(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 895 694 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.03.2008 Bulletin 2008/10

(51) Int Cl.:
H04H 40/27 *(2008.01)*

(21) Application number: **07114974.4**

(22) Date of filing: **24.08.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **28.08.2006 JP 2006230926**

(71) Applicant: **Mitsumi Electric Co., Ltd.**
Tama-shi,
Tokyo 206-8567 (JP)

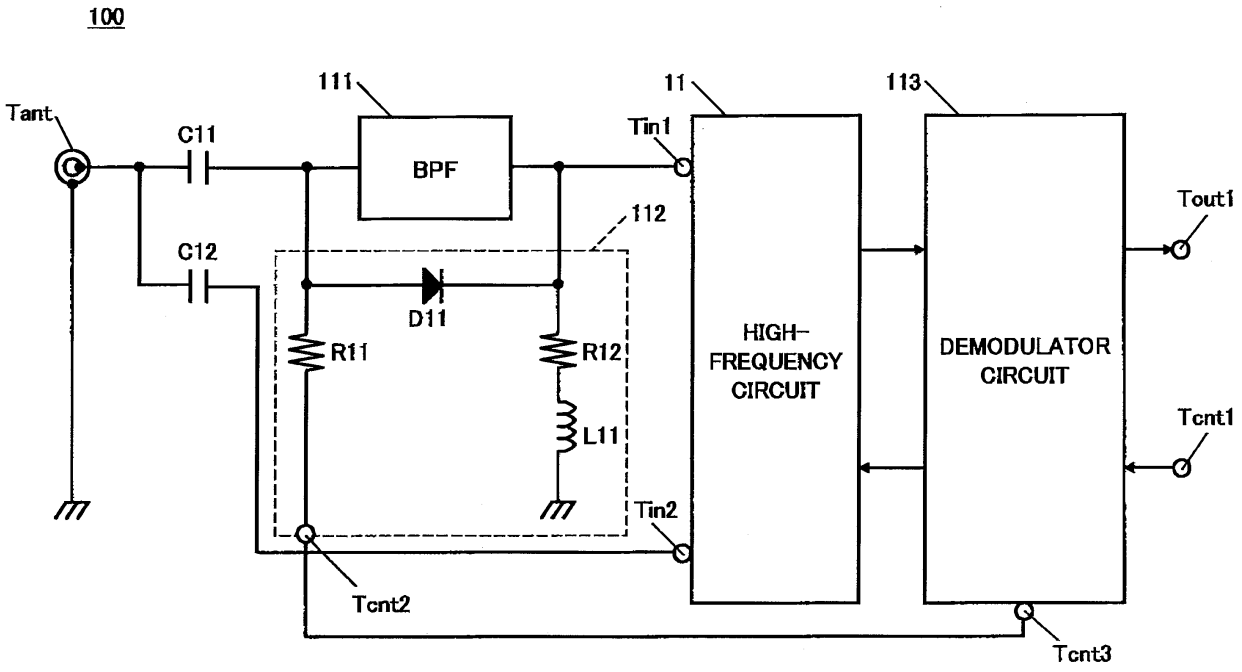
(72) Inventor: **MIYAGAWA, Yoichi**
Mitsumi Electric Co., Ltd.
Kanagawa Kanagawa 243-8533 (JP)

(74) Representative: **Rees, Alexander Ellison et al**
Urquhart-Dykes & Lord LLP
30 Welbeck Street
London W1G 8ER (GB)

(54) **Receiving Apparatus**

(57) A disclosed receiving apparatus includes a receiving circuit configured to receive signals of a first frequency band and signals of a second frequency band; a filter (111) configured to allow the signals of the first frequency band to pass through the filter and be supplied to the receiving circuit, and to attenuate the signals of the second frequency band; and a switch unit (112) provided in parallel with the filter (111) and configured to switch its status based on a control signal.

FIG.1



EP 1 895 694 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates generally to receiving apparatuses, and more particularly to a receiving apparatus with a receiving circuit for receiving signals of a first frequency band and signals of a second frequency band.

