

DATA SHEET

TDA7056AT

**3 W mono BTL audio amplifier with
DC volume control**

Product specification
File under Integrated Circuits, IC01

1998 Feb 23

3 W mono BTL audio amplifier with DC volume control

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FEATURES

- DC volume control
- Few external components
- Mute mode
- Thermal protection
- Short-circuit proof
- No switch-on or switch-off clicks
- Good overall stability
- Low power consumption
- Low HF radiation
- ESD protected on all pins.

GENERAL DESCRIPTION

The TDA7056AT is a mono Bridge-Tied Load (BTL) output amplifier with DC volume control. It is designed for use in TVs and monitors, but is also suitable for battery-fed portable recorders and radios. The device is contained in a 20-lead small outline package.

A Missing Current Limiter (MCL) is built in. The MCL circuit is activated when the difference in current between the output terminal of each amplifier exceeds 100 mA (300 mA typ.). This level of 100 mA allows for Single-Ended (SE) headphone applications.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	supply voltage		4.5	–	18	V
P_o	output power	$V_P = 12\text{ V}; R_L = 16\ \Omega$	3	3.5	–	W
$G_{V(\max)}$	maximum total voltage gain	$V_P = 12\text{ V}; R_L = 16\ \Omega$	34.5	35.5	36.5	dB
ΔG_V	voltage gain control range		75	80	–	dB
$I_{q(\text{tot})}$	total quiescent current	$V_P = 12\text{ V}; R_L = \infty$	–	8	16	mA
THD	total harmonic distortion	$P_o = 0.5\text{ W}$	–	0.3	1	%

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA7056AT	SO20	plastic small outline package with 20 leads; body width 7.5 mm	SOT163-1

