table 14: Standards and EMC

Standard type	Standard	Title	Limit Values
Type	IP 20 to IEC/EN 60947-1 (EN 60529)		
Interference immunity	IEC/EN 61000-4-2	Electrostatic discharge	8 kV air discharge 4 kV Contactdischarge
	IEC/EN 61000-4-3	Electromagnetic fields Frequency range 80 to 1000 MHz	10 V/1 m
	IEC/EN 61000-4-6	High frequency field Frequency range 0.15 to 80 MHz, 80 % amplitude modulated	140 dB (µV)
	IEC/EN 61000-4-4	Fast transients, burst on power terminals	2 kV/5 kHz
		Burst on bus and control cables	2 kV/5 kHz
	IEC/EN 61000-4-5	Surge voltage test, supply cable	2 kV phase ground 1 kV phase-phase
Emitted interference	IEC/EN 60947-4-2	Radio interference, housing and network	Class A for use in industrial environment, class A1 (all devices) Class B for use in public networks (only for DS7-340… devices (24 V AC/DC))
Insulation resistance	Insulation resistance test to EN 60947-1 Appendix K		
Permissible pollution	Pollution degree 2 to EN 60947-1		
Permissible humidity rating	Relative air humidity 85 %, non condensing		

7.2 Applicable product standards and approvals

Document type	Name
Product standard	EN/IEC 60947-4-2
Approvals	UL (UL 508) CSA (CSA C22.2 No 14-05) CCC (GB 14048.6) Gost Gost-R
Markings	CE marking for LVD (Low-Voltage Directive) and EMC (Electromagnetic compatibility - EMC Directive)

7.3 Control inputs and outputs

Table 15: Control inputs/control outputs

Terminal	Function	Factory setting	Current consumption/load rating
Digital inputs			
A1	Control input (DS7-34…)	Start/stop	Depending on variant 24 V AC/DC / 1.6 mA 230 V AC / 4 mA
A2/-Us	0 V reference point for A1		
+Us	Supply voltage		Depending on variant 24 V AC/DC / 150 mA 230 V AC / 100 mA
Relay outputs			
13	N/O contact K1	Top of Ramp	230 V AC, 1 A, AC-11 (only 24 V AC/DC with devices up to 12 A and 24 V supply voltage)
-Us (up to 12 A) 14 (over 12 A)	Supply to K1		
From 16 A also			
23	N/O K2	RUN	230 V AC, 1 A, AC-11
24	Supply to K2		

→ The control inputs must only be operated with the same voltage stated as the supply voltage on the device.

7.3.1 Overload withstand capability

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

7.3.2 Overload capability (load to AC-53a)

The following values are shown:

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**	**Duty factor** **F**	**Starts per hour** **CSA**
DS7-34…	3	5	75	10

7.3.3 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:

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

In which:

X_{new} = Required overcurrent (must be less than the stated values)
T_{xnew} = New permissible time for the new overcurrent X_{new}

Example:

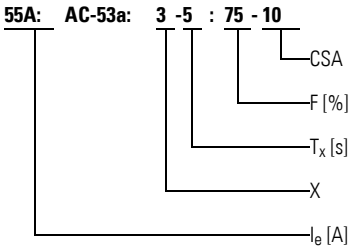
For X = 3, T_X = 5 s; calculate T_X for X = 2.5!

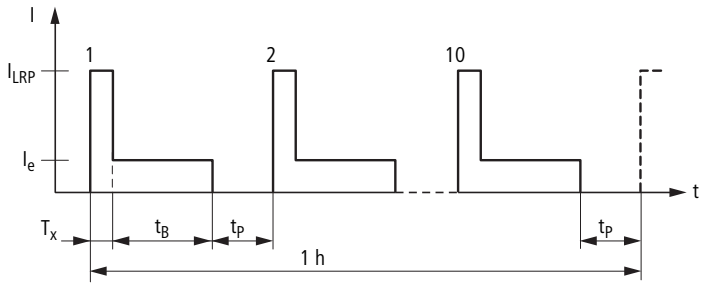
$$T_{xneu} = \frac{3^2 \times 5\,s}{2.5^2} = 7.2\,s$$

→ Other overload cycles and switch frequencies are available on request.

