Designation: D5948 – 05$^{\varepsilon 1}$

StandardSpecification for Molding Compounds, Thermosetting[1]

This standard is issued under the fixed designation D5948; 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 Department of Defense.

ε^1 NOTE—Editorial corrections were made in August 2005.

1. Scope*

1.1 This specification covers the basic properties of thermoset molding compounds and the test methods used to establish the properties.

1.2 *Classification*—Molding thermosetting plastic compounds shall be of the following resins and are covered by the individual specification sheets (see 5.1 and Annex A1-Annex A8).

Resin
Phenolic, cellulose filled
Phenolic, mineral/glass filled
Melamine
Polyester
Diallyl iso-phthalate
Diallyl ortho-phthalate
Silicone
Epoxy

NOTE 1—There is no equivalent ISO standard.

1.3 *Order of Precedence*—In the event of a conflict between the text of this specification and the references cited in Section 2 (except for related specification sheets), the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

1.4 The values stated in SI units are to be considered standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D229 Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D495 Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation

D570 Test Method for Water Absorption of Plastics

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

D695 Test Method for Compressive Properties of Rigid Plastics

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D796 Practice for Compression Molding Test Specimens of Phenolic Molding Compounds (Withdrawn 1992)[3]

D883 Terminology Relating to Plastics

D1896 Practice for Transfer Molding Test Specimens of Thermosetting Compounds

D3419 Practice for In-Line Screw-Injection Molding Test Specimens From Thermosetting Compounds

D3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials

D3638 Test Method for Comparative Tracking Index of Electrical Insulating Materials

D4350 Test Method for Corrosivity Index of Plastics and Fillers

D4697 Guide for Maintaining Test Methods in the User's Laboratory (Withdrawn 2009)[3]

E994 Guide for Calibration and Testing Laboratory Accreditation Systems General Requirements for Operation and Recognition (Withdrawn 2003)[3]

E1224 Guide for Categorizing Fields of Capability for Laboratory Accreditation Purposes (Withdrawn 2002)[3]

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.16 on Thermosetting Materials.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

TABLE 1 Sampling and Conditioning for Mechanical/Physical Qualification Tests

NOTE 1—A50 % retention of initial flexural strength is required.

NOTE 2—The side of a test specimen is that area formed by the chase of the mold.

NOTE 3—The face of the test specimen is that area formed by the top or bottom force plug.

NOTE 4—When specified.

Property to Be Tested-Mechanical/Physical	ASTM Test Method	Modified by	Specimens, Form, and Dimension	Number Tested	Conditioning Procedure (see Section 6)	Unit of Value
Compressive strength, end-wise	D695	...	25.4 by 12.7 by 12.7 mm	5	E-48/50 + C-96/23/50	MPa (minimum average)
Dimensional stability	...	7.2.1	127 bar, 12.7 by 12.7 mm	5	C-96/23/50	Percent (maximum average)
Flexural strength	D790	7.2.2	127 bar, 6.4 by 12.7 mm	5	E-48/50 + C-96/23/50	MPa (minimum average)
Heat deflection temperature	D648	7.2.3	127 bar, 12.7 by 12.7 mm	3	A	Degrees Celsius (minimum average)
Heat resistance (1)	D790	7.2.4	127 bar, 6.4 by 12.7 mm	5	E-1/at designated temperature test. Test at temperature	Degrees Celsius (minimum average) at temperature
Impact strength						
Side (2)	D256	...	As per Test Method D256	5	E-48/50 + C96/23/50	J/m notch (minimum average)
Face (3), (4)	D256	...	As per Test Method D256	5	E-48/50 + C96/23/50	J/m notch (minimum average)
Tensile strength	D638	...	As per Test Method D638	5	E-48/50 + C-96/23/50	MPa (minimum average)
Water absorption	D570	7.2.5	51-mm disk, 3.2 mm thick	3	E-24/100 + des + D-48/50	Percent (maximum average)

2.2 *Underwriters Laboratory Standard:*[4]

UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

2.3 *Other Standard:*

DDC AD 297457 Procedure for Determining Toxicity of Synthetic Compounds[5]

3. Terminology

3.1 For definitions of technical terms pertaining to plastics used in this specification, refer to Terminology D883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *batch*—a homogeneous unit of finished molding compound manufactured at one time.

3.2.2 *heat resistance*—the elevated temperature at which a particular material retains a minimum of 50 % of its original flexural strength measured at 23°C.

4. Significance and Use

4.1 This specification is a revision of STD MIL-M-14H, Specification for Molding Compound, Thermosetting, retaining the MIL-M-14H material designations and property requirements while conforming to ASTM form and style. It is intended for qualification and batch acceptance for materials used by government and industry, and is intended as a direct replacement for MIL-M-14H.

5. Requirements

5.1 *Specification Sheets*—The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet (see Annex A1-Annex A8). In the event of any conflict between the requirements of this specification and the material specification, the latter shall govern.

