

To all our customers

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

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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

**PRELIMINARY**  
 Notice: This is not a final specification.  
 Some parametric limits are subject to change.

**M61503FP**

**TONE CONTROL/VOLUME CONTROL**

**DESCRIPTION**

The M61503FP is a sound controller IC with the "BBE sound" sound technology. It can realize articulation of reconstruction sound by BBE surround built-in reproduce tone more naturally.

(Note) This device is produced under license from BBE sound Lab, Inc.(USA) and available to only licenses.

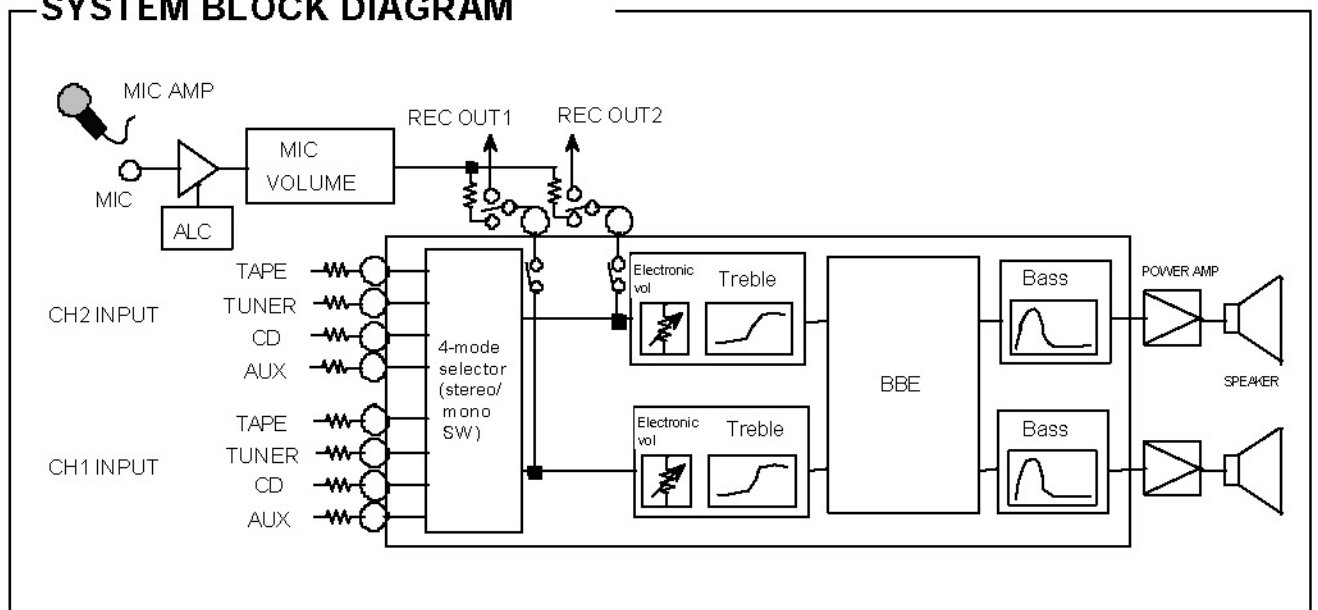
**FEATURES**

- Built-in "BBE surround" sound technology
- Electronic volume.  
0 ~ -84dB, the infinitesimal
- 2-band tone control  
Bass(0 ~ +21dB/3dB STEP)  
Treble(0 ~ +9dB/3dB STEP)

