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Electrically propelled road vehicles — Electrical specifications and tests for voltage class B systems and components —

Part 2:
Electrical tests for components

Véhicules à propulsion electrique — Spécifications et essais electriques pour les systèmes et composants de classe B —

Partie 2: Composants et essais electriques

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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*.

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

The requirements for voltage class B electric circuits that are used for electric power transfer for the propulsion of electric road vehicles and their characteristics are significantly different to those of voltage class A electric circuits. Moreover, the range of voltage class B is too wide to be used for a component design regarding to voltage.

This standard divides voltage class B in a set of voltage sub-classes to enable a component design for each voltage sub-class regarding to voltage. It provides appropriate descriptions and definitions for requirements and characteristics of voltage class B systems for electrically propelled vehicles.

The voltage sub-class itself and the component characteristics have a large cost impact on the component design and on the overall design of the electric system. Additionally, a high variety of different voltage sub-classes and operating conditions impedes the use of an existing component in different vehicle models. The standardisation of voltage sub-classes and characteristics and the reduction of varieties will enable the reduction of component and system costs. It allows the decoupling of the system or component designs of a voltage class B electric circuit from the design of the electric energy source. Finally, the exchange of components from different suppliers for different customers is facilitated.

Part 1 of this standard provides definitions of and for voltage sub-classes and characteristics for rechargeable energy storage systems (RESS) and electric propulsion systems. It defines specific values for these sub-classes based on maximum working voltage. Voltage sub-classes listed in this document are used for voltage class B systems of all kinds of current or future electrically propelled road vehicles.

Part 2 of this standard provides electrical tests for electric and electronic components at voltage class B used for electrically propelled road vehicles. All relevant characteristics are covered considering usual driving scenarios as well as deviations from normal operation. The descriptions are generalized and include purpose, setup, procedure and requirements for the tests.

The specifications in this standard are not intended to restrict the development of component performance or technology. The given definition of sub-classes does not exclude the use of other maximum operating voltages for an individual system design.

Electrically propelled road vehicles — Electrical specifications and tests for voltage class B systems and components – Part 2 Electrical tests for components

1 Scope

This document applies to voltage class B electric propulsion systems and connected auxiliary electric systems of electrically propelled road vehicles. It applies to electric circuits and components in these systems.

This document focuses on the characteristics at the DC voltage class B terminals of these components as specified in part 1 of this standard. It describes testing methods, test conditions and test requirements for components exposed to electrical behaviour caused by operation of electric loads and power sources.

Note: This document does not cover electrical safety (see ISO 6469, ISO 17409).

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 cited edition applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TR 8713, Electrically propelled road vehicles — Vocabulary

ISO 21498-1 Electrically propelled road vehicles – Electrical specifications and tests for voltage class B systems and components – Part 1: Voltage sub-classes and characteristics

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 8713 and the following 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
component operating status
general functional behaviour of components which depend directly on the voltage in voltage class B electric circuits

3.2
customer
party that is interested in using voltage class B components or systems

3.3
electric circuit
entire set of interconnected electric/electronic parts through which electrical current is designed to flow under normal operating conditions

3.4
generator mode
mode where the electric power is provided by the component

3.5
lower voltage limit
minimum voltage of a voltage class B sub-class

3.6
maximum working voltage
highest value of AC voltage (rms) or of DC voltage that can occur under any normal operating conditions according to the customer's specifications, disregarding transients and ripple

3.7
power-net
All components within voltage class B DC network including their connections

3.8
rechargeable energy storage system
RESS
rechargeable system that stores energy for delivery of electric energy for the electric drive

Examples to entry: batteries, capacitors, flywheel

3.9
ripple
set of unwanted periodic deviations with respect to the average value of the measured or supplied quantity, occurring at frequencies which can be related to that of components within a system

3.10
supplier
party that provides voltage class B components or systems

3.11
transient
phenomenon or quantity which varies between two consecutive steady states during a short time interval compared to the time-scale of interest

3.12
upper voltage limit
maximum voltage of a voltage class B sub-class

Note 1 to entry: Maximum working voltages within a voltage sub-class are less than or equal to the upper voltage limit.

3.13
voltage class A
classification of an electric component or circuit with a maximum working voltage of ≤ 30 V AC (rms) or ≤ 60 V DC respectively

3.14
voltage class B
classification of an electric component or circuit with a maximum working voltage of (> 30 and ≤ 1 000) V AC (rms) or (> 60 and ≤ 1 500) V DC respectively

3.15
voltage range
general term covering voltage sub-class, working voltages and deviations from working voltages

3.16
voltage sub-class
classification of an electric component or circuit with a DC voltage within the voltage class B

3.17
working voltage
AC voltage (rms) or DC voltage that can occur in an electric system under normal operating conditions according to the customer's specifications, disregarding transients and ripple.