2. Description of the Related Art

[0002] In recent years and continuing, digital audio broadcasting (DAB) has been proposed and put into practice as radio broadcasting, due to requirements for higher sound quality. When DAB is practically used, it competes with existing broadcast waves such as those of FM (frequency modulation) broadcasting. For this reason, a high-frequency IC installed in a digital audio broadcast receiving apparatus is configured to receive not only DAB but also FM broadcasting. In such a high-frequency IC, in order to reduce the number of chip terminals, a signal terminal is shared by Band 3 and FM broadcasting, as they have similar receiving frequency bands.

[0003] FIG. 4 is a block diagram of a conventional digital audio broadcast receiving apparatus.

[0004] A digital audio broadcast receiving apparatus 10 includes capacitors C11, C12, a high-frequency circuit 11, and a demodulator circuit 12.

[0005] High-frequency signals are supplied from an antenna to an antenna terminal Tant. The high-frequency signals supplied to the antenna terminal Tant are supplied to a Band 3/FM input terminal Tin1 of the high-frequency circuit 11 via the capacitor C11 and to an L-band input terminal Tin2 of the high-frequency circuit 11 via the capacitor C12.

[0006] The high-frequency circuit 11 primarily includes one semiconductor chip. The high-frequency circuit 11 extracts from the demodulator circuit 12 high-frequency signals corresponding to channel select signals, and supplies the extracted high-frequency signals to the demodulator circuit 12. The demodulator circuit 12 demodulates the high-frequency signals received from the high-frequency circuit 11 and supplies them to an external circuit.

[0007] However, the frequency band (174 MHz through 242 MHz) of Band 3 includes a higher harmonic wave (216 MHz) that is two times as high as a receivable frequency band of FM broadcast (108 MHz).

Accordingly, in an area where the strength for Band 3 is generally low and the strength for FM broadcast of 108 MHz is generally high, a higher harmonic wave (216 MHz) that is two times as high as the receivable frequency band of FM broadcast is superimposed onto Band 3 as noise. This noise obstructs the reception of Band 3.

[0008] Generally, in order to eliminate the impact of noise, a plurality of band-pass filters are provided. Each band-pass filter extracts signals of the desired frequency band (see Patent Documents 1, 2).

[0009] Patent Document 1: Japanese Laid-Open Utility Model Application No. H5-48440

[0010] Patent Document 2: Published Japanese Translation of PCT International Publication (for Patent Application) No. 2004-502375

[0011] However, if only the frequency band of Band 3 is allowed to pass through a band-pass filter, FM broadcast cannot be received. Furthermore, if a filter is provided for each of the frequency bands to be received, the circuit configuration becomes complex and the cost increases.

SUMMARY OF THE INVENTION

[0012] The present invention provides a receiving apparatus in which one or more of the above-described disadvantages are eliminated.

[0013] A preferred embodiment of the present invention provides a receiving apparatus in which higher harmonic waves can be reduced.

[0014] An embodiment of the present invention provides a receiving apparatus including a receiving circuit configured to receive signals of a first frequency band and signals of a second frequency band; a filter (111) configured to allow the signals of the first frequency band to pass through the filter and be supplied to the receiving circuit, and to attenuate the signals of the second frequency band; and a switch unit (112) provided in parallel with the filter (111) and configured to allow the signals to pass through or prevent the signals from passing through based on a control signal.

[0015] According to one embodiment of the present invention, a receiving apparatus includes a receiving circuit configured to receive signals of a first frequency band and signals of a second frequency band; a filter (111) configured to allow the signals of the first frequency band to pass through the filter and be supplied to the receiving circuit, and to attenuate the signals of the second frequency band; and a switch unit (112) provided in parallel with the filter (111) and configured to allow the signals to pass through or prevent the signals from passing through based on a control signal. Therefore, when the switch unit (112) switches on based on the control signal, signals of both the first and second frequency bands are supplied to the receiving circuit. When the switch unit (112) switches off based on the control signal, signals of only the first frequency band that have passed through the filter (111) are supplied to the receiving circuit. Hence, it is possible to reduce the intrusion of higher harmonic waves.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Other objects, features and advantages of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a block diagram of a receiving apparatus according to an embodiment of the present invention;

FIG. 2 is a flowchart of a process performed by a demodulator circuit of the receiving apparatus shown in FIG. 1;

FIG. 3 is a chart for describing an operation according to an embodiment of the present invention; and

FIG. 4 is a block diagram of a conventional digital audio broadcast receiving apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] A description is given, with reference to the accompanying drawings, of an embodiment of the present invention.

