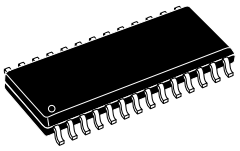
# TDA7443D

## TONE CONTROL AND SURROUND DIGITALLY CONTROLLED AUDIO PROCESSOR WITH AGC

**PRODUCT PREVIEW**

- INPUT MULTIPLEXER
  - 5 STEREO INPUTS
  - SELECTABLE INPUT GAIN FOR OPTIMAL ADAPTATION TO DIFFERENT SOURCES
- ONE STEREO OUTPUT
- AGC
- TREBLE AND BASS CONTROL IN 2.0dB STEPS
- VOLUME CONTROL IN 1.0dB STEPS
- TWO SPEAKER ATTENUATORS:
  - TWO INDEPENDENT SPEAKER CONTROL IN 1.0dB STEPS FOR BALANCE FACILITY
  - INDEPENDENT MUTE FUNCTION
- TWO SURROND MODES AVAILABLE
  - MUSIC
  PSEUDO STEREO
- ALL FUNCTION ARE PROGRAMMABLE VIA SERIAL BUS



**SO28**
**ORDERING NUMBER: TDA7443D**

### DESCRIPTION

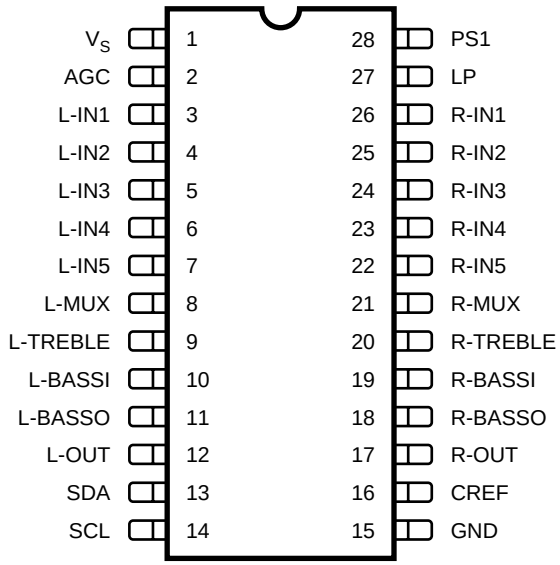
The TDA7443D is a volume tone (bass and treble) balance (Left/Right) processor for quality audio applications in Hi-Fi systems.

Selectable input gain is provided. Control of all the functions is accomplished by serial bus.

The AC signal setting is obtained by resistor networks and switches combined with operational amplifiers.