4 Abbreviated terms

DUT	Device Under Test
EV	Electrically Propelled Road Vehicle
HV	High Voltage
AN	Artificial Network
OS	Operating Status
LV	Low Voltage

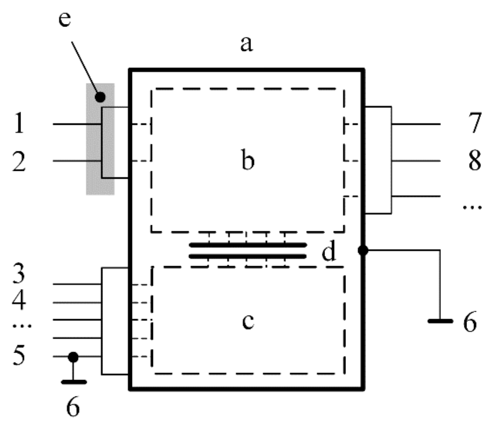
5 General assumptions for voltage class B components

General assumptions and definitions for voltage class B systems are given in ISO 21498-1.

Figure 1 shows a generalized view on a voltage class B component. Some of the connections shown may not be available for all voltage class B components. All voltage profiles or voltage values in this document refer to the voltage between the "HV+" and "HV-" terminals of a voltage class B component, if not otherwise stated.

A voltage class B component may have multiple interfaces for each type of voltage (voltage class B DC, voltage class B AC, voltage class A, according to Figure 1). For example, a DC/DC converter may interface to two voltage class B electric circuits.

A voltage class B component may have multiple voltage class B DC terminals, which can be galvanically separated. The tests described in this document shall be fulfilled for each of these terminals.



Key

a	DUT	3	Voltage class A power
b	Voltage class B circuit	4	I/O and bus signals
c	Voltage class A circuit	5	Terminal with direct connection to voltage class A ground reference
d	Galvanic separation between voltage class A and voltage class B	6	Ground reference
e	Voltage class B terminals under test	7	Connection to further voltage class B component (e.g. electric motor)
1	Voltage class B connection: HV+	8	Connection to further voltage class B component (e.g. AC or DC power-net)
2	Voltage class B connection: HV-		

Figure 1 - Generalized voltage class B component diagram

For the purpose of testing Figure 2 summarizes the voltage operating ranges and OS of a voltage class B component at its voltage class B DC voltage terminals. The overvoltage limit, the upper voltage limit and the lower voltage limit are properties of the component. Each voltage class B component shall have a voltage range in which it can be operated with its specified performance (unlimited operating capability). All designated functions, including short-time overload operations, shall be available. Within this voltage range, the component operates in OS1.

Above a maximum voltage, a component may reduce its performance as specified. This maximum voltage is called the “maximum unlimited operating voltage” ($U_{max\_unlimited\_op}$). The component shall provide its upper limited operating capability until the upper voltage limit (U_{upper_limit}) is reached. In this case, the component operates in OS2.

Above the upper voltage limit (U_{upper_limit}) the component may derate or cut-off its performance for self-protection. The component shall withstand this overvoltage until the overvoltage limit (U_{over_limit}) is reached. In this case, the component operates in OS3 or OS4.

A component shall perform in OS1 until the supply voltage drops to the “minimum unlimited operating voltage” ($U_{min\_unlimited\_op}$). Between this voltage and the “lower voltage limit” (U_{lower_limit}), the component may reduce its performance as specified. In this case, the component operates in OS2.

If the supply voltage is below the lower voltage limit (U_{lower_limit}), the component may derate or cut-off its performance. In this case, the component operates in OS3 or OS4.

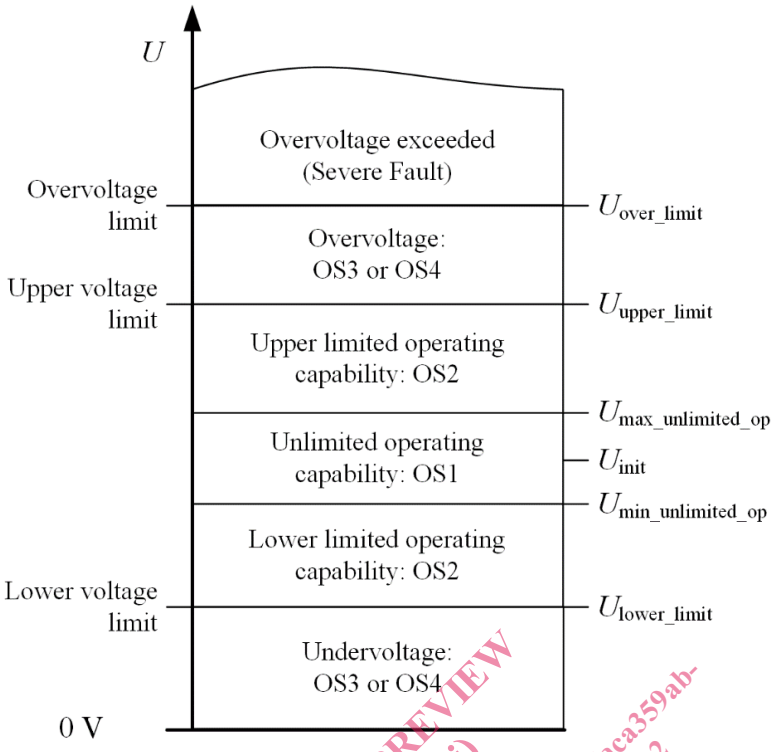


Figure 2 - Component voltage range and limits of corresponding OS

6 Tests and requirements

6.1 Test parameters and general test requirements

6.1.1 Purpose

This subclause describes the specification of test parameters including tolerances and general test requirements. Frequency, time and voltage levels used for the tests are introduced.

