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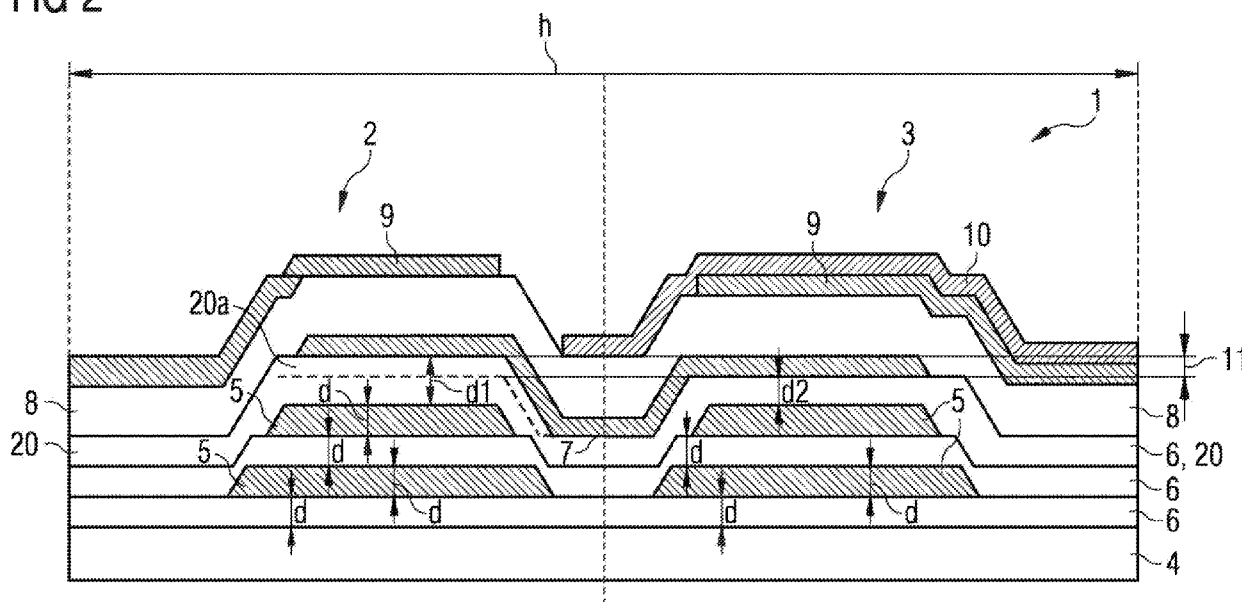
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FIG 2



(57) Abstract: A filter component (1) for the suppression of parasitic passbands is described which has a substrate (4), at least one parallel resonator (3) in each case designed as a volume wave resonator, a plurality of reflector layers (5, 6), wherein the reflector layers (5, 6) are arranged as a stack on the substrate (4), and wherein the parallel resonator (3) and the series resonator (2) are formed on the stack of reflector layers (5, 6), wherein the stack of reflector layers (5, 6) has a different layer thickness in the parallel resonator (3) section and in the series resonator (2) section. In addition, a method is described for manufacturing a filter component.

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FILTER COMPONENT AND MANUFACTURE OF A FILTER COMPONENT

PRIORITY CLAIM

The present Application for Patent claims benefit of and priority to German Patent Application No. 102016116263.9, filed August 31, 2016, the content of which is hereby expressly incorporated by reference in its entirety.

Description

The present invention relates to a filter component with suppression of parasitic passbands. The invention also relates to the manufacture of a filter component with suppression of parasitic passbands.

Volume wave resonators used in industry have two basically different designs: diaphragm resonators which have, for example, a cavity beneath the bottom electrode (FBAR or film bulk acoustic resonators), and solidly mounted resonators (SMR) on a Bragg reflector (alternating $\lambda/4$ layers of high and low acoustic impedance) which prevents the propagation of acoustic energy in the direction of the substrate (low transmission).

In addition to the main resonance (longitudinal TE₁ mode), SMR resonators have harmonics at higher frequencies, but also still other modes (resonances) whose energy is essentially localized in the reflector layers (so-called reflector modes). These modes can result in unwanted sidebands in addition to the actual passband, so-called parasitic passbands.

Since tight specifications for selection levels typically apply above the filter passband, one important design aspect is to allow these modes only when they are far from specification limits or to suppress them, although this does restrict other degrees of design freedom (dispersion behavior of the stack, reflector reflectivities, thermal behavior, and so on).

One problem to be solved is to provide an improved filter component for the suppression of parasitic passbands. In addition, the manufacture of an improved filter component for the suppression of parasitic passbands is to be described.

This problem is solved by a device and also a method of manufacture according to the independent claims.

According to one aspect a filter component is described. The filter component is a bandpass filter. The filter component is designed to suppress parasitic passbands. In particular, the filter component is designed such that resonances occurring in addition to the main resonance are effectively suppressed or routed out of the system.

The filter component has a substrate. The substrate serves as a carrier element for other components of the filter component. The substrate is a component that provides the system's mechanical stability. The substrate contains silicon, for example.

The filter component also has SMR resonators. In particular, the filter component has at least one parallel resonator, preferably a plurality of parallel resonators. These are also referred to below as P resonators. The filter

component has at least one series resonator, preferably a plurality of series resonators, also referred to below as S resonators. The S or P resonators take the form of volume wave resonators. The filter component has, for example, a so-called ladder-type structure or a lattice structure. In particular, the filter component has at least one series branch. The series branch connects a signal input to a signal output. The filter component also has at least one parallel branch. The parallel branch branches off from the series branch to ground. A P resonator is arranged in each parallel branch. Preferably a plurality of S resonators is connected in series in every series branch.

The filter component has a plurality of Bragg reflectors or reflector layers. The reflector layers are arranged on the substrate. The reflector layers are arranged in a stack. The reflector layers are used for preventing the propagation of acoustic energy in the direction of the substrate.

The parallel resonator and the series resonator are formed on the stack of the reflector layers. In other words, the stack of reflector layers is located between the substrate and the resonators. The resonators thus share a common stack of reflector layers.