7.3.4 Different load cycles and start frequencies

If load cycles or start frequencies are different the following graphs can be used for reading the possible time current combination for devices over 41 A.



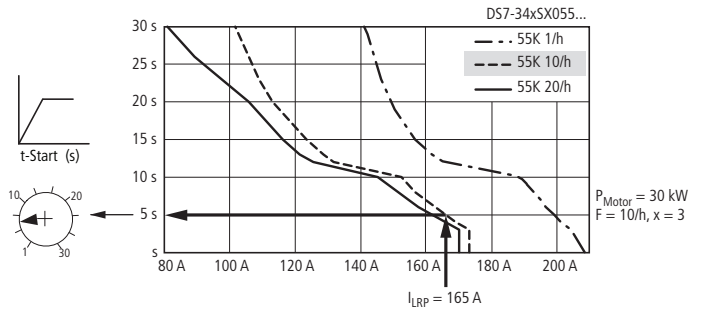


$F = 10/h \rightarrow 1\ h = 3600\ s \rightarrow T_X + t_B + t_P = 360\ s$

$$F = \frac{T_X + t_B}{T_X + t_B + t_P} \times 100\ \% \rightarrow$$

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

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



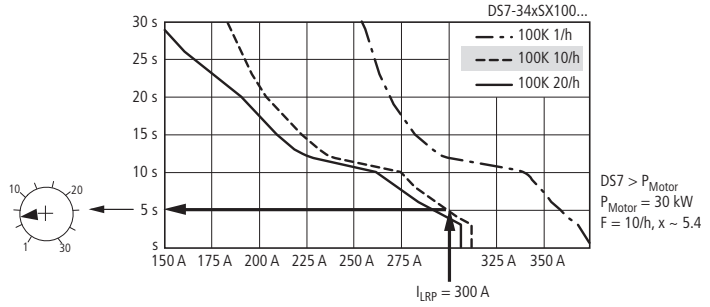
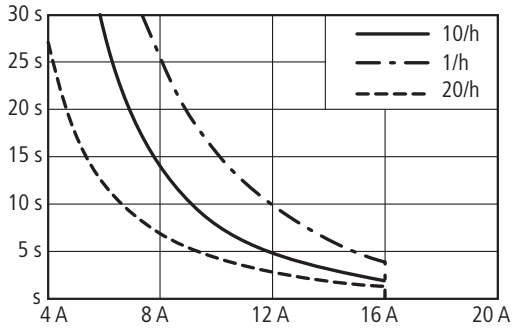


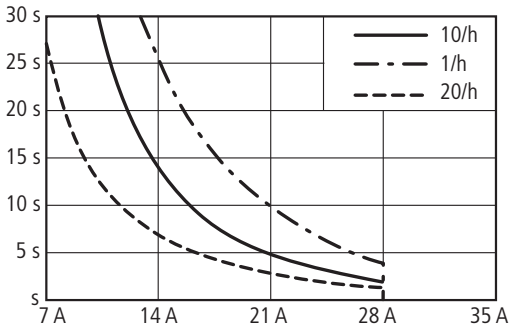
Figure 58: Conversion to other load cycles, use of graphs

