

4-CHANNEL ELECTRONIC VOLUME

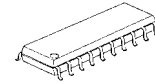
■ GENERAL DESCRIPTION

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

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

These functions are controlled by I²C 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

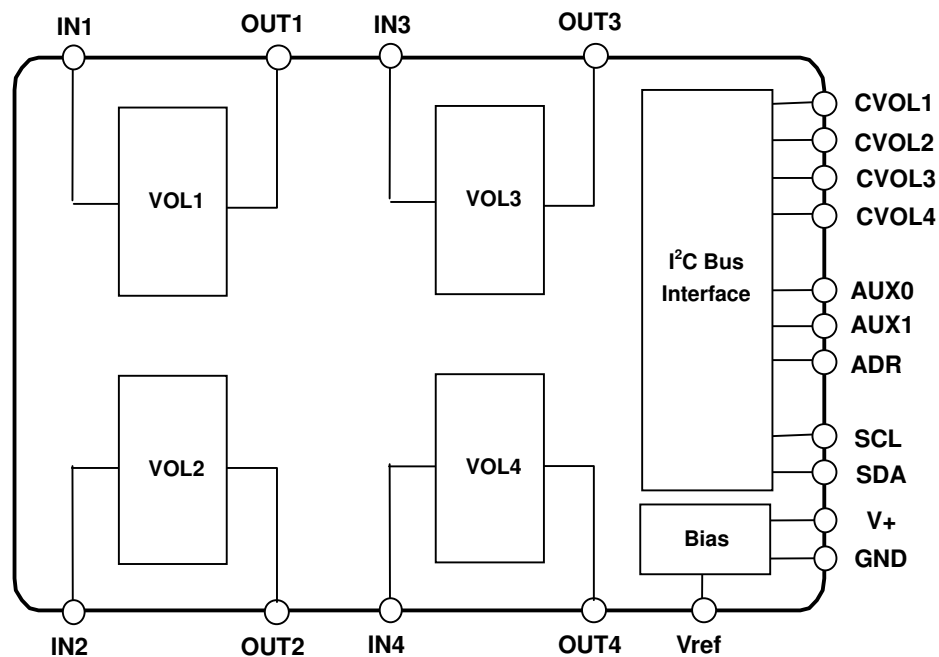


NJW1184M

■ FEATURES

- Operating Voltage 7.5 to 13V
- I²C 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

1	IN1	IN3	20
2	OUT1	OUT3	19
3	IN2	IN4	18
4	OUT2	OUT4	17
5	CVOL1	CVOL3	16
6	CVOL2	CVOL4	15
7	ADR	AUX1	14
8	SDA	AUX0	13
9	SCL	Vref	12
10	GND	V+	11

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 ² C BUS)	18	IN4	Input 4
9	SCL	SCL Data Input (I ² 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^+	15	V
Maximum Input Voltage	V_{IM}	0 to $V^{+(*)}$	V
Power Dissipation	P_D	DMP20 : 350	mW
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-40 to +125	°C

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

■ ELECTRICAL CHARACTERISTICS

(Ta=25°C, $V^+=9V$, $R_L=47k\Omega$, $V_{in}=100mV_{rms}/1kHz$, unless otherwise specified)

● POWER SUPPLY

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	V^+		7.5	9.0	13.0	V
Supply Current	I_{CC}	No Signal	-	4	10	mA
Reference Voltage	V_{REF}	No Signal	4.0	4.5	5.0	V