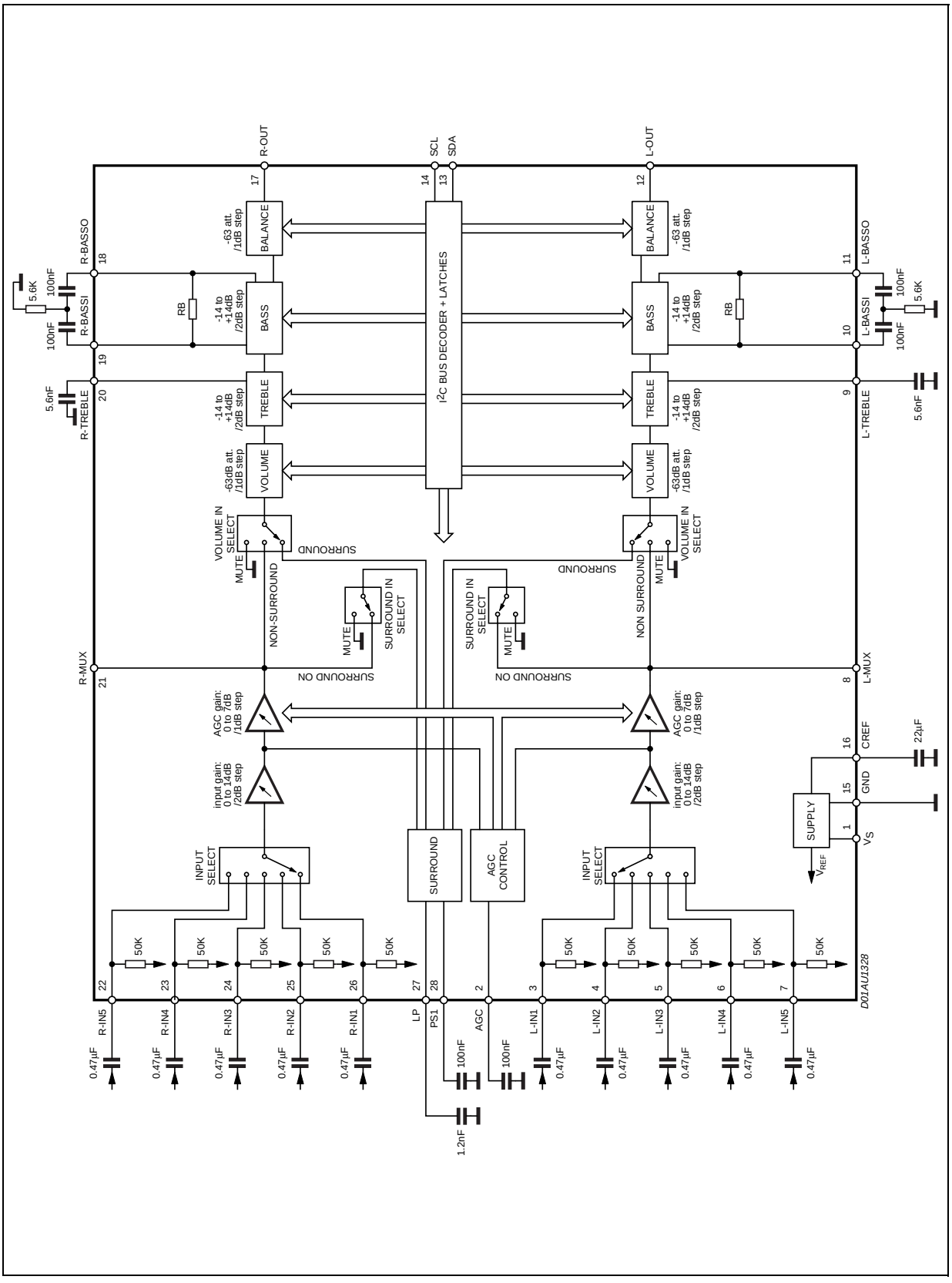
Thanks to the used BIPOLAR/CMOS Technology, Low Distortion, Low Noise and DC stepping are obtained.

**PIN CONNECTION** (Top view)




*D01AU1319*

## BLOCK DIAGRAM & TEST CIRCUIT



## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_S$ | Operating Supply Voltage | 10.5 | V |
| $T_{amb}$ | Operating Ambient Temperature | -10 to 85 | °C |
| $T_{stg}$ | Storage Temperature Range | -55 to 150 | °C |

## THERMAL DATA

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{th\ j\text{-}pin}$ | Thermal Resistance Junction-pins | 85 | °C/W |

## QUICK REFERENCE DATA

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $V_S$ | Supply Voltage | 5 | 9 | 10 | V |
| $V_{CL}$ | Max. input signal handling | 2 | | | Vrms |
| THD | Total Harmonic Distortion V=1Vrms f=1kHz | | 0.01 | 0.1 | % |
| S/N | Signal to Noise Ratio VOUT=1Vrms(mode=OFF) | | 100 | | dB |
| $S_C$ | Channel Separation f=1kHz | | 90 | | dB |
| | Input Gain (2dB step) | 0 | | 14 | dB |
| | AGC Gain (1dB step) | 0 | | 7 | dB |
| | Volume Control (1dB step) | -63 | | 0 | dB |
| | Treble Control (2dB step) | -14 | | +14 | dB |
| | Bass Control (2dB step) | -14 | | +14 | dB |
| | Balance Control (1dB step) | -63 | | 0 | dB |
| | Mute Attenuation | | 90 | | dB |

