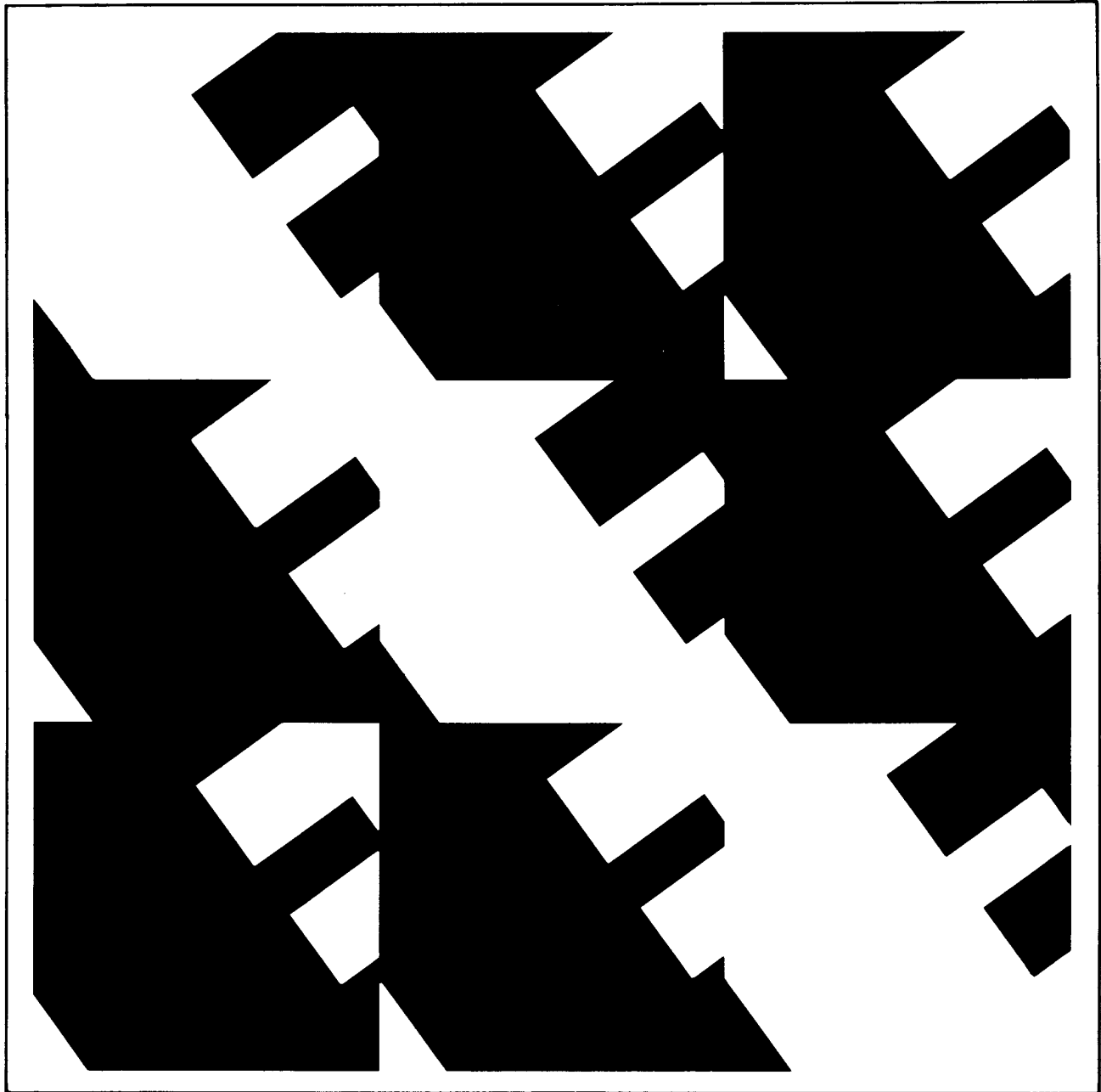


IEEE Standard Definitions and Requirements for Thyristor AC Power Controllers

IEEE Std 428-1981



Published by The Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street, New York, New York 10017
October 13, 1981

SH08417

IEEE Standard Definitions and Requirements for Thyristor AC Power Controllers

Sponsor

Static Power Converter Committee of the
IEEE Industry Applications Society

© Copyright 1981 by

The Institute of Electrical and Electronics Engineers
345 East 47th Street, New York, NY 10017

*No part of this publication may be reproduced in any form,
in an electronic retrieval system or otherwise,
without the prior written permission of the publisher.*

IEEE Standards documents are developed within the Technical Committees of the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE which have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least once every five years for revision or reaffirmation. When a document is more than five years old, and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of all concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason IEEE and the members of its technical committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE Standards Board
345 East 47th Street
New York, NY 10017
USA

Foreword

(This Foreword is not a part of IEEE Std 428-1981, IEEE Standard Definitions and Requirements for Thyristor AC Power Controllers.)

The project P428 was originally initiated as an IEEE Standard. Then when the IEC working group was formed to prepare a similar standard, the IEEE standard was used as the starting point for that work, with the chairman of the IEEE Subcommittee on Thyristor AC Power Controls as the US delegate to the IEC working group. This standard is substantially the same as the IEC document except for minor changes in language and symbols.

As of the submission date of this standard, the appropriate reference for the IEC draft was Document 22B (Control Office) 40. Once approved, the IEC standard will be incorporated as a section of IEC Pub 146 (1973) on Semiconductor Converters. This latter document is referenced in several sections of this standard.

