Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

Analog Audio Processors series

Sound Processors for Car Audio

BD37033FV-M

General Description

BD37033FV-M is sound processors for car audio. The functions are stereo input selector with single end 3 and ground isolation input 2, volume, 3-band parametric equalizer, loudness, 6ch fader volume, LPF for subwoofer, anti-aliasing-filter, Mixing volume. Moreover, “Advanced switch circuit”, that is ROHM original technology, can reduce various switching noise (ex. No-signal, low frequency likes 20Hz & large signal inputs). “Advanced switch” makes control of microcomputer easier, and can construct high quality car audio system.

Features

- Reduce switching noise of volume, mute, fader volume, bass, middle, treble, loudness by using advanced switch circuit [Possible to control all steps].
- Built-in input selector (single 3 / diff 2).
- Decrease the number of external components by built-in 3-band equalizer filter, LPF for subwoofer, loudness filter. And, possible to control Q, Gv, fo of 3-band equalizer and fc of LPF, Gv, fo of loudness by I^2C BUS control freely.
- Built-in mixing volume and anti-aliasing-filter.
- Built-in anti-GSM-noise-filter.
- Package is SSOP-B28. Putting input-terminals together and output-terminals together can make PCB layout easier and can makes area of PCB smaller.
- It is possible to control by 3.3V / 5V for I^2C BUS.
- AEC-Q100 Qualified.

Applications

- It is the optimal for the car audio. Besides, it is possible to use for the audio equipment of mini Compo, micro Compo, TV etc with all kinds.

Key Specifications

- Current upon no signal: 31mA(Typ.)
- Total harmonic distortion: 0.002%(Typ.)
- Maximum input voltage: 2.1Vrms(Typ.)
- Cross-talk between selectors: 100dB(Typ.)
- Ripple rejection -65dB(Typ.)
- Output noise voltage: 5.5μVrms(Typ.)
- Residual output noise voltage: 3.5μVrms(Typ.)
- Operating Range of Temperature: -40℃ to +85℃

package(s) W(Typ.) x D(Typ.) x H(Max.)
SSOP-B28 10.00mm x 7.60mm x 1.35mm

SSOP-B28

Typical Application Circuit

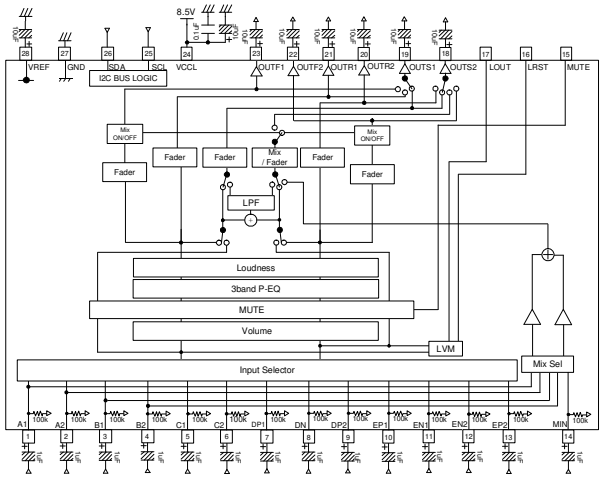


Figure 1. Application Circuit Diagram

Pin Configuration

SSOP-B28
(TOP VIEW)

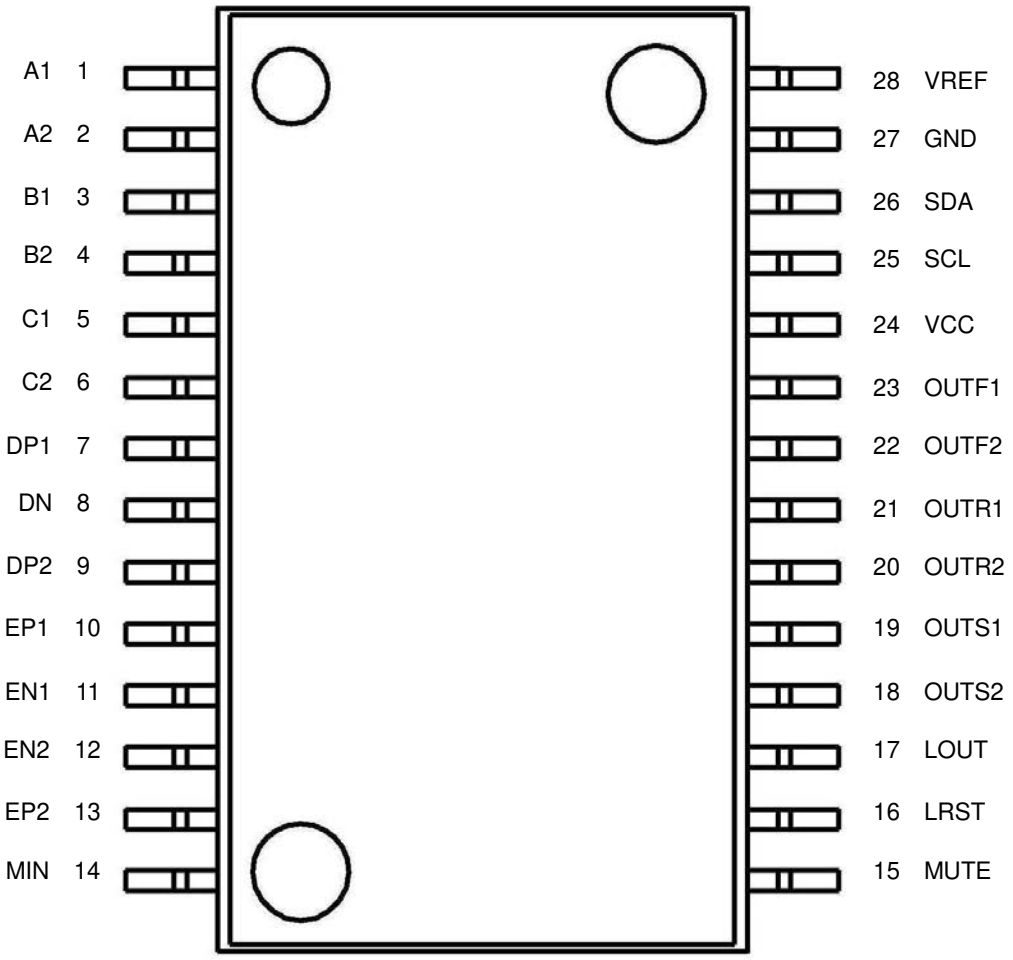


Figure 2. Pin configuration

Pin Descriptions

Terminal Number	Terminal Name	Description	Terminal Number	Terminal Name	Description
1	A1	A input terminal of 1ch	15	MUTE	External compulsory mute terminal
2	A2	A input terminal of 2ch	16	LRST	Level meter reset terminal
3	B1	B input terminal of 1ch	17	LOUT	Output terminal for Level meter
4	B2	B input terminal of 2ch	18	OUTS2	SW output terminal of 2ch
5	C1	C input terminal of 1ch	19	OUTS1	SW output terminal of 1ch
6	C2	C input terminal of 2ch	20	OUTR2	Rear output terminal of 2ch
7	DP1	D positive input terminal of 1ch	21	OUTR1	Rear output terminal of 1ch
8	DN	D negative input terminal	22	OUTF2	Front output terminal of 2ch
9	DP2	D positive input terminal of 2ch	23	OUTF1	Front output terminal of 1ch
10	EP1	E positive input terminal of 1ch	24	VCC	VCC terminal for power supply
11	EN1	E negative input terminal of 1ch	25	SCL	I^2C Communication clock terminal
12	EN2	E negative input terminal of 2ch	26	SDA	I^2C Communication data terminal
13	EP2	E positive input terminal of 2ch	27	GND	GND terminal
14	MIN	Mixing input terminal	28	VREF	VREF terminal

