SIEMENS

Industrial Controls

SIRIUS

Controls with IE3 / IE4 motors

Application manual

Edition 11/2015

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Legal information

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⚠WARNING
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⚠CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

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Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Siemens AG
Division Digital Factory
Postfach 48 48
90026 NÜRNBERG
GERMANY

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1 Standards and legislation

1.1 Efficiency classes for IEC line motors

Standards and legislation

Comprehensive laws have been introduced in the European Union with the objective of reducing energy consumption and therefore CO2 emissions. EU Regulation 640/2009, amended by Commission Regulation 04/2014, concerns the energy consumption or energy efficiency of induction motors for mains operation in industrial environments. This Regulation is in force in all countries of the European Union.
The IEC 60034-30-1:2014 standard defines the efficiency levels or classes for 50 and 60-Hz operation and as well as which motors are affected and which exceptions apply worldwide. The EU Regulation is based essentially on this standard.

Nomenclature

- In IEC 60034-30-1, new efficiency classes have been defined for induction motors (IE = International Efficiency):
- IE1 (Standard Efficiency)
- IE2 (High Efficiency)
- **IE3 (Premium Efficiency)**
- IE4 (Super Premium Efficiency)

Schedule

The changes will come into effect on the following dates:

- Since June 16, 2011:
  Compliance with the legally required minimum efficiency classes IE2 for induction motors suitable for S1 duty in accordance with EU Regulation.
- Since July 27, 2014:
  Commission Regulation 04/2014 amending EU Regulation 640/2009.
- From January 1, 2015:
  Compliance with the legally required minimum efficiency classes IE3 for outputs from 7.5 to 375 kW or IE2 motor with frequency converter.
- From January 1, 2017:
  Compliance with the legally required minimum efficiency classes IE3 for outputs from 0.75 to 375 kW or IE2 motor with frequency converter.

Scope of validity

Affected motors: EU Regulations 640/2009 and 04/2014 based on standard IEC 60034-30	
Description	The EU Regulation is in force in every country of the EU. Losses, and therefore the efficiency, are determined in accordance with IEC 60034-2-1: 2007.
Number of poles	2, 4, 6
Output range	0.75 - 375 kW
Level	IE1 - Standard Efficiency IE2 - High Efficiency IE3 - Premium Efficiency
Voltage	< 1000 V, 50/60 Hz
Degree of protection	All
Validity	IEC 60034-30-1 standard, valid since March 2014; the EU Regulation has been in force since June 16, 2011. Manufacturers are no longer permitted to market IE1 motors within the European Economic Area.

NEMA Premium motors

Motors according to NEMA Premium for the North American market must comply with the energy efficiency standards stipulated in the Energy Independence and Security Act of 2007 (EISA 2007). Since December 2010, motors must comply with the provisions of the NEMA Premium efficiency program. The requirements are similar to those stipulated for IE3. The technical requirements for motors for the North American market are described in NEMA MG-1.

Requirements in Australia are similar to those in North America.

Energy-efficient use of motor starters or frequency converters

You will find a joint position paper by CAPIEL and CEMEP on Regulation (EC) 640/2009 on the Internet (http://www.ebpg.bam.de/de/produktgruppen/ener11motor.htm).

1.2 Exceptions in the EU Regulation

Affected motors: EU Regulations 640/2009 and 04/2014 based on standard IEC 60034-30

Valid to July 26, 2014	Valid from July 27, 2014
• At altitudes greater than 1,000 m above sea level	• At altitudes greater than 4,000 m above sea level
• At ambient temperatures above 40 ℃	• At ambient temperatures above 60 ℃
• At ambient temperatures under -15 °C (any motor) or under 0 °C (water-cooled motor)	• At ambient temperatures under -30 ℃ (any motor) or under 0 °C (water-cooled motor)
• With cooling liquid temperatures at the product intake of below 5 °C or above 25 °C	• With cooling liquid temperatures at the product intake of below 0 ℃ or above 32 ℃

Unchanged exceptions

- Motors designed to be operated totally submerged in a liquid
- Motors fully integrated into a product (e.g. a gearbox, pump, fan or compressor) whose energy efficiency cannot be measured independently of the product
- Motors that are specially designed for operation under the following conditions:
  – At maximum operating temperatures above 400 °C
  – In explosive atmospheres in the context of Directive 94/9/EC of the European Parliament and of the Council
- Brake motors

Not affected

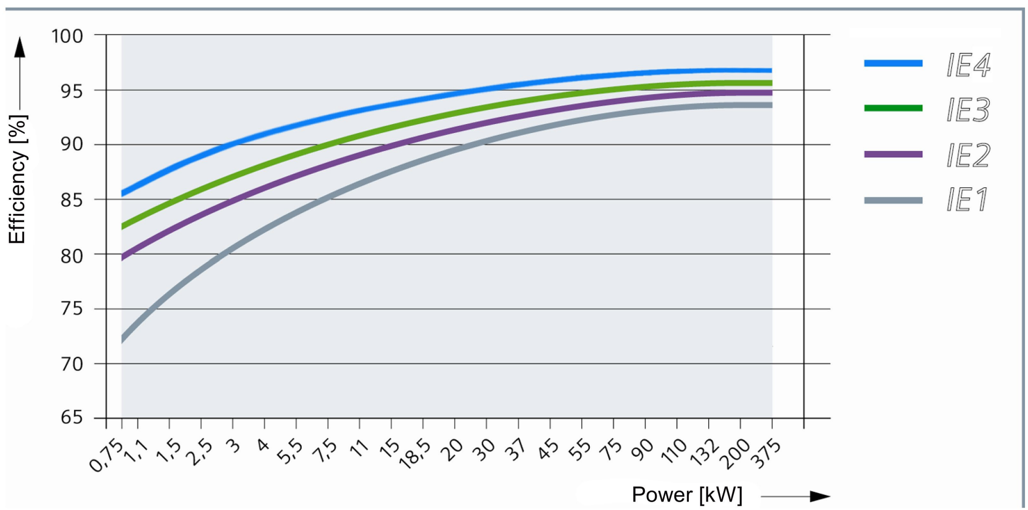
- 8-pole motors
- Pole-changing motors
- Synchronous motors
- Motors that are suitable exclusively for duty types S2 to S9
- Single-phase motors

1.3 Standard motors according to IEC 60034-30-1

Description

The new standard **EN 60034-30-1:2014** defines the following efficiency classes worldwide for low-voltage three-phase induction motors in the power rating range 0.12 kW to 1000 kW:

- IE1 = Standard Efficiency (comparable to EFF2)
- IE2 = High Efficiency (comparable to EFF1)
- IE3 = Premium Efficiency
- IE4 = Super Premium Efficiency



The old European designations (EFF3, EFF2 and EFF1) are not currently invalid, but they will be gradually replaced by the new IE classes.

Note

Standard sizes

Problem-free 1:1 interchanging is possible thanks to specified standard sizes (especially the shaft heights).

IE3 motors 2

2.1 IE3 motors from Siemens

Description

IE3-compliant induction motors from Siemens are characterized by their reliability, long service life, and ruggedness.

IE3 Premium Efficiency motors from Siemens are available with power ratings from 500 W to 375 kW in countless standard variants.

The IEC motors are uniformly designed in compliance with efficiency class IE3 for the scope of EU Regulation 640/2009 from 750 W to 375 kW.

The motors are well-suited to all applications in the manufacturing and process industries.

Note

EU Regulation 640/2009 from January 2015

From January 2015, efficiency class IE3 will become mandatory for the power range between 7.5 kW and 375 kW.

Alternatively, an IE2 motor with a frequency converter can be used. Please observe the following notice.

Note

Comparison between IE3 motors and IE2 motors with frequency converters

From an energy efficiency viewpoint, an IE3 motor is not equivalent to an IE2 motor with a frequency converter. In constant-speed applications, an IE3 motor with a motor starter is the most energy-efficient and economical solution. Frequency converters should only be used where the application requires speed control.

Note

Problem-free 1:1 interchanging is possible thanks to specified standard sizes (especially the shaft heights).

Explanation and application of the ecodesign regulation - Regulation (EC) No. 640/2009 (electric motors)

You will find information on the practical application of the current EU regulation for achieving energy-efficient drive systems on the Internet (http://www.capiel.eu/en/publications/leaflet/).

Range of IE3 Premium Efficiency motors

	SIMOTICS GP General Purpose	SIMOTICS SD Severe Duty	SIMOTICS XP Explosion-Proof	SIMOTICS DP Definite Purpose	SIMOTICS TN Trans-standard
Enclosure material	Aluminum	Cast iron	Aluminum or gray cast iron	Aluminum or gray cast iron	Cast iron
Output range	0.09 … 45 kW	0.75 … 315 kW	0.09 … 1,000 kW	0.37 … 481 kW	200 … 3,500 kW
Legal requirements	Usually subject to the minimum efficiency classes from 750 W	Usually subject to the minimum efficiency classes	Are not subject to the minimum efficiency classes, but are available in IE3 for a wide range of areas	Are subject to the minimum efficiency classes in a wide range of areas (e.g. marine applications, smoke extraction)	Usually subject to the minimum efficiency classes up to 375 W
Application areas and industries	Pumps, fans, compressors, and conveyor systems with especially low weight and high efficiency requirements	Pumps, fans, compressors, conveyor systems, marine and offshore applications, mixers, mills, extruders, rollers with special demands in terms of ruggedness, particularly in the chem. and petrochem. industry	For general industrial applications with special explosion protection requirements, e.g. in the process industry	Special motors for e.g. work and transport roller tables, ventilation of tunnels, multi-story car parks, shopping malls, dockside cranes, container terminals	Pumps, fans, compressors, mixers, extruders in the chem. and petrochem. industry, paper-making machines, mining, cement, steel industry, and marine applications including propulsion
Further information	SIMOTICS GP (http://www.siemens.com/simotics-gp)	SIMOTICS SD (http://www.siemens.com/simotics-sd)	SIMOTICS XP (http://www.siemens.com/simotics-xp)	SIMOTICS DP (http://www.siemens.com/simotics-dp)	SIMOTICS N-compact (http://www.siemens.com/simotics-n-compact)

