



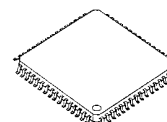
Audio Processor with Sound Enhancement and TruSurround 5.1ch Virtualizer

GENERAL DESCRIPTION

The NJW1149A is an audio processor with BBE sound enhancement and SRS Labs' TruSurround 5.1 channel virtualizer. It includes all of functions processing audio signal for TV, such as volume, balance, mute, tone control, eala NJRC surround and simulated stereo functions. All of internal status and variables are controlled by I²C BUS.

The NJW1149 is available for Virtual Dolby Surround or Virtual Dolby Digital with Dolby Pro Logic or Dolby Digital system*.

PACKAGE OUTLINE



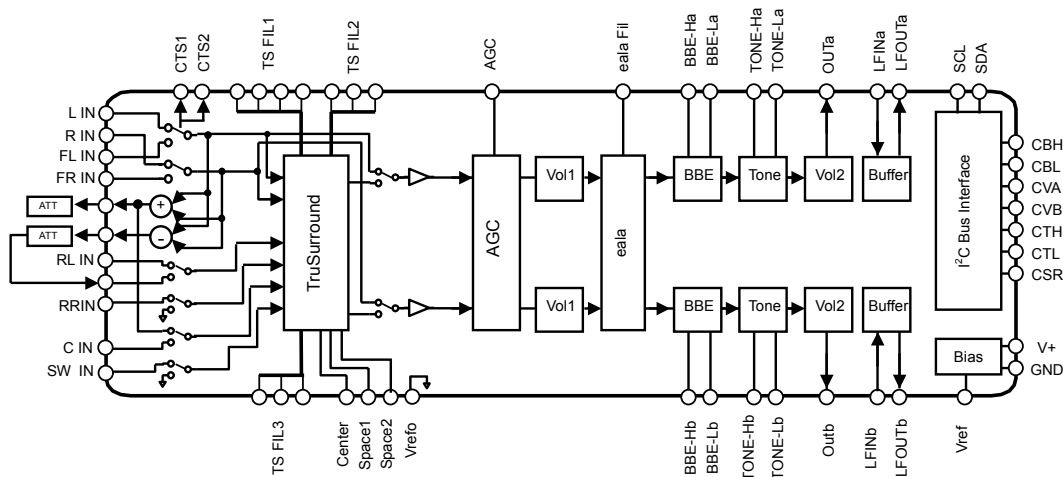
NJW1149AFH1

*For use in Virtual Dolby Surround(VDS) and/or Virtual Dolby Digital(VDD) products, please contact Dolby Laboratories for licensing information. Dolby and the double-D symbol are trademarks of Dolby Laboratories Licensing Corporation. Licensing and application information may be obtained from Dolby Lab.

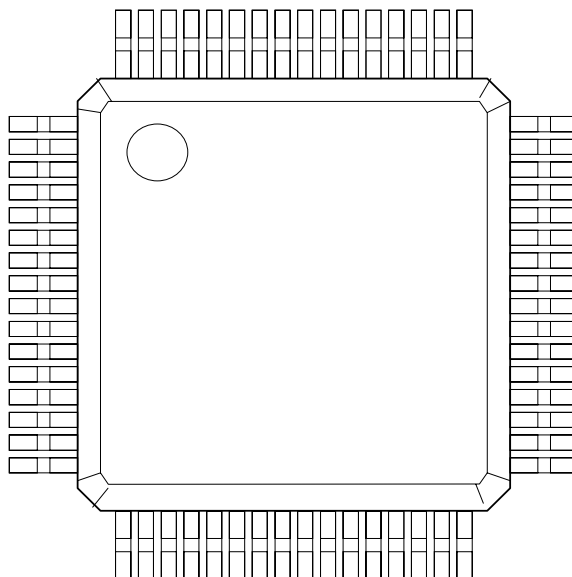
FEATURES

- Operating Voltage 8 to 10 V
- I²C BUS Interface
- TruSurround 5.1ch. / 4ch. / 2ch. Inputs
- BBE 0dB to +15dB(0.5dB/step)
- eala (surround effect ; 2 steps) and Simulated Stereo
- Volume 0 to -80dB, MUTE (0.33dB/step)
- Balance 0 to -30dB, MUTE (1dB/step)
- Tone Control -15dB to +15dB(0.5dB/step)
- Bi-CMOS Technology
- Package Outline QFP64-H1

BLOCK DIAGRAM



■ PIN FUNCTION



| No. | SYMBOL | FUNCTION | No. | SYMBOL | FUNCTION |
|-----|---------|---|-----|---------|---|
| 1 | TS12 | TruSurround Filter Capacitor 12 | 33 | CBH | BBE High switching noise rejection Capacitor |
| 2 | TS13 | TruSurround Filter Capacitor 13 | 34 | LFOUTb | Buffer Output for Bch Low Pass Filter |
| 3 | TS14 | TruSurround Filter Capacitor 14 | 35 | LFINb | Buffer Input for Bch Low Pass Filter |
| 4 | SPACE1 | SPACE Volume1 | 36 | OUTb | Bch Output |
| 5 | SPACE2 | SPACE Volume2 | 37 | TONE-Lb | Bch TONE Bass Filter Capacitor |
| 6 | CENTER | CENTER Volume | 38 | TONE-Hb | Bch TONE Treble Filter Capacitor |
| 7 | VREFO | Reference Voltage Output Capacitor | 39 | BBE2b | Bch BBE Low-Pass Filter Capacitor |
| 8 | ealaFil | eala Filter Capacitor | 40 | BBE1b | Bch BBE High-Pass Filter Capacitor |
| 9 | BBE1a | Ach BBE High-Pass Filter Capacitor | 41 | CSR | eala switching noise rejection Capacitor |
| 10 | BBE2a | Ach BBE Low-Pass Filter Capacitor | 42 | N.C. | No Connection |
| 11 | TONE-Ha | Ach TONE Treble Filter Capacitor | 43 | CTS2 | TruSurround switching noise rejection Capacitor 2 |
| 12 | TONE-La | Ach TONE Bass Filter Capacitor | 44 | CTS1 | TruSurround switching noise rejection Capacitor 1 |
| 13 | OUTa | Ach Output | 45 | TS33 | TruSurround Filter Capacitor 33 |
| 14 | LFINa | Buffer Input for Ach Low Pass Filter | 46 | TS32 | TruSurround Filter Capacitor 32 |
| 15 | LFOUTa | Buffer Output for Ach Low Pass Filter | 47 | TS31 | TruSurround Filter Capacitor 31 |
| 16 | AGC | AGC Smoothing Filter Capacitor | 48 | ATTC | Center Attenuation Resistor |
| 17 | CVA | Ach Volume switching noise rejection Capacitor | 49 | N.C. | No Connection |
| 18 | CVB | Bch Volume switching noise rejection Capacitor | 50 | ATTS2 | Surround Attenuation Resistor 2 |
| 19 | SDA | I ² C Data Input | 51 | ATTS1 | Surround Attenuation Resistor 1 |
| 20 | SCL | I ² C Clock Input | 52 | TS23 | TruSurround Filter Capacitor 23 |
| 21 | GND | Ground | 53 | TS22 | TruSurround Filter Capacitor 22 |
| 22 | N.C. | No Connection | 54 | TS21 | TruSurround Filter Capacitor 21 |
| 23 | N.C. | No Connection | 55 | SWIN | SW ch Input |
| 24 | N.C. | No Connection | 56 | CIN | C ch Input |
| 25 | N.C. | No Connection | 57 | RRIN | Rear-R ch Input |
| 26 | N.C. | No Connection | 58 | RLIN | Rear-L ch Input |
| 27 | N.C. | No Connection | 59 | FRIN | Front-R ch Input |
| 28 | V+ | Power Supply | 60 | FLIN | Front-L ch Input |
| 29 | VREF | Reference Voltage stabilizing Capacitor | 61 | RIN | R ch Input |
| 30 | CTL | Tone Control Bass switching noise rejection Capacitor | 62 | LIN | L ch Input |
| 31 | CTH | Tone Control Treble switching noise rejection Capacitor | 63 | TS11 | TruSurround Filter Capacitor 21 |
| 32 | CBL | BBE Low switching noise rejection Capacitor | 64 | N.C. | No Connection |

■ ABSOLUTE MAXIMUM RATING (Ta=25°C)

| PARAMETER | SYMBOL | RATING | UNIT |
|-----------------------------|----------------|-------------|------|
| Supply Voltage | V ⁺ | 12 | V |
| Power Dissipation | P _D | 1400* | mW |
| Operating Temperature Range | Topr | -20 to +75 | °C |
| Storage Temperature Range | Tstg | -40 to +125 | °C |

*(Note) EIA/JEDEC STANDARD Test board (76.2 x 114.3 x 1.6mm, 2-Layers, FR-4) mounting

■ ELECTRICAL CHARACTERISTICS (Ta=25°C, V⁺=9V, R_L=47kΩ, Vin=100mVrms/1kHz MODE ; VOL=0dB, BAL=0dB, TS=By-Pass, AGC=OFF, BBE=OFF, Tone=0dB, eala=By-Pass)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|---------------------------|-------------------|-----------------------------------|------|---------------|---------------|----------------|
| Operating Voltage | V ⁺ | | 8.0 | 9.0 | 10.0 | V |
| Supply Current | I _{CC} | No Signal | - | 30 | 45 | mA |
| Reference Voltage | V _{REF} | No Signal | 4.0 | 4.5 | 5.0 | V |
| Maximum Input Voltage | V _{IM} | VOL=-20dB, THD=10% | 2.8 | 3.0 | - | Vrms |
| Maximum Output Voltage | V _{OM} | OUTPUT VOL=0dB, THD=1% | - | 2.5 | - | Vrms |
| Channel Balance | G _{CB} | VOL=0dB | -1.5 | 0.0 | 1.5 | dB |
| Balance Boost A | G _{BBA} | CHS="0", BAL=Mute | -2.0 | 0.0 | 2.0 | dB |
| Balance Cut A | G _{BCA} | CHS="1", BAL=Mute Vin = 1Vrms | - | - | -70 | dB |
| Balance Boost B | G _{BBB} | CHS="1", BAL=Mute | -2.0 | 0.0 | 2.0 | dB |
| Balance Cut B | G _{BCB} | CHS="0", BAL=Mute Vin = 1Vrms | - | - | -70 | dB |
| Total Harmonic Distortion | THD | Vo=0.5Vrms BW=400Hz to 30kHz | - | - | 0.5 | % |
| Maximum Voltage Gain | G _{VMAX} | VOL= 0dB | -2.0 | 0.0 | 2.0 | dB |
| Minimum Voltage Gain | G _{VMIN} | VOL= Mute | - | - | -70 | dB |
| Channel Separation | CS | Vin = 1Vrms | - | - | -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) |

BW : Band Width

◆ TONE CONTROL CHARACTERISTICS (Ta=25°C, V⁺=9V, R_L=47kΩ, Vin=100mVrms/1kHz MODE ; VOL=0dB, BAL=0dB, TS=By-Pass, AGC=OFF, BBE=OFF, eala=By-Pass)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-------------------|--------------------|---------------------|-------|-------|-------|------|
| Treble Boost Gain | G _{HFBST} | TREB=+15dB, f=10kHz | 12.5 | 15.0 | 17.5 | dB |
| Treble Boost Flat | G _{HFFLT} | TREB=0dB, f=10kHz | -2.0 | 0.0 | 2.0 | dB |
| Treble Boost Cut | G _{HFCUT} | TRBE=-15dB, f=10kHz | -17.5 | -15.0 | -12.5 | dB |
| Bass Boost Gain | G _{LFBST} | BASS=+15dB, f=100Hz | 12.5 | 15.0 | 17.5 | dB |
| Bass Boost Flat | G _{LFFLT} | BASS=0dB, f=100Hz | -2.0 | 0.0 | 2.0 | dB |
| Bass Boost Cut | G _{LFcut} | BASS=-15dB, f=100Hz | -17.5 | -15.0 | -12.5 | dB |