● VOLUME

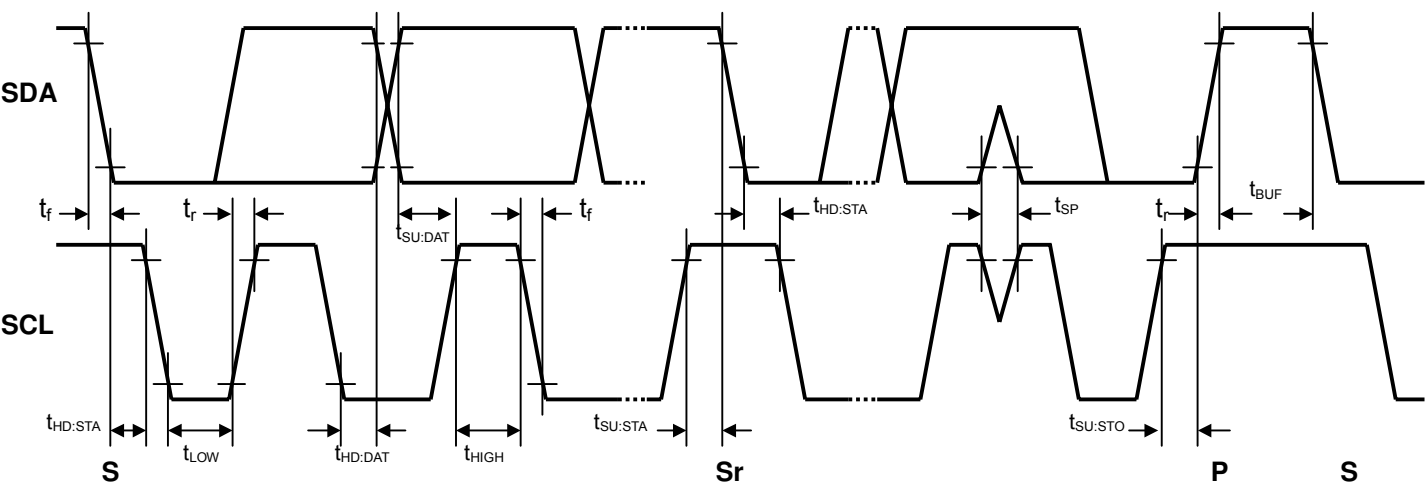
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Maximum Input Voltage	V_{IM}	$VOL=-20dB, THD=1\%$	2.8	3.0	-	Vrms
Maximum Output Voltage	V_{OM}	OUTPUT $VOL=0dB, THD=1\%$	-	2.5	-	Vrms
Channel Balance	G_{CB}	$VOL=0dB$	-1.0	0.0	1.0	dB
Total Harmonic Distortion	THD	$V_o=0.5V_{rms}$ $BW=400Hz$ to $30kHz$	-	-	0.3	%
Maximum Gain	G_{VMAX}	$VOL=0dB$	-2.0	0.0	2.0	dB
Minimum Gain	G_{VMIN}	$VOL= MUTE, V_{in}=2V_{rms}$	-	-100	-90	dB
Channel Separation	CS	$V_{in} = 1V_{rms}$ A-weighting	-	-80	-70	dB
Output Noise 1	V_{NO1}	$VOL = 0dB$ A-weighting	-	-90 (31.6)	-85 (56.2)	dBV (μV_{rms})
Output Noise 2	V_{NO2}	$VOL = MUTE$ A-weighting	-	-106 (5.0)	-96 (15.8)	dBV (μV_{rms})
Input Impedance	R_i		-	20	-	k Ω
AUX Output Voltage	V_{AUX}	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_{ADRH}	High : Slave Address 82H	$V^+/2$	-	-	V
Low Level Input Voltage	V_{ADRL}	Low : Slave Address 80H	-	-	1.0	V

■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 4k Ω (Connected to +5V), Load capacitance 200pF (Connected to GND)

FAST MODE : Pull up resistance 4k Ω (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 _{IL}	0.0	-	1.5	0.0	-	1.5	V
High Level Input Voltage	V _{IH}	2.7	-	5.0	2.7	-	5.0	V
Low level output voltage (3mA at SDA pin)	V _{OL}	0	-	0.4	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	-10	-	10	μ A

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

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

C_b ; total capacitance of one bus line in pF.

