IEC 60034-16-1

Edition 2.0 2011-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Rotating electrical machines –
Part 16-1: Excitation systems for synchronous machines – Definitions

Machines électriques tournantes –
Partie 16-1: Systèmes d'excitation pour machines synchrones – Définitions

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 60034-16-1

Edition 2.0 2011-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Rotating electrical machines –
Part 16-1: Excitation systems for synchronous machines – Definitions

Machines électriques tournantes –
Partie 16-1: Systèmes d'excitation pour machines synchrones – Définitions

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX L

ICS 29.160

ISBN 978-2-88912-487-9

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

ROTATING ELECTRICAL MACHINES –

Part 16-1: Excitation systems for synchronous machines – Definitions

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60034-16-1 has been prepared by IEC technical committee 2: Rotating machinery.

This second edition cancels and replaces the first edition, issued in 1991, and constitutes a technical revision.

The major technical changes with regard to the previous edition are as follows:

Clause or subclause	**Change**
2.1.1	Additional definition for digital excitation system
2.1.2	Additional definition for reversible excitation system
2.3	Edited definition of excitation control

2.4	Additional definition for excitation control system. Added block diagram of excitation control system
2.17	Additional definition for excitation system negative ceiling voltage U_n
2.19	Edited definition of excitation system on-load ceiling voltage U_{pL}
2.20	Additional definition for excitation system on-load negative ceiling voltage U_{nL}
2.22	Additional definition for excitation system voltage response time
2.23	Additional definition for high initial response excitation system
3.1	Edited definition of rotating exciter
3.1.2	Edited definition of AC exciter
3.2.3	Additional definition for auxiliary winding source static exciter
3.3	Additional definition for pilot exciter
4.1 to 4.7	Edited definitions of control functions

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

CDV	Report on voting
2/1598/CDV	2/1617/RVC

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

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

NOTE A table of cross-references of all IEC TC 2 publications can be found on the IEC TC 2 dashboard on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

ROTATING ELECTRICAL MACHINES –

Part 16-1: Excitation systems for synchronous machines – Definitions

1 Scope

This part of IEC 60034 defines terms applicable to the excitation systems of synchronous rotating electrical machines.

2 General

2.1
excitation system
equipment providing the field current of a machine, including all regulating and control elements, as well as field discharge or suppression equipment and protective devices

2.1.1
digital excitation system
excitation system of a machine where some, if not all, of regulating, control, limiting and protective functionality is implemented using digital technology

NOTE As a minimum, the voltage regulation function must be implemented digitally in such a system.

2.1.2
reversible excitation system
excitation system providing compulsory change of sign of magnetic flux, created by a winding or excitation windings of a synchronous machine

2.2
exciter
source of the electrical power, providing field voltage and current of a synchronous machine, regulated by excitation control

NOTE Examples of the source are:

a rotating machine, either d.c. or a.c. with associated rectifiers;

one or several transformers with associated rectifiers.

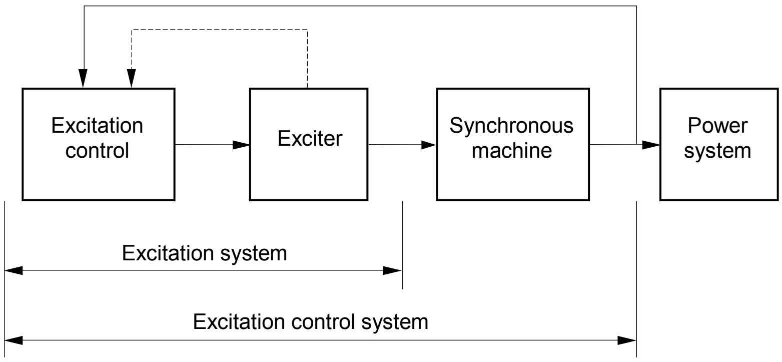
2.3
excitation control
control of excitation system modifying the excitation power, responding to signals characteristic of the state of the system encompassing the synchronous machine, its exciter, and the network to which it is connected

NOTE Synchronous machine voltage is predominantly the controlled quantity.

