

## Gain and Attenuation Volume Controller IC One Set of Stereo Input, Low voltage Gain and Attenuation 15~-79dB, Good PSRR

### FEATURES

- Operation range: 2.7V~5.5V
- Low power consumption
- Gain/Attenuation: 15dB to -79dB at 1dB/step
- Good PSRR and low pop noise
- Housed in 10 pin MSOP package
- I<sup>2</sup>C interface

### APPLICATIONS

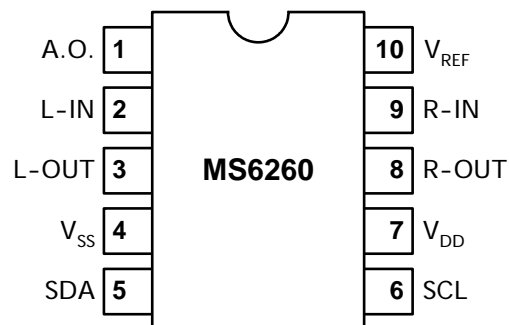
- Multimedia system
- Hi-Fi audio system
- MP3, PDA

### DESCRIPTION

The MS6260 is the stereo audio volume controller IC. It uses CMOS technology specially for the low voltage application with low noise, rail-to-rail output. The MS6260 provide an I<sup>2</sup>C control interface with gain / attenuation range of 15dB to -79dB, 1dB/step. The excellent power supply ripple reject is a good for audio system. The initial condition is set to be maximum attenuation -79dB and mute on mode when power on.

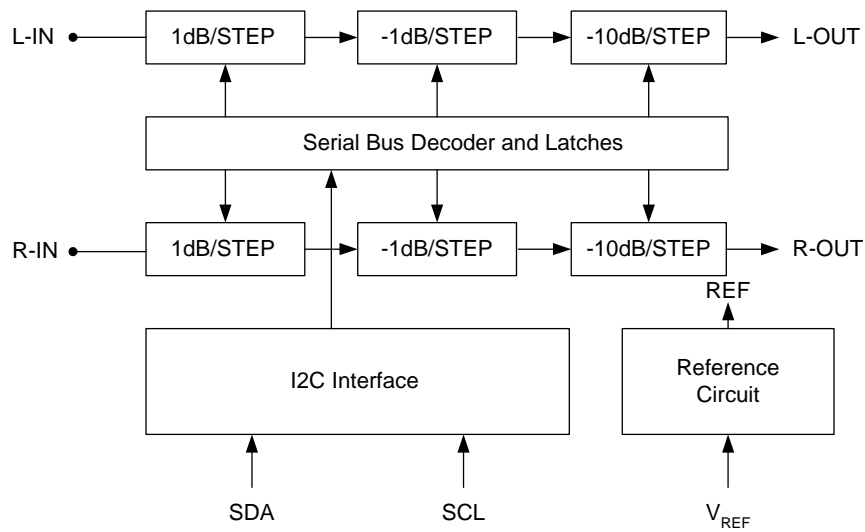
### PIN CONFIGURATION

Symbol	Pin	Description
A.O.	1	Address option *
L-IN	2	Left channel input
L-OUT	3	Left channel output
V <sub>SS</sub>	4	Ground
SDA	5	I <sup>2</sup> C data input
SCL	6	I <sup>2</sup> C clock input
V <sub>DD</sub>	7	Positive supply voltage
R-OUT	8	Right channel output
R-IN	9	Right channel input
V <sub>REF</sub>	10	Reference voltage = 1/2V <sub>DD</sub>



- Note: 1. Pin 1 is set to Lo or open , the address code is 88H (10001000B).  
 2. Pin 1 is set to Hi , the address code is 8CH (10001100B).  
 3. The V<sub>REF</sub> connects a capacitor to V<sub>SS</sub>.

## BLOCK DIAGRAM



## ORDERING INFORMATION

Package	Part number	Packaging Marking	Transport Media
10-Pin MSOP	MS6260MTR	6260	3.5k Units Tape and Reel
10-Pin MSOP	MS6260MU	6260	80 Units Tube
10-Pin MSOP (lead free)	MS6260MGTR	6260G	3.5k Units Tape and Reel
10-Pin MSOP (lead free)	MS6260MGU	6260G	80 Units Tube

## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Rating	Unit
V <sub>DD</sub>	Supply Voltage	6	V
V <sub>ESD</sub>	Electrostatic Handling	-4500 to 4500	V
T <sub>STG</sub>	Storage Temperature Range	-65 to 150	°C
T <sub>A</sub>	Operating Ambient Temperature Range	-40 to 85	°C
T <sub>J</sub>	Maximum Junction Temperature	150	°C
T <sub>S</sub>	Soldering Temperature, 10 seconds	260	°C
R <sub>THJA</sub>	Thermal Resistance from Junction to Ambient in Free Air MSOP10	194	°C/W

## OPERATING RATINGS

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>DD</sub>	Supply Voltage	2.7	-	5.5	V

## 5V ELECTRICAL CHARACTERISTICS

( $V_{DD}=5.0V$ ,  $V_{SS}=0V$ , Attenuation=0dB, Gain=0dB,  $f=1kHz$ ,  $V_O=0dBV$ ,  $V_{REF}$  Cap=10uF; unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>DC Characteristics</b>						
$I_Q$	Quiescent current		-	3.8	4.2	mA
$A_{GA}$	Gain/Attenuation	Max gain	-	15	-	dB
		Max attenuation	-	-79	-	dB
$A_{STEP}$	Gain/Attenuation step		-	1	-	dB
$E_{GA}$	Gain/Attenuation step error		-	0.3	-	dB
$E_{IGA}$	Interchannel gin/attenuation error		-	0.3	-	dB
CS	Channel separation		95	105	-	dB
PSRR	Power supply rejection ratio	Vripple = -20dBV, 100Hz	-	53	-	dB
MUTE	Mute Attenuation	Vin=0dBV	-	85	-	dB
Rin	Input Impedance		18	20	-	k $\Omega$
Rout	Output Impedance		-	50	100	$\Omega$
<b>AC Characteristics</b>						
$V_o$	Maximum output voltage swing	(THD+N)/S < 0.1%	-	4.8	-	Vpp
THD+N	Total harmonic distortion plus noise		-	-69	-64	dB
S/N	Signal-to-noise ratio	$V_O=4.5V_{pp}$	95	100	-	dB
<b>Bus Characteristics</b>						
$V_{IH}$	Bus high input level		-	-	$0.7V_{DD}$	V
$V_{IL}$	Bus low input level		$0.3V_{DD}$	-	-	V

## 3.3V ELECTRICAL CHARACTERISTICS

( $V_{DD}=3.3V$ ,  $V_{SS}=0V$ , Attenuation=0dB, Gain=0dB,  $f=1kHz$ ,  $V_O=-3dBV$ ,  $V_{REF}$  Cap=10uF; unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>DC Characteristics</b>						
$I_Q$	Quiescent current		-	3.7	4.1	mA
CS	Channel separation		90	100	-	dB
PSRR	Power supply rejection ratio	Vripple = -20dBV, 100Hz	-	52	-	dB
MUTE	Mute Attenuation	Vin=-3dBV	-	80	-	dB
<b>AC Characteristics</b>						
$V_o$	Maximum output voltage swing	(THD+N)/S < 0.1%	-	3	-	Vpp
THD+N	Total harmonic distortion plus noise		-	-69	-64	dB
S/N	Signal-to-noise ratio		85	90	-	dB

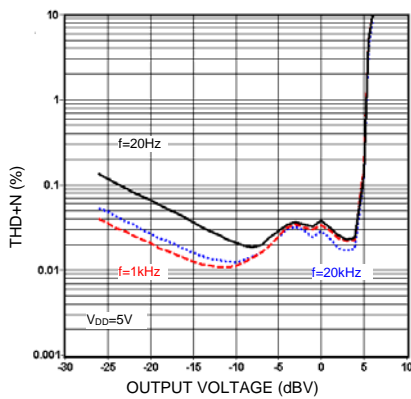
## 2.7V ELECTRICAL CHARACTERISTICS

( $V_{DD}=2.7V$ ,  $V_{SS}=0V$ , Attenuation=0dB, Gain=0dB,  $f=1kHz$ ,  $V_O=-3dBV$ ,  $V_{REF}$  Cap=10uF; unless otherwise specified)

