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Sound Processor with Built-in 3-band Equalizer

BD37544FS

General Description

BD37544FS is a sound processor with built-in 3-band equalizer for car audio. The functions are stereo input selector (which can switch single and GND isolation), input-gain control, main volume, super bass, 5ch fader volume, LPF/HPF for subwoofer, and mixing input. Moreover, "Advanced switch circuit", which is an original ROHM technology, can reduce various switching noise (ex. No-signal, low frequency like 20Hz & large signal inputs). Also, "Advanced switch" makes control of microcomputer easier, and can construct a high quality car audio system.

Features

- Reduced switching noise of input gain control, mute, main volume, fader volume, bass, middle, treble, super bass, mixing by using advanced switch circuit.
- Built-in differential input selector that can make various combination of single-ended / differential input.
- 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.
- Decreased number of external components due to built-in 3-band equalizer filter, LPF for subwoofer, and HPF. It is possible to control Q, G_v, f₀ of 3-band equalizer and f_c of LPF/HPF through I²C BUS control.
- It is possible to adjust the gain of the bass, middle, and treble up to ±20dB with 1 dB step gain adjustment.
- It is equipped with output terminals for Subwoofer. Moreover, the stereo signal output of the front and rear can also be chosen by the I²C BUS control.
- Built-in mixing input and mixing attenuator.
- 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 terminals and output terminals are organized and separately laid out to keep the signal flow in one direction which results in simpler and smaller PCB layout.
- It is possible to control the I²C BUS by 3.3V / 5V.

Applications

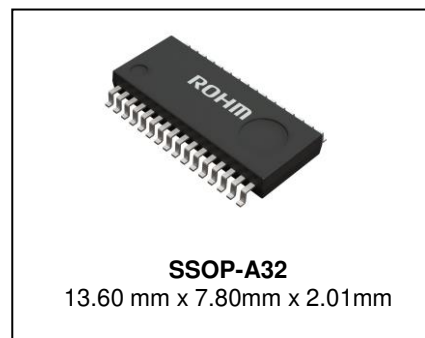
It is optimal for car audio systems. It can also be used for audio equipment of mini Compo, micro Compo, TV, etc.

Key Specifications

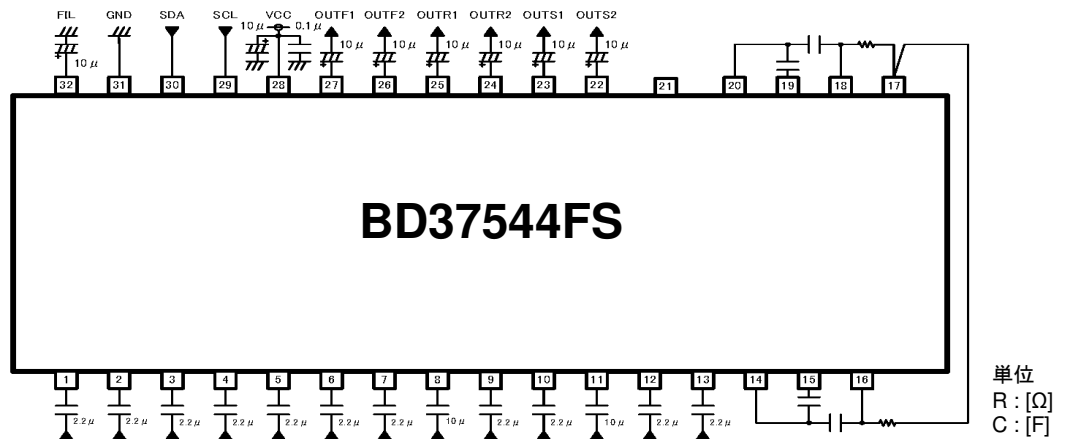
■ Power Supply Voltage Range:	7.0V to 9.5V
■ Circuit Current (No Signal):	38mA (Typ)
■ Total Harmonic Distortion:	
THD+N1	0.001% (Typ)
THD+N2	0.002% (Typ)
■ Maximum Input Voltage:	2.3Vrms(Typ)
■ Cross-talk Between Selectors:	-100dB(Typ)
■ Volume Control Range:	+15 dB to -79dB
■ Output Noise Voltage:	
V _{NO1}	3.8μVrms(Typ)
V _{NO2}	4.8μVrms(Typ)
■ Residual Output Noise Voltage:	1.8μVrms(Typ)
■ Operating Temperature Range:	-40°C to +85°C

Package

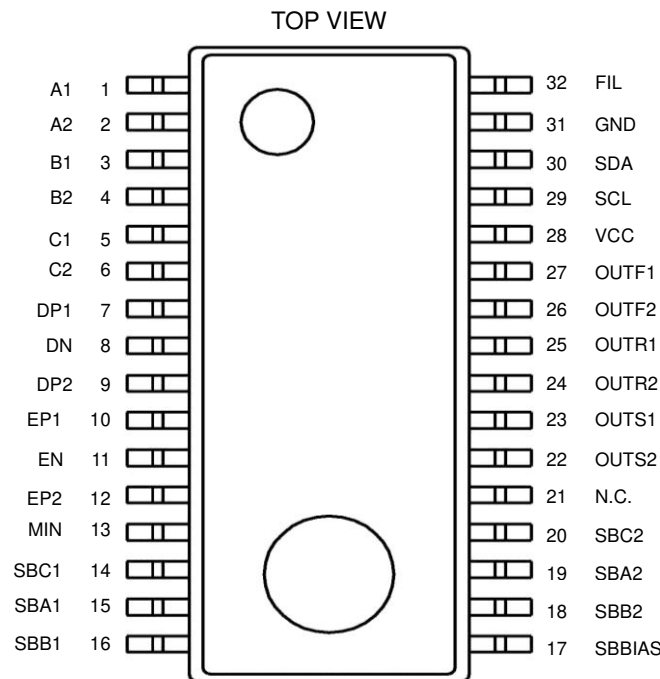
W(Typ) x D(Typ) x H(Max)



