

# M61538FP

## 6-Channel Electronic Volume

REJ03F0103-0100Z

Rev.1.0

Mar.23.2004

### Description

The M61538FP is 6ch electronic volume. This IC is controlled by 2-wire serial bus and is suitable for Home Audio System.

### Features

- Electronic Volume 0 to -95dB, -∞/1dBstep  
6-Channel independent Electronic Volume
- MUC I/F Controlled by serial data from microcomputer
- Low Noise 0.85μVrms: typ. [Volume = 0dB, Rg = 0Ω, IHF-A]
- Low Distortion 0.0012%: typ. [Vi:0.3Vrms, f:1kHz, BW:400Hz to 30kHz]
- Power Supply ±Power supplies or Single power supply

### Applications

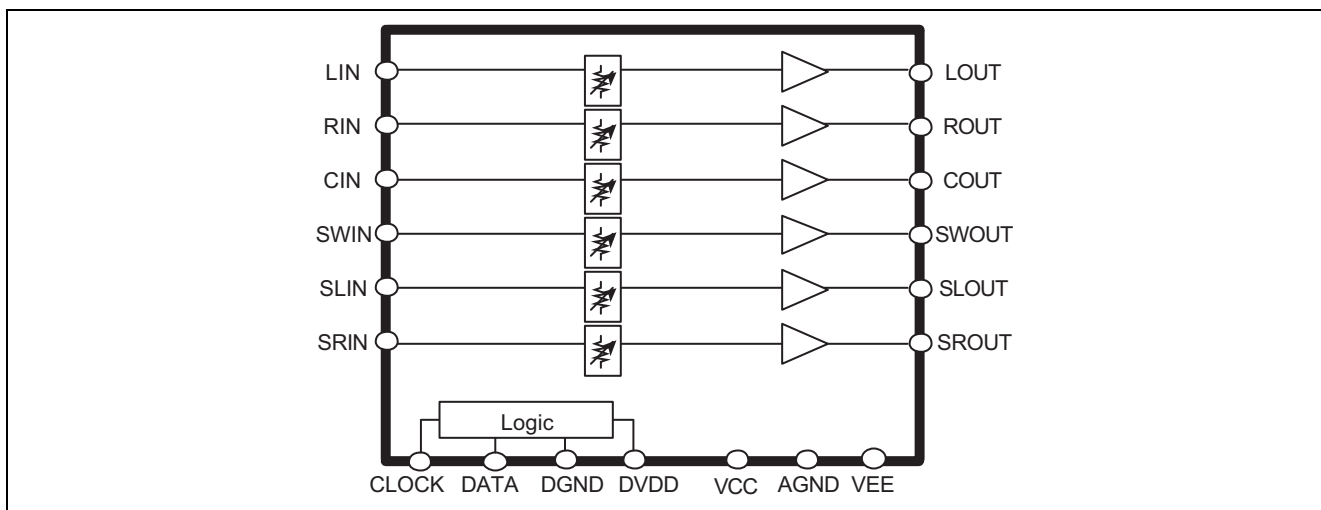
- Receiver, AV Amp, Mini Stereo etc.

