

## H10N

### ELECTRIC SOLID-STATE DEVICES NOT OTHERWISE PROVIDED FOR

#### Definition statement

*This place covers:*

Discrete and integrated solid-state devices not otherwise provided for in the IPC and details and fabrication thereof.

Assemblies of multiple devices comprising at least one solid-state device covered by this subclass not otherwise provided for in the IPC.

This includes the following kinds of devices:

- Electric solid-state devices using thermoelectric or thermomagnetic effects, e.g. thermo couples, Peltier elements;
- Electric solid-state devices using piezoelectric, electrostrictive, magnetostrictive effects, e.g. piezo elements;
- Electric solid-state devices using galvanomagnetic effects, e.g. magnetic tunnel junctions, Hall elements;
- Electric solid-state devices using superconductive effects, e.g. Josephson elements, superconductive quantum bits;
- Electric solid-state devices adapted for rectifying, amplifying, oscillating or switching without potential barriers;
- Electric solid-state devices using bulk negative resistance effects, e.g. Gunn diodes;
- Electric solid-state devices, not otherwise provided for;
- Integrated devices comprising any of the above listed electric solid-state components;
- Assemblies of multiple devices, comprising any of the above listed electric solid-state devices.

#### Relationships with other classification places

Microstructural transducer devices or systems are classified in subclass [B81B](#), and the processes and apparatus specially adapted for the manufacture or treatment thereof are classified in subclass [B81C](#). Therefore, by way of example, microelectromechanical systems (MEMS), containing microelectronic and mechanical components, are classified in group [B81B 7/02](#), and their manufacture, treatment or assembling in the relevant groups of [B81C](#).

Microstructural devices or systems working purely electrically or electronically, or related processes or apparatus for the manufacture or treatment thereof are however not covered by subclasses [B81B](#) or [B81C](#) and are classified in section [H](#), for example in the groups of the current subclass [H10N](#).

Microstructural devices or systems being of other than purely electrical or electronically type, and apparatus or processes for the manufacture or treatment thereof, which are normally classified in the subclasses [B81B](#) and [B81C](#), may be also classified in those groups of subclass [H10N](#) providing for their structural or functional features, whenever such features are of interest per se.

Nanostructures, which are normally classified in subclass [B82B](#), may be also classified in those groups of subclass [H10N](#) providing for their structural or functional features, whenever such features are of interest per se.

## References

### Application-oriented references

Examples of places where the subject matter of this place is covered when specially adapted, used for a particular purpose, or incorporated in a larger system:

Measurement of mechanical vibrations or ultrasonic, sonic or infrasonic waves	<a href="#">G01H</a>
Measuring electrical or magnetic variables	<a href="#">G01R</a>

### References out of a residual place

Examples of places in relation to which this place is residual:

Magnets, inductors, transformers	<a href="#">H01F</a>
Capacitors in general	<a href="#">H01G</a>
Electrolytic devices	<a href="#">H01G 9/00</a>
Waveguides, resonators or lines of the waveguide type	<a href="#">H01P</a>
Line connectors, current collectors	<a href="#">H01R</a>
Electronic memory devices	<a href="#">H10B</a>

### Informative references

Attention is drawn to the following places, which may be of interest for search:

Micromechanical devices (MEMS)	<a href="#">B81B</a>
Processes and apparatus specially adapted for the manufacture or treatment of microstructural devices or systems	<a href="#">B81C</a>
Static stores	<a href="#">G11C</a>
Conductive and insulating materials	<a href="#">H01B</a>
Resistors in general	<a href="#">H01C</a>
Resistors, e.g. non-adjustable resistors from semiconductor material	<a href="#">H01C 7/00</a>
Organic electric solid-state devices	<a href="#">H10K</a>

## Glossary of terms

In this place, the following terms or expressions are used with the meaning indicated:

chip	a piece of a wafer or a substrate that has been processed to contain devices therein or thereon. The expression "diced chip" refers to the result of dicing a wafer or a substrate into a plurality of chips, whereas "undiced chip" refers to a chip before dicing or with no dicing.
device	an electric circuit element (e.g. diode, transistor, LED, etc.); (depending on the context) can also refer to an integrated device (e.g. CMOS-IC, DRAM device, etc.). A device may be in the form of a bare or packaged chip.
dopant	the atoms or compounds added to a material during doping

doping	the intentional addition of a small quantity of atoms or compounds into a material to achieve a desired characteristic, e.g. to produce an n-type or p-type material
individual	refers to: an electric circuit element not being an integrated device; or a component of an integrated device. Examples of individual devices include: diodes, transistors, photovoltaic cells, Josephson-junction devices, light-emitting diodes [LED], organic LEDs or a single LED component within an integrated device.
integrated device	a device consisting of a plurality of semiconductor or other solid-state electric circuit elements formed in or on a common substrate
integrated circuit	an integrated device where all the electric circuit elements (e.g. diodes, transistors, LEDs, etc.) are formed in or on a common substrate, including interconnections between the elements
component	an electric circuit element (e.g. diode, transistor, LED, etc.) that is one of a plurality of elements formed in or on a common substrate, e.g. in an integrated device
wafer	it can be one of the following: (a) a slice of semiconductor or electric solid-state active material. For example: a slice of silicon; a slice of a semiconducting compound, e.g. gallium nitride [GaN]; a slice of lithium tantalate [LiTaO <sub>3</sub> ] for superconductor applications. (b) A multilayered laminate, having at least one layer of semiconductor or electric solid-state active material, the layer being meant to be processed into devices. For example: silicon-on-insulator [SOI]; silicon-on-glass [SOG]; silicon-on-sapphire [SOS]; a composite wafer comprising silicon carbide [SiC] on polycrystalline silicon [Si] support; a layer of semiconducting nanowires on glass. A wafer is typically processed by (e.g.) deposition, etching, doping or diffusion, and is then typically diced into chips.
body	the region of semiconductor (resp. solid-state) material(s) within which, or at the surface of which, the physical effects that are characteristic of the device occur, and any bordering semiconductor (resp. solid-state) material(s) that are contiguous with this region. Examples: in a field-effect transistor [FET], the physical effects occur in the channel region between the source and the drain. The semiconductor body includes the channel region, the source and drain regions, and any contiguous semiconductor material; in a light-emitting diode [LED], the physical effects occur at a junction of active semiconductor layers. The semiconductor body includes these active semiconductor layers and any contiguous semiconductor layers, such as buffer layers, possibly a growth substrate, etc., that are between the cathode and anode electrodes; in a thermoelectric device, the solid-state body includes all solid-state materials in the path of current between the electrodes.

electrode	a conductive region in or on the semiconductor body or solid-state body of a device (and other than the body itself) which exerts an electrical influence on the body, irrespective of whether or not an external electrical connection is made thereto. The term covers metallic regions which exert electrical influence on the body through an insulating region (e.g. in intentional non-parasitic capacitive coupling), or inductive coupling arrangements. In a capacitive coupling arrangement, the dielectric region is regarded as part of the electrode. The overall conductive wiring may comprise multiple portions. In such a case, only the wiring portions that exert an electrical influence on the body are considered portions of the electrode. Examples: conductive layer(s) in direct physical contact with the body; conductive region(s) exerting an inductive coupling onto the body; a multilayer structure which exerts influence on the body through an insulating region, e.g. in intentional non-parasitic capacitive coupling.
interconnection	a conductive arrangement for conducting electric current from an electrode of a circuit element to another part of the circuit. Examples include metal wirings.
container	a solid construction in which (one or more) devices are placed, or which is formed around the devices, for forming packaged devices. A container requires a partial or total enclosure and it may also comprise a filling.
encapsulation	an enclosure consisting of (one or more) layers, e.g. comprising organic polymers, which at least partially enclose the (one or more) devices, thereby protecting them. An encapsulation is often used to hermetically seal devices.
field-effect	refers to semiconductor technology wherein a voltage applied to a gate electrode creates an electric field that allows for control of current near the interface of the gate and the body, e.g. to create an inversion channel between the source and drain of a MOSFET
package	the collection of all elements, which are external to the chip, that protect the chip or connect it to another object. Package therefore covers encapsulations, containers, package substrates, interposers, heatsinks or the like. Package does not include objects at a higher system level, like circuit boards and beyond, e.g. a housing in which the circuit board is enclosed.
unipolar	refers to semiconductor technology that primarily involves one type only of charge carrier, i.e. it involves either holes or electrons but not both
bipolar	refers to semiconductor technology that involves multi-carrier-type operation, i.e. which simultaneously uses both electrons and holes as charge carriers
MIS	metal-insulator-semiconductor
MOS	metal-oxide-semiconductor
FET	field-effect transistor
MISFET	metal-insulator-semiconductor field-effect transistor
TFT	thin-film transistor
active material	material within which the physical effects that are characteristic of the device occur

