

## 4-CHANNEL ELECTRONIC VOLUME

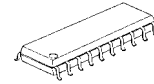
### ■ GENERAL DESCRIPTION

The **NJW1184** is a four channel electronic volume.

The **NJW1184** performs click-noiseless characteristics with VCA circuit.

These functions are controlled by I<sup>2</sup>C Bus. And the Slave Address selector is available for using two chips on same serial bus line. It's available for two-channel stereo and or multi-channel audio volume.

### ■ PACKAGE OUTLINE

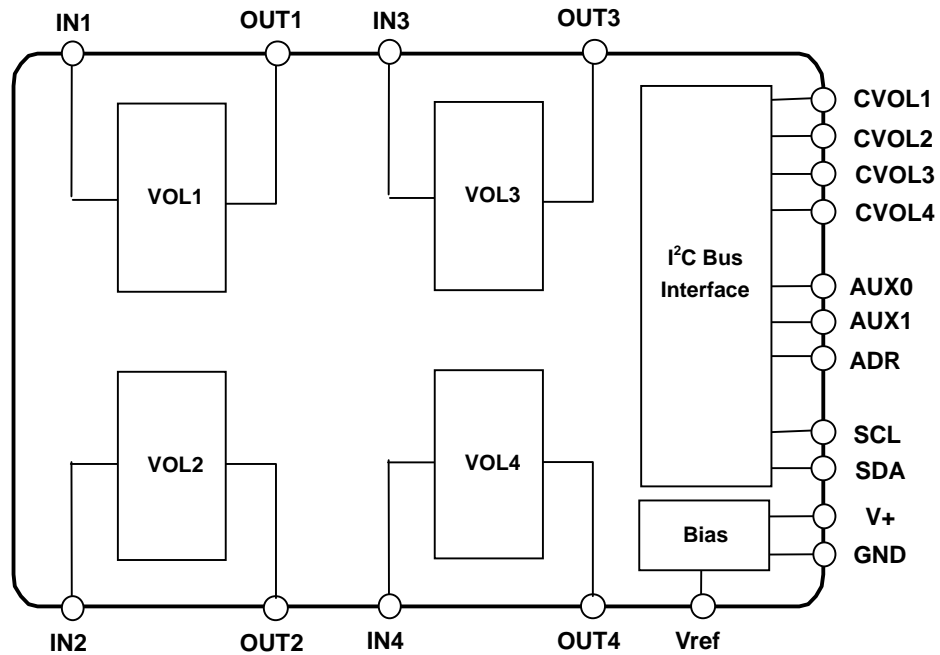


**NJW1184M**

### ■ FEATURES

- Operating Voltage                      7.5 to 13V
- I<sup>2</sup>C Bus control
- Slave Address Selector                available for using two chips on same serial bus line
- Volume (VCA type)                    0 to -100dB/0.5dBstep, MUTE
- 2 Auxiliary Port
- Bi-CMOS Technology
- Package Outline                         DMP20

### ■ BLOCK DIAGRAM



## ■PIN CONFIGURATION



No.	Symbol	Function	No.	Symbol	Function
1	IN1	Input 1	11	V+	Power Supply Pin
2	OUT1	Output 1	12	Vref	Reference Voltage
3	IN2	Input 2	13	AUX0	Auxiliary Output0
4	OUT2	Output 2	14	AUX1	Auxiliary Output1
5	CVOL1	DAC Output for Volume 1	15	CVOL4	DAC Output for Volume 4
6	CVOL2	DAC Output for Volume 2	16	CVOL3	DAC Output for Volume 3
7	ADR	Slave Address Setting	17	OUT4	Output 4
8	SDA	SDA Data Input (I <sup>2</sup> C BUS)	18	IN4	Input 4
9	SCL	SCL Data Input (I <sup>2</sup> C BUS)	19	OUT3	Output 3
10	GND	GND	20	IN3	Input 3

## ■ ABSOLUTE MAXIMUM RATING (Ta=25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V <sup>+</sup>	15	V
Maximum Input Voltage	V <sub>IM</sub>	0 to V <sup>+</sup> (*)	V
Power Dissipation	P <sub>D</sub>	DMP20 : 350	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<sup>+</sup>

## ■ ELECTRICAL CHARACTERISTICS

(Ta=25°C, V+=9V, R<sub>L</sub>=47kΩ, Vin=100mVrms/1kHz, unless otherwise specified)

### ● POWER SUPPLY

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	V <sup>+</sup>		7.5	9.0	13.0	V
Supply Current	I <sub>CC</sub>	No Signal	-	4	10	mA
Reference Voltage	V <sub>REF</sub>	No Signal	4.0	4.5	5.0	V

