

To all our customers

Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.

The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

M61516FP

7.1ch ELECTRONIC VOLUME WITH 10 INPUT SELECTOR

APPLICATION

Receiver, AV Amp, Mini Stereo etc.

FEATURE

FUNCTION	FEATURE
Electronic Volume	(1) 8 channel Independent Electronic Volume with High Voltage Transistor. (0~-92dB/1dBstep, -95, -∞dB) (2) Built-in Zero-Crossing Detector Circuit for reduce click noise at changing volume value.
Tone Control	(1) Bass/Treble, 0~ ±10dB/2dBstep (2) Add a Bypass Mode/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/-12dB
Output Gain Control	0/+3/+6/+9/+12dB
Balance Out	Built-in Balance out (for ADC)
Loudness *1	Built-in Loudness circuit of center tap type in FL/FRch

OUTLINE



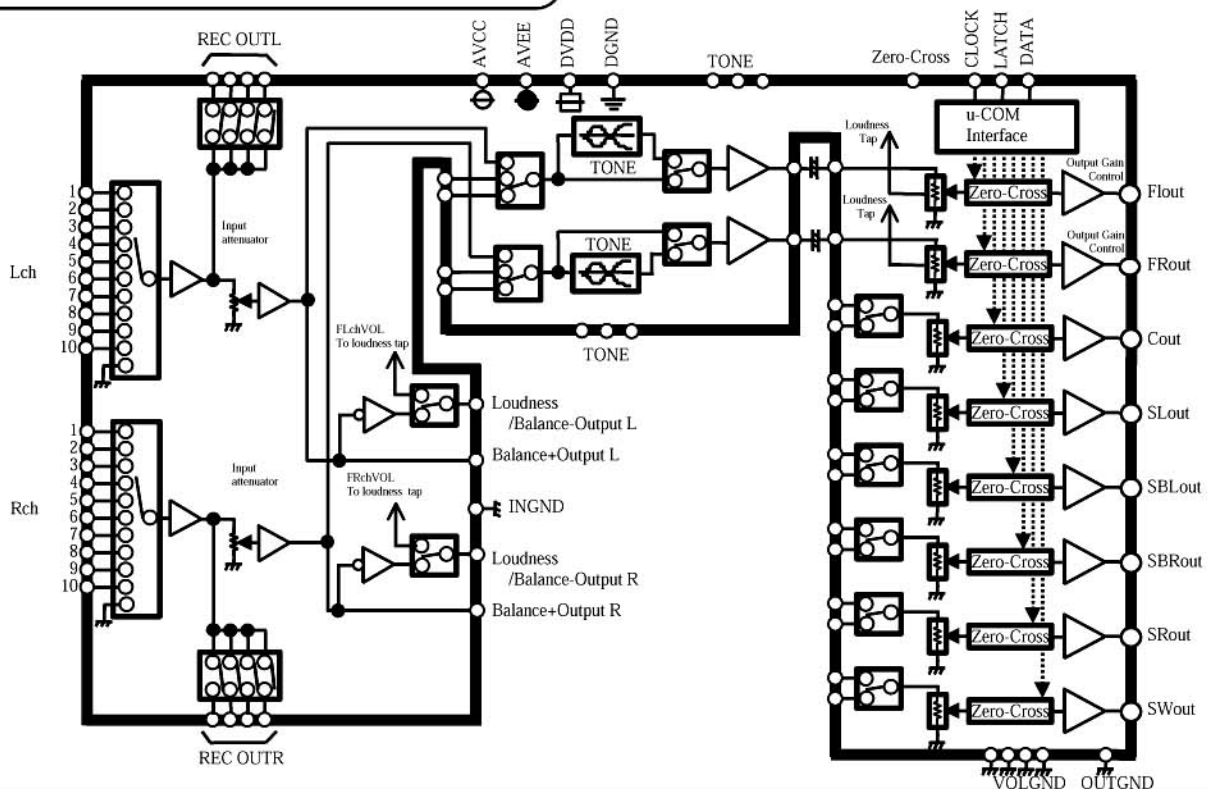
Outline 80P6N-A
0.8mm Pitch QFP
(20.0mm x 14.0mm x 2.8mm)

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

RECOMMENDED OPERATING CONDITION

Supply Voltage Range AVCC=7.0V(typ) , AVEE=-7.0V(typ) , DVDD=5.0V(typ)

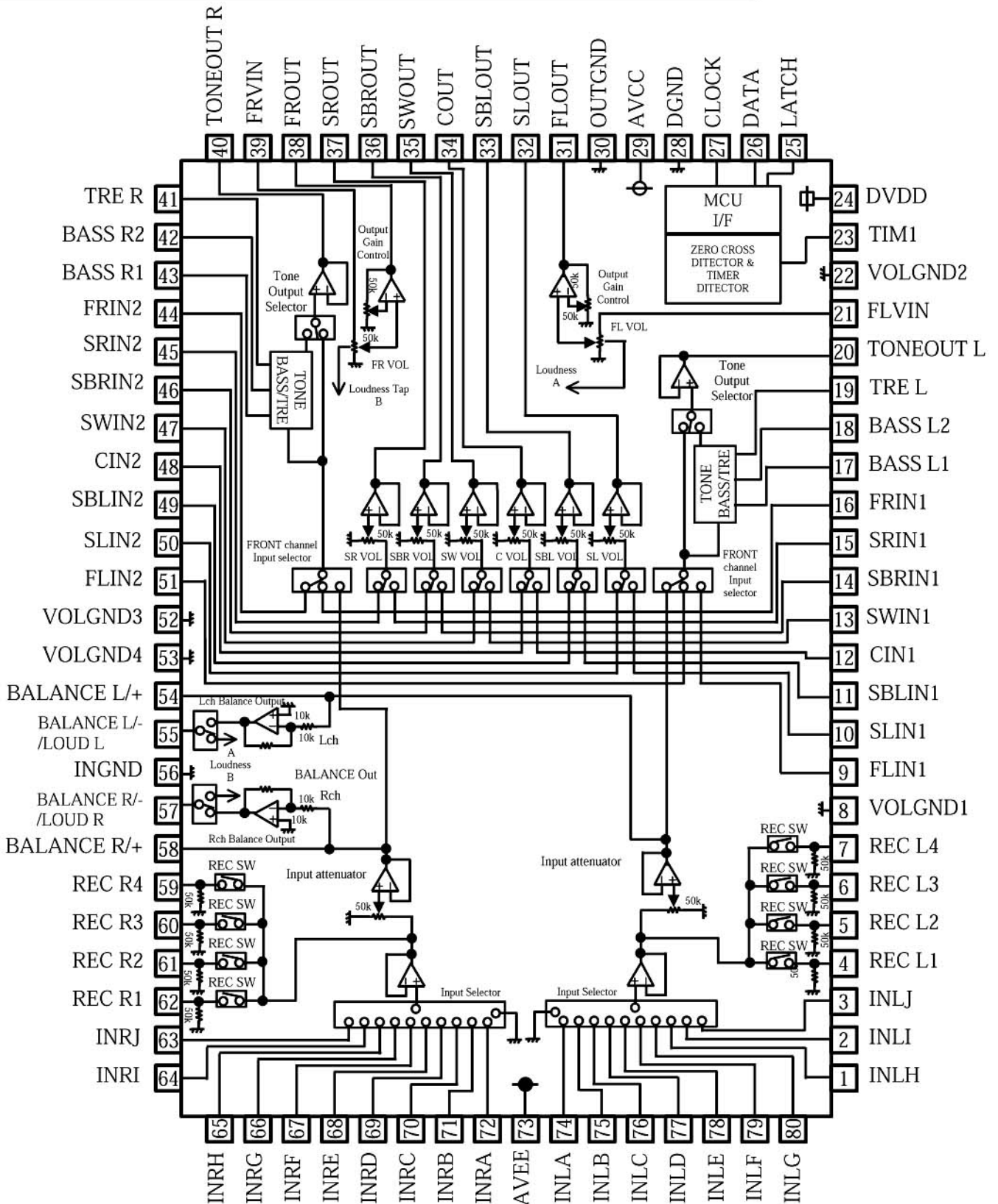
SYSTEM BLOCK DIAGRAM



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BLOCK DIAGRAM AND PIN CONFIGURATION (TOP VIEW)



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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, 59,59,60,61	REC L1,L2,L3,L4 /REC R1,R2,R3,R4	Output pin of REC (Lch and Rch)
8,22,52,53	VOLGND1,2,3,4	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	FROUT	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 (+/-)
62,63,64,65,66, 67,68,69,70	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

