



# TDA7449L

## LOW COST DIGITALLY CONTROLLED AUDIO PROCESSOR

### 1 FEATURES

- INPUT MULTIPLEXER
  - 2 STEREO INPUTS
  - SELECTABLE INPUT GAIN FOR OPTIMAL ADAPTATION TO DIFFERENT SOURCES
- ONE STEREO OUTPUT
- VOLUME CONTROL IN 1.0dB STEPS
- TWO SPEAKER ATTENUATORS:
  - TWO INDEPENDENT SPEAKER CONTROL IN 1.0dB STEPS FOR BALANCE FACILITY
  - INDEPENDENT MUTE FUNCTION
- ALL FUNCTION ARE PROGRAMMABLE VIA SERIAL BUS

### 2 DESCRIPTION

The TDA7449L is a volume control and balance (Left/Right) processor for quality audio applications in TV systems.

Figure 1. Package

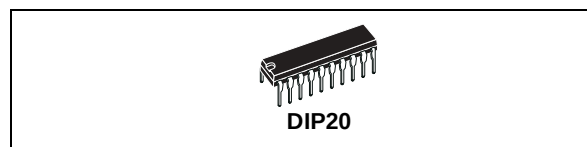


Table 1. Order Codes

| Part Number | Package |
|-------------|---------|
| TDA7449L    | DIP20   |

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.

Figure 2. Block Diagram

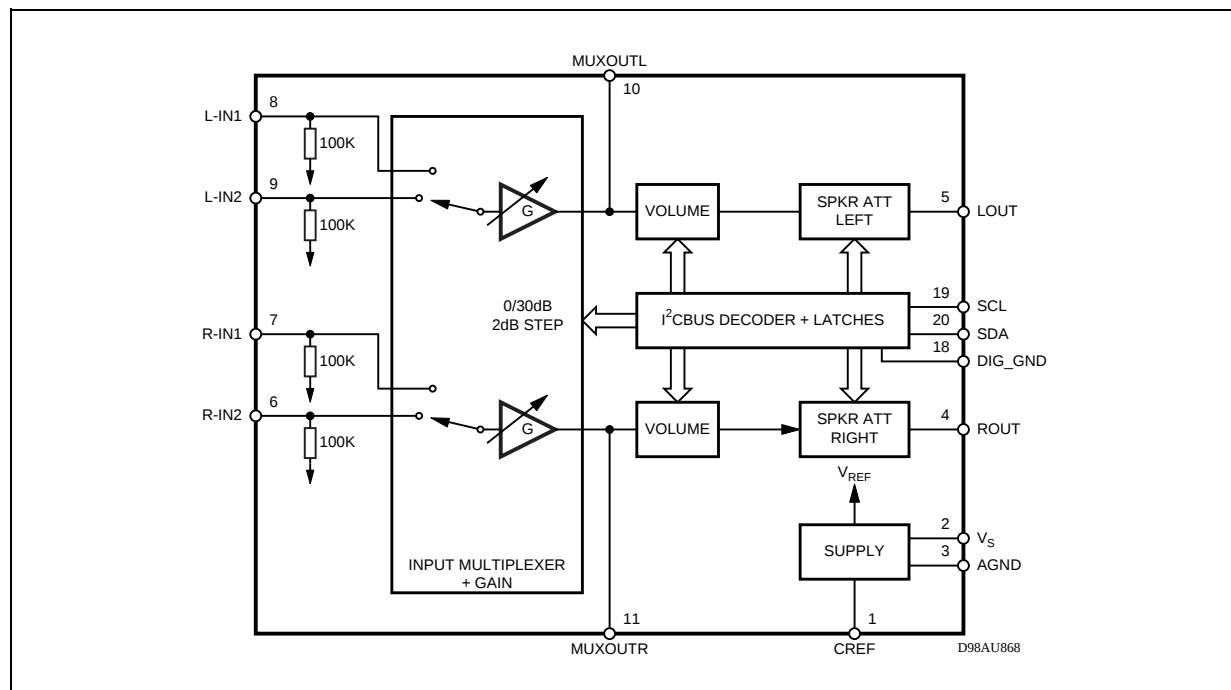


Table 2. Absolute Maximum Ratings

| Symbol           | Parameter                     | Value      | Unit |
|------------------|-------------------------------|------------|------|
| V <sub>S</sub>   | Operating Supply Voltage      | 10.5       | V    |
| T <sub>amb</sub> | Operating Ambient Temperature | 0 to 70    | °C   |
| T <sub>stg</sub> | Storage Temperature Range     | -55 to 150 | °C   |

