

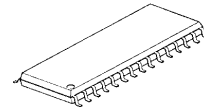
6-CHANNEL ELECTRONIC VOLUME

■ GENERAL DESCRIPTION

The **NJW1151** is a 6-CHANNEL ELECTRONIC VOLUME, which also includes tone control, balance and trim level control. The **NJW1151** is suitable for multi-channel audio system, such as AV amplifier, mini stereo component, speaker system, and others.

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

■ PACKAGE OUTLINE

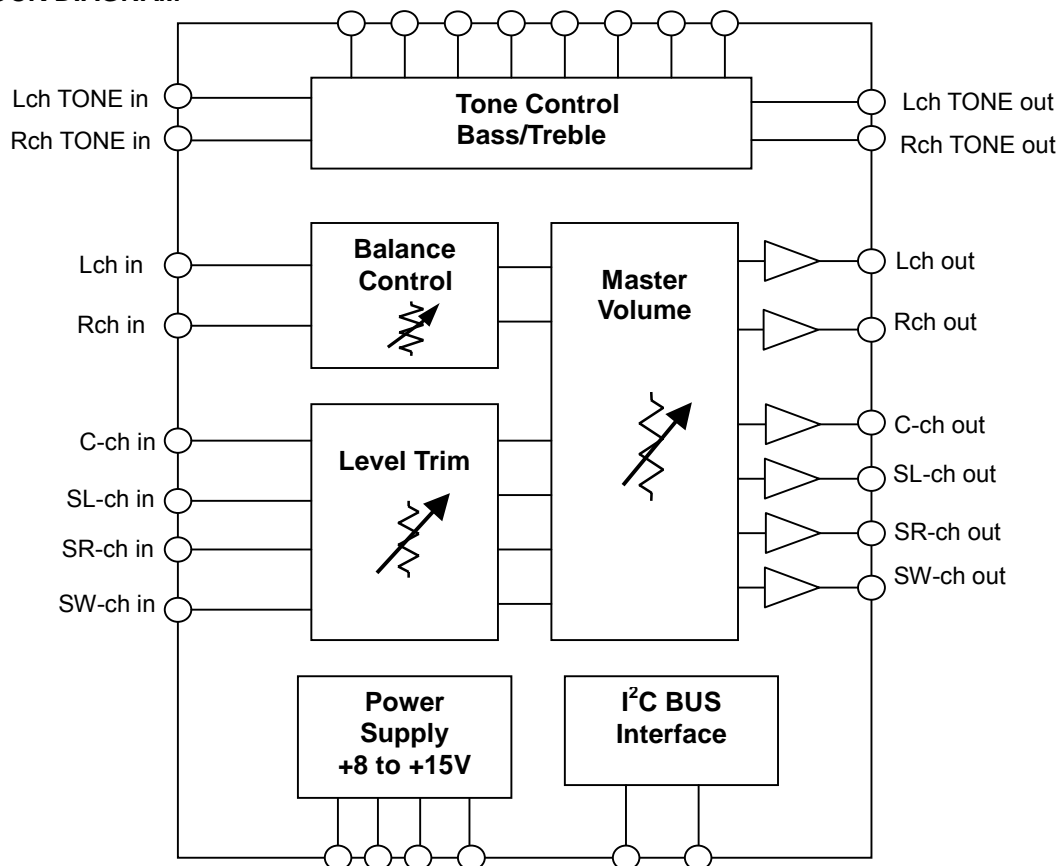


NJW1151M

■ FEATURES

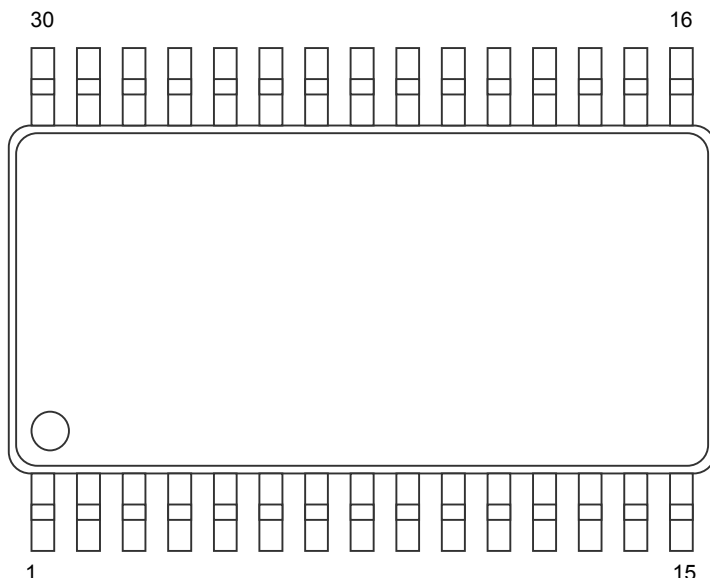
- Operating Voltage +8.0 to +15.0V
- I²C BUS Interface
- 6-Channel Master Volume 0 to -79dB, MUTE
- Balance control for L, R-ch 0 to -30dB, MUTE
- Trim Level Control for C, SL, SR, SW-ch 0 to -20dB
- Independent Tone Control (Bass, Treble) for L, R-ch
- Bi-CMOS Technology
- Package Outline SDMP30

