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

(11) EP 1 003 282 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.05.2000 Bulletin 2000/21

(51) Int. Cl.[7]: **H03G 3/00**

(21) Application number: **99122312.4**

(22) Date of filing: **09.11.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **17.11.1998 JP 32652798**

(71) Applicant: **Pioneer Corporation**
Meguro-ku, Tokyo (JP)

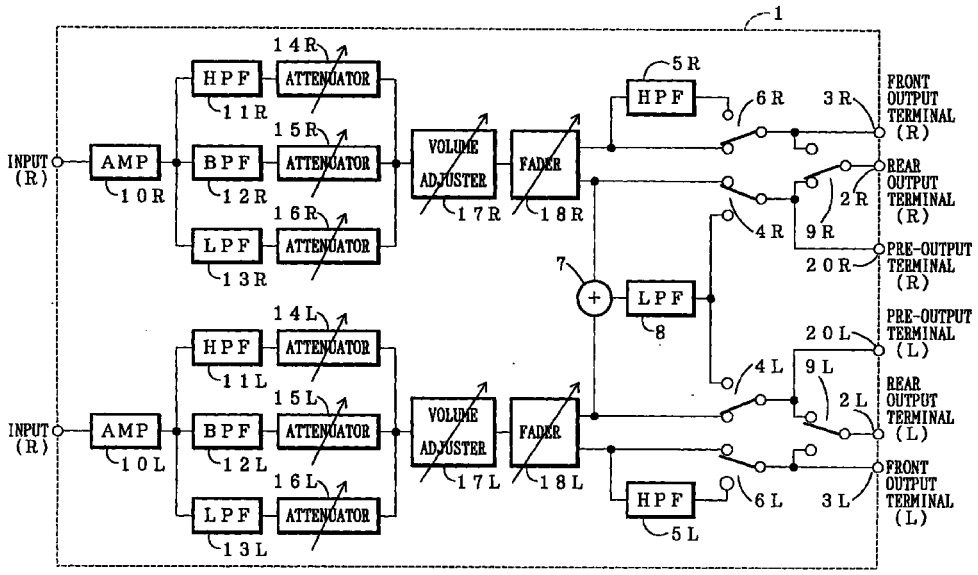
(72) Inventors:
- **Kageyama, Toru,**
  Pioneer Corporation
  Kawagoe-shi, Saitama 350-0822 (JP)
- **Takami, Yusuke,**
  c/o Pioneer Corporation
  Kawagoe-shi, Saitama 350-0822 (JP)
- **Hasegawa, Tatsuzo,**
  c/o Pioneer Corporation
  Kawagoe-shi, Saitama 350-0822 (JP)
- **Kudo, Kazuyuki,**
  c/o Pioneer Corporation
  Kawagoe-shi, Saitama 350-0822 (JP)

(74) Representative:
Grünecker, Kinkeldey,
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) Integrated circuit for processing audio signal

(57) An integrated circuit for processing an audio signal includes a circuit for processing an input audio signal to create a front output signal, rear output signal and a sub-woofer output signal which are to be outputted to a front speaker, a rear speaker and a sub-woofer; and a switch for selecting the rear output signal or the sub-woofer output signal. The output from said switch is connected to a common output to the front speaker and the sub-woofer. In this configuration, the number of input/output terminals can be reduced.

FIG. 1



EP 1 003 282 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an integrated circuit for processing an audio signal.

2. Description of the Related Art

[0002] An audio circuit for a vehicle is constructed by a circuit for creating, from an input signal, stereophonic signals to be connected to a speaker installed at the front of the vehicle (hereinafter referred to simply as "front speaker"), another speaker installed at the rear of the vehicle (hereinafter referred to simply as "rear speaker") and a sub-woofer speaker for emphasizing a low frequency band (hereinafter referred to simply as "sub-woofer") and for changing the sound volume and frequency characteristic of the input signal.

[0003] Fig. 2 is a block diagram of the configuration of a conventional audio circuit.

[0004] In the conventional audio circuit, an input audio signal is amplified by an amplifier 10. The amplified audio signal is separated in tents of frequency by a high-pass filter 11, band-pass filter 12 and a low-pass filter 13. The respective frequency components are connected to the corresponding attenuators which change the frequency characteristic of the input signal.

