

ANSI/IEEE Std 421.1-1986

(Revision of IEEE Std 421-1972)

An American National Standard

IEEE Standard Definitions for Excitation Systems for Synchronous Machines

Sponsor

**Power Generation Committee
of the
IEEE Power Engineering Society**

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IEEE Standards Board

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Foreword

(This Foreword is not a part of ANSI/IEEE Std 421.1-1986, IEEE Standard Definitions for Excitation Systems for Synchronous Machines.)

This standard defines elements and commonly used components in excitation systems and contains definitions for excitation systems applied to synchronous machines, for general requirements of a synchronous machine refer to ANSI C50.10-1977.

A synchronous machine excitation control system operating under automatic control is a feedback control system. Thus, the working group Terminology of the Excitation Subcommittee of the Power Generation Committee adopted definitions that had common basis to excitation systems. Efforts were made not to conflict terms found in ANSI/IEEE Std 100-1984, IEEE Standard Dictionary of Electrical and Electronics Terms, but to clarify or more fully define terms as related specifically to excitation of synchronous machines.

The task of the working group can be divided into two areas:

- 1) To gather all the existing definitions applicable to the field of excitation systems, and from these definitions to extract those definitions of value.
- 2) To formulate new definitions where these are needed.

Three definitions to classify exciters are now established:

- 1) dc generator — commutator exciter
- 2) alternator — rectifier exciter
- 3) static — rectifier exciter

It is thought that these types of exciters cover most if not all of the types used in modern excitation systems for large synchronous machines. The commutator exciter can have a continuous or noncontinuous acting regulator, and the rectifier exciter can have controlled or noncontrolled rectifiers.

This standard would also like to draw particular attention to three other recent excitation system documents:

- 1) ANSI/IEEE Std 421A-1978¹. This guide presents dynamic performance criteria, definitions and test procedures for excitation control systems as applied by electric utilities.
- 2) ANSI/IEEE Std 421B-1979¹. This standard applies to high-potential testing of complete excitation systems and their components for synchronous machines.
- 3) IEEE Committee Report, Excitation System Models for Power System Stability Studies. This paper presents excitation system models suitable for use in large-scale system stability studies. With these models, most of the excitation systems currently in widespread use on large, system-connected generators in North America can be represented. This paper replaces a similar committee report dated 1968.

IEEE Std 421-1972 was a definitions standard that is referenced in many other IEEE standards, papers, committee reports, etcetera. The changes being made in this revision do not invalidate any standard, paper, report, etcetera, that used IEEE Std 421-1972 as a reference document.

Previous definitions which included a phrase *response ratio* have been deleted. Only a single definition, excitation system nominal response, encompassing the overall performance of the excitation system is presented. Unique conditions for various excitation systems as related to this performance parameter are identified.

¹When the documents ANSI/IEEE Std 421A-1978 and ANSI/IEEE Std 421B-1979 are superseded by a revision, the revisions will be redesignated as ANSI/IEEE Std 421.2 and ANSI/IEEE Std 421.3, respectively.

This revision has deleted a few basic terms, such as amplifier, drift, error, and input signal. These terms are taken care of in the IEEE Standard Dictionary. A few additional terms have been added. Table 1 of this revision shows a detailed correlation between the various excitation systems and the appropriate computer model type as described in the IEEE committee report on computer modeling of excitation systems.

Members of the Working Group of the Excitation Systems Subcommittee of the Power Generation Committee of the IEEE Power Engineering Society, which formulated the 1972 standard, were as follows:

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An American National Standard

IEEE Standard Definitions for Excitation Systems for Synchronous Machines

1. Scope

This standard defines elements and commonly used components in excitation control systems and contains definitions for excitation systems as applied to synchronous machines. The primary purpose is to provide a vocabulary for

- 1) Writing excitation systems specifications
- 2) Evaluating excitation system performance
- 3) Specifying methods for excitation system tests
- 4) Preparing excitation system standards
- 5) Serving as an educational means for those becoming acquainted with excitation systems

2. Excitation System Definitions

accuracy: The degree of correspondence between the controlled variable and the desired value under specified conditions such as load changes, ambient temperature, humidity, frequency, and supply voltage variations. Quantitatively, it is expressed as the ratio of difference between the controlled variable and the desired value to the desired value.

air gap field voltage: The synchronous machine field voltage required to produce rated voltage on the air-gap line of the synchronous machine with its field winding at (1) 75 °C for field windings designed to operate at rating with a temperature rise of 60 °C or less; or (2) 100 °C for field windings designed to operate at rating with a temperature rise greater than 60 °C. *Note.* This defines one per unit excitation system voltage for use in computer representation of excitation systems.

air-gap line: The extended straight line part of the no-load saturation curve of the synchronous machine.

alternator-rectifier exciter: An exciter whose energy is derived from an alternator and converted to direct current by rectifiers. The exciter includes an alternator and power rectifiers which may be either noncontrolled or controlled, including gate circuitry. It is exclusive of input control elements. The alternator may be driven by a motor, prime mover, or by the shaft of the synchronous machine. The rectifiers may be stationary or rotating with the alternator shaft.