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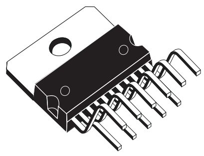
TDA2004R

10 + 10 W stereo amplifier for car radio

Features

- Low distortion
- Low noise
- Protection against:
  - Output AC short circuit to ground
  - Overrating chip temperature
  - Load dump voltage surge
  - Fortuitous open ground
  - Very inductive loads



Multiwatt11

Description

The TDA2004R is a class B dual audio power amplifier in Multiwatt11 package specifically designed for car radio applications.

Power booster amplifiers can be easily designed using this device that provides a high current capability (up to 3.5 A) and can drive very low impedance loads (down to 1.6 Ω).

The TDA2004R allows very compact applications because few external components are required and it doesn't need electrical insulation between the package and the heatsink.

Table 1. Device summary

Order code	Package	Packing
TDA2004R	Multiwatt11	Tube

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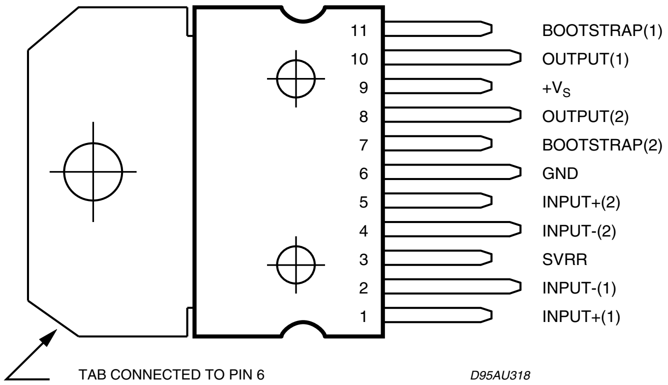
1 Pins description

Figure 1. Pins connection diagram (top view)



2 Electrical specifications

2.1 Absolute maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_S	Operating supply voltage	18	V
	DC supply voltage	28	
	Peak supply voltage (50 ms)	40	
Io[1]	Output peak current (non repetitive t = 0.1 ms)	4.5	A
	Output peak current (repetitive f ≥10 Hz)	3.5	
P_{tot}	Power dissipation at T_{case} = 60 °C	30	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	°C

1. The max. output current is internally limited.

2.2 Thermal data

Table 3. Thermal data

Symbol	Parameter		Value	Unit
$R_{th\text{-}j\text{-}case}$	Thermal resistance junction-to-case	max	3	°C/W

2.3 Electrical characteristics

Refer to the stereo application circuit T_{amb} = 25 °C; G_v = 50 dB; $R_{th(heatsink)}$ = 4 °C/W unless otherwise specified

Table 4. Electrical characteristics

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_S	Supply voltage		8		18	V
V_o	Quiescent offset voltage	V_S = 14.4 V V_S = 13.2 V	6.6 6	7.2 6.6	7.8 7.2	V V
I_d	Total quiescent drain current	V_S = 14.4 V V_S = 13.2 V	-	65 62	120 120	mA mA
P_o	Output power (each channel)	f = 1 kHz; THD = 10 % V_S = 14.4 V; R_L = 4 Ω V_S = 14.4 V; R_L = 3.2 Ω V_S = 14.4 V; R_L = 2 Ω V_S = 14.4 V; R_L = 1.6 Ω	 6 7 9 10	 6.5 8 10 11	-	W

