FINAL DRAFT
International Standard

ISO/FDIS 21498-2

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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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 document 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 37, *Electrically propelled vehicles*.

This second edition cancels and replaces the first edition (ISO 21498-2:2021), which has been technically revised.

The main changes are as follows:

— testcase “Short circuit” has been added;

— Annex B “Testing at different temperatures” has been deleted;

— additional values have been added in Tables B.2 and B.3;

— example current limit values have been added to Table B.4;

— Annex C has been revised;

— methods for conversion from time domain to frequency domain for generated ripple have been revised and moved from main body to informative Annex D.

A list of all parts in the ISO 21498 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.

Introduction

The requirements for voltage class B electric circuits 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 relating to voltage.

The ISO 21498 series divides voltage class B in a set of voltage sub-classes to enable a component design for each voltage sub-class relating 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. Standardising voltage sub-classes and characteristics and reducing varieties cuts component and system costs. This 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.

ISO 21498-1 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 ISO 21498-1 are used for voltage class B systems of all kinds of current or future electrically propelled road vehicles.

This document 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 document 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 ISO 21498-1. It describes testing methods, test conditions and test requirements for components exposed to electrical behaviour caused by the operation of electric loads and power sources.

This document does not cover electrical safety (see ISO 6469-3 and 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 https://www.electropedia.org/

3.1
customer
party that is interested in using *voltage class B* (3.12) components or systems

[SOURCE: ISO 21498-1:2021, 3.2]

3.2
electric circuit
entire set of interconnected electric/electronic parts through which electrical current is designed to flow under normal operating conditions

[SOURCE: ISO 21498-1:2021, 3.3]

3.3
lower voltage limit
minimum voltage of a *voltage class B* (3.12) sub-class disregarding *transients* (3.9) and *ripple* (3.7)

[SOURCE: ISO 21498-1:2021, 3.4]

3.4
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* (3.1) specifications, disregarding *transients* (3.9) and *ripple* (3.7)

[SOURCE: ISO 21498-1:2021, 3.5]

3.5
power network
all components within *voltage class B* (3.12) DC network including their connections

[SOURCE: ISO 21498-1:2021, 3.6]

3.6
rechargeable energy storage system
RESS
rechargeable system that stores energy for delivery of electric energy for the electric drive

EXAMPLE Batteries, capacitors, flywheel.

[SOURCE: ISO 21498-1:2021, 3.7]

3.7
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

[SOURCE: ISO 21498-1:2021, 3.8]

3.8
supplier
party that provides *voltage class B* (3.12) components or systems

[SOURCE: ISO 21498-1:2021, 3.9]

3.9
transient
phenomenon or quantity which varies between two consecutive steady states during a short time interval compared to the timescale of interest

[SOURCE: ISO 21498-1:2021, 3.10]

3.10
upper voltage limit
maximum voltage of a *voltage class B* (3.12) sub-class disregarding *transients* (3.9) and *ripple* (3.7)

Note 1 to entry: *Maximum working voltages* (3.4) within a *voltage sub-class* (3.14) are less than or equal to the upper voltage limit.

[SOURCE: ISO 21498-1:2021, 3.11]

3.11
voltage class A
classification of an electric component or circuit with a *maximum working voltage* (3.4) of ≤30 V AC (rms) or ≤60 V DC respectively

[SOURCE: ISO 21498-1:2021, 3.12]

3.12
voltage class B
classification of an electric component or circuit with a *maximum working voltage* (3.4) of (> 30 and ≤ 1 000) V AC (rms) or (> 60 and ≤ 1 500) V DC respectively

[SOURCE: ISO 21498-1:2021, 3.13]

3.13
voltage range
general term covering *voltage sub-class* (3.14), *working voltages* (3.15) and deviations from working voltages

[SOURCE: ISO 21498-1:2021, 3.14]

3.14
voltage sub-class
classification of an electric component or circuit with a DC voltage within the *voltage class B* (3.12)

[SOURCE: ISO 21498-1:2021, 3.15]

3.15
working voltage
AC voltage (rms) or DC voltage that can occur in an electric system under normal operating conditions according to the *customer's* (3.1) specifications, disregarding *transients* (3.9) and *ripple* (3.7)

[SOURCE: ISO 21498-1:2021, 3.16]

4 Abbreviated terms

DUT	device under test
EV	electrically propelled road vehicle
OS	operating status
VCB	voltage class B
VCA	voltage class A

