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Electrically propelled road vehicles — Test specification for electric propulsion components —

Part 3: Performance testing of the motor and the inverter

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Foreword

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This document was prepared by Technical Committee ISO/TC 22, *Road Vehicles,* Subcommittee SC 37, *Electrically propelled vehicles.*

A list of all parts in the ISO 21782 series can be found on the ISO website.

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Electrically propelled road vehicles — Test specification for electric propulsion components —

Part 3: Performance testing of the motor and the inverter

1 Scope

This document specifies performance tests for the motor and the inverter designed as a voltage class B electric propulsion system for electrically propelled road vehicles.

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 21782-1, *Electrically propelled road vehicles — Test specification for electric propulsion components — Part 1: General test conditions and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21782-1 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/

4 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO 21782-1 apply.

5 Tests

5.1 Motor test

5.1.1 Measurement of loss and efficiency

5.1.1.1 General

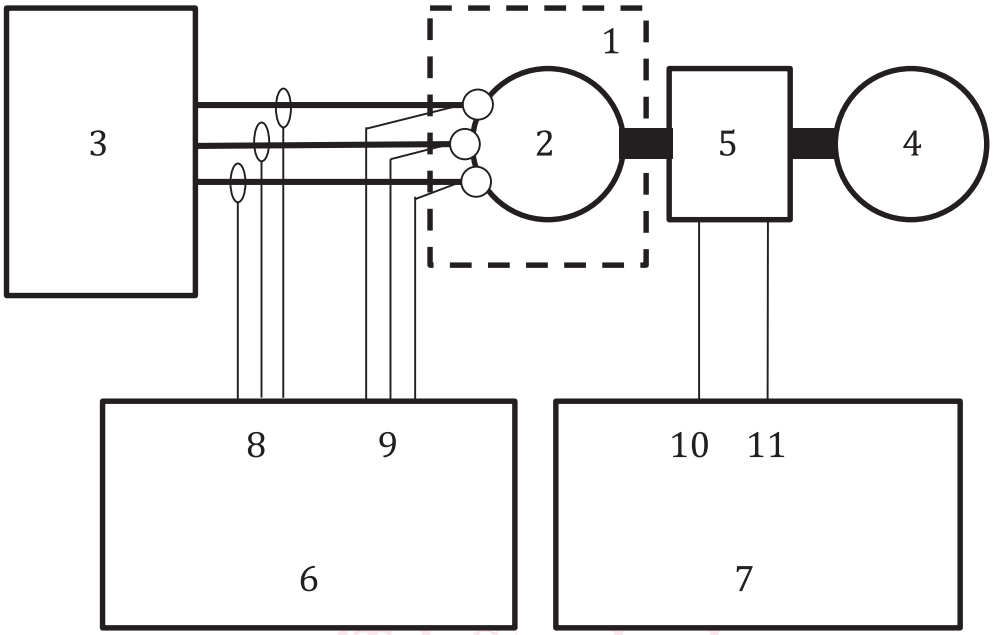
The purpose of this test is to operate the motor under the specified operating conditions and to measure the loss and efficiency of the motor in order to ensure that the performance is as designed.

5.1.1.2 Test diagram

The test diagram is shown in Figure 1.

Either the two-wattmeter method or the three-wattmeter method may be used for the three-phase power measurement.

Using the three-wattmeter method is recommended.



Key

1 DUT
2 motor
3 inverter
4 load
5 torque/speed detector
6 spectrum analyser/power meter
7 torque/speed meter
8 motor input current (in A)
9 motor input voltage (in V)
10 motor torque (in Nm)
11 motor speed (in min^{-1})

Figure 1 — Diagram for measurement of loss and efficiency of the motor

5.1.1.3 Test conditions

The test conditions are shown in Table 1.

Table 1 — Conditions for measurement of loss and efficiency of the motor

Test conditions	Value	Remark
Inverter input voltage	Rated voltage as defined in ISO 21782-1:2019, 3.22.	For the inverter input voltage tolerance, see ISO 21782-1:2019, 5.3.
Ambient conditions	Room temperature (RT) and humidity as defined in ISO 21782-1:2019, 5.4.	

Table 1 *(continued)*

Test conditions		Value	Remark
Coolant temperature		Maximum temperature for unlimited operating capability	— In case of liquid cooling — Ethylene glycol and propylene glycol as examples of coolant — If technically feasible, the tests shall be performed at coolant temperature of 65 °C. Otherwise the deviation shall be documented in the test report.
Coolant flow rate	Liquid	Minimum flow rate for unlimited operating capability	
	Air	Minimum flow rate for unlimited operating capability	
Operating point		Test points as defined in ISO 21782-1:2019, Figure 1 — "a", "a'", "b", "p_1" to "p_{10}" (optional "e", "e'", "f", "p_1'" to "p_{10}'")	
Switching frequency		The frequency shall be agreed between the supplier and customer.	
Operating time		— The operating points "a", "a'", "p_1", "p_3", "p_5", "p_7", "p_9", "p_{10}": 2 s or 10 s (optional 30 s, 60 s) — The operating point "b": 1 800 s — The operating points "p_2", "p_4", "p_6", "p_8": 1 800 s or maximum allowable time for temperature protection	For regenerative operating points, the same operating time applies as for corresponding motoring operating points.

