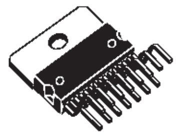
TDA7296S

60V - 60W DMOS AUDIO AMPLIFIER WITH MUTE/ST-BY

- VERY HIGH OPERATING VOLTAGE RANGE (±30V)
- DMOS POWER STAGE
- HIGH OUTPUT POWER (THD = 10%, UP TO 60W)
- MUTING/STAND-BY FUNCTIONS
- NO SWITCH ON/OFF NOISE
- VERY LOW DISTORTION
- VERY LOW NOISE
- SHORT CIRCUIT PROTECTION
- THERMAL SHUTDOWN
- CLIP DETECTOR
- MODULARITY (MORE DEVICES CAN BE EASILY CONNECTED IN PARALLEL TO DRIVE VERY LOW IMPEDANCES)

MULTIPOWER BCD TECHNOLOGY



Multiwatt15

ORDERING NUMBER: TDA7296SV

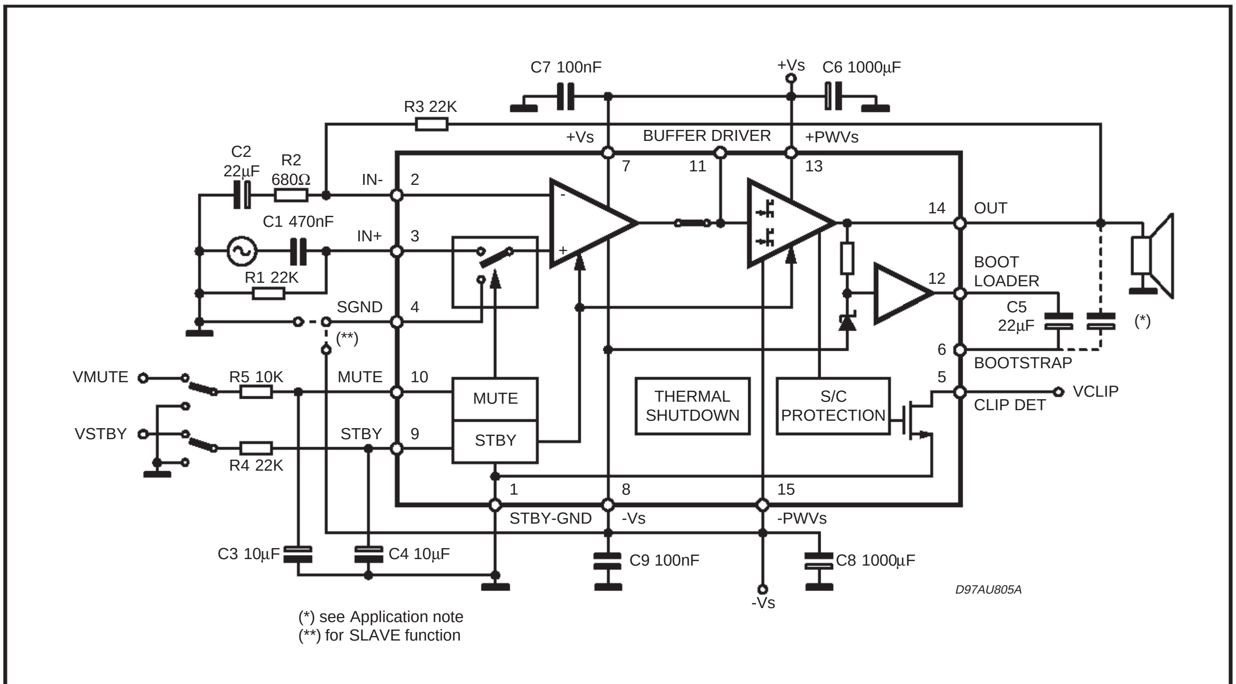
DESCRIPTION

The TDA7296S is a monolithic integrated circuit in Multiwatt15 package, intended for use as audio class AB amplifier in Hi-Fi field applications (Home Stereo, self powered loudspeakers, Top-class TV). Thanks to the wide voltage range and to the high out current capability it is able to supply the highest power into both 4Ω and 8Ω loads.