The stack of reflector layers has a layer thickness or a vertical extension. In the section of the at least one parallel resonator, the stack has a different layer thickness from that in the section of the at least one series resonator. Consequently, the stack of reflector layers has a layer thickness difference between the series resonator section and the parallel resonator section. To put it another way, the stack of reflector layers in the one

resonator section is higher than in the other resonator section.

Due to the different reflector layer thicknesses of the parallel resonator and the series resonator, undesirable passbands can be reduced in their transmittance. Parasitic passbands, such as reflector-mode passbands, can thus be specifically suppressed. A particularly effective filter component is thereby created.

According to one embodiment, the reflector layers have at least one displacement reflector layer. The reflector layers can also have more than one displacement reflector layer, for example, two or three displacement reflector layers. Parallel resonator and series resonator share the displacement reflector layer. The displacement reflector layer in the series resonator section has a first layer thickness. The displacement reflector layer in the parallel resonator section has a second layer thickness. The first and second thicknesses are different or not of the same size.

Preferably, the first thickness of the displacement reflector layer is greater than the second thickness of the displacement reflector layer. In other words, the displacement reflector layer in the series resonator section is thicker than in the parallel resonator section. Consequently, the stack of reflector layers in the series resonator section has a greater layer thickness than in the parallel resonator section. The first thickness may be, for example, 1.05 times, 1.2 times, 1.5 times or 2 times the second thickness of the displacement reflector layer.

A reflector layer of varying thickness is introduced into the stack by the displacement reflector layer. In

particular, the thickness of this reflector layer varies between a section of the stack of reflector layers assigned to a P resonator and a section assigned to an S resonator. By changing the thickness of one of the reflector layers and thus of the entire stack of reflector layers, reflector modes can be selectively shifted.

According to one embodiment, the reflector layers have at least one reflector layer of high acoustic impedance. Tungsten, for example, is a constituent of the reflector layer of high acoustic impedance. In addition, the reflector layers have at least one reflector layer of low acoustic impedance. Silicon dioxide, for example, is a constituent of the reflector layer of low acoustic impedance. Reflector layers of high and low acoustic impedance are arranged one above the other to form the stack.

A reflector layer of low acoustic impedance is preferably arranged directly adjacent to the substrate or on the substrate. A reflector layer of low acoustic impedance is preferably arranged directly adjacent to the resonators. In other words, the resonators are arranged on a reflector layer of low acoustic impedance. The displacement reflector layer preferably has a reflector layer of low acoustic impedance. Tungsten is preferably a constituent of the displacement reflector layer.

A reflector layer of low acoustic impedance has a high sensitivity to the reflector modes which occur. In particular, the sensitivity of reflector layers of low acoustic impedance is considerably higher with reflector modes than with main modes. Even just a slight change in the thickness of a reflector layer in a resonator type

section (the P resonator, for example) can thus have a marked effect on the frequency of the reflector mode of the resonator in question. This causes a shift in the frequency of the reflector layers of the P resonator.

For example, the displacement reflector layer lies immediately adjacent to the parallel resonator and the series resonator. To put it another way, the resonators can be formed directly on the displacement reflector layer. In this case the displacement reflector layer represents the topmost layer of the stack of reflector layers. The topmost layer of the stack has a high acoustic energy at reflector-mode frequencies. In addition, the proximity of this layer to the piezo-layer encourages the displacement of the reflector-mode frequencies. A displacement reflector layer, which represents the topmost layer of the stack of reflector layers, is thus particularly suitable for suppressing parasitic passbands.

As an alternative, the displacement reflector layer can however also directly adjoin the substrate. In other words, the displacement reflector layer can be located directly on an upper face of the substrate and the other reflector layers be located above that displacement reflector layer. In this case the displacement reflector layer represents the bottom layer of the stack of reflector layers.

Alternatively, the displacement reflector layer can be located between two reflector layers of high acoustic impedance. In this case, a layer inside the stack of reflector layers represents the displacement reflector layer.

Due to the deliberately different layer thicknesses for individual resonators (series resonator and parallel resonator) in layers in which the sensitivity of the frequency position to reflector-layer variations differs in the case of wanted modes (longitudinal TE₁ mode, for example) and unwanted modes (reflector modes, for example), the filter characteristic is changed such that the unwanted modes are effectively suppressed.

According to one embodiment, the filter component has a horizontal extension or width. The displacement reflector layer extends over the entire horizontal extension of the filter component. This ensures that the layer-thickness variation of the stack of reflector layers applies to the sections of all resonators.

According to one embodiment, the displacement reflector layer is so designed and arranged that reflector modes occurring in the parallel resonator are shifted to frequencies above the reflector modes occurring in the series resonator. In other words, the displacement reflector layer has a material, a thickness, a width and/or a position within the stack or the filter component by means of which frequency displacement of the reflector modes of the parallel resonator is effected. Due to the displacement reflector layer the reflector modes thus become a bandstop or a notch filter which is no longer critical for the specification limits.

According to a further aspect of the invention, a method is given for manufacturing a filter component for the suppression of parasitic passbands. The filter component described above is preferably manufactured by this method.

All features which were described in connection with the filter component also apply to the method and vice versa.

The process has the following steps:

- Provision of a substrate. A mechanically stabilizing carrier is provided. Silicon is, for example, a constituent of the substrate. In the finished filter component the substrate preferably forms a base of the filter component.
- Provision of reflector layers. The reflector layers have reflector layers of high and low acoustic impedance. Furthermore, the reflector layers have at least one displacement reflector layer.
- Alternating arrangement of the reflector layers on the substrate. Reflector layers of high and low acoustic impedance are arranged alternately on the substrate. For example, the displacement reflector layer is arranged at a maximum distance from the substrate. However, other positions of the displacement reflector layer within the stack are also possible.
- Formation of at least one parallel resonator and at least one series resonator on the reflector layers. The completed filter component preferably has a plurality of parallel and series resonators. The resonators are formed on a shared stack of reflector layers.

In the series resonator section the displacement reflector layer has a first layer thickness and in the parallel resonator section a second layer thickness. The first and second layer thicknesses are different. This means that the stack of reflector layers in the one resonator type section

(the series resonator, for example) has a different layer thickness to that in the other resonator type section (the parallel resonator, for example). Reflector modes are effectively suppressed by the selectively different layer thicknesses for parallel and series resonators.