5.1.1.4 Test procedure

1) The test motor shall be operated at specified operating points for the operating time defined in Table 1. Motor input power, output torque and speed shall be recorded. Each average of the last one second of the records shall be used. See Annex A for information about the input power measurement.

2) The loss and efficiency shall be calculated by using Formulae (1) and (2):

$$\eta_{\mathrm{m}} = \frac{P_{\mathrm{mo}}}{P_{\mathrm{mi}}} \times 100 \tag{1}$$

$$P_{\mathrm{ml}} = P_{\mathrm{mi}} - P_{\mathrm{mo}} \tag{2}$$

where

η_{m} is the efficiency of the motor (in %);

P_{mo} is the motor output power (in W);

P_{mi} is the motor input power (in W);

P_{ml} is the loss of the motor (in W).

The measurement of regenerate operation may be decided by agreement between the supplier and customer.

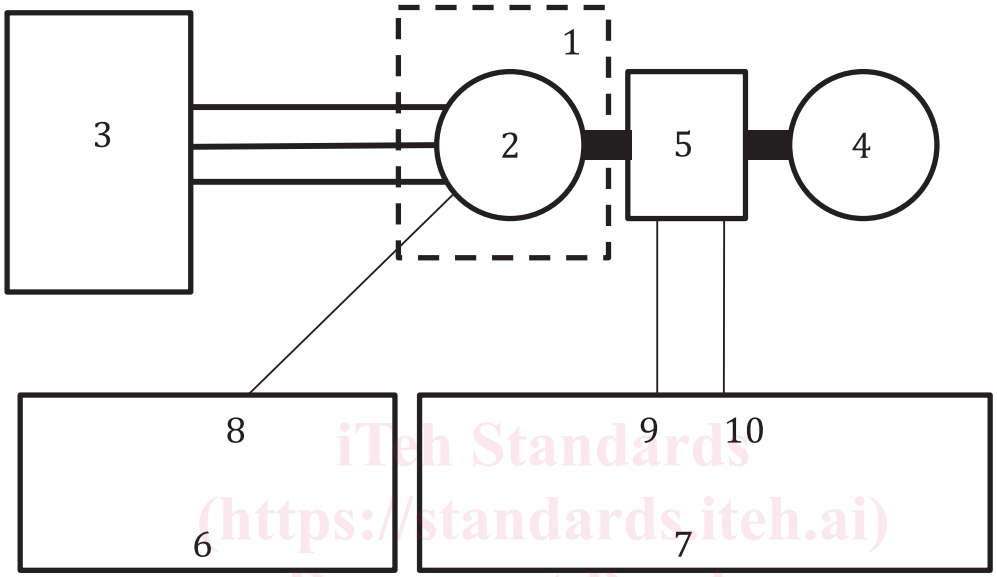
5.1.2 Temperature rise test

5.1.2.1 General

The purpose of this test is to operate the motor under the specified conditions and to measure the temperature rise in the motor in order to ensure that the motor thermal performance is as designed.

5.1.2.2 Test diagram

The test diagram is shown in Figure 2.



Key

1 DUT
2 motor
3 inverter
4 load
5 torque/speed detector
6 thermometer
7 torque/speed meter
8 measurement point temperature (in °C)
9 motor torque (in Nm)
10 motor speed (in min^{-1})

Figure 2 — Diagram for temperature rise test of the motor

5.1.2.3 Test conditions

The test conditions are shown in Table 2.

Table 2 — Conditions for temperature rise test of the motor

Test conditions	Value	Remark
Inverter input voltage	Rated voltage as defined in ISO 21782-1:2019, 3.22.	For the inverter input voltage tolerance, see ISO 21782-1:2019, 5.3.
Ambient conditions	RT and humidity as defined in ISO 21782-1:2019, 5.4.	

Table 2 *(continued)*

Test conditions		Value	Remark
Coolant temperature		Maximum temperature for unlimited operating capability	— In case of liquid cooling — Ethylene glycol and propylene glycol as examples of coolant — If technically feasible, the tests shall be performed at coolant temperature of 65 °C. Otherwise the deviation shall be documented in the test report.
Coolant flow rate	Liquid	Minimum flow rate for unlimited operating capability	
	Air	Minimum flow rate for unlimited operating capability	
Operating point		The points as defined in ISO 21782-1:2019, Figure 1 — "a", "b"	May be set by agreement between the supplier and customer.
Switching frequency		The frequency shall be set by agreement between the supplier and customer.	
Operating time		— The operating point "a": 2 s or 10 s — The operating point "b": 1 800 s	

5.1.2.4 Test procedure

The test motor shall be operated at specified operating points, and the temperature at the measurement points shall be recorded.