### ● VOLUME

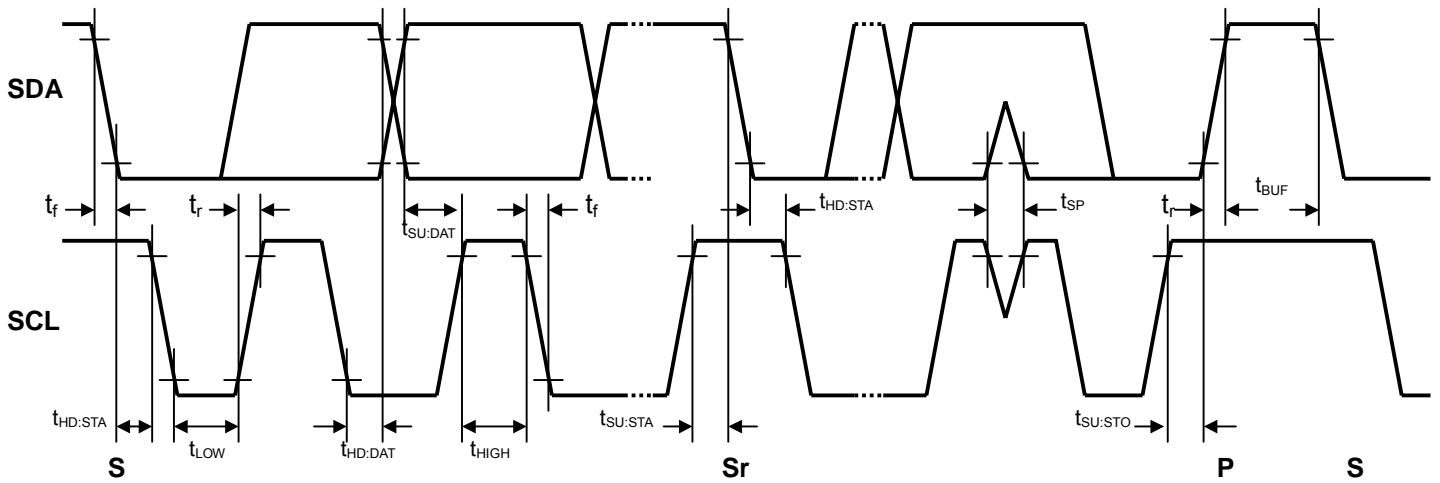
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Maximum Input Voltage	V <sub>IM</sub>	VOL=-20dB, THD=1%	2.8	3.0	-	Vrms
Maximum Output Voltage	V <sub>OM</sub>	OUTPUT VOL=0dB, THD=1%	-	2.5	-	Vrms
Channel Balance	G <sub>CB</sub>	VOL=0dB	-1.0	0.0	1.0	dB
Total Harmonic Distortion	THD	Vo=0.5Vrms BW=400Hz to 30kHz	-	-	0.3	%
Maximum Gain	G <sub>VMAX</sub>	VOL= 0dB	-2.0	0.0	2.0	dB
Minimum Gain	G <sub>VMIN</sub>	VOL= MUTE, Vin=2Vrms	-	-100	-90	dB
Channel Separation	CS	Vin = 1Vrms A-weighting	-	-80	-70	dB
Output Noise 1	V <sub>NO1</sub>	VOL = 0dB A-weighting	-	-90 (31.6)	-85 (56.2)	dBV (μVrms)
Output Noise 2	V <sub>NO2</sub>	VOL = MUTE A-weighting	-	-106 (5.0)	-96 (15.8)	dBV (μVrms)
Input Impedance	R <sub>i</sub>		-	20	-	kΩ
AUX Output Voltage	V <sub>AUX</sub>	Logic Output: High	4.5	-	5.5	V
		Logic Output: Low	0	-	0.5	

BW: Band Width

### ● CONTROL

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
High Level Input Voltage	V <sub>ADRH</sub>	High : Slave Address 82H	V <sup>+</sup> /2	-	-	V
Low Level Input Voltage	V <sub>ADRL</sub>	Low : Slave Address 80H	-	-	1.0	V

## ■TIMING ON THE I<sup>2</sup>C BUS (SDA,SCL)



## ■CHARACTERISTICS OF I/O STAGES FOR I<sup>2</sup>C BUS (SDA,SCL)

I<sup>2</sup>C BUS Load Conditions

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

FAST MODE : Pull up resistance 4kΩ (Connected to +5V), Load capacitance 50pF (Connected to GND)

