



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.08.2014 Bulletin 2014/34

(51) Int Cl.:
H01P 1/20 (2006.01) H03H 11/04 (2006.01)

(21) Application number: **13290028.3**

(22) Date of filing: **14.02.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

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(54) **A method of filtering and a filter assembly**

(57) A filter assembly is provided comprising a first filter 12, a notch filter 26, and a phase-shifter 36. The first filter has a stop-band. The filter assembly is configured to receive an input signal and the filter assembly being configured to, in use, split the output S1 of the first filter 12 into a main output signal and a secondary signal, and to pass the secondary signal through the notch filter 26 having a stop-band corresponding to the pass-band

of the first filter 12 and, or including, through the phase-shifter 36 so as to be phase-shifted at least substantially into anti-phase to the input signal to provide an adjustment signal $\Phi_f(\omega)$. The filter assembly is further configured to then combine 18 the adjustment signal with the then input signal so as to provide the then main output signal S2 attenuated in the stop-band.

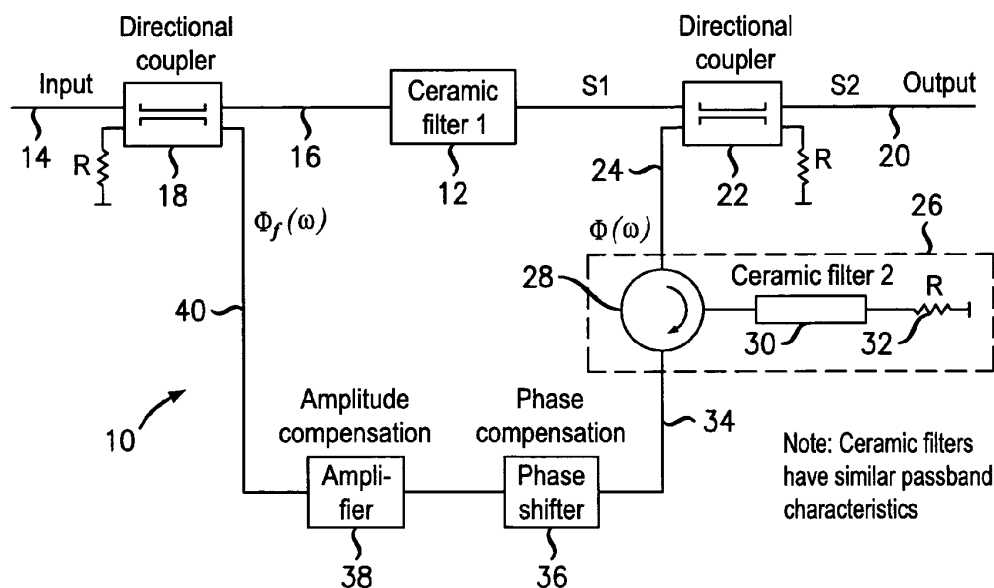


FIG. 2

Description

Field of the Invention

[0001] The present invention relates to a filter assembly and filtering, for example for telecommunications.

Description of the Related Art

[0002] Filters are widely used in telecommunications. Their applications include in base stations, in radar systems, in amplifier linearization, in point-to-point radio and in RF signal cancellation, to name but a few. Which filter to use depends on the application but there are certain desirable characteristics that filters share. For example, the amount of insertion loss in the pass-band of a filter should be as low as possible whilst the attenuation in the stop-band should be high as possible. Furthermore, in some applications, the guard band, which is the frequency separation between the pass-band and stop-band, needs to be very small. This requires a filter of high order to be deployed. A high order filter is, of course, one that includes a high number of resonators. A high order filter is, of course, more technically complex and large than a corresponding filter of a lower order. Furthermore, even though increasing the order of the filter increases the attenuation in the stop-band, it inevitably increases attenuation in the pass-band too.

[0003] Generally, a demand for higher attenuation in the stop-band is driven by demands for higher isolation between transmit and receive channels. Accordingly, much attention is focussed on techniques that allow the insertion of a transmission zero, also known as a notch, in the response of the filter. This transmission zero is normally introduced in the stop-band of the filter so that attenuation is increased.

[0004] The transmission zero can be introduced in a variety of ways depending in the type of filter. For example, in cavity filters, the transmission zero is introduced by providing additional coupling between the non-adjacent cavities of the filter. This coupling causes the transmission zero in the filter's response and its exact position of the transmission zero is dependent on the parameters of the particular filter's circuitry.

[0005] On the other hand, for surface mount technology filters, the best way to implement a transmission zero is less obvious. One known approach is to take advantage of the cascade connection of a band-stop (notch) filter with a filter into which a transmission zero needs to be inserted. However, this approach is difficult as it depends on the quality (Q) factor of the notch filter, which itself represents the effect of the transmission zero on the overall performance of the filter, in particular its insertion loss in the pass-band.