According to one embodiment, the displacement reflector layer has a smaller thickness in the parallel resonator section than in the series resonator section. In other words, the second layer thickness is smaller than the first layer thickness.

According to one embodiment, the different layer thicknesses of the displacement reflector layer are achieved by reducing the layer thickness of the displacement reflector layer in the parallel resonator section. For example, the second layer thickness in the parallel resonator section is reduced by structuring the displacement reflector layer (by photolithography or etching). In particular, the different layer thicknesses of the displacement reflector layer can be created by etching the displacement reflector layer in the region of the parallel resonator. Alternatively, the different layer thicknesses of the displacement reflector layer can be formed, for example, by applying an additional layer to the displacement reflector layer in the series resonator section, for example, by means of photolithography (separate deposition and structuring).

The drawings described below should not be regarded as drawn to scale. On the contrary, some dimensions may have been enlarged, reduced or even distorted for the sake of an improved representation.

Elements which resemble each other or have the same function are designated by the same reference numbers.

The drawings show:

Figure 1 a broadband measurement of a bandpass filter in SMR technology with reflector modes,

Figure 2 a schematic representation of a filter component,

Figure 3 admittance curves of main and reflector modes for S resonators and P resonators,

Figure 4 admittance curves of main and reflector modes for S resonators and P resonators,

Figure 5 a transmission curve of a bandpass filter with main and secondary passbands.

Figure 1 shows a broadband measurement of a filter component in SMR technology with reflector modes. The passband 30 and also reflector modes 31 are shown. The dashed curve 32 shows the target design in which the reflector mode 31 lies within a range of relaxed selection specification 34. The dotted curve 33 shows a variation of the frequency position of the mode 31 with (reflector) layer thickness variation according to prior art which results in an infringement of the specification 34.

According to prior art, a frequency displacement can only be avoided by close tolerances in layer thickness variation even in the reflector, or the intensity of the mode can be reduced by changing the design of the stack,

which can however be in conflict with other optimization objectives.

Figure 2 shows a schematic representation of a filter component according to the invention. The filter component 1 has a substrate 4. Silicon (Si) may, for example, be a constituent of the substrate 4. The filter component 1 takes the form of an SMR on a Bragg reflector. In particular, the filter component 1 has Bragg reflectors or reflector layers 5, 6. The reflector layers 5, 6 are arranged or stacked on the substrate 4.

The reflector layers 5, 6 are divided into reflector layers of high acoustic impedance 5 and of low acoustic impedance 6. The reflector layers of high and low acoustic impedance 5, 6 are here preferably arranged in alternation. Tungsten (W), for example, is a constituent of the reflector layers of high acoustic impedance 5. SiO₂, for example, is a constituent of the reflector layers of low acoustic impedance 6. The individual reflector layers 5, 6 have a thickness or vertical extension d. In particular, the thickness d denotes the extension of the corresponding reflector layer 5, 6 in the stack direction. Here different reflector layers 5, 6 can also have different thicknesses d.

The reflector layers of low acoustic impedance 6 in this embodiment cover the full area of the component. This means that the reflector layers 6 (in particular here the lowest reflector layer 6) fully cover the surface of the substrate 4. A surface area of the reflector layer 6 is equal to the surface area of the substrate 4. In other words, the reflector layer of low acoustic impedance 6 extends over the full width or horizontal extension h of the filter component 1.

The reflector layers of high acoustic impedance 5 on the other hand cover a smaller surface area than the reflector layers of low acoustic impedance 6. In particular, a reflector layer of high acoustic impedance 5 arranged on a reflector layer of low acoustic impedance 6 does not fully cover but only partially covers a surface of the reflector layer of low acoustic impedance. In other words, the reflector layer of high acoustic impedance 5 does not extend over the full width of the filter component 1. The reflector layer 5 is thus formed of sections or partial areas, as can be seen from Figure 2.

The filter component 1 has a so-called ladder-type structure. A ladder-type filter component comprises at least one serial branch which connects a signal input to a signal output. In addition, the filter component has at least one parallel branch which branches off from the series branch to ground. A parallel resonator or P resonator 3 is arranged in every parallel branch and at least one or a plurality of series resonators or S resonators 2 is connected in series in every series branch.

In this case, for reasons of clarity, only one P resonator 3 and one S resonator 2 is shown in Figure 2. Naturally the filter component 1 preferably has a plurality of P resonators 3 and of S resonators 2 which are arranged as described above.

The particular resonator 2, 3 is located on the layer stack of reflector layers 5, 6. The reflector layers 5, 6 are in particular located between the resonators 2, 3 and the substrate 4. The P resonator 3 and the S resonator 2 share the reflector layers 5, 6. In other words, the P resonator

3 and the S resonator 2 are formed on a shared stack of reflector layers 5, 6.

Each resonator 2, 3 has a piezoelectric layer 8, on top of and beneath of which electrode layers 7, 9 are arranged at least partially overlapping in order to excite mechanical vibrations. Each resonator 2, 3 has in particular a lower bottom electrode 7. In the present case, the resonators 2, 3 share the bottom electrode 7. AlCu or W, for example, are constituents of the lower bottom electrode 7. AlN is preferably a constituent of the piezoelectric layer 8. In addition, each resonator 2, 3 has a top electrode 9. AlCu or W, for example, are constituents of the top electrode 9. The piezo-layer 8 lies between the bottom electrode 7 and the top electrode 9.

The P resonator 3 has a ground layer 10. SiO₂, for example, may be a constituent of the ground layer 10 but other materials are also conceivable for the ground layer 10. In this embodiment, the ground layer 10 is disposed on the top electrode 9 of the P resonator 3. In addition, the ground layer 10 is in the present case disposed at least partially on the piezo-layer 8 of the P resonator 3. However, the ground layer 10 can of course be implemented in a different position in the stack of layers.

