

# M61500FP

## Tone Control/Volume Control

REJ03F0274-0200  
Rev.2.00  
Jun 16, 2008

### Description

The M61500FP is the sound controller powered by "QSurround" system.

The "QSurround" system decodes and virtualize multi-speaker surround sound from various matrix surround encoded sources: Dolby Surround, stereo downmixed AC-3, stereo downmixed DTS.

Produces normal and wide 3D sound expansion from any stereo input signal.

Note: This device is produced under license from QSound Lab, Inc. (Canada).

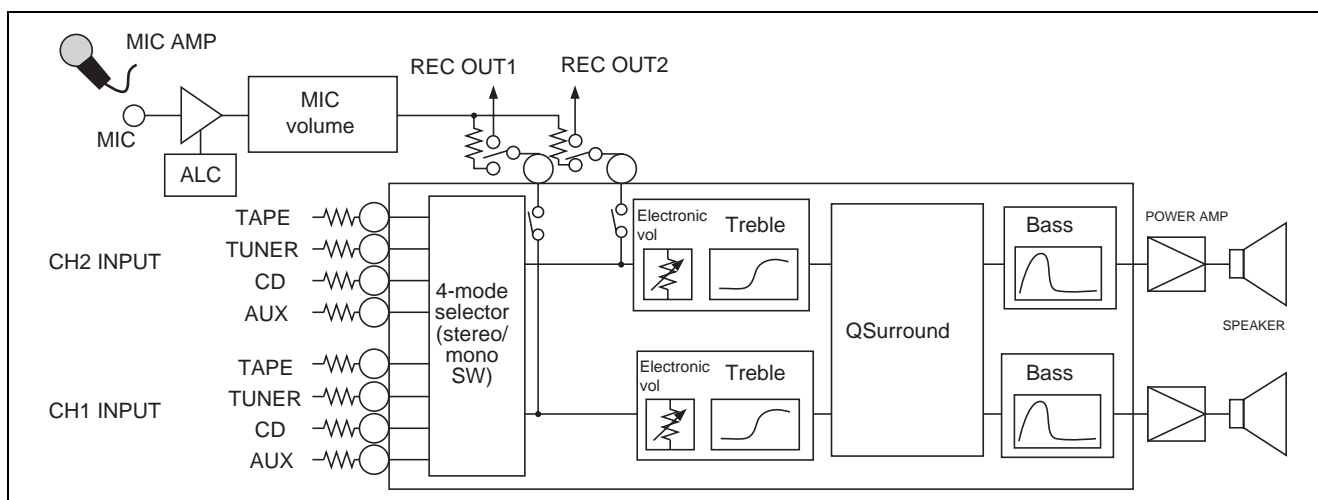
### Features

- Built-in "QSurround" sound technology
- Electronic volume  
0 to -84 dB, infinitesimal
- 2-band tone control  
Bass (0 to +21 dB / 3 dB STEP)  
Treble (0 to +9 dB / 3 dB STEP)
- 5 input selector (The fifth input can be used as REC OUT or MIC MIX.)

