

M61516FP

7.1ch Electronic Volume with 10 Input Selector

REJ03F0204-0201

Rev.2.01

Mar 31, 2008

Application

Receiver, AV Amp, Mini Stereo etc.

Feature

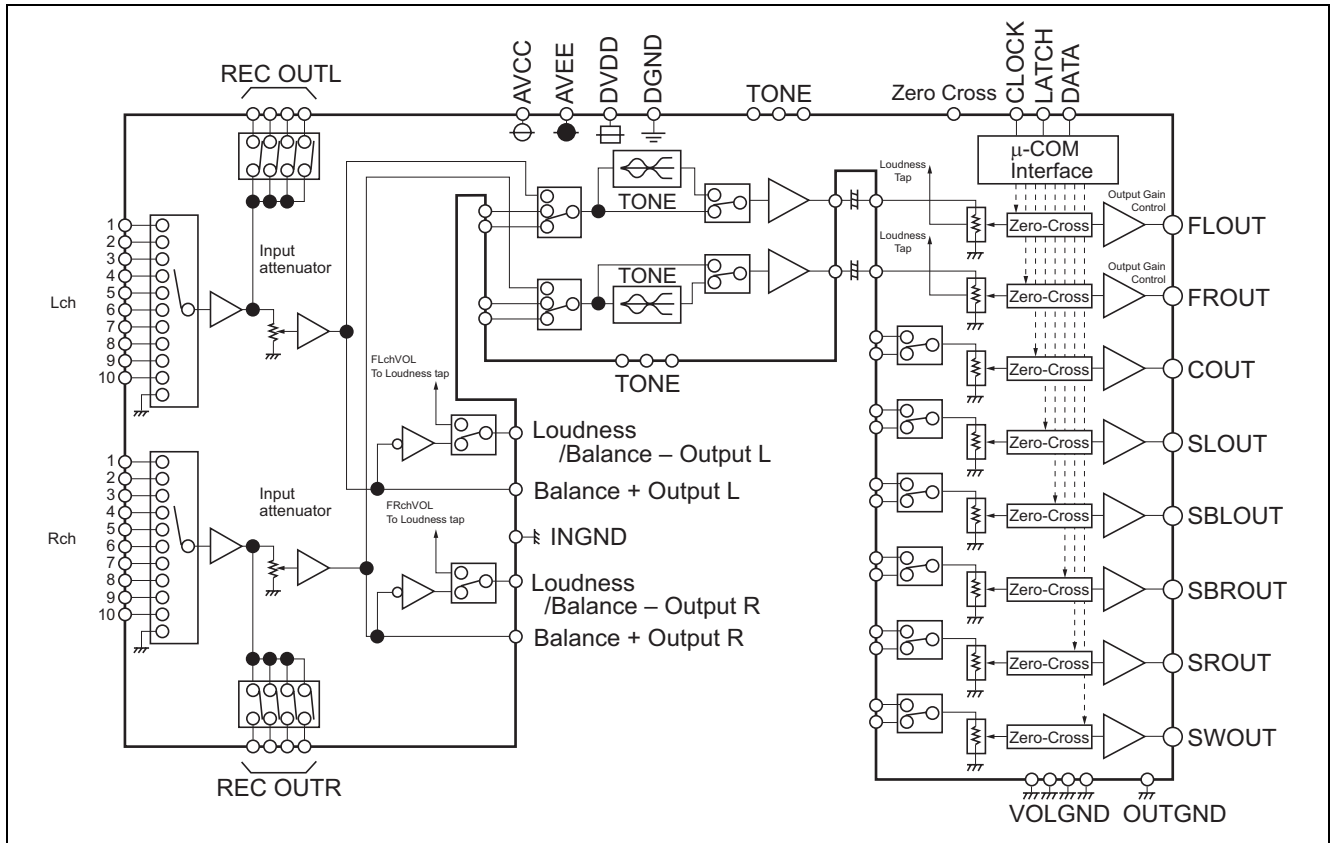
- Electronic volume
 - (1) 8 channel Independent Electronic Volume with High Voltage Transistor. (0 ~ -92 dB/1 dB step, -95, -∞ dB)
 - (2) Built-in Zero-Crossing Detector Circuit for reduce click noise at changing volume value.
- Tone control
 - (1) Bass/Treble, 0 to ±10 dB/2 dB step
 - (2) Add a Bypass Model/Tone Mode changing SW
- Input selector
 - (1) Front L/R channel 10 Input Selector
 - (2) 2 sets of multi channel input
- REC output
4 Lines REC Output (Both L and R channels)
- Input attenuator
0/-3/-6/-9/-12 dB
- Output gain control
0/+3/+6/+9/+12 dB
- Balance out
Built-in Balance out (for ADC)
- Loudness *¹
Built-in Loudness circuit of center tap type in FL/FRch

Note: 1. Balance output and loudness function can't be used at the same time.

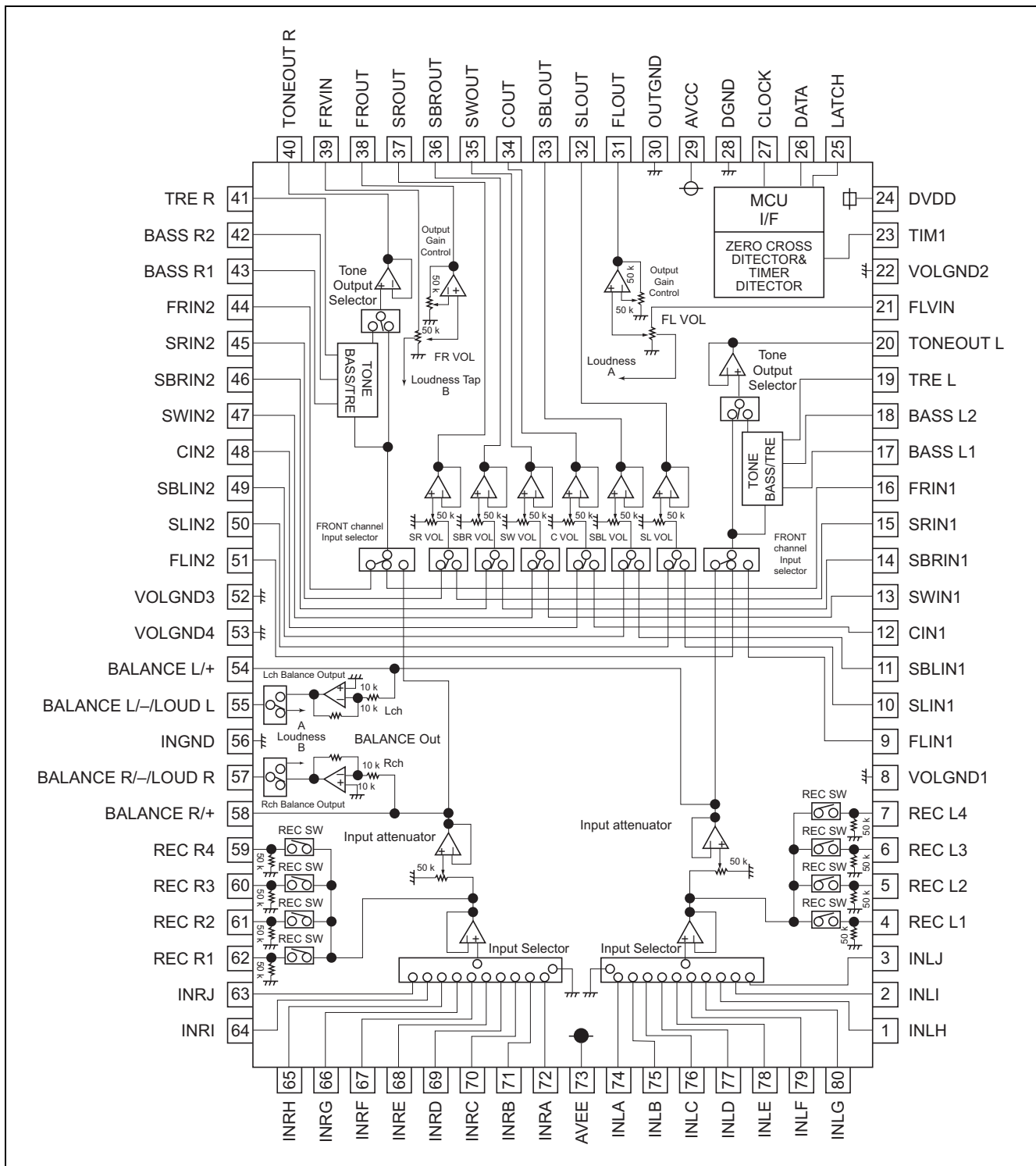
Recommended Operating Condition

Supply voltage range: AVCC = 7.0 V (Typ), AVEE = -7.0 V (Typ), DVDD = 5.0 V (Typ)

System Block Diagram



Block Diagram and Pin Configuration (Top View)

