UL 2557

STANDARD FOR SAFETY

Membrane Switches

UL Standard for Safety for Membrane Switches, UL 2557

First Edition, Dated December 4, 2020

Summary of Topics

This First Edition ANSI/UL 2557 dated December 4, 2020 covers membrane switches actuated by human activity, via a membrane or sensing substrate, to operate or control appliances and electrical equipment. The membrane switch electrical rating is not to exceed 30 Vrms and power not greater than 100 VA.

The requirements are substantially in accordance with Proposal(s) on this subject dated May 8, 2020 and July 31, 2020.

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This ANSI/UL Standard for Safety consists of the First Edition.

The most recent designation of ANSI/UL 2557 as an American National Standard (ANSI) occurred on October 5, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements apply to membrane switches actuated by human activity, via a membrane or sensing substrate, to operate or control appliances and electrical equipment. The membrane switch electrical rating not to exceed 30 Vrms and power not greater than 100 VA.

1.2 When this standard references "switches" it shall mean "membrane switches" unless specifically indicated.

1.3 Membrane switches which incorporate additional control functions governed by the switch function are within the scope of these requirements. Additional control functions shall be evaluated for their suitability using the applicable standards for the application.

1.4 These membrane switches are intended to be operated by a person, via a membrane or by actuating a sensing substrate.

1.5 These requirements cover the indirect actuation of the switch when the operation of the actuating member or sensing unit is provided by a remote control or a part of an appliance or equipment such as a door.

1.6 Embedded components are evaluated with regards to their safety and application to the membrane switch construction. The acceptability of an embedded component in the membrane switch shall be considered with regards to construction and performance requirements in the end product final application.

2 Components

2.1 Except as indicated in this section, a component of a product covered by this standard shall comply with the requirements for that component.

2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 References

4.1 Undated references

4.1.1 Any undated reference to a code or standard appearing in the requirements of the standard shall be interpreted as referring to the latest edition of that code or standard.

4.2 Normative references

4.2.1 The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of the standard.

4.2.2 The following are ASTM test procedures referenced:

a) Standard Test Methods for DC Resistance or Conductance of Insulating Materials, ASTM D257

b) Standard Test Methods for Thickness of Solid Electrical Insulation, ASTM D374

c) Standard Test Method for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications, ASTM D1000

d) Standard Test Method for Contact Closure Cycling of a Membrane Switch, ASTM F1578

e) Standard Practice for Viewing Conditions for Visual Inspection of Membrane Switches, ASTM F1595

f) Standard Test Method for Exposure of a Membrane Switches or Printed Electronic Device to Temperature and Relative Humidity, ASTM F1596

g) Standard Test Method for Determining the Effects of Chemical/Solvent Exposure to a Membrane Switch/Graphic Overlay (Spot Test Method), ASTM F1598

h) Standard Test Method for Determining the Contact Bounce Time of a Membrane Switch, ASTM F1661

i) Standard Test Method for Verifying the Specified Dielectric Withstand Voltage and Determining the Dielectric Breakdown Voltage of a Membrane Switch or Printed Electronic Device, ASTM F1662

j) Standard Test Method for Determining the Capacitance of a Membrane Switch or Printed Electronic Device, ASTM F1663

k) Standard Test Method for Determining Circuit Resistance of a Membrane Switch, ASTM F1680

l) Standard Test Method for Determining the Insulation Resistance of a Membrane Switch, ASTM F1689

m) Standard Test Method for Determining the Effects of Atmospheric Pressure Variation on a Membrane Switch, ASTM F1762

n) Standard Test Method for Determining the Effect of an ESD Discharge on a Membrane Switch or Printed Electronic Device, ASTM F1812

o) Standard Test Method for Submersion of a Membrane Switch, ASTM F1895

p) Standard Test Method for Determining the Shear Strength of the Bond between a Surface Mount Device (SMD) and Substrate in a Membrane Switch, ASTM F1995

q) Standard Test Method for Silver Migration for Membrane Switch Circuitry, ASTM F1996

r) Standard Test Method for Hosedown of a Membrane Switch, ASTM F2072

s) Standard Test Method for Measuring the Force-Displacement of a Membrane Switch, ASTM F2592

4.2.3 These requirements are intended to be used in conjunction with the following requirements or standards.

a) Polymeric Materials – Short Term Property Evaluations, UL 746A

b) Polymeric Materials – Long Term Property Evaluations, UL 746B

c) Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C

d) Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards, UL 746E

e) Polymeric Materials – Flexible Dielectric Film Materials For Use In Printed-Wiring Boards and Flexible Materials Interconnect Constructions, UL 746F

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

5 Glossary

5.1 For the purpose of this standard, the following definitions apply.

5.2 ABNORMAL CONDITIONS – Conditions which may occur in the appliance or in the switch during normal operation.

5.3 ACCESS HOLE – Holes (such as through hole or via) on the same axis through successive layers of materials intended to provide access to the surface of the land on an inner conductor layer of a multi-layer category construction.