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BLOCK DIAGRAM

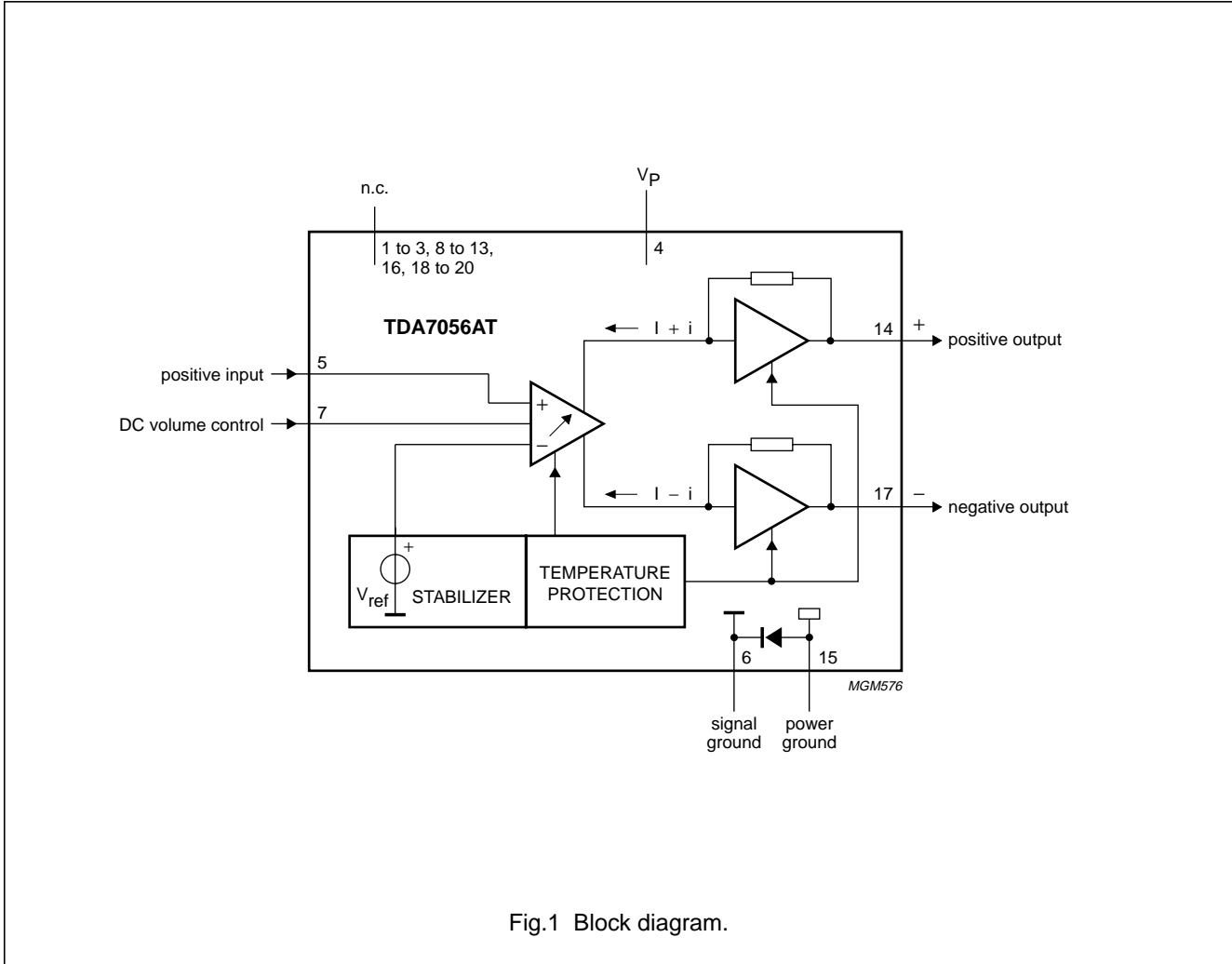


Fig.1 Block diagram.

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PINNING

SYMBOL	PIN	DESCRIPTION
n.c.	1	not connected
n.c.	2	not connected
n.c.	3	not connected
V _P	4	positive supply voltage
V _I	5	positive input
GND1	6	signal ground
VC	7	DC volume control
n.c.	8	not connected
n.c.	9	not connected
n.c.	10	not connected
n.c.	11	not connected
n.c.	12	not connected
n.c.	13	not connected
OUT+	14	positive output
GND2	15	power ground
n.c.	16	not connected
OUT-	17	negative output
n.c.	18	not connected
n.c.	19	not connected
n.c.	20	not connected

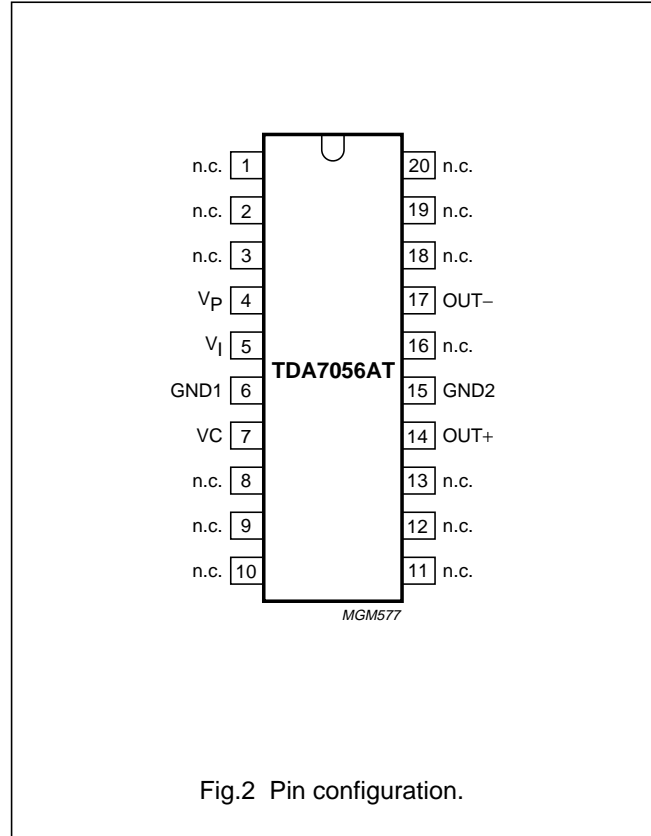


Fig.2 Pin configuration.

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FUNCTIONAL DESCRIPTION

The TDA7056AT is a mono BTL output amplifier with DC volume control. It is designed for use in TVs and monitors but is also suitable for battery-fed portable recorders and radios.

In conventional DC volume circuits the control or input stage is AC-coupled to the output stage via external capacitors to keep the offset voltage low. In the TDA7056AT the DC volume control stage is integrated into the input stage so that no coupling capacitors are required. With this configuration, a low offset voltage is still maintained and the minimum supply voltage remains low.

The BTL principle offers the following advantages:

- Lower peak value of the supply current
- The frequency of the ripple on the supply voltage is twice the signal frequency.

