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(54) **Title**: TUNABLE FILTER DEVICES AND METHODS

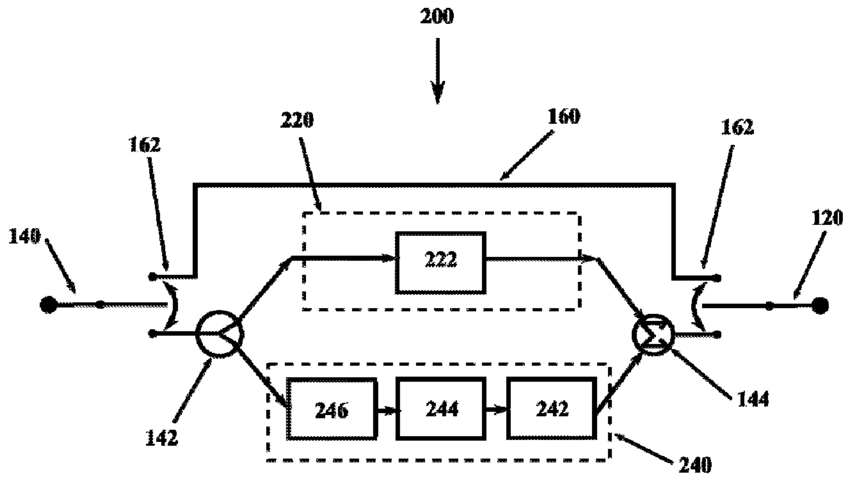


FIG. 2A

(57) **Abstract**: Analog interference filter devices and methods for isolation of desirable portions of a radio frequency signal. Signal compensation is used to provide desirable center frequency, passband width, ripple, rolloff, stopband and distortion performance. The filter is implemented with passive and/or active components.

WO 2012/030658 A2

# TUNABLE FILTER DEVICES AND METHODS

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## CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of the filing date of U.S. Provisional Patent Application Serial No. 61/402,416 filed by the present inventor on August 30, 2010 and U.S. Provisional Patent Application Serial No. 61/510,330 filed by the present inventor on July 21, 2011.

[0002] The aforementioned provisional patent applications are hereby incorporated by reference in their entirety.

## STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0003] None.

## BACKGROUND OF THE INVENTION

### Field Of The Invention

[0004] This invention relates to radio frequency communication. More specifically, it relates to tuning of devices to selectively receive desired signals.

### Brief Description Of The Related Art

[0005] Consumer demand for wireless connectivity by smart phones, pads and notebook computers ("smart phones") is exploding, with national demand expected to exceed capacity by 2013. In response, the federal government is expanding the amount of unlicensed spectrum available to consumers. This newly available spectrum and the need for more efficient use of existing spectrum are driving the rapid proliferation of frequency band to which a smart phone must tune.

[0006] Existing filter and off-chip resonator technology used to select frequency channels can be tuned only over a limited frequency range. As a result, the number of filters integrated in a smart phone is growing rapidly, increasing the cost, complexity and space burden imposed by the filters. Without a widely tunable filter the proliferation of filters will adversely impact the economic value of smart phone, degrade consumer acceptance and slow growth of the industry.

[0007] In light of the above, we disclose interference based tuning devices and methods for smart phones to isolate radio frequency signals of interest. Tuning by interference employing control of amplitude, phase and group delay enables an ultra-wideband tunable filter that can be tuned rapidly and reliably to any current or anticipated mobile wireless frequency.

## SUMMARY OF THE INVENTION

[0008] The first object of the invention is to provide better utilization of RF spectrum. The second object is to provide a tunable filter for RF signals. The third object is to provide a band-passed signal output having a tunable center frequency and/or pass-band bandwidth. The fourth object is to provide a rapidly tunable filter. The fifth object is to provide a plurality of signals tuned to different center frequencies and/or pass-band widths. The sixth object is to provide a band-passed signal having reduced distortion content.

[0009] The invention comprises devices and methods for inherently stable continuously-variable ultra-wideband tunable filtering of radio frequency signals for use with a multiband smart phone or other type of radio. This filter comprises devices and methods of analog, feed-forward interference filtering to provide a desirably band-passed signal.

[0010] The invention comprises devices and methods for continuously tuning a signal to provide at least one desirable aspect of: center frequency, passband width, ripple, rolloff and stopband. The filter comprises devices and methods for providing a plurality of desirably received signals from a detected signal. And, it comprises devices and methods for spatial domain filtering of detected signals.

[0011] The filter can be implemented in any type of circuitry such as the physical layer of a cell phone handset, although other implementations are also acceptable. It can be implemented with passive and/or active components not requiring high voltage. It is described in terms of receivers, but can also be used in transmitters.

[0012] Still other aspects, features, and advantages of the present invention are readily apparent from the following detailed description, simply by illustrating a preferable embodiments and implementations. The present invention is also capable of other and different embodiments and its several details can be modified in various obvious respects, all without departing from the spirit and scope of the present invention. Accordingly, the drawings and descriptions are to be regarded as illustrative in nature, and not as restrictive. Additional objects and advantages of the invention will be set forth in part in the description which follows and in part will be obvious from the description, or may be learned by practice of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0013] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description and the accompanying drawings, in which:

[0014] FIG. 1: Schematic of a unit comprising a series of cells.

[0015] FIG. 2A: Schematic of a cell comprising a first channel delay element.

[0016] FIG. 2B: Schematic of a cell comprising first channel element, phase shifter and amplitude compensator.

[0017] FIG. 2C: Schematic of a distortion removing type cell.

[0018] FIG. 3: Schematic of a cell comprising a vector modulator.

[0019] FIG. 4: Schematic of a dual-unit filter.

[0020] FIG. 5: Schematic of a multi-channel filter.

[0021] FIG. 6: Schematic of a spatial steering filter.

[0022] FIG. 7: Primary steps of the method.

[0023] FIG. 8A: Additional steps of the method.

[0024] FIG. 8B: Method steps including distortion removing.

[0025] FIG. 9A: Single unit filter with 100 MHz passband at 530 MHz.

[0026] FIG. 9B: Single unit filter with 30 MHz passband at 530 MHz.

[0027] FIG. 9C: Single unit filter with 30 MHz passband at 140 MHz.

[0028] FIG. 9D: Single unit filter with 30 MHz passband at 830 MHz.

[0029] FIG. 10: Dual-unit filter with maximally flat passband centered at 570 MHz.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] Unless defined otherwise, terms are used herein according to their generally accepted engineering definitions. Although described in terms of signal reception, filter can be used in signal transmission. Although described in terms of RF electrical signals, this disclosure is intended to cover electrical and electromagnetic signals of any frequency as well as other physical signals including radar, light, and sound among others. The device, herein after referred to as a filter, can comprise any circuit type, such as electrical, electronic, optoelectronic, complementary metallic- oxide semiconductor or other.

[0031] Although the filter is illustrated here as a series configuration, parallel and mixed parallel and series configurations are acceptable. For purposes of this disclosure, configuring is intended to include tuning and connections of cells and/or units. It should also be noted that steps of configuring, e.g. tuning, are mathematically associative and commutative and, therefore can be conducted in any desirable temporal and/or spatial sequence. Although described in terms of two channels and two units, any number of channels and units are acceptable.

[0032] Desired frequency is defined as one or more frequency component of a signal that is desirably retained. Desired frequency can comprise one or more passband, although other types are acceptable. Undesired frequency is defined as not a desired frequency. A null bandpass signal is defined as having substantially reduced amplitude at desired frequency. Distortion free signal is defined as having distortion substantially removed or prevented at desired frequency. A native signal is defined as substantially unmodified other than with respect to transit time.

[0033] The invention comprises filter devices and methods for continuously-variable ultra-wideband tuning of a radio frequency (RF) filter center frequency, passband bandwidth, passband ripple, passband rolloff, and stopband attenuation. Filter output comprises at least one desirable passband feature of; center frequency, width, ripple and rolloff, as well as stopband attenuation. Feed-forward interference filtering among a detected signal and modified variants thereof is used to provide a desirably filtered signal.

[0034] Filter can be implemented with any type of passive and/or active analog components that can modify at least one signal aspect of; phase, amplitude and group delay. In some cases, analog components can be connected to at least one mixed signal and/or digital component, such as for communications, digitizing or control. Filter operates by at least one of; splitting, phase shifting, amplitude adjusting, delaying, interfering, bypassing, and combining, which operations can be modified before or in use. Filter can operate at low voltage, e.g. less than 5 volts. Filter is preferably a solid state device fabricated with any suitable solid state, nano- or other material. It can comprise any physical type, e.g. chip component, chip, module, or circuit board.