2.2 IE3 motor properties that diverge from IE1 / IE2 motors

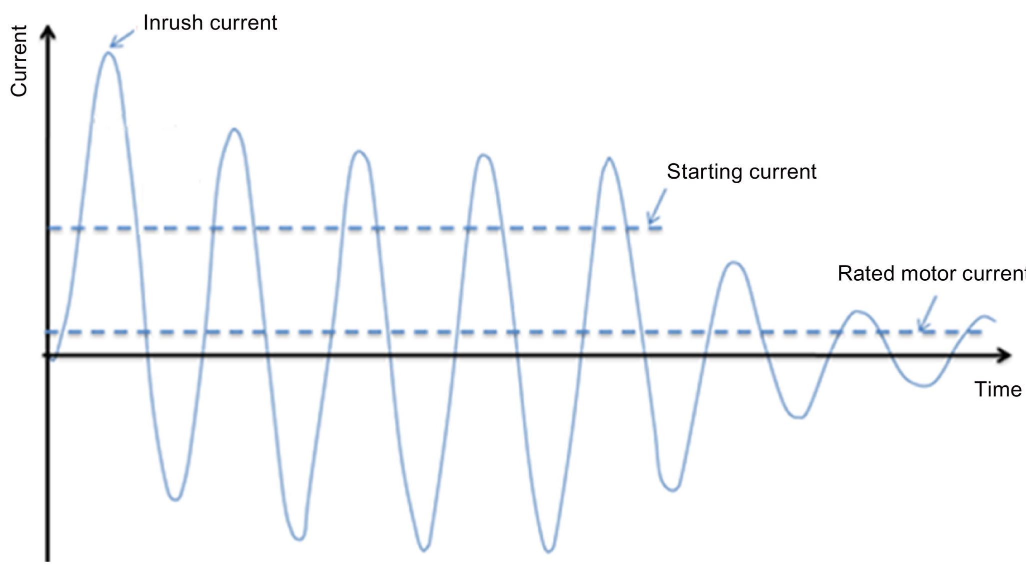
2.2.1 Analyses and measurements

Analyses and measurements

Siemens has carried out extensive analyses and measurements on the IE3 motors available on the market. The following curves show the trends for IE3 motors. The results always refer to the mean value of the variables represented. In the case of all variables that describe motor startup, results can be highly scattered due to the different manufacturers, types, and product ranges.

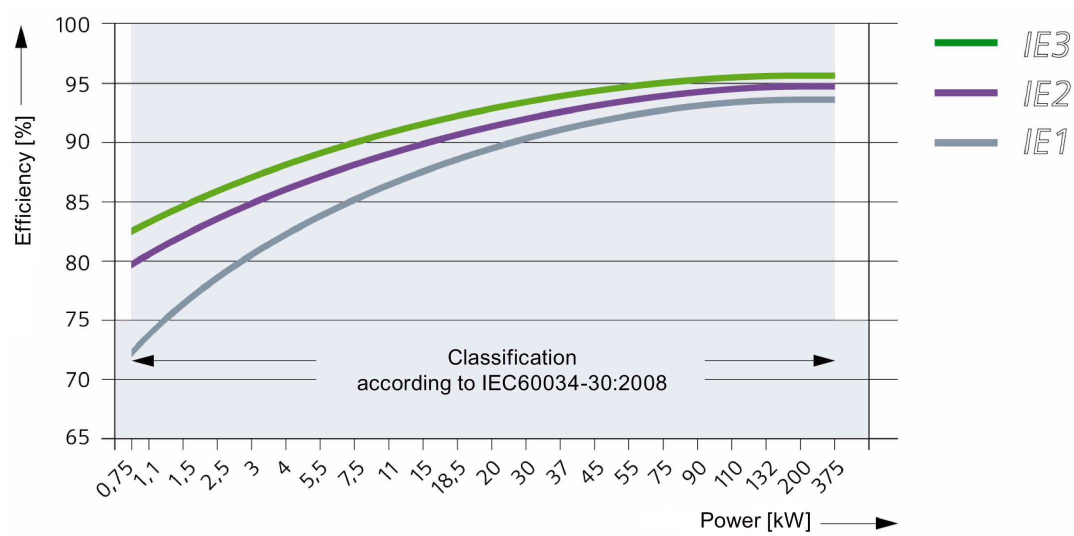
Differences to IE2 motors

- Higher efficiency of IE3 motors
- Lower rated currents
- Increasing starting current
- Increasing inrush current



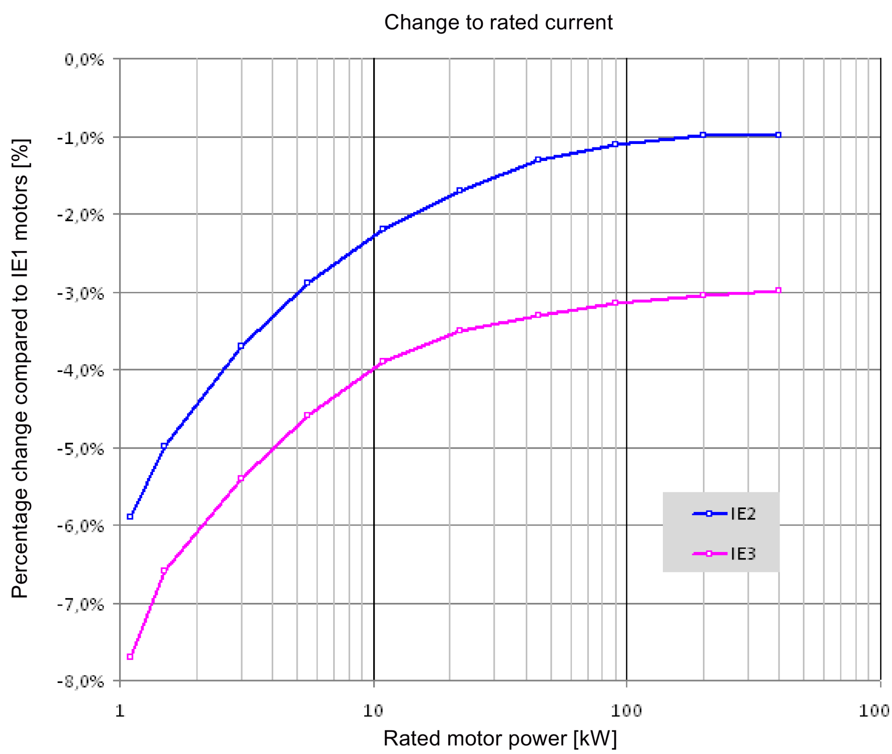
Higher efficiency of IE3 motors

IE3 motors are characterized by higher efficiency compared to the previous IE1 / IE2 motors. In the higher output range, IE1 or IE2 motors are already extremely efficient - as power reduces, efficiency deteriorates. For this reason, the legally required efficiency increase of the IE3 motors is higher in the lower performance range. The figure below shows the required efficiency class in relation to the power rating of the motor for IE1, IE2 and IE3 motors.



Lower rated currents

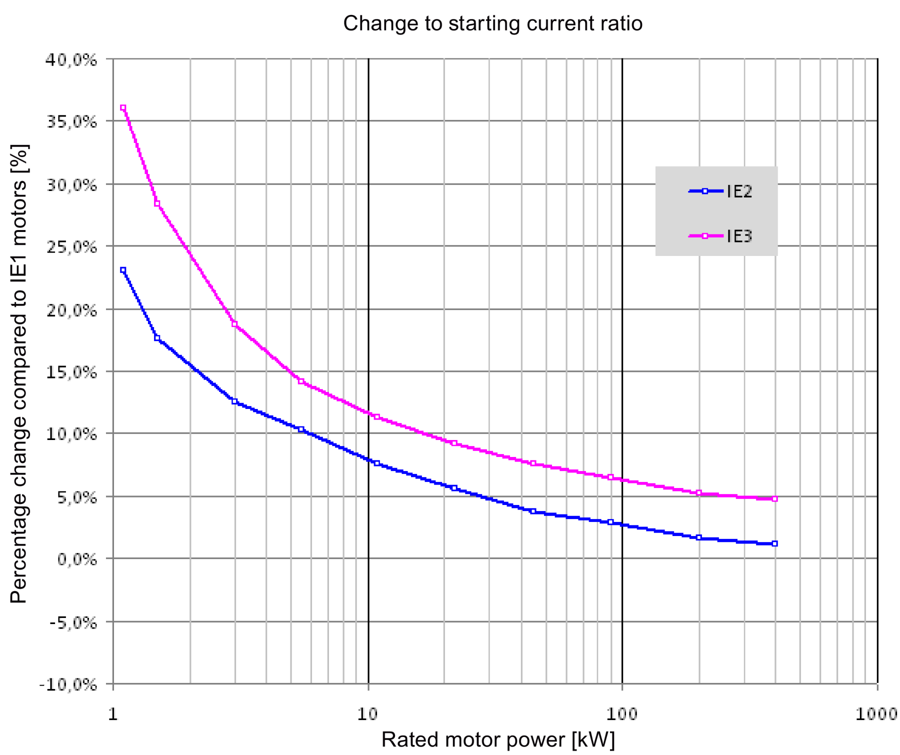
The required efficiency increase for IE3 motors is usually implemented using lower rated motor currents. In the low-end performance ranges, the required efficiency increase is greater and the deviation in the rated current is therefore greater here. The higher the power rating, the lower the deviation of the rated currents compared to IE1 / IE2 motors. The figure below shows the change in the mean value of the rated currents for IE2 and IE3 motors compared to IE1 motors. However, in practice, the rated currents for each performance class are highly scattered.



Increasing starting current ratios

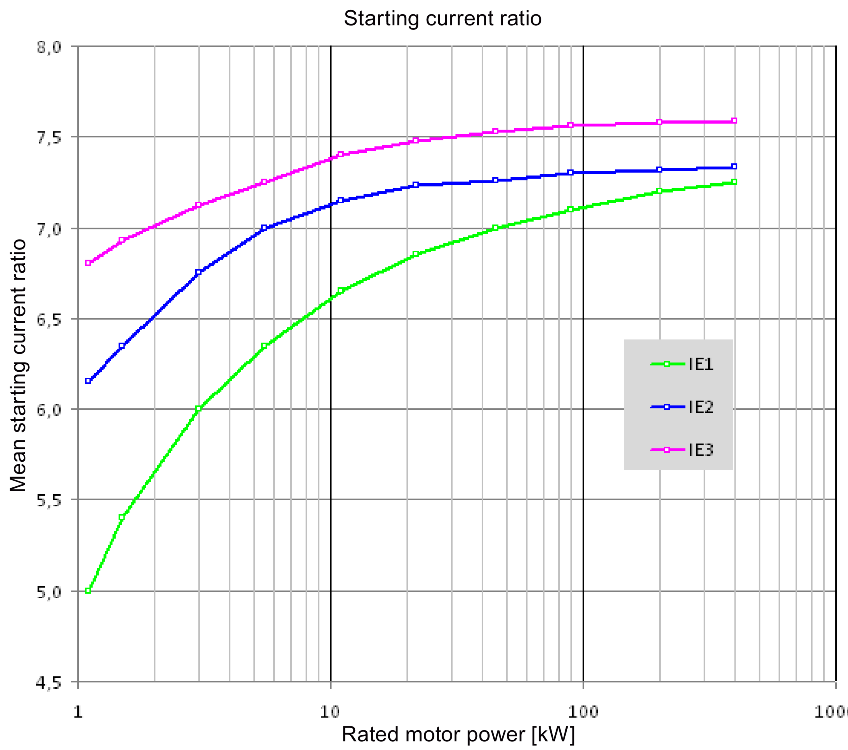
The starting current ratios (ratio of starting current to rated current; steady state, locked rotor) increase as the IE class increases.

