NEMA and IEC Premium Efficiency Motors

Choosing the Right Motor Control and Protection Components

Data Bulletin

EDCED115066ENUS
Release date 08/2017

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Executive Summary

Amid mushrooming global demand for energy and increasing concern for the environment, countries around the world are implementing tighter environmental restrictions. Industrial motors, a major global consumer of electricity, are one of the prime targets of the new regulations and standards.

The transition to NEMA Premium efficiency motors in North America began in the early 2010s, and the global transition to IE3 premium efficiency motors is underway, both raising challenges for businesses. However, these challenges also bring opportunities for businesses to reduce energy costs and increase efficiency while limiting their impact on the environment.

To make the right motor starter choices and ensure maximum energy efficiency, you must understand how NEMA Premium and IE3 motors behave during starting, and how this behavior impacts protective devices. Schneider Electric's offerings—TeSys™ motor starter products (manual motor protectors, contactors, and overload relays)— have undergone extensive laboratory testing with different motor brands to confirm their compatibility with NEMA Premium and IE3 motors. Square D Type S NEMA products have been fully tested to meet NEMA standards pertaining to the corresponding FLA and hp ratings of all NEMA motors.

The guidelines in this data bulletin are designed to help you make the right choices for your electrical installation and motor.

Introduction

Worldwide demand for energy is expected to double by 2050. Growing concern for the environment is driving the emergence of more stringent energy-efficiency regulations around the globe. And the industrial sector is on the front lines. Electric motors account for up to 80% of electricity consumption in the industrial sector, making them a prime target for energy-saving measures.

The U.S. led the energy efficiency movement with regulations dating back to the 1990s. The Energy Policy and Conservation Act (EPAct), valid until December 2010, was superseded by the Energy Independence and Security Act (EISA). The EISA introduced premium efficiency motors, equivalent to IE3, and the strictest regulations worldwide for minimum efficiencies for 2 to 6-pole three-phase asynchronous motors from 1–200 hp (0.75–149.2 kW).

Legislators are addressing energy efficiency in the industrial sector with new regulations. The EU Directive on Energy-related Products (ErP) came into force in 2009. And since January 2015, the Directive has required most direct on line (DOL) or across the line motors to be of the IE3 premium efficiency class.

Market research by global information company IHS has revealed the continued gradual market penetration of IE3 motors. Because motor regulations are not strictly enforced, the transition is expected to remain gradual. Despite demand from customers for IE3 motors, and more generally for energy-efficient solutions, some OEMs continue to offer IE1. As customers begin to include IE3 motors in their requirements, the market will inevitably shift toward these motors.

The arrival of these new motors at industrial sites has created some new challenges. Most notably, the electrical behavior of these motors differs from that of their less efficient counterparts, with typically higher inrush peaks and locked rotor currents. Standard motor starters and related equipment could therefore be inadequate in some cases.

To help you address these issues, this paper begins with a review of the new standards for high-efficiency motors and the work currently being done by the international standards technical committees to update motor and motor-starter standards. It then continues with a discussion of how the new IE3-class motors affect DOL starting. Finally, it provides guidelines for selecting the most energy-efficient and robust motor starters for IE3 motors.

The Drive for Energy Efficiency

Industrial Motors: A Key Contributor to Consumption and Potential Savings

42%

Factories account for 42% of total worldwide electricity consumption.

2/3

Two thirds of a typical plant's electricity is attributed to motors.

28%

Industrial motors use 28% of all electricity worldwide.

17%

Residential and non-industrial commercial motors account for 17% of electricity consumption.

45%

Motors in all sectors (residential, commercial, industrial) use 45% of all electricity.

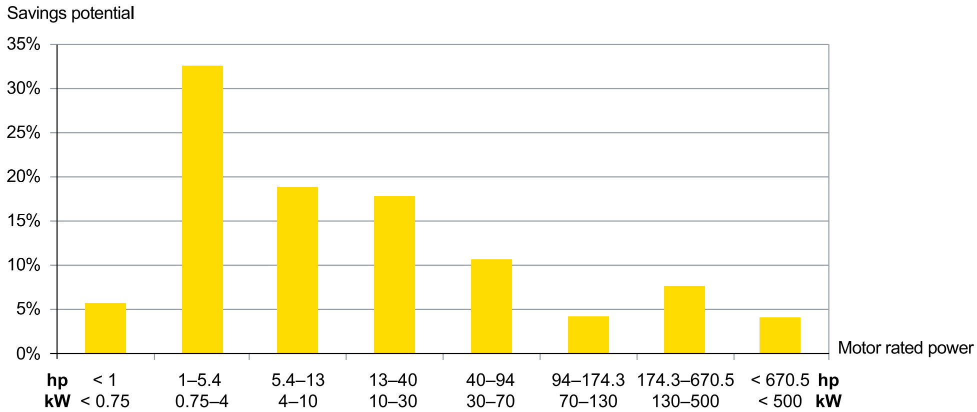
Worldwide demand for energy is expected to double by 2050. At the same time, governments are under pressure to halve their countries' carbon dioxide (CO_2) emissions to head off climate change before it's too late.[1]

If we are to find a solution, we must look beyond measures like turning off the lights when we leave a room and also target the biggest energy consumers. For example, according to the International Energy Agency, electric motors account for 45% of total global electricity consumption, coming in ahead of lighting, a far better-known culprit, which weighs in at just 19%.

