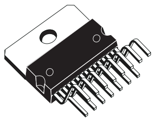
TDA7296

Datasheet

70 V-60 W DMOS audio amplifier with mute/ST-BY



Multiwatt 15

Features

- Multipower BCD technology
- Very high operating voltage range (± 35 V)
- DMOS power stage
- High output power (up to 60 W music power)
- Muting/standby functions
- No switch on/off noise
- No boucherot cells
- Very low distortion
- Very low noise
- Short-circuit protection
- Thermal shutdown

Description

The TDA7296 is a monolithic integrated circuit in multiwatt15 package, intended to be used as audio class AB amplifier in Hi-Fi field applications (home stereo, self powered loudspeakers, top class TV).

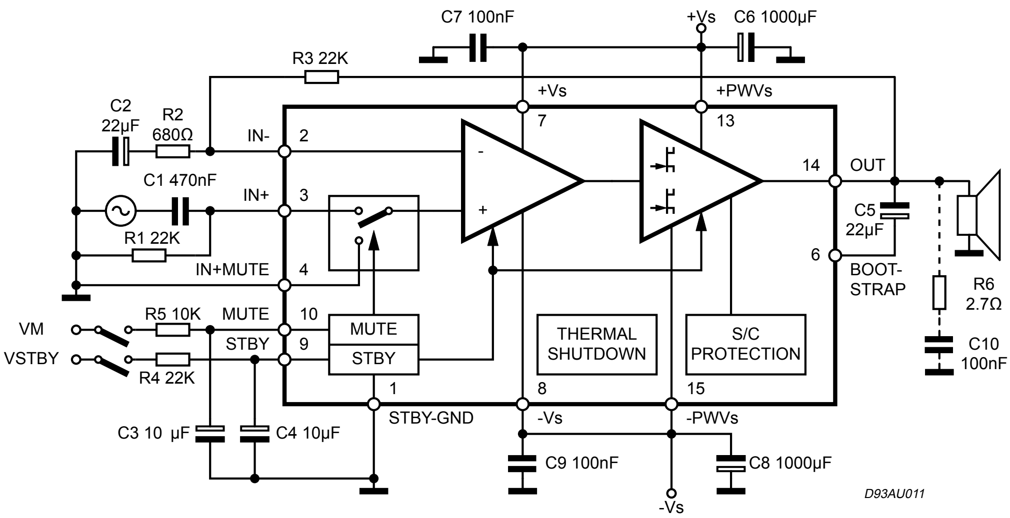
Thanks to the wide voltage range and to the high out current capability, it is able to supply the highest power into both 4 Ω and 8 Ω loads even in presence of poor supply regulation, with high supply voltage rejection.

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

Product status link
TDA7296

1 Typical application and test circuit

Figure 1. Typical application and test circuit



Note: The Boucherot cell R6, C10, normally not necessary for a stable operation it could be needed in presence of particular load impedances at Vs <±25V.

2 Pin connection

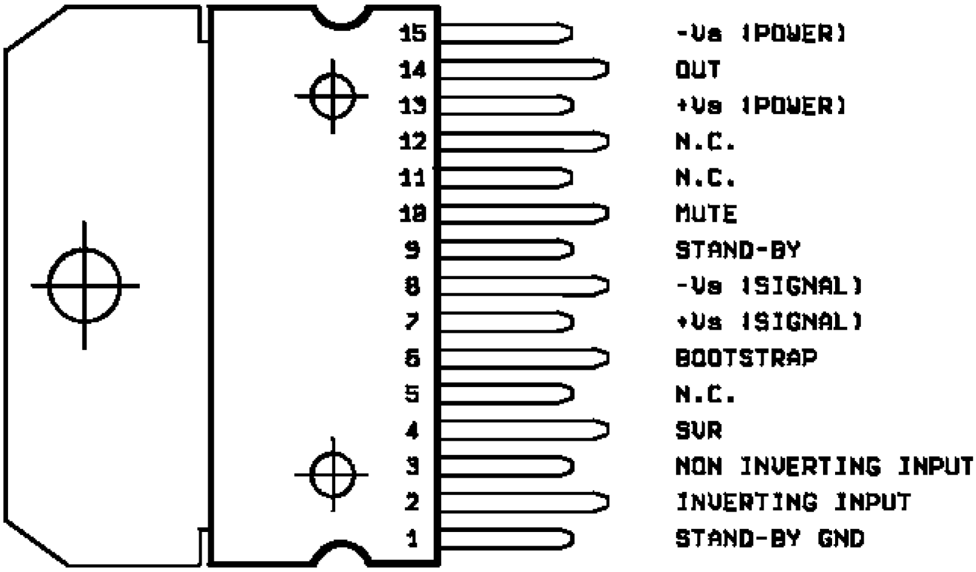
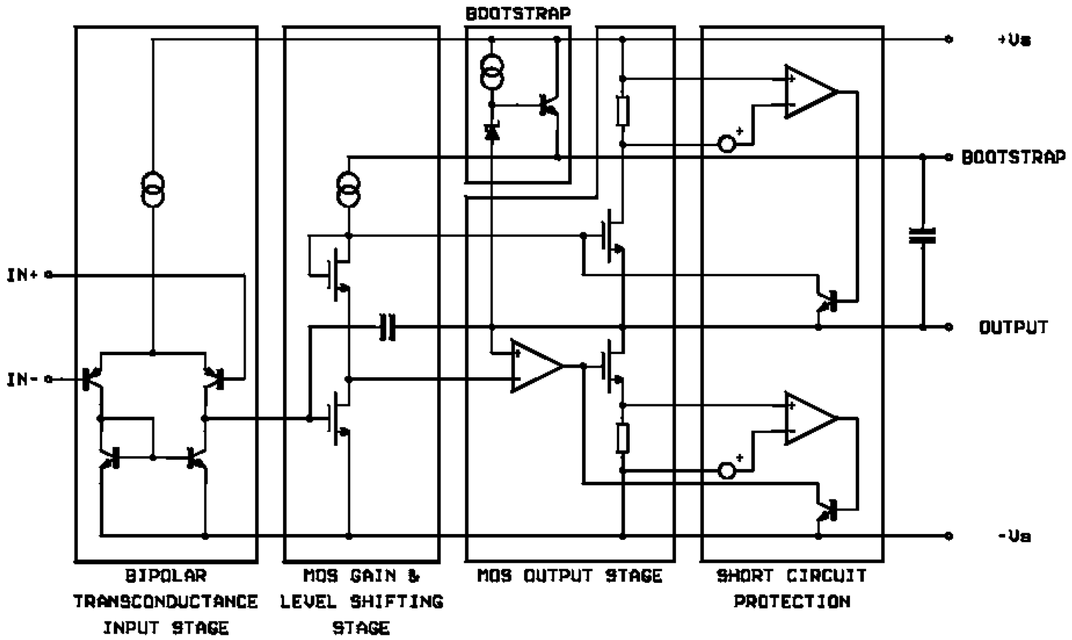


