



## Analog Front End

PRODUCT PREVIEW

TDA7521 is a BiCMOS analog front end for CD applications. Four input signals ( $AC^*$ ,  $BD^*$ ,  $E^*$  and  $F^*$ ), coming from the pick-up (whose laser diode is driven and controlled by the device itself), are preamplified by a programmable voltage-to-voltage or current-to-voltage stage, depending on the used pick-up. The output signals from the preamplifier stage ( $AC$ ,  $BD$ ,  $E$ ,  $F$  and  $HF$ , a radio frequency signal obtained by combining the photo-detector outputs as  $A+B+C+D$ ) are fed to an 8-bit HF ADC (for  $HF$ , which carries encoded audio data) and a 6-bit Servo ADC (for  $AC$ ,  $BD$ ,  $E$  and  $F$ , used for focusing, tracking the laser beam and controlling revolution speed). All these signals are digitized, multiplexed, synchronized with the external clock ( $768 \times F_s$  or  $394 \times F_s$ ,  $F_s = 44.1 \text{ KHz}$ ) and fed to the digital counterpart in one only digital stream ( $AC/HF/BD/HF/E/HF/F/HF$ ). Two stereo DACs convert the input bitstreams from TDA7522.

All the clock signals (for ADCs and DACs) are generated by a low-jitter PLL-based clock manager. All TDA7521's analog preprocessing is controlled by TDA7522 by means of an UART interface (which implements an  $I^2C$ -like protocol). Housed in a TQFP 44,  $10 \times 10 \text{ mm}$  package, TDA7521 features the functions shown in figure below.

TDA7521 uses the HF4CMOS technology and is supplied @5Vdc.