Consequently, a reduced power supply with smaller capacitors can be used which also results in cost reductions. For portable applications there is a trend to decrease the supply voltage, resulting in a reduction of output power at conventional output stages. Using the BTL principle increases the output power.

The maximum gain of the amplifier is fixed at 35.5 dB. The DC volume control stage has a logarithmic control characteristic.

The total gain can be controlled from +35.5 to -44 dB.

If the DC volume control voltage is below 0.3 V, the device switches to the mute mode.

The amplifier is short-circuit proof to ground, V_P and across the load. A thermal protection circuit is also implemented. If the crystal temperature rises above +150 °C the gain will be reduced, thereby reducing the output power. Special attention is given to switch-on and switch-off clicks, low HF radiation and a good overall stability.

Power dissipation

Assume $V_P = 12\text{ V}$; $R_L = 16\ \Omega$.

The maximum sine wave dissipation is 1.8 W.

The $R_{th\ vj-a}$ of the package is 60 K/W.

Therefore $T_{amb(max)} = 150 - 60 \times 1.8 = 42\ \text{°C}$.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage		–	18	V
$V_{5,7}$	input voltage pins 5 and 7		–	5	V
I_{ORM}	repetitive peak output current		–	1.25	A
I_{OSM}	non-repetitive peak output current		–	1.5	A
P_{tot}	total power dissipation	$T_{case} < 60\ \text{°C}$	–	1.5	W
T_{amb}	operating ambient temperature		–40	+85	°C
T_{stg}	storage temperature		–55	+150	°C
T_{vj}	virtual junction temperature		–	150	°C
t_{sc}	short-circuit time		–	1	h

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	60	K/W

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CHARACTERISTICS

$V_P = 12\text{ V}$; $V_{DC} = 1.4\text{ V}$; $f = 1\text{ kHz}$; $R_L = 16\ \Omega$; $T_{amb} = 25\text{ }^\circ\text{C}$; unless otherwise specified (see Fig.14).