■ BLOCK DIAGRAM



NJW1151

■ PIN FUNCTION



| No. | SYMBOL | FUNCTION | No. | SYMBOL | FUNCTION |
|-----|--------|--|-----|--------|---|
| 1 | VREF | Reference voltage | 16 | SCL | I ² C bus clock input |
| 2 | V+ | Power supply voltage | 17 | SDA | I ² C bus data input |
| 3 | VREFC | Reference voltage stabilization capacitor | 18 | SWOUT | Volume Sub Woofer channel output |
| 4 | RTIN | Tone control Right channel input | 19 | SROUT | Volume Surround Right channel output |
| 5 | RTOUT | Tone control Right channel output | 20 | SLOUT | Volume Surround Left channel volume output |
| 6 | RTC | Tone control Right channel Treble filter capacitor | 21 | COUT | Volume Center channel output |
| 7 | RBC1 | Tone control Right channel Bass filter capacitor | 22 | ROUT | Volume Right channel output |
| 8 | RBC2 | Tone control Right channel Bass filter capacitor | 23 | LOUT | Volume Left channel output |
| 9 | RBC3 | Tone control Right channel Bass DC cut capacitor | 24 | LBC3 | Tone control Left channel Bass DC cut capacitor |
| 10 | LIN | Volume Left channel input | 25 | LBC2 | Tone control Left channel Bass filter capacitor |
| 11 | RIN | Volume Right channel input | 26 | LBC1 | Tone control Left channel Bass filter capacitor |
| 12 | CIN | Volume Center channel input | 27 | LTC | Tone control Left channel Treble filter capacitor |
| 13 | SLIN | Volume Surround Left channel input | 28 | LTOUT | Tone control Left channel output |
| 14 | SRIN | Volume Surround Right channel input | 29 | LTIN | Tone control Left channel input |
| 15 | SWIN | Volume Sub Woofer channel input | 30 | GND | Ground (IC substrate) |

■ ABSOLUTE MAXIMUM RATING (Ta=25°C)

| PARAMETER | SYMBOL | RATING | UNIT |
|-----------------------------|-----------------|--------------------|------|
| Supply Voltage | V ⁺ | +15 | V |
| Maximum Input Voltage | V _{IM} | V ⁺ (*) | V |
| Power Dissipation | P _D | 700 | mW |
| Operating Temperature Range | Topr | -40 to +85 | °C |
| Storage Temperature Range | Tstg | -40 to +125 | °C |

(*) For the maximum input voltage less than 0 to V⁺

■ ELECTRICAL CHARACTERISTICS (Ta=25°C, V⁺=14V, V_{DD}=5V)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-----------------------|-----------------|----------------|------|------|------|------|
| ◆ Power Supply | | | | | | |
| Operating Voltage | V ⁺ | | 8.0 | 14.0 | 15.0 | V |
| Supply Current | I _{CC} | No Signal | - | 10 | 30 | mA |

◆ Input/Output Characteristics

| | | | | | | |
|---------------------------|------------------|--|------|----------------|---------------|---------------|
| Voltage Gain | G _V | V _{IN} =1Vrms, f=1kHz Master=0dB, Balance=0dB Trimmer=0dB | -0.5 | 0 | 0.5 | dB |
| Voltage Gain Error | ΔG _V | V _{IN} =1Vrms, f=1kHz Master=0dB | -0.5 | 0 | 0.5 | dB |
| Maximum Attenuation 1 | A _{TT1} | f=1kHz, V _{IN} =1Vrms Master=-79dB | - | -79 | - | dB |
| Maximum Attenuation 2 | A _{TT2} | f=1kHz, V _{IN} =1Vrms Mute | - | -90 | - | dB |
| Attenuation Error | ΔA _{TT} | f=1kHz, V _{IN} =1Vrms Master=-50dB Trimmer=-10dB | -1 | 0 | 1 | dB |
| Maximum Output Voltage | V _{OM} | f=1kHz, THD=1% Master=0dB | 3.0 | 4.0 | - | Vrms |
| Output Noise | V _{NO} | Master=0dB, Rg=0, A-weight | - | -110 (3.2μ) | -100 (10μ) | dBV (Vrms) |
| Total Harmonic Distortion | T.H.D. | f=1kHz, Vo=1Vrms, Master=0dB, Trimmer=0dB | - | 0.005 | 0.05 | % |
| Channel Separation | CS | f=1kHz, Vo=1Vrms Master=0dB, A-weight | - | -90 | -80 | dB |