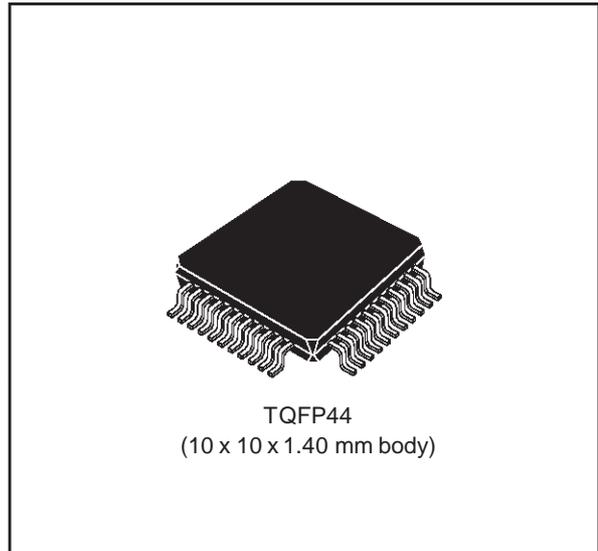
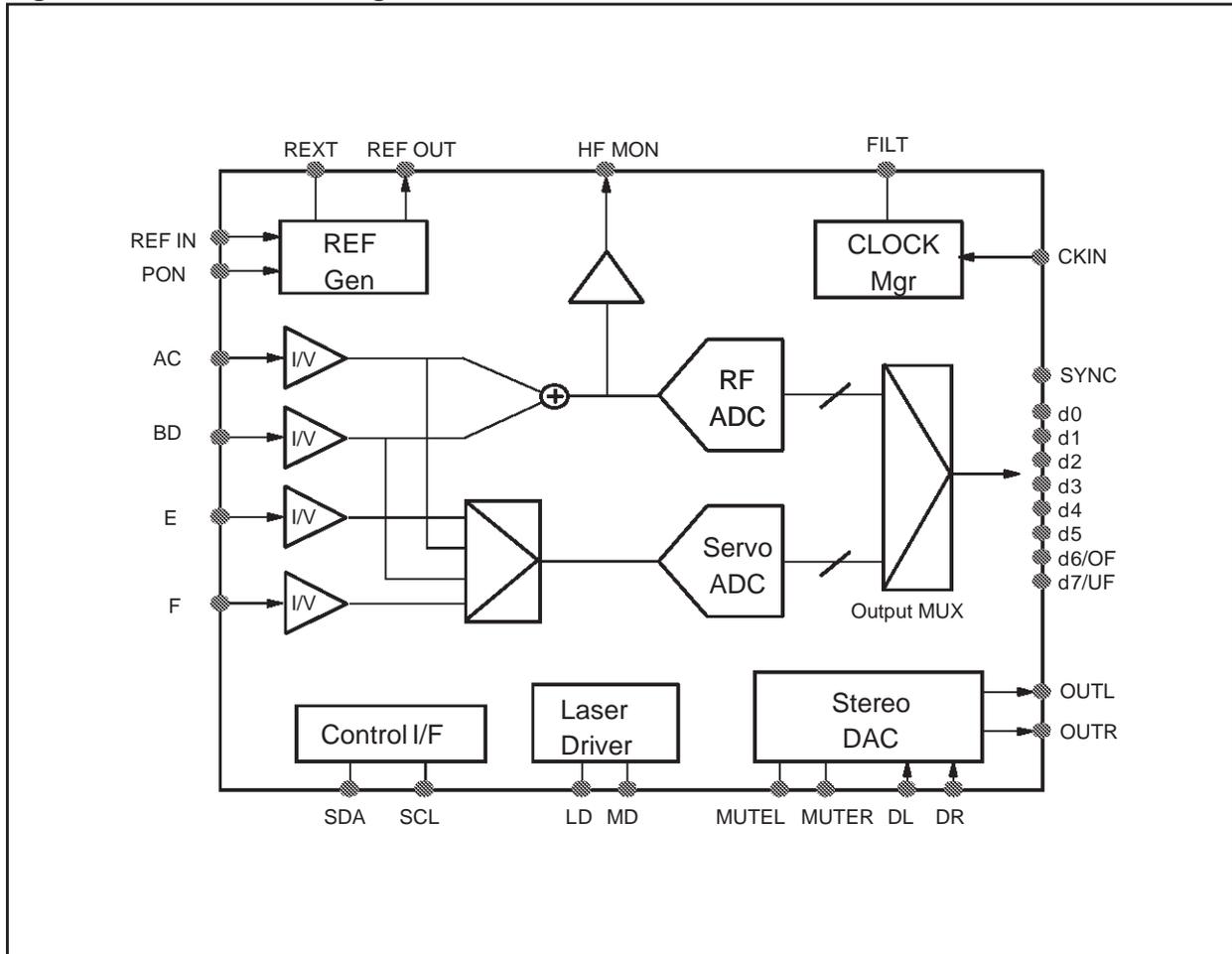


Figure 1. TDA7521 Block Diagram



**1.0 HARDWARE DESCRIPTION**

**1.1 Clock source and generation**

The master clock to operate the device is  $768 \times F_s$  (High Frequency mode, HFM) or  $384 \times F_s$  (Low Frequency mode, LFM).  $F_s = 44.1 \text{ KHz}$  for CD applications. In either case, the clock is generated by TDA7522: an internal low-jitter Charge-Pump PLL (CPPLL) and a Finite State Machine (FSM) synthesize all the needed clocks for the internal blocks: a  $512 \times F_s$  for the DAC and three  $384 \times F_s$  (HFM) or  $192 \times F_s$  (LFM), with different phases for ADCs and output digital multiplexer. The required loop filter network is made up of a 160pF capacitor from FILT to GND\_pll in parallel with the series of a 10nF and a 4kΩ resistor. All clock-related setups are communicated to TDA7521 via UART interface.

**1.2 Voltage references**

REFIN is an internal voltage reference generated by a resistor divider between  $VCC_{dac}$  and  $VSS_{dac}$ . Nominal value (with  $VCC_{dac} = 5V$ ) is  $REFIN = 2.5V$ . Careful filtering of this pin is essential; recommended value of external capacitor is  $47\mu F$  paralleled with 100nF ceramic. REFOUT is a 2.5V (nominal) buffered output to bias the pickup. All the internal voltage references for ADCs and DACs are generated by band-gap-based circuits, thus allowing to reduce the noise induced by the power supply.

