

TECHNICAL SPECIFICATION



**Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection – Glossary –
Part 5: Piezoelectric sensors**



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Part 5: Piezoelectric sensors**

INTERNATIONAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC DEVICES
AND ASSOCIATED MATERIALS FOR FREQUENCY CONTROL,
SELECTION AND DETECTION –
GLOSSARY –**

Part 5: Piezoelectric sensors

FOREWORD

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IEC TS 61944-5 has been prepared by IEC technical committee 49: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection. It is a Technical Specification.

This second edition cancels and replaces the first edition published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) New terms and definitions have been added from IEC 63041-1:2021 and IEC 63041-3:2020.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
49/1421/DTS	49/1439/RVDTS

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 Technical Specification 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/publications.

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PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC DEVICES AND ASSOCIATED MATERIALS FOR FREQUENCY CONTROL, SELECTION AND DETECTION – GLOSSARY –

Part 5: Piezoelectric sensors

1 Scope

This part of IEC 61994 gives the terms and definitions for sensors representing the state of the art, which are intended for manufacturing piezoelectric elements, cells, modules and the systems.

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 terminology databases for use in standardization at the following addresses:

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

3.1

delay line type sensor element

piezoelectric sensor component using a delay line of ~~surface acoustic wave (SAW)~~ transversal filter type

[SOURCE: ~~IEC 63041-1:2017, 3.2.3, modified – The phrase has been rewritten in an easy-to-understand manner using a well-known term~~ IEC 63041-1:2021, 3.1.3, modified – "surface acoustic wave (SAW) transversal filter type" of the definition has been replaced by "SAW transversal filter type".]

~~3.2~~

~~non-acoustic type sensor element~~

~~piezoelectric sensor component using the electrical charge induced by a quasi-static force, torque or the like~~

[SOURCE: IEC 63041-1:2017, 3.2.4, modified – Note 1 to entry has been deleted.]

3.2

differential sensor

piezoelectric sensor element that can detect physical quantities from a differential change in resonance frequencies or delays of two independent and same micro-acoustic structures assembled on the same or different piezoelectric plates

Note 1 to entry: The differential sensor is a general term for sensors of the above type.

[SOURCE: IEC 63041-3:2020, 3.1.6, modified – "piezoelectric sensor which is able to" of the definition has been replaced by "piezoelectric sensor element that can". "from a change in resonance frequencies" has been replaced by "from a differential change in resonance frequencies".]

3.3

dual mode sensor

piezoelectric sensor element that can detect physical quantities from a change in resonance frequencies of two independent modes on a single piezoelectric plate

Note 1 to entry: In order to achieve improved precision and/or to eliminate undesirable influence factors, sensor solutions are employed that utilize two or more modes. By evaluation of combinations of those modes' sensitivities to various ambient conditions, improved detection sensitivity can be achieved, whereas undesirable sensitivities can be reduced or eliminated.

Note 2 to entry: The dual mode sensor is a general term for sensors of the above type

[SOURCE: IEC 63041-3:2020, 3.1.5, modified – "piezoelectric sensor which is able to" of definition has been replaced by "piezoelectric sensor element that can". Note 1 to entry has been rewritten. Note 2 to entry has been added.]

3.4

dual mode sensor module

dual mode sensor element or cell equipped with circuit units for temperature compensation and electronic accessories for interfacing to external data acquisitions

[SOURCE: IEC 63041-1:2021, 3.4.2, modified – The note to entry has been removed.]

3.5

dual mode sensor system

system that consists of dual mode sensor modules, electronic devices, PCs, memory, wired or wireless devices, software, etc.

Note 1 to entry: The dual mode quartz crystal sensor system is used in oil-well exploration and gas-well exploration systems.

[SOURCE: IEC 63041-1:2021, 3.5.2, modified – Since the dual mode sensor is not necessarily limited to quartz crystal-based sensors, the definition was rewritten as above.]

3.6

multi-measurand sensor

piezoelectric sensor element that can detect two or more different physical quantities from an analysis of different sensor responses

Note 1 to entry: The multi-measurand sensor is a general term for sensors of the above type,

[SOURCE: IEC 63041-3:2020, 3.1.7, modified – The words "piezoelectric sensor which is able to" of the definition have been replaced by "piezoelectric sensor element that can". Note 1 to entry has been added.]

