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April 1st, 2010
Renesas Electronics Corporation

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M61529FP

Audio Signal Processor with Surround

REJ03F0010-0100Z

Rev.1.00

Sep.04.2003

Description

M61529FP is the semiconductor integrated circuit for Home Audio. M61529FP includes 2ch electronic volume, Tone control, 4 Input Selector, Bass Boost, REC output and Mic Mixing. This IC is suitable for Mini Component. A difference in M61529FP and M61519FP has just changed Tone Input ATT from 0/-13dB to 0/-8.2dB.

Features

- 2ch Master Volume (L,R Independent Control)
 - Main Volume : 0dB to -76dB (2dB or 4dB step), $-\infty$
 - Trim Volume : 0dB to -15dB (1dB step)
- *Total level is fixed at -87dB, on condition that the total level of Trim and Master volume is under "-87dB".
- Tone Control (Bass/Mid/Treble)
 - ± 8 dB (2dB step)
- 4 Input Selector with Mute
- Surround Function
- Vocal Cut Function
- Bass Boost Function
- L+R Output for Spectrum Analysis Display
- L+R Output for Subwoofer
- MIC Mixing Function
- 2 REC output with mute
- Input ATT : -5/0/+3.5dB
- Tone Input ATT : 0/-8.2dB
- External Input ATT : +3/0/-3/-6dB

Application

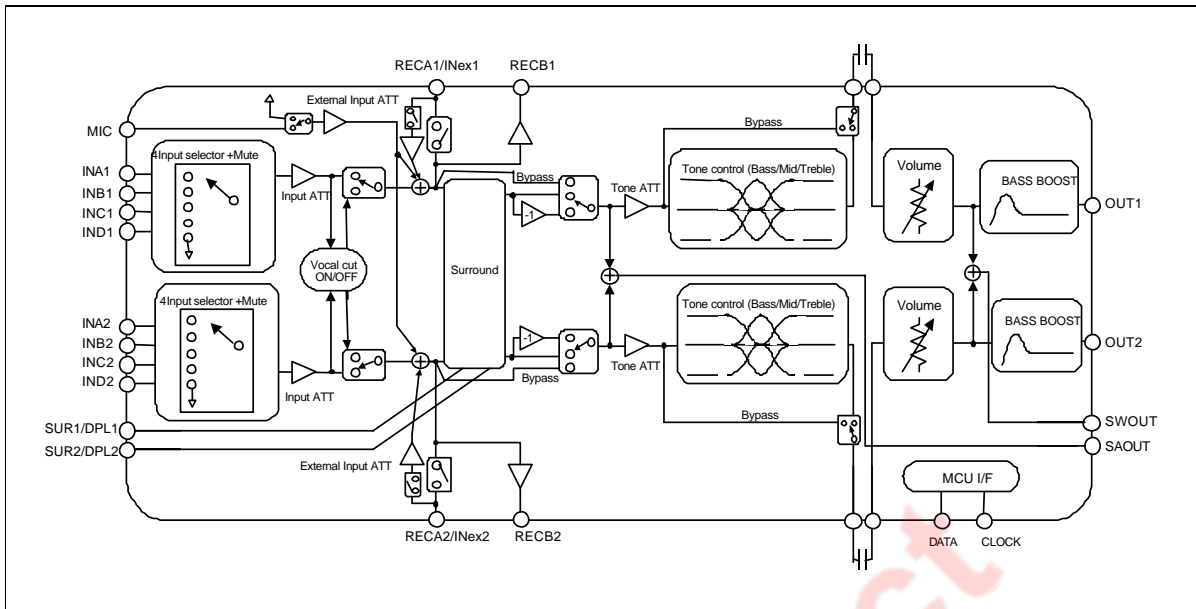
Mini/Micro Component, Radio-Cassette Recorder with CD Player, etc.