[0018] FIG. 1 is a block diagram of a receiving apparatus according to an embodiment of the present invention.

[0019] A receiving apparatus 100 according to an embodiment of the present invention is for receiving DAB, and includes capacitors C11, C12, a filter circuit (band-pass filter) 111, a switch circuit 112, a high-frequency circuit 11, and a demodulator circuit 113.

[0020] In the receiving apparatus 100, an antenna terminal Tant receives signals from an antenna. The antenna terminal Tant is connected to the band-pass filter 111 via the capacitor C11 and also to an L-band input terminal Tin2 of the high-frequency circuit 11 via the capacitor C12. The capacitors C11, C12 remove direct-current components from signals received from the antenna terminal Tant.

[0021] The frequency band of the band-pass filter 111 is specified so that signals of frequency bands of DAB and Band 3 can pass through the band-pass filter 111. Signals that have passed through the band-pass filter 111 are supplied to a Band 3/FM signal input terminal Tin1 of the high-frequency circuit 11. The switch circuit 112 is connected in parallel with the high-frequency circuit 11.

[0022] The switch circuit 112 includes a PIN (positive-intrinsic-negative) diode D11, resistances R11, R12, and a coil L11.

[0023] The PIN diode D11 is connected in parallel with the band-pass filter 111. The anode of the PIN diode D11 is connected to the connection point of the capacitor C11 and the band-pass filter 111 and the cathode of the PIN diode D11 is connected to the Band 3/FM signal input terminal Tin1 of the high-frequency circuit 11.

[0024] The PIN diode D11 is caused to switch its status when a bias voltage is applied between the anode and the cathode of the PIN diode D11 by the resistances R11, R12 and the coil L11.

[0025] The resistance R11 has one end connected to the anode of the PIN diode D11 and the other end connected to a control terminal Tcnt2. The resistance R12 has one end connected to the cathode of the PIN diode D11 and the other end connected to one end of the coil L11. The other end of the coil L11 is grounded.

[0026] A direct-current voltage is applied from the demodulator circuit 113 to the control terminal Tcnt2 of the switch circuit 112. When a direct-current voltage is applied to the control terminal Tcnt2, the PIN diode D11 switches on.

[0027] The resistances R11, R12 control the forward current of the PIN diode D11 to prevent unnecessary currents from flowing to the PIN diode D11. The coil L11 prevents signal components from flowing from the antenna terminal Tant to ground.

[0028] The control terminal Tcnt2 of the switch circuit 112 is connected to the control terminal Tcnt3 of the demodulator circuit 113. Channel select information is supplied from an external circuit to a control terminal Tcnt1 of the demodulator circuit 113. Based on the channel select information supplied to the control terminal Tcnt1, the demodulator circuit 113 controls the high-frequency circuit 11 so that signals of frequencies corresponding to the channel select information are supplied to the demodulator circuit 113.

[0029] The demodulator circuit 113 controls the high-frequency circuit 11 according to the channel select information received from the external circuit, and extracts, from the high-frequency circuit 11, high-frequency signals corresponding to channel select information. The demodulator circuit 113 demodulates the high-frequency signals supplied from the high-frequency circuit 11, and supplies them to the external circuit.

[0030] FIG. 2 is a flowchart of a process performed by the demodulator circuit 113.

[0031] In step S1-1, when the demodulator circuit 113 receives, from an external circuit, an instruction to receive signals from an FM broadcasting station; in step S1-2 the demodulator circuit 113 turns control signals into high-level signals, which control signals are to be supplied from the control terminal Tcnt3 to the control terminal Tcnt2 of the switch circuit 112. When the control signals supplied to the control terminal Tcnt2 become high-level, the PIN diode D11 of the switch circuit 112 is turned on. When the PIN diode D11 is turned on, high-frequency signals are supplied from the antenna terminal Tant via the PIN diode D11 to the Band 3/FM signal input terminal Tin1 of the high-frequency circuit 11. Accordingly, FM signals can be supplied to the high-frequency circuit 11 without reducing the FM signals with the filter circuit 111. From among high-frequency signals supplied to the Band 3/FM signal input terminal Tin1 through the PIN diode D11, the high-frequency circuit 11 selects high-frequency signals of the frequency corresponding to the channel select information from the demodulator circuit 113, and supplies them to the demodulator circuit 113. The demodulator circuit 113 demodulates the high-frequency signals received from the high-frequency circuit 11 to obtain FM signals corresponding to the channel select information.