### 1.3 Laser driver section

The laser driver system is composed by the pick-up, the laser driver and the external PNP bipolar transistor. It controls the external pick-up current level (up to 100mA) through its base current in order to maintain a certain amount of diode power emission, independently from temperature and aging effects. This is done in a digital way by using a 6-bit DAC to set the monitor diode analog reference voltage at a constant level (and so the current in the laser diode). Thus, 26-1 different bias currents (with relative monitor voltage between 100 and 300mV) can be selected via UART interface. A negative feedback loop sets both the monitor diode voltage and the laser diode bias current.

### 1.4 Preamplifier section

The goal of this section is to free the four voltage signals coming from either the CD pickup itself (voltage inputs) or the internal current-to-voltage converters (current inputs) from their intrinsic DC component and to amplify them to a level suitable for efficient A/D conversion. In case of current inputs, four transimpedance amplifiers convert the currents from AC (A+C), BD (B+D), E and F inputs into output voltages suitable for the programmable preamplification chain; otherwise, this stage is by-passed and the voltage inputs are directly connected to the preamplification stage. The two paths (for input current or input voltage) are digitally selected via UART interface. In the same way also the gain of the path and the offset cancellation for the preamplification chain are controlled (the gain programmability range is spanning from 6 up to 29.5dB in 48 discrete steps of 0.5dB each, while the offset nulling circuit allows a minimum correction step of about 22mV via a 6-bit DAC). Moreover the preamplification chain generates an HF signal, which carries the encoded audio data and is obtained by combining the photo-detector outputs as A+B+C+D. All these signals (AC, BD, E, F and HF), which can be evaluated by means of the monitor output, are fed to the ADC section.

### 1.5 ADC section

The HF and servo (AC, BD, E and F) paths are digitized by means of two ADCs: the former (8-bit resolution, interleaved comparator two step architecture) samples the HF signal at a frequency of  $384F_s$  (HFM) or  $192F_s$  (LFM), the latter (6-bit resolution, interleaved comparator two step architecture) allows to multiplex the data for the servo path (AC, BD, E and F) in an only analog signal AC/BD/E/F and samples this signal at  $384F_s$  (HFM) or  $192F_s$  (LFM); that means each servo signal is sampled at  $96F_s$  or  $48F_s$ . Then both the bitstreams (HF and AC/BD/E/F) are digitally multiplexed in a single bitstream (AC/HF/BD/HF/E/HF/F/HF). A SYNC signal (high during the period of HF before AC output) is provided in order to point out the start of a new frame. It is worth noting that output data change on the falling edge of the master clock.

The Table 1 shows the output data format for the ADC section: referring to AC/HF/BD/HF/E/ HF/F, the HF signal have an *8-bit format which represents the digitized value of the HF analog signal* while the data for the servo path (AC, BD, E and F) have a different format: *6 bit for the digitized value of the analog output from the preamplifiers plus underflow and overflow*<sup>(1)</sup>.

**Table 1. TDA7521 Output Format**

| LSB |    |    |    |    |    |       | MSB   |
|-----|----|----|----|----|----|-------|-------|
| D0  | D1 | D2 | D3 | D4 | D5 | D6/UF | D7/OF |

Note: 1. Overflow and Underflow for the HF ADC are latched by a dedicated FSM and read via UART interface.

