# 16-Bits Stereo Audio DAC
# Low Power Consumption
# Low Voltage, Excellent PSRR

## FEATURES

- Operation range: 2.5V~6.5V
- Excellent Power Supply Rejection Ratio(PSRR)
- Low operating current
- Low power consumption
  8mW at $V_{DD}$=3.3V (Full scale output )
- Low distortion
- No zero crossing distortion
- Wide dynamic range(16-bit resolution)
- Voltage Output
- Fast setting time permits 2*, 4*, and 8* oversampling (serial input) or double speed operation at 4* oversampling
- Compatible with most of the Japanese input formats; time multiplexed, two's complement, CMOS and TTL input level, MS6323AS for CMOS level, MS6323T for TTL level
- Output voltage swing is proportional to supply voltage ($V_{OPP}$=$V_{DD}$/2)
- Cost efficient
- Space saving package SOP8, MSOP8

## APPLICATIONS

- Multimedia system
- MP3, PDA, Portable Digital Audio.

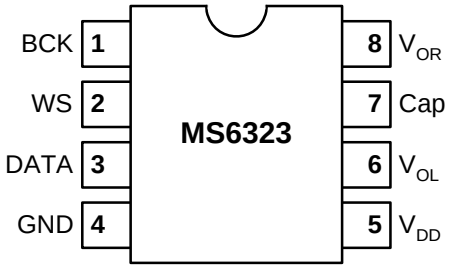
## DESCRIPTION

The MS6323 is a 16-bit voltage-output Digital-to-Analog Converter(DAC). It gives the excellent Power Supply Rejection Ratio(PSRR). It features extremely low power dissipation, small package size and easy application. The accuracy of the weight current sources, combined with the unique symmetrical decoding method, preclude zero-crossing distortion and ensures high quality audio reproduction. These unique features, combined with its exceptional performance, make the MS6323 ideally suited for use in portable audio equipment. MS6323 is pin and function compatible with MS6313.

## PIN CONFIGURATION

| Symbol | Pin | Description |
|---|---|---|
| BCK | 1 | Bit clock input |
| WS | 2 | Word select input |
| DATA | 3 | Data input |
| GND | 4 | Ground |
| $V_{DD}$ | 5 | Positive supply voltage |
| $V_{OL}$ | 6 | Left channel output |
| Cap | 7 | Cap |
| $V_{OR}$ | 8 | Right channel output |

Pin 7 : Capacitor = 1μF (ripple rejection)