5.4 ACTUATING MEMBER – Part which is pulled, pushed, or otherwise moved to cause an operation.

5.5 ACTUATION – Movement of the actuating member of the switch by hand, by foot, or by any other human activity to provide electrical closure of the momentary switch.

5.6 ACTUATION FORCE – The maximum force measured prior to or including point at which contact closure is achieved on a membrane switch.

5.7 ADDITIVE PROCESS – A selective or non-selective process used to deposit a pattern of conductor material(s) on clad or unclad base material.

5.8 ADD-ON COMPONENT – Discrete, integrated, packaged, or chip components that are attached to a membrane switch to function as part of a complete circuit or assembly.

5.9 ADHESIVE – A gelatinous substance such as glue used to join, bond, or fasten materials or objects together.

5.10 AS-RECEIVED – Specimens or samples in an unconditioned state, prior to being subject to conditioning, or without a history of conditioning.

5.11 ASSEMBLY – Various parts, subassemblies, and combinations thereof, joined together.

5.12 BASIC INSULATION – Insulation applied to live parts to provide basic protection against electric shock.

5.13 BEND – To force from a straight form into different and especially a curved one.

5.14 BEND CYCLE – A fold of a specimen around a specified mandrel which is "rolled" in one direction, followed by rolling in the opposite direction, returning the specimen to its original position.

5.15 BLIND VIA – A via extending to only one surface of the membrane switch construction.

5.16 BONDING FILM – The layer of insulation used to bond discrete layers during lamination of membrane switch constructions. See spacer layer.

5.17 BONDING LAYER – An adhesive layer used to bond discrete layers of multilayer membrane switch constructions. See spacer layer.

5.18 BUILD-UP THICKNESS – Overall thickness of a combination of materials. Unless otherwise indicated, the build-up thickness will refer to the overall thickness in the area of a membrane switch construction where no internal or external conductor material resides.

5.19 BURIED VIA – A via that does not extend to the surface of a membrane switch construction.

5.20 CALCULATED THICKNESS – The calculated thickness is a thickness value determined by adding suggested material component thicknesses, or a thickness value determined by adding or subtracting one measured value to or from another measured value.

5.21 CIRCUIT – Electrical devices and elements interconnected to perform a desired electrical function.

5.22 CIRCUIT LAYER – Conductor layer or plane in or on a membrane switch construction.

5.23 CIRCUIT LAYER BASE MATERIAL – An organic or inorganic dielectric barrier material, used to support conductor material, with or without adhesive material.

5.24 CIRCUIT LAYER BASE MATERIAL THICKNESS – The thickness of the base dielectric material. If an adhesive is used for the base material, the adhesive thickness and number of sides is indicated separately.

5.25 CIRCUIT RESISTANCE – Electrical resistance as measured between two test points whose internal contacts, when held closed, complete a circuit.

5.26 CLASS 0 APPLIANCE – Appliance in which protection against electric shock relies upon basic insulation; this implies that there are no means for the connection of accessible conductive parts, if any, to the protective conductor in the fixed wiring of the installation, reliance in the event of a failure of the basic insulation being placed upon the environment.

5.27 CLASS I APPLIANCE – Appliance in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of conductive parts (which are not live parts) to the protective (earthing) conductor in the fixed wiring in such a way that these parts cannot become live in the event of a failure of the basic insulation.

5.28 CLASS II APPLIANCE – Appliance in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as double insulation or reinforced insulation are provided, there being no provision for protective earthing or reliance upon installation conditions. A Class II appliance may be provided with means for maintaining the continuity of protective circuits, provided that such means are within the appliance and are insulated from accessible surfaces according to the requirements of Class II.

5.29 CLASS III APPLIANCE – Appliance in which protection against electric shock relies on supply at SELV and in which voltages higher than those of SELV are not generated.

5.30 CLASS 2 CIRCUIT – A control circuit supplied from a source having limited voltage (30 Vrms or less) and current capacity, such as from the secondary of a Class 2 transformer, and rated for use with Class 2 remote-control or signaling circuits.