5.2 *Qualification*—Molding compounds furnished under this specification shall be products which conform to the applicable material specification and quality assurance provisions in this specification.

5.3 *Material Safety Data Sheet (MSDS)*— The user shall be provided with a material safety data sheet.

5.4 *Uniformity*—All molding compound of the same brand from one manufacturer shall be uniform in texture, in color, and in the specified properties as determined by the batch-acceptance inspection specified in 8.3.

5.5 *Property Values*—Standard specimens of the compounds shall conform to the property values shown in the individual specification sheets for qualification (see 8.2) and batch acceptance (see 8.3).

6. Conditioning

6.1 Standard test specimens shall be conditioned before testing, as specified in Tables 1-4.

6.1.1 *Nomenclature*—The following letters shall be used to indicate the respective general conditioning procedures:

6.1.1.1 *Condition A*—As received; no special conditioning.

6.1.1.2 *Condition C*—Humidity conditioning in accordance with Practice D618.

6.1.1.3 *Condition D*—Immersion conditioning in distilled water in accordance with Practice D618.

6.1.1.4 *Condition E*—Temperature conditioning in accordance with Practice D618; Condition Desiccation–cooling over silica gel or calcium chloride in a desiccator at 23°C for 16 to 20 h after temperature conditioning in accordance with Practice D618.

6.2 *Designation*—Conditioning procedures shall be designated as follows:

[4] Available from Underwriters Laboratories (UL), Corporate Progress, 333 Pfingsten Rd., Northbrook, IL 60062.

[5] Available from National Technical Information Service (NTIS), U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

TABLE 2 Sampling and Conditioning for Electrical Qualification Tests

Property to Be Tested-Mechanical/Physical	ASTM Test Method	Modified by	Specimens, Form, and Dimension	Number Tested	Conditioning Procedure (see Section 6)	Unit of Value
Arc resistance	D495	...	102-mm disk, 3.17 mm thick	3	A	seconds (minimum average)
Dielectric breakdown:						
Short-time test	D149	7.2.6	102-mm disk, 12.7 mm thick	1	E-48/50 + C-96/23/50	kilovolt (minimum average)
Step-by-step test				3	E-48/50 + C-96/23/50	
Short-time test				1	E-48/50 + D-48/50	
Step-by-step test				3	E-48/50 + D-48/50	
Dielectric constant:						
At 1 kHz	D150	...	51-mm disk, 3.2 mm thick	3	E-48/50 + des	maximum average
				3	E-48/50 + D-24/23	
At 1 MHz			51-mm disk, 3.2 mm thick	3	E-48/50 + des	
				3	E-48/50 + D-24/23	
Dielectric strength:						
Short-time test	D149	7.2.6	102-mm disk, 3.2 mm thick	3	E-48/50 + C-96/23/50	kV/mm (minimum
Step-by-step test				5	E-48/50 + C-96/23/50	average)
Short-time test				3	E-48/50 + D-48/50	
Step-by-step test				5	E-48/50 + D-48/50	
Dissipation factor:						
At 1 kHz	D150	...	51-mm disk, 3.2 mm thick	3	E-48/50 + des	maximum average
				3	E-48/50 + D-24/23	
At 1 MHz			51-mm disk, 3.2 mm thick	3	E-48/50 + des	
				3	E-48/50 + D-24/23	
Surface resistance	...	7.2.7	102-mm disk, 3.2 mm thick	5	C-720/70/100 + dew	megaohms (minimum individual)
Comparative track index	D3638	7.2.8	51-mm disk, 3.2 mm thick	5	A	volts
Volume resistance	...	7.2.7	102-mm disk, 3.2 mm thick	5	C-720/70/100 + dew	megaohms (minimum individual)
Water extract conductance	D4350	...	...	...	E-144/71	siemens per centimetre

TABLE 3 Sampling and Conditioning for Combustion Qualification Tests

Property to Be Tested-Mechanical/Physical	ASTM Test Method	Modified by	Specimens, Form, and Dimension	Number Tested	Conditioning Procedure (see Section 6)	Unit of Value
Flame resistance ignition time	D229	7.2.9	127-mm bar, 12.7 by 12.7 mm	5	A	seconds (minimum average)
Burning time						seconds (maximum average)
Flammability	UL 94	7.2.10	127-mm bar, 12.7-mm thickness	5	A	rating/thickness (1.6, 3.2, or 6.4 mm)
Toxicity when heated:						
Carbon dioxide						
Carbon monoxide						
Ammonia						
Aldehydes as HCHO						
Cyanide and HCN	—	7.2.11	127-mm bar, 12.7 by 12.7 mm	4	A	parts per million (maximum average)
Oxide of nitrogen as NO2						
Hydrogen chloride						

6.2.1 A capital letter indicating the general condition of the specimen; that is, as-received, humidity, immersion, or temperature conditioning.

