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IEEE Recommended Practice for

**Powering and
Grounding
Electronic
Equipment**

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IEEE Std 1100™-2005
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IEEE Recommended Practice for Powering and Grounding Electronic Equipment

Sponsor

**Power Systems Engineering Committee
of the
Industrial and Commercial Power Systems Department
of the
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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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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 mechanisms 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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Contents

Chapter 1	
Overview.....	1
1.1 Scope.....	1
1.2 Purpose.....	1
1.3 Background.....	1
1.4 Text organization	2
1.5 Bibliography	4
Chapter 2	
Definitions	5
2.1 Introduction.....	5
2.2 Alphabetical listing of terms.....	5
2.3 Words avoided	13
2.4 Acronyms and abbreviations.....	14
2.5 Normative references	18
2.6 Bibliography	19
Chapter 3	
General needs guidelines	21
3.1 Introduction.....	21
3.2 Power quality considerations	23
3.3 Grounding considerations	33
3.4 Protection of susceptible equipment	38
3.5 Information technology equipment (ITE).....	40
3.6 Shielded, filtered, enclosed EMI/EMC areas.....	46
3.7 Safety systems.....	47
3.8 Coordination with other codes, standards, and agencies	48
3.9 Normative references	50
3.10 Bibliography	51
Chapter 4	
Fundamentals	53
4.1 Introduction.....	53
4.2 Electric power supplier’s distribution system voltage disturbances	54
4.3 Voltage disturbances—subtractive	56
4.4 Voltage surges and interference—Additive.....	63
4.5 Steady-state voltage/current wave shape distortion.....	81
4.6 High- and low-frequency regimes defined	98
4.7 Impedance considerations	103
4.8 Grounding subsystems.....	121
4.9 Shielding concepts	150
4.10 Surge protective devices	154
4.11 Normative references	158
4.12 Bibliography	158
Chapter 5	
Instrumentation	163
5.1 Introduction.....	163
5.2 Range of available instrumentation	163
5.3 Voltage and current measurements.....	163
5.4 Descriptions of site survey tools.....	169

5.5	Measurement considerations.....	176
5.6	Normative references	179
5.7	Bibliography	179
 Chapter 6		
	Site surveys and site power analyses	181
6.1	Introduction.....	181
6.2	Objectives and approaches.....	181
6.3	Coordinating involved parties.....	182
6.4	Conducting a site survey	183
6.5	Harmonic current and voltage measurements.....	201
6.6	Applying data to select cost-effective solutions	202
6.7	Long-term power monitoring.....	203
6.8	Conclusions.....	203
6.9	Normative references	204
6.10	Bibliography	205
 Chapter 7		
	Specification and selection of equipment and materials.....	207
7.1	Introduction.....	207
7.2	Commonly used power correction devices	207
7.3	Equipment specifications	236
7.4	Procurement specifications	243
7.5	Verification testing.....	246
7.6	Equipment maintenance.....	248
7.7	Bibliography	250
 Chapter 8		
	Recommended design/installation practices	253
8.1	Introduction.....	253
8.2	Equipment room wiring and grounding.....	254
8.3	Electrical power system selection considerations.....	255
8.4	Equipment selection and installation considerations	262
8.5	Grounding considerations	279
8.6	Lightning/surge protection considerations.....	300
8.7	380 Hz to 480 Hz systems	304
8.8	Normative references	307
8.9	Bibliography	308
 Chapter 9		
	Telecommunications, information technology, and distributed computing	311
9.1	Introduction.....	311
9.2	Vulnerability concerns vs. immunity	314
9.3	Environmental exposure	316
9.4	Industry guidelines.....	316
9.5	General compliance	316
9.6	Principles for establishing recommended practices	318
9.7	General considerations.....	320
9.8	Powering	321
9.9	Grounding and bonding	370
9.10	Evaluations and audits	421
9.11	Normative references	423
9.12	Bibliography	424

Annex 9A (normative) General	426
Annex 9B (normative) Nomenclature	436
Annex 9C (informative) List of telecommunications-related industry guidelines	439
Annex 9D (informative) Trends and changing responsibilities.....	469
Annex 9E (informative) Background on telecommunications	475
Annex 9F (normative) Industry-described telecommunications surge environment	480
Annex 9G (informative) Impact of technology convergence on ac and dc powering.....	496
Annex 9H (informative) Factors in selecting large-scale ac and dc power.....	498
Annex 9I (informative) Highlights of ANSI T1.311 requirements for dc power systems	504
Annex 9J (informative) Understanding telecommunications circuit protection.....	506
Annex 9K (normative) Fundamental concepts on surge protection	514
Annex 9L (informative) Additional information on surge protection	519
 Chapter 10	
Industrial systems	529
10.1 Introduction.....	529
10.2 Basic noise control theory.....	529
10.3 Method of analysis.....	536
10.4 Recommended practices	537
10.5 Distance, long power cable runs	559
10.6 Bibliography	559
 Chapter 11	
Case histories	561
11.1 Introduction.....	561
11.2 Typical utility-sourced power quality problems	561
11.3 Premises switching generated surges.....	563
11.4 Electronic loads.....	564
11.5 Premises-wiring-related problems	566
11.6 Transient voltage surge suppression network design—primary and secondary network design.....	572
11.7 Typical radiated EMI problems	573
11.8 Flicker	574
11.9 Typical electrical inspection problems	574
11.10 Typical life-safety system problems	575
11.11 Typical misapplication of equipment problems.....	576
11.12 Normative references	576
11.13 Bibliography	576
 Index	577

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,

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