Block Diagram

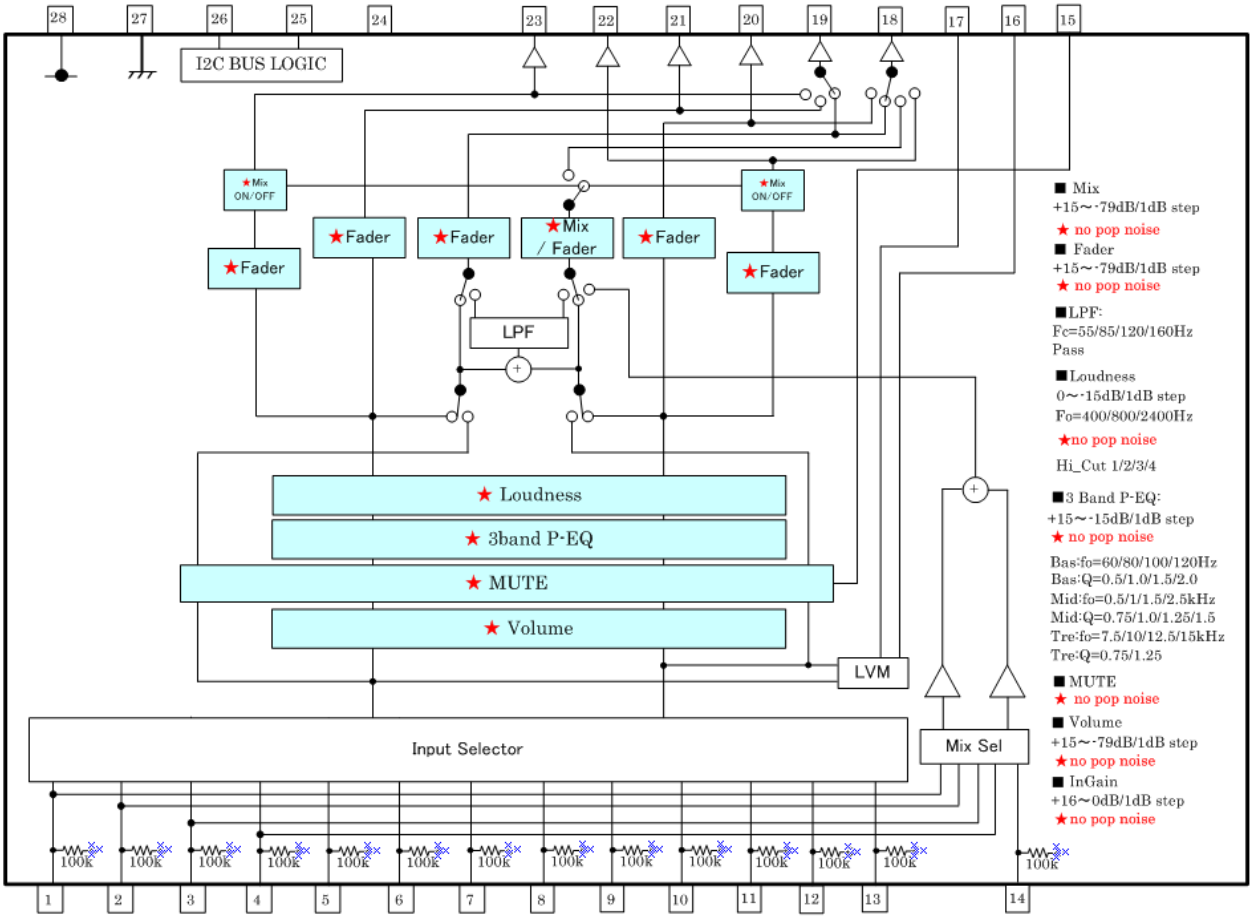


Figure 3. Block Diagram

Absolute Maximum Ratings

Parameter	Symbol	Limits	Unit
Power supply Voltage	VCC※1	10.0	V
Input Voltage	Vin※1	VCC+0.3 to GND-0.3 Only SCL,SDA 7 to GND-0.3	V
Power Dissipation	Pd	1.06 ※2	W
Storage Temperature	Tastg	-55 to +150	℃

※Maximum voltage which can be impressed referencing GND. Operation using batteries which is used in automobiles directly cannot be guaranteed.
※2 This value decreases 8.5mW/℃ for Ta=25℃ or more.
ROHM standard board shall be mounted
Thermal resistance θja = 117.6(℃/W)
ROHM Standard board Size:70×70×1.6(㎜)
Material:A FR4 grass epoxy board(3% or less of copper foil area)

Operating Range

Parameter	Symbol	Limits	Unit
Power supply voltage	VCC	7.0 to 9.5	V
Temperature	Topr	-40 to +85	℃

Electrical Characteristic

Unless specified particularly Ta=25℃, VCC=8.5V, f=1kHz, Vin=1Vrms, Rg=600Ω, RL=10kΩ, A input, Volume 0dB, Tone control 0dB, Loudness 0dB, LPF OFF, Fader 0dB, Mix OFF, anti-aliasing-filter OFF

BLOCK	Item	Symbol	Limit			Unit	Condition
			Min.	Typ.	Max.		
General	Current upon no signal	I_Q	—	31	43	mA	No signal
	Voltage gain	G_V	-1.5	0	+1.5	dB	Gv=20log(VOUT/VIN)
	Channel balance	CB	-1.5	0	+1.5	dB	CB = GV1-GV2
	Total harmonic distortion	THD+N	—	0.002	0.05	%	VOUT=1Vrms BW=400-30KHz
	Output noise voltage *	V_{NO}	—	5.5	15	μVrms	Rg = 0Ω BW = IHF-A
	Residual output noise voltage *	V_{NOR}	—	3.5	10	μVrms	Fader = -∞dB Rg = 0Ω, BW = IHF-A
	Cross-talk between channels *	CTC	—	-100	-85	dB	Rg = 0Ω CTC=20log(VOUT/VIN) BW = IHF-A
	Ripple rejection	RR	—	-65	-40	dB	f=1kHz, VRR=100mVrms RR=20log(VCC IN/VOUT)
Input Selector	Input impedance	R_{IN}	70	100	130	kΩ	
	Maximum input voltage	V_{IM}	2.0	2.1	—	Vrms	VIM at THD+N(VOUT)=1% BW=400-30KHz
	Cross-talk between selectors *	CTS	—	-100	-85	dB	Rg = 0Ω CTS=20log(VOUT/VIN) BW = IHF-A
	Common mode rejection ratio *	CMRR	46	60	—	dB	XP1 and XN input XP2 and XN input CMRR=20log(VIN/VOUT) BW = IHF-A [※X・・・D/E]
InputGain	Maximum input gain	$G_{v\ MAX}$	+14	+16	+18	dB	InputGain +16dB VIN=100mVrms Gin=20log(VOUT/VIN)
	Minimum input gain	$G_{v\ MIN}$	-2	0	+2	dB	InputGain 0dB VIN=1Vrms Gin=20log(VOUT/VIN)
	Gain set error	$G_{V\ ERR1}$	-2	0	+2	dB	GAIN=+16 to +1dB
Volume	Maximum boost gain	$G_{v\ MAX}$	+13	+15	+17	dB	Volume +15dB VIN=100mVrms Gin=20log(VOUT/VIN)
	Maximum attenuation *	$G_{v\ MIN}$	-83	-79	-75	dB	Volume -79dB VIN=2Vrms Gin=20log(VOUT/VIN)
	Gain set error	$G_{V\ ERR1}$	-2	0	+2	dB	GAIN=+15 to +1dB
	Attenuation set error	$G_{V\ ERR2}$	-2	0	+2	dB	ATT=0dB to -79dB
Mute	Mute attenuation *	G_{MUTE}	—	-100	-85	dB	Mute ON Gmute=20log(VOUT/VIN) BW = IHF-A
Bass	Maximum boost gain	$G_{B\ BST}$	+13	+15	+17	dB	Gain=+15dB f=100Hz VIN=100mVrms GB=20log (VOUT/VIN)
	Maximum cut gain	$G_{B\ CUT}$	-17	-15	-13	dB	Gain=-15dB f=100Hz VIN=2Vrms GB=20log (VOUT/VIN)
	Gain set error	$G_{B\ ERR}$	-2	0	+2	dB	Gain=+15 to -15dB f=100Hz

BLOCK	Item	Symbol	Limit			Unit	Condition
			Min.	Typ.	Max.		
Middle	Maximum boost gain	$G_{M\ BST}$	+13	+15	+17	dB	Gain=+15dB f=1kHz VIN=100mVrms G_M=20log (VOUT/VIN)
	Maximum cut gain	$G_{M\ CUT}$	-17	-15	-13	dB	Gain=-15dB f=1kHz VIN=2Vrms G_M=20log (VOUT/VIN)
	Gain set error	$G_{M\ ERR}$	-2	0	+2	dB	Gain=+15 to -15dB f=1kHz
Treble	Maximum boost gain	$G_{T\ BST}$	+13	+15	+17	dB	Gain=+15dB f=10kHz VIN=100mVrms G_T=20log (VOUT/VIN)
	Maximum cut gain	$G_{T\ CUT}$	-17	-15	-13	dB	Gain=-15dB f=10kHz VIN=2Vrms G_T=20log (VOUT/VIN)
	Gain set error	$G_{T\ ERR}$	-2	0	+2	dB	Gain=+15 to -15dB f=10kHz
Loudness	Maximum gain	$G_{L\ MAX}$	-17	-15	-13	dB	Gain -15dB f=800Hz VIN=1Vrms G_L=20log(VOUT/VIN)
	Gain set error	$G_{L\ ERR}$	-2	0	+2	dB	Gain=-15 to -1dB
Mix	Maximum boost gain	$G_{F\ BST}$	+13	+15	+17	dB	Fader=+15dB V_{IN}=100mVrms G_F=20log(VOUT/VIN)
	Maximum attenuation *	$G_{F\ MIN}$	—	-100	-85	dB	Fader=-∞dB G_F=20log(VOUT/VIN) BW = IHF-A
	Input impedance	R_{IN_M}	70	100	130	kΩ	
	Gain set error	$G_{F\ ERR}$	-2	0	2	dB	Gain=+15 to 1dB
	Attenuation set error 1	$G_{F\ ERR1}$	-2	0	2	dB	ATT=-1 to -15dB
	Attenuation set error 2	$G_{F\ ERR2}$	-3	0	3	dB	ATT=-16 to -47dB
	Attenuation set error 3	$G_{F\ ERR3}$	-4	0	4	dB	ATT=-48 to-79dB
Fader	Maximum boost gain	$G_{F\ BST}$	+13	+15	+17	dB	Fader=+15dB V_{IN}=100mVrms G_F=20log(VOUT/VIN)
	Maximum attenuation *	$G_{F\ MIN}$	—	-100	-85	dB	Fader=-∞dB G_F=20log(VOUT/VIN) BW = IHF-A
	Gain set error	$G_{F\ ERR}$	-2	0	2	dB	Gain=+15 to +1dB
	Attenuation set error 1	$G_{F\ ERR1}$	-2	0	2	dB	ATT=-1 to -15dB
	Attenuation set error 2	$G_{F\ ERR2}$	-3	0	3	dB	ATT=-16 to -47dB
	Attenuation set error 3	$G_{F\ ERR3}$	-4	0	4	dB	ATT=-48 to -79dB
	Output impedance	R_{OUT}	-	—	50	Ω	VIN=100mVrms
	Maximum output voltage	V_{OM}	2.0	2.2	—	Vrms	THD+N=1% BW=400-30KHz
Level Meter	Maximum output voltage	$V_{L\ MAX}$	2.8	3.1	3.5	V	
	Maximum offset voltage	$V_{L\ OFF}$	-	15	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 Curve(s)

