

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.

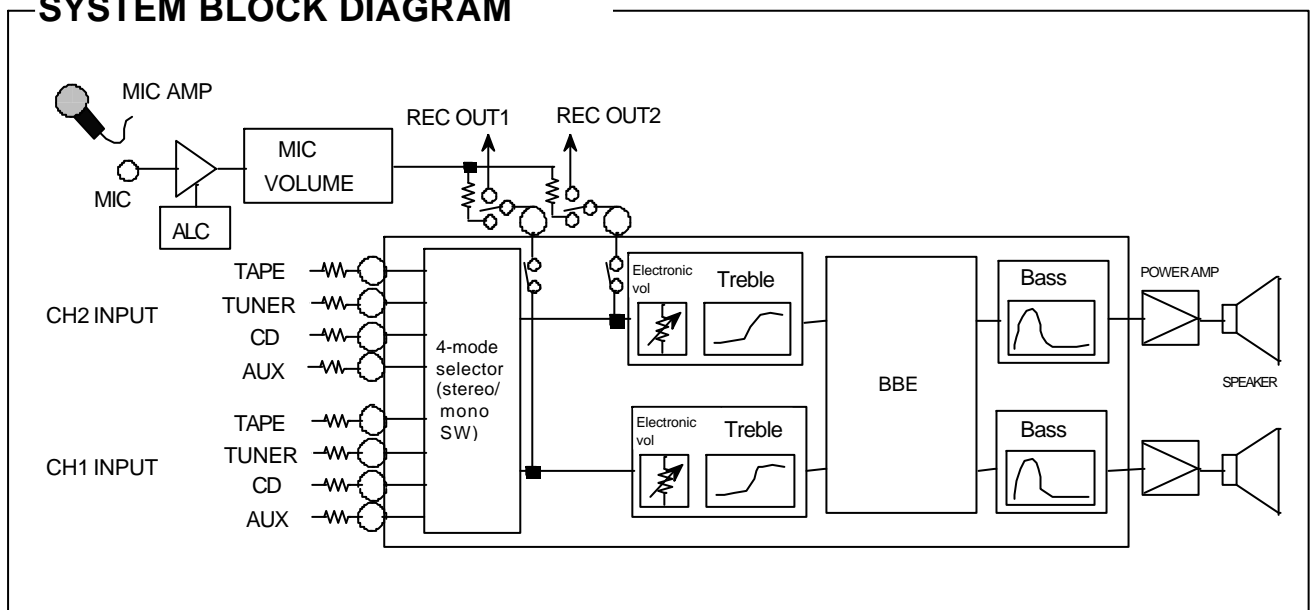
FEATURES

- 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)

