
Električni rotacijski stroji - 3. del: Posebne zahteve za sinhronske generatorje, ki jih poganjajo parne ali plinske turbine, in za sinhronske kompenzatorje (IEC 60034-3:2007)

Rotating electrical machines - Part 3: Specific requirements for synchronous generators driven by steam turbines or combustion gas turbines and for synchronous compensators

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<input checked="" type="checkbox"/> SUBMITTED FOR CENELEC PARALLEL VOTING Attention IEC-CENELEC parallel voting The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	<input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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TITLE:

Rotating electrical machines - Part 3: Specific requirements for synchronous generators driven by steam turbines or combustion gas turbines and for synchronous compensators

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES

**Part 3: Specific requirements for synchronous generators
driven by steam turbines or combustion gas turbines
and for synchronous compensators**

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International Standard IEC 60034-3 has been prepared by IEC Technical Committee 2: Rotating machinery.

This seventh edition cancels and replaces the sixth edition published in 2007. This edition constitutes a technical revision. The significant technical changes with respect to the previous edition are as follows:

- Scope extended to synchronous compensators
- Rotor overcurrent requirements added
- Impact of stator harmonics on rotor unbalanced load capability introduced
- Synchronisation requirements added
- Adjustments of temperatures or temperature rise revised for gas turbine applications
- Requirements for auxiliaries updated

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

FDIS	Report on voting
2/XXXX/FDIS	2XXXX/RVD

56
57 Full information on the voting for the approval of this standard can be found in the report on
58 voting indicated in the above table.

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

60 A list of all parts of IEC 60034 series, published under the general title *Rotating electrical machines*,
61 can be found on the IEC website.

62 The committee has decided that the contents of this publication will remain unchanged until
63 the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in
64 the data related to the specific publication. At this date, the publication will be

- 65 • reconfirmed,
- 66 • withdrawn,
- 67 • replaced by a revised edition, or
- 68 • amended.

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ROTATING ELECTRICAL MACHINES

Part 3: Specific requirements for synchronous generators driven by steam turbines or combustion gas turbines and for synchronous compensators

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1 Scope

79 This part of IEC 60034 applies to large three-phase synchronous generators, having rated
80 outputs of 10 MVA and above driven by steam turbines or combustion gas turbines. Also
81 included are synchronous MVar compensators of the same output range connected to a grid
82 for the purpose of exchanging reactive power.

83 This standard supplements basic requirements for rotating machines given in IEC 60034-1.

84 Common requirements are prescribed together with specific requirements for air, hydrogen or
85 liquid cooled synchronous generators or compensators.

86 This part of IEC 60034 also gives the precautions to be taken when using hydrogen cooled
87 generators including:

- 88 – rotating exciters driven by synchronous generators;
- 89 – auxiliary equipment needed for operating the generators;
- 90 – parts of the building where hydrogen might accumulate.

91 NOTE 1 These requirements also apply to a synchronous generator driven by both a steam turbine and a
92 combustion gas turbine as part of a single shaft combined cycle unit.

93 NOTE 2 These requirements do not apply to synchronous generators driven by water (hydraulic) turbines or wind
94 turbines.

95 NOTE 3 The precautions to be taken when using hydrogen are valid for all cases where hydrogen is used as a
96 coolant.

2 Normative references

98 The following referenced documents are indispensable for the application of this document.
99 For dated references, only the edition cited applies. For undated references, the latest edition
100 of the referenced document (including any amendments) applies.

101 IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

102 IEC 60034-4, *Rotating electrical machines – Part 4: Methods for determining synchronous
103 machine quantities from tests*

104 IEC 60034-18, *Rotating electrical machines - Part 18-1: Functional evaluation of insulation
105 systems - General guidelines*. Depending on the insulation system used and the winding
106 design, additional parts of IEC 60034-18 are applicable.

107 IEC 60045-1, *Steam turbines – Part 1: Specifications*

108 IEC 60079 (all parts), *Electrical apparatus for explosive gas atmospheres*

109 IEC 60085, *Electrical insulation - Thermal evaluation and designation*

3 Terms and definitions

111 For the purposes of this document, the terms and definitions in IEC 60034-1 together with the
112 following additions apply.

113 3.1 Grid

114 In this standard 'grid' is used for a public electrical network or a local (e.g. industrial) network,
115 which is connected to the generator or compensator either directly or through a transformer.