[0006] Two known ways of realising a notch using surface mount technology are shown in Figure 1. The filter shown in Figure 1(a) consists of a microstrip line 2 coupled to grounded band-stop resonators 4 by capacitive

gaps 6. The filter shown in Figure 1(b) consists of a microstrip line 2' coupled to grounded band-stop resonators 4' by parallel line couplings 8. The number of grounded resonators 4,4' depends on the number of desired transmission zeros. A known refinement of this approach is where the open port of a grounded resonator is terminated by a reactance. This allows reduced size but with an increase of insertion loss, due to the finite Q factor of that connected reactance.

Summary

[0007] The reader is referred to the appended independent claims. Some preferred features are laid out in the dependent claims.

[0008] An example of the present invention is a filter assembly comprising a first filter, a notch filter, and a phase-shifter. The first filter has a stop-band. The filter assembly is configured to receive an input signal. The filter assembly is configured to, in use, split the output of the first filter into a main output signal and a secondary signal, and to pass the secondary signal through the notch filter having a stop-band corresponding to the pass-band of the first filter and, or including, through the phase-shifter so as to be phase-shifted at least substantially into anti-phase to the main output signal to provide an adjustment signal. The filter assembly is further configured to then combine the adjustment signal with the then input signal so as to provide the then main output signal attenuated in the stop-band.

[0009] Preferably, to provide the adjustment signal, the secondary signal is amplified to substantially the same amplitude as the input signal.

[0010] Preferred embodiments provide a filter assembly having both a high stop-band attenuation and a low pass-band insertion loss.

[0011] Preferred embodiments may be considered as feed-forward filters with a broad transmission zero, in other words a broad and deep notch. Preferred embodiments provide improved attenuation in the stop-band with little change in pass-band insertion loss.

[0012] The present invention also relates to corresponding methods.

Brief Description of the Drawings

[0013] Embodiments of the present invention will now be described by way of example and with reference to the drawings, in which:

Figure 1 is a diagram illustrating two known filters (PRIOR ART)

Figure 2 is a diagram illustrating a filter according to a first embodiment of the present invention,

Figure 3 illustrates schematically the Input signal as a function of radio frequency at time t_0 , in the filter shown in Figure 2,

Figure 4 illustrates schematically the signal S1 as a

function of radio frequency at time t_0 , in the filter shown in Figure 2,

Figure 5 illustrates schematically the signal S_2 as a function of radio frequency at time t_0 , in the filter shown in Figure 2,

Figure 6 illustrates schematically the signal $\Phi(\omega)$ as a function of radio frequency at time t_0 , in the filter shown in Figure 2,

Figure 7 illustrates schematically the signal $\Phi_f(\omega)$ as a function of radio frequency at time $t_0 + \Delta t$, in the filter shown in Figure 2,

Figure 8 illustrates schematically the signal S_1 as a function of radio frequency at time $t_0 + \Delta t$, in the filter shown in Figure 2,

Figure 9 illustrates schematically the signal S_2 as a function of radio frequency at time $t_0 + \Delta t$, in the filter shown in Figure 2, and

Figure 10 is a diagram illustrating a filter according to a second embodiment of the present invention.

Detailed Description

[0014] When considering the known approach shown in Figure 1, the inventor realised that a drawback of this known approach is that the introduced transmission zero is small and one would need to introduce several such transmission zeros next to each other to significantly improve the stop-band attenuation. However this would have the disadvantage of increasing the insertion loss in the pass-band.

[0015] The inventor realised that it would be possible to introduce a broad transmission zero (also known as a notch) into a filter assembly's attenuation characteristic by coupling a small part of the signal output from a ceramic filter into a notch filter block. This is in order to produce a signal which, in the stop-band, is similar in magnitude but in anti-phase to the main signal output from the ceramic filter. The main signal and correction signal are then combined at the input to the ceramic filter. In consequence, there is little increase in insertion loss but significant extra attenuation in the stop-band. This can be considered as a "feed-back" correction.

Filter Assembly

[0016] More specifically, as shown in Figure 2, a filter assembly 10 includes a loosely couple directional coupler 18 having an input 14 for an Input signal and an output 16. The output 16 is connected to a first ceramic filter 12. The inventor considered that ceramic filter 12 has an acceptably low insertion loss but itself provides insufficient attenuation in the stop-band. The output S_1 of the ceramic filter 12 is connected to a second loosely-coupled directional coupler 22. The second directional coupler 22 has a main output 20 that provides Output signal S_2 , and a secondary output 24 that is connected to a notch filter block 26.

[0017] The notch filter block 26 has its pass-band at

the location of the stop-band of the first ceramic filter 12. The stop-band of the notch filter block 26 is the same range of frequencies as the pass-band of the first ceramic filter 12. In this example, the notch filter block 26 includes a circulator 28, a second ceramic filter 30 and a resistor 32. The secondary output 24 of the second directional coupler 22 is connected to the circulator 28.

[0018] The output 34 of the circulator 28 is connected to a frequency dependent phase shifter 36 which is connected to an amplifier 38. The amplifier 38 has an output 40 which is provided as an input to the first directional coupler 18.

[0019] The first ceramic filter 12 and the second ceramic filter 30 have similar pass-band characteristics.

