

EUROPEAN PATENT OFFICE  
U.S. PATENT AND TRADEMARK OFFICE

CPC NOTICE OF CHANGES 1643

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PROJECT MP12340

The following classification changes will be effected by this Notice of Changes:

| <u>Action</u>       | <u>Subclass</u> | <u>Group(s)</u>  |
|---------------------|-----------------|--|
| <b>DEFINITIONS:</b> |                 |  |
| Definitions New:    | H10N            | SUBCLASS   |
|                     | H10N            | 10/00, 10/01, 10/853, 10/854   |
|                     | H10N            | 15/00  |
|                     | H10N            | 19/00  |
|                     | H10N            | 30/00, 30/01, 30/02, 30/05, 30/06, 30/063,<br>30/067, 30/07, 30/093, 30/50 |
|                     | H10N            | 35/00, 35/01   |
|                     | H10N            | 39/00  |
|                     | H10N            | 50/00, 50/01, 50/10, 50/20   |
|                     | H10N            | 52/00, 52/01   |
|                     | H10N            | 59/00  |
|                     | H10N            | 60/00, 60/01   |
|                     | H10N            | 69/00  |
|                     | H10N            | 70/00  |
|                     | H10N            | 79/00  |
|                     | H10N            | 80/00  |
|                     | H10N            | 89/00  |
|                     | H10N            | 97/00  |
|                     | H10N            | 99/00  |

No other subclasses/groups are impacted by this Notice of Changes.

This Notice of Changes includes the following:

1. CLASSIFICATION SCHEME CHANGES

- A. New, Modified or Deleted Group(s)
- B. New, Modified or Deleted Warning(s)
- C. New, Modified or Deleted Note(s)
- D. New, Modified or Deleted Guidance Heading(s)

2. DEFINITIONS

- A. New or Modified Definitions (Full definition template)
- B. Modified or Deleted Definitions (Definitions Quick Fix)

3.  REVISION CONCORDANCE LIST (RCL)

4.  CHANGES TO THE CPC-TO-IPC CONCORDANCE LIST (CICL)

5.  CHANGES TO THE CROSS-REFERENCE LIST (CRL)

## 2. A. DEFINITIONS (new)

### H10N

#### 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.

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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 | G01H |
| Measuring electrical or magnetic variables                                    | G01R |

### References out of a residual place

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

|   |          |
|---|----------|
| Magnets, inductors, transformers                      | H01F     |
| Capacitors in general                                 | H01G     |
| Electrolytic devices                                  | H01G9/00 |
| Waveguides, resonators or lines of the waveguide type | H01P     |
| Line connectors, current collectors                   | H01R     |
| Electronic memory devices                             | H10B     |

### Informative references

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

|                                |      |
|--------------------------------|------|
| Micromechanical devices (MEMS) | B81B |
|--------------------------------|------|

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|  |          |
|--|----------|
| Processes and apparatus specially adapted for the manufacture or treatment of microstructural devices or systems | B81C     |
| Static stores  | G11C     |
| Conductive and insulating materials  | H01B     |
| Resistors in general   | H01C     |
| Resistors, e.g. non-adjustable resistors from semiconductor material   | H01C7/00 |
| Semiconductor devices  | H01L     |
| Organic electric solid-state devices   | H10K     |

## Glossary of terms

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

|                    |  |
|--------------------|--|
| active material    | material within which the physical effects that are characteristic of the device occur   |
| 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.  |
| 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 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. 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 |

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|   |   |
|---|---|
|   | <p>[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.</p>  |
| <p>body<br/>semiconductor body<br/>solid-state body</p> | <p>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.</p> |
| <p>electrode</p>  | <p>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</p>  |

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|                 |  |
|-----------------|--|
|                 | 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. |
| 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   |

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**H10N 10/00**

**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 | H10N19/00 |
|---|-----------|

**Informative references**

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

|   |           |
|---|-----------|
| Selenium; Tellurium; Compounds thereof  | C01B19/00 |
| Alloys  | C22C      |
| Refrigeration – machines, plant or systems, using electric or magnetic effects  | F25B21/00 |
| Heat-exchange apparatus, not provided for in another subclass, in which the heat-exchange media do not come into direct contact | F28D      |
| Details of heat-exchange and heat-transfer apparatus  | F28F      |
| Radiation pyrometers using thermoelectric devices   | G01J5/12  |

