

Controlling High Efficiency Motors



Components for IE3 Motors:

- Circuit Breakers
- Contactors
- Starters
- Overload Relays
- Load Switches
- Smart Motor Controllers
- Solid-State Contactors

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Introduction

Over the last decade, significant efforts have been invested in developing standards and regulations to protect the environment, limit our carbon footprint and reduce energy consumption.

With Directive 2009/125/EC, the European Union has established a framework for the integration of environmental aspects into product design. Ecodesign regulations for individual product groups then require manufacturers to reduce the energy consumption of their products by establishing minimum energy efficiency requirements.

New regulations for energy efficiency.

Electric motors are accountable for almost 50 % of the electricity consumption in Europe and for 60 to 70 % of the electrical energy consumption in the industry. For this reason, electric motors were one of the first product groups to be subject to mandatory energy efficiency requirements under the EU Ecodesign Directive. According to the European Commission, Europe could save around 135 TWh of electricity by 2020 – equivalent to the annual electricity consumption of Sweden – if higher efficiency motors were to be utilised. This would mean that over 60 million tonnes of CO₂ emissions would be avoided.

(Source: European Commission - Energy)

Commission Regulation (EC) 640/2009 (as amended by Commission Regulation (EU) 4/2014) sets mandatory efficiency requirements for 2- to 6-pole, single speed, three-phase squirrel cage induction motors rated up to 1000 V, with a power range of 0.75 kW to 375 kW, and on the basis of continuous duty operation.

This regulation specifies that

- From 16 June 2011, motors shall not be less efficient than the IE2 efficiency level.
- From 1 January 2015, motors with a rated output of 7,5-375 kW shall not be less efficient than the IE3 efficiency level or meet the IE2 efficiency level and be equipped with a variable speed drive.
- From 1 January 2017, all motors with a rated output of 0,75-375 kW shall not be less efficient than the IE3 efficiency level or meet the IE2 efficiency level and be equipped with a variable speed drive.

The efficiency levels are specified in the Regulation and are equivalent to the following efficiency classes as defined in harmonized standard EN 60034-30:

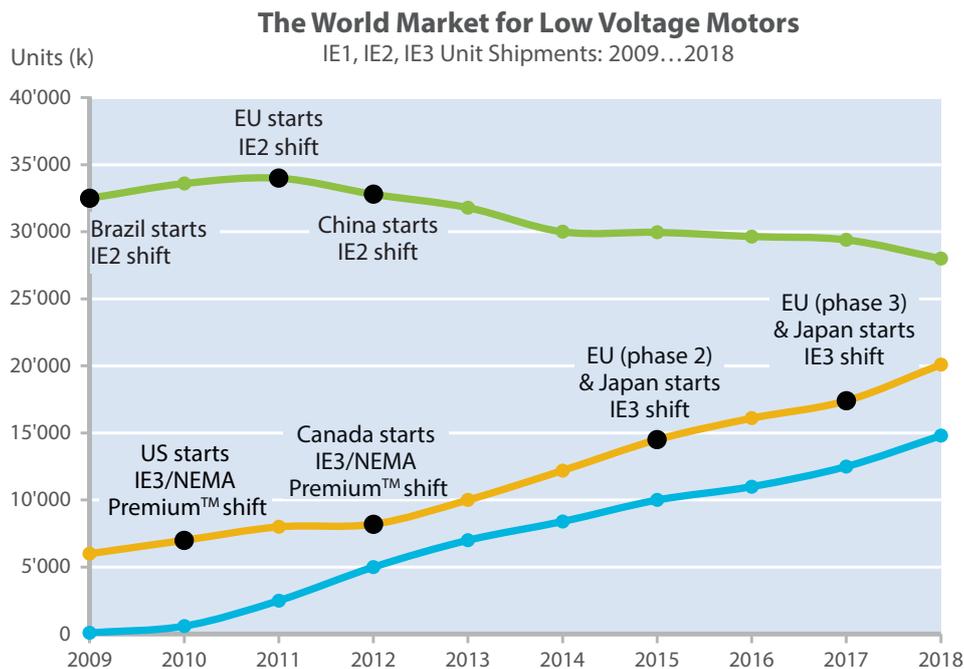
IE1: Standard efficiency

IE2: High efficiency

IE3: Premium efficiency

Market in evolution

According to a study from IHS, the motor market continues to grow at a rate of about 5% per year, and the migration from IE1 motors towards the more efficient types IE2 and IE3 is happening rapidly. Other parts of the world also are going through a similar process, making this evolution a worldwide development.



