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Sound Processor with Built-in 3-band Equalizer

BD37543FS

General Description

BD37543FS is a sound processor with built-in 3-band equalizer for car audio. The functions are stereo input selector (which can switch single and ground isolation input), input-gain control, main volume, loudness, 5ch fader volume, LPF and 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, loudness, 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, f_O of 3-band equalizer, and f_C of LPF/HPF through the I^2C BUS control.
- It is possible to adjust the gain of the bass, middle, 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 I^2C 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 I^2C BUS by 3.3V / 5V.

Applications

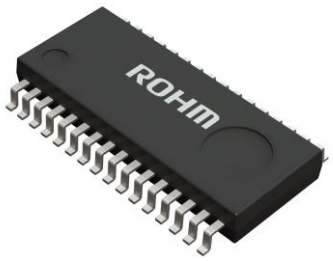
It is optimal for car audio systems. It can also be used for audio equipment of mini Compo, micro Compo, TV, etc.

Key Specifications

- Power Supply Voltage Range: 7.0V to 9.5V
- Circuit Current (No Signal): 38mA (Typ)
- Total Harmonic Distortion 1: (FRONT,REAR) 0.001%(Typ)
- Total Harmonic Distortion 2: (SUBWOOFER) 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 1: (FRONT,REAR) 3.8µVrms(Typ)
- Output noise voltage 2: (SUBWOOFER) 4.8µVrms(Typ)
- Residual Output Noise Voltage: 1.8µVrms(Typ)
- Operating Temperature Range: -40°C to +85°C

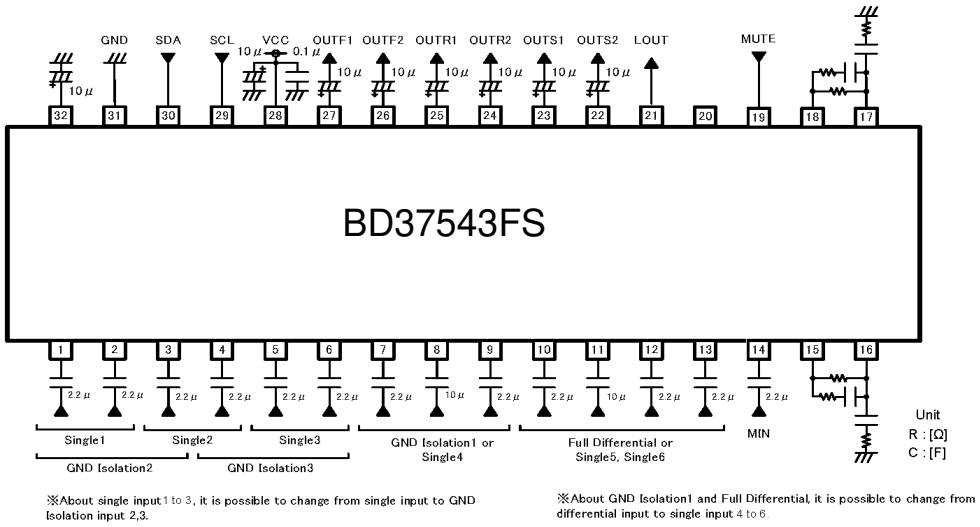
Package

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

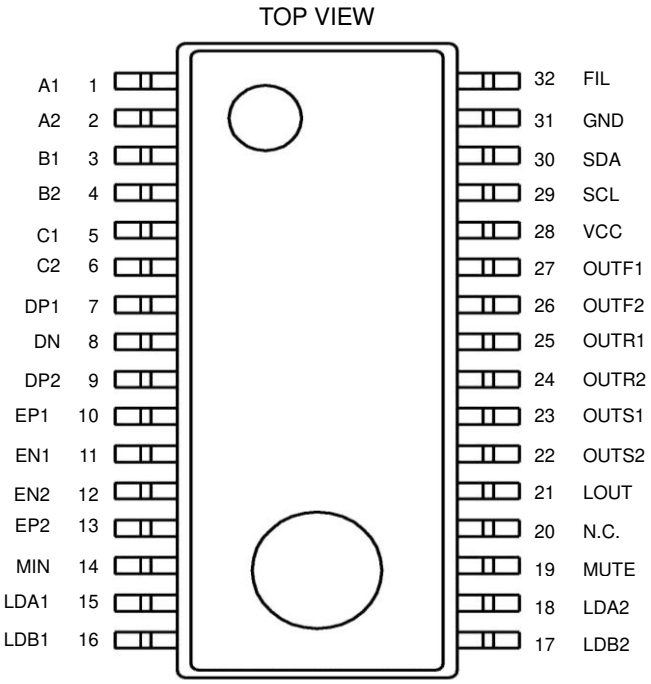


SSOP-A32
13.60 mm x 7.80mm x 2.01mm

Typical Application Circuit



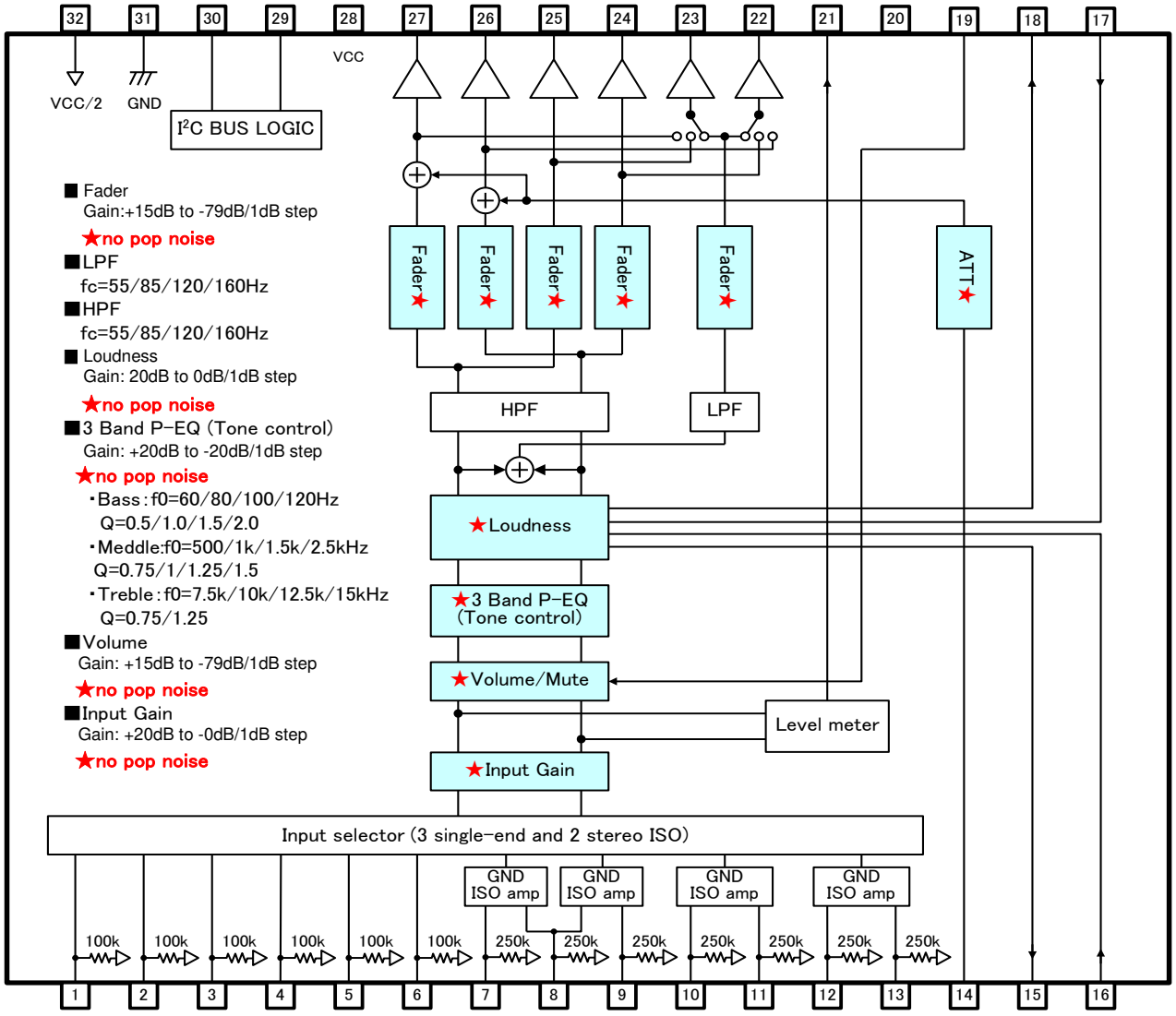
Pin Configuration



Pin Descriptions

Pin No.	Pin Name	Description	Pin No.	Pin Name	Description
1	A1	A input terminal of 1ch	17	LDB2	Loudness setting terminal of 2ch
2	A2	A input terminal of 2ch	18	LDA2	Loudness setting terminal of 2ch
3	B1	B input terminal of 1ch	19	MUTE	External compulsory mute terminal
4	B2	B input terminal of 2ch	20	N.C.	No Connection
5	C1	C input terminal of 1ch	21	LOUT	Output terminal for Level meter
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	EN1	E negative input terminal of 1ch	27	OUTF1	Front output terminal of 1ch
12	EN2	E negative input terminal of 2ch	28	VCC	Power supply terminal
13	EP2	E positive input terminal of 2ch	29	SCL	I^2C Communication clock terminal
14	MIN	Mixing input terminal	30	SDA	I^2C Communication data terminal
15	LDA1	Loudness setting terminal of 1ch	31	GND	GND terminal
16	LDB1	Loudness 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	Pd	0.95 (Note 1)	W
Storage Temperature	Tstg	-55 to +150	°C

(Note 1) When mounted on the standard board (70 x 70 x 1.6 mm^3), derate by 7.6mW/°C for Ta above 25°C.
Thermal resistance θja = 131.6(°C/W)
Material : A FR4 grass 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	Topr	-40	-	+85	°C

