TDA7375AV

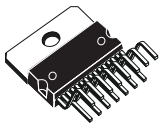
2 x 37W dual/quad power amplifier for car radio

Features

- High output power capability
  - 2 x 43 W max./4 Ω
  - 2 x 37 W/4 Ω EIAJ
  - 2 x 26 W/4 Ω @14.4 V, 1 kHz, 10 %
  - 4 x 7 W/4 Ω @14.4 V, 1 kHz, 10 %
  - 4 x 12 W/2 Ω @14.4 V, 1 kHz, 10 %
- Minimum external components count:
  - No bootstrap capacitors
  - No Boucherot cells
  - Internally fixed gain (26 dB BTL)
  - Standby function (CMOS compatible)
- No audible pop during standby operations
- Diagnostics facility for:
  - Clipping
  - Out to GND short
  - Out to V_S short
  - Soft short at turn-on
  - Thermal shutdown proximity

Protections

- Output AC/DC short circuit
  - To GND
  - To V_S
  - Across the load
- Soft short at turn-on
- Overrating chip temperature with soft thermal limiter



Multiwatt15

- Load dump voltage surge
- Very inductive loads
- Fortuitous open GND
- Reversed battery
- ESD

Description

The TDA7375AV is a technology class AB car radio amplifier able to work either in dual bridge or quad single ended configuration.

The exclusive fully complementary structure of the output stage and the internally fixed gain guarantee the highest possible power performances with extremely reduced component count.

The on-board clip detector simplifies gain compression operation. The fault diagnostics makes it possible to detect mistakes during car radio set assembly and wiring in the car.

Table 1. Device summary

Order code	Package	Packing
TDA7375AV	Multiwat15	Tube

Contents

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1 Block and pin connection diagrams

Figure 1. Block diagram

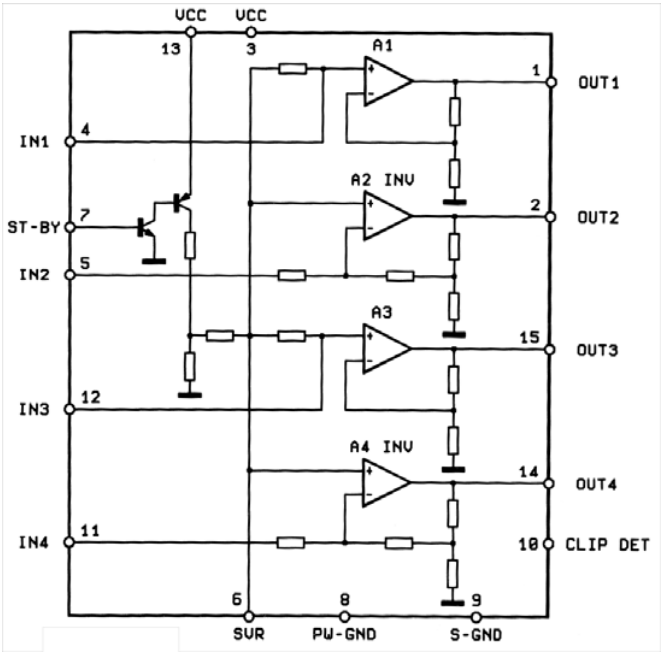
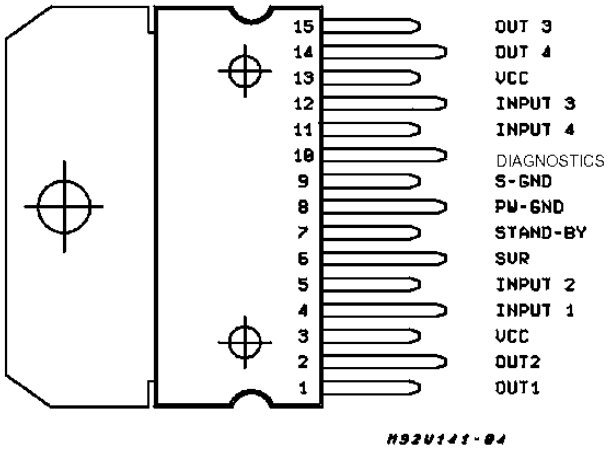


Figure 2. Pin connection (top view)



2 Electrical specification

2.1 Absolute maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{op}	Operating supply voltage	18	V
V_S	DC supply voltage	28	V
V_{peak}	Peak supply voltage (for t = 50ms)	40	V
I_O	Output peak current (not repetitive t = 100µs)	4.5	A
I_O	Output peak current (repetitive f > 10Hz)	3.5	A
P_{tot}	Power dissipation (T_{case} = 85°C)	36	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	°C

2.2 Thermal data

Table 3. Thermal data

Symbol	Parameter		Value	Unit
$R_{th\ j\text{-}case}$	Thermal resistance junction to case	max	1.8	°C/W

