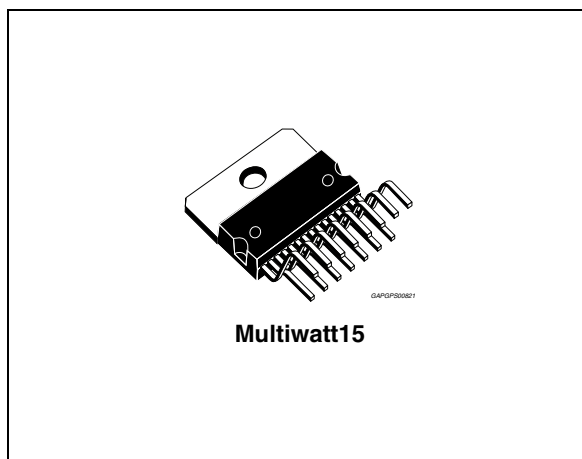# TDA7576B

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

Multiwatt15

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

September 2013

This is information on a product in full production.

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Figure 1. Block diagram

Figure 2. Application diagram

2   Pins description

Figure 3.   Pins connection (top view)

			15	PM
			14	IN1
			13	STBY
			12	VCC1
			11	OUT1
			10	PGND1
			9	HVCC
			8	SGND
			7	VCC2
			6	OUT2
			5	PGND2
			4	SVR
			3	IN2
			2	OD
			1	CD

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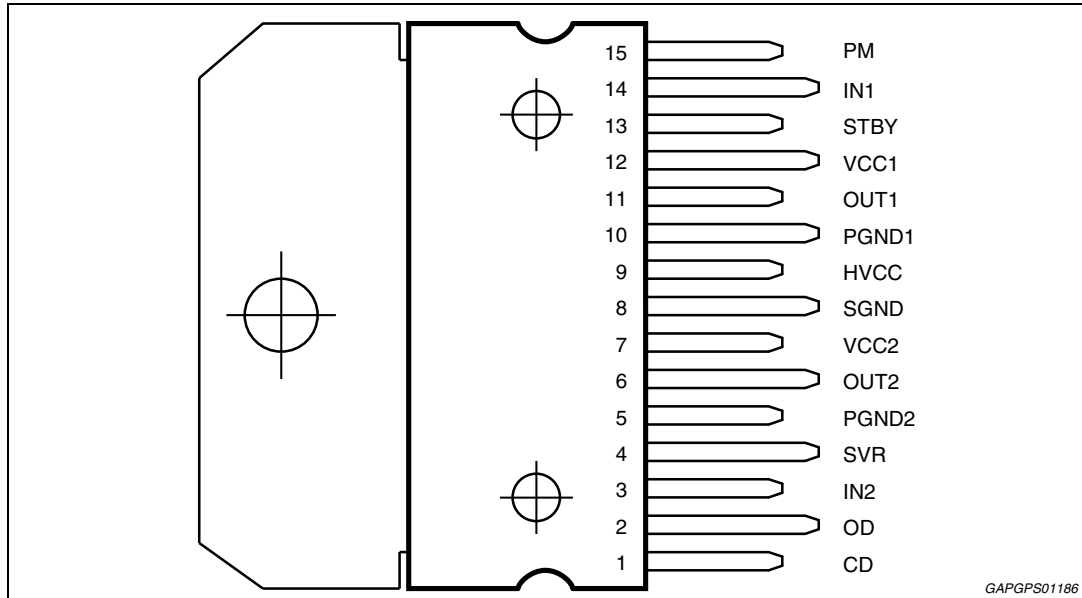
Table 2.   Pins information

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 °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
$R_{th\ j\text{-}case}$	Thermal resistance junction-to-case	Max.	2	°C/W

3.3   Electrical characteristics

Refer to the test circuit; V_S = 28 V; R_L = 4 Ω, T_{amb} = 25 °C, f = 1 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
$I_{ST\text{-}BY}$	Standby current consumption	0 < V_{ST_BY} < 1.2 V	-	-	10	µA
R_{IN}	Input impedance	-	50	55	-	kΩ