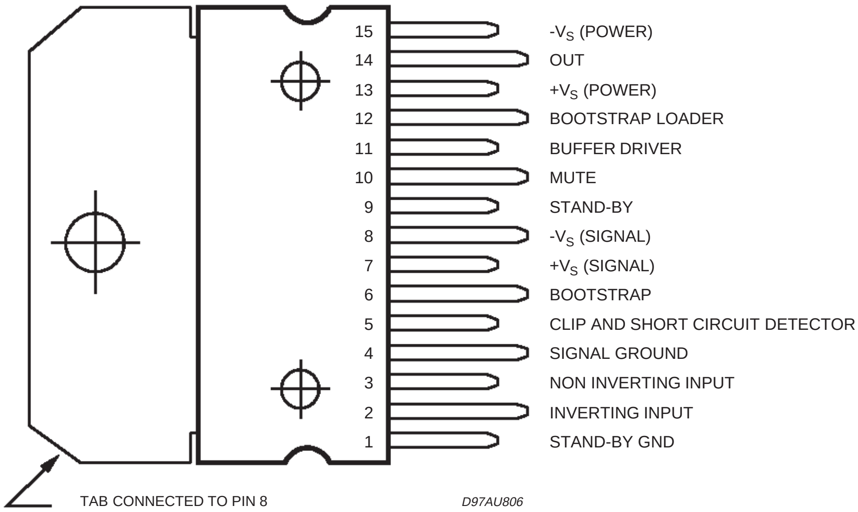
The built in muting function with turn on delay simplifies the remote operation avoiding switching on-off noises.

Parallel mode is made possible by connecting more device through of pin11. High output power can be delivered to very low impedance loads, so optimizing the thermal dissipation of the system.

Figure 1: Typical Application and Test Circuit



PIN CONNECTION (Top view)



QUICK REFERENCE DATA

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_S	Supply Voltage Operating		±12		± 30	V
G_{LOOP}	Closed Loop Gain		26		40	dB
P_{tot}	Output Power	V_S = ±30V; R_L = 8Ω; THD = 10%		60		W
		V_S = ±25V; R_L = 4Ω; THD = 10%		60		W
SVR	Supply Voltage Rejection			75		dB

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage (No Signal)	±35	V
V_1	$V_{STAND-BY}$ GND Voltage Referred to -V_S (pin 8)	60	V
V_2	Input Voltage (inverting) Referred to -V_S	60	V
V_2 - V_3	Maximum Differential Inputs	±30	V
V_3	Input Voltage (non inverting) Referred to -V_S	60	V
V_4	Signal GND Voltage Referred to -V_S	60	V
V_5	Clip Detector Voltage Referred to -V_S	60	V
V_6	Bootstrap Voltage Referred to -V_S	60	V
V_9	Stand-by Voltage Referred to -V_S	60	V
V_{10}	Mute Voltage Referred to -V_S	60	V
V_{11}	Buffer Voltage Referred to -V_S	60	V
V_{12}	Bootstrap Loader Voltage Referred to -V_S	60	V
I_O	Output Peak Current	10	A
P_{tot}	Power Dissipation T_{case} = 70°C	50	W
T_{op}	Operating Ambient Temperature Range	0 to 70	°C
T_{stg}, T_j	Storage and Junction Temperature	150	°C

THERMAL DATA

Symbol	Description	Typ	Max	Unit
$R_{th\ j-case}$	Thermal Resistance Junction-case	1	1.5	°C/W

