



AUDIO PROCESSOR

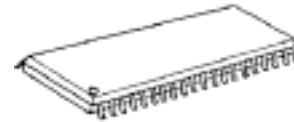
■ GENERAL DESCRIPTION

The **NJW1172** is a sound processor includes all of the functions required to process the audio signal for TV, such as tone control, balance, volume, mute, and AGC functions.

Also the **NJW1172** performs BBE sound enhancement and SRS 3D Stereo. The BBE regenerates high definitive and nearly real sound, and SRS 3D Stereo regenerates 3D surround sound with only two speakers.

All of the internal status and variables are controlled by I²C BUS interface.

■ PACKAGE OUTLINE

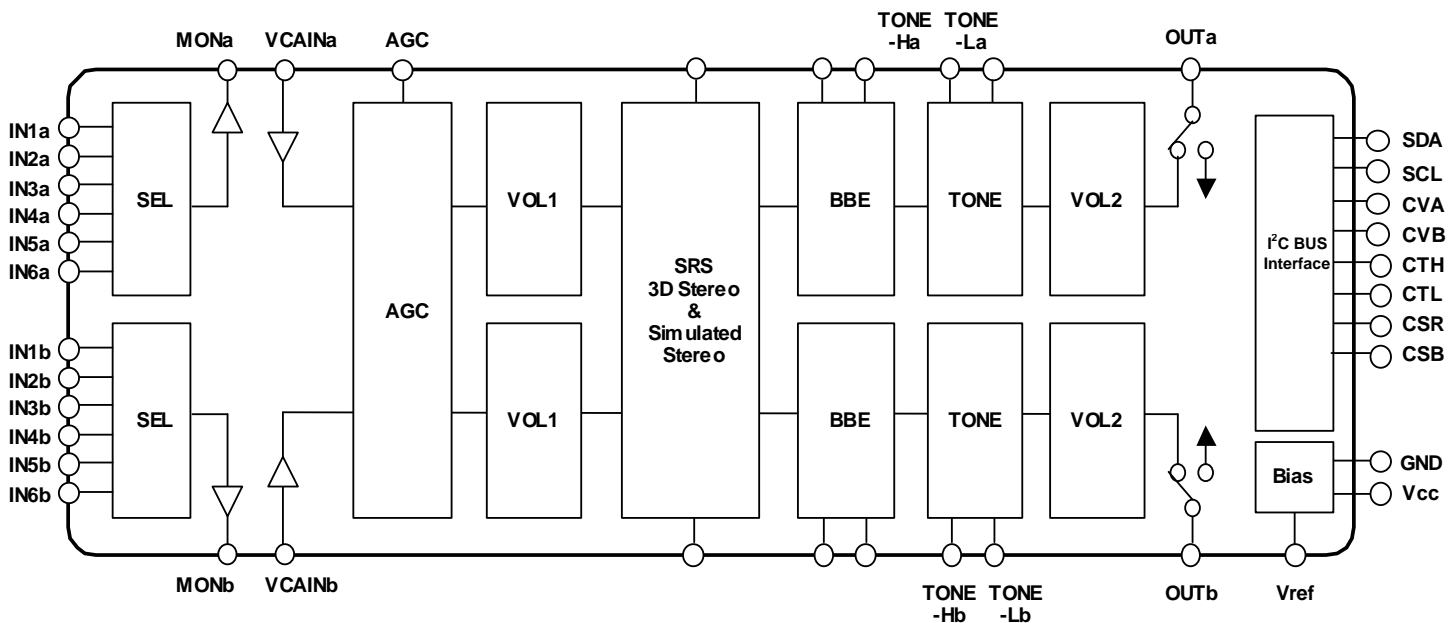


NJW1172GK1

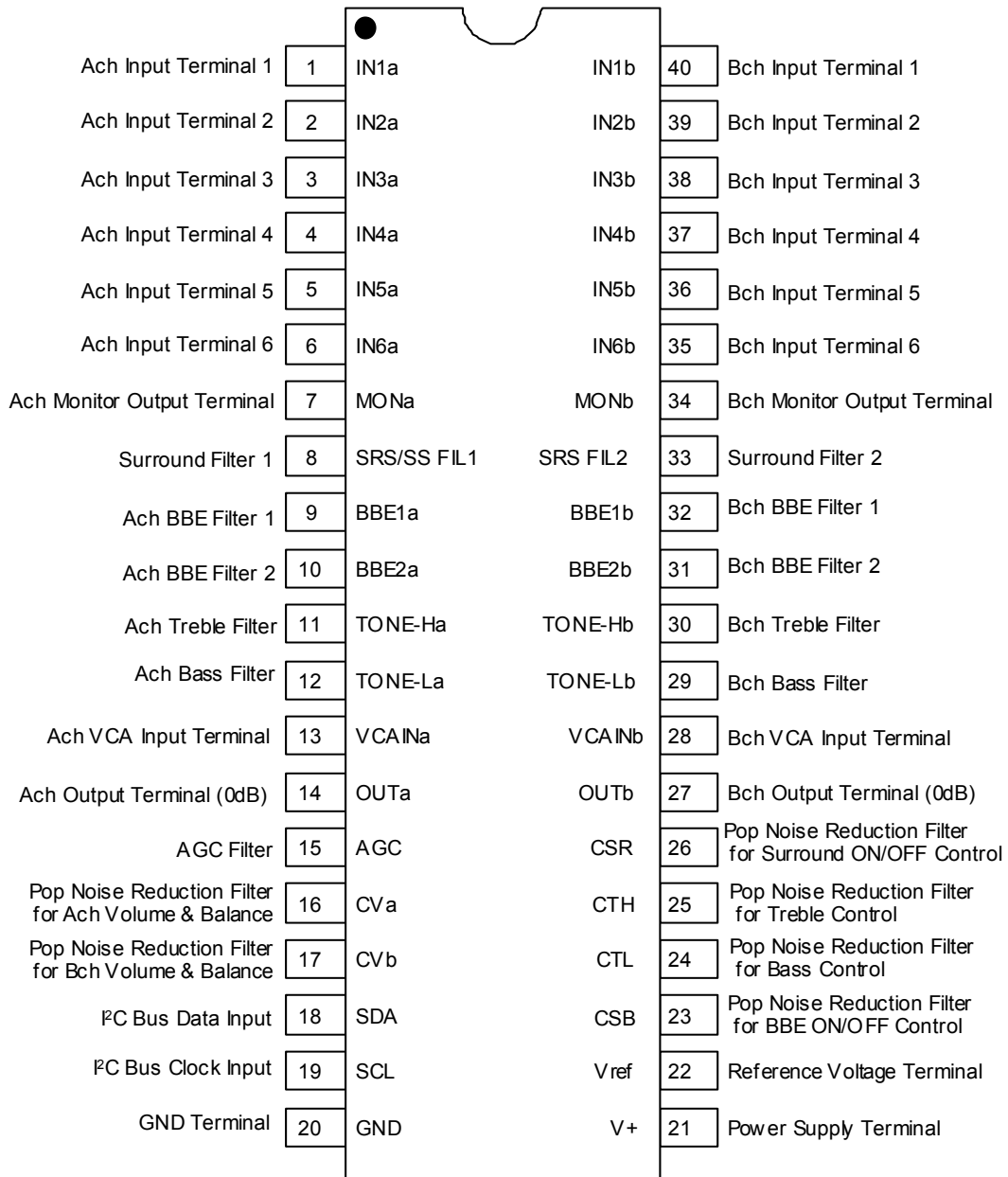
■ FEATURES

- Operating Voltage 8 to 13V
- I²C BUS Interface
- BBE Sound Enhancement (Low Boost and High Boost: 15dB max.)
- Internal 6 Input Audio Selectors and Monitor Output
- The AGC circuit reduces volume difference among input sources.
- Variable AGC Compression Level via I²C (4-levels)
- SRS 3D Stereo and Simulated Stereo
- Variable Surround Effect Level via I²C
- Low Noise VCA
- Bi-CMOS Technology
- Package Outline SOP40

■ BLOCK DIAGRAM



■ PIN CONFIGURATION



■ ABSOLUTE MAXIMUM RATING (Ta=25°C)

| PARAMETER | SYMBOL | RATING | UNIT |
|-----------------------------|----------------|-------------|------|
| Supply Voltage | V ⁺ | 14 | V |
| Power Dissipation | P _D | 700 | mW |
| Operating Temperature Range | Topr | -20 to +75 | °C |
| Storage Temperature Range | Tstg | -40 to +125 | °C |

■ ELECTRICAL CHARACTERISTICS (Ta=25°C, V⁺=9V, Rg=600Ω, RL=47kΩ, Vin=100mVrms/1kHz)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|---------------------------|-------------------|---|------|---------------|---------------|----------------|
