3 Stereo Inputs (1 differential Input) With Gain 0~+15dB Volume Controller -79dB~+15dB With Soft Step Class AB Headphone Driver, Low voltage

FEATURES

- Operation range: 2.5V~6.5V.
- One quasi-differential input.
- Soft step volume control：-79dB ~ +15dB.
- Input Gain: 0dB ~ +15dB.
- Low power consumption.
- Good PSRR and low pop noise.
- I^2C interface.
- Housed in 16 pin SSOP packages.

APPLICATIONS

- Multimedia system
- Hi-Fi audio system.
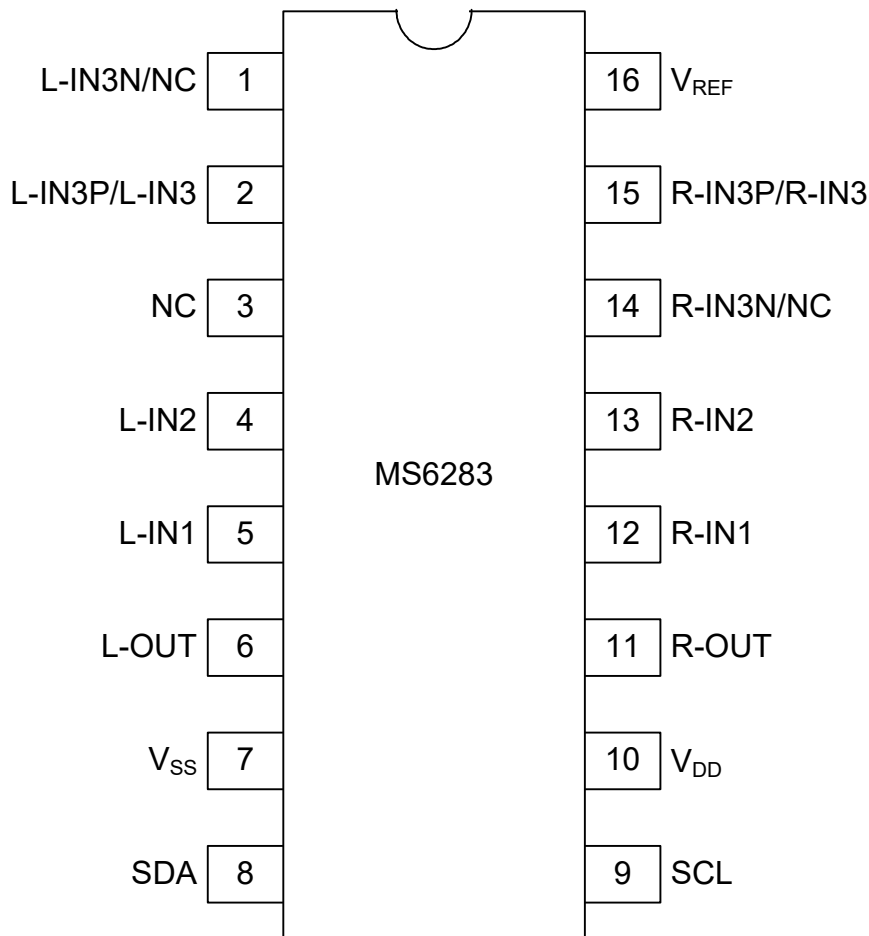- Bluetooth.
- DAB

DESCRIPTION

The MS6283 is a class AB headphone drivers with audio volume controller. The MS6283 have 3 sets of stereo input(1 differential Input), soft step control with programmable blend times. It uses CMOS technology specially for the low voltage application with low noise, rail-to-rail output.
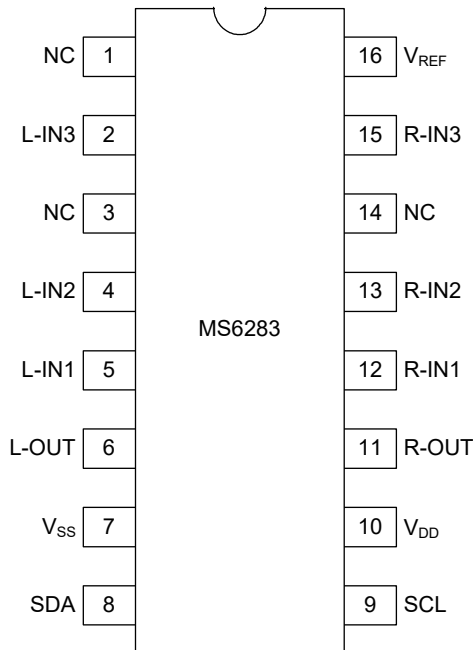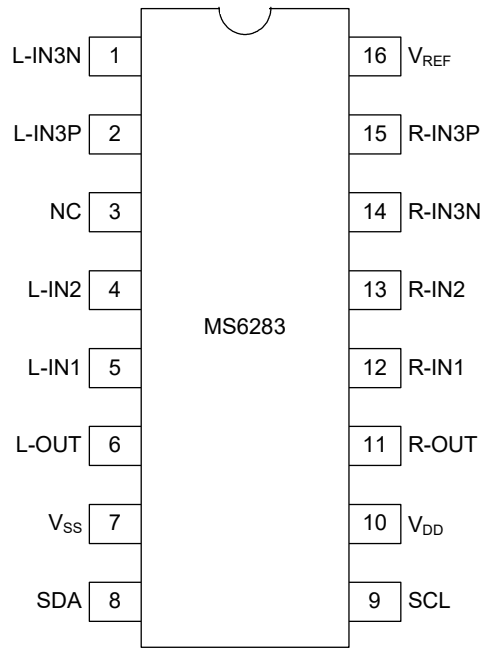
BLOCK DIAGRAM
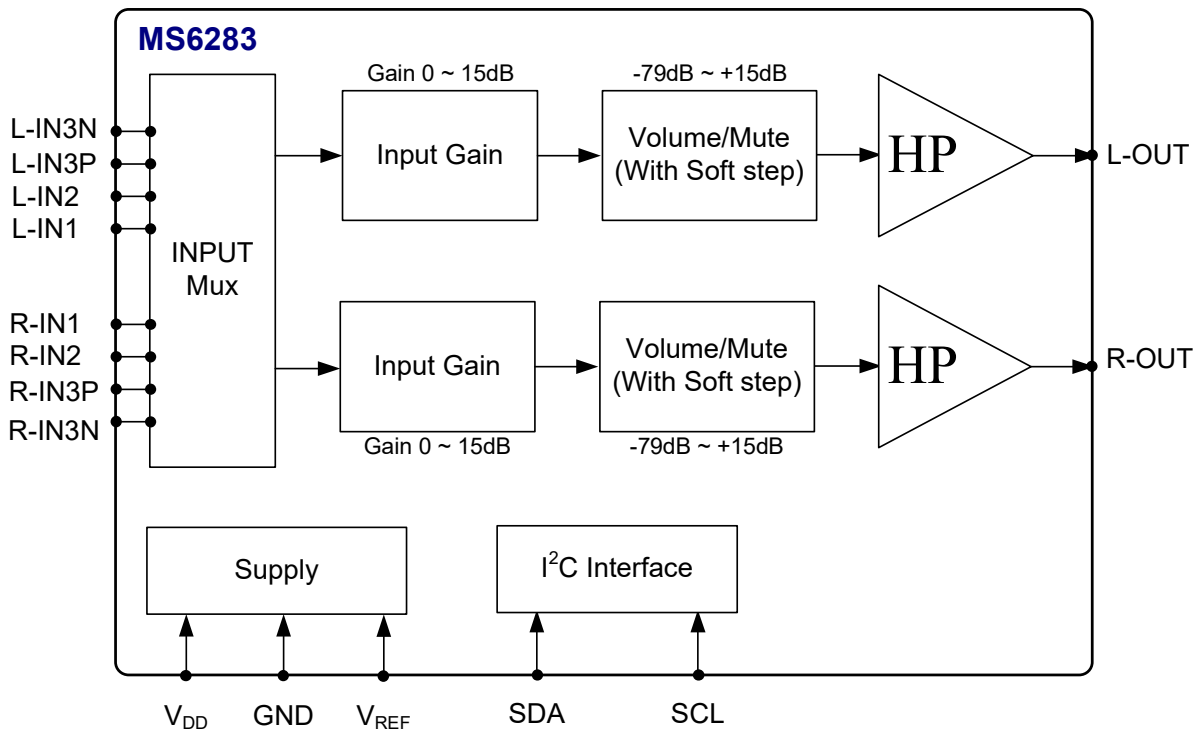
PIN CONFIGURATION

