

## DIGITAL CONTROLLED AUDIO PROCESSOR

PRODUCT PREVIEW

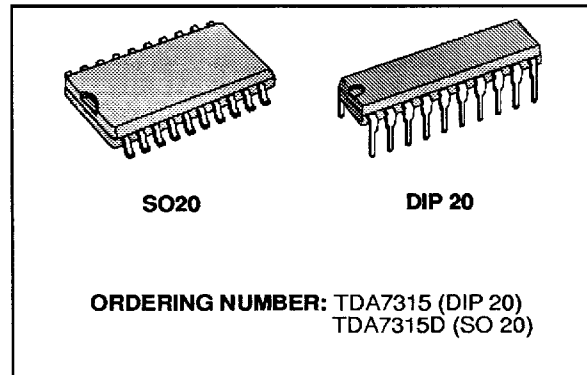
- 1 STEREO INPUT
- LOUDNESS FUNCTION
- VOLUME CONTROL IN 1.25dB STEPS
- TREBLE AND BASS CONTROL
- TWO SPEAKERS ATTENUATORS:
  - INDEPENDENT SPEAKERS CONTROL IN 1.25dB STEPS
  - INDEPENDENT MUTE FUNCTION
- ALL FUNCTIONS PROGRAMMABLE VIA SERIAL BUS

### DESCRIPTION

The TDA7315 is a volume, tone (bass and treble) balance (Left/Right) processor for quality audio applications in car radio and Hi-Fi systems.

Control is accomplished by serial bus microprocessor interface.

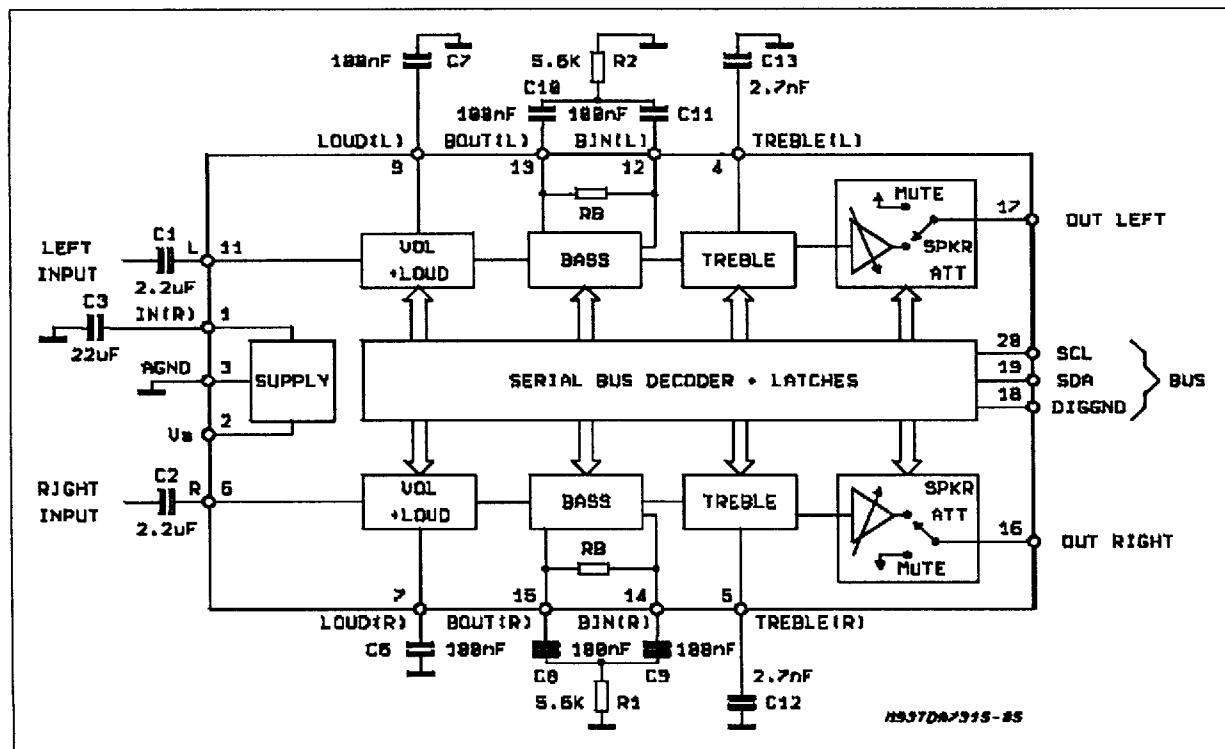
The AC signal setting is obtained by resistor networks



