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Semiconductor devices – Micro-electromechanical devices – Part 33: MEMS piezoresistive pressure-sensitive device

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FOREWORD

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International Standard IEC 62047-33 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/327FDIS	47F/332/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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 33: MEMS piezoresistive pressure-sensitive device

1 Scope

This part of IEC 62047 defines terms, definitions, essential ratings and characteristics, as well as test methods applicable to MEMS piezoresistive pressure-sensitive device. This document applies to piezoresistive pressure-sensitive devices for automotive, medical treatment, electronic products.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-10, *Environmental testing – Part 2-10: Tests – Test J and guidance: Mould growth*

IEC 60747-14-3, *Semiconductor devices – Part 14-3: Semiconductor sensors – Pressure sensors*

IEC 60749-2, *Semiconductor devices-Mechanical and climatic test methods – Part 2: Low air pressure*

IEC 60749-6, *Semiconductor devices-Mechanical and climatic test methods – Part 6: Storage at high temperature*

IEC 60749-10, *Semiconductor devices – Mechanical and climatic tests methods – Part 10: Mechanical shock*

IEC 60749-12, *Semiconductor devices – Mechanical and climatic tests methods – Part 12: Vibration, variable frequency*

IEC 60749-13, *Semiconductor devices – Mechanical and climatic test methods – Part 13: Salt atmosphere*

IEC 60749-24, *Semiconductor devices – Mechanical and climatic test methods – Part 24: Accelerated moisture resistance-Unbiased HAST*

IEC 60749-25, *Semiconductor devices – Mechanical and climatic test methods – Part 25: Temperature cycling*

IEC 60749-36, *Semiconductor devices – Mechanical and climatic tests methods – Part 36: Acceleration, steady state*

IEC TR 61000-4-1, *Electromagnetic compatibility (EMC) – Part 4-1:Testing and measurement techniques – Overview of the IEC 61000-4 series*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60747-14-3 and the following 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
MEMS piezoresistive pressure-sensitive device
device that transforms pressure signal into electric signal due to piezoresistive effect, usually including cavity-membrane structure on silicon substrate and Wheatstone bridge in the membrane fabricated by MEMS technology

Key

1 membrane
2 sensitive resistance
3 silicon
4 cavity

Figure 1 – Structure schematic diagram of the device

3.2
frequency response
ratio variation of output to measurand depending on frequency

Note 1 to entry: The frequency response should be based on the given frequency range.

3.3
resonant frequency
frequency at which the device responds with the maximum output amplitude

3.4
ringing frequency
frequency of free oscillations in the transducer output resulting from a step change in measurand

3.5
damping ratio
ratio of the practical damping coefficient to the critical damping coefficient

3.6
rise time
length of time required for the output of the device to rise from 10 % to 90 % of its final steady value when excited by a step change in measurand

3.7
overshoot
amount of output measured beyond the final steady output value in response to a step change in the measurand

4 Essential ratings and characteristics

4.1 Ratings (Limiting values)

The following items should be described in the specification, unless otherwise stated in the relevant procurement specifications. Stresses over these limits can be one of the causes of permanent damage to the devices:

a) power supply voltage;
b) storage temperature;
c) mechanical shock;
d) acceleration;
e) vibration.

4.2 Recommended operating conditions

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

a) power supply voltage;
b) operating temperature.

4.3 Characteristics

Characteristics of the pressure-sensitive devices are listed as shown in Table 1.

Table 1 – Characteristics of the device

Parameter	Mandatory	Optional	Value			Symbol	Test method
			Min	Type	Max		
Input resistance		×		×		R_i	See 5.1
Output resistance		×		×		R_o	See 5.2
Leakage current	×		×		×	I_L	See 5.3
Breakdown voltage		×	×		×	U_b	See 5.4
Isolation voltage		×	×		×	U_s	See 5.5
Output under normal pressure		×	×		×	Y_c	See 5.6.2
Zero output	×		×		×	Y_0	See 5.6.3
Output symmetry		×			×	P_d	See 5.6.4
Full-span output	×			×		$Y^{F \cdot S}$	See 5.6.5
Nonlinearity	×			×		ξ_L	See 5.6.6
Pressure hysteresis	×			×		ξ_H	See 5.6.7
Repeatability	×				×	ξ_R	See 5.6.8
Accuracy	×				×	ξ	See 5.6.9
Sensitivity	×			×		b	See 5.6.10
Zero drift	×				×	D_0	See 5.6.11
Zero long-term stability		×			×	r_z	See 5.7.2

Parameter	Mandatory	Optional	Value			Symbol	Test method
			Min	Type	Max		
Sensitivity long-term stability		×			×	r_s	See 5.7.3
Thermal zero drift	×				×	α	See 5.8.2
Thermal sensitivity drift	×				×	β	See 5.8.3
Thermal zero output hysteresis		×			×	α_H	See 5.8.4
Thermal sensitivity hysteresis		×			×	β_H	See 5.8.5
Temperature hysteresis		×			×	σ	See 5.8.6
Zero static pressure deviation		×			×	p_0	See 5.9.1.2
Full-span output static pressure deviation		×			×	$p_{F\cdot S}$	See 5.9.1.3
Overload	×				×	O_l	See 5.10
Frequency response	×		×		×	F_r	See 5.11.2
Ringing frequency		×		×		w_d	See 5.11.3
Damping ratio		×		×		ζ	See 5.11.4
Rise time		×		×		T_r	See 5.11.5
Resonant frequency	×			×		w_x	See 5.11.6
Overshoot		×			×	O_s	See 5.11.7

5 Test methods

5.1 Input resistance

Measure the resistance value of power supply terminals with the output terminals of device staying open circuited.

5.2 Output resistance

Measure the resistance value of output terminals of device with the power supply terminals staying short circuited.

5.3 Leakage current

5.3.1 P-N junction isolation type sensitive device

Connect the P-N junction isolation type sensitive device according to Figure 2. There are P-N junctions between the sensitive resistance and the silicon substrate. Measure the voltage V of the standard resistance R under the condition of specified bias voltage and no light. Calculate the leakage current according to Formula (1):

$$I_l = \frac{V}{R} \tag{1}$$

where

I_l is the leakage current;

V is the voltage of the standard resistance;