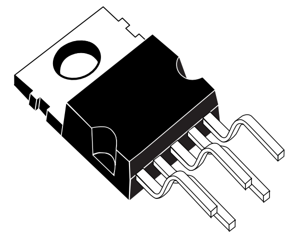
TDA2040

20-watt hi-fi audio power amplifier

Features

- Wide supply voltage range, up to 40 V
- Single or split supply operation
- Short-circuit protection to ground
- Thermal shutdown



Pentawatt V

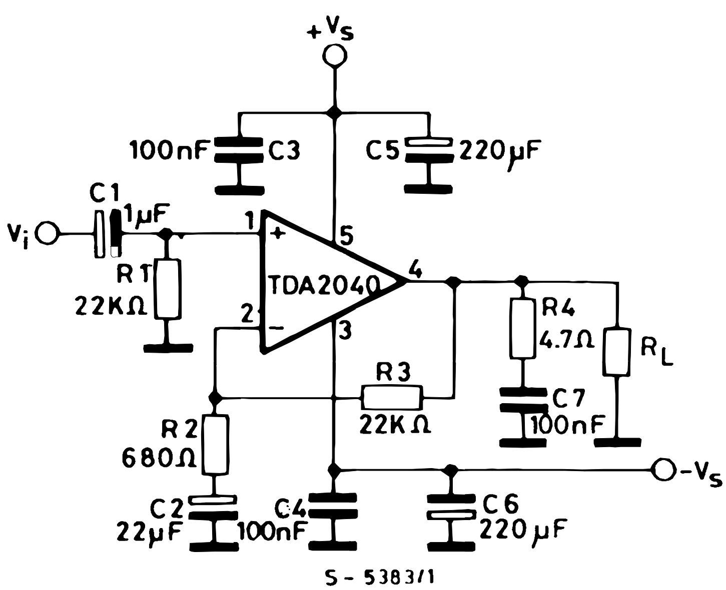
Description

The TDA2040 is a monolithic integrated circuit in Pentawatt® package, intended for use as an audio class AB amplifier. Typically, it provides 22 W output power into 4 Ω with THD = 0.5% at Vs = 32 V. The TDA2040 provides high output current and has very low harmonic and crossover distortion. Furthermore, the device incorporates a 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 thermal shut-down system is also included.

Table 1. Device summary

Order code	Package
TDA2040V	Pentawatt V (vertical)

Figure 1. TDA2040 test circuit



1 Pin connections

Figure 2. Schematic diagram

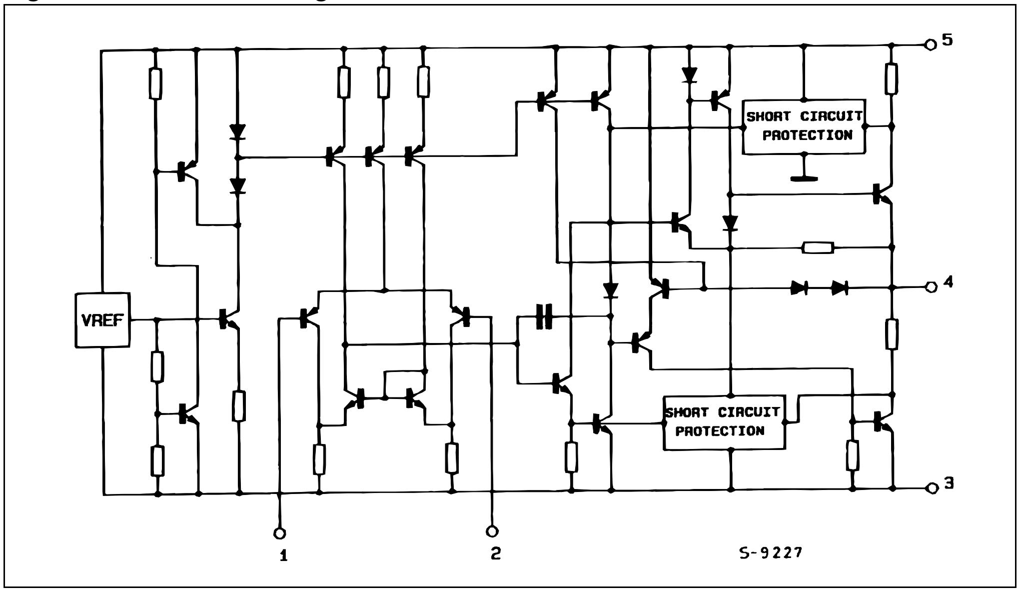
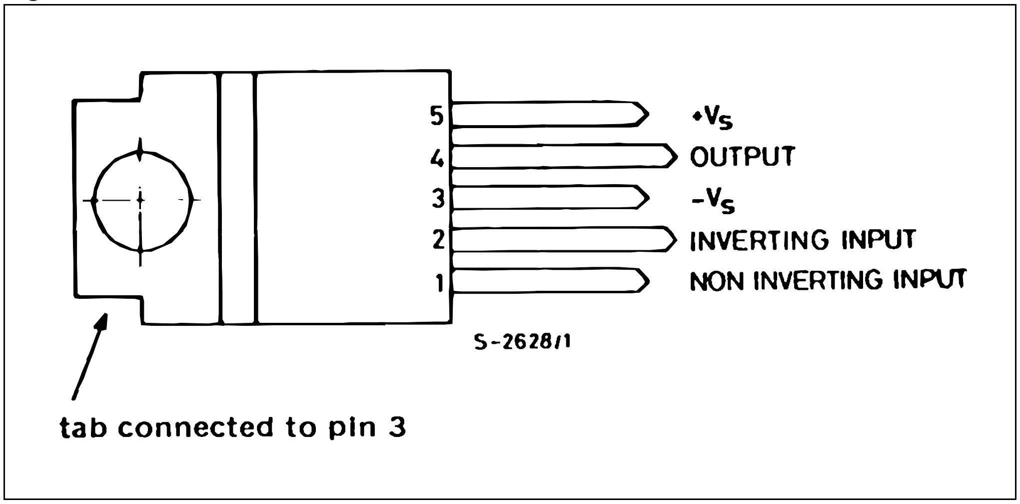