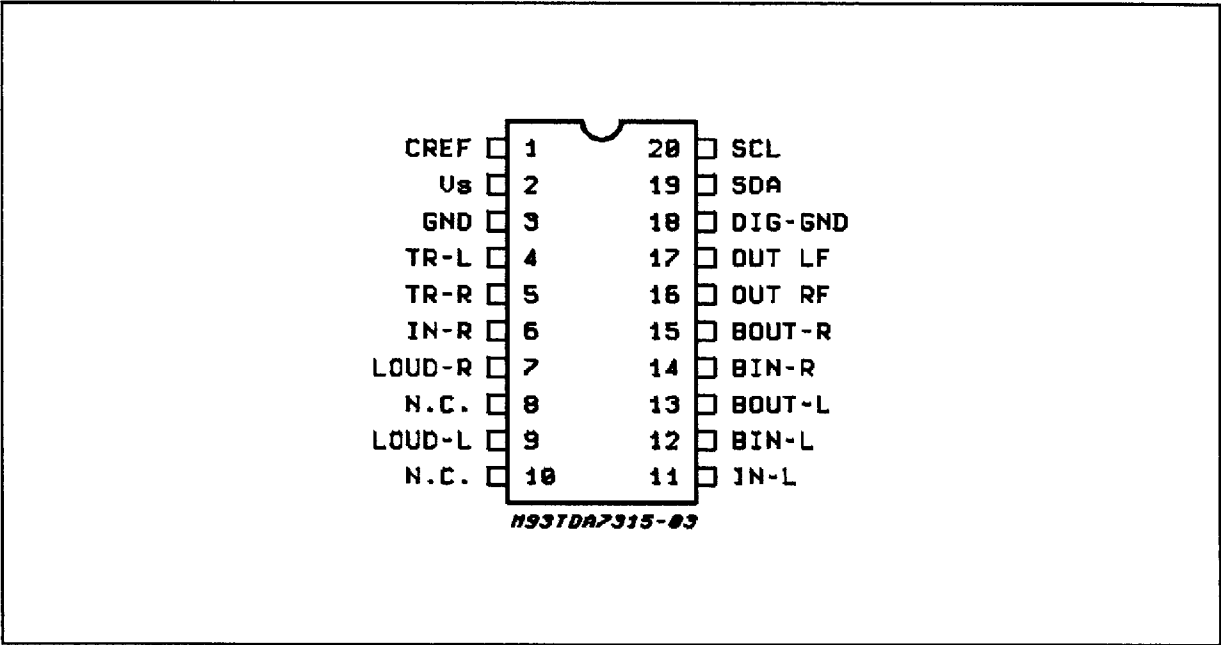
and switches combined with operational amplifiers.

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

### BLOCK DIAGRAM



PIN CONNECTION (Top view)



THERMAL DATA

| Symbol                 | Parameter                             | SO 20 | DIP 20 | Unit |
|------------------------|---------------------------------------|-------|--------|------|
| R <sub>th j-pins</sub> | Thermal Resistance Junction-pins Max. | 150   | 150    | °C/W |

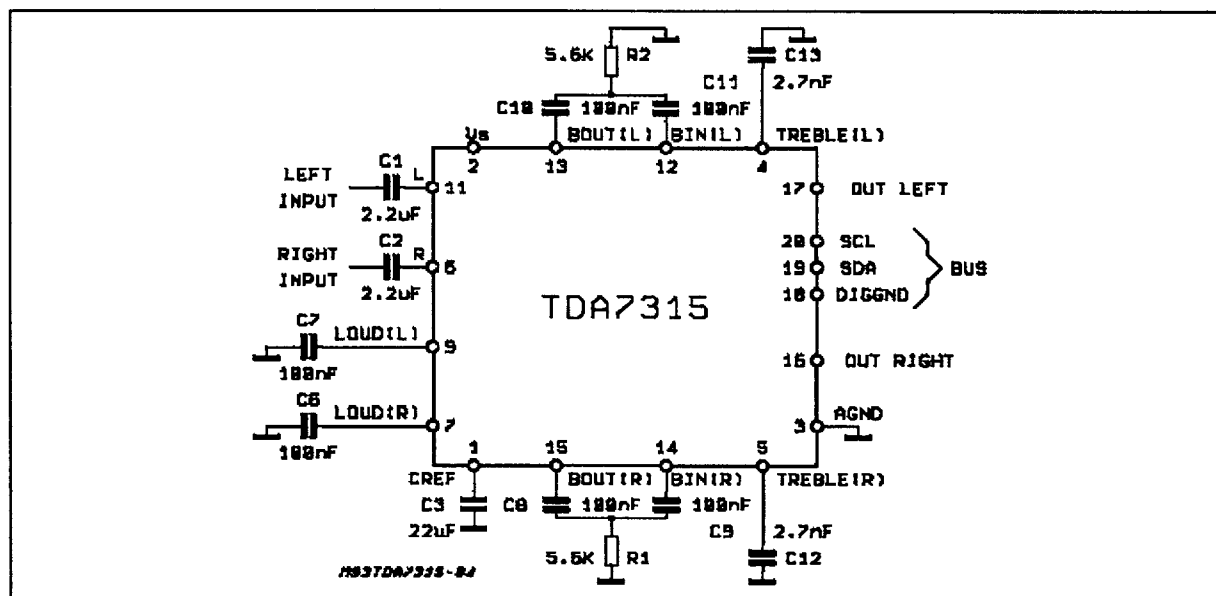
ABSOLUTE MAXIMUM RATINGS

| Symbol           | Parameter                     | Value       | Unit |
|------------------|-------------------------------|-------------|------|
| V <sub>s</sub>   | Operating Supply Voltage      | 10.2        | V    |
| T <sub>amb</sub> | Operating Ambient Temperature | -10 to 85   | °C   |
| T <sub>stg</sub> | Storage Temperature Range     | -55 to +150 | °C   |