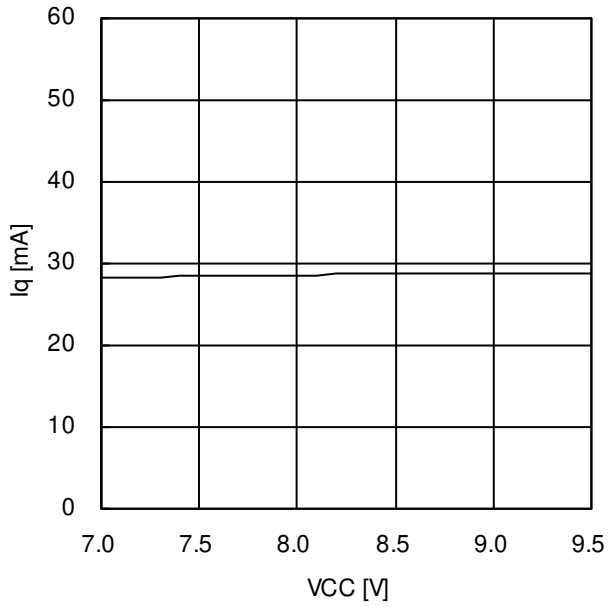


Figure 4. Vcc vs Iq

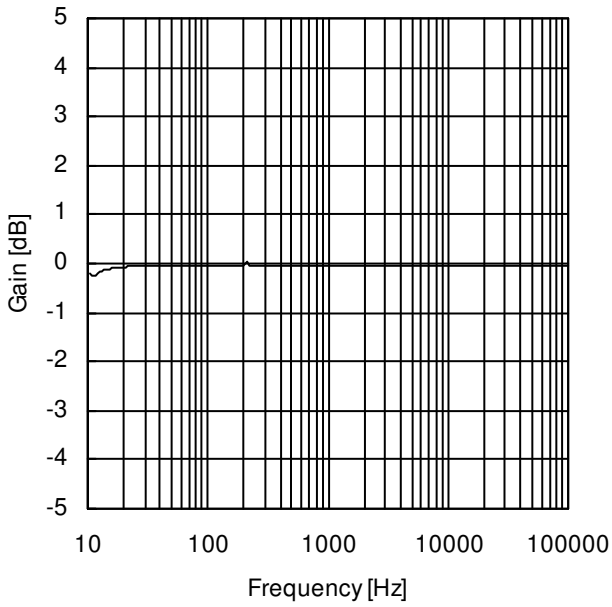


Figure 5. Gain vs frequency

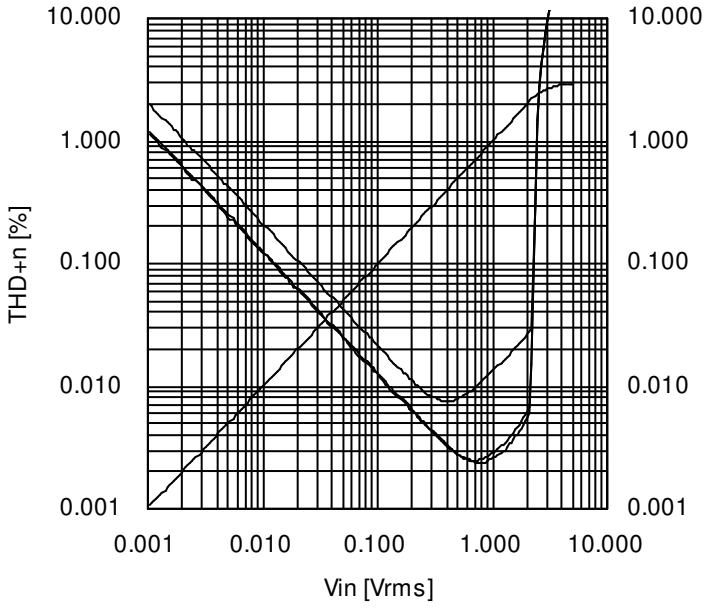


Figure 6. THD vs Vin / Vo

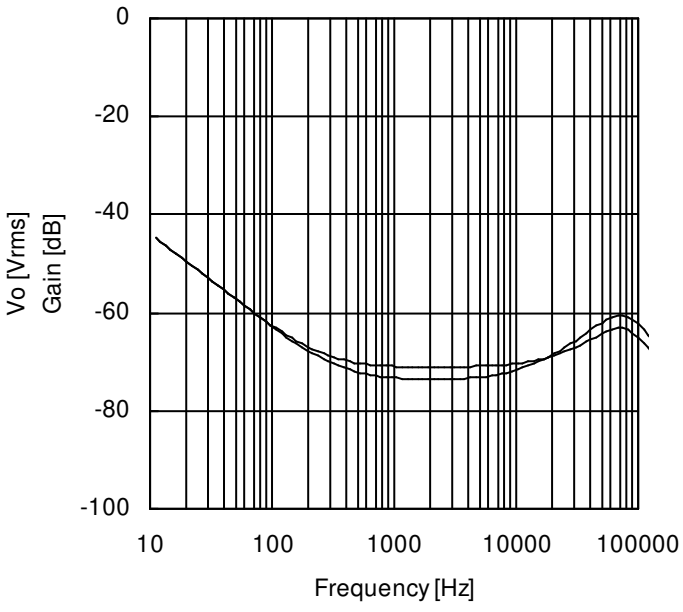


Figure 7. CMRR

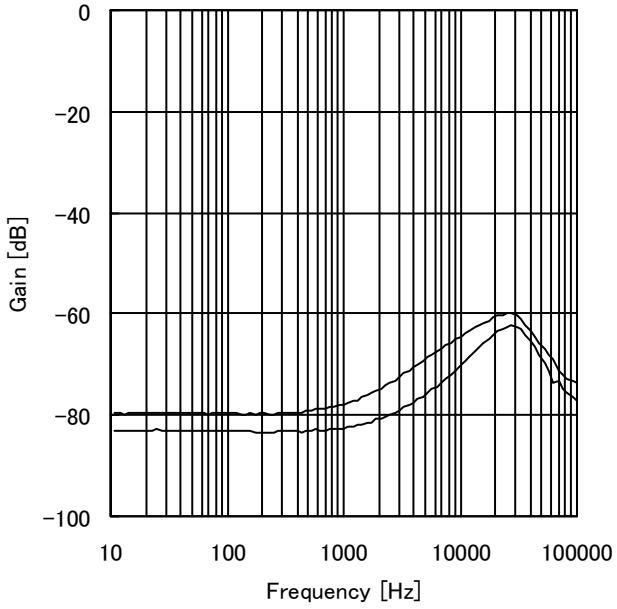


Figure 8. PSRR

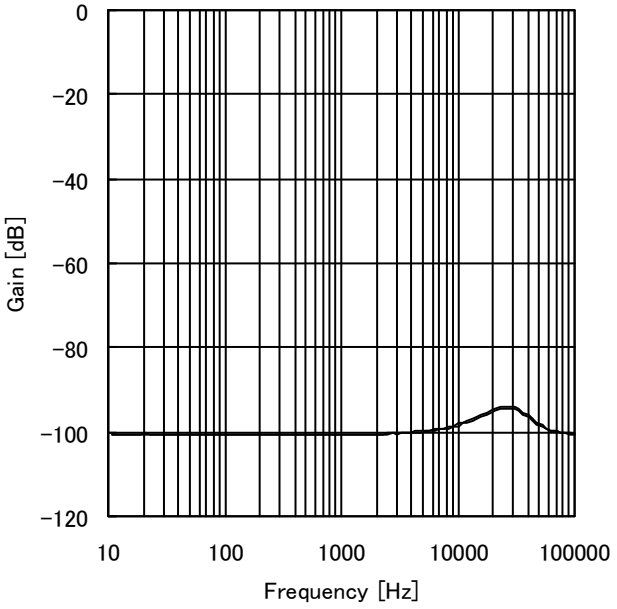


Figure 9. CTC

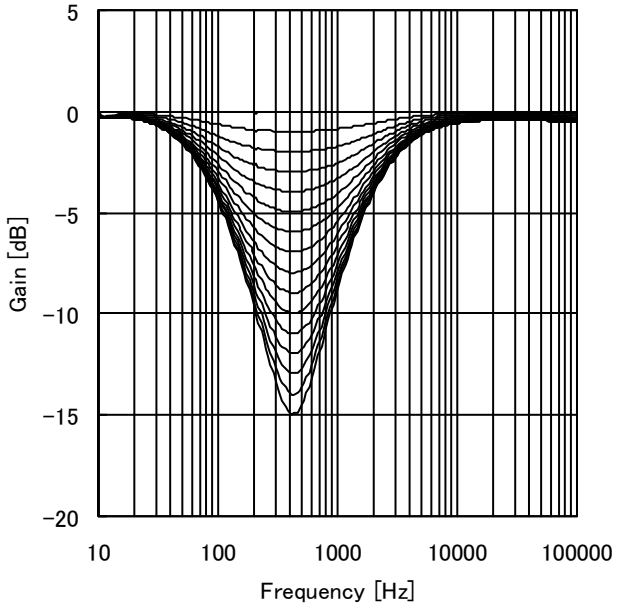


Figure 10. Loudness

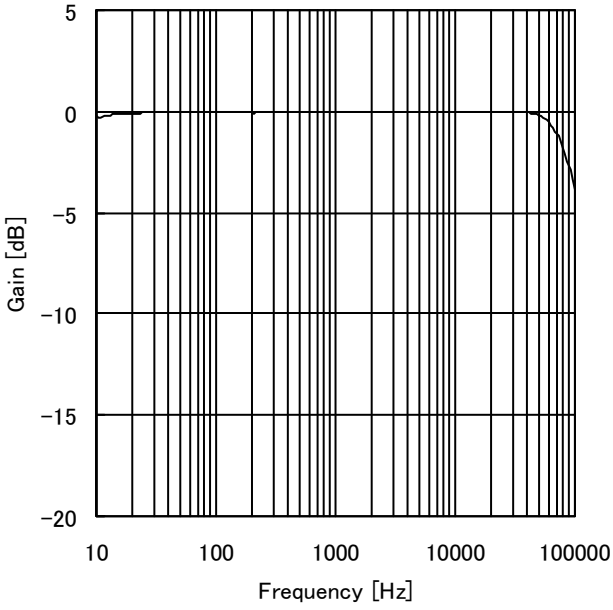


Figure 11. Anti aliasing Filter

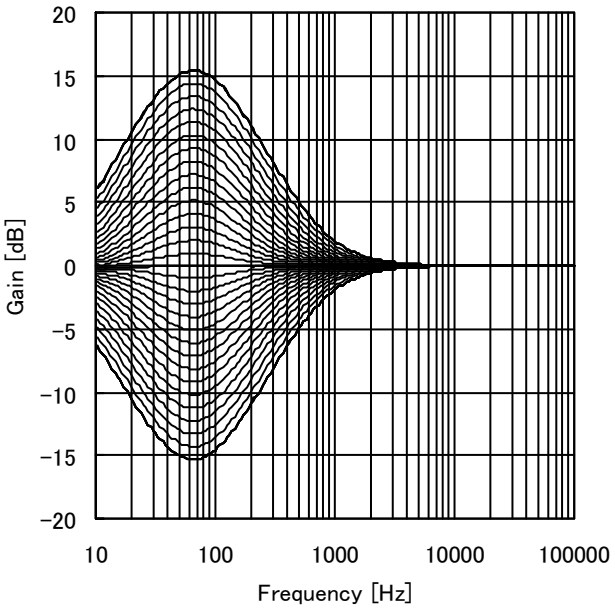


Figure 12. Bass gain vs frequency

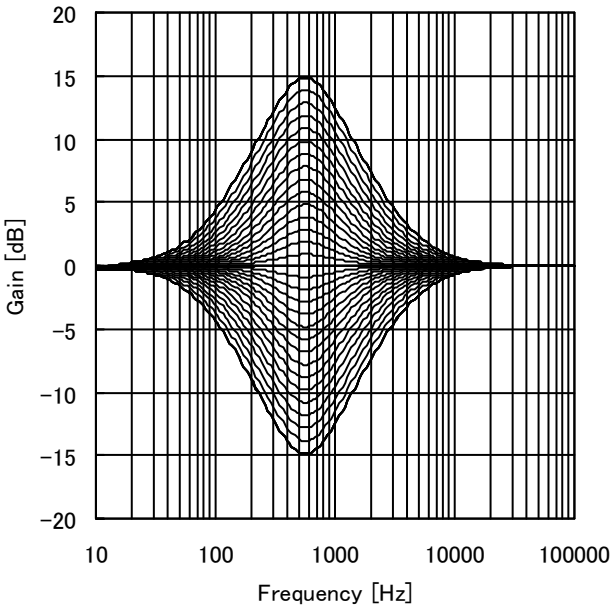


Figure 13. Middle gain vs frequency

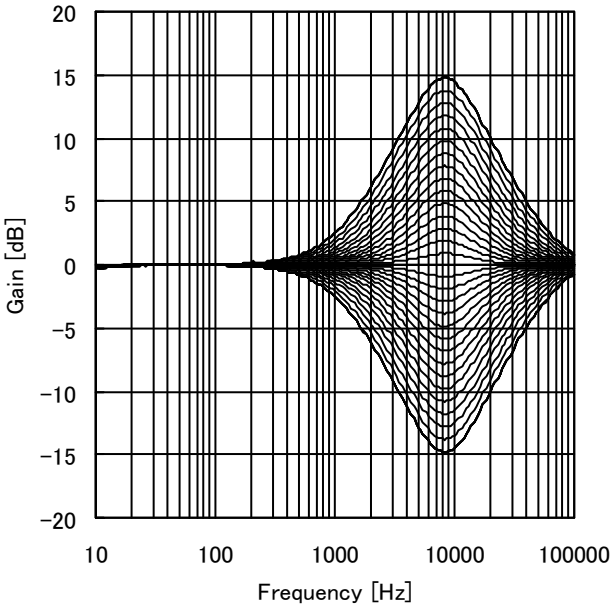


Figure 14. Treble gain vs frequency

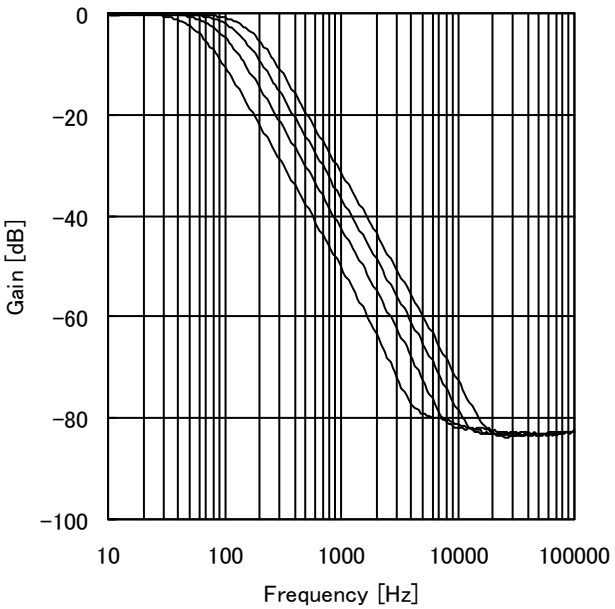


Figure 15. LPF

I²C BUS CONTROL SIGNAL SPECIFICATION

(1) Electrical specifications and timing for bus lines and I/O stages

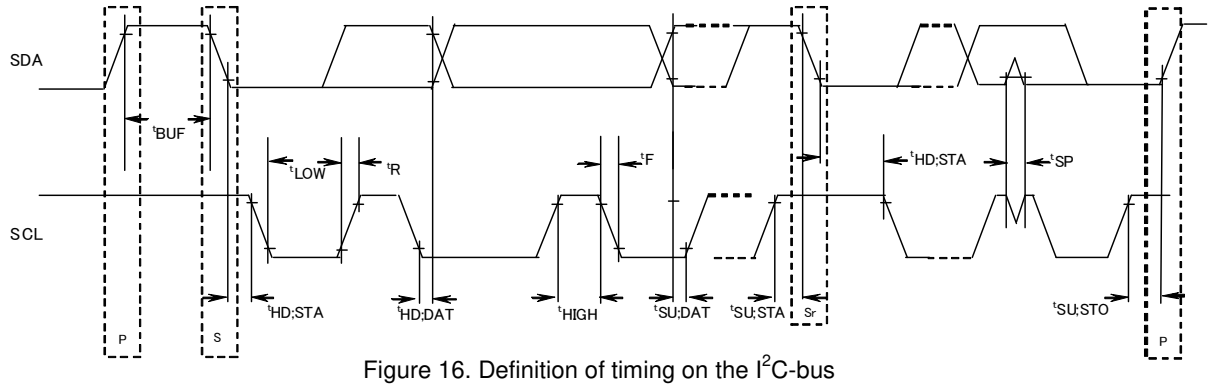


Figure 16. Definition of timing on the I²C-bus

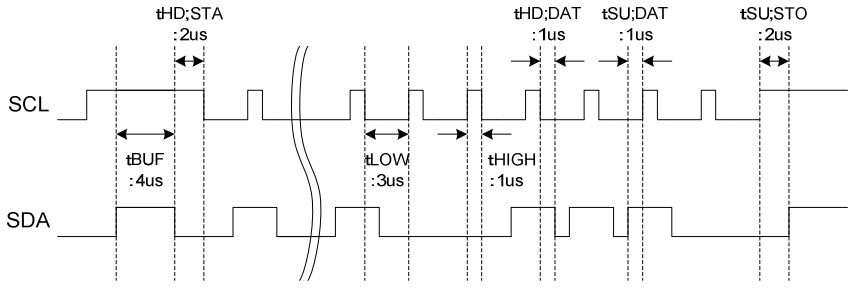
Table 1 Characteristics of the SDA and SCL bus lines for I²C-bus devices(Ta=25℃, VCC=8.5V)

Parameter		Symbol	Fast-mode I²C-bus		Unit
			Min.	Max.	
1	SCL clock frequency	fSCL	0	400	kHz
2	Bus free time between a STOP and START condition	tBUF	1.3	–	μS
3	Hold time (repeated) START condition. After this period, the first clock pulse is generated	tHD;STA	0.6	–	μS
4	LOW period of the SCL clock	tLOW	1.3	–	μS