Operation

[0020] The operation of the filter assembly shown in Figure 2 is basically as follows.

[0021] The first directional coupler 18 applies a correction $\Phi_f(\omega)$ to its Input signal to provide a corrected input signal to the first ceramic filter 12. The ceramic filter 12 filters the corrected input signal at its input (16) to provide a filtered signal S_1 .

[0022] The filtered signal S_1 is then passed to the second directional coupler 22 which has a very low attenuation to the main output signal S_2 provided at output 20 but creates, at its secondary output 24, a relatively low power replica signal, denoted $\Phi(\omega)$, of the filtered signal S_1 .

[0023] The replica signal $\Phi(\omega)$ is then passed through the notch filter 26 to provide at the notch filter output 34 a processed signal 42 that is greatly attenuated in the pass-band of the second filter 30 but has minimal effect in its pass-band. The processed signal 42 is then phase-adjusted in the phase shifter 36 and then amplified by amplifier 38, and the resultant signal $\Phi_f(\omega)$ is fed to the first directional coupler 18.

[0024] In the first directional coupler 18, the Input signal and the correction signal $\Phi_f(\omega)$ are combined to provide a corrected input signal to the first ceramic filter 12. In the pass-band the correction signal $\Phi_f(\omega)$ is relatively small and so has little or no effect on the insertion loss performance. However, in the stop-band the correction signal $\Phi_f(\omega)$ is, as intended, basically equal in magnitude and in anti-phase to the Input signal. This results in a greater stop-band attenuation, as is desirable. In consequence, a sharp stop-band attenuation characteristic is seen as a function of frequency going between pass-band and stop-band.

More detail about operation

[0025] To aid in explanation, we need to consider timing. We consider the input signal at the input port 14 of the first directional coupler 18 at a first time t_0 . The first ceramic filter 12 and the two directional coupler 18, 22 introduce negligible delay to signals, in other words upon

a signal appearing at the input 14 it is converted to S1 and S2 practically instantaneously. The only significant delay is that caused by the amplifier 38 in the feedback path. This delay is denoted Δt .

[0026] At a first time t_0 , the signals in the filter shown in Figure 2 are as shown in Figure 3 to 6.

[0027] Figure 3 illustrates schematically the input signal to the filter assembly 10 as a function of radio frequency at the first time t_0 .

[0028] Figure 4 illustrates schematically the filtered signal S1 output from the first ceramic filter 12 at time t_0 as a function of radio frequency. The passband of the ceramic filter 12 is the frequency range f_1 to f_2 .

[0029] Figure 5 illustrates schematically the output signal S2 as a function of radio frequency at time t_0 . This is very similar to S1 as a function of frequency (see Figure 4). However, as shown in Figure 5, some slight attenuation occurs due to the presence of the second directional coupler 22.

[0030] Figure 6 illustrates schematically the replica signal $\Phi(\omega)$ as a function of radio frequency at time t_0 .

[0031] Figure 7 illustrates schematically the correction signal $\Phi_f(\omega)$ as a function of radio frequency following the delay Δt due to the amplifier 38, in other words at time $t_0 + \Delta t$. This is the notch-filtered, phase compensated and amplitude compensated signal provided by the feed-back path. The coupling of the second directional coupler 22 is indicated by C2 and the amplification is shown by a change in amplitude of $C2+A$, where A is the amplifier's gain.

[0032] At that time $t_0 + \Delta t$, the signals S1 and S2 are subject to the correction signal $\Phi_f(\omega)$.

[0033] Figure 8 illustrates schematically the filtered signal S1 from the first ceramic filter 12 at time $t_0 + \Delta t$ as a function of radio frequency.

[0034] Figure 9 illustrates schematically the output signal S2 as a function of radio frequency at time $t_0 + \Delta t$. This is very similar to S1 as a function of frequency at that time as shown in Figure 8. However, as shown in Figure 9, some slight attenuation occurs due to the presence of the second directional coupler 22.

[0035] Significantly, looking at Figure 9 compared to Figure 5, "narrowing" of the "shoulders" is evident.

[0036] It will be understood that starting from time t_0 , it is only from time $t_0 + \Delta t$ that the feedback path provides a correction signal $\Phi_f(\omega)$ to adjust the Input signal to the filter assembly 10.

Some Operational Details

[0037] As regards some implementation details, in the example shown in Figure 2, the gain of the amplifier 38 is the sum of the coupling of the first directional coupler 18 and the coupling of the second directional coupler 22, where coupling here is a known measure of the proportion of the main signal input to a directional coupler that is output or input via a secondary port.

[0038] Furthermore, the power of the signal in the

'feed-back' branch, namely via the notch filter 26, phase shifter 38 and amplifier 38, prior to the first directional coupler 18, specifically correction signal $\Phi_f(\omega)$, has an amplitude of about -10 dB or lower relative to the Input signal; for example -11 dB relative to the Input signal. This enables the amplifier 38 to be low power and to provide a correction signal $\Phi_f(\omega)$ signal which is of good linearity.

