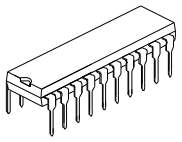
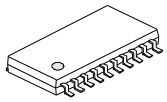
# 2-CH OUTPUT STEREO AUDIO PROCESSOR

## DESCRIPTION

The SC7315 is a volume, tone (bass and treble), balance (left/ right) and fader processor for quality audio applications in car radio and Hi-Fi systems. Selectable input gain and external loudness function are provided. Control is accomplished by serial $I^2C$ bus microprocessor interface. The AC signal settings is obtained by resistor networks and switches combined with operational amplifiers. Due to the Used CMOS technology, low distortion, low noise and low DC stepping are obtained.



DIP-20-300-2.54



SOP-20-375-1.27

## FEATURES

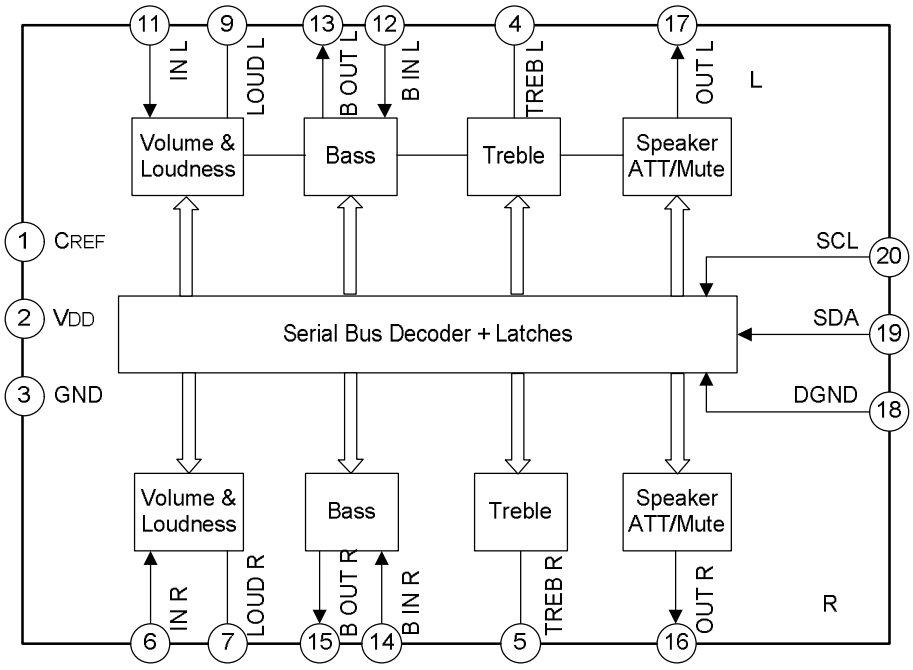
* 2 stereo inputs
* Two speaker attenuators:
  --2 independent speakers control in 1.25dB steps for balance and fader facilities
  --Independent mute function
* All functions programmable via serial $I^2C$ Bus
* Loudness function
* Volume control in 1.25dB steps
* Treble and bass control
* Input and output for external equalizer ornoise reduction system

## ORDERING INFORMATION

| Device | Package |
|---|---|
| SC7315 | DIP-20-300-2.54 |
| SC7315S | SOP-20-375-1.27 |

## BLOCK DIAGRAM





## ABSOLUTE MAXIMUM RATING

| Characteristics | Symbol | Ratings | Unit |
|---|---|---|---|
| Supply Voltage | $V_S$ | 10.2 | V |
| Operating Temperature | $T_{amb}$ | -40 ~ +85 | °C |
| Storage Temperature | $T_{stg}$ | -55 ~ +150 | °C |

## QUICK REFERENCE DATA

| Characteristics | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Voltage | $V_S$ | 6 | 9 | 10 | V |
| Maximum Input Signal Handling | $V_{CL}$ | 2 | | | $V_{rms}$ |
| Total Harmonic Distortion ,V=1Vrms, f=1kHz | THD | | 0.01 | 0.1 | % |
| Signal to Noise Ratio | S/N | | 106 | | dB |
| Channel Separation, f=1kHz | SC | | 103 | | dB |
| Volume Control, 1.25dB Step | | -78.75 | | 0 | dB |
| Bass and Treble Control, 2dB step | | -14 | | +14 | dB |
| Fader and Balance Control, 1.25dB step | | -38.75 | | 0 | dB |
| Input Gain, 3.75dB Step | | 0 | | 11.25 | dB |
| Mute Attenuation | | | 100 | | dB |