## H10N 10/00

**Thermoelectric devices comprising a junction of dissimilar materials, i.e. devices exhibiting Seebeck or Peltier effects (integrated devices or assemblies of multiple devices [H10N 19/00](#))**

### Definition statement

*This place covers:*

Thermoelectric devices being based on:

- The Seebeck effect (a temperature difference between two dissimilar materials produces a voltage between the two materials), e.g. thermocouples;
- The Peltier effect (a voltage applied between two dissimilar materials produces a thermal gradient between the two materials), e.g. thermoelectric coolers or heaters.

### Relationships with other classification places

This group covers thermoelectric devices per se. The application or incorporation of thermoelectric devices in systems are covered by subclasses for the systems, e.g. refrigeration, heat exhaust etc.

### References

#### Limiting references

*This place does not cover:*

Integrated devices or assemblies comprising thermoelectric or thermomagnetic elements	<a href="#">H10N 19/00</a>
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#### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Thermoelectric devices without a junction of dissimilar materials or thermomagnetic devices	<a href="#">H10N 15/00</a>
Selenium; Tellurium; Compounds thereof	<a href="#">C01B 19/00</a>
Alloys	<a href="#">C22C</a>
Refrigeration – machines, plant or systems, using electric or magnetic effects	<a href="#">F25B 21/00</a>
Heat-exchange apparatus, not provided for in another subclass, in which the heat-exchange media do not come into direct contact	<a href="#">F28D</a>
Details of heat-exchange and heat-transfer apparatus	<a href="#">F28F</a>
Radiation pyrometers using thermoelectric devices	<a href="#">G01J 5/12</a>
Measuring temperature based on the use of electric or magnetic elements directly sensitive to heat	<a href="#">G01K 7/00</a>
Cooling means directly associated or integrated with the PV cell	<a href="#">H10F 77/63</a>
Cooling arrangements using the Peltier effect in semiconductor or other electric solid-state devices	<a href="#">H10W 40/28</a>

## Glossary of terms

*In this place, the following terms or expressions are used with the meaning indicated:*

thermocouple	temperature measuring device consisting of two conductors of different materials joined at the end
thermopile	a thermopile is an electronic device that converts thermal energy into electrical energy. It is composed of several thermocouples connected usually in series or less commonly in parallel.

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

TEG	thermoelectric generator
TEC	thermoelectric cooler
TEM	thermoelectric module
ZT	dimensionless figure of merit that determines the maximum efficiency of the energy conversion process in a thermoelectric system

## H10N 10/01

### Manufacture or treatment

#### References

##### *Informative references*

*Attention is drawn to the following places, which may be of interest for search:*

Processes or apparatus specifically adapted for manufacture or treatment of semiconductor or solid-state devices or of parts thereof in general	<a href="#">H10P</a>
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## H10N 10/853

comprising arsenic, antimony or bismuth ([H10N 10/852](#) takes precedence)

#### References

##### *Limiting references*

*This place does not cover:*

Thermoelectric active materials comprising tellurium, selenium or sulfur	<a href="#">H10N 10/852</a>
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**H10N 10/854**

comprising only metals ([H10N 10/852](#), [H10N 10/853](#) take precedence)

**References****Limiting references**

*This place does not cover:*

Thermoelectric active materials comprising tellurium, selenium or sulfur	<a href="#">H10N 10/852</a>
Thermoelectric active materials comprising arsenic, antimony or bismuth	<a href="#">H10N 10/853</a>

**H10N 15/00**

**Thermoelectric devices without a junction of dissimilar materials;  
Thermomagnetic devices, e.g. using the Nernst-Ettingshausen effect  
(integrated devices or assemblies of multiple devices [H10N 19/00](#))**

**Definition statement**

*This place covers:*

Devices directly converting thermal energy to electrical or magnetic quantities, or vice versa, using thermoelectric or thermomagnetic effects of solid-state bulk materials. This main group also covers the related active materials and fabrication of such devices.

These include devices based on:

- The pyroelectric effect (heating or cooling a solid-state body generates fixed electric charges on the surfaces of the solid-state body);
- The electrocaloric effect (change of an electrical field applied to a solid-state body results in a change in temperature of the solid-state body);
- The bolometric effect (heating or cooling a solid-state body changes the resistivity);
- The Thomson effect (applying a thermal gradient to a solid-state body in the direction of an electrical current through the solid-state body produces thermal energy);
- The magneto-Thomson effect (applying a thermal gradient to a solid-state body in the direction of an electrical current through the solid-state body and additionally placing the solid-state body in an orthogonal external magnetic field produces thermal energy);
- The Nernst effect (placing a solid object with a thermal gradient in an orthogonal external magnetic field to generate a voltage perpendicular to the thermal gradient and magnetic field);
- The Ettingshausen effect (flowing an electrical current through a solid-state body in the presence of an orthogonal external magnetic field generates a thermal gradient transverse to both the magnetic field and the electrical current);
- The pyromagnetic effect (heating or cooling a solid-state body changes the magnetisation of the solid-state body);
- The magnetocaloric effect (change of an external magnetic field applied to a solid-state body results in a change in temperature of the solid-state body);
- The Spin Seebeck effect (applying a thermal gradient to a magnetic solid-state body produces an orthogonal spin current);
- The Spin Nernst effect (flowing an electrical current through a solid-state body having a thermal gradient produces a transverse spin current);
- The Spin Peltier effect (applying a spin current between two dissimilar materials produces a thermal gradient between the two materials).

## Relationships with other classification places

This group covers thermoelectric or thermomagnetic devices per se. The application or incorporation of either thermoelectric or thermomagnetic devices in systems are covered by subclasses for the systems, e.g. refrigeration, heat exhaust, etc.

## References

### Limiting references

*This place does not cover:*

Integrated devices or assemblies comprising thermoelectric or thermomagnetic elements	<a href="#">H10N 19/00</a>
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### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Thermoelectric devices with junctions of different materials, e.g. based on Peltier or Seebeck effects	<a href="#">H10N 10/00</a>
Heating or cooling arrangements, e.g. heat pumps, using electric or magnetic effects	<a href="#">F25B 21/00</a>
Measuring thermal radiation; Pyrometers	<a href="#">G01J 5/20</a>
Measuring temperature based on thermoelectric or thermomagnetic elements; Thermoelectric or thermomagnetic thermometers	<a href="#">G01K 7/00</a>
Magnetography and selection of materials thereof, e.g. Curie-point-writing	<a href="#">G03G 5/00</a> , <a href="#">G03G 5/16</a>
Thermistors	<a href="#">H01C 7/02</a> , <a href="#">H01C 7/04</a>
Devices using ballistic electron transport across a (vacuum) gap, e.g. thermotunnel diodes	<a href="#">H01J 45/00</a>
Devices based on simple Joule heating (heat generated by current flow through a resistive material)	<a href="#">H05B 3/00</a>
Semiconductor infrared radiation sensitive devices – Photoresistors	<a href="#">H10F 30/10</a>
Semiconductor infrared radiation sensitive devices – Photodiodes, phototransistors	<a href="#">H10F 30/20</a> , <a href="#">H10F 30/22</a>
Cooling means directly associated or integrated with the PV cell	<a href="#">H10F 77/63</a>

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

TEG	thermoelectric generator
TMG	thermomagnetic generator
SSE	Spin Seebeck effect



## H10N 19/00

**Integrated devices, or assemblies of multiple devices, comprising at least one thermoelectric or thermomagnetic element covered by groups [H10N 10/00](#) - [H10N 15/00](#)**

### Definition statement

*This place covers:*

Integrated devices comprising thermoelectric and/or thermomagnetic components individually covered by groups [H10N 10/00](#) or [H10N 15/00](#), e.g. integrating Seebeck, Peltier, or pyroelectric components either with components of the same kind, (e.g. thermocouple arrays), or with components of a different kind (e.g. semiconductor diodes, transistors).