6.2.2 A number indicating the duration of the conditioning in hours.

6.2.3 A number indicating the conditioning temperature in degrees Celsius.

6.2.4 A number indicating relative humidity, whenever relative humidity is controlled.

6.3 The numbers shall be separated from each other by slant marks and from the capital letter by a dash. A sequence of conditions shall be denoted by use of a plus sign (+) between successive conditions.

Examples:

Condition C-96/23/50:	Humidity condition, 96 h at 23 ± 1.1°C and 50 ± 2 % relative humidity.
Condition D-48/50:	Immersion condition, 48 h at 50 ± 1°C.
Condition E-48/50:	Temperature condition, 48 h at 50 ± 3°C.
Condition E-48/50 + C-96/23/50:	Temperature condition, 48 h at 50± 3°C followed by + C-96/23/50 humidity condition, 96 h at 23 ± 1.1°C and 50 ± 2 % relative humidity.

7. Test Procedure

7.1 *Standard Test Specimens:*

7.1.1 *Number*—The minimum number of standard test specimens to be tested is specified in Tables 1-4.

7.1.2 *Form*—The form of the standard test specimens shall be as specified in the referenced ASTM test method or other applicable test method.

TABLE 4 Sampling and Conditioning for Batch Acceptance Tests

NOTE 1—The side of a test specimen is that area formed by the chase of the mold.

Property to Be Tested-Mechanical/Physical	ASTM Test Method	Modified by	Specimens, Form, and Dimension	Number Tested	Conditioning Procedure (see Section 6)	Unit of Value
Arc resistance	D495	...	102-mm disk, 3.2 mm thick	3	A	seconds (minimum average)
Comparative track index	D3638	7.2.8	51-mm disk, 3.17 mm thick	5	A	volts
Dielectric constant at 1 MHz	D150	...	51-mm disk, 3.2 mm thick	3	E-48/50 + D-24/23	maximum average
Dissipation factor at 1 MHz	D150	...	51-mm disk, 3.2 mm thick	3	E-48/50 + D-24/23	maximum average maximum average
Dielectric strength, step-by-step	D149	7.2.6	102-mm disk, 3.2 mm thick	5	E-48/50 + D-48/50	kV/mm (minimum average)
Flexural strength	D790	7.2.2	127-mm bar, 6.4 by 12.7 mm	5	E-48/50 + C-96/23/50	mPa (minimum average)
Impact strength, side (1)	D256	...	in accordance with Test Methods D256	5	E-48/50 + C-96/23/50	J/m notch (minimum average)
Water absorption	D570	7.2.5	51-mm disk, 3.2 mm thick	3	E-24/100 + des + D-48/50	percent (maximum average)
Water extract conductance	D4350	7.2.12...	...	E-144/71		siemens per centimetre

7.1.3 *Molding of Test Specimens*—Mold test specimens by methods that could include post-cure. No special treatment shall be used to improve the properties of the specimens when compared with parts molded in commercial productions. (Practices D796, D1896, and D3419 represent the best molding practices for thermosets.)

7.1.4 *Tolerance*—Test specimens shall conform to the dimensional tolerances of the appropriate test method, as listed in Tables 1-4. When not otherwise stated, tolerance on dimensions shall be ±5 %.

7.2 *Methods of Test*—Unless otherwise specified, take all test measurements at the standard laboratory atmosphere of 23 ± 1.1°C and 50 ± 2 % relative humidity. The test methods shall be conducted in accordance with the applicable ASTM test method, except where modified (see 7.2.1-7.2.12).

7.2.1 *Dimensional Stability*—Mold or machine the specimens so the 12.7 by 12.7-mm ends are smooth and parallel. Subject the specimens to the condition C-96/23/50 (see 6.2). Then measure the initial length of the specimens to the nearest 0.01 mm. Subject the specimens to 10 cycles, each cycle as follows: 48 h in a circulating air oven at 125 ± 5°C plus 24 h at 23 ± 1.1°C and 50 ± 2 % relative humidity. At the completion of 10 cycles, measure the final length of the specimens to the nearest 0.01 mm. The percentage dimensional change is calculated to the nearest 0.1 % as follows:

$$\text{Dimensional change, \%} = \frac{(\text{initial length} - \text{final length})}{\text{initial length}} \times 100 \quad (1)$$

The average percent dimensional change of the five specimens shall be recorded.

7.2.2 *Flexural Strength*—Use Test Method D790 to determine flexural strength. The span-depth ratio shall be 16:1, and the dimensions of the test bar shall be 127 by 12.7 by 6.4 mm.

7.2.3 *Heat-Deflection Temperature*—Use Test Method D648 to determine heat-deflection temperature. The specimens shall be placed directly in the oil bath and not in air. The stress load shall be 1.82 MPa.

