M61509FP

QXpander built-in, Tone control, Volume control

REJ03F0215-0201
Rev.2.01
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Description

The M61509FP is the sound controller powered by “QXpander” system.

The “QXpander” system produces normal and wide 3D sound expansion from any stereo input signal.

Note: This device is producted under license from QSound Lab, Ins. (Canada)

Features

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

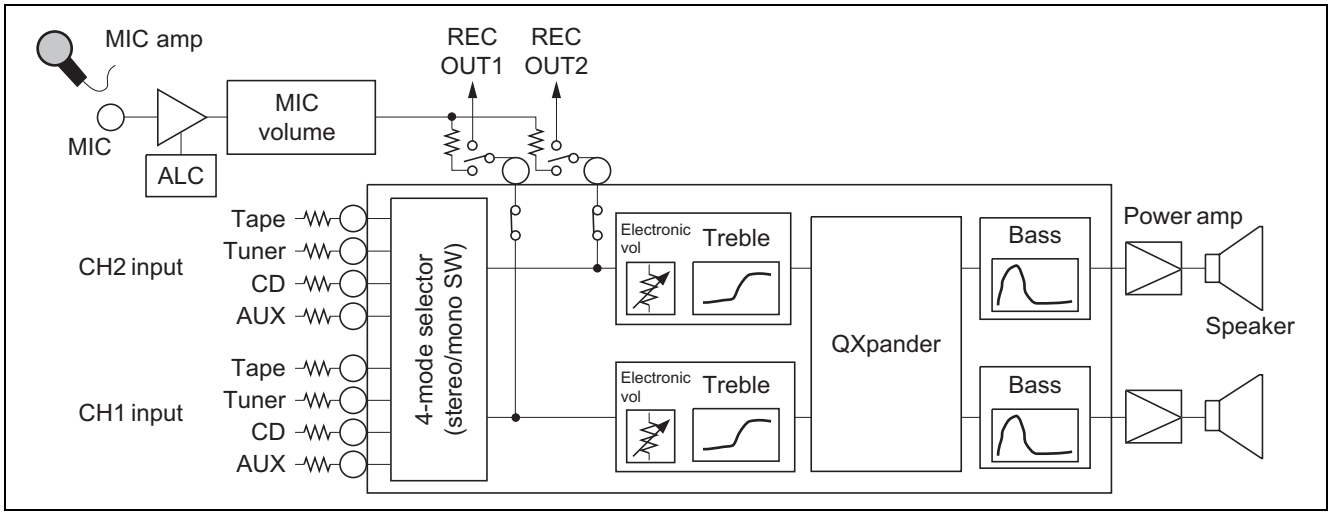
Recommended Operating Condition

Supply voltage range: ±2.25 to ±2.75V

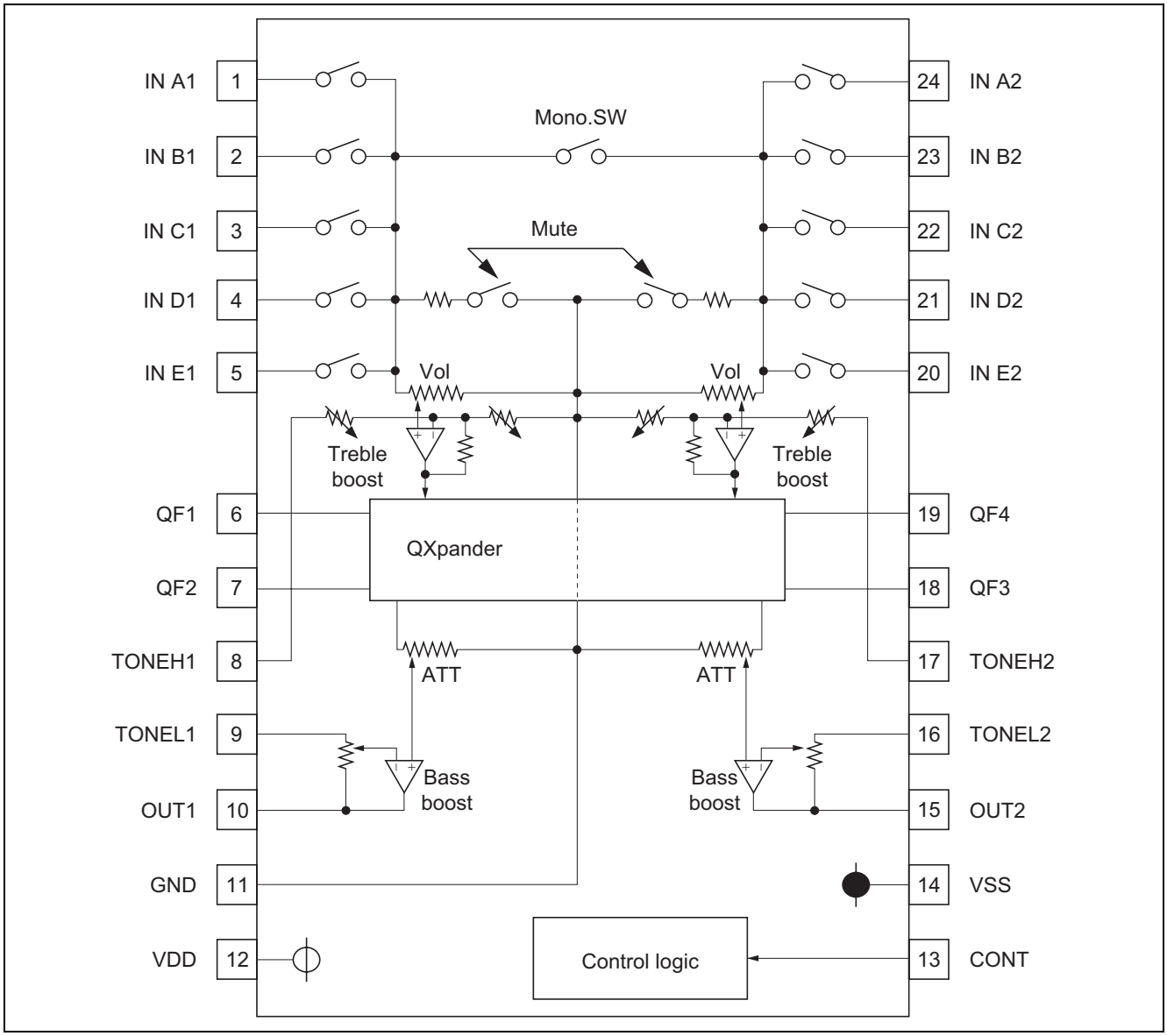
Application

Radio Cassette Recorders, Mini-stereo Set, Audio Equipment

