

To all our customers

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

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

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 produced under license from QSound Lab, Inc. (Canada) .

FEATURES

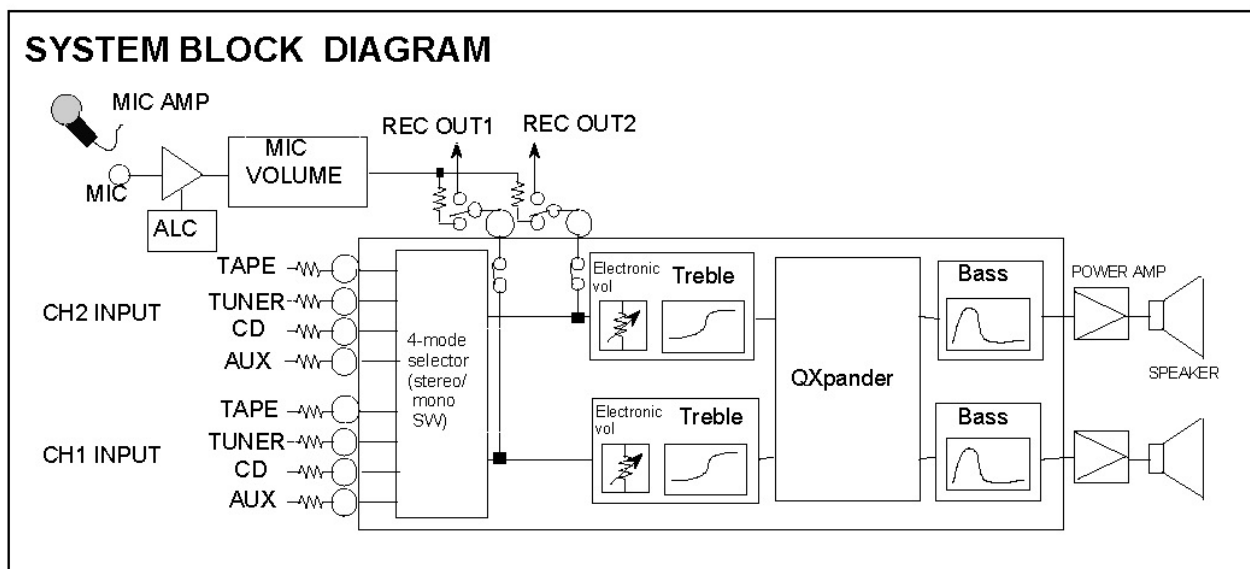
- Built-in "QXpander" sound technology
- Electronic volume.
 - 0 ~ -84dB, infinitesimal
- 2-band tone control
 - Bass(0 ~ +21dB/3dB STEP)
 - Treble(0 ~ +9dB/3dB STEP)
- 5 input selector(The fifth input can be used as REC OUT or MIC MIX.)