The figure below shows the increase in starting current ratios. The shift toward higher starting current ratios with higher IE classes is clearly evident.



Mean values of the starting current ratio

The graph below shows the mean values of the starting current ratio of the different efficiency classes in relation to the performance range. Here, it becomes clear that despite the large increase in the starting current ratio in the lower performance range, the mean values are still at a lower level than in the higher performance range:



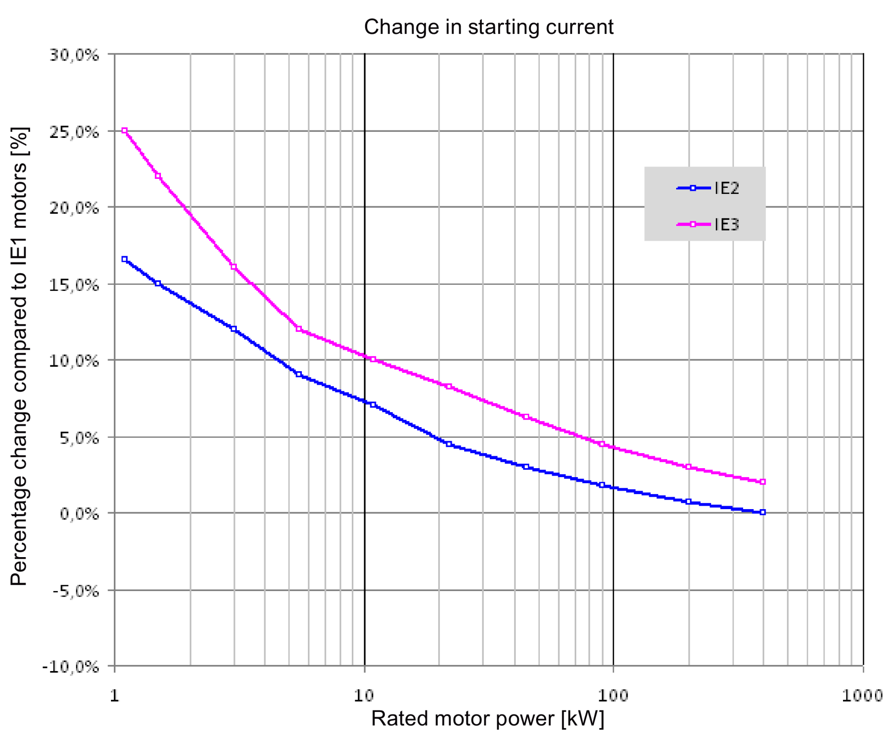
Change in starting current

Starting current = rated current * starting current ratio

In contrast to the starting current ratio, the starting current changes less. This effect is due to the lower rated current of the IE3 motors.

Example: Performance class 4 - 15 kW for IE3 compared to IE2

- The rated currents drop to 4.5 % on average
- The starting current ratios rise by 13.5 %
- The starting current increases by only 11.5 %.



Increasing inrush current

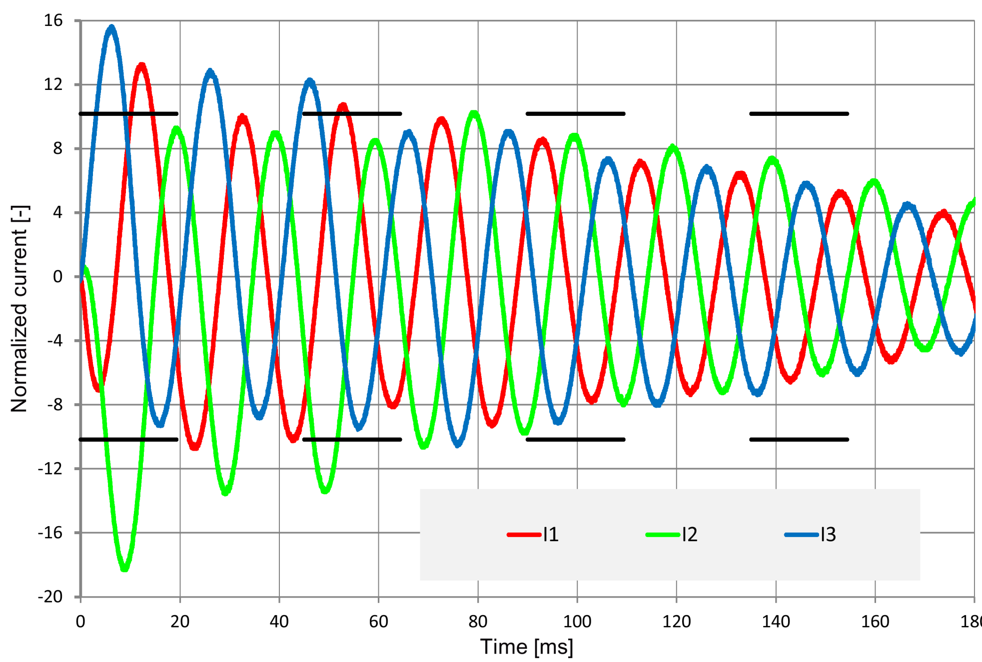
The inrush current is a dynamic compensation event. It results from the following operations:

1. Connection of an inductive load (motor) to an AC system
2. Dynamic current transients in the motor
3. Saturation effects in the laminated cores of the motors

These occur for all switch-on (direct-on-line starting) and changeover operations (YD changeover).

The highest currents usually occur in one or two phases in the first half-wave. In the diagram below, you can clearly see this on Phase 2 and Phase 3. The absolute level depends above all on the switch-on phase positions and the specific line voltage.

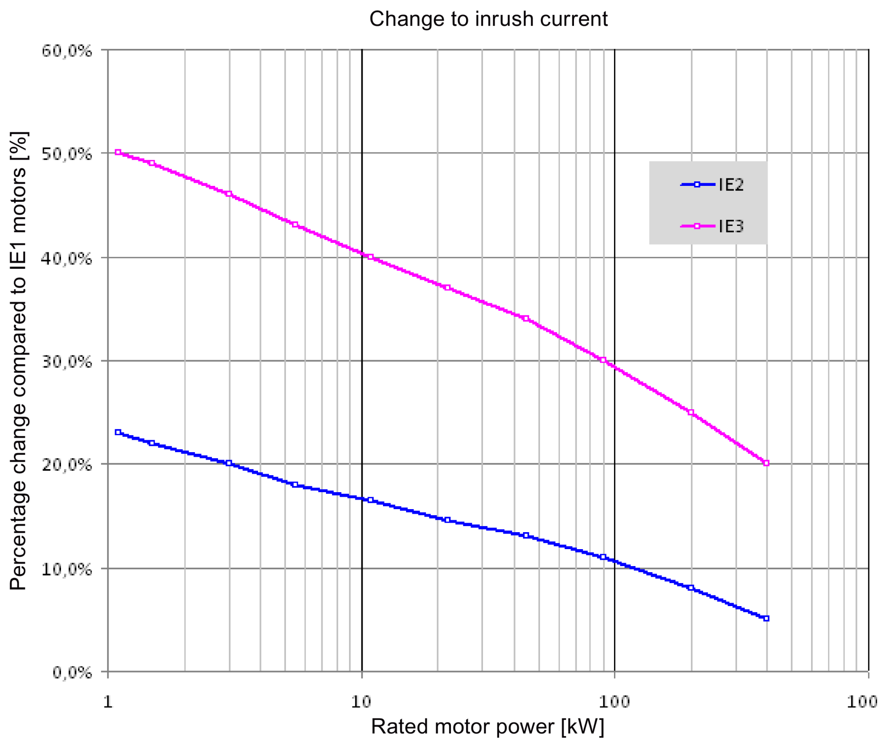
Switch-on operation (startup) of a 250 kW IE3 motor, standardized to the rated current



Inrush current value

The inrush currents for IE1, IE2 and IE3 depend on the following factors in the respective application:

- Motor design
- Power supply conditions (especially the short-circuit rating of the transformer, and thus the voltage stability)
- Length and routing of the motor supply lines
- Switch-on phase position in the respective phase.



Industrial controls with IE3 motors 3

Method of determining the energy efficiency index of an application according to DIN EN 50598

The European series of standards DIN EN 50598 describes a method for determining the energy efficiency index of an application. This method is based on the concept of the semi-analytical model (SAM).

More information is available at DIN EN 50598-1:2014-01 (http://www.industry.siemens.com/topics/global/en/energy-efficient-production/legislation-and-standards/Pages/legislation-and-standards.aspx)

System components of a drive train

- Protective device
- Motor starting unit (e.g., motor starter, contactors)
- Motor controller (e.g. motor management systems, soft starters)
- Motor control unit (e.g. frequency converter)
- Motor
- Gear units
- Cabling
- Driven machine

Electric drives

- Fixed-speed drives - non-stabilized systems (approx. 75 % of all drives)
- Variable-speed drives - stabilized systems (approx. 25 %)

Fixed-speed drives

With fixed-speed drives, a motor is operated continuously at its rated speed. Fixed speeds are implemented by means of industrial controls such as contactors, motor starters, or soft starters. These controls are characterized by low inherent power losses.

Focal points:

- Speed adjustment in the process is impractical
- Optimal adaptation of the system to the load requirements
- Load requirements (torque change) between 40 % and 120 % possible since the induction motor autonomously retains the high efficiency
- Additional measures are not required. Maximum efficiency between 40 % and 120 % of the load requirements can be achieved.

Variable-speed drives

The speed of these drives is varied steplessly by changing the voltage and frequency. This is achieved by using a frequency converter.

