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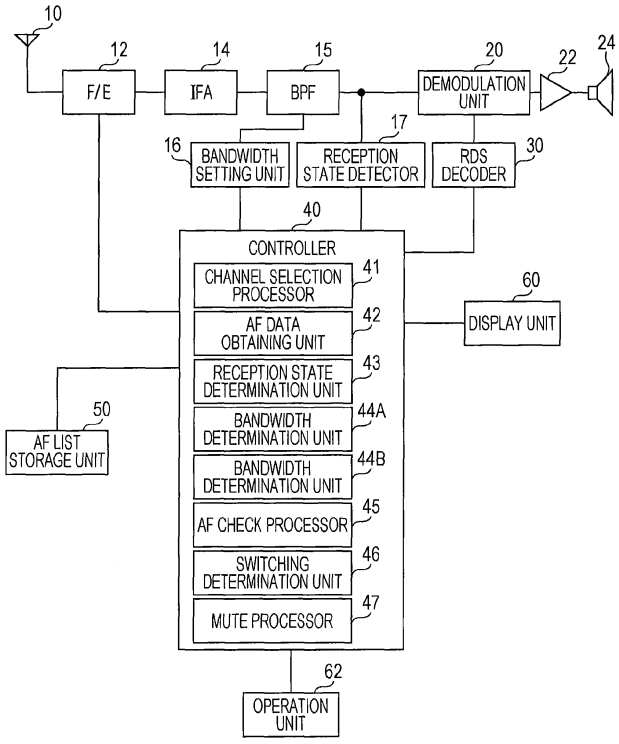
(54) Radio receiver

(57) A radio receiver includes a reception state determination unit (43) for determining a reception state of a broadcasting signal being received, a bandwidth determination unit (44B) for determining a pass-band width of a bandpass filter (15) in accordance with the reception state determined by the reception state determination unit (43), and an AF check processor (45) for receiving a broadcasting signal specified by frequency information represented by alternative frequency data and determining a reception state of the broadcasting signal while the pass-band width determined by the bandwidth determination unit (44B) is set to the bandpass filter (15).

FIG. 1



EP 2 693 668 A1

Description

[0001] The present invention relates to a radio receiver that receives broadcasting signals of Radio Data System (RDS) or the like.

[0002] Conventionally, an FM radio receiver including an RDS data receiving function is known. Such FM radio receiver starts alternative frequency (AF) search when determining that a current reception state is not good, and performs control similar to a bandwidth automatic changing operation that is performed at a normal reception when adjacent channel interference occurs in a destination channel (control for changing a bandwidth in accordance with reception electric-field intensity). The FM radio receiver performs control for fixing the bandwidth to a wide reference bandwidth when the adjacent channel interference does not occur (refer to JP 2009-105729 A, for example). By performing such control, a bit error rate in a weak electric field state in the AF search can be improved.

[0003] In the FM radio receiver disclosed in JP 2009-105729 A, after an AF search operation is started, it is determined whether adjacent channel interference occurs in a destination channel (a broadcast station of an alternative frequency) and control for changing the bandwidth is performed in accordance with a result of the determination. Therefore, it takes time to determine whether to actually switch to the destination channel. In particular, it is necessary for a one-tuner radio receiver to perform the AF search operation while reception of a broadcasting signal which is a target of audio output is temporarily interrupted, and therefore, if the AF search operation takes time, interruption of the audio output is prolonged, and accordingly, listeners may have uncomfortable feelings or discomfort feelings, which is not preferable. Meanwhile, a bandwidth at the time of AF search operation may be fixed. However, when the bandwidth is fixed to a narrow bandwidth, whether there is an adjacent channel interference or not is not determined. On the other hand, when the bandwidth is fixed to a wide bandwidth, a broadcasting station which is subjected to the adjacent channel interference is excluded from a switching target at all times. Therefore, in either of the cases, appropriate switching to a broadcasting station of an alternative frequency is not realized.

[0004] An object of the present invention is to provide a radio receiver capable of performing appropriate switching to a broadcasting station of an alternative frequency in a short time.

[0005] The object is solved by the features of the independent claims . Further embodiments and aspects are defined in the dependent claims and further herein below.

[0006] A radio receiver according to an aspect of the present invention is a radio receiver that receives a broadcasting signal on which alternative frequency data including information on a frequency of a broadcasting station which broadcasts a program the same as a program corresponding to the broadcasting signal being received is superposed. The radio receiver includes a front end for receiving the broadcasting signal and converting the broadcasting signal into an intermediate frequency signal, bandpass means for receiving the intermediate frequency signal output from the front end and allowing a component included in a predetermined pass-band width to pass, reception state determination means for determining a reception state of the broadcasting signal being received, bandwidth determination means for determining a pass-band width of the bandpass means in accordance with the reception state determined by the reception state determination means, and alternative broadcasting station determination means for receiving a broadcasting signal specified by information on a frequency represented by the alternative frequency data and determining a reception state of the broadcasting signal while the pass-band width determined by the bandwidth determination means is set to the bandpass means. The bandwidth determination means described above may set a wider pass-band width of the bandpass means as the reception state determined by the reception state determination means is better.

[0007] Since the pass-band width of the bandpass means is set in accordance with the reception state of the broadcasting signal being received before the reception state of the alternative frequency broadcasting station is determined, a period of time to be used for an AF search operation may be reduced when compared with a case where a pass-band width is changed in accordance with reception states of alternative frequency broadcasting stations. Furthermore, since the pass-band width of the bandpass means is variably set in accordance with the reception state of the broadcasting signal being received before the AF search operation is performed, the AF search operation may be performed while adjacent channel interference or the like is eliminated as appropriate, and appropriate switching to an alternative frequency station may be performed.

[0008] Furthermore, the reception state determination means may select one of a plurality of reception state levels categorized according to signal levels, and the bandwidth determination means may determine a pass-band width corresponding to the reception state level selected by the reception state determination means. Since a reception state determination and a pass-band width determination may be performed by selecting one of a plurality of candidates, the determination operations and the operation of setting the pass-band width of the bandpass means may be simplified.