5	HIGH period of the SCL clock	tHIGH	0.6	–	μS
6	Set-up time for a repeated START condition	tSU;STA	0.6	–	μS
7	Data hold time	tHD;DAT	0	–	μS
8	Data set-up time	tSU;DAT	100	–	ns
9	Set-up time for STOP condition	tSU;STO	0.6	–	μS

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

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	VIL	-0.3	1	V
11	HIGH level input voltage	VIH	2.3	5	V
12	Pulse width of spikes which must be suppressed by the input filter.	tSP	0	50	ns
13	LOW level output voltage: at 3mA sink current	VOL1	0	0.4	V
14	Input current each I/O pin with an input voltage between 0.4V and 4.5V	Ii	-10	10	μA



SCL clock frequency :250kHz

Figure 17.
Command timing example in the
I2C data transmission

(2)I²C 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 conditions (Recognition of start bit)
Slave Address = Recognition of slave address. 7 bits in upper order are voluntary. The least significant bit is "L" due to writing.
A = ACKNOWLEDGE bit (Recognition of acknowledgement)
Select Address = Select every of volume, bass and treble.
Data = Data on every volume and tone.
P = Stop condition (Recognition of stop bit)

(3)I²C BUS Interface Protocol

1)Basic form

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

2)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)①Data 1 is set as data of Select Address (20h).
②Data 2 is set as data of Select Address +1 (28h).
③Data N is set as data of Select Address +N-1.