### Recommended Operating Condition

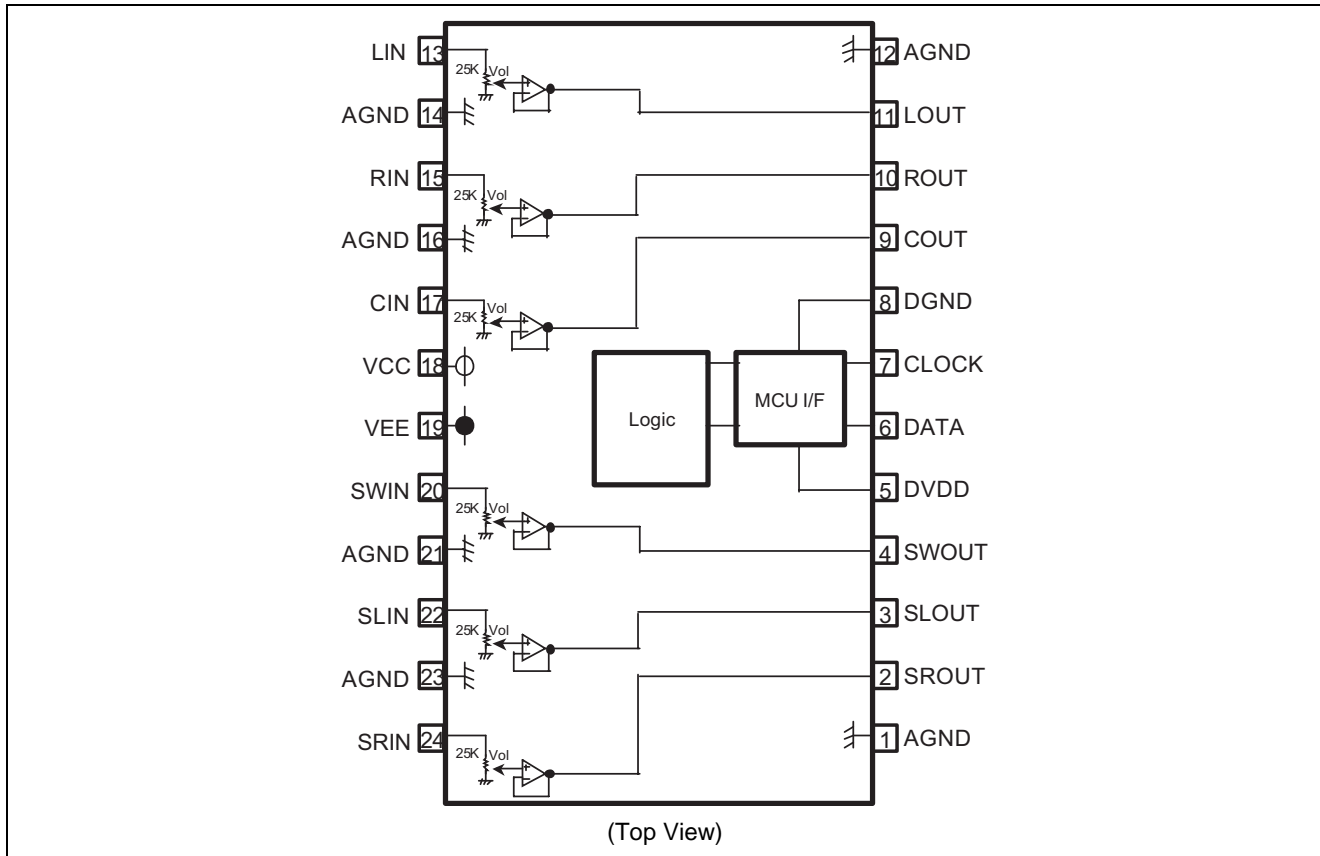
- Supply Voltage Range
  - ±Power supplies VCC: +4.5 to +7.5V [Typ: 7V], VEE: -4.5 to -7.5V[Typ: -7V], DVDD: +2.7 to +5.5V [Typ:5V]
  - Single power supply VCC: +9 to +12V[Typ: 10V], DVDD: 4.5 to +5.5V[Typ: 5V]

### System Block Diagram

(±Power supplies used)



## Block Diagram and Pin Configuration



### Pin Description

(±Power supplies used)