[0035] FIG. 1 illustrates a filter **10** connected to an antenna **20**, which filter **10** comprises at least one unit **100** comprising at least one cell **200** shown here connected in series although other configurations are also acceptable. Unit **100** can comprise any number of cell **200** such as between 1 and 100. Filter **10** comprises unit input lead **102** and unit output lead **104**. First cell output lead **140** can further comprise second cell input lead **120**. A unit **100** can comprise a bypass **160** of any type that can bypass a signal with respect to one or more cell **200**.

[0036] FIG. 2A illustrates a cell **200** comprising cell input line **140**, splitter **142**, combiner **144** cell output line **120**, bypass **160**, first channel **220** and second channel **240**. Splitter **142** is any type of device that can provide input signal to first channel **220** and to second channel **240**. Combiner **144** is any type that can combine signal from first channel **220** and signal from second channel **240**. Bypass **160** further comprises at least one bypass switch **162** of any type that can be used to bypass a signal around cell **200**. Bypass can comprise any type, including but not limited to delay providing. In the illustrated embodiment, first channel **220** comprises a first channel delay element **222** and second channel **240** comprises at least one of; second channel delay element **242**, second channel phase shifter **244** and second channel amplitude compensator **246**. Delay element **222, 242** and phase shifter **224, 244** comprise any type, including but not limited to gyrator, active inductor and variable gain amplifier type.

[0037] FIG. 2B illustrates a cell **200** comprising a first channel **220** further comprising at least one of; first phase shifter **224** and first amplitude compensator **226**, with the phase shifter **224** configured before or after amplitude compensator **226.** Delay element **222, 242** is any type of circuit element that can alter travel time of at least a portion of a signal. Phase shifter **224, 244** is any type of device that can alter phase of at least a portion of a signal. Amplitude compensator **226, 246** is any type of device that can alter amplitude of at least a portion of a signal.

[0038] Referring to FIG. 2C, cell **200** is any type that, on receiving a distortion inducing input signal, can provide a distortion removed output signal. Cell **200** is any type that can remove distortion created by an active or other distortion-susceptible type of component.

[0039] Cell **200** comprises an input **140**, splitter **142,** distortion removing path **2000** and native signal path **3000** and combiner **144.** Distortion removing path **2000** comprises a splitter **142**, first channel **240**, second channel **220** and combiner **144.** Distortion removing path **2000** is any type that can provide a null passband type signal having amplitude reduced by between 1 dB and 200 dB at desired frequency. Native signal path **3000** is type that can provide a native type signal.

[0040] First channel **240** is any type that can provide a signal that is at least partly amplitude balanced and/or anti-phase with respect to signal from second channel **240**. First channel **240** and/or second channel **220** can comprise one or more active, or other distortion-susceptible component such as an active type. Distortion removing path **2000** can additionally comprise phase shifter **244** and/or amplitude compensator **246**. In some cases, native signal path **3000** can comprises a delay providing element **3200** of any type.

[0041] Cell **200** further comprises a combiner **144** of any type that can combine signal from distortion removing path **2000** and from native signal path **3000** to provide signal substantially free of distortion at desired frequency. Cell output **120** can be connected to second device **400** of any type, e.g. filter or cell, that can reduce signal amplitude at least one undesired frequency.

[0042] FIG. 3 illustrates a cell **200** wherein at least one channel **220, 240** can comprise a vector modulator **248**, which is **any** type of device that can modify at least one signal aspect of; phase, amplitude and delay. In some cases, vector modulator **248** can further comprise at least one of; analog/digital converter **249a** and control input **249b**. Converter **249a** is any type that can convert a signal between digital and analog type. Control input **249b** is any type that can provide a digital and/or analog signal. In some cases, channel **220, 240** comprising a vector modulator **249a** can further comprise at least one of; delay element **222, 242**, phase shifter **224, 244** and amplitude compensator **226, 246**.

[0043] FIG. 4 illustrates a dual-unit type filter **10** comprising unit input element **102**, splitter **142**, first unit **100**, second unit **100**, and combiner **144**. In some cases, dual-unit filter additionally comprises at least one of additional phase shifter and additional delay element. While described as a dual-unit type of parallel configuration, filter **10** can comprise other numbers of units **100** and/or other configurations.

[0044] FIG. 5 illustrates the filter **10** configured as a multi-channel device for modifying a detected signal to provide a plurality of desirably received signal, such as for disjoint aggregation of channels to provide greater bandwidth. Multi-channel filter **10** comprises a splitter network **420** and a plurality of unit **100** each having an output element **104**. It will be evident that dual-unit or other configuration can be substituted for one or more unit filter **100** in such a configuration of filter **10**.

[0045] FIG. 6 illustrates a filter **10** for filtering and combining signals from a plurality of antenna **20** such as to provide spatial filtering or enhanced signal gain. In this example, first antenna **20** is connected to a first unit **100,** a second antenna **20** connected to a second unit **100** and first unit **100** and second unit **100** are connected to a combiner **144**. In some cases, at least one unit **100** further comprises a phase shifter **180**. Configurations in addition to that shown are also acceptable.

[0046] FIG. 7 summarizes the filter method, which comprises at least one step of; **A)** receiving a signal, **B)** providing signal to a unit, **C)** providing signal to a cell, **D)** modifying provided signals to provide desirable signal, and **E)** providing said modified signal to a user or secondary device such as a radio receiver. In some cases, the method comprises transmitting a signal via an antenna or other type transducer. In some cases, transmitting and/or receiving comprises selecting frequency corresponding to one or more channel frequency having available capacity. In some cases, receiving comprises removing at least a portion of a signal transmitted via antenna providing received signal.

[0047] FIG. 8A provides additional detail of the method, wherein; **D1**) cell input signal is split into a first channel input signal and a second channel input signal, **D2**) first channel signal is modified by delaying, **D3**) second channel signal is modified by at least one of; phase shifting, amplitude compensating and delaying, **D4**) combining first channel signal and second channel signal by constructive and/or destructive interference, as means of providing a filter performance characterized by at least one of; center frequency, passband width, ripple, stopband, loss, settling time, and tuning rate.

[0048] Additional filtering can be provided by at least one serially connected second cell which can receive a first cell output signal as a second cell input signal. Second cell input signal is modified by second cell with respect to at least one of; delay, phase and amplitude to provide at least one of; second center frequency, second passband width, second rolloff and second stopband. Second center frequency can be equivalent to first center frequency although this is not required. Output signal of second cell can comprise a passband width equal to or less than first cell output signal passband width. Output signal of second cell roll off can be steeper that output signal roll off of first cell. Output signal of second cell stopband rejection can be greater than first cell output signal stopband rejection. Although described in terms of a method of decreasing passband width, the invention comprises a plurality of cells for which tuning can be conducted in any sequence, i.e. tuning is of commutative type.

[0049] Filter center frequency is provided by selecting group delay difference and/or phase difference between first channel signal and second channel signal. In some cases, center frequency is selected by controlling gyrator or active inductor to provide a circuit resonance proximate the desired frequency. Difference in delay and/or phase can be negative, positive or zero. Passband width is provided by group delay difference between first channel signal and second channel signal. Unit passband width is initially determined in the first cell but can be narrowed (around the set center frequency) by selection of delay and/or center frequency in one or more of the additional cells. Rolloff and stopband rejection can be determined by selecting the number of cells in a unit.

[0050] Filter can provide any center frequency between 0 Hz and 300 GHz for any type of signal. In typical practice signals are filtered to provide any center frequency between 3 MHz and 200 GHz. Filter can provide any passband width between 0.0001% and 200% of center frequency. In some cases, center frequency and/or passband width can be altered during use. Filter can be configured by selection of number of cells to provide any rolloff between 1 and 90 dB per octave and stopband providing between 1 dB and 150 dB of out of band rejection.

[0051] The method comprises providing a desirably received signal further comprising spatial filtering by any means, such as beam and/or null steering. Steering is conducted by providing a phase delay of signal from one unit with respect to a second. For example, output of a first unit is phase shifted with respect to output of a second unit, and first and second output signals are combined to provide a steered desirably received signal. Additional spatial filtering can be provided by range gating to provide desirably received signals further comprising ranging.