[0005] The signal whose frequency characteristic has been changed is controlled in its output volume by a volume controller 17 and fader 18. Thus, a front output signal and a rear output signal, which are outputted to a front speaker and rear speaker, are produced. A sub-woofer signal to be outputted to a sub-woofer speaker is produced from the rear output signal through a low-pass filter 19.

[0006] The above conventional audio circuit, which is composed of individual circuit components, is expensive in production cost. In addition, it has been demanded that the characteristic of each of the high-pass filter, band-pass filter and low-pass filter can be changed.

[0007] For this reason, the filtering was carried out by means of switched capacitor filters or digital signal processing, and volume control was made in electronics. In this way, the audio circuit was configured in a semiconductor integrated circuit.

[0008] Where the audio circuit is configured by a semiconductor integrated circuit, the number of pins to connected to the integrated circuit is problematic. The number of pins is prescribed for a common integrated circuit. For example, if the number of input/output pins is 44 or less, the integrated circuit with 44 pins is used. However, the number of input/output pins exceeds 44, the integrated circuit with 64 pins which is one-rank higher in the number of pins must be used.

[0009] The one-rank higher integrated circuit, which has an increased number of pins, increases the freedom of circuit design. However, it increases a leak current from the packaged portion. This attenuates the reliability and increases the production cost. Therefore, in designing an internal circuit of the integrated circuit, how the number of input/output pins is reduced is critical.

SUMMARY OF THE INVENTION

[0010] An object of the present invention is to provide an integrated circuit for processing an audio signal having a reduced number of input/output pins.

[0011] In order to attain the above object, there is provided an integrated circuit for processing an audio signal comprising: means for processing an input audio signal to create a front output signal, rear output signal and a sub-woofer output signal which are to be outputted to a front speaker, a rear speaker and a sub-woofer; and first switch means for selecting the rear output signal or the sub-woofer output signal, an output from the switch means being connected to a common output for the front speaker and the sub-woofer.

[0012] In this configuration, the number of input/output terminals can be reduced.

[0013] Preferably, the integrated circuit further comprises a high-pass filter for inhibiting a low frequency band of the front output signal from passing; and second switch means for selecting an output signal from the high-pass filter or the front output signal, an output from the second switch means being connected to an output to the front speaker.

[0014] In this configuration, while the output signal from the sub-woofer is outputted from the rear output terminal, if the front output signal is passed through the high-pass filter, the distortion of signal from the front speaker in a low frequency band can be removed.

[0015] The above and other object and features of the present invention will be more apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a schematic diagram of the configuration of an embodiment of the integrated circuit for processing an audio signal according to the present invention; and

Fig. 2 is a block diagram of a configuration of a conventional audio circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] Now referring to Fig. 1, an explanation will be given of an embodiment of the integrated circuit for

processing an audio signal according to the present invention. Fig. 1 is a schematic diagram of the configuration of this embodiment. In Fig. 1, like reference numerals refer to like elements in Fig. 2 showing the conventional audio circuit. Subscript R assigned to each reference numeral is directed to the line carrying the signal at an R (right) channel whereas subscript L assigned to each reference numeral is directed to the line carrying the signal at an L (left) channel.

[0018] In the integrated circuit 1 as shown in Fig. 1, rear output signals produced from faders 18R and 18L for the R channel and L channel are added to each other by an adder 7 to provide a monophonic signal. The monophonic signal is passed through a low-pass filter (LPF) 8 to produce a low frequency signal. The rear output signals from the faders 18R and 18L or the signal from the LPF 8 are selected by switches 4R and 4L, respectively.

[0019] The front output signals produced from faders 18R and 18L for the R channel and L channel are passed through high-pass filters (HPFs) 5R and 5L to provide high frequency signals with the lower frequency component stopped. The signals having passed through the HPFs 5R and 5L or the front output signals are selected by switches 6R and 6L, respectively. The signal selected by the switch 4R or the signal selected by the switch 6R is selected by a switch 9R. The signal selected by the switch 4L or the signal selected by the switch 6L is selected by a switch 9L.