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 V	-	18	40	mA
Audio section						
P_o	Output power	THD = 1 %	20	22	-	W
		THD = 10 %	25	28	-	
$P_{o\,max.}$	Max. output power[1]	-	43	45	-	W
THD	Distortion	P_o = 4 W; f = 1 kHz	-	0.05	0.1	%
CT	Cross talk	f = 1 kHz; P_o = 4 W f = 10 kHz; P_o = 4 W	50 45	65 60	-	dB dB
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 kHz; V_R = 1 Vpk	-	50	-	dB
Standby						
$V_{SB\,IN}$	Standby input threshold voltage	-	-	-	1.2	V
$V_{SB\,OUT}$	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
$V_{M\,IN}$	Mute input threshold voltage	(Amp: Mute)	-	-	1.2	V
$V_{M\,OUT}$	Mute output threshold voltage	(Amp: Play)	2.6	-	-	V
$V_{AM\,in}$	V_S automute threshold	Amp: play, attenuation = -3 dB V_{out} = 2 Vrms; f = 1 kHz	6.7	7.25	8	V
Clipping detector[3]						
CD_{THD}	Clipping detector THD level	10 V < V_s < 32 V	-	2	-	%
CD_{SAT}	Clipping detector saturation voltage	10 V < V_s < 32 V; Cd; On; I_{CD} = 1 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 V, I_{OD} = 1 mA	-	-	0.2	V

1. Square wave input.

2. 22 Hz to 22 kHz.

3. Clip detector not guaranteed for V_s < 10 V.

Figure 4.   **Audio section waveforms**

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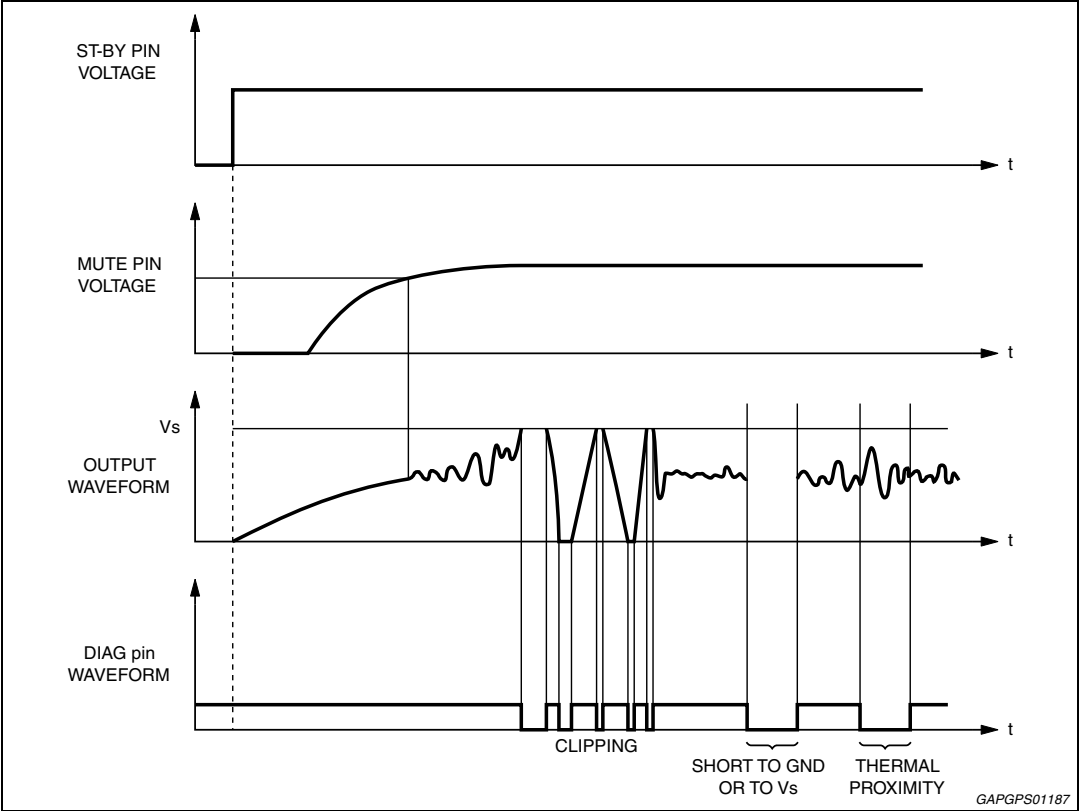
3.4   Electrical characteristics curves

