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# Sound Processor with Built-in 3-band Equalizer

## BD37524FS

### General Description

BD37524FS is a sound processor with built-in 3-band equalizer for car audio. Other features are stereo 5ch input selector, input-gain control, main volume, loudness, 5ch fader volume, LPF for subwoofer, level meter. It is equipped with an "Advanced switch circuit", which is an original ROHM technology that reduces various switching noise (ex. No-signal, low frequency likes 20Hz & large signal inputs). The "Advanced switch" makes control of microcomputer easier and can be used for designing high quality car audio systems.

### Features

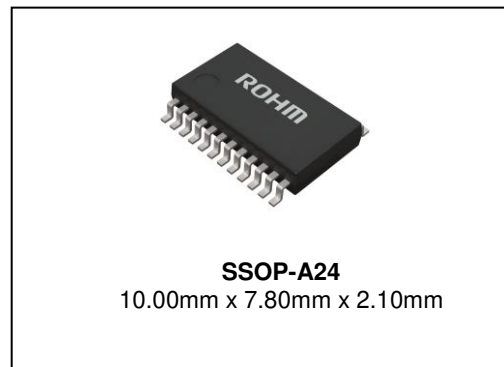
- Reduced switching noise of input gain control, mute, main volume, fader volume, bass, treble, and loudness by using advanced switch circuit
- Built-in differential input selector and 4 single-ended input selectors
- Built-in ground isolation amplifier inputs, which is ideal for external stereo input.
- Built-in input gain controller reduces switching noise for volume of a portable audio input.
- Lesser number of external components due to built-in 3-band equalizer filter, LPF for subwoofer, loudness filter. This makes it possible to control the Q, Gv, fo of 3-band equalizer, fc of LPF, fo, and Gv of loudness through I<sup>2</sup>C BUS.
- A gain adjustment quantity of  $\pm 20$ dB with 1 dB step gain adjustment is possible for bass, middle, and treble.
- Built-in subwoofer output terminals.
- Energy-saving design resulting in low current consumption is achieved by utilizing the Bi-CMOS process. It has the advantage in quality over scaling down the power heat control of the internal regulators.
- Input pins and output pins are organized and separately laid out to keep the signal flow in one direction which consequently, simplify pattern layout of the set board and decrease the board dimensions. .
- It is possible to be controlled by a 3.3V / 5V I<sup>2</sup>C BUS

### Key Specifications

- |   |                     |
|---|---------------------|
| ■ Power Supply Voltage Range:                 | 7.0V to 9.5V        |
| ■ Circuit Current (No Signal):                | 38mA(Typ)           |
| ■ Total Harmonic Distortion1<br>(FRONT,REAR): | 0.001%(Typ)         |
| ■ Total Harmonic Distortion2<br>(SUBWOOFER):  | 0.002%(Typ)         |
| ■ Maximum Input Voltage:                      | 2.3Vrms(Typ)        |
| ■ Cross-talk Between Selectors:               | -100dB(Typ)         |
| ■ Volume Control Range:                       | +15dB to -79dB      |
| ■ Output Noise Voltage1<br>(FRONT,REAR):      | 3.8 $\mu$ Vrms(Typ) |
| ■ Output Noise Voltage2<br>(SUBWOOFER):       | 4.8 $\mu$ Vrms(Typ) |
| ■ Residual Output Noise Voltage:              | 1.8 $\mu$ Vrms(Typ) |
| ■ Operating Temperature Range:                | -40°C to +85°C      |

### Package

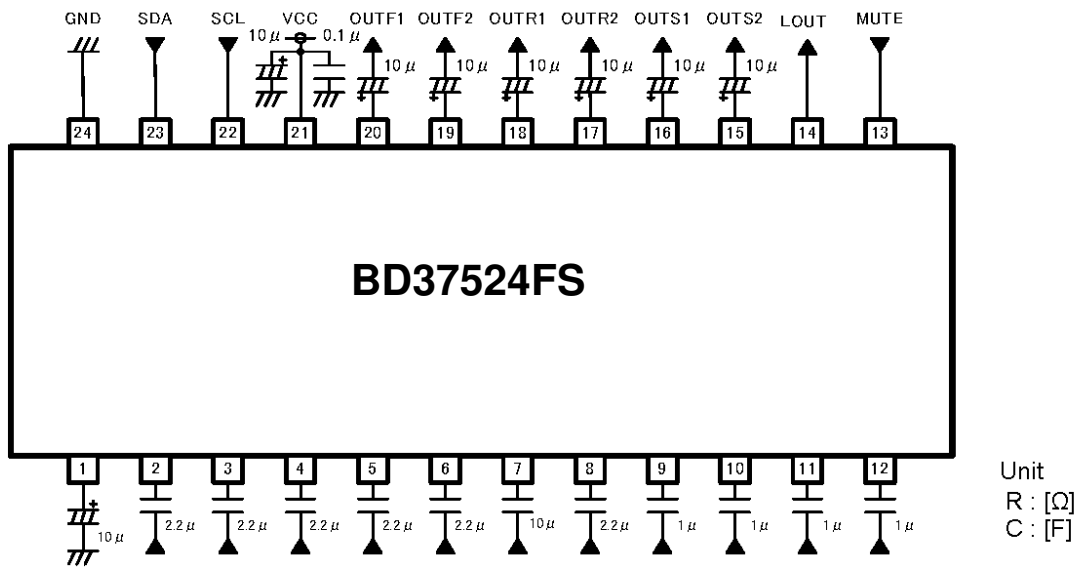
W(Typ) x D(Typ) x H(Max)



### Applications

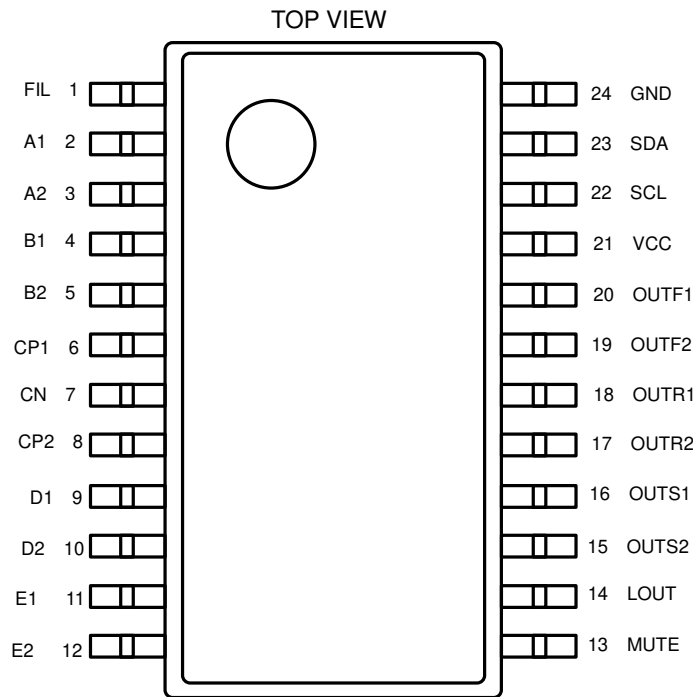
It is optimal for car audio systems. It is also suitable for other audio equipment such as mini Compo, micro Compo, TV etc

Typical Application Circuit



Unit  
R : [Ω]  
C : [F]

Pin Configuration



Pin Descriptions

Pin No.	Pin Name	Description	Pin No.	Pin Name	Description
1	FIL	VCC/2 terminal	13	MUTE	External compulsory mute terminal
2	A1	A input terminal of 1ch	14	LOUT	Output terminal for Level meter
3	A2	A input terminal of 2ch	15	OUTS2	Subwoofer output terminal of 2ch
4	B1	B input terminal of 1ch	16	OUTS1	Subwoofer output terminal of 1ch
5	B2	B input terminal of 2ch	17	OUTR2	Rear output terminal of 2ch
6	CP1	C positive input terminal of 1ch	18	OUTR1	Rear output terminal of 1ch
7	CN	C negative input terminal	19	OUTF2	Front output terminal of 2ch
8	CP2	C positive input terminal of 2ch	20	OUTF1	Front output terminal of 1ch
9	D1	D input terminal of 1ch	21	VCC	Power supply terminal
10	D2	D input terminal of 2ch	22	SCL	I <sup>2</sup> C Communication clock terminal
11	E1	E input terminal of 1ch	23	SDA	I <sup>2</sup> C Communication data terminal
12	E2	E input terminal of 2ch	24	GND	GND terminal





## Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Rating	Unit
Power supply Voltage	V <sub>CC</sub>	10.0	V
Input voltage	V <sub>IN</sub>	V <sub>CC</sub> +0.3 to GND-0.3	V
Power Dissipation	P <sub>d</sub>	1 (Note 1)	W
Storage Temperature	T <sub>stg</sub>	-55 to +150	°C

(Note 1) When mounted on standard board (70 x 70 x 1.6(mm<sup>3</sup>)), derate by 8mW/°C for Ta above 25°C.  
Thermal resistance  $\theta_{ja} = 125(^{\circ}\text{C}/\text{W})$

Material : A FR4 glass epoxy board(3% or less of copper foil area)

**Caution:** Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

## Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V <sub>CC</sub>	7.0	-	9.5	V
Temperature	T <sub>opr</sub>	-40	-	+85	°C

## Electrical Characteristics

(Unless otherwise noted, Ta=25°C, V<sub>CC</sub>=8.5V, f=1kHz, V<sub>IN</sub>=1Vrms, R<sub>g</sub>=600Ω, R<sub>L</sub>=10kΩ, A1 input, Input gain 0dB, Mute OFF, Volume 0dB, Tone control 0dB, Loudness 0dB, LPF OFF, Fader 0dB)