[0020] The signal selected by the switch 6R goes to the front output terminal 3R at the R channel; the signal selected by the switches 4R and 9R goes to the rear output terminal 2R at the R channel; and the signal selected by only the switch 4R goes to a pre-output terminal 20R at the R channel. This applies to the L channel side.

[0021] In this configuration, as seen from Fig. 1, the front output terminals 3R and 3L are connected to power amplifiers for front R-channel and front L-channel, respectively. The outputs from these power amplifiers are connected to front speakers for the front R channel and front L channel, respectively. On the other hand, the rear output terminals 2R and 2L are connected to power amplifiers for rear R-channel and front L-channel, respectively. The outputs from these power amplifiers are connected to rear speakers for the rear R channel and rear L channel, respectively. In this case, the switches 6R and 6L are set at the side where the front signals from the faders 18R and 18L are directly supplied, whereas the switches 4R and 4L are set at the side where the rear signals from the faders 18R and 18L are directly supplied. In addition, the switches 9R and 9L are set to select the sides of the switches 4R and 4L.

[0022] By connecting these switches in this manner, the front signals at the R channel and L channel are guided to the front output terminals 3R and 3L, respectively so that the front power amplifiers drive the front speakers, respectively. Further, the rear signals at the R channel and L channel are guided to the rear output terminals 2R and 2L through the switches 4R, 4L and 9R, 9L, respectively so that the rear power amplifiers drive the rear speakers, respectively.

[0023] By connecting the switches 9R, 9L to the switches 6R, 6L, the front signals from the faders 18R, 18L are directly supplied so that the rear power amplifiers drive the rear speakers, respectively. The signal levels supplied to the front speakers and rear speakers by the faders 18R and 18L are controlled independently or correlatively.

[0024] Next, the front output terminals 3R and 3L are connected to power amplifiers for front R-channel and front L-channel, respectively. The outputs from these power amplifiers are connected to speakers for the front R channel and front L channel, respectively. On the other hand, the rear output terminals 2R and/or 2L are connected to power amplifiers for driving the sub-woofers, respectively. Further, when the sub-woofers are connected to the power amplifiers therefor, the switches 6R, 6L are connected to the signals passed through the HPFs 5R and 5L, the switches 4R, 4L are connected to the LPF 8, and the switches 9R, 9L are connected to the switches 4R, 4L, respectively.

[0025] By connecting the switches in the manner described above, the front signals at the R channel and L channel with the low frequency band suppressed are guided to the front output terminals 3R and 3L. In addition, the low-frequency monophonic signals passed through the adder 7 and LPF 8 are guided to the rear output terminals 2R and 2L. Thus, the power amplifiers for the sub-woofers drive the sub-woofers. Further, since the low frequency band of the signals supplied to the front speakers is stopped by the HPFs 5R and 5L, the distortion of the outputs from the front speakers can be reduced. Incidentally, in such a setting state, according to the acoustic status within the vehicle, the outputs from the faders 18R and 18L may be directly guided to the front output terminals 3R and 3L through the switches 6R and 6L.

[0026] In the embodiment described above, the power amplifiers for driving the respective speakers may be integrated into a power IC. Where the power IC is connected, the pre-output terminals may be connected to other power amplifiers for the R channel and L channel so as to drive the rear speakers. Further, the pre-output terminals 20R and 20L may be connected to an external circuit having the same configuration as the adder 7 and LPF 8, and connected to other amplifiers for the sub-woofers so as to drive the sub-woofers.

Claims

1. An integrated circuit for processing an audio signal comprising:

   means for processing an input audio signal to create a front output signal, rear output signal

and a sub-woofer output signal which are to be outputted to a front speaker, a rear speaker and a sub-woofer; and

first switch means for selecting said rear output signal or said sub-woofer output signal, an output from said switch means being connected to a common output to said front speaker and said sub-woofer.

2. An integrated circuit for processing an audio signal according to claim 1, further comprising:

a high-pass filter for inhibiting a low frequency band of said front output signal from passing; and

second switch means for selecting an output signal from said high-pass filter or said front output signal, an output from said second switch means being connected to an output for said front speaker.