Typical Application Circuit



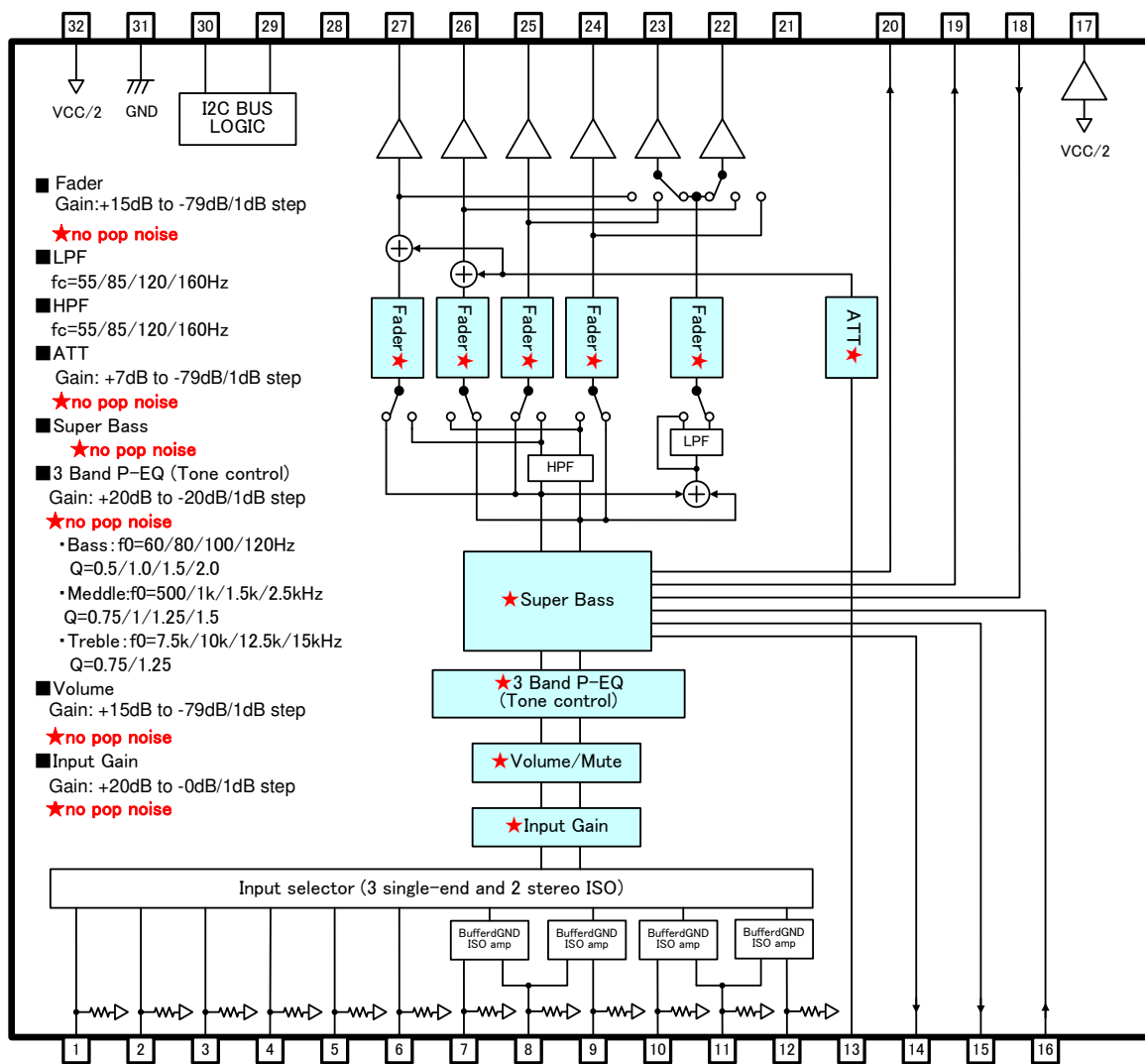
Pin Configuration



Pin Descriptions

Pin No.	Pin Name	Description	Pin No.	Pin Name	Description
1	A1	A input terminal of 1ch	17	SBBIAS	SuperBass bias terminal
2	A2	A input terminal of 2ch	18	SBB2	SuperBass setting terminal of 2ch
3	B1	B input terminal of 1ch	19	SBA2	SuperBass setting terminal of 2ch
4	B2	B input terminal of 2ch	20	SBC2	SuperBass setting terminal of 2ch
5	C1	C input terminal of 1ch	21	N.C.	No connection
6	C2	C input terminal of 2ch	22	OUTS2	Subwoofer output terminal of 2ch
7	DP1	D positive input terminal of 1ch	23	OUTS1	Subwoofer output terminal of 1ch
8	DN	D negative input terminal	24	OUTR2	Rear output terminal of 2ch
9	DP2	D positive input terminal of 2ch	25	OUTR1	Rear output terminal of 1ch
10	EP1	E positive input terminal of 1ch	26	OUTF2	Front output terminal of 2ch
11	EN	E negative input terminal	27	OUTF1	Front output terminal of 1ch
12	EP2	E positive input terminal of 2ch	28	VCC	Power supply terminal
13	MIN	Mixing input terminal	29	SCL	I ² C Communication clock terminal
14	SBC1	SuperBass setting terminal of 1ch	30	SDA	I ² C Communication data terminal
15	SBA1	SuperBass setting terminal of 1ch	31	GND	GND terminal
16	SBB1	SuperBass setting terminal of 1ch	32	FIL	VCC/2 terminal

Block Diagram



Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Rating	Unit
Power Supply Voltage	V _{CC}	10.0	V
Input Voltage	V _{IN}	V _{CC} +0.3 to GND-0.3	V
Power Dissipation	P _d	0.95 (Note 1)	W
Storage Temperature	T _{stg}	-55 to +150	°C

(Note 1) When mounted on the standard board (70 x 70 x 1.6 mm³), derate by 7.6mW/°C for Ta above 25°C.
 Thermal resistance θ_{ja} = 131.6(°C/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 _{CC}	7.0	-	9.5	V
Temperature	T _{opr}	-40	-	+85	°C

Electrical Characteristics

(Unless specified, Ta=25°C, V_{CC}=8.5V, f=1kHz, V_{IN}=1V_{rms}, R_g=600Ω, R_L=10kΩ, A1 input, Input gain 0dB, Mute OFF, Volume 0dB, Tone control 0dB, Loudness 0dB, LPF OFF, HPF OFF, Mixing OFF, Fader 0dB)

BLOCK	Parameter	Symbol	Limit			Unit	Conditions
			Min	Typ	Max		
GENERAL	Circuit Current (No Signal)	I _Q	-	38	48	mA	No signal
	Voltage Gain	G _V	-1.5	0	+1.5	dB	G _V =20log(V _{OUT} /V _{IN})
	Channel Balance	CB	-1.5	0	+1.5	dB	CB = G _{V1} -G _{V2}
	Total Harmonic Distortion 1 (FRONT,REAR)	THD+N1	-	0.001	0.05	%	V _{OUT} =1V _{rms} BW=400Hz-30KHz
	Total Harmonic Distortion 2 (SUBWOOFER)	THD+N2	-	0.002	0.05	%	V _{OUT} =1V _{rms} BW=400Hz-30KHz
	Output Noise Voltage 1 (FRONT,REAR) *	V _{NO1}	-	3.8	15	μV _{rms}	R _g = 0Ω BW = IHF-A
	Output Noise Voltage 2 (SUBWOOFER) *	V _{NO2}	-	4.8	15	μV _{rms}	R _g = 0Ω BW = IHF-A
	Residual Output Noise Voltage*	V _{NOR}	-	1.8	10	μV _{rms}	Fader = -∞dB R _g = 0Ω BW = IHF-A
	Cross-talk Between Channels *	CTC	-	-100	-90	dB	R _g = 0Ω CTC=20log(V _{OUT} /V _{IN}) BW = IHF-A
INPUT SELECTOR	Ripple Rejection	RR	-	-70	-40	dB	f=1kHz V _{RR} =100mV _{rms} RR=20log(V _{CC} IN/V _{OUT})
	Input Impedance(A, B,C)	R _{IN_S}	70	100	130	kΩ	
	Input Impedance(D, E)	R _{IN_D}	175	250	325	kΩ	
	Maximum Input Voltage	V _{IM}	2.1	2.3	-	V _{rms}	V _{IM} at THD+N(V _{OUT})=1% BW=400Hz-30KHz
	Cross-talk Between Selectors *	CTS	-	-100	-90	dB	R _g = 0Ω CTS=20log(V _{OUT} /V _{IN}) BW = IHF-A
Common Mode Rejection Ratio*	CMRR	50	65	-	dB	XP1 and XN input XP2 and XN input CMRR=20log(V _{IN} /V _{OUT}) BW = IHF-A,[*X...D,E]	

Electrical Characteristics - continued

BLOCK	Parameter	Symbol	Limit			Unit	Conditions
			Min	Typ	Max		
INPUT GAIN	Minimum Input Gain	G_{IN_MIN}	-2	0	+2	dB	Input gain 0dB $V_{IN}=100mV_{rms}$ $G_{IN}=20\log(V_{OUT}/V_{IN})$
	Maximum Input Gain	G_{IN_MAX}	18	20	22	dB	Input gain 20dB $V_{IN}=100mV_{rms}$ $G_{IN}=20\log(V_{OUT}/V_{IN})$
	Gain Set Error	G_{IN_ERR}	-2	0	+2	dB	$G_{AIN}=+20dB$ to $+1dB$
MUTE	Mute Attenuation *	G_{MUTE}	-	-105	-85	dB	Mute ON $G_{MUTE}=20\log(V_{OUT}/V_{IN})$ BW = IHF-A
VOLUME	Maximum Gain	G_V_MAX	13	15	17	dB	Volume = 15dB $V_{IN}=100mV_{rms}$ $G_V=20\log(V_{OUT}/V_{IN})$
	Maximum Attenuation *	G_V_MIN	-	-100	-85	dB	Volume = $-\infty$ dB $G_V=20\log(V_{OUT}/V_{IN})$ BW = IHF-A
	Attenuation Set Error 1	G_V_ERR1	-2	0	+2	dB	G_{AIN} & $ATT=+15dB$ to $-15dB$
	Attenuation Set Error 2	G_V_ERR2	-3	0	+3	dB	$ATT=-16dB$ to $-47dB$
	Attenuation Set Error 3	G_V_ERR3	-4	0	+4	dB	$ATT=-48dB$ to $-79dB$
BASS	Maximum Boost Gain	G_B_BST	18	20	22	dB	Gain= $+20dB$ $f=100Hz$ $V_{IN}=100mV_{rms}$ $G_B=20\log(V_{OUT}/V_{IN})$
	Maximum Cut Gain	G_B_CUT	-22	-20	-18	dB	Gain= $-20dB$ $f=100Hz$ $V_{IN}=2V_{rms}$ $G_B=20\log(V_{OUT}/V_{IN})$
	Gain Set Error	G_B_ERR	-2	0	+2	dB	Gain= $-20dB$ to $+20dB$ $f=100Hz$
MIDDLE	Maximum Boost Gain	G_M_BST	18	20	22	dB	Gain= $+20dB$ $f=1kHz$ $V_{IN}=100mV_{rms}$ $G_M=20\log(V_{OUT}/V_{IN})$
	Maximum Cut Gain	G_M_CUT	-22	-20	-18	dB	Gain= $-20dB$ $f=1kHz$ $V_{IN}=2V_{rms}$ $G_M=20\log(V_{OUT}/V_{IN})$
	Gain Set Error	G_M_ERR	-2	0	+2	dB	Gain= $-20dB$ to $+20dB$ $f=1kHz$
TREBLE	Maximum Boost Gain	G_T_BST	18	20	22	dB	Gain= $+20dB$ $f=10kHz$ $V_{IN}=100mV_{rms}$ $G_T=20\log(V_{OUT}/V_{IN})$
	Maximum Cut Gain	G_T_CUT	-22	-20	-18	dB	Gain= $-20dB$ $f=10kHz$ $V_{IN}=2V_{rms}$ $G_T=20\log(V_{OUT}/V_{IN})$
	Gain Set Error	G_T_ERR	-2	0	+2	dB	Gain= $-20dB$ to $+20dB$ $f=10kHz$
MIXING	Input Impedance	R_{IN_M}	19	27	35	k Ω	
	Maximum Input Voltage	V_{IM_M}	2.0	2.2	-	V _{rms}	V_{IM} at THD+N(V_{OUT})=1 % BW=400Hz-30KHz
	Maximum Attenuation *	G_{MX_MIN}	-	-100	-85	dB	MIX=OFF $G_{MX}=20\log(V_{OUT}/V_{IN})$ BW=INF-A
	Maximum Gain	G_{MX_MAX}	5	7	9	dB	$ATT=+7dB$ $G_{MX}=20\log(V_{OUT}/V_{IN})$