Electrical Characteristics

(Unless specified, Ta=25°C, V_{CC}=8.5V, f=1kHz, V_{IN}=1Vrms, Rg=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}=1Vrms BW=400Hz-30KHz
	Total Harmonic Distortion 2 (SUBWOOFER)	THD+N2	-	0.002	0.05	%	V_{OUT}=1Vrms BW=400Hz-30KHz
	Output Noise Voltage 1 (FRONT,REAR) *	V_{NO1}	-	3.8	15	μVrms	Rg = 0Ω BW = IHF-A
	Output Noise Voltage 2 (SUBWOOFER) *	V_{NO2}	-	4.8	15	μVrms	Rg = 0Ω BW = IHF-A
	Residual Output Noise Voltage *	V_{NOR}	-	1.8	10	μVrms	Fader = -∞dB Rg = 0Ω BW = IHF-A
	Cross-talk Between Channels *	CTC	-	-100	-90	dB	Rg = 0Ω CTC=20log(V_{OUT}/V_{IN}) BW = IHF-A
	Ripple Rejection	RR	-	-70	-40	dB	f=1kHz V_{RR}=100mVrms RR=20log(V_{CC} IN/V_{OUT})
INPUT SELECTOR	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	-	Vrms	V_{IM} at THD+N(V_{OUT})=1% BW=400Hz-30KHz
	Cross-talk Between Selectors *	CTS	-	-100	-90	dB	Rg = 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}=100mVrms G_{IN}=20log(V_{OUT}/V_{IN})
	Maximum Input Gain	G_{IN_MAX}	18	20	22	dB	Input gain 20dB V_{IN}=100mVrms G_{IN}=20log(V_{OUT}/V_{IN})
	Gain Set Error	G_{IN_ERR}	-2	0	+2	dB	GAIN=+1dB to +20dB
MUTE	Mute Attenuation *	G_{MUTE}	-	-105	-85	dB	Mute ON G_{MUTE}=20log(V_{OUT}/V_{IN}) BW = IHF-A
VOLUME	Maximum Gain	G_{V_MAX}	13	15	17	dB	Volume = 15dB V_{IN}=100mVrms G_V=20log(V_{OUT}/V_{IN})
	Maximum Attenuation *	G_{V_MIN}	-	-100	-85	dB	Volume = -∞dB G_V=20log(V_{OUT}/V_{IN}) BW = IHF-A
	Attenuation Set Error 1	G_{V_ERR1}	-2	0	+2	dB	GAIN & 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}=100mVrms G_B=20log (V_{OUT}/V_{IN})
	Maximum Cut Gain	G_{B_CUT}	-22	-20	-18	dB	Gain=-20dB f=100Hz V_{IN}=2Vrms G_B=20log (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}=100mVrms G_M=20log (V_{OUT}/V_{IN})
	Maximum Cut Gain	G_{M_CUT}	-22	-20	-18	dB	Gain=-20dB f=1kHz V_{IN}=2Vrms G_M=20log (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}=100mVrms G_T=20log (V_{OUT}/V_{IN})
	Maximum Cut Gain	G_{T_CUT}	-22	-20	-18	dB	Gain=-20dB f=10kHz V_{IN}=2Vrms G_T=20log (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	kΩ	
	Maximum Input Voltage	V_{IM_M}	2.0	2.2	-	Vrms	V_{IM} at THD+N(V_{OUT})=1% BW=400Hz-30KHz
	Maximum Attenuation	G_{MX_MIN}	-	-100	-85	dB	MIX=OFF G_{MX}=20log(V_{OUT}/V_{IN}) BW=INF-A
	Maximum Gain	G_{MX_MAX}	5	7	9	dB	ATT=+6dB G_{MX}=20log(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}=100mVrms G_F=20log(V_{OUT}/V_{IN})
	Maximum Attenuation *	G_{F_MIN}	-	-100	-90	dB	Fader = -∞dB G_F=20log(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} =100mVrms
	Maximum Output Voltage	V_{OM}	2	2.2	-	Vrms	THD+N=1% BW=400Hz-30KHz
LOUDNESS	Maximum Gain	G_{L_MAX}	17	20	23	dB	Gain 20dB V_{IN}=100mVrms G_L=20log(V_{OUT}/V_{IN})
	Gain Set Error	G_{L_ERR}	-2	0	+2	dB	Gain=+1dB to +20dB
Level meter	Maximum Output Voltage	V_{L_MAX}	2.8	3.1	3.5	V	
	Output Offset Voltage	V_{L_OFF}	-	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