Industry is also a major global energy consumer. And the electric motors used in many industrial plants typically consume 65% to 80% of total plant electricity. On a global scale, industrial motors represent 28% of total worldwide electricity consumption. This is no surprise when you consider that an estimated 300 million industrial motors worldwide are running at full speed for extended periods of time.

More efficient industrial motors can have a huge impact on energy consumption and generate substantial cost savings for plants. The German Federal Environmental Agency has estimated that increasing motor efficiency could save 135 billion kWh and 63 million tons of carbon dioxide by 2020 in the EU alone. In the United States, the NEMA Premium® energy efficiency motor program is also expected to save 5,800 gigawatts of electricity and 80 million tons of carbon dioxide over the next ten years.

Figure 1 - Energy-efficient motors have the potential to generate huge savings in the industrial sector.



1. IEA (International Energy Agency)

New Motor Efficiency Standards

The European Union

The European Union's (EU) Ecodesign Directive (Directive 2009/125/EC) provides EU Member States with a framework for their energy-efficiency legislation. Most notably, the Directive requires manufacturers to design energy efficient products.

The incandescent light bulb is perhaps the best-known example: the EU outlawed the energy-hungry bulbs in 2009, spurring the emergence of eco-halogen bubble, LED, and other high-efficiency lamps. The Directive also covers other types of products, from home appliances and electronics to building materials like windows and insulation and–crucially–industrial motors.

What the New EU Regulations and Standards Say

Implementation in the member states will take place through instruments like laws, regulations, and standards, such as regulation EC 640/2009 on ecodesign requirements for electric motors, which came into force in January 2015, and the associated parts of IEC 60034 harmonizing standards for motor ecodesign.

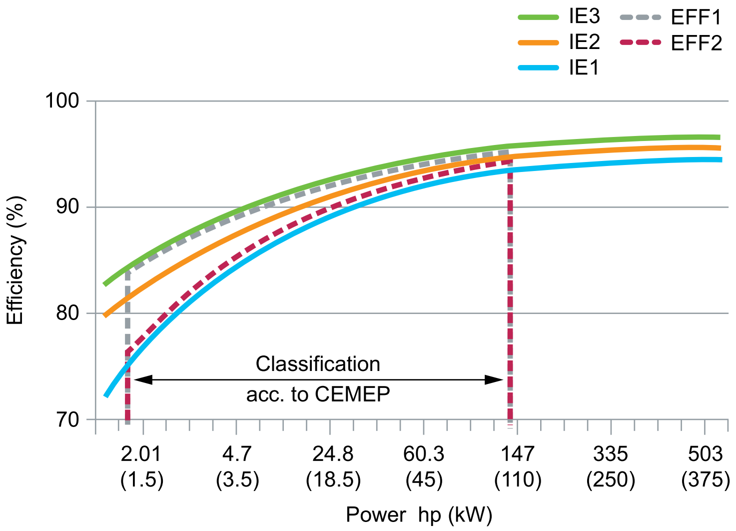
IEC60034-30 sets forth new energy-efficiency classes for single-speed, three-phase, cage-induction motors with two, four, or six poles. According to this standard, motors from 0.75 kW up to 375 kW make up the vast majority of the installed motor base.[2] Therefore, the standard defines efficiency for outputs within this range.

The energy-efficiency classes in the standard are:

- IE1 (standard efficiency)
- IE2 (high efficiency)
- IE3 (premium efficiency), of particular interest in this paper
- IE4 (super premium efficiency), not yet enforced

IE3-class, or premium efficiency motors, are more energy-efficient than their EFF1- and EEF2-rated equivalents. (EFF1, EFF2, and EFF3 were the three classes issued in 1998 by the European Committee of Manufacturers of Electrical Machines and Power systems, or CEMEP, and compliance with the classification was voluntary. The IEC classification replaced this older system.)

Figure 2 - Comparison of IE1, IE2, and IE3 Motors to EFF1 and EFF2 Predecessors



2. International Electrotechnical Commission, 2014

The new classes became mandatory according to the following timeline:

- All motors must be IE2 by June 16, 2011.
- All motors with output between 10.1 and 503 hp (7.5 and 375 kW) must be IE3 by January 1, 2015; or IE2 if a variable speed drive is used.
- All motors with output between 1 and 503 hp (0.75 and 375 kW) must be IE3 by January 1, 2017.

While IE2 motors were still permitted when used with a variable speed drive through 2016, this was not necessarily the most energy-efficient choice. Variable speed drives create significant additional power losses and should be used only when they improve the overall energy efficiency, considering the characteristics of the whole application. Consult the paper at this link for more information about the factors you should consider for choosing the right motor equipment for your needs: *http://www.capiel.eu/data/6685-Capiel-Tryptique-EN2-Version-Web.pdf*.

Exceptions to the European Minimum Energy Performance Standards (MEPS)

When making your choice, it's important to know which types of motors are exempt from the new efficiency regulations. The transport of goods and persons is excluded from the ErP Directives. Therefore specific motors used for lifting, hoisting, etc. are not in the scope of regulation EC 640/2009.