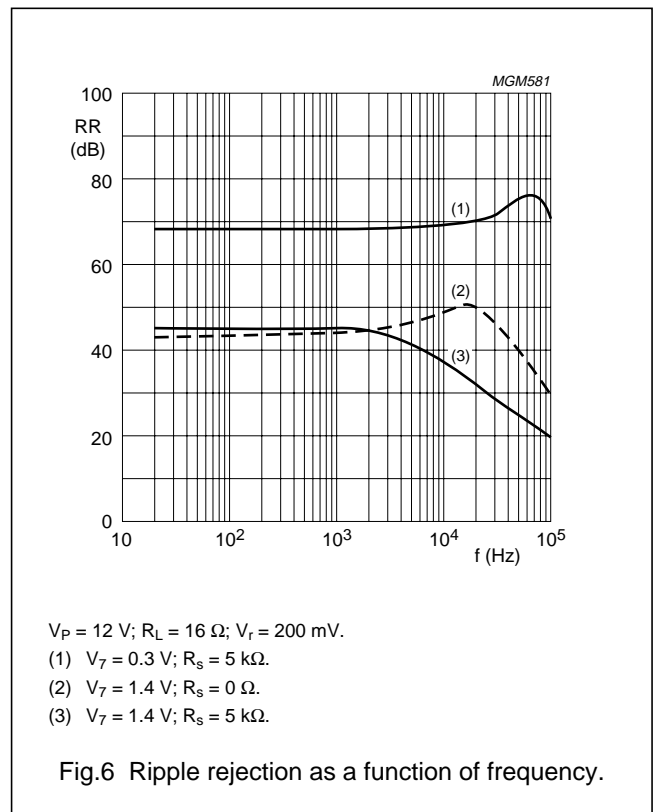
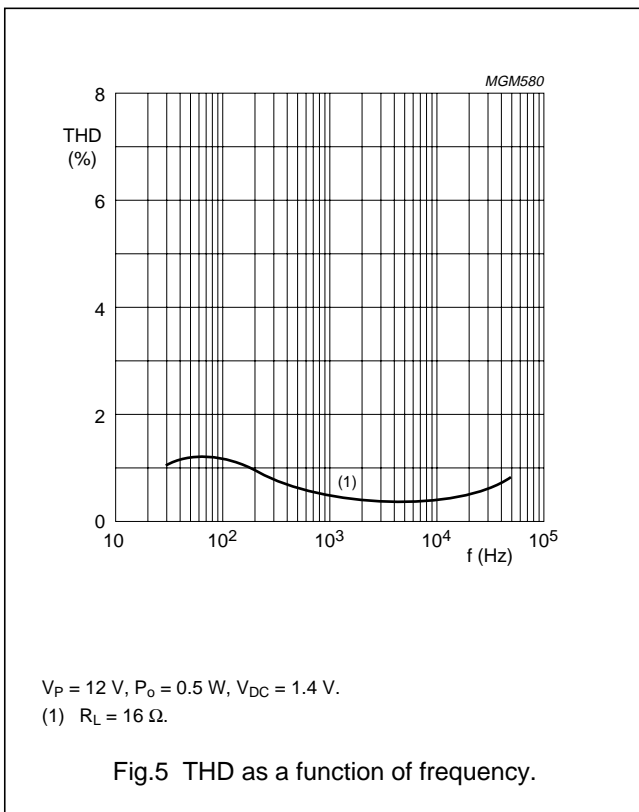
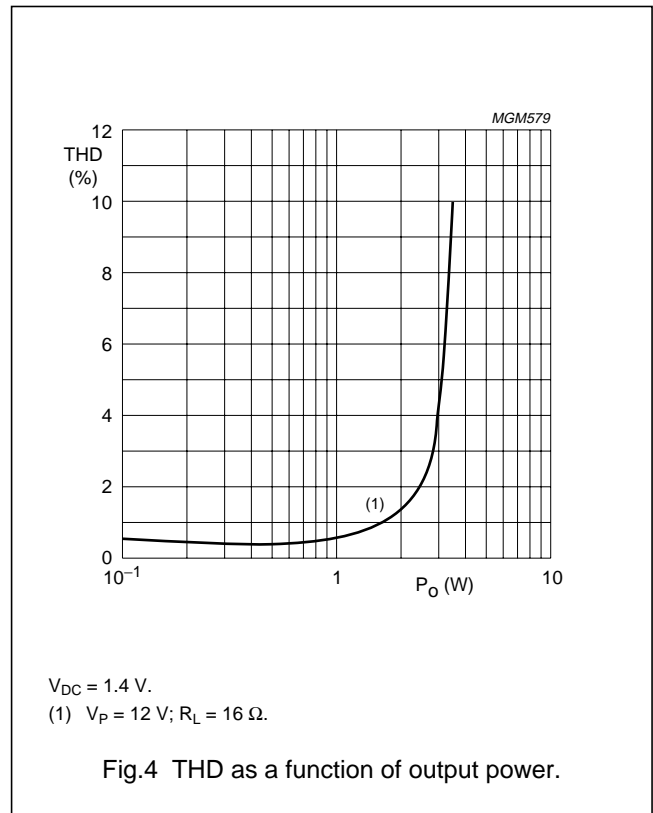
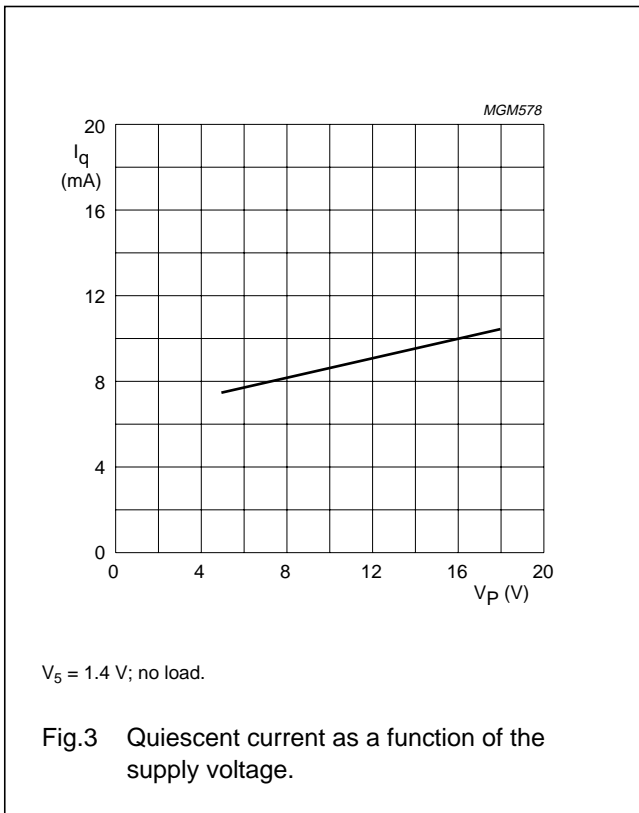
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage		4.5	–	18	V
$I_{q(\text{tot})}$	total quiescent current	$R_L = \infty$; note 1	–	8	16	mA
Maximum gain ($V_7 = 1.4\text{ V}$)						
P_o	output power	THD = 10%; $R_L = 16\ \Omega$	3	3.5	–	W
THD	total harmonic distortion	$P_o = 0.5\text{ W}$	–	0.3	1	%
$G_{V(\text{max})}$	maximum total voltage gain		34.5	35.5	36.5	dB
$V_{i(\text{rms})}$	input signal handling (RMS value)	$V_{VC} = 0.8\text{ V}$; THD < 1%	0.5	0.65	–	V
$V_{n(o)(\text{rms})}$	noise output voltage (RMS value)	$f = 500\text{ kHz}$; note 2	–	210	–	μV
B	bandwidth	at –1 dB	–	0.02 to 300	–	kHz
SVRR	supply voltage ripple rejection	note 3	38	46	–	dB
$ \Delta V_{OS} $	DC output offset voltage	$ V_{17} - v_{14} $	–	0	150	mV
Z_i	input impedance (pin 3)		15	20	25	$\text{k}\Omega$
Minimum gain ($V_7 = 0.5\text{ V}$)						
G_v	voltage gain		–	–44	–	dB
$V_{o(n)(\text{rms})}$	noise output voltage (RMS value)	note 4	–	20	30	μV
Mute position						
$V_{o(\text{mute})}$	output voltage in mute position	$V_{VC} \leq 0.3\text{ V}$; $V_I = 600\text{ mV}$; note 4	–	35	45	μV
DC volume control						
ΔG_v	voltage gain control range		75	80	–	dB
I_{VC}	control current	$V_{VC} = 0\text{ V}$	60	70	80	μA

