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INTERNATIONAL STANDARD

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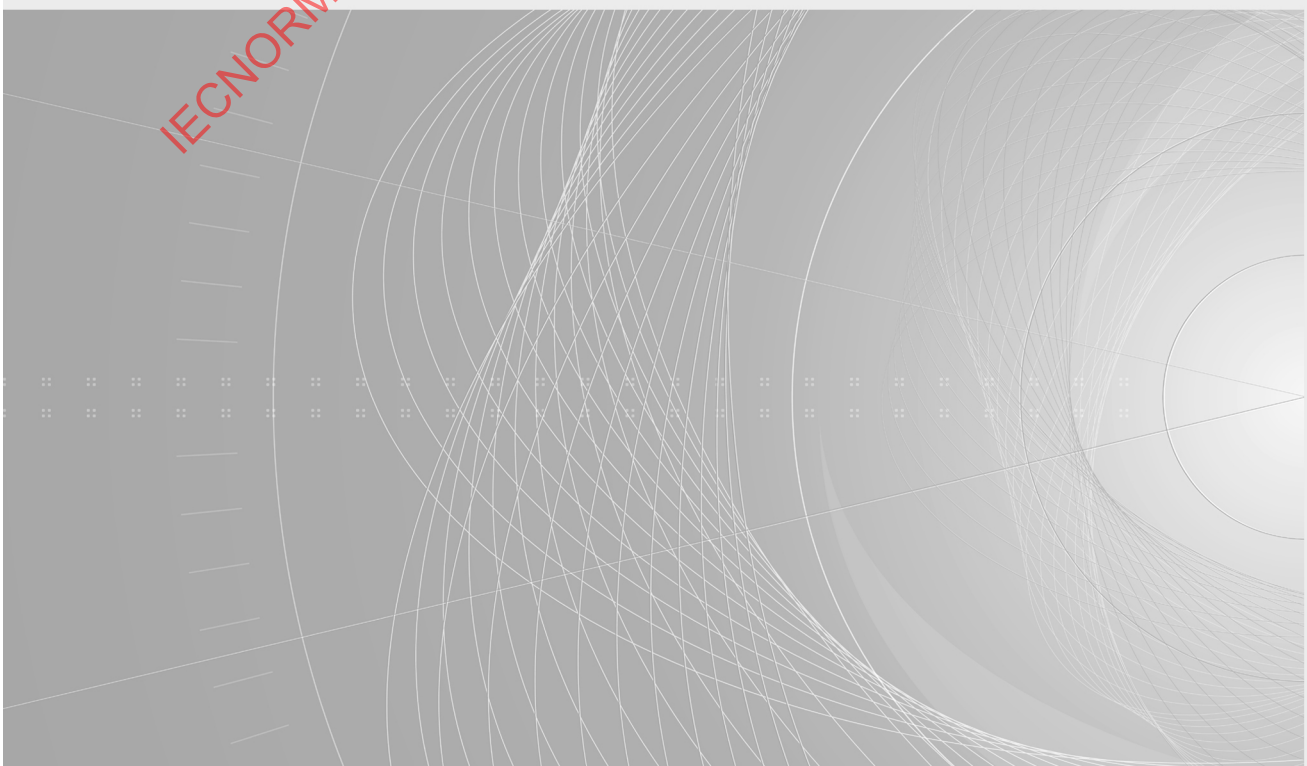
Semiconductor devices – Micro-electromechanical devices – Part 40: Test methods of micro-electromechanical inertial shock switch threshold



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SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 40: Test methods of micro-electromechanical inertial shock switch threshold

FOREWORD

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The text of this International Standard is based on the following documents:

DRAFT	Report on voting
47F/384/FDIS	47F/388/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 62047 series, published under the general title *Semiconductor devices – Micro-electromechanical devices*, can be found on the IEC website.

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- replaced by a revised edition, or
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SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 40: Test methods of micro-electromechanical inertial shock switch threshold

1 Scope

This part of IEC 62047 specifies the test conditions and methods of micro-electromechanical inertial shock switch threshold. This document applies to normally open micro-electromechanical inertial shock switch.

2 Normative references

There are no normative references in this document.