Recommended Operating Conditions

Supply voltage range.....8.0 to 10.0V

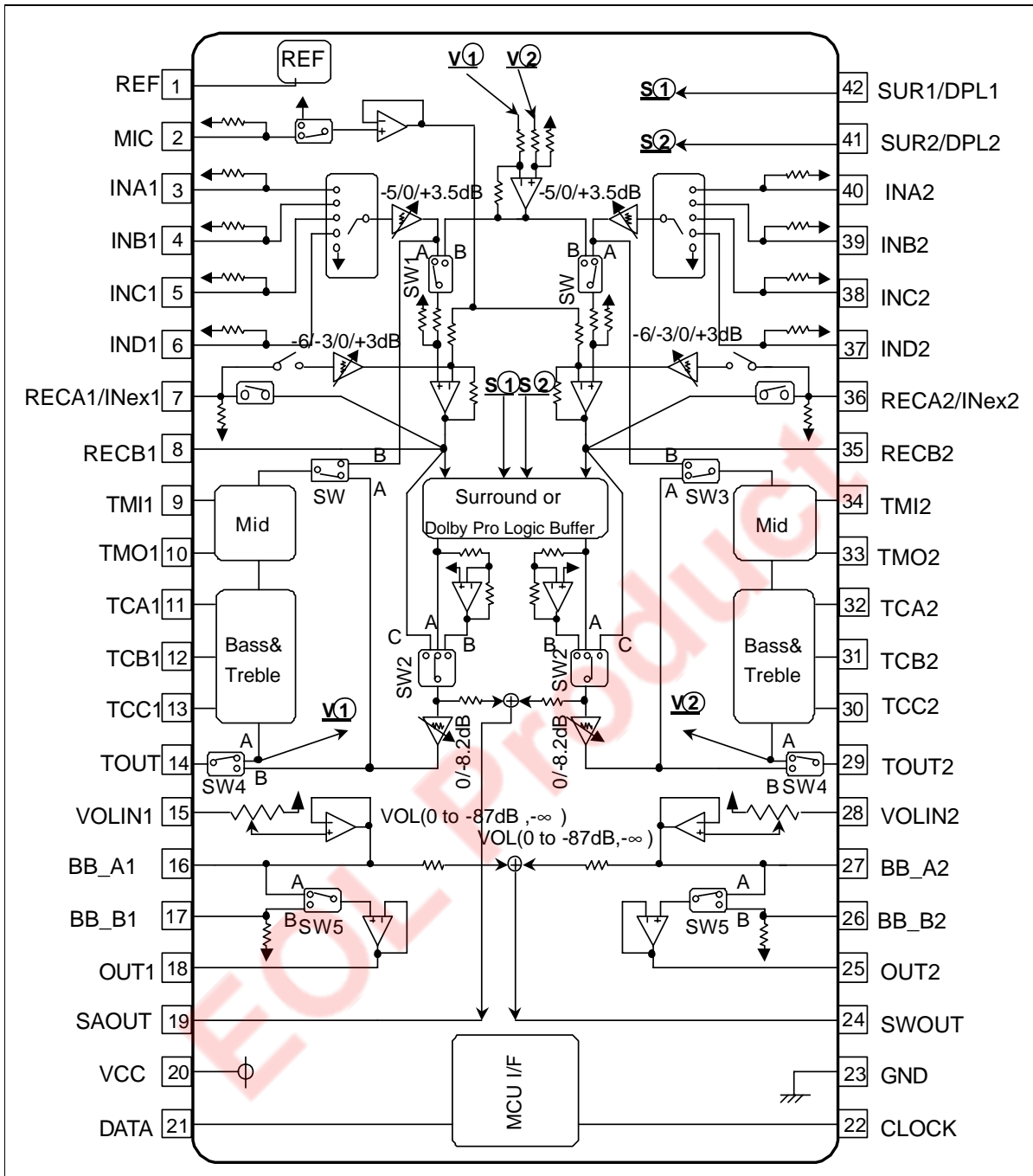
Recommended supply voltage.....9.0V

System Block Diagram



EOL Product

Pin Configuration and Block Diagram



Note : Dolby

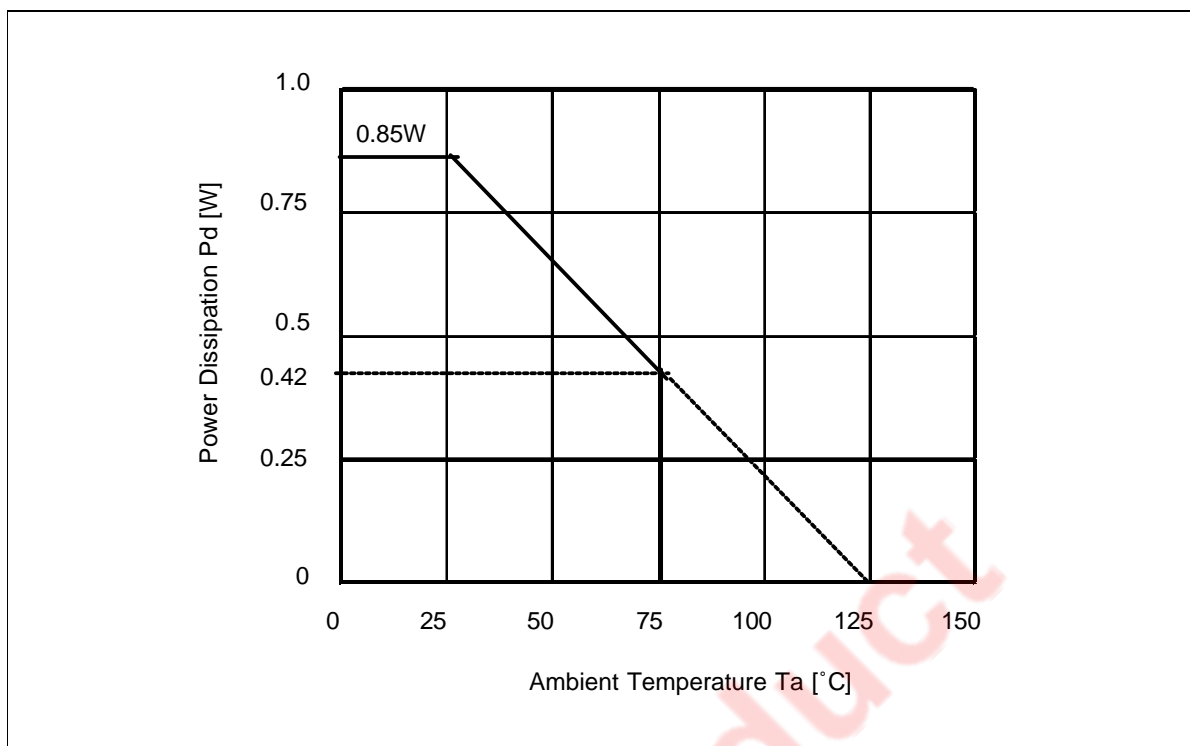
Pin Description

Pin No.	Symbol	Function
1	REF	Input pin of internal reference (REF=4.5V)
2	MIC	Input pin of MIC Mixing
3, 4, 5, 6 37, 38, 39, 40	INA to IND	Input Selector
41, 42	SUR/DPL	External pins for surround, Switching use with DPL Input pin
7, 8, 35, 36	RECA/INex, RECB	Output pins for REC, RECA can switch mute function and external Input pins (At external input, RECA Switch is fixed mute position.)
9, 10, 33, 34	TMI, TMO	External pins for Mid (sympathetic vibration type)
11, 12, 13, 30, 31, 32	TCA, TCB, TCC	External pins for Bass/Treble (Shelving type)
14, 29	TOUT	Output pins of tone control
15, 28	VOLIN	Input pins of electronic volume
16, 17, 26, 27	BB_A, BB_B	External pins for Bass boost
18, 25	OUT	Output pins
19	SAOUT	Mix pins for spectrum Analyzer (L+R/2)
24	SWOUT	Mix pin for super woofer
20	VCC	Internal analog, power pin for digital circuit
23	GND	Internal analog, GND pin for digital circuit
21, 22	DATA, CLOCK	DATA for serial data, Clock input pin

Absolute Maximum Ratings

Symbol	Parameter	Conditions	Limits	Units
V_{cc}	Supply voltage		10.5	V
P_d	Power dissipation	$T_a \leq 25^\circ\text{C}$	850	mW
K	Thermal derating	$T_a > 25^\circ\text{C}$	8.6	mW/ $^\circ\text{C}$
Topr	Operating temperature		-20 to +75	$^\circ\text{C}$
Tstg	Storage temperature		-40 to +125	$^\circ\text{C}$

Thermal Derating

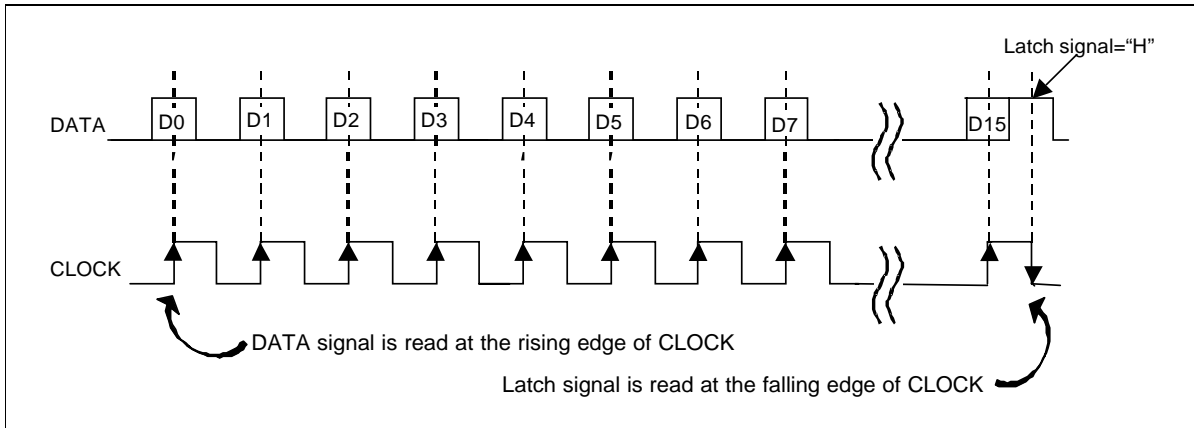


Recommended Operating Condition

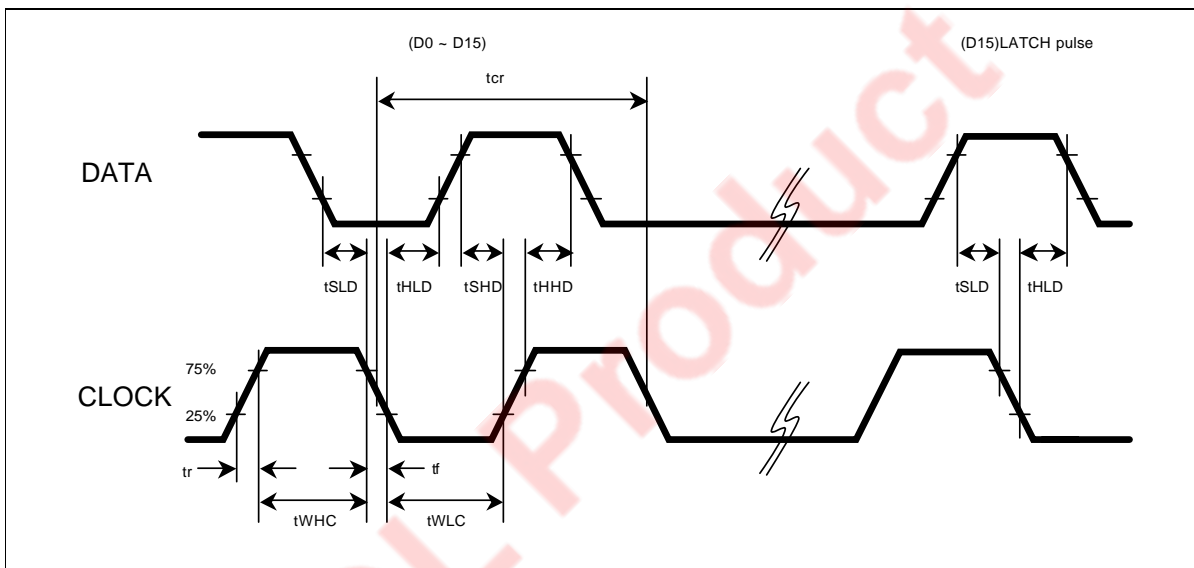
(Ta = 25°C, unless otherwise noted.)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage	V_{CC}		8	9	10	V
Logic "H" level Input voltage	V_{IH}	$V_{CC} = 9V$	2.2	—	5.5	V
Logic "L" level Input voltage	V_{IL}	$V_{CC} = 9V$	0	—	0.6	V

Relationship Between Data and Clock and Latch



Data Timing (Recommended conditions)



Digital Block Timing Regulation

Symbol	Parameter	Limits			Unit
		Min	typ	Max	
t_{cr}	CLOCK cycle time	4	—	—	
t_{WHC}	CLOCK pulse width ("H" level)	1.6	—	—	
t_{WLC}	CLOCK pulse width ("L" level)	1.6	—	—	
t_r	CLOCK rise time	—	—	0.4	
t_f	CLOCK fall time	—	—	0.4	μs
t_{SHD}	DATA setup time ("H" level) CLOCK rise	0.8	—	—	
t_{SLD}	DATA setup time ("L" level) CLOCK rise	0.8	—	—	
t_{HHD}	DATA hold time ("H" level)	0.8	—	—	
t_{HLD}	DATA hold time ("L" level)	0.8	—	—	

Digital Control Specification

Prohibit using except specified Data code as follows.

(At power on, initial position is • mark's setting.)

	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
A	Input Selector			Input ATT	Tone ATT	Vocal cut Tone bypass	Mic MIX	RECA/ External Input			Surround/ DPLIN		0	0		
B	Tone Control SW	Tone Ccontrol Bass			Tone control Mid			Tone control Treble			0	1				
C	Lch Trim Volume			Rch Trime Volume		Bass Boost	0	0	0	0	0	0	1	0		
D	Lch Master Volume			Rch Master Volume			0	0	0	0	0	1	1			

← Input direction

(1) Input selector

Selector	D0A	D1A	D2A
INA	0	0	0
INB	0	0	1
INC	0	1	0
IND	0	1	1
Mute	1	*	*

(2) Input ATT

Input ATT	D3A	D4A
-5dB	0	0
0dB	0	1
+3.5dB	1	0

(3) Tone ATT

Tone ATT	D5A
-8.2dB	0
0dB	1

(4) Vocal cut & Tone bypass

Switching	D6A	D7A
Vocal cut OFF, Tone Bypass	0	0
Vocal cut OFF, Tone ON	0	1
Vocal cut ON, Tone Bypass	1	*

(5) MIC Mixing

Mic Mixing	D8A
OFF	0
ON	1

(6) RECA / External Input

Switching	D9A	D10A	D11A
RECA-OFF	0	*	0
RECA-ON	0	*	1
+3dB	1	0	0
0dB	1	0	1
-3dB	1	1	0
-6dB	1	1	1

External Input OFF

External Input ON

• At external Input setting ,RECA is OFF.