## ELECTRICAL CHARACTERISTICS (Refer to the test circuit)

(Tamb=25°C, VS=9.0V,RL=10kΩ，RG=600Ω，all controls flat(G=0), f=1kHz,Unless otherwise specified)

| Characteristics | Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **SUPPLY VOLTAGE** | | | | | | |
| Operating Supply Voltage | $V_S$ | | 6 | 9 | 10.0 | V |
| Operating Supply Current | $I_S$ | | | 20.0 | 35.0 | mA |
| Ripple Rejection of Supply Voltage | $S_{VR}$ | | 60 | 80 | | dB |
| **VOLUME CONTROL** | | | | | | |
| Input Resistance | $R_{IV}$ | | 20 | 33 | 50 | kΩ |
| Control Range | $C_{range}$ | | 70 | 75 | 80 | dB |
| Minimum Attenuation | $A_{V(min)}$ | | -1 | 0 | 1 | dB |
| Maximum Attenuation | $A_{V(max)}$ | | 70 | 75 | 80 | dB |
| Step Resolution | $A_{STEP}$ | | 0.5 | 1.25 | 1.75 | dB |
| Attenuation Set Error | EA | $A_V$=0 to –20dB | -1.25 | 0 | 1.25 | dB |
| | | $A_V$=-20 to –60dB | -3 | | 2 | |
| Tracking Error | ET | | | | 2 | dB |
| DC Steps | $V_{DC}$ | Adjacent attenuation steps | | 0 | 3 | mV |
| | | From 0dB to AV max | | 0.5 | 7.5 | mV |
| **SPEAKER ATTENUATORS** | | | | | | |
| Control Range | $C_{range}$ | | 35 | 37.5 | 40 | dB |

(To be continued)

(Continued)

| Characteristics | Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Step Resolution | $S_{STEP}$ | | 0.5 | 1.25 | 1.75 | dB |
| Attenuation Set Error | EA | | | | 1.5 | dB |
| Output Mute Attenuation | $A_{MUTE}$ | | 80 | 100 | | dB |
| DC Steps | $V_{DC}$ | Adjacent attenuation steps | | 0 | 3 | mV |
| | | From 0dB to MUTE | | 1 | 10 | mV |
| **BASS CONTROL (note 1)** | | | | | | |
| Control Range | GB | Maximum boost/cut | ±12 | ±14 | ±16 | dB |
| Step Resolution | $B_{STEP}$ | | 1 | 2 | 3 | dB |
| Internal Feedback Resistance | RB | | 34 | 44 | 58 | kΩ |
| **TREBLE CONTROL (note 1)** | | | | | | |
| Control Range | Gt | Maximum boost/cut | ±13 | ±14 | ±15 | dB |
| Step Resolution | TSTEP | | 1 | 2 | 3 | dB |
| **AUDIO OUTPUTS** | | | | | | |
| Clipping Level | $V_{OCL}$ | THD=0.3% | 2 | 2.5 | | Vrms |
| Output Load Resistance | $R_L$ | | 4 | | | kΩ |
| Output Load Capacitance | $C_L$ | | | | 10 | nF |
| Output Resistance | $R_{OUT}$ | | 30 | 75 | 120 | Ω |
| DC Voltage Level | $V_{OUT}$ | | 4.2 | 4.5 | 4.8 | V |
| **GENERAL** | | | | | | |
| Output Noise | $e_{NO}$ | BW=20 ~20kHz,flat output muted | | 2.5 | | μV |
| | | BW=20 ~20kHz,flat All gains=0dB | | 5 | 15 | μV |
| | | A curve, all gains =0 dB | | 3 | | μV |
| Signal to Noise Ratio | S/N | All gains=0dB; Vo=1$V_{rms}$ | | 106 | | dB |
| Distortion | d | $A_V$=0,$V_{IN}$=10mV | | 0.01 | 0.1 | % |
| | | $A_V$=-20dB, $V_{IN}$=1$V_{rms}$ | | 0.09 | 0.3 | % |
| | | $A_V$=-20dB,$V_{IN}$=0.3$V_{rms}$ | | 0.04 | | % |
| Channel Separation Left/Right | $S_C$ | | 80 | 103 | | dB |
| Total Tracking Error | | $A_V$=0 to –20 dB | | 0 | 1 | dB |
| | | $A_V$=-20 to –60 dB | | 0 | 2 | dB |
| **BUS INPUTS** | | | | | | |
| Input Low Voltage | $V_{IL}$ | | | | 1 | V |
| Input High Voltage | $V_{IH}$ | | 3 | | | V |
| Input Current | $I_{IN}$ | | -5 | | +5 | μA |
| Output Voltage SDA Acknowledge | $V_O$ | $I_O$=1.6mA | | | 0.4 | V |