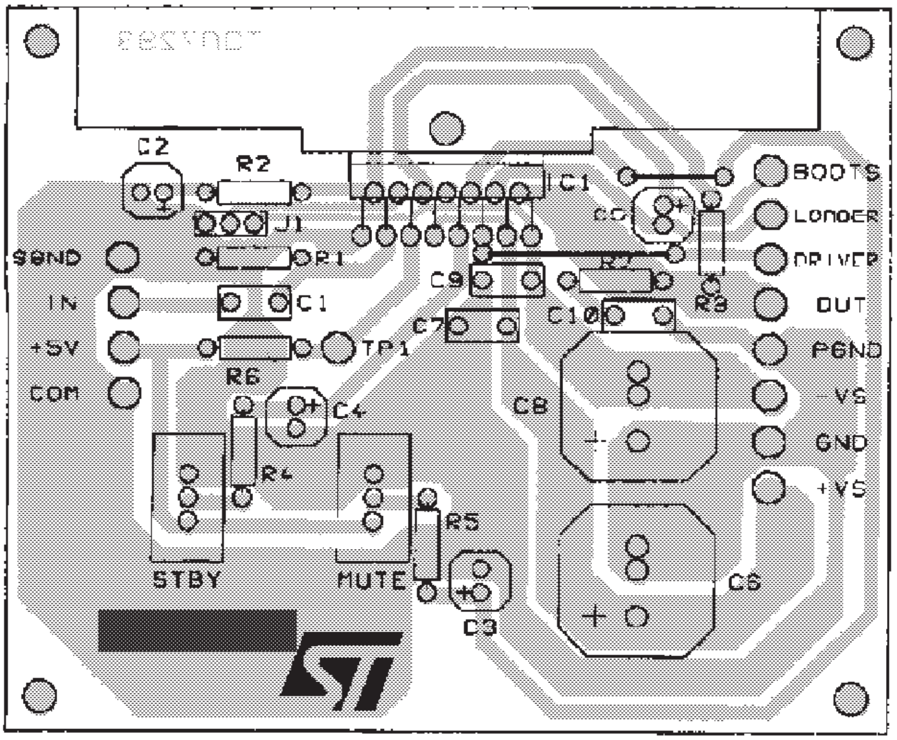
ELECTRICAL CHARACTERISTICS (Refer to the Test Circuit V_S = ±24V, R_L = 8Ω, G_V = 30dB; R_g = 50 Ω; T_{amb} = 25°C, f = 1 kHz; unless otherwise specified).

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_S	Operating Supply Range		±10		±30	V
I_q	Quiescent Current		20	30	60	mA
I_b	Input Bias Current				500	nA
V_{OS}	Input Offset Voltage				±10	mV
I_{OS}	Input Offset Current				±100	nA
P_O	RMS Continuous Output Power	d = 0.5%: V_S = ± 24V, R_L = 8Ω V_S = ± 21V, R_L = 6Ω V_S = ± 18V, R_L = 4Ω	 27 27 27	 30 30 30		 W W W
	Music Power (RMS) (*) Δt = 1s	d = 10%; R_L = 8Ω ; V_S = ±30V R_L = 6Ω ; V_S = ±24V R_L = 4Ω; V_S = ±23V		 60 60 60		 W W W
d	Total Harmonic Distortion (**)	P_O = 5W; f = 1kHz P_O = 0.1 to 20W; f = 20Hz to 20kHz		0.005	 0.1	% %
		V_S = ±18V, R_L = 4Ω: P_O = 5W; f = 1kHz P_O = 0.1 to 20W; f = 20Hz to 20kHz		 0.01	 0.1	 % %
SR	Slew Rate		7	10		V/µs
G_V	Open Loop Voltage Gain			80		dB
G_V	Closed Loop Voltage Gain		24	30	40	dB
e_N	Total Input Noise	A = curve f = 20Hz to 20kHz		1 2	 5	µV µV
f_L, f_H	Frequency Response (-3dB)	P_O = 1W	20Hz to 20kHz			
R_i	Input Resistance		100			kΩ
SVR	Supply Voltage Rejection	f = 100Hz; V_{ripple} = 0.5Vrms	60	75		dB
T_S	Thermal Shutdown			150		°C
STAND-BY FUNCTION (Ref: -V_S or GND)						
$V_{ST\ on}$	Stand-by on Threshold				1.5	V
$V_{ST\ off}$	Stand-by off Threshold		3.5			V
ATT_{st-by}	Stand-by Attenuation		70	90		dB
$I_{q\ st-by}$	Quiescent Current @ Stand-by			1	3	mA
MUTE FUNCTION (Ref: -V_S or GND)						
V_{Mon}	Mute on Threshold				1.5	V
V_{Moff}	Mute off Threshold		3.5			V
ATT_{mute}	Mute Attenuation		60	80		dB

Note (**):
MUSIC POWER is the maximal power which the amplifier is capable of producing across the rated load resistance (regardless of non linearity) 1 sec after the application of a sinusoidal input signal of frequency 1KHz.

