

Description

Background of the invention

The present invention is related generally to radio frequency (RF) signal filters, and more particularly to an improved ceramic bandpass filter that is particularly well adapted for use in radio transmitting and receiving circuitry.

Conventional multi-resonator filters include a plurality of resonators that are typically foreshortened short-circuited quarter-wavelength coaxial or helical transmission lines. The resonators are arranged in a conductive enclosure and may be inductively coupled one to another by apertures in their common walls. Each resonator can be tuned by means of a tuning screw which inserts into a hole extending through the middle of the resonator. Once tuned, the overall response of the filter is determined by the size of the interstage coupling apertures. Since the tuning of the filter can be disturbed by a slight adjustment of the tuning screw, a locknut is required to keep the tuning screw properly positioned at all times. The use of tuning screws not only renders these filters susceptible to becoming detuned, but also creates additional problems including mechanical locking of the tuning screw and arcing between the tuning screw and the resonator structure. Furthermore, such filters tend to be rather bulky and therefore are relatively unattractive for applications where size is an important factor.

From United States Patent 3,505,618 there is known a bandpass filter comprising: a block comprised of dielectric material having top and bottom surfaces, said dielectric block further including at least first and second holes extending from the top surface toward the bottom surface thereof and spatially disposed at a predetermined distance from one another; input electrode means coupled to said first hole in the dielectric block; output electrode means coupled to said second hole in the dielectric block.

However, in this known bandpass filter the whole of the exterior surface of the dielectric is covered with conductive silver film and the holes must be one quarter-wavelength long in order for the filter to be properly tuned.

Summary of the invention

It is an object of the present invention to provide a bandpass filter which can be tuned automatically.

In accordance with the present invention as claimed a bandpass filter is characterized in that: said input electrode means is comprised of a conductive material and disposed on the dielectric block at a predetermined distance from one end of said first hole; said output electrode means is comprised of a conductive material and disposed on the dielectric block at a predetermined distance from one end of said second hole; and said dielectric block is covered entirely with a conductive material with the exception of portions surrounding said input and output electrode means and said one ends of the first and second

holes, and said ends of the first and second holes further being capacitively coupled to the surrounding conductive material whereby a foreshortened coaxial resonator is produced for each hole.

Brief description of the drawings

Figure 1 is a perspective view of a ceramic bandpass filter embodying the present invention.

Figure 2 is a cross section of the ceramic bandpass filter in Figure 1 taken along lines 2—2.

Figure 3 is a cross section of another embodiment of the ceramic bandpass filter in Figure 1 taken along lines 2—2.

Figure 4 is a cross section of a further embodiment of the ceramic bandpass filter in Figure 1 taken along lines 2—2.

Figure 5 is another embodiment of the ceramic bandpass filter of the present invention.

Figure 6 is an equivalent circuit diagram for the ceramic bandpass filter in Figure 1.

Figure 7 illustrates an input signal coupling arrangement suitable for use in the ceramic bandpass filter of the present invention.

Figure 8 illustrates another input signal coupling arrangement suitable for use in the ceramic bandpass filter of the present invention.

Figure 9 illustrates yet another input signal coupling arrangement suitable for use in the ceramic bandpass filter of the present invention.

Figure 10 illustrates one arrangement for cascading two ceramic bandpass filters of the present invention.

Figure 11 illustrates another arrangement for cascading two ceramic bandpass filters of the present invention.

Figure 12 illustrates yet another embodiment of the ceramic bandpass filter of the present invention.

Figure 13 illustrates a multi-band filter comprised of two ceramic band-pass filters of the present invention.

Detailed description of the preferred embodiments

In Figure 1, there is illustrated a ceramic bandpass filter 100 embodying the present invention. Filter 100 includes a block 130 which is comprised of a dielectric material that is selectively plated with a conductive material. Filter 100 can be constructed of any suitable dielectric material that has low loss, a high dielectric constant and a low temperature coefficient of the dielectric constant. In a preferred embodiment, filter 100 is comprised of a ceramic compound including barium oxide, titanium oxide and zirconium oxide, the electrical characteristics of which are described in more detail in an article by G. H. Jonker and W. Kwestroo, entitled "The Ternary Systems $\text{BaO-TiO}_2\text{-SnO}_2$ and $\text{BaO-TiO}_2\text{-ZrO}_2$ ", published in the Journal of the American Ceramic Society, volume 41, number 10, at pages 390—394. Of the ceramic compounds described in this article, the compound in Table VI having the composition 18.5 mole % BaO, 77.0 mole %

TiO₂ and 4.5 mole % ZrO₂ and having a dielectric constant of 40 is well suited for use in the ceramic filter of the present invention.

