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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Road vehicles — Starter motors — Test methods and general requirements

Véhicules routiers — Démarreurs — Méthodes d'essai et conditions générales

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Foreword

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International Standard ISO 8856 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

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Road vehicles — Starter motors — Test methods and general requirements

1 Scope and field of application

This International Standard lays down test methods and general requirements for the determination of the electrical characteristic data of starter motors.

It applies to d.c. starter motors mounted on internal combustion engines for road vehicles.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 nominal power: As defined by the starter motor manufacturer; it corresponds to the maximum power output when tested in accordance with this International Standard.

2.2 power output: Power derived from measurements of torque and speed.

2.3 power supply: Battery or simulator which delivers a voltage characteristic as defined in this International Standard.

2.4 voltage/current characteristic of power supply: In the voltage/current diagram, the straight line directed downwards. The voltage values are taken at the starter motor terminals.

NOTE — The characteristic in the voltage/current diagram can be determined by:

a) two pairs of values U_1, I_1 and U_2, I_2;

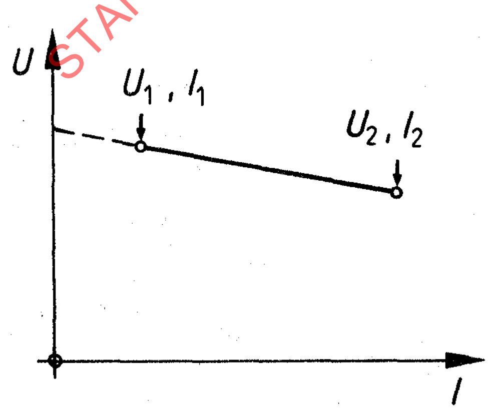

Figure 1 — Voltage/current characteristic of starter motor power supply

b) one pair of values U, I and the internal resistance of the starter motor power supply;

c) one pair of values U, I and the slope mV/A.

2.5 internal resistance of the starter motor: Value of the terminal voltage divided by the starter motor current draw with the armature shaft locked (no rotation).

3 Test conditions

3.1 Temperature and time

Tests shall be carried out at an ambient temperature of 23 ± 5 °C.

3.1.1 Test method A

Time for single point measurements: 3 s.

Starter motor at ambient temperature of 23 ± 5 °C.

3.1.2 Test method B

Total test time: 10 s.

a) Starter motor at ambient temperature of 23 ± 5 °C, or

b) to avoid a need for temperature correction, the starter motor preconditioned at 20 ± 0,5 °C.

3.2 Accuracy of measurement

The overall capability of the test equipment shall enable the parameters to be measured within the tolerances shown in table 1.

Table 1 — Measurement accuracy

Parameter	Accuracy %
Current	± 1
Voltage	± 1
Rotational frequency	± 2
Torque	± 2

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3.3 Voltage/current characteristic of starter motor power supply

The selection of voltage/current characteristic shall be taken from table 2, shall not exceed the recommendations of the starter motor manufacturer, and shall meet the battery discharge capability as agreed between the starter motor manufacturer and the vehicle manufacturer.

Table 2 — Voltage/current characteristic of starter motor power supply

Nominal voltage	Pair of values				
V	U_1 V	I_1 A	U_2 V	I_2[1)] A	I_2[2)] A
				250	
				300	300
				350	
				400	
				450	
				500	
				550	
12	12	0	6	600	600
				800	
				900	900
				1 000	
				1 200	1 200
				1 500	1 500
				1 700	
				3 000	
				500	
				600	600
				800	
				900	900
24	24	0	12	1 000	
				1 200	1 200
				1 500	1 500
				1 700	
				2 000	
				2 400	

1) Extended list.
2) Short list.

3.4 Number of tests

In order to ensure uniform functioning of the new starter motors under test, the test shall be repeated three times : the performance recorded shall be the last of these.

4 Test benches

The following two types of test bench, as shown in figures 2 and 3, can be applied.

NOTE — Geared and non-geared test benches produce different apparent power and this should be taken into consideration, particularly when testing small power starter motors.

4.1 Type 1

The test bench in figure 2 (type 1) allows performance measurements to be established by engaging the pinion with a ring-gear. The backlash between the pinion and the ring-gear teeth shall be in accordance with the starter motor manufacturer's recommendations.

4.2 Type 2

The test bench in figure 3 (type 2) permits direct starter motor measurement at the armature shaft.

The starter motor shall be coupled to the test device coaxially through a suitable coupling. The starter motor end bracket may be replaced by a special bracket with bearing to permit coupling to the starter motor shaft.

5 Procedure

5.1 Test methods

One of the following two test methods, A or B, may be applied to measure performance data.

5.1.1 Method A — Discrete point method

Run the starter motor at various discrete torque loads and record the torque, current, voltage and rotational frequency at each of these discrete points.

Enough points shall be recorded to develop a curve which shall be plotted in accordance with this International Standard (see figure 4).