[0009] Moreover, the radio receiver according to an aspect of the invention may further include switching means for performing switching from the broadcasting signal being received to a broadcasting signal specified by frequency information represented by the alternative frequency data when the reception state determined by the alternative broadcasting station determination means is better than the reception state determined by the re-

ception state determination means. By this, switching to a broadcasting signal corresponding to a better reception state may be performed taking the reception state of the broadcasting signal being received into consideration. For example, when the reception state of the broadcasting signal being received is good, switching may be performed only when there is a broadcasting signal of an alternative frequency corresponding to a reception state that is better than the reception state of the signal being received. On the other hand, when the reception state of the broadcasting signal being received is poor, a broadcasting signal of an alternative frequency may be searched for while a value corresponding to a reception state serving as a reference for switching is reduced.

[0010] Furthermore, the alternative frequency data described above may be included in a broadcasting signal of Radio Data System. By this, the alternative frequency data required for the operation of the present invention may be easily obtained.

[0011] The front end may have a single tuner configuration for receiving a single broadcasting signal. Accordingly, when the single tuner configuration in which a background process is not allowed to be performed is employed, an AF search operation may be performed in a short time and switching to a broadcasting station of an alternative frequency may be swiftly performed.

[0012] Furthermore, the radio receiver according to an aspect of the invention may further include audio output means for outputting audio corresponding to the broadcasting signal being received and making an output be in a mute state when the alternative broadcasting station determination means performs a determination operation. By this, audio of a program of a broadcasting station of an alternative frequency may be prevented from being output in a fragmentary fashion while a reception state of the broadcasting station is checked.

[0013] Moreover, the determination of a reception state performed by each of the reception state determination means and the alternative broadcasting station determination means may be performed in accordance with an intensity of the intermediate frequency signal, presence or absence of occurrence of multipath interference, and presence or absence of occurrence of adjacent channel interference. By this, a determination of a reception state of a broadcasting station of an alternative frequency may be performed while adjacent channel interference is eliminated by narrowing the pass-band width of the bandpass means, and such a broadcasting station may be selected as a switching destination.

[0014] Furthermore, the radio receiver according to an aspect of the invention may be installed in a vehicle. The alternative broadcasting station determination means may perform an operation of determining a reception state of a broadcasting station of an alternative frequency at predetermined intervals or when a reception state of the broadcasting signal being received is deteriorated. By this, a broadcasting station of an alternative frequency may be reliably searched for and switching to the broadcasting station may be performed while a broadcasting signal in which a reception state thereof varies in accordance with traveling of the vehicle is received.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a diagram illustrating a configuration of a radio receiver according to an embodiment;

Fig. 2 is a diagram illustrating a configuration of basic baseband coding of RDS data;

Fig. 3 is a flowchart illustrating a procedure of an operation of AF check by changing a pass-band width of a bandpass filter in accordance with a reception state of a broadcasting signal being received;

Fig. 4 is a diagram illustrating the relationships between reception states of broadcasting signals being received and bandwidths of the bandpass filter at a time of the AF check; and

Fig. 5 is a diagram illustrating the relationships between the reception states and the pass-band widths illustrated in Fig. 4 in detail.

[0016] Hereinafter, a radio receiver according to an embodiment of the present invention will be described with reference to the accompanying drawings. Fig. 1 is a diagram illustrating a configuration of the radio receiver according to the embodiment. The radio receiver illustrated in Fig. 1 which is installed in a vehicle and which receives RDS broadcasting includes an antenna 10, a front end (F/E) 12, an intermediate frequency amplifier (IFA) 14, a bandpass filter (BPF) 15, a bandwidth setting unit 16, a reception state detector 17, a demodulation unit 20, an amplifier 22, a speaker 24, an RDS decoder 30, a controller 40, an AF list storage unit 50, a display unit 60, and an operation unit 62. The radio receiver has a single tuner configuration which receives a single broadcasting signal.

[0017] In the RDS broadcasting, a signal of 57 kHz as a third-order harmonic of a stereo pilot signal of 19 kHz is used as a subcarrier, the subcarrier is amplitude-modulated by a data signal which has been filtered and biphase-encoded and which indicates data of program information or traffic information so that radio data (RDS data) is obtained, and the amplitude-modulated subcarrier is frequency-modulated into a main carrier and is broadcasted.

[0018] Fig. 2 is a diagram illustrating a configuration of basic baseband coding of RDS data. As illustrated in Fig. 2, the RDS data is composed of a group of 104 bits, the group includes four blocks (A, B, C, and D), and each of the blocks includes an information word of 16 bits (m0 to m15) and a check word and an offset word (C'0 to C'9) of 10 bits.

[0019] The block A includes a program identification (PI) code that is program identification data representing

a network and including country name data and program data. The block B includes a traffic program identification (TP) code that is traffic information broadcasting station identification data representing a traffic information broadcasting station which broadcasts a traffic information program and a program type (PTY) code that is program identification data representing a type of program. The block C includes data associated with frequencies of stations included in a network station group which are broadcasting the same program, that is, the block C includes alternative frequency (AF) data. The AF data includes reception frequencies of broadcasting stations which broadcast a program the same as that of a broadcasting signal being received. The block D includes a program service (PS) code that is broadcasting station name data, such as a name of a broadcasting station or a name of a network.

[0020] The F/E 12 extracts a desired broadcasting signal from among broadcasting signals received through the antenna 10, performs frequency transform, and generates an intermediate frequency (IF) signal corresponding to a broadcasting wave of the desired broadcasting signal. Note that the radio receiver of this embodiment has a one-tuner configuration and the F/E 12 receives only one broadcasting signal. The IFA 14 amplifies the IF signal output from the F/E 12.