System Block Diagram



Block Diagram



Pin Function Description

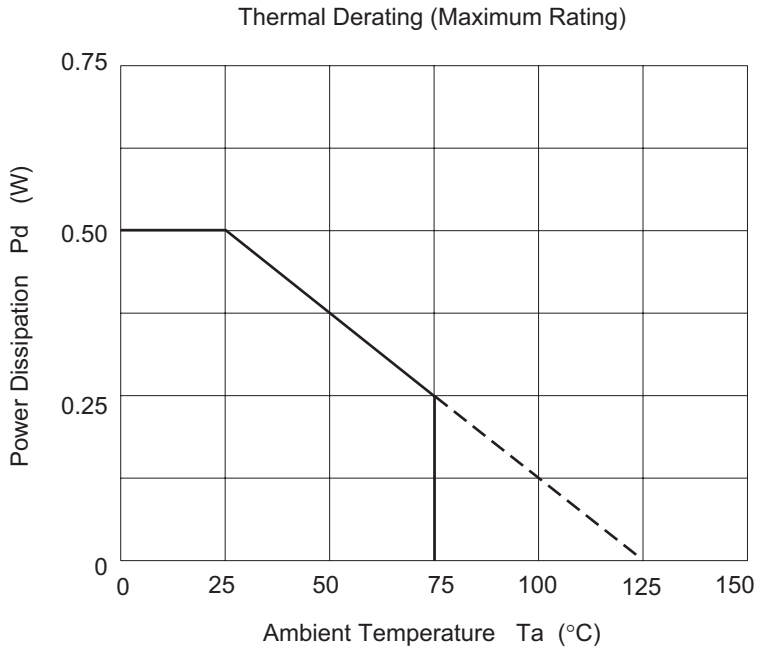
Pin No.	Name	Function
1	IN A1	INPUTs of the channel 1 The switch of INE can be controlled in dependently. Please set “ALL OFF” mode when the switch of E is only ON.
2	IN B1	
3	IN C1	
4	IN D1	
5	IN E1	
6	QF1	QXpander filter 1
7	QF2	QXpander filter 2
8	TONEH1	Treble control adjustment of the channel 1
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	QXpander filter 3
19	QF4	QXpander filter 4
20	IN E2	INPUTs of the channel 2 The switch of INE can be controlled independently. Please set “ALL OFF” mode when the switch of E is only ON.
21	IN D2	
22	IN C2	
23	IN B2	
24	IN A2	