◆ Tone Control Characteristics

| | | | | | | |
|--------------------|-------------------|----------------------------------|-----|-----|----|----|
| Treble Boost Gain1 | HF _{BST} | Vo=1Vrms f=10kHz Treble=10dB | 8 | 10 | 12 | dB |
| Treble Boost Gain2 | HF _{CUT} | Vo=1Vrms f=10kHz Treble=-10dB | -12 | -10 | -8 | dB |
| Bass Boost Gain1 | LF _{BST} | Vo=1Vrms f=50Hz Bass=10dB | 8 | 10 | 12 | dB |
| Bass Boost Gain2 | LF _{CUT} | Vo=1Vrms f=50Hz Bass=-10dB | -12 | -10 | -8 | dB |

■ 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 : $t_{HD:DAT}$

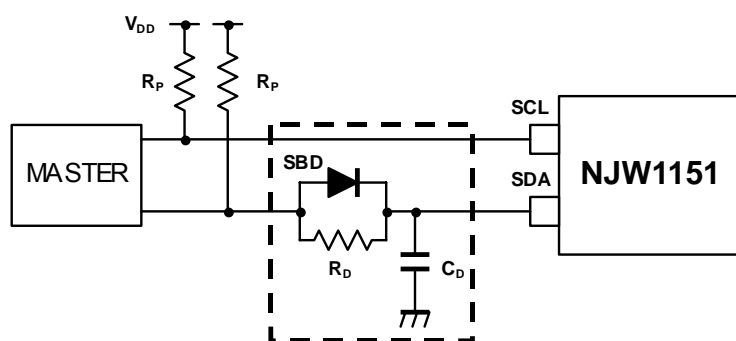
Please hold the Data Hold Time ($t_{HD:DAT}$) to 300ns or more to avoid status of unstable at SCL falling edge.

The SDA block in the NJW1151 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 \rightarrow High level: $T_{LH} \approx R_P * C_D$
- (b) High level \rightarrow Low level: $T_{HL} \approx R_D * C_D$

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.



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■ TERMINAL DESCRIPTION

| No. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|---------|--------------|---|--------------------|------------------|
| 1 | VREF | Reference voltage | | $V+ / 2$ |
| 2 | V+ | Power supply voltage | | $V+$ |
| 3 | VREFC | Reference voltage stabilization capacitor | | $V+ / 2$ |
| 4 29 | RTIN LTIN | Tone control Right channel input Left channel input | | $V+ / 2$ |

■TERMINAL DESCRIPTION

| No. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|---------|----------------|---|--------------------|------------------|
| 5 28 | RTOUT LTOUT | Tone control Right channel output Left channel output | | $V+ / 2$ |
| 6 27 | RTC LTC | Tone control Right channel Treble filter capacitor Left channel Treble filter capacitor | | $V+ / 2$ |
| 7 26 | RBC1 LBC1 | Tone control Right channel Bass filter capacitor Left channel Bass filter capacitor | | $V+ / 2$ |
| 8 25 | RBC2 LBC2 | Tone control Right channel Bass filter capacitor Left channel Bass filter capacitor | | $V+ / 2$ |