## ELECTRICAL CHARACTERISTICS

(Refer to the test circuit Tamb=25C, Vs=9V, f=1kHz ,all controls flat, unless otherwise specified)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **SUPPLY** | | | | | | |
| $V_S$ | Supply Voltage | | 5 | 9 | 10 | V |
| $I_S$ | Supply Current | | | tbd | | mA |
| SVR | Ripple Rejection | | 60 | 80 | | dB |
| **INPUT STAGE** | | | | | | |
| $R_{IN}$ | Input Resistance | | 35 | 50 | 65 | kΩ |
| $V_{CL}$ | Clipping Level | THD = 0.3% | 2 | 2.5 | | Vrms |
| $S_{IN}$ | Input Separation | | 80 | 100 | | dB |
| $G_{in\ min}$ | Minimum Input Gain | | -1 | 0 | 1 | dB |
| $G_{in\ max}$ | Maximum Input Gain | | 13 | 14 | 15 | dB |
| $G_{in\ step}$ | Step Resolution | | 1.5 | 2 | 2.5 | dB |
| **AGC** | | | | | | |
| $G_{AGCmin}$ | Minimum AGC Gain | | -1 | 0 | 1 | dB |
| $G_{AGCmax}$ | Maximum AGC Gain | | 6 | 7 | 8 | dB |
| $G_{AGCstep}$ | Step Resolution | | 0.5 | 1 | 1.5 | dB |
| **SURROUND** | | | | | | |
| $R_{IN}$ | Input Resistance | | 35 | 50 | 65 | kΩ |
| $R_{PS0}$ | Phase Shifter:D1=0,D0=0 | | 8.3 | 11.8 | 15.2 | kΩ |
| $R_{PS1}$ | Phase Shifter:D1=0,D0=1 | | 10 | 14.1 | 18.3 | kΩ |
| $R_{PS2}$ | Phase Shifter:D1=1,D0=0 | | 12.6 | 17.9 | 23.3 | kΩ |
| $R_{PS3}$ | Phase Shifter:D1=1,D0=1 | | 26.4 | 37.3 | 48.85 | kΩ |
| $C_{RANGE}$ | Effect Control Range | | -21 | | -6 | dB |
| $S_{step}$ | Effect Control Step Resolution | | 0.5 | 1 | 1.5 | dB |
| **VOLUME CONTROL** | | | | | | |
| $A_{VOLmin}$ | Minimum Attenuation | | -1 | 0 | 1 | dB |
| $A_{VOLmax}$ | Maximum Attenuation | | 61 | 63 | 65 | dB |
| $A_{VOLstep}$ | Step Resolution | | 0.5 | 1 | 1.5 | dB |
| $E_A$ | Attenuation set error | $A_V$ = 0 to –24 dB | -1 | 0 | 1 | dB |
| | | $A_V$ = –24 to –63 dB | -2 | 0 | 2 | dB |
| $V_{DC}$ | DC Steps | Adjacent att. steps | -3 | 0 | 3 | mV |
| **BASS CONTROL** | | | | | | |
| $G_B$ | Control Range | Max. Boost/Cut | ±12 | ±14 | ±16 | dB |