[0021] The BPF 15 performs band limitation on the input IF signal and allows a component corresponding to a set pass-band width to pass. The bandwidth setting unit 16 variably sets a pass-band width of the BPF 15. For example, four pass-band widths are assumed in advance, and one of the four pass-band widths is selected and set as the pass-band width of the BPF 15. Four pass-band widths may be set, that is, a "wide band", a "middle band", a "narrow band", and an "extreme narrow band". When the "wide band" is set, the pass-band width is set to 200 kHz. When the "middle band" is set, the pass-band width is set to 150 kHz. When the "narrow band" is set, the pass-band width is set to 120 kHz. When the "extreme narrow band" is set, the pass-band width is set to 90 kHz.

[0022] The reception state detector 17 detects a reception state of a broadcasting signal in accordance with the IF signal output from the BPF 15. For example, an intensity of the IF signal, presence or absence of occurrence of multipath interference, and presence or absence of occurrence of adjacent channel interference are detected as a reception state.

[0023] The demodulation unit 20 performs an FM demodulation process and a stereo demodulation process in accordance with the IF signal which has passed the BPF 15 and which has been subjected to the band limitation. Data obtained after the FM demodulation includes RDS data including the PI code, the program identification data (TYP), and the alternative frequency (AF) data superposed thereon. An audio signal obtained through the stereo demodulation performed by the demodulation unit 20 is amplified by the amplifier 22, and audio sound is output from the speaker 24.

[0024] The RDS decoder 30 restores the RDS data by performing a predetermined decoding process on the data obtained through the FM demodulation performed by the demodulation unit 20. Furthermore, the RDS decoder 30 detects an error of the RDS data while performing block synchronization and performs an operation of correcting the error. Note that, in general, the operation of detecting an error of the RDS data and correcting the error is different from the decoding process performed on the RDS data, and an error detection-and-correction unit is separately provided.

[0025] The controller 40 controls the entire radio receiver. The controller 40 including a CPU, a RAM, and a ROM performs various operations by executing certain programs. For example, a channel selection operation and an alternative broadcasting station switching operation are performed under control of the controller 40. The channel selection operation is an operation of selecting and receiving a program and the alternative broadcasting station switching operation is an operation of searching for another broadcasting station which is broadcasting the same program and performing switching to the broadcasting station when a reception state of a broadcasting signal being received is deteriorated. Therefore, the controller 40 includes a channel selection processor 41, an AF data obtaining unit 42, a reception state determination unit 43, bandwidth determination units 44A and 44B, an AF check processor 45, a switching determination unit 46, and a mute processor 47.

[0026] When a user uses the operation unit 62 and specifies a program to be received, the channel selection processor 41 sets a reception frequency corresponding to the program to be received to the F/E 12.

[0027] The AF data obtaining unit 42 obtains alternative frequency data (AF data) included in a broadcasting signal being received and extracts a reception frequency included in the obtained AF data so as to generate an alternative frequency list (an AF list). The generated alternative frequency list is stored in the AF list storage unit 50. The reception state determination unit 43 determines a reception state of the broadcasting signal being received in accordance with a result of the detection performed by the reception state detector 17.

[0028] The bandwidth determination unit 44A determines a pass-band width of the BPF 15 corresponding to the broadcasting signal being received in accordance with a result of the determination performed by the reception state determination unit 43 corresponding to the broadcasting signal being received. When the reception state of the broadcasting signal being received is good, a wide bandwidth (200 kHz, for example) is determined as the pass-band width of the BPF 15. Furthermore, when the reception state of the broadcasting signal being received is deteriorated due to occurrence of the adjacent channel interference, it is determined that the pass-band width of the BPF 15 is reduced in order to prevent reception quality from being deteriorated due to the occurrence

of the adjacent channel interference. The determined pass-band width is supplied to the bandwidth setting unit 16 which changes the pass-band width of the BPF 15.

[0029] At a predetermined timing, for example, at certain intervals or when the deterioration of the reception state is detected, the AF check processor 45 issues an instruction for reading the AF list stored in the AF list storage unit 50 and receiving broadcasting signals of alternative frequencies included in the AF list to the F/E 12 and performs quality check on the broadcasting signals so as to determine reception states of the broadcasting signals. In this specification, a series of operations from the reading of the AF list to the determination of the reception states of the broadcasting signals of the alternative frequencies is referred to as "AF check". The quality check is performed in accordance with a result of the detection performed by the reception state detector 17 such as an intensity of an IF signal, presence or absence of occurrence of multipath interference, and presence or absence of occurrence of adjacent channel interference.

[0030] The bandwidth determination unit 44B determines a pass-band width of the BPF 15 corresponding to a broadcasting signal which is a target of the AF check in accordance with a result of the determination performed by the reception state determination unit 43 corresponding to the broadcasting signal being received. Specifically, as the reception state of the broadcasting signal being received is good, the pass-band width of the BPF 15 is set wide whereas as the reception state of the broadcasting signal being received is poor, the pass-band width of the BPF 15 is set narrow.

[0031] The switching determination unit 46 compares the reception states of the broadcasting waves of the alternative frequencies determined by the AF check processor 45 with the reception state of the broadcasting signal being received determined by the reception state determination unit 43. When one of the reception states of the broadcasting signals of the alternative frequencies is better, the switching determination unit 46 instructs the F/E 12 to perform switching to the broadcasting signal.

[0032] In parallel to the operation performed by the AF check processor 45, the mute processor 47 makes the audio sound output from the speaker 24 be in a mute state by transmitting an instruction to the demodulation unit 20. Note that, instead of rapidly changing to the mute state, the mute processor 47 may perform a fade-out process on the output sound before the operation of the AF check processor 45 is performed, and may perform a fade-in process on the output sound after the operation is terminated.

[0033] The BPF 15 described above corresponds to bandpass means, the reception state detector 17 and the reception state determination unit 43 described above correspond to reception state determination means, the bandwidth determination unit 44B described above corresponds to bandwidth determination means, the bandwidth setting unit 16, the reception state detector 17, and the AF check processor 45 described above correspond to alternative broadcasting station determination means, the switching determination unit 46 described above corresponds to switching means, the demodulation unit 20, the amplifier 22, the speaker 24, and the mute processor 47 described above correspond to audio outputting means.

