To our customers,

Old Company Name in Catalogs and Other Documents

   On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

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Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

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RENESAS

M61540FP

6ch Electronic Volume with 5 Input Selector

Description

M61540FP is an audio signal processor for home audio. This IC contains 6 channel electronic volume, gain control, input selector and 2 band tone control.

Features

- Electric Volume   6 channel independent Electronic Volume with High Voltage Transistor.
                         (0 to –99dB/1dBstep, –∞dB)
- Gain Control   6 channel independent Gain Control (0, 6, 12, 18dB)
- Input Selector   L/R channel 5 Input Selector
- Multi Channel Input   6 channel Input
- Tone Control   Bass: –14 to + 14dB(2dB step),
                         Treble: –14 to + 14dB(2dB step)
- REC Output   Can use 2 Input for REC Output
- ADC Out   Built-in ADC out

Recommended Operating Condition

Supply Voltage Range   AVCC = 7.0V(typ), AVEE = –7.0V(typ), DVDD = 3.0 to 5.5V

System Block Diagram
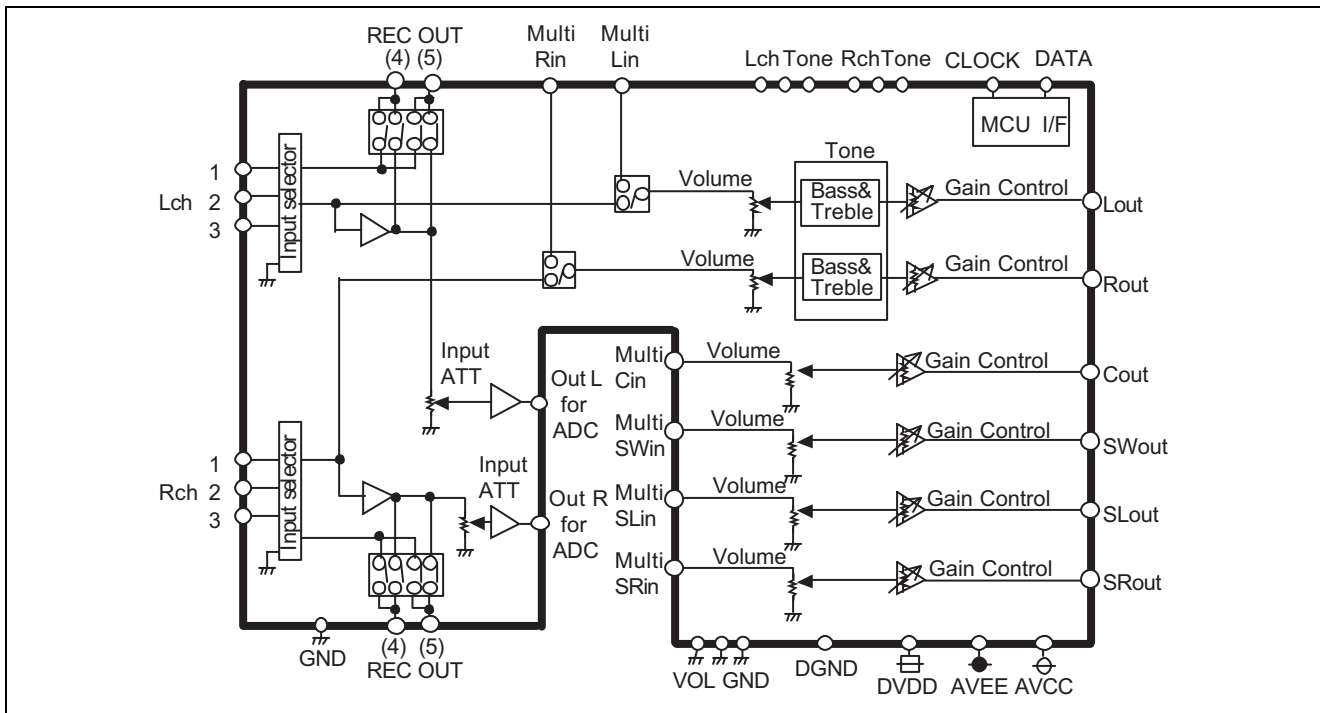
Block Diagram and Pin Configuration

BASR1 20
BASR2 19
LOUT 18
ROUT 17
DGND 16
CLOCK 15
DATA 14
DVDD 13
COUT 12
SWOUT 11

BASL2 21
BASL1 22
TRER 23
TREL 24
AGND 25
INR1 26
INL1 27
INR2 28
INL2 29
INR3 30

MCU I/F
DVDD
Gain Control
Gain Control

Bass /Tre
Bass /Tre

Gain Control
Gain Control
Gain Control
Gain Control

10 SLOUT
9 SROUT
8 AGND
7 SRIN
6 SLIN
5 SWIN
4 CIN
3 RIN
2 LIN
1 AGND

50K Rch Vol
50K Lch Vol

25K Cch Vol
25K SWch Vol
25K SLch Vol
25K SRch Vol

Logic

50K INR1
50K INL1
50K INR2
50K INL2
50K INR3

Input ATT
Input ATT

50K RIN
50K LIN

AVEE
AVCC
Rch
Lch

31 INL3
32 AGND
33 INL4 (RECL1)
34 INR4 (RECR1)
35 INL5 (RECL2)
36 INR5 (RECR2)
37 AVEE
38 AVCC
39 ADCR
40 ADCL

50K INL3
50K
50K
50K
50K

(Top View)