Due to the additional ground layer 10 the P resonator 3 is shifted to lower frequencies than the S resonator 2 (see the dashed curve 35 for the S resonators and the dotted curve 36 for the P resonators in Figure 3 and 4). The ladder-type circuitry of filter component 1 then results in bandpass behavior.

Since the reflector modes of the P resonators 3 also occur at lower frequencies than those of the S resonators 2 a second passband (reflector mode) is created, which is unwanted. In the filter component 1 according to the invention the S resonator 2 and P resonator 3 have different reflector layer thicknesses in order to suppress or remove the second passband. In other words, the stack of reflector layers 5, 6 has a layer thickness difference 11 in the P resonator 3 section than in the S resonator section.

In particular the reflector layers 5, 6 have at least one so-called displacement reflector layer 20. A plurality of displacement reflector layers 20, for example, two, three or four displacement reflector layers 20, is also conceivable.

The displacement reflector layer 20 is essentially a conventional Bragg reflector layer, characterized however by the layer thickness of this one special layer being different in the P resonator 3 section and the S resonator 2 section. In other words, the displacement reflector layer 20 which the P resonator 3 and the S resonator 2 share has a different or a second thickness d_2 in the P resonator 3 section than in the S resonator 2 section (first thickness d_1). The displacement reflector layer 20 has a varying layer thickness d_1 , d_2 , whereby the layer thickness varies in a direction perpendicular to the stack direction of the reflector layers 5, 6.

For example, the displacement reflector layer 20 has a smaller thickness d_2 in the P resonator 3 section than in the S resonator 2 section. For example, the second thickness d_2 in the P resonator 3 section is half as large

as the first thickness d_1 of the displacement reflector layer 20 in the S resonator 2 section. The difference between the first thickness d_1 and the second thickness d_2 preferably lies in the nanometer range. The first thickness d_1 is preferably ≤ 100 nm, for example, ≤ 10 nm, greater than the second thickness d_2 . In other words, the layer thickness difference 11 is smaller in comparison with the absolute layer thicknesses d of the reflector layers 5, 6. In particular, the layer thickness difference 11 lies in the nm range, preferably at less than or equal to 100 nm, for example, 10 nm, 20 nm, 30 nm or 50 nm.

In contrast to the displacement reflector layer 20, each of the other reflector layers 5, 6 has the same thickness d in the P resonator 3 and S resonator 2 sections. In other words, each of the other reflector layers 5, 6 in the P resonator 3 section has a thickness d which corresponds to the thickness d of the respective reflector layer 5, 6 in the S resonator 2 section.

The different layer thicknesses d_1 , d_2 of the displacement reflector layer 20 in the P resonator 3 and S resonator 2 sections can, for example, be created by etching the displacement reflector layer 20 in the P resonator 3 section. A lower thickness d_2 is thus created in the P resonator 3 section than in the S resonator 2 section.

The different layer thicknesses d_1 , d_2 of the displacement reflector layer in the P resonator 3 and S resonator sections can alternatively be created by applying a separate or additional layer 20a to the displacement reflector layer 20 in the S resonator 2 section by, for example, photolithography. The thickness of the displacement reflector layer 20 can even be increased by a

second deposition step in the S resonator 2 section. This creates a greater thickness d_1 in the S resonator 2 section than in the P resonator 3 section.

The displacement reflector layer 20 is preferably a reflector layer of low acoustic impedance. SiO_2 is preferably a constituent of the displacement reflector layer 20. The displacement reflector layer 20 preferably extends over the full width of the filter component 1.

The displacement mirror layer 20 can represent the 'topmost' reflector layer. In other words, the displacement reflector layer 20 can be configured to lie adjacent, preferably directly adjacent, to the respective resonator 2, 3. Alternatively, however, the displacement reflector layer 20 can also represent the 'lowest' reflector layer. In other words, the displacement reflector layer 20 can be arranged adjacent, preferably directly adjacent, to the substrate 4. Alternatively, however, the displacement reflector layer 20 can also represent the 'middle' reflector layer. In other words, the displacement reflector layer 20 can be given any vertical position in the layer stack of the mirror layers 5, 6. The decisive factor is only the variation in the layer thickness of the displacement reflector layer 20.

The sensitivity of certain reflector layers 5, 6, for example, of the upper reflector oxide, is significantly higher in the reflector modes than the main modes. If the layer thickness d , for example, of the upper reflector oxide, is now only slightly varied or reduced by means of the form taken by the displacement reflector layer 20 and, for example, as shown in Figure 2, with this only applying to the P resonator 3 section, the reflector mode of the P

resonator 3 can be shifted to frequencies above the reflector mode of the S resonator 2, as may be seen from the solid curve 37 in Figures 3 and 4.

In this way, the parasitic reflector mode passband becomes a notch filter or bandstop, as shown in Figure 5. Here the solid curve 38 represents the parasitic reflector mode passband in the standard case (prior art) and the dashed curve 39 represents the notch due to displacement of the reflector modes of the P resonators to frequencies above the reflector modes of the S resonators.

By means of different layer thicknesses for individual resonators 2, 3 of a filter 1 in layers in which the sensitivity of the frequency position to layer thickness variation in desired modes (longitudinal TE₁ mode, for example) and unwanted modes (reflector modes, for example) differs, the filter characteristic is consequently suitably changed so as to reduce unwanted passbands in its transmittance.

By adjusting a thickness or vertical extension of the ground layer 10 a minimal bandwidth variation thereby arising can easily be compensated by the frequency displacement of the main mode of the P resonator 3. Alternatively, however, this can also be done by frequency trimming.

A method for manufacturing a filter component 1, in particular the filter component 1 described in connection with Figure 2, is described below. All features which were described in connection with the filter component 1 also apply to the method and vice versa.

In one step, a substrate 4, for example Si, is provided. The substrate 4 serves as a carrier element of the filter component 1.

In one step, volume wave resonators are provided. In particular, the filter component 1 produced by the method has at least one P resonator 3, preferably a plurality of P resonators 3, and at least one S resonator 2, preferably a plurality of S resonators 2. The resonator 2, 3 in question has an active or piezoelectric layer 8 arranged between electrodes 7, 9.

