

# I<sup>2</sup>C Bus Control 13-Input 4-Output Audio Switch

## Monolithic IC MM1699XJ

### Outline

This IC is an I<sup>2</sup>C bus controlled audio switch IC for rear projection, PDP, and LCD TVs (medium-end to high-end TVs).

The design of the input select block can be simplified by using with a video switch IC.

It provides stereo or selected mono output.

### Features

1. 13 audio signal (L, R) input channels, 4 output channels
2. 4 output channels are independent and can receive any input.
3. High input dynamic range (3Vrms)
4. All the outputs can be switched to stereo/mono.
5. Built-in gain switch (0dB/12dB) \* OUT1 only
6. Built-in power save function

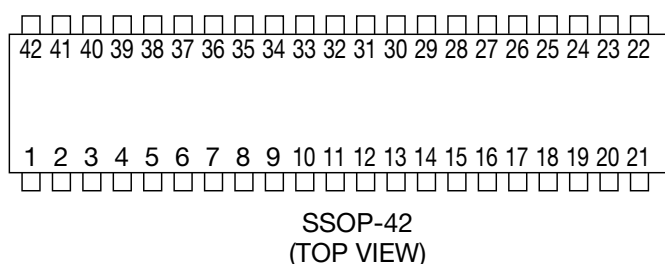
### Package

SSOP-42A

### Applications

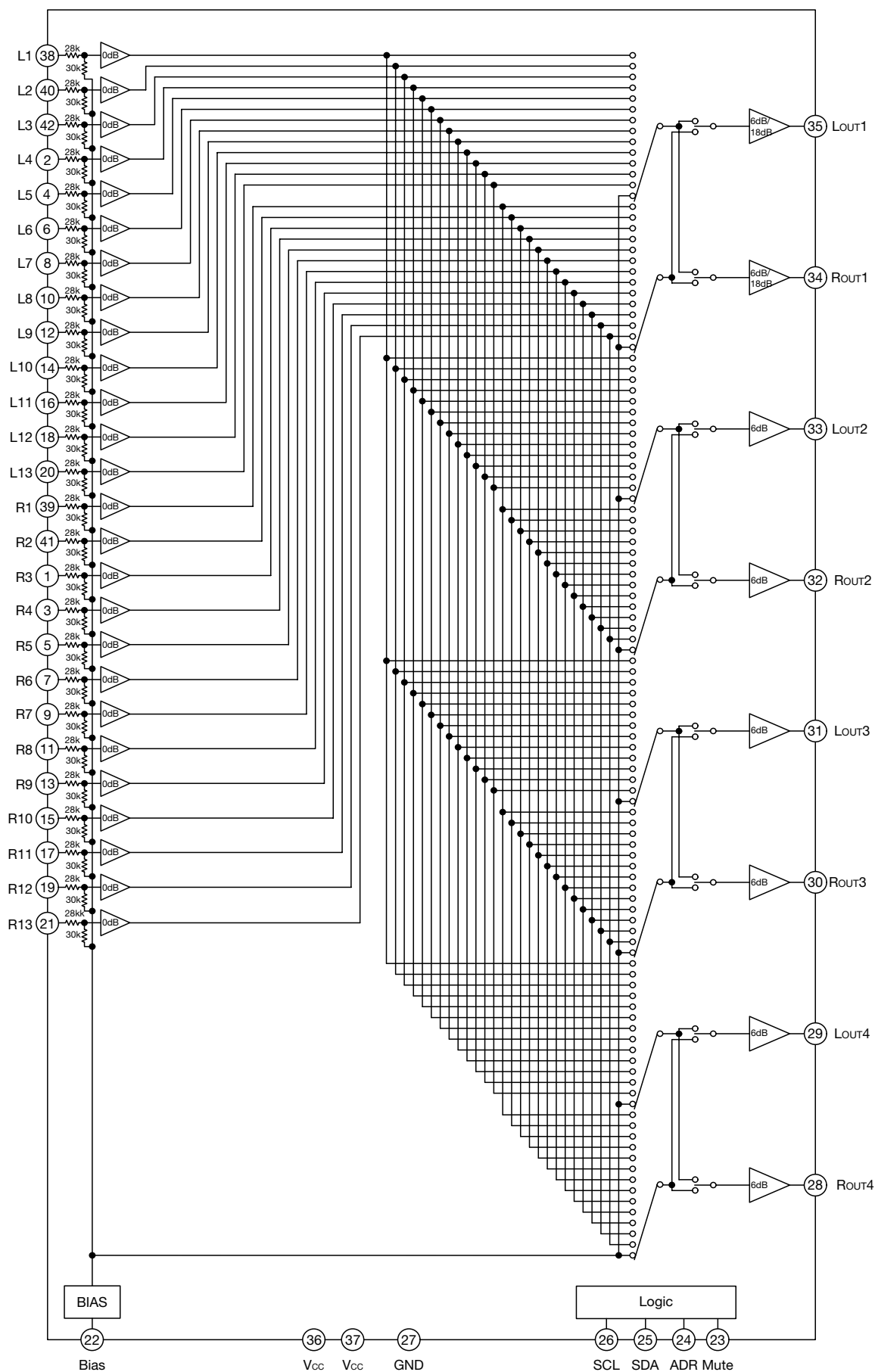
1. Rear projection TVs
2. PDP TVs
3. TVs (medium-end to high-end TVs)
4. CRT TVs

