## Analog Audio Processors
# Sound Processors with Built-in Surround Sound Function

Pb Free
ROHM Electronic Components

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Directive Compliance

## BD3490FV

● General Description

Built in stereo 4 input selectors and volume that there is not an impedance change of a volume terminal. And this is sound processor can realize 2-band equalizer (bass/treble, gain±14dB / 2dB_step) and bass-boost, output-gain, surround by external components.
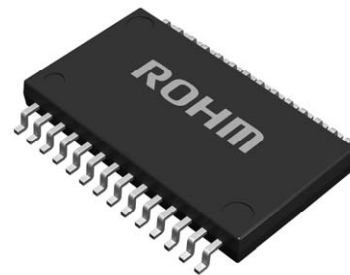
● Features

■ Built in stereo 4 input selectors (single end).
■ Built-in input gain controller for volume of a portable audio input.
■ When the volume setting exchanging, it can use a volume input terminal as a microphone input terminal because there is not an impedance change of a volume input terminal.
■ Bi-CMOS process is suitable for the design of low current and low energy. And it provides more quality for Bi-CMOS small scale regulator and heat in a set.
■ The package of this IC is SSOP-B28. It gathers a sound input terminals, sound output terminals respectively and it arranges them, to be arranging facilitates the laying-out of PCB pattern and reduces PCB area to one-way in the flow of the signal.

● Applications

■ It is the optimal for the mini compo or micro compo. Besides, it is possible to use for the audio equipment of TV, DVD etc with all kinds
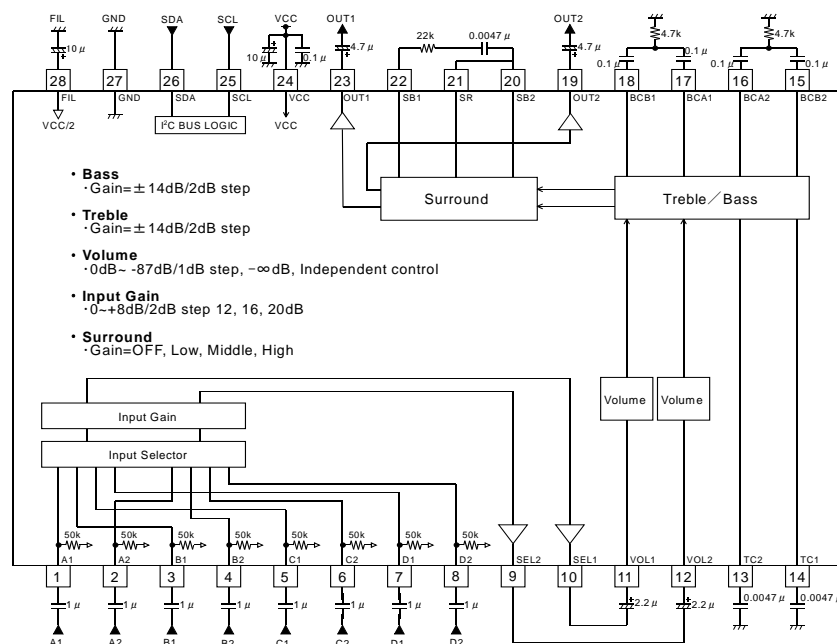
● Key Specifications

| | | |
|---|---|---|
| ■ Current upon no signal: | | 7mA(Typ.) |
| ■ Total harmonic distortion: | | 0.002%(Typ.) |
| ■ Maximum input voltage: | | 2.4Vrms(Typ.) |
| ■ Cross-talk between selectors: | | 100dB(Typ.) |
| ■ Volume Control range: | | 0dB to -87dB |
| ■ Output noise voltage: | | 5 $\mu$ Vrms(Typ.) |
| ■ Residual output noise voltage: | | 5 $\mu$ Vrms(Typ.) |
| ■ Operating Range of Temperature: | | -40℃ to +85℃ |

● package(s)     W(Typ.) x D(Typ.) x H(Max.)
SSOP-B28     10.00mm x 7.60mm x 1.35mm

SSOP-B28

● Typical Application Circuit



Figure 1. Application Circuit Diagram

○Product structure : Silicon monolithic integrated circuit     ○This product is not designed protection against radioactive rays

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●Pin Configuration

SSOP-B28
(TOP VIEW)

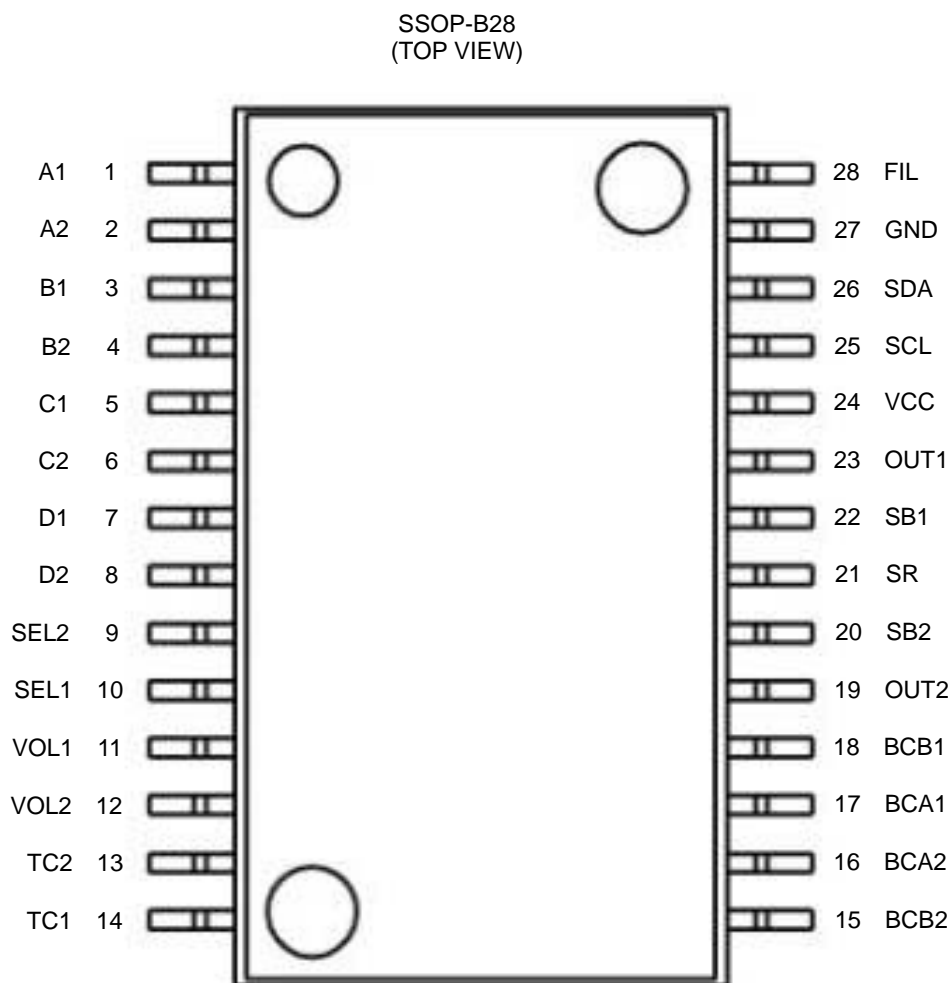| | | | | |
|---|---|---|---|---|
| A1 | 1 | | 28 | FIL |
| A2 | 2 | | 27 | GND |
| B1 | 3 | | 26 | SDA |
| B2 | 4 | | 25 | SCL |
| C1 | 5 | | 24 | VCC |
| C2 | 6 | | 23 | OUT1 |
| D1 | 7 | | 22 | SB1 |
| D2 | 8 | | 21 | SR |
| SEL2 | 9 | | 20 | SB2 |
| SEL1 | 10 | | 19 | OUT2 |
| VOL1 | 11 | | 18 | BCB1 |
| VOL2 | 12 | | 17 | BCA1 |
| TC2 | 13 | | 16 | BCA2 |
| TC1 | 14 | | 15 | BCB2 |

Figure 2. Pin configuration

●Pin Descriptions

| Terminal No. | Terminal Name | Description | Terminal No. | Terminal Name | Description |
|---|---|---|---|---|---|
| 1 | A1 | A input terminal of 1ch | 15 | BCB2 | Bass filter terminal of 2ch |
| 2 | A2 | A input terminal of 2ch | 16 | BCA2 | Bass filter terminal of 2ch |
| 3 | B1 | B input terminal of 1ch | 17 | BCA1 | Bass filter terminal of 1ch |
| 4 | B2 | B input terminal of 2ch | 18 | BCB1 | Bass filter terminal of 1ch |
| 5 | C1 | C input terminal of 1ch | 19 | OUT2 | Output terminal of 2ch |
| 6 | C2 | C input terminal of 2ch | 20 | SB2 | Bass boost terminal of 2ch |
| 7 | D1 | D input terminal of 1ch | 21 | SR | Surround terminal |
| 8 | D2 | D input terminal of 2ch | 22 | SB1 | Bass boost terminal of 1ch |
| 9 | SEL2 | SEL output terminal of 2ch | 23 | OUT1 | Output terminal of 1ch |
| 10 | SEL1 | SEL output terminal of 1ch | 24 | VCC | Power supply terminal |
| 11 | VOL1 | Volume input terminal of 1ch | 25 | SCL | $I^2C$ Communication clock terminal |
| 12 | VOL2 | Volume input terminal of 2ch | 26 | SDA | $I^2C$ Communication data terminal |
| 13 | TC2 | Treble filter terminal of 2ch | 27 | GND | GND terminal |
| 14 | TC1 | Treble filter terminal of 1ch | 28 | FIL | VCC/2 terminal |

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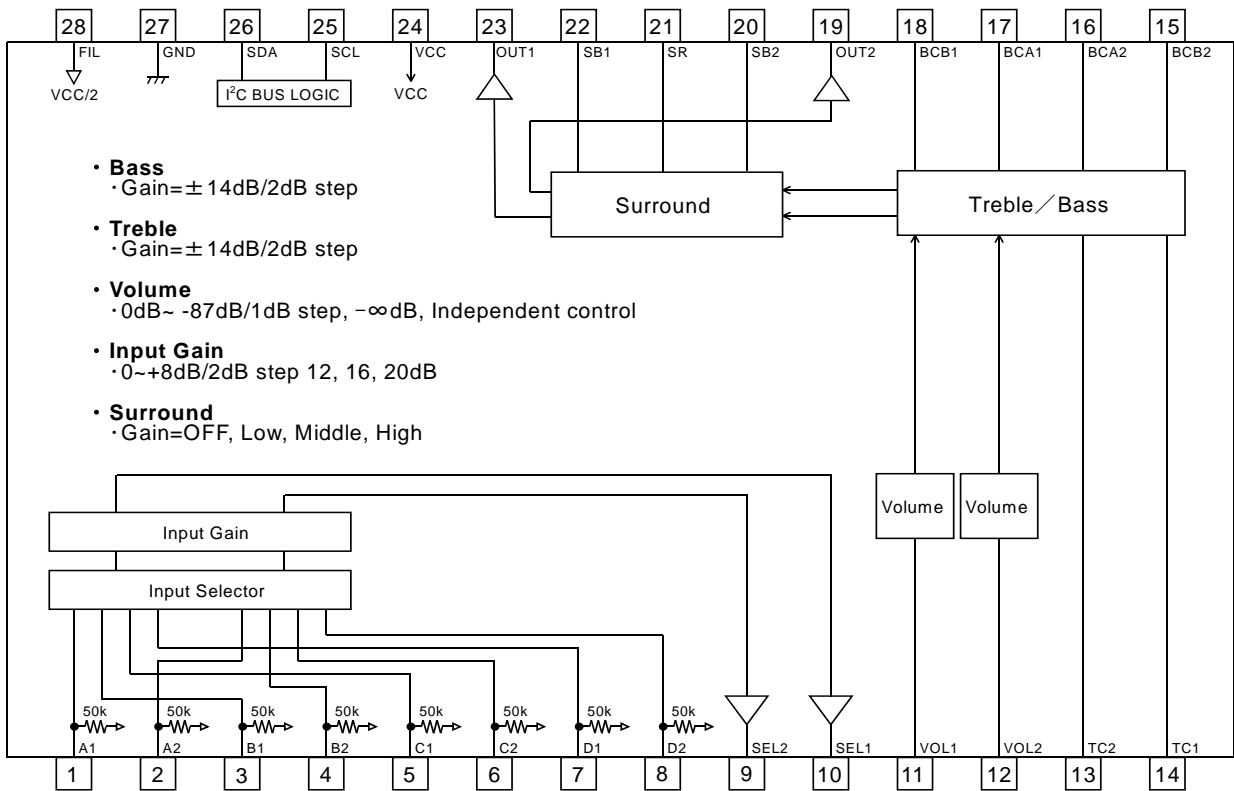
●Block Diagram