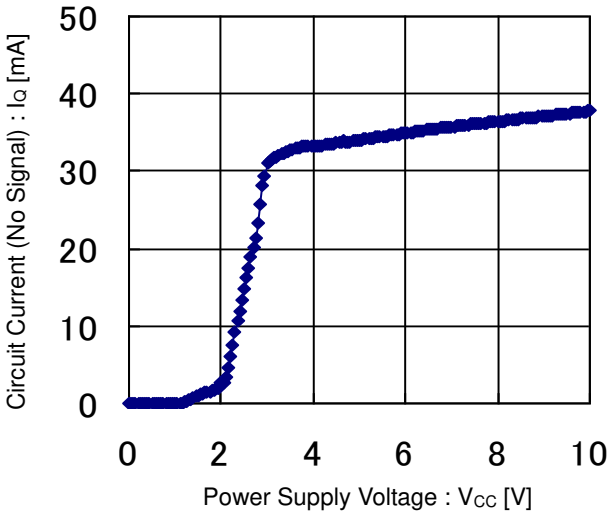


Figure 1. Circuit Current (No Signal) vs Power Supply Voltage

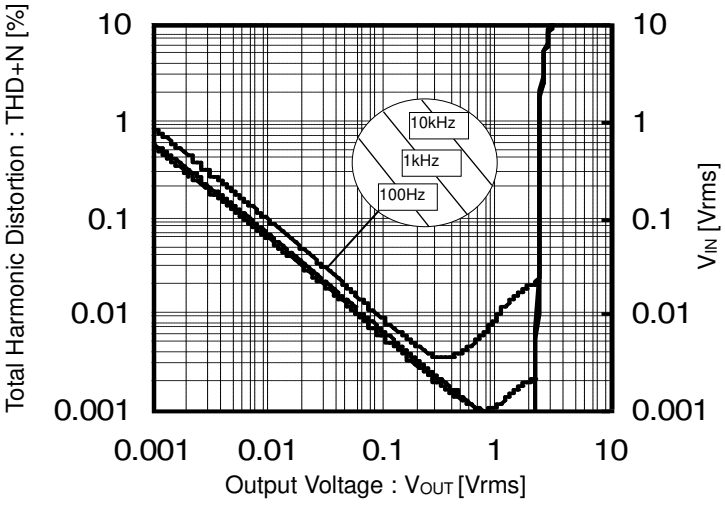


Figure 2. Total Harmonic Distortion vs Output Voltage

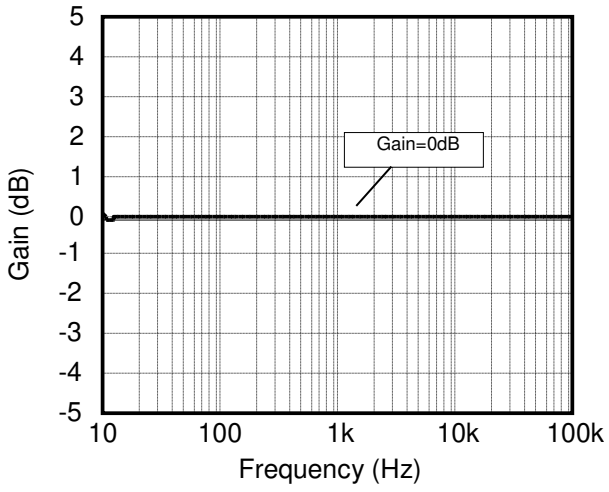


Figure 3. Gain vs Frequency

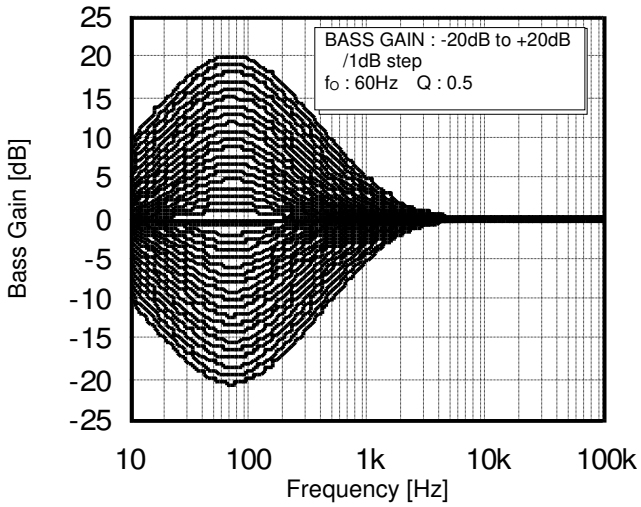


Figure 4. Bass Gain vs Frequency

Typical Performance Curves – continued

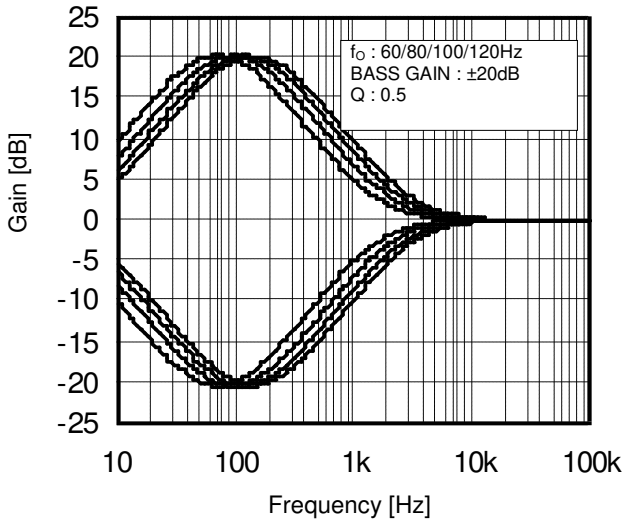


Figure 5. Bass fo vs Frequency

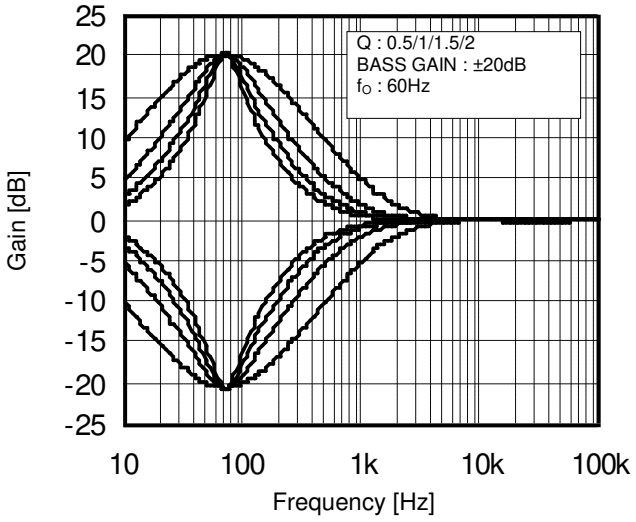


Figure 6. Bass Q vs Frequency

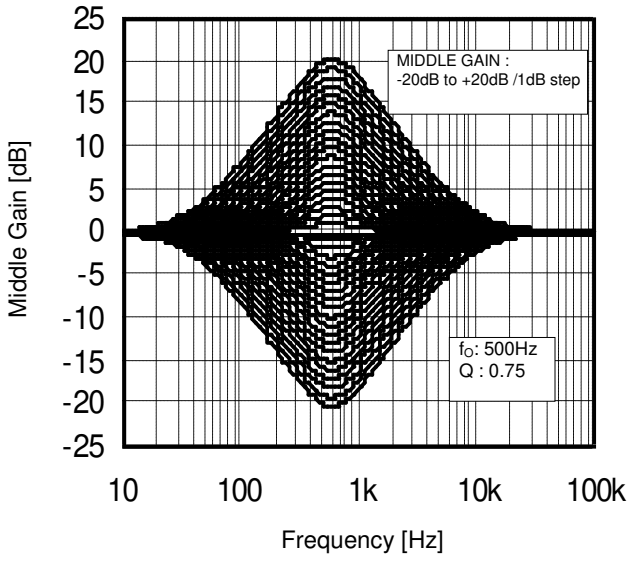


Figure 7. Middle Gain vs Frequency

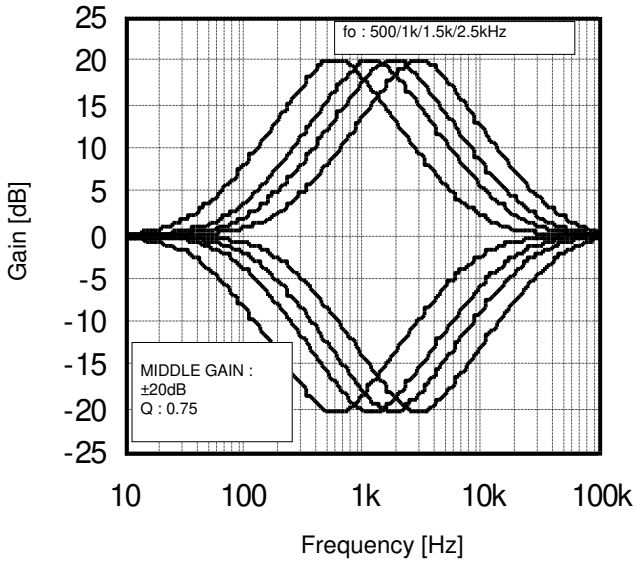


Figure 8. Middle fo vs Frequency

Typical Performance Curves – continued

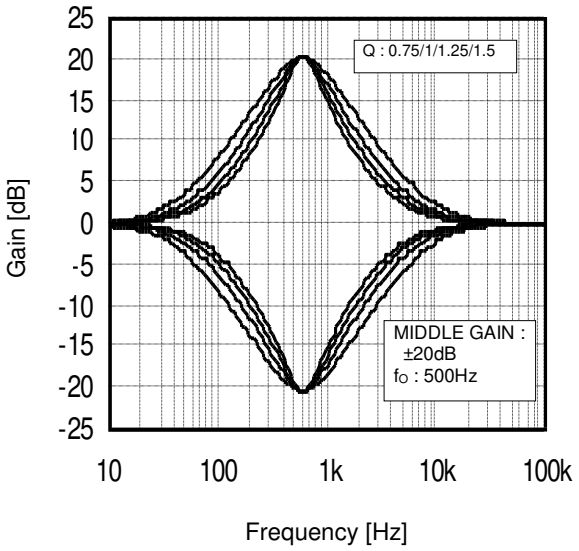


Figure 9. Middle Q vs Frequency

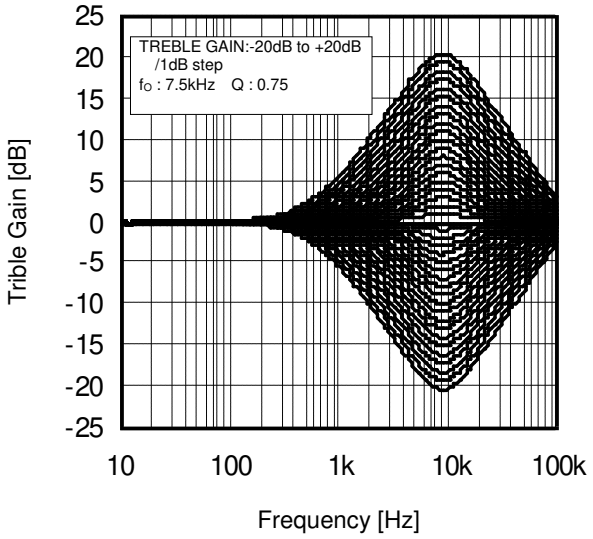


Figure 10. Treble Gain vs Frequency

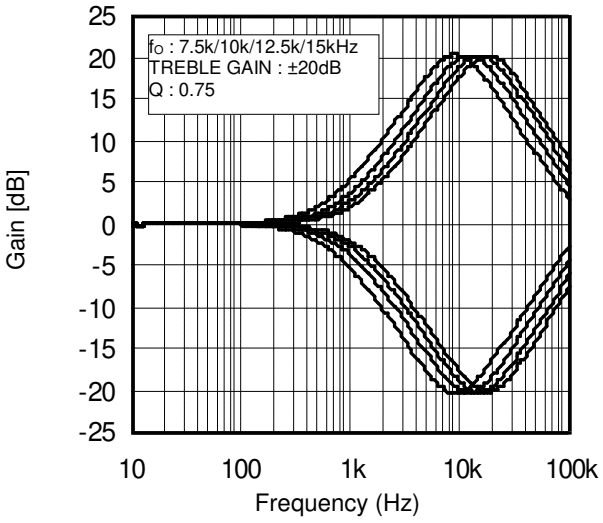


Figure 11. Treble fo vs Frequency