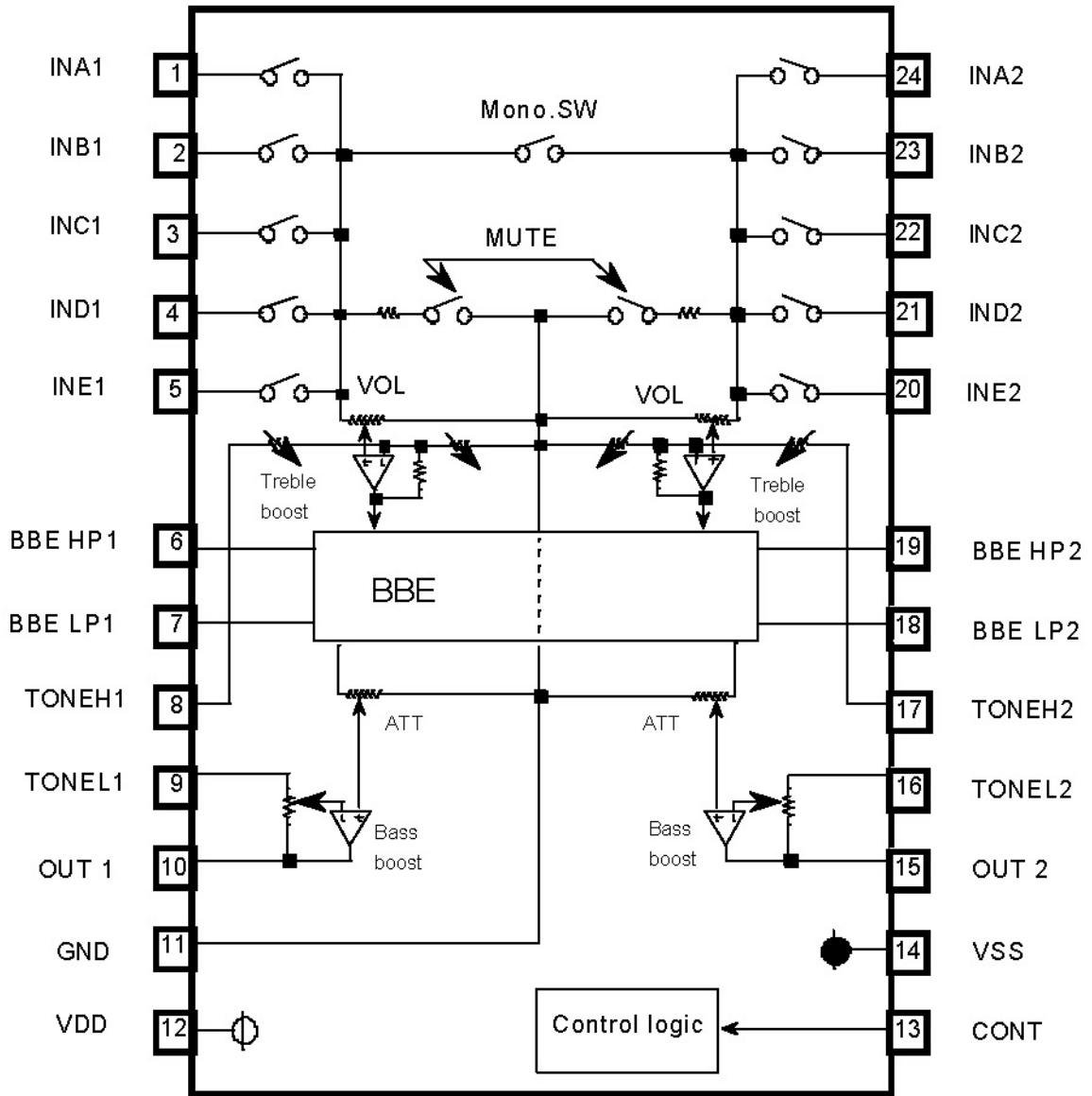
**RECOMMENDED OPERATING CONDITIONS**

Supply voltage range ——— + 2.25~+ 2.75V

**SYSTEM BLOCK DIAGRAM**



# BLOCK DIAGRAM



Units Resistance :ohm  
Capacitance: F

## PIN DESCRIPTION

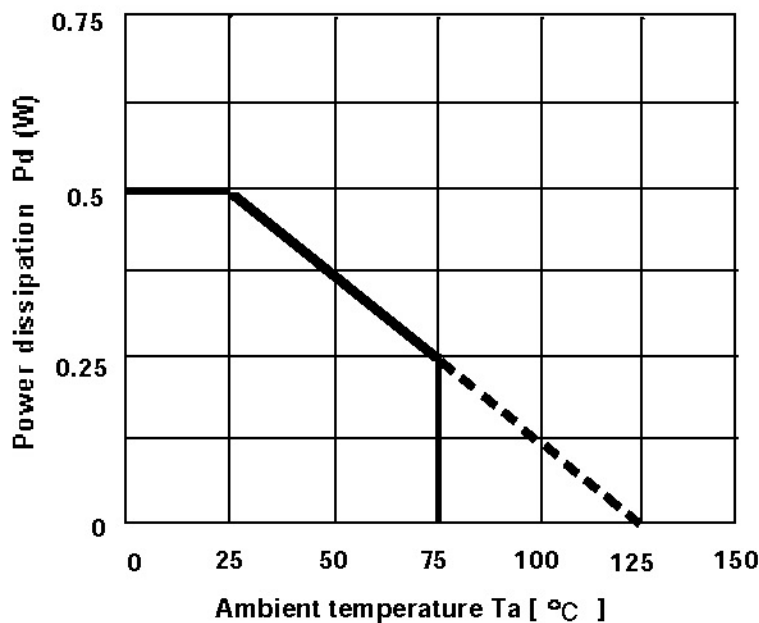
Pin No.	Name	Function
1	IN A1	INPUTs of the channel 1  <div style="border: 1px solid black; padding: 5px;">             The switch of INE can be controlled independently.              Please set "ALL OFF" mode when the switch of E is only ON.           </div>
2	IN B1	
3	IN C1	
4	IN D1	
5	INE1	
6	BBE HP1	BBE high pass filter 1
7	BBE LP1	BBE low pass filter 1
8	TONEH1	Treble control adjustment of the channel 1
9	TONEL1	Bass control adjustment of the channel 1
10	OUT1	OUTPUT of the channel 1
11	GND	Ground
12	VDD	Supply voltage(+)
13	CONT	Control data input from a microcontroller
14	VSS	Supply voltage(-)
15	OUT2	OUTPUT of the channel 2
16	TONEL2	Bass control adjustment of the channel 2
17	TONEH2	Treble control adjustment of the channel 2
18	BBE HP2	BBE high pass filter 2
19	BBE LP2	BBE low pass filter 2
20	INE2	<div style="border: 1px solid black; padding: 5px;">             The switch of INE can be controlled independently.              Please set "ALL OFF" mode when the switch of E is only ON.           </div> INPUTs of the channel 2
21	IN D2	
22	IN C2	
23	IN B2	
24	IN A2	

## ABSOLUTE MAXIMUM RATINGS

(Ta=25 °C, unless otherwise noted)

Symbol	Parameter	Test conditions	Rating	Unit
VDD-VSS	Supply voltage		6.0	V
$K_{\theta}$	Thermal derating	Note:1	5	mW/°C
Pd	Power dissipation		500	mW
Topr	Operating temperature		-20 ~ 75	°C
Tstg	Storage temperature		-40 ~ 125	°C