Figure 5.   **Quiescent current vs. supply voltage**

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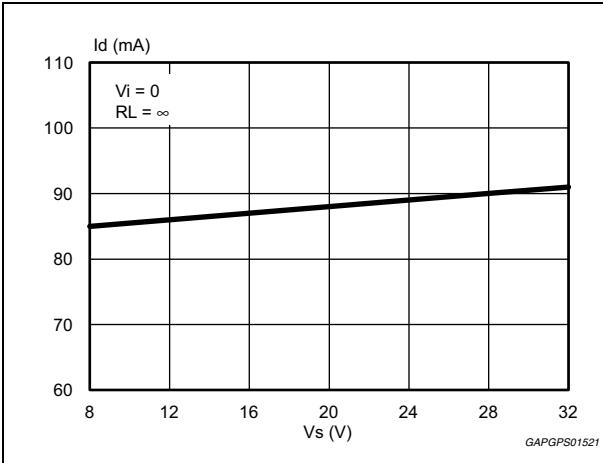
Figure 6.   **Output power vs. supply voltage ($R_L = 4 \ \Omega$)**
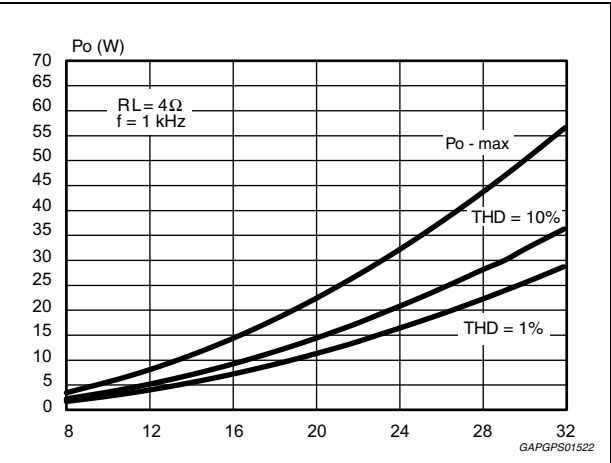

GAPGPS01522

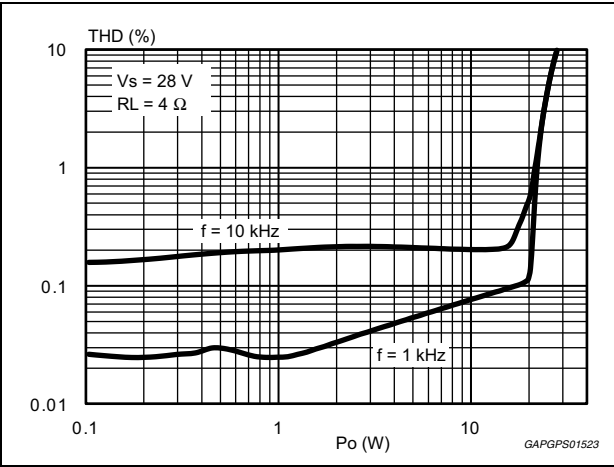**Figure 7.   Distortion vs. output power (R_L = 4 Ω)**