RECOMMENDED OPERATING CONDITIONS

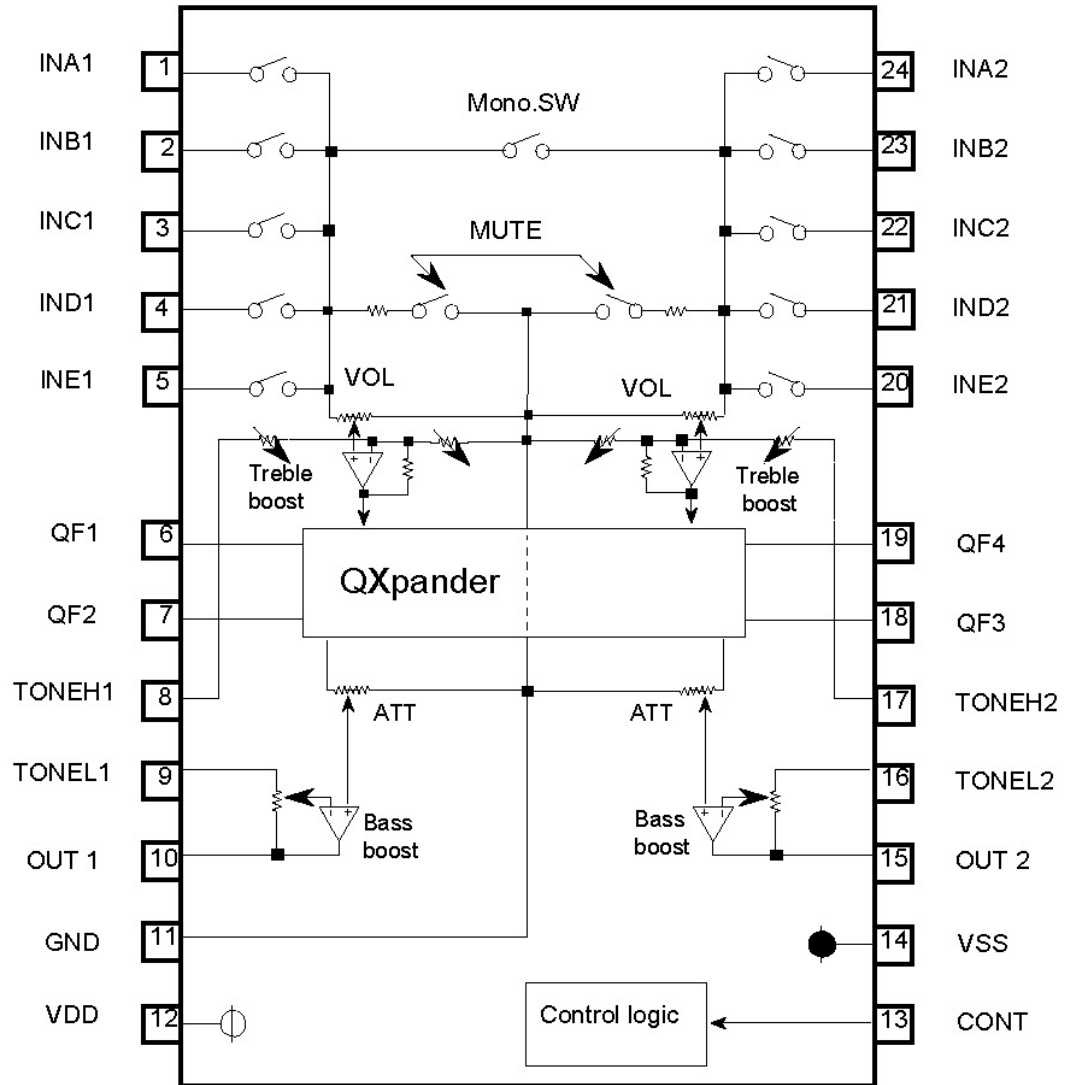
Supply voltage range $\pm 2.25 \sim \pm 2.75V$

APPLICATION

Radio Cassette Recorders, Mini-stereo Set, Audio Equipment



BLOCK DIAGRAM



PIN DESCRIPTION

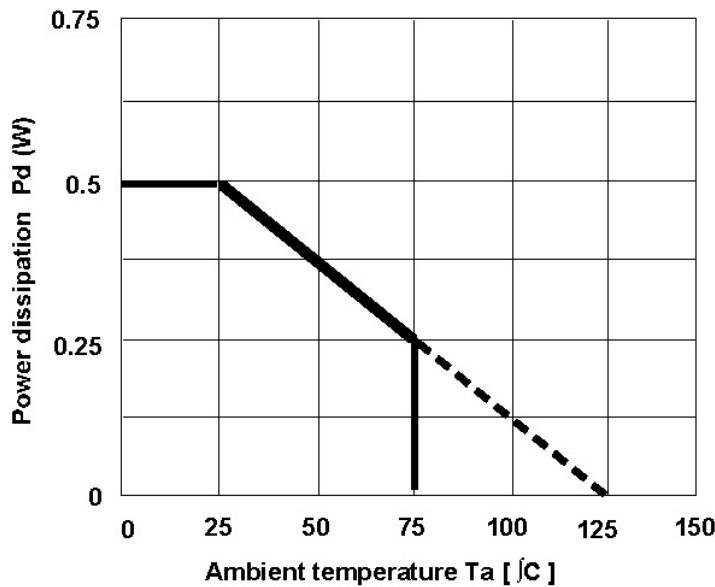
Pin No.	Name	Function
1	IN A1	INPUTs of the channel 1 The switch of INE can be controlled independently. Please set "ALL OFF" mode when the switch of E is only ON.
2	IN B1	
3	IN C1	
4	IN D1	
5	IN E1	
6	QF1	QXpander filter 1
7	QF2	QXpander filter 2
8	TONEH1	Treble control adjustment of the channel 1
9	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 ℃, unless otherwise noted)

