
**Road vehicles — Durability test
method of starter relay for stop and
start system**

*Véhicules routiers — Méthodes de test d'endurance pour le relais
démarrreur stop and start system*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

A stop and start system requires more frequent engine starting therefore, the starter relay used in such an engine should be durable. Currently, there is no common durability test method for starter relays, and most individual durability test methods of vehicle manufacturers and relay suppliers use actual starter solenoids as electrical loads of the relay. However, heat mass of the starter solenoid is not sufficient, so cooling equipment and/or a longer test cycle time are necessary to prevent starter solenoid damage.

This document provides a test method using a simulated electrical load which can shorten the test period or eliminate cooling equipment.

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

1 Scope

This document defines the durability test methods of a starter relay for passenger vehicles (12 V) with a stop and start system. It uses a simulated electrical load to represent the starter solenoid.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

3.2

starter solenoid

mechanical switch equipped with a solenoid that supplies current to the DC motor of the starter motor and/or shifts starter motor pinion to engage the ring gear of internal combustion engine

3.3

starter relay

relay that opens and closes the circuit to the starter solenoid

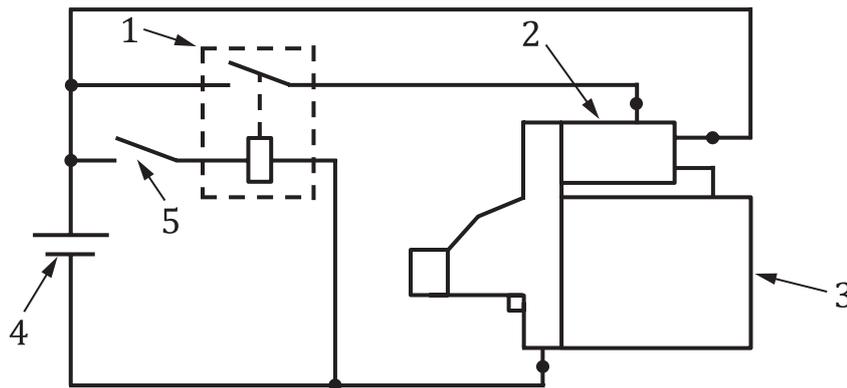
3.4

simulated load

electric load used as a substitute for the starter solenoid

4 Structure of starting circuit

The starting circuit is shown in the [Figure 1](#). The starter relay opens and closes the circuit to the starter solenoid.



Key

- 1 starter relay
- 2 starter solenoid
- 3 DC motor of starter motor
- 4 DC constant-voltage power supply
- 5 switch

Figure 1 — Starting circuit

5 Types of starter solenoid

Starter solenoids are categorized into the following two types according to their coil structure:

- a) single-coil type;
- b) double-coil type having hold-in and pull-in coils.

6 Test methods

6.1 Test method of the starter relay for the single-coil solenoid

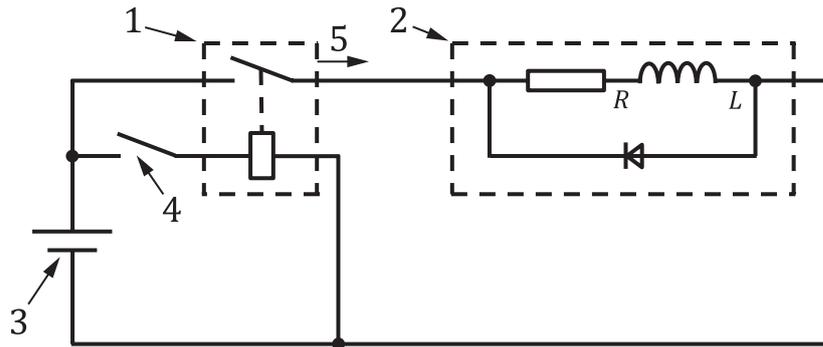
6.1.1 General

This test applies to the starter relay that opens and closes the circuit to the single-coil solenoid.

6.1.2 Test circuit

The test circuit is shown in the [Figure 2](#).

If the actual starter solenoid has a built-in diode, the diode shall be added in the simulated loads.