QUICK REFERENCE DATA

| Symbol          | Parameter                                                | Min.   | Typ. | Max. | Unit             |
|-----------------|----------------------------------------------------------|--------|------|------|------------------|
| V <sub>s</sub>  | Supply Voltage                                           | 6      | 9    | 10   | V                |
| V <sub>CL</sub> | Max. input signal handling                               | 2      |      |      | V <sub>rms</sub> |
| THD             | Total Harmonic Distortion V = 1V <sub>rms</sub> f = 1KHz |        | 0.01 | 0.1  | %                |
| S/N             | Signal to Noise Ratio                                    |        | 106  |      | dB               |
| Sc              | Channel Separation f = 1KHz                              |        | 103  |      | dB               |
|                 | Volume Control 1.25dB step                               | -78.75 |      | 0    | dB               |
|                 | Bass and Treble Control 2db step                         | -14    |      | +14  | dB               |
|                 | Balance Control 1.25dB step                              | -38.75 |      | 0    | dB               |
|                 | Mute Attenuation                                         |        | 100  |      | dB               |

## TEST CIRCUIT



**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 ( $G = 0$ ),  $f = 1\text{KHz}$  unless otherwise specified)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|--------|-----------|----------------|------|------|------|------|
|--------|-----------|----------------|------|------|------|------|

## SUPPLY

|       |                  |  |    |    |    |    |
|-------|------------------|--|----|----|----|----|
| $V_S$ | Supply Voltage   |  | 6  | 9  | 10 | V  |
| $I_S$ | Supply Current   |  |    | 8  | 11 | mA |
| SVR   | Ripple Rejection |  | 60 | 80 |    | dB |

## VOLUME CONTROL

|                    |                       |                                                              |             |          |           |                  |
|--------------------|-----------------------|--------------------------------------------------------------|-------------|----------|-----------|------------------|
| $R_{IV}$           | Input Resistance      |                                                              | 20          | 33       | 50        | $\text{k}\Omega$ |
| $C_{\text{RANGE}}$ | Control Range         |                                                              | 70          | 75       | 80        | dB               |
| $A_{\text{VMIN}}$  | Min. Attenuation      |                                                              | -1          | 0        | 1         | dB               |
| $A_{\text{VMAX}}$  | Max. Attenuation      |                                                              | 70          | 75       | 80        | dB               |
| $A_{\text{STEP}}$  | Step Resolution       |                                                              | 0.5         | 1.25     | 1.75      | dB               |
| $E_A$              | Attenuation Set Error | $A_v = 0$ to $-20\text{dB}$<br>$A_v = -20$ to $-60\text{dB}$ | -1.25<br>-3 | 0        | 1.25<br>2 | dB<br>dB         |
| $E_T$              | Tracking Error        |                                                              |             |          | 2         | dB               |
| $V_{\text{DC}}$    | DC Steps              | adjacent attenuation steps<br>From $0\text{dB}$ to $A_v$ max |             | 0<br>0.5 | 3<br>7.5  | mV<br>mV         |

## SPEAKER ATTENUATORS

|                    |                         |                                       |     |        |         |          |
|--------------------|-------------------------|---------------------------------------|-----|--------|---------|----------|
| $C_{\text{range}}$ | Control Range           |                                       | 35  | 37.5   | 40      | dB       |
| $S_{\text{STEP}}$  | Step Resolution         |                                       | 0.5 | 1.25   | 1.75    | dB       |
| $E_A$              | Attenuation set error   |                                       |     |        | 1.5     | dB       |
| $A_{\text{MUTE}}$  | Output Mute Attenuation |                                       | 80  | 100    |         | dB       |
| $V_{\text{DC}}$    | DC Steps                | adjacent att. steps<br>from 0 to mute |     | 0<br>1 | 3<br>10 | mV<br>mV |

## BASS CONTROL (1)

|                   |                              |                |          |          |          |                  |
|-------------------|------------------------------|----------------|----------|----------|----------|------------------|
| $G_B$             | Control Range                | Max. Boost/cut | $\pm 12$ | $\pm 14$ | $\pm 16$ | dB               |
| $B_{\text{STEP}}$ | Step Resolution              |                | 1        | 2        | 3        | dB               |
| $R_B$             | Internal Feedback Resistance |                | 34       | 44       | 58       | $\text{K}\Omega$ |

## ELECTRICAL CHARACTERISTICS (continued)

| Symbol            | Parameter       | Test Condition | Min.     | Typ.     | Max.     | Unit |
|-------------------|-----------------|----------------|----------|----------|----------|------|
| Gt                | Control Range   | Max. Boost/cut | $\pm 13$ | $\pm 14$ | $\pm 15$ | dB   |
| T <sub>STEP</sub> | Step Resolution |                | 1        | 2        | 3        | dB   |

## TREBLE CONTROL (1)

|                   |                 |                |          |          |          |    |
|-------------------|-----------------|----------------|----------|----------|----------|----|
| Gt                | Control Range   | Max. Boost/cut | $\pm 13$ | $\pm 14$ | $\pm 15$ | dB |
| T <sub>STEP</sub> | Step Resolution |                | 1        | 2        | 3        | dB |