Symbol	Pin	Description
L-IN3N/NC	1	Negative Input For 3rd Left Channel(Differential) / No Connected(Single End)
L-IN3P/L-IN3	2	Positive Input For 3rd Left Channel(Differential) / 3rd Left Channel Input
NC	3	No Connected
L-IN2	4	2nd Left Channel Input
L-IN1	5	1st Left Channel Input
L-OUT	6	Left Channel Output
V$_{SS}$	7	Ground
SDA	8	I^{2}C Data Input
SCL	9	I^{2}C Clock Input
V$_{DD}$	10	Positive Supply Voltage
R-OUT	11	Right Channel Output
R-IN1	12	1st Right Channel Input
R-IN2	13	2nd Right Channel Input
R-IN3N/NC	14	Negative Input For 3rd Right Channel(Differential) / No Connected(Single End)
R-IN3P/R-IN3	15	Positive Input For 3rd Right Channel(Differential) / 3rd Right Channel Input
V$_{REF}$	16	Reference Voltage = 1/2V$_{DD}$

```
L-IN3N/NC      1                    16    V_REF

L-IN3P/L-IN3   2                    15    R-IN3P/R-IN3

NC             3                    14    R-IN3N/NC

L-IN2          4                    13    R-IN2

L-IN1          5      MS6283        12    R-IN1

L-OUT          6                    11    R-OUT

V_SS           7                    10    V_DD

SDA            8                     9    SCL
```

NC	1		16	V_{REF}
L-IN3	2		15	R-IN3
NC	3		14	NC
L-IN2	4	MS6283	13	R-IN2
L-IN1	5		12	R-IN1
L-OUT	6		11	R-OUT
V_{SS}	7		10	V_{DD}
SDA	8		9	SCL

I2C selects SE mode

L-IN3N	1		16	V_{REF}
L-IN3P	2		15	R-IN3P
NC	3		14	R-IN3N
L-IN2	4	MS6283	13	R-IN2
L-IN1	5		12	R-IN1
L-OUT	6		11	R-OUT
V_{SS}	7		10	V_{DD}
SDA	8		9	SCL

I2C selects Differential Mode

ORDERING INFORMATION

Package	Part number	Packaging Marking	Transport Media
16-Pin SSOP (lead free)	MS6283SSGTR	MS6283G	2.5k Units Tape and Reel
16-Pin SSOP (lead free)	MS6283SSGU	MS6283G	100 Units Tube

RoHS Compliance

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Rating	Unit
V_{DD}	Supply Voltage	6.5	V
V_{ESD}	Electrostatic Handling	-3000 to 3000	V
T_{STG}	Storage Temperature Range	-65 to 150	℃
T_A	Operating Ambient Temperature Range	-40 to 85	℃
T_J	Maximum Junction Temperature	120	℃
T_S	Soldering Temperature, 10 seconds	260	℃
R_{THJA}	Thermal Resistance from Junction to Ambient in Free Air SSOP16	210	℃/W

OPERATING RATINGS

Symbol	Parameter	Min	Typ	Max	Unit
V_{DD}	Supply Voltage	2.5	-	6.5	V

5V ELECTRICAL CHARACTERISTICS

(Ta=25℃;V_{DD}=5V, V_{SS}=0V; C_{REF} = 1uF ; R_L=32 Ω ; refer to the application circuit; unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply						
I_Q	Quiescent Current	V_{IN}=0V	-	6	-	mA
I_{PD}	Power down current	V_{IN}=0V	-	130	-	uA
PSRR	Power Supply Rejection Ratio	f = 100Hz	55	58	-	dB
Input Selectors						
R_{IN}	Input Resistance	Input 1,2,3		100		kΩ
$R_{IN\text{-}Diff}$	Input Resistance	Differential		100		kΩ
G_{IN}	Input Gain Range	Gain	0	-	15	dB
G_{STEP}	Step Resolution		-	1	-	dB
ERR_G	Gain Setting error		-0.2	0	0.2	dB
CMRR	Common mode rejection ratio	VCM = 1Vrms @ 1KHz	40	55	-	dB
		VCM = 1Vrms @ 10KHz	40	55	-	dB
Volume control						
CR_{VOL}	Volume Control Range	Attenuation & Gain	-79	-	+15	dB
RES_{VOL}	Volume Step Resolution		-	1	-	dB
ERR_{VOL}	Volume Setting Error	Av = +15 to -40dB	-0.5	0	1	dB
		Av = -40 to -79dB	-1	0	5	dB
MUTE	Mute Attenuation	Vin=0dBV		-90		dB
General						
VO_{MAX}	Maximum Output Voltage Swing	(THD+N)/S <0.1%	-	1.45	-	Vrms
THD+N	Total Harmonic Distortion Plus Noise	V_{OUT} = 1Vrms	-	-64	-	dB
			-	0.063	-	%
S/N	Signal-to-Noise Ratio	V_{OUT} = 1Vrms	-	93	-	dB
CS	Channel Separation		90	95	-	dB
Bus Input						
V_{IH}	Bus High Input Level		1.8	-	-	V
V_{IL}	Bus Low Input Level		-	-	0.8	V

3.3V ELECTRICAL CHARACTERISTICS

(Ta=25℃;V_{DD}=3.3V, V_{SS}=0V; C_{REF} = 1uF ; R_L=32 Ω ; refer to the application circuit; unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply						
I_Q	Quiescent Current	V_{IN}=0V	-	5.4	-	mA
I_{PD}	Power down current	V_{IN}=0V	-	82	-	uA
PSRR	Power Supply Rejection Ratio	f = 100Hz	65	70	-	dB
General						
V_{OMAX}	Maximum Output Voltage Swing	(THD+N)/S <0.1%	-	1	-	Vrms
THD+N	Total Harmonic Distortion Plus Noise	V_{OUT} = 0.707Vrms	-	-65	-	dB
			-	0.056	-	%
S/N	Signal-to-Noise Ratio	V_{OUT} = 0.707Vrms	-	90	-	dB
CS	Channel Separation Left/Right		90	93	-	dB

2.5V ELECTRICAL CHARACTERISTICS

(Ta=25℃ ;V_{DD}=2.5V, V_{SS}=0V; C_{REF} = 1uF ; R_L=32 Ω ; refer to the application circuit; unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply						
I_Q	Quiescent Current	V_{IN}=0V	-	4.6	-	mA
I_{PD}	Power down current	V_{IN}=0V	-	60	-	uA
PSRR	Power Supply Rejection Ratio	f = 100Hz	60	65	-	dB
General						
VO_{MAX}	Maximum Output Voltage Swing	(THD+N)/S <0.1%	-	0.707	-	Vrms
THD+N	Total Harmonic Distortion Plus Noise	V_{OUT} = 0.707Vrms	-	-65	-	dB
			-	0.056	-	%
S/N	Signal-to-Noise Ratio	V_{OUT} = 0.707Vrms	-	90	-	dB
CS	Channel Separation Left/Right		90	93	-	dB

TYPICAL PERFORMANCE CHARACTERISTICS

(Ta=25℃ ; C_{REF} = 1uF,10uF; R_L=32 Ω ; refer to the application circuit; unless otherwise specified)
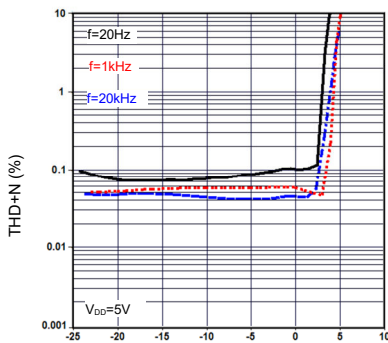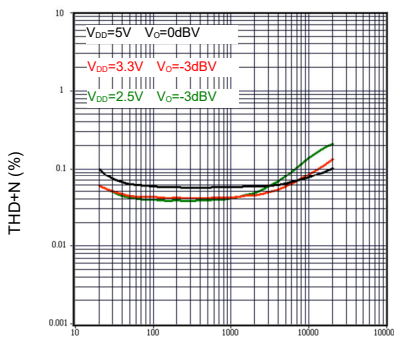

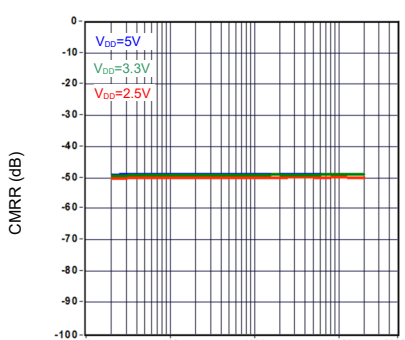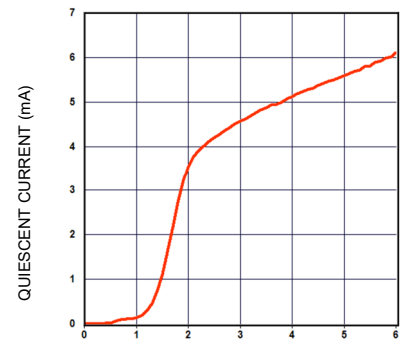**THD+N vs. output voltage**
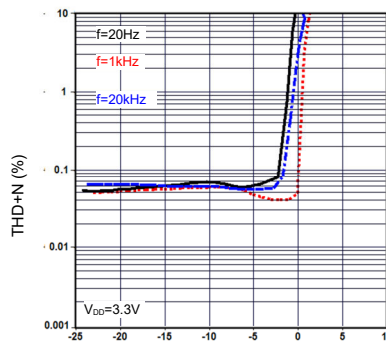
THD+N vs. output voltage
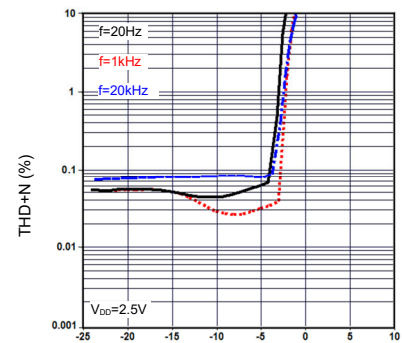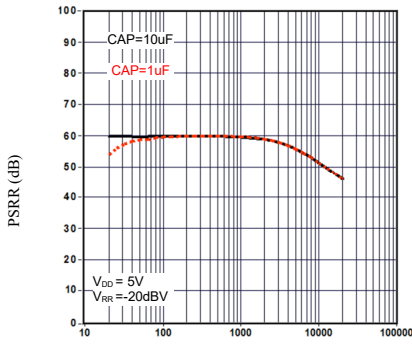

THD+N vs. output voltage
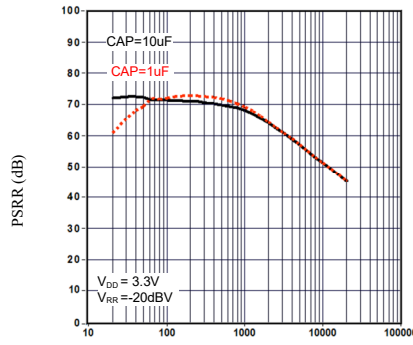

THD+N vs. frequency
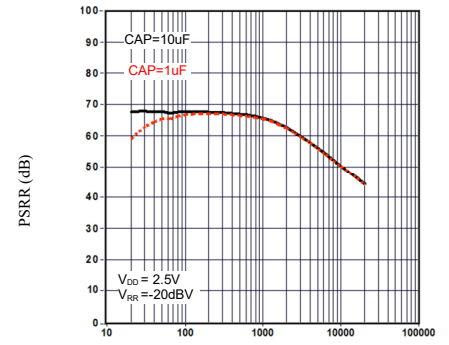

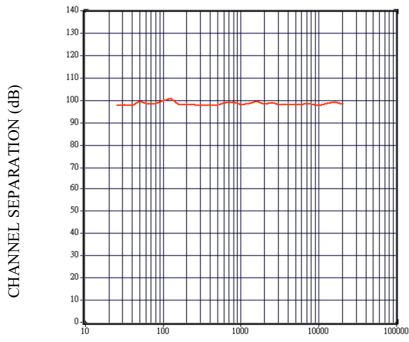**CMRR vs. frequency**

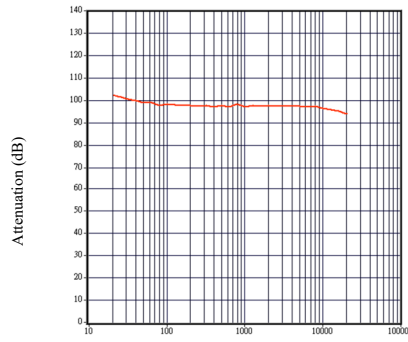**Quiescent current vs. supply voltage**

PSRR vs. frequency

PSRR vs. frequency

PSRR vs. frequency

Channel separation vs. frequency

Mute vs. frequency

I²C 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.
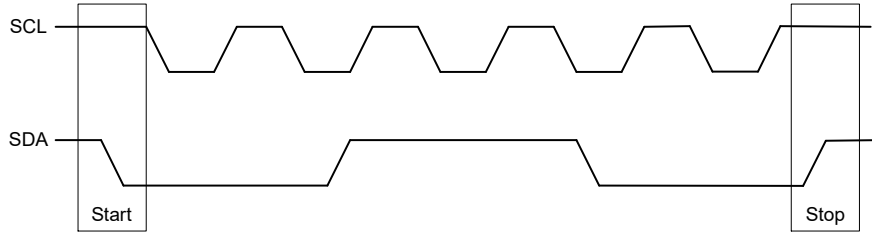
SCL : Serial Clock Line, SDA : Serial Data Line

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.
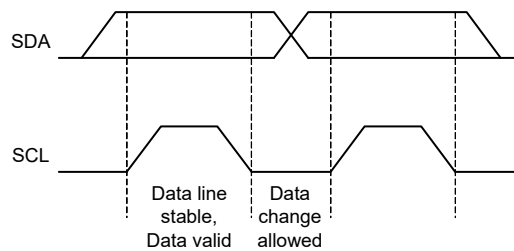
Byte format

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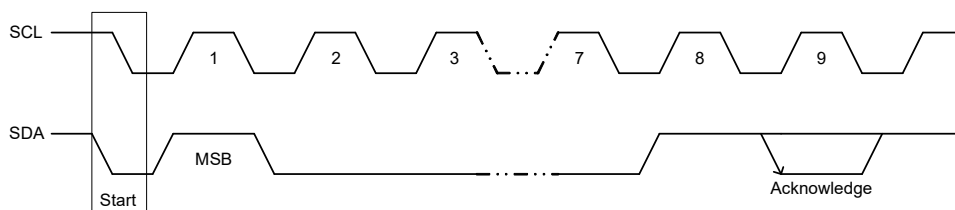
The audio processor that has been addressed has to generate an Acknowledge after receiving each byte, otherwise, the SDA line will remain at the HIGH level during the ninth (9th) clock pulse. In this case, the master transmitter can generate the STOP information in order to abort the transfer.

BUS INTERFACE

Data are transmitted to and from the MCU to the MS6283 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.
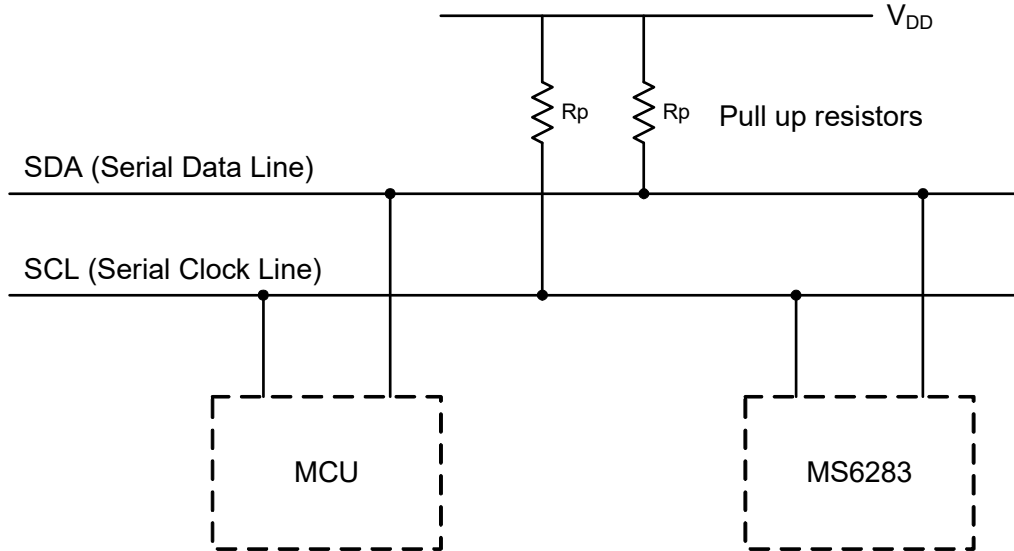
Interface protocol

The format consists of the following
 ・A START condition
 ・A chip address byte including the MS6283 address. (7bits)
 ・The 8th bit of the byte must be "0".
 ・The MS6283 must always acknowledge the end of each transmitted byte.
 ・A data sequence (N-bytes + Acknowledge)
 ・A STOP condition

Start	1	0	0	0	1	0	0	0	ACK	Sub Address	ACK	Data	ACK	STOP

MSB ... LSB
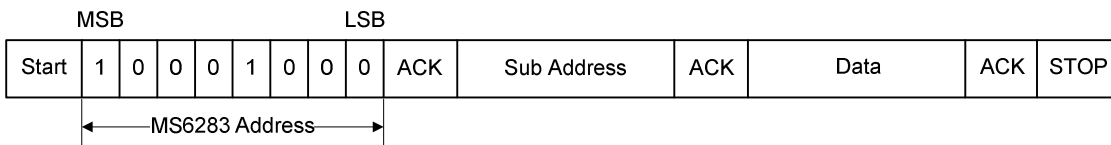
←——MS6283 Address——→

Chip Address

The chip address of the MS6283 is 88H.

1	0	0	0	1	0	0	0

←——MS6283 address——→
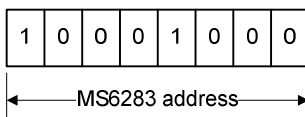
SubAddress

MSB							LSB	Function
A7	A6	A5	A4	A3	A2	A1	A0	
0	0	0	0	0	0	0	0	Soft-step time / ON/OFF , SE/DIFF Selector
0	0	0	0	0	0	0	1	L-channel, Input selector / Input Gain Control
0	0	0	0	0	0	1	0	R-channel, Input selector / Input Gain Control
0	0	0	0	0	0	1	1	2-channel, Input selector / Input Gain Control
0	0	0	0	0	1	0	0	L-channel, Volume Control
0	0	0	0	0	1	0	1	R-channel, Volume Control
0	0	0	0	0	1	1	0	2-channel, Volume Control
0	0	0	0	0	1	1	1	Power management

Soft-step time / ON / OFF , SE/DIFF Selector (0H)

MSB							LSB	Function
D7	D6	D5	D4	D3	D2	D1	D0	
								Soft-step Time
					0	0	0	0.64ms
					0	0	1	1.28ms
					0	1	0	2.56ms
					0	1	1	5.12ms
					1	0	0	10.24ms
					1	0	1	20.48ms
					1	1	0	40.96ms
					1	1	1	81.92ms
								Soft-step
				0				On
				1				Off
								SE/DIFF
0								Differential
1								Single-ended

The initial condition is Single-ended, Soft-step Off, Soft-step time 40.96ms.

Input selector & Gain Control (01H , 02H , 03H)

MSB							LSB	Function
D7	D6	D5	D4	D3	D2	D1	D0	
								Input selector
		0	0					IN 1
		0	1					IN 2
		1	0					Grouded
		1	1					IN 3 / DIFF
								Input Gain
				0	0	0	0	0dB
				0	0	0	1	1dB
				0	0	1	0	2dB
				0	0	1	1	3dB
				0	1	0	0	4dB
				0	1	0	1	5dB
				0	1	1	0	6dB
				0	1	1	1	7dB
				1	0	0	0	8dB
				1	0	0	1	9dB
				1	0	1	0	10dB
				1	0	1	1	11dB
				1	1	0	0	12dB
				1	1	0	1	13dB
				1	1	1	0	14dB
				1	1	1	1	15dB

The initial condition is IN3, 14dB. We suggest the gain is set as the power is up. For example, set and fix the gain +10dB, the volume range will be controlled from -69dB to +25dB.

Volume Control (04H , 05H , 06H)

MSB							LSB	Function
D7	D6	D5	D4	D3	D2	D1	D0	
	0	0	0	1	1	1	1	＋15dB
	0	0	0	1	1	1	0	＋14dB
	:	:	:	:	:	:	:	:
	0	0	0	0	0	0	0	0dB
	0	0	1	0	0	0	0	0dB
	0	0	1	0	0	0	1	－ 1dB
	:	:	:	:	:	:	:	:
	0	0	1	1	1	1	1	－15dB
	0	1	0	0	0	0	0	－16dB
	:	:	:	:	:	:	:	:
	0	1	0	1	1	1	1	－31dB
	0	1	1	0	0	0	0	－32dB
	:	:	:	:	:	:	:	:
	0	1	1	1	1	1	1	－47dB
	1	0	0	0	0	0	0	－48dB
	:	:	:	:	:	:	:	:
	1	0	0	1	1	1	1	－63dB
	1	0	1	0	0	0	0	－64dB
	:	:	:	:	:	:	:	:
	1	0	1	1	1	1	1	－79dB
	1	1	X	X	X	X	X	Mute

The initial condition is Mute.

Power management (07H)

MSB							LSB	Function
D7	D6	D5	D4	D3	D2	D1	D0	
							0	Release of V_{REF} to GND.
							1	Set the voltage of V_{REF} to $V_{DD}/2$.
					0	X		All devices Active
					1	1		Power down

The initial condition is Power down , V_{REF} = GND.

Example

Soft-step Time 10.24ms , Soft-step ON , Single-ended Mode.

	MSB				LSB					Data byte									Data byte								
Start	1	0	0	0	1	0	0	0	ACK	0	0	0	0	0	0	0	0	ACK	1	0	0	0	0	1	0	0	ACK	Stop

← MS6283 address → ← SubAddress → Soft-step Time 10.24ms / Soft-step ON / Single-ended Mode

Set the $1/2V_{DD}$, All device active.

	MSB				LSB					Data byte									Data byte								
Start	1	0	0	0	1	0	0	0	ACK	0	0	0	0	0	1	1	1	ACK	0	0	0	0	0	0	0	1	ACK	Stop
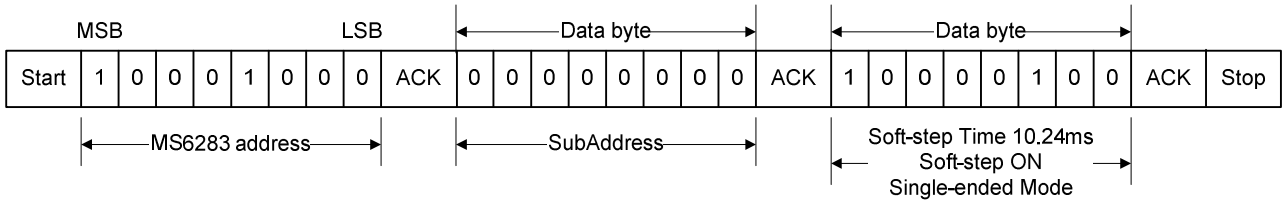
← MS6283 address → ← SubAddress → Set the $1/2V_{DD}$ / All device active

Set Input gain of both channels at +4dB , select Input as IN1.

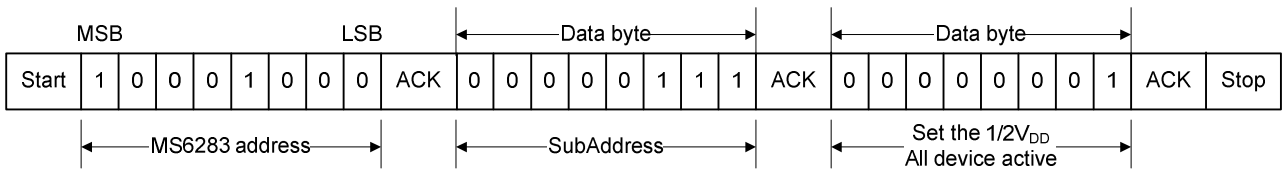|	MSB				LSB					Data byte									Data byte								
Start	1	0	0	0	1	0	0	0	ACK	0	0	0	0	0	0	1	1	ACK	0	0	0	0	0	1	0	0	ACK	Stop

← MS6283 address → ← SubAddress → ← Both-channels , IN1 , +4dB →
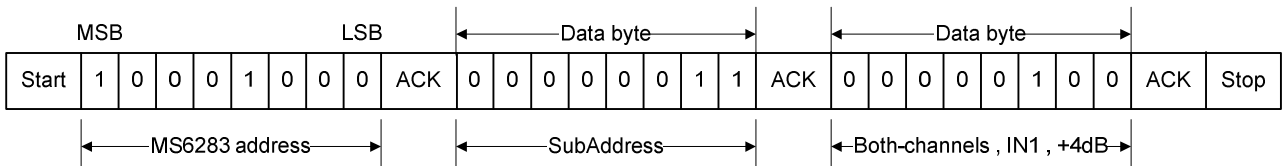
Set Volume of both-channels at -15dB

	MSB				LSB					Data byte									Data byte								
Start	1	0	0	0	1	0	0	0	ACK	0	0	0	0	0	1	1	0	ACK	0	0	0	1	1	1	1	1	ACK	Stop

← MS6283 address → ← SubAddress → ← Both-channels , -15dB →
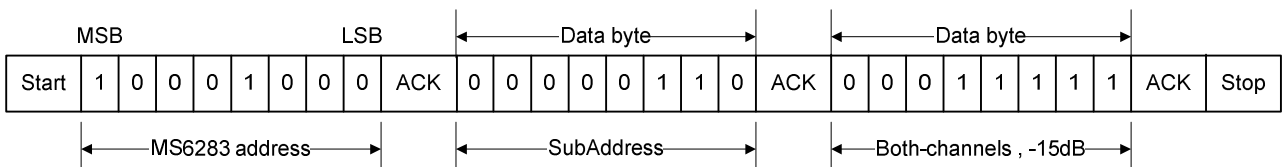
Soft-step volume

When the volume-level is changed audible clicks could appear at the output. The root cause of those clicks could be the sudden change of the envelope of the audio signal. With the Soft-step feature, this click could be reduced to a minimum. Soft-step supports N dB volume change, including mute.

Example

Soft-Step Time = 5.12ms

0dB → -16dB → 0dB

Vin = 1Vrms @ 1KHz
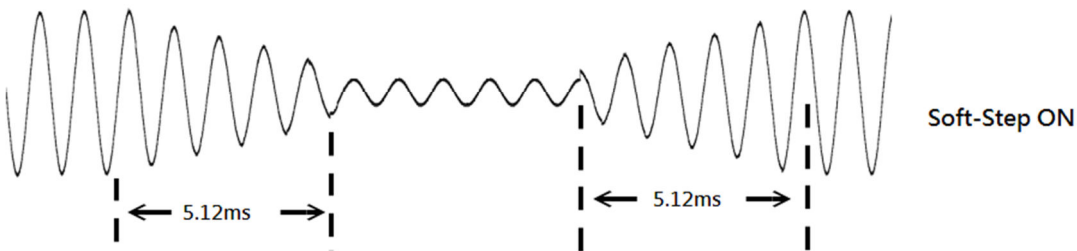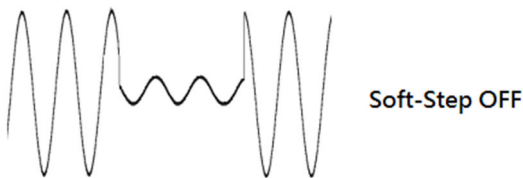
Vin = 1Vrms @ 2KHz
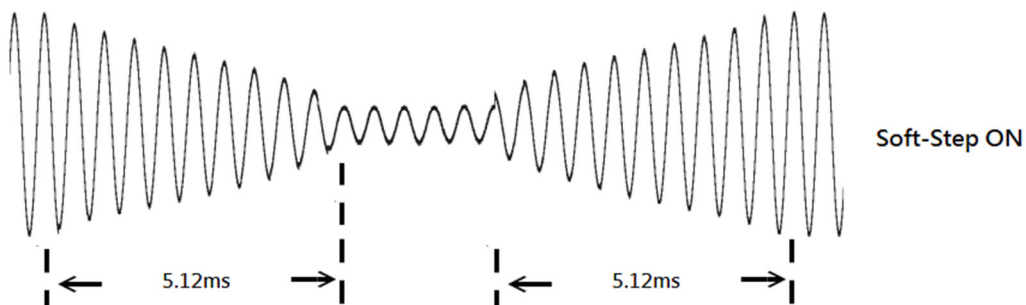
+8dB → -16dB → +8dB

Vin = 0.5Vrms @ 1KHz

Soft-Step OFF

Soft-Step ON

5.12ms * 2

5.12ms * 2
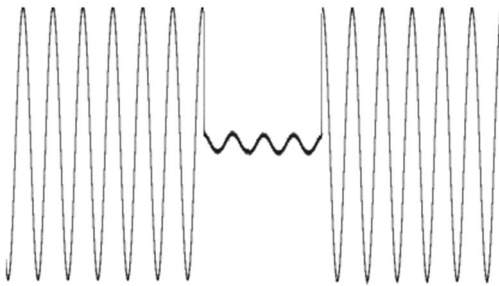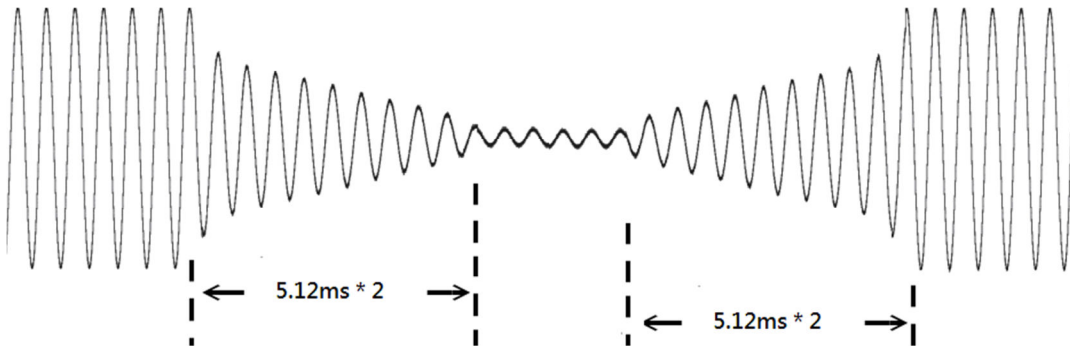
0dB → Mute →0dB