### Pin Assignment

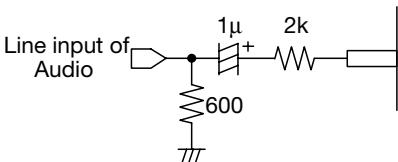
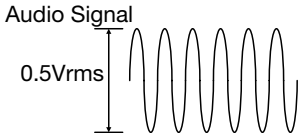
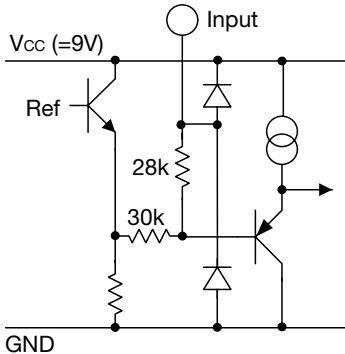


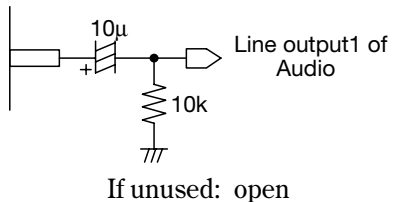
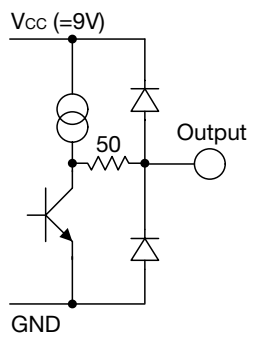
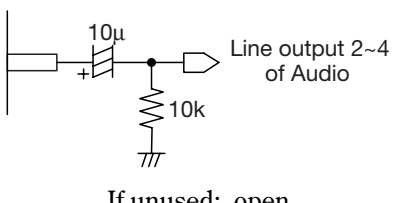
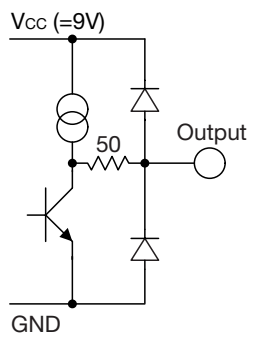
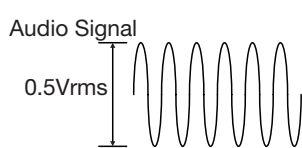
1	R3	8	L7	15	R10	22	BIAS	29	Lout4	36	V <sub>CC</sub>
2	L4	9	R7	16	L11	23	MUTE	30	Rout3	37	V <sub>CC</sub>
3	R4	10	L8	17	R11	24	ADR	31	Lout3	38	L1
4	L5	11	R8	18	L12	25	SDA	32	Rout2	39	R1
5	R5	12	L9	19	R12	26	SCL	33	Lout2	40	L2
6	L6	13	R9	20	L13	27	GND	34	Rout1	41	R2
7	R6	14	L10	21	R13	28	Rout4	35	Rout1	42	L3

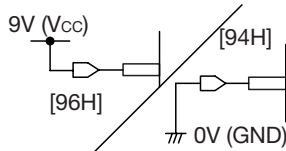
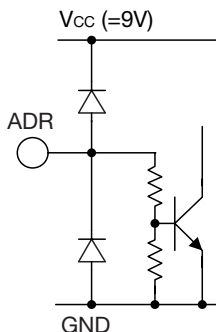
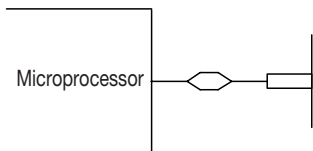
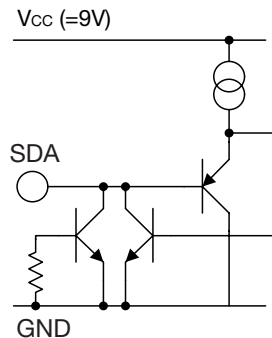
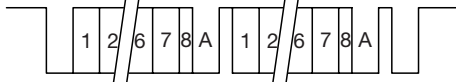
## Block Diagram

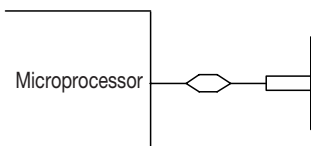
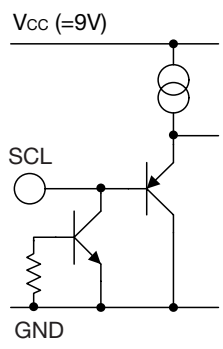

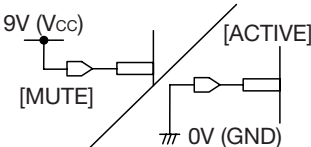
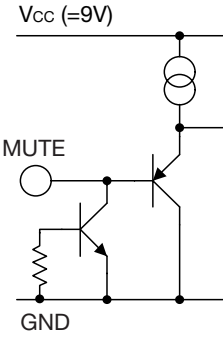


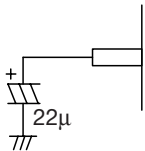
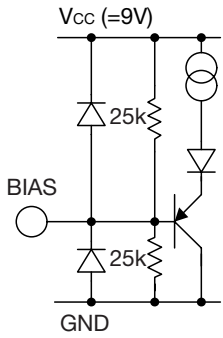
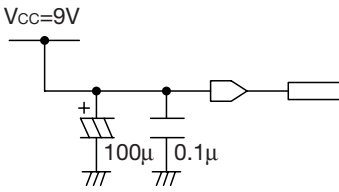
## Pin Description

