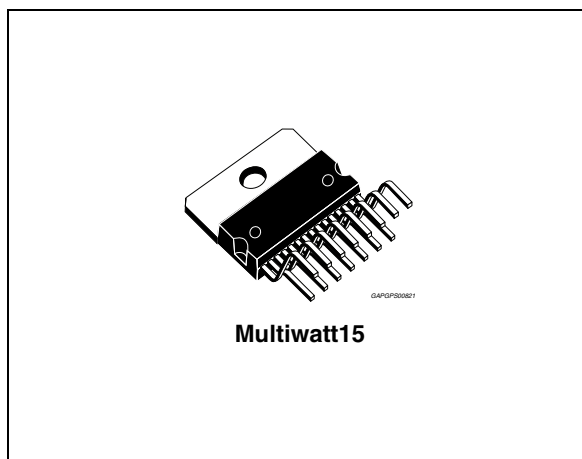


Dual bridge MOSFET power amplifier for 24 V systems

Datasheet — production data

Features

- Multipower BCD technology
- 24 V battery operation
- MOSFET output power stage
- High output power capability
 - 2 x 20 W/4 Ω @ 24 V, 1 kHz; 10 %
- Minimized external components
 - No decoupling capacitors
 - No bootstrap capacitor
 - No external compensation
 - Internally fixed gain
- Standby function
- Mute function
- Diagnostic pin for:
 - clip detector (THD 2 %)
 - short circuit detection
 - thermal protection
- Output DC offset detection
- Protections:
 - 60 V load dump
 - Overrating chip temperature
 - Out short circuit protection (to GND, Vcc and across the load)
 - ESD



Description

The TDA7576B is a dual bridge power amplifier with MOSFET output power stages. It has been specifically designed for 24 V power supply systems making it compatible with truck/bus applications.

The feedback topology allows excellent distortion performances and the integrated buffer minimizes the need for external components. The fully complementary P-channel/N-channel output structure allows rail-to-rail output voltage swing minimizing saturation losses.

The TDA7576B integrates a DC offset detector, a clipping detector and a diagnostic output.

Table 1. Device summary

| Order code | Package | Packing |
|------------|-------------|---------|
| TDA7576B | Multiwatt15 | Tube |

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1 Block and application diagrams

