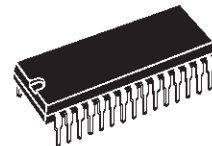


FIVE BANDS DIGITAL CONTROLLED GRAPHIC EQUALIZER

- VOLUME CONTROL IN 0.375dB STEP
- FIVE BANDS STEREO GRAPHIC EQUALIZER
- CENTER FREQUENCY, BANDWIDTH, MAX BOOST/CUT DEFINED BY EXTERNAL COMPONENTS
- $\pm 14\text{dB}$ CUT/BOOST CONTROL IN 2dB/STEP
- ALL FUNCTIONS PROGRAMMABLE VIA SERIAL BUS
- VERY LOW DISTORTION
- VERY LOW NOISE AND DC STEPPING BY USE OF A MIXED BIPOLAR/CMOS TECHNOLOGY



SDIP30

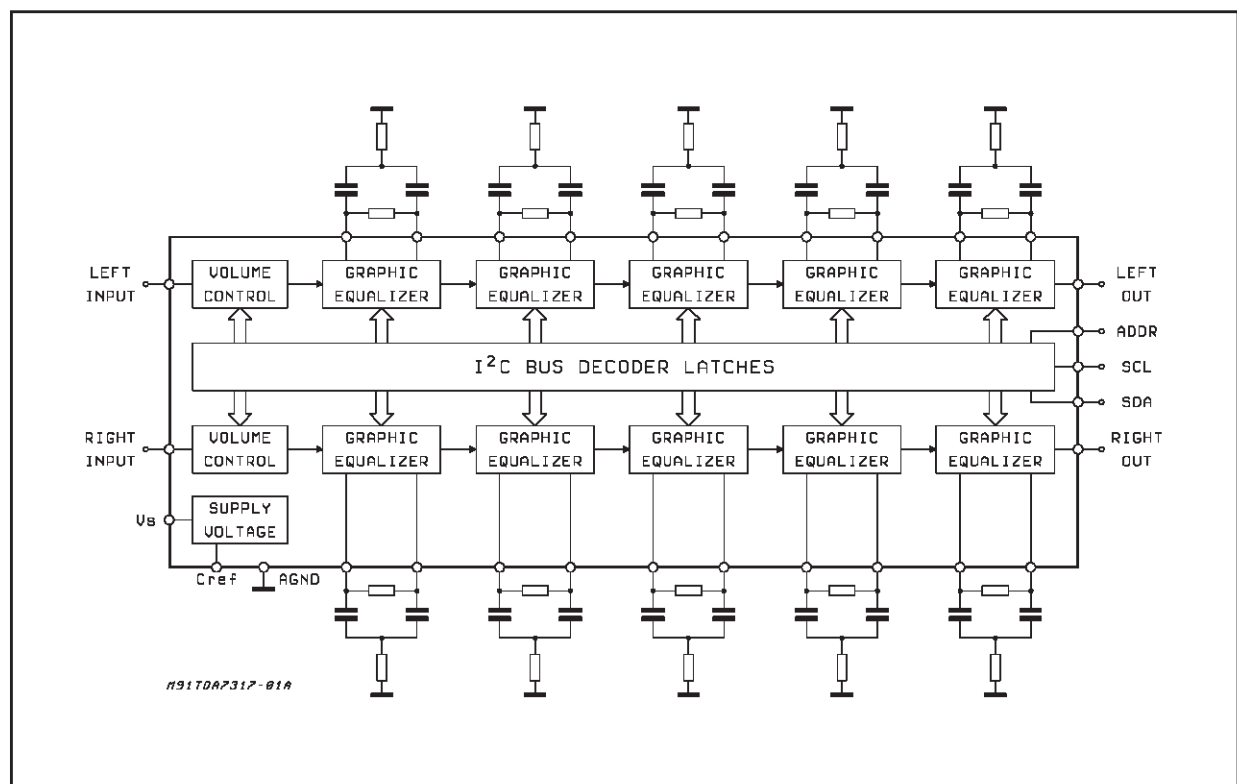
ORDERING NUMBER: TDA7317

DESCRIPTION

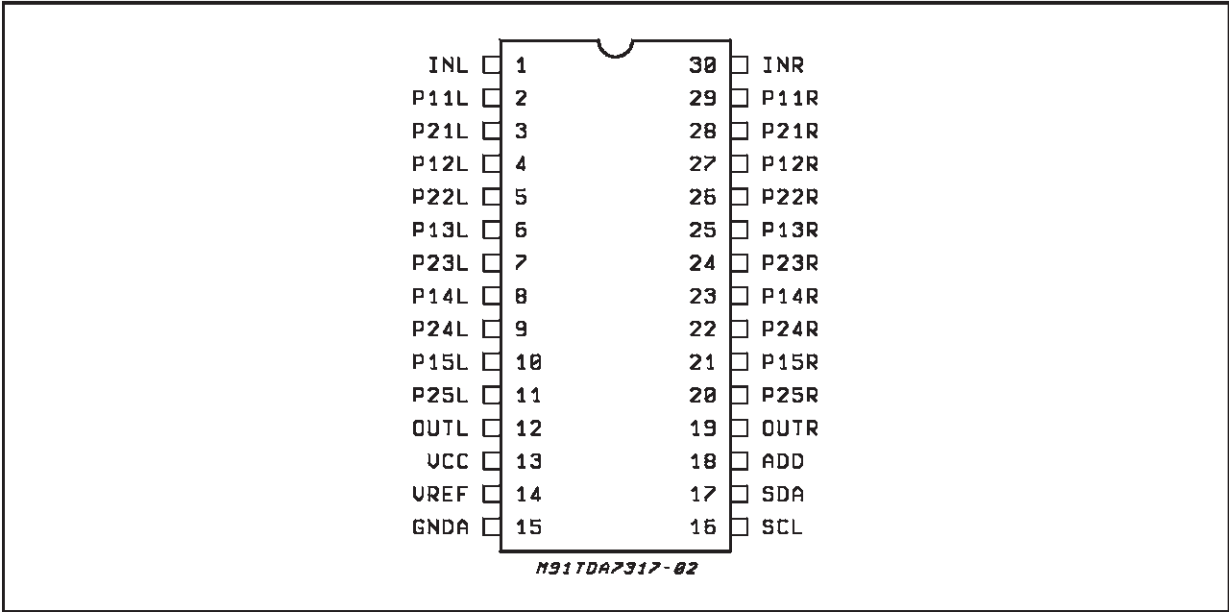
The TDA7317 is a monolithic, digitally controlled graphic equalizer realized in BiCMOS mixed technology. The stereo signal, before any filtering, can be at-