### Thermal derating(maximum rating)



Note.1 reference PC Board

Size :70mmX70mm

Thickness:1.6mm

Material :glass epoxy

Copper pattern dimension

Width :0.25mm

Length :25 ~ 30mm/lead

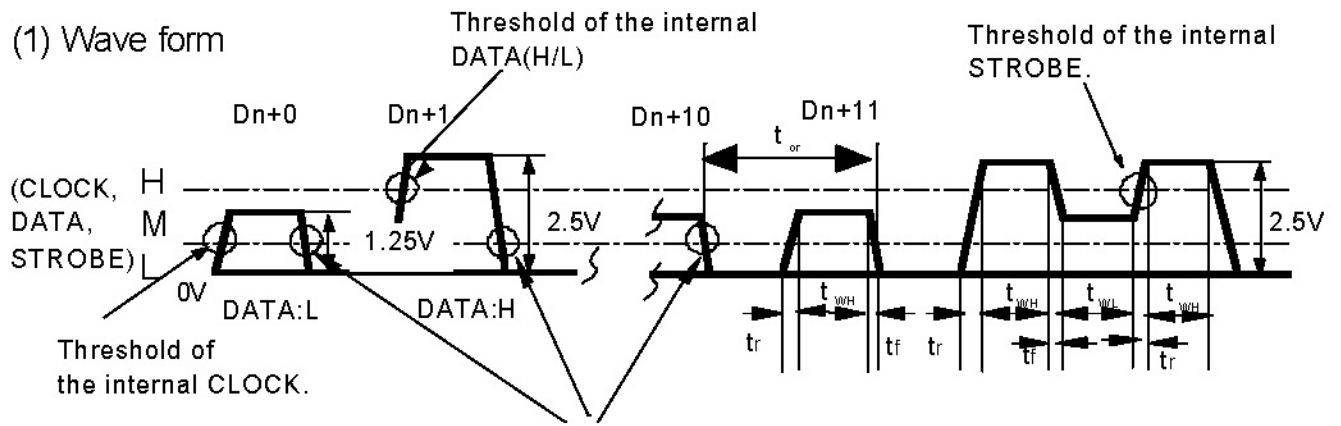
Thickness:18um

## Recommended operating conditions

Symbol	Parameter	Pin No.	Condition	Limits			Unit
				min.	typ.	max.	
VDD	Supply voltage(+)	12		2.25	2.5	2.75	V
VSS	Supply voltage(-)	14		-2.75	-2.5	-2.25	
CONT	Control data input voltage	13		GND	—	VDD	

## CONTROL SIGNALS SPECIFICATION

### (1) Wave form



### (2) Voltage control signal

Digital input signal		Condition	Limits			Unit
			min.	typ.	max.	
L signal	L	VDD=2.5V,VSS=-2.5V	GND	—	0.4	V
M signal	M	VDD=2.5V,VSS=-2.5V	1.0	1.25 (VDD/2)	1.5	
H signal	H	VDD=2.5V,VSS=-2.5V	2.1	—	VDD	

### (3) Timing control signal

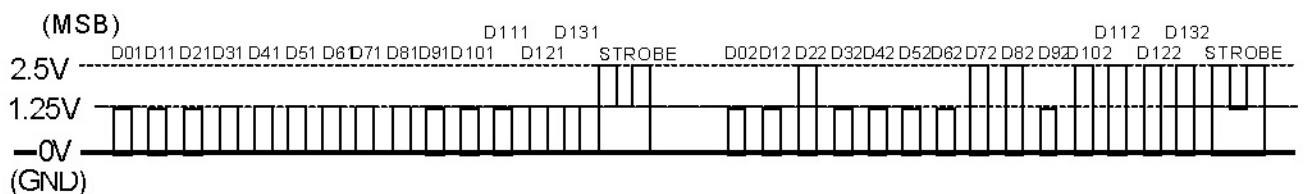
Symbol	Parameter	Limits			Unit
		min	typ	max	
$t_{or}$	Cycle time of digital signal	4	—	—	usec
$t_{WH}$	Pulse width of digital signal("H"level)	1.6	—	—	
$t_{WLC}$	Pulse width of digital signal("L"level)	1.6	—	—	
$t_r$	Rise time of digital signal	—	—	0.4	
$t_f$	Fall time of digital signal	—	—	0.4	

### (4) Control signal example(Refer to page 6 on the control data)

An example of the mode control

VOL/TREBLE SHARE AMP GAIN:20dB  
 INPUT :INA,  
 VOLUME :0dB  
 MUTE :OFF

BBE EFFECT:High level(+3dB)  
 MODE:STEREO  
 BASS:18dB  
 TREBLE:6dB  
 RECOUT:ON(INE)



# CONTROL DATA FORMAT

\*It's necessary to set up the all control data after power on.

## (1) INPUT DATA

(MSB) ← Input order

Slot1	D01	D11	D21	D31	D41	D51	D61	D71	D81	D91	D101	D111	D121	D131
	0	0	Vol/Treble share amp gain 3V 0: 20dB 1: 18dB 2: 16dB 3: 14dB		INPUT 0: IN A 1: IN B 2: IN C 3: IN D		D2 to D6:(a)Master volume condition				MUTE ON/OFF 0:OFF 1:ON  (INPUT ALL OFF)	CHIP/SLOT SELECT 0:select 1:no select 2:no select 3:no select		
Slot2	D02	D12	D22	D32	D42	D52	D62	D72	D82	D92	D102	D112	D122	D132
	0	0	BBE effect		Mode select 0:stereo 1:mono1 only 2:mono2 only 3:mono1+2		Bass(boost) 0:0dB, 1:3dB, 2:6dB, 3:9dB, 4:12dB, 5:15dB, 6:18dB, 7:21dB		Treble(boost) 0:0dB,1:3dB 2:6dB,3:9dB		INE ON/OFF 0:OFF 1:ON	CHIP/SLOT SELECT 0:no select 1:no select 2:no select 3:select		

(a) Master volume

ATT	D61	D71	D81	D91	D101
-0.0dB	0	0	0	0	0
-2.0dB	1	0	0	0	0
-4.0dB	0	1	0	0	0
-6.0dB	1	1	0	0	0
-8.0dB	0	0	1	0	0
-10.0dB	1	0	1	0	0
-12.0dB	0	1	1	0	0
-14.0dB	1	1	1	0	0
-16.0dB	0	0	0	1	0
-18.0dB	1	0	0	1	0
-20.0dB	0	1	0	1	0
-22.0dB	1	1	0	1	0
-24.0dB	0	0	1	1	0
-26.0dB	1	0	1	1	0
-28.0dB	0	1	1	1	0
-30.0dB	1	1	1	1	0
-32.0dB	0	0	0	0	1
-34.0dB	1	0	0	0	1
-36.0dB	0	1	0	0	1
-40.0dB	1	1	0	0	1
-44.0dB	0	0	1	0	1
-48.0dB	1	0	1	0	1
-52.0dB	0	1	1	0	1
-56.0dB	1	1	1	0	1
-60.0dB	0	0	0	1	1
-64.0dB	1	0	0	1	1
-68.0dB	0	1	0	1	1
-72.0dB	1	1	0	1	1
-76.0dB	0	0	1	1	1
-80.0dB	1	0	1	1	1
-84.0dB	0	1	1	1	1
the infinitesimal	1	1	1	1	1

(b) Input select

Input select		D41	D51	D111	D112
IN A	IN E off	0	0	0	0
IN B		1	0		
IN C		0	1		
IN D		1	1		
IN A to D all OFF		*	*	1	1 *1
IN A-D select	IN E on	A: 0	0	0	1 *2
		B: 1	0		
		C: 0	1		
		D: 1	1		

\*1) The input impedance is about 5k as input INE.

\*2) INE can be controlled independently.  
It can be used as Rec output.

(c) Mode control

Mode	D42	D52
stereo	0	0
mono1 only	1	0
mono2 only	0	1
mono1+2	1	1

(d) Treble control

Treble	D92	D102
0dB	0	0
3dB	1	0
6dB	0	1
9dB	1	1

(e) Bass control

Bass	D62	D72	D82
0dB	0	0	0
3dB	1	0	0
6dB	0	1	0
9dB	1	1	0
12dB	0	0	1
15dB	1	0	1
18dB	0	1	1
21dB	1	1	1

(f) Chip/Slot control

Chip/Slot	D12*	D13*
select(slot1)	0	0
no select	1	0
no select	0	1
select(slot1)	1	1

(g) Treble amp gain

SW

Gain SW	D21	D31
20dB	0	0
18dB	1	0
16dB	0	1
14dB	1	1

(i) BBE effect

Effect	D22	D32
Bypass	0	0
BBE1 high level +3dB	1	0
BBE2 high level +7dB	0	1
BBE3 high level +11dB	1	1

## (2) NOTICE OF CONTROL DATA

1. Input only the control data at (1) INPUT DATA.
2. It's necessary to set up the all control data after power-on, although the internal circuit is forced as follows, when  $(VDD-VSS) < 3.3V(TYP)$ .
3. The interval of data transmission from the microcontroller is over 0.1 sec. This is waiting time for soft-switching to reduce the shocknoise.