(7) Surround / DPLIN

Switching	D12A	D13A
Bypass	0	0
Surround	0	1
DPLIN	1	0

(8) Switching of Tone control

Switching	D0B	D1B
Lch and Rch	0	0
Lch only	0	1
Rch only	1	0

(9) Tone control (Bass, Mid, Treble)

Tone	D2,6,10B	D3,7,11B	D4,8,12B	D5,9,13B
+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

(11) Bass boost

Bass Boost	D8C
OFF	0
ON	1

(10) Trim volume (Lch and Rch)

Trim	D0, 4C	D1, 5C	D2, 6C	D3, 7C
● 0dB	0	0	0	0
-1dB	0	0	0	1
-2dB	0	0	1	0
-3dB	0	0	1	1
-4dB	0	1	0	0
-5dB	0	1	0	1
-6dB	0	1	1	0
-7dB	0	1	1	1
-8dB	1	0	0	0
-9dB	1	0	0	1
-10dB	1	0	1	0
-11dB	1	0	1	1
-12dB	1	1	0	0
-13dB	1	1	0	1
-14dB	1	1	1	0
-15dB	1	1	1	1

Note : Total level is fixed at -87dB, on condition that the total level of Trim and Master volume is under "-87dB".
(example: Trim -15dB, Master -76dB Total level is -87dB)

M61529FP

(12) Master volume (L, Rch)

Master	D0, 5D	D1, 6D	D2, 7D	D3, 8D	D4, 9D
0dB	0	0	0	0	0
-2dB	0	0	0	0	1
-4dB	0	0	0	1	0
-6dB	0	0	0	1	1
-8dB	0	0	1	0	0
-10dB	0	0	1	0	1
-12dB	0	0	1	1	0
-14dB	0	0	1	1	1
-16dB	0	1	0	0	0
-18dB	0	1	0	0	1
-20dB	0	1	0	1	0
-22dB	0	1	0	1	1
-24dB	0	1	1	0	0
-26dB	0	1	1	0	1
-28dB	0	1	1	1	0
-30dB	0	1	1	1	1
-32dB	1	0	0	0	0
-34dB	1	0	0	0	1
-36dB	1	0	0	1	0
-38dB	1	0	0	1	1
-40dB	1	0	1	0	0
-42dB	1	0	1	0	1
-44dB	1	0	1	1	0
-48dB	1	0	1	1	1
-52dB	1	1	0	0	0
-56dB	1	1	0	0	1
-60dB	1	1	0	1	0
-64dB	1	1	0	1	1
-68dB	1	1	1	0	0
-72dB	1	1	1	0	1
-76dB	1	1	1	1	0
• -∞dB	1	1	1	1	1

Electrical Characteristics

Unless otherwise noticed, $T_a = 25^\circ\text{C}$, $V_{CC} = 9\text{V}$, $f = 1\text{kHz}$, Surround bypass, tone bypass and bass boost = OFF

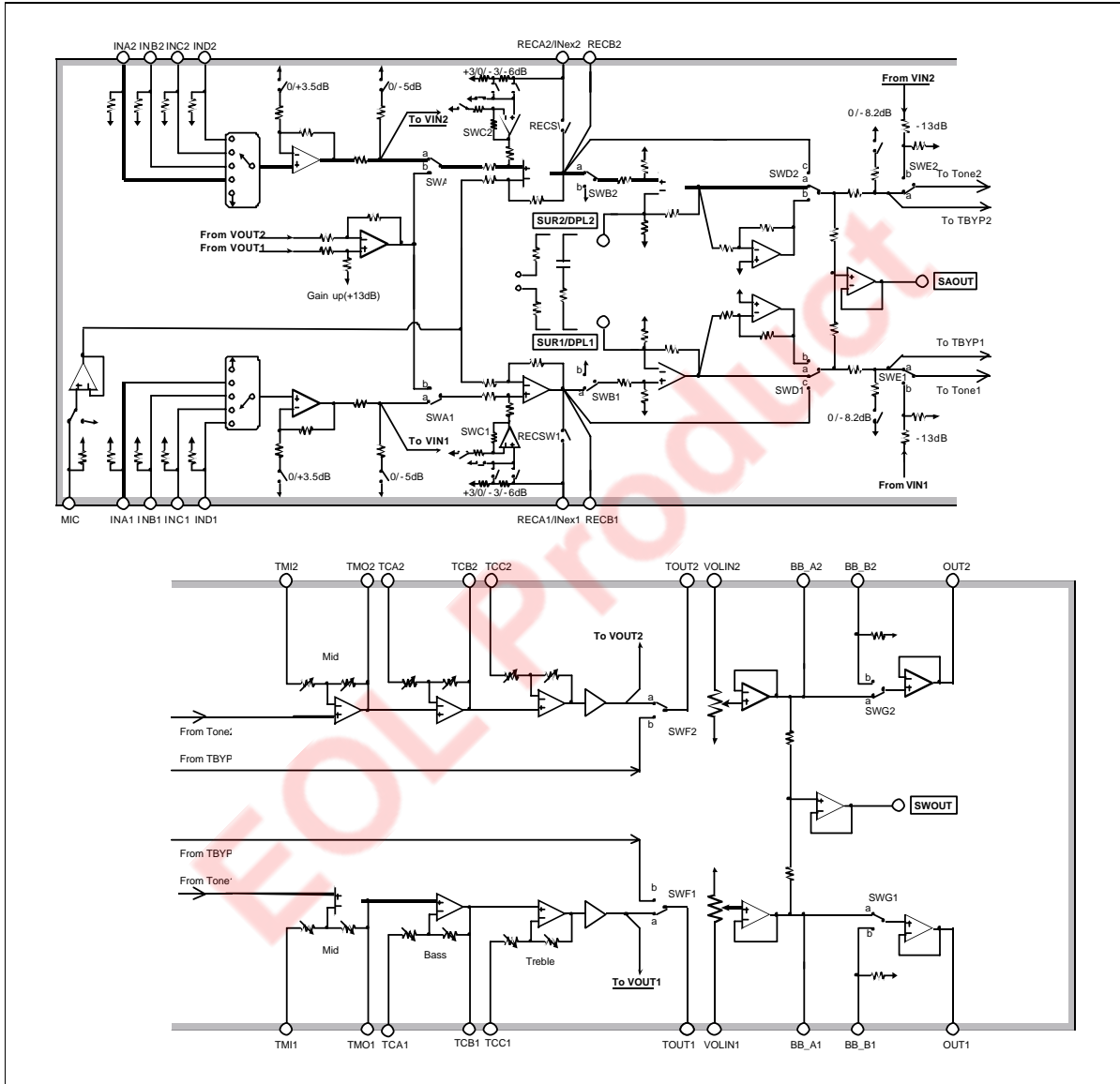
Parameter	Symbol	Test Condition	Limits			Unit			
			Min	Typ	Max				
Voltage	Analog positive power circuit current	Alcc	At $V_{CC}=9.0\text{V}$, 20 pin terminal current and no signal	—	25	40	mA		
Input and Output	Input resistance	Rin	Input pin 3-6pin,37-40pin,2pin	30	60	90	k Ω		
	Maximum input voltage	VIM	(3,40)pin IN, (8,35)pin OUT $R_L=10\text{k}\Omega$, THD=1%, Input ATT=-5dB	1.8	2.2	—	Vrms		
	Maximum output voltage	VOM	(3,40)pin IN, (18,25)pin OUT Bass boost ON, $f=100\text{Hz}$, $R_L=10\text{k}\Omega$, THD=5%	1.8	2.2	—	Vrms		
		VrecOM	(3,40)pin IN, (7,8)(35,36)pin OUT $R_L=47\text{k}\Omega$, THD=1%, Input ATT=+3.5dB	1.6	2.0	—	Vrms		
	Output terminal voltage	Vodc	At No signal, (18,25)pin OUT	4.0	4.5	5.0	V		
		Vrecdc		4.0	4.5	5.0	V		
	Pass gain	Gv	$V_i=1\text{Vrms}$, FLAT, Gain from (3-18 pin) to (40-25 pin), Input ATT=0dB	-2.0	0.0	2.0	dB		
	Maximum attenuation	ATT	$V_o=1\text{Vrms}$, (18,25)pin OUT JIS-A, Vol.= $-\infty$	—	-92	-87	dB		
	Output noise voltage	Vono	JIS-A, At no signal, $R_g=0\Omega$ Vol.=0dB	—	10.0	20.0	μVrms		
			(8,35)pin OUT Vol.= $-\infty$	—	4.0	8.0	μVrms		
Distortion factor	Vrecno	JIS-A, At no signal, $R_g=0\Omega$ (18,25)pin OUT	—	6.0	12.0	μVrms			
		THD	BW:400-30kHz, $V_o=0.5\text{Vrms}$, $R_L=10\text{k}\Omega$	—	0.02	0.05	%		
		THDrec	BW:400-30kHz, $V_o=0.5\text{Vrms}$, $R_L=47\text{k}\Omega$	—	0.01	0.05	%		
Cross talk between channels	CT	$V_o.=0.5\text{Vrms}$, $R_L=10\text{k}\Omega$, JIS-A, $R_g=0\text{k}\Omega$	—	-70	55	dB			
		CT rec $V_o.=0.5\text{Vrms}$, $R_L=47\text{k}\Omega$, JIS-A, $R_g=0\text{k}\Omega$	—	-70	55	dB			
Tone Control	Bass voltage gain	G _{bassb}	$f=100\text{Hz}$	-8dB	6	8	10	dB	
				+8dB	-10	-8	-6	dB	
	Mid voltage gain	G _{midb}	$f=1\text{kHz}$		-8dB	6	8	10	dB
					-8dB	-10	-8	-6	dB
	Treble voltage gain	G _{trebb}	$f=10\text{kHz}$		+8dB	6	8	10	dB
					-8dB	-10	-8	-6	dB
Balance between channel	BALton	At each boost value of -8dB and +8dB, $V_o=1\text{Vrms}$, (14,29)pin OUT	-2	0	2	dB			
MIX Signal	Super woofa output gain	G _{vSW}	$V_i=1\text{Vrms}$, FLAT, Gain from (3-18 pin) to (40-25 pin), Input ATT=0dB	-8.0	-6.0	-4.0	dB		
	distortion factor	THDSW	BW:400-30kHz, $V_o=0.3\text{Vrms}$, $R_L=47\text{k}\Omega$ 15pin IN, 24pin OUT	—	0.03	0.1	%		
	Output noise voltage	V _{noSW}	JIS-A, At no signal, $R_g=0\Omega$, 24pin OUT	—	20	—	μVrms		
	Output gain for spectrum Analyzer Display	G _{vSP}	$V_i=1\text{Vrms}$, FLAT, Input ATT=0dB, 3pin IN, 19pin OUT	-8.0	-6.0	-4.0	dB		