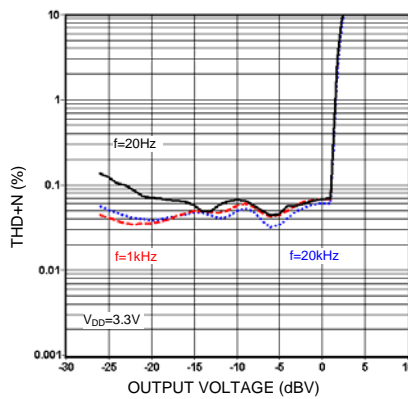
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>DC Characteristics</b>						
$I_Q$	Quiescent current		-	3.2	3.6	mA
CS	Channel separation		90	100	-	dB
PSRR	Power supply rejection ratio	Vripple = -20dBV, 100Hz	-	50	-	dB
MUTE	Mute Attenuation	Vin=-3dBV	-	80	-	dB
<b>AC Characteristics</b>						
$V_o$	Maximum output voltage swing	(THD+N)/S < 0.3%	-	2	-	V <sub>pp</sub>
THD+N	Total harmonic distortion plus noise		-	-69	-64	dB
S/N	Signal-to-noise ratio		85	90	-	dB

## TYPICAL PERFORMANCE CHARACTERISTICS

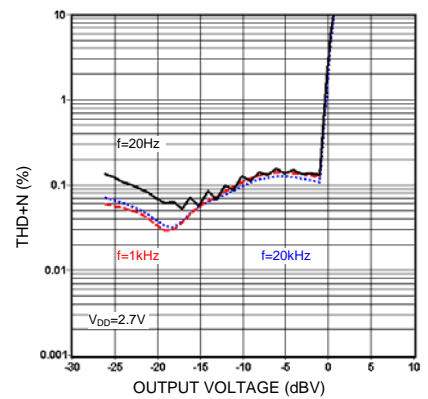
( $T_a=25^\circ C$ ,  $R_L=10k\Omega$ ,  $V_{REF}$  Cap=10uF; unless otherwise specified)