Parameter	Condition
Gain SW	18dB
Input select	ALL OFF
Master volume	the infinitesimal
MUTE	ON(Input ALLOFF)
BBE effect	Bypass
Mode select	stereo
Bass	0dB
Treble	0dB
IN E	ON



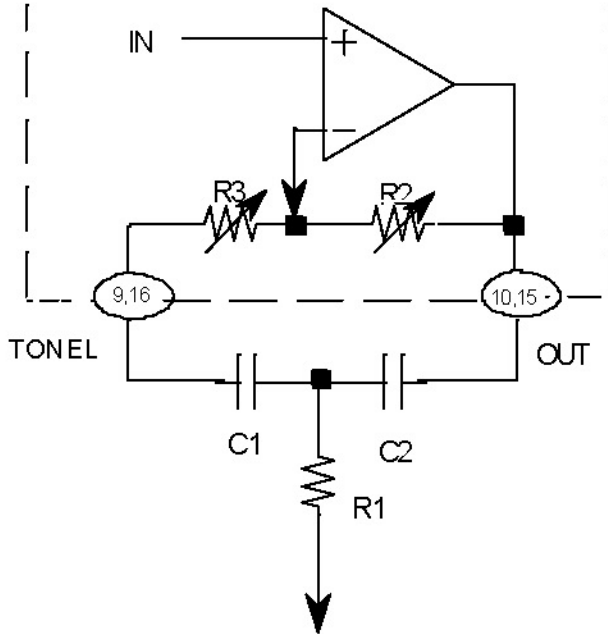
## ELECTRICAL CHARACTERISTICS

(VDD=2.5V,VSS=-2.5V,f=1kHz,Vi=100mV(rms),VOL=0dB,BASS=0dB,TREBLE=0dB,VOL/TREBLE SHARE AMP=18dB,SURROUND=BYPASS,RL=10K,Ta=25°C,unless otherwise noted)

Symbol	Parameter	Condition	Limits			Unit	
			min.	typ.	max.		
IDD	Circuit current of positive power supply	Quiescent	—	30	45	mA	
ISS	Circuit current of negative power supply	Quiescent	—	-30	-45	mA	
Gv1	Voltage gain (selector)	Vol/Treble share amp gain=18dB Bypass	16	18	20	dB	
Gv2	Voltage gain (tone control)	Vol/Treble share amp gain=18dB Q surround mode Vi=20mVrms	25.5	27.5	29.5	dB	
Vomax	Maximum output voltage	RL=10k,THD=1%	1.2	1.6	—	Vrms	
THD	Total harmonic distortion	BW=400 ~ 30kHz	—	0.02	0.08	%	
No1	Output noise voltage	JIS-A,Rg=5.1k,VOL=the infinitesimal BYPASS	—	8	20	uVrms	
No2		JIS-A,Rg=5.1k,VOL=the infinitesimal BBE3(High level+11dB) mode	—	15	40	uVrms	
ATTmax	Maximum attenuation	Output reference level(Vo=1Vrms), ATT=the infinitesimal ,JIS-A	—	-95	-90	dB	
GB1	Bass boost	3dB	f=1kHz, Vo=80mVrms	1.5	3	4.5	dB
GB2		6dB		4.5	6	7.5	
GB3		9dB		7.5	9	10.5	
GB4		12dB		10.5	12	13.5	
GB5		15dB		13.5	15	16.5	
GB6		18dB		16.5	18	19.5	
GB7		21dB		19.5	21	22.5	
GT1	Treble boost	3dB	f=1kHz, Vo=80mVrms	1.5	3	4.5	dB
GT2		6dB		4.5	6	7.5	
GT3		9dB		7.5	9	10.5	
BBE1	Low level boost(f=20Hz)	f=20Hz,Vo=80mVrms	—	3	—	dB	
BBE2	High level boost(f=10kHz)	f=10kHz,Vo=80mVrms	—	11	—		