Figure 3. Block Diagram

●Absolute Maximum Ratings

| Parameter | Symbol | Limits | Unit |
|---|---|---|---|
| Power supply Voltage | VCC | 10.0 | V |
| Input Voltage | Vin | VCC+0.3 to GND-0.3<br>SCL,SDA only 7 to GND-0.3 | V |
| Power Dissipation | Pd | 1063  ※1 | mW |
| Storage Temperature | Tastg | -55 to +150 | ℃ |

1 This value decreases 8.5mW/℃ for Ta=25℃ or more.
  ROHM standard board shall be mounted.   Thermal resistance θja = 117.6(℃/W)。
  ROHM standard board          Size:70×70×1.6(㎜)
                               Material: A FR4 grass epoxy board (3% or less of copper foil area)

●Operating Range

| Parameter | Symbol | Limits | Unit |
|---|---|---|---|
| Power supply voltage | VCC | 4.75 to 9.5 | V |
| Temperature | Topr | -40 to +85 | ℃ |

●Electrical Characteristic
(Unless specified particularly, Ta=25℃, VCC=9.0V, f=1kHz, Vin=1Vrms, Rg=600Ω, RL=10kΩ, A input, Input gain 0dB,
Volume 0dB, Bass 0dB, Treble 0dB, Surround off)

| BLOCK | Item | Symbol | Limit | | | Unit | Condition |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| GENERAL | Current upon no signal | $I_Q$ | — | 7 | 15 | mA | No signal |
| | Voltage gain | $G_V$ | -1.5 | 0 | 1.5 | dB | Gv=20log(VOUT/VIN) |
| | Channel balance | CB | -1.5 | 0 | 1.5 | dB | CB = GV1-GV2 |
| | Total harmonic distortion | THD+N | — | 0.002 | 0.1 | % | VOUT=1Vrms BW=400-30KHz |
| | Output noise voltage * | $V_{NO1}$ | — | 5 | 20 | μVrms | Rg = 0Ω BW = IHF-A |
| | Residual output noise voltage * | $V_{NO1}$ | — | 5 | 20 | μVrms | Rg = 0Ω BW = IHF-A |
| | Cross-talk between channels * | CTC | — | -100 | -80 | dB | Rg = 0Ω CTC=20log(VOUT/VOUT) BW = IHF-A |
| INPUT SELECTOR | Input impedance | $R_{IN}$ | 35 | 50 | 65 | kΩ | |
| | Maximum input voltage | $V_{IM}$ | 2.1 | 2.4 | - | Vrms | VIM at THD+N(VOUT)=1% BW=400-30KHz |
| | Cross-talk between selectors * | CTS | — | -100 | -84 | dB | Rg = 0Ω CTS=20log(VOUT/VOUT) BW = IHF-A |
| VOLUME | Control range | $G_{V\ MAX}$ | -90 | -87 | -84 | dB | VIN=2Vrms Gv=20log(VOUT/VIN) |
| | Maximum attenuation * | $G_{V\ MIN}$ | — | -100 | -80 | dB | Volume = -∞ Gv=20log(VOUT/VIN) |
| BASS | Maximum boost gain | $G_{B\ BST}$ | 11.5 | 14 | 16.5 | dB | Gain = 14dB, f = 100Hz VIN=100mVrms Gv=20log(VOUT/VIN) |
| | Maximum cut gain | $G_{B\ CUT}$ | -16.5 | -14 | -11.5 | dB | Gain = -14dB, f = 100Hz VIN=2Vrms Gv=20log(VOUT/VIN) |
| TREBLE | Maximum boost gain | $G_{T\ BST}$ | 11.5 | 14 | 16.5 | dB | Gain = 14dB, f = 100Hz VIN=100mVrms Gv=20log(VOUT/VIN) |
| | Maximum cut gain | $G_{T\ CUT}$ | -16.5 | -14 | -11.5 | dB | Gain = -14dB, f = 100Hz VIN=2Vrms Gv=20log(VOUT/VIN) |

VP-9690A(Average value detection, effective value display) filter by Matsushita Communication is used for ＊ measurement.
Phase between input / output is same.
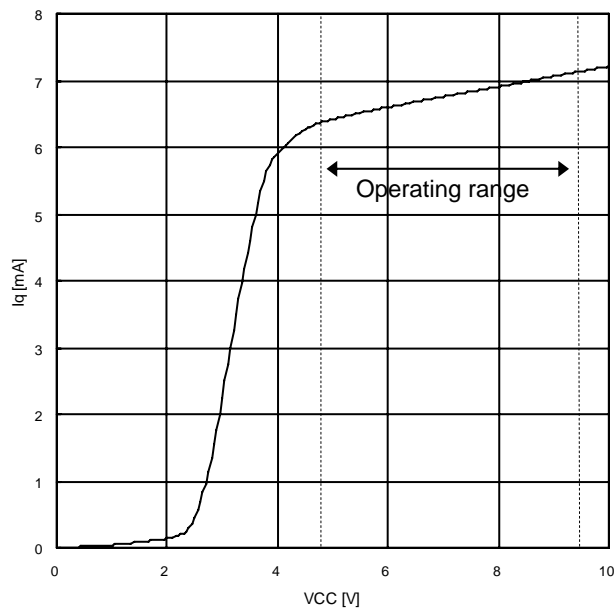
●Typical Performance Curve(s)
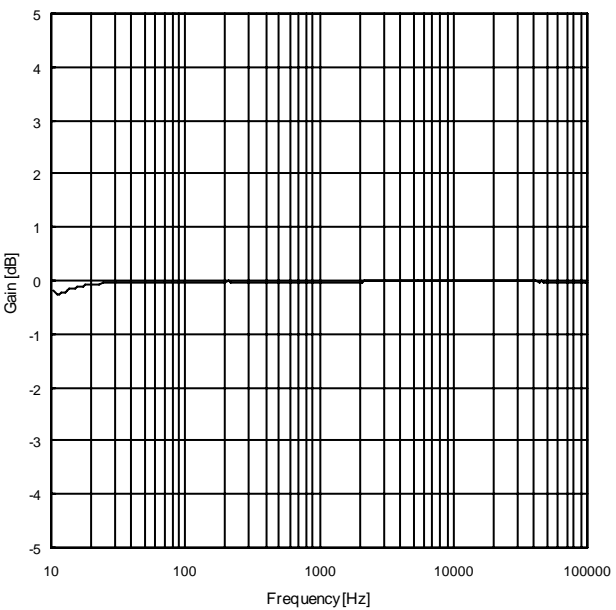


Figure 4. Vcc vs Iq
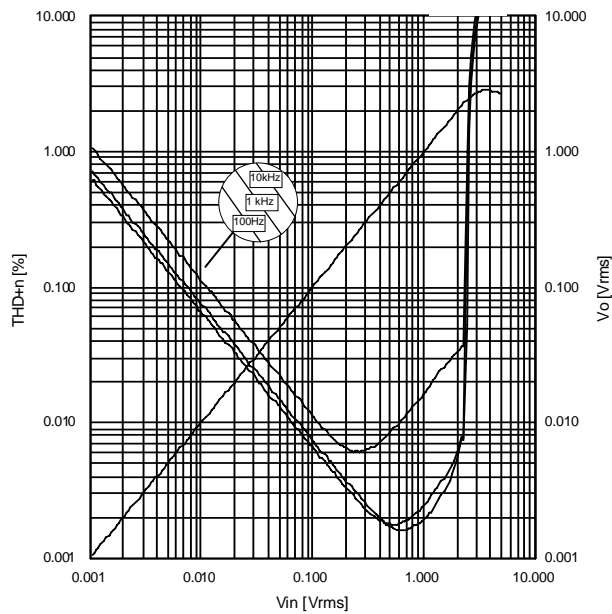


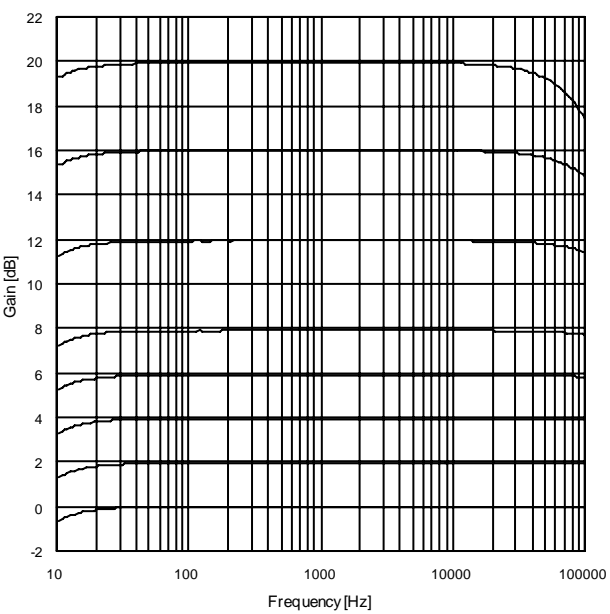Figure 5. Gain vs Freq.



Figure 6. THD+n vs Vo



Figure 7. InputGain vs Freq.

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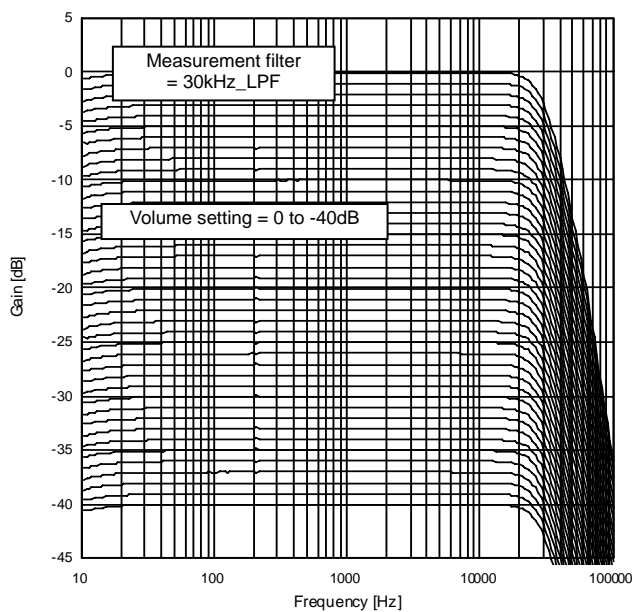**TSZ02201-0V2V0E100030-1-2**
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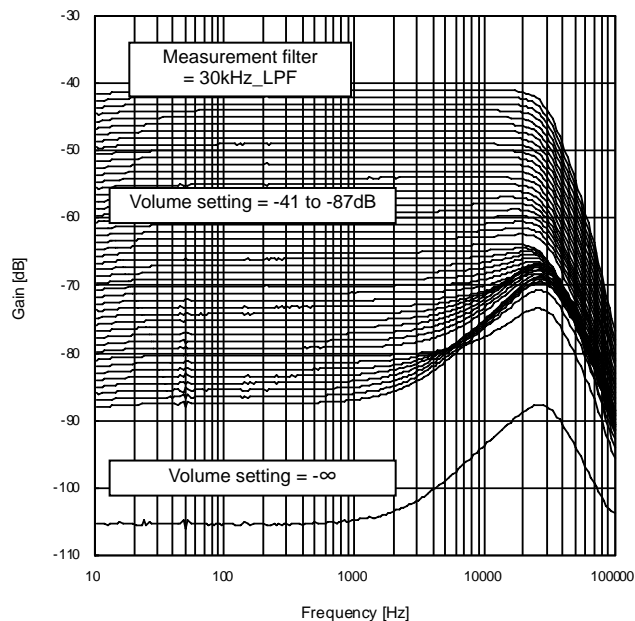Figure 8. Volume attenuation 1


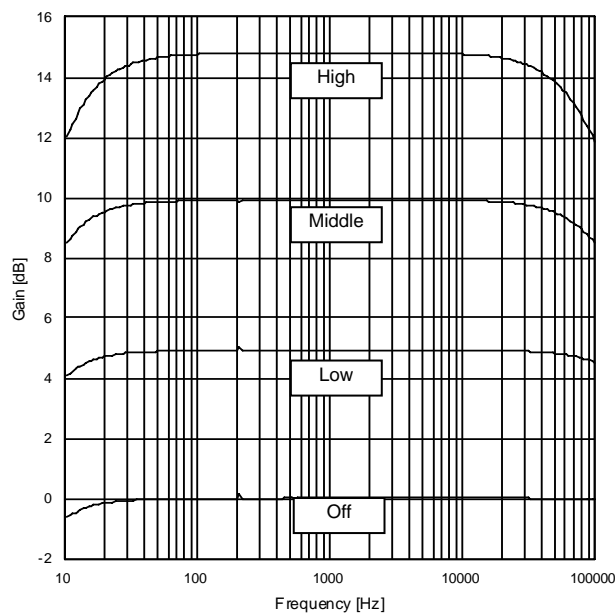
Figure 9. Volume attenuation 2
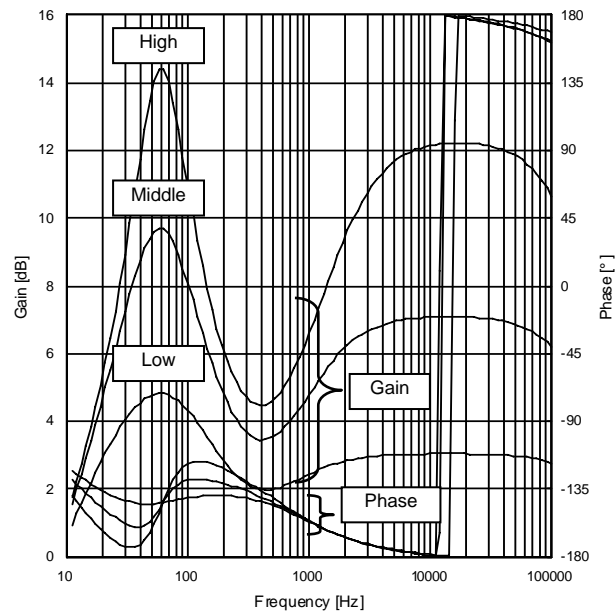