Notes

1. With a load connected to the outputs the quiescent current will increase, the maximum value of this increase being equal to the DC output offset voltage divided by R_L .
2. The noise output voltage ($V_{n(o)(\text{rms})}$) at $f = 500\text{ kHz}$, is measured with $R_s = 0\ \Omega$ and $B = 5\text{ kHz}$.
3. The ripple rejection is measured with $R_s = 0\ \Omega$ and $f = 100\text{ Hz}$ to 10 kHz . The ripple voltage ($V_{\text{ripple}} = 200\text{ mV RMS}$) is applied to the positive supply rail.
4. The noise output voltage ($V_{n(o)(\text{rms})}$) is measured with $R_s = 5\text{ k}\Omega$ unweighted.

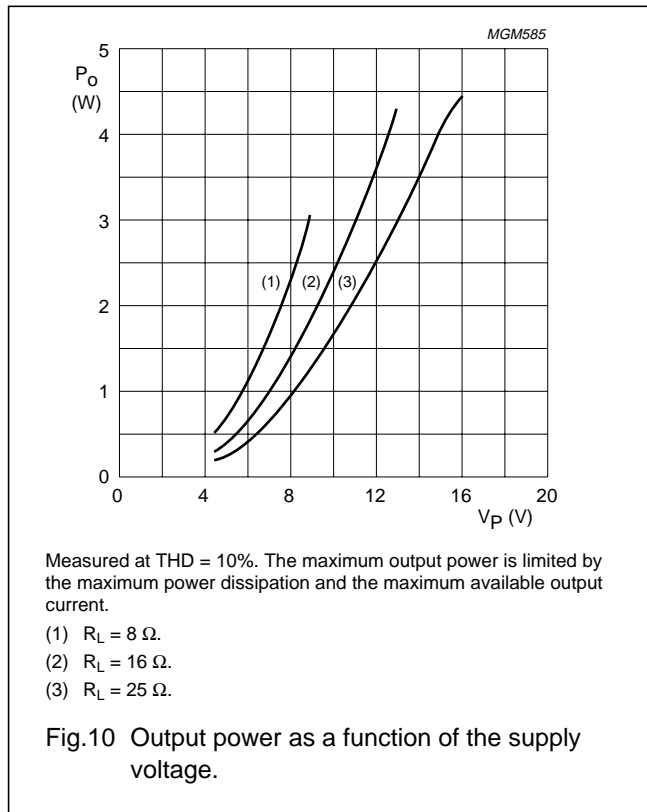
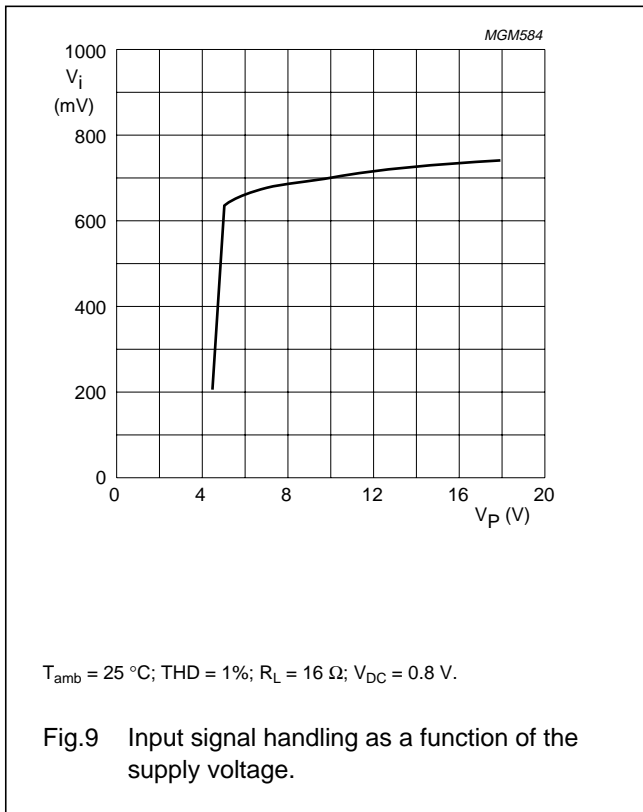
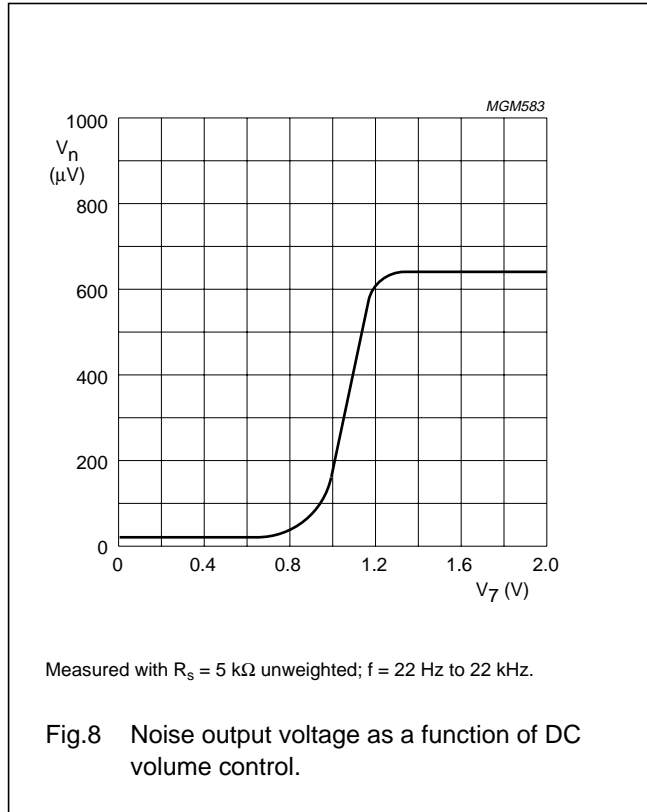
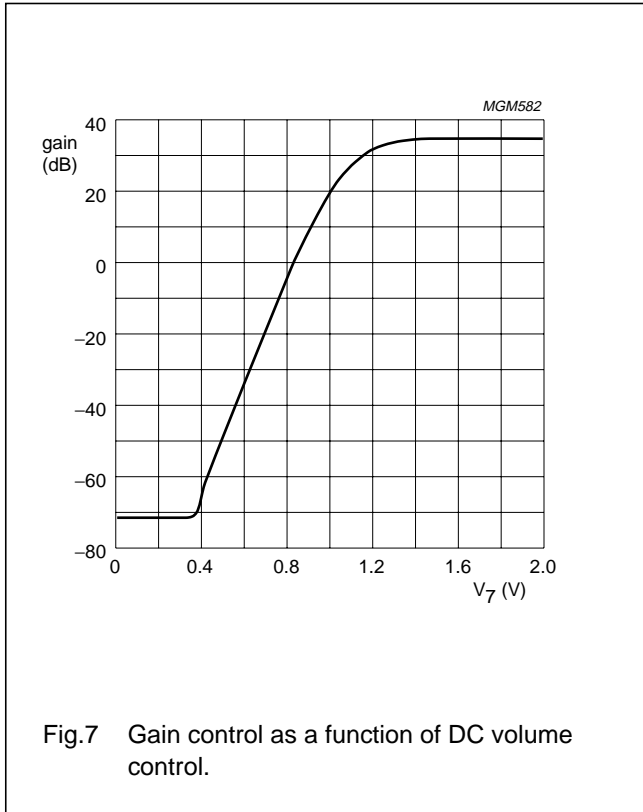
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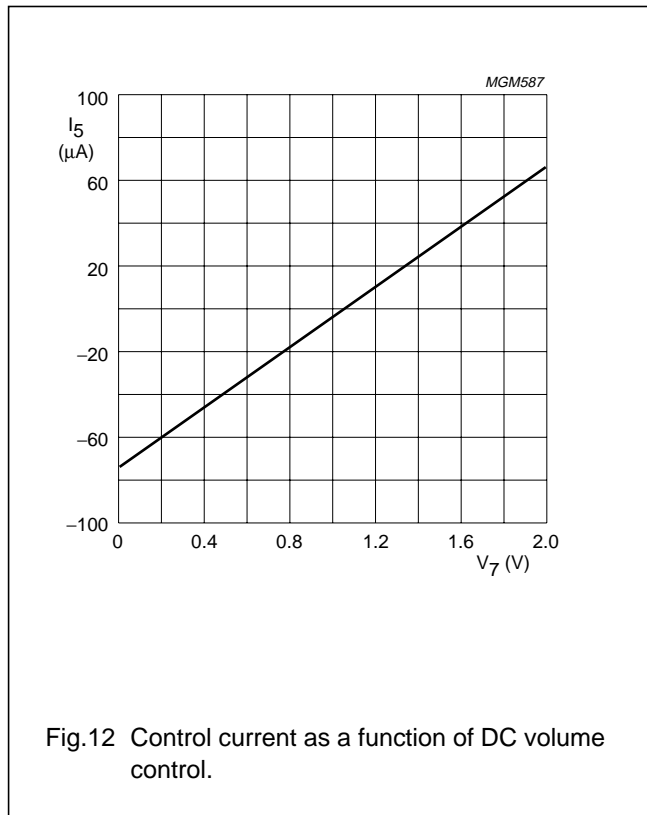
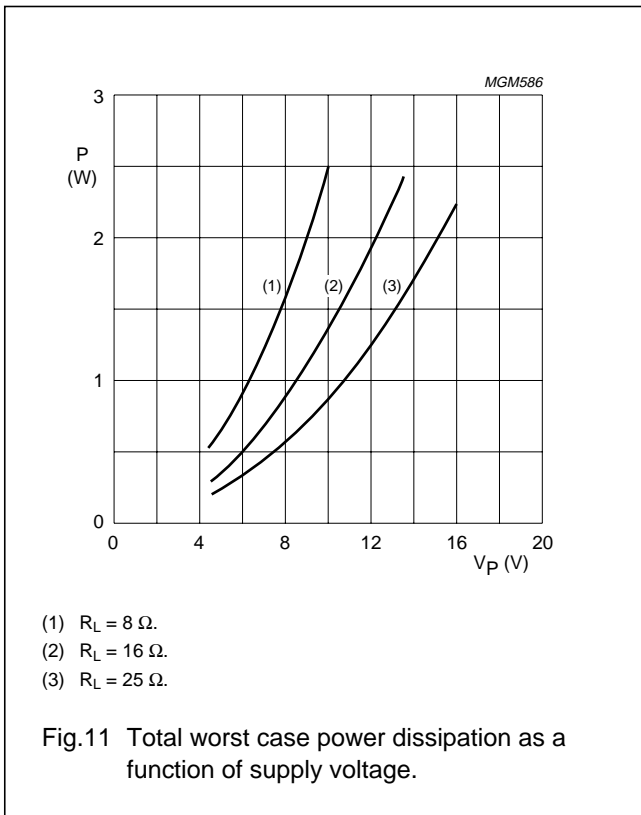
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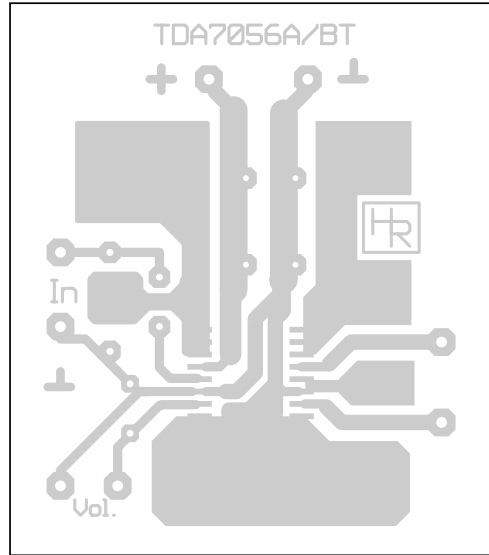
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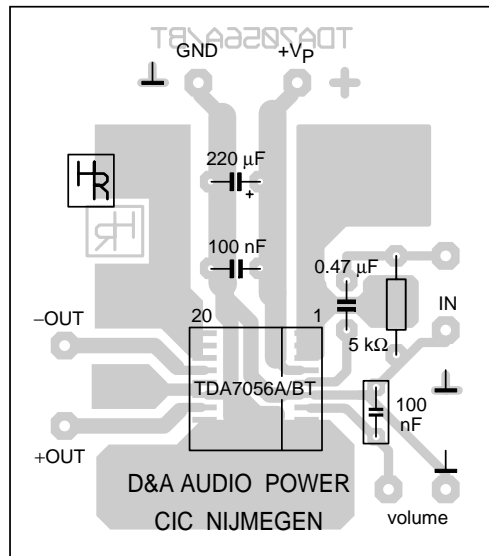


