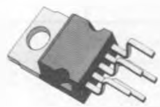
SGS-THOMSON MICROELECTRONICS

TDA2040

20W Hi-Fi AUDIO POWER AMPLIFIER

The TDA2040 is a monolithic integrated circuit in Pentawatt® package, intended for use as an audio class AB amplifier. Typically it provides 22W output power (d = 0.5%) at $V_s = 32V/4\Omega$. The TDA2040 provides high output current and has very low harmonic and cross-over distortion. Further 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.



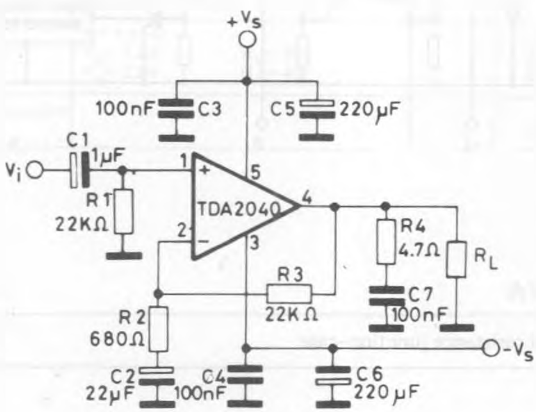
Pentawatt

ORDERING NUMBER: TDA2040V
TDA2040H

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	± 20	V
V_i	Input voltage	V_s	
V_i	Differential input voltage	± 15	V
I_o	Output peak current (internally limited)	4	A
P_{tot}	Power dissipation at T_{case} = 75°C	25	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	°C

TEST CIRCUIT



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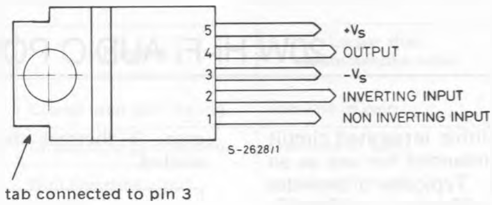
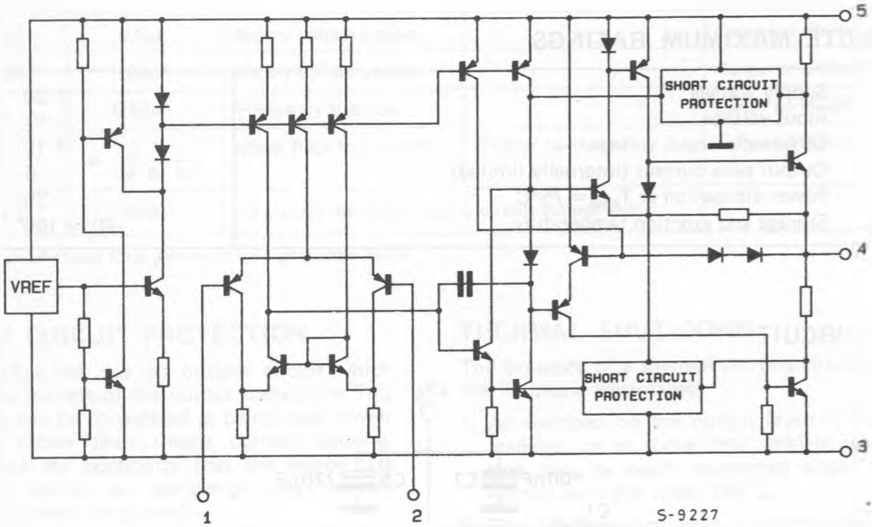
CONNECTION DIAGRAM

(Top view)