◆AGC CHARACTERISTICS (Ta=25°C, V⁺=9V, R_L=47kΩ

MODE ; VOL=0dB, BAL=0dB, TS=By-Pass, AGC=ON, BBE=OFF, Tone=0dB, eala=By-Pass)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|------------|----------------------|----------------------|------|------|------|------|
| AGC Boost | G _{AGCBST} | Vin=50mVrms, f=1kHz | 1.5 | 3.5 | 5.5 | dB |
| AGC Flat 1 | G _{AGCFLT1} | Vin=300mVrms, f=1kHz | -2.5 | 0.0 | 2.5 | dB |
| AGC Flat 2 | G _{AGCFLT2} | Vin=400mVrms, f=1kHz | -2.5 | 0.0 | 2.5 | dB |
| AGC Flat 3 | G _{AGCFLT3} | Vin=500mVrms, f=1kHz | -2.5 | 0.0 | 2.5 | dB |
| AGC Flat 4 | G _{AGCFLT4} | Vin=600mVrms, f=1kHz | -2.5 | 0.0 | 2.5 | dB |
| AGC Cut | G _{AGCCUT} | Vin=2Vrms, f=1kHz | -14 | -10 | -6.0 | dB |

◆BBE CHARACTERISTICS (Ta=25°C, V⁺=9V, R_L=47kΩ, Vin=100mVrms/1kHz

MODE ; VOL=0dB, BAL=0dB, TS=By-Pass, AGC=OFF, Tone=0dB, eala=By-Pass)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-----------------|----------------------|--------------------------|------|------|------|------|
| Low Boost Gain | G _{BBELOW} | BBE-LOW =+15dB, f=50Hz | 12.5 | 15 | 17.5 | dB |
| High Boost Gain | G _{BBEHIGH} | BBE-HIGH =+15dB, f=10kHz | 12.5 | 15 | 17.5 | dB |

◆eala CHARACTERISTICS (Ta=25°C, V⁺=9V, R_L=47kΩ, Vin=100mVrms/1kHz

MODE ; VOL=0dB, BAL=0dB, TS=By-Pass, AGC=OFF, BBE=0dB, Tone=0dB)

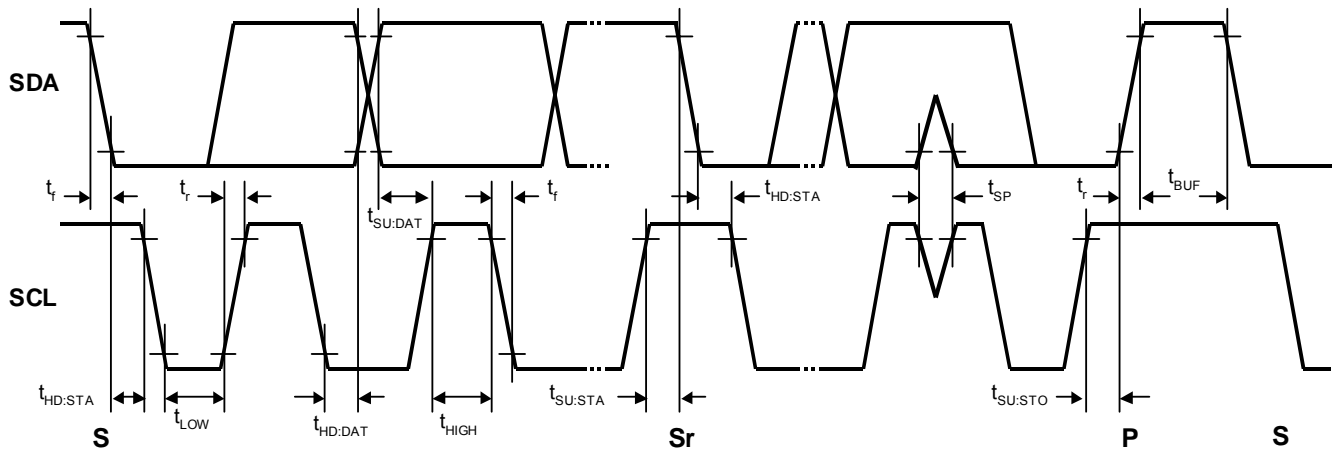
| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|--------------------|-------------------|---------------------------|------|------|------|------|
| Simulated Stereo A | G _{SIMA} | LIN+RIN→OUTa, f=1kHz, SIM | 1.0 | 3.0 | 5.0 | dB |
| Simulated Stereo B | G _{SIMB} | LIN+RIN→OUTb, f=1kHz, SIM | 1.0 | 3.0 | 5.0 | dB |
| Surround 3D1 | G _{3D1} | LIN→OUTa, f=100Hz, SR2 | 5.5 | 7.5 | 9.5 | dB |
| Surround 3D2 | G _{3D2} | LIN→OUTa, f=10kHz, SR2 | -2.0 | 0.0 | 2.0 | dB |
| Surround 3D3 | G _{3D3} | LIN→OUTb, f=100Hz, SR2 | 0.5 | 2.5 | 4.5 | dB |
| Surround 3D4 | G _{3D4} | LIN→OUTa, f=100Hz, SR1 | 3.5 | 5.5 | 7.5 | dB |