Referring to Figure 1, block 130 of filter 100 is covered or plated with an electrically conductive material, such as copper or silver, with the exception of areas 140. Block 130 includes six holes 101—106, which each extend from the top surface to the bottom surface thereof. Holes 101—106 are likewise plated with an electrically conductive material. Each of the plated holes 101—106 is essentially a foreshortened coaxial resonator comprised of a short-circuited coaxial transmission line having a length selected for desired filter response characteristics.

Block 130 in Figure 1 also includes input and output electrodes 124 and 125 and corresponding input and output connectors 120 and 122. Although block 130 is shown with six plated holes 101—106, any number of plated holes can be utilized depending on the filter response characteristics desired. For example, an embodiment of the ceramic bandpass filter of the present invention may include only one plated hole, an input electrode and an output electrode, as illustrated by filter 500 in Figure 5. In addition, RF signals can be coupled to filter 500 by means of coaxial cables 520 and 522 in Figure 5 instead of connectors 120 and 122 in Figure 1.

The plating of holes 101—106 in filter 100 in Figure 1 is illustrated more clearly by the cross section in Figure 2 which is taken along lines 2—2 in Figure 1. Referring to Figure 2, conductive plating 204 on dielectric material 202 extends through hole 201 to the top surface with the exception of a circular portion 240 around hole 201. Other conductive plating arrangements can be utilized, two of which are illustrated in Figures 3 and 4. In Figure 3, conductive plating 304 on dielectric material 302 extends through hole 301 to the bottom surface with the exception of circular portion 340. The plating arrangement in Figure 3 is substantially identical to that in Figure 2, the difference being that unplated portion 340 is on the bottom surface instead of on the top surface. In Figure 4, conductive plating 404 on dielectric material 402 extends partially through hole 401 leaving part of hole 401 unplated. The plating arrangement in Figure 4 can also be reversed as in Figure 3 so that the unplated portion 440 is on the bottom surface.

Coupling between the coaxial resonators provided by plated holes 101—106 in Figure 1 is accomplished through the dielectric material and is varied by varying the width of the dielectric material and the distance between adjacent coaxial resonators. The width of the dielectric material between adjacent holes 101—106 can be adjusted in any suitable regular or irregular manner, such as, for example, by the use of slots, cylindrical holes, square or rectangular holes, or irregular shaped holes. According to another feature of the present invention, filter 100 in Figure 1 includes slots 110—114 for adjusting the coupling between coaxial resonators provided by holes 101—106.

The amount of coupling is varied by varying the depth of the slots 110—114. Although slots 110—114 are shown on the side surfaces of filter 100 in Figure 1, slots may also be disposed on the top and bottom surfaces as illustrated in Figure 12. Furthermore, slots 110—114 can be disposed between adjacent plated holes on one surface, opposite surfaces or all surfaces. Slots 110—114 in Figure 1 can be either plated or unplated depending on the amount of coupling desired.

Furthermore, plated or unplated holes located between the coaxial resonators provided by holes 101—106 can also be utilized for adjusting the coupling. Similarly, such holes can be either plated or unplated and varied in size, location and orientation to obtain the desired coupling. In Figure 11, holes 1150 and 1152 are utilized to adjust the coupling of filter 1110, and slots 1160 and 1162 are utilized to adjust the coupling of filter 1112. Holes 1150 and 1152 in filter 1110 in Figure 11 may extend part or all of the way from the top surface to the bottom surface and may also be located on the side surface of filter 1110 instead of its top surface.