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|  |            |
|--|------------|
| Measuring temperature based on the use of electric or magnetic elements directly sensitive to heat   | G01K7/00   |
| Cooling arrangements using the Peltier effect in semiconductor or other electric solid-state devices | H01L23/38  |
| Cooling means directly associated or integrated with the PV cell                                     | H01L31/052 |
| Thermoelectric devices without a junction of dissimilar materials or thermomagnetic devices          | H10N15/00  |

### 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 |



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## H10N 10/01

### 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="#">H01L21/00</a> |
|---|---------------------------|

## H10N 10/853

### References

#### Limiting references

*This place does not cover:*

|  |                            |
|--|----------------------------|
| Thermoelectric active materials comprising tellurium, selenium or sulfur | <a href="#">H10N10/852</a> |
|--|----------------------------|

## H10N 10/854

### References

#### Limiting references

*This place does not cover:*

|  |                            |
|--|----------------------------|
| Thermoelectric active materials comprising tellurium, selenium or sulfur | <a href="#">H10N10/852</a> |
| Thermoelectric active materials comprising arsenic, antimony or bismuth  | <a href="#">H10N10/853</a> |

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## H10N 15/00

### 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).

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**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="#">H10N19/00</a> |
|---|---------------------------|

**Informative references**

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

|   |  |
|---|--|
| Heating or cooling arrangements, e.g. heat pumps, using electric or magnetic effects                                    | <a href="#">F25B21/00</a>                              |
| Measuring thermal radiation; Pyrometers   | <a href="#">G01J5/20</a>                               |
| Measuring temperature based on thermoelectric or thermomagnetic elements; Thermoelectric or thermomagnetic thermometers | <a href="#">G01K7/00</a>                               |
| Magnetography and selection of materials thereof, e.g. Curie-point-writing  | <a href="#">G03G5/00</a> ,<br><a href="#">G03G5/16</a> |
| Thermistors   | <a href="#">H01C7/02</a> ,<br><a href="#">H01C7/04</a> |
| Devices using ballistic electron transport across a (vacuum) gap, e.g. thermotunnel diodes                              | <a href="#">H01J45/00</a>                              |
| Semiconductor infrared radiation sensitive devices – Photoresistors   | <a href="#">H01L31/09</a>                              |
| Semiconductor infrared radiation sensitive devices – Photodiodes, phototransistors                                      | <a href="#">H01L31/101</a>                             |
| Cooling means directly associated or integrated with the PV cell  | <a href="#">H01L31/052</a>                             |
| Devices based on simple Joule heating (heat generated by current flow through a resistive material)                     | <a href="#">H05B3/00</a>                               |
| Thermoelectric devices with junctions of different materials, e.g. based on Peltier or Seebeck effects                  | <a href="#">H10N10/00</a>                              |

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**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****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:*

|  |                          |
|--|--------------------------|
| Measuring thermal radiation                                  | <a href="#">G01J5/00</a> |
| Measuring thermal radiation using thermocouples              | <a href="#">G01J5/12</a> |
| Measuring thermal radiation using resistors, e.g. bolometers | <a href="#">G01J5/20</a> |

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|  |            |
|--|------------|
| Measuring thermal radiation using capacitors, e.g. pyroelectric sensors                              | G01J5/34   |
| Measuring temperature based on the use of electric or magnetic elements directly sensitive to heat   | G01K7/00   |
| Cooling arrangements using the Peltier effect in semiconductor or other electric solid-state devices | H01L23/38  |
| Cooling means directly associated or integrated with the PV cell                                     | H01L31/052 |
| Thermoelectric devices comprising a junction of dissimilar materials                                 | H10N10/00  |
| Thermoelectric devices without a junction of dissimilar materials                                    | H10N15/00  |

## 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

### Definition statement

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*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:*

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|   |                           |
|---|---------------------------|
| Integrated devices or assemblies comprising PE and/or MS elements | <a href="#">H10N39/00</a> |
|---|---------------------------|