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■TERMINAL DESCRIPTION

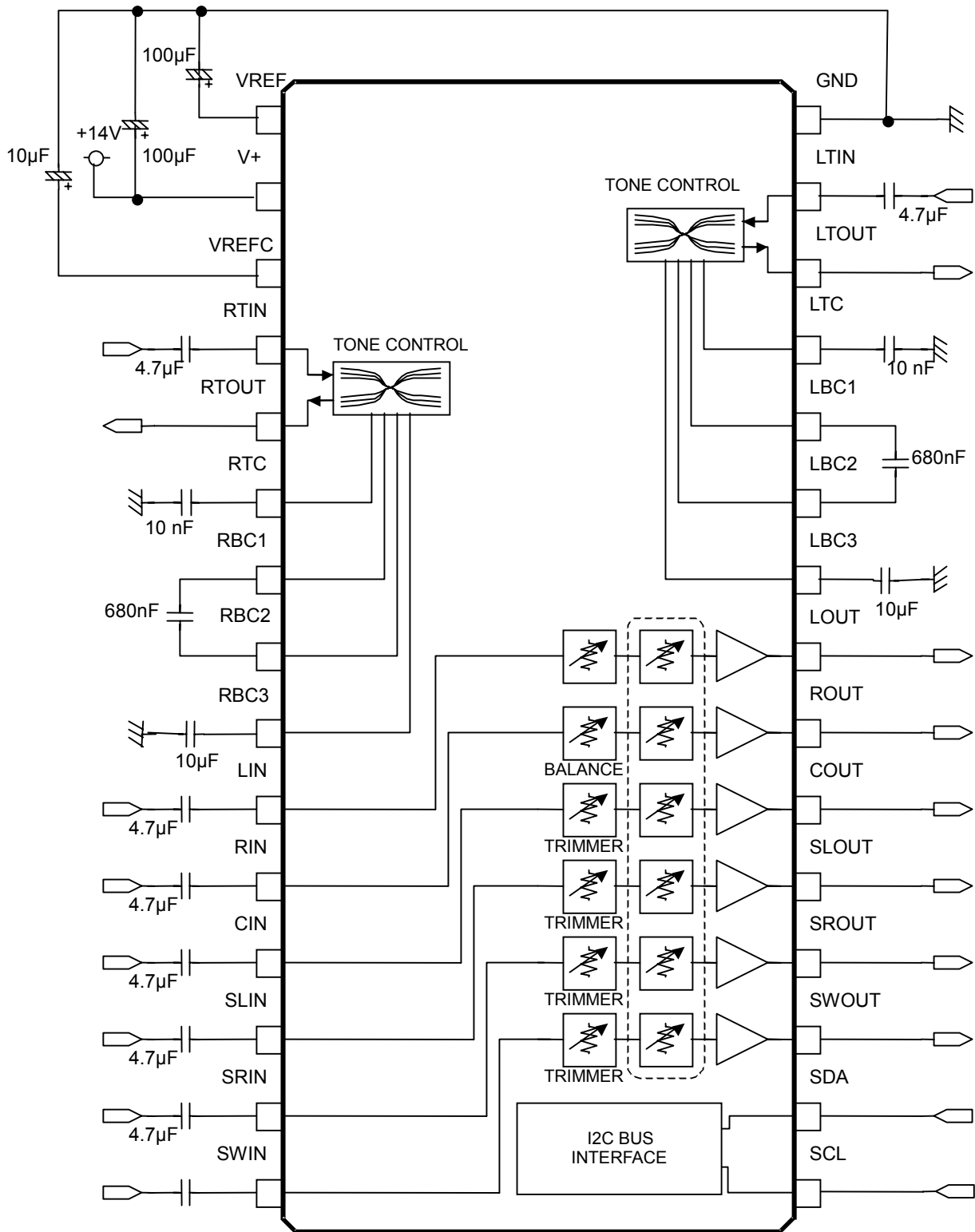
| No. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|----------------------------------|---|--|---|------------------|
| 9 24 | RBC3 LBC3 | Tone control Right channel Bass DC cut capacitor Left channel Bass DC cut capacitor | | $V+ / 2$ |
| 10 11 12 13 14 15 | LIN RIN CIN SLIN SRIN SWIN | Volume Left channel input Right channel input Center channel input Surround Left channel input Surround Right channel input Sub Woofer channel input | | $V+ / 2$ |
| 16 | SCL | I ² C bus clock input | <p>(Rp ; External pull up resistor)</p> | - |
| 17 | SDA | I ² C bus data input | <p>(Rp ; External pull up resistor)</p> | - |

■TERMINAL DESCRIPTION

| No. | SYMBOL | FUNCTION | EQUIVALENT CIRCUIT | TERMINAL VOLTAGE |
|-----|--------|-------------------------------|---------------------------|------------------|
| 18 | SWOUT | Volume | | $V+ / 2$ |
| 19 | SROUT | Left channel output | | |
| 20 | SLOUT | Right channel output | | |
| 21 | COUT | Center channel output | | |
| 22 | ROUT | Surround Left channel output | | |
| 23 | LOUT | Surround Right channel output | Sub Woofer channel output | |

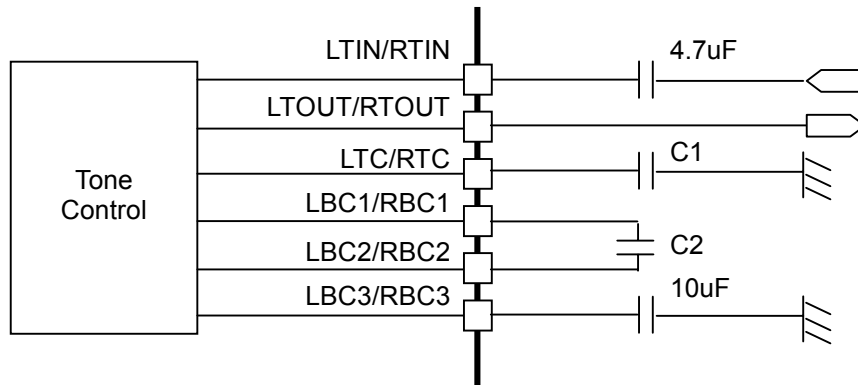
NJW1151

APPLICATION CIRCUIT



■ Definition of cut-off frequency for Tone Control

Cut-off frequency for Tone Control is adjustable with changing the capacitor C1, C2 in below circuit.
See the next function for the cut-off frequency.