**ELECTRICAL CHARACTERISTICS** (continued)
(Refer to the test circuit Tamb=25C, Vs=9V, f=1kHz ,all controls flat, unless otherwise specified)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $B_{step}$ | Step Resolution | | 1 | 2 | 3 | dB |
| $R_B$ | Internal Feedback Resistance | | 33 | 44 | 55 | kΩ |
| **TREBLE CONTROL** | | | | | | |
| $G_T$ | Control Range | Max. Boost/Cut | ±13 | ±14 | ±15 | dB |
| $T_{step}$ | Step Resolution | | 1 | 2 | 3 | dB |
| $R_T$ | Internal Feedback Resistance | | | 25 | | kΩ |
| **BALANCE CONTROL** | | | | | | |
| $A_{BALmin}$ | Minimum Attenuation | | -1 | 0 | 1 | dB |
| $A_{BALmax}$ | Maximum Attenuation | | 61 | 63 | 65 | dB |
| $A_{BALstep}$ | Step Resolution | | | 1 | | dB |
| $E_A$ | Attenuation set error | $A_V$ = 0 to –24 dB | -1 | 0 | 1 | dB |
| | | $A_V$ = –24 to –63 dB | -2 | 0 | 2 | dB |
| $V_{DC}$ | DC Steps | Adjacent att. steps | -3 | 0 | 3 | mV |
| **AUDIO OUTPUTS** | | | | | | |
| $V_{OCL}$ | Clipping Level | THD = 0.3% | 2 | 2.5 | | Vrms |
| $R_L$ | Output Load Resistance | | 2 | | | kΩ |
| $V_{OUT}$ | DC Voltage Level | | | 4.5 | | V |
| $N_{O(OFF)}$ | Output Noise (OFF) | BW=20Hz to 20kHz;<br>All gains 0dB;<br>Output muted<br>flat | | <br><br>5<br>10 | <br><br><br>15 | <br><br>µV<br>µV |
| $N_{O(MUS)}$ | Output Noise (Music) | BW=20Hz to 20kHz;<br>Mode=Music | | 30 | | µV |
| $N_{O(PS)}$ | Output Noise(Pseudo Stereo) | BW=20Hz to 20kHz;<br>Mode=Pseudo Stereo | | 30 | | µV |
| $A_{MUTE}$ | Output Mute Condition | | | 90 | | dB |
| S/N | Signal to Noise Ratio | All gains 0dB;$V_O$ = 1Vrms | | 100 | | dB |
| $S_C$ | Channel Separation Left/Right | | | 90 | | dB |
| d | Distortion | $A_V$ = 0; $V_I$ = 1Vrms | | 0.01 | 0.1 | % |
| **BUS INPUT** | | | | | | |
| $V_{IL}$ | Input Low Voltage | | | | 1 | V |
| $V_{IH}$ | Input High Voltage | | 2.5 | | | V |
| $I_{IN}$ | Input Current | $V_{IN}$ = 0.4V | -5 | | 5 | µA |
| $V_O$ | Output Voltage (ACK) | $I_O$ = 1.6mA | | 0.4 | 0.8 | V |

## I²C BUS INTERFACE

Data transmission from microprocessor to the TDA7443D and vice versa takes place through the 2 wires I²C BUS interface, consisting of the two lines SDA and SCL (pull-up resistors to positive supply voltage must be connected).

### Data Validity

As shown in fig. 1, the data on the SDA line must be stable during the high period of the clock. The HIGH and LOW state of the data line can only change when the clock signal on the SCL line is LOW.

### Start and Stop Conditions

As shown in fig. 2 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.

### Byte Format

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

### Acknowledge

The master (µP) puts a resistive HIGH level on the SDA line during the acknowledge clock pulse (see fig. 3). The peripheral (audio processor) that acknowledges has to pull-down (LOW) the SDA line during this clock pulse.

The audio processor which has been addressed has to generate an acknowledge after the reception of each byte, otherwise the SDA line remains 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.

### Transmission without Acknowledge

Avoiding to detect the acknowledge of the audio processor, the µP can use a simpler transmission: simply it waits one clock without checking the slave acknowledging, and sends the new data.

This approach of course is less protected from misworking.