2.3 Electrical characteristics

Table 4. Electrical characteristics
(Refer to the test circuit, V_S = 14.4V; R_L = 4Ω; f = 1kHz; T_{amb} = 25°C, unless otherwise specified)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_S	Supply voltage range		8		18	V
I_d	Total quiescent drain current	$R_L = \infty$			150	mA
V_{OS}	Output offset voltage				150	mV
P_O	Output power	THD = 10 %; R_L = 4Ω Bridge Single Ended Single Ended, R_L = 2 Ω	 23 6.5	 25 7 12		 W W W
P_O max	Max. output power(1)	V_S = 14.4 V, Bridge	37	43		W
$P_{O\ EIAJ}$	EIAJ output power(1)	V_S = 13.7 V, Bridge	33	37		W
THD	Distortion	R_L = 4 Ω Single Ended, P_O = 0.1 to 4 W Bridge, P_O = 0.1 to 10 W		 0.02 0.03	 0.3	 % %

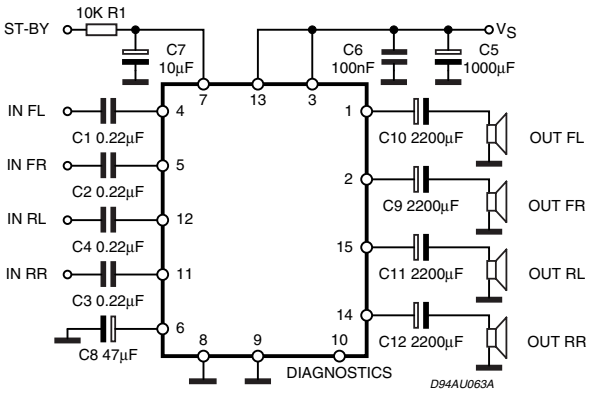
Table 4. Electrical characteristics (continued)
(Refer to the test circuit, V_S = 14.4V; R_L = 4Ω; f = 1kHz; T_{amb} = 25°C, unless otherwise specified)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
C_T	Cross talk	f = 1 kHz Single ended		70		dB
		f = 10 kHz Single ended		60		dB
		f = 1 kHz Bridge	55			dB
		f = 10 kHz Bridge		60		dB
R_{IN}	Input impedance	Single Ended	20	30		kΩ
		Bridge	10	15		kΩ
G_V	Voltage gain	Single Ended	19	20	21	dB
		Bridge	25	26	27	dB
G_V	Voltage gain match				0.5	dB
E_{IN}	Input noise voltage	R_g = 0; "A" weighted, S.E. Non inverting channels Inverting channels		 2 5		 µV µV
		Bridge R_g = 0; 22 Hz to 22 kHz		 3.5		 µV
SVR	Supply voltage rejection	R_g = 0; f = 300 Hz	50			dB
A_{SB}	Standby attenuation	P_O = 1 W	80	90		dB
I_{SB}	Standby current consumption	$V_{St\text{-}by}$ = 0 to 1.5 V			100	µA
V_{SB}	Standby In threshold voltage				1.5	V
V_{SB}	Standby Out threshold voltage		3.5			V
I_{pin7}	Standby pin current	Play mode V_{pin7} = 5 V			50	µA
		Max. driving current under fault (2)			5	mA
$I_{cd\ off}$	Clipping detector output average current	d = 1% (3)		90		µA
$I_{cd\ on}$	Clipping detector output average current	d = 5%(3)		160		µA
$V_{sat\ pin10}$	Voltage saturation on pin 10	Sink current at Pin 10 = 1mA			0.7	V

1. Saturated square wave output.
2. See built-in S/C protection description
3. Pin 10 pulled-up to 5V with 10 kΩ; R_L = 4Ω

3 Standard test and application circuits

Figure 3. Quad stereo circuit



Note:

The output decoupling capacitors (C9,C10,C11,C12) could be reduced to 1000µF if the 2Ω operation is not required.