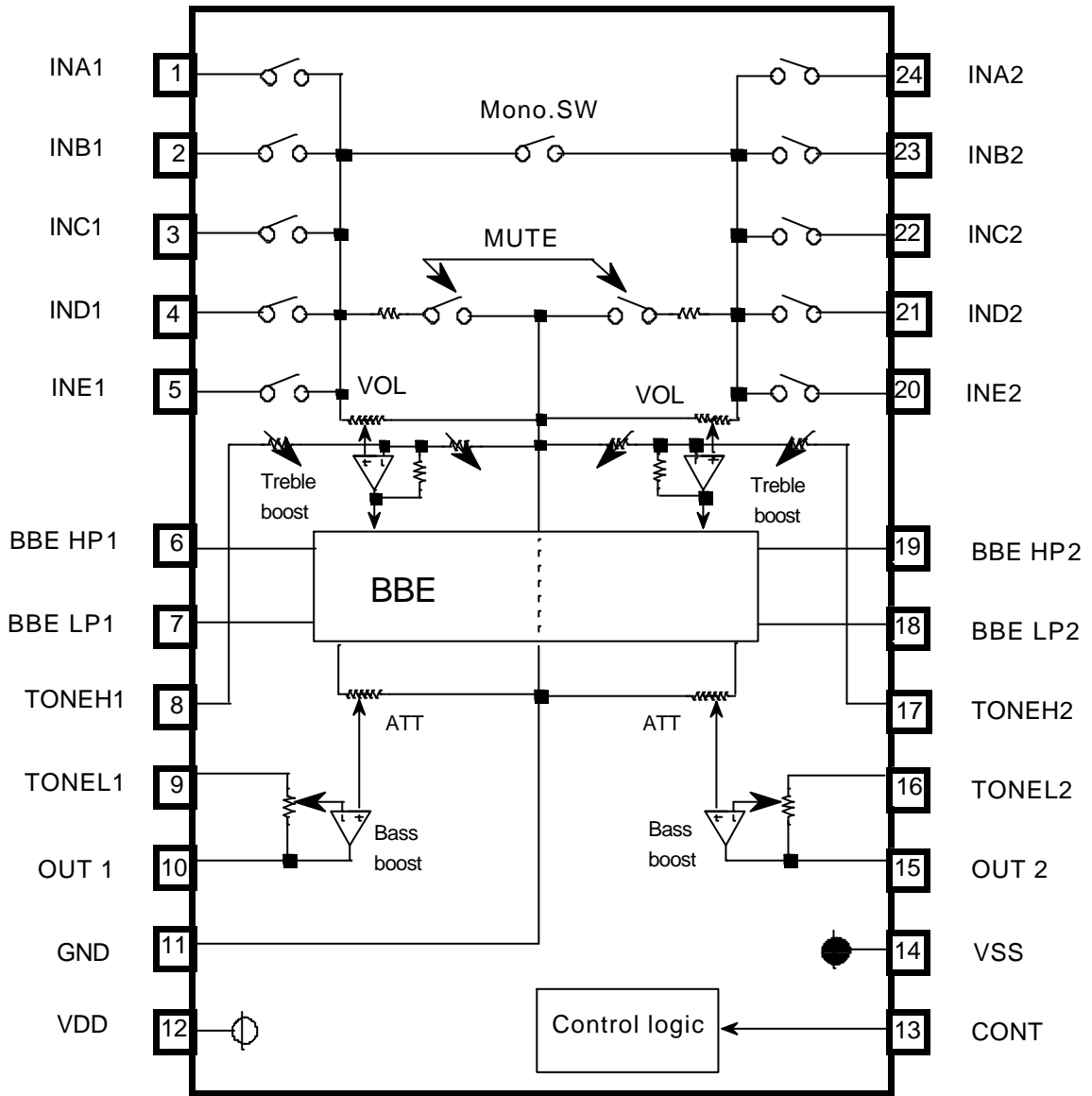
RECOMMENDED OPERATING CONDITIONS

Supply voltage range $\text{---} + 2.25 \sim + 2.75\text{V}$

SYSTEM BLOCK DIAGRAM



BLOCK DIAGRAM



Units Resistance :ohm
Capacitance: F

PIN DESCRIPTION

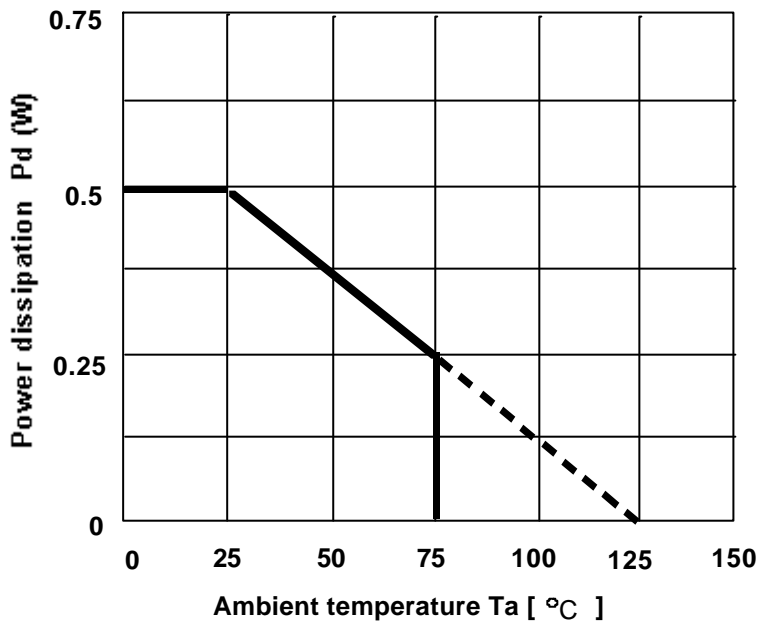
| Pin No. | Name | Function |
|---------|---------|---|
| 1 | IN A1 | INPUTs of the channel 1 <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> The switch of INE can be controlled independently. Please set "ALL OFF" mode when the switch of E is only ON. </div> |
| 2 | IN B1 | |
| 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; margin-bottom: 10px;"> 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_{θ} | 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