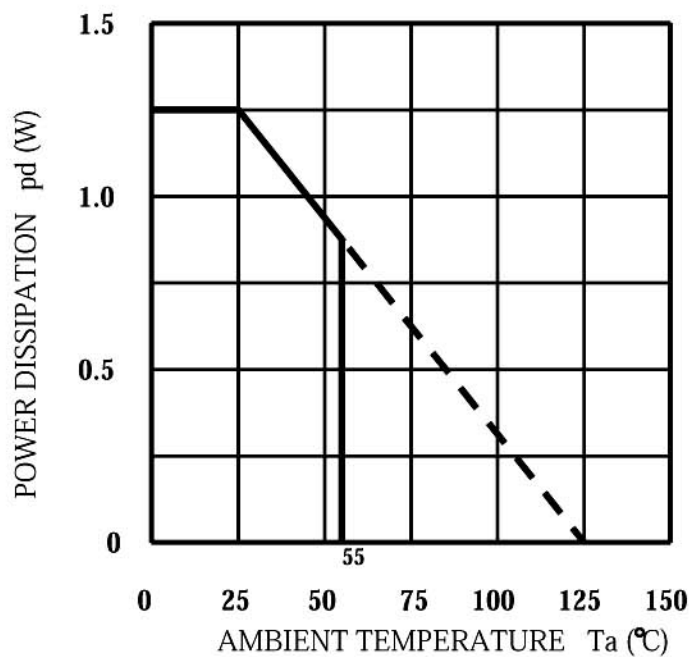
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7.1ch ELECTRONIC VOLUME WITH 10 INPUT SELECTOR

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Condition	Ratings	Unit
Supply voltage	Power supply	AVCC-AVEE	± 7.8	V
		DVDD-GND	6.0	
Pd	Power dissipation	Ta $\leq 25^{\circ}\text{C}$	1250	mW
Ke	Thermal derating	Ta $> 25^{\circ}\text{C}$	12.5	mW/ $^{\circ}\text{C}$
Topr	Operating temperature		-20~+55	$^{\circ}\text{C}$
Tstg	Storage temperature		-40~+125	$^{\circ}\text{C}$

THERMAL DERATINGS
(MAXIMUM RATING)



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7.1ch ELECTRONIC VOLUME WITH 10 INPUT SELECTOR

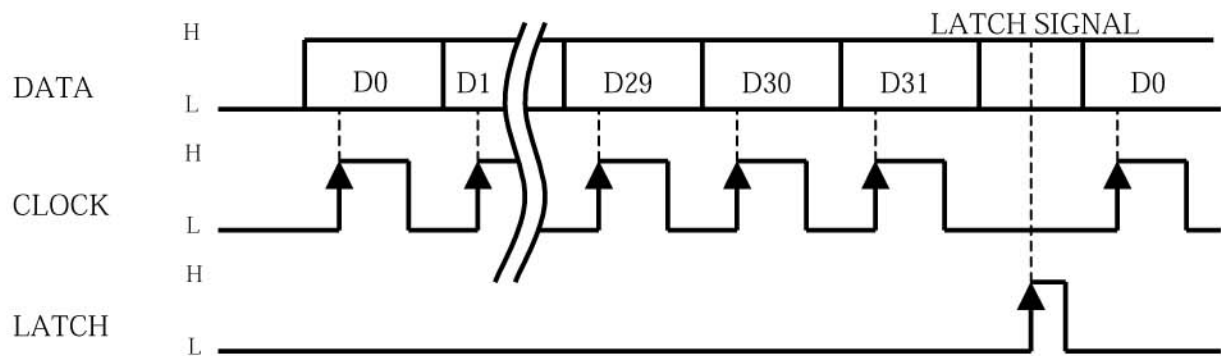
RECOMMENDED OPERATING CONDITIONS

(Ta=25℃, unless otherwise noted)

Parameter	Symbol	Condition	MIN	TYP	MAX	Unit
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	DGND reference	2.4	—	DVDD	V
Logic "L" level input voltage	VIL	DGND reference	DGND	—	0.5	V

Note: VEE < DGND < VDD < VCC

RELATIONSHIP BETWEEN DATA AND CLOCK

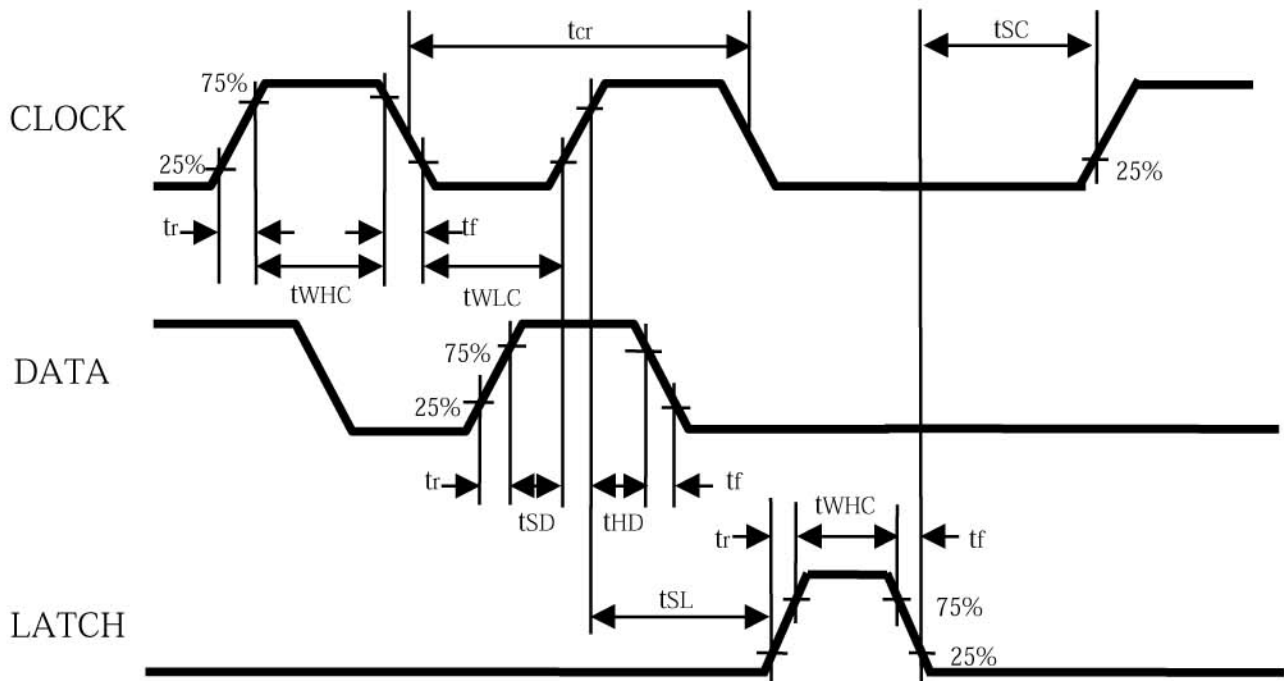


Data signal is read at the rising edge of clock.
Signal is latched at the rising edge of the latch signal.

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CLOCK AND DATA TIMINGS



TIMING DEFINITION OF DIGITAL BLOCK

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

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DATA CONTROL SPECIFICATION

For kinds of input format options are available by changing slot settings of D30,D31. When the IC is powered up,the internal setting are not fixed.

D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	
Input Selector				Input attenuator			Output Gain Control			VOL Input Selector		Front Channel Input Selector		Tone Output Selector		Tone Control Bass		Tone Control Treble			REC Output 1		REC Output 2		REC Output 3		REC Output 4		Balance /loudness			
FLch Volume							FRch Volume			FRch Volume				Cch Volume				SWch Volume				All ch Output Mute		Loudness		0		1				
SLch Volume							SRch Volume			SRch Volume				SBLch Volume				SBRch Volume				0		0		1		0				

Note: When $D30=0$, $D31=1$ and $D30=1$, $D31=0$ slots are set up, the detection movement of Zero-Cross is done.
Refer to 16~20 pages for the setting data transmitting interval.