Figure 3. Pin Connection

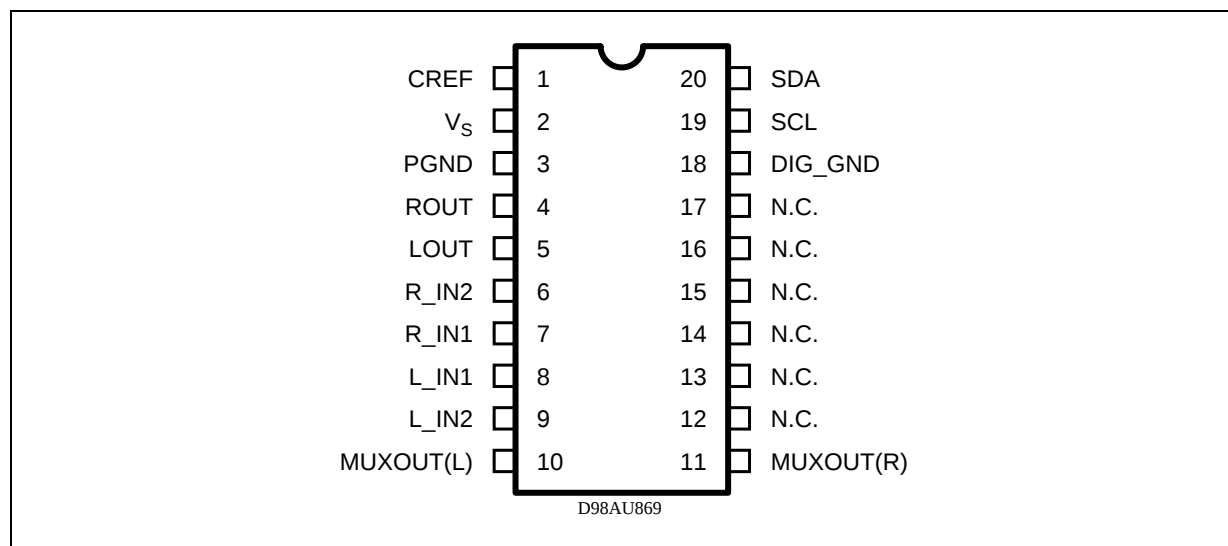


Table 3. Thermal Data

| Symbol                | Parameter                         | Value | Unit |
|-----------------------|-----------------------------------|-------|------|
| R <sub>th j-pin</sub> | Thermal Resistance Junction- pins | 150   | °C/W |

Table 4. Quick Reference Data

| Symbol          | Parameter                                                   | Min. | Typ. | Max. | Unit             |
|-----------------|-------------------------------------------------------------|------|------|------|------------------|
| V <sub>S</sub>  | Supply Voltage                                              | 6    | 9    | 10.2 | V                |
| V <sub>CL</sub> | Max Input Signal Handling                                   | 2    |      |      | V <sub>RMS</sub> |
| THD             | Total Harmonic Distortion V = 0.1Vrms f = 1KHz              |      | 0.01 | 0.1  | %                |
| S/N             | Signal to Noise Ratio V <sub>out</sub> = 1Vrms (mode = OFF) |      | 106  |      | dB               |
| S <sub>C</sub>  | Channel Separation f = 1KHz                                 |      | 90   |      | dB               |
|                 | Input Gain (2dB step)                                       | 0    |      | 30   | dB               |
|                 | Volume Control (1dB step)                                   | -47  |      | 0    | dB               |
|                 | Balance Control 1dB step                                    | -79  |      | 0    | dB               |
|                 | Mute Attenuation                                            |      | 100  |      | dB               |

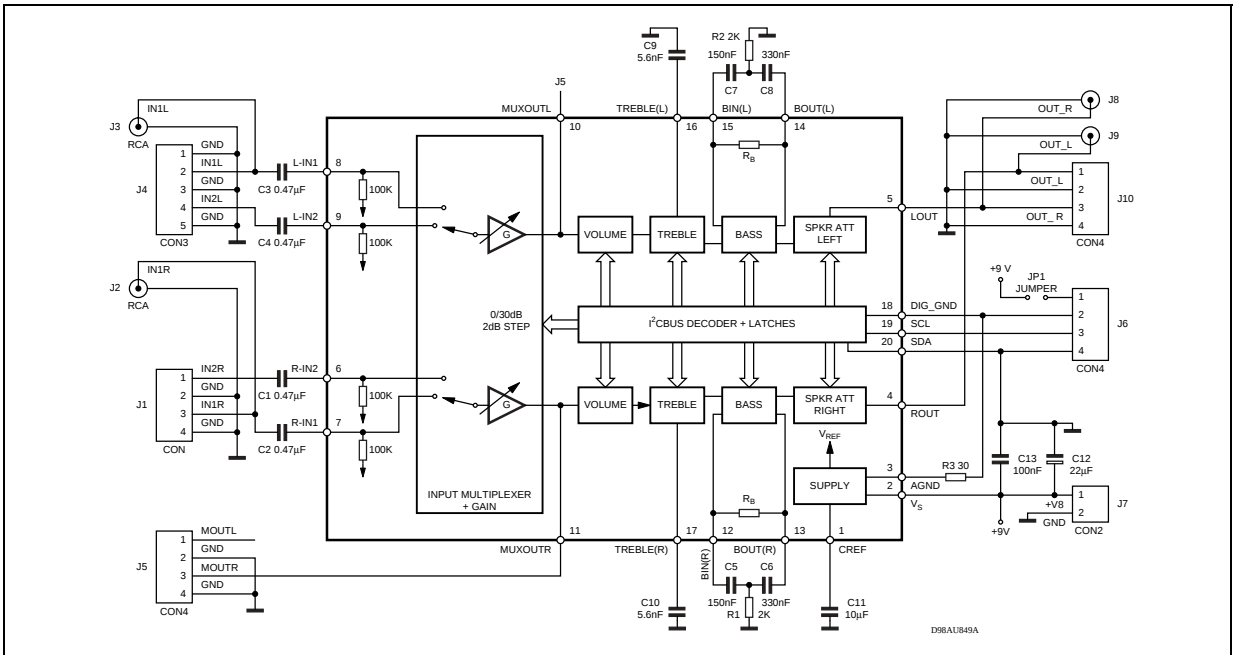
**Table 5. Electrical Characteristics** (refer to the test circuit  $T_{amb} = 25^{\circ}\text{C}$ ,  $V_S = 9\text{V}$ ,  $R_L = 10\text{k}\Omega$ ,  $R_G = 600\Omega$ , all controls flat ( $G = 0\text{dB}$ ), unless otherwise specified)