BLOCK	Parameter	Symbol	Limit			Unit	Conditions
			Min	Typ	Max		
GENERAL	Circuit Current (No Signal)	I <sub>Q</sub>	-	38	48	mA	No signal
	Voltage Gain	G <sub>V</sub>	-1.5	0	+1.5	dB	G <sub>V</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Channel Balance	CB	-1.5	0	+1.5	dB	CB = G <sub>V1</sub> -G <sub>V2</sub>
	Total Harmonic Distortion 1 (FRONT,REAR)	THD+N1	-	0.001	0.05	%	V <sub>OUT</sub> =1Vrms BW=400Hz-30KHz
	Total Harmonic Distortion 2 (SUBWOOFER)	THD+N2	-	0.002	0.05	%	V <sub>OUT</sub> =1Vrms BW=400Hz-30KHz
	Output Noise Voltage 1 (FRONT,REAR) *	V <sub>NO1</sub>	-	3.8	15	μVrms	R <sub>g</sub> = 0Ω BW = IHF-A
	Output Noise Voltage 2 (SUBWOOFER) *	V <sub>NO2</sub>	-	4.8	15	μVrms	R <sub>g</sub> = 0Ω BW = IHF-A
	Residual Output Noise Voltage *	V <sub>NOR</sub>	-	1.8	10	μVrms	Fader = -∞dB R <sub>g</sub> = 0Ω BW = IHF-A
	Crosstalk Between Channels *	CTC	-	-100	-90	dB	R <sub>g</sub> = 0Ω CTC=20log(V <sub>OUT</sub> /V <sub>IN</sub> ) BW = IHF-A
	Ripple Rejection	RR	-	-70	-40	dB	f=1KHz V <sub>RR</sub> =100mVrms RR=20log(V <sub>CC</sub> IN/V <sub>OUT</sub> )
INPUT SELECTOR	Input Impedance(A, B)	R <sub>IN_S</sub>	70	100	130	kΩ	
	Input Impedance (C,D,E)	R <sub>IN_D</sub>	175	250	325	kΩ	
	Maximum Input Voltage	V <sub>IM</sub>	2.1	2.3	-	Vrms	V <sub>IM</sub> at THD+N(V <sub>OUT</sub> )=1% BW=400Hz-30KHz
	Crosstalk Between Selectors *	CTS	-	-100	-90	dB	R <sub>g</sub> = 0Ω CTS=20log(V <sub>OUT</sub> /V <sub>IN</sub> ) BW = IHF-A
	Common Mode Rejection Ratio *	CMRR	50	65	-	dB	CP1 and CN input CP2 and CN input CMRR=20log(V <sub>IN</sub> /V <sub>OUT</sub> ) BW = IHF-A
INPUT GAIN	Minimum Input Gain	G <sub>IN_MIN</sub>	-2	0	+2	dB	Input gain 0dB V <sub>IN</sub> =100mVrms G <sub>IN</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Maximum Input Gain	G <sub>IN_MAX</sub>	18	20	22	dB	Input gain 20dB V <sub>IN</sub> =100mVrms G <sub>IN</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Gain Set Error	G <sub>IN_ERR</sub>	-2	0	+2	dB	G <sub>AIN</sub> =+20dB to +1dB

Electrical Characteristics - continued

BLOCK	Parameter	Symbol	Limit			Unit	Conditions
			Min	Typ	Max		
MUTE	Mute Attenuation *	G <sub>MUTE</sub>	-	-105	-85	dB	Mute ON G <sub>MUTE</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> ) BW = IHF-A
VOLUME	Maximum Gain	G <sub>V_MAX</sub>	13	15	17	dB	Volume = 15dB V <sub>IN</sub> =100mVrms G <sub>V</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Maximum Attenuation *	G <sub>V_MIN</sub>	-	-100	-85	dB	Volume = -∞dB G <sub>V</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> ) BW = IHF-A
	Attenuation Set Error 1	G <sub>V_ERR1</sub>	-2	0	+2	dB	GAIN & ATT=+15dB to -15dB
	Attenuation Set Error 2	G <sub>V_ERR2</sub>	-3	0	+3	dB	ATT=-16dB to -47dB
	Attenuation Set Error 3	G <sub>V_ERR3</sub>	-4	0	+4	dB	ATT=-48dB to -79dB
BASS	Maximum Boost Gain	G <sub>B_BST</sub>	18	20	22	dB	Gain=+20dB f=100Hz V <sub>IN</sub> =100mVrms G <sub>B</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Maximum Cut Gain	G <sub>B_CUT</sub>	-22	-20	-18	dB	Gain=-20dB f=100Hz V <sub>IN</sub> =2Vrms G <sub>B</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Gain Set Error	G <sub>B_ERR</sub>	-2	0	+2	dB	Gain=+20dB to -20dB f=100Hz
MIDDLE	Maximum Boost Gain	G <sub>M_BST</sub>	18	20	22	dB	gain=+20dB f=1KHz V <sub>IN</sub> =100mVrms G <sub>M</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Maximum Cut Gain	G <sub>M_CUT</sub>	-22	-20	-18	dB	Gain=-20dB f=1KHz V <sub>IN</sub> =2Vrms G <sub>M</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Gain Set Error	G <sub>M_ERR</sub>	-2	0	+2	dB	Gain=+20dB to -20dB f=1KHz
TREBLE	Maximum Boost Gain	G <sub>T_BST</sub>	18	20	22	dB	Gain=+20dB f=10kHz V <sub>IN</sub> =100mVrms G <sub>T</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Maximum Cut Gain	G <sub>T_CUT</sub>	-22	-20	-18	dB	Gain=-20dB f=10kHz V <sub>IN</sub> =2Vrms G <sub>T</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Gain Set Error	G <sub>T_ERR</sub>	-2	0	+2	dB	Gain=+20dB to -20dB f=10kHz
FADER / SUBWOOFER	Maximum Boost Gain	G <sub>F_BST</sub>	13	15	17	dB	Fader=15dB V <sub>IN</sub> =100mVrms G <sub>F</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Maximum Attenuation *	G <sub>F_MIN</sub>	-	-100	-90	dB	Fader = -∞dB G <sub>F</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> ) BW = IHF-A
	Gain Set Error	G <sub>F_ERR</sub>	-2	0	+2	dB	Gain=+15dB to +1dB
	Attenuation Set Error 1	G <sub>F_ERR1</sub>	-2	0	+2	dB	ATT=-1dB to -15dB
	Attenuation Set Error 2	G <sub>F_ERR2</sub>	-3	0	+3	dB	ATT=-16dB to -47dB
	Attenuation Set Error 3	G <sub>F_ERR3</sub>	-4	0	+4	dB	ATT=-48dB to -79dB
	Output Impedance	R <sub>OUT</sub>	-	-	50	Ω	V <sub>IN</sub> =100mVrms
Maximum Output Voltage	V <sub>OM</sub>	2	2.2	-	Vrms	THD+N=1% BW=400Hz-30KHz	
LOUDNESS	Maximum Gain	G <sub>L_MAX</sub>	17	20	23	dB	Gain 20dB V <sub>IN</sub> =100mVrms G <sub>L</sub> =20log(V <sub>OUT</sub> /V <sub>IN</sub> )
	Gain Set Error	G <sub>L_ERR</sub>	-2	0	+2	dB	GAIN=+20dB to +1dB
Level meter	Maximum Output Voltage	V <sub>L_MAX</sub>	2.8	3.1	3.5	V	
	Output Offset Voltage	V <sub>L_OFF</sub>	-	0	100	mV	

VP-9690A(Average value detection, effective value display) filter by Matsushita Communication is used for \* measurement.  
Phase between input / output is same.