Pin No.	Pin name	Pin description																				
1~21 38~42	L1~L13 R1~R13	<b>Function</b>																				
		Audio line input Pin to input audio signals. It includes 13 channels; L1 - L13, R1 - R13. Voltage gain can be adjusted by changing a constant of an external input resistor.																				
		Adjusting voltage gain with an external input resistor																				
		<table><tr><th>External input resistor</th><th>Input impedance</th><th>Voltage gain of OUT1</th><th>Voltage gain of OUT2-4</th></tr><tr><td>0Ω</td><td>58kΩ</td><td>0.3dB/12.3dB</td><td>0.3dB</td></tr><tr><td>2kΩ</td><td>60kΩ</td><td>0dB/12dB</td><td>0dB</td></tr><tr><td>3.9kΩ</td><td>61.9kΩ</td><td>-0.3dB/11.7dB</td><td>-0.3dB</td></tr><tr><td>5.6kΩ</td><td>63.6kΩ</td><td>-0.5dB/11.5dB</td><td>-0.5dB</td></tr></table>	External input resistor	Input impedance	Voltage gain of OUT1	Voltage gain of OUT2-4	0Ω	58kΩ	0.3dB/12.3dB	0.3dB	2kΩ	60kΩ	0dB/12dB	0dB	3.9kΩ	61.9kΩ	-0.3dB/11.7dB	-0.3dB	5.6kΩ	63.6kΩ	-0.5dB/11.5dB	-0.5dB
		External input resistor	Input impedance	Voltage gain of OUT1	Voltage gain of OUT2-4																	
		0Ω	58kΩ	0.3dB/12.3dB	0.3dB																	
		2kΩ	60kΩ	0dB/12dB	0dB																	
		3.9kΩ	61.9kΩ	-0.3dB/11.7dB	-0.3dB																	
		5.6kΩ	63.6kΩ	-0.5dB/11.5dB	-0.5dB																	
		Terminal voltage: 4.50V typ. Input impedance: 60kΩ typ. ★Input impedance contains an external input resistor of 2kΩ. Input dynamic range: 3Vrms typ.																				
<b>External circuit</b>																						
 <p>If unused, connect to GND with 1μF.</p>																						
<b>Input signal</b>																						
																						
<b>Equivalent circuit diagram</b>																						
																						

Pin No.	Pin name	Pin description	
34~35	Lout1 Rout1	Function	
		Audio line output 1 Pin to output audio signals · Select voltage gain 0dB/12dB with control resistor, b34. (b34=0: 0dB mode, b34=1: 12dB mode) · Select stereo/mono with control registers, b21/b20. (b21=0 b20=0: stereo, b21=0 b20=1: mono1, b21=1 b20=0: mono2) Terminal voltage: 4.50V typ. Voltage gain: 0dB/12dB typ. Frequency characteristic: -3dB at 50kHz min.	
		External circuit	Equivalent circuit diagram
		 If unused: open	
28~33	Lout2~4 Rout2~4	Function	
		Audio line output 2-4 Pin to output audio signals · Select stereo/mono with control registers b27 - b22. Audio line output 2 (b23=0 b22=0: stereo, b23=0 b22=1: mono1, b23=1 b22=0: mono2) Audio line output 3 (b25=0 b24=0: stereo, b25=0 b24=1: mono1, b25=1 b24=0: mono2) Audio line output 4 (b27=0 b26=0: stereo, b27=0 b26=1: mono1, b27=1 b26=0: mono2) Terminal voltage: 4.50V typ. Voltage gain: 0dB typ. Frequency characteristic: -3dB at 50kHz min.	
		External circuit	Equivalent circuit diagram
		 If unused: open	
		Output signal	
			

Pin No.	Pin name	Pin description	
24	ADR	Function	
		<p>Slave address select pin</p> <p>I<sup>2</sup>C slave address 94H or 96H can be selected with voltage to be applied to this pin.</p> <p>Set ADR pin to "L" for address 94H and "H" for 96H.</p> <p>Threshold: 2.0V typ.</p> <p>Input impedance: 100kΩ typ.</p>	
		External circuit	Equivalent circuit diagram
			
		If unused: open	
		Input signal	
DC voltage: 0V (GND) or 9V (V <sub>cc</sub> )			
25	SDA	Function	
		<p>Data input of I<sup>2</sup>C BUS</p> <p>I/O pin for data signal of I<sup>2</sup>C BUS</p> <p>Threshold: 2.1V typ.</p>	
		External circuit	Equivalent circuit diagram
			
		Input signal	
		<p>Input signal: Control registers</p> <p>Output signal: Status registers</p> 	

Pin No.	Pin name	Pin description	
26	SCL	Function	
		CLK input of I <sup>2</sup> C BUS I/O pin for clock signal of I <sup>2</sup> C BUS  Threshold: 2.1V typ.	
		External circuit	Equivalent circuit diagram
			
		Input signal	
			
23	MUTE	Function	
		Mute select pin Output can be selected mute/active by applying voltage to this pin. Set MUTE pin to "H" for mute and "L" for active. When MUTE pin is set to "H", all the audio output pins are connected to internal bias voltage. When Mute level returns from "H" to "L", audio output select returns to the previous condition.  Threshold: 2.1V typ.	
		External circuit	Equivalent circuit diagram
			
		Input signal	
		DC voltage: 0V (GND) or 9V (Vcc)	

