Designation: A341/A341M – 16 (Reapproved 2022)

Standard Test Method for Direct Current Magnetic Properties of Soft Magnetic Materials Using D-C Permeameters and the Point by Point (Ballistic) Test Methods[1]

This standard is issued under the fixed designation A341/A341M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method provides dc permeameter tests for the basic magnetic properties of soft magnetic materials in the form of bars, rods, wire, or strip specimens which may be cut, machined, or ground from cast, compacted, sintered, forged, extruded, rolled, or other fabricated materials. It includes tests for determination of the normal induction under symmetrically cyclically magnetized (SCM) conditions and the hysteresis loop (B-H loop) taken under conditions of rapidly changing or steep wavefront reversals of the direct current magnetic field strength. This method has been historically referred to as the ballistic test method. For testing hard or permanent magnet materials, Test Method A977/A977M shall be used.

1.2 This test method shall be used in conjunction with Practice A34/A34M.

1.3 This test method covers a range of magnetic field strength in the specimen from about 0.05 Oe [4 A/m] up to above 5000 Oe [400 kA/m] through the use of several permeameters. The separate permeameters cover this test region in several overlapping ranges.

1.4 Normal induction and hysteresis properties may be determined over the magnetic flux density range from essentially zero to the saturation induction for most materials.

1.5 Recommendations of the useful magnetic field strength range for each of the permeameters are shown in Table 1.[2] Permeameters particularly well suited for general testing of soft magnetic materials are shown in boldface. Also, see Sections 3 and 4 for general limitations relative to the use of permeameters.

1.6 The symbols and abbreviated definitions used in this test method appear with Fig. 1 and in appropriate sections of this document. For the official definitions, see Terminology A340. Note that the term magnetic flux density used in this document is synonymous with the term magnetic induction.

1.7 **Warning—**Mercury has been designated by EPA and many state agencies as a hazardous material that can cause central nervous system, kidney, and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury-containing products. See the applicable product Material Safety Data Sheet (MSDS) for details and EPA's website (http://www.epa.gov/mercury/faq.htm) for additional information. Users should be aware that selling mercury or mercury-containing products, or both, in your state may be prohibited by state law.

1.8 The values and equations stated in customary (cgs-emu and inch-pound) 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.

1.9 *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.*

1.10 *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.*

[1] This test method is under the jurisdiction of ASTM Committee A06 on Magnetic Properties and is the direct responsibility of Subcommittee A06.01 on Test Methods.

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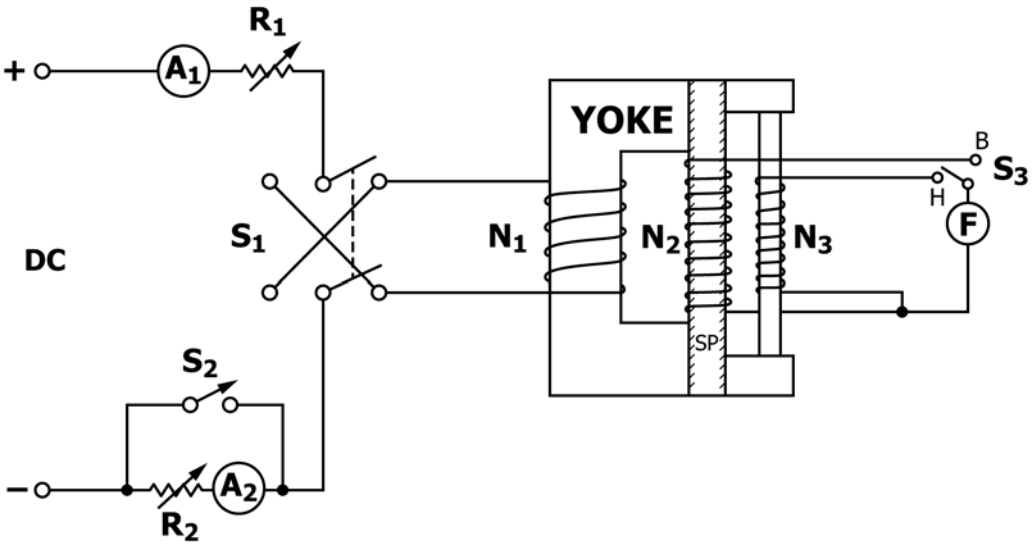
[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.

TABLE 1 Permeameters

Permeameter	Useful Magnetic Field Strength Range[A]		*H* Measuring Device[B]	Reluctance Compensation	Magnetizing Coil Surrounds Specimen	References[D]
	Oe	kA/m				
Babbit	40/1000	3.2/80	*I, HC*	yes	yes	(1,2)
Burroughs	0.1/300	0.008/24	*I*	yes	yes	(1,3,4,5)
Fahy Simplex[C]	0.1/300	0.008/24	*HC*	no	no	(1,4,5,6,7)
Fahy Simplex Super H adapter[C]	100/2500	8/200	*HC*	no	no	(1,3)
Full range	0.05/1400	0.004/112	*HC*	yes	yes	(1,8)
High H	100/5000	8/400	*FC*	yes	no	(1,5,7,9)
Iliovici	0.5/500	0.04/400	*I, HC*	yes	yes	(4,10,11)
IEC Type A	0.1/2500	0.008/200	*HC, HP*	no	yes	IEC 60404-4
IEC Type B	0.1/630	0.008/50	*RCC*	no	no	IEC 60404-4
Isthmus	100/20 000+	8/1600+	*HC, HP*	no	no	(1,4,12,13)
MH	0.1/300	0.008/24	*FC*	yes	yes	(1,6,14)
NPL	0.5/2500	0.04/200	*I, HC*	yes	yes	(15)
Saturation	100/4000	8/320	*HC*	no	yes	(5,16,17)

[A] Although the permeameters are capable of being used at the lower end of the measurement range, the measurement accuracy is reduced.
[B] *I*—magnetizing current; *HC*—fixed *H* coil; *FC*—flip coil; *HP*—Hall probe; *RCC* —Rogowski-Chattock coil.
[C] Fahy permeameters require a standard of known magnetic properties for calibration of the *H* coil.
[D] The boldface numbers in parentheses refer to a list of references at the end of this standard.



NOTE 1—
A_1—Multirange ammeter (main current)
A_2—Multirange ammeter (hysteresis current)
B—Magnetic flux density test position for Switch S_3
F—Electronic Fluxmeter
H—Magnetic field strength test position for Switch S_3
N_1—Magnetizing coil
N_2—Magnetic flux sensing (*B*) coil
N_3—Magnetic field strength (*H*) sensing coil
R_1—Main current control rheostat
R_2—Hysteresis current control rheostat
S_1—Reversing switch for magnetizing current
S_2—Shunting switch for hysteresis current control rheostat
S_3—Fluxmeter selector switch
SP—Specimen

FIG. 1 Basic Circuit Using Permeameter