PARAMETER	SYMBOL	Standard mode			Fast mode			UNIT
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Low Level Input Voltage	V <sub>IL</sub>	0.0	-	1.5	0.0	-	1.5	V
High Level Input Voltage	V <sub>IH</sub>	2.7	-	5.0	2.7	-	5.0	V
Low level output voltage (3mA at SDA pin)	V <sub>OL</sub>	0	-	0.4	0	-	0.4	V
Input current each I/O pin with an input voltage between 0.1V <sub>DD</sub> and 0.9V <sub>DDmax</sub>	I <sub>i</sub>	-10	-	10	-10	-	10	μA

## ■CHARACTERISTICS OF BUS LINES (SDA,SCL) FOR I<sup>2</sup>C-BUS DEVICES

PARAMETER	SYMBOL	Standard mode			Fast mode			UNIT
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
SCL clock frequency	f <sub>SCL</sub>	-	-	100	-	-	400	kHz
Hold time (repeated) START condition.	t <sub>HD:STA</sub>	4.0	-	-	0.6	-	-	μs
Low period of the SCL clock	t <sub>LOW</sub>	4.7	-	-	1.3	-	-	μs
High period of the SCL clock	t <sub>HIGH</sub>	4.0	-	-	0.6	-	-	μs
Set-up time for a repeated START condition	t <sub>SU:STA</sub>	4.7	-	-	0.6	-	-	μs
Data hold time <sup>(NOTE)</sup>	t <sub>HD:DAT</sub>	0	-	-	0	-	-	μs
Data set-up time	t <sub>SU:DAT</sub>	250	-	-	100	-	-	ns
Rise time of both SDA and SCL signals	t <sub>r</sub>	-	-	1000	-	-	300	ns
Fall time of both SDA and SCL signals	t <sub>f</sub>	-	-	300	-	-	300	ns
Set-up time for STOP condition	t <sub>SU:STO</sub>	4.0	-	-	0.6	-	-	μs
Bus free time between a STOP and START condition	t <sub>BUF</sub>	4.7	-	-	1.3	-	-	μs
Capacitive load for each bus line	C <sub>b</sub>	-	-	400	-	-	400	pF
Noise margin at the Low level	V <sub>nL</sub>	0.5	-	-	0.5	-	-	V
Noise margin at the High level	V <sub>nH</sub>	1	-	-	1	-	-	V

C<sub>b</sub> ; total capacitance of one bus line in pF.

NOTE). Data hold time : t<sub>HD:DAT</sub>

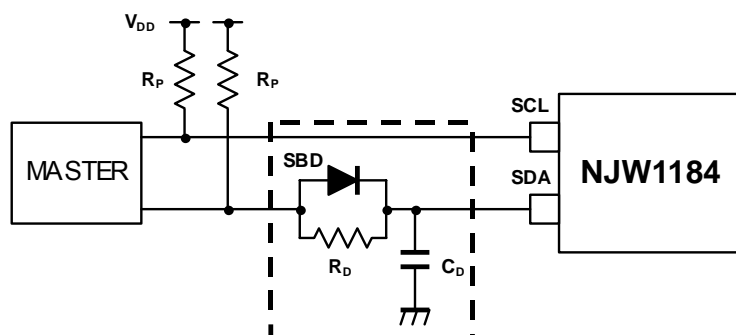
Please hold the Data Hold Time (t<sub>HD:DAT</sub>) to 300ns or more to avoid status of unstable at SCL falling edge.

The SDA block in the NJW1184 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<sub>f</sub>) as much as possible.



