

PRELIMINARY DATA

12 W Hi-Fi AUDIO POWER AMPLIFIER WITH SHORT CIRCUIT PROTECTION AND THERMAL SHUT-DOWN

The TDA 2010 is a monolithic integrated operational amplifier in a 14-lead quad in-line* plastic package, intended for use as a low frequency class B power amplifier. Typically it provides 12 W output power ($d = 1\%$) at $\pm 14 \text{ V}/4 \Omega$; at $V_s = \pm 14 \text{ V}$ the guaranteed output power is 10 W on a 4Ω load and 8 W on a 8Ω load (DIN norm 45500). The TDA 2010 provides high output current (up to 3.5 A) and has very low harmonic and cross-over distortion. Further, the device incorporates an original (and patented) short circuit protection system, comprising an arrangement for automatically limiting the dissipated power so as to keep the working point of the output transistors within their safe operating area. A conventional thermal shut-down system is also included. The TDA 2010 is pin to pin equivalent to TDA 2020.

* (or, optionally, dual in-line)

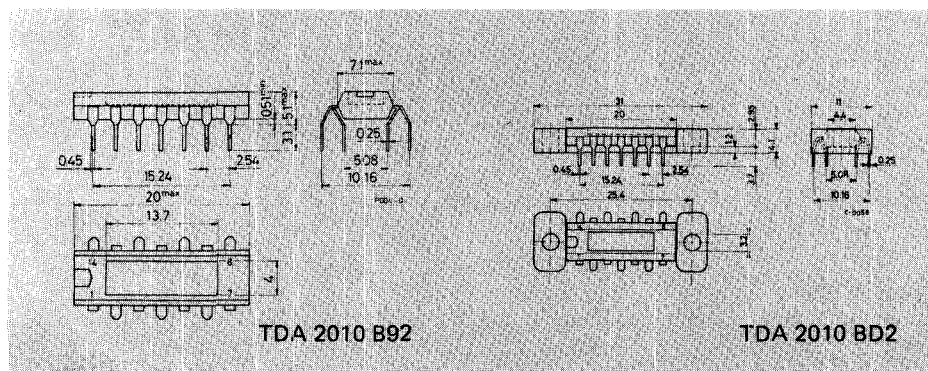
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	± 18	V
V_i	Input voltage	V_s	
V_i	Differential input voltage	± 15	V
I_o	Output peak current (internally limited)	3.5	A
P_{tot}	Power dissipation at $T_{case} \leq 95^\circ \text{C}$	18	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ \text{C}$

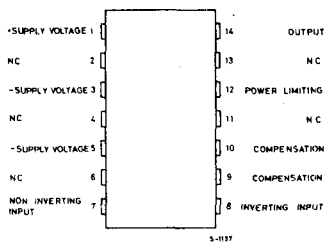
ORDERING NUMBERS: TDA 2010 B82 dual in-line plastic package
 TDA 2010 B92 quad in-line plastic package
 TDA 2010 BC2 dual in-line plastic package with spacer
 TDA 2010 BD2 quad in-line plastic package with spacer