SCHEMATIC DIAGRAM



THERMAL DATA

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

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, V_s = ±16V, T_{amb} = 25°C unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s	Supply voltage		± 2.5		± 20	V
I_d	Quiescent drain current	V_s = ± 4.5V			30	mA
		V_s = ± 20V		45	100	mA
I_b	Input bias current	V_s = ± 20V		0.3	1	μA
V_{os}	Input offset voltage	V_s = ± 20V		± 2	± 20	mV
I_{os}	Input offset current				±200	nA
P_o	Output power	d = 0.5% T_{case} = 60°C f = 1 KHz R_L = 4Ω R_L = 8Ω	20	22 12		W
		f = 15 KHz R_L = 4Ω	15	18		W
BW	Power bandwidth	P_o = 1W R_L = 4Ω		100		KHz
G_v	Open loop voltage gain	f = 1 KHz		80		dB
G_v	Closed loop voltage gain	f = 1 KHz	29.5	30	30.5	dB
d	Total harmonic distortion	P_o = 0.1 to 10W R_L = 4Ω f = 40 to 15000Hz f = 1 KHz		0.08 0.03		%
e_N	Input noise voltage	B = curve A		2		μV
		B = 22 Hz to 22 KHz		3	10	μV
i_N	Input noise current	B = curve A		50		pA
		B = 22 Hz to 22 KHz		80	200	pA
R_i	Input resistance (pin 1)		0.5	5		MΩ
SVR	Supply voltage rejection	R_L = 4Ω G_v = 30 dB R_g = 22 KΩ f = 100 Hz V_{ripple} = 0.5 V_{rms}	40	50		dB
η	Efficiency	f = 1 KHz P_o = 12W R_L = 8Ω P_o = 22W R_L = 4Ω		66 63		%
T_j	Thermal shut-down junction temperature			145		°C

Fig. 1 - Output power vs. supply voltage

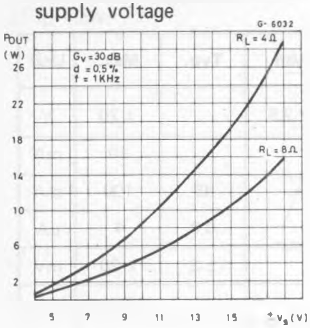


Fig. 2 - Output power vs. supply voltage

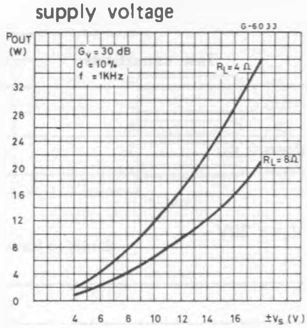


Fig. 3 - Output power vs. supply voltage

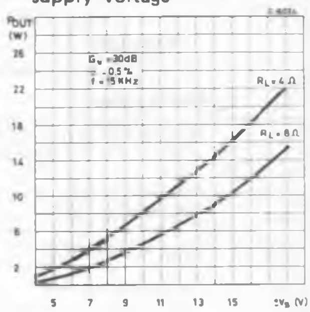


Fig. 4 - Distortion vs. frequency

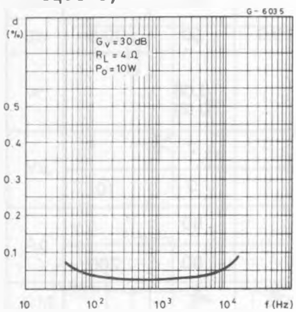


Fig. 5 - Supply voltage rejection vs. frequency

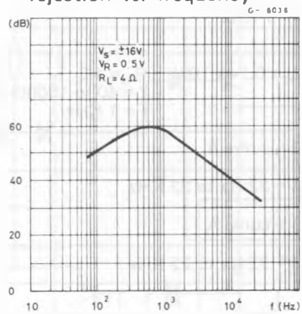


Fig. 6 - Supply voltage rejection vs. voltage gain

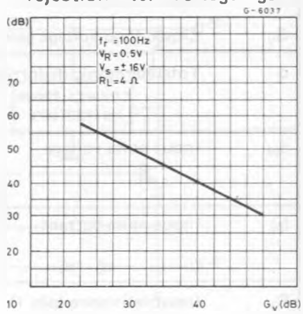


Fig. 7 - Quiescent drain current vs. supply voltage

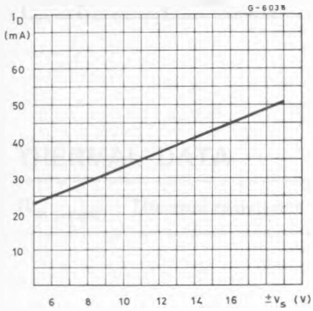


Fig. 8 - Open loop gain vs. frequency

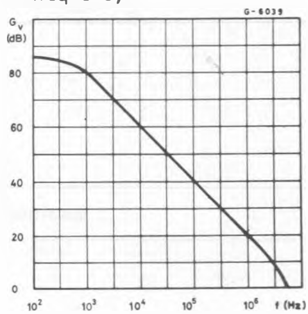
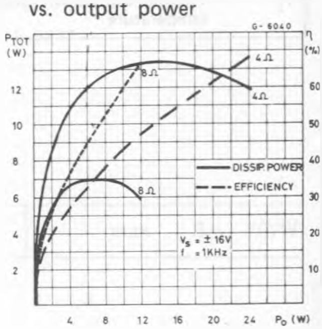
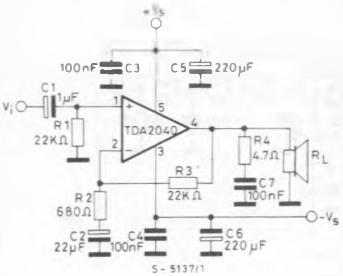