| Operating Voltage | V ⁺ | | 8.0 | 9.0 | 13.0 | V |
| Supply Current | I _{CC} | No Signal | - | 13 | 25 | mA |
| Reference Voltage | V _{REF} | No Signal | 4.0 | 4.5 | 5.0 | V |
| Maximum Input Voltage | V _{IM} | IN1a-6a/IN1b-6b VOL=-20dB, THD=10% | 2.8 | 3.0 | - | Vrms |
| Maximum Output Voltage | V _{OM} | OUTa/OUTb VOL=0dB, THD=3% | 2.0 | 2.5 | - | Vrms |
| MON OUT Gain | G _{VMON} | MON OUT | - | 0.0 | - | dB |
| Maximum Gain | G _{VMAX} | VOL=0dB | -2.0 | 0.0 | 2.0 | dB |
| Minimum Gain | G _{VMIN} | VOL=Mute, Vin=1Vrms BW=400Hz to 30kHz | - | - | -70 | dB |
| Channel Balance | G _{CB} | VOL=0dB | -1.5 | 0.0 | 1.5 | dB |
| Balance Level A-A | BAL _{AA} | Full panning to Ach, OUTa | -2.0 | 0.0 | 2.0 | dB |
| Balance Level A-B | BAL _{AB} | Full panning to Ach, OUTb Vin=1Vrms BW=400Hz to 30kHz | - | - | -70 | dB |
| Balance Level B-B | BAL _{BB} | Full panning to Bch, OUTb | -2.0 | 0.0 | 2.0 | dB |
| Balance Level B-A | BAL _{BA} | Full panning to Bch, OUTa Vin=1Vrms BW=400Hz to 30kHz | - | - | -70 | dB |
| Total Harmonic Distortion | THD | Vo=0.5Vrms BW=400Hz to 30kHz | - | - | 0.5 | % |
| Input Selector Cross Talk | CT | Vin=1Vrms BW=400Hz to 30kHz | - | - | -70 | dB |
| Channel Separation | CS | Vin=1Vrms BW=400Hz to 30kHz | - | - | -70 | dB |
| Output Noise 1 | V _{NO1} | VOL=0dB BW=400Hz to 30kHz | - | -90 (31.6) | -85 (56.2) | dBV (μVrms) |
| Output Noise 2 | V _{NO2} | VOL=Mute BW=400Hz to 30kHz | - | -106 (5.0) | -96 (15.8) | dBV (μVrms) |

