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First edition

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

Part 7: Operating load testing of the DC/DC converter

Véhicules à propulsion électrique — Spécification d'essai pour les composants de propulsion électrique —

Partie 7: Test de charge de fonctionnement du convertisseur DC/DC

PROOF/ÉPREUVE

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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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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.

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.

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

Part 7: Operating load testing of the DC/DC converter

1 Scope

This document specifies the operating load test and test criteria for the DC/DC converter designed as a voltage class B electric propulsion system of 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 21782-1:2019, *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 Symbols and abbreviated terms

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

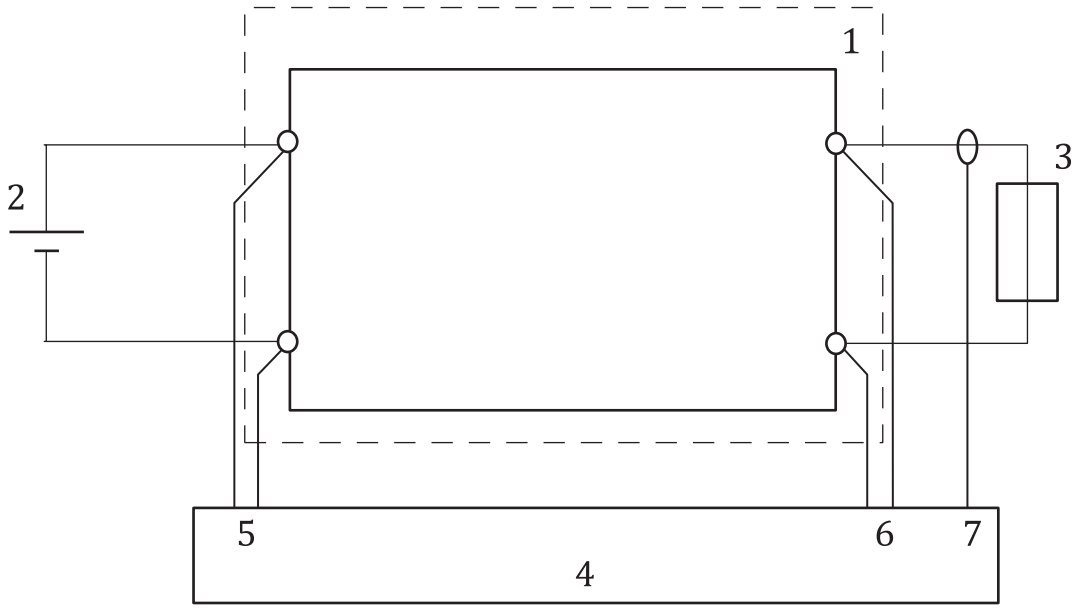
5 Operation endurance test and requirements

5.1 General

The operation endurance test method may be conducted depending on an agreement between the supplier and customer. The test methods take into account repeated operations with a representative current output pattern of the DC/DC converter. The test, including test objectives and time, aims to prevent failures in main power conversion parts.

5.2 Test diagram

The test diagram is shown in Figure 1.



Key

1 DUT
2 DC power supply
3 load
4 power meter
5 DC/DC converter input voltage (in V)
6 DC/DC converter output voltage (in V)
7 DC/DC converter output current (in A)

Figure 1 — Diagram for operation endurance test of the DC/DC converter

5.3 Test conditions

Temperature conditions of the DC/DC converter are shown in Table 1. Unless otherwise specified, the conditions shall be decided by an agreement between the supplier and customer. If an accelerated test with raised temperature conditions is conducted, it shall be agreed between the supplier and customer.