Focal points:

- Speed adjustment when the process requires it (no increase in efficiency)
- Speed control for adapting to the load requirements (high efficiency as with full load)
- Additional measures such as frequency converter not required for control
- Additional losses in the drive train due to inherent frequency converter losses as well as additional losses in the motor and any necessary filters
- In frequent partial-load operation, such additional losses can be compensated for and/or considerable energy savings achieved by means of speed control.

3.1 Low energy consumption

Examples of energy-saving controls

- **Contactors**
  The energy-efficient 3RT2 contactors have an electronic coil control. This reduces intrinsic power loss by up to 92 % - at the same time as the lowest closing power. In this way, 24 V DC load power supplies can often be dimensioned smaller.
- **Compact starter**
  Compared to conventional feeders, the intrinsic loss for the 3RA6 compact starter has been reduced by up to 80 % thanks to the reduction in contact points and solid-state current monitoring.
- **Soft starters**
  3RW soft starters use intelligent, integrated current bypass circuits. This reduces intrinsic power losses during operation by up to 92 %.
- **Overload relays**
  3RB overload relays with solid-state trip units instead of bimetal trip units are characterized not only by a wider setting range but also a reduction of up to 98 % in intrinsic power losses.

3.2 Siemens industrial control portfolio for use with IE3 motors

SIRIUS Industrial Controls - energy-efficient products

Figure	Product designation	Article number	Size	Output range	Current range
	Power contactors for switching motors	3RT2	S00 - S2	3 - 37 kW	7 - 80 A
	Power contactors for switching motors	3RT1	S3 - S12	30 - 250 kW	65 - 500 A
	Vacuum contactors for switching motors	3RT12	S10 - S12	110 - 250 kW	225 - 500 A
	Vacuum contactors for switching motors	3TF6	14	335 kW	630 A
	Coupling contactors	3RT20	S00 - S0	3 - 15 kW	7 - 32 A
	Contactor assembly, reversing contactor assembly	3RA23	S00 - S2	3 - 37 kW	7 - 80 A

Figure	Product designation	Article number	Size	Output range	Current range
	Contactor assembly, reversing contactor assembly	3RA13	S3	30 - 45 kW	65 - 95 A
	Contactor assembly, contactor assembly for wye-delta start	3RA24	S00 - S2	5.5 - 55 kW	12 - 115 A
	Contactor assembly, contactor assembly for wye-delta start	3RA14	S3	55 - 75 kW	115 - 150 A
	Soft starters for standard applications	3RW30	-	1.5 - 55 kW	3 - 106 A
	Soft starters for standard applications	3RW40	-	5.5 - 250 kW	12.5 - 432 A
	Soft starters for High-Feature applications	3RW44	-	15 - 710 kW	29 - 1,214 A
	Solid-state switching devices for switching motors	3RF34	-	2.2 - 7.5 kW (1.5 - 3 kW reversing contactors)	5.2 - 16 A (3.8 - 7.4 A reversing contactors)
	Motor starter protectors	3RV20	S00 - S2	0.04 - 37 kW	0.11 - 80 A

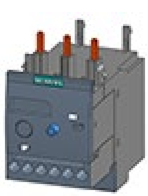
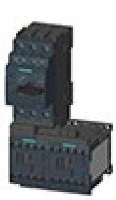
Figure	Product designation	Article number	Size	Output range	Current range
	Motor starter protectors for starter combinations	3RV23	S00 - S2	0.04 - 37 kW	0.16 A - 80 A
	Motor starter protectors	3RV10	S3	18.5 - 45 kW	11 - 100 A
	Motor starter protectors for starter combinations	3RV13	S3	18.5 - 45 kW	11 - 100 A
	Thermal overload relay	3RU2	S00 - S2	-	0.11 - 80 A
	Thermal overload relay	3RU1	S3	-	18 - 100 A
	Solid-state overload relay	3RB3	S00 - S2	-	0.1 - 80 A
	Solid-state overload relay	3RB2	S3 - S12	-	12.5 - 630 A
	Load feeders	3RA2	S00 - S2	0.06 - 30 kW	0.2 - 65 A

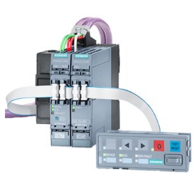
Figure	Product designation	Article number	Size	Output range	Current range
	Compact starters	3RA6	-	0.09 - 15 kW	0.1 - 32 A
	Motor starters	3RM1	-	0.1 - 3 kW	0.1 - 7 A
	ET 200S motor starters	3RK1301	-	up to 7.5 kW	0.3 - 16 A
	ET 200pro motor starters	3RK1304	-	up to 5.5 kW	0.15 - 12 A
	M200D motor starters	3RK1305 3RK1315 3RK1325		up to 5.5 kW	0.15 - 12 A
	MCU motor starters	3RK4320	-	0.25 - 5.5 kW	0.7 - 12.5 A
	SIMOCODE pro motor management and control devices	3UF7	S00 - S12 (Sizes of the current transformers)	Up to 800 kW (Upper performance limit S14 contactor at 820 A and 690 V / 1000 V)	0.3 - 820A

Figure	Product designation	Article number	Size	Output range	Current range
	SENTRON molded case circuit breakers for motor protection	3VL	-	45 - 250 kW	80 - 430 A
	SENTRON molded case circuit breakers for starter protection	3VL	-	37 - 315 kW	66 - 540 A

Design information for the SIRIUS industrial controls 4

4.1 Efficiency class IE4

As described in chapter "Standard motors according to IEC 60034-30-1 (Page 10)" the efficiency class IE4 (Super Premium Efficiency) has also already been specified in IEC 60034-30-1. At the moment no legal regulations are defined for this efficiency class.

At Siemens, we have also taken efficiency class IE4 into consideration in our analyses and have not just optimized our controls for IE3 motors, but also already for IE4 motors.

All the following configuration notes are therefore applicable not only for the use of SIRIUS controls with IE3 motors, but also for use with IE4 motors.

For this reason, all the SIRIUS controls in the overview in chapter "Siemens industrial control portfolio for use with IE3 motors (Page 24)" are also suitable for use with IE4 motors.

4.2 Contactors for switching motors

4.2.1 3RT2 power contactors

Description

3RT2 power contactors have been optimized for switching IE3 motors and can be used without further constraints with IE3 motors for direct-on-line and reversing starting.

The most energy-efficient contactors of the 3RT2 series are fitted with an electronic coil control. This enables the holding power to be reduced to the necessary minimum while also keeping the closing power low. As a consequence, the 24 V DC load power supplies can often be dimensioned smaller.

4.2.2 3RT1 power contactors

Description

3RT1 power contactors size S3 have been optimized for switching IE3 motors and can be used without further constraints with IE3 motors for direct-on-line and reversing starting.

3RT1 power contactors sizes S6 to S12 can be used without further constraints with IE3 motors for direct-on-line and reversing starting up to a starting current factor of 8.5. From a starting current ratio greater than 8.5, we recommend the use of the solid-state drive for direct-on-line and reversing starting for individual performance classes.

AC-3 / 400V / 60°C	Starting current ratio Motor < 8.5	Starting current ratio Motor > 8.5
55 kW	3RT1054	
75 kW	3RT1055	
90 kW	3RT1056	3RT1056-.N
110 kW	3RT1064	
132 kW	3RT1065	
160 kW	3RT1066	3RT1066-.N
200 kW	3RT1075-.N	
250 kW	3RT1076	3RT1076-.N

The selection criteria apply analogously for other voltages.

4.2.3 3RT12/3TF68 vacuum contactors

Description

3RT12/3TF68 vacuum contactors can be used without further constraints with IE3 motors for direct-on-line and reversing starting up to a starting current ratio of 8.5.

From a starting current ratio greater than 8.5, we recommend the use of an solid-state drive for direct-on-line and reversing starting for individual performance classes of the 3RT12.

For 3TF6 vacuum contactors, we recommend the use of the next higher performance class from a starting current ratio greater than 8.5.

AC-3 / 400V / 60°C	Starting current ratio Motor < 8.5	Starting current ratio Motor > 8.5
110 kW	3RT1264	
132 kW	3RT1265	
160 kW	3RT1266	3RT1266-N
200 kW	3RT1275	
250 kW	3RT1276	3RT1276-N
335 kW	3TF68	3TF69

The selection criteria apply analogously for other voltages.

4.2.4 Special contactors

Description

The rating for IE3 motors is available on request for all special motor contactor variants, including customized versions, for 3RT2 coupling relays, 3RT25 four-pole contactors, traction contactors with contactor control unit and size S00 contactors with diode/diode combination circuitry or int. full-wave rectification.

4.3 Contactor assemblies for switching motors

4.3.1 3RA23, 3RA13 reversing contactor assemblies

Description

3RT2 and 3RT1 power contactors size S3 have been optimized for switching IE3 motors and can be used without further constraints with IE3 motors. The same also applies for the pre-mounted reversing contactor assemblies 3RA23 (size S00, S0 and S2) and 3RA13 (size S3).

4.3.2 3RA24, 3RA14 star-delta (wye-delta) contactor assemblies (pre-mounted and mounted by the customer)

Description

3RT2 power contactors have been optimized for switching IE3 motors and can be used without further constraints with IE3 motors. This also applies for pre-mounted 3RA24 star-delta (wye-delta) contactor assemblies.

For pre-mounted 3RA14 star-delta (wye-delta) contactor assemblies, use with IE3 motors is recommended only up to a starting current ratio of 8.5. For higher starting current ratios, we recommend that, where possible, you use 3RA24 star-delta (wye-delta) contactor assemblies or that you observe the configuring instructions for the customer-mounted assemblies.

From a starting current ratio greater than 8.5, we recommend the use of the next higher size for star-delta (wye-delta) contactor assemblies for individual performance classes.

AC-3 / 400V / 60°C	**Starting current ratio Motor < 8.5**		**Starting current ratio Motor > 8.5**	
	Delta contactor / line contactor	**Star contactor**	**Delta contactor / line contactor**	**Star contactor**
75 kW	3RT1045	3RT1036	3RT1045	**3RT1044**
90 kW	3RT1054	3RT1044	3RT1054	**3RT1045**
110 kW	3RT1054	3RT1044	3RT1054	**3RT1045**
132 kW	3RT1055	3RT1045	3RT1055	**3RT1054**
160 kW	3RT1056	3RT1046	**3RT1064**	**3RT1054**
200 kW	3RT1064	3RT1054	**3RT1065**	**3RT1055**
250 kW	3RT1065	3RT1055	**3RT1066**	**3RT1064**
315 kW	3RT1075	3RT1064	3RT1075	**3RT1065**
355 kW	3RT1075	3RT1064	3RT1075	**3RT1065**
400 kW	3RT1075	3RT1065	3RT1075	3RT1065
500 kW	3RT1076	3RT1066	3RT1076	3RT1066

Short-circuit protection with fuses for direct-on-line, reversing and star-delta (wye-delta) starting

With the correct dimensioning, fused designs function without problems in combination with IE3 motors. The fuse manufacturer's dimensioning information must be observed.