FIG. 1

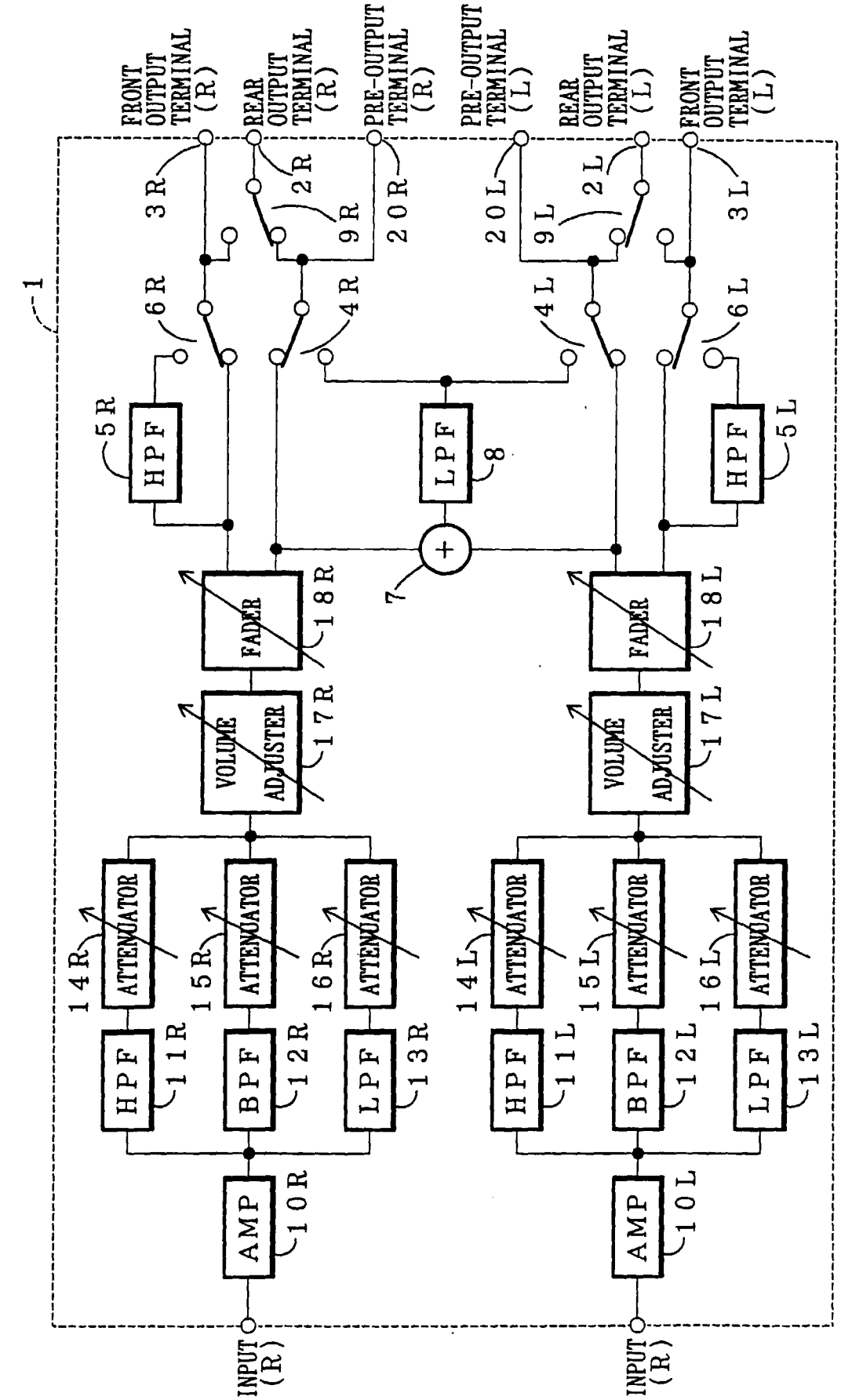
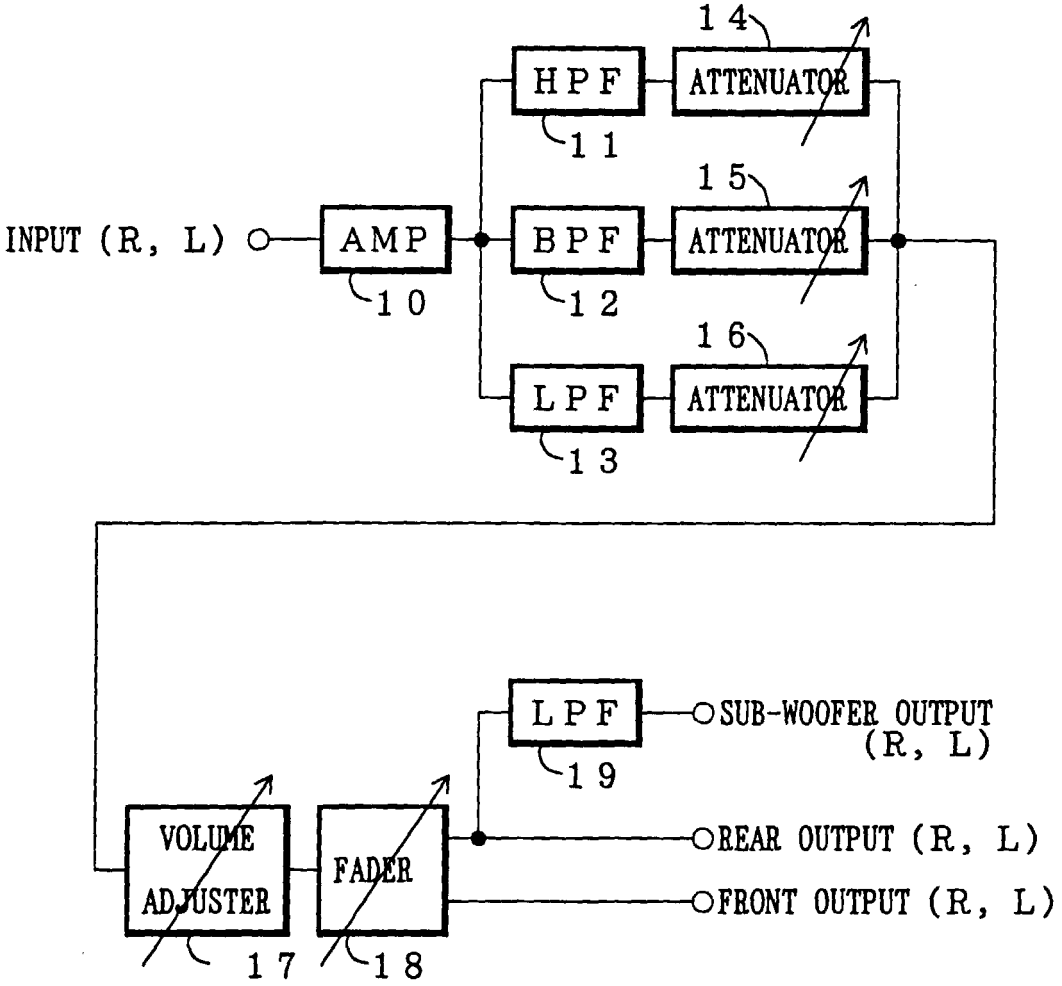