## BLOCK DIAGRAM

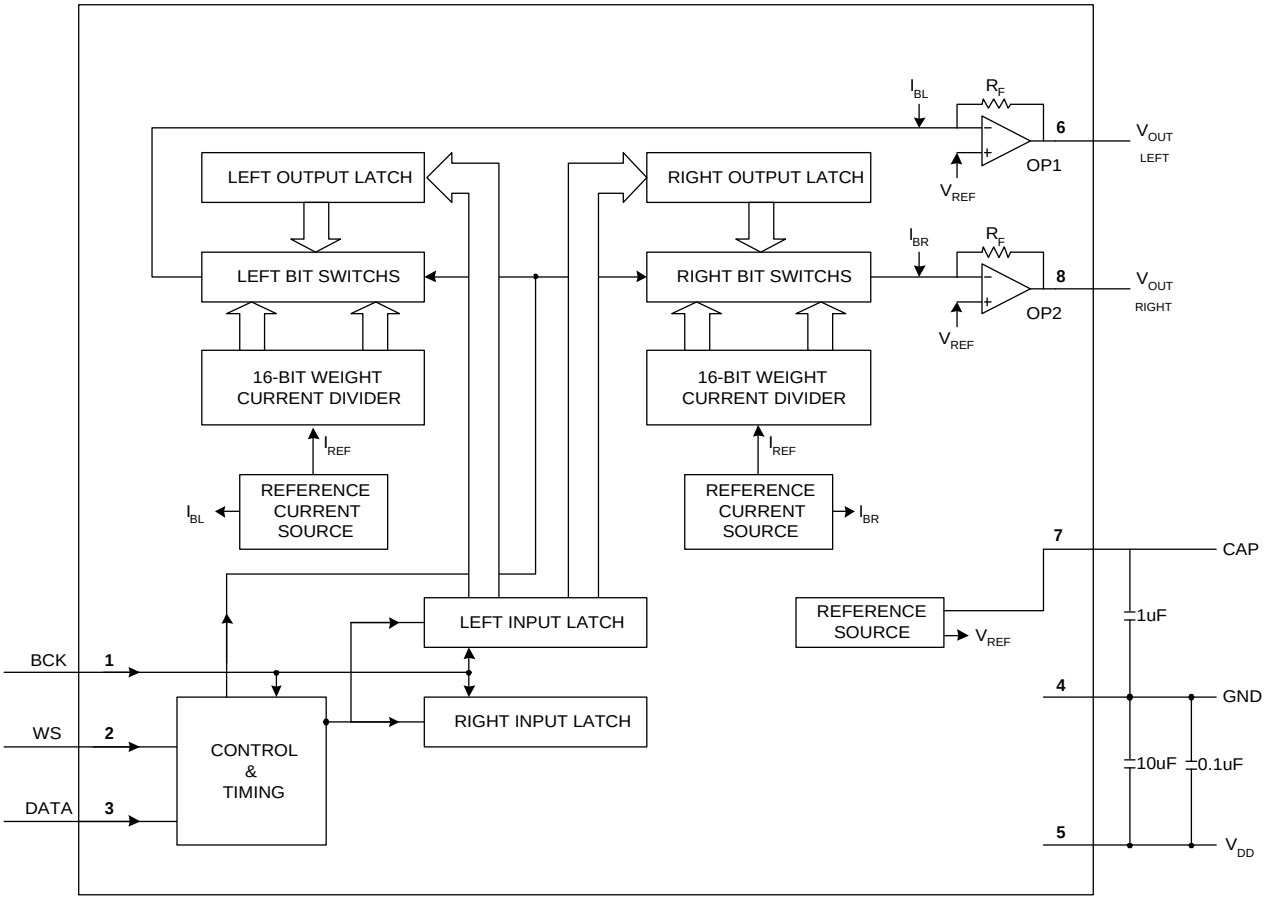



**Fig.1 Block diagram.**

## ORDERING INFORMATION

CMOS input level

| Package | Part number | Marking | Transport Media |
|---|---|---|---|
| 8-Pin SOP (lead free) | MS6323ASGTR | MS6323ASG | 2.5k Units Tape and Reel |
| 8-Pin SOP (lead free) | MS6323ASGU | MS6323ASG | 100 Units Tube |
| 8-Pin MSOP (lead free) | MS6323ASMGTR | 6323G | 3.5k Units Tape and Reel |
| 8-Pin MSOP (lead free) | MS6323ASMGU | 6323G | 80 Units Tube |

TTL input level

| Package | Part number | Marking | Transport Media |
|---|---|---|---|
| 8-Pin SOP (lead free) | MS6323TGTR | MS6323TG | 2.5k Units Tape and Reel |
| 8-Pin SOP (lead free) | MS6323TGU | MS6323TG | 100 Units Tube |
| 8-Pin MSOP (lead free) | MS6323TMGTR | 6323TG | 3.5k Units Tape and Reel |
| 8-Pin MSOP (lead free) | MS6323TMGU | 6323TG | 80 Units Tube |

RoHS Compliance

## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Rating | Unit |
|---|---|---|---|
| VDD | Positive Supply Voltage | 6.5 | V |
| $V_{ESD}$ | Electrostatic Handling | -2000 to 2000 | V |
| $T_{STG}$ | Storage Temperature Range | -65 to 150 | ℃ |
| $T_A$ | Operating Ambient Temperature Range | -40 to 85 | ℃ |
| $T_J$ | Maximum Junction Temperature | 150 | ℃ |
| $T_S$ | Soldering Temperature, 10 seconds | 260 | ℃ |
| $R_{THJA}$ | Thermal Resistance from Junction to Ambient in Free Air<br>SOP8<br>MSOP8 | <br>210<br>235 | ℃/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, f=1kHz, Cap=1uF; unless otherwise specified)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| $V_{CAP}$ | Voltage at Cap | | 2.45 | 2.5 | 2.55 | V |
| $V_{DC}$ | Output DC level | | 2.45 | 2.5 | 2.55 | V |
| $V_{FS}$ | Full scale output voltage | $V_{FS}$=0.5$V_{DD}$ | 2.3 | 2.5 | 2.7 | Vpp |
| $I_Q$ | Quiescent current | At code 0000H | - | 2.6 | - | mA |
| $I_{FS}$ | Maximum operation current | $V_{FS}$=0.5$V_{DD}$ | - | 3.8 | - | mA |
| PSRR | Power supply rejection ratio | Cap=1uF, f=100Hz | 44 | 49 | - | dB |
| | | Cap=10uF, f=100Hz | 60 | 65 | - | dB |
| CS | Channel separation | | 81 | 87 | - | dB |
| **AC Characteristics** | | | | | | |
| Res | Resolution | | - | - | 16 | bits |
| THD+N | Total harmonic distortion plus noise | | - | -68 | -64 | dB |
| | | | - | 0.04 | 0.063 | % |
| S/N | Signal-to-noise ratio | | 89 | 95 | - | dB |