Figure 1. Block diagram

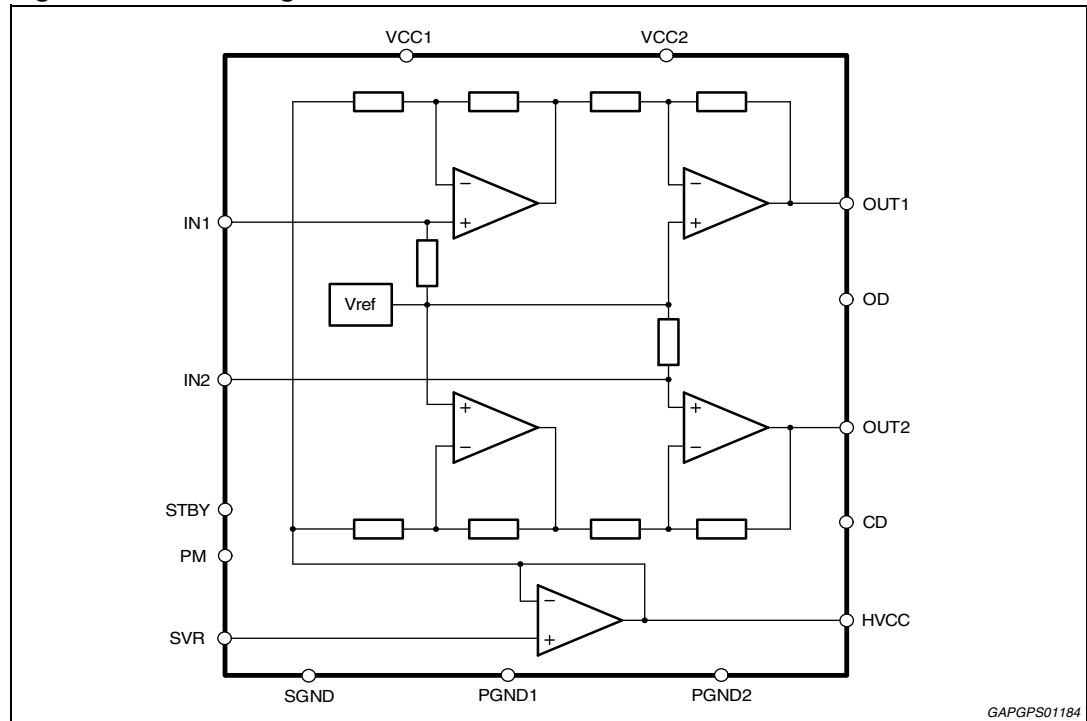
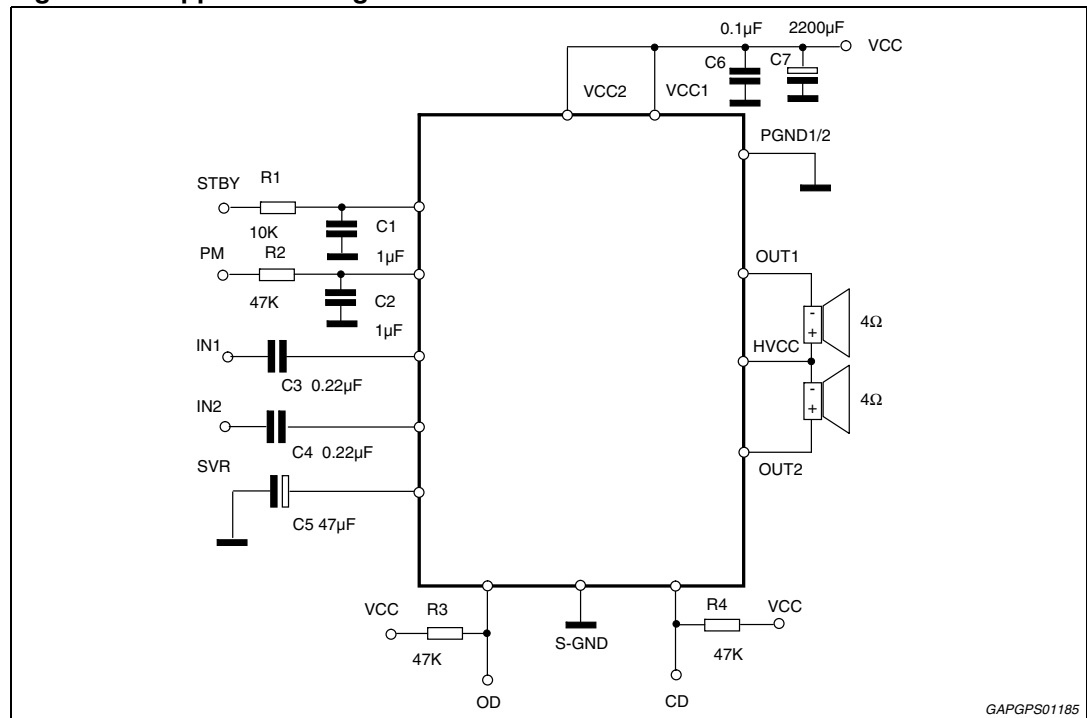
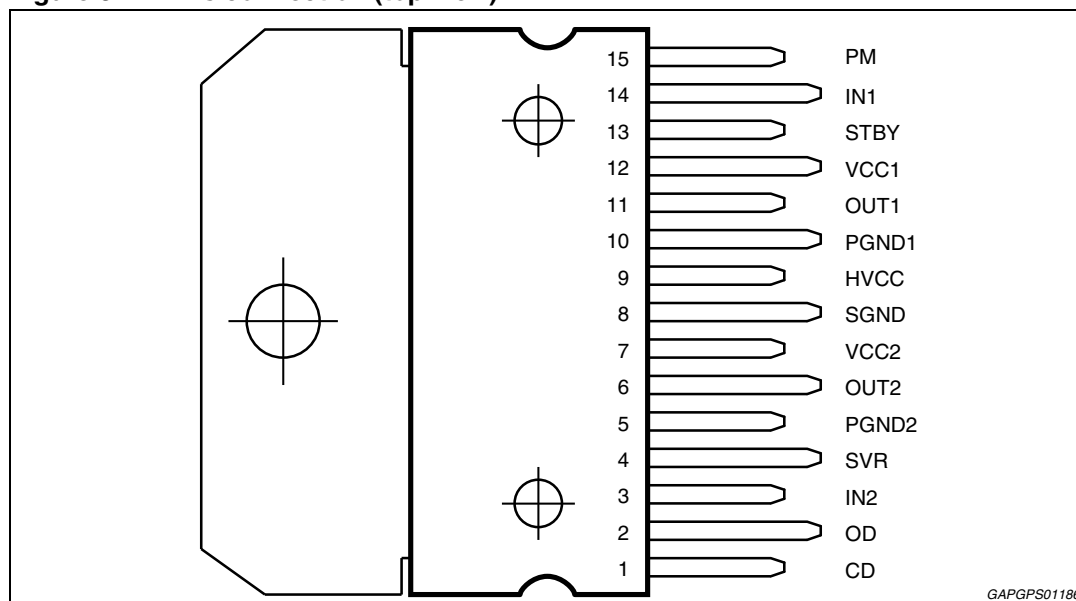


Figure 2. Application diagram



2 Pins description

Figure 3. Pins connection (top view)