**Key**

- | | | | |
|---|------------------------------------|-----|-----------------|
| 1 | starter relay for evaluation | R | resistance of 2 |
| 2 | simulated load of starter solenoid | L | inductance of 2 |
| 3 | DC constant-voltage power supply | | |
| 4 | switch | | |
| 5 | starter relay current | | |

Figure 2 — Test circuit of single-coil solenoid**6.1.3 Test conditions**

The test conditions are as follows:

- a) Test voltage: $(13 \pm 0,5)$ V DC:
 - The power supply shall have a current capacity that can reproduce the actual starter relay current.
- b) Ambient temperature: room temperature of (23 ± 5) °C shall be applied.
- c) Inductance and resistance of simulated load:
 - Inductance and resistance values are determined by the actual starter solenoid.
 - To setup a simulated load, a resistance material with a small temperature coefficient should be selected. Using small temperature coefficient, the OFF time of starter relay can be shortened because a smaller temperature coefficient has less resistance change due to temperature rise.
 - If the actual starter solenoid has a built-in diode, forward current (average rectified current) and reverse voltage of diode are also determined by the actual starter solenoid.
- d) Target starter relay current:
 - Target value with tolerance shall be determined between the relevant parties.
- e) Operation pattern:
 - ON time of starter relay: The ON time is the time to reach the steady current of the actual load.
 - OFF time of starter relay: The OFF time is set so that the relay current does not deviate from the allowable value due to the heat generation of the simulated load when it is operated repeatedly.
- f) Confirmation of starter relay current:
 - Activate the starter relay with above ON and OFF time and compare and confirm that starter relay current flowing in the simulated load per a) to e) are saturated and within the target of the starter relay current.

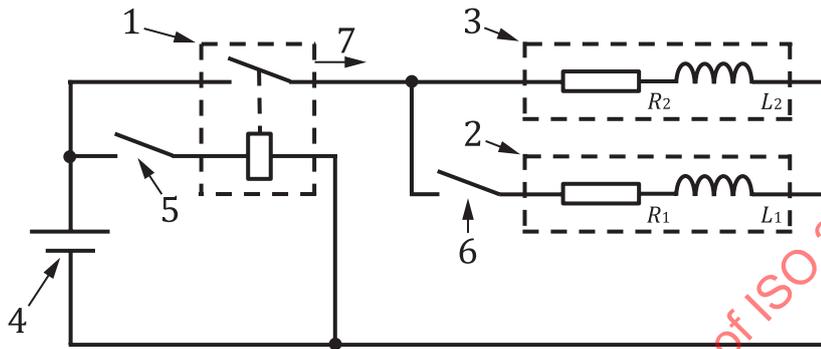
6.2 Test method of the starter relay for the double-coil solenoid

6.2.1 General

This test applies to the starter relay that opens and closes the circuit to the double-coil solenoid.

6.2.2 Test circuit

A test circuit is shown in the Figure 3.



Key

- | | | | |
|---|---|-------|-----------------|
| 1 | starter relay for evaluation | R_1 | resistance of 2 |
| 2 | simulated load 1 equivalent to pull-in coil | L_1 | inductance of 2 |
| 3 | simulated load 2 equivalent to hold-in coil | R_2 | resistance of 3 |
| 4 | DC constant-voltage power supply | L_2 | inductance of 3 |
| 5 | switch 1 | | |
| 6 | switch 2 | | |
| 7 | starter relay current | | |