Pin No.	Pin name	Pin description	
22	BIAS	Function	
		<p>BIAS</p> <p>All the reference voltages used inside the IC are generated based on the resistance divider of this pin. It is the pin which connects a filter capacitor for criteria voltage stabilization.</p> <p>Input impedance: 12.5kΩ typ.</p>	
		External circuit	Equivalent circuit diagram
		<div></div> <p>If unused, connect to GND with 22μF.</p>	<div></div>
		Input signal	
36 37	V <sub>CC</sub>	Function	
		<p>Voltage supply</p> <p>Pin to apply supply voltage. Apply 9V.</p> <p>36pin and 37pin are shorted inside the IC.</p> <p>Note: Place a bypass capacitor as close to the pin as possible.</p>	
		External circuit	Equivalent circuit diagram
		<div></div>	
		Input signal	
		DC voltage: +8.0~+10.0V	
27	GND	Function	
		GND pin	

## Absolute Maximum Ratings (Ta=25°C)

Item	Symbol	Ratings	Units
Storage temperature	T <sub>STG</sub>	-65~+150	°C
Operating temperature	T <sub>OPR</sub>	-40~+85	°C
Supply voltage	V <sub>CC max.</sub>	-0.2~+13	V
I/O terminal voltage	V <sub>IN max.</sub> , V <sub>OUT max.</sub>	-0.2~V <sub>CC</sub> +0.2	V
Output current	I <sub>OUT max.</sub>	25	mA
Junction temperature	T <sub>j max.</sub>	150	°C
Allowable loss (Note1)	P <sub>d</sub>	2.4	W

Note1: Power dissipation when mounted on a board. Board size 190mm×150mm×1.6mm

## Recommended Operating Conditions

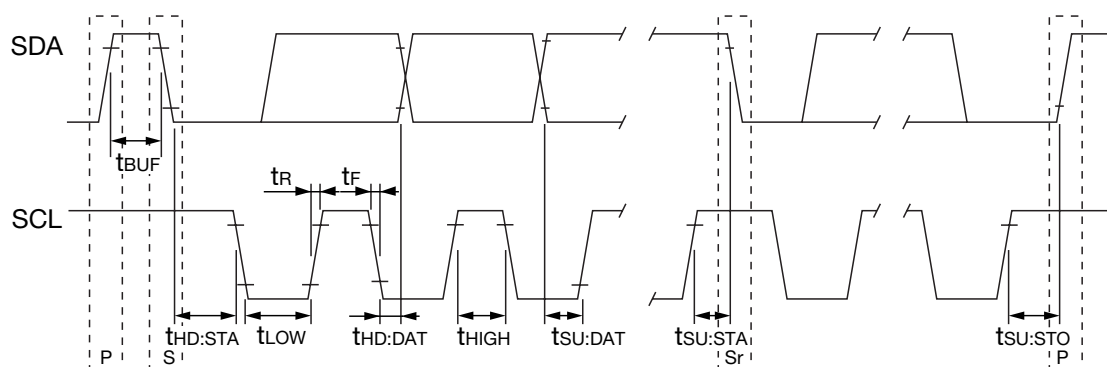
Item	Symbol	Ratings	Units
Operating temperature	T <sub>OPR</sub>	-40~+85	°C
Operating voltage	V <sub>CCOP</sub>	+8.0~+10.0	V
Operating I/O voltage	V <sub>INOP</sub> , V <sub>OUTOP</sub>	0~V <sub>CC</sub>	V

## Electrical Characteristics (Except where noted otherwise Ta=25°C, V<sub>CC</sub>=9V, SW1 ON, SW2 OFF, SW3 ON)

Item		Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Current consumption		I <sub>CC0</sub>	No signal, No load		42	55	mA
Current consumption 1 in power save mode		I <sub>CC1</sub>	Out1 (or Out2 or Out3 or Out4) : power-save Out2 & Out3 & Out4 (or Out1 & Out3 & Out4 or Out1 & Out2 & Out4 or Out1 & Out2 & Out3) : active		37	49	mA
Current consumption 2 in power save mode		I <sub>CC2</sub>	Out1 & Out2 (or Out1 & Out3 or Out1 & Out4 or Out2 & Out3 or Out2 & Out4 or Out3 & Out4) : power-save Out3&Out4 (or Out2 & Out4 or Out2 & Out3 or Out1 & Out4 or Out1 & Out3 or Out1 & Out2) : active		32	42	mA
Current consumption 3 in power save mode		I <sub>CC3</sub>	Out1 & Out2 & Out3 (or Out1 & Out2 & Out4 or Out1 & Out2 & Out4 or Out2 & Out3 & Out4) : power-save Out4 (or Out3 or Out2 or Out1) : active		27	36	mA
Current consumption 4 in power save mode		I <sub>CC4</sub>	Out1 & 2 & Out3 & Out4: power-save		22	30	mA
Voltage gain	0dB	G <sub>v1</sub>	SG: 1V <sub>rms</sub> , 1kHz	-0.5	0	0.5	dB
	12dB	G <sub>v2</sub>	SG: 0.25V <sub>rms</sub> , 1kHz	11.4	12.0	12.6	
Frequency characteristic	0dB	FBW1	SG: 1V <sub>rms</sub> , 50kHz/1kHz	-3			dB
	12dB	FBW2	SG: 0.25V <sub>rms</sub> , 50kHz/1kHz				
Total harmonic distortion		THD	SG: 1V <sub>rms</sub> , 1kHz, G <sub>v</sub> =0dB		0.03	0.05	%
Input dynamic range		DR	f=1kHz, THD=0.5%, G <sub>v</sub> =0dB	2.8	3.0		V <sub>rms</sub>
Crosstalk		CT	SG: 1V <sub>rms</sub> , f=1kHz Without power save mode		-90	-80	dB
Ripple rejection ratio		PSRR	V <sub>r</sub> : 100mV <sub>rms</sub> , 100Hz, G <sub>v</sub> =0dB SW1 OFF, SW2 ON, SW3 OFF		-50	-40	dB
Output offset voltage	0dB	V <sub>OFF1</sub>	V <sub>OUT</sub> (Active)-V <sub>OUT</sub> (Mute)	-15	0	15	mV
	12dB	V <sub>OFF2</sub>		-60	0	60	
S/N ratio	OUT1, 2, 3, 4	S/N1	SG: 1V <sub>rms</sub> , 1kHz, G <sub>v</sub> =0dB, A curve		-90	-80	dB
	OUT1	S/N2	SG: 0.25V <sub>rms</sub> , 1kHz, G <sub>v</sub> =12dB, A curve		-80	-70	



