

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

**6CH ELECTRONIC VOLUME WITH TONE CONTROL****DESCRIPTION**

The M62446AFP is 6ch electronic volume with tone control. This IC is revised from M62446FP. The extended function of M62446AFP is volume level and tone control level. M62446AFP is easy to use more than M62446FP.

**FEATURES** *(note) \* is an extended function.*

- 6ch Electric volume  
Volume level : 0 to -95dB(1dB/step)\*  
<M62446FP:0 to -79dB(1dB/step)>
- Tone control  
Bass/Treble : -14dB to +14dB(2dB/step)\*  
<M62446FP:-10dB to +10dB(2dB/step)>
- Noise voltage : 1.5 $\mu$ Vrms <M62446FP:2.2 $\mu$ Vrms>
- 4 Output ports
- Bypass mode is high quality sound.



Outline 42P2R-A  
0.8mm pitch 450mil ssop  
(8.4mm×17.5mm×2.0mm)

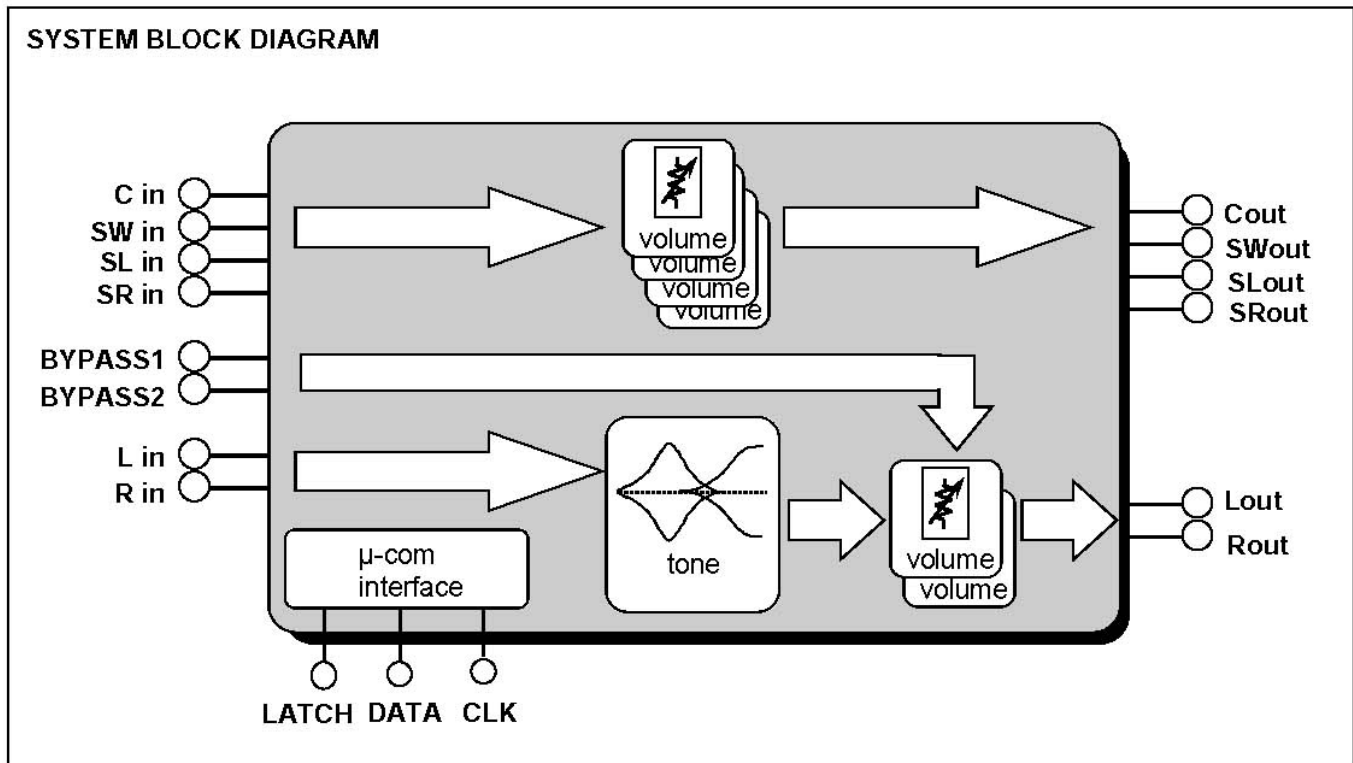
**APPLICATION**

DVD, Home Audio equipment, TV

**RECOMMENDED OPERATING CONDITIONS**

Supply voltage range----- $\pm 4.5$  to  $\pm 7.5$ V(analog), 4.5 to 5.5V(digital)

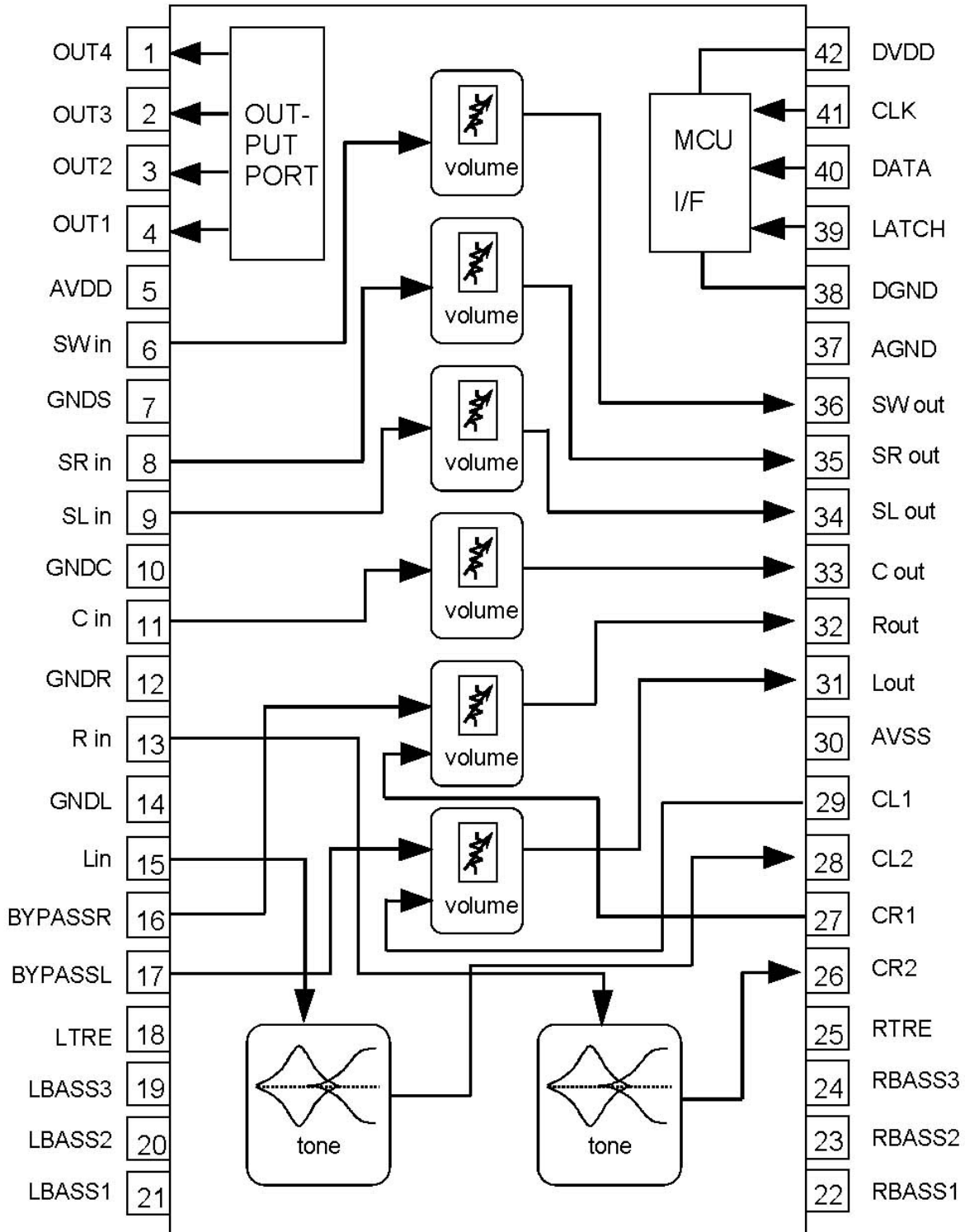
Recommended supply voltage----- $\pm 7.0$ V(analog), 5.0V(digital)

**SYSTEM BLOCK DIAGRAM**

# M62446AFP

## 6CH ELECTRONIC VOLUME WITH TONE CONTROL

### PIN CONFIGURATION AND BLOCK DIAGRAM



# M62446AFP

## 6CH ELECTRONIC VOLUME WITH TONE CONTROL

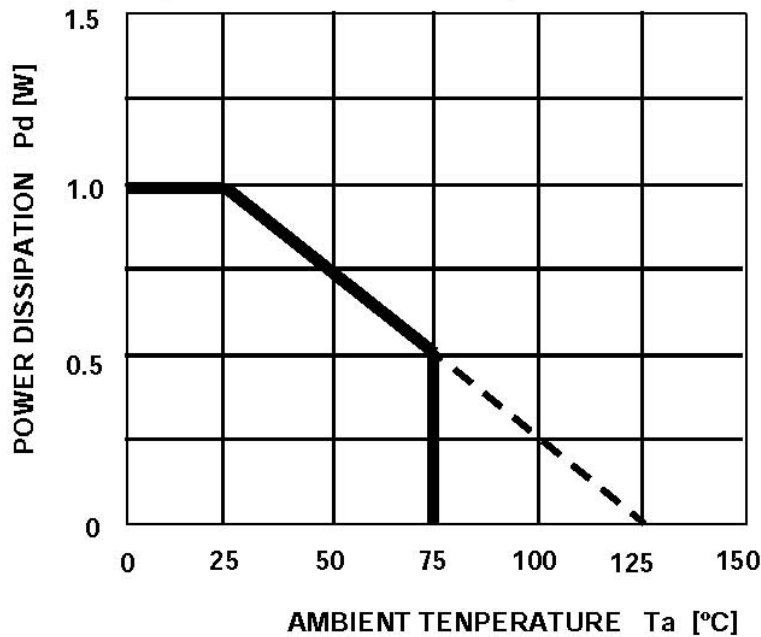
### PIN DESCRIPTION

Pin No.	Symbol	Function	Circuit
1	OUT4	Port OUTPUT	OUTPUT:PMOS Transistor open drain 
2	OUT3		
3	OUT2		
4	OUT1		
5	AVDD	Analog positive Power supply	+7V
7	GNDS	GND	Connect to analog GND
10	GNDC		
12	GNDR		
14	GNDL		
6	SW in		
8	SR in		
9	SL in		
11	C in		
36	SW out	Volume OUTPUT	
35	SR out		
34	SL out		
33	C out		
13	R in	Tone INPUT	
15	L in		
16	BYPASSR	L,R Volume INPUT in BYPASS mode	
17	BYPASSL		
31	Lout	L OUTPUT	
32	Rout	R OUTPUT	
18	LTRE	tone Treble cycle control	
25	RTRE		
19	LBASS3	tone Bass cycle control	
24	RBASS3		
20	LBASS2		
23	RBASS2		
21	LBASS1		
26	RBASS1		
22	CR2	Tone OUTPUT	
28	CL2		
27	CR1	L,R Volume INPUT	
29	CL1		
31	Lout		
32	Rout		
30	AVSS	Analog negative Power Supply	-7V
37	AGND	Analog GND	
38	DGND	Digital GND	
39	LATCH	Latch INPUT	
40	DATA	Data INPUT	
41	CLK	Clock INPUT Forward data	INPUT : schmitt trigger type
42	DVDD	Digital Power supply	

**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Condition	Ratings	Unit
Vsupply	Supply Voltage	AVDD-AVSS	16	V
		DVDD-DGND	7	
Pd	Power dissipation	Ta ≤ 25 °C	1000	mW
Kθ	Thermal derating	Ta > 25 °C	10	mW/°C
Topr	Operating temperature		-20 to +75	°C
Tstg	Storage temperature		-40 to +125	°C

THERMAL DERATING(MAXMUM RATING)  
(with the standard board)



