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# Standard Test Method for Measuring the Force-Displacement of a Membrane Switch[1]

This standard is issued under the fixed designation F2592; 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 measurement of force displacement characteristics of a membrane switch.

1.1.1 This test method replaces Test Method F1570 (Tactile Ratio). Tactile Actuating Slope Angle and Tactile Recovery Slope Angle better represent the characterization of tactile sensation, previously called "Tactile Ratio" in Test Method F1570.

1.1.2 This test method replaces Test Method F1682 (Travel).

1.1.3 This test method replaces Test Method F1597 (Actuation and Contact Force).

1.1.4 This test method replaces Test Method F1997 (Switch Sensitivity).

1.2 Force displacement hysterisis loop curve can be used in the determination of Actuation Force, Displacement, Contact Force, Return Force, and Tactile Actuating Slope Angle and Tactile Recovery Slope Angle.

1.3 *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. Terminology

2.1 *Definitions:*

2.1.1 *break displacement (Tb)*—the displacement at contact break.

2.1.2 *break force (Fb)*—the force at contact break.

2.1.3 *circuit resistance*—electrical resistance as measured between two test points whose internal contacts, when held closed, complete a circuit.

2.1.4 *closure (make)*—the event at which a specified resistance is achieved.

2.1.5 *contact break*—point at which circuit resistance is higher than specified resistance on return.

2.1.6 *contact displacement (Tc)*—the displacement at contact closure.

2.1.7 *contact force (Fc)*—the force at contact closure.

2.1.8 *displacement*—measured distance of movement when membrane is depressed.

2.1.8.1 *Discussion*—Displacement is sometimes referred to as "switch travel."

2.1.9 *F*max—an applied force, maximum force measured prior to or including point (*F*min) (see Fig. 1).

2.1.9.1 *Discussion*—Sometimes referred to as Actuation Force.

2.1.10 *F*min—an applied force, minimum force seen between *F*max and point at which probe movement ceases.

2.1.10.1 *Discussion*—*F*max can equal *F*min.

2.1.11 *force-displacement hysteresis curve*—relationship between force applied and displacement of a membrane switch in terms of the actuation and return (recovery).

2.1.11.1 *Discussion*—Usually expressed as a line graph; sometimes referred to as Force-Travel curve (see Fig. 1).

2.1.12 *force factor – make (Ffactor)*—mathematical expression for the change in force between *F*max and *F*min (see Eq 7.1.1).

2.1.12.1 *Discussion*—*F*factor = 0 for non-tactile switch.

2.1.13 *force factor – break (Frfactor)*—mathematical expression for the change in force between *Fr*max and *Fr*min (see Eq 7.1.2).

2.1.13.1 *Discussion*—*Fr*factor = 0 for non-tactile switch.

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

2.1.15 *non-tactile switch*—switch that does not have a tactile response and therefore has a response slope equal to zero because *F*max and *F*min are the same (see Fig. 2).

2.1.16 *return min force (Fr*min*)*—minimum force seen during return cycle before reaching *Fr*max.

2.1.17 *return max force (Fr*max*)*—maximum force measured during return cycle after achieving *Fr*min.

2.1.18 *specified resistance*—maximum allowable resistance as measured between two terminations whose internal switch contacts are held closed to complete a circuit.