The IEC60034 standard includes only motors rated either duty-type S1 or S3 with a rated cyclic duration factor (CDF) of 80% or higher. CDF is defined as:

$$\text{CDF} = \frac{\text{Total On Times } (t1 + t2 + t3...)}{\text{Cycle Duration } (T)} \times 100\%$$

Table 1 - Determining Whether a Motor is Continuous or Intermittent Duty

S1: Continuous Duty	S3: Intermittent Periodic Duty with CDF > 80%
The motor works at a constant load for enough time to reach temperature equilibrium.	Sequential, identical run and rest cycles with constant load. Temperature equilibrium is never reached. Starting current has little effect on temperature rise.

Motors not meeting these specifications do not need to be IE3 (premium efficiency). In fact, premium efficiency motors are not recommended for intermittent or periodic duty because efficiency gains decrease greatly with frequent motor stops. AC-4 motor utilization categories are not appropriate with IE3 motors since they are not efficient during starting and are not required by the standard for this type of use.

Table 2 - In some instances, IE3 motors are not required or recommended.

IE3 Motor is Required or Recommended if:	IE3 Motor is Not Required or Recommended for:
• Rated voltage U_N is up to 1,000 V. The standard also applies to motors rated for two or more voltages or frequencies. • Rated output P_N is 1–503 hp (0.75–375 kW). • Rating is based on duty type S1 (continuous duty) or S3 (intermittent periodic duty) with a rated CDF of 80% or higher • Motors can operate direct on line • Motors are rated for operating conditions in accordance with IEC 60034–1, Clause 6	• Motors immersed in liquid • Brake motors or motors integrated into a machine (for example, a pump, fan, or compressor) that cannot be tested separately from the machine • Motors made solely for converter operation • Motors used to transport people or goods (lifts, elevators, hoists, and conveyors) • Intermittent-duty motors with rated CDF of under 80%

Efficiency Classification and Efficiency Determination According to IEC Standard

In the last few years, the world-wide development of energy saving motors has led to a multitude of country-related regulations, laws, and standards. This has made it difficult to compare and evaluate the individual products. To create a uniform world-wide base, the new IEC standard 60034-30 was issued. This standard replaces the former "Voluntary Agreement of CEMEP."[3] At the same time, it extends the former scope to 2, 4, and 6 poles and to 1–503 hp (0.75–375 kW).

The marking is according to the classification for type of protection IP (International Protection) with IE (International Efficiency). Only the following are directly excluded:

- Motors rated especially for inverter operation in accordance with IEC 60034-25
- Motors that are completely included in another machine (for example, pumps, fans, and compressors) and that cannot therefore be tested separately

Motors with flanges, feet, or shaft ends that deviate from the mechanical dimensions given in standard IEC 60072-1 are included in IEC 60034-30. Also included are gear and brake motors, and explosion-protected motors complying with IEC 60079 ff.

Table 3 - Efficiency Classifications According to IEC, CEMEP, NEMA, and CSA

IEC/EN 60034-30		Voluntary Agreement of CEMEP	NEMA MG 1 (Tab. 12-11/12)	CSA C390-10 (Tab. 2-5)
Code	**Efficiency Class**	**EFF-Code**	**Efficiency Class**	**Efficiency Class**
IE4[4]	Super Premium	—	Super Premium	Super Premium
IE3	Premium	—	Premium	Premium
IE2	High	EFF1	High	High
IE1	Standard	EFF2	Standard	Standard
None	Below Standard Efficiency	EFF3	—	—

Application of Classifications

The efficiency classification according to IEC 60034-30 is valid for single-speed three-phase asynchronous motors with squirrel-cage rotor and the following specifications:

- Rated voltages up to 1,000 V
- Suitable for operation on a fixed three-phase supply network
- Rated outputs from 1–500 hp (0.75–373 kW)
- 2, 4, or 6 poles
- Rated for continuous duty (S1) or nearly continuous duty (S3) with operation times of 80% or more
- Suitable for the ambient temperatures specified in IEC 60034-1, Chapter 6 (temperature, installation, altitude)

Motors complying with IEC 60034-30 can also be operated with adjustable speed. Because of the increased losses at inverter operation, the rated efficiency can only be stated for equivalent mains operation.

With the introduction of the new efficiency classes, the standard for the determination of efficiencies has changed as well. According to standard IEC/EN 60034-2-1, the additional losses are not generally taken as 0.5% of the input power, but are determined in accordance with IEEE 112. At the same time, the measurement method in IEC 60034-2-1 was harmonized with the U.S. standards. The limit values in IEC 60034-30 conform to the values from NEMA standards.

3. CEMEP: European Committee of Manufacturers of Electrical Machines and Power Electronics
4. From draft IEC 60034-31

Regulations and Standards in the United States

In the United States, NEMA (the National Electrical Manufacturers Association) has rolled out an initiative—similar to what is being seen in Europe—called the NEMA Premium® Motors program, a label equivalent to IE3 premium efficiency. NEMA Premium motors accounted for an estimated 20% of market share in the U.S. in 2015.

High prices and low return on investment are slowing the widespread adoption of these motors. Their design disruption is lower than in Europe, though, due to their savings of 20%—a result of their 60 Hz frequency and their longer NEMA frame size. Consequently, they have a lower rise of inrush current compared to European 50 Hz asynchronous motors.

Table 4 details the current US and Canadian regulations and efficiency requirements.