- \*Standard board
- board size 70mm X 70mm
- board thickness 1.6mm
- board material glass epoxy
- copper pattern
- copper thickness 18µm
- copper size 0.25mm(wide) 30mm(length/lead)

6CH ELECTRONIC VOLUME WITH TONE CONTROL

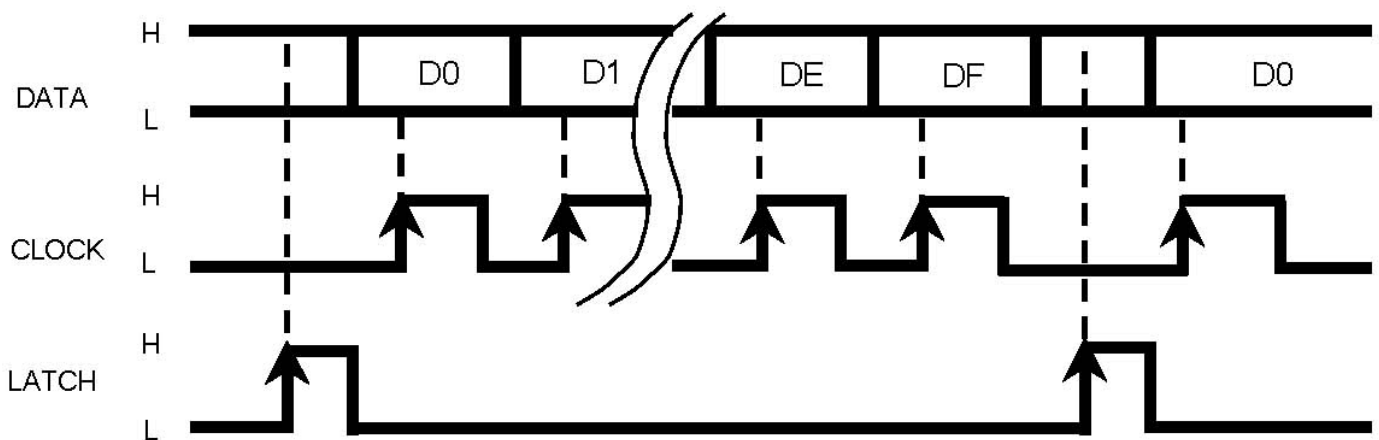
**RECOMMENDED OPERATING CONDITION**

(Ta=25°C, unless otherwise noted. )

Parameter	Symbol	Condition	MIN	TYP	MAX	Unit
Analog positive Supply Voltage	AVDD		4.5	7.0	7.5	V
Analog negative Supply Voltage	AVSS		-7.5	-7.0	-4.5	V
Digital Supply Voltage	DVDD		4.5	5.0	5.5	V
High-level Input Voltage	VIH		DVDD×0.7	—	DVDD	V
Low-level Input Voltage	VIL		DGND	—	DVDD×0.3	V

(Note) AVSS≤DGND<DVDD≤AVDD

**RELATIONSHIP BETWEEN DATA AND CLOCK AND LATCH**

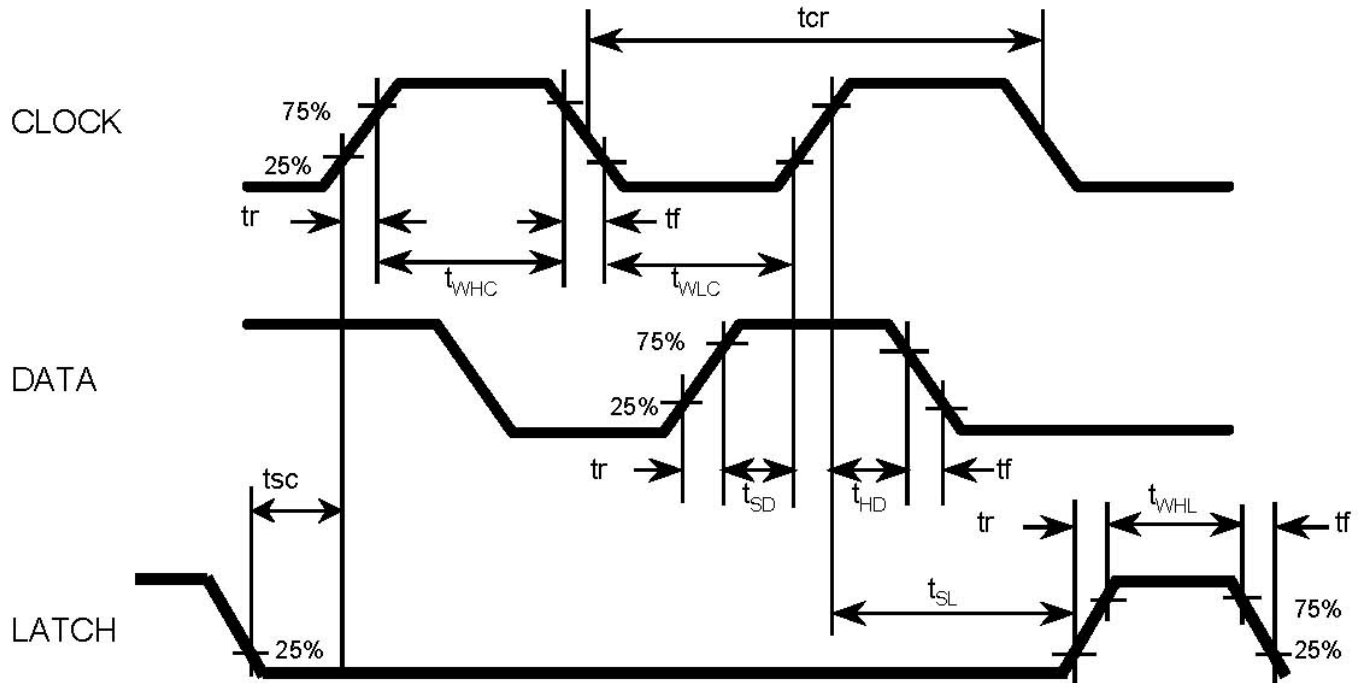


note : CLOCK and LATCH function at raising edges of pulse .