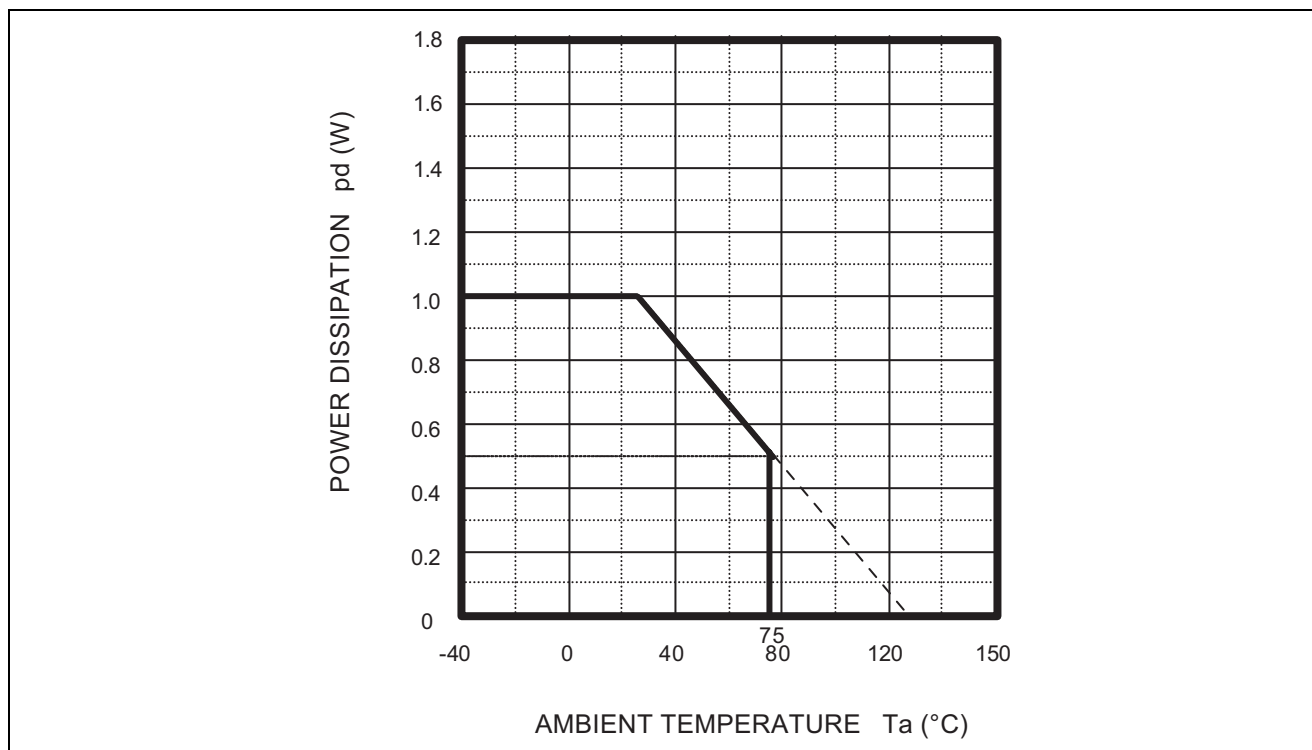
PIN No.	Name	Function
1, 23	AGND	Analog ground of SW/SL/SR volume
2	SROUT	Output pin of SR channel
3	SLOUT	Output pin of SL channel
4	SWOUT	Output pin of SW channel
5	DVDD	Digital Power supply (Typ: 5V)
6, 7	DATA, CLOCK	Input pin of Control data/clock
8	DGND	Digital ground
9	COUT	Output pin of C channel
10	ROUT	Output pin of R channel
11	LOUT	Output pin of L channel
12, 14	AGND	Analog ground of L/R/C volume
13	LIN	Input pin of L channel
15	RIN	Input pin of R channel
16, 21	AGND	Analog ground of all channels
17	CIN	Input pin of C channel
18	VCC	Positive Power supply (Typ: +7V)
19	VEE	Negative Power supply (Typ: -7V)
20	SWIN	Input pin of SW channel
22	SLIN	Input pin of SL channel
24	SRIN	Input pin of SR channel

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Condition
Analog Power supply	VCC-VEE	16	V	VCC-VEE ( $\pm$ Power supplies used)
Digital Power supply	DVDD-DGND	7	V	DVDD-DGND
Power dissipation	Pd	1.0	W	Ta $\leq$ 25°C
Thermal derating	K	10.0	mW/°C	Ta > 25°C
Operating temperature	Topr	-20 to +75	°C	
Storage temperature	Tstg	-40 to +125	°C	