[0052] The method can comprise at least one of converting, down converting, up converting and modulating. The method can comprise providing analog and/or digital signal to a secondary device, such as receiver, memory, antenna, indicator, or display.

[0053] Referring to FIG. 8B, a distortion free passband signal (**DFBS**) is provided by at least one step of; a) split a cell input signal to provide a signal to distortion removing path and a signal to a native path, b) split distortion removing path signal **(DRPS)** to provide a first channel signal (**FCS**) to first channel and a second channel signal (**SCS**) to second channel, c) adjust **FCS** phase to be at least partly anti-phase with respect to **SCS** at desired frequency as means of providing destructive interference, d) adjust **SCS** delay to provide desirable output signal passband width, e) combine **FCS** and **SCS** to form a null bandpass signal (**NBS**) having substantially null amplitude at desired frequency or frequencies, f) adjust phase of **NBS** relative to signal from native path (**NPS)** at desired frequency, g) adjust delay of **NPS** to provide desired passband width, h) combine **NBS** and **NPS** to provide constructive interference there-between to form a distortion free bandpass signal **(DFBS)**, i) provide **DFBS** to other component of any type that can reduce amplitude of at least one undesired, or out of band (**OOB**), frequency, j) provide **DFBS** to receiver or other device.

[0054] FIG. 9A, 9B and 9C illustrate performance **600** of some acceptable single-unit configurations having values of passband center frequency **620** and width **640,** showing only a representative portion of the frequency range of the inventive **10**. It should be noted that configuration of filter **10** providing performance **600** illustrated FIGs. 9b, 9c and 9d can differ only in the tuning aspect of configuring. It should further be noted that performance **600** illustrated in FIG. 9A can be provided by reducing the number of cells **200** operative in a unit **100** such as by using a bypass **160** to circumvent one or more cell **200** with the signal.

[0055] FIG. 9A illustrates performance **600** comprising a center frequency **620** of 530 MHz, width of passband **640** of 100 MHz and stopband **660** at -60 dB. FIG. 9B illustrates performance **600** comprising center frequency **620** of 530 MHz, with of passband **640** of 30 MHz and stopband **660** at -60 dB. FIG. 9C illustrates performance **600** of filter comprising center frequency **620** of 140 MHz, a width of passband **640** of 30 MHz and stopband **660** at -60 dB containing. FIG. 9D illustrates performance **600** of filter **10** comprising center frequency **620** of 830 MHz, width of passband **640** of 30 MHz and stopband **660** at -60 dB. The filters of FIG. 9B, 9C, and 9D can have the same number of cells and group delay differences but are configured differently with respect to phase difference. Any center frequency **620** between 0 Hz and 300 GHz, width of passband **640** between 0% and 200% of center frequency and/or stopband **660** between -3 dB and -200 dB are also acceptable.

[0056] FIG. 10 illustrates filter performance **600** of a dual-unit type of filter **10** having a first unit 100 and a second unit 100, the latter configured in this example to modify at least one of; phase, amplitude and phase and phase difference to provide a 570 MHz value for center frequency **620**, width of passband **640** of 180 MHz and a stopband **660** at -100 dB. The performance **600** of such a dual-unit type filter 10 can provide a flat passband type, such as one comprising ripple less than 0.1 dB, although any value between 0 dB and 10 dB is also acceptable. In some cases, filter performance **600** comprises at least one type of; maximally flat and zero loss.

[0057] Performance **600** comprising a flattened passband is provided by combining performance **620a, 620b** of two filter units in a parallel configuration filter **10**, which units are configured in this example to provide a passband width **640** of 100 MHz and stopband **660** of -100 dB and to provide respective center frequencies of 530 MHz and 610 MHz.

[0058] Center frequency providing is conducted by shifting frequency of a portion of cell interference pattern to the desired passband center frequency by means of phase shifting and/or resonance tuning, e.g. of gyrator type component. Center frequency providing can be conducted together with passband width providing, although this is not required.

[0059] Frequency shifting is conducted by providing phase shift of second channel signal relative to first channel signal, creating a phase difference between them. Combining of first channel signal and phase shifted second channel signal is used to provide constructive interference at a plurality of frequencies with respect to a desirable center frequency and to provide destructive interference at a plurality of other frequencies. Center frequency providing can be conducted using a plurality of cell.

[0060] One method of center frequency providing by phase shifting is conducted by determination of the constructive and destructive interference regions, represented by the maxima of function $x(f)$, defined as

$$x(f)=k\lfloor f|\tau_1-\tau_2|\rfloor-\pi f|\tau_1-\tau_2|,$$

where $f$ is the frequency, $\tau_1$ is the group delay through the first channel, $\tau_2$ is the group delay through the second channel, and $k$ is a normalization function. In some cases $k$ is equal to $\pi$, but can be any constant or normalization function used to isolate maximum regions of constructive or destructive interference as local function maxima.

[0061] Normalization of $x(f)$ is conducted to provide maxima of $x(f)$ that approximately equal zero, although this is not required. Maxima of $x(f)$ are approximately equal to zero due to the periodic normalization provided by $k\lfloor f|\tau_1-\tau_2|\rfloor$, allowing the exact center frequencies of constructive and destructive interference for a given cell to be located. If $x(f)$ contains at least one maximum and a delay difference between first and second channels, phase shift $\phi_s$ providing desirable center frequency shift is described by

$$\phi_s = \pi k_t \tau_2 \left(f_m - f_c\right),$$

where $f_m$ is the frequency of the selected portion of the interference, $f_c$ is the desired center frequency of the filter, and $k_t$ is a tuning parameter which is usually but not necessarily equal to one.

[0062] If $x(f)$ does not contain at least one maximum, phase shift $\phi_s$ can be described by

$$\phi_s = \pi \pm \pi f_c |\tau_1 - \tau_2|,$$

where the sign of the phase shift is chosen according to sign of group delay difference between channels. From the foregoing, it will be apparent that selection of center frequency can be automated, although this is not required. It will be appreciated by those versed in the art that desirable phase shifting can be determined by other means such as coherence, statistical or gradient search methods. It will further be appreciated that center frequency can be provided by embodiments comprising a gyrator, active inductor or other controllable resonance providing component such as provided by bias voltages controlling component resonance frequency

[0063] A plurality of cells each having individual values for second-channel group delay with respect to group delay of first channel, can be used to provide desirable passband width and desirable center frequency. In some cases, group delay can be set equal in a plurality of cells, in which cases cell number is selected to provide a desired stopband and/or rolloff without altering passband width.

[0064] According to the method, the output signal from any filter covered by this disclosure can be provided to any type of secondary device. In some cases, output signal is converted to digital form and/or further processed as part of such providing. In some cases, the method can further comprise at least one of; storing filter output for at least a time and/or presenting output to user by any means.

[0065] Summarizing the basic method, a signal is filtered by splitting an initial signal, e.g. of antenna type, into first and second channel signals, modifying at least one channel signal by at least one of amplitude compensation, phase shifting and delaying. Amplitude compensation is conducted to provide desirable amplitude of at least one channel. Phase shifting is conducted according to an analytic calculation to provide a desirable center frequency. Delaying is conducted to provide desirable passband width. Output of the filter is the provided, for example to a receiver or transmitter.

[0066] In some cases, the inventive device can comprise a tunable duplexer of any type that can protect a receiver against adverse effects of a transit signal entering at least one of filter and receiver. Duplexer is ay type that can substantially prevent entry of at least a portion of a desirably transmitted signal from entering filter and/or receiver. Duplexer can be of any type that can reduce transmit signal power by filtering according to the inventive method. Duplexer is any type that can provide full duplex operation. Duplexer can comprise an active type diplexer that can prevent a transmitted signal comprising at least one frequency component at a desirably received signal from entering filter and/or receiver. Diplexer is any type that can provide that can full duplex operation for transmit and receive signals comprising signal components at a desirably received frequency.

[0067] The foregoing description of the preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiment was chosen and described in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto, and their equivalents. The entirety of each of the aforementioned documents is incorporated by reference herein.

IN THE CLAIMS

What we claim is:

1. A method for analog filtering of a signal comprising the steps of;

a) providing an input signal to at least one cell;

b) providing a first input signal to at least a first channel and a second channel in said at least one cell;

c) modifying said first input signal in said first channel with respect to at least one of delay, amplitude, and phase, to provide a first channel signal;

d) modifying input signal in second channel with respect to at least one of; delay, amplitude and phase, to provide a second channel signal; and

e) combining said first channel signal and said second channel signal by at least one of constructive, destructive and null interference to provide an output comprising a desirable signal.