Figure 2. Pin connection

3 Block diagram

Figure 3. Block diagram



4 Maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_S	Supply voltage (no signal)	±35	V
I_O	Output peak current	5	A
P_{tot}	Power dissipation T_{case}= 70 °C	50	W
T_{op}	Operating ambient temperature range	0 to 70	°C
T_{stg}	Storage temperature	150	°C
T_j	Junction temperature		°C

Table 2. Thermal data

Symbol	Parameter	Typ.	Max.	Unit
$R_{th\text{-}jcase}$	Thermal resistance junction-case	1	1.5	°C/W

5 Electrical characteristics

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

Table 3. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_S	Supply range		±10		±35	V
I_q	Quiescent current		20	30	65	mA
I_b	Input bias current				500	nA
V_{OS}	Input offset voltage		-10		10	mV
I_{OS}	Input offset current		-100		100	nA
P_o	RMS continuous output power	d = 05% V_S = ± 24 V, R_L = 8 Ω	27	30		W
		d = 05% V_S = ± 21 V, R_L = 6 Ω	27	30		
		d = 05% V_S = ± 18 V, R_L = 4 Ω	27	30	W	
	Music power (RMS) Δt = 1 s[1]	d = 10% V_S = ± 29 V, R_L = 8 Ω		60		
		d = 10% V_S = ± 24 V, R_L = 6 Ω		60		
		d = 10% V_S = ± 22 V, R_L = 4 Ω		60		
d	Total harmonic distortion[2]	P_O = 5 W; f = 1 kHz		0.005		%
		P_O = 0.1 to 20 W; f = 20 Hz to 20 kHz			0.1	
		V_S = ± 18 V, R_L = 4 Ω; P_O = 5 W; f = 1 kHz		0.01		
		V_S = ± 18 V, R_L = 4 Ω; P_O = 0.1 to 20 W; f = 20 Hz to 20 kHz			0.1	
SR	Slew rate		7	10		V/μs
G_V	Open loop voltage gain			80		dB
	Closed loop voltage gain		24	30	40	
e_N	Total input noise	A= curve		1		μV
		f= 20 Hz to 20 kHz		2	5	
f_L, f_H	Frequency response (-3 dB)	P_O=1 W	20 Hz to 20 kHz			
R_I	Input resistance		100			kΩ
SVR	Supply voltage rejection	f = 100 Hz; V_{ripple} = 0.5 Vrms	60	75		db
T_S	Thermal shutdown			145		°C
Standby function (Ref: -V_s or GND)						

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{ST\ on}$	Standby on treshold				1.5	V
$V_{ST\ off}$	Standby off treshold		3.5			
$ATT_{st\text{-}by}$	Standby attenuation		70	90		dB
$I_{q\ st\text{-}by}$	Quiescent current @standby			1	3	mA
Mute function (ref $-V_S$ to GND)						
V_{MON}	Mute on threshold				1.5	V
V_{Moff}	Mute off threshold		3.5			
ATT_{mute}	Mute attenuation		60	80		dB

1. *Music power is the maximal power which the amplifier is capable of producing across the rated load resistance (regardless of non linearity) 1 s after the application of a sinusoidal input signal of frequency 1 kHz.*
2. *Tested with optimized application board.*

6 Typical characteristics

Figure 4. Output power vs. supply voltage

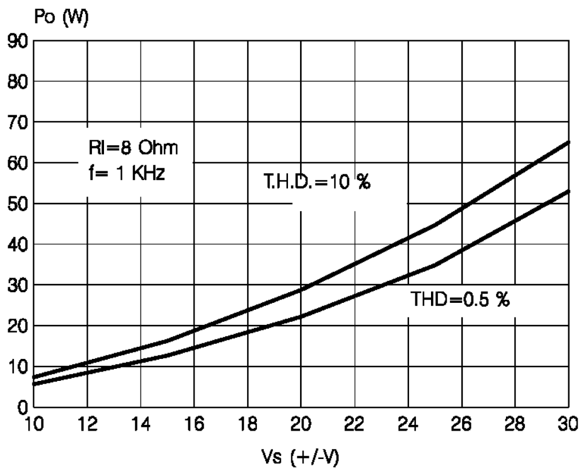


Figure 5. Distortion vs. output power

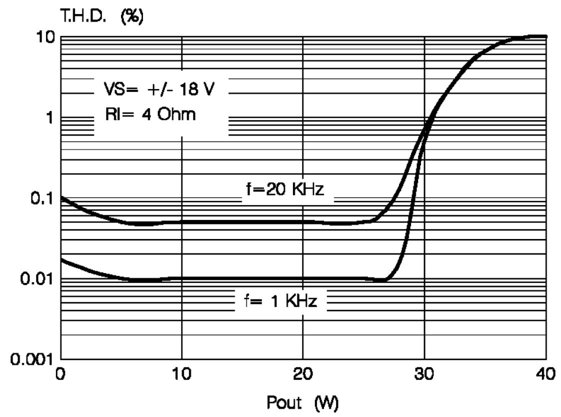


Figure 6. Distortion vs. output power (RL=8 Ω)