Typical Performance Curves

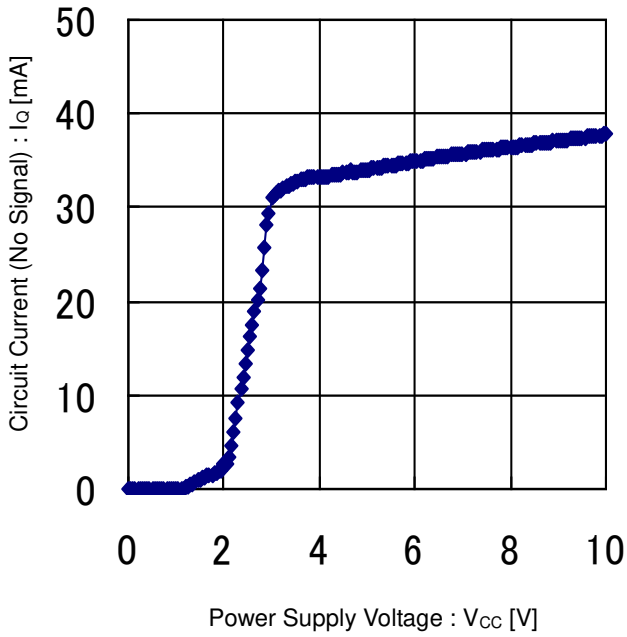


Figure 1. Circuit Current (No Signal) vs Power Supply Voltage

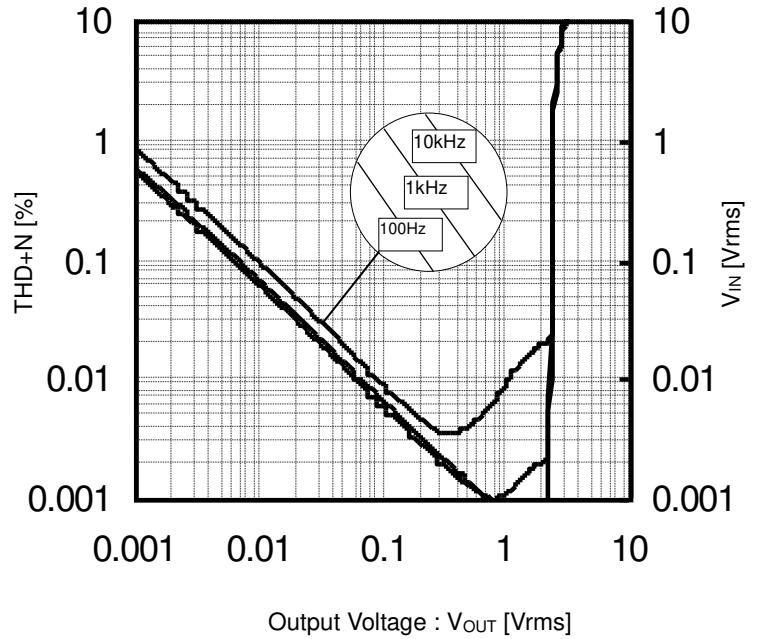


Figure 2. THD+N vs Output Voltage

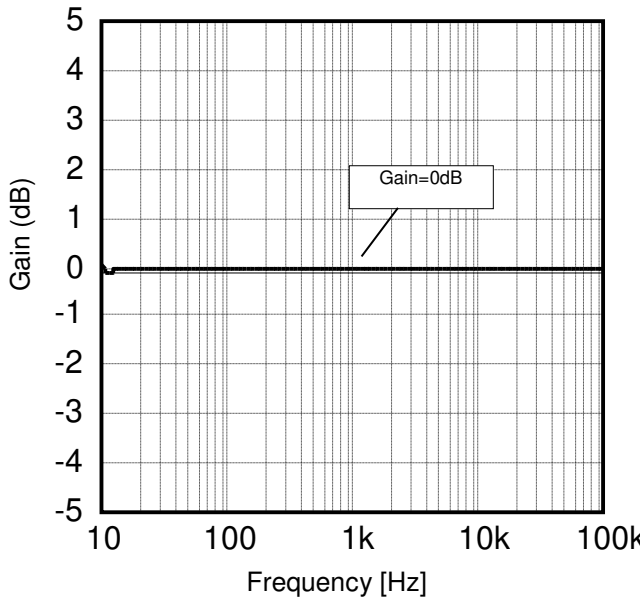


Figure 3. Gain vs Frequency

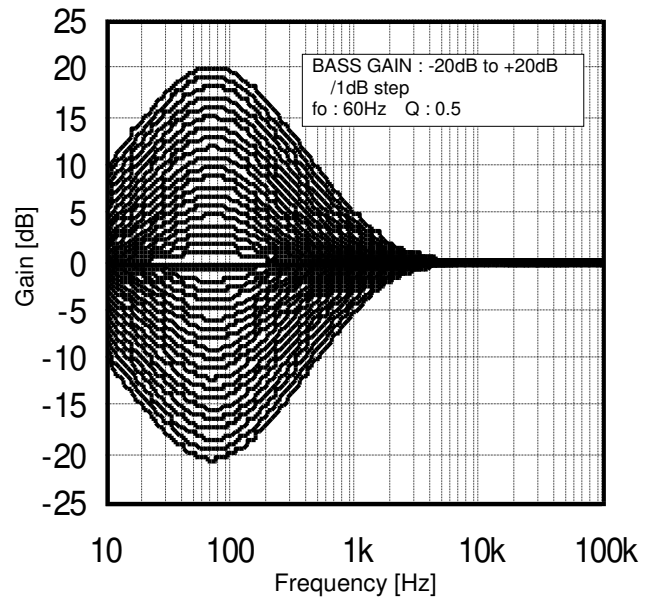


Figure 4. Bass Gain vs Frequency

Typical Performance Curves – continued

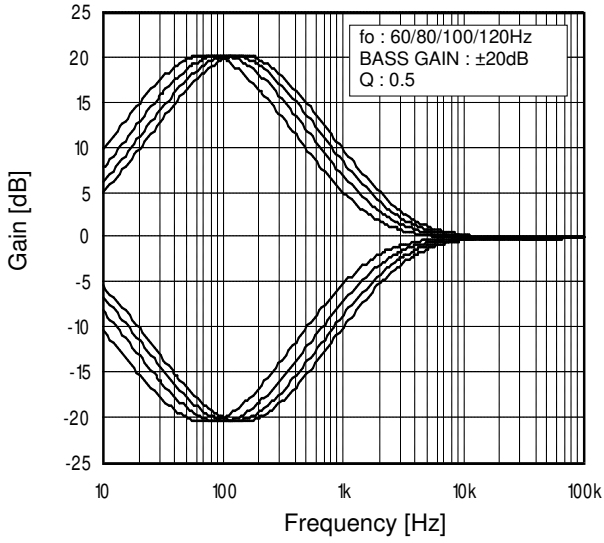


Figure 5. Bass fo vs Frequency

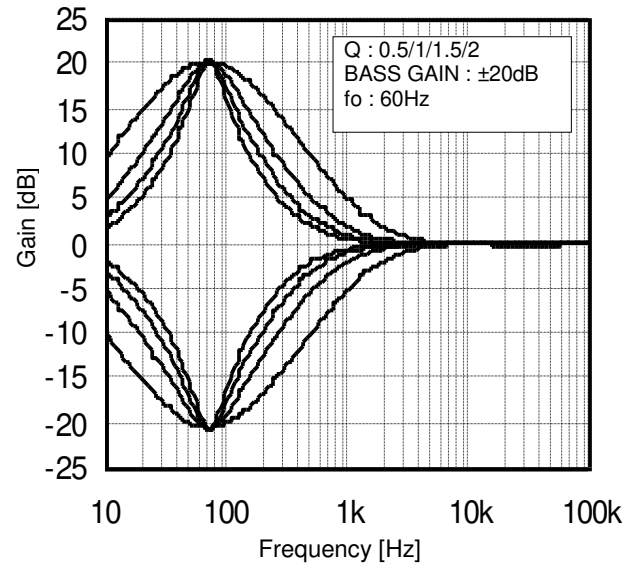


Figure 6. Bass Q vs Frequency

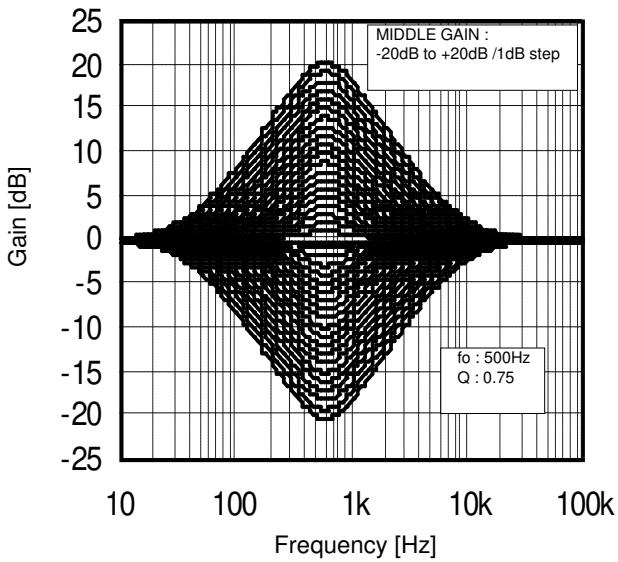


Figure 7. Middle Gain vs Frequency

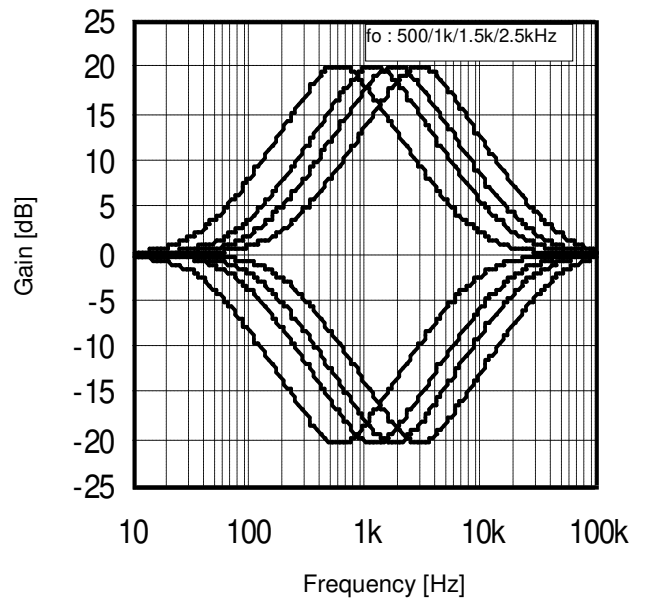


Figure 8. Middle fo vs Frequency



Typical Performance Curves – continued

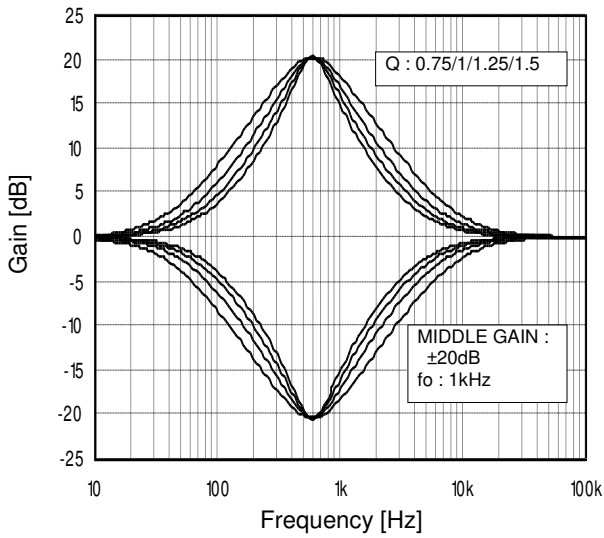


Figure 9. Middle Q vs Frequency

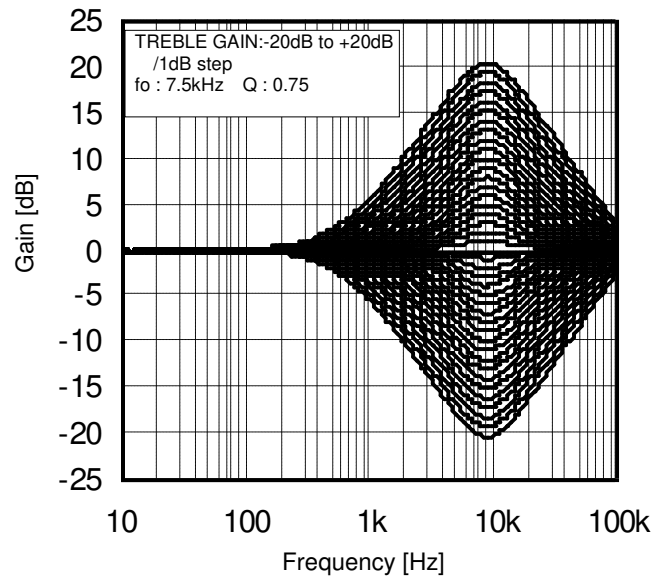


Figure 10. Treble Gain vs Frequency

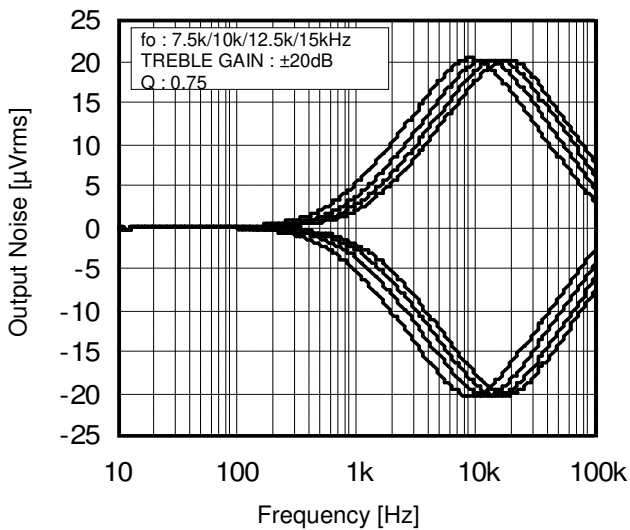


Figure 11. Treble fo vs Frequency

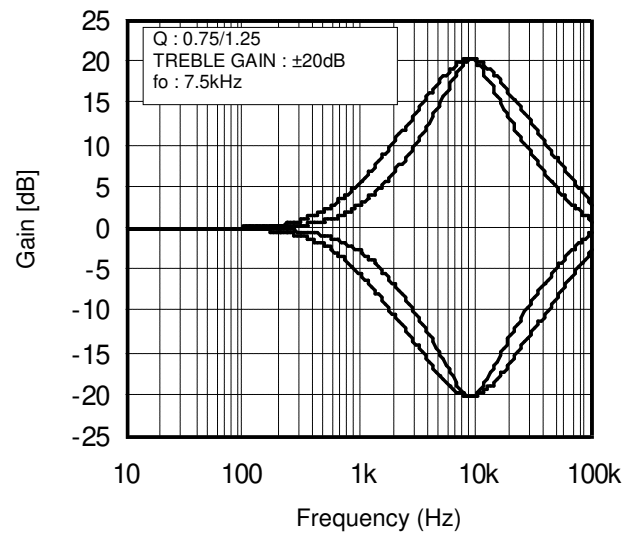


Figure 12. Treble Q vs Frequency

Typical Performance Curves – continued

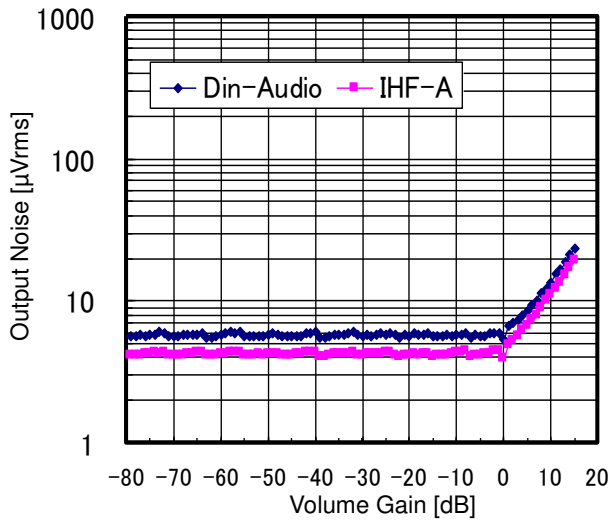


Figure 13. Output Noise vs Volume Gain

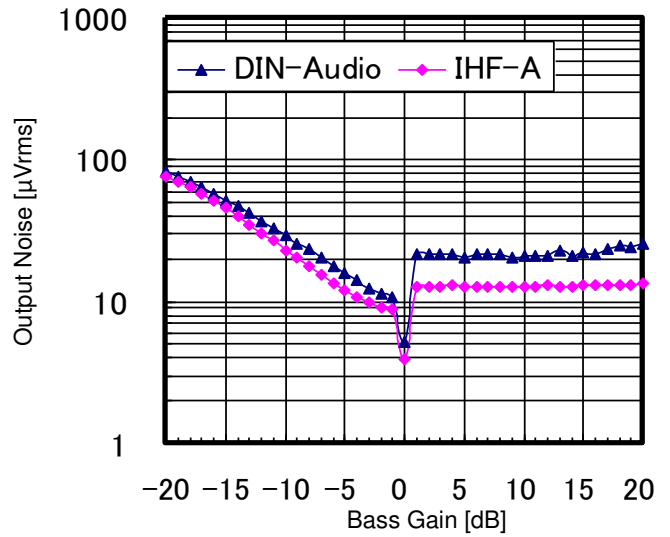


Figure 14. Output Noise vs Bass Gain

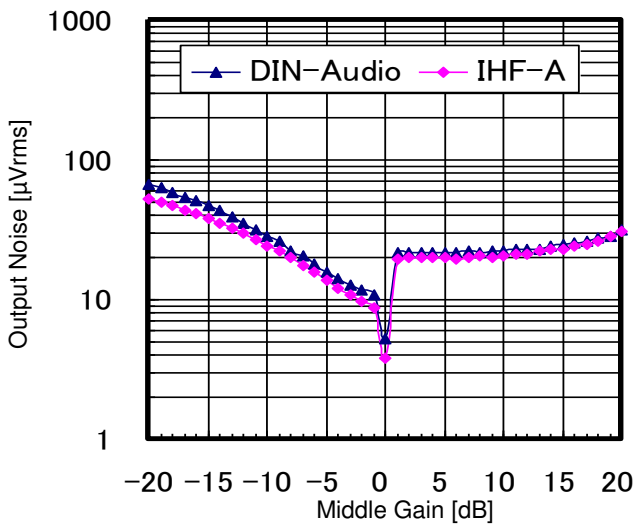


Figure 15. Output Noise vs Middle Gain

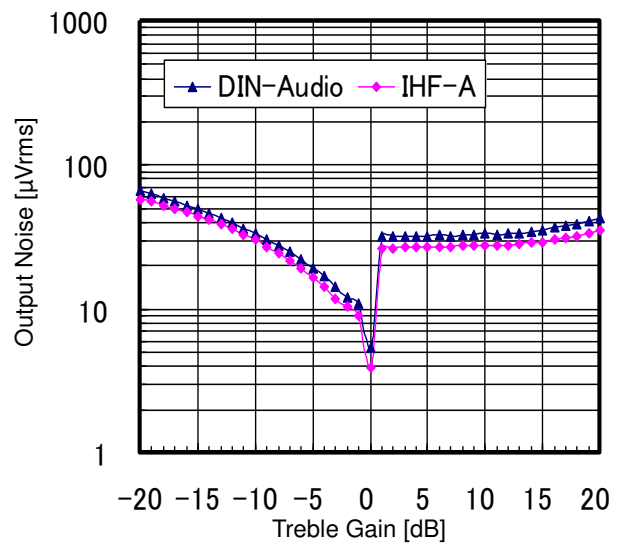


Figure 16. Output Noise vs Treble Gain

Typical Performance Curves – continued

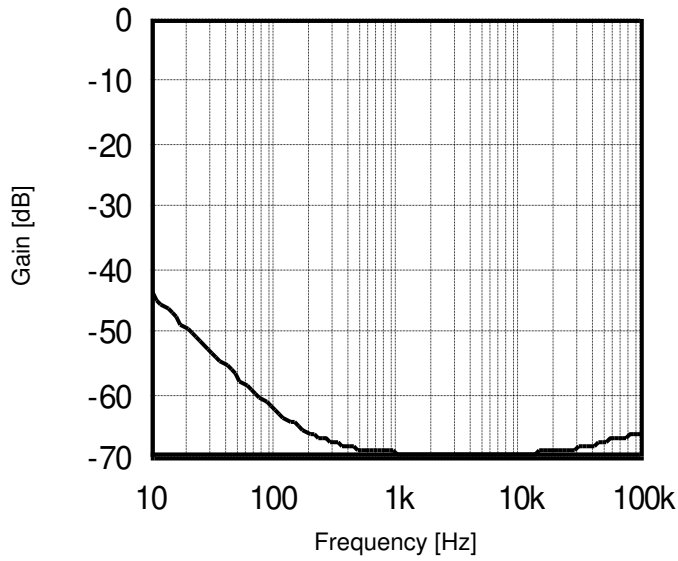


Figure 17. CMRR vs Frequency