■ **ELECTRICAL CHARACTERISTICS** (Ta=25°C, V⁺=9V, R_g=600Ω, R_L=47kΩ, V_{in}=100mVrms/1kHz)

● **● TONE CONTROL** (Tone Control-ON)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|----------------------|-------------------|-----------------------|-------|-------|-------|------|
| High Frequency Boost | HF _{BST} | TREBLE=+15dB, f=10kHz | 12.5 | 15.0 | 17.5 | dB |
| High Frequency Flat | HF _{FLT} | TRBE=0dB, f=10kHz | -2.0 | 0.0 | 2.0 | dB |
| High Frequency Cut | HF _{CUT} | TREBLE=-15dB, f=10kHz | -17.5 | -15.0 | -12.5 | dB |
| Low Frequency Boost | LF _{BST} | BASS=+15dB, f=100Hz | 12.5 | 15.0 | 17.5 | dB |
| Low Frequency Flat | LF _{FLT} | BASS=0dB, f=100Hz | -2.0 | 0.0 | 2.0 | dB |
| Low Frequency Cut | LF _{CUT} | BASS=-15dB, f=100Hz | -17.5 | -15.0 | -12.5 | dB |

● **● SUB-TONE CONTROL** (Sub-Tone Control-ON)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|----------------------|--------------------|--------------------------|------|------|------|------|
| High Frequency Boost | SHF _{BST} | SUB-TREBLE=+3dB, f=10kHz | 2.0 | 3.0 | 4.0 | dB |
| High Frequency Flat | SHF _{FLT} | SUB-TREBLE=0dB, f=10kHz | -2.0 | 0.0 | 2.0 | dB |
| High Frequency Cut | SHF _{CUT} | SUB-TREBLE=-3dB, f=10kHz | -4.0 | -3.0 | -2.0 | dB |
| Low Frequency Boost | SLF _{BST} | SUB-BASS=+3dB, f=100Hz | 2.0 | 3.0 | 4.0 | dB |
| Low Frequency Flat | SLF _{FLT} | SUB-BASS=0dB, f=100Hz | -2.0 | 0.0 | 2.0 | dB |
| Low Frequency Cut | SLF _{CUT} | SUB-BASS=-3dB, f=100Hz | -4.0 | -3.0 | -2.0 | dB |

● **● AGC** (AGC-ON)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|------------|---------------------|---------------------------|------|------|------|------|
| AGC BOOST | AGC _{BST} | V _{in} =50mVrms | 1.5 | 3.5 | 5.5 | dB |
| AGC FLAT 1 | AGC _{FLT1} | V _{in} =300mVrms | -2.5 | 0.0 | 2.5 | dB |
| AGC FLAT 2 | AGC _{FLT2} | V _{in} =400mVrms | -2.5 | 0.0 | 2.5 | dB |
| AGC FLAT 3 | AGC _{FLT3} | V _{in} =500mVrms | -2.5 | 0.0 | 2.5 | dB |
| AGC FLAT 4 | AGC _{FLT4} | V _{in} =600mVrms | -2.5 | 0.0 | 2.5 | dB |
| AGC CUT | AGC _{CUT} | V _{in} =2Vrms | -14 | -10 | -6.0 | dB |

● **● BBE** (BBE-ON)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|--------------------------------|---------------------|----------------|------|------|------|------|
| BBE Low Frequency Boost Level | BBE _{LOW} | BBE-Low=+15dB | - | 15.0 | - | dB |
| BBE High Frequency Boost Level | BBE _{HIGH} | BBE-High=+15dB | - | 15.0 | - | dB |

■ **ELECTRICAL CHARACTERISTICS** ($T_a=25^{\circ}\text{C}$, $V^+=9\text{V}$, $R_g=600\Omega$, $R_L=47\text{k}\Omega$, $V_{in}=100\text{mVrms}$)

● **SIMULATED SURROUND** (Simulated Surround-ON, $f=1\text{kHz}$)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|----------------|-------------|-------------------------------------|------|------|------|------|
| SURROUND SIM A | SR_{SIMA} | $A_{in}+B_{in} \rightarrow A_{out}$ | 1.0 | 3.0 | 5.0 | dB |
| SURROUND SIM B | SR_{SIMB} | $A_{in}+B_{in} \rightarrow B_{out}$ | 1.0 | 3.0 | 5.0 | dB |