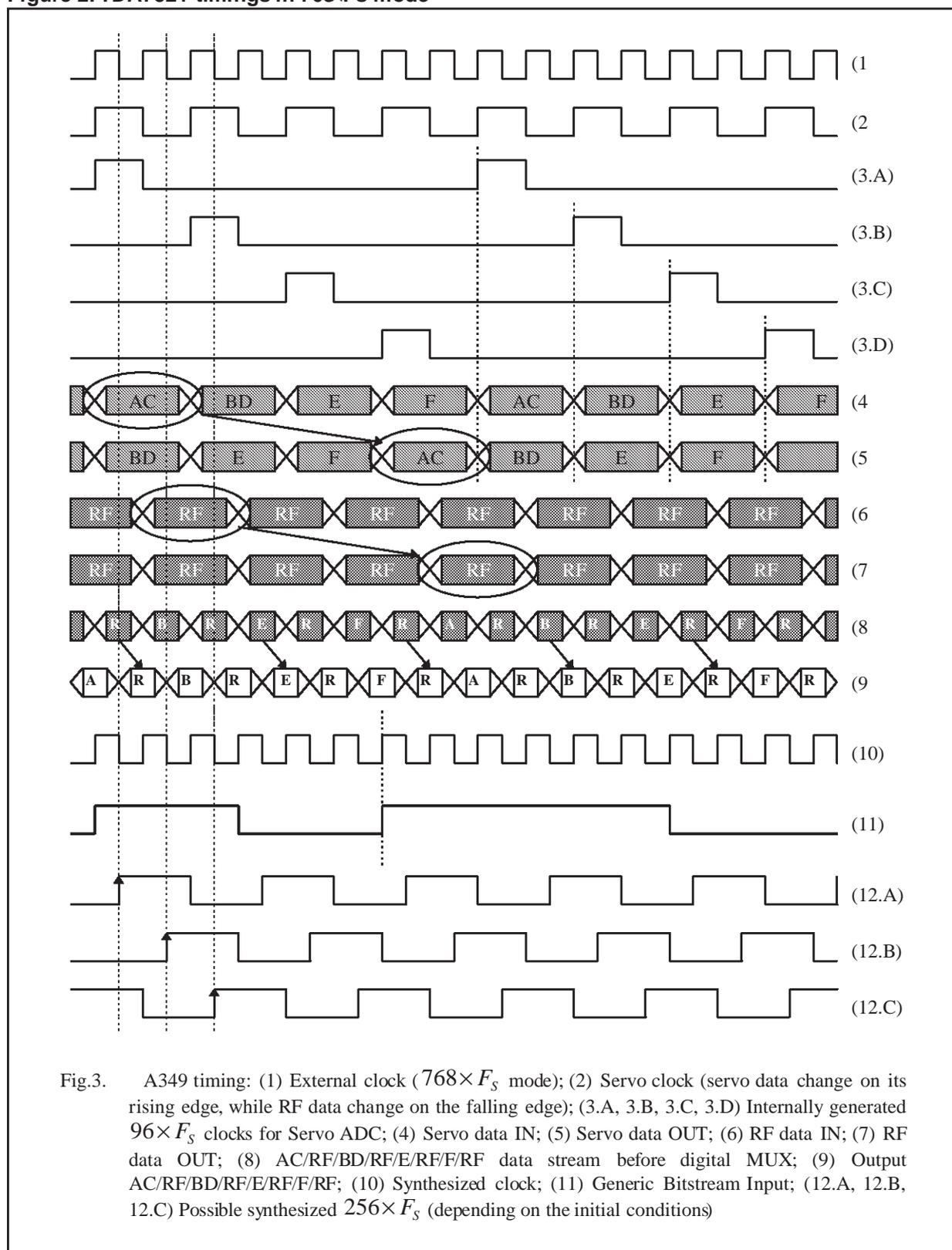
### 1.6 DAC section

In TDA7521 are present two 3rd order SC smoothing filters to be used in Digital-to-Analog conversion. Its input signal is a bitstream created by a 2nd order digital  $\Sigma\Delta$  modulator present in TDA7522. From there

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the bitstream is passed to the analog chip and properly processed by the filter. The filter exhibits 96dB SNR and more than -80dB THD for a full scale input signal.