Figure 10. OutputGain vs Freq



Figure 11. BassBoost+Surround

●CONTROL SIGNAL SPECIFICATION

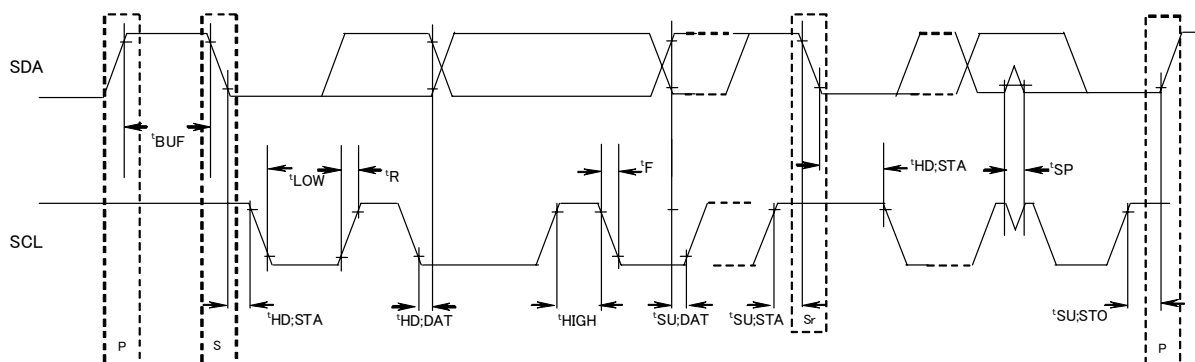(1) Electrical specifications and timing for bus lines and I/O stages



Figure 12. Definition of timing on the I²C-bus

Table 1. Characteristics of the SDA and SCL bus lines for I²C-bus devices

| | Parameter | Symbol | Fast-mode I²C-bus | | Unit |
|---|---|---|---|---|---|
| | | | Min. | Max. | |
| 1 | SCL clock frequency | fSCL | 0 | 400 | kHz |
| 2 | Bus free time between a STOP and START condition | tBUF | 1.3 | — | µS |
| 3 | Hold time (repeated) START condition. After this period, the first clock pulse is generated | tHD;STA | 0.6 | — | µS |
| 4 | LOW period of the SCL clock | tLOW | 1.3 | — | µS |
| 5 | HIGH period of the SCL clock | tHIGH | 0.6 | — | µS |
| 6 | Set-up time for a repeated START condition | tSU;STA | 0.6 | — | µS |
| 7 | Data hold time: | tHD;DAT | 300* | — | µS |
| 8 | Data set-up time | tSU;DAT | 300* | — | ns |
| 9 | Set-up time for STOP condition | tSU;STO | 0.6 | — | µS |

All values referred to VIH min. and VIL max. Levels (see Table 2).

Table 2. Characteristics of the SDA and SCL I/O stages for I²C-bus devices

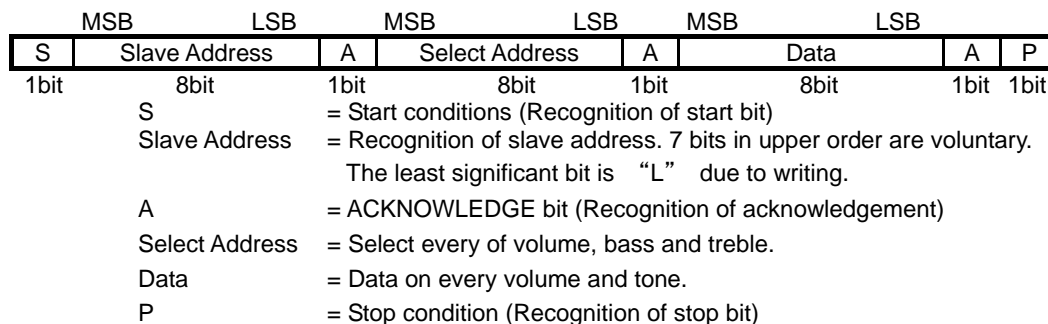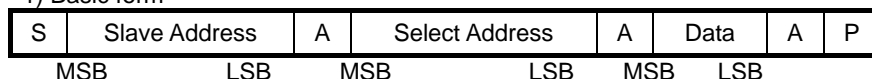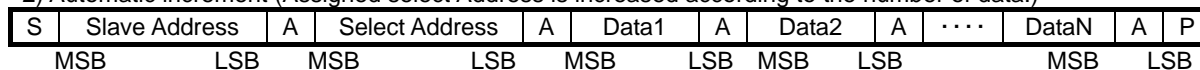| | Parameter | Symbol | Fast-mode devices | | Unit |
|---|---|---|---|---|---|
| | | | Min. | Max. | |
| 10 | LOW level input voltage: fixed input levels | VIL | -0.3 | 1 | V |
| 11 | HIGH level input voltage: fixed input levels | VIH | 2.3 | 5 | V |
| 12 | Pulse width of spikes which must be suppressed by the input filter. | tSP | 0 | 50 | ns |
| 13 | LOW level output voltage (open drain or open collector): at 3mA sink current. | VOL1 | 0 | 0.4 | V |
| 14 | Input current each I/O pin with an input voltage between 0.4V and 0.9 VDDmax. | Ii | -10 | 10 | µA |



SCL clock frequency:250kHz
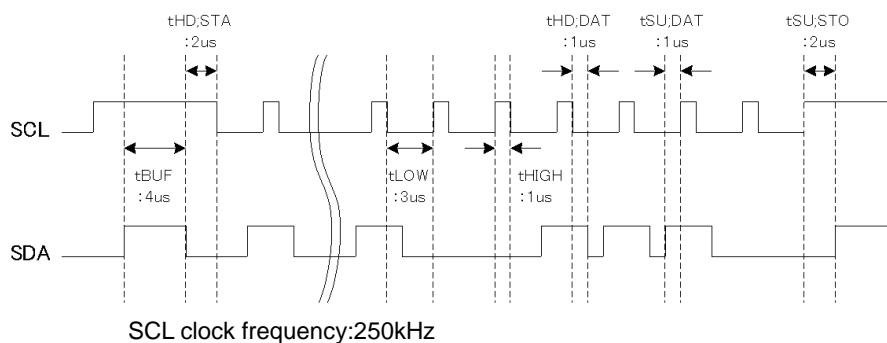
Figure 13. A command timing example in the I2C data transmission

## (2) I²C BUS FORMAT

| | MSB | LSB | | MSB | LSB | | MSB | LSB | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S | Slave Address | | A | Select Address | | A | Data | | A | P |
| 1bit | 8bit | | 1bit | 8bit | | 1bit | 8bit | | 1bit | 1bit |

S = Start conditions (Recognition of start bit)

Slave Address = Recognition of slave address. 7 bits in upper order are voluntary.
The least significant bit is "L" due to writing.

A = ACKNOWLEDGE bit (Recognition of acknowledgement)

Select Address = Select every of volume, bass and treble.

Data = Data on every volume and tone.

P = Stop condition (Recognition of stop bit)

## (3) I²C BUS Interface Protocol

### 1) Basic form

| S | Slave Address | A | Select Address | A | Data | A | P |
|---|---|---|---|---|---|---|---|
| | MSB ... LSB | | MSB ... LSB | | MSB ... LSB | | |

### 2) Automatic increment (Assigned select Address is increased according to the number of data.)

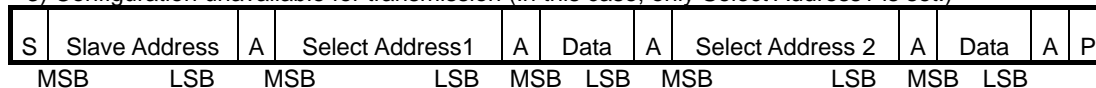| S | Slave Address | A | Select Address | A | Data1 | A | Data2 | A | ···· | DataN | A | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MSB ... LSB | | MSB ... LSB | | MSB ... LSB | | MSB ... LSB | | | MSB ... LSB | | |

(Example) No.1. Data1 shall be set as data of address specified by Select Address.
No.2. Data2 shall be set as data of next one of address specified by the No.1.
No.3. DataN shall be set as data of N times incremented one of address specified by the No.1.

### 3) Configuration unavailable for transmission (In this case, only Select Address1 is set.)

| S | Slave Address | A | Select Address1 | A | Data | A | Select Address 2 | A | Data | A | P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MSB ... LSB | | MSB ... LSB | | MSB LSB | | MSB ... LSB | | MSB LSB | | |

（Note）If any data is transmitted as Select Address 2 next to data,
it is recognized as data, not as Select Address 2.

## (4) Slave address

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| A6 | A5 | A4 | A3 | A2 | A1 | A0 | R/W |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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(5) Select Address & Data

| Items to be set | Select Address (hex) | MSB D7 | D6 | D5 | D4 | D3 | D2 | D1 | LSB D0 |
|---|---|---|---|---|---|---|---|---|---|
| Input Selector | 04 | 0 | 0 | 0 | 0 | 0 | Input Selector | | |
| Input gain | 06 | 0 | 0 | 0 | Input Gain | | | | 0 |
| Volume gain 1ch | 21 | 1 | Volume Attenuation 1ch | | | | | | |
| Volume gain 2ch | 22 | 1 | Volume Attenuation 2ch | | | | | | |
| Bass gain | 51 | Bass Boost/Cut | 0 | 0 | 0 | Bass Gain | | | 0 |
| Treble gain | 57 | Treble Boost/Cut | 0 | 0 | 0 | Treble Gain | | | 0 |
| Gain | 78 | Surround Mode | 0 | 0 | 0 | Surround gain | | | |
| Test Mode | F0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| System Reset | FE | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Notes of data format

Upon continuous data transfer, the Select Address is circulated by the automatic increment function as shown below

04→06→21→22→51→57→78
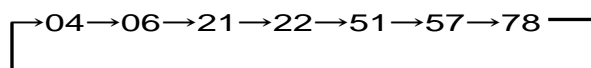
Select address 04 (hex)

| Mode | MSB | | Input Selector | | | | | LSB |
|---|---|---|---|---|---|---|---|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | | | | | | 0 | 0 | 1 |
| C | | | | | | 0 | 1 | 0 |
| D | | | | | | 0 | 1 | 1 |
| INPUT SHORT | | | | | | 1 | 0 | 1 |
| INPUT MUTE | | | | | | 1 | 1 | 1 |
| Prohibition | | | | | | 1 | 0 | 0 |
| | | | | | | 1 | 1 | 0 |

INPUT MUTE : Mute is done at the input signal in the part of Input Selector.