EX) C1 = 10nF, C2 = 680nF
 Cut-off frequency for Treble = 3.9kHz
 Cut-off frequency for Bass = 238Hz

1) TREBLE = +/-10dB

2) BASS = +/-10dB

$$f_c = \frac{39.2 * 10^{-6}}{C1} (kHz)$$

$$f_c = \frac{161.7 * 10^{-6}}{C2} (Hz)$$

NJW1151

■ DEFINITION OF I²C REGISTER

● I²C BUS FORMAT

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



● SLAVE ADDRESS



R/W=0: Receive Only

R/W=1: No Output Data

● CONTROL REGISTER TABLE

| Select Address | BIT | | | | | | | |
|----------------|---------------|---------------|------|------------------------|-------------|----|----|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 00H | * | Master Volume | | | | | | |
| 01H | * | | | Left channel Balance | | | | |
| 02H | * | | | Right channel Balance | | | | |
| 03H | * | | | Center Channel Trimmer | | | | |
| 04H | * | | | SL Channel Trimmer | | | | |
| 05H | * | | | SR Channel Trimmer | | | | |
| 06H | * | | | SW Channel Trimmer | | | | |
| 07H | Tone (Treble) | | | | Tone (Bass) | | | |
| 08H | * | | MUTE | | | | | |

* : Don't care.

On Power up, the master volume mute is activated.

● CONTROL REGISTER DEFAULT VALUE

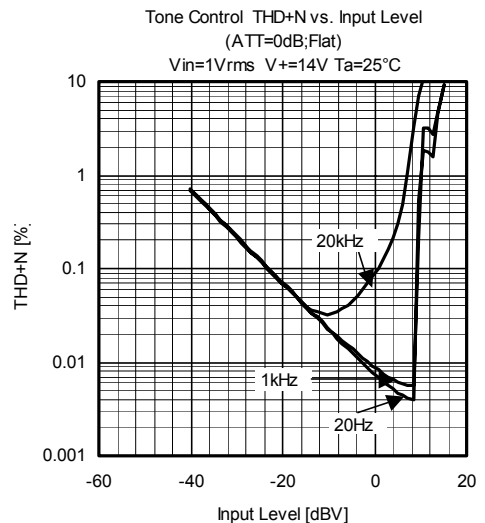
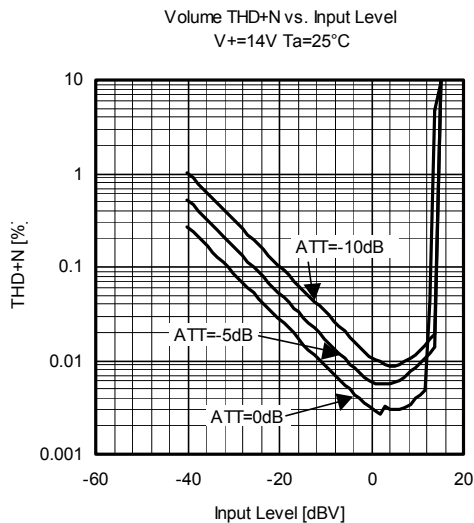
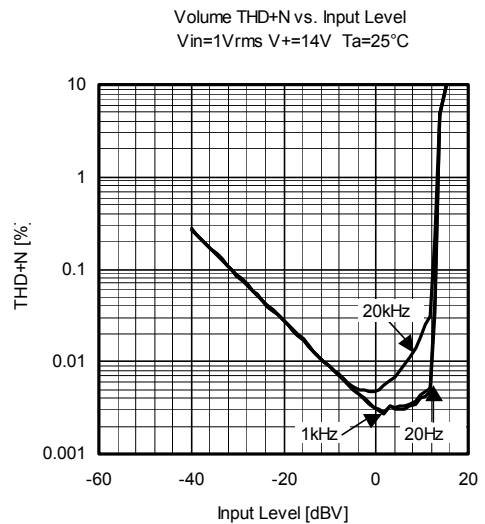
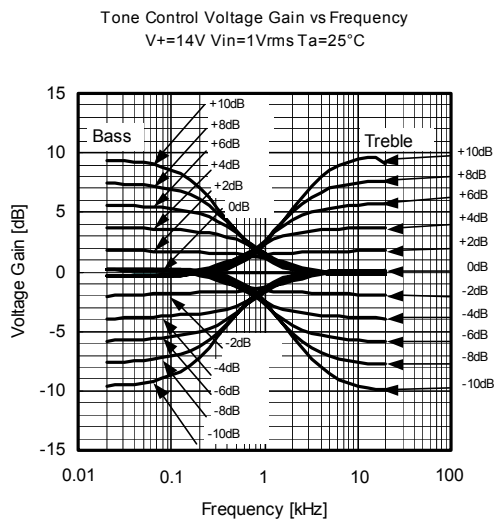
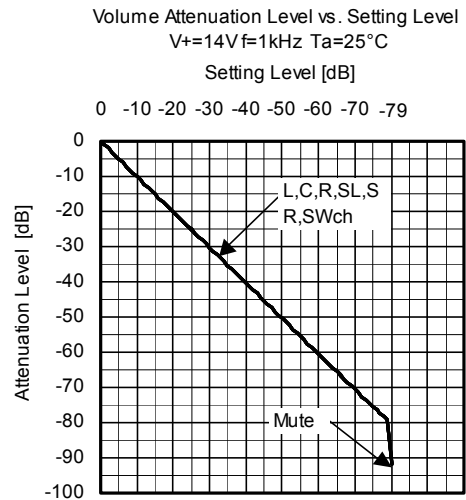
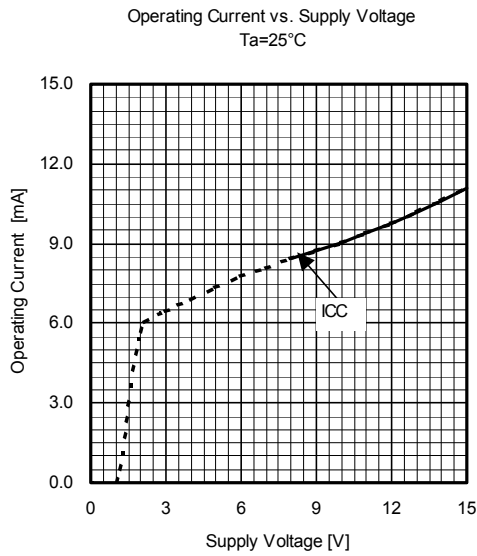
| Select Address | BIT | | | | | | | |
|----------------|-----|----|----|----|----|----|----|----|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 00H | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 01H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 02H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 03H | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 