Table 4. Electrical characteristics (continued)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
P_o	Output power (each channel)	f = 1 kHz; THD = 10 % V_S = 13.2 V; R_L =3.2 Ω V_S = 13.2 V; R_L = 1.6 Ω V_S = 16 V; R_L = 2 Ω	6 9	6.5 10(1) 12	-	W
THD	Total harmonic distortion	f = 1 kHz; V_S = 14.4 V; R_L = 4 Ω; P_o = 50 mW to 4 W;	-	0.2	1	%
		f = 1 kHz; V_S = 14.4 V; R_L = 2 Ω; P_o = 50 mW to 6 W;	-	0.3	1	%
		f = 1 kHz; V_S = 13.2 V; R_L = 3.2 Ω; P_o = 50 mW to 3W;	-	0.2	1	%
		f = 1KHz; V_S = 13.2V; R_L = 1.6Ω; P_o = 40mW to 6W;	-	0.3	1	%
CT	Cross talk	V_S = 14.4 V; V_o = 4 V_{RMS}; R_g = 5 kΩ; R_L = 4 Ω; f = 1 kHz f = 10 kHz	50 40	60 45	-	mW mW
V_i	Input saturation voltage	-	300		-	mW
R_i	Input resistance	f = 1 kHz	70	200	-	kΩ
f_L	Low frequency roll off (-3 dB)	R_L = 4 Ω R_L = 2 Ω R_L = 3.2 Ω R_L = 1.6 Ω	-	-	35 50 40 55	Hz
f_H	High frequency roll off (-3 dB)	R_L = 1.6 Ω to 4 Ω	15	-	-	kHz
G_v	Open loop voltage gain	f = 1 kHz	-	90	-	dB
	Closed loop voltage gain	f = 1 kHz	48	50	51	
ΔG_v	Closed loop gain matching	-	-	0.5	-	dB
e_N	Total input noise voltage	R_g = 10 kΩ(2)	-	1.5	5	μV
SVR	Supply voltage rejection	V_{ripple} = 0.5 Vrms; f_{ripple} =100 Hz; R_g = 10 kΩ; C_3 = 10 μF	35	45	-	dB
η	Efficiency	f = 1 kHz; V_S = 14.4 V; R_L = 4 Ω; P_o = 6.5 W; R_L = 2Ω; P_o = 10 W;	-	70 60	-	%
		f = 1 kHz; V_S = 13.2 V; R_L = 3.2 Ω; P_o = 6.5 W; R_L = 1.6 Ω; P_o = 10 W;	-	70 60	-	%
T_J	Thermal shutdown junction temperature	-	-	145	-	°C

1. 9.3 W without bootstrap.
2. Bandwidth filter: 22 Hz to 22 kHz.

2.4 Test and application circuit

Figure 2. Test and application circuit

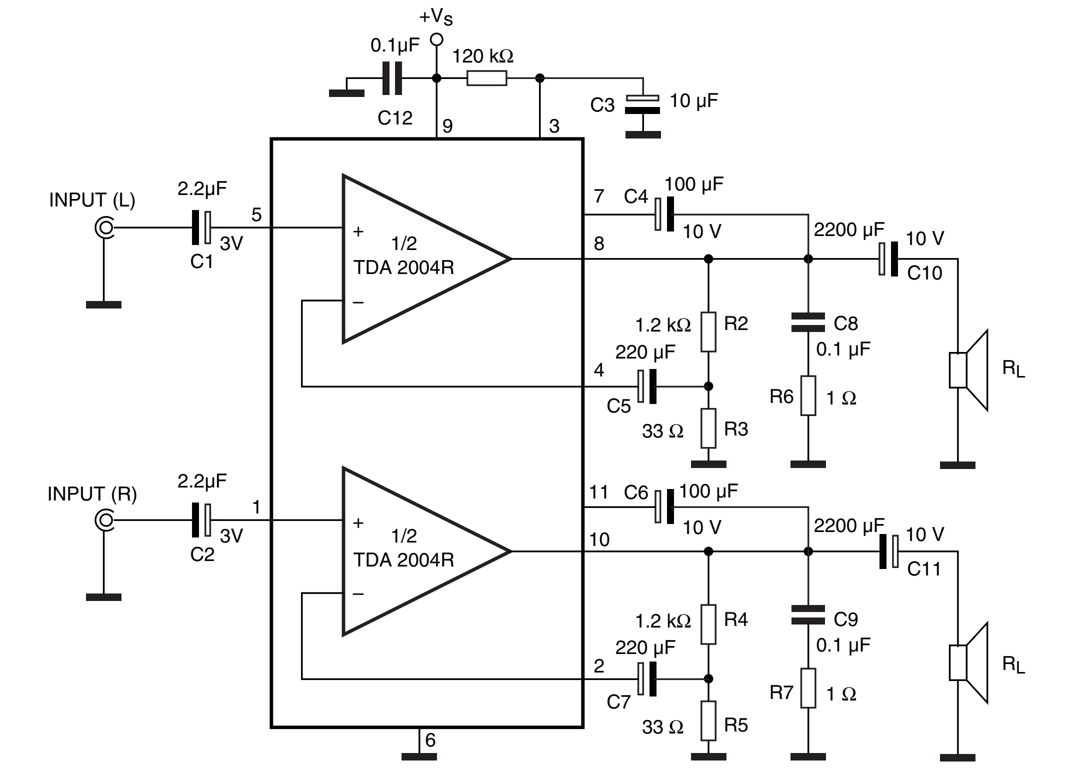
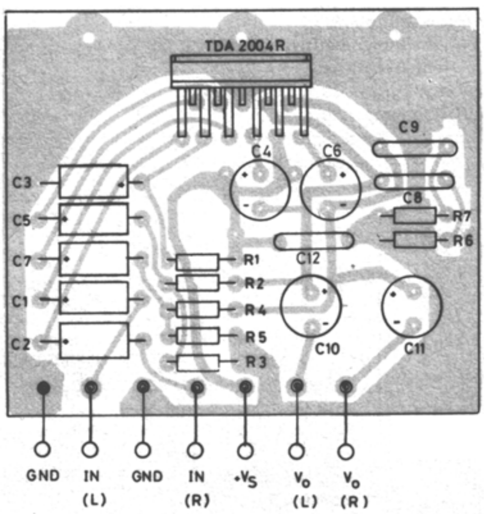


