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Véhicules routiers — Méthodes de test d'endurance pour les démarreur stop and start system

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Stop and start systems contribute to fuel saving by stopping the engine when its operation is not needed, and to start the engine automatically when its operation is needed. The more frequent starting of the engine requires higher durability of the starter motor. Since there is no standard to evaluate the durability of starter motors for stop and start systems, individual specifications are used by engine and/or vehicle manufacturers and starter motor manufacturers. Because the stop and start systems require much more frequent starter motor operations, the testing period is much longer compared to conventional starter motors.

In addition to engine and/or vehicle manufacturers and starter motor manufacturers, testing companies also began to conduct tests. In order to carry out the time-consuming test accurately and to use the test results effectively, the test procedure in this document includes how to summarize the test results.

Road vehicles — Durability test method for starter motor for stop and start system

1 Scope

This document defines requirements and recommendations for starter motor durability testing of 12 V start systems for internal combustion engines. This includes test methods, test procedures and capabilities of test benches.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 8856, *Road vehicles — Electrical performance of starter motors — Test methods and general requirements*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
stop and start system
system to stop the engine when its operation is not needed, and to start the engine automatically when its operation is needed

3.2
manual start
event when the engine is started manually by the driver

3.3
automatic start
event when the engine is started by the stop and start system automatically

3.4
dummy starter motor
starter motor used for installation purpose only

3.5
calibration starter motor
starter motor used for calibration of test condition, which is equipped for measuring temperatures of its components

3.6
engine simulator
device which simulates engine behaviour during engine start

3.7
battery simulator
electrical power supply equipment which simulates battery behaviour

3.8
engine mount
mechanical frame to support engine and gearbox

3.9
number of test start cycles
counted durability test start cycles

3.10
remaining brush length
length of brush after the test

3.11
usable brush length
length of brush that is available to be consumed

3.12
initial brush length
length of brush before starting the test

3.13
vehicle manufacturer
company which designs and produces vehicles

3.14
engine manufacturer
company which designs and produces internal combustion engines

3.15
starter motor manufacturer
company which designs and produces starter motors

3.16
cranking
condition in which the starter motor rotates the engine

3.17
overrunning
condition in which the engine rotates the starter motor pinion before starter motor OFF

3.18
engine ECU
electronic control unit for controlling internal combustion engine operation

3.19
starter solenoid
electromagnetic component of starter motor to move pinion and to switch electric motor

3.20
bi-control solenoid
starter solenoid which is able to control separately pinion movement and to switch electric motor

3.21
bench controller
device which is capable of controlling required test bench functions

3.22
nominal power
P_{nom}
power declared by the starter motor manufacturer corresponding to the maximum power output at the reference temperature when determined according to ISO 8856

3.23
battery internal and line resistance
R_{BL}
sum of power supply (battery or battery simulator) internal resistance and total resistance of external line (positive and negative sides and connections)

3.24
device under test
DUT
starter motor used for durability test

3.25
change of mind
CoM
start event before complete engine stall

3.26
starter motor voltage
U_{STR}
voltage at battery terminal of starter motor

3.27
starter motor current
I_{STR}
current drawn by starter motor

3.28
starter motor open circuit voltage
U_{0_STR}
voltage at starter motor terminals without electrical load

3.29
virtual starter motor voltage
$U_{0\_STR\_v}$
virtual starter motor voltage at I_{STR} = 0A derived from V-I curve

3.30
battery internal resistance
R_B
power supply (battery or battery simulator) resistance

3.31
line resistance
R_L
total resistance of external line (positive and negative sides and connections)

3.32
front end accessory drive
FEAD
equipment driven by belt which is connected to engine

3.33
starter motor temperature at control point
$T_{control}$
temperature measured at defined control point location

EXAMPLE At starter motor yoke surface.

3.34
temperature of starter motor brush
T_{brush}
temperature measured inside of starter motor brush

3.35
pinion to ring gear axial gap
d_{prg}
axial distance from front surface of pinion to ring gear at rest condition

3.36
starter motor input curve
V-I curve
straight line calculated from starter motor voltage vs starter motor current diagram defining starter motor input conditions

4 Planning of durability test

4.1 Determination of durability test types

The durability test is performed with an engine simulator or an engine. The following test types can be selected. See Table 1 for comparison of each test type.

1) Engine, using bench controller to control fuel/spark to specifically achieve pre-determined cranking time and overrunning time (see Table 3).

2) Engine, using its engine ECU to control the test parameters.

3) Engine simulator, using engine waveform data provided by engine and/or vehicle manufacturers as input to simulator (for cranking time, overrunning time, or torque) (see Table 3).

4) Engine simulator, using synthetic pattern or engine simulation model where starter motor manufacturer or engine and/or vehicle manufacturers define values for torque, cranking and overrunning behaviour (see Table 3).

Table 1 — Overview of test types

Test type	Starter load	Starter load characteristic	Reference
1	Engine	Engine using bench controller	Annex A
2		Engine using engine ECU	Annex B
3	Engine Simulator	Engine simulation using engine waveform data	Annex C
4		Engine simulation using synthetic pattern	Annex C

4.2 Determination of durability test conditions

The starter motor manufacturer and engine and/or vehicle manufacturers should define the test conditions according to the test planning matrix shown in Table 2.

The following items should be specifically considered:

1) In case of engine simulator, multiple starter motors can be tested simultaneously with the same ring gear. In that case, the orientation of the starter motors deviate from those of the target application. Hence, the usage of multiple starter motors shall correspond to the test purpose (e.g. verification of brush durability but not verification of pinion and ring gear durability).

2) The starter motor manufacturer and engine and/or vehicle manufacturers should agree starter motor temperature level during the durability test. Different approaches to define temperature level are established.

   For example:

   — test at maximum brush temperature defined by starter motor manufacturer;

   — test at maximum brush temperature derived from vehicle real drive cycle; and

   — test at an average brush temperature derived from brush temperature distributions of vehicle real drive cycle.

   Each approach covers different testing purposes such as focusing on thermal stress, test duration, mechanical loads or balanced field representation.

3) The starter motor manufacturer and engine and/or vehicle manufacturers should define the test pass criteria and define test stop criteria according to Table 6.

4) Additional test conditions may be defined and shall be documented in test planning matrix.

   For example:

   — always using “100 % new” battery for every test;

   — testing with maximum pinion to ring gear axial gap; and

   — number and orientation of starter motors mounted to engine simulator ring gear.

Table 2 — Test planning matrices

Test planning matrix (1/3)						**Reference**
Test type (test type #1 to #4)						4.1
Target test duration (number of test start cycles)						
Test sequence		__ x[M/S] + __ x[A/S] + __ x[CoM] + __ x[A/S] + __ x[CoM]				
	Manual start [M/S]	t_1	s	t_2	s	Table 3 including NOTE 1
		t_3	s	t_4	s	
		t_5	s	n_1	min^{-1}	
	Automatic start [A/S]	t_6	s	t_7	s	Table 3 including NOTE 2
		t_8	s	t_9	s	
		t_{10}	s	n_2	min^{-1}	
	CoM start [CoM]	n_3	min^{-1}	n_4	min^{-1}	Table 3
		t_{11}	s			