2. The method in Claim 1 wherein said step of modifying said first input signal in said first channel comprises delaying said first input signal with a delay inherent in said first channel. 3. The method in Claim 1 wherein said step of modifying said second signal is conducted using components of at least one of passive, analog, active, low voltage and mixed signal components.

4. The method in Claim 1 wherein said modifying step is at least partly conducted with a vector modulator.

5. The method in Claim 1 wherein modifying step provides a passband having at least one desirable parameter of; center frequency, width, ripple, rolloff and stopband.

6. The method in Claim 1 further comprising the step of:

f) providing an output signal from said first cell to an input of a second cell.

7. The method of Claim 6, further comprising the steps of:

g) providing said signal input to said second cell to at least a first channel and a second channel in said second cell;

h) modifying said signal provided to said first channel of said second cell with respect to at least one of delay, amplitude, and phase, to provide a second cell first channel signal;

i) modifying said signal input to said second channel of said second cell with respect to at least one of delay, amplitude and phase, to provide a second cell second channel signal; and

j) combining said second cell first channel signal and said second cell second channel signal by at least one of constructive, destructive and null interference to provide an output comprising a desirable signal.

8. The method in Claim 1 providing a plurality of desirably received signals at the same time and/or different times.

9. A method for analog filtering of a signal comprising the steps of;

providing an input signal to a first unit, said first unit comprising a first cell, a second cell and a first unit ouptut;

providing said input signal to said first cell;

providing said first input signal to a first channel and a second channel in said at least one cell;

modifying said first input signal in said first channel with respect to at least one of delay, amplitude, and phase, to provide a first channel signal;

modifying input signal in second channel with respect to at least one of; delay, amplitude and phase, to provide a second channel signal;

combining said first channel signal and said second channel signal by at least one of constructive, destructive and null interference to provide a first output signal;

providing said first output signal to said second cell;

providing said first output signal to a first channel and a second channel in said second cell;

h) modifying said first output signal provided to said first channel of said second cell with respect to at least one of delay, amplitude, and phase, to provide a second cell first channel signal;

i) modifying said first output signal provided to said second channel of said second cell with respect to at least one of delay, amplitude and phase, to provide a second cell second channel signal; and

j) combining said second cell first channel signal and said second cell second channel signal by at least one of constructive, destructive and null interference to provide a second output signal.

10. A method for analog filtering of a signal according to Claim 9, further comprising the step of providing said second output signal to a second unit having a second unit output.

11. A method for analog filtering of a signal comprising according to Claim 10further comprising providing a difference in center frequency between said first unit output and second unit output.

12. A device for performing analog filtering of a signal, comprising:

a unit comprising:

a cell comprising:

a splitter for splitting said signal into a first signal and a second signal;

a first channel connected to said first signal;

a second channel having a second input and at least one of a second delay element, a second phase shifter and a second amplitude compensator, wherein said second channel is connected to said second signal; and

a combiner for combining a signal output from said first channel with a signal output from said second channel.

13. A device for performing analog filtering according to Claim 12, wherein said first channel comprisesat least one of an amplitude compensator, a phase shifter, and a delay element.

14. A device for performing analog filtering according to Claim 12 wherein said second channel further comprises a vector modulator.

15. A device for performing analog filtering according to Claim 12 further comprising a second unit connected to said first unit.

16. A device for performing analog filtering according to Claim 15 wherein said second unit comprises a first cell and a second cell.

17. A device for performing analog filtering according to Claim 12 wherein said second channel comprises a delay element of one of the following types: fixed and variable.

18. A device for performing analog filtering according to Claim 15 wherein said second unit is connected in parallel to said first unit.

19. A device for performing analog filtering according to Claim 15 wherein said second unit is connected in series with said first unit.