7.3.5 Conversion to other load cycles

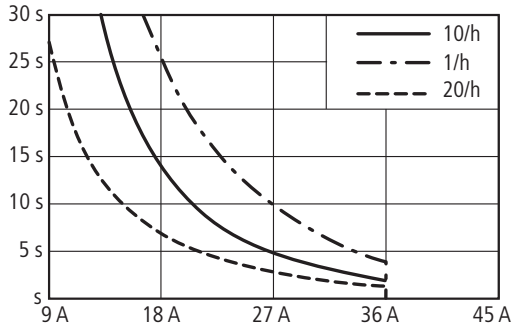
DS7-34xSX004…



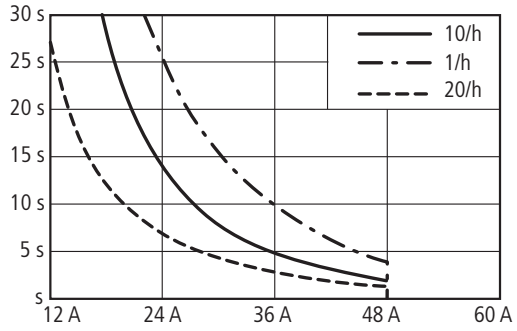
DS7-34xSX007…



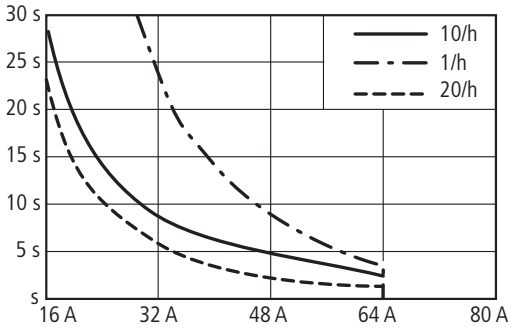
DS7-34xSX009…



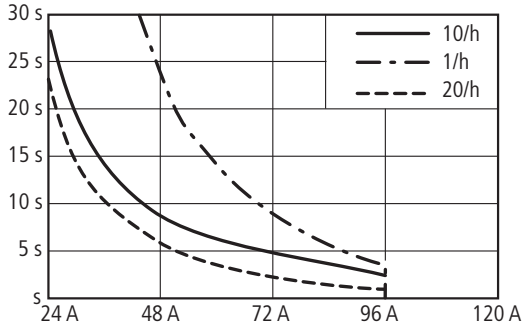
DS7-34xSX012…



DS7-34xSX016…



DS7-34xSX024…



DS7-34xSX032…

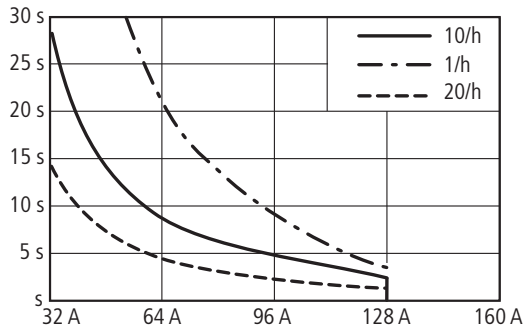
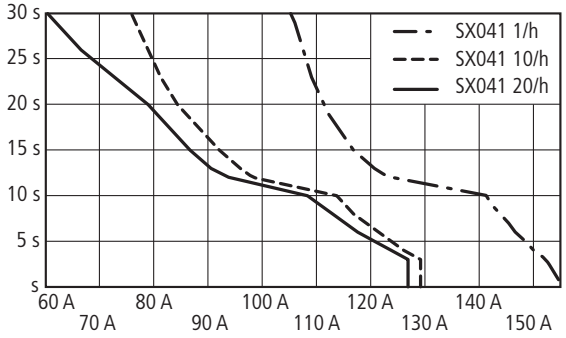
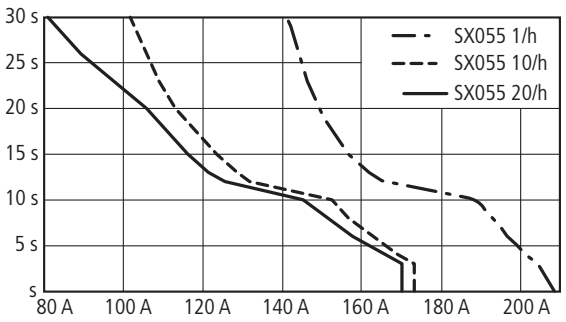


Figure 59: Conversion to other load cycles (rated operational current up to 32 A)