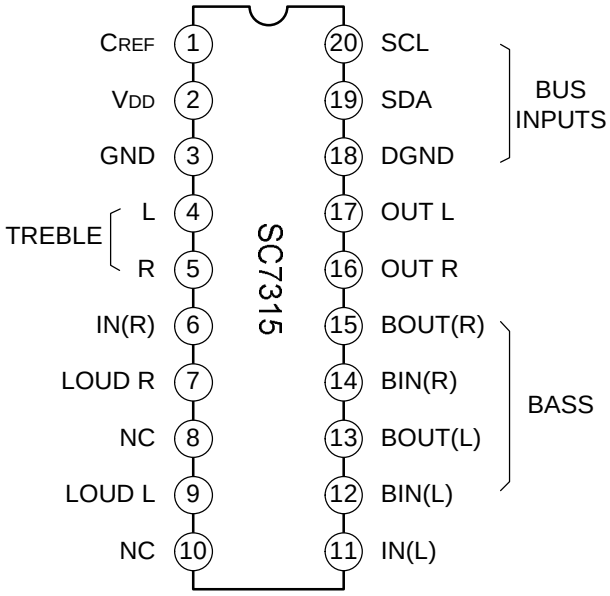


NOTES:

(1) Bass and treble response see Figure 16. The center frequency and quality of the response behavior can be chosen by the external circuitry. A standard first order bass response can realized by a standard feedback network.

(2) The input is grounded through the 2.2μF capacitor.