Table 1 — Conditions for operation endurance test of the DC/DC converter

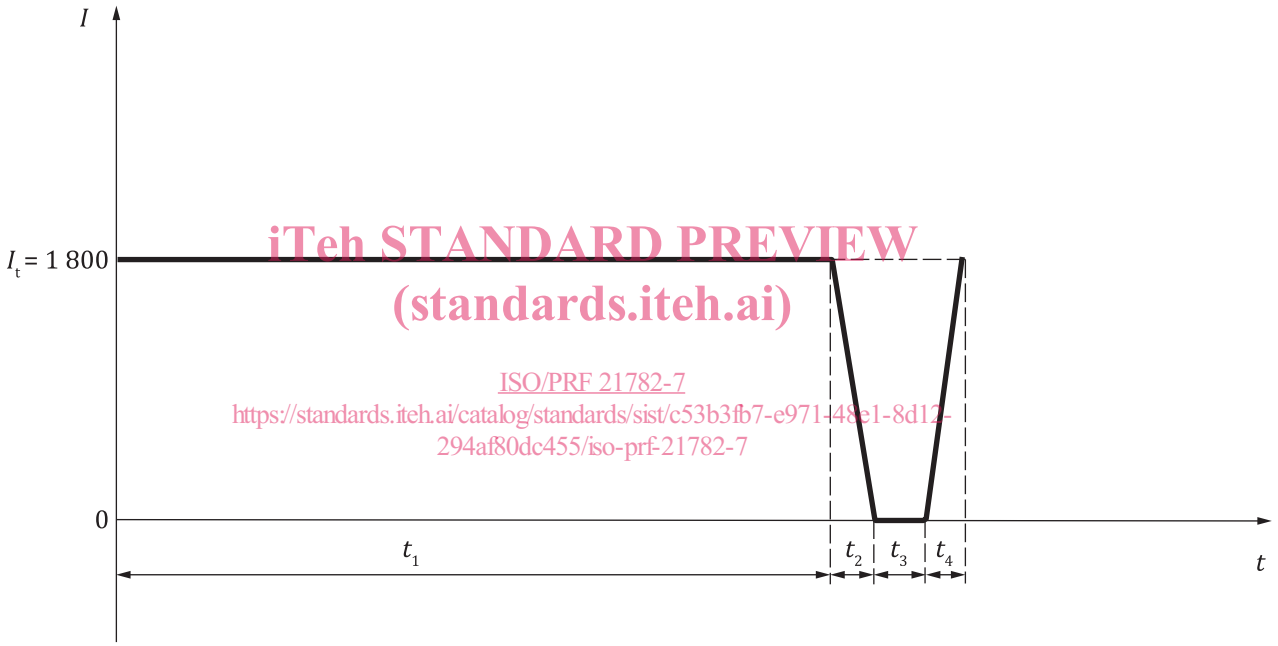
Test conditions		Value	Remarks
DC/DC converter input voltage		Rated voltage as defined in ISO 21782-1:2019, 3.22	DC/DC converter input voltage tolerance, see ISO 21782-1:2019, 5.3
DC/DC converter output voltage		Design value	
DC/DC converter output current		Defined in Figures 2 and 3	
Ambient conditions		— Maximum temperature for unlimited operating capability — Humidity as defined in ISO 21782-1:2019, 5.4	
Coolant temperature	Liquid	Maximum temperature for unlimited operating capability	
	Air	Maximum temperature for unlimited operating capability	

Table 1 *(continued)*

Test conditions		Value	Remarks
Coolant flow rate	Liquid	Minimum flow rate for unlimited operating capability	
	Air	Minimum flow rate for unlimited operating capability	
Operating time		1 800 000 s	