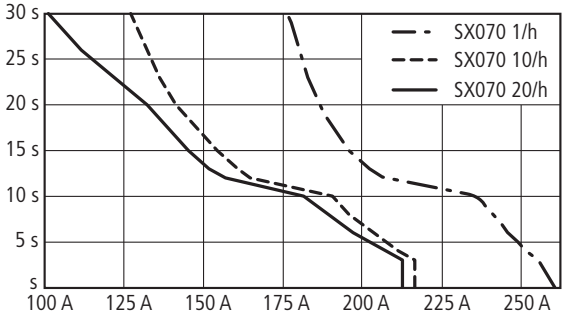
DS7-34xSX041…



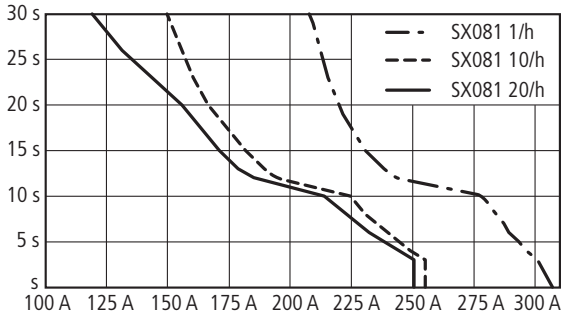
DS7-34xSX055…



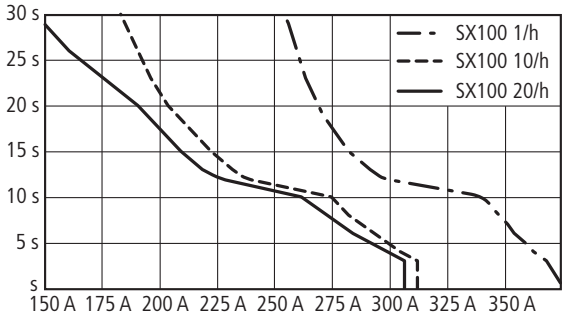
DS7-34xSX070…



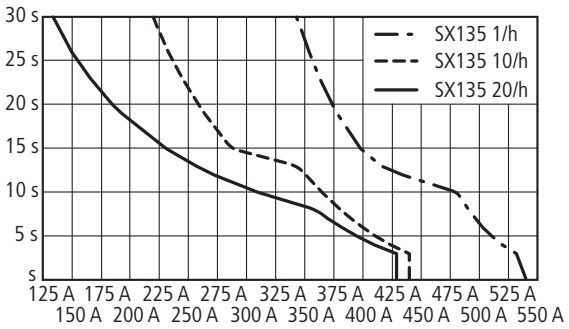
DS7-34xSX081…



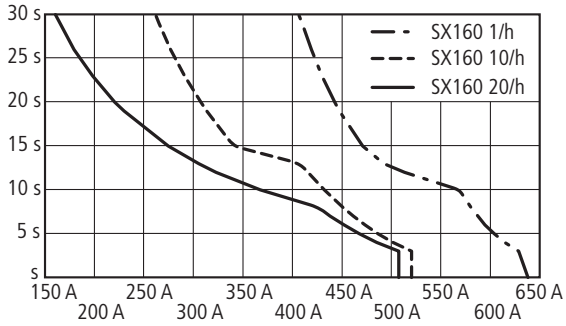
DS7-34xSX100…



DS7-34xSX135…



DS7-34xSX160…



DS7-34xSX200…

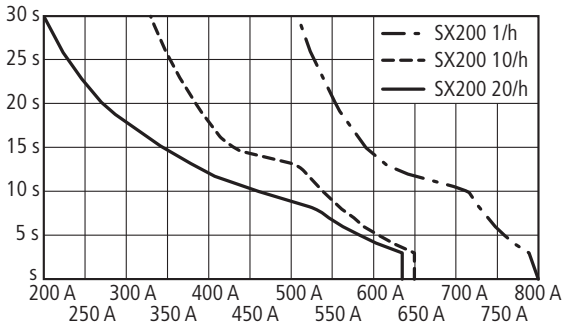


Figure 60: Conversion to other load cycles (rated operational current from 41 A)

7.4 Technical data

The technical data is divided up into data applicable to all devices and data applicable to specific device series and device types.