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a. Top view of bottom copper.



MGM591

b. Top view of component side.

Fig.13 Printed-circuit board layout.

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TEST AND APPLICATION INFORMATION

Test conditions

$T_{amb} = 25\text{ °C}$ if not specified; $V_P = 12\text{ V}$; $V_{DC} = 1.4\text{ V}$; $f = 1\text{ kHz}$; $R_L = 16\text{ }\Omega$; audio bandpass: 22 Hz to 22 kHz.

In Figures 5 and 6 a low-pass filter of 80 kHz was applied. It should be noted that capacitive loads (100 pF and 5 nF) connected between the output pins to a common ground can cause oscillations. The BTL application circuit diagram is shown in Fig.14. To avoid instabilities and too high distortion, the input and power ground traces must be separated as far as possible and connected together as close as possible to the IC. The quiescent current has been measured without load impedance.

Voltage gain

The maximum closed-loop voltage gain has been internally fixed at 35.5 dB. The input sensitivity at maximum gain for $P_o = 3\text{ W}$ ($R_L = 16\text{ }\Omega$) is 115 mV. The gain bandwidth is 20 Hz to 300 kHz within 1 dB.

Output power

The output power as a function of supply voltage has been measured at THD = 10%. The maximum output power is limited by the maximum allowed power dissipation at $T_{amb} = 25\text{ °C}$ approximately 2 W, and the maximum available output current is 1.25 A repetitive peak current.

Switch-on/switch-off

The switch-on behaviour depends on the following:

- The rise time of the power supply (if $t_r > 40\text{ ms}$ for $V_P = 0$ to 12 V then the switch-on behaviour will be good)
- The input capacitor and source impedance (a higher source impedance and/or lower input capacitor value will have a positive influence on the switch-on/switch-off behaviour)
- The DC volume control pin (a capacitor of $>0.1\text{ }\mu\text{F}$ avoids disturbances).

Thermal behaviour:

The measured thermal resistance of the IC package is highly dependent on the configuration and size of the application board. Data may not be comparable between different semiconductor manufacturers because the application boards and test methods are not (yet) standardized. The thermal performance of packages for a specific application may also be different than presented here, because the configuration of the application boards (copper area) may be different. Philips Semiconductors uses FR-4 type application boards with 1 oz copper traces with solder coating. The measurements have been carried out with vertical placed boards.

Using a practical PCB layout with wider copper tracks and some copper area to the IC pins and just under the IC, the thermal resistance from junction to ambient can be reduced. In the demonstