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2/1967/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

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IEC TC 2 : ROTATING MACHINERY	
SECRETARIAT: United Kingdom	SECRETARY: Mr Charles Whitlock
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: <input type="checkbox"/> EMC <input type="checkbox"/> ENVIRONMENT <input type="checkbox"/> QUALITY ASSURANCE <input type="checkbox"/> SAFETY	
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TITLE:

Rotating machinery – Test methods and apparatus for the measurement of the operational characteristics of brushes

PROPOSED STABILITY DATE: 2022

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

TEST METHODS AND APPARATUS FOR THE MEASUREMENT
OF THE OPERATIONAL CHARACTERISTICS OF BRUSHES

FOREWORD

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PREFACE

International standard IEC 60773:XXX has been prepared by IEC subcommittee MT14: Brushes and Brush-Holders for electrical machinery, under the responsibility of IEC technical committee 2:Rotating Machinery.

This second edition cancels and replaces the first edition published in 1983. It constitutes a technical revision.

All changes and additions are too numerous to be listed. However main changes can be summarized as follow:

- The layout has been updated and adjusted to comply with the ISO/IEC Directives, Part 2.
- The clause structure has been modified on the view point of a laboratory testing procedure. The new sequence is as follows: test rig specification (clause 4), general

56 testing procedure (clause 5), and each operational characteristic procedure (clauses 6 to
57 8).

58 – A new clause 9 has been added to introduce the black band test for the characterisation of
59 the brush grades for DC machines.

60 The text of this standard is based on the following documents:

FDIS	Report on voting
1/####/FDIS	1/####/RVD

61 Full information on the voting for the approval of this standard can be found in the report on
62 voting indicated in the above table.

63 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

64 The National Committees are requested to note that for this document the stability date
65 is 2029.

66 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE
67 DELETED AT THE PUBLICATION STAGE.

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ROTATING ELECTRICAL MACHINES –

TEST METHODS AND APPARATUS FOR THE MEASUREMENT OF THE OPERATIONAL CHARACTERISTICS OF BRUSHES

78 **1 Scope**

79 This standard applies to test methods for the measurement of the operational characteristics
80 of brushes designed to operate on commutating and slip ring machines under specified test
81 conditions.

82 By extension some tests may be relevant for other kind of sliding electrical contacts for
83 electrical appliances.

84 **2 Normative References**

85 The following documents are referred to in the text in such a way that some or all of their
86 content constitutes requirements of this document. For dated references, only the edition
87 cited applies. For undated references, the latest edition of the referenced document (including
88 any amendments) applies.

89 IEC 60027-1, *Letter symbols to be used in electrical technology – Part 1: General*

90 IEC 60027-4, *Letter symbols to be used in electrical technology – Part 4: Rotating electrical*
91 *machines*
<https://standards.iteh.ai/catalog/standards/sist/87c56119-e6b9-4c85-bd65-d8f2b8d5942c/ksist-fpren-iec-60773-2021>

92 IEC 60034-19:2014, *Rotating electrical machines - Part 19: Specific test methods for d.c.*
93 *machines on conventional and rectifier-fed supplies*

94 IEC 60050-411, *International Electrotechnical Vocabulary - Chapter 411: Rotating machinery*

95 IEC 60136, *Dimensions of Brushes and Brush-holders for Electrical Machinery*

96 IEC 60276:2018, *Definitions and nomenclature for brushes, brush-holders, commutators and*
97 *slip rings*

98 IEC 60560, *Definitions and terminology of brush-holders for electrical machines*

99 IEC 60584-1:2013, *Thermocouples – Part 1: EMF specifications and tolerances*

100 IEC 60751:2008, *Industrial platinum resistance thermometers and platinum temperature*
101 *sensors*

102 IEC/TR 61015, *Brush-holders for electrical machines. Guide to the measurement of the static*
103 *thrust applied to brushes*

104 ISO 1190-1:1982, *Copper and copper alloys – code of designation – Part 1: Designation of*
105 *materials*

106 ISO 3274:1996, *Geometrical Product Specifications (GPS) - Surface texture: Profile method -*
107 *Nominal characteristics of contact (stylus) instruments*

108 ISO 4287:1997/Amd 1:2009, *Geometrical Product Specifications (GPS) - Surface texture:*
 109 *Profile method - Terms, definitions and surface texture parameters - AMENDMENT 1: Peak*
 110 *count number*

111 ISO 15510, *Stainless steel – Chemical composition*

112 **3 Terms, definitions, symbols and abbreviated terms**

113 For the purposes of this document, the terms and definitions given in standards specified in
 114 clause 2, some of which are repeated here for convenience, and the following apply.