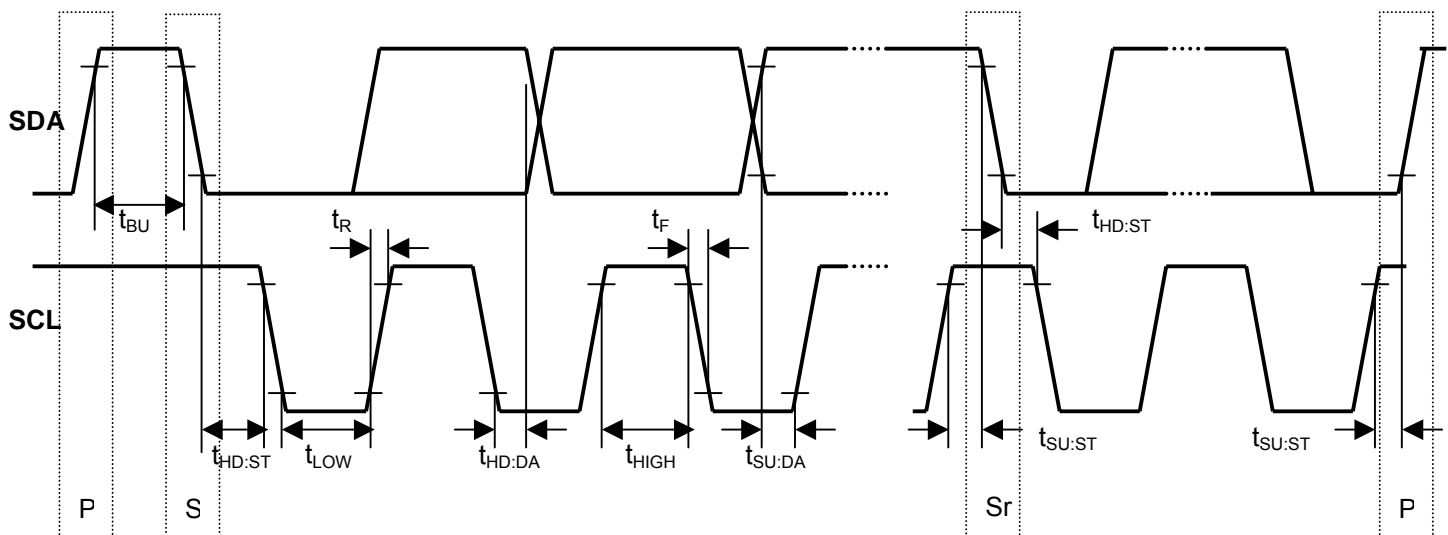
● **SRS 3D-Stereo** (SRS 3D Stereo-ON, $f=125\text{Hz}$)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-----------------|-------------|--|------|------|------|------|
| SRS GAIN HIGH 1 | SRS_{GH1} | $A_{in} \rightarrow A_{out}$, Mode=High | 10.0 | 12.0 | 14.0 | dB |
| SRS GAIN HIGH 2 | SRS_{GH2} | $B_{in} \rightarrow B_{out}$, Mode=High | 10.0 | 12.0 | 14.0 | dB |
| SRS GAIN LOW 1 | SRS_{GL1} | $A_{in} \rightarrow A_{out}$, Mode=Low | 7.0 | 9.0 | 11.0 | dB |
| SRS GAIN LOW 2 | SRS_{GL2} | $B_{in} \rightarrow B_{out}$, Mode=Low | 7.0 | 9.0 | 11.0 | dB |
| SRS GAIN HIGH 3 | SRS_{GH3} | $B_{in} \rightarrow A_{out}$, Mode=High | 6.8 | 8.8 | 10.8 | dB |
| SRS GAIN HIGH 4 | SRS_{GH4} | $A_{in} \rightarrow B_{out}$, Mode=High | 6.8 | 8.8 | 10.8 | dB |

■ I²C BUS BLOCK CHARACTERISTICS (SDA, SCL)

| PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|--------------|------|------|------|---------|
| High Level Input Voltage | V_{IH} | 3.0 | - | 5.0 | V |
| Low Level Input Voltage | V_{IL} | 0 | - | 1.5 | V |
| High Level Input Current | I_{IH} | - | - | 10 | μ A |
| Low Level Input Current | I_{IL} | - | - | 10 | μ A |
| Low Level Output Voltage (3mA at SDA pin) | V_{OL} | 0 | - | 0.4 | V |
| Maximum Output Current | I_{OL} | -3.0 | - | - | mA |
| Maximum Clock Frequency | f_{SCL} | - | - | 100 | kHz |
| Data Change Minimum Waiting Time | t_{BUF} | 4.7 | - | - | μ s |
| Data Transfer Start Minimum Waiting Time | $t_{HD:STA}$ | 4.0 | - | - | μ s |
| Low Level Clock Pulse Width | t_{LOW} | 4.7 | - | - | μ s |
| High Level Clock Pulse Width | T_{HIGH} | 4.0 | - | - | μ s |
| Minimum Start Preparation Waiting Time | $t_{SU:STA}$ | 4.7 | - | - | μ s |
| Minimum Data Hold Time | $t_{HD:DAT}$ | 5.0 | - | - | μ s |
| Minimum Data Preparation Time | $t_{SU:DAT}$ | 250 | - | - | ns |
| Rise Time | t_R | - | - | 1.0 | μ s |
| Fall Time | t_F | - | - | 300 | ns |
| Minimum Stop Preparation Waiting Time | $t_{SU:STO}$ | 4.0 | - | - | μ s |

I²C BUS Load Condition: Pull up resistance 4k Ω (Connected to +5V)
Load capacitance 200pF (Connected to GND)



■ TERMINAL DESCRIPTION

| No. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | VOLTAGE |
|--|--|--|--------------------|---------|
| 1 2 3 4 5 6 35 36 37 38 39 40 | IN1a IN2a IN3a IN4a IN5a IN6a IN6b IN5b IN4b IN3b IN2b IN1b | Ach Input Terminal 1 Ach Input Terminal 2 Ach Input Terminal 3 Ach Input Terminal 4 Ach Input Terminal 5 Ach Input Terminal 6 Bch Input Terminal 6 Bch Input Terminal 5 Bch Input Terminal 4 Bch Input Terminal 3 Bch Input Terminal 2 Bch Input Terminal 1 | | V+/2 |
| 7 14 27 34 | MONa OUTa OUTb MONb | Ach Monitor Output Terminal Ach Output Terminal Bch Output Terminal Bch Monitor Output Terminal | | V+/2 |
| 8 | SRS/SS FIL1 | Surround Filter 1 | | V+/2 |
| 9 10 31 32 | BBE1a BBE2a BBE2b BBE1b | Ach BBE Filter 1 Ach BBE Filter 2 Bch BBE Filter 2 Bch BBE Filter 1 | | V+/2 |
| 11 30 | TONE-Ha TONE-Hb | Ach Treble Filter Bch Treble Filter | | V+/2 |