RF signals are capacitively coupled to and from filter 100 in Figure 1 and filter 500 in Figure 5 by means of input and output electrodes, 124, 125 and 524, 525, respectively. The resonant frequency of the coaxial resonators provided by plated holes 101—106 in Figure 1 and plated hole 501 in Figure 5 is determined primarily by the depth of the hole, thickness of the dielectric block in the direction of the hole and the amount of plating removed from the top of the filter near the hole. Tuning of filter 100 or 500 is accomplished by the removal of additional ground plating near the top of each plated hole. The removal of ground plating for tuning the filter can easily be automated, and can be accomplished by means of a laser, sandblast trimmer or other suitable trimming devices while monitoring the return loss angle of the filter. This tuning process is implemented by initially grounding the plating at the top of each plated hole 101—106 in Figure 1 and measuring the return loss angle. Then, the ground to each plated hole is removed one at a time, and the ground plating near the top of that plated hole is trimmed until 180 degrees of phase shift is achieved. The grounding of each plated hole 101 to 106 can be done by means of a small plating runner that bridges the unplated area 140 between the plated hole and the surrounding plating on dielectric block 130.

Referring to Figure 6, there is illustrated an equivalent circuit diagram for the ceramic bandpass filter 100 in Figure 1. An input signal from a signal source may be applied via connector 120 to input electrode 124 in Figure 1, which corresponds to the common junction of capacitors 624 and 644 in Figure 6. Capacitor 644 is the capacitance between electrode 124 and the surrounding ground plating, and capacitor 624 is the capacitance between electrode 124, and the coaxial resonator provided by plated hole 101 in Figure 1. The coaxial resonators provided by plated holes

101—106 in Figure 1 correspond to shorted transmission lines 601—606 in Figure 6. Capacitors 631—636 in Figure 6 represent the capacitance between the coaxial resonators provided by plated holes 101—106 in Figure 1 and the surrounding ground plating on the top surface. Capacitor 625 represents the capacitance between the resonator provided by plated hole 106 and electrode 125 in Figure 1, and capacitor 645 represents the capacitance between electrode 125 and the surrounding ground plating. An output signal is provided at the junction of capacitors 625 and 645, which corresponds to output electrode 125 in Figure 1.

RF signals can be coupled to the ceramic bandpass filter of the present invention by capacitively coupling plated hole 101 or 106 by way of electrodes 124 or 125 in Figure 1, or by the capacitive and inductive coupling arrangements shown in Figures 7, 8 and 9. In Figure 7, electrode 702 surrounded by unplated area 740 is disposed on the side of the dielectric block opposite to the coaxial resonator provided by plated hole 701. An RF signal from coaxial cable 710 is applied to electrode 702 and capacitively coupled to the coaxial resonator provided by plated hole 701. In Figure 8, a strip electrode 802 surrounded by unplated area 840 inductively couples an RF signal from coaxial cable 810 to the coaxial resonator provided by plated hole 801. The center conductor from coaxial cable 810 is attached to the tip of strip electrode 802 and the grounded shield of coaxial cable 810 is connected to the ground plating at the opposite end of strip electrode 802. In Figure 9, the center conductor of coaxial cable 910 is connected to the ground plating above unplated area 940 and opposite the coaxial resonator provided by plated hole 901, and the grounded shield of coaxial cable 910 is connected to the ground plating below unshielded area 940 and also opposite the coaxial resonator provided by plated hole 901. Depending on the requirements of each application of the ceramic bandpass filter of the present invention, RF signals can be coupled to and from the inventive coaxial bandpass filter in any of the ways illustrated in Figures 1, 5, 7, 8 and 9. Moreover, if coupling of RF signals to the inventive ceramic bandpass filter is accomplished by means of electrodes as illustrated in Figures 1 and 5, the electrode can be oriented as illustrated in Figures 1 and 5 or can be located at any suitable position of the periphery of the corresponding plated hole. For example, an electrode can extend out to the end of the dielectric block as do electrodes 124 and 125 in Figure 1, or to the side of the dielectric block as do electrodes 1014, 1016, 1018 and 1020 in Figure 10.

According to another feature of the present invention, two or more of the inventive ceramic bandpass filters can be cascaded to provide more selectively, or can be intercoupled to provide a multi-band response characteristic. Two different cascade arrangements of the inventive ceramic bandpass filter are illustrated in Figs. 10 and 11. In

Fig. 10, filters 1010 and 1012 are arranged side by side. An input signal is coupled from coaxial cable 1002 to input electrode 1014 on filter 1010. Output electrode 1016 from filter 1010 is coupled to input electrode 1018 on filter 1012 by means of a short jumper wire. An output signal from output electrode 1020 on filter 1012 is connected to coaxial cable 1004. For ease of interconnection, electrodes 1016 and 1018 extend out to the sides of filters 1010 and 1012 instead to the end of the filter as do electrodes 124 and 125 in Fig. 1.

