Grundfos white paper about IE5

For good reasons, the attention has turned to look at the complete system when classifying the most energy-saving solution. Grundfos, a world-leading pump manufacturer with own production of motors, has now extended the IE5 motor range of MGE motors with integrated frequency converter to 11kW.

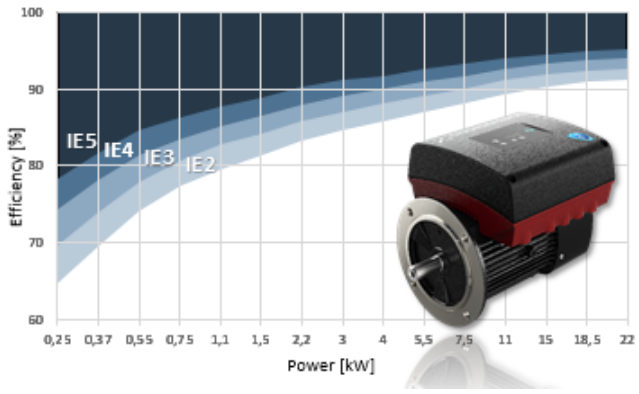
This document is intended to provide information on the new standards EN 50598-2 and IEC/TS 60034-30-2 relevant for the MGE motors.

Relevant Standards and Technical specifications:

Standard	Status
IEC 60034-30-1 Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code)	Approved
IEC 60034-2-1 Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)	Approved
IEC 60034-30-2 IEC 60034-30-2 TS Ed.1: Rotating electrical machines – Part 30-2: Efficiency classes of variable speed AC motors (IE-code)	Approved
IEC 60034-2-3 Rotating electrical machines – Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC induction motors	Pending
EN 50598-2 Ecodesign for power drive systems, motor starters, power electronics & their driven applications – Part 2: Energy efficiency indicators for power drive systems and motor starters	Approved

The standard IEC 60034-30-1 defines the commonly known IE classifications from IE1 to IE4, where the efficiency of the motor must exceed a defined level to meet a certain class. Motors classified according to this standard must be single-speed electric motors that are rated for operation on a sinusoidal voltage supply. In other words, capable of operation either by frequency converter or direct-on-line.

Grundfos has with the MGE motors long believed in the most efficient motor technology and therefore developed an exceptionally efficient motor based on the permanent-magnet synchronous motor (PMSM)



*"the losses in an IE5 motor is more than 30% lower than the IE3, this alone reduces the energy consumption by **10%** with a typical pump profile"*

technology. This motor exceeded the IE4 level (according to IEC 60034-30-1) including the losses from the frequency converter – and now we can mark these motors IE5 that currently is the highest efficiency level worldwide for electrical motors.

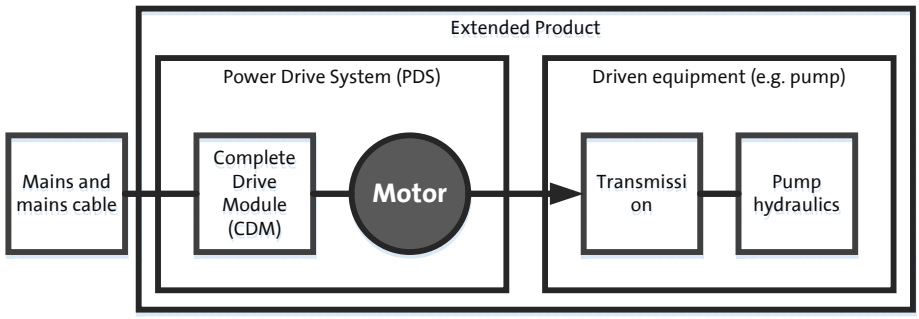
The recently approved IEC 60034-30-2 defines efficiency classes for variable speed AC motors not covered in IEC 60034-30-1, including the PMSM and synchronous reluctance motors that must be controlled by a frequency converter. This new standard also extends to an IE5 level – Grundfos motors among the first IE5 motors on the market.

Highest MEPS (Minimum Efficiency Performance Standard) around the world is IE3 effective in Europe January 1st, 2017 and Premium Efficiency effective in US from June, 2016. With this IE5 marking, Grundfos again "Reach for Higher Performance".

The full load efficiency levels are identical between the two standards 60034-30-1 and -2. A user should expect that the losses in the IE5 motor is more than 30% lower than the IE3, this alone reduces the energy consumption by **10%** with a typical pump profile in the Extended Product.

The European Standard EN50598-2 defines the IE classifications for power drive systems and IES classifications IES0 to IES2 for the complete motor system, containing both motors and frequency converters.