## PIN CONFIGURATIONS



## TYPICAL CHARACTERISTICS PERFORMANCE

Fig.1 Loudness vs. Volume Attention

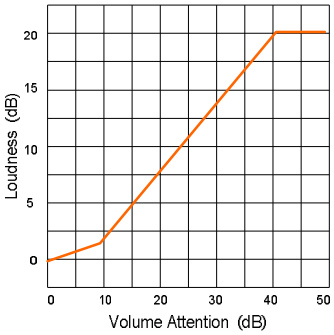



Fig.2 Loudness vs. Frequency vs. volume Attenuation

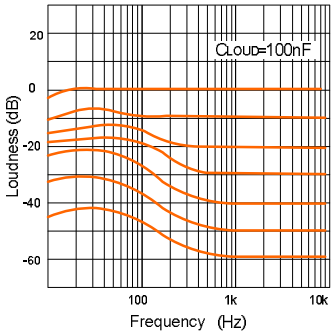



Fig.3 Loudness vs. External Capacitors

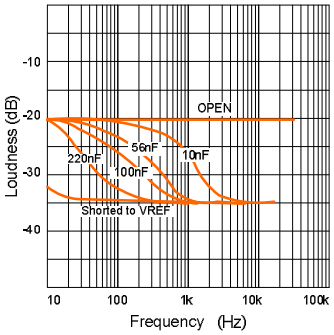



Fig.4 Noise vs. Volume/Gain settings

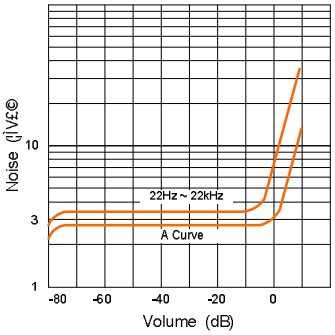



Fig.5 Signal to Noise Ratio vs.Volume settings

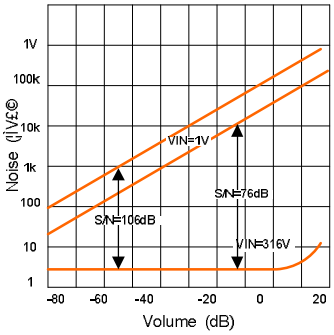



Fig.6 Distortion & Noise vs. Frequency

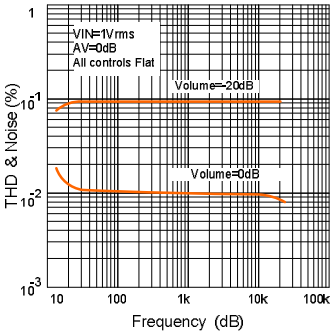



Fig.7 Distortion & Noise vs. Frequency

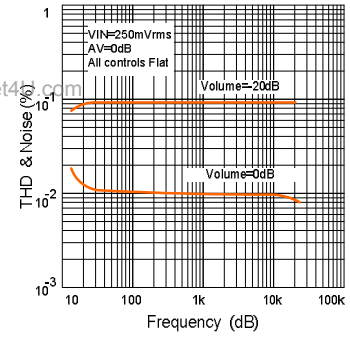





Fig.8 Distortion vs. Load Resistance

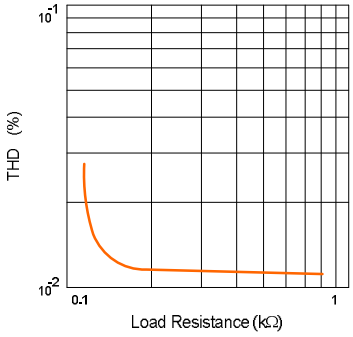
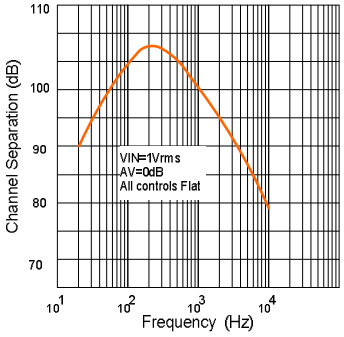