Figure 2. TDA7521 timings in  $768 \times F_s$  mode

**2.0 FEATURE**

The main performance of TDA7521 are reported below

**Table 2. Main DC Characteristics (I)**

| Current input   | Condition | Min | Typ | Max | Unit |
|-----------------|-----------|-----|-----|-----|------|
| A+C diode input |           | 1   |     | 16  | μA   |
| B+D diode input |           | 1   |     | 16  | μA   |
| E diode input   |           | 1   |     | 16  | μA   |
| F diode input   |           | 1   |     | 16  | μA   |

**Table 3. Main DC Characteristics (II)**

| Voltage input   | Condition | Min | Typ | Max | Unit |
|-----------------|-----------|-----|-----|-----|------|
| A+C diode input |           | 45  |     | 700 | mVpp |
| B+D diode input |           | 45  |     | 700 | mVpp |
| E diode input   |           | 45  |     | 700 | mVpp |
| F diode input   |           | 45  |     | 700 | mVpp |

The polarity of input signals can be defined by ST7 individually

**Table 4. AC Main Performances**

| Contents                                     | Condition         | Min | Typ | Max     | Unit |
|--|-------------------|-----|-----|---------|------|
| DC offset range of each diode signals        | (*) Max input P-P | 0   |     | 3/2 (*) | mVpp |
| Frequency Range                              |                   | DC  |     | 4M      | MHz  |
| Group delay Flatness                         |                   |     |     | 4       | nsec |
| SNR  |                   | 48  |     |         | dB   |
| Individual Gain Adjustment on AC, BD, E, F   |                   | 0   |     | 23.5    | dB   |
| Gain Step range                              |                   |     | 0.5 |         | dB   |
| Individual Offset Adjustment on AC, BD, E, F |                   |     |     |         |      |
| MD (Monitor Diode) voltage range             |                   | 100 |     | 300     | mV   |
| MD Adjustment Step                           |                   |     | 5   |         | mV   |

**Table 5. AC Main Performances**

| DAC                | Condition | Min | Typ | Max | Unit |
|--------------------|-----------|-----|-----|-----|------|
| Single end Output  | VCC/2 DC  |     |     | 1   | Vrms |
| Frequency response |           | 20  |     | 22K | Hz   |
| Dynamic Range      |           |     | 96  |     | dB   |
| THD@Full scale     |           |     | -80 |     | dB   |

### 3.0 PIN FUNCTION

TDA7521 is housed in a 44 quad flat pack package; the related pin list is reported below.

**Table 6. TDA7521 Pin List**

| Pin Number | Name        | Pin | Description  |
|------------|-------------|-----|--|
| 01         | AC          | I   | A+C diode current input / voltage input DC coupled (1) |
| 02         | BD          | I   | B+D diode current input / voltage input DC coupled (1) |
| 03         | E           | I   | E diode current input / voltage input DC coupled (1)   |
| 04         | F           | I   | F diode current input / voltage input DC coupled (1)   |
| 05         | REXT        | I   | External Reference resistor (2)                        |
| 06         | REFOUT      | O   | Output Reference Voltage (5)                           |
| 07         | REFIN       | I   | VCC/2 Reference Voltage (4)                            |
| 08         | MUTER       | I   | Right Audio Channel Mute (6)                           |
| 09         | MUTEL       | I   | Left Audio Channel Mute (6)                            |
| 10         | PON         | I   | Power shutdown / Reset (7)                             |
| 11         | OUTR        | O   | Right Audio Channel Analog output (8)                  |
| 12         | VSS_DAC     | Gnd | DAC Analog Ground                                      |
| 13         | OUTL        | O   | Left Audio Channel Analog output (8)                   |
| 14         | VCC_DAC     | Vdd | DAC Analog Supply (5V)                                 |
| 15         | VDD_DAC     | Vdd | DAC Digital Supply (5V)                                |
| 16         | GND_DAC     | Gnd | DAC Digital Ground                                     |
| 17         | Vss,DAC_Ref |     | (3)  |
| 18         | Vcc,DAC_Ref |     | (3)  |
| 19         | VDD_PLL     | Vdd | PLL 5V Supply  |
| 20         | FILT        | I/O | PLL Loop Filter (9)                                    |
| 21         | GND_PLL     | Gnd | PLL Ground   |
| 22         | CKIN        | I   | Master clock input                                     |
| 23         | BSL         | I   | Digital Bit Stream input, Left Channel                 |