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Pin Description

Pin No.	Name	Function
1, 8, 25, 32	AGND	Analog Ground
2	LIN	Input pin of L channel (Multi)
3	RIN	Input pin of R channel (Multi)
4	CIN	Input pin of C channel (Multi)
5	SWIN	Input pin of SW channel (Multi)
6	SLIN	Input pin of SL channel (Multi)
7	SRIN	Input pin of SR channel (Multi)
9	SROUT	Output pin of SR channel
10	SLOUT	Output pin of SL channel
11	SWOUT	Output pin of SW channel
12	COUT	Output pin of C channel
13	DVDD	Power supply to internal logic circuit
14	DATA	Input pin of control data
15	CLOCK	Input pin of control clock
16	DGND	Ground of internal logic circuit
17	ROUT	Output pin of R channel
18	LOUT	Output pin of L channel
19, 20	BASR1, BASR2	Frequency characteristic setting pin of R channel tone control (BASS)
21, 22	BASL1, BASL2	Frequency characteristic setting pin of L channel tone control (BASS)
23	TRER	Frequency characteristic setting pin of R channel tone control (Treble)
24	TREL	Frequency characteristic setting pin of L channel tone control (Treble)
26, 28, 30	INR1, 2, 3	Input pin of R channel (Input Selector)
27, 29, 31	INL1, 2, 3	Input pin of L channel (Input Selector)
33, 35	INL4, 5/ RECL1, 2	Input pin of L channel (Input Selector) can use REC output pin
34, 36	INR4, 5/ RECR1, 2	Input pin of R channel (Input Selector) can use REC output pin
37	AVEE	Negative power supply to internal analog circuit
38	AVCC	Positive power supply to internal analog circuit
39, 40	ADCR, ADCL	Output pin for ADC

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Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Condition
Power Supply	Supply Voltage	16	V	AVCC-AVEE
		6		DVDD-DGND
Power dissipation	Pd	1.46	W	Ta≤25°C
Thermal derating	K	85.3	mW/°C	Ta>25°C
Operating temperature	Topr	−20 to +75	°C	
Storage temperature	Tstg	−40 to +125	°C	

Note: AVEE≤DGND<DVDD≤AVCC

THERMAL DERATINGS (MAXIMUM RATING)

POWER DISSIPATION pd (W)

AMBIENT TEMPERATURE   Ta (°C)

1.46W

0.88
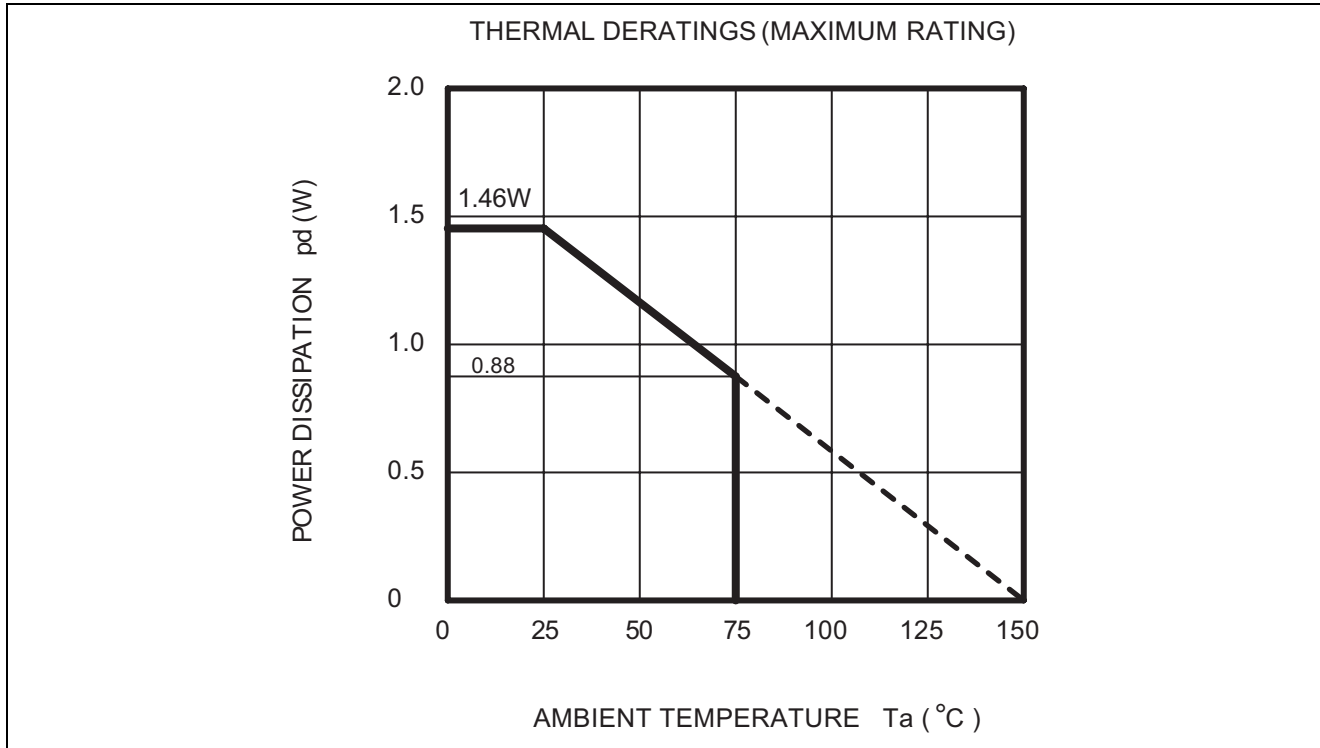
Recommended Operating Conditions

(Ta=25°C, unless otherwise noted.)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Analog Supply Voltage (Positive)	AVCC	4.5	7.0	7.5	V	
Analog Supply Voltage (Negative)	AVEE	−7.5	−7.0	−4.5	V	
Digital Supply Voltage	DVDD	3.0	3.3	5.5	V	
Logic "H" level Input Voltage	VIH	DVDD×0.7	—	DVDD	V	DGND reference
Logic "L" level Input Voltage	VIL	DGND	—	DVDD×0.2	V	DGND reference

Note: AVEE≤DGND<DVDD≤AVCC

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Relationship Between Data and Clock

Data signal is read at the rising edge of CLOCK.

Make "H" at the timing which
DATA of D0-D23 make latch.

DATA   D0   D1   D2   D3   D21   D22   D23

CLOCK

When DATA is "H", latch signal is
created at the falling edge of CLOCK.

Clock and Data Timings

(D0 to D23)
t_{cr}

DATA

LATCH

75%

25%

tSLD tHLD tSHD tHHD

tSLD   tHLD

tSC

75%
50%
25%

CLOCK   tr

tf

tWHC   tWLC
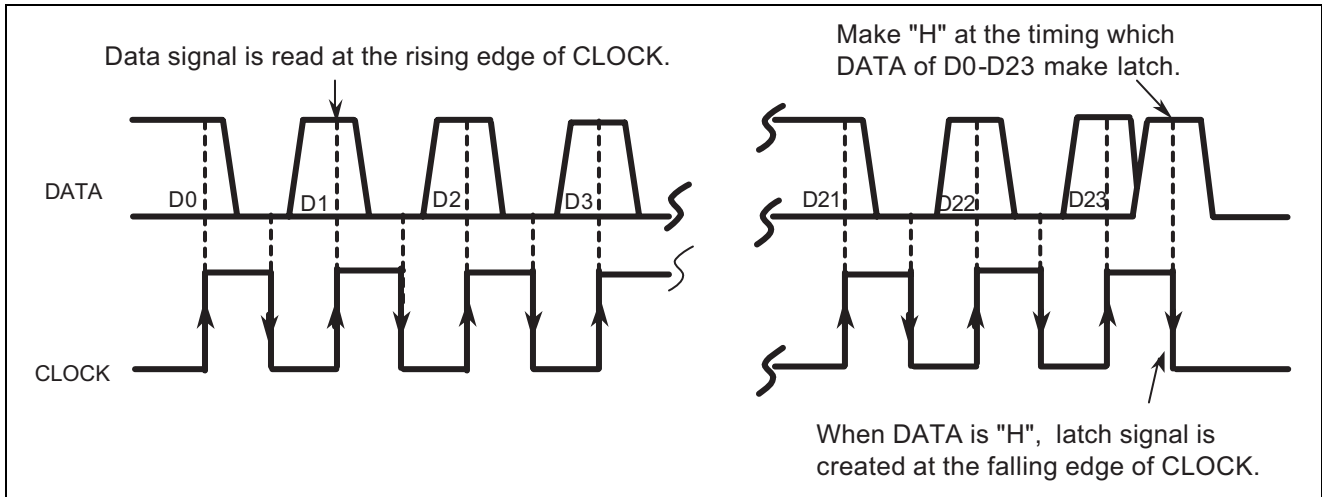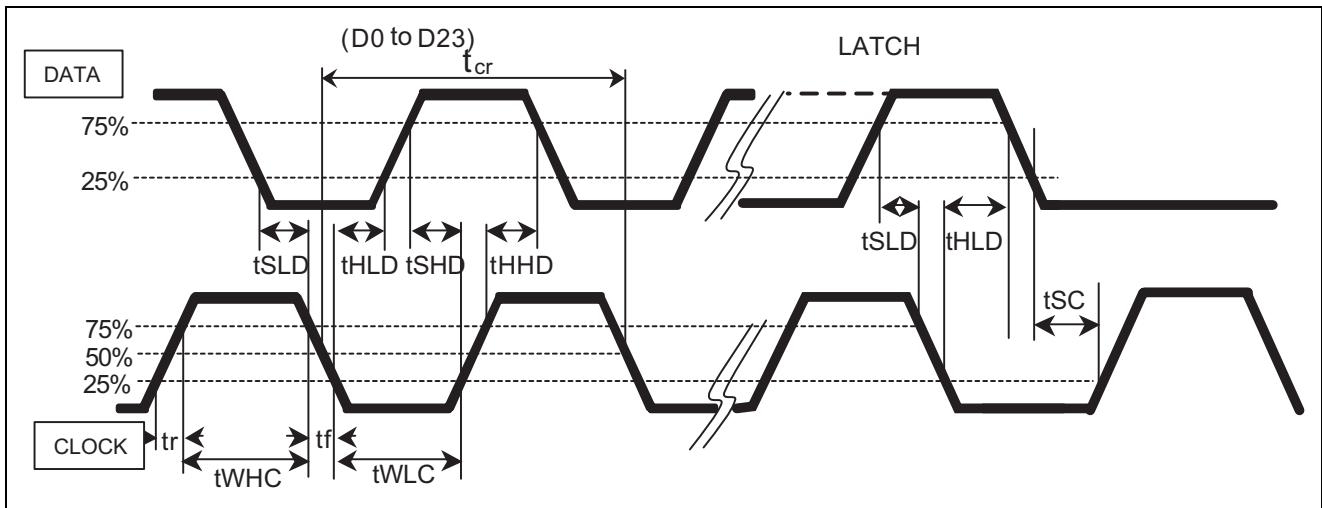
Timing Definition of Digital Block

Parameter	Symbol	Limits			Unit
		Min	**Typ**	**Max**	
CLOCK cycle time	tcr	8	—	—	
CLOCK pulse width ("H" level)	tWHC	3.2	—	—	
CLOCK pulse width ("L" level)	tWLC	3.2	—	—	
Rising time of clock and data	tr	—	—	0.8	
Falling time of clock and data	tf	—	—	0.8	µs
DATA setup time (Rising time of clock)	tSHD	1.6	—	—	
DATA setup time (Falling time of clock)	tSLD	1.6	—	—	
DATA hold time ("H" level)	tHHD	1.6	—	—	
DATA hold time ("L" level)	tHLD	1.6	—	—	
CLOCK setup time	tSC	1.6	—	—	

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Power on Reset

This IC built-in the power on reset function.
The voltage of DVDD (13 pin) -DGND (16 pin) less than 2.6V, the serial DATA can not accept.

