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# ELECTRONIC COMPONENT


## Abstract

An electronic component includes a first main body including a first element, a second main body including a second element, and a circuit including the first element and the second element. The first main body further includes a first columnar conductor connected to the ground. The first element is a capacitor including a capacitor conductor layer. The capacitor conductor layer is arranged between the second element and the first columnar conductor.



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## Background/Summary

## CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Japanese Priority Patent Application No. 2024-020063 filed on Feb. 14, 2024, the entire contents of which are incorporated herein by reference.

## BACKGROUND

[0002] The disclosure relates to an electronic component including a main body and a mounted component that is mounted to the main body.

[0003] A filter such as a low-pass filter, a high-pass filter, and a band-pass filter is formed by using a plurality of resonators. As examples of the resonators used in such a filter, there have been known an LC resonator formed by using an inductor and a capacitor and an acoustic wave resonator formed by using an acoustic wave element. The acoustic wave element is an element that utilizes an acoustic wave. Examples of the acoustic wave element include a surface acoustic wave element that utilizes a surface acoustic wave and a bulk acoustic wave element that utilizes a bulk acoustic wave.

[0004] WO 2007/119356 A discloses a multilayer band-pass filter including a plurality of LC parallel resonators, wherein adjacent LC parallel resonators are coupled to each other. The LC parallel resonator is formed by a capacitor electrode and an inductor electrode. In the inductor electrode, a via electrode passing through in a stacking direction of dielectric layers and a line path electrode extending in a vertical direction with respect to the stacking direction of the dielectric layers form a coil-like shape.

[0005] WO 2013/061694 A discloses an acoustic wave filter formed of a surface acoustic wave filter with a ladder-type circuit configuration and an acoustic wave filter formed of a longitudinally-coupled surface acoustic wave resonator filter.

[0006] As a filter device, a hybrid-type filter device formed by using an LC resonator and an acoustic wave resonator is also known, in addition to a filter device formed by using only an LC resonator or only an acoustic wave resonator. In the hybrid-type filter device, for example, a second main body including an acoustic wave resonator is mounted on a first main body including an LC resonator.

[0007] In general, the overall characteristics of the filter device are adjusted by adjusting the characteristics of each of the plurality of elements of the filter device. In the hybrid-type filter device, the characteristics of each of the LC resonator and the acoustic wave resonator are adjusted. However, depending on a product, it may be difficult to achieve overall adjustment only with the characteristics of the acoustic wave resonator, or adjusting the characteristics of the elastic wave resonator itself may be difficult.

[0008] The issue described above is not limited to a case in which the second main body includes the acoustic wave resonator, and also applies in a situation where it is difficult to achieve overall adjustment only with the characteristics of the elements included in the second main body or adjusting the characteristics of the elements included in the second main body itself is difficult.

## SUMMARY

[0009] An electronic component according to one embodiment of a first aspect of the disclosure includes a first main body including a plurality of dielectric layers being stacked and a first element, a second main body being mounted to the first main body and including a second element, and a circuit including the first element and the second element. The first main body further includes a first columnar conductor extending in a direction parallel to a stacking direction of the plurality of dielectric layers and being connected to the ground. The first element is a capacitor including a capacitor conductor layer extending along an orthogonal direction orthogonal to the stacking direction. The capacitor conductor layer is arranged between the second element and the first columnar conductor.

[0010] An electronic component according to one embodiment of a second aspect of the disclosure includes a first main body including a plurality of dielectric layers, a capacitor, and an inductor, a

second main body being mounted to the first main body and including an acoustic wave element, and a circuit. The circuit includes a first signal port, a second signal port, and a signal path connecting the first signal port and the second signal port to each other. In a circuit configuration, the acoustic wave element is provided between the signal path and the ground. The capacitor and the inductor are connected to each other in series, and are provided between the acoustic wave element and the ground in the circuit configuration.
[0011] Other and further objects, features and advantages of the technology will appear more fully from the following description.

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## Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0012] The accompanying drawings are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this specification. The drawings illustrate example embodiments and, together with the specification, serve to explain the principles of the technology.
[0013] FIG. **1** is a perspective view showing an electronic component according to an exemplary embodiment of the disclosure.
[0014] FIG. **2** is a perspective view showing a first main body in the exemplary embodiment of the disclosure.
[0015] FIG. **3** is a perspective view showing the first main body in the exemplary embodiment of the disclosure.
[0016] FIG. **4** is a block diagram schematically showing a circuit configuration of a band-pass filter circuit in the exemplary embodiment of the disclosure.
[0017] FIG. **5** is a circuit diagram showing an example of a configuration of a third circuit section in the exemplary embodiment of the disclosure.
[0018] FIG. **6** is a perspective view showing a part of the internal structure of the first main body in the exemplary embodiment of the disclosure.
[0019] FIG. **7** is a plan view showing a part of the internal structure of the first main body in the exemplary embodiment of the disclosure.
[0020] FIG. **8** is a side view showing a part of the internal structure of the first main body in the exemplary embodiment of the disclosure.
[0021] FIG. **9** is a characteristic chart showing pass attenuation characteristics of a sub circuit, which are obtained by a first simulation.
[0022] FIG. **10** is a characteristic chart showing pass attenuation characteristics of the sub circuit, which are obtained by a second simulation.
[0023] FIG. **11** is a characteristic chart showing return attenuation characteristics of the sub circuit, which are obtained by the second simulation.
[0024] FIG. **12** is a side view showing a part of the internal structure of a first main body in a first modification example of the electronic component according to the exemplary embodiment of the disclosure.
[0025] FIG. **13** is a side view showing a part of the internal structure of a first main body in a second modification example of the electronic component according to the exemplary embodiment of the disclosure.
DETAILED DESCRIPTION
[0026] An object of the disclosure is to provide an electronic component including a first main body and a second main body mounted to the first main body, wherein elements in the first main body enable the overall characteristics of the electronic component to achieve the desired characteristics.