7.4.1 General data

General data		
General		
Standards		IEC/EN 60 947-4-2
Approvals		
Climatic proofing		Damp heat, constant according to DIN IEC 68 part 2-10; damp heat, cyclical, according to DIN IEC 68 part 2-3
Ambient temperature	°C	-5 - 40, up to 60 °C at 1 % derating per Kelvin temperature rise
Ambient temperature storage	°C	-25 – +60
Installation altitude1)	m	0 - 1000, above that 1 % derating per 100 m max. 2000
Mounting position		Vertical
Protection type2)		IP20
Busbar tag shroud		Finger- and back-of-hand proof
Overvoltage category/pollution degree		II/2
Mechanical shock resistance		8 g/11 ms
Vibration resistance to EN 60721-3-2		2M2
MTBF		
Main contacts		
Rated operational voltage	V AC	200 – 480
Mains frequency	Hz	50/60
Overload cycle to EN 60947-4-2		AC53a: 3-5: 75-10
Power section		
Rated impulse withstand voltage U_{imp} 1.2/50 µs	kV	4
Rated insulation voltage U_i	V	500
soft start functions		
Ramp times		
Acceleration	s	1 – 30
Deceleration	s	0 – 30
Start voltage (= switch-off voltage)		30 % – 100 %

1) Higher installation heights on request.
2) Protection type applies to the front and operator control and operating elements. Protection type from all sides is IP00.

7.4.2 Terminal capacity, control cables, actuating circuit

The following technical data depends on size.

		Construction size 1: 4 to 12 A	Construction size 2: 16 to 32 A	Construction size 3: 41 to 100 A	Construction size 4: 135 to 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	mm^2	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	mm^2	1 x (0.75 – 2.5) 2 x (0.75 – 2.5)	1 x (0.75 – 16) 2 x (0.75 – 10)		
Stranded	mm^2		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	min, mm			2 x 9 x 0.8	2 x 9 x 0.8
	max, mm			9 x 9 x 0.8	10 x 16 x 0.8
Tightening torque	Nm	1.2	3.2	9 (> 10 mm^2); 6 (≦ 10 mm^2)	14 (> 10 mm^2); 5 (≦ 10 mm^2)
Control cables					
Solid	mm^2	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	mm^2	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	mm^2				
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)
Flat conductor	mm	–	–	–	–
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
Control circuit					
Relay outputs					
Number		1 (TOR)	2 (TOR, Ready)	2 (TOR, Ready)	2 (TOR, Ready)
Voltage range	V AC/DC	= U_s	250	250	250
Current range	CSA	1	1	1	1

7.4.3 Non power supply dependent data

		Supply voltage U_c		
		24 V AC/DC	**110/230 V AC**	**+24 V (SmartWire-DT)**
General				
Radio interference level		"B"	"A" group 1	"B"
Control circuit				
Regulator supply voltage U_s				
Voltage	V DC	+24 V AC/DC +10 %/-15 %	120 -15 % to 230 +10 % VAC	+24 V AC/DC +10 %/-15 %
Current consumption no-load losses	mA			
Current consumption operation	mA	150	100	150
Current consumption peak performance (Bypass close)	mA			
Control voltage range				
AC/DC operated		24 V AC/DC +10 %/-15 %	120 -15% to 230 +10 % V AC	24 V DC +10 %/-15 %
Electricity consumption	mA	1.6	4	1.6
Pick-up voltage				
DC operated	V DC	+17.3 to +27		+17.3 to +27
AC operated	V AC	17.3 to 27	120 -15% to 230 +10 % V AC	
Drop-out voltage				
DC operated	V DC	0 to +3		0 to +3
AC operated	V AC	0 to 3	0 to 28	
Pick-up time				
DC operated	ms			
AC operated	ms			
Drop-out time				
DC operated	ms			
AC operated	ms			