Figure 3. Pin connections



2 Electrical specifications

2.1 Absolute maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
Vs	Supply voltage	±20	V
Vi	Input voltage	Vs	
Vi	Differential input voltage	±15	V
Io	Output peak current (internally limited)	4	A
P_{tot}	Power dissipation at Tcase = 75 °C	25	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	°C
V_{ESD_HBM}	ESD maximum withstanding voltage range, test condition CDF-AEC-Q100-002- "Human body model"	±1500	V

2.2 Thermal data

Table 3. Thermal data

Symbol	Parameter	Min	Typ	Max	Unit
$R_{th\_j\text{-}case}$	Thermal resistance junction to case	-	-	3	°C/W

2.3 Electrical characteristics

The specifications given here were obtained with the conditions V_S = ±16 V, T_{amb} = 25 °C unless otherwise specified.

Table 4. Electrical characteristics

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V_S	Supply voltage	-	±4.5	-	±20	V
I_d	Quiescent drain current	V_S = ±4.5 V V_S = ±20 V	-	- 45	30 100	mA mA
I_b	Input bias current	V_S = ±20 V	-	0.3	1	µA
V_{OS}	Input offset voltage	V_S = ±20 V	-	±2	±20	mV
I_{OS}	Input offset current	-	-		±200	nA

Table 4. Electrical characteristics (continued)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
P_o	Output power	d = 0.5%, f = 1 kHz, T_{amb} = 60 °C R_L = 4 Ω R_L = 8 Ω	 20 -	 22 12	 - -	W
		d = 0.5%, f = 15 kHz; T_{amb} = 60 °C R_L = 4 Ω	15	18	-	
BW	Power bandwidth	P_o = 1 W, R_L = 4 Ω	-	100	-	Hz
G_{vOL}	Voltage gain (open loop)	f = 1 kHz	-	80	-	dB
G_v	Voltage gain (closed loop)	f = 1 kHz	29.5	30	30.5	dB
d	Total harmonic distortion	P_o = 0.1 to 10 W, R_L = 4 Ω, f = 40 to 15000 Hz	-	0.08	-	%
		P_o = 0.1 to 10 W, R_L = 4 Ω, f = 1 kHz	-	0.03	-	%
e_N	Input noise voltage	B = Curve A B = 22 Hz to 22 kHz	- -	2 3	- 10	µV
I_N	Input noise current	B = Curve A B = 22 Hz to 22 kHz	- -	50 80	- 200	pA
R_i	Input resistance (pin 1)	-	0.5	5	-	MΩ
SVRR	Supply voltage rejection ratio	G_V = 30 dB, R_L = 4 Ω, R_g = 22 kΩ, f = 100 Hz V_{ripple} = 0.5 V RMS	40	50	-	dB
h	Efficiency	f = 1 kHz P_o = 12 W, R_L = 8 Ω P_o = 22 W, R_L = 4 Ω	 - -	 66 63	 - -	%
T_j	Thermal shutdown junction temperature	-	-	-	145	°C