## 3.3V ELECTRICAL CHARACTERISTICS

(Ta=25℃, $V_{DD}$=3.3V, f=1kHz, Cap=1uF; unless otherwise specified)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| $V_{CAP}$ | Voltage at CAP | | 1.6 | 1.65 | 1.7 | V |
| $V_{DC}$ | Output DC level | | 1.6 | 1.65 | 1.7 | V |
| $V_{FS}$ | Full scale output voltage | $V_{FS}$=0.5$V_{DD}$ | 1.5 | 1.65 | 1.8 | Vpp |
| $I_Q$ | Quiescent current | At code 0000H | - | 2.2 | - | mA |
| $I_{FS}$ | Maximum operation current | $V_{FS}$=0.5$V_{DD}$ | - | 2.3 | - | mA |
| PSRR | Power supply rejection ratio | Cap=1uF, f=100Hz | 45 | 50 | - | dB |
| | | Cap=10uF, f=100Hz | 63 | 68 | - | dB |
| CS | Channel separation | | 78 | 84 | - | dB |
| **AC Characteristics** | | | | | | |
| THD+N | Total harmonic distortion plus noise | | - | -66 | -62 | dB |
| | | | - | 0.05 | 0.08 | % |
| S/N | Signal-to-noise ratio | | 86 | 92 | - | dB |

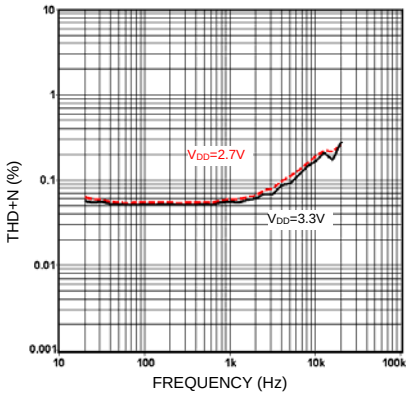
## 2.5V ELECTRICAL CHARACTERISTICS

(Ta=25℃, $V_{DD}$=2.5V, f=1kHz, Cap=1uF; unless otherwise specified)

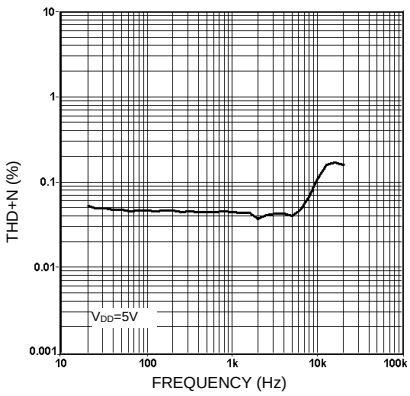
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| $V_{CAP}$ | Voltage at CAP | | 1.2 | 1.25 | 1.3 | V |
| $V_{DC}$ | Output DC level | | 1.2 | 1.25 | 1.3 | V |
| $V_{FS}$ | Full scale output voltage | $V_{FS}$=0.5$V_{DD}$ | 1.2 | 1.25 | 1.5 | Vpp |
| $I_Q$ | Quiescent current | At code 0000H | - | 2.0 | - | mA |
| $I_{FS}$ | Maximum operation current | $V_{FS}$=0.5$V_{DD}$ | - | 2.1 | - | mA |
| PSRR | Power supply rejection ratio | Cap=1uF, f=100Hz | 44 | 49 | - | dB |
| | | Cap=10uF, f=100Hz | 59 | 64 | - | dB |
| CS | Channel separation | | 77 | 83 | - | dB |
| **AC Characteristics** | | | | | | |
| THD+N | Total harmonic distortion plus noise | | - | -66 | -62 | dB |
| | | | - | 0.05 | 0.08 | % |
| S/N | Signal-to-noise ratio | | 83 | 89 | - | dB |

## TYPICAL PERFORMANCE CHARACTERISTICS

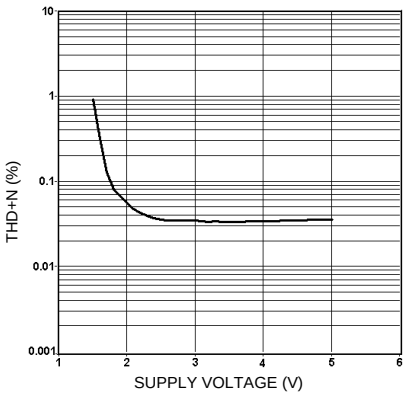
(Ta=25℃, f=1kHz, Cap=1uF, sampling rate=4fs; unless otherwise specified, )