7.2.4 *Heat Resistance*—Condition the specimen for 1 h at the designated temperature. After conditioning, the flexural strength (see 7.2.2) shall be tested at the same temperature in accordance with Test Method D790. When measured at the elevated test temperature, the molding compound shall meet the heat resistance requirement of retaining 50 % of the flexural strength value as determined at 23°C. The average of five determinations divided by the average flexural strength as determined at 23°C shall be multiplied by 100 and recorded as percent flexural strength retained at the specified conditioning and testing temperature. For example:

7.2.4.1 The temperature specified under heat resistance for each material grade in Annexes A1.1 through A8.1 is the E1 temperature designated in Table 1. It is the temperature at which that particular grade shall retain a minimum of 50 % of its original flexural strength.

7.2.5 *Water Absorption*—Use Test Method D570 to determine water absorption, modified as follows:

7.2.5.1 Condition the specimens at 100 ± 2°C for 24 h, followed by a 16 to 20-h period of cooling over silica gel or calcium chloride in a desiccator at 23 ± 1.1°C.

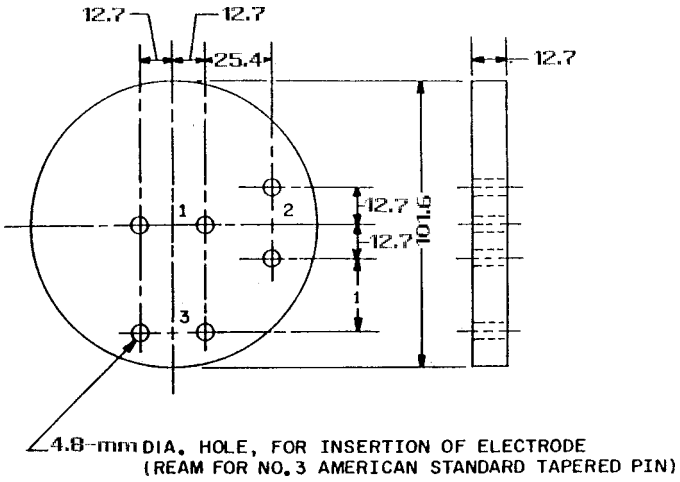
7.2.5.2 Immerse the specimens in distilled water and maintain at a temperature of 50 ± 1°C for 48 h. Include in the report only the percentage increase in weight during immersion calculated to the nearest 0.01 % as follows:

$$\text{Increase in weight, \%} = \frac{(\text{wet weight} - \text{conditioned weight})}{\text{conditioned}} \times 100 \quad (2)$$

7.2.6 *Dielectric Test:*

7.2.6.1 *Dielectric Breakdown*—Use the apparatus and procedure specified in Test Method D149. The electrodes shall be American Standard No. 3 tapered pins.[6] The test potential shall be applied successively between the numbered pairs of electrodes (see Fig. 1), and the average of the three readings shall be taken as the reading for the specimen.

[6] Can be found in Machinery's Handbook.



NOTE 1—All dimensions in millimetres.

NOTE 2—Tolerances with dimensions, ±5 %.

NOTE 3—Disks shall be furnished undrilled and shall be drilled by the laboratory.

FIG. 1 Standard Test Specimen Drilled for Three Pairs of Electrodes—Dielectric Breakdown Test

7.2.6.2 *Dielectric Strength*—Use the apparatus and procedure specified in Test Method D149. Conduct the test under oil at a frequency not exceeding 100 Hz. The electrodes shall be brass or stainless steel cylinders 25.4 mm long with the edges rounded to a 3.2-mm radius.

(*1*) *Short-Time Test*—The voltage shall be increased uniformly at the rate of 500 V/s.

(*2*) *Step-by-Step Test*—Increase the voltage in increments, as shown in Table 5, up to failure and hold it at each step for 1 min. The change from one step to the next higher step shall be made within 10 s.

7.2.7 *Volume and Surface Resistance:*

7.2.7.1 *Specimens*—Use five 102-mm diameter 3.2-mm thick specimens. Clean specimens by noninjurious methods to ensure freedom from contamination. Take precautions in handling the specimens to avoid additional contamination.

7.2.7.2 *Electrodes*—Electrodes shall consist of a guarded electrode 51 mm in diameter, 6.4-mm guard ring spaced 6.4 mm from the guarded electrode on the same side, and the third electrode 76 mm in diameter on the opposite side and concentric with the guarded electrode. Dimensions of electrodes shall be maintained at a tolerance of ±0.40 mm [±1⁄64 in.]. Silver paint, permeable to moisture,[7] shall be used for painting electrodes on the specimens. The electrodes shall exhibit a resistance of not more than 5 Ω both before and after the C-720/70/100 + dew conditioning when measured with a potential of not greater than 3 V between points diametrically opposite each electrode. After painting, permit the specimens to air dry for at least one week in an atmosphere of less than 60 % relative humidity at a temperature of 25 ± 5°C.

[7] DuPont silver paint No. 4517, or its equivalent, available from DuPont Corp., Electronic Materials, Photo Products Dept., Wilmington, DE 19898, has been found suitable for this purpose.

TABLE 5 Voltage Increase for Step-by-Step Test

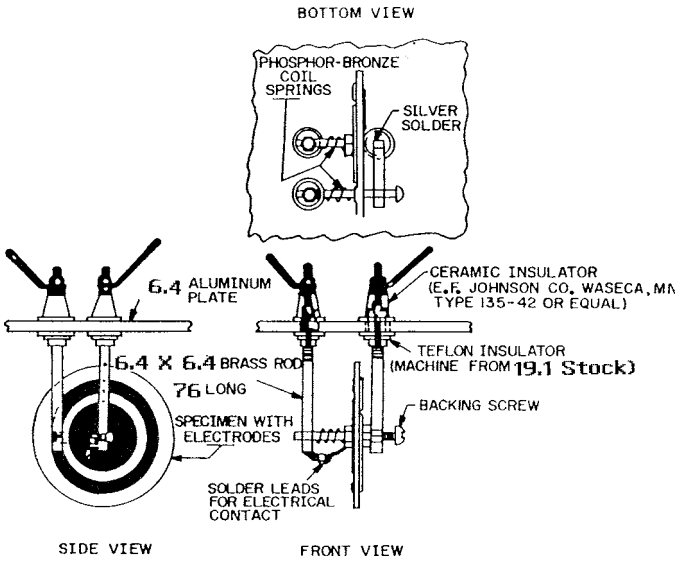
Breakdown by Short-Time Method, kV	Increment of Increase, kV
12.5 or less	0.5
Over 12.5 to 25, inclusive	1.0
Over 25 to 50, inclusive	2.5
Over 50 to 100, inclusive	5.0
Over 100	10.0

7.2.7.3 *Humidity Chamber*—The humidity chamber shall consist of a glass container with a corrosion-resistant cover. The cover shall be provided with through-panel-type insulators. The insulators may serve as supports for the electrode holders as shown in Fig. 2. The chambers shall be of such size that the ratio of specimen surface area to water surface area shall not exceed 2.5. The ratio of volume of air in the humidity chamber to surface area of the water shall not exceed 10. Obtain 100 % relative humidity with condensation by natural evaporation from a quantity of distilled water located at the bottom of the chamber. Seal the cover to the chamber with an inert sealing compound applied to the exterior points formed by the cover and the walls of the chamber. Provide a small vent hole in the cover to equalize the pressure. Seal the vent hole as soon as the air temperature in the humidity chamber has reached 70°C.

7.2.7.4 *Specimen Holders*—Install the specimens in a vertical plane in the conditioning chamber with the lower edge of the specimen not closer than 25.4 mm from the surface of the water. Hold the specimens in position with the electrode contactors in a matter similar to that shown in Fig. 2. Make the electrical connection to the specimen holders with through-panel insulators. The insulators shall be capable of withstanding the adverse conditions within the chamber without excessive loss of insulating properties. (Insulator resistance to cover plate shall at all times exceed 10 MΩ). Polytetrafluoroethylene insulators on the humidity side of the conditioning chamber are recommended to meet this requirement. These should be cleaned with alcohol before the start of each test. Electrode contactors and all other metallic parts of the sample shall be silver plated. Contact pressure against the electrodes may be provided by backing the contactors with phosphor bronze springs or other corrosion-resistant spring material.

7.2.7.5 *Heating Chamber*—Install the humidity chamber in an oven or other heating chamber capable of maintaining a temperature of 70 ± 1°C. The rate of heating of the oven shall be so that the air temperature at a point near the volumetric center of the humidity chamber shall attain 70°C in 4 ± 1 h. The quality of water in the chamber shall be so that the water temperature shall attain 65°C in 4 ± 1 h. Maintain room temperature at 25 ± 5°C. The insulation of the conductors connecting the through-panel insulators to the measuring equipment shall not be significantly deteriorated by the elevated temperatures encountered in the oven. Polytetrafluoroethylene-coated wire is recommended.

7.2.7.6 *Measurements*—Measure volume and surface resistances using the three-terminal method, employing measuring equipment such as a megaohm bridge capable of applying 500-V direct current (dc) to the specimen. A single set of



NOTE 1—All dimensions in millimetres.

NOTE 2—Material — brass except as indicated.

NOTE 3—Silver plate all metallic parts except plate.

FIG. 2 Specimen Holders Electrodes Test Samples and Humidity Chamber Cover—Volume and Surface Resistance Test

measurements shall be made of each specimen while in the conditioning chamber after 30 days of the specified conditioning.

NOTE 2—Because of the variability of the resistance of a given specimen with test conditions and because of nonuniformity of the same material from specimen to specimen, determinations are usually not reproducible to closer than 10 % and are often even more widely divergent. A range of values from 10 to 1 may be obtained under apparently identical conditions. Errors in resistance determinations may result from the fact that the current measuring device is shunted by the resistance between the guarded terminal and the guard system. To ensure validity of the volume and surface resistance measurements obtained by the bridge methods, the resistance between the unguarded and the guarded terminal should be at least five times greater than the standard resistance employed in the bridge. This may be ascertained by direct two-terminal measurements between these two terminals. Conversion of the measurements to resistivities is not required since electrode dimensions are specified. The potentials shall be applied to the specimens as shown in Fig. 3 or with polarities opposite to those shown on Fig. 3. Take surface resistance measurements on the same specimens as those used for volume resistance, except interchange the potentials of guard and low electrodes. Measure the volume and surface resistance in each case, 1 min after the potentials are applied. Low values of volume and surface resistance (below 5 MΩ) may be measured by the circuits shown on Fig. 4.