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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
0dB	0	0	0
-3dB	0	0	1
-6dB	0	1	0
-9dB	0	1	1
-12dB	1	0	0

(3) Output Gain Control
(D30=0,D31=0)

Setting	D7	D8	D9
0dB	0	0	0
+3dB	0	0	1
+6dB	0	1	0
+9dB	0	1	1
+12dB	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
+10dB		1	1	0	1
+8dB		1	1	0	0
+6dB		1	0	1	1
+4dB		1	0	1	0
+2dB		1	0	0	1
0dB		0	0	0	0
-2dB		0	0	0	1
-4dB		0	0	1	0
-6dB		0	0	1	1
-8dB		0	1	0	0
-10dB		0	1	0	1

(7) Volume Input Selector
(D30=0,D31=0)

Setting	D10
External IN1	0
External IN2	1

(9) FRONT Input Selector
(D30=0,D31=0)

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

(8) Loudness
(D30=0,D31=1)

Setting	D29
OFF	0
ON	1

(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

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(10)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
0dB		0	0	0	0	0	0	0
-1dB		0	0	0	0	0	0	1
-2dB		0	0	0	0	0	1	0
-3dB		0	0	0	0	0	1	1
-4dB		0	0	0	0	1	0	0
-5dB		0	0	0	0	1	0	1
-6dB		0	0	0	0	1	1	0
-7dB		0	0	0	0	1	1	1
-8dB		0	0	0	1	0	0	0
-9dB		0	0	0	1	0	0	1
-10dB		0	0	0	1	0	1	0
-11dB		0	0	0	1	0	1	1
-12dB		0	0	0	1	1	0	0
-13dB		0	0	0	1	1	0	1
-14dB		0	0	0	1	1	1	0
-15dB		0	0	0	1	1	1	1
-16dB		0	0	1	0	0	0	0
-17dB		0	0	1	0	0	0	1
-18dB		0	0	1	0	0	1	0
-19dB		0	0	1	0	0	1	1
-20dB		0	0	1	0	1	0	0
-21dB		0	0	1	0	1	0	1
-22dB		0	0	1	0	1	1	0
-23dB		0	0	1	0	1	1	1
-24dB		0	0	1	1	0	0	0
-25dB		0	0	1	1	0	0	1
-26dB		0	0	1	1	0	1	0
-27dB		0	0	1	1	0	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
-28dB		0	0	1	1	1	0	0
-29dB		0	0	1	1	1	0	1
-30dB		0	0	1	1	1	1	0
-31dB		0	0	1	1	1	1	1
-32dB		0	1	0	0	0	0	0
-33dB		0	1	0	0	0	0	1
-34dB		0	1	0	0	0	1	0
-35dB		0	1	0	0	0	1	1
-36dB		0	1	0	0	1	0	0
-37dB		0	1	0	0	1	0	1
-38dB		0	1	0	0	1	1	0
-39dB		0	1	0	0	1	1	1
-40dB		0	1	0	1	0	0	0
-41dB		0	1	0	1	0	0	1
-42dB		0	1	0	1	0	1	0
-43dB		0	1	0	1	0	1	1
-44dB		0	1	0	1	1	0	0
-45dB		0	1	0	1	1	0	1
-46dB		0	1	0	1	1	1	0
-47dB		0	1	0	1	1	1	1
-48dB		0	1	1	0	0	0	0
-49dB		0	1	1	0	0	0	1
-50dB		0	1	1	0	0	1	0
-51dB		0	1	1	0	0	1	1
-52dB		0	1	1	0	1	0	0
-53dB		0	1	1	0	1	0	1
-54dB		0	1	1	0	1	1	0
-55dB		0	1	1	0	1	1	1

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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
-56dB		0	1	1	1	0	0	0
-57dB		0	1	1	1	0	0	1
-58dB		0	1	1	1	0	1	0
-59dB		0	1	1	1	0	1	1
-60dB		0	1	1	1	1	0	0
-61dB		0	1	1	1	1	0	1
-62dB		0	1	1	1	1	1	0
-63dB		0	1	1	1	1	1	1
-64dB		1	0	0	0	0	0	0
-65dB		1	0	0	0	0	0	1
-66dB		1	0	0	0	0	1	0
-67dB		1	0	0	0	0	1	1
-68dB		1	0	0	0	1	0	0
-69dB		1	0	0	0	1	0	1
-70dB		1	0	0	0	1	1	0
-71dB		1	0	0	0	1	1	1
-72dB		1	0	0	1	0	0	0
-73dB		1	0	0	1	0	0	1
-74dB		1	0	0	1	0	1	0
-75dB		1	0	0	1	0	1	1
-76dB		1	0	0	1	1	0	0
-77dB		1	0	0	1	1	0	1
-78dB		1	0	0	1	1	1	0
-79dB		1	0	0	1	1	1	1
-80dB		1	0	1	0	0	0	0
-81dB		1	0	1	0	0	0	1
-82dB		1	0	1	0	0	1	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
-83dB		1	0	1	0	0	1	1
-84dB		1	0	1	0	1	0	0
-85dB		1	0	1	0	1	0	1
-86dB		1	0	1	0	1	1	0
-87dB		1	0	1	0	1	1	1
-88dB		1	0	1	1	0	0	0
-89dB		1	0	1	1	0	0	1
-90dB		1	0	1	1	0	1	0
-91dB		1	0	1	1	0	1	1
-92dB		1	0	1	1	1	0	0
-95dB		1	0	1	1	1	1	1
-∞dB		1	1	1	1	0	0	0

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ELECTRICAL CHARACTERISTICS

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

(1) Power supply characteristics

Parameter	Symbol	Test condition	Limits			Unit
			Min	typ	Max	
Analog positive power circuit current	AIcc	With AVDD=7V and AVSS=-7V Pin29 pin current, when no signal is provided	—	50	70	mA
Analog negative power Circuit current	AIee	With AVDD=7V and AVSS=-7V Pin73 pin current, when no signal is provided	—	50	70	mA
Digital power circuit current	Dldd	With DVDD=5V, Pin24 pin current, when no signal is provided	—	3.0	6.0	mA

(2) Input/Output characteristics(OVER ALL)

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

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(3) 8 channel Volume characteristics

Parameter	Symbol	Test condition	Limits			Unit
			Min	typ	Max	
Maximum attenuation	ATTmax	Volume setting=0dB Vi=1Vrms,JIS-A,VOL=-∞	—	-100	-90	dB
Volume gain Between channels	Dvol	Pin31,32,33,34,35,36,37,38 output	-1.5	0	1.5	dB
Cross talk between channels	CT	Vo=0.5Vrms,RL=10kohm, JIS-A,Rg=0ohm	—	-80	-65	dB