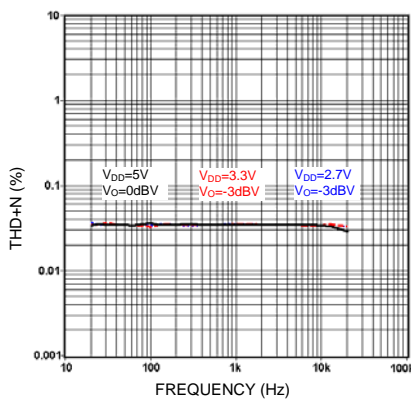
THD+N vs. output voltage



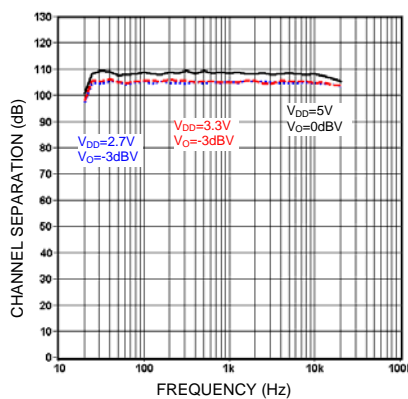
THD+N vs. output voltage



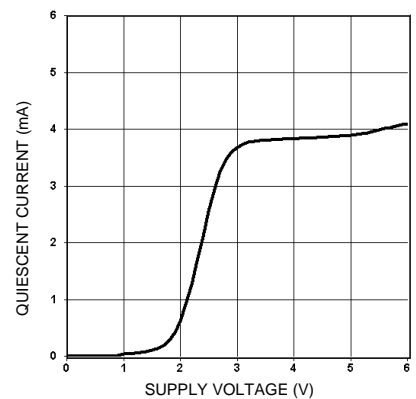
THD+N vs. output voltage



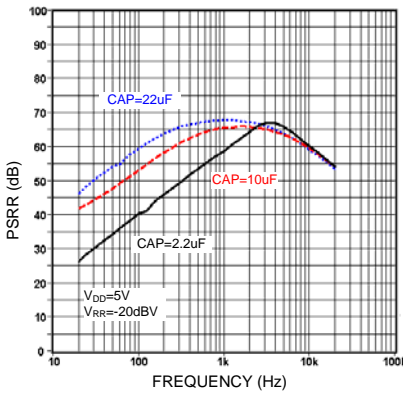
THD+N vs. frequency



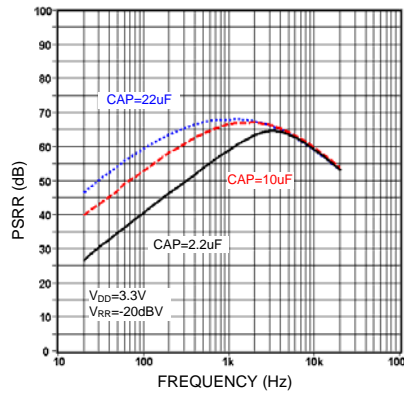
Channel separation vs. frequency



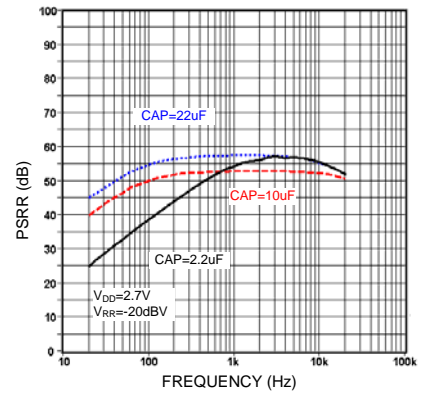
Quiescent current vs. supply voltage



PSRR vs. frequency



PSRR vs. frequency

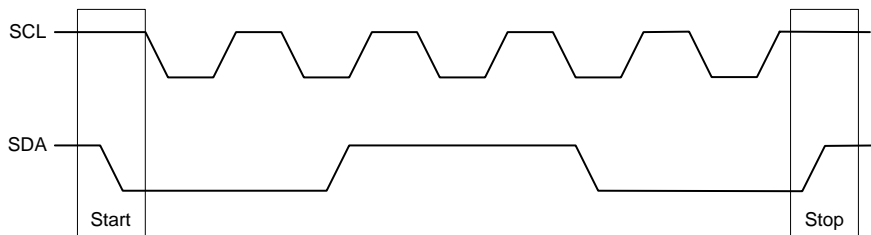


PSRR vs. frequency

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

### Start and stop conditions

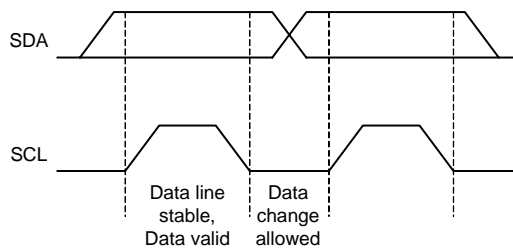
A start condition is activated when the SCL is set to HIGH and SDA shifts from HIGH to LOW state. The stop condition is activated when SCL is set to HIGH and SDA shifts from LOW to HIGH state. Please refer to the timing diagram below.



SCL : Serial Clock Line, SDA : Serial Data Line

### Data validity

A data on the SDA line is considered valid and stable only when the SCL signal is in HIGH state. The HIGH and LOW states of the SDA line can only change when the SCL signal is LOW. Please refer to the figure below.

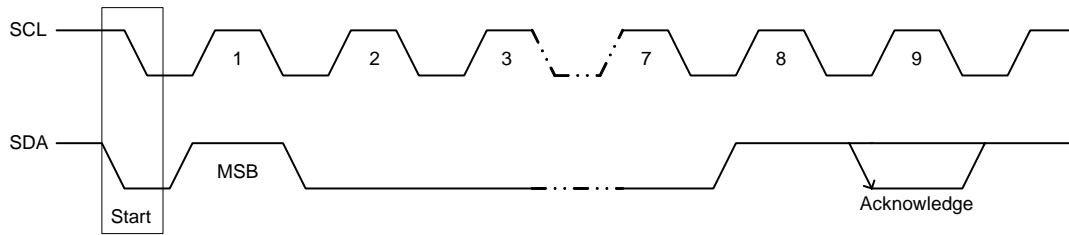


### Byte format

Every byte transmitted to the SDA line consists of 8 bits. Each byte must be followed by an acknowledge bit. The MSB is transmitted first.

