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STMicroelectronics
TDA7407

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# TDA7407

## Advanced car signal processor

## Features

- Fully integrated signal processor optimized for car radio applications
- Fully programmable by i²c bus
- Includes audioprocessor, stereo decoder with noise blanker and multipath detector
- Softmute function
- Programmable roll-off compensation
- No external components

**LQFP44**

## Description

The TDA7407 is the newcomer of the CSP family introduced by TDA7460/61. It uses the same innovative concepts and design technologies allowing fully software programmability through I²C bus and overall cost optimisation for the system designer.

The device includes a three band audioprocessor with configurable inputs, and absence of external components for filter settings, a last generation stereo decoder with multipath detector, and a sophisticated stereo blend and noise cancellation circuitry. Strength points of the CSP approach are flexibility and overall cost/room saving in the application, combined with high performances.

## Order codes

| Part number | Package | Packing |
|---|---|---|
| TDA7407 | LQFP44 | Tray |
| TDA7407TR | LQFP44 | Tape and reel |

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**Distributor of STMicroelectronics: Excellent Integrated System Limited**
Datasheet of TDA7407 - IC PROCESSOR CAR SIGNAL 44TQFP
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# 1      Block diagram and pin connections

Figure 1.      Block diagram



Figure 2.      Pin connections (top view)

**Table 1.     Pin Description**

| N. | Name | Function | Type |
|---|---|---|---|
| 1 | CDR | CD right channel input | I |
| 2 | CDROUT | CD output right channel | O |
| 3 | CDGND | CD input common ground | I |
| 4 | CDLOUT | CD output left channel | O |
| 5 | CDL | CD input left channel | I |
| 6 | nc | | - |
| 7 | PH - | Differential phone input - | I |
| 8 | PH + | Differential phone input + | I |
| 9 | AFS | AFS drive | I |
| 10 | AM | AM input | I |
| 11 | nc | | - |
| 12 | MPX | FM stereo decoder input | I |
| 13 | nc | | - |
| 14 | LEVEL | Level input stereo decoder | I |
| 15 | MPIN | Multipath input | I |
| 16 | MPOUT | Multipath output | O |
| 17 | nc | | - |
| 18 | MUXL | Multiplexer output left channel | O |
| 19 | MUXR | Multiplexer output right channel | O |
| 20 | nc | | - |
| 21 | QUAL | Stereo decoder quality output | O |
| 22 | SMUTE | Soft mute drive | I |
| 23 | SCL | I$^2$C clock line | I |
| 24 | SDA | I$^2$C data line | I/O |
| 25 | nc | | - |
| 26 | GND | Supply ground | S |
| 27 | VS | Supply voltage | S |
| 28 | nc | | - |
| 29 | OUTRR | Right rear speaker output | O |
| 30 | OUTLR | Left rear speaker output | O |
| 31 | OUTRF | Right front spaeaker output | O |
| 32 | OUTLF | Left front speaker output | O |
| 33 | nc | | - |
| 34 | ACOUTR | Pre-speaker AC output right channel | O |
| 35 | ACOUTL | Pre-speaker AC output left channel | O |

**Table 1.      Pin Description  (continued)**

| N. | Name | Function | Type |
|---|---|---|---|
| 36 | nc | | - |
| 37 | ACINLR | Pre-speaker input left rear channel | I |
| 38 | ACINRR | Pre-speaker input right rear channel | I |
| 39 | ACINRF | Pre-speaker input right front channel | I |
| 40 | ACINLF | Pre-speaker input left front channel | I |
| 41 | VREF | Reference voltage output | O |
| 42 | CREF | Reference capacitor pin | S |
| 43 | TAPEL | Tape input left | I |
| 44 | TAPER | Tape input right | I |

Pin type legend: I = Input ; O = Output; I/O = Input/Output; S = Supply; nc = not connected

**Table 2.      Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_S$ | Operating supply voltage | 10.5 | V |
| $T_{amb}$ | Operating ambient temperature range | -40 to 85 | °C |
| $T_{stg}$ | Operating storage temperature range | -55 to 150 | °C |

**Table 3.      Supply**

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_S$ | Supply voltage | | 7.5 | 9 | 10 | V |
| $I_S$ | Supply current | $V_S$ = 9V | 30 | 35 | 40 | mA |
| SVRR | Ripple rejection @ 1KHz | Audioprocessor (all filters flat) | 50 | 60 | | dB |
| | | Stereo decoder + audioprocessor | 45 | 55 | | dB |

**Table 4.      Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{th\text{-}j\ pins}$ | Thermal resistance junction to pins (max) | 85 | °C/W |

## 1.1    ESD

All pins are protected against ESD according to the MIL883 standard.

# 2        Audio processor part

## 2.1      List of features

### 2.1.1    Input multiplexer

- Quasi differential CD and cassette stereo input
- AM mono input
- Phone differential input
- Multiplexer signal after In-Gain available at separate pins

### 2.1.2    Volume control

- 1dB attenuator
- Max. gain 15dB
- Max. attenuation 79dB

### 2.1.3    Bass control

- $2^{nd}$ order frequency response
- Q-factor programmable in 4 steps
- Center frequency programmable in 4(5) steps
- DC gain programmable
- ±15 x 1dB steps

### 2.1.4    Mid control

- $2^{nd}$ order frequency response
- Q-factor programmable in 2 steps
- Center frequency programmable in 4 steps
- ±15 x 1dB steps

### 2.1.5    Treble control

- $2^{nd}$ order frequency response
- Center frequency programmable in 4 steps
- ±15 x 1dB steps

### 2.1.6    Speaker control

- 4 independent speaker controls in 1dB steps
- max gain 15dB
- max. attenuation 79dB

### 2.1.7 Mute functions

● Direct mute
● Digitally controlled softmute with 4 programmable mute time.


## 2.2 Electrical characteristics

**Table 5.    Audio processor electrical characteristics**
($V_S$ = 9V; $T_{amb}$ = 25°C; $R_L$ = 10KΩ; all gains = 0dB; f = 1KHz; unless otherwise specified)

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Input selector** | | | | | | |
| $R_{in}$ | Input resistance | all inputs except phone | 70 | 100 | 130 | KΩ |
| $V_{CL}$ | Clipping level | | 2.2 | 2.6 | | $V_{RMS}$ |
| $S_{IN}$ | Input separation | | 80 | 100 | | dB |
| $G_{IN MIN}$ | Min. input gain | | -1 | 0 | 1 | dB |
| $G_{IN MAX}$ | Max. input gain | | 13 | 15 | 17 | dB |
| $G_{STEP}$ | Step resolution | | 0.5 | 1 | 1.5 | dB |
| $V_{DC}$ | DC steps | Adjacent gain step | -5 | 0.5 | 5 | mV |
| | | GMIN to GMAX | -10 | 5 | 10 | mV |
| **Differential CD stereo input** | | | | | | |
| $R_{in}$ | Input resistance | Differential | 70 | 100 | 130 | KΩ |
| | | Common mode | 70 | 100 | 130 | KΩ |
| CMRR | Common mode rejection ratio | $V_{CM}$ = 1$V_{RMS}$ @ 1KHz | 45 | 70 | | dB |
| | | $V_{CM}$ = 1$V_{RMS}$ @ 10KHz | 45 | 60 | | dB |
| $e_N$ | Output noise @ speaker outputs | 20Hz to 20KHz flat; all stages 0dB | | 6 | 15 | mV |
| **Differential phone input** | | | | | | |
| $R_{in}$ | Input resistance | Differential | 40 | 56 | | KΩ |
| CMRR | Common mode rejection ratio | $V_{CM}$ = 1$V_{RMS}$ @ 1KHz | 40 | 70 | | dB |
| | | $V_{CM}$ = 1$V_{RMS}$ @ 10KHz | 40 | 60 | | dB |
| **Volume control** | | | | | | |
| $G_{MAX}$ | Max gain | | 13 | 15 | 17 | dB |
| $A_{MAX}$ | Max attenuation | | 70 | 79 | | dB |
| $A_{STEP}$ | Step resolution | | 0.5 | 1 | 1.5 | dB |
| $E_A$ | Attenuation set error | G = -20 to 20dB | -1.25 | 0 | 1.25 | dB |
| | | G = -60 to 20dB | -4 | 0 | 3 | dB |
| $E_T$ | Tracking error | | | | 2 | dB |

**Audio processor part**　　　　　　　　　　　　　　　　　　　　　　　**TDA7407**

**Table 5.**　　**Audio processor electrical characteristics**　(continued)
$(V_S = 9V; T_{amb} = 25°C; R_L = 10K\Omega;$ all gains = 0dB; f = 1KHz; unless otherwise specified)

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{DC}$ | DC steps | Adjacent attenuation steps | | 0.1 | 3 | mV |
| | | From 0dB to GMIN | | 0.5 | 5 | mV |
| **Soft mute/AFS** | | | | | | |
| $A_{MUTE}$ | Mute attenuation | | 80 | 100 | | dB |
| $T_D$ | Delay time | T1 | | 0.48 | | ms |
| | | T2 | | 0.96 | | ms |
| | | T3 | | 40.4 | | ms |
| | | T4 | | 324 | | ms |
| $V_{TH\ low}$ | Low threshold for SM-/AFS- Pin[1] | | | | 1 | V |
| $V_{TH\ high}$ | High threshold for SM-/AFS-Pin | | 2.5 | | | V |
| $R_{PD}$ | Internal pull-up resistor | | | 45 | | $K\Omega$ |
| **Bass control** | | | | | | |
| $C_{RANGE}$ | Control range | | ±13 | ±15 | ±17 | dB |
| $A_{STEP}$ | Step resolution | | 0.5 | 1 | 1.5 | dB |
| $f_C$ | Center frequency | $f_{C1}$ | 54 | 60 | 66 | Hz |
| | | $f_{C2}$ | 63 | 70 | 77 | Hz |
| | | $f_{C3}$ | 72 | 80 | 88 | Hz |
| | | $f_{C4}$ | 90 | 100 (150) [2] | 110 | Hz |
| $Q_{BASS}$ | Quality factor | $Q_1$ | 0.9 | 1 | 1.1 | |
| | | $Q_2$ | 1.1 | 1.25 | 1.4 | |
| | | $Q_3$ | 1.3 | 1.5 | 1.7 | |
| | | $Q_4$ | 1.8 | 2 | 2.2 | |
| $DC_{GAIN}$ | Bass-DC-gain | DC = off | -1 | 0 | 1 | dB |
| | | DC = on | 3.5 | 4.4 | 5.5 | dB |
| **MID control** | | | | | | |
| $C_{RANGE}$ | Control range | | ±13 | ±15 | ±17 | dB |
| $A_{STEP}$ | Step resolution | | 0.5 | 1 | 1.5 | dB |
| $f_C$ | Center frequency | $f_{C1}$ | 450 | 500 | 550 | Hz |
| | | $f_{C2}$ | 0.9 | 1 | 1.1 | kHz |
| | | $f_{C3}$ | 1.35 | 1.5 | 1.65 | kHz |
| | | $f_{C4}$ | 1.8 | 2 | 2.2 | kHz |

**TDA7407** **Audio processor part**

### Table 5. Audio processor electrical characteristics (continued)
($V_S$ = 9V; $T_{amb}$ = 25°C; $R_L$ = 10KΩ; all gains = 0dB; f = 1KHz; unless otherwise specified)

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|--------|-----------|----------------|------|------|------|------|
| $Q_{MID}$ | Quality factor | $Q_1$ | 0.9 | 1 | 1.1 | |
| | | $Q_2$ | 1.8 | 2 | 2.2 | |
| **Treble control** | | | | | | |
| $C_{RANGE}$ | Control range | | ±13 | ±15 | ±17 | dB |
| $A_{STEP}$ | Step resolution | | 0.5 | 1 | 1.5 | dB |
| $f_C$ | Center frequency | $f_{C1}$ | 8 | 10 | 12 | KHz |
| | | $f_{C2}$ | 10 | 12.5 | 15 | KHz |
| | | $f_{C3}$ | 12 | 15 | 18 | KHz |
| | | $f_{C4}$ | 14 | 17.5 | 21 | KHz |

1. The SM pin is active low (mute = 0)

2. See note in programming section

# 3 Stereo decoder part

**Table 6.** **Stereo decoder electrical characteristics**
($V_S$ = 9V; de-emphasis time constant = 50μs, $V_{MPX}$ = 500mV (75KHz deviation), fm= 1KHz, Gv = 6dB. $T_{amb}$ = 25°C; unless otherwise specified)