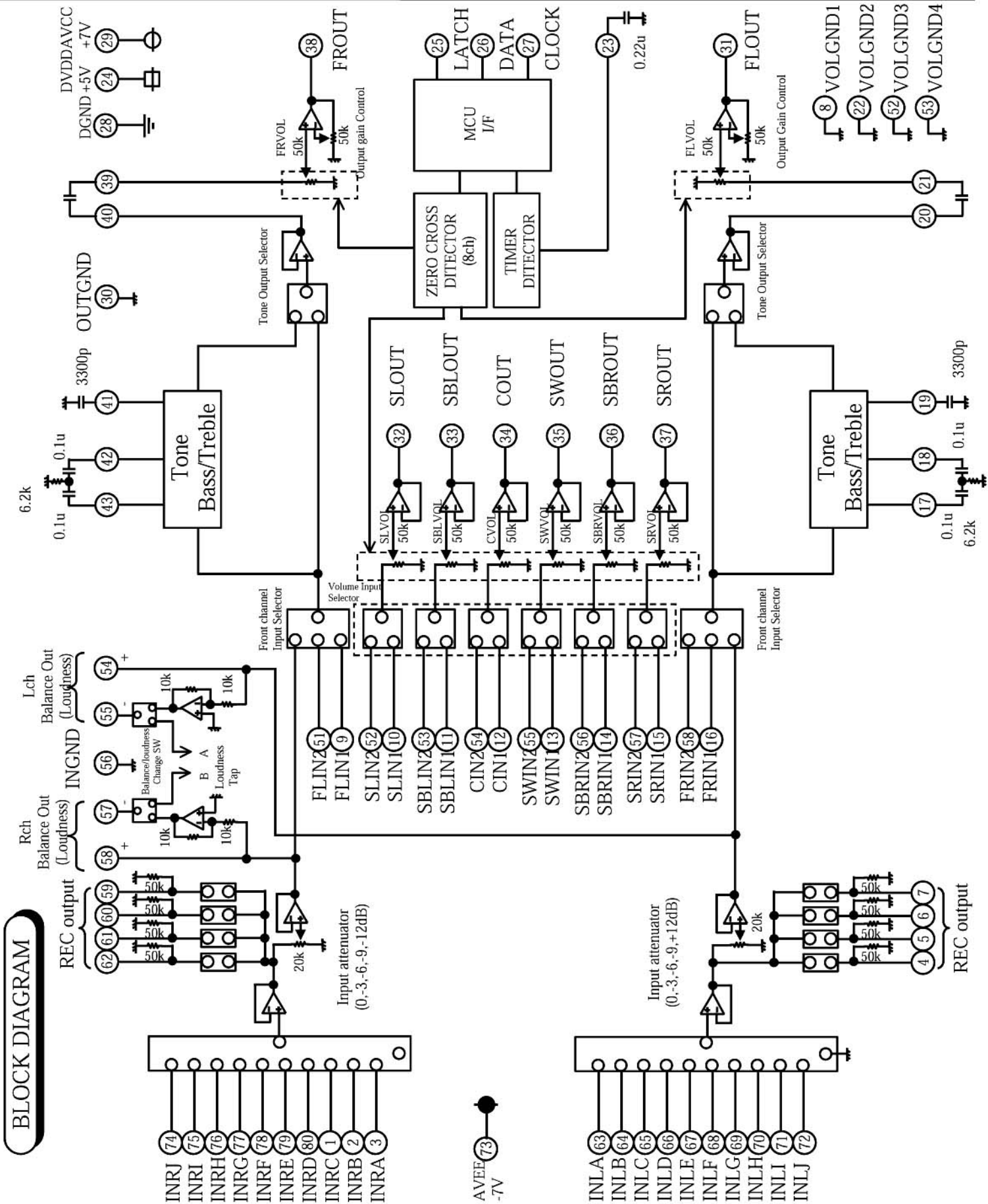
(4) Tone control characteristics

Unless otherwise noted,Front channel Input selector=external IN1,Tone Output Selector=Tone,
Input pin9,16 , Output pin20,40

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

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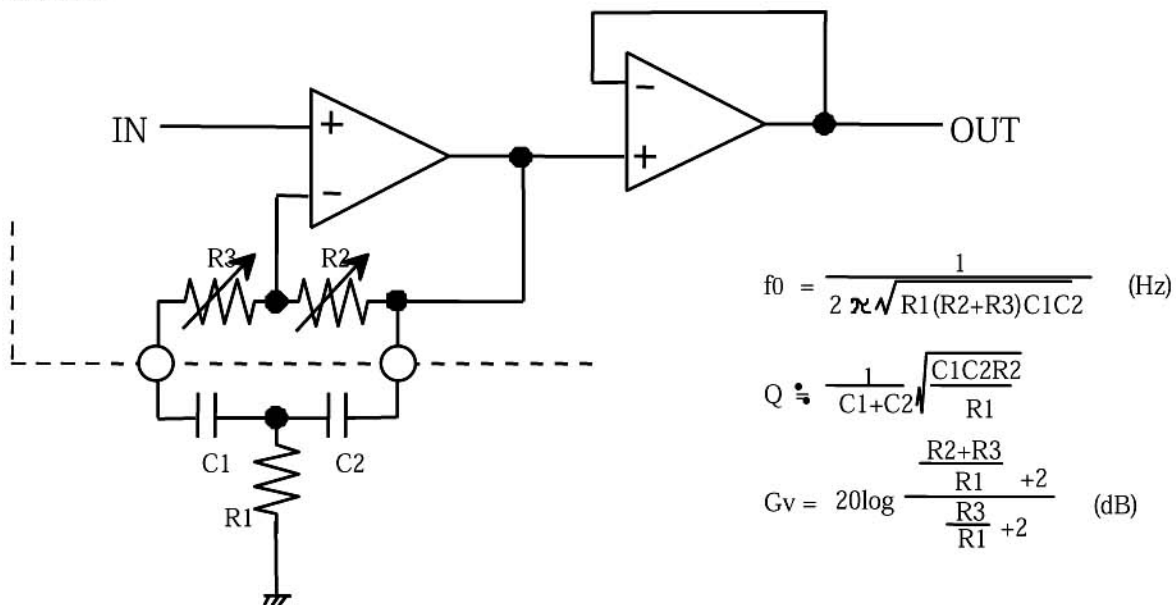
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7.1ch ELECTRONIC VOLUME WITH 10 INPUT SELECTOR

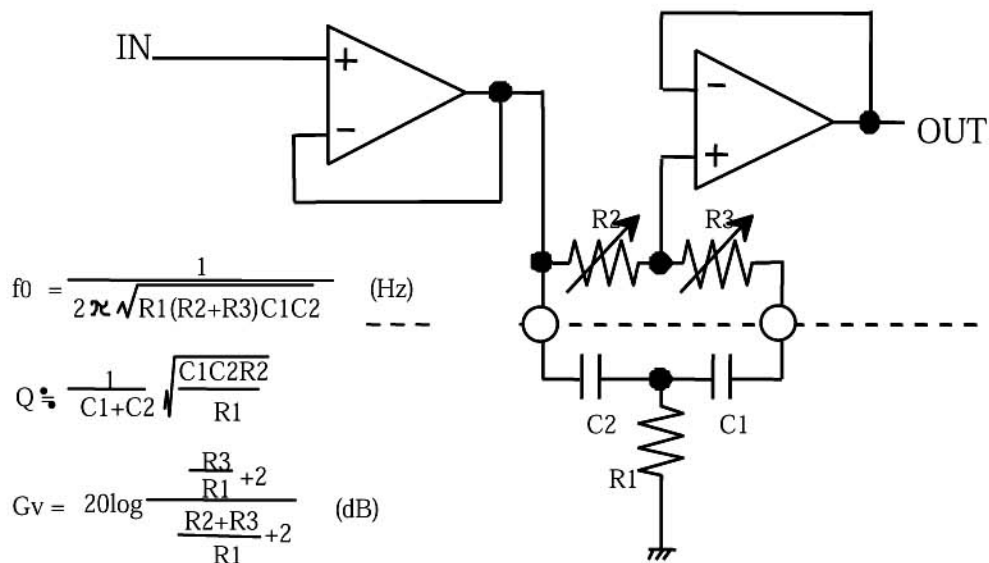
TONE CONTROL

(1)Bass

<Boost>



<Cut>

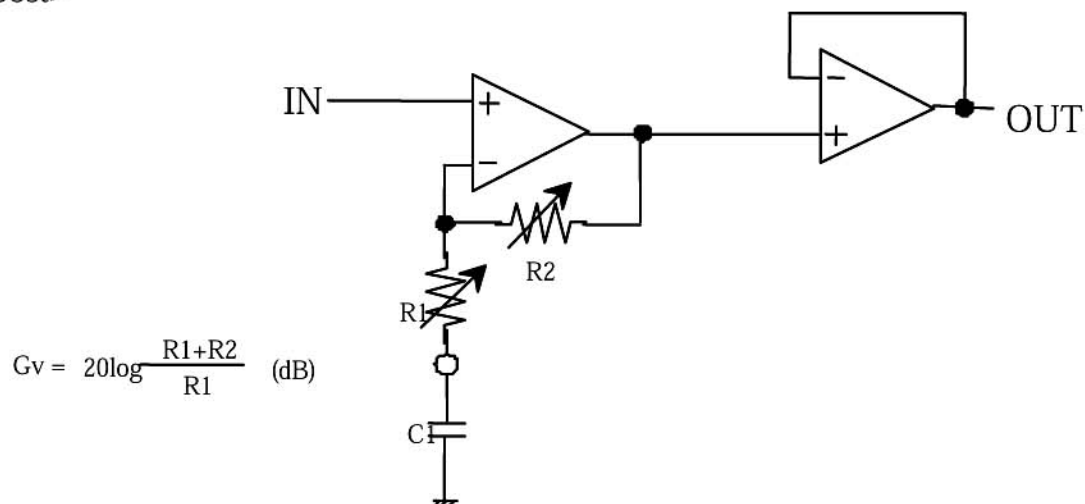


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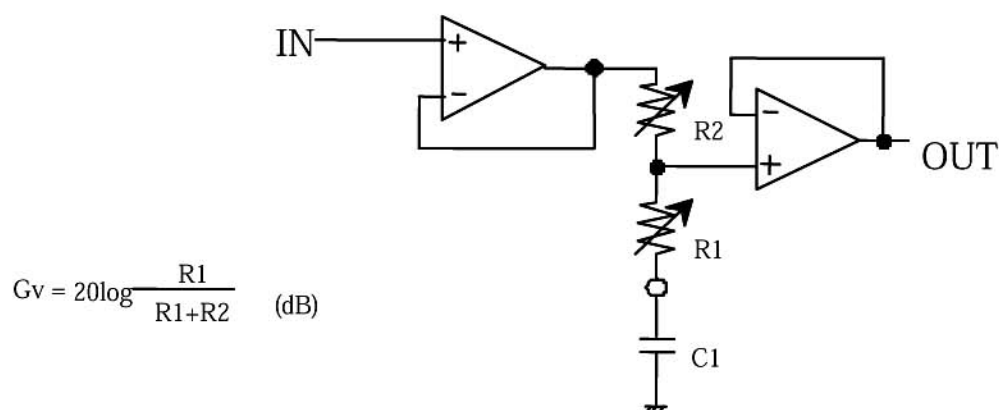
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(2) Treble