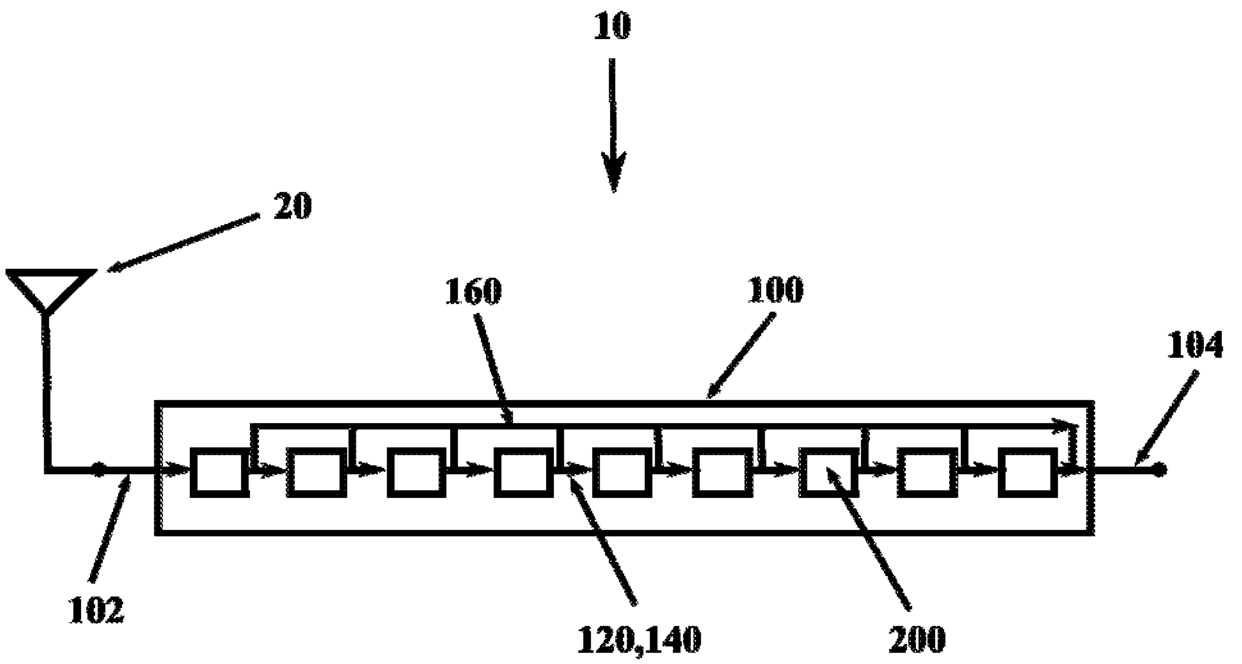

10
20
160
100
104
102
120,140
200

FIG. 1

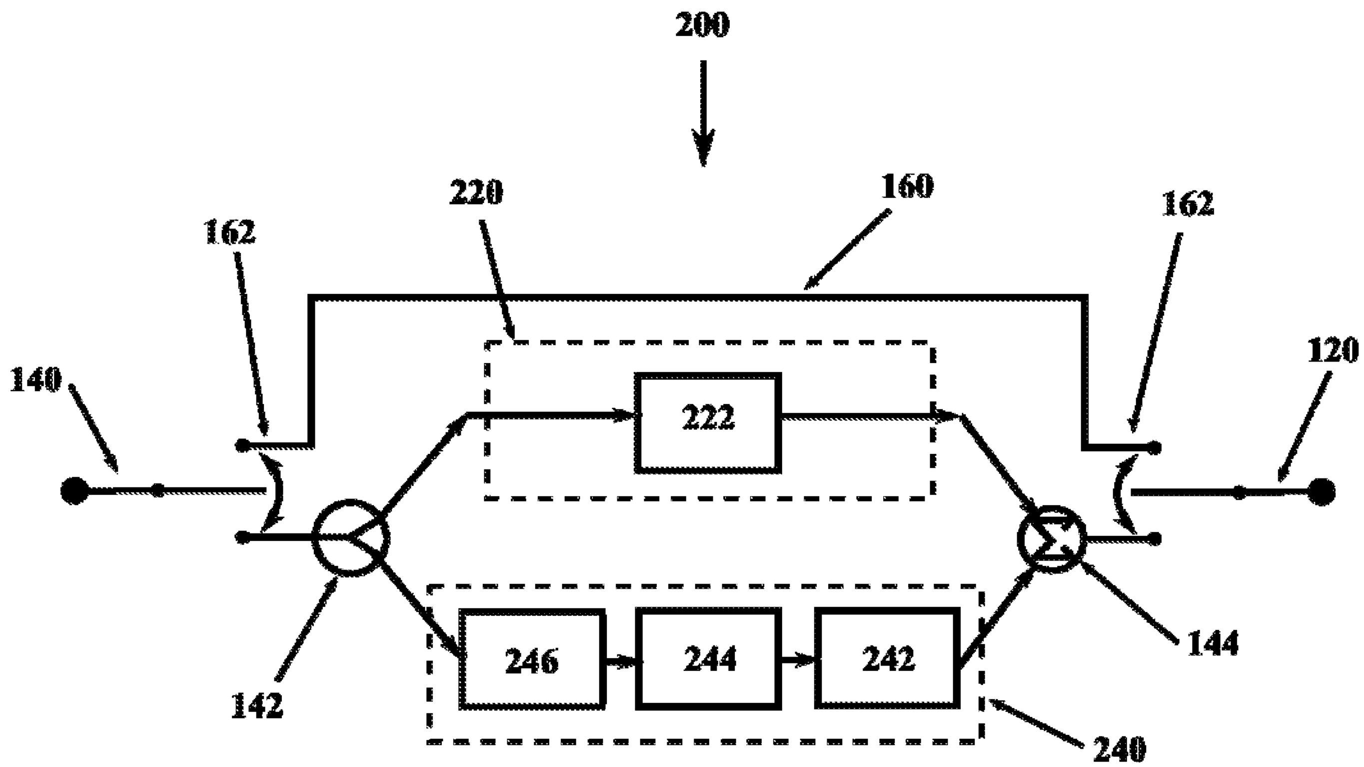

200
220
160
162
162
140
120
222
246
244
242
142
144
240

FIG. 2A

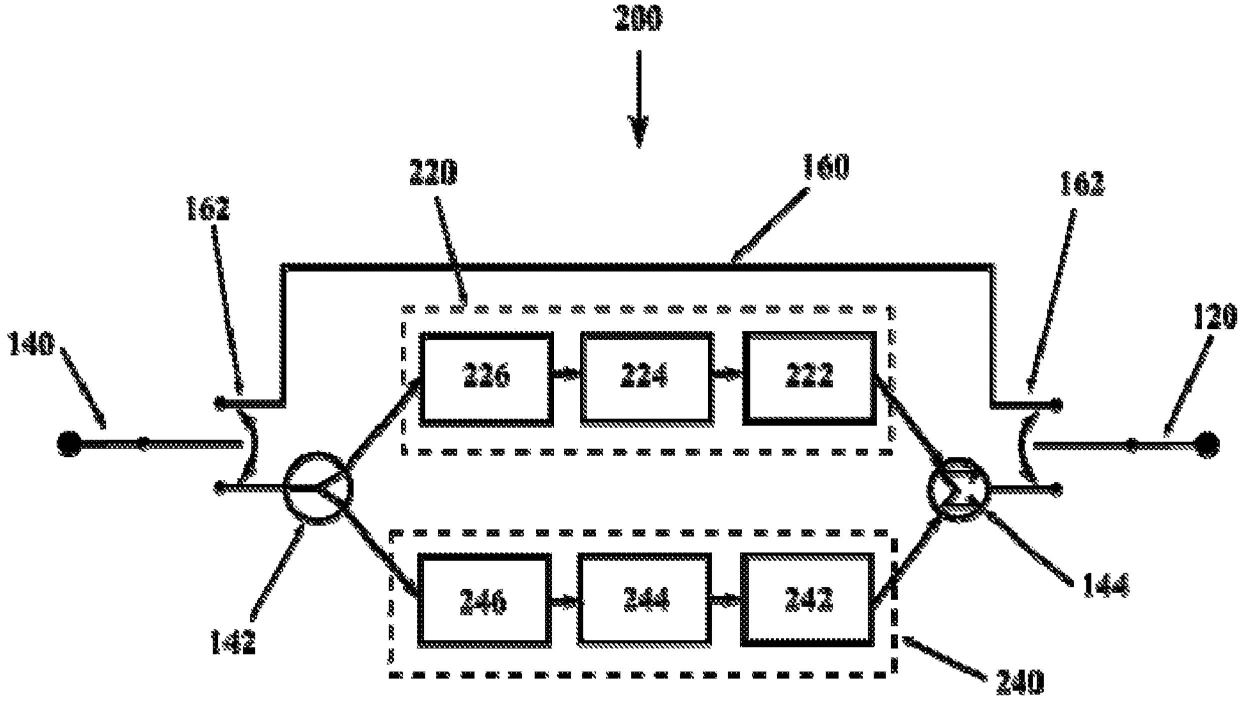
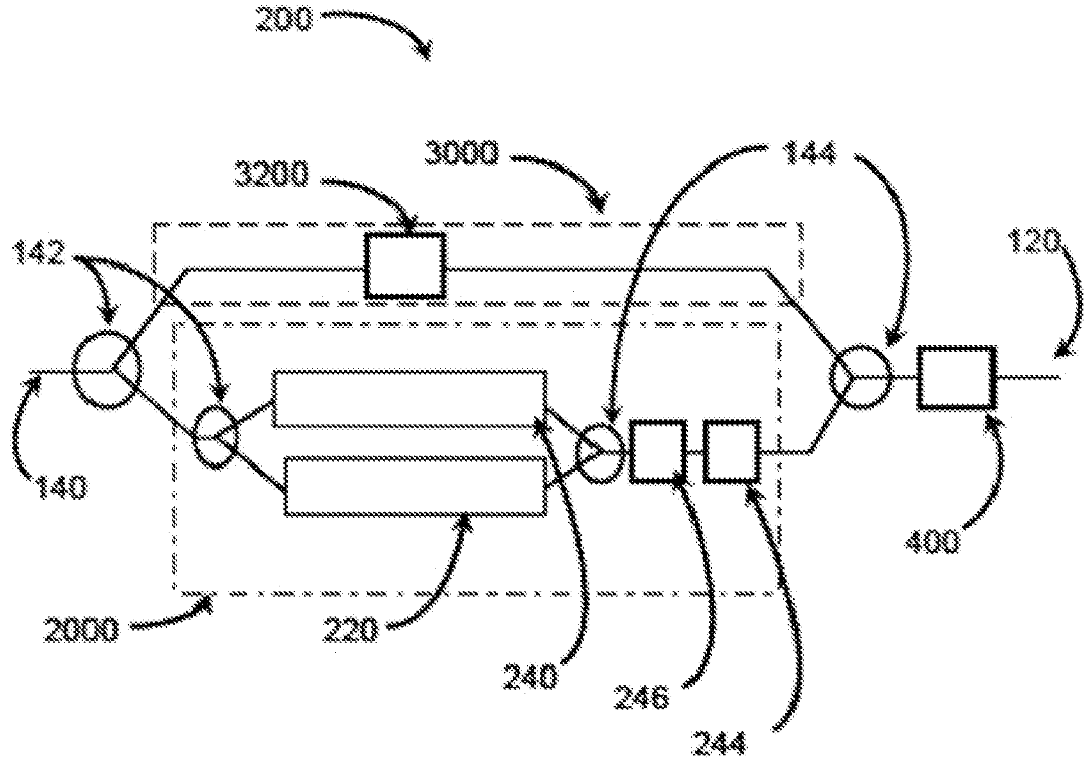



FIG. 2B

FIG 2C



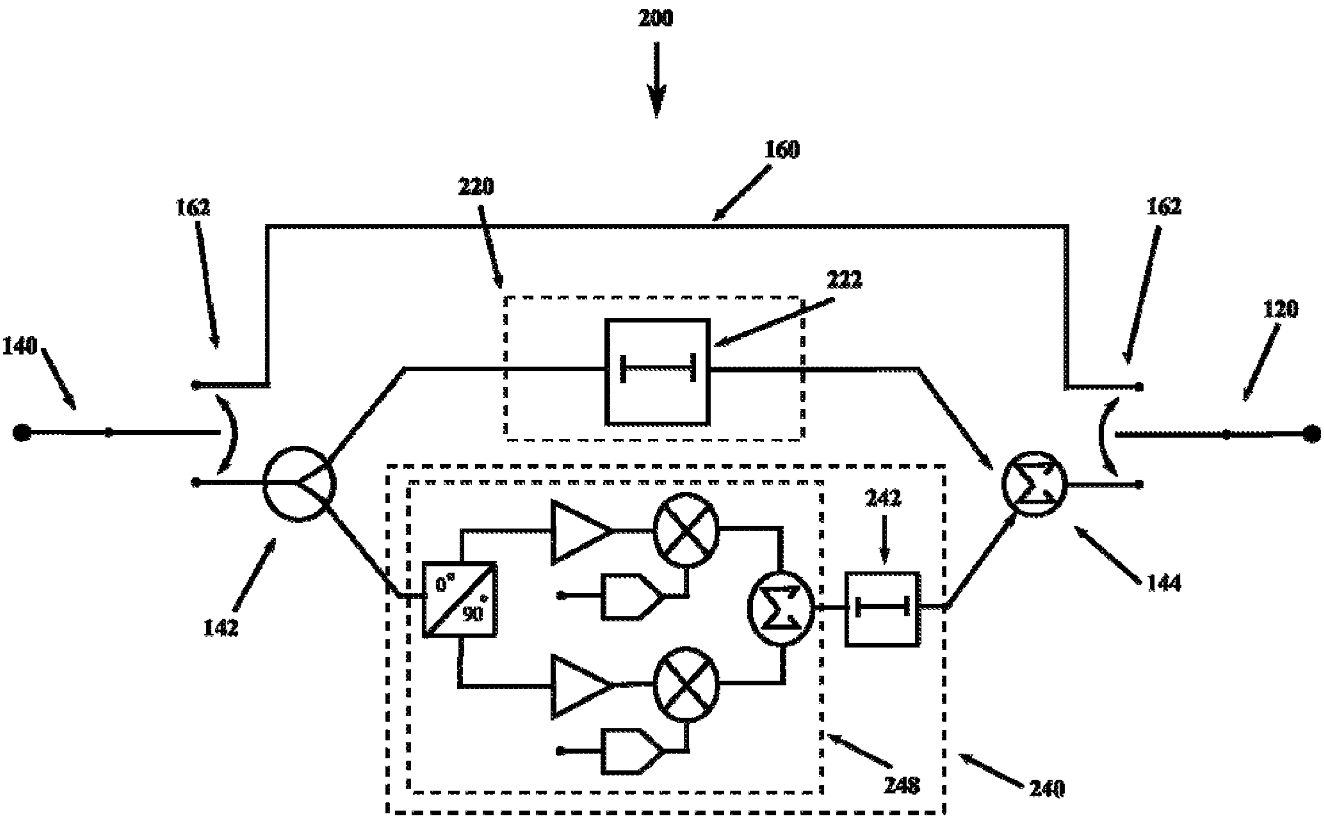



FIG. 3

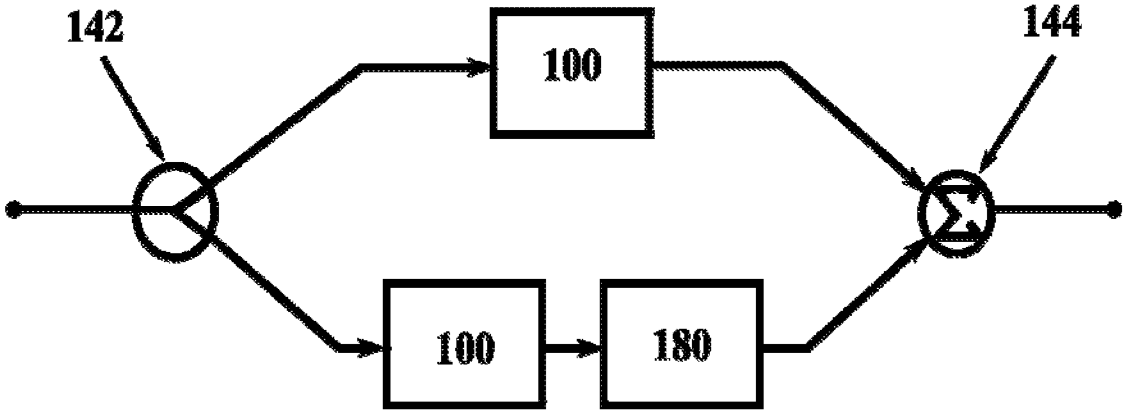



FIG. 4

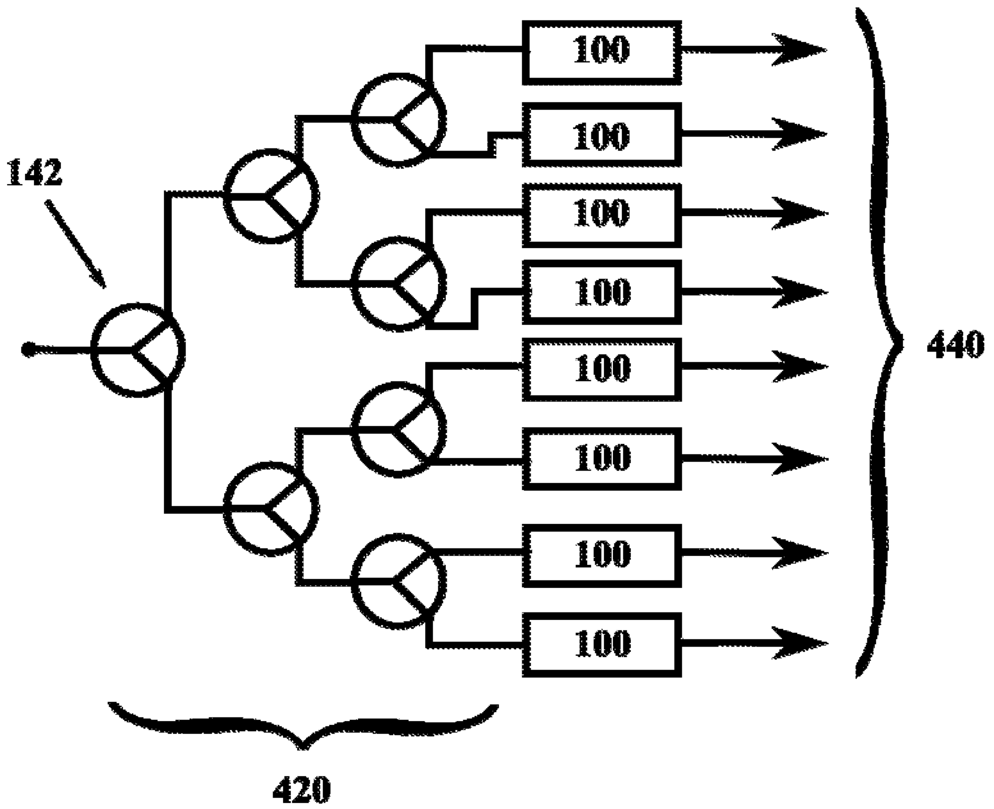

142
100
100
100
100
100
100
100
100
440
420

FIG. 5

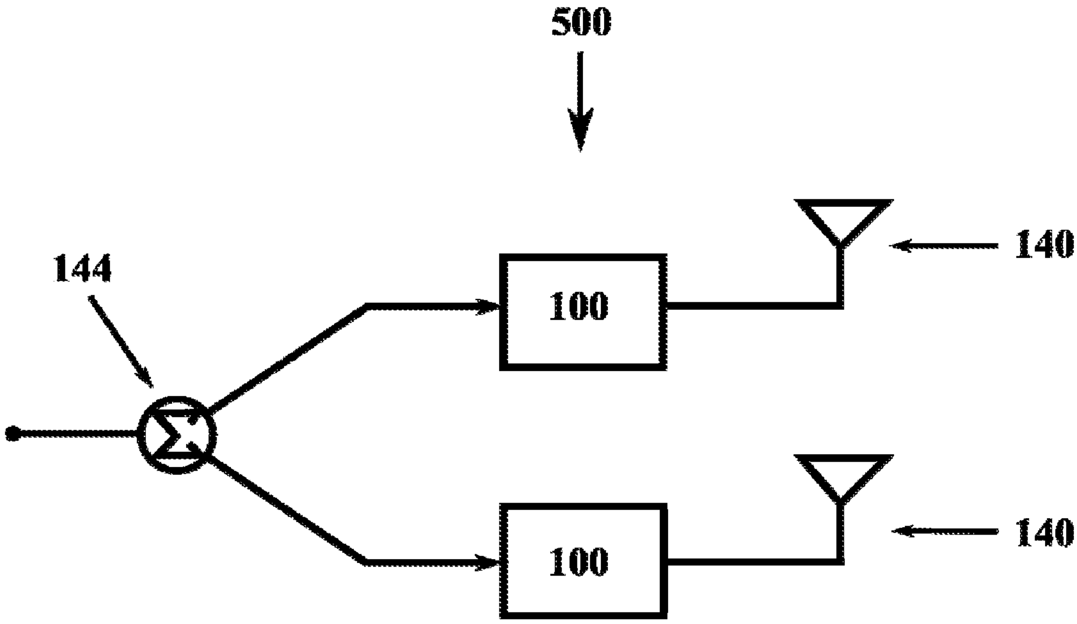

500
144
100
100
140
140

FIG. 6

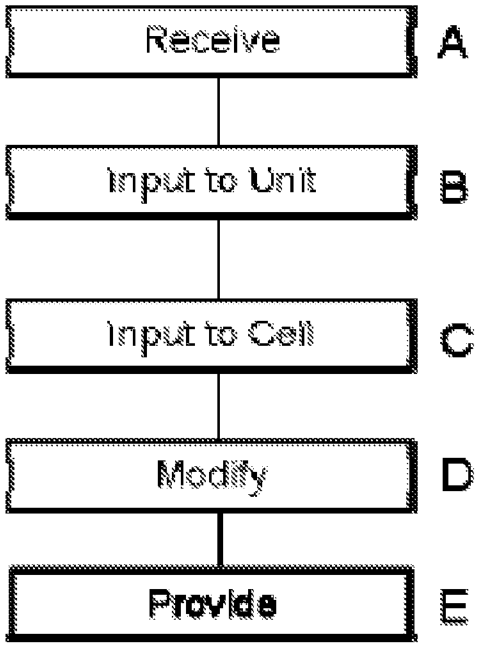

Receive
A
Input to Unit
B
Input to Cell
C
Modify
D
Provide
E

FIG. 7

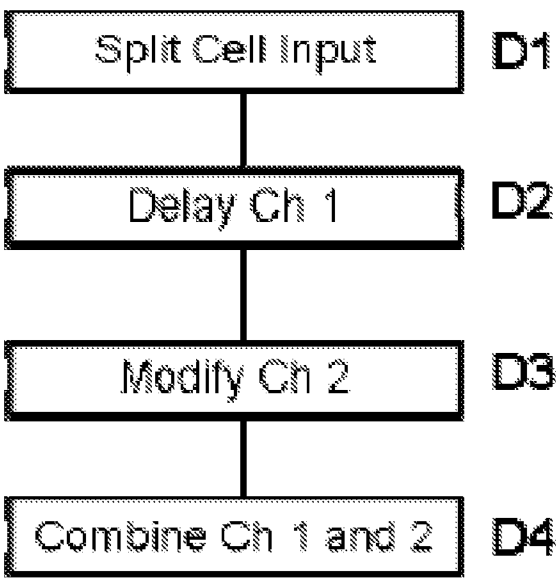
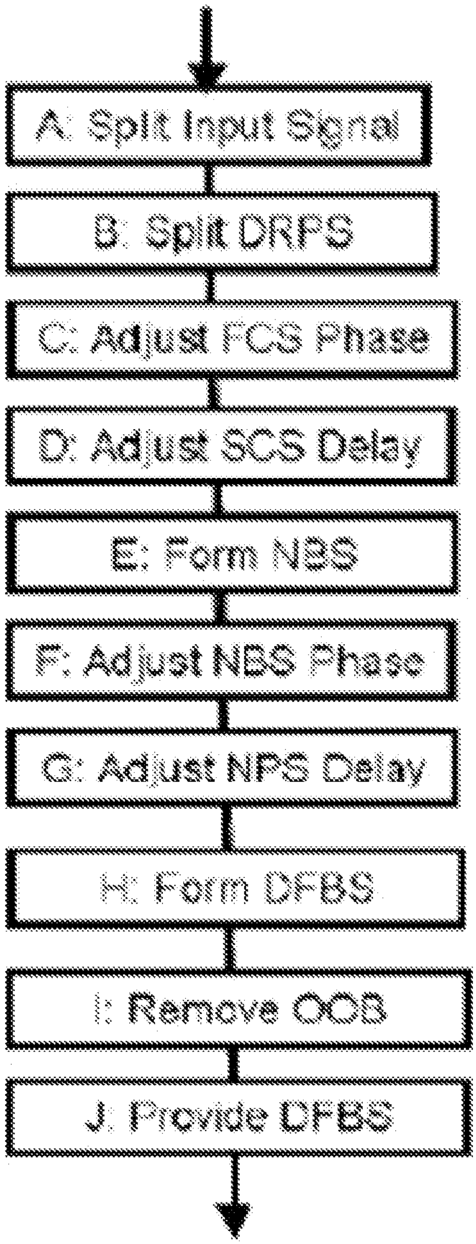

Split Cell Input
D1