Figure 4. Double bridge circuit

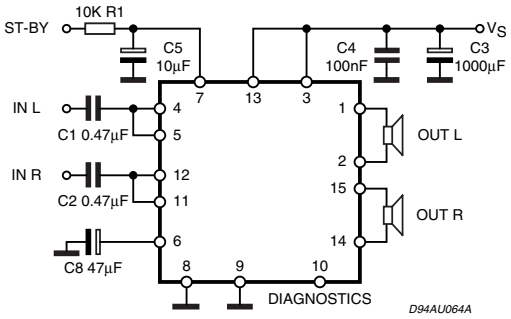


Figure 5. Stereo/bridge circuit

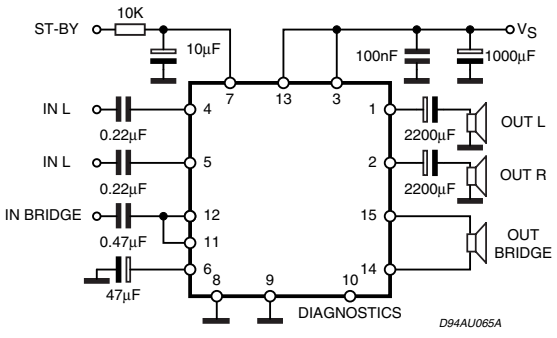


Figure 6. PCB and component layout of the *Figure 3*

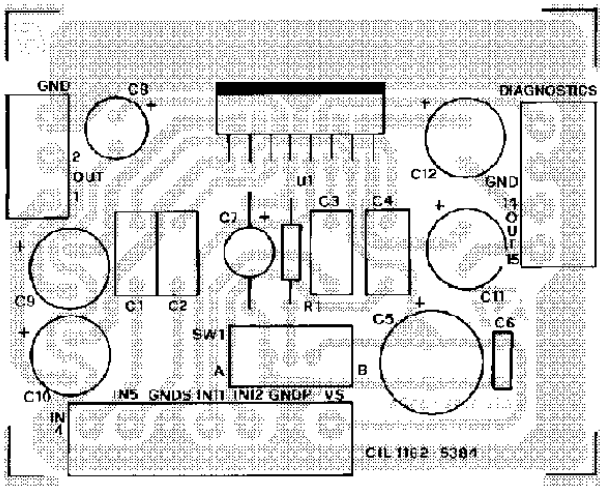
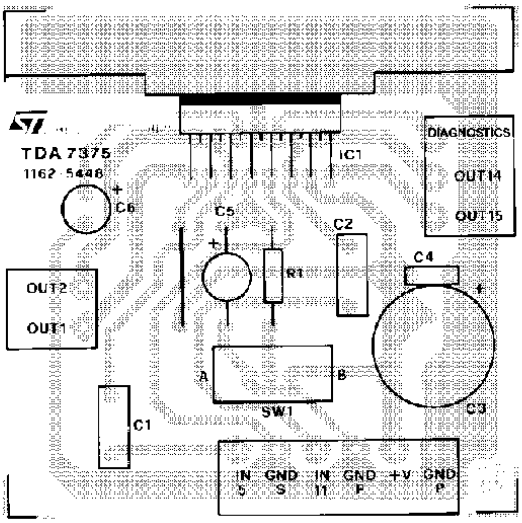


Figure 7. PCB and component layout of the *Figure 4*



3.1 Electrical characteristics curves

Figure 8. Quiescent drain current vs. supply voltage (Single ended and bridge)

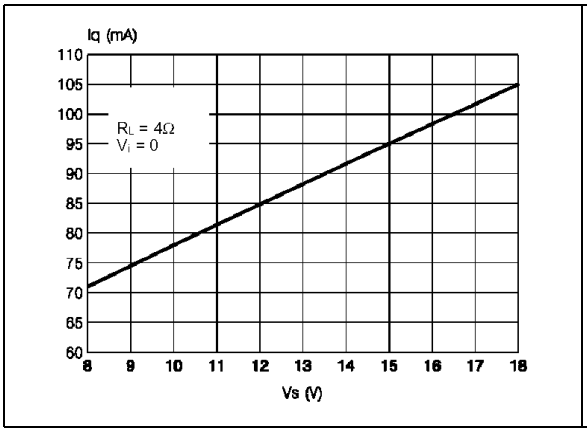


Figure 9. Quiescent output voltage vs. supply voltage (Single ended and bridge)

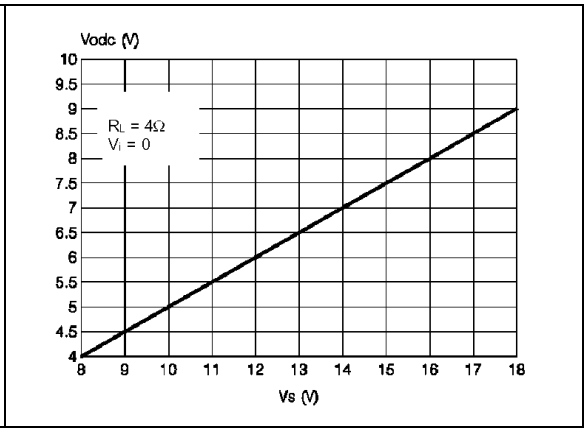


Figure 10. Output power vs. supply voltage (2Ω, S.E.)

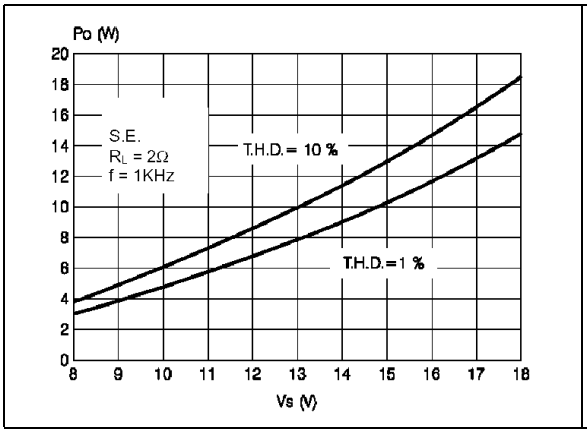


Figure 11. Output power vs. supply voltage (4Ω, S.E.)