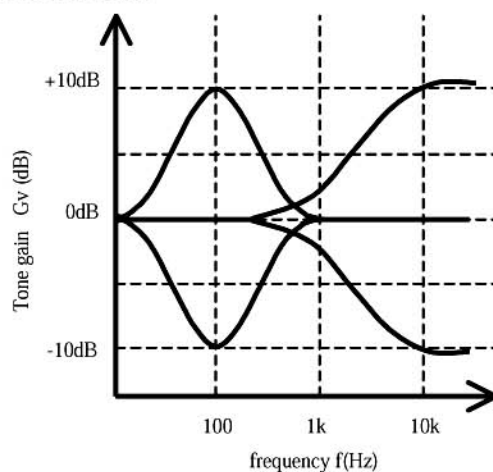
<Boost>



<Cut>



<Curve of characteristics>



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7.1ch ELECTRONIC VOLUME WITH 10 INPUT SELECTOR

Balance/Loudness

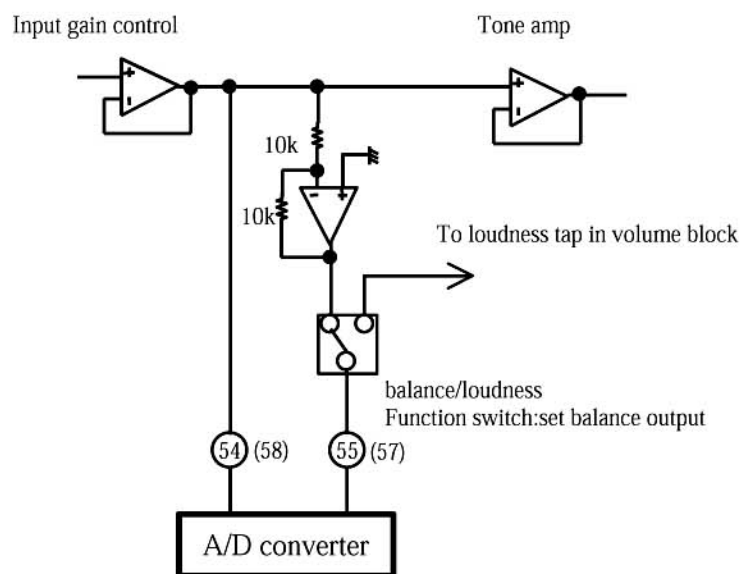
M61516FP has balance output (L/R channel) for external A/D converter.

The balance output (negative side/pin55,57) 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 be used at the same time.

1.Balance output

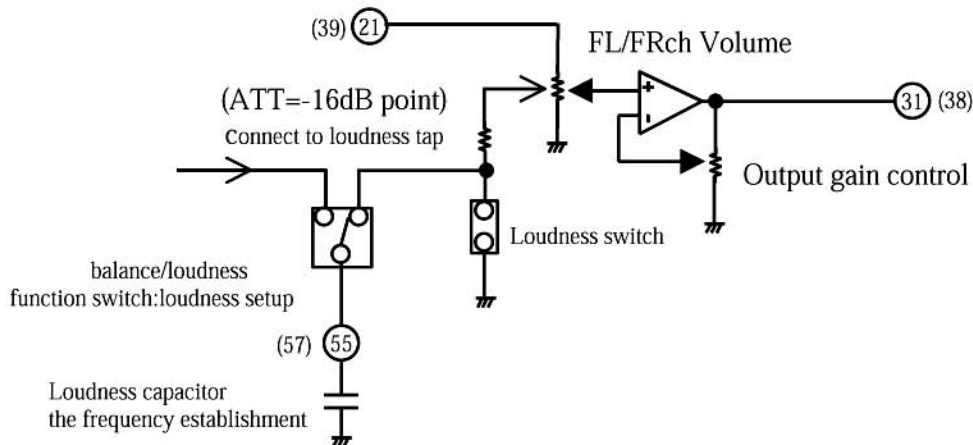
Balance/Loudness function switch setting:Balance Output(D26=0,D30=0,D31=0)



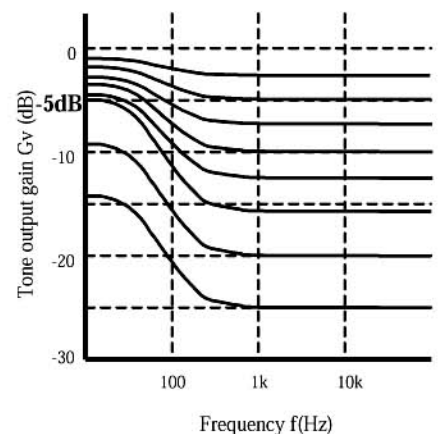
2.Loudness

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

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



<A characteristic curve>



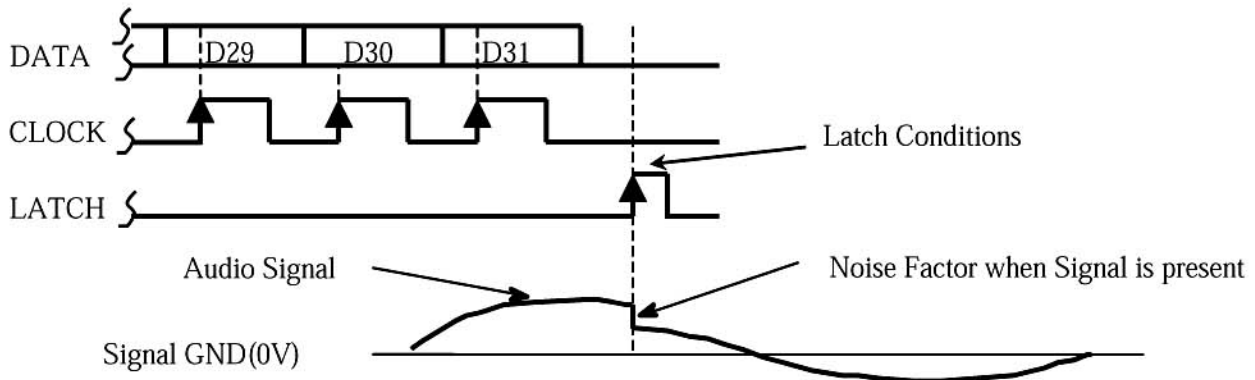
M61516FP

7.1ch ELECTRONIC VOLUME WITH 10 INPUT SELECTOR

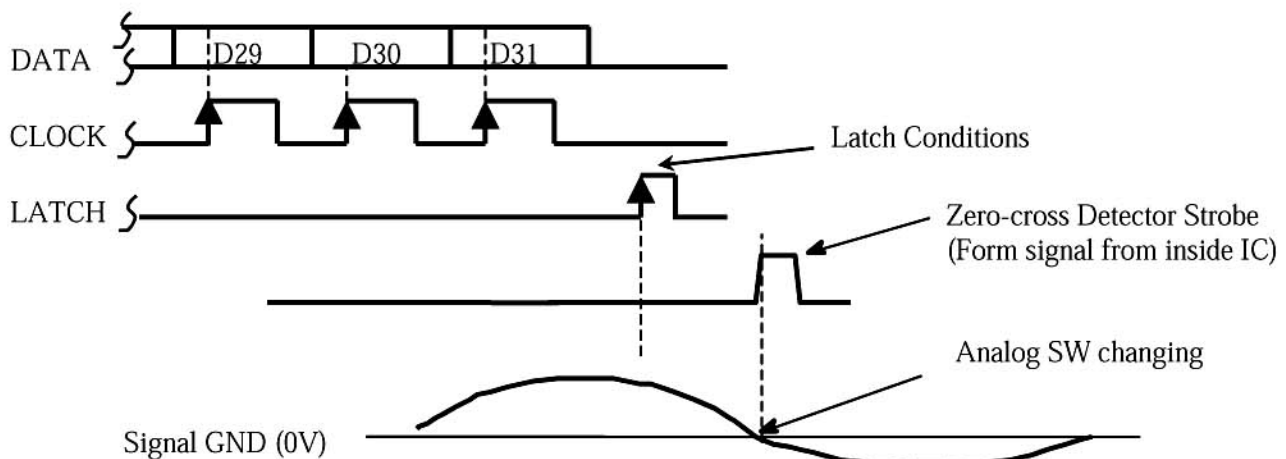
ZERO-CROSSING DETECTION CIRCUIT

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 (0V).