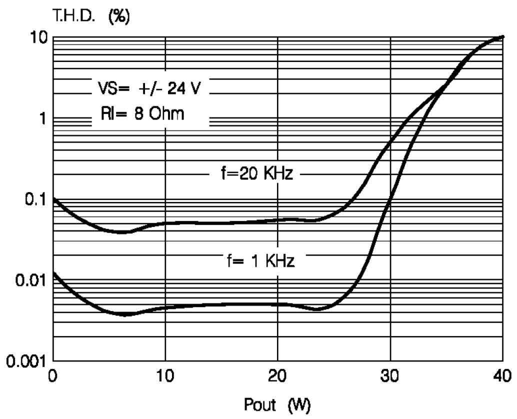


Figure 7. Distortion vs. frequency

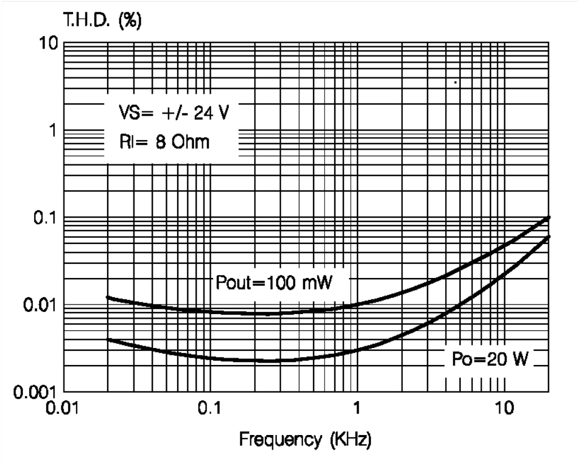


Figure 8. **Output power vs. supply voltage (R_L= 4 Ω)**

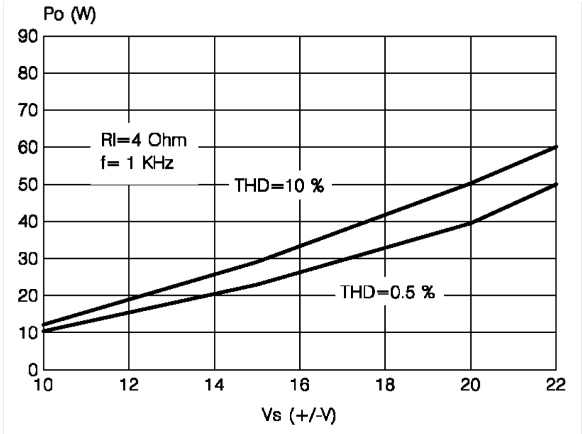


Figure 9. **Distortion vs. frequency (R_L= 4 Ω)**

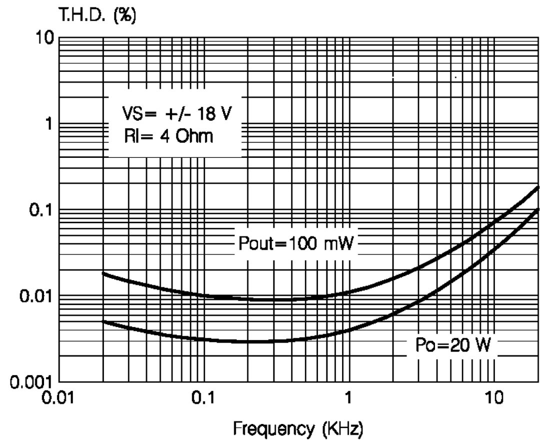


Figure 10. **Quiescent current vs. supply voltage**

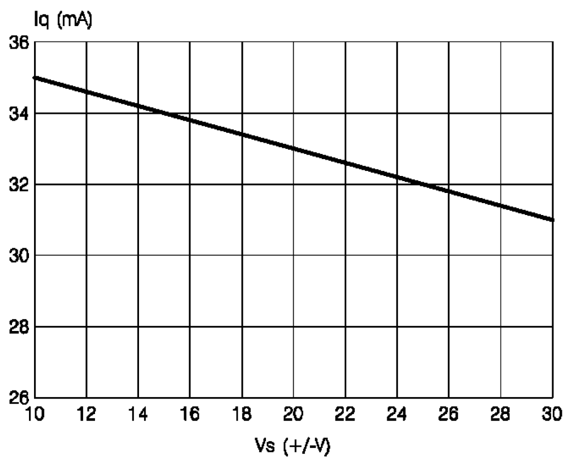


Figure 11. **Standby attenuation vs. V_{pin9}**

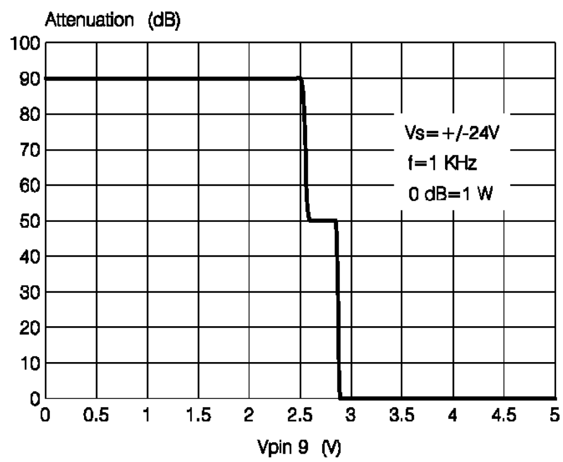


Figure 12. **Supply voltage rejection vs. frequency**

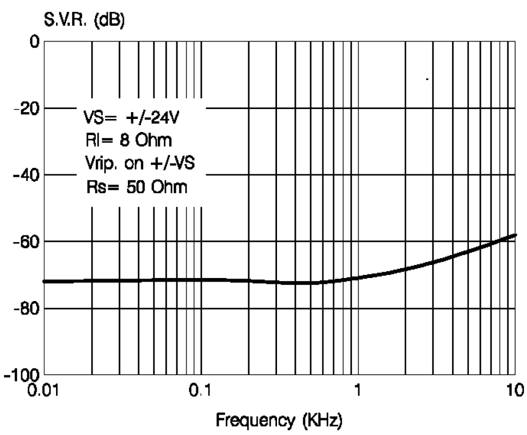


Figure 13. **Power dissipation vs. output power (R_L= 4 Ω)**

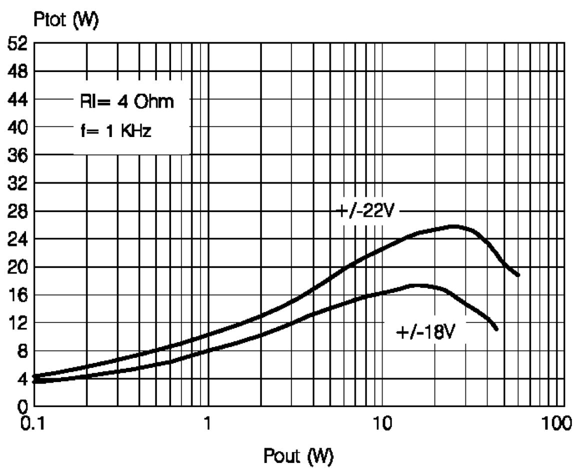


Figure 14. Mute attenuation vs. V_{pin10}

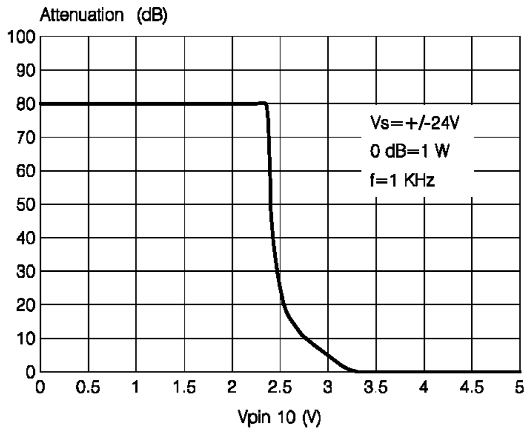
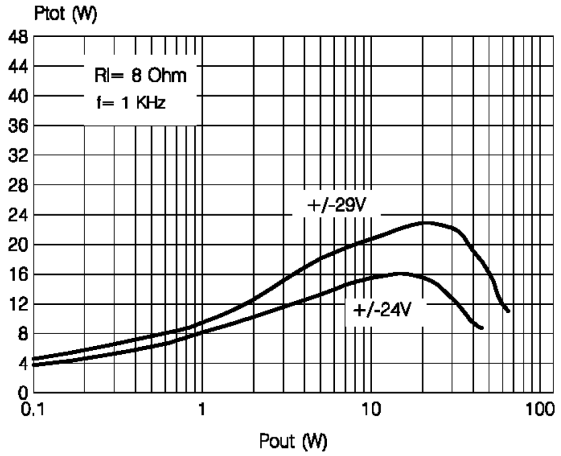


Figure 15. Power dissipation vs. output power (R_L= 8 Ω)



7 General information

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 occurrence of 2^{nd} breakdown phenomenon. 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 for sophisticated protection circuits.

To overcome these substantial drawbacks, the use of power MOS devices, which are immune from secondary breakdown, is highly desirable. The device described has therefore been developed in a mixed bipolar-MOS high voltage technology called BCD 80.

7.1 Output stage

The main design task to cope with, while developing an integrated circuit as a power operational amplifier, regardless the technology used, is to develop the output stage. The solution shown as a principle schematic by Fig 18 represents the DMOS unity-gain output buffer of the TDA7296.

This large-signal, high-power buffer must be able to handle 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 linearising feedback, provided by differential amplifier A, is used to fulfil 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 linearisation 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.

7.2 Protections

When a power IC is being designed, 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 2^{nd} 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.