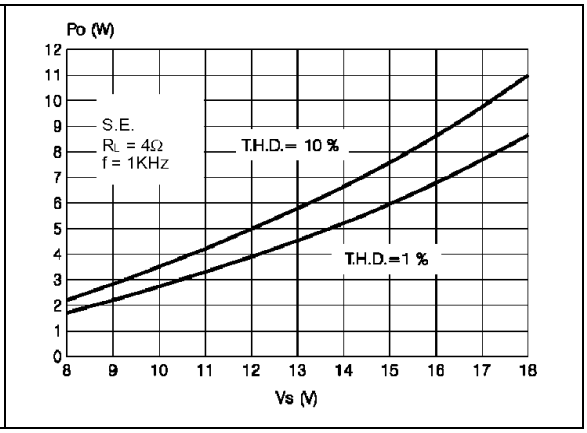


Figure 12. Output power vs. supply voltage (4Ω, BTL)

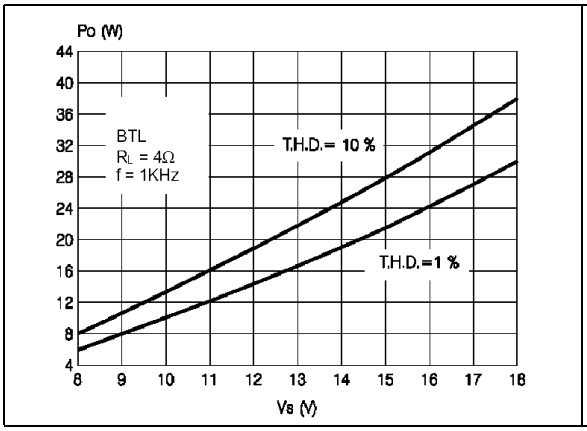


Figure 13. Distortion vs. output power (2Ω, S.E.)

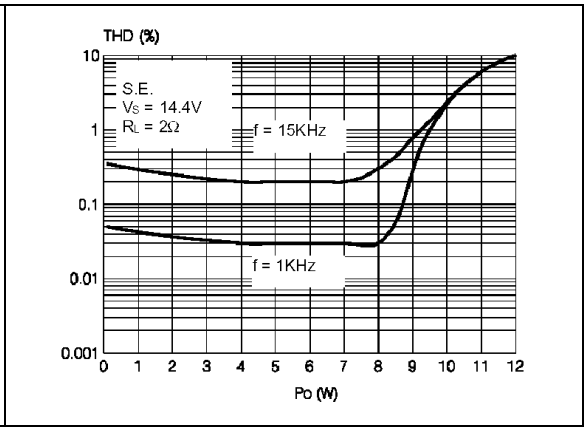


Figure 14. Distortion vs. output power (4Ω, S.E.)

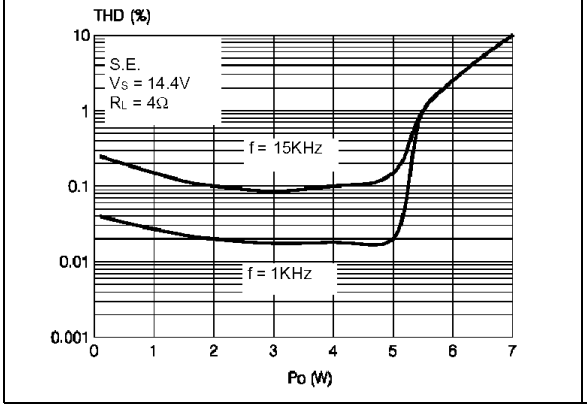


Figure 15. Distortion vs. output power (4Ω, BTL)

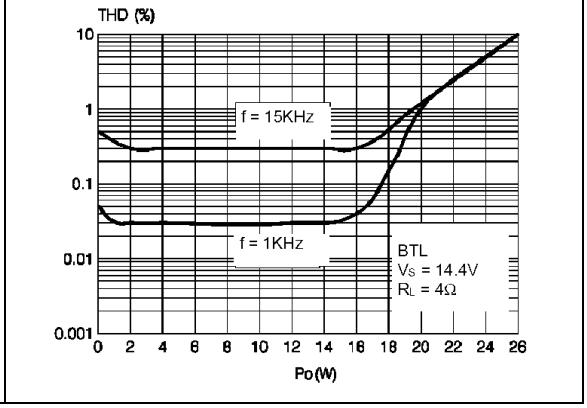


Figure 16. Crosstalk vs. frequency

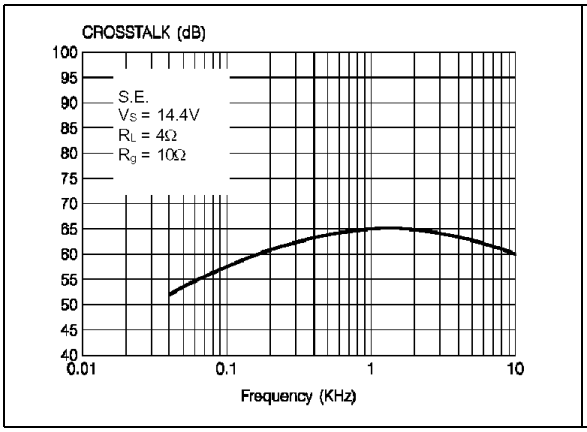


Figure 17. Supply voltage rejection vs. frequency (BTL)

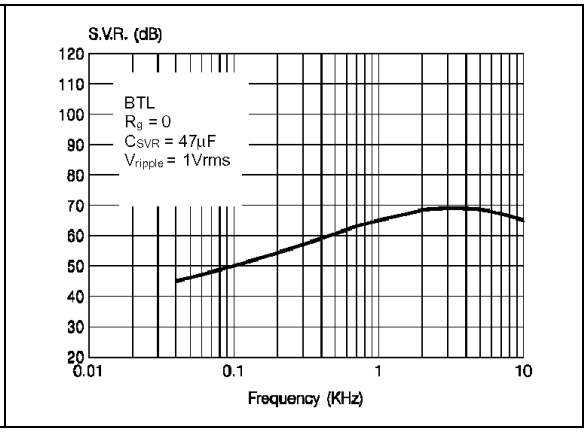


Figure 18. Supply voltage rejection vs. frequency (S.E.)

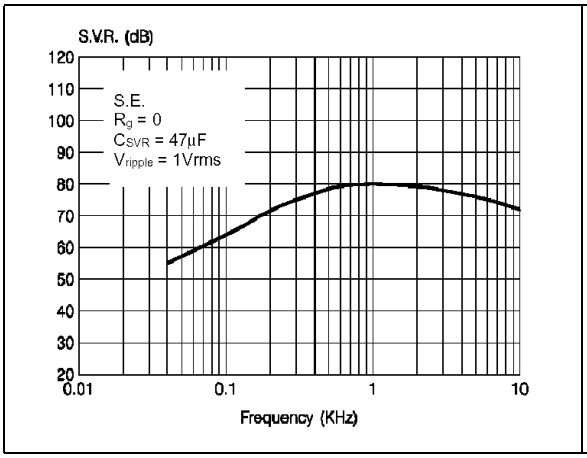


Figure 19. Standby attenuation vs. threshold voltage

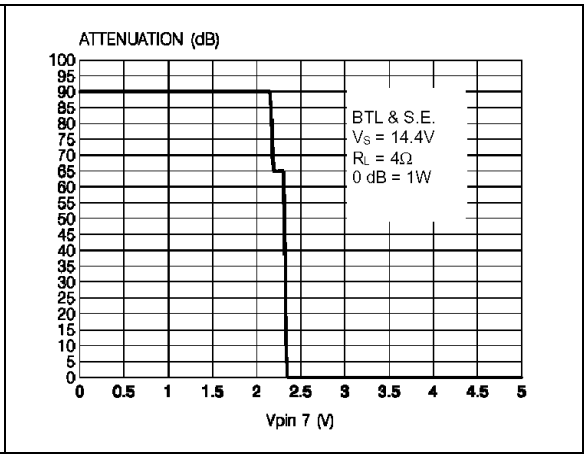


Figure 20. Total power dissipation and efficiency vs. output power (S.E.)

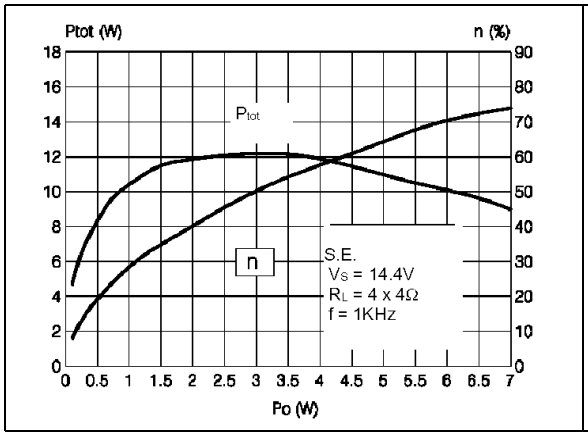
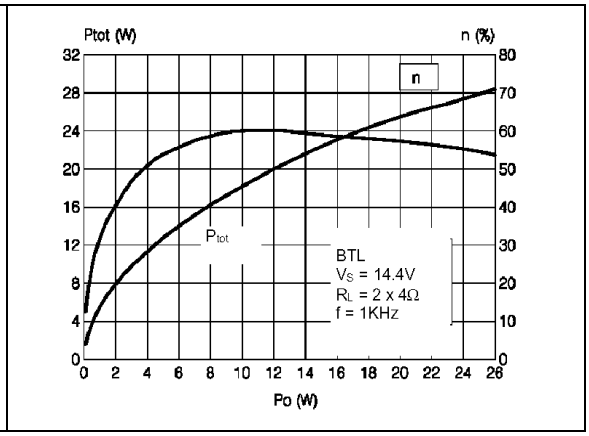


Figure 21. Total power dissipation and efficiency vs. output power (BTL)



4 Functional description

4.1 High application flexibility

The availability of 4 independent channels makes it possible to accomplish several kinds of applications ranging from 4 speakers stereo (F/R) to 2 speakers bridge solutions.

In case of working in single ended conditions the polarity of the speakers driven by the inverting amplifier must be reversed respect to those driven by non inverting channels. This is to avoid phase inconveniences causing sound alterations especially during the reproduction of low frequencies.

4.2 Easy single ended to bridge transition

The change from single ended to bridge configurations is made simply by means of a short circuit across the inputs, that is no need of further external components.

4.3 Gain internally fixed to 20dB in single ended, 26dB in bridge

Advantages of this design choice are in terms of:

- components and space saving
- output noise, supply voltage rejection and distortion optimization

4.4 Silent turn on/off and muting/standby function

The standby can be easily activated by means of a CMOS level applied to pin 7 through a RC filter.

Under stand-by condition the device is turned off completely (supply current = 1μA typ.; output attenuation = 80dB min.). Every ON/OFF operation is virtually pop free. Furthermore, at turn-on the device stays in muting condition for a time determined by the value assigned to the SVR capacitor.

While in muting the device outputs becomes insensitive to any kinds of signal that may be present at the input terminals. In other words every transient coming from previous stages produces no unpleasant acoustic effect to the speakers.

4.5 Output stage

The fully complementary output stage was made possible by the development of a new component: the ST exclusive power ICV PNP.

A novel design based upon the connection shown in *Figure 22* has then allowed the full exploitation of its possibilities. The clear advantages this new approach has over classical output stages are as follows:

4.5.1 Rail-to-rail output voltage swing with no need of bootstrap capacitors

The output swing is limited only by the V_{CEsat} of the output transistors, which is in the range of 0.3Ω (R_{sat}) each. Classical solutions adopting composite PNP-NPN for the upper output stage have higher saturation loss on the top side of the waveform.

This unbalanced saturation causes a significant power reduction. The only way to recover power consists of the addition of expensive bootstrap capacitors.

4.5.2 Absolute stability without any external compensation

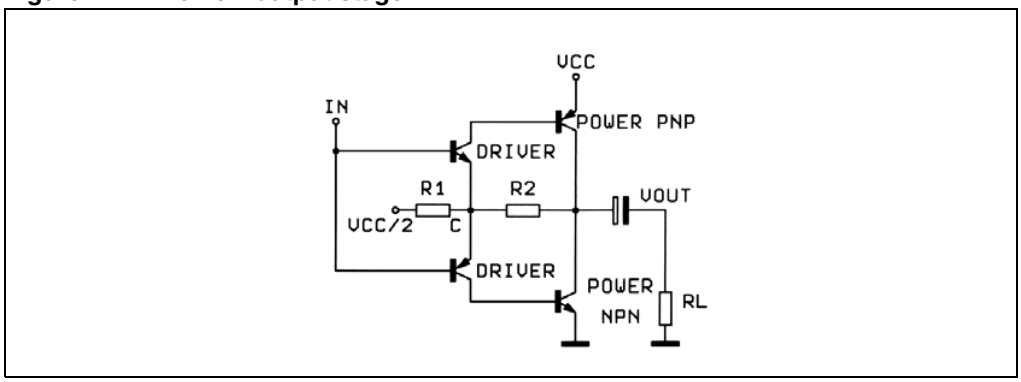
Referring to the circuit of *Figure 22* the gain V_{Out}/V_{In} is greater than unity, approximately 1+R2/R1. The DC output ($V_{CC}/2$) is fixed by an auxiliary amplifier common to all the channels.

By controlling the amount of this local feedback it is possible to force the loop gain (A*β) to less than unity at frequency for which the phase shift is 180°. This means that the output buffer is intrinsically stable and not prone to oscillation.

Most remarkably, the above feature has been achieved in spite of the very low closed loop gain of the amplifier. In contrast, with the classical PNP-NPN stage, the solution adopted for reducing the gain at high frequencies makes use of external RC networks, namely the Boucherot cells.

4.6 Built–in short circuit protection

Figure 22. The new output stage



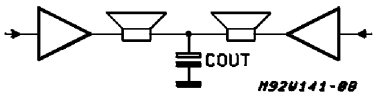
Reliable and safe operation, in presence of all kinds of short circuit involving the outputs is assured by BUILT-IN protectors. Additionally to the AC/DC short circuit to GND, to V_S, across the speaker, a SOFT SHORT condition is signalled out during the TURN-ON PHASE so assuring correct operation for the device itself and for the loudspeaker.

This particular kind of protection acts in a way to avoid that the device is turned on (by Standby) when a resistive path (less than 16 ohms) is present between the output and GND. As the involved circuitry is normally disabled when a current higher than 5mA is flowing into the ST-BY pin, it is important, in order not to disable it, to have the external current source driving the ST-BY pin limited to 5mA.

This extra function becomes particularly attractive when, in the single ended configuration, one capacitor is shared between two outputs (see *Figure 23*). Supposing that the output

capacitor C_{out} for any reason is shorted, the loudspeaker will not be damaged being this soft short circuit condition revealed.

Figure 23. Single ended configuration



4.6.1 Diagnostics facility

The TDA7375AV is equipped with a diagnostic circuitry able to detect the following events:

- Clipping in the output signal
- Thermal shutdown
- Output fault
  - short to GND
  - short to V_S
  - soft short at turn on

The information is available across an open collector output (pin 10) through a current sinking when the event is detected A current sinking at pin 10 is triggered when a certain distortion level is reached at any of the outputs. This function allows gain compression possibility whenever the amplifier is over driven.

4.6.2 Thermal shutdown

In this case the output 10 will signal the proximity of the junction temperature to the shutdown threshold. Typically current sinking at pin 10 will start ~10°C before the shutdown threshold is reached.