[0034] The radio receiver of this embodiment has the configuration described above, and operation thereof will be described below. Fig. 3 is a flowchart illustrating a procedure of an operation of performing the AF check by changing the pass-band width of the BPF 15 in accordance with a reception state of a broadcasting signal being received.

[0035] During driving, when the radio receiver according to the embodiment is receiving a certain broadcasting signal (in step S100), the AF check processor 45 determines whether an AF check timing has been reached (in step S102). When it is determined that the AF check timing has not been reached, the determination is negative and the process returns to step S100 so that the operation of receiving a broadcasting signal is performed again. On the other hand, when it is determined that the AF check timing has been reached, the determination is affirmative in step S102.

[0036] Subsequently or in parallel to the operation of receiving a broadcasting signal, the reception state detector 17 detects a reception state of the broadcasting signal being received (in step S104). Furthermore, the reception state determination unit 43 determines whether the detected reception state is the most excellent state A (in step S106). In this embodiment, a reception state is categorized by four levels, that is, the most excellent state A followed by states B, C, and D in descending order of excellence of a reception state. When the reception state is A, the determination is affirmative in step S106. In this case, the bandwidth determination unit 44B sets the pass-band width of the BPF 15 to the "wide band" for the broadcasting signal to be subjected to the AF check, and the bandwidth setting unit 16 sets the pass-band width (in step S108).

[0037] When the reception state is not A, the determination is negative in step S106. Subsequently, the reception state determination unit 43 determines whether the detected reception state is the second most excellent state B (in step S110). In the case of the reception state B, the determination is affirmative. In this case, the bandwidth determination unit 44B sets the pass-band width of the BPF 15 to the "middle band" for the broadcasting signal to be subjected to the AF check, and the bandwidth setting unit 16 sets the pass-band width (in step S112).

[0038] When the reception state is not B, the determination is negative in step S110. Next, the reception state determination unit 43 determines whether the detected reception state is the poor state C (in step S114). When the reception state is C, the determination is affirmative. In this case, the bandwidth determination unit 44B sets the pass-band width of the BPF 15 to the "narrow band" for the broadcasting signal to be subjected to the AF

check, and the bandwidth setting unit 16 sets the pass-band width (in step S116).

[0039] When the reception state is not C, the determination is negative in step S114. In this case, the bandwidth determination unit 44B sets the pass-band width of the BPF 15 to the "extreme narrow band" for the broadcasting signal to be subjected to the AF check, and the bandwidth setting unit 16 sets the pass-band width (in step S118).

[0040] As described above, after the pass-band width of the BPF 15 is set in step S108, S112, S116, or S118, the AF check processor 45 performs the AF check so as to determine reception states of broadcasting waves of alternative frequencies (in step S120). Next, the switching determination unit 46 compares the reception states of the broadcasting signals of the alternative frequencies determined by the AF check processor 45 with the reception state of the broadcasting signal being received determined by the reception state determination unit 43 (in step S122) so as to determine whether one of the broadcasting signals (AF stations) of the alternative frequencies corresponds to a good reception state (in step S124). When the determination is affirmative, the switching determination unit 46 instructs the F/E 12 to perform switching to the AF station, and the switching to the broadcasting signal of the alternative frequency is performed (in step S126). On the other hand, when an AF station corresponding to a good reception state does not exist, the determination is negative in step S124, the switching to a broadcasting signal of an alternative frequency is not performed, the process returns to step S100, and the operation of receiving the broadcasting signal which has been received is performed again.

[0041] Fig. 4 is a diagram illustrating the relationships between reception states of a broadcasting signal being received and content of setting of bandwidths of the BPF 15 at a time of the AF check. In Fig. 4, the item "reception state" represents a reception state of a broadcasting signal which is currently received, and the item "bandwidth in AF check" represents content of setting of the bandwidth of the BPF 15 at the time of the AF check. Fig. 5 is a diagram illustrating the relationships between the reception states and pass-band widths illustrated in Fig. 4 in detail.

[0042] As illustrated in Fig. 4, in the case of the reception state A of the broadcasting signal being received which is the most excellent reception state and the case of the reception state B which is the second most excellent reception state, the pass-band width of the BPF 15 is set to the "wide band" which is the widest band and "middle band" which is the second widest band, respectively. Specifically, the reception state of the broadcasting signal being received is good or comparatively good, and therefore, switching to an AF station of the same level or more is performed if any.

[0043] Furthermore, in the case of the reception state C which is the poor reception state of the broadcasting signal being received, the pass-band width of the BPF 15 is set to the "narrow band" which represents a narrow pass-band width. Specifically, the reception state of the broadcasting signal being received is deteriorated, and therefore, switching to an AF station ensuring a good reception state is performed if any, even if the AF station suffers from interference more or less.

[0044] Furthermore, in the case of the reception state D which is the worst reception state of the broadcasting signal being received, the pass-band width of the BPF 15 is set to the "extreme narrow band" which represents the narrowest pass-band width. Specifically, the reception state of the broadcasting signal being received is too bad to listen to, and therefore, switching to a listenable AF station is performed if any, even if the AF station suffers from interference.

[0045] As described above, according to the radio receiver of this embodiment, the pass-band width of the BPF 15 is set in accordance with a reception state of a broadcasting signal being received, and reception states of AF stations are determined. Accordingly, a period of time required for the AF search operation may be reduced when compared with a case where the pass-band width is changed in accordance with reception states of AF stations. Furthermore, since the pass-band width of the BPF 15 is variably set in accordance with a reception state of a broadcasting signal being received before the AF search operation is performed, the AF search operation may be performed while the adjacent channel interference or the like is eliminated where appropriate, and switching to an appropriate AF station can be performed.

[0046] Furthermore, since the reception state determination and the pass-band width determination may be performed by selecting one of a plurality of candidates (four types), the determination operations and the operation of setting the pass-band width of the BPF 15 can be simplified.