## 6CH ELECTRONIC VOLUME WITH TONE CONTROL

## DATA TIMING(Recommended conditions)



## DIGITAL BLOCK TIMING REGULATION

Symbol	Parameter	Limits			Unit
		Min	typ	Max	
t <sub>cr</sub>	CLOCK cycle time	8	-	-	μsec
t <sub>whc</sub>	CLOCK pulse width ("H" level)	3.2	-	-	
t <sub>wlc</sub>	CLOCK pulse width ("L" level)	3.2	-	-	
t <sub>r</sub>	CLOCK, DATA, LATCH rise time	-	-	0.8	
t <sub>f</sub>	CLOCK, DATA, LATCH fall time	-	-	0.8	
t <sub>SD</sub>	DATA setup time	1.6	-	-	
t <sub>HD</sub>	DATA hold time	1.6	-	-	
t <sub>SL</sub>	LATCH setup time	2	-	-	
t <sub>WHL</sub>	LATCH pulse width	3.2	-	-	
t <sub>SC</sub>	CLOCK start time after LATCH	3.2	-	-	

**6CH ELECTRONIC VOLUME WITH TONE CONTROL****DIGITAL CONTROL SPECIFICATION**

Fore kinds of input format options are available by changing slot settings of DE and DF.  
 (When the IC is powered up , the internal settings are not fixed.)

(1)

D01	D11	D21	D31	D41	D51	D61	D71	D81	D91	DA1	DB1	DC1	DD1	DE	DF
TONE CONT TLEBLE				1	2	3	4	TONE CONT BASS				0	TONE :0 BYPASS :1	0	0
				OUTPUT PORT n CONT High:1,Low:0											

(2)

D02	D12	D22	D32	D42	D52	D62	D72	D82	D92	DA2	DB2	DC2	DD2	DE	DF
VOLUME Lch								VOLUME Rch						0	1

(3)

D03	D13	D23	D33	D43	D53	D63	D73	D83	D93	DA3	DB3	DC3	DD3	DE	DF
VOLUME Cch								VOLUME SWch						1	0

(4)

D04	D14	D24	D34	D44	D54	D64	D74	D84	D94	DA4	DB4	DC4	DD4	DE	DF
VOLUME SLch								VOLUME SRch						1	1



**SETTING CODE**

## (1) Tone control (bass / treble)

(Note) \* is an extended function.

ATT	Treble	D01	D11	D21	D31
	bass	D81	D91	DA1	DB1
* - 14dB		1	1	1	1
* - 12dB		1	1	0	1
- 10dB		1	1	1	0
- 8dB		1	1	0	0
- 6dB		1	0	1	1
- 4dB		1	0	1	0
- 2dB		1	0	0	1
+ 0dB		0	0	0	0
+ 2dB		0	0	0	1
+ 4dB		0	0	1	0
+ 6dB		0	0	1	1
+ 8dB		0	1	0	0
+ 10dB		0	1	1	0
* + 12dB		0	1	0	1
* + 14dB		0	1	1	1

## (2) Port output

D41	D51
D61	D71
Out:H	1
Out:L	0

## (3) BYPASS control

DD1	
BYPASS	1
TONE	0

Note : Do not input other data than the above.

**6CH ELECTRONIC VOLUME WITH TONE CONTROL**

(4)-1 VOLUME ( 0 to -39dB ) Note : Do not input other data than the above.

A T T	VOLUME	D0X	D1X	D2X	D3X	D4X	D5X	D6X
		D7X	D8X	D9X	DAX	DBX	DCX	DDX
	0dB	0	0	0	0	0	0	0
	-1dB	0	0	0	0	0	0	1
	-2dB	0	0	0	0	0	1	0
	-3dB	0	0	0	0	0	1	1
	-4dB	0	0	0	0	1	0	0
	-5dB	0	0	0	0	1	0	1
	-6dB	0	0	0	0	1	1	0
	-7dB	0	0	0	0	1	1	1
	-8dB	0	0	0	1	0	0	0
	-9dB	0	0	0	1	0	0	1
	-10dB	0	0	0	1	0	1	0
	-11dB	0	0	0	1	0	1	1
	-12dB	0	0	0	1	1	0	0
	-13dB	0	0	0	1	1	0	1
	-14dB	0	0	0	1	1	1	0
	-15dB	0	0	0	1	1	1	1
	-16dB	0	0	1	0	0	0	0
	-17dB	0	0	1	0	0	0	1
	-18dB	0	0	1	0	0	1	0
	-19dB	0	0	1	0	0	1	1
	-20dB	0	0	1	0	1	0	0
	-21dB	0	0	1	0	1	0	1
	-22dB	0	0	1	0	1	1	0
	-23dB	0	0	1	0	1	1	1
	-24dB	0	0	1	1	0	0	0
	-25dB	0	0	1	1	0	0	1
	-26dB	0	0	1	1	0	1	0
	-27dB	0	0	1	1	0	1	1
	-28dB	0	0	1	1	1	0	0
	-29dB	0	0	1	1	1	0	1
	-30dB	0	0	1	1	1	1	0
	-31dB	0	0	1	1	1	1	1
	-32dB	0	1	0	0	0	0	0
	-33dB	0	1	0	0	0	0	1
	-34dB	0	1	0	0	0	1	0
	-35dB	0	1	0	0	0	1	1
	-36dB	0	1	0	0	1	0	0
	-37dB	0	1	0	0	1	0	1
	-38dB	0	1	0	0	1	1	0
	-39dB	0	1	0	0	1	1	1

## 6CH ELECTRONIC VOLUME WITH TONE CONTROL

(4)-2 VOLUME( -40 to  $-\infty$ dB )

Note : Do not input other data than the above.