5.31 CLEARANCE – The shortest distance in air between two conductive parts.

5.32 COATING – A non-metallic substance applied by some process, such as dipping, curtain coating, film laminating, screening, spraying, or melt-flow.

5.33 COMPARATIVE TRACKING INDEX (CTI) – Expressed as that voltage which causes tracking after 50 drops of 0.1% ammonium chloride solution have fallen on the material.

5.34 COMPONENT – An individual or combination of parts intended to perform a desired function.

5.35 CONDITIONING – Exposure of test specimens to an environment for a period of time, prior to or after testing, and prior to evaluation.

5.36 CONDUCTIVE FOIL – A thin metal sheet intended for forming a conductor pattern on a base material.

5.37 CONDUCTIVE PASTE – An organic or inorganic paste substance capable of transmitting electricity, used for circuit conductors, including but not limited to carbon, copper, and silver.

5.38 CONDUCTOR – A trace or path for electricity to transmit in a conductor pattern.

5.39 CONDUCTOR ADHESIVE – Adhesive material used to attach conductor material to a base material or dielectric material.

5.40 CONDUCTOR LAYER – A single plane of a conductor material or pattern on base material.

5.41 CONDUCTOR MATERIAL – An organic or inorganic substance capable of transmitting electricity, used for circuit conductors, including but not limited to copper, tin, nickel, gold, copper paste, silver paste, carbon paste, ruthenium oxide paste, etc.

5.42 CONDUCTOR PATTERN – The path, design, or configuration of conductor material on the base material, including but not limited to conductors, lands, through-holes, and vias.

5.43 CONDUCTOR RESISTANCE – The measured electrical resistance through a circuit loop between two test points.

5.44 CONDUCTOR SPACING – The minimum distance between adjacent conductors.

5.45 CONDUCTOR THICKNESS – The thickness of the conductor and additional metallic platings or coatings, excluding non-conductive coatings.

5.46 CONDUCTOR WIDTH – The width of the conductor as viewed from a top view or at the plane of the surface of a base material, whichever is less.

5.47 CONFORMAL COATING – An insulating, environmentally protective coating capable of conforming to the objects coated.

5.48 CONNECTOR – A terminal device capable of connect/disconnect service for electrical components.

5.49 CONSTRUCTION – A variation in membrane switch material build-up, including but not limited to film, adhesive, base material, bond ply, cover layer, or other insulation materials. Variations include single layer, multi-layer, flexible, flex-to-install, rigid, and multi-layer flex/rigid composite constructions.

5.50 CONTACT BOUNCE – Intermittent contact opening and contact closure that may occur after switch operation.

5.51 CONTACT CLOSURE – The event at which a specified resistance is achieved on a membrane switch.

5.52 CONTACT FINGER – A conductive surface used to provide electrical connection by pressure contact, usually located at an edge of a membrane switch.

5.53 CONTACT FORCE – The force at contact closure.

5.54 CONTINUITY – An uninterrupted path of electrical current.

5.55 COPPERCLAD POLYIMIDE FLEXIBLE CONSTRUCTION – Switches that use a polyimide substrate with copper traces and either a metal dome, polydome or silicone rubber overlay to provide the electrical closure of the switch and tactile response.

5.56 COVERCOAT – A thin dielectric material deposited as a liquid used to cover the circuit pattern that subsequently becomes a permanent coating. See coverlay, 5.58.

5.57 COVERFILM ADHESIVE – Adhesive used with film to prepare cover film on a base material or dielectric material. The film may be a base dielectric material.

5.58 COVERLAY – A combination of film and adhesive, which may be made from different chemistries, used to cover the circuit pattern.

5.59 CREASE – A ridge or groove made by folding and pressing.

5.60 CREASE CYCLE – A 180° crease followed by a flattening of the crease.

5.61 CREEPAGE DISTANCE – The shortest distance along the surface of the insulation material between two conductive parts.

5.62 CRITICAL OPERATION – Production process or fabrication step considered potentially detrimental to the materials subject to the operation.

5.63 CURRENT – The movement or flow of electrons in a conductor due to a voltage potential difference at opposing ends of the conductor.

5.64 CURRENT CARRYING CAPACITY – The maximum level of electrical current that a circuit can conduct without sustaining damage.

5.65 DELAMINATION – A planar separation of materials (i.e., separation between conductor and base material, bonding layer and base material, coverfilm and conductor, etc.).