| Symbol                     | Parameter             | Test Condition                                               | Min. | Typ. | Max. | Unit             |
|----------------------------|-----------------------|--------------------------------------------------------------|------|------|------|------------------|
| <b>SUPPLY</b>              |                       |                                                              |      |      |      |                  |
| $V_S$                      | Supply Voltage        |                                                              | 6    | 9    | 10.2 | V                |
| $I_S$                      | Supply Current        |                                                              |      | 7    |      | mA               |
| SVR                        | Ripple Rejection      |                                                              | 60   | 90   |      | dB               |
| <b>INPUT STAGE</b>         |                       |                                                              |      |      |      |                  |
| $R_{IN}$                   | Input Resistance      |                                                              |      | 100  |      | $\text{k}\Omega$ |
| $V_{CL}$                   | Clipping Level        | THD = 0.3%                                                   | 2    | 2.5  |      | V <sub>rms</sub> |
| $S_{IN}$                   | Input Separation      | The selected input is grounded through a 2.2 $\mu$ capacitor | 80   | 100  |      | dB               |
| $G_{inmin}$                | Minimum Input Gain    |                                                              | -1   | 0    | 1    | dB               |
| $G_{inmax}$                | Maximum Input Gain    |                                                              |      | 30   |      | dB               |
| $G_{step}$                 | Step Resolution       |                                                              |      | 2    |      | dB               |
| <b>VOLUME CONTROL</b>      |                       |                                                              |      |      |      |                  |
| $C_{RANGE}$                | Control Range         |                                                              | 45   | 47   | 49   | dB               |
| $A_{VMAX}$                 | Max. Attenuation      |                                                              | 45   | 47   | 49   | dB               |
| $A_{STEP}$                 | Step Resolution       |                                                              | 0.5  | 1    | 1.5  | dB               |
| $E_A$                      | Attenuation Set Error | $A_V = 0$ to $-24\text{dB}$                                  | -1.0 | 0    | 1.0  | dB               |
|                            |                       | $A_V = -24$ to $-47\text{dB}$                                | -1.5 | 0    | 1.5  | dB               |
| $E_T$                      | Tracking Error        | $A_V = 0$ to $-24\text{dB}$                                  |      | 0    | 1    | dB               |
|                            |                       | $A_V = -24$ to $-47\text{dB}$                                |      | 0    | 2    | dB               |
| $V_{DC}$                   | DC Step               | adjacent attenuation steps                                   |      | 0    | 3    | mV               |
|                            |                       | from 0dB to $A_V$ max                                        |      | 0.5  |      | mV               |
| $A_{mute}$                 | Mute Attenuation      |                                                              | 80   | 100  |      | dB               |
| <b>SPEAKER ATTENUATORS</b> |                       |                                                              |      |      |      |                  |
| $C_{RANGE}$                | Control Range         |                                                              |      | 76   |      | dB               |
| $S_{STEP}$                 | Step Resolution       |                                                              | 0.5  | 1    | 1.5  | dB               |
| $E_A$                      | Attenuation Set Error | $A_V = 0$ to $-20\text{dB}$                                  | -1.5 | 0    | 1.5  | dB               |
|                            |                       | $A_V = -20$ to $-56\text{dB}$                                | -2   | 0    | 2    | dB               |
| $V_{DC}$                   | DC Step               | adjacent attenuation steps                                   |      | 0    | 3    | mV               |
| $A_{mute}$                 | Mute Attenuation      |                                                              | 80   | 100  |      | dB               |

Table 5. Electrical Characteristics (continued)

| AUDIO OUTPUTS |                                |                                             |     |      |      |           |
|---------------|--------------------------------|---------------------------------------------|-----|------|------|-----------|
| $V_{CLIP}$    | Clipping Level                 | $d = 0.3\%$                                 | 2.1 | 2.6  |      | $V_{RMS}$ |
| $R_L$         | Output Load Resistance         |                                             | 2   |      |      | $K\Omega$ |
| $R_O$         | Output Impedance               |                                             | 10  | 40   | 70   | W         |
| $V_{DC}$      | DC Voltage Level               |                                             |     | 3.8  |      | V         |
| GENERAL       |                                |                                             |     |      |      |           |
| $E_{NO}$      | Output Noise                   | All gains = 0dB;<br>BW = 20Hz to 20KHz flat |     | 5    | 15   | $\mu V$   |
| $E_t$         | Total Tracking Error           | $A_V = 0$ to -24dB                          |     | 0    | 1    | dB        |
|               |                                | $A_V = -24$ to -47dB                        |     | 0    | 2    | dB        |
| S/N           | Signal to Noise Ratio          | All gains 0dB; $V_O = 1V_{RMS}$ ;           |     | 106  |      | dB        |
| $S_C$         | Channel Separation Left/Right  |                                             | 80  | 100  |      | dB        |
| d             | Distortion                     | $A_V = 0$ ; $V_I = 1V_{RMS}$ ;              |     | 0.01 | 0.08 | %         |
| BUS INPUT     |                                |                                             |     |      |      |           |
| $V_{IL}$      | Input Low Voltage              |                                             |     |      | 1    | V         |
| $V_{IH}$      | Input High Voltage             |                                             | 3   |      |      | V         |
| $I_{IN}$      | Input Current                  | $V_{IN} = 0.4V$                             | -5  |      | 5    | $\mu A$   |
| $V_O$         | Output Voltage SDA Acknowledge | $I_O = 1.6mA$                               |     | 0.4  | 0.8  | V         |

Figure 4. Test Circuit



### 3 APPLICATION SUGGESTIONS

The first and the last stages are volume control blocks. The control range is 0 to -47dB (mute) for the first one, 0 to -79dB (mute) for the last one. Both of them have 1dB step resolution.