A T T	VOLUME	D0X	D1X	D2X	D3X	D4X	D5X	D6X
		D7X	D8X	D9X	DAX	DBX	DCX	DDX
	-40dB	0	1	0	1	0	0	0
	-41dB	0	1	0	1	0	0	1
	-42dB	0	1	0	1	0	1	0
	-43dB	0	1	0	1	0	1	1
	-44dB	0	1	0	1	1	0	0
	-45dB	0	1	0	1	1	0	1
	-46dB	0	1	0	1	1	1	0
	-47dB	0	1	0	1	1	1	1
	-48dB	0	1	1	0	0	0	0
	-49dB	0	1	1	0	0	0	1
	-50dB	0	1	1	0	0	1	0
	-51dB	0	1	1	0	0	1	1
	-52dB	0	1	1	0	1	0	0
	-53dB	0	1	1	0	1	0	1
	-54dB	0	1	1	0	1	1	0
	-55dB	0	1	1	0	1	1	1
	-56dB	0	1	1	1	0	0	0
	-57dB	0	1	1	1	0	0	1
	-58dB	0	1	1	1	0	1	0
	-59dB	0	1	1	1	0	1	1
	-60dB	0	1	1	1	1	0	0
	-61dB	0	1	1	1	1	0	1
	-62dB	0	1	1	1	1	1	0
	-63dB	0	1	1	1	1	1	1
	-64dB	1	0	0	0	0	0	0
	-65dB	1	0	0	0	0	0	1
	-66dB	1	0	0	0	0	1	0
	-67dB	1	0	0	0	0	1	1
	-68dB	1	0	0	0	1	0	0
	-69dB	1	0	0	0	1	0	1
	-70dB	1	0	0	0	1	1	0
	-71dB	1	0	0	0	1	1	1
	-72dB	1	0	0	1	0	0	0
	-73dB	1	0	0	1	0	0	1
	-74dB	1	0	0	1	0	1	0
	-75dB	1	0	0	1	0	1	1
	-76dB	1	0	0	1	1	0	0
	-77dB	1	0	0	1	1	0	1
	-78dB	1	0	0	1	1	1	0
	-79dB	1	0	0	1	1	1	1
	$-\infty$ dB	1	0	1	0	0	0	0

6CH ELECTRONIC VOLUME WITH TONE CONTROL

(4)-3 VOLUME ( -80 to -∞dB )

This is an extended function from M62446FP.

A T T	VOLUME	D0X	D1X	D2X	D3X	D4X	D5X	D6X
		D7X	D8X	D9X	DAX	DBX	DCX	DDX
	-∞dB	1	0	1	0	0	0	1
	-∞dB	1	0	1	0	0	1	0
	-∞dB	1	0	1	0	0	1	1
	↓							
	-∞dB	1	0	1	1	1	1	0
	-∞dB	1	0	1	1	1	1	1
	-80dB	1	1	0	0	0	0	0
	-81dB	1	1	0	0	0	0	1
	-82dB	1	1	0	0	0	1	0
	-83dB	1	1	0	0	0	1	1
	-84dB	1	1	0	0	1	0	0
	-85dB	1	1	0	0	1	0	1
	-86dB	1	1	0	0	1	1	0
	-87dB	1	1	0	0	1	1	1
	-88dB	1	1	0	1	0	0	0
	-89dB	1	1	0	1	0	0	1
	-90dB	1	1	0	1	0	1	0
	-91dB	1	1	0	1	0	1	1
	-92dB	1	1	0	1	1	0	0
	-93dB	1	1	0	1	1	0	1
	-94dB	1	1	0	1	1	1	0
	-95dB	1	1	0	1	1	1	1
	-∞dB	1	1	1	0	0	0	0
	-∞dB	1	1	1	0	0	0	1
	↓							
	-∞dB	1	1	1	1	1	1	0
	-∞dB	1	1	1	1	1	1	1

**6CH ELECTRONIC VOLUME WITH TONE CONTROL**

**ELECTRICAL CHARACTERISTICS**

(Ta=25°C, AVDD/AVSS/DVDD=7/-7V/5V, f=1kHz, unless otherwise noted.  
Rg=1KΩ, RL=10KΩ, TONE CONTROL • VOL are set to 0dB/FLAT.)

(1) Power supply characteristics

Parameter	Symbol	Test condition	Limits			Unit
			Min	typ	Max	
Analog positive circuit current	A <sub>l</sub> dd	Current at pin 5 No signal	—	22	35	mA
Analog negative circuit current	A <sub>l</sub> ss	Current at pin 30 No signal	—	22	35	mA
Digital circuit current	D <sub>l</sub> dd	Current at pin 42 No signal	—	1.0	2.0	mA

(2) Input / Output characteristics

Parameter	Symbol	Test condition	Limits			Unit
			Min	typ	Max	
Input resistance	R <sub>i</sub>	13,15,16,17,27,29pin	35	70	150	KΩ
Maximum output voltage	V <sub>OM</sub>	6,8,9,11,13,15,16,17pin INPUT 31 to 36pin OUTPUT THD=1%	3.0	4.2	—	V <sub>rms</sub>
Pass gain	G <sub>v</sub>	V <sub>i</sub> =0.2V <sub>rms</sub> , FLAT ,8,9,11,13,15,16,17pin INPUT 31 to 36pin OUTPUT	-2.0	0	2.0	dB
Distortion	THD	BW=400 to 30KHz V <sub>i</sub> =0.2V <sub>rms</sub> , RL=10KΩ	—	0.002	0.09	%
Output noise voltage	V <sub>n</sub> (VOL)	31 to 36pin, R <sub>g</sub> =0KΩ, JIS-A, VOL=0dB	—	1.5	6	μV <sub>rms</sub>
	V <sub>n</sub> (tone)	31,32pin JIS-A, VOL=0dB	—	5	20	μV <sub>rms</sub>
Maximum attenuation	ATT <sub>max</sub>	31 to 36pin JIS-A, VOL=-∞dB	—	-100	-95	dB
Volume gain between channels	D <sub>vol</sub>		-1.5	0	1.5	dB
Crosstalk between channels	CT	V <sub>o</sub> =0.5V <sub>rms</sub> , RL=10KΩ, JIS-A R <sub>g</sub> =1KΩ	—	-80	-65	dB
Port output current	I <sub>L</sub>		0.2	—	—	mA

**6CH ELECTRONIC VOLUME WITH TONE CONTROL**

## (3) Tone control characteristics

(Note) \* is an expanded function.