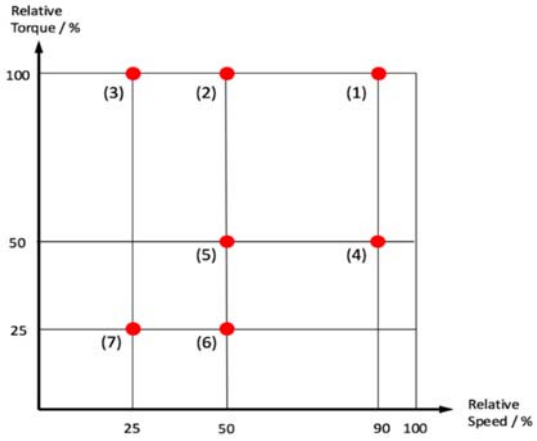
Important abbreviations
IE class – International Efficiency (efficiency classification of an electric motor)
IES class - International Efficiency of Systems (efficiency classification of a drive system, i.e. of a PDS)
PDS – Power Drive System (Drive system comprising CDM and motor, including the motor cable)
CDM – Complete Drive Module (Complete frequency converter with all components such as infeed,
input and output filters, etc.)
EEI – Energy Efficiency Index (energy efficiency of an Extended Product Approach, e.g. a pump drive with a defined load and operation profile)



What's next ? The Extended Product Approach (EPA)

It's worth to mention that the standard IEC 60034-2-3 specifying the test methods for determining losses and efficiency of motors covered by IEC 60034-30-2 has not been approved. Grundfos has tested according to the draft and documented PDS efficiency available.

However, the Extended Product Approach (EPA) is in the works for pump applications and is a methodology to calculate the Energy Efficiency Index (EEI), which incorporates load profiles and control method. The EPA is not necessarily using the energy-optimal operating conditions, but comparable between Extended Products (EP).



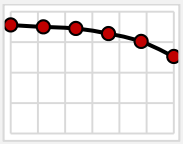
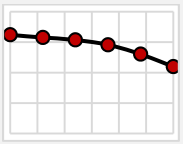
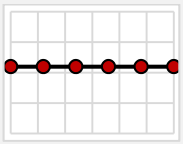
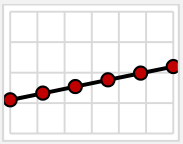
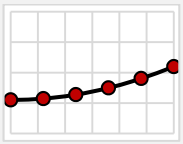
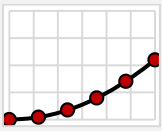
"Grundfos FINS goes beyond and further optimizes energy savings up to even 70%"

In IEC 60034-2-3 are proposals to determine the motor losses at any load point (torque, speed) based on measurements of losses at seven standardized load points as foundation for the EEI calculations.

This becomes relevant when the outstanding part-load efficiency improvements delivered by the new PMSM motors used in MGE together with world-class functionalities Grundfos iSOLUTIONS goes beyond and further optimizes energy savings up to even **70%** compared to unregulated standard pumps with IE3 motors.

The part-load efficiency and the Grundfos iSOLUTIONS way of thinking are illustrated below with the resulting annual savings in an Industrial Cooling application.

It also illustrates how an uncontrolled fixed speed pump not always can deliver the optimal duty point, and are consequently oversized. In this example, a 3600rpm variable speed pump can displace a larger fixed speed pump with 2-pole 50Hz motor.

CONTROL MODE		UN-CONTROLLED	MAXIMUM SPEED	CONSTANT PRESSURE	PROPORTIONAL PRESSURE	QUADRATIC PRESSURE	DIRECT TEMPERATURE
QH							
PUMP		CR20-6	CRE15-4	CRE15-4	CRE15-4	CRE15-4	CRE15-4
OPERATING HOURS							
Flow	20%	660 hours	660 hours	660 hours	660 hours	660 hours	660 hours
	40%	880 hours	880 hours	880 hours	880 hours	880 hours	880 hours
	60%	330 hours	330 hours	330 hours	330 hours	330 hours	330 hours
	80%	220 hours	220 hours	220 hours	220 hours	220 hours	220 hours
	100%	110 hours	110 hours	110 hours	110 hours	110 hours	110 hours
ANNUAL CONSUMPTION		9.158 kWh	8.243 kWh	5.992 kWh	4.408 kWh	3.845 kWh	2.021 kWh
INDEX		111	100	73	53	47	25
ANNUAL SAVINGS		-	-	**270 EUR** (27%)	**460 EUR** (47%)	**528 EUR** (53%)	**747 EUR** (75%)

Our assumptions for the calculations:

- Operating 220 days per year, 10 hours per day.
- Variable flow profile with same annual hours for each control mode to accomplish same return temperature of heat exchanger.
- Fixed speed pump is IE3 and variable speed pump is IE5.
- Energy cost 0.12 EUR/kWh.