tenuated up to -17.625dB in 0.375dB step. All the functions can be programmed via serial bus making easy to build a μP controlled system. Signal path is designed for very low noise and distortion.

BLOCK DIAGRAM



PIN CONNECTION



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|--------------------|--------------------------------------|-------------|------|
| V_S | Supply Voltage | 10.2 | V |
| T_{op} | Operating Temperature Range | -40 to +85 | °C |
| T_{stg} | Storage Temperature Range | -55 to +150 | °C |
| $R_{\theta jvins}$ | Thermal Resistance Junction pins max | 85 | °C/W |

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}\text{C}$, $V_S = 9\text{V}$, $R_L = 10\text{K}\Omega$, $R_g = 600\Omega$, $f = 1\text{KHz}$ $V_{in} = 1\text{Vrms}$, all controls in flat position ($AV = 0\text{dB}$) 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 | 14 | 20 | mA |
| SVR | Ripple Rejection | $f = 300\text{Hz to } 10\text{KHz}$ | 60 | 80 | | dB |

ELECTRICAL CHARACTERISTICS (continued)

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

INPUT

| | | | | | | |
|---------------|----------------------|------------|----|-----|----|------------|
| R_I | Input Resistance | | 20 | 30 | 40 | K Ω |
| $V_{IN\ max}$ | Max Input Signal | THD = 0.3% | 2 | 2.5 | | V_{RMS} |
| I_{NS} | Input Separation (1) | | 80 | 100 | | dB |

VOLUME CONTROL

| | | | | | | |
|--------------|-----------------------|----------------------------|-------|--------|-------|----|
| C_{RANGE} | Control Range | | | 17.625 | | dB |
| $A_{V\ MIN}$ | Min. Attenuation | | -0.5 | 0 | 0.5 | dB |
| $A_{V\ MAX}$ | Max. Attenuation | | 16.7 | 17.625 | 18.6 | dB |
| A_{STEP} | Step Resolution | | 0.175 | 0.375 | 0.575 | dB |
| E_A | Attenuation Set Error | | -1 | | 1 | dB |
| E_T | Tracking Error | | | | 0.5 | dB |
| V_{DC} | DC Steps | adjacent attenuation steps | | 0 | 3 | mV |

GRAPHIC EQUALIZER

| | | | | | | |
|-------------|-----------------------|--|----------|----------|----------|---------|
| THD | Distortion | | | 0.01 | 0.1 | % |
| C_s | Channel Separation | | 80 | 100 | | dB |
| e_{NO} | Output Noise | BW = 20Hz to 20KHz flat, $A_V = 0dB$ | | 8 | 20 | μV |
| | | A curve | | 6 | | μV |
| | | BW = 20Hz to 20KHz $A_V = 0dB$ | | 24 | | μV |
| | | All bands = max. boost All bands = max. cut | | 6 | | μV |
| S/N | Signal to Noise Ratio | $A_V = 0dB$; $V_{ref} = 1V_{RMS}$ | | 100 | | dB |
| B_{step} | Step Resolution | | 1 | 2 | 3 | dB |
| C_{RANGE} | Control Range | max boost/cut | ± 12 | ± 14 | ± 16 | dB |
| VDC | DC Steps | Adiacent Control Steps | | 0.5 | 3 | mV |

AUDIO OUTPUTS

| | | | | | | |
|-----------|-------------------------|------------|-----|-----|-----|------------|
| V_O | Output Voltage | THD = 0.3% | 2 | 2.5 | | V_{RMS} |
| R_L | Output Load Resistance | | 2 | | | K Ω |
| C_L | Output Load Capacitance | | | | 10 | nF |
| R_O | Output Resistance | | 5 | 10 | 20 | Ω |
| V_{OUT} | DC Voltage Level | | 4.2 | 4.5 | 4.8 | V |

BUS INPUTS

| | | | | | | |
|----------|--------------------------------|---------------|----|--|-----|---------|
| V_{IL} | Input Low Voltage | | | | 1 | V |
| V_{IH} | Input High Voltage | | 3 | | | V |
| I_{IN} | Input Current | | -5 | | +5 | μA |
| V_O | Output Voltage SDA Acknowledge | $I_O = 1.6mA$ | | | 0.4 | V |

ADDRESS PIN (Internal 50K Ω pull down resistor)

| | | | | | | |
|----------|--------------------|--|---------------|--|---|---|
| V_{IL} | Input Low Voltage | | | | 1 | V |
| V_{IH} | Input High Voltage | | $V_{CC} - 1V$ | | | V |

NOTE: The input is grounded thru the 2.2 μP capacitors

DEVICE DESCRIPTION

The TDA7317 is a five bands, digitally controlled stereo Graphic Equalizer.