[0027] In the following, some example embodiments and modification examples of the disclosure are described in detail with reference to the accompanying drawings. Note that the following description is directed to illustrative examples of the disclosure and not to be construed as limiting the technology. Factors including, without limitation, numerical values, shapes, materials, components, positions of the components, and how the components are coupled to each other are illustrative only and not to be construed as limiting the technology. Further, elements in the following example embodiments which are not recited in a most-generic independent claim of the disclosure are optional and may be provided on an as-needed basis. The drawings are schematic and are not intended to be drawn to scale. Like elements are denoted with the same reference numerals to avoid redundant descriptions.
[0028] First, with reference to FIG. **1** to FIG. **3**, a configuration of an electronic component **1** according to the exemplary embodiment of the disclosure is described. FIG. **1** is a perspective view showing the electronic component **1**. FIG. **2** and FIG. **3** are perspective views showing a first main body.
[0029] The electronic component **1** according to the exemplary embodiment includes a first main body **50** and a second main body **80** mounted to the first main body **50**. The electronic component **1** further includes a circuit including a plurality of elements provided in the first main body **50** and at least one element provided in the second main body **80**. In the exemplary embodiment, the electronic component **1** includes, as the circuit described above, a band-pass filter circuit **5** that selectively passes a signal of a frequency within a predetermined passband. Note that the band-pass filter circuit **5** is shown in FIG. **4** described below.
[0030] The first main body **50** includes a plurality of dielectric layers being stacked together and a plurality of conductors (a plurality of conductor layers and a plurality of through holes). Each of the plurality of dielectric layers is formed of a dielectric material. In the exemplary embodiment, for example, low-temperature co-fired ceramics (LTCC) are used as the dielectric material. The specific dielectric constant of the dielectric material may be, for example, 8 or greater, and is preferably 10 or greater.
[0031] The first main body **50** includes a first surface **50**A and a second surface **50**B located at both ends in a stacking direction T of the plurality of dielectric layers, and four side surfaces **50**C to **50**F connecting the first surface **50**A and the second surface **50**B to each other. The side surfaces **50**C and **50**D are opposite to each other, and the side surfaces **50**E and **50**F are also opposite to each other. The side surfaces **50**C to **50**F are perpendicular to the first surface **50**A and the second surface **50**B.
[0032] Here, as shown in FIG. **1** to FIG. **3**, an X direction, a Y direction, and a Z direction are defined. The X direction, the Y direction, and the Z direction are orthogonal to one another. In the exemplary embodiment, a direction parallel to the stacking direction T is defined as the Z direction. The Z direction is also a direction parallel to a direction in which the first main body **50** and the second main body **80** are arrayed. A direction opposite to the X direction is defined as a −X direction, a direction opposite to the Y direction is defined as a −Y direction, and a direction opposite to the Z direction is defined as a −Z direction. The expression “when seen in the(a) predetermined direction (for example, the stacking direction T)” indicates that a target object is seen from a position away from the target object in the predetermined direction or a direction parallel to the predetermined direction.
[0033] As shown in FIG. **1** to FIG. **3**, the first surface **50**A is located at the end of the first main body **50** in the Z direction. The first surface **50**A is a top surface of the first main body **50**, and is a mounting surface for mounting the second main body **80**. The second surface **50**B is located at the end of the first main body **50** in the −Z direction. The second surface **50**B is a bottom surface of the first main body **50**. FIG. **2** shows the first main body **50** when seen from the first surface **50**A side. FIG. **3** shows the first main body **50** when seen from the second surface **50**B side.
[0034] The side surface **50**C is located at the end of the first main body **50** in the −X direction. The

side surface **50**D is located at the end of the first main body **50** in the X direction. The side surface **50**E is located at the end of the first main body **50** in the −Y direction. The side surface **50**F is located at the end of the first main body **50** in the Y direction.

[0035] The first main body **50** further includes a plurality of electrodes **111**, **112**, **113**, **114**, **115**, **116**, **117**, **118**, and **119** that are provided to the second surface **50**B of the first main body **50**. The electrodes **111**, **112**, and **113** are arrayed in the X direction in the stated order at positions closer to the side surface **50**E than the side surface **50**F. The electrodes **115**, **116**, and **117** are arrayed in the −X direction in the stated order at positions closer to the side surface **50**F than the side surface **50**E.

[0036] The electrode **114** is arranged between the electrode **113** and the electrode **115**. The electrode **118** is arranged between the electrode **111** and the electrode **117**. The electrode **119** is arranged between the electrode **112** and the electrode **116**. The electrode **119** is arranged substantially at the center of the second surface **50**B.

[0037] The first main body **50** further includes four electrodes **121**, **122**, **123**, and **124** provided to the first surface **50**A of the first main body **50**. The electrodes **121** and **122** are arrayed in the X direction in the stated order at positions closer to the side surface **50**E than the side surface **50**F. The electrodes **123** and **124** are arrayed in the −X direction in the stated order at positions ahead of the electrodes **121** and **122** in the Y direction.

[0038] The second main body **80** further includes four electrodes **81**, **82**, **83**, and **84**. When the second main body **80** is mounted to the first main body **50**, the electrodes **81** to **84** face the electrodes **121** to **124** of the first main body **50**, respectively. For example, the electrodes **81** to **84** are physically connected to the electrodes **121** to **124** via solder bumps **7**.

[0039] The planar shape of the first main body **50** (the shape when seen in the stacking direction T) is different from the planar shape of the second main body **80** in size. In the example shown in FIG. **1**, the planar shape of the first main body **50** is larger than the planar shape of the second main body **80**.

[0040] In the example shown in FIG. **1**, the second main body **80** is arranged so as to overlap with the gravity center of the first surface **50**A when seen in the stacking direction T. The gravity center of the second main body **80** when seen in the stacking direction T may match or may not match with the gravity center of the first surface **50**A.

[0041] The electronic component **1** may further include a sealing portion (omitted in illustration) that seals the second main body **80**. The sealing portion (omitted in illustration) covers the periphery of the second main body **80** and at least a part of the first surface **50**A of the first main body **50**. The sealing portion may further cover the side surfaces **50**C to **50**F of the first main body **50**. The sealing portion is formed of, for example, a resin.

[0042] Next, with reference to FIG. **4**, the circuit configuration of the band-pass filter circuit **5** of the electronic component **1** is described. FIG. **4** is a block diagram schematically showing the circuit configuration of the band-pass filter circuit **5**. The band-pass filter circuit **5** includes a first signal port **2**, a second signal port **3**, and a signal path **4** connecting the first signal port **2** and the second signal port **3** to each other.

[0043] Each of the first and second signal ports **2** and **3** is a port for inputting or outputting a signal. In other words, when a signal is input to the first signal port **2**, a signal is output from the second signal port **3**. When a signal is input to the second signal port **3**, a signal is output from the first signal port **2**.

[0044] The two electrodes of the electrodes **111** to **119** shown in FIG. **2** and FIG. **3** correspond to the first and second signal ports **2** and **3**. Among the electrodes **111** to **119**, the seven electrodes other than the two electrodes described above may be connected to the ground.

[0045] The band-pass filter circuit **5** further includes a first circuit section **10**, a second circuit section **20**, and a third circuit section **30**. The first circuit section **10** and the second circuit section **20** are provided in the signal path **4**. In the circuit configuration, the third circuit section **30** is provided between the signal path **4** and the ground. Note that, in the present application, the expression “in the(a) circuit configuration” is used to indicate not a layout in a physical configuration but a layout in a circuit diagram.

[0046] The first circuit section **10** includes a first end **10***a* and a second end **10***b*. The second circuit section **20** includes a first end **20***a* and a second end **20***b*. The third circuit section **30** includes a first end **30***a* and a second end **30***b*. The first end **10***a* of the first circuit section **10** is connected to the first signal port **2**. The first end **20***a* of the second circuit section **20** is connected to the second end **10***b* of the first circuit section **10**. The second end **20***b* of the second circuit section **20** is connected to the second signal port **3**.

[0047] The first end **30***a* of the third circuit section **30** is connected to the signal path **4** between the second end **10***b* of the first circuit section **10** and the first end **20***a* of the second circuit section **20**. The second end **30***b* of the third circuit section **30** is connected to the ground.

[0048] The band-pass filter circuit **5** includes the first to third circuit sections **10**, **20**, and **30**. For example, the band-pass filter circuit **5** can be formed by connecting a high-pass filter circuit and a low-pass filter circuit to each other in series. One of the first circuit section **10** and the second circuit section **20** may be a high-pass filter circuit. The other of the first circuit section **10** and the second circuit section **20** may be a low-pass filter circuit. Alternatively, at least one of the first circuit section **10** and the second circuit section **20** may be a circuit including a high-pass filter circuit and a low-pass filter circuit.

[0049] The first circuit section **10** and the second circuit section **20** include a plurality of elements provided in the first main body **50**. The plurality of elements include a plurality of inductors and a plurality of capacitors. The plurality of inductors are formed by a plurality of conductors in the first main body **50**. The plurality of capacitors is formed of the plurality of conductors and a plurality of dielectrics in the first main body **50**. Each of the plurality of dielectrics is a part of the plurality of dielectric layers forming the first main body **50**.

[0050] At least one of the first circuit section **10** and the second circuit section **20** may further include at least one element provided in the second main body **80**.

[0051] The third circuit section **30** includes a first element provided in the first main body **50** and a second element provided in the second main body **80**. The first element and the second element are connected to each other via some of the plurality of electrodes **81** to **84** shown in FIG. **1** and some of the plurality of electrodes **121** to **124** shown in FIG. **2** and FIG. **3**.

[0052] In the exemplary embodiment, in particular, the first element is a capacitor, and the second element is an acoustic wave element. The capacitor includes a plurality of capacitor conductor layers in the first main body **50** and a dielectric. Each of the plurality of capacitor conductor layers extends along an orthogonal direction orthogonal to the stacking direction T. The dielectric interposed between the plurality of capacitor conductor layers is a part of the plurality of dielectric layers forming the first main body **50**. Hereinafter, the dielectric of the capacitor (the first element) is referred to as a first dielectric. As the first dielectric, various ceramic materials, various glass ceramic materials used in low-temperature co-fired ceramics (LTCC), or a mixture thereof can be used.

[0053] The acoustic wave element includes a dielectric. Hereinafter, the dielectric of the acoustic wave element (the second element) is referred to as the second dielectric. The acoustic wave element may be a bulk acoustic wave element or a surface acoustic wave element. In the bulk acoustic wave element, vibration of the second dielectric is used. In the surface acoustic wave element, the second dielectric is utilized as a substrate. A dielectric that is generally used as an acoustic wave element can be used as the second dielectric.

[0054] FIG. **5** shows an example of a configuration of the third circuit section **30**. In FIG. **5**, a reference symbol C**1** represents the capacitor being the first element, and a reference symbol **31** represents the acoustic wave element being the second element. The third circuit section **30** further includes an inductor L**1**. The inductor L**1** is provided in the first main body **50**.

[0055] The capacitor C**1** and the acoustic wave element **31** are connected to each other in series, and are provided between the signal path **4** and the ground in the circuit configuration. The capacitor C**1** and the inductor L**1** are connected to each other in series, and are provided between the acoustic wave element **31** and the ground in the circuit configuration. In the example shown in FIG. **5**, one end of the acoustic wave element **31** is connected to the first end **30***a* of the third circuit section **30**. One end of the capacitor C**1** is connected to the other end of the acoustic wave element **31**. One end of the inductor L**1** is connected to the other end of the capacitor C**1**. The other end of the inductor L**1** is connected to the second end **30***b* of the third circuit section **30**.

[0056] The inductor L**1** may include a plurality of inductor portions. In the circuit configuration, the plurality of inductor portions may be connected to each other in parallel. The plurality of inductor portions are described below.

[0057] Next, with reference to FIG. **6** to FIG. **8**, the structural features of the electronic component **1** according to the exemplary embodiment are described. FIG. **6** is a perspective view showing a part of the internal structure of the first main body **50**. FIG. **7** is a plan view showing a part of the internal structure of the first main body **50**. FIG. **8** is a side view showing a part of the internal structure of the first main body **50**.

[0058] First, the structure of the capacitor C**1** is described. The capacitor C**1** is formed of capacitor conductor layers C**1***a* and C**1***b* that are arranged at a predetermined interval in the stacking direction T and face each other and a dielectric between the capacitor conductor layer C**1***a* and the capacitor conductor layer C**1***b*. Each of the capacitor conductor layers C**1***a* and C**1***b* extends along an orthogonal direction orthogonal to the stacking direction T.

[0059] As shown in FIG. **8**, the capacitor conductor layers C**1***a* and C**1***b* are arrayed along the Z direction in the stated order. The capacitor conductor layer C**1***a* is arranged between the capacitor conductor layer C**1***b* and the first surface **50**A. As shown in FIG. **7**, the capacitor conductor layer C**1***a* overlaps with the capacitor conductor layer C**1***b* when seen in the Z direction. In the exemplary embodiment, in particular, the planar shape of the capacitor conductor layer C**1***a* (the shape when seen in the Z direction) and the planar shape of the capacitor conductor layer C**1***b* are similar to each other. In the example shown in FIG. **7**, the planar shape of the capacitor conductor layer C**1***a* and the planar shape of the capacitor conductor layer C**1***b* are both L-shapes. The planar shape of the capacitor conductor layer C**1***a* is larger than the planar shape of the capacitor conductor layer C**1***b*. The capacitor conductor layer C**1***a* overlaps with the entire capacitor conductor layer C**1***b* when seen in the Z direction.

[0060] The capacitor conductor layer C**1***a* is electrically connected to the electrode **121** via a conductor such as a through hole. Although omitted in illustration, the acoustic wave element **31** is electrically connected to the electrode **81**. Thus, the capacitor C**1** is connected to the acoustic wave element **31** in series via the electrodes **81** and **121**.

[0061] Next, the structure of the inductor L**1** is described. The inductor L**1** includes a first inductor portion L**1***a* and a second inductor portion L**1***b* that are connected to each other in parallel. Here, a columnar structure formed with a plurality of through holes being connected in series is referred to as a columnar conductor. The columnar conductor extends in a direction parallel to the stacking direction T. The first main body **50** includes a first columnar conductor T**1** and a second columnar conductor T**2**. The first inductor portion L**1***a* is formed of the first columnar conductor T**1**. The second inductor portion L**1***b* is formed of the second columnar conductor T**2**.

[0062] As shown in FIG. **8**, the first columnar conductor T**1** is arranged between the capacitor conductor layer C**1***a* and the second surface **50**B of the first main body **50**. The first columnar conductor T**1** includes a first end T**1***a* and a second end T**1***b* that are located on sides opposite to each other in a direction parallel to the stacking direction T. The first end T**1***a* of the first columnar conductor T**1** is electrically connected to the capacitor conductor layer C**1***b* via a conductor such as a through hole.

[0063] As shown in FIG. **8**, the second columnar conductor T**2** is arranged between the capacitor conductor layer C**1***a* and the second surface **50**B of the first main body **50**. The second columnar conductor T**2** includes a first end T**2***a* and a second end T**2***b* that are located on sides opposite to each other in a direction parallel to the stacking direction T. The first end T**2***a* of the second columnar conductor T**2** is electrically connected to the capacitor conductor layer C**1***b* via a conductor such as a through hole.

[0064] As described above, the first end T**1***a* of the first columnar conductor T**1** and the first end T**2***a* of the second columnar conductor T**2** are connected to the capacitor conductor layer C**1***b* via a conductor such as a through hole. The capacitor conductor layer C**1***b* functions as both a "capacitor conductor layer" and a "first conductor layer" in the disclosure.

[0065] The first main body **50** further includes a conductor layer **11** extending along an orthogonal direction orthogonal to the stacking direction T. The second end T**1***b* of the first columnar conductor T**1** and the second end T**2***b* of the second columnar conductor T**2** are electrically connected to the conductor layer **11**. The conductor layer **11** is connected to the ground via a conductor such as a through hole and some of the electrodes **111** to **119**. The first columnar conductor T**1** and the second columnar conductor T**2** are connected to each other in parallel via the capacitor conductor layer C**1***b*, the conductor layer **11**, and a conductor such as a through hole. The first columnar conductor T**1** and the second columnar conductor T**2** is connected to the ground via the conductor layer **11**, a conductor such as a through hole, and some of the electrodes **111** to **119**. The conductor layer **11** corresponds to a "second conductor layer" in the disclosure.

[0066] Note that the first end T**1***a* of the first columnar conductor T**1** may be connected directly to the capacitor conductor layer C**1***b* without a conductor such as a through hole. Similarly, the first end T**2***a* of the second columnar conductor T**2** may be connected directly to the capacitor conductor layer C**1***b* without a conductor such as a through hole.

[0067] Next, the features related to arrangement of the capacitor C**1** and the acoustic wave element **31** are described. In FIG. **7**, a rectangular region that is surrounded by a two-dot chain line and is denoted with a reference symbol **80** indicates a region of the first surface **50**A of the first main body **50** to which the second main body **80** is mounted. The second main body **80** overlaps with a part of the capacitor C**1** when seen in the stacking direction T. Although omitted in illustration, the acoustic wave element **31** is arranged ahead of the capacitor C**1** in the Z direction. No element is arranged between the capacitor C**1** and the acoustic wave element **31**.

[0068] The capacitor conductor layers C**1***a* and C**1***b* forming the capacitor C**1** are arranged between the acoustic wave element **31** and the first and second columnar conductors T**1** and T**2** forming the first and second inductor portions L**1***a* and L**1***b*. The capacitor conductor layers C**1***a* and C**1***b* entirely cover the first and second columnar conductors T**1** and T**2** when seen in the Z direction.

[0069] Next, actions and effects of the electronic component **1** according to the exemplary embodiment are described. In the exemplary embodiment, the capacitor conductor layers C**1***a* and C**1***b* are arranged between the acoustic wave element **31** and the first and second columnar conductors T**1** and T**2**. With this, according to the exemplary embodiment, magnetic coupling between the acoustic wave element **31** and the first and second columnar conductors T**1** and T**2** can be suppressed. As a result, according to the exemplary embodiment, it is possible to suppress deviation of the overall characteristics of the electronic component **1** from the desired characteristics due to magnetic coupling between the acoustic wave element **31** and the first and second columnar conductors T**1** and T**2**. In other words, according to the exemplary embodiment, the capacitor conductor layers C**1***a* and C**1***b* enable the overall characteristics of the electronic component **1** to achieve the desired characteristics.

[0070] In the exemplary embodiment, both the first end T**1***a* of the first columnar conductor T**1** and the first end T**2***a* of the second columnar conductor T**2** are connected to the capacitor conductor layer C**1***b*, and both the second end T**1***b* of the first columnar conductor T**1** and the second end T**2***b* of the second columnar conductor T**2** are connected to the conductor layer **11**. Thus, in the exemplary embodiment, a direction in which an electric current flows in the first columnar conductor T**1** and a direction in which an electric current flows in the second columnar conductor

T**2** match with each other, and a magnetic field generated in the periphery of the first columnar conductor T**1** and a magnetic field generated in the periphery of the second columnar conductor T**2** cancel each other. With this, according to the exemplary embodiment, it is also possible to suppress deviation of the overall characteristics of the electronic component **1** from the desired characteristics due to magnetic coupling between the acoustic wave element **31** and the first and second columnar conductors T**1** and T**2**. In other words, according to the exemplary embodiment, the capacitor conductor layer C**1***b*, the first and second columnar conductors T**1** and T**2**, and the conductor layer **11** enable the overall characteristics of the electronic component **1** to achieve the desired characteristics.

[0071] In the exemplary embodiment, in the circuit configuration, the acoustic wave element **31** is provided between the signal path **4** and the ground. The capacitor C**1** and the inductor L**1** are connected to each other in series, and are provided between the acoustic wave element **31** and the ground in the circuit configuration. The capacitor C**1** includes a function of increasing a resonance frequency of a sub circuit including the third circuit section **30**. The function is described below with reference to a result of a first simulation.

[0072] In the first simulation, a model of the sub circuit including the third circuit section **30** is used. The model of the sub circuit includes a first signal port, a second signal port, a signal path connecting the first signal port and the second signal port to each other, and the third circuit section **30** provided between the signal path and the ground. In the model of the sub circuit, the third circuit section **30** includes an acoustic wave element provided between the signal path and the ground and a capacitor provided between the signal path and the acoustic wave element.

[0073] In the first simulation, the model of the sub circuit described above is used to obtain the pass attenuation characteristics of the sub circuit while changing the capacitance of the capacitor within a range from 0.3 to ∞ pF. The pass attenuation characteristics in a case in which the capacitance of the capacitor is ∞ pF indicates the pass attenuation characteristics in a case in which the capacitor is not provided. In the first simulation, each of a Q value of a resonance frequency and a Q value of an anti-resonant frequency of the acoustic wave element is set to 300, and an electromechanical coupling coefficient of the acoustic wave element is set to 0.091.

[0074] FIG. **9** is a characteristic chart showing the pass attenuation characteristics of the sub circuit, which are obtained by the first simulation. In FIG. **9**, the horizontal axis represents frequency, and the vertical axis represents attenuation. In FIG. **9**, a reference symbol **91** represents the pass attenuation characteristics in a case in which the capacitance of the capacitor is ∞ pF, a reference symbol **92** represents the pass attenuation characteristics in a case in which the capacitance of the capacitor is 10 pF, a reference symbol **93** represents the pass attenuation characteristics in a case in which the capacitance of the capacitor is 3 pF, a reference symbol **94** represents the pass attenuation characteristics in a case in which the capacitance of the capacitor is 1 pF, and a reference symbol **95** represents the pass attenuation characteristics in a case in which the capacitance of the capacitor is 0.3 pF.

[0075] As shown in FIG. **9**, the resonance frequency of the sub circuit is increased as the capacitance of the capacitor is reduced. According to the exemplary embodiment, the resonance frequency of the sub circuit including the third circuit section **30** can be adjusted by the capacitor. In particular, a resonance frequency of the sub circuit in a case in which the capacitor is provided is higher than a resonance frequency of the sub circuit in a case in which the capacitance of the capacitor is ∞ pF, in other words, the capacitor is not provided.

[0076] Note that the characteristics of the sub circuit can also be adjusted by the acoustic wave element. Description is made below on a second simulation where the characteristics of the sub circuit are examined when the characteristics of the acoustic wave element are changed. In the second simulation, the model of the sub circuit is used to obtain the pass attenuation characteristics and the return attenuation characteristics of the sub circuit in a first case in which the capacitance of the capacitor is set to 0.3 pF, each of a Q value of a resonance frequency and a Q value of an

anti-resonant frequency of the acoustic wave element is set to 500, and an electromechanical coupling coefficient of the acoustic wave element is set to 0.13. In the second simulation, the model of the sub circuit is used to obtain the pass attenuation characteristics and the return attenuation characteristics of the sub circuit in a second case in which the capacitance of the capacitor is set to 0.3 pF, each of a Q value of a resonance frequency and a Q value of an anti-resonant frequency of the acoustic wave element is set to 300, and an electromechanical coupling coefficient of the acoustic wave element is set to 0.091.
[0077] FIG. **10** is a characteristic chart showing the pass attenuation characteristics of the sub circuit, which are obtained by the second simulation. FIG. **11** is a characteristic chart showing the return attenuation characteristics of the sub circuit, which are obtained by the second simulation. In FIG. **10** and FIG. **11**, the horizontal axis represents frequency, and the vertical axis represents attenuation. In FIG. **10** and FIG. **11**, the solid curved line indicates the characteristics in the first case, and the broken curved line indicates the characteristics in the second case. As understood from FIG. **10** and FIG. **11**, the characteristics of the sub circuit can also be adjusted by the acoustic wave element.
[0078] According to the exemplary embodiment, the characteristics of the sub circuit can be adjusted by the capacitor C**1** and the acoustic wave element **31** as understood from the results of the first and second simulations.
[0079] Next, other effects of the exemplary embodiment are described. The dielectric has characteristics that change depending on a temperature. Thus, the band-pass filter circuit **5** formed by the elements including the dielectric also has characteristics that change depending on a temperature. Here, description is made while focusing on a resonance frequency of the dielectric material. As an indicator showing the temperature dependency of the resonance frequency of the dielectric material, a temperature coefficient TCF of the resonance frequency is known. The temperature coefficient TCF (a unit is ppm/K) of the resonance frequency is expressed by Equation (1) given below as defined in Japanese Industrial Standards R1627 (JIS R1627) (Testing method for dielectric properties of fine ceramics at microwave frequency). Note that f.sub.ref represents a resonance frequency at a reference temperature t.sub.ref, and f.sub.T represents a resonance frequency at a predetermined temperature t.
[00001] $\mathrm{TCF} = [(f_T - f_{\mathrm{ref}}) / \{f_{\mathrm{ref}}(t - t_{\mathrm{ref}})\}] \times 10^6 .\quad (1)$
[0080] In general, the temperature dependency of the pass attenuation characteristics of the band-pass filter circuit **5** can be suppressed by using the element including the dielectric having a small absolute value for the temperature coefficient TCF of the resonance frequency. However, depending on the element, it may be difficult to use the dielectric having a small absolute value for the temperature coefficient TCF of the resonance frequency. The absolute value for the temperature coefficient TCF of the resonance frequency can be reduced by combining materials having different temperature coefficients TCF of the resonance frequency. However, when the acoustic wave element **31** is formed by using a dielectric material obtained by combining a plurality of materials, a problem is a cost increase of the acoustic wave element **31**. Another problem is a difficulty in achieving a combination of such materials that can satisfy the characteristics of the acoustic wave element **31** and the characteristics of the band-pass filter circuit **5**.
[0081] In the exemplary embodiment, the first dielectric used for the capacitor C**1** (the first element) is formed of a first dielectric material having a first value for the temperature coefficient TCF of the resonance frequency, and the second dielectric used for the acoustic wave element **31** (the second element) is formed of a second dielectric material having a second value for the temperature coefficient TCF of the resonance frequency.
[0082] The first dielectric and the second dielectric may be selected so that the absolute value of the sum of the first value and the second value or the absolute value of the average value of the first value and the second value are less than the absolute value of the second value. Even when it is

difficult to reduce the absolute value of the temperature coefficient TCF of the resonance frequency of one of the first dielectric and the second dielectric, the other of the first dielectric and the second dielectric is selected so as to satisfy the above-mentioned requirements. With this, it is possible to suppress changes of the characteristics (the resonance frequency) of the sub circuit including the third circuit section **30**. As a result, according to the exemplary embodiment, it is possible to suppress changes of the pass attenuation characteristics of the band-pass filter circuit **5** due to temperature variations.

[0083] For example, when one of the first value and the second value is a negative value, the other of the first value and the second value is set to a positive value. With this, the absolute value of the sum of the first value and the second value can be set to a value less than the absolute value of the second value. In an example, the first value is 40 ppm/K, and the second value is −25 ppm/K.

[0084] When both the first value and the second value are negative values, the absolute value of the first value is set to a value less than the absolute value of the second value. With this, the absolute value of the average value of the first value and the second value can be set to a value less than the absolute value of the second value. In an example, the first value is −5 ppm/K, and the second value is −25 ppm/K.

[0085] Both the sum of the first value and the second value and the average value of the first value and the second value may fall within a range from −75 to 40 ppm/K, for example.

MODIFICATION EXAMPLES

[0086] Next, first and second modification examples of the electronic component **1** according to the exemplary embodiment are described. First, with reference to FIG. **12**, the first modification example is described. FIG. **12** is a side view showing a part of the internal structure of the first main body **50** in the first modification example. In the first modification example, in place of the first and second inductor portions L**1***a* and L**1***b*, the inductor L**1** includes inductor portions L**1***a***1** and L**1***b***1** that are connected to each other in parallel, inductor portions L**1***a***2** and L**1***b***2** that are connected to each other in parallel, and inductor portions L**1***a***3** and L**1***b***3** that are connected to each other in parallel.