## AUDIO OUTPUTS

|                  |                         |          |     |     |     |            |
|------------------|-------------------------|----------|-----|-----|-----|------------|
| V <sub>OCL</sub> | Clipping Level          | d = 0.3% | 2   | 2.5 |     | Vrms       |
| R <sub>L</sub>   | Output Load Resistance  |          | 2   |     |     | K $\Omega$ |
| C <sub>L</sub>   | Output Load Capacitance |          |     |     | 10  | nF         |
| R <sub>OUT</sub> | Output resistance       |          | 30  | 75  | 120 | $\Omega$   |
| V <sub>OUT</sub> | DC Voltage Level        |          | 4.2 | 4.5 | 4.8 | V          |

## GENERAL

|                 |                               |                                                        |    |          |     |                    |
|-----------------|-------------------------------|--------------------------------------------------------|----|----------|-----|--------------------|
| e <sub>NO</sub> | Output Noise                  | BW = 20-20KHz, flat<br>output muted<br>all gains = 0dB |    | 2.5<br>5 | 15  | $\mu$ V<br>$\mu$ V |
|                 |                               | A curve all gains = 0dB                                |    | 3        |     | $\mu$ V            |
| S/N             | Signal to Noise Ratio         | all gains = 0dB; V <sub>O</sub> = 1Vrms                |    | 106      |     | dB                 |
| d               | Distortion                    | A <sub>V</sub> = 0, V <sub>IN</sub> = 1Vrms            |    | 0.01     | 0.1 | %                  |
|                 |                               | A <sub>V</sub> = -20dB V <sub>IN</sub> = 1Vrms         |    | 0.09     | 0.3 | %                  |
|                 |                               | V <sub>IN</sub> = 0.3Vrms                              |    | 0.04     |     | %                  |
| Sc              | Channel Separation left/right |                                                        | 80 | 103      |     | dB                 |
|                 | Total Tracking error          | A <sub>V</sub> = 0 to -20dB                            |    | 0        | 1   | dB                 |
|                 |                               | -20 to -60 dB                                          |    | 0        | 2   | dB                 |

## BUS INPUTS

|                 |                                   |                        |    |  |     |         |
|-----------------|-----------------------------------|------------------------|----|--|-----|---------|
| V <sub>IL</sub> | Input Low Voltage                 |                        |    |  | 1   | V       |
| V <sub>IH</sub> | Input High Voltage                |                        | 3  |  |     | V       |
| I <sub>IN</sub> | Input Current                     |                        | -5 |  | +5  | $\mu$ A |
| V <sub>O</sub>  | Output Voltage SDA<br>Acknowledge | I <sub>O</sub> = 1.6mA |    |  | 0.4 | V       |

Note:

(1) Bass and Treble response see attached diagram (fig.19). The center frequency and quality of the resonance behaviour can be chosen by the external circuitry. A standard first order bass response can be realized by a standard feedback network.

Figure 1: Loudness versus Volume Attenuation

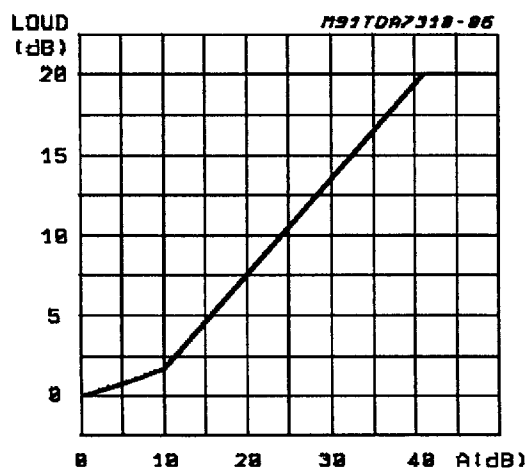


Figure 2: Loudness versus Frequency

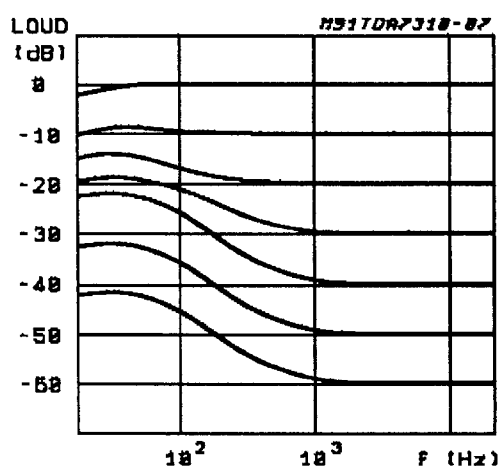
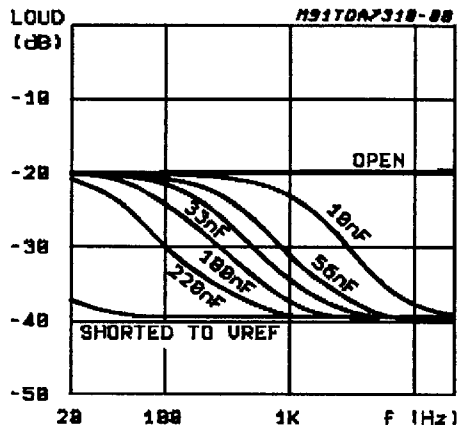


Figure 3: Loudness versus External Capacitors



LOUDNESS

 $V_s = 9V$ 

Volume = -40dB

All other control flat

 $C_{in} = 2.2\mu F$  $C_{load} = 220nF, 100nF, 33nF, 10nF, Open, Shorter to Vref$ 