- Mix Signal Characteristics is provided only CH1 Input. (CH2 $R_g=0\Omega$)

Block Diagram

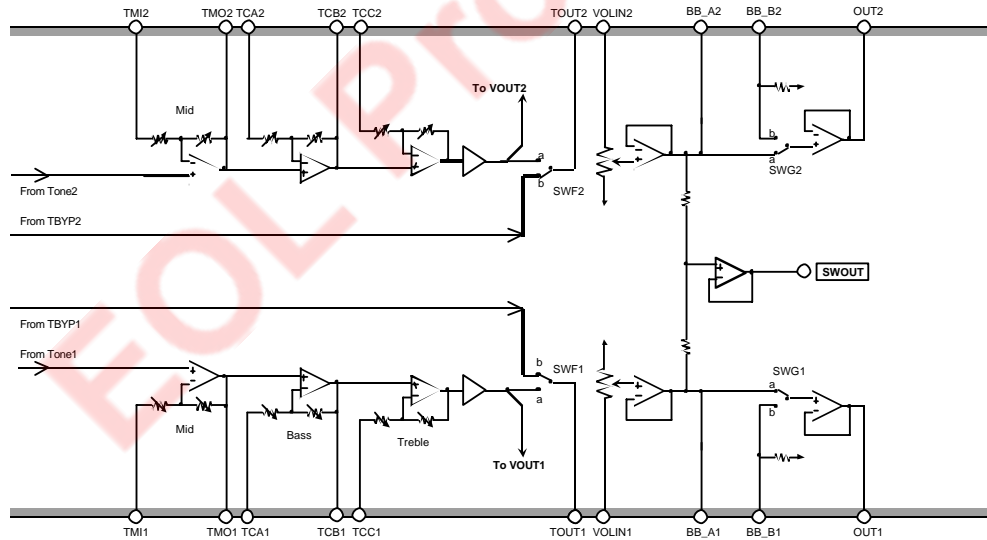
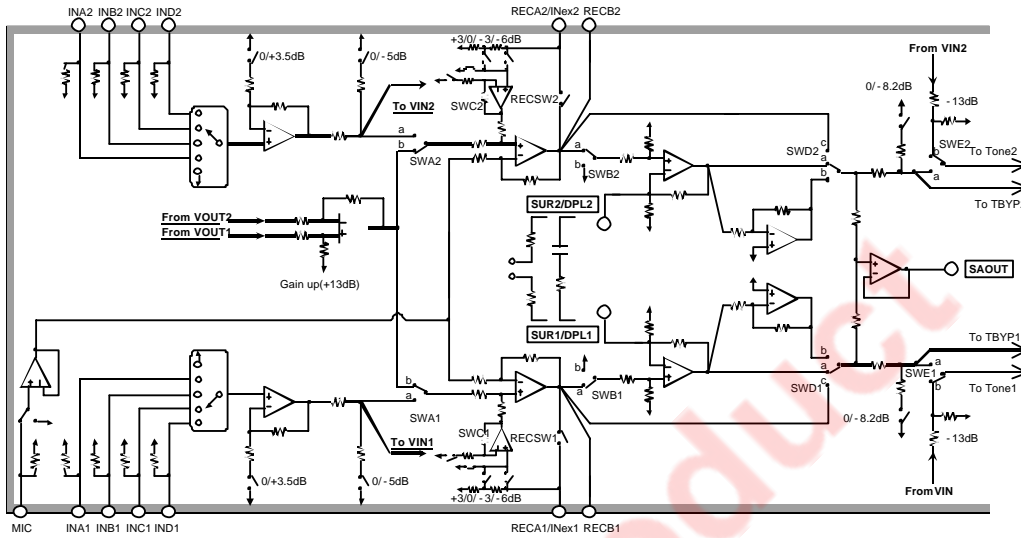
(1) Vocal cut OFF (Bold line; Selector INA, Surround ON, Tone ON, Bassboost OFF)

- SWA a; Vocal Cut OFF b; Vocal Cut ON
- SWB a; Surround b; DPL
- SWC External Input ATT(+3/0/-3/-6dB/OFF)
- SWD a; Surround b; DPL c; BYPASS
- SWE a; Tone control b; Vocal Cut
- SWF a; Tone control b; Tone bypass, Vocal Cut
- SWG a; Bassboost OFF b; Bassboost ON

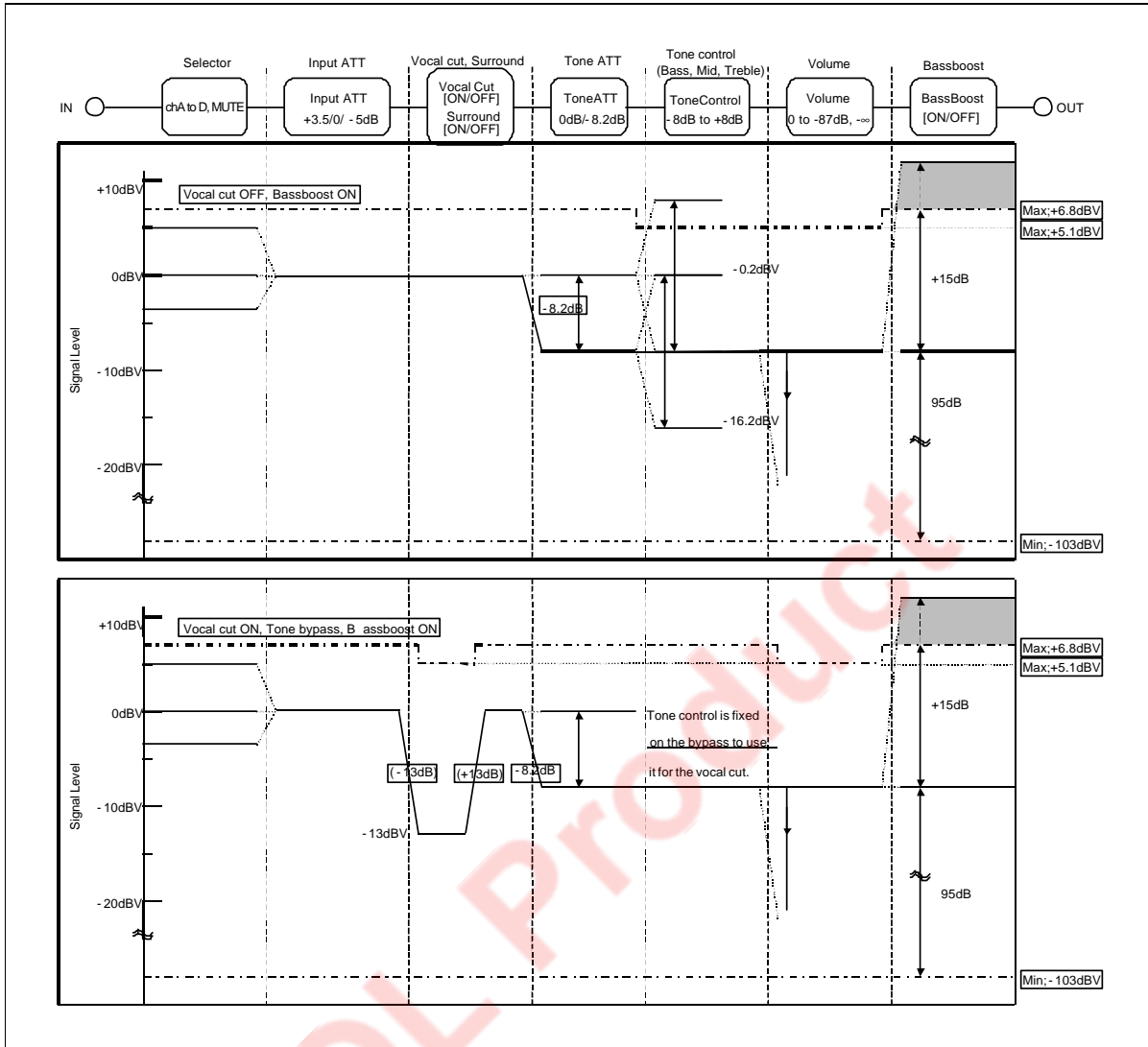


(2) Vocal cut ON (Bold line; Selector INA, Surround ON, Tone OFF, Bassboost OFF)