MECHANICAL DATA

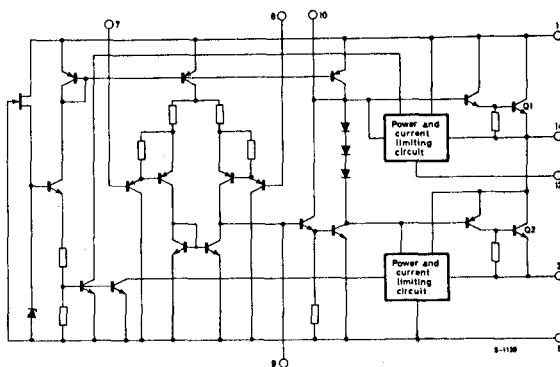
Dimensions in mm



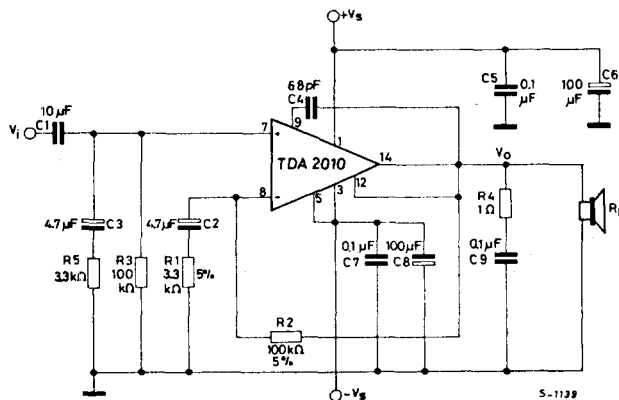
CONNECTION AND SCHEMATIC DIAGRAMS



The copper slug is electrically connected to pin 5 (substrate)



TEST CIRCUIT



THERMAL DATA

$R_{th \text{ j-case}}$	Thermal resistance junction-case	max	3	$^{\circ}C/W$
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ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $V_s = \pm 14V$, $T_{amb} = 25^\circ C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s Supply voltage		± 5		± 18	V
I_d Quiescent drain current	$V_s = \pm 18V$		45		mA
I_b Bias current	$V_s = \pm 17V$		0.15		μA
$V_{i(off)}$ Input offset voltage			5		mV
$I_{i(off)}$ Input offset current			0.05		μA
$V_{o(off)}$ Output offset voltage		10	100		mV
P_o Output power	$d = 1\%$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 40 \text{ to } 15,000 \text{ Hz}$ $R_L = 4 \Omega$ $R_L = 8 \Omega$	10 8	12 9		W W
	$d = 10\%$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $R_L = 4 \Omega$ $R_L = 8 \Omega$		15 12		W W
V_i Input sensitivity	$G_v = 30 \text{ dB}$ $f = 1 \text{ kHz}$				
	$P_o = 10 \text{ W}$ $R_L = 4 \Omega$ $P_o = 8 \text{ W}$ $R_L = 8 \Omega$		220 250		mV mV
B Frequency response(-3 dB)	$R_L = 4 \Omega$ $C4 = 68 \text{ pF}$		10 to 160,000		Hz
d Distortion	$P_o = 100 \text{ mW to } 10 \text{ W}$ $R_L = 4 \Omega$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $f = 40 \text{ to } 15,000 \text{ Hz}$		0.1 0.3	% 1 %	
	$P_o = 100 \text{ mW to } 8 \text{ W}$ $R_L = 8 \Omega$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $f = 40 \text{ to } 15,000 \text{ Hz}$		0.1 0.2	% 1 %	

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
R_i Input resistance (pin 7)		5			$M\Omega$
G_v Voltage gain (open loop)	$R_L = 4\Omega$ $f = 1\text{ kHz}$	100			dB
G_v Voltage gain (closed loop)		29.5	30	30.5	dB
e_N Input noise voltage	$R_L = 4\Omega$	4			μV
i_N Input noise current	$B(-3\text{ dB}) = 10\text{ to }20,000\text{ Hz}$	0.1			nA
SVR Supply voltage rejection ratio	$R_L = 4\Omega$ $G_v = 30\text{ dB}$ $f_{\text{ripple}} = 100\text{ Hz}$	50			dB
I_d Drain current	$P_o = 12\text{ W}$ $R_L = 4\Omega$	0.8			A
	$P_o = 9\text{ W}$ $R_L = 8\Omega$	0.5			A
Thermal shut-down junction temperature		145			$^{\circ}\text{C}$
* Thermal shut-down case temperature	$P_{\text{tot}} = 10.5\text{ W}$	120			$^{\circ}\text{C}$

* See fig. 15

Fig. 1 – Typical output power vs. supply voltage ($d = 1\%$)