7.2.8 *Track Resistance*—Measure the track resistance by the comparative tracking index method described in Test Method D3638.

Example:

DAP type	Volts, min
SDG & SDG-F	600 +
MDG & MDG-F	600 +
GDI-30 & GDI-30F	600 +
SIG & SIG-F	600 +
MIG & MIG-F	600 +
GII-30 & GII-30F	600 +

7.2.9 *Flame Resistance*—Determine flame resistance in accordance with Method II of Test Methods D229, with the following exceptions:

7.2.9.1 *Flame Cabinet*—The 14.3-mm slot at the bottom of the flame cabinet shall be on all four sides. The door shall be provided with a 31.8-mm diameter peep hole located directly opposite the heater coil when the door is closed. Keep the hole closed during testing with a cover.

7.2.9.2 *Pyrometer*—The means of correction from black-body radiation to actual conditions of this test shall be as follows:

(*1*) When a pyrometer calibrated for black-body emission is used, add 6°C to the pyrometer to obtain the true temperature of the Nichrome V coil.

7.2.9.3 *Specimens*—Test specimens shall be as follows:

(*1*) Specimens shall be molded to 12.7 by 12.7 by 127 ± 1 mm.

(*2*) The test sample shall consist of five test specimens.

7.2.9.4 *Calibration*—In the calibration of this equipment, adjust the heater current to obtain an equilibrium temperature of 860 ± 2°C.

7.2.9.5 *Calculation of Burning Time*—Arrange the five values of burning time in increasing order of magnitude, as T_1, T_2, T_3, T_4, T_5. Compute the following ratios:

$$\frac{T_2 - T_1}{T_5 - T_1} \text{ and } \frac{T_5 - T_4}{T_5 - T_1} \quad (3)$$

If either of these ratios exceeds 0.642, then T_1 or T_5 is judged to be abnormal and is eliminated. The burning time reported shall be the average of the remaining four values.

7.2.9.6 *Average Ignition Time*—The average ignition time is calculated as the arithmetic mean time for the five specimens.

7.2.10 *Flammability*—Determine the flammability rating in accordance with UL 94 using the vertical or horizontal burning test and either 1.6, 3.2, or 6.4-mm thick specimens. Record as rating/thickness in inches.

7.2.11 *Toxicity When Heated*—The method described in DDC AD 297457 shall be used to determine toxicity of the test specimen when heated.

7.2.12 *Water Extract Conductance*—This test shall be performed in accordance with Test Method D4350, using the conditioning procedure listed in the specification tables.

7.3 *Toxicological Product Formulations*— The supplier shall have the toxicological product formulations and associated information available for review by the user to evaluate the safety of the material for the proposed use.

8. Quality Assurance Provisions

8.1 *Responsibility for Inspection*—The supplier is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. The supplier shall use a laboratory accredited in accordance with Guide E994, within the required categories in compliance with Guide E1224.

8.1.1 *Responsibility for Compliance*—The absence of any inspection requirements in the specification shall not relieve the supplier of the responsibility of ensuring that all products or supplies comply with all requirements. Sampling inspection, as part of the manufacturing operations and in accordance with Practice D3636, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize

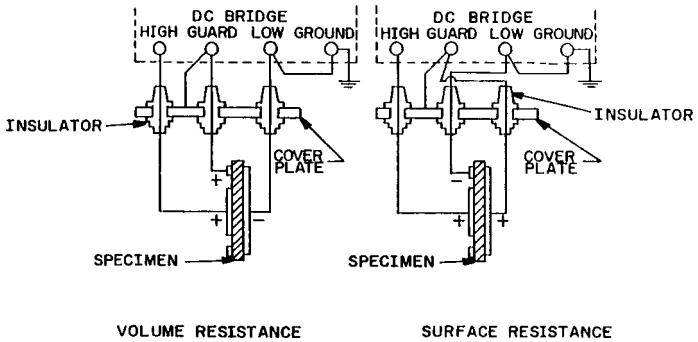


FIG. 3 Arrangements for Volume Resistance and Surface Resistance Test

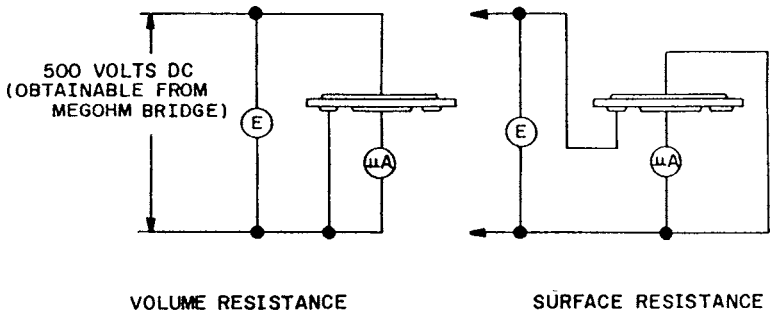


FIG. 4 Circuits for Measuring Low Values of Volume and Surface Resistance

submission of known defective material, either indicated or actual, nor does it commit the user to accept defective material.