**Figure 1. Data Validity on the I²CBUS**

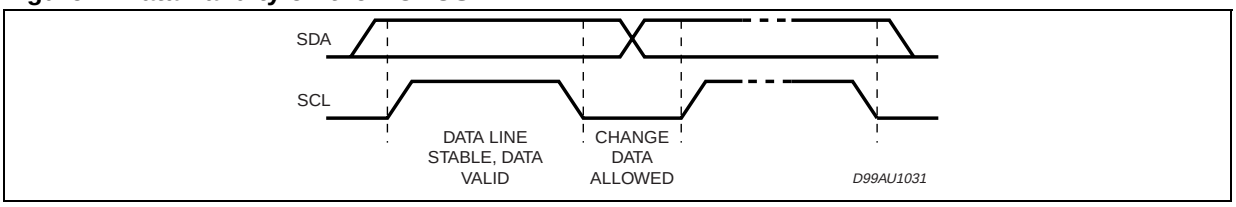



**Figure 2. Timing Diagram of I²CBUS**

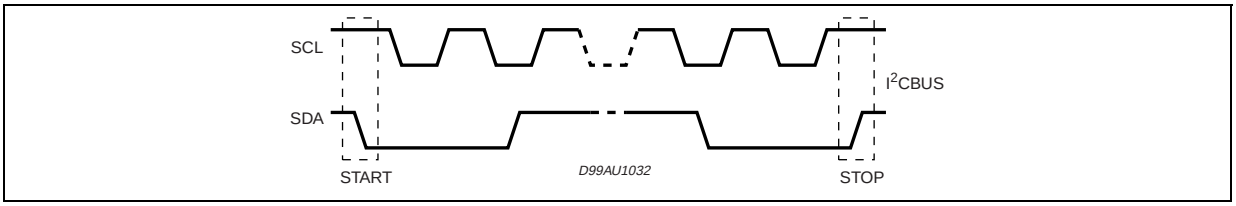
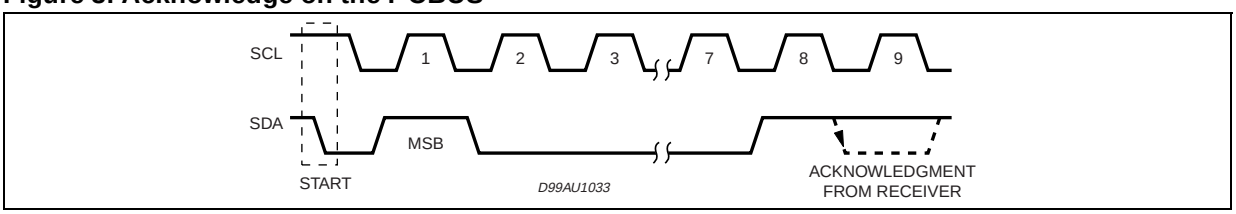



**Figure 3. Acknowledge on the I²CBUS**

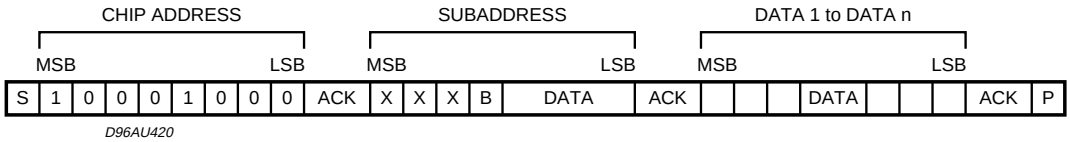


## SOFTWARE SPECIFICATION

Interface Protocol

The interface protocol comprises:

- A start condition (S)
- A chip address byte, containing the TDA7440D address
- A subaddress bytes
- A sequence of data (N byte + acknowledge)
- A stop condition (P)

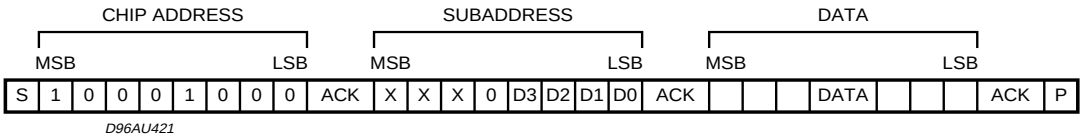



ACK = Acknowledge; S = Start; P = Stop; A = Address; B = Auto Increment

## EXAMPLES

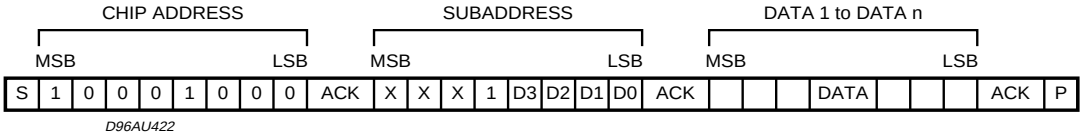
### No Incremental Bus

The TDA7443D receives a start condition, the correct chip address, a subaddress with the B = 0 (no incremental bus), N-data (all these data concern the subaddress selected), a stop condition.