2.4 Characterizations

Figure 4. Output power vs supply voltage

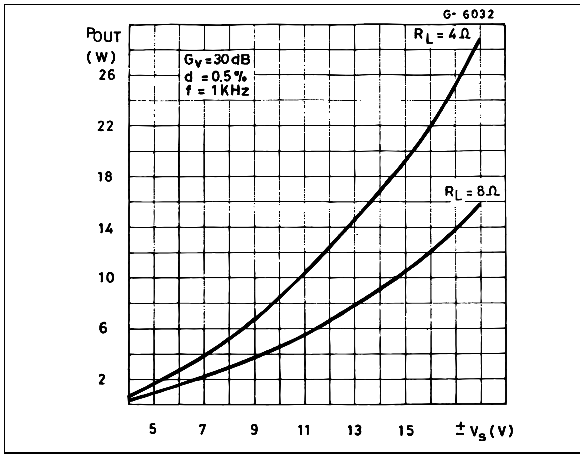


Figure 5. Output power vs supply voltage

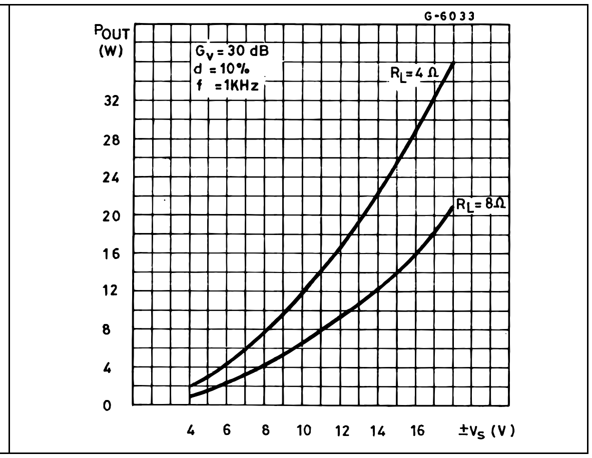


Figure 6. Output power vs supply voltage

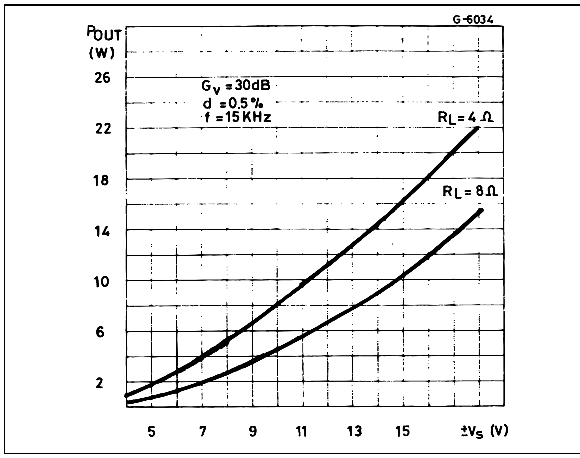


Figure 7. Distortion vs frequency

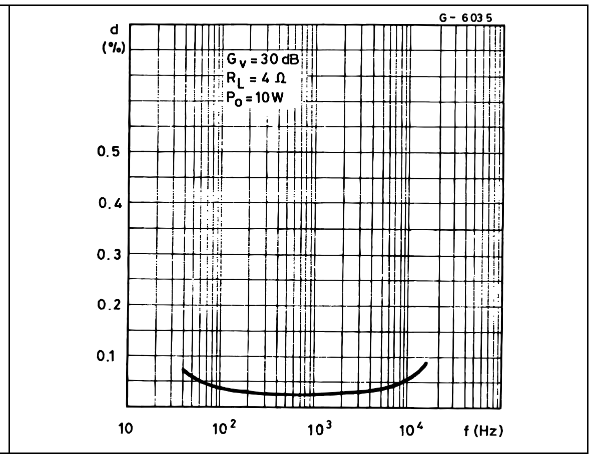


Figure 8. SVRR vs frequency

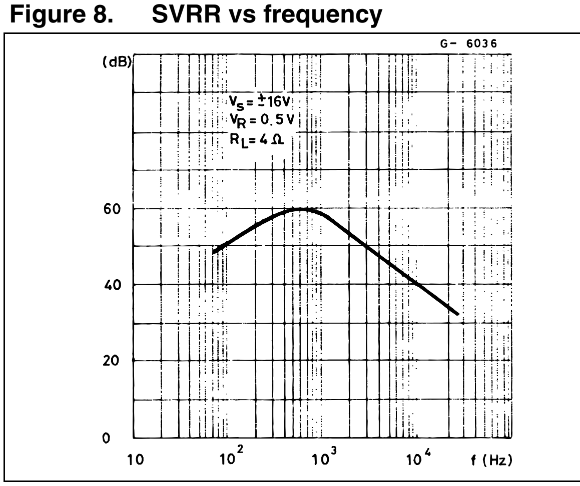


Figure 9. SVRR vs voltage gain

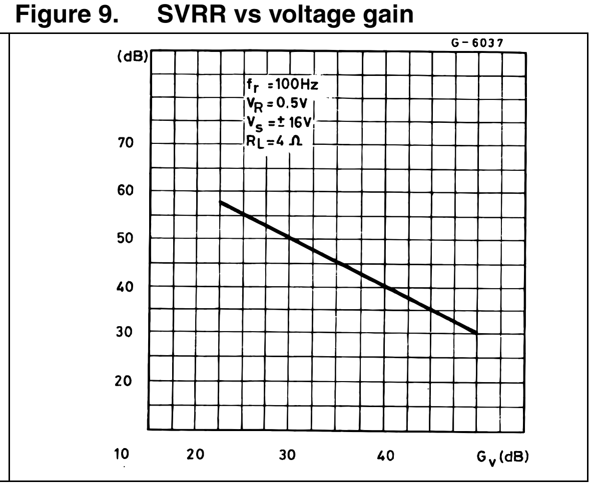


Figure 10. Quiescent drain current vs supply voltage

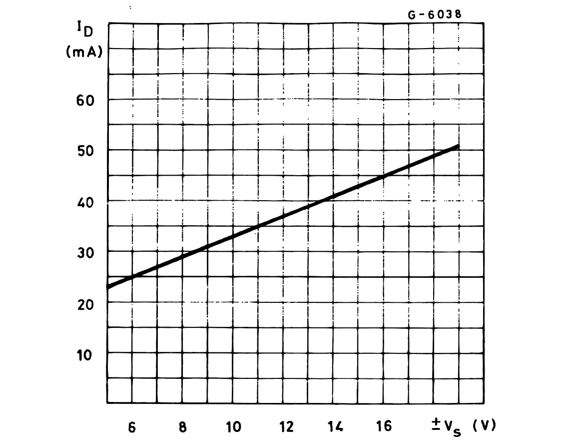


Figure 11. Open loop gain vs frequency

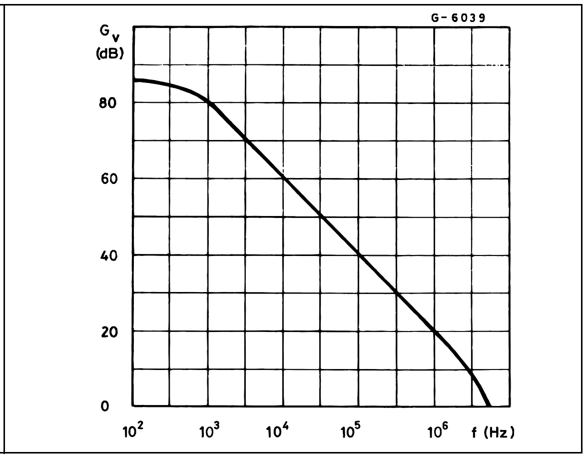
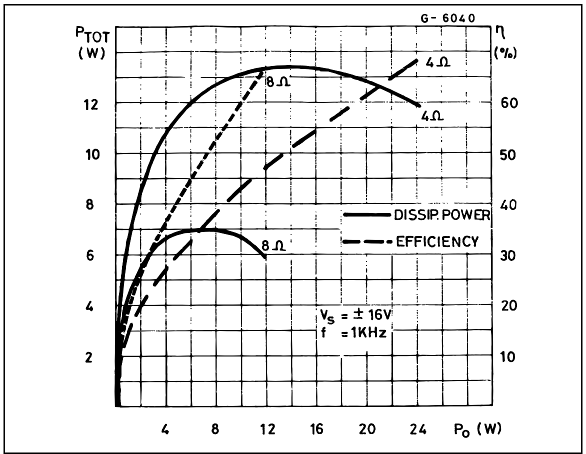