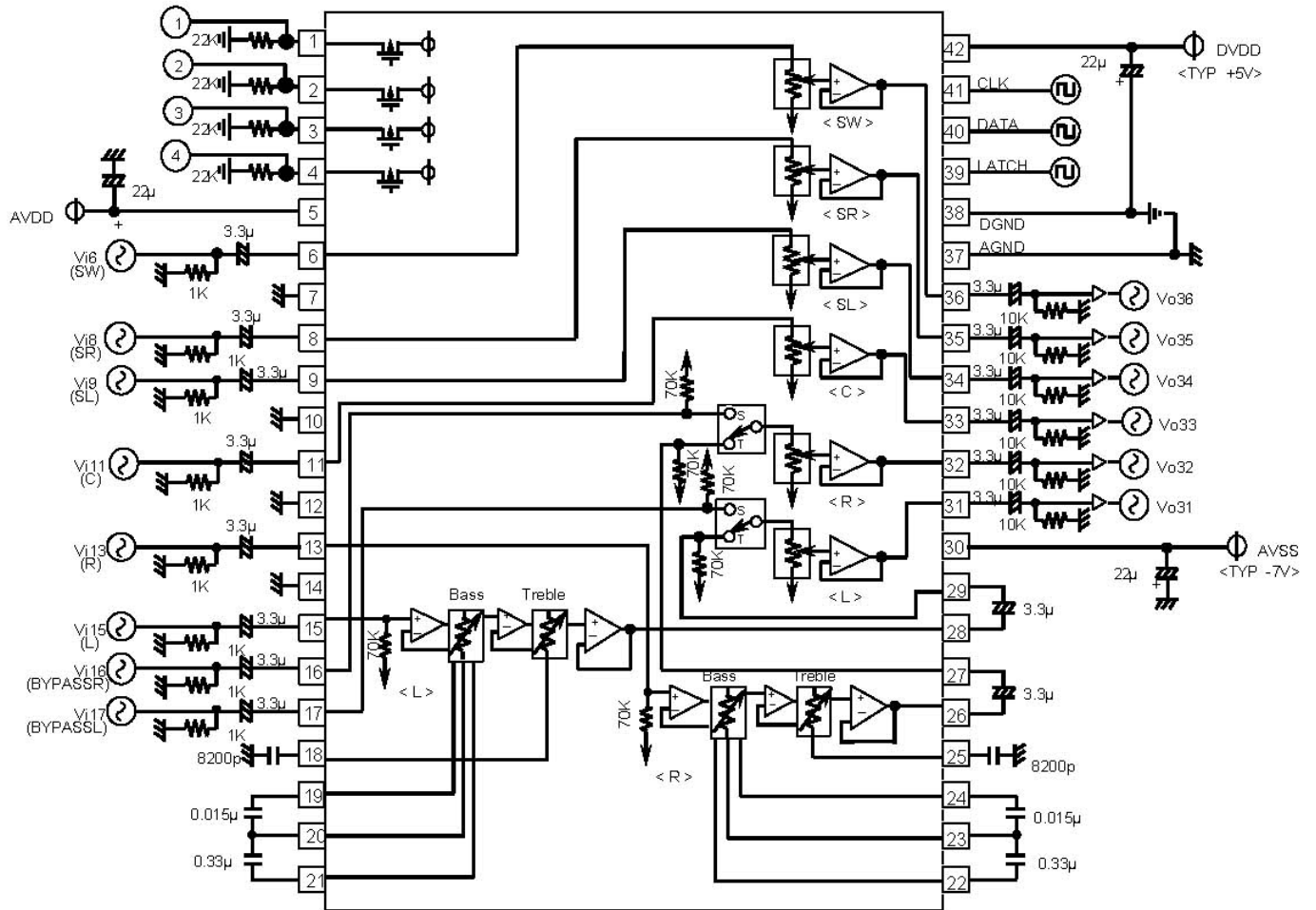
Parameter	Symbol	Test condition	Limits			Unit
			Min	typ	Max	
Tone control voltage gain	* T +14dB	Vo=0.2Vrms TLEBLE(f=10kHz), BASS(f=100Hz)  Voltage gain ( Input to pin13,15 Output from pin31,32 )  INPUT 13,15pin OUTPUT 31,32pin	12	14	16	dB
	* T +12dB		10	12	14	dB
	T +10dB		8	10	12	dB
	T +8dB		6	8	10	dB
	T +6dB		4.5	6	7.5	dB
	T +4dB		2.5	4	5.5	dB
	T +2dB		1	2	3	dB
	T -2dB		-3	-2	-1	dB
	T -4dB		-5.5	-4	-2.5	dB
	T -6dB		-7.5	-6	-4.5	dB
	T -8dB		-10	-8	-6	dB
	T -10dB		-12	-10	-8	dB
	* T -12dB		-14	-12	-10	dB
	* T -14dB		-16	-14	-12	dB
Balance between channel	BALT	Input 13 , 15pin Vo=0.2Vrms Output31,32pin	-1.5	0	+1.5	dB