GAPGPS01186

Table 2. Pins information

| Pin number | Pin name | Description | Type | Max. applicable voltage |
|------------|----------|----------------------------|-----------------------|-------------------------|
| 1 | CD | Clip Detector | Open collector output | -0.3/V _S |
| 2 | OD | Offset Detector | Open collector output | -0.3/V _S |
| 3 | IN2 | Left channel input | Input | -0.3/5 V |
| 4 | SVR | SVR | Output | -0.3/20 V |
| 5 | PGND2 | Power ground 2 | Ground | -0.3/0.3 |
| 6 | OUT2 | Left channel output | Output | N.A. |
| 7 | VCC2 | Supply voltage 2 | Supply | -0.3/V _S |
| 8 | SGND | Signal ground | Ground | -0.3/0.3 |
| 9 | HVCC | Half supply voltage buffer | Output | N.A. |
| 10 | PGND1 | Power ground 1 | Ground | -0.3/0.3 |
| 11 | OUT1 | Right channel output | Output | N.A. |
| 12 | VCC1 | Supply voltage 1 | Supply | -0.3/V _S |
| 13 | STBY | STBY pin | Input | -0.3/V _S |
| 14 | IN1 | Right channel input | Input | -0.3/5 V |
| 15 | PM | Play/Mute pin | Input | -0.3/5 V |

3 Electrical specification

3.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|-----------------|--|---------------|------|
| V_S | Operating supply voltage | 32 | V |
| V_{SPK} | Peak supply voltage (t = 50 ms) not operating | 60 | V |
| V_{DCS} | Not operating max. DC supply voltage | 36 | V |
| PGND, SGND | Ground pins | -0.3 to 0.3 | V |
| V_{CC} | Supply voltage | -0.3 to V_S | V |
| SVR | Supply voltage rejection filter | -0.3 to 20 | V |
| IN1, IN2 | Inputs | -0.3 to 5 | V |
| OD, CD | Offset detector, clip detector pins | -0.3 to V_S | V |
| PM | Play-mute pin | -0.3 to 5 | V |
| $P_{tot}^{(1)}$ | Power dissipation at $T_{case} = 85\text{ °C}$ | 85 | W |
| T_{stg}, T_j | Storage and junction temperature range | -40 to 150 | °C |

1. Refer to [Section 5](#) for detailed description of this value.

3.2 Thermal data

Table 4. Thermal data

| Symbol | Parameter | Value | Unit |
|------------------|-------------------------------------|--------|------|
| $R_{th\ j-case}$ | Thermal resistance junction-to-case | Max. 2 | °C/W |

3.3 Electrical characteristics

Refer to the test circuit; $V_S = 28\text{ V}$; $R_L = 4\text{ }\Omega$; $T_{amb} = 25\text{ °C}$; $f = 1\text{ kHz}$; $R_g = 0$, unless otherwise specified.

Table 5. Electrical characteristics

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|----------------|-----------------------------|---------------------------------|------|------|------|---------------|
| General | | | | | | |
| V_S | Supply voltage | - | 8 | - | 32 | V |
| I_q | Total quiescent current | $R_L = \infty$ | - | 90 | 130 | mA |
| I_{ST-BY} | Standby current consumption | $0 < V_{ST_BY} < 1.2\text{ V}$ | - | - | 10 | μA |
| R_{IN} | Input impedance | - | 50 | 55 | - | k Ω |

Table 5. Electrical characteristics (continued)

