M61508FP

The Electric Volume of Built-in Non Fader Volume with Tone Control

REJ03F0203-0201
Rev.2.01
Mar 31, 2008

Application

- This IC can be used Analog Signal processing of Power Amp. front stage
- This IC can be used Car Audio System, Home Audio System and TV.

Features

- This IC is unnecessary for outside putting CR by using SCF for Loudness and Tone Control.
  Bass: +16 dB to –12 dB/2 dBstep. f0, Q = variable. f0 = 50 Hz, 80 Hz, 120 Hz Q = 1, 1.25, 1.5, 2
  Mid: +12 dB to –12 dB/2 dBstep. f0, Q = variable. f0 = 700 Hz, 1 kHz, 2 kHz, 10 kHz Q = 1.5, 2
  Treble: +12 dB to –12 dB/2 dBstep. f0 = variable. f0 = 8 kHz, 12 kHz
  Loudness: f0 = variable. f0 = 60 Hz, 80 Hz, 100 Hz
- Built-in Non Fader Volume
  +12 dB to –12 dB/2 dB step, –∞ dB
- Built-in Zero-Crossing Detector Circuit for Changing Noise Measure.
- Built-in Differential Input and Differential Output
- Built-in Input Selector (4 input + Differential Input)
- Built-in Input Gain Control
  0 dB to +18.75 dB/1.25 dB step
- Built-in Master Volume and Fader Volume (Front, Rear)
  Volume: 0 dB to –83 dB, –∞ dB/1 dB step
  Fader: 0 dB, –1 dB, –2 dB, –3 dB, –4 dB, –6 dB, –8 dB, –12 dB, –16 dB, –20 dB, –30 dB, –45 dB, –60 dB, –∞ dB/16 step
- Serial Data Control of 2 lines formula.

Recommended Operating Conditions

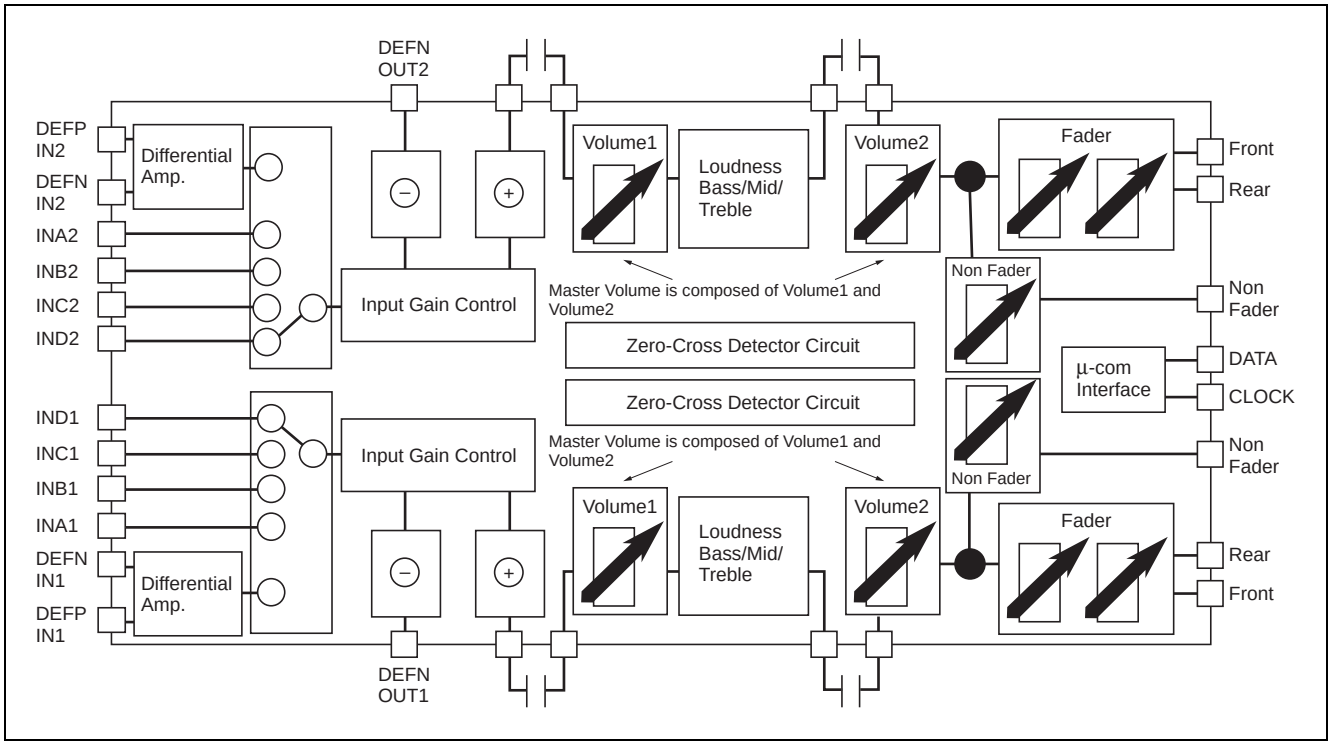
Supply voltage range… V_{CC} = 7 V to 9 V