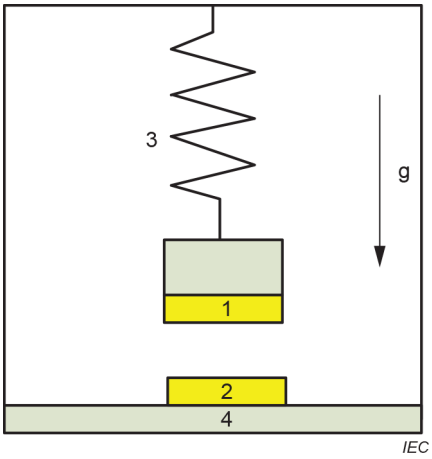
3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
micro-electromechanical shock inertial switch
device that is fabricated by micro-electromechanical system technology, and is closed or open via the contact or separation of fixed and movable electrode under or above a certain acceleration, also as known threshold switch, acceleration switch, or g switch



Key

1 movable electrode

2 fixed electrode

3 spring

4 substrate

Figure 1 – The schematic drawing of micro-electromechanical inertia shock switch

3.2
normally open micro-electromechanical shock inertial switch
micro-electromechanical inertial shock switch that is switched from open state to closed state under a certain acceleration, and recovered to open state after the acceleration disappears

3.3
closed state
contact of fixed and movable electrode

3.4
open state
separation of fixed and movable electrode

3.5
static threshold
constant acceleration at which the normally open inertial shock switch is closed

3.6
dynamic threshold
impact acceleration at which the normally open inertial shock switch is closed

3.7
contact resistance
resistance between fixed and movable electrode when inertial shock switch is closed

3.8
wireless gather system
system that gathers data by wireless communication technology

4 Essential ratings and characteristics

4.1 Recommended operating condition

The following items should be described in the specification, unless otherwise stated in the relevant procurement specifications.

a) temperature: −20 °C to 50 °C;

b) relative humidity: 20 %RH to 80 %RH;

c) atmospheric pressure: atmospheric pressure of test site.

4.2 Characteristics

Characteristics of the switch threshold are listed as shown in Table 1.

Table 1 – Characteristics of the switch threshold

Parameters		Symbol	Switch state	Test method
Static threshold	minimum	a_1	≤ a_1, open	See 5.2
	maximum	a_2	≥ a_2, closed	See 5.2
Contact resistance		R	Meet the product requirements, closed	See 5.2
Dynamic threshold	minimum	b_1	≤ b_1, open	See 5.3
	maximum	b_2	≥ b_2, closed	See 5.3

5 Test items and methods

5.1 Switch type

The resistance is measured by digital multimeter, which determines whether the switch is a normally open inertial switch.

5.2 Static threshold

5.2.1 Test method 1

5.2.1.1 Test system

Test system includes four parts: centrifuge, switch, open-closed test circuit and status indicator, as shown in Figure 2. The status indicator is the part of test system to indicate the closed state or open state of switch. For example，the lamp.

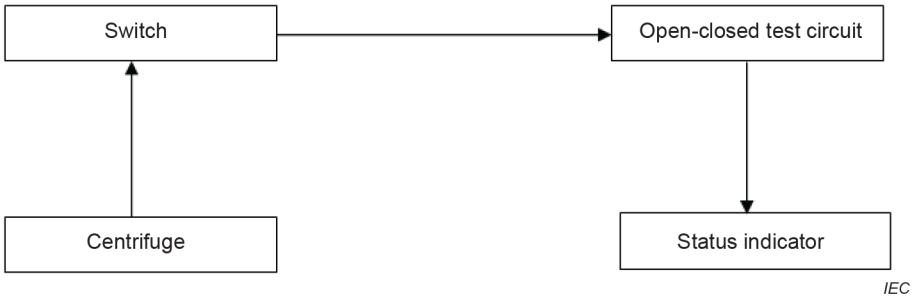


Figure 2 – Test system 1 of static threshold

5.2.1.2 Test procedure

1) Assemble open-closed test circuit and status indicator on centrifuge, and assemble switch on open-closed test circuit, ensuring centrifugal acceleration direction is the switch sensing direction.
2) Apply excitation voltage and reset open-closed test circuit, status indicator indicates the closed state.
3) According to static threshold design value of product, give centrifuge an acceleration which equals to the design value A_{11}.
   a) If status indicator indicates the closed state, then decreasing A_{11} to A_{12} at a rate of product precision, and recording the indicator's state. Decreasing acceleration by degrees until status indicator indicates the open state, then the previous and current acceleration are the maximum static threshold and minimum static threshold respectively, as shown in Table 2, in which a_1 equals to A_{15}, and a_2 equals to A_{14}.
   b) If status indicator indicates the open state, then increasing A_{11} to A_{21} at a rate of product precision, and recording the indicator's state. Increasing acceleration by degrees until status indicator indicates the closed state, then the previous and current acceleration are the minimum static threshold and maximum static threshold respectively, as shown in Table 2, in which a_1 equals to A_{41}, and a_2 equals to A_{51}.

Table 2 – Test parameters of static threshold

Case 1		Case 2	
Acceleration	**State**	**Acceleration**	**State**
A_{11}	×	A_{11}	√
A_{12}	×	A_{21}	√
A_{13}	×	A_{31}	√
A_{14}	×	A_{41}	√
A_{15}	√	A_{51}	×
Key:			
×: closed			
√: open			

5.2.2 Test method 2

5.2.2.1 Test system

Test system includes five parts: centrifuge, reference accelerometer, switch, open-closed test circuit and wireless gather system, as shown in Figure 3. The acceleration value is acquired through the output of reference accelerometer.

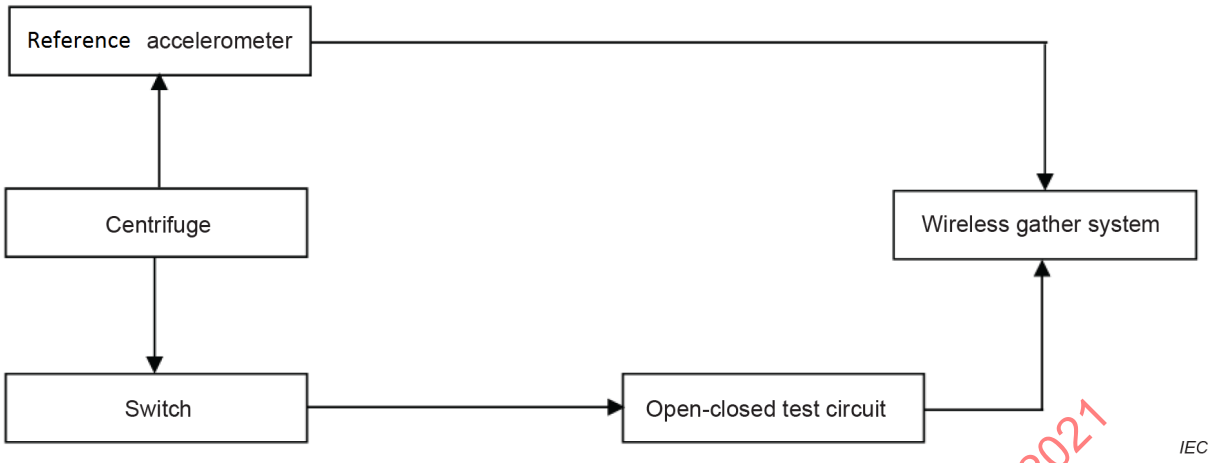


Figure 3 – Test system 2 of static threshold

5.2.2.2 Test procedure

1) Assemble wireless gather system (data can be transmitted or stored wirelessly in real time) and open-closed test circuit, as shown in Figure 4, on centrifuge, and assemble switch on open-closed test circuit. At the same time, assemble a reference accelerometer on centrifuge at the same radius location as switch, which makes the sensitive direction of switch and reference accelerometer is consistent with direction of centrifugal acceleration.
2) Apply excitation voltage, and give centrifuge an acceleration which equals to the design value according to static threshold design value of product. Sampling data in the test process according to technical requirement, and sampling output of reference accelerometer and voltage output of load resistance. Those output data points become two synchronous output curves in gather system, and acquiring jump point on voltage output of load resistance curve, as shown in Figure 5. If there is no jump point on curve, increasing acceleration given on centrifuge according to actual demand.
3) Starting from jump point in Figure 5, using Formula (1) to calculate contact resistance of switch corresponding to each sample point. When contact resistance of switch meets technical specifications, corresponding output of reference accelerometer is the static threshold. Comparing with test method 1 in 5.2.1, test method 2 can acquire more accurate static threshold.

$$R = R_L\left(\frac{U_S - U_{RL}}{U_{RL}}\right) \quad (1)$$

where,

U_S is excitation voltage, in Volts;

R_L is load resistance, in Ohms;

R is contact resistance, in Ohms;

U_{RL} is voltage of load resistance, in Volts.