Figure 24. Clipping detection waveforms

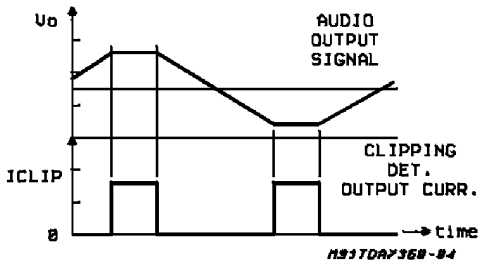


Figure 25. Output fault waveforms (see *Figure 26*)

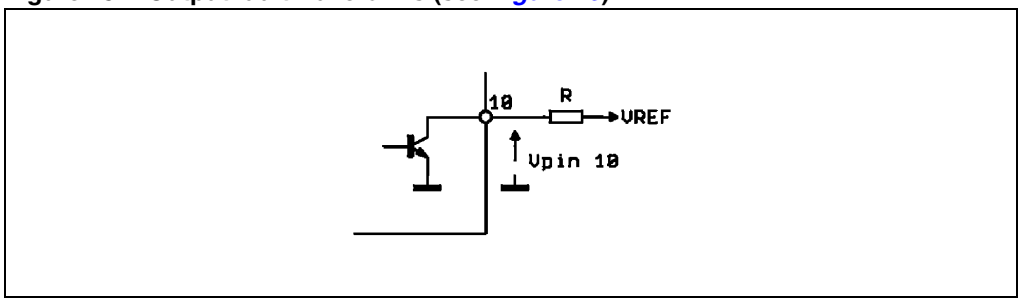
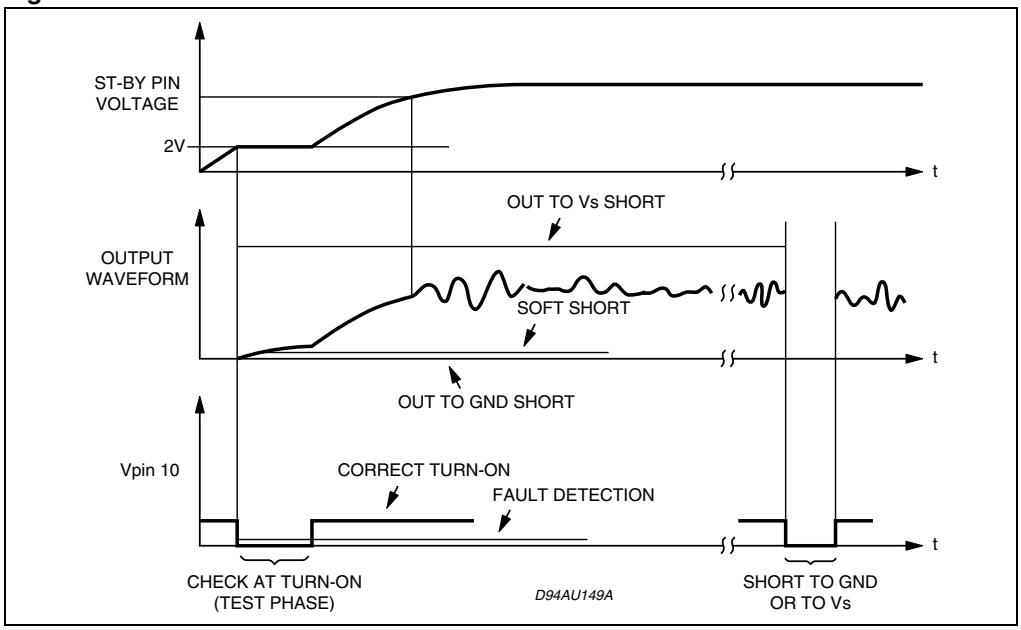


Figure 26. Fault waveforms



4.7 Handling of the diagnostics information

As various kinds of information is available at the same pin (clipping detection, output fault, thermal proximity), this signal must be handled properly in order to discriminate each event.

This could be done by taking into account the different timing of the diagnostic output during each case.

Normally the clip detector signalling produces a low level at pin 10 that is shorter referred to every kind of fault detection; based on this assumption an interface circuitry to differentiate the information is represented in the following schematic.