## ■ TERMINAL DESCRIPTION

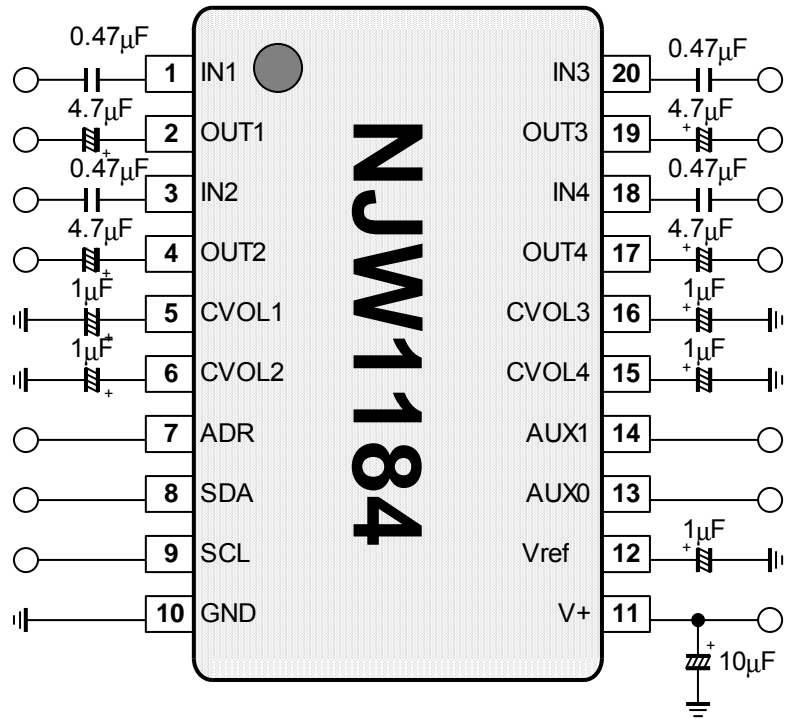
PIN NO.	SYMBOL	FUNCTION	EQUIVALENT CIRCUIT	TERMINAL DC VOLTAGE
1 3 20 18	IN1 IN2 IN3 IN4	Input 1 Input 2 Input 3 Input 4		$V^+/2$
2 4 19 17	OUT1 OUT2 OUT3 OUT4	Output 1 Output 2 Output 3 Output 4		$V^+/2$
5 6 16 15	CVOL1 CVOL2 CVOL3 CVOL4	DAC Output for Volume 1 DAC Output for Volume 2 DAC Output for Volume 3 DAC Output for Volume 4		$V^+/2 - 0.7V$ (0dB setting)
7	ADR	Slave Address Setting		82(h) $V_{ADR} > V^+/2$  80(h) $V_{ADR} \leq 1.0V$

## ■ TERMINAL DESCRIPTION

PIN NO.	SYMBOL	FUNCTION	EQUIVALENT CIRCUIT	TERMINAL DC VOLTAGE
8 9	SDA SCL	SDA Data Input (I <sup>2</sup> C BUS) SCL Data Input (I <sup>2</sup> C BUS)	<p>SCL:GND SDA:ACK</p>	-
12	Vref	Reference Voltage		$V^+/2$
13 14	AUX0 AUX1	Auxiliary Output 0 Auxiliary Output 1		0V / 5V

# NJW1184

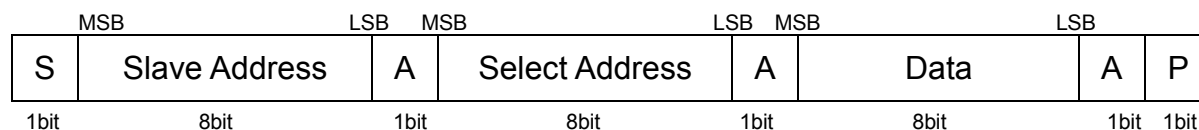
## APPLICATION CIRCUIT





■ DEFINITION OF I<sup>2</sup>C REGISTER

● I<sup>2</sup>C BUS FORMAT



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

● SLAVE ADDRESS



ADR: Hardware pin programmable address bits  
80(h), 82(h)

R/W=0: Write mode for register setting  
R/W=1: Not available

● CONTROL REGISTER TABLE

The select address sets each function (Volume, Aux).  
The auto-increment function cycles the select address as follows.  
00H→01H→02H→03H→04H→00H

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
00H	VOL-1							
01H	VOL-2							
02H	VOL-3							
03H	VOL-4							
04H	Don't Care	Don't Care	Don't Care	Don't Care	Don't Care	Don't Care	AUX1	AUX0

● 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

## ■ I<sup>2</sup>C CONTROL COMMAND DESCRIPTION

a) Master Volume (Select Address: 00H, 01H, 02H, 03H) Volume level : 0 to -100dB(0.5dB/step), MUTE