◆TruSurround CHARACTERISTICS (Ta=25°C, V⁺=9V, R_L=47kΩ, Vin=100mVrms/1kHz

MODE; VOL=0dB, BAL=0dB, AGC=OFF, BBE=OFF, Tone=0dB, eala=By-Pass)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-------------------|----------------------|--|------|------|------|------|
| Mix Down Gain | G _{TSMX} | FLIN→LTS, f=1KHz Mix Down | -5 | -3 | -1 | dB |
| By-Pass Gain | G _{TSBP} | LIN→LTS, f=1KHz By-Pass | -2 | 0 | 2 | dB |
| Tru Front Gain | G _{TSP} | FLIN→LTS, f=125Hz TS5.1ch | -0.5 | 1.5 | 3.5 | dB |
| Tru Rear Gain 1 | G _{TSR1} | RLIN→LTS, f=125Hz TS5.1ch | 1 | 3 | 5 | dB |
| Tru Rear Gain 2 | G _{TSR2} | RLIN→LTS, f=125Hz TS4ch | 2 | 4 | 6 | dB |
| Center Gain | G _{TSC} | CIN→LTS, f=1KHz TS4ch | -5 | -3 | -1 | dB |
| Sub Woofer Gain | G _{TSS} | SWIN→LTS, f=1KHz TS4ch | -2 | 0 | 2 | dB |
| Feed Through Gain | G _{THROUGH} | LIN→LTS, f=1KHz SRS 3D,Space=Min, Center=Min | -20 | -18 | -16 | dB |
| L+R Gain | G _{L+R} | LIN→RTS, f=1KHz SRS 3D,Space=Min, Center=Max | -15 | -13 | -11 | dB |
| L-R Gain | G _{L-R} | LIN→LTS, f=125Hz SRS 3D,Space=Max, Center=Min | -2 | 0 | 2 | dB |
| Passive Gain 1 | G _{TSP1} | LIN→LTS, f=125Hz TS2ch, Space=Max, Center=Max | 4.0 | 6.0 | 8.0 | dB |
| Passive Gain 2 | G _{TSP2} | LIN→RTS, f=125Hz TS2ch, Space=Max, Center=Max | -5.5 | -3.5 | -1.5 | dB |

■TIMING ON THE I²C BUS (SDA,SCL)



■CHARACTERISTICS OF I/O STAGES FOR I²C BUS (SDA,SCL)

I²C BUS Load Conditions

STANDARD MODE : Pull up resistance 4kΩ (Connected to +5V), Load capacitance 200pF (Connected to GND)

| PARAMETER | SYMBOL | Standard mode | | | UNIT |
|---|-----------------|---------------|------|------|------|
| | | MIN. | TYP. | MAX. | |
| Low Level Input Voltage | V _{IL} | 0.0 | - | 1.5 | V |
| High Level Input Voltage | V _{IH} | 3.0 | - | 5.0 | V |
| Low level output voltage (3mA at SDA pin) | V _{OL} | 0 | - | 0.4 | V |
| Input current each I/O pin with an input voltage between 0.1V _{DD} and 0.9V _{DDmax} | I _i | -10 | - | 10 | μA |

CHARACTERISTICS OF BUS LINES (SDA,SCL) FOR I²C-BUS DEVICES

| PARAMETER | SYMBOL | Standard mode | | | UNIT |
|--|---------------------|---------------|------|------|------|
| | | MIN. | TYP. | MAX. | |
| SCL clock frequency | f _{SCL} | - | - | 100 | kHz |
| Hold time (repeated) START condition. | t _{HD:STA} | 4.0 | - | - | μs |
| Low period of the SCL clock | t _{LOW} | 4.7 | - | - | μs |
| High period of the SCL clock | t _{HIGH} | 4.0 | - | - | μs |
| Set-up time for a repeated START condition | t _{SU:STA} | 4.7 | - | - | μs |
| Data hold time ^{NOTE)} | t _{HD:DAT} | 0 | - | - | μs |
| Data set-up time | t _{SU:DAT} | 250 | - | - | ns |
| Rise time of both SDA and SCL signals | t _r | - | - | 1000 | ns |
| Fall time of both SDA and SCL signals | t _f | - | - | 300 | ns |
| Set-up time for STOP condition | t _{SU:STO} | 4.0 | - | - | μs |
| Bus free time between a STOP and START condition | t _{BUF} | 4.7 | - | - | μs |
| Capacitive load for each bus line | C _b | - | - | 400 | pF |
| Noise margin at the Low level | V _{nL} | 0.5 | - | - | V |
| Noise margin at the High level | V _{nH} | 1 | - | - | V |

C_b ; total capacitance of one bus line in pF.

NOTE). Data hold time : t_{HD:DAT}

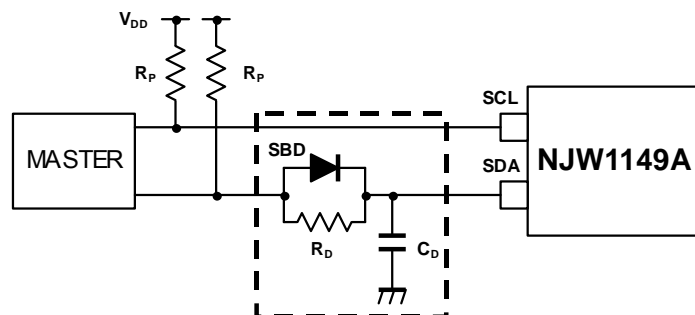
Please hold the Data Hold Time (t_{HD:DAT}) to 300ns or more to avoid status of unstable at SCL falling edge.

The SDA block in the NJW1149A does not hold data. Add external data-delay-circuit of the SDA terminal, in case of not providing a hold time of at least 300nsec for the SDA in the master device.