4.4 Soft starters

4.4.1 Shared features of the soft starters

Description

Soft starters are used to start three-phase induction motors with reduced torque and reduced starting current.

The inrush current is largely reduced for SIRIUS soft starters. In the case of soft start of the motor, the starting current and the load on the power supply system are reduced.

3RW soft starters use intelligent, integrated current bypass circuits, therefore reducing intrinsic power losses in operation.

Key functions

- Soft starting
- Soft stop (3RW40/44 only)
- Avoidance of current peaks, torque surges, and water hammer in pumps and pipes
- Standard series 3RW30/40 (to 55 kW/106 A) and High-Feature series 3RW44 (to 1200 kW) with optional PROFIBUS or PROFINET interface

Limitations

The soft starters are dimensioned in accordance with IEC 60947-4-2. In accordance with the device standard, the maximum motor current to be taken into account is 8 times the rated motor current (locked rotor current).

4.4.2 SIRIUS 3RW30 and 3RW40 soft starters for standard applications

Description

SIRIUS 3RW30 and 3RW40 soft starters represent an alternative to direct-on-line or star-delta (wye-delta) starters. The main area of application is low to medium power ratings.

- As a replacement for star-delta (wye-delta) contactor assemblies
  - Reduced wiring
  - Minimized space requirements
  - Fewer potential error sources
  - Maintenance-free
- For smooth, jerk-free operation in the startup phase
- Optional soft stop provides advantages over the mechanical solution.

Limitations

The soft starters are dimensioned in accordance with IEC60947-4-2. In accordance with the device standard, the maximum motor current to be taken into account is 8 times the rated motor current (locked rotor current). For the correct dimensioning of soft starters for motors with high starting current ratios ($I/I_e >= 8$), we recommend our Simulation Tool for Soft Starters (STS) (available from the end of 2014):

- Download (http://support.automation.siemens.com/WW/view/en/101494917)
- Readme (http://support.automation.siemens.com/WW/view/en/101494773)

Short-circuit protection

With the correct dimensioning, designs with motor starter protectors, circuit breakers or fuses function without problems in combination with IE3 motors. The manufacturer's dimensioning information must be observed.

Technical background

You will find additional information on the technical background in the chapter "Technical background to the soft starters (Page 58)".

4.4.3 SIRIUS 3RW44 soft starters for High-Feature applications

Description

3RW44 solid-state soft starters offer not only soft starting and ramping down but also numerous features for more demanding requirements.

- The performance ranges extends up to 1200 kW.
- Voltage levels 200 to 690 V.
- All devices have adjustable current limitation for avoiding current peak loading.

Important features

- Motor protection equipment
- Monitoring and protection equipment for the supply network and soft starters
- Programmable inputs and outputs (different inputs, if applicable)
- Motor diagnostics and statistics
- Optional PROFIBUS and PROFINET communication modules
- Inside-delta circuit
- Torque control for especially difficult startups
- Pump ramp-down function for avoiding water hammer

Limitations

The soft starters are dimensioned in accordance with IEC60947-4-2. In accordance with the device standard, the maximum motor current to be taken into account is 8 times the rated motor current (locked rotor current).

For the correct dimensioning of soft starters for motors with high starting current ratios (I/I_e >= 8), we recommend our "Simulation Tool for Soft Starters (STS)" (available at the end of 2014):

- Download (http://support.automation.siemens.com/WW/view/en/101494917)
- Readme (http://support.automation.siemens.com/WW/view/en/101494773)

Short-circuit protection with fuses

With the correct dimensioning, designs with motor starter protectors, circuit breakers or fuses function without problems in combination with IE3 motors. The manufacturer's dimensioning information must be observed.

Technical background

You will find additional information on the technical background in the chapter "Technical background to the soft starters (Page 58)".

4.5 Solid-state switching devices for switching motors

4.5.1 3RF34 solid-state switching devices

Description

Solid-state switching devices are used for very high switching frequencies.

The solid-state contactor and solid-state reversing contactor versions listed in this manual are intended specifically for operation on three-phase motors up to 7.5 kW.

Important features

- Insulated enclosure with integrated heat sink
- IP20 protection
- Integrated mounting foot for snapping on a DIN rail or mounting on a support plate
- Variety of connection systems
- Plug-in control connection
- LED to indicate control voltage

Limitations

In accordance with the product standard IEC 60947-4-2, the solid-state switching devices are designed for motors with a maximum starting current ratio of 8 times the rated current (I/Ie ≤ 8).

For dimensioning for motors with higher starting current conditions (typically I/Ie > 8), the maximum permissible rated operational current has to be reduced in accordance with the following table:

Starting current ratio	Maximum permissible rated operational current [A]						
	Solid-state contactors				Solid-state reversing contactor		
	3RF3405-.BB..	3RF3410-.BB..	3RF3412-.BB..	3RF3416-.BB..	3RF34 03-.BD.4	3RF34 05-.BD.4	3RF34 10-.BD.4
<= 8 times	5.2	9.2	12.5	16.0	3.8	5.4	7.4
8.5 times	4.9	8.7	11.8	15.1	3.6	5.1	7.0
9 times	4.6	8.2	11.1	14.2	3.4	4.8	6.6
9.5 times	4.4	7.7	10.5	13.5	3.2	4.5	6.2
10 times	4.2	7.4	10.0	12.8	3.0	4.3	5.9

4.6 Protective devices

4.6.1 3RV2, 3RV1 motor starter protectors

Description

Motor starter protectors are designed to switch and protect motors, and provide line protection in the event of overload and short-circuit.

For this purpose, the devices are equipped with overload and short-circuit detection sensors and have an interruption point for switching the motor and short-circuit currents.

Technical background

The motor starter protectors are suitable for use on IE3 motors. You will find additional information on the technical background in the chapter "Technical background to the motor starter protectors (Page 55)".

Limitations of 3RV2 motor starter protectors

One constraint in the maximum starting current is necessary in one setting range of each of the sizes S0 and S2. The reason can be found in the making and breaking capacity of the corresponding variants:

3RV2 motor starter protectors	3RV2.21-4E...	3RV2.3.-4R...
Setting range overload release	27 ... 32 A	70 ... 80 A
Reduced starting current ratio	8 times	9 times
max. permissible starting current	32 A x 8 = 256 A	80 A x 9 = 720 A

Starting current ratio:	Maximum permissible rated operational current [A]	
	3RV2.21-4E...	3RV2.3.-4R...
≤ 8 times	32,0	80,0
8.5 times	30,2	80,0
9 times	28,4	80,0
9.5 times	27,0	75,8
10 times	-	72,0

Note

For size S0, the setting range variants "-4P" (30 to 36 A) and "-4F" (34 to 40 A) are not suitable for use with IE3 motors.

We recommend the use of size S2 for these current ranges.

Extended setting ranges for motor starter protectors S00 and S0

The setting ranges of the overload releases have been extended for the following versions of the motor starter protectors S00 and S0 and thus adjusted to the lower rated currents of the IE3 motors:

Size	Article number	Setting range of overload release, previously	Setting range of overload release, new
S00	3RV2.11-4A...	11 ... 16 A	10 ... 16 A
S0	3RV2.21-4A...	11 ... 16 A	10 ... 16 A
	3RV2.21-4B...	14 ... 20 A	13 ... 20 A
	3RV2.21-4C...	17 ... 22 A	16 ... 22 A
	3RV2.21-4D...	20 ... 25 A	18 ... 25 A

Limitations of size S3 3RV1 motor starter protectors

For the following versions of the 3RV1 motor starter protectors of size S3, we recommend the use of a contactor with IE3 motors for switching of the motor under normal operating conditions.
The reason can be found in the making and breaking capacity of the corresponding variants:

Size	Article number	Setting range overload release
S3	3RV1.4.-4K...	57 ... 75 A
S3	3RV1.4.-4L...	70 ... 90 A
S3	3RV1.4.-4M...	80 ... 100 A

Selection example

In this example, two motor starter protectors are compared with each other.

- Motor starter protector [A]: Setting scale 10 ... 16 A
- Motor starter protector B: Setting scale 14 ... 20 A
- Rated motor current: 15 A

Motor starter protector B (14 ... 20 A) is recommended since its power loss is lower and it has a higher distance to the response limits.

The power loss of motor starter protector B is approximately 35 % lower than that of motor starter protector A.

The response limits of the short-circuit release always refer to the maximum setting value:

- In the case of motor starter protector A, the response value of the short-circuit release is 208 A (13 x 16 A). With a setting value of 15 A, the distance to the response limit of the short-circuit release is 13.86 times the setting current (208 A: 15 A = 13.86).
- In the case of motor starter protector B, the response value of the short-circuit release is 260 A (13 x 20 A). With a setting value of 15 A, the distance to the response limit of the short-circuit release is 17.33 times the setting current (260 A: 15 A = 17.33).

In the present example, the distance to the response limit of 13.86 times the setting current for motor starter protector A thus increases to 17.33 times the setting current for motor starter protector B.

4.6.2 MSPs for starter combinations

Description

The MSP for starter combinations in the load feeder with overload relay and switching device is responsible for short-circuit protection. MSPs for starter combinations are designed in a similar manner to motor starter protectors.

Technical background

The MSPs for starter combinations are suitable for use on IE3 motors. You will find additional information on the technical background in the chapter "Technical background to the motor starter protectors (Page 55)".

Feeders with MSPs for starter combinations and thermal overload relays

As described in the "Motor starter protectors" chapter, the integrated short-circuit detection in the MSP for starter combinations can result in premature trips in the event of higher motor starting and inrush currents. For this reason, we recommend that you proceed in a similar way to selecting motor starter protectors when selecting a thermal overload relay and motor circuit protector combination; in other words, make your selection in such a way that the devices are not operated in the upper range of the setting scale. This also reduces power losses on the thermal overload relays.

Sizes S00 and S0

On feeders of sizes S00 and S0, we recommend you select the motor circuit protector and the thermal overload relay each with the same rated current: e.g. MSP for starter combination 3RV2311-1FC10 (with rated current 5 A) and thermal overload relay 3RU2116-1FB10 (setting range 3.5 ... 5 A → rated current 5 A).