SWA	a; Vocal Cut OFF	b; Vocal Cut ON	
SWB	a; Surround	b; DPL	
SWC	External Input ATT(+3/0/-3/-6dB/OFF)		
SWD	a; Surround	b; DPL	c; BYPASS
SWE	a; Tone control	b; Vocal Cut	
SWF	a; Tone control	b; Tone bypass, Vocal Cut	
SWG	a; Bassboost OFF	b; Bassboost ON	



Signal Level Diagram



Function Discription

(1) Equivalent circuit of tone control

(a) Mid

Boost Mode

Cut Mode

$$f_0 = \frac{1}{2\pi\sqrt{R1(R2+R3)C1C2}} \text{ (Hz)}$$

$$Q \approx \frac{1}{C1+C2} \sqrt{\frac{C1C2R2}{R1}} \quad (R3=0)$$

$$G_v = 20\log \left[\frac{\frac{R2+R3}{R1} + 2}{\frac{R3}{R1} + 2} \right] \text{ (dB)} \quad (C1=C2)$$

$$f_0 = \frac{1}{2\pi\sqrt{R1(R2+R3)C1C2}} \text{ (Hz)}$$

$$Q \approx \frac{1}{C1+C2} \sqrt{\frac{C1C2R2}{R1}} \quad (R3=0)$$

$$G_v = 20\log \left[\frac{\frac{R3}{R1} + 2}{\frac{R2+R3}{R1} + 2} \right] \text{ (dB)} \quad (C1=C2)$$

Setting	R2	R3
±8dB	17.00kΩ	6.80kΩ
±6dB	14.10kΩ	9.70kΩ
±4dB	10.40kΩ	13.40kΩ
±2dB	5.80kΩ	18.00kΩ

(b) Bass

Boost Mode

Cut Mode

$$f_0 = \frac{R+R1}{2\pi CR(R1+R2)} \text{ (Hz)}$$

$$G_v = 20\log \left[\frac{R+R1+R2}{R+R1} \right] \text{ (dB)}$$

$$f_0 = \frac{R+R1}{2\pi CR(R1+R2)} \text{ (Hz)}$$

$$G_v = 20\log \left[\frac{R+R1}{R+R1+R2} \right] \text{ (dB)}$$

Setting	R1	R2
±8dB	0.60kΩ	19.40kΩ
±6dB	4.20kΩ	15.80kΩ
±4dB	8.30kΩ	11.70kΩ
±2dB	13.49kΩ	6.51kΩ

(c) Treble

Boost Mode

Cut Mode

$$f_o = \frac{1}{2\pi CR1} \text{ (Hz)}$$

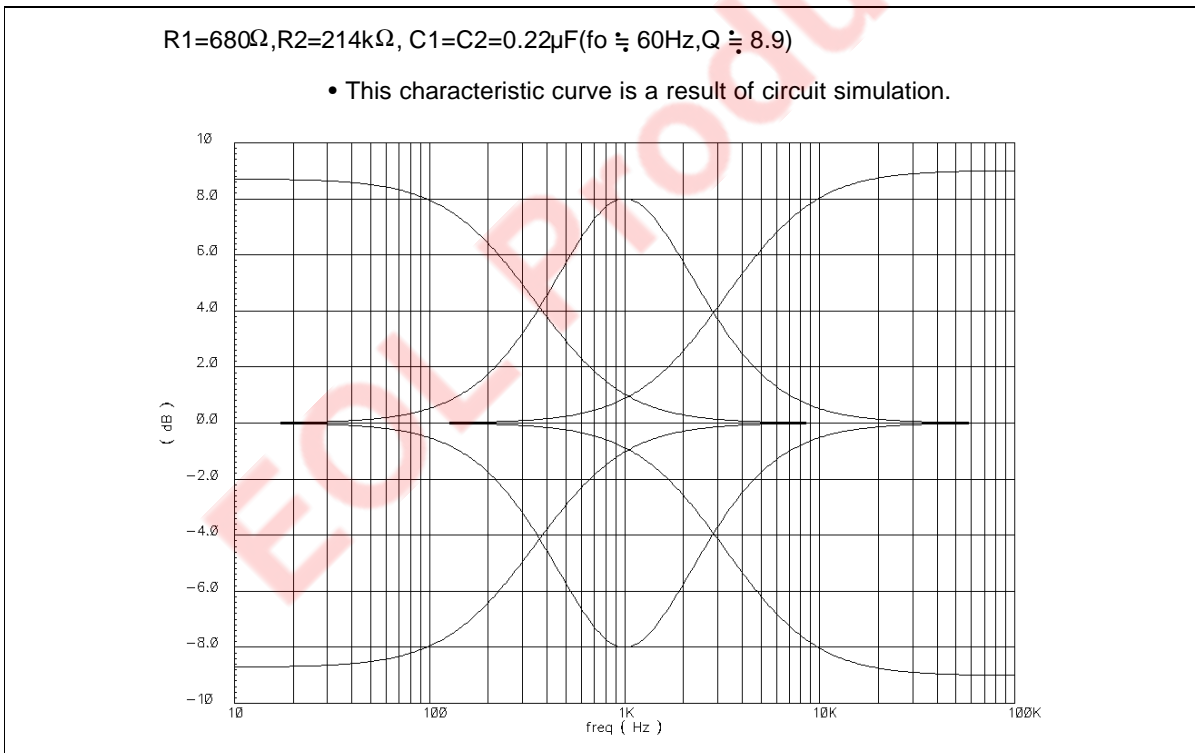
$$G_v = 20\log \left[\frac{R1+R2}{R1} \right] \text{ (dB)}$$

$$f_o = \frac{1}{2\pi CR1} \text{ (Hz)}$$

$$G_v = 20\log \left[\frac{R1}{R1+R2} \right] \text{ (dB)}$$

Setting	R1	R2
±8dB	5.12kΩ	9.91kΩ
±6dB	6.92kΩ	8.11kΩ
±4dB	9.12kΩ	5.91kΩ
±2dB	11.73kΩ	3.30kΩ

(d) Characteristic Curve of Tone Control



(2) Equivalent circuit of bass boost

The diagram shows a bass boost circuit using an internal IC. The input signal passes through a series of capacitors and a resistor network before entering the IC. A feedback path is provided by a resistor. A note indicates to "Decrease Circuit of Switching noise". The output is taken from the IC. To the right, a graph shows the amplitude characteristic with a peak at frequency f_0 and a gain G_0 relative to 0dB. The quality factor is given as $Q=4$ ($G=10\text{dB}$).

The equivalent circuit diagram shows an input V_{IN} connected to a series combination of capacitors C_1 and C_2 . A resistor R_2 is connected from the node between C_1 and C_2 to ground. The signal then passes through a resistor R_1 and enters an amplifier with gain $K=1$. The output is V_{OUT} .

The Internal IC have built-in R_2 resistance. ($R_2 = 214\text{k}\Omega$)

$$f_0 = \frac{1}{2\pi\sqrt{R_1R_2C_1C_2}} \text{ (Hz)}$$

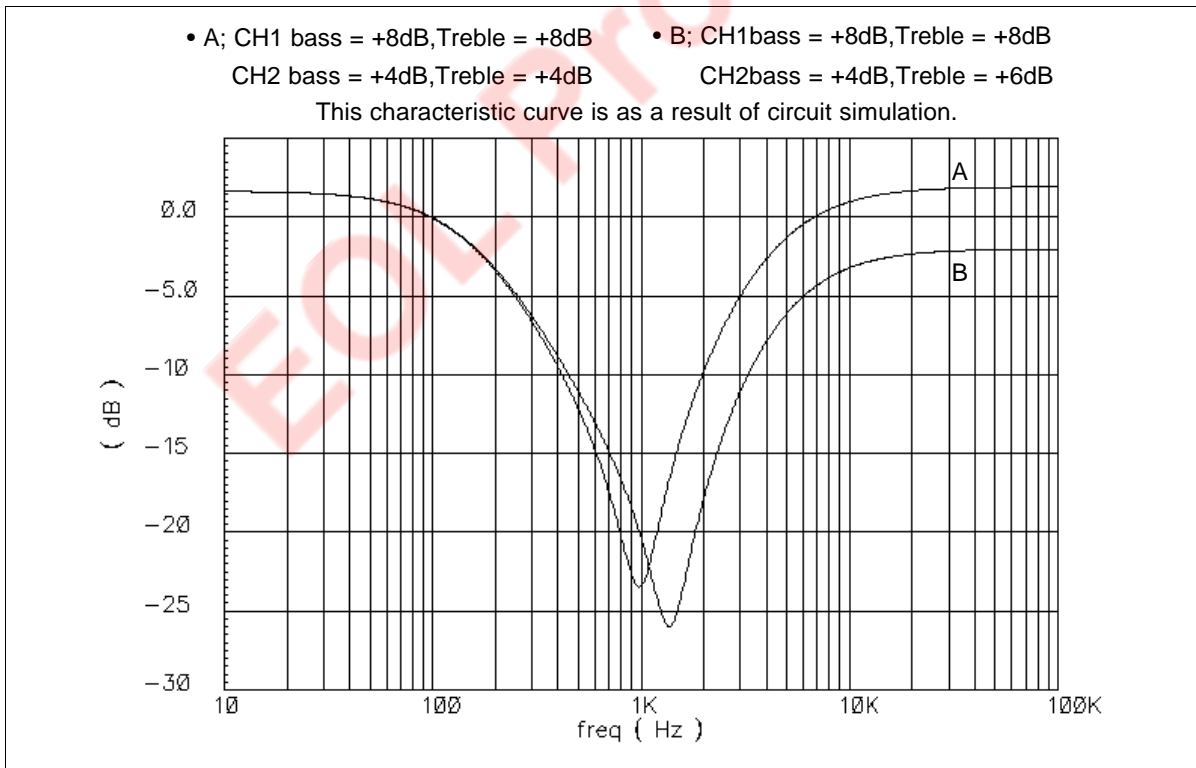
$$Q = \frac{\sqrt{R_1R_2C_1C_2}}{R_1(C_1+C_2)+(1-K)R_2C_2}$$