The device is intended for high quality audio application in Hi-Fi, TV and car radio systems where feature like low noise and THD are key factors. A mixed Bipolar Cmos Technology allows:

Cmos analog switches for pop free commutations, high frequency op.amp. (GWB = 10MHz) and high linearity polysilicon resistor for THD = 0.01 (at $V_{in} = 1V_{rms}$) and a S/N ratio of 102dB. The internal Block Diagram is shown on page 1.

The first stage is a volume control. The control range is 0 to -17.625dB with 0.375dBstep.

The very high resolution (0.375dB step) allows the implementation of closed loop amplitude control system completely free from any acoustical effect (stepping variation and pumping effect).

The volume control is followed by a serial five bands equalizer. Each filtering cell is the biquad cell shown in fig. 1

The internal resistor string is fixing the boost/cut value while the buffer makes the Q (quality factor) and central frequency, set by external components, fully independent from the internal resistors. Each filtering cell is realized using only 4 external components (2 capacitors and 2 resistors) allowing a flexible selection of centre frequency f_0 , Q factor and gain. Here below the basic formulae and the key features of each band pass filter are reported:

f_0 = center frequency

G_v = gain/loss at the center frequency f_0

$G_v = 20\log(A_v)$

$$Q = \frac{f_0}{f_2 - f_1}$$

where f_2, f_1 = 3dB Bandwidth limits.

$$A_v = \frac{(R_2 \cdot C_2) + (R_2 \cdot C_1) + (R_1 \cdot C_1)}{(R_2 \cdot C_1) + (R_2 \cdot C_2)}$$

$$Q = \frac{\sqrt{(R_1 \cdot C_1 \cdot R_2 \cdot C_2)}}{(R_2 \cdot C_1) + (R_2 \cdot C_2)}$$

$$f_0 = \frac{1}{2\pi \cdot \sqrt{(R_1 \cdot R_2 \cdot C_1 \cdot C_2)}}$$

If C_1 is fixed, then:

$$C_2 = \frac{Q^2}{A_v - 1 - Q^2} \cdot C_1$$

$$R_2 = \frac{1}{2\pi \cdot C_1 \cdot f_0 \cdot \frac{(A_v - 1) \cdot Q}{(A_v - 1 - Q^2)}}$$

$$R_1 = \frac{(A_v - 1)^2}{A_v - 1 - Q^2} \cdot R_2$$

Likewise, the components' values can be determined by fixing one of the other three parameters. Referring to fig. 1 the suggested R_2 value should be higher than 2K Ω in order to have a good THD (internal op. amp. current limit).

Viceversa the R_1 value should be equal or lower than 51K Ω in order to keep the "click"(DC step) very low.