Table 4 - US and Canadian Motor Efficiency Requirements

US	**Regulation**	10 CFR Part 431: Energy Efficiency Program for Certain Commercial and Industrial Equipment			
	Edition	October 10, 1999	March 23, 2009		
	Policy/Act	EPAct (Energy Policy and Conservation)	EISA (Energy Independence and Security Act)		
	Validity	Expired on 12/18/2010	Started 12/19/2010		
Canada	**Regulation**	CSA-C390-98	CSA-C390-10		
	Validity	Expired on 12/31/2010	Started 1/1/2011		
	Minimum Efficiency	High efficiency (complies with IE2)	Premium efficiency (complies with IE3)	High efficiency (complies with IE2)	Without minimum efficiency
	HP (kW) Range	1–200 (0.75–149)	1–200 (0.75–149)	1–500 (0.75–373)	1–500 (0.75–373)
	Poles	2, 4, 6	2, 4, 6	2, 4, 6, 8	2, 4, 6, 8
	Motor Design	—	• Subtype I	• Subtype II • NEMA Design B > 200 hp (149 kW) • Fire pump motor	• NEMA Design D • Inverter motors • Intermittent duty S3, S4, S5, S6, S8, S9 • Submersible motors • Pole-changing motors

Regulations and Standards in Other Parts of the World

India

The Bureau of Indian Standards (BIS) has released updated energy-efficient motor standards (IS12615:2011) that align with EU regulations: "The efficiency performance values of motors under the scope shall be IE3 only and shall be effective from 31 January 2014. However, when these motors are used with variable frequency drives, they shall conform to IE2 values of efficiency."

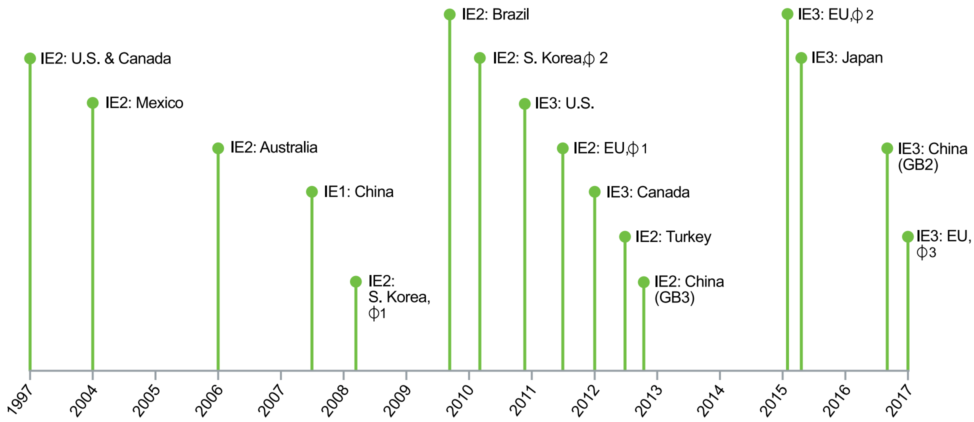
China

The Chinese government published standard GB18613, setting the energy-efficiency requirements for general purpose motors. It was updated in 2012 to more closely align with IEC 60034-30-1.

Other Countries

Australia, Korea, Brazil, Mexico, Taiwan, Costa Rica, Israel, and New Zealand are among the other countries that have taken steps to improve motor efficiency through more stringent regulations.

Figure 3 - Countries are tightening their motor efficiency requirements. (Source: www.eemods15.info)



What You Need to Know About Asynchronous Motors Before You Choose

Robust and reliable, asynchronous (or induction) motors represent 95% of the worldwide installed motor base. Therefore, the protection of these motors is a matter of great importance in a variety of applications.

Direct On Line (DOL) Starting of Induction Motors

Different starting methods can be used for asynchronous motors. The simplest is DOL starting. Depending on the protection level and the components used, a DOL motor starter usually consists of a circuit breaker, a contactor, and an overload relay for protection.

Table 5 - DOL Motor Starter Advantages and Disadvantages

Advantages	Disadvantages
• Simple • Low purchase price • Good starting torque	• May not be suitable for use with high-torque motors • Must be carefully selected to avoid nuisance tripping during starting

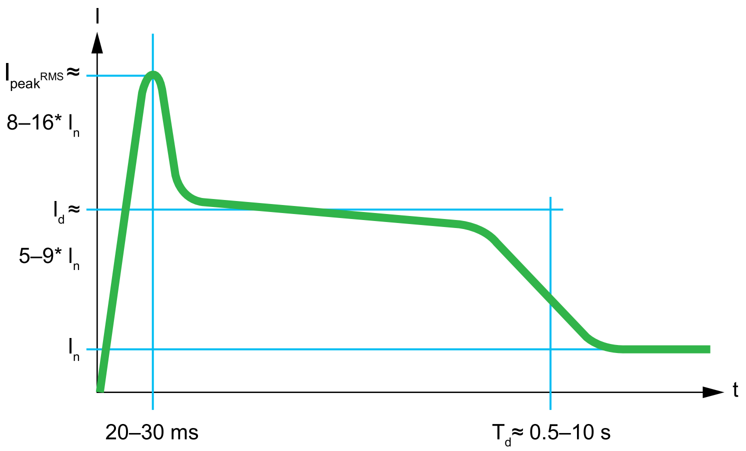
You will find more information about DOL starting of asynchronous motors and their different protections and control methods below. To explore other starting methods, please refer to Schneider Electric's Electrical Installation Wiki: *http://www.electrical-installation.org/enwiki/Asynchronous_motors_(full_page)*.