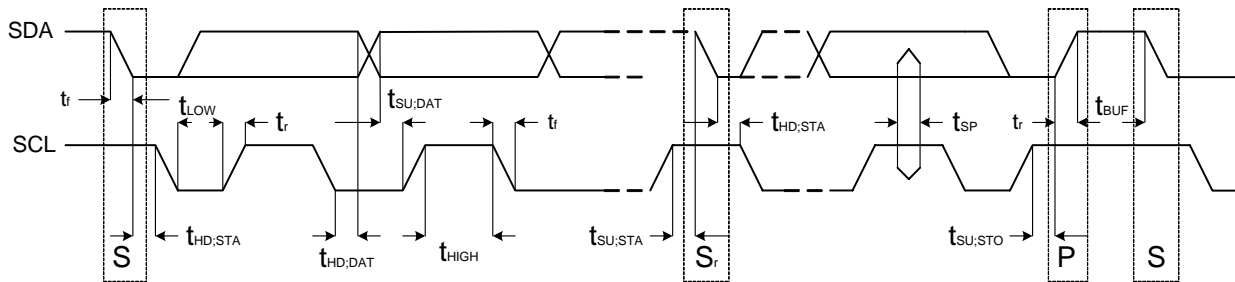
## Acknowledge

During the Acknowledge clock pulse, the master (up) put a resistive HIGH level on the SDA line. The peripheral (audio processor) that acknowledges has to pull-down (LOW) the SDA line during the Acknowledge clock pulse so that the SDA line is in a stable LOW state during this clock pulse. Please refer to the diagram below.



The audio processor that has been addressed has to generate an Acknowledge after receiving each byte, otherwise, the SDA line will remain at the HIGH level during the ninth (9<sup>th</sup>) clock pulse. In this case, the master transmitter can generate the STOP information in order to abort the transfer.

## Timing of SDA and SCL bus lines

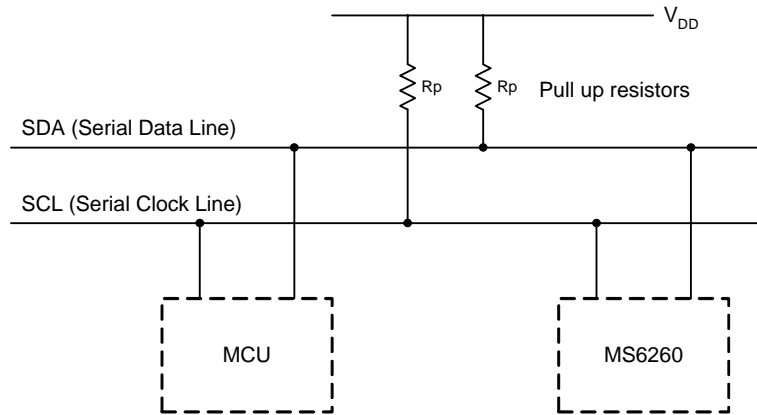


## Standard mode

Symbol	Parameter	Min	Max	Unit
$f_{SCL}$	SCL clock frequency	0	100	kHz
$t_{HD:STA}$	Hold time (repeated) START condition. After this period, the first clock pulse is generated	4.0	-	us
$t_{LOW}$	LOW period of the SCL clock	4.7	-	us
$t_{HIGH}$	HIGH period of the SCL clock	4.0	-	us
$t_{SU:STA}$	Set-up time for a repeated START condition	4.7	-	us
$t_{HD:DAT}$	Data hold time: For I <sup>2</sup> C-bus devices	0	3.45	us
$t_{SU:DAT}$	Data-set-up time	250	-	ns
$t_r$	Rise time of both SDA and SCL signals	-	1000	ns
$t_f$	Fall time of both SDA and SCL signals	-	300	ns
$t_{SU:STO}$	Set-up time for STOP condition	4.0	-	us
$t_{BUF}$	Bus free time between a STOP and START condition	4.7	-	us
$C_b$	Capacitive load for each bus line	-	400	pF
$V_{nL}$	Noise margin at the LOW level for each connected device (including hysteresis)	$0.1V_{DD}$	-	V
$V_{nH}$	Noise margin at the HIGH level for each connected device (including hysteresis)	$0.2V_{DD}$	-	V

## BUS INTERFACE

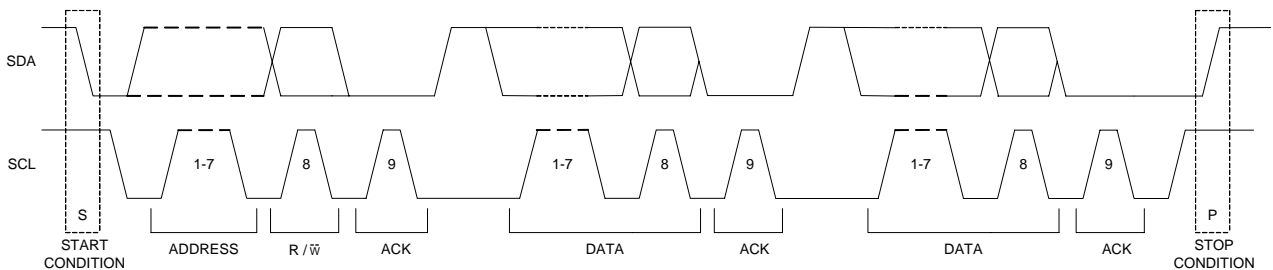
Data are transmitted to and from the MCU to the MS6260 via the SDA and SCL. The SDA and SCL make up the BUS interface. It should be noted that pull-up resistors must be connected to the positive supply voltage.