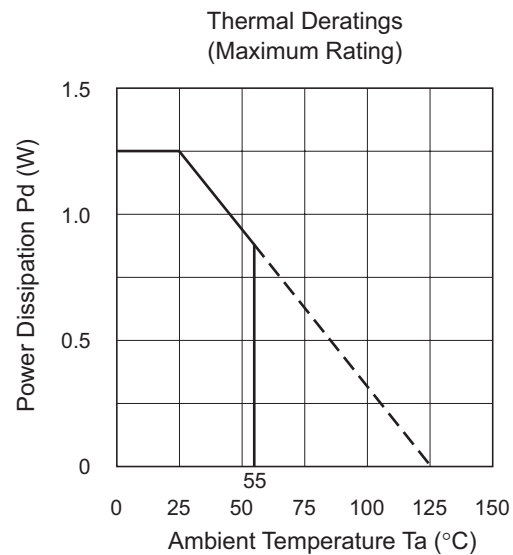


Pin Description

Pin No.	Name	Function
74, 75, 76, 77, 78, 79, 80, 1, 2, 3	INLA, B, C, D, E, F, G, H, I, J	Input pin of L channel (10 Input Selector)
4, 5, 6, 7, 59, 60, 61, 62	REC L1, L2, L3, L4 REC R1, R2, R3, R4	Output pin of REC (Lch and Rch)
8, 22, 52, 53	VOLGND 1, 2, 3, 4	Analog Ground (for 8ch Volume)
9, 51	FLIN1/FLIN2	Input pin of FL channel (2 Input Selector)
10, 50	SLIN1/SLIN2	Input pin of SL channel (2 Input Selector)
11, 49	SBLIN1/SBLIN2	Input pin of SBL channel (2 Input Selector)
12, 48	CIN1/CIN2	Input pin of C channel (2 Input Selector)
13, 47	SWIN1/SWIN2	Input pin of SW channel (2 Input Selector)
14, 46	SBRIN1/SBRIN2	Input pin of SBR channel (2 Input Selector)
15, 45	SRIN1/SRIN2	Input pin of SR channel (2 Input Selector)
16, 44	FRIN1/FRIN2	Input pin of FR channel (2 Input Selector)
17, 18, 42, 43	BASS L1, L2/BASS R1, R2	Frequency characteristic setting pin in the tone control (BASS)
19, 41	TRE L/ TRE R	Frequency characteristic setting pin in the tone control (TREBLE)
20, 40	TONEOUT L/TONEOUT R	Output pin of tone
21	FLVIN	Input pin of FL channel volume
23	TIM1	Timer setting terminal for Zero-Cross Detector
24	DVDD	Power supply to internal logic circuit
12, 26, 27	LATCH, DATA, CLOCK	Input pin of Control trigger/data/clock
28	DGND	Ground of internal logic circuit
29	AVCC	Positive power supply to internal analog circuit
30	OUTGND	Ground for OUTPUT Block
31	FLOUT	Output pin of FL channel
32	SLOUT	Output pin of SL channel
33	SBLOUT	Output pin of SBL channel
34	COUT	Output pin of C channel
35	SWOUT	Output pin of SW channel
36	SBROUT	Output pin of SBR channel
37	SROUT	Output pin of SR channel
38	FRONT	Output pin of FR channel
39	FRVIN	Input pin of FR channel volume
54, 55	LOUDL/BALANCE L/+, L/-	Pin of L channel loudness setting/Balance output (+/-)
56	INGND	Ground for Input Block
57, 58	LOUDR/BALANCE R/+, R/-	Pin of R channel loudness setting/Balance output (+/-)
63, 64, 65, 66, 67, 68, 69, 70, 71, 72	INRA, B, C, D, E, F, G, H, I, J	Input pin of R channel (10 Input Selector)
73	AVEE	Negative power supply to internal analog circuit

Absolute Maximum Ratings

Item	Symbol	Ratings	Unit	Condition
Power supply	Supply voltage	± 7.8	V	AVCC – AVEE
		6.0		DVDD – GND
Power dissipation	Pd	1250	mW	Ta $\leq$ 25 °C
Thermal derating	K θ	12.5	mW/°C	Ta > 25 °C
Operating temperature	Topr	–20 ~ +55	°C	
Storage temperature	Tstg	–40 ~ +125	°C	



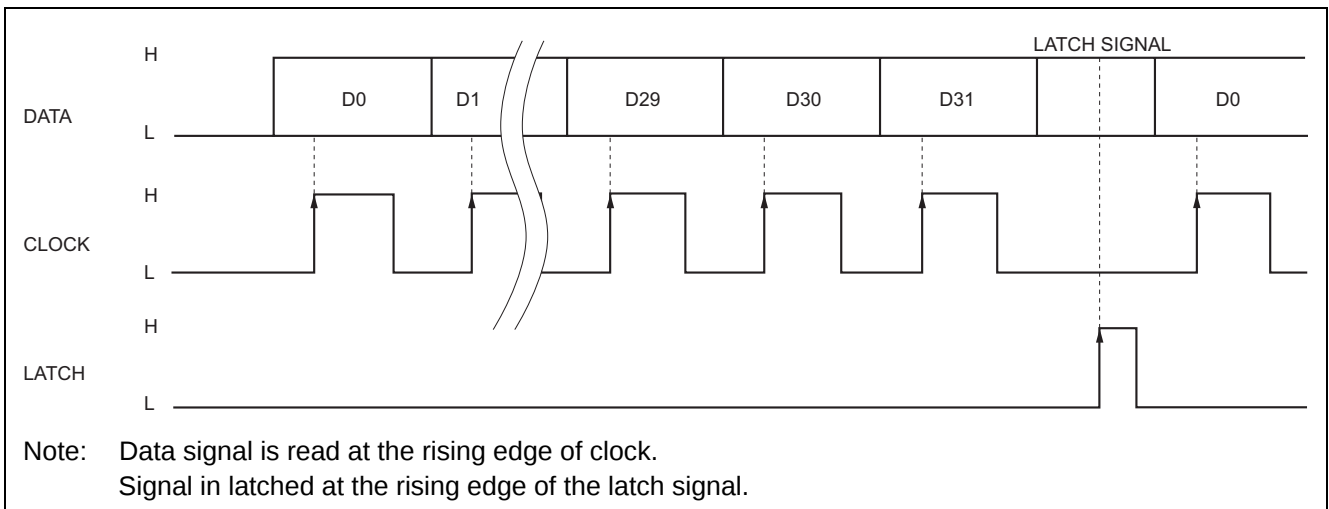
Recommended Operating Conditions

(Ta = 25 °C, unless otherwise noted)

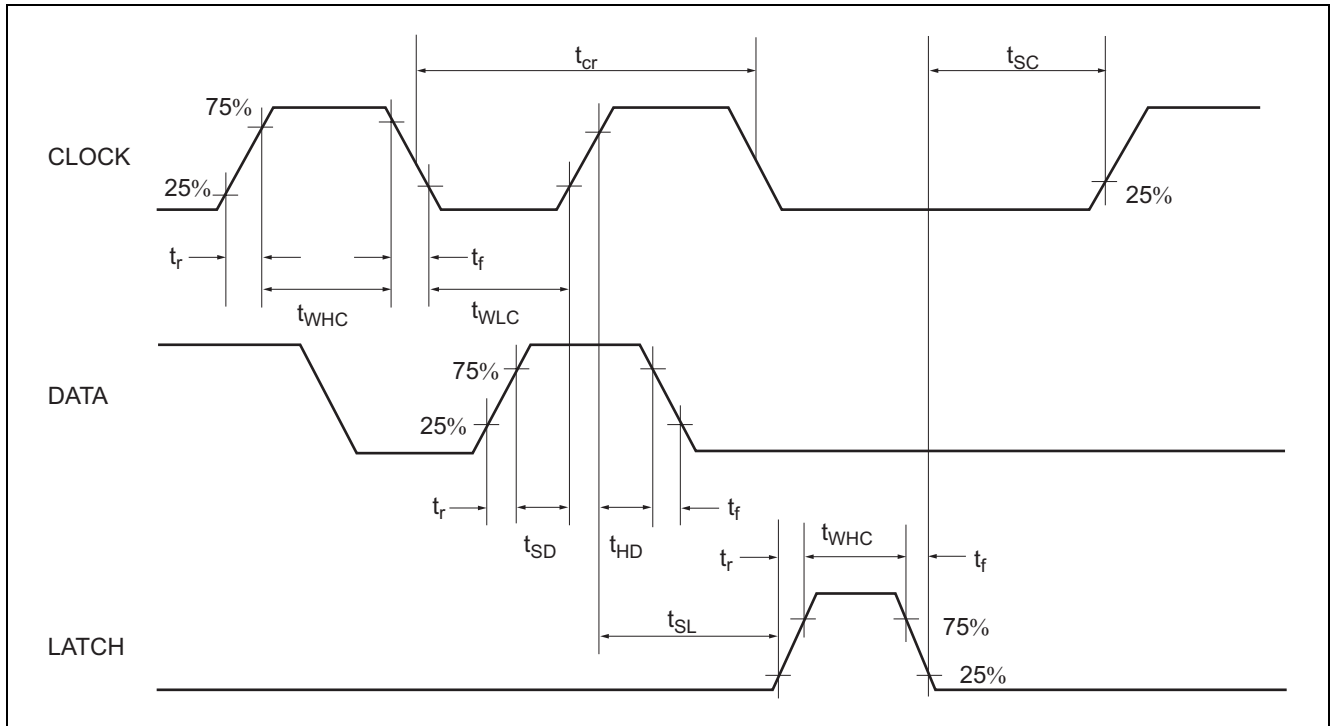
Item	Symbol	Min	Typ	Max	Unit	Condition
Analog supply voltage (Positive)	AVCC	4.5	7.0	7.3	V	
Analog supply voltage (Negative)	AVEE	-7.3	-7.0	-4.5	V	
Digital supply voltage	DVDD	4.5	5.0	5.5	V	
Logic "H" level input voltage	VIH	2.4	—	DVDD	V	DGND reference
Logic "L" level input voltage	VIL	DGND	—	0.5	V	DGND reference