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

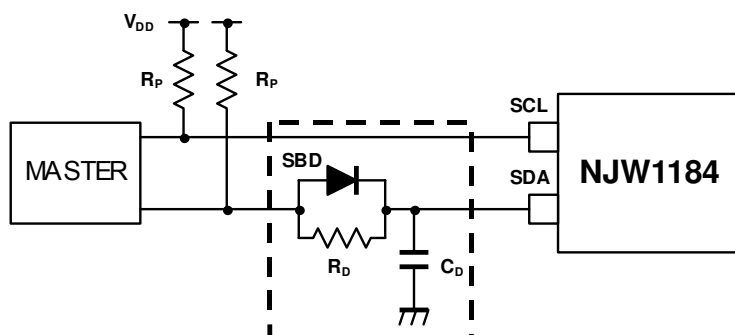
Please hold the Data Hold Time ($t_{HD:DAT}$) to 300ns or more to avoid status of unstable at SCL falling edge.

The SDA block in the 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.

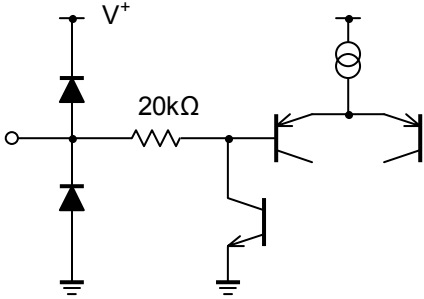
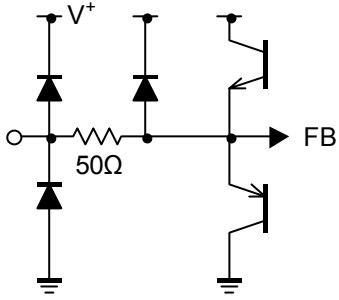
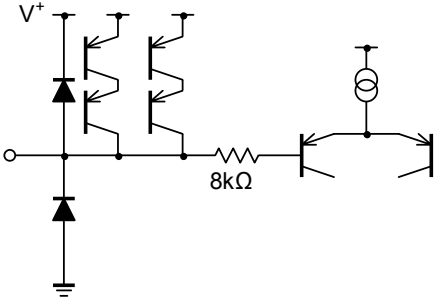
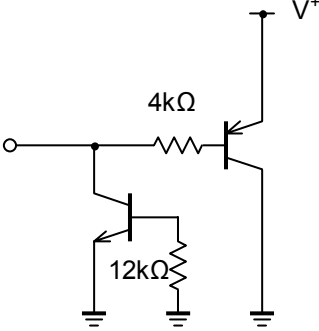
The time-consists of the data-delay-circuit of the SDA terminal are as follows.

- (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_f) as much as possible.



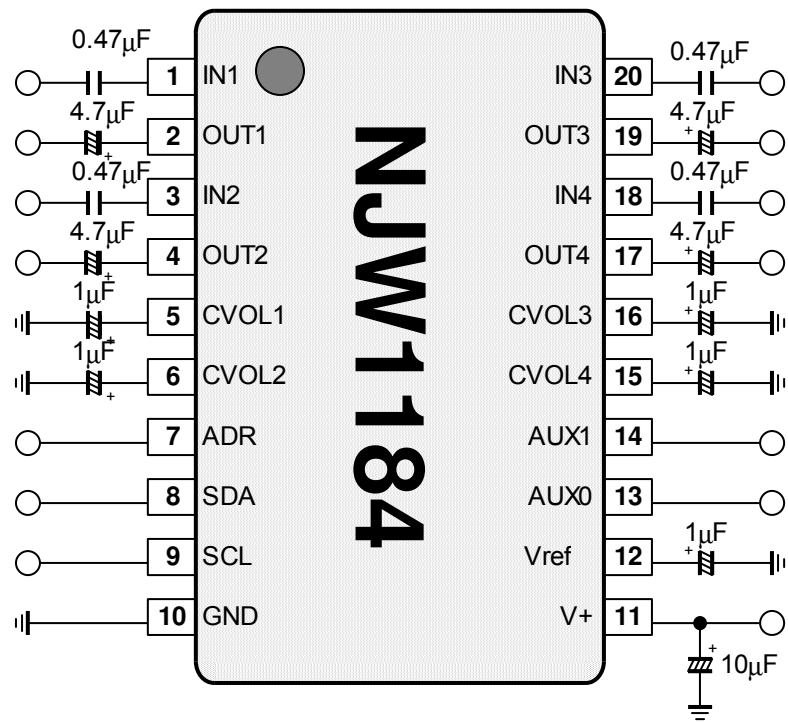
■ TERMINAL DESCRIPTION

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 ² C BUS) SCL Data Input (I ² C BUS)	VREG 5V 4kΩ 12kΩ SCL:GND SDA:ACK	-
12	Vref	Reference Voltage	V⁺ 200kΩ	V ⁺ /2
13 14	AUX0 AUX1	Auxiliary Output 0 Auxiliary Output 1	V⁺ 50Ω VREG 5V	0V / 5V

■ APPLICATION CIRCUIT



■ DEFINITION OF I²C REGISTER

● I²C 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

■ I²C 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

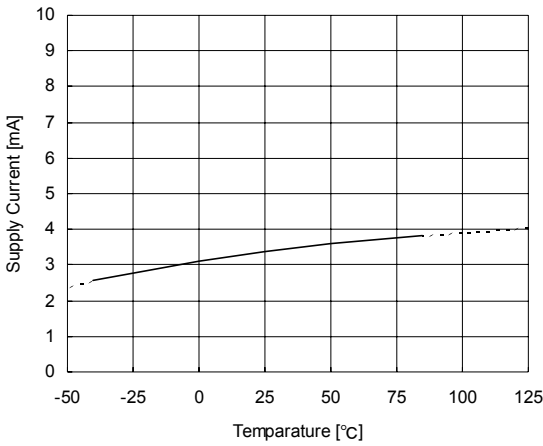
b) AUXILIARY SETTING

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

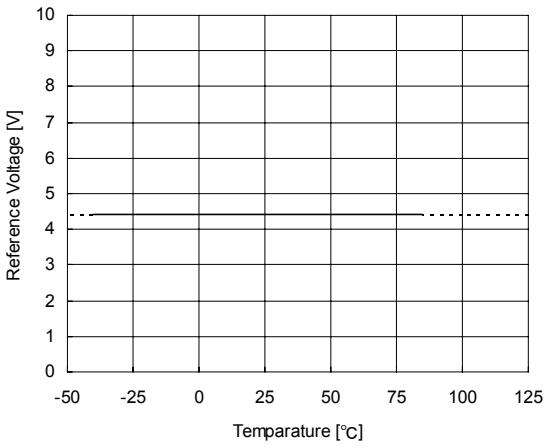
- AUX1/AUX0: Auxiliary port High/Low
 "0" : Logic output "Low"
 "1" : Logic output "High"

■ TYPICAL CHARACTERISTICS

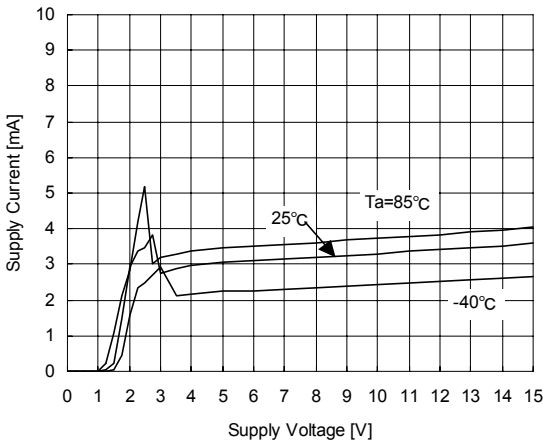
Supply Current vs Temperature
V+=9V , Vin=No Signal , Volume=0dB



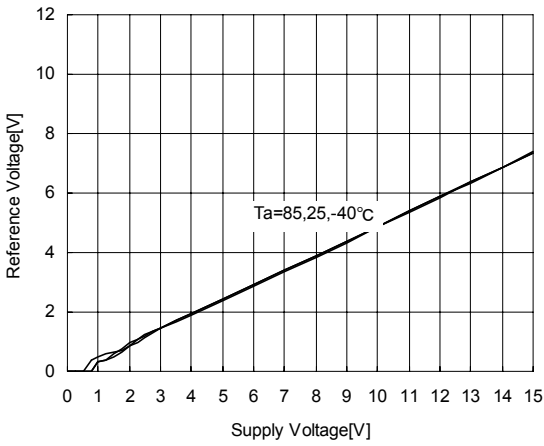
Reference Voltage vs Temperature
V+=9V , Vin=No Signal , Volume=0dB