The very high resolution allows the implementation of systems free from any noisy acoustical effect. The TDA7449L audioprocessor provides 2 bands tones control.

#### 3.1 CREF

The suggested 10 $\mu$ F reference capacitor (CREF) value can be reduced to 4.7 $\mu$ F if the application requires faster power ON.

Figure 5. THD vs. frequency

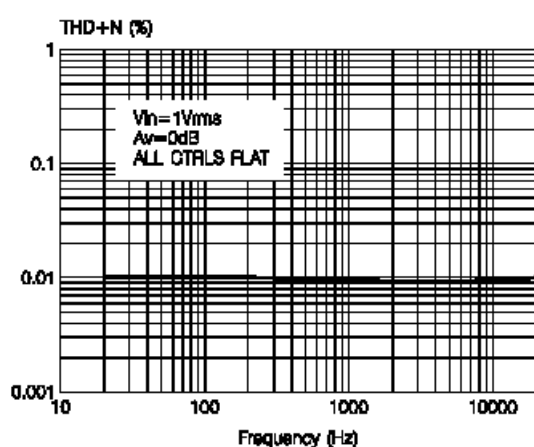


Figure 7. Channel separation vs. frequency

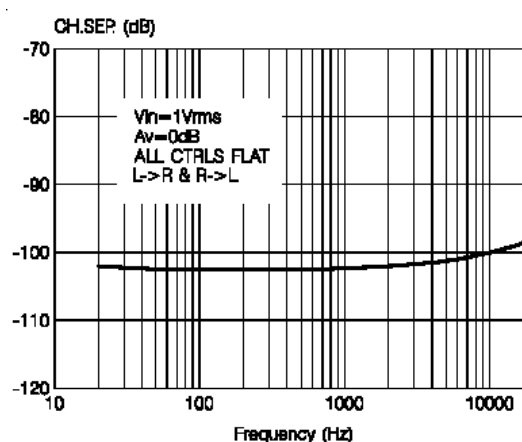
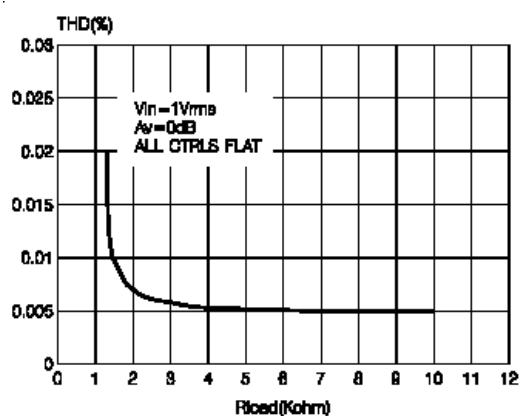


Figure 6. THD vs. RLOAD



## 4 I<sup>2</sup>C BUS INTERFACE

Data transmission from microprocessor to the TDA7449L and vice versa takes place through the 2 wires I<sup>2</sup>C BUS interface, consisting of the two lines SDA and SCL (pull-up resistors to positive supply voltage must be connected).

### 4.1 Data Validity

As shown in fig. 8, 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.

### 4.2 Start and Stop Conditions

As shown in fig.9 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.

### 4.3 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.

### 4.4 Acknowledge

The master ( $\mu$ P) puts a resistive HIGH level on the SDA line during the acknowledge clock pulse (see fig. 10). 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.

### 4.5 Transmission without Acknowledge

Avoiding to detect the acknowledge of the audio processor, the  $\mu$ P 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 8. Data Validity on the I<sup>2</sup>C BUS