Note: AVEE≤DGND<DVDD≤AVCC
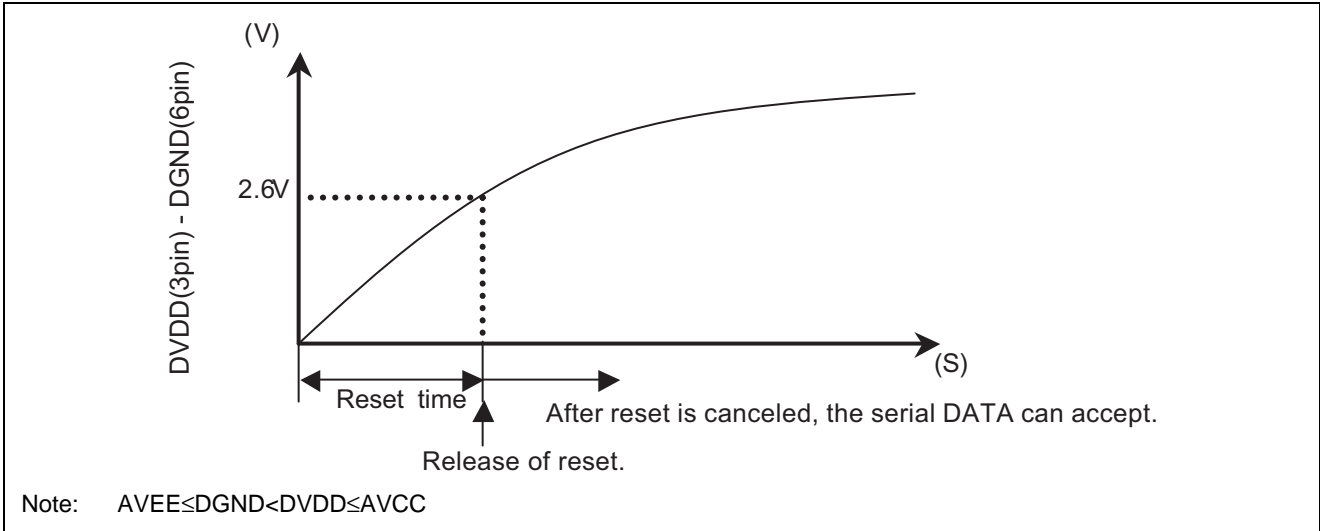
Data Control Specification

Initialize all data of the 4 formats when Digital Power supply (DVDD) turns on.

Prohibit using except specified Data code as follows.

Slot1

D0a	D1a	D2a	D3a	D4a	D5a	D6a	D7a	D8a	D9a	D10a	D11a	D12a	D13a	D14a	D15a	D16a	D17a	D18a	D19a	D20a	D21a	D22	D23
(1) Input Selector					(2) REC Output		(3) ADC Input ATT	(4) L/R Vol Input	(5) Bass/ Tone control Bypass			(6) Treble				0	0	0	0	0	0	0	0

Slot2

D0b	D1b	D2b	D3b	D4b	D5b	D6b	D7b	D8b	D9b	D10b	D11b	D12b	D13b	D14b	D15b	D16b	D17b	D18b	D19b	D20b	D21b	D22	D23
(7) Lch Gain Control	(8) Lch Volume								(7) Rch Gain Control	(8) Rch Volume								0	0	0	0	0	1

Slot3

D0c	D1c	D2c	D3c	D4c	D5c	D6c	D7c	D8c	D9c	D10c	D11c	D12c	D13c	D14c	D15c	D16c	D17c	D18c	D19c	D20c	D21c	D22	D23
(7) Cch Gain Control	(8) Cch Volume								(7) SWch Gain Control	(8) SWch Volume								0	0	0	0	1	0

Slot4

D0d	D1d	D2d	D3d	D4d	D5d	D6d	D7d	D8d	D9d	D10d	D11d	D12d	D13d	D14d	D15d	D16d	D17d	D18d	D19d	D20d	D21d	D22	D23
(7) SLch Gain Control	(8) SLch Volume								(7) SRch Gain Control	(8) SRch Volume								0	0	0	0	1	1

Note: No guarantee except for these codes.

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Setting Code

☐ It's initial setting when power is turned on.

(1) Input Selector

Setting	D0a	D1a	D2a
ALL OFF	0	0	0
IN1	0	1	0
IN2	1	0	0
IN3	1	1	0
IN4*	0	0	1
IN5*	0	1	1

Note: *No guarantee except for these codes.

(2) REC Output

REC Output	REC1	REC2
Setting	D3a	D4a
OFF	0	0
ON	1*1	1*2

*1: When IN4 selected, REC1 can not use.

IN4	REC1	D0a	D1a	D2a	D3a
ON	OFF	0	0	1	1

*2: When IN5 selected, REC2 can not use.

IN5	REC2	D0a	D1a	D2a	D4a
ON	OFF	0	1	1	1

(3) ADC Input ATT

ATT Setting	D5a	D6a
0dB	0	0
−6dB	0	1
−12dB	1	0
−18dB	1	1

(4) L/R Volume Input

Setting	D7a
Selector In	0
Multi In	1

RENESAS

It's initial setting when power is turned on.

(5) Bass/Bypass

ATT Setting	D8a	D9a	D10a	D11a
+14dB	1	1	1	1
+12dB	1	1	1	0
+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	1	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
−12dB	0	1	1	0
−14dB	0	1	1	1
Bypass*3	0	0	0	0

*3: Tone control is bypass.

(6) Treble

ATT Setting	D12a	D13a	D14a	D15a
+14dB	1	1	1	1
+12dB	1	1	1	0
+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	1/0	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
−12dB	0	1	1	0
−14dB	0	1	1	1

(7) Gain Control

ATT Setting	Lch	D0b	D1b
	Rch	D9b	D10b
	Cch	D0c	D1c
	SWch	D9c	D10c
	SLch	D0d	D1d
	SRch	D9d	D10d
0dB		0	0
6dB		0	1
12dB		1	0
18dB		1	1

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(8) 6ch Volume

It's initial setting when power is turned on.