3)Configuration unavailable for transmission (In this case, only Select Address 1 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

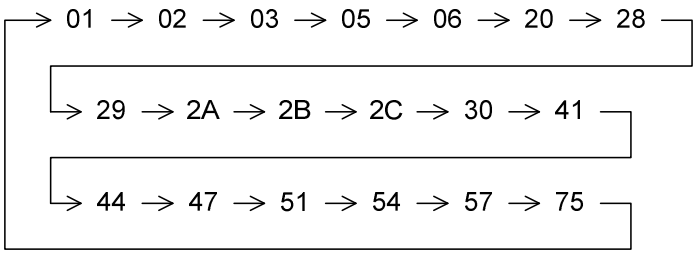
(5)Select Address and Data

Items	Select Address (hex)	MSB			Data				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Initial Setup	01	Advanced Switch ON/OFF	Anti Alias Filter ON/OFF	Advanced Switch Time of Volume/Fader /Tone/Loudness		0	1	Advanced Switch Time of Mute	
LPF Setup	02	LPF Phase 0°/180°	Level Meter Reset	Subwoofer Output Selector		Subwoofer Input Selector	Subwoofer LPF fc		
Mixing Setup	03	Mixing Input Selector		0	Loudness f0		MIX_2CH ON/OFF	MIX_1CH ON/OFF	1
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 1ch Sub	2C	Fader Gain / Attenuation							
Mixing (2ch Sub)	30	Mixing Gain / Attenuation							
Bass setup	41	0	0	Bass f0		0	0	Bass Q	
Middle setup	44	0	0	Middle f0		0	0	Middle Q	
Treble setup	47	0	0	Treble f0		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 Hi_Cut		Loudness Gain				
System Reset	FE	1	0	0	0	0	0	0	1

: Advanced Switch

※(Set up bit (It is written with “0” by the above table) which hasn’t been used in “0”.

Note
1. In function changing of the hatching part, it works Advanced switch..
2. Upon continuous data transfer, the Select Address is circulated by the automatic increment function, as shown below.



3. For the function of input selector and subwoofer input select etc, it is not corresponded for advanced switch. Therefore, please apply mute on the side of a set when changes these setting.
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) Default:8'ha0

Function Name	Mode	MSB			Initial Setup				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Advanced Switch Time of Mute	0.6msec							0	0
	1.0msec							0	1
	1.4msec							1	0
	3.2msec							1	1
Advanced Switch Time of Volume /Fader /Tone/Loudness	4.7msec			0	0				
	7.2msec			0	1				
	11.2msec			1	0				
	14.4msec			1	1				
Anti Alias Filter ON/OFF	OFF		0						
	ON		1						
Advanced Switch ON/OFF	OFF	0							
	ON	1							

Select address 02(hex) Default:8'h00

Function Name	Mode	MSB			LPF Setup				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Subwoofer LPF fc	OFF						0	0	0
	55Hz						0	0	1
	85Hz						0	1	0
	120Hz						0	1	1
	160Hz						1	0	0
	PASS						1	0	1
	Prohibition						1	1	0
							1	1	1
Subwoofer Input Selector	Loudness					0			
	Input Selector					1			
Subwoofer Output Selector	LPF			0	0				
	Front			0	1				
	Rear			1	0				
	Subwoofer (*1)			1	1				
Level Meter Reset (*2)	Hold		0						
	Reset		1						
LPF Phase 0°/180°(*3)	0°	0							
	180°	1							

: Initial condition

(*1): If Subwoofer Output Selector is set as 「Subwoofer」('b11), Mixing volume can be used as Subwoofer 2ch. Mixing volume and Subwoofer 2ch volume cannot be used simultaneously.

(*2): If "Level Meter Reset" is set as Reset("b1), a reset pulse will be outputted only once to a level meter block. Also about this register, after a reset pulse output returns to a Hold("b0) state, without holding a Reset("b1) state. Therefore, in order to change into a Hold state, it is not necessary to carry out a register setup again.

(*3): If Subwoofer LPF fc is set as 「PASS」('b000), LPF PHASE is compulsorily fixed to 0°('b0) .

Select address 03(hex) Default:8'h00

Function Name	Mode	Pin				MSB			HPF Setup				LSB
		1p	1n	2n	2p	D7	D6	D5	D4	D3	D2	D1	D0
Mixing 1ch ON/OFF	ON											0	
	OFF											1	
Mixing 2ch ON/OFF	ON										0		
	OFF										1		
Loudness f0	400Hz								0	0			
	800Hz								0	1			
	2400Hz								1	0			
	Prohibition								1	1			
Mixing Input Selector	Mix	MIN	-		MIN	0	0						
	A_Single	A1	-		A2	0	1						
	B_Single	B1	-		B2	1	0						
	Prohibition					1	1						

Select address 05(hex) Default:8'h00

Function Name	Mode	Pin				MSB			Input Selector				LSB
		1p	1n	2n	2p	D7	D6	D5	D4	D3	D2	D1	D0
Input Selector	A_Single	A1	-	-	A2				0	0	0	0	0
	B_Single	B1	-	-	B2				0	0	0	0	1
	C_Single	C1	-	-	C2				0	0	0	1	0
	D_Single	DP1	-	-	DP2				0	0	0	1	1
	E1_Single	EP1	-	-	EN1				0	1	0	1	0
	E2_Single	EN2	-	-	EP2				0	1	0	1	1
	D_Diff	D_Diff	DN		DP2				0	0	1	1	0
	E_Full_Diff	EP1	EN1	EN2	EP2				0	1	0	0	0
	Prohibition								Other setting				
	Input short								0	1	0	0	1
Full-diff Type	Negative input					0							
	Bias					1							

Select address 06 (hex) Default:8'h00

Function Name	Gain	MSB			Input Gain				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Input Gain	0dB				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
	(16dB)				1	0	0	0	1
	(16dB)				1	0	0	1	0
	(16dB)				1	0	0	1	1
	(16dB)				1	0	1	0	0
	Prohibition				Other setting				
Mute ON/OFF	OFF	0							
	ON	1							

: Initial condition

Select address 20 (hex) Default:8'h00

Function Name	Mode	MSB Volume Gain LSB							
		D7	D6	D5	D4	D3	D2	D1	D0
Volume Gain	Prohibition	0	0	0	0	0	0	0	0
		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
		0	1	1	1	0	0	0	0
	+15dB	0	1	1	1	0	0	0	1
	+14dB	0	1	1	1	0	0	1	0
	+13dB	0	1	1	1	0	0	1	1
	+12dB	0	1	1	1	0	1	0	0
	+11dB	0	1	1	1	0	1	0	1
	+10dB	0	1	1	1	0	1	1	0
	+9dB	0	1	1	1	0	1	1	1
	+8dB	0	1	1	1	1	0	0	0
	+7dB	0	1	1	1	1	0	0	1
	+6dB	0	1	1	1	1	0	1	0
	+5dB	0	1	1	1	1	0	1	1
	+4dB	0	1	1	1	1	1	0	0
	+3dB	0	1	1	1	1	1	0	1
	+2dB	0	1	1	1	1	1	1	0
	+1dB	0	1	1	1	1	1	1	1
	-0dB	1	0	0	0	0	0	0	0
	-1dB	1	0	0	0	0	0	0	1
	-2dB	1	0	0	0	0	0	1	0
	-3dB	1	0	0	0	0	0	1	1
	-4dB	1	0	0	0	0	1	0	0
	-5dB	1	0	0	0	0	1	0	1
	-6dB	1	0	0	0	0	1	1	0
	-7dB	1	0	0	0	0	1	1	1
	-8dB	1	0	0	0	1	0	0	0
	-9dB	1	0	0	0	1	0	0	1
	-10dB	1	0	0	0	1	0	1	0
	-11dB	1	0	0	0	1	0	1	1
	-12dB	1	0	0	0	1	1	0	0
	-13dB	1	0	0	0	1	1	0	1
	-14dB	1	0	0	0	1	1	1	0
	-15dB	1	0	0	0	1	1	1	1
	-16dB	1	0	0	1	0	0	0	0
	-17dB	1	0	0	1	0	0	0	1
	-18dB	1	0	0	1	0	0	1	0
	-19dB	1	0	0	1	0	0	1	1
	-20dB	1	0	0	1	0	1	0	0

: Initial condition

Function Name	Mode	MSB			Volume Gain				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Volume Gain	-21dB	1	0	0	1	0	1	0	1
	-22dB	1	0	0	1	0	1	1	0
	-23dB	1	0	0	1	0	1	1	1
	-24dB	1	0	0	1	1	0	0	0
	-25dB	1	0	0	1	1	0	0	1
	-26dB	1	0	0	1	1	0	1	0
	-27dB	1	0	0	1	1	0	1	1
	-28dB	1	0	0	1	1	1	0	0
	-29dB	1	0	0	1	1	1	0	1
	-30dB	1	0	0	1	1	1	1	0
	-31dB	1	0	0	1	1	1	1	1
	-32dB	1	0	1	0	0	0	0	0
	-33dB	1	0	1	0	0	0	0	1
	-34dB	1	0	1	0	0	0	1	0
	-35dB	1	0	1	0	0	0	1	1
	-36dB	1	0	1	0	0	1	0	0
	-37dB	1	0	1	0	0	1	0	1
	-38dB	1	0	1	0	0	1	1	0
	-39dB	1	0	1	0	0	1	1	1
	-40dB	1	0	1	0	1	0	0	0
	-41dB	1	0	1	0	1	0	0	1
	-42dB	1	0	1	0	1	0	1	0
	-43dB	1	0	1	0	1	0	1	1
	-44dB	1	0	1	0	1	1	0	0
	-45dB	1	0	1	0	1	1	0	1
	-46dB	1	0	1	0	1	1	1	0
	-47dB	1	0	1	0	1	1	1	1
	-48dB	1	0	1	1	0	0	0	0
	-49dB	1	0	1	1	0	0	0	1
	-50dB	1	0	1	1	0	0	1	0
	-51dB	1	0	1	1	0	0	1	1
	-52dB	1	0	1	1	0	1	0	0
	-53dB	1	0	1	1	0	1	0	1
	-54dB	1	0	1	1	0	1	1	0
	-55dB	1	0	1	1	0	1	1	1
	-56dB	1	0	1	1	1	0	0	0
	-57dB	1	0	1	1	1	0	0	1
	-58dB	1	0	1	1	1	0	1	0
	-59dB	1	0	1	1	1	0	1	1
	-60dB	1	0	1	1	1	1	0	0
	-61dB	1	0	1	1	1	1	0	1
	-62dB	1	0	1	1	1	1	1	0
	-63dB	1	0	1	1	1	1	1	1
	-64dB	1	1	0	0	0	0	0	0
	-65dB	1	1	0	0	0	0	0	1
	-66dB	1	1	0	0	0	0	1	0
	-67dB	1	1	0	0	0	0	1	1
	-68dB	1	1	0	0	0	1	0	0
	-69dB	1	1	0	0	0	1	0	1
	-70dB	1	1	0	0	0	1	1	0

Function Name	Mode	MSB Volume Gain LSB							
		D7	D6	D5	D4	D3	D2	D1	D0
Volume Gain	-71dB	1	1	0	0	0	1	1	1
	-72dB	1	1	0	0	1	0	0	0
	-73dB	1	1	0	0	1	0	0	1
	-74dB	1	1	0	0	1	0	1	0
	-75dB	1	1	0	0	1	0	1	1
	-76dB	1	1	0	0	1	1	0	0
	-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
	'-79dB	1	1	1	1	1	1	1	1

Select address 28, 29, 2A, 2B, 2C, 30(hex) Default:8'hFF

Function Name	Mode	MSB Fader / Mixing Gain LSB							
		D7	D6	D5	D4	D3	D2	D1	D0
Fader/Mixing Gain(*1)	Prohibition	0	0	0	0	0	0	0	0
		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
		0	1	1	1	0	0	0	0
	+15dB	0	1	1	1	0	0	0	1
	+14dB	0	1	1	1	0	0	1	0
	+13dB	0	1	1	1	0	0	1	1
	+12dB	0	1	1	1	0	1	0	0
	+11dB	0	1	1	1	0	1	0	1
	+10dB	0	1	1	1	0	1	1	0
	+9dB	0	1	1	1	0	1	1	1
	+8dB	0	1	1	1	1	0	0	0
	+7dB	0	1	1	1	1	0	0	1
	+6dB	0	1	1	1	1	0	1	0
	+5dB	0	1	1	1	1	0	1	1
	+4dB	0	1	1	1	1	1	0	0
	+3dB	0	1	1	1	1	1	0	1
	+2dB	0	1	1	1	1	1	1	0
	+1dB	0	1	1	1	1	1	1	1

(*1): When Subwoofer Output Selector is set as 「Subwoofer」('b11), Mixing Gain (Select Address 30) becomes a gain setup of Subwoofer 2ch.

Function Name	Mode	MSB			Fader Gain				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Fader/Mixing Gain	-0dB	1	0	0	0	0	0	0	0
	-1dB	1	0	0	0	0	0	0	1
	-2dB	1	0	0	0	0	0	1	0
	-3dB	1	0	0	0	0	0	1	1
	-4dB	1	0	0	0	0	1	0	0
	-5dB	1	0	0	0	0	1	0	1
	-6dB	1	0	0	0	0	1	1	0
	-7dB	1	0	0	0	0	1	1	1
	-8dB	1	0	0	0	1	0	0	0
	-9dB	1	0	0	0	1	0	0	1
	-10dB	1	0	0	0	1	0	1	0
	-11dB	1	0	0	0	1	0	1	1
	-12dB	1	0	0	0	1	1	0	0
	-13dB	1	0	0	0	1	1	0	1
	-14dB	1	0	0	0	1	1	1	0
	-15dB	1	0	0	0	1	1	1	1
	-16dB	1	0	0	1	0	0	0	0
	-17dB	1	0	0	1	0	0	0	1
	-18dB	1	0	0	1	0	0	1	0
	-19dB	1	0	0	1	0	0	1	1
	-20dB	1	0	0	1	0	1	0	0
	-21dB	1	0	0	1	0	1	0	1
	-22dB	1	0	0	1	0	1	1	0
	-23dB	1	0	0	1	0	1	1	1
	-24dB	1	0	0	1	1	0	0	0
	-25dB	1	0	0	1	1	0	0	1
	-26dB	1	0	0	1	1	0	1	0
	-27dB	1	0	0	1	1	0	1	1
	-28dB	1	0	0	1	1	1	0	0
	-29dB	1	0	0	1	1	1	0	1
	-30dB	1	0	0	1	1	1	1	0
	-31dB	1	0	0	1	1	1	1	1
	-32dB	1	0	1	0	0	0	0	0
	-33dB	1	0	1	0	0	0	0	1
	-34dB	1	0	1	0	0	0	1	0
	-35dB	1	0	1	0	0	0	1	1
	-36dB	1	0	1	0	0	1	0	0
	-37dB	1	0	1	0	0	1	0	1
	-38dB	1	0	1	0	0	1	1	0
	-39dB	1	0	1	0	0	1	1	1
	-40dB	1	0	1	0	1	0	0	0

Function Name	Mode	MSB			Fader Gain				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Fader/Mixing Gain	-41dB	1	0	1	0	1	0	0	1
	-42dB	1	0	1	0	1	0	1	0
	-43dB	1	0	1	0	1	0	1	1
	-44dB	1	0	1	0	1	1	0	0
	-45dB	1	0	1	0	1	1	0	1
	-46dB	1	0	1	0	1	1	1	0
	-47dB	1	0	1	0	1	1	1	1
	-48dB	1	0	1	1	0	0	0	0
	-49dB	1	0	1	1	0	0	0	1
	-50dB	1	0	1	1	0	0	1	0
	-51dB	1	0	1	1	0	0	1	1
	-52dB	1	0	1	1	0	1	0	0
	-53dB	1	0	1	1	0	1	0	1
	-54dB	1	0	1	1	0	1	1	0
	-55dB	1	0	1	1	0	1	1	1
	-56dB	1	0	1	1	1	0	0	0
	-57dB	1	0	1	1	1	0	0	1
	-58dB	1	0	1	1	1	0	1	0
	-59dB	1	0	1	1	1	0	1	1
	-60dB	1	0	1	1	1	1	0	0
	-61dB	1	0	1	1	1	1	0	1
	-62dB	1	0	1	1	1	1	1	0
	-63dB	1	0	1	1	1	1	1	1
	-64dB	1	1	0	0	0	0	0	0
	-65dB	1	1	0	0	0	0	0	1
	-66dB	1	1	0	0	0	0	1	0
	-67dB	1	1	0	0	0	0	1	1
	-68dB	1	1	0	0	0	1	0	0
	-69dB	1	1	0	0	0	1	0	1
	-70dB	1	1	0	0	0	1	1	0
	-71dB	1	1	0	0	0	1	1	1
	-72dB	1	1	0	0	1	0	0	0
	-73dB	1	1	0	0	1	0	0	1
	-74dB	1	1	0	0	1	0	1	0
	-75dB	1	1	0	0	1	0	1	1
	-76dB	1	1	0	0	1	1	0	0
	-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
	MUTE	1	1	1	1	1	1	1	1

: Initial condition

Select address 41(hex) Default:8'h00

Function Name	Mode	MSB			Bass setup				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Bass Q	0.5							0	0
	1.0							0	1
	1.5							1	0
	2.0							1	1
Bass f0	60Hz			0	0				
	80Hz			0	1				
	100Hz			1	0				
	120Hz			1	1				

Select address 44(hex) Default:8'h00

Function Name	Mode	MSB			Middle setup				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Middle Q	0.75							0	0
	1.00							0	1
	1.25							1	0
	1.50							1	1
Middle f0	0.5kHz			0	0				
	1kHz			0	1				
	1.5kHz			1	0				
	2.5kHz			1	1				