Note: $VEE \leq DGND < VDD \leq VCC$

Relationship between Data and Clock



Clock and Data Timings



Timing Definition of Digital Block

Item	Symbol	Limits			Unit
		Min	Typ	Max	
Clock cycle time	t_{cr}	8	—	—	μs
Clock pulse width ("H" level)	t_{WHC}	3.2	—	—	
Clock pulse width ("L" level)	t_{WLC}	3.2	—	—	
Rising time of clock, data and latch	t_r	—	—	0.8	
Falling time of clock, data and latch	t_f	—	—	0.8	
Data setup time	t_{SD}	1.6	—	—	
Data hold time	t_{HD}	1.6	—	—	
Latch setup time	t_{SL}	2	—	—	
Latch pulse width	t_{WHL}	3.2	—	—	
Clock setup time	t_{SC}	8	—	—	

Setting Code

Early Establishment

(1) Input Selector

(D30 = 0, D31 = 0)

Setting	D0	D1	D2	D3
ALL OFF	0	0	0	0
A	0	0	0	1
B	0	0	1	0
C	0	0	1	1
D	0	1	0	0
E	0	1	0	1
F	0	1	1	0
G	0	1	1	1
H	1	0	0	0
I	1	0	0	1
J	1	0	1	0

(2) Input Attenuator

(D30 = 0, D31 = 0)

Setting	D4	D5	D6
0 dB	0	0	0
-3 dB	0	0	1
-6 dB	0	1	0
-9 dB	0	1	1
-12 dB	1	0	0

(3) Output Gain Control

(D30 = 0, D31 = 0)

Setting	D7	D8	D9
0 dB	0	0	0
+3 dB	0	0	1
+6 dB	0	1	0
+9 dB	0	1	1
+12 dB	1	0	0

(4) Tone Input Selector

(D30 = 0, D31 = 0)

Setting	D13
Bypass	0
Tone	1

(5) All Channel Output Mute

(D30 = 0, D31 = 1)

Setting	D28
Mute OFF	0
Mute ON	1

(6) Tone Control (Bass/Treble)

(D30 = 0, D31 = 0)

ATT	Bass	D14	D15	D16	D17
	Treble	D18	D19	D20	D21
+10 dB		1	1	0	1
+8 dB		1	1	0	0
+6 dB		1	0	1	1
+4 dB		1	0	1	0
+2 dB		1	0	0	1
0 dB		0	0	0	0
-2 dB		0	0	0	1
-4 dB		0	0	1	0
-6 dB		0	0	1	1
-8 dB		0	1	0	0
-10 dB		0	1	0	1

(7) Volume Input Selector

(D30 = 0, D31 = 0)

Setting	D10
External IN1	0
External IN2	1

(8) Loudness

(D30 = 0, D31 = 1)

Setting	D29
OFF	0
ON	1

(9) FRONT Input Selector

(D30 = 0, D31 = 0)

Setting	D11	D12
Bypass	0	0
External IN1	0	1
External IN2	1	0

(10) Balance/Loudness Change SW

(D30 = 0, D31 = 0)

Setting	D26
Balance Out	0
Loudness	1

(11) REC Output

(D30 = 0, D31 = 0)

REC Output	REC1	REC2	REC3	REC4
Setting	D22	D23	D24	D25
OFF	0	0	0	0
ON	1	1	1	1

(12) 8 Channel Volume

(FLch, FRch, Cch, SWch: D30 = 0, D31 = 1/SLch, SRch, SBLch, SBRch: D30 = 1, D31 = 0)

ATT	FLch SLch	D0	D1	D2	D3	D4	D5	D6
	FRch SRch	D7	D8	D9	D10	D11	D12	D13
	Cch SBLch	D14	D15	D16	D17	D18	D19	D20
	SWch SBRch	D21	D22	D23	D24	D25	D26	D27
0 dB		0	0	0	0	0	0	0
-1 dB		0	0	0	0	0	0	1
-2 dB		0	0	0	0	0	1	0
-3 dB		0	0	0	0	0	1	1
-4 dB		0	0	0	0	1	0	0
-5 dB		0	0	0	0	1	0	1
-6 dB		0	0	0	0	1	1	0
-7 dB		0	0	0	0	1	1	1
-8 dB		0	0	0	1	0	0	0
-9 dB		0	0	0	1	0	0	1
-10 dB		0	0	0	1	0	1	0
-11 dB		0	0	0	1	0	1	1
-12 dB		0	0	0	1	1	0	0
-13 dB		0	0	0	1	1	0	1
-14 dB		0	0	0	1	1	1	0
-15 dB		0	0	0	1	1	1	1
-16 dB		0	0	1	0	0	0	0
-17 dB		0	0	1	0	0	0	1
-18 dB		0	0	1	0	0	1	0
-19 dB		0	0	1	0	0	1	1
-20 dB		0	0	1	0	1	0	0
-21 dB		0	0	1	0	1	0	1
-22 dB		0	0	1	0	1	1	0
-23 dB		0	0	1	0	1	1	1
-24 dB		0	0	1	1	0	0	0
-25 dB		0	0	1	1	0	0	1
-26 dB		0	0	1	1	0	1	0
-27 dB		0	0	1	1	0	1	1
-28 dB		0	0	1	1	1	0	0
-29 dB		0	0	1	1	1	0	1
-30 dB		0	0	1	1	1	1	0
-31 dB		0	0	1	1	1	1	1
-32 dB		0	1	0	0	0	0	0
-33 dB		0	1	0	0	0	0	1
-34 dB		0	1	0	0	0	1	0
-35 dB		0	1	0	0	0	1	1
-36 dB		0	1	0	0	1	0	0
-37 dB		0	1	0	0	1	0	1
-38 dB		0	1	0	0	1	1	0
-39 dB		0	1	0	0	1	1	1
-40 dB		0	1	0	1	0	0	0
-41 dB		0	1	0	1	0	0	1
-42 dB		0	1	0	1	0	1	0
-43 dB		0	1	0	1	0	1	1
-44 dB		0	1	0	1	1	0	0
-45 dB		0	1	0	1	1	0	1
-46 dB		0	1	0	1	1	1	0
-47 dB		0	1	0	1	1	1	1

ATT	FLch SLch	D0	D1	D2	D3	D4	D5	D6
	FRch SRch	D7	D8	D9	D10	D11	D12	D13
	Cch SBLch	D14	D15	D16	D17	D18	D19	D20
	SWch SBRch	D21	D22	D23	D24	D25	D26	D27
-48 dB		0	1	1	0	0	0	0
-49 dB		0	1	1	0	0	0	1
-50 dB		0	1	1	0	0	1	0
-51 dB		0	1	1	0	0	1	1
-52 dB		0	1	1	0	1	0	0
-53 dB		0	1	1	0	1	0	1
-54 dB		0	1	1	0	1	1	0
-55 dB		0	1	1	0	1	1	1
-56 dB		0	1	1	1	0	0	0
-57 dB		0	1	1	1	0	0	1
-58 dB		0	1	1	1	0	1	0
-59 dB		0	1	1	1	0	1	1
-60 dB		0	1	1	1	1	0	0
-61 dB		0	1	1	1	1	0	1
-62 dB		0	1	1	1	1	1	0
-63 dB		0	1	1	1	1	1	1
-64 dB		1	0	0	0	0	0	0
-65 dB		1	0	0	0	0	0	1
-66 dB		1	0	0	0	0	1	0
-67 dB		1	0	0	0	0	1	1
-68 dB		1	0	0	0	1	0	0
-69 dB		1	0	0	0	1	0	1
-70 dB		1	0	0	0	1	1	0
-71 dB		1	0	0	0	1	1	1
-72 dB		1	0	0	1	0	0	0
-73 dB		1	0	0	1	0	0	1
-74 dB		1	0	0	1	0	1	0
-75 dB		1	0	0	1	0	1	1
-76 dB		1	0	0	1	1	0	0
-77 dB		1	0	0	1	1	0	1
-78 dB		1	0	0	1	1	1	0
-79 dB		1	0	0	1	1	1	1
-80 dB		1	0	1	0	0	0	0
-81 dB		1	0	1	0	0	0	1
-82 dB		1	0	1	0	0	1	0
-83 dB		1	0	1	0	0	1	1
-84 dB		1	0	1	0	1	0	0
-85 dB		1	0	1	0	1	0	1
-86 dB		1	0	1	0	1	1	0
-87 dB		1	0	1	0	1	1	1
-88 dB		1	0	1	1	0	0	0
-89 dB		1	0	1	1	0	0	1
-90 dB		1	0	1	1	0	1	0
-91 dB		1	0	1	1	0	1	1
-92 dB		1	0	1	1	1	0	0
-95 dB		1	0	1	1	1	1	1
-∞ dB		1	1	1	1	0	0	0

Electrical Characteristics

Unless otherwise noted, Ta = 25 °C, AVCC = 7 V, AVEE = -7 V, DVDD = 5 V, f = 1 kHz, RL = 10 kΩ,
Tone/Volume = 0 dB, Front channel Input selector/Tone Output Selector = Bypass,
Input attenuator/output Gain Control = 0 dB

(1) Power Supply Characteristics

Item	Symbol	Limits			Unit	Test Condition
		Min	Typ	Max		
Analog positive power circuit current	Alcc	—	50	70	mA	With AVDD = 7 V and AVSS = -7 V Pin 29 pin current, when no signal is provided
Analog negative power circuit current	Alee	—	50	70	mA	With AVDD = 7 V and AVSS = -7 V Pin 73 pin current, when no signal is provided
Digital power circuit current	Dlidd	—	3.0	6.0	mA	With DVDD = 5 V Pin 24 pin current, when no signal is provided

(2) Input/Output Characteristics (Over All)

Item	Symbol	Limits			Unit	Test Condition
		Min	Typ	Max		
Input resistance	Ri	25	50	100	kΩ	9 ~ 16, 44 ~ 51 pin When each selector chooses a terminal concerned.
Maximum input voltage	VOM	3.0	4.2	—	Vrms	THD = 1%
Pass gain	Gv	-2.0	0	2.0	dB	Vi = 0.3 Vrms, FLAT
Distortion	THD	—	0.005	0.09	%	DIN-AUDIO Vi = 0.3 Vrms
Output noise voltage	Vn (VOL)	—	4	12	μVrms	JIS-A, Rg = 0 Ω Tone Output selector = Bypass
	Vn (tone)	—	8	16	μVrms	JIS-A, Rg = 0 Ω Tone Output Selector = Tone

(3) 8 Channel Volume Characteristics

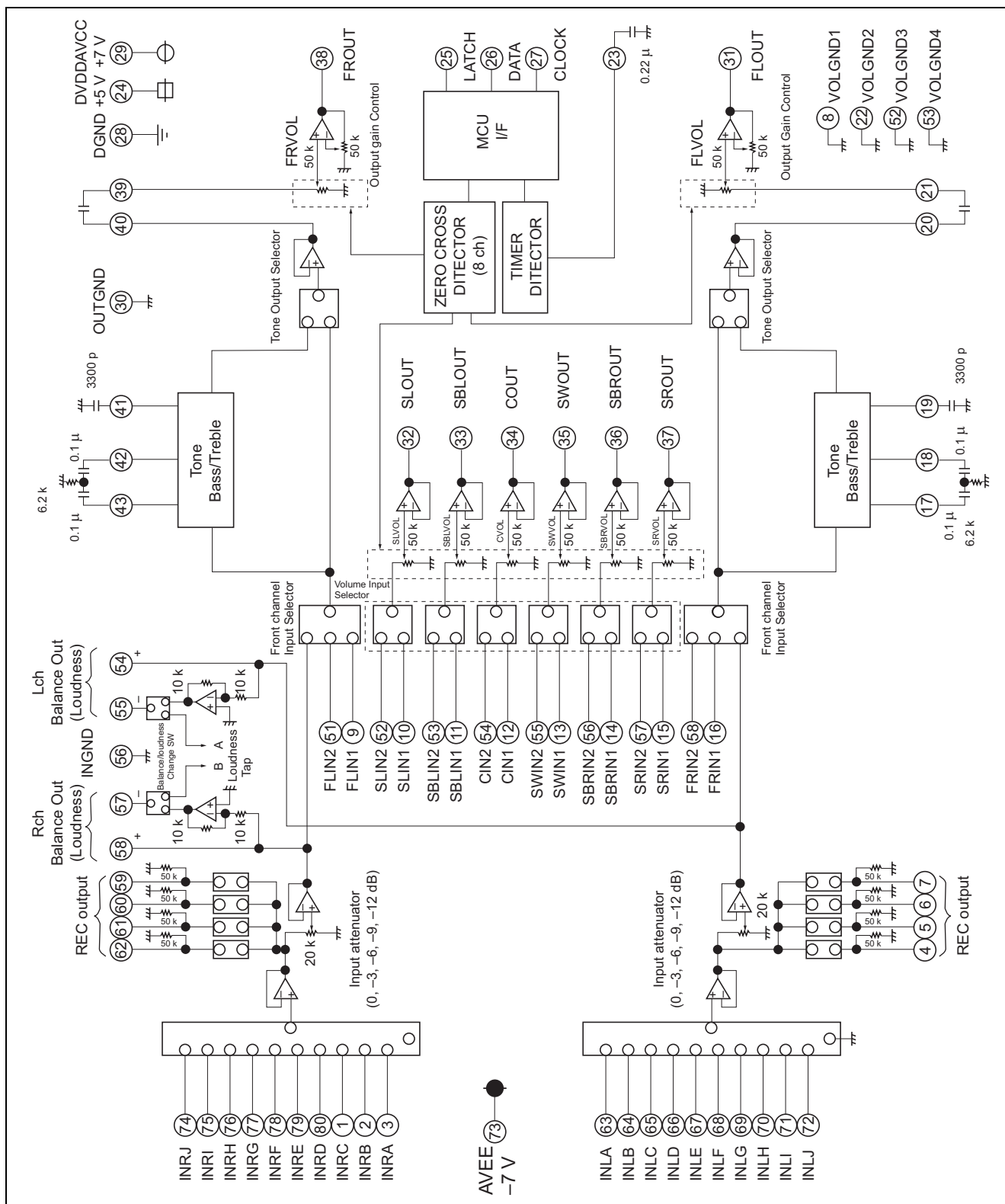
Item	Symbol	Limits			Unit	Test Condition
		Min	Typ	Max		
Maximum attenuation	ATTmax	—	-100	-90	dB	Volume setting = 0 dB Vi = 1 Vrms, JIS-A, VOL = -∞
Volume gain between channels	Dvol	-1.5	0	1.5	dB	Pin 31, 32, 33, 34, 35, 36, 37, 38 output
Cross talk between channels	CT	—	-80	-65	dB	Vo = 0.5 Vrms, RL = 10 kΩ, JIS-A, Rg = 0 Ω

(4) Tone Control Characteristics

Unless otherwise noted, Front channel Input selector = external IN1, Tone Output Selector = Tone,
Input pin 9, 16, Output pin 20, 40

Item	Symbol	Limits			Unit	Test Condition
		Min	Typ	Max		
Tone control voltage gain (Boost/Bass)	G (BASS) B	+8	+10	+12	dB	f = 100 Hz Bass +10 dB setting
Tone control voltage gain (Cut/Bass)	G (BASS) C	-8	-10	-12	dB	f = 100 Hz Bass -10 dB setting
Tone control voltage gain (Boost/Treble)	G (TRE) B	+8	+10	+12	dB	f = 10 kHz Treble +10 dB setting
Tone control voltage gain (Cut/Treble)	G (TRE) B	-8	-10	-12	dB	f = 10 kHz Treble -10 dB setting
Balance between channels	BALT	-2	0	+2	dB	Boost condition +10, -10 dB