Inrush Current

High-power asynchronous motors directly connected to the line draw a high start-up current, which is mostly reactive. Figure 4 shows a typical starting RMS current curve for an asynchronous motor in a DOL connection. In general, the motor draws current in three steps:

- During the first 20–30 ms: shortly after starting, a high peak current (inrush) is observed, symbolized here as Ipeak.
- Between inrush and 0.5–10 s (depending on rated power and inertia), a steady-state current called locked rotor current (LRC, but here abbreviated as Id) is seen. The current remains constant while the rotor is rotating but not accelerating. Its duration depends on the motor's load and design.
- After 0.5–10 s: the rotor accelerates and reaches its final speed. The current stabilizes to reach the motor's nominal current (In) at full load.

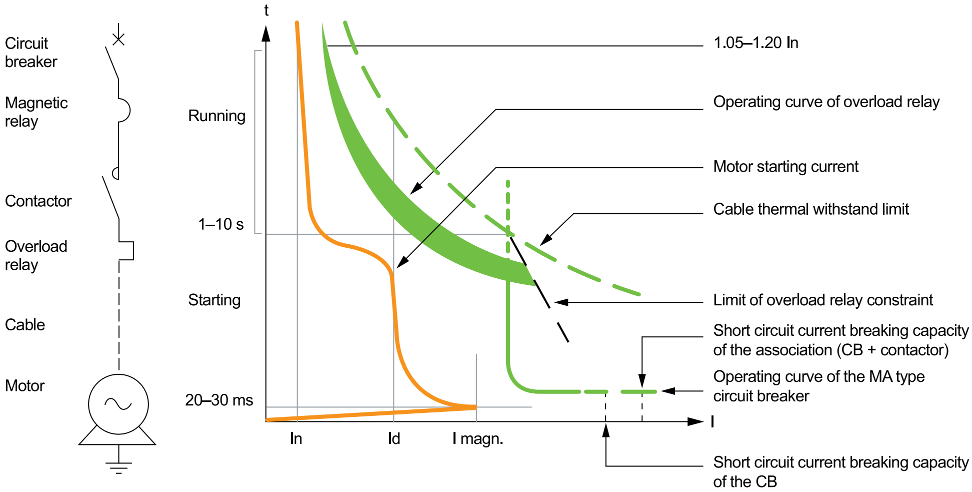
Figure 4 - DOL Starting Current for the Average Induction Motor



Protection for DOL Starters

The most common way of building DOL starters is by combining a circuit breaker, a contactor, and a thermal overload relay (Figure 5). This system offers several advantages. Installation, operation, and maintenance are relatively simple since it is easier to reset components than to replace fuses. And when Type 2 coordination is selected, immediate restarting helps ensure high uptime. The system can be controlled remotely and is compatible with mechanical and electrical interlocks. Motor manufacturers usually provide tables to facilitate the selection of these components.

Figure 5 - Tripping Characteristics of a Circuit Breaker, Contactor, and Overload Relay Protection System



However, before you choose, it's important to understand how premium efficiency motors behave differently during starting than previous generation motors. Most notably, improvements in motor design have resulted in changes to inrush current and locked rotor current. The following section outlines the main changes and explains how they affect your choice of circuit breaker, contactor, and overload relay.

Premium Efficiency Motors

Design Characteristics

The new premium efficiency motors have several new design characteristics compared to previous generation motors:

- Lower stator and rotor resistances
- Longer motor length
- Improved silicon steel and lamination for better magnetization and lower eddy currents
- Reduced air gap for lower magnetic resistance
- Various improvements in rotor design, bearings, and cooling to reduce other losses

As more efficient IE4 motors penetrate the market, the trend toward higher inrush peak and starting current will continue. Table 6 provides typical values. However, due to different design characteristics, large variations exist between one motor and another, even for the same rated power.

Table 6 - Difference in Motor Behavior from IE1 to IE3/IE4 Motors

Parameter	Typical Value for IE1 Motors	Typical Evolution from IE1 Motors to IE3/IE4 Motors
Rated Current $I_{e,rms}$	Depends on rated power	5 to 10% less
LRC = I_d / I_n	Motors < 20.1 hp (15 kW): no more than 6 times I_d / I_n	+10 to +30%
	Motors 20.1–73.7 hp (15–55 kW): no more than 6 times I_d / I_n	+10%
	Motors > 73.7 hp (55 kW): ~7	+4%
Starting time tstart	Depends on torque	Expected to decrease, but the effect is marginal in practice
Inrush current factor $k = I_{peak} / I_d$	1.2 to 1.4	+30 to +50%
Steady-state temperature	Depends on class	Temperature rise decreases and fan size is reduced

Current Load of Premium Efficiency Motors

IE3 motors are more energy efficient than IE2 motors. As shown in Figure 6, IE3 motors have a higher inrush current and a higher starting current. But in full run, they have a lower current consumption than IE2 motors. Figure 6 is a simplified version of Figure 7 based on measurements made on actual motors in our laboratory.