Figure 12. Power dissipation vs output power



3 Applications

3.1 Circuits and PCB layouts

Figure 13. Amplifier with split power supply

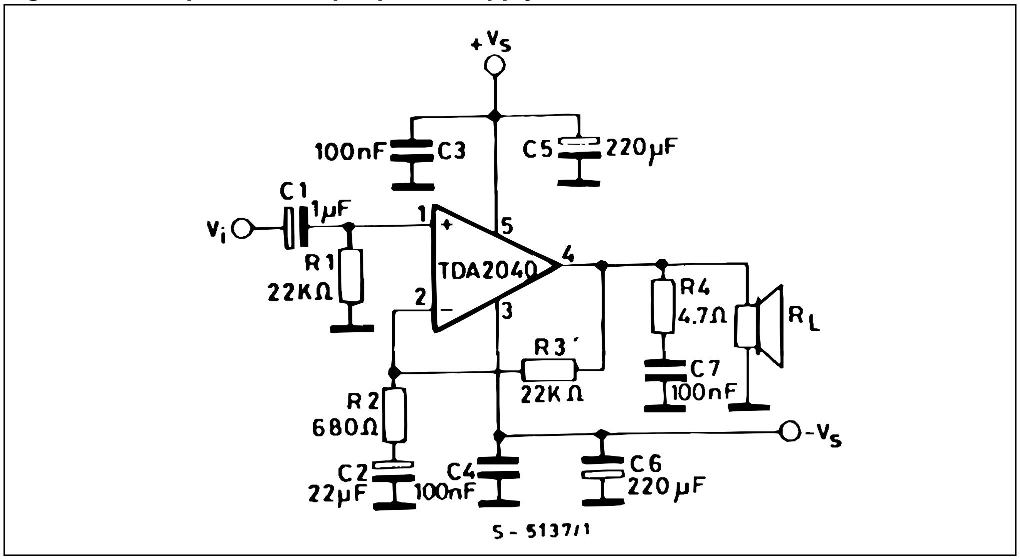


Figure 14. PCB and components layout for the circuit of *Figure 13*

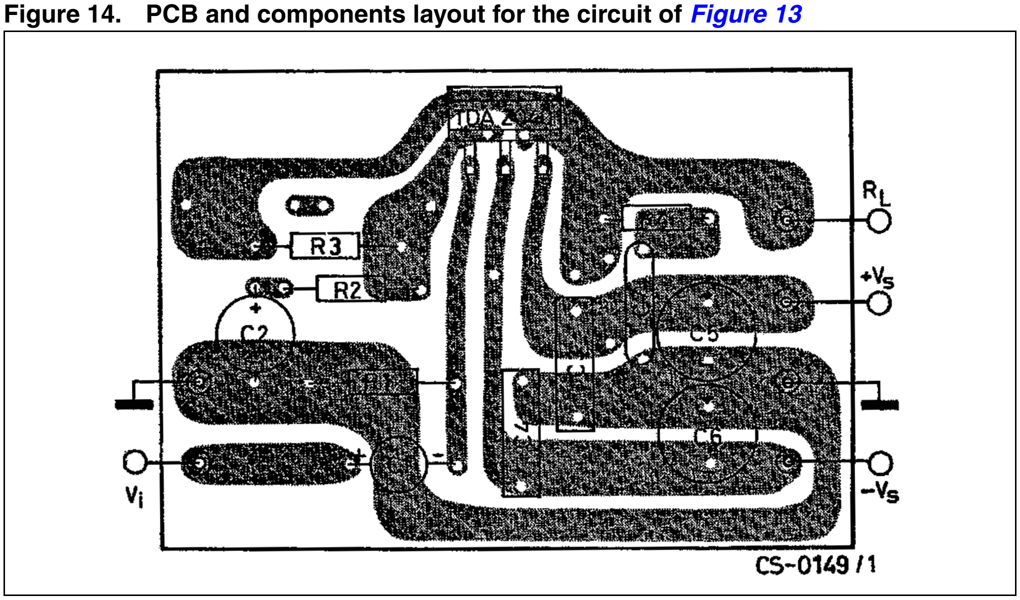
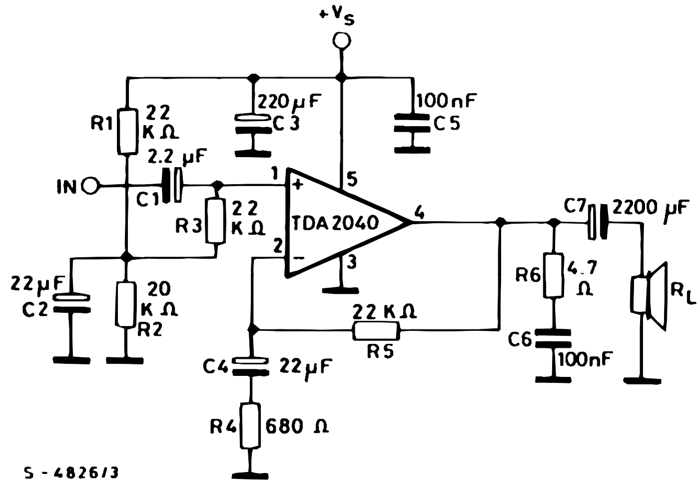


Figure 15. Amplifier with single power supply



Note : In this case of highly inductive loads protection diodes may be necessary.