Fig.9 Channel Separation(L¡úR) vs. Frequency



## TYPICAL CHARACTERISTICS PERFORMANCE (continued)

Fig.10 Input Separation vs. Frequency

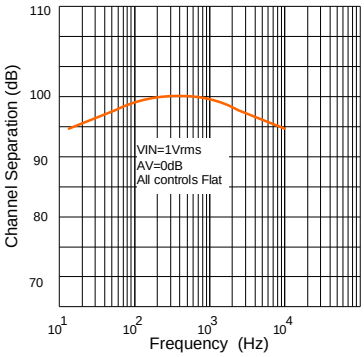



Fig.11 Supply Voltage Rejection vs. Frequency

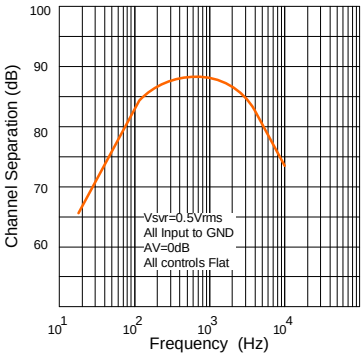



Fig.12 Output Clipping Level vs. Supply Voltage

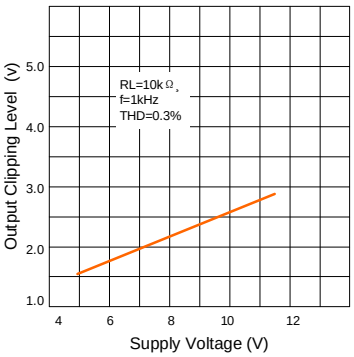



Fig.13 Quiescent current vs. Supply Voltage

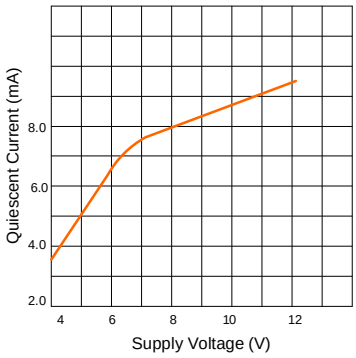



Fig.14 Supply current vs. Temperature

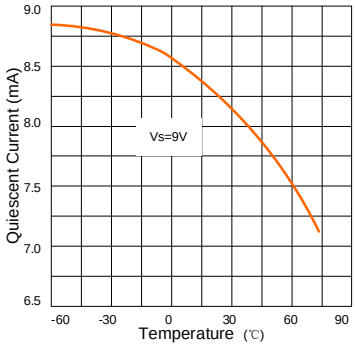



Fig.15 Bass resistance vs. Temperature

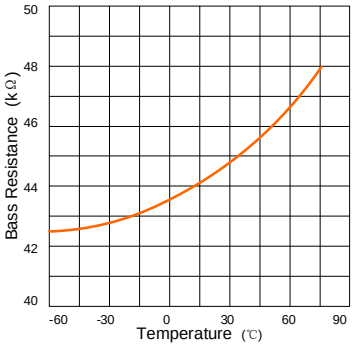
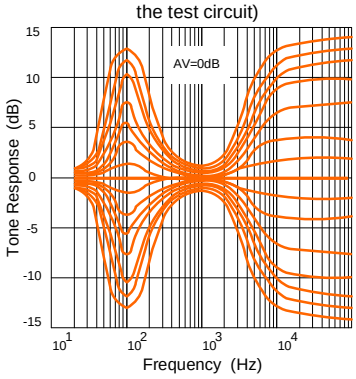



Fig.16 Typical Tone Response (with the Ext components indicated the test circuit)



## APPLICATION NOTES

### 1. I²C BUS INTERFACE

Data transmission from microprocessor to the SC7315 and viceversa takes place through the 2 wires $I^2C$ BUS interface, consisting of the two lines SDA and SCL(pull-up resistors to positive supply voltage must be connected).

### 2. DATA VALIDITY

As shown in Figure 17, the data of the SDA line must be stable during the high period of the clock. The HIGH and LOW state of the dtat line can only change when the clock signal on the SCL line is LOW.

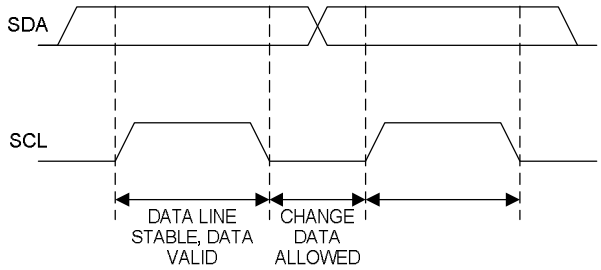



Fig. 17 Data Validity on the $I^2C$ BUS

### 3. START AND STOP CONDITIONS

As shown in Figure 18, a start condition is a HIGH to LOW transition of the SDA line while SCL is HIGH. The stop condition is a LOW to HIGH transition of the SDA line while SCL is HIGH.

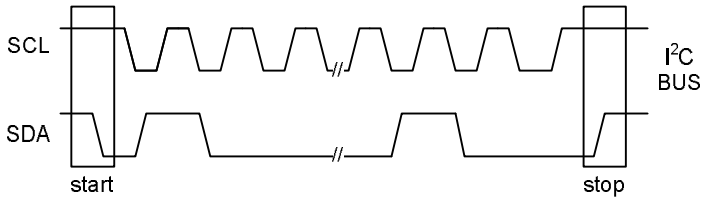





Fig. 18 Timing diagram of I2C BUS

### 4. BYTE FORMAT

Every byte transferred on the SDA line must obtain 8 bits. Each byte must be followed by the an acknowledge bit. The MSB is transferred first.

### 5. ACKNOWLEDGE

The master(microprocessor) puts a resistive HIGH level on the SDA line during the acknowledge clock pulse(see Figure 19). The peripheral(audioprocessor) that acknowledges has to pull-down(LOW) the SDA line during the acknowledge clock pulse, so that the SDA line is stable LOW during this clock pulse.

The audioprocessor which has been addressed has to generate an acknowledge after the reception of each byte , otherwise the SDA line remain at the HIGH level during the ninth clock pulse time. In this case the master transmitter can generate the STOP information in order to abort the transfer.

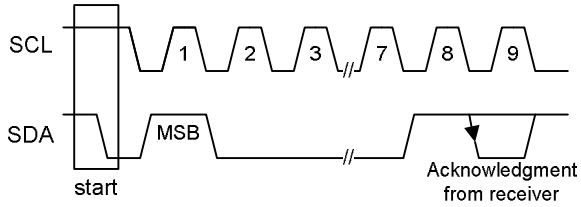



Fig. 19 Acknowledge on the $I^2C$ BUS

### 6. Transmission without acknowledge

Avoiding to detect the acknowledge of the audioprocessor, the microprocessor can use a simpler transmission: simply it waits one clock without checking the slave acknowledgig, and sends the new data.