### Incremental Bus

The TDA7443D receivea start conditions, the correct chip address, a subaddress with the B = 1 (incremental bus): now it is in a loop condition with an autoincrease of the subaddress whereas SUBADDRESS from "XXX1000" to "XXX1111" of DATA are ignored.The DATA 1 concern the subaddress sent, and the DATA 2 concern the subaddress sent plus one in the loop etc, and at the end it receivers the stop condition.



**POWER ON RESET CONDITION**

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |

**DATA BYTES**

Address=(HEX) 10001000

FUNCTION SELECTION: First byte (subaddress)

| MSB | | | | | | | LSB | SUBADDRESS |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| X | X | X | B | 0 | 0 | 0 | 0 | INPUT |
| X | X | X | B | 0 | 0 | 0 | 1 | AGC |
| X | X | X | B | 0 | 0 | 1 | 0 | SURROUND |
| X | X | X | B | 0 | 0 | 1 | 1 | VOLUME |
| X | X | X | B | 0 | 1 | 0 | 0 | TONE |
| X | X | X | B | 0 | 1 | 0 | 1 | BALANCE “L” |
| X | X | X | B | 0 | 1 | 1 | 0 | BALANCE “R” |

B=1: INCREMENTAL BUS; ACTIVE

B=0: NO INCREMENTAL BUS

X= INDIFFERENT 0/1

**INPUT**

| MSB | | | | | | | LSB | SUBADDRESS |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **INPUT SELECT** |
| | | | | | 0 | 0 | 0 | IN1 |
| | | | | | 0 | 0 | 1 | IN2 |
| | | | | | 0 | 1 | 0 | IN3 |
| | | | | | 0 | 1 | 1 | IN4 |
| | | | | | 1 | X | X | IN5 |
| | | | | | | | | **MUTE** |
| | | | | 0 | | | | Output Mute OFF |
| | | | | 1 | | | | Output Mute ON |
| | | | | | | | | **SURROUND IN SELECT** |
| | | | 0 | | | | | Surround ONl |
| | | | 1 | | | | | Mute |
| | | | | | | | | **INPUT GAIN** |
| 0 | 0 | 0 | | | | | | 0dB |
| 0 | 0 | 1 | | | | | | 2dB |
| 0 | 1 | 0 | | | | | | 4dB |
| 0 | 1 | 1 | | | | | | 6dB |
| 1 | 0 | 0 | | | | | | 8dB |
| 1 | 0 | 1 | | | | | | 10dB |
| 1 | 1 | 0 | | | | | | 12dB |
| 1 | 1 | 1 | | | | | | 14dB |

**AGC**

| MSB | | | | | | | LSB | SUBADDRESS |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **AGC MODE** |
| | | | | | | | 0 | OFF |
| | | | | | | | 1 | ON |
| | | | | | | | | **DETECTOR** |
| | | | | | | 0 | | OFF |
| | | | | | | 1 | | ON |
| | | | | | | | | **RELEASE CURRENT** |
| | | | | | 0 | | | OFF |
| | | | | | 1 | | | ON |
| | | | | | | | | **ATTACK TIME** |
| | | | 0 | 0 | | | | ATTACK1 |
| | | | 0 | 1 | | | | ATTACK2 |
| | | | 1 | 0 | | | | ATTACK3 |
| | | | 1 | 1 | | | | ATTACK4 |
| | | | | | | | | **TARGET LEVEL** |
| | 0 | 0 | | | | | | TARGET1 |
| | 0 | 1 | | | | | | TARGET2 |
| | 1 | 0 | | | | | | TARGET3 |
| | 1 | 1 | | | | | | TARGET4 |
| | | | | | | | | **ZEROCROSS** |
| 0 | | | | | | | | OFF |
| 1 | | | | | | | | ON |