A typical application is shown by fig. 2

Fig. 1

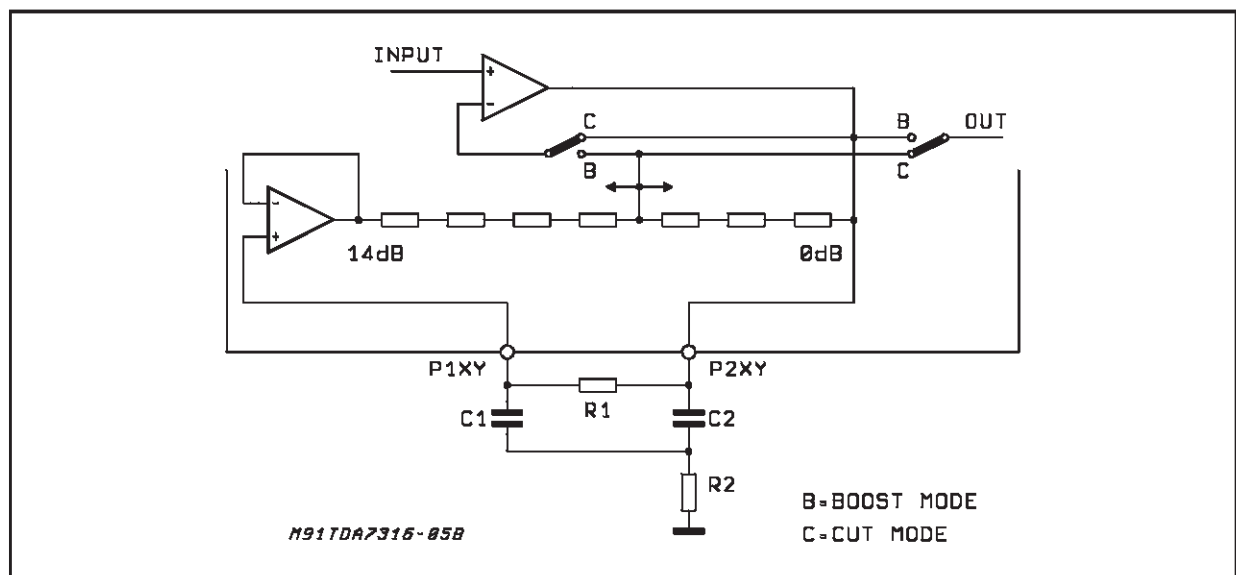
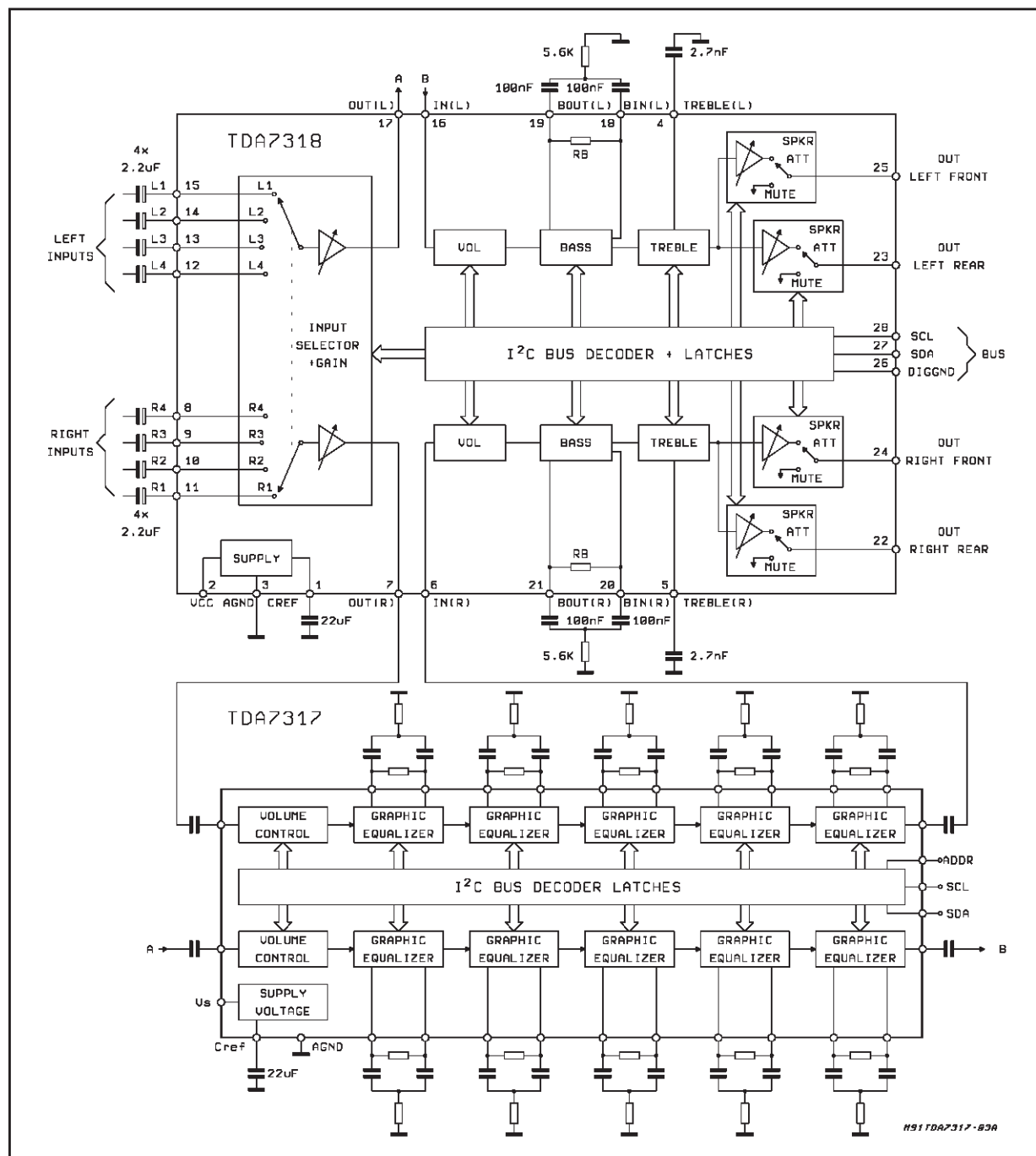


Figure 2: Application Circuit



The five bands graphic equalizer is used in conjunction with a TDA7318 (or another audioprocessor of the SGS-THOMSON 731X family).

The audioprocessor bass and treble tone can furnish two extra filter bands.

Application requiring higher number of external equalizer bands could be implemented by cascading 2 or more TDA7317 devices. In fact the

dedicated ADDR pin allows 2 addresses selection. Anyway, the address of the graphic equalizer is different from the audioprocessor one.

For example 11 bands are implemented by use of 2 TDA7317 plus an audioprocessor (TDA731X family).

In case one filtering cell is not needed, a short circuit must be provided between the P1xy and P2xy pins.

I²C BUS INTERFACE

Data transmission from microprocessor to the TDA7317 and viceversa takes place thru the 2 wires I²C BUS interface, consisting of the two lines SDA and SCL (pull-up resistors to positive supply voltage must be externally connected).

Data Validity

As shown in fig. 3, 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.4 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 to the SDA line must contain 8 bits. Each byte must be followed by an acknowledge bit. The MSB is transferred first.