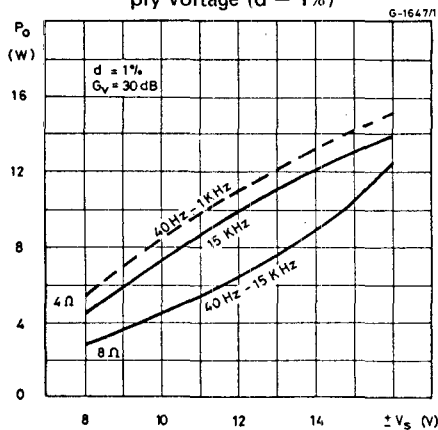


Fig. 2 – Typical output power vs. supply voltage ($d = 10\%$)

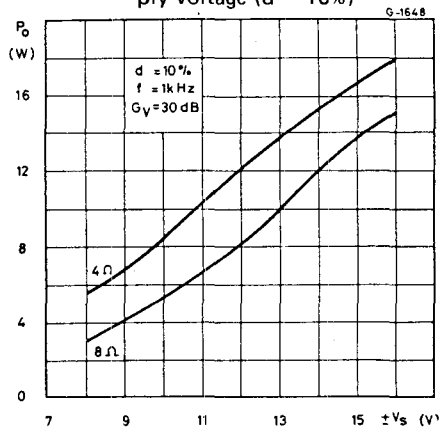


Fig. 3 - Typical distortion vs. output power ($R_L = 4 \Omega$)

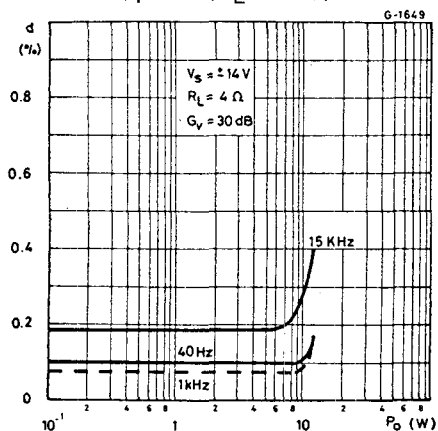


Fig. 4 - Typical distortion vs. output power ($R_L = 4 \Omega$)

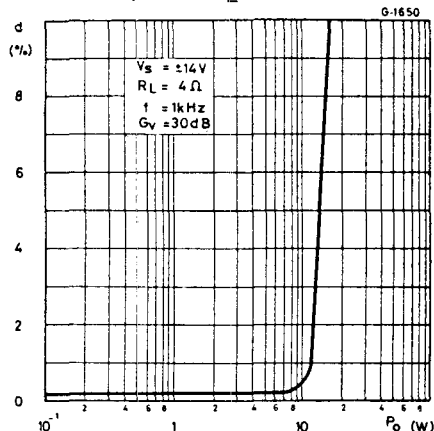


Fig. 5 - Typical distortion vs. output power ($R_L = 8 \Omega$)

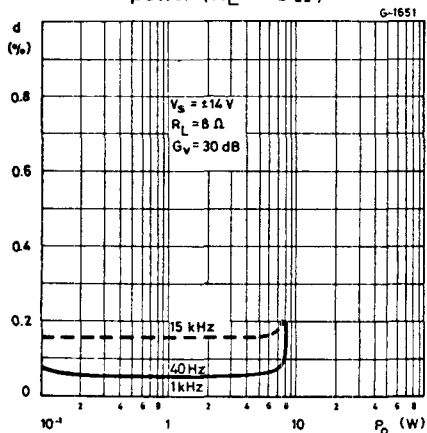


Fig. 6 - Typical distortion vs. output power ($R_L = 8 \Omega$)