[0039] Furthermore, the phase of the correction signal $\Phi_f(\omega)$ is controlled to be in anti-phase with the phase of the replica signal $\Phi(\omega)$ in the feed-back branch in the frequency range where increased attenuation is sought. This may be represented as $\Phi_f(\omega) = \Phi(\omega) + K$, where K is a constant.

[0040] Still furthermore, in examples described above with reference to Figures 2 to 9, constant phase monitoring is not required, (however in some alternative embodiments constant phase monitoring may be undertaken). Phase monitoring may be considered a step in the equipment calibration procedure. Phase calibration is repeated periodically so as to compensate for component performance drift due to aging. In practise, the amplifier 38 may be the first component to show signs of aging, but as it is in a feedback path operating at relatively low powers, the amplifier 38 may be less sensitive to aging than otherwise.

An alternative filter assembly

[0041] As shown in Figure 10, in an alternative example which is otherwise similar to the Figure 2 example, the frequency dependent phase shifter 36' is instead connected between the circulator 28' and second ceramic filter 30' in the notch filter 26'. This integration of the phase compensation into the notch filter effectively compensates for any unwanted changes in phase due to the circulator 28'.

[0042] The Figure 10 example may be considered an alternative realisation of the feed-back filter shown in Figure 2. In the Figure 10 example, (as for the Figure 2 example), both the signals Input, S1, S2, $\Phi(\omega)$ at time t_0 , and $\Phi_f(\omega)$, S1, and S2 at time $t_0 + \Delta t$, are as shown schematically in Figures 3 to 9.

Some Further Alternative Embodiments

[0043] In the examples described above with reference to Figures 2 to 10 the phase compensation is done in the Radio Frequency domain. In some alternative examples (not shown) the phase compensation is done in the digital domain. This enables the bandwidth of the high attenuation stop-band to be extended.

[0044] In the examples described above with reference to Figures 2 to 10, only the amplifier 38 was considered to provide significant delay. In other embodiments, other components can introduce delays, but the operation would be similar.

General

[0045] The present invention may be embodied in other specific forms without departing from its essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

Claims

1. A filter assembly comprising a first filter(12), a notch filter(26,26'), and a phase-shifter (36), the first filter having a stop-band, the filter assembly being configured to, receive an input signal, and the filter assembly being configured to, in use, split the output (S1) of the first filter (12) into a main output signal (S2) and a secondary signal, and to pass the secondary signal (24) through the notch filter (26) having a stop-band corresponding to the pass-band of the first filter (12) and, or including, through the phase-shifter (36) so as to be phase-shifted at least substantially into anti-phase to the input signal to provide an adjustment signal ($\Phi_f(\omega)$), the filter assembly further being configured to then combine (18) the adjustment signal with the then input signal so as to provide the then main output signal (S2) attenuated in the stop-band.
2. A filter assembly according to claim 1, in which the notch filter (26) comprises a circulator (28), a second filter (30), and a resistor (32), the circulator (28) being connected to the second filter (30) which is connected to the resistor (32).
3. A filter assembly according to claim 2, in which the first filter (12) and the second filter (30) have similar pass-band characteristics.
4. A filter assembly according to any preceding claim, in which the first filter (12) comprises a ceramic filter and the second filter comprises a ceramic filter.
5. A filter assembly according to any preceding claim, in which the notch filter (26') includes the phase-shifter.
6. A filter assembly according to any preceding claim, in which, in use, the signal from the notch filter (26) is amplified by an amplifier (38) to substantially the same amplitude as the input signal.
7. A filter assembly according to any preceding claim, in which, in use, the combining is performed by a

first directional coupler (18) and the splitting is performed by a second directional coupler (22).

8. A filter assembly according to claim 7 as dependent upon claim 6, in which the amplifier has a gain corresponding to the coupling of the first directional amplifier plus the coupling of the second directional amplifier, where coupling is a measure of the proportion of the main input/output to a respective directional coupler provided at a secondary port of the respective directional coupler.
9. A filter assembly according to any preceding claim, in which the adjustment signal ($\Phi_f(\omega)$) has an amplitude of -10 dB or lower relative the amplitude of the input signal (14).
10. A filter assembly according to any preceding claim, in which, in use, the secondary signal (24) is altered by 180 degrees in phase by the phase-shifter (36) to provide the adjustment signal.
11. A method of filtering an input signal, the method comprising:
 - receiving the input signal;
 - filtering by a first filter (12) having a stop-band;
 - splitting the output (S1) of the first filter (12) into a main output signal (S2) and a secondary signal;
 - providing an adjustment signal ($\Phi_f(\omega)$) by passing the secondary signal (24) through a notch filter (26) having a stop-band corresponding to the pass-band of the first filter, and, or including, phase-shifting the secondary signal at least substantially into anti-phase to the input signal;
 - then combining (18) the adjustment signal ($\Phi_f(\omega)$) with the then input signal so as to provide the then main output signal (S2) attenuated in the stop-band.

Amended claims in accordance with Rule 137(2) EPC.