Figure 3: Data Validity on the I²C BUS

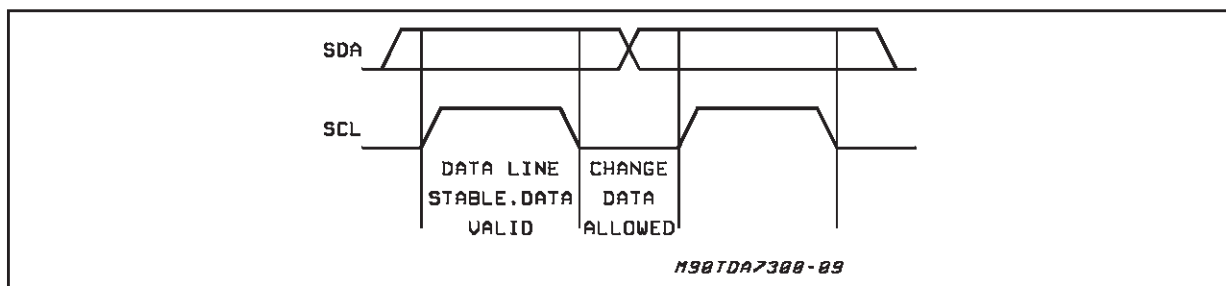


Figure 4: Timing Diagram of I²C BUS

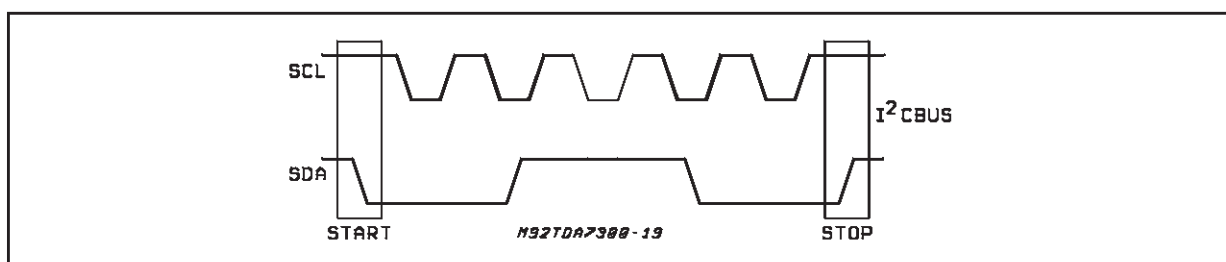
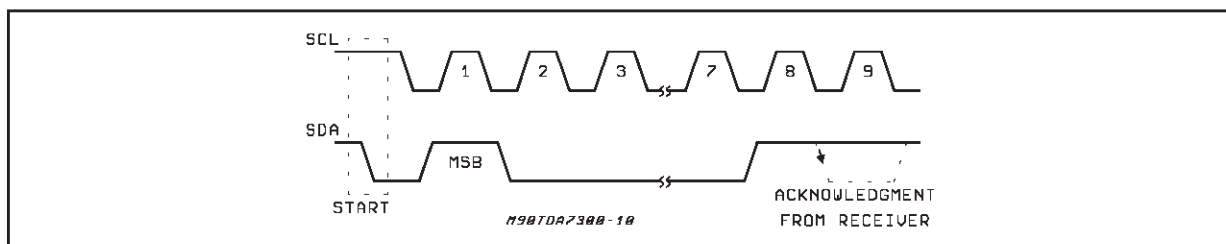


Figure 5: Acknowledge on the I²C BUS



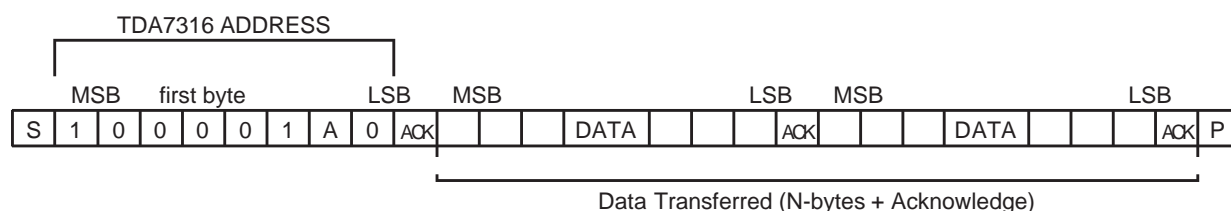
SOFTWARE SPECIFICATION**Interface Protocol**

The interface protocol comprises:

- A start condition (s)
- A chip address byte, containing the TDA7317

address (the 8th bit of the byte must be 0). The TDA7317 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 100kbts/s

SOFTWARE SPECIFICATION

Chip address (84 or 86 Hex)

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

A = Logic level on pin ADDR

A = 1 if ADDR pin = open

A = 0 if ADDR pin = connected to ground

SOFTWARE SPECIFICATION (continued)

DATA BYTES (detailed description)

Volume

| MSB | | | | LSB | | | FUNCTION | |
|-----|---|----|----|-----|----|----|----------|----------------------|
| 0 | X | B2 | B1 | B0 | A2 | A1 | A0 | Volume 0.375dB steps |
| | | | | | 0 | 0 | 0 | 0 |
| | | | | | 0 | 0 | 1 | -0.375 |
| | | | | | 0 | 1 | 0 | -0.75 |
| | | | | | 0 | 1 | 1 | -1.125 |
| | | | | | 1 | 0 | 0 | -1.5 |
| | | | | | 1 | 0 | 1 | -1.875 |
| | | | | | 1 | 1 | 0 | -2.25 |
| | | | | | 1 | 1 | 1 | -2.625 |
| 0 | X | B2 | B1 | B0 | A2 | A1 | A0 | Volume -3dB steps |
| | | 0 | 0 | 0 | | | | 0 |
| | | 0 | 0 | 1 | | | | -3 |
| | | 0 | 1 | 0 | | | | -6 |
| | | 0 | 1 | 1 | | | | -9 |
| | | 1 | 0 | 0 | | | | -12 |
| | | 1 | 0 | 1 | | | | -15 |