Referring to Fig. 11, filters 1110 and 1112 are arranged one on top of the other. An input signal from coaxial cable 1102 is connected to input electrode 1114 on filter 1010. Hole 1140 of filter 1010 is plated as illustrated in Fig. 3, such that the circular unplated portion around plated hole 1140 is on the bottom surface of filter 1010. Therefore, the output of filter 1010 can be capacitively coupled therefrom by means of output electrode 1116 in the same manner as illustrated and described with respect to Fig. 7 hereinabove. The same type of capacitive coupling is provided by input electrode 1118 and output electrode 1120 in filter 1112. Accordingly, the output from filter 1110 is coupled from output electrode 1116 to input electrode 1118 of filter 1112 by means of a jumper wire. The output from filter 1112 provided at output electrode 1120 may be coupled to coaxial cable 1104.

According to yet another feature of the present invention, the coupling between the coaxial resonators provided by plated holes 1140—1142 in filter 1110 can be adjusted by means of additional holes 1150 and 1152, which are located between adjacent plated holes 1140—1142. The size, location, orientation and plating of additional holes 1150 and 1152 can be varied for varying the amount of coupling between adjacent coaxial resonators. For example, additional holes 1150 and 1152 can be parallel or perpendicular to plated holes 1140, 1141 and 1142. In filter 1112, the coupling has been adjusted by means of slots 1160 and 1162 located on the top and bottom surfaces between adjacent coaxial resonators. Furthermore, slots could also be provided on the side surfaces of filter 1112, such that slots are provided on all surfaces between adjacent resonators.

In Fig. 12 there is illustrated another embodiment of the ceramic bandpass filter of the present invention that includes six plated holes 1230—1236 arranged in two rows. The coaxial resonator provided by each plated hole in filter 1210 is coupled to two adjacent coaxial resonators, instead of one as illustrated by the filter in Fig. 1. Coupling from any one of the coaxial resonators to the two adjacent resonators can be individually adjusted by means of slots 1222, 1223 and 1224 provided therebetween. An input signal may be coupled by coaxial cable 1202 to input electrode 1214, and an output signal can be coupled to electrode 1220 by means of coaxial cable 1204. If the portion of slot 1224 between plated holes 1230 and 1235 and between plated

holes 1231 and 1234 is deeper than slots 1222 and 1223, the input signal from coaxial cable 1202 may be coupled between plated holes 1230, 1231 and 1232, then across to plated hole 1233 and between plated holes 1233, 1234 and 1235 to coaxial cable 1204. A zig zag coupling path could be provided by making the slots between plated holes 1230 and 1231 and between plated holes 1234 and 1233 deeper and placing output electrode 1220 near hole 1233 instead of hole 1235. Also, input electrode 1214 and output electrode 1220 can be disposed on the end surface so that filter 1210 can be stood on end to conserve space.

According to yet a further of the present invention, coupling also occurs between plated holes 1230 and 1235 and between plated holes 1231 and 1234 in Figure 12, and provides transmission zeros in the response characteristic of filter 1210. These transmission zeros make the skirt attenuation of filter 1210 steeper. As can be ascertained from filter 1210 in Figure 12, the number and configuration of plated holes utilized in the ceramic bandpass filter of the present invention can be varied to achieve the response characteristics required for a particular application.

Referring to Fig. 13, there is illustrated a multiband filter comprised of two intercoupled ceramic bandpass filters 1304 and 1312 of the present invention. Two or more of the inventive ceramic bandpass filters can be intercoupled to provide apparatus that combines and/or frequency sorts two RF signals into and/or from a composite RF signal. For example, one application of this feature of the present invention is the arrangement in Fig. 13 which couples a transmit signal from an RF transmitter 1302 to an antenna 1308 and a receive signal from antenna 1308 to an RF receiver 1314. The arrangement in Fig. 13 can be advantageously utilized in mobile, portable and fixed station radios as an antenna duplexer. The transmit signal from RF transmitter 1302 is coupled to filter 1304 and thereafter by transmission line 1306 to antenna 1308. Filter 1304 is a ceramic bandpass filter of the present invention, such as the filter illustrated in Figs. 1, 5, 10, 11 and 12. The passband of filter 1304 is centered about the frequency of the transmit signal from RF transmitter 1302, while at the same time greatly attenuating the frequency of the receive signal. In addition, the length of transmission line 1306 is selected to maximize its impedance at the frequency of the receive signal.