Figure 3. Printed circuit board and components layout of the figure 2



2.5 Electrical characteristics curves

Figure 4. Quiescent output voltage vs. supply voltage

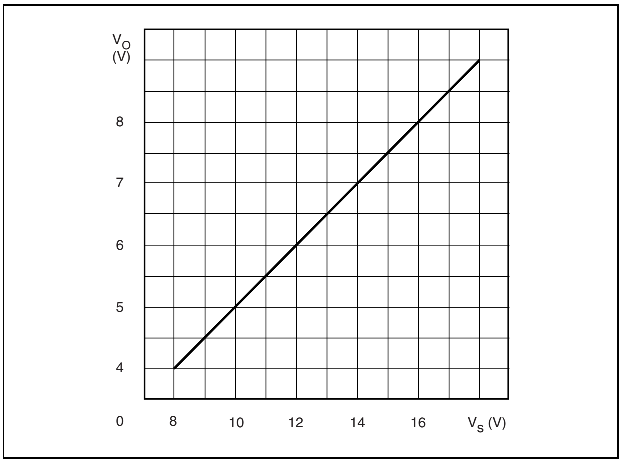


Figure 5. Quiescent drain current vs. supply voltage

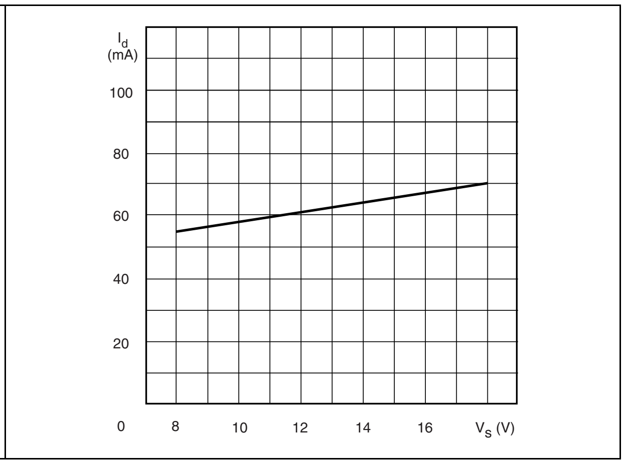


Figure 6. Distortion vs. output power

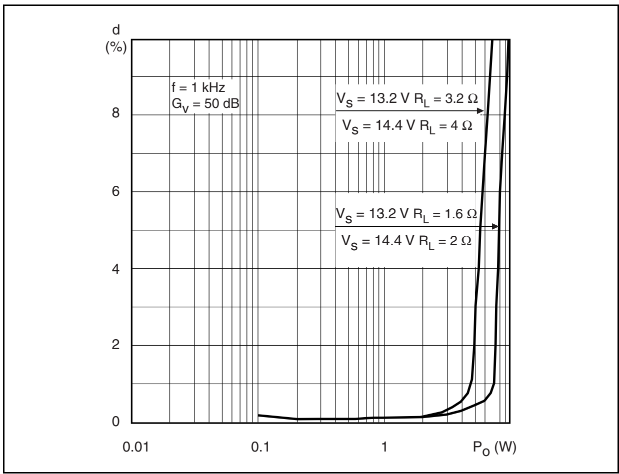


Figure 7. Output power vs. supply voltage, R_L = 2 and 4 Ω

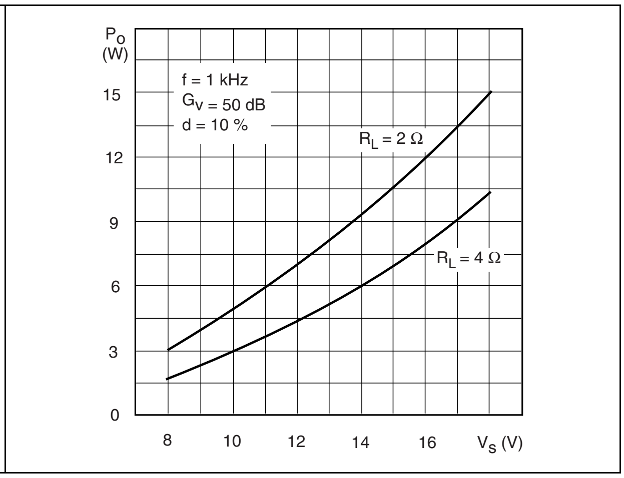