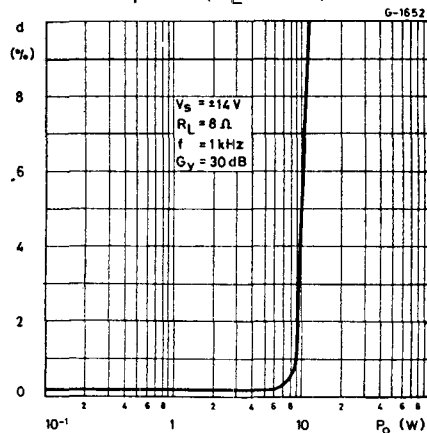


Fig. 7 - Typical distortion vs. frequency

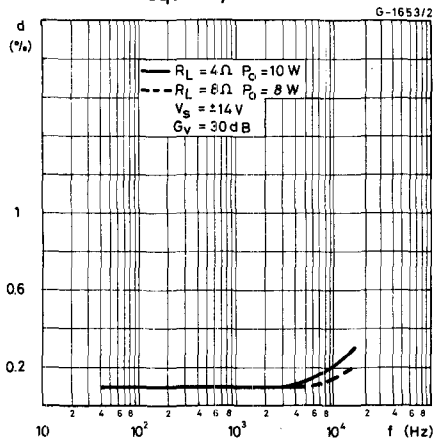


Fig. 8 - Typical output power vs. frequency

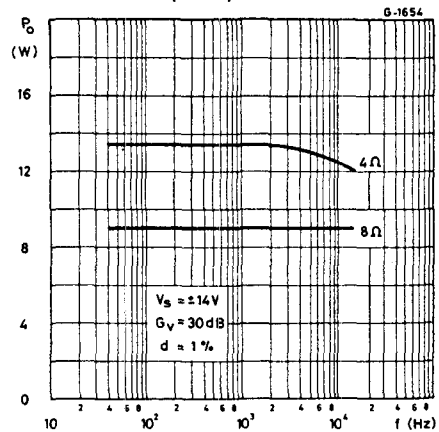


Fig. 9 - Typical sensitivity vs. output power ($R_L = 4\Omega$)

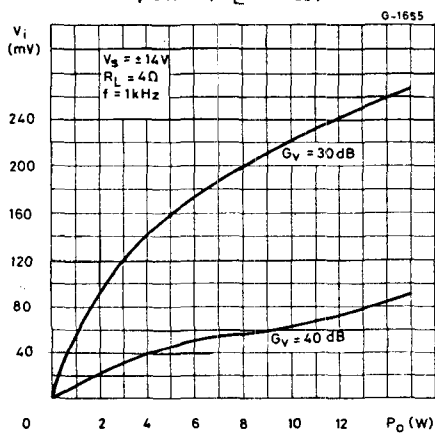


Fig. 10 - Typical sensitivity vs. output power ($R_L = 8\Omega$)

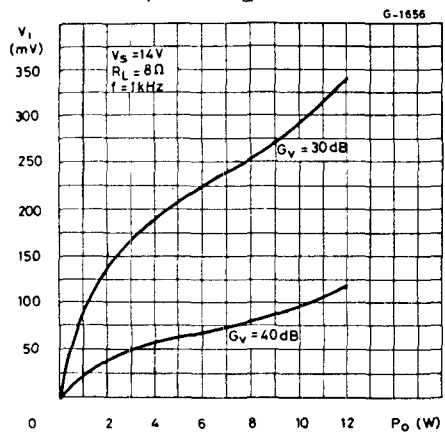


Fig. 11 - Open loop frequency response with different values of the rolloff capacitor C4

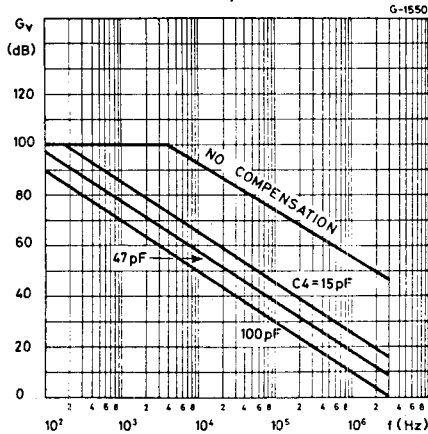


Fig. 12 - Typical value of C4 vs. voltage gain for different bandwidths

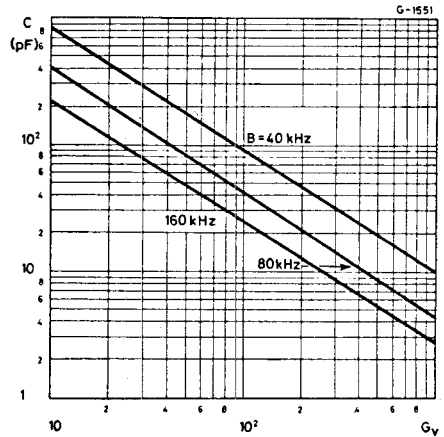


Fig. 13 - Typical quiescent current vs. supply voltage

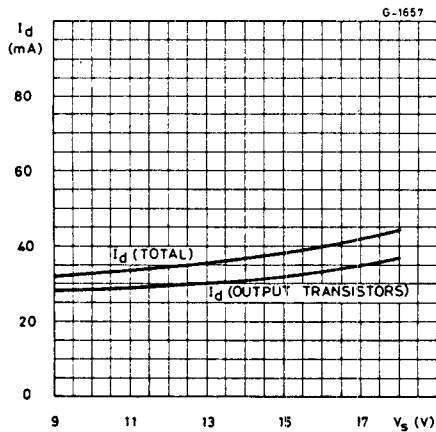


Fig. 14 - Typical supply voltage rejection ratio vs. voltage gain

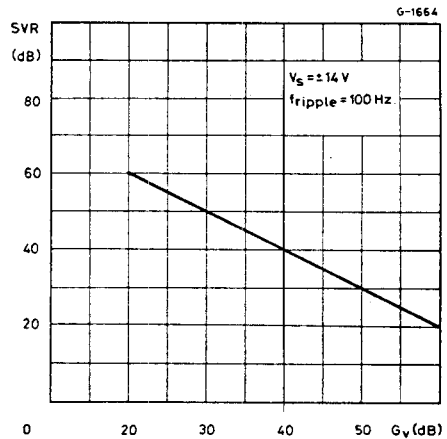


Fig. 15 - Typical power dissipation and efficiency vs. output power

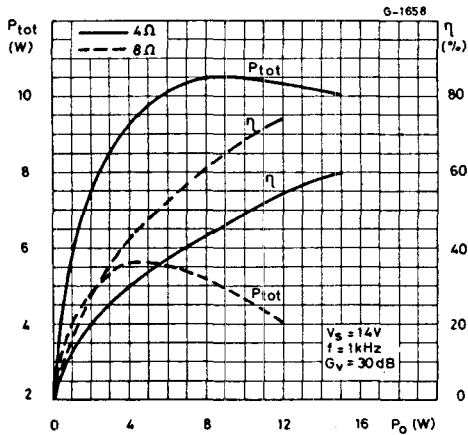
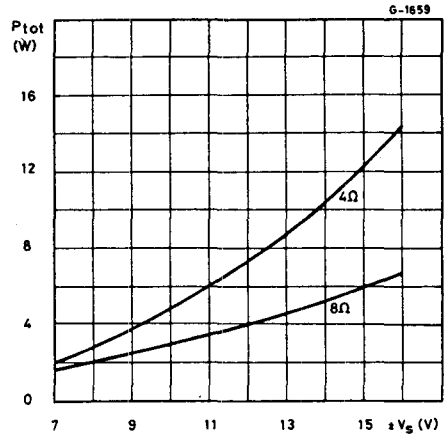


Fig. 16 - Maximum power dissipation vs. supply voltage (sine wave operation)



APPLICATION INFORMATION

Fig. 17 - Typical amplifier with split power supply

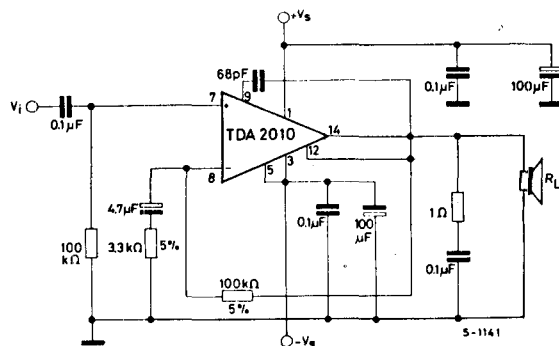


Fig. 18- P.C. board and component layout for the circuit of fig. 17 (1:1 scale)

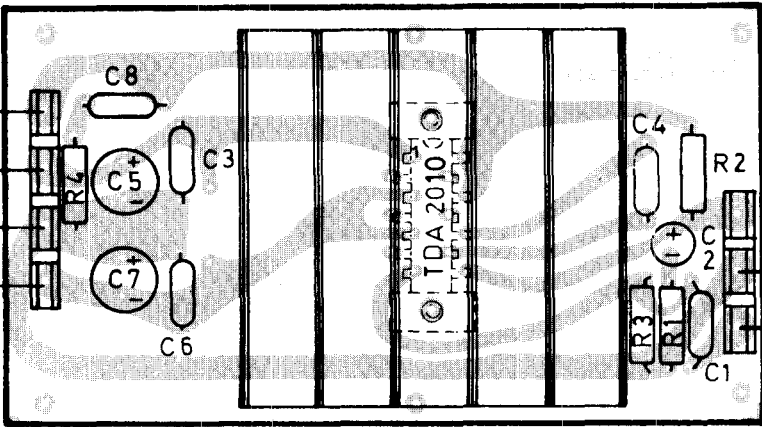


Fig.19- 10W Hi-Fi stereo amplifier with preamplifier-equalizer for ceramic pick-ups