2.4
excitation control system
feedback control system that includes the synchronous machine operating in the power system and its excitation system

NOTE 1 The term is used to distinguish the performance of the synchronous machine and excitation system in closed loop control conjunction with the power system from that of the excitation system alone.

NOTE 2 Figure 1 shows a block diagram of an excitation control system.



IEC 828/11

Figure 1 – Block diagram of excitation control system

2.5
field winding terminals
place of input to the field winding of the machine

NOTE 1 If there are brushes and slip-rings, these are considered to be part of the field winding.

NOTE 2 In a brushless machine, the connecting points between the rotating rectifier and the leads of the machine field winding are the field winding terminals.

2.6
excitation system output terminals
place of output from the equipment comprising the excitation system

NOTE Excitation system output terminals may be different from the field winding terminals.

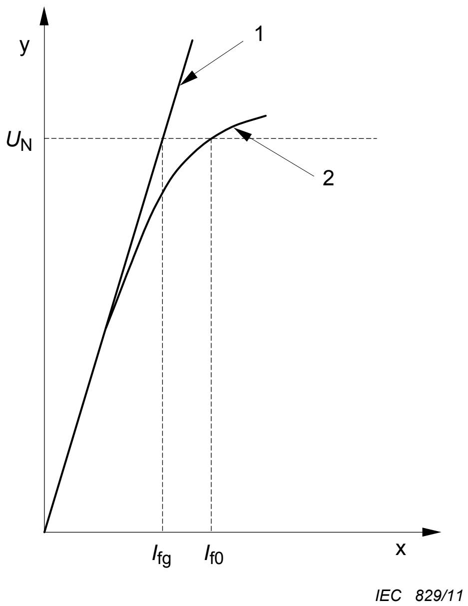
2.7
rated field current I_{fN}
direct current in the field winding of the machine when operating at rated voltage, current, power-factor and speed

2.8
rated field voltage U_{fN}
direct voltage at the field winding terminals of the machine required to produce rated field current with the field winding at the temperature resulting from rated loading and rated conditions and with the primary coolant at its maximum temperature

NOTE If the machine has a duty cycle which does not result in a steady field winding temperature being reached, then U_{fN} is based upon the maximum field winding temperature reached in the duty cycle.

2.9
no-load field current I_{f0}

direct current in the field winding of the machine required to produce rated voltage at no-load and rated speed (see Figure 2)



Key

y Terminal voltage U (U_N is the rated voltage of the synchronous machine)

x Field current I_f

1 Air gap line characteristic

2 No-load characteristic

Figure 2 – Determination of no-load field current I_{f0} and air-gap field current I_{fg}

NOTE The air-gap field current is the base value for use in computer representation models of excitation systems.

2.10
no-load field voltage U_{f0}
direct voltage at the field winding terminals of the machine required to produce the no-load field current with the field winding at 25 °C

2.11
air-gap field current I_{fg}
current in the field winding of the synchronous machine which theoretically would be required to produce rated voltage at no-load on the air-gap line (see Figure 2)

2.12
air-gap field voltage U_{fg}
direct voltage at the field winding terminals of the synchronous machine which is required to produce the air-gap field current when the field winding resistance is equal to U_{fN}/I_{fN}

NOTE The air-gap field voltage is the base value for use in computer representation models of excitation systems.

2.13
excitation system rated current I_{eN}
direct current at the excitation system output terminals which the excitation system can supply under defined conditions of operation, taking into account the most demanding excitation requirements of the machine (generally resulting from machine voltage and frequency variations)

2.14
excitation system rated voltage U_{eN}
direct voltage at the excitation system output terminals which the excitation system can provide when delivering excitation system rated current, under defined conditions of operation

NOTE The excitation system rated voltage is at least that value required by the field of the machine under the most demanding excitation requirements (generally resulting from machine voltage and frequency variations).

2.15
excitation system ceiling current I_p
maximum direct current which the excitation system is able to supply from its terminals for a specified time, starting from continuously supplying rated field current

NOTE The specified time is counted from the achievement of 95 % of the current final steady value.

2.16
excitation system positive ceiling voltage U_p
maximum direct voltage, which the excitation system is able to provide from its terminals under defined conditions

NOTE 1 For excitation systems whose supply depends on the machine voltage and (if applicable) current, the nature of the power system disturbance and specific design parameters of the excitation system and the synchronous machine influence the excitation system output. For such systems, the ceiling voltage is determined considering an appropriate defined voltage drop and (if applicable) current increase.