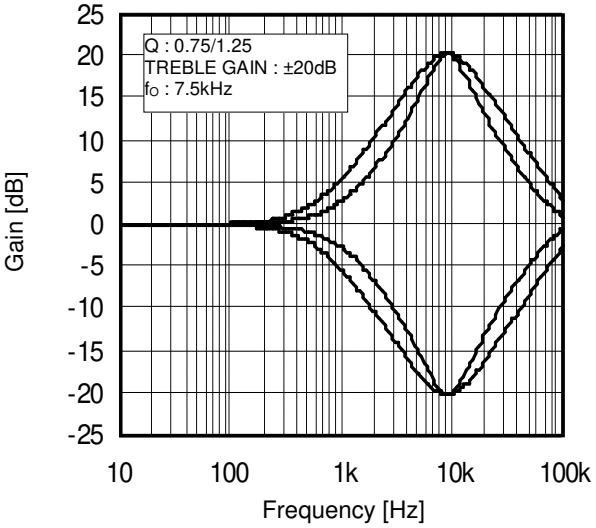


Figure 12. Treble Q vs Frequency

Typical Performance Curves – continued

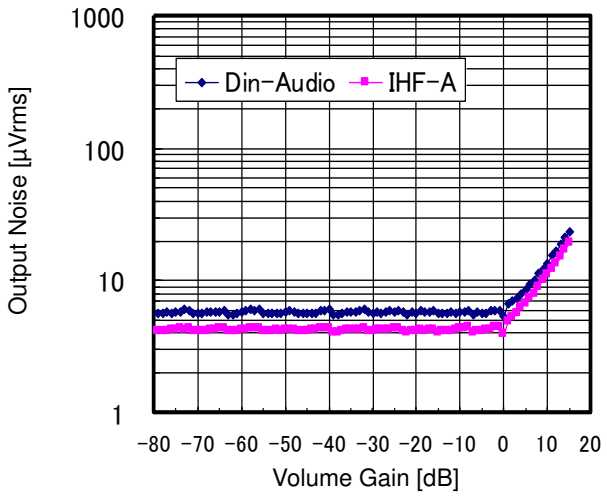


Figure 13. Output Noise vs Volume Gain

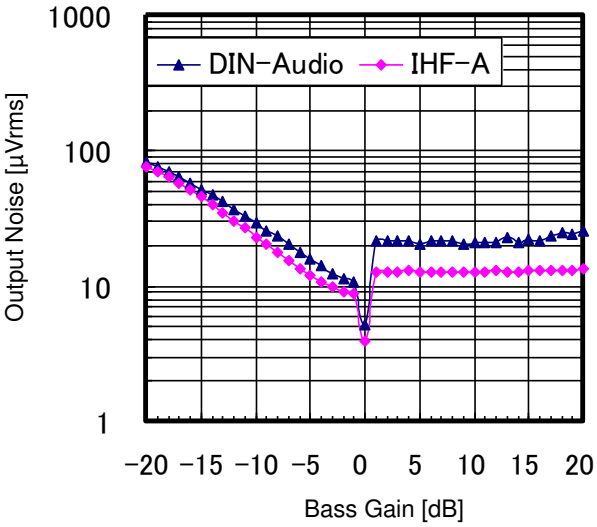


Figure 14. Output Noise vs Bass Gain

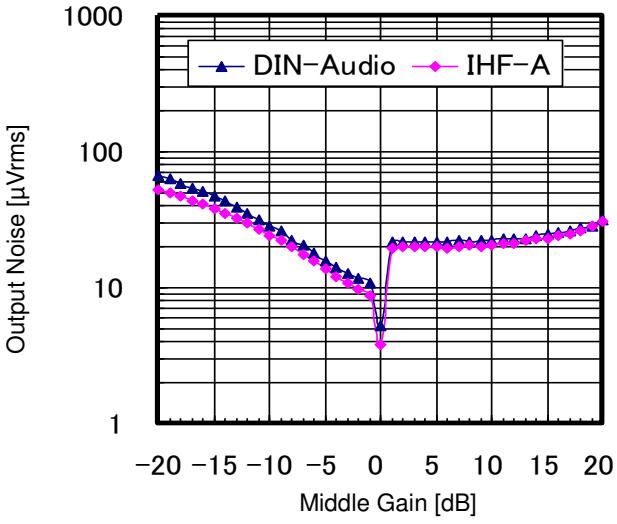


Figure 15. Output Noise vs Middle Gain

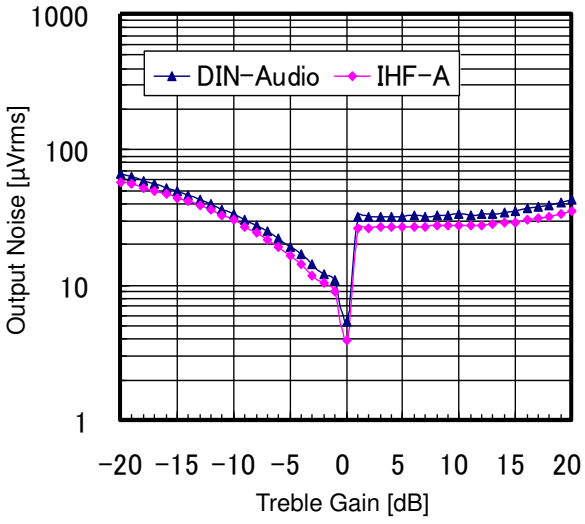


Figure 16. Output Noise vs Treble Gain

Typical Performance Curves – continued

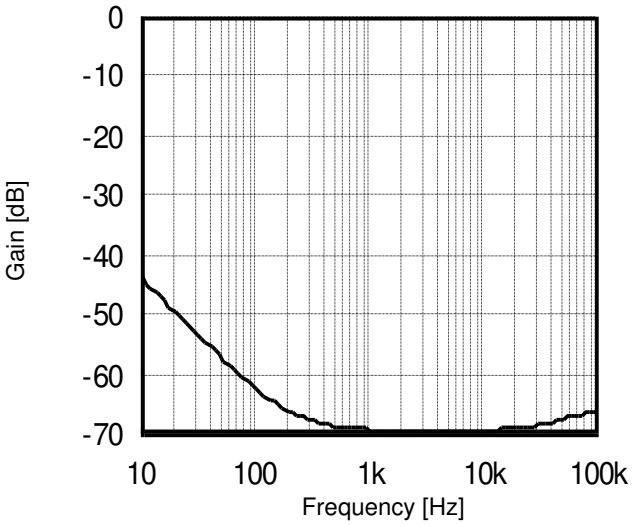


Figure 17. CMRR vs Frequency

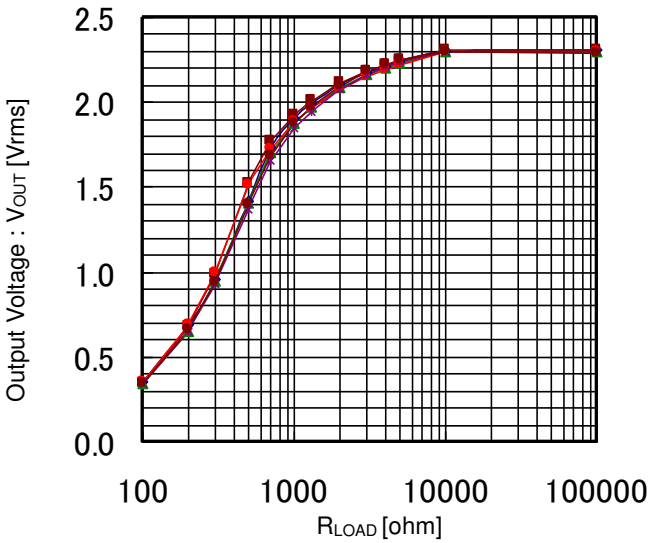


Figure 18. Output Voltage vs R_{LOAD}

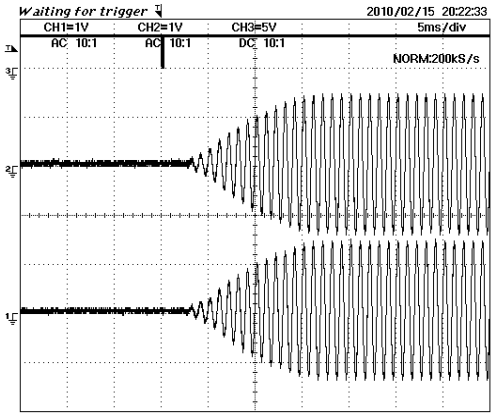


Figure 19. Advanced Switch 1

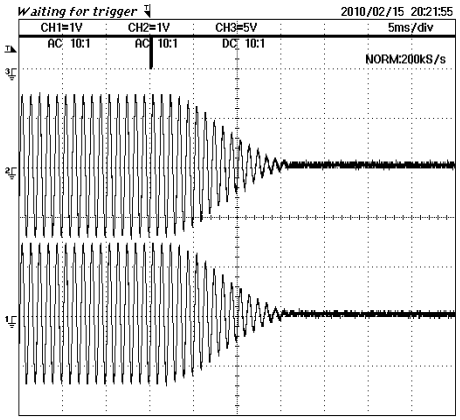


Figure 20. Advanced Switch 2

Typical Performance Curves – continued

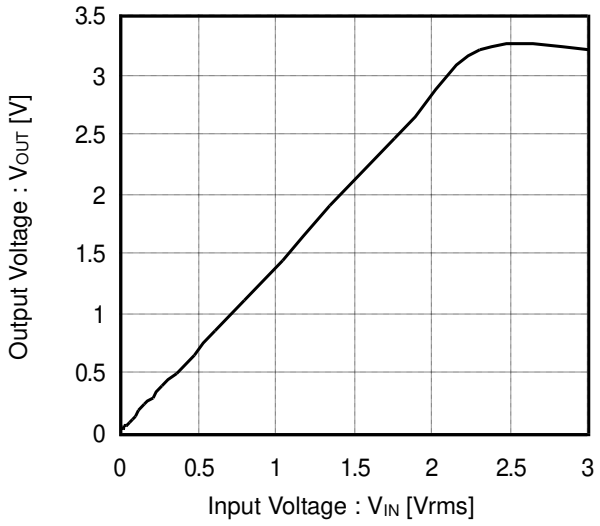


Figure 21. Output Voltage vs Input Voltage
(Level Meter V_{IN})

Timing Chart