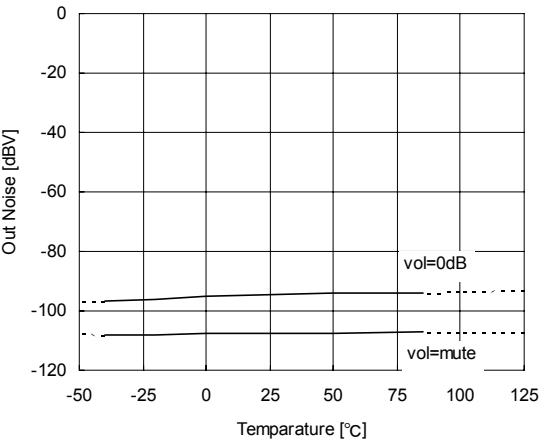
Supply Current vs Supply Voltage
Vin=No Signal , Volume=0dB



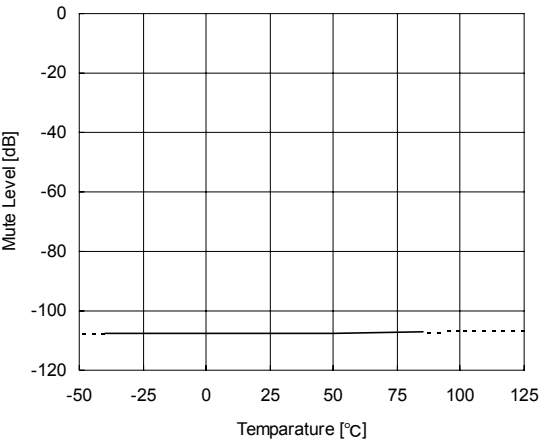
Reference Voltage vs Supply Voltage
Vin=No Signal , Volume=0dB



Out Noise vs Temperature
V+=9V, Rg=600Ω, A-Weighting



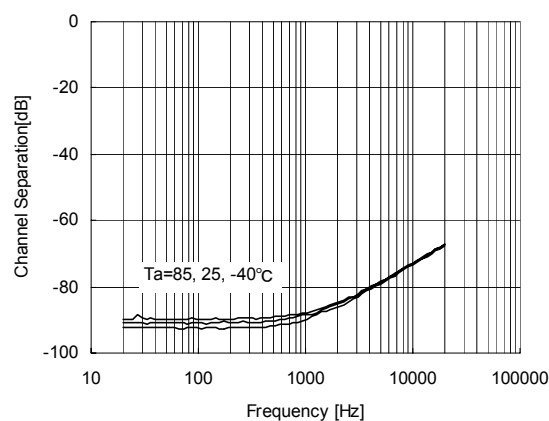
Mute Level vs Temperature
V+=9V, Rg=600Ω, Vin=1Vrms , A-Weighting