TDA7317

Graphic Equalizer

| MSB | | | | | LSB | | | FUNCTION |
|-----|----|----|----|----|-----|----|----|----------|
| 1 | D3 | D2 | D1 | D0 | S2 | C1 | C0 | |
| | 0 | 0 | 0 | | | | | Band 1 |
| | 0 | 0 | 1 | | | | | Band 2 |
| | 0 | 1 | 0 | | | | | Band 3 |
| | 0 | 1 | 1 | | | | | Band 4 |
| | 1 | 0 | 0 | | | | | Band 5 |
| | D3 | D2 | D1 | 1 | C2 | C1 | C0 | cut |
| | D3 | D2 | D1 | 0 | C2 | C1 | C0 | Boost |
| | | | | | 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 |

AX = 0.375dB steps, BX = 3dB steps, CX = 2dB steps, X = don't care

| STATUS AFTER POWER-ON RESET | |
|-----------------------------|----------|
| Volume | -17.25dB |
| Graphic equalizer bands | -12dB |

APPLICATION INFORMATION

A typical application is indicated in figure 4, while

the P.C. Board and components layout are reported in figure 5. The external components, are calculated for 2 different max boost/cut conditions

TABLE 1: Max Boost/cut = 20 dB (each cell = ± 14 dB)

| | F (HZ) | Q | R1 (K Ω) | R2 (K Ω) | C1 (nF) | C2 (nF) | Av max (dB) |
|---------------|----------|------|------------------|------------------|---------|---------|-------------|
| BAND 1 | 10363.38 | 1.49 | 47 | 5.1 | 0.820 | 1.2 | 13.52 |
| BAND 2 | 261.03 | 1.49 | 47 | 5.1 | 33 | 47 | 13.63 |
| BAND 3 | 1036.34 | 1.49 | 47 | 5.1 | 8.2 | 12 | 13.52 |
| BAND 4 | 3168.08 | 1.49 | 47 | 5.1 | 2.7 | 3.9 | 13.57 |
| BAND 5 | 59.75 | 1.11 | 43 | 7.5 | 220 | 100 | 13.88 |

For THD performance the sequence Band 1, 2, 3, 4, 5, is recommended

TABLE2: Max Boost/cut = 17dB (each cell = ± 12 dB)

| | F (HZ) | Q | R1 (K Ω) | R2 (K Ω) | C1 (nF) | C2 (nF) | Av max (dB) |
|---------------|----------|------|------------------|------------------|---------|---------|-------------|
| BAND 1 | 10158.00 | 1.15 | 33 | 6.2 | 1.2 | 1 | 11.83 |
| BAND 2 | 250.81 | 1.21 | 30 | 5.1 | 47 | 56 | 11.33 |
| BAND 3 | 977.34 | 1.20 | 39 | 6.8 | 10 | 10 | 11.75 |
| BAND 4 | 3429.00 | 1.25 | 39 | 6.2 | 2.7 | 3.3 | 11.67 |
| BAND 5 | 61.82 | 1.15 | 33 | 6.2 | 180 | 180 | 11.27 |