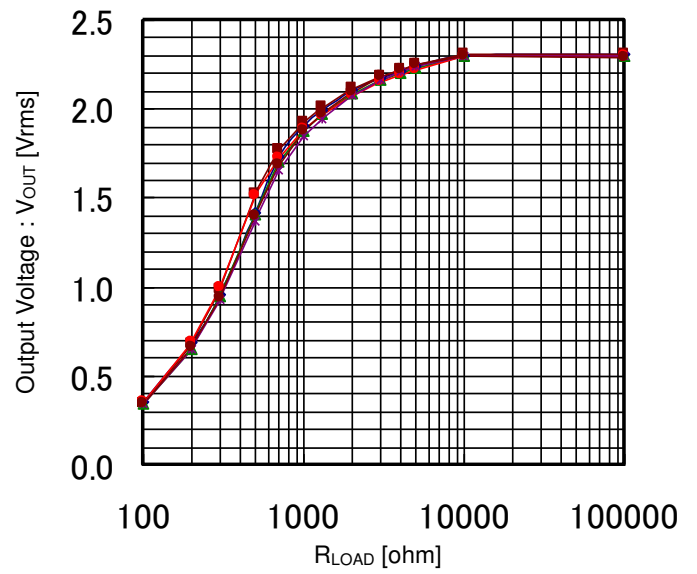


Figure 18. Output Voltage vs R<sub>LOAD</sub>

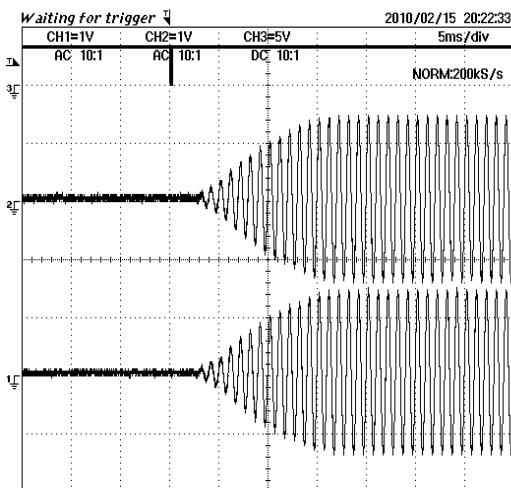


Figure 19. Advanced Switch 1

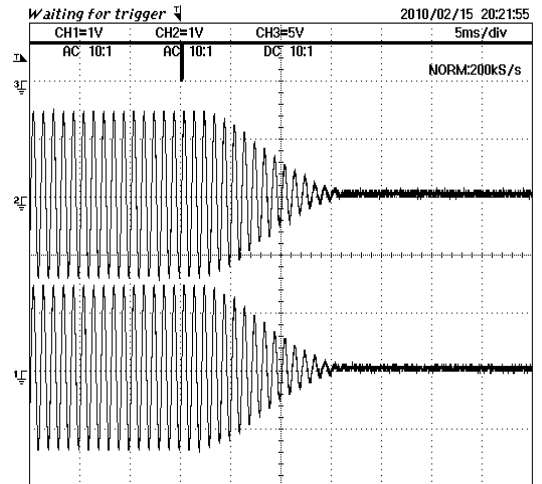
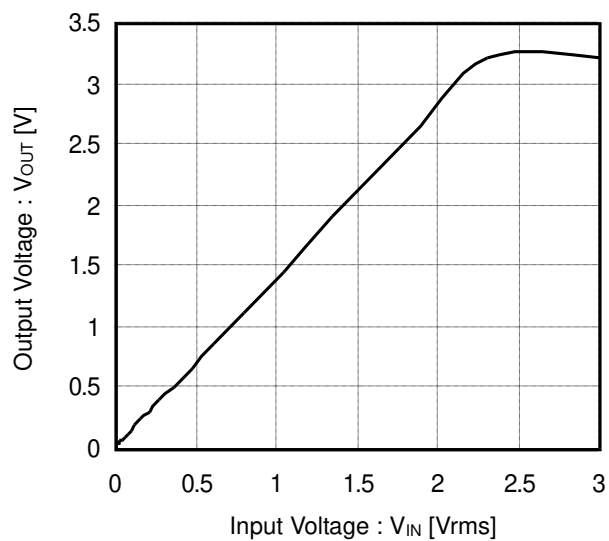


Figure 20. Advanced Switch 2

## Typical Performance Curves – continued

Figure 21. Output Voltage vs Level Meter  $V_{IN}$

Timing Chart

Control Signal Specification

(1) Electrical Specifications and Timing for Bus Lines and I/O Stages

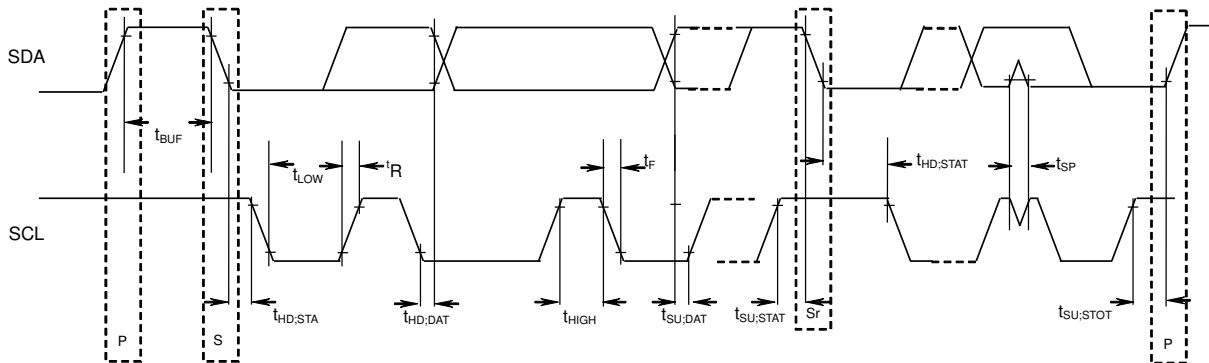


Figure 22. Definition of Timing on the I<sup>2</sup>C-bus

Table 1 Characteristics of the SDA and SCL bus lines for I<sup>2</sup>C-bus devices (Unless specified otherwise, Ta=25°C, VCC=8.5V)

Parameter	Symbol	Fast-mode I <sup>2</sup> C-bus		Unit
		Min	Max	
1 SCL clock frequency	$f_{SCL}$	0	400	kHz
2 Bus free time between a STOP and START condition	$t_{BUF}$	1.3	-	$\mu$ S
3 Hold time (repeated) START condition. After this period, the first clock pulse is generated	$t_{HD:STA}$	0.6	-	$\mu$ S
4 LOW period of the SCL clock	$t_{LOW}$	1.3	-	$\mu$ S
5 HIGH period of the SCL clock	$t_{HIGH}$	0.6	-	$\mu$ S
6 Set-up time for a repeated START condition	$t_{SU:STA}$	0.6	-	$\mu$ S
7 Data hold time:	$t_{HD:DAT}$	0.06 <sup>(Note)</sup>	-	$\mu$ S
8 Data set-up time	$t_{SU:DAT}$	120	-	ns
9 Set-up time for STOP condition	$t_{SU:STO}$	0.6	-	$\mu$ S

All values are referred to VIH min and VIL max Levels (see Table 2).

(Note) The device must internally provide a hold time of at least 300 ns for the SDA signal (refer to the VIH min of the SCL signal) in order to bridge the undefined region of the falling edge of SCL.  