Gain(dB)	HEX	VOL-1 / VOL-2 / VOL-3 / VOL-4							
		D7	D6	D5	D4	D3	D2	D1	D0
0	FF	1	1	1	1	1	1	1	1
-0.5	FE	1	1	1	1	1	1	1	0
-1.0	FD	1	1	1	1	1	1	0	1
-1.5	FC	1	1	1	1	1	1	0	0
-2.0	FB	1	1	1	1	1	0	1	1
-2.5	FA	1	1	1	1	1	0	1	0
-3.0	F9	1	1	1	1	1	0	0	1
-3.5	F8	1	1	1	1	1	0	0	0
-4.0	F7	1	1	1	1	0	1	1	1
-4.5	F6	1	1	1	1	0	1	1	0
-5.0	F5	1	1	1	1	0	1	0	1
-5.5	F4	1	1	1	1	0	1	0	0
-6.0	F3	1	1	1	1	0	0	1	1
-6.5	F2	1	1	1	1	0	0	1	0
-7.0	F1	1	1	1	1	0	0	0	1
-7.5	F0	1	1	1	1	0	0	0	0
-8.0	EF	1	1	1	0	1	1	1	1
-8.5	EE	1	1	1	0	1	1	1	0
-9.0	ED	1	1	1	0	1	1	0	1
-9.5	EC	1	1	1	0	1	1	0	0
-10.0	EB	1	1	1	0	1	0	1	1
-10.5	EA	1	1	1	0	1	0	1	0
-11.0	E9	1	1	1	0	1	0	0	1
-11.5	E8	1	1	1	0	1	0	0	0
-12.0	E7	1	1	1	0	0	1	1	1
-12.5	E6	1	1	1	0	0	1	1	0
-13.0	E5	1	1	1	0	0	1	0	1
-13.5	E4	1	1	1	0	0	1	0	0
-14.0	E3	1	1	1	0	0	0	1	1
-14.5	E2	1	1	1	0	0	0	1	0
-15.0	E1	1	1	1	0	0	0	0	1
-15.5	E0	1	1	1	0	0	0	0	0
-16.0	DF	1	1	0	1	1	1	1	1
-16.5	DE	1	1	0	1	1	1	1	0
-17.0	DD	1	1	0	1	1	1	0	1
...	...	...	...	...	...	...	...	...	...
-99.5	38	0	0	1	1	1	0	0	0
-100.0	37	0	0	1	1	0	1	1	1
...	...	...	...	...	...	...	...	...	...
Mute	00	0	0	0	0	0	0	0	0

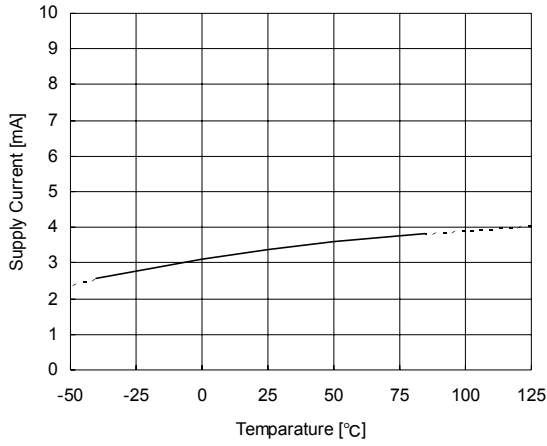
## b) AUXILIARY SETTING

Select Address	BIT							
	D7	D6	D5	D4	D3	D2	D1	D0
<b>04H</b>	Don't Care	Don't Care	Don't Care	Don't Care	Don't Care	Don't Care	<b>AUX1</b>	<b>AUX0</b>

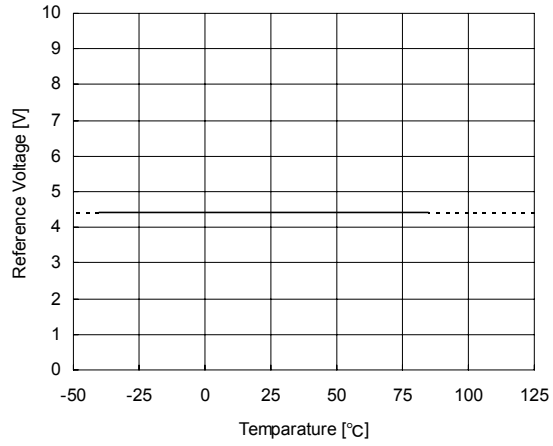
- AUX1/AUX0: Auxiliary port High/Low
  - “0” : Logic output "Low"
  - “1” : Logic output "High"

## ■ TYPICAL CHARACTERISTICS

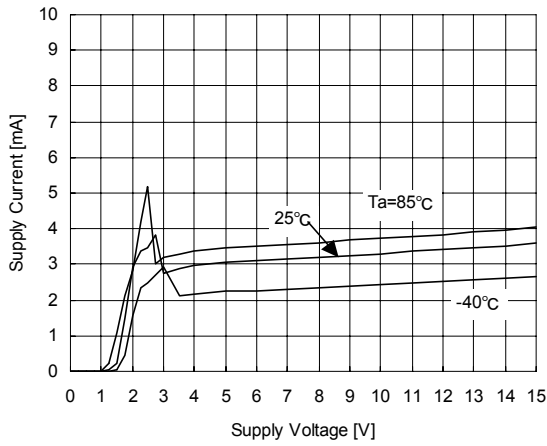
**Supply Current vs Temperature**  
 $V+=9V$ ,  $V_{in}$ =No Signal, Volume=0dB