Figure 16. Principle schematic of a DMOS unity-gain buffer

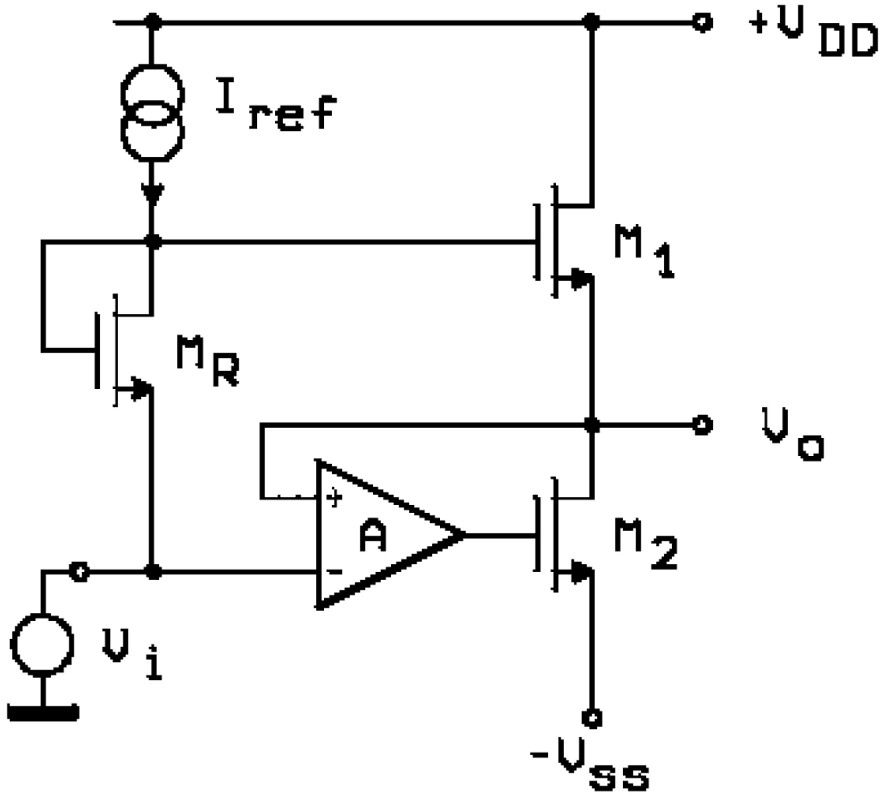
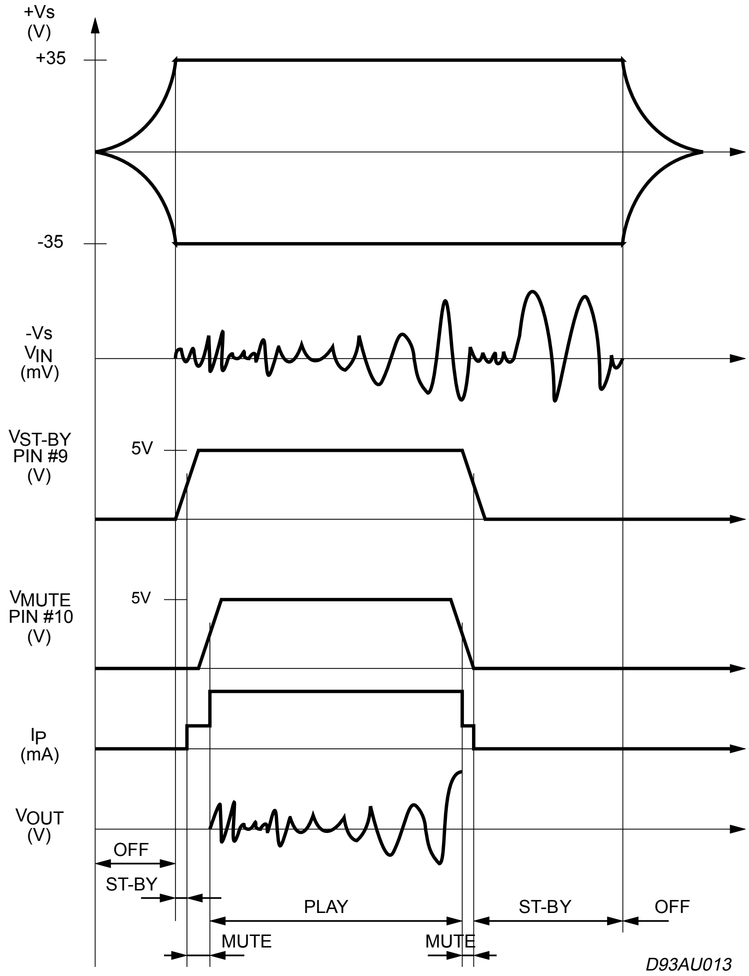


Figure 17. Turn-ON/OFF suggested sequence



In addition to the overload protection described above, the device features a thermal shutdown circuit, which initially puts the device into a muting state (@ T_j = 145 °C) and then into standby (@ T_j = 150 °C).

Full protection against electrostatic discharges on every pin is included.

7.3 Other features

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

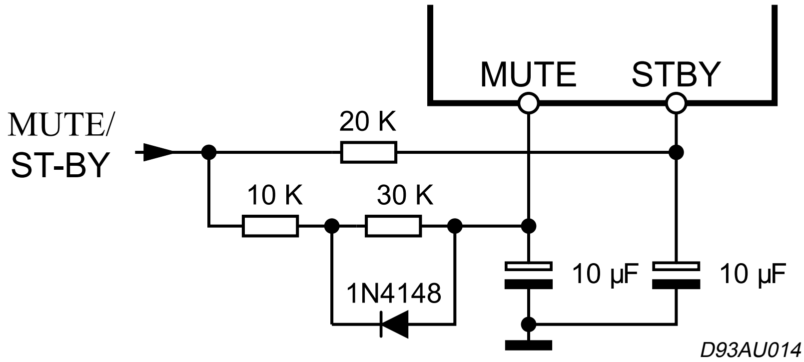
The circuits, dedicated to the switching on and off of the amplifier, have been carefully optimized to avoid any kind of uncontrolled audible transient on the output.

The sequence we recommend during the ON/OFF transients is shown in Figure 16. Principle schematic of a DMOS unity-gain buffer.