Figure 8.   Crosstalk vs. frequency

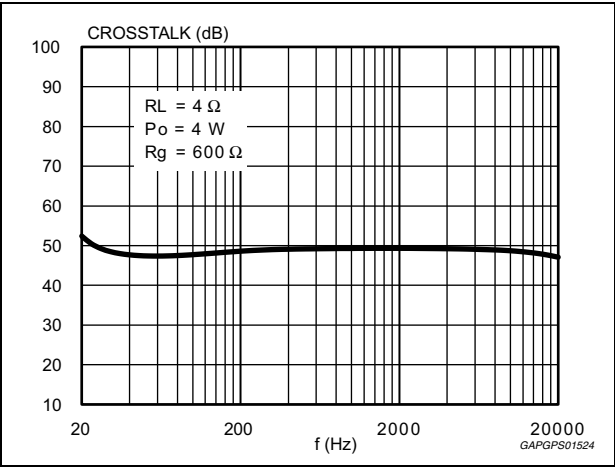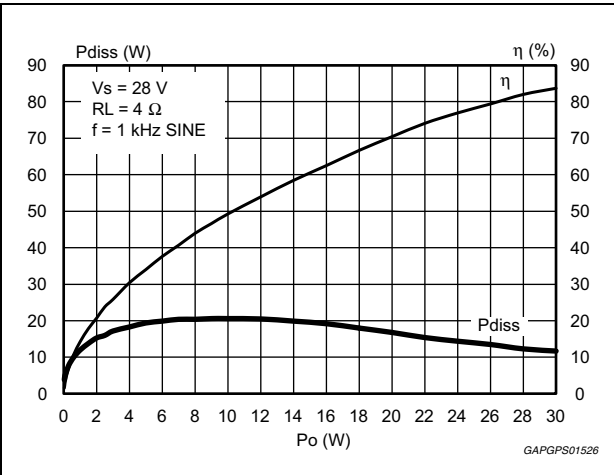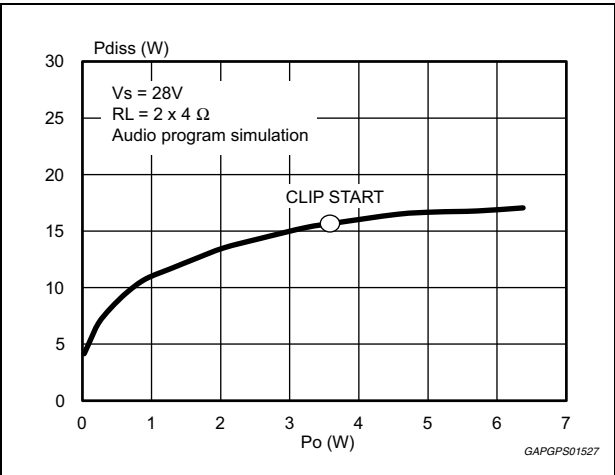**Figure 9.   Total power dissipation and efficiency vs. Po (R_L = 4 Ω)**

Figure 10.   Power dissipation vs. average Po (audio program simulation, 4 Ω)

