TDA2004

LINEAR INTEGRATED CIRCUIT

10 + 10W STEREO AMPLIFIER FOR CAR RADIO

The TDA 2004 is a class B dual audio power amplifier in MULTIWATT® package specifically designed for car radio applications: stereo amplifiers are easily designed using this device that provides a high current capability (up to 3.5A) and that can drive very low impedance loads (down to 1.6Ω).
Its main features are:

Low distortion.
Low noise.
High reliability of the chip and of the package with additional complete safety during operation thanks to protections against:
- output AC short circuit to ground
- very inductive loads
- overrating chip temperature
- load dump voltage surge
- fortuitous open ground
- polarity inversion

Space and cost saving: very low number of external components, very simple mounting system with no electrical isolation between the package and the heatsink (one screw only).

ABSOLUTE MAXIMUM RATINGS

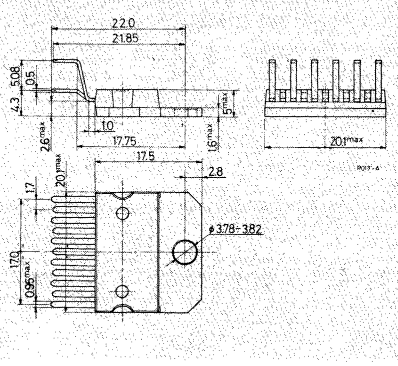
V_s	Operating supply voltage	18	V
V_s	DC supply voltage	28	V
V_s	Peak supply voltage (for 50 ms)	40	V
I_o (*)	Output peak current (non repetitive t = 0.1 ms)	4.5	A
I_o (*)	Output peak current (repetitive f ≥ 10 Hz)	3.5	A
P_{tot}	Power dissipation at T_{case} = 60 °C	30	W
T_j, T_{stg}	Storage and junction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

(*) The max. output current is internally limited.

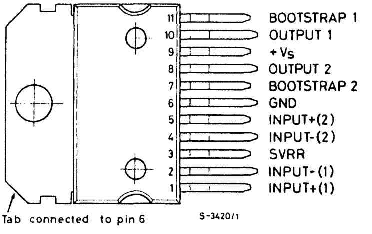
ORDERING NUMBER: TDA 2004

MECHANICAL DATA

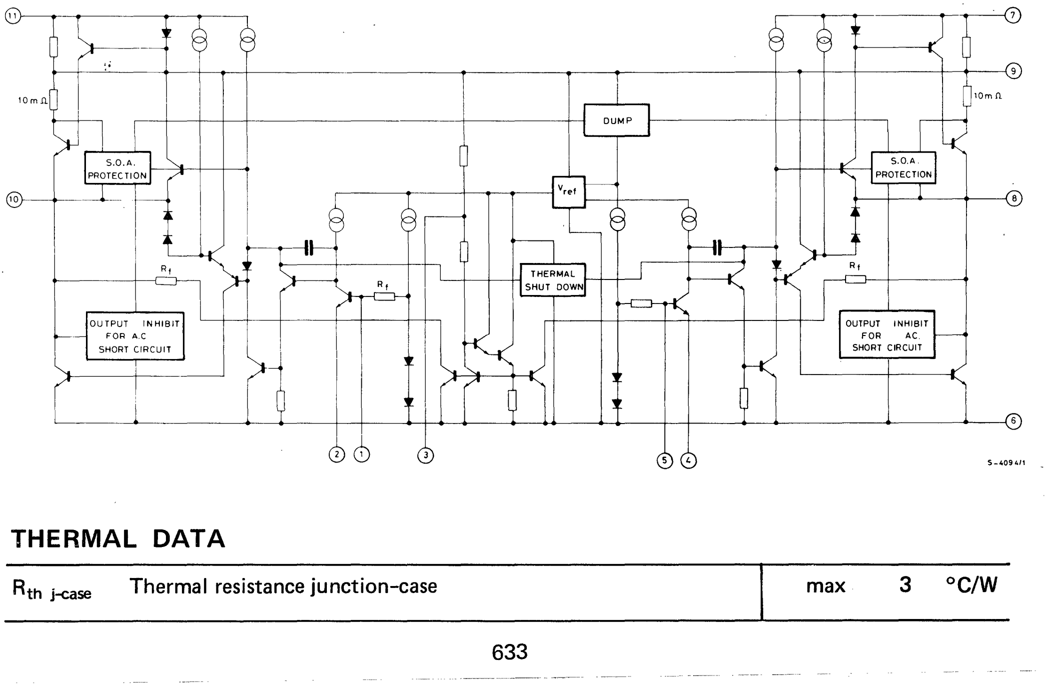
Dimensions in mm



CONNECTION DIAGRAM
(top view)