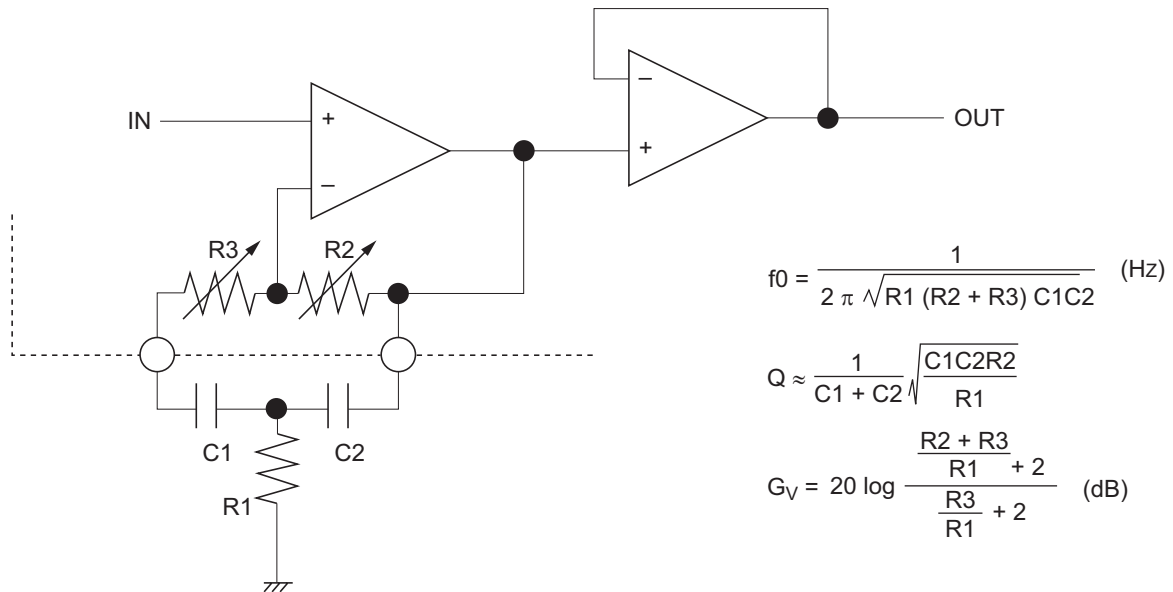
Block Diagram



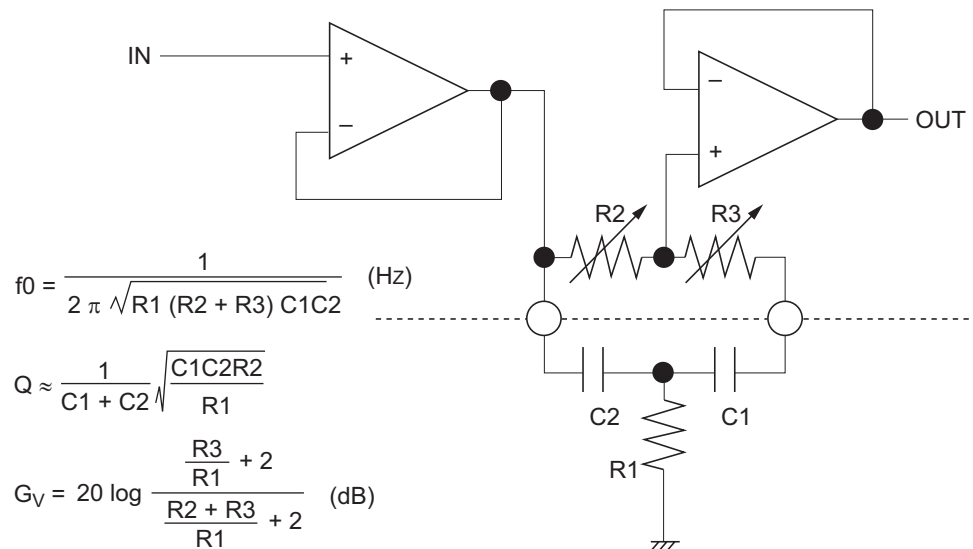
Tone Control

(1) Bass

<Boost>

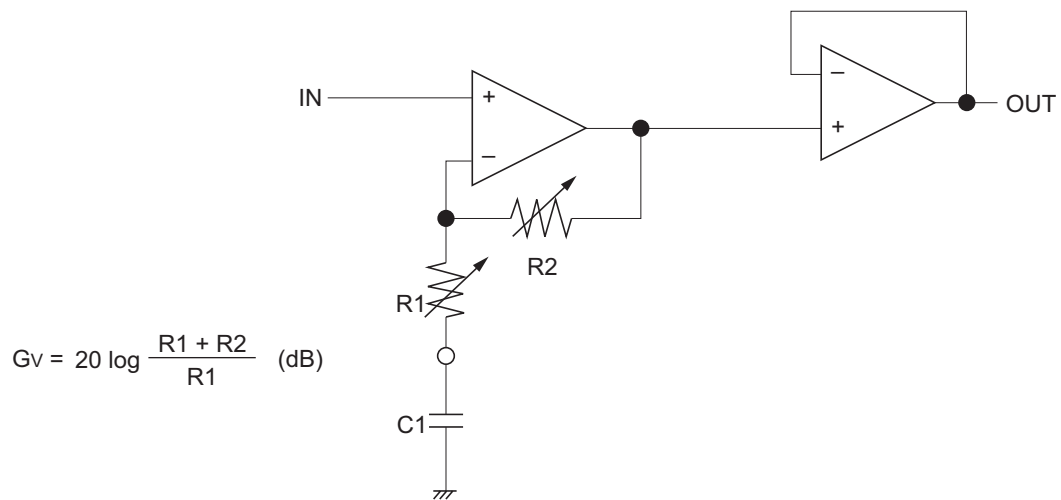


<Cut>

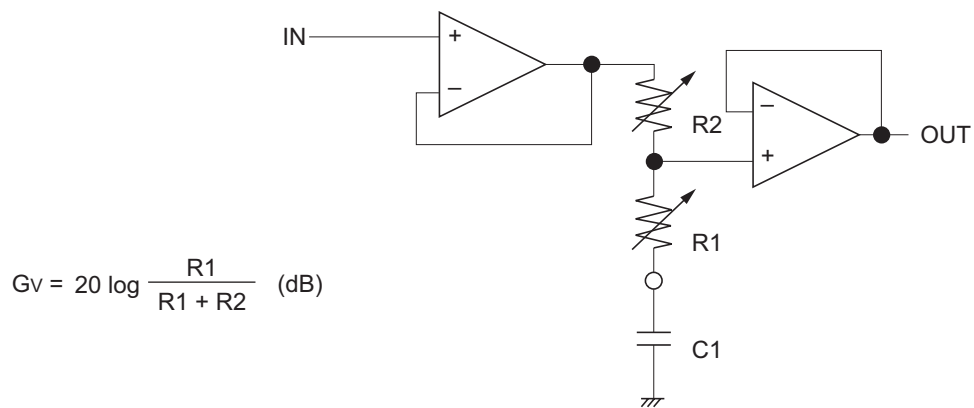


(2) Treble

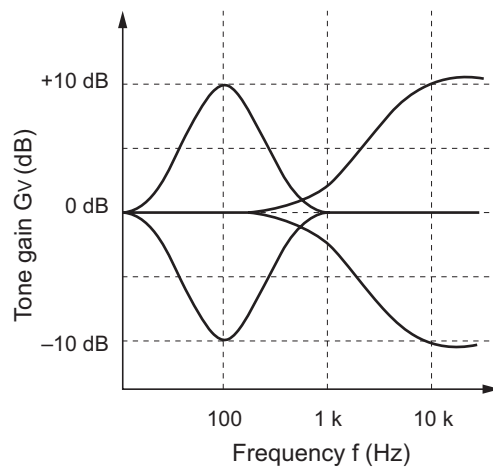
<Boost>



<Cut>



<Curve of characteristics>



Balance/Loudness

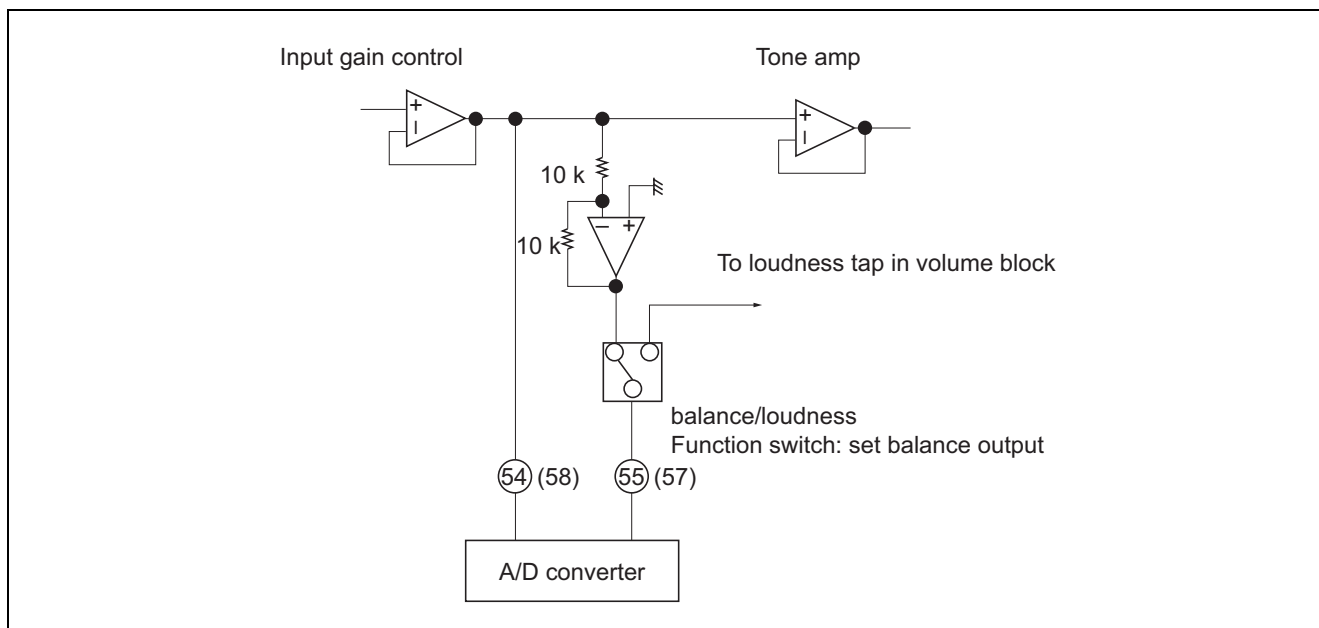
M61516FP has balance output (L/R channel) for external A/D converter.

The balance output (negative side/pin 55, 57) can use not only balance output also loudness capacitor connection terminal. (for loudness frequency setting) Please choose balance output or loudness capacitor connection terminal comply with your system.

Balance output and loudness function can't used at the same time.

1. Balance Output

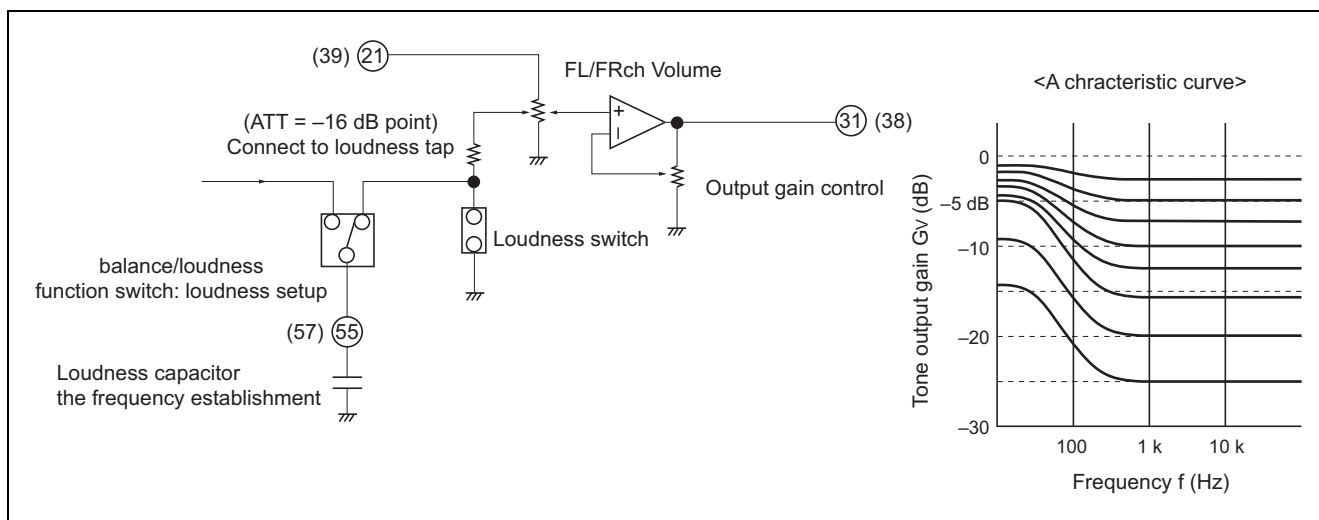
Balance/Loudness function switch setting: Balance Output (D26 = 0, D30 = 0, D31 = 0)



2. Loudness

Balance/Loudness function switch setting: loudness (D26 = 1, D30 = 0, D31 = 0)

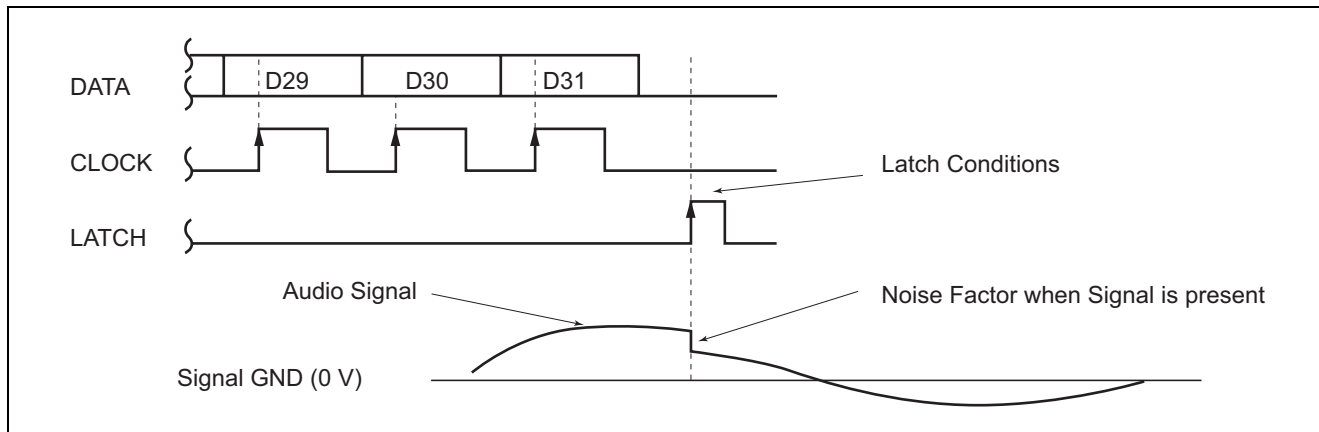
M61516FP has loudness circuit center tap type in FL/FRch volume block



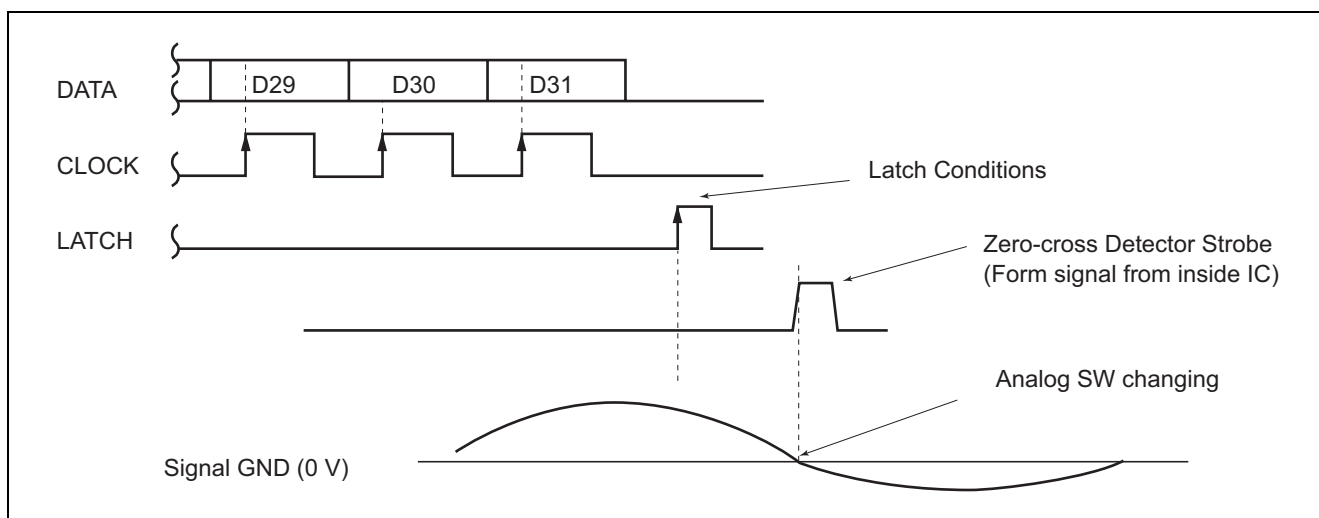
Zero-Crossing Detection Circuit

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 (0 V).



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 (0 V).

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

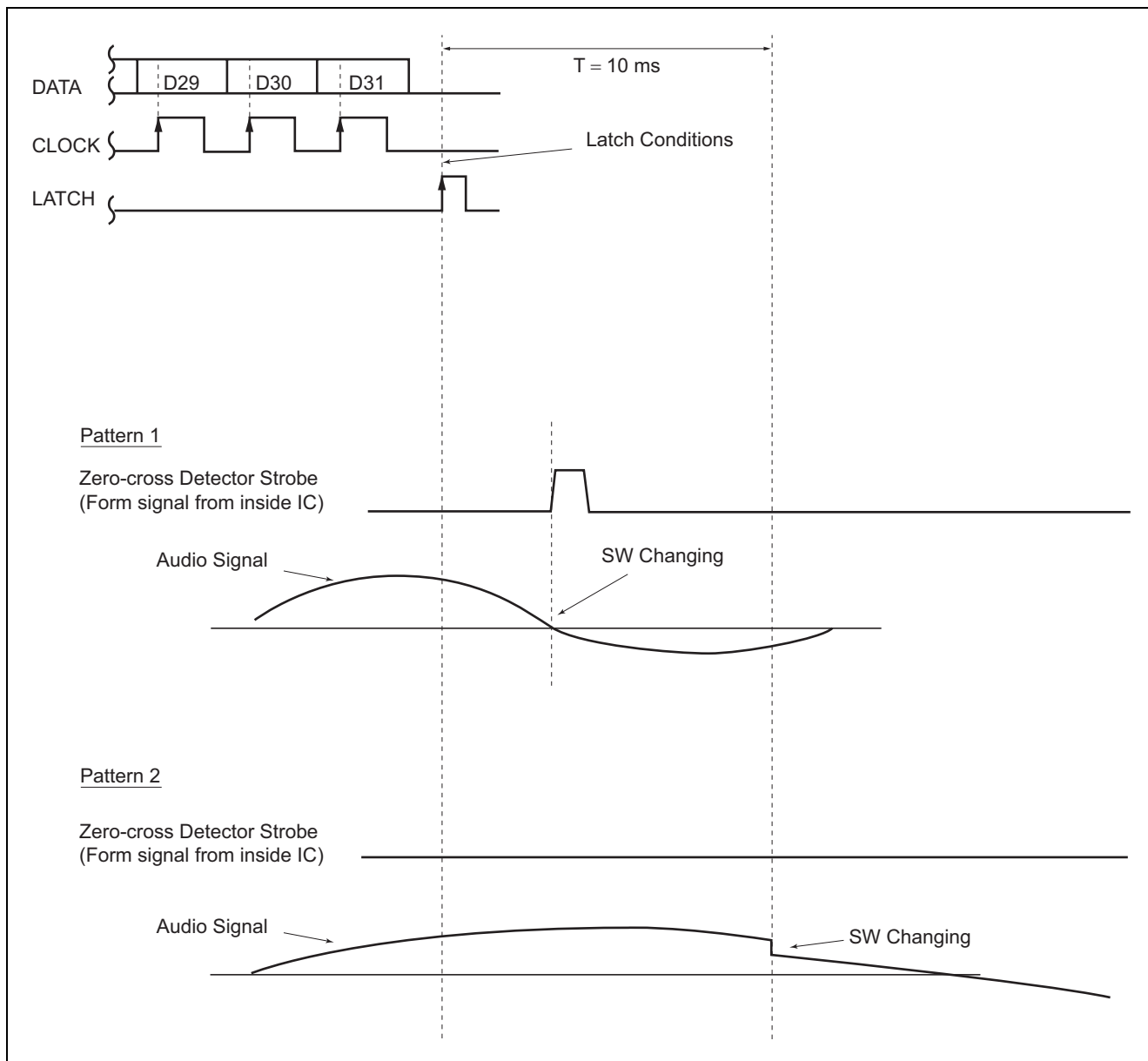
The related type of C (Pin 23) and T is as the following.