Electrical Characteristics - continued

BLOCK	Parameter	Symbol	Limit			Unit	Conditions
			Min	Typ	Max		
FADER / SUBWOOFER	Maximum Boost Gain	G_{F_BST}	13	15	17	dB	Fader=15dB $V_{IN}=100mV_{rms}$ $G_F=20\log(V_{OUT}/V_{IN})$
	Maximum Attenuation *	G_{F_MIN}	-	-100	-90	dB	Fader = $-\infty$ dB $G_F=20\log(V_{OUT}/V_{IN})$ BW = IHF-A
	Gain Set Error	G_{F_ERR}	-2	0	+2	dB	GAIN=+1dB to +15dB
	Attenuation Set Error 1	G_{F_ERR1}	-2	0	+2	dB	ATT=-1dB to -15dB
	Attenuation Set Error 2	G_{F_ERR2}	-3	0	+3	dB	ATT=-16dB to -47dB
	Attenuation Set Error 3	G_{F_ERR3}	-4	0	+4	dB	ATT=-48dB to -79dB
	Output Impedance	R_{OUT}	-	-	50	Ω	$V_{IN}=100mV_{rms}$
	Maximum Output Voltage	V_{OM}	2	2.2	-	Vrms	THD+N=1% BW=400Hz-30KHz

