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Semiconductor devices – Micro-electromechanical devices – Part 28: Performance testing method of vibration-driven MEMS electret energy harvesting devices

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SEMICONDUCTOR DEVICES –
MICRO-ELECTROMECHANICAL DEVICES –

Part 28: Performance testing method of vibration-driven MEMS electret energy harvesting devices

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International Standard IEC 62047-28 has been prepared by subcommittee 47F: Micro-electromechanical systems, of IEC technical committee 47: Semiconductor devices.

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

FDIS	Report on voting
47F/266/FDIS	47F/271/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,
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- amended.

A bilingual version of this publication may be issued at a later date.

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SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 28: Performance testing method of vibration-driven MEMS electret energy harvesting devices

1 Scope

This part of IEC 62047 specifies terms and definitions, and a performance testing method of vibration driven MEMS electret energy harvesting devices to determine the characteristic parameters for consumer, industry or any application.

This document applies to vibration driven electret energy harvesting devices whose electrodes with a gap below 1 000 µm are covered by dielectric material with trapped charges and are fabricated by MEMS processes such as etching, photolithography or deposition.

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.

3.1
vibration frequency
frequency of the periodic motion of vibration-driven MEMS electret energy harvesting devices

3.2
vibration acceleration
acceleration applied to the vibration-driven MEMS electret energy harvesting devices

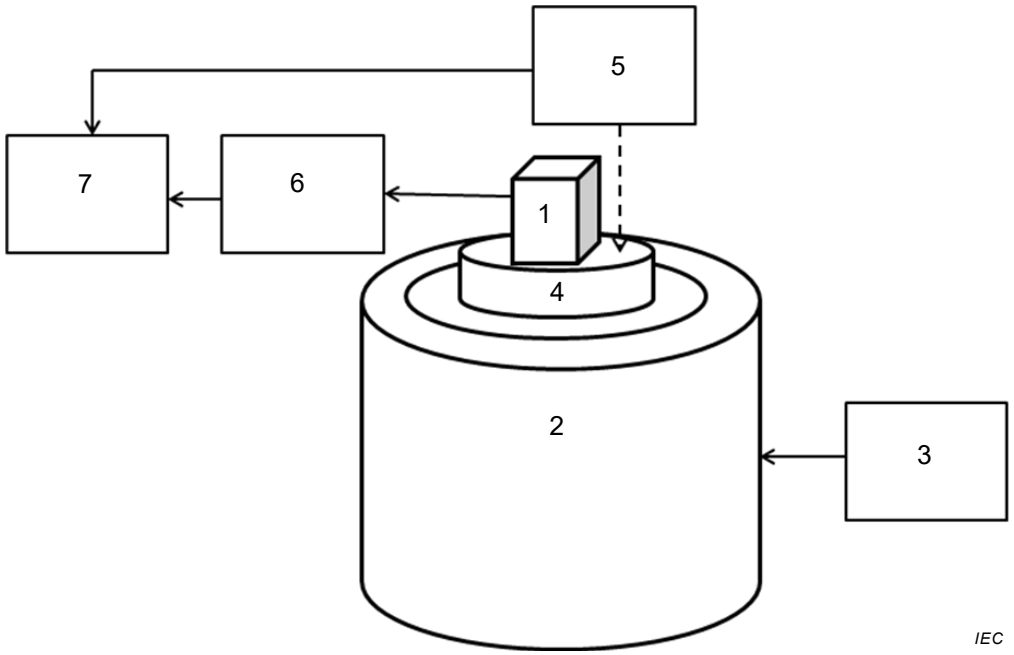
3.3
amplitude
maximum displacement in movement of the vibration-driven MEMS electret energy harvesting devices

3.4
vibration direction
direction of vibration applied to the vibration-driven MEMS electret energy harvesting device

4 Vibration testing equipment

4.1 General

Figure 1 provides fundamental configurations consisted of functional blocks or components for vibration testing equipment for MEMS electrets energy harvesting devices at a specified constant frequency and constant acceleration. Details of the functional blocks or components named as the keys are provided in the following 4.2 to 4.5.



Key

1	DUT: Device under test	2	Vibration exciter
3	Vibration controller	4	Mounting bracket
5	Vibration detector	6	External load/output detector
7	Data recorder		

Figure 1 – Testing equipment for vibration driven MEMS electret energy harvesting devices

4.2 Vibration exciter

The vibration exciter shall generate vibration acceleration of necessary frequency along with necessary direction. Also the amplitude of the vibration perpendicular to the driving direction should be small enough.

The vibration acceleration control can be performed by either of the following methods:

a) Constant amplitude control: To maintain the vibration acceleration, by detecting and controlling the amplitude of the vibration for given vibration frequency;

b) Constant acceleration control: To maintain the vibration acceleration, by detecting and controlling vibration acceleration directly for given vibration frequency.

4.3 Mounting bracket

The mounting bracket shall fix the MEMS electret energy harvesting device under testing to the vibration exciter so that the generated vibration can drive the test device correctly. In addition, the direction of the vibration generated by the vibration exciter shall be within 2 degrees from the determined direction of vibration of the tested device.

4.4 Vibration or acceleration detector

The vibration or acceleration detector shall measure the vibration amplitude or vibration acceleration of the bracket or the DUT.

4.5 Output detector

The output detector and relevant equipment shall measure the voltage across the external load and the output power of the MEMS electret energy harvesting device within 3 % measurement error. The sampling frequency of the output detector shall be high enough to capture the wave form of the output voltage. In addition, the wiring between the electrical output and the DUT shall be short enough to minimize unwanted effect of parasitic capacitance.

4.6 Data recorder

The test system of vibration driven MEMS electret energy harvesting devices shall include data recorder to collect recording data as shown in 7.4.

5 Vibration-driven MEMS energy harvesting devices for testing

5.1 General

The vibration-driven MEMS energy harvesting devices for testing shall indicate way of mounting and direction of vibration. Furthermore the device for testing shall be mounted on the vibration exciter with the mounting bracket, and driven with determined vibration frequency and acceleration.

5.2 Electrical output

The device for testing shall comprise an electrical output.

6 Test conditions

6.1 Vibration frequency

Vibration frequency shall be constant during testing. When changing frequency, vibration shall be stopped before adjusting frequency. In case of sweeping frequency, sweep rate shall be low enough to minimize unintentional influence to characteristics of power generation. Data for sweeping in both directions (low to high or vice versa) shall be recorded. Also the testing vibration frequency range shall include the resonant frequency.

NOTE Resonant frequency is the frequency given in specification, or the frequency that generates peak output power in case of frequency sweeping.

6.2 Vibration acceleration

Vibration acceleration shall be constant during testing.

6.3 Waveform

Waveform of vibration shall be sinusoidal wave.

6.4 External load

External load shall be pure resistor of known value. Also parasitic capacitance of the external load and the output detector shall be measured.

6.5 Testing time

Testing time shall be long enough to stabilize electrical output of power generator for testing in comparison with vibration frequency and acceleration.

6.6 Test environment

The temperature and relative humidity should be constant during the test.

7 Measuring procedures

7.1 General

The following measuring procedures and measuring conditions are to be applied to the vibration testing equipment for MEMS energy harvesting devices as provided in Figure 1.

7.2 Vibration frequency response

The following steps are measuring procedures of the vibration frequency response.

a) Set an ambient temperature and relative humidity;
b) Fix the DUT on the vibration exciter with the mounting bracket;
c) Set an external load to the output of the DUT;
d) Apply input voltage to the vibration exciter to generate sinusoidal vibration and vibrate the DUT;
e) Measure vibration frequency and amplitude of the DUT;
f) Measure output voltage and power output of the DUT.

7.3 Vibration acceleration response

The following steps are measuring procedures of the vibration acceleration response.

a) Set an ambient temperature and relative humidity;
b) Fix the DUT on the vibration exciter with the mounting bracket;
c) Set an external load to the output of the DUT;
d) Apply appropriate input voltage to the vibration exciter to generate sinusoidal vibration and vibrate the DUT with a given frequency;
e) Measure acceleration of the DUT;
f) Measure output voltage and power output of the DUT.

7.4 Measuring conditions and electric characteristics of the external load

The measuring conditions and electric characteristics of the external load as provided in Figure 1 are as follows.

a) Set an ambient temperature and relative humidity.
b) Measure values of a specified resistance and parasitic capacitance of the external load and the output detector provided in Figure 1.

The resistor as the external load should be specified by considering resistance value, parasitic capacitance value and applied equipments or systems of the DUT.

8 Test report

Test report shall include at least the following information.

a) Mandatory:
   1) reference to this document;
   2) shape, weight and dimensions of tested energy harvesting device;
   3) test equipment;

4) detail of output detector and data recorder;
5) method for fixation of the energy harvesting device on the vibration exciter;
6) test conditions;
   – vibration frequency;
   – vibration acceleration;
   – external load;
   – parasitic capacitance;
   – testing time;
   – test environment (temperature and relative humidity);
7) test results;
   – output voltage;
   – output power.

b) Optional:
1) purpose of testing;
2) structure of tested device;
3) principle of power generation.