3.7

piezoelectric acceleration sensor element

piezoelectric sensor component whose resonance frequency or delay is used to measure the change in velocity of an object with time

[SOURCE: IEC 63041-3:2020, 3.1.1]

3.8**piezoelectric biochemical sensor element**

piezoelectric sensor component including a receptive layer ~~-(target recognition material)~~, which is necessary for the practical measurement of complex biological molecules in quantity, and which works mainly in aqueous media and detects biomolecules therein

Note 1 to entry: The receptive layer is usually formed as a thin film of a target recognition material on the surface of the piezoelectric sensor element and is often called a target recognition material.

[SOURCE: ~~IEC 63041-1:2017, 3.3.2~~ IEC 63041-1:2021, 3.2.2, modified – In the definition, "(target recognition material)" has been deleted. Note 1 to entry has been added.]

3.9**piezoelectric chemical sensor element**

piezoelectric sensor component including a sensitive layer ~~-(target recognition material)~~, which is necessary for the practical measurement of simple non-biological molecules in quantity, and which works and detects chemical substances mainly in the gas phase

Note 1 to entry: The sensitive layer is usually formed as a thin film of a target recognition material on the surface of the piezoelectric sensor element and is often called a target recognition material.

Note 2 to entry: A gas sensor element is one of the chemical sensor elements

[SOURCE: ~~IEC 63041-1:2017, 3.3.1, modified – Note 1 to entry has been deleted~~ IEC 63041-1:2021, 3.2.1, modified – In the definition, "(target recognition material)" has been deleted. Note 1 to entry has been moved to Note 2 to entry. A new Note 1 to entry has been added.]

3.10**piezoelectric film-thickness sensor element**

piezoelectric sensor component whose resonance frequency is used for film-thickness measurement

EXAMPLE Film-thickness control in vacuum deposition and sputter deposition

[SOURCE: ~~IEC 63041-1:2017, 3.4.6~~ IEC 63041-1:2021, 3.3.6, modified – The example has been added.]

3.11**piezoelectric force sensor element**

piezoelectric sensor component whose resonance frequency, delay ~~-or~~, electrical charge ~~/~~, or voltage is used for force measurement

EXAMPLE Inertial measurement system

[SOURCE: ~~IEC 63041-1:2017, 3.4.1~~ IEC 63041-1:2021, 3.3.1, modified – "delay or electrical charge/voltage" of the definition has been replaced by "delay, electrical charge, or voltage". The example has been added.]

3.12**piezoelectric humidity sensor element**

piezoelectric sensor component whose resonance frequency or delay is used for dew point and moisture detection

[SOURCE: IEC 63041-3:2020, 3.1.2]

3.13

piezoelectric pressure sensor element

piezoelectric sensor component whose resonance frequency, delay, electrical charge, or voltage is used for pressure measurement

EXAMPLE Oil pressure measuring device and flow meter.

[SOURCE: IEC 63041-1:2021, 3.3.2, modified – "delay or electrical charge/voltage" of the definition has been replaced by "delay, electrical charge, or voltage". The example has been added.]

3.14

piezoelectric sensor

~~generic term that includes a sensor element, cell and module~~

general term for a piezoelectric sensor element, piezoelectric sensor cell, piezoelectric sensor module, and piezoelectric sensor system

[SOURCE: ~~IEC 63041-1:2017, 3.2.7~~ IEC 63041-1:2021, 3.1.8, modified – In the definition, "a sensor element, cell, module and system" has been replaced by "piezoelectric sensor element, piezoelectric cell, piezoelectric module, and piezoelectric system".]

3.15

piezoelectric sensor cell

piezoelectric sensor element equipped with necessary mechanical accessories and attachments to correctly detect the parameters to be measured

[SOURCE: ~~IEC 63041-1:2017, 3.2.5~~ IEC 63041-1:2021, 3.1.5, modified – In the definition, "sensor" has been replaced by "piezoelectric sensor".]

3.16

piezoelectric sensor element

electronic component ~~which is able to~~ that can piezoelectrically detect physical quantities as a change in its frequency, phase, delay, electrical charge, resistance, Q-value, bandwidth, etc.