Note: VEE  $\leq$  DGND < DVDD  $\leq$  VCC

## Thermal Deratings (Maximum Rating)



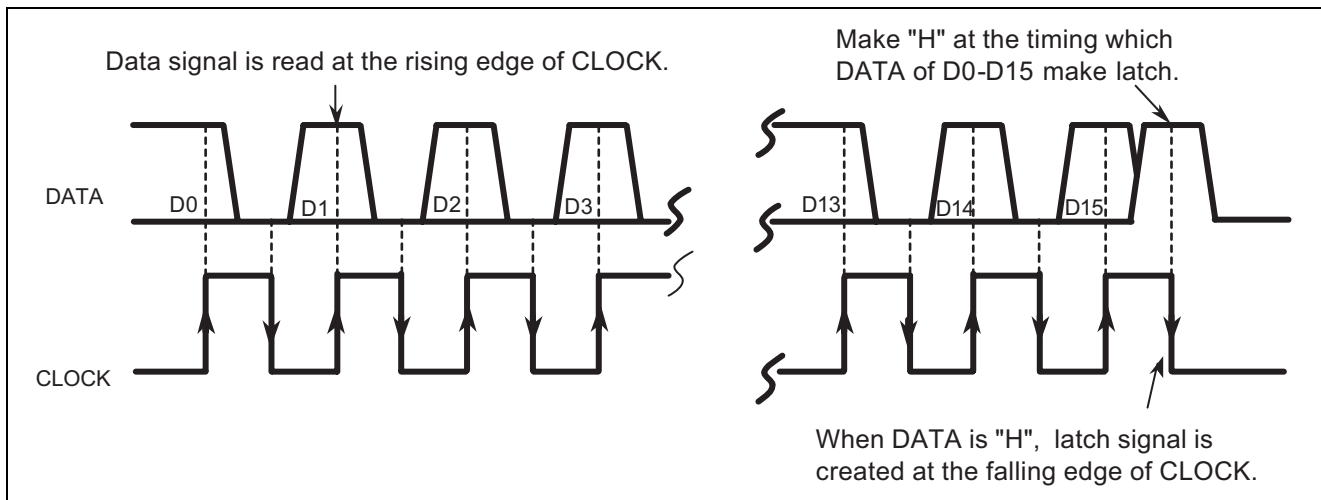
## Recommended Operating Conditions

(Ta = 25°C, unless otherwise noted)

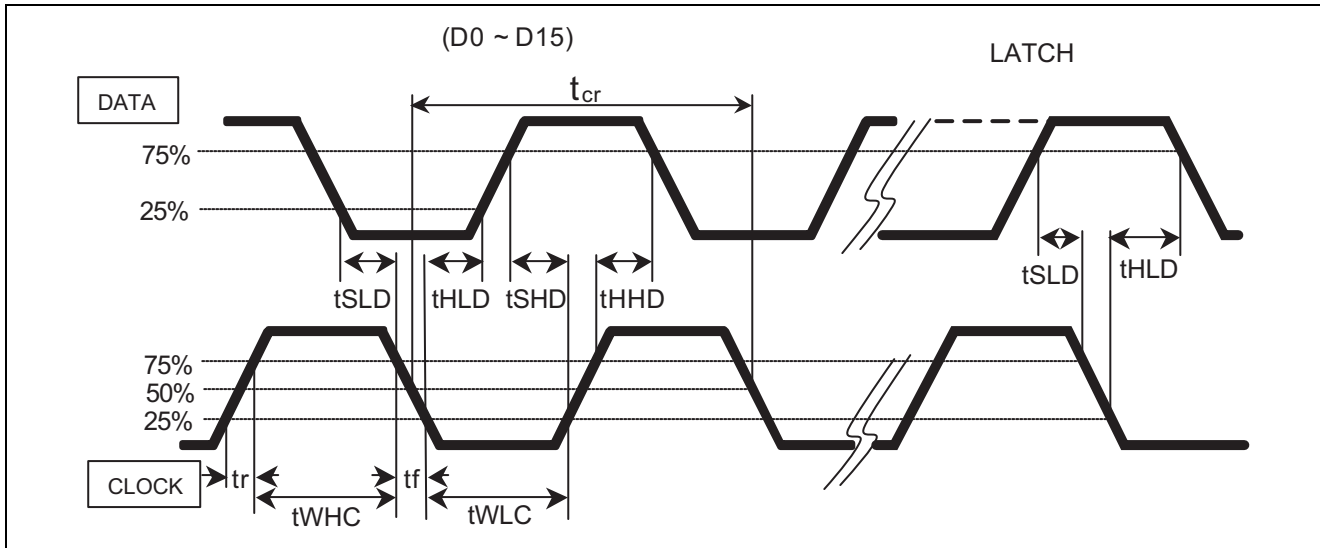
Parameter	Symbol	Limits			Units	Conditions
		Min	Typ	Max		
Analog supply voltage (Positive)	VCC	4.5	7	7.5	V	±Power supplies used
Analog supply voltage (Negative)	VEE	-7.5	-7	-4.5	V	±Power supplies used
Analog supply voltage	VCC	9	10	12	V	Single power supply used
Digital supply voltage	VDD	2.7	5	5.5	V	±Power supplies used, DGND = 0V
		4.5	5	5.5	V	Single power supply used, DGND = 0V
Logic "H" level input voltage	VIH	DVDD ×0.7	—	DVDD	V	DGND = 0V
Logic "L" level input voltage	VIL	DGND	—	DVDD ×0.3	V	DGND = 0V

- Notes: 1.  $VEE \leq DGND < DVDD \leq VCC$   
 2. Apply VCC, VEE and DVDD at the same time.