5.4 Test procedure

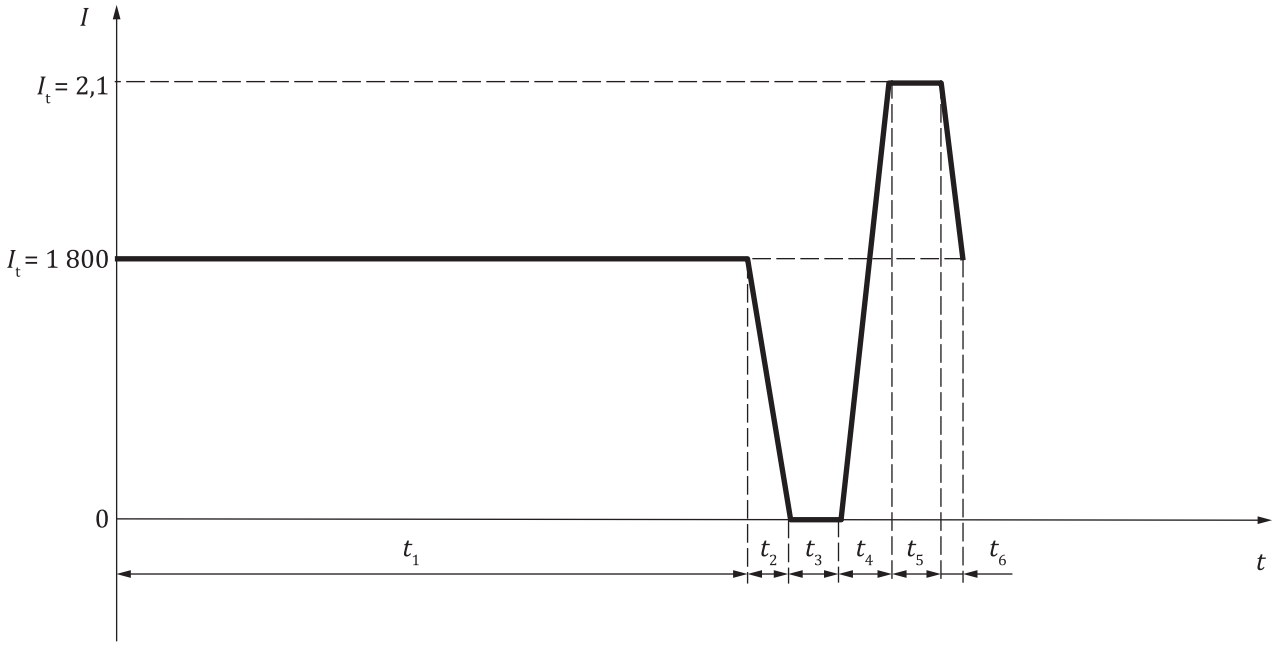
The DC/DC converter shall be tested with an equivalent load (e.g. electrical load). The load shall be applied according to the conditions defined in Table 1 and the test pattern defined in Figures 2 and 3. When the output current specification of DUT has no $I_{t=2,10}$, the test pattern shown in Figure 2 shall be applied. On the other hand, the output current specification of DUT has $I_{t=2,10}$ the test pattern shown in Figure 3 shall be applied.



Key

t	time (in s)
I	DC/DC converter output current (in A)
t_1, t_2, t_3, t_4	time parameter (in s)

Figure 2 — Operation endurance test pattern without $I_{t=2,10}$



Key

t	time (in s)
I	DC/DC converter output current (in A)
t_1, t_2, t_3, t_4, t_5, t_6	time parameter (in s)

Figure 3 — Operation endurance test pattern with $I_{t=2,10}$

Table 2 — Description of time parameter in Figure 2

Time parameters	Requirements
t_1	1 800 s – (t_2 + t_3 + t_4)
t_2	<1 s
t_3	<2 s
t_4	<1 s
NOTE t_2, t_3, t_4 can be set to 0 s by an agreement between the supplier and customer.	

Table 3 — Description of time parameter in Figure 3

Time parameters	Requirements
t_1	1 800 s – (t_2 + t_3 + t_4 + t_5 + t_6)
t_2	<1 s
t_3	This shall be controlled so that the temperature of DC/DC converter does not exceed the maximum temperature for unlimited operating capability.
t_4	<2 s
t_5	2 s or 10 s
t_6	<1 s

5.5 Test requirements

5.5.1 General

The rank listed in Table 4 classifies the time before physical and/or functional deterioration is observed on the DC/DC converter by percentage of operating time. To confirm the time before physical and/or functional deterioration, energizing and/or disassembling shall be conducted.