In a further step, reflector layers 5, 6 are provided. The reflector layers have reflector layers of high acoustic impedance 5 and low acoustic impedance 6. The reflector layers 5, 6 are arranged alternately one above the other on the substrate 4. A reflector layer of low acoustic impedance 6 is preferably formed directly on the substrate 4, for example by a deposition method (by photolithography, for example). The reflector layer of low acoustic impedance 6 is preferably formed so as to be continuous over the substrate 4. In other words, the reflector layer 6 fully covers the substrate 4.

Next a reflector layer of high acoustic impedance 5 is deposited on the reflector layer of low acoustic impedance 6. The reflector layer of high acoustic impedance 5 is preferably applied to the reflector layer of low acoustic impedance 6 such that a surface of the reflector layer 6 is only partially covered by the reflector layer 5. In other words, the reflector layer 5 is not continuous in form. The reflector layer 5 rather consists of several partial sections. The number of partial sections of the reflector

layer 5 preferably corresponds to the number of resonators 2, 3 in the filter component 1.

In addition, the reflector layers 5, 6 include a displacement reflector layer 20. The displacement reflector layer 20 is preferably a reflector layer of low acoustic impedance. In this case, the P and S resonators 2, 3 share the displacement mirror layer 20. In other words, a common displacement reflector layer 20 is assigned to the resonators 2, 3. The displacement reflector layer 20 preferably extends over the full width of the filter component 1.

The displacement reflector layer 20 has a different layer thickness d_1 , d_2 in the P resonator 3 section and the S resonator 2 section. In particular, the layer thickness d_2 of the displacement reflector layer 20 is smaller in the P resonator 3 section than the layer thickness d_1 in the S resonator 2 section.

The different layer thicknesses d_1 , d_2 of the displacement reflector layer are created by, for example, etching the displacement reflector layer 20 in the P resonator 3 section. Alternatively, the different layer thicknesses d_1 , d_2 are formed by carrying out a second deposition step or by applying an additional layer 20a to the displacement reflector layer 20 in the S resonator 2 section.

The displacement reflector layer 20 is preferably arranged at a maximum distance from the substrate 4. In other words, the displacement reflector layer 20 is applied directly to the resonators 2, 3 and adjacent to the other reflector layers 5, 6. Alternatively any other position of the

displacement reflector layer 20 within the stack of reflector layers 5, 6 is also conceivable.

The description of the objects given here is not limited to the individual specific embodiments.

Instead the features of the individual embodiments can be arbitrarily combined as far as is technically meaningful.

List of reference numbers

- 1 Filter component
- 2 S resonator / series resonator
- 3 P resonator / parallel resonator
- 4 Substrate
- 5 Reflector layers of high acoustic impedance
- 6 Reflector layers of low acoustic impedance
- 7 Bottom electrode
- 8 Piezo-layer
- 9 Top electrode
- 10 Ground layer
- 11 Layer thickness difference

- d Layer thickness
- d1 First layer thickness
- d2 Second layer thickness
- h Horizontal extension

- 20 Displacement reflector layer
- 20a Additional layer

- 30 Passband
- 31 Reflector modes
- 32 Curve
- 33 Curve
- 34 Selection specification
- 35 Curve
- 36 Curve
- 37 Curve
- 38 Curve
- 39 Curve

Claims

1. Filter component (1) for the suppression of parasitic passbands comprising:

- a substrate (4),
 - at least one parallel resonator (3) and at least one series resonator (2) in each case designed as a volume wave resonator,
 - a plurality of reflector layers (5, 6) whereby the reflector layers (5, 6) are arranged as a stack on the substrate (4), and whereby the parallel resonator (3) and the series resonator (2) are formed on the stack of reflector layers (5, 6),
- wherein the stack of reflector layers (5, 6) has a different layer thickness in the parallel resonator (3) section and the series resonator (2) section.

2. Filter component (1) according to Claim 1, wherein the reflector layers (5, 6) have at least one displacement reflector layer (20), wherein the displacement reflector layer (20) has a first layer thickness (d1) in the S resonator (2) section and a second layer thickness (d2) in the P resonator (3) section, and wherein the first and second layer thicknesses (d1, d2) are different.

3. Filter component (1) according to Claim 2, wherein the first thickness (d1) of the displacement reflector layer (20) is greater than the second thickness (d2) of the displacement reflector layer (20).

4. Filter component (1) according to one of Claims 2 or 3, wherein the reflector layers (5, 6) have at least one reflector layer of high acoustic impedance (5) and one

reflector layer of low acoustic impedance (6), and wherein the displacement reflector layer (20) has a reflector layer of low acoustic impedance.

5. Filter component (1) according to any of Claims 2 to 4, wherein the displacement reflector layer (20) lies immediately adjacent to the parallel resonator (3) and the series resonator (2).

6. Filter component (1) according to any of Claims 2 to 4, wherein the displacement reflector layer (20) directly adjoins the substrate (4).

7. Filter component (1) according to Claim 4, wherein the displacement reflector layer (20) is located between two reflector layers of high acoustic impedance (5).

8. Filter component (1) according to any of Claims 2 to 7, wherein the filter component (1) has a horizontal extension (h), and wherein the displacement reflector layer (20) extends over the full horizontal extension (h) of the filter component (1).

9. Filter component (1) according to any of Claims 2 to 8, wherein the displacement reflector layer (20) is so designed and arranged that the transmittance is reduced by the reflector modes (31) generated by the reflector layers (5, 6).

10. Filter component (1) according to any of Claims 2 to 9, wherein the displacement reflector layer (20) is so designed and arranged that reflector modes (31) occurring in the parallel resonator (3) are shifted to frequencies

above the reflector modes (31) occurring in the series resonator (2).

11. Method for manufacturing a filter component (1) for the suppression of parasitic passbands comprising the following steps:

- Provision of a substrate (4);
- Provision of reflector layers (5,6) wherein the reflector layers (5, 6) have at least one displacement reflector layer (20),
- Alternating arrangement of the reflector layers (5, 6, 20) on the substrate (4);
- Creation of at least one parallel resonator (3) and at least one series resonator (2) on the reflector layers (5, 6, 20),

wherein the displacement reflector layer (20) has a first layer thickness (d1) in the S resonator (2) section and a second layer thickness (d2) in the P resonator (3) section, wherein the first and second layer thicknesses (d1, d2) are different.