8.2 *Retention of Qualification*—Any manufacturer who makes a significant change in raw materials or process used in the manufacture of such compounds shall continue to meet the applicable material qualification test requirements.

8.3 *Quality Conformance Inspection*— Quality conformance inspection shall consist of the batch acceptance tests and shall be as specified in the applicable material specification (see 8.1). They shall be conducted at an accredited laboratory in compliance with Guide D4697, on each batch of compound to be supplied to molders for production of molded parts.

9. Keywords

9.1 diallyl phthalate plastics; epoxy plastics; melamine-formaldehyde plastics; molding compounds; phenolic plastics; plastics; polyester plastics; silicone resin molding compounds

ANNEXES

(Mandatory Information)

A1. MOLDING COMPOUNDS, PHENOLIC, THERMOSETTING, CONTAINING CELLULOSE FILLERS

A1.1 The requirements for acquiring the product described herein shall consist of this specification sheet.

A1.2 *Requirements* —Qualification test requirements are specified in Table A1.1. Batch acceptance test requirements are specified in Table A1.2.

A1.2.1 *Type CFG*—This type is a general-purpose, wood-flour-filled phenolic compound.

A1.2.2 *Type CFI-5*—This type is a moderate-impact, cotton- or paper-filled phenolic compound.

A1.2.3 *Type CFI-10*—This type is a medium-impact, cotton rag-filled phenolic compound.

A1.2.4 *Type CFI-20*—This type is a high-impact, rag- or cotton-filled phenolic compound.

A1.2.5 *Type CFI-30*—This type is a high-impact, cotton-filled phenolic compound.

A1.2.6 *Type CFI-40*—This type is the highest impact grade of cotton-filled phenolic compound.

TABLE A1.1 Qualification Test Requirements for Phenolic Resin Molding Compounds: Cellulose Filled

Requirement	Type CFG	Type CFI-5	Type CFI-10	Type CFI-20	Type CFI-30	Type CFI-40
			Mechanical/Physical			
Compressive strength, endwise	172	159	138	138	131	124
Flexural strength	62	55	55	55	55	55
Heat deflection temperature	115	115	115	115	115	115
Heat resistance	115	115	115	115	115	115
Impact strength, side[A]	11	27	53	93	160	187
Tensile strength	41	39	39	39	39	41
Water absorption	3.0	4.0	4.0	4.0	4.0	4.0
			Electrical			
Dielectric breakdown:						
Short-time test[B]						
Step-by-step test	30	18	18	18	18	18
Short-time test[B]						
Step-by-step test	2.5	2.5	2.5	2.5	2.5	2.5
Dielectric strength:						
Short-time test	11.8	9.8	9.5	8.3	9.8	6.9
Step-by-step test	7.9	5.9	7.1	5.9	5.9	...
Short-time test	3.0	2.0	1.6	1.8	0.3	1.0
Step-by-step	1.8	1.1	1.1	1.0	0.4	0.6
			Combustion			
Flame resistance:						
Ignition time	60	60	60	60	60	60
Burning time	270	330	330	330	330	330
Flammability						
Rating	94HB	94HB	94HB	94HB	94HB	94HB
Thickness	3.2	3.2	3.2	3.2	3.2	3.2

[A] The side of the test specimen is that area formed by the chase of the mold.
[B] To be recorded as the basis for determining initial voltage in the step-by-step test.

TABLE A1.2 Batch Acceptance Test Requirements for Phenolic Resin Molding Compounds, Cellulose Filled

Property to Be Tested	Type CFG	Type CFI-5	Type CFI-10	Type CFI-20	Type CFI-30	Type CFI-40
Arc resistance	...	...	...	...	...	...
Dielectric strength, step-by-step	1.8	1.1	1.1	1.0	0.4	0.6
Flexural strength	62	55	55	55	55	55
Impact strength, side[A]	11	27	53	93	160	187
Water absorption	3.0	4.0	4.0	4.0	4.0	4.0

[A] The side of the test specimen is that area formed by the chase of the mold.

A2. MOLDING COMPOUNDS, PHENOLIC, THERMOSETTING, CONTAINING MINERAL/GLASS FILLERS

A2.1 The requirements for acquiring the product described herein shall consist of this specification sheet.

A2.2 *Requirements* —Qualification test requirements are specified in Table A2.1. Batch acceptance test requirements are specified in Table A2.2.

A2.2.1 *Type MFE*—This type is a low-loss, high-dielectric-strength, low-water absorption mineral-filled phenolic compound.