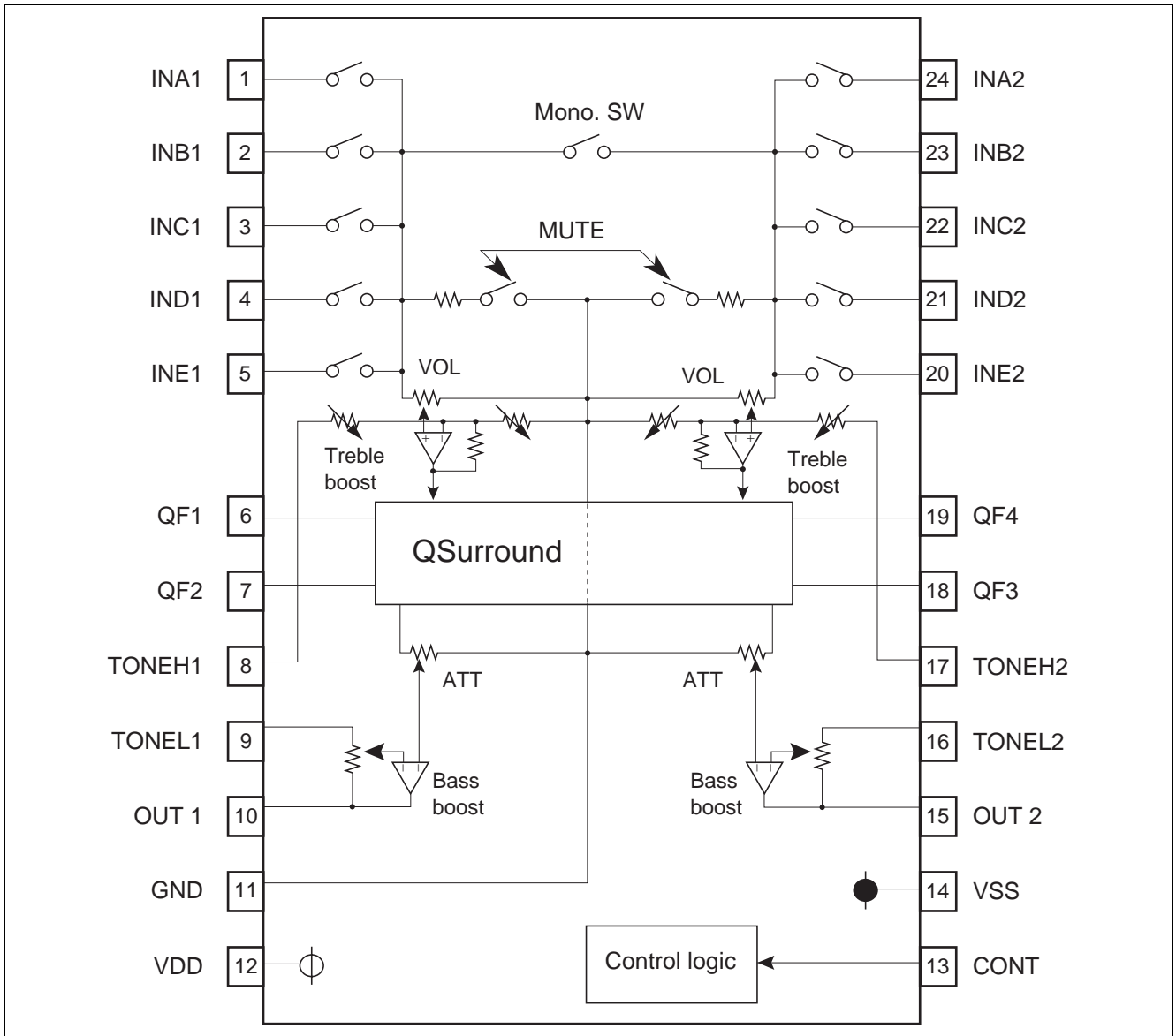
### Recommended Operating Conditions

Supply voltage range:  $\pm 2.25$  to  $\pm 2.75$  V

### System Block Diagram



Block Diagram



## Pin Description

| Pin No. | Pin Name | Function                                                                                                                                        |
|---------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | INA1     | INPUTs of the channel 1<br><br>The switch of INE can be controlled independently.<br>Please set "ALL OFF" mode when the switch of E is only ON. |
| 2       | INB1     |                                                                                                                                                 |
| 3       | INC1     |                                                                                                                                                 |
| 4       | IND1     |                                                                                                                                                 |
| 5       | INE1     |                                                                                                                                                 |
| 6       | QF1      | QSurround filter 1                                                                                                                              |
| 7       | QF2      | QSurround filter 2                                                                                                                              |
| 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      | QF3      | QSurround filter 3                                                                                                                              |
| 19      | QF4      | QSurround filter 4                                                                                                                              |
| 20      | INE2     | INPUTs of the channel 2<br><br>The switch of INE can be controlled independently.<br>Please set "ALL OFF" mode when the switch of E is only ON. |
| 21      | IND2     |                                                                                                                                                 |
| 22      | INC2     |                                                                                                                                                 |
| 23      | INB2     |                                                                                                                                                 |
| 24      | INA2     |                                                                                                                                                 |

## Absolute Maximum Ratings

(Ta = 25°C, unless otherwise noted)

| Item                             | Symbol     | Ratings     | Unit  |
|----------------------------------|------------|-------------|-------|
| Supply voltage                   | VDD-VSS    | 6.0         | V     |
| Thermal derating <sup>Note</sup> | K $\theta$ | 5           | mW/°C |
| Power dissipation                | Pd         | 500         | mW    |
| Operating temperature            | Topr       | -20 to +75  | °C    |
| Storage temperature              | Tstg       | -40 to +125 | °C    |