$$T = 13.8E10^4 \cdot C \text{ (s)}$$

2. Connection of Zero-Crossing Detector and Timer Setting

Internal analog SW moves by [Zero-cross Detector Strobe] or [Compulsion SW of Timer Circuit].

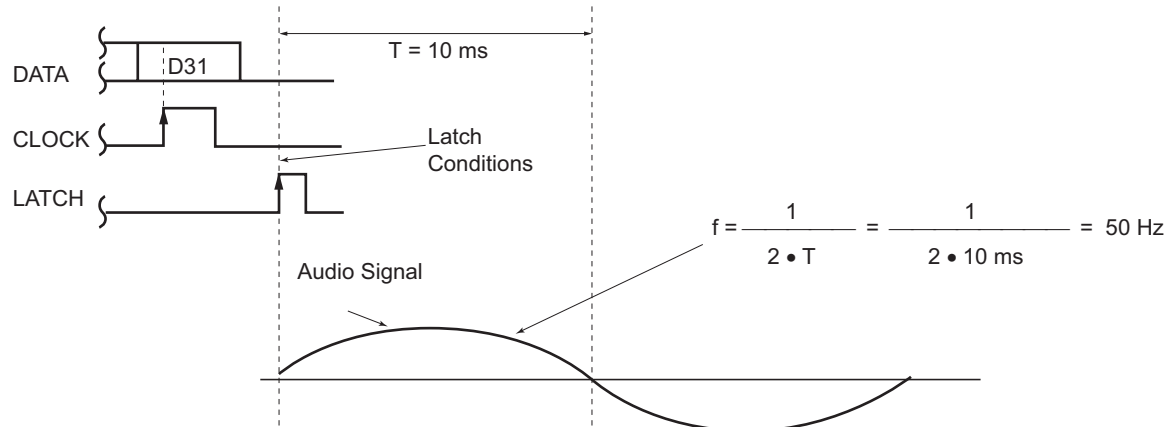
For example, case of $T = 10$ ms.



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.

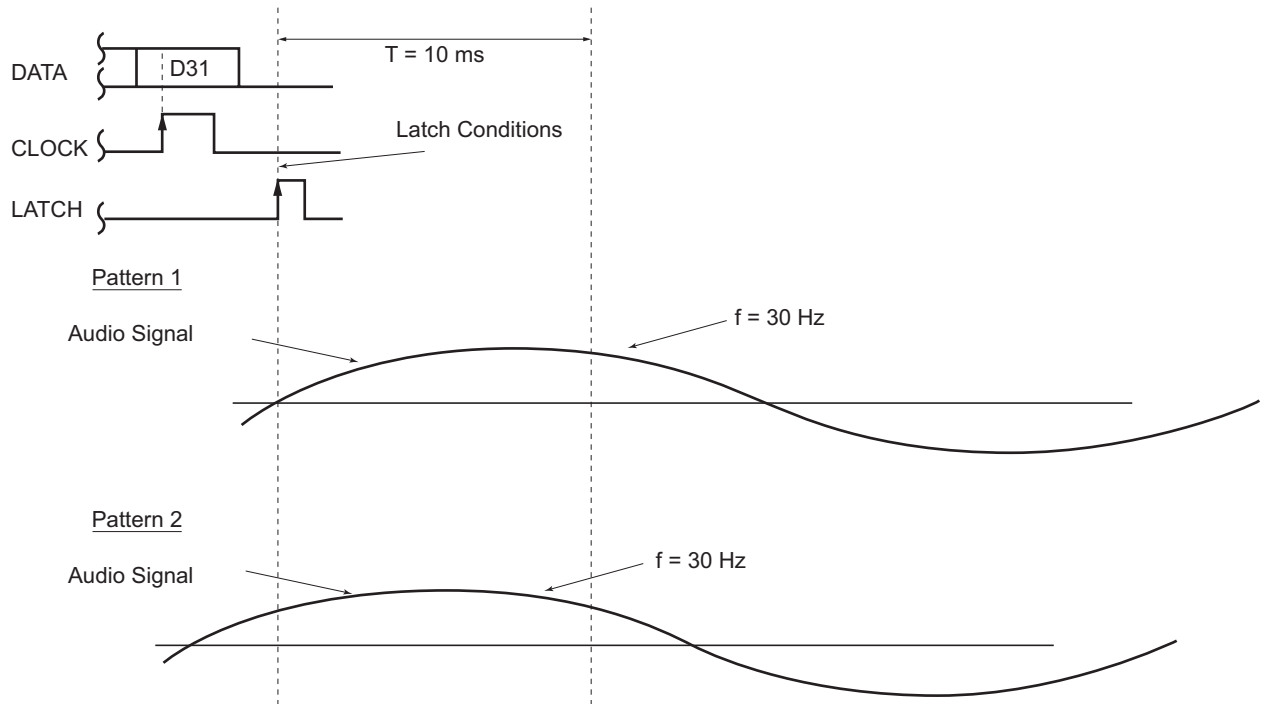
Timer Setting Time setting for Frequency band of Input Audio Signal.

3. Timer Setting System



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

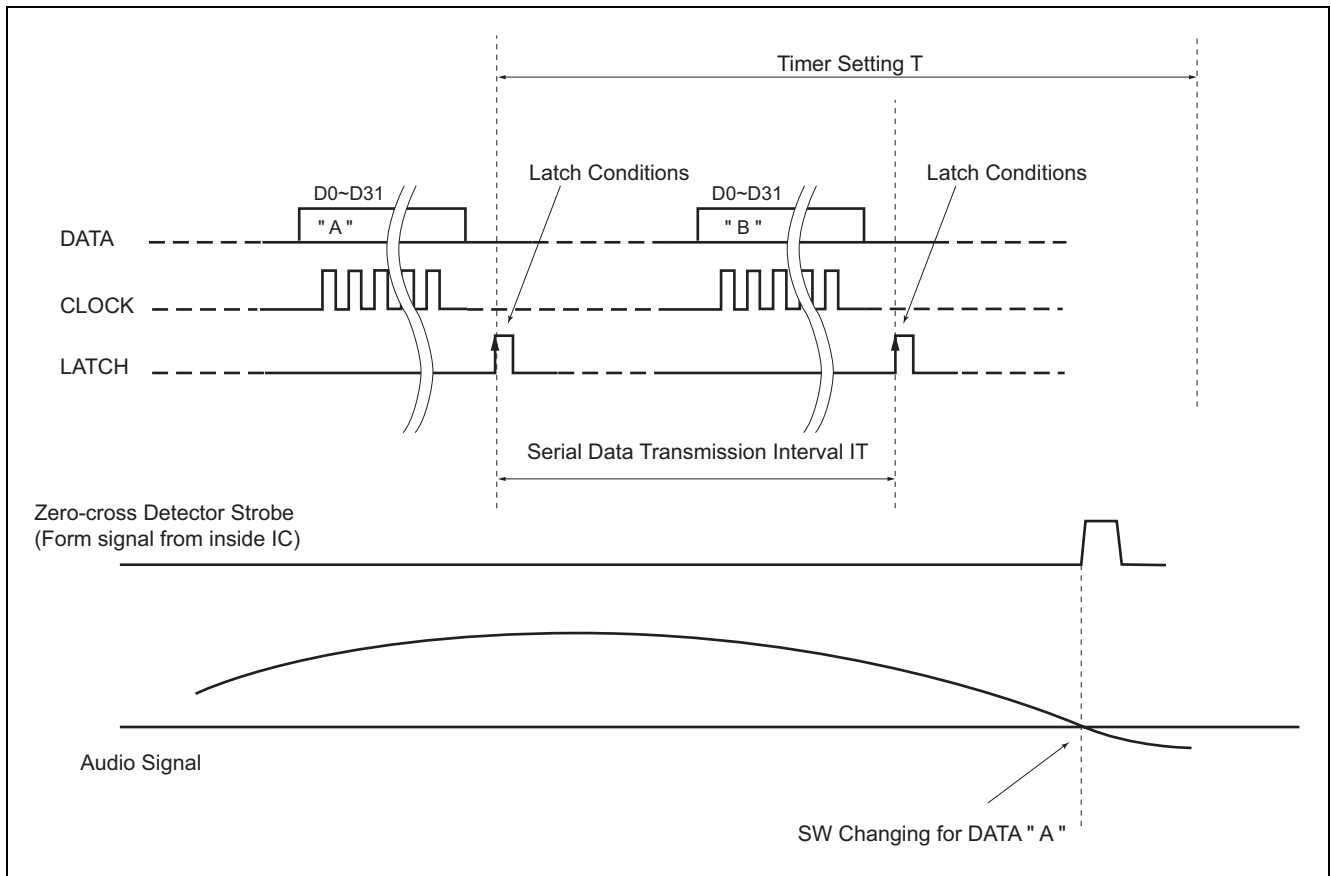
Audio Signal	Zero-cross Detect	
50 Hz ≤	OK	Upper figure
50 Hz ≥	OK	Pattern 1
	NG	Pattern 2