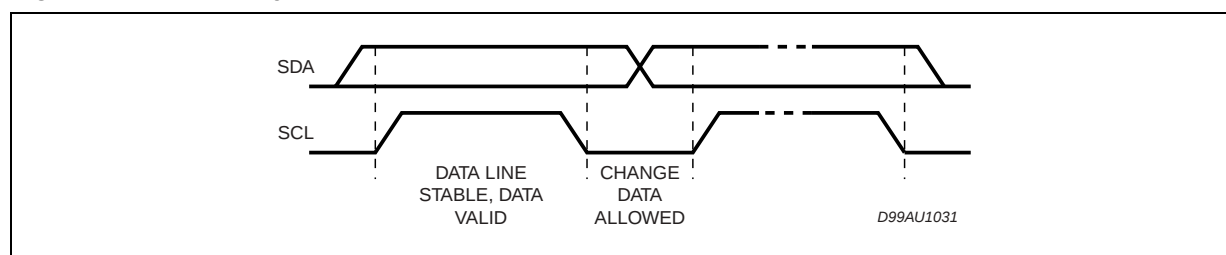
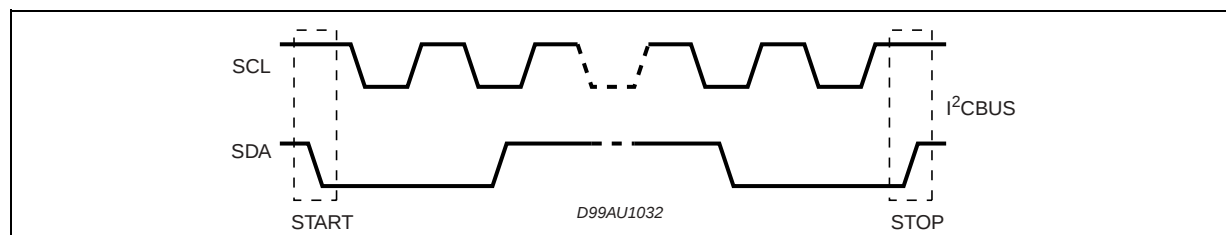
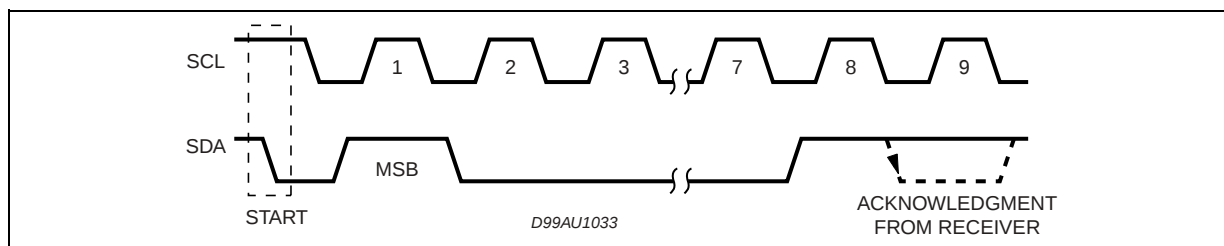


Figure 9. Timing Diagram of I<sup>2</sup>C BUS



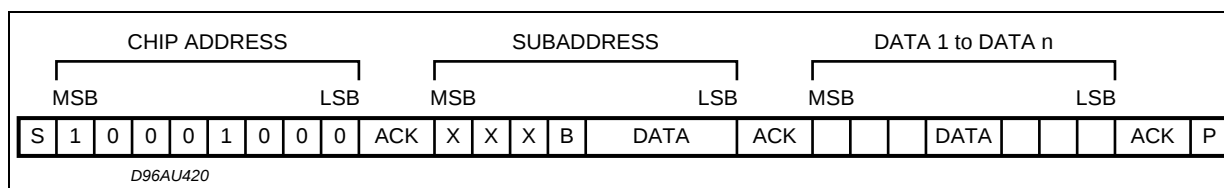
**Figure 10. Acknowledge on the I<sup>2</sup>C BUS**

## 5 SOFTWARE SPECIFICATION

### 5.1 Interface Protocol

The interface protocol comprises:

- A start condition (S)
- A chip address byte, containing the TDA7449L address
- A subaddress bytes
- A sequence of data (N byte + acknowledge)
- A stop condition (P)

**Figure 11.**

ACK = Acknowledge

S = Start

P = Stop

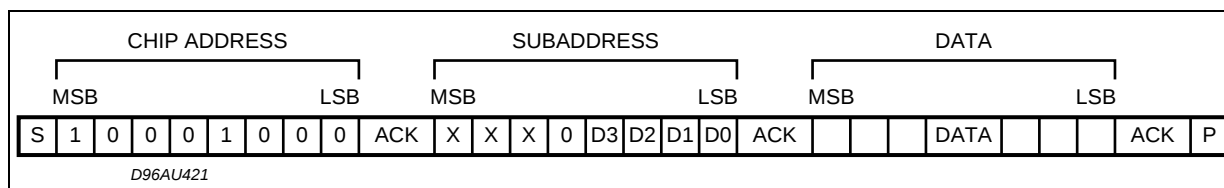
A = Address

B = Auto Increment

## 6 EXAMPLES

### 6.1 No Incremental Bus

The TDA7449L 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.

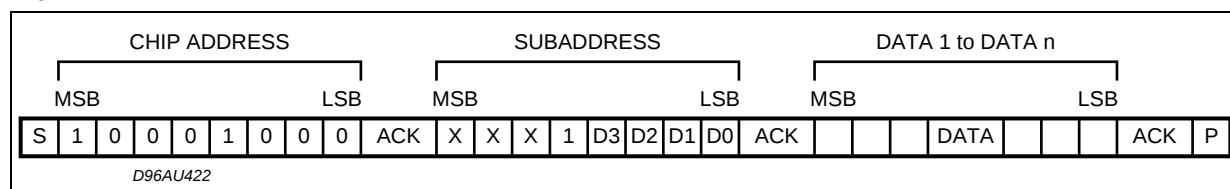
**Figure 12.**

## 6.2 Incremental Bus

The TDA7449L receive a 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 receives the stop condition.

**Figure 13.**



**Table 6. POWER ON RESET CONDITION**

|                 |      |
|-----------------|------|
| INPUT SELECTION | IN2  |
| INPUT GAIN      | 28dB |
| VOLUME          | MUTE |
| SPEAKER         | MUTE |

## 7 DATA BYTES

Address = 88 HEX (ADDR:OPEN).