[0047] Moreover, switching to a broadcasting signal corresponding to a better reception state may be performed taking the reception state of the broadcasting signal being received into consideration. For example, when the reception state of the broadcasting signal being received is good, switching may be performed only when an AF station corresponding to a reception state better than the reception state of the broadcasting signal being received exists. On the other hand, when the reception state of the broadcasting signal being received is poor, an AF station may be searched for while a value corresponding a reception state serving as a reference for switching is reduced.

[0048] In a radio receiver which receives a broadcasting signal of Radio Data System (RDS), alternative frequency data required may be easily obtained. In particular, when a single tuner configuration in which a background process is not allowed to be performed is employed, an AF search operation can be performed in a short time and switching to an AF station can be swiftly performed.

[0049] Furthermore, when the radio receiver is employed as a radio receiver installed in a vehicle, a broadcasting station of an alternative frequency can be reliably searched for and switching to the broadcasting station can be reliably performed while a broadcasting signal is received in which a reception state thereof varies in accordance with traveling of the vehicle.

[0050] Note that the present invention is not limited to the foregoing embodiment and various modifications may be made within the scope of the present invention. Although the radio receiver which receives RDS broadcasting has been described as an example in the foregoing embodiment, the present invention may be applied to any radio receiver including a Digital Audio Broadcasting (DAB) receiver as long as the radio receiver can receive alternative frequency data. Furthermore, although the reception state is determined from four levels and the setting of the pass-band width is selected from the corresponding four levels in the foregoing embodiment, they may be determined and selected from a plurality of levels other than four levels.

[0051] As described above, according to the radio receiver of this embodiment, a pass-band width of bandpass means is set in accordance with a reception state of a broadcasting signal being received before reception states of alternative frequency broadcasting stations are determined. Accordingly, a period of time required for an AF search operation may be reduced when compared with a case where the pass-band width is changed in accordance with reception states of alternative frequency broadcasting stations.

Claims

1. A radio receiver that receives a broadcasting signal on which alternative frequency data including information on a frequency of a broadcasting station which broadcasts a program the same as a program corresponding to the broadcasting signal being received is superposed, the radio receiver comprising:

a front end (12) for receiving the broadcasting signal and converting the broadcasting signal into an intermediate frequency signal;
a bandpass unit (15) for receiving the intermediate frequency signal output from the front end and allowing a component included in a predetermined pass-band width to pass;
a reception state determination unit (17, 43) for determining a reception state of the broadcasting signal being received;
a bandwidth determination unit (44B) for determining a pass-band width of the bandpass unit in accordance with the reception state determined by the reception state determination unit; and
an alternative broadcasting station determination unit (16, 17, 45) for receiving a broadcasting signal specified by information on a frequency represented by the alternative frequency data and determining a reception state of the broadcasting signal while the pass-band width determined by the bandwidth determination unit is set to the bandpass unit.

2. The radio receiver according to claim 1,
wherein the bandwidth determination unit sets a wider pass-band width of the bandpass unit as the reception state determined by the reception state determination unit is better.

3. The radio receiver according to claim 2,
wherein the reception state determination unit selects one of a plurality of reception state levels categorized according to signal levels, and
the bandwidth determination unit determines a pass-band width corresponding to the reception state level selected by the reception state determination unit.

4. The radio receiver according to any one of claims 1 to 3, further comprising:

a switching unit (46) for performing switching from the broadcasting signal being received to a broadcasting signal specified by frequency information represented by the alternative frequency data when the reception state determined by the alternative broadcasting station determination unit is better than the reception state determined by the reception state determination unit.

5. The radio receiver according to any one of claims 1 to 4,
wherein the alternative frequency data is included in a broadcasting signal of Radio Data System.

6. The radio receiver according to any one of claims 1 to 5,
wherein the front end has a single tuner configuration for receiving a single broadcasting signal.

7. The radio receiver according to claim 6, further comprising:

an audio output unit (20, 22, 24, 47) for outputting audio corresponding to the broadcasting signal being received and making an output be in a mute state when the alternative broadcasting station determination unit performs a determination operation.

8. The radio receiver according to any one of claims 1 to 7,
wherein the determination of a reception state per-

formed by the reception state determination unit and the alternative broadcasting station determination unit is performed in accordance with an intensity of the intermediate frequency signal, presence or absence of occurrence of multipath interference, and presence or absence of occurrence of adjacent channel interference.

9. The radio receiver according to any one of claims 1 to 8, wherein the radio receiver is installed in a vehicle.

10. The radio receiver according to claim 9, wherein the alternative broadcasting station determination unit performs an operation of determining a reception state of a broadcasting station of an alternative frequency at predetermined intervals or when a reception state of the broadcasting signal being received is deteriorated.