116 3.2 Synchronous Generator

117 Generators covered by this standard are large synchronous machines driven by steam or gas
118 turbines. They convert mechanical energy into electrical energy and supply it to an electrical
119 grid. Generators can also provide reactive power to the grid. The driving unit itself or
120 additional equipment is used to start up the generating unit.

121 3.3 Synchronous Compensator

122 A synchronous compensator is a large synchronous machine electrically coupled to the grid
123 but not exchanging mechanical energy through the shaft during steady state operation.
124 Reactive power is supplied to the grid or imported to the compensator by means of adjusting
125 the field current. The losses are covered by the grid. A compensator needs a start-up device,
126 which accelerates the unit to operating speed.

127 3.4 Mechanical start

128 Change in speed from zero or turning gear speed to rated speed.

129 3.5 Turning gear operation

130 Rotation at low speed to avoid undesirable bending of turbine- and/or generator/compensator-
131 rotors due to uneven circumferential temperature distribution.

132 4 General

133 4.1 General rules

134 Turbine driven synchronous generators and synchronous compensators shall fulfil the basic
135 requirements for rotating machines specified in IEC 60034-1 unless otherwise specified in this
136 standard.

137 Wherever there is reference to an agreement in this standard, it shall be understood as an
138 agreement between manufacturer and purchaser.

139 4.2 Rated conditions

140 4.2.1 Generators

141 The rated conditions of a generator are given by the rated values of

- 142 – the apparent power;
- 143 – frequency;
- 144 – voltage;
- 145 – power factor;
- 146 – primary coolant temperature (40°C unless otherwise agreed upon);
- 147 – field current and field voltage (see also NOTE below);

148 and where applicable

- 149 – site altitude;
- 150 – hydrogen pressure with indication whether the figure is to be interpreted as absolute or
151 gauge pressure;
- 152 – range of hydrogen purity, see IEC 60034-1.

153 4.2.2 Compensators

154 The rated conditions of a compensator are basically the same as those of a generator but with
155 different definitions of apparent power and power factor.

- 156 – The rated apparent power consists mainly of the maximum reactive output at rated voltage
157 when the machine is overexcited, and of a small amount of active power delivered to the
158 compensator.

159 - The rated power factor is close to zero, reflecting mainly the maximum reactive power and
160 the losses compensated by the grid.

161 For compensators, the range of reactive power shall be agreed upon.

162 NOTE During operation, the field current of a generator or compensator is adjusted depending on the demand of
163 reactive power. Generator/compensator rated field current and field voltage are those values needed to operate the
164 generator/compensator at rated conditions. Generator/compensator modelling studies may require base values for
165 field current and field voltage other than rated.

166 4.3 Rated voltage

167 The rated voltage shall be agreed upon.

168 4.4 Power factor

169 The power factor of a generator shall be agreed upon. Standardised rated power factors at
170 the generator terminals are 0,8, 0,85 and 0,9 overexcited.

171 NOTE 1 The lower the rated power factor the larger the generator will be.

172 NOTE 2 The rated power factor should reflect the demand on reactive power overexcited at rated active power
173 output including some margin.

174 NOTE 3 It is recommended that the generator is capable of providing a power factor of 0,95 underexcited at rated
175 active power output.

176 The power factor of a synchronous compensator deviates from zero only by an amount, which
177 depends on the losses compensated by the grid.

178 4.5 Rated speed

179 Synchronous generators or compensators are typically connected to a grid with a fundamental
180 operating frequency of 50Hz or 60Hz.

181 The rated speed is

182 $3\,000/p \text{ min}^{-1}$ for 50 Hz generators or compensators;

183 $3\,600/p \text{ min}^{-1}$ for 60 Hz generators or compensators;

184 where p is the number of pole pairs.