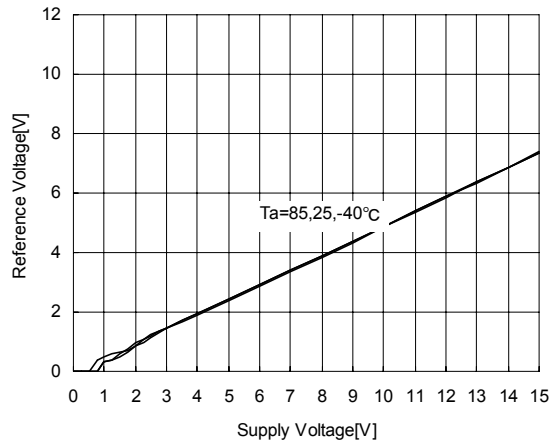
**Reference Voltage vs Temperature**  
 $V+=9V$ ,  $V_{in}$ =No Signal, Volume=0dB



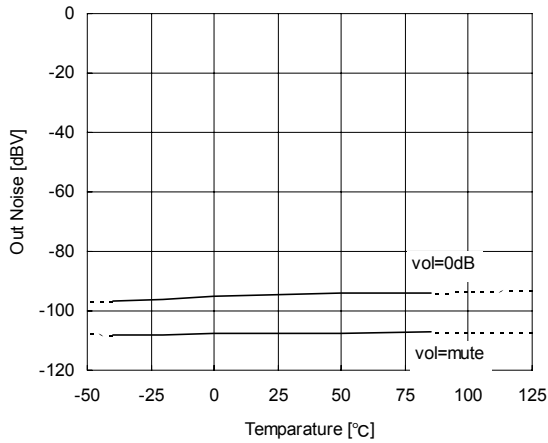
**Supply Current vs Supply Voltage**  
 $V_{in}$ =No Signal, Volume=0dB



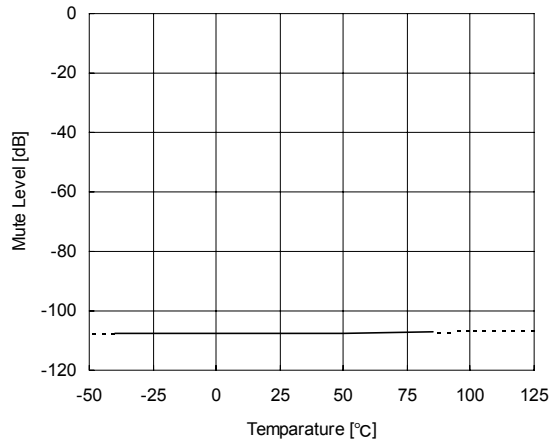
**Reference Voltage vs Supply Voltage**  
 $V_{in}$ =No Signal, Volume=0dB



**Out Noise vs Temperature**  
 $V+=9V$ ,  $R_g=600\Omega$ , A-Weighting



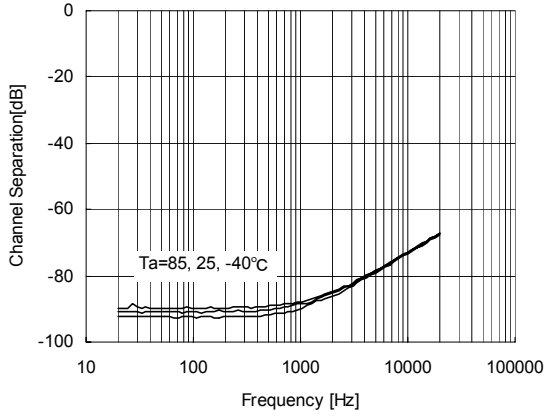
**Mute Level vs Temperature**  
 $V+=9V$ ,  $R_g=600\Omega$ ,  $V_{in}=1V_{rms}$ , A-Weighting