V_{DD} = 4.5 V to 5.5 V

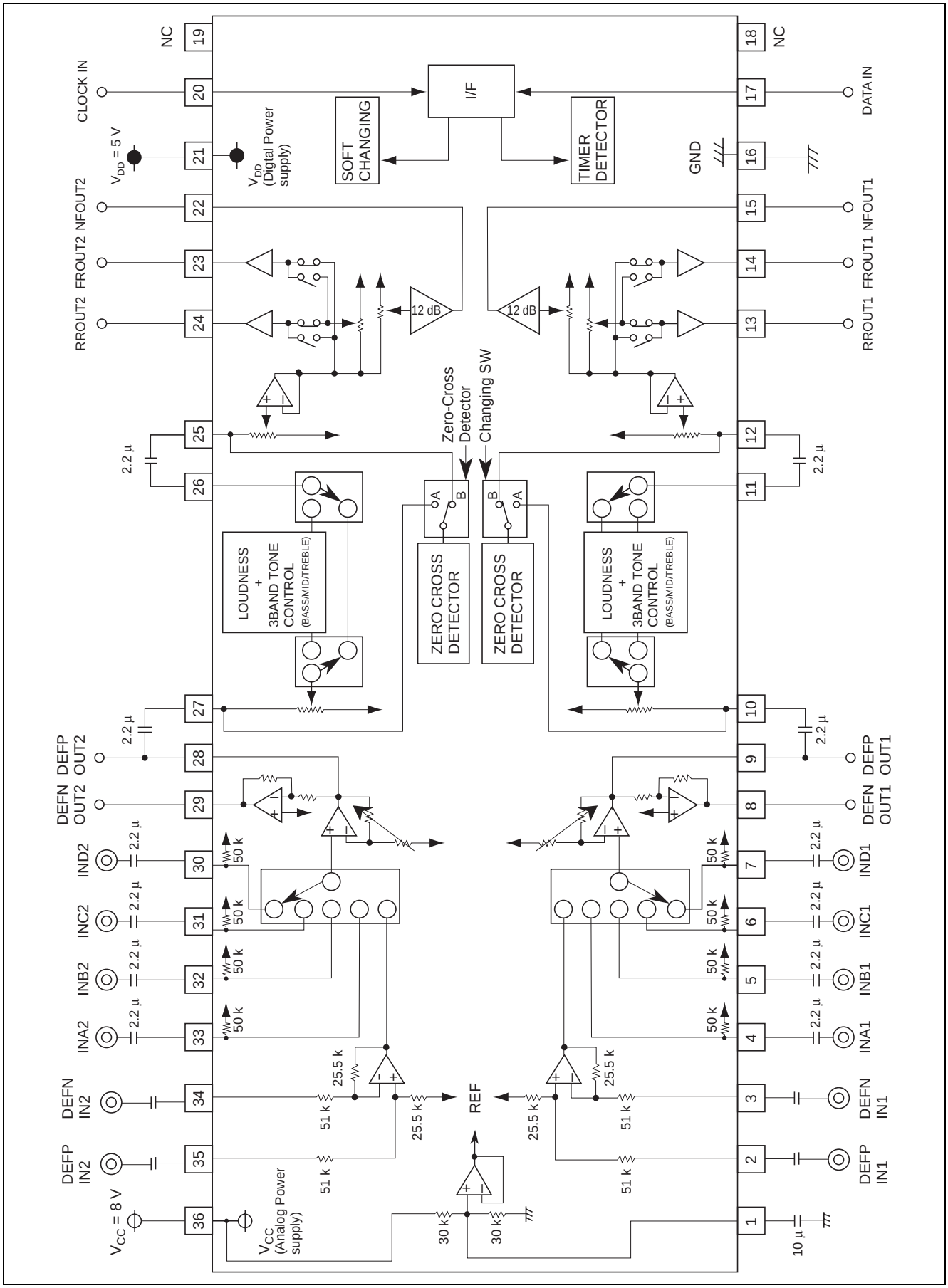
Rated supply voltage… V_{CC} = 8 V

V_{DD} = 5 V

System Block Diagram



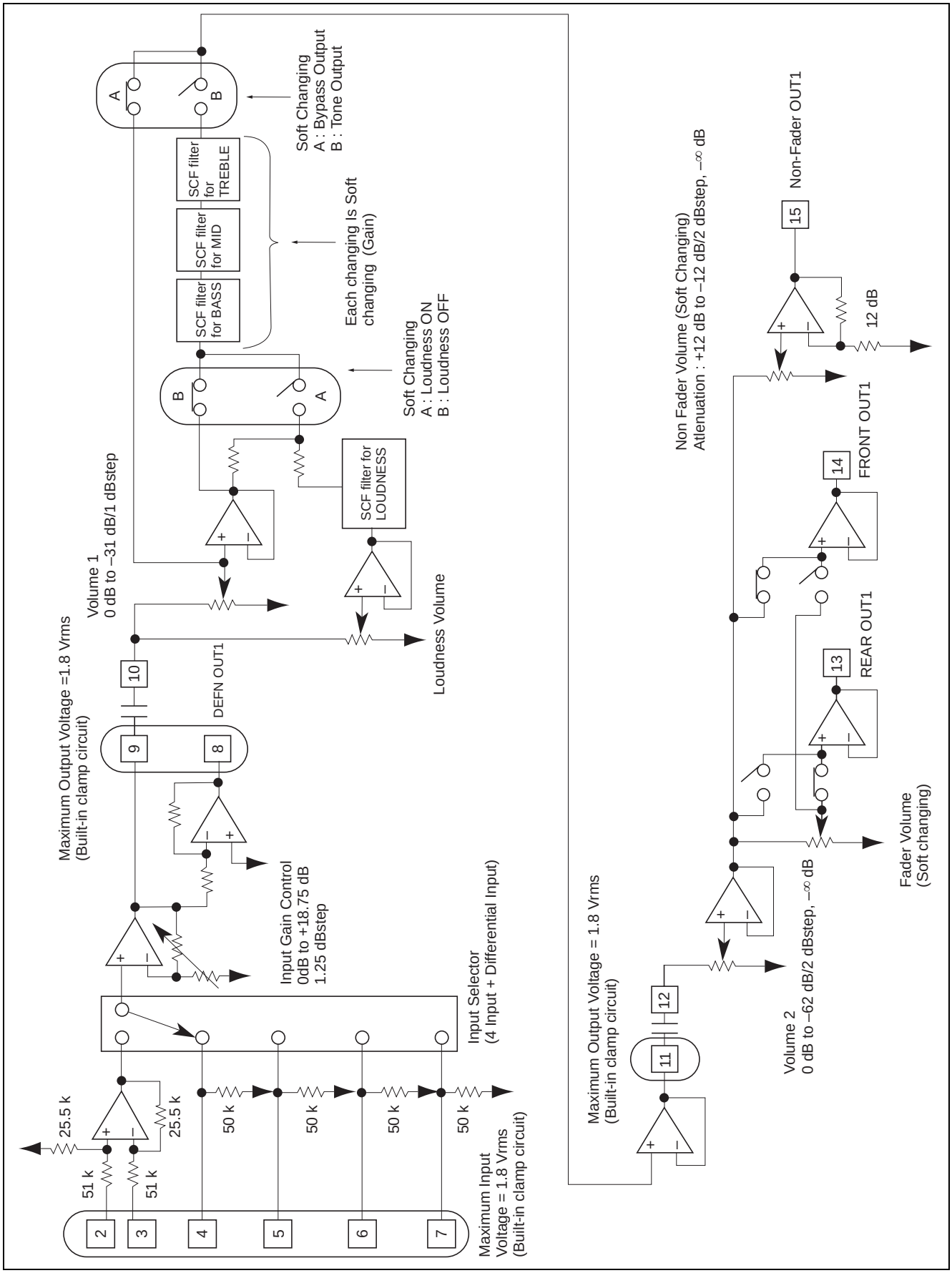
IC Internal Block Diagram



Pin Description

Pin No.	Symbol	Function
1	REF	Signal Ground of IC. Grounding about 10 μF
2	DEFP IN1	Positive Input pin of Differential Amp.
3	DEFN IN1	Negative Input pin of Differential Amp.
4	INA1	Input pin of Channel 1 for Input Selector SW
5	INB1	
6	INC1	
7	IND1	
8	DEFN OUT1	Output pin (–) of Differential Amp.
9	SEL OUT1	Output pin of Input Selector
10	VOL IN1	Input pin of Volume1
11	TONE OUT1	Output pin of Tone
12	FADER IN1	Input pin of Volume2
13	REAR OUT1	Output pin of Fader Volume (rear)
14	FRONT OUT1	Output pin of Fader Volume (front)
15	Non Fader OUT1	Output pin of Non Fader Volume
16	GND	Ground Pin
17	DATA	Input pin of Control Data. It synchronized at CLOCK and inputted Data
18	N.C.	N.C. Pin
19	N.C.	N.C. Pin
20	CLOCK	Clock Input pin for Serial Data Transmission
21	V_{DD}	Digital Power Supply pin
22	Non Fader OUT2	Output pin of Non Fader Volume
23	FRONT OUT2	Output pin of Fader Volume (front)
24	REAR OUT2	Output pin of Fader Volume (rear)
25	FADER IN2	Input pin of Volume2
26	TONE OUT2	Output pin of Tone
27	VOL IN2	Input pin of Volume1
28	SEL OUT2	Output pin of Input Selector
29	DEFN OUT1	Output pin (–) of Differential Amp.
30	IND2	Input pin of Channel 2 for Input Selector SW
31	INC2	
32	INB2	
33	INA2	
34	DEFN IN1	Negative Input pin of Differential Amp.
35	DEFP IN1	Positive Input pin of Differential Amp.
36	V_{CC}	Analog Power Supply pin

Signal Communication Diagram (Channel 1 side only)

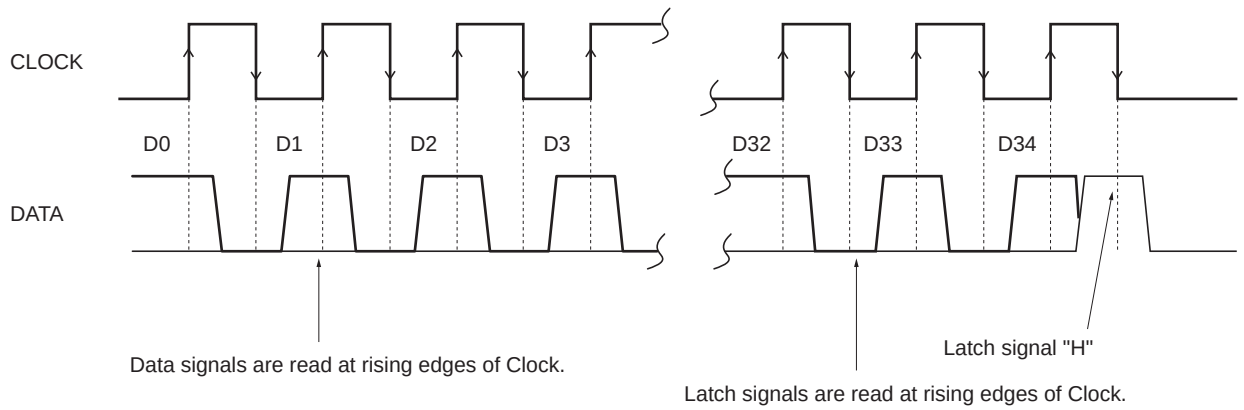


Electrical Characteristics

(Ta = 25 °C, V_{CC} = 8 V, V_{DD} = 5 V, Input Gain/Volume/Tone/fader = 0 dB, Loudness = OFF, unless otherwise noted.)

Item	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Circuit current	I_{CC}	—	—	40	mA	No signal setting
Pass gain	Gv	–2	0	+2	dB	—
Volume maximum Attenuation quantity	A_{TT} (VOL)	—	–90	–80	dB	Vi = 1 Vrms, f = 1 kHz ATT (VOL) = –∞ dB
Crosstalk between Channels	ΔA_{TT} (VOL)	–2	0	+2	dB	ATT (VOL) = 0 dB
Maximum input voltage	V_{IM}	—	—	1.8	Vrms	f = 1 kHz, DIN-AUDIO THD = 1%
Boost quantity (Bass)	G (Bass) B	13	16	19	dB	f = 100 Hz
Cut quantity (Bass)	G (Bass) C	–15	–12	–9	dB	f = 100 Hz
Boost quantity (Mid)	G (MID) B	9	12	15	dB	f = 1 kHz
Cut quantity (Mid)	G (MID) C	–15	–12	–9	dB	f = 1 kHz
Boost quantity (Treble)	G (Tre) B	9	12	15	dB	f = 10 kHz
Cut quantity (Treble)	G (Tre) C	–15	–12	–9	dB	f = 10 kHz
Fader maximum attenuation quantity	A_{TT} (FED)	—	–90	–80	dB	Vi = 1 Vrms, f = 1 kHz, DIN-AUDIO ATT (FED) = –∞ dB
Maximum input voltage	V_{OM}	1.8	—	—	Vrms	f = 1 kHz, DIN-AUDIO THD = 1%
Output noise voltage	Vno 1	—	12	—	μVrms	Rg = 0, DIN-AUDIO
	Vno 2	—	5	—		Bypass setting Rg = 0, DIN-AUDIO
	Vno 3	—	3.5	—		ATT (VOL) = –∞ dB Rg = 0, DIN-AUDIO
Total harmonic distortion	THD	—	0.01	0.05	%	f = 1 kHz, V_0 = 0.5 Vrms BW : 400 Hz to 30 kHz
Channel separation	CS	—	–90	–75	dB	f = 1 kHz, DIN-AUDIO
Input selector crosstalk	CT	—	–75	–60	dB	f = 1 kHz, DIN-AUDIO
Loudness voltage gain	Gv (LOUD)	10	13	16	dB	Loudness ON, f = 100 Hz VOL1 = –30 dB, VOL2 = 0 dB LOUD_VOL = –20 dB
Input gain control	Gv (GAIN)	15.75	18.75	21.75	dB	Gv (GAIN) = +18.75 dB
Common mode rejection ratio	CMRR	—	50	—	dB	2, 3 pin/34, 35 pin Common mode signal input setting