Sizes S2

For the design of feeders of size S2, we recommend the device combinations given in the following table:

Motor starter protector for starter protection		Thermal overload relay	
Rated current [A]	**Article number**	**Setting range [A]**	**Article number**
17	3RV233x-4TC10	11 … 16	3RU2136-4AB0
20	3RV233x-4BC10	14 … 20	3RU2136-4BB0
25	3RV233x-4DC10	18 … 25	3RU2136-4DB0
32	3RV233x-4EC10	22 … 32	3RU2136-4EB0
40	3RV233x-4UC10	28 … 40	3RU2136-4FB0
45	3RV233x-4VC10	36 … 45	3RU2136-4GB0
52	3RV233x-4WC10	40 … 50	3RU2136-4HB0
59	3RV233x-4XC10	47 … 57	3RU2136-4QB0
65	3RV233x-4JC10	54 … 65	3RU2136-4JB0
73	3RV233x-4KC10	62 … 73	3RU2136-4KB0
80	3RV233x-4RC10	70 … 80	3RU2136-4RB0

x = 1: 65 kA

x = 2: 100 kA

Feeders with MSPs for starter combinations and solid-state overload relays

Please consult Technical Assistance for information about the correct selection of devices for assembling feeders with MSPs for starter combinations and solid-state overload relays.

4.6.3 3RU2, 3RU1, 3RB3, 3RB2 overload relays

Description

3RB overload relays with solid-state release are characterized by reduced power losses of up to 98 %.

Overload relays can be used for IE3 motors without adjustments. When using the overload relays in load feeders with other devices, problems can result in conjunction with IE3 motors. With the following devices, observe the information in the relevant chapter:

- Contactors
- Soft starters
- MSPs for starter combinations

Short-circuit protection with fuses

The fuses in the load feeder with overload relay and switching device are responsible for short-circuit protection.

Observe the higher inrush currents and the correct dimensioning of the fuses.

4.7 Load feeders and motor starters for operation in the control cabinet

4.7.1 SIRIUS 3RA21, 3RA22 load feeders

Description

The pre-mounted 3RA2 fuseless load feeders consist of a 3RV2 motor starter protector and 3RT2 electromechanical contactor. They are available as direct-on-line and reversing starters.

The devices are electrically and mechanically connected using preassembled assembly kits (link modules, wiring kits, and standard mounting rail or busbar adapters).

In the 3RA2 load feeder, the 3RV2 motor starter protector handles overload and short-circuit protection, and the 3RT2 contactor handles switching under normal operating conditions. Back-up protective devices, such as melting fuses or limiters, are superfluous here, as the motor starter protector is short-circuit proof up to 150 kA at 400 V.

3RA2 load feeders are available in sizes S00 / S0 to 15 kW / 32 A. Please consult Technical Assistance for size S2.

Use of 3RA2 feeders with IE3 motors

The information / recommendations from the chapter on motor starter protectors also apply in general for 3RA2 load feeders.

For this reason, we recommend that you select the load feeder in such a way that the motor current does not have to be set in the upper range of the setting scale (as with the motor starter protector). This reduces power loss in the device (cost saving and reduced temperature rise in the control cabinet) and increases the distance from the short-circuit releases' response limits.

Limitations of 3RA2 load feeders

- Reduction in the maximum starting current is necessary with a setting range of size S0. The reason can be found in the making and breaking capacity of the corresponding variants (see the chapter on motor starter protectors):

Load feeder	3RA2.20-4E..
Setting range overload release	27 ... 32 A
Reduced starting current ratio	8 times
Max. permissible starting current	32 x 8 = 256 A

Starting current ratio	Maximum permissible rated operational current [A]
	3RA2.20-4E..
<= 8 times	32,0
8.5 times	30,2
9 times	28,4
9.5 times	27,0
10 times	-

- The setting ranges of the overload releases have been extended for the following versions of the load feeders S00 and S0 and thus adjusted to the lower rated currents of the IE3 motors:

Size	Article number	Setting range of overload release, previously	Setting range of overload release, new
S00	3RA2.10-4A…	11 … 16 A	10 … 16 A
S0	3RA2.21-4A…	11 … 16 A	10 … 16 A
	3RA2.21-4B…	14 … 20 A	13 … 20 A
	3RA2.21-4C…	17 … 22 A	16 … 22 A
	3RA2.21-4D…	20 … 25 A	18 … 25A

- 3RA2 load feeders size S2
  Please consult Technical Assistance for information on possible limitations.

4.7.2 SIRIUS 3RA6 compact starters

Description

The SIRIUS 3RA6 compact starter is a load feeder that combines a host of functions in a single unit.

The compact starter is available as either a direct or a reversing starter.

An AS-i mounting module can be optionally mounted on the 3RA61 / 3RA62 compact starter with a 24 V DC control supply voltage. The AS-i mounting module enables the compact starter to communicate via an AS-Interface.

The 3RA64 / 3RA65 compact starter with IO-Link can communicate via IO-Link.

Limitations

Compact starters with a current setting range from 3 to 12 A are suitable for up to 8.5 times the rated motor current, and compact starters with a current setting range of 8 to 32 A are suitable for starting current ratios up to 9 times the rated motor current.

If motors are operated that have a higher starting current, refer to the following table for the maximum adjustable motor current:

Starting current ratio	Maximum adjustable motor current [A]	
	Current setting range 3 to 12 A	Current setting range 8 to 32 A
≤ 8 times	12.0	32.0
8.5 times	12.0	32.0
9 times	11.3	32.0
9.5 times	10.7	30.3
10 times	10.2	28.8

Note

Compact starters with lower current setting ranges

There are no constraints to observe with compact starters with lower current setting ranges.

Compact starters with a current setting range from 8 to 32 A can be used as an alternative to compact starters with a current setting range from 3 to 12 A.

4.7.3 SIRIUS 3RM1 motor starters

Description

SIRIUS 3RM1 motor starters are compact, 22.5-mm-wide devices that combine a large number of functions in a single enclosure. They consist of combinations of relay contacts, power semiconductors (hybrid technology), and a solid-state overload relay for switching induction motors up to 3 kW (at 400 V) and resistive loads up to 10 A (at AC voltages to 500 V) under normal operating conditions.

The 3RM1 motor starters combine the functions of direct-on-line/reversing starting, electronic overload protection and safety-related shutdown in a single device, without changing in size.

Limitations

High starting currents may have to be taken into consideration when using 3RM1 motor starters on motors with a high efficiency (IE3 or IE4). 3RM1 motor starters are designed for motors with a maximum of 8 times the starting current in accordance with IEC 60947-4-2.

If motors are operated that have a higher starting current, refer to the following table for the maximum adjustable motor current:

Starting current ratio	Maximum adjustable motor current [A]		
	3RM1.01-.....	3RM1.02-.....	3RM1.07-.....
<= 8 times	0,50	2,00	7,00
8.5 times	0,47	1,90	6,60
9 times	0,45	1,80	6,20
9.5 times	0,42	1,70	5,90
10 times	0,40	1,60	5,60

The device protection may respond sooner in the case of motors with a higher starting current.

4.7.4 ET 200S Motor Starters and Safety Motor Starters

Description

With ET 200S motor starters, any AC loads can be protected and switched. The communication interface makes them ideal for operation in distributed control cabinets or control enclosures.

The ET 200S motor starters are available as direct-on-line, reversing or soft starter versions:

- Standard motor starters up to 5.5 kW (direct-on-line and reversing starters)
- High Feature motor starters up to 7.5 kW (direct-on-line, reversing and direct-on-line soft starters)
- Failsafe motor starters up to 7.5 kW (direct-on-line and reversing starters)

Limitations

High starting currents may have to be taken into consideration when using motor starters on high-efficiency motors. The motor starters are designed in accordance with the product standard IEC 60947-4-1 (soft starters: IEC 60947-4-2).

If motors are operated that have a higher starting current, refer to the following tables for the maximum adjustable motor current:

ET 200S Standard motor starters

Motor starter version	Maximum adjustable motor current [A] at starting current ratio		
	<= 8 times	9 times	10 times
3RK1301-0BB00*	0,20	0,18	0,16
3RK1301-0CB00*	0,25	0,22	0,20
3RK1301-0DB00*	0,32	0,29	0,26
3RK1301-0EB00*	0,40	0,35	0,30
3RK1301-0FB00*	0,50	0,41	0,32
3RK1301-0GB00*	0,63	0,49	0,40
3RK1301-0HB00*	0,80	0,65	0,50
3RK1301-0JB00*	1,00	0,85	0,70
3RK1301-0KB00*	1,25	1,00	0,80
3RK1301-1AB00*	1,60	1,30	1,00
3RK1301-1BB00*	2,00	1,65	1,30
3RK1301-1CB00*	2,50	2,10	1,70
3RK1301-1DB00*	3,20	2,65	2,10
3RK1301-1EB00*	4,00	3,25	2,50
3RK1301-1FB00*	5,00	4,10	3,20

ET 200S High Feature motor starter

Starting current ratio	Maximum adjustable motor current [A]		
	3RK1301-0AB*	3RK1301-0BB*	3RK1301-0CB*
<= 8 times	3,0	8,0	16,0
9 times	2,9	6,8	13,0
10 times	2,6	6,0	12,0

4.8 Motor starters for use in the field, high degree of protection

4.8.1 ET 200pro motor starters

Description

Any type of AC load can be protected and switched with ET 200pro motor starters.
ET 200pro motor starters are available both with mechanical as well as electronic contacts.

ET 200pro electromechanical starters are offered as direct-on-line (DSe) and reversing starters (RSe) in the Standard and High-Feature versions. There are device versions with or without control for externally fed brakes with 400 V AC.

The electronic motor starters are dimensioned in accordance with IEC60947-4-2. In accordance with the device standard, the maximum motor current to be taken into account is 8 times the rated motor current (locked rotor current).

Limitations

High starting currents may have to be taken into consideration when using motor starters on high-efficiency motors. In accordance with the product standard IEC 60947-4-2, the motor starters are designed for motors with up to 8 times the starting current.

If motors are operated that have a higher starting current, refer to the following table for the maximum adjustable motor current:

Starting current ratio	**Maximum adjustable motor current [A]**			
	3RK1304-5LS40*	**3RK1304-5KS70-3***	**3RK1304-5LS70-2***	**3RK1304-5LS70-3***
<= 8 times	12,0	2,0	12,0	12,0
9 times	10,0	1,5	8,0	6,0
10 times	9,0	1,0	7,0	5,0

4.8.2 SIRIUS M200D motor starters

Description

M200D motor starters are standalone devices with a high degree of protection (IP65) for distributed use near the motor.