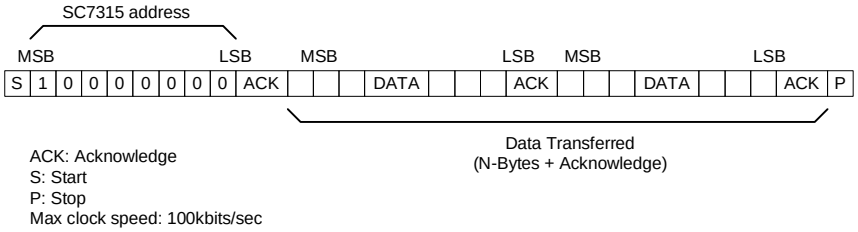
This approach of course is less protected from mis-working and decreases the noise immunity.

## SOFTWARE SPECIFICATION

### 1. Interface protocol

The interface protocol comprises:

- A start conditions
- A chip address byte, containing the SC7315 address(the 8th bit of the bytes must be 0). The SC7315 must always acknowledge at the end of each transmitted byte.
- A sequence of data(N-bytes + acknowledge)
- A stop condition (P)






### 2. Chips address

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 (MSB) | 0 | 0 | 0 | 0 | 0 | 0 | 0 (LSB) |

### 3. Data bytes

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | B2 | B1 | B0 | A2 | A1 | A0 | Volume Control |
| 1 | 0 | 0 | B1 | B0 | A2 | A1 | A0 | Speaker ATT L |
| 1 | 0 | 1 | B1 | B0 | A2 | A1 | A0 | Speaker ATT R |
| 0 | 1 | 0 | * | * | L | * | * | Loudness control |
| 0 | 1 | 1 | 0 | C3 | C2 | C1 | C0 | Bass control |
| 0 | 1 | 1 | 1 | C3 | C2 | C1 | C0 | Treble control |

Note: Ax=1.25dB steps;Bx=10dB steps;Cx=2dB steps;Gx=3.75dB steps;*=no effect.

## DETAILED DESCRIPTION OF DATA BYTES

### 1. Volume

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | B2 | B1 | B0 | A2 | A1 | A0 | Volume 1.25dB steps |
| | | | | | 0 | 0 | 0 | 0 |
| | | | | | 0 | 0 | 1 | -1.25 |
| | | | | | 0 | 1 | 0 | -2.5 |
| | | | | | 0 | 1 | 1 | -3.75 |
| | | | | | 1 | 0 | 0 | -5 |
| | | | | | 1 | 0 | 1 | -6.25 |
| | | | | | 1 | 1 | 0 | -7.5 |
| | | | | | 1 | 1 | 1 | -8.75 |
| 0 | 0 | B2 | B1 | B0 | A2 | A1 | A0 | Volume 10dB steps |
| | | 0 | 0 | 0 | | | | 0 |
| | | 0 | 0 | 1 | | | | -10 |
| | | 0 | 1 | 0 | | | | -20 |
| | | 0 | 1 | 1 | | | | -30 |
| | | 1 | 0 | 0 | | | | -40 |
| | | 1 | 0 | 1 | | | | -50 |
| | | 1 | 1 | 0 | | | | -60 |
| | | 1 | 1 | 1 | | | | -70 |

For example, a volume of –45dB is given by: 00100100

### 2. Speaker attenuators

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | B1 | B0 | A2 | A1 | A0 | Speaker ATT L |
| 1 | 0 | 1 | B1 | B0 | A2 | A1 | A0 | Speaker ATT R |
| | | | | | 0 | 0 | 0 | 0 |
| | | | | | 0 | 0 | 1 | -1.25 |
| | | | | | 0 | 1 | 0 | -2.5 |
| | | | | | 0 | 1 | 1 | -3.75 |
| | | | | | 1 | 0 | 0 | -5 |
| | | | | | 1 | 0 | 1 | -6.25 |
| | | | | | 1 | 1 | 0 | -7.5 |
| | | | | | 1 | 1 | 1 | -8.75 |
| | | | 0 | 0 | | | | 0 |
| | | | 0 | 1 | | | | -10 |
| | | | 1 | 0 | | | | -20 |
| | | | 1 | 1 | | | | -30 |
| | | | 1 | 1 | 1 | 1 | 1 | MUTE |

For example, attenuation of 25dB on speaker R is given by: 10110100

### 3.Loudness function

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | * | * | L | * | * | Loudness control |
| | | | | | 0 | | | Loudness ON |
| | | | | | 1 | | | Loudness OFF |