04H | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 05H | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 06H | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 07H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 08H | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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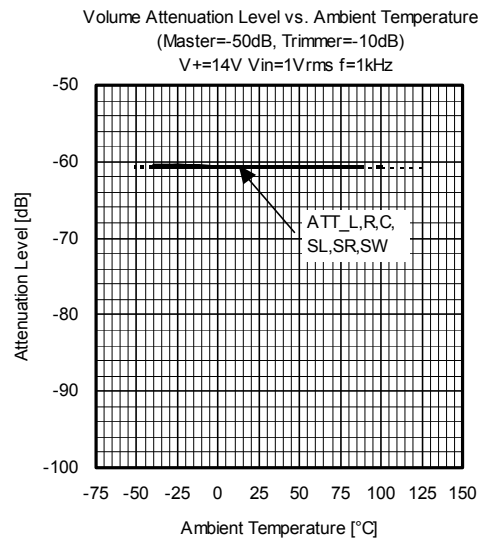
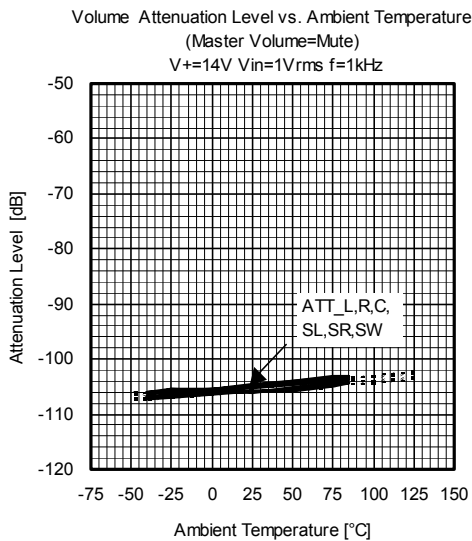
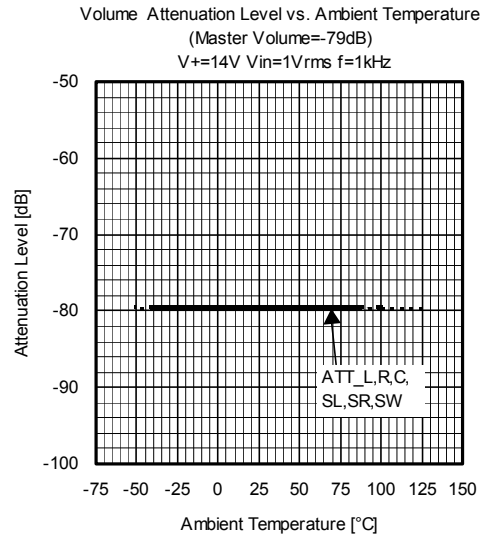
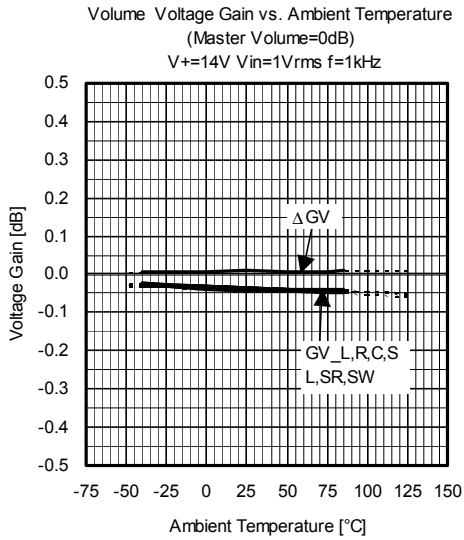
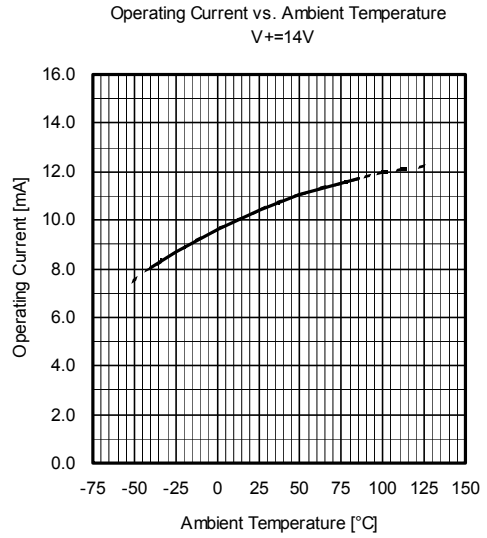
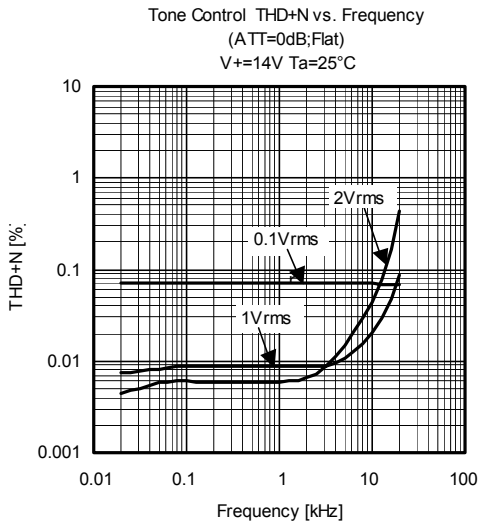
● CONTROL COMMAND TABLE

