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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Rotating electrical machines – Part 12: Starting performance of single-speed three-phase cage induction motors

Machines électriques tournantes – Partie 12: Caractéristiques de démarrage des moteurs triphasés à induction à cage à une seule vitesse

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FOREWORD

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International Standard IEC 60034-12 has been prepared by IEC technical committee 2: Rotating machinery.

This consolidated version of IEC 60034-12 consists of the second edition (2002) [documents 2/1187/FDIS and 2/1199/RVD] and its amendment 1 (2007) [documents 2/1433/FDIS and 2/1446/RVD].

The technical content is therefore identical to the base edition and its amendment(s) and has been prepared for user convenience.

It bears the edition number 2.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

ROTATING ELECTRICAL MACHINES –

Part 12: Starting performance of single-speed three-phase cage induction motors

1 Scope

This International standard specifies the parameters for four designs of starting performance of single-speed three-phase 50 Hz or 60 Hz cage induction motors in accordance with IEC 60034-1 that:

- have a rated voltage up to 1 000 V;
- are intended for direct-on-line or star-delta starting;
- are rated on the basis of duty type S1;
- are constructed to any degree of protection.

The standard also applies to dual voltage motors provided that the flux saturation level is the same for both voltages and to motors having type of protection 'e – increased safety' with temperature classes T1 to T3 complying with IEC 60079-0 and IEC 60079-7.

NOTE 1 It is not expected that all manufacturers will produce machines for all four designs. The selection of any specific design in accordance with this standard will be a matter of agreement between the manufacturer and the purchaser.

NOTE 2 Designs other than the four specified may be necessary for particular applications.

NOTE 3 The values of torque and apparent power given in this standard are limiting values (that is, minimum or maximum without tolerance), but it should be noted that values given in manufacturers' catalogues may include tolerances in accordance with IEC 60034-1.

NOTE 4 The values tabled for locked rotor apparent power are based on r.m.s. symmetrical steady state locked rotor currents; at motor switch on there will be a one-half cycle asymmetrical instantaneous peak current which may range from 1,8 to 2,8 times the steady state value. The current peak and decay time are a function of the motor design and switching angle.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60079-0, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-7, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety 'e'*

3 Definitions

For the purposes of this part of IEC 60034, the following definitions apply.

3.1
rated torque (T_N)
the torque the motor develops at its shaft end at rated output and speed
[IEV 411-48-05]

3.2
locked-rotor torque (T_l)
the smallest measured torque the motor develops at its shaft end with the rotor locked, over all its angular positions, at rated voltage and frequency
[IEV 411-48-06]

3.3
pull-up torque (T_u)
the smallest steady-state asynchronous torque which the motor develops between zero speed and the speed which corresponds to the breakdown torque, when the motor is supplied at the rated voltage and frequency.

This definition does not apply to those motors of which the torque continually decreases with increase in speed.

NOTE In addition to the steady-state asynchronous torques, harmonic synchronous torques, which are a function of rotor load angle, will be present at specific speeds. At such speeds, the accelerating torque may be negative for some rotor load angles. Experience and calculation show this to be an unstable operating condition and therefore harmonic synchronous torques do not prevent motor acceleration and are excluded from this definition.

3.4
breakdown torque (T_b)
the maximum steady-state asynchronous torque which the motor develops without an abrupt drop in speed, when the motor is supplied at the rated voltage and frequency.

This definition does not apply to those motors of which the torque continually decreases with increase in speed.

3.5
rated output (P_N)
the value of the output included in the rating

3.6
locked rotor apparent power (S_l)
the apparent power input with the motor held at rest at rated voltage and frequency

4 Symbols

Symbol	Quantity
J	External inertia
p	Number of pole pairs
P_N	Rated output
S_l	Locked rotor apparent power
T_N	Rated torque
T_l	Locked rotor torque
T_u	Pull-up torque
T_b	Breakdown torque

5 Designation

5.1 General

Motors designed according to this standard are classified according to subclauses 5.2 to 5.5.