Absolute Maximum Ratings

(Ta = 25°C, unless otherwise noted)

Item	Symbol	Ratings	Unit	Test Condition
Supply voltage	VDD-VSS	6.0	V	
Thermal derating	Kθ	5	mW/°C	(Note)
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 μm

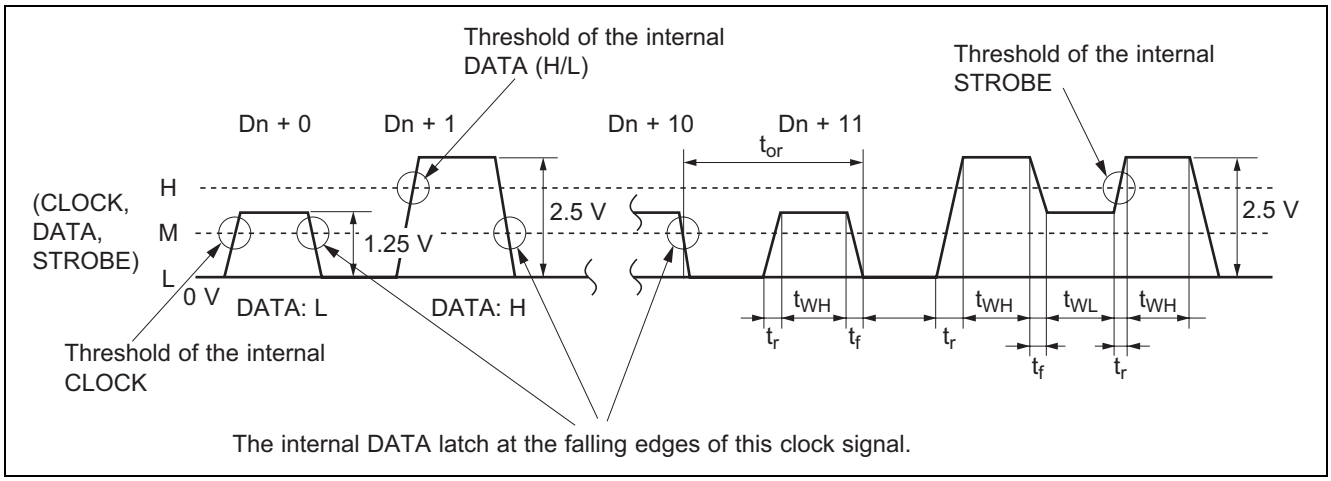


Recommended Operating Conditions

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

Control Signals Specification

(1) Wave Form



(2) Voltage Control Signal

Digital input signal		Limits			Unit	Condition
		Min	Typ	Max		
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

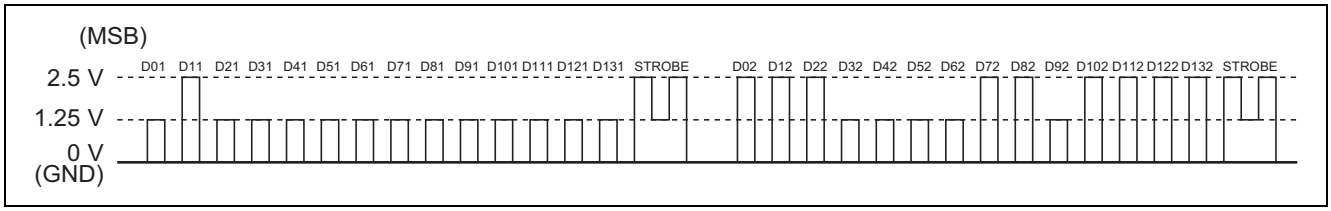
(3) Timing Control Signal

Item	Symbol	Limits			Unit
		Min	Typ	Max	
Cycle time of digital signal	t_{cr}	8	—	—	µs
Pulse width of digital signal (“H” level)	t_{WH}	3.6	—	—	
Pulse width of digital signal (“L” level)	t_{WLC}	3.6	—	—	
Rise time of digital signal	t_r	—	—	0.4	
Fall time of digital signal	t_f	—	—	0.4	