SCHEMATIC DIAGRAM



THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	3	°C/W

Fig. 1 - Test and application circuit

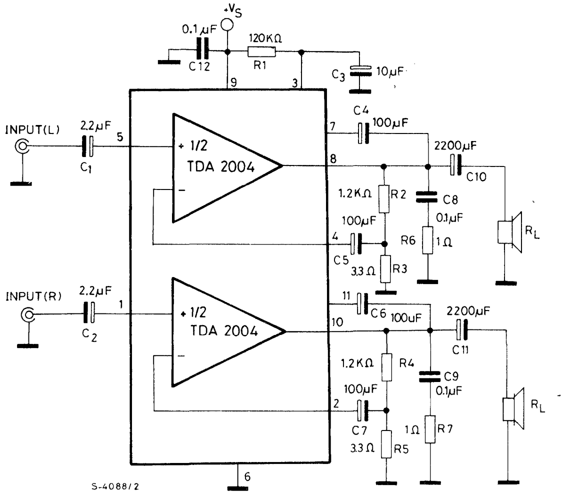
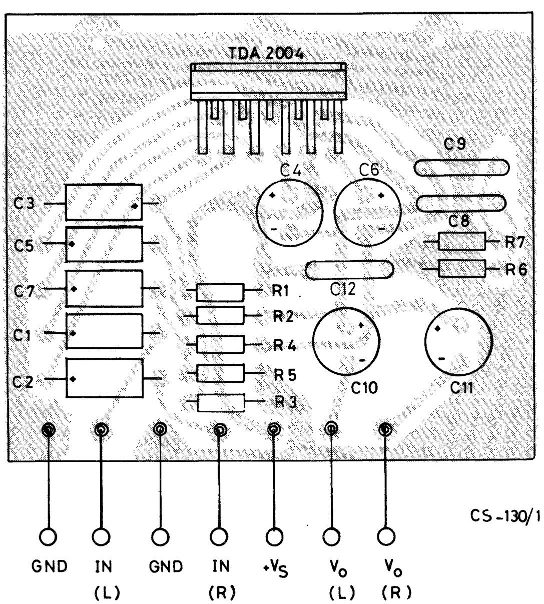


Fig. 2 - PC board and components layout (scale 1:1)



ELECTRICAL CHARACTERISTICS (Refer to the test circuit, T_{amb} = 25°C, G_v = 50 dB, $R_{th\ (heatsink)}$ = 4°C/W, unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_s	Supply voltage		8		18	V
V_o	Quiescent output voltage	V_s = 14.4V V_s = 13.2V	6.6 5.0	7.2 6.6	7.8 7.2	V V
I_d	Total quiescent drain current	V_s = 14.4V V_s = 13.2V		65 62	120 120	mA mA
I_{SB}	Stand-by current	Pin 3 grounded		5		mA
P_o	Output power (each channel)	f = 1 KHz d = 10% V_s = 14.4V R_L = 4Ω R_L = 3.2Ω R_L = 2Ω R_L = 1.6Ω V_s = 13.2V R_L = 3.2Ω R_L = 1.6Ω V_s = 16V R_L = 2 Ω	 6 7 9 10 6 9 	 6.5 8 10(*) 11 6.5 10 12		 W W W W W W W
d	Distortion (each channel)	f = 1 KHz V_s = 14.4V R_L = 4Ω P_o = 50 mW to 4W V_s = 14.4V R_L = 2Ω P_o = 50 mW to 6W V_s = 13.2V R_L = 3.2Ω P_o = 50 mW to 3W V_s = 13.2V R_L = 1.6Ω P_o = 50 mW to 6W		 0.2 0.3 0.2 0.3	 1 1 1 1	 % % % %
CT	Cross talk	V_s = 14.4V V_o = 4 V_{rms} R_L = 4Ω f = 1 KHz f = 10 KHz	 50 40	 60 45		 dB dB
V_i	Input sensitivity	f = 1 KHz P_o = 1W R_L = 4Ω R_L = 3.2Ω		 6 5.5		 mV mV
V_i	Input saturation voltage		300			mV
R_i	Input resistance (non inverting input)	f = 1 KHz	70	200		KΩ
R_i	Input resistance (inverting input)	f = 1 KHz		10		KΩ
f_L	Low frequency roll off (-3 dB)	R_L = 4Ω R_L = 2Ω R_L = 3.2Ω R_L = 1.6Ω			35 50 40 55	Hz Hz Hz Hz
f_H	High frequency roll off (-3 dB)	R_L = 4Ω R_L = 2Ω R_L = 3.2Ω R_L = 1.6Ω	15 15 15 15			KHz KHz KHz KHz