A receive signal from antenna 1308 in Fig. 13 is coupled by transmission line 1310 to filter 1312 and thereafter to RF receiver 1314. Filter 1312 which also may be one of the inventive ceramic bandpass filters illustrated in Figs. 1, 5, 10, 11 and 12 has a passband centered about the frequency of the receive signal, while at the same time greatly attenuating the transmit signal. Similarly, the length of transmission line 1310 is selected to maximize its impedance at the transmit signal frequency for further attenuating the transmit signal.

In the embodiment of the RF signal duplexing

apparatus in Fig. 13, transmit signals having a frequency range from 825 MHz to 845 MHz and receive signals having a frequency range from 870 MHz to 890 MHz were coupled to the antenna of a mobile radio. The ceramic bandpass filters 1304 and 1312 were of the type shown in Fig. 1. The filters 1304 and 1312 each had a length of 77.6 mm., a height of 11.54 mm. and a width of 11.74 mm. Filter 1304 had an insertion loss of 1.6 db and attenuated receive signals by at least 55 db. Filter 1312 had an insertion loss of 1.6 db and attenuated receive signals by at least 55 db.

In summary, an improved ceramic bandpass filter has been described that is more reliable and smaller than prior art filters. The construction of the ceramic bandpass filter of the present invention not only is simple but also amenable to automatic fabricating and adjusting techniques. The inventive ceramic bandpass filter can be cascaded with one or more other ceramic bandpass filters for providing greater selectivity, and can be intercoupled with one or more other ceramic bandpass filters to provide apparatus that combines and/or frequency sorts two or more RF signals into/from a composite RF signal. This feature of the present invention can be advantageously utilized for providing an antenna duplexer where a transmit signal is coupled to an antenna and a receive signal is coupled from the antenna.

Claims

1. A bandpass filter comprising:

a block (130) comprised of a dielectric material having top and bottom surfaces, said dielectric block further including at least first and second holes (101—106) extending from the top surface toward the bottom surface thereof and spatially disposed at a predetermined distance from one another;

input electrode means (124) coupled to said first hole (101) in the dielectric block;

output electrode means (125) coupled to said second hole (106) in the dielectric block; and further characterized in that:

said input electrode means (124) is comprised of a conductive material and disposed on the dielectric block at a predetermined distance from one end of said first hole; and

said output electrode means (125) is comprised of a conductive material and disposed on the dielectric block at a predetermined distance from one end of said second hole; and

said dielectric block (130) is covered entirely with a conductive material with the exception of portions (140) surrounding said input and output electrode means (124, 125) and said one ends of the first and second holes (101, 106), and said ends of the first and second holes (101, 106) further being capacitively coupled to the surrounding conductive material whereby a fore-shortened coaxial resonator is produced for each hole.

2. The bandpass filter according to claim 1.

holes 1231 and 1234 is deeper than slots 1222 and 1223, the input signal from coaxial cable 1202 may be coupled between plated holes 1230, 1231 and 1232, then across to plated hole 1233 and between plated holes 1233, 1234 and 1235 to coaxial cable 1204. A zig zag coupling path could be provided by making the slots between plated holes 1230 and 1231 and between plated holes 1234 and 1233 deeper and placing output electrode 1220 near hole 1233 instead of hole 1235. Also, input electrode 1214 and output electrode 1220 can be disposed on the end surface so that filter 1210 can be stood on end to conserve space.

According to yet a further of the present invention, coupling also occurs between plated holes 1230 and 1235 and between plated holes 1231 and 1234 in Figure 12, and provides transmission zeros in the response characteristic of filter 1210. These transmission zeros make the skirt attenuation of filter 1210 steeper. As can be ascertained from filter 1210 in Figure 12, the number and configuration of plated holes utilized in the ceramic bandpass filter of the present invention can be varied to achieve the response characteristics required for a particular application.