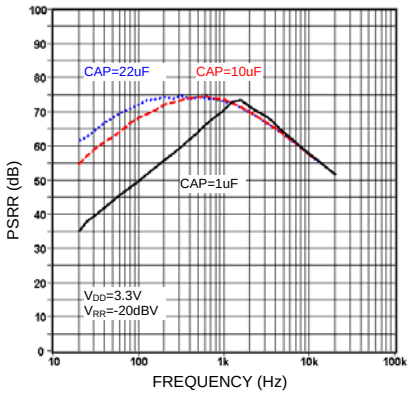

**THD+N vs. frequency**



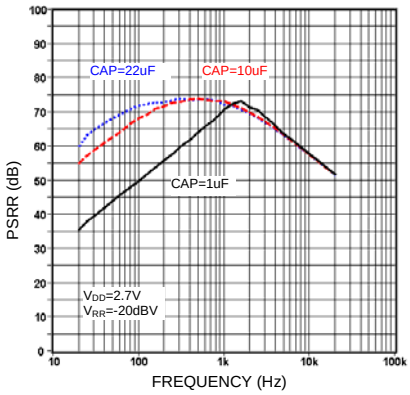

**THD+N vs. frequency**



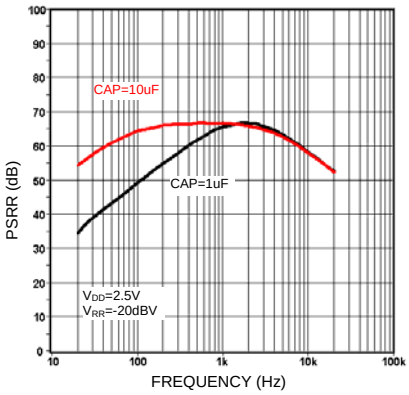

**THD+N vs. supply voltage**



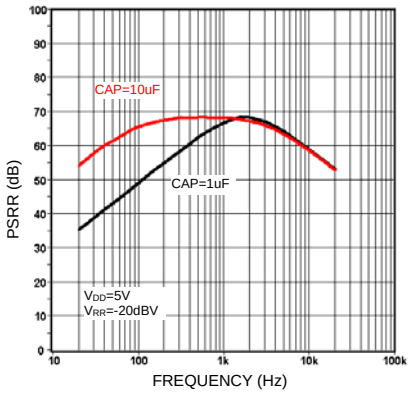

**PSRR vs. frequency**



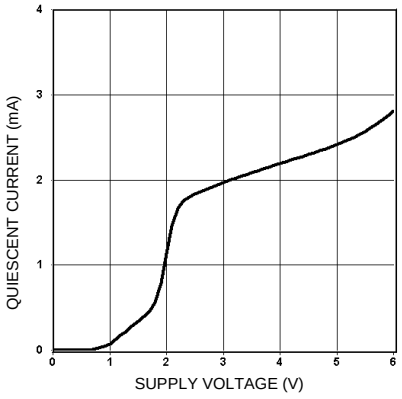

**PSRR vs. frequency**



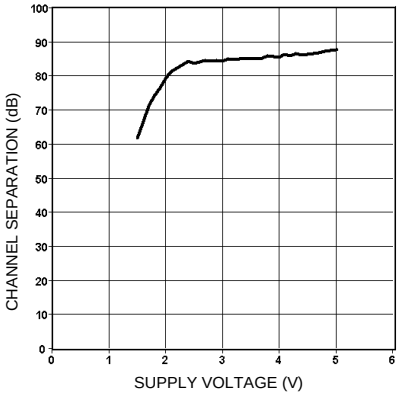

**PSRR vs. frequency**




**PSRR vs. frequency**




**Quiescent current vs. supply voltage**




**Channel separation vs. supply voltage**

## TIMING AND DATA FORMAT

The MS6323 accepts input serial data formats of 16-bit word length. Left and right data words are time multiplexed. The MSB must always be first. The format of data input is shown in Figs. 2 and 3. With a HIGH level on the word select input (WS), data is placed in the left input register and with LOW level on the WS input, data is placed in the right register (Fig. 1). The data in the input registers are simultaneously latched in the output registers which control the bit switches. Internal bias currents $I_{BL}$ and $I_{BR}$ are each added to the full scale output current $I_{FS}$ in order to achieve the maximum dynamic range at the outputs of OP1 and OP2(Fig. 1). In this way the maximum dynamic range is achieved over the entire power supply range.