A2.2.2 *Type MFH*—This type is a mineral-filled phenolic compound intended for applications requiring heat resistance.

A2.2.3 *Type GPG*—This type is a general purpose glass-filled phenolic compound intended for applications requiring good mechanical, electrical, and heat resistant properties.

A2.2.4 *Type GPI-5*—This type is a heat-resistant, moderate-impact, glass-filled phenolic compound having good electrical properties.

A2.2.5 *Type GPI-10*—This type is a heat-resistant, medium-impact, glass-filled phenolic compound having good electrical properties.

A2.2.6 *Type GPI-20*—This type is the heat-resistant, moderately high-impact, glass-filled phenolic compound having good electrical properties.

A2.2.7 *Type GPI-30*—This type is a heat-resistant, high-impact, glass-filled phenolic compound having good electrical properties.

A2.2.8 *Type GPI-50*—This type is a heat-resistant, high-impact, glass-filled phenolic compound having good electrical properties.

A2.2.9 *Type GPI-100*—This type is a glass-fiber-filled phenolic resin molding compound of very high-impact strength and good electrical properties.

TABLE A2.1 Qualification Test Requirements for Phenolic Resin Molding Compounds, Mineral/Glass Filled

Requirement	Type MFE	Type MFH	Type GPG	Type GPI-5	Type GPI-10	Type GPI-20	Type GPI-30	Type GPI-50	Type GPI-100
				Mechanical/Physical					
Compressive strength, endwise	103	103	159	172	172	159	138	138	138
Flexural strength	55	48	62	83	83	83	83	97	103
Heat deflection temperature	115	130	170	175	175	175	175	175	200
Heat resistance	175	200	175	200	175	175	175	175	175
Impact strength, side[A]	...	13	16	27	53	107	160	267	534
Tensile strength	29	29	31	48	45	45	45	41	31
Water absorption	0.10	0.35	0.30	0.35	0.35	0.40	0.50	1.0	1.5
				Electrical					
Dielectric breakdown:									
Short-time test[B]									
Step-by-step test	45	35	35	35	35	35	35	35	40
Short-time test[B]									
Step-by-step test	40	10	15	15	15	15	15	15	15
Dielectric constant:									
at 1 kHz	6.0	...	7.0	7.0	7.0	7.0	7.0	7.0	7.0
	6.0	...	8.0	8.0	8.0	8.0	8.0	8.0	8.0
at 1 MHz	6.0	...	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	6.0	...	6.3	6.3	6.3	6.3	6.3	6.3	6.3
Dielectric strength:									
Short-time test	12.8	8.5	10.8	9.8	9.8	9.8	9.8	9.8	11.8
Step-by-step test	10.8	5.9	8.9	7.9	7.9	7.9	7.9	7.9	7.9
Short-time test	12.8	4.9	8.9	6.9	6.9	6.9	6.9	6.9	6.9
Step-by-step test	10.8	3.2	7.9	4.9	4.9	4.9	4.9	4.9	2.0
Dissipation factor									
at 1 kHz	0.03	...	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	0.03	...	0.09	0.09	0.09	0.09	0.09	0.09	0.09
at 1 MHz	0.15	...	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	0.02	...	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Surface resistance	5.0	...	...	...	...	...	...	...	...
Volume resistance	2.0	...	...	...	...	...	...	...	...
				Combustion					
Flame resistance:[C]									
Ignition time	60	100	100	100	100	100	100	100	100
Burning time	210	200	200	200	200	200	200	200	200
Flammability/Thickness-Inch:[D]									
	V-1/1.6	V-0/1.6	V-1/1.6	V-0/1.6	V-1/1.6	V-1/1.6	V-1/1.6	V-1/1.6	V-1/1.6

[A] The side of the test specimen is that area formed by the chase of the mold.
[B] To be recorded as the basis for determining initial voltage in step-by-step test.
[C] Units–Seconds (minimum average) Test Method D229 (see 7.2.9).
[D] UL 94 (see 7.2.10).

TABLE A2.2 Batch Acceptance Test Requirements for Phenolic Resin Molding Compounds, Mineral/Glass Filled

Property to Be Tested	Type MFE	Type MFH	Type GPG	Type GPI-5	Type GPI-10	Type GPI-20	Type GPI-30	Type GPI-50	Type GPI-100
Dielectric constant at 1 MHz	6.0	...	6.3	6.3	6.3	6.3	6.3	6.3	6.3
Dielectric strength, step-by-step	10.8	3.2	7.9	4.9	4.9	4.9	4.9	4.9	2.0
Dissipation factor at 1 MHz	0.02	...	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Flexural strength	55	48	62	83	83	83	83	97	103
Impact strength, side[A]	...	13	16	27	53	107	160	267	534
Water absorption	0.10	0.35	0.30	0.35	0.35	0.40	0.50	1.0	1.5

[A] The side of the test specimen is that area formed by the chase of the mold.