[0032] In step S1-1, when the demodulator circuit 113

receives, from an external circuit, an instruction to receive digital audio broadcasting of Band 3, in step S1-3, the demodulator circuit 113 turns control signals into low-level signals, which control signals are to be supplied from the control terminal Tcnt3 to the control terminal Tcnt2 of the switch circuit 112. When the control signals supplied to the control terminal Tcnt2 become low-level, the PIN diode D11 of the switch circuit 112 is turned off. When the PIN diode D11 is turned off, high-frequency signals are supplied from the antenna terminal Tant to the filter circuit 111. Among the high-frequency signals from the antenna terminal Tant, signals of the frequency band of Band 3 are selectively allowed to pass through the band-pass filter 111, and are supplied to the demodulator circuit 113. Hence, only signals of the frequency band of Band 3 are supplied via the Band 3/FM signal input terminal Tin1 to the demodulator circuit 113. That is, higher harmonic wave components of FM signals are removed from the high-frequency signals before the signals are supplied.

[0033] Accordingly, higher harmonic wave noise is prevented from being superimposed on Band 3 signals, and therefore, Band 3 signals can be reliably demodulated.

[0034] FIG. 3 is a chart for describing an operation according to an embodiment of the present invention.

[0035] For example, the frequency band of Band 3 is 174 MHz through 242 MHz. Meanwhile, the frequency band of FM broadcasting is 108 MHz. A higher harmonic wave that is two times 108 MHz is 216 MHz, as indicated by a dashed line shown in FIG. 3.

[0036] The frequency band of Band 3 is within 174 MHz through 242 MHz, and therefore, if the frequency band 108 MHz of FM broadcasting is included, reception of Band 3 is obstructed by higher harmonic noise of FM broadcasting. In the present embodiment, when receiving Band 3, the switch circuit 112 is turned off so that signals from the antenna terminal Tant are supplied to the Band 3/FM signal input terminal Tin1 of the high-frequency circuit 11 through the band-pass filter 111. Hence, the higher harmonic wave that is two times the FM broadcast wave 108 MHz is not superimposed to the Band 3 signals as noise. Consequently, Band 3 signals can be demodulated without receiving the impact of noise.

[0037] According to one embodiment of the present invention, a receiving apparatus includes a receiving circuit configured to receive signals of a first frequency band and signals of a second frequency band; a filter (111) configured to allow the signals of the first frequency band to pass through the filter and be supplied to the receiving circuit, and to attenuate the signals of the second frequency band; and a switch unit provided in parallel with the filter and configured to switch its status based on a control signal.

[0038] Additionally, in the receiving apparatus, the switch unit (112) includes a diode (D11) whose anode is connected to an input end of the filter (111) and whose cathode is connected to an output end of the filter (111); and a bias circuit (R11, R12, L11) configured to apply a bias voltage to the diode (D11) based on the control signal.

[0039] Additionally, in the receiving apparatus, the diode (D11) includes a positive-intrinsic-negative diode.

[0040] Additionally, in the receiving apparatus, the bias circuit (R11, R12, L11) includes a first resistance (R11) including one end configured to receive the control signal and another end connected to the anode of the diode (D11); a second resistance (R12) comprising one end connected to the cathode of the diode (D11); and an alternating-current prevention coil (L11) comprising one end connected to another end of the second resistance (R12), and another end grounded.

[0041] Additionally, in the receiving apparatus, the first frequency band is used for digital audio broadcasting; and the second frequency band is used for frequency modulation broadcasting.

[0042] These reference numerals are indicated merely as references; the scope of the present invention is not limited thereto.

[0043] The present invention is not limited to the specifically disclosed embodiment, and variations and modifications may be made without departing from the scope of the present invention.

[0044] The present application is based on Japanese Priority Patent Application No. 2006-230926, filed on August 28, 2006, the entire contents of which are hereby incorporated by reference.