The application in Figure 18. Single signal standby/mute control circuit shows the possibility to use only one command for both standby and mute functions.

On both pins, the maximum applicable range matches the operating supply voltage.

Figure 18. **Single signal standby/mute control circuit**



8 Bridge application

Another application suggestion is the bridge configuration, where two TDA7296 are used, as shown by the schematic diagram.

In this application, the value of the load must not be lower than 8 Ω 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 performance with limited supply voltage level
- Considerably high output power even with high load values (i.e. 16 Ω)

The characteristics shown by Figure 21. Distortion vs. output power (R_l= 16 Ω) and Figure 22. Distortion vs. output power (V_S= ± 18 V) , measured with loads respectively 8 Ω and 16 Ω.

With R_l= 8 Ω, V_S = ±18 V the maximum output power obtainable is 60 W, while with R_l=16 Ω, Vs = ±24 V the maximum P_{out} is 60 W.

Figure 19. Bridge application circuit

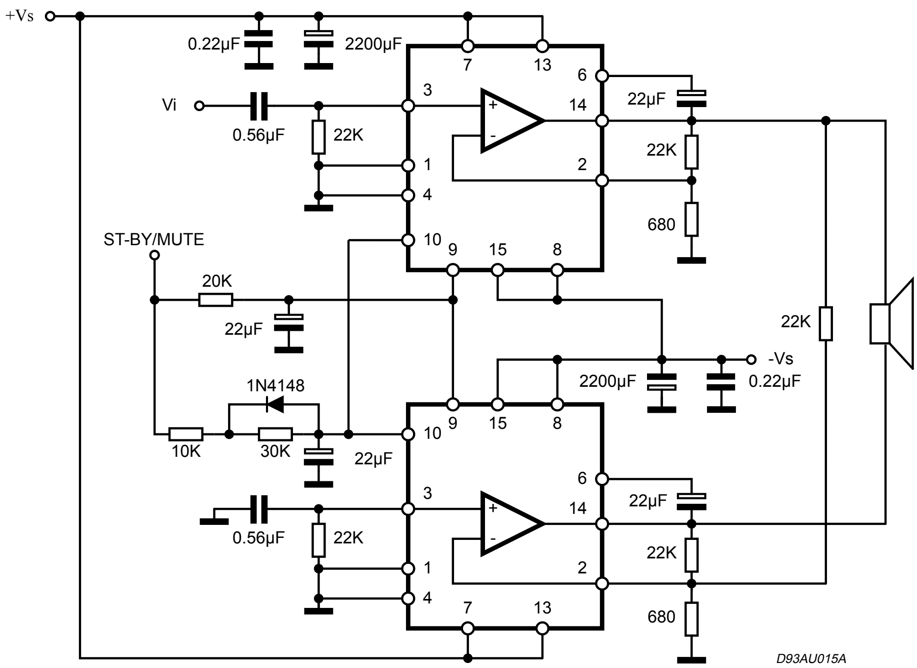


Figure 20. **Frequency response of the bridge application**

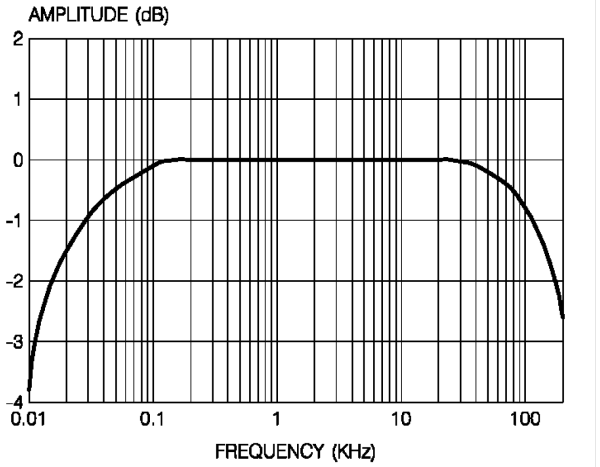


Figure 21. **Distortion vs. output power (R_l= 16 Ω)**

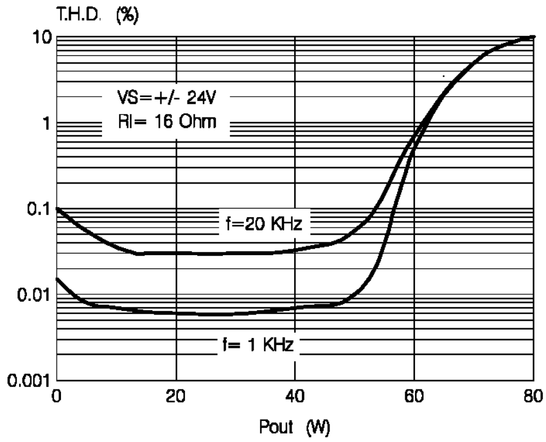
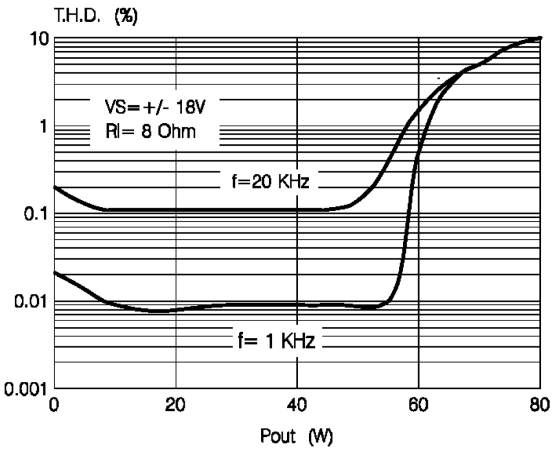


Figure 22. **Distortion vs. output power (V_S= ± 18 V)**



9 Application suggestion

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

Table 4. Application suggestion

Components	Suggested value	Purpose	Larger than suggested	Smaller than suggested
R1 [1]	22 k	Input resistance	Increase input impedance	Decrease input impedance
R2	680 Ω	Closed loop gain set to 30 db[2]	Decrease of gain	Increase of gain
R3[1]	22 k		Increase of gain	Decrease of gain
R4	22 k	Standby time constant	Larger standby on/off time	Smaller standby on/off time; pop noise
R5	10 k	Mute time constant	Larger mute on/off time	Smaller mute on/off time
C1	0.47 µF	Input DC decoupling		Higher low frequency cut-off
C2	22 µF	Feedback DC decoupling		Higher low frequency cut-off
C3	10 µF	Mute time constant	Larger mute on/off time	Smaller mute on/off time
C4	10 µF	Standby time constant	Larger standby on/off time	Smaller standby on/off time; pop noise
C5	22 µF	Bootstrapping		Signal degradation at low frequency
C6, C8	1000 µF	Supply voltage bypass		Danger of oscillation
C7, C9	0.1 µF			

1. *R1= R3 for pop optimization.*
2. *Closed loop gain has to be ≥ 24 dB.*

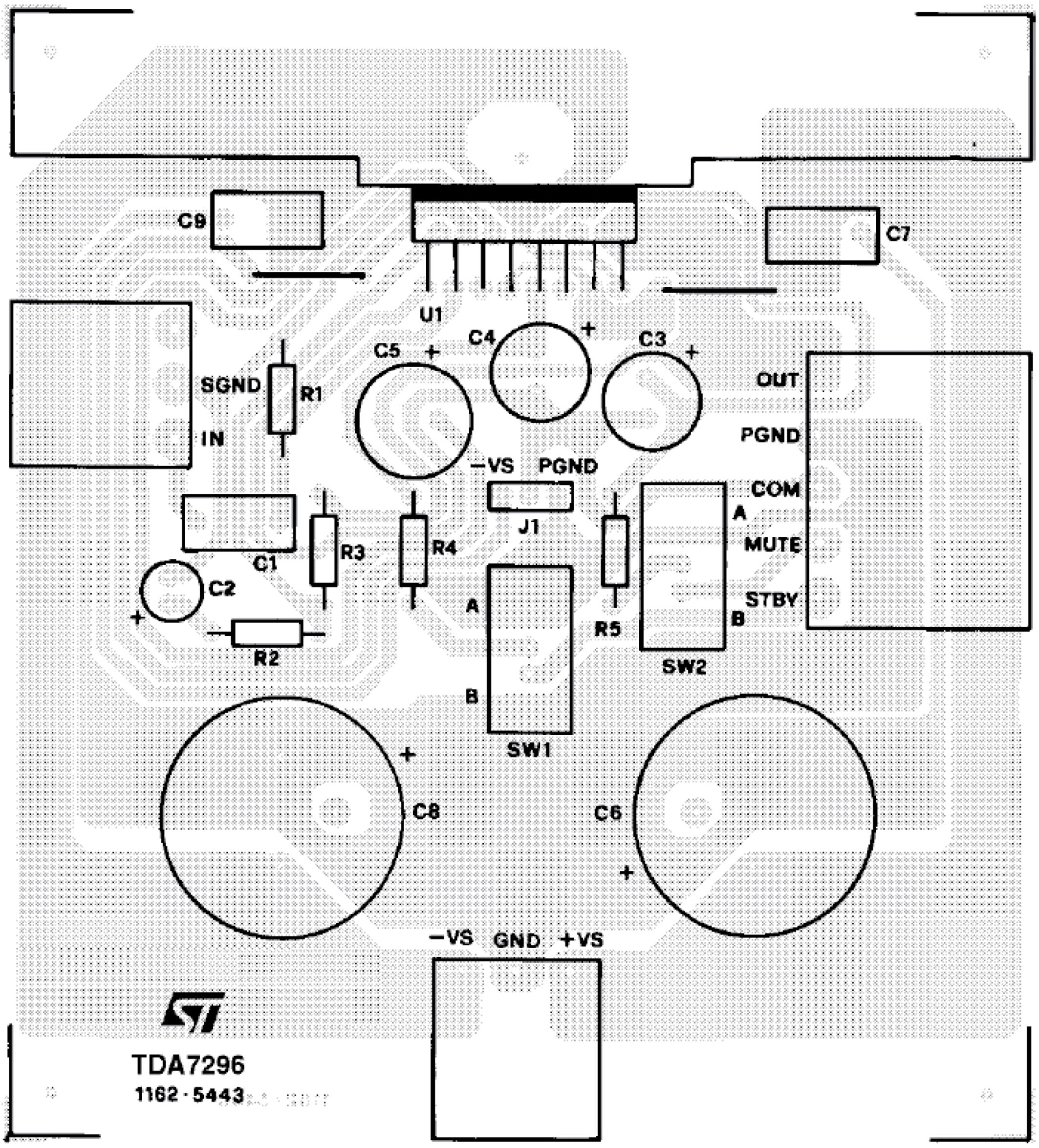


Figure 23. **PCB and component layout of the circuit**

10 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.