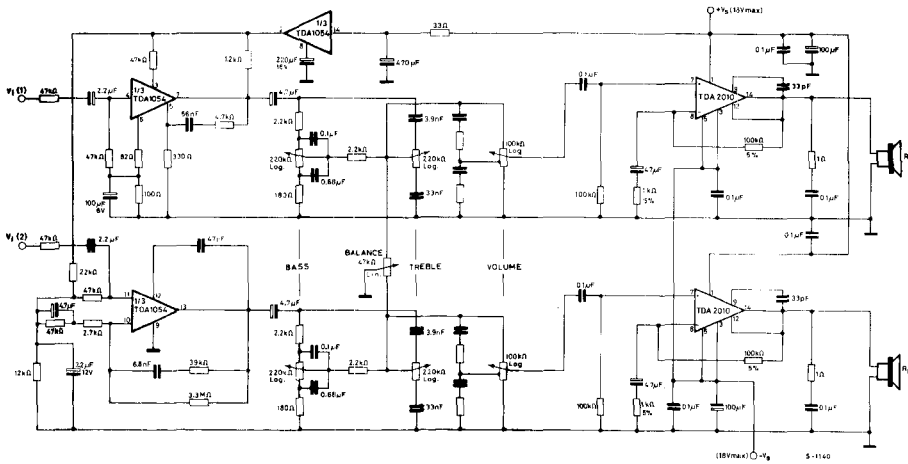


Fig. 20 - Typical stereo amplifier with split power supply

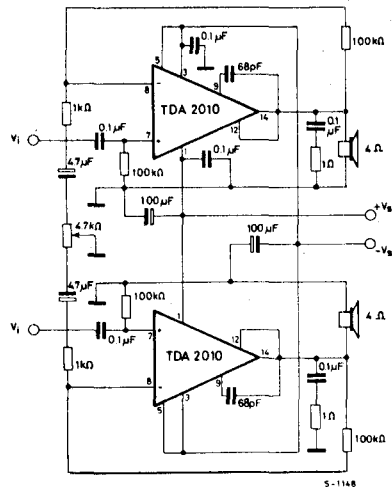
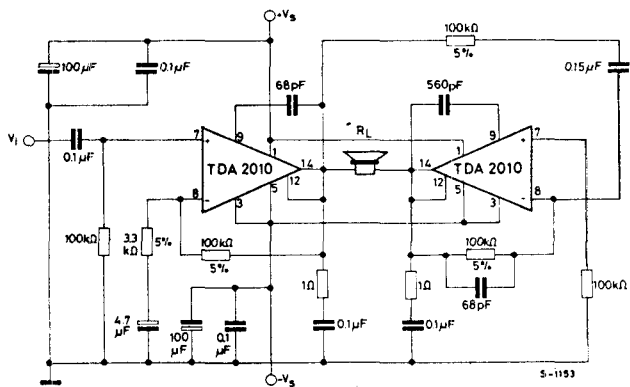


Fig. 21 - Typical bridge amplifier configuration with split power supply ($P_o = 20\text{ W}$, $V_s = \pm 13\text{V}$, $R_L = 8\ \Omega$, $d \leq 1\%$)



SHORT CIRCUIT PROTECTION

The most important innovation in the TDA 2010 is an original circuit which limits the current of the output transistors. Fig. 22 shows that the maximum output current is a function of the collector-emitter voltage; hence the output transistors work within their safe operating area (fig. 23). This function can therefore be considered as being peak power limiting rather than simple current limiting. The TDA 2010 is thus protected against temporary overloads or short circuit. Should the short circuit exists for a longer time, the thermal shut-down comes into action and keeps the junction temperature within safe limits.

Fig. 22 - Maximum output current vs. voltage (V_{CE}) across each output transistor

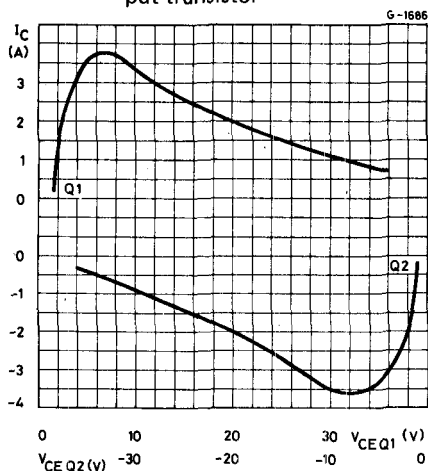
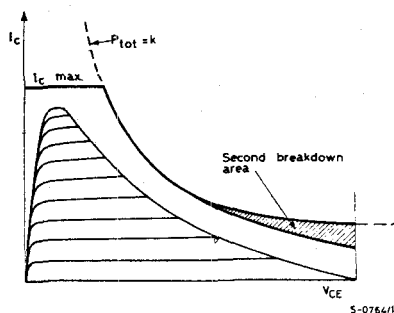


Fig. 23 - Safe operating area and collector characteristics of the protected power transistor



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 above-limit ambient temperature can be easily supported since the T_j cannot be higher than 150°C
- 2) the heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no possibility of device damage due to high junction temperature.

If, for any reason, the junction temperature increases up to 150°C , the thermal shut-down simply reduces the power dissipation and the current consumption.

Fig.24- Output power and drain current vs. case temperature
($R_L = 8\ \Omega$)

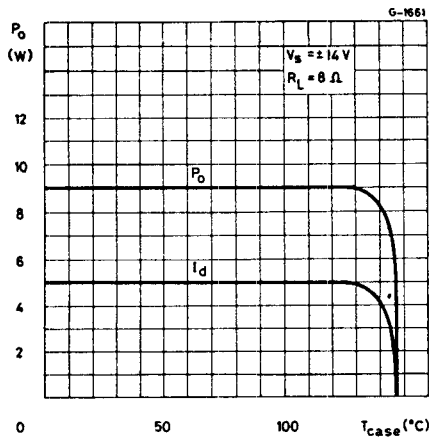
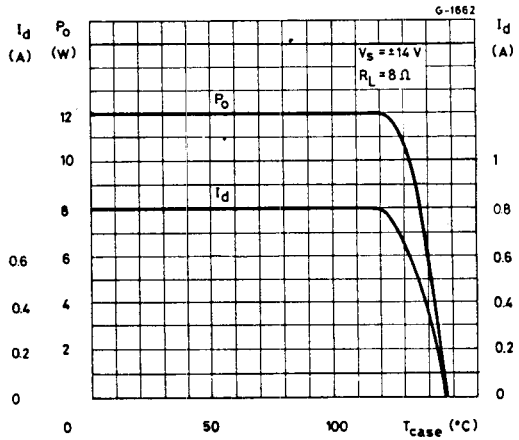