1. A filter assembly comprising a first filter(12), a notch filter(26,26'), and a phase-shifter (36), the first filter having a stop-band and a pass-band, the filter assembly being configured to, receive an input signal, and the filter assembly being configured to, in use, split the output (S1) of the first filter (12) into a main output signal (S2) and a secondary signal, and to pass the secondary signal (24) through the notch filter (26) having a stop-band corresponding to the pass-band of the first filter (12) and, or including, through the phase-shifter (36) so as to be phase-shifted at least substantially into anti-phase to the input signal to provide an adjustment signal ($\Phi_f(\omega)$),

the filter assembly further being configured to then combine (18) the adjustment signal with the then input signal so as to provide the then main output signal (S2) attenuated in the stop-band.

2. A filter assembly according to claim 1, in which the notch filter (26) comprises a circulator (28), a second filter (30), and a resistor (32), the circulator (28) being connected to the second filter (30) which is connected to the resistor (32).

3. A filter assembly according to claim 2, in which the first filter (12) and the second filter (30) have similar pass-band characteristics.

4. A filter assembly according to any preceding claim, in which the first filter (12) comprises a ceramic filter and the second filter comprises a ceramic filter.

5. A filter assembly according to any preceding claim, in which the notch filter (26') includes the phase-shifter.

6. A filter assembly according to any preceding claim, in which, in use, the signal from the notch filter (26) is amplified by an amplifier (38) to substantially the same amplitude as the input signal.

7. A filter assembly according to any preceding claim, in which, in use, the combining is performed by a first directional coupler (18) and the splitting is performed by a second directional coupler (22).

8. A filter assembly according to claim 7 as dependent upon claim 6, in which the amplifier has a gain corresponding to the coupling of the first directional amplifier plus the coupling of the second directional amplifier, where coupling is a measure of the proportion of the main input/output to a respective directional coupler provided at a secondary port of the respective directional coupler.

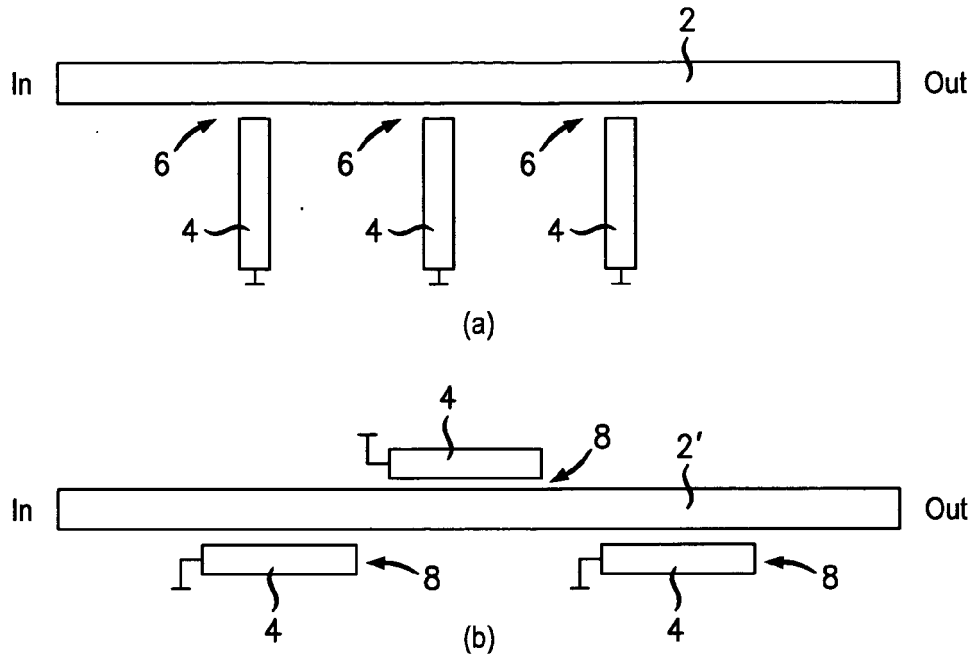
9. A filter assembly according to any preceding claim, in which the adjustment signal ($\Phi_f(\omega)$) has an amplitude of -10 dB or lower relative the amplitude of the input signal (14).

10. A filter assembly according to any preceding claim, in which, in use, the secondary signal (24) is altered by 180 degrees in phase by the phase-shifter (36) to provide the adjustment signal.

11. A method of filtering an input signal, the method comprising:

receiving the input signal;
filtering by a first filter (12) having a stop-band and a pass-band;

splitting the output (S1) of the first filter (12) into a main output signal (S2) and a secondary signal;
providing an adjustment signal ($\Phi_f(\omega)$) by passing the secondary signal (24) through a notch filter (26) having a stop-band corresponding to the pass-band of the first filter, and, or including, phase-shifting the secondary signal at least substantially into anti-phase to the input signal;
then combining (18) the adjustment signal ($\Phi_f(\omega)$) with the then input signal so as to provide the then main output signal (S2) attenuated in the stop-band.