Assemblies of multiple devices comprising thermoelectric and/or thermomagnetic devices individually covered by groups [H10N 10/00](#) or [H10N 15/00](#) that are not provided for elsewhere in the IPC.

### Relationships with other classification places

This group covers integrated devices and assemblies comprising thermoelectric or thermomagnetic elements per se. The application or incorporation of integrated devices and/or assemblies comprising thermoelectric or thermomagnetic elements in systems are covered by subclasses for the systems, e.g. refrigeration, heat exhaust etc.

### References

#### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Thermoelectric devices comprising a junction of dissimilar materials	<a href="#">H10N 10/00</a>
Thermoelectric devices without a junction of dissimilar materials	<a href="#">H10N 15/00</a>
Measuring thermal radiation	<a href="#">G01J 5/00</a>
Measuring thermal radiation using thermocouples	<a href="#">G01J 5/12</a>
Measuring thermal radiation using resistors, e.g. bolometers	<a href="#">G01J 5/20</a>
Measuring thermal radiation using capacitors, e.g. pyroelectric sensors	<a href="#">G01J 5/34</a>
Measuring temperature based on the use of electric or magnetic elements directly sensitive to heat	<a href="#">G01K 7/00</a>
Cooling means directly associated or integrated with the PV cell	<a href="#">H10F 77/63</a>
Cooling arrangements using the Peltier effect in semiconductor or other electric solid-state devices	<a href="#">H10W 40/28</a>

### Glossary of terms

*In this place, the following terms or expressions are used with the meaning indicated:*

thermocouple	temperature measuring device consisting of two conductors of different materials joined at the end
thermopile	a thermopile is an electronic device that converts thermal energy into electrical energy. It is composed of several thermocouples connected usually in series or less commonly in parallel.

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

TEG	thermoelectric generator
TEC	thermoelectric cooler
TEM	thermoelectric module
ZT	dimensionless figure of merit that determines the maximum efficiency of the energy conversion process in a thermoelectric system
TMG	thermomagnetic generator
SSE	Spin Seebeck effect

## H10N 30/00

**Piezoelectric or electrostrictive devices (integrated devices or assemblies of multiple devices [H10N 39/00](#))**

### Definition statement

*This place covers:*

Piezoelectric or electrostrictive (PE) devices based on:

- The piezoelectric effect (applying mechanical stress to a dielectric solid-state body generates fixed electric charges on the surfaces of the solid-state body due to dielectric polarisation);
- The inverse piezoelectric effect (applying a voltage to a dielectric solid-state body generates mechanical deformation of the solid-state body, particularly linear expansion or contraction based on the polarity of the voltage);
- The electrostrictive effect (applying a voltage to a dielectric solid-state body causes a change in shape, particularly a nonlinear expansion, irrespective of the polarity of the voltage);
- The flexoelectric effect (applying a strain gradient to a solid-state body causes a spontaneous electrical polarisation);
- The quasi-electrostrictive effect (applying a voltage to an elastic dielectric solid-state body, e.g. a dielectric electroactive polymer, induces and holds a change in size, shape or displacement).

### Relationships with other classification places

This main group covers PE devices which are pertinent to several technical fields like primary motion producing or electricity generating elements (actuators, sensors, transducers) usable in a multitude of application areas, or which are not limited to a particular application, i.e. PE devices in general. Aspects such as their function, structure, details, materials used, fabrication etc. are classified here.

Devices with cooperating magnetostrictive (MS) and PE parts or effects, e.g. magnetoelectric (ME) converters, are covered by group [H10N 35/00](#). Particularly relevant details of the respective PE parts should also be classified in group [H10N 30/00](#).

Electrical machines based on PE effects, i.e. motors or generators using PE devices as primary motion producing or electricity generating parts, are covered by group [H02N 2/00](#). Aspects such as the mechanical construction built around said PE devices, driving or control circuits and methods are classified there, i.e. the PE devices covered by group [H10N 30/00](#) are seen as black boxes, and could in principle be replaced by any device of equal electromechanical conversion functionality.

## References

### Limiting references

*This place does not cover:*

Integrated devices or assemblies comprising PE and/or MS elements	<a href="#">H10N 39/00</a>
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### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Devices with cooperating MS and PE parts, e.g. magnetoelectric converters	<a href="#">H10N 35/00</a>
Ultrasonic probes for medical diagnosis	<a href="#">A61B 8/00</a>
PE mechanical vibration generators, e.g. (ultra)sonic probes	<a href="#">B06B 1/06</a>
Ink jet print heads, fabrication thereof	<a href="#">B41J 2/14</a> , <a href="#">B41J 2/16</a>
PE typewriters	<a href="#">B41J 2/295</a>
Electrochemical actuators, e.g. based on ion transport in electroactive polymers	<a href="#">F03G 7/00</a>
Thermal actuators, e.g. based on shape memory materials	<a href="#">F03G 7/06</a>
PE generators in firing or trigger mechanisms of weapons	<a href="#">F41A 19/62</a>
Gyroscopes	<a href="#">G01C 19/56</a>
Sensors for measuring level of liquids or fluent solid materials	<a href="#">G01F 23/296</a>
Measuring mechanical vibrations	<a href="#">G01H 11/08</a>
PE force or stress sensors, strain gauges	<a href="#">G01L 1/16</a>
Piezoresistive strain gauges	<a href="#">G01L 1/18</a>
Piezoresistive circuits	<a href="#">G01L 9/06</a>
PE pressure sensors, for rapid changes, for knock detection in combustion engines	<a href="#">G01L 9/08</a> , <a href="#">G01L 23/10</a> , <a href="#">G01L 23/22</a>
Fluid sensors, e.g. quartz crystal microbalance	<a href="#">G01N 29/02</a>
Analysing fluids by acoustic waves	<a href="#">G01N 29/036</a>
Ultrasonic probes for material analysis	<a href="#">G01N 29/24</a>
PE accelerometers	<a href="#">G01P 15/09</a>
Scanning probe microscopy (SPM) using piezoelectric or electrostrictive devices, probes thereof	<a href="#">G01Q 10/04</a> , <a href="#">G01Q 20/04</a> , <a href="#">G01Q 60/38</a>
Measuring PE properties	<a href="#">G01R 29/22</a>
Adjustable mountings for optical elements, e.g. PE motorised lenses, objectives	<a href="#">G02B 7/02</a> , <a href="#">G02B 7/10</a>
Clocks or watches driven by PE or MS means- Timing standards	<a href="#">G04C 3/12</a>
PE sound producing horns, buzzers	<a href="#">G10K 9/122</a>
PE relays	<a href="#">H01H 57/00</a>
Electric machines in general using PE or MS effect	<a href="#">H02N 2/00</a>
Frequency generators	<a href="#">H03B 5/32</a>
Manufacturing impedance networks, frequency selective elements or circuits, e.g. resonators, filters, delay lines using BAW or SAW	<a href="#">H03H 3/00</a>