### Interface protocol

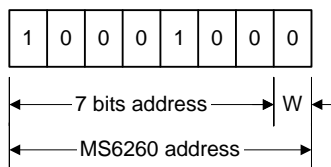
The format consists of the following

- A START condition
- A chip address byte including the MS6260 address. (7bits)
- The 8<sup>th</sup> bit of the byte must be "0".(write=0, read=1)
- The MS6260 must always acknowledge the end of each transmitted byte.
- A data sequence (N-bytes + Acknowledge)
- A STOP condition

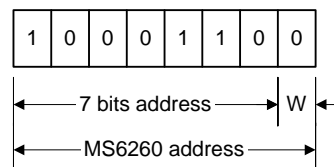


### Protocol Address

**Pin1(A.O.) = Low or Open**



**Pin1(A.O.) = High**



**Data bytes description**

Function bits								
MSB				LSB				Function
1	1	1	1	1	1	1	1	Function off (-79dB)
1	1	0	1	A3	A2	A1	A0	2-channel, -1dB/step
1	1	1	0	0	B2	B1	B0	2-channel, -10dB/step
1	0	1	0	A3	A2	A1	A0	Left channel, -1dB/step
1	0	1	1	0	B2	B1	B0	Left channel, -10dB/step
0	0	1	0	A3	A2	A1	A0	Right channel, -1dB/step
0	0	1	1	0	B2	B1	B0	Right channel, -10dB/step
1	1	0	0	C3	C2	C1	C0	2-channel, +1dB/step
0	1	1	0	C3	C2	C1	C0	Left channel, +1dB/step
0	1	0	1	C3	C2	C1	C0	Right channel, +1dB/step
0	1	1	1	0	0	0	1	Power off preparation (pop noise free)
				1	0	0	1	2-channel, mute On
				1	0	0	0	2-channel, mute Off

Gain / Attenuation bits						
A3	A2	A1	A0	Gain / Attenuation value (dB)		
-	B2	B1	B0	A	B	C
C3	C2	C1	C0			
0	0	0	0	0	0	0
0	0	0	1	-1	-10	+1
0	0	1	0	-2	-20	+2
0	0	1	1	-3	-30	+3
0	1	0	0	-4	-40	+4
0	1	0	1	-5	-50	+5
0	1	1	0	-6	-60	+6
0	1	1	1	-7	-70	+7
1	0	0	0	-8	-	+8
1	0	0	1	-9	-	+9
1	0	1	0	-	-	+10
1	0	1	1	-	-	+11
1	1	0	0	-	-	+12
1	1	0	1	-	-	+13
1	1	1	0	-	-	+14
1	1	1	1	-	-	+15

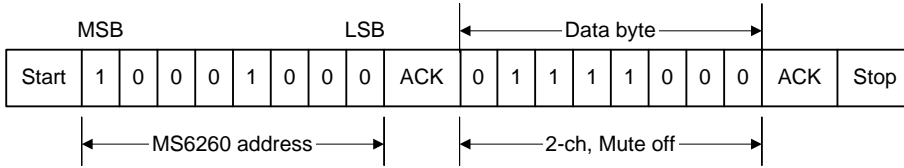
1. Where Ax=-1dB/step, Bx=-10dB/step, Cx=+1dB/step
2. The function of power off preparation is to prevent pop noise when power off.
3. The initial condition is set to be maximum attenuation -79dB and mute on mode when power on.



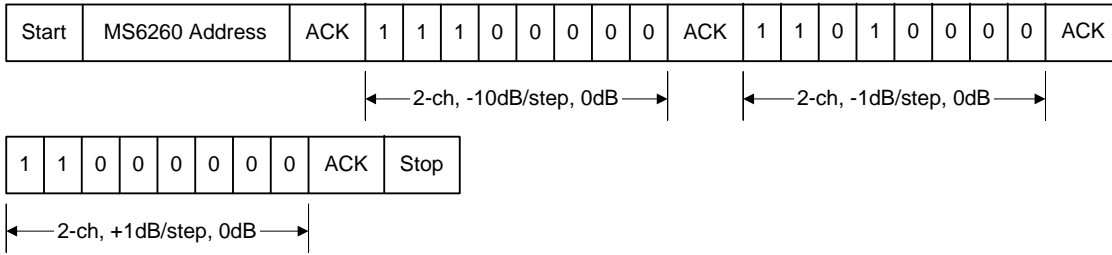
### Example

#### Mute off

The initial condition is  $-79\text{dB}$  and mute on when power on. The first command must disable the mute function.