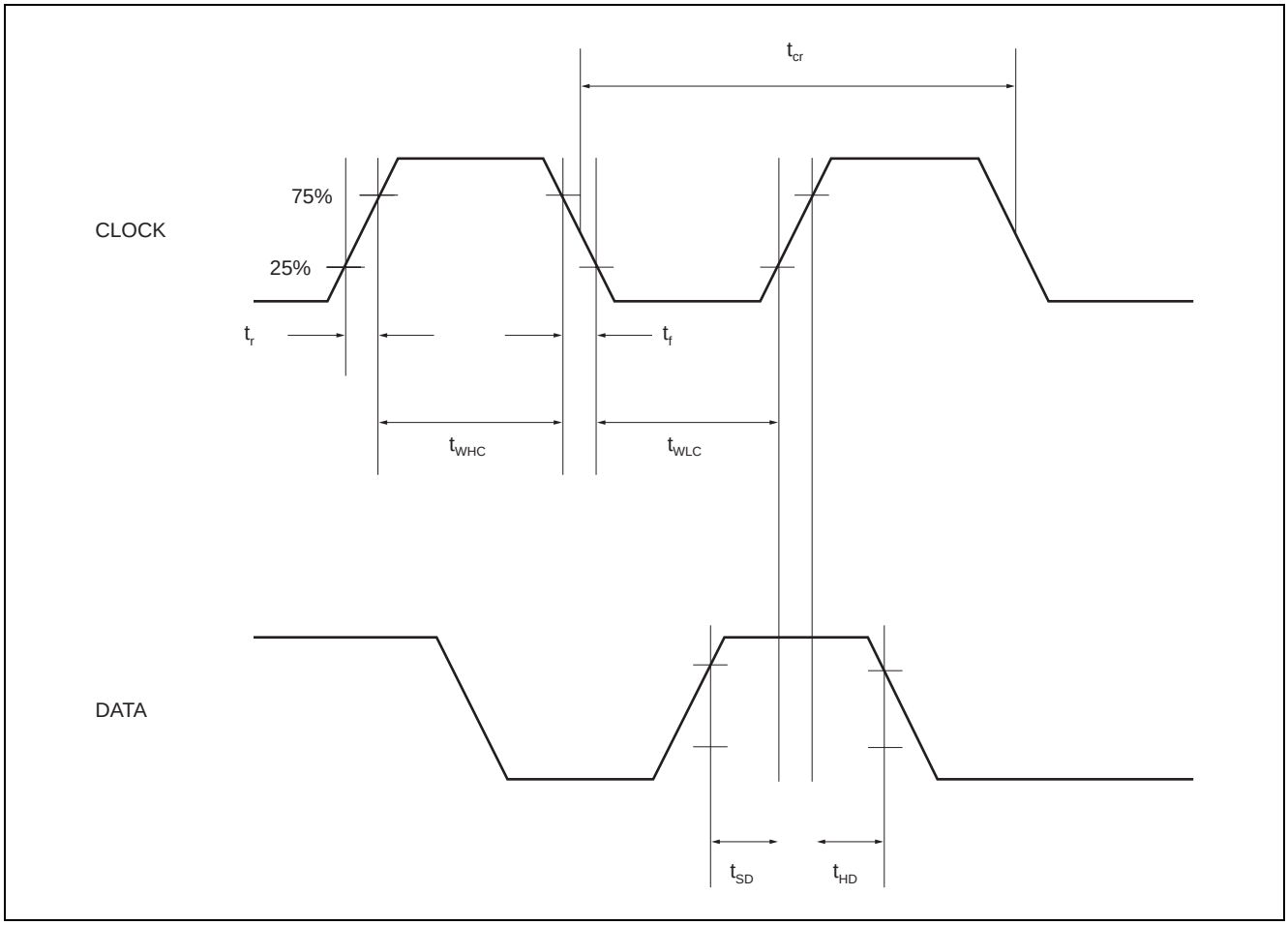
Connection of Data and Clock



Digital Block Direct Current Characteristic

Item	Symbol	Limits			Unit	Test Conditions	
		Min	Typ	Max			
"L" Level Input Voltage	V_{IL}	0	∿	1.0	V	V_{DD} = 5 V setting	
"H" Level Input Voltage	V_{IH}	4.0	∿	5.0		DATA, CLOCK Pin	
"L" Level Input Electric Current	I_{IL}	–10	—	10	μA	V = 0 V	DATA, CLOCK Pin
"H" Level Input Electric Current	I_{IH}	—	—	10		V = 5 V	

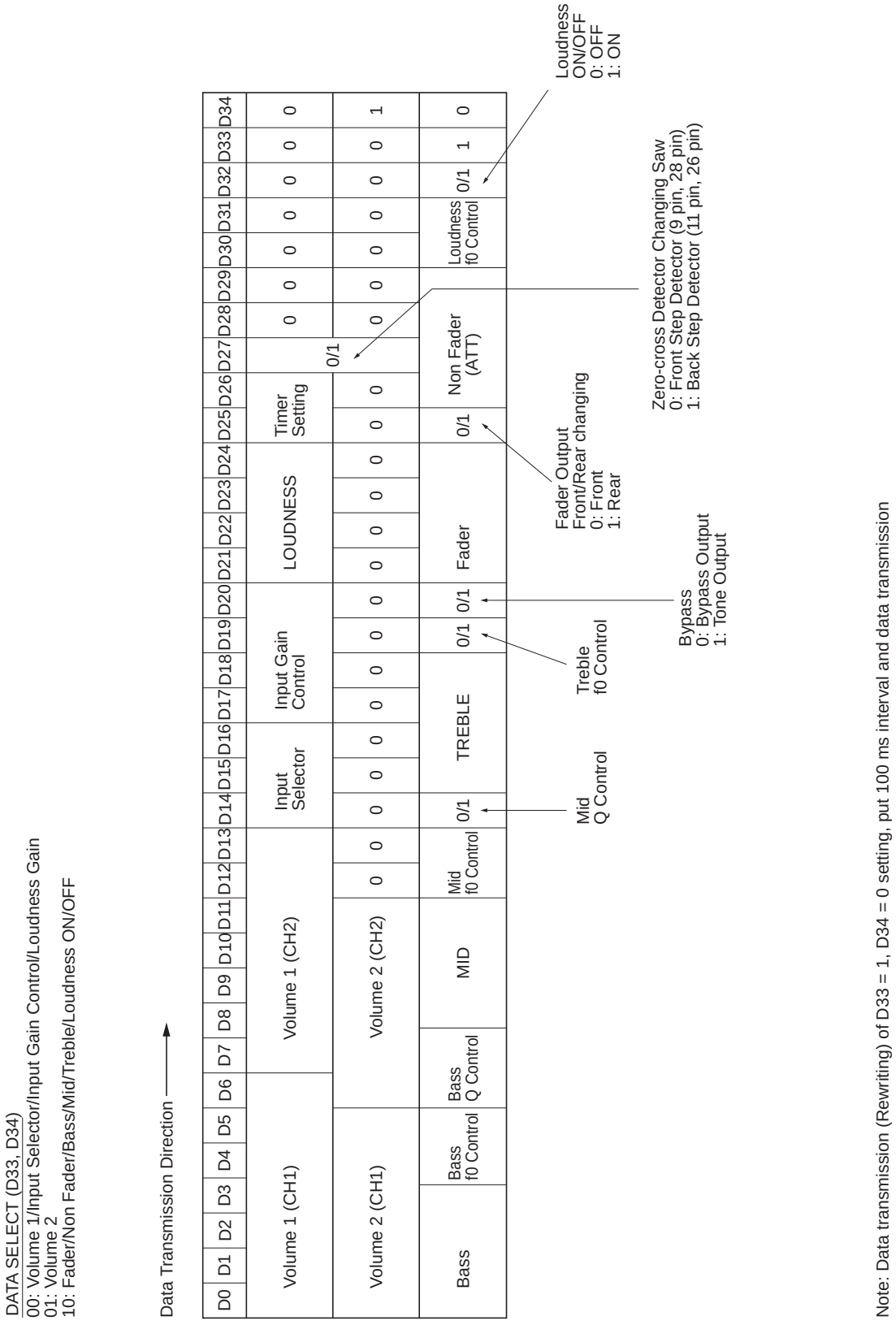
Clock and Data Timing



Digital Block Alternating Current Characteristic

Item	Symbol	Limits			Unit
		Min	Typ	Max	
CLOCK Cycle Time	t_{cr}	4	—	—	µs
CLOCK Pulse Width ("H" level)	t_{WHC}	1.6	—	—	
CLOCK Pulse Width ("L" level)	t_{WLC}	1.6	—	—	
CLOCK Rise Time	t_r	—	—	0.4	
CLOCK Hall Time	t_f	—	—	0.4	
DATA Setup Time	t_{SD}	0.8	—	—	
DATA Hold Time	t_{HD}	0.8	—	—	

Data Input Format



Volume 1 Code

ATTVA1	CH1 / CH2	D0 / D7	D1 / D8	D2 / D9	D3 / D10	D4 / D11
0 dB		0	0	0	0	1
–1 dB		1	1	1	1	0
–2 dB		0	1	1	1	0
–3 dB		1	0	1	1	0
–4 dB		0	0	1	1	0
–5 dB		1	1	0	1	0
–6 dB		0	1	0	1	0
–7 dB		1	0	0	1	0
–8 dB		0	0	0	1	0
–9 dB		1	1	1	0	0
–10 dB		0	1	1	0	0
–11 dB		1	0	1	0	0
–12 dB		0	0	1	0	0
–16 dB		1	1	0	0	0
–20 dB		0	1	0	0	0
–24 dB		1	0	0	0	0
–28 dB		0	0	0	0	0

ATTVA2	CH1 / CH2	D5 / D12	D6 / D13
0 dB		1	1
–1 dB		0	1
–2 dB		1	0
–3 dB		0	0

ATTVA2 fixed to 0 dB
when 0 dB to –12 dB setting.