Note: Reference PC board

Size: 70 mm × 70 mm

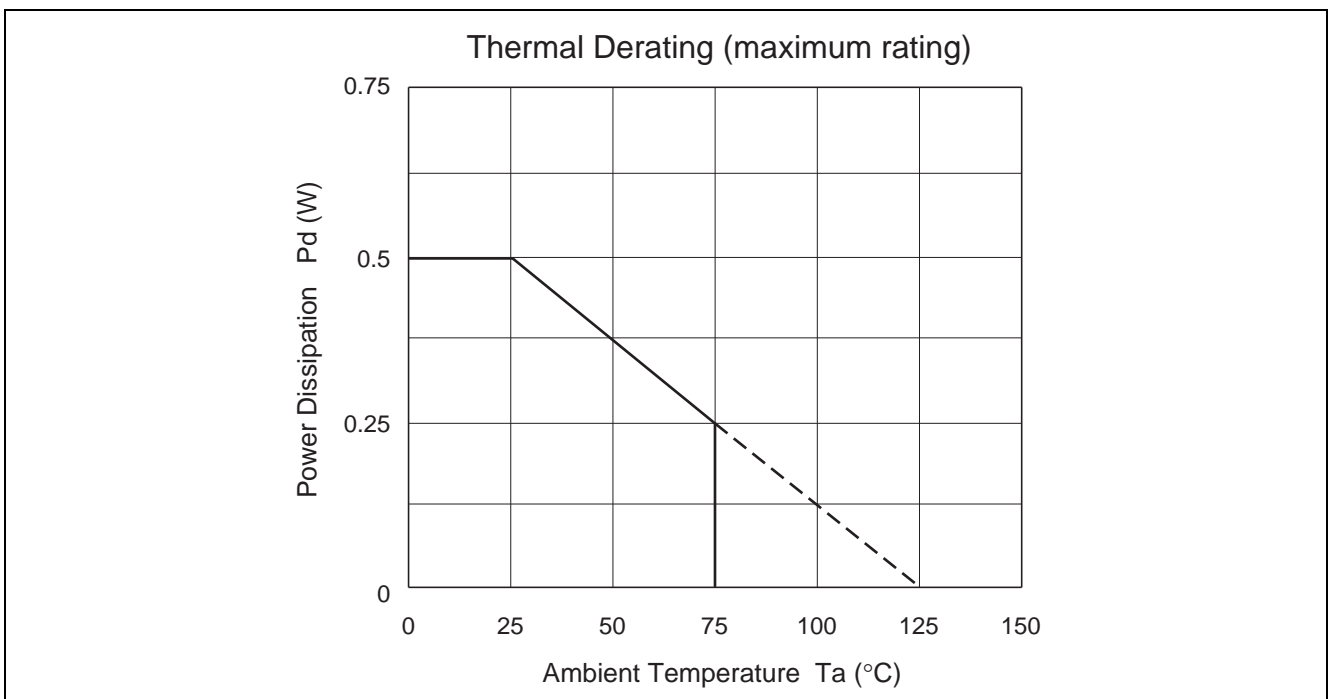
Thickness: 1.6 mm

Material: glass epoxy

Copper pattern dimension

Width: 0.25 mm

Length: 25 to 30 mm/lead

Thickness: 18  $\mu$ m

## Recommended Operating Conditions

| Item                       | Symbol | Pin No. | Min   | Typ  | Max   | Unit |
|----------------------------|--------|---------|-------|------|-------|------|
| Supply voltage (+)         | VDD    | 12      | 2.25  | 2.5  | 2.75  | V    |
| Supply voltage (-)         | VSS    | 14      | -2.75 | -2.5 | -2.25 |      |
| Control data input voltage | CONT   | 13      | GND   | —    | VDD   |      |