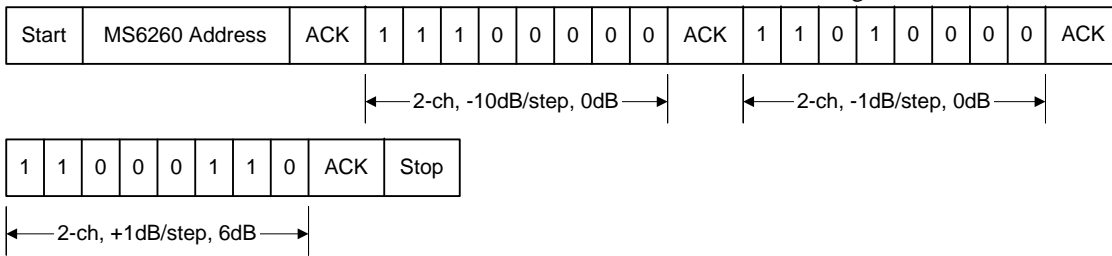


#### Set gain of 2 channel at 0dB



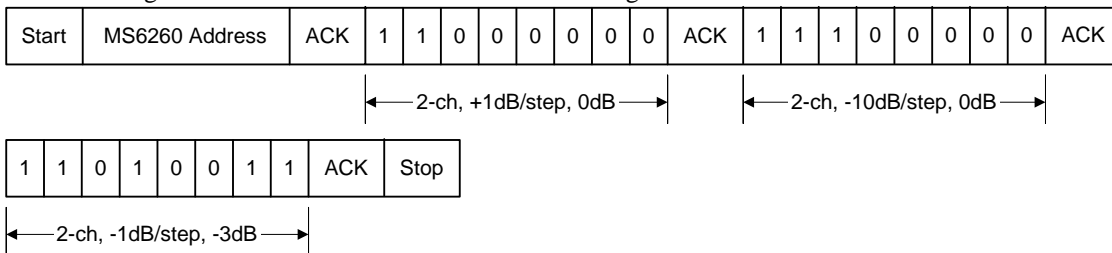
#### Set gain of 2 channel at 6dB

The value of attenuation must be set zero when the volume from attenuation to gain.

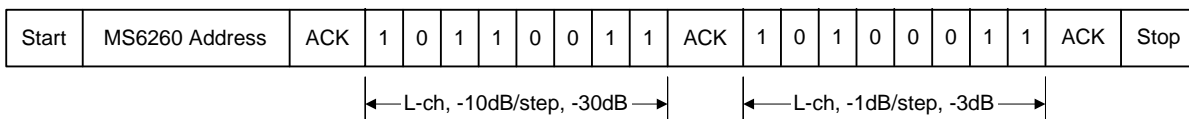


#### Set gain of 2 channel at -3dB

The value of gain must be set zero when the volume from gain to attenuation.