Select address 06 (hex)

| Gain | MSB | | Input Gain | | | | | LSB |
|---|---|---|---|---|---|---|---|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 0dB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2dB | | | | 0 | 0 | 0 | 1 | |
| 4dB | | | | 0 | 0 | 1 | 0 | |
| 6dB | | | | 0 | 0 | 1 | 1 | |
| 8dB | | | | 0 | 1 | 0 | 0 | |
| 12dB | | | | 0 | 1 | 1 | 0 | |
| 16dB | | | | 1 | 0 | 0 | 0 | |
| 20dB | | | | 1 | 0 | 1 | 0 | |
| Prohibition | | | | 0 | 1 | 0 | 1 | 0 |
| | | | | 0 | 1 | 1 | 1 | |
| | | | | 1 | 0 | 0 | 1 | |
| | | | | 1 | 0 | 1 | 1 | |
| | | | | 1 | 1 | 0 | 0 | |
| | | | | 1 | 1 | 0 | 1 | |
| | | | | 1 | 1 | 1 | 0 | |
| | | | | 1 | 1 | 1 | 1 | |

▭ : Initial condition

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Select address 21, 22 (hex)

| ATT | MSB | Volume Attenuation | | | | | | LSB |
|---|---|---|---|---|---|---|---|---|
|  | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 0dB |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1dB |  | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| -2dB |  | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| -3dB |  | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| -4dB |  | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| -5dB |  | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| -6dB |  | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| -7dB |  | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| -8dB |  | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| -9dB |  | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| -10dB |  | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| -11dB |  | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| -12dB |  | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| -13dB |  | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| -14dB |  | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| -15dB |  | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| -16dB | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| -17dB |  | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| -18dB |  | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| -19dB |  | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| -20dB |  | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| -21dB |  | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| -22dB |  | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| . . . |  | . . . | . . . | . . . | . . . | . . . | . . . | . . . |
| -83dB |  | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| -84dB |  | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| -85dB |  | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| -86dB |  | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| -87dB |  | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| Prohibition |  | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
|  |  | . . . | . . . | . . . | . . . | . . . | . . . | . . . |
|  |  | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| -∞dB |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

: Initial condition

Select address 51(hex)

| Gain | MSB | | Bass Gain | | | | | LSB |
|------|-----|-----|-----|-----|-----|-----|-----|-----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 0dB | | | | | 0 | 0 | 0 | |
| 2dB | | | | | 0 | 0 | 1 | |
| 4dB | | | | | 0 | 1 | 0 | |
| 6dB | Bass | | | | 0 | 1 | 1 | |
| 8dB | Boost /Cut | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 10dB | | | | | 1 | 0 | 1 | |
| 12dB | | | | | 1 | 1 | 0 | |
| 14dB | | | | | 1 | 1 | 1 | |

| Mode | MSB | | Bass Boost/Cut | | | | | LSB |
|------|-----|-----|-----|-----|-----|-----|-----|-----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| Boost | 0 | 0 | 0 | 0 | Bass gain | | | 0 |
| Cut | 1 | | | | | | | |

Select address 57(hex)

| Gain | MSB | | Treble Gain | | | | | LSB |
|------|-----|-----|-----|-----|-----|-----|-----|-----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 0dB | | | | | 0 | 0 | 0 | |
| 2dB | | | | | 0 | 0 | 1 | |
| 4dB | | | | | 0 | 1 | 0 | |
| 6dB | Treble | | | | 0 | 1 | 1 | |
| 8dB | Boost /Cut | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 10dB | | | | | 1 | 0 | 1 | |
| 12dB | | | | | 1 | 1 | 0 | |
| 14dB | | | | | 1 | 1 | 1 | |

| Mode | MSB | | Treble Boost Cut | | | | | LSB |
|------|-----|-----|-----|-----|-----|-----|-----|-----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| Boost | 0 | 0 | 0 | 0 | Treble gain | | | 0 |
| Cut | 1 | | | | | | | |

⬜ : Initial condition

Select address 78(hex)

| Gain | MSB | | Surround Gain | | | | | LSB |
|---|---|---|---|---|---|---|---|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| OFF | Surround SW | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Low | | | | | 0 | 1 | 0 | 1 |
| Middle | | | | | 1 | 0 | 1 | 0 |
| High | | | | | 1 | 1 | 1 | 1 |
| Prohibition | | | | | 0 | 0 | 0 | 1 |
| | | | | | 0 | 0 | 1 | 0 |
| | | | | | 0 | 0 | 1 | 1 |
| | | | | | 0 | 1 | 0 | 0 |
| | | | | | 0 | 1 | 1 | 0 |
| | | | | | 0 | 1 | 1 | 1 |
| | | | | | 1 | 0 | 0 | 0 |
| | | | | | 1 | 0 | 0 | 1 |
| | | | | | 1 | 0 | 1 | 1 |
| | | | | | 1 | 1 | 0 | 0 |
| | | | | | 1 | 1 | 0 | 1 |
| | | | | | 1 | 1 | 1 | 0 |

| Mode | MSB | | Surround SW | | | | | LSB |
|---|---|---|---|---|---|---|---|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| (A)=ON, (B)=OFF | 0 | 0 | 0 | 0 | Surround Gain | | | |
| (A)=OFF, (B)=ON | 1 | | | | | | | |

▨ : Initial condition

(6) About power on reset

At on of supply voltage circuit made initialization inside IC is built-in. Please send data to all address as initial data at supply voltage on. And please supply mute at set side until this initial data is sent.

| Item | Symbol | Limit | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Rise time of VCC | Trise | 20 | — | — | usec | VCC rise time from 0V to 3V |
| VCC voltage of release power on reset | Vpor | — | 3.0 | — | V | |

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●Volume attenuation of the details

| ATT(dB) | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| -2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| -3 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| -4 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| -5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| -6 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| -7 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| -8 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| -9 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| -10 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| -11 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| -12 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| -13 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| -14 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| -15 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| -16 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| -17 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| -18 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| -19 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| -20 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| -21 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| -22 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| -23 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| -24 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| -25 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| -26 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| -27 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| -28 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| -29 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| -30 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| -31 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| -32 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| -33 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -34 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| -35 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| -36 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| -37 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| -38 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| -39 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| -40 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| -41 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| -42 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| -43 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| -44 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| -45 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |

| ATT(dB) | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|
| -46 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| -47 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| -48 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| -49 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| -50 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| -51 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| -52 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| -53 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| -54 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| -55 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| -56 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| -57 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| -58 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| -59 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| -60 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| -61 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| -62 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| -63 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| -64 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| -65 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| -66 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| -67 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| -68 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| -69 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| -70 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| -71 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| -72 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| -73 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| -74 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| -75 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| -76 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| -77 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| -78 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| -79 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| -80 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| -81 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| -82 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| -83 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| -84 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| -85 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| -86 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| -87 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| Prohibition | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| -∞ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

: Initial condition

● Application Circuit Diagram
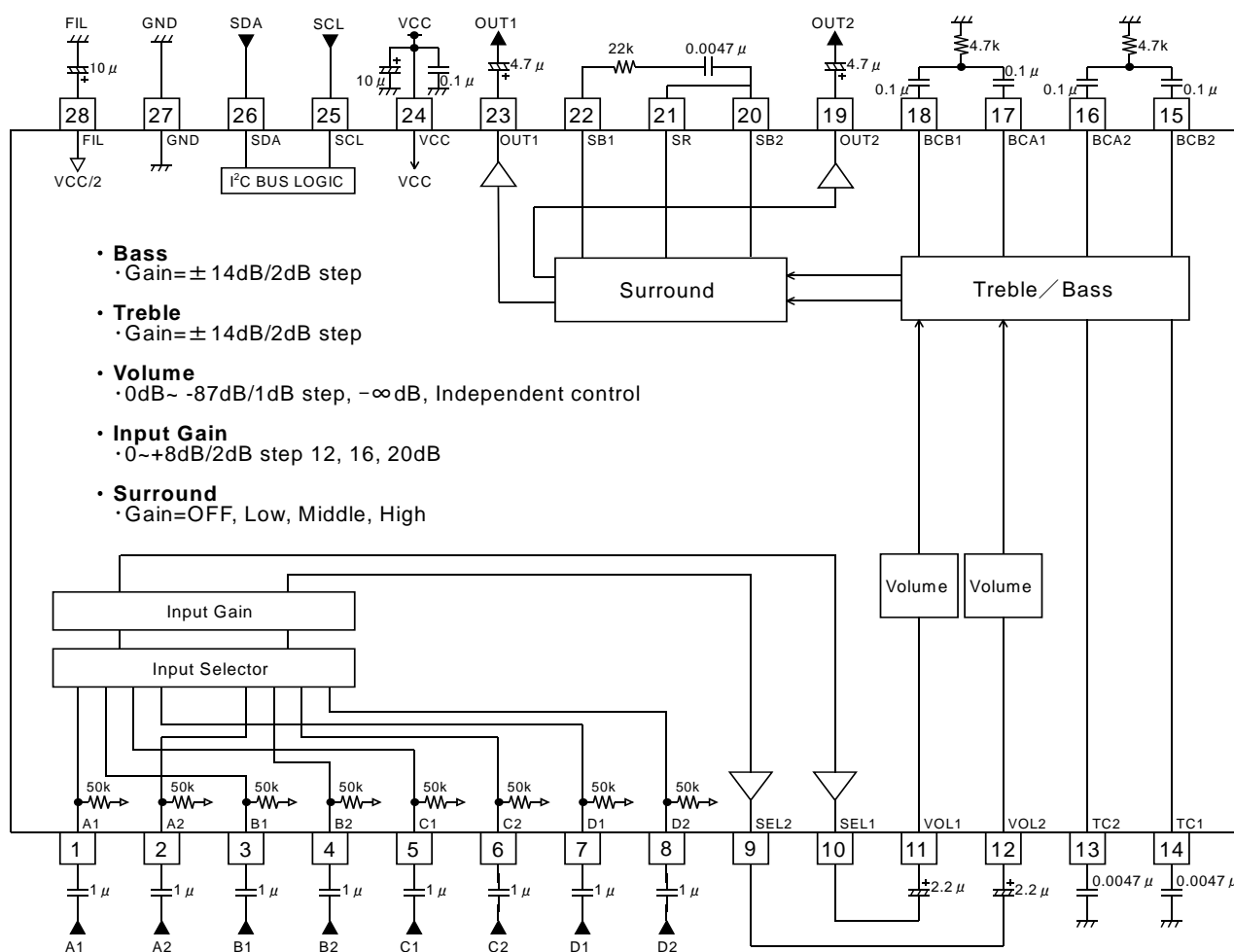


Figure 14. Application Circuit Diagram

UNIT
RESISTANCE: Ω
CAPACITANCE: F

**Notes on wiring**
① Please connect the decoupling capacitor of a power supply in the shortest distance as much as possible to GND.
② Lines of GND shall be one-point connected.
③ Wiring pattern of Digital shall be away from that of analog unit and cross-talk shall not be acceptable.
④ Lines of SCL and SDA of I²C BUS shall not be parallel if possible.
  The lines shall be shielded, if they are adjacent to each other.
⑤ Lines of analog input shall not be parallel if possible. The lines shall be shielded, if they are adjacent to each other.

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●**Thermal Derating Curve**

About the thermal design by the IC
Characteristics of an IC have a great deal to do with the temperature at which it is used, and exceeding absolute maximum ratings may degrade and destroy elements. Careful consideration must be given to the heat of the IC from the two standpoints of immediate damage and long-term reliability of operation.
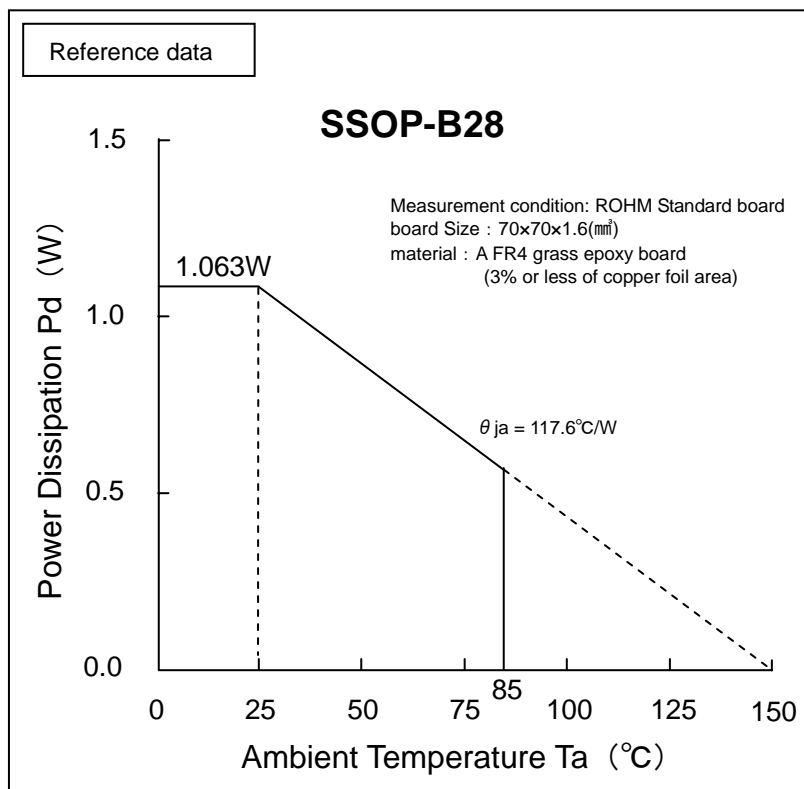


Fig.15 Temperature Derating Curve
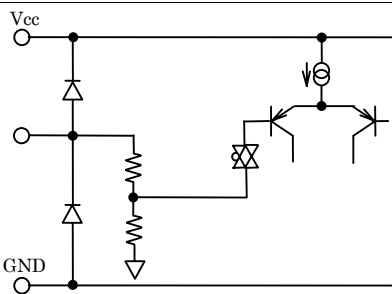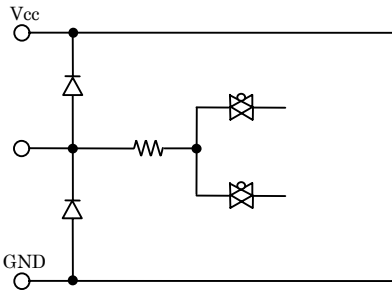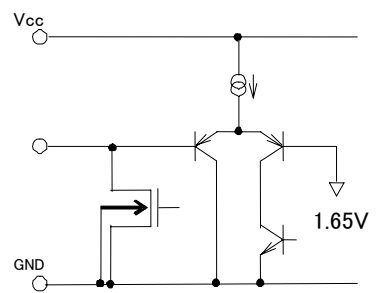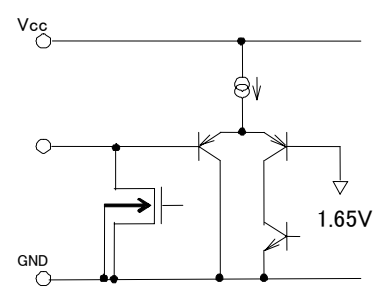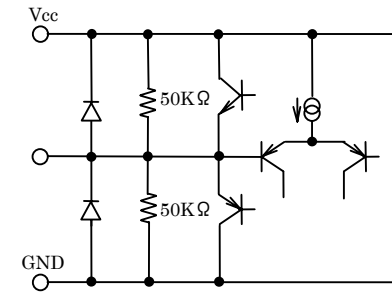
Note) Values are actual measurements and are not guaranteed.

