

IEEE Standard for Ferroresonant Voltage Regulators

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Computer

*Electromagnetics and
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IEEE Power Electronics Society

*Signals and
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IEEE Standard for Ferroresonant Voltage Regulators

Sponsor

**Electronics Transformer Technical Committee
of the
IEEE Power Electronics Society**

Approved February 15, 1990

IEEE Standards Board

IEEE Std 449-1990, *IEEE Standard for Ferroresonant Voltage Regulators*, pertains to ferroresonant transformers used as regulators in electronic power supplies and in other equipment. Guides to application and test procedures are included.

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Foreword

(This Foreword is not a part of IEEE Std 449-1990, IEEE Standard for Ferroresonant Voltage Regulators.)

The purpose of this standard is to provide a common ground of understanding between engineers involved in the design, manufacture, sale, and use of ferroresonant transformers. It pertains to ferroresonant transformers used as regulators in electronic power supplies and in other equipment where the inherent properties of voltage regulation and current limiting are useful.

This publication was prepared by the Ferroresonant Transformer Subcommittee of the Electronics Transformer Technical Committee of the IEEE Power Electronics Society.

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IEEE Standard for Ferroresonant Voltage Regulators

1. Scope

This standard pertains to ferroresonant voltage regulators that operate at relatively constant frequencies and provide substantially constant output voltages in spite of relatively large changes of input voltage, and to controlled ferroresonant regulators that maintain substantially constant output voltages regardless of variations, within limits, of input voltage, temperature, frequency, and output load. Guides to application and test procedures are included. Provision is made for relating the characteristics of ferroresonant regulators to associated rectifiers and circuits. Definitions pertaining to ferroresonance and ferroresonant regulators that have not been found elsewhere are included with an appropriate discussion.

This standard includes, but is not limited to, the following types of ferroresonant regulators:

- (1) Series ferroresonant regulators
- (2) Series-parallel ferroresonant regulators (electrically connected)
- (3) Ferroresonant transformer regulators (magnetically coupled)
- (4) Controlled ferroresonant regulators

2. References

[1] ANSI S1.2-1962 (Reaff 1976), Method for the Physical Measurement of Sound.¹

[2] ANSI S1.4-1983, Specification for Sound Level Meters.²

¹ANSI S1.2-1962 (Reaff 1976) has been withdrawn. Copies can be obtained from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

²ANSI documents are available from ANSI.

[3] IEEE Std 100-1988, IEEE Standard Dictionary of Electrical and Electronics Terms—4th ed. (ANSI).³

[4] IEEE Std 260-1978 (Reaff 1985), IEEE Standard Letter Symbols for Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units) (ANSI).

[5] IEEE Std 280-1985, IEEE Standard Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

[6] IEEE Std 389-1979, IEEE Recommended Practice for Testing Electronics Transformers and Inductors.

[7] IEEE Std 436-1977, IEEE Guide for Making Corona (Partial Discharge) Measurements on Electronics Transformers.

3. Definitions, Symbols, and Circuit Schematics

3.1 Electrical Terms. The electrical terms used in this standard shall be in accordance with those given in IEEE Std 100-1988 [3].⁴

3.2 Symbols. The letters and graphic symbols used in this standard shall be in accordance with IEEE Std 260-1978 [4] and IEEE Std 280-1985 [5] insofar as they apply, except as herein stated.

³IEEE documents may be obtained from the IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

⁴The numbers in brackets correspond to those of the references listed in Section 2.

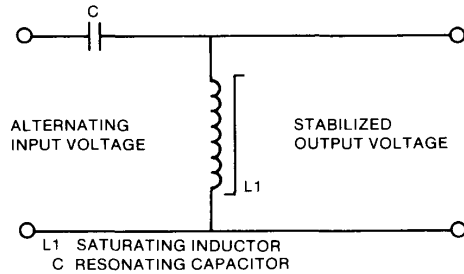


Fig 1
Basic Series Ferroresonant Voltage Regulator

3.3 Definitions

3.3.1 ferroresonance. The steady-state mode of operation that exists when an alternating voltage of sufficient magnitude is applied to a circuit consisting of capacitance and ferromagnetic inductance causing changes in the ferromagnetic inductance which are repeated each half cycle.

NOTE: When certain critical relations exist among circuit parameters, self-sustaining subharmonic or harmonic oscillations may also be excited in the circuit.

3.3.2 ferroresonant voltage regulation. The effect obtained by the limiting action of the saturation characteristic of the magnetic material in a ferroresonant circuit, which regulates the output voltage over a specified range of input voltages and a specified frequency of excitation.

NOTE: This effect regulates the half-cycle average value of the output voltage.

3.3.3 Ferroresonant Voltage Regulators

3.3.3.1 basic series ferroresonant voltage regulator. This regulator consists of a series connection of a saturating inductor and a capacitor connected across the source. The load is inductively or conductively coupled to the saturating inductor. See Fig 1.