Reference Table

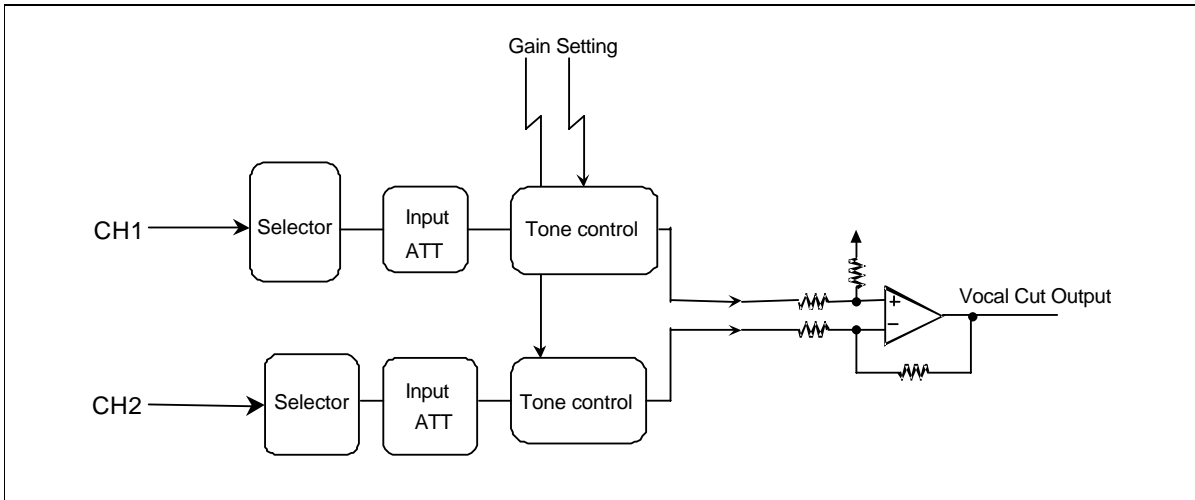
Q	G ₀
1	0 to 1dB
2	6dB
4	10dB
5	13dB
10	20dB

Amplitude characteristic of secondary high pass filter

• Characteristic Curve of bass boost



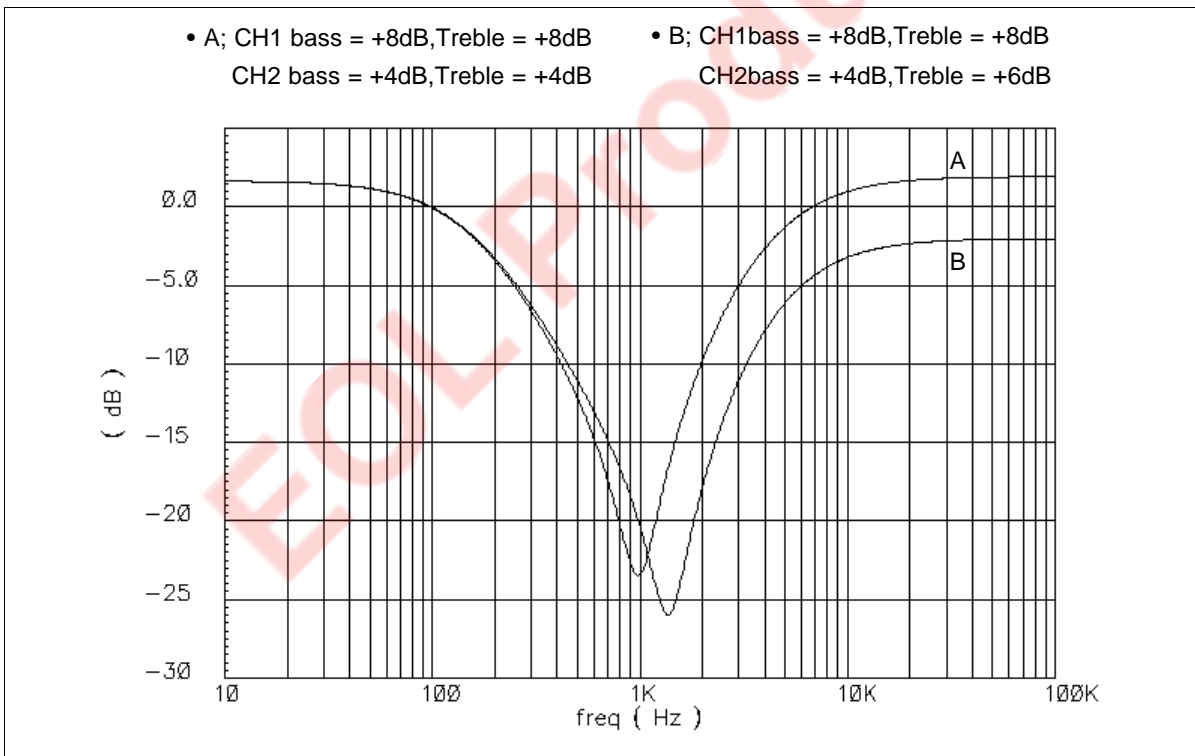
(3) Equivalent circuit of vocal cut



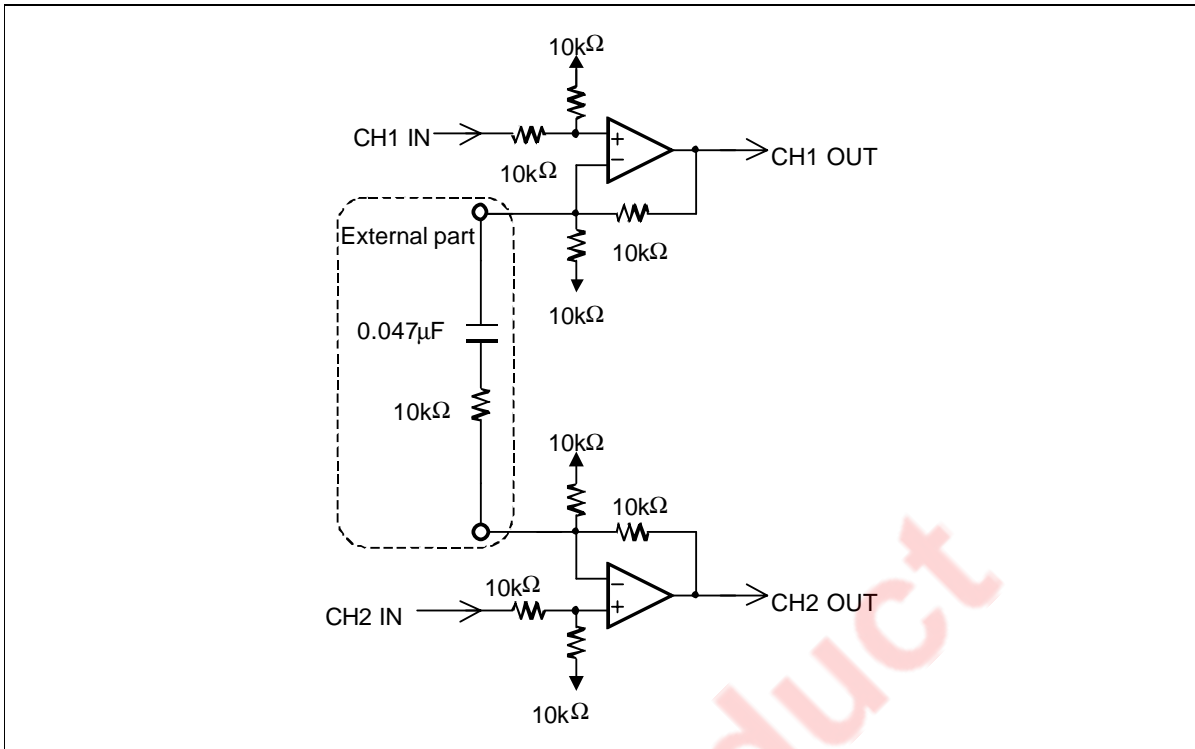
- Tone control cannot use at Vocal cut mode.
- Tone control can use only Bass & Treble mode. (Mid mode is 0dB fixed.)

Output difference of Tone control CH1 and CH2, The characteristic to cut only Middle part of Phase Input Signal is realized.