Figure 4: Noise vs. Volume/Gain Settings

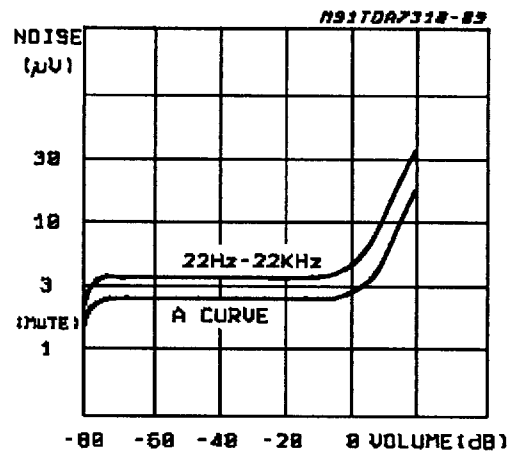


Figure 6: Distortion &amp; Noise vs. Frequency

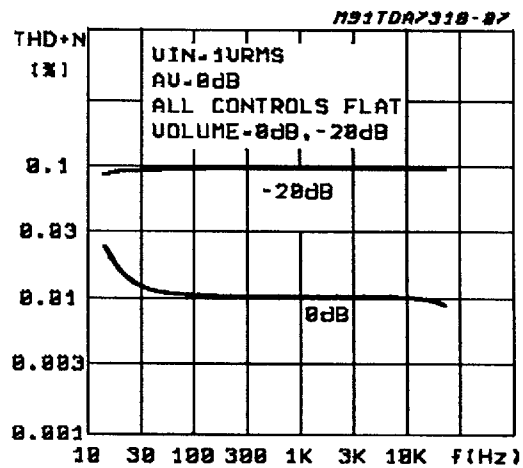


Figure 5: Signal to Noise Ratio vs. Volume Setting

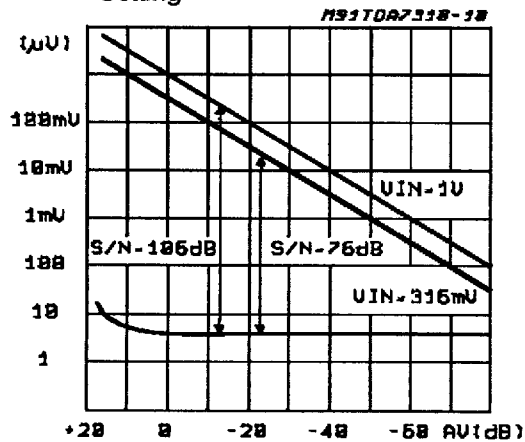


Figure 7: Distortion &amp; Noise vs. Frequency

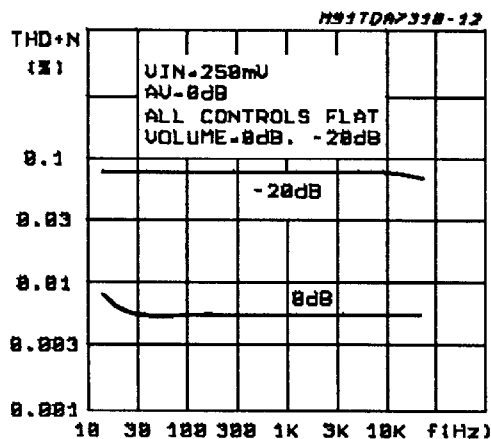
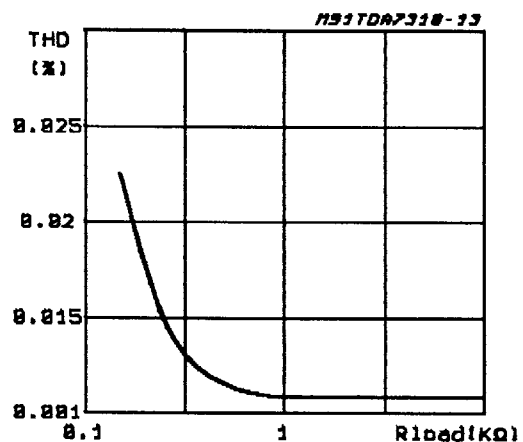
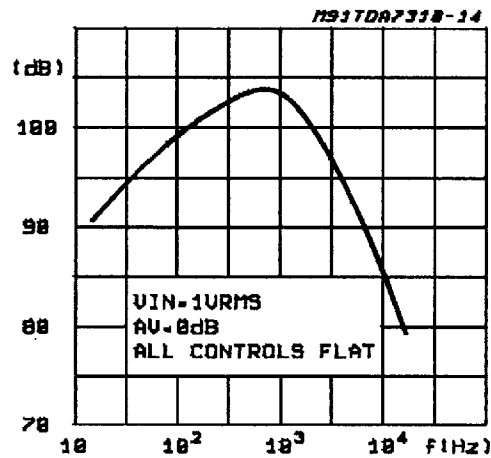
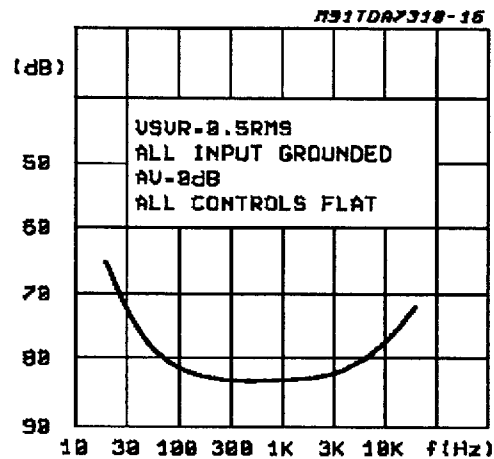
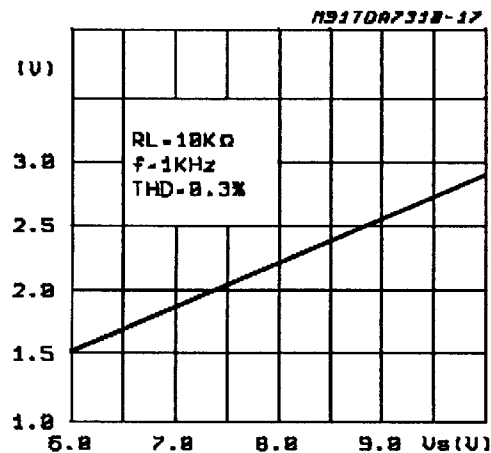
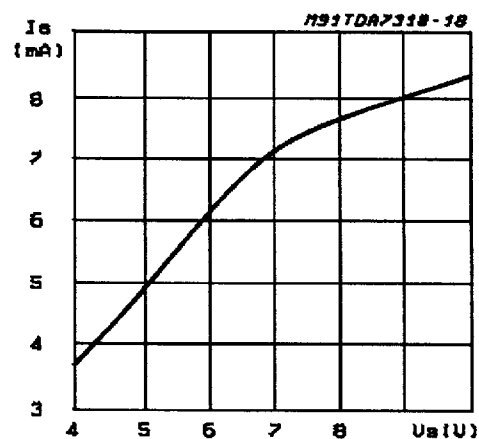
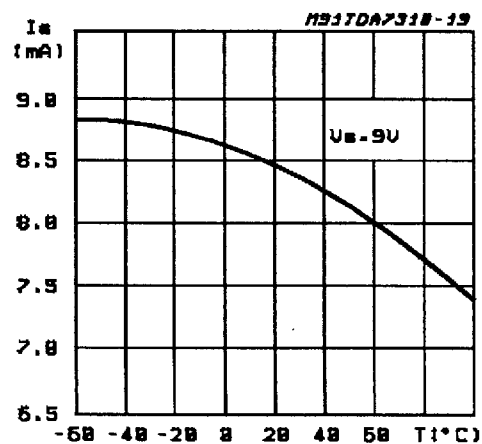
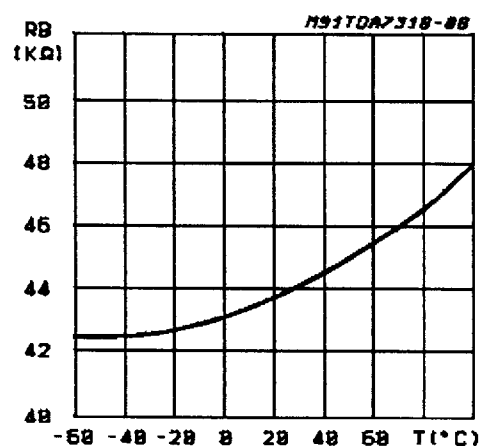