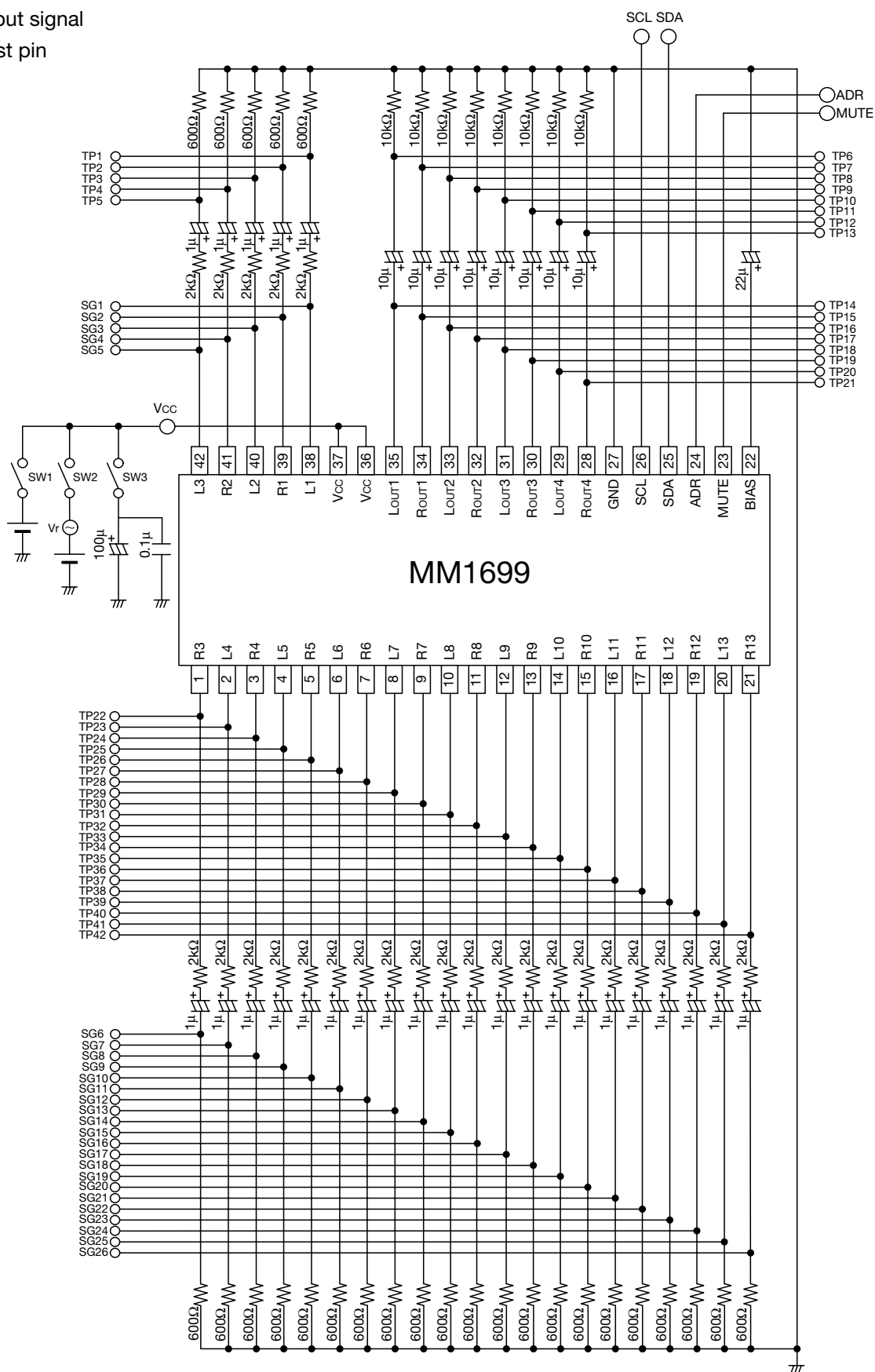
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Input impedance of input terminals	$Z_{IN}$	Including an external input resistor of 2k $\Omega$	47	60	73	k $\Omega$
Input terminal voltage	$V_{IN}$	No signal, No load	4.25	4.50	4.75	V
Output terminal voltage	$V_{OUT}$	No signal, No load	4.25	4.50	4.75	V
Audio signal input voltage (SG1~22)	$V_{SG}$	No output signal turnup			7.1	V <sub>rms</sub>
MUTE input voltage L	$V_{MUIL}$	Out: Active	0.0		0.8	V
MUTE input voltage H	$V_{MUIH}$	Out: Mute	2.5		9.0	V
ADR input voltage L	$V_{ADRL}$	94H select	0.0		0.8	V
ADR input voltage H	$V_{ADRH}$	96H select	2.5		9.0	V
[I <sup>2</sup> C conditions]						
Input voltage L	$V_{IL}$		0.0		0.8	V
Input voltage H	$V_{IH}$		2.2		5.0	V
SDA low level output voltage	$V_{OL}$	SDA sink 3mA	0.0		0.4	V
High level input current	$I_{IH}$	SDA, SCL=4.5V	-10		10	$\mu$ A
Low level input current	$I_{IL}$	SDA, SCL=0.4V	-10		10	$\mu$ A
Clock frequency	$f_{SCL}$				100	kHz
Data transfer wait time	$t_{BUF}$		4.7			$\mu$ s
SCL start hold time	$t_{HD;STA}$		4.0			$\mu$ s
SCL low level hold time	$t_{LOW}$		4.7			$\mu$ s
SCL high level hold time	$t_{HIGH}$		4.0			$\mu$ s
Start condition setup time	$t_{SU;STA}$		4.7			$\mu$ s
SDA data hold time	$t_{HD;DAT}$		0			$\mu$ s
SDA data setup time	$t_{SU;DAT}$		250			ns
SDA, SCL rise time	$t_R$				1000	ns
SDA, SCL fall time	$t_F$				300	ns
Stop condition setup time	$t_{SU;STO}$		4.0			$\mu$ s

