

MULTI-BAND FM RECEIVER
FOR RECEIVING FM BROADCASTING SIGNALS
AND TV BROADCASTING SOUND SIGNALS

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The present invention relates generally to a multi-band FM receiver, and more particularly to a multi-band FM receiver for receiving FM broadcasting signals and TV broadcasting sound signals.

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Recently, FM receivers which are adapted for receiving not only usual FM broadcasting signals, but also TV broadcasting sound signals have been developed. Such an FM receiver usually is provided with an FM receiving band and a TV sound receiving band. The bands are selected by a band selector.

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In a conventional multi-band FM receiver, however, the FM receiving band is assigned to receive the FM broadcasting signals and TV broadcasting sound signals of the lower frequency channels, i.e., the channels 1, 2 and 3. On the other hand, the TV sound receiving band is assigned to receive the TV broadcasting sound signals of the higher frequency channels, i.e., the channels 4, 5, ..., 12.

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This is because the frequencies of the lower frequency TV channels are closer to the frequencies of the FM broadcasting signals than to the frequencies of the higher

frequency TV channels. Under the circumstances, the multi-band FM receiver can be designed easily by assigning the lower frequency TV channels to the FM receiving band, instead of the TV sound receiving band. Thus, the TV channels are separated into at least two receiving bands in the conventional multi-band FM receiver.

However, users of the conventional multi-band FM receiver must select the FM receiving band, when reception of the TV broadcasting sound signals of any the lower frequency channels is desired. Therefore, the conventional multi-band FM receiver has a drawback in that it confuses the users, due to the inconsistency between the use of the FM receiving band and the reception of the TV sound signals.

In addition, the FM broadcasting signals and the TV broadcasting sound signals are different in the degree of FM modulation. The degree of FM modulation of the TV broadcasting sound signals is less than that of the FM broadcasting signals. As a result, different sound levels are output from the FM receiver for the FM broadcasting signals and the TV broadcasting sound signals. Thus, a user must operate the volume control for adjusting the output sound level, when changing between the FM broadcasting signals and the TV broadcasting sound signals in the FM receiving band.

The present invention seeks to provide an improved multi-band FM receiver.

According to one aspect of the present invention there is provided a multi-band receiver for receiving broadcast signals divided by frequencies into an FM group and a TV group, the TV group including two
5 different frequency ranges separated by a substantial frequency gap, with the frequencies of one of said TV group ranges being closer to the frequencies of the FM group than to the frequencies of the other TV group range, and the receiver comprising:

10 switch means for selecting a desired one of said two groups;

tuning control means for selecting a desired broadcast frequency within the desired group;

15 oscillation means for separating signals of the desired frequency from the received broadcast signals and converting the separated signals into audio signals; and

means responsive to the switch means and the tuning control means for automatically effecting a step
20 change in the oscillation frequency of the oscillation means, when, whilst the switch means is in the position selecting the TV group, the frequency selected by the tuning control means is changed from one frequency in one of said two different frequency ranges to one in
25 the other range.

According to a second aspect of the present invention there is provided a method for receiving and reproducing signals broadcast in two groups of different frequencies, including an FM group and a TV
30 group, the TV group including two different frequency ranges separated by a substantial frequency gap, with the frequencies of one of said TV group ranges being closer to the frequencies of the FM group than to the frequencies of the other TV group range,
35 and the method comprising the steps of:

manually selecting a desired one of said two

groups;

manually selecting a desired broadcast frequency within the desired group;

5 separating the desired signals from the received broadcast signals with an oscillator and converting the separated signals into audio signals; and

automatically effecting a step change in the oscillation frequency of the oscillation means, when,
10 whilst the TV group is selected, the desired frequency selected is changed from one frequency in one of said two different frequency ranges to one in the other range.

A more complete appreciation of the invention and
15 many of the attendant advantages thereof will be readily obtained

as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing showing, by way of example, one embodiment of the multi-band FM receivers according to the present invention.

The present invention will be described in detail with reference to the accompanying drawing.

Referring now to the accompanying drawing, an embodiment of the multi-band FM receiver according to the present invention will be described in detail.

In the accompanying, an input terminal 11 is provided for receiving RF signals of the FM broadcasting signals and the TV broadcasting sound signals. The RF signals are supplied to a frequency converter 12. The frequency converter 12 is also supplied with a local oscillation signal from a local oscillation circuit 100, which will be described in detail later.

Therefore, the RF signal is converted to an intermediate frequency signal in the frequency converter 12. The intermediate frequency signal output from the frequency converter 12 is supplied to an intermediate frequency amplifier 13. The intermediate frequency amplifier 13 amplifies the intermediate frequency signal to a predetermined level. The amplified intermediate frequency signal is supplied to an FM demodulator 14. The FM demodulator 14 demodulates the intermediate frequency signal so that a sound signal is obtained from the FM demodulator 14. The sound signal output from the FM demodulator 14 is

fed to an audio amplifier (not shown) for driving a loudspeaker.

The local oscillation circuit 100 has a phase locked loop (referred to hereafter as a PLL) configuration. That is, the local oscillation circuit 100 is provided with a voltage controlled oscillator (referred to hereafter as VCO) 15, a resonance circuit 15a which is a part of the VCO 15, a buffer amplifier 16, a coupling capacitor 17, a two-state frequency divider 18, a system control section 19, a low pass filter (referred as LPF hereafter) 20 and a reference signal oscillator 21. The VCO 15 and the other components are connected in the form of a PLL. The local oscillation circuit 100 generates a local oscillation signal stabilized in frequency by the reference signal oscillator 21. However, the frequency of the local oscillation signal is varied by the system control section 19. The frequency dividing ratio N1 of the two-state frequency divider 18 is changeable between two ratios, e.g., 1 and 1/2.

Now, the system control section 19 will be described in detail. The system control section 19 is provided with a programmable frequency divider 22, a phase comparator 23 and a processor 24. The processor 24 may usually be comprised of a microcomputer. The programmable frequency divider 22 divides an output from the two-state frequency divider 18. The frequency dividing ratio N2 of the programmable frequency divider 22 is controlled by the processor 24. The phase of the output of the programmable frequency divider 22 is compared with the phase of the reference frequency signal from the reference signal oscillator 24. The phase error signal obtained by the phase comparator 23 is fed back to

the VCO 15 through the LPF 20. Thus, the frequency of the local oscillation signal generated by the VCO 15 is controlled in accordance with frequency dividing ratio control data D1 applied from the processor 24 to the
5 programmable frequency divider 22.

The frequency dividing ratio control data D1 is varied by tuning data supplied from a tuning controller 25 coupled to the system control section 19. Thus, a user can select a desired broadcasting signal through the tuning controller
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The resonance circuit 15a of the VCO 15 includes a variable capacitor 26 and a series circuit of inductor coils 27a and 27b. The variable capacitor 26 is coupled in parallel with the series circuit of the inductor coils 27a
15 and 27b. A bias voltage source 28 applies a prescribed bias voltage Vb to a connection node 27c between the inductor coils 27a and 27b through a transistor 29 and a diode 30. The base of the transistor 29 is coupled to the processor 24 of the system control circuit 19 for receiving band control
20 data D3. The collector of the transistor 29 is coupled to the resonance circuit 15a. Further, the collector of the transistor 29 is coupled to the two-state frequency divider 18.

Further, the multi-band FM receiver is provided with a
25 band selector 31. The band selector 31 has a slider 31a movable between an FM position (shown by a broken line) and a TV position (shown by a solid line). In the TV position, the slider 31a supplies the predetermined bias Vb of the bias voltage source 28 to the processor 24 through a first
30 selector terminal 31b. In the FM position, the slider 31a

supplies the predetermined bias V_b to the FM demodulator 14 through a second selector terminal 31c.

The processor 24 generates the receiving band control data D3 in response to the bias voltage V_b supplied from the band selector 31. That is, the processor 24 generates the receiving band control data D3 when the TV position is selected in the band selector 31. The receiving band control data D3 automatically changes between two states, e.g., between a low level "L" or "0" and a high level "H" or "1", in response to selection of the lower channels 1, 2 and 3 or the high channels 4, 5, ..., 12 of the TV broadcasting signals.

Now, the operation of the multi-band FM receiver will be described in detail.

When setting to the FM receiving band is assumed, the output of the first selector terminal 31b of the band selector 31 becomes the low level "0". The output of the level "0" is input to the processor 24 and the processor 24 responds to this so that a fixed output "1" is obtained at a band control data output terminal 19a. That is, the output level of the control data output terminal 19a is fixed to the level "1" in the selection of the FM position. In response to the level "1", the transistor 29 is turned off and the diode 30 is cut off. Therefore, the series circuit of inductor coils 27a and 27b connected in parallel to the variable capacitor 26 is activated, and the resonance frequency of the resonance circuit 15a is determined by the variable capacitor 26 and the coils 27a and 27b. The collector output of the transistor 29, at this time, further is supplied to the control terminal 18a of the two-state

frequency divider 18. Thus, the frequency dividing ratio N1 of the two-state frequency divider 18 is set, e.g. to 1.

When the band selector 31 is changed over to the TV position, the output of the band selector 31 through the first selector terminal 31b becomes the high level "1". At this moment, the output level on the band control data output terminal 19a of the system control section 19 becomes variable between a high level "1" and a low level "0".