ATT	Lch Rch Cch SWch SLch SRch	D2b D11b D2c D11c D2d D11d	D3b D12b D3c D12c D3d D12d	D4b D13b D4c D13c D4d D13d	D5b D14b D5c D14c D5d D14d	D6b D15b D6c D15c D6d D15d	D7b D16b D7c D16c D7d D16d	D8b D17b D8c D17c D8d D17d
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
−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

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ATT	Lch Rch Cch SWch SLch SRch	D2b D11b D2c D11c D2d D11d	D3b D12b D3c D12c D3d D12d	D4b D13b D4c D13c D4d D13d	D5b D14b D5c D14c D5d D14d	D6b D15b D6c D15c D6d D15d	D7b D16b D7c D16c D7d D16d	D8b D17b D8c D17c D8d D17d
−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
−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
−83dB		1	0	1	0	0	1	1
−84dB		1	0	1	0	1	0	0

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ATT	Lch	D2b	D3b	D4b	D5b	D6b	D7b	D8b
	Rch	D11b	D12b	D13b	D14b	D15b	D16b	D17b
	Cch	D2c	D3c	D4c	D5c	D6c	D7c	D8c
	SWch	D11c	D12c	D13c	D14c	D15c	D16c	D17c
	SLch	D2d	D3d	D4d	D5d	D6d	D7d	D8d
	SRch	D11d	D12d	D13d	D14d	D15d	D16d	D17d
−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
−93dB	1	0	1	1	1	0	1
−94dB	1	0	1	1	1	1	0
−95dB	1	0	1	1	1	1	1
−96dB	1	1	0	0	0	0	0
−97dB	1	1	0	0	0	0	1
−98dB	1	1	0	0	0	1	0
−99dB	1	1	0	0	0	1	1
−∞dB	1	1	1/0	1/0	1	1/0	1/0

Note: No guarantee except for these codes.

Electrical Characteristics

Unless otherwise noted, Ta = 25°C, AVCC = 7V, AVEE = –7V, DVDD = 5V, f = 1kHz, Volume = 0dB,
Input Selector = IN1, Gain Control = 0dB, ADC Input ATT = 0dB, Tone = Bypass

(1) Power supply characteristics

| Parameter | Symbol | Limits | | | Unit | Test condition |
		Min	Typ	Max		
Analog positive power circuit current	AIcc	—	32	42	mA	With AVCC = 7V and AVEE = –7V 38pin current, when no signal is provided
Analog negative power circuit current	AIee	–42	–32	—	mA	With AVCC = 7V and AVEE = –7V 37pin current, when no signal is provided
Digital power circuit current	DIdd	—	2	3	mA	With DVDD = 3.3V, 13pin current, when no signal is provided

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(2) Input/Output characteristics (OVER ALL)

Parameter	Symbol	Min	Typ	Max	Unit	Test condition	
Input resistance	Rin	17	25	33	Ω	2 to 7, 26, 27 pin	
Maximum output voltage	VOM	3.8	4.4	—	Vrms	2 to 7pin input, 9 to 12,17,18pin output, THD = 1%, RL = 10kΩ, Output Gain Control = +6dB	
Pass gain	Gv	−2.0	0	2.0	dB	2 to 7,26,27 pin input, 9 to 12,17,18pin output, Vi = 0.3Vrms, FLAT	
Total harmonic distortion	THD1	—	0.002	0.008	%	2 to 7pin input, 9 to12, 17,18 pin output, BW: 400Hz to 30kHz, f = 1kHz, Vo = 0.3Vrms, RL=10kΩ	
	THD2	—	0.01	0.1		2 to 7pin input, 9 to 12, 17,18pin output, BW: 400Hz to 30kHz, f = 1kHz, Vo = 2Vrms, RL = 10kΩ	
Balance of mutual channels	CBAL	−0.5	0	0.5	dB	26,27pin input, 17,18pin output, Vi = 0.3Vrms	
Output noise voltage	Vono1	—	1	3	μVrms	JIS-A, Rg = 0Ω, 17,18pin output, Volume = −∞dB setting	Output Gain Control = 0dB
		—	5	15			Output Gain Control = +12dB
	Vono2	—	1.5	4.5		JIS-A, Rg = 0Ω, 17,18pin output, Volume = 0dB setting	Output Gain Control = 0dB
		—	7.2	22			Output Gain Control = +12dB
	Vono3	—	1	3		JIS-A, Rg = 0Ω, 9 to 12pin output, Volume = 0dB setting	Output Gain Control = 0dB
		—	5	15			Output Gain Control = +12dB
Selector separation	SS1	—	−90	−70	dB	< Input Selector> Vo = 1Vrms, Rg = 0Ω, RL = 10kΩ, JIS-A	
	SS2	—	−90	−70		< Multi Input Selector > Vo = 1Vrms, Rg = 0Ω, RL = 10kΩ, JIS-A	
Channel separation	CS	—	−90	−70		Vo = 1Vrms, Rg = 0Ω, RL = 10kΩ, JIS-A	

(3) 6 channel Volume characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Test condition
Maximum attenuation	ATTmax	—	−100	−95	dB	Vi = 2Vrms, JIS-A, VOL = −∞dB
Volume gain gang error of mutual channels	Dvol	−0.5	0	+0.5	dB	Volume = 0dB

(4) Tone control characteristics

Unless otherwise noted, Tone ON/OFF = ON

Parameter	Symbol	Min	Typ	Max	Unit	Test condition
Tone control voltage gain (Boost/Bass)	G (BASS) B	+12	+14	+16	dB	f = 100Hz Bass +14dB setting
Tone control voltage gain (Cut/Bass)	G (BASS) C	−16	−14	−12	dB	f = 100Hz Bass −14dB setting
Tone control voltage gain (Boost/Treble)	G (TRE) B	+12	+14	+16	dB	f = 10kHz Treble +14dB setting
Tone control voltage gain (Cut/Treble)	G (TRE) C	−16	−14	−12	dB	f = 10kHz Treble −10dB setting
Balance of mutual channels	BALT	−2	0	+2	dB	Bass setting +14, −14dB Treble setting +14, −14dB