## FUNCTION DESCRIPTION

### (1) Equivalent circuit of the bass boost



$$F_c = \frac{1}{2\pi\sqrt{R_1(R_2+R_3)C_1C_2}} \quad (\text{Hz})$$

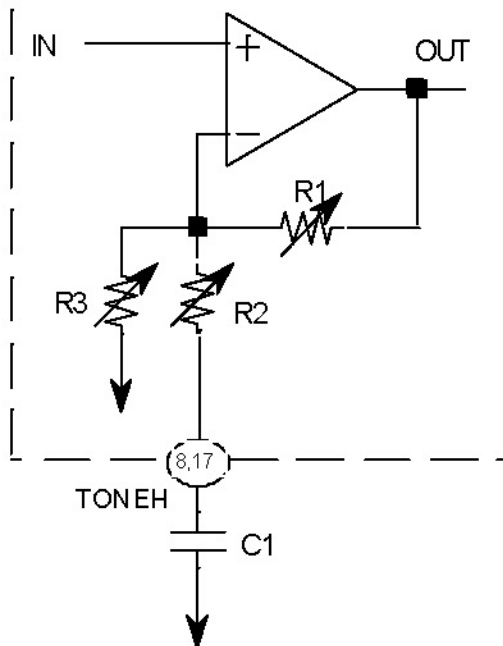
$$Q = \frac{1}{C_1+C_2} \sqrt{\frac{C_1C_2R_2}{R_1}}$$

$$(C_1=C_2) \quad G_v = 20 \log \frac{\frac{R_2+R_3}{R_1} + 2}{\frac{R_3}{R_1} + 2} \quad (\text{dB})$$

R2, R3 (typical)

Bassboost	3dB	6dB	9dB	12dB	15dB	18dB	21dB	
Resistor	R2	15.4	25.7	32.9	38.7	41.6	44.2	46
(k)	R3	30.6	20.3	13.1	7.3	4.4	1.8	0

### (2) Equivalent circuit of the treble boost



$$F_c = \frac{1}{2\pi R_2 C_1} \quad (\text{Hz})$$

$$G_v = 20 \log \frac{R_1 + \{(R_2 + Z_c) // R_3\}}{(R_2 + Z_c) // R_3} \quad (\text{dB})$$

$$Z_c = \frac{1}{j\omega C_1} \quad (\text{ohm})$$

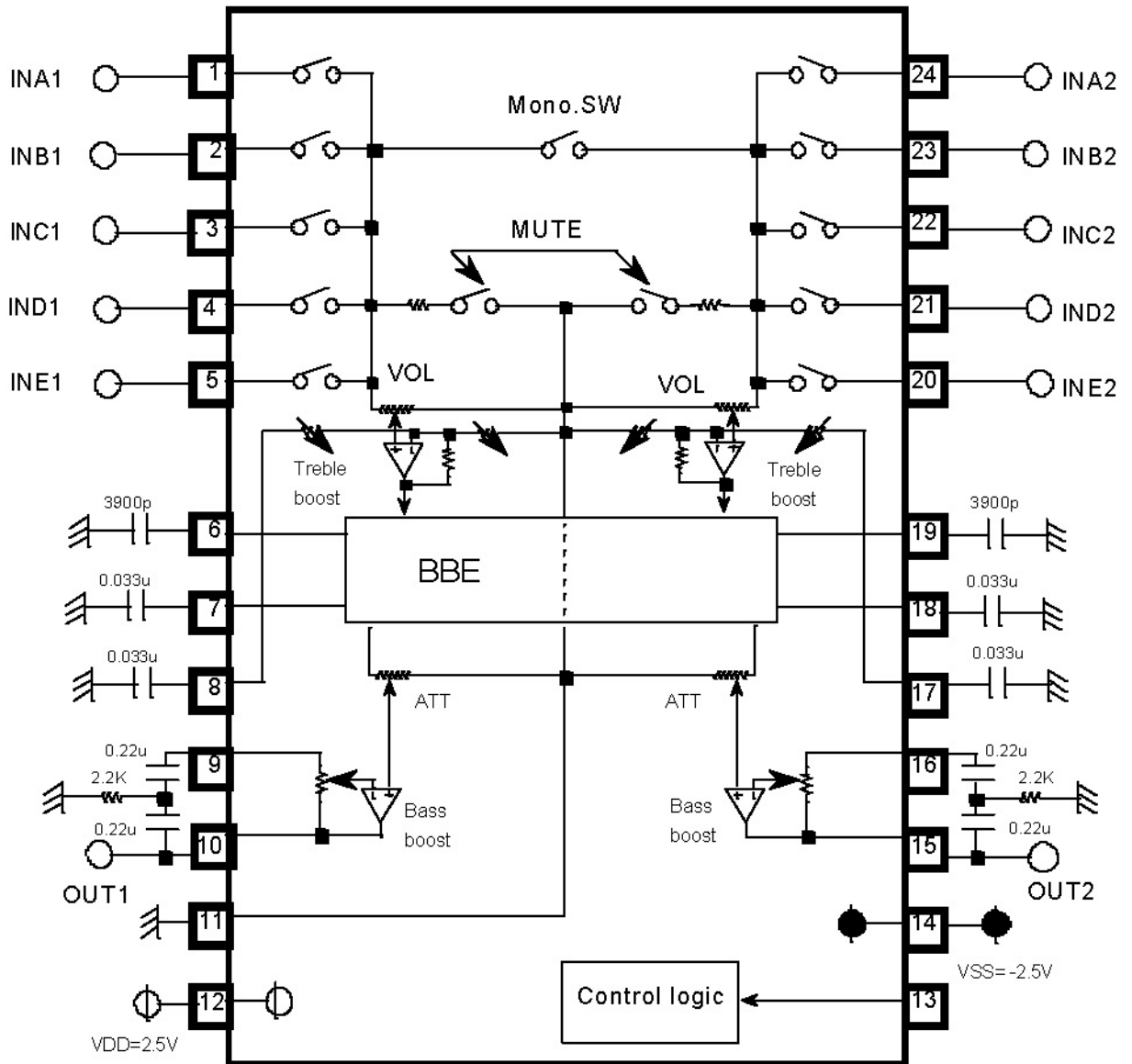
R2 (typical)