Power dissipation values vary according to the board on which the IC is mounted.

●Terminal Equivalent Circuit and Description

| Terminal No. | Terminal name | Terminal voltage | Equivalent Circuit | Terminal Description |
|---|---|---|---|---|
| 1<br>2<br>3<br>4<br>5<br>6<br>7<br>8 | A1<br>A2<br>B1<br>B2<br>C1<br>C2<br>D1<br>D2 | 4.5 | Vcc ... 50KΩ ... GND | A terminal for stereo signal input.<br>Input impedance = 50kΩ(typ). |
| 9<br>10<br>19<br>23 | SEL2<br>SEL1<br>OUT2<br>OUT1 | 4.5 | Vcc ... GND | A terminal for output. |
| 11<br>12 | VOL1<br>VOL2 | 4.5 | Vcc ... Total 50KΩ ... GND | A terminal for volume input.<br>Input impedance = 50kΩ(typ). |
| 13<br>14<br>15<br>18 | TC2<br>TC1<br>BCB2<br>BCB1 | 4.5 | Vcc ... GND | TC1,TC2 : A terminal for treble filter.<br>About resistance, please reference P21, Figure 20 and Table 4.<br><br>BCB1,BCB2 : A terminal for bass filter.<br>About resistance, please reference P20, Figure 18 and Table 3. |
| 16<br>17 | BCA2<br>BCA1 | 4.5 | Vcc ... GND | A terminal for bass filter. |
| 24 | VCC | 8.5 | | Power supply terminal. |

The figure in the pin explanation, terminal voltage and input/output equivalent circuit is reference value, it doesn't guarantee the value.

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| Terminal No. | Terminal name | Terminal voltage | Equivalent Circuit | Terminal Description |
|---|---|---|---|---|
| 20<br><br>22 | SB2<br><br>SB1 | 4.5 |  | A terminal for Bass boost.<br>About resistance, please reference P22, Figure 22 and Table 5. |
| 21 | SR | 4.5 |  | A terminal for surround.<br>About resistance, please reference P22, Figure 22 and Table 5. |
| 25 | SCL | — |  | A terminal for clock input of I$^2$C BUS communication. |
| 26 | SDA | — |  | A terminal for data input of I$^2$C BUS communication. |
| 27 | GND | 0 |  | Analog ground terminal. |
| 28 | FIL | 4.5 |  | 1/2 VCC terminal.<br>Voltage for reference bias of analog signal system.<br>The simple precharge circuit and simple discharge circuit for an external capacitor are built in. |

The figure in the pin explanation, terminal voltage and input/output equivalent circuit is reference value, it doesn't guarantee the value.

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●Cautions on use

1. Absolute Maximum Ratings: Impressed Voltage
 When it impressed the voltage on VCC more than the absolute maximum rating voltage, circuit currents increase rapidly, and there is absolutely a case to reach characteristic deterioration and destruction of a device. In particular in a serge examination of a set, when it is expected the impressing serge at VCC terminal (24pin), please do not impress the large and over the absolute maximum rating voltage (including a operating voltage + serge ingredient (around 14V)).

2. About input signal
 1) About constant set up of input coupling capacitor
 In the signal input terminal, the constant setting of input coupling capacitor C(F) be sufficient input impedance $R_{IN}(\Omega)$ inside IC and please decide. The first HPF characteristic of RC is composed.

$$A(f) = \sqrt{\frac{(2\pi fCR_{IN})^2}{1 + (2\pi fCR_{IN})^2}}$$
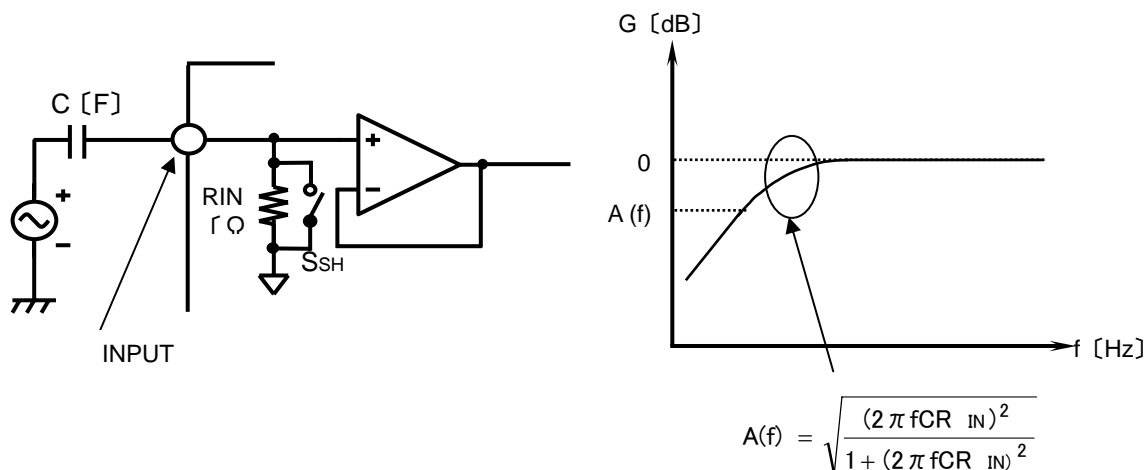
Figure 16. Input short circuit

 2) About the input selector SHORT
 SHORT mode is the command which makes switch $S_{SH}$ =ON an input selector part and input impedance RIN of all terminals, and makes resistance small. Switch $S_{SH}$ is OFF when not choosing a SHORT command.
 A constant time becomes small at the time of this command twisting to the resistance inside the capacitor connected outside and LSI. The charge time of a capacitor becomes short.
 Since SHORT mode turns ON the switch of $S_{SH}$ and makes it low impedance, please use it at the time of a non-signal.

3.About output load characteristics
 The usages of load for output are below (reference). Please use the load more than 10[kΩ](TYP)

| Terminal No. | Terminal name | Terminal No. | Terminal name |
|---|---|---|---|
| 9 | SEL2 | 19 | OUT2 |
| 10 | SEL1 | 23 | OUT1 |

VCC=9.0V
THD+n=1%
BW=400～30kHz
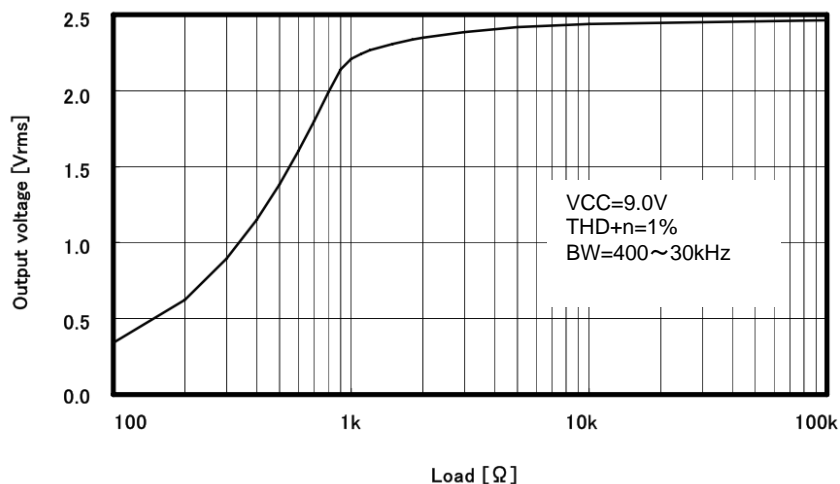
Figure 17. Output load characteristic. Reference Vcc=9.0V

4.About the voice input terminal

When a terminal is made open, the inside resistance of the terminal is 50kΩ. Therefore, it sometimes causes a trouble by the plunge noise from the outside. When there is a voice input terminal which isn't used, please connect it to GND by using the capacitor, or, set up input selector by the microcomputer so that the input terminal which isn't used may not be chosen.

5. Constant set up of bass filter
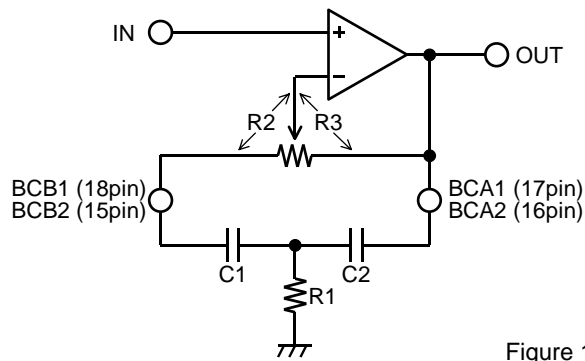
**Bass Boost**                                                              **Bass Cut**
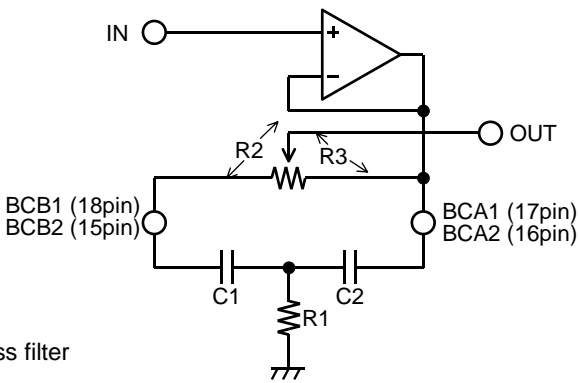
Figure 18. Bass filter

$$fo = \frac{1}{2\pi\sqrt{R1(R2+R3)\cdot C1\cdot C2}} [Hz]$$

$$Q = \frac{\sqrt{R1(R2+R3)\cdot C1\cdot C2}}{R1(C1+C2)+R2C1}$$

$$BOOST\ GAIN = 20\log\frac{\dfrac{R2+R3}{R1}+\dfrac{C2}{C1}+1}{\dfrac{R2}{R1}+\dfrac{C2}{C1}+1}[dB]$$

$$CUT\ GAIN = 20\log\frac{\dfrac{R2}{R1}+\dfrac{C2}{C1}+1}{\dfrac{R2+R3}{R1}+\dfrac{C2}{C1}+1}[dB]$$
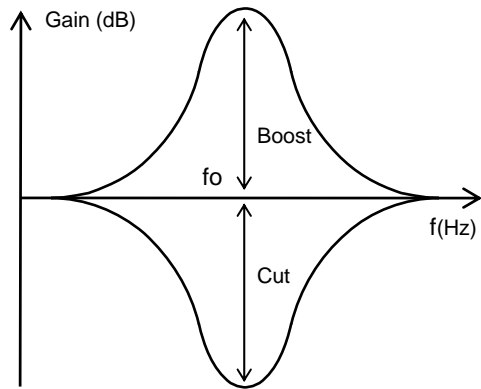
Figure 19. Bass frequency characteristics

Table 3.
Standard value of R3, R4(reference)

| Bass Boost/Cut gain | Resistance(kΩ) ※TYP. | |
|---|---|---|
| | R2 | R3 |
| ±0dB | 53.5 | 0 |
| ±2dB | 40.9 | 12.6 |
| ±4dB | 30.5 | 23.0 |
| ±6dB | 22.3 | 31.2 |
| ±8dB | 15.8 | 37.7 |
| ±10dB | 10.6 | 42.9 |
| ±12dB | 6.5 | 47.0 |
| ±14dB | 3.2 | 50.3 |

Actual boost/cut amount may be dispositioned somewhat.

