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

Véhicules routiers à propulsion électrique — Essais électriques pour des composants ayant une tension de classe B

ICS: 43.120

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56 Foreword

57 ISO (the International Organization for Standardization) is a worldwide federation of national
58 standards bodies (ISO member bodies). The work of preparing International Standards is normally
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62 the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all
63 matters of electrotechnical standardization.

64 The procedures used to develop this document and those intended for its further maintenance are
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66 different types of ISO documents should be noted. This document was drafted in accordance with the
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73 constitute an endorsement.

74 For an explanation on the meaning of ISO specific terms and expressions related to conformity
75 assessment, as well as information about ISO's adherence to the WTO principles in the Technical
76 Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](https://standards.iteh.ai/coupling/standards/iso/21498)

77 The committee responsible for this document is TC ISO/22/SC37.

78 **Introduction**

79 Nowadays, the market size of electric propulsion vehicles and their components is expanding over the
80 world. In accordance with this popularization, to establish various types of standards for developing the
81 equipment has gotten largely required. First specifications and requirements for sub-classes of voltage
82 class B are given in ISO PAS 19295. The existing Standard ISO 16750-2 on electrical tests of automotive
83 components covers only equipment used for voltage class A. It is not suitable to apply on components
84 for electric propulsion system operating at high voltage known as voltage class B because there are
85 differences of working conditions and requirements between low and high voltage systems.

86 This Standard provides electrical tests for electric and electronic components at voltage class B used for
87 electrically propelled road vehicles. The tests are described in a general way. Examples for optional
88 component specific adaptations are given in the Annex.

89 When considering contents of this Standard, normal conditions of components from usual driving
90 status have to be simulated as testing operations. Class B systems experience normal operation at a
91 wide voltage range as well as rapid d.c. voltage increase and decrease due to specific operating
92 conditions. Additional to this an a.c. voltage overlay caused by switching semiconductors inside
93 components has to be taken into account. To guarantee stable operation of class B systems, its
94 components have not only to meet the required robustness against such effects but also to limit e.g. the
95 a.c. voltage they generate.

96 Furthermore deviations from normal operation have to be addressed. Such deviations can occur
97 intentionally or may be caused by a fault. For example, an abrupt voltage change known as load dump
98 caused by switching off electric loads is considered to be a part of this standard.

99 Voltage class B components may have a class A terminal handled by ISO 16750-2. Currently, the
100 influence of the voltage class B by load variation of Class A is very small. Therefore, no tests have to be
101 considered at present. But in the future, it is expected that DCDC converter will supply the electric
102 power from voltage Class A to voltage class B the so-called "bidirectional conversion". As soon as this
103 technology reaches a maturity, adding of respective tests might be necessary.

104 **Electrically propelled road vehicles — Electrical tests for voltage** 105 **class B components**

106 **1 Scope**

107 This Standard applies to electric and electronic components used for electrically propelled road
108 vehicles. It applies to components including electric power sources and loads connected to voltage class
109 B electric circuit of an electric propulsion system. The standard focuses on the behaviour at the d.c.
110 voltage class B terminals of these components.

111 The standard describes testing methods, test conditions and test requirements for components exposed
112 to electrical behaviour at a d.c. voltage class B electric circuit, caused by operation of electric loads and
113 power sources.

114 This standard does not cover electrical safety (see ISO 6469, ISO 17409).

115 **2 Normative references**

116 The following documents, in whole or in part, are normatively referenced in this document and are
117 indispensable for its application. For dated references, only the edition cited applies. For undated
118 references, the latest edition of the referenced document (including any amendments) applies.

119 *ISO PAS 19295:2016, Electrically propelled road vehicles - Specification of voltage sub-classes for voltage*
120 *class B*

121 **3 Terms and definitions**

122 For the purposes of this document the definitions in ISO TR 8713 and the following terms and
123 definitions apply.

124 ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- 125 – IEC Electropedia: available at <http://www.electropedia.org/>
- 126 – ISO Online browsing platform: available at <http://www.iso.org/obp>

127 **3.1**

128 **component operating status**

129 describes the general functional behaviour of components which depend directly on the voltage in
130 voltage class B electric circuits

131 **3.2**

132 **customer**

133 party that is interested in using voltage class B component or system

134 **3.3**

135 **electric circuit**

136 entire set of interconnected live parts through which electrical current is designed to flow under normal
137 operating conditions