Note:*=no effect

### 4.Bass and treble

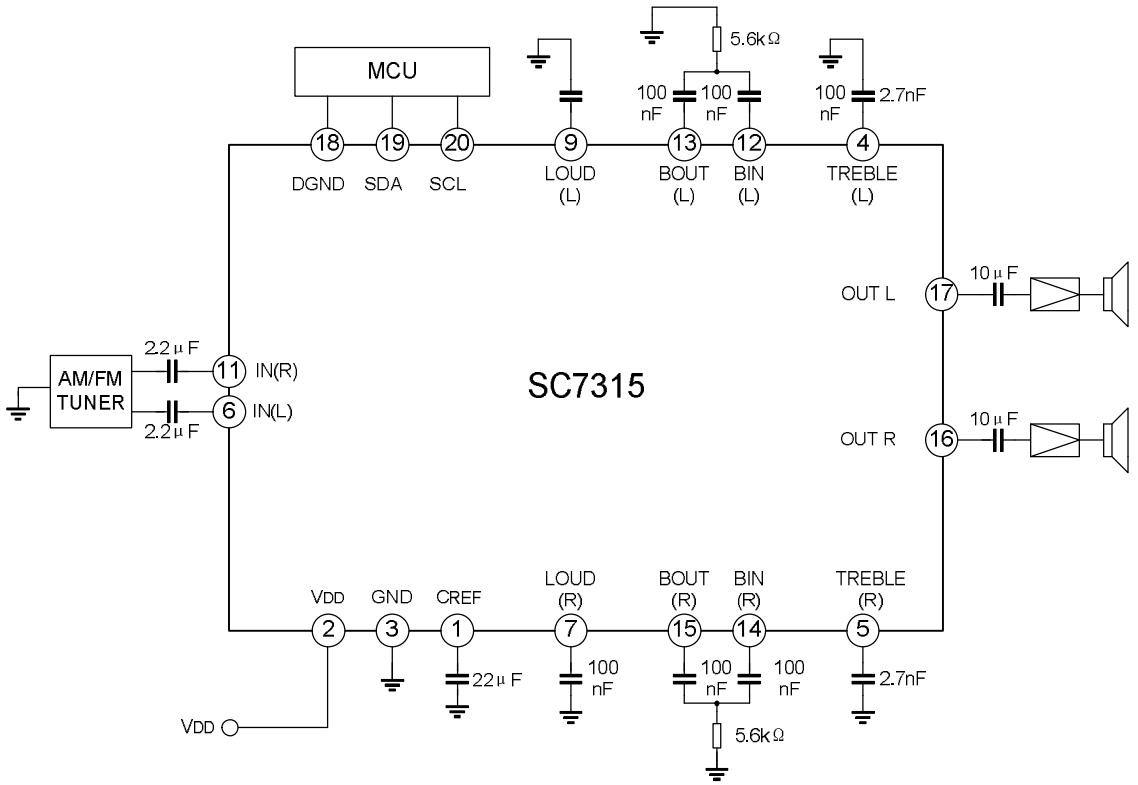
| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | 0 | C3 | C2 | C1 | C0 | Bass |
| 0 | 1 | 1 | 1 | C3 | C2 | C1 | C0 | Terble |
| | | | | 0 | 0 | 0 | 0 | -14 |
| | | | | 0 | 0 | 0 | 1 | -12 |
| | | | | 0 | 0 | 1 | 0 | -10 |
| | | | | 0 | 0 | 1 | 1 | -8 |
| | | | | 0 | 1 | 0 | 0 | -6 |
| | | | | 0 | 1 | 0 | 1 | -4 |
| | | | | 0 | 1 | 1 | 0 | -2 |
| | | | | 0 | 1 | 1 | 1 | 0 |
| | | | | 1 | 1 | 1 | 1 | 0 |
| | | | | 1 | 1 | 1 | 0 | 2 |
| | | | | 1 | 1 | 0 | 1 | 4 |
| | | | | 1 | 1 | 0 | 0 | 6 |
| | | | | 1 | 0 | 1 | 1 | 8 |
| | | | | 1 | 0 | 1 | 0 | 10 |
| | | | | 1 | 0 | 0 | 1 | 12 |
| | | | | 1 | 0 | 0 | 0 | 14 |