## TYPICAL CHARACTERISTICS

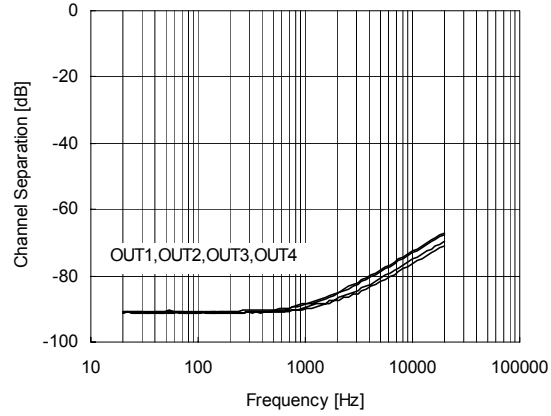
**Channel Separation vs Frequency**

V+=9V, Vin=1Vrms, A-Weighting, Rg=600Ω  
Vin:IN2+IN3+IN4, Vout:OUT1



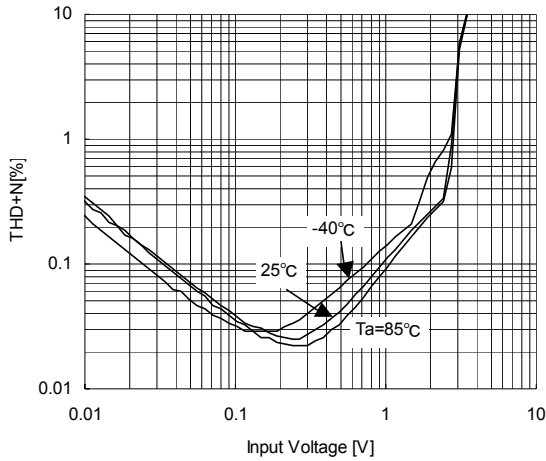
**Channel Separation vs Frequency**

V+=9V, Vin=1Vrms, A-Weighting, Ta=25°C  
Rg=600Ω



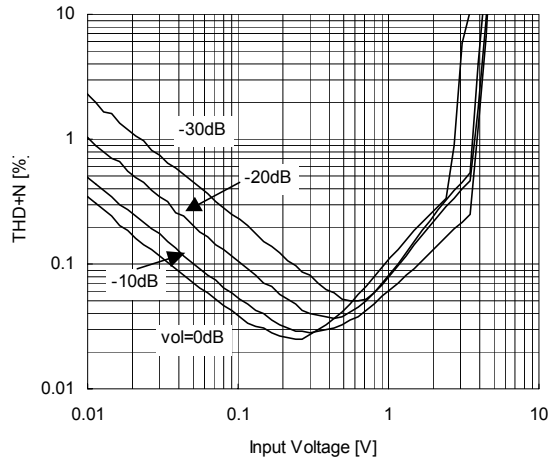
**THD+N vs Input Voltage (Temperature)**

V+=9V, Vin=CH1, f=1kHz, volume=0dB  
Rg=600Ω, BW=400Hz-30kHz, Vout=OUT1



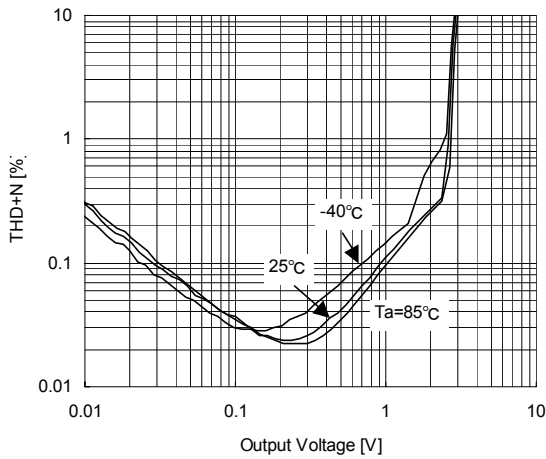
**THD+N vs Input Voltage (Volume Control)**

V+=9V, Vin=CH1, f=1kHz, Ta=25°C  
Rg=600Ω, BW=400Hz-30kHz, Vout=OUT1



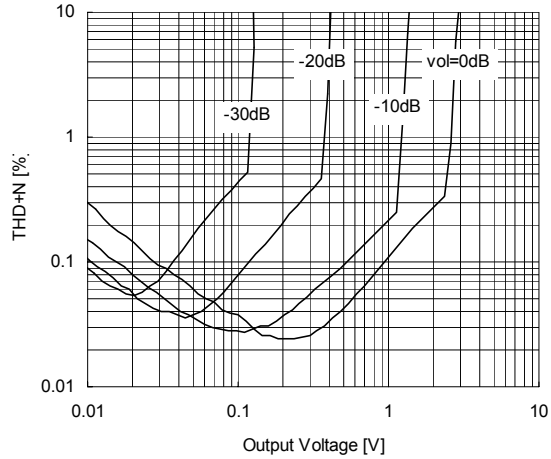
**THD+N vs Output Voltage (Temperature)**

V+=9V, Vin=CH1, f=1kHz, volume=0dB  
Rg=600Ω, BW=400Hz-30kHz, Vout=OUT1



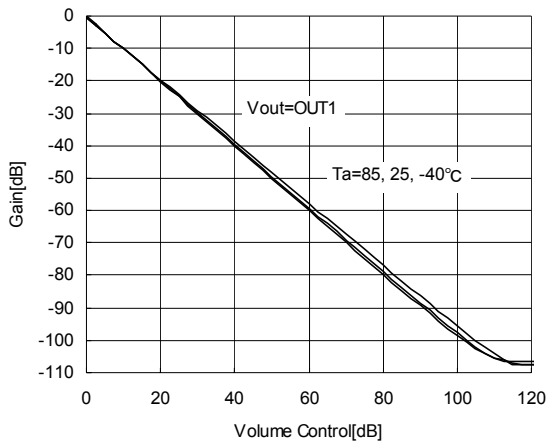
**THD+N vs Output Voltage (Volume Control)**