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

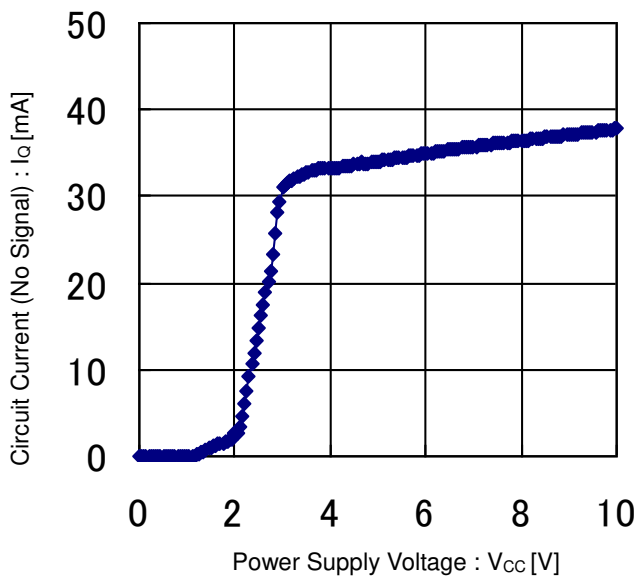


Figure 1. Circuit Current (No Signal) vs Power Supply Voltage

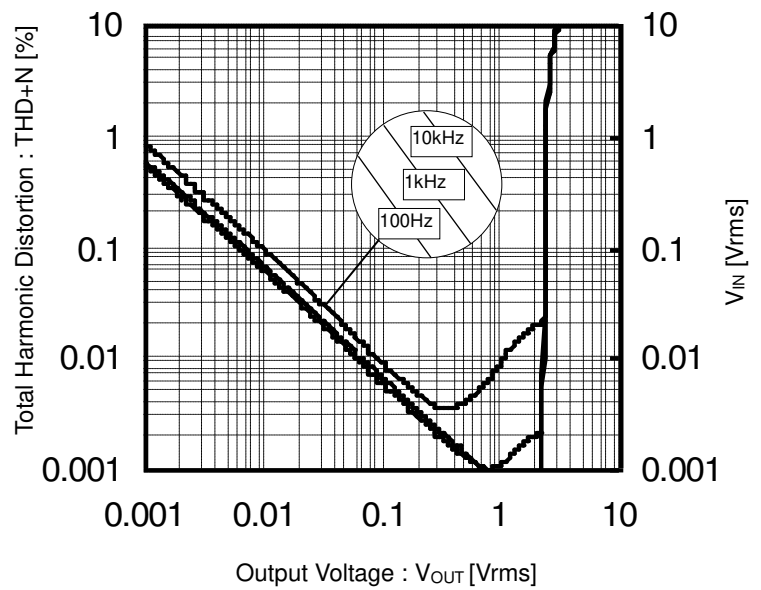


Figure 2. Total Harmonic Distortion vs Output Voltage

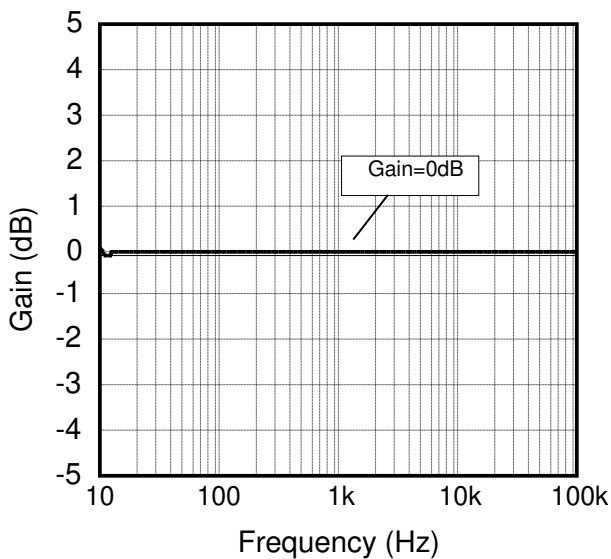


Figure 3. Gain vs Frequency

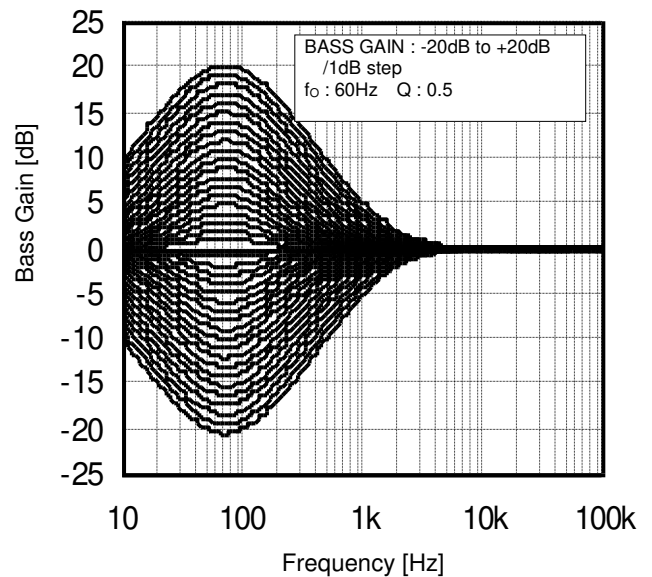


Figure 4. Bass Gain vs Frequency

Typical Performance Curves – continued

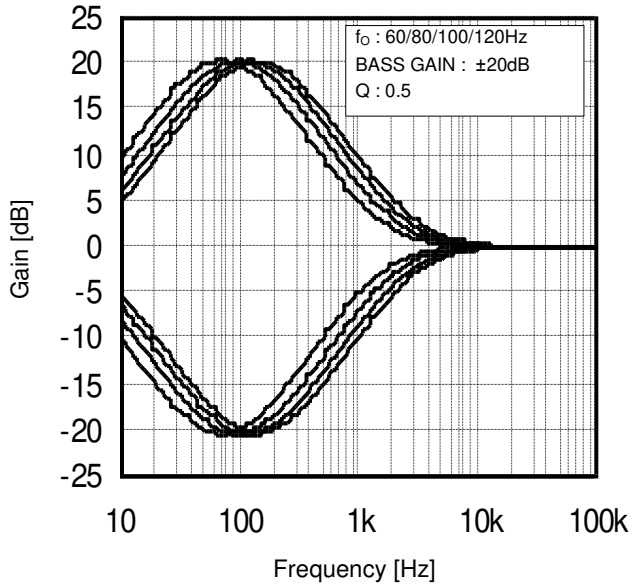


Figure 5. Bass fo vs Frequency

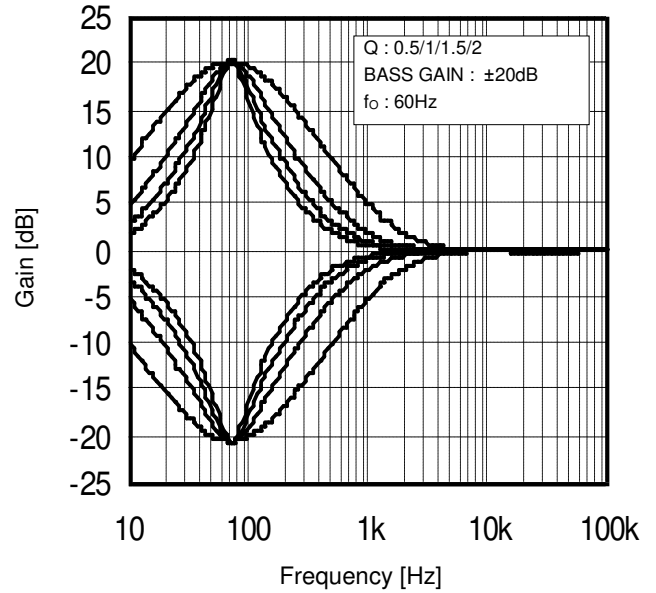


Figure 6. Bass Q vs Frequency

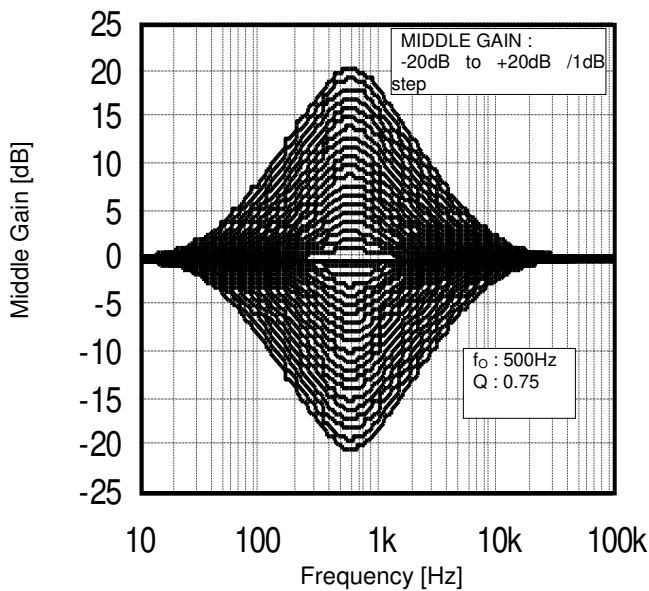


Figure 7. Middle Gain vs Frequency

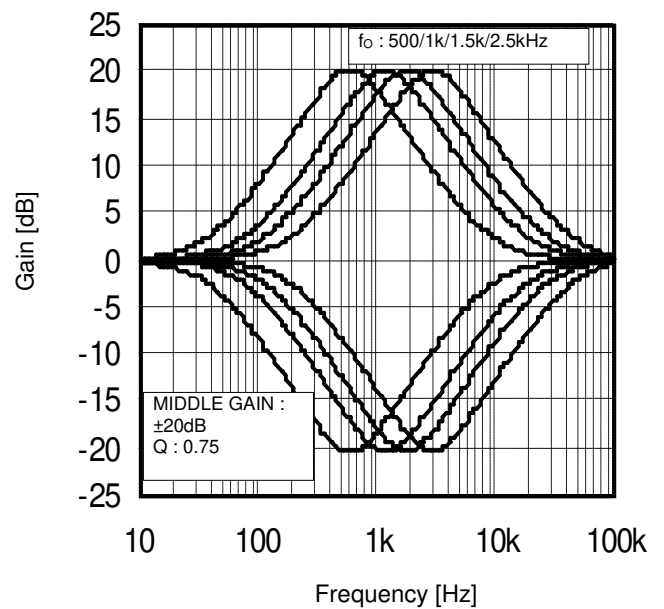


Figure 8. Middle fo vs Frequency

Typical Performance Curves – continued

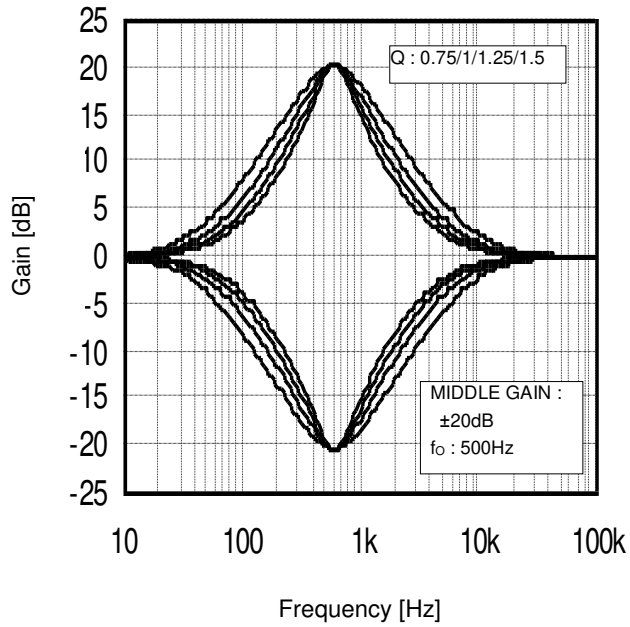


Figure 9. Middle Q vs Frequency

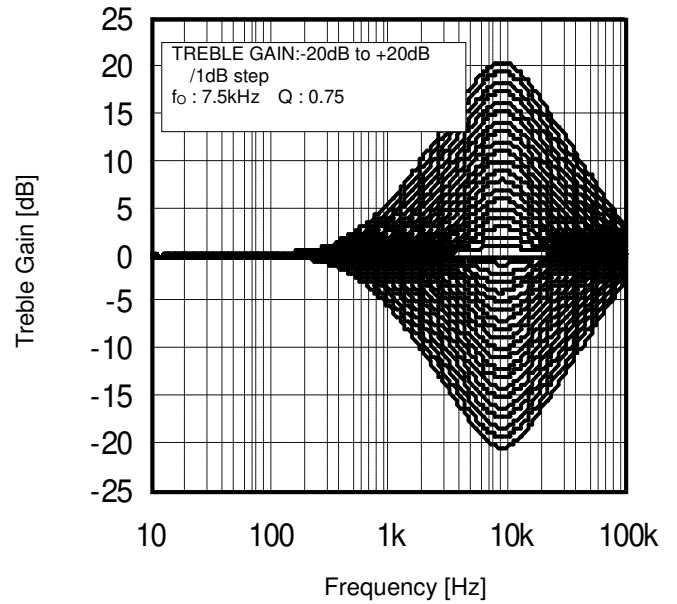


Figure 10. Treble Gain vs Frequency

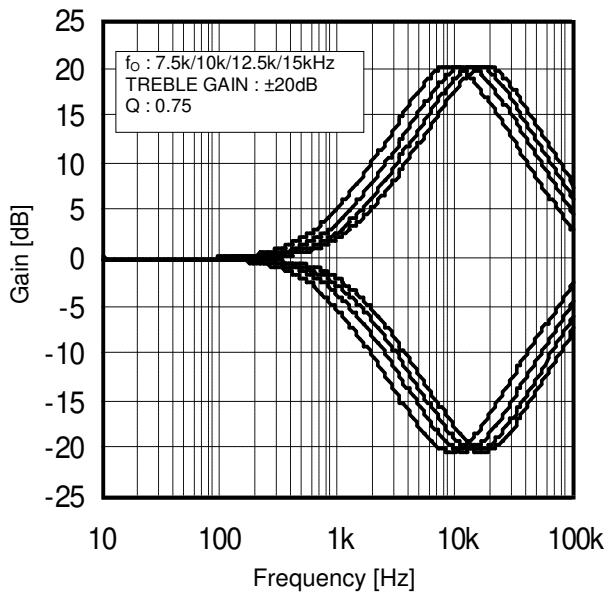


Figure 11. Treble fo vs Frequency

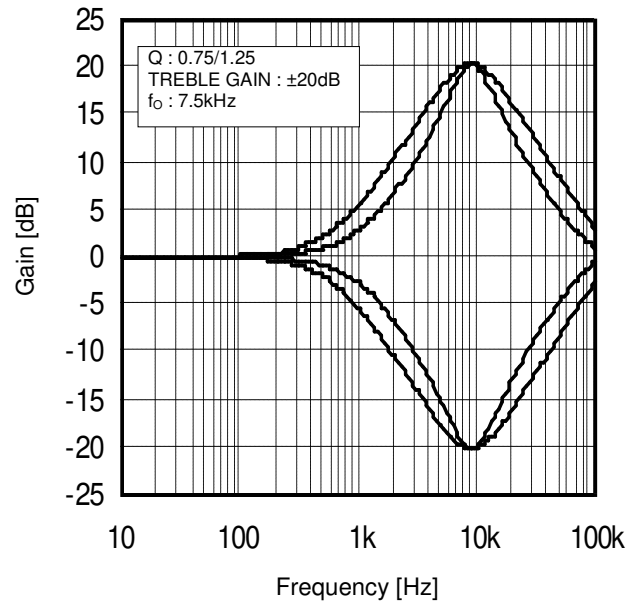


Figure 12. Treble Q vs Frequency

Typical Performance Curves – continued

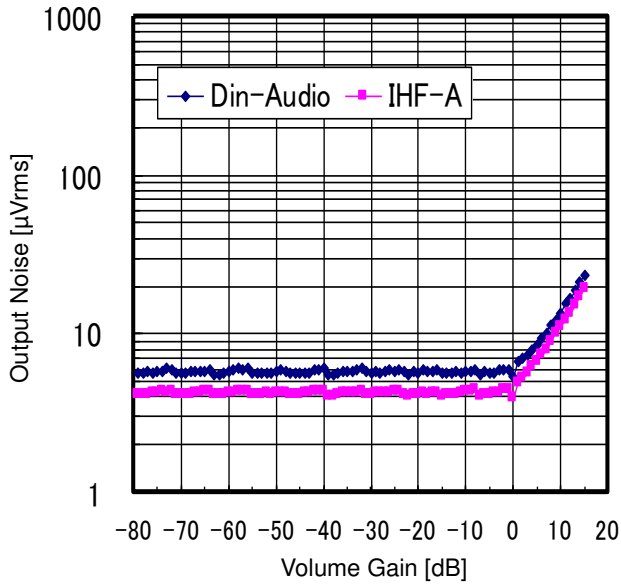


Figure 13. Output Noise vs Volume Gain

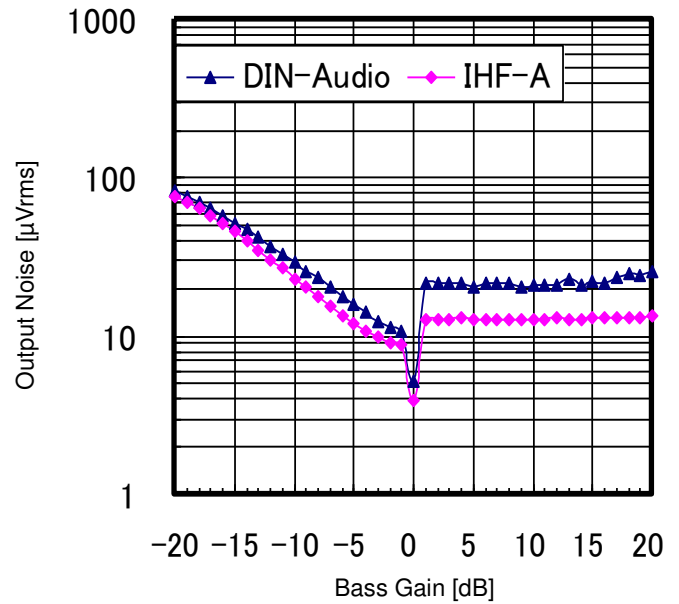


Figure 14. Output Noise vs Bass Gain

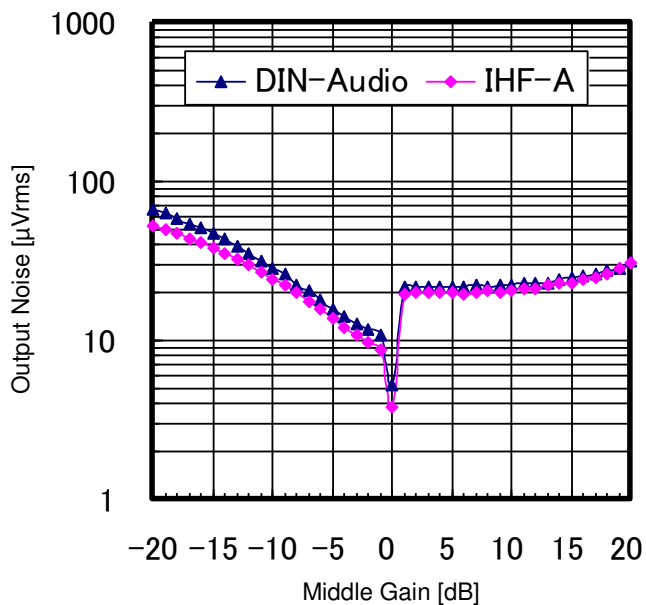


Figure 15. Output Noise vs Middle Gain

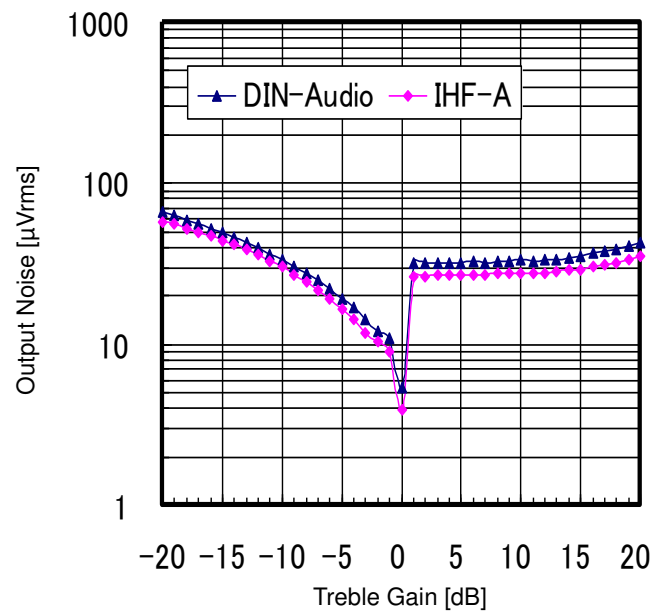


Figure 16. Output Noise vs Treble Gain

Typical Performance Curves – continued

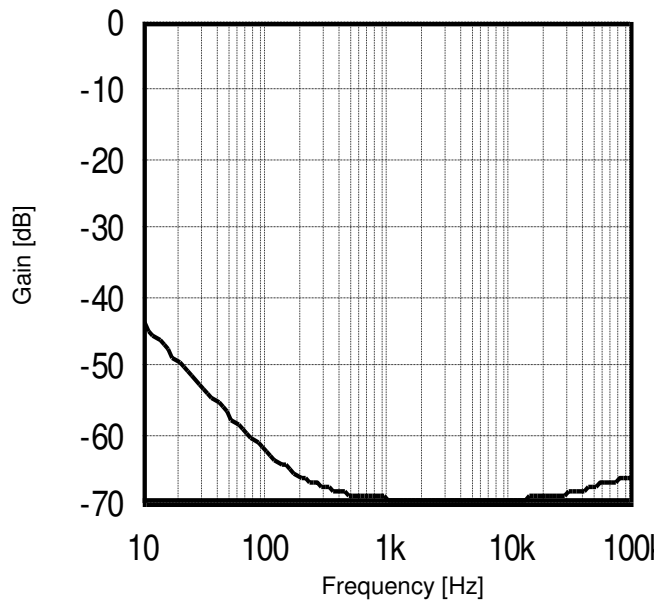


Figure 17. CMRR vs Frequency

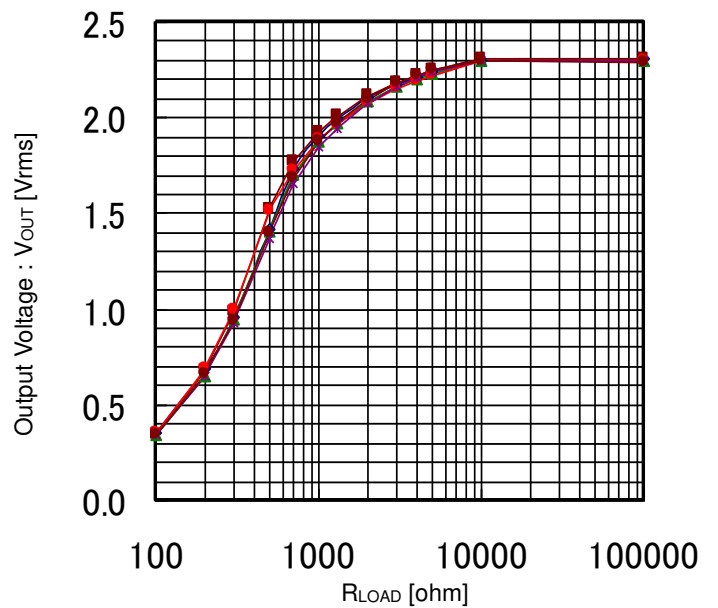


Figure 18. Output Voltage vs R_LOAD

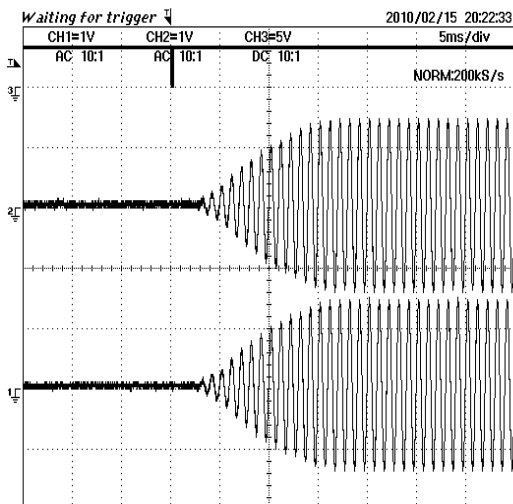


Figure 19. Advanced Switch 1

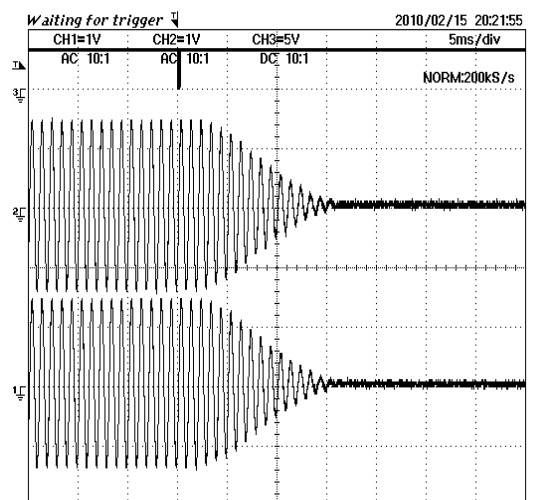


Figure 20. Advanced Switch 2

Timing Chart
CONTROL SIGNAL SPECIFICATION

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

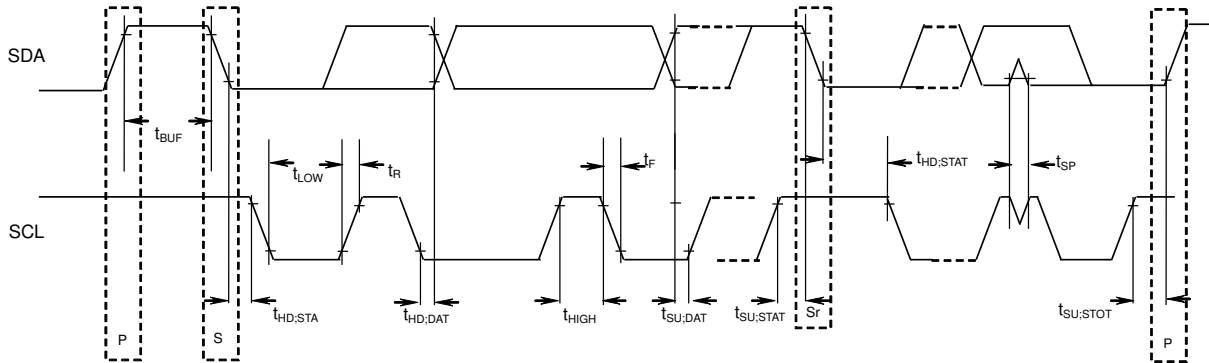


Figure 21. I²C-bus Signal Timing Diagram

Table 1 Characteristics of the SDA and SCL bus lines for I²C-bus devices (Ta=25°C, VCC=8.5V)

Parameter	Symbol	Fast-mode I²C-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	-	µs
3 Hold time (repeated) START condition. After this period, the first clock pulse is generated	t _{HD:STA}	0.6	-	µs
4 LOW period of the SCL clock	t _{LOW}	1.3	-	µs
5 HIGH period of the SCL clock	t _{HIGH}	0.6	-	µs
6 Set-up time for a repeated START condition	t _{SU:STA}	0.6	-	µs
7 Data hold time:	t _{HD:DAT}	0.06 (Note)	-	µs
8 Data set-up time	t _{SU:DAT}	120	-	ns
9 Set-up time for STOP condition	t _{SU:STO}	0.6	-	µs

All values refer to VIH Min and VIL Max Levels (see Table 2).

(Note) A device must internally provide a hold time of at least 300 ns for the SDA signal (referred 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}), 8(t_{SU:DAT}), make the setup in which the margin is full.

Table 2 Characteristics of the SDA and SCL I/O stages for I²C-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	µA

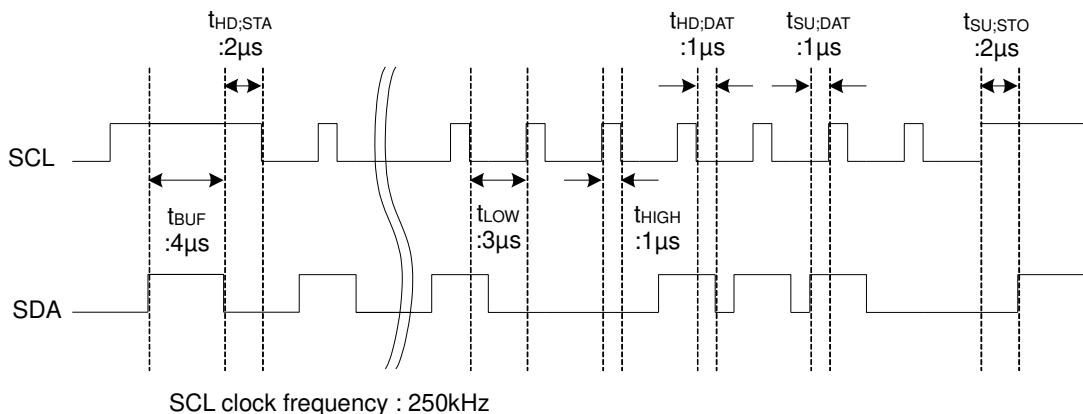
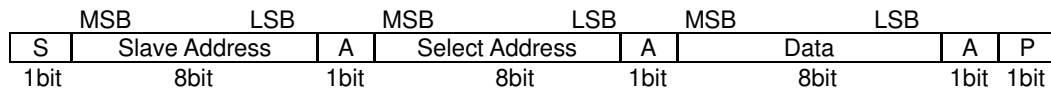


Figure 22. A Command Timing Example in the I²C Data Transmission

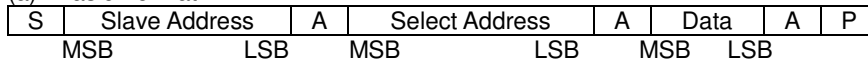
(2) I²C BUS FORMAT



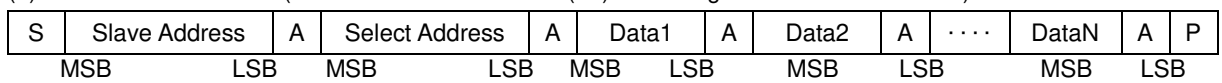
- S = Start condition (Recognition of start bit)
- Slave Address = Recognition of slave address. The first 7 bits correspond to the slave address. The least significant bit is "L" which corresponds to write mode.
- A = ACKNOWLEDGE bit (Recognition of acknowledgement)
- Select Address = Select address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

(3) I²C BUS Interface Protocol

(a) Basic Format



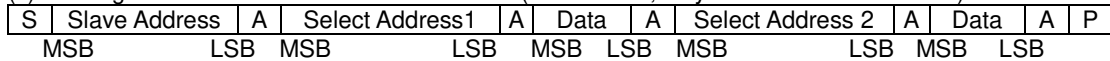
(b) Automatic Increment (Select Address increases (+1) according to the number of data.)