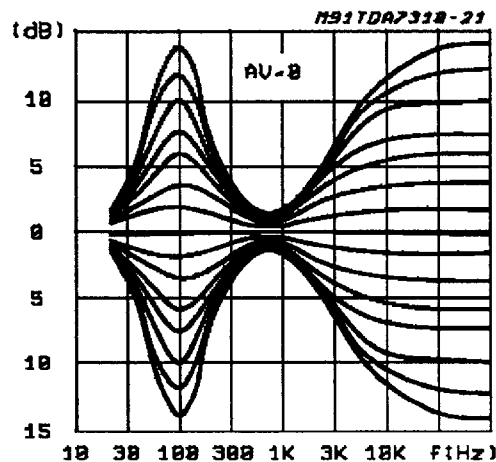


Figure 8: Distortion vs. Load Resistance



**Figure 9:** Channel Separation (L → R) vs. Frequency**Figure 10:** Supply Voltage Rejection vs. Frequency**Figure 11:** Output Clipping Level vs. Supply Voltage**Figure 12:** Quiescent Current vs. Supply Voltage**Figure 13:** Supply Current vs. Temperature**Figure 14:** Bass Resistance vs. Temperature

**Figure 15:** Typical Tone Response (with the ext. components indicated in the test circuit)

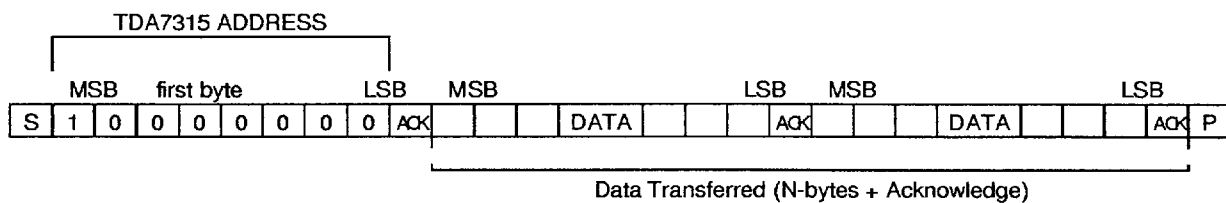


## SOFTWARE SPECIFICATION

### Interface Protocol

The interface protocol comprises:

- A start condition (S)
- A chip address byte, containing the TDA7315 address (the 8th bit of the byte must be 0). The TDA7315 must always acknowledge at the end of each transmitted byte.
- A sequence of data (N-bytes + acknowledge)
- A stop condition (P)



ACK = Acknowledge

S = Start

P = Stop

MAX CLOCK SPEED 100kbits/s

## SOFTWARE SPECIFICATION

Chip address = 80 Hex

|     |   |   |   |   |   |   |     |
|-----|---|---|---|---|---|---|-----|
| 1   | 0 | 0 | 0 | 0 | 0 | 0 | 0   |
| MSB |   |   |   |   |   |   | LSB |

### 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  | X  | X   | L  | X  | X  | Loudness       |
| 0   | 1 | 1  | 0  | C3  | C2 | C1 | C0 | Bass control   |
| 0   | 1 | 1  | 1  | C3  | C2 | C1 | C0 | Treble control |

Ax = 1.25dB steps; Bx = 10dB steps; Cx = 2dB steps; X = don't care.

**SOFTWARE SPECIFICATION (continued)****DATA BYTES (detailed description)****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:

0 0 1 0 0 1 0 0

**Speaker Attenuators**

| MSB |   |   |    |    |    | LSB |     | FUNCTION  |      |
|-----|---|---|----|----|----|-----|-----|-----------|------|
| 1   | 0 | 0 | B1 | B0 | A2 | A1  | A0  | Speaker L |      |
| 1   | 0 | 1 | B1 | B0 | A2 | A1  | A0  | Speaker 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   |           |      |
|     |   |   |    |    |    |     | -10 |           |      |
|     |   |   |    |    |    |     | -20 |           |      |
|     |   |   |    |    |    |     | -30 |           |      |
|     |   |   | 1  |    | 1  |     | 1   |           | Mute |

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

1 0 1 1 0 1 0 0

**Loudness**

| MSB |   |   |   |   |   | LSB |   | FUNCTION     |
|-----|---|---|---|---|---|-----|---|--------------|
| 0   | 1 | 0 | X | X | L | X   | X |              |
|     |   |   |   |   | 0 |     |   | LOUDNESS ON  |
|     |   |   |   |   | 1 |     |   | LOUDNESS OFF |

x = don't care

For examples Loudness on can be programmed by the following 8 bit string:

0 1 0 0 0 1 0 0

**Bass and Treble**

| 0 | 1 | 1 | 0 | C3 | C2 | C1 | C0 | Bass<br>Treble |
|---|---|---|---|----|----|----|----|----------------|
| 0 | 1 | 1 | 1 | C3 | C2 | C1 | C0 |                |
|   |   |   |   | 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             |

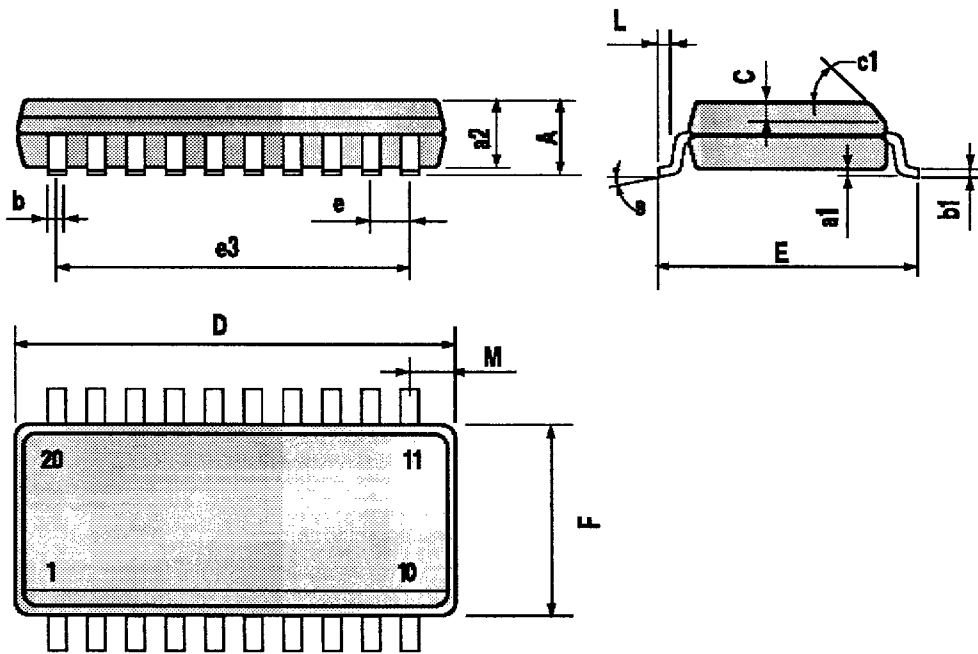
C3 = Sign

For example Bass at -10dB is obtained by the following 8 bit string:

0 1 1 0 0 0 1 0

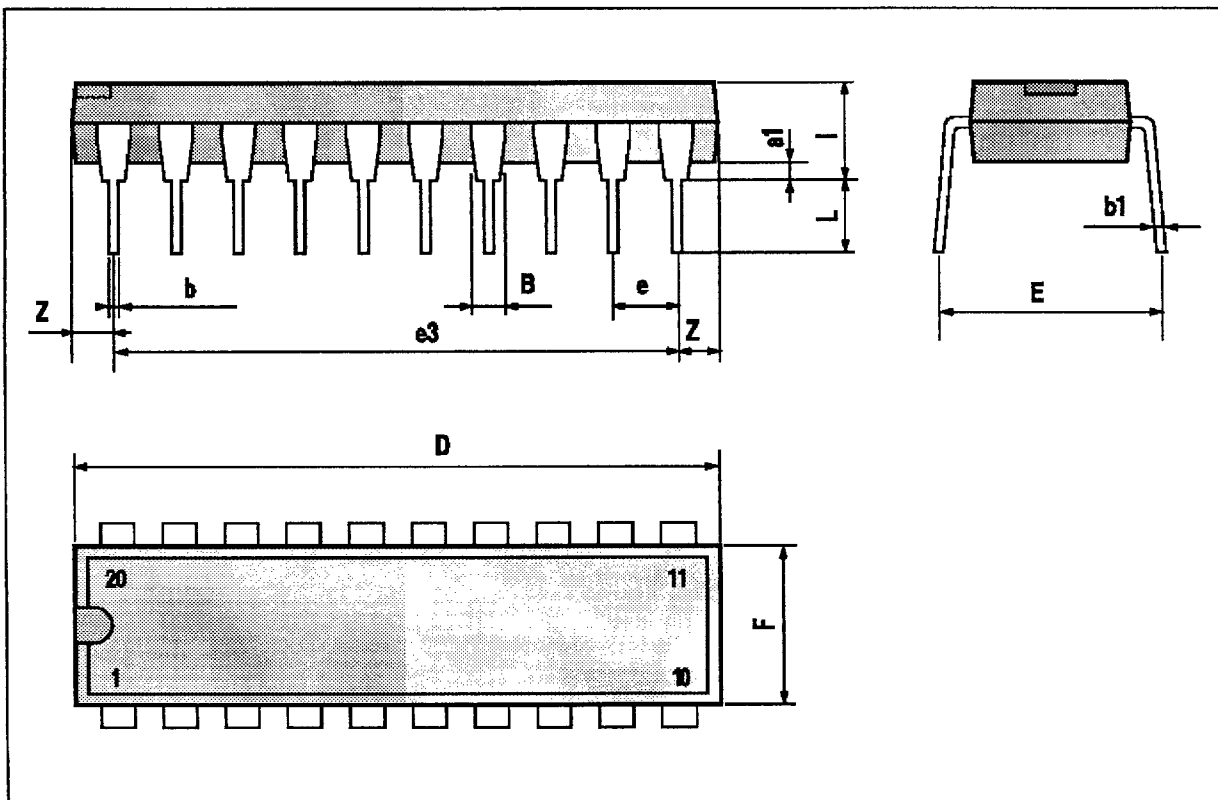
SO20 PACKAGE MECHANICAL DATA

| DIM. | mm        |       |       | Inch  |       |       |
|------|-----------|-------|-------|-------|-------|-------|
|      | MIN.      | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |           |       | 2.65  |       |       | 0.104 |
| a1   | 0.1       |       | 0.3   | 0.004 |       | 0.012 |
| a2   |           |       | 2.45  |       |       | 0.096 |
| 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    | 12.6      |       | 13.0  | 0.496 |       | 0.512 |
| E    | 10        |       | 10.65 | 0.394 |       | 0.419 |
| e    |           | 1.27  |       |       | 0.050 |       |
| e3   |           | 11.43 |       |       | 0.450 |       |
| F    | 7.4       |       | 7.6   | 0.291 |       | 0.299 |
| L    | 0.5       |       | 1.27  | 0.020 |       | 0.050 |
| M    |           |       | 0.75  |       |       | 0.030 |
| S    | 8 (max.)  |       |       |       |       |       |



## DIP20 PACKAGE MECHANICAL DATA

| DIM. | mm    |       |      | Inch  |       |       |
|------|-------|-------|------|-------|-------|-------|
|      | MIN.  | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.254 |       |      | 0.010 |       |       |
| B    | 1.39  |       | 1.65 | 0.055 |       | 0.065 |
| b    |       | 0.45  |      |       | 0.018 |       |
| b1   |       | 0.25  |      |       | 0.010 |       |
| D    |       |       | 25.4 |       |       | 1.000 |
| E    |       | 8.5   |      |       | 0.335 |       |
| e    |       | 2.54  |      |       | 0.100 |       |
| e3   |       | 22.86 |      |       | 0.900 |       |
| F    |       |       | 7.1  |       |       | 0.280 |
| I    |       |       | 3.93 |       |       | 0.155 |
| L    |       | 3.3   |      |       | 0.130 |       |
| Z    |       |       | 1.34 |       |       | 0.053 |



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