7.4.4 Power

Part no.	Rated operational current	average heat dissipation with nominal load cycle	Assigned motor power at				
	I_e	P_v	230 V	400 V	200 V	230 V	480 V
	A	W	kW	kW	HP	HP	HP
DS7-34xSX004N0-…	4	5	0.75	1.5	0.75	0.75	2
DS7-34xSX007N0-…	7	6	1.5	3	1.5	2	3
DS7-34xSX009N0-…	9	6	2.2	4	2	2	5
DS7-34xSX012N0-…	12	7	3	5.5	3	5	10
DS7-34xSX016N0-…	16	7	4	7.5	3	5	10
DS7-34xSX024N0-…	24	9	5.5	11	5	7.5	15
DS7-34xSX032N0-…	32	12	7.5	15	10	10	25
DS7-34xSX041N0-…	41	8	11	22	10	15	30
DS7-34xSX055N0-…	55	10	15	30	15	20	40
DS7-34xSX070N0-…	70	12	15	37	20	25	50
DS7-34xSX081N0-…	81	13	22	45	25	30	60
DS7-34xSX100N0-…	100	17	30	55	30	30	75
DS7-34xSX135N0-…	135	24	30	75	40	50	100
DS7-34xSX160N0-…	160	31	45	90	50	60	125
DS7-34xSX200N0-…	200	43	55	110	60	75	150

7.4.5 Protection, short-circuit strength

Part no.	Type "1" coordination	Type of coordination 2 (in addition to fuses for type of coordination 1)	Fuse holders
DS7-34xSX004N0-…	PKZM0-4 (+ CL-PKZ0)	3 x 50.179.06-16	3 x 51.060.04
DS7-34xSX007N0-…	PKZM0-10 (+ CL-PKZ0)	3 x 50.140.06-25	3 x 51.060.04
DS7-34xSX009N0-…	PKZM0-10 (+ CL-PKZ0)	3 x 20.282.20-32	3 x 21.189.01
DS7-34xSX012N0-…	PKZM0-12 (+ CL-PKZ0)	3 x 20.282.20-32	3 x 21.189.01
DS7-34xSX016N0-…	PKZM0-16 (+ CL-PKZ0)	3 x 50.140.06-50	3 x 51.060.04
DS7-34xSX024N0-…	PKZM0-25 (+ CL-PKZ0)	3 x 50.140.06-63	3 x 51.060.04
DS7-34xSX032N0-…	PKZM0-32 (+ CL-PKZ0)	3 x 50.140.06-80	3 x 51.060.04
DS7-34xSX041N0-…	NZMN1-M50 / PKZM4-50	3 x 20.282.20-100	3 x 21.189.01
DS7-34xSX055N0-…	NZMN1-M63 / PKZM4-58	3 x 20.282.20-125	3 x 21.189.01
DS7-34xSX070N0-…	NZMN1-M80	3 x 20.610.32-200	3 x 21.313.02
DS7-34xSX081N0-…	NZMN1-M100	3 x 20.610.32-200	3 x 21.313.02
DS7-34xSX100N0-…	NZMN1-M100	3 x 20.610.32-200	3 x 21.313.02
DS7-34xSX135N0-…	NZMN2-M160	3 x 20.610.32-350	3 x 21.313.02
DS7-34xSX160N0-…	NZMN2-M200	3 x 20.610.32-400	3 x 21.313.02
DS7-34xSX200N0-…	NZMN2-M200	3 x 20.610.32-500	3 x 21.313.02

7.4.6 Protection, overload relay, optional mains contactor

Part no.	Soft starter function with soft stop in case of overload		Optional mains contactor
	Cable protection[1)]	Overload relays2[2)]	
DS7-34xSX004N0-…	PKM0-4 (+ CL-PKZ0)	ZB12-4	DILM7
DS7-34xSX007N0-…	PKM0-10 (+ CL-PKZ0)	ZB12-10	DILM7
DS7-34xSX009N0-…	PKM0-10 (+ CL-PKZ0)	ZB12-10	DILM9
DS7-34xSX012N0-…	PKM0-12 (+ CL-PKZ0)	ZB12-12	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	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.

7.4.7 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 use of the wrong tools may cause damage to the soft starter.