Band-stop filters with (a) capacitive and (b) with parallel couplings

FIG. 1
PRIOR ART

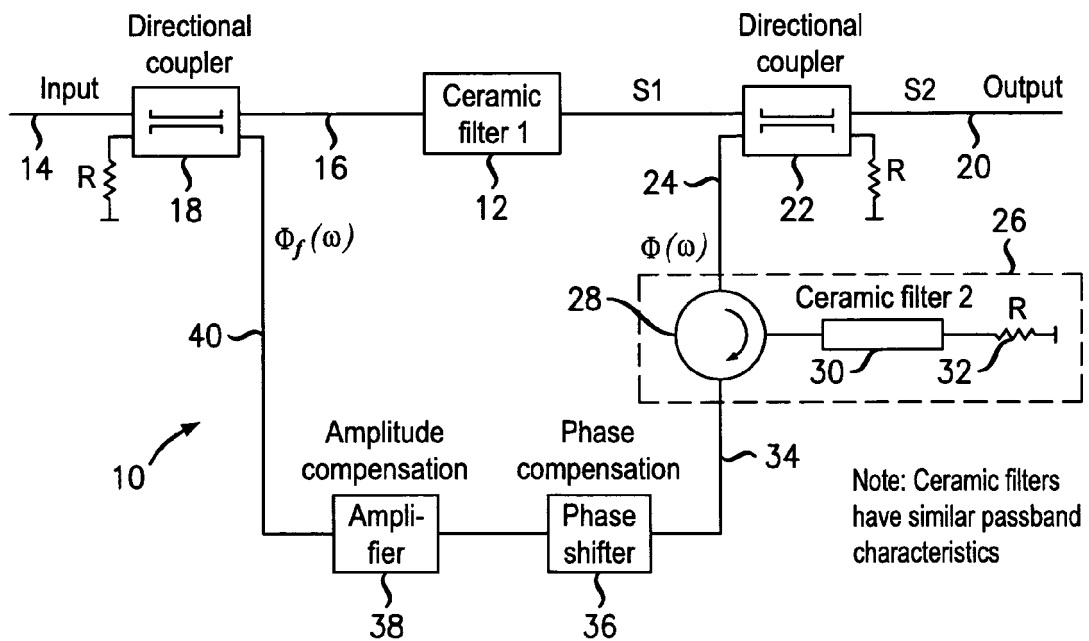
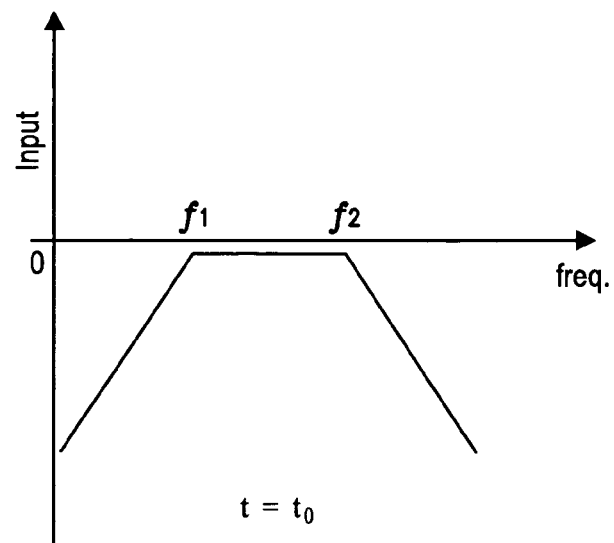
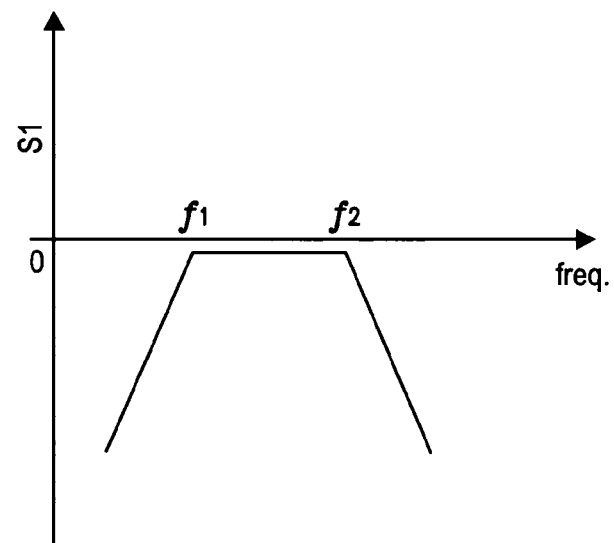