Figure 6 - IE2 and IE3 Motor Efficiency Simplified

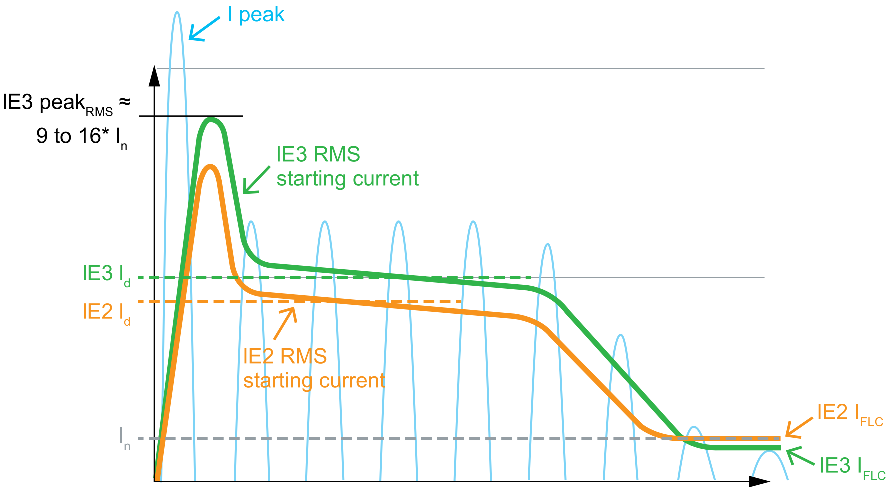
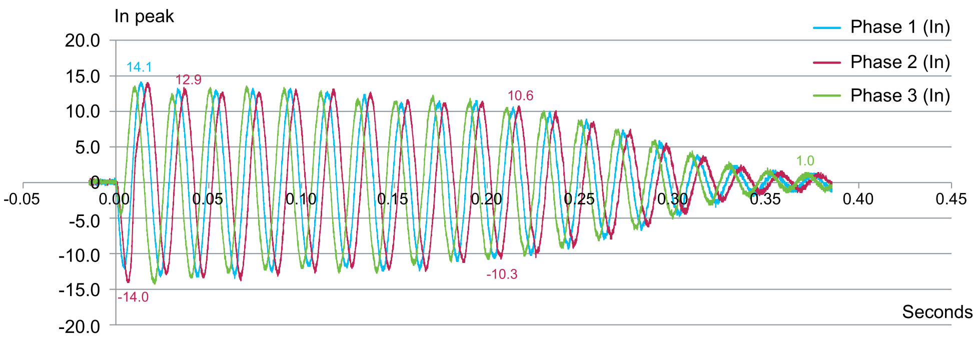


Figure 7 - Motor Efficiency



This higher inrush current has a potential impact on the performance of protection and control products. The locked rotor current (LRC) increases the thermal stress on all devices, risking untimely thermal tripping of circuit breakers and relays. The high peak of the inrush can also lead to circuit breaker nuisance tripping.

Motor manufacturers usually state the LRC as an Id/In ratio. However, it is hard to know in advance how high the initial peak of the inrush will be—important information when selecting the right circuit breakers.

The ratio between the highest inrush peak and the locked rotor current is commonly called the kappa ratio (K). Its order of magnitude is on average between 1.4 and 1.6 for IE3 motors; it can be as high as 2.0 for very high torque according to IEC 60034-12. The kappa ratio is calculated as follows:

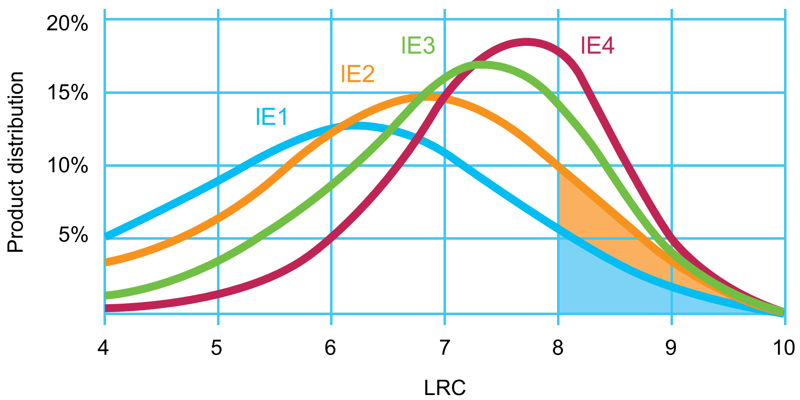
$$K = \frac{\text{Ipeak}}{\text{Locked Rotor Current}} \cong 1.4 \rightarrow 2.0$$

The Influence of Efficiency on Locked Rotor Current

Some motor manufacturers offer super-premium efficiency (IE4) motors following standard IEC 60034-30-1. Depending on the manufacturer, some IE2 motors on the market have an LRC superior to 8*In, similar to the performance achieved by IE3 motors.