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{in}$ | MPX input level | $G_v$ = 3.5dB | | 0.5 | 1.25 | $V_{RMS}$ |
| $R_{in}$ | Input resistance | | 70 | 100 | 130 | KΩ |
| $G_{MIN}$ | Min. input gain | | 1.5 | 3.5 | 4.5 | dB |
| GMAX | Max. input gain | | 8.5 | 11 | 12.5 | dB |
| GSTEP | Step resolution | | 1.75 | 2.5 | 3.25 | dB |
| SVRR | Supply voltage ripple rejection | Vripple = 100mV; f = 1KHz | 35 | 60 | | dB |
| α | Max. channel separation | | 30 | 50 | | dB |
| THD | Total harmonic distortion | | | 0.02 | 0.3 | % |
| $\frac{S+N}{N}$ | Signal plus noise to noise ratio | A-weighted, S = $2V_{RMS}$ | 80 | 91 | | dB |
| **Mono / stereo switch** | | | | | | |
| $V_{PTHST1}$ | Pilot threshold voltage | for Stereo, PTH = 1 | 10 | 15 | 25 | mV |
| $V_{PTHST0}$ | Pilot threshold voltage | for Stereo, PTH = 0 | 15 | 25 | 35 | mV |
| $V_{PTHMO1}$ | Pilot threshold voltage | for Mono, PTH = 1 | 7 | 12 | 17 | mV |
| $V_{PTHMO0}$ | Pilot threshold voltage | for Mono, PTH = 1 | 10 | 19 | 25 | mV |
| **PLL** | | | | | | |
| Δf/f | Capture range | | 0.5 | | | % |
| **De-emphasis and highcut** | | | | | | |
| $t_{HC50}$ | De-emphasis time constant | Bit 7, Subadr, 10 = 0, $V_{LEVEL}$ >> $V_{HCH}$ | 25 | 50 | 75 | μs |
| $t_{HC75}$ | De-emphasis time constant | Bit 7, Subadr, 10 = 1, $V_{LEVEL}$ >> $V_{HCH}$ | 50 | 75 | 100 | μs |
| $t_{HC50}$ | Highcut time constant | Bit 7, Subadr, 10 = 0, $V_{LEVEL}$ >> $V_{HCL}$ | 100 | 150 | 200 | μs |
| $t_{HC75}$ | Highcut time constant | Bit 7, Subadr, 10 = 1, $V_{LEVEL}$ >> $V_{HCL}$ | 150 | 225 | 300 | μs |
| **Stereo blend and highcut control** | | | | | | |
| REF5V | Internal reference voltage | | 4.7 | 5 | 5.3 | V |
| $T_{CREF5V}$ | Temperature coefficient | | | 3300 | | ppm |
| $L_{Gmin}$ | Min. LEVEL gain | | -1 | 0 | 1 | dB |
| $L_{Gmax}$ | Max. LEVEL gain | | 8 | 10 | 12 | dB |

**TDA7407**                                                                           **Stereo decoder part**

**Table 6.     Stereo decoder electrical characteristics (continued)**
($V_S$ = 9V; de-emphasis time constant = 50$\mu$s, $V_{MPX}$ = 500mV (75KHz deviation), fm= 1KHz, Gv = 6dB. $T_{amb}$ = 25°C; unless otherwise specified)

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|--------|-----------|----------------|------|------|------|------|
| $L_{Gstep}$ | LEVEL gain step resolution | | 0.3 | 0.67 | 1 | dB |
| $VSBL_{min}$ | Min. voltage for mono | | 25 | 29 | 33 | %REF5V |
| $VSBL_{max}$ | Min. voltage for mono | | 54 | 58 | 62 | %REF5V |
| $VSBL_{step}$ | Step resolution | | 2.2 | 4.2 | 6.2 | %REF5V |
| $VHCH_{min}$ | Min. voltage for NO highcut | | 38 | 42 | 46 | %REF5V |
| $VHCH_{max}$ | Min. voltage for NO highcut | | 62 | 66 | 70 | %REF5V |
| $VHCH_{step}$ | Step resolution | | 5 | 8.4 | 12 | %REF5V |
| $VHCL_{min}$ | Min. voltage for full highcut | | 12 | 17 | 22 | %VHCH |
| $VHCL_{max}$ | Max. voltage for full highcut | | 28 | 33 | 38 | %VHCH |
| $VHCL_{step}$ | Step resolution | | 2.2 | 4.2 | 6.2 | %VHCH |
| **Carrier and harmonic suppression at the output** | | | | | | |
| $\alpha19$ | Pilot signal f = 19KHz | | 40 | 50 | | dB |
| $\alpha38$ | Subcarrier f = 38KHz | | | | 75 | dB |
| $\alpha57$ | Subcarrier f = 57KHz | | | | 62 | dB |
| $\alpha76$ | Subcarrier f = 76KHz | | | | 90 | dB |
| **Intermodulation (Note 1)** | | | | | | |
| $\alpha2$ | $f_{mod}$ = 10KHz, $f_{spur}$ = 1KHz | | | | 65 | dB |
| $\alpha3$ | $f_{mod}$ = 13KHz, $f_{spur}$ = 1KHz | | | | 75 | dB |
| **Traffic Ratio (Note 2)** | | | | | | |
| $\alpha57$ | Signal f = 57KHz | | | | 70 | dB |
| **SCA - Subsidiary communications authorization (note 3)** | | | | | | |
| $\alpha67$ | Signal f = 67KHz | | | | 75 | dB |
| **ACI - Adjacent channel interference (note 4)** | | | | | | |
| $\alpha114$ | Signal f = 114KHz | | | | 95 | dB |
| $\alpha190$ | Signal f = 190KHz | | | | 84 | dB |

## 3.1    Notes to the characteristics:

1.   Intermodulation suppression:

$$\alpha 2 \; = \; \frac{V_{O(signal)(at1kHz)}}{V_{O(spurious)(at1kHz)}} \; ; \; f_s = (2 \times 10kHz) - 19kHz$$

$$\alpha 3 \; = \; \frac{V_{O(signal)(at1kHz)}}{V_{O(spurious)(at1kHz)}} \; ; \; f_s = (3 \times 13kHz) - 38kHz$$

measured with: 91% pilot signal; fm = 10kHz or 13kHz.

2.   Traffic radio (V.F.) suppression: measured with: 91% stereo signal;
   9% pilot signal; fm = 1kHz; 5% subcarrier (f = 57kHz, fm = 23Hz AM, m = 60%)

$$\alpha 57(V.W > F.) \; = \; \frac{V_{O(signal)(at1kHz)}}{V_{O(spurious)(at1kHz \pm 23kHz)}}$$

3.   SCA (Subsidiary Communications Authorization) measured with: 81% mono signal;
   9% pilot signal; fm = 1kHz; 10% SCA - subcarrier (fs = 67kHz, unmodulated).

$$\alpha 67 \; = \; \frac{V_{O(signal)(at1kHz)}}{V_{O(spurious)(at9kHz)}} \; ; \; F_s =(2 \times 38kHz) - 67kHz$$

4.   ACI (Adjacent Channel Interference):

$$\alpha 114 \; = \; \frac{V_{O(signal)(at1kHz)}}{V_{O(spurious)(at4kHz)}} \; ; \; F_s = 110kHz - (3 \times 38kHz)$$

$$\alpha 114 \; = \; \frac{V_{O(signal)(at1kHz)}}{V_{O(spurious)(at4kHz)}} \; ; \; F_s = 186kHz - (5 \times 38kHz)$$

measured with: 90% mono signal; 9% pilot signal; fm =1kHz; 1% spurious signal
(fs = 110kHz or 186kHz, unmodulated).

# 4 Noise blanker part

- internal 2nd order 140kHz high pass filter
- programmable trigger threshold
- trigger threshold dependent on high frequency noise with programmable gain
- additional circuits for deviation and fieldstrength dependent trigger adjustment
- very low offset current during hold time due to opamps wMOS inputs
- four selectable pulse suppression times
- programmable noise rectifier charge/discharge current

**Table 7.    Noise blanker electrical characteristics**

| Symbol | Parameter | Test condition | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{TR}$ | Trigger threshold [1] [2] | meas. with $V_{PEAK}$ = 0.9V | NBT = 111 | [10] | 30 | [10] | $mV_{OP}$ |
| | | | NBT = 110 | [10] | 35 | [10] | $mV_{OP}$ |
| | | | NBT = 101 | [10] | 40 | [10] | $mV_{OP}$ |
| | | | NBT = 100 | [10] | 45 | [10] | $mV_{OP}$ |
| | | | NBT = 011 | [10] | 50 | [10] | $mV_{OP}$ |
| | | | NBT = 010 | [10] | 55 | [10] | $mV_{OP}$ |
| | | | NBT = 001 | [10] | 60 | [10] | $mV_{OP}$ |
| | | | NBT = 000 | [10] | 65 | [10] | $mV_{OP}$ |
| $V_{TRNOISE}$ | Noise controlled trigger threshold [3] | meas. with $V_{PEAK}$ = 1.5V | NCT = 00 | [10] | 260 | [10] | $mV_{OP}$ |
| | | | NCT = 01 | [10] | 220 | [10] | $mV_{OP}$ |
| | | | NCT = 10 | [10] | 180 | [10] | $mV_{OP}$ |
| | | | NCT = 11 | [10] | 140 | [10] | $mV_{OP}$ |
| $V_{RECT}$ | Rectifier voltage | $V_{MPX}$ = 0mV | NRD [7] = 00 | 0.5 | 0.9 | 1.3 | V |
| | | $V_{MPX}$ = 50mV; f = 150KHz | | 1.5 | 1.7 | 2.1 | V |
| | | $V_{MPX}$ = 200mV; f = 150KHz | | 2.2 | 2.5 | 2.9 | V |
| $V_{RECT\ DEV}$ | Deviation dependent rectifier voltage [4] | means. with $V_{MPX}$ = 800mV (75KHz dev.) | OVD = 11 | 0.5 | 0.9(off) | 1.3 | $V_{OP}$ |
| | | | OVD = 10 | 0.9 | 1.2 | 1.5 | $V_{OP}$ |
| | | | OVD = 01 | 1.7 | 2.0 | 2.3 | $V_{OP}$ |
| | | | OVD = 00 | 2.5 | 2.8 | 3.1 | $V_{OP}$ |
| $V_{RECT\ FS}$ | Fieldstrength controlled rectifier voltage [5] | means. with $V_{MPX}$ = 0mV $V_{LEVEL}$ << $V_{SBL}$ (fully mono) | FSC = 11 | 0.5 | 0.9(off) | 1.3 | V |
| | | | FSC = 10 | 0.9 | 1.4 | 1.5 | V |
| | | | FSC = 01 | 1.7 | 1.9 | 2.3 | V |
| | | | FSC = 00 | 2.1 | 2.4 | 3.1 | V |

**Noise blanker part** TDA7407

**Table 7. Noise blanker electrical characteristics (continued)**

| Symbol | Parameter | Test condition | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $T_S$ | Suppression pulse duration [6] | Signal HOLDN in testmode | BLT = 00 | TBD | 38 | TBD | µs |
| | | | BLT = 10 | TBD | 32 | TBD | µs |
| | | | BLT = 01 | TBD | 25.5 | TBD | µs |
| | | | BLT = 00 | TBD | 22 | TBD | µs |
| $V_{RECTADJ}$ [7] | Noise rectifier discharge adjustment | Signal PEAK in testmode | NRD = 00 [5] | [10] | 0.3 | [10] | V/ms |
| | | | NRD = 01 [5] | [10] | 0.8 | [10] | V/ms |
| | | | NRD = 10 [5] | [10] | 1.3 | [10] | V/ms |
| | | | NRD = 11 [5] | [10] | 2.0 | [10] | V/ms |
| $SR_{PEAK}$ | Noise rectifier charge | Signal PEAK in testmode | PCH = 0 [8] | [10] | 10 | [10] | mV/µs |
| | | | PCH = 1 [8] | [10] | 20 | [10] | mV/µs |
| $V_{ADJMP}$ | Noise rectifier adjustment through multipath [9] | Signal PEAK in testmode | MPNB = 00 [9] | [10] | 0.3 | [10] | V/ms |
| | | | MPNB = 01 [9] | [10] | 0.5 | [10] | V/ms |
| | | | MPNB = 10 [9] | [10] | 0.7 | [10] | V/ms |
| | | | MPNB = 11 [9] | [10] | 0.9 | [10] | V/ms |

1. All Thresholds are measured using a pulse with TR =2ms, THIGH = 2ms and TF = 10ms. The repetition rate must not increase the PEAK voltage