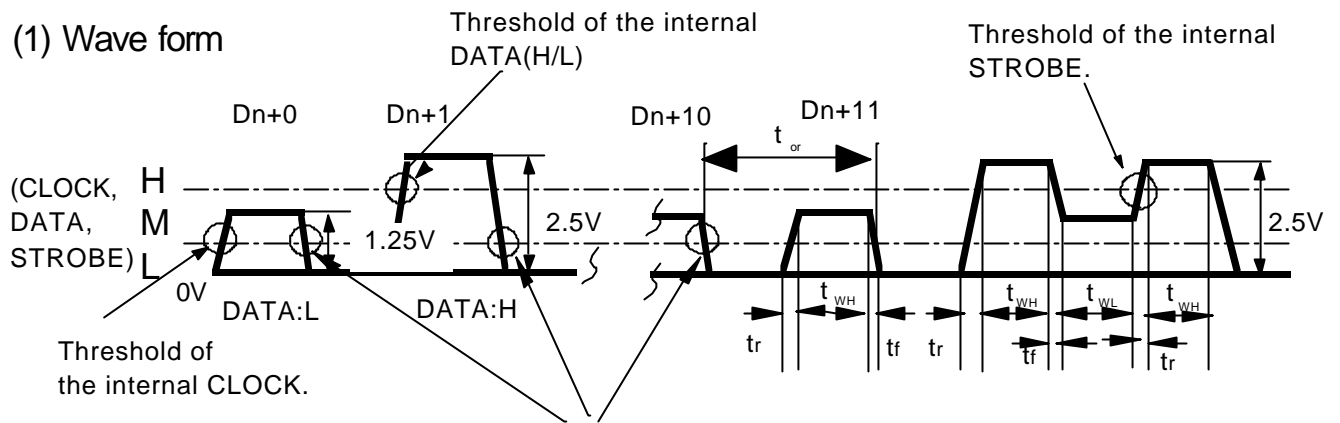
Thickness:18um

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



The internal DATA latch at the falling edges of this clock signal.

(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

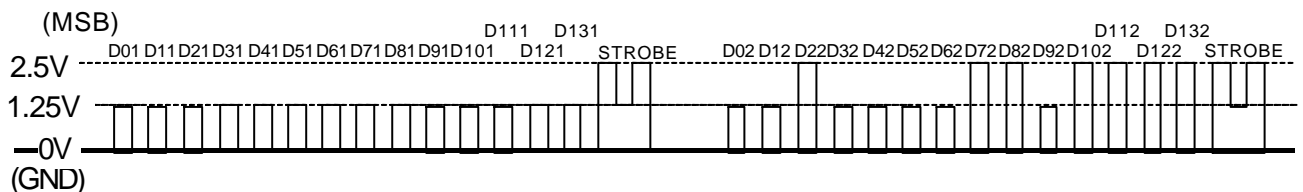
| Symbol | Parameter | Limits | | | Unit |
|-----------|---|--------|-----|-----|------|
| | | min | typ | max | |
| t_{cr} | Cycle time of digital signal | 4 | — | — | usec |
| t_{WH} | Pulse width of digital signal("H"level) | 1.6 | — | — | |
| t_{WLC} | Pulse width of digital signal("L"level) | 1.6 | — | — | |
| 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 SW 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 |