185 4.6 Ranges of voltage and frequency

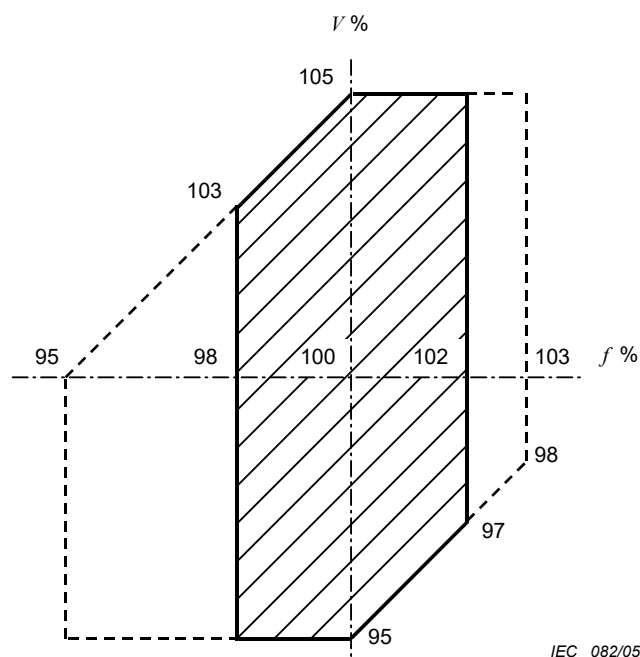
186 Synchronous generators and compensators shall be capable of continuous rated output at the
187 rated power factor over the ranges of $\pm 5\%$ in voltage and $\pm 2\%$ in frequency, as defined by
188 the shaded area of Figure 1.

189 The temperature rise limits in Tables 8 and 9, or the temperature limits in Table 13 of
190 IEC 60034-1:2017 shall apply at the rated voltage and frequency.

191 Potentially required operation outside the dashed borderline of Fig. 1 shall be the subject of
192 an agreement.

193 NOTE 1 If the operating point deviates from the rated values of voltage and frequency, the temperature rise or
194 total temperatures change and may progressively increase. Continuous operation at rated output at certain parts of
195 the boundary of the shaded area may cause additional temperature rise of up to approximately 10 K. Generators or
196 compensators will also carry output at rated power factor within the ranges of $\pm 5\%$ in voltage and $-5\% \dots +3\%$ in
197 frequency, as defined by the outer boundary of Figure 1, but temperature rises will be further increased. As
198 IEC 60034-1 applies to rated conditions, operation outside the shaded area should be limited in extent, duration
199 and frequency of occurrence in order to minimize the reduction of lifetime due to thermal effects. The output should
200 be reduced or other corrective measures taken as soon as practicable.

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IEC 082/05

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Figure 1 – Operation over ranges of voltage and frequency

NOTE 2 Overvoltage together with low frequency, or low voltage with over-frequency, are considered to be unlikely operating conditions. The former condition most likely increases the temperature rise of the field winding. Figure 1 shows operation in these quadrants restricted to conditions that will cause the generator or compensator and its transformer to be over- or under-fluxed by approximately 5%. Margins of excitation and of stability will be reduced under some of the operating conditions shown. With the operating frequency deviating from the rated frequency, effects outside the generator or compensator may become important and need to be considered. For example: The turbine manufacturer will specify permissible ranges of frequency and corresponding operating periods. Also, a certain range of permissible operating voltages and frequencies may apply to auxiliary equipment.

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212 **4.7 Direction of rotation** [eh.ai/catalog/standards/sist/3655bbda-ca34-481a-8a30-](https://eh.ai/catalog/standards/sist/3655bbda-ca34-481a-8a30-60034-3-2020)

213 The direction of rotation shall be shown on the machine or on its rating plate, and the time-
214 phase sequence of the stator voltage shall then be indicated by marking the terminals in the
215 sequence in which their voltages reach maximum, for example, U_1 , V_1 , W_1 .

216 NOTE Terminal markings may not be consistent with IEC 60034-8.

217 For generators having one driven end, this shall be the reference end for the direction of
218 rotation.

219 For generators driven on both ends, the end of the more powerful drive shall be the reference
220 end. In case of comparable drive power on either end, the end opposite to the excitation
221 terminals shall be the reference end for the direction of rotation.

222 The reference end of synchronous compensators shall be the end opposite to the excitation
223 terminals

224 The sense of rotation (clockwise or counter-clockwise) shall be defined when facing the rotor
225 from the reference side.

226 The phase sequence of the generator or compensator must coincide with the phase sequence
227 of the grid to which the generator or compensator is to be connected.

228 **4.8 Stator winding, output voltage**

229 Unless otherwise agreed upon, the stator winding shall be arranged in star configuration. All
230 phase ends shall be accessible from outside of the casing. The arrangement of the electrical
231 terminals shall be agreed upon.

232 Output voltage is defined as the line to line voltage of the stator winding.