2. NBT represents the Noiseblanker Byte bits D2, D0 for the noise blanker trigger threshold

3. NAT represents the Noiseblanker Byte bit pair D4, D3 for the noise controlled triggeradjustment

4. OVD represents the Noiseblanker Byte bit pair D7, D6 for the over deviation detector

5. FSC represents the Fieldstrength Byte bit pair D1, D0 for the fieldstrength control

6. BLT represents the Speaker RR Byte bit pair D7, D6 for the blanktime adjustment

7. NRD represents the Configuration Byte bit pair D1, D0 for the noise rectifier discharge adjustment

8. PCH represents the Stereo decoder Byte bit D5 for the noise rectifier charge current adjustment

9. MPNB represents the HighCut Byte bit D7 and the Fieldstrength Byte D7 for the noise rectifier multipath adjustment

10. By design / characterization functionally guaranteed through dedicated test mode structure

**Figure 3. Vn timing diagram**
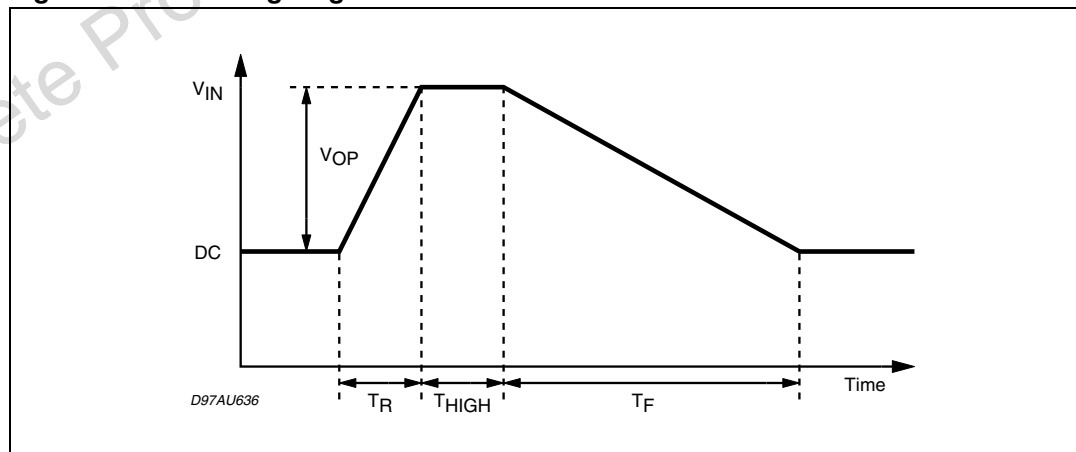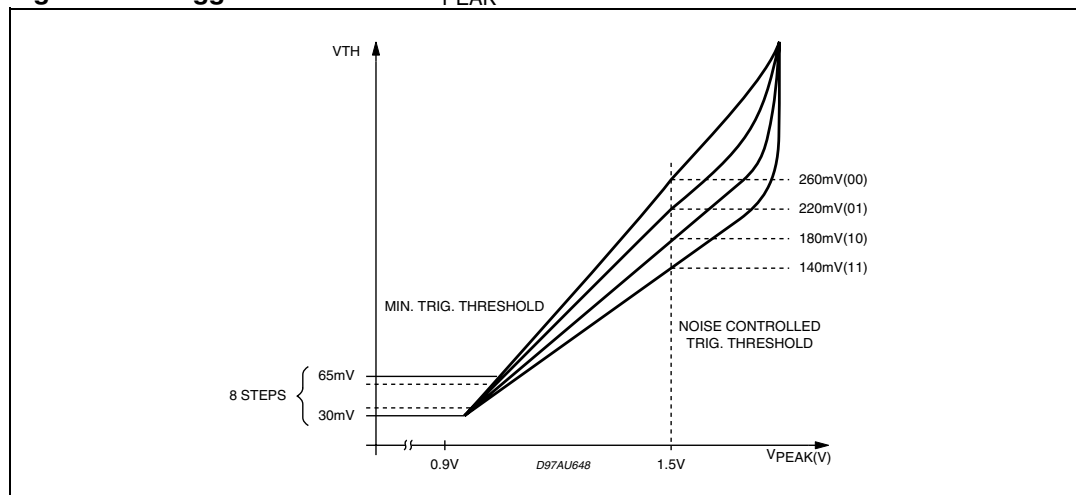
**Figure 4.    Trigger threshold vs.$V_{PEAK}$**



**Figure 5.    Deviation controlled trigger adjustment**
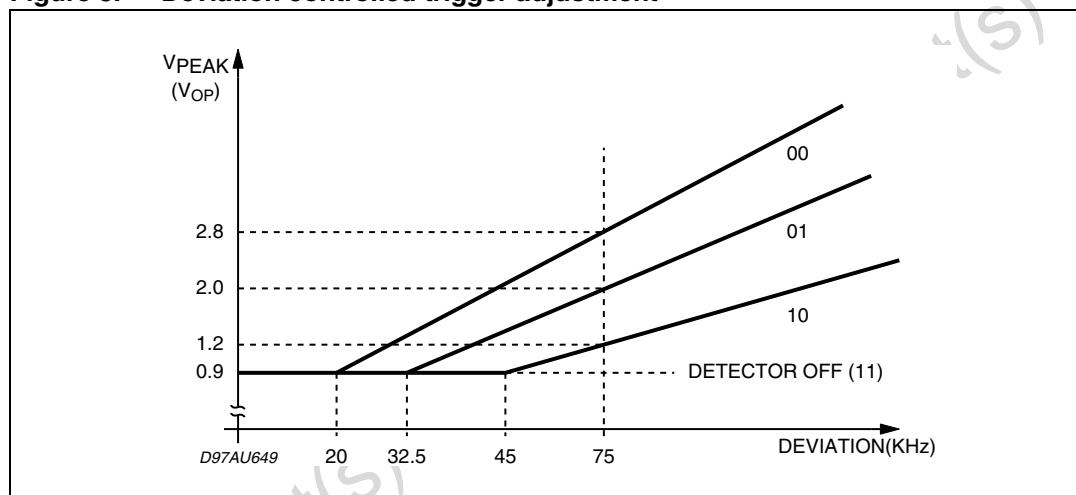


**Figure 6.    Fieldstrength controlled trigger adjustment**
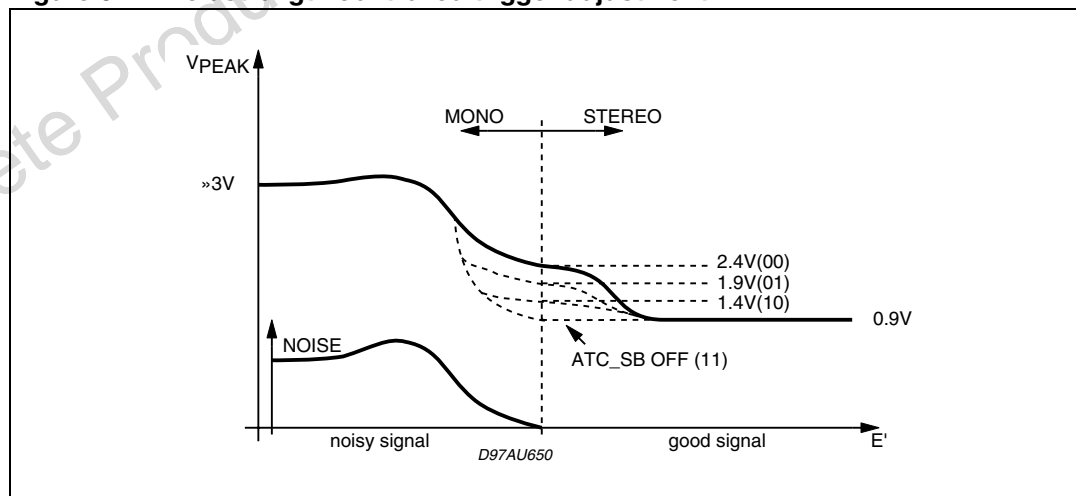
# 5 Multipath detector

- Internal 19kHz band pass filter
- Programmable band pass and rectifier gain
- two pin solution fully independent usable for external programming
- selectable internal influence on Stereoblend

**Table 8.    Multipath electrical characteristics**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $f_{CMP}$ | Center frequency of multipath-bandpass | stereo decoder locked on pilot tone | | 19 | | KHz |
| $G_{BPMP}$ | Bandpass gain | bits $D_2$, $D_1$ configuration byte = 00 | | 6 | | dB |
| | | bits $D_2$, $D_1$ configuration byte = 10 | | 12 | | dB |
| | | bits $D_2$, $D_1$ configuration byte = 01 | | 16 | | dB |
| | | bits $D_2$, $D_1$ configuration byte = 11 | | 18 | | dB |
| $G_{RECTMP}$ | Rectifier gain | bits $D_7$, $D_6$ configuration byte = 00 | | 7.6 | | dB |
| | | bits $D_7$, $D_6$ configuration byte = 01 | | 4.6 | | dB |
| | | bits $D_7$, $D_6$ configuration byte = 10 | | 0 | | dB |
| | | bits $D_7$, $D_6$ configuration byte = 11 | | off | | dB |
| $I_{CHMP}$ | Rectifier charge current | bit $D_5$ configuration byte = 0 | | 0.5 | | μA |
| | | bit $D_5$ configuration byte = 1 | | 1.0 | | μA |
| $I_{DISMP}$ | Rectifier discharge current | | 0.5 | 1 | 1.5 | mA |

**Table 9.    Quality detector**

| Symbol | Parameter | Test Condition | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| A | Multipath Influence factor | Addr. 12 / Bit 5+6 | 00 | | 0.7 | | dB |
| | | | 01 | | 0.85 | | dB |
| | | | 10 | | 1.00 | | dB |
| | | | 11 | | 1.15 | | dB |
| B | Noise influence factor | Addr. 16 / Bit 1+2 | 00 | | 15 | | dB |
| | | | 01 | | 12 | | dB |
| | | | 10 | | 9 | | dB |
| | | | 11 | | 6 | | dB |

## 5.1      Description of the audioprocessor part

### 5.1.1      Input multiplexer

● CD quasi differential
● Cassette stereo
● Phone differential
● AM mono
● Stereo decoder input.

### 5.1.2      Input stages

Most of the input stages have remained the same as in preceeding ST audioprocessors with the exception of the CD inputs (see *Figure 7*). In the meantime there are some CD players on the market having a significant high source impedance which strongly affects the common mode rejection of the normal differential input stage. The additional buffer of the CD input avoids this drawback and offers the full common mode rejection even with those CD players.

The output of the CD stage is permanently available of the CD out-pins

### 5.1.3      AutoZero

In order to reduce the number of pins, there is no AC coupling between the In-Gain and the following stage, so that any offset generated by or before the In-Gain stage would be transferred or even amplified to the output. To avoid that effect a special offset cancellation stage called AutoZero is implemented.
This stage is located before the volume block to eliminate all offsets generated by the stereo decoder, the input stage and the In-Gain (please notice that externally generated offsets, e.g. generated through the leakage current of the coupling capacitors, are not cancelled).

Auto-zeroing is started every time the DATA-BYTE 0 is selected and takes a time of max. 0.3ms. To avoid audible clicks the audioprocessor is muted before the volume stage during this time.

### 5.1.4      AutoZero remain

In some cases, for example if the $\mu$P is executing a refresh cycle of the I$^2$C bus programming, it is not useful to start a new AutoZero action because no new source is selected and an undesired mute would appear at the outputs. For such applications the TDA7407 could be switched in the "Auto Zero Remain mode" (Bit 6 of the subaddress byte). If this bit is set to high, the DATABYTE 0 could be loaded without invoking the AutoZero and the old adjustment value remains.

### 5.1.5      Multiplexer output

The output signal of the input multiplexer is available at separate pins (please see the block diagram). This signal represents the input signal amplifier by the In-Gain stage and is also going into the mixer stage.

### 5.1.6    Softmute

The digitally controlled softmute stage allows muting/demuting the signal with a $I^2C$ bus programmable slope. The mute process can either be activated by the softmute pin or by the $I^2C$ bus. The slope is realized in a special S shaped curve to mute slow in the critical regions.