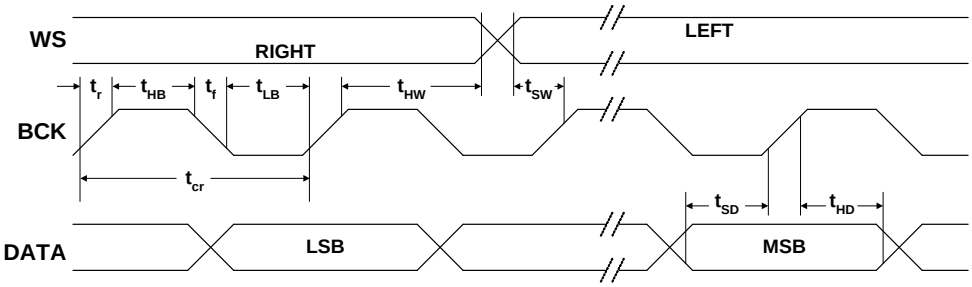



**Fig.2 Timing and input signals.**

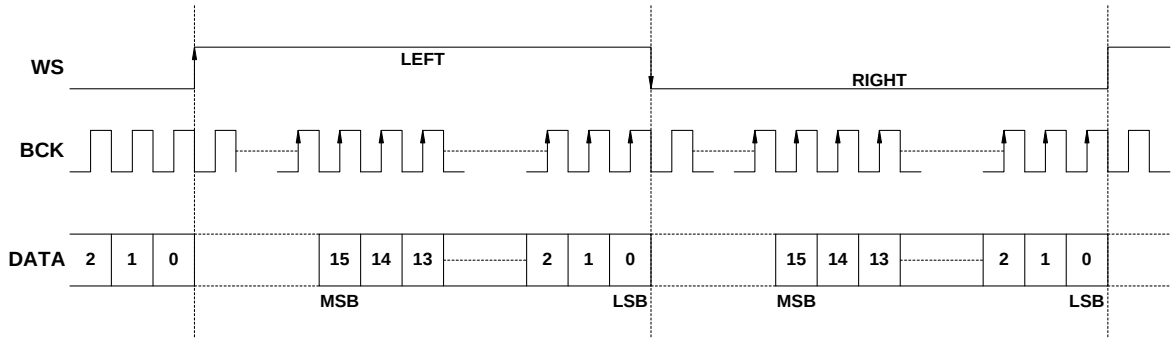



**Fig.3 Format of input signals.**

**Data format (BCK, WS, DATA)**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input LOW CMOS level | MS6323AS | - | - | 0.3$V_{DD}$ | V |
| | Input LOW TTL level | MS6323T | - | - | 0.8 | V |
| $V_{IH}$ | Input HIGH COMS level | MS6323AS | 0.7$V_{DD}$ | - | - | V |
| | Input HIGH TTL level | MS6323T | 2 | - | - | V |
| $\| I_{IL} \|$ | Input Leakage Current LOW | | - | - | 10 | μA |
| $\| I_{IH} \|$ | Input Leakage Current HIGH | | - | - | 10 | μA |
| $f_{BCK}$ | Input Clock Frequency | | - | - | 18.4 | MHz |
| BR | Bit Rate Data Input | | - | - | 18.4 | Mbits/s |
| $f_{ws}$ | Word Select Input | | - | - | 384 | kHz |
| $t_r$ | Rise Time | | - | - | 12 | ns |
| $t_f$ | Fall Time | | - | - | 12 | ns |
| $t_{Cr}$ | Bit Clock Cycle Time | | 54 | - | - | ns |
| $t_{HB}$ | Bit Clock High Time | | 15 | - | - | ns |
| $t_{LB}$ | Bit Clock Low Time | | 15 | - | - | ns |
| $t_{SD}$ | Data Set-up Time | | 12 | - | - | ns |
| $t_{HD}$ | Data Hold Time to Bit Clock | | 2 | - | - | ns |
| $t_{HW}$ | Word Select Hold Time | | 2 | - | - | ns |
| $t_{SW}$ | Word Select Set-up Time | | 12 | - | - | ns |