6. Constant set up of treble filter

**Treble Boost**
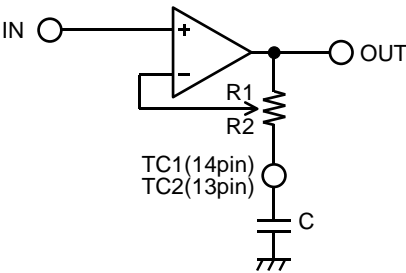
**Treble Cut**
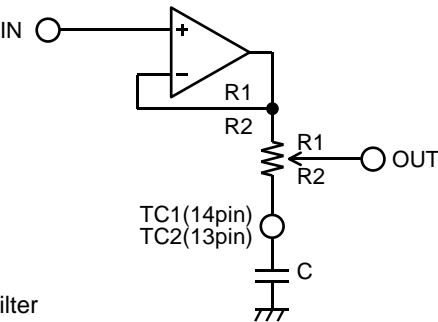
Figure 20. Treble filter

$$fc = \frac{1}{2\pi R2C}[Hz]$$

$$BOOST\ GAIN = 20\log\frac{R1 + R2 + ZC}{R2 + ZC}[dB]$$

$$CUT\ GAIN = 20\log\frac{R2 + ZC}{R1 + R2 + ZC}[dB]$$
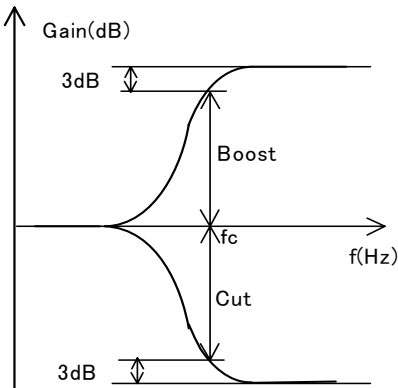
Figure 21. Treble frequency characteristics

Table 4.
Standard value of R1, R2(reference)

| Treble<br><br>Boost/Cut gain | Resistance(kΩ)<br>※TYP. | |
|---|---|---|
| | R1 | R2 |
| ±0dB | 0 | 29.1 |
| ±2dB | 6.1 | 23.0 |
| ±4dB | 10.9 | 18.2 |
| ±6dB | 14.8 | 14.3 |
| ±8dB | 17.9 | 11.2 |
| ±10dB | 20.5 | 8.6 |
| ±12dB | 22.6 | 6.5 |
| ±14dB | 24.4 | 4.7 |

Actual boost/cut amount may be
dispositioned somewhat.

7.The use example of Bass Boost

7-1.The application circuit example of Bass Boost



Figure 22. The application circuit example of Bass Boost
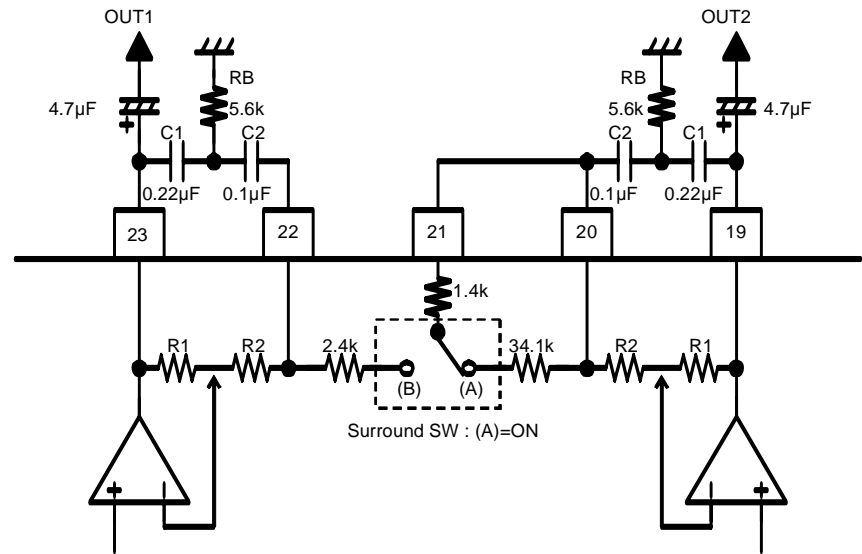
Table 5.
Standard value of R1, R2 (reference)

| Surround Gain | R1[kΩ] | R2[kΩ] |
|---|---|---|
| OFF | 0 | 84.5 |
| Low | 44.8 | 39.7 |
| Middle | 70.0 | 14.5 |
| High | 84.2 | 0.3 |

7-2. The computation formula and the representative characteristic of Bass Boost Gain
(fo=50Hz, Q=1.8(Surround Gain=High))

$$Gain = 20\log \frac{\dfrac{R1+R2}{RB}+\dfrac{C1}{C2}+1}{\dfrac{R2}{RB}+\dfrac{C1}{C2}+1}\,[dB]$$

$$fo = \frac{1}{2\pi\sqrt{RB(R1+R2)\cdot C1\cdot C2}}\,[Hz]$$

$$Q = \frac{\sqrt{RB(R1+R2)\cdot C1\cdot C2}}{RB(C1+C2)+R2\cdot C2}$$
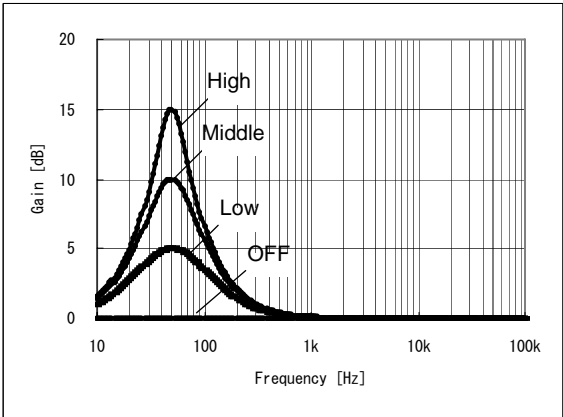


Figure 23. The representative characteristic
of Bass Boost

7-3. The representative characteristic in fixed number change

Table 6. The fixed number example [*1]

| No. | The specification | C1 [μF] | C2 [μF] | RB [kΩ] |
|---|---|---|---|---|
| ① | fo=60Hz,Q=1.8,Gain=16.8dB | 0.15 | 0.1 | 5.6 |
| ② | fo=72Hz,Q=1.7,Gain=15.0dB | 0.15 | 0.068 | 5.6 |
| ③ | fo=79Hz,Q=1.9,Gain=16.2dB | 0.15 | 0.068 | 4.7 |
| ④ | fo=89Hz,Q=1.8,Gain=16.9dB | 0.1 | 0.068 | 5.6 |

[*1]: Surround Gain=High
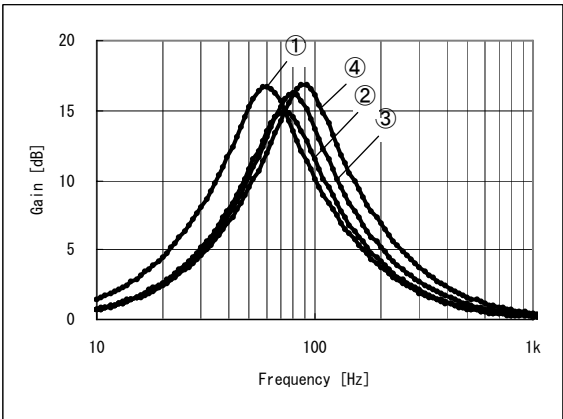


Figure 24. The representative characteristic
in fixed number change of Bass Boost

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8.The use example of Bass Boost & Surround

8-1. The application circuit example of Bass Boost & Surround
In this application circuit example, it isn't possible to do the use only of Surround. Also, Surround Gain depends on the setting value of Bass Boost Gain.
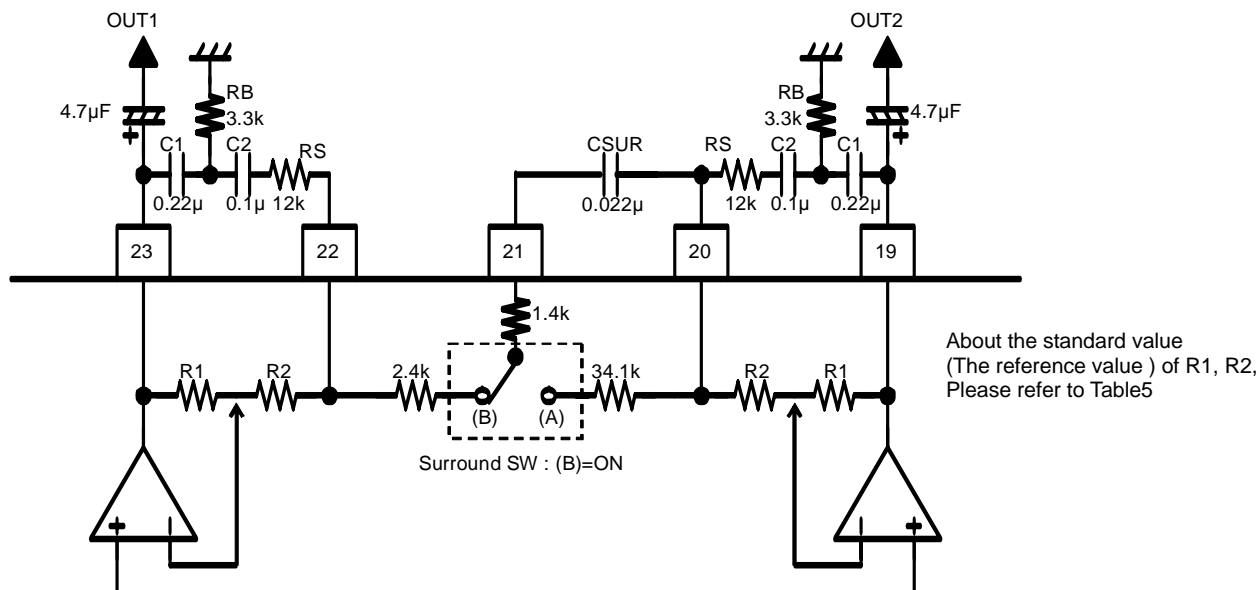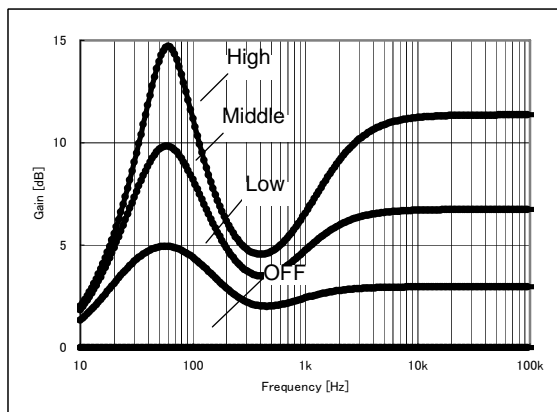


Figure 25. The application circuit example of Bass Boost & Surround

8-2. The computation formula and the representative characteristic Bass Boost Gain (Surround SW : (A)=ON)

$$\text{Gain} = 20\log \frac{\dfrac{R1+R2+RS}{RB} + \dfrac{C1}{C2} + 1}{\dfrac{R2+RS}{RB} + \dfrac{C1}{C2} + 1} [dB]$$

$$fo = \frac{1}{2\pi\sqrt{RB(R1+R2+RS)\cdot C1\cdot C2}} [Hz]$$

$$Q = \frac{\sqrt{RB(R1+R2+RS)\cdot C1\cdot C2}}{RB(C1+C2)+C2(R2+RS)}$$
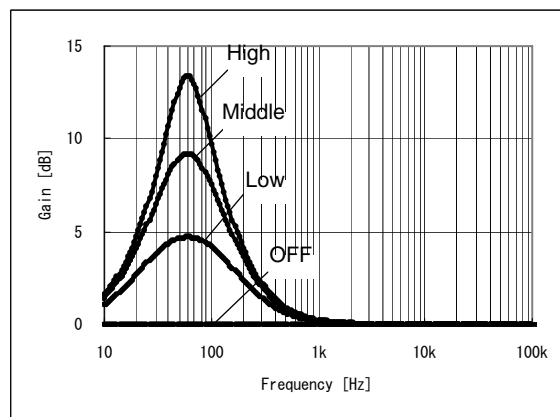


Figure 26. Bass Boost (Surround SW : (A)=ON)の代表特性

8-3. The representative characteristic of Surround Gain (Surround SW : (B)=ON)
In this application circuit example, it isn't possible to do the use only of Surround. Also, Surround Gain depends on the setting value of Bass Boost Gain.