### Informative references

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

|   |   |
|---|---|
| Ultrasonic probes for medical diagnosis   | <a href="#">A61B8/00</a>  |
| PE mechanical vibration generators, e.g. (ultra)sonic probes                                    | <a href="#">B06B1/06</a>  |
| Ink jet print heads, fabrication thereof  | <a href="#">B41J2/14</a> ,<br><a href="#">B41J2/16</a>                                  |
| PE typewriters  | <a href="#">B41J2/295</a>   |
| Electrochemical actuators, e.g. based on ion transport in electroactive polymers                | <a href="#">F03G7/00</a>  |
| Thermal actuators, e.g. based on shape memory materials   | <a href="#">F03G7/06</a>  |
| PE generators in firing or trigger mechanisms of weapons  | <a href="#">F41A19/62</a>   |
| Gyroscopes  | <a href="#">G01C19/56</a>   |
| Sensors for measuring level of liquids or fluent solid materials                                | <a href="#">G01F23/296</a>  |
| Measuring mechanical vibrations   | <a href="#">G01H11/08</a>   |
| PE force or stress sensors, strain gauges   | <a href="#">G01L1/16</a>  |
| Piezoresistive strain gauges  | <a href="#">G01L1/18</a>  |
| Piezoresistive circuits   | <a href="#">G01L9/06</a>  |
| PE pressure sensors, for rapid changes, for knock detection in combustion engines               | <a href="#">G01L9/08</a> ,<br><a href="#">G01L23/10</a> ,<br><a href="#">G01L23/22</a>  |
| Fluid sensors, e.g. quartz crystal microbalance   | <a href="#">G01N29/02</a>   |
| Analysing fluids by acoustic waves  | <a href="#">G01N29/036</a>  |
| Ultrasonic probes for material analysis   | <a href="#">G01N29/24</a>   |
| PE accelerometers   | <a href="#">G01P15/09</a>   |
| Scanning probe microscopy (SPM) using piezoelectric or electrostrictive devices, probes thereof | <a href="#">G01Q10/04</a> ,<br><a href="#">G01Q20/04</a> ,<br><a href="#">G01Q60/38</a> |
| Measuring PE properties   | <a href="#">G01R29/22</a>   |
| Adjustable mountings for optical elements, e.g. PE motorised lenses, objectives                 | <a href="#">G02B7/02</a> ,<br><a href="#">G02B7/10</a>                                  |
| Clocks or watches driven by PE or MS means- Timing standards                                    | <a href="#">G04C3/12</a>  |
| PE sound producing horns, buzzers   | <a href="#">G10K9/122</a>   |

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|  |                           |
|--|---------------------------|
| PE relays  | <a href="#">H01H57/00</a> |
| Manufacture or treatment of semiconductor or solid-state devices in general  | <a href="#">H01L21/00</a> |
| Semiconductor devices wherein carrier transport therein is modulated through stress generated by PE parts, e.g. strained channel FET | <a href="#">H01L29/68</a> |
| Semiconductor devices controlled by applied mechanical force or pressure, e.g. piezoresistive devices                                | <a href="#">H01L29/84</a> |
| Electric machines in general using PE or MS effect   | <a href="#">H02N2/00</a>  |
| Frequency generators   | <a href="#">H03B5/32</a>  |
| Manufacturing impedance networks, frequency selective elements or circuits, e.g. resonators, filters, delay lines using BAW or SAW   | <a href="#">H03H3/00</a>  |
| Impedance networks, frequency selective elements or circuits, e.g. resonators, filters, delay lines using BAW or SAW                 | <a href="#">H03H9/00</a>  |
| PE acoustic transducers, e.g. microphones, speakers  | <a href="#">H04R17/00</a> |
| Devices with cooperating MS and PE parts, e.g. magnetoelectric converters  | <a href="#">H10N35/00</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 |
|-------------------------------------|--|

## 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       |



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|     |   |
|-----|---|
| PEG | PE generator                                      |
| PT  | lead titanate                                     |
| PZ  | piezoelectric; lead zirconate                     |
| PZT | piezoelectric transducer; lead zirconate titanate |
| SAW | surface acoustic wave                             |