## APPLICATION INFORMATION

### MP3 digital to analog converting solution

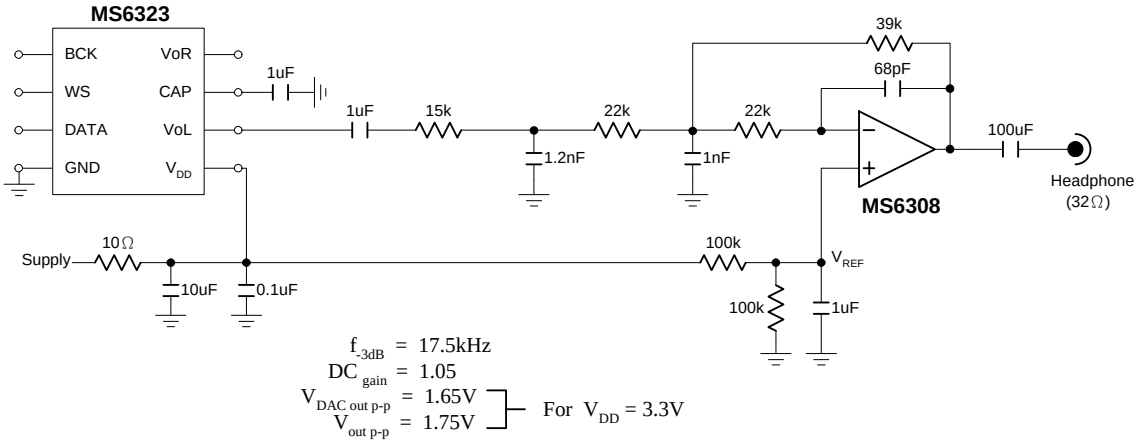



**Fig.4 A third order lowpass filter ( Smoothing filter ) for DAC output.**

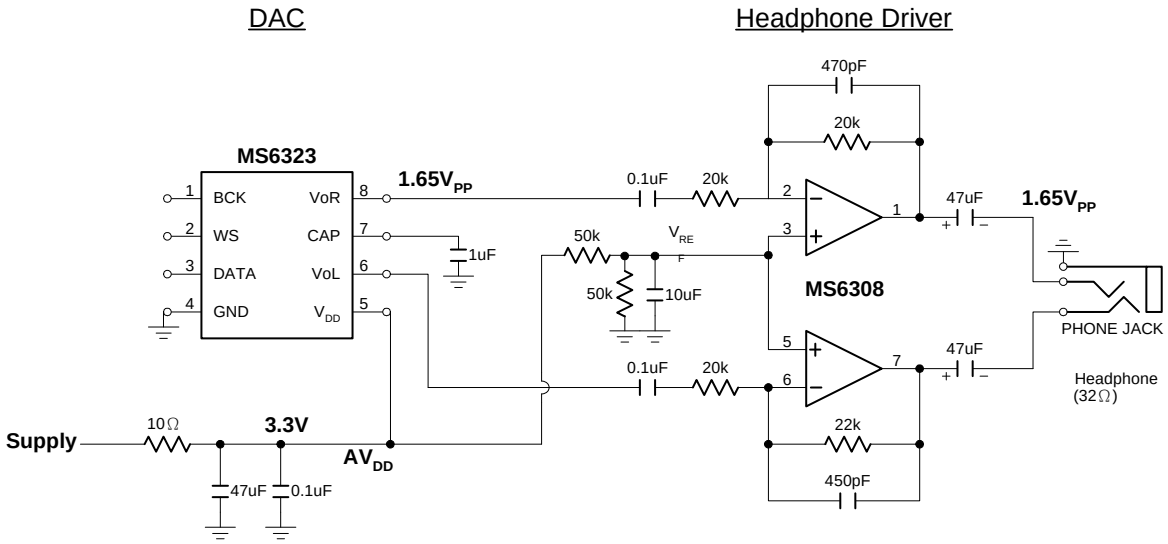
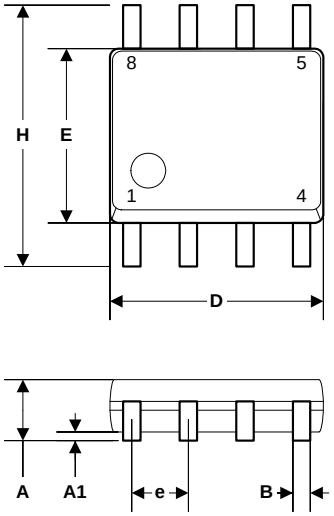


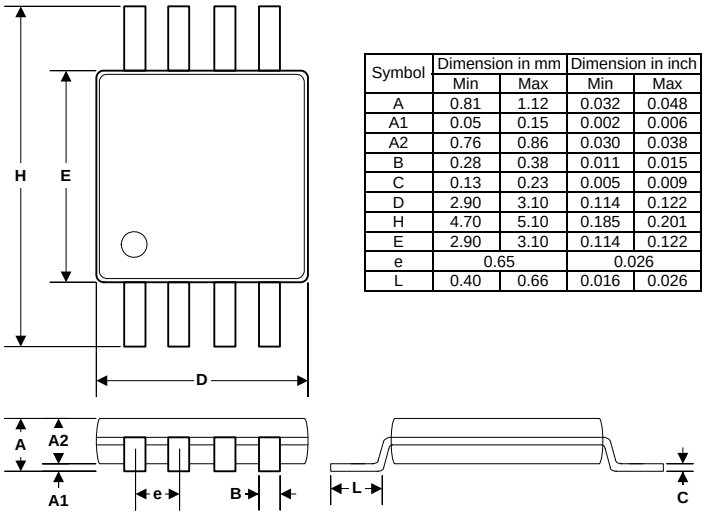

**Fig.5 A first order lowpass filter for DAC output.**

## EXTERNAL DIMENSIONS




| Symbol | Dimension in mm | | Dimension in inch | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.35 | 1.75 | 0.0532 | 0.0688 |
| A1 | 0.10 | 0.25 | 0.0040 | 0.0098 |
| B | 0.33 | 0.51 | 0.013 | 0.020 |
| C | 0.19 | 0.25 | 0.0075 | 0.0098 |
| D | 4.80 | 5.00 | 0.1890 | 0.1968 |
| H | 5.80 | 6.20 | 0.2284 | 0.2440 |
| E | 3.80 | 4.00 | 0.1497 | 0.1574 |
| e | 1.27 BSC | | 0.050 BSC | |
| L | 0.40 | 1.27 | 0.016 | 0.050 |