(4) Control Signal Example (Refer to the “Control Data Format”)

An example of the mode control

- Bypass/QXpander SW: QXpander
- VOL/Treble Share AMP Gain: 20 dB
- Input: IN A,
- Volume: 0 dB
- Mute: OFF
- Mode: STEREO
- Bass: 18 dB
- Treble: 6 dB
- Recout: ON (IN E)



Control Data Format

It is 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	Bypass/QXpander SW	Vol/Treble share amp gain SW 0: 20 dB 1: 18 dB 2: 16 dB 3: 14 dB		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
1	1	0	1	Mode select 0: stereo 1: mono1 only 2: mono2 only 3: mono 1+2		Bass (boost) 0: 0 dB, 1: 3 dB, 2: 6 dB, 3: 9 dB, 4: 12 dB, 5: 15 dB, 6: 18 dB, 7: 21 dB			Treble (boost) 0: 0 dB, 1: 3 dB, 2: 6 dB, 3: 9 dB		IN E 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
−0.0 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
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	IN E on	*	*	1	1 (Note 1)
IN A-D select		A: 0	0	0	1 (Note 2)
		B: 1	0		
		C: 0	1		
		D: 1	1		

Notes: 1. The input impedance is about 5 k as input IN E.
2. IN E can be controlled independently.
It can be used as Rec output.

(c) Mode Control

Mode	D42	D52
stereo	0	0
mono 1 only	1	0
mono 2 only	0	1
mono 1+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/QXpander SW

Bypass/QXpander SW	D11
Bypass	0
QXpander	1

(2) Notice of Control Data

1. use only the control data of (1) Input Data.
2. The interval of data transmission from the microcontroller is over 0.1 s.
   : This is the waiting time for the “soft–switching” to reduce the shock noise. (The “soft-switching” is available at the volume and QXpander.)
   Note:
   (1) The “Slot1” and the “Slot2” are independent data.
   Each data need each waiting time.
   (2) The some function of the volume and other function have no “soft-switching”.
   Example1:
   When the volume is set as “infinitesimal”, it’s immediately attenuated (but, it needs the waiting time to reach the final attenuation).
   Example2:
   The change of tone control is immediately executed.
3. It is necessary to set the all control data after power-on, although the internal circuit is forced as below, when (VDD-VSS) ≤ 3.3 V (Typ).

Item	Condition
Gain SW	18 dB
Input select	ALL OFF
Master volume	infinitesimal
MUTE	ON (Input ALL OFF)
Bypass/QXpander	Bypass
Mode select	stereo
Bass	0 dB
Treble	0 dB
IN E	ON

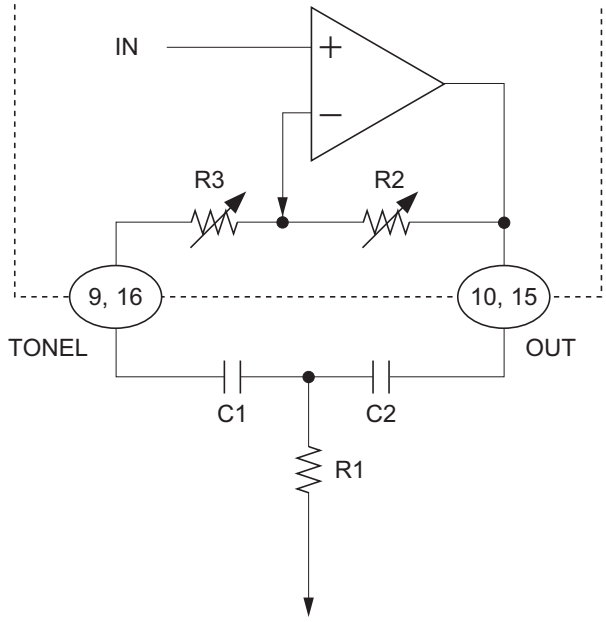
Electrical Characteristics

(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	Limits			Unit	Conditions	
		Min	Typ	Max			
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 QXpander mode Vi = 20 mVrms	
Maximum output voltage	Vomax	1.2	1.6	—	Vrms	RL = 10 k, 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 k, VOL = the infinitesimal BYPASS	
	No2	—	11	30	μVrms	JIS-A, Rg = 5.1 k, VOL = the infinitesimal QXpander mode	
Maximum attenuation	ATTmax	—	–95	–90	dB	Output referencelevel (Vo = 1 Vrms), ATT = the infinitesimal, JIS-A	
Bass boost	GB1	1.5	3	4.5	dB	3 dB	f = 1 kHz, 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		3 dB	f = 1 kHz, Vo = 80 mVrms
	GT2	4.5	6	7.5		6 dB	
	GT3	7.5	9	10.5		9 dB	