Delay Ch 1
D2
Modify Ch 2
D3
Combine Ch 1 and 2
D4

FIG. 8A

FIG 8B


A: Split Input Signal
B: Split DRPS
C: Adjust FCS Phase
D: Adjust SCS Delay
E: Form NBS
F: Adjust NBS Phase
G: Adjust NPS Delay
H: Form DFBS
I: Remove OOB
J: Provide DFBS

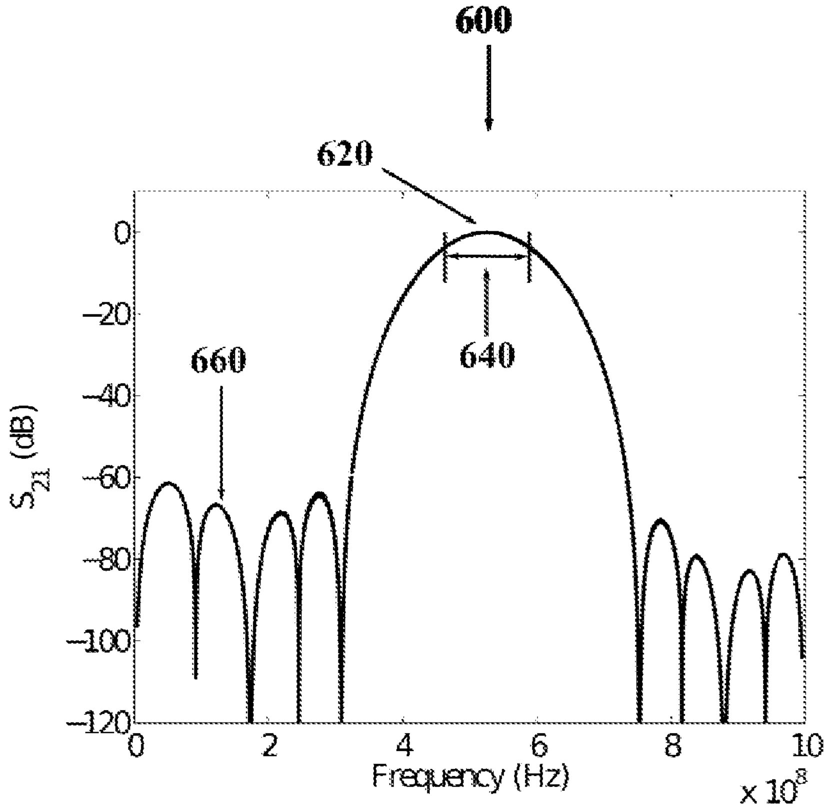

600
620
640
660
S21 (dB)
0
−20
−40
−60
−80
−100
−120
0
2
4
6
8
10
Frequency (Hz)
x 10^8

FIG. 9A

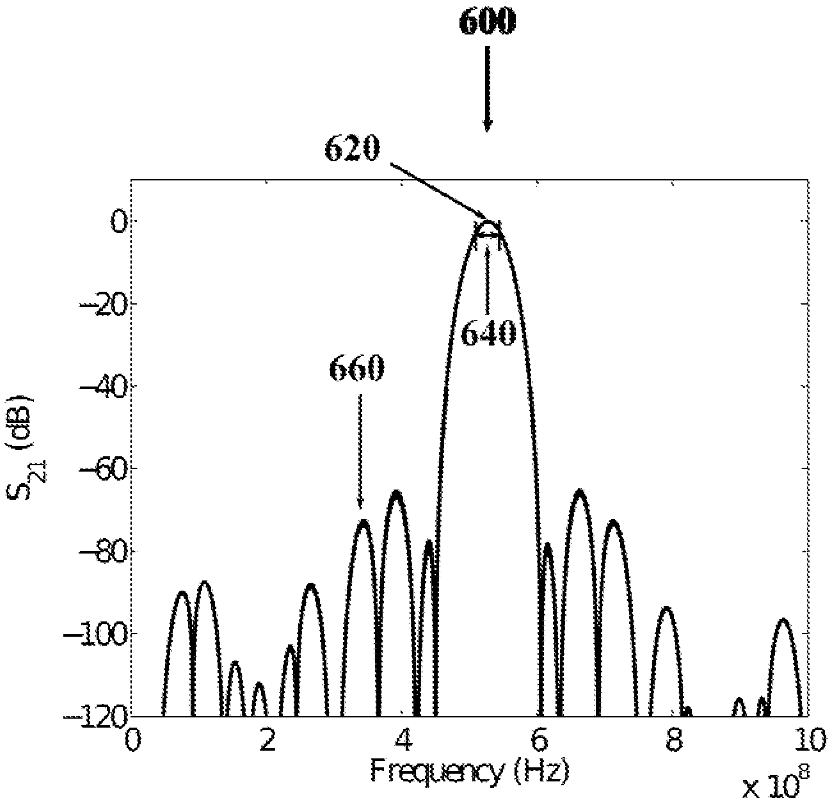

600
620
640
660
S21 (dB)
0
−20
−40
−60
−80
−100
−120
0
2
4
6
8
10
Frequency (Hz)
x 10^8