Table 4 — Capital letter indicating operation endurance test of the DC/DC converter

Ranks	Time before physical and/or functional deterioration
S	>220 % of the operating time
A	200 % of the operating time
B	180 % of the operating time
C	160 % of the operating time
D	140 % of the operating time
E	120 % of the operating time
F	100 % of the operating time

5.5.2 Energizing

To investigate the functional deterioration, the data listed in Table 5 shall be obtained before the operation endurance test in order to compare the data before and after this test. Additional measurement items can be added by agreement between supplier and customer.

Table 5 — Criteria of energizing

Measurement items	Conditions	Criteria
DC/DC converter output voltage	Conditions defined in Table 1 $I_{t=1\,800}$ ($I_{t=2,10}$ optional)	Within ±5 % difference before and after the test
Efficiency of DC/DC converter	Conditions defined in Table 1 $I_{t=1\,800}$ ($I_{t=2,10}$ optional)	Within ±7 % difference before and after the test

5.5.3 Disassembling

To investigate the physical deterioration, the power semiconductor and DC bus capacitor shall be disassembled and investigated according to Table 6. The investigation items and/or criteria may be decided by agreement between the supplier and customer.

Table 6 — Investigation items of the DC/DC converter

Items/places	Details of investigation
Power semiconductor chip	No physical and/or functional deterioration
DC bus capacitor	No physical and/or functional capacitor film deterioration
Transformer	No physical and/or functional deterioration
Choke coil	No physical and/or functional deterioration

6 Test report

Each test shall be reported with a test report, containing information on test conditions and results.

An example for a test report on conditions and results is given in Table A.1.

Annex A
(informative)

Test report

A.1 Operation endurance test

Table A.1 — Operation endurance test of the DC/DC converter

<table>
<tr><td colspan="5">1 Common conditions</td></tr>
<tr><td rowspan="9"></td><td colspan="2">Items</td><td>Value</td><td>Remark</td></tr>
<tr><td rowspan="2">Ambient conditions</td><td>Temperature (in °C)</td><td></td><td></td></tr>
<tr><td>Humidity (in %)</td><td></td><td></td></tr>
<tr><td colspan="2">Cooling type</td><td>Liquid / Air</td><td></td></tr>
<tr><td colspan="2">Coolant temperature (in °C)</td><td></td><td></td></tr>
<tr><td colspan="2">Coolant flow rate (in l/min)</td><td></td><td></td></tr>
<tr><td colspan="2">DC/DC converter input voltage (in V)</td><td></td><td></td></tr>
<tr><td colspan="2">DC/DC converter output voltage (in V)</td><td></td><td></td></tr>
<tr><td colspan="2">Test pattern</td><td>Figure 2 / Figure 3</td><td></td></tr>
<tr><td colspan="5">2 Results</td></tr>
<tr><td rowspan="3"></td><td colspan="2">Items</td><td>Value</td><td>Remark</td></tr>
<tr><td colspan="2">Rank</td><td>S/A/B/C/D/E/F</td><td></td></tr>
<tr><td colspan="2">operating time (in s)</td><td></td><td></td></tr>
<tr><td colspan="5">3 Test requirements — Energizing</td></tr>
<tr><td rowspan="3"></td><td colspan="2">Items</td><td>Value</td><td>Remark</td></tr>
<tr><td colspan="2">DC / DC converter output voltage</td><td>Pass / Fail</td><td></td></tr>
<tr><td colspan="2">Efficiency of DC / DC converter</td><td>Pass / Fail</td><td></td></tr>
<tr><td colspan="5">4 Test requirements — Disassembling</td></tr>
<tr><td rowspan="5"></td><td colspan="2">Items</td><td>Value</td><td>Remark</td></tr>
<tr><td colspan="2">Power semiconductor chip</td><td>Pass / Fail</td><td></td></tr>
<tr><td colspan="2">DC bus capacitor</td><td>Pass / Fail</td><td></td></tr>
<tr><td colspan="2">Transformer</td><td>Pass / Fail</td><td></td></tr>
<tr><td colspan="2">Choke coil</td><td>Pass / Fail</td><td></td></tr>
</table>

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