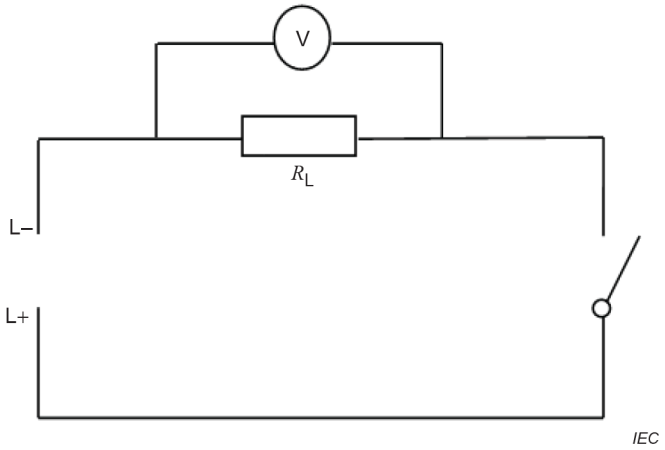


Figure 4 – Circuit diagram of switch

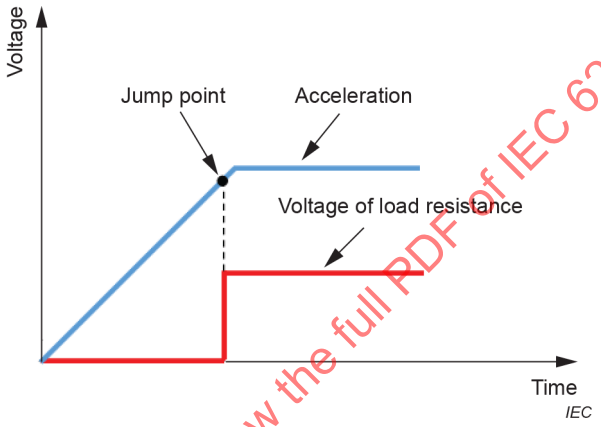


Figure 5 – Static threshold of switch

5.3 Dynamic threshold

5.3.1 Test system

Test system includes seven parts: shock test apparatus, reference accelerometer, switch, charge amplifier, open-closed test circuit, DC voltage regulator, and data acquisition system, as shown in Figure 6.

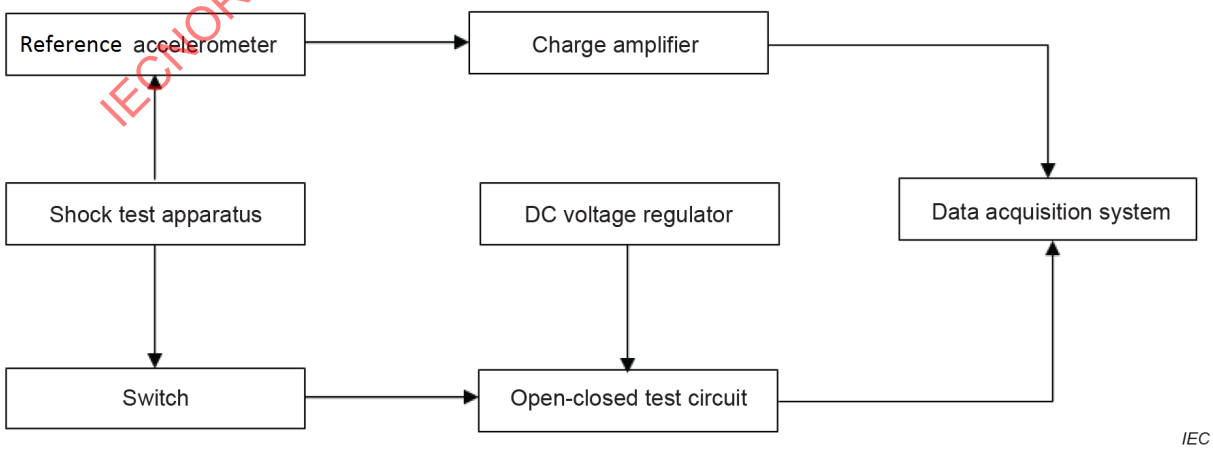


Figure 6 – Test system of dynamic threshold