FIG. 2



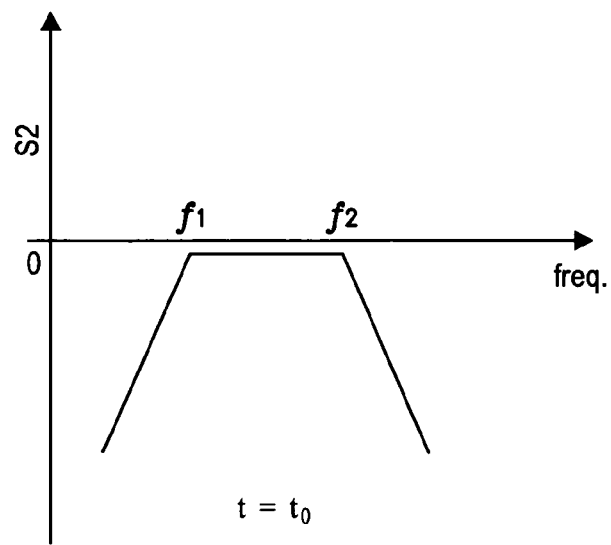
$t = t_0$
INPUT SIGNAL

FIG. 3



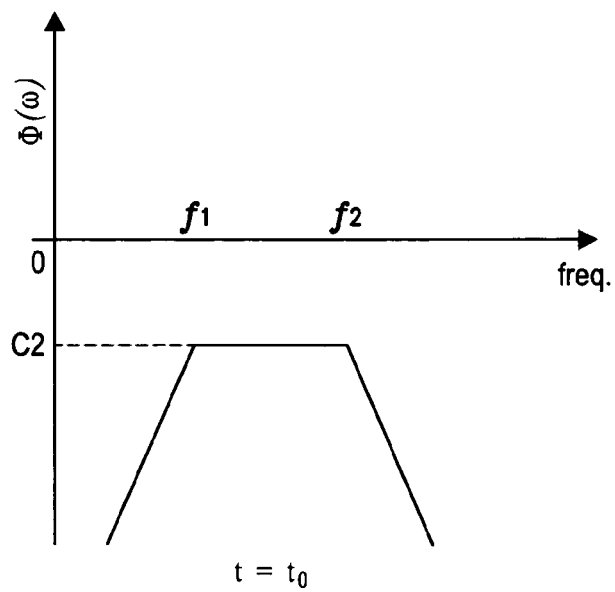
$t = t_0$
FILTERED SIGNAL

FIG. 4



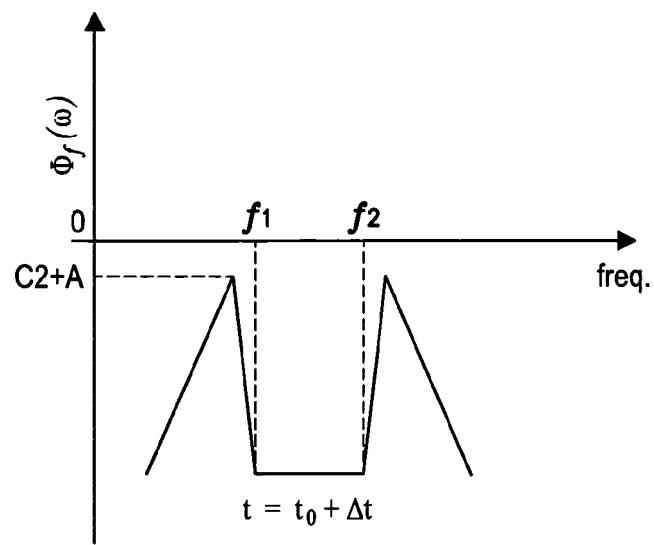
OUTPUT SIGNAL

FIG. 5



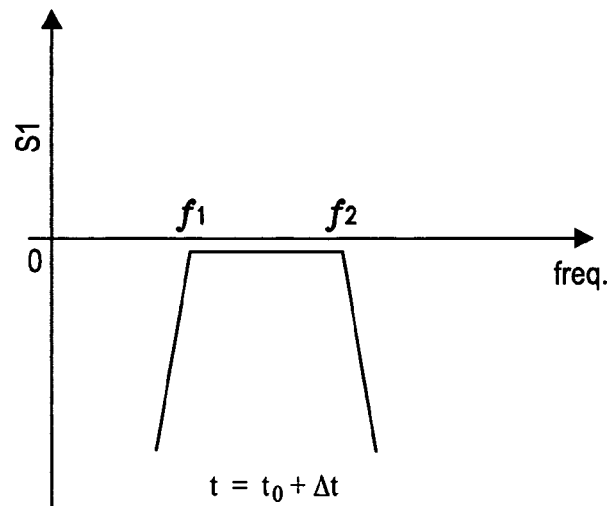
REPLICA SIGNAL

FIG. 6



CORRECTION SIGNAL

FIG. 7



FILTERED SIGNAL

FIG. 8

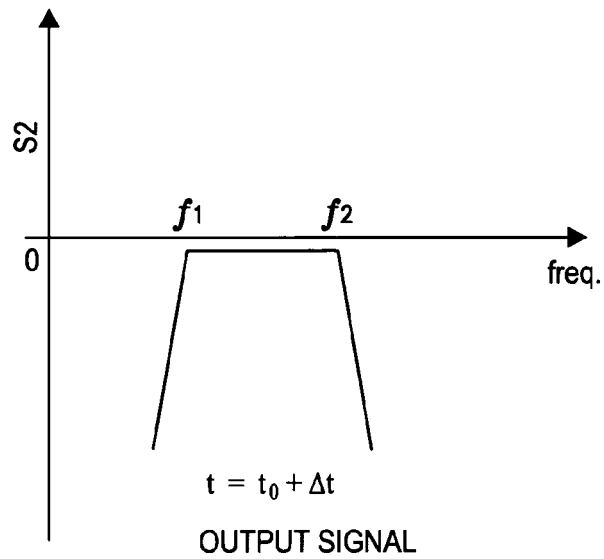


FIG. 9

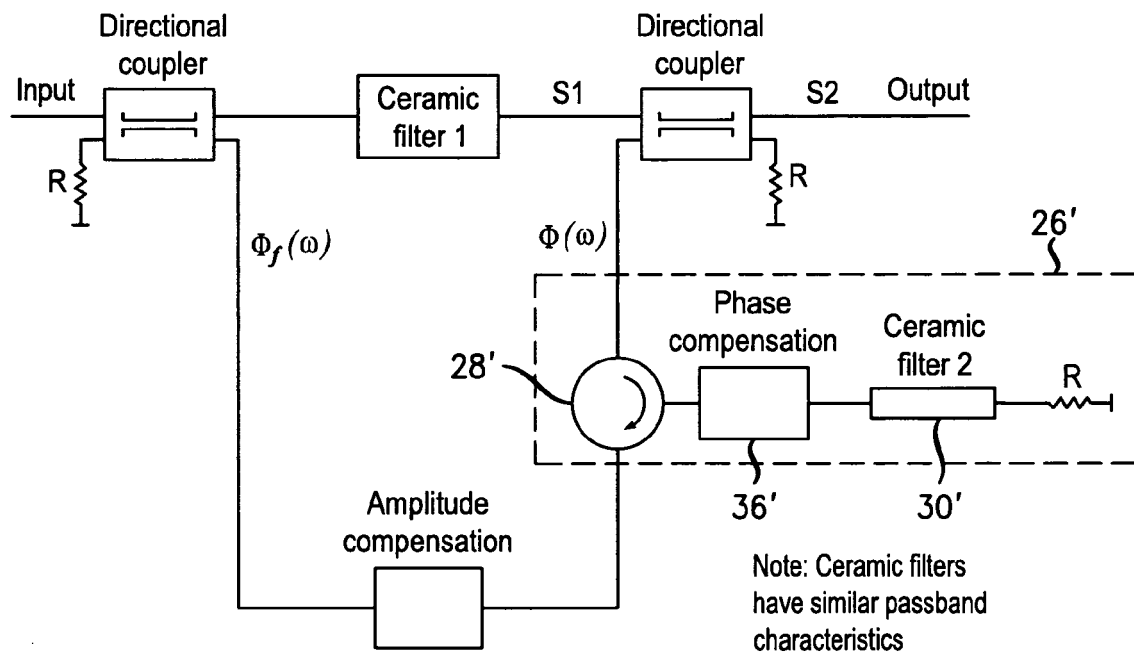


FIG. 10



EUROPEAN SEARCH REPORT

 Application Number
 EP 13 29 0028

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP S62 194717 A (NIPPON TELEGRAPH & TELEPHONE) 27 August 1987 (1987-08-27) * abstract; figure 1 *	1-11	INV. H01P1/20 H03H11/04
A	CN 1 776 957 A (SANWEI COMM CO LTD ZHEJIANG [CN]) 24 May 2006 (2006-05-24) * the whole document *	2	
A	US 2009/309649 A1 (TSUYAMA ISAO [JP]) 17 December 2009 (2009-12-17) * paragraph [0053] - paragraph [0054]; figure 1 *	1-11	
A	FR 2 880 742 A1 (MAGAGNINI ALAIN MAURICE ANGE [FR]) 14 July 2006 (2006-07-14) * the whole document *	1,11	
A	JP S56 103523 A (FUJITSU LTD) 18 August 1981 (1981-08-18) * the whole document *	1,11	
A	JP H11 186873 A (MATSUSHITA ELECTRIC IND CO LTD) 9 July 1999 (1999-07-09) * the whole document *	1,11	TECHNICAL FIELDS SEARCHED (IPC)
			H01P H03H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 June 2013	Examiner Ribbe, Jonas
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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 EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 29 0028

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18-06-2013

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP S62194717 A	27-08-1987	JP H0693587 B2 JP S62194717 A	16-11-1994 27-08-1987
-----	-----	-----	-----
CN 1776957 A	24-05-2006	NONE	
-----	-----	-----	-----
US 2009309649 A1	17-12-2009	JP 2009302857 A US 2009309649 A1	24-12-2009 17-12-2009
-----	-----	-----	-----
FR 2880742 A1	14-07-2006	NONE	
-----	-----	-----	-----
JP S56103523 A	18-08-1981	NONE	
-----	-----	-----	-----
JP H11186873 A	09-07-1999	NONE	
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