Volume 2 Code

ATTVB1	CH1 / CH2	D0 / D6	D1 / D7	D2 / D8	D3 / D9
0 dB		0	1	1	1
–2 dB		1	0	1	1
–4 dB		0	0	1	1
–6 dB		1	1	0	1
–8 dB		0	1	0	1
–10 dB		1	0	0	1
–12 dB		0	0	0	1
–14 dB		1	1	1	0
–16 dB		0	1	1	0
–24 dB		1	0	1	0
–32 dB		0	0	1	0
–40 dB		1	1	0	0
–48 dB		0	1	0	0
–56 dB		1	0	0	0
–∞ dB		0	0	0	0

ATTVB2	CH1 / CH2	D4 / D10	D5 / D11
0 dB		1	1
–2 dB		0	1
–4 dB		1	0
–6 dB		0	0

ATTVB2 fixed to 0 dB
when 0 dB to –16 dB setting.

Timer Setting Code

Timer	D25	D26
5 ms	1	1
10 ms	0	1
15 ms	1	0
20 ms	0	0

Tone Code

Mid	D8	D9	D10	D11
Treble	D15	D16	D17	D18
12 dB	0	1	1	0
10 dB	1	0	1	0
8 dB	0	0	1	0
6 dB	1	1	0	0
4 dB	0	1	0	0
2 dB	1	0	0	0
0 dB	0	0	0	0/1
–2 dB	1	0	0	1
–4 dB	0	1	0	1
–6 dB	1	1	0	1
–8 dB	0	0	1	1
–10 dB	1	0	1	1
–12 dB	0	1	1	1

Bass	D0	D1	D2	D3
16 dB	0	0	0	1
14 dB	1	1	1	0
12 dB	0	1	1	0
10 dB	1	0	1	0
8 dB	0	0	1	0
6 dB	1	1	0	0
4 dB	0	1	0	0
2 dB	1	0	0	0
0 dB	0	0	0	0
–2 dB	1	0	0	1
–4 dB	0	1	0	1
–6 dB	1	1	0	1
–8 dB	0	0	1	1
–10 dB	1	0	1	1
–12 dB	0	1	1	1

Loudness Volume Code

Loudness	D21	D22	D23	D24
–2 dB	1	1	1	1
–4 dB	0	1	1	1
–6 dB	1	0	1	1
–8 dB	0	0	1	1
–10 dB	1	1	0	1
–12 dB	0	1	0	1
–14 dB	1	0	0	1
–16 dB	0	0	0	1
–18 dB	1	1	1	0
–20 dB	0	1	1	0
–22 dB	1	0	1	0
–24 dB	0	0	1	0
–26 dB	1	1	0	0
–28 dB	0	1	0	0
–30 dB	1	0	0	0
–∞ dB	0	0	0	0

Please refer to 21, 22 page for Loudness gain setting.

Loudness f0 Control

Loudness f0 Control	D30	D31
f0 = 60 Hz	1	1
f0 = 80 Hz	0	1
f0 = 100 Hz	1	0

Tone f0, Q Control Code

Bass f0 Control	D4	D5
f0 = 50 Hz	1	1
f0 = 80 Hz	0	1
f0 = 120 Hz	1	0

Mid f0 Control	D12	D13
f0 = 700 Hz	1	1
f0 = 1 kHz	0	1
f0 = 2 kHz	1	0
f0 = 10 kHz	0	0

Treble f0 Control	D19
f0 = 8 kHz	1
f0 = 12 kHz	0

Bass Q Control	D6	D7
Q = 2	1	1
Q = 1.5	0	1
Q = 1.25	1	0
Q = 1	0	0

Mid Q Control	D14
Q = 1.5	1
Q = 2	0

Selector Code

Selector	D14	D15	D16
INA	0	0	1
INB	1	1	0
INC	0	1	0
IND	1	0	0
Differential Input	0	0	0

Non Fader Code

ATT	D26	D27	D28	D29
+12 dB	1	0	1	1
+10 dB	0	0	1	1
+8 dB	1	1	0	1
+6 dB	0	1	0	1
+4 dB	1	0	0	1
+2 dB	0	0	0	1
0 dB	1	1	1	0
–2 dB	0	1	1	0
–4 dB	1	0	1	0
–6 dB	0	0	1	0
–8 dB	1	1	0	0
–10 dB	0	1	0	0
–12 dB	1	0	0	0
–∞ dB	0	0	0	0

Input Gain Control Code

Input Gain Control	D17	D18	D19	D20
0 dB	1	1	1	1
1.25 dB	0	1	1	1
2.50 dB	1	0	1	1
3.75 dB	0	0	1	1
5.00 dB	1	1	0	1
6.25 dB	0	1	0	1
7.50 dB	1	0	0	1
8.75 dB	0	0	0	1
10.00 dB	1	1	1	0
11.25 dB	0	1	1	0
12.50 dB	1	0	1	0
13.75 dB	0	0	1	0
15.00 dB	1	1	0	0
16.25 dB	0	1	0	0
17.50 dB	1	0	0	0
18.75 dB	0	0	0	0

Fader Code

Fader	D21	D22	D23	D24
0 dB	1	1	1	1
–1 dB	0	1	1	1
–2 dB	1	0	1	1
–3 dB	0	0	1	1
–4 dB	1	1	0	1
–6 dB	0	1	0	1
–8 dB	1	0	0	1
–10 dB	0	0	0	1
–12 dB	1	1	1	0
–14 dB	0	1	1	0
–16 dB	1	0	1	0
–20 dB	0	0	1	0
–30 dB	1	1	0	0
–45 dB	0	1	0	0
–60 dB	1	0	0	0
–∞ dB	0	0	0	0

Loudness, Tone Control Frequency Characteristic

Figure 1 Loudness Frequency Characteristic

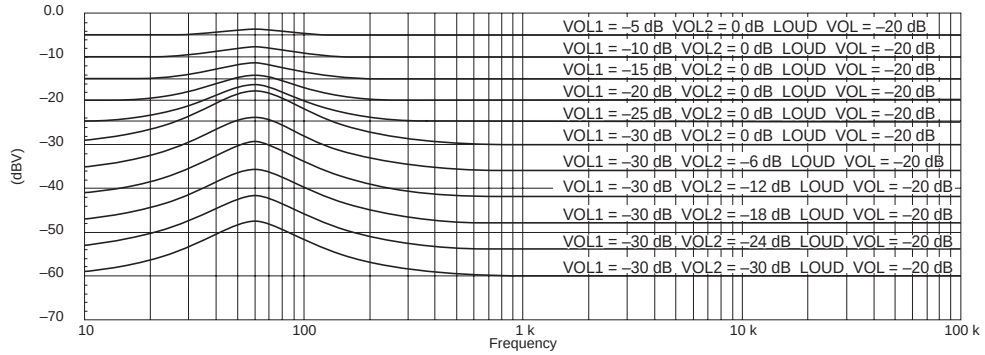


Figure 2 Loudness Frequency Characteristic (VOL = –30 dB, Loudness = –20 dB, f0 = Variable)

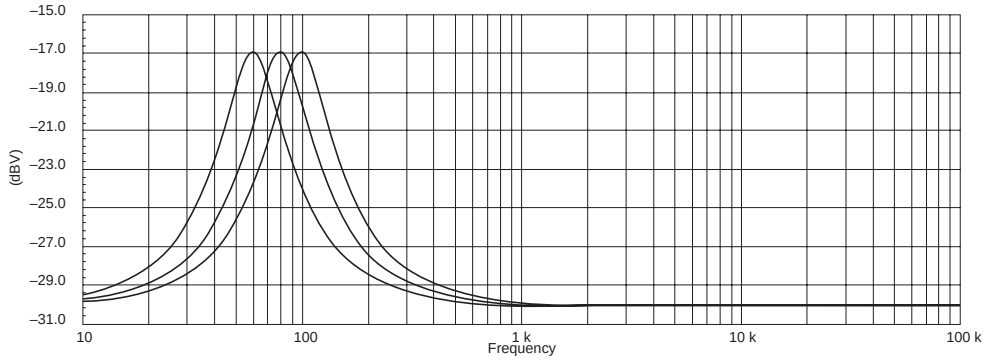


Figure 3 Bass Frequency Characteristic (f0 = 50 Hz, Q = 2, Gv = Variable)

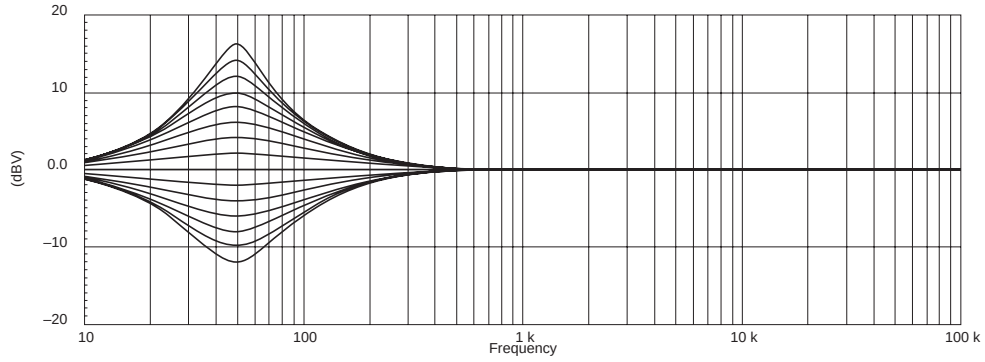


Figure 4 Bass Frequency Characteristic (Gv = +16 dB, f0 = Variable, Q = 2)

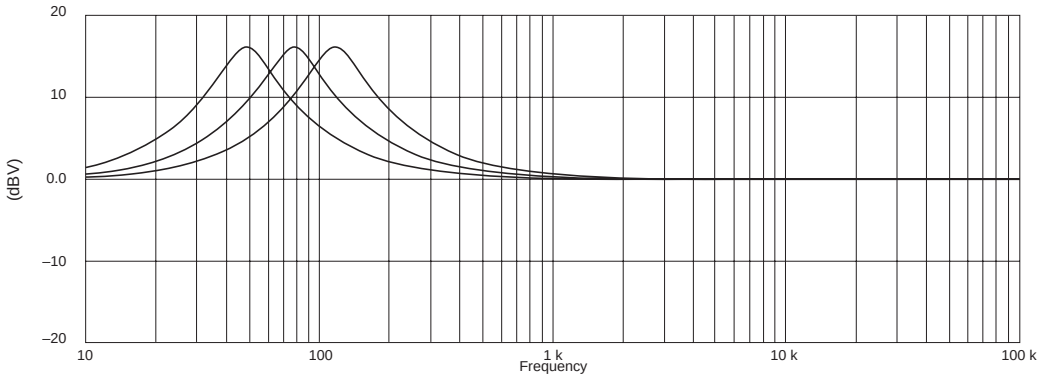


Figure 5 Bass Frequency Characteristic (Gv = +16 dB, Q = Variable, f0 = 50 Hz)

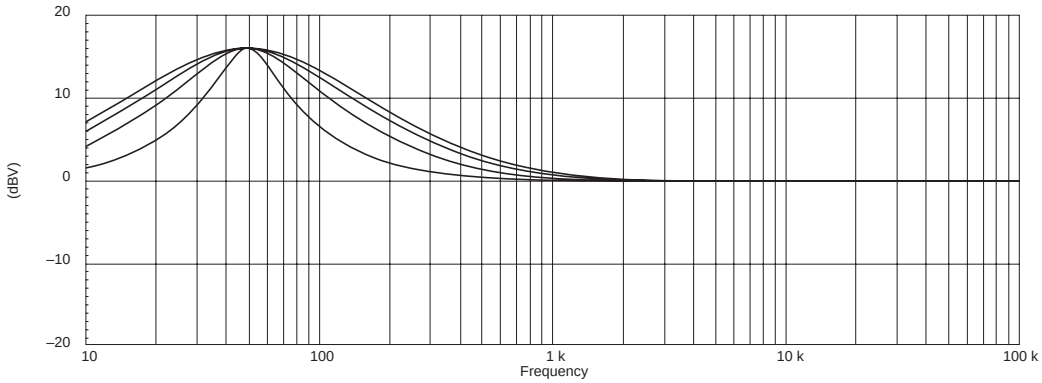


Figure 6 Mid Frequency Characteristic (f0 = 1 kHz, Q = 2, Gv = Variable)

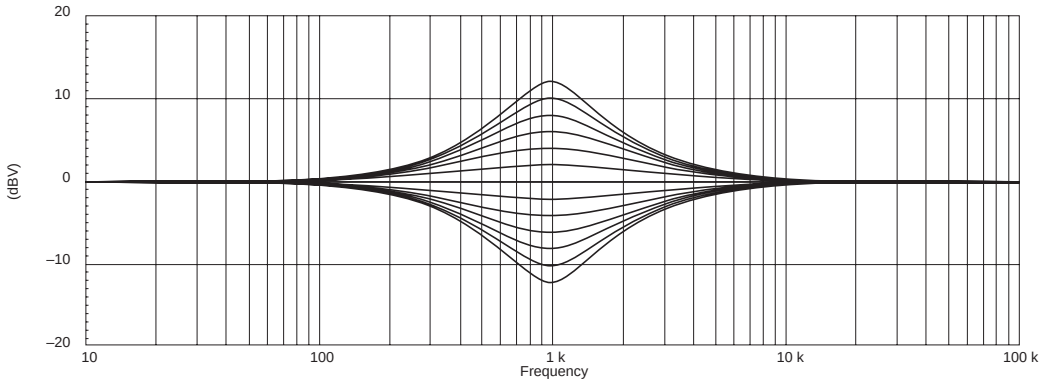


Figure 7 Mid Frequency Characteristic (Gv = +12 dB, Q = 2, f0 = Variable)

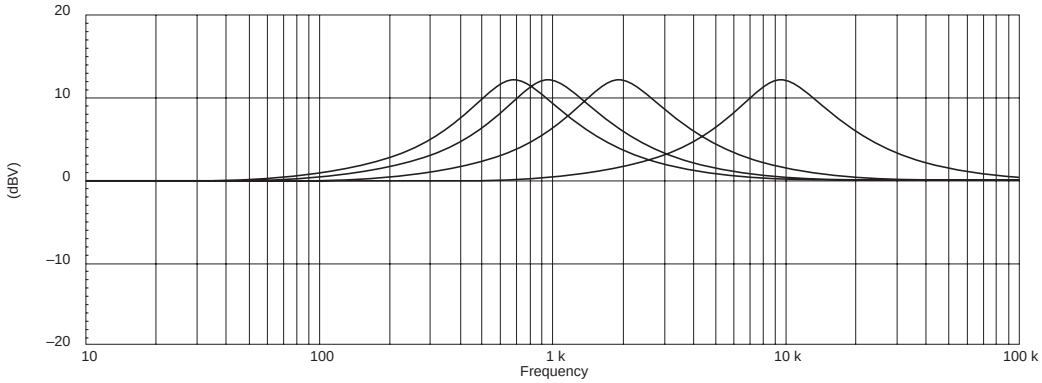


Figure 8 Mid Frequency Characteristic (Gv = +12 dB, f0 = 1 kHz, Q = Variable)

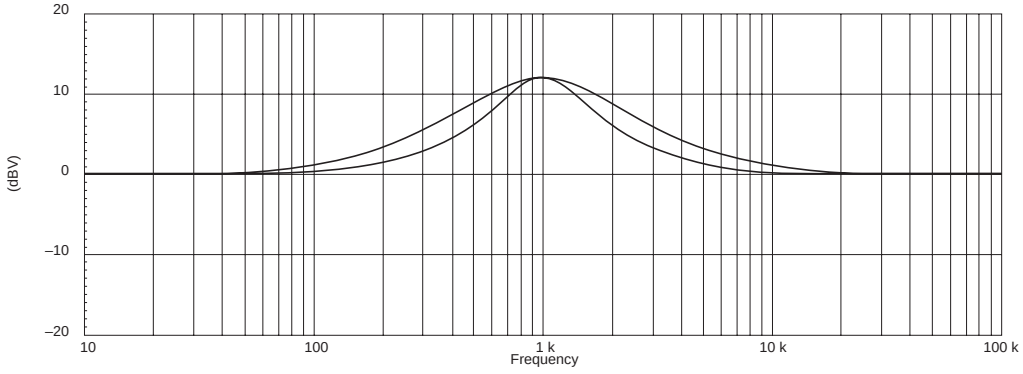


Figure 9 Treble Frequency Characteristic (Gv = Variable)

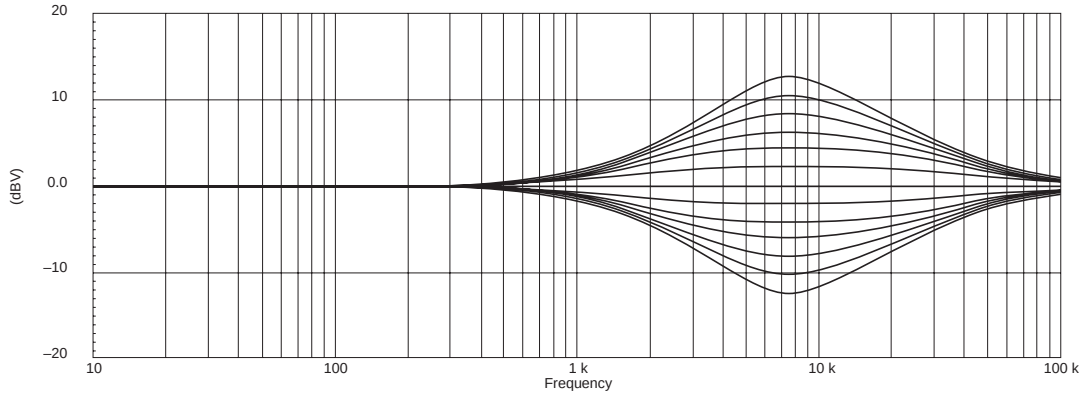
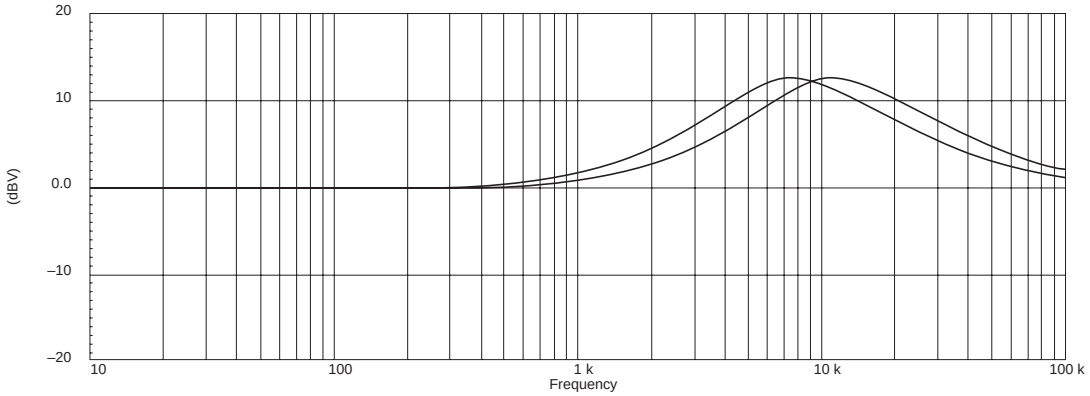


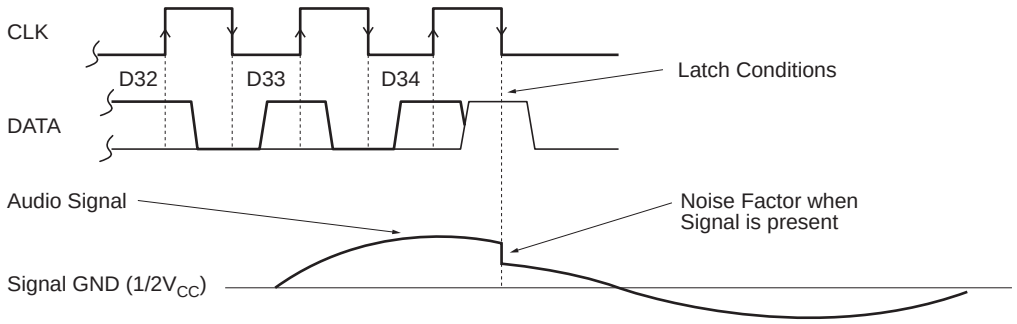
Figure 10 Treble Frequency Characteristic (Gv = +12 dB, f0 = Variable)



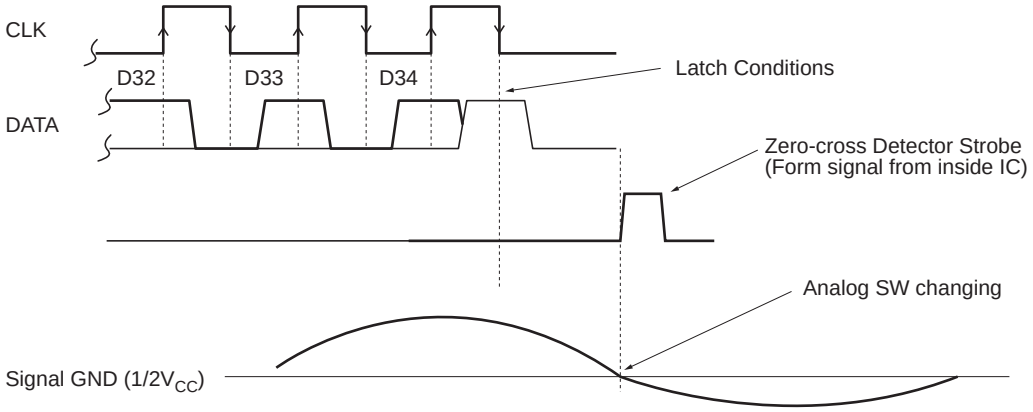
Zero-Crossing Detection Circuit

1. Meaning of Zero-Crossing Detection Circuit

In the conventional Serial Data Control Type Volume, Analog SW inside switches over simultaneously with Latch Condition Detector. And the operation completes.



In this case the changing noise occurs at the time of Latch Condition Detector, the Analog SW switches over (Zero-cross Detector Strobe occurs) in the moment that the Analog Signal cross Signal Ground (1/2V_{CC}).



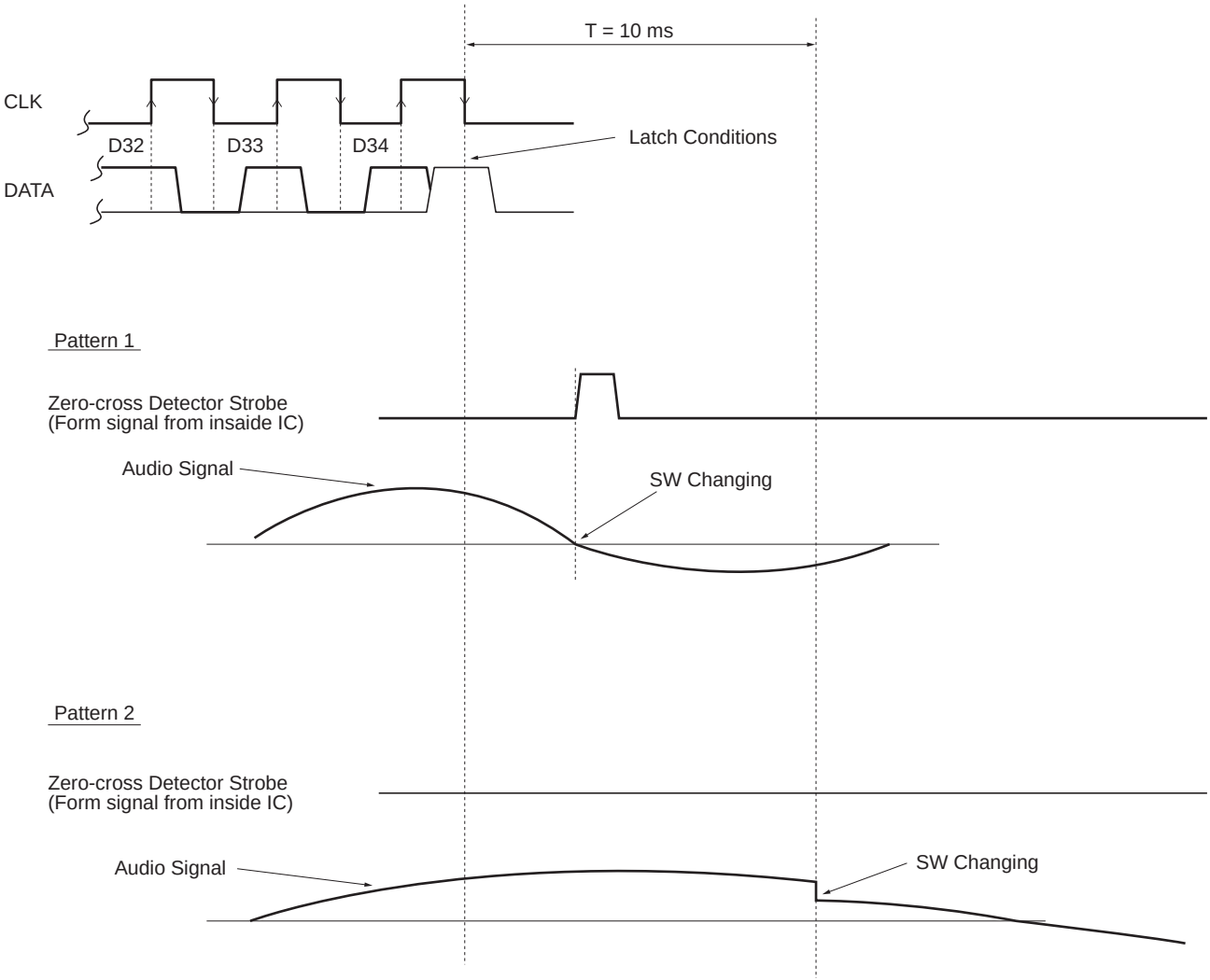
Other, In the case of Audio Signal isn't inputted (No signal), even if only Zero-cross Detector Circuit detects Latch Condition, Analog SW doesn't switch over for the Audio Signal never cuts Signal Ground (1/2V_{CC}).

The Time Function switches the Analog SW after some time T.

The Timer Time can setting with the Serial Data of 5 ms, 10 ms, 15 ms, 20 ms.

2. Connection of Zero-Crossing Detector and Timer Setting

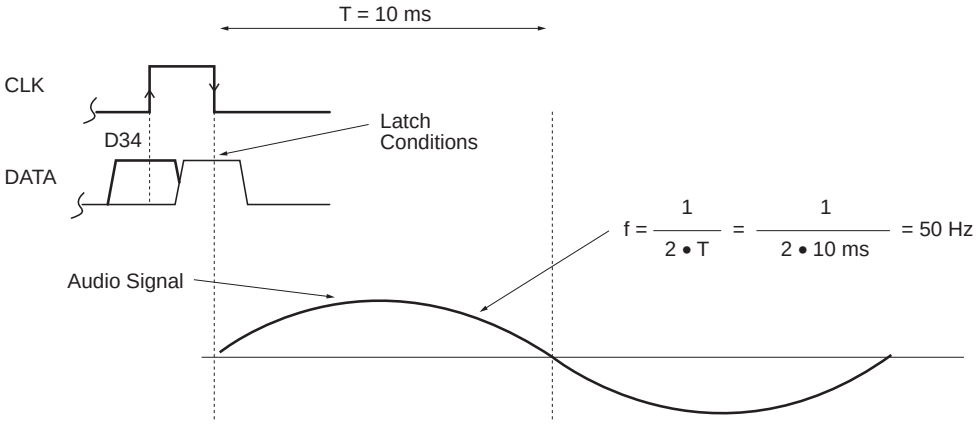
"OR" of [Zero-cross Detector Strobe] or [Compulsion SW of Timer Circuit] moves Internal Analog SW. When for example, suppose that it set to T = 10 ms.



In case of Pattern 1, the Zero-cross Detector Strobe occurs with the Zero-cross Detector Function, and SW is switched. But in case of Pattern 2, the Timer Function switches the Analog SW after T = 10 ms, for the Audio Input Signal didn't cut the Signal Ground after T = 10 ms which were set with the timer.

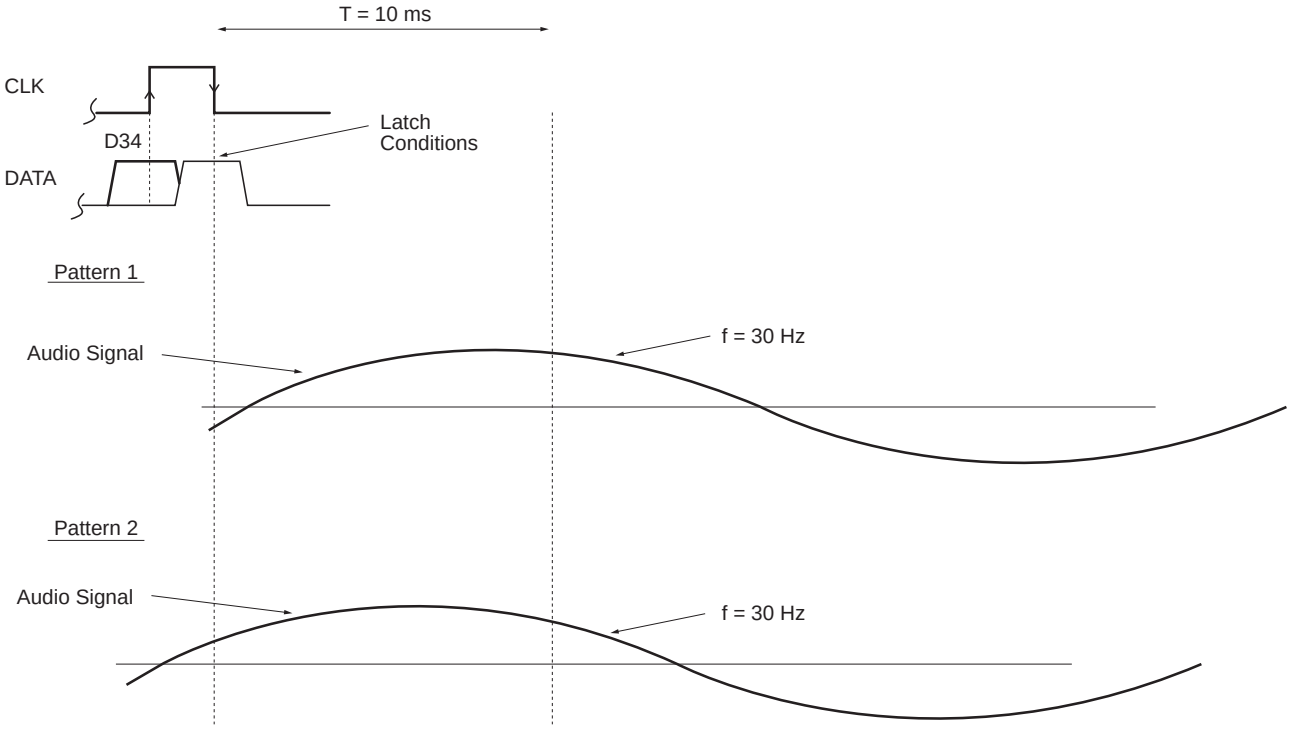
Timer Setting Time setting for Frequency band of Input Audio Signal.

3. Timer Setting System



In case of Timer Setting Time/T = 10 ms setting

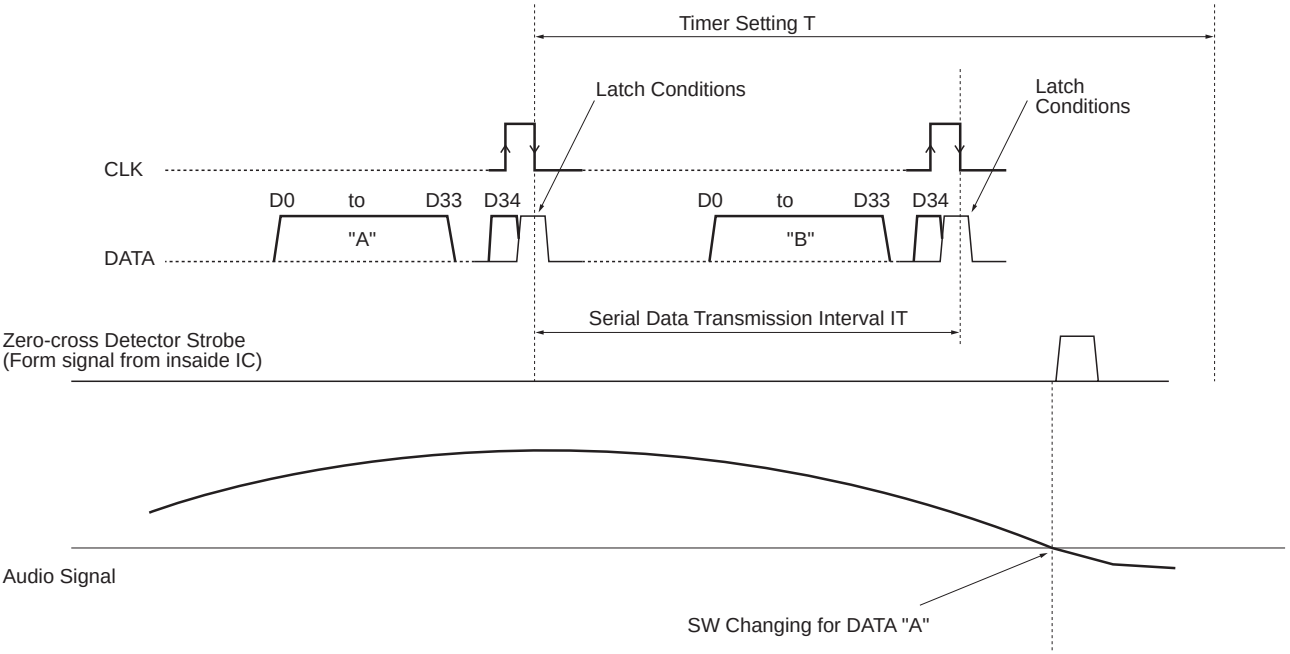
Audio Signal	Zero-cross Detector	
50 Hz <	100%	Upper fig.
50 Hz >	100%	Pattern 1
	0%	Pattern 2



The Timer Setting Time T makes T = 20 ms (Zero-cross detect of 25 Hz is 100%) maximum and it is setting by it.

4. Connection of Data Transmission and Timer Setting

M61508FP has the function to make the Serial Data invalid until it generation the Zero-cross Detector Strobe in IC, after the Latch Condition detected.



* In case of upper figurative. The order of DATA "B" is invalid.

In to make the Serial Data Transmission Interval IT from MCU (microcomputer) to M61508FP

Serial Data Transmission Interval = IT > Timer Setting = T

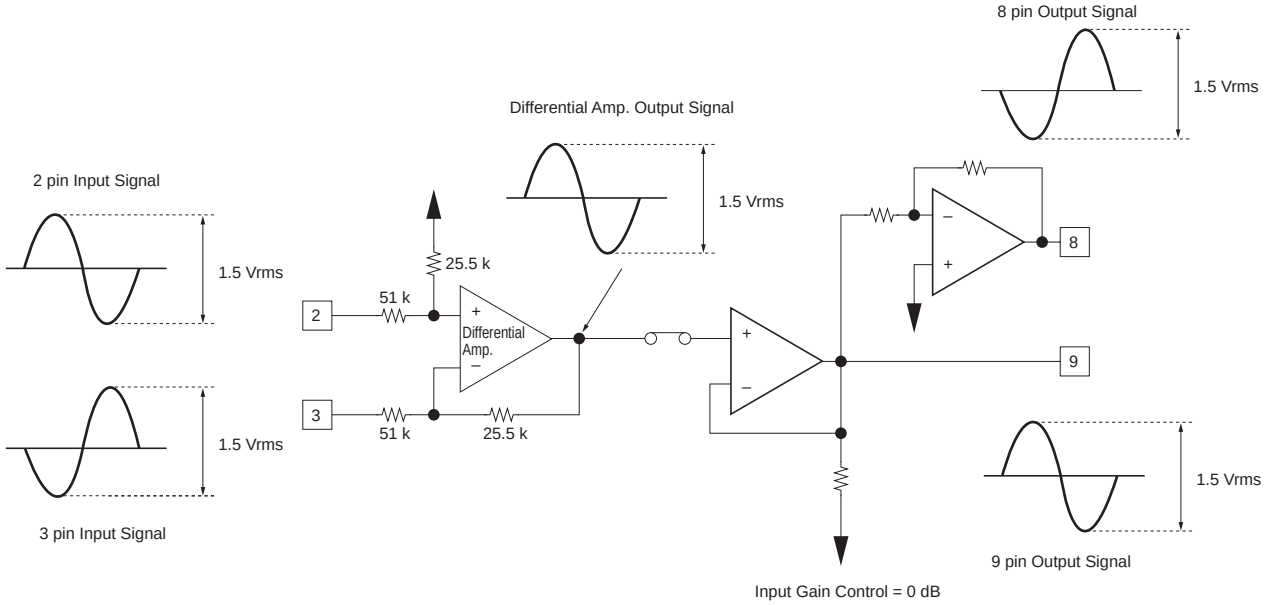
the reading error of the data doesn't occur.

* Serial Data Transmission Interval IT = Interval of between Latch Condition and Latch Condition

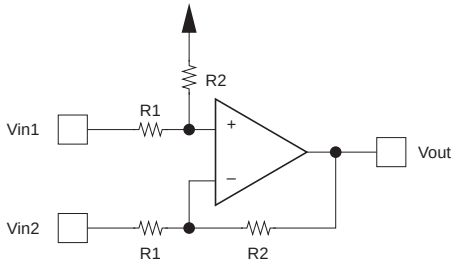
The Others

1. Differential Amp.

The lower fig. is Equalizing Circuit, Output Signal/Output Voltage of each point.