■ TYPICAL CHARACTERISTICS

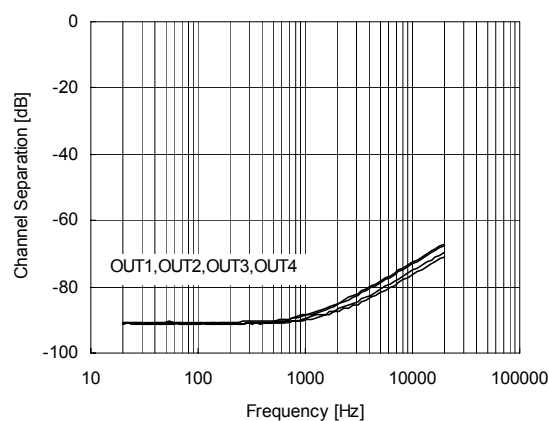
Channel Separation vs Frequency

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



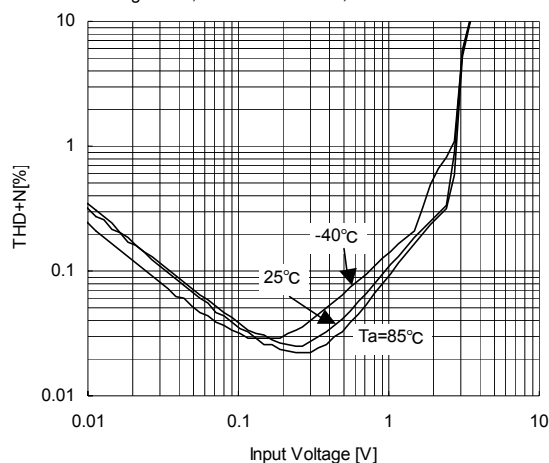
Channel Separation vs Frequency

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



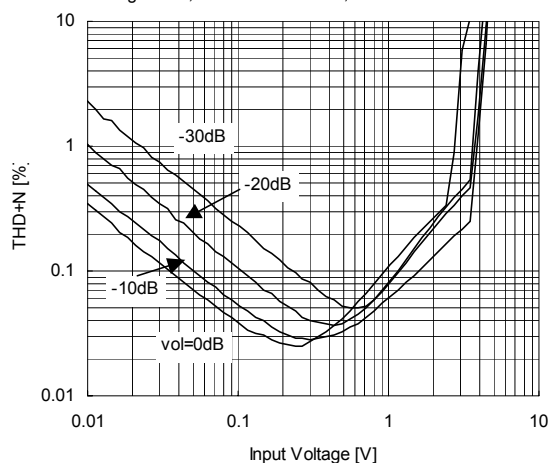
THD+N vs Input Voltage (Temperature)

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



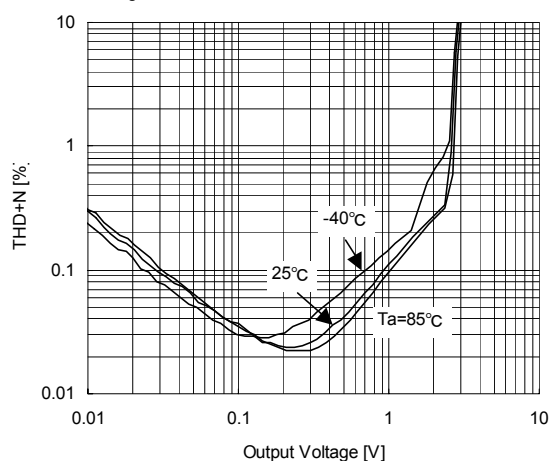
THD+N vs Input Voltage (Volume Control)

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



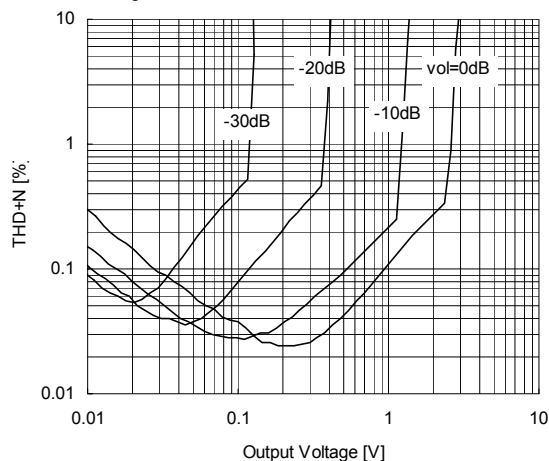
THD+N vs Output Voltage (Temperature)

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



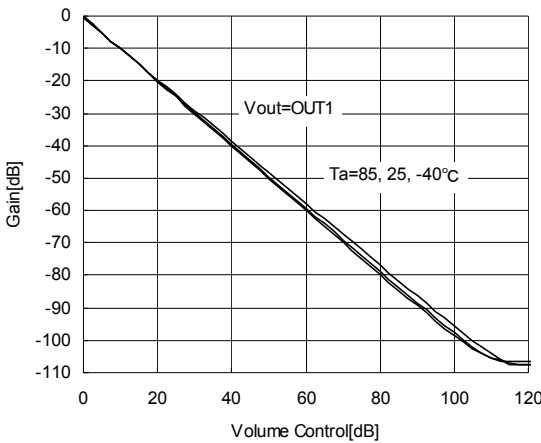
THD+N vs Output Voltage (Volume Control)