**Figure 7.    Input stages**



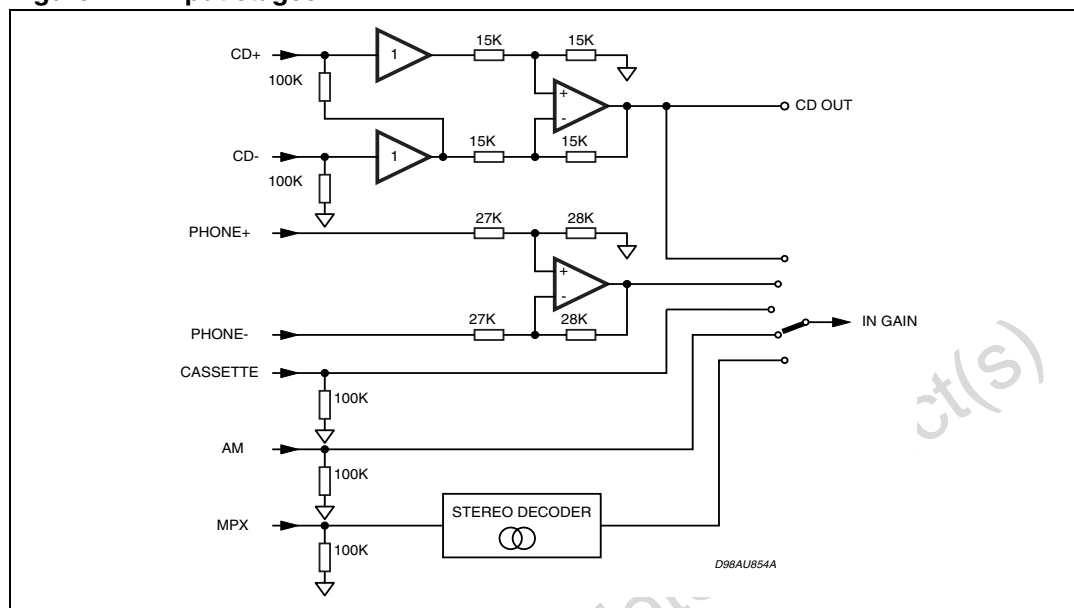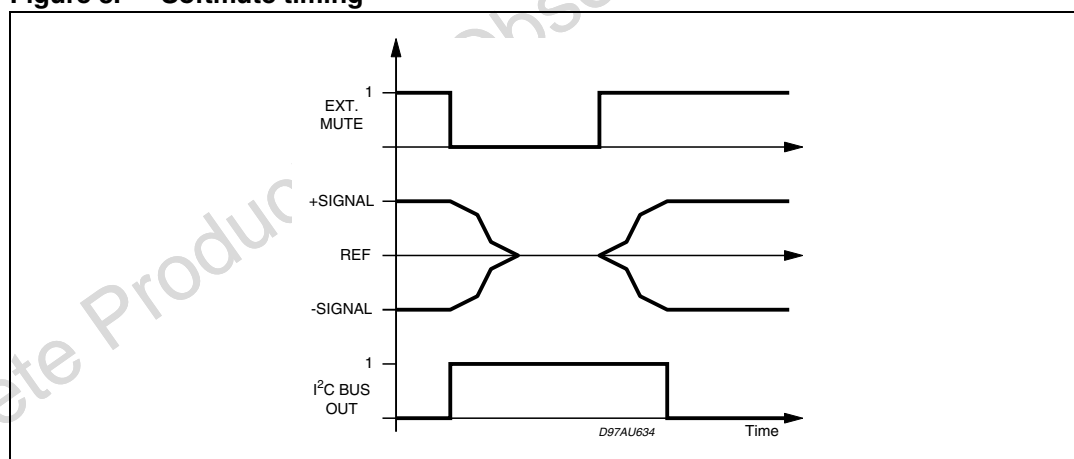**Figure 8.    Softmute timing**



*Note:*    *Please notice that a started Mute action is always terminated and could not be interrupted by a change of the mute signal.*

For timing purposes the Bit 3 of the $I^2C$ bus output register is set to 1 from the start of muting until the end of demuting.

### 5.1.7    BASS

There are four parameters programmable in the bass stage: (see figs *9*, *10*, *11*, *12*):

### 5.1.8 Attenuation (80Hz)

*Figure 9* shows the attenuation as a function of frequency at a center frequency of 80Hz.

### 5.1.9 Center frequency (60, 70, 80, 100Hz)

*Figure 10* shows the four possible center frequencies 60,70,80 and 100Hz.

### 5.1.10 Quality factors (1, 1.25, 1.5, 2)

*Figure 11* shows the four possible quality factors 1, 1.25, 1.5 and 2.

### 5.1.11 DC mode

In this mode the DC gain is increased by 5.1dB. In addition the programmed center frequency and quality factor is decreased by 25%, which can be used to reach alternative center frequencies or quality factors. (see *Figure 12*)

### 5.1.12 MID

There are 3 parameters programmable in the mid stage (see figures *13*, *14* and *15*)

### 5.1.13 Attenuation (1kHz)

*Figure 13* shows the attenuation as a function of frequency at a center frequency of 1kHz.

### 5.1.14 Center frequency (500, 1k, 1.5k, 2k Hz)

*Figure 14* shows the four possible center frequencies 500Hz, 1kHz, 1.5kHz and 2kHz.

### 5.1.15 Quality factor (2 at 1kHz)

*Figure 15* shows the two possible quality factors 1 and 2 at a center frequency of 1kHz.

### 5.1.16 Treble

There are two parameters programmable in the treble stage (see figures *16*, and *17*):

### 5.1.17 Attenuation (17.5kHz)

*Figure 16* shows the attenuation as a function of frequency at a center frequency of 17.5KHz.

### 5.1.18 Center frequency (10, 12.5, 15, 17.5kHz)

*Figure 17* shows the four possible Center Frequency (10, 12.5, 15 and 17.5kHz).

### 5.1.19 AC coupling

In some applications additional signal manipulations are desired, for example surround sound or more band equalizing. For this purpose AC Coupling is placed before the speaker attenuators, which can be activated or internally shorted by Bit7 in the Bass/Treble configuration byte. In short condition the input signal of the speaker attenuator is available at

AC Outputs and the AC Input could be used as additional stereo inputs. The input impedance of the AC Inputs is always 50KΩ.

## 5.1.20 Speaker Attenuator

The speaker attenuators have exactly the same structure and range like the volume stage.

**Figure 9.     Bass control @ fc = 80Hz, Q = 1     Figure 10.     Bass center @ Gain = 14dB, Q =1**
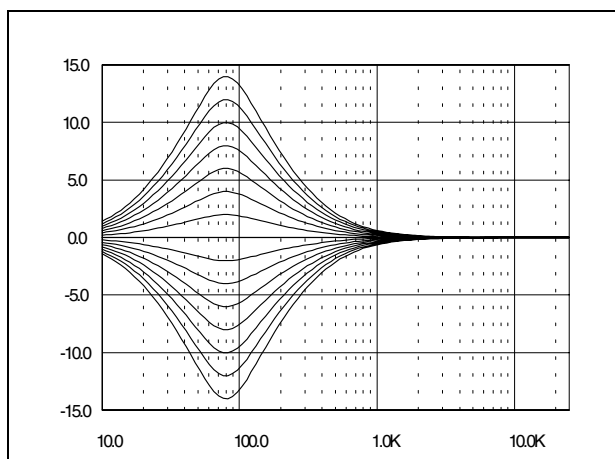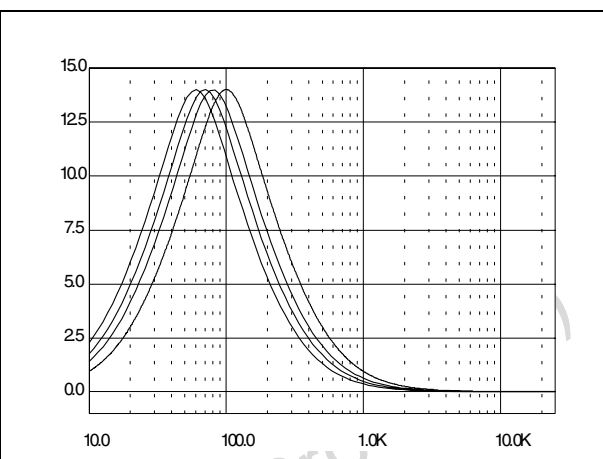


**Figure 11.     Bass quality factors @ Gain =14dB,     Figure 12.     Bass normal and DC mode @ Gain fc = 80Hz     = 14dB, fc = 80Hz**
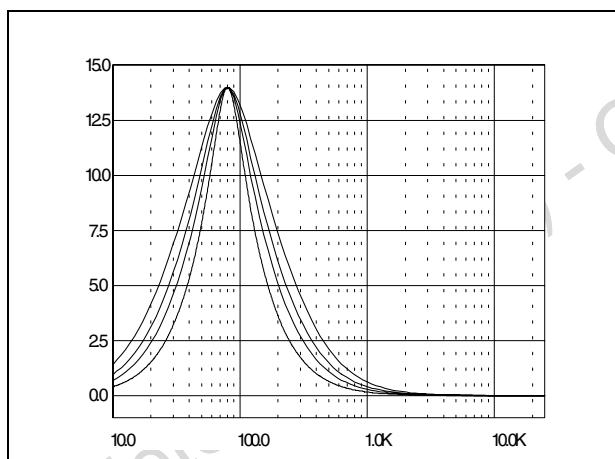


Note: In general the center frequency, Q and DC-mode can be set independently. The exception from this rule is the mode (5/xx1111xx) where the center frequency is set to 150Hz instead of 100Hz.
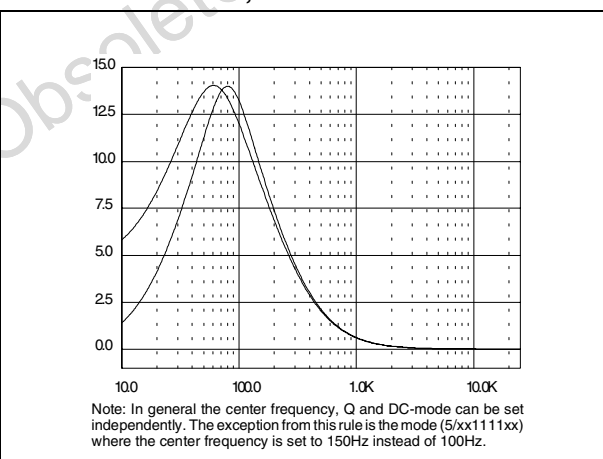
**TDA7407**                                                              **Multipath detector**

**Figure 13.  Mid control @ fc=1kHz, Q=1**
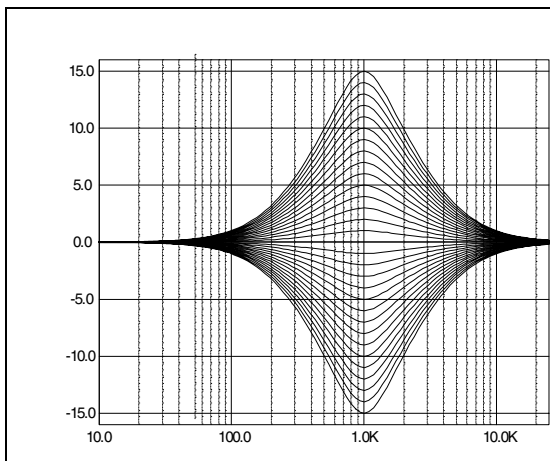


**Figure 14.  Mid center frequency @ Gain=14dB, Q1**
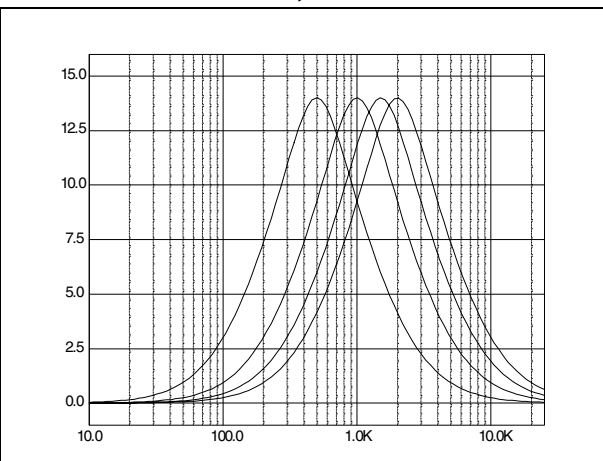


**Figure 15.  Mid Q factor @ fc=1kHz, Gain=14dB**
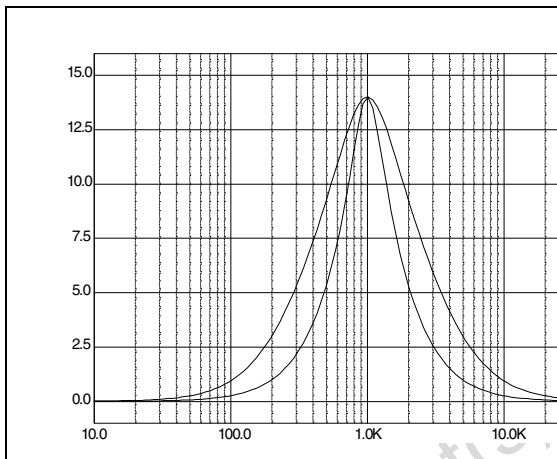


**Figure 16.  Treble control @ fc = 17.5KHz**
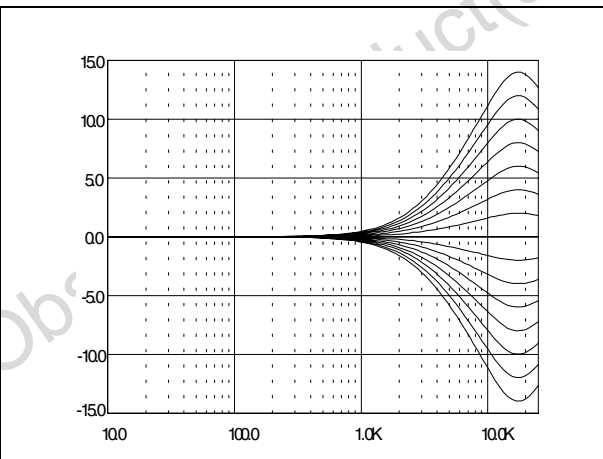


**Figure 17.  Treble center frequencies @ Gain = 14dB**
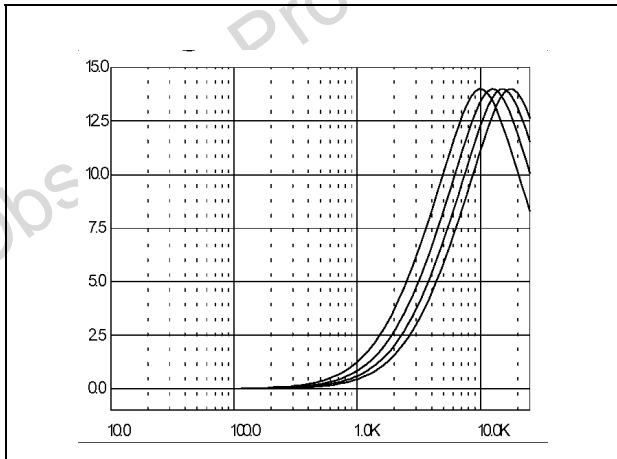
## 5.2 Functional description of the stereo decoder

The stereo decoder part of the TDA7407 (see *Figure 18*) contains all functions necessary to demodulate the MPX signal like pilot tone dependent MONO/STEREO switching as well as "stereoblend" and "highcut" functions.