Vin = 1Vrms @ 1KHz

Soft-Step OFF

Soft-Step ON

5.12ms

5.12ms

APPLICATION INFORMATION

Basic application example(Single-ended Mode)

Basic application example(Differential Mode)

Basic application flowchart

```
        ┌─────────────────┐                    ┌─────────────────┐
        │    Power Up     │                    │    Power off    │
        └────────┬────────┘                    └────────┬────────┘
                 │                                       │
                 ▼                                       ▼
     ┌───────────────────────┐            ┌───────────────────────┐
     │     [Power up]        │            │ [Volume down to mute] │
     │                       │            │                       │
     │     V_DD = 5V         │            │  volume down to mute  │
     │                       │            │     step by step      │
     └───────────┬───────────┘            └───────────┬───────────┘
                 │                                     │
                 ▼                                     ▼
     ┌───────────────────────┐            ┌───────────────────────────┐
     │  [Initial Conditions] │            │ [Power Down Preparation]  │
     │                       │            │                           │
     │   IN3, 14dB, Mute     │            │        07H, 00H           │
     │  Powerdown, Vref = 0V │            │      Wait 0.5 sec         │
     └───────────┬───────────┘            └───────────┬───────────────┘
                 │                                     │
                 ▼                                     ▼
     ┌───────────────────────┐            ┌───────────────────────────┐
     │   [Pop Noise Free]    │            │  [All device power down]  │
     │                       │            │                           │
     │     wait 0.5 sec      │            │        07H, 06H           │
     └───────────┬───────────┘            └───────────┬───────────────┘
                 │                                     │
                 ▼                                     ▼
  ┌──────────────────────────┐            ┌───────────────────────┐
  │ [Set the default function]│           │     [Power off]       │
  │                          │            │                       │
  │  (Soft-step Time,ON/OFF  │            │     V_DD = 0V         │
  │  differential Input ON/OFF│           └───────────────────────┘
  │   Input selection , Gain) │
  └──────────────┬───────────┘
                 │
                 ▼
     ┌───────────────────────┐
     │  [All device Active]  │
     │                       │
     │       07H,01H         │
     │     Wait 0.5 sec      │
     └───────────┬───────────┘
                 │
                 ▼
     ┌───────────────────────┐
     │   [Volume Control]    │
     │                       │
     │    volume up/down     │
     └───────────────────────┘
```
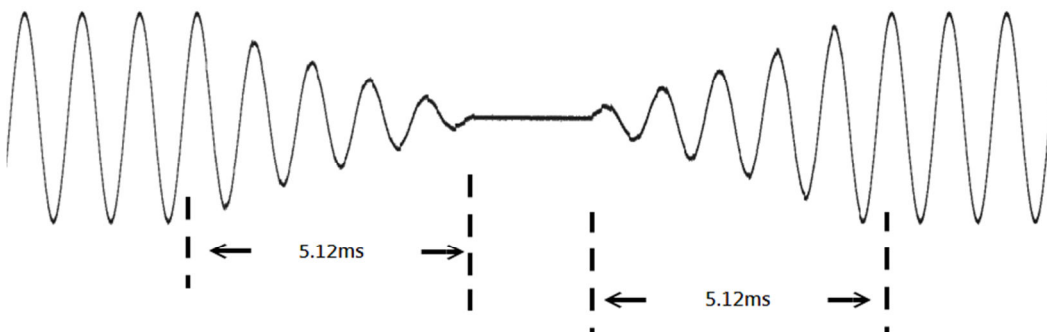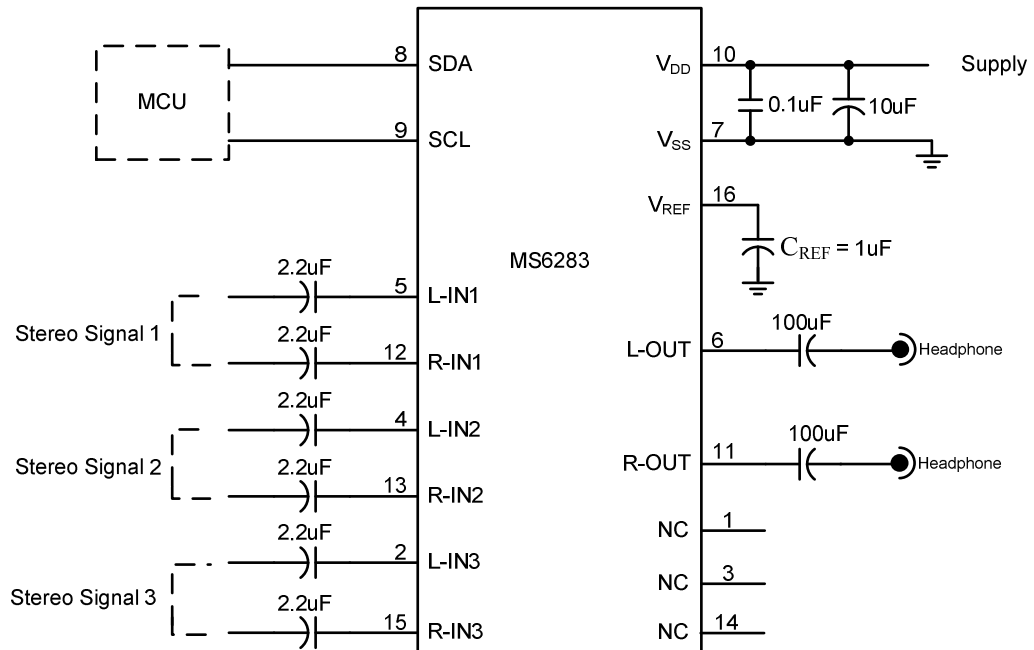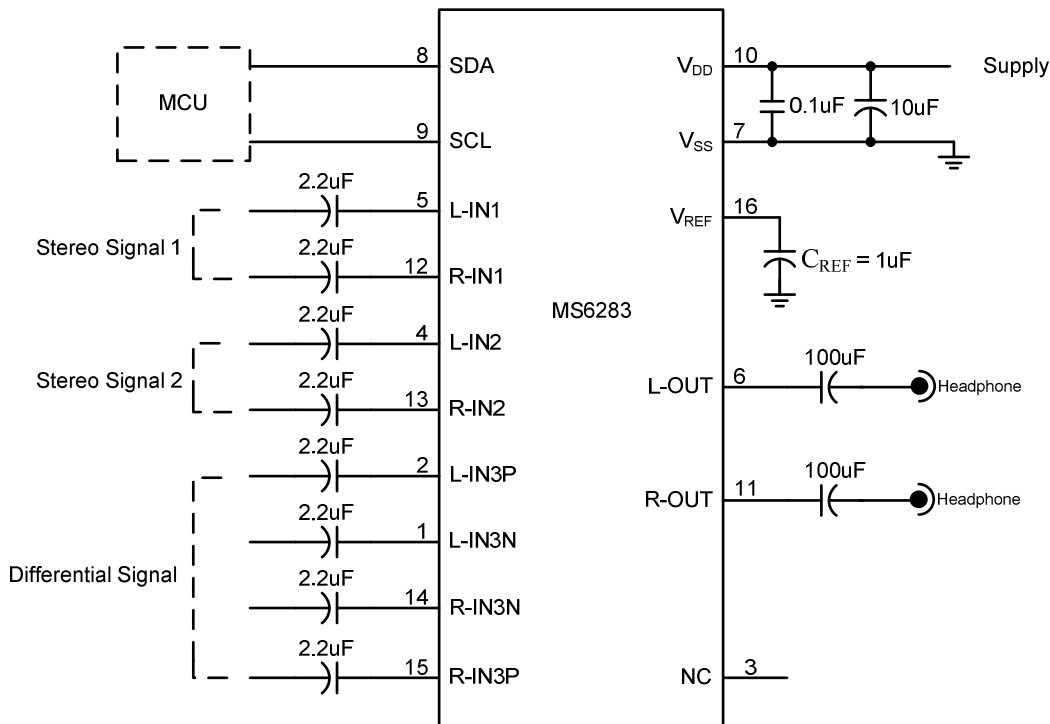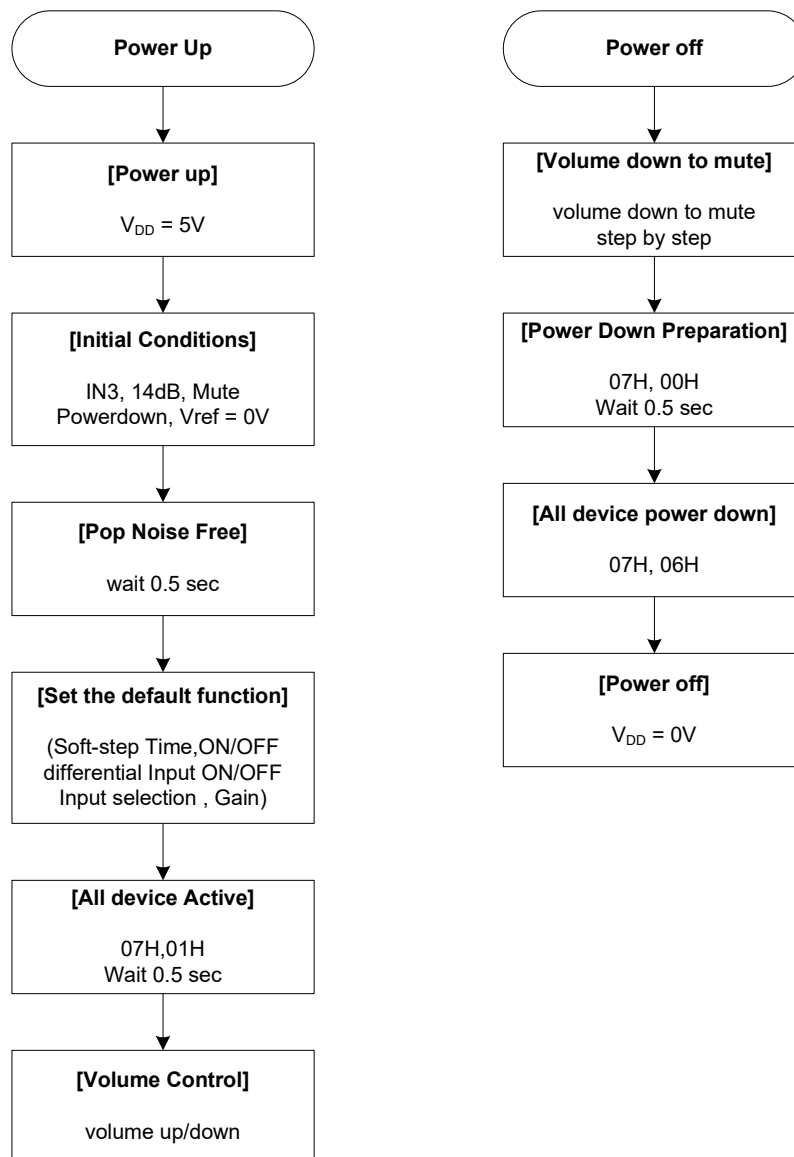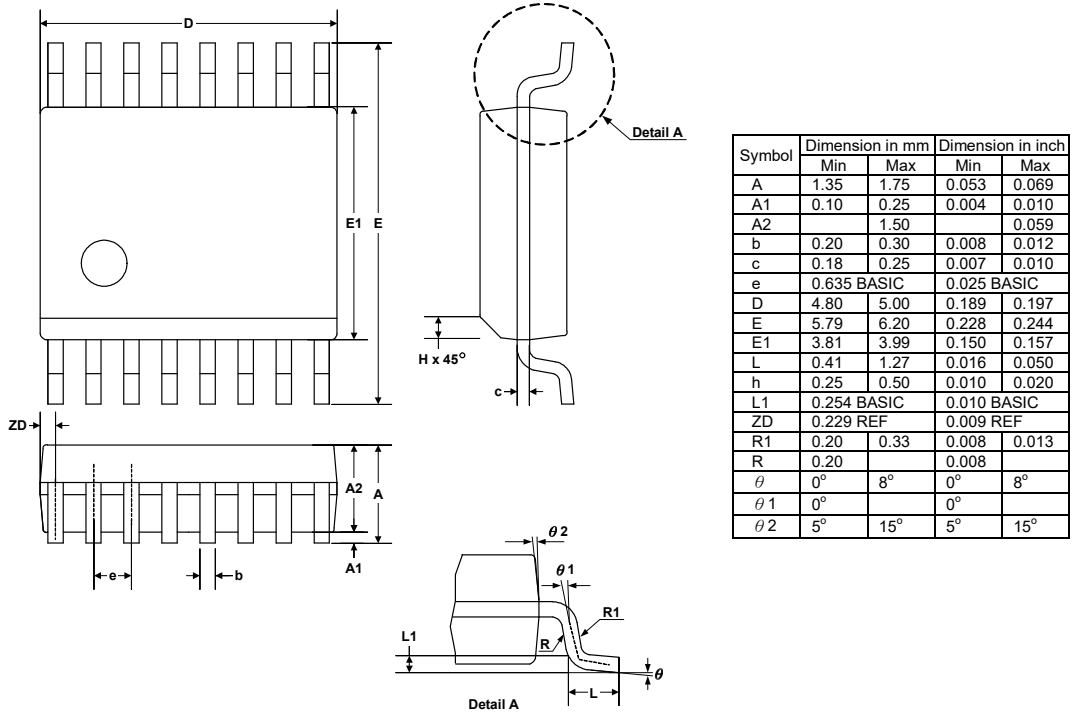
EXTERNAL DIMENSIONS