RENESAS

Tone Control

(1) Bass

< Boost >

IN

OUT

R3   R2

$$f0 = \frac{1}{2\pi\sqrt{R1(R2+R3)C1C2}} \quad (Hz)$$

C1   C2
0.047μ   0.15μ

$$Q = \frac{\sqrt{(R2+R3)R1C1C2}}{R1(C1+C2)+R3C1}$$

R1
4.7K

$$Gv = 20\log\left\{\frac{R1(C1+C2)+(R2+R3)C1}{R1(C1+C2)+R3C1}\right\} \quad (dB)$$

< Cut >

IN

OUT

R2   R3

C2   C1
0.15 μ   0.047μ

R1
4.7K

$$f0 = \frac{1}{2\pi\sqrt{R1(R2+R3)C1C2}} \quad (Hz)$$

$$Q = \frac{\sqrt{(R2+R3)R1C1C2}}{R1(C1+C2)+R3C1}$$

$$Gv = 20\log\left\{\frac{R1(C1+C2)+R3C1}{R1(C1+C2)+(R2+R3)C1}\right\} \quad (dB)$$

(2) Treble

< Boost >

IN —— (op-amp +/−) R5, R4

$$Gv = 20\log\left(\frac{\sqrt{(R4+R5)^2 + RC^2}}{\sqrt{R4^2 + RC^2}}\right) \text{(dB)}$$

RC —— 0.022μ

<Cut >

IN —— (op-amp) R5, R4

$$Gv = 20\log\left(\frac{\sqrt{R4^2 + RC^2}}{\sqrt{(R4+R5)^2 + RC^2}}\right) \text{(dB)}$$

RC —— 0.022μ
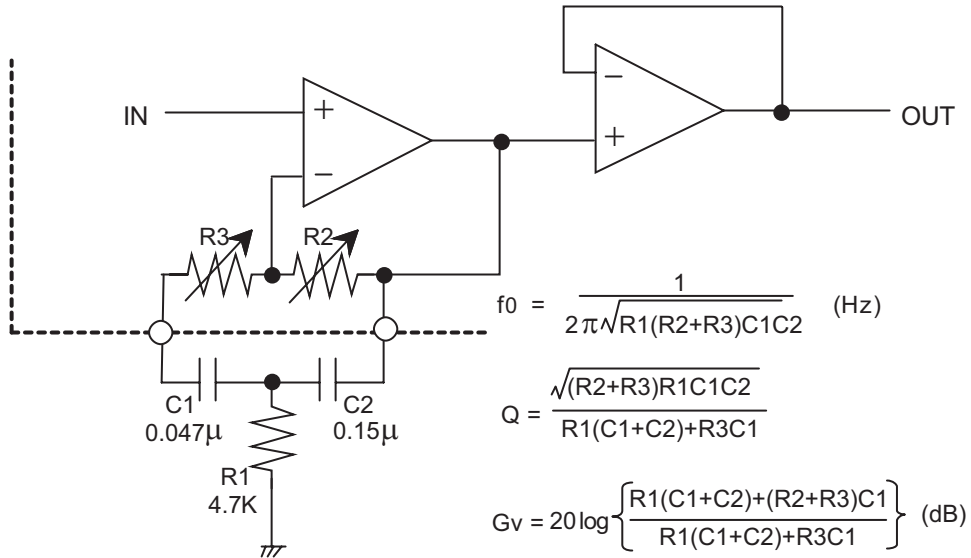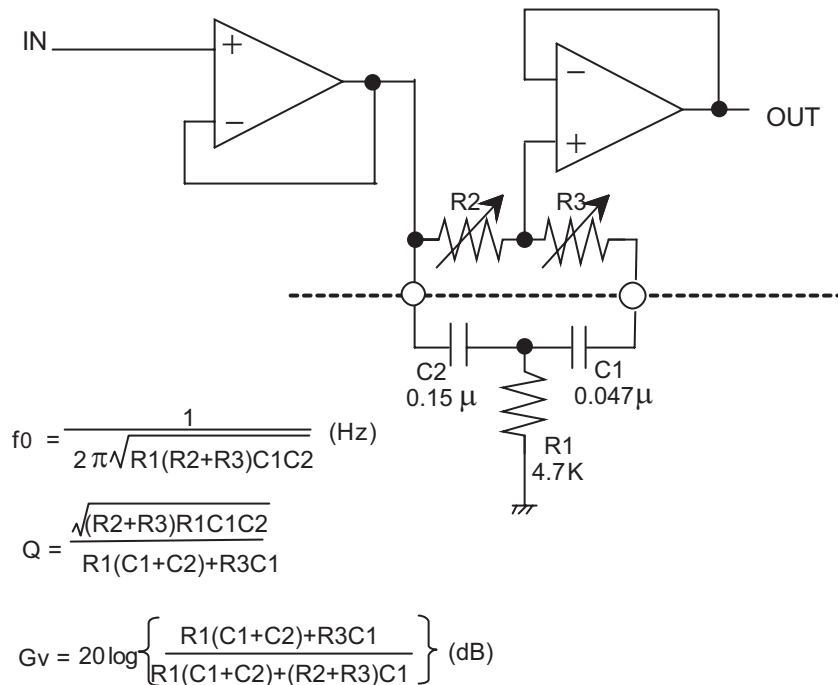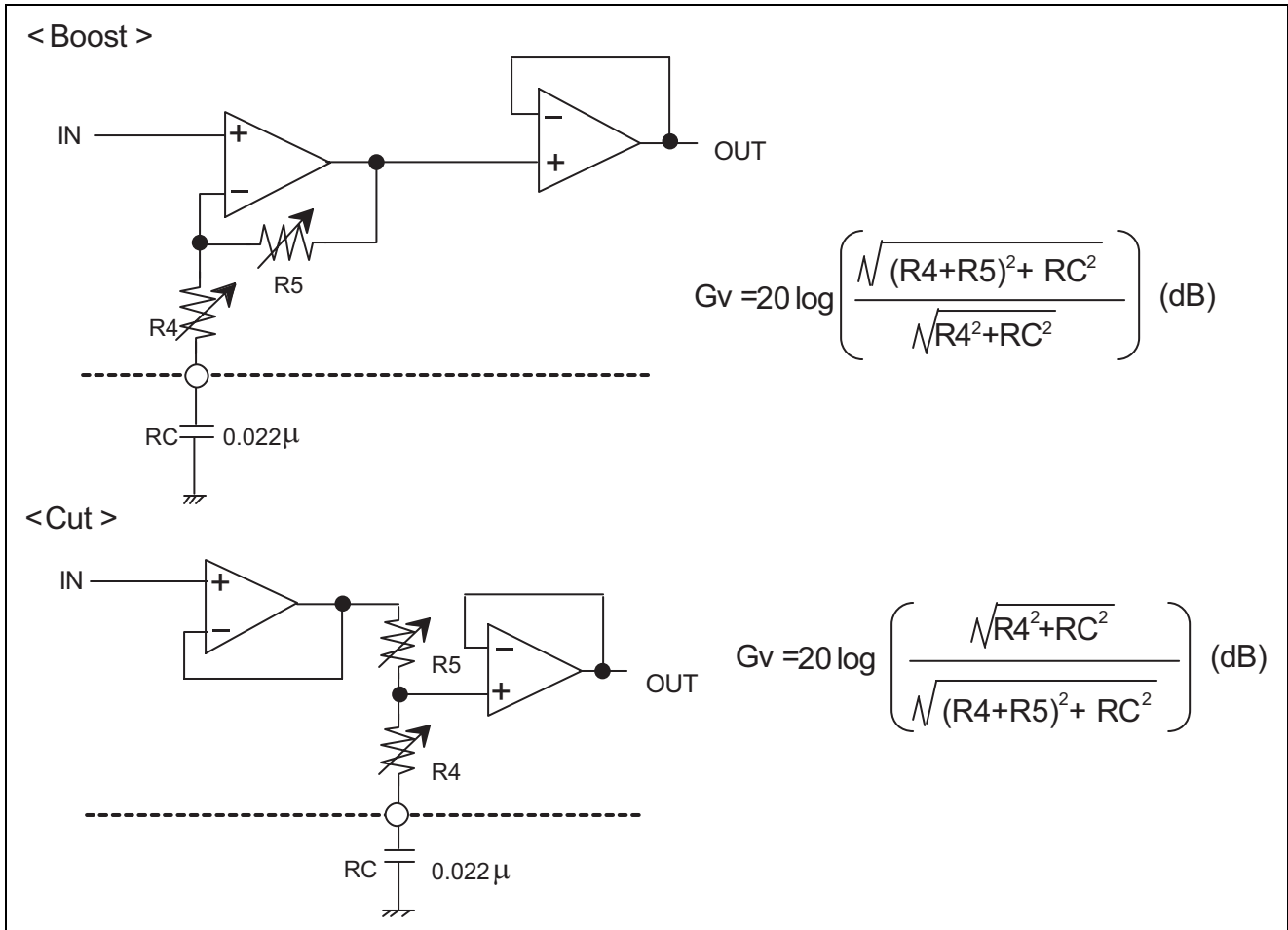
Curve of characteristics

Tone gain Gv (dB)

Frequency f(Hz)
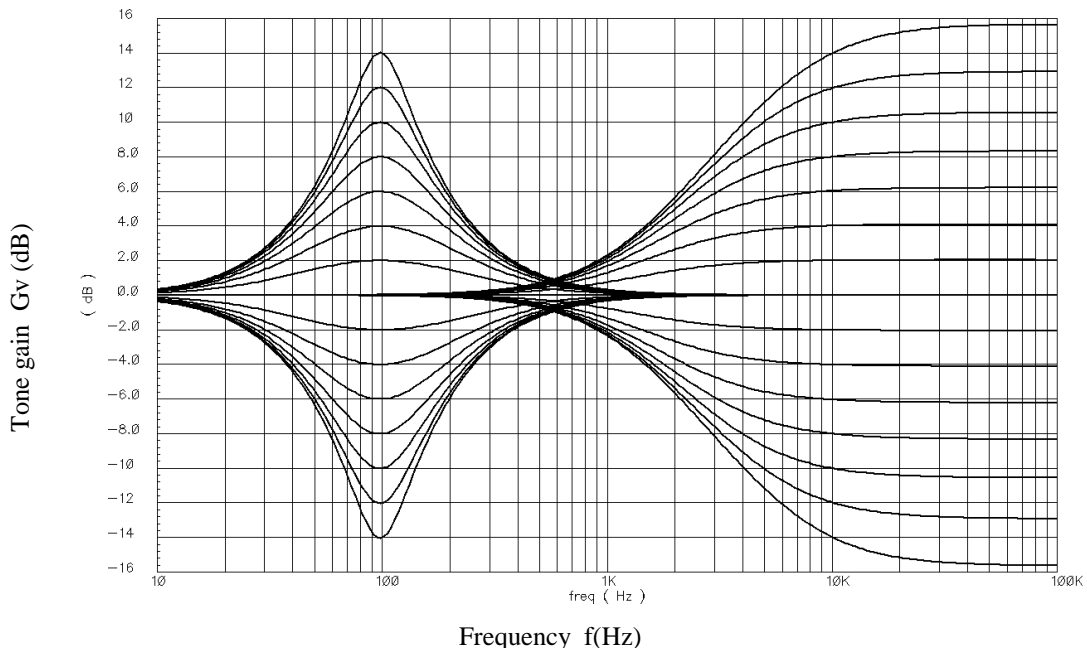
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Application Example
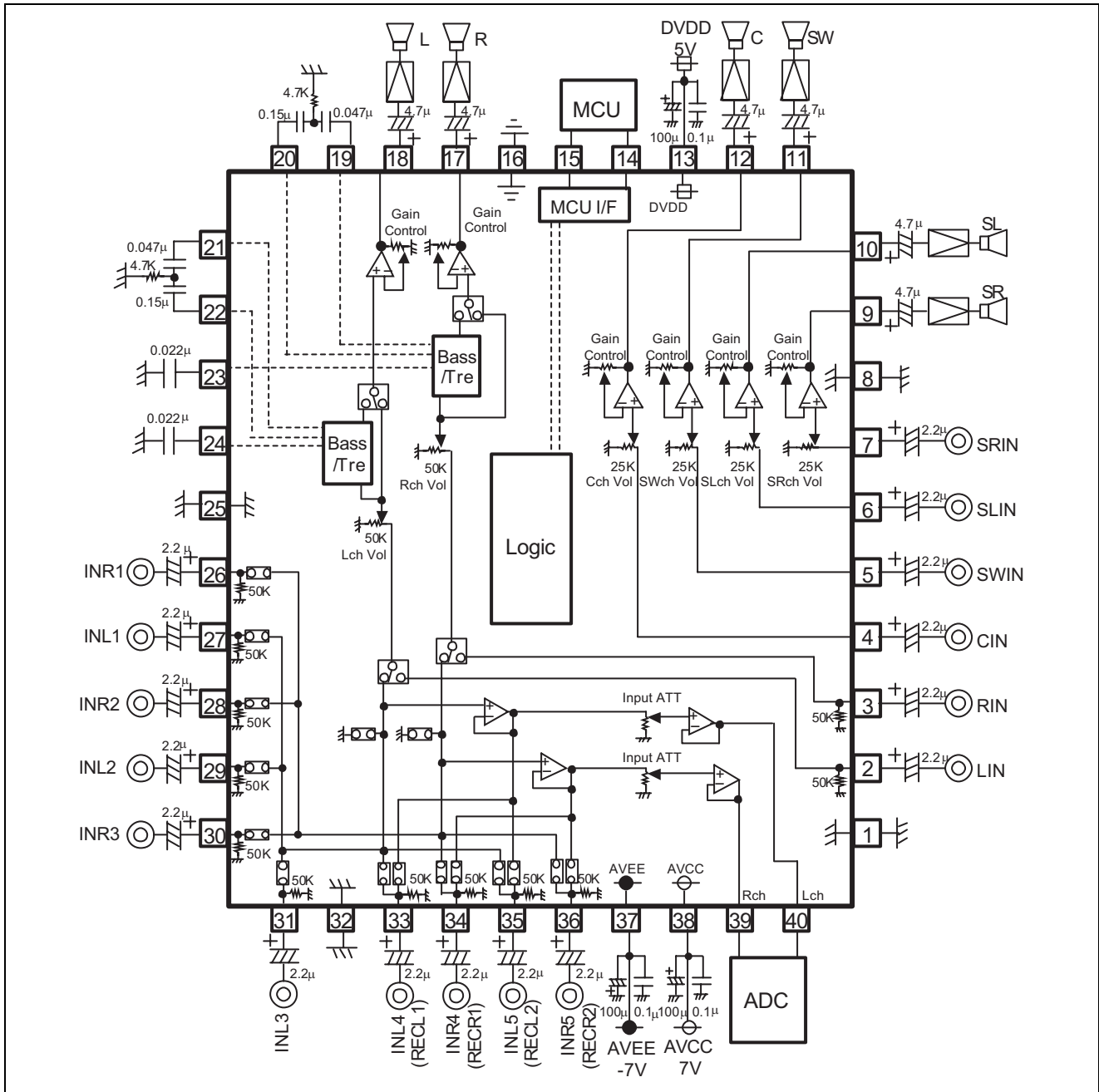
Package Dimensions

As of January, 2003
Unit: mm

9.0 ± 0.2
□ 7.0
30   21
31   20   0.65
9.0 ± 0.2
40   11
1   10

*0.25 ± 0.05
0.22 ± 0.04   ⊕ 0.13 Ⓜ

0.575   1.40   1.70 Max

*0.17 ± 0.05
0.15 ± 0.04

1.0
0.575

0° − 8°

0.50 ± 0.10

0.10   0.13 +0.09 −0.05
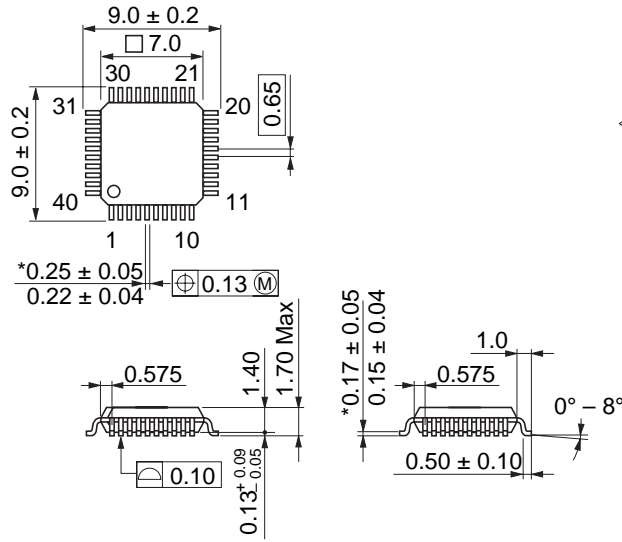
*Dimension including the plating thickness
Base material dimension

Package Code	FP-40B
JEDEC	—
JEITA	Conforms
Mass(reference value)	0.2 g

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