(Example)

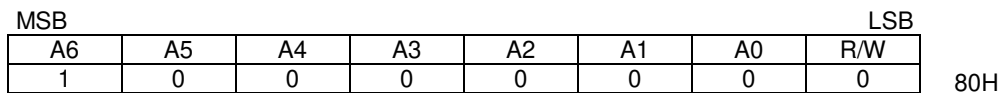
- ① Data1 shall be set as data of address specified by Select Address.
- ② Data2 shall be set as data of address specified by Select Address +1.
- ③ DataN shall be set as data of address specified by Select Address +N-1.

(c) Configuration Unavailable for Transmission (In this case, only Select Address1 is set.)



(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



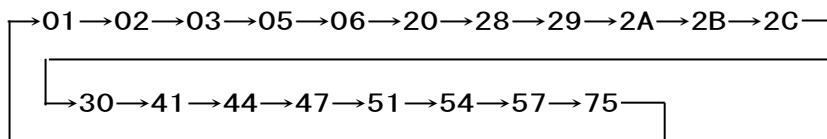
(5) Select Address & Data

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/Super Bass Mixing		0	1	Advanced switch time of Mute	
Initial setup 2	02	LPF Phase	0	Subwoofer Output Select		0	Subwoofer LPF f _c		
Initial setup 3	03	Front HPF Pass	Rear HPF Pass	Front / Rear HPF f _c			0	1	0
Input Selector	05	Full-diff Type	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							
Mixing	30	Mixing Gain / Attenuation							
Bass setup	41	0	0	Bass f ₀		0	0	Bass Q	
Middle setup	44	0	0	Middle f ₀		0	0	Middle Q	
Treble setup	47	0	0	Treble f ₀		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				
Super Bass Gain	75	0	0	0	Super Bass Gain				
System Reset	FE	1	0	0	0	0	0	0	1

 Advanced switch

Note

1. The Advanced Switch works in the latch part while changing from one function to another.
2. Upon continuous data transfer, the Select Address rolls over because of the automatic increment function, as shown below.



3. Advanced switch is not used for the function of input selector and subwoofer output select, etc. Therefore, please apply mute on the side when changing these settings.
4. When using mute function of this IC at the time of changing input selector, please switch mute ON/OFF for waiting advanced-mute time.

Select address 01 (hex)

Time	MSB 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/Super Bass/Mixing		0	1	0	0	
1.0msec			0	1					
1.4msec			1	0					
3.2msec			1	1					

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

Mode	MSB 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/Super Bass/Mixing		0	1	Advanced switch Time of Mute		
ON	1								

Select address 02(hex)

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

Mode	MSB Subwoofer Output Select							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
LPF	LPF Phase	0	0	0	0	Subwoofer LPF fc			
Front			0	1					
Rear			1	0					
Prohibition			1	1					

Phase	MSB LPF Phase							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
0°	0	0	Subwoofer output select		0	Subwoofer LPF fc			
180°	1								

 : Initial condition

Select address 03(hex)

Mode	MSB Front/Rear HPF f _c							LSB	
	D7	D6	D5	D4	D3	D2	D1	D0	
55Hz	Front HPF Pass	Rear HPF Pass	0	0	0	0	1	0	
85Hz			0	0	1				
120Hz			1	1	0				
160Hz			0	1	0				
Prohibition	Other setting								


Mode	MSB Rear HPF						LSB	
	D7	D6	D5	D4	D3	D2	D1	D0
pass	Front HPF Pass	0	Front/Rear HPF f _c			0	1	0
NOT pass		1						

Mode	MSB Front HPF					LSB		
	D7	D6	D5	D4	D3	D2	D1	D0
pass	0	Rear HPF Pass	Front/Rear HPF f _c			0	1	0
NOT pass	1							

Select address 05(hex)

Mode	MSB Input Selector								LSB	
	OUTF1	OUTF2	D7	D6	D5	D4	D3	D2	D1	D0
A	A1	A2	Full-diff bias type select	0	0	0	0	0	0	0
B	B1	B2				0	0	0	0	1
C	C1	C2				0	0	0	1	0
D single	DP1	DP2				0	0	0	1	1
E single	EP1	EP2				0	0	1	0	0
A diff	A1	B1				0	1	1	1	1
C diff	B2	C2				1	0	0	0	0
D diff	DP1	DP2				0	0	1	1	0
E diff	EP1	EP2				0	0	1	1	1
Input SHORT						0	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)

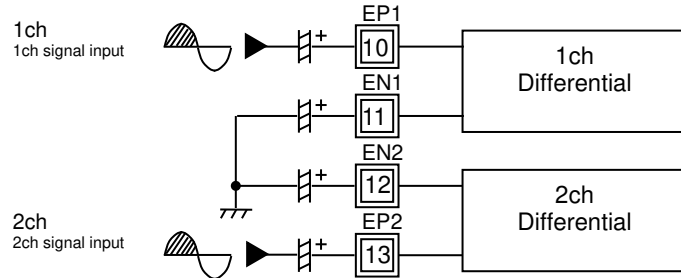
 : Initial condition

Select address 05(hex)

Mode	Full-diff Bias Type Select							
	MSB							LSB
	D7	D6	D5	D4	D3	D2	D1	D0
Negative Input	0	0	0	Input Selector				
Bias	1							

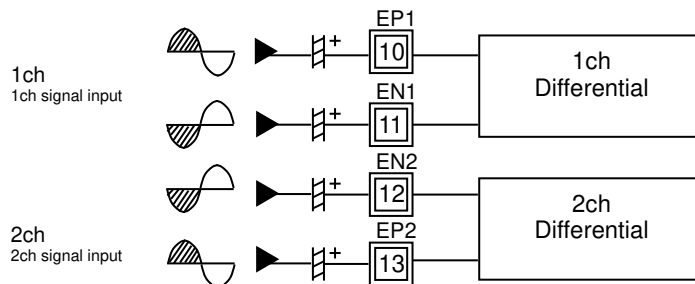
Negative input type

For Ground –isolation type.



Bias type

For differential amplifier type



Select address 06 (hex)

Gain	Input Gain							
	MSB							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	0	1	1			
	:	:	:	:	:			
	1	1	1	1	1			

Initial condition

Select address 06 (hex)

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


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

Gain & ATT	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
	:	:	:	:	:	:	:	:
	1	1	1	1	1	1	1	0
-∞dB	1	1	1	1	1	1	1	1

Select address 30(hex)

Gain & ATT	Mixing 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
	:	:	:	:	:	:	:	:
7dB	0	1	1	1	1	0	0	0
6dB	0	1	1	1	1	0	1	0
5dB	0	1	1	1	1	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
	:	:	:	:	:	:	:	:
	1	1	1	1	1	1	1	0
MIX OFF	1	1	1	1	1	1	1	1

(Note) See the precaution on P30 together, too.

 : Initial condition

Select address 41(hex)

Q factor	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	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	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	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				

Select address 47 (hex)

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

 : Initial condition

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	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	0
				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)

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

(Note) About Super Bass, the above Gain is for in indication purposes. Actual Gain (=20log (V_{OUT}/V_{IN})) is different. Refer to P31 to P34 for the details.

 : Initial condition

(6) About Power ON Reset

Built-in IC initialization is made during power ON of the supply voltage. Please send initial data to all addresses at supply voltage on. And please turn ON mute until this initial data is sent.

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

Application Information


1. Function and Specifications

Function	Specifications																		
Input selector	<ul style="list-style-type: none"> • Stereo input • Single-End/Differential (Possible to set the number of single-end/ differential as follows) <table border="1" style="margin-left: 40px;"> <thead> <tr> <th></th> <th>Single-End</th> <th>Differential</th> </tr> </thead> <tbody> <tr> <td>Mode 1</td> <td>0</td> <td>4</td> </tr> <tr> <td>Mode 2</td> <td>1</td> <td>3</td> </tr> <tr> <td>Mode 3</td> <td>3</td> <td>2</td> </tr> <tr> <td>Mode 4</td> <td>4</td> <td>1</td> </tr> <tr> <td>Mode 5</td> <td>5</td> <td>0</td> </tr> </tbody> </table> <p style="text-align: center;">Table.1 Combination of input selector</p>		Single-End	Differential	Mode 1	0	4	Mode 2	1	3	Mode 3	3	2	Mode 4	4	1	Mode 5	5	0
	Single-End	Differential																	
Mode 1	0	4																	
Mode 2	1	3																	
Mode 3	3	2																	
Mode 4	4	1																	
Mode 5	5	0																	
Input gain	<ul style="list-style-type: none"> • +20dB to 0dB (1dB step) • Possible to use "Advanced switch" for prevention of switching noise. 																		
Mute	<ul style="list-style-type: none"> • Possible to use "Advanced switch" for prevention of switching noise. 																		
Volume	<ul style="list-style-type: none"> • +15dB to -79dB (1dB step), -∞dB • Possible to use "Advanced switch" for prevention of switching noise. 																		
Bass	<ul style="list-style-type: none"> • +20dB to -20dB (1dB step) • Q=0.5, 1, 1.5, 2 • f₀=60, 80, 100, 120Hz • Possible to use "Advanced switch" for prevention of switching noise. 																		
Middle	<ul style="list-style-type: none"> • +20dB to -20dB (1dB step) • Q=0.75, 1, 1.25, 1.5 • f₀=500, 1k, 1.5k 2.5kHz • Possible to use "Advanced switch" for prevention of switching noise. 																		
Treble	<ul style="list-style-type: none"> • +20dB to -20dB (1dB step) • Q=0.75, 1.25 • f₀=7.5k, 10k, 12.5k, 15kHz • Possible to use "Advanced switch" for prevention of switching noise. 																		
Fader	<ul style="list-style-type: none"> • +15dB to -79dB(1dB step), -∞dB • Possible to use "Advanced switch" for prevention of switching noise. 																		
LPF	<ul style="list-style-type: none"> • f_c=55/85/120/160Hz, pass • Phase shift (0°/180°) 																		
HPF	<ul style="list-style-type: none"> • f_c=55/85/120/160Hz, pass 																		
Mixing	<ul style="list-style-type: none"> • Monaural input • +7dBdB to -79dB (1dB step), -∞dB • Possible to use "Advanced switch" for prevention of switching noise. 																		
Super Bass	<ul style="list-style-type: none"> • +20dB to 0dB (1dB step) • Possible to use "Advanced switch" for prevention of switching noise. 																		

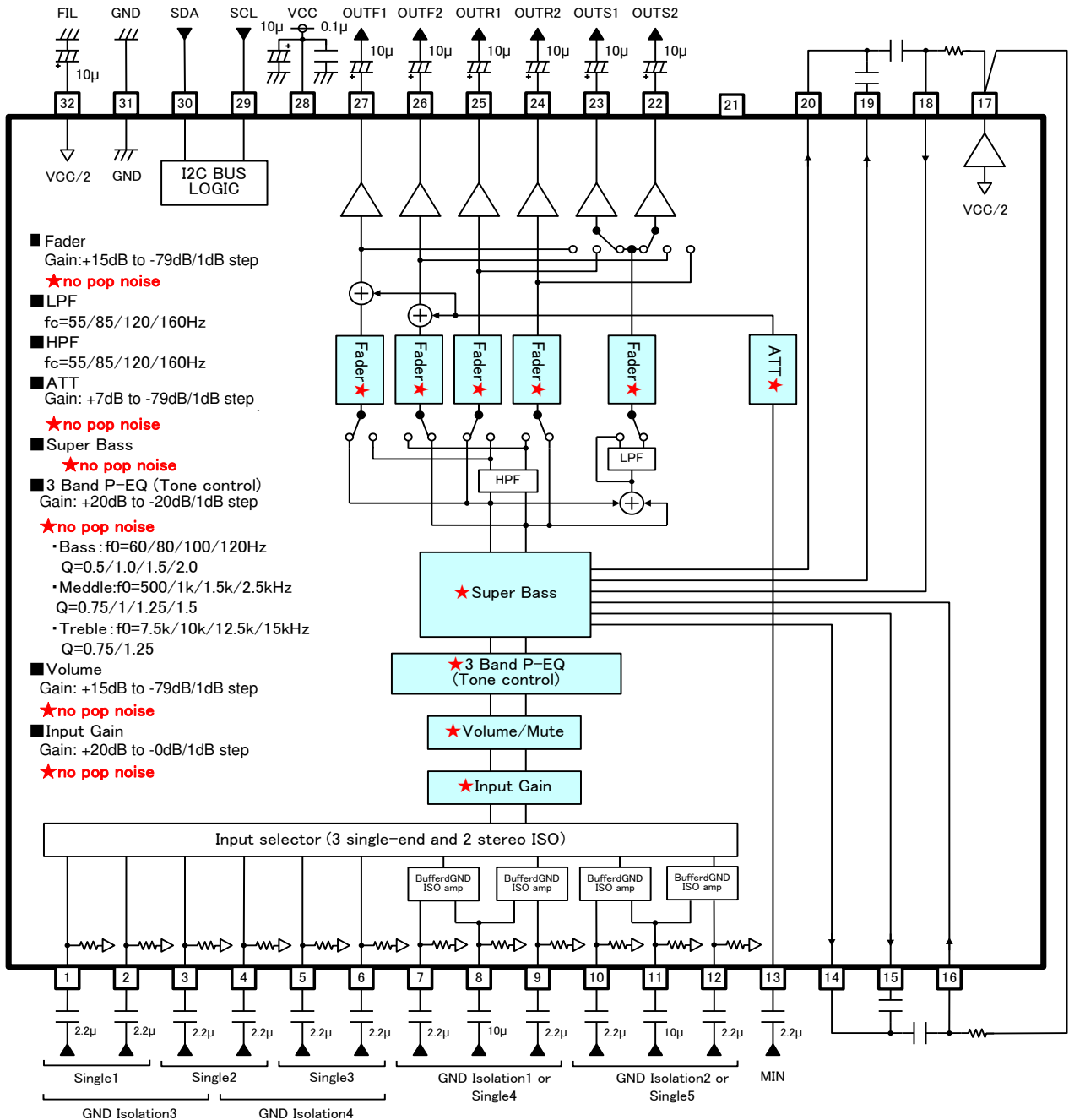
2. Volume / Fader Volume / Mixing ATT Attenuation Data

(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

Adjustable range of mixing ATT is +7dB to -∞dB.

 : Initial condition

3. Application Circuit



※About single input 1 to 3 it is possible to change from single input to GND Isolation input 3,4.

※About GND Isolation1 and GND Isolation2, it is possible to change from differential input to single input 4 to 5.

Figure 23. BD37544FS

Unit
R : [Ω]
C : [F]

Notes on wiring

- ① Please connect the decoupling capacitor of the power supply in the shortest possible distance to GND.
- ② GND lines should be one-point connected.
- ③ Wiring pattern of Digital should be away from that of Analog unit and cross-talk should not be acceptable.
- ④ SCL and SDA lines 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.
- ⑥ Please short Pins 15-16, and Pins 18-19 if the Super Bass is not used.

Power Dissipation

About the thermal design of the IC

Characteristics of an IC have a great deal to do with the temperature at which it is used, and exceeding absolute maximum ratings may degrade and destroy elements. Careful consideration must be given to the heat of the IC from the two standpoints of immediate damage and long-term reliability of operation.

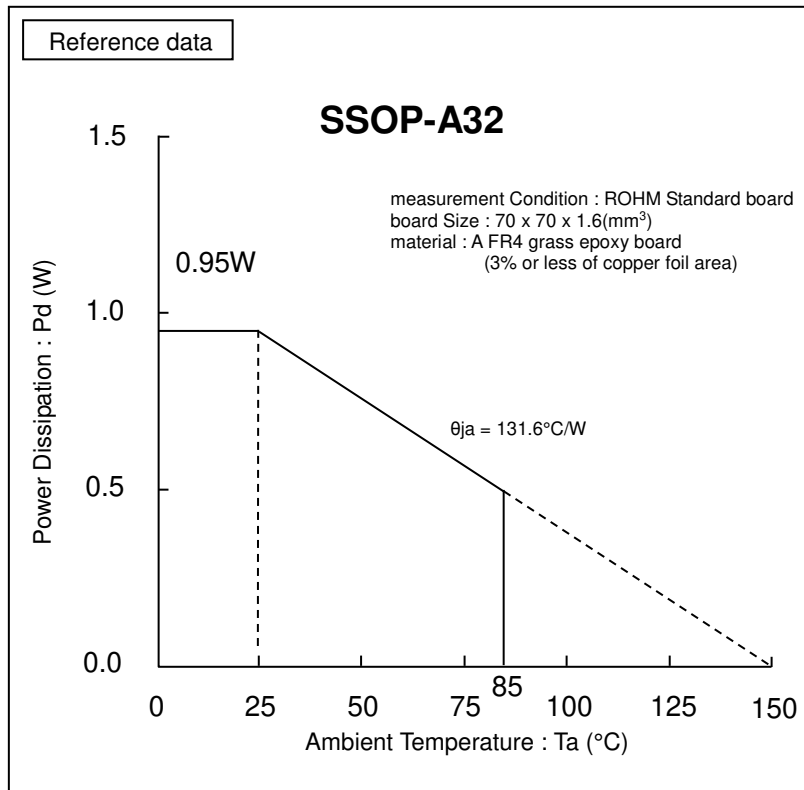


Figure 24. Temperature Derating Curve
(Note) Values are actual measurements and are not guaranteed.

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