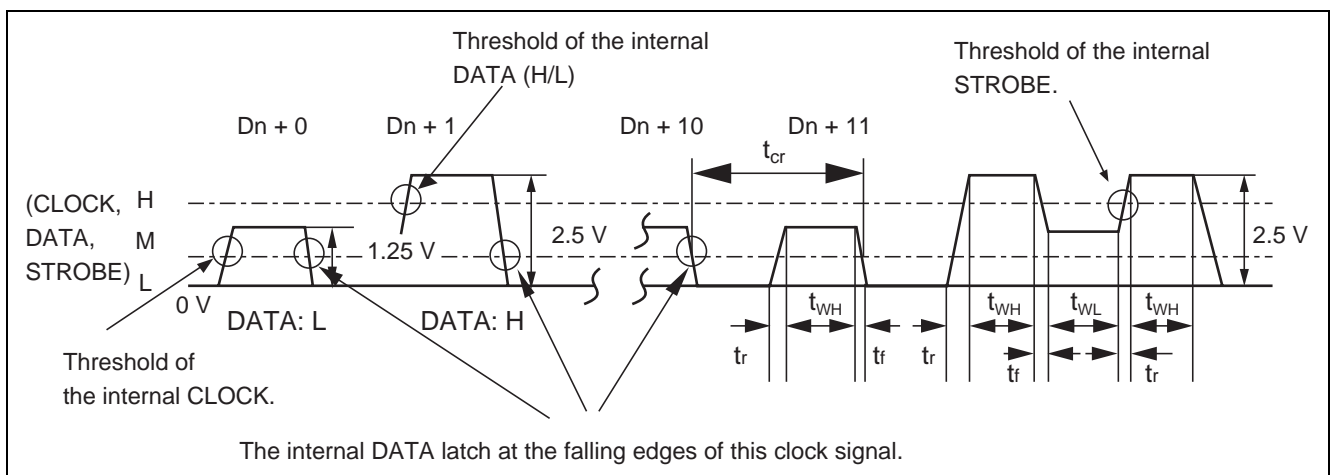
## Electrical Characteristics

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

| Item                                     | Symbol | Min  | Typ  | Max  | Unit  | Test Conditions                                                      |       |
|------------------------------------------|--------|------|------|------|-------|----------------------------------------------------------------------|-------|
| Circuit current of positive power supply | IDD    | —    | 30   | 45   | mA    | Quiescent                                                            |       |
| Circuit current of negative power supply | ISS    | —    | -30  | -45  | mA    | Quiescent                                                            |       |
| Voltage gain (selector)                  | Gv1    | 16   | 18   | 20   | dB    | Vol/Treble share amp gain = 18 dB, Bypass                            |       |
| Voltage gain (tone control)              | Gv2    | 25.5 | 27.5 | 29.5 | dB    | Vol/Treble share amp gain = 18 dB, QSurround mode, Vi = 20 mVrms     |       |
| Maximum output voltage                   | Vomax  | 1.2  | 1.6  | —    | Vrms  | RL = 10 kΩ, THD = 1%                                                 |       |
| Total harmonic distortion                | THD    | —    | 0.02 | 0.08 | %     | BW = 400 to 30 kHz                                                   |       |
| Output noise voltage                     | No1    | —    | 6    | 15   | μVrms | JIS-A, Rg = 5.1 kΩ, VOL = the infinitesimal, BYPASS                  |       |
|                                          | No2    | —    | 11   | 30   | μVrms | JIS-A, Rg = 5.1 kΩ, VOL = the infinitesimal, QSurround mode          |       |
| Maximum attenuation                      | ATTmax | —    | -95  | -90  | dB    | Output reference level (Vo = 1 Vrms), ATT = the infinitesimal, JIS-A |       |
| Bass boost                               | GB1    | 1.5  | 3    | 4.5  | dB    | 3 dB<br>f = 1 kHz,<br>Vo = 80 mVrms                                  |       |
|                                          | GB2    | 4.5  | 6    | 7.5  |       |                                                                      | 6 dB  |
|                                          | GB3    | 7.5  | 9    | 10.5 |       |                                                                      | 9 dB  |
|                                          | GB4    | 10.5 | 12   | 13.5 |       |                                                                      | 12 dB |
|                                          | GB5    | 13.5 | 15   | 16.5 |       |                                                                      | 15 dB |
|                                          | GB6    | 16.5 | 18   | 19.5 |       |                                                                      | 18 dB |
|                                          | GB7    | 19.5 | 21   | 22.5 |       |                                                                      | 21 dB |
| Treble boost                             | GT1    | 1.5  | 3    | 4.5  | dB    | f = 1 kHz,<br>Vo = 80 mVrms                                          |       |
|                                          | GT2    | 4.5  | 6    | 7.5  |       |                                                                      | 6 dB  |
|                                          | GT3    | 7.5  | 9    | 10.5 |       |                                                                      | 9 dB  |

## Control Signals Specification

### (1) Waveform



**(2) Voltage Control Signal**

| Digital Input Signal |   | Min | Typ          | Max | Unit | Condition                 |
|----------------------|---|-----|--------------|-----|------|---------------------------|
| L signal             | L | GND | —            | 0.4 | V    | VDD = 2.5 V, VSS = -2.5 V |
| M signal             | M | 1.0 | 1.25 (VDD/2) | 1.5 |      | VDD = 2.5 V, VSS = -2.5 V |
| H signal             | H | 2.1 | —            | VDD |      | VDD = 2.5 V, VSS = -2.5 V |