Note 1 to entry: For chemical and biochemical sensor applications, the piezoelectric sensor element includes a sensitive or receptive layer (target recognition material).

[SOURCE: ~~IEC 63041-1:2017, 3.2.1, modified – Note 1 to entry has been deleted~~ IEC 63041-1:2021, 3.1.1, modified – In the definition, "which is able to" has been replaced by "that can piezoelectrically detect".]

3.17

piezoelectric sensor module

piezoelectric sensor element or cell equipped with electronic accessories for interfacing to external data acquisitions

[SOURCE: ~~IEC 63041-1:2017, 3.2.6~~ IEC 63041-1:2021, 3.1.6, modified – In the definition, "sensor element" has been replaced by "piezoelectric sensor element".]

3.18

piezoelectric sensor system

organized system including detection and amplification of raw data, communication with other equipment, and processing and analysis of observation data

[SOURCE: IEC 63041-1:2021, 3.1.7, modified – In the definition "amplification of detected value" has been replaced by "amplification of raw data" and "analysis of detected value" has been replaced by "analysis of observation data".]

3.19**piezoelectric temperature sensor element**

piezoelectric sensor component whose resonance frequency or delay is used for temperature measurement

[SOURCE: ~~IEC 63041-1:2017, 3.4.5~~ IEC 63041-1:2021, 3.3.5.]

3.20**piezoelectric tilt angle sensor element**

piezoelectric sensor component whose resonance frequency or delay is used to measure tilt angles, elevation, or depression of an object with respect to gravity's detection

EXAMPLE Gyro sensor

[SOURCE: IEC 63041-3:2020, 3.1.3, modified – The example has been added.]

3.21**piezoelectric torque sensor element**

piezoelectric sensor component whose resonance frequency, delay or electrical charge¹, or voltage is used for torque measurement

[SOURCE: ~~IEC 63041-1:2017, 3.4.3~~ IEC 63041-1:2021, 3.3.3, modified – In the definition, "delay or electrical charge/voltage" has been replaced by "delay, electrical charge, or voltage".]

3.22**piezoelectric vibration sensor element**

piezoelectric sensor component whose resonance frequency or delay is used for measurement of vibration

EXAMPLE Volcano infrasound monitoring system

[SOURCE: IEC 63041-3:2020, 3.1.4, modified – The example has been added.]

3.23**piezoelectric viscosity sensor element**

piezoelectric sensor component whose resonance frequency, delay^{or}, insertion loss¹, or gain is used for viscosity measurement

EXAMPLE Hydrogen leak detector for fuel-cell

[SOURCE: ~~IEC 63041-1:2017, 3.4.4~~ IEC 63041-1:2021, 3.3.4, modified – In the definition, "delay, or insertion loss/gain" has been replaced by "delay, insertion loss, or gain". The example has been added.]

3.24**quartz crystal microbalance****QCM**

~~one of the families of chemical and biochemical sensors using crystal resonators~~

piezoelectric sensor element for detecting small mass change using quartz crystal resonators

Note 1 to entry: A thickness shear mode (TSM) sensor is identical with a QCM.

[SOURCE: ~~IEC 63041-1:2017, 3.2.8, modified – Note 1 to entry has been deleted~~ IEC 63041-1:2021, 3.1.9, modified – "one of the families of chemical and biochemical sensors using crystal resonators" of the definition has been replaced by "piezoelectric sensor element for detecting small mass change using quartz crystal resonators" to make it easier to understand if the principle of the sensor is specified.]

3.25**quasi-static piezoelectric sensor element**

piezoelectric sensor component using the electrical charge induced by a quasi-static force, torque, or the like

[SOURCE: IEC 63041-1:2021, 3.1.4, modified – The term "non-acoustic type sensor element" has been replaced by "quasi-static piezoelectric sensor element" has been replaced as the first preferred term. The note to entry has been removed.]