10.1 Multiwatt 15 leads package information

Figure 24. Multiwatt 15 leads package outline

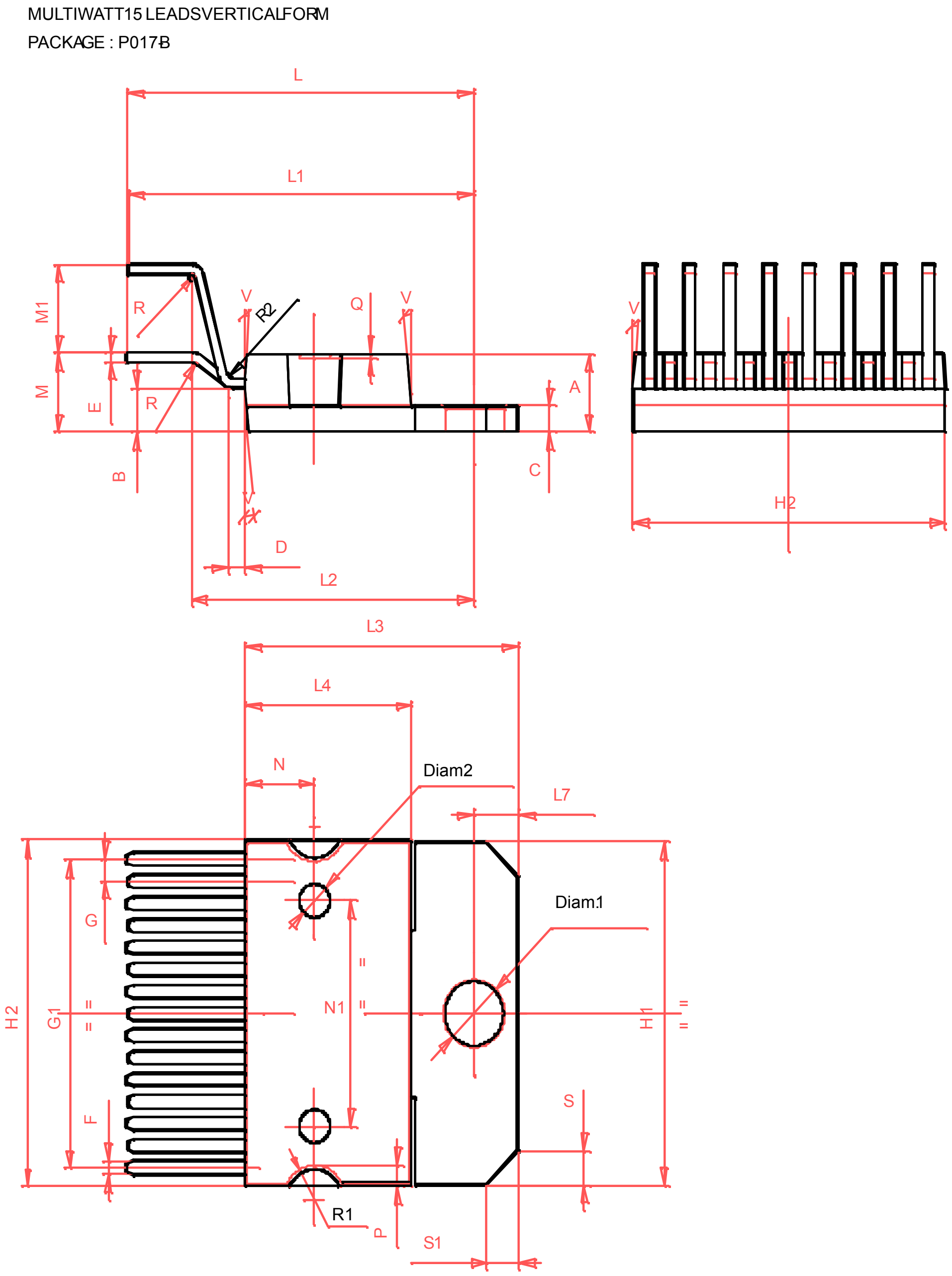


Table 5. Multiwatt 15 leads package mechanical data

Symbol	Milimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.42	4.50	4.58	.174	.177	.180
B	2.45	2.55	2.65	.096	.100	.104
C	1.490	1.515	1.540	.059	.060	.061
D		1.00			.040	
E	0.490	0.515	0.540	.020	.019	.021
F	0.66	0.70	0.72	.026	.028	.029
G	1.12	1.27	1.42	.044	.050	.056
G1	17.63	17.78	17.93	.694	.700	.706
H1	19.65	19.85	20.05	.774	.781	.789
H2	19.90	20.00	20.10	.783	.787	.791
L	22.00	22.20	22.40	.866	.874	.882
L1	21.90	22.10	22.30	.862	.870	.878
L2	17.75	17.88	18.00	.699	.704	.709
L3	17.40	17.50	17.60	.685	.689	.693
L4	10.60	10.70	10.80	.417	.421	.425
L7	2.77	2.80	2.85	.109	.110	.112
M	4.40	4.55	4.70	.173	.179	.185
M1	4.93	5.08	5.23	.194	.200	.206
N		4.60			.179	
N1		13.0			.512	
P		1.20			.047	
Q			0.20			.008
R	0.60		1.20	.023		.047
R1		1.90		.077		
R2			0.40			.016
S	2.10	2.25	2.40	.083	.089	.094
S1	2.10	2.25	2.40	.083	.089	.094
V		5d			5d	
Diam.1	3.70	3.75	3.80	.146	.148	.150
Diam.2		2.00			.079	

Revision history

Table 6. **Document revision history**

Date	Version	Changes
24-Jan-2004	8	First issue in EDOCS DMS.
24-Sep-2004	9	Added package Multiwatt15 horizontal (short leads)
24-Feb-2005	10	Corrected mistyping error in table 2.
03-Dec-2018	11	Removed package "Multiwatt15 horizontal (short leads)" and the whole document has been updated accordingly.

Contents