I<sup>2</sup>C condition

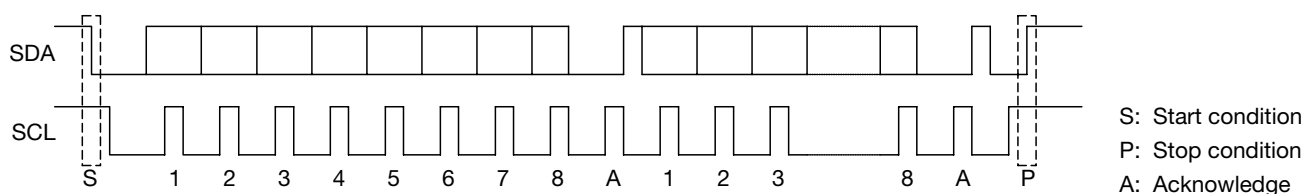
## Measuring Circuit

SG: Input signal

TP: Test pin



## I<sup>2</sup>C BUS

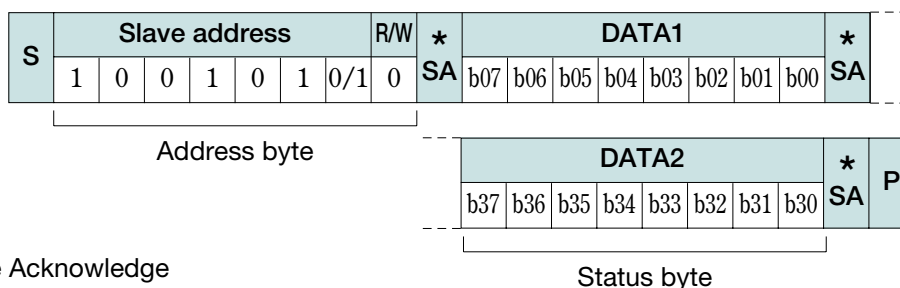


I<sup>2</sup>C BUS is inter-IC BUS system to transfer data by 2 lines of SDA and SCL.

Data transfer is performed by 1 byte, and acknowledgment is sent when each byte is complete. Data transfer takes place MSB first from the Start condition.

### [Control registers]

Control registers are data transmitted from the master to determine the status of MM1699 (switch). The data format is set as shown in the figure below.



\*SA: Slave Acknowledge

The first 7 bits of the address byte are assigned to the slave address, and the remaining 1 bit to the R/W bit. To use as control registers, set 0 to the R/W bit.

In addition, MM1699 allows users to select address 94H or 96H according to the ADR pin condition. When ADR pin is set to "L", address 94H is selected.

The following table shows the relation between each bit of control registers and switch control.

Each bit of control registers is reset to 0 during power-up.

MM1699 consists of 1 address byte and 4 control data bytes, 5 bytes in total to control switches. All the prolonged data (after the 6th byte) are ignored.

Refer to the attached switch control table for details.

No.	DATA condition							
DATA1 [00H]	b07	b06	b05	b04	b03	b02	b01	b00
	L2, R2 LINE SELECT				L1, R1 LINE SELECT			
DATA2 [00H]	b17	b16	b15	b14	b13	b12	b11	b10
	L4, R4 LINE SELECT				L3, R3 LINE SELECT			
DATA3 [00H]	b27	b26	b25	b24	b23	b22	b21	b20
	OUT SELECT (out4)		OUT SELECT (out3)		OUT SELECT (out2)		OUT SELECT (out1)	
DATA4 [00H]	b37	b36	b35	b34	b33	b32	b31	b30
				GAIN SW (out1)	Power Save (out4)	Power Save (out3)	Power Save (out2)	Power Save (out1)

\*[00H] is in the initial state of control registers.