### 5.2.1 Stereo decoder Mute

The TDA7407 has a fast and easy to control RDS mute function which is a combination of the audioprocessor's softmute and the high ohmic mute of the stereo decoder. If the stereo decoder is selected and a softmute command is sent (or activated through the SM pin), the stereo decoder will be set automatically to the high ohmic mute condition after the audio signal has been softmuted.

Hence a checking of alternate frequencies could be performed. To release the system from the mute condition, the unmute command must be sent: the stereo decoder is unmuted immediately and the audioprocessor is softly unmuted. *Figure 19* shows the output signal VO as well as the internal stereo decoder mute signal. This influence of Softmute on the stereo decoder mute can be switched off by setting bit 3 of the Softmute byte to "0". A stereo decoder mute command (bit 0, stereo decoder byte set to "1") will set the stereo decoder in any case independently to the high ohmic mute state.

**Figure 18. Block diagram of the stereo decoder**
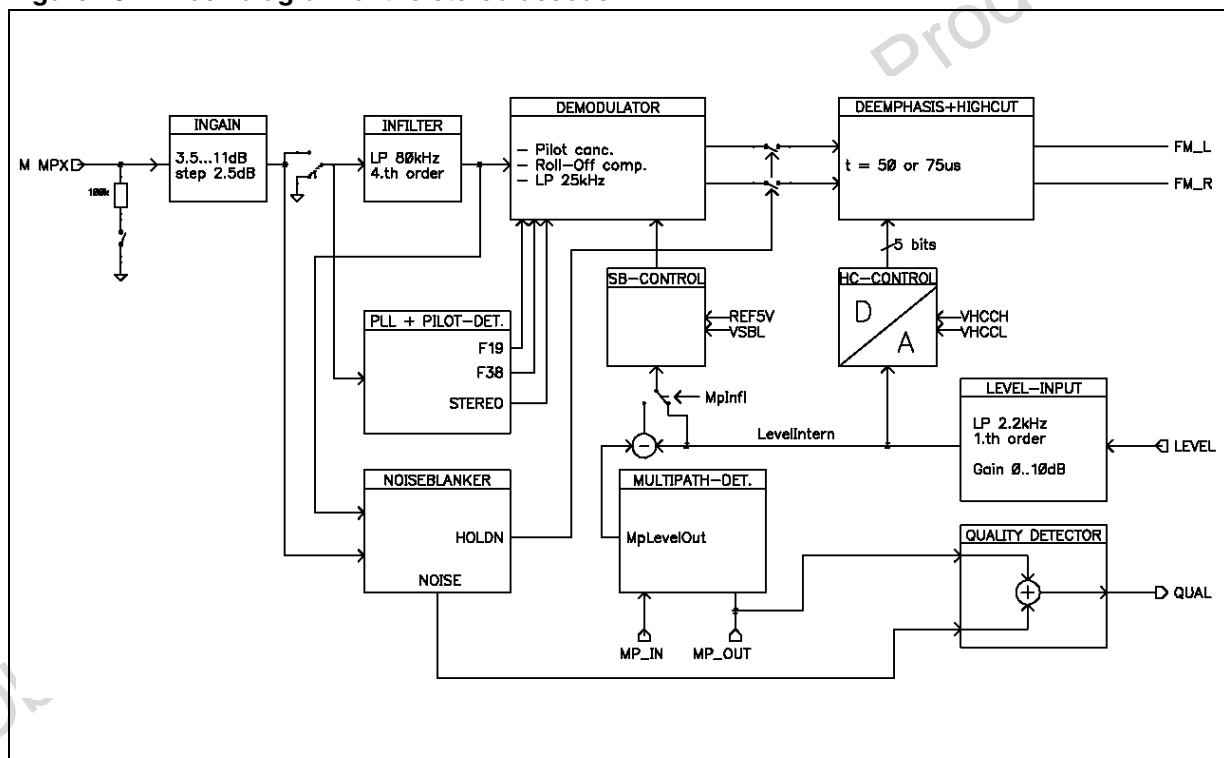
**Figure 19.   Signals during stereo decoder's softmute**
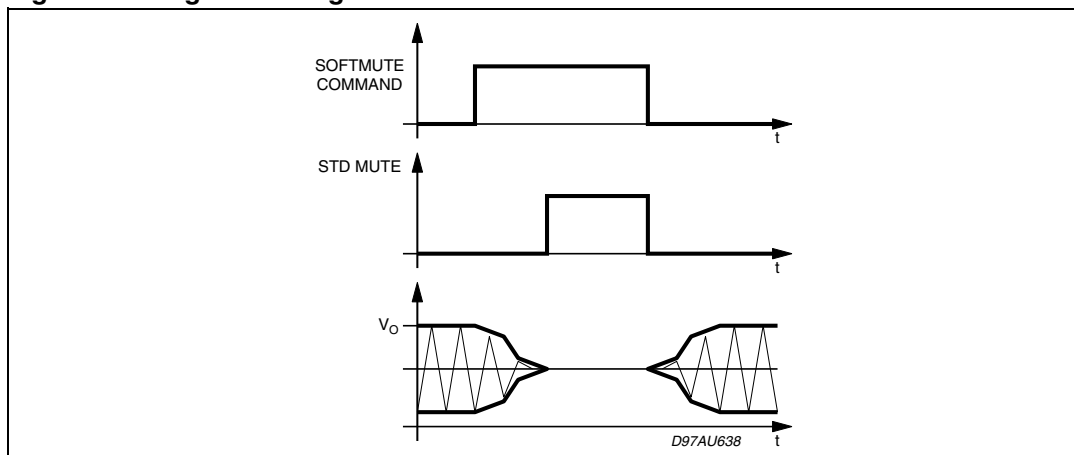


**Figure 20.   Internal Stereoblend characteristics**
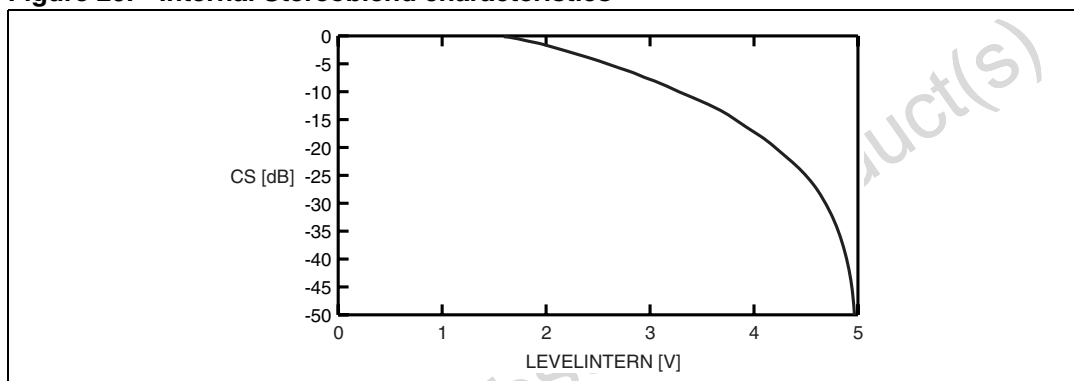


If any other source than the stereo decoder is selected the decoder remains muted and the MPX pin is connected to Vref to avoid any discharge of the coupling capacitor through leakage currents.

## 5.2.2    Ingain + Infilter

The Ingain stage allows to adjust the MPX signal to a magnitude of about 1Vrms internally which is the recommended value. The 4th order input filter has a corner frequency of 80KHz and is used to attenuate spikes and nose and acts as an anti allasing filter for the following switch capacitor filters.

## 5.2.3    Demodulator

In the demodulator block the left and the right channel are separated from the MPX signal. In this stage also the 19 kHz pilot tone is cancelled. For reaching a high channel separation the TDA7407 offers an I$^2$C bus programmable roll-off adjustment which is able to compensate the lowpass behaviour of the tuner section. If the tuner attenuation at 38kHz is in a range from 4.2% to 31.0% the TDA7407 needs no external network in front of the MPX pin. Within this range an adjustment to obtain at least 40dB channel separation is possible. The bits for this adjustment are located together with the fieldstrength adjustment in one byte. This gives the possibility to perform an optimization step during the production of the car radio where the channel separation and the fieldstrength control are trimmed.

### 5.2.4 De-emphasis and Highcut.

The lowpass filter for the de-emphasis allows to choose between a time constant of 50µs and 75µs (bit D7, stereo decoder byte).

The highcut control range will be in both cases $\tau_{HC} = 2 \cdot \tau_{Deemp}$. Inside the highcut control range (between VHCH and VHCL) the LEVEL signal is converted into a 5 bit word which controls the lowpass time constant between $\tau_{Deemp}...3 \cdot \tau_{Deemp}$. There by the resolution will remain always 5 bits independently of the absolute voltage range between the VHCH and VHCL values.

The highcut function can be switched off by $I^2C$ bus (bit D7, fieldstrength byte set to "0").

### 5.2.5 PLL and pilot tone detector

The PLL has the task to lock on the 19kHz pilotone during a stereo transmission to allow a correct demodulation. The included detector enables the demodulation if the pilot tone reaches the selected pilot tone threshold $V_{PTHST}$. Two different thresholds are available. The detector output (signal STEREO, see block diagram) can be checked by reading the status byte of the TDA7407 via $I^2C$ bus.

### 5.2.6 Field strength control

The fieldstrength input is used to control the high cut and the stereoblend function. In addition the signal can be also used to control the noiseblanker thresholds and as input for the multipath detector.

**Figure 21. Relation between internal and external LEVEL voltage and setup of stereoblend**
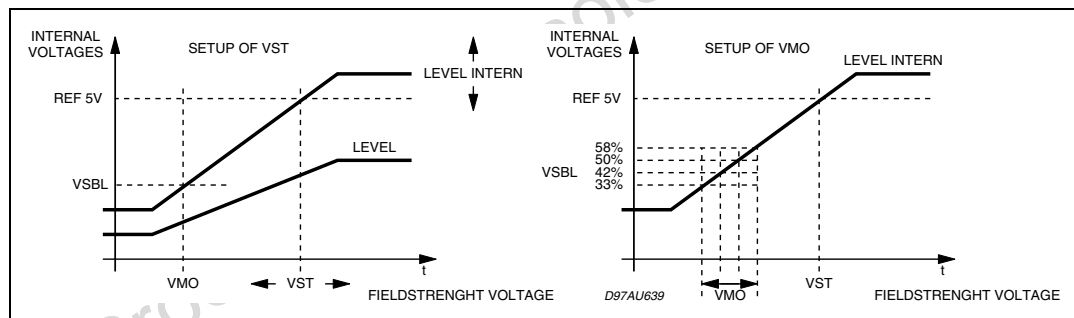


**Figure 22. High cut characteristics**
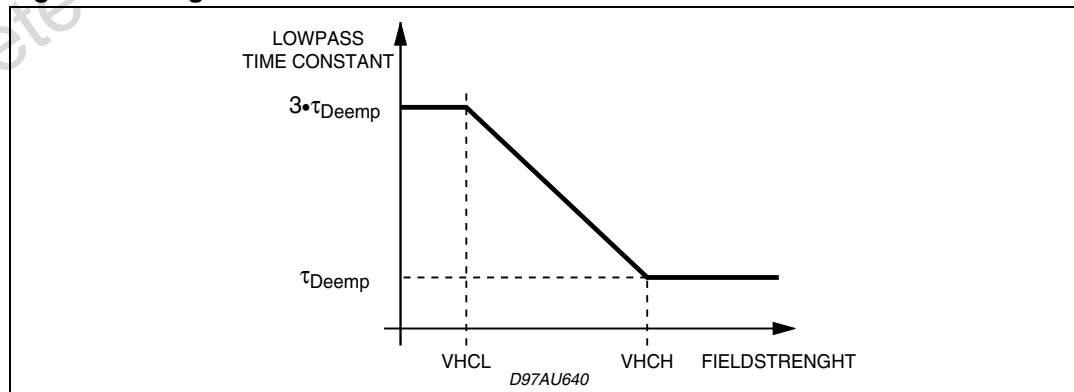
### 5.2.7        LEVEL Input and Gain

To suppress undesired high frequency modulation on the highcut and stereoblend function the LEVEL signal is lowpass filtered firstly.