Note: Timer Setting Time is about T = 10 ms usually.

4. Connection of Data Transmission and Timer Setting

M61516FP has the function to make the Serial Data invalid until it generates 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 M61516FP

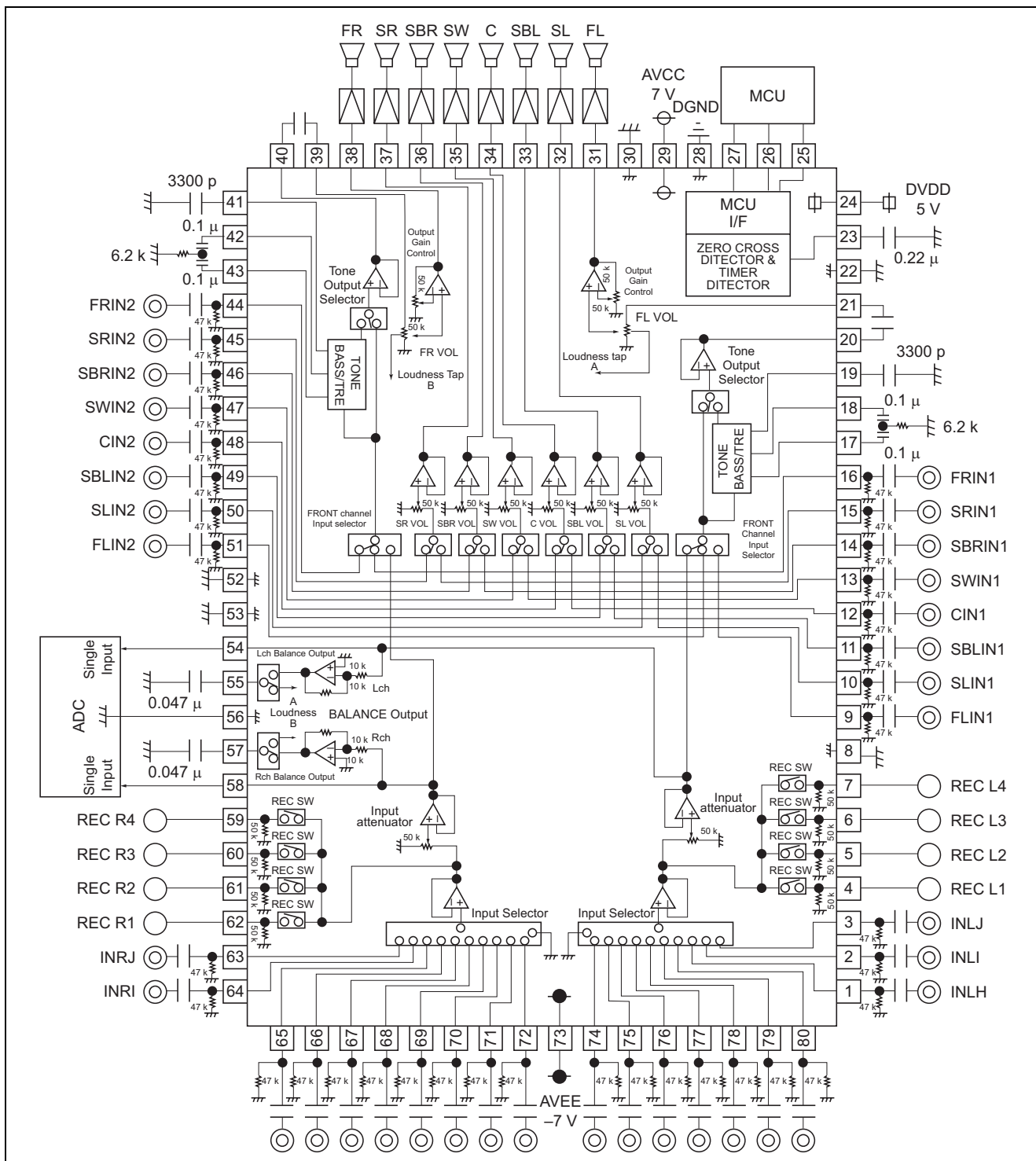
$$\text{Serial Data Transmission Interval} = IT > \text{Timer Setting} = T$$

the reading error of the data doesn't occur.

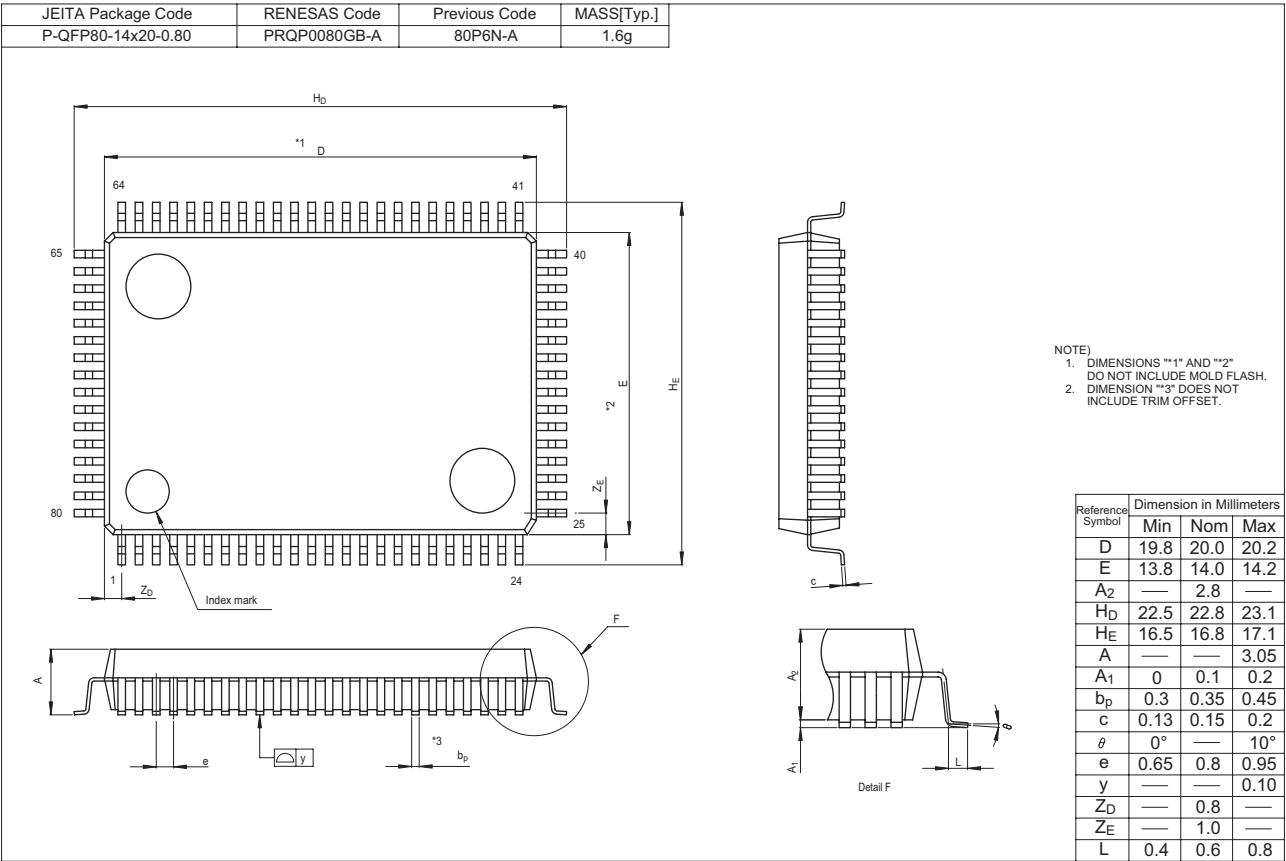
Note: Serial Data Transmission Interval IT = Interval of between Latch Condition and Latch Condition

Application Example

1. Loudness



Package Dimensions



Notes:

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