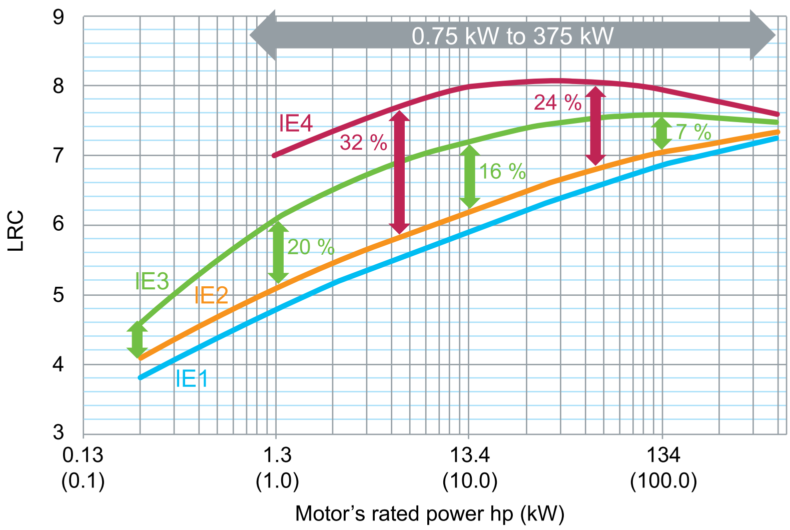
Figure 8 shows the statistical distribution of 50 Hz motors available on the market by stated efficiency (according to manufacturers' catalog information). As efficiency improves, LRC increases. So all components in a motor protection system must be assessed to align with the move toward higher motor efficiency standards. In all cases, the best practice is to follow the motor manufacturer's instructions and recommendations to avoid nuisance tripping and downtime due to higher starting currents.

Figure 8 - Statistical Distribution of LRC According to Motor Manufacturer Catalog Specifications



Expected LRC also depends on the motor's rated power. Figure 9 shows the average LRC of motors with ratings from 0.3–536 hp (0.2–400 kW), depending on motor efficiency. For IE3 and IE4 motors, the range of increase in starting current is from 16–32% for motors rated between 1–134 hp (0.75–100 kW), the most common motor ratings on the market right now.

Figure 9 - LRC and Rated Power



The Influence of the Electrical Installation on Starting Current and Inrush Peak Current

Certain characteristics of the electrical installation can influence the current consumed by the motor during the starting phase. The following are the most relevant ones to consider when using premium efficiency motors:

- Cable length and cross section: a limited cross section (a cable not over-dimensioned for the motor’s In) limits the peak that can run through the cable; this is also true of longer wire lengths.
- Rotor position: when starting the motor, the physical position of the rotor relative to the stator can influence the magnitude of the inrush peak.
- Power factor: a low power factor is caused by any inductive/reactive load and has a negative impact on the whole electrical installation; this problem can be diminished by the use of capacitors.
- Electrical angle
- Motor brand and rating

Selecting the Right Protective Devices

As stated above, the most common way of protecting DOL motors is by combining a circuit breaker, a contactor, and an overload relay.

- A magnetic or thermal-magnetic circuit breaker provides short-circuit protection and a disconnect means to avoid damage to the installation.
- An overload relay detects overload currents and shuts the motor down before overheating has a chance to damage the insulation.
- A contactor controls the motor, providing on/off switching.

Choosing the right devices and knowing which devices to use in combination is crucial.

Circuit Breaker and Overload Relay

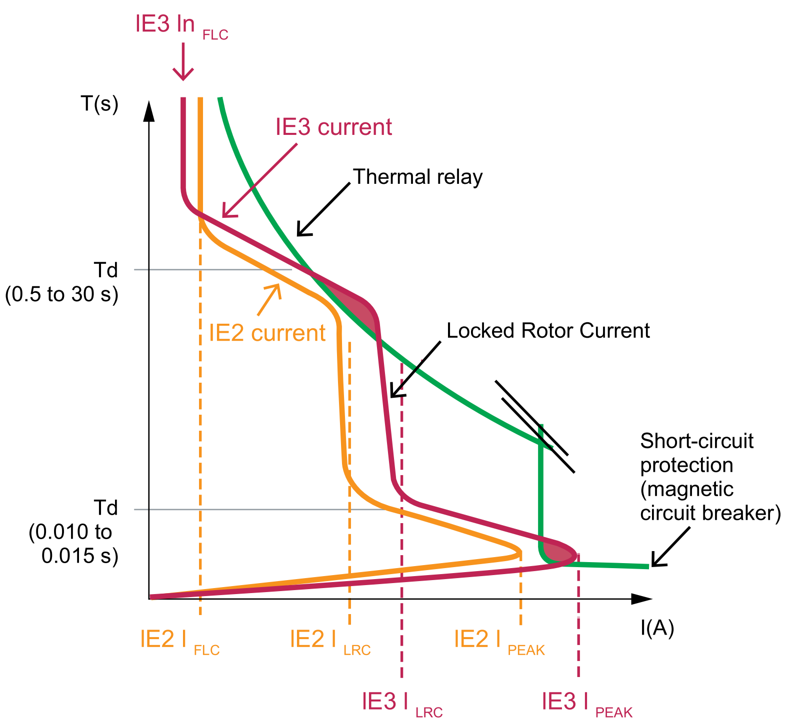
As described above, as starting current increases, so does the risk of nuisance tripping. Figure 10 shows a hypothetical case of a suboptimal circuit breaker and overload relay. The orange curve shows the starting current of an IE2 motor, and the red curve shows the IE3 version. If the motor's starting current and the equipment's threshold are too close together, then using the IE2 configuration for the IE3 motor can result in nuisance tripping and downtime. This depends on the motor technology, the electrical equipment brand, and the correct installation of all electrical wiring, devices, and equipment.