[0087] In the first modification example, the first main body **50** includes columnar conductors T**1**A, T**1**B, T**1**C, T**2**A, T**2**B, and T**2**C in place of the first and second columnar conductors T**1** and T**2**. The inductor portions L**1***a***1**, L**1***a***2**, and L**1***a***3** are formed of the columnar conductors T**1**A, T**1**B, and T**1**C, respectively. The inductor portions L**1***b***1**, L**1***b***2**, and L**1***b***3** are formed of the columnar conductors T**2**A, T**2**B, and T**2**C respectively.

[0088] The columnar conductors T**1**A, T**1**B, and T**1**C are arrayed along the Z direction in the stated order. In the example shown in FIG. **12**, the columnar conductors T**1**A and T**1**C are arranged at the same position in a direction parallel to the Y direction. The columnar conductor T**1**B is arranged ahead of the columnar conductors T**1**A and T**1**C in the Y direction.

[0089] The columnar conductor T**1**A includes a first end T**1**Aa and a second end T**1**Ab that are located on sides opposite to each other in a direction parallel to the stacking direction T. The columnar conductor T**1**B includes a first end and a second end that are located on sides opposite to each other in a direction parallel to the stacking direction T. The columnar conductor T**1**C includes a first end and a second end that are located on sides opposite to each other in a direction parallel to the stacking direction T.

[0090] The columnar conductors T**2**A, T**2**B, and T**2**C are arrayed along the Z direction in the stated order. In the example shown in FIG. **12**, the columnar conductors T**2**A and T**2**C are arranged at the same position in a direction parallel to the Y direction. The columnar conductor T**2**B is arranged ahead of the columnar conductors T**2**A and T**2**C in the −Y direction.

[0091] The columnar conductor T**2**A includes a first end T**2**Aa and a second end T**2**Ab that are located on sides opposite to each other in a direction parallel to the stacking direction T. The columnar conductor T**2**B includes a first end and a second end that are located on sides opposite to each other in a direction parallel to the stacking direction T. The columnar conductor T**2**C includes a first end and a second end that are located on sides opposite to each other in a direction parallel to the stacking direction T.

[0092] The first end T**1**Aa of the columnar conductor T**1**A and the first end T**2**Aa of the columnar conductor T**2**A are electrically connected to the capacitor conductor layer C**1***b* forming the capacitor C**1**.

[0093] In the first modification example, the first main body **50** further includes two conductor layers **12** and **13** each extending along an orthogonal direction orthogonal to the stacking direction T. The conductor layers **12** and **13** are arranged between the capacitor conductor layer C**1***b* and the conductor layer **11**. The conductor layer **12** is arranged at a position closer to the capacitor conductor layer C**1***b* than the conductor layer **13**. The conductor layer **13** is arranged at a position closer to the conductor layer **11** than the conductor layer **12**.

[0094] The second end T**1**Ab of the columnar conductor T**1**A, the second end T**2**Ab of the columnar conductor T**2**A, the first end of the columnar conductor T**1**B, and the first end of the columnar conductor T**2**B are connected to the conductor layer **12**. The second end of the columnar conductor T**1**B, the second end of the columnar conductor T**2**B, the first end of the columnar conductor T**1**C, and the first end of the columnar conductor T**2**C are connected to the conductor layer **13**. The second end of the columnar conductor T**1**C and the second end of the columnar conductor T**2**C are connected to the conductor layer **11**.

[0095] Next, with reference to FIG. **13**, the second modification example is described. FIG. **13** is a side view showing a part of the internal structure of the first main body **50** in the second modification example. In the second modification example, the second columnar conductor T**2** is arranged ahead of the first columnar conductor T**1** in the −Z direction. The first end T**1***a* of the first columnar conductor T**1** is electrically connected to the capacitor conductor layer C**1***b*. The second end T**2***b* of the second columnar conductor T**2** is electrically connected to the conductor layer **11**.

[0096] In the second modification example, the first main body **50** includes a conductor layer **14** extending along an orthogonal direction orthogonal to the stacking direction T. In the second modification example, the second end T**1***b* of the first columnar conductor T**1** and the first end T**2***a* of the second columnar conductor T**2** are electrically connected to the conductor layer **14**.

[0097] Note that the disclosure is not limited to the exemplary embodiment described above, and various modifications can be made thereto. For example, the electronic component of the disclosure is applicable not only to a band-pass filter but also to other filters such as a low-pass filter and a high-pass filter, and is applicable to an electronic component including a plurality of resonators, such as a branching filter that splits a plurality of signals in different frequency bands.

[0098] As described above, an electronic component according to one embodiment of a first aspect of the disclosure includes a first main body including a plurality of dielectric layers being stacked together and a first element, a second main body being mounted to the first main body and including a second element, and a circuit including the first element and the second element. The first main body further includes a first columnar conductor extending in a direction parallel to a stacking direction of the plurality of dielectric layers and being connected to the ground. The first element is a capacitor including a capacitor conductor layer extending along an orthogonal direction orthogonal to the stacking direction. The capacitor conductor layer is arranged between the second element and the first columnar conductor.

[0099] In the electronic component according to one embodiment of the first aspect of the disclosure, the first main body may further include a first surface on which the second main body is mounted and a second surface opposite to the first surface. The first columnar conductor may be arranged between the capacitor conductor layer and the second surface.

[0100] In the electronic component according to one embodiment of the first aspect of the disclosure, the first columnar conductor may form an inductor. The circuit may further include the inductor.

[0101] In the electronic component according to one embodiment of the first aspect of the disclosure, the second element may be connected to the capacitor conductor layer.

[0102] In the electronic component according to one embodiment of the first aspect of the disclosure, the first main body may further include a first conductor layer extending along the orthogonal direction and a second columnar conductor extending in a direction parallel to the stacking direction. One end of the first columnar conductor and one end of the second columnar conductor may be connected to the first conductor layer. The first conductor layer and the capacitor conductor layer may face each other. The first main body may further include a second conductor layer extending along the orthogonal direction. The other end of the first columnar conductor and the other end of the second columnar conductor may be connected to the second conductor layer. The first columnar conductor and the second columnar conductor may form a first inductor and a second inductor, respectively. The circuit may further include the first inductor and the second inductor. The first inductor and the second inductor may be connected to each other in parallel.