5.66 DIELECTRIC – A material capable of high resistance to the flow of electrical current and capable of being polarized by electric field.

5.67 DIELECTRIC WITHSTAND VOLTAGE – The maximum voltage a dielectric can withstand in a membrane switch without a visual change from a voltage discharge or specified change of insulation resistance, or both.

5.68 DISSCONNECTION – Interruption of an electrical circuit in a pole so as to provide insulation between the supply and those parts intended to be disconnected from the supply.

5.69 DOUBLE INSULATION – Insulation comprising both basic insulation and supplementary insulation.

5.70 DOUBLE SIDED – A single layer membrane switch construction or printed wiring board with conductor pattern on the two external sides of the circuit base material.

5.71 DUTY CYCLE – The ratio of switch closed time to total cycle time.

5.72 EDGE, CONDUCTOR – A conductor parallel with and spaced not more than 0.4 mm (1/64 in) from the edge of the base material.

5.73 ELASTOMERIC (RUBBER) CONSTRUCTION – Switches that use mold injected rubber, with an impregnated carbon pill or screen printed emboss as the means for electrical closure of the switch, the spring force is inherent to the upper layer substrate material and dependent upon design and webbing thickness.

5.74 ELECTROLESS PLATING – The depositing of conductor material from an autocatalytic plating solution without the application of electrical current.

5.75 ELECTRONIC DISCONNECTION – A high resistance open, that provides a non-cycling correct functional performance without a complete micro or full "air gap" disconnect.

5.76 ELECTROPLATING – The depositing of conductor material from a plating solution by the application of electrical current.

5.77 EMBEDDED COMPONENT – A discrete component integrated into the membrane switch during fabrication.

5.78 END PRODUCT – A device or appliance in which a membrane switch is installed as a component.

5.79 ETCHANT – A chemically reactive solution used to remove portions or all material from a base material.

5.80 ETCHING – The action of chemical, or chemical and electrolytic, removal of conductive or resistive material.

5.81 FILM – A thin coating or membrane material, usually 0.25 mm (0.010 in) or less in thickness.

5.82 FLAMMABILITY CLASSIFICATION ONLY – A membrane switch construction intended for use where the construction shall be evaluated for flammability classification only, and the thermal, mechanical, and electrical capacity of the construction materials is not of concern and only the flammability classification of the resulting membrane switch is of concern in the end product.

5.83 FLAT (PANEL) – Any number of membrane switch constructions assembled together in a sheet, usually with a frame around the side.

5.84 FLAT MEMBRANE CONSTRUCTION – Switches that use a spacer layer (air gap) or a matrix of dielectric dots to separate the conductive surfaces, the spring force is inherent to the substrate materials.

5.85 FLEXIBLE CONSTRUCTION – A sub-category membrane switch construction intended for use where some portion of the construction shall be subject to flexing in the end product application.

5.86 FLEX-TO-INSTALL CONSTRUCTION – A sub-category membrane switch construction intended for use where some portion of the construction may be subject to flex for installation or service in the end product.

5.87 FUNCTIONAL INSULATION – Insulation between live parts which is necessary only for the proper functioning of the switch.

5.88 GRADE – A designation arbitrarily assigned to a material by the material manufacturer.

5.89 GRAPHIC LAYER – Optional decorated layer of a membrane switch. See Figure Figure 7.1.

5.90 GROUND – A common reference point for conductor circuits.

5.91 GROUND PLANE – A conductor plane used as a common reference point for conductor circuits.

5.92 HAND SOLDERING – Hand-held, operator-controlled soldering, usually with a soldering iron.

5.93 HEATSINK – A device made of high thermal conductivity and low specific heat material capable of dissipating heat generated by a component or assembly.

5.94 HEATSINK PLANE – A continuous sheet of high thermal conductivity and low specific heat material intended to dissipate heat from heat generating components or assemblies.

5.95 IDENTICAL PROCESSING – Production or fabrication processes with the same manufacturing steps required to fabricate a membrane switch.

5.96 IMMERSION SILVER – Consists of a very thin coating typically less than 0.55 microns (0.0217 mils) of nearly pure silver created by galvanic displacement and may contain a slight amount of organic material deposited with the silver.

5.97 INCORPORATED SWITCH – A switch intended to be incorporated in or fixed to an appliance, which however can be tested separately.

5.98 INTEGRATED SWITCH – A switch, the function of which depends on its correct mounting and fixing in an appliance, and which can be tested only in combination with the relevant parts of that appliance.