ELECTRICAL CHARACTERISTICS (continued)

Parameters		Test conditions	Min.	Typ.	Max.	Unit
G_v	Voltage gain (open loop)	f = 1 KHz		90		dB
G_v	Voltage gain (closed loop)	f = 1 KHz	48	50	51	dB
	Closed loop gain matching			0.5		dB
e_N	Total input noise voltage	R_g= 10 KΩ(°)		1.5	5	μV
SVR	Supply voltage rejection	f_{ripple}= 100 Hz R_g= 10 KΩ C_3= 10 μF V_{ripple}=0.5V_{rms}	35	45		dB
η	Efficiency	V_s = 14.4V f = 1 KHz R_L= 4Ω P_o= 6.5W R_L= 2Ω P_o= 10W V_s = 13.2V f = 1 KHz R_L= 3.2Ω P_o= 6.5W R_L= 1.6Ω P_o= 10W		 70 60 70 60		 % % % %
T_{sd}	Thermal shut down case temperature	V_s = 14.4V R_L= 4Ω f = 1 KHz P_{tot}= 5.5W	125	135		°C

(*) 9.3W without bootstrap.
(°) Bandwidth filter: 22 Hz to 22 KHz.

Fig. 3 - Quiescent output voltage vs. supply voltage

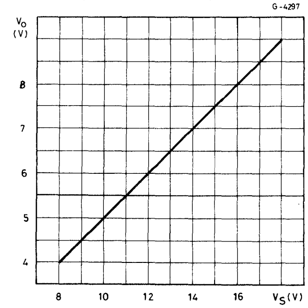


Fig. 4 - Quiescent drain current vs. supply voltage

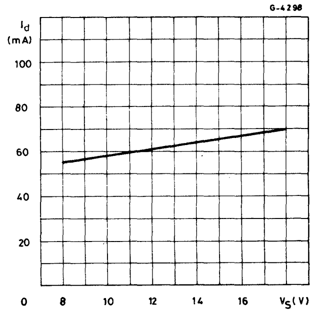


Fig. 5 - Distortion vs. output power

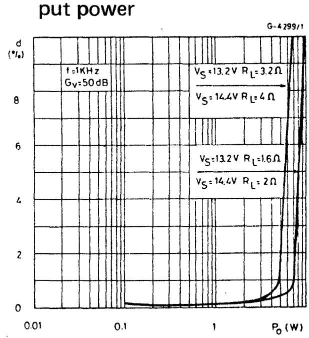


Fig. 6 - Output power vs. supply voltage

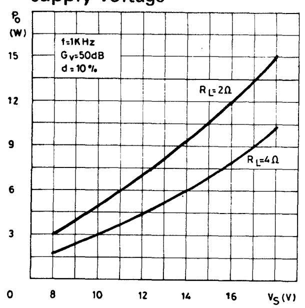


Fig. 7 - Output power vs. supply voltage

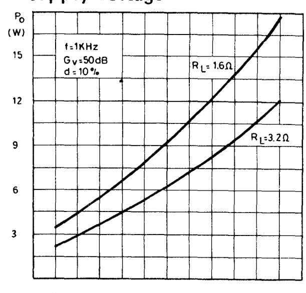


Fig. 8 - Distortion vs. frequency

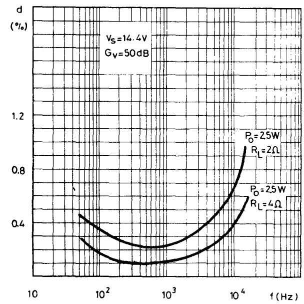


Fig. 9 - Distortion vs. frequency

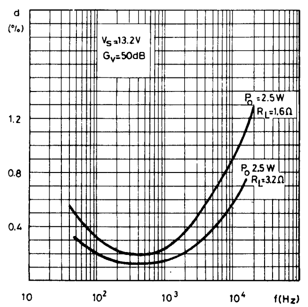


Fig. 10 - Supply voltage rejection vs. C_3

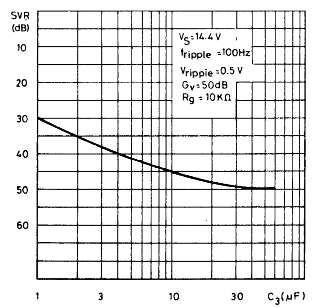


Fig. 11 - Supply voltage rejection vs. frequency

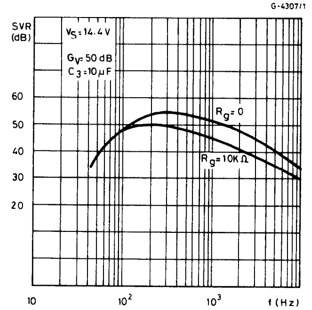


Fig. 12 - Supply voltage rejection vs. values of capacitors C_2 and C_3

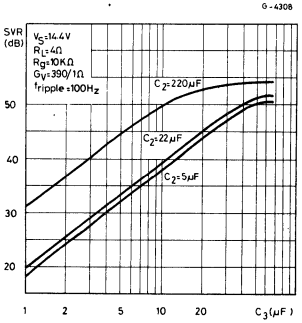


Fig. 13 - Supply voltage rejection vs. values of capacitors C_2 and C_3

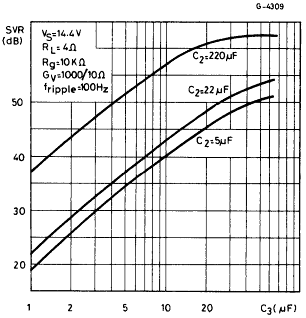


Fig. 14 - Gain vs. input sensitivity

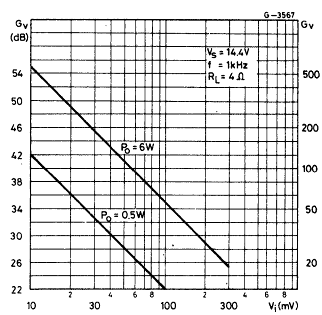


Fig. 15 - Gain vs. input sensitivity

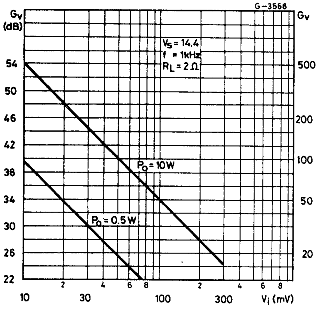


Fig. 16 - Total power dissipation and efficiency vs. output power

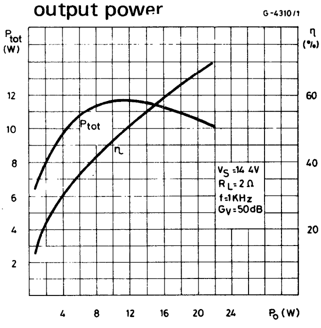
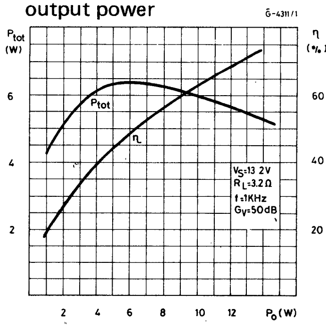


Fig. 17 - Total power dissipation and efficiency vs. output power



APPLICATION SUGGESTION

The recommended values of the components are those shown on application circuit of fig. 1. Different values can be used; the following table can help the designer.