**SURROUND**

| MSB | | | | | | | LSB | SUBADDRESS |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **SURROUND MODE** |
| | | | | | | 0 | | PSEUDO STEREO |
| | | | | | | 1 | | MUSIC |
| | | | | | | | | **EFFECT CONTROL** |
| | | 0 | 0 | 0 | 0 | | | -6 dB |
| | | 0 | 0 | 0 | 1 | | | -7 dB |
| | | 0 | 0 | 1 | 0 | | | -8 dB |
| | | 0 | 0 | 1 | 1 | | | -9 dB |
| | | 0 | 1 | 0 | 0 | | | -10 dB |
| | | 0 | 1 | 0 | 1 | | | -11 dB |
| | | 0 | 1 | 1 | 0 | | | -12 dB |
| | | 0 | 1 | 1 | 1 | | | -13 dB |
| | | 1 | 0 | 0 | 0 | | | -14 dB |
| | | 1 | 0 | 0 | 1 | | | -15 dB |
| | | 1 | 0 | 1 | 0 | | | -16 dB |
| | | 1 | 0 | 1 | 1 | | | -17 dB |
| | | 1 | 1 | 0 | 0 | | | -18 dB |
| | | 1 | 1 | 0 | 1 | | | -19 dB |
| | | 1 | 1 | 1 | 0 | | | -20 dB |
| | | 1 | 1 | 1 | 1 | | | -21 dB |
| | | | | | | | | **PHASE SHIFT RESISTOR** |
| 0 | 0 | | | | | | | 12 kohm |
| 0 | 1 | | | | | | | 14 kohm |
| 1 | 0 | | | | | | | 18 kohm |
| 1 | 1 | | | | | | | 37 kohm |

**VOLUME**

| MSB | | | | | | | LSB | SUBADDRESS |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **VOLUME IN SELECT** |
| | | | | | | 0 | 0 | Surround |
| | | | | | | 0 | 1 | Non Surround |
| | | | | | | 1 | X | Mute |
| | | | | | | | | **1dB STEPS** |
| | | | 0 | 0 | 0 | | | 0dB |
| | | | 0 | 0 | 1 | | | -1dB |
| | | | 0 | 1 | 0 | | | -2dB |
| | | | 0 | 1 | 1 | | | -3dB |
| | | | 1 | 0 | 0 | | | -4dB |
| | | | 1 | 0 | 1 | | | -5dB |
| | | | 1 | 1 | 0 | | | -6dB |
| | | | 1 | 1 | 1 | | | -7dB |
| | | | | | | | | **8dB STEPS** |
| 0 | 0 | 0 | | | | | | 0dB |
| 0 | 0 | 1 | | | | | | -8dB |
| 0 | 1 | 0 | | | | | | -16dB |
| 0 | 1 | 1 | | | | | | -24dB |
| 1 | 0 | 0 | | | | | | -32dB |
| 1 | 0 | 1 | | | | | | -40dB |
| 1 | 1 | 0 | | | | | | -48dB |
| 1 | 1 | 1 | | | | | | -56dB |