Note (**): Tested with optimized Application Board (see fig. 2)

Figure 2: Typical Application P.C. Board and Component Layout (scale 1:1)



APPLICATION SUGGESTIONS (see Test and Application Circuits of the Fig. 1)

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

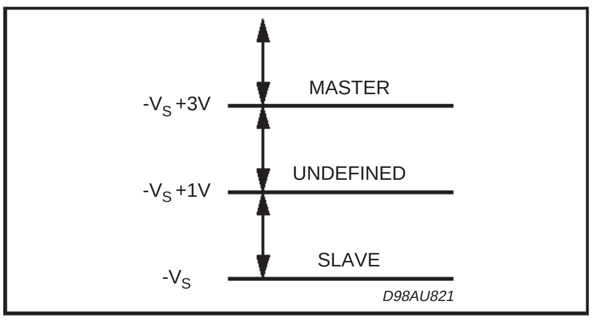
COMPONENTS	SUGGESTED VALUE	PURPOSE	LARGER THAN SUGGESTED	SMALLER THAN SUGGESTED
R1 (*)	22k	INPUT RESISTANCE	INCREASE INPUT IMPEDANCE	DECREASE INPUT IMPEDANCE
R2	680Ω	CLOSED LOOP GAIN SET TO 30dB (**)	DECREASE OF GAIN	INCREASE OF GAIN
R3 (*)	22k		INCREASE OF GAIN	DECREASE OF GAIN
R4	22k	ST-BY TIME CONSTANT	LARGER ST-BY ON/OFF TIME	SMALLER ST-BY ON/OFF TIME; POP NOISE
R5	10k	MUTE TIME CONSTANT	LARGER MUTE ON/OFF TIME	SMALLER MUTE ON/OFF TIME
C1	0.47μF	INPUT DC DECOUPLING		HIGHER LOW FREQUENCY CUTOFF
C2	22μF	FEEDBACK DC DECOUPLING		HIGHER LOW FREQUENCY CUTOFF
C3	10μF	MUTE TIME CONSTANT	LARGER MUTE ON/OFF TIME	SMALLER MUTE ON/OFF TIME
C4	10μF	ST-BY TIME CONSTANT	LARGER ST-BY ON/OFF TIME	SMALLER ST-BY ON/OFF TIME; POP NOISE
C5	22μFXN (***)	BOOTSTRAPPING		SIGNAL DEGRADATION AT LOW FREQUENCY
C6, C8	1000μF	SUPPLY VOLTAGE BYPASS		
C7, C9	0.1μF	SUPPLY VOLTAGE BYPASS		DANGER OF OSCILLATION

(*) R1 = R3 for pop optimization

(**) Closed Loop Gain has to be ≥ 26dB

(***) Multiply this value for the number of modular part connected

Slave function: pin 4 (Ref to pin 8 -V_S)



Note:

If in the application, the speakers are connected via long wires, it is a good rule to add between the output and GND, a Boucherot Cell, in order to avoid dangerous spurious oscillations when the speakers terminal are shorted.

The suggested Boucherot Resistor is 3.9Ω/2W and the capacitor is 1μF.

INTRODUCTION

In consumer electronics, an increasing demand has arisen for very high power monolithic audio amplifiers able to match, with a low cost, the performance obtained from the best discrete designs.

The task of realizing this linear integrated circuit in conventional bipolar technology is made extremely difficult by the occurence of 2nd breakdown phoenomenon. It limits the safe operating area (SOA) of the power devices, and, as a consequence, the maximum attainable output power, especially in presence of highly reactive loads.

Moreover, full exploitation of the SOA translates into a substantial increase in circuit and layout complexity due to the need of sophisticated protection circuits.

To overcome these substantial drawbacks, the use of power MOS devices, which are immune from secondary breakdown is highly desirable.

1) Output Stage

The main design task in developping a power operational amplifier, independently of the technology used, is that of realization of the output stage.

The solution shown as a principle shematic by Fig3 represents the DMOS unity - gain output buffer of the TDA7296S.

This large-signal, high-power buffer must be capable of handling extremely high current and voltage levels while maintaining acceptably low harmonic distortion and good behaviour over frequency response; moreover, an accurate control of quiescent current is required.

A local linearizing feedback, provided by differential amplifier A, is used to fullfil the above requirements, allowing a simple and effective quiescent current setting.

Proper biasing of the power output transistors alone is however not enough to guarantee the absence of crossover distortion.

While a linearization of the DC transfer characteristic of the stage is obtained, the dynamic behaviour of the system must be taken into account.

A significant aid in keeping the distortion contributed by the final stage as low as possible is provided by the compensation scheme, which exploits the direct connection of the Miller capacitor at the amplifier's output to introduce a local AC feedback path enclosing the output stage itself.

2) Protections

In designing a power IC, particular attention must be reserved to the circuits devoted to protection of the device from short circuit or overload conditions.