138 **3.4**
139 **electric propulsion system maximum working voltage**
140 highest value of d.c. voltage that can occur in an electric propulsion system under any normal operating
141 conditions according to the customer's specifications, disregarding transients

142 **3.5**
143 **generator mode**
144 electric power is provided by the component

145 **3.6**
146 **maximum working voltage**
147 highest value of a.c. voltage (rms) or of d.c. voltage that can occur in an electric system under any
148 normal operating condition according to the customer's specifications, disregarding transients

149 Note 1 to entry: In this definition taken from ISO 6469-3, transients includes ripple.

150 **3.7**
151 **rechargeable energy storage system (RESS)**
152 system that stores energy for delivery of electric power and which is rechargeable

153 EXAMPLE to entry Batteries, capacitors, etc.

154 **3.8**
155 **ripple**
156 set of unwanted periodic deviations with respect to the average value of the measured or supplied
157 quantity, occurring at frequencies which can be related to that of components within a system

158 **3.9**
159 **supplier**
160 party that provides voltage class B component or system

161 **3.10**
162 **transient**
163 pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady
164 states during a time interval short compared with the time-scale of interest

165 **3.11**
166 **voltage class A**
167 classification of an electric component or circuit with a maximum working voltage of less than 30 V a.c.
168 (rms) or 60 V d.c.

169 NOTE 1 to entry: Values for voltage class A are taken from ISO/DIS 6469-3.

170 **3.12**
171 **voltage class B**
172 classification of an electric component or circuit with a maximum working voltage between 30 V a.c.
173 (rms) and 1000 V a.c. (rms) or between 60 V d.c. and 1500 V d.c.

174 **3.13**
175 **upper voltage limit**
176 maximum voltage of a voltage class B sub-class

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

178 3.14

179 **voltage range**

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

181 3.15

182 **voltage sub-class**

183 classification of an electric component or circuit with a d.c. voltage within the voltage class B

184 3.16

185 **working voltage**

186 a.c. voltage (rms) or d.c. voltage that can occur in an electric system under normal operating conditions
187 according to the customer's specifications, disregarding transients

188 Note 1 to entry: In this definition taken from ISO 6469-3, transients include ripple.

189 4 List of Abbreviations

190 DUT device under test

191 EV electrically propelled road vehicle

192 HV high voltage

193 LISN line impedance stabilization network [ISO/DIS 21498](#)

194 OS operating status <https://standards.iteh.ai/catalog/standards/sist/21b62db9-3c80-46e9-9ef2-ae5e2a082bd3/iso-dis-21498>

195 RT room temperature

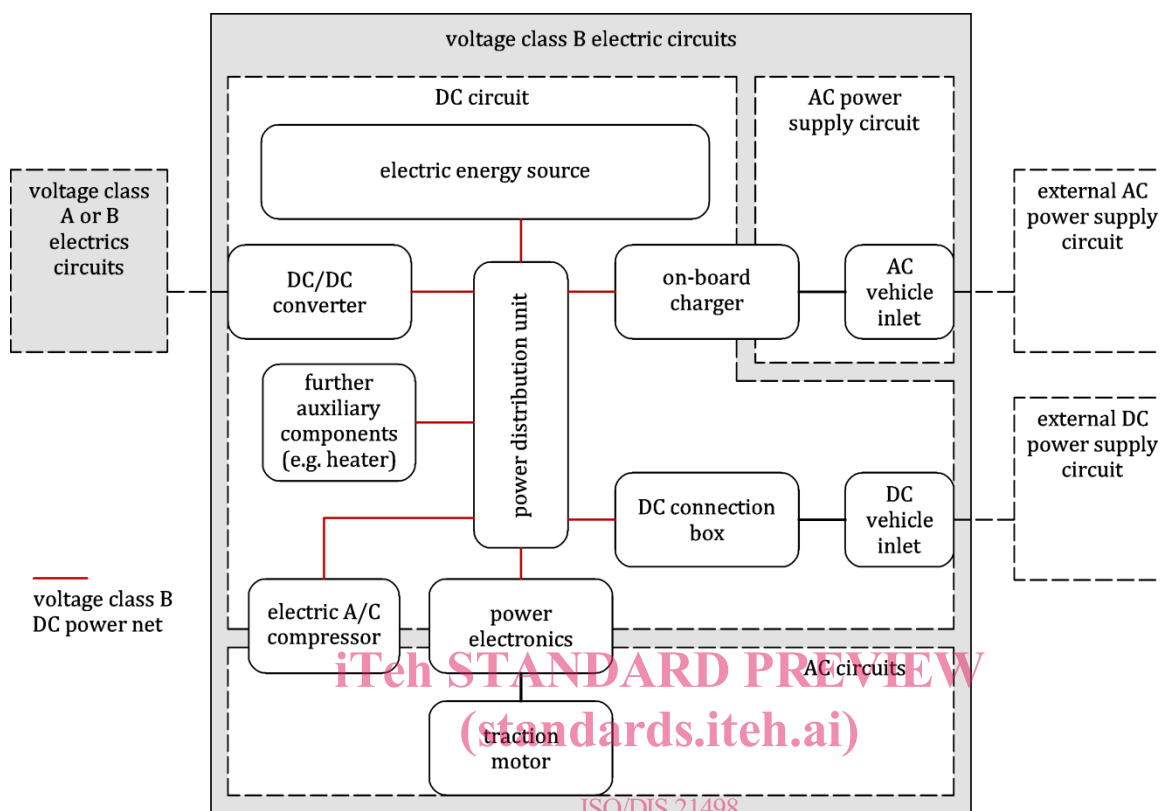
196 5 General assumptions for voltage class B-Network

197 5.1 The d.c. voltage class B system

198 The d.c. voltage class B system in electrically propelled road vehicles consists of electric components
199 and the wiring harness to connect the components. Its main parts are the electric energy source and the
200 electric drive. The primary function of the d.c. voltage class B system is the supply of electric energy to
201 propel the EV. Other functions are charging of an RESS, supply of voltage class A electric circuits and
202 auxiliary components.

203 The main energy flow in the d.c. voltage class B system is caused by the electric drive, the energy source
204 and an external d.c. power supply if any. Besides the high current load also transients and ripple in the
205 system mostly originate from these components. Therefore they have major influence on the design of
206 the d.c. voltage class B system. Within this standard transients and ripples, which are generated by a
207 single component, are referred to as "generated transient" and "generated ripple". Transients and
208 ripples within this class B system, which the components of the system are exposed to, are referred to
209 as "present transient" and "present ripple".

210 An example of a voltage class B system is shown in Figure 1. The actual configuration of the voltage
 211 class B electric circuit of the electric propulsion system and its conductively connected auxiliary electric
 212 components is vehicle specific and specified by the customer.



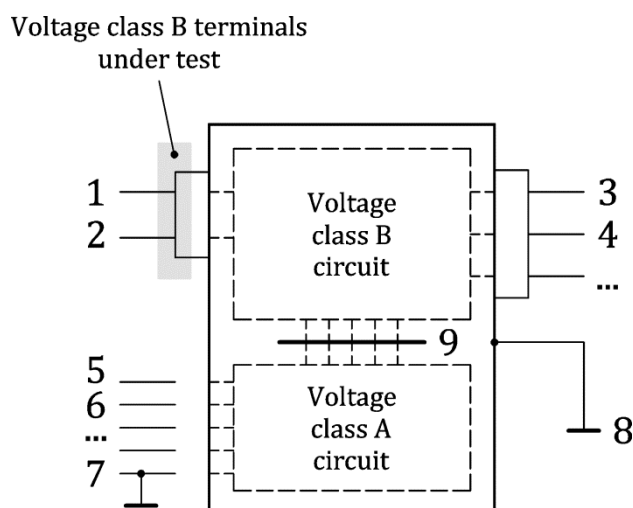
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 214 <https://standards.iteh.ai/catalog/standards/sist/21b62db9-3c80-46e9-9ef2->
 Figure 1 - Example of an electric system for an EV

215 **5.2 HV components**

216 Figure 2 shows a generalized view on a voltage class B component. Some of the connections shown may
 217 not be available with all voltage class B components. The specifications and descriptions of voltages for
 218 a component shall apply in this standard to the voltage at its terminals “HV+” and “HV-“ if not otherwise
 219 stated.