Figure 27. The representative characteristic of Surround Gain (Surround SW : (B)=ON)

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**2012.10.05 Rev.001**

9.The use example easy Surround

9. The application circuit example of easy Surround

About the standard value
(The reference value ) of R1, R2,
Please refer to Table5
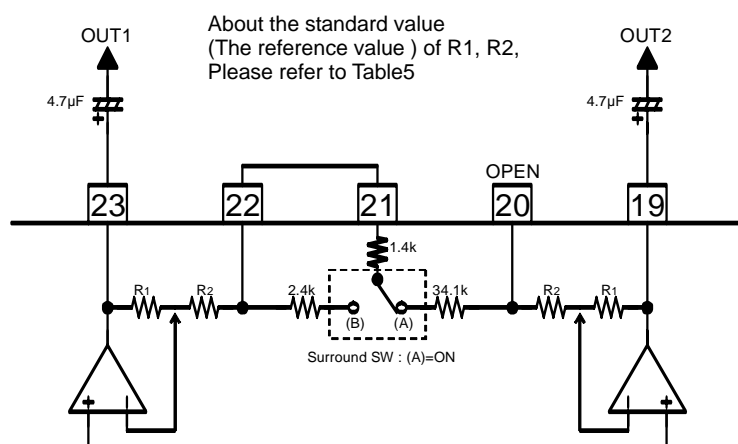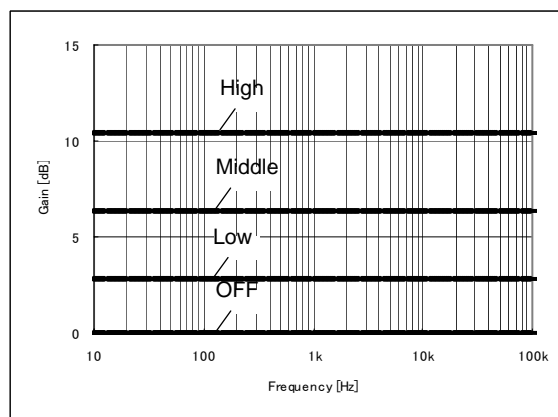
Figure 28. The application circuit example
of easy Surround

Figure 29. The representative characteristic
Of easy Surround

10.The use example Surround
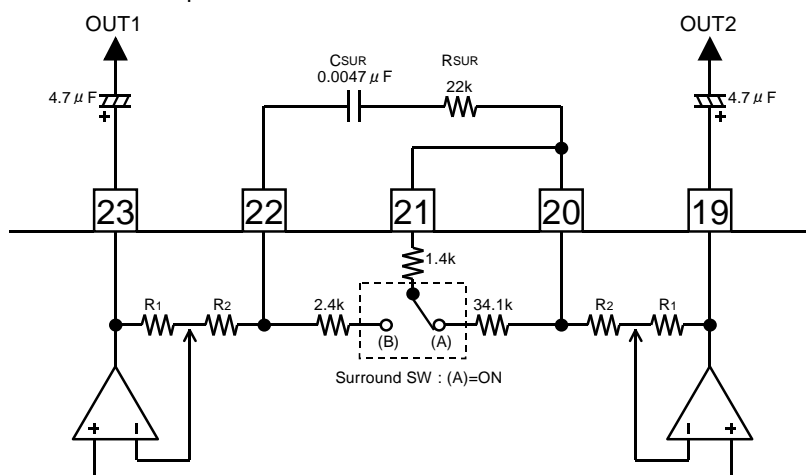
10-1. The application circuit example of Surround

About the standard value
(The reference value ) of R1, R2,
Please refer to Table5

Figure 30. The application circuit example of Surround

10-2. The representative characteristic
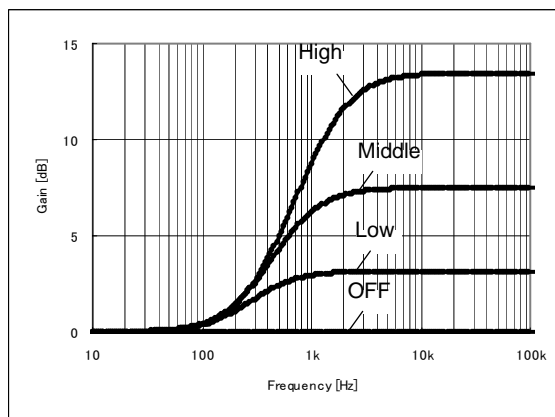
Figure 31. The representative characteristic of Surround

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11.The use example Output Gain

11-1. The application circuit example of Output Gain
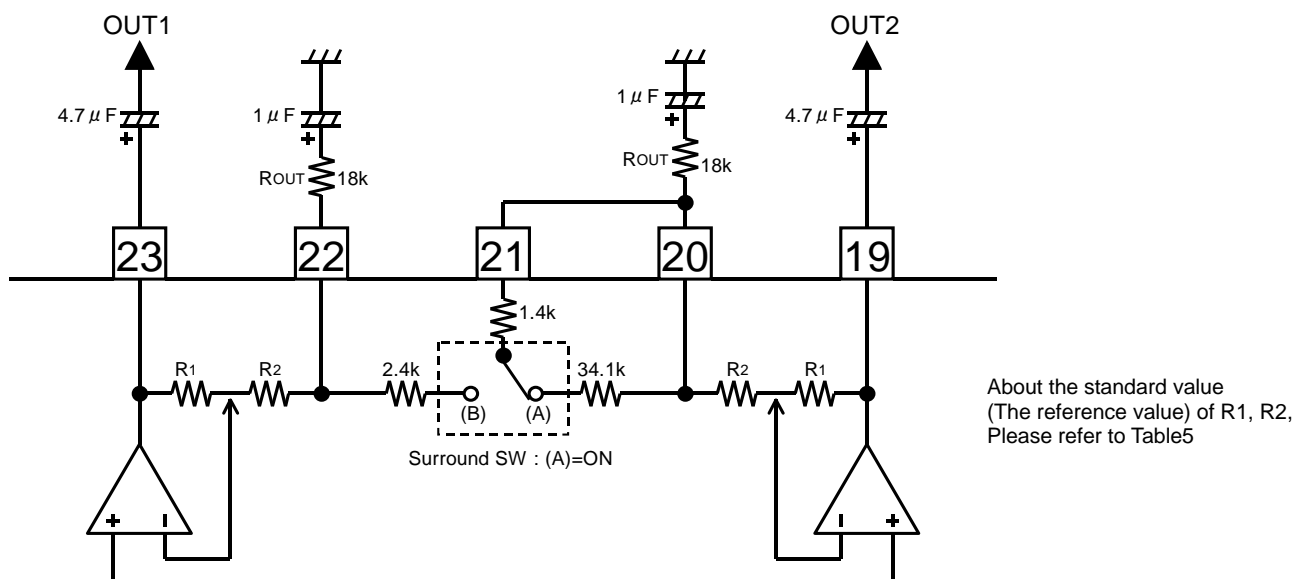


Figure 32. The application circuit example of Output Gain

11-2. The computation formula and the representative characteristic Output Gain

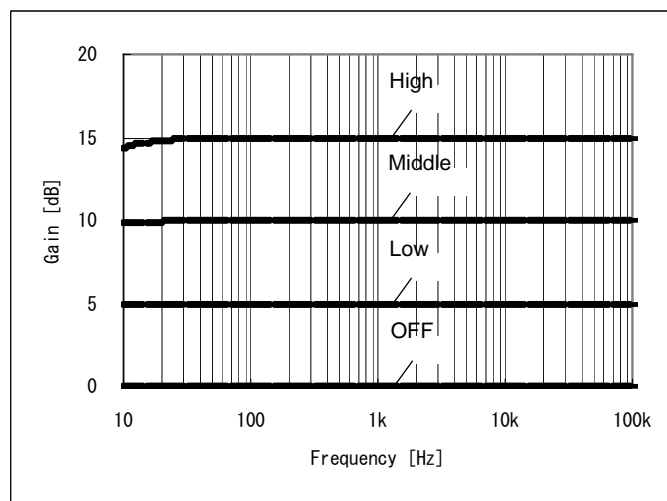$$\text{Gain} = 20\log\frac{R1 + R2 + R_{OUT}}{R2 + R_{OUT}}[\text{dB}]$$



Figure 33. The representative characteristic of Output Gain

12. The use example easy 3band

12-1. The application circuit example of easy 3band
・ Easy 3 band can be composed using Bass Boost, Bass, Treble.
・ Use Bass Boost in the Bass band, use Bass in the Middle band and use Treble just as it is as the Treble band.
・ The Middle band, the Treble band are Gain=±14dB/2dB step but the Bass band becomes 4 step changing by Gain=OFF/Low/Middle/High.
・ At the addition function unused time, it is Surround Gain=OFF, Surround SW : Use in (A)=ON.
・Surround SW : Be careful because it damages output (23pin, 19pin) short-circuiting next, a characteristic when having made (B)=ON.
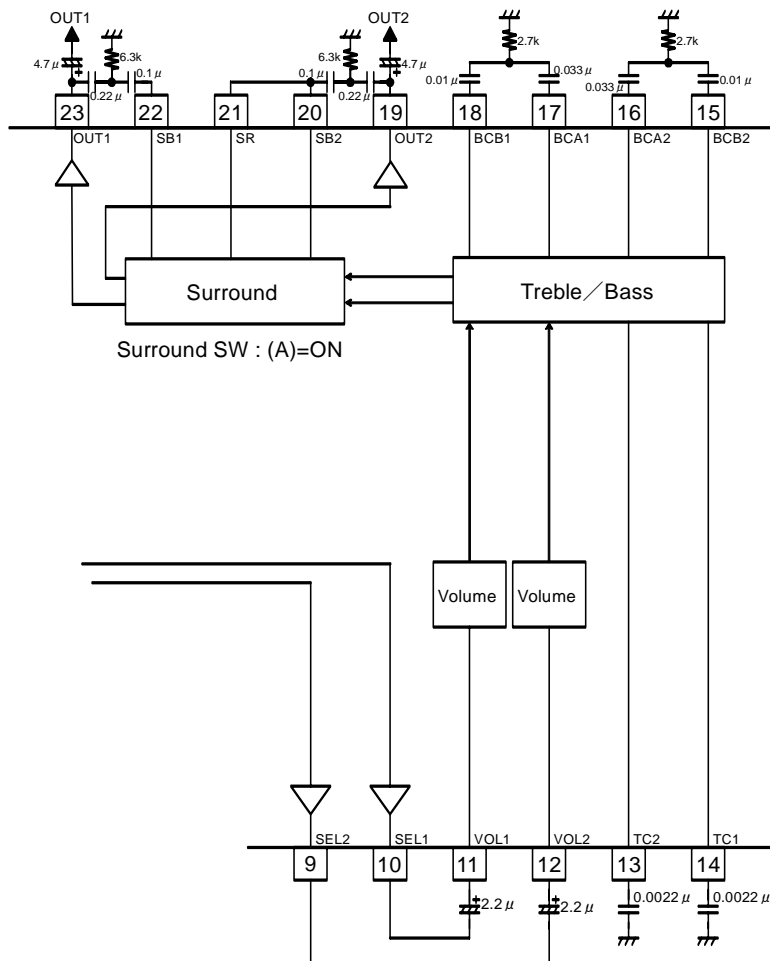


Figure 34. The application circuit example of easy 3band

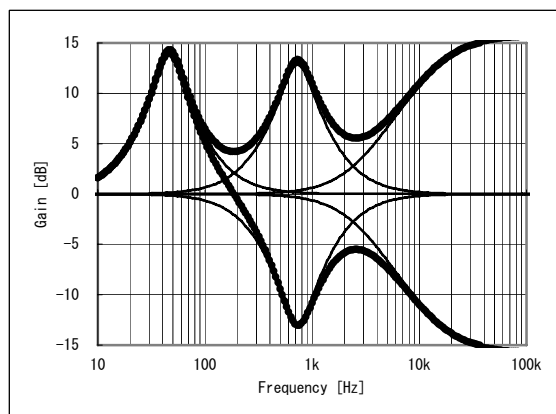6-2. The representative characteristic of easy 3band



Figure 35. The representative characteristic of easy 3band

13.The application circuit example at the addition function unused time

・At the addition function unused time, it is Surround Gain=OFF, Surround SW : Use in (A)=ON.
・Surround SW : Be careful because it damages output (23pin, 19pin) short-circuiting next, a characteristic when having made (B)=ON.