## Switch control table

### L1, R1 Line select

b03	b02	b01	b00	L1, R1OUT
0	0	0	0	Mute
0	0	0	1	L1, R1
0	0	1	0	L2, R2
0	0	1	1	L3, R3
0	1	0	0	L4, R4
0	1	0	1	L5, R5
0	1	1	0	L6, R6
0	1	1	1	L7, R7
1	0	0	0	L8, R8
1	0	0	1	L9, R9
1	0	1	0	L10, R10
1	0	1	1	L11, R11
1	1	0	0	L12, R12
1	1	0	1	L13, R13
1	1	1	0	Mute
1	1	1	1	Mute

### L2, R2 Line select

b07	b06	b05	b04	L2, R2OUT
0	0	0	0	Mute
0	0	0	1	L1, R1
0	0	1	0	L2, R2
0	0	1	1	L3, R3
0	1	0	0	L4, R4
0	1	0	1	L5, R5
0	1	1	0	L6, R6
0	1	1	1	L7, R7
1	0	0	0	L8, R8
1	0	0	1	L9, R9
1	0	1	0	L10, R10
1	0	1	1	L11, R11
1	1	0	0	L12, R12
1	1	0	1	L13, R13
1	1	1	0	Mute
1	1	1	1	Mute

### L3, R3 Line select

b13	b12	b11	b10	L3, R3OUT
0	0	0	0	Mute
0	0	0	1	L1, R1
0	0	1	0	L2, R2
0	0	1	1	L3, R3
0	1	0	0	L4, R4
0	1	0	1	L5, R5
0	1	1	0	L6, R6
0	1	1	1	L7, R7
1	0	0	0	L8, R8
1	0	0	1	L9, R9
1	0	1	0	L10, R10
1	0	1	1	L11, R11
1	1	0	0	L12, R12
1	1	0	1	L13, R13
1	1	1	0	Mute
1	1	1	1	Mute

### L4, R4 Line select

b17	b16	b15	b14	L4, R4OUT
0	0	0	0	Mute
0	0	0	1	L1, R1
0	0	1	0	L2, R2
0	0	1	1	L3, R3
0	1	0	0	L4, R4
0	1	0	1	L5, R5
0	1	1	0	L6, R6
0	1	1	1	L7, R7
1	0	0	0	L8, R8
1	0	0	1	L9, R9
1	0	1	0	L10, R10
1	0	1	1	L11, R11
1	1	0	0	L12, R12
1	1	0	1	L13, R13
1	1	1	0	Mute
1	1	1	1	Mute

### OUT1 select

b21	b20	L1, R1OUT
0	0	Stereo
0	1	Mono1
1	0	Mono2
1	1	Don't Use

### OUT3 select

b21	b20	L1, R1OUT
0	0	Stereo
0	1	Mono1
1	0	Mono2
1	1	Don't Use

Mono1: L→L, R OUT

Mono2: R→L, R OUT

### OUT2 select

b23	b22	L2, R2OUT
0	0	Stereo
0	1	Mono1
1	0	Mono2
1	1	Don't Use

### OUT4 select

b27	b26	L4, R4OUT
0	0	Stereo
0	1	Mono1
1	0	Mono2
1	1	Don't Use

### OUT1 Gain Switch

b34	Gain
0	0dB
1	12dB

### Out1 PowerSave select

b30	L1, R1OUT
0	Active
1	PowerSave

### Out2 PowerSave select

b31	L2, R2OUT
0	Active
1	PowerSave

### Out3 PowerSave select

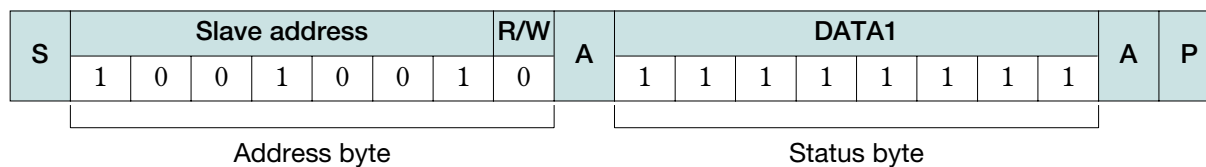
b32	L3, R3OUT
0	Active
1	PowerSave

### Out4 PowerSave select

b33	L4, R4OUT
0	Active
1	PowerSave

## [Status registers]

MM1699 does not provide device information return processing to the master. When R/W bit is set to 1, all the status registers return 1. Then, any switch control is not performed.