Function Description

(1) Equivalent Circuit of the Bass Boost



$$Fob = \frac{1}{2\pi \sqrt{R1\,(R2 + R3)\,C1\,C2}} \quad (Hz)$$

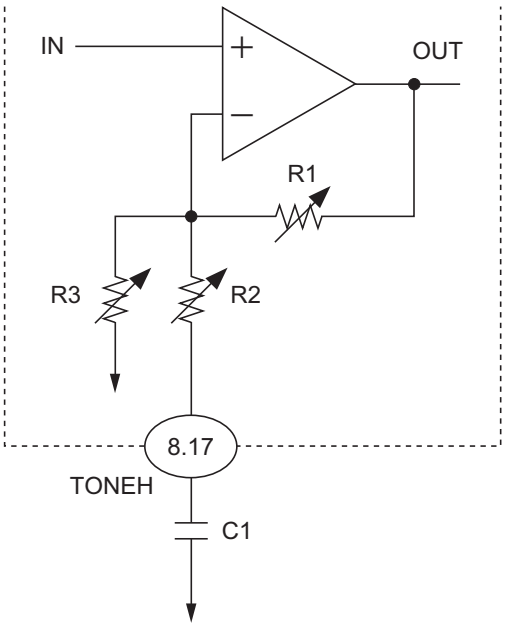
$$Q \approx \frac{1}{C1 + C2}\sqrt{\frac{C1\,C2\,R2}{R1}}$$

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

R2, R3 (typical)

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



$$Fc \approx \frac{1}{2\pi \bullet R2 \bullet C1} \quad (Hz)$$

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

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

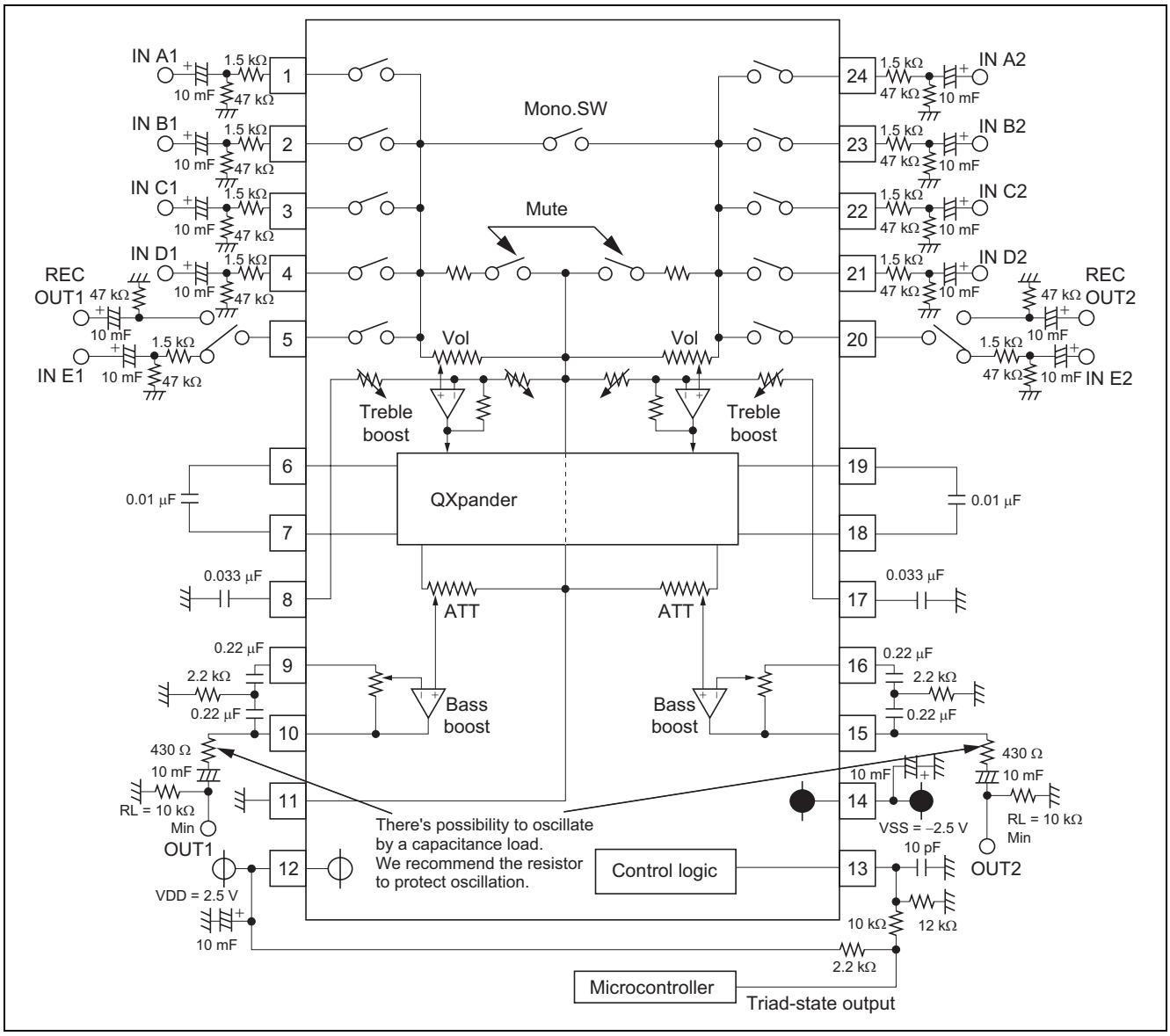
R2 (typical)

