Designation: F1681 – 14

Standard Test Method for Determining Current Carrying Capacity of a Membrane Switch Circuit[1]

This standard is issued under the fixed designation F1681; 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 the determination of the current carrying capacity of a conductor as part of a membrane switch.

1.2 This test method may be used to test a circuit to destruction, that is, to determine its maximum current carrying capacity, or it may be used to test the ability of a circuit to withstand a desired current level.

1.3 This test method applies only to static conditions, and does not apply to contact closure cycling of a membrane switch under current load (test method forthcoming).

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]

F1578 Test Method for Contact Closure Cycling of a Membrane Switch

F1680 Test Method for Determining Circuit Resistance of a Membrane Switch

3. Terminology

3.1 *Definitions:*

3.1.1 *conductor resistance*—the measured electrical resistance through a circuit loop between two test points.

3.1.2 *Discussion*—When a switch is included in that loop, it shall be "closed" in accordance with Test Method F1680.

3.1.3 *current carrying capacity (CCC)*—the maximum level of electrical current that a circuit can conduct without sustaining damage.

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

3.1.5 *power capacity*—electrical power is defined as current × voltage = V × I (watts).

3.1.6 *test points*—two preselected conductive points in a circuit loop, possibly including a switch.

4. Significance and Use

4.1 Current carrying capacity is used by designers and manufacturers of electronic interface circuitry to ensure that the membrane switch can reliably handle the loads occurring in normal use and under extreme circumstances. A thorough understanding of CCC allows manufacturers to take it into account when developing design rules for membrane switches.

4.2 Failures due to exceeding the CCC of a circuit may take the form of a significant change in conductor resistance, insulation breakdown (shorts), or conductor breakdown (opens).

4.3 Since a number of design parameters, such as trace width, ink film thickness, and heat transfer (mounting substrates, active cooling such as fans) affect the final test results, any conclusions should only be applied to specific designs, rather than to a general combination of materials.

4.4 Current carrying capacity tests may be destructive and units that have been tested should be considered unreliable for future use.

4.5 Current carrying capacity may be significantly different for static loads and dynamic (that is, cycling) loads. Failure modes are also generally different.

4.6 The use of a thermocouple to monitor the temperature of the UUT may be helpful to monitor the progress of the test.

4.7 Initial expected starting current should be calculated in advance to prevent damage to test equipment.

5. Interferences

5.1 The following parameters may affect the results of this test:

5.1.1 Temperature,

5.1.2 Relative humidity,

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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.

5.1.3 Heat transfer characteristics of mounting substrates,
5.1.4 Active cooling,
5.1.5 Imperfection or variation in conductor deposition,
5.1.6 Inconsistencies in the homogeneity of the conductor.

6. Hazard

6.1 The user must be aware of the operating range of their equipment to prevent damage to the device from overload during testing. For example, the current should be adjusted starting from a minimum setting, and a decade box should start on the highest rating.

7. Apparatus

7.1 *Controlled current and voltage source,* capable of supplying sufficient current for the range in question.

7.2 *Suitable Meter(s),* capable of measuring current and resistance (with range appropriate to the test). Do not apply a voltage greater than the intended operating range of the circuit under test.

7.3 *Suitable Device,* to apply a consistent, repeatable force with an elastomeric probe in accordance with Test Method F1578 to close the switch (if a switch is part of the conductor circuit being tested).

7.3.1 Since the switch may heat up during the test it is advisable to use a mechanical device instead of a human finger to close the switch.

8. Procedure

8.1 *Pre-Test Setup:*

8.1.1 Turn on the power supply; set the power supply voltage to the specified operating level and the current to the initial zero test level.

8.2 *In Process Test:*

8.2.1 With the power supply turned off connect the test specimen to the power supply.

8.2.1.1 If the specimen includes a switch close the switch in accordance with F1680.

8.2.2 Turn on the power supply and adjust the current to the initial test level. After 1 min record the actual current through the circuit and record the applied voltage. If a thermocouple is used record the temperature at the end of each level. Record visual observations. Record the resistance value of the specimen (with the power supply off) or by calculation (using a volt meter across the specimen).

8.2.3 Adjust the power supply to the next current level, dwell for 1 min and record the current, voltage and visual observations (and temperature – when applicable) as in 8.2.2. Repeat for each additional current level.

8.2.4 If the test is intended to go to destruction, and no degradation occurs at the maximum level, the test may be repeated using a higher power (voltage and current) level, a change in the voltage range is permissible.

8.2.5 At the conclusion of testing record the final results as in 8.2.2.

9. Calculations

9.1 Calculate power capacity (in watts) from CCC and test voltage V as follows:

$$P = CCC \times V$$

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10. Report

10.1 Report the following information:
10.1.1 Description and specifications of all apparatus,
10.1.2 Date of test,
10.1.3 Person performing test,
10.1.4 Ambient Temperature,
10.1.5 Relative humidity,
10.1.6 Barometric pressure,
10.1.7 Test voltage (dc, ac, ac-r/min, etc.),
10.1.8 Test type (destructive or specified range),
10.1.9 Part number, revision level and description of part under test,
10.1.10 Description of test points and connection,
10.1.11 Description of device and method used to close switch (if applicable),
10.1.12 For each test cycle at a different current level, report the following:
10.1.12.1 Current and voltage values,
10.1.12.2 Description of any visual or resistance changes observed, and
10.1.12.3 The user interface temperature (thermocouple), if measured.
10.1.13 At the conclusion of the test, report either the CCC (that is, the maximum) or whether the circuit was able to maintain the current without discoloration or change of resistance less than the specified amount (at the desired voltage and current level) or without exceeding a temperature of 60°C at the user interface.

11. Precision and Bias

11.1 The precision and bias of this test method are under investigation.

12. Keywords

12.1 circuit resistance; current carrying capacity; membrane switch; power capacity