VOLUME=0 to –63dB

**TREBLE & BASS**

| MSB | | | | | | | LSB | SUBADDRESS |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | TREBLE |
| | | | | 0 | 0 | 0 | 0 | -14 dB |
| | | | | 0 | 0 | 0 | 1 | -12 dB |
| | | | | 0 | 0 | 1 | 0 | -10 dB |
| | | | | 0 | 0 | 1 | 1 | -8 dB |
| | | | | 0 | 1 | 0 | 0 | -6 dB |
| | | | | 0 | 1 | 0 | 1 | -4 dB |
| | | | | 0 | 1 | 1 | 0 | -2 dB |
| | | | | 0 | 1 | 1 | 1 | 0 dB |
| | | | | 1 | 0 | 0 | 0 | 14 dB |
| | | | | 1 | 0 | 0 | 1 | 12 dB |
| | | | | 1 | 0 | 1 | 0 | 10 dB |
| | | | | 1 | 0 | 1 | 1 | 8 dB |
| | | | | 1 | 1 | 0 | 0 | 6 dB |
| | | | | 1 | 1 | 0 | 1 | 4 dB |
| | | | | 1 | 1 | 1 | 0 | 2 dB |
| | | | | 1 | 1 | 1 | 1 | 0 dB |
| | | | | | | | | BASS |
| 0 | 0 | 0 | 0 | | | | | -14 dB |
| 0 | 0 | 0 | 1 | | | | | -12 dB |
| 0 | 0 | 1 | 0 | | | | | -10 dB |
| 0 | 0 | 1 | 1 | | | | | -8 dB |
| 0 | 1 | 0 | 0 | | | | | -6 dB |
| 0 | 1 | 0 | 1 | | | | | -4 dB |
| 0 | 1 | 1 | 0 | | | | | -2 dB |
| 0 | 1 | 1 | 1 | | | | | 0 dB |
| 1 | 0 | 0 | 0 | | | | | 14 dB |
| 1 | 0 | 0 | 1 | | | | | 12 dB |
| 1 | 0 | 1 | 0 | | | | | 10 dB |
| 1 | 0 | 1 | 1 | | | | | 8 dB |
| 1 | 1 | 0 | 0 | | | | | 6 dB |
| 1 | 1 | 0 | 1 | | | | | 4 dB |
| 1 | 1 | 1 | 0 | | | | | 2 dB |
| 1 | 1 | 1 | 1 | | | | | 0 dB |

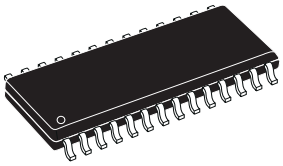
**BALANCE**

| MSB | | | | | | | LSB | SUBADDRESS |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | 1dB STEPS |
| | | | 0 | 0 | 0 | | | 0dB |
| | | | 0 | 0 | 1 | | | -1dB |
| | | | 0 | 1 | 0 | | | -2dB |
| | | | 0 | 1 | 1 | | | -3dB |
| | | | 1 | 0 | 0 | | | -4dB |
| | | | 1 | 0 | 1 | | | -5dB |
| | | | 1 | 1 | 0 | | | -6dB |
| | | | 1 | 1 | 1 | | | -7dB |
| | | | | | | | | 8dB STEPS |
| 0 | 0 | 0 | | | | | | 0dB |
| 0 | 0 | 1 | | | | | | -8dB |
| 0 | 1 | 0 | | | | | | -16dB |
| 0 | 1 | 1 | | | | | | -24dB |
| 1 | 0 | 0 | | | | | | -32dB |
| 1 | 0 | 1 | | | | | | -40dB |
| 1 | 1 | 0 | | | | | | -48dB |
| 1 | 1 | 1 | | | | | | -56dB |

VOLUME=0 to –63dB

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 2.65 | | | 0.104 |
| a1 | 0.1 | | 0.3 | 0.004 | | 0.012 |
| b | 0.35 | | 0.49 | 0.014 | | 0.019 |
| b1 | 0.23 | | 0.32 | 0.009 | | 0.013 |
| C | | 0.5 | | | 0.020 | |
| c1 | 45° (typ.) | | | | | |
| D | 17.7 | | 18.1 | 0.697 | | 0.713 |
| E | 10 | | 10.65 | 0.394 | | 0.419 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 16.51 | | | 0.65 | |
| F | 7.4 | | 7.6 | 0.291 | | 0.299 |
| L | 0.4 | | 1.27 | 0.016 | | 0.050 |
| S | 8 ° (max.) | | | | | |

## OUTLINE AND MECHANICAL DATA



**SO28**