Figure 8. Output power vs. supply voltage, R_L = 1.6 and 3.2Ω

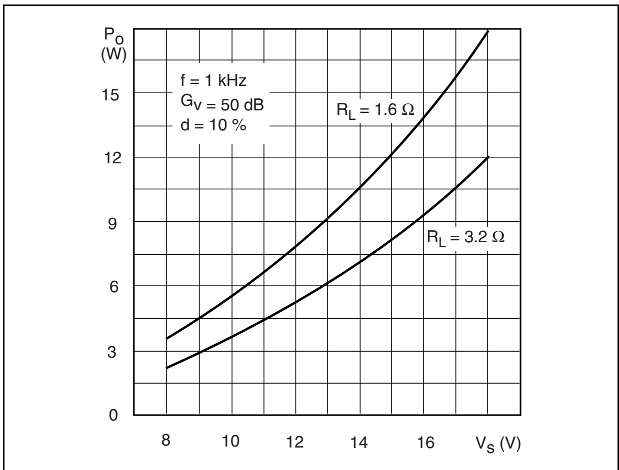


Figure 9. Distortion vs. frequency, R_L = 2 and 4 Ω

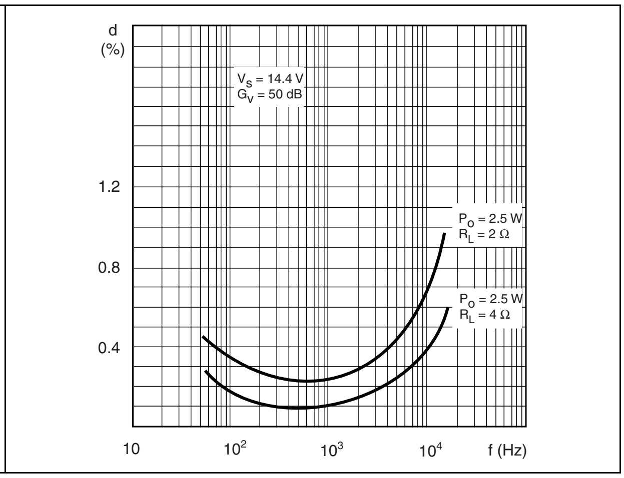


Figure 10. Distortion vs. frequency, R_L = 1.6 and 3.2 Ω

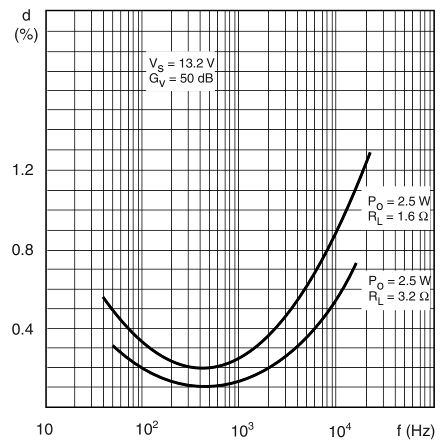


Figure 11. Supply voltage rejection vs. C3

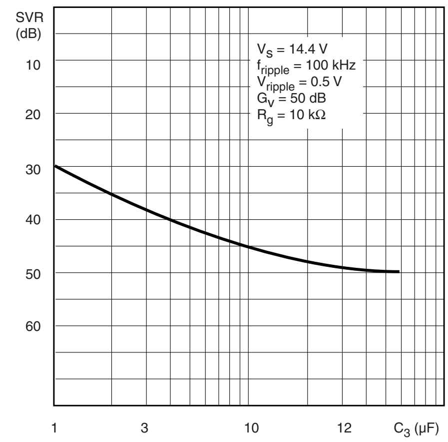


Figure 12. Supply voltage rejection vs. frequency

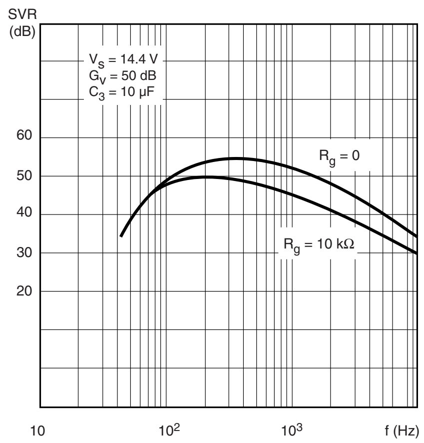


Figure 13. Supply voltage rejection vs. C2 and C3, G_V = 390/1Ω

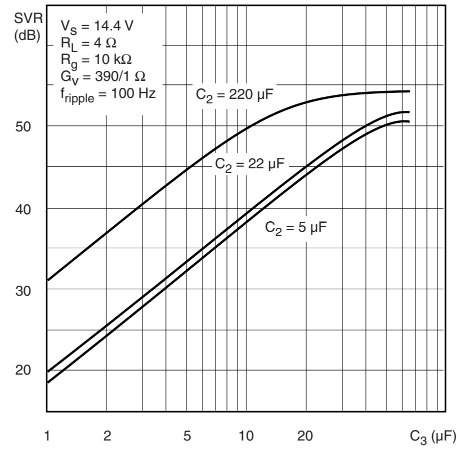


Figure 14. Supply voltage rejection vs. C2 and C3, G_V = 1000/10Ω

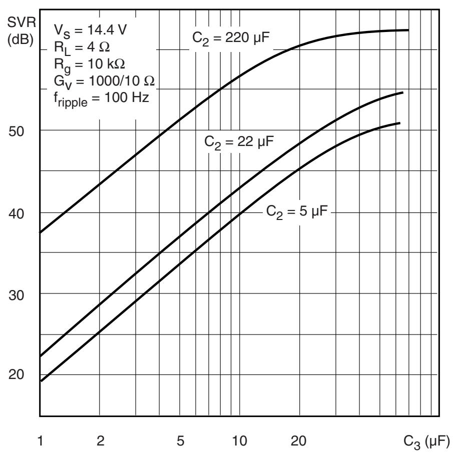


Figure 15. Gain vs. input sensitivity

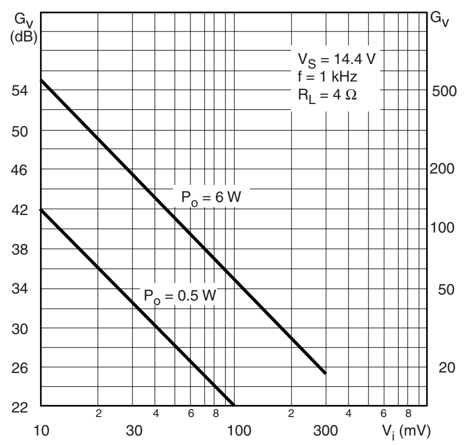


Figure 16. Total power dissipation and efficiency vs. output power (R_L = 2 Ω)

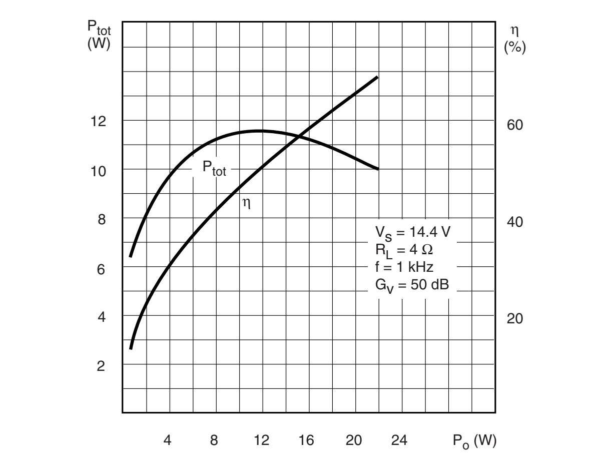


Figure 17. Total power dissipation and efficiency vs. output power (R_L = 3.2 Ω)