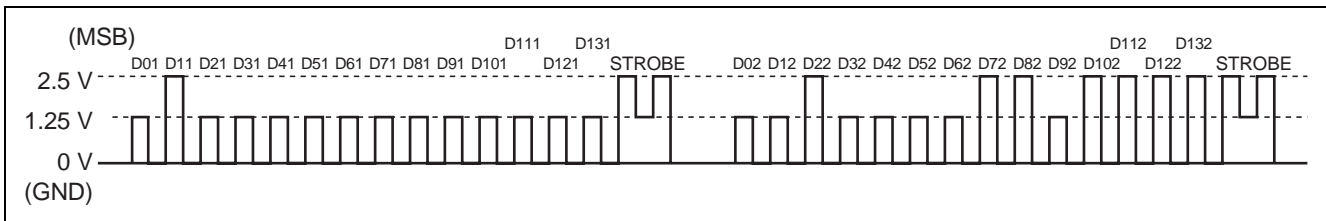
**(3) Timing Control Signal**

| Item                                      | Symbol          | Min | Typ | Max | Unit |
|-------------------------------------------|-----------------|-----|-----|-----|------|
| Cycle time of digital signal              | t <sub>cr</sub> | 8   | —   | —   | μs   |
| Pulse width of digital signal ("H" level) | t <sub>WH</sub> | 3.6 | —   | —   |      |
| Pulse width of digital signal ("L" level) | t <sub>WL</sub> | 3.6 | —   | —   |      |
| Rise time of digital signal               | t <sub>r</sub>  | —   | —   | 0.4 |      |
| Fall time of digital signal               | t <sub>f</sub>  | —   | —   | 0.4 |      |

**(4) Control Signal Example (Refer to "Control Data Format")**

An example of the mode control

|                                  |                          |
|----------------------------------|--------------------------|
| BYPASS/SURROUND SW: SURROUND     | SURROUND MODE: QSurround |
| VOL/TREBLE SHARE AMP GAIN: 20 dB | SURROUND EFFECT: 0 dB    |
| INPUT: INA                       | MODE: STEREO             |
| VOLUME: 0 dB                     | BASS: 18 dB              |
| MUTE: OFF                        | TREBLE: 6 dB             |
|                                  | RECOU: ON (INE)          |



## Control Data Format

Note: It's necessary to set up the all control data after power on.

### (1) Input Data

(MSB) ← Input order

|       | D01 | D11                       | D21                                                                             | D31 | D41                                           | D51 | D61                                   | D71 | D81 | D91 | D101                                                    | D111                                                                          | D121 | D131 |
|-------|-----|---------------------------|---------------------------------------------------------------------------------|-----|-----------------------------------------------|-----|---------------------------------------|-----|-----|-----|---------------------------------------------------------|-------------------------------------------------------------------------------|------|------|
| Slot1 | 0   | Bypass/<br>Surround<br>SW | Vol/Treble share<br>amp gain SW<br>0: 20 dB<br>1: 18 dB<br>2: 16 dB<br>3: 14 dB |     | Input<br>0: INA<br>1: INB<br>2: INC<br>3: IND |     | D2 to D6: (a) Master volume condition |     |     |     | Mute<br>ON/OFF<br>0: OFF<br>1: ON<br>(Input<br>all OFF) | Chip/Slot Select<br>0: select<br>1: no select<br>2: no select<br>3: no select |      |      |

|       | D02           | D12 | D22             | D32 | D42                                                                        | D52 | D62                                                                                          | D72 | D82                                                        | D92 | D102                             | D112                                                                          | D122 | D132 |
|-------|---------------|-----|-----------------|-----|----------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------------------|-----|------------------------------------------------------------|-----|----------------------------------|-------------------------------------------------------------------------------|------|------|
| Slot2 | Surround mode |     | Surround effect |     | Mode select<br>0: stereo<br>1: mono1 only<br>2: mono2 only<br>3: mono1 + 2 |     | Bass (boost)<br>0: 0 dB 1: 3 dB<br>2: 6 dB 3: 9 dB<br>4: 12 dB 5: 15 dB<br>6: 18 dB 7: 21 dB |     | Treble (boost)<br>0: 0 dB<br>1: 3 dB<br>2: 6 dB<br>3: 9 dB |     | INE<br>ON/OFF<br>0: OFF<br>1: ON | Chip/Slot Select<br>0: no select<br>1: no select<br>2: no select<br>3: select |      |      |

### (a) Master Volume

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

**(b) Input Select**

| Input Select       |         | D41 | D51 | D111 | D112            |   |
|--------------------|---------|-----|-----|------|-----------------|---|
| INA                | INE off | 0   | 0   | 0    | 0               |   |
| INB                |         | 1   | 0   |      |                 |   |
| INC                |         | 0   | 1   |      |                 |   |
| IND                |         | 1   | 1   |      |                 |   |
| INA to IND all OFF |         | *   | *   | 1    | 1* <sup>1</sup> |   |
| INA to IND select  | INE on  | 0   | 0   | 0    | 1* <sup>2</sup> |   |
|                    |         | A   | 1   |      |                 | 0 |
|                    |         | B   | 0   |      |                 | 1 |
|                    |         | C   | 1   |      |                 | 1 |
|                    | D       |     |     |      |                 |   |

Notes: 1. The input impedance is about 5 kΩ 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 |
|--------|-----|------|
| 0 dB   | 0   | 0    |
| 3 dB   | 1   | 0    |
| 6 dB   | 0   | 1    |
| 9 dB   | 1   | 1    |

**(e) Bass Control**

| Bass  | D62 | D72 | D82 |
|-------|-----|-----|-----|
| 0 dB  | 0   | 0   | 0   |
| 3 dB  | 1   | 0   | 0   |
| 6 dB  | 0   | 1   | 0   |
| 9 dB  | 1   | 1   | 0   |
| 12 dB | 0   | 0   | 1   |
| 15 dB | 1   | 0   | 1   |
| 18 dB | 0   | 1   | 1   |
| 21 dB | 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 |
|---------|-----|-----|
| 20 dB   | 0   | 0   |
| 18 dB   | 1   | 0   |
| 16 dB   | 0   | 1   |
| 14 dB   | 1   | 1   |

**(h) Bypass/Surround SW**

| Bypass/Surround SW | D11 |
|--------------------|-----|
| Bypass             | 0   |
| Surround           | 1   |

**(i) Surround Mode**

| Mode            | D02 | D12 |
|-----------------|-----|-----|
| QSurround       | 0   | 0   |
| —               | 1   | 0   |
| Wide surround   | 0   | 1   |
| Normal surround | 1   | 1   |

**(j) Surround Effect**

(Valid in the surround mode. Set 0 dB at QSurround.)

| Effect | D22 | D32 |
|--------|-----|-----|
| +3 dB  | 0   | 0   |
| 0 dB   | 1   | 0   |
| -3 dB  | 0   | 1   |
| -6 dB  | 1   | 1   |



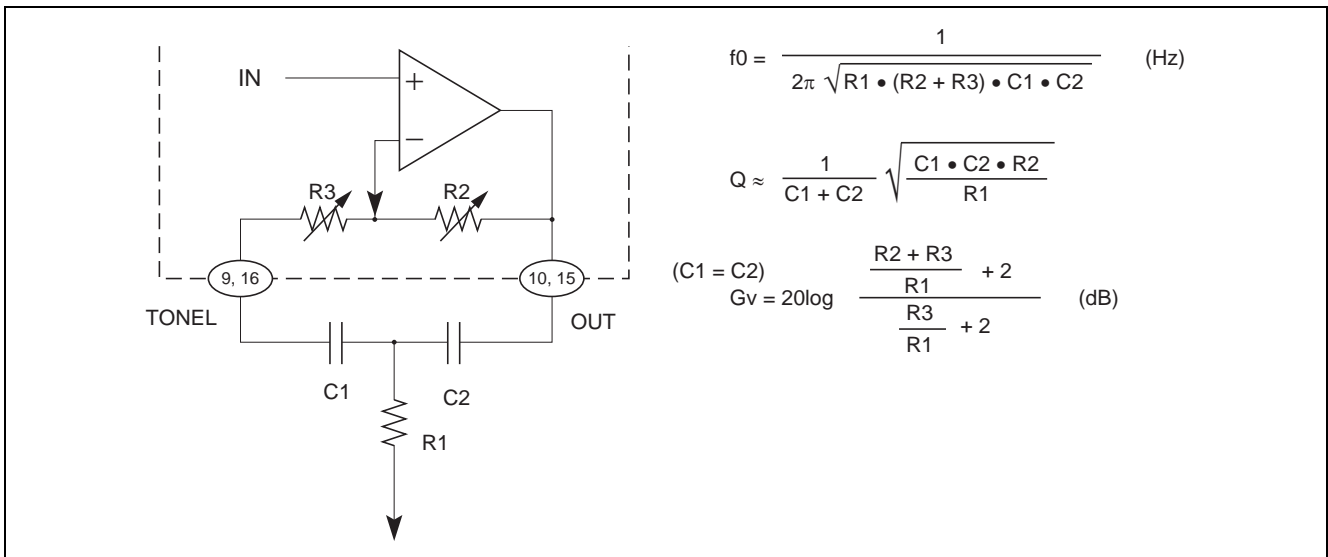
**(2) Notice of Control Data**

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

| <b>Item</b>     | <b>Condition</b>   |
|-----------------|--------------------|
| Gain SW         | 18 dB              |
| Input select    | ALL OFF            |
| Master volume   | infinitesimal      |
| MUTE            | ON (Input ALL OFF) |
| Surround effect | -6 dB              |
| Surround        | OFF                |
| Surround mode   | QSurround          |
| Mode select     | stereo             |
| Bass            | 0 dB               |
| Treble          | 0 dB               |
| INE             | ON                 |