\*SA: Slave Acknowledge

\*NA: Non Acknowledge

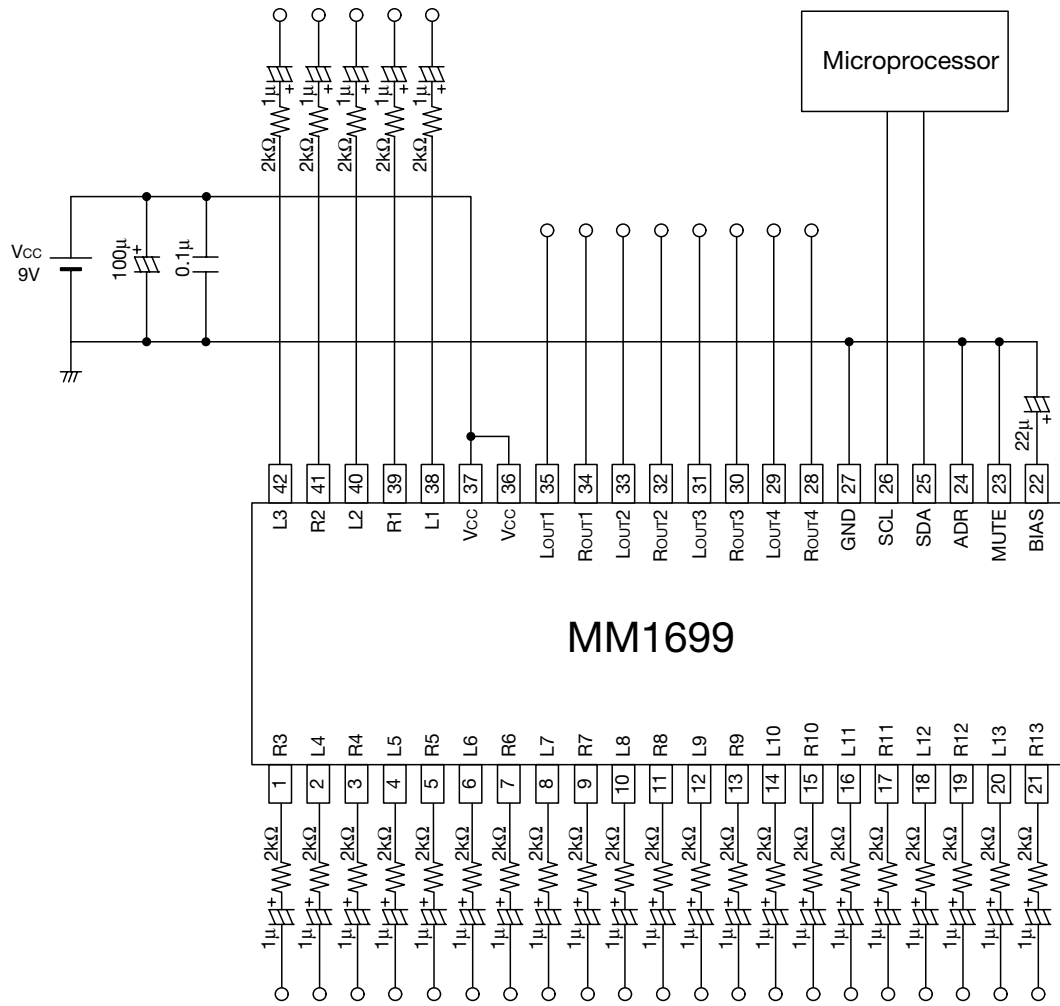
## · Operation of Mute pin

When Mute pin is set to "H", all the audio output pins are connected to internal bias voltage. When Mute level returns from "H" to "L", audio output select returns to the previous condition.

## ■ Mute select

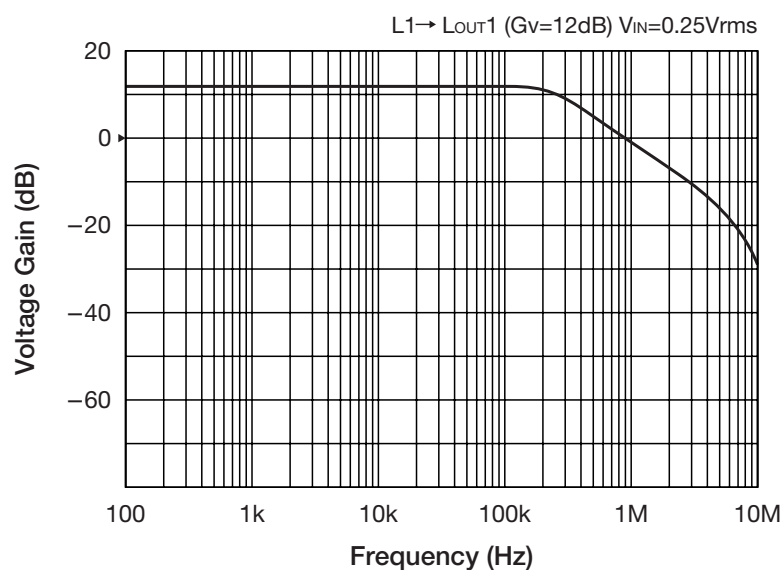
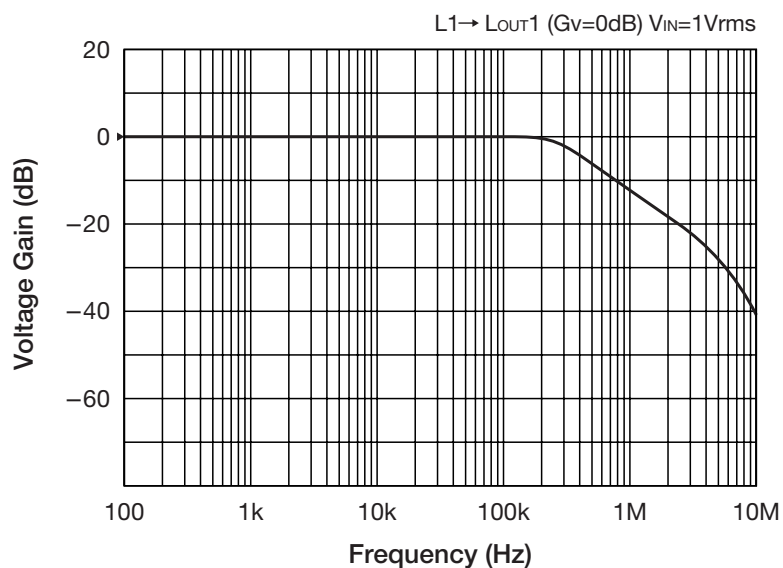
Mute	Output
H	Mute
L	Active

## Application Circuit



## Characteristics

### ■ Frequency characteristic



### ■ Total harmonic distortion - input voltage