| Select Address | BIT | | | | | | | | REMARKS |
|----------------|--------|----|----|----|------|----|----|----|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| 07H | TREBLE | | | | BASS | | | | TONE CONTROL Ex.) "11011101"=+10dB "11001100"=+8dB : "10001000"=0dB "00000000"=0dB : "01000111"=-8dB "01010101"=-10dB |
| | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | |
| | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | |
| | : | : | : | : | : | : | : | : | |
| | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | : | : | : | : | : | : | : | : | |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | | |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | | |
| 08H | MUTE | | | | | | | | MUTE CONTROL Ex.) "0"=OFF "1"=MUTE D5=L ch,D4=R ch,D3=C ch,D2=SL ch,D1=SR ch,D0=SW ch |
| | 0 | | | | | | | | |
| | 1 | | | | | | | | |

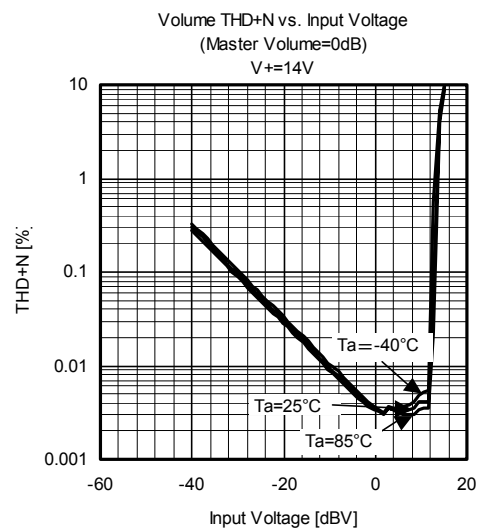
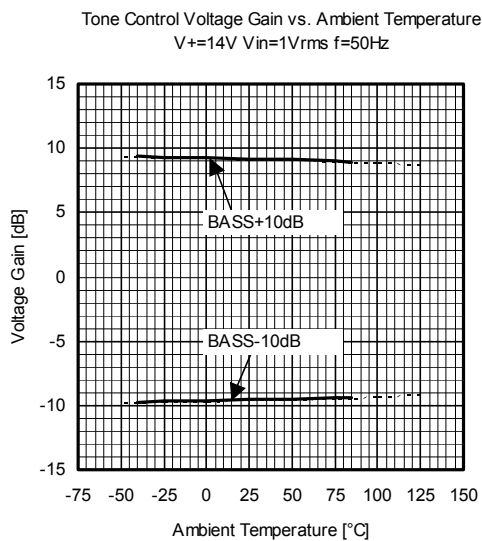
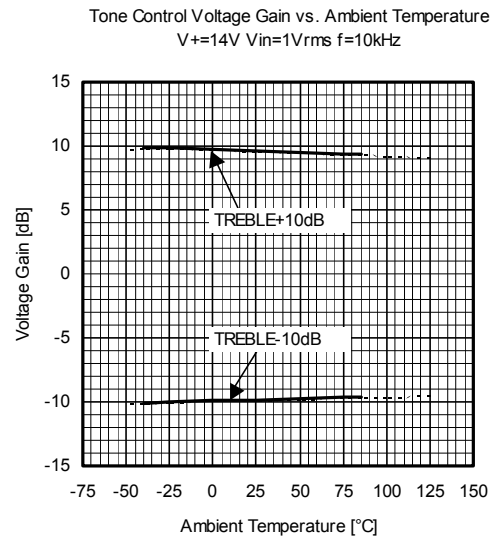
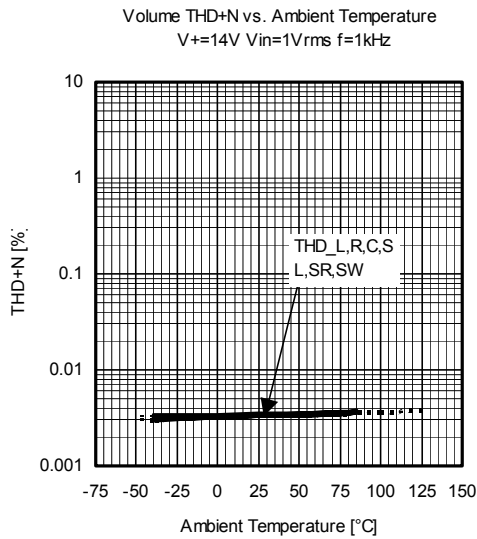
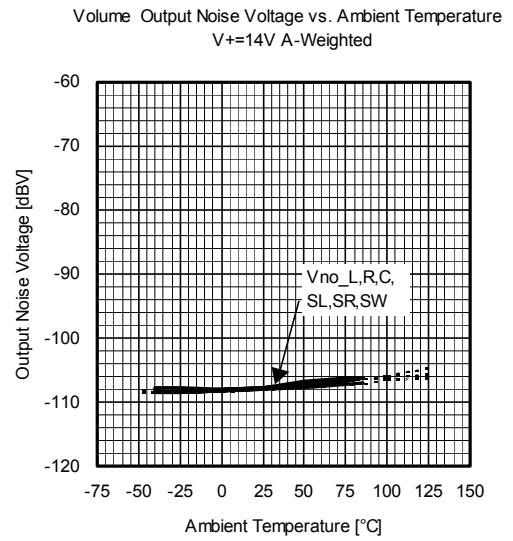
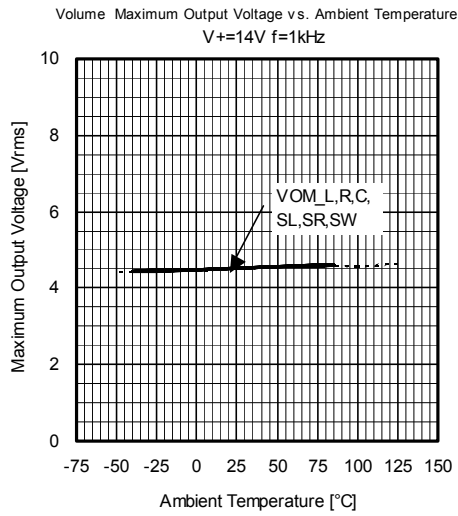
TYPICAL CHARACTERISTICS



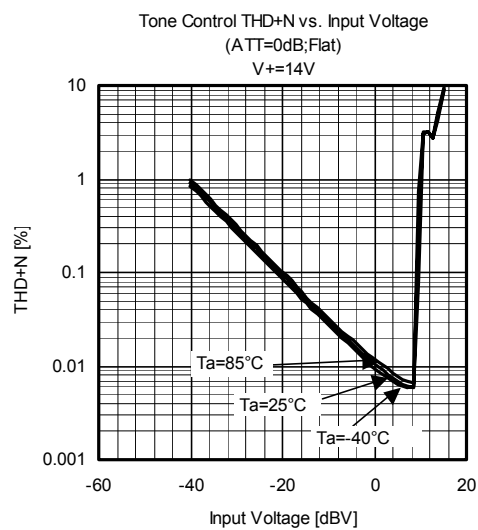
■ TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS





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