

IEEE Standard for Electronics Power Transformers

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FOREWORD

The Electronics Transformer Technical Committee for several years has been working towards the generation of a Standard for electronics purpose power transformers even while under AIEE auspices. Earlier attempts seemed to parallel the distribution and power transformer Standards too closely, and hence missed the point of departure of how electronics transformers needed, at least in part, a different, treatment than power distribution transformer Standards. After the completion of the Wide-Band Standards Nos. 111 and 264 by the committee, a pattern was established that could be followed in the Power Transformer Standard to achieve the desired results. This proposed Standard can be well considered to be the product of the merger of AIEE and IRE people into the new blend of IEEE as it represents concessions on the part of each to the other at various points.

Some interesting problems had to be resolved in the process. For example, in the use of solid-state rectifiers it is necessary to provide fast and sensitive protection for the easily destroyed diodes in the event of faulting. This, in turn, led to a new definition of transformer inrush current, which we found was not previously defined satisfactorily. Also, the extensive use of combined alternating and direct voltages and currents in electronics transformers made it necessary to resolve certain insulation testing problems that have plagued the industry for years. Yet to say that these problems are resolved is an oversimplification of the situation. Nevertheless, a good start has been made in this regard.

We have attempted to give guidance and direction in the sensitive area of corona testing without foreclosing on the adoption of new Standards and understandings on the subject.

For all sizes of electronics purpose power transformers, it is expected that this Standard will supersede the use of USA C57 Standards.

PURPOSE

The character and applications of transformers used in electronic circuits are enough different from other categories so that none of the existing Standards does a satisfactory job. Much confusion and conflict has obtained in the past several years because of this lack, with different people having a wide variety of opinion relative to many aspects of specification and testing.

This Standard is intended to control by exception in the areas where conflict and disagreement have been most noticeable. Other well-known Standards are listed that should be used in areas where general agreement exists.

ACKNOWLEDGMENT

The Institute wishes to acknowledge its indebtedness to those who have so freely given of their time and knowledge, and have conducted experimental work on which many of the IEEE publications are based.

This publication was prepared by the Electronics Power Transformer Subcommittee of the Electronics Transformers Committee of the IEEE Parts, Materials, and Packaging Group. The membership of the Subcommittee was:

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IEEE Standard for Electronics Power Transformers

1. SCOPE

This Standard pertains to power transformers and inductors that are used in electronic equipments and supplied by power lines or generators of essentially sine wave or polyphase voltage. Guides to application and test procedures are included. Appendices contain certain precautions, recommended practices, and guidelines for typical values. Provision is made for relating the characteristics of transformers to the associated rectifiers and circuits.

Certain pertinent definitions relating to transformers and transformer applications, which have not been found elsewhere, are included with appropriate discussion. Attempts are made to alert the industry and profession to factors that are commonly overlooked.

This Standard includes, but is not limited to, the following specific transformers and inductors.

- Rectifier supply transformers for either high- or low-voltage supplies.
- Filament and cathode heater transformers.
- Transformers for alternating current resonant charging circuits.
- Inductors used in rectifier filters.
- Autotransformers with fixed taps.

1.1 Related and Reference Standards

- a) USA Standard C57: Transformers, Regulators and Reactors.
 - USA Standard C57: 12.00—1965, General.
 - USA Standard C57: 12.20—1964, Overhead-Type Distribution Transformers, 67 000 Volts and Below, 500 kVA and Smaller.
 - USA Standard C57: 12.80—1958, Terminology.
 - USA Standard C57: 12.90—1965, Test Code.
 - USA Standard C57: 18—1964, Pool-Cathode Mercury-Arc Rectifier Transformers, Requirements, Terminology and Test Code.
 - USA Standard C57: 31—1948, Guide for Operation of Transformers at Altitudes Greater Than 1000 Meters.
 - USA Standard C57: 32—1948, Guide for Operation of Transformers, Regulators and Reactors.
- b) USA Standard C42.
 - USA Standard C42.25—1956, Definitions of Electrical Terms (Industrial Control Equipment).
 - USA Standard C42.65—1957, Definitions of Electrical Terms (Communications).

- c) IEEE Standards Publication No. 111, Low-Power Wide-Band Transformers.
- d) IEEE Standards Publication No. 264, High-Power Wide-Band Transformers.
- e) Standards in Preparation.
Corona Test Guide.

