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(54) Strip line filter having a switching function

(57) A strip line filter with a switching function so that there is no need for a separate switch to prevent transmission power loss to a receiving unit includes an input unit resonator and an output unit resonator. Both the input unit resonator and the output unit resonator have a first open stub 301, 307 and a second open stub 302, 305 grounded in parallel with the first open stub by at least one capacitor 303. They are positioned within a distance of one wavelength of a pass band frequency front one another. The input/output terminals of the second open stubs are connected to a direct current blocking capacitor 100, 106 and at least one grounded diode switching unit 308, 309 is connected to each of the first open stubs. The filter is used in a radio transceiver.

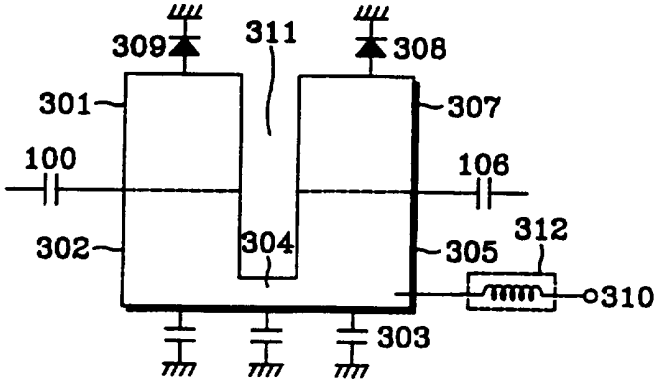

Fig. 3

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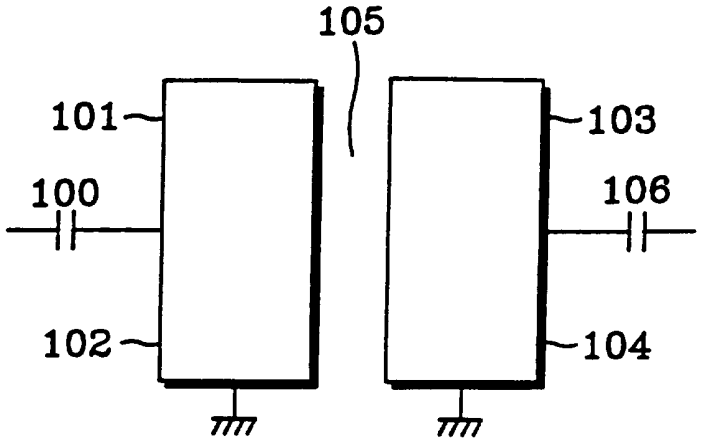

Fig. 1
(PRIOR ART)

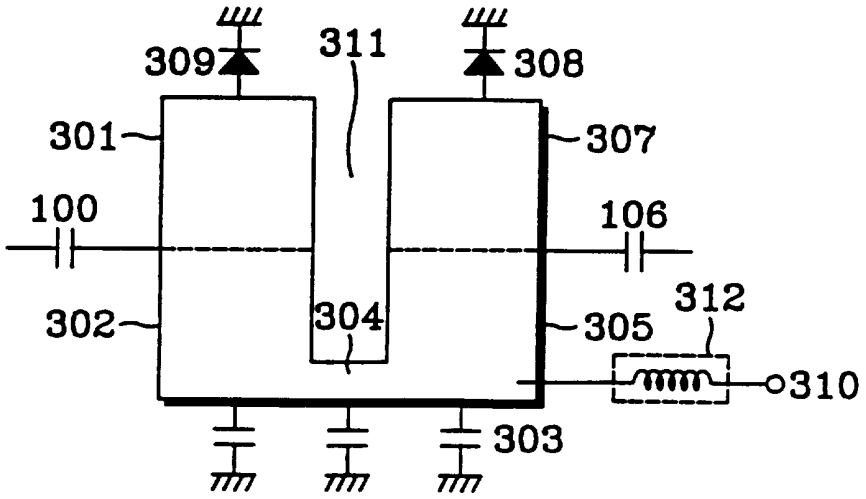

Fig. 3

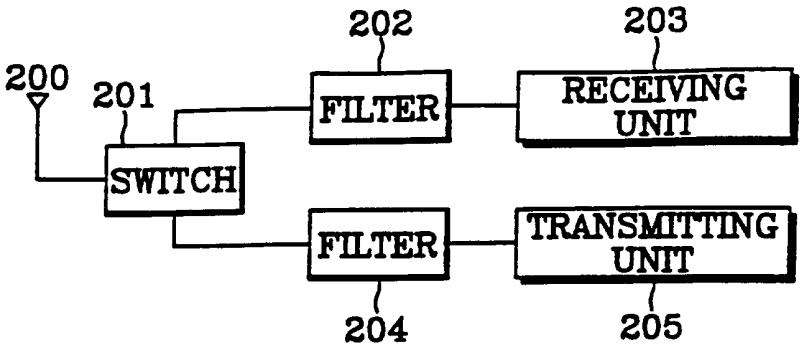

Fig. 2
(PRIOR ART)

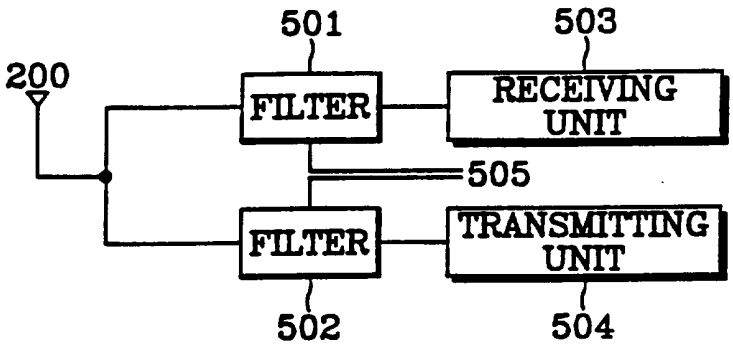

Fig. 5

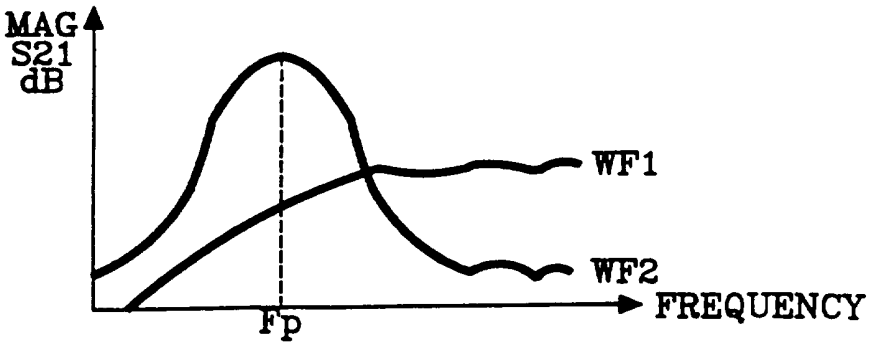

Fig. 4

A STRIP LINE FILTER HAVING A SWITCHING FUNCTION

Background to the Invention

The present invention relates to transmission line filters, and in particular to strip line filters with a switching function.

Conventionally, when a strip line or a micro strip line ("strip line") filter with a distributed element is used in a transmitting/receiving system, a separate switch is used to reduce transmission power to the receiving unit. Use of this separate switch increases the size of the transmitting/receiving system unnecessarily.

There are further problems with the conventional technology. The resonator within the strip line is geometrically fixed. In addition, the size of the band pass is often fixed. Since the centre or characteristic frequency of the band pass filter depends on the size of the filter, a fixed filter size means a fixed centre frequency. This poses the particular problem that it is difficult to move or eliminate a centre frequency.

An additional problem occurs when either a diode or varactor diode is used in the strip line filter. Use of a diode entails the shortening of one side of the resonator. This problem is illustrated by the example below.

Fig. 1 shows a conventional micro strip line filter. Fig. 2 is a schematic diagram of a transmitting/receiving system with the conventional micro strip line filter. 101 and 103 are open stubs, which act as a capacitor. Similarly, short stubs 102 and 104 act as an inductor. In addition, slit 105 between the resonator 101 and 102 and the resonator 103 and 104 generates a coupling capacitance. Therefore, centre frequency, pass bandwidth and ripple can be controlled by controlling the lengths of open stubs 101 and 103, the lengths of short stubs 102 and 104, and the size of slit

105.

For example, if the lengths of the open stubs 101 and 103 and the short stubs 102 and 104 are reduced, the centre frequency is increased. On the other hand, if the width of the resonator is increased, the bandwidth is reduced. Likewise, changing the size of the slit 105 varies the degree of ripple.

Switch 201 has an additional function in the system described above as well as in conventional systems with channel selection. The switch is necessary for connecting antenna 200 with receiving unit 201 during frequency reception. It is also required for connecting antenna 200 to transmitting unit 205 during frequency transmission.

U.S. Patent No. 4,806,890 discloses a tunable microwave filter with a controllable centre frequency. The tunable microwave filter contains a short stub, a varactor diode, and a second short stub connected in a series.

U.S. Patent No. 5,138,288 discloses a micro strip filter with a varactor coupled between two micro strip line resonators. The micro strip filter has a strip line resonator, varactor diode and second strip line resonator connected in series. This filter changes the shape of frequency filtering.

Korean patent publication No. 3343 discloses a method for controlling a resonant frequency of a strip line resonator. The circuit for implementing the frequency controlling method contains a varactor diode connected in parallel with the strip line. This provides an RF choke. It also contains a short stub connected in series with a capacitor.

EP-0,552,701-A discloses a package for a microwave device. The disclosed package circuit prevents the breakdown of the microwave part. The circuit consists of the package, a $\lambda/4$ strip line, and a grounded diode connected in series.

According to a report by Ray Waugh of the Hewlett Packard company, an attenuator with a diode can also be used to control frequency. The attenuator consists of an inductor, an RF choke, a strip line, and a grounded diode connected in sequence.

As shown above, there are numerous examples of solutions to the problem of frequency control. These cases, however, fail to supply answers for the problems of system size reduction and smooth system operation.

It is therefore an object of the present invention to provide a strip line filter which does not require a separate switch to prevent transmission power from being lost to the receiving unit.

Summary of the Invention

To achieve this and other objects, the present invention provides a strip line filter comprising:

an input resonator having a first open stub and a second open stub grounded in parallel with the first open stub by at least one capacitor; and

an output resonator having a first open stub and a second open stub grounded in parallel with the first open stub by at least one capacitor and being positioned within a distance of one wavelength of a pass band frequency from the input unit resonator.

Preferably, the sides of the second open stubs opposite their input/output terminals are shorted to one other.

Preferably, the input/output terminals of the second open stubs are connected to a direct current blocking capacitor and at least one grounded switching unit is connected to each of the first open stubs.

The switching unit may be a diode having its anode connected to the first open stub and its cathode grounded. The diode may be a varactor diode. Alternatively, the

switching unit may be a transistor, such as a FET.

Preferably, at least one second open stub is connected to a control terminal. The connection may be via a radio choke, or a $\lambda/4$ transformer, or a diode bias circuit, or any other suitable connection.

The present invention also extends to a radio transceiver comprising:

an antenna;

a transmitting unit for transmitting a radio signal;

a transmitter filter as described above as being in accordance with the invention for filtering a signal output from the transmitting unit and supplying the filtered signal to the antenna;

a receiving unit for receiving a radio signal; and

a receiving filter as described above as being in accordance with the invention for filtering a signal received through the antenna and supplying the filtered signal to the receiving unit.

Preferably, a plurality of transmitting and receiving filters are connected between the antenna and the transmitting and receiving units. Each of the plurality of transmitting and/or receiving filters may have different characteristic frequencies.

Preferably, diodes are connected to the first open stubs, the polarity of the diodes in the transmitting units being opposite to those in the receiving unit.

Brief Description of the Drawings

The present invention will now be described by way of example with reference to the accompanying drawings in which:

Fig. 1 shows a conventional micro strip line filter;

Fig. 2 is a schematic diagram of a transmitting and receiving system with a conventional micro strip line filter;

Fig. 3 shows a strip line filter according to the present invention;

Fig. 4 is the characteristic diagram of a strip line filter according to the present invention; and

Fig. 5 is a schematic diagram of a transmitting and receiving system containing a strip line filter according to the present invention.

Detailed Description of the Invention

Fig. 3 shows a strip line filter with a switching function, according to the present invention. The strip line filter comprises resonators consisting of strip lines 301, 302, 305 and 307; an inputting/outputting unit 100 and 106; an RF choke or $\lambda/4$ transformer or a diode bias 312 for driving a diode 308; a control terminal 310; and a capacitor 303 for opening the short stubs in direct current ("DC") operation but not alternating current (AC) operation.

As shown in Fig. 3, the diodes are connected to the open stubs 301 and 307. The moment the diodes are turned on, the characteristics of the open stubs 301 and 307 are changed into the characteristics of short stubs. The characteristic of the pass band filter is also eliminated, and the circuit between the inputting unit 100 and the outputting unit 106 is turned off, thereby opening up an input end and an output end. In contrast, in the previously described Fig. 1, when the diode is connected to the open stubs 101 and 103, a bias voltage cannot be applied to the open stubs 101 and 103 because of the short stubs 102 and 104.

In addition, to maintain the characteristic of the short stub and open up short stub in DC, at least one capacitor 303 is grounded by connecting it to stubs 302 and 305. On the other hand, when diodes 308 and 309 are connected to the resonators, the $\lambda/4$ transformer or the bias circuit or the RF choke for supplying the DC should be used. Therefore, the portions of the stubs 302 and 305 opposite

input/output feed portions are shorted by short 304, which allows simultaneous central control of diodes 308 and 309 connected to the two resonator by one control terminal.

Fig. 4 shows the characteristic diagram of the strip line filter with a switching function according to the present invention. As shown in Fig. 4, Fp indicates the centre frequency of the band pass filter. WF1 indicates the waveform when the two diodes 308 and 309 are turned on, and WF2 indicates the waveform when the two diodes 308 and 309 are turned off.

Fig. 5 is a schematic diagram of the transmitting and receiving system containing the strip line filter with switching function according to the present invention. At least one switching filter is utilized in the transmitting unit and at least one is used in the receiving unit. The direction of the diodes in switching filter 501 is different from those in 502. Alternatively, opposite signals are applied to switching filters 501 and 502 through the switching control terminal 505. So, at the time of transmission, the transmitting filter 502 is adjusted so that the antenna 500 is connected to the transmitting unit 504, thereby allowing transmission.

During transmission, the receiving unit is protected by turning off receiving filter 501. Similarly during receiving, the receiving filter 501 is adjusted so that antenna 500 is connected to receiving unit 503, thereby making possible frequency reception. During frequency reception, turning off transmitting filter 502 prevents transmittance leakage noise.

If the strip line filter according to the present invention is utilized for selecting a channel, at least one filter per channel should be used as in Fig. 5. In this case, the length or thickness of stubs 301, 302, 307 and 305, the interval of slit 311, and the value of capacitor 303 are controlled in order to adapt the centre frequency of each

filter to each channel. The channel is selected by control terminal 505 in the same manner as the transmitting unit or the receiving unit is selected.

The differences between the strip line filter according to the present invention and the conventional technology will be discussed below.

In the embodiment of the present invention described, the diodes are positioned on only one side of the two strip lines, not between the two strip lines as in U.S. Patent No. 4,806,890. In addition, the diode is not limited to being a varactor diode, unlike that in U.S. Patent No. 5,138,288. Furthermore, the diodes are not connected to two resonators in series, but are connected to ground potential.

The described embodiment of the present invention is similar to Korean patent publication no. 3343 in that the characteristics of the resonator are varied. However, the placement of the diode differs greatly. That is, in the embodiment of the present invention described, the diode is not positioned between the strip lines. It also differs greatly from EP-0,552,701-A because a package is not utilized.

In the report by Ray Waugh of the Hewlett Packard Company, the diode is turned on/off through one micro strip line and the choke and a capacitor alone is provided between the input/output terminals. In contrast, the described embodiment of the present invention performs filtering through the strip line and is constructed so that the two strip lines are entirely separate from each other.

As discussed, an advantage of the strip line filter according to the present invention is that the strip line filter includes the diode: the switching function is achieved by varying the characteristic of the distributed element of the strip line. This characteristic is varied

in response to turning the diode on or off. Hence, switching speed is dependent only upon the diode characteristics and the strip line is utilized as a landing pad for the diode, the result of this being a reduction in system size.

The strip line filter has another advantage because the open stub provided with the diode may be operated as a short stub. Owing to this arrangement, the pass band is entirely transformed by simply turning on or turning off the diode. Furthermore, a large insertion loss results when the switched off characteristics are utilized.

A further advantage of the strip line filter is that the resonator is made open in DC and the diode is connected to ground. This eliminates the need for a short stub.

CLAIMS:

1. A strip line filter comprising:

an input resonator having a first open stub and a second open stub grounded in parallel with the first open stub by at least one capacitor; and

an output resonator having a first open stub and a second open stub grounded in parallel with the first open stub by at least one capacitor and being positioned within a distance of one wavelength of a pass band frequency from the input unit resonator.

2. A filter according to claim 1 in which the sides of the second open stubs opposite their input/output terminals are shorted to one other.

3. A filter according to claim 1 or claim 2 in which the input/output terminals of the second open stubs are connected to a direct current blocking capacitor and at least one grounded switching unit is connected to each of the first open stubs.

4. A filter according to claim 3 in which the switching unit is a diode having its anode connected to the first open stub and its cathode grounded.

5. A filter according to claim 3 or claim 4 in which the switching unit is a varactor diode.

6. A filter according to claim 3 in which the switching unit is a transistor.

7. A filter according to claim 3 or claim 6 in which the switching unit is a field effect transistor.

8. A filter according to any one of claims 3-7 in which at least one second open stub is connected to a control terminal.

9. A filter according to claim 8 in which the control terminal is so connected via a radio choke.

10. A filter according to claim 8 in which the control terminal is so connected via to a $\lambda/4$ transformer.

11. A filter according to claim 8 in which the control terminal is so connected via a diode bias circuit.

12. A strip line filter substantially as described herein with reference to Figs. 3 and 4 of the accompanying drawings.

13. A radio transceiver comprising:

an antenna;

a transmitting unit for transmitting a radio signal;

a transmitter filter according to any preceding claim for filtering a signal output from the transmitting unit and supplying the filtered signal to the antenna;

a receiving unit for receiving a radio signal; and

a receiving filter according to any preceding claim for filtering a signal received through the antenna and supplying the filtered signal to the receiving unit.

14. A radio transceiver according to claim 13 in which a plurality of transmitting and receiving filters are connected between the antenna and the transmitting and receiving units.

15. A radio transceiver according to claim 14 in which each of the plurality of transmitting and/or receiving filters have different characteristic frequencies.

16. A radio transceiver according to any one of claims 13-15 in which diodes are connected to the first open stubs, the polarity of the diodes in the transmitting units being opposite to those in the receiving unit.

17. A radio transceiver substantially as described herein

with reference to Figs. 3-5 of the accompanying drawings.

The Patent Office

12

Application No: GB 9615343.2
Claims searched: 1-17

Examiner: Miss J.E.Evans
Date of search: 30 September 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H1W (WBA, WBX)

Int Cl (Ed.6): H01P 1/203

Other: ONLINE:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2246670A	(Moazzam) see fig 3	1
X	EP0371446A2	(Fujitsu) see figs 2A and 4-7	1 and 2
X	WO94/25996A1	(France Telecom) see figs 1-6	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.