Treble boost	3dB	6dB	9dB
R2 (k)	5.3	2.2	1.2

R1, R3 (typical)

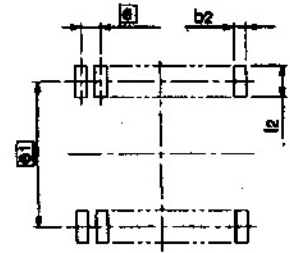
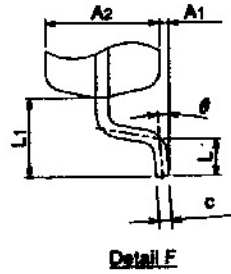
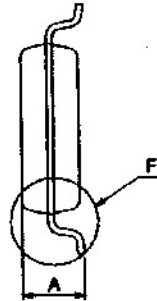
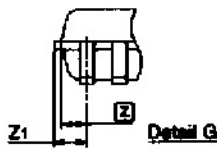
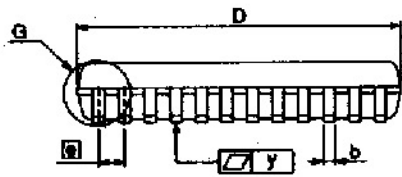
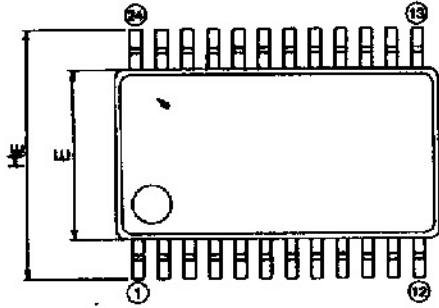
Gain	14dB	16dB	18dB	20dB
R1 (k)	10.88	13.65	17.21	21.60
R3 (k)	2.72	2.57	2.48	2.40

# APPLICATION EXAMPLE



Units Resistor : ohm  
Capacitor: F

# OUTLINE



Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	-	-	2.1
A1	0	0.1	0.2
A2	-	1.8	-
b	0.3	0.35	0.45
c	0.18	0.2	0.25
D	10.0	10.1	10.2
E	5.2	5.3	5.4
g	-	0.8	-
HE	7.5	7.8	8.1
L	0.4	0.8	0.8
L1	-	1.25	-
L2	-	0.65	-
Z1	-	-	0.8
y	-	-	0.1
$\phi$	0°	-	8°
b2	-	0.5	-
g1	-	7.62	-
lc	1.27	-	-