V+=9V, Vin=CH1, f=1kHz, Ta=25°C  
Rg=600Ω, BW=400Hz-30kHz, Vout=OUT1

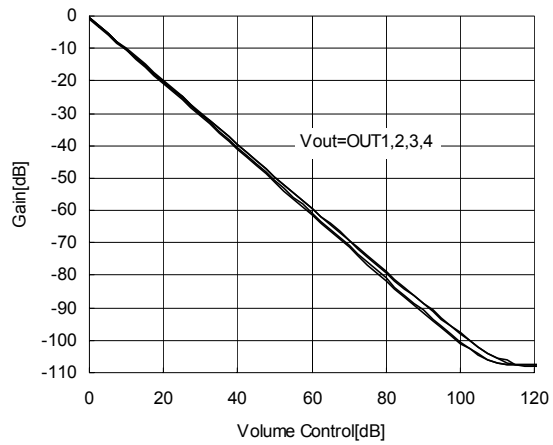


## ■ TYPICAL CHARACTERISTICS

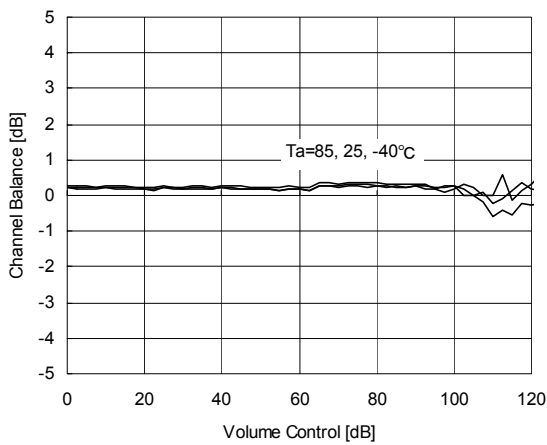
**Gain vs Volume Control (Temperature)**  
 $V+=9V, R_g=600\Omega, V_{in}=1V_{rms}, V_{in}=IN1$



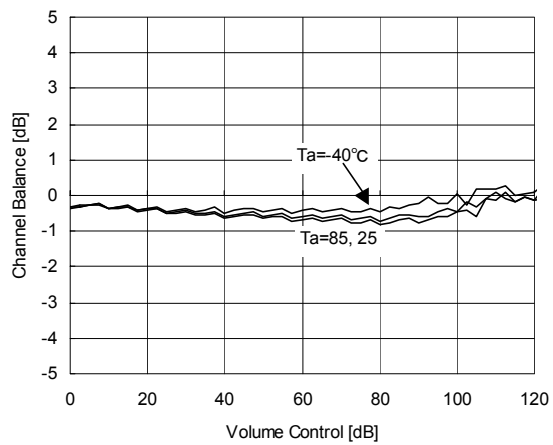
**Gain vs Volume Control**  
 $V+=9V, R_g=600\Omega, V_{in}=1V_{rms}, T_a=25^\circ\text{C}$



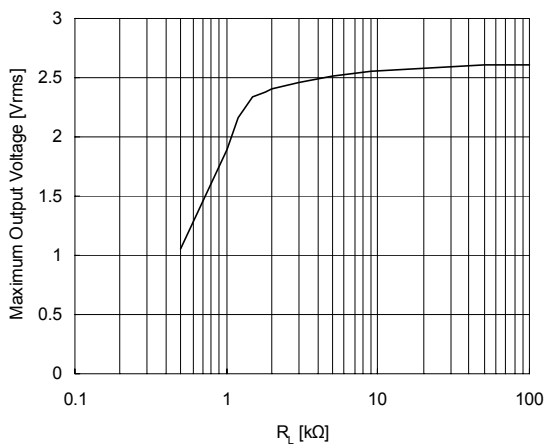
**Channel Balance vs Volume Control (CH1-CH2)**  
 $V_{in}=1V_{rms}, V+=9V$



**Channel Balance vs Volume Control (CH3-CH4)**  
 $V_{in}=1V_{rms}, V+=9V$



**Maximum Output Voltage vs  $R_L$**   
 $V+=9V, THD=1\%$



**[CAUTION]**

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