Impedance networks, frequency selective elements or circuits, e.g. resonators, filters, delay lines using BAW or SAW	<a href="#">H03H 9/00</a>
PE acoustic transducers, e.g. microphones, speakers	<a href="#">H04R 17/00</a>
Semiconductor devices wherein carrier transport therein is modulated through stress generated by PE parts, e.g. strained channel FET	<a href="#">H10D 48/32</a>
Semiconductor devices controlled by applied mechanical force or pressure, e.g. piezoresistive devices	<a href="#">H10D 48/50</a>
Manufacture or treatment of semiconductor or solid-state devices in general	<a href="#">H10P</a>

## Glossary of terms

*In this place, the following terms or expressions are used with the meaning indicated:*

stacked or multilayer(ed) structure	PE parts, e.g. PE layers, and electrodes alternating in one, i.e. stacking direction
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## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

BAW	bulk acoustic wave
DEA	dielectric elastomeric actuator
EAP	electroactive polymer
EPAM	electroactive polymer artificial muscle
ME	magnetoelectric
MEMS	microelectromechanical system
MS	magnetostrictive
PE	piezoelectric or electrostrictive
PEG	PE generator
PT	lead titanate
PZ	piezoelectric; lead zirconate
PZT	piezoelectric transducer; lead zirconate titanate
SAW	surface acoustic wave

## H10N 30/01

### Manufacture or treatment

#### Definition statement

*This place covers:*

Processes or apparatus for manufacturing a material, product or device which exhibits or changes an electrostatic polarisation when subjected to mechanical stress or which exhibits a mechanical deformation, e.g. tending to produce a deflection, when subjected to electric stress.

## References

### Informative references

Attention is drawn to the following places, which may be of interest for search:

Processes or apparatus specifically adapted for manufacture or treatment of semiconductor or solid-state devices or of parts thereof in general	<a href="#">H10P</a>
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## H10N 30/02

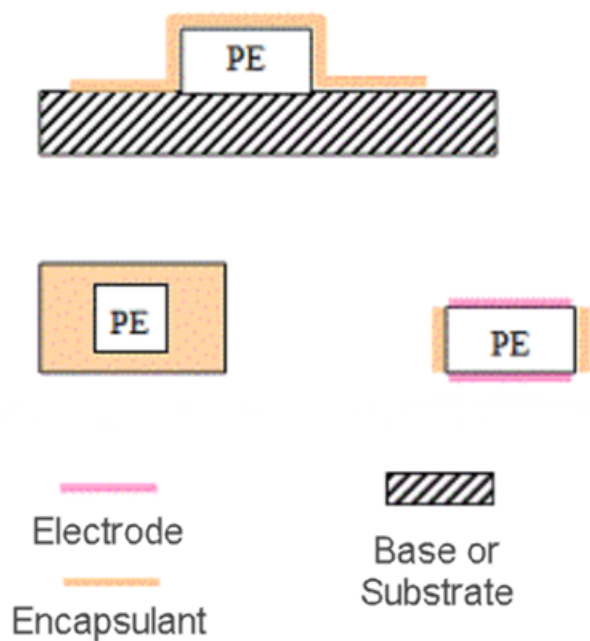
### Forming enclosures or casings

#### Definition statement

*This place covers:*

Processes or apparatus for forming enclosures or casings with encapsulants.

Illustrative example of subject matter classified in this place:



## H10N 30/05

### Manufacture of multilayered piezoelectric or electrostrictive devices, or parts thereof, e.g. by stacking piezoelectric bodies and electrodes

#### Definition statement

*This place covers:*

Processes or apparatus for manufacturing devices comprising multiple piezoelectric or electrostrictive [PE] parts that alternate with electrodes in a stacking direction, wherein the PE parts may comprise, for example, single PE layers, multilayered PE stacks or bulk PE bodies.

## H10N 30/06

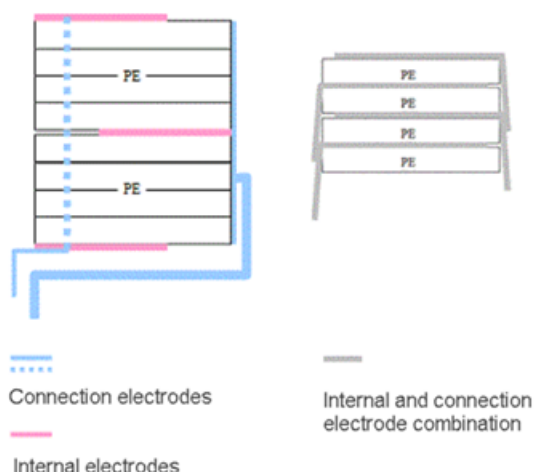
### Forming electrodes or interconnections, e.g. leads or terminals

#### Definition statement

*This place covers:*

Generic processes or apparatus, for forming electrodes, leads or terminal arrangements for piezoelectric or electrostrictive devices or parts thereof.

Illustrative examples of subject matter classified in this place:



#### References

##### Informative references

Attention is drawn to the following places, which may be of interest for search:

Apparatus or processes specially adapted for manufacturing conductors or cables	<a href="#">H01B 13/00</a>
Processes or apparatus specifically adapted for manufacture or treatment of semiconductor or solid-state devices or of parts thereof in general	<a href="#">H10P</a>

## H10N 30/063

### Forming interconnections, e.g. connection electrodes of multilayered piezoelectric or electrostrictive parts

#### Definition statement

*This place covers:*

Processes or apparatus for manufacturing connection electrodes of multilayered piezoelectric or electrostrictive [PE] parts, including lead-in or terminal arrangements.

#### Special rules of classification

The integral arrangement of internal electrode and connection electrode is classified in both groups [H10N 30/063](#) and [H10N 30/067](#).

## H10N 30/067

### Forming single-layered electrodes of multilayered piezoelectric or electrostrictive parts

#### Definition statement

*This place covers:*

Processes or apparatus for manufacturing internal electrodes of multilayered piezoelectric or electrostrictive [PE] parts.

#### Special rules of classification

The integral arrangement of internal electrode and connection electrode is classified in both groups [H10N 30/063](#) and [H10N 30/067](#).

## H10N 30/07

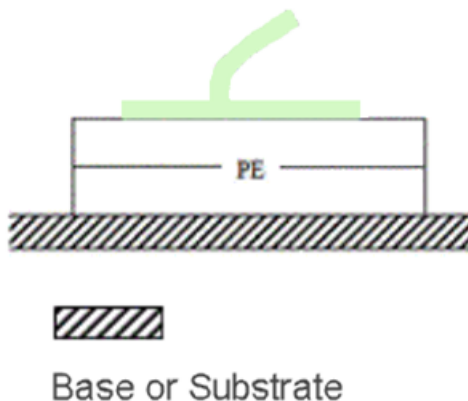
### Forming of piezoelectric or electrostrictive parts or bodies on an electrical element or another base

#### Definition statement

*This place covers:*

Processes or apparatus for applying piezoelectric or electrostrictive [PE] parts or bodies onto an electrical element or another base.

Illustrative example of subject matter classified in this place:



## References

### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Manufacture or treatment of devices consisting of a plurality of solid-state components or integrated circuits formed in or on a common substrate or of specific parts thereof; Manufacture of integrated circuit devices or of specific parts thereof	<a href="#">H10D 84/01</a>
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**H10N 30/093****Forming inorganic materials****References****Informative references**

*Attention is drawn to the following places, which may be of interest for search:*

Ceramic compositions for piezoelectric or electrostrictive devices or parts	<a href="#">H10N 30/853</a>
Shaped ceramic products characterised by their composition; Ceramic compositions; Processing powders of inorganic compounds preparatory to the manufacturing of ceramic products	<a href="#">C04B 35/00</a>
Ceramic compositions containing free metal bonded to carbides, diamond, oxides, borides, nitrides, silicides, e.g. cermets, or other metal compounds, e.g. oxynitrides or sulfides, other than as macroscopic reinforcing agents	<a href="#">C22C</a>

**H10N 30/50****having a stacked or multilayer structure****Definition statement**

*This place covers:*

Devices comprising multiple piezoelectric or electrostrictive [PE] parts that alternate with electrodes in a stacking direction, wherein the PE parts may comprise, for example, single PE layers, multilayered PE stacks or bulk PE bodies.