## Relationship between Data and Clock



## Clock and Data Timings



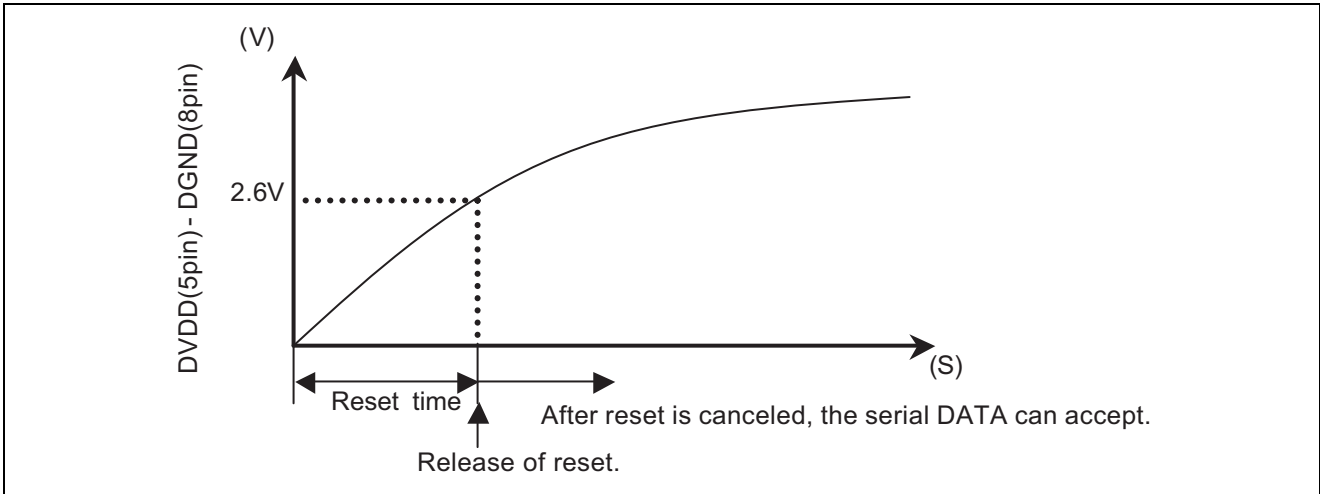
### Timing Definition of Digital Block

Parameter	Symbol	Limits			Units
		Min	Typ	Max	
CLOCK cycle time	t <sub>cr</sub>	8	—	—	
CLOCK pulse width ("H" level)	t <sub>WHC</sub>	3.2	—	—	
CLOCK pulse width ("L" level)	t <sub>WLC</sub>	3.2	—	—	
Rising time of clock and data	t <sub>r</sub>	—	—	0.8	
Falling time of clock and data	t <sub>f</sub>	—	—	0.8	μs
DATA setup time (Rising time of clock)	t <sub>SHD</sub>	1.6	—	—	
DATA setup time (Falling time of clock)	t <sub>SLD</sub>	1.6	—	—	
DATA hold time ("H" level)	t <sub>HHD</sub>	1.6	—	—	
DATA hold time ("L" level)	t <sub>HLD</sub>	1.6	—	—	

### Power on Reset

This IC built-in the power on reset function.

The voltage of DVDD (5 pin) -DGND (8 pin) less than 2.6V, the serial DATA can not accept.



### Data Control Specification

Three types of input format can be selected by changing the D14/D15 slot setting status.

(Initialize all data of the 3 formats when power supply (DVDD) turn on.)

(1)	D0a	D1a	D2a	D3a	D4a	D5a	D6a	D7a	D8a	D9a	D10a	D11a	D12a	D13a	D14	D15	
L Channel volume														R Channel volume		0	0
(2)	D0b	D1b	D2b	D3b	D4b	D5b	D6b	D7b	D8b	D9b	D10b	D11b	D12b	D13b	D14	D15	
C Channel volume														SW Channel volume		0	1
(3)	D0c	D1c	D2c	D3c	D4c	D5c	D6c	D7c	D8c	D9c	D10c	D11c	D12c	D13c	D14	D15	
SL Channel volume														SR Channel volume		1	0
(4)	D0c	D1c	D2c	D3c	D4c	D5c	D6c	D7c	D8c	D9c	D10c	D11c	D12c	D13c	D14	D15	
Test Mode														1	1		

Setting Code

L/R/C/SW/SL/SR Channel Volume

It's initial setting when DVDD turn on.