After each point, the starter motor shall be cooled down to ambient temperature (see 3.1.1).

5.1.2 Method B — Continuous mode method

Operate the starter motor in a continuous mode, increase the torque load (until the stall point, if required) while torque, current, voltage and rotational frequency are automatically recorded.

5.2 Measurement correction

5.2.1 Correction to reference temperature of 20 °C

In the case where the starter motor temperature is not 20 ± 0,5 °C [see 3.1.1 and 3.1.2 a)], a correction of rotational frequency and torque may be necessary (depending upon the type of field system used).

5.2.2 Correction of torque

5.2.2.1 Correction of torque with inertia

Torque measurement is recorded as either a frame reaction or as taken at the torque loading point.

In the second case the following corrections apply.

a) For a type 1 test bench

Correction shall be made for pinion and ring-gear efficiency. (This type of test bench produces smaller torques than a type 2 test bench.)

b) For test method B

Use the following correction for torque, M, for armature deceleration:

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$$M = M_{\text{measured}} - M_{\text{correction}} \qquad \dots (1)$$

where

$$M_{\text{correction}} = \frac{\pi \times \Delta n}{30 \times \Delta t} \times (J_{br} + J_a)$$

in which

Δn is the rotational frequency difference between two braking points expressed in minutes to the power minus one;

Δt is the time difference between two braking points expressed in seconds;

J_{br} is the moment of inertia of the measuring device expressed in kilogram square metres;

J_a is the moment of inertia of armature and other revolving parts expressed in kilogram square metres.

For starter motors with built-in reduction gear, the moment of inertia of the armature shall be referred to the pinion shaft.

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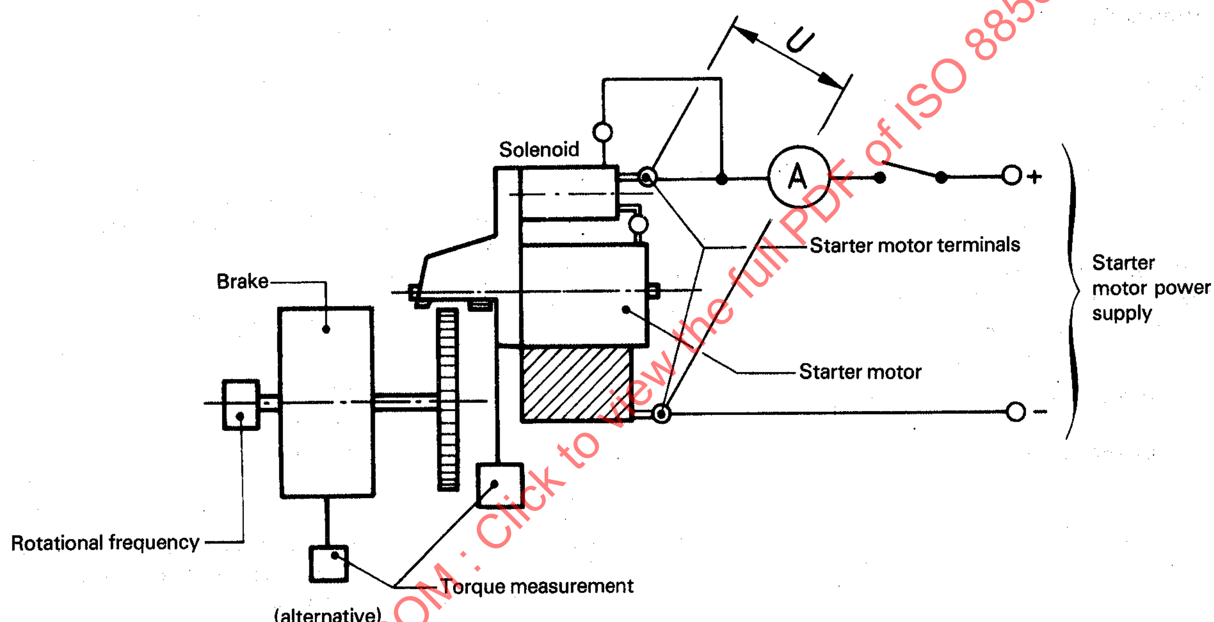