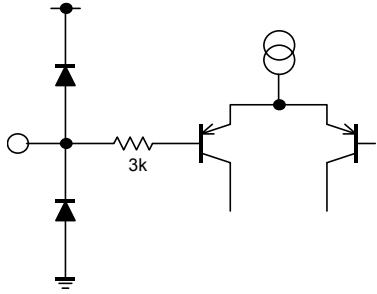
■ TERMINAL DESCRIPTION

| No. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | VOLTAGE |
|----------|--------------------|--|--------------------|-------------|
| 12 29 | TONE-La TONE-Lb | Ach Bass Filter Bch Bass Filter | | V+/2 |
| 13 28 | VCAINa VCAINb | Ach VCA Input Terminal Bch VCA Input Terminal | | V+/2 |
| 15 | AGC | AGC Filter | | 0.9V |
| 16 17 | CVa CVb | Pop Noise Reduction Filter for Ach Volume & Balance Pop Noise Reduction Filter for Bch Volume & Balance | | V+/2 - 0.7V |
| 18 19 | SDA SCL | I ² C Bus Data Input I ² C Bus Clock Input | | - |

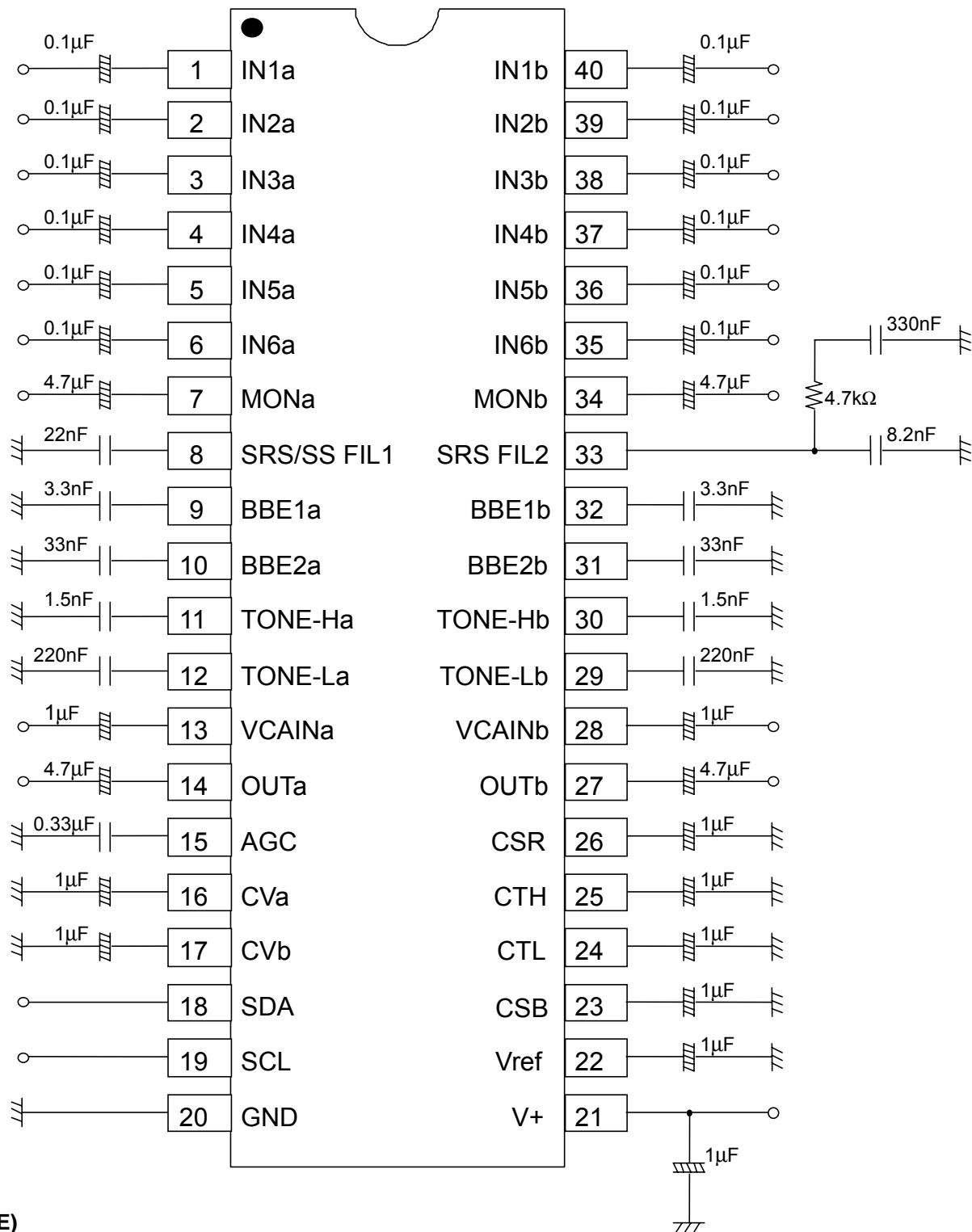
■ TERMINAL DESCRIPTION

| No. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | VOLTAGE |
|----------|------------|--|--------------------|---------|
| 20 | GND | GND Terminal | ————— | 0V |
| 21 | V+ | Power Supply Terminal | ————— | GND |
| 22 | Vref | Reference Voltage | | V+/2 |
| 23 | CSB | Pop Noise Reduction Filter for BBE ON/OFF Control | | V+/2 |
| 24 25 | CTL CTH | Pop Noise Reduction Filter for Bass Control Pop Noise Reduction Filter for Treble Control | | V+/2 |
| 26 | CSR | Pop Noise Reduction Filter for Surround ON/OFF Control | | V+/2 |