**Table 7. 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 SELECT          |
| X   | X  | X  | B  | 0  | 0  | 0  | 1   | INPUT GAIN            |
| X   | X  | X  | B  | 0  | 0  | 1  | 0   | VOLUME                |
| X   | X  | X  | B  | 0  | 0  | 1  | 1   | NOT USED              |
| X   | X  | X  | B  | 0  | 1  | 0  | 0   | BASS USED             |
| X   | X  | X  | B  | 0  | 1  | 0  | 1   | TREBLE USED           |
| X   | X  | X  | B  | 0  | 1  | 1  | 0   | SPEAKER ATTENUATE "R" |
| X   | X  | X  | B  | 0  | 1  | 1  | 1   | SPEAKER ATTENUATE "L" |

B = 1: INCREMENTAL BUS ACTIVE

B = 0: NO INCREMENTAL BUS

X = DON'T CARE

In Incremental Bus Mode, the three "not used" functions must be addressed in any case. For example to refresh "Volume = 0dB" and Speaker\_R = -40dB", the following bytes must be sent:

Table 8.

|                 |          |
|-----------------|----------|
| SUBADDRESS      | XXX10010 |
| VOLUME DATA     | X0000000 |
| NOT USED 1 DATA | XXXX1111 |
| NOT USED 2 DATA | XXXX1111 |
| NOT USED 3 DATA | XXXX1111 |
| SPEAKER_R DATA  | X0000010 |

Table 9. INPUT SELECTION

| MSB |    |    |    |    |    |    | LSB | INPUT MULTIPLEXER |
|-----|----|----|----|----|----|----|-----|-------------------|
| D7  | D6 | D5 | D4 | D3 | D2 | D1 | D0  |                   |
| X   | X  | X  | X  | X  | X  | 0  | 0   | NOT ALLOWED       |
| X   | X  | X  | X  | X  | X  | 0  | 1   | NOT ALLOWED       |
| X   | X  | X  | X  | X  | X  | 1  | 0   | IN2               |
| X   | X  | X  | X  | X  | X  | 1  | 1   | IN1               |

Table 10. INPUT GAIN SELECTION

| MSB |    |    |    |    |    |    | LSB | INPUT GAIN |
|-----|----|----|----|----|----|----|-----|------------|
| D7  | D6 | D5 | D4 | D3 | D2 | D1 | D0  | 2dB STEPS  |
|     |    |    |    | 0  | 0  | 0  | 0   | 0dB        |
|     |    |    |    | 0  | 0  | 0  | 1   | 2dB        |
|     |    |    |    | 0  | 0  | 1  | 0   | 4dB        |
|     |    |    |    | 0  | 0  | 1  | 1   | 6dB        |
|     |    |    |    | 0  | 1  | 0  | 0   | 8dB        |
|     |    |    |    | 0  | 1  | 0  | 1   | 10dB       |
|     |    |    |    | 0  | 1  | 1  | 0   | 12dB       |
|     |    |    |    | 0  | 1  | 1  | 1   | 14dB       |
|     |    |    |    | 1  | 0  | 0  | 0   | 16dB       |
|     |    |    |    | 1  | 0  | 0  | 1   | 18dB       |
|     |    |    |    | 1  | 0  | 1  | 0   | 20dB       |
|     |    |    |    | 1  | 0  | 1  | 1   | 22dB       |
|     |    |    |    | 1  | 1  | 0  | 0   | 24dB       |
|     |    |    |    | 1  | 1  | 0  | 1   | 26dB       |
|     |    |    |    | 1  | 1  | 1  | 0   | 28dB       |
|     |    |    |    | 1  | 1  | 1  | 1   | 30dB       |

GAIN = 0 to 30dB

Table 11. VOLUME SELECTION

| MSB |    |    |    |    |    |    | LSB | VOLUME    |
|-----|----|----|----|----|----|----|-----|-----------|
| 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      |
|     | 0  | 0  | 0  | 0  |    |    |     | 0dB       |
|     | 0  | 0  | 0  | 1  |    |    |     | -8dB      |
|     | 0  | 0  | 1  | 0  |    |    |     | -16dB     |
|     | 0  | 0  | 1  | 1  |    |    |     | -24dB     |
|     | 0  | 1  | 0  | 0  |    |    |     | -32dB     |
|     | 0  | 1  | 0  | 1  |    |    |     | -40dB     |
|     | X  | 1  | 1  | 1  | X  | X  | X   | MUTE      |

VOLUME = 0 to 47dB/MUTE

Table 12. SPEAKER ATTENUATE SELECTION

| MSB |    |    |    |    |    |    | LSB | SPEAKER ATTENUATION |
|-----|----|----|----|----|----|----|-----|---------------------|
| D7  | D6 | D5 | D4 | D3 | D2 | D1 | D0  | 1dB                 |
|     |    |    |    |    | 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                |
|     | 0  | 0  | 0  | 0  |    |    |     | 0dB                 |
|     | 0  | 0  | 0  | 1  |    |    |     | -8dB                |
|     | 0  | 0  | 1  | 0  |    |    |     | -16dB               |
|     | 0  | 0  | 1  | 1  |    |    |     | -24dB               |
|     | 0  | 1  | 0  | 0  |    |    |     | -32dB               |
|     | 0  | 1  | 0  | 1  |    |    |     | -40dB               |
|     | 0  | 1  | 1  | 0  |    |    |     | -48dB               |
|     | 0  | 1  | 1  | 1  |    |    |     | -56dB               |
|     | 1  | 0  | 0  | 0  |    |    |     | -64dB               |
|     | 1  | 0  | 0  | 1  |    |    |     | -72dB               |
|     | 1  | 1  | 1  | 1  | X  | X  | X   | MUTE                |