About the standard value
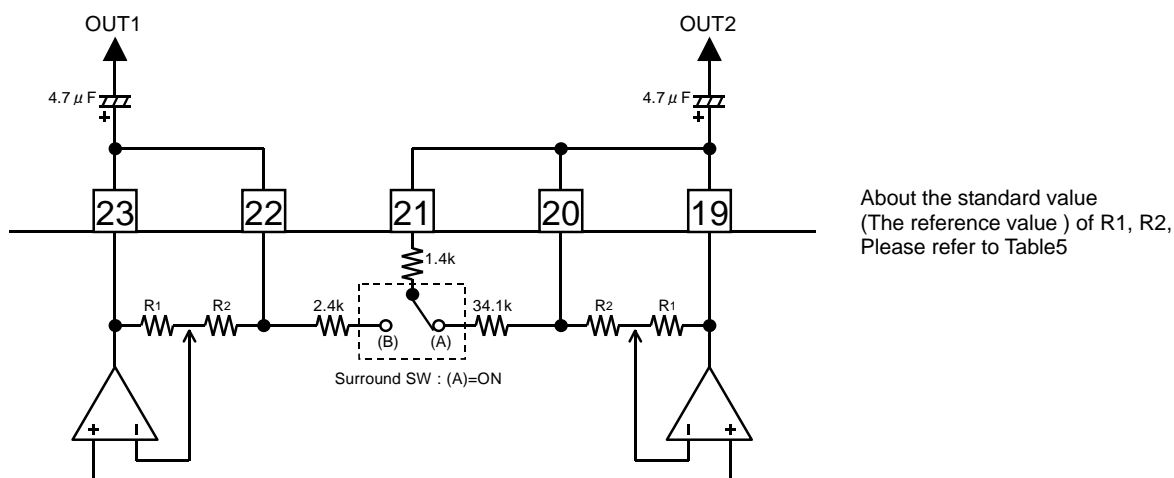(The reference value ) of R1, R2,
Please refer to Table5

Figure 36. The application circuit example at the addition function unused time

14. The use example of INPUT SHORT function

・The INPUT SHORT function makes input impedance RIN small in the switch control and it charges rapidly in external coupling capacitance.
・The DC bias voltage of the input terminal can be rapidly changed to regular condition (1/2VCC) in transmitting I2C BUS direction immediately after power start-up and working this function.
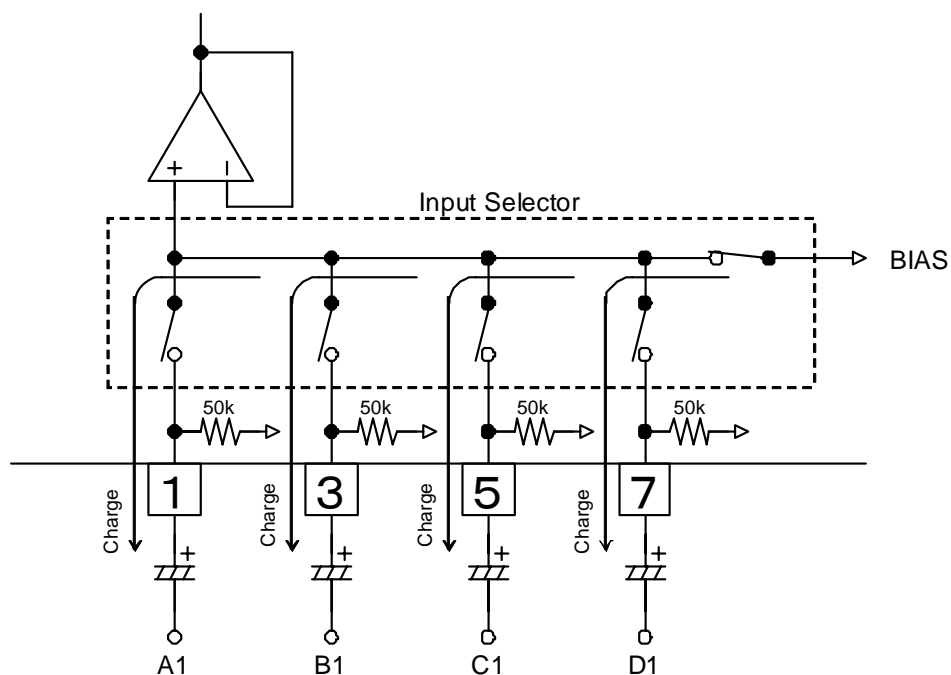・Always use INPUT SHORT function in the signal less condition and give it.



Figure 37. About INPUT SHORT mode （The illustration only of 1ch）

15. The use example The microphone input

・Because the input impedance of VOL1(11pin) and VOL2(12pin) is constant(50kohm(TYP)) even if it changes the setting attenuation quantity of VOLUME, the outside sound signal can be added to this terminal. It is possible to use as the microphone input terminal.

・Because it is a resistance addition to the VOL1 and VOL2 terminal, the signal level of this terminal (VOL1, VOL2) is decided by the addition quantity and works VOLUME to the signal level.



\*Rin=50kΩ(TYP.) constant
\*Make R2 bigger sufficiently than the output−impedance of the outside sound signal.
\* When making R1, R2 big, it becomes the cause to aggravate output noise voltage.
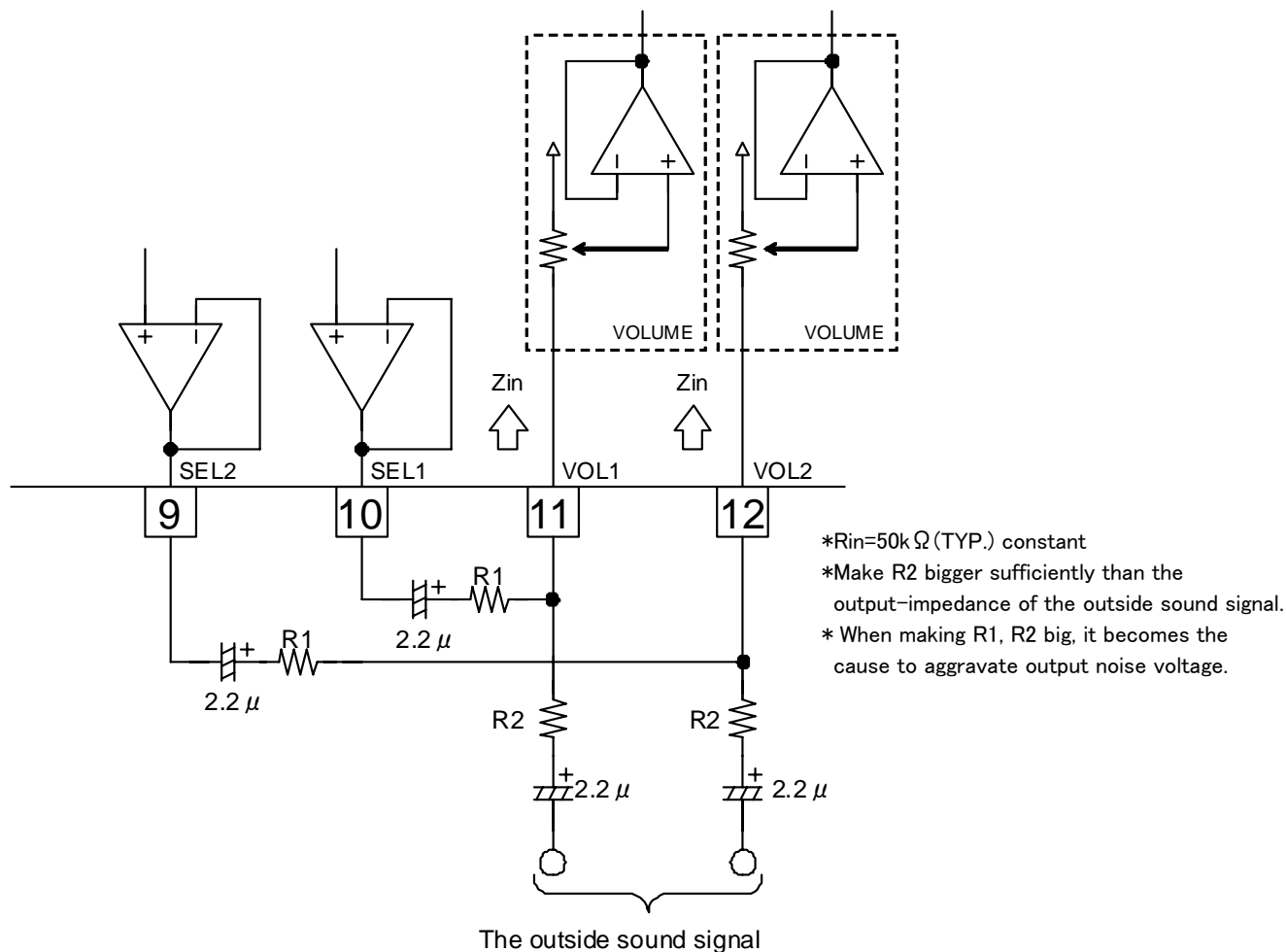
The outside sound signal

Figure 38. The application circuit example in microphone input use
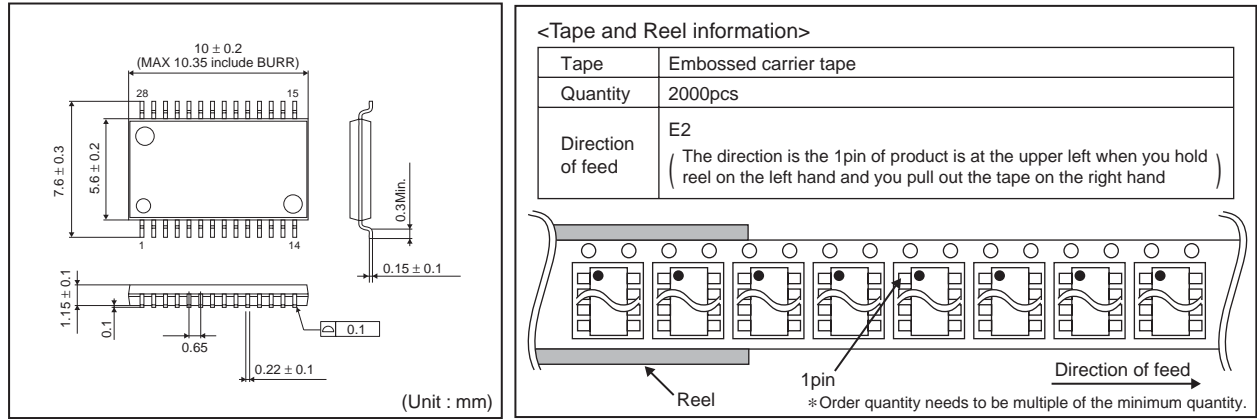
Status of this document
The Japanese version of this document is the formal specification. A customer may use this translation only for a reference to help reading the formal version. If there are any differences in translation version of this document, formal version takes priority.
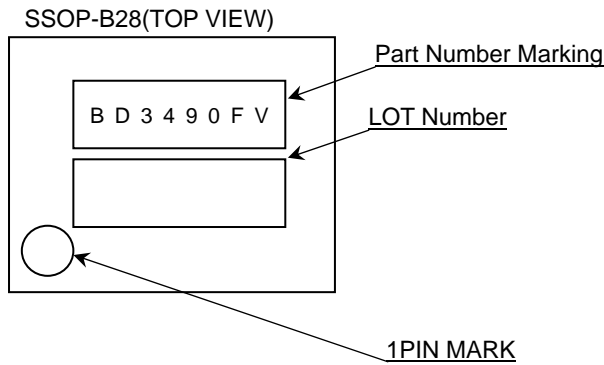
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●Ordering Information

| B | D | 3 | 4 | 9 | 0 | F | V | | E 2 |

Part Number

Package
FV: SSOP-B28

Packaging and forming specification
E2: Embossed tape and reel
(SSOP-B28)

●Physical Dimension Tape and Reel Information

**SSOP-B28**



10 ± 0.2
(MAX 10.35 include BURR)

28    15

7.6 ± 0.3
5.6 ± 0.2

1    14

0.3Min.

0.15 ± 0.1

1.15 ± 0.1
0.1
0.65
0.22 ± 0.1

0.1

(Unit : mm)

<Tape and Reel information>

| Tape | Embossed carrier tape |
|---|---|
| Quantity | 2000pcs |
| Direction of feed | E2<br>The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand |

1pin

Reel

Direction of feed

＊Order quantity needs to be multiple of the minimum quantity.

●**Marking Diagram(s)(TOP VIEW)**

SSOP-B28(TOP VIEW)

Part Number Marking

B D 3 4 9 0 F V

LOT Number

1PIN MARK

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**2012.10.05 Rev.001**

●Revision history

| Date | Revision | Changes |
|------|----------|---------|
| 5.Oct.2012 | 001 | New Release |

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    [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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    [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
    [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
    [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
    [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
    [f] Sealing or coating our Products with resin or other coating materials
    [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
    [h] Use of the Products in places subject to dew condensation

4) The Products are not subject to radiation-proof design.

5) Please verify and confirm characteristics of the final or mounted products in using the Products.

6) In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse) is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7) De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8) Confirm that operation temperature is within the specified range described in the product specification.

9) ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## ●Precaution for Mounting / Circuit board design

1) When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2) In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

## ●Precautions Regarding Application Examples and External Circuits

1) If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2) You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use.  Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document.   ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

## ●Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

## ●Precaution for Storage / Transportation

1) Product performance and soldered connections may deteriorate if the Products are stored in the places where:
    [a]  the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
    [b]  the temperature or humidity exceeds those recommended by ROHM
    [c]  the Products are exposed to direct sunshine or condensation
    [d]  the Products are exposed to high Electrostatic

2) Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3) Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4) Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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## ●Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

## ●Precaution for Foreign Exchange and Foreign Trade act

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