NOTE: Applications of this circuit are limited by the requisite large ratio of reactive to real powers.

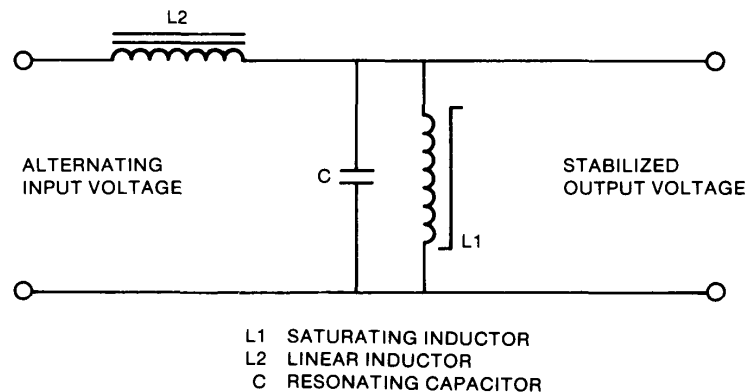
3.3.3.2 basic series parallel ferroresonant voltage regulator. This regulator consists of an essentially linear inductor connected in series with a parallel combination of a nonlinear inductor and a capacitor. This combination is connected across the source as shown in Fig 2. Load voltage is derived by inductive or conductive coupling to the nonlinear inductor.

3.3.4 ferroresonant voltage regulator transformer. A high-reactance transformer employing magnetic shunts that allow the magnetic functions of the basic series parallel ferroresonant regulator circuits to be combined into a single magnetic component. See Figs 3 and 4.

NOTE: Hereafter this will be referred to as a ferroresonant transformer.

3.3.4.1 primary winding. The winding of the ferroresonant transformer to which the input voltage is applied.

Fig 2
Basic Series Parallel Ferroresonant Voltage Regulator



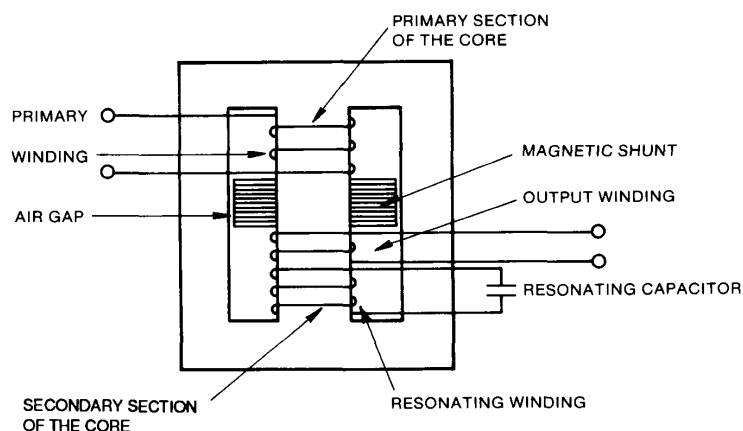


Fig 3
A Common Form of the Ferroresonant Transformer Voltage Regulator

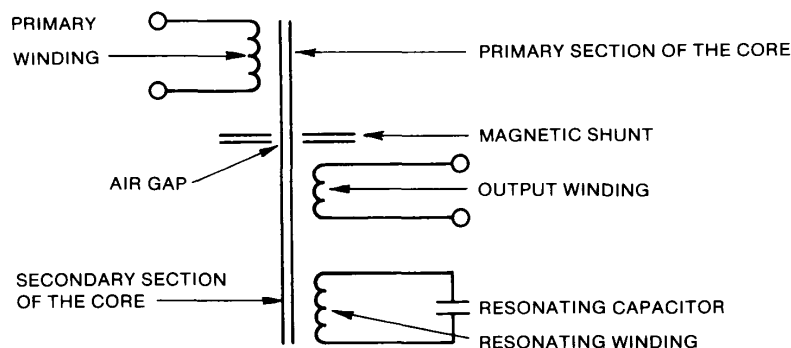


Fig 4
Schematic of Fig 3

3.3.4.2 output winding. The winding of the ferroresonant transformer used to provide the regulated output voltage.

NOTE: It is wound on the secondary section of the core and separated from the primary by a magnetic shunt.

3.3.4.3 resonating winding. The winding of the ferroresonant transformer used to connect the resonating capacitance to the circuit.

NOTE: It is wound on the secondary section of the core and is separated from the primary winding by a magnetic shunt. It may itself be the output winding or a portion of the output winding.

3.3.4.4 primary section of the core. The section of the core of a ferroresonant trans-

former on which the primary winding is wound.

3.3.4.5 secondary section of the core. The section of the ferroresonant transformer on which the output and resonating windings are wound. In steady-state operation, this section of the core is normally driven into magnetic saturation.

3.3.4.6 magnetic shunt. The section of the core of the ferroresonant transformer that provides the major path for flux generated by the primary winding current that does not link the secondary winding. In addition, the shunts provide a major path for the flux resulting from the output and resonating