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 (0V). The Time Function switches the Analog SW after some time T.

The related type of C(PIN23) and T is as the following.

$$T = 13.8 \times 10^{-4} \cdot C \text{ (SEC)}$$

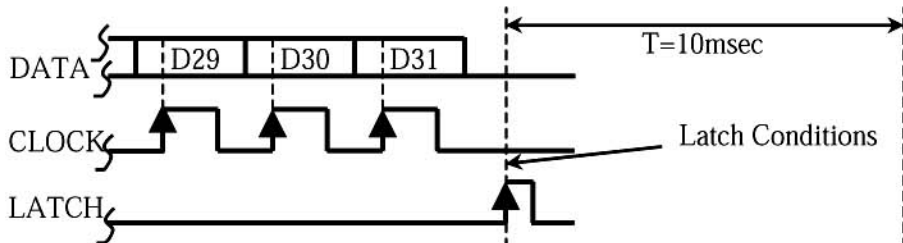
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2. Connection of Zero-Crossing Detector and Timer Setting

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

For example, case of $T=10\text{msec}$.

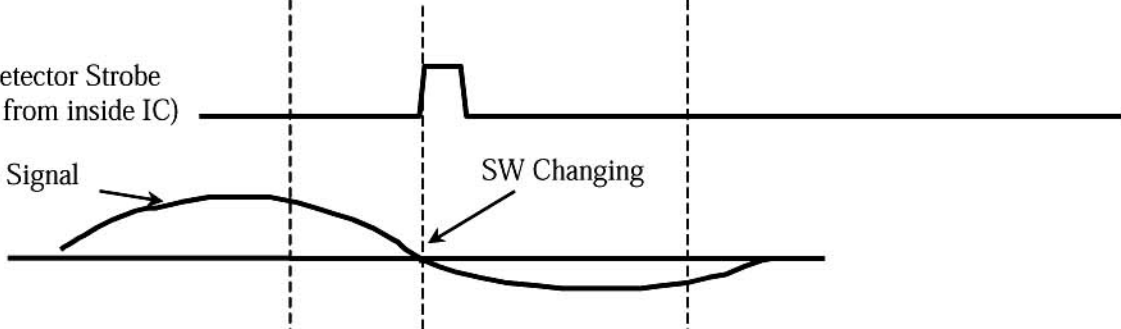


Pattern 1

Zero-cross Detector Strobe
(Form signal from inside IC)

Audio Signal

SW Changing



Pattern 2

Zero-cross Detector Strobe
(Form signal from inside IC)

Audio Signal

SW Changing



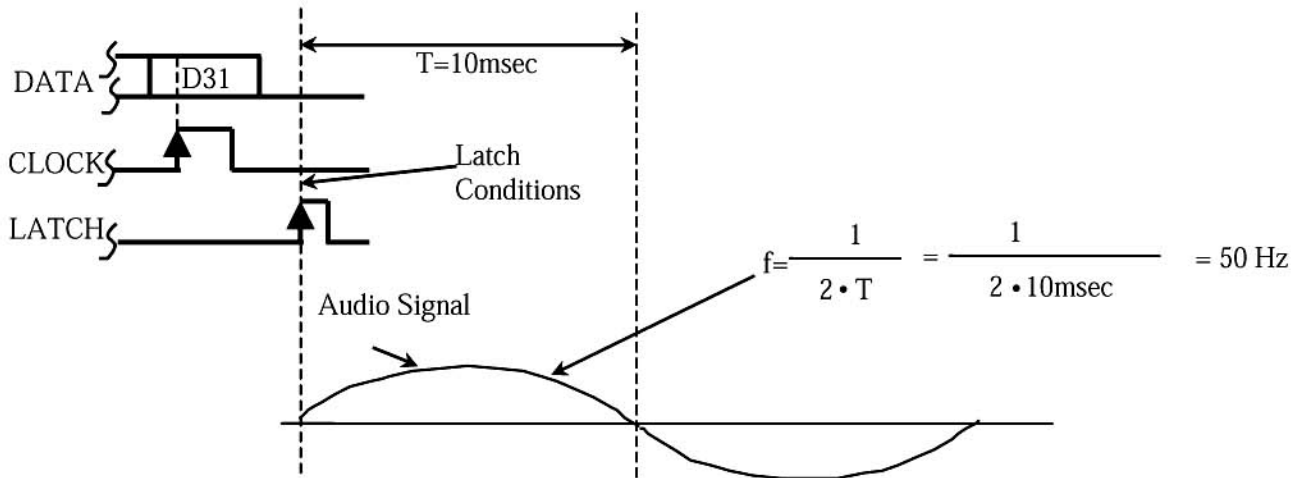
In case of Pattern1, the Zero-cross Detector Strobe occurs with the Zero-cross Detector Function, and SW is switched. But in case of Pattern2, the Timer Function switches the Analog SW after $T=10\text{msec}$, for the Audio Input Signal didn't cut the Signal Ground after $T=10\text{msec}$ which were set with the timer.

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

M61516FP

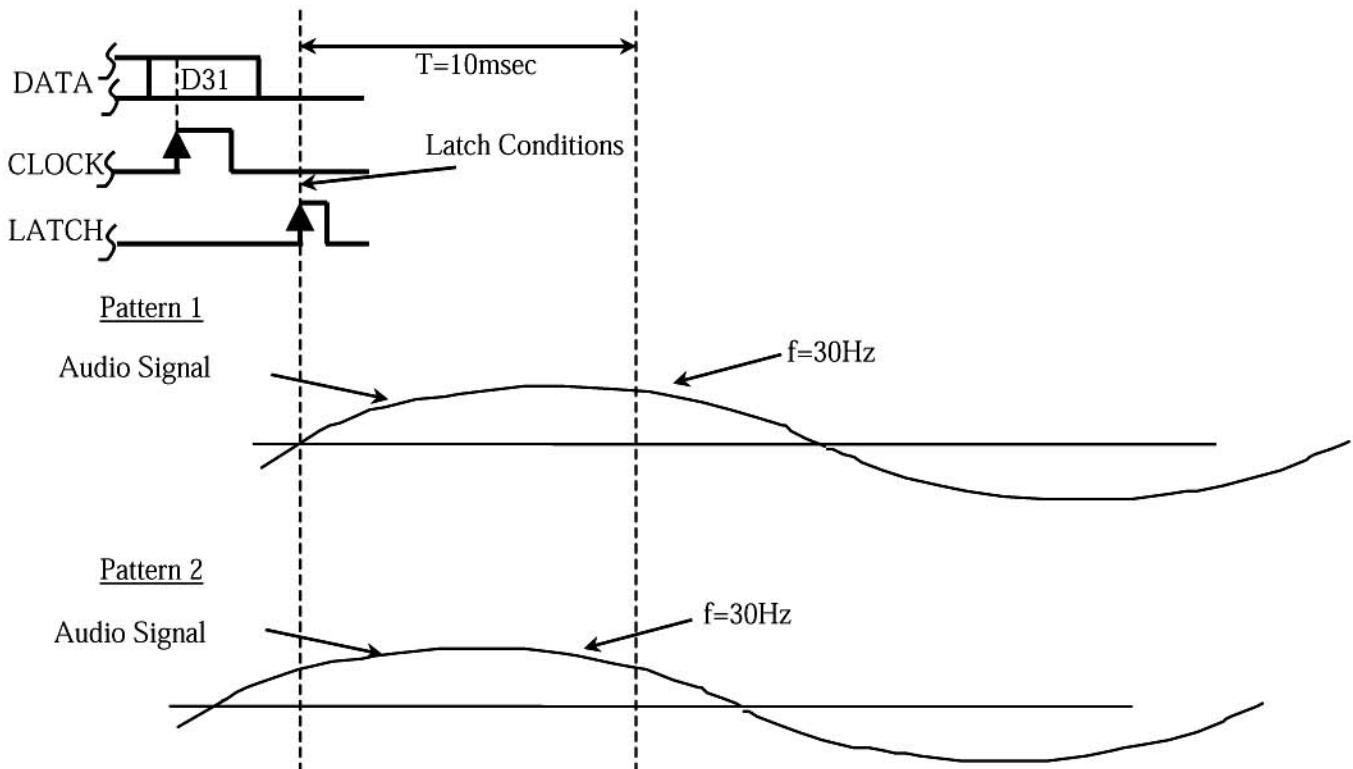
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3. Timer Setting System



