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# INTERNATIONAL STANDARD

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## Semiconductor devices – Micro-electromechanical devices – Part 36: Environmental and dielectric withstand test methods for MEMS piezoelectric thin films

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

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International Standard IEC 62047-36 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/329/FDIS | 47F/334/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- withdrawn,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.

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# INTRODUCTION

Piezoelectric MEMS technology belongs to an interdisciplinary field founded on a wide range of element technologies including piezoelectric thin film materials, thin film deposition and microfabrication processes, device design, and system formulation. Along with the increased sophistication of MEMS functionality, research on MEMS applications for piezoelectric thin films, such as $Pb(Zr,Ti)O_3$ (PZT) or AlN, has become increasingly popular in recent years. MEMS piezoelectric thin films have the capability of configuring simple compact devices that have a lower power consumption, higher sensitivity, and quicker response than conventional bulk-type, electrostatic, or electromagnetic thin films. However, their device performance is greatly affected by the properties of the thin film materials.

Several test methods for thin film materials have been established to date. Among these, the overriding property that determines device performance is the material's piezoelectric property. Standardization of IEC 62047-30 (*Semiconductor devices – Micro-electromechanical devices – Part 30: Measurement methods of electro-mechanical conversion characteristics of MEMS piezoelectric thin film*) has been promoted for the purpose of precisely measuring and evaluating MEMS piezoelectric thin films using simply structured test pieces and inexpensive equipment.

In order to realize a viable MEMS piezoelectric thin film, it is essential to gain a clear understanding of how its piezoelectric properties change as a result of the environmental stress of temperature and humidity, and degradation in the piezoelectric material over time at its surfaces and interfaces. Achieving a viable MEMS piezoelectric thin film will also require a clear understanding of dielectric withstand for the electrical stress of a voltage (electric field) higher than the drive voltage (electric field) used for normal operations.

The following summarizes the features of this standard.

- The degree of degradation in a device under test (DUT) is evaluated by measuring the piezoelectric properties of the DUT before and after applying the environmental stress of temperature and humidity using the measurement methods in IEC 62047-30.
- Test conditions for moist heat and dielectric withstand tests are derived from existing standards for semiconductor devices and fixed capacitors of ceramic dielectric.
- The dielectric withstand property is evaluated by measuring the leakage current under the DC bias voltage.

# SEMICONDUCTOR DEVICES –
# MICRO-ELECTROMECHANICAL DEVICES –

## Part 36: Environmental and dielectric withstand test methods for MEMS piezoelectric thin films

## 1 Scope

This part of IEC 62047 specifies test methods for evaluating the durability of MEMS piezoelectric thin film materials under the environmental stress of temperature and humidity and under electrical stress, and test conditions for appropriate quality assessment. Specifically, this document specifies test methods and test conditions for measuring the durability of a DUT under temperature and humidity conditions and applied voltages. It further applies to evaluations of converse piezoelectric properties in piezoelectric thin films formed primarily on silicon substrates, i.e., piezoelectric thin films used as actuators.

This document does not cover reliability assessments, such as methods of predicting the lifetime of a piezoelectric thin film based on a Weibull distribution.

## 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 62047-30, *Semiconductor devices – Micro-electromechanical devices – Part 30: Measurement methods of electro-mechanical conversion characteristics of MEMS piezoelectric thin film*

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*