C3=Sign

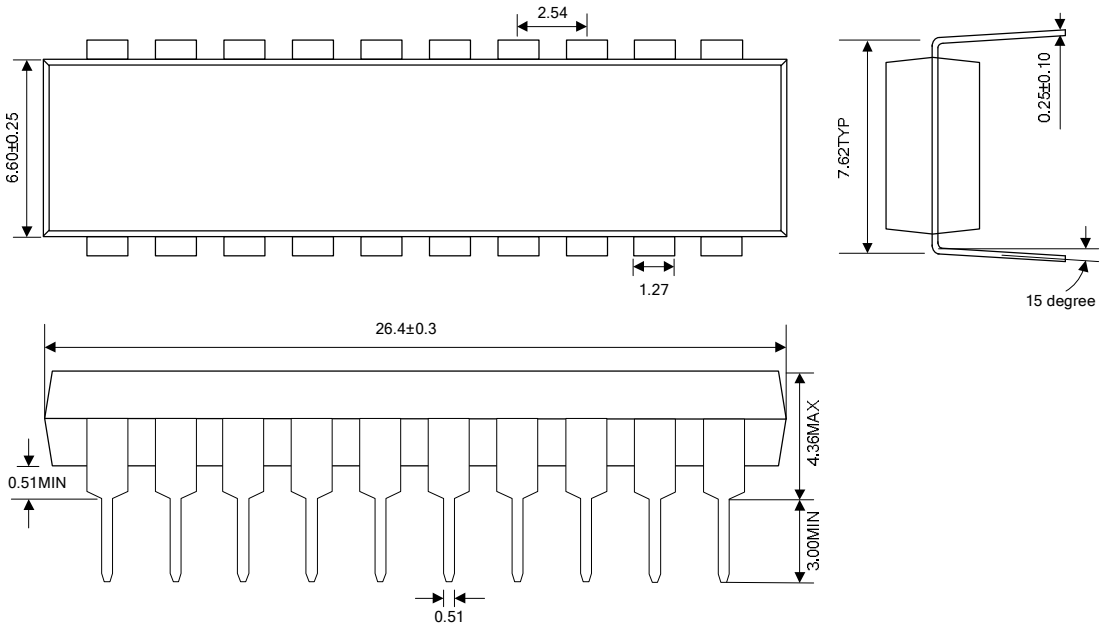
For Example, bass at –10dB is obtained by the following 8 bit string is: 01100010.

## TEST AND TYPICAL APPLICATION CIRCUIT



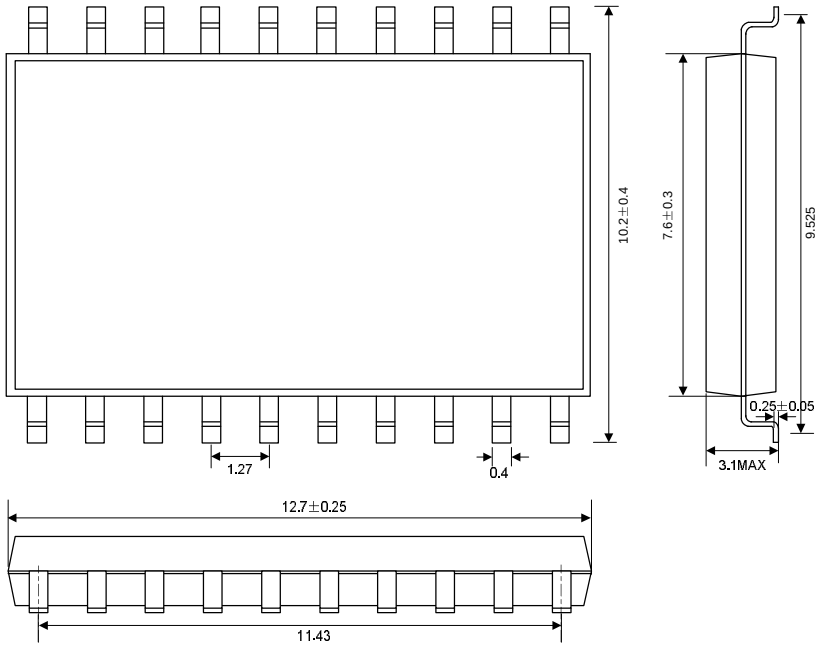
## PACKAGE OUTLINE

**DIP-20-300-2.54** UNIT: mm




**SOP-20-375-1.27** UNIT: mm






**HANDLING MOS DEVICES:**

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic discharge but they can be damaged if the following precautions are not taken:

- Persons at a work bench should be earthed via a wrist strap.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed for dispatch in antistatic/conductive containers.