220 A voltage class B component may have multiple interfaces of each type of voltage (Voltage class B d.c.,
 221 voltage class B a.c., voltage class A, according to Figure 2). For example a d.c./d.c. converter may
 222 interface to two voltage class B electric circuits.

223 A HV component may have different voltage class B d.c. terminals. The tests described in this document
 224 shall be fulfilled for each of these terminals.

**Key**

d.c. voltage class B connection:

1 HV+

2 HV-

Secondary voltage class B connection:

3 e.g. electric motor

4 e.g. a.c. or d.c. power net

Voltage class A connections:

5 Voltage class A power

6 I/O and bus signals

7 Terminal with direct connection to battery minus or ground

Equipotential bonding:

8 Electrical chassis

Internal galvanic separation:

9 Galvanic separation between voltage class A and voltage class B circuits

Figure 2 - Generalized voltage class B component diagram

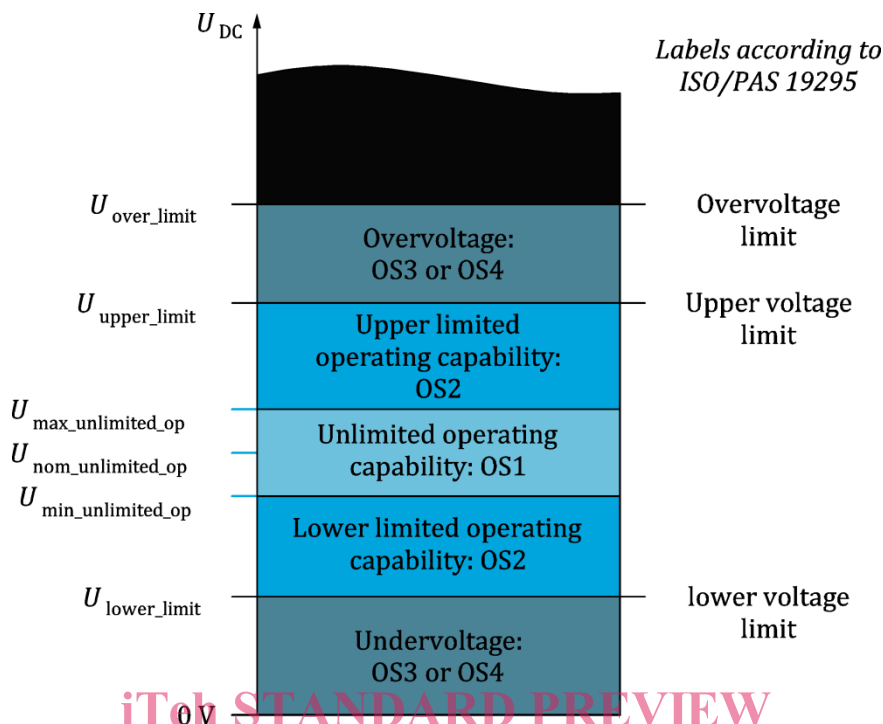
For the purpose of testing Figure 3 summarizes the voltage operating ranges and OS of a voltage class B component at its voltage class B d.c. voltage terminals according to ISO PAS 19295. The overvoltage limit, the upper voltage limit and the lower voltage limit are properties of the component. Each voltage class B component shall have a voltage range within it can be operated in full performance (unlimited operating capability) and in which all designated functions, including short-time overload operations shall be available. According to ISO PAS 19295 components operating within this voltage range are 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 ($U_{\text{upper_limit}}$) is reached. According to ISO PAS 19295 the component operates in OS2.

Above the upper voltage limit ($U_{\text{upper_limit}}$) the component may derate or cut-off its performance for self-protection. The component shall withstand this overvoltage until the overvoltage limit ($U_{\text{over_limit}}$) is reached. In this case the component operates in OS3 or OS4 according to ISO PAS 19295.

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” ($U_{\text{lower_limit}}$) the component may reduce its performance as specified. In this case, the component performs in OS2 according to ISO PAS 19295.

260 If the supply voltage is below the lower voltage limit ($U_{\text{lower_limit}}$) the component may derate or cut-off its
 261 performance. In this case the component operates in OS3 or OS4 according to ISO PAS 19295.