Figure 16. PCB and components layout for the circuit of *Figure 15*

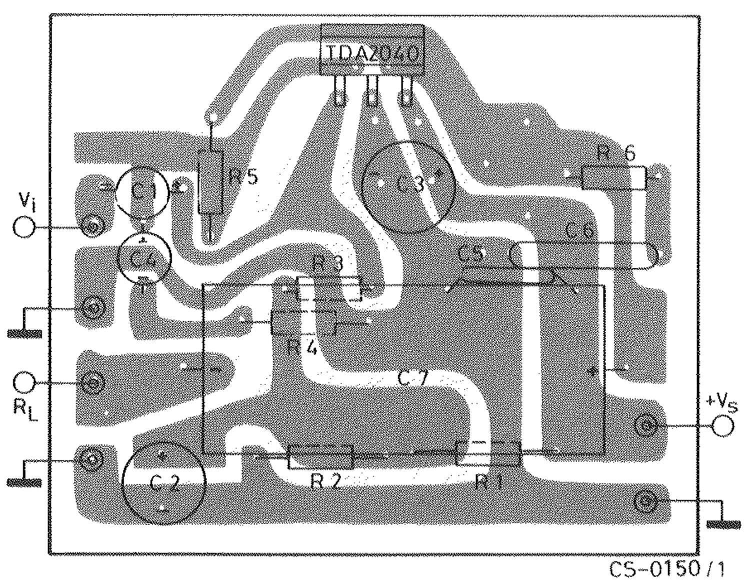


Figure 17. 30-watt bridge amplifier with split power supply

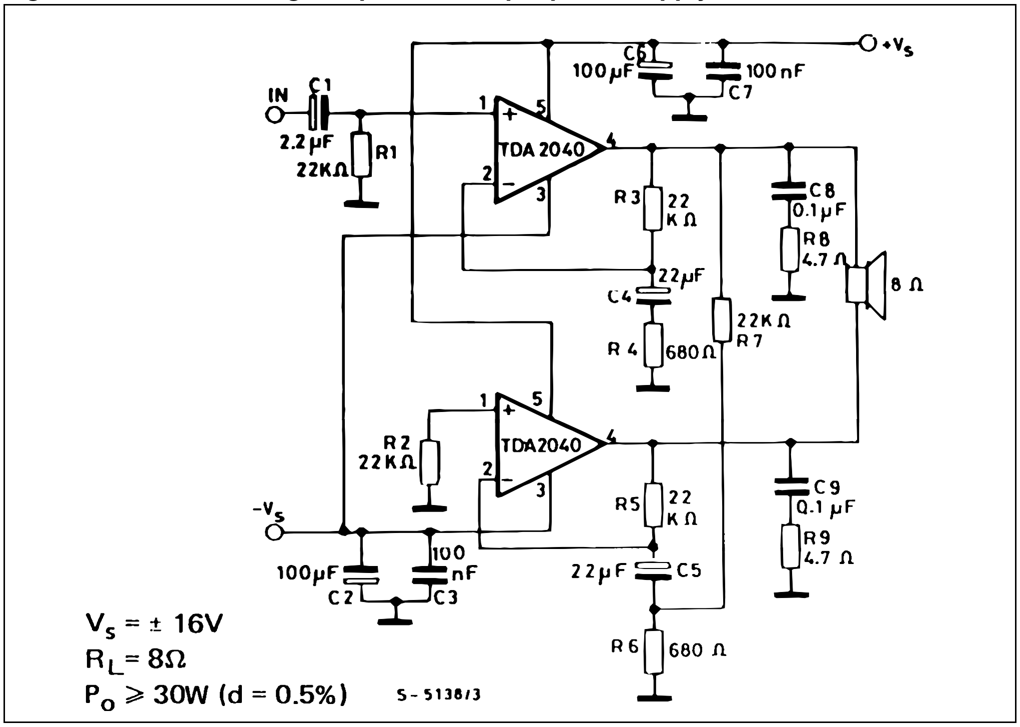


Figure 18. PCB and components layout for the circuit of *Figure 17*

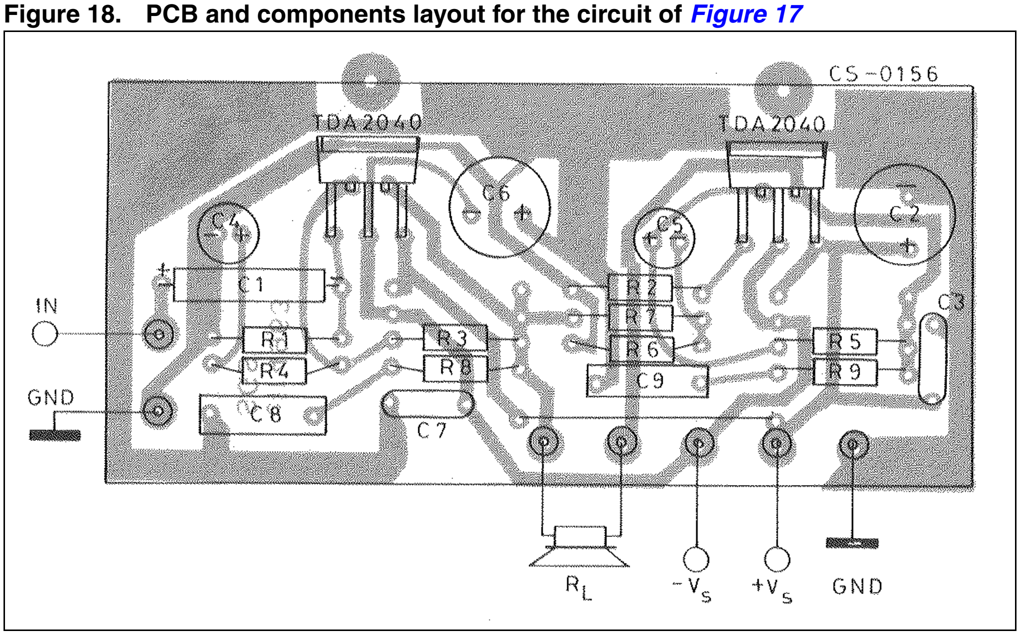


Figure 19. Two-way hi-fi system with active crossover

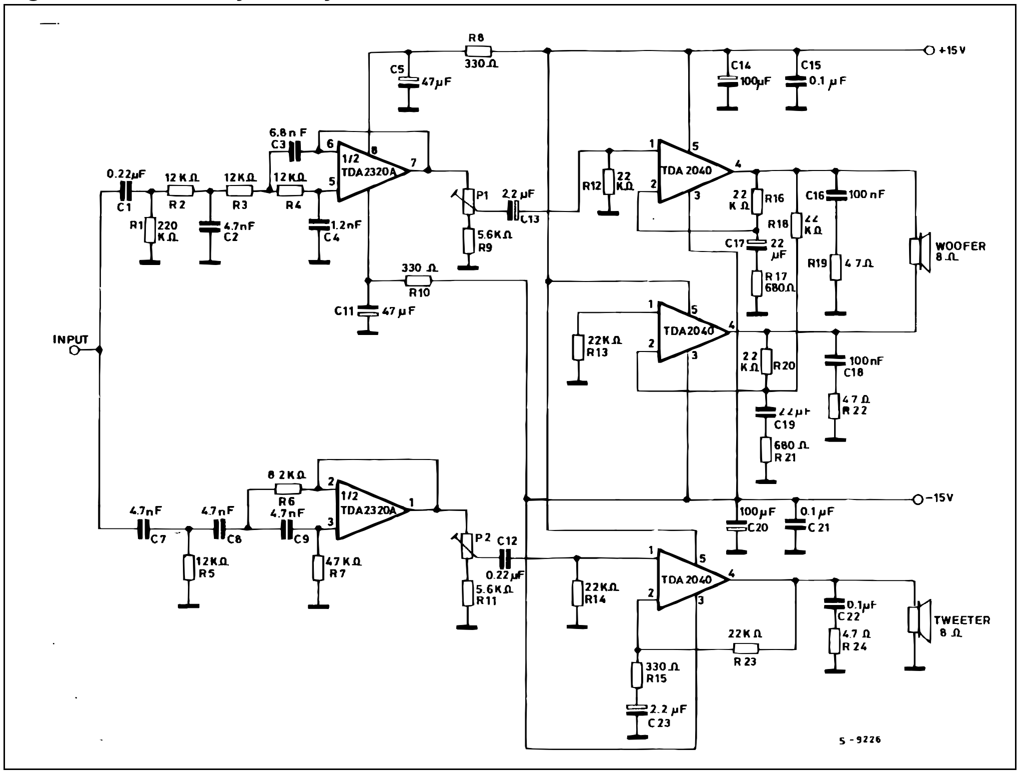