● Differential Amp. Gain Calculation Formula

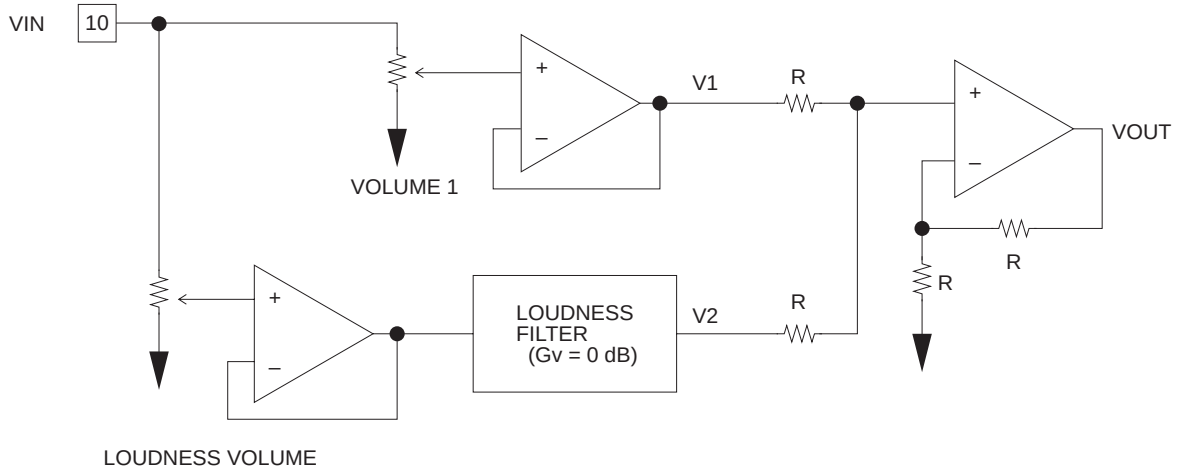


$$V_{out} = \frac{R2}{R1}(Vin1 - Vin2)$$

$$Gv = 20 \log \frac{R2}{R1}$$

2. Loudness Gain Setting

Lower Figure is Structure of Loudness Circuit.



Output Voltage (VOUT) of Setting Structure of Upper Figure

It is noted as Volume 1 Output Voltage = V1, Loudness Filter Output Voltage = V2, VOUT and Gv (Boost quantity) is given at the lower formula

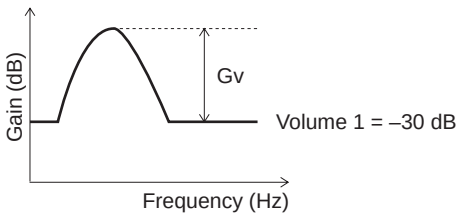
$$VOUT = V1 + V2 \text{ (Vrms)}$$

$$Gv = 20 \log \frac{(V1 + V2)}{VIN} - \text{(Volume 1 attenuation quantity) (dB)}$$

ex.) VIN = 1 Vrms/60 Hz, Volume1 = –30 dB,
Output Volutage and Boost Quantity of 60 Hz of Loudness Volume = –20 dB setting

From: Volume1, Loudness Volume attenuation quantity
Become: V1 = 31.6 mVrms
V2 = 100 mVrms

If the sub situdes the equation for the upper formula,
the following equation is given,



$$VOUT = 31.6\text{ m} + 100\text{ m}$$

$$= 131.6 \text{ mVrms}$$

$$Gv = 20 \log \frac{(31.6\text{ m} + 100\text{ m})}{1} - (-30 \text{ dB})$$

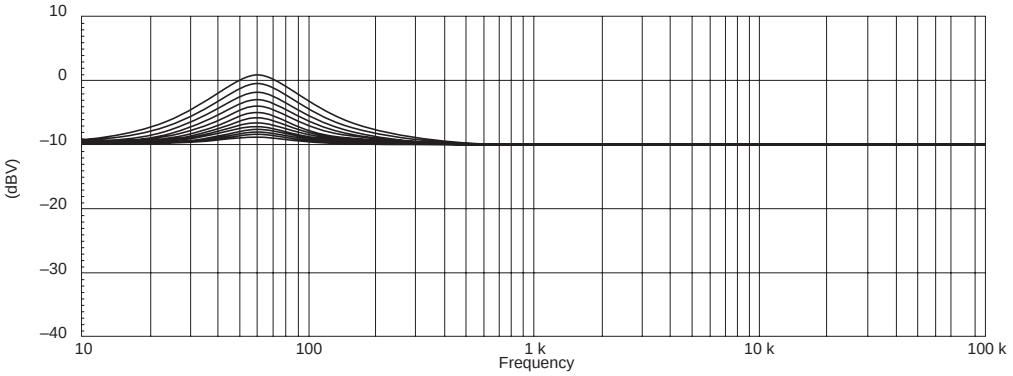
=12.4 dB is obtained

In the item, the Loudness Gain Setting example is shown, when Volume 1 fixation and doing the Loudness Volume variably. Please refer to Plan.

Loudness Gain Setting Example

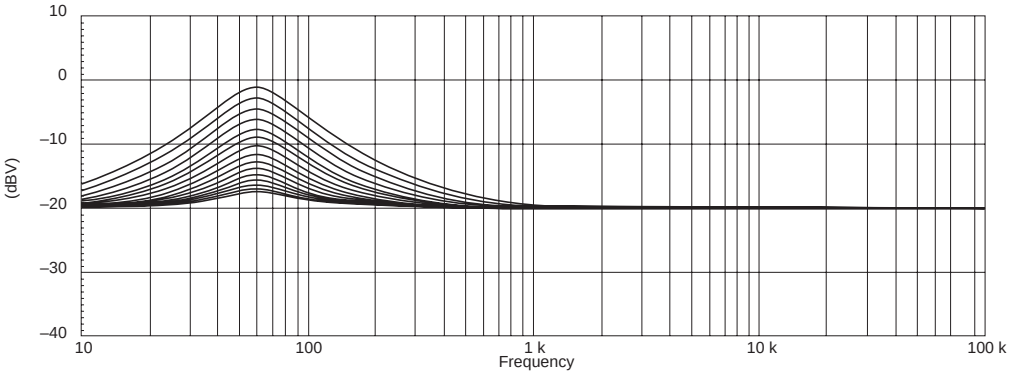
1. Volume 1 = –10 dB

Loudness Volume	Loudness Gain
–2 dB	10.9 dB
–4 dB	9.5 dB
–6 dB	8.2 dB
–8 dB	7.1 dB
–10 dB	6.0 dB
–12 dB	5.1 dB
–14 dB	4.2 dB
–16 dB	3.5 dB
–18 dB	2.9 dB
–20 dB	2.4 dB
–22 dB	1.9 dB
–24 dB	1.6 dB
–26 dB	1.3 dB
–28 dB	1.0 dB
–30 dB	0.8 dB
–∞ dB	0 dB



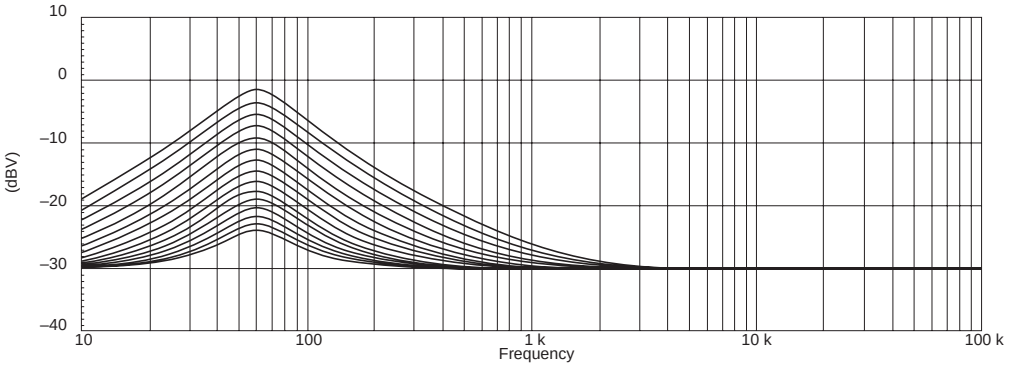
2. Volume 1 = –20 dB

Loudness Volume	Loudnes s Gain
–2 dB	19.0 dB
–4 dB	17.3 dB
–6 dB	15.6 dB
–8 dB	13.9 dB
–10 dB	12.4 dB
–12 dB	10.9 dB
–14 dB	9.5 dB
–16 dB	8.2 dB
–18 dB	7.1 dB
–20 dB	6.0 dB
–22 dB	5.1 dB
–24 dB	4.2 dB
–26 dB	3.5 dB
–28 dB	2.9 dB
–30 dB	2.4 dB
–∞ dB	0 dB



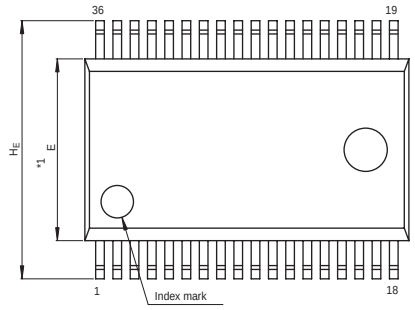
3. Volume 1 = –30dB

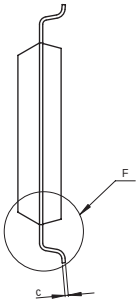
Loudness Volume	Loudness Gain
–2 dB	28.3 dB
–4 dB	26.4 dB
–6 dB	24.5 dB
–8 dB	22.7 dB
–10 dB	20.8 dB
–12 dB	19.0 dB
–14 dB	17.3 dB
–16 dB	15.6 dB
–18 dB	13.9 dB
–20 dB	12.4 dB
–22 dB	10.9 dB
–24 dB	9.5 dB
–26 dB	8.2 dB
–28 dB	7.1 dB
–30 dB	6.0 dB
–∞dB	0 dB

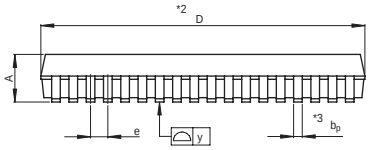


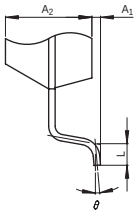
Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SSOP36-8.4x15-0.80	PRSP0036GA-A	36P2R-A	0.5g









Detail F

NOTE)
1. DIMENSIONS "*1" AND "*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION "*3" DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	14.8	15.0	15.2
E	8.2	8.4	8.6
A_2	—	2.0	—
A	—	—	2.4
A_1	0.05	—	—
b_p	0.35	0.4	0.5
c	0.13	0.15	0.2
θ	0°	—	10°
H_E	11.63	11.93	12.23
e	0.65	0.8	0.95
y	—	—	0.15
L	0.3	0.5	0.7

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Colophon .7.2