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

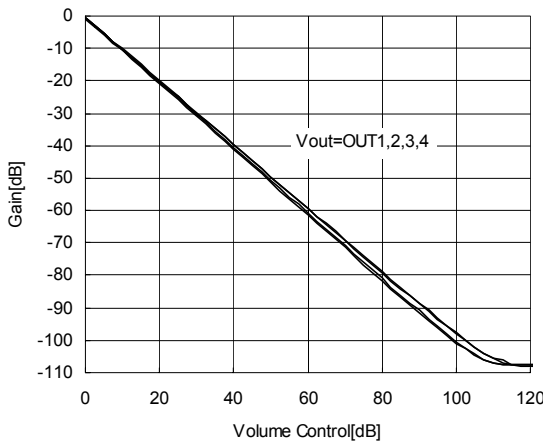


TYPICAL CHARACTERISTICS

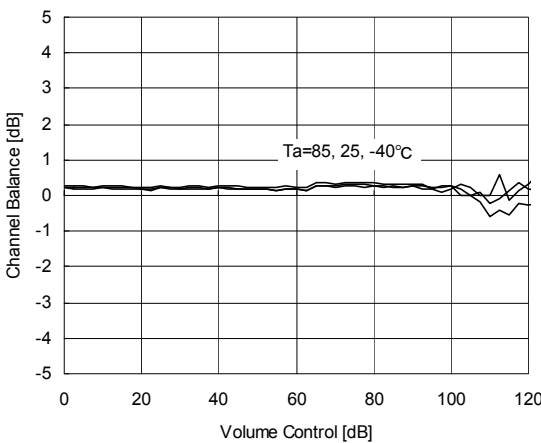
Gain vs Volume Control (Temperature)
V+=9V, Rg=600Ω, Vin=1Vrms, Vin=IN1



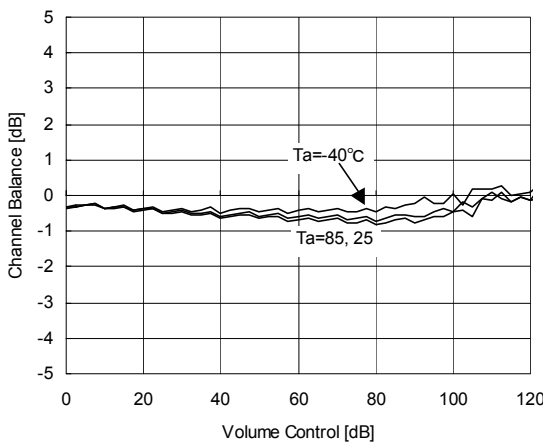
Gain vs Volume Control
V+=9V, Rg=600Ω, Vin=1Vrms, Ta=25°C



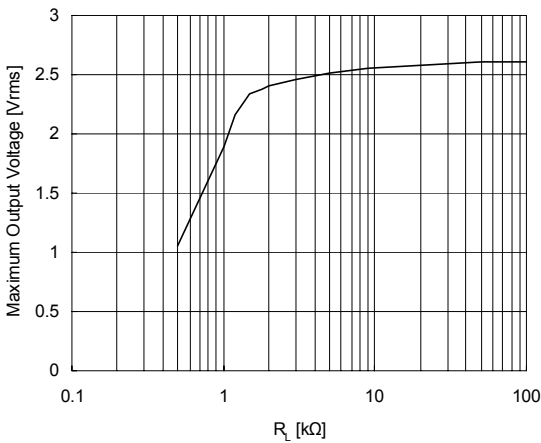
Channel Balance vs Volume Control (CH1-CH2)
Vin=1Vrms, V+=9V



Channel Balance vs Volume Control (CH3-CH4)
Vin=1Vrms, V+=9V



Maximum Output Voltage vs RL
V+=9V, THD=1%



[CAUTION]

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