Due to the absence of the 2nd breakdown phenomenon, the SOA of the power DMOS transistors is delimited only by a maximum dissipation curve dependent on the duration of the applied stimulus.

In order to fully exploit the capabilities of the power transistors, the protection scheme implemented in this device combines a conventional SOA protection circuit with a novel local temperature sensing technique which " dynamically" controls the maximum dissipation.

In addition to the overload protection described

Figure 3: Principle Schematic of a DMOS unity-gain buffer.

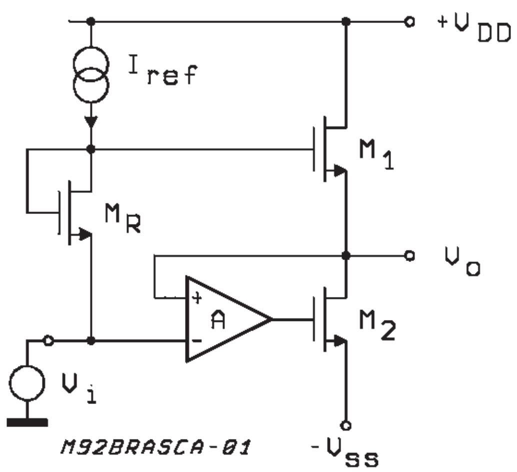
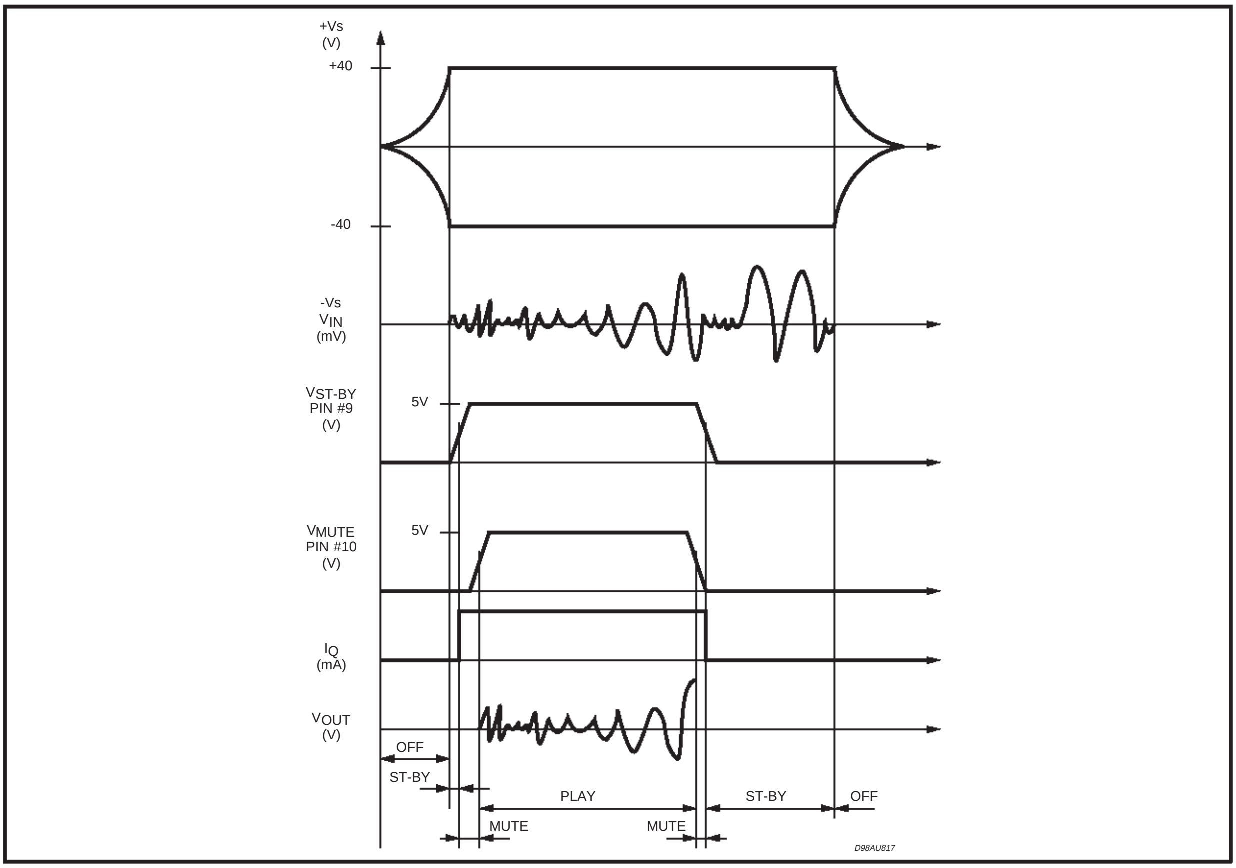


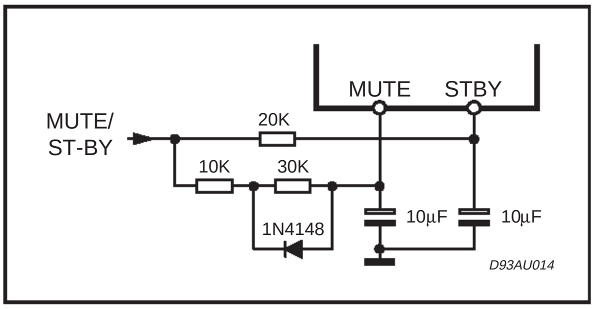
Figure 4: Turn ON/OFF Suggested Sequence



above, the device features a thermal shutdown circuit which initially puts the device into a muting state (@ Tj = 150 ^oC) and then into stand-by (@ Tj = 160 ^oC).

Full protection against electrostatic discharges on every pin is included.

Figure 5: Single Signal ST-BY/MUTE Control Circuit



3) Other Features

The device is provided with both stand-by and mute functions, independently driven by two CMOS logic compatible input pins.

The circuits dedicated to the switching on and off of the amplifier have been carefully optimized to avoid any kind of uncontrolled audible transient at the output.

The sequence that we recommend during the ON/OFF transients is shown by Figure 4.

The application of figure 5 shows the possibility of using only one command for both st-by and mute functions. On both the pins, the maximum applicable range corresponds to the operating supply voltage.

APPLICATION INFORMATION

BRIDGE APPLICATION

Another application suggestion is the BRIDGE configuration, where two TDA7296S are used.

In this application, the value of the load must not be lower than 8 Ohm for dissipation and current capability reasons.

A suitable field of application includes HI-FI/TV subwoofers realizations.

The main advantages offered by this solution are:

- High power performances with limited supply voltage level.
- Considerably high output power even with high load values (i.e. 16 Ohm).

With Rl= 8 Ohm, Vs = ±23V the maximum output power obtainable is 120W (Music Power)

APPLICATION NOTE: (ref. fig. 7)

Modular Application (more Devices in Parallel)

The use of the modular application lets very high power be delivered to very low impedance loads. The modular application implies one device to act as a master and the others as slaves.

The slave power stages are driven by the master device and work in parallel all together, while the input and the gain stages of the slave device are disabled, the figure below shows the connections required to configure two devices to work together.

- The master chip connections are the same as the normal single ones.
- The outputs can be connected together **without the need of any ballast resistance.**
- The slave SGND pin must be tied to the negative supply.
- The slave ST-BY pin must be connected to ST-BY pin.
- The bootstrap lines must be connected together and the bootstrap capacitor must be increased: for N devices the boostrap capacitor must be 22µF times N.
- The slave Mute and IN-pins must be grounded.

THE BOOTSTRAP CAPACITOR

For compatibility purpose with the previous devices of the family, the boostrap capacitor can be connected both between the bootstrap pin (6) and the output pin (14) or between the boostrap pin (6) and the bootstrap loader pin (12).

Figure 6: Modular Application Circuit

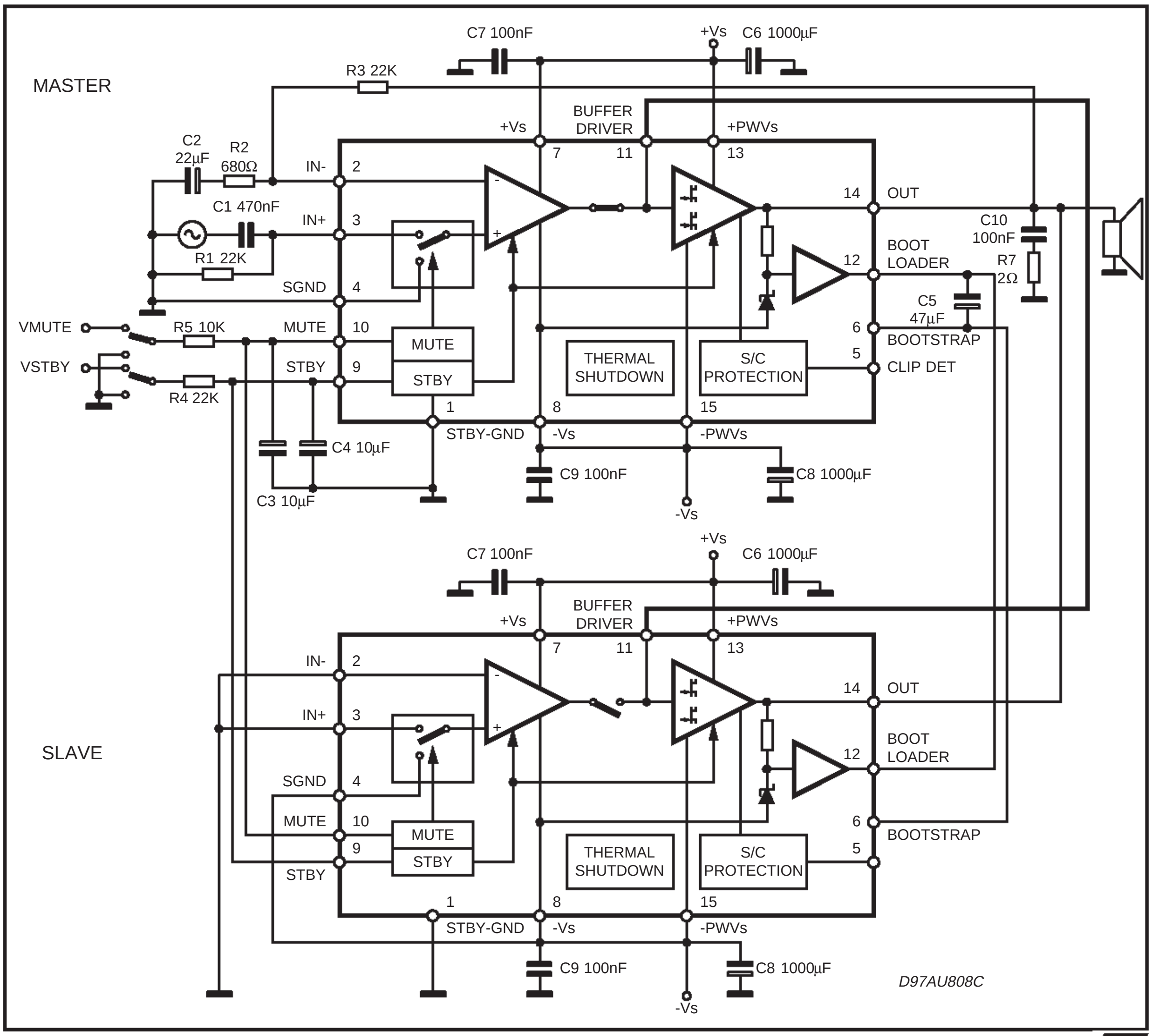


Figure 7a: Modular Application P.C. Board and Component Layout (scale 1:1) (Component SIDE)