L	D0a	D1a	D2a	D3a	D4a	D5a	D6a
R	D7a	D8a	D9a	D10a	D11a	D12a	D13a
C	D0b	D1b	D2b	D3b	D4b	D5b	D6b
SW	D7b	D8b	D9b	D10b	D11b	D12b	D13b
SL	D0c	D1c	D2c	D3c	D4c	D5c	D6c
SR	D7c	D8c	D9c	D10c	D11c	D12c	D13c
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
-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

L	D0a	D1a	D2a	D3a	D4a	D5a	D6a
R	D7a	D8a	D9a	D10a	D11a	D12a	D13a
C	D0b	D1b	D2b	D3b	D4b	D5b	D6b
SW	D7b	D8b	D9b	D10b	D11b	D12b	D13b
SL	D0c	D1c	D2c	D3c	D4c	D5c	D6c
SR	D7c	D8c	D9c	D10c	D11c	D12c	D13c
-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
-80dB	1	0	1	0	0	0	0
-81dB	1	0	1	0	0	0	1
-82dB	1	0	1	0	0	1	0
-83dB	1	0	1	0	0	1	1
-84dB	1	0	1	0	1	0	0
-85dB	1	0	1	0	1	0	1
-86dB	1	0	1	0	1	1	0
-87dB	1	0	1	0	1	1	1
-88dB	1	0	1	1	0	0	0
-89dB	1	0	1	1	0	0	1
-90dB	1	0	1	1	0	1	0
-91dB	1	0	1	1	0	1	1
-92dB	1	0	1	1	1	0	0
-93dB	1	0	1	1	1	0	1
-94dB	1	0	1	1	1	1	0
-95dB	1	0	1	1	1	1	1
- dB	1	1	1/0	1/0	1/0	1/0	1/0

## Electrical Characteristics (Supply current)

(Unless otherwise noted,  $T_a = 25^\circ\text{C}$ ,  $V_{CC}(18\text{pin}) = 7\text{V}$ ,  $V_{EE}(19\text{pin}) = -7\text{V}$ ,  $DVDD(5\text{pin}) = 5\text{V}$ ,  $R_L = 10\text{k}\Omega$ )

Parameter	Symbol	Limits			Units	Test Condition
		Min	Typ	Max		
Positive Supply current	ICC	—	11	20	mA	when no signal is provided
Negative Supply current	IEE	-20	-11	—	mA	when no signal is provided
Digital Supply current	IDD	—	0.5	2	mA	when no signal is provided

## Electrical Characteristics (Input/Output)

(Unless otherwise noted,  $T_a = 25^\circ\text{C}$ ,  $V_{CC}(18\text{pin}) = 7\text{V}$ ,  $V_{EE}(19\text{pin}) = -7\text{V}$ ,  $DVDD(5\text{pin}) = 5\text{V}$ ,  $f = 1\text{kHz}$ ,  $R_L = 10\text{k}\Omega$ )