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

Thermal derating(maximum rating)



Note.1 reference PC Board

Size :70mm×70mm
 Thickness :1.6mm
 Material :glass epoxy

Copper pattern dimension
 Width :0.25mm
 Length :25 ~ 30mm/lead
 Thickness:18μm

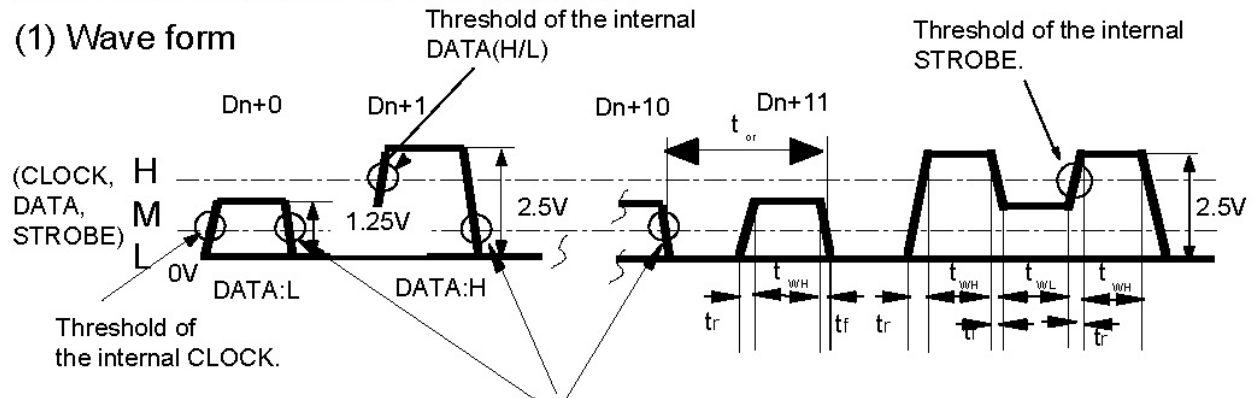
Recommended operating conditions

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	

QXpander built-in, Tone control, Volume control

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

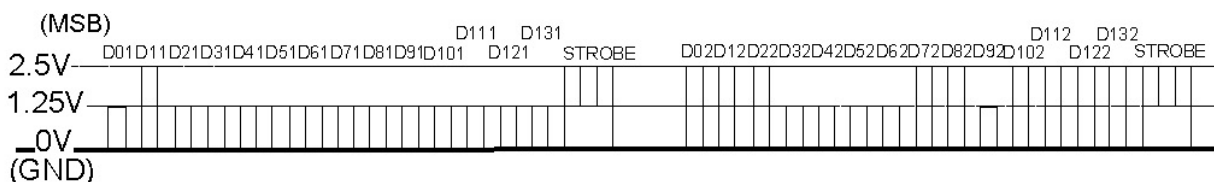
Symbol	Parameter	Limits			Unit
		min	typ	max	
t_{or}	Cycle time of digital signal	8	—	—	usec
t_{WH}	Pulse width of digital signal("H"level)	3.6	—	—	
t_{WL}	Pulse width of digital signal("L"level)	3.6	—	—	
t_r	Rise time of digital signal	—	—	0.4	
t_f	Fall time of digital signal	—	—	0.4	

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

An example of the mode control

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

MODE:STEREO
 BASS:18dB
 TREBLE:6dB
 RECOU: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	Bypass/ QXpander SW	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 <small>(INPUT ALL OFF)</small>	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: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		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

(b) Input select

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

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

CONTROL DATA FORMAT (continued)

(g) Treble amp gain SW

Gain SW	D21	D31
20dB	0	0
18dB	1	0
16dB	0	1
14dB	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 sec.
: 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".

<Example 1>

When the volume is set as "infinitesimal", it's immediately attenuated (but, it needs the waiting time to reach the final attenuation).

<Example 2>

The change of tone control is immediately executed.

3. It's necessary to set the all control data after power-on, although the internal circuit is forced as below, when $(VDD - VSS) \leq 3.3V$ (TYP).