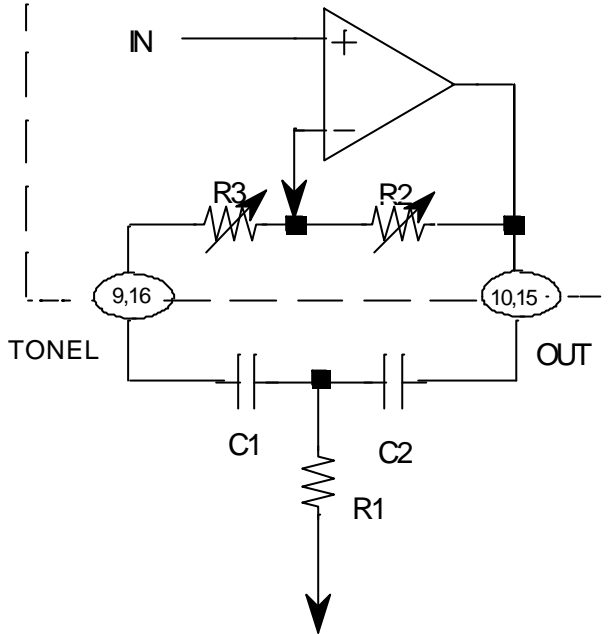
ELECTRICAL CHARACTERISTICS

(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



$$F_0 = \frac{1}{2\pi \sqrt{R1(R2+R3)C1C2}} \quad (\text{Hz})$$

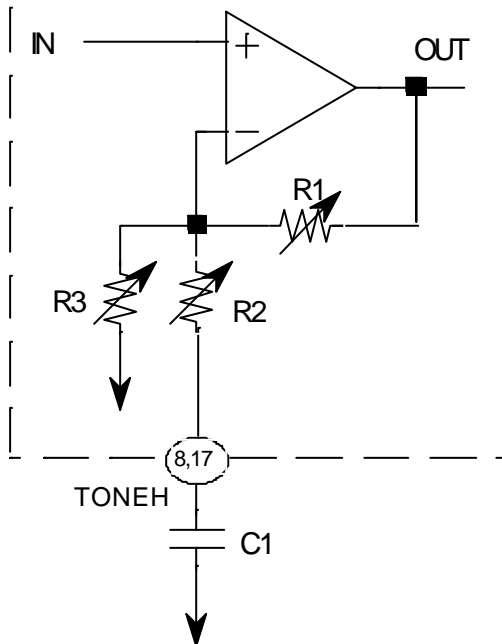
$$Q = \frac{1}{C1+C2} \sqrt{\frac{C1C2R2}{R1}}$$

$$(C1=C2) \quad Gv = 20 \log \frac{\frac{R2+R3}{R1} + 2}{\frac{R3}{R1} + 2} \quad (\text{dB})$$

R2,R3 (typical)

| Bass boost | 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



$$F_c = \frac{1}{2\pi R2 C1} \quad (\text{Hz})$$

$$Gv = 20 \log \frac{R1 + \{(R2+Zc)\} // R3}{(R2+Zc) // R3} \quad (\text{dB})$$

$$Zc = \frac{1}{j\omega C1} \quad (\text{ohm})$$

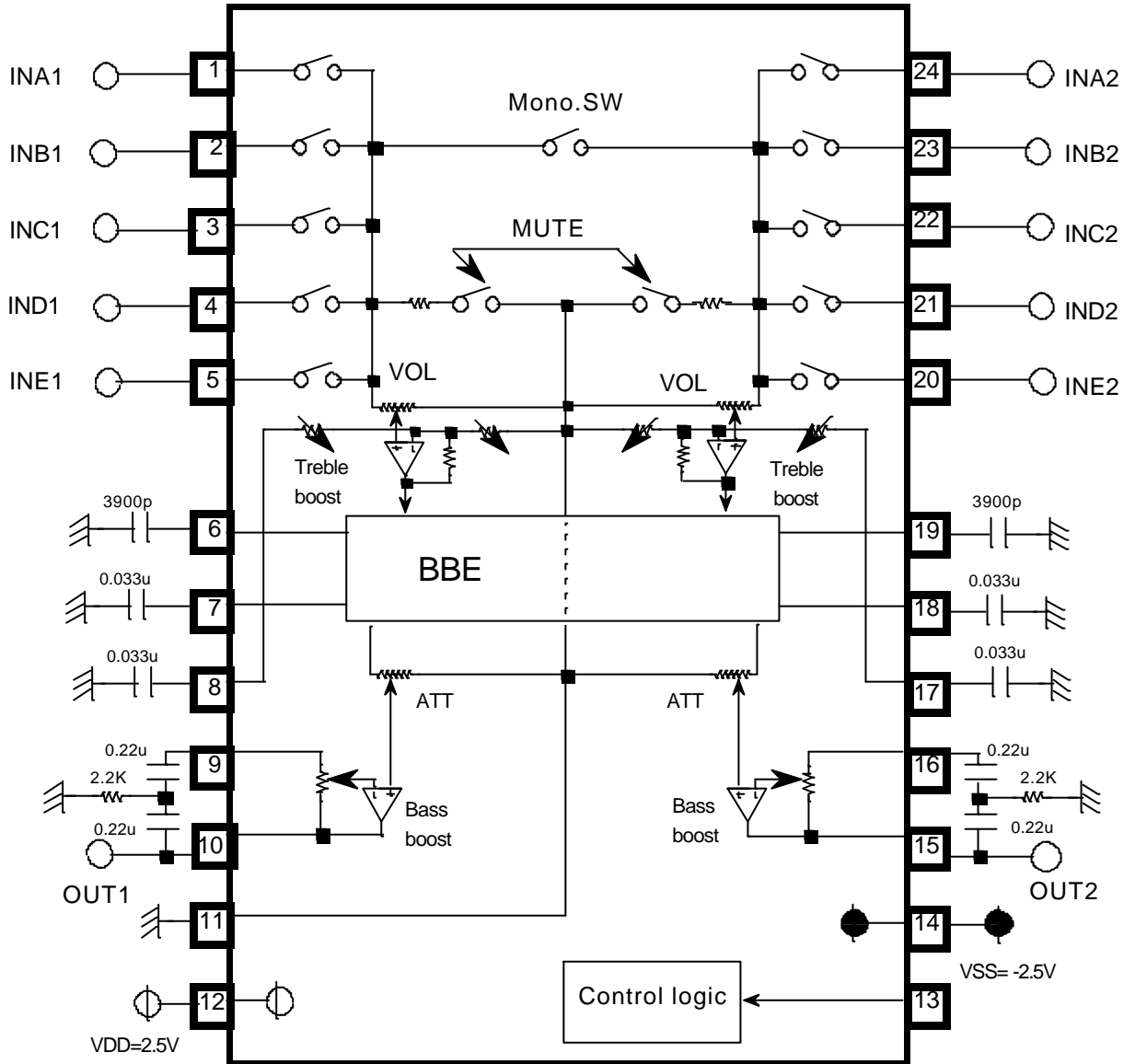
R2 (typical)