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

R1, R3 (typical)

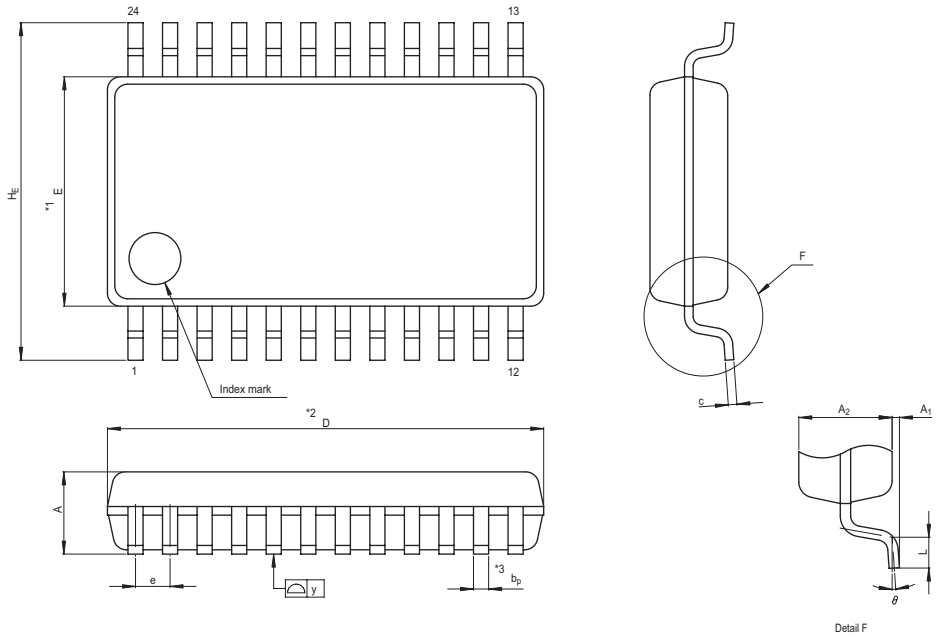
Gain	14 dB	16 dB	18 dB	20 dB
R1 (k)	10.88	13.65	17.21	21.60
R3 (k)	2.72	2.57	2.48	2.40

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_2	—	1.8	—
A	—	—	2.1
A_1	0	0.1	0.2
b_p	0.3	0.35	0.45
c	0.18	0.2	0.25
θ	0°	—	8°
H_E	7.5	7.8	8.1
e	0.65	0.8	0.95
y	—	—	0.10
L	0.4	0.6	0.8

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