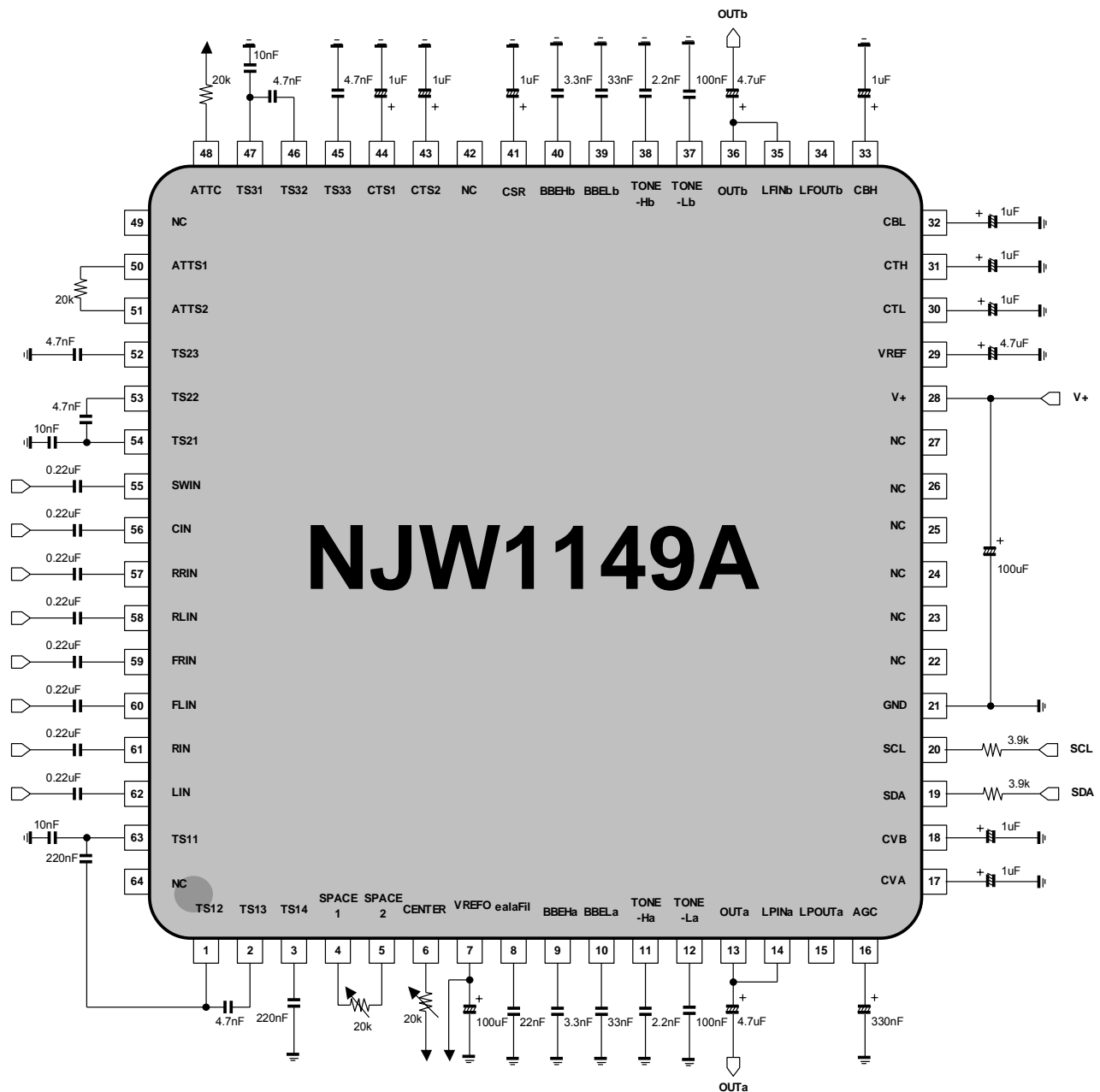
The time-consists of the data-delay-circuit of the SDA terminal are as follows.

- (a) Low level → High level : $T_{LH} \approx R_p \cdot C_D$
 (b) High level → Low level : $T_{HL} \approx R_D \cdot C_D$

In addition, Schottky barrier diode (SBD) influences a Low level at the Acknowledge. Therefore choose the low forward voltage (V_f) as much as possible.



APPLICATION CIRCUIT 1 (Bi-Amp outputs)



(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 |
|---------|----------|---------|---------|---------|---------|---------|--------|---------|--------|
| 1 | TS12 | 9 | BBE1a | 37 | TONE-Lb | 45 | TS33 | 53 | TS22 |
| 2 | TS13 | 10 | BBE2a | 38 | TONE-Hb | 46 | TS32 | 54 | TS21 |
| 3 | TS14 | 11 | TONE-Ha | 39 | BBE2b | 47 | TS31 | 63 | TS11 |
| 8 | eala Fil | 12 | TONE-La | 40 | BBE1b | 52 | TS23 | - | - |

2. The constant of capacitors connected to the terminals No.9, 10, 39 and 40 are designated by BBE Sound Inc.

3. The constant of capacitors connected to the terminals No.1,2,3,4,5,46,47,52,53,54,55 and 63 are designated by SRS Labs, Inc.