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

R1,R3 (typical)

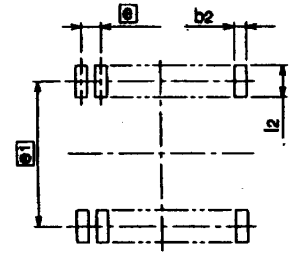
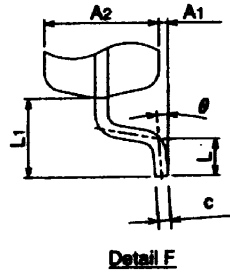
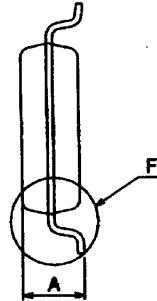
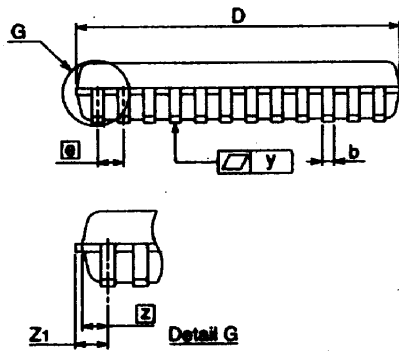
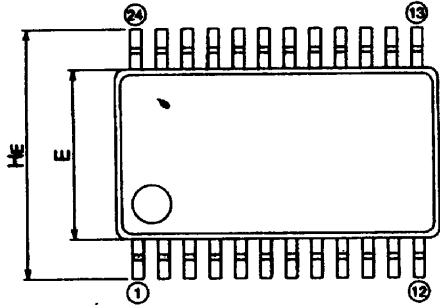
| Gain | 14dB | 16dB | 18dB | 20dB |
|--------|-------|-------|-------|-------|
| R1 (k) | 10.88 | 13.65 | 17.21 | 21.60 |
| R3 (k) | 2.72 | 2.57 | 2.48 | 2.40 |

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 |
| ⓐ | - | 0.8 | - |
| HE | 7.5 | 7.8 | 8.1 |
| L | 0.4 | 0.6 | 0.8 |
| L1 | - | 1.25 | - |
| ⓑ | - | 0.65 | - |
| Z1 | - | - | 0.8 |
| y | - | - | 0.1 |
| θ | 0° | - | 8° |
| b2 | - | 0.5 | - |
| ⓓ | - | 7.62 | - |
| l2 | 1.27 | - | - |