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

- 117 • IEC Electropedia: available at <http://www.electropedia.org/>
- 118 • ISO Online browsing platform: available at <http://www.iso.org/obp>

119 **3.1 Terms and definitions**

120 **3.1.1**

121 **run-out**

122 runout

123 an inaccuracy of the rotating system, measured on the surface of the ring while turning

124 Note 1 to entry: This includes out-of-round (that is, lacking sufficient roundness); eccentricity (that is, lacking
 125 sufficient concentricity); or axial bending, (regardless of whether the surfaces are perfectly round and concentric at
 126 every cross-sectional point).

127 **3.1.2**

128 **roughness**

129 *Ra*

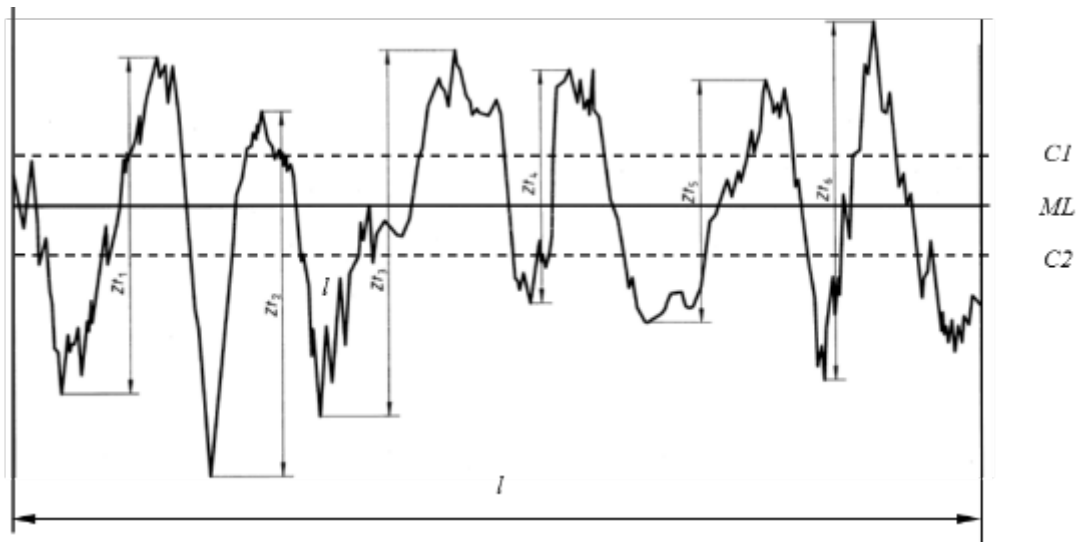
130 arithmetic mean of the absolute ordinate value $Z(x)$ of a profile within a sampling length l

$$Ra = \frac{1}{l} \times \int_0^l |Z(x)| dx$$

131 Example: Figure 1 below shows an example of profile.

132

133



134

135 **Key:**

editorial note 1 for IEC: figure, key and title are expected to be only on one page

136 z_{t_i} profile element i height137 l sampling length138 ML mean line139 $C1$ and $C2$ upper and lower intersection lines (respectively)

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140 **Figure 1 – Profile and determination of height of profile elements**

141 [source: ISO 4287:1997] <https://standards.iteh.ai/catalog/standards/sist/87c56119-e6b9-4c85-bd65-d8f2b8d5942c/ksist-fpren-iec-60773-2021>

142 **3.1.3**143 **peak count**144 **RP_c**

145 number of profile elements per centimeter of sampling length which exceed the upper
146 intersection line $C1$ and fall short of the lower intersection line $C2$

147 Note 1 to entry: Both intersection lines are parallel to the diagram mean line (see figure 1).

148 [source: ISO 4287/A1:2007]

149 **3.1.4**150 **abrasive stone**

151 material used to grind a surface

152 Note 1 to entry: The quality of the material and the method of appliance depend on its use. Therefore for this
153 standard purpose we will use the definitions 3.1.5, 3.1.7 and 3.1.8.