In case of Timer Setting Time/ $T = 10 \text{ msec}$ setting

Audio Signal	Zero-cross Detect	
$50\text{Hz} \leq$	OK	Upper fig.
$50\text{Hz} \geq$	OK	Pattern 1
	NG	Pattern 2



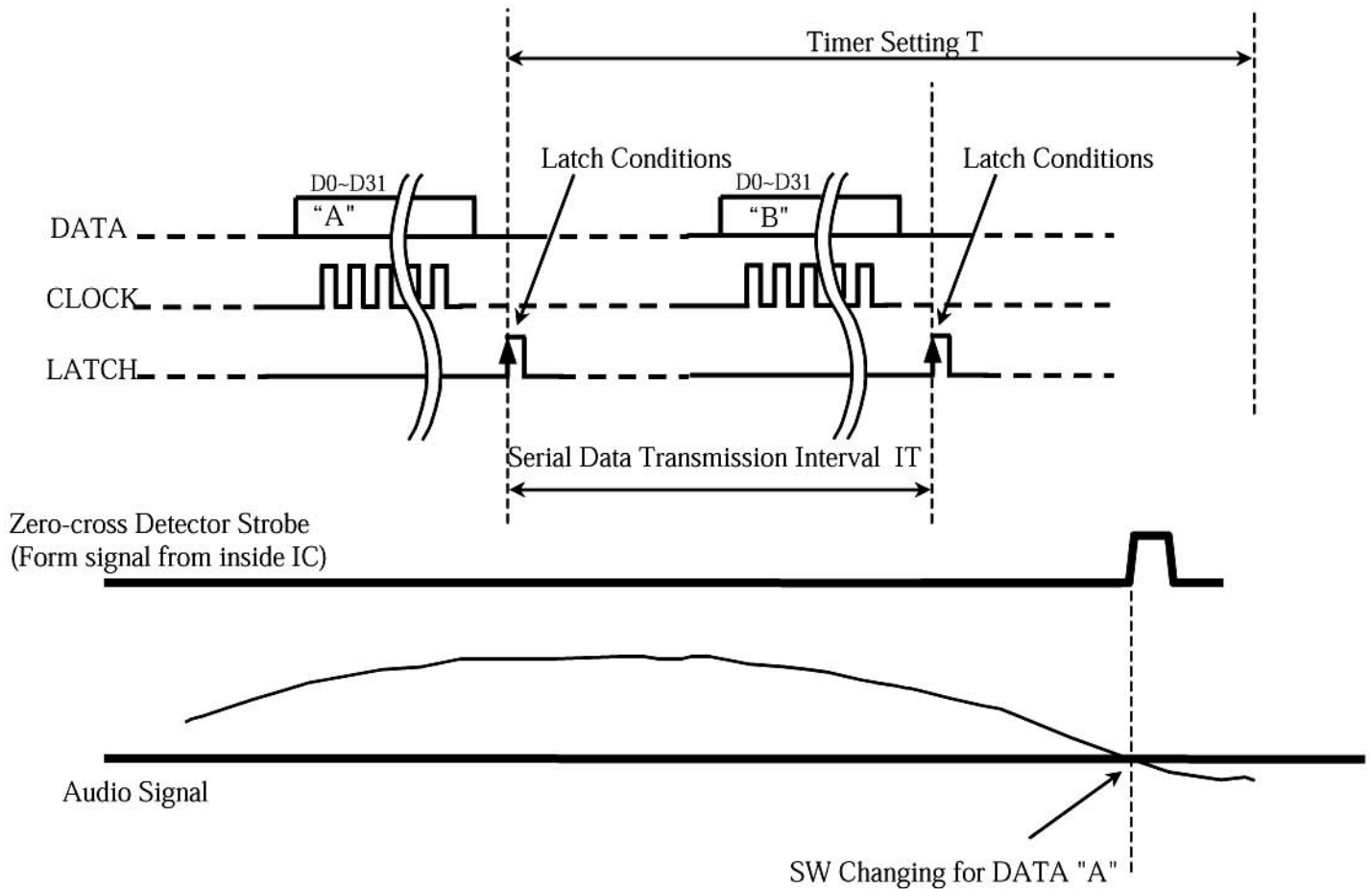
Timer Setting Time is about $T=10\text{msec}$ usually .

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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.

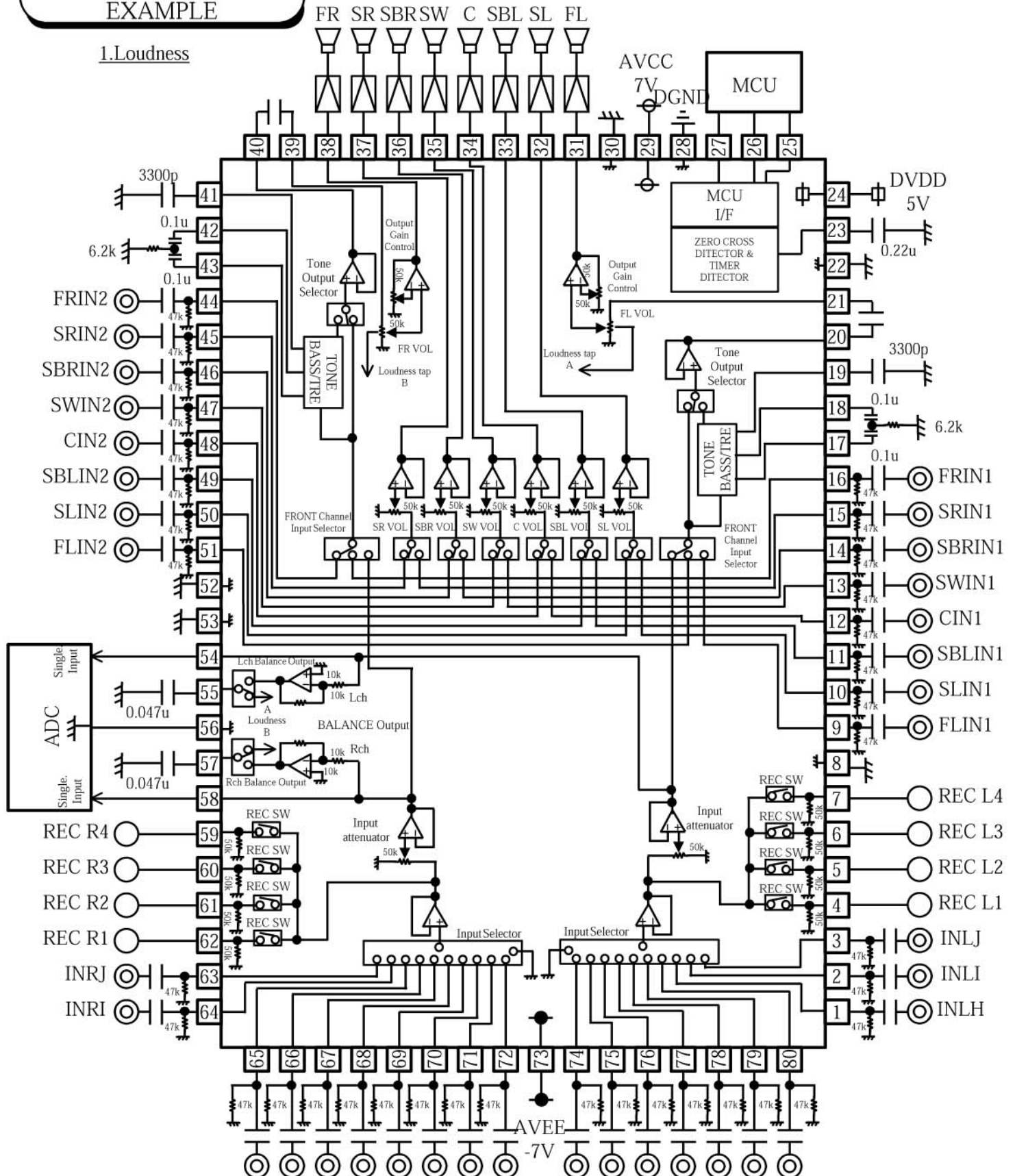
Serial Data Transmission Interval IT = Interval of between Latch Condition and Latch Condition