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| Pin Number | Name    | Pin | Description                             |
|------------|---------|-----|---|
| 24         | BSR     | I   | Digital Bit Stream input, Right Channel |
| 25         | SYNC    | O   | ADC Mux Sync output (10)                |
| 26         | D7      | O   | ADC output [MSB]                        |
| 27         | D6      | O   | ADC output                              |
| 28         | D5      | O   | ADC output                              |
| 29         | D4      | O   | ADC output                              |
| 30         | D3      | O   | ADC output                              |
| 31         | D2      | O   | ADC output                              |
| 32         | D1/UF   | O   | (11)                                    |
| 33         | D0/OF   | O   | (12)                                    |
| 34         | GND_ADC | Gnd | ADC Ground                              |
| 35         | VDD_ADC | Vdd | ADC 5V Supply                           |
| 36         | GND_ADC | Gnd | ADC Ground                              |
| 37         | VCC_ADC | Vdd | ADC 5V Supply                           |
| 38         | SCK     | I   | ST7 Control I/F Clock input             |
| 39         | SDA     | I/O | ST7 Control I/F Data (14)               |
| 40         | HFMON   | O   | HF output (13)                          |
| 41         | LD      | O   | Laser Control output (15)               |
| 42         | MD      | I   | Monitor diode input                     |
| 43         | VSS_PRE | Gnd | Pre_AMP Ground                          |
| 44         | VCC_PRE | Vdd | Pre_AMP 5V Supply                       |

- Notes:
1. Current or Voltage input, DC coupled
  2. Precision Resistor connected between Rext and ground
  3. These pins are to be left unconnected
  4. Internally generated, need external filtering cap
  5. Buffered Vcc/2 Output
  6. Driven by IC6D, active high
  7. Driven by IC6D, active low
  8. 1 Vrms max., VCC/2 DC component
  9. Needs RC-C externals network
  10. High in correspondence of the HF sample preceding the AC one
  11. LSB+1 of the HF ADC, Underflow bit of the servo one
  12. LSB of the HF ADC, Overflow bit of the servo one
  13. Can be selected among HF, AC, BD, E, F (via control interface)
  14. Bidirectional, needs a pull-up resistor to 5 V line
  15. Drives an external pnp.

#### 4.0 TDA7521 REGISTERS ADDRESS MAP

Inside TDA7521 there are 16 registers that are to programmed by TDA7522; table nr.9 report the list. All registers are 8 bit wide.