154 **3.1.5**155 **grinding stone**

156 abrasive stone used to grind the test ring

157 Note 1 to entry: It is generally made of hard abrasive grains

158 **3.1.6**159 **brush fitting**

160 operation at the end of which the brush contact surface is matching the ring profile

161 **3.1.7**
 162 **fitting stone**
 163 abrasive stone used for fitting the brush to the commutator/ring

164 **3.1.8**
 165 **roughness stone**
 166 abrasive stone used to obtain the proper range of roughness to the test ring, generally made
 167 of soft abrasive grain

168 **3.1.9**
 169 **brush contact area**
 170 S
 171 area of the brush in contact with the ring surface

172 Note 1 to entry: When radial brush is used the brush contact surface area S_r is the cross section of the brush:

173 **editorial note 2 for IEC : formula size**
 174 **changes when adding the numbering**
 175 **(2) – same issue with other formula**
 176 **(see note 1 beside the formula)**
 177 **Original is:**

$$S_\alpha = \frac{t \times a}{\cos \alpha} \quad (1)$$

and axial dimensions of the brush.
 is part of the formula giving the brush contact surface area S_α :

$$S_\alpha = \frac{t \times a}{\cos \alpha} \quad (2)$$

177 where α is the contact angle (or bottom angle).

178 **3.1.10**
 179 **brush specific pressure**
 180 p
 181 force per contact area of the brush, given by the the formula below.

182
$$p = \frac{F_p}{S} \quad \text{see note 2} \quad (3)$$

183 where F_p is the force applied by the pressure system
 184 and S is the brush contact surface area

185 Note 1 to entry: When F_p is expressed in grams force (gf) and brush contact surface in cm^2 the calculated specific
 186 pressure is in gf/cm^2 . To convert into SI units: the result in gf/cm^2 multiplied by 98,07 gives p in N/m^2 (98,07 is the
 187 gravitational acceleration in m/s^2 multiplied by 10).

188 **3.1.11**
 189 **current ripple factor**
 190 q_i
 191 ratio of the difference between the maximum value I_{\max} and the minimum value I_{\min} of an
 192 undulating current to two times the average value \bar{I} (mean value integrated over one period):

$$q_i = \frac{I_{\max} - I_{\min}}{2 \times \bar{I}}$$

193 Note 1 to entry: For small values of current ripple, the ripple factor may be approximated by the following
 194 expression:

$$q_i = \frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$$

195 Note 2 to entry: The above expression may be used as an approximation if the resulting calculated value of q_i is
 196 equal to or less than 0,4.

197 [source: IEC 60034-1:2017]

198 **3.1.12**
199 **stable state**

200 state of a physical system in which the relevant characteristics is considered to be sensibly constant
201 with time

202 [source: IEC 60050-103-05-01]

203 **3.1.13**
204 **sensibly constant**

205 a measurement result is considered as sensibly constant when deviation from mean value of a
206 minimum of 3 consecutive measurements is less than 2,5 % (except otherwise specified)

207 Note 1 to entry: Stability state may be determined from the time-measurement rise plot when the straight lines
208 between points at the beginning and end of two successive intervals of half hour each have a deviation of less than
209 the criteria of 2,5 %.

210 **3.1.14**
211 **friction coefficient**

212 μ

213 ratio of tangential force F_t acting at the interface to the radial force F_r acting at the interface

214 it is calculated from the formula (4) below:

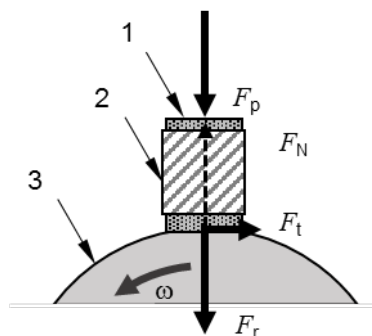
$$\mu = \frac{F_t}{F_r} \quad (4)$$

see note 2

215 where F_t is the tangential component of the forces acting at the interface

216 F_r is the radial component of the forces acting at the interface

217 NOTE 1 to entry: Figure 2 illustrates the forces acting on the brush when a radial brush-holder is applied. The
218 numerical value of radial force F_r is equal to the numerical value of the normal reaction force F_N (of the brush
219 contact surface on the ring) and to the numerical value of the pressure system force F_p on the brush top.
220



221

222 **Key:**

223 1 Brush

224 2 Brush-holder

225 3 Test ring

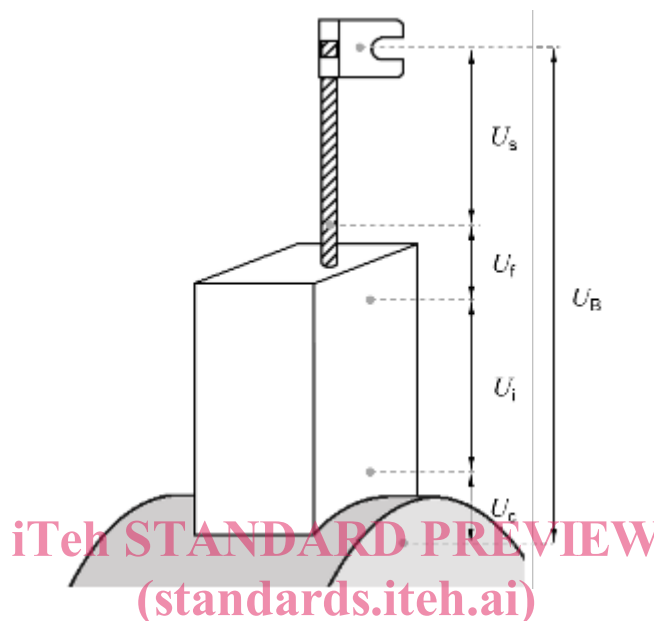
226 ω Angular velocity (giving the rotation direction)

227

Figure 2 – Forces acting on a brush

228 **3.1.15**
 229 **brush voltage drop**
 230 U_B
 231 total voltage drop between the brush terminal and the slip ring or commutator

232 NOTE 1 to entry: U_B is a complex parameter which is made up from the sum of the voltage drops U_s , U_f , U_i , and
 233 U_c as illustrated in Figure 2 (which concerns a brush with a tamped flexible).



234

235

Figure 3 – Voltage drops in a brush when in operation

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236 **3.1.16** [https://standards.iteh.ai/catalog/standards/sist/87c56119-e6b9-4c85-bd65-](https://standards.iteh.ai/catalog/standards/sist/87c56119-e6b9-4c85-bd65-d8f2b8d5942c/ksist-fpren-iec-60773-2021)
 237 **shunt voltage drop** [d8f2b8d5942c/ksist-fpren-iec-60773-2021](https://standards.iteh.ai/catalog/standards/sist/87c56119-e6b9-4c85-bd65-d8f2b8d5942c/ksist-fpren-iec-60773-2021)

238 U_s

239 voltage drop in the shunt (flexible) and in the shunt connection to the brush terminal

240 **3.1.17**

241 **connection drop**

242 U_f

243 voltage drop between the shunt (flexible) and the brush grade

244 Note 1 to entry: The connection drop U_f measurement is described in IEC 60136

245 **3.1.18**

246 **brush internal drop**

247 U_i

248 internal voltage drop of the brush (due to the brush grade resistance)

249 **3.1.19**

250 **brush contact drop**

251 U_c

252 voltage contact drop between the brush grade and the ring

253 Note 1 to entry: The brush contact drop U_c is an operating characteristic of a brush. See clause 7.

254 **3.1.20**

255 **slot pitch**

256 τ_Q

257 distance between two consecutive slots of the ring, defined by the periphery of the ring $\pi \times D$
 258 divided by the number of slots Q