FIG. 1

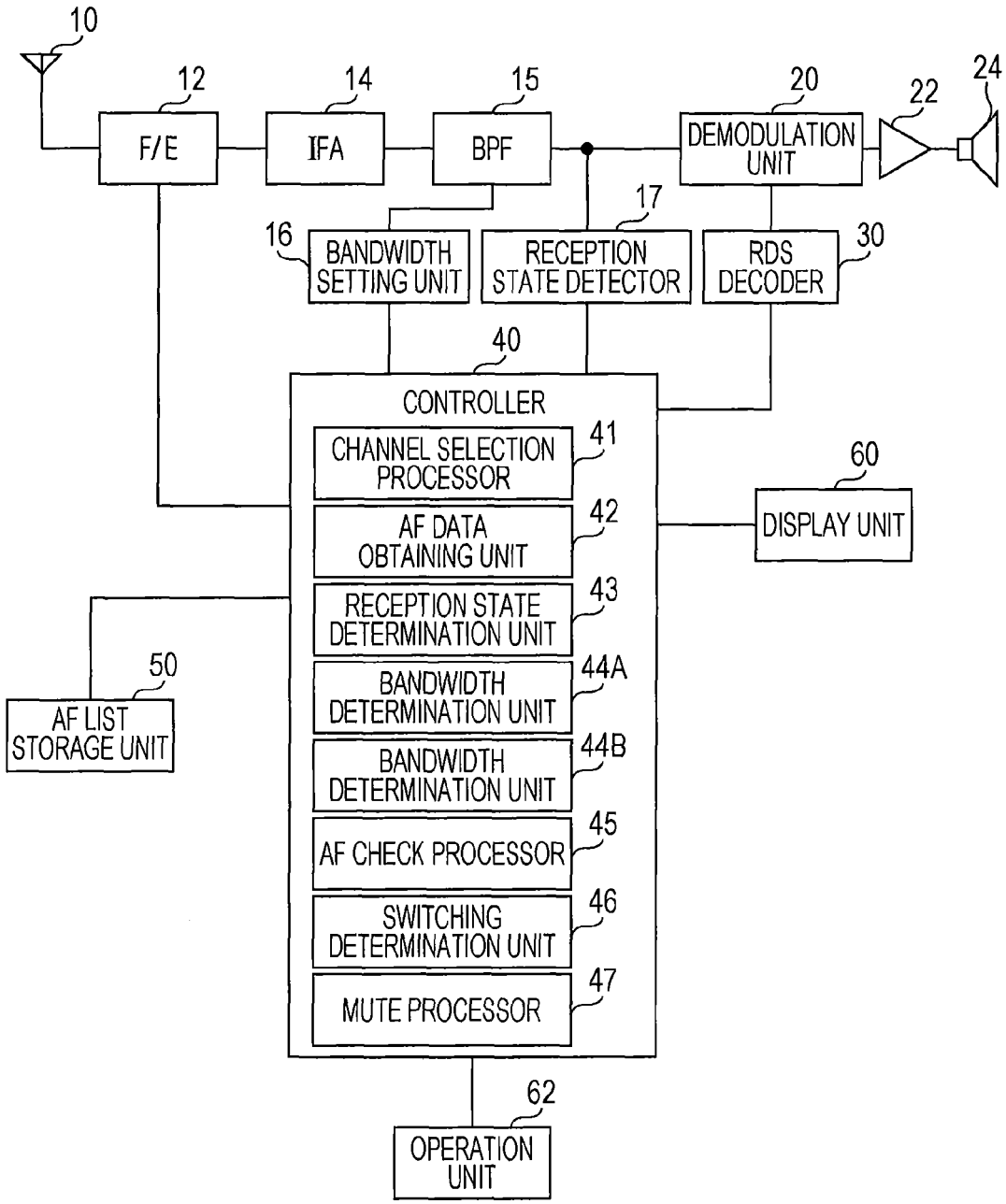

10
12
F/E
14
IFA
15
BPF
20
DEMODULATION UNIT
22
24
16
BANDWIDTH SETTING UNIT
17
RECEPTION STATE DETECTOR
RDS DECODER
30
40
CONTROLLER
CHANNEL SELECTION PROCESSOR
41
AF DATA OBTAINING UNIT
42
RECEPTION STATE DETERMINATION UNIT
43
BANDWIDTH DETERMINATION UNIT
44A
BANDWIDTH DETERMINATION UNIT
44B
AF CHECK PROCESSOR
45
SWITCHING DETERMINATION UNIT
46
MUTE PROCESSOR
47
60
DISPLAY UNIT
50
AF LIST STORAGE UNIT
62
OPERATION UNIT