## H10N 30/01

### 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="#">H01L21/00</a> |
|---|---------------------------|

## H10N 30/02

### Definition statement

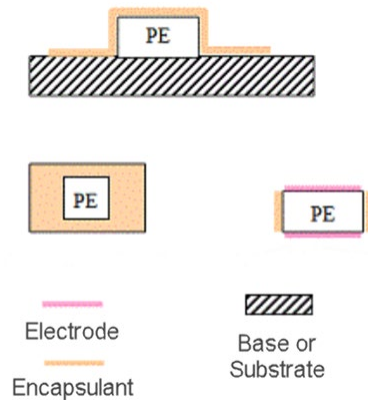
*This place covers:*

Processes or apparatus for forming enclosures or casings with encapsulants.

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Illustrative example of subject matter classified in this place:



## H10N 30/05

### 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

### Definition statement

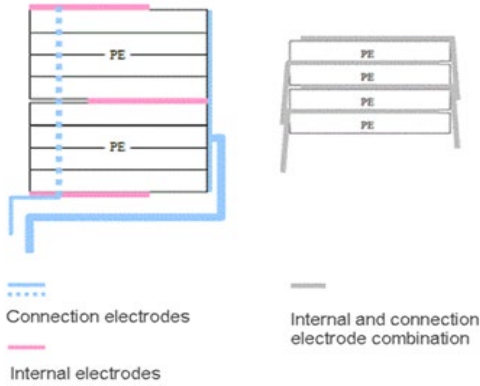
*This place covers:*

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:

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## 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="#">H01B13/00</a> |
| Processes or apparatus specifically adapted for manufacture or treatment of semiconductor or solid-state devices or of parts thereof in general | <a href="#">H01L21/00</a> |

## H10N 30/063

### 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.

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## H10N 30/067

### 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.

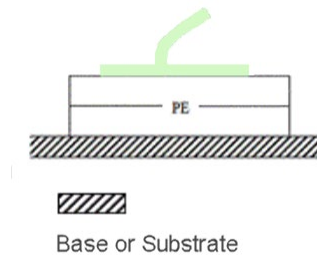
## H10N 30/07

### 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 | <a href="#">H01L21/70</a> |
|--|---------------------------|

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|   |  |
|---|--|
| formed in or on a common substrate or of specific parts thereof; Manufacture of integrated circuit devices or of specific parts thereof |  |
|---|--|

**H10N 30/093**

**References**

**Informative references**

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

|  |                            |
|--|----------------------------|
| Shaped ceramic products characterised by their composition; Ceramic compositions; Processing powders of inorganic compounds preparatory to the manufacturing of ceramic products   | <a href="#">C04B35/00</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>       |
| Ceramic compositions for piezoelectric or electrostrictive devices or parts  | <a href="#">H10N30/853</a> |

**H10N 30/50**

**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**

**Definition statement**

*This place covers:*

Magnetostrictive (MS) devices based on:

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- 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 | H10N 39/00 |
|---|------------|

#### Informative references

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

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|  |                            |
|--|----------------------------|
| MS mechanical vibration generators, e.g. (ultra)sonic probes   | <a href="#">B06B1/08</a>   |
| Sensors for measuring level of liquids or fluent solid materials   | <a href="#">G01F23/296</a> |
| Force or stress sensors, strain gauges   | <a href="#">G01L1/12</a>   |
| Torque sensors   | <a href="#">G01L3/10</a>   |
| Pressure sensors for knock detection in combustion engines   | <a href="#">G01L23/22</a>  |
| Timing standards using MS resonators   | <a href="#">G04F5/08</a>   |
| Electromagnetic actuators, e.g. solenoids  | <a href="#">H01F7/06</a>   |
| MS relays  | <a href="#">H01H55/00</a>  |
| Manufacture or treatment of semiconductor or solid-state devices in general  | <a href="#">H01L21/00</a>  |
| Electric machines in general using PE or MS effect   | <a href="#">H02N2/00</a>   |
| Manufacturing impedance networks, frequency selective elements or circuits, e.g. resonators, filters, delay lines using BAW or SAW | <a href="#">H03H3/00</a>   |
| Impedance networks, frequency selective elements or circuits, e.g. resonators, filters, delay lines using BAW or SAW               | <a href="#">H03H9/00</a>   |
| MS acoustic transducers, e.g. microphones, speakers  | <a href="#">H04R15/00</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