The filter is a combination of a 1st order RC lowpass at 53kHz (working as anti-aliasing filter) and a 1st-order switched capacitor lowpass at 2.2kHz. The second stage is a programmable gain stage to adapt the LEVEL signal internally to different IF device (see Testmode section 5 LEVELINTERN).

The gain is widely programmable in 16 steps from 0dB to 10dB (step = 0.67dB). These 4 bits are located together with the roll off bits in the "Stereo decoder adjustment" byte to simplify a possible adaptation during the production of the car radio.

### 5.2.8        Stereoblend control

The stereoblend control block converts the internal LEVEL voltage (LEVEL INTERN) into an demodulator compatible analog signal which is used to control the channel separation between 0dB and the maximum separation. Internally this control range has a fixed upper limit which is the internal reference voltage REF5V. The lower limit can be programmed between 29.2% and 58%, of REF5V in 4.167% steps (see *Figure 21*).

To adjust the external LEVEL voltage to the internal range two values must be defined: the LEVEL gain LG and VSBL (see *Figure 21*). To adjust the voltage where the full channel separation is reached (VST) the LEVEL gain LG has to be defined. The following equation can be used to estimate the gain:

$$L_G = \frac{REF5V}{\text{Field strenght voltage [STEREO]}}$$

The gain can be programmed through 4 bits in the "Stereo Decoder Adjustment" byte.

The MONO voltage VMO (0dB channel separation) can be choosen selecting VSBLAll necessary internal reference voltages like REF5V are derived from a bandgap circuit. Therefore they have a temperature coefficient near zero. This is useful if the fieldstrength signal is also temperature compensated.

But most IF devices apply a LEVEL voltage with a TC of 3300ppm. The TDA7407 offers this TC for the reference voltages, too. The TC is selectable with bit D7 of the "stereo decoder adjustment" byte.

### 5.2.9        Highcut control

The highcut control setup is similar to the stereoblend control setup: the starting point VHCH can be set with 2 bits to be 42, 50, 58 or 66% of REF5V whereas the range can be set to be 17, 22, 28 or 33% of VHCH (*Figure 22*).

### 5.2.10        Functional description of the noiseblanker

In the automotive environment the MPX signal is disturbed by spikes produced by the ignition, for example; the wiper motor. The aim of the noiseblanker part is to cancel the audible influence of the spikes.

Therefore the output of the stereo decoder is held at the actual voltage for a time between 22 and 38$\mu$s (programmable).

The block diagram of the noiseblanker is given in *Figure 23*.

In the first stage the spikes must be detected but to avoid wrong triggering on high frequency (white) noise, a complex trigger control is implemented. Behind the trigger stage a pulse former generates the "blanking" pulse. To avoid any crosstalk to the signal path the noiseblanker is supplied by his own biasing circuit.

### 5.2.11 Trigger path

The incoming MPX signal is highpass filtered, amplified and rectified. This second order highpass filter has a corner frequency of 140kHz.

The rectified signal, RECT, is lowpass filtered to generate a signal called PEAK. Also noise with a frequency 140kHz increases the PEAK voltage. The resulting voltage can be adjusted by use of the noise rectifier discharge current.

The PEAK voltage is fed to a threshold generator, which adds to the PEAK voltage a DC dependent threshold VTH. Both signals, RECT and PEAK+VTH are fed to a comparator which triggers a re-triggerable monoflop. The monoflop's output activates the sample and hold circuits in the signal path for selected duration.

**Figure 23.    Block Diagram of the Noiseblanker**
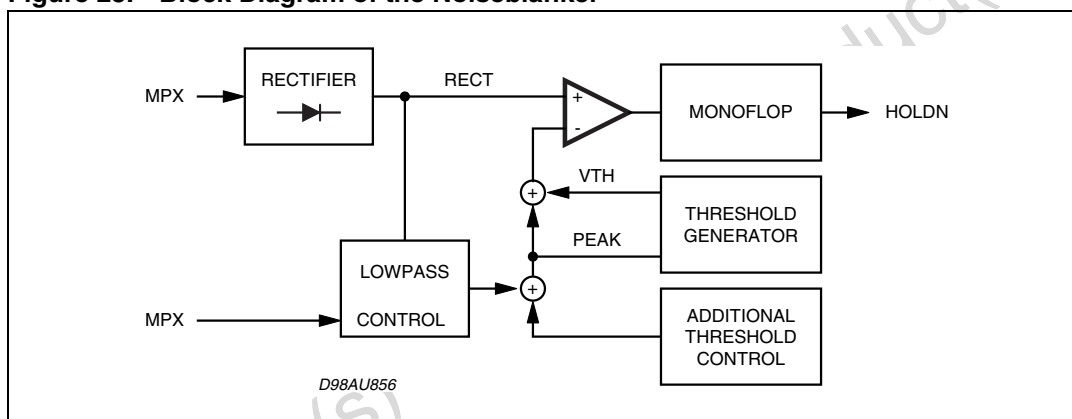


### 5.2.12 Automatic noise controlled threshold adjustment (ATC)

There are mainly two independent possibilities for programming the trigger threshold:
   a)    the low threshold in 8 steps (bits D0 to D2 of the noiseblanker byte)
   b)    the noise adjusted threshold in 4 steps (bits D3 and D4 of the noiseblanker byte, see *Figure 23*).

The low threshold is active in combination with a good MPX signal without any noise; the PEAK voltage is less than 1V. The sensitivity in this operation is high.

If the MPX signal is noisy the PEAK voltage increases due to the higher noise, which is also rectified. With increasing of the PEAK voltage the trigger threshold increases, too. This particular gain is programmable in 4 steps.

## 5.3      Automatic threshold control mechanism

### 5.3.1      Automatic threshold control by the stereoblend voltage

Besides the noise controlled threshold adjustment there is an additional possibility for influencing the trigger threshold. It is depending on the stereoblend control.

The point where the MPX signal starts to become noisy is fixed by the RF part. Therefore also the starting point of the normal noise-controlled trigger adjustment is fixed. In some cases the behaviour of the noiseblanker can be improved by increasing the threshold even in a region of higher fieldstrength.

Sometimes a wrong triggering occures for the MPX signal often shows distortion in this range which can be avoided even if using a low threshold. Because of the overlap of this range and the range of the stereo/mono transition it can be controlled by stereoblend.

This threshold increase is programmable in 3 steps or switched off with bits D0 and D1 of the fieldstrength control byte.

### 5.3.2      Over deviation detector

If the system is tuned to stations with a high deviation the noiseblanker can trigger on the higher frequencies of the modulation. To avoid this wrong behaviour, which causes noise in the output signal, the noiseblanker offers a deviation dependent threshold adjustment.

By rectifying the MPX signal a further signal representing the actual deviation is obtained. It is used to increase the PEAK voltage. Offset and gain of this circuit are programmable in 3 steps with the bits D6 and D7 of the stereo decoder byte (the first step turns off the detector, see fig. 18).

## 5.4      Functional description of the multipath detector

Using the internal multipath detector the audible effects of a multipath condition can be minimized. A multipath condition is detected by rectifying the 19kHz spectrum in the fieldstrength signal.An external capacitor is used to define the attack and decay times (see block diagram *Figure 24*). the MPOUT pin is used as detector output connected to a capacitor of about 47nF and additionally the MPIN pin is selected to be the fieldstrength input.

Using the configuration, an external user requirement adaptation is given in *Figure 24*.

To keep the old value of the Multipath Detector during an AF-jump, the external capacitor can be disconnected by the MP Hold switch. This switch can be controlled directly by the AFS Pin.

Selecting the "internal influence" in the configuration byte, the channel separation is automatically reduced during a multipath condition according to the voltage appearing at the MP_OUT pin. A possible application is shown in *Figure 24*.

**Figure 24. Block diagram of the multipath detector**
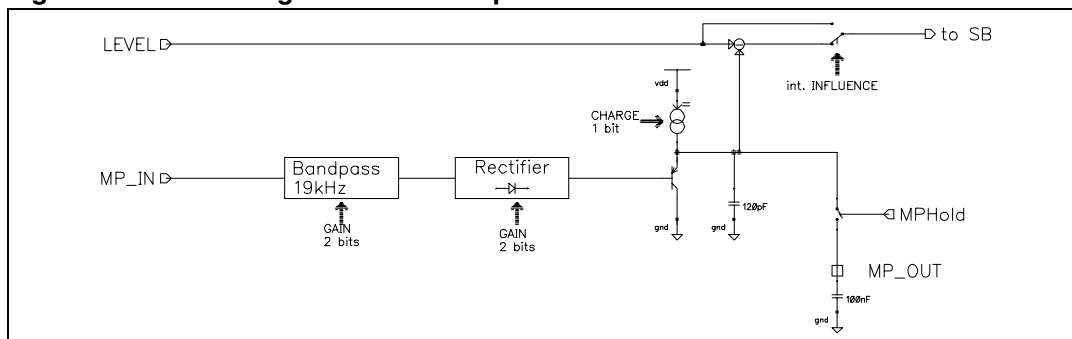


### 5.4.1 Programming

To obtain a good multipath performance an adaptation is necessary. Therefore the gain of the 19kHz bandpass is programmable in four steps as well as the rectifier gain. The attack and decay times can be set by the external capacitor value.

### 5.4.2 Quality detector

The TDA7407 offers a quality detector output which gives a voltage representing the FM reception conditions. To calculate this voltage the MPX noise and the multipath detector output are summed according to the following formula:

$$Quality = 1.6\,(V_{noise} - 0.8V) + a\,(REF5V - V_{MPOUT})$$

The noise signal is the PEAK signal without additional influences. The factor "a" can be programmed from 0.7 to 1.15. the output is a low impedance output able to drive external circuitry as well as simply fed to an A/D converter for RDS applications.

### 5.4.3 AF Search Control

The TDA7407 is supplied with several functionality to support AF checks using the stereo decoder. As mentioned already before the high ohmic mute feature avoids any clicks during the jump condition. It is possible at the same time, to evaluate the noise and multipath content of the alternate frequency, by using the quality detector output. Therefore the multipath detector is switched automatically to a small time constant. No additional pin (AFS) is implemented in order to separate the audioprocessor mute and stereo decoder AF functions. In *Figure 25* the block diagram and control functions of the complete AFS functionality is shown (please note that the pins AFS and SM are active low as well as all control bits indicated by an overbar).

## 5.5 Test mode

During the test mode, which can be activated by setting bit D0 of the testing byte and bit D5 of the subaddress byte to "1", several internal signals are available at the CASSR pin.

During this mode the input resistor of 100kOhm is disconnected from the pin. The internal signals available are shown in the software specification.

**TDA7407** <span style="float:right">**Multipath detector**</span>

**Figure 25.   Mute control logic**
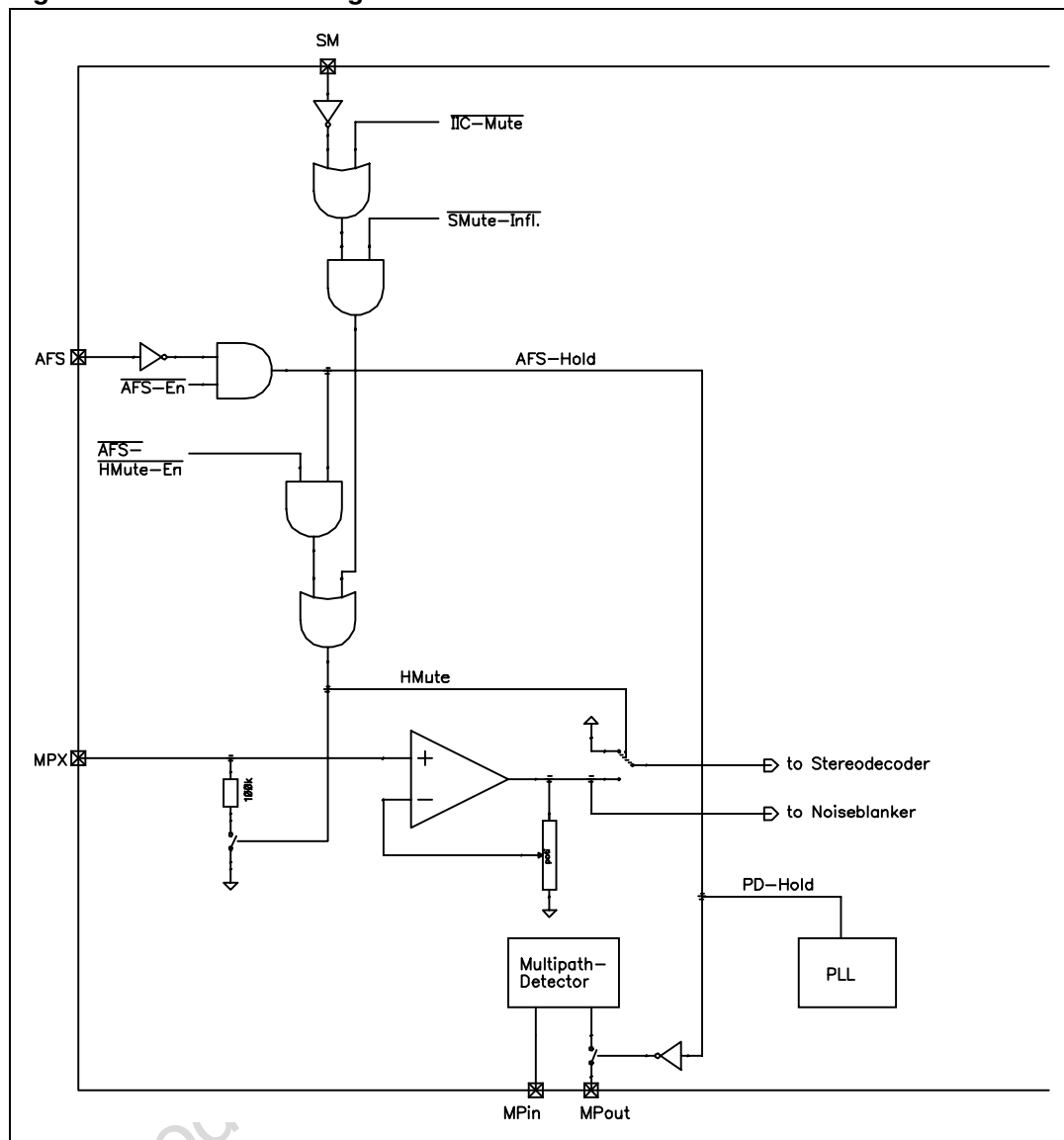
# 6 I²C Bus interface description

## 6.1 Interface protocol

The interface protocol comprises:

- a start condition (S)
- a chip address byte (the LSB bit determines read / write transmission)
- a subaddress byte
- a sequence of data (N-bytes + acknowledge)
- a stop condition (P

**Table 10. Addresses**
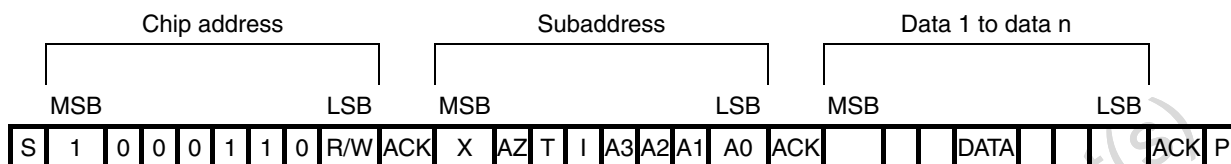


*D97AU627*

S = Start

ACK = Acknowledge

AZ = AutoZero Remain

T = Testing

I = Auto increment

P = Stop

Max clock speed 500kbits/s

The transmitted data is automatically updated after each ACK. Transmission can be repeated without new chip address.

## 6.2 Auto increment

If bit I in the subaddress byte is set to "1", the autoincrement of the subaddress is enabled.

**Table 11. Transmitted data** (send mode)

| MSB | | | | | | | LSB |
|-----|---|---|---|----|----|---|-----|
| X | X | X | X | ST | SM | X | X |

SM = Soft mute activated

ST = Stereo

X = Not Used

**Table 12.      Subaddress** (receive mode)

| MSB | | | | | | LSB | Function |
|-----|-----|-----|-----|-----|-----|-----|----------|
| I3 | I2 | I1 | I0 | A3 | A2 | A1 | A0 | |
| | 0 | | | | | | | **AutoZero Remain** off |
| | 1 | | | | | | | on |
| | | 0 | | | | | | **Testmode** off |
| | | 1 | | | | | | on |
| | | | 0 | | | | | **Auto Increment Mode** off |
| | | | 1 | | | | | on |
| 0 | | | | 0 | 0 | 0 | 0 | Input Multiplexer |
| 0 | | | | 0 | 0 | 0 | 1 | Volume |
| 0 | | | | 0 | 0 | 1 | 0 | Treble |
| 0 | | | | 0 | 0 | 1 | 1 | Bass |
| 0 | | | | 0 | 1 | 0 | 0 | Speaker attenuator LF |
| 0 | | | | 0 | 1 | 0 | 1 | Speaker attenuator RF |
| 0 | | | | 0 | 1 | 1 | 0 | Speaker attenuator LR |
| 0 | | | | 0 | 1 | 1 | 1 | Speaker attenuator RR |
| 0 | | | | 1 | 0 | 0 | 0 | Soft Mute / Bass Prog. |
| 0 | | | | 1 | 0 | 0 | 1 | Stereo Decoder |
| 0 | | | | 1 | 0 | 1 | 0 | Noiseblanker |
| 0 | | | | 1 | 0 | 1 | 1 | High Cut Control |
| 0 | | | | 1 | 1 | 0 | 0 | Fieldstrength & Quality |
| 0 | | | | 1 | 1 | 0 | 1 | Configuration |
| 0 | | | | 1 | 1 | 1 | 0 | EEPROM |
| 0 | | | | 1 | 1 | 1 | 1 | Testing |
| 1 | | | | 0 | 0 | 0 | 0 | New Quality/Control |
| 1 | | | | 0 | 0 | 0 | 1 | Middle Filter |

# 7 Data byte specification

After power on reset all register are set to 11111110

**Table 13.    Input selector** (subaddress 0H)

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|----|----|----|----|----|----|----|----|----------|
| MSB | | | | | | | LSB | |
| | | | | | | | | **Source selector** |
| | | | | | 0 | 0 | 0 | CD |
| | | | | | 0 | 0 | 1 | Cassette |
| | | | | | 0 | 1 | 0 | Phone |
| | | | | | 0 | 1 | 1 | AM |
| | | | | | 1 | 0 | 0 | Stereo Decoder |
| | | | | | 1 | 0 | 1 | AC Inputs Front |
| | | | | | 1 | 1 | 0 | Mute |
| | | | | | 1 | 1 | 1 | AC inputs Rear |
| | | | | | | | | **In-Gain** |
| | 0 | 0 | 0 | 0 | | | | 15dB |
| | 0 | 0 | 0 | 1 | | | | 14dB |
| | : | : | : | : | | | | : |
| | 1 | 1 | 1 | 0 | | | | 1 dB |
| | 1 | 1 | 1 | 1 | | | | 0 dB |
| | | | | | | | | **Coupl. front speaker** |
| 0 | | | | | | | | external |
| 1 | | | | | | | | internal |

**Table 14.    Volume and speaker attenuation** (subaddress 1H, 4H, 5H, 6H, 7H)

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|----|----|----|----|----|----|----|----|----------|
| MSB | | | | | | | LSB | |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | |
| : | : | : | : | : | : | : | : | |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | not used configurations |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | +15dB |
| : | : | : | : | : | : | : | : | : |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | +1dB |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0dB |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0dB |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | -1dB |
| : | : | : | : | : | : | : | : | : |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | -15dB |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | -16dB |
| : | : | : | : | : | : | : | : | : |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | -78dB |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | -79dB |
| X | 1 | 1 | X | X | X | X | X | Mute |

**Table 15.    Treble filter** (subaddress 2H)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **Treble steps** |
| | | | 0 | 0 | 0 | 0 | 0 | -15dB |
| | | | 0 | 0 | 0 | 0 | 1 | -14dB |
| | | | : | : | : | : | : | : |
| | | | 0 | 1 | 1 | 1 | 0 | -1dB |
| | | | 0 | 1 | 1 | 1 | 1 | 0dB |
| | | | 1 | 1 | 1 | 1 | 1 | 0dB |
| | | | 1 | 1 | 1 | 1 | 0 | +1dB |
| | | | : | : | : | : | : | : |
| | | | 1 | 0 | 0 | 0 | 1 | +14dB |
| | | | 1 | 0 | 0 | 0 | 0 | +15dB |
| | | | | | | | | **Treble center frequency** |
| | 0 | 0 | | | | | | 10.0KHz |
| | 0 | 1 | | | | | | 12.5KHz |
| | 1 | 0 | | | | | | 15.0KHz |
| | 1 | 1 | | | | | | 17.5KHz |
| | | | | | | | | **Coupl. rear speaker** |
| 0 | | | | | | | | external (AC) |
| 1 | | | | | | | | internal |

**Table 16.    Bass filter** (subaddress 3H)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **Bass Steps** |
| | | | 0 | 0 | 0 | 0 | 0 | -15dB |
| | | | 0 | 0 | 0 | 0 | 1 | -14dB |
| | | | : | : | : | : | : | : |
| | | | 0 | 1 | 1 | 1 | 0 | -1dB |
| | | | 0 | 1 | 1 | 1 | 1 | 0dB |
| | | | 1 | 1 | 1 | 1 | 1 | 0dB |
| | | | 1 | 1 | 1 | 1 | 0 | +1dB |
| | | | : | : | : | : | : | : |
| | | | 1 | 0 | 0 | 0 | 1 | +14dB |
| | | | 1 | 0 | 0 | 0 | 0 | +15dB |
| | | | | | | | | **Bass Q factor** |
| | 0 | 0 | | | | | | 1.0 |
| | 0 | 1 | | | | | | 1.25 |
| | 1 | 0 | | | | | | 1.50 |
| | 1 | 1 | | | | | | 2.0 |
| | | | | | | | | **Bass DC mode** |
| 0 | | | | | | | | off |
| 1 | | | | | | | | on |

**Data byte specification** TDA7407

**Table 17. Soft mute and bass programming** (subaddress 8H)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **Mute** |
| | | | | | | | 0 | Enable Soft Mute |
| | | | | | | | 1 | Disable Soft Mute |
| | | | | | 0 | 0 | | Mutetime = 0.48ms |
| | | | | | 0 | 1 | | Mutetime = 0.96ms |
| | | | | | 1 | 0 | | Mutetime = 40.4ms |
| | | | | | 1 | 1 | | Mutetime = 324ms |
| | | | | 0 | | | | Stereo decoder Soft Mute Influence = on |
| | | | | 1 | | | | Stereo decoder Soft Mute Influence = off |
| | | | | | | | | **Bass center frequency** |
| | | 0 | 0 | | | | | Center Frequency = 60 Hz |
| | | 0 | 1 | | | | | Center Frequency = 70 Hz |
| | | 1 | 0 | | | | | Center Frequency = 80 Hz |
| | | 1 | 1 | | | | | Center Frequency = 100Hz |
| | | 1 | 1 | | | | | Center Frequency = 150Hz |
| | | | | | | | | **Noise blanker time** |
| 0 | 0 | | | | | | | 38ms |
| 0 | 1 | | | | | | | 25.5ms |
| 1 | 0 | | | | | | | 32ms |
| 1 | 1 | | | | | | | 22ms |

1 Only for Bass Q-Factor = 2.0

**Table 18. Stereo decoder** (subaddress 9H)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | 0 | STD Unmuted |
| | | | | | | | 1 | STD Muted |
| | | | | | 0 | 0 | | In Gain 11dB |
| | | | | | 0 | 1 | | In Gain 8.5dB |
| | | | | | 1 | 0 | | In Gain 6dB |
| | | | | | 1 | 1 | | In Gain 3.5dB |
| | | | | 0 | | | | Stereo decoder = on |
| | | | | 1 | | | | Stereo decoder = off |
| | | | 0 | | | | | Forced Mono |
| | | | 1 | | | | | Mono/Stereo switch automatically |
| | | 0 | | | | | | Noiseblanker PEAK charge current low |
| | | 1 | | | | | | Noiseblanker PEAK charge current high |
| | 0 | | | | | | | Pilot Threshold HIGH |
| | 1 | | | | | | | Pilot Threshold LOW |
| 0 | | | | | | | | De-emphasis 50µs |
| 1 | | | | | | | | De-emphasis 75µs |

**TDA7407**                                                                      **Data byte specification**

**Table 19.    Noiseblanker** (subaddress AH)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | 0 | 0 | 0 | Low Threshold 65mV |
| | | | | | 0 | 0 | 1 | Low Threshold 60mV |
| | | | | | 0 | 1 | 0 | Low Threshold 55mV |
| | | | | | 0 | 1 | 1 | Low Threshold 50mV |
| | | | | | 1 | 0 | 0 | Low Threshold 45mV |
| | | | | | 1 | 0 | 1 | Low Threshold 40mV |
| | | | | | 1 | 1 | 0 | Low Threshold 35mV |
| | | | | | 1 | 1 | 1 | Low Threshold 30mV |
| | | | 0 | 0 | | | | Noise Controlled Threshold 320mV |
| | | | 0 | 1 | | | | Noise Controlled Threshold 260mV |
| | | | 1 | 0 | | | | Noise Controlled Threshold 200mV |
| | | | 1 | 1 | | | | Noise Controlled Threshold 140mV |
| | | 0 | | | | | | Noise blanker OFF |
| | | 1 | | | | | | Noise blanker ON |
| 0 | 0 | | | | | | | Over deviation Adjust 2.8V |
| 0 | 1 | | | | | | | Over deviation Adjust 2.0V |
| 1 | 0 | | | | | | | Over deviation Adjust 1.2V |
| 1 | 1 | | | | | | | Over deviation Detector OFF |

**Table 20.    High Cut** (subaddress BH)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | 0 | High Cut OFF |
| | | | | | | | 1 | High Cut ON |
| | | | | | 0 | 0 | | Max. High Cut 2dB |
| | | | | | 0 | 1 | | Max. High Cut 5dB |
| | | | | | 1 | 0 | | Max. High Cut 7dB |
| | | | | | 1 | 1 | | Max. High Cut 10dB |
| | | | 0 | 0 | | | | VHCH at 42% REF 5V |
| | | | 0 | 1 | | | | VHCH at 50% REF 5V |
| | | | 1 | 0 | | | | VHCH at 58% REF 5V |
| | | | 1 | 1 | | | | VHCH at 66% REF 5V |
| | 0 | 0 | | | | | | VHCL at 16.7% VHCH |
| | 0 | 1 | | | | | | VHCL at 22.2% VHCH |
| | 1 | 0 | | | | | | VHCL at 27.8% VHCH |
| | 1 | 1 | | | | | | VHCL at 33.3% VHCH |
| 0 | | | | | | | | Strong Multipath influence on PEAK 18K OFF |
| 1 | | | | | | | | ON (18K Discharge if VMPOUT <2.5V) |

**Data byte specification**                                                                 **TDA7407**

**Table 21.    Field strength Control** (subaddress CH)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | 0 | 0 | 0 | VSBL at 29% REF 5V |
| | | | | | 0 | 0 | 1 | VSBL at 33% REF 5V |
| | | | | | 0 | 1 | 0 | VSBL at 38% REF 5V |
| | | | | | 0 | 1 | 1 | VSBL at 42% REF 5V |
| | | | | | 1 | 0 | 0 | VSBL at 46% REF 5V |
| | | | | | 1 | 0 | 1 | VSBL at 50% REF 5V |
| | | | | | 1 | 1 | 0 | VSBL at 54% REF 5V |
| | | | | | 1 | 1 | 1 | VSBL at 58% REF 5V |
| | | | 0 | 0 | | | | Noiseblanker Field strength Adj 2.3V |
| | | | 0 | 1 | | | | Noiseblanker Field strength Adj 1.8V |
| | | | 1 | 0 | | | | Noiseblanker Field strength Adj 1.3V |
| | | | 1 | 1 | | | | Noiseblanker Field strength Adj OFF |
| | 0 | 0 | | | | | | Quality Detector Coefficient a = 0.7 |
| | 0 | 1 | | | | | | Quality Detector Coefficient a = 0.85 |
| | 1 | 0 | | | | | | Quality Detector Coefficient a = 1.0 |
| | 1 | 1 | | | | | | Quality Detector Coefficient a = 1.15 |
| 0 | | | | | | | | Multipath off influence on PEAK discharge -1V/ms (at MPout = 2.5V |
| 1 | | | | | | | | |

**Table 22.    Configuration** (subaddress DH)

| MSB | | | | | | LSB | | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | 0 | 0 | Noise Rectifier Discharge Resistor R = infinite |
| | | | | | | 0 | 1 | R = 56kΩ |
| | | | | | | 1 | 0 | R = 33kΩ |
| | | | | | | 1 | 1 | R =18kΩ |
| | | | | 0 | 0 | | | Multipath Detector Bandpass Gain 6dB |
| | | | | 1 | 0 | | | 12dB |
| | | | | 0 | 1 | | | 16dB |
| | | | | 1 | 1 | | | 18dB |
| | | | 0 | | | | | Multipath Detector internal influence ON |
| | | | 1 | | | | | OFF |
| | | 0 | | | | | | Multipath Detector Charge Current 0.5μA |
| | | 1 | | | | | | Multipath Detector Charge Current 1μA |
| 0 | 0 | | | | | | | Multipath Detector Reflection Gain Gain = 7.6dB |
| 0 | 1 | | | | | | | Gain = 4.6dB |
| 1 | 0 | | | | | | | Gain = 0dB |
| 1 | 1 | | | | | | | disabled |

**Table 23.**  **Stereo decoder adjustment** (subaddress EH)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **Roll Off Compensation** |
| 0 | | | | | 0 | 0 | 0 | not allowed |
| 0 | | | | | 0 | 0 | 1 | 7.2% |
| 0 | | | | | 0 | 1 | 0 | 9.4% |
| : | | | | | : | : | : | : |
| 0 | | | | | 1 | 0 | 0 | 13.7% |
| : | | | | | : | : | : | : |
| 0 | | | | | 1 | 1 | 1 | 20.2% |
| 1 | | | | | 0 | 0 | 0 | not allowed |
| 1 | | | | | 0 | 0 | 1 | 19.6% |
| 1 | | | | | 0 | 1 | 0 | 21.5% |
| : | | | | | : | : | : | : |
| 1 | | | | | 1 | 0 | 0 | 25.3% |
| : | | | | | : | : | : | : |
| 1 | | | | | 1 | 1 | 1 | 31.0% |
| | | | | | | | | **Level Gain** |
| | 0 | 0 | 0 | 0 | | | | 0dB |
| | 0 | 0 | 0 | 1 | | | | 0.66dB |
| | 0 | 0 | 1 | 0 | | | | 1.33dB |
| | : | : | : | : | | | | : |
| | 1 | 1 | 1 | 1 | | | | 10dB |

**Table 24.**  **Testing** (subaddress FH)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | 0 | **Stereo decoder test signals** OFF |
| | | | | | | | 1 | Test signals enabled if bit D5 of the subaddress (test mode bit) is set to "1", too |
| | | | | | | 0 | | External Clock |
| | | | | | | 1 | | Internal Clock |

**Table 24.    Testing** (subaddress FH)  (continued)

| MSB | | | | | | LSB | | Function |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **Testsignals at CASS_R** |
| | | 0 | 0 | 0 | 0 | | | VHCCH |
| | | 0 | 0 | 0 | 1 | | | Level intern |
| | | 0 | 0 | 1 | 0 | | | Pilot magnitude |
| | | 0 | 0 | 1 | 1 | | | VCOCON; VCO Control Voltage |
| | | 0 | 1 | 0 | 0 | | | Pilot threshold |
| | | 0 | 1 | 0 | 1 | | | HOLDN |
| | | 0 | 1 | 1 | 0 | | | NB threshold |
| | | 0 | 1 | 1 | 1 | | | F228 |
| | | 1 | 0 | 0 | 0 | | | VHCCL |
| | | 1 | 0 | 0 | 1 | | | VSBL |
| | | 1 | 0 | 1 | 0 | | | not used |
| | | 1 | 0 | 1 | 1 | | | not used |
| | | 1 | 1 | 0 | 0 | | | PEAK |
| | | 1 | 1 | 0 | 1 | | | not used |
| | | 1 | 1 | 1 | 0 | | | REF5V |
| | | 1 | 1 | 1 | 1 | | | not used |
| | | | | | | | | **VCO** |
| | 0 | | | | | | | OFF |
| | 1 | | | | | | | ON |
| | | | | | | | | **Audioprocessor test mode** |
| 0 | | | | | | | | enabled if bit D5 of the subaddress(test mode bit) is set to "1" |
| 1 | | | | | | | | OFF |

*Note:*     *This byte is used for testing or evaluation purposes only and must not be set to other values than the default "11111110" in the application!*

**Table 25.    New quality / control** (subaddress 10H)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | | | | | | **Reference generation** |
| | | | | | | | 0 | Internal Reference-Divider |
| | | | | | | | 1 | External Reference Force |
| | | | | | | | | **Quality Noise Gain** |
| | | | | | 0 | 0 | | 15dB |
| | | | | | 0 | 1 | | 12dB |
| | | | | | 1 | 0 | | 9dB |
| | | | | | 1 | 1 | | 6dB |
| | | | | | | | | **SC Clock Mode** |
| | | | | 0 | | | | Fast Mode |
| | | | | 1 | | | | Normal Mode |

**Table 25.    New quality / control** (subaddress 10H)  (continued)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| | | | 0 | | | | | **Auto Zero**<br>Off |
| | | | 1 | | | | | On |
| | | 0 | | | | | | **Smoothing Filter**<br>On |
| | | 1 | | | | | | Off |
| | 0 | | | | | | | **Enable AF Pin**<br>Enable Pin |
| | 1 | | | | | | | Disable Pin |
| 0 | | | | | | | | **AF Pin ST Decoder Mute Influence**<br>On |
| 1 | | | | | | | | Off |

**Table 26.    Mid filter** (subaddress 11H)

| MSB | | | | | | | LSB | Function |
|---|---|---|---|---|---|---|---|---|
| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | | | 0 | 0 | 0 | 0 | 0 | **Attenuation**<br>-15dB |
| | | | 0 | 0 | 1 | 1 | 1 | -14dB |
| | | | : | : | : | : | : | : |
| | | | 0 | 1 | 1 | 1 | 0 | -1dB |
| | | | 0 | 1 | 1 | 1 | 1 | 0dB |
| | | | 1 | 1 | 1 | 1 | 1 | 0dB |
| | | | 1 | 1 | 1 | 1 | 0 | +1dB |
| | | | : | : | : | : | : | : |
| | | | 1 | 0 | 0 | 0 | 1 | +14dB |
| | | | 1 | 0 | 0 | 0 | 0 | +15dB |
| | 0 | 0 | | | | | | **Middle Center frequency**<br>500Hz |
| | 0 | 1 | | | | | | 1.0kHz |
| | 1 | 0 | | | | | | 1.5kHz |
| | 1 | 1 | | | | | | 2.0kHz |
| 0 1 | | | | | | | | Mid Q Factor 1.02.0 |

# 8 Package information

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label.

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| DIM. | 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 | 0.015 | 0.018 |
| C | 0.09 | | 0.20 | 0.004 | | 0.008 |
| D | 11.80 | 12.00 | 12.20 | 0.464 | 0.472 | 0.480 |
| D1 | 9.80 | 10.00 | 10.20 | 0.386 | 0.394 | 0.401 |
| D3 | | 8.00 | | | 0.315 | |
| E | 11.80 | 12.00 | 12.20 | 0.464 | 0.472 | 0.480 |
| E1 | 9.80 | 10.00 | 10.20 | 0.386 | 0.394 | 0.401 |
| E3 | | 8.00 | | | 0.315 | |
| e | | 0.80 | | | 0.031 | |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | | 1.00 | | | 0.039 | |
| k | 0°(min.), 3.5°(typ.), 7°(max.) | | | | | |
| ccc | | | 0.10 | | | 0.0039 |

**OUTLINE AND MECHANICAL DATA**
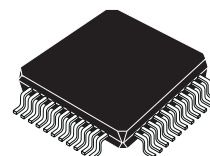


**LQFP44 (10 x 10 x 1.4mm)**
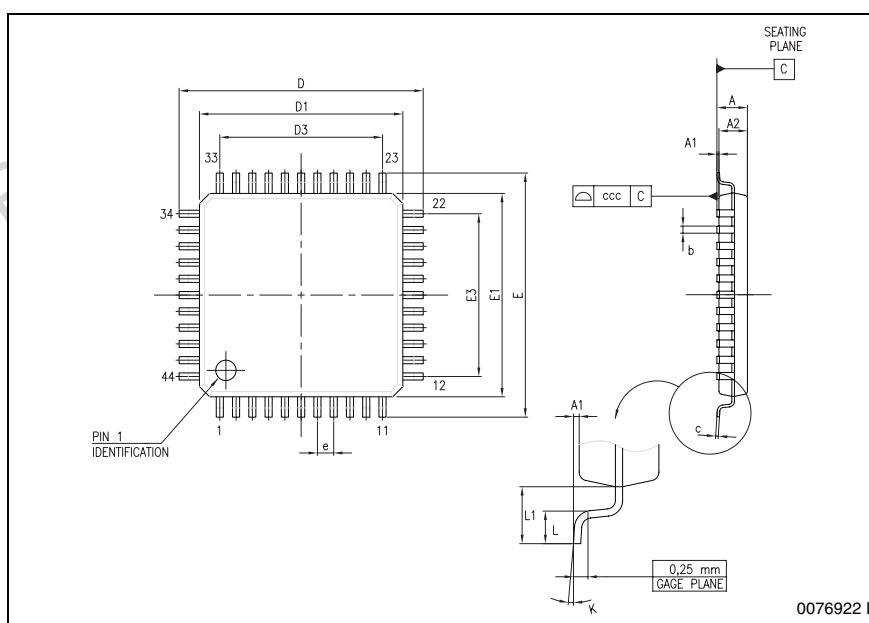


0076922 E

# 9 Revision history

**Table 27.    Document revision history**

| Date | Revision | Changes |
|------|----------|---------|
| 04-Oct-2004 | 1 | Initial release. |
| 01-Apr-2005 | 2 | Style sheet changed to comply with corporate guidelines. |
| 22-Jan-06 | 3 | Package change, layout changes, text modifications. |

**TDA7407**

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