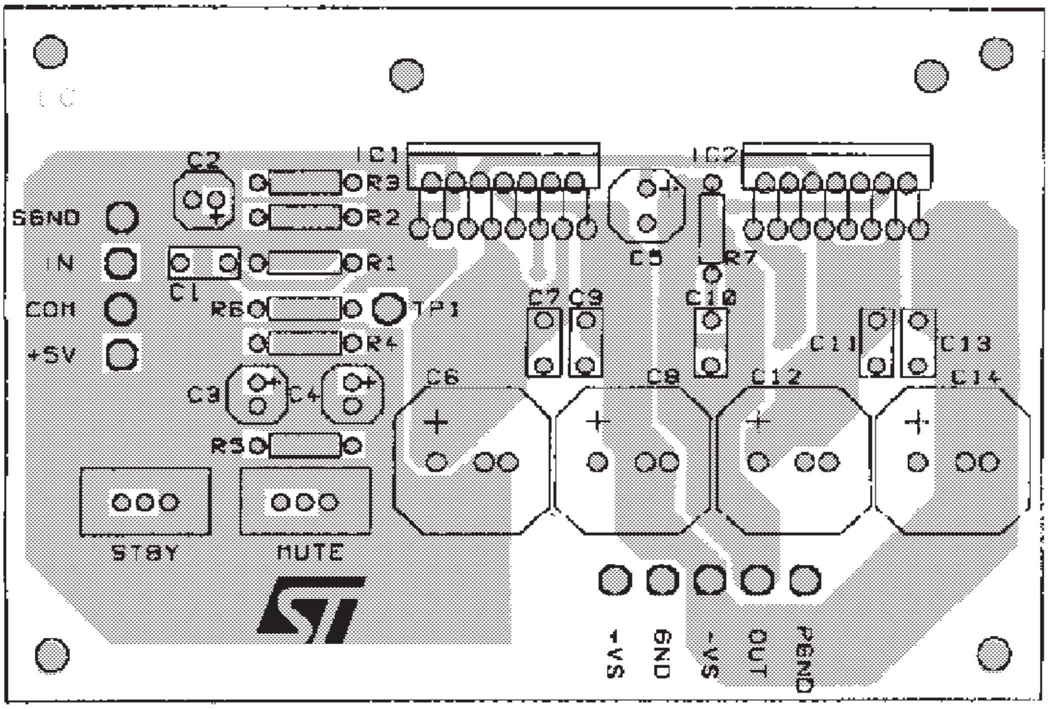
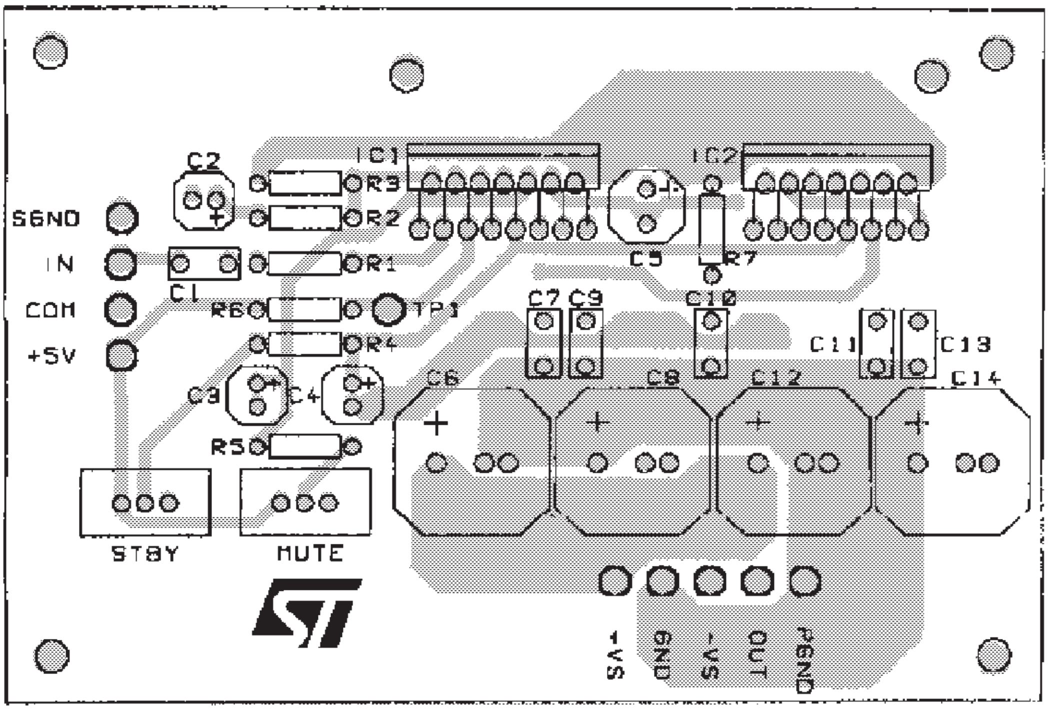
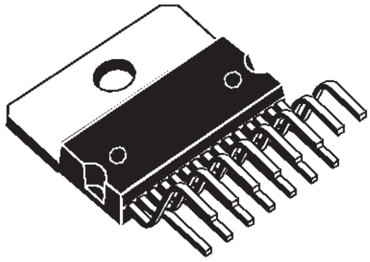


Figure 7b: Modular Application P.C. Board and Component Layout (scale 1:1) (Solder SIDE)



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	0.870	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	4.63	5.08	5.53	0.182	0.200	0.218
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 V