Source: IHS, Motor Market Update, Motor summit 2014, Zurich/October 2014

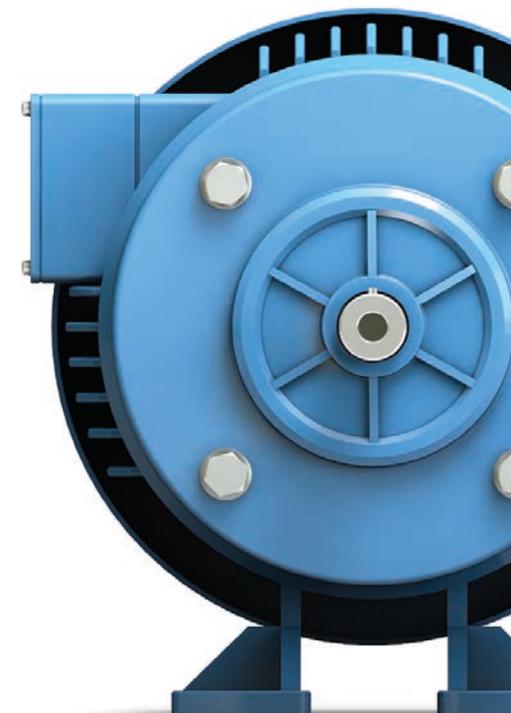
IE3 motor or IE2 with AC Drives

Regulation 640/2009 does still allow IE2 motors to be used when controlled by a variable speed drive. However, whilst there are some applications in which variable speed drives (VSD) are the better alternative, it is also clear that motor starters offer often the most energy efficient solution for fixed speed applications independently from the efficiency class of the motor (IE2/IE3).

Other advantages of motor starters (such as direct-on-line starters, Star Delta starters or soft starters) include:

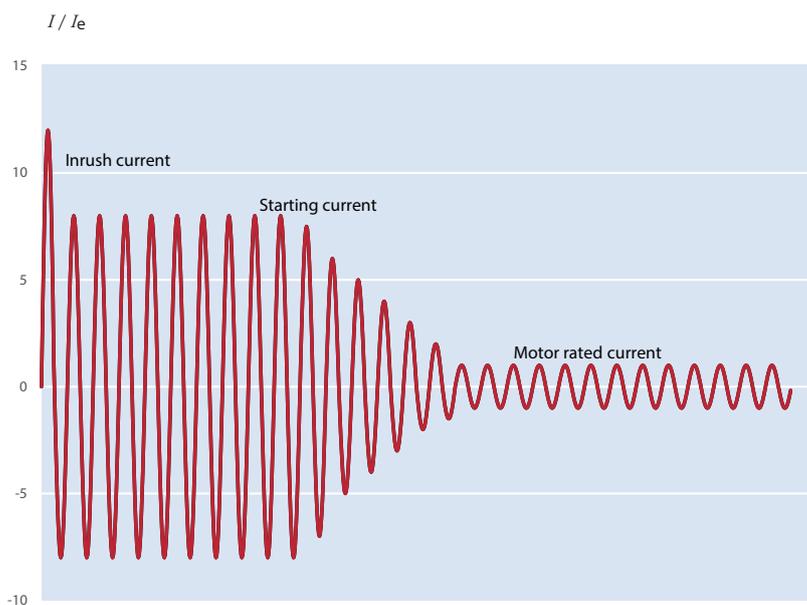
- **Optimal control cabinet design (reduced need for additional cooling and thus lower energy consumption)**
- **Simple implementation**
- **Robust motor system**
- **Lower cost (affordable price, simple installation, operation & maintenance)**

As a consequence, for fixed speed applications, traditional motor starters are often the most preferred solution.



How do IE3 motors differ from lower efficiency motors?

Even if their rated current is lower, higher efficiency motors have a higher inrush current and an increased starting current compared with motors of lower efficiency classes. This behavior can generate nuisance trips or other undesirable effects during starting and needs to be carefully considered when selecting components for IE3 motor applications.



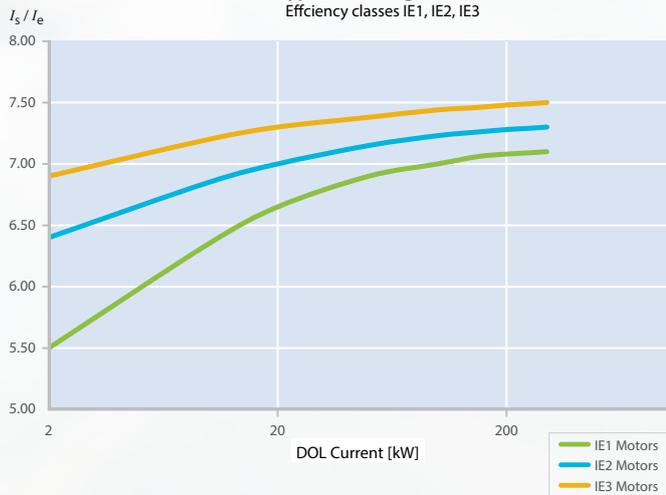
In the picture above, which shows the typical starting phase of an induction motor, three levels of current can be noticed:

- The inrush current with a very high value during the first half cycle. In IE3 motors this value is noticeably higher than in other classes of motor because of the additional saturation effect around the windings which is in turn caused by lower stator resistances.
- The inrush current is followed for a certain period of time by what is normally defined as 'starting current' with a value several times greater than the rated current.
- Finally, the motor progressively reaches its nominal current value, defined as motor rated current.





Typical Starting Current
Efficiency classes IE1, IE2, IE3



Typical Inrush Current
Efficiency classes IE1, IE2, IE3



The specific starting current characteristics of the higher efficiency motors are requiring a special attention. A proper selection of the motor starting and switching components will make sure that the application starts without disturbances nor component damages. In particular, the following risks exist and must be avoided:

- Motor Protection Circuit Breaker & Molded Case Circuit Breakers – risk of nuisance tripping on start
- Contactors – potential tack welding on start
- Overloads – nuisance tripping on Overload especially on high duty cycle applications
- Solid State Contactors – additional heating and potential tripping (Thyristors Overtemperature) especially on high duty cycle applications
- Soft Starters – additional heating and potential tripping (Thyristors Overtemperature or Overload) especially on high duty cycle applications

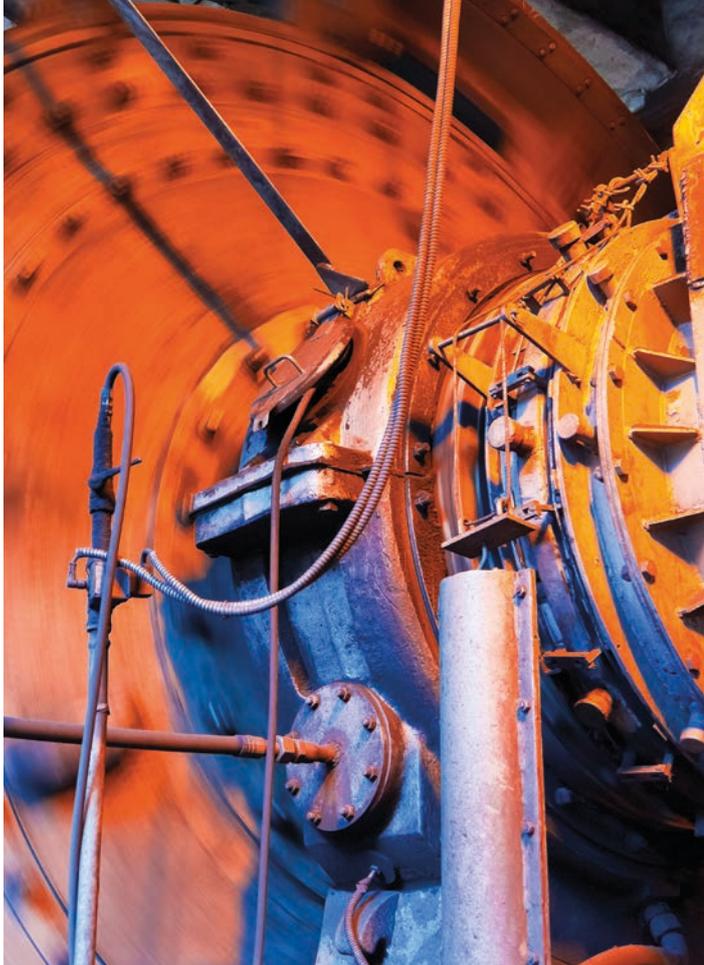
Conclusion

The recent evolution of the regulations for Energy-related Products requires machine builders and engineering companies to use modern energy-efficient motors. The electric characteristics of these motors present some challenges to the manufacturers of motor starting devices.

Due to the higher current drawn by the motors during the starting phase, nuisance tripping can occur, contacts can be damaged and the life of

the devices can be reduced. If a majority of motor starting equipment can still be used with the new IE3 motors, care must be taken that their limits are respected. Electric equipment manufacturers are issuing corresponding guidelines and designers of motor systems must verify the compatibility of motor and starter in their specific applications.

Rockwell Automation offers a broad portfolio of motor starter components that are compatible with IE3 motors.



Description	<ul style="list-style-type: none"> • Motor Protection Circuit Breaker 	<ul style="list-style-type: none"> • Molded Case Circuit Breakers • Molded Case Motor Circuit Protector • Molded Case Motor Protection Circuit Breakers 	<ul style="list-style-type: none"> • Contactors 	<ul style="list-style-type: none"> • Motor Starters 	<ul style="list-style-type: none"> • Bimetal Thermal Overload Relay
Bulletin number	140M-C 140M-D 140M-F	140G 140MG 140MG	100-K 100-C 100-D 100-G	190-S, 191-S 190-E, 191-E 103, 105, 107, 109	193-K 193-T1
Current range	0.16...2.5 A 2.5...32 A 25...45 A	15...3000 A 3...1200 A 25...150 A	5...12 A 9...97 A 115...860 A 550...1200 A	0.1...45 A 0.1...25 A	0.1...12.5 A 0.1...90 A



Description	• Electronic Overload Relay	• Control and Load Switches	• Solid-State Contactors	• Soft Starters	• AC Drives
Bulletin number	193-ED 193-EE 193-EC 193-ESM	194E 194R 194L	156-B	150-C 150-F 150-S	All PowerFlex AC drives
Current range	0.1...45 A 0.1...800 A 0.4...5000 A 0.5...200 A	16...100 A 30...800 A 12...40 A	20...32 A	3...480 A 5...1250 A 90...520 A	0.2 kW...1.5 MW



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