[0103] In the electronic component according to one embodiment of the first aspect of the disclosure, the first main body may further include a first conductor layer extending along the orthogonal direction. A shape of the capacitor conductor layer when seen in the stacking direction may be similar to a shape of the first conductor layer when seen in the stacking direction.

[0104] In the electronic component according to one embodiment of the first aspect of the disclosure, the circuit may further include a sub circuit including a first signal port, a second signal port, and a signal path connecting the first signal port and the second signal port to each other. The first element and the second element may be connected to each other in series, and may be provided between the signal path and the ground in the circuit configuration. A resonance frequency of the sub circuit may be higher than a resonance frequency of the sub circuit in a case in which the first element is not provided.

[0105] In the electronic component according to one embodiment of the first aspect of the disclosure, the second main body may overlap with a part of the first element when seen in the stacking direction.

[0106] In the electronic component according to one embodiment of the first aspect of the disclosure, the second element may be an acoustic wave element.

[0107] An electronic component according to one embodiment of a second aspect of the disclosure includes a first main body including a plurality of dielectric layers, a capacitor, and an inductor, a second main body being mounted to the first main body and including an acoustic wave element, and a circuit. The circuit includes a first signal port, a second signal port, and a signal path connecting the first signal port and the second signal port to each other. The acoustic wave element is provided between the signal path and the ground in the circuit configuration. The capacitor and the inductor are connected to each other in series, and are provided between the acoustic wave element and the ground in the circuit configuration.

[0108] In the electronic component according to one embodiment of the second aspect of the disclosure, the inductor may include a plurality of inductor portions. In the circuit configuration, the plurality of inductor portions may be connected to each other in parallel.

[0109] In the electronic component in the first aspect of the disclosure, the capacitor conductor layer is arranged between the second element and the first columnar conductor. With this, according to the disclosure, the overall characteristics of the electronic component can be achieved as the desired characteristics.

[0110] In the electronic component in the second aspect of the disclosure, the capacitor and the inductor are connected to each other in series, and are provided between the acoustic wave element and the ground in the circuit configuration. With this, according to the disclosure, the overall characteristics of the electronic component can be achieved as the desired characteristics.

[0111] Based on the above description, obviously, various forms and modifications of the disclosure can be implemented. Thus, within the scope of the appended claims and equivalents thereof, the disclosure can be implemented in forms other than the above example embodiments.

## Claims

**1**. An electronic component comprising: a first main body including a plurality of dielectric layers being stacked together and a first element; a second main body being mounted to the first main body and including a second element; and a circuit including the first element and the second element, wherein the first main body further includes a first columnar conductor extending in a direction parallel to a stacking direction of the plurality of dielectric layers and being connected to a ground, the first element is a capacitor including a capacitor conductor layer extending along an orthogonal direction orthogonal to the stacking direction, and the capacitor conductor layer is arranged between the second element and the first columnar conductor.
**2**. The electronic component according to claim 1, wherein the first main body further includes a first surface on which the second main body is mounted and a second surface opposite to the first surface, and the first columnar conductor is arranged between the capacitor conductor layer and the second surface.
**3**. The electronic component according to claim 1, wherein the first columnar conductor forms an inductor, and the circuit further includes the inductor.
**4**. The electronic component according to claim 1, wherein the second element is connected to the capacitor conductor layer.
**5**. The electronic component according to claim 1, wherein the first main body further includes a first conductor layer extending along the orthogonal direction and a second columnar conductor extending in a direction parallel to the stacking direction, and one end of the first columnar conductor and one end of the second columnar conductor are connected to the first conductor layer.
**6**. The electronic component according to claim 5, wherein the first conductor layer and the capacitor conductor layer face each other.
**7**. The electronic component according to claim 5, wherein the first main body further includes a second conductor layer extending along the orthogonal direction, and the other end of the first columnar conductor and the other end of the second columnar conductor are connected to the second conductor layer.
**8**. The electronic component according to claim 5, wherein the first columnar conductor and the second columnar conductor form a first inductor and a second inductor, respectively, the circuit further includes the first inductor and the second inductor, and the first inductor and the second inductor are connected to each other in parallel.
**9**. The electronic component according to claim 1, wherein the first main body further includes a first conductor layer extending along the orthogonal direction, and a shape of the capacitor conductor layer when seen in the stacking direction is similar to a shape of the first conductor layer when seen in the stacking direction.
**10**. The electronic component according to claim 1, wherein the circuit further includes a sub circuit including a first signal port, a second signal port, and a signal path connecting the first signal port and the second signal port to each other, the first element and the second element are connected to each other in series, and are provided between the signal path and the ground in a circuit configuration, and a resonance frequency of the sub circuit is higher than a resonance frequency of the sub circuit in a case in which the first element is not provided.
**11**. The electronic component according to claim 1, wherein the second main body overlaps with a part of the first element when seen in the stacking direction.
**12**. The electronic component according to claim 1, wherein the second element is an acoustic wave element.
**13**. An electronic component comprising: a first main body including a plurality of dielectric layers, a capacitor, and an inductor; a second main body being mounted to the first main body and including an acoustic wave element; and a circuit, wherein the circuit includes a first signal port, a

second signal port, and a signal path connecting the first signal port and the second signal port to each other, the acoustic wave element is provided between the signal path and a ground in a circuit configuration, and the capacitor and the inductor are connected to each other in series, and are provided between the acoustic wave element and the ground in the circuit configuration.

**14**. The electronic component according to claim 13, wherein the inductor includes a plurality of inductor portions, and the plurality of inductor portions are connected to each other in parallel in the circuit configuration.