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
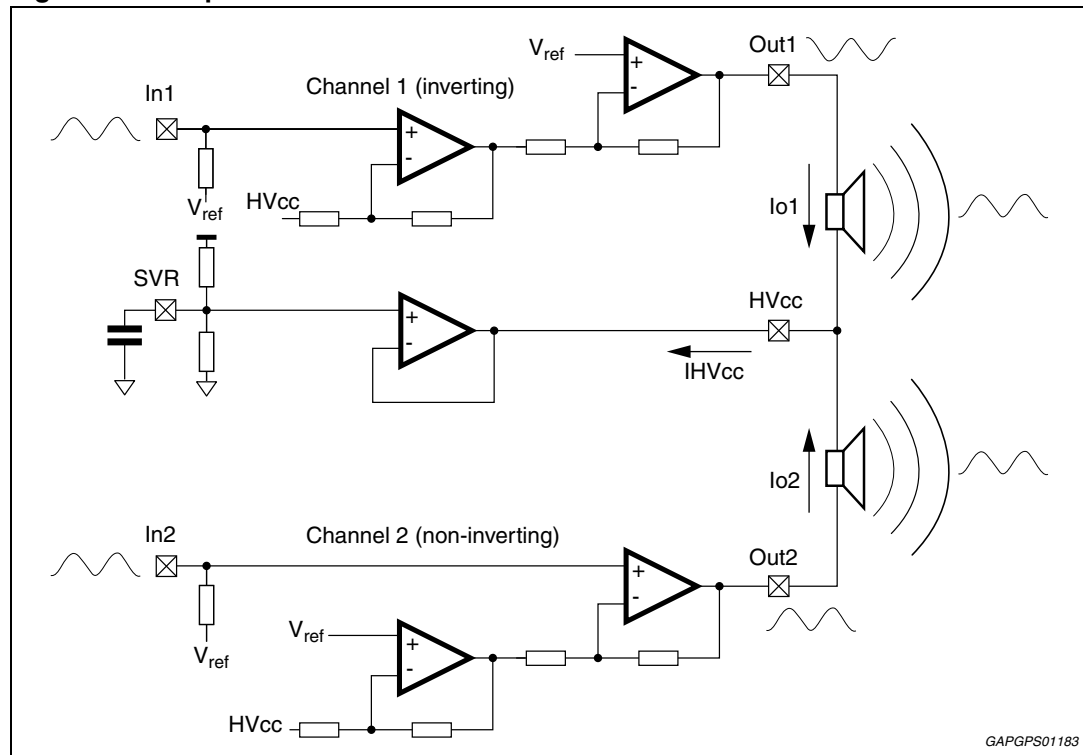
Channel 1 is electrically inverting its input signal whereas channel 2 is not; if the speakers are connected with the positive pole of speaker 2 connected to Out2 and the negative pole of speaker 1 connected to Out1, then the two channels both behave as non-inverting. Speaker 1 and speaker 2 have one 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:

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

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

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

where $V_{L1,2}$ is the voltage across speaker 1 or 2, G is the gain of the amplifiers and RL 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:

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

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 IHVcc flows into or out of the half Vcc buffer; this current causes dissipation within the HVcc buffer given by:

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

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 = typ 140 °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 °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.
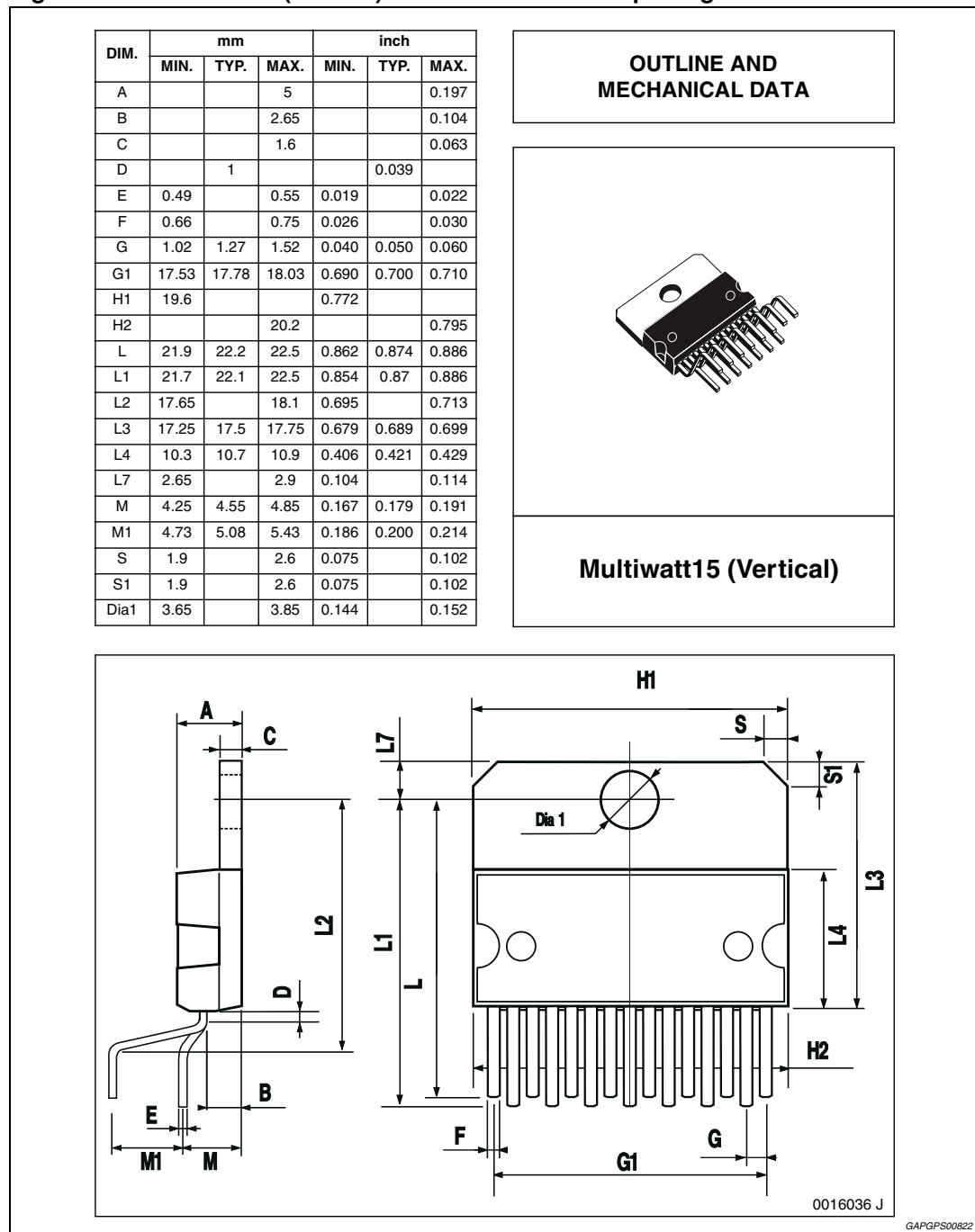
Figure 12. Thermal protection diagram
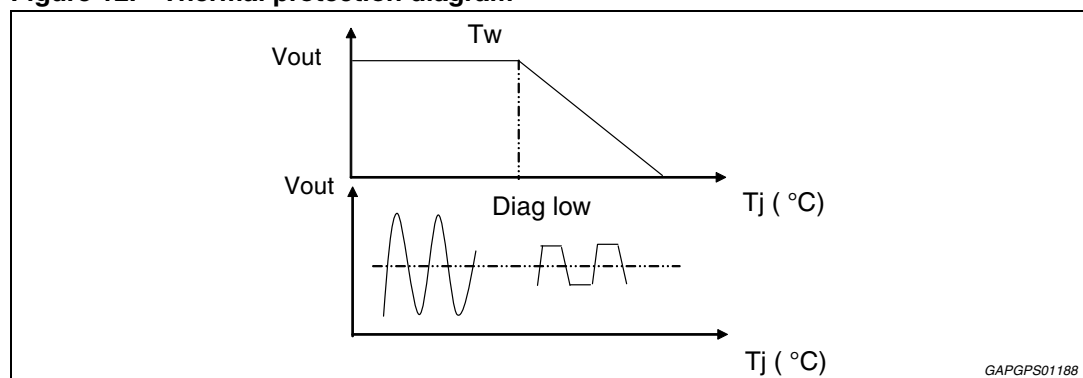
7   Package information

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

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
D		1			0.039	
E	0.49		0.55	0.019		0.022
F	0.66		0.75	0.026		0.030
G	1.02	1.27	1.52	0.040	0.050	0.060
G1	17.53	17.78	18.03	0.690	0.700	0.710
H1	19.6			0.772		
H2			20.2			0.795
L	21.9	22.2	22.5	0.862	0.874	0.886
L1	21.7	22.1	22.5	0.854	0.87	0.886
L2	17.65		18.1	0.695		0.713
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
M	4.25	4.55	4.85	0.167	0.179	0.191
M1	4.73	5.08	5.43	0.186	0.200	0.214
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152

OUTLINE AND MECHANICAL DATA

Multiwatt15 (Vertical)

0016036 J

GAPGPS00822

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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