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

QXpander built-in, Tone control, Volume control

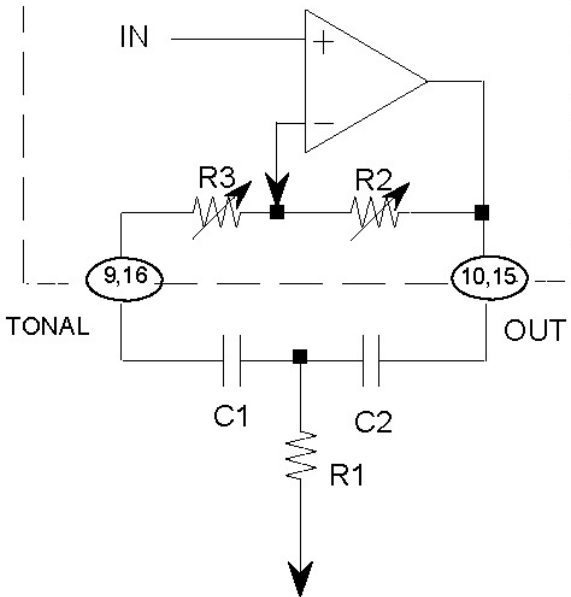
ELECTRICAL CHARACTERISTICS

(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 QXpander 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	—	6	15	μVrms	
No2		JIS-A, Rg=5.1k, VOL=the infinitesimal QXpander mode	—	11	30	μVrms	
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	

FUNCTION DESCRIPTION

(1) Equivalent circuit of the bass boost



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

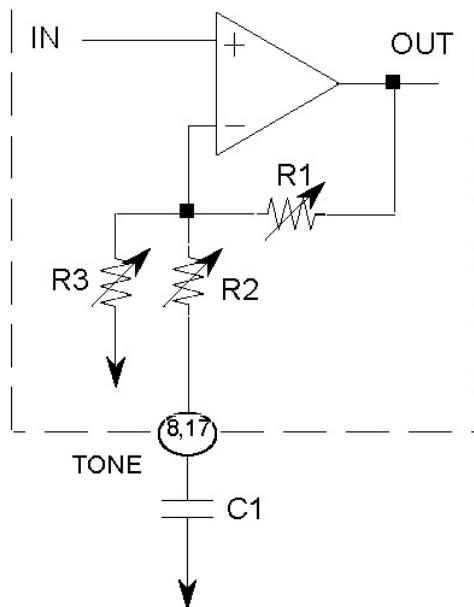
$$Q = \frac{1}{C1+C2} \sqrt{\frac{C1C2R2}{R1}}$$

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

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



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

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

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

R2 (typical)

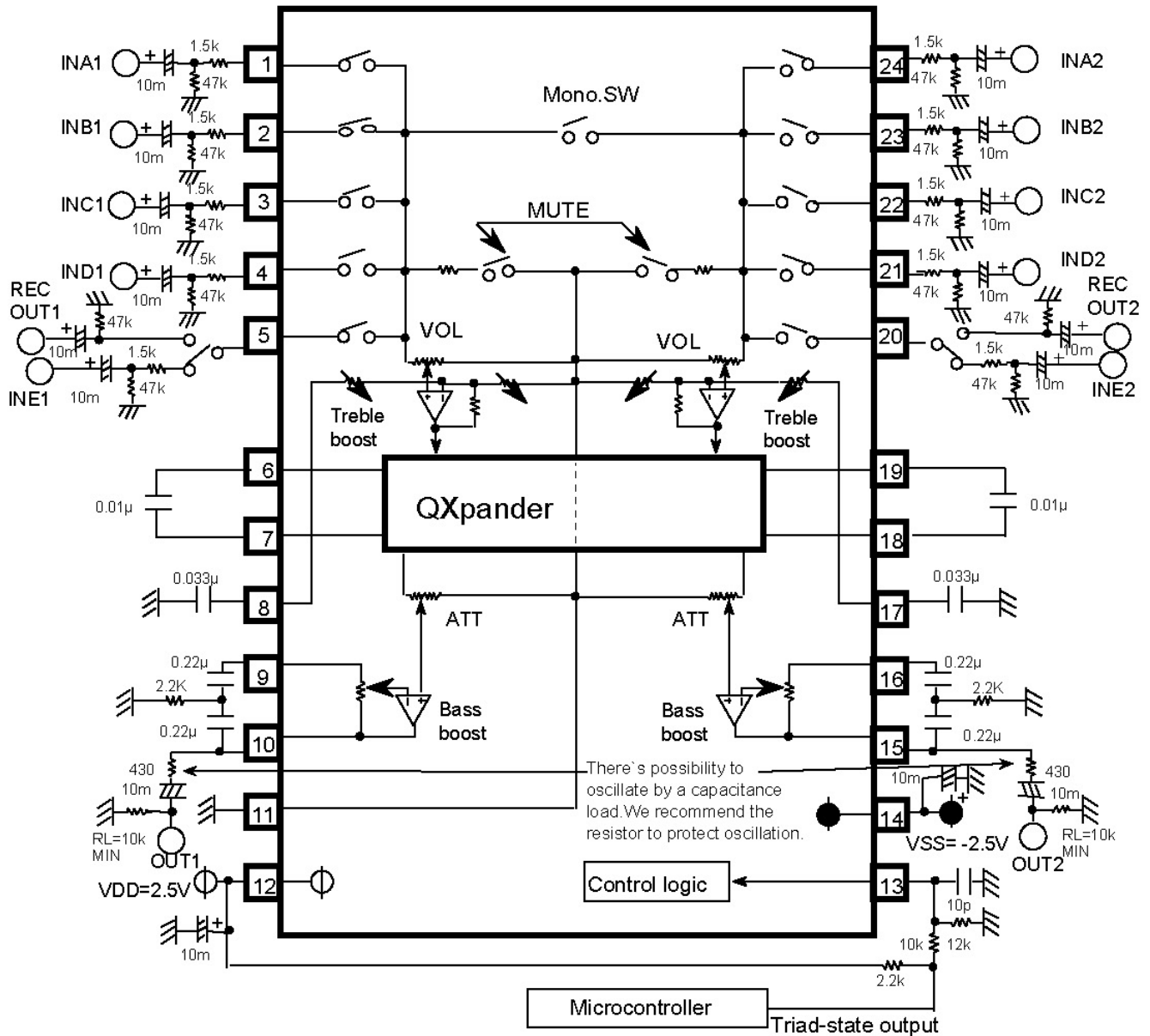
Treble boost	3dB	6dB	9dB
R2 (k)	5.3	2.2	1.2

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

QXpander built-in, Tone control, Volume control

APPLICATION EXAMPLE



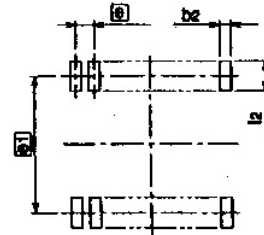
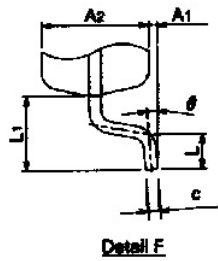
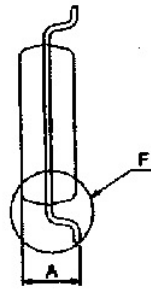
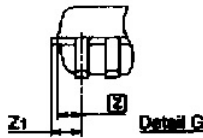
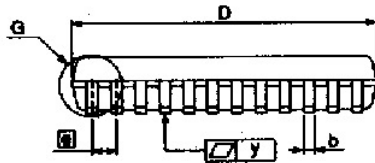
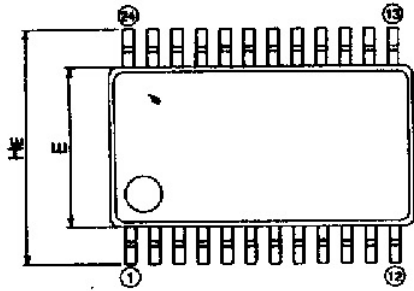
Units Resistor : ohm
Capacitor: F

M61509FP

QXpander built-in, Tone control, Volume control

OUTLINE

24P2Q (24pin SSOP, 300mil)



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
e	-	0.8	-
He	7.5	7.8	8.1
L	0.4	0.6	0.8
L1	-	1.25	-
L2	-	0.65	-
Z1	-	-	0.8
y	-	-	0.1
phi	0°	-	8°
be	-	0.5	-
e	-	7.62	-
le	1.27	-	-