Referring to Fig. 13, there is illustrated a multiband filter comprised of two intercoupled ceramic bandpass filters 1304 and 1312 of the present invention. Two or more of the inventive ceramic bandpass filters can be intercoupled to provide apparatus that combines and/or frequency sorts two RF signals into and/or from a composite RF signal. For example, one application of this feature of the present invention is the arrangement in Fig. 13 which couples a transmit signal from an RF transmitter 1302 to an antenna 1308 and a receive signal from antenna 1308 to an RF receiver 1314. The arrangement in Fig. 13 can be advantageously utilized in mobile, portable and fixed station radios as an antenna duplexer. The transmit signal from RF transmitter 1302 is coupled to filter 1304 and thereafter by transmission line 1306 to antenna 1308. Filter 1304 is a ceramic bandpass filter of the present invention, such as the filter illustrated in Figs. 1, 5, 10, 11 and 12. The passband of filter 1304 is centered about the frequency of the transmit signal from RF transmitter 1302, while at the same time greatly attenuating the frequency of the receive signal. In addition, the length of transmission line 1306 is selected to maximize its impedance at the frequency of the receive signal.

A receive signal from antenna 1308 in Fig. 13 is coupled by transmission line 1310 to filter 1312 and thereafter to RF receiver 1314. Filter 1312 which also may be one of the inventive ceramic bandpass filters illustrated in Figs. 1, 5, 10, 11 and 12 has a passband centered about the frequency of the receive signal, while at the same time greatly attenuating the transmit signal. Similarly, the length of transmission line 1310 is selected to maximize its impedance at the transmit signal frequency for further attenuating the transmit signal.

In the embodiment of the RF signal duplexing

apparatus in Fig. 13, transmit signals having a frequency range from 825 mHz to 845 mHz and receive signals having a frequency range from 870 mHz to 890 mHz were coupled to the antenna of a mobile radio. The ceramic bandpass filters 1304 and 1312 were of the type shown in Fig. 1. The filters 1304 and 1312 each had a length of 77.6 mm., a height of 11.54 mm. and a width of 11.74 mm. Filter 1304 had an insertion loss of 1.6 db and attenuated receive signals by at least 55 db. Filter 1312 had an insertion loss of 1.6 db and attenuated receive signals by at least 55 db.

In summary, an improved ceramic bandpass filter has been described that is more reliable and smaller than prior art filters. The construction of the ceramic bandpass filter of the present invention not only is simple but also amenable to automatic fabricating and adjusting techniques. The inventive ceramic bandpass filter can be cascaded with one or more other ceramic bandpass filters for providing greater selectivity, and can be intercoupled with one or more other ceramic bandpass filters to provide apparatus that combines and/or frequency sorts two or more RF signals into/from a composite RF signal. This feature of the present invention can be advantageously utilized for providing an antenna duplexer where a transmit signal is coupled to an antenna and a receive signal is coupled from the antenna.

Claims

1. A bandpass filter comprising:

a block (130) comprised of a dielectric material having top and bottom surfaces, said dielectric block further including at least first and second holes (101—106) extending from the top surface toward the bottom surface thereof and spatially disposed at a predetermined distance from one another;

input electrode means (124) coupled to said first hole (101) in the dielectric block;

output electrode means (125) coupled to said second hole (106) in the dielectric block; and further characterized in that:

said input electrode means (124) is comprised of a conductive material and disposed on the dielectric block at a predetermined distance from one end of said first hole; and

said output electrode means (125) is comprised of a conductive material and disposed on the dielectric block at a predetermined distance from one end of said second hole; and

said dielectric block (130) is covered entirely with a conductive material with the exception of portions (140) surrounding said input and output electrode means (124, 125) and said one ends of the first and second holes (101, 106), and said ends of the first and second holes (101, 106) further being capacitively coupled to the surrounding conductive material whereby a fore-shortened coaxial resonator is produced for each hole.

2. The bandpass filter according to claim 1,



characterized in that the dielectric block (130) is comprised of a block of dielectric material having the shape of parallelepiped.

3. The bandpass filter according to claim 1, further characterized by at least one slot (110—114) in the dielectric block between said holes for adjusting the electrical signal coupling from the input electrode means to the output electrode means.

4. The bandpass filter according to claim 3, characterized in that said slots (110—114) are covered with a conductive material.

5. The bandpass filter according to claim 3 or 4, characterized in that said dielectric block (130) has two end surfaces and two side surfaces, and said slots (110—114) are disposed on at least one of the top, bottom and side surfaces.

6. The bandpass filter according to claim 5, characterized in that said slots (110—114) are disposed on at least two opposite surfaces.

7. The bandpass filter according to claim 5, characterized in that said slots (110—114) are disposed on the top, bottom and side surfaces.

8. The bandpass filter according to claim 1, 2 or 3, further characterized by a signal source (1302) for the input signal being coupled to the input electrode means (124), and the conductive material being coupled to signal ground.

9. The bandpass filter according to claim 1, characterized in that the coupling of said filter is adjusted by removing a portion (1150, 1152) of the conductive material from the surface of the dielectric block between said holes; and the resonant frequency of said filter is adjusted by removing portions (140) of the conductive material surrounding said one ends of the first and second holes to produce a pre-selected resonant frequency of said filter.

10. The bandpass filter according to claim 1, characterized in that the resonant frequency of said filter is adjusted by removing portions (140) of the conductive material surrounding said one ends of the first and second holes.

Patentansprüche

1. Bandpaßfilter mit:

einem Block (130) aus einem dielektrischen Material mit einer oberen Fläche und einer Unterfläche, wobei der genannte dielektrische Block ferner wenigstens erste und zweite Löcher (101—106) aufweist, die sich von der oberen Fläche zu der Unterfläche erstrecken und räumlich mit einem vorbestimmten Abstand voneinander angeordnet sind,

einer mit dem ersten Loch (101) in dem dielektrischen Block gekoppelten Eingangselektroden-einrichtung (124),

einer mit dem genannten zweiten Loch (106) in dem dielektrischen Block gekoppelten Ausgangselektroden-einrichtung (125), dadurch gekennzeichnet, daß:

die genannte Eingangselektroden-einrichtung (124) aus einem leitenden Material besteht und

auf dem dielektrischen Block mit einem vorbestimmten Abstand von einem Ende des genannten ersten Lochs angeordnet ist, und

die genannte Ausgangselektroden-einrichtung (125) aus einem leitenden Material besteht und auf dem dielektrischen Block mit einem vorbestimmten Abstand von einem Ende des genannten zweiten Lochs angeordnet ist, und

der genannte dielektrische Block (130) vollständig mit einem leitenden Material überzogen ist mit Ausnahme der Bereiche (140), die die genannte Eingangs- und Ausgangselektroden-einrichtung (124, 125) und die genannten einen Enden des ersten und zweiten Lochs (101, 106) umgeben, und ferner die genannten Enden des ersten und zweiten Lochs (101, 106) kapazitiv mit dem umgebenden, leitenden Material gekoppelt sind, wodurch ein verkürzter, coaxialer Resonator für jedes Loch erzeugt wird.

2. Bandpaßfilter nach Anspruch 1, dadurch gekennzeichnet, daß der dielektrische Block (130) ein Block aus einem dielektrischen Material in der Form eines Parallelepipedes ist.

3. Bandpaßfilter nach Anspruch 1, ferner gekennzeichnet durch wenigstens einen Schlitz (110—114) in dem dielektrischen Block zwischen den genannten Löchern, um das elektrische Signal einzustellen, welches von der Eingangselektroden-einrichtung auf die Ausgangselektroden-einrichtung koppelt.

4. Bandpaßfilter nach Anspruch 3, dadurch gekennzeichnet, daß die genannten Schlitz (110—114) mit einem leitenden Material überdeckt sind.

5. Bandpaßfilter nach Anspruch 3 oder 4, dadurch gekennzeichnet, daß der genannte dielektrische Block (130) zwei Endoberflächen und zwei Seitenoberflächen aufweist und die genannten Schlitz (110—114) wenigstens an der oberen Fläche, der Unterfläche oder einer der Seitenoberflächen angeordnet sind.

6. Bandpaßfilter nach Anspruch 5, dadurch gekennzeichnet, daß die genannten Schlitz (110—114) an wenigstens zwei gegenüberliegenden Oberflächen angeordnet sind.

7. Bandpaßfilter nach Anspruch 5, dadurch gekennzeichnet, daß die genannten Schlitz (110—114) an der oberen Fläche, der Unterfläche und den Seitenoberflächen angeordnet sind.

8. Bandpaßfilter nach Anspruch 1, 2 oder 3, ferner gekennzeichnet durch eine Signalquelle (1302) für das Eingangssignal, welches auf die Eingangselektroden-einrichtung (124) gekoppelt wird, und wobei das leitende Material mit der Masse des Signals gekoppelt wird.