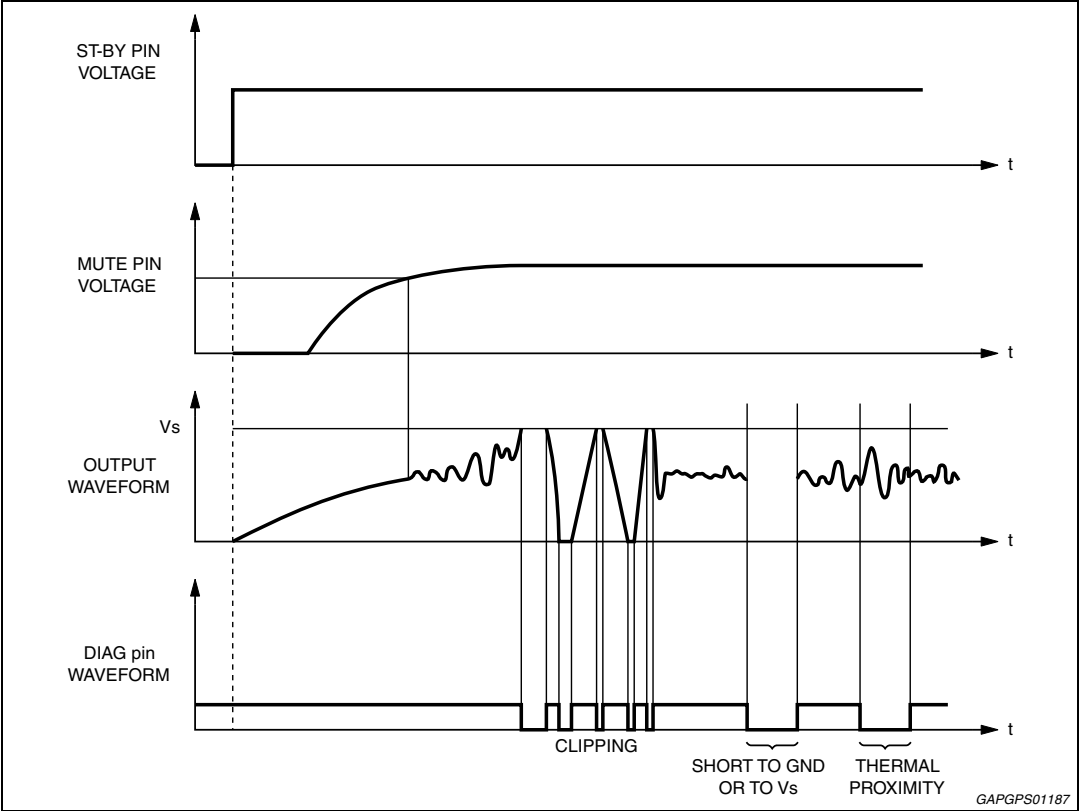
| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|--|--------------------------------------|---|---------|---------|---------|---------------|
| V_{OS} | Offset voltage | - | -100 | - | +100 | mV |
| V_{dth} | Dump threshold | - | 36 | 37.5 | 39 | V |
| I_D | Dump current | $V_S = 60\text{ V}$ | - | 18 | 40 | mA |
| Audio section | | | | | | |
| P_O | Output power | THD = 1 % | 20 | 22 | - | W |
| | | THD = 10 % | 25 | 28 | - | |
| $P_{O\text{ max.}}$ | Max. output power ⁽¹⁾ | - | 43 | 45 | - | W |
| THD | Distortion | $P_O = 4\text{ W}$; $f = 1\text{ kHz}$ | - | 0.05 | 0.1 | % |
| CT | Cross talk | $f = 1\text{ kHz}$; $P_O = 4\text{ W}$ | 50 | 65 | - | dB |
| | | $f = 10\text{ kHz}$; $P_O = 4\text{ W}$ | 45 | 60 | - | |
| G_V | Voltage gain | | 25 | 26 | 27 | dB |
| E_{NO} | Output noise voltage ⁽²⁾ | Amplifier in Mute | - | 60 | 100 | μV |
| SVR | Supply voltage rejection | $f = 1\text{ kHz}$; $V_R = 1\text{ Vpk}$ | - | 50 | - | dB |
| Standby | | | | | | |
| $V_{SB\text{ IN}}$ | Standby input threshold voltage | - | - | - | 1.2 | V |
| $V_{SB\text{ OUT}}$ | Standby output threshold voltage | - | 2.6 | - | - | V |
| ASB | Standby attenuation | - | 90 | 110 | - | dB |
| I_{PIN} | Standby pin current | Play mode | -1 | - | 1 | μA |
| Mute pin | | | | | | |
| A_M | Mute attenuation | - | 90 | 100 | - | dB |
| $V_{M\text{ IN}}$ | Mute input threshold voltage | (Amp: Mute) | - | - | 1.2 | V |
| $V_{M\text{ OUT}}$ | Mute output threshold voltage | (Amp: Play) | 2.6 | - | - | V |
| $V_{AM\text{ in}}$ | V_S automute threshold | Amp: play, attenuation = -3 dB $V_{out} = 2\text{ Vrms}$; $f = 1\text{ kHz}$ | 6.7 | 7.25 | 8 | V |
| Clipping detector⁽³⁾ | | | | | | |
| CD_{THD} | Clipping detector THD level | $10\text{ V} < V_S < 32\text{ V}$ | - | 2 | - | % |
| CD_{SAT} | Clipping detector saturation voltage | $10\text{ V} < V_S < 32\text{ V}$; Cd; On; $I_{CD} = 1\text{ mA}$ | - | - | 0.2 | V |
| Offset detector | | | | | | |
| O_D | Offset detector | Power amp. in play AC input = 0 | ± 1 | ± 2 | ± 3 | V |
| V_{OFF_SAT} | Offset detector saturation voltage | $V_O - V_{HVCC} > 3\text{ V}$, $I_{OD} = 1\text{ mA}$ | - | - | 0.2 | V |

1. Square wave input.

2. 22 Hz to 22 kHz.

3. Clip detector not guaranteed for $V_S < 10\text{ V}$.

Figure 4. Audio section waveforms



3.4 Electrical characteristics curves

Figure 5. Quiescent current vs. supply voltage

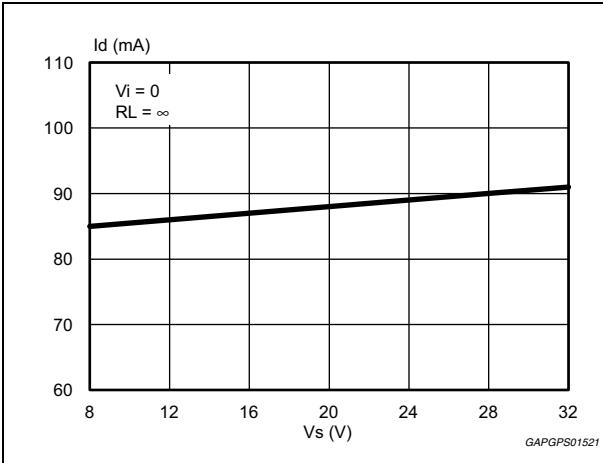


Figure 6. Output power vs. supply voltage ($R_L = 4 \Omega$)

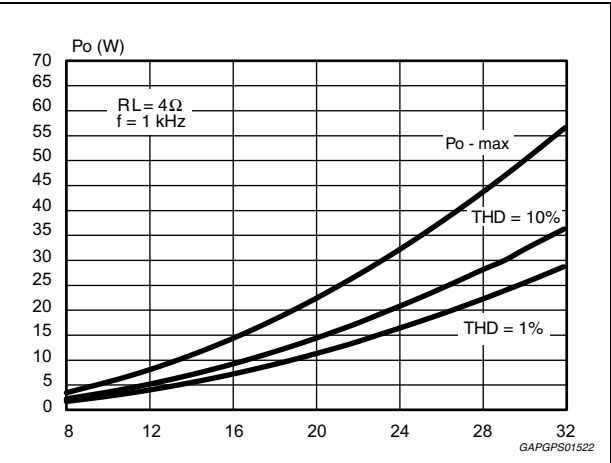


Figure 7. Distortion vs. output power
($R_L = 4\ \Omega$)

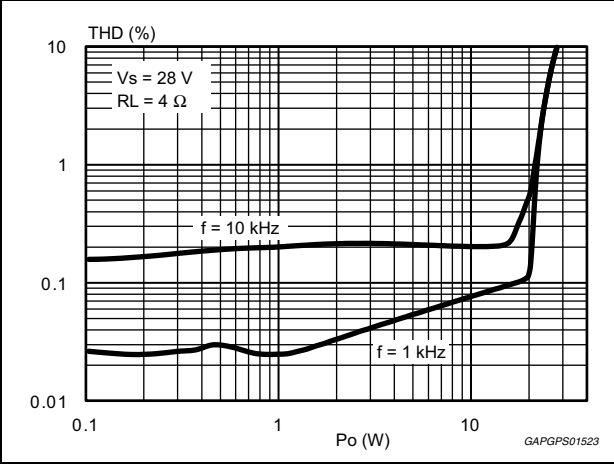


Figure 8. Crosstalk vs. frequency

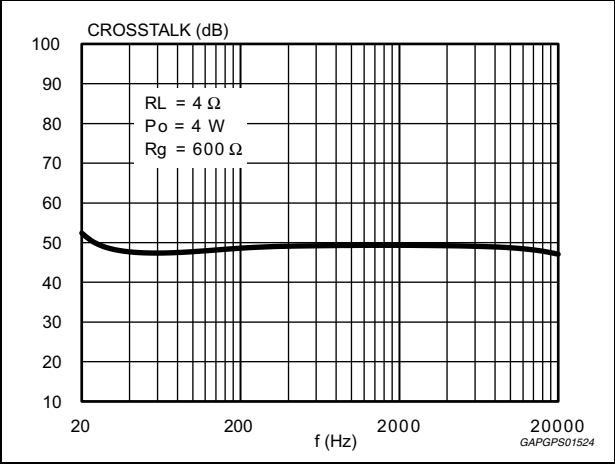


Figure 9. Total power dissipation and efficiency vs. P_o ($R_L = 4\ \Omega$)

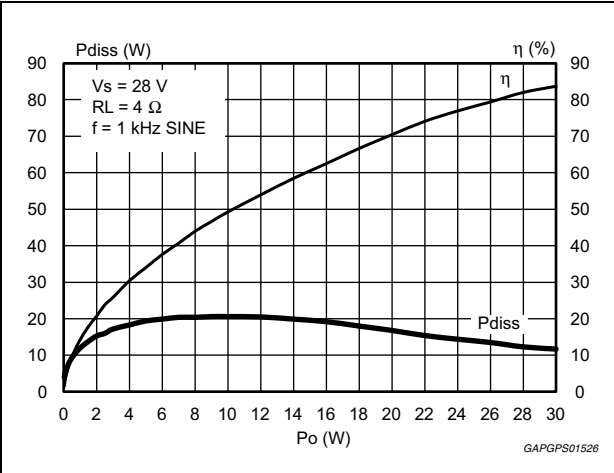
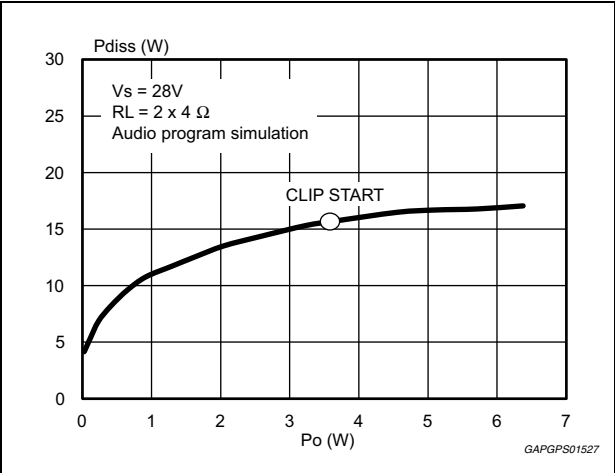


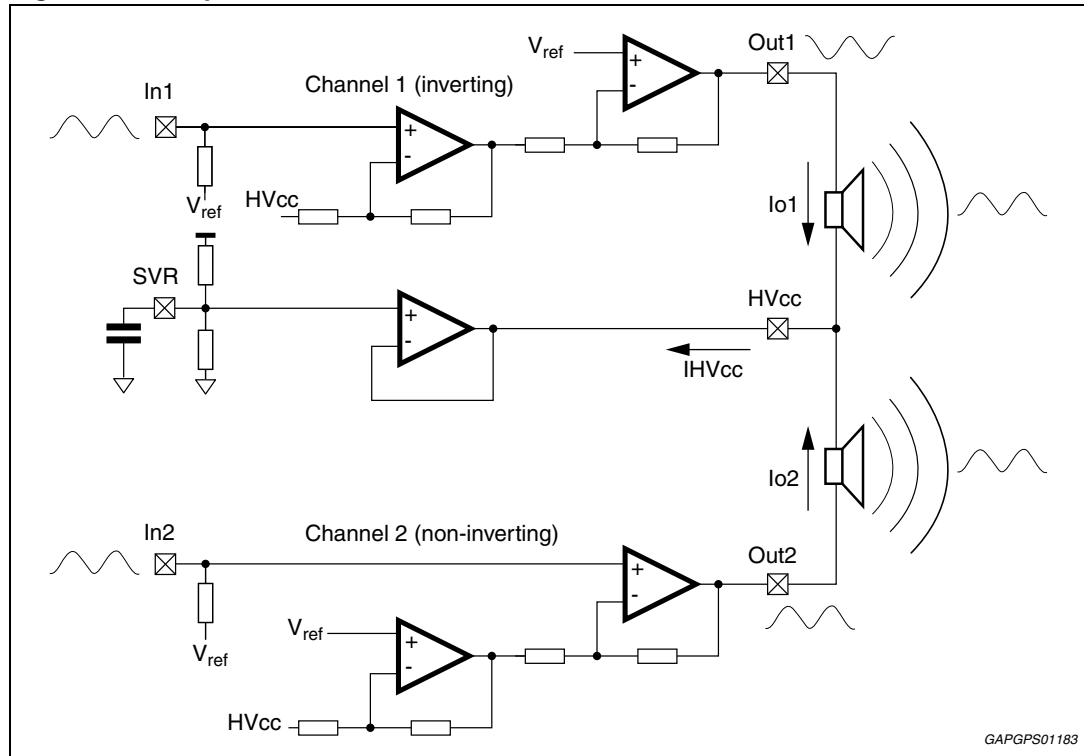
Figure 10. Power dissipation vs. average P_o
(audio program simulation, $4\ \Omega$)



4 Principle of operation

The TDA7576B is an innovative stereo audio amplifier meant for 24 V battery vehicles. The amplifier works in a single-ended configuration without the large decoupling capacitors on the outputs normally required by the s.e. topology. Its principle of operation is depicted in [Figure 11](#).

Figure 11. Amplifier structure



Channel 1 is electrically inverting its input signal whereas channel 2 is not; if the speakers are connected with the positive pole of speaker 2 connected to Out2 and the negative pole of speaker 1 connected to Out1, then the two channels both behave as non-inverting. Speaker 1 and speaker 2 have one terminal in common and further connected to a half Vcc (HVCC) buffer.

If the signals at In1 and In2 are identical, then the voltage at Out1 and Out2 is identical in magnitude but inverted ($Out1 = -Out2$), and the current flowing through speaker 1 is all coming from speaker 2, with no current going into the HVCC buffer. If the signal at In1 is not identical to that at In2, then the signal at the two outputs will not be identical either, and some current will flow into or out of the HVCC buffer, keeping the voltage at HVCC constant.