Select address 47(hex) Default:8'h00

Function Name	Mode	MSB			Treble setup				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Treble Q	0.75								0
	1.25								1
Treble f0	7.5kHz			0	0				
	10kHz			0	1				
	12.5kHz			1	0				
	15kHz			1	1				

: Initial condition

Select address 51, 54, 57(hex) Default:8'h00

Function Name	Mode	MSB			Bass/Middle/Treble Gain				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Bass /Middle /Treble Gain	0dB				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
	(15dB)				1	0	0	0	0
	(15dB)				1	0	0	0	1
	(15dB)				1	0	0	1	0
	(15dB)				1	0	0	1	1
	(15dB)				1	0	1	0	0
	Prohibition				other setting				
Bass/Middle/Treble Boost/Cut	Boost	0							
	Cut	1							

Select address 75(hex) Default:8'h00

Function Name	Mode	MSB			Loudness Gain				LSB
		D7	D6	D5	D4	D3	D2	D1	D0
Loudness Gain	0dB				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
	(15dB)				1	0	0	0	0
	(15dB)				1	0	0	0	1
	(15dB)				1	0	0	1	0
	(15dB)				1	0	0	1	1
	(15dB)				1	0	1	0	0
	Prohibition				other setting				
Loudness HICUT	HICUT1		0	0					
	HICUT2		0	1					
	HICUT3		1	0					
	HICUT4		1	1					

: Initial condition

Recommendation of VOLUME DIAGRAM

The example of the SET VOLUME DIAGRAM by Volume(SelectAddress 20(hex)) and Fader(SelectAddress 28,29,2A,2B,2C, 30(hex)) is explained in the following.

Example 1) It is recommended when a signal level is made to attenuate, a decline by Volume is done by -24dB. It is adjusted with Fader after -24dB. S/N ratio can improve in comparison with the case that it is made to attenuate only with Volume.

Display (※)	Total Gain [dB]	Volume [dB]	Fader [dB]
50	6	6	0
49	5	5	0
48	4	4	0
47	3	3	0
46	2	2	0
45	1	1	0
44	0	0	0
43	-1	-1	0
42	-2	-2	0
41	-3	-3	0
40	-4	-4	0
39	-5	-5	0
38	-6	-6	0
37	-7	-7	0
36	-8	-8	0
35	-9	-9	0
34	-10	-10	0
33	-11	-11	0
32	-12	-12	0
31	-13	-13	0
30	-14	-14	0
29	-15	-15	0
28	-16	-16	0
27	-17	-17	0
26	-18	-18	0

Display (※)	Total Gain [dB]	Volume [dB]	Fader [dB]
25	-19	-19	0
24	-20	-20	0
23	-21	-21	0
22	-22	-22	0
21	-23	-23	0
20	-24	-24	0
19	-26	-24	-2
18	-28	-24	-4
17	-30	-24	-6
16	-32	-24	-8
15	-34	-24	-10
14	-36	-24	-12
13	-38	-24	-14
12	-40	-24	-16
11	-42	-24	-18
10	-44	-24	-20
9	-46	-24	-22
8	-48	-24	-24
7	-50	-24	-26
6	-52	-24	-28
5	-54	-24	-30
4	-56	-24	-32
3	-58	-24	-34
2	-60	-24	-36
1	-62	-24	-38
0	-∞	Mute	Mute

Table 1. A decline by Volume is done by -24dB. It is adjusted with Fader after -24dB.
(※Display=SET VOLUME)

※When a attenuate after -32dB is used with Volume, in case of use Subwoofer Input Selector = Input Selector (SelectAddress 02(hex), D3 = 1), Output level of OUTS1/S2 is attenuated 「 Volume – (-31dB) 」.

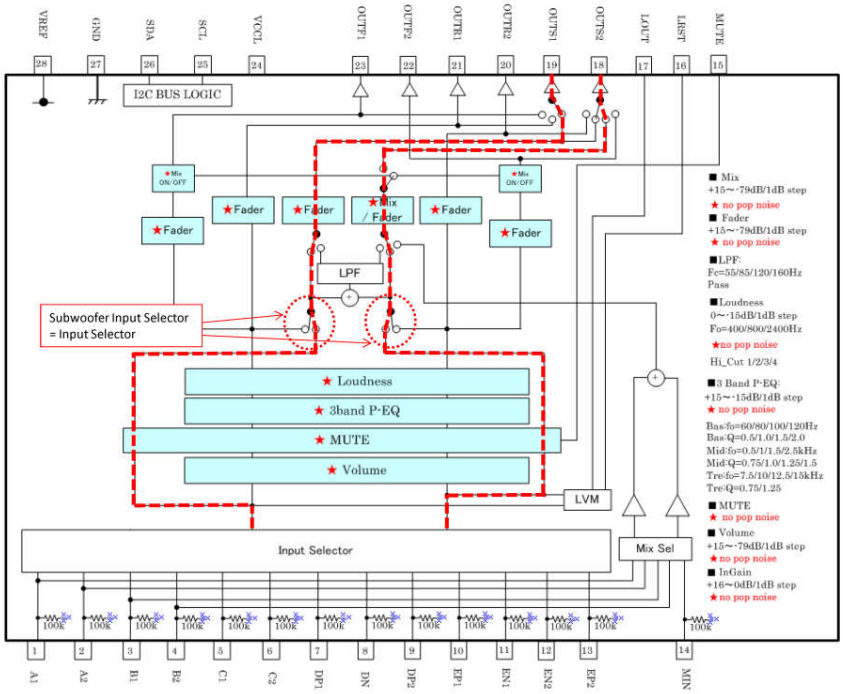


Figure 18. Subwoofer Input Selector = Input Selector (SelectAddress 02(hex), D3 = 1)

Volume [dB]	OUTS1/S2 [dB]	
Select Address 20(hex)	Subwoofer Input Selector=Loudness (Select Address 02(hex), D3=0)	Subwoofer Input Selector= Input Selector (Select Address 02(hex), D3=1)
6	6	0
5	5	0
4	4	0
3	3	0
2	2	0
1	1	0
0	0	0
-1	-1	0
-2	-2	0
-3	-3	0
-4	-4	0
-5	-5	0
-6	-6	0
-7	-7	0
-8	-8	0
-9	-9	0
-10	-10	0
-11	-11	0
-12	-12	0
-13	-13	0
-14	-14	0
-15	-15	0
-16	-16	0
-17	-17	0
-18	-18	0

Volume [dB]	OUTS1/S2 [dB]	
Select Address 20(hex)	Subwoofer Input Selector=Loudness (Select Address 02(hex), D3=0)	Subwoofer Input Selector= Input Selector (Select Address 02(hex), D3=1)
-19	-19	0
-20	-20	0
-21	-21	0
-22	-22	0
-23	-23	0
-24	-24	0
-26	-26	0
-28	-28	0
-30	-30	0
-32	-32	-1
-34	-34	-3
-36	-36	-5
-38	-38	-7
-40	-40	-9
-42	-42	-11
-44	-44	-13
-46	-46	-15
-48	-48	-17
-50	-50	-19
-52	-52	-21
-54	-54	-23
-56	-56	-25
-58	-58	-27
-60	-60	-29
-62	-62	-31

Table 2. Subwoofer Input Selector = Input Selector (SelectAddress 02(hex), D3 = 1)
Volume attenuation vs Output Level of OUTS1/S2

About loudness

When Loudness is set up in on, signal level in fo (set up by (SelectAddress 03(hex), D3,D4))is attenuated) is made attenuated.
Therefore to make it put emphasis on the low and high band, use volume together

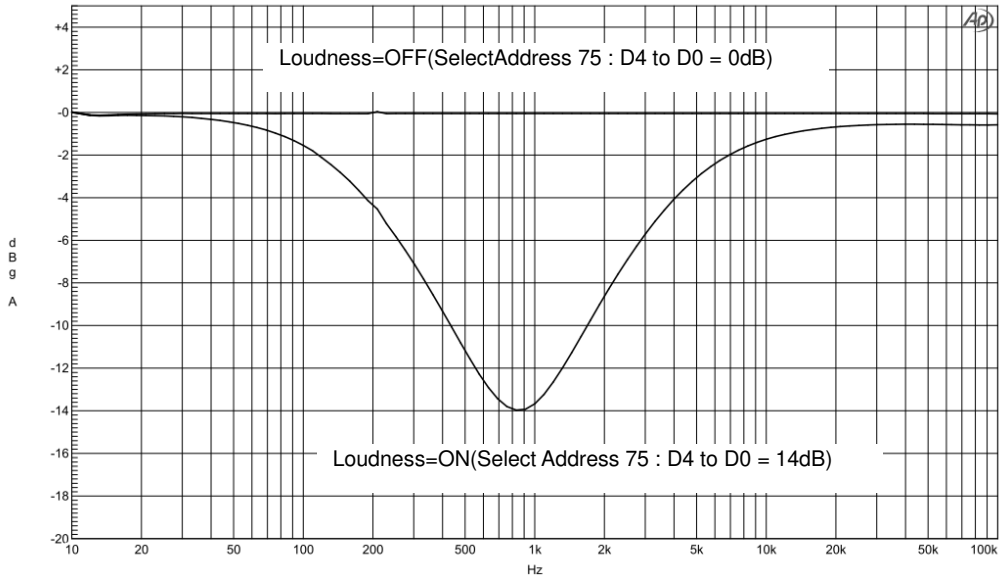


Figure 19. Loudness gain vs frequency (fo=800Hz)

Display (※)	Total Gain A [dB]	Total Gain B [dB]	Volume [dB]	Loudness [dB]	Fader [dB]
50	6	6	6	0	0
49	5	5	5	0	0
48	4	4	4	0	0
47	3	3	3	0	0
46	2	2	2	0	0
45	1	1	1	0	0
44	0	0	0	0	0
43	-1	-1	-1	0	0
42	-2	-2	-2	0	0
41	-3	-3	-3	0	0
40	-4	-4	-4	0	0
39	-5	-5	-5	0	0
38	-6	-6	-6	0	0
37	-7	-7	-7	0	0
36	-8	-8	-8	0	0
35	-9	-9	-9	0	0
34	-10	-10	-10	0	0
33	-10	-10	-10	-1	0
32	-10	-10	-10	-2	0
31	-10	-10	-10	-3	0
30	-10	-10	-10	-4	0
29	-10	-10	-10	-5	0
28	-10	-10	-10	-6	0
27	-10	-10	-10	-7	0
26	-10	-10	-10	-8	0

Display (※)	Total Gain A [dB]	Total Gain B [dB]	Volume [dB]	Loudness [dB]	Fader [dB]
25	-10	-19	-10	-9	0
24	-10	-20	-10	-10	0
23	-10	-21	-10	-11	0
22	-10	-22	-10	-12	0
21	-10-10	-23	-10	-13	0
20	-10	-24	-10	-14	0
19	-12	-26	-10	-14	-2
18	-14	-28	-10	-14	-4
17	-16	-30	-10	-14	-6
16	-18	-32	-10	-14	-8
15	-20	-34	-10	-14	-10
14	-22	-36	-10	-14	-12
13	-24	-38	-10	-14	-14
12	-26	-40	-10	-14	-16
11	-28	-42	-10	-14	-18
10	-30	-44	-10	-14	-20
9	-32	-46	-10	-14	-22
8	-34	-48	-10	-14	-24
7	-36	-50	-10	-14	-26
6	-38	-52	-10	-14	-28
5	-40	-54	-10	-14	-30
4	-42	-56	-10	-14	-32
3	-44	-58	-10	-14	-34
2	-46	-60	-10	-14	-36
1	-48	-62	-10	-14	-38
0	-∞	-∞	Mute	-14	Mute

Table 3. A decline by Volume is done by -24dB. It is adjusted with Fader after -24dB. Loudness=ON
(※Display=SET VOLUME)

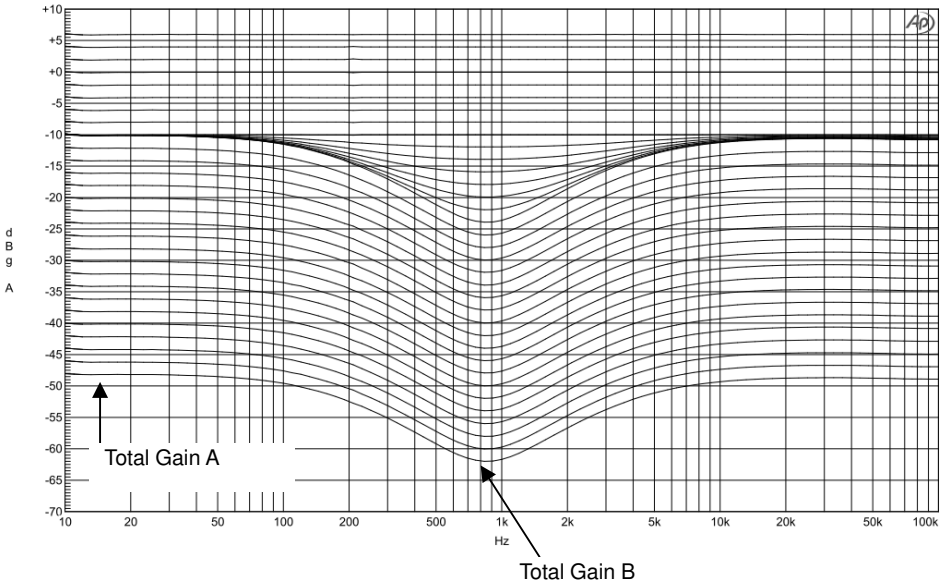


Figure 20. Gain vs frequency of Table.3

Attention about Loudness ON/OFF

To make it put emphasis on the low and high band, when it is made to boost with Volume so long as it was made to attenuate with Loudness.

・Loudness OFF →ON : Send data of loudness before volume
・Loudness ON →OFF : Send data of volume before loudness

※Transmit data in the above turn. A signal level declines first, and it is amplified after that. And so natural switching can be realized.

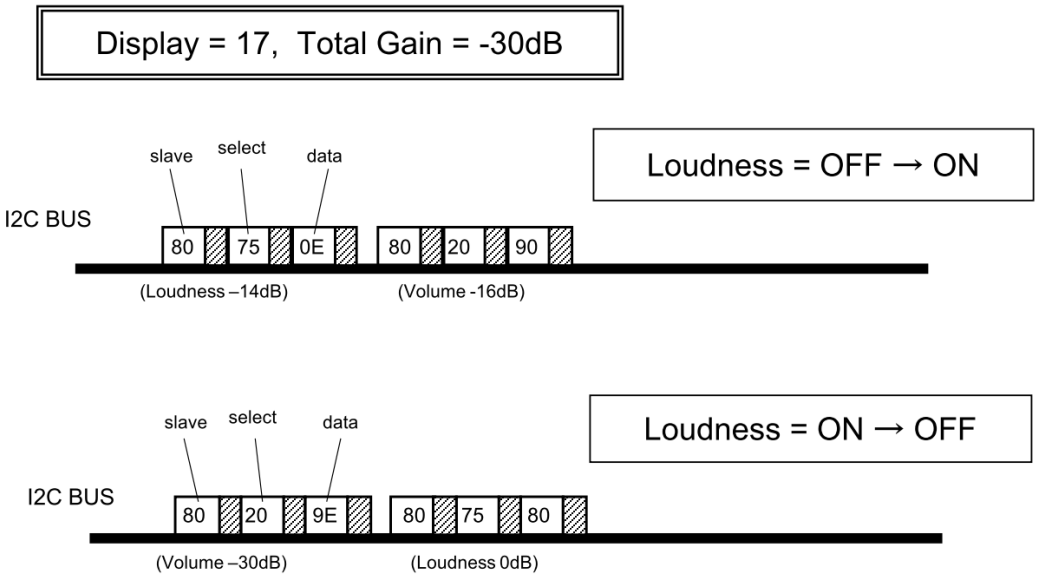


Figure 21. example of data sending about Loudness ON/OFF

(6)About power on reset

At on of supply voltage circuit made initialization inside IC is built-in. Please send data to all address as initial data at supply voltage on. And please supply mute at set side until this initial data is sent.)

Item	Symbol	Limit			Unit	Condition
		Min.	Typ.	Max.		
Rise time of VCC	Trise	33	—	—	usec	VCC rise time from 0V to 5V)
VCC voltage of release power on reset	Vpor	—	4.1	—	V	

(7)About external compulsory mute terminal

Mute is possible forcibly than the outside after input again department, by the setting of the MUTE terminal.

Mute Voltage Condition	Mode
GND to 1. 0V	MUTE ON
2.3V to 5.0V	MUTE OFF

Establish the voltage of MUTE in the condition to have been defined.)

About VCC response of VREF terminal)

Output voltage of VREF terminal keep fixed voltage in operational range.

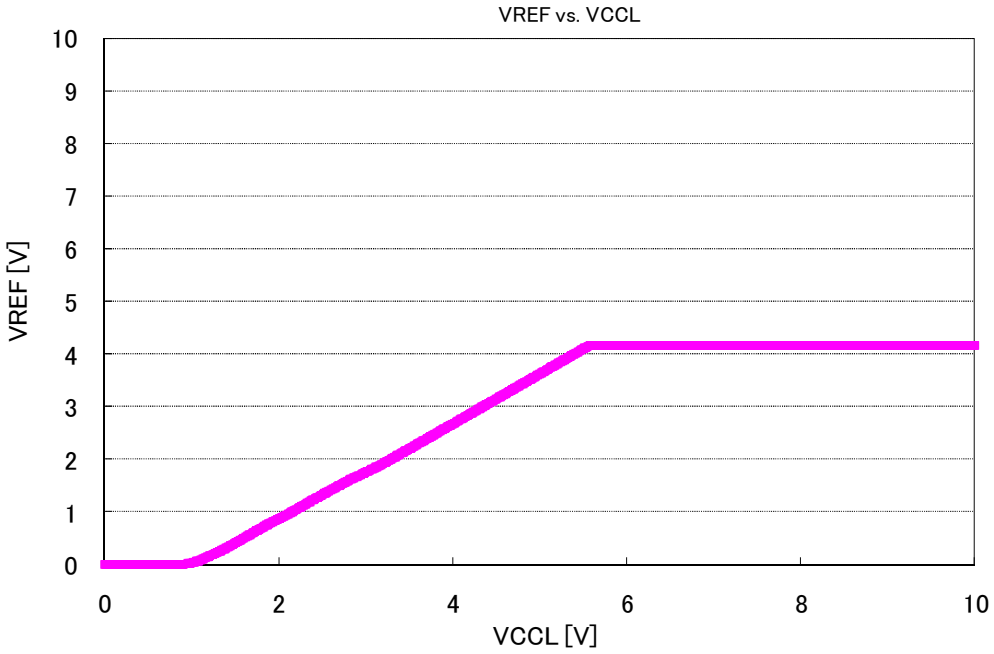


Figure 22. OUT(18 to 23pin)_DC-Bias = 4.15V fixed.