Figure 4

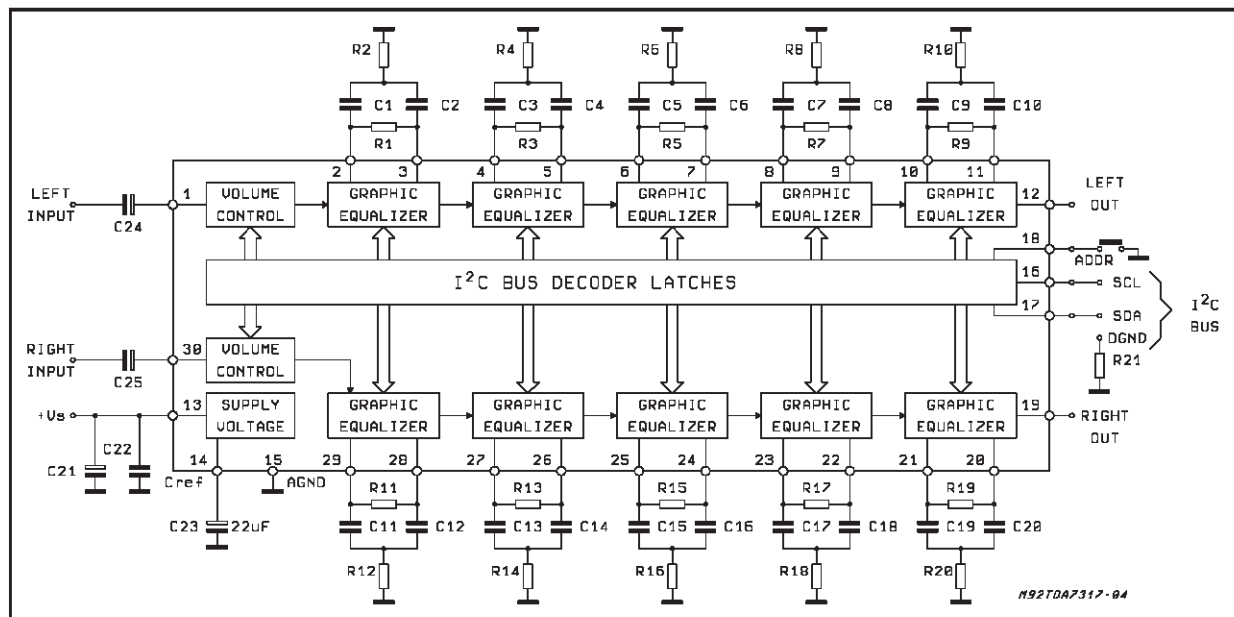
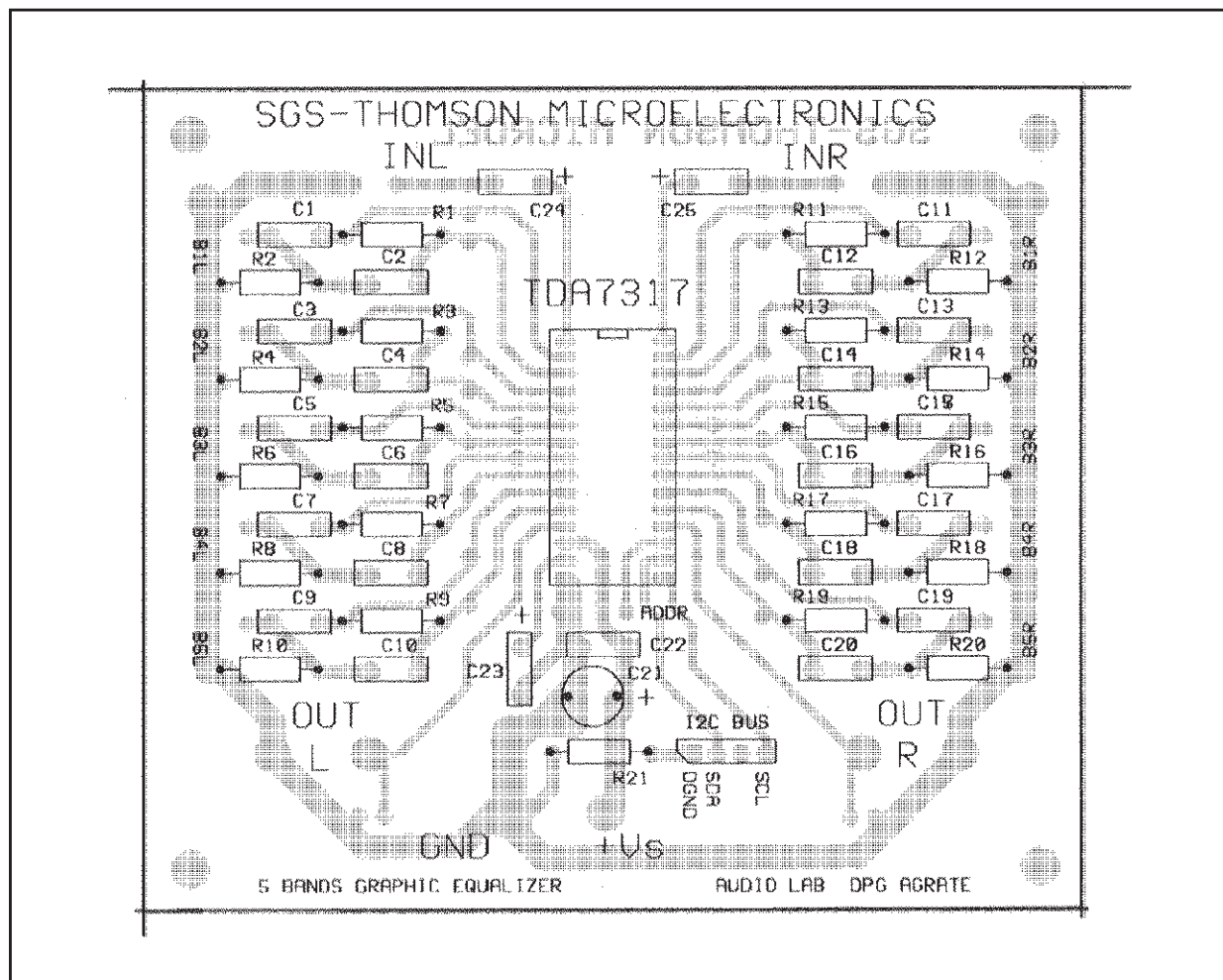
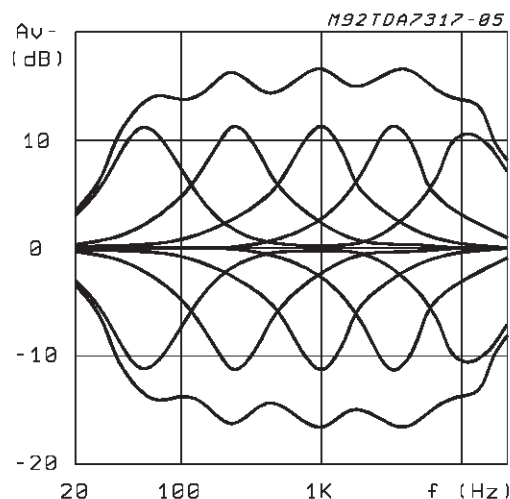


Figure 5: PCP Board and components layout of the figure 4 (scale 1:1)



Measurements done on the test jig of fig. 5 using the components indicated in table 2, are reported

Figure 6: Frequency Response



in figg. 6, 7, 8.