**H10N 35/00****Magnetostrictive devices (integrated devices or assemblies of multiple devices [H10N 39/00](#))****Definition statement**

*This place covers:*

Magnetostrictive (MS) devices based on:

- The piezomagnetic effect (applying a mechanical stress to a solid-state body causes a change of magnetisation), which is also known as the magnetoelastic effect or Villari effect;
- The magnetostrictive effect (applying an external magnetic field to a solid-state body causes a change in shape), which is also known as the Joule effect.

**Relationships with other classification places**

This main group covers MS devices which are pertinent to several technical fields like primary motion producing or electricity generating elements (actuators, sensors, transducers) usable in a multitude of application areas, or which are not limited to a particular application, i.e. MS devices in general. Aspects such as their function, structure, details, materials used, fabrication etc. are classified here.

Electrical machines based on MS effects, i.e. motors or generators using MS devices as primary motion producing or electricity generating parts, are covered by group [H02N 2/00](#). Aspects such as the mechanical construction built around said MS devices, driving or control circuits and methods are classified there, i.e. the MS devices covered by group [H10N 35/00](#) are seen as black boxes, and could in principle be replaced by any device of equal electromechanical conversion functionality. If no relevant details of the MS elements themselves are given, classification is done only in group



[H02N 2/00](#). If particular details of the MS elements are concerned, classification in group [H10N 35/00](#) is required.

Group [H10N 35/00](#) itself covers devices with cooperating PE and MS parts or combined PE and MS effects, e.g. magnetoelectric converters. Particularly relevant details of the respective PE parts should also be classified in group [H10N 30/00](#).

## References

### Limiting references

*This place does not cover:*

Integrated devices or assemblies comprising PE and/or MS elements	<a href="#">H10N 39/00</a>
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### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

MS mechanical vibration generators, e.g. (ultra)sonic probes	<a href="#">B06B 1/08</a>
Sensors for measuring level of liquids or fluent solid materials	<a href="#">G01F 23/296</a>
Force or stress sensors, strain gauges	<a href="#">G01L 1/12</a>
Torque sensors	<a href="#">G01L 3/10</a>
Pressure sensors for knock detection in combustion engines	<a href="#">G01L 23/22</a>
Timing standards using MS resonators	<a href="#">G04F 5/08</a>
Electromagnetic actuators, e.g. solenoids	<a href="#">H01F 7/06</a>
MS relays	<a href="#">H01H 55/00</a>
Electric machines in general using PE or MS effect	<a href="#">H02N 2/00</a>
Manufacturing impedance networks, frequency selective elements or circuits, e.g. resonators, filters, delay lines using BAW or SAW	<a href="#">H03H 3/00</a>
Impedance networks, frequency selective elements or circuits, e.g. resonators, filters, delay lines using BAW or SAW	<a href="#">H03H 9/00</a>
MS acoustic transducers, e.g. microphones, speakers	<a href="#">H04R 15/00</a>
Manufacture or treatment of semiconductor or solid-state devices in general	<a href="#">H10P</a>

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

BAW	bulk acoustic wave
MEMS	microelectromechanical system
MS	magnetostrictive
ME	magnetoelectric
MSM	magnetic shape memory (effect)
SAW	surface acoustic wave

## H10N 35/01

### Manufacture or treatment

#### Definition statement

*This place covers:*

Processes or apparatus for manufacturing a material, product or device, which exhibits or changes a magnetisation when subjected to mechanical stress or which exhibits a mechanical deformation when subjected to a magnetic field.

#### References

##### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Processes or apparatus specifically adapted for manufacture or treatment of semiconductor or solid-state devices or of parts thereof in general	<a href="#">H10P</a>
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## H10N 39/00

**Integrated devices, or assemblies of multiple devices, comprising at least one piezoelectric, electrostrictive or magnetostrictive element covered by groups [H10N 30/00](#) – [H10N 35/00](#)**

#### Definition statement

*This place covers:*

- Integrated devices comprising components that are individually covered by group [H10N 30/00](#), e.g. piezoelectric [PE] devices or covered by group [H10N 35/00](#), e.g. magnetostrictive [MS] devices, either with components of the same kind, (e.g. actuator arrays), or with components of a different kind, (e.g. semiconductor diodes, transistors).
- Assemblies of multiple devices comprising devices that are individually covered by group [H10N 30/00](#) or [H10N 35/00](#) that are not provided for elsewhere in the IPC.

#### Relationships with other classification places

This main group covers integrated devices and assemblies comprising PE and/or MS devices which are pertinent to several technical fields like primary motion producing or electricity generating elements (actuators, sensors, transducers) usable in a multitude of application areas, or which are not limited to a particular application.

#### References

##### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Piezoelectric or electrostrictive devices	<a href="#">H10N 30/00</a>
Magnetostrictive or piezomagnetic devices	<a href="#">H10N 35/00</a>
Piezoelectric ultrasonic transducer arrays	<a href="#">B06B 1/06</a>
Ink-jet print heads	<a href="#">B41J 2/14</a>
Digital memories, e.g. FRAMs	<a href="#">G11C 11/22</a>
Ferroelectric memory	<a href="#">H10B 51/00</a> , <a href="#">H10B 53/00</a>

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

BAW	bulk acoustic wave
SAW	surface acoustic wave
MS	magnetostrictive
PE	piezoelectric or electrostrictive

## H10N 50/00

**Galvanomagnetic devices (Hall-effect devices [H10N 52/00](#); integrated devices or assemblies of multiple devices [H10N 59/00](#))**

### Definition statement

*This place covers:*

Galvanomagnetic devices, wherein an external magnetic field or a spin-polarised current directly influence properties of an electric current, e.g. amplitude, direction, or electronic spin, through a solid-state body.

These include devices based on:

- Magnetoresistance effects (applying an external magnetic field to a solid-state body changes the electrical resistance of the solid-state body), in particular tunnel magnetoresistance (TMR) or giant magnetoresistance (GMR), e.g. magnetic tunnel junctions (MTJ), spin valves;
- Spintronic effects (wherein the spin, magnetic moment and/or charge of the electron are controlled within the solid-state body, e.g. using spin-transfer torque (STT), a spin-polarised current, or spin exchange coupling);
- The spin Hall-effect (SHE) (flowing an electrical current through a solid-state body generates an orthogonal spin current whereby spin-polarised electrons accumulate on opposing lateral surfaces of the solid-state body);
- The inverse spin Hall-effect (ISHE) (applying a spin polarised current to a solid-state body induces an orthogonal electrical current in the solid-state body);
- Spin Hall magnetoresistance (SMR) (flowing an electrical current through a solid-state body in the presence of an external orthogonal magnetic field changes the electrical resistance of the solid-state body).

This group covers galvanomagnetic devices which are pertinent to several technical fields or which are not limited to a particular application, i.e. galvanomagnetic devices in general. Aspects such as their structure, active materials and fabrication are classified here.

### Relationships with other classification places

This group covers galvanomagnetic devices per se. The application or incorporation of galvanomagnetic devices in systems are covered by subclasses for the systems, e.g. MRAM memory, magnetic recording heads etc.