SSOP16

Symbol	Dimension in mm		Dimension in inch	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2		1.50		0.059
b	0.20	0.30	0.008	0.012
c	0.18	0.25	0.007	0.010
e	0.635 BASIC		0.025 BASIC	
D	4.80	5.00	0.189	0.197
E	5.79	6.20	0.228	0.244
E1	3.81	3.99	0.150	0.157
L	0.41	1.27	0.016	0.050
h	0.25	0.50	0.010	0.020
L1	0.254 BASIC		0.010 BASIC	
ZD	0.229 REF		0.009 REF	
R1	0.20	0.33	0.008	0.013
R	0.20		0.008	
θ	0°	8°	0°	8°
$\theta 1$	0°		0°	
$\theta 2$	5°	15°	5°	15°

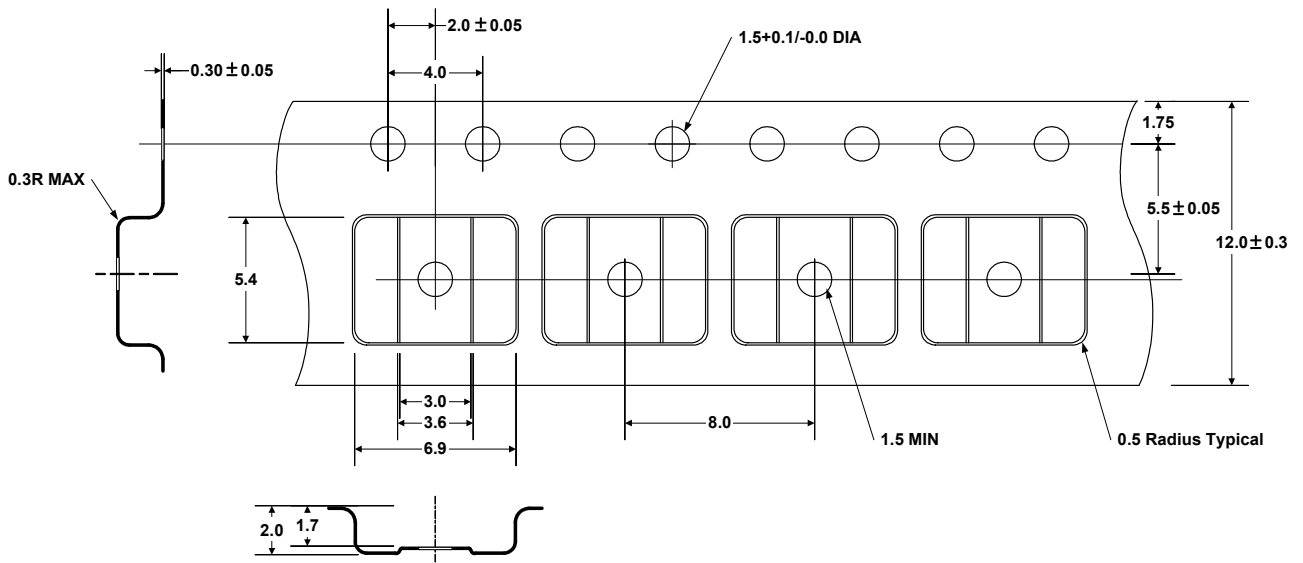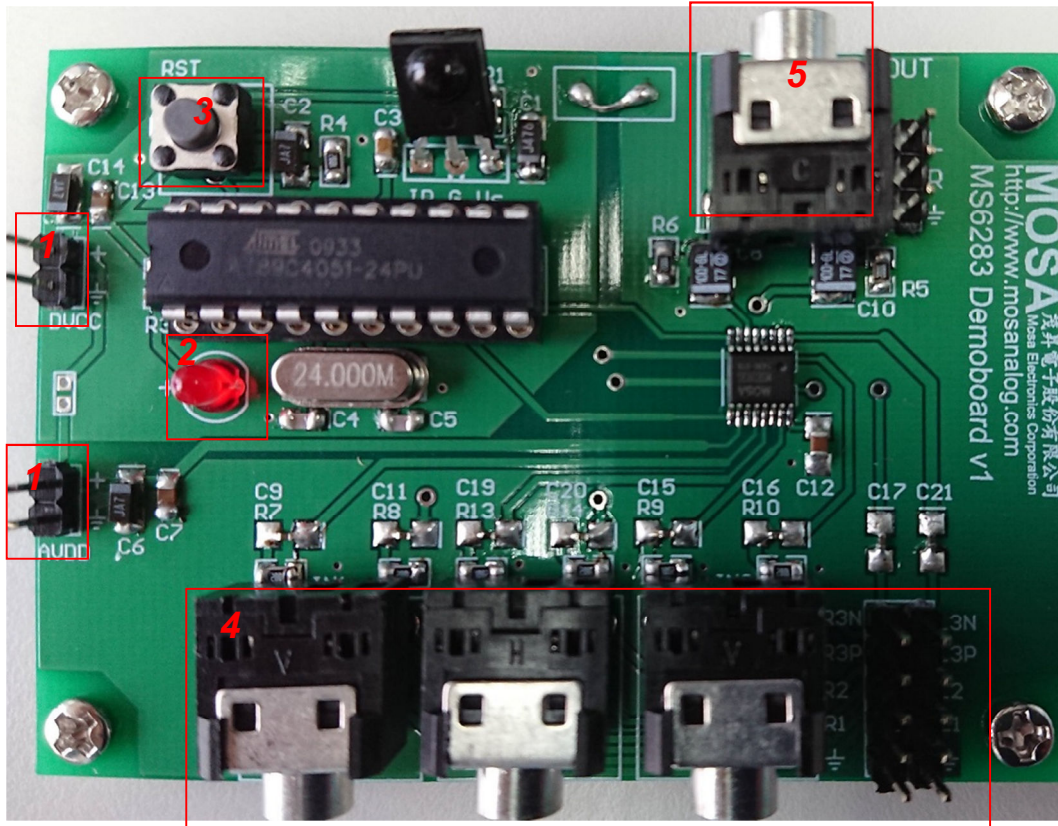## TAPE AND REEL   (Unit : mm)

SSOP16

DEMO BOARD

The demo board used IR technique controller to control the MS6283. The default states of demo board are INPUT3, Input Gain 0dB, Volume 0dB, SE Mode, Softstep on, Softstep Time 20.48ms, Mute off .

Label 1: Supply Voltage

The AVDD and DVDD should be the same supply voltage, the supply range is 2.5 ~ 6.5 VDC.

Label 2: LED Indicator

The LED indicates the power status and the IR received status. It is red-dark blink once when the MCU has received the function code correctly.

Label 3: MCU Reset

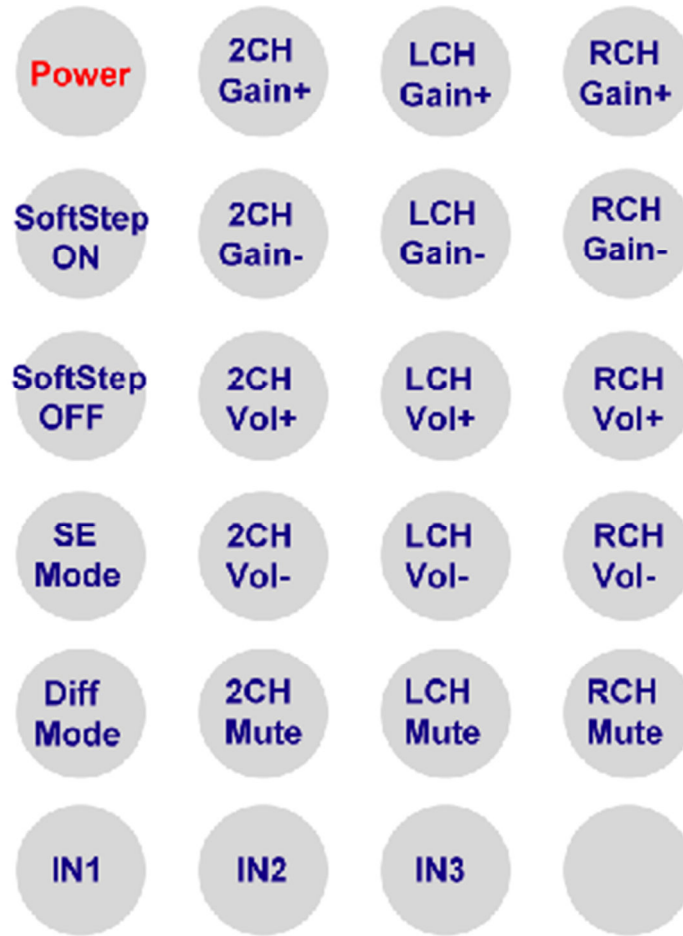The MS6283 will be loaded the default values by MCU.

Label 4: Input Section

Please input stereo audio signal, as music or sine wave.

Label 5: Output Section

Used 3.5mm diameter of headphone.

MOSA

IR Controller

Power ON/OFF : The power key.

Press the key once to set power-on or power-off for MS6283.

The default values are INPUT3, Input Gain 0dB, Volume 0dB, SE Mode, Softstep on, Softstep Time 20.48ms, Mute off .

Gain+/-： The gain control keys.

    The gain control in 1dB/step as the switch is pressed once, the range is 0dB to 15dB.

Vol+/-： The volume control keys.

    The volume control in 1dB/step as the switch is pressed once, the range is –79dB to +15dB.

MUTE： The mute key controls all speaker outputs

    Press the key once to set mute-on or mute-off.

SE/Diff Mode： The Input Mode control Keys.

SoftStep： The SoftStep key.

    Press the key once to set Softstep on or SoftStep off.

IN1~IN3： Stereo channel selection

    There are four sets, stereo 1 to 3. The default channel is stereo 3 on initial status.

Circuit