5 General assumptions for voltage class B components

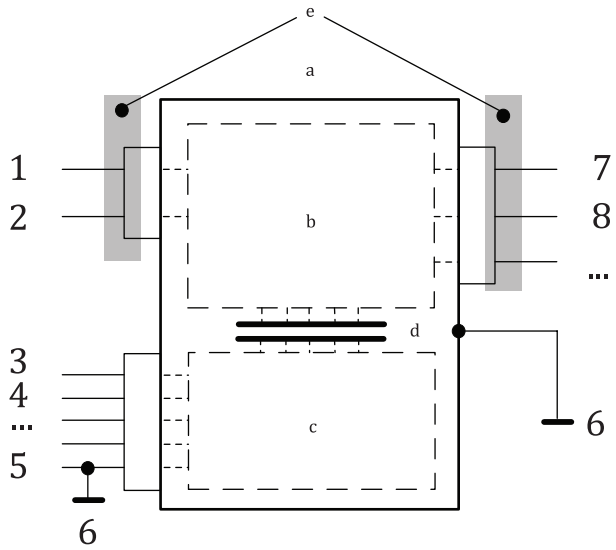
General assumptions and definitions for voltage class B systems shall be in accordance with ISO 21498-1.

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 "U_{VCB}+" and "U_{VCB}-" terminals of a voltage class B component, if not otherwise stated.

Annex A gives an overview of typical components within an electrically propelled road vehicle.

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

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



Key

1	VCB positive connection: U_{VCB}+	8	connection to further VCB component (e.g. AC or DC power network)
2	VCB negative connection: U_{VCB}-	a	DUT.
3	VCA power	b	VCB circuit.
4	I/O and bus signals	c	VCA circuit.
5	VCA terminal with direct connection to the reference potential	d	Galvanic separation between VCA and VCB.
6	reference potential	e	VCB terminals under test.
7	connection to further VCB component (e.g. electric motor)		

Figure 1 — Generalized VCB component diagram

For testing, Figure 2 summarizes the voltage operating ranges and OS of a voltage class B component at its DC voltage class B 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 specified 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 the minimum unlimited operating voltage ($U_{min\_unlimited\_op}$) 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 U_{lower_limit}, the component may derate or cut-off its performance. In this case, the component operates in OS3 or OS4.

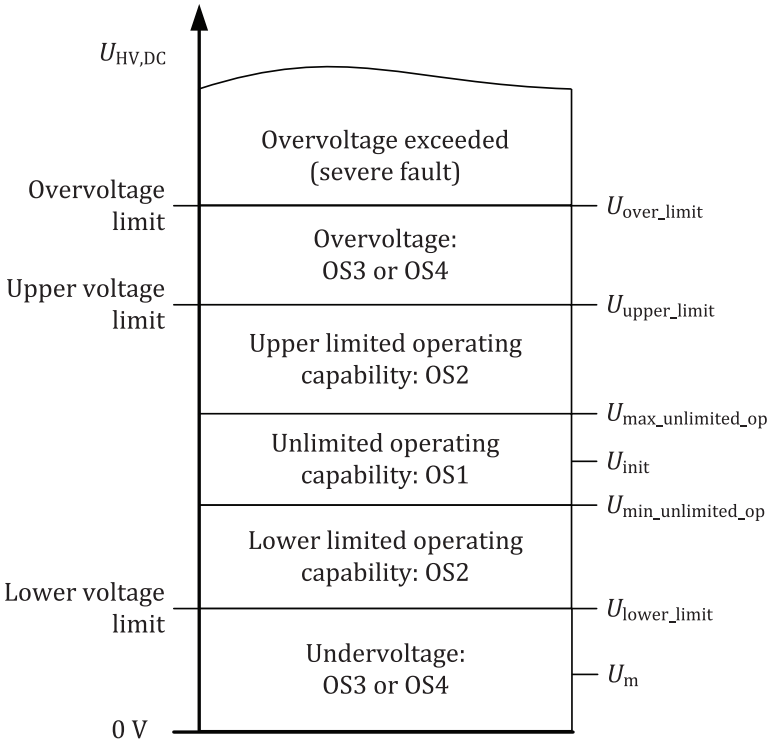


Figure 2 — Component voltage range and limits of corresponding OS

6 Tests and requirements

6.1 Test parameters and general test requirements

6.1.1 Purpose

In 6.1, the specification of test parameters are described, including tolerances and general test requirements. Frequency, time and voltage levels used for the tests are also introduced.

6.1.2 Applicability of tests

Not all tests described in this document are applicable for all voltage class B components. The customer and the supplier shall agree on the applicability of the individual tests for each component.

6.1.3 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.

6.1.4 Voltages

Table 1 contains voltage definitions and their abbreviations.

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_{VCB}	Voltage within voltage class B range
$U_{VCB,DC}$	DC part of the voltage U_{VCB} at the terminals of the DUT
$U_{VCB,AC}$	AC part of the voltage U_{VCB} at the terminals of the DUT (peak value)
U_{PP}	Peak-to-peak value of AC voltage
$U_{VCB,Pidle}$	$U_{VCB,DC}$ at no load operation
$U_{VCB,Ppeak}$	$U_{VCB,DC}$ 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.	