# M62446AFP

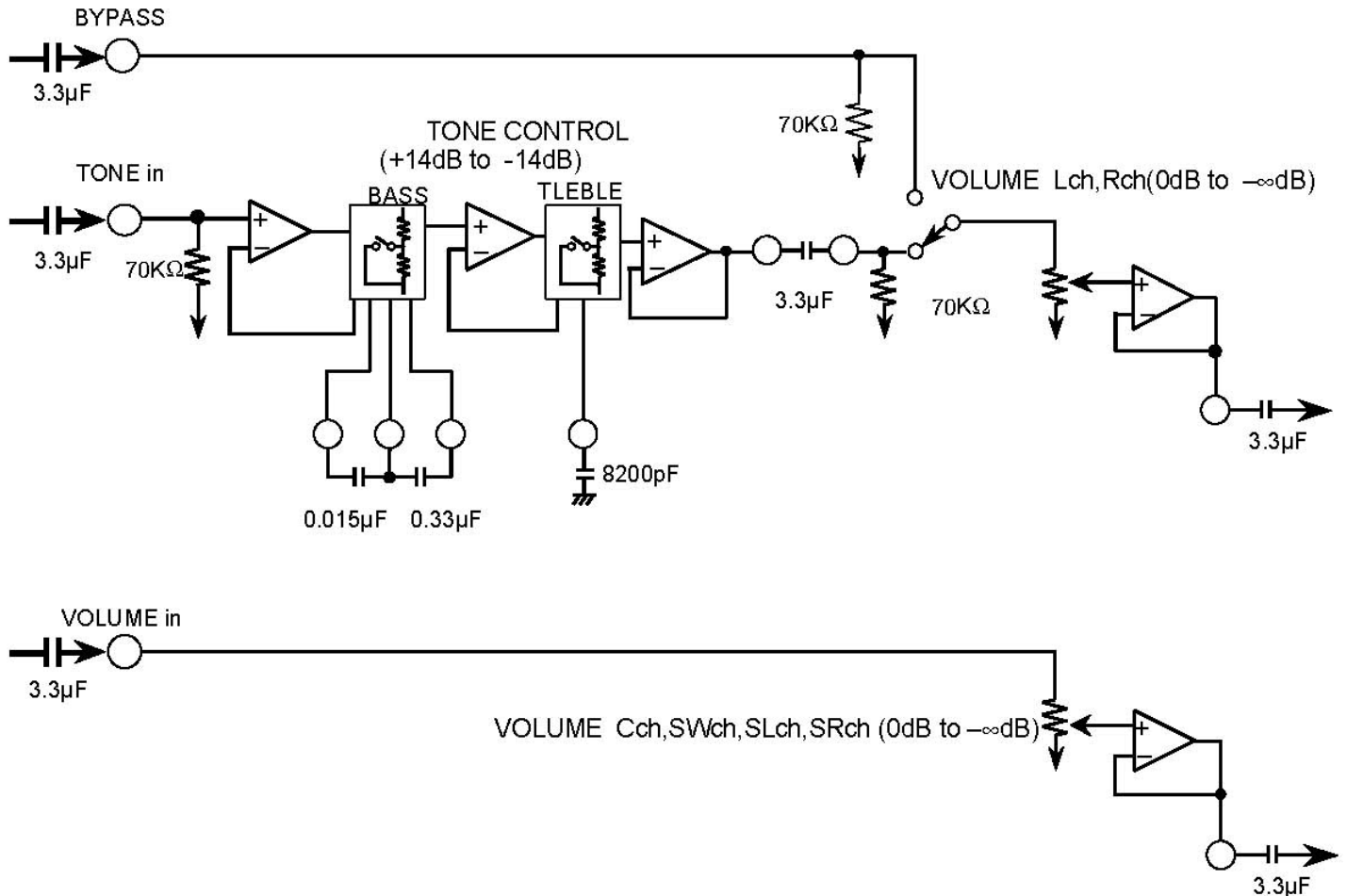
## 6CH ELECTRONIC VOLUME WITH TONE CONTROL

### TEST CIRCUIT

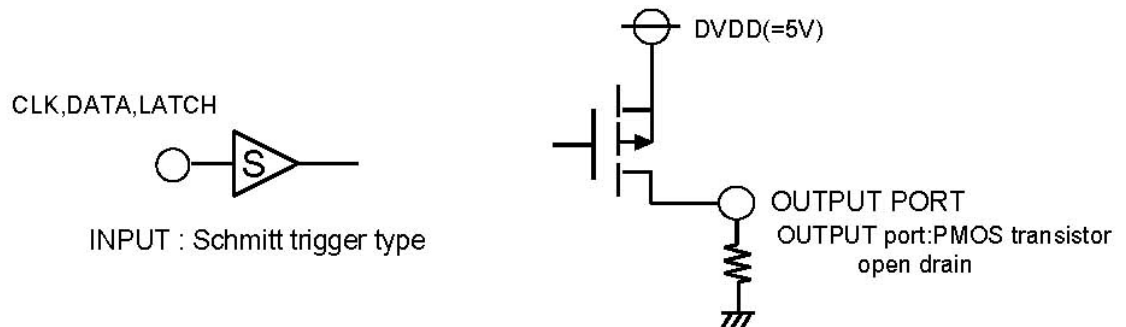


6CH ELECTRONIC VOLUME WITH TONE CONTROL

SIGNAL PROCESSING DIAGRAM



Note.(1)The resistance value of Volume change about 18 to 22KΩ by attenuated condition.  
 (2)No built in a zero cross circuit.  
 (3)When the mode changed(BYPASS/TONE),it is necessary the muting function.