NOTE 2 For excitation systems employing a rotating exciter, the ceiling voltage is defined at rated speed and at rated working conditions of exciter.

2.17
excitation system negative ceiling voltage U_n
most negative (direct) voltage, if any, which the excitation system is able to provide from its terminals under defined conditions

2.18
excitation system no-load ceiling voltage U_{p0}
maximum direct voltage which the excitation system is able to provide from its terminals when it is not loaded

2.19
excitation system on-load positive ceiling voltage U_{pL}
maximum direct voltage which the excitation system is able to provide from its terminals at initial current equal to rated field current at rated conditions of the machine

2.20
excitation system on-load negative ceiling voltage U_{nL}
most negative (direct) voltage, if any, which the excitation system is able to provide at initial current equal to rated field current at rated conditions of the machine

2.21
excitation system nominal response V_e
rate of increase of the excitation system output voltage (see Figure 3), determined from the excitation system voltage response curve divided by the rated field voltage according to the equation:

$$V_{\mathrm{e}} = \frac{\Delta U_{\mathrm{e}}}{0,5 U_{\mathrm{fN}}} \ \mathrm{s}^{-1}$$

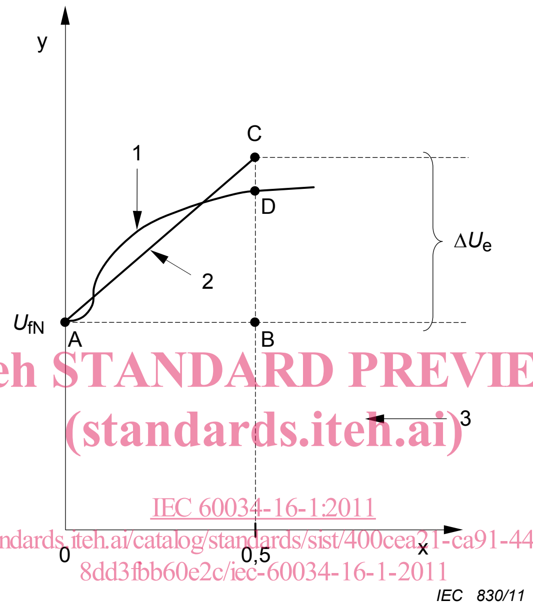
NOTE 1 This rate, if maintained constant (line A–C in Figure 3), would develop the same voltage-time area as obtained from the actual curve (line A–D in Figure 3) over the first half-second interval (or different time interval, if specified).

NOTE 2 The excitation system nominal response is defined with the excitation system loaded with a resistance equal to U_{fN}/I_{fN} and sufficient inductance so that voltage drop effects and current and voltage waveform are reasonably accounted for.

NOTE 3 The excitation system nominal response is defined with the excitation system voltage initially equal to the rated field voltage of the synchronous machine, after which the excitation system ceiling voltage is rapidly attained by introducing a specified voltage error step.

NOTE 4 For excitation systems whose supply depends on the synchronous machine voltage and (if applicable) current, the nature of the power system disturbance and specific design parameters of the excitation system and the synchronous machine influence the excitation system output. For such systems, the excitation system nominal response is defined taking into consideration an appropriate voltage drop and (if applicable) current increase.

NOTE 5 For excitation systems employing a rotating exciter, the excitation system nominal response is defined at rated speed and at rated working conditions of exciter.



Key

y excitation system voltage U_e

x time in s

1 Actual build-up curve

2 Slope

3 Area ABC = ABD

Figure 3 – Determination of excitation system nominal response, V_e

2.22
excitation system voltage response time
time in seconds for the excitation voltage to attain 95 % of the difference between ceiling voltage and rated field voltage, counted from the moment of specified step change in synchronous machine terminal voltage

2.23
high initial response excitation systems
excitation systems whose voltage response time is 0,1 s or less

NOTE For high initial response excitation systems, the response time is very short relative to the synchronous machine field time constant and to power system characteristic swings, and the shape of initial response is not of concern.