■TERMINAL DESCRIPTION

| No. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | VOLTAGE |
|-----|----------|-------------------|---|---------|
| 33 | SRS FI12 | Surround Filter 2 |  <p>The diagram shows an input terminal on the left. A series combination of two diodes is connected to ground. This is followed by a resistor labeled '3k'. The output stage consists of two transistors in a push-pull configuration, with a load inductor connected to their common emitter point.</p> | V+/2 |

APPLICATION CIRCUIT



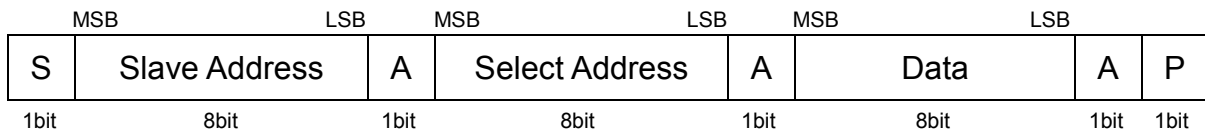
(NOTE)

1. Separate the I²C bus line from the following terminals for avoiding digital noise problem.

| Pin No. | Symbol | Pin No. | Symbol | Pin No. | Symbol | Pin No. | Symbol | Pin No. | Symbol |
|---------|-------------|---------|---------|---------|---------|---------|---------|---------|----------|
| 8 | SRS/SS FIL1 | 10 | BBE2a | 12 | TONE-La | 30 | TONE-Hb | 32 | BBE1b |
| 9 | BBE1a | 11 | TONE-Ha | 29 | TONE-Lb | 31 | BBE2b | 33 | SRS FIL2 |

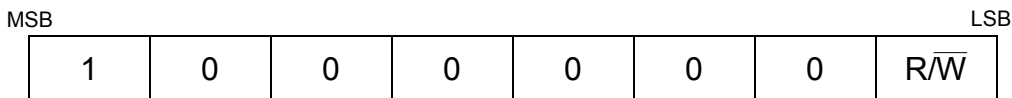
■ DEFINITION OF I²C REGISTER

● I²C BUS FORMAT



S: Starting Term
A: Acknowledge Bit
P: Ending Term

● SLAVE ADDRESS



$\overline{R/W}$ =0: Write mode for register setting
 $\overline{R/W}$ =1: Not available

● CONTROL REGISTER TABLE

| Select Address | BIT | | | | | | | |
|----------------|---------|------|----|----|----------|----------|-----|-----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 00H | VOL | | | | | | | |
| 01H | CHS | BAL | | | | | SR1 | SR0 |
| 02H | BCB | BASS | | | BCSB | SUB-BASS | | |
| 03H | BCT | TREB | | | BCST | SUB-TREB | | |
| 04H | BBE-Low | | | | BBE-High | | | |
| 05H | OUT | SEL | | | AGC1 | AGC0 | AGC | BBE |

● CONTROL REGISTER DEFAULT VALUE

| Select Address | BIT | | | | | | | |
|----------------|-----|----|----|----|----|----|----|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 00H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 01H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 02H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 03H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

■ I²C CONTROL COMMAND DESCRIPTION

● MASTER VOLUME CONTROL

| Select Address | BIT | | | | | | | |
|----------------|-----|----|----|----|----|----|----|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 00H | VOL | | | | | | | |

The attenuator is consisted of both the Volume1 and Volume2. The total attenuation level is summing of each attenuation level of the Volume1 and Volume2. The attenuation for both the Volume1 and Volume2 are always synchronized to have the same attenuation levels for each other, and are not controllable independently for each other.

- "VOL": Sets the total attenuation level for the both Ach and Bch (up to 84dB, 0.33dB/step)

● CHANNEL BALANCE AND SURROUND MODE CONTROL

| Select Address | BIT | | | | | | | |
|----------------|-----|-----|----|----|----|----|-----|-----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 01H | CHS | BAL | | | | | SR1 | SR0 |

◆ Channel Balance Control

To control the balance between Ach and Bch, the both commands "CHS" and "BAL" should be set. For example, to move a sound image to Ach-side, Bch should be attenuated with no attenuation on Ach. The command "CHS" defines the channel should be attenuate, and the command "BAL" defines the attenuation level itself. The attenuation for the balance control is consisted of the both Volume1 and Volume2, has the same structure with Master Volume Control described above.

- "CHS": Defines the channel should be attenuated

| The channel should be attenuated | CHS (D7) |
|----------------------------------|----------|
| Bch | 0 |
| Ach | 1 |

- "BAL": Defines the attenuation level for the specified channel with command "CHS" (up to 30dB, 1dB/Step)

◆ Surround Mode Control

- "SR1", "SR0": Surround Mode Switch

| Surround Mode | SR1 (D1) | SR0 (D0) |
|----------------------------------|----------|----------|
| Surround OFF (Bypass) | 0 | 0 |
| NJRC Original Simulated Surround | 0 | 1 |
| SRS 3D-Stereo – High Mode | 1 | 0 |
| SRS 3D-Stereo – Low Mode | 1 | 1 |

●BASS-TONE CONTROL SETTING

| Select Address | BIT | | | | | | | |
|----------------|-----|------|----|----|----|------|----------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 02H | BCB | BASS | | | | BCSB | SUB-BASS | |

- "BCB": Defines the Bass-Tone Control Mode as Boost or Cut

| Bass Tone Control Mode | BCB (D7) |
|------------------------|----------|
| Cut | 0 |
| Boost | 1 |

- "BASS": Sets the Cut or Boost level for Bass-Tone Control (up to 15dB, 1dB/Step)
- "BCSB": Defines the Sub-Bass-Tone Control Mode as Boost or Cut

| Sub-Bass Tone Control Mode | BCSB (D2) |
|----------------------------|-----------|
| Cut | 0 |
| Boost | 1 |