Fig. 9 - Power dissipation vs. output power



APPLICATION INFORMATION

Fig. 10 - Amplifier with split power supply (*)



$V_s = \pm 16V$
$R_L = 4\Omega$
$P_o \geqslant 15W$ (d = 0.5%)

Fig. 11 - P.C. board and components layout of the circuit of fig. 10 (1:1 scale)

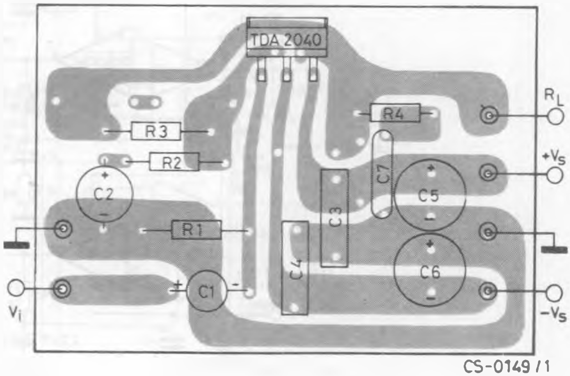


Fig. 12 - Amplifier with single supply (*)

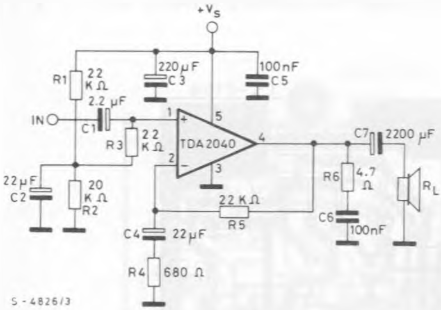
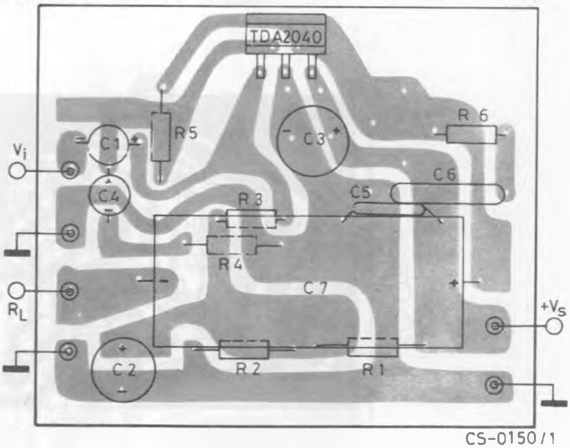


Fig. 13 - P.C. board and components layout of the circuit of fig. 12 (1:1 scale)



* In the case of highly inductive loads protection diodes may be necessary.

APPLICATION INFORMATION (continued)

Fig. 14 - 30W Bridge amplifier with split power supply

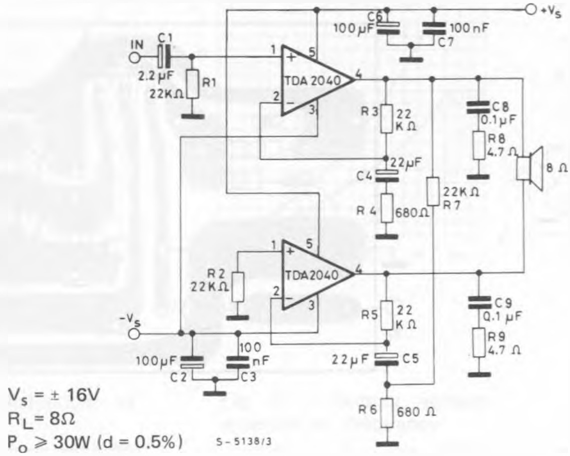
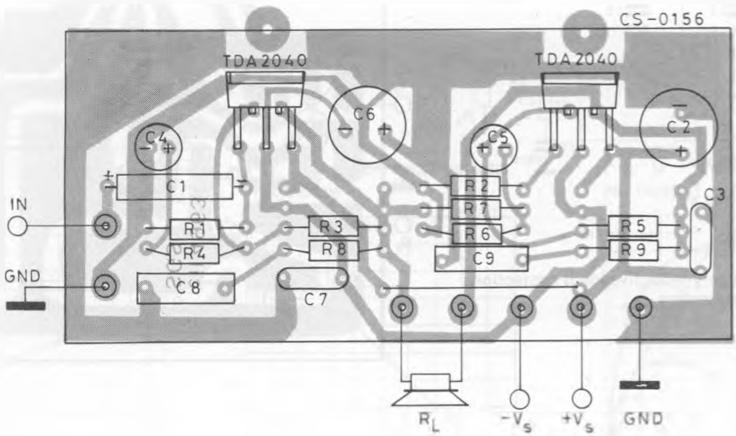


Fig. 15 - P.C. board and components layout for the circuit of fig. 14 (1:1 scale)



APPLICATION INFORMATION (continued)

Fig. 16 - Two way Hi-Fi system with active crossover

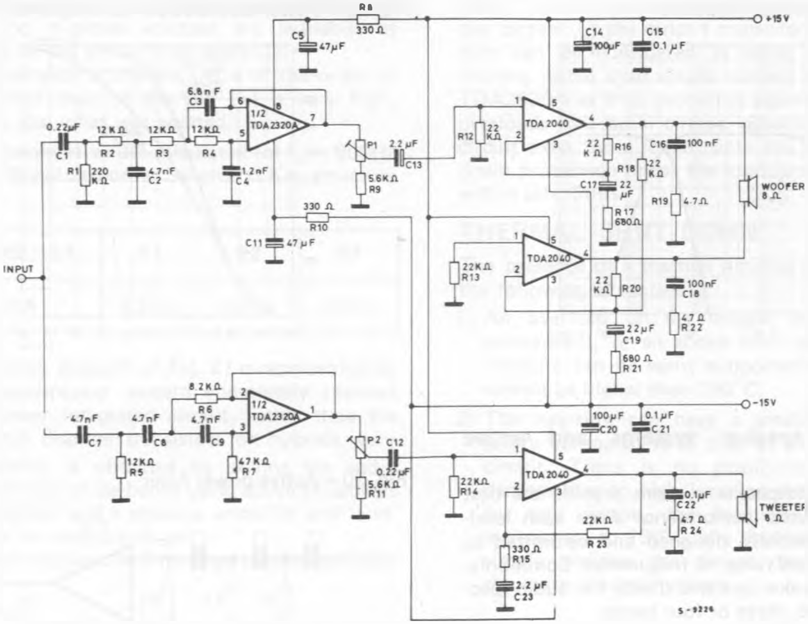
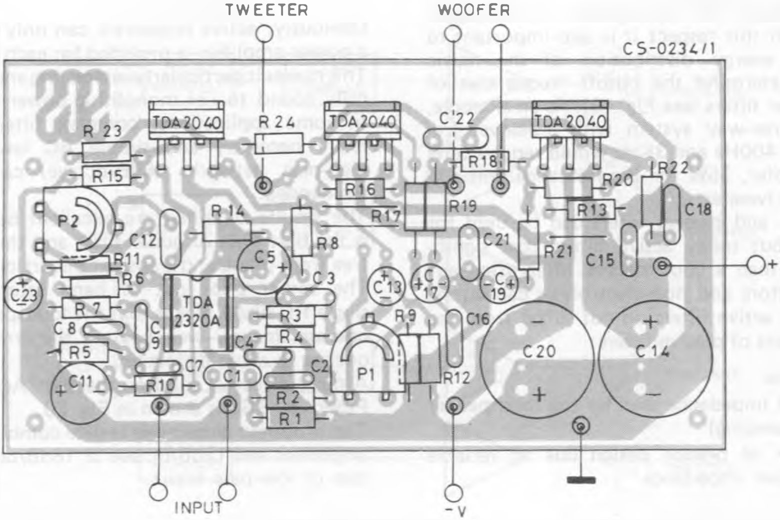


Fig. 17 - P.C. board and component layout of the circuit of fig. 16 (1:1 scale)



APPLICATION INFORMATION (continued)

Fig. 18 - Frequency response

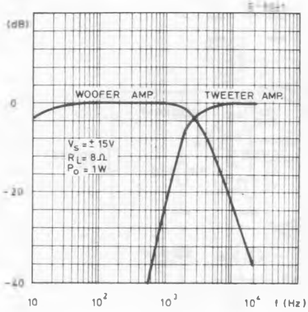
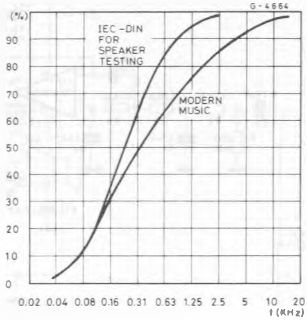


Fig. 19 - Power distribution vs. frequency



Multiway speaker systems and active boxes

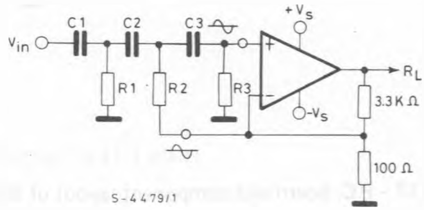
Multiway loudspeaker systems provide the best possible acoustic performance since each loudspeaker is specially designed and optimized to handle a limited range of frequencies. Commonly, these loudspeaker systems divide the audio spectrum into two, three or four bands.

To maintain a flat frequency response over the Hi-Fi audio range the bands covered by each loudspeaker must overlap slightly. 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 determine the cutoff frequencies of the crossover filters (see Fig. 19). As an example, a 100W three-way system with crossover frequencies of 400Hz and 3KHz would require 50W for the woofer, 35W for the midrange unit and 15W 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

Fig. 20 - Active power filter



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 (6dB/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.

A more effective solution, named "Active Power Filter" by SGS is shown in Fig. 20.

The proposed circuit can realize combined power amplifiers and 12dB/octave or 18dB/octave high-pass or low-pass filters.

APPLICATION INFORMATION (continued)

In practice, at the input pins of the amplifier two equal and in-phase voltages are available, as required for the active filter operation.
The impedance at the pin (-) is of the order of 100Ω, while that of the pin (+) is very high, which is also what was wanted.

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

C1 = C2 = C3	R1	R2	R3
22nF	8.2KΩ	5.6KΩ	33KΩ

In the block diagram of Fig. 21 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.

SHORT CIRCUIT PROTECTION

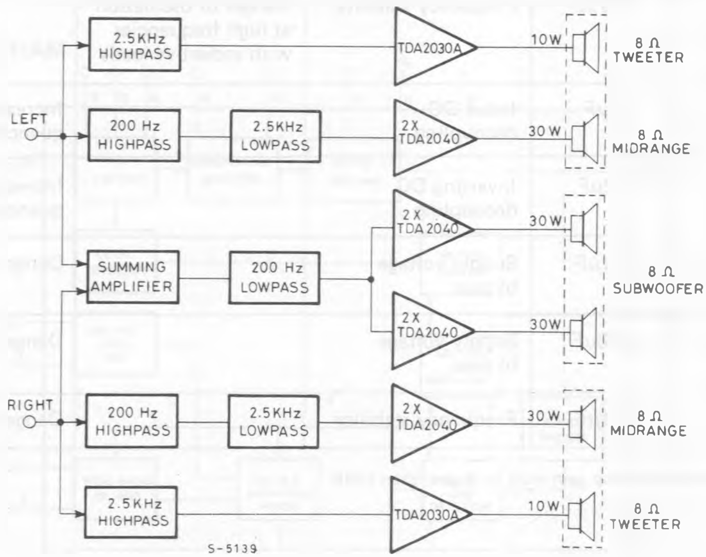
The TDA2040 has an original circuit which limits the current of the output transistors. This function can be considered as being peak power limiting rather than simple current limiting. The TDA2030A is thus protected against temporary overloads or short circuit. Should the short circuit exist for a longer time the thermal shut down protection keeps the junction temperature within safe limits.

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 increase up to 150°C, the thermal shut-down simply reduces the power dissipation and the current consumption.

Fig. 21 - High power active loudspeaker system using TDA2030A and TDA2040



PRACTICAL CONSIDERATION

Printed circuit board

The layout shown in Fig. 11 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 gorund return of the output in which a high current flows.

Assembly suggestion

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

Application suggestions

The recommended values of the components are those shown on application circuit of Fig. 10. Different values can be used. The following table can help the designer.

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

(*) The value of closed loop gain must be higher than 24dB.