## Function Description

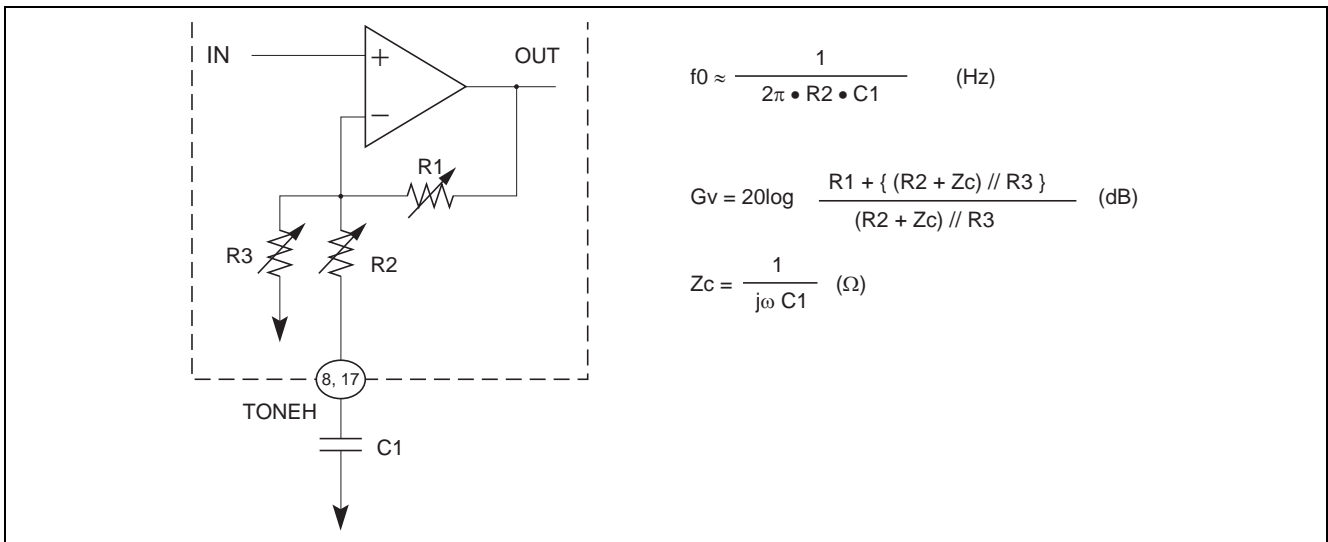
### (1) Equivalent Circuit of the Bass Boost



#### R2, R3 (Typ)

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

### (2) Equivalent Circuit of the Treble Boost



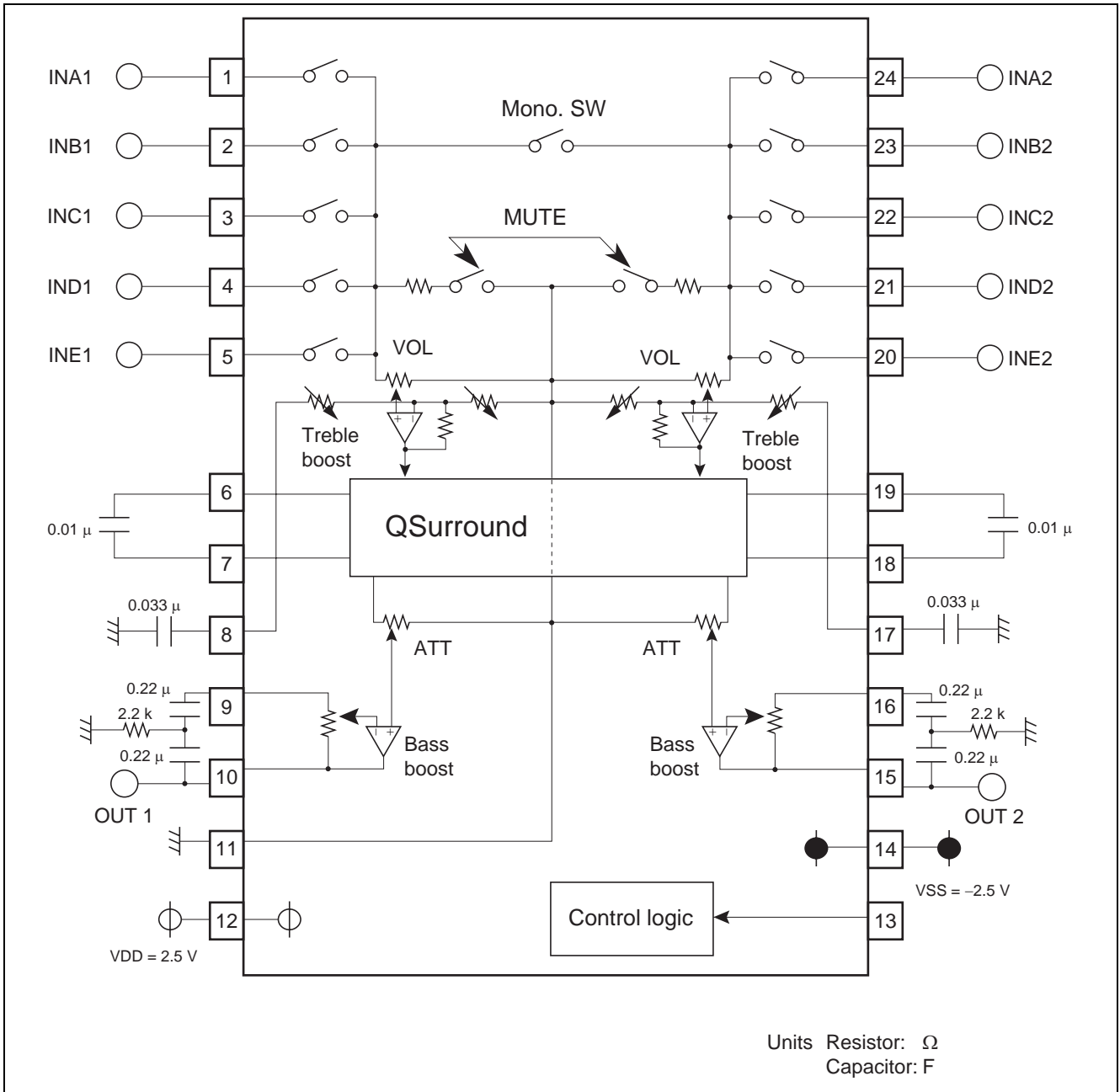
#### R2 (Typ)