9. Bandpaßfilter nach Anspruch 1, dadurch gekennzeichnet, daß die Kopplung des genannten Filters durch Entfernen eines Teils (1150, 1152) des leitenden Materials von der Oberfläche des dielektrischen Blocks zwischen den genannten Löchern eingestellt wird und die Resonanzfrequenz des genannten Filters durch Entfernen von Bereichen (140) des leitenden Materials, die die genannten einen Enden der



ersten und zweiten Löcher umgeben, eingestellt wird, um eine vorausgewählte Resonanzfrequenz des genannten Filters herzustellen.

10. Bandpaßfilter nach Anspruch 1, dadurch gekennzeichnet, daß die Resonanzfrequenz des genannten Filters eingestellt wird, indem Bereiche (140) des leitfähigen Materials entfernt werden, die die genannten einen Enden der ersten und zweiten Löcher umgeben.

Revendications

1. Filtre passe-bande comportant:

un bloc (130) constitué d'une matière diélectrique avec une surface supérieure et une surface inférieure, ledit bloc diélectrique comportant en outre au moins un premier et en second trous (101—106) s'étendant depuis la surface supérieure vers la surface inférieure et disposés spatialement à une distance prédéterminée l'un de l'autre;

une électrode d'entrée (124) couplée avec ledit premier trou (101) dans le bloc diélectrique;

une électrode de sortie (125) couplée avec ledit second trou (106) dans le bloc diélectrique; et caractérisé en outre en ce que:

ladite électrode d'entrée (124) est constituée d'une matière conductrice et elle est disposée sur le bloc diélectrique à une distance prédéterminée d'une extrémité dudit premier trou; et

ladite électrode de sortie (125) est constituée d'une matière conductrice et elle est disposée sur le bloc diélectrique à une distance prédéterminée d'une extrémité dudit second trou; et

ledit bloc diélectrique (130) est recouvert entièrement d'une matière conductrice, à l'exception près des parties (140) entourant ladite électrode d'entrée et ladite électrode de sortie (124, 125) et lesdites extrémités du premier et du second trous (101, 106), et lesdites extrémités du premier et du second trous (101, 106) étant en outre couplées par capacité avec la matière conductrice environnante de manière à produire pour chaque trou un résonateur coaxial raccourci.

2. Filtre passe-bande selon la revendication 1, caractérisé en ce que le bloc diélectrique (130) est

constitué par un bloc de matière diélectrique ayant la forme d'un parallélépipède.

3. Filtre passe-bande selon la revendication 1, caractérisé en outre par au moins une fente (110—114) dans le bloc diélectrique entre lesdits trous pour régler le couplage du signal électrique entre l'électrode d'entrée et l'électrode de sortie.

4. Filtre passe-bande selon la revendication 3, caractérisé en ce que lesdites fentes (110—114) sont recouvertes d'une matière conductrice.

5. Filtre passe-bande selon la revendication 3 ou la revendication 4, caractérisé en ce que ledit bloc diélectrique (130) comporte deux surfaces d'extrémité et deux surfaces latérales et lesdites fentes (110—114) sont disposées sur l'une au moins des surfaces supérieure, inférieure et latérales.

6. Filtre passe-bande selon la revendication 5, caractérisé en ce que lesdites fentes (110—114) sont disposées sur au moins deux surfaces opposées.

7. Filtre passe-bande selon la revendication 5, caractérisé en ce que lesdites fentes (110—114) sont disposées sur les surfaces supérieure, inférieure et latérales.

8. Filtre passe-bande selon la revendication 1, 2 ou 3, caractérisé en outre par une source de signaux (1302) pour le signal d'entrée, couplée avec l'électrode d'entrée (124) et la matière conductrice étant couplée à la masse des signaux.

9. Filtre passe-bande selon la revendication 1, caractérisé en ce que le couplage dudit filtre est réglé en enlevant une partie (1150, 1152) de la matière conductrice de la surface du bloc diélectrique entre lesdits trous; et la fréquence de résonance dudit filtre est réglée en enlevant des parties (140) de la matière conductrice entourant lesdites extrémités du premier et du second trous pour produire une fréquence de résonance prédéterminée dudit filtre.

10. Filtre passe-bande selon la revendication 1, caractérisé en ce que la fréquence de résonance dudit filtre est réglée en enlevant des parties (140) de la matière conductrice entourant lesdites extrémités du premier et du second trous.



* C L M S *