For each torque-speed point, after the operating time as defined in Table 2 passes, the temperature shall be recorded.

An inverter that has the ability to operate continuously at the maximum torque point may be used.

The temperature of coil shall be measured at the points assumed as the highest. The measurement points in the coil and other measurement points can be added by agreement between the supplier and customer.

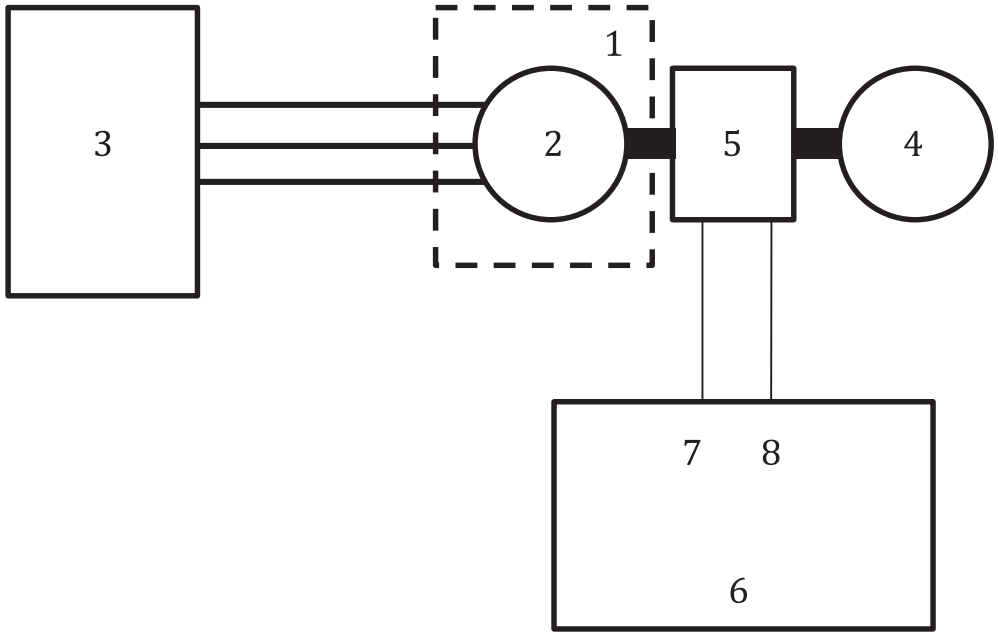
5.1.3 Torque characteristic test

5.1.3.1 General

The purpose of this test is to operate the motor under the specified operating conditions and to check the torque characteristics in order to ensure that the motor performance is as designed.

5.1.3.2 Test diagram

The test diagram is shown in Figure 3.



Key

1 DUT
2 motor
3 inverter
4 load
5 torque/speed detector
6 torque/speed meter
7 motor torque (in Nm)
8 motor speed (in min^{-1})

Figure 3 — Diagram for torque characteristic test of the motor

5.1.3.3 Test conditions

The test conditions are shown in Table 3.

Table 3 — Conditions for torque characteristic test of the motor

Test conditions	Value	Remark
Inverter input voltage	Rated voltage as defined in ISO 21782-1:2019, 3.22.	For the inverter input voltage tolerance, see ISO 21782-1:2019, 5.3.
Ambient conditions	RT and humidity as defined in ISO 21782-1 2019, 5.4.	

Table 3 *(continued)*

Test conditions		Value	Remark
Coolant temperature		Maximum temperature for unlimited operating capability	— In case of liquid cooling — Ethylene glycol and propylene glycol as examples of coolant — If technically feasible, the tests shall be performed at coolant temperature of 65 °C. Otherwise the deviation shall be documented in the test report.
Coolant flow rate	Liquid	Minimum flow rate for unlimited operating capability	
	Air	Minimum flow rate for unlimited operating capability	
Operating point		The points as defined in ISO 21782-1:2019, Figure 1 — "a", "a'", "c", "d"	
Operating time		— The operating points "a", "a'", "c" and "d": 2 s or 10 s (optional 30 s, 60 s)	

5.1.3.4 Test procedure

The test motor shall be operated at specified operating points for the operating time as defined in Table 3. Motor input power, output torque and speed shall be recorded. Each average of the last one second of the records shall be used.

5.1.4 Cogging torque test

5.1.4.1 General

The purpose of this test is to operate the permanent-magnet motor at a low speed on the motor dynamometer and to measure the waveform of torque in order to ensure that the cogging torque is as designed.

5.1.4.2 Test diagram

The test diagram is shown in Figure 4.