Figure 7 THD vs Frequency Max Boost/cut = ± 14 dB

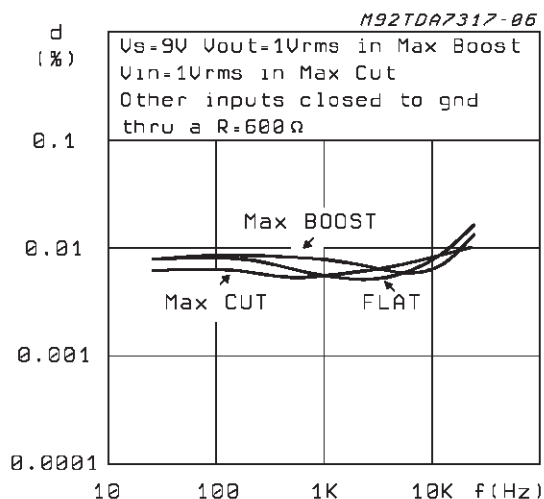
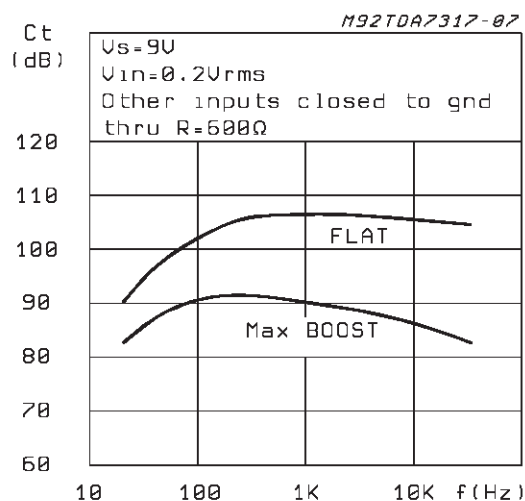


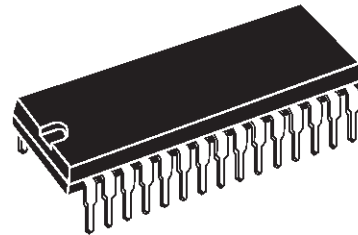
Figure 8: Cross Talk vs Frequency



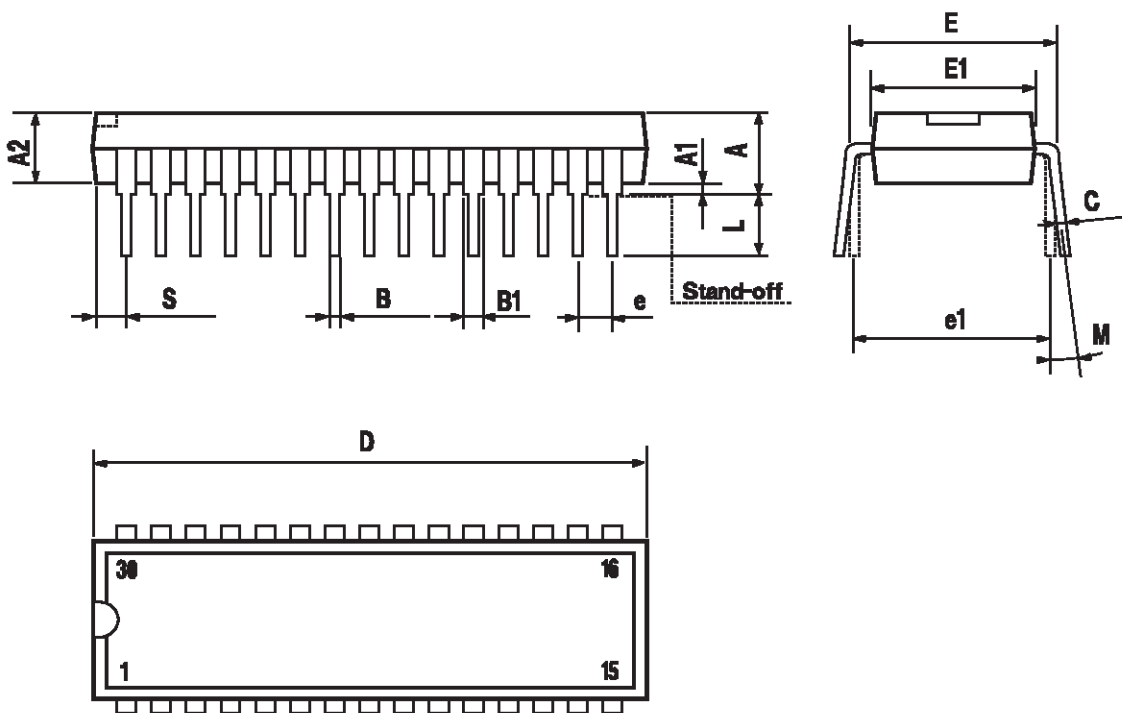
Purchase of I²C Components of SGS-THOMSON Microelectronics, conveys a license under the Philips I²C Patent Rights to use these components in an I²C system, provided that the system conforms to the I²C Standard Specifications as defined by Philips.

| DIM. | mm | | | inch | | |
|------|---------------------|-------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 5.08 | | | 0.20 |
| A1 | 0.51 | | | 0.020 | | |
| A2 | 3.05 | 3.81 | 4.57 | 0.12 | 0.15 | 0.18 |
| B | 0.36 | 0.46 | 0.56 | 0.014 | 0.018 | 0.022 |
| B1 | 0.76 | 0.99 | 1.40 | 0.030 | 0.039 | 0.055 |
| C | 0.20 | 0.25 | 0.36 | 0.008 | 0.01 | 0.014 |
| D | 27.43 | 27.94 | 28.45 | 1.08 | 1.10 | 1.12 |
| E | 10.16 | 10.41 | 11.05 | 0.400 | 0.410 | 0.435 |
| E1 | 8.38 | 8.64 | 9.40 | 0.330 | 0.340 | 0.370 |
| e | | 1.778 | | | 0.070 | |
| e1 | | 10.16 | | | 0.400 | |
| L | 2.54 | 3.30 | 3.81 | 0.10 | 0.13 | 0.15 |
| M | 0°(min.), 15°(max.) | | | | | |
| S | 0.31 | | | 0.012 | | |

OUTLINE AND MECHANICAL DATA



SDIP30 (0.400")



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