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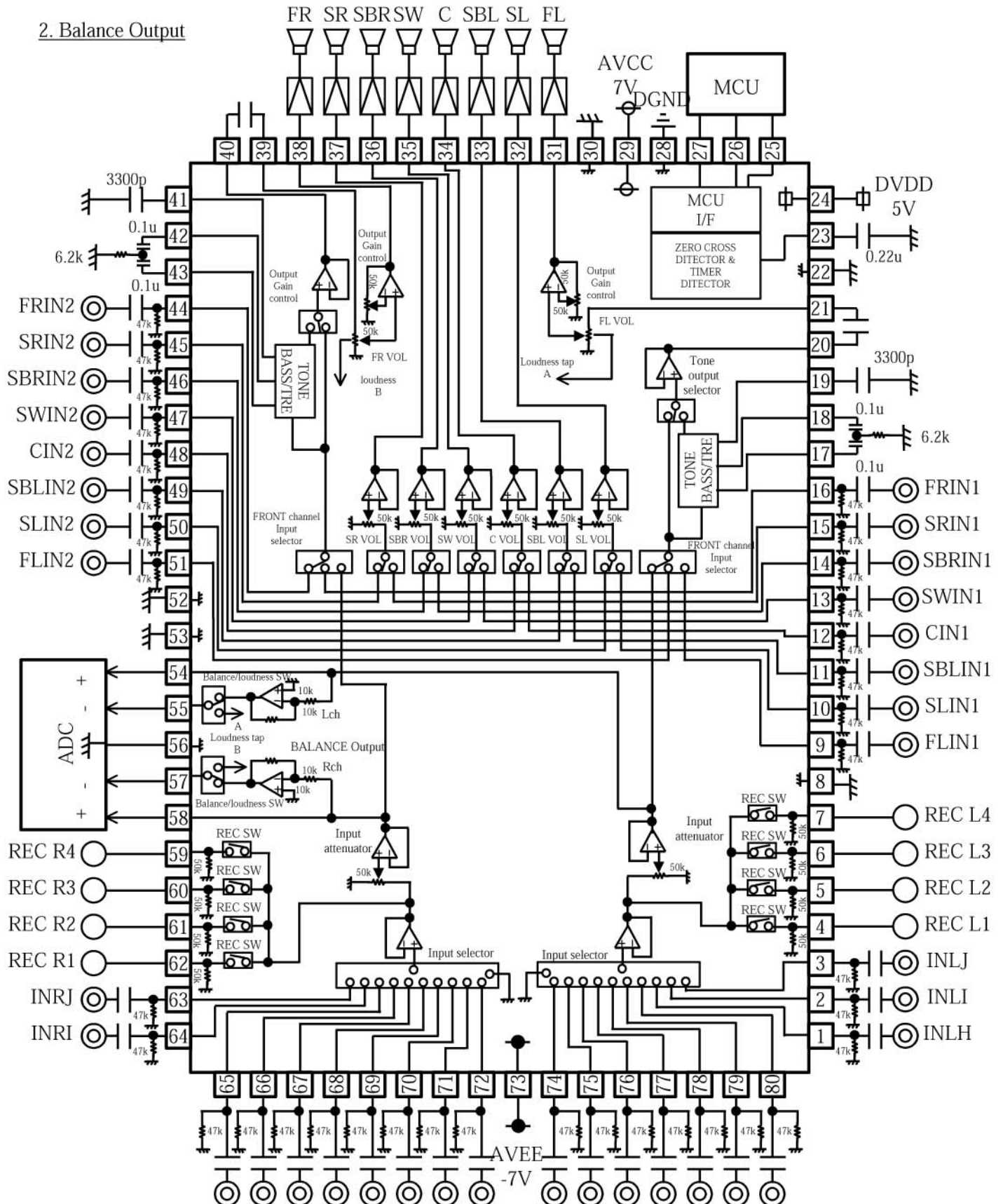
APPLICATION EXAMPLE

1.Loudness



M61516FP

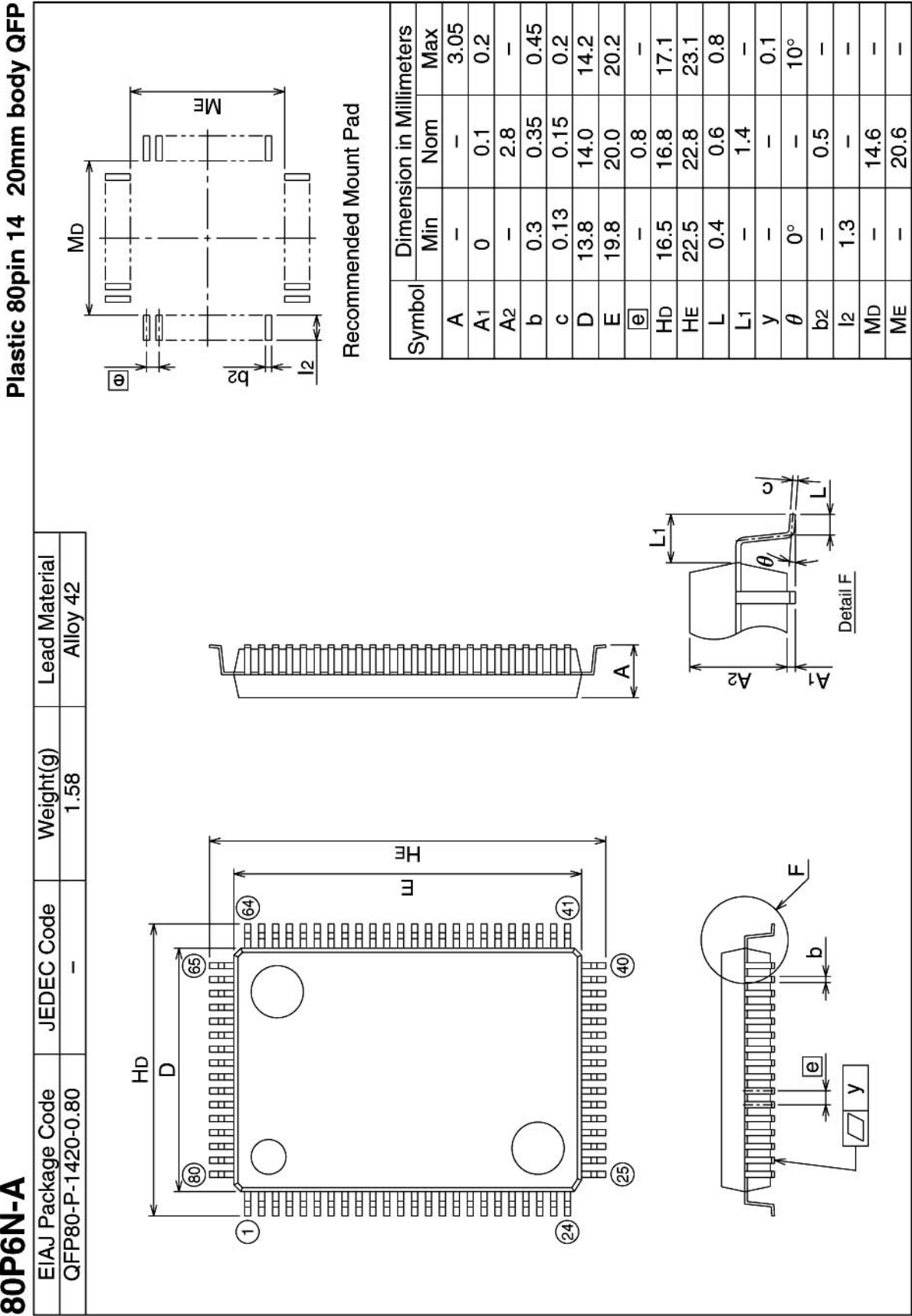
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DETAILED DIAGRAM OF PACKAGE OUTLINE



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