FIG. 2

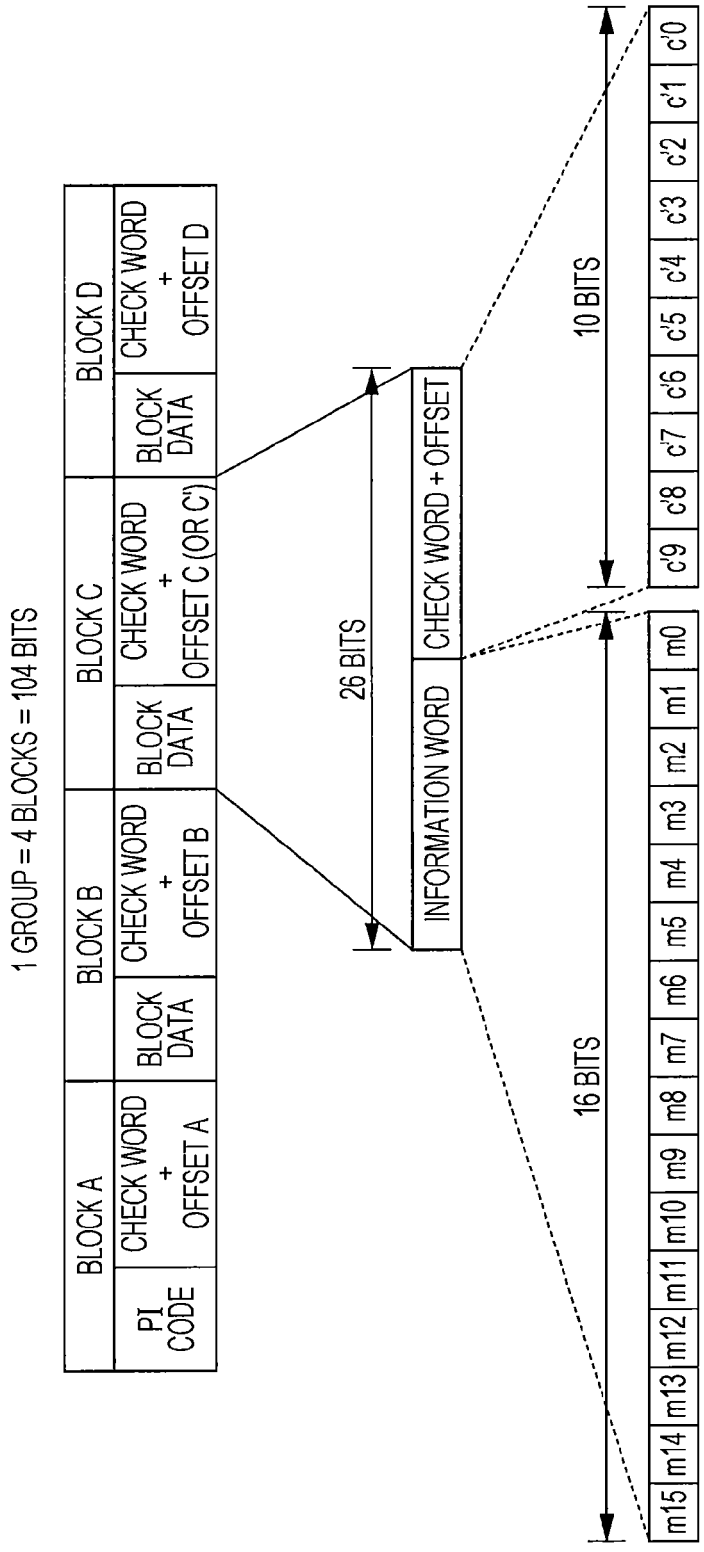

1 GROUP = 4 BLOCKS = 104 BITS
BLOCK A
PI CODE
CHECK WORD + OFFSET A
BLOCK B
BLOCK DATA
CHECK WORD + OFFSET B
BLOCK C
BLOCK DATA
CHECK WORD + OFFSET C (OR C')
BLOCK D
BLOCK DATA
CHECK WORD + OFFSET D
26 BITS
INFORMATION WORD
CHECK WORD + OFFSET
16 BITS
10 BITS
m15 m14 m13 m12 m11 m10 m9 m8 m7 m6 m5 m4 m3 m2 m1 m0
c'9 c'8 c'7 c'6 c'5 c'4 c'3 c'2 c'1 c'0

FIG. 3

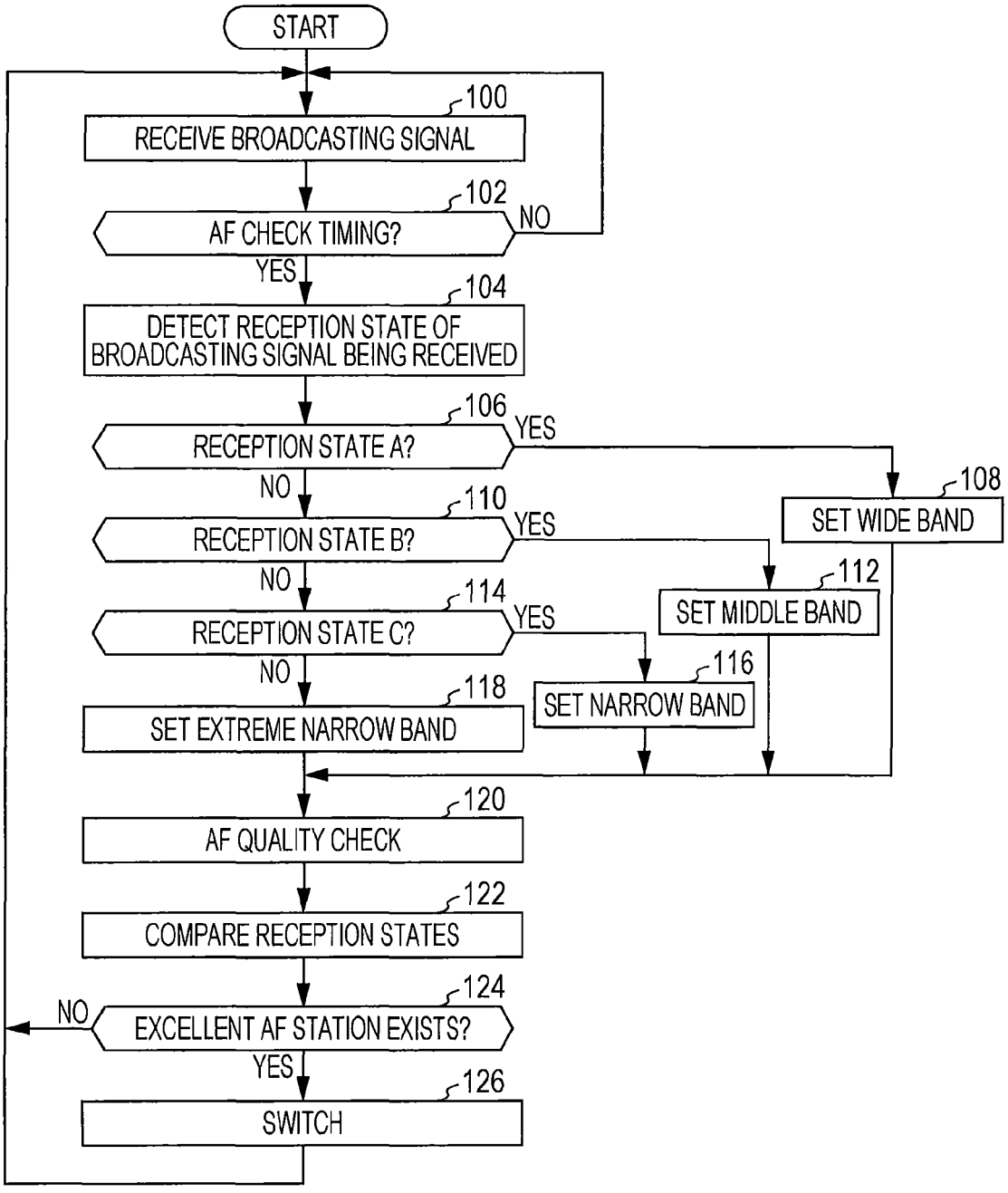
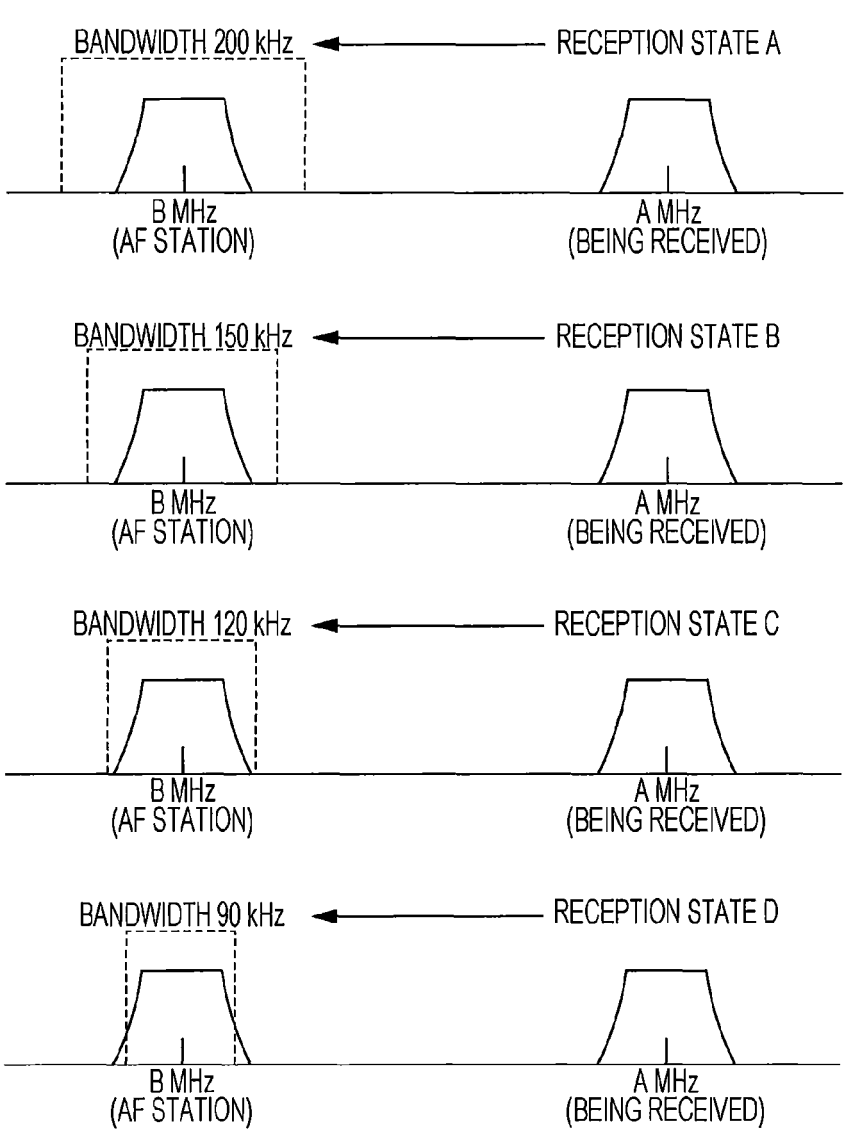