For 7( $t_{HD:DAT}$ ) and 8( $t_{SU:DAT}$ ), make the setup in which the margin is fully in .

Table 2 Characteristics of the SDA and SCL I/O stages for I<sup>2</sup>C-bus devices

Parameter	Symbol	Fast-mode devices		Unit
		Min	Max	
10 LOW level input voltage:	$V_{IL}$	-0.3	+1	V
11 HIGH level input voltage:	$V_{IH}$	2.3	5	V
12 Pulse width of spikes which must be suppressed by the input filter.	$t_{SP}$	0	50	ns
13 LOW level output voltage: at 3mA sink current	$V_{OL1}$	0	0.4	V
14 Input current each I/O pin with an input voltage between 0.4V and 4.5V.	$I_I$	-10	+10	$\mu$ A

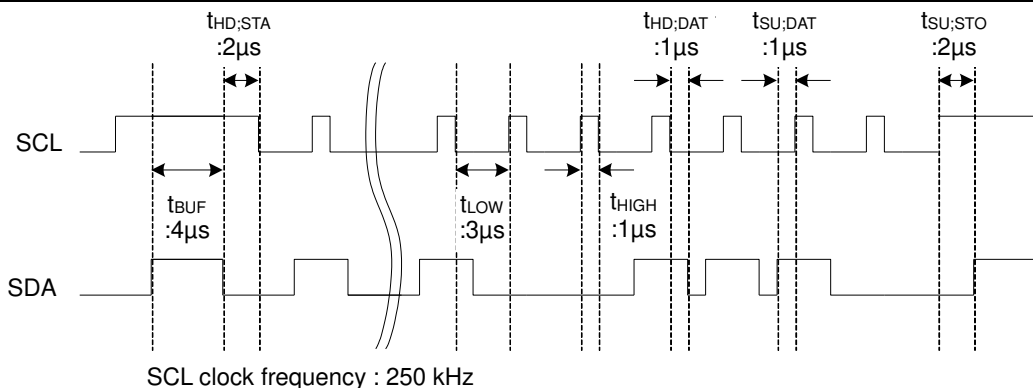


Figure 23. A Command Timing Example in the I<sup>2</sup>C Data Transmission



(2) I<sup>2</sup>C BUS FORMAT

MSB	LSB	MSB	LSB	MSB	LSB		
S	Slave Address	A	Select Address	A	Data	A	P
1bit	8bit	1bit	8bit	1bit	8bit	1bit	1bit

- S = Start condition (Recognition of start bit)
- Slave Address = Recognition of slave address. The first 7 bits corresponds to slave address.. The least significant bit is "L" corresponds to write mode.
- A = ACKNOWLEDGE bit (Recognition of acknowledgement)
- Select Address = Select address for volume, bass and treble.
- Data = Data on every volume and tone.
- P = Stop condition (Recognition of stop bit)

(3) I<sup>2</sup>C BUS Interface Protocol

(a) Basic form

S	Slave Address	A	Select Address	A	Data	A	P
MSB	LSB	MSB	LSB	MSB	LSB		

(b) Automatic increment (Select Address increases (+1) according to the number of data.