Figure 3 — Test circuit of double-coil solenoid

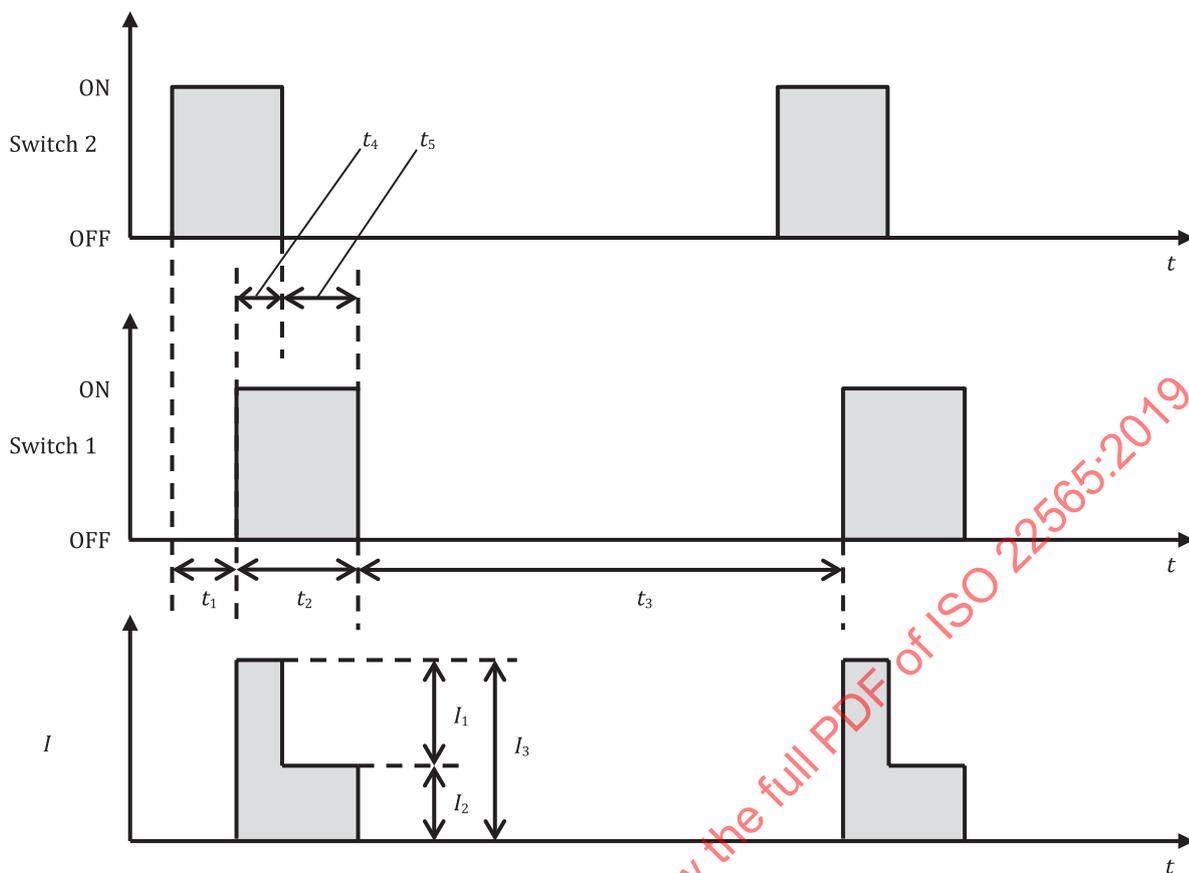
6.2.3 Test conditions

The test conditions are as follows:

- a) Test voltage: (13 ± 0.5) V DC:
 - The power supply shall have a current capacity that can reproduce the actual starter relay current.
- b) Ambient temperature: Room temperature of (23 ± 5) °C shall be applied.
- c) Inductance and resistance of simulated load:
 - Inductance and resistance values are determined by the actual starter solenoid.

- To setup a simulated load, a resistance material with a small temperature coefficient should be selected. Using small temperature coefficient, the OFF time of starter relay can be shortened because a smaller temperature coefficient has less resistance change due to temperature rise.
- d) Target starter relay current:
- Target value with tolerance (I_2, I_3 on [Figure 4](#)) shall be determined between the relevant parties.
- e) Operation Pattern:
- Activate the simulated starter solenoid coils as shown in the [Figure 4](#) operation pattern of switches and [Figure 5](#) starter relay current conditions at each switching mode, taking into consideration ON time and OFF time as following.
 - ON time of starter relay (t_2): The ON time is the time to reach the steady current of simulated loads.
 - OFF time of starter relay (t_3): The OFF time is set so that the relay current does not deviate from the allowable value due to the heat generation of the simulated load when it is operated repeatedly.
 - Time to supply current to both of simulated load 1 and 2 (t_4): An operation time for pull-in coil of the actual starter solenoid.
- f) Confirmation of starter relay current:
- Activate the starter relay with above ON and OFF time and compare and confirm that starter relay current (I_2, I_3 on [Figure 4](#)) flowing in the simulated load per a) to e) are saturated and within the target of the starter relay current.

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Key

- t time in seconds
- t_1 preparation time to supply current to both of simulated load 1 and 2
- t_2 ON time of starter relay
- t_3 OFF time of starter relay
- t_4 time to supply current to both of simulated load 1 and 2
- t_5 time to supply current to simulated load 2 only
- I starter relay current
- I_1 current to simulated load 1 when switch 2 is ON
- I_2 current to simulated load 2 only
- I_3 current to both of simulated load 1 and 2

Figure 4 — Switch 1 and 2 operation patterns and resulting starter relay current