



Designation: A804/A804M – 04 (Reapproved 2021)

Standard Test Methods for Alternating-Current Magnetic Properties of Materials at Power Frequencies Using Sheet-Type Test Specimens¹

This standard is issued under the fixed designation A804/A804M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover the determination of specific core loss and peak permeability of single layers of sheet-type specimens tested with normal excitation at a frequency of 50 or 60 Hz.

NOTE 1—These test methods have been applied only at the commercial power frequencies, 50 and 60 Hz, but with proper instrumentation and application of the principles of testing and calibration embodied in the test methods, they are believed to be adaptable to testing at frequencies ranging from 25 to 400 Hz.

1.2 These test methods use calibration procedures that provide correlation with the 25-cm [250-mm] Epstein test.

1.3 The range of test magnetic flux densities is governed by the properties of the test specimen and by the available instruments and other equipment components. Normally, non-oriented electrical steels can be tested over a range from 8 to 16 kG [0.8 to 1.6 T] for core loss. For oriented electrical steels, the normal range extends to 18 kG [1.8 T]. Maximum magnetic flux densities in peak permeability testing are limited principally by heating of the magnetizing winding and tests are limited normally to a maximum ac magnetic field strength of about 150 Oe [12 000 A/m].

1.4 These test methods cover two alternative procedures as follows:

Test Method 1—Sections **6 – 12**

Test Method 2—Sections **13 – 19**

1.4.1 Test Method 1 uses a test fixture having (1) two windings that encircle the test specimen, and (2) a ferromagnetic yoke structure that serves as the flux return path and has low core loss and low magnetic reluctance.

1.4.2 Test Method 2 uses a test fixture having (1) two windings that encircle the test specimen, (2) a third winding located inside the other two windings and immediately adjacent to one surface of the test specimen, and (3) a ferromag-

netic yoke structure which serves as the flux-return path and has low magnetic reluctance.

1.5 The values and equations stated in customary (cgs-emu and inch-pound) units or SI units are to be regarded separately as standard. Within this standard, SI units are shown in brackets except for the sections concerning calculations where there are separate sections for the respective unit systems. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[A34/A34M Practice for Sampling and Procurement Testing of Magnetic Materials](#)

[A340 Terminology of Symbols and Definitions Relating to Magnetic Testing](#)

[A343/A343M Test Method for Alternating-Current Magnetic Properties of Materials at Power Frequencies Using Wattmeter-Ammeter-Voltmeter Method and 25-cm Epstein Test Frame](#)

[A677 Specification for Nonoriented Electrical Steel Fully Processed Types](#)

[A683 Specification for Nonoriented Electrical Steel, Semi-processed Types](#)

¹ These test methods are under the jurisdiction of ASTM Committee [A06](#) on Magnetic Properties and are the direct responsibility of Subcommittee [A06.01](#) on Test Methods.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

A876 Specification for Flat-Rolled, Grain-Oriented, Silicon-Iron, Electrical Steel, Fully Processed Types

3. Terminology

3.1 Definitions:

3.1.1 *General*—The definitions of terms, symbols, and conversion factors relating to magnetic testing found in Terminology [A340](#) are used in these test methods.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *sheet specimen*—a rectangular specimen comprised of a single piece of material or paralleled multiple strips of material arranged in a single layer.

4. Significance and Use

4.1 *Materials Evaluation*—These test methods were developed to supplement the testing of Epstein specimens for applications involving the use of flat, sheared laminations where the testing of Epstein specimens in either the as-sheared or stress-relief-annealed condition fails to provide the most satisfactory method of predicting magnetic performance in the application. As a principal example, the test methods have been found particularly applicable to the control and evaluation of the magnetic properties of thermally flattened, grain-oriented electrical steel (Condition F5, Specification [A876](#)) used as lamination stock for cores of power transformers. Inasmuch as the test methods can only be reliably used to determine unidirectional magnetic properties, the test methods have limited applicability to the testing of fully processed nonoriented electrical steels as normally practiced (Specification [A677](#)).

4.2 *Specification Acceptance*—The reproducibility of test results and the accuracy relative to the 25-cm [250-mm] Epstein method of test are considered such as to render the test methods suitable for materials specification testing.

4.3 *Interpretation of Test Results*—Because of specimen size, considerable variation in magnetic properties may be present within a single specimen or between specimens that may be combined for testing purposes. Also, variations may

exist in test values that are combined to represent a test lot of material. Test results reported will therefore, in general, represent averages of magnetic quality and in certain applications, particularly those involving narrow widths of laminations, deviations in magnetic performance from those expected from reported data may occur at times. Additionally, application of test data to the design or evaluation of a particular magnetic device must recognize the influence of magnetic circuitry upon performance and the possible deterioration in magnetic properties arising from construction of the device.

4.4 *Recommended Standard Tests*—These test methods have been principally applied to the magnetic testing of thermally flattened, grain-oriented electrical steels at 50 and 60 Hz. Specific core loss at 15 or 17 kG [1.5 or 1.7 T] and peak permeability (if required) at 10 Oe [796 A/m] are the recommended parameters for evaluating this class of material.

5. Sampling

5.1 *Lot Size and Sampling*—Unless otherwise established by mutual agreement between the manufacturer and the purchaser, determination of a lot size and the sampling of a lot to obtain sheets for specimen preparation shall follow the recommendations of Practice [A34/A34M](#), Sections 5 and 6.

METHOD 1 TWO-WINDING YOKE-FIXTURE TEST METHOD

6. Basic Test Circuit

6.1 [Fig. 1](#) provides a schematic circuit diagram for the test method. A power source of precisely controllable ac sinusoidal voltage is used to energize the primary circuit. To minimize flux-waveform distortion, current ratings of the power source and of the wiring and switches in the primary circuit shall be such as to provide very low impedance relative to the impedance arising from the test fixture and test specimen. Ratings of switches and wiring in the secondary circuit also shall be such as to cause negligible voltage drop between the terminals of the secondary test winding and the terminals of the measuring instruments.

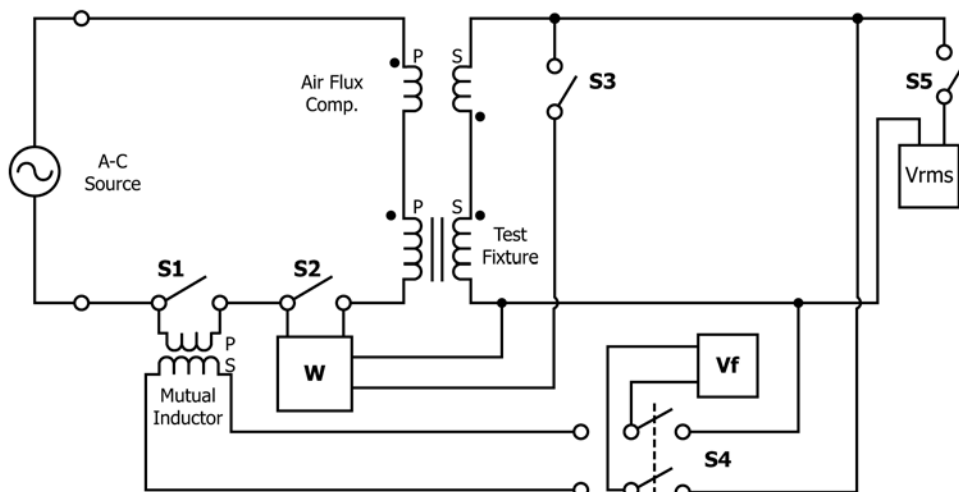


FIG. 1 Basic Circuit Diagram for Method 1