Fig.25- Output power and drain current vs. case temperature
($R_L = 4\ \Omega$)



MOUNTING INSTRUCTIONS

The power dissipated in the circuit must be removed by adding an external heatsink as shown in figs. 26 and 27.

The system for attaching the heatsink is very simple: it uses a plastic spacer which is supplied with the device.

Thermal contact between the copper slug (of the package) and the heatsink is guaranteed by the pressure which the screws exert via the spacer and the printed circuit board; this is due to the particular shape of the spacer.

Note: the most negative supply voltage is connected to the copper slug, hence to the heatsink (because it is in contact with the slug).

Fig.26 - Mounting system of TDA 2010

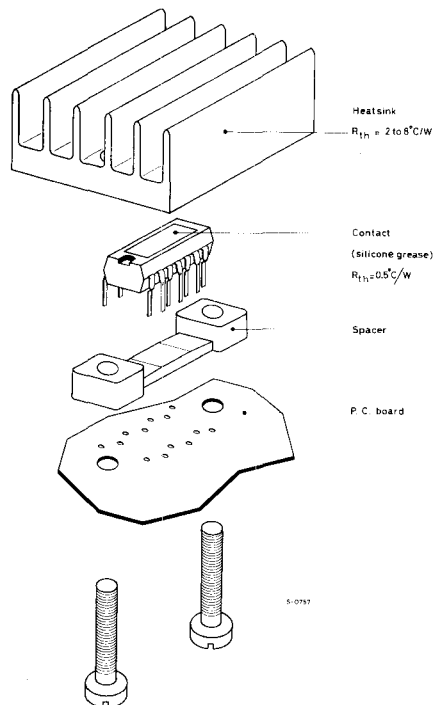
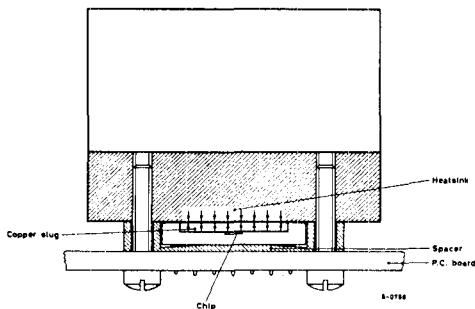
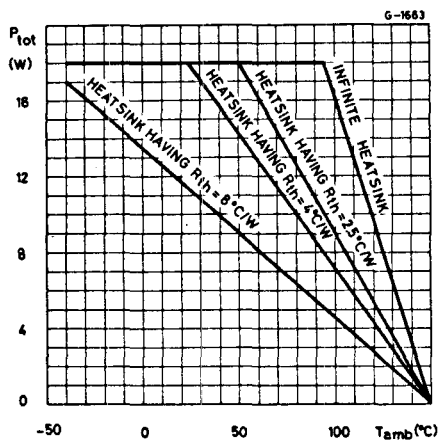


Fig.27 - Cross-section of mounting system



The maximum allowable power dissipation depends upon the size of the external heatsink (i. e. its thermal resistance); fig. 28 shows this dissippable power as a function of ambient temperature for different thermal resistance.

Fig.28 - Maximum allowable power dissipation vs. ambient temperature



For a more detailed description of the TDA 2010 and related performance refer to SGS-ATES Application Note n. 130.