CONTROL SIGNAL SPECIFICATION

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

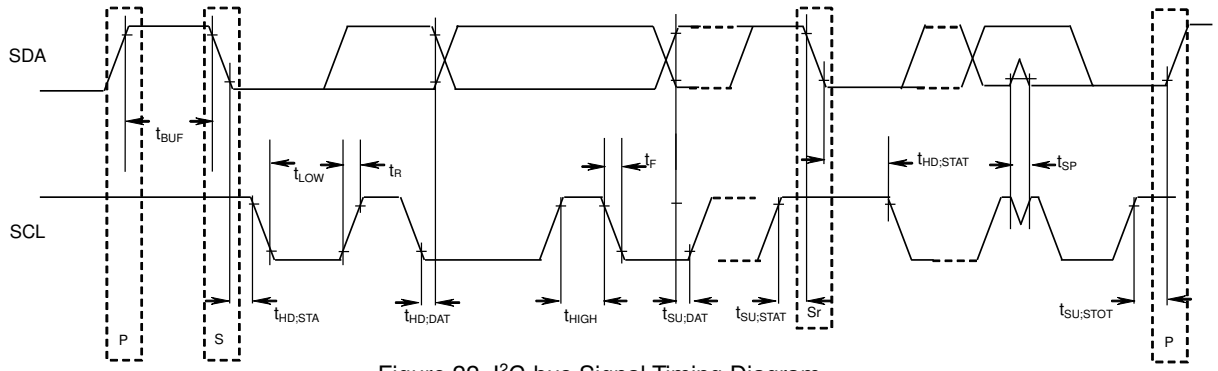


Figure 22. I²C-bus Signal Timing Diagram

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

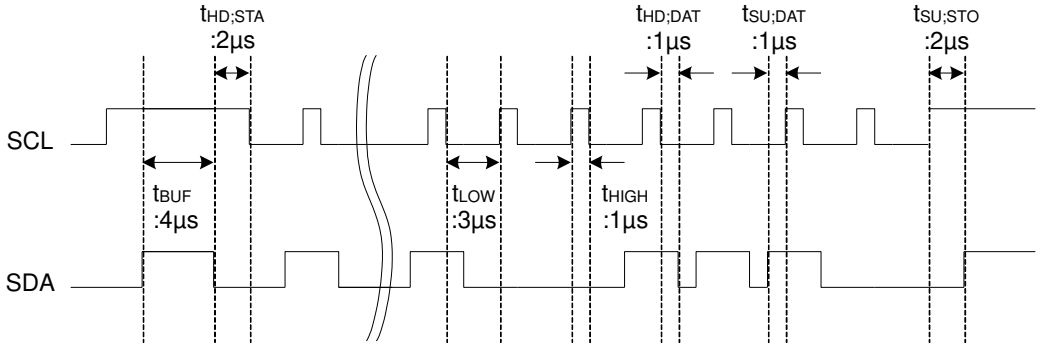
	Parameter	Symbol	Fast-mode I²C-bus		Unit
			Min	Max	
1	SCL clock frequency	f_{SCL}	0	400	kHz
2	Bus free time between a STOP and START condition	t_{BUF}	1.3	-	µS
3	Hold time (repeated) START condition. After this period, the first clock pulse is generated	$t_{HD;STA}$	0.6	-	µS
4	LOW period of the SCL 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



SCL clock frequency : 250kHz

Figure 23. A 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 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

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

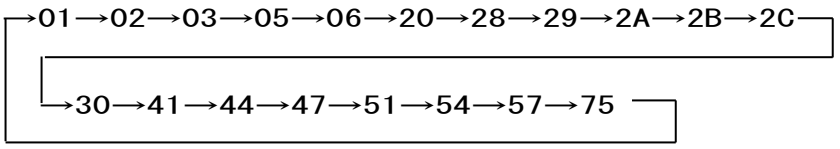
(5) Select Address & Data

Items	Select Address (hex)	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 Mixing		0	1	Advanced switch time of Mute	
Initial setup 2	02	LPF Phase	Level Meter RESET	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_O		0	0	Bass Q	
Middle setup	44	0	0	Middle f_O		0	0	Middle Q	
Treble setup	47	0	0	Treble f_O		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 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/Loudness 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/ Loudness/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/Loudness Mixing		0	1	Advanced switch Time of Mute	
ON	1							

Select address 02(hex)

f_C	MSB Subwoofer LPF f_C LSB							
	D7	D6	D5	D4	D3	D2	D1	D0
OFF	LPF Phase	Level Meter RESET	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	Level Meter RESET	0	0	0	Subwoofer LPF f_C		
Front			0	1				
Rear			1	0				
Prohibition			1	1				

Mode	MSB Level Meter RESET LSB							
	D7	D6	D5	D4	D3	D2	D1	D0
HOLD	LPF Phase	0	Subwoofer output select		0	Subwoofer LPF f_C		
RESET		1						

Phase	MSB LPF Phase LSB							
	D7	D6	D5	D4	D3	D2	D1	D0
0°	0	Level Meter RESET	Subwoofer output select		0	Subwoofer LPF f_C		
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
E1 single	EP1	EN1				0	1	0	1	0
E2 single	EN2	EP2				0	1	0	1	1
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 full diff	EP1	EP2				0	1	0	0	0
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)

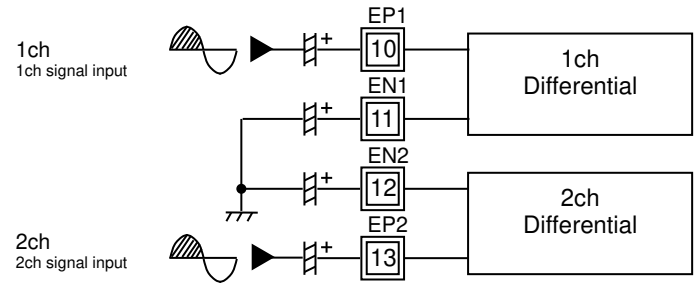
: Initial condition

Select address 05(hex)

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

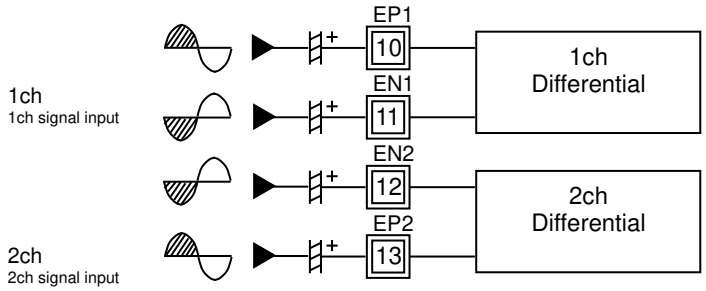
Negative input type

For Ground –isolation type.



Bias type

For differential amplifier type



Select address 06 (hex)

Mode	**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	0	1	1
				:	:	:	:	:
				1	1	1	1	1

: Initial condition

Select address 06 (hex)

Mode	MSB 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	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
	:	:	:	:	:	:	:	:
	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
:	:	:	:	:	:	:	:	:
-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	MSB 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
	:	:	:	:	:	:	:	:
	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
:	:	:	:	:	:	:	:	:
-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

: Initial condition

Select address 41(hex)

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

f_O	MSB		Bass f_O				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

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

f_O	MSB		Treble f_O					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	0	1	0	1
				:	:	:	:	:
				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)

Mode	MSB		Loudness Hicut					LSB
	D7	D6	D5	D4	D3	D2	D1	D0
Hicut1	0	0	0	Loudness Gain				
Hicut2		0	1					
Hicut3		1	0					
Hicut4		1	1					

Gain	MSB		Loudness Gain					LSB
	D7	D6	D5	D4	D3	D2	D1	D0
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	0	1	0	1
				:	:	:	:	:
				1	1	1	1	1

: 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	

(7) About External Compulsory Mute Terminal

It is possible to force mute externally by setting an input voltage to the MUTE terminal.

Mute Voltage Condition	Mode
GND to 1.0V	MUTE ON
2.3V to V_{CC}	MUTE OFF

Establish the voltage of MUTE in the condition you want to set.

Application Information

1. Function and Specifications

<table>
<tr><th>Function</th><th>Specifications</th></tr>
<tr><td>Input selector</td><td>・ Stereo input
・ Single-End/Diff/Full-Diff
(Possible to set the number of single-end/diff/full-diff as follows)
<table>
<tr><th></th><th>Single-End</th><th>Differential</th><th>Full-Differential</th></tr>
<tr><td>Mode 1</td><td>0</td><td>3</td><td>1</td></tr>
<tr><td>Mode 2</td><td>1</td><td>2</td><td>1</td></tr>
<tr><td>Mode 3</td><td>3</td><td>1</td><td>1</td></tr>
<tr><td>Mode 4</td><td>4</td><td>0</td><td>1</td></tr>
<tr><td>Mode 5</td><td>5</td><td>1</td><td>0</td></tr>
<tr><td>Mode 6</td><td>6</td><td>0</td><td>0</td></tr>
</table>
Table.1 Combination of input selector</td></tr>
<tr><td>Input gain</td><td>・ +20dB to 0dB (1dB step)
・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
<tr><td>Mute</td><td>・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
<tr><td>Volume</td><td>・ +15dB to -79dB (1dB step), -∞dB
・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
<tr><td>Bass</td><td>・ +20dB to -20dB (1dB step)
・ Q=0.5, 1, 1.5, 2
・ f_O=60, 80, 100, 120Hz
・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
<tr><td>Middle</td><td>・ +20dB to -20dB (1dB step)
・ Q=0.75, 1, 1.25, 1.5
・ f_O=500, 1k, 1.5k 2.5kHz
・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
<tr><td>Treble</td><td>・ +20dB to -20dB (1dB step)
・ Q=0.75, 1.25
・ f_O=7.5k, 10k, 12.5k, 15kHz
・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
<tr><td>Fader</td><td>・ +15dB to -79dB(1dB step), -∞dB
・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
<tr><td>Loudness</td><td>・ 20dB to 0dB(1dB step)
・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
<tr><td>LPF</td><td>・ f_C=55/85/120Hz/160Hz, pass
・ Phase shift (0°/180°)</td></tr>
<tr><td>HPF</td><td>・ f_C=55/85/120Hz/160Hz, pass</td></tr>
<tr><td>Level meter</td><td>・ I^2C BUS control
・ DC Output</td></tr>
<tr><td>Mixing</td><td>・ Monaural input
・ +7dB to -79dB (1dB step), -∞dB
・ Possible to use “Advanced switch” for prevention of switching noise.</td></tr>
</table>

2. Volume / Fader Volume / Mixing 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	1	0		-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

Mixing Adjustable range is +7dB to -∞dB.

: Initial condition

(1) About Level Meter

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

(b) The Way to Reset Level Meter Output
Please send reset data through I²C BUS
How to reset output of level meter : Send D6 = " 1 " to select address 02(hex).
How to cancel output reset of level meter (HOLD) : Send D6 = " 0 " to select address 02(hex).

(c) The Settings About Reset Period
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 Diagram Example by I²C BUS