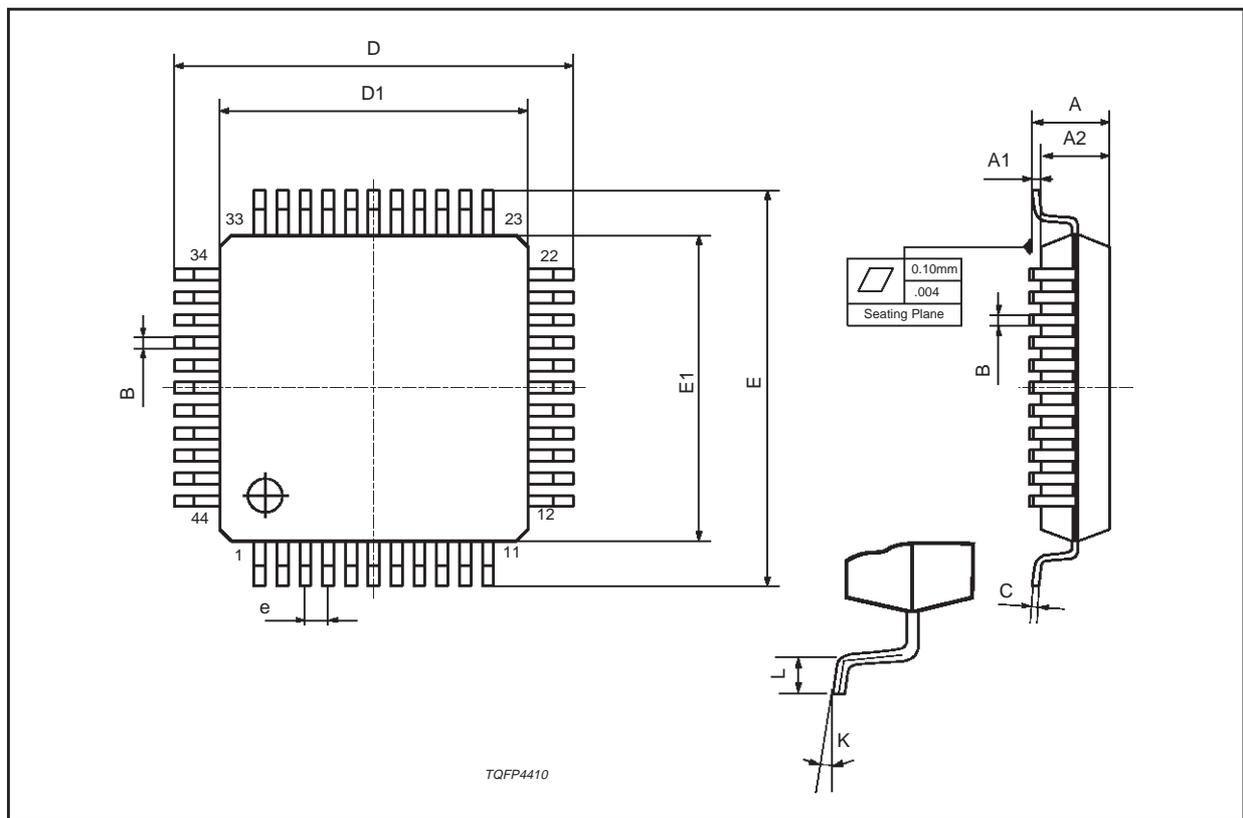
**Table 7. TDA7521 registers Map**

| Address | Register                 |
|---------|--------------------------|
| 0000    | AC Gain reg              |
| 0001    | BD Gain reg              |
| 0010    | E Gain reg               |
| 0011    | F Gain reg               |
| 0100    | AC Offset Adjustment reg |
| 0101    | BD Offset Adjustment reg |
| 0110    | E Offset Adjustment reg  |
| 0111    | F Offset Adjustment reg  |
| 1000    | Monitor Output reg       |
| 1001    | Laser Driver reg         |
| 1010    | PLL reg                  |
| 1011    | Overflow reg (read only) |
| 1100    | Test mode register       |
| 1101    | --unused--               |
| 1110    | Every Gain reg *         |
| 1111    | Every Offset reg *       |

Note: 1. With these two configuration the data sent to the slave section is written inside every Gain/Offset register. This function can thus be used to have a quick and global programming of the afore said register.

## TQFP44 - 44 lead Quad Flat Package

| Symb | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | Min  | Typ   | Max  | Min   | Typ   | Max   |
| A    |      |       | 1.60 |       |       | 0.063 |
| A1   | 0.05 |       | 0.15 | 0.002 |       | 0.006 |
| A2   | 1.35 | 1.40  | 1.45 | 0.053 | 0.055 | 0.057 |
| B    | 0.30 | 0.37  | 0.45 | 0.012 | 0.014 | 0.018 |
| C    | 0.09 |       | 0.20 | 0.004 |       | 0.008 |
| D    |      | 12.00 |      |       | 0.472 |       |
| D1   |      | 10.00 |      |       | 0.394 |       |
| D3   |      | 8.00  |      |       | 0.315 |       |
| e    |      | 0.80  |      |       | 0.031 |       |
| E    |      | 12.00 |      |       | 0.472 |       |
| E1   |      | 10.00 |      |       | 0.394 |       |
| E3   |      | 8.00  |      |       | 0.315 |       |
| L    | 0.45 | 0.60  | 0.75 | 0.018 | 0.024 | 0.030 |
| L1   |      | 1.00  |      |       | 0.039 |       |
| k    | 0°   | 3.5°  | 7°   | 0°    | 3.5°  | 7°    |



Drawing is not to scale.

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