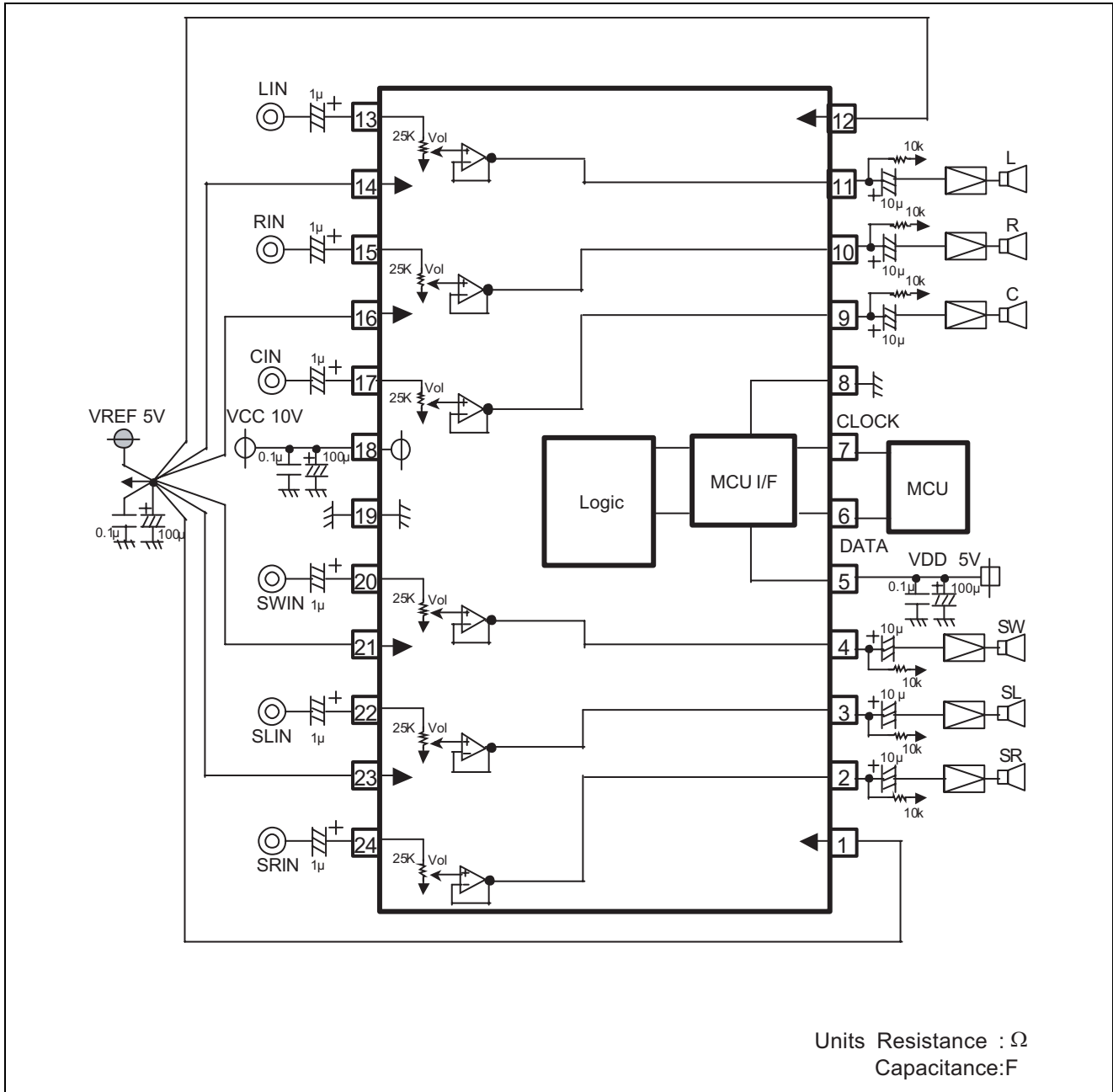
Parameter	Symbol	Limits			Units	Test Condition
		Min	Typ	Max		
Input resistance	Rin	17	25	33	k $\Omega$	13, 15, 17, 20, 22, 24pin, Volume = 0 to $-\infty$ dB
Maximum output voltage	VOM	4.0	4.5	—	Vrms	2, 3, 4, 9, 10, 11pin output, $R_L = 10\text{k}\Omega$ , THD = 1%
Pass gain	Gv	-2	0	2	dB	13, 15, 17, 20, 22, 24pin input, 2, 3, 4, 9, 10, 11pin output
Distortion	THD	—	0.0012	0.009	%	BW = 400Hz to 30kHz, $V_i = 0.3\text{Vrms}$ , $R_L = 10\text{k}\Omega$
Output noise voltage	Vno	—	0.85	8	$\mu\text{Vrms}$	Volume = 0dB, $R_g = 0$ , IHF-A
Maximum attenuation	ATTmax	—	-120	-70	dB	$V_i = 2\text{Vrms}$ , Volume = $-\infty$ dB, IHF-A
Volume gain between channels	Dvol	-1	0	1	dB	Volume = 0, IHF-A
Cross talk between channels	CT	—	-110	-70	dB	$V_i = 2\text{Vrms}$ , $R_L = 10\text{k}\Omega$ , IHF-A, $R_g = 0\Omega$