< Output Type >

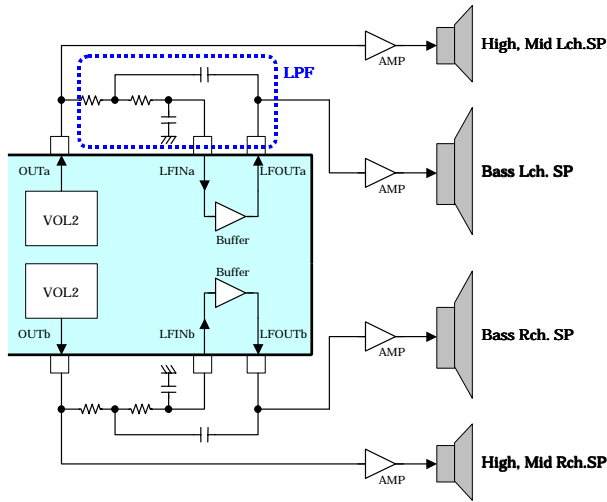


Fig 1. Bi-Amp

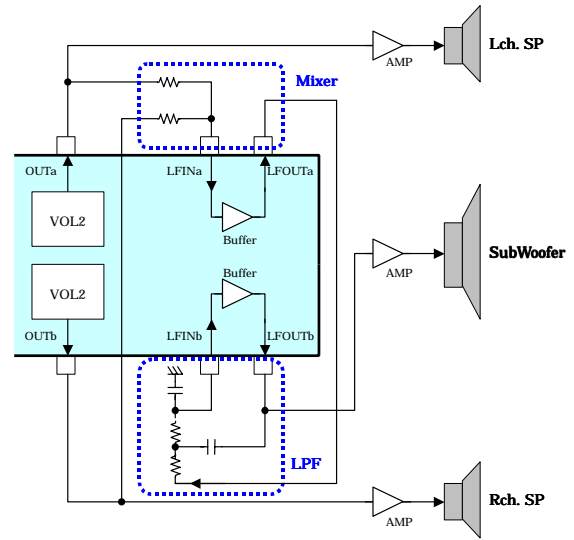
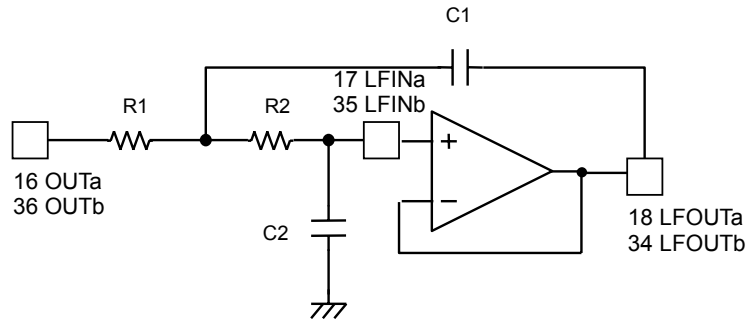


Fig 2. Sub-Woofer

< OUT, LFIN, LFOUT Low Pass Filter Setting >

LPF cut off frequency and quality factor are adjusted by the external parts and given by the following functions.



$$f_c = \frac{1}{2\pi\sqrt{R1 \cdot R2 \cdot C1 \cdot C2}} \text{ (Hz)}$$

$$Q = \frac{1}{\sqrt{C2 \cdot R1} + \sqrt{C1 \cdot R2}}$$

■ TERMINAL DESCRIPTION

| PIN NO. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|--|--|---|--------------------|------------------|
| 1 2 3 | TS12 TS13 TS14 | TruSurround Filter Capacitor 12 TruSurround Filter Capacitor 13 TruSurround Filter Capacitor 14 | | V+/2 |
| 4 51 | SPACE1 ATTS1 | SPACE Volume1 Surround Attenuation Resistor 1 | | V+/2 |
| 5 7 50 | SPACE2 VREFO ATTS2 | SPACE Volume2 Reference Voltage Output Capacitor Surround Attenuation Resistor 2 | | V+/2 |
| 6 8 14 35 48 55 56 57 58 59 60 61 62 | CENTER ealaFil LFINa LFINb ATTC SWIN CIN RRIN RLIN FRIN FLIN RIN LIN | CENTER Volume eala Filter Capacitor Buffer Input for Ach Low Pass Filter Buffer Input for Bch Low Pass Filter Center Attenuation Resistor SW ch Input C ch Input Rear-R ch Input Rear-L ch Input Front-R ch Input Front-L ch Input R ch Input L ch Input | | V+/2 |

NJW1149A

| PIN NO. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|---------|---------|---------------------------------------|--------------------|------------------|
| 22 | N.C. | No Connection | | |
| 23 | N.C. | No Connection | | |
| 24 | N.C. | No Connection | | |
| 25 | N.C. | No Connection | | |
| 26 | N.C. | No Connection | | |
| 27 | N.C. | No Connection | | |
| 42 | N.C. | No Connection | | |
| 49 | N.C. | No Connection | | |
| 64 | N.C. | No Connection | | |
| 16 | OUTa | Ach Output | | V+/2 |
| 18 | LFOUTa | Buffer Output for Ach Low Pass Filter | | |
| 34 | LFOUTb | Buffer Output for Bch Low Pass Filter | | |
| 36 | OUTb | Bch Output | | |
| 9 | BBE1a | Ach BBE High-Pass Filter Capacitor | | V+/2 |
| 10 | BBE2a | Ach BBE Low-Pass Filter Capacitor | | |
| 39 | BBE2b | Bch BBE Low-Pass Filter Capacitor | | |
| 40 | BBE1b | Bch BBE High-Pass Filter Capacitor | | |
| 11 | TONE-Ha | Ach TONE Treble Filter Capacitor | | V+/2 |
| 38 | TONE-Hb | Bch TONE Treble Filter Capacitor | | |

| PIN NO. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|--------------|------------------------|--|--------------------|------------------|
| 12 37 | TONE-La TONE-Lb | Ach TONE Bass Filter Capacitor Bch TONE Bass Filter Capacitor | | V+/2 |
| 19 | AGC | AGC Smoothing Filter Capacitor | | - |
| 17 18 | CVA CVB | Ach Volume switching noise rejection Capacitor Bch Volume switching noise rejection Capacitor | | VREF-0.7V |
| 19 20 | SDA SCL | I ² C Data Input I ² C Clock Input | | - |

NJW1149A

| PIN NO. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|----------|------------|--|--------------------|------------------|
| 21 | GND | Ground | - | - |
| 28 | V+ | Power Supply | - | V+ |
| 29 | VREF | Reference Voltage Capacitor | | V+/2 |
| 30 31 | CTL CTH | Tone Control Bass switching noise rejection Capacitor Tone Control Treble switching noise rejection Capacitor | | VREF-0.7V |