The motor starters are dimensioned in accordance with IEC 60947-4-2. In accordance with the device standard, the motor current to be taken into account is 8 times the rated motor current (locked rotor current).

Depending on the order variant, they are available as:

- Direct starters, electromechanical (DSte) or electronic (sDSte)
- Reversing starters, electromechanical (RSte) or electronic (sRSte)
- Direct soft starters, electronic (sDSSte)
- Reversing soft starters, electronic (sRSSte)

Limitations

High starting currents may have to be taken into consideration when using motor starters on high-efficiency motors. Motor starters are designed for motors with a maximum 8-fold starting current in accordance with IEC 60947-4-2.

If motors are operated that have a higher starting current, refer to the following table for the maximum adjustable motor current:

Starting current ratio	Maximum adjustable motor current [A]		
	3RK1395-6KS*	3RK1395-6LS41*	3RK1395-6LS71*
<= 8 times	2.0	12.0	12.0
9 times	1.7	10.0	8.0
10 times	1.5	9.0	7.0

4.8.3 MCU motor starters

Description

The MCU motor starters are completely pre-wired inside, have a high degree of protection and are designed for switching and protecting any AC loads. They are mostly used on standard three-phase motors in direct or reversing duty up to 5.5 kW at 400/500 V AC (electromechanical switching) and 400/460 V AC (electronic switching).

The SIRIUS MCU motor starter contains a motor starter protector (circuit breaker) with overload function (3RV2021) for protecting the motor.

Limitations

High starting currents may have to be taken into consideration when using motor starters on high-efficiency motors. The motor starters are designed for motors with up to 8 times the starting current in accordance with IEC 60947-4-2.

If you are operating motors with a higher starting current, please contact Technical Assistance regarding the dimensioning of the motor starters.

4.9 Monitoring and control devices

4.9.1 SIMOCODE pro motor management and control devices

Description

SIMOCODE pro is a flexible, modular motor management system for motors with constant speeds in the low-voltage performance range. It optimizes the link between the control system and the motor feeder, increases plant availability and allows significant savings to be made during installation, commissioning, operation and maintenance.

SIMOCODE pro devices can be used for IE3 motors without constraints. However, when using SIMOCODE pro in the load feeder, there may be constraints with regard to the other components (motor starter protector, contactor). Please observe the information in the relevant device chapter.

Device series

SIMOCODE pro is structured into several functionally tiered series:

- SIMOCODE pro C, as a compact system for direct-on-line starters and reversing starters or for controlling a motor starter protector
- SIMOCODE pro S - the smart system for direct-on-line, reversing, and wye-delta starters or for controlling a motor starter protector or soft starter. Its expandability with a multifunction module provides comprehensive input/output project data volume, precise ground-fault detection via the 3UL23 residual-current transformers and temperature measurement.
- SIMOCODE pro V, as a variable system with all control functions and with the possibility of expanding the inputs, outputs and functions of the system at will using expansion modules.

Dimensioning information for SENTRON protective devices

5

5.1 Molded case circuit breaker

5.1.1 3VL molded case circuit breakers for motor protection

Description

3VL molded case circuit breakers for motor protection can also be used with IE3 motors. Due to the higher inrush and starting currents during the start-up phase of the motor, 3VL molded case circuit breakers must be partially over-dimensioned. This applies especially to the operating current of the instantaneous short-circuit release. Since 3VL molded case circuit breakers for motor protection have a solid-state release with a setting range of 0.4 ... 1 x I_n, overload protection of the motor is ensured.

Selection table for 400 V AC

Standard power rating of the motor	Motor current (guide value)	3VL molded case circuit breakers for IE2 motors	3VL molded case circuit breakers for IE3 motors
45 kW	80 A	3VL2710	**3VL2710**
55 kW	97 A	3VL2710	**3VL2716**
75 kW	132 A	3VL2716	**3VL3720**
90 kW	160 A	3VL2716	**3VL3720**
110 kW	195 A	3VL3720	**3VL3725**
132 kW	230 A	3VL3720	**3VL4731**
160 kW	280 A	3VL4731	**3VL5750**
200 kW	350 A	3VL5750	**3VL5750**
250 kW	430 A	3VL5750	**3VL5750***

* 3VL5750 can only be used up to a motor current of I_n = 430 A

Selection table for 500 V AC

Standard power rating of the motor	Motor current (guide value)	3VL molded case circuit breakers for IE2 motors	3VL molded case circuit breakers for IE3 motors
45 kW	64 A	3VL2710	**3VL2710**
55 kW	78 A	3VL2710	**3VL2710**
75 kW	106 A	3VL2716	**3VL2716**
90 kW	128 A	3VL2716	**3VL3720**
110 kW	156 A	3VL2716	**3VL3720**
132 kW	184 A	3VL3720	**3VL3725**
160 kW	224 A	3VL3725	**3VL4731**
200 kW	280 A	3VL4731	**3VL5750**
250 kW	344 A	3VL5750	**3VL5750**

Please consult Technical Assistance for information on the correct selection of the devices for constructing feeders with 3VL molded case circuit breakers and 3RT contactors.

5.1.2 3VL molded case circuit breakers for starter protection

Description

3VL molded case circuit breakers for starter protection can also be used with IE3 motors. Due to the higher inrush and starting currents during the start-up phase of the motor, 3VL molded case circuit breakers must be partially over-dimensioned. This applies especially to the operating current of the instantaneous short-circuit release. Overload protection of the motor is ensured separately using an appropriate solid-state overload relay.

Selection table for 500 V AC:

* 3VL5750 can only be used up to a motor current of I_n = 432 A

Selection table for 400 V AC

Standard power rating of the motor	Motor current (guide value)	3VL molded case circuit breakers for IE2 motors	3VL molded case circuit breakers for IE3 motors
37 kW	66 A	3VL2710	**3VL2710**
45 kW	80 A	3VL2710	**3VL2710**
55 kW	97 A	3VL2710	**3VL2716**
75 kW	132 A	3VL2716	**3VL2716**
90 kW	160 A	3VL2716	**3VL3725**
110 kW	195 A	3VL3725	**3VL3725**
132 kW	230 A	3VL4725	**3VL4731**
160 kW	280 A	3VL4731	**3VL5750**
200 kW	350 A	3VL5750	**3VL5750**
250 kW	430 A	3VL5750	**3VL5750***
250 kW	430 A	3VL5750	**3VL7712**
315 kW	540 A	3VL7712	**3VL7712**

* 3VL5750 can only be used up to a motor current of I_n = 430 A

Selection table for 500 V AC

Standard power rating of the motor	Motor current (guide value)	3VL molded case circuit breakers for IE2 motors	3VL molded case circuit breakers for IE3 motors
45 kW	64 A	3VL2710	**3VL2710**
55 kW	78 A	3VL2710	**3VL2710**
75 kW	106 A	3VL2716	**3VL2716**
90 kW	128 A	3VL2716	**3VL2716**
110 kW	156 A	3VL2716	**3VL2716**
132 kW	184 A	3VL3725	**3VL3725**
160 kW	224 A	3VL3725	**3VL3725**
200 kW	280 A	3VL4731	**3VL5750**
250 kW	344 A	3VL5750	**3VL5750**
315 kW	432 A	3VL5750	**3VL5750***
315 kW	432 A	3VL5750	**3VL7712**
355 kW	488 A	3VL5750	**3VL7712**

* 3VL5750 can only be used up to a motor current of I_n = 432 A

Please consult Technical Assistance for information on the correct selection of the devices for constructing feeders with 3VL molded case circuit breakers and 3RT contactors.

Technical background 6

6.1 Technical background to the motor starter protectors

Short-circuit detection

In the event of unusually high currents in the electrical installation, short-circuit detection serves to keep the thermal and dynamic load low and ensure safe shutdown. The response threshold should lie above the currents that a starting motor causes. The dimensioning of a system is influenced by the response value. The higher the response value, the higher the chosen cable cross-sections to be protected must be. This increases costs in the system and for the switching devices. This is why the response values have been adapted to the previously typical motor starting currents.

The drawback of the new, more efficient motors (IE3) is that, on average, the locked rotor and magnetization currents (inrush currents) arising at the moment of switching on are considerably higher than in the case of the previous generations of motors. The spread of locked rotor and inrush currents is very wide. Motors with high values can therefore cause the motor starter protector's short-circuit detection to respond. This leads to unintentional shutdown ("early tripping") during motor starting. Early tripping can occur whenever the motor current lies in the top range of the motor starter protector's setting scale and a motor with a high inrush current is used.

Making and breaking capacity of motor starter protectors

Making and breaking capacity tests are conducted in compliance with the standard under three-phase AC loading with 10 to 8 times the rated current. In some cases, the locked rotor and inrush currents of IE3 motors are clearly above these values. In isolated cases, current spikes that arise during switching on can cause brief lifting of the contacts without triggering a breaking operation by short-circuit detection.

Where the motor is switched on by a contactor, for example, the motor starter protector's making/breaking capacity is irrelevant. In this case, the motor current is only carried. The current that can be carried without any problems is normally higher than the switching device's making/breaking capacity.

Rated motor current/setting scale

For motor protection, the motor's rated current must be set on the motor starter protector's setting scale. The new IE3 motors generally have lower rated currents. This can lead to situations in which a motor starter protector with a lower rated current has to be chosen for the same motor rating. Thus, the short-circuit detection response value also drops and can lead to tripping during motor starting.

The optimization of motor starter protectors for use on IE3 motors

The motor starter protectors have been revised in relation to the higher starting currents and inrush currents as follows:

- Increase in the lower response tolerances of the short-circuit detection, without changing the maximum values

  → No change to system dimensioning

- Increase in the making/breaking capacity

  → Substantial avoidance of restrictions due to increased motor starting and inrush currents

- Adaptation of the overload releases and setting scales of some motor starter protector versions

  → Avoidance of using smaller motor starter protectors due to lower rated motor currents

In the case of motors with very high locked rotor and inrush currents, problems can arise despite adaptations, e.g. undesired tripping on starting. It is recommended that motor starter protectors be selected such that the setting does not need to be made in the upper range of the setting scale. This reduces power loss in the device (cost saving and reduced temperature rise in the control cabinet) and increases the distance from the short-circuit releases' response limits.

Selection example

In this example, two motor starter protectors are compared with each other.

- Motor starter protector [A]: Setting scale 10 ... 16 A
- Motor starter protector B: Setting scale 14 ... 20 A
- Rated motor current: 15 A

Motor starter protector B (14 ... 20 A) is recommended since its power loss is lower and it has a higher distance to the response limits.