12. Method according to Claim 11,
wherein the different layer thicknesses (d1, d2) of the displacement reflector layer (20) are created by etching the displacement reflector layer (20) in the P resonator (3) section.

13. Method according to Claim 11,
wherein the different layer thicknesses (d1, d2) of the displacement reflector layer (20) are created by applying an additional layer (20a) to the displacement reflector layer (20) in the S resonator (2) section.

14. Method according to any of Claims 11 to 13,

wherein the displacement reflector layer (20) is arranged at a maximum distance from the substrate (4).

FIG 1

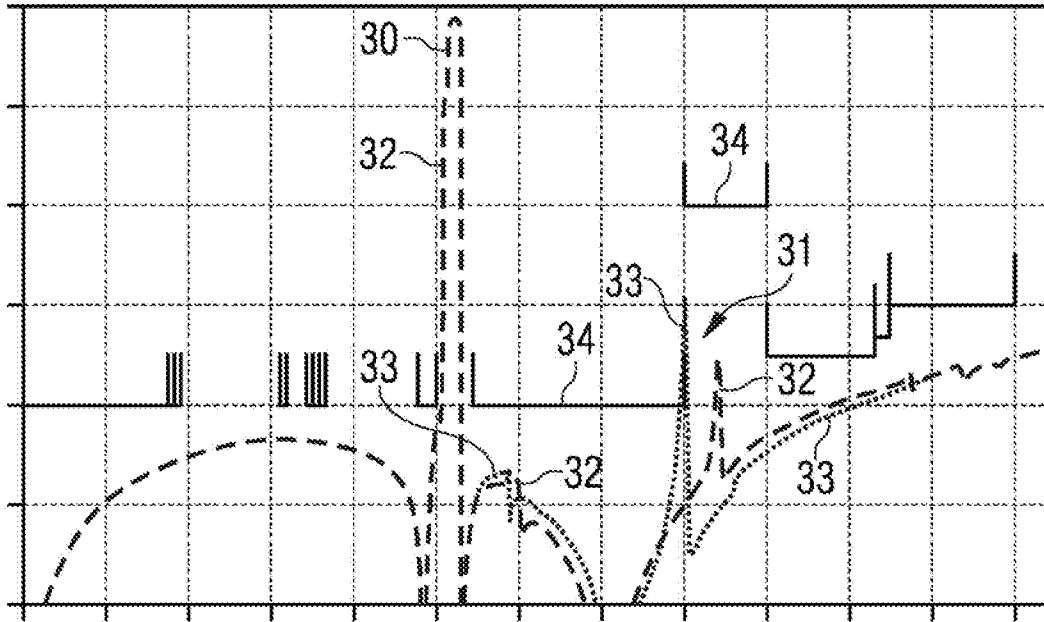


FIG 2

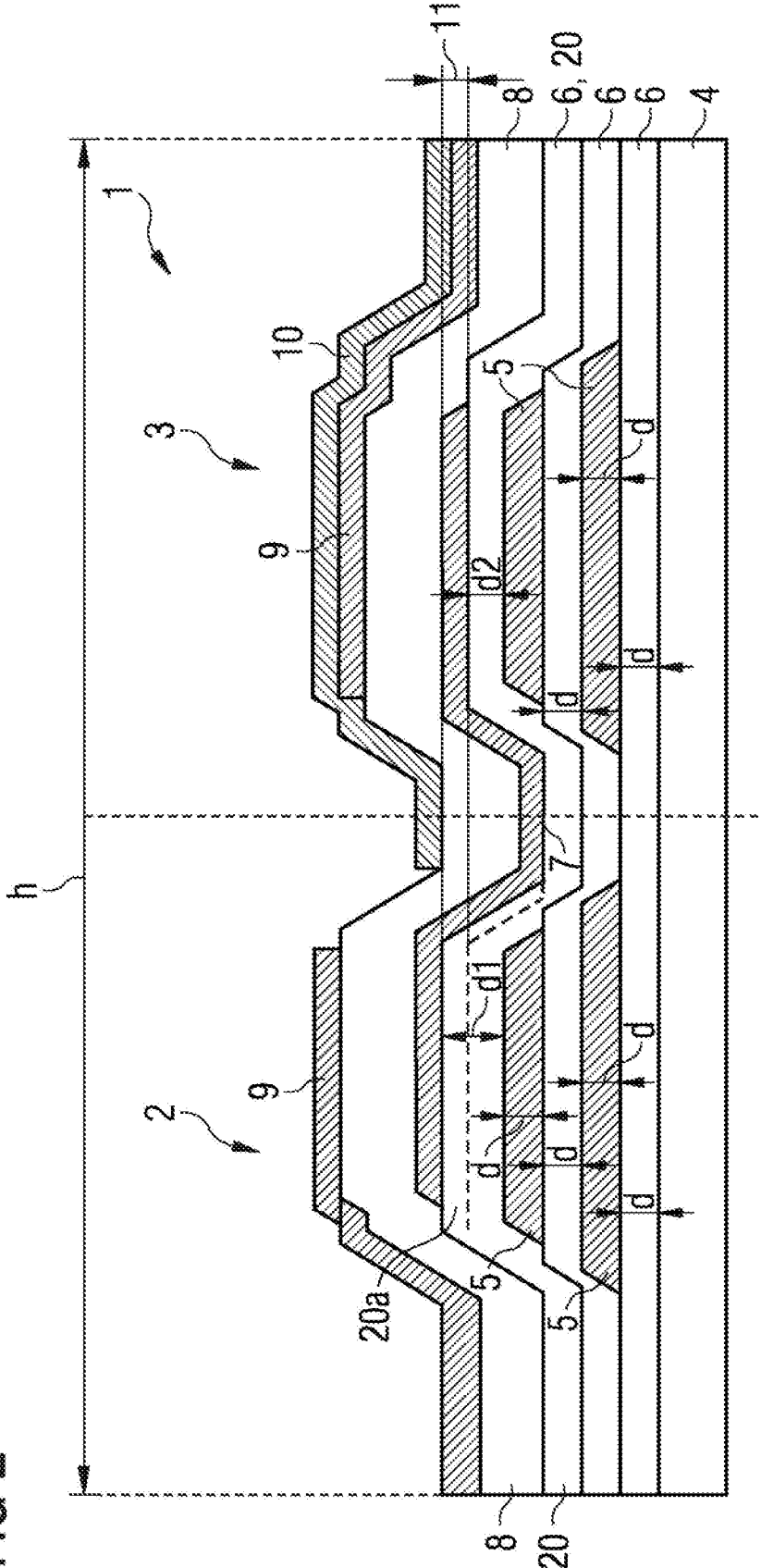


FIG 3

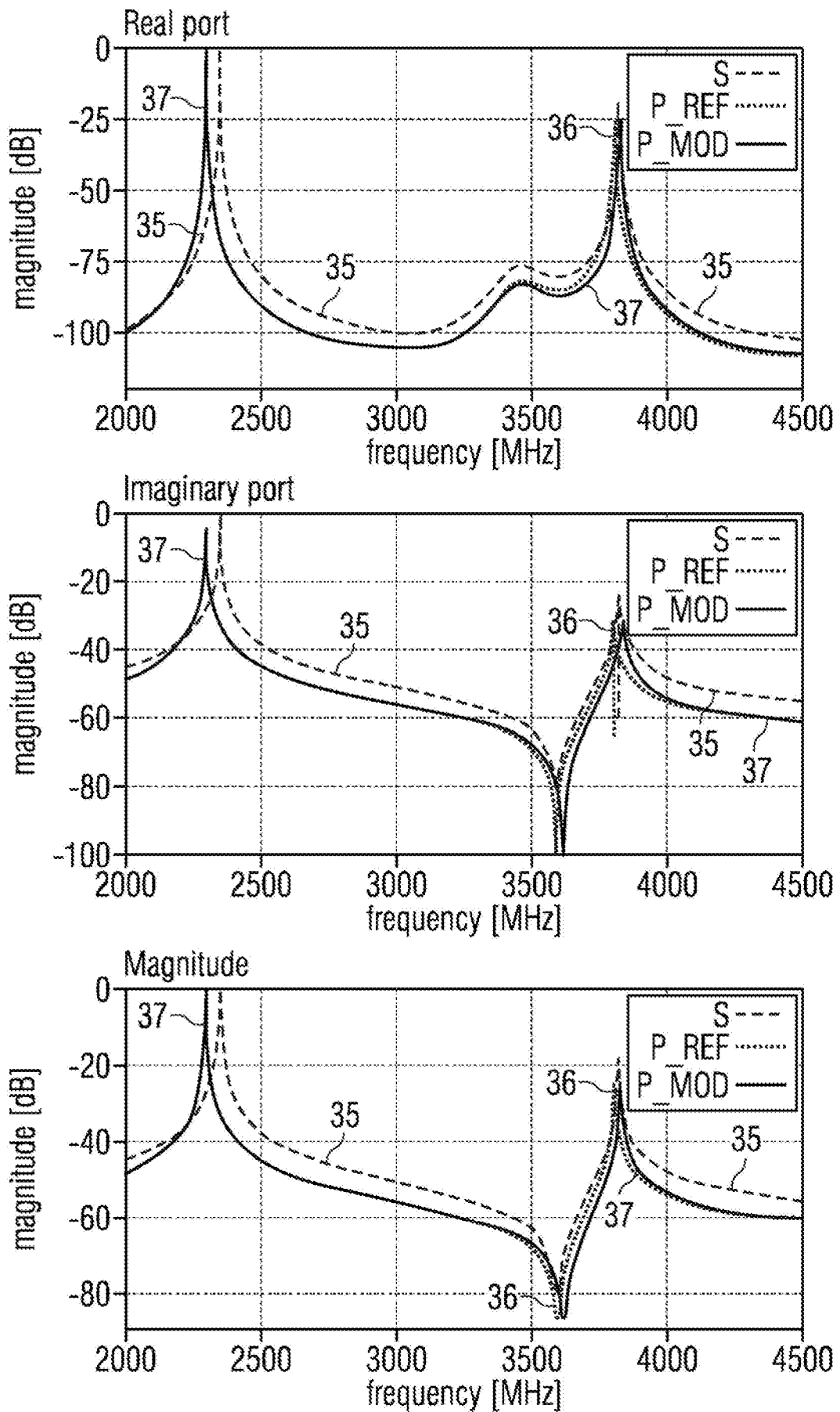


FIG 4

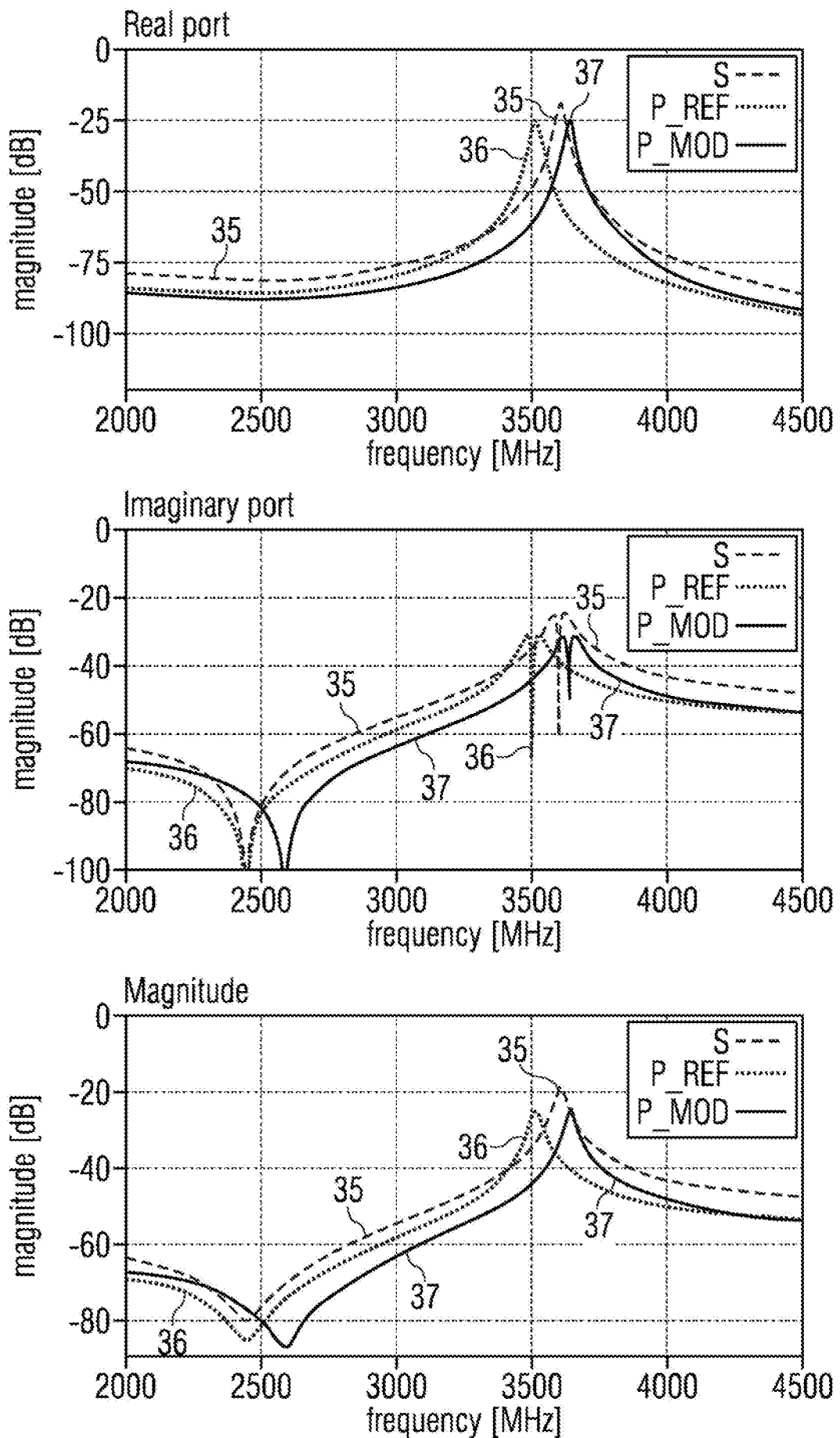
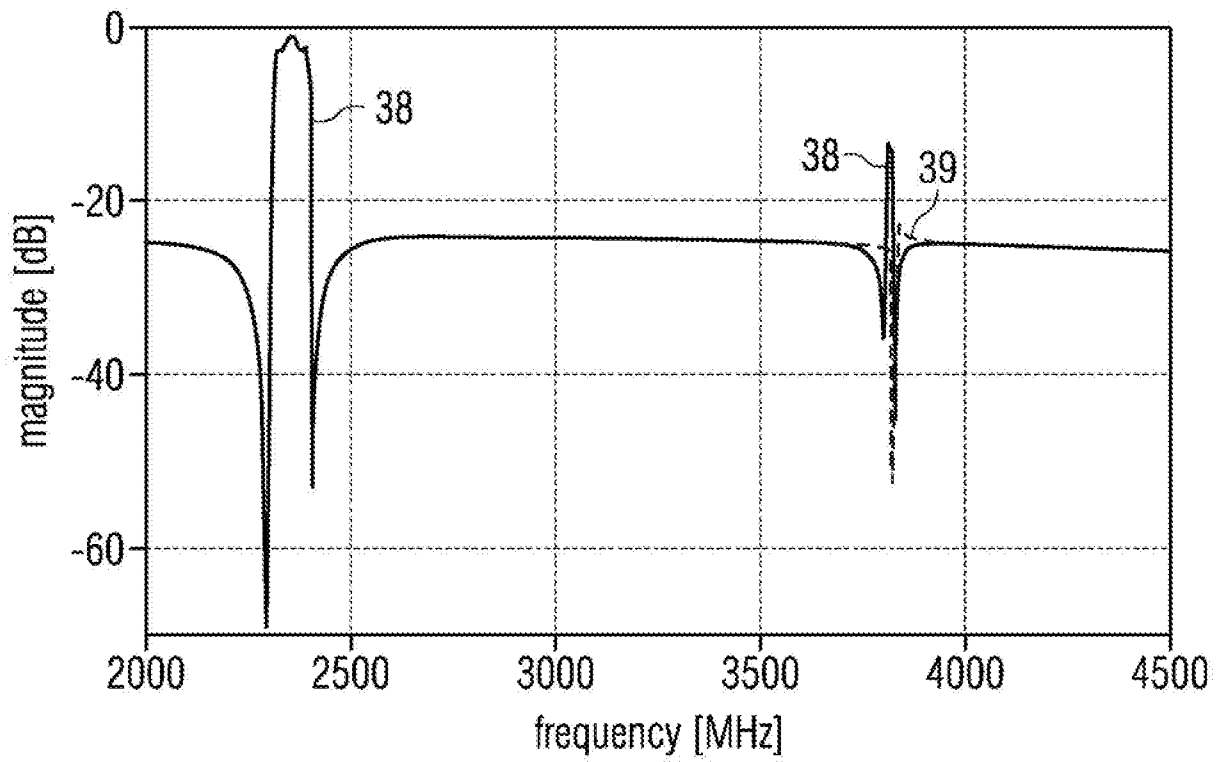


FIG 5



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/046792A. CLASSIFICATION OF SUBJECT MATTER
INV. H03H9/56 H03H9/58
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H03H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 575 165 A1 (INFINEON TECHNOLOGIES AG [DE]) 14 September 2005 (2005-09-14) paragraphs [0038] - [0039]; figure 4 -----	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

6 November 2017

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/046792

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
EP 1575165	A1	14-09-2005	CN 1667947 A	14-09-2005
			EP 1575165 A1	14-09-2005
			JP 4318653 B2	26-08-2009
			JP 2005260964 A	22-09-2005
			US 2005200433 A1	15-09-2005