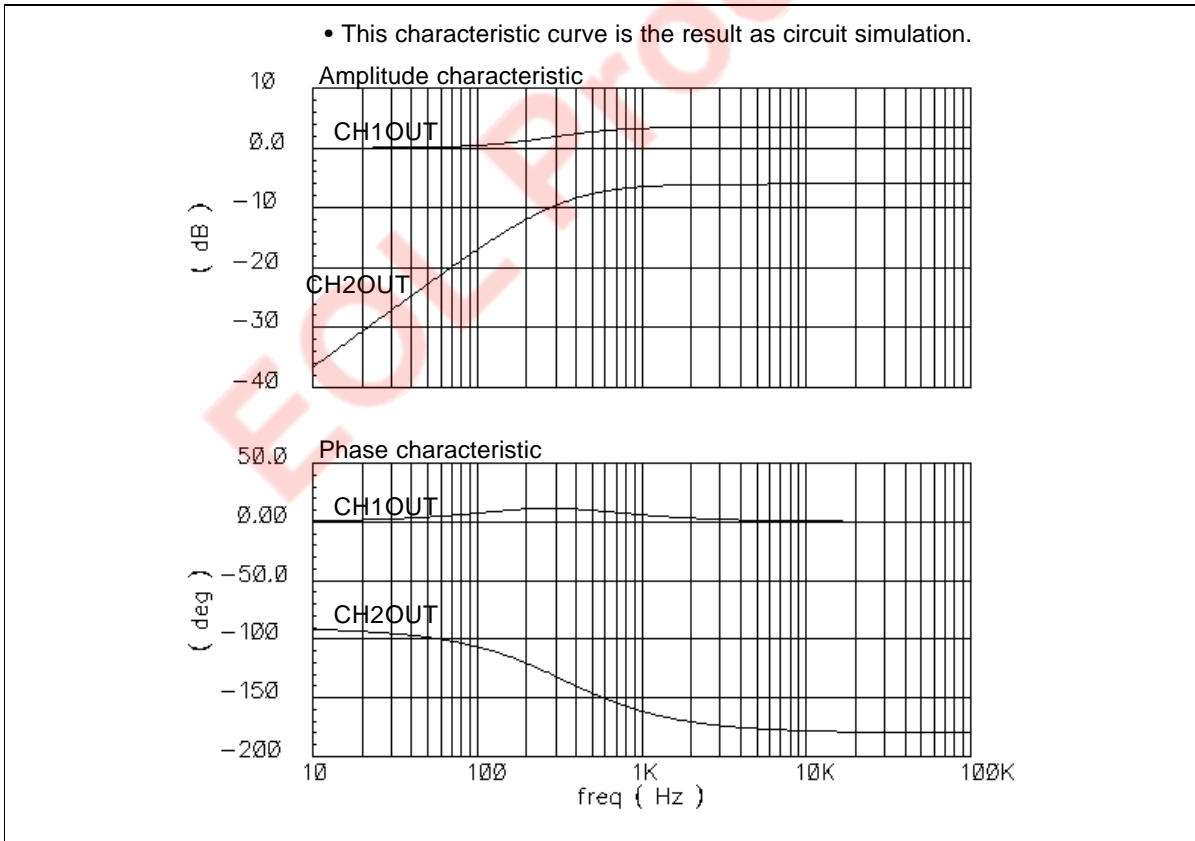
- Characteristic curve example (Phase signal input CH1,CH2)



(4) Surround equivalent circuit

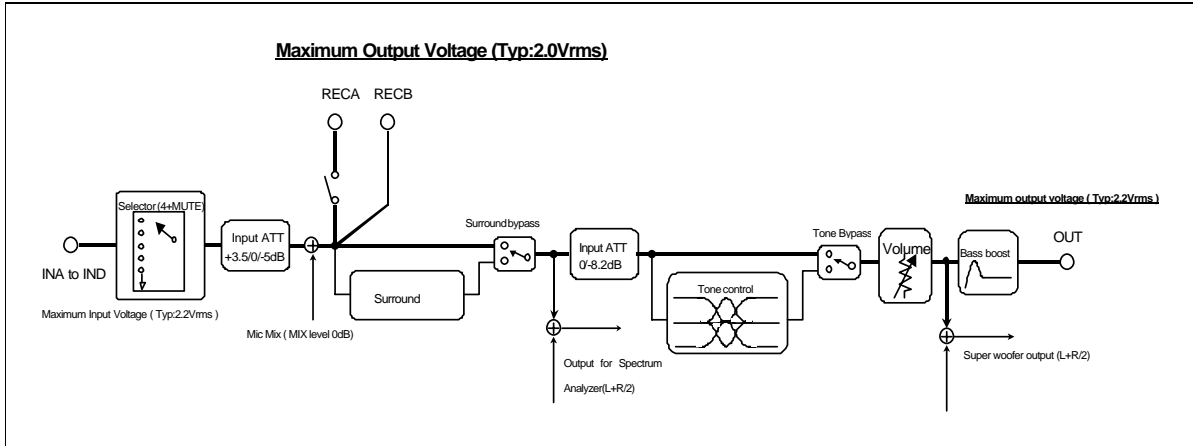


- Characteristic curve example (Only CH1 Input)

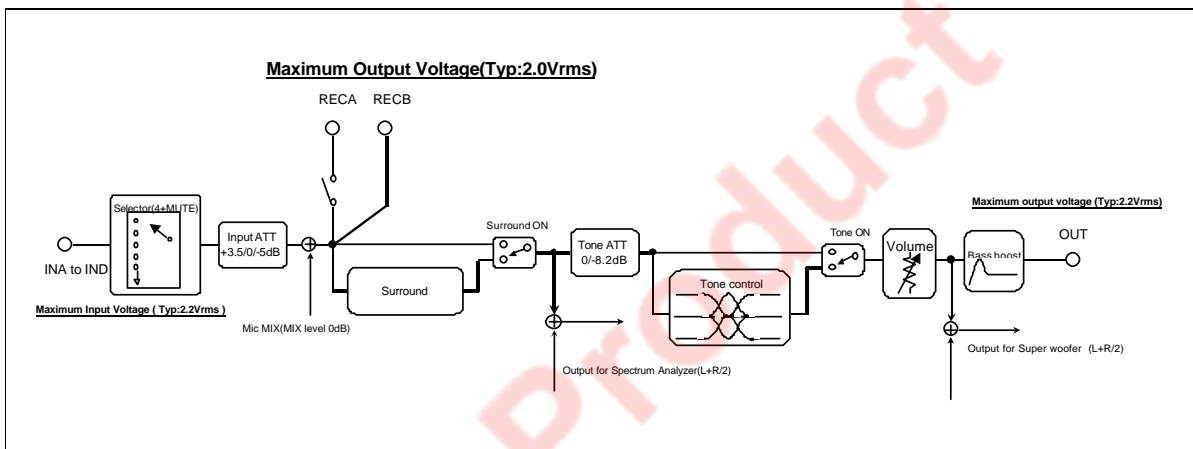


(5) Total equivalent circuit (signal flow diagram)

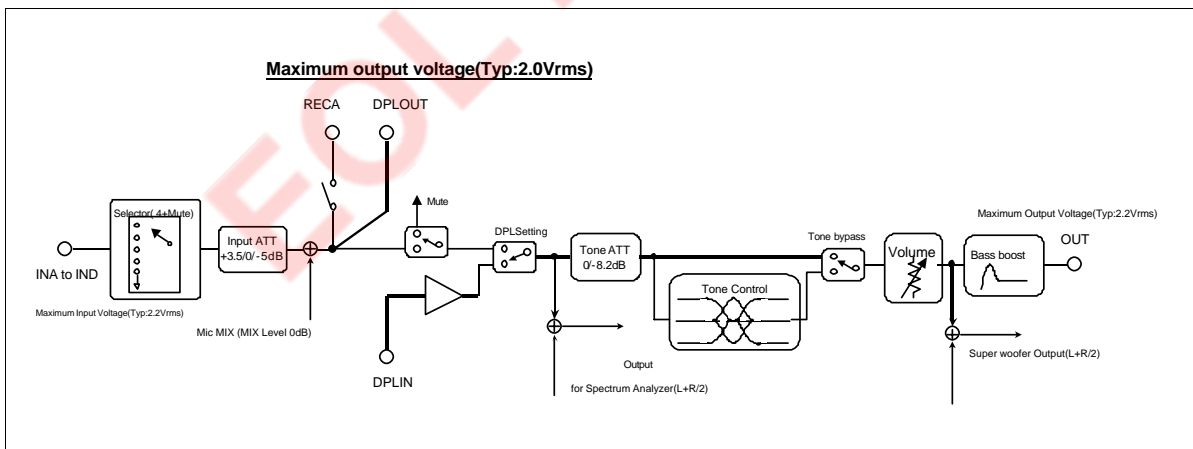
(a) Surround bypass, Tone bypass, Bass boost ON