When the tuning controller 25 selects any one of the lower channels 1, 2 and 3, the receiving band control data D3 on the band control data output terminal 19a becomes the high level "1". When the tuning controller 25 selects any one of the higher channels 4, 5, ..., and 12, the receiving band control data D3 on the band control data output terminal 19a becomes "0". The receiving band control data D3 is automatically changed between the levels "1" and "0" by the processor 24. For the output level "0" on the band control data output terminal 19a of the system control section 19, the transistor 29 is turned on and the diode 30 also is turned on. As a result, the connection node 27c between the inductor coils 27a and 27b is grounded in respect to the oscillation signal. Thus, the inductor coil 27b is grounded.

Therefore, the resonance frequency of the resonance circuit 15a is determined by the variable capacitor 26 and the inductor coil 27a. At the same time, the control terminal of the two-state frequency divider 18 is supplied with the bias "1", so that the frequency dividing ratio N1 of the two-state frequency divider 18 is set, e.g. to 1/2.

According to the automatic changes of the resonance

frequency of the resonance circuit 15a or the frequency dividing ratio N1 of the two-state frequency divider 18, the frequency band gap between the group of the lower channels 1, 2, 3 and the other group of the higher channels 4, 5, ... 12 is substantially eliminated. The tuning operation by the tuning controller 25, then, become easy.

Furthermore, the bias voltage Vb of the bias voltage source 28 is applied to the FM demodulator 14 through the second selector terminal 31c of the band selector 31. By this bias voltage Vb, the audio volume level output from the FM demodulator 14 is modified so that the level difference between audio outputs of the FM reception and the TV sound reception is eliminated.

Usually, as the lower channels 1, 2 and 3 of the TV broadcasting signal are received in the FM frequency band, a difference of sound volume is produced due to the difference of the degree of modulation degree between the FM broadcast wave and television sound signal. However, with this embodiment of the invention such a problem is alleviated.

In the prior conventional system explained in the introduction, the lower channels 1, 2 and 3 are received in the usual receiving condition of the FM receiving band, so that a band selector does not correspond to the actually received band, i.e., the FM band and the TV band.

In this invention, however, the lower channels 1, 2 and 3 and the higher channels 4, 5, ..., and 12 are included within a single TV receiving band, without widening the tuning range in this TV band. As a result, the operation of the band selector accurately corresponds to the actually received channel. That is, the circuit of inductor coils

27a and 27b at the local oscillation circuit 100 and the two-state frequency divider 18 are suitable in receiving all the channels 1 through 12 of the TV broadcasting signals in a single TV receiving band.

CLAIMS

1. A multi-band receiver for receiving broadcast signals divided by frequencies into an FM group and a TV group, the TV group including two different
5 frequency ranges separated by a substantial frequency gap, with the frequencies of one of said TV group ranges being closer to the frequencies of the FM group than to the frequencies of the other TV group range, and the receiver comprising:
- 10 switch means for selecting a desired one of said two groups;
- tuning control means for selecting a desired broadcast frequency within the desired group;
- 15 oscillation means for separating signals of the desired frequency from the received broadcast signals and converting the separated signals into audio signals; and
- means responsive to the switch means and the tuning control means for automatically effecting a step
20 change in the oscillation frequency of the oscillation means, when, whilst the switch means is in the position selecting the TV group, the frequency selected by the tuning control means is changed from one frequency in one of said two different frequency ranges to one in
25 the other range.
2. The receiver of claim 1 wherein said means for automatically effecting a step change includes means for varying the resonance frequency of the oscillation means.
- 30 3. The receiver of claim 1 wherein said means for automatically effecting a step change includes means for changing the dividing ratio of the oscillation means.
4. The receiver of claim 1 wherein said means
35 for automatically effecting a step change includes a programmable frequency divider and a phase comparator.



5. The receiver of claim 1 wherein the oscillation means includes a frequency converter, an amplifier and a demodulator, and the switch means includes means for controlling the volume of the audio signals.

6. A method for receiving and reproducing signals broadcast in two groups of different frequencies, including an FM group and a TV group, the TV group including two different frequency ranges separated by a substantial frequency gap, with the frequencies of one of said TV group ranges being closer to the frequencies of the FM group than to the frequencies of the other TV group range, and the method comprising the steps of:

manually selecting a desired one of said two groups;

manually selecting a desired broadcast frequency within the desired group;

separating the desired signals from the received broadcast signals with an oscillator and converting the separated signals into audio signals; and

automatically effecting a step change in the oscillation frequency of the oscillation means, when, whilst the TV group is selected, the desired frequency selected is changed from one frequency in one of said two different frequency ranges to one in the other range.

7. A multi-band receiver substantially as hereinbefore described with reference to the accompanying drawing.

8. A method for receiving and reproducing signals substantially as hereinbefore described with reference to the accompanying drawing.