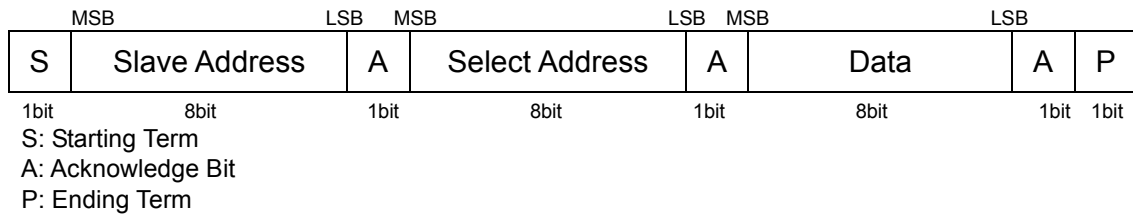
| PIN NO. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|----------------------------------|--|--|--------------------|--------------------------|
| 32 33 | CBL CBH | BBE Low switching noise rejection Capacitor BBE High switching noise rejection Capacitor | | VREF-0.7V |
| 41 43 | CSR CTS2 | eala switching noise rejection Capacitor TruSurround switching noise rejection Capacitor 2 | | 0.54V(CSR) 1.4V(CTS2) |
| 44 | CTS1 | TruSurround switching noise rejection Capacitor 1 | | - |
| 45 46 47 52 53 54 | TS33 TS32 TS31 TS23 TS22 TS21 | TruSurround Filter Capacitor 33 TruSurround Filter Capacitor 32 TruSurround Filter Capacitor 31 TruSurround Filter Capacitor 23 TruSurround Filter Capacitor 22 TruSurround Filter Capacitor 21 | | V+/2 |

NJW1149A

| PIN NO. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|---------|--------|---------------------------------|--------------------|------------------|
| 63 | TS11 | TruSurround Filter Capacitor 11 | | V+/2 |

■ DEFINITION OF I²C REGISTER

● I²C BUS FORMAT



● SLAVE ADDRESS



● CONTROL REGISTER TABLE

The select address sets each function (Volume, Balance, AGC, Surround, BBE, Tone Control).
The auto-increment function cycles the select address as follows.
00H→01H→02H→03H→04H→05H→06H→00H

| Select Address | BIT | | | | | | | |
|----------------|------|------|---------|----|----|-----|------------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 00H | VOL | | | | | | | |
| 01H | CHS | BAL | | | | | Don't Care | |
| 02H | BCB | BASS | | | | | Don't Care | |
| 03H | BCT | TREB | | | | | Don't Care | |
| 04H | BBEL | | | | | BBE | Don't Care | |
| 05H | BBEH | | | | | AGC | AGC LVL | |
| 06H | eala | | TS MODE | | | | Don't Care | |

● CONTROL REGISTER DEFAULT VALUE

Control register default value is all "0".

| 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 |
| 06H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

● CONTROL COMMAND TABLE

a) Master Volume

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

●VOL : Master Volume

Attenuation level : 0 to -80dB(0.33dB/step), MUTE

The volume is consisted of VOL1 and VOL2 and the level is divided into half to each VOL1 and VOL2.

ex) Volume setting is -2dB ; VOL1 and VOL2 is set -1dB each.

b) Balance

| Select Address | BIT | | | | | | | |
|----------------|-----|-----|----|----|----|----|------------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 01H | CHS | BAL | | | | | Don't Care | |

●CHS : Balance channel select

"0" : Ach "Bch is attenuated"

"1" : Bch "Ach is attenuated"

●BAL : Ach and Bch Balance

Balance Level : 0 to -30dB (1dB/Step) , MUTE

c) Tone Control BASS

| Select Address | BIT | | | | | | | |
|----------------|-----|------|----|----|----|----|------------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 03H | BCB | BASS | | | | | Don't Care | |

●BCB : Bass Boost or Cut

"0" : Cut

"1" : Boost

●BASS : BASS Level

Cut Level : -15 to 0dB(0.5dB/Step)

Boost Level : 0 to +15dB(0.5dB/Step)

e) Tone Control TREBLE

| Select Address | BIT | | | | | | | |
|----------------|-----|------|----|----|----|----|------------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 04H | BCT | TREB | | | | | Don't Care | |

●BCT : Treble Boost or Cut

"0" : Cut

"1" : Boost

●TREB : Treble Level

Cut Level : -15 to 0dB(0.5dB/Step)

Boost Level : 0 to +15dB(0.5dB/Step)

f) BBE-Low

| Select Address | BIT | | | | | | | |
|----------------|------|----|----|----|----|-----|------------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 05H | BBEL | | | | | BBE | Don't Care | |

●BBEL:BBE-LOW Level

0dB to 15dB (0.5dB/step)

●BBE : BBE ON or OFF

g) BBE-High

| Select Address | BIT | | | | | | | |
|----------------|------|----|----|----|----|-----|---------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 05H | BBEH | | | | | AGC | AGC LVL | |

- BBEH: BBE-HIGH Level**

0dB to 15dB (0.5dB/step)

- AGC : AGC ON or OFF**

- AGC LVL : AGC Level**

300mVrms, 400mVrms, 500mVrms, 600mVrms

h) Surround (eala, TruSurround)

| Select Address | BIT | | | | | | | |
|----------------|------|----|---------|----|----|----|------------|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 06H | eala | | TS MODE | | | | Don't Care | |

- eala : eala mode**

Surround effect small (SR1), large (SR2), Simulated Stereo (SIM), By-Pass

- TS MODE : TruSurround mode**

By-Pass, SRS 3D, TS2ch (Passive Matrix TruSurround), TS4ch (for Dolby Pro Logic), TS5.1ch (for Dolby Digital), Mix Down

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■ Master Volume (Select Address: 00H)

| | | VOL | | | | | | | |
|----------|-----|-----|----|----|----|----|----|----|----|
| Gain(dB) | HEX | 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 |
| -41 | 84 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| -42 | 81 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| | | VOL | | | | | | | |
|----------|-----|-----|----|----|----|----|----|----|----|
| Gain(dB) | HEX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| -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 |
| Mute | 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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■ Balance (Select Address: 01H)

| Channel Setting (CHS) | D7 |
|-----------------------|----|
| Attenuated Bch Gain | 0 |
| Attenuated Ach Gain | 1 |

| 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 |

■ **Tone Control Bass (Select Address: 02H)**

| Bass Cut or Boost | BCB |
|----------------------|-----|
| | D7 |
| Cut | 0 |
| Boost | 1 |