START
100
RECEIVE BROADCASTING SIGNAL
102
AF CHECK TIMING?
NO
YES
104
DETECT RECEPTION STATE OF BROADCASTING SIGNAL BEING RECEIVED
106
RECEPTION STATE A?
YES
108
SET WIDE BAND
NO
110
RECEPTION STATE B?
YES
112
SET MIDDLE BAND
NO
114
RECEPTION STATE C?
YES
116
SET NARROW BAND
NO
118
SET EXTREME NARROW BAND
120
AF QUALITY CHECK
122
COMPARE RECEPTION STATES
124
NO
EXCELLENT AF STATION EXISTS?
YES
126
SWITCH

FIG. 4

RECEPTION STATE	BANDWIDTH IN AF CHECK	SWITCHING CONDITION
A	WIDE BAND	RECEPTION STATE OF BROADCASTING SIGNAL BEING RECEIVED IS GOOD OR COMPARATIVELY GOOD. SWITCH TO AF STATION OF THE SAME LEVEL OR MORE IF ANY.
B	MIDDLE BAND	
C	NARROW BAND	RECEPTION STATE OF BROADCASTING SIGNAL BEING RECEIVED IS DETERIORATED. SWITCH TO AF STATION ENSURING GOOD RECEPTION STATE EVEN IF THE AF STATION SUFFERS FROM INTERFERENCE MORE OR LESS.
D	EXTREME NARROW BAND	BROADCASTING SIGNAL BEING RECEIVED IS UNLISTENABLE. SWITCH TO LISTENABLE AF STATION, IF ANY, EVEN IF THE AF STATION SUFFERS FROM INTERFERENCE.

FIG. 5


BANDWIDTH 200 kHz
RECEPTION STATE A
B MHz
(AF STATION)
A MHz
(BEING RECEIVED)
BANDWIDTH 150 kHz
RECEPTION STATE B
B MHz
(AF STATION)
A MHz
(BEING RECEIVED)
BANDWIDTH 120 kHz
RECEPTION STATE C
B MHz
(AF STATION)
A MHz
(BEING RECEIVED)
BANDWIDTH 90 kHz
RECEPTION STATE D
B MHz
(AF STATION)
A MHz
(BEING RECEIVED)

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EUROPEAN SEARCH REPORT

Application Number
EP 13 17 7043

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	JP 2009 105729 A (SANYO ELECTRIC CO; SANYO SEMICONDUCTOR CO LTD) 14 May 2009 (2009-05-14) * paragraphs [0007], [0010], [0014] - [0016], [0029], [0033], [0035] - [0037], [0041], [0043] - [0044] * * figure 1 * -----	1-10	INV. H04H20/22 H04H20/12 H04H40/18
X	DE 42 39 759 A1 (TELEFUNKEN MICROELECTRON [DE] ATMEL GERMANY GMBH [DE]) 1 June 1994 (1994-06-01) * column 4, lines 9-31 * * figure 3 * * column 5, lines 4-16 * -----	1	
A	US 5 745 845 A (SUENAGA SHOJI [JP] ET AL) 28 April 1998 (1998-04-28) * column 3, lines 32-47 * * figure 3 * * column 5, lines 24-53 * * column 6, line 56 - column 7, line 14 * -----	1-10	TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 September 2013	Iovescu, Vladimir

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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26-09-2013

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EP 2073409 A1	24-06-2009	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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