6.1.5 Powers

Table 2 contains power definitions and their abbreviations.

Table 2 — Power definitions and abbreviations

Test parameter	Meaning
P_{cont}	Continuous power of the DUT
P_{max_gen}	Generated 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.	

6.1.6 Temperatures

The tests in this document focus on the electrical behaviour of the component at the voltage class B terminals. Thermal derating is not considered. All tests shall therefore 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.

When performing the electric tests at different temperature levels, the customer and the supplier shall agree on how these tests are to be performed e.g. using a climate chamber or using a heat exchanger for the liquid coolant.

6.1.7 Times and durations

Table 3 contains definitions of times and durations and their abbreviations.

Table 3 — Times/duration definitions and abbreviations

Test parameter	Meaning
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_{idle}	Duration of P_{idle}
t_{peak}	Duration of P_{peak}
t_r	Rise time (e.g. of a voltage profile or a transient event)
t_{test}	Test duration

6.1.8 Standard tolerances

Unless otherwise specified, the tolerances outlined in Table 4 apply with accuracy as shown in Table 5.

The tolerances of the test equipment 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
Amplitude of AC voltage	0 % to +5 % relating to the specified value [b]
Capacitance	±10 % of specified component value [a]
DC voltage	±0,2 % of U_{upper_limit}
Frequency of AC voltage	±1 % relating to the specified value [a]
Inductance	±10 % of specified component value [a]
Resistance	±10 % of specified component value [a]
Time/duration	0 % to +5 % relating to the specified value [b]
[a] The specified value is given in the test description or in Annex B and Annex C.	
[b] The specified value is given in the test description. The value may not be below the given value.	

Table 5 — Accuracy of measurement

Test parameter	Value
DC voltage measurement	±0,5 % of U_{upper_limit}
AC voltage measurement	±1 % of $U_{VCB,AC}$ [a]
DC current measurement	±1 % of measured DC current or 100 mA, whichever is higher
AC current measurement	±3 % of measured AC current or 100 mA, whichever is higher
[a] For the $U_{VCB,AC}$ level, see Annex B.	

6.1.9 Default ambient conditions

Unless otherwise specified, the parameter values of ambient conditions outlined in Table 6 shall be used.

Table 6 — Default ambient conditions

Test parameter	Value	Remark
RT	(23 ± 5) °C	Room temperature
RH	25 % to 75 %	Relative humidity
T_{amb}	RT	Ambient temperature
T_{cool}	According to specification or as agreed by the customer and the supplier	Coolant temperature

6.1.10 Wiring

The DUT shall be connected to the test setup using the following conditions. If there is an attached cable tail at the DUT or a designated wiring, the test setup shall be connected at the end of the existing wiring. If not, a cable with a maximum length of 2 m (straight and parallel if possible) shall be used to connect the DUT to the test setup. The shielding of the wiring depends on DUT target configuration.

6.1.11 Load conditions

The DUT shall be connected to an appropriate load or source. For all tests, the DUT shall be operated at continuous power, if not otherwise stated. If this condition can be reached at several operating points (e.g. speed, torque), the customer and the supplier shall agree on an appropriate operating point.

If a component can consume and deliver electrical energy (e.g. a motor or generator), the component shall be tested in both energy flow directions.

6.1.12 Sampling rates and measured value resolutions

The sampling rate, bandwidth and resolution of the measuring system shall be adapted for the respective test. This document contains tests concerning DC operation only and tests concerning AC characteristics within a frequency range from 10 Hz to 150 kHz.

6.1.13 Data acquisition and processing

Data acquisition is the measurement of electrical signals (e.g. voltage or current) and the conversion into digital signals (acquired data).

Data processing is the processing of the acquired data e.g. filtering. The processing can be done by the measurement device or by post processing.

6.1.14 Parameter monitoring

All additional parameters to be monitored shall be defined for the relevant tests with their value ranges. During the complete test, the parameters to be monitored shall be recorded. The data resulting from the continuous parameter monitoring shall be examined for trends and drifting to detect abnormalities or malfunctions of the component. For components with fault memory, the customer and the supplier shall prior to the testing agree on which component behaviour to store during the test. The fault memory shall be monitored and all entries shall be documented.

6.1.15 Interface description

A detailed description of the states and electrical properties of all interfaces (measuring setup and component) shall be provided.

6.1.16 Documentation

For documentation, see individual requirements given during the test description.

6.2 DC supply voltage variation within operational range

6.2.1 Purpose

This test verifies that the voltage class B component can perform as specified when the DC voltage varies in the range between the lower voltage limit and the upper voltage limit. The purpose is to emulate real battery operation.