## References

### Limiting references

*This place does not cover:*

Ordinary Hall-effect devices	<a href="#">H10N 52/00</a>
Integrated devices or assemblies comprising galvanomagnetic or Hall-effect elements	<a href="#">H10N 59/00</a>

### Application-oriented references

Examples of places where the subject matter of this place is covered when specially adapted, used for a particular purpose, or incorporated in a larger system:

Isolation couplers in electrical sensors	<a href="#">G01R 15/20</a>
Arrangements for measuring electrical power or power factor	<a href="#">G01R 21/08</a>
Magnetometers using galvanomagnetic devices	<a href="#">G01R 33/06</a>
Magnetometers using MR devices	<a href="#">G01R 33/09</a>
Magnetic recording heads - using galvanomagnetic devices	<a href="#">G11B 5/37</a>
Magnetic recording heads - using MR devices	<a href="#">G11B 5/39</a>
MRAM arrangements	<a href="#">H10B 61/00</a>

### Informative references

Attention is drawn to the following places, which may be of interest for search:

Voltage or current regulators	<a href="#">G05F 1/635</a>
Digital memories using magnetic layers	<a href="#">G11C 11/15</a>
Digital memories using spin effects	<a href="#">G11C 11/16</a>
Thin magnetic films with spin-exchange-coupled multi-layers	<a href="#">H01F 10/32</a>
Frequency generators	<a href="#">H03B 15/00</a>
Amplifiers	<a href="#">H03F 15/00</a>
Pulse generators using galvanomagnetic devices	<a href="#">H03K 3/59</a>
Electronic switching circuits or gating using galvanomagnetic devices	<a href="#">H03K 17/90</a>
Logic circuits using galvanomagnetic devices	<a href="#">H03K 19/18</a>
Semiconductor devices with at least one potential barrier, e.g. diodes or transistors, controllable by a magnetic field	<a href="#">H10D 48/40</a>

### Synonyms and Keywords

In patent documents, the following abbreviations are often used:

AMR	anisotropic magnetoresistance
CMR	colossal magnetoresistance
EMR	extraordinary magnetoresistance
GMR	giant magnetoresistance
OMR	ordinary magnetoresistance
XMR	extreme magnetoresistance; any of GMR or TMR
MR	magnetoresistance
MTJ	magnetic tunnel junction; MR tunnel junction
Spin-FET	FET using spin-polarised carrier transport
STJ	spin tunnel junction
TMR	tunnel magnetoresistance
STT	spin-transfer torque
FM	ferromagnetic

NM	non-magnetic
AF	anti-ferromagnetic
SOT	spin-orbit torque
TI	topological insulator
DW	domain wall
YIG	yttrium iron garnet

## H10N 50/01

### Manufacture or treatment

#### References

##### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Processes or apparatus specifically adapted for manufacture or treatment of semiconductor or solid-state devices or of parts thereof in general	<a href="#">H10P</a>
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## H10N 50/10

### Magnetoresistive devices

#### Definition statement

*This place covers:*

Devices based on magnetoresistance effects, in particular tunnel magnetoresistance (TMR) or giant magnetoresistance (GMR), e.g. magnetic tunnel junctions, spin valves. These devices can be controlled by an external magnetic field or a spin-polarised current, e.g. spin-transfer torque (STT).

## H10N 50/20

### Spin-polarised current-controlled devices (magnetoresistive devices [H10N 50/10](#))

#### Definition statement

*This place covers:*

Devices operating based on a spin-polarised current, such as for spin current generator, spin logic or spin memory elements.

#### References

##### Limiting references

*This place does not cover:*

Magnetoresistive devices	<a href="#">H10N 50/10</a>
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## H10N 52/00

### Hall-effect devices (integrated devices or assemblies of multiple devices

#### [H10N 59/00](#))

#### Definition statement

*This place covers:*

Devices based on:

- The ordinary Hall-effect (wherein an electrical potential or "Hall voltage" is induced perpendicular to the direction of an electrical current through and perpendicular to the direction of a magnetic field applied to a solid-state body);
- The anomalous Hall-effect or extraordinary Hall-effect wherein the ordinary Hall-effect is more pronounced due to the magnetisation of the solid-state body.

#### Relationships with other classification places

This group covers Hall-effect devices per se. The application or incorporation of Hall-effect devices in systems are covered by subclasses for the systems, e.g. digital memory, magnetic recording heads, etc.

#### References

##### Limiting references

*This place does not cover:*

Integrated devices or assemblies comprising galvanomagnetic or Hall-effect elements	<a href="#">H10N 59/00</a>
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##### Application-oriented references

*Examples of places where the subject matter of this place is covered when specially adapted, used for a particular purpose, or incorporated in a larger system:*

Isolation couplers in electrical sensors	<a href="#">G01R 15/20</a>
Arrangements for measuring electrical power or power factor	<a href="#">G01R 21/08</a>
Magnetometers using Hall-effect devices	<a href="#">G01R 33/07</a>
Magnetic recording heads - using Hall devices	<a href="#">G11B 5/37</a>

##### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Spin Hall-effect devices	<a href="#">H10N 50/00</a>
Voltage or current regulators	<a href="#">G05F 1/635</a>
Digital memories using Hall devices	<a href="#">G11C 11/18</a>
Frequency generators	<a href="#">H03B 15/00</a>
Amplifiers	<a href="#">H03F 15/00</a>
Pulse generators using Hall-effect devices	<a href="#">H03K 3/59</a>
Electronic switching circuits or gating using Hall-effect devices	<a href="#">H03K 17/90</a>
Logic circuits using Hall-effect devices	<a href="#">H03K 19/18</a>

Semiconductor devices with at least one potential barrier, e.g. diodes or transistors, controllable by a magnetic field	<a href="#">H10D 48/40</a>
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## H10N 52/01

### Manufacture or treatment

#### References

##### Informative references

Attention is drawn to the following places, which may be of interest for search:

Processes or apparatus specifically adapted for manufacture or treatment of semiconductor or solid-state devices or of parts thereof in general	<a href="#">H10P</a>
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## H10N 59/00

**Integrated devices, or assemblies of multiple devices, comprising at least one galvanomagnetic or Hall-effect element covered by groups [H10N 50/00](#) - [H10N 52/00](#) (MRAM devices [H10B 61/00](#))**

#### Definition statement

*This place covers:*

- Integrated devices comprising components that are individually covered by group [H10N 50/00](#), e.g. galvanomagnetic devices or covered by group [H10N 52/00](#), e.g. Hall-effect devices, either with components of the same kind, (e.g. sensor arrays), or with components of a different kind, (e.g. semiconductor diodes, transistors).
- Assemblies of multiple devices comprising devices that are individually covered by group [H10N 50/00](#) or [H10N 52/00](#) that are not provided for elsewhere in the IPC.

#### Relationships with other classification places

This group covers integrated devices and assemblies comprising galvanomagnetic or Hall-effect elements per se. The application or incorporation of integrated devices and/or assemblies comprising galvanomagnetic or Hall-effect elements in systems are covered by subclasses for the systems, e.g. digital memory, magnetic recording heads etc.

#### References

##### Limiting references

*This place does not cover:*

Magnetic memory devices	<a href="#">H10B 61/00</a>
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##### Informative references

Attention is drawn to the following places, which may be of interest for search:

Magnetoresistive devices and galvanomagnetic devices not otherwise provided	<a href="#">H10N 50/00</a>
Hall-effect devices	<a href="#">H10N 52/00</a>
Measuring magnetic quantities; Magnetometers	<a href="#">G01R 33/06</a>
Magnetometers using Hall-effect devices	<a href="#">G01R 33/07</a>

Magnetometers using MR devices	<a href="#">G01R 33/09</a>
Digital memories using magnetic layers	<a href="#">G11C 11/15</a>
Digital memories using spin effects	<a href="#">G11C 11/16</a>
Digital memories using Hall-effect devices	<a href="#">G11C 11/18</a>
Electronic switching circuits or gating using galvanomagnetic or Hall-effect devices	<a href="#">H03K 17/90</a>
Logic circuits using galvanomagnetic or Hall-effect devices	<a href="#">H03K 19/18</a>

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

AMR	anisotropic magnetoresistance
CMR	colossal magnetoresistance
EMR	extraordinary magnetoresistance
GMR	giant magnetoresistance
OMR	ordinary magnetoresistance
XMR	extreme magnetoresistance; any of GMR or TMR
MR	magnetoresistance
MTJ	magnetic tunnel junction; MR tunnel junction
Spin-FET	FET using spin-polarised carrier transport
STJ	spin tunnel junction
TMR	tunnel magnetoresistance
STT	spin-transfer torque
FM	ferromagnetic
NM	non-magnetic
AF, AFM	anti-ferromagnetic
SOT	spin-orbit torque
TI	topological insulator
DW	domain wall
YIG	yttrium iron garnet

## H10N 60/00

### Superconducting devices (integrated devices or assemblies of multiple devices [H10N 69/00](#))

#### Definition statement

*This place covers:*

Superconducting devices, such as:

- Devices based on materials having zero electrical resistance below a critical temperature ( $T_c$ ), current density ( $J_c$ ), and magnetic field ( $H_c$ ), e.g. Josephson junction devices, superconducting switches;



## Definition statement

- Superconducting quantum bits (qubits) of quantum computer hardware, e.g. based on Majorana fermions induced in superconducting nanowires;
- Intermediate products used in specially adapted arrangements, e.g. tape or wire like parts for cables or coils, basic conductor elements like films etc., and fabrication thereof until superconductive material is obtained.

This place also covers aspects such as the structure, active materials and fabrication of these devices.

### Relationships with other classification places

Superconductive (ceramic, crystalline) materials in devices are classified in this group.

Superconducting bulk permanent magnets solely characterised by their superconducting materials are classified both in this group and in [H01F 6/00](#).

### References

#### Limiting references

*This place does not cover:*

Integrated devices or assemblies comprising multiple superconducting elements	<a href="#">H10N 69/00</a>
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#### Application-oriented references

*Examples of places where the subject matter of this place is covered when specially adapted, used for a particular purpose, or incorporated in a larger system:*

Magnetic holding or levitation devices using superconductivity for trains	<a href="#">B60L 13/00</a>
Superconductive magnetometers, e.g. SQUIDs	<a href="#">G01R 33/035</a>
Superconductive magnetometers using magnetic resonance	<a href="#">G01R 33/3815</a>
Systems for storing electric energy specially adapted for power networks	<a href="#">H02J 15/00</a>
Dynamo-electric machines, e.g. electric motors or generators, with superconductive windings	<a href="#">H02K 55/00</a>
Magnetic holding or levitation devices using superconductivity	<a href="#">H02N 15/04</a>

#### References out of a residual place

*Examples of places in relation to which this place is residual:*

Superconductive inductors such as magnets or coils composed of superconductive filaments or tapes covered by this group	<a href="#">H01F 6/00</a>
Transformers with superconductive windings	<a href="#">H01F 36/00</a>
Manufacturing of superconductive inductors such as magnets or coils composed of superconductive filaments or tapes covered by this group	<a href="#">H01F 41/00</a>
Superconducting connectors such as current leads, splices	<a href="#">H01R 4/68</a>

#### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Thermoelectric junctions, e.g. Peltier or Seebeck devices comprising superconductors	<a href="#">H10N 10/855</a>
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Superconductive materials characterised by the ceramic-forming technique or the ceramic composition in general, and precursor materials thereof	<a href="#">C04B 35/00</a>
Superconductive (single) crystals and fabrication thereof including epitaxy	<a href="#">C30B</a>
Photometers, e.g. single photon detectors	<a href="#">G01J 1/42</a>
Pyrometers	<a href="#">G01J 5/20</a>
Quantum computers	<a href="#">G06N 10/00</a>
Digital memories using superconductive elements, e.g. cryotrons	<a href="#">G11C 11/44</a>
Content addressed memories using cryogenic elements	<a href="#">G11C 15/06</a>
Shift register memories using superconductive elements	<a href="#">G11C 19/32</a>
Superconductive conductors such as cables or transmission lines composed of superconductive filaments or tapes covered by this group	<a href="#">H01B 12/00</a>
Manufacturing of superconductive conductors such as cables or transmission lines composed of superconductive filaments or tapes covered by this group	<a href="#">H01B 13/00</a>
Current limiting circuits using superconducting devices, e.g. FCL circuits	<a href="#">H02H 9/02</a>
Frequency generators	<a href="#">H03B 15/00</a>
Amplifiers	<a href="#">H03F 19/00</a>
Pulse generators using superconductive elements	<a href="#">H03K 3/38</a>
Electronic switching circuits using superconductive elements	<a href="#">H03K 17/92</a>
Logic circuits using superconductive elements, e.g. RSFQ circuits	<a href="#">H03K 19/195</a>
Cavities or resonators in particle accelerators	<a href="#">H05H 7/20</a>
Semiconductor devices having single quantum well structures	<a href="#">H10D 62/81</a>

## Glossary of terms

*In this place, the following terms or expressions are used with the meaning indicated:*

Abrikosov vortex	vortex of supercurrent in a superconductor circulating around the normal conducting core of the vortex
cryotron	device that uses externally induced switching of a current carrying element between superconductive and normal states by electric, magnetic or heating means, e.g. using a gate conductor, coil, resistive heater
T <sub>c</sub>	critical temperature; Curie temperature; Curie point
high T <sub>c</sub>	T <sub>c</sub> above 30 K; more frequently T <sub>c</sub> above 90 K, may be cooled by liquid nitrogen

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

B(P)SCCO	bismuth (lead) strontium calcium copper oxide
CC	coated conductor; a superconducting film on a tape like substrate
FCL	fault current limiter
HBCCO	mercury barium calcium copper oxide

Hc	critical magnetic field
HTC	high Tc
HTS; HTSC	high Tc superconductor
IBAD	ion beam assisted deposition
Ic	critical current
Jc	critical current density
JJ	Josephson junction
LHe	liquid helium
LN; LN2	liquid nitrogen
Low Tc	not high Tc; more frequently Tc of only a few K, needs cooling by liquid helium
LTC	low Tc
LTS	low Tc superconductor
PCS	persistent current switch
(O)PIT	(oxide) powder-in-tube; method for forming superconductive filaments
qubit	quantum bit
RABITS	rolling assisted biaxially textured substrate
RE	rare earth
RBC; RBCO; REBCO	rare earth barium copper oxide
RSFQ	rapid single flux quantum
SIS	superconductor-insulator-superconductor (stacked layers in junctions)
SNS	superconductor-normal conductor-superconductor (stacked layers in junctions)
SQUID	superconducting quantum interference device
TES	transition edge sensor
TBCCO	thallium barium calcium copper oxide
YBC; YBCO; BYC; BYCO	yttrium barium copper oxide

## H10N 60/01

### Manufacture or treatment

#### References

##### Informative references

Attention is drawn to the following places, which may be of interest for search:

Processes or apparatus specifically adapted for manufacture or treatment of semiconductor or solid-state devices or of parts thereof in general	<a href="#">H10P</a>
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## H10N 69/00

**Integrated devices, or assemblies of multiple devices, comprising at least one superconducting element covered by group [H10N 60/00](#)**

### Definition statement

*This place covers:*

Integrated devices comprising components that are individually covered by main group [H10N 60/00](#), e.g. Josephson junction devices either with components of the same kind, (e.g. Josephson junction arrays), or with components of a different kind, (e.g. semiconductor diodes, transistors).

Assemblies of multiple devices comprising devices that are individually covered by group [H10N 60/00](#) that are not provided for elsewhere in the IPC.

### Relationships with other classification places

This group covers integrated devices and assemblies comprising superconducting elements per se. The application or incorporation of integrated devices and/or assemblies comprising superconducting elements in systems are covered by subclasses for the systems.

### References

#### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Superconducting devices	<a href="#">H10N 60/00</a>
Quantum computers	<a href="#">G06N 10/00</a>
Digital memories using superconductive elements	<a href="#">G11C 11/44</a>
Electronic switching circuits using superconductive elements	<a href="#">H03K 17/92</a>
Logic circuits using superconductive elements	<a href="#">H03K 19/195</a>

## H10N 70/00

**Solid-state devices having no potential barriers, and specially adapted for rectifying, amplifying, oscillating or switching (integrated devices or assemblies of multiple devices [H10N 79/00](#))**

### Definition statement

*This place covers:*

Devices wherein the electrical conductivity within a bulk solid-state body is directly influenced by an electrical current flowing through the body or by an electrical field that is applied to the body. This place also covers the active materials and fabrication of such devices.

These include devices based on:

- Electroresistive switching (change of electrical resistance caused by an applied current or voltage), e.g. switching based on phase change, migration of ions or electron trapping;
- Electron tunnelling through insulators, e.g. MIM diodes;
- Ferroelectric tunneling junctions (FTJ) that demonstrate giant electroresistance; or
- Charge density travelling waves.

## Definition statement

The group [H10N 70/00](#) itself covers conductor-insulator-conductor devices, e.g. metal-insulator-metal [MIM] diodes, having one branch in their current-voltage characteristics only; the insulator (I) may comprise multiple different insulator layers. It extends also to transistor like MIMIM devices.

## Relationships with other classification places

This group covers bulk switching devices per se. The application or incorporation of bulk switching devices in systems are covered by subclasses for the systems, e.g. digital memory etc.

## References

## Limiting references

*This place does not cover:*

Integrated devices or assemblies comprising solid-state elements without a potent-jump barrier or surface barrier	<a href="#">H10N 79/00</a>
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## Application-oriented references

*Examples of places where the subject matter of this place is covered when specially adapted, used for a particular purpose, or incorporated in a larger system:*

Resistance change memory [ReRAM] devices	<a href="#">H10B 63/00</a>
Phase change memory [PCRAM, PRAM] devices	<a href="#">H10B 63/10</a>

## Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Superconductive devices of MIM type	<a href="#">H10N 60/10</a>
Bulk negative differential resistance devices, e.g. Gunn diodes	<a href="#">H10N 80/00</a>
Amplifiers	<a href="#">H03F 11/00</a>

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

memristor	memory resistor
MIM	metal-insulator-metal

## H10N 79/00

**Integrated devices, or assemblies of multiple devices, comprising at least one solid-state element covered by group [H10N 70/00](#) (ReRAM devices [H10B 63/00](#); PCRAM devices [H10B 63/10](#))**

## Definition statement

*This place covers:*

Integrated devices comprising components that are individually covered by main group [H10N 70/00](#), e.g. devices comprising bulk switching components, such as memristors, integrated either with components of the same kind, (e.g. arrays), or with components of a different kind, (e.g. semiconductor diodes, transistors).

Assemblies of multiple devices comprising devices that are individually covered by group [H10N 70/00](#).

## Relationships with other classification places

This group covers integrated devices and assemblies comprising bulk switching elements per se. The application or incorporation of integrated devices and/or assemblies comprising bulk switching elements in systems are covered by subclasses for the systems.

## References

### Limiting references

*This place does not cover:*

Resistance change memory [ReRAM] devices	<a href="#">H10B 63/00</a>
Phase change memory [PCRAM, PRAM] devices	<a href="#">H10B 63/10</a>

### Informative references

*Attention is drawn to the following places, which may be of interest for search:*

Bulk switching components	<a href="#">H10N 70/00</a>
Devices integrating bulk negative differential resistance components, e.g. Gunn elements	<a href="#">H10N 89/00</a>
Resistor or anti-fuse arrays - integrated with junction diodes - integrated with transistors	<a href="#">H10B 20/00</a>

## H10N 80/00

**Bulk negative-resistance effect devices (integrated devices or assemblies of multiple devices [H10N 89/00](#))**

## Definition statement

*This place covers:*

- Devices based on negative differential resistance (NDR) in bulk solid-state materials, e.g. Gunn diodes.
- The NDR mostly originates from transferred electron effects in semiconductors (i.e. electrons are transferred from a conduction band region of high mobility to a conduction band region of higher energy and lower mobility on the application of an appropriate electric field strength), the Gunn effect being the most prominent one.
- Devices of this type are mainly used as primary voltage or current oscillation generating elements in high frequency generators.

This place also covers the fabrication of such devices.

## Relationships with other classification places

This group covers bulk NDR devices per se. The application or incorporation of bulk NDR devices in systems are covered by subclasses for the systems, e.g. generators, amplifiers etc.

## References

### Limiting references

*This place does not cover:*

Integrated devices or assemblies comprising NDR elements	<a href="#">H10N 89/00</a>
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### Informative references

Attention is drawn to the following places, which may be of interest for search:

Bistable or multistable bulk switching devices	<a href="#">H10N 70/20</a>
Frequency generators	<a href="#">H03B 9/12</a>
Amplifiers	<a href="#">H03F 3/10</a>
Pulse generators using NDR devices	<a href="#">H03K 3/357</a>
Electronic switching circuits using NDR devices	<a href="#">H03K 17/70</a>
NDR devices having potential-jump barriers, e.g. resonant tunnel diodes, Esaki diodes	<a href="#">H10D 8/70</a>

### Synonyms and Keywords

In patent documents, the following abbreviations are often used:

NDR	negative differential resistance; a negative slope region in the current-voltage characteristics
TED	transferred electron device; transferred electron diode

## H10N 89/00

**Integrated devices, or assemblies of multiple devices, comprising at least one bulk negative resistance effect element covered by group [H10N 80/00](#)**

### Definition statement

This place covers:

- Integrated devices comprising components that are individually covered by main group [H10N 80/00](#), e.g. by integrating Gunn effect components, either with components of the same kind, (e.g. arrays), or with components of a different kind, (e.g. semiconductor diodes, transistors).
- Assemblies of multiple devices comprising devices that are individually covered by group [H10N 80/00](#) that are not provided for elsewhere in the IPC.

### Relationships with other classification places

This group covers integrated devices and assemblies comprising NDR elements per se.

The application or incorporation of integrated devices and/or assemblies comprising NDR elements in systems are covered by subclasses for the systems.

### References

#### Informative references

Attention is drawn to the following places, which may be of interest for search:

Integrated device comprising bulk switching components	<a href="#">H10N 79/00</a>
NDR devices	<a href="#">H10N 80/00</a>
ReRAM	<a href="#">H10B 63/00</a>

## H10N 97/00

### Electric solid-state thin-film or thick-film devices, not otherwise provided for

#### Definition statement

*This place covers:*

Electric solid-state devices formed by thick-film technology (e.g. printing and firing of conductive pastes) or thin-film technology (e.g. PVD or CVD) and not provided for in any other subclass (e.g. not based on semiconducting materials) and not provided for in groups [H10N 10/00](#) - [H10N 89/00](#) (e.g. not based on thermoelectric, piezoelectric, electrostrictive, magnetostrictive, galvanomagnetic or bulk negative differential resistance materials; e.g. not based on bulk switching effects in devices without potential barriers), based on thin-film or thick-film technology. These devices are based on other, potentially unknown, solid-state effects for rectifying, amplifying, oscillating or switching.

For example, devices based on metal-insulator transition (also called the Mott transition) or on plasmons.

This place also covers the fabrication of such devices.

#### References

##### References out of a residual place

*Examples of places in relation to which this place is residual:*

Printed circuits	<a href="#">H05K 1/00</a>
Incorporating printed electric components	<a href="#">H05K 1/16</a>
Manufacturing of printed circuits	<a href="#">H05K 3/00</a>

## H10N 99/00

### Subject matter not provided for in other groups of this subclass

#### Definition statement

*This place covers:*

Electric solid-state devices not provided for in any other subclass and not provided for in groups [H10N 10/00](#) - [H10N 97/00](#).