1
FRONT OUTPUT TERMINAL (R)
REAR OUTPUT TERMINAL (R)
PRE-OUTPUT TERMINAL (R)
PRE-OUTPUT TERMINAL (L)
REAR OUTPUT TERMINAL (L)
FRONT OUTPUT TERMINAL (L)
3R
2R
9R
20R
20L
9L
2L
3L
6R
4R
4L
6L
5R
HPF
LPF
8
HPF
5L
7
FADER
18R
FADER
18L
VOLUME ADJUSTER
17R
VOLUME ADJUSTER
17L
14R
ATTENUATOR
15R
ATTENUATOR
16R
ATTENUATOR
14L
ATTENUATOR
15L
ATTENUATOR
16L
ATTENUATOR
HPF
11R
BPF
12R
LPF
13R
HPF
11L
BPF
12L
LPF
13L
AMP
10R
AMP
10L
INPUT (R)
INPUT (R)

FIG. 2


14
HPF
ATTENUATOR
11
15
INPUT (R, L)
AMP
BPF
ATTENUATOR
10
12
16
LPF
ATTENUATOR
13
LPF
SUB-WOOFER OUTPUT
(R, L)
19
VOLUME
ADJUSTER
FADER
REAR OUTPUT (R, L)
FRONT OUTPUT (R, L)
17
18