Component	Recomm. value	Purpose	Larger than	Smaller than
R_1	120 KΩ	Optimisation of the output signal simmetry	Smaller $P_{o\ max}$	Smaller $P_{o\ max}$
R_2 and R_4	1 KΩ	Close loop gain setting	Increase of gain	Decrease of gain
R_3 and R_5	3.3 Ω		Decrease of gain	Increase of gain
R_6 and R_7	1 Ω	Frequency stability	Danger of oscillation at high frequency with inductive load	
C_1 and C_2	2.2 μF	Input DC decoupling	High turn-on delay	High turn-on pop Higher low frequency cutoff. Increase of noise.
C_3	10 μF	Ripple rejection	Increase of SVR. Increase of the switch-on time.	Degradation of SVR.
C_4 and C_6	100 μF	Bootstrapping		Increase of distortion at low frequency.
C_5 and C_7	100 μF	Feedback Input DC decoupling.		
C_8 and C_9	0.1 μF	Frequency stability.		Danger of oscillation.
C_{10} and C_{11}	1000 μF to 2200 μF	Output DC decoupling.		Higher low-frequency cut-off.

BUILT-IN PROTECTION SYSTEMS

Load dump voltage surge

The TDA 2004 has a circuit which enables it to withstand a voltage pulse train, on pin 9, of the type shown in fig. 19.
If the supply voltage peaks to more than 40V, 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 fig. 18. With this network, a train of pulses with amplitude up to 120V and width of 2 ms can be applied to point A. This type of protection is ON when the supply voltage (pulse or DC) exceeds 18V. For this reason the maximum operating supply voltage is 18V.

Fig. 18

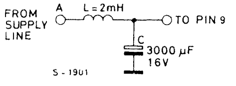
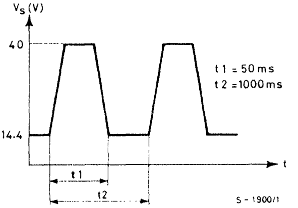


Fig. 19



Short circuit (AC conditions)

The TDA 2004 can withstand a permanent short-circuit on the output for a supply voltage up to 16V.

Polarity inversion

High current (up to 10A) can be handled by the device with no damage for a longer period than the blow-out time of a quick 2A 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.

Open ground

When the radio is the ON condition and the ground is accidentally opened, a standard audio amplifier will be damaged. On the TDA 2004 protection diodes are included to avoid any damage.

Inductive load

A protection diode is provided to allow use of the TDA 2004 with inductive loads.

DC voltage

The maximum operating DC voltage on the TDA 2004 is 18V.
However the device can withstand a DC voltage up to 28V with no damage. This could occur during winter if two batteries are series connected to crank the engine.

BUILD-IN PROTECTION SYSTEMS (continued)

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); fig. 20 shows this dissipable power as a function of ambient temperature for different thermal resistance.

Fig. 20 - Maximum allowable power dissipation vs. ambient temperature

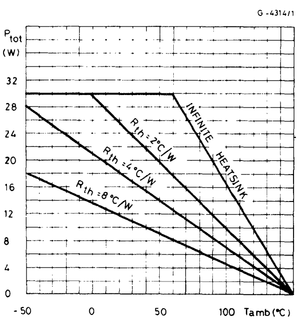


Fig. 21 - Output power and drain current vs. case temperature

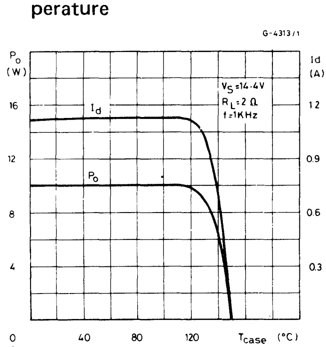
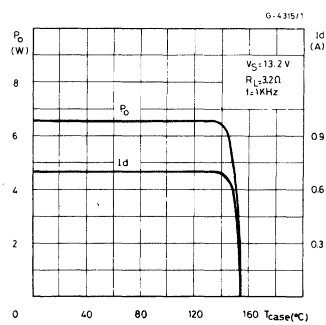


Fig. 22 - Output power and drain current vs. case temperature



MOUNTING INSTRUCTIONS

The power dissipated in the circuit must be removed by adding an external heatsink.
Thanks to the MULTIWATT® package attaching the heatsink is very simple, a screw or a compression spring (clip) being sufficient. Between the heatsink and the package it is better to insert a layer of silicon grease, to optimize the thermal contact; no electrical isolation is needed between the two surfaces.

MOUNTING INSTRUCTIONS (continued)

Fig. 23 – Mounting examples