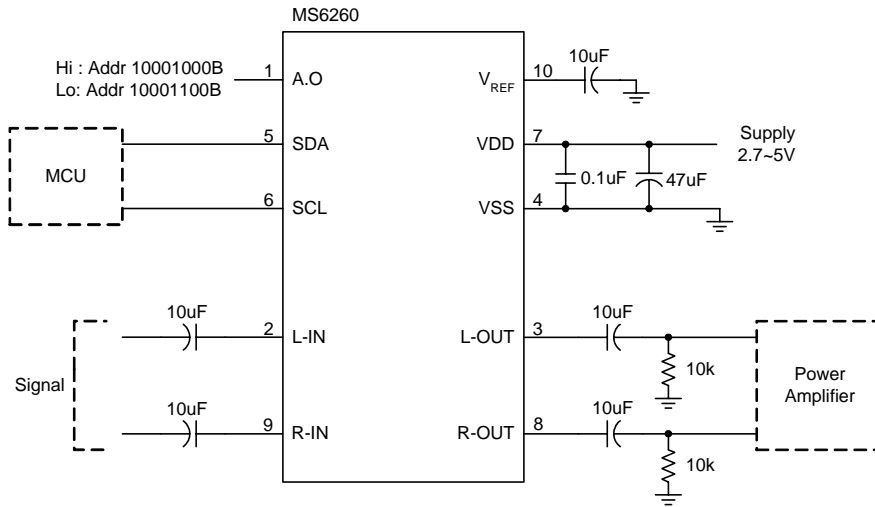


#### Set attenuation of left channel at $-33\text{dB}$

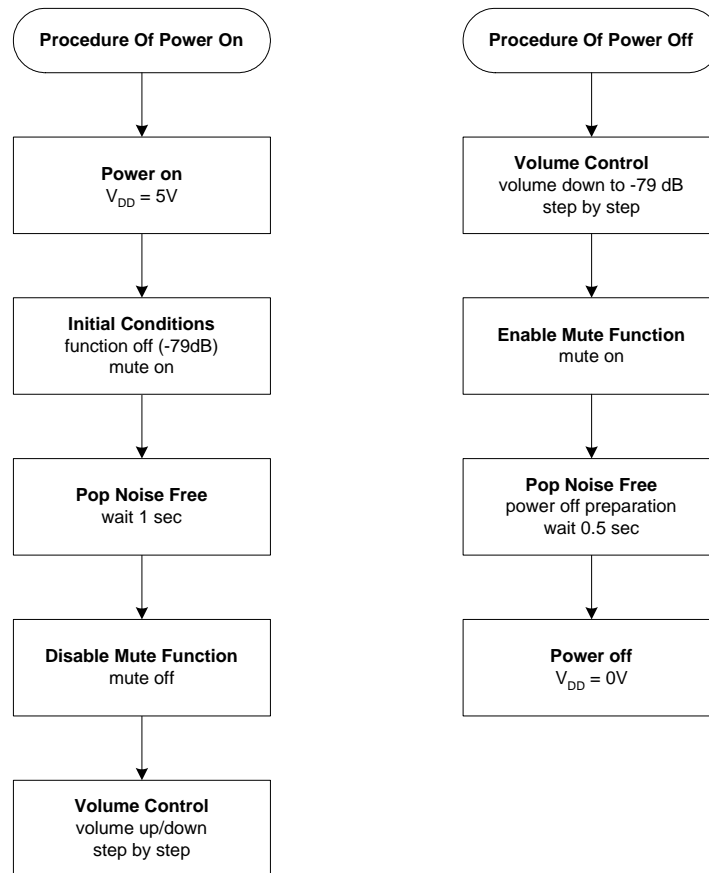


## APPLICATION INFORMATION

### Basic application example



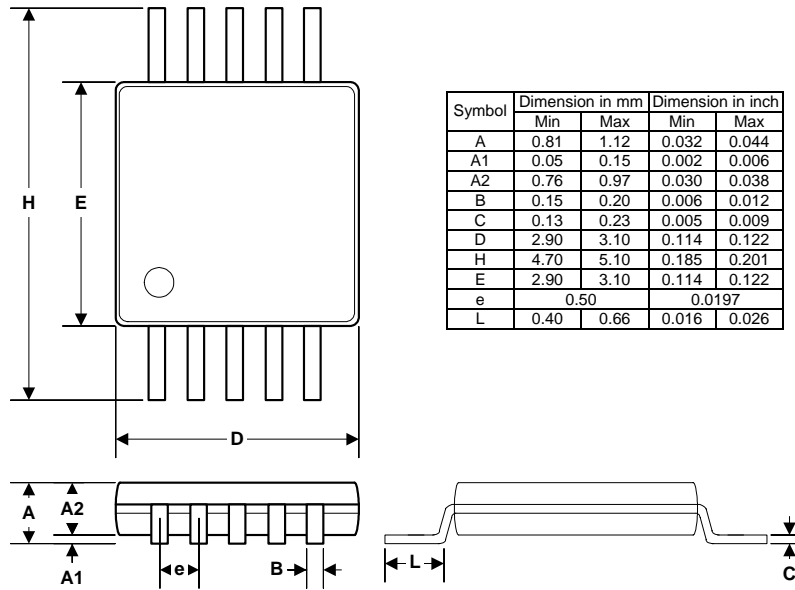
### Basic application flow chart



1. The initial condition is  $-79\text{dB}$  and mute on when power up.
2. In order to prevent pop noise when power on, please wait 1 sec to transmit I<sup>2</sup>C command.

## EXTERNAL DIMENSIONS

MSOP10 package



## TAPE AND REEL (Unit : mm)