| | | BASS | | | | |
|--------------|----------------|------|----|----|----|----|
| Cut Gain(dB) | Boost Gain(dB) | D6 | D5 | D4 | D3 | D2 |
| -15 | 15 | 1 | 1 | 1 | 1 | 0 |
| -14 | 14 | 1 | 1 | 1 | 0 | 0 |
| -13 | 13 | 1 | 1 | 0 | 1 | 0 |
| -12 | 12 | 1 | 1 | 0 | 0 | 0 |
| -11 | 11 | 1 | 0 | 1 | 1 | 0 |
| -10 | 10 | 1 | 0 | 1 | 0 | 0 |
| -9 | 9 | 1 | 0 | 0 | 1 | 0 |
| -8 | 8 | 1 | 0 | 0 | 0 | 0 |
| -7 | 7 | 0 | 1 | 1 | 1 | 0 |
| -6 | 6 | 0 | 1 | 1 | 0 | 0 |
| -5 | 5 | 0 | 1 | 0 | 1 | 0 |
| -4 | 4 | 0 | 1 | 0 | 0 | 0 |
| -3 | 3 | 0 | 0 | 1 | 1 | 0 |
| -2 | 2 | 0 | 0 | 1 | 0 | 0 |
| -1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

■ **Tone Control Treble (Select Address: 03H)**

| Treble Cut or Boost | BCT |
|------------------------|-----|
| | D7 |
| Cut | 0 |
| Boost | 1 |

| | | TREB | | | | |
|--------------|----------------|------|----|----|----|----|
| Cut Gain(dB) | Boost Gain(dB) | D6 | D5 | D4 | D3 | D2 |
| -15 | 15 | 1 | 1 | 1 | 1 | 0 |
| -14 | 14 | 1 | 1 | 1 | 0 | 0 |
| -13 | 13 | 1 | 1 | 0 | 1 | 0 |
| -12 | 12 | 1 | 1 | 0 | 0 | 0 |
| -11 | 11 | 1 | 0 | 1 | 1 | 0 |
| -10 | 10 | 1 | 0 | 1 | 0 | 0 |
| -9 | 9 | 1 | 0 | 0 | 1 | 0 |
| -8 | 8 | 1 | 0 | 0 | 0 | 0 |
| -7 | 7 | 0 | 1 | 1 | 1 | 0 |
| -6 | 6 | 0 | 1 | 1 | 0 | 0 |
| -5 | 5 | 0 | 1 | 0 | 1 | 0 |
| -4 | 4 | 0 | 1 | 0 | 0 | 0 |
| -3 | 3 | 0 | 0 | 1 | 1 | 0 |
| -2 | 2 | 0 | 0 | 1 | 0 | 0 |
| -1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

■ BBE-LOW Gain Code (Select Address: 04H)

| Gain(dB) | BBEL | | | | |
|----------|------|----|----|----|----|
| | D7 | D6 | D5 | D4 | D3 |
| 15 | 1 | 1 | 1 | 1 | 0 |
| 14 | 1 | 1 | 1 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 | 0 |
| 12 | 1 | 1 | 0 | 0 | 0 |
| 11 | 1 | 0 | 1 | 1 | 0 |
| 10 | 1 | 0 | 1 | 0 | 0 |
| 9 | 1 | 0 | 0 | 1 | 0 |
| 8 | 1 | 0 | 0 | 0 | 0 |
| 7 | 0 | 1 | 1 | 1 | 0 |
| 6 | 0 | 1 | 1 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 | 0 |
| 4 | 0 | 1 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 1 | 0 |
| 2 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |

■ BBE (Select Address: 04H)

| BBE ON/OFF | BBE |
|------------|-----|
| | D2 |
| OFF | 0 |
| ON | 1 |

■ BBE-HIGH Gain Code (Select Address: 05H)

| Gain(dB) | BBEH | | | | |
|----------|------|----|----|----|----|
| | D7 | D6 | D5 | D4 | D3 |
| 15 | 1 | 1 | 1 | 1 | 0 |
| 14 | 1 | 1 | 1 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 | 0 |
| 12 | 1 | 1 | 0 | 0 | 0 |
| 11 | 1 | 0 | 1 | 1 | 0 |
| 10 | 1 | 0 | 1 | 0 | 0 |
| 9 | 1 | 0 | 0 | 1 | 0 |
| 8 | 1 | 0 | 0 | 0 | 0 |
| 7 | 0 | 1 | 1 | 1 | 0 |
| 6 | 0 | 1 | 1 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 | 0 |
| 4 | 0 | 1 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 1 | 0 |
| 2 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |

■ AGC (Select Address: 05H)

| AGC ON/OFF | AGC |
|------------|-----|
| | D2 |
| OFF | 0 |
| ON | 1 |

■ AGC Level (Select Address: 05H)

| AGC Level | AGC LVL | |
|-----------|---------|----|
| | D1 | D0 |
| 300mVrms | 0 | 0 |
| 400mVrms | 0 | 1 |
| 500mVrms | 1 | 0 |
| 600mVrms | 1 | 1 |

■ eala mode (Select Address: 06H)

| eala MODE | eala | |
|------------------------|------|----|
| | D7 | D6 |
| By-Pass | 0 | 0 |
| Simulated Stereo (SIM) | 0 | 1 |
| 3D Effect Large (SR2) | 1 | 0 |
| 3D Effect Small (SR1) | 1 | 1 |

■ TruSurround mode(Select Address: 06H)


| TruSurround MODE | TS MODE | | | |
|------------------|---------|----|----|----|
| | D5 | D4 | D3 | D2 |
| By-Pass | 0 | 0 | 0 | 0 |
| SRS 3D | 0 | 0 | 1 | 1 |
| TS2ch | 0 | 1 | 0 | 1 |
| TS4ch | 1 | 0 | 0 | 0 |
| TS5.1ch | 1 | 1 | 0 | 0 |
| Mix Down | 1 | 1 | 1 | 0 |

NJW1149A

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BBE Sound, Inc.
5381 Production Drive
Huntington Beach, CA 92649
Tel:(714) 897-6766
Fax:(714) 896-0736

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For further information, please contact:

SRS Labs, Inc.
2909 Daimler Street. Santa Ana, CA 92705 USA

Tel: 949-442-1070 Fax: 949-852-1099 <http://www.srslabs.com>

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