Figure 27. Waveforms

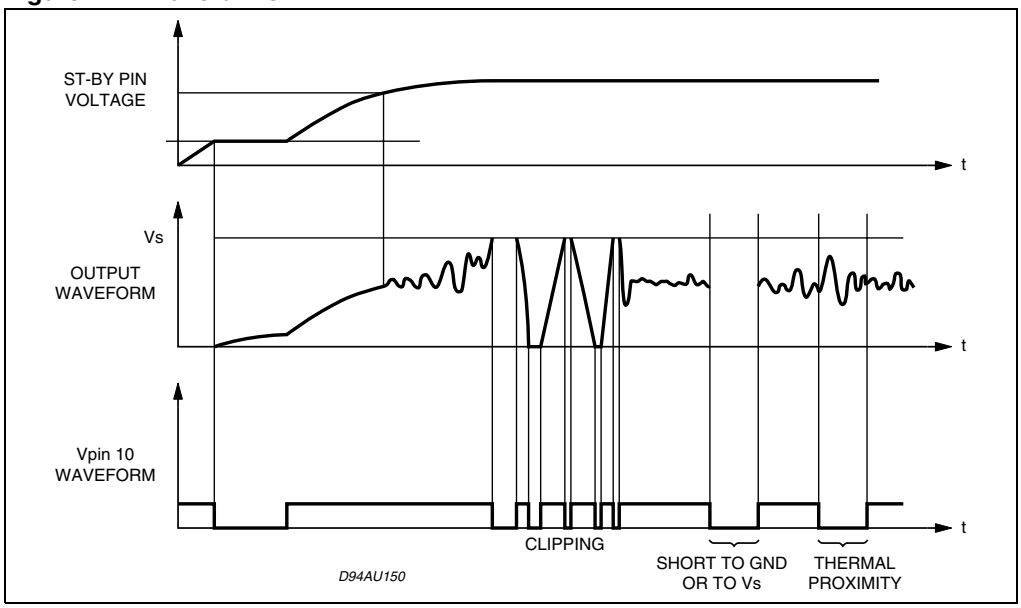
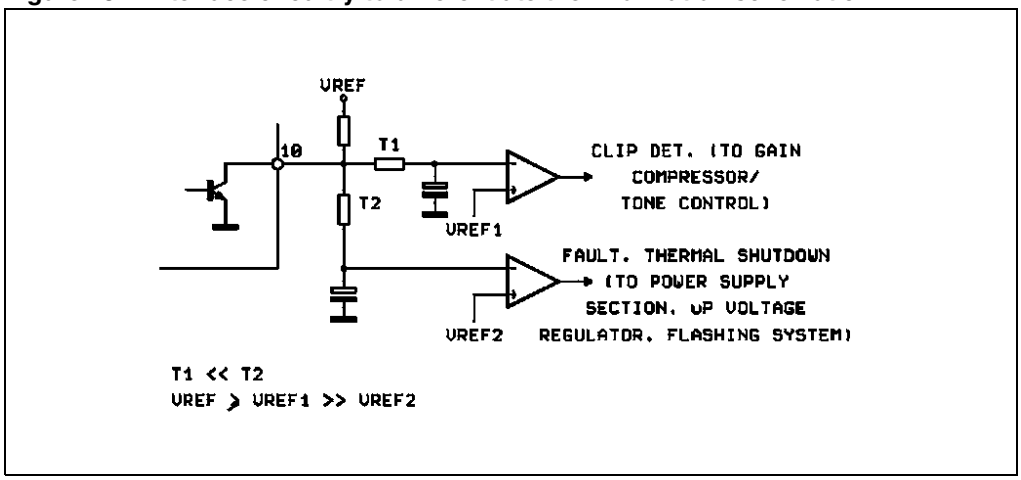


Figure 28. Interface circuitry to differentiate the information schematic



5 Package information

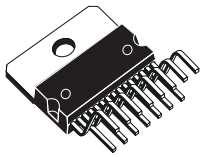
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*.

ECOPACK® is an ST trademark.

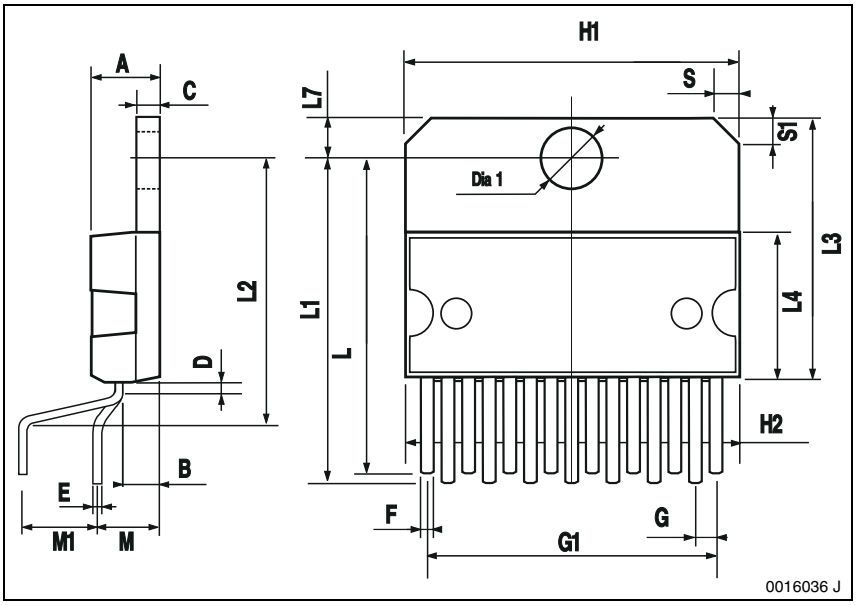
Figure 29. Multiwatt 15 mechanical data and package dimensions

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A5						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)



6 Revision history

Table 5. Document revision history

Date	Revision	Changes
24-Jul-2008	1	Initial release.
15-Mar-2005	2	Removed the package Multiwatt 15 horizontal.
05-Dec-2008	3	Document reformatted. Updated *Section 5: Package information*.

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