DS7-34…SX…	Ø [mm]	Weight [kg]
…003…	4	0.35
…004…		
…005…		
…007…		
…009…		
…012…		

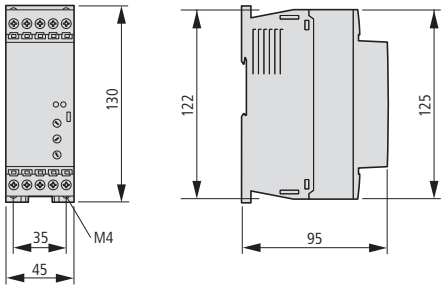


Figure 61: Dimension drawing DS7: to 12 A

DS7-34…SX…	Ø [mm]	Weight [kg]
…016…	4	0.4
…024…		
…032…		

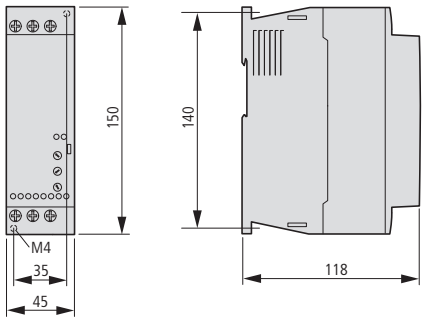


Figure 62: Dimension drawing DS7: 16 to 32 A

DS7-34…SX…	Ø [mm]	Weight [kg]
…036…	4	1.8
…041…		
…055…		
…070…		
…081…		
…100…		

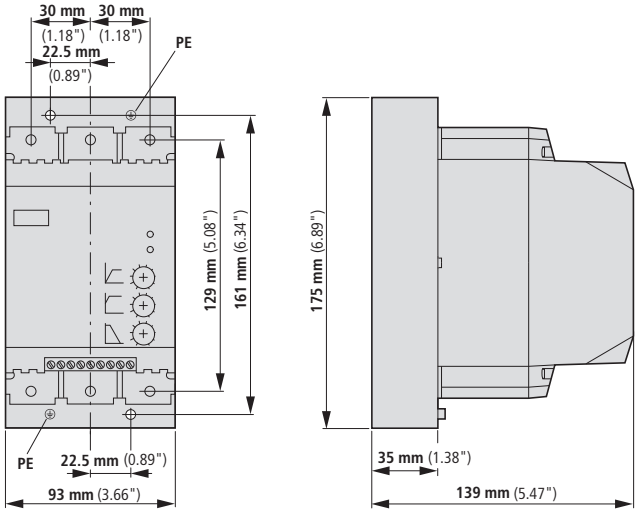


Figure 63: Dimension drawing DS7: 41 to 100 A

DS7-34…SX…	Ø [mm]	Weight [kg]
…135…	5	3.4
…160…		
…200…		

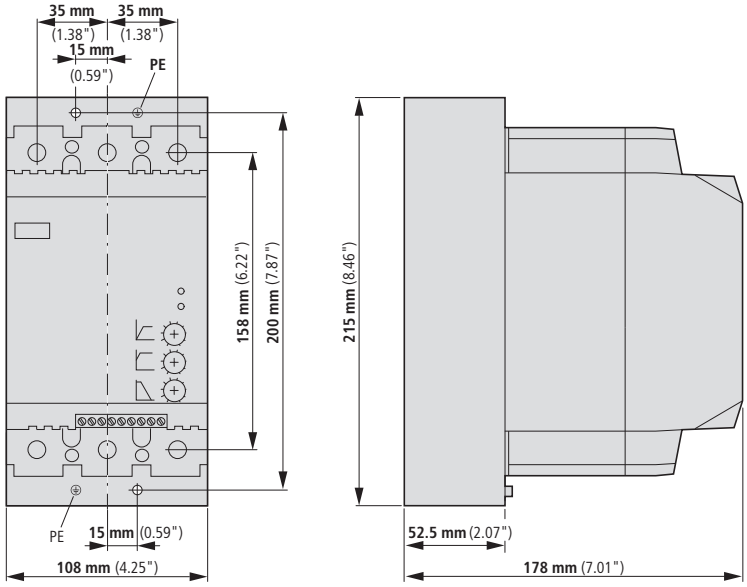


Figure 64: Dimension drawing DS7:135 to 200 A

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