This structure allows therefore the amplifier to operate in a single-ended configuration with no need for decoupling capacitors.

Mathematically this can be expressed as:

$$V_{L1} = -G * Vin1$$

$$V_{L2} = +G * Vin2$$

$$I_{HVCC} = Io1 + Io2 = V_{L1}/RL + V_{L2}/RL = G (Vin2 - Vin1) / RL$$

where $V_{L1,2}$ is the voltage across speaker 1 or 2, G is the gain of the amplifiers and R_L is the load resistance (supposed identical for the two speakers).

In the common practice the two channels of the amplifier are used for the left and the right audio parts of the stereo signal, and therefore the two outputs are not identical. This means that it is never mathematically true that all the current into one speaker comes from the other speaker, so the HVcc buffer will always have to provide a certain amount of difference current.

Apart from the fact that the left and the right audio channels are not identical unless the program is monophonic, other reasons why the HVcc buffer has to provide current are: imbalance in the level of the L and the R channel, equalization-induced delay in one channel compared to the other.

The current provided by the HVCC buffer leads to non-negligible power dissipation inside the IC: this should be added to power dissipation the output stages 1 and 2. It is necessary to keep this additional dissipation in mind when dimensioning the car-radio heat sink.

5 Power dissipation computation

The instantaneous power dissipated by each output stage is given by the formula below:

$$P_{D1,2}(t) = 1/R_L |V_{L1,2}(t)| (V_{CC}/2 - |V_{L1,2}(t)|)$$

with $V_{L1,2}(t)$ being the output signal on each of the two channels ($V_{L1,2}(t) = G * V_{in1,2}(t)$).

If the two input signals are not identical, as seen in [Section 4](#) a current I_{HVCC} flows into or out of the half V_{CC} buffer; this current causes dissipation within the HV_{CC} buffer given by:

$$P_{DHVCC}(t) = V_{CC}/(2R_L) |V_{L2}(t) - V_{L1}(t)|$$

which is obviously 0 when the two channels have identical signals.

The total instantaneous power dissipation inside the TDA7576B is therefore given by:

$$P_{dtot}(t) = P_{D1}(t) + P_{D2}(t) + P_{DHVCC}(t).$$

The dimensioning of the heat sink of the system must take into consideration these three components.

For more details on power dissipation and recommendations on heat-sink characteristics computation, please refer to the complete application note related to this subject.

6 Functional description

6.1 Diagnostics pins description

TDA7576B includes an offset detector pin and a clip detector and diagnostic pin.

DC offset detector is intended to avoid that an anomalous DC offset on the inputs of the amplifier may be multiplied by the gain and result in a dangerous large offset on the outputs. This may lead to speakers damage due to overheating.

The feature works with the amplifier unmuted and no signal at the inputs.

Moreover there is a pin named CD/Diag: the behavior of this pin is showed on [Figure 4](#).

Whenever a failure condition (between thermal warning, output waveform clipping, short circuit to GND or V_{CC}) is verified by the IC the level of this pin goes true (low).

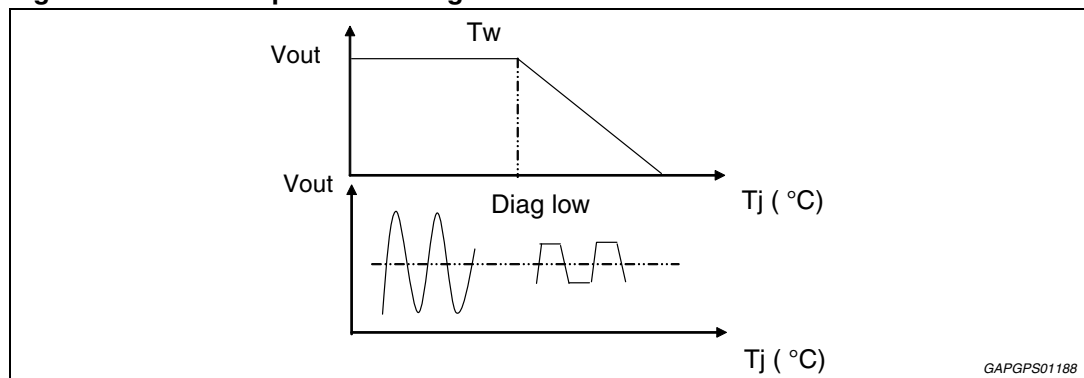
6.2 Thermal protections

Thermal protection function is triggered when junction temperature rises above the normal operating range, thus avoiding chip damaging.

