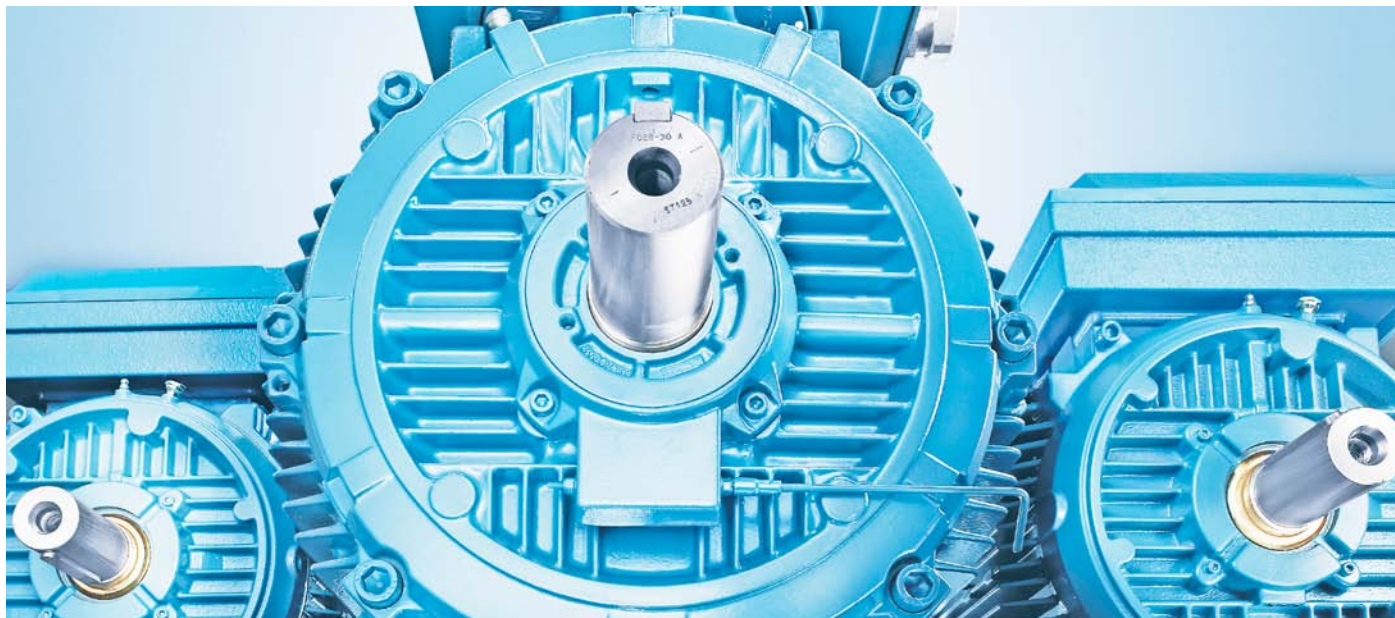


Technical note IEC 60034-2-1 standard on efficiency measurement methods for low voltage AC motors.



The International Electrotechnical Commission (IEC) has introduced a new standard IEC/EN 60034-2-1: 2007. This standard cancels and replaces the previous one IEC 60034-2: 1996. IEC/EN 60034-2-1, which came into force in September 2007, introduces new rules concerning the testing methods to be used for determining losses and efficiency. The resulting efficiency values differ from those obtained under the previous IEC testing standard, IEC 60034-2: 1996.

How is motor efficiency measured?

The efficiency of a motor is defined as the ratio of output (mechanical) power to input (electrical) power. It can be measured or determined directly or indirectly.

Direct measurement involves measuring the input power on the basis of the voltage and current supplied, and the output power based on the rotational speed and torque.

Indirect measurement involves measuring the input power and calculating the output power on the basis of the losses within the motor.

Motor losses can be split into five major areas:

- copper losses
- iron losses
- rotor losses
- friction and windage losses
- additional load losses (P_{LL})

Of these, the first four types of loss can be determined from input power, voltage, current, rotational speed and torque. Additional load losses (P_{LL}) are much more difficult to determine, IEC/EN 60034-2-1 therefore specifies different methods of determining P_{LL} which involve low, medium or high uncertainty.

IEC60034-30 stipulates, however, that for motors in efficiency classes IE2 and IE3 only low uncertainty methods are acceptable. This requirement is met by the determination of P_{LL} from residual losses measured.

How do the efficiency figures differ between IEC 60034-2: 1996 and IEC 60034-2-1: 2007

The table below shows examples of how the efficiency figures differ under the old and new standards for three different

sizes of motor. The rated current stamped on the motor rating plate will be slightly higher to comply with the new efficiency testing standard.

Rated output power	IEC/EN 60034-2: 1996	IEC 60034-2-1: 2007-09
7.5 kW, 2-pole motor	88.4%	87.9%
11 kW, 4-pole motor	90.9%	90.3%
160 kW, 4-pole motor	96.0%	95.4%

How has the IEC/EN 60034-2-1: 2007 efficiency testing standard changed measurement methods?

Efficiency testing standard IEC/EN 60034-2: 1996	Efficiency testing standard IEC 60034-2-1: 2007-09
Direct method	Direct method
Indirect method: – P_{LL} estimated at 0.5% of input power at rated load	Indirect method: – P_{LL} determined from measurement – P_{LL} estimated at 2.5% - 0.5% of input power at rated load – Eh star - alternative indirect method with mathematical calculation of P_{LL}
Winding losses in stator and rotor determined at 95°C.	Winding losses in stator and rotor determined at [25°C + temperature rise measured]

The indirect method based on P_{LL} determined from measurements is used in the USA and Canada, where it is required under the IEEE 112-B (2004) and CSA 390-98 (Reaffirmed 2005) standards. It is likely to be much more widely used under the IEC60034-2-1: 2007 standard.

P_{LL} determined on the basis of the input power of the motor (0.5%) was widely used by manufacturers under IEC 60034-2: 1996. However, the rules concerning the estimation of P_{LL} in the indirect measurement method have been made much more rigorous under the new standard and the new values are now taking into account the actual measured losses. The new standard also introduces new indirect measurement method options:

- P_{LL} determined from measurement.
- P_{LL} estimated at 2.5% - 0.5% of input power at rated load.
- Eh star: P_{LL} losses calculated by mathematical means.

How can motor users identify which measuring method has been used?

Manufacturers can select which of the measuring methods they apply. The motor documentation must state which method was used.

Please note that efficiency values provided by different motor manufacturers are comparable only if the same measuring method has been used.

How does ABB apply the new standard?

Under the efficiency testing standard (IEC 60034-2-1: 2007),

- ABB has calculated efficiency values according to indirect method, with additional losses determined from measurement, which is the preferred low uncertainty method outlined in the standard.
- ABB has the equipment needed to perform the testing.
- ABB provides efficiency values according to IEC/EN 60034-2-1: 2007 and publish the values in the printed technical catalogs.

Standard IEC 60034-30, published October, 2008 defines three IE (International Efficiency) classes of single-speed, three-phase, cage induction motors. The efficiency classes are based on the testing methods specified in IEC 60034-2-1: 2007.

For more information please contact:
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Key to abbreviations:

IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
CSA	Canadian Standards Association
EN	European Norm
P_{LL}	Additional Load Losses