[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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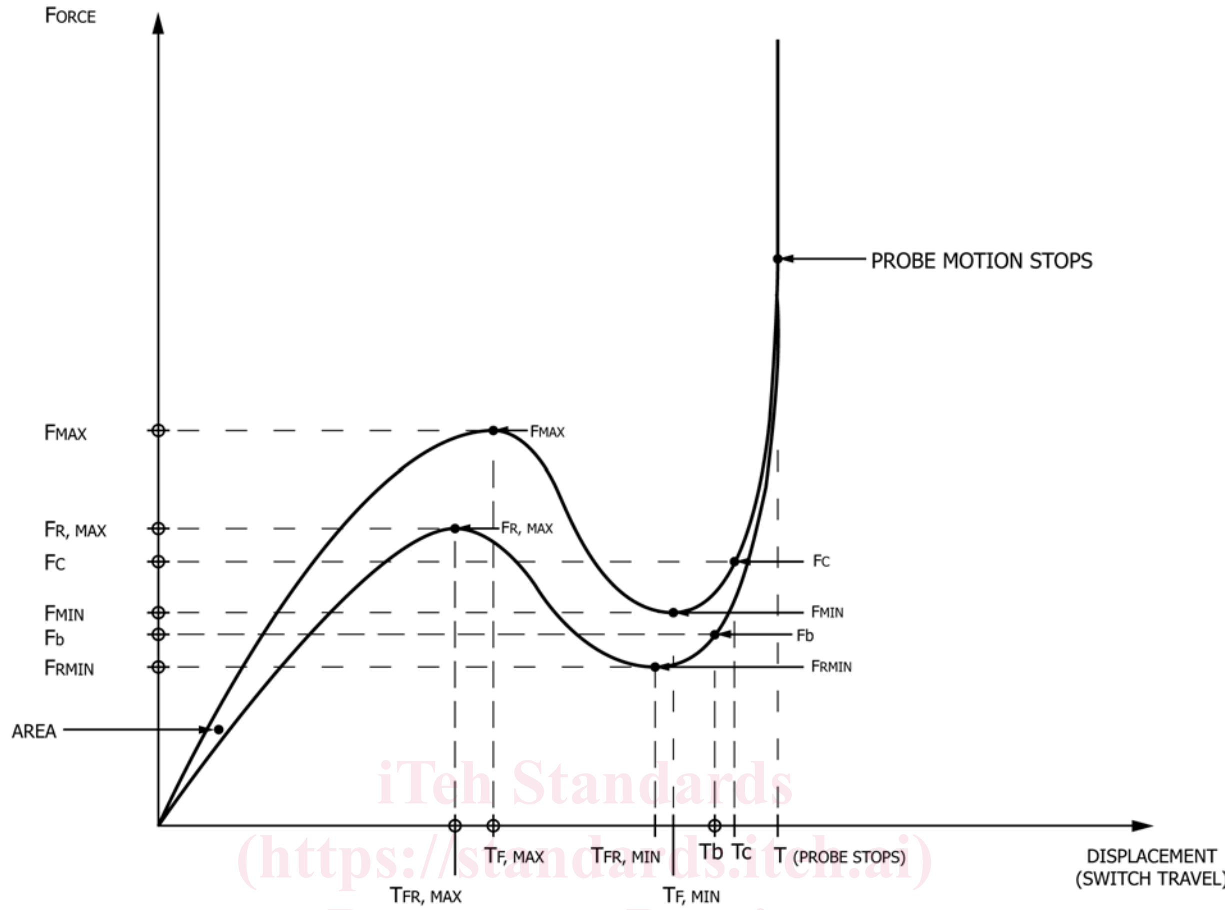




NOTE 1—Area between forward and return curves is the difference in work by the tactile mechanism showing hysterisis in the tactile system.

**FIG. 1 Force Displacement Hysterisis Loop**



2.1.19 *switch teasing (break)*—the displacement measurement on the force-displacement curve between contact break (*Fb*) and return force (*F*rmin).

2.1.20 *switch teasing (make)*—the displacement measurement on the force-displacement curve between contact force (*Fc*) and minimum force (*F*min).

2.1.21 *tactile actuation slope angle (TASø)*—mathematical representation of the functional relationship between displacement and force of a tactile switch on the closure stroke of the switch (see Eq 7.1.5 and Fig. 3).

2.1.22 *tactile recovery slope angle (TRSø)*—mathematical representation of the functional relationship between displacement and force of a tactile switch on the contact break stroke of the switch (see Eq 7.1.6 and Fig. 4).

2.1.23 *tactile response*—a physical sensation, caused by a sudden collapse or snapback, or both, of a membrane switch.

2.1.24 *tactile switch*—a switch that has a tactile response and therefore has a response slope less than zero (negative slope).

2.1.25 *Tf*max—Displacement at *F*max.

2.1.26 *Tf*min—Displacement at *F*min.

2.1.27 *Tfr*max—displacement at *F*rmax.

2.1.28 *Tfr*min—displacement at *F*rmin.

2.1.29 *travel factor – make (Tfactor)*—mathematical expression for the change in displacement between *Tf*max and *Tf*min (see Eq 7.1.3).

2.1.29.1 *Discussion—T*factor = 0 for non-tactile switch.

2.1.30 *travel factor – break (Trfactor)*—mathematical expression for the change in displacement between *Trf*max and *Trf*min (see Eq 7.1.4).

2.1.30.1 *Discussion—Trf*actor = 0 for non-tactile switch.

## 3. Significance and Use

3.1 The force and displacement values when converted to a slope are useful in quantifying the differences in tactile response among membrane switches.

3.2 Specified resistance is useful to manufacturers and users when designing membrane switch interface circuitry.

3.3 Actuation force and contact force are useful to manufacturers and users in determining the suitability, reference and aesthetics of a membrane switch in a given application.

3.4 The tendency of a switch to make or break electrical contact at unexpected moments during closure or release can be a sign of a poor design. The degree of teasing can range from a simple annoyance to a failure of critical control process.