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

#### R1, R3 (Typ)

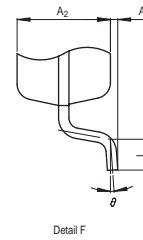
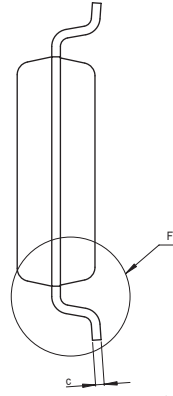
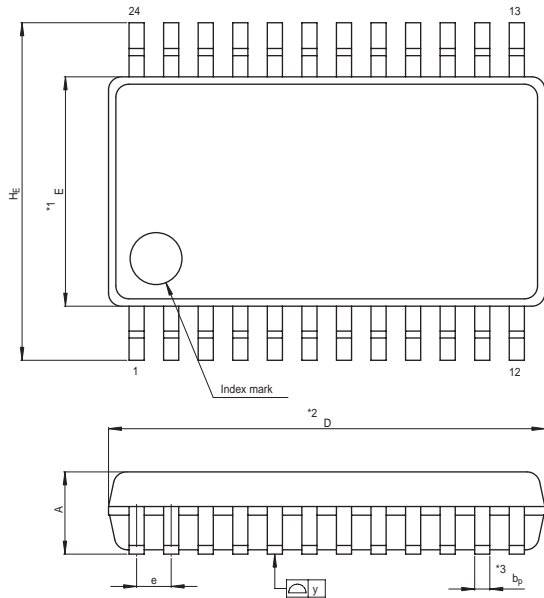
| Gain   | 14 dB | 16 dB | 18 dB | 20 dB |
|--------|-------|-------|-------|-------|
| R1 (k) | 10.88 | 13.65 | 17.21 | 21.60 |
| R3 (k) | 2.72  | 2.57  | 2.48  | 2.40  |

Application Example



### Package Dimensions

|                        |              |               |            |
|------------------------|--------------|---------------|------------|
| JEITA Package Code     | RENESAS Code | Previous Code | MASS[Typ.] |
| P-SSOP24-5.3x10.1-0.80 | PRSP0024GA-A | 24P2Q-A       | 0.2g       |



NOTE)  
 1. DIMENSIONS \*\*1\* AND \*\*2\* DO NOT INCLUDE MOLD FLASH.  
 2. DIMENSION \*\*3\* DOES NOT INCLUDE TRIM OFFSET.

| Reference Symbol | Dimension in Millimeters |      |      |
|------------------|--------------------------|------|------|
|                  | Min                      | Nom  | Max  |
| D                | 10.0                     | 10.1 | 10.2 |
| E                | 5.2                      | 5.3  | 5.4  |
| A <sub>2</sub>   | —                        | 1.8  | —    |
| A                | —                        | —    | 2.1  |
| A <sub>1</sub>   | 0                        | 0.1  | 0.2  |
| b <sub>p</sub>   | 0.3                      | 0.35 | 0.45 |
| c                | 0.18                     | 0.2  | 0.25 |
| θ                | 0°                       | —    | 8°   |
| H <sub>E</sub>   | 7.5                      | 7.8  | 8.1  |
| e                | 0.65                     | 0.8  | 0.95 |
| y                | —                        | —    | 0.10 |
| L                | 0.4                      | 0.6  | 0.8  |

Notes:

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