262
 263 Figure 3 - Component OS at voltage operating ranges

264 **6 Tests and requirements**

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265 **6.1 Test parameters and general test requirements**

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266 **6.1.1 Purpose**

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

269 **6.1.2 Test setup**

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

272 6.1.3 Voltages

273

Table 1 – Voltages used

Test parameter	Value
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)}
$U_{nom_unlimited_op}$	Nominal voltage for unlimited operating capability ^{b)}
$U_{min_unlimited_op}$	Minimum voltage for unlimited operating capability ^{b)}
^{a)} Voltage defined in ISO PAS 19295	
^{b)} See Figure 3 for illustration. The unlimited operating capability is defined in ISO PAS 19295	

274

275 The nominal voltage for unlimited operating capability shall be calculated as follows:

$$U_{nom_unlimited_op} = (U_{max_unlimited_op} + U_{min_unlimited_op}) \div 2$$

276 6.1.4 Temperatures

277

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Test parameter	Value
T_{min}	Minimum operating temperature
T_{max}	Maximum operating temperature
T_{test}	Test temperature
T_{cool}	Coolant temperature
$T_{cool,high}$	Highest coolant temperature
$T_{cool,low}$	Lowest coolant temperature

278

279 Temperature classification is shown in Annex B.

280 If the electric tests are performed at different temperature levels, Annex C gives guidance how to
 281 perform these tests.

282 6.1.5 Times and durations

283 Table 3 - Abbreviations for times/durations

Test parameter	Value
t_r	Rise time (e.g., of a voltage profile)
t_f	Fall time (e.g., of a voltage profile)
t_h	Hold time (e.g., of a voltage profile)
t_{test}	Test duration

284

285 6.1.6 Standard tolerances

286 Unless otherwise specified, the tolerances in accordance with Table 4 apply with accuracy as shown in
287 Table 5

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

290 Table 4 - Standard tolerances for test equipment

Test parameter	Value
d.c. voltage value	$\pm 0,2 \%$ of U_{upper_limit}
Amplitude of a.c. voltage value	- 0 % to +5 % relating to the specified value ^{a)}
Frequency of a.c. voltage	$\pm 1 \%$
Resistance	$\pm 5 \%$
Inductance and capacitance	$\pm 10 \%$
Time/duration	-0 % to + 5 %
a) The specified value is given in the test description. The amplitude may not be smaller than the given value.	

291

292 Table 5 - Accuracy of measurement

Test parameter	Value
Voltage measurement	$\pm 0,5 \%$ of U_{upper_limit}
Current measurement	$\pm 1 \%$ or 100 mA, whichever is greater

293

294 6.1.7 Ambient conditions

295 Unless otherwise specified, the values in accordance with Table 6 apply.

296

Table 6 – Test conditions

Test parameter	Value
RT	$T_{RT} = 23 \text{ °C} \pm 5 \text{ °C}$
Relative Humidity	25 % to 75 %
Test temperature	$T_{test} = T_{RT}^{a)}$
Coolant temperature	$T_{cool} = T_{RT}^{a)}$
a) RT shall be used if temperature has no impact	

297

298 6.1.8 Sampling rates and measured value resolutions

299 Sampling rate and/or bandwidth and resolution of the measuring system shall be adapted for the
300 respective test. This standard contains tests concerning d.c. operation only and tests concerning a.c.
301 characteristics within a frequency range from 10 Hz to 150 kHz.

302 6.1.9 Parameter monitoring

303 All additional parameters to be monitored shall be defined for the relevant tests with their value ranges.
304 During the complete test, the parameters to be monitored shall be recorded. For components with fault
305 memory, the fault memory shall be monitored and all entries shall be documented. The data resulting
306 from the continuous parameter monitoring shall be examined for trends and drifting to detect
307 abnormalities or malfunctions of the component.

308 6.1.10 Interface description

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

311 6.2 Direct current supply voltage

312 6.2.1 Purpose

313 The following test verifies that the DUT is able to perform as specified, when d.c. voltage changes in the
314 range between the lower voltage limit and the upper voltage limit, considering the real battery
315 operation.

316 6.2.2 Test setup

317 The test setup in Figure 4 shall be used for all d.c. supply voltage tests of the voltage class B electric
318 system. Length l for the shielded cables shall be at least 200 mm or the length of the original cables
319 installed in the dedicated vehicle project.