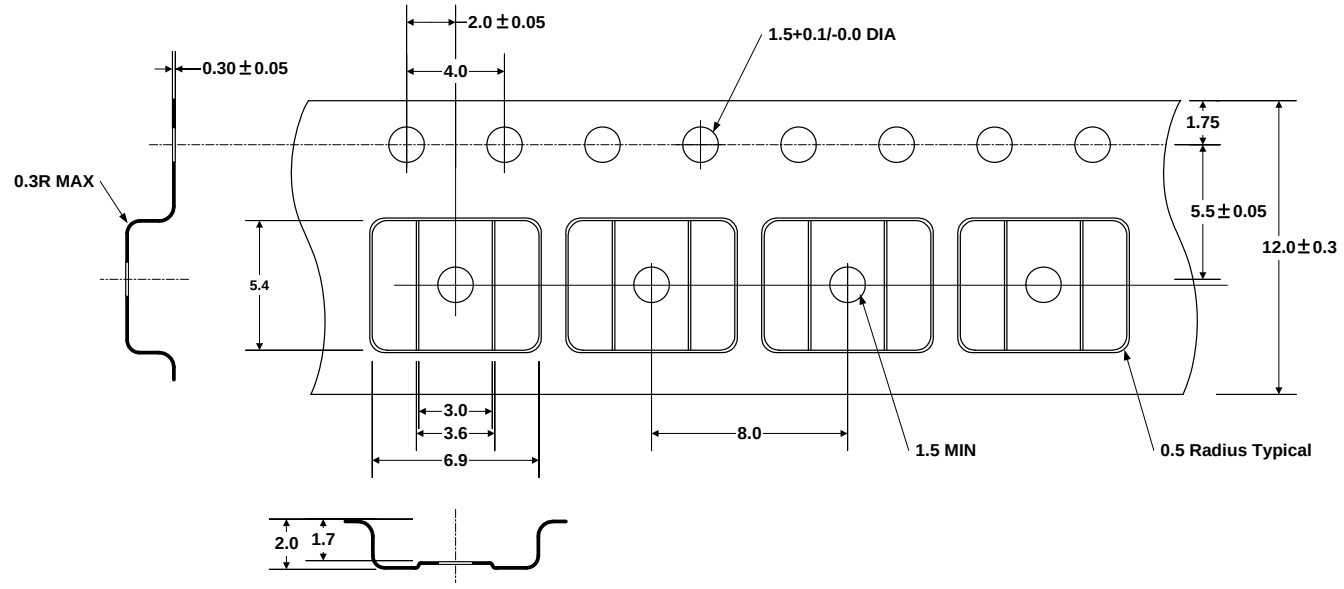
**SOP8**



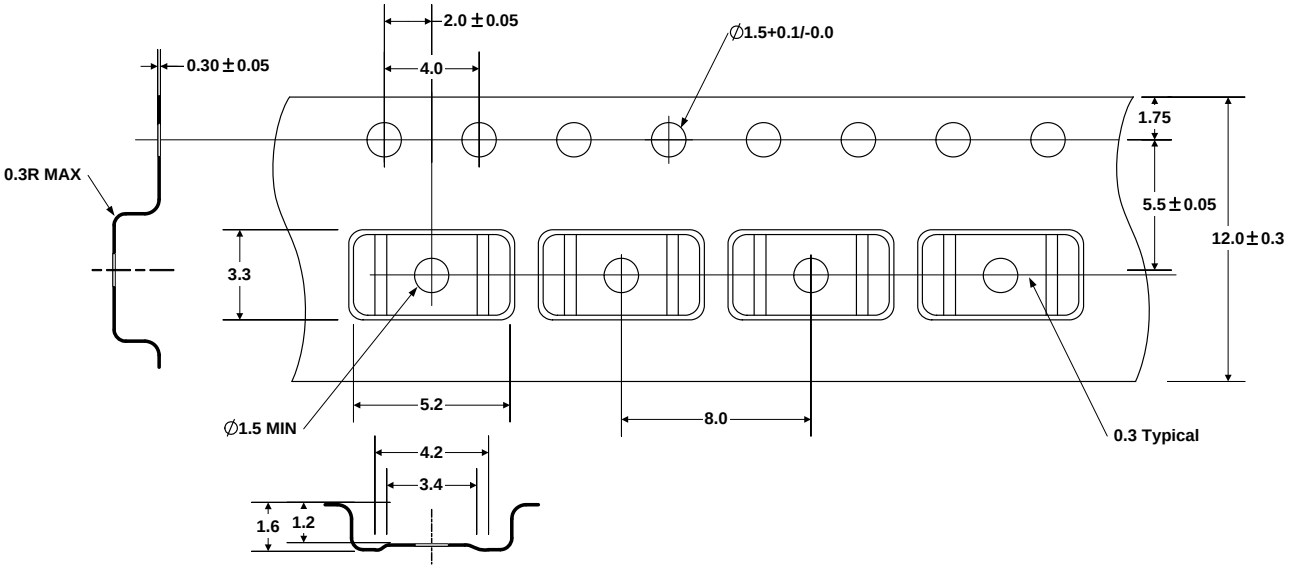

| Symbol | Dimension in mm | | Dimension in inch | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.81 | 1.12 | 0.032 | 0.048 |
| A1 | 0.05 | 0.15 | 0.002 | 0.006 |
| A2 | 0.76 | 0.86 | 0.030 | 0.038 |
| B | 0.28 | 0.38 | 0.011 | 0.015 |
| C | 0.13 | 0.23 | 0.005 | 0.009 |
| D | 2.90 | 3.10 | 0.114 | 0.122 |
| H | 4.70 | 5.10 | 0.185 | 0.201 |
| E | 2.90 | 3.10 | 0.114 | 0.122 |