#### 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.

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## 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="#">H01L21/00</a> |
|---|---------------------------|

## H10N 39/00

### 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



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

|  |   |
|--|---|
| Ink-jet print heads                        | <a href="#">B41J2/14</a>                                  |
| Piezoelectric ultrasonic transducer arrays | <a href="#">B06B1/06</a>                                  |
| Digital memories, e.g. FRAMs               | <a href="#">G11C11/22</a>                                 |
| Ferroelectric memory                       | <a href="#">H10B51/00</a> ,<br><a href="#">H10B 53/00</a> |
| Piezoelectric or electrostrictive devices  | <a href="#">H10N30/00</a>                                 |
| Magnetostrictive or piezomagnetic devices  | <a href="#">H10N35/00</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****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;

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- 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="#">H10N52/00</a> |
| Integrated devices or assemblies comprising galvanomagnetic or Hall-effect elements | <a href="#">H10N59/00</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="#">G01R15/20</a> |
| Arrangements for measuring electrical power or power factor | <a href="#">G01R21/08</a> |

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|  |                           |
|--|---------------------------|
| Magnetometers using galvanomagnetic devices              | <a href="#">G01R33/06</a> |
| Magnetometers using MR devices                           | <a href="#">G01R33/09</a> |
| Magnetic recording heads - using galvanomagnetic devices | <a href="#">G11B5/37</a>  |
| Magnetic recording heads - using MR devices              | <a href="#">G11B5/39</a>  |
| MRAM arrangements  | <a href="#">H10B61/00</a> |

## Informative References

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

|   |                           |
|---|---------------------------|
| Voltage or current regulators   | <a href="#">G05F1/635</a> |
| Digital memories using magnetic layers  | <a href="#">G11C11/15</a> |
| Digital memories using spin effects   | <a href="#">G11C11/16</a> |
| Thin magnetic films with spin-exchange-coupled multi-layers   | <a href="#">H01F10/32</a> |
| Semiconductor devices with at least one potential barrier, e.g. diodes or transistors, controllable by a magnetic field | <a href="#">H01L29/82</a> |
| Frequency generators  | <a href="#">H03B15/00</a> |
| Amplifiers  | <a href="#">H03F15/00</a> |
| Pulse generators using galvanomagnetic devices  | <a href="#">H03K3/59</a>  |
| Electronic switching circuits or gating using galvanomagnetic devices   | <a href="#">H03K17/90</a> |
| Logic circuits using galvanomagnetic devices  | <a href="#">H03K19/18</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                         |

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|     |                       |
|-----|-----------------------|
| 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

### 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="#">H01L21/00</a> |
|---|---------------------------|

## H10N 50/10

### 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

### 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.

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## References

### Limiting references

*This place does not cover:*

|                          |                           |
|--------------------------|---------------------------|
| Magnetoresistive devices | <a href="#">H10N50/10</a> |
|--------------------------|---------------------------|

## H10N 52/00

### 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="#">H10N59/00</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="#">G01R15/20</a> |
| Arrangements for measuring electrical power or power factor | <a href="#">G01R21/08</a> |
| Magnetometers using Hall-effect devices                     | <a href="#">G01R33/07</a> |
| Magnetic recording heads - using Hall devices               | <a href="#">G11B5/37</a>  |

**Informative references**

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

|   |                           |
|---|---------------------------|
| Voltage or current regulators   | <a href="#">G05F1/635</a> |
| Digital memories using Hall devices   | <a href="#">G11C11/18</a> |
| Semiconductor devices with at least one potential barrier, e.g. diodes or transistors, controllable by a magnetic field | <a href="#">H01L29/82</a> |
| Frequency generators  | <a href="#">H03B15/00</a> |
| Amplifiers  | <a href="#">H03F15/00</a> |
| Pulse generators using Hall-effect devices  | <a href="#">H03K3/59</a>  |
| Electronic switching circuits or gating using Hall-effect devices   | <a href="#">H03K17/90</a> |
| Logic circuits using Hall-effect devices  | <a href="#">H03K19/18</a> |
| Spin Hall-effect devices  | <a href="#">H10N50/00</a> |