6.1.2 Test setup

The test setup shall provide appropriate interfaces, connections and loads to achieve representative DUT operation and characteristics. Measurement of voltages shall be performed at the voltage class B terminals of the DUT.

6.1.3 Voltages

Table 1 – Voltage definitions and abbreviations

Test parameter	Meaning
U_{over_limit}	Overvoltage limit[a]
U_{upper_limit}	Upper voltage limit[a]
U_{lower_limit}	Lower voltage limit[a]
$U_{max\_unlimited\_op}$	Maximum voltage for unlimited operating capability[b]
$U_{min\_unlimited\_op}$	Minimum voltage for unlimited operating capability[b]
U_{init}	Initial voltage for all tests
U_{HV}	Voltage at the terminals of the DUT
$U_{HV,DC}$	DC part of the voltage at the terminals of the DUT
$U_{HV,AC}$	AC part of the voltage at the terminals of the DUT (peak value)
U_{PP}	Peak-to-peak value of AC voltage
$U_{HV,idle}$	HV DC voltage at no load operation
$U_{HV,Ppeak}$	HV DC voltage at peak power operation
U_m	Voltage in the undervoltage range

[a] Voltage defined in ISO 21498-1.
[b] See Figure 2 for illustration. The unlimited operating capability is defined in ISO 21498-1.

6.1.4 Powers

Table 2 – Power definitions and abbreviations

Test parameter	Meaning
P_{cont}	Continuous power of the DUT
P_{max_gen}	Generated HV DC maximum power by the DUT
P_{peak}	Maximum short term power of the DUT
P_{idle}	Power of the DUT during no load operation
$P_{request}$	Power request to the DUT[a]

[a] This value is related to the desired output power of the DUT, the actual set value may have another physical quantity (e.g. current, speed, torque) depending on the DUT

6.1.5 Temperatures

The focus of all tests in this document is on the electrical behaviour of the component at the voltage class B terminals. Thermal derating is not considered. Therefore, all tests shall be performed at ambient temperature.

If a component needs additional liquid cooling, the cooling system shall be chosen as such that the DUT's performance is not affected by thermal derating. Flow rate and coolant temperature shall be documented.

If the electric tests have to be performed at different temperature levels, Annex B gives guidance how to perform these tests.

6.1.6 Times and durations

Table 3 - Times/Duration definitions and abbreviations

Test parameter	Meaning
t_r	Rise time (e.g. of a voltage profile or a transient event)
t_f	Fall time (e.g. of a voltage profile or a transient event)
t_h	Hold time (e.g. of a voltage profile)
t_{test}	Test duration

6.1.7 Standard tolerances

Unless otherwise specified, the tolerances in accordance with Table 4 apply with accuracy as shown in

Test parameter	Value	Remark
ΔC	±10 % of specified component value [b]	Tolerance of capacitance
Δf	±1 % relating to the specified value [b]	Tolerance of AC voltage frequency
ΔL	±10 % of specified component value [b]	Tolerance of inductance
ΔR	±10 % of specified component value [b]	Tolerance of resistance
Δt	0 % to +5 % relating to the specified value [c]	Tolerance of time/ duration
ΔU_{DC}	±0,2 % of U_{upper_limit}	Tolerance of DC voltage
ΔU_{AC}	0 % to +5 % relating to the specified value [a]	Tolerance of AC voltage
[a] The specified value is given in the test description. The amplitude may not be below the given value.		

Table 5.

Tolerances refer to the required setting value. Tolerances of the component measurement shall not lead to an OS change.

Tolerances shall only be applied in a way that requirements are not weakened.

Table 4 - Standard tolerances for test equipment

Test parameter	Value	Remark
ΔC	±10 % of specified component value [b]	Tolerance of capacitance
Δf	±1 % relating to the specified value [b]	Tolerance of AC voltage frequency
ΔL	±10 % of specified component value [b]	Tolerance of inductance
ΔR	±10 % of specified component value [b]	Tolerance of resistance
Δt	0 % to +5 % relating to the specified value [c]	Tolerance of time/ duration
ΔU_{DC}	±0,2 % of U_{upper_limit}	Tolerance of DC voltage
ΔU_{AC}	0 % to +5 % relating to the specified value [a]	Tolerance of AC voltage
[a] The specified value is given in the test description. The amplitude may not be below the given value.		