S	Slave Address	A	Select Address	A	Data1	A	Data2	A	...	DataN	A	P
	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB		MSB	LSB	

- (Example)
- ① Data1 shall be set as data of address specified by Select Address.
  - ② Data2 shall be set as data of address specified by Select Address +1.
  - ③ DataN shall be set as data of address specified by Select Address +N-1.

(c) Configuration unavailable for transmission (In this case, only Select Address1 is set.

S	Slave Address	A	Select Address1	A	Data	A	Select Address 2	A	Data	A	P
	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	

(Note) If any data is transmitted as Select Address 2 next to data, it is recognized as data, not as Select Address 2.

(4) Slave address

MSB							LSB	
A6	A5	A4	A3	A2	A1	A0	R/W	
1	0	0	0	0	0	0	0	80H

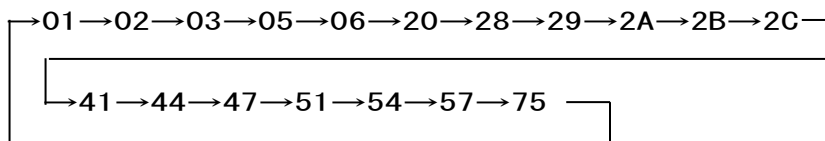
(5) Select Address & Data

Items	Select Address (hex)	Data								
		MSB	Data						LSB	
		D7	D6	D5	D4	D3	D2	D1	D0	
Initial setup 1	01	Advanced switch ON/OFF	0	Advanced switch time of Input Gain/Volume Tone/Fader/Loudness			0	0	Advanced switch time of Mute	
Initial setup 2	02	LPF Phase	Level Meter RESET	0	0	0	Subwoofer LPF fc	LPF Phase	Level Meter RESET	
Initial setup 3	03	0	0	0	Loudness fo		0	0	1	
Input Selector	05	0	0	0	Input selector					
Input gain	06	Mute ON/OFF	0	0	Input Gain					
Volume gain	20	Volume Gain / Attenuation								
Fader 1ch Front	28	Fader Gain / Attenuation								
Fader 2ch Front	29	Fader Gain / Attenuation								
Fader 1ch Rear	2A	Fader Gain / Attenuation								
Fader 2ch Rear	2B	Fader Gain / Attenuation								
Fader Subwoofer	2C	Fader Gain / Attenuation								
Bass setup	41	0	0	Bass fo		0	0	Bass Q		
Middle setup	44	0	0	Middle fo		0	0	Middle Q		
Treble setup	47	0	0	Treble fo		0	0	0	Treble Q	
Bass gain	51	Bass Boost/Cut	0	0	Bass Gain					
Middle gain	54	Middle Boost/Cut	0	0	Middle Gain					
Treble gain	57	Treble Boost/Cut	0	0	Treble Gain					
Loudness Gain	75	0	Loudness HiCut		Loudness Gain					
System Reset	FE	1	0	0	0	0	0	0	1	

 Advanced switch

Note

1. The advance switch works in the latch part while changing from one function to another.
2. Upon continuous data transfer, the Select Address rolls back to the first address on automatic increment function, as shown below.



3. Advanced switch is not used for the function of input selector. Therefore, please turn on MUTE when changing the settings of this side of a set.
4. When using Mute function when changing input selector, please switch Mute ON/OFF for waiting advanced-mute time.

Select address 01 (hex)

Time	Advanced switch time of Mute							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
0.6msec	Advanced Switch ON/OFF	0	Advanced switch time of Input gain/Volume Tone/Fader/Loudness		0	0	0	0	
1.0msec			0	1					
1.4msec			1	0					
3.2msec			1	1					

Time	Advanced switch time of Input gain/Volume/Tone/Fader/Loudness							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
4.7 msec	Advanced Switch ON/OFF	0	0	0	0	0	Advanced switch Time of Mute		
7.1 msec			0	1					
11.2 msec			1	0					
14.4 msec			1	1					

Mode	Advanced switch ON/OFF							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
OFF	0	0	Advanced switch time of Input gain/Volume Tone/Fader/Loudness		0	0	Advanced switch Time of Mute		
ON	1								

Select address 02(hex)


fc	Subwoofer LPF fc							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
OFF	LPF Phase	Level Meter RESET	0	0	0	0	0	0	
55Hz						0	0	1	
85Hz						0	1	0	
120Hz						0	1	1	
160Hz						1	0	0	
Prohibition						Other setting			

Mode	Level Meter RESET							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
HOLD	LPF Phase	0	0	0	0	Subwoofer LPF fc			
RESET		1							

Phase	LPF Phase							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
0°	0	Level Meter RESET	0	0	0	Subwoofer LPF fc			
180°	1								

Select address 03(hex)

f0	Loudness fo							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
250Hz	0	0	0	0	0	0	0	1	
400Hz				0	1				
800Hz				1	0				
Prohibition				1	1				

 : Initial condition

Select address 05(hex)


Mode	OUT F1/R1	OUT F2/R2	Input Selector							
			MSB D7	D6	D5	D4	D3	D2	D1	LSB D0
Initial			0	0	0	0	0	0	0	0
A	A1	A2					0	0	0	1
B	B1	B2					0	0	1	0
C diff	CP1	CP2					0	1	1	0
D	D1	D2					1	0	1	0
E	E1	E2					1	0	1	1
Input SHORT							1	0	0	1
Prohibition							Other setting			

**Input SHORT** : The input impedance of each input terminal is lowered from 100kΩ(Typ) to 6 kΩ(Typ).  
(For quick charge of coupling capacitor)

Select address 06 (hex)

Gain	MSB			Input Gain				LSB
	D7	D6	D5	D4	D3	D2	D1	D0
0dB	Mute ON/OFF	0	0	0	0	0	0	0
1dB				0	0	0	0	1
2dB				0	0	0	1	0
3dB				0	0	0	1	1
4dB				0	0	1	0	0
5dB				0	0	1	0	1
6dB				0	0	1	1	0
7dB				0	0	1	1	1
8dB				0	1	0	0	0
9dB				0	1	0	0	1
10dB				0	1	0	1	0
11dB				0	1	0	1	1
12dB				0	1	1	0	0
13dB				0	1	1	0	1
14dB				0	1	1	1	0
15dB				0	1	1	1	1
16dB				1	0	0	0	0
17dB				1	0	0	0	1
18dB				1	0	0	1	0
19dB				1	0	0	1	1
20dB	1	0	1	0	0			
Prohibition	:	:	:	:	:			
	1	1	1	1	1			

Mode	MSB			Mute ON/OFF				LSB
	D7	D6	D5	D4	D3	D2	D1	D0
OFF	0	0	0	Input Gain				
ON	1							

 : Initial condition

Select address 20, 28, 29, 2A, 2B, 2C (hex)

Gain & ATT	MSB Vol, Fader Gain / Attenuation							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
Prohibition	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	1	
	:	:	:	:	:	:	:	:	
15dB	0	1	1	1	0	0	0	0	
14dB	0	1	1	1	0	0	1	0	
13dB	0	1	1	1	0	0	1	1	
:	:	:	:	:	:	:	:	:	
-77dB	1	1	0	0	1	1	0	1	
-78dB	1	1	0	0	1	1	1	0	
-79dB	1	1	0	0	1	1	1	1	
Prohibition	1	1	0	1	0	0	0	0	
	:	:	:	:	:	:	:	:	
-∞dB	1	1	1	1	1	1	1	1	

Select address 41(hex)


Q factor	MSB Bass Q factor						LSB	
	D7	D6	D5	D4	D3	D2	D1	D0
0.5	0	0	Bass fo		0	0	0	0
1.0							0	1
1.5							1	0
2.0							1	1

fo	MSB Bass fo						LSB	
	D7	D6	D5	D4	D3	D2	D1	D0
60Hz	0	0	0	0	0	0	Bass Q factor	
80Hz			0	1				
100Hz			1	0				
120Hz			1	1				

Select address 44(hex)

Q factor	MSB Middle Q factor						LSB	
	D7	D6	D5	D4	D3	D2	D1	D0
0.75	0	0	Middle fo		0	0	0	0
1.0							0	1
1.25							1	0
1.5							1	1

fo	MSB Middle fo						LSB	
	D7	D6	D5	D4	D3	D2	D1	D0
500Hz	0	0	0	0	0	0	Middle Q factor	
1kHz			0	1				
1.5kHz			1	0				
2.5kHz			1	1				

 : Initial condition



Select address 47 (hex)


Q factor	MSB		Treble				Q factor		LSB
	D7	D6	D5	D4	D3	D2	D1	D0	
0.75	0	0	Treble fo		0	0	0	0	
1.25			1						

fo	MSB		Treble				fo		LSB
	D7	D6	D5	D4	D3	D2	D1	D0	
7.5kHz	0	0	0	0	0	0	0	0	Treble Q factor
10kHz			0	1					
12.5kHz			1	0					
15kHz			1	1					

Select address 51, 54, 57 (hex)