Application Example 2

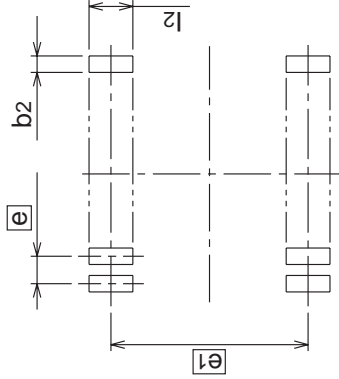
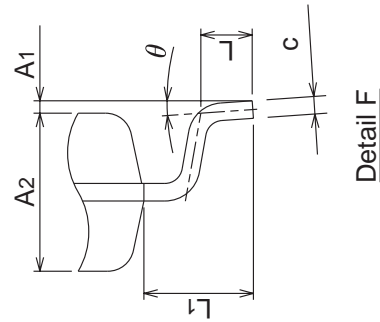
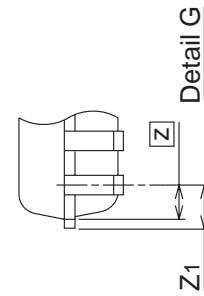
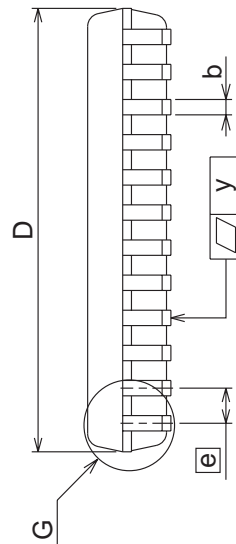
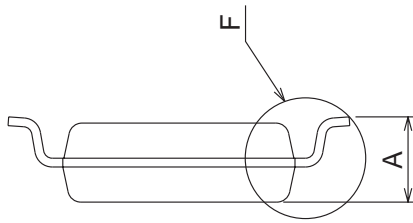
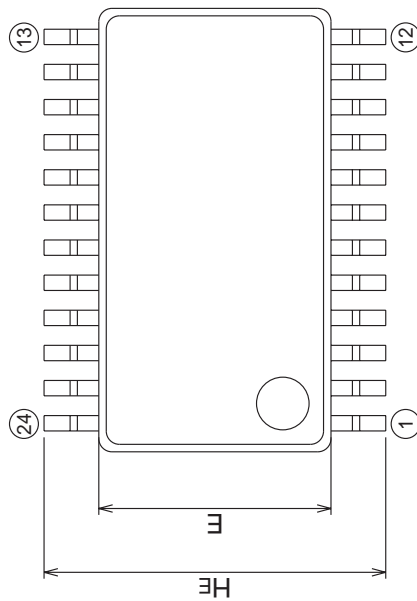
(Single power supply used)



Package Dimensions

24P2Q-A (MMP) Plastic 24pin 300mil SSOP

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
SSOP24-P-300-0.80	—	0.2	Cu Alloy



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	—
Z	—	0.65	—
Z1	—	—	0.8
y	—	—	0.1
theta	0°	—	8°
b2	—	0.5	—
el	—	7.62	—
l2	1.27	—	—

## Renesas Technology Corp. Sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

Keep safety first in your circuit designs!

1. Renesas Technology Corp. 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 nonflammable material or (iii) prevention against any malfunction or mishap.

### Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corp. 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 Renesas Technology Corp. or a third party.
2. Renesas Technology Corp. 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.
3. 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 Renesas Technology Corp. without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corp. or an authorized Renesas Technology Corp. product distributor for the latest product information before purchasing a product listed herein.  
The information described here may contain technical inaccuracies or typographical errors.  
Renesas Technology Corp. assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.  
Please also pay attention to information published by Renesas Technology Corp. by various means, including the Renesas Technology Corp. Semiconductor home page (<http://www.renesas.com>).
4. 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. Renesas Technology Corp. assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corp. 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 Renesas Technology Corp. or an authorized Renesas Technology Corp. 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.
6. The prior written approval of Renesas Technology Corp. is necessary to reprint or reproduce in whole or in part these materials.
7. 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.
8. Please contact Renesas Technology Corp. for further details on these materials or the products contained therein.



### RENEASAS SALES OFFICES

<http://www.renesas.com>

#### Renesas Technology America, Inc.

450 Holger Way, San Jose, CA 95134-1368, U.S.A  
Tel: <1> (408) 382-7500 Fax: <1> (408) 382-7501

#### Renesas Technology Europe Limited.

Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, United Kingdom  
Tel: <44> (1628) 585 100, Fax: <44> (1628) 585 900

#### Renesas Technology Europe GmbH

Dornacher Str. 3, D-85622 Feldkirchen, Germany  
Tel: <49> (89) 380 70 0, Fax: <49> (89) 929 30 11

#### Renesas Technology Hong Kong Ltd.

7/F., North Tower, World Finance Centre, Harbour City, Canton Road, Hong Kong  
Tel: <852> 2265-6688, Fax: <852> 2375-6836

#### Renesas Technology Taiwan Co., Ltd.

FL 10, #99, Fu-Hsing N. Rd., Taipei, Taiwan  
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

#### Renesas Technology (Shanghai) Co., Ltd.

26/F., Ruijin Building, No.205 Maoming Road (S), Shanghai 200020, China  
Tel: <86> (21) 6472-1001, Fax: <86> (21) 6415-2952

#### Renesas Technology Singapore Pte. Ltd.

1, Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632  
Tel: <65> 6213-0200, Fax: <65> 6278-8001