SPEAKER ATTENUATION = 0 to -79dB/MUTE

Figure 14. PIN :1

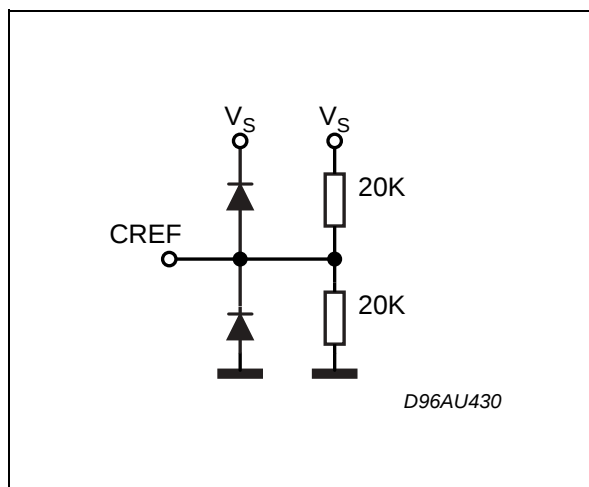


Figure 17. PINS: 10, 11

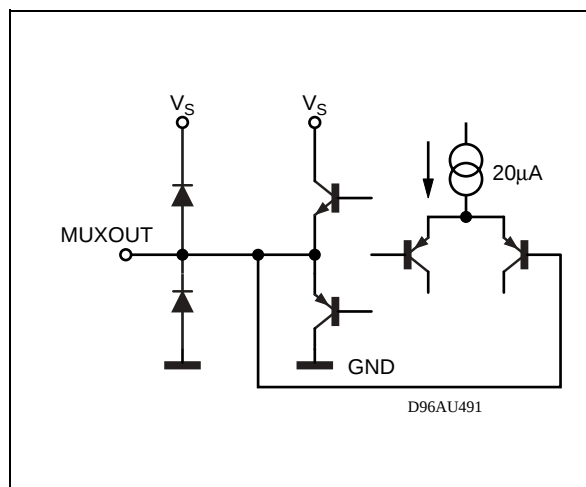


Figure 15. PINS: 4, 5

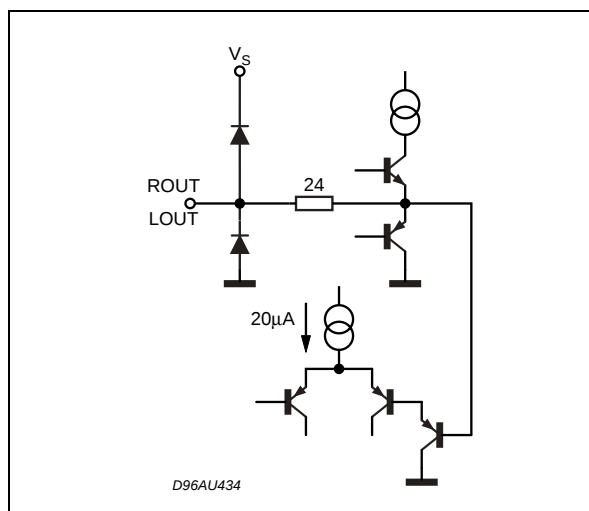


Figure 18. PIN: 19,

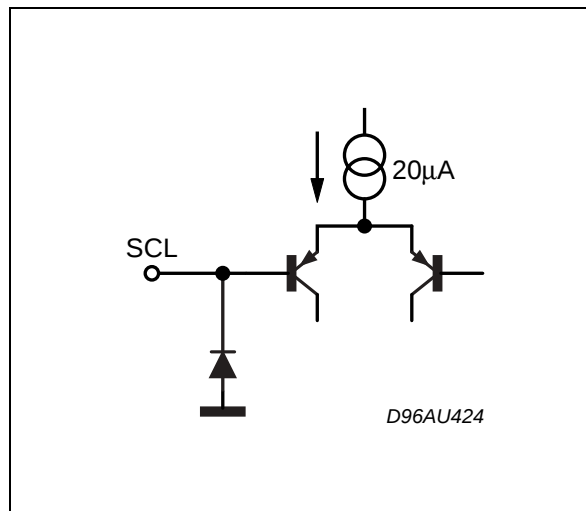


Figure 16. PINS: 6, 7, 8, 9

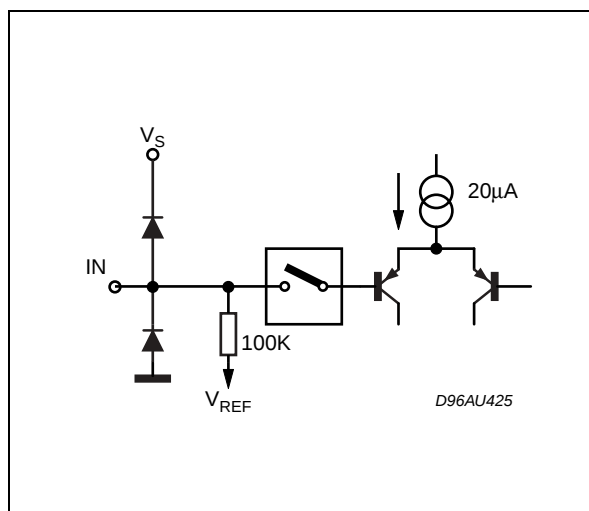


Figure 19. PIN: 20

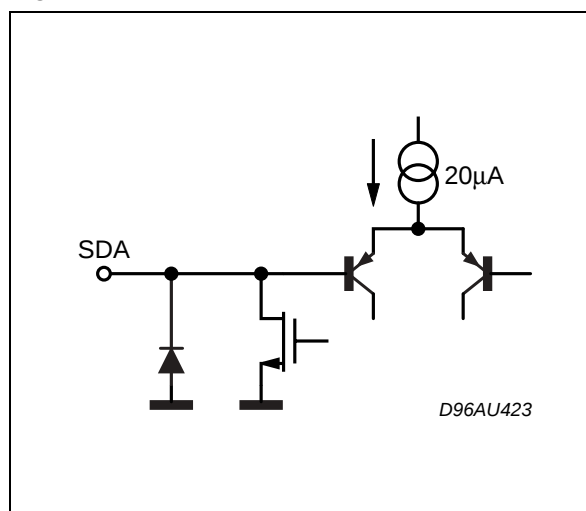
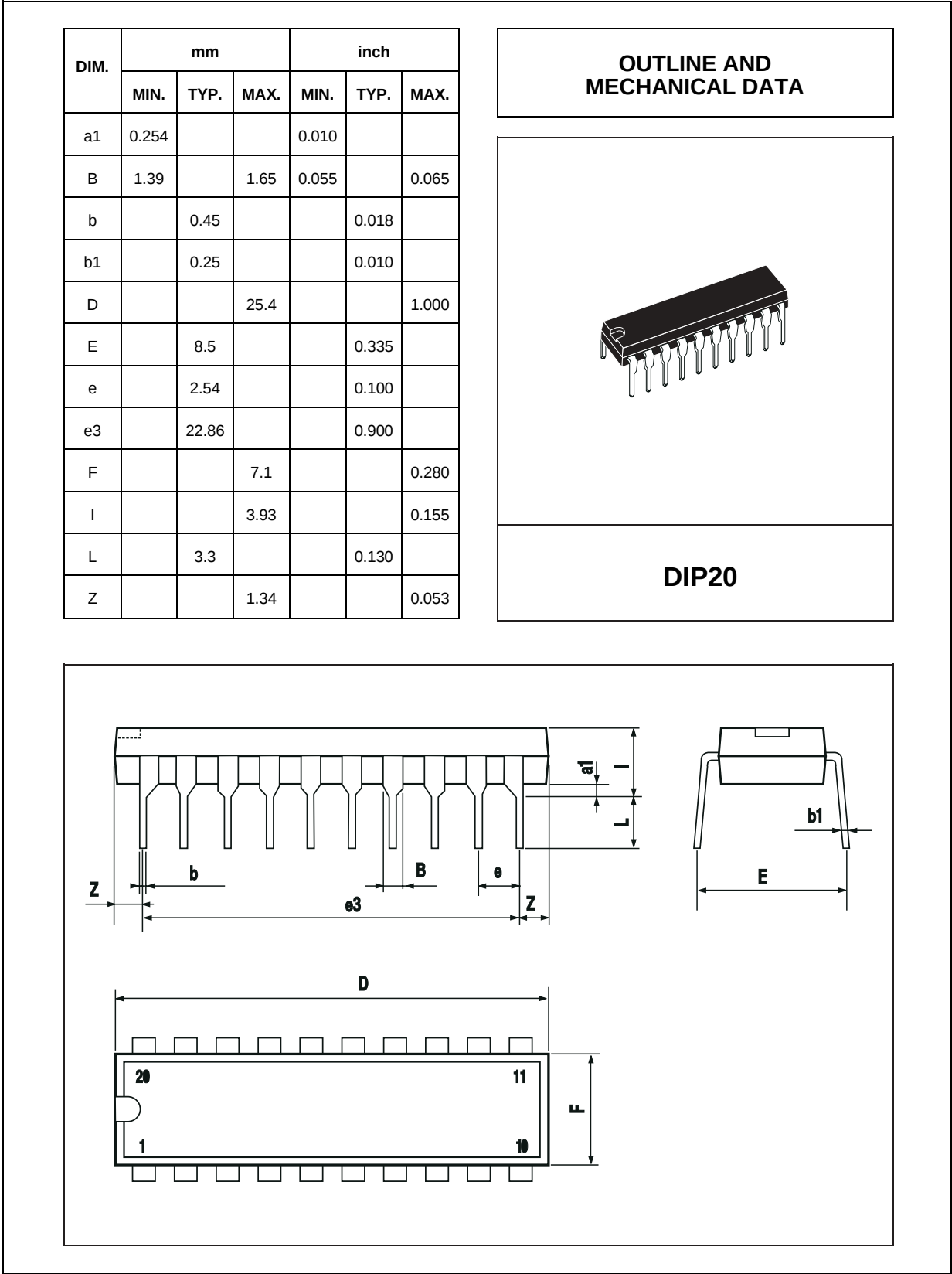


Figure 20. DIP20 Mechanical Data & Package Dimensions



**Table 13. Revision History**

| Date       | Revision | Description of Changes                                                                                                |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------|
| April 1999 | 2        | Second Issue                                                                                                          |
| June 2004  | 3        | Modified the style-sheet in compliance with the last revision of the "Corporate Technical Publications Design Guide". |

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