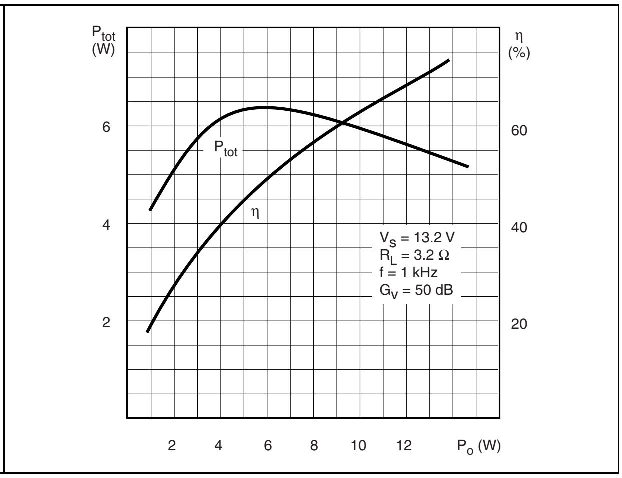
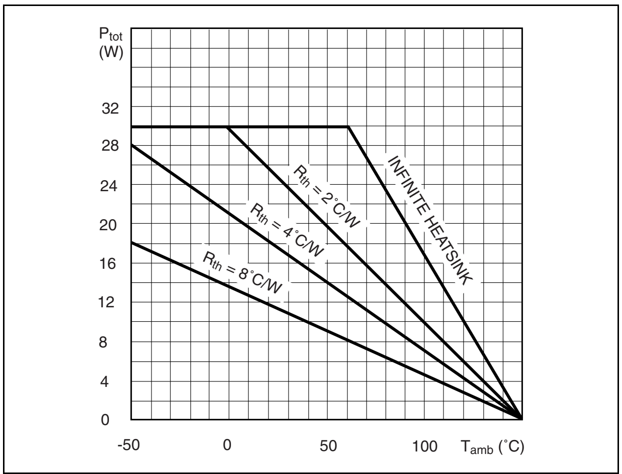


Figure 18. Maximum allowable power dissipation vs. ambient temperature



3 Application suggestion

The recommended values of the components are those shown on application circuit of *Figure 2*. Different values can be used; the following table can help the designer.

Table 5. Recommended values of the component of the application circuit

Component	Recommended value	Purpose	Larger than	Smaller than r
R1	120 kΩ	Optimization of the output signal symmetry	Smaller P_{omax}	Smaller P_{omax}
R2, R4	1 kΩ	Closed loop gain setting (1)	Increase of gain	Decrease of gain
R3, R5	3.3 Ω		Decrease of gain	Increase of gain
R6, R7	1 Ω	Frequency stability	Danger of oscillation at high frequency with inductive load	
C1, C2	2.2 µF	Input DC decoupling	High turn-on delay	High turn-on pop, higher low frequency cutoff. Increase of noise
C3	10 µF	Ripple rejection	Increase of SVR, Increase of the switch-on time	Degradation of SVR
C4, C6	100 µF	Bootstrapping	-	Increase of distortion at low frequency
C5, C7	100 µF	Feedback input DC decoupling	-	-
C8, C9	0.1 µF	Frequency stability	-	Danger of oscillation
C10, C11	1000 to 2200 µF	Output DC decoupling	-	Higher low-frequency cut-off

1. The closed loop gain must be higher than 26 dB.

3.1 Built-in protection systems

3.1.1 Load dump voltage surge

The TDA2004R has a circuit which enables it to withstand voltage pulse train, on Pin 9, of the type shown in *Figure 20*. If the supply voltage peaks to more than 40 V, then an LC filter must be inserted between the supply and pin 9, in order to assure that the pulses at pin 9 will be held within the limits shown.

A suggested LC network is shown in *Figure 19*. With this network, a train of pulses with amplitude up to 120 V and width of 2 ms can be applied at point A. This type of protection is ON when the supply voltage (pulse or DC) exceeds 18 V. For this reason the maximum operating supply voltage is 18 V.