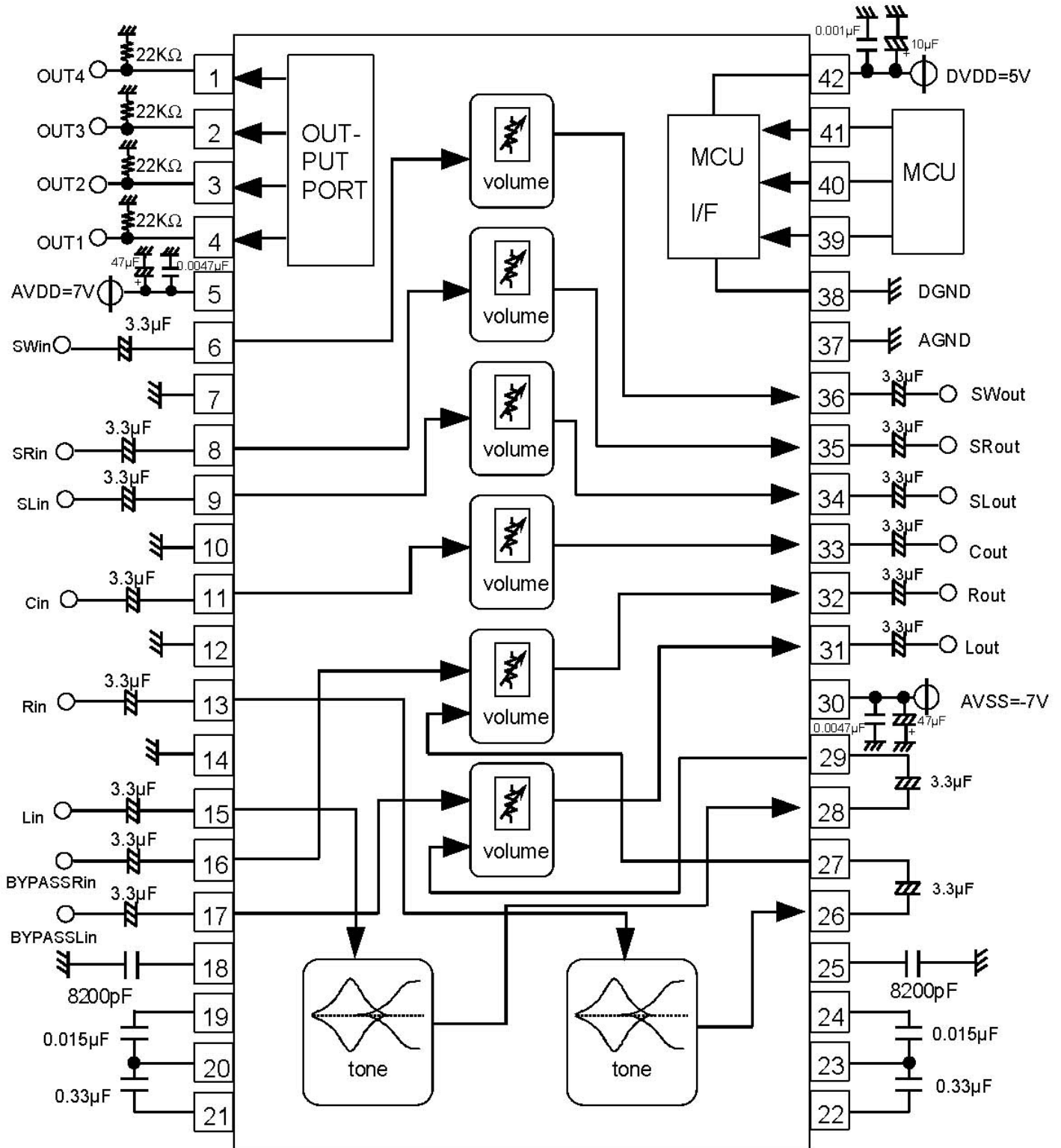


# M62446AFP

## 6CH ELECTRONIC VOLUME WITH TONE CONTROL

### APPLICATION EXAMPLE

(When using Tone control and Bypass)



# M62446AFP

## 6CH ELECTRONIC VOLUME WITH TONE CONTROL

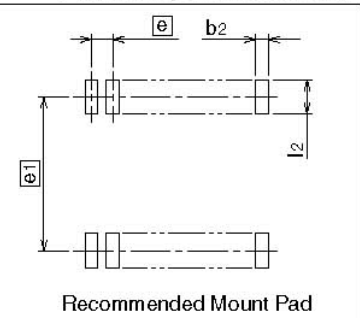
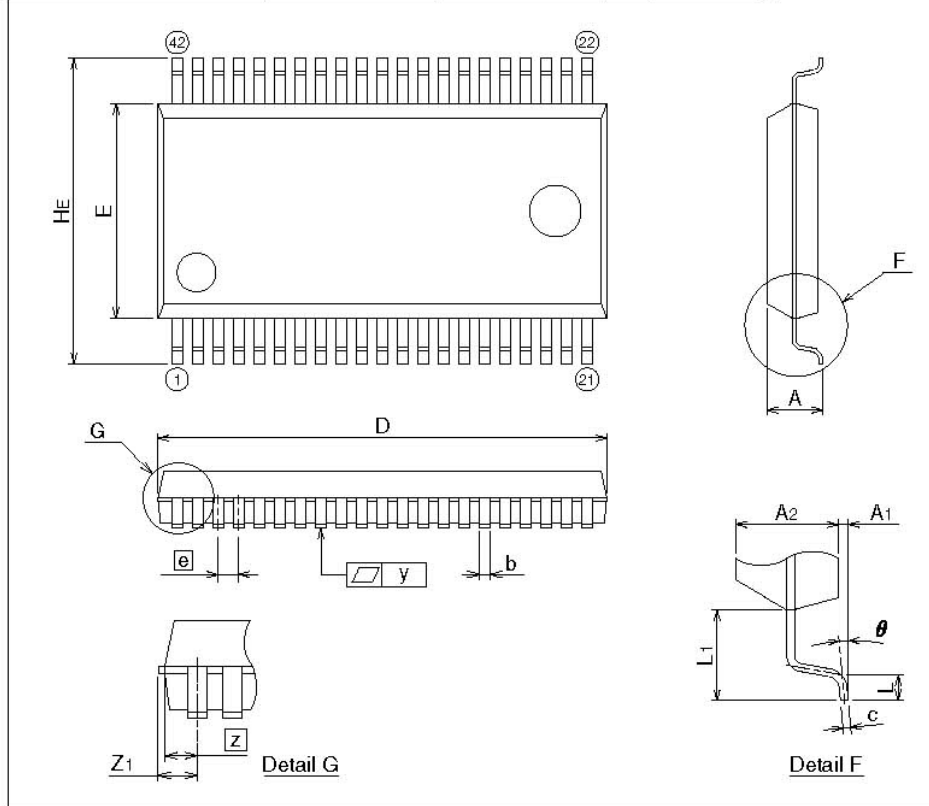
### DETAILED DIAGRAM OF PACKAGE OUTLINE

**42P2R-A**

(MMP)

Plastic 42pin 450mil SSOP

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
SSOP42-P-450-0.80	-	0.63	Alloy 42/Cu Alloy



Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	-	-	2.4
A1	0.05	-	-
A2	-	2.0	-
b	0.35	0.4	0.5
c	0.13	0.15	0.2
D	17.3	17.5	17.7
E	8.2	8.4	8.6
e	-	0.8	-
HE	11.63	11.93	12.23
L	0.3	0.5	0.7
L1	-	1.765	-
Z	-	0.75	-
Z1	-	-	0.9
y	-	-	0.15
θ	0	-	10
b2	-	0.5	-
e1	-	11.43	-
l2	1.27	-	-



Keep safety first in your circuit designs!

●Mitsubishi Electric Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

●These materials are intended as a reference to assist our customers in the selection of the Mitsubishi semiconductor product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Mitsubishi Electric Corporation or a third party.

●Mitsubishi Electric Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.

●All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Mitsubishi Electric Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor for the latest product information before purchasing a product listed herein. The information described here may contain technical inaccuracies or typographical errors. Mitsubishi Electric Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.

Please also pay attention to information published by Mitsubishi Electric Corporation by various means, including the Mitsubishi Semiconductor home page (<http://www.mitsubishichips.com>).

●When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Mitsubishi Electric Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.

●Mitsubishi Electric Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.

●The prior written approval of Mitsubishi Electric Corporation is necessary to reprint or reproduce in whole or in part these materials.

●If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.

Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.

●Please contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor for further details on these materials or the products contained therein.