The power loss of motor starter protector B is approximately 35 % lower than that of motor starter protector A.

The response limits of the short-circuit release always refer to the maximum setting value:

- In the case of motor starter protector A, the response value of the short-circuit release is 208 A (13 x 16 A). With a setting value of 15 A, the distance to the response limit of the short-circuit release is 13.86 times the setting current (208 A: 15 A = 13.86).
- In the case of motor starter protector B, the response value of the short-circuit release is 260 A (13 x 20 A). With a setting value of 15 A, the distance to the response limit of the short-circuit release is 17.33 times the setting current (260 A: 15 A = 17.33).

In the present example, the distance to the response limit of 13.86 times the setting current for motor starter protector A thus increases to 17.33 times the setting current for motor starter protector B.

6.2 Technical background to the soft starters

Function

Soft starters limit the starting current and starting torque. This reliably prevents mechanical stress and line voltage dips. The motor voltage is reduced here by means of phase control, and it is raised within a ramp time from an adjustable start voltage up to the line voltage. Thanks to stepless control of the voltage supply, the motor is adapted to the load behavior of the driven machine.
With soft starters, the starting currents can be reduced in most applications to less than 50 % of the value for direct-on-line starting. If we assume starting currents of no more than 8 times the rated current, this results in a maximum of 4 times the starting current when starting with soft starters.

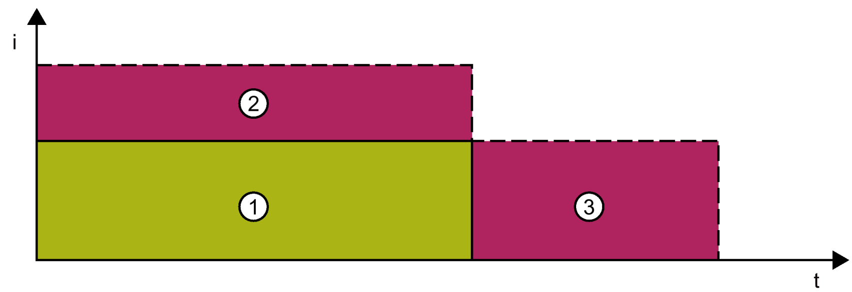
Special considerations for motors with high starting currents

For motors with high starting currents in particular, soft starters are especially suitable since the high starting currents are reduced to lower values and the supply network is therefore subject to a comparatively lower load.
Current-limiting starting of motors with high starting currents using soft starters can have different effects. It is necessary here that the other conditions for startup, such as the load conditions, do not change as well:

- Case A
  Motors that have higher starting currents but also an improved torque curve can be started under comparable conditions under certain circumstances.

  In this case, further consideration of the startup is not necessary since changes in startup are rarely required under ideal circumstances.
- Case B
  Motors that pick up higher starting currents but have no changes in torque behavior in comparison to standard motors must be provided with more energy during startup.

In **Case B**, the effects on startup must be considered more closely:
the diagram shows how the startup-current-time ratio can change when using motors with higher starting currents than described.
A motor with normally high starting current ratios (5 to 8 times the rated motor current) is taken as the starting point.



① Normal
② Starting current higher
③ Starting time longer

Startup diagram		Starting time	Starting current	Application
①	Normal case Motor with normal starting current	Normal	Normal	The resulting starting torque is sufficient for correct power up of the motor.
②	Higher starting current	Normal	Higher	The resulting starting torque cannot be reduced further because, for example, the acceleration resulting from a high load torque is not sufficient and the motor does not start up
③	Longer starting time	Longer	Normal	The resulting starting torque can be reduced further since sufficient acceleration is available.

Operation and settings

As described above (Case B), the startup changes especially when the startup current is increased but other motor parameters have only changed slightly. The achievable current limitations depend on the startup situation:

- If the acceleration torque is low, current limitation that is possible with motors with normal starting currents is no longer achievable. Higher values must therefore be accepted here. SIRIUS 3RW40 and 3RW44 soft starters with integrated motor protection permit current limiting values of up to 5.5 times the set motor current (I_{emotor}) depending on the version. If this is not sufficient, higher values can be achieved by doing without the integrated motor protection.
- If a high acceleration torque is available, it is usually possible to achieve a current limit that is also achieved with motors with normal starting currents. Only the startup takes longer since more energy is required for power-up. In this case, it is only rarely necessary to change the setting parameters of the soft starter. The dimensioning of the soft starter must be checked.

Dimensioning of the soft starter

Dimensioning of the soft starters takes place essentially in the same way as for motors with normally high starting currents:
Depending on the conditions of use, such as the installation altitude, ambient temperature, requirements of the application, starting currents and start duration, a soft starter is determined that can handle the motor current during continuous operation and at startup. You can find further details on dimensioning in the catalogs or manuals.

For the correct dimensioning of soft starters for motors with high starting current ratios ($I/I_e >= 8$), we recommend our Simulation Tool for Soft Starters (STS) (available from the end of 2014):

- Download (http://support.automation.siemens.com/WW/view/en/101494917)
- Readme (http://support.automation.siemens.com/WW/view/en/101494773)

Link collection

A

A.1 Standards - Regulations - Directives

REGULATION (EC) No. 640/2009 OF THE COMMISSION of 22 July, 2009

REGULATION (EC) No. 640/2009 OF THE COMMISSION of 22 July, 2009 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:191:0026:0034:EN:PDF)

CE Directives Ecodesign Directive 2009/125/EC (incl. Directive 2010/30/EC concerning energy labeling)

CE Directives Ecodesign Directive 2009/125/EC (http://www.ce-richtlinien.eu/richtlinien/OekoD_RL.html)

CE Directive DIN EN 50598-1:2014-01

CE Directive DIN EN 50598 (http://www.beuth.de/en/draft-standard/din-en-50598-1/195842113;jsessionid=JZNNCKX9H8E6F807Z8V7QBXC.4?)

Motors according to NEMA

Motors according to NEMA (http://www.industry.siemens.com/drives/global/en/motor/low-voltage-motor/nema-motors/Pages/nema-motors.aspx)

Energy-efficient use of motor starters or frequency converters

Joint position paper by CAPIEL and CEMEP on Regulation (EC) 640/2009 (http://www.ebpg.bam.de/de/produktgruppen/ener11motor.htm)

Explanation and application of the ecodesign regulation - Regulation (EC) No. 640/2009 (electric motors)

Explanation and application of the ecodesign regulation

A.2 Drive technology

SIMOTICS GP General Purpose motors

SIMOTICS GP (http://www.siemens.com/simotics-gp)

SIMOTICS SD Severe Duty motors

SIMOTICS SD (http://www.siemens.com/simotics-sd)

SIMOTICS XP Explosion-Proof motors

SIMOTICS XP (http://www.siemens.com/simotics-xp)

SIMOTICS DP Definite Purpose motors

SIMOTICS DP (http://www.siemens.com/simotics-dp)

SIMOTICS TN N-compact series

SIMOTICS N-compact (http://www.siemens.com/simotics-n-compact)

A.3 Industrial controls

SIRIUS Innovations - System Overview

SIRIUS Innovations - System Overview
(http://support.automation.siemens.com/WW/view/en/60317144)

Industrial controls - SIRIUS 3RT2 contactors/contactor assemblies - Overview of technical data

Industrial controls - SIRIUS 3RT2 contactors/contactor assemblies
(http://support.automation.siemens.com/WW/view/en/61193329)

SIRIUS 3RW30 / 3RW40 Soft Starters - Manual

SIRIUS 3RW30 / 3RW40 Soft Starters Manual
(http://support.automation.siemens.com/WW/view/en/38752095)

SIRIUS 3RW44 Soft Starters - Manual

SIRIUS 3RW44 Soft Starters Manual
(http://support.automation.siemens.com/WW/view/en/21772518)

SIRIUS 3RF34 Solid-State Switching Devices - Manual

SIRIUS 3RF34 Solid-State Switching Devices Manual
(http://support.automation.siemens.com/WW/view/en/60298187)

SIRIUS Innovations - SIRIUS 3RV2 Motor Starter Protectors - Manual

SIRIUS Innovations Manual - SIRIUS 3RV2 Motor Starter Protectors
(http://support.automation.siemens.com/WW/view/en/60279172)

A.4 Load feeders and motor starters

SIRIUS 3RA11 / 12 Load Feeders - System Manual

SIRIUS 3RA11 / 12 load feeders
(http://support.automation.siemens.com/WW/view/en/6009084)

SIRIUS 3RA21 / 22 Load Feeders - Overview of Technical Data - Product Information

SIRIUS 3RA21/22 load feeders
(http://support.automation.siemens.com/WW/view/en/61187308)

Configuring SIRIUS Load Feeders - Configuration Manual

Configuring SIRIUS load feeders
(http://support.automation.siemens.com/WW/view/en/40625241)

SIRIUS 3RA6 Compact Starters - System Manual

SIRIUS 3RA6 Compact Starter - System Manual
(http://support.automation.siemens.com/WW/view/en/27865747)

SIRIUS Infeed System for 3RA6 - Operating Instructions

SIRIUS infeed system for 3RA6
(http://support.automation.siemens.com/WW/view/en/40625241)

SIRIUS 3RM1 motor starters

SIRIUS 3RM1 Motor Starters - Manual and Operating Instructions
(http://support.automation.siemens.com/WW/view/en/60497779/133300)

ET 200S motor starters

SIMATIC ET 200S - Manual
(http://support.automation.siemens.com/WW/view/en/22144419/133300)

ET 200pro motor starters

ET 200pro motor starters (http://support.automation.siemens.com/WW/view/en/21025641/133300)

SIRIUS M200D motor starters

M200D motor starters (http://support.automation.siemens.com/WW/view/en/29108203/133300)

SIRIUS MCU motor starters

SIRIUS MCU motor starters (http://support.automation.siemens.com/WW/view/en/32033334)

A.5 SIMOCODE pro motor management and control devices

SIMOCODE pro motor management and control devices

SIMOCODE pro motor management and control devices (http://www.siemens.com/simocode)

Configuring SIRIUS Innovations - Manual

Configuring SIRIUS Innovations (http://support.automation.siemens.com/WW/view/en/39714188)

SIMOCODE pro PROFIBUS - System Manual

SIMOCODE pro PROFIBUS (http://support.automation.siemens.com/WW/view/en/20017780)

SIMOCODE pro PROFINET - System Manual

SIMOCODE pro PROFINET (http://support.automation.siemens.com/WW/view/en/61896631)