| e | 0.65 | | 0.026 | |
| L | 0.40 | 0.66 | 0.016 | 0.026 |

**MSOP8**

## TAPE AND REEL (Unit : mm)

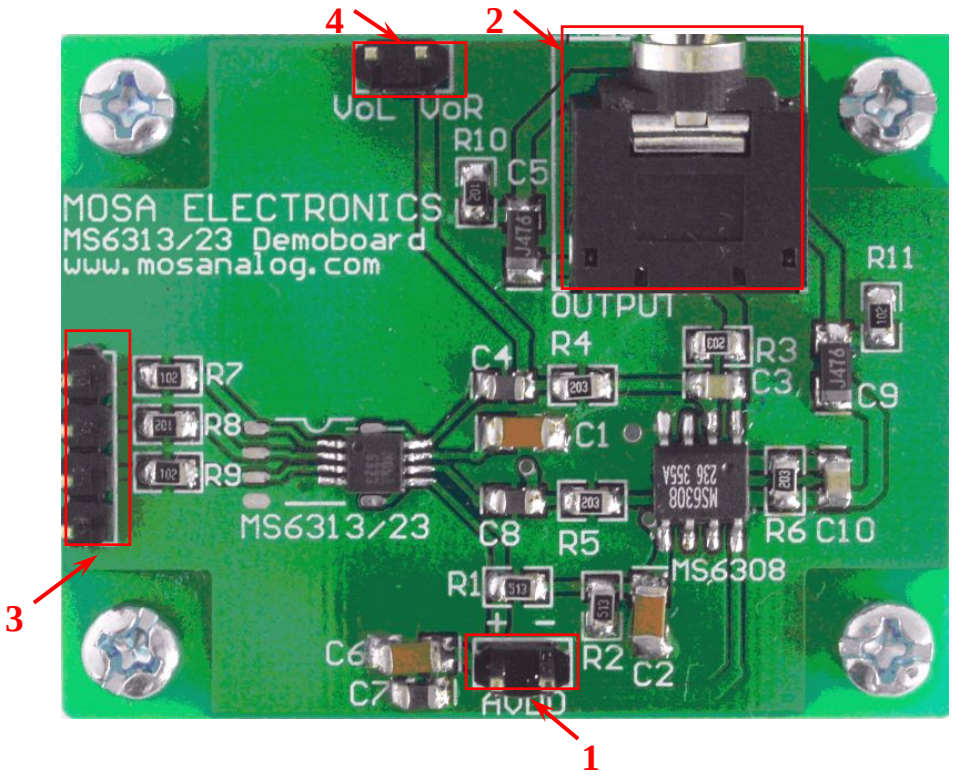



**SOP8**




**MSOP8**

## Demo board




## Function description

Label 1: Supply Input
Supply voltage range is 2.5V to 6.5V.

Label 2: Headphone Jack
Used 3.5mm diameter of headphone with 32ohm.

Label 3: Digital Signal Input
Connected to digital audio format.

Label 4: MS6323 output
MS6323 output test ports.

## Circuit