To select the right circuit breaker and overload relay:

- Follow the recommendations from the manufacturer of the protection components.
- Avoid over-dimensioning the cable sections.
- Select a motor starter in accordance with the electrical characteristics stated by the motor manufacturer.
- Verify the coordination of the motor starter components, if they were selected separately (without using recommended coordination tables).

TeSys motor circuit protectors, contactors, and overload relays from Schneider Electric have undergone magnetic, electrical, and thermal endurance testing in laboratory conditions to ensure their compatibility with IE3 motors.

Figure 10 - In the Red Zone: Nuisance Tripping With IE3 Motors



Contactor

A contactor is an electromechanical device designed to switch the current on and off in an electrical circuit. The maximum breaking current of a contactor is often given as a ratio of the nominal current (In). For standard applications, a contactor rated 12 In for closing and 10 In for opening is sufficient. But for IE3 motors, the contactor should be able to make and break the current even during the higher inrush peak at startup to avoid harm to people or equipment.

TeSys D contactors from Schneider Electric can sustain a making and breaking capacity up to the equivalent of 20 In RMS, and are suitable for use with IE3 motors.

Type S NEMA contactors and starters by Square D have been fully tested to meet NEMA standards pertaining to the corresponding FLA and hp ratings of NEMA style motors.

Figure 11 - TeSys D Contactor

Coordinating Products for IEC Markets

Schneider Electric recommends the following combinations of circuit breaker and contactor. Note that upgrading from an IE2 to an IE3 motor does not change the recommended combination.

Motor type	IE2 motor: 7.4 hp (5.5 kW)	IE3 motor: 7.4 hp (5.5 kW)
Circuit breaker and contactor	GV2ME16 + LC1D25	GV2ME16 + LC1D25

These combinations are stated in the TeSys 2016 catalog *MKTED210011EN* and can be used for IE3 motors without restriction.

Coordinating Products for UL and CSA Markets

Schneider Electric offers tested combination ratings and high-fault component ratings for the UL and CSA markets. Upgrading from high efficiency to premium efficiency (or IE2 to IE3) motors does not change product selection.

For tested combination ratings, please refer to UL's “Short Circuit Current Ratings for Combination Motor Controller Components” at this link: *http://industries.ul.com/industrial-systems-and-components/industrial-control-products-and-systems/short-circuit-current-ratings-for-combination-motor-controller-components*.

And for component high-fault short circuit current ratings, please refer to data bulletin 8536DB0901, “Motor Control Solutions for the North American Market,” at this link: *http://www.schneider-electric.us/en/download/document/8536DB0901/*.

Getting Started with TeSys Starters from Schneider Electric

The TeSys motor starter range from Schneider Electric will help you transition to more energy efficient motors with peace of mind. TeSys products are fully compatible with IE3 motors as confirmed in laboratory testing for magnetic, thermal, and electrical endurance. Using TeSys circuit breakers, contactors, and overload relays helps ensure optimal energy efficiency for your installation and compliance with the latest regulations.

You can stay up to date on the latest TeSys news at the following link: *www.schneider-electric.com/tesys*

The Motor Data Calculator app is available to provide quick and easy access to motor data, wire data, and transformer data.

- Easily determine motor FLA and wire sizes
- Product selection included, based on motor size
- From 1/6 to 200 hp (0.12 to 149.2 kW)
- For smartphone and tablet

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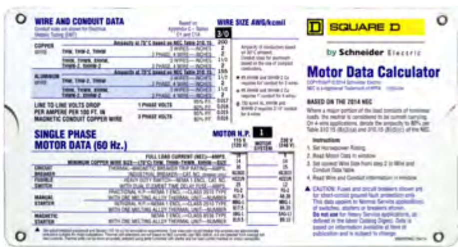

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Glossary

CEMEP: European Committee of Manufacturers of Electrical Machines and Power Electronics

DOL (direct on line) motor starter, also called across the line starter: The simplest type of motor starter. Also includes protection devices and in some cases monitoring.

EISA: Energy Independence and Security Act

EPAct: Energy Policy and Conservation Act

I_d: Starting current

IE3: Premium-efficiency class for single speed motors according to IEC 60034–30.

I_n: Abbreviation for Nominal Current

Inrush Current Peak: A short, high-current transient occurring during the first milliseconds when the motor is started.

I_{Peak}: Abbreviation for Inrush Current Peak

LRC (locked rotor current), also called LRA (locked rotor amperes): The amount of electrical current drawn at the moment the motor is started, but not yet up to speed.

MEPS (Minimum Energy Performance Standard): Local regulation specifying the minimum required energy performance for energy-using products. In Europe, the EU MEPS for direct on line motors is IE3.

NEMA: National Electrical Manufacturers Association.

NEMA Premium: Designation for efficient motors in the NEMA Premium efficiency electric motor program.

OEM: Original equipment manufacturer.

RMS (root mean square): The RMS value of an AC supply is the steady DC equivalent, which would convert electrical energy to thermal energy at the same rate in a given resistance.

VSD: Variable speed drive. Also called VFD (variable frequency drive).

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