- "SUB-BASS": Sets the Cut or Boost level for Sub-Bass-Tone Control (up to 3dB, 1dB/Step)

●TREBLE-TONE CONTROL SETTING

| Select Address | BIT | | | | | | | |
|----------------|-----|------|----|----|----|------|----------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 03H | BCT | TREB | | | | BCST | SUB-TREB | |

- "BCT": Defines the Treble-Tone Control Mode as Boost or Cut

| Treble-Tone Control Mode | BCT (D7) |
|--------------------------|----------|
| Cut | 0 |
| Boost | 1 |

- "TREB": Sets the Cut or Boost level for Treble-Tone Control (up to 15dB, 1dB/Step)
- "BCST": Defines the Sub-Treble-Tone Control Mode as Boost or Cut

| Sub-Treble-Tone Control Mode | BCST (D2) |
|------------------------------|-----------|
| Cut | 0 |
| Boost | 1 |

- "SUB-TREB": Sets the Cut or Boost level for Sub-Treble-Tone Control (up to 3dB, 1dB/Step)

●BBE BOOST LEVEL SETTING

| Select Address | BIT | | | | | | | |
|----------------|---------|----|----|----|----------|----|----|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 04H | BBE-Low | | | | BBE-High | | | |

The command "BBE-Low" and "BBE-High" can set the only BBE boost level, not BBE ON/OFF control. To activate the BBE, the command "BBE" (Address=05H) must be ON.

- "BBE-Low": Sets the BBE low frequency boost level (up to 15dB, 1dB/Step)
- "BBE-High": Sets the BBE high frequency boost level (up to 15dB, 1dB/Step)

● **OUTPUT ON/OFF, INPUT SELECTOR, AGC and BBE ON/OFF CONTROL**

| Select Address | BIT | | | | | | | |
|----------------|-----|-----|----|----|------|------|-----|-----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 05H | OUT | SEL | | | AGC1 | AGC0 | AGC | BBE |

◆ **Output ON/OFF**

- "OUT": Output ON/OFF Switch

| | |
|-------------------|----------|
| Output | OUT (D7) |
| Output OFF (Mute) | 0 |
| Output ON | 1 |

◆ **Input Selector**

- "SEL": Input Selector Control

| Input Select | SEL | | |
|---------------|-----|----|----|
| | D6 | D5 | D4 |
| IN1a and IN1b | 0 | 0 | 0 |
| IN2a and IN2b | 0 | 0 | 1 |
| IN3a and IN3b | 0 | 1 | 0 |
| IN4a and IN4b | 0 | 1 | 1 |
| IN5a and IN5b | 1 | 0 | 0 |
| IN6a and IN6b | 1 | 0 | 1 |

◆ **AGC Control**

- "AGC1", "AGC0": Set the AGC Flat Level
- "AGC": AGC ON/OFF Switch

| AGC Flat Level | AGC1 (D3) | AGC0 (D2) | AGC (D0) |
|----------------|-----------|-----------|----------|
| 300mVrms | 0 | 0 | 1 |
| 400mVrms | 0 | 1 | 1 |
| 500mVrms | 1 | 0 | 1 |
| 600mVrms | 1 | 1 | 1 |
| AGC OFF | - | - | 0 |

◆ **BBE ON/OFF Control**

- "BBE": BBE ON/OFF Switch

| | |
|------------|----------|
| BBE ON/OFF | BBE (D0) |
| BBE OFF | 0 |
| BBE ON | 1 |

●MASTER VOLUME CONTROL (Select Address: 00H)

| Gain (dB) | HEX | VOL | | | | | | | |
|-----------|-----|-----|----|----|----|----|----|----|----|
| | | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 0 | FF | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| -1 | FC | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| -2 | F9 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| -3 | F6 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| -4 | F3 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| -5 | F0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| -6 | ED | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| -7 | EA | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| -8 | E7 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| -9 | E4 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| -10 | E1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| -11 | DE | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| -12 | DB | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| -13 | D8 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| -14 | D5 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| -15 | D2 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| -16 | CF | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| -17 | CC | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| -18 | C9 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| -19 | C6 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| -20 | C3 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| -21 | C0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| -22 | BD | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| -23 | BA | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| -24 | B7 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| -25 | B4 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| -26 | B1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| -27 | AE | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| -28 | AB | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| -29 | A8 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| -30 | A5 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| -31 | A2 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| -32 | 9F | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| -33 | 9C | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| -34 | 99 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| -35 | 96 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| -36 | 93 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| -37 | 90 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| -38 | 8D | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| -39 | 8A | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| -40 | 87 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

●MASTER VOLUME CONTROL (cont'd)

| Gain (dB) | HEX | VOL | | | | | | | |
|-----------|-----|-----|----|----|----|----|----|----|----|
| | | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| -41 | 84 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| -42 | 81 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| -43 | 7E | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| -44 | 7B | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| -45 | 78 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| -46 | 75 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| -47 | 72 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| -48 | 6F | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| -49 | 6C | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| -50 | 69 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| -51 | 66 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| -52 | 63 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| -53 | 60 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| -54 | 5D | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| -55 | 5A | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| -56 | 57 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| -57 | 54 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| -58 | 51 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| -59 | 4E | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| -60 | 4B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| -61 | 48 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| -62 | 45 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| -63 | 42 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| -64 | 3F | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| -65 | 3C | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| -66 | 39 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| -67 | 36 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| -68 | 33 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| -69 | 30 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| -70 | 2D | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| -71 | 2A | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| -72 | 27 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| -73 | 24 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| -74 | 21 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| -75 | 1E | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |
| -76 | 1B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| -77 | 18 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| -78 | 15 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| -79 | 12 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| -80 | 0F | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| -81 | 0C | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| -82 | 09 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| -83 | 06 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| -84 | 03 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Mute | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

