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IEEE Recommended Practice for Powering and Grounding Electronic Equipment

Sponsor

Power Systems Engineering Committee
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Abstract: The *IEEE Emerald Book*™ presents a collection of consensus best practices for the powering and grounding of electronic equipment used in commercial and industrial applications. The main objective is to provide consensus recommended practices in an area where conflicting information and conflicting design philosophies have dominated. The recommended practices described are intended to enhance equipment performance while maintaining a safe installation. A description of the nature and origin of power disturbances is provided, followed by theory on the various parameters that impact power quality. Information on quantifying and resolving power and grounding related concerns using measurement and diagnostic instrumentation and standardized investigative procedures are included. Recommended power protection equipment and wiring and grounding system design practices are presented. Information on telecommunications system power protection as well as grounding, industrial system grounding, and noise control is included. Finally a selection of case studies are presented to support the recommended practices presented throughout the book.
Keywords: commercial applications, electrical power, electronic equipment, grounding, industrial applications, power conditioning, power disturbance, power monitor, power quality

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The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

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Introduction

(This introduction is not part of IEEE Std 1100-2005, IEEE Recommended Practice for Powering and Grounding Electronic Equipment.)

This recommended practice is a publication of the Industry Applications Society (IAS) of the IEEE and is one of the *IEEE Color Books*®, which relate to industrial and commercial power systems. The recommended practices described are intended to enhance equipment performance from an electric powering and grounding standpoint, while maintaining a safe installation as prescribed by national and local electric code requirements. The purpose of this recommended practice is to provide consensus recommended practices in an area where conflicting information and conflicting design philosophies have dominated.

As the proliferation of digital electronic equipment continues to change the way society utilizes and relies on electric power continuity, the need for standardized practices for power protection and grounding continues to grow. The requirements of the digital society have essentially outgrown the capabilities of the present day electric power supply, and the need for practices that promote system compatibility of both the electric supply and the connected equipment is important from the largest industrial facilities all the way down to home offices. The concept of system compatibility, which is covered extensively in this book, describes the mechanisms of interaction and requirements necessary to ensure that not only does the electrical power equipment connected to its power source operate properly even during moderate power fluctuations, but also that same equipment does not interfere with other equipment connected to the common power system. The responsibility for system compatibility is shared among all parties, including the electric suppliers, the equipment manufacturers, the building designers, the power conditioning equipment manufacturers, and the facility equipment specifiers, and this document supplies methods to ensure that when a system compatibility problem is present, there are adequate means of investigating and resolving the concern. It is also the intent of this document to supply power system design guidelines and recommended practices that would minimize the potential for a system compatibility concern to occur.

To address the topics detailed in the *IEEE Emerald Book*™*,* the IEEE Working Group on Powering and Grounding Electronic Equipment was originally formed in 1986 to write a recommended practice. The first *IEEE Emerald Book*™ was subsequently published in 1992, followed by a revision in 1999. The project was sponsored by the IAS Industrial and Commercial Power Systems Engineering Subcommittee. This recommended practice is intended to complement other recommended practices in the *IEEE Color Books*® and has been coordinated with other related codes and standards.

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The following persons contributed to the revision of IEEE Recommended Practice for Powering and Grounding Electronic Equipment:

Douglas S. Dorr, *Chair*
Christopher J. Melhorn, *Secretary*
Zade Shaw, Kate Langley, *Editors*

Chapter 1: Overview—**Douglas S. Dorr,** *Chair*

Chapter 2: Definitions—**Carl E. Becker,** *Previous Chair*

Chapter 3: General needs guidelines—**Christopher J. Melhorn,** *Chair*

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Chapter 7: Specifications and selection of equipment and materials—**Thomas M. Gruzs,** *Chair*

Chapter 8: Recommended design and installation practices—**Michael Butkiewicz,** *Previous Chair*

Chapter 9: Telecommunications and distributed computing—**William Bush,** *Chair*

Chapter 10: Industrial systems—**Van E. Wagner,** *Chair*

Chapter 11: Case histories—**Mark Waller,** *Chair*

Vladimir F. Basch
J. Allen Byrne
David Chau
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Baskar Vairamohen
Christopher Weathers
George Zeigler

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*Editor*s—**Bradford Connatser, Nanette Jones, Michael C. Keeling, Kate Langley, François Martzloff, Zade Shaw**

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Former Working Group members and contributors:

Math Bollen
James A. Canham
Wendall Carter
John E. Curlett
John B. Dagenhart
John G. Dalton
Dennis Darling
Robert J. Deaton
Michael J. Demartini
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The final conditions for approval of this standard were met on 9 December 2005. This standard was conditionally approved by the IEEE-SA Standards Board on 22 September 2005, with the following membership:

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Contents

IEEE Recommended Practice for Powering and Grounding Electronic Equipment

Chapter 1
Overview

1.1 Scope

This document presents recommended design, installation, and maintenance practices for electrical power and grounding (including both safety and noise control) and protection of electronic loads such as industrial controllers, computers, and other information technology equipment (ITE) used in commercial and industrial applications.

1.2 Purpose

The main objective is to provide a consensus of recommended practices in an area where conflicting information and confusion, stemming primarily from different viewpoints of the same problem, have dominated. Practices herein address electronic equipment electrical performance and protection issues while maintaining a safe installation, as specified in the National Electrical Code® (NEC®) (NFPA 70, 2005 Edition) [B1][1] and recognized testing laboratories' standards. This recommended practice is not intended to replace or to take precedence over any codes or standards adopted by the jurisdiction where the installation resides.

1.3 Background

As electronic loads and ITE proliferate in industrial and commercial power systems, so do problems related to power quality. Powering and grounding electronic equipment continues to be a growing concern for commercial and industrial power system designers. This concern frequently materializes after start-up, when electronic system operating problems begin to occur. Efforts to alleviate these problems have ranged from installing power conditioning equipment to applying special grounding techniques that are not found in conventional safe grounding practice. In some cases this approach has led to unsafe practices and violations of the NEC, without solving operating problems. Many times even after installing power conditioning devices, the protected equipment still fails or does not operate as expected during thunderstorms and power outages. In response to this situation, this recommended practice attempts to provide an understanding of the fundamentals of proper powering and grounding for facilities and electronic equipment as well as examples of the various problems that can arise.

The concept of load and source compatibility is not new. The need to provide power with steady voltage and frequency has been recognized since the inception of the electric utility industry. Some of the early concerns were flicker of light bulbs due to voltage fluctuations and overheating of motors due to voltage waveform distortion (harmonics). Recognition of these problems led to the development of voluntary standards that contributed significantly to reductions in occurrences.

More recently, transient voltage disturbances associated with lightning and power system switching have emerged as a major concern to manufacturers and users of electronic equipment. The issue of grounding,

[1]The numbers in brackets correspond to those of the bibliography in 1.5.