2. DEFINITIONS

Electrical terms used in this Standard shall be in accordance with those given in USA Standard C42 “American Standard Definitions of Electrical Terms” insofar as they apply except as herein stated.

The IEEE Dictionary, when issued, shall be applicable and included as a part of this Standard and shall take precedence over USA Standard C42 in case of conflict.

2.1 Additional Definitions

2.1.1 Turns Ratio: shall be preferably defined in terms of the primary turns as the number of turns of a given secondary divided by the number of primary turns. Thus a ratio less than one (1) is a step-down transformation, a ratio greater than one (1) is a step-up transformation, and a ratio equal to one (1) is unity ratio.

2.1.2 Loaded Voltage Ratio: shall be equal to the secondary voltage divided by the primary voltage. (See paragraph 2.1.1.) For linear loads, the ratio shall be stated for a specified load current and power factor. For rectifier loads, the ratio should be given for the specified circuit configuration, including the filters, and the rated direct-current load. Unless otherwise stated, the ratio shall be given for rated conditions, line voltage, frequency, load, and stabilized temperature. Primary voltages shall be given as line to line and secondary voltages as leg values (terminal to neutral or center tap if used) unless otherwise indicated.

2.1.3 No-Load Loss: (excitation loss) is the input power, expressed in watts, to a completely assembled transformer that is excited at rated terminal voltage and frequency, but not supplying load current.

2.1.4 Full-Load Losses:

2.1.4.1 Core Loss: is the measured power loss, expressed in watts, attributable to the material in the core and associated clamping structure, of a transformer that is excited, with no connected load, at a core flux density and frequency equal to that in the core when rated voltage and frequency is applied and rated load current is supplied.

2.1.4.2 Winding Loss: (copper loss) is the power losses of all windings involved, expressed in watts, in an inductor or transformer with the values measured at or corrected to the rated load current, frequency, and waveshape and stabilized at the maximum ambient temperature.

2.1.4.3 Stray Losses: are those occurring in the core and case structure that result from the leakage flux and stray flux of a transformer when supplying rated load current.

2.1.5 Graded Insulation: is the selective arrangement of the insulation components of a composite insulation system to more nearly equalize the voltage stresses throughout the insulation system

2.1.6 Inrush Current: is the maximum root-mean-square or average current value, determined for a specified interval, resulting from the excitation of the transformer with no connected load, and with essentially zero source impedance, and using the minimum primary turns tap available and its rated voltage. (See Annex V.)

2.1.7 Peak Inrush Current: is the peak instantaneous current value resulting from the excitation of the transformer with no connected load, and with essentially zero source impedance, and using the minimum turns primary tap and rated voltage.

2.1.8 Essentially Zero Source Impedance: implies that the source impedance is low enough so that the test currents under consideration would cause less than five (5) percent distortion (instantaneous) in the voltage amplitude or waveshape at the load terminals. (See Annex V.)

3. SYMBOLS

The proposed IEEE Standards Publication No. 276 “Letter and Graphic Symbols for Electronics Transformers” or revisions shall apply.

4. TRANSFORMER ELECTRICAL TESTS

Transformer terminals normally grounded in service should be grounded during these tests or connected as otherwise required or noted in the following test description.

4.1 Electrical Tests

(values not recorded) It is recommended that the following electrical tests be made on all transformers.

- Ratio, polarity, terminal marking tests.
- No-load excitation; exciting current (amperes), loss (watts).
- Corona test (when specified).
- Induced voltage.
- Electric strength of insulation.

4.2 Characteristic Tests

(may be performed on a limited basis unless otherwise specified).

- Inrush current (when specified).
- Winding loss, impedance, regulation.
- Leakage inductance.
- Impulse (when specified).
- Temperature rise, winding resistance.

5. ELECTRICAL TESTS

5.1 Electrical Strength Tests

(see paragraph 5.3 for retesting). Applied high-voltage tests to major insulation systems should be made with windings shorted. Windings and shields on one side of the insulation should be connected to frame and ground while windings or shields on the other side should be connected together. Sine wave test voltages having a frequency in the operating range of the transformer and having adequate current capacity for the application is applied between the two sets of terminals in the manner set forth herein. All voltages should be defined in the same terms; e.g., root mean square, peak, average.

5.1.1 Method Voltage

should be increased at a convenient uniform rate of not greater than 2000 volts per second, from zero to the specified value, maintained for the specified period (unless breakdown occurs) then decreased to zero at the same rate.