●CHANNEL BALANCE CONTROL (Select Address: 01H)

| Gain (dB) | BAL | | | | |
|-----------|-----|----|----|----|----|
| | D6 | D5 | D4 | D3 | D2 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| -1 | 0 | 0 | 0 | 0 | 1 |
| -2 | 0 | 0 | 0 | 1 | 0 |
| -3 | 0 | 0 | 0 | 1 | 1 |
| -4 | 0 | 0 | 1 | 0 | 0 |
| -5 | 0 | 0 | 1 | 0 | 1 |
| -6 | 0 | 0 | 1 | 1 | 0 |
| -7 | 0 | 0 | 1 | 1 | 1 |
| -8 | 0 | 1 | 0 | 0 | 0 |
| -9 | 0 | 1 | 0 | 0 | 1 |
| -10 | 0 | 1 | 0 | 1 | 0 |
| -11 | 0 | 1 | 0 | 1 | 1 |
| -12 | 0 | 1 | 1 | 0 | 0 |
| -13 | 0 | 1 | 1 | 0 | 1 |
| -14 | 0 | 1 | 1 | 1 | 0 |
| -15 | 0 | 1 | 1 | 1 | 1 |
| -16 | 1 | 0 | 0 | 0 | 0 |
| -17 | 1 | 0 | 0 | 0 | 1 |
| -18 | 1 | 0 | 0 | 1 | 0 |
| -19 | 1 | 0 | 0 | 1 | 1 |
| -20 | 1 | 0 | 1 | 0 | 0 |
| -21 | 1 | 0 | 1 | 0 | 1 |
| -22 | 1 | 0 | 1 | 1 | 0 |
| -23 | 1 | 0 | 1 | 1 | 1 |
| -24 | 1 | 1 | 0 | 0 | 0 |
| -25 | 1 | 1 | 0 | 0 | 1 |
| -26 | 1 | 1 | 0 | 1 | 0 |
| -27 | 1 | 1 | 0 | 1 | 1 |
| -28 | 1 | 1 | 1 | 0 | 0 |
| -29 | 1 | 1 | 1 | 0 | 1 |
| -30 | 1 | 1 | 1 | 1 | 0 |
| Mute | 1 | 1 | 1 | 1 | 1 |

●BASS-TONE CONTROL (Select Address: 02H)
/ TREBLE-TONE CONTROL (Select Address: 03H)

| | | BASS TREB | | | |
|------------------|--------------------|--------------|----|----|----|
| Cut Gain (dB) | Boost Gain (dB) | D6 | D5 | D4 | D3 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| -1 | 1 | 0 | 0 | 0 | 1 |
| -2 | 2 | 0 | 0 | 1 | 0 |
| -3 | 3 | 0 | 0 | 1 | 1 |
| -4 | 4 | 0 | 1 | 0 | 0 |
| -5 | 5 | 0 | 1 | 0 | 1 |
| -6 | 6 | 0 | 1 | 1 | 0 |
| -7 | 7 | 0 | 1 | 1 | 1 |
| -8 | 8 | 1 | 0 | 0 | 0 |
| -9 | 9 | 1 | 0 | 0 | 1 |
| -10 | 10 | 1 | 0 | 1 | 0 |
| -11 | 11 | 1 | 0 | 1 | 1 |
| -12 | 12 | 1 | 1 | 0 | 0 |
| -13 | 13 | 1 | 1 | 0 | 1 |
| -14 | 14 | 1 | 1 | 1 | 0 |
| -15 | 15 | 1 | 1 | 1 | 1 |

●SUB-BASS-TONE CONTROL (Select Address: 02H)
/ SUB-TREBLE-TONE CONTROL (Select Address: 03H)

| | | SUB-BASS SUB-TREB | |
|------------------|--------------------|----------------------|----|
| Cut Gain (dB) | Boost Gain (dB) | D1 | D0 |
| 0 | 0 | 0 | 0 |
| -1 | 1 | 0 | 1 |
| -2 | 2 | 1 | 0 |
| -3 | 3 | 1 | 1 |

●BBE Low-Frequency Boost Level (Select Address: 04H)

| Boost Gain (dB) | BBE-Low | | | |
|-----------------|---------|----|----|----|
| | D6 | D5 | D4 | D3 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 1 | 1 |
| 4 | 0 | 1 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 |
| 6 | 0 | 1 | 1 | 0 |
| 7 | 0 | 1 | 1 | 1 |
| 8 | 1 | 0 | 0 | 0 |
| 9 | 1 | 0 | 0 | 1 |
| 10 | 1 | 0 | 1 | 0 |
| 11 | 1 | 0 | 1 | 1 |
| 12 | 1 | 1 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 |
| 14 | 1 | 1 | 1 | 0 |
| 15 | 1 | 1 | 1 | 1 |


●BBE High-Frequency Boost Level (Select Address: 04H)

| Boost Gain (dB) | BBE-High | | | |
|-----------------|----------|----|----|----|
| | D3 | D2 | D1 | D0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 1 | 1 |
| 4 | 0 | 1 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 |
| 6 | 0 | 1 | 1 | 0 |
| 7 | 0 | 1 | 1 | 1 |
| 8 | 1 | 0 | 0 | 0 |
| 9 | 1 | 0 | 0 | 1 |
| 10 | 1 | 0 | 1 | 0 |
| 11 | 1 | 0 | 1 | 1 |
| 12 | 1 | 1 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 |
| 14 | 1 | 1 | 1 | 0 |
| 15 | 1 | 1 | 1 | 1 |

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