Claims

1. A receiving apparatus comprising:

a receiving circuit configured to receive signals of a first frequency band and signals of a second frequency band;
a filter configured to allow the signals of the first frequency band to pass through the filter and be supplied to the receiving circuit, and to attenuate the signals of the second frequency band; and
a switch unit provided in parallel with the filter and configured to switch its status based on a control signal.

2. The receiving apparatus according to claim 1, wherein the switch unit comprises:

a diode whose anode is connected to an input end of the filter and whose cathode is connected to an output end of the filter; and
a bias circuit configured to apply a bias voltage to the diode based on the control signal.

3. The receiving apparatus according to claim 2, wherein:

the diode comprises a positive-intrinsic-negative diode.

4. The receiving apparatus according to claim 2, wherein the bias circuit comprises:

a first resistance comprising one end configured to receive the control signal and another end connected to the anode of the diode;
a second resistance comprising one end connected to the cathode of the diode; and
an alternating-current prevention coil comprising one end connected to another end of the second resistance, and another end grounded.

5. The receiving apparatus according to claim 1, wherein:

the first frequency band is used for digital audio broadcasting; and
the second frequency band is used for frequency modulation broadcasting.

FIG.1

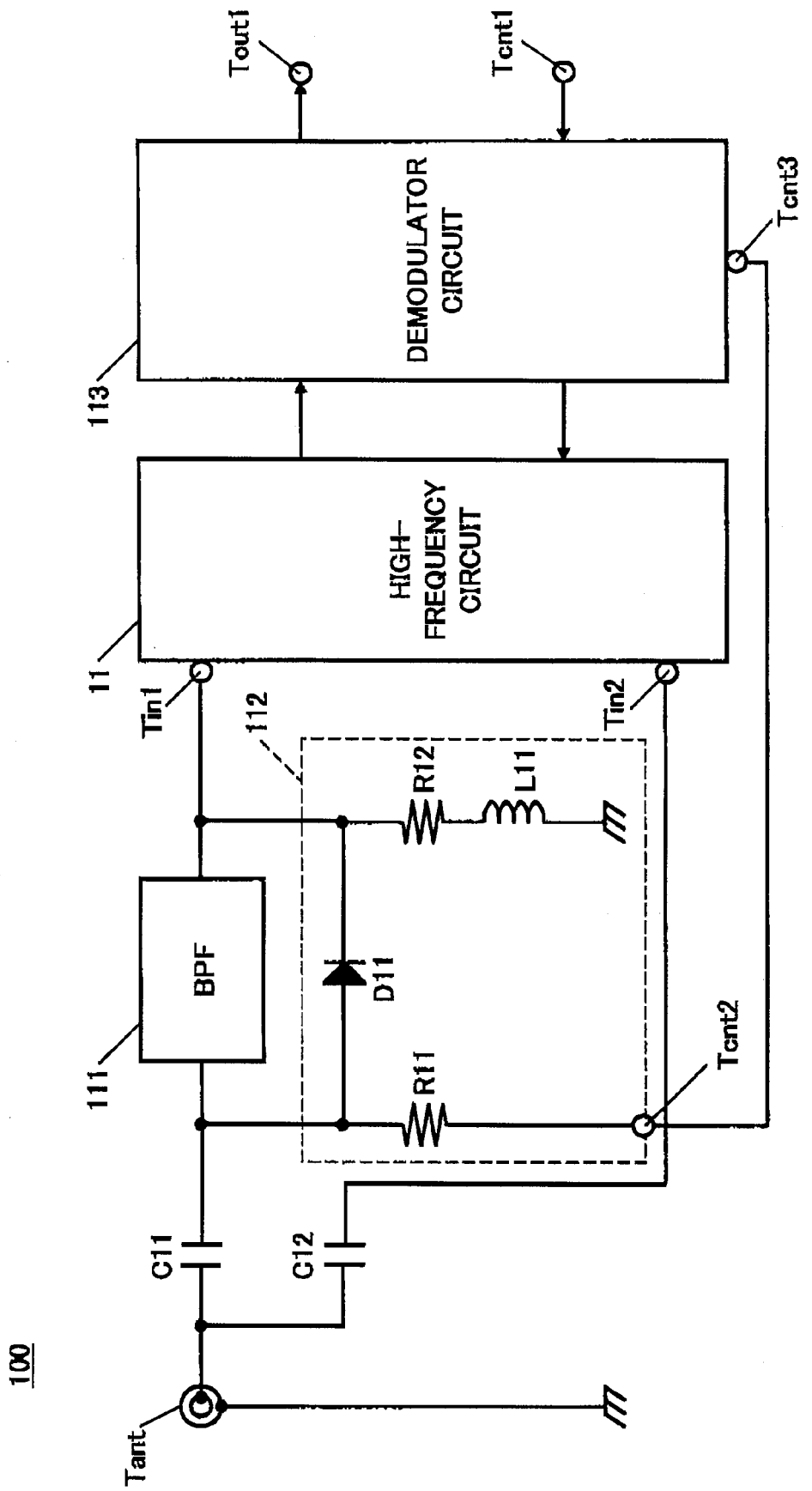

Tout1
Tcnt1
DEMODULATOR CIRCUIT
Tcnt3
113
HIGH-FREQUENCY CIRCUIT
11
Tin1
112
Tin2
R12
L11
BPF
D11
111
R11
Tcnt2
C11
C12
100
Tant

