Designation: F1596 – 15

Standard Test Method for Exposure of a Membrane Switch or Printed Electronic Device to Temperature and Relative Humidity[1]

This standard is issued under the fixed designation F1596; 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 This test method covers a procedure for temperature and humidity cycling of a membrane switch or printed electronic device.

1.2 This test method is performed to evaluate the properties of materials used in the construction of membrane switch or printed electronic assemblies as they are influenced by the absorption and diffusion of moisture and moisture vapor. This is an accelerated environmental test, accomplished by the continuous exposure of the test specimen to high relative humidity at an elevated temperature. Absorption of moisture by many materials results in swelling, which destroys their functional utility, causes loss of physical strength, and changes in other mechanical properties. Insulating materials which absorb moisture may suffer degradation of their electrical properties.

1.2.1 Physical changes:

1.2.1.1 Differential contraction or expansion rates or induced strain of dissimilar materials.

1.2.1.2 Cracking of surface coatings.

1.2.1.3 Leaking of sealed compartments.

1.2.1.4 Deformation or fracture of components.

1.2.2 Chemical changes:

1.2.2.1 Separation of constituents.

1.2.2.2 Failure of chemical agent protection.

1.2.3 Electrical changes:

1.2.3.1 Changes in electronic and electrical components.

1.2.3.2 Electronic or mechanical failures due to rapid water of condensate formation.

1.2.3.3 Excessive static electricity.

1.3 This test method is not intended to be a thermal shock procedure; a ramp rate between temperature extremes should not exceed 2°C/min.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1595 Practice for Viewing Conditions for Visual Inspection of Membrane Switches

F1661 Test Method for Determining the Contact Bounce Time of a Membrane Switch

F1662 Test Method for Verifying the Specified Dielectric Withstand Voltage and Determining the Dielectric Breakdown Voltage of a Membrane Switch

F1663 Test Method for Determining the Capacitance of a Membrane Switch or Printed Electronic Device

F1680 Test Method for Determining Circuit Resistance of a Membrane Switch

F1689 Test Method for Determining the Insulation Resistance of a Membrane Switch

F2592 Test Method for Measuring the Force-Displacement of a Membrane Switch

3. Terminology

3.1 *Definitions:*

3.1.1 *membrane switch*—a momentary switching device in which at least one contact is on, or made of, a flexible substrate.

4. Significance and Use

4.1 Changes in temperature and humidity during shipping, storage or use can affect the visual appearance, mechanical integrity, or electrical functionality of switches. This practice simulates three different environments to which membrane switches may be exposed.

4.2 The three industry-recognized switch categories based on performance levels are Level 1, Level 2, and Level 3 (see section 9.1).

[1] This test method is under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.18 on Printed Electronics.

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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.

4.3 Additionally, there may be custom requirements that vary by application, therefore, these requirements can be determined by customer and vendor agreement and be established as a Level 4.

4.4 This practice defines the duration of a single cycle. Multiple cycles may be appropriate depending on the requirements of the application.

5. Apparatus

5.1 *Closed system,* with temperature and humidity control.[3]

5.2 The formation of condensation during rising temperature cycles is acceptable; the formation of ice during low temperature cycling is not acceptable.

6. Test Specimens

6.1 The specimens shall be finished switches as delivered and mounted to an actual or agreed upon substrate.

7. Conditioning

7.1 Condition all specimens for 72 h at 20 to 25°C (68 to 77°F) and 20 to 80 % relative humidity (RH) immediately prior to exposure, or prior to temperature and humidity cycling. This is to enable the specimens to stabilize.

[3] A closed system such as a Tenney T3ORC, Despatch EC 619, or Espec EMX, available from Tenney, Inc., Union, NJ 07083; Despatch Industries, Minneapolis, MN 55440-1320; ESPEC Corp., Grand Rapids, MI 49509, have been found satisfactory for this purpose.

8. Pre-Test Setup

8.1 Take pre-test measurements per these test methods, or as specified, and record results.

8.1.1 Force Displacement per Test Method F2592.
8.1.2 Circuit Resistance per Test Method F1680.
8.1.3 Contact Bounce per Test Method F1661.
8.1.4 Insulation Resistance per Test Method F1689.
8.1.5 Capacitance per Test Method F1663.
8.1.6 Visual Inspection per Practice F1595.

9. Procedure

9.1 Subject the preconditioned specimens to the exposure test cycle as illustrated in Table 1.

9.2 Return to room temperature and prepare for post-test measurements.

10. Post-Test Measurements

10.1 Take post-test measurements using the same procedures and test points as used in 8.1 and record results.

11. Report

11.1 Report the changes in test measurements between Pre-test (8.1) and Post-test (10.1).

11.1.1 Test Conditions:
11.1.1.1 Test level.
11.1.1.2 Ramp rate.
11.1.1.3 Condensing or non-condensing environment.

12. Keywords

12.1 membrane switch; printed electronic device; relative humidity (RH); temperature

TABLE 1 Exposure Test Cycle

Level 1 [–40°C (–40°F) to 85°C (185°F)] 72 h at 85°C (185°F) [A] dry heat 24 h at 38°C (100°F) [A] and 95 % RH [B] 8 h at – 40°C (–40°F) 40 h at 85°C (185°F) [A] —dry heat 24 h at 38°C (100°F) [A] and 95 % RH [B] 72 h at – 40°C (–40°F) [A] —dry heat	**Level 2 [–25°C (–13°F) to 70°C (158°F)]** 72 h at 70°C (158°F) [A] 24 h at 38°C (100°F) [A] and 95 % RH [B] 8 h at – 25°C (–13°F) [A] 40 h at 70°C (158°F) [A] 24 h at 38°C (100°F) [A] and 95 % RH [B] 72 h at – 25°C (–13°F) [A]
Level 3 [–10°C (14°F) to 55°C (131°F)] 72 h at 55°C (131°F) [A] 24 h at 38°C (100°F) [A] and 95 % RH [A] 8 h at – 10°C (14°F) [A] 40 h at 55°C (131°F) [A] 24 h at 38°C (100°F) [A] and 95 % RH [A] 72 h at – 10°C (14°F) [A]	**Level 4 (Custom Requirement)** See 4.3

[A] Testing to be performed in non-condensing manner unless otherwise specified.
[B] Place these samples in a rack at a 45° angle to allow condensate to drain from samples and arrange to allow adequate air flow between samples.