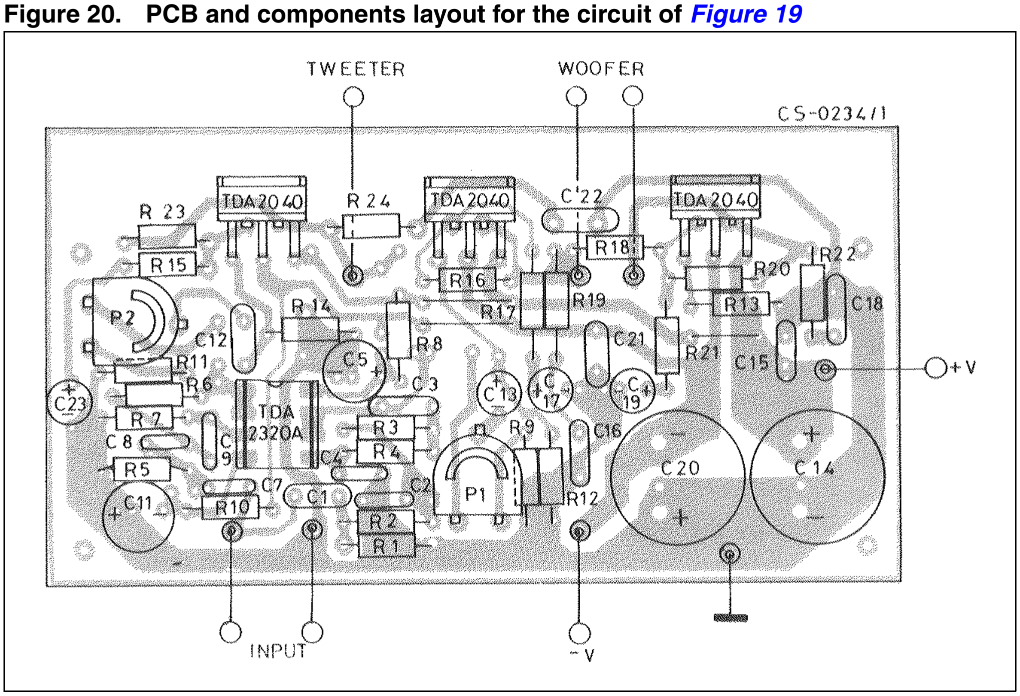


Figure 20. PCB and components layout for the circuit of *Figure 19*



3.2 Multiway speaker systems and active boxes

Multiway loudspeaker systems provide the best possible acoustic performance since each loudspeaker is specially designed and optimized to handle a limited range of frequencies. Commonly, these loudspeaker systems divide the audio spectrum into two, three or four bands.