3.26**resonator type sensor element**

piezoelectric sensor component using acoustic resonances

[SOURCE: ~~IEC 63041-1:2017, 3.2.2~~ IEC 63041-1:2021, 3.1.2]

3.27**wireless and passive SAW sensor module**

SAW sensor element or cell equipped with an antenna for wireless connection, and powered by electromagnetic wave

Note 1 to entry: Here, SAW resonators and delay lines are used for the wireless SAW sensor element or cell.

[SOURCE: IEC 63041-1:2021, 3.4.1, modified – The term "wireless SAW sensor module" has been changed to "wireless and passive SAW sensor module". In addition, "piezoelectric sensor" and "wirelessly connecting with interrogation unit" have been replaced by "SAW sensor", and "wireless connection, and powered by electromagnetic wave", respectively. Note 1 to entry has been modified.]

3.28**wireless and passive SAW sensor system**

system that consists of wireless and passive SAW sensor modules, and an RF transmitter and receiver for getting observation data

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IEC 60862-1:2015, *Surface acoustic wave (SAW) filters of assessed quality – Part 1: Generic specification*

IEC 63041-1:~~2017~~2021, *Piezoelectric sensors – Part 1: Generic specifications*

IEC 63041-3:2020, *Piezoelectric sensors – Part 3: Physical sensors*

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Part 5: Piezoelectric sensors

1 Scope

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2 Normative references

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3 Terms and definitions

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

3.1

delay line type sensor element

piezoelectric sensor component using a delay line of SAW transversal filter type

[SOURCE: IEC 63041-1:2021, 3.1.3, modified – "surface acoustic wave (SAW) transversal filter type" of the definition has been replaced by "SAW transversal filter type".]

3.2

differential sensor

piezoelectric sensor element that can detect physical quantities from a differential change in resonance frequencies or delays of two independent and same micro-acoustic structures assembled on the same or different piezoelectric plates

Note 1 to entry: The differential sensor is a general term for sensors of the above type.

[SOURCE: IEC 63041-3:2020, 3.1.6, modified – "piezoelectric sensor which is able to" of the definition has been replaced by "piezoelectric sensor element that can". "from a change in resonance frequencies" has been replaced by "from a differential change in resonance frequencies".]

3.3

dual mode sensor

piezoelectric sensor element that can detect physical quantities from a change in resonance frequencies of two independent modes on a single piezoelectric plate

Note 1 to entry: In order to achieve improved precision and/or to eliminate undesirable influence factors, sensor solutions are employed that utilize two or more modes. By evaluation of combinations of those modes' sensitivities to various ambient conditions, improved detection sensitivity can be achieved, whereas undesirable sensitivities can be reduced or eliminated.

Note 2 to entry: The dual mode sensor is a general term for sensors of the above type

[SOURCE: IEC 63041-3:2020, 3.1.5, modified – "piezoelectric sensor which is able to" of definition has been replaced by "piezoelectric sensor element that can". Note 1 to entry has been rewritten. Note 2 to entry has been added.]

3.4

dual mode sensor module

dual mode sensor element or cell equipped with circuit units for temperature compensation and electronic accessories for interfacing to external data acquisitions

[SOURCE: IEC 63041-1:2021, 3.4.2, modified – The note to entry has been removed.]

3.5

dual mode sensor system

system that consists of dual mode sensor modules, electronic devices, PCs, memory, wired or wireless devices, software, etc.

Note 1 to entry: The dual mode quartz crystal sensor system is used in oil-well exploration and gas-well exploration systems.

[SOURCE: IEC 63041-1:2021, 3.5.2, modified – Since the dual mode sensor is not necessarily limited to quartz crystal-based sensors, the definition was rewritten as above.]

3.6

multi-measurand sensor

piezoelectric sensor element that can detect two or more different physical quantities from an analysis of different sensor responses

Note 1 to entry: The multi-measurand sensor is a general term for sensors of the above type,

[SOURCE: IEC 63041-3:2020, 3.1.7, modified – The words "piezoelectric sensor which is able to" of the definition have been replaced by "piezoelectric sensor element that can". Note 1 to entry has been added.]