Figure 19. Suggested LC network circuit

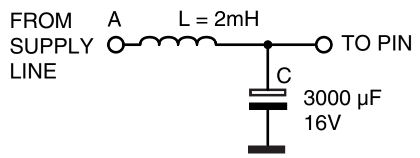
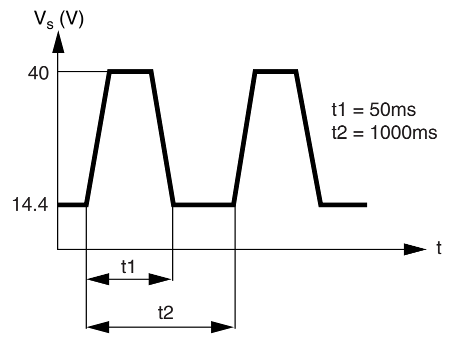


Figure 20. Voltage gain bridge configuration



3.1.2 Short circuit (AC condition)

The TDA2004R can withstand a permanent short-circuit from the output to ground caused by a wrong connection during normal working.

3.1.3 Polarity inversion

High current (up to 10 A) can be handled by the device with no damage for a longer period than the blow-out time of a quick 2 A fuse (normally connected in series with the supply). This feature is added to avoid destruction, if during fitting to the car, a mistake on the connection of the supply is made.

3.1.4 Open ground

When the ratio is in the ON condition and the ground is accidentally opened, a standard audio amplifier will be damaged. On the TDA2004R protection diodes are included to avoid any damage.

3.1.5 Inductive load

A protection diode is provided to allow use of the TDA2004R with inductive loads.

3.1.6 DC voltage

The maximum operating DC voltage for the TDA2004R is 18 V. However the device can withstand a DC voltage up to 28 V with no damage. This could occur during winter if two batteries are series connected to crank the engine.

3.1.7 Thermal shut-down

The presence of a thermal limiting circuit offers the following advantages:

1. an overload on the output (even if it is permanent), or an excessive ambient temperature can be easily withstood.
2. the heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no device damage in the case of excessive junction temperature: all that happens is that P_o (and therefore P_{tot}) and I_d are reduced.

The maximum allowable power dissipation depends upon the size of the external heatsink (i.e. its thermal resistance); *Figure 18* shows the power dissipation as a function of ambient temperature for different thermal resistance.

4 Package information

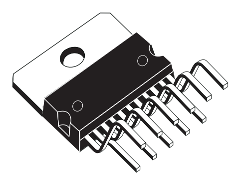
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*.

ECOPACK® is an ST trademark.

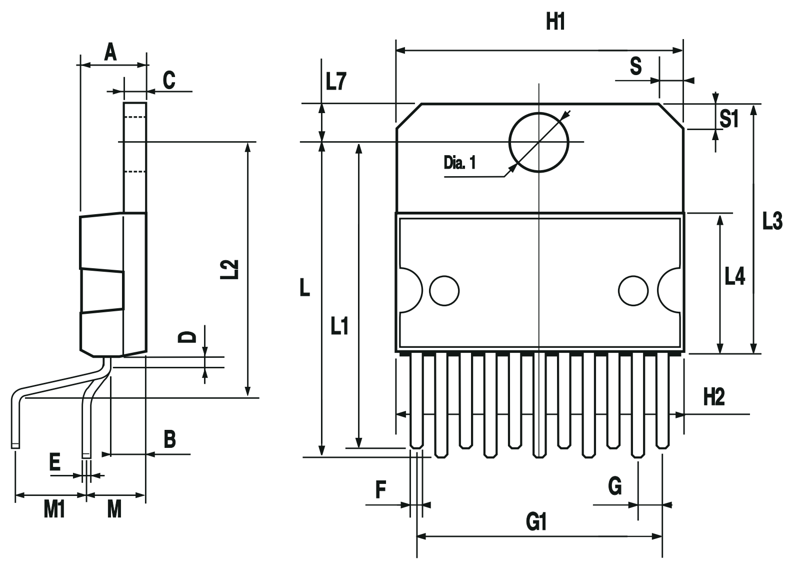
Figure 21. Multiwatt11 mechanical data and package dimensions

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	0.88		0.95	0.035		0.037
G	1.45	1.7	1.95	0.057	0.067	0.077
G1	16.75	17	17.25	0.659	0.669	0.679
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	17.4		18.1	0.685		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



Multiwatt11 (Vertical)



5 Revision history

Table 6. Document revision history

Date	Revision	Changes
18-Jun-2010	1	Initial release.
18-Sep-2013	2	Updated Disclaimer.