Figure 2 — Type 1 test bench

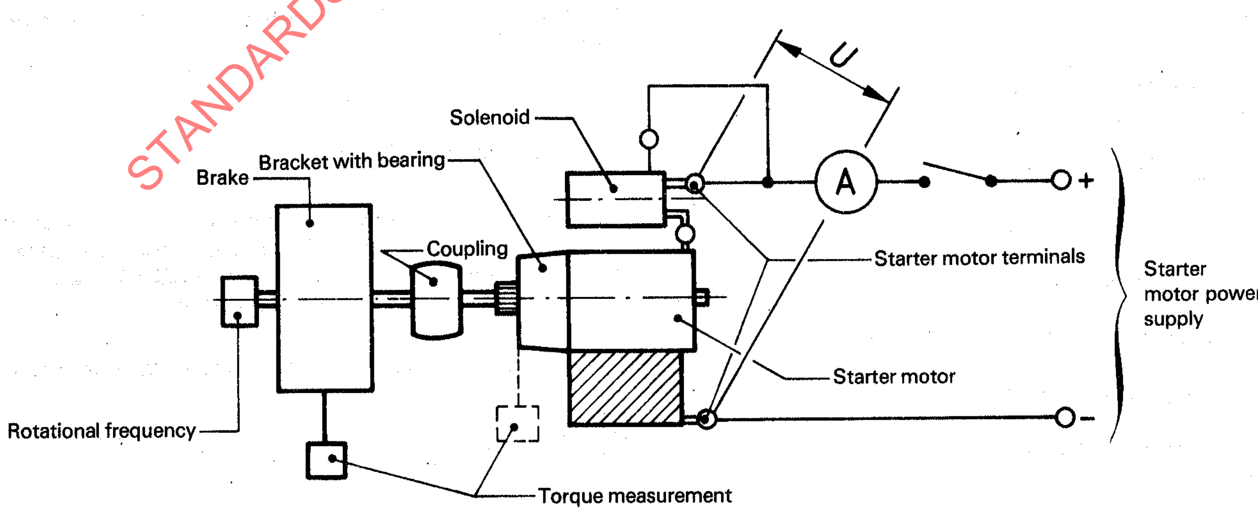

Figure 3 — Type 2 test bench

5.2.2.2 Correction of torque with temperature

If the temperature changes from t_1 to t_2, the torque M_1 as corrected in 5.2.2.1 shall be corrected in accordance with the following formula to give torque M_2:

$$M_2 = M_1 [1 - \beta (t_1 - t_2)] \quad \ldots (2)$$

where β is the magnetic induction coefficient of the permanent magnetic field as a function of temperature.[1)]

In the case of a wound field starter motor, $\beta = 0$.

5.3 Determination of starter motor output characteristic

The power characteristic, P, in kilowatts, of the starter motor may be determined by

$$P = \frac{M \times n}{9\,549{,}3} \quad \ldots (3)$$

where

M is the torque, in newton metres;

n is the rotational frequency which is the number of revolutions divided by time, in minutes to the power minus one.

5.4 Determination of rotational frequency

5.4.1 The rotational frequency, n, is given by the formula

$$n = k \frac{E}{\phi} \quad \ldots (4)$$

where

k is a constant depending on the starter motor size;

E is the back-electromotive force;

ϕ is the magnetic flux available in the starter motor field.

5.4.2 Frequency change is generally calculated by comparing the back-electromotive forces using the equation

$$E = U - I \times R \quad \ldots (5)$$

where

E is the back-electromotive force;

U is the applied voltage;

I is the starter motor current;

R is the internal resistance of the starter motor.

5.4.3 For temperature change t_1 to t_2, in degrees Celsius, the starter motor's internal resistance changes from R_1 to R_2. R_2 is given by the formula

$$R_2 = [1 + \alpha (t_2 - t_1)] \times R_1 \quad \ldots (6)$$

where α is the temperature coefficient of resistance at temperature t_2 for the starter motor winding material.[2)]

5.4.4 In the case of permanent magnetic field starter motors, the magnetic flux ϕ changes with the temperature t. The rotational frequency change n_1 to n_2 is then calculated using the formula

$$n_2 = \frac{E_2}{E_1} \times \frac{1}{1 - \beta(t_1 - t_2)} \times n_1 \quad \ldots (7)$$

For β, see 5.2.2.2

5.4.5 To change the frequency characteristic of a performance curve as in figure 4, the following data are taken at suitable steps of current:

a) starter motor rotational frequency, n;

b) terminal voltage, U;

c) starter motor resistance, R.

5.4.6 The rotational frequency is corrected using equation (7) at each selected value of current and thus a new frequency characteristic curve is established.

5.4.7 For changes in applied voltage, the value U in equation (5) is affected, and the rotational frequency calculated using equation (7). The power output characteristic is calculated as in 5.3.

6 Presentation of results

Performance characteristics shall be presented in accordance with figure 4. Where necessary, the measured parameters shall be corrected to the reference temperature of 20 °C (see 5.2.1) and the test bench employed shall be specified.

If a calculated value of α is used, the value should be recorded.

If so desired, the starter motor performance may be reproduced as a rotational frequency/torque characteristic.

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1) The value of β may vary between -2×10^{-3} °C^{-1} and $-2{,}3 \times 10^{-3}$ °C^{-1}.

2) The value of α for copper (100 %) as in the International Annealed Copper Standard (IACS), is equal to $3{,}93 \times 10^{-3}$ °C^{-1} at 20 °C. For starter motors constructed with composite copper/aluminium windings, it will be necessary to calculate a value for α.