3.7

piezoelectric acceleration sensor element

piezoelectric sensor component whose resonance frequency or delay is used to measure the change in velocity of an object with time

[SOURCE: IEC 63041-3:2020, 3.1.1]

3.8

piezoelectric biochemical sensor element

piezoelectric sensor component including a receptive layer, which is necessary for the practical measurement of complex biological molecules in quantity, and which works mainly in aqueous media and detects biomolecules therein

Note 1 to entry: The receptive layer is usually formed as a thin film of a target recognition material on the surface of the piezoelectric sensor element and is often called a target recognition material.

[SOURCE: IEC 63041-1:2021, 3.2.2, modified – In the definition, "(target recognition material)" has been deleted. Note 1 to entry has been added.]

3.9

piezoelectric chemical sensor element

piezoelectric sensor component including a sensitive layer, which is necessary for the practical measurement of simple non-biological molecules in quantity, and which works and detects chemical substances mainly in the gas phase

Note 1 to entry: The sensitive layer is usually formed as a thin film of a target recognition material on the surface of the piezoelectric sensor element and is often called a target recognition material.

Note 2 to entry: A gas sensor element is one of the chemical sensor elements.

[SOURCE: IEC 63041-1:2021, 3.2.1, modified – In the definition, "(target recognition material)" has been deleted. Note 1 to entry has been moved to Note 2 to entry. A new Note 1 to entry has been added.]

3.10

piezoelectric film-thickness sensor element

piezoelectric sensor component whose resonance frequency is used for film-thickness measurement

EXAMPLE Film-thickness control in vacuum deposition and sputter deposition

[SOURCE: IEC 63041-1:2021, 3.3.6, modified – The example has been added.]

3.11

piezoelectric force sensor element

piezoelectric sensor component whose resonance frequency, delay, electrical charge, or voltage is used for force measurement

EXAMPLE Inertial measurement system

[SOURCE: IEC 63041-1:2021, 3.3.1, modified – "delay or electrical charge/voltage" of the definition has been replaced by "delay, electrical charge, or voltage". The example has been added.]

3.12

piezoelectric humidity sensor element

piezoelectric sensor component whose resonance frequency or delay is used for dew point and moisture detection

[SOURCE: IEC 63041-3:2020, 3.1.2]

3.13

piezoelectric pressure sensor element

piezoelectric sensor component whose resonance frequency, delay, electrical charge, or voltage is used for pressure measurement

EXAMPLE Oil pressure measuring device and flow meter.

[SOURCE: IEC 63041-1:2021, 3.3.2, modified – "delay or electrical charge/voltage" of the definition has been replaced by "delay, electrical charge, or voltage". The example has been added.]

3.14

piezoelectric sensor

general term for a piezoelectric sensor element, piezoelectric sensor cell, piezoelectric sensor module, and piezoelectric sensor system

[SOURCE: IEC 63041-1:2021, 3.1.8, modified – In the definition, "a sensor element, cell, module and system" has been replaced by "piezoelectric sensor element, piezoelectric cell, piezoelectric module, and piezoelectric system".]

3.15

piezoelectric sensor cell

piezoelectric sensor element equipped with necessary mechanical accessories and attachments to correctly detect the parameters to be measured

[SOURCE: IEC 63041-1:2021, 3.1.5, modified – In the definition, "sensor" has been replaced by "piezoelectric sensor".]

3.16

piezoelectric sensor element

electronic component that can piezoelectrically detect physical quantities as a change in its frequency, phase, delay, electrical charge, resistance, Q-value, bandwidth, etc.

Note 1 to entry: For chemical and biochemical sensor applications, the piezoelectric sensor element includes a sensitive or receptive layer (target recognition material).

[SOURCE: IEC 63041-1:2021, 3.1.1, modified – In the definition, "which is able to" has been replaced by "that can piezoelectrically detect".]

3.17

piezoelectric sensor module

piezoelectric sensor element or cell equipped with electronic accessories for interfacing to external data acquisitions

[SOURCE: IEC 63041-1:2021, 3.1.6, modified – In the definition, "sensor element" has been replaced by "piezoelectric sensor element".]

3.18

piezoelectric sensor system

organized system including detection and amplification of raw data, communication with other equipment, and processing and analysis of observation data

[SOURCE: IEC 63041-1:2021, 3.1.7, modified – In the definition "amplification of detected value" has been replaced by "amplification of raw data" and "analysis of detected value" has been replaced by "analysis of observation data".]