Figure 21. Frequency response

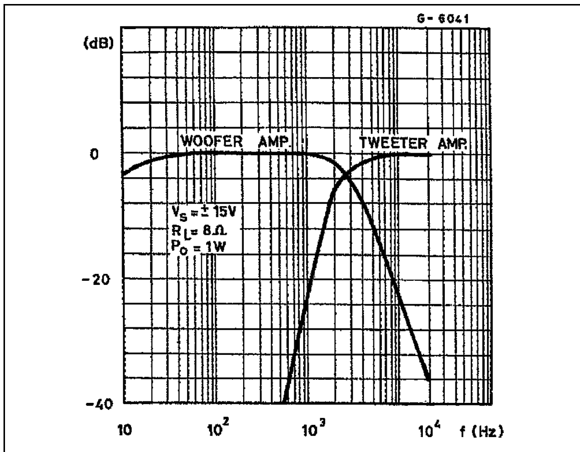
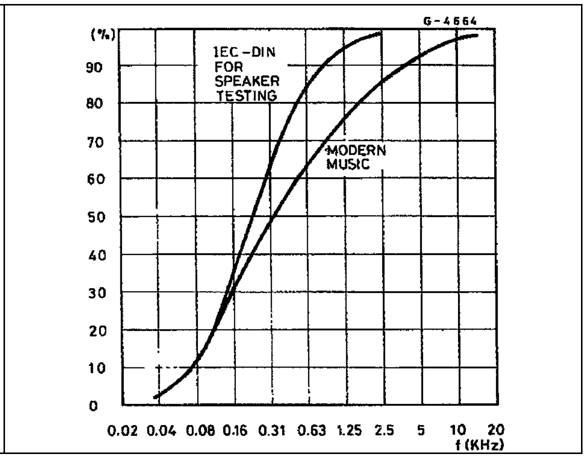


Figure 22. Power distribution vs frequency



To maintain a flat frequency response over the hi-fi audio range the bands covered by each loudspeaker must overlap slightly. Any imbalance between the loudspeakers produces unacceptable results, therefore, it is important to ensure that each unit generates the correct amount of acoustic energy for its segment of the audio spectrum. In this respect it is also important to know the energy distribution of the music spectrum (see Figure 22) in order to determine the cut-off frequencies of the crossover filters. As an example, a 100-W three-way system with crossover frequencies of 400 Hz and 3 kHz would require 50 W for the woofer, 35 W for the midrange unit and 15 W for the tweeter.

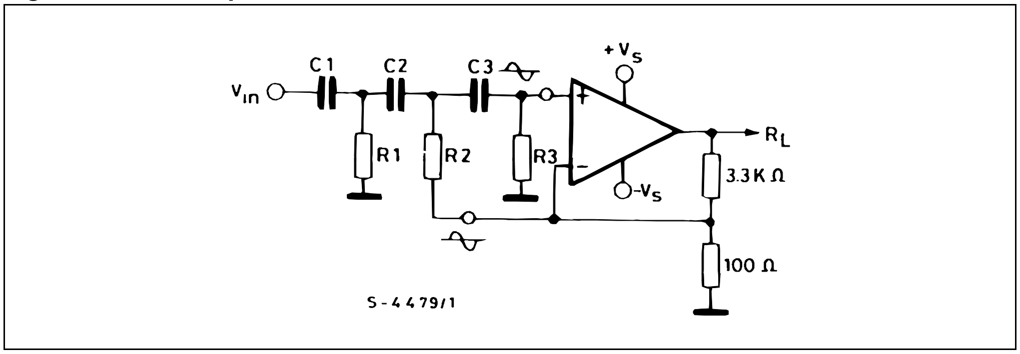
Both active and passive filters can be used for crossovers but today active filters cost significantly less than a good passive filter using air-cored inductors and non-electrolytic capacitors. In addition, active filters do not suffer from the typical defects of passive filters:

- power loss
- increased impedance seen by the loudspeaker (lower damping)
- difficulty of precise design due to variable loudspeaker impedance

Obviously, active crossovers can only be used if a power amplifier is provided for each drive unit. This makes it particularly interesting and economically sound to use monolithic power amplifiers.

In some applications, complex filters are not really necessary and simple RC low-pass and high-pass networks (6 dB/octave) can be recommended. The results obtained are excellent because this is the best type of audio filter and the only one free from phase and transient distortion. The rather poor out of band attenuation of single RC filters means that the loudspeaker must operate linearly well beyond the crossover frequency to avoid distortion.

Figure 23. Active power filter



A more effective solution, named "Active Power Filter" by STMicroelectronics, is shown in *Figure 23*. The proposed circuit can be realized by combined power amplifiers and 12-dB/octave or 18-dB/octave high-pass or low-pass filters.

The component values calculated for fc = 900Hz using a Bessel 3rd order Sallen and Key structure are:

C1 = C2 = C3 = 22 nF

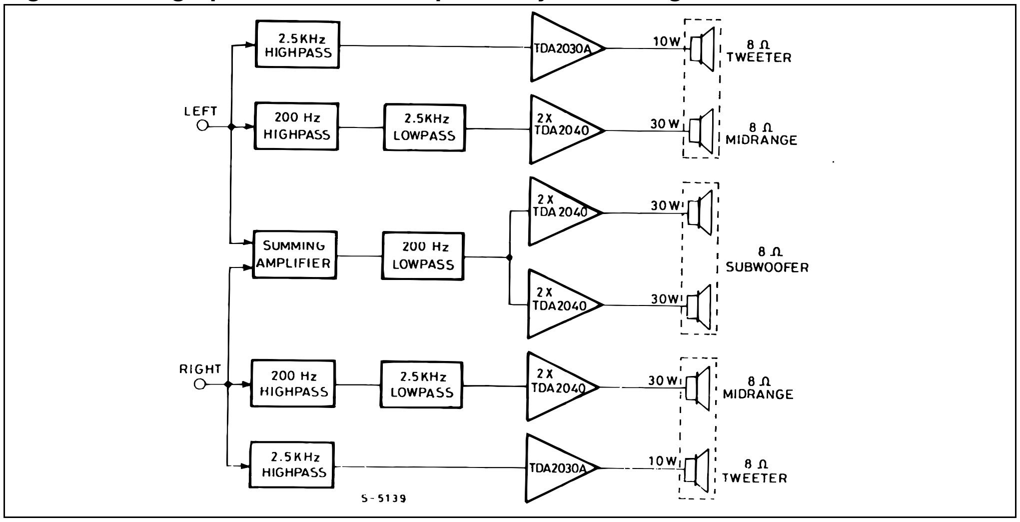
R1 = 8.2 kΩ

R2 = 5.6 kΩ

R3 = 33 kΩ

In the block diagram of Figure 24 is represented an active loudspeaker system completely realized using power integrated circuit, rather than the traditional discrete transistors on hybrids, very high quality is obtained by driving the audio spectrum into three bands using active crossovers (TDA2320A) and a separate amplifier and loudspeakers for each band. A modern subwoofer/midrange/tweeter solution is used.

Figure 24. High-power active loudspeaker system using TDA2030A and TDA2040



3.3 Pratical consideration

3.3.1 Printed circuit board

The layout shown in Figure 14 should be adopted by the designers. If different layouts are used, the ground points of input 1 and input 2 must be well decoupled from the ground return of the output in which a high current flows.

3.3.2 Assembly suggestion

No electrical isolation is needed between the package and the heatsink with single supply voltage configuration.

3.3.3 Application suggestions

The recommended values of the components are those shown on application circuit of *Figure 13*. However, if different values are chosen then the following table can be helpful.

Table 5. Variations from recommended values

Component	Recommended value	Purpose	Larger than recommended value	Smaller than recommended value
R1	22 kΩ	Non-inverting input biasing	Increase in input impedance	Decrease in input impedance
R2	680 Ω	Closed-loop gain setting	Decrease in gain (1)	Increase in gain
R3	22 kΩ	Closed-loop gain setting	Increase in gain	Decrease in gain (1)
R4	4.7 Ω	Frequency stability	Danger of oscillation at high frequencies with inductive loads	-
C1	1 µF	Input DC decoupling	-	Increase in low-frequency cut-off
C2	22 µF	Inverting DC decoupling	-	Increase in low-frequency cut-off
C3, C4	0.1 µF	Supply voltage bypass	-	Danger of oscillation
C5, C6	220µF	Supply voltage bypass	-	Danger of oscillation
C7	0.1µF	Frequency stability	-	Danger of oscillation

1. The value of closed loop gain must be higher than 24 dB

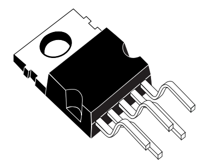
4 Package mechanical data

Figure 25. Pentawatt V outline drawing

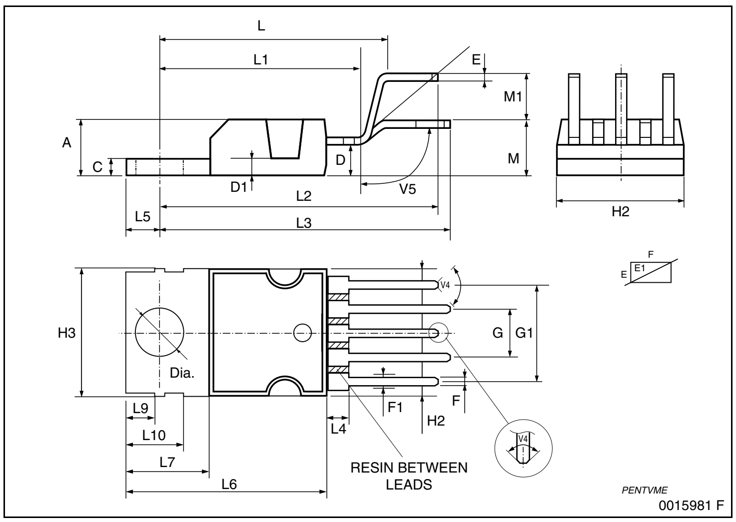
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.80			0.188
C			1.37			0.054
D	2.40		2.80	0.094		0.11
D1	1.20		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
E1	0.76		1.19	0.030		0.047
F	0.80		1.05	0.031		0.041
F1	1.00		1.40	0.039		0.055
G	3.20	3.40	3.60	0.126	0.134	0.142
G1	6.60	6.80	7.00	0.260	0.267	0.275
H2			10.40			0.41
H3	10.05		10.40	0.395		0.409
L	17.55	17.85	18.15	0.691	0.703	0.715
L1	15.55	15.75	15.95	0.612	0.620	0.628
L2	21.2	21.4	21.6	0.831	0.843	0.850
L3	22.3	22.5	22.7	0.878	0.886	0.894
L4			1.29			0.051
L5	2.60		3.00	0.102		0.118
L6	15.10		15.80	0.594		0.622
L7	6.00		6.60	0.236		0.260
L9	2.10		2.70	0.083		0.106
L10	4.30		4.80	0.170		0.189
M	4.23	4.5	4.75	0.167	0.178	0.187
M1	3.75	4.0	4.25	0.148	0.157	0.187
V4	40° (Typ.)					
V5	90° (Typ.)					
DIA	3.65		3.85	0.143		0.151

OUTLINE AND MECHANICAL DATA

Weight: 2.00gr



Pentawatt V



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.

5 Revision history

Table 6. Document revision history

Date	Revision	Changes
Apr-2003	3	Changes not recorded
28-Oct-2010	4	Added features list on page 1 Updated minimum supply voltage to ±4.5 V in *Table 4 on page 3* Corrected the title of *Figure 15 on page 8* Updated presentation

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