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Guide for the Measurement of Voltage, Current, Power, Energy, and Power Factor

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Foreword

This NEMA guide establishes definitions in the time domain and frequency domain for the various quantities used in the measurement of voltage, current, power, and energy for legal metrology purposes. The equations in this guide provide the ideal result to be obtained for any particular quantity. **This guide does not attempt to prescribe any specific implementation of the measurement process. Rather, the attempt is to describe the “desired” or “target” answer that can be obtained by the best and most careful implementation of the definitions.** Such a device would function as the primary reference standard at a recognized national authority. Practical measurement devices would then be judged for accuracy against such a primary reference.

This document is not an implementation guide for creating a device. There are many different ways to achieve the desired accuracy of a device.

This guide establishes acceptable performance criteria for the measurement of volts, amps, active power, apparent power, and reactive power; active energy, apparent energy, and reactive energy; and power factor by electricity meters and reference standards.

It was decided to initially publish as a guide to give the industry a chance to become familiar with the content. The plan is to convert this guide to a standard as part of the issuance of the coordinated next generation of standards, which includes C12.1, C12.10, C12.32, C12.33, and C12.46.

Publication of this technical report that has been registered with ANSI has been approved by the accredited standards developer (National Electrical Manufacturers Association, 1300 North 17th Street, Rosslyn, VA 22209). This document is registered as a technical report according to the ANSI *Procedures for the Registration of Technical Reports*. This document is not an American National Standard and the material contained herein is not normative in nature.

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Suggestions for improvement to this guide are welcome. They should be sent to:

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Note: The user's attention is called to the possibility that compliance with this standard could require use of an invention covered by patent rights.

By publication of this guide, no position is taken with respect to the validity of any such claim(s) or of any patent rights in connection therewith. If a patent holder has filed a statement of willingness to grant a license under these rights on reasonable and non-discriminatory terms and conditions to applicants desiring to obtain such a license, then details may be obtained from the Secretary.

This guide was processed and approved for publication by Accredited Standards Committee for Electricity Metering, C12. At the time the committee approved this standard, the C12 Committee had the following members:

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1 Scope

This document establishes standard definitions for the measurement of AC, DC, and AC+DC voltage; current; electrical power (active, reactive, and apparent); AC electrical energy (active, reactive, and apparent); and power factor in terms of sampled voltage and current measurements. The definitions are provided to facilitate uniform comparison of the voltage, current, power, energy, and power factor measurement values reported by electricity meters in comparison to equipment used as reference standards that implement these definitions for the determination of meter accuracy in the time domain and frequency domain. In the limit of “perfect implementation,” the answers given by the time domain and frequency domain formulas should give the same answers within the claimed uncertainty limits.

2 Background

ANSI C12 standards have only defined the value for VA when the waveforms for current and voltage were sinusoidal. Since in the modern world this is seldom the case outside of the laboratory, this guide is a first step to bring definitions and testing more in line with the contemporary load environment.

The purpose of this document is to define a standard value that can be computed from a set of simultaneous samples of voltages and currents. **The exact computational method to be used is not prescribed, only that the resultant value from whatever calculational method is employed must agree, within the claimed uncertainty, with the results obtained from the formulas defined by this guide.** For further background and guidance on interpreting this guide, see Annex A.

3 References

International Electrotechnical Commission

IEC 62053-23	<i>Electricity metering equipment – Particular requirements - Part 23: Static meters for reactive energy (classes 2 and 3)</i>
IEC 62056-6-1	<i>Electricity metering data exchange – The DLMS/COSEM suite – Part 6-1: Object Identification System (OBIS)</i>
ISO/IEC 14882:2020(E)	<i>Programming Languages – C++</i>
IEC 61000-4-7:2002	<i>Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto</i>
IEC 6100-4-30:2015+AMD1:2021 CSV	<i>Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods</i>