At the time this standard was approved, the Thyristor AC Power Control Subcommittee of the Static Power Converter Committee had the following membership:

C. J. Amato, *Chairman*

A. L. Lijoi, *Secretary*

D. L. Ashcroft
W. V. Chumakov
S. B. Dewan

D. L. Duff
J. D. Fahey
F. B. Golden
W. R. Hodgson

W. C. Jordan
A. F. Wilkenson
D. F. Williamson

When the IEEE Standards Board approved this standard on March 5, 1981, it had the following membership:

I. N. Howell, Jr., *Chairman*

Irving Kolodny, *Vice Chairman*

Sava I. Sherr, *Secretary*

G. Y. R. Allen
J. H. Beall
J. T. Boettger
Edward Chelotti
Edward J. Cohen
Warren H. Cook
Len S. Corey

Jay Forster
Kurt Greene
Loering M. Johnson
Joseph L. Koepfinger
J. E. May
Donald T. Michael*

F. Rosa
R. W. Seelbach
J. S. Stewart
W. E. Vannah
Virginius N. Vaughan, Jr
Art Wall
Robert E. Weiler

*Member emeritus

Contents

SECTION	PAGE
1. Scope	7
2. References	7
3. Definitions	7
3.1 Basic Terms	7
3.2 Controller Characteristics	8
3.3 Circuit Properties	12
3.4 Circuit Components	12
3.5 Auxiliary	13
3.6 Controller Ratings	14
3.7 Controller Protection	15
3.8 Semiconductor Characteristics	15
4. Classification Code	17
4.1 Basic Control Elements	17
4.2 Controller Connections	17
4.3 Load Connections	17
5. Service Conditions	17
5.1 Normal Service Conditions	18
5.2 Special Service Conditions	19
6. Duty Classes	20
6.1 Classification	20
6.2 Basis of Rated Current Values	20
6.3 Determination of Requirements for Rated Current Values	21
7. Test	22
7.1 General	22
7.2 Test Specifications	22
 FIGURES	
Fig 1 Line Voltage	8
Fig 2 Waveform of AC Power Controller Current	9
Fig 3 Typical Examples of Operation Modes	11
Fig 4 Suppression Characteristic	16
Fig 5 Latching and Holding Current	16
Fig 6 Limited Values of Each Non-Line Frequency Component of the Line Voltage	18
Fig 7 Periodic Deviations of the Line Voltage	18
Fig 8 Maximum Expected Overvoltage Versus Duration of Transient	19
 TABLES	
Table 1 Operation Modes	10
Table 2 Standard Duty Classes	20
Table 3 Examples of Load Cycles as Guidance for Choice of Duty Class	21
Table 4 AC Power Controller Test Program Categories	23

APPENDIX

Appendix A Examples for Using the Classification Code.	24
--	----

APPENDIX FIGURES

Fig A1 Bidirectional Control, Single Phase	24
Fig A2 Bidirectional Control, Three Phase	24
Fig A3 Bidirectional Control, Three Phase, Two-Line Control	24
Fig A4 Unidirectional Control, Reverse Conducting, Three Phase.	24
Fig A5 Three Phase, Polygon Connection	25
Fig A6 Bidirectional Control, Three Phase, Tie Control	25
Fig A7 Bidirectional Control, Three Phase, Neutral Connected, Tie Control.	25
Fig A8 Bidirectional Control, Three Phase, Delta (Control Element and Load).	25
Fig A9 Bidirectional Control, Three Phase, Neutral Connected.	26
Fig A10 Unidirectional Control, Reverse Conducting, Three Phase.	26

IEEE Standard

Definitions and Requirements for Thyristor AC Power Controllers

1. Scope

These recommendations apply to thyristor ac power controllers that are low voltage, power electronic, industrial class equipment for the control or switching of ac power. Switching, multicycle control and phase control are included. Cycloconverters are excluded. Examples of application include, but are not limited to, industrial oven controls, static motor starters, static relays, etc.

This standard is intended to be used in conjunction with IEC Pub 146 (1973) [2].¹ Reference is made to the appropriate section of IEC Pub 146 (1973) [2] where required.

2. References

- [1] ANSI/NEMA MG1-1978, Motors and Generators²
- [2] IEC Pub 146 (1973), Semiconductor Converters³

3. Definitions

The only definitions included are those needed for the understanding of the later text. Adjectives which are implicit by virtue of the subject matter of the recommendation are omitted for brevity and clarity, for example, semiconductor, static, etc.

¹ The numbers in brackets correspond to the references listed in Section 2 of this standard.

² ANSI documents are available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

³ IEC documents are available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

3.1 Basic Terms

3.1.1 thyristor ac power controller. A power electronic equipment for the control or switching of ac power where switching, multicycle control and phase control are included. The only power controlling element is the thyristor, although other power elements may be included.

3.1.2 thyristor stack. A single structure of one or more thyristors with its (their) associated mounting(s), cooling attachments, if any, connections whether electrical or mechanical, and auxiliary components, if any. A thyristor stack may consist of thyristors and semiconductor rectifier diodes in combination and in this case it may be referred to as a non-uniform thyristor stack.

Trigger equipments are not included in this definition.

3.1.3 thyristor assembly. An electrical and mechanical functional assembly of thyristors in combination with diodes, if any, or thyristor stacks, complete with all its connections and auxiliary components, including trigger equipment, together with means for cooling, if any, in its own mechanical structure, but without the controller transformers and other switching devices.

NOTE: A thyristor assembly may be combined of several subassemblies, which are made and traded as mechanically combined units, for example, thyristor stacks or other combinations or one or more thyristors with control devices, protective devices, etc.

3.1.4 controller equipment. An operative unit for ac power control comprising one or more thyristor assemblies together with any input or output transformers, filters, other switching devices and auxiliaries required by the thyristor ac power controller to function.

3.1.5 principal power. The power which is consumed in the load circuit plus the losses in the power circuit elements including switching losses.