FIG. 9B

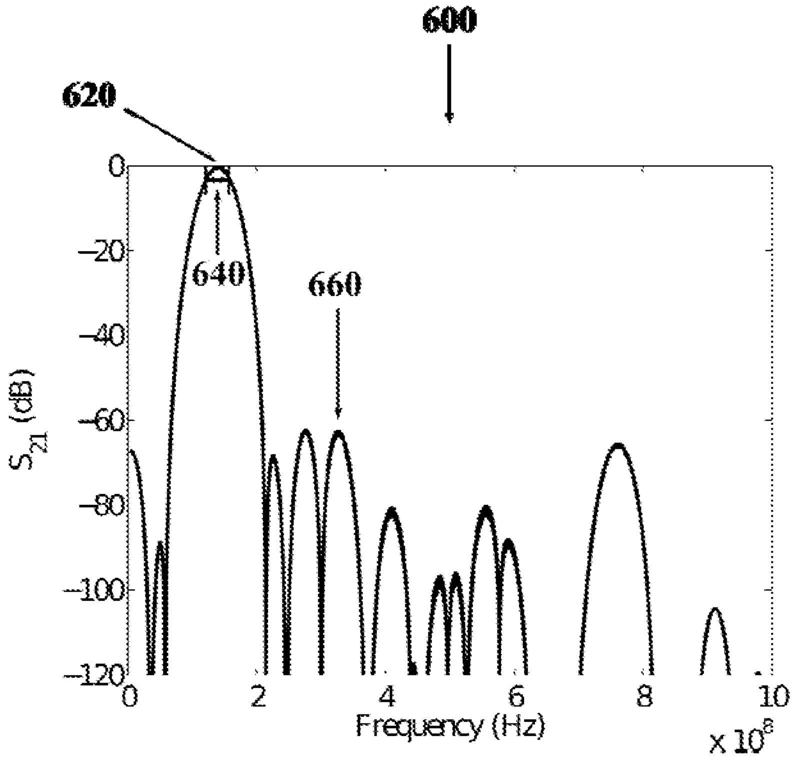

600
620
640
660
0
−20
−40
−60
−80
−100
−120
$S_{21}$ (dB)
0
2
4
6
8
10
Frequency (Hz)
x $10^8$

FIG. 9C

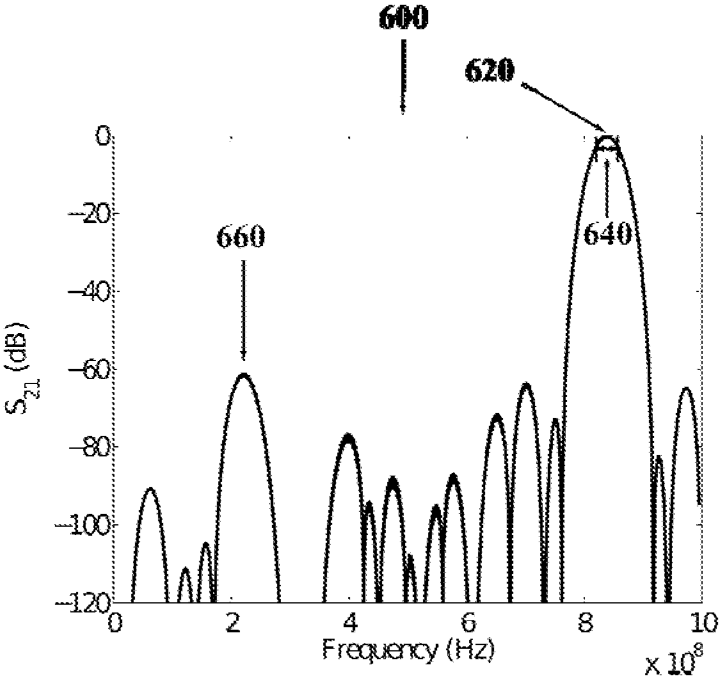

600
620
640
660
0
−20
−40
−60
−80
−100
−120
$S_{21}$ (dB)
0
2
4
6
8
10
Frequency (Hz)
x $10^8$

FIG. 9D

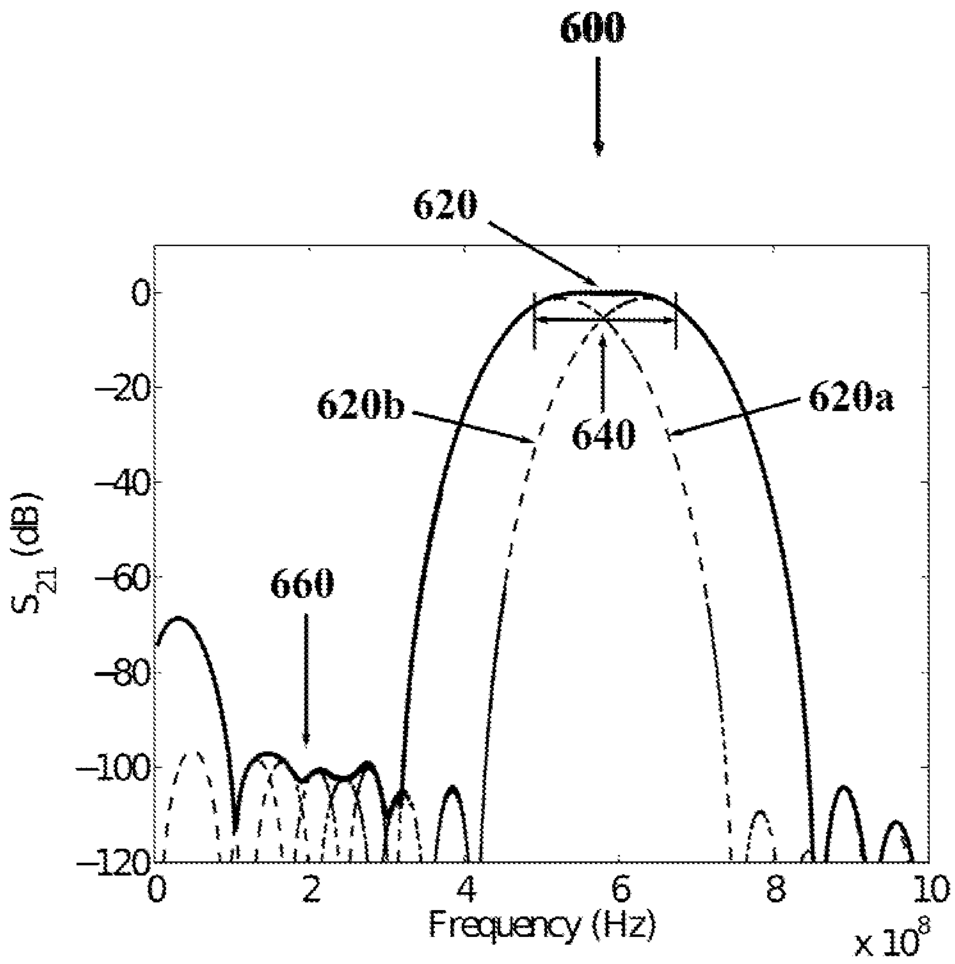

600
620
620b
620a
640
660
0
−20
−40
−60
−80
−100
−120
S21 (dB)
0
2
4
6
8
10
Frequency (Hz)
x 10^8

FIG. 10