FIG.2

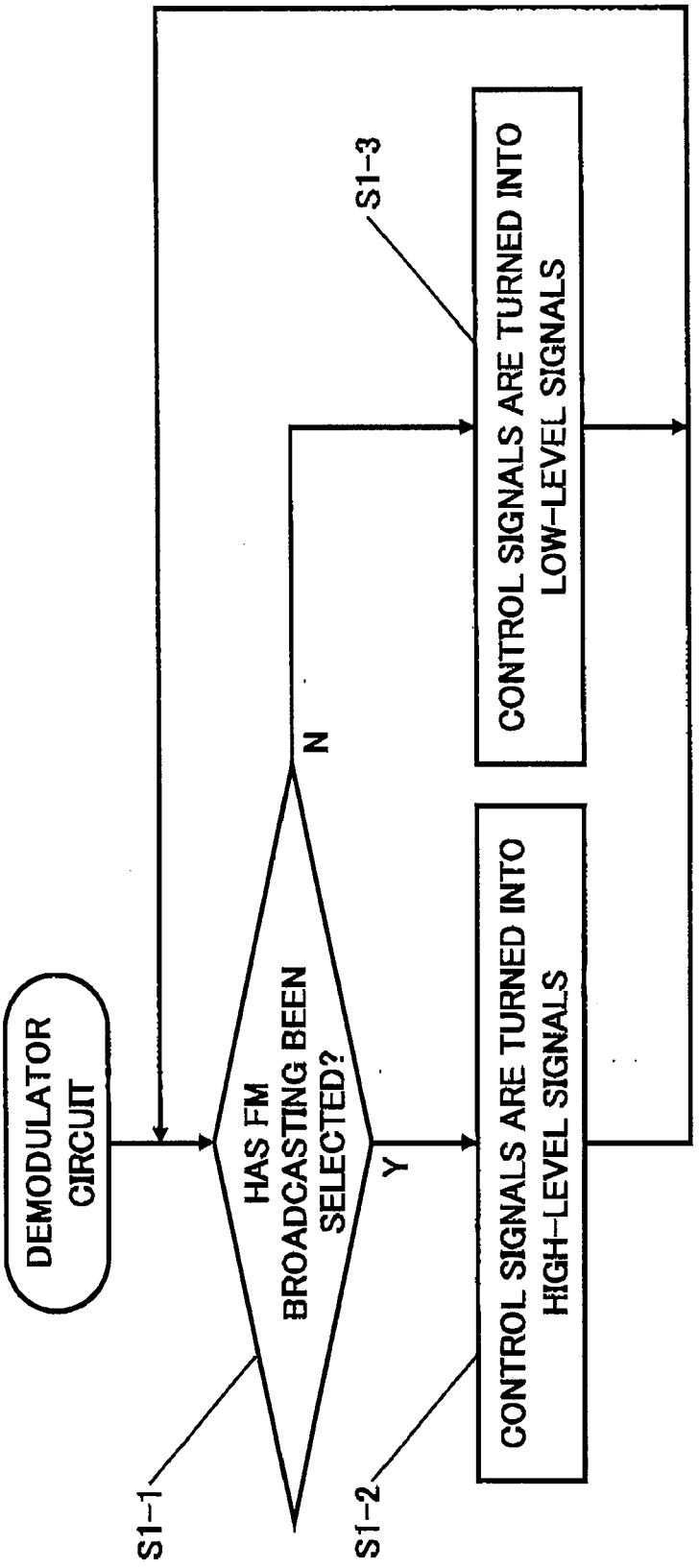

DEMODULATOR CIRCUIT
HAS FM BROADCASTING BEEN SELECTED?
N
Y
CONTROL SIGNALS ARE TURNED INTO LOW-LEVEL SIGNALS
CONTROL SIGNALS ARE TURNED INTO HIGH-LEVEL SIGNALS
S1-1
S1-2
S1-3

FIG.3

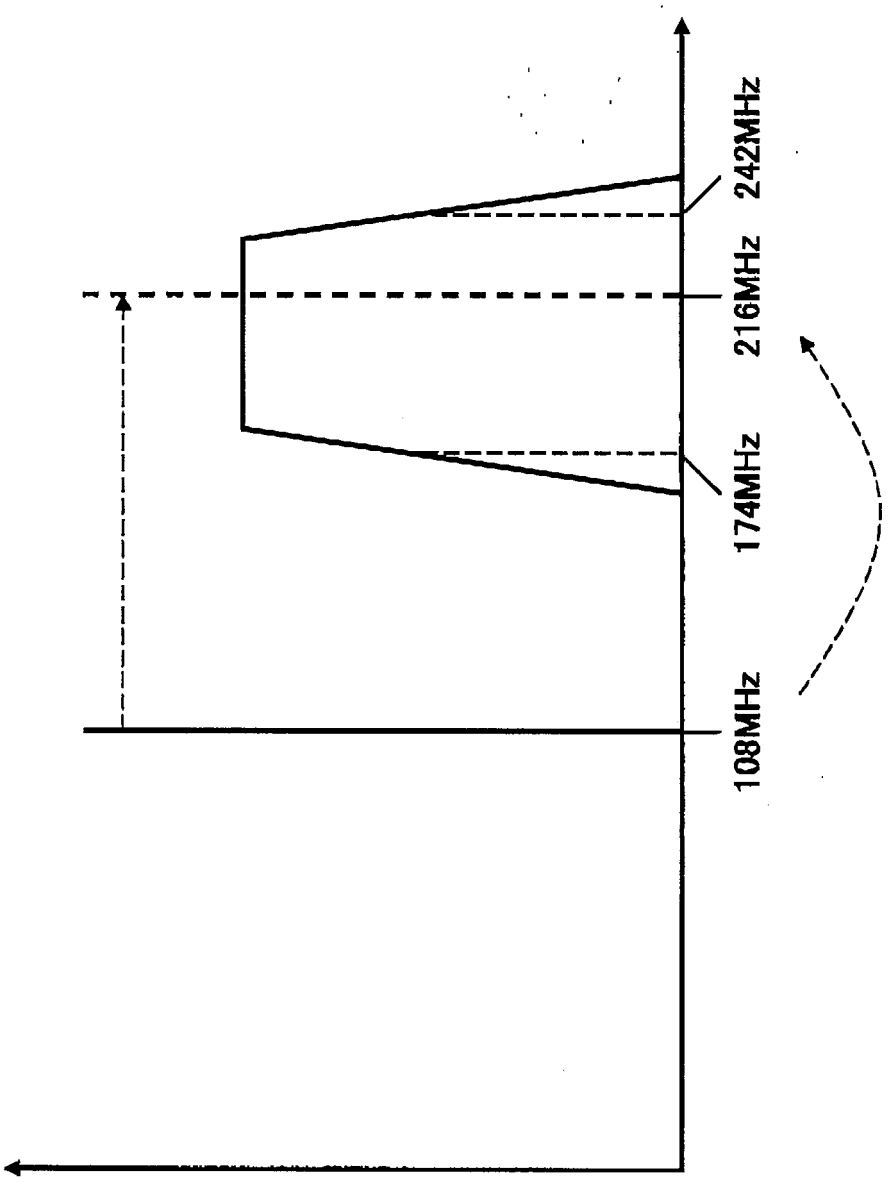
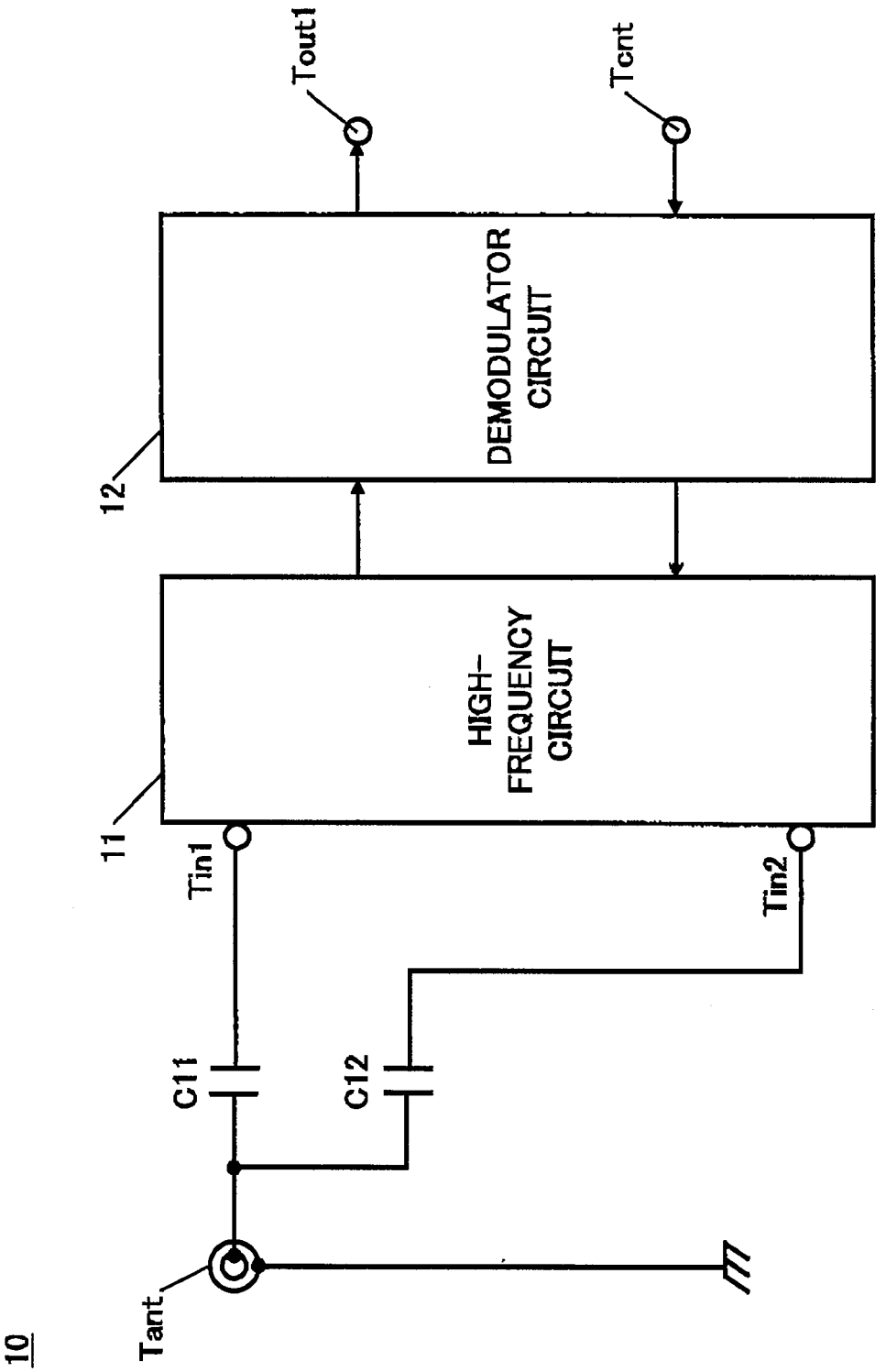


FIG.4


Tout1
Tcnt
DEMODULATOR CIRCUIT
12
HIGH-FREQUENCY CIRCUIT
11
Tin1
Tin2
C11
C12
Tant
10

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H548440 A **[0009]**
- JP 2004502375 A **[0010]**
- JP 2006230926 A **[0044]**