For behavior description, refer to [Figure 4](#) and [12](#). When temperature is reaching thermal warning ($T_w = \text{typ } 140^\circ\text{C}$) the CD/Diag pin is driven low. Thermal foldback begins limiting the audio input to the amplifier stage, this effectively limits the output power capability of the device thus reducing the temperature to acceptable levels without totally interrupting the operation of the device. Thermal mute is temperature when -6 dB output attenuation is reached (typical $T_m = 160^\circ\text{C}$).

The output power will decrease to the point at which thermal equilibrium is reached. Thermal equilibrium will be reached when the reduction in output power reduces the dissipated power such that the die temperature falls below the thermal foldback threshold.

Figure 12. Thermal protection diagram

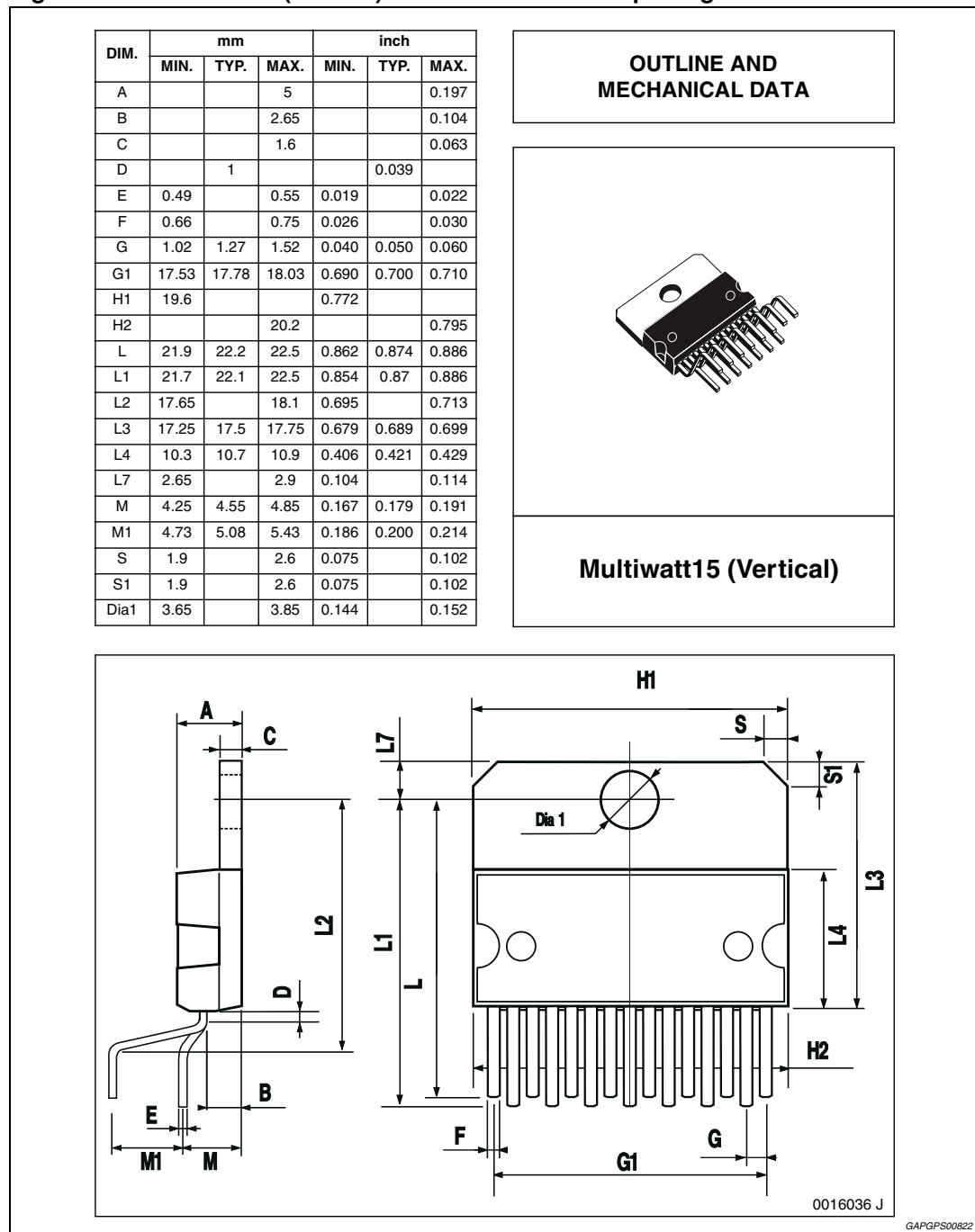


7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com.

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Figure 13. Multiwatt 15 (vertical) mechanical data and package dimensions



8 Revision history

Table 6. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 26-Sep-2012 | 1 | Initial release. |
| 05-Oct-2012 | 2 | Updated Section 1: Block and application diagrams . Updated Section 2: Pins description . |
| 18-Sep-2013 | 3 | Updated Disclaimer. |

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