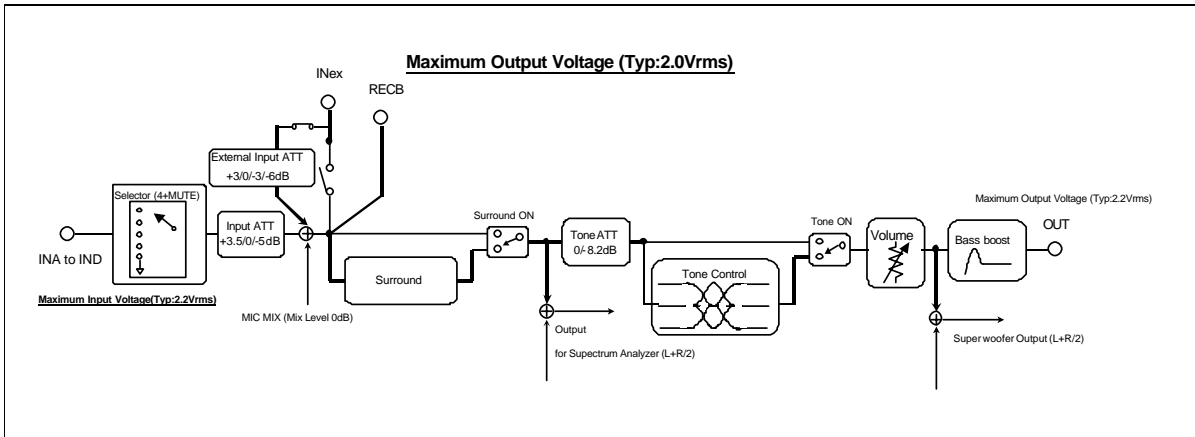
(b) Surround ON, Tone ON, Bass boost ON



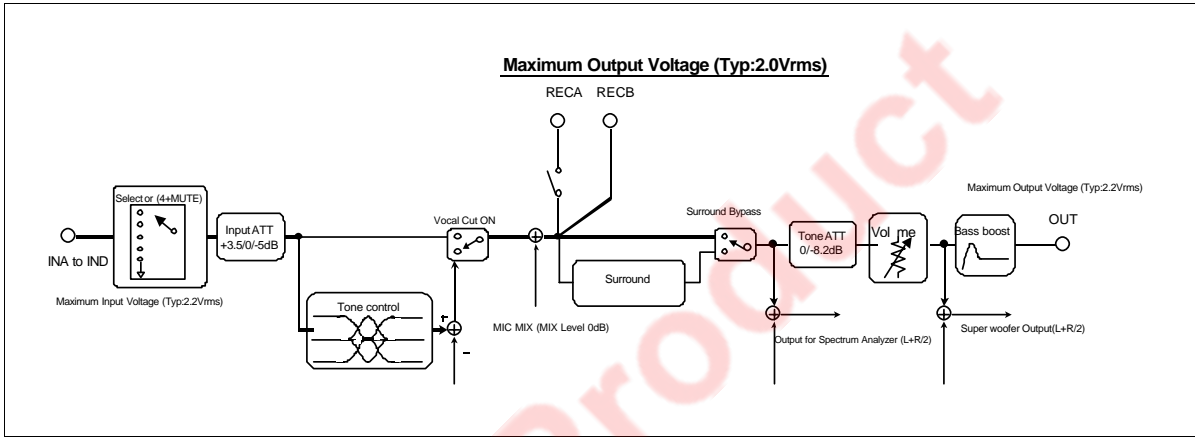
(c) DPL Input setting, Tone bypass, Bass boost ON



(d) External Input Setting, Surround ON, Tone ON, Bass boost ON



(e) Vocal Cut ON, Surround Bypass, Bass boost ON

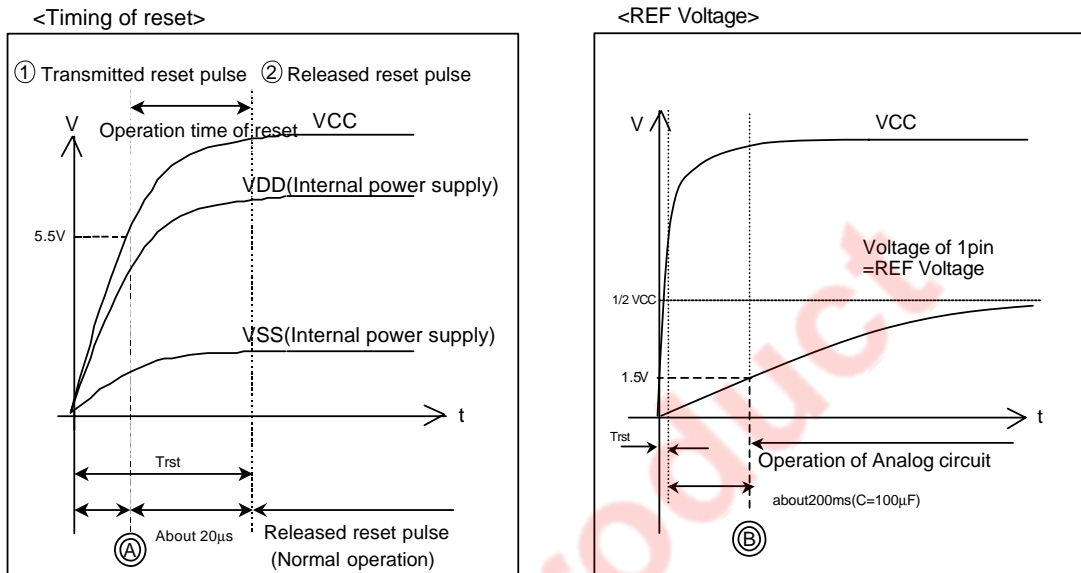


System Reset

(a) IC's condition of power supply turn on

This IC is the system composition which compulsory resetting when power supply turn on.

- Time constant of power supply is used, and reset pulse is formed.
- When V_{CC} exceed 5.5V, reset pulse is transmitted. (Logic circuit ON) [1]
- The operation time of reset is released reset pulse [2] from transmitted reset pulse [1].
- $Trst =$ [Timing A + about 20 μ s] is time of released reset pulse.
(Timing A is time of V_{CC} exceed 5.5V.)



The power supply is turned on, and resetting is released after $Trst$, and the reception of the serial data becomes possible in Logic block.

However, REF voltage doesn't operate in less than 1.5V in the analog block. Make REF voltage is to transmit serial data by more than 1.5V.

- REF Voltage \geq Time of REF=1.5V =Timing B
(Timing B is time when analog block operates and to become possible.)

<EX> Capacitor of 1pin =100 μ F

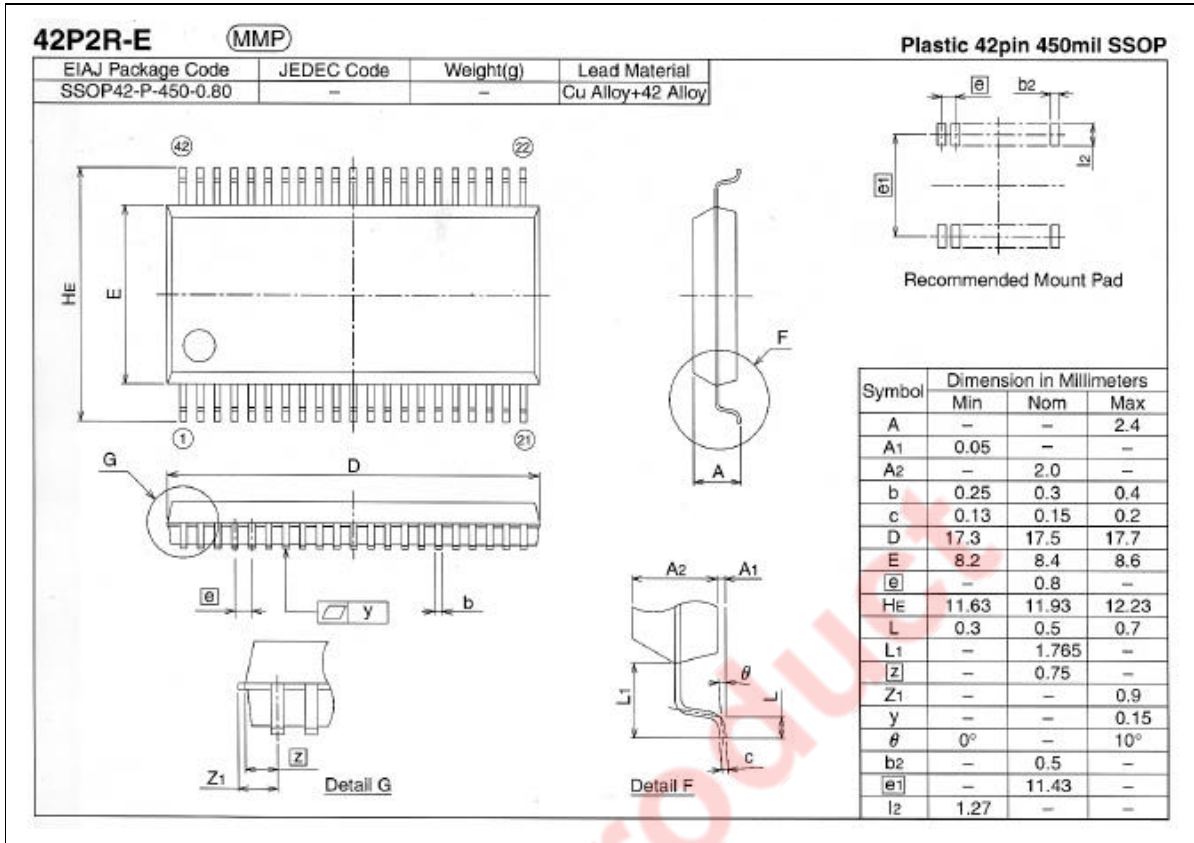
Becomes REF \geq 1.5V in about 200ms.

(b) IC's condition of power supply turn off

Internal power supply (V_{DD} , V_{SS}) decreases to V_{CC} together, too.

All the data set up when Logic turned it off become invalid.

Detailed Diagram Of Package Outline



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