**H10N 52/01****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="#">H01L21/00</a> |
|---|---------------------------|

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## H10N 59/00

### 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="#">H10B61/00</a> |
|-------------------------|---------------------------|

#### Informative references

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

|  |                           |
|--|---------------------------|
| Measuring magnetic quantities; Magnetometers | <a href="#">G01R33/06</a> |
| Magnetometers using Hall-effect devices      | <a href="#">G01R33/07</a> |
| Magnetometers using MR devices               | <a href="#">G01R33/09</a> |
| Digital memories using magnetic layers       | <a href="#">G11C11/15</a> |

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|  |                           |
|--|---------------------------|
| Digital memories using spin effects  | <a href="#">G11C11/16</a> |
| Digital memories using Hall-effect devices   | <a href="#">G11C11/18</a> |
| Electronic switching circuits or gating using galvanomagnetic or Hall-effect devices | <a href="#">H03K17/90</a> |
| Logic circuits using galvanomagnetic or Hall-effect devices                          | <a href="#">H03K19/18</a> |
| Magnetoresistive devices and galvanomagnetic devices not otherwise provided          | <a href="#">H10N50/00</a> |
| Hall-effect devices  | <a href="#">H10N52/00</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                          |



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## H10N 60/00

### 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;
- 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 | H10N 69/00 |
|---|------------|

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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:*

|   |                             |
|---|-----------------------------|
| Superconductive magnetometers, e.g. SQUIDs  | <a href="#">G01R33/035</a>  |
| Superconductive magnetometers using magnetic resonance                                      | <a href="#">G01R33/3815</a> |
| Systems for storing electric energy   | <a href="#">H02J15/00</a>   |
| Dynamo-electric machines, e.g. electric motors or generators, with superconductive windings | <a href="#">H02K55/00</a>   |
| Magnetic holding or levitation devices using superconductivity                              | <a href="#">H02N15/04</a>   |
| Magnetic holding or levitation devices using superconductivity for trains                   | <a href="#">B60L13/00</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="#">H01F6/00</a>  |
| Transformers with superconductive windings   | <a href="#">H01F36/00</a> |
| Manufacturing of superconductive inductors such as magnets or coils composed of superconductive filaments or tapes covered by this group | <a href="#">H01F41/00</a> |
| Superconducting connectors such as current leads, splices  | <a href="#">H01R4/68</a>  |

**Informative references**

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

|   |                           |
|---|---------------------------|
| Superconductive materials characterised by the ceramic-forming technique or the ceramic composition in general, and precursor materials thereof | <a href="#">C04B35/00</a> |
| Superconductive (single) crystals and fabrication thereof including epitaxy   | <a href="#">C30B</a>      |
| Photometers, e.g. single photon detectors   | <a href="#">G01J1/42</a>  |
| Pyrometers  | <a href="#">G01J5/20</a>  |

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|   |            |
|---|------------|
| Quantum computers   | G06N10/00  |
| Digital memories using superconductive elements, e.g. cryotrons   | G11C11/44  |
| Content addressed memories using cryogenic elements   | G11C15/06  |
| Shift register memories using superconductive elements  | G11C19/32  |
| Superconductive conductors such as cables or transmission lines composed of superconductive filaments or tapes covered by this group                  | H01B12/00  |
| Manufacturing of superconductive conductors such as cables or transmission lines composed of superconductive filaments or tapes covered by this group | H01B13/00  |
| Semiconductor devices having single quantum well structures   | H01L29/12  |
| Current limiting circuits using superconducting devices, e.g. FCL circuits  | H02H9/02   |
| Frequency generators  | H03B15/00  |
| Amplifiers  | H03F19/00  |
| Pulse generators using superconductive elements   | H03K3/38   |
| Electronic switching circuits using superconductive elements  | H03K17/92  |
| Logic circuits using superconductive elements, e.g. RSFQ circuits   | H03K19/195 |
| Cavities or resonators in particle accelerators   | H05H7/20   |
| Thermoelectric junctions, e.g. Peltier or Seebeck devices comprising superconductors  | H10N10/855 |

## 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  |

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**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  |
| H <sub>c</sub>       | critical magnetic field  |
| HTC                  | high T <sub>c</sub>  |
| HTS; HTSC            | high T <sub>c</sub> superconductor   |
| IBAD                 | ion beam assisted deposition   |
| I <sub>c</sub>       | critical current   |
| J <sub>c</sub>       | critical current density   |
| JJ                   | Josephson junction   |
| LHe                  | liquid helium  |
| LN; LN <sub>2</sub>  | liquid nitrogen  |
| Low T <sub>c</sub>   | not high T <sub>c</sub> ; more frequently T <sub>c</sub> of only a few K, needs cooling by liquid helium |
| LTC                  | low T <sub>c</sub>   |
| LTS                  | low T <sub>c</sub> 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  |

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## H10N 60/01

### 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="#">H01L21/00</a> |
|---|---------------------------|

## H10N 69/00

### 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:*

|   |                           |
|---|---------------------------|
| Quantum computers                               | <a href="#">G06N10/00</a> |
| Digital memories using superconductive elements | <a href="#">G11C11/44</a> |

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|  |                            |
|--|----------------------------|
| Electronic switching circuits using superconductive elements | <a href="#">H03K17/92</a>  |
| Logic circuits using superconductive elements                | <a href="#">H03K19/195</a> |
| Superconducting devices                                      | <a href="#">H10N60/00</a>  |

## H10N 70/00

### 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.

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.

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**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="#">H10N79/00</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:*

|   |                           |
|---|---------------------------|
| Resistance change memory [ReRAM] devices  | <a href="#">H10B63/00</a> |
| Phase change memory [PCRAM, PRAM] devices | <a href="#">H10B63/10</a> |

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

|   |                           |
|---|---------------------------|
| Amplifiers  | <a href="#">H03F11/00</a> |
| Superconductive devices of MIM type                             | <a href="#">H10N60/10</a> |
| Bulk negative differential resistance devices, e.g. Gunn diodes | <a href="#">H10N80/00</a> |

**Synonyms and Keywords***In patent documents the following abbreviations are often used:*

|           |                       |
|-----------|-----------------------|
| memristor | memory resistor       |
| MIM       | metal-insulator-metal |

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**H10N 79/00****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="#">H10B63/00</a> |
| Phase change memory [PCRAM, PRAM] devices | <a href="#">H10B63/10</a> |

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

|  |                           |
|--|---------------------------|
| Resistor or anti-fuse arrays - integrated with junction diodes - integrated with transistors | <a href="#">H10B20/00</a> |
| Bulk switching components  | <a href="#">H10N70/00</a> |
| Devices integrating bulk negative differential resistance components, e.g. Gunn elements     | <a href="#">H10N89/00</a> |



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**H10N 80/00****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="#">H10N89/00</a> |
|--|---------------------------|

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

|   |                           |
|---|---------------------------|
| NDR devices having potential-jump barriers, e.g. resonant tunnel diodes, Esaki diodes | <a href="#">H01L29/88</a> |
| Frequency generators  | <a href="#">H03B9/12</a>  |
| Amplifiers  | <a href="#">H03F3/10</a>  |
| Pulse generators using NDR devices  | <a href="#">H03K3/357</a> |
| Electronic switching circuits using NDR devices                                       | <a href="#">H03K17/70</a> |
| Bistable or multistable bulk switching devices  | <a href="#">H10N70/20</a> |

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**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****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:*

|  |                           |
|--|---------------------------|
| ReRAM  | <a href="#">H10B63/00</a> |
| Integrated device comprising bulk switching components | <a href="#">H10N79/00</a> |
| NDR devices  | <a href="#">H10N80/00</a> |

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## H10N 97/00

### 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="#">H05K1/00</a> |
| Incorporating printed electric components | <a href="#">H05K1/16</a> |
| Manufacturing of printed circuits         | <a href="#">H05K3/00</a> |

## H10N 99/00

### 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.