5.2 Design N

Normal starting torque three-phase cage induction motors intended for direct-on-line starting, having 2, 4, 6 or 8 poles and rated from 0,4 kW to 1 600 kW.

5.3 Design NY

Motors similar to design N, but intended for star-delta starting. For these motors in star-connection, minimum values for T_l and T_u are 25 % of the values of design N, see table 1.

5.4 Design H

High starting torque three-phase cage induction motors with 4, 6 or 8 poles, intended for direct-online starting, and rated from 0,4 kW to 160 kW at a frequency of 60 Hz.

5.5 Design HY

Motors similar to design H but intended for star-delta starting. For these motors in star-connection, minimum values for T_l and T_u are 25 % of the values of design H, see table 4.

6 Design N requirements

6.1 Torque characteristics

The starting torque is represented by three characteristic features. These features shall be in accordance with the appropriate values given in table 1 or table 5. The values in table 1 and table 5 are minimum values at rated voltage. Higher values are allowed.

The motor torque at any speed between zero and that at which breakdown torque occurs shall be not less than 1,3 times the torque obtained from a curve varying as the square of the speed and being equal to rated torque at rated speed. However, for 2-pole motors with type of protection 'e – increased safety' having a rated output greater than 100 kW, the motor torque at any speed between zero and that at which breakdown torque occurs shall not be less than 1,3 times the torque obtained from a curve varying as the square of the speed and being equal to 70 % rated torque at rated speed. For motors with type of protection 'e', the three characteristic torques shall be in accordance with the appropriate values given in table 5.

NOTE The factor 1,3 has been chosen with regard to an undervoltage of 10 % in relation to the rated voltage at the motor terminals during the acceleration period.

6.2 Locked rotor apparent power

The locked rotor apparent power shall be not greater than the appropriate value given in table 2 or table 6. The values given in table 2 and table 6 are independent of the number of poles and are maximum values at rated voltage. For motors with type of protection 'e', locked rotor apparent power shall be in accordance with the appropriate values given in table 6.

6.3 Starting requirements

Motors shall be capable of withstanding two starts in succession (coasting to rest between starts) from cold conditions and one start from hot after running at rated conditions. The retarding torque due to the driven load will be in each case proportional to the square of the speed and equal to the rated torque at rated speed with the external inertia given in table 3 or table 7.

In each case, a further start is permissible only if the motor temperature before starting does not exceed the steady temperature at rated load. However, for 2-pole motors with type of protection 'e – increased safety' having a rated output greater than 100 kW, the retarding torque due to the driven load is proportional to the square of the speed and equal to 70 % rated torque at rated speed, with the external inertia given in table 7. After this starting, load with rated torque is possible.

NOTE It should be recognized that the number of starts should be minimized since these affect the life of the motor.

7 Design NY starting requirements

The starting requirements are as for design N. In addition, however, a reduced retarding torque is necessary as the starting torque in ‘star connection’ may be insufficient to accelerate some loads to an acceptable speed.

NOTE It should be recognized that the number of starts should be minimized since these affect the life of the motor.

8 Design H requirements

8.1 Starting torque

The starting torque is represented by three characteristic features. These featurest shall be in accordance with the appropriate values given in table 4. These values are minimum values at rated voltage. Higher values are allowed.

8.2 Locked rotor apparent power

The locked rotor apparent power shall be not greater than the appropriate value given in table 2. The values in table 2 are independent of the number of poles and are maximum values at rated voltage.

8.3 Starting requirements

Motors shall be capable of withstanding two starts in succession (coasting to rest between starts) from cold conditions, and one start from hot after running at rated conditions. The retarding torque due to the driven load is assumed to be constant and equal to rated torque, independent of speed, with an external inertia of 50 % of the values given in table 3.

In each case, a further start is permissible only if the motor temperature before starting does not exceed the steady temperature at rated load.

NOTE It should be recognized that the number of starts should be minimized since these affect the life of the motor.