Gain	MSB		Bass/ Middle/ Treble Gain					LSB		
	D7	D6	D5	D4	D3	D2	D1	D0		
0dB	Bass/ Middle/ Treble Boost /Cut	0	0	0	0	0	0	0		
1dB				0	0	0	0	1		
2dB				0	0	0	0	1	0	
3dB				0	0	0	0	1	1	
4dB				0	0	0	0	1	0	0
5dB				0	0	0	0	1	0	1
6dB				0	0	0	0	1	1	0
7dB				0	0	0	0	1	1	1
8dB				0	0	0	1	0	0	0
9dB				0	0	0	1	0	0	1
10dB				0	0	0	1	0	1	0
11dB				0	0	0	1	0	1	1
12dB				0	0	0	1	1	0	0
13dB				0	0	0	1	1	0	1
14dB				0	0	0	1	1	1	0
15dB				0	0	0	1	1	1	1
16dB				1	0	0	0	0	0	0
17dB				1	0	0	0	0	0	1
18dB				1	0	0	0	0	1	0
19dB				1	0	0	0	0	1	1
20dB	1	0	0	0	1	0	0			
Prohibition	1	0	0	1	0	1	0	1		
	:	:	:	:	:	:	:	:		
	1	1	1	1	1	1	1	0		
	1	1	1	1	1	1	1	1		


Mode	MSB		Bass/ Middle/ Treble Boost/Cut					LSB
	D7	D6	D5	D4	D3	D2	D1	D0
Boost	0	0	0	Bass/Middle/Treble Gain				
Cut	1							

 : Initial condition

Select address 75 (hex)

Mode	Loudness HiCut							D0
	D7	D6	D5	D4	D3	D2	D1	
HiCut1	0	0	0	Loudness Gain				
HiCut2		0	1					
HiCut3		1	0					
HiCut4		1	1					

Gain	Loudness Gain							D0
	D7	D6	D5	D4	D3	D2	D1	
0dB	0	Loudness HiCut		0	0	0	0	0
1dB				0	0	0	0	1
2dB				0	0	0	1	0
3dB				0	0	0	1	1
4dB				0	0	1	0	0
5dB				0	0	1	0	1
6dB				0	0	1	1	0
7dB				0	0	1	1	1
8dB				0	1	0	0	0
9dB				0	1	0	0	1
10dB				0	1	0	1	0
11dB				0	1	0	1	1
12dB				0	1	1	0	0
13dB				0	1	1	0	1
14dB				0	1	1	1	0
15dB				0	1	1	1	1
16dB				1	0	0	0	0
17dB				1	0	0	0	1
18dB				1	0	0	1	0
19dB				1	0	0	1	1
20dB	1	0	1	0	0			
Prohibition	:	:	:	:	:			
	1	1	1	1	1			

 : Initial condition

(6) About Power ON Reset

The IC has a built-in initialization circuit that triggers at power ON of supply voltage. Please send initial data to all addresses at supply voltage ON. Also, please turn ON MUTE at the set side until this initial data is sent.

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
Rise Time of VCC	t <sub>RISE</sub>	33	-	-	μsec	V <sub>CC</sub> rise time from 0V to 5V
VCC Voltage of Release Power ON Reset	V <sub>POR</sub>	-	4.1	-	V	

(7) About External Compulsory Mute Terminal

It is possible to forcibly set Mute externally by setting the input voltage at the MUTE terminal.

Mute Voltage Condition	Mode
GND to 1.0V	MUTE ON
2.3V to V <sub>CC</sub>	MUTE OFF

Establish the voltage of MUTE in the condition to be defined.

## Application Information

## 1. Function and Specifications

Function	Specifications
Input selector	<ul style="list-style-type: none"> <li>· Stereo 4 input</li> <li>· Differential 1 input</li> </ul>
Input gain	<ul style="list-style-type: none"> <li>· +20dB to 0dB (1dB step)</li> <li>· Possible to use "Advanced switch" for prevention of switching noise.</li> </ul>
Mute	<ul style="list-style-type: none"> <li>· Possible to use "Advanced switch" for prevention of switching noise.</li> </ul>
Volume	<ul style="list-style-type: none"> <li>· +15dB to -79dB (1dB step), -∞dB</li> <li>· Possible to use "Advanced switch" for prevention of switching noise.</li> </ul>
Bass	<ul style="list-style-type: none"> <li>· +20dB to -20dB (1dB step)</li> <li>· fo=60, 80, 100, 120Hz</li> <li>· Q=0.5, 1, 1.5, 2 variable</li> <li>· Possible to use "Advanced switch" at changing gain</li> </ul>
Middle	<ul style="list-style-type: none"> <li>· +20dB to -20dB (1dB step)</li> <li>· fo=500, 1k, 1.5k, 2.5kHz variable</li> <li>· Q=0.75, 1, 1.25, 1.5 variable</li> <li>· Possible to use "Advanced switch" when changing gain</li> </ul>
Treble	<ul style="list-style-type: none"> <li>· +20dB to -20dB (1dB step)</li> <li>· fo=7.5k, 10k, 12.5k, 15kHz variable</li> <li>· Q=0.75, 1.25 variable</li> <li>· Possible to use "Advanced switch" when changing gain</li> </ul>
Fader	<ul style="list-style-type: none"> <li>· +15dB to -79dB(1dB step), -∞dB</li> <li>· Possible to use "Advanced switch" for prevention of switching noise.</li> </ul>
Loudness	<ul style="list-style-type: none"> <li>· 20dB to 0dB(1dB step)</li> <li>· fo=250/400/800Hz</li> <li>· Possible to use "Advanced switch" for prevention of switching noise.</li> </ul>
LPF	<ul style="list-style-type: none"> <li>· fc=55/85/120/160Hz, pass</li> <li>· Phase shift (0°/180°)</li> </ul>
Level meter	<ul style="list-style-type: none"> <li>· I<sup>2</sup>C BUS control</li> <li>· DC Output</li> </ul>

2. Volume / Fader Volume Attenuation Data

(dB)	D7	D6	D5	D4	D3	D2	D1	D0	(dB)	D7	D6	D5	D4	D3	D2	D1	D0
+15	0	1	1	1	0	0	0	1	-33	1	0	1	0	0	0	0	1
+14	0	1	1	1	0	0	1	0	-34	1	0	1	0	0	0	1	0
+13	0	1	1	1	0	0	1	1	-35	1	0	1	0	0	0	1	1
+12	0	1	1	1	0	1	0	0	-36	1	0	1	0	0	1	0	0
+11	0	1	1	1	0	1	0	1	-37	1	0	1	0	0	1	0	1
+10	0	1	1	1	0	1	1	0	-38	1	0	1	0	0	1	1	0
+9	0	1	1	1	0	1	1	1	-39	1	0	1	0	0	1	1	1
+8	0	1	1	1	1	0	0	0	-40	1	0	1	0	1	0	0	0
+7	0	1	1	1	1	0	0	1	-41	1	0	1	0	1	0	0	1
+6	0	1	1	1	1	0	1	0	-42	1	0	1	0	1	0	1	0
+5	0	1	1	1	1	0	1	1	-43	1	0	1	0	1	0	1	1
+4	0	1	1	1	1	1	0	0	-44	1	0	1	0	1	1	0	0
+3	0	1	1	1	1	1	0	1	-45	1	0	1	0	1	1	0	1
+2	0	1	1	1	1	1	1	0	-46	1	0	1	0	1	1	1	0
+1	0	1	1	1	1	1	1	1	-47	1	0	1	0	1	1	1	1
0	1	0	0	0	0	0	0	0	-48	1	0	1	1	0	0	0	0
-1	1	0	0	0	0	0	0	1	-49	1	0	1	1	0	0	0	1
-2	1	0	0	0	0	0	0	1	-50	1	0	1	1	0	0	1	0
-3	1	0	0	0	0	0	1	1	-51	1	0	1	1	0	0	1	1
-4	1	0	0	0	0	1	0	0	-52	1	0	1	1	0	1	0	0
-5	1	0	0	0	0	1	0	1	-53	1	0	1	1	0	1	0	1
-6	1	0	0	0	0	1	1	0	-54	1	0	1	1	0	1	1	0
-7	1	0	0	0	0	1	1	1	-55	1	0	1	1	0	1	1	1
-8	1	0	0	0	1	0	0	0	-56	1	0	1	1	1	0	0	0
-9	1	0	0	0	1	0	0	1	-57	1	0	1	1	1	0	0	1
-10	1	0	0	0	1	0	1	0	-58	1	0	1	1	1	0	1	0
-11	1	0	0	0	1	0	1	1	-59	1	0	1	1	1	0	1	1
-12	1	0	0	0	1	1	0	0	-60	1	0	1	1	1	1	0	0
-13	1	0	0	0	1	1	0	1	-61	1	0	1	1	1	1	0	1
-14	1	0	0	0	1	1	1	0	-62	1	0	1	1	1	1	1	0
-15	1	0	0	0	1	1	1	1	-63	1	0	1	1	1	1	1	1
-16	1	0	0	1	0	0	0	0	-64	1	1	0	0	0	0	0	0
-17	1	0	0	1	0	0	0	1	-65	1	1	0	0	0	0	0	1
-18	1	0	0	1	0	0	1	0	-66	1	1	0	0	0	0	1	0
-19	1	0	0	1	0	0	1	1	-67	1	1	0	0	0	0	1	1
-20	1	0	0	1	0	1	0	0	-68	1	1	0	0	0	1	0	0
-21	1	0	0	1	0	1	0	1	-69	1	1	0	0	0	1	0	1
-22	1	0	0	1	0	1	1	0	-70	1	1	0	0	0	1	1	0
-23	1	0	0	1	0	1	1	1	-71	1	1	0	0	0	1	1	1
-24	1	0	0	1	1	0	0	0	-72	1	1	0	0	1	0	0	0
-25	1	0	0	1	1	0	0	1	-73	1	1	0	0	1	0	0	1
-26	1	0	0	1	1	0	1	0	-74	1	1	0	0	1	0	1	0
-27	1	0	0	1	1	0	1	1	-75	1	1	0	0	1	0	1	1
-28	1	0	0	1	1	1	0	0	-76	1	1	0	0	1	1	0	0
-29	1	0	0	1	1	1	0	1	-77	1	1	0	0	1	1	0	1
-30	1	0	0	1	1	1	1	0	-78	1	1	0	0	1	1	1	0
-31	1	0	0	1	1	1	1	1	-79	1	1	0	0	1	1	1	1
-32	1	0	1	0	0	0	0	0	-∞	1	1	1	1	1	1	1	1

 : Initial condition

(1) About Level Meter

(a) The Operation of Circuit

Level meter is a function which gives DC voltage proportional to the size of signal of sound. It detects the peak level of signal and keeps the peak level, so that it is possible to monitor the size of signal by resetting DC voltage kept with suitable interval.

(b) The Way to Reset Level Meter Output

Please send reset data through I<sup>2</sup>C BUS

To reset output of level meter : Send D6 = " 1 " of select address 02(hex).

To cancel output reset of level meter (HOLD)... to Send D6 = " 0 " of select address 02(hex).

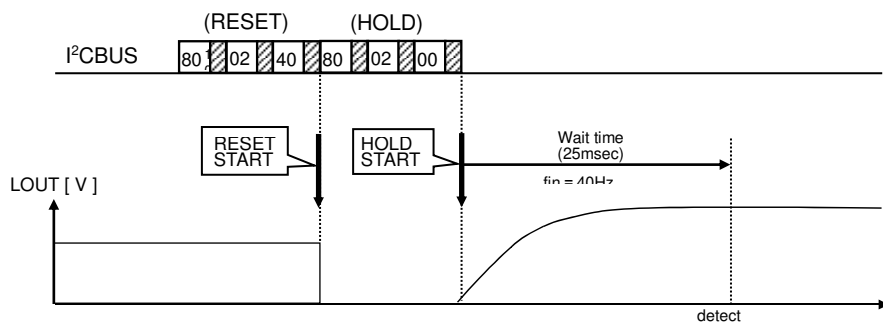
(c) The Settings About Period of Reset

Peak hold operation will start after HOLD data is transmitted. Set the WAIT time after HOLD data transmission according to the frequency bandwidth detected.

WAIT time must be set to a minimum of one cycle over the detected frequency bandwidth.

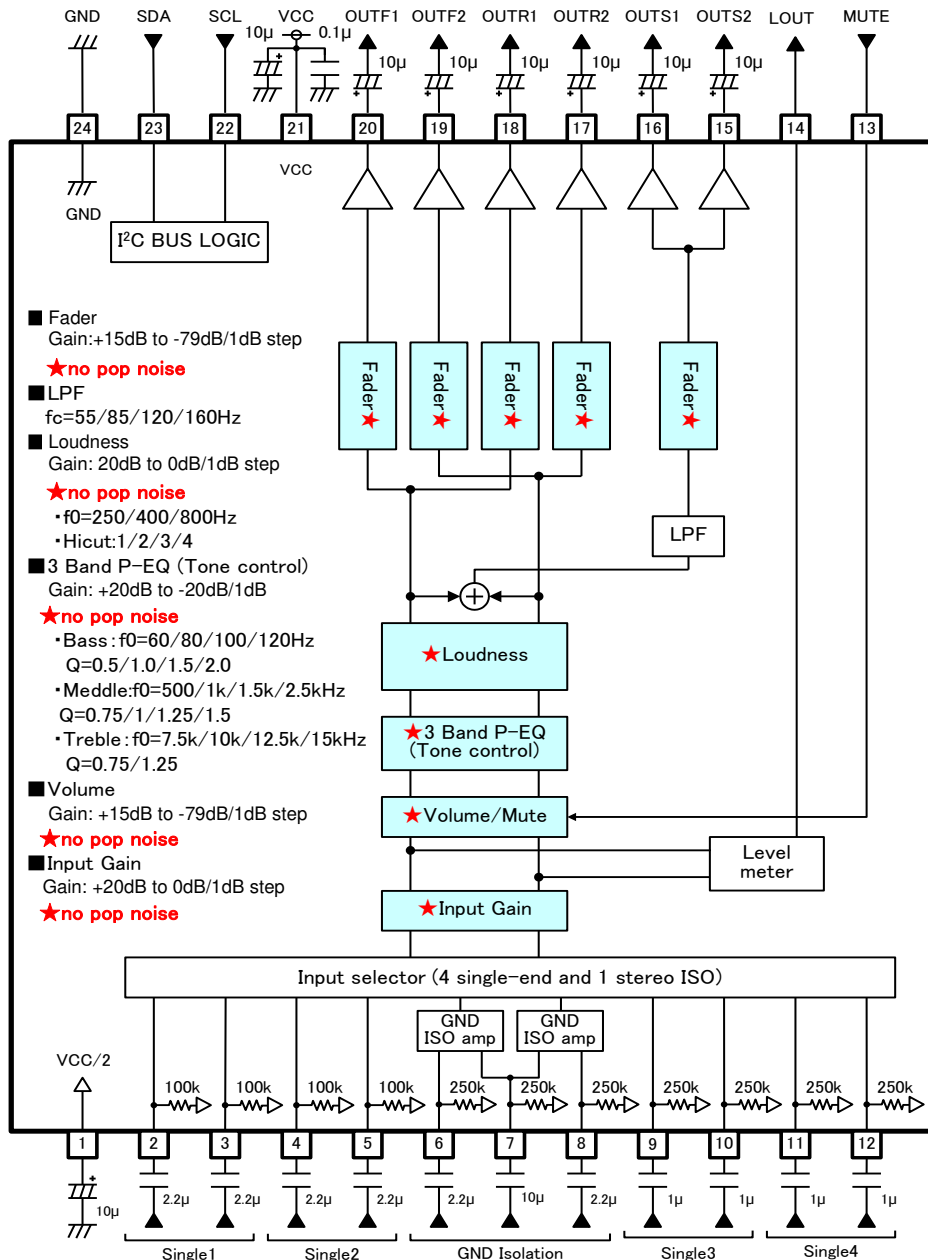
Ex) Detected frequency bandwidth is above 40Hz, 『40Hz = 25ms = WAIT time』

Transmission Example by I<sup>2</sup>C BUS





3. Application Circuit



**Notes on wiring**

- ① Please connect the decoupling capacitor of a power supply in the shortest distance as much as possible to GND.
- ② GND lines should be one-point connected.
- ③ Wiring pattern of Digital should be away from that of analog unit and crosstalk is not acceptable.
- ④ Lines of SCL and SDA of I²C BUS should not be parallel if possible.  
The lines should be shielded, if they are adjacent to each other.
- ⑤ Analog input lines should not be parallel if possible. The lines should be shielded if they are adjacent to each other.

**Power Dissipation**

About the thermal design of the IC

Characteristics of an IC are greatly affected by the temperature at which it is used. Exceeding absolute maximum ratings may degrade and destroy the device. Careful consideration must be given to the heat of the IC from the two standpoints of immediate damage and long-term reliability of operation..

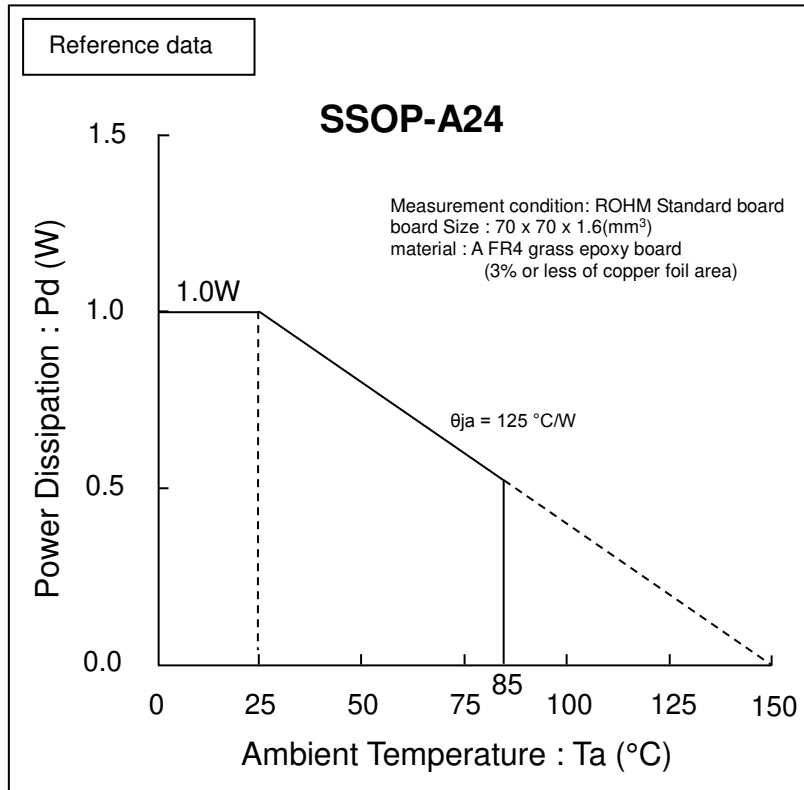


Figure 24. Temperature Derating Curve

(Note) Values are actual measurements and are not guaranteed.

Power dissipation values vary according to the board on which the IC is mounted.

I/O Equivalent Circuits

Pin No.	Pin Name	Pin Voltage	Equivalent Circuit	Pin Description
2 3 4 5	A1 A2 B1 B2	4.25		A terminal for signal input. The input impedance is 100kΩ(typ).
6 7 8 9 10 11 12	CP1 CN CP2 D1 D2 E1 E2	4.25		A terminal for signal input. The input impedance is 250kΩ(typ).
13	MUTE	-		A terminal for external compulsory mute. If terminal voltage is High level, the mute is OFF. If the terminal voltage is Low level, the Mute is ON.
16 17 18 19 20	OUTS1 OUTR2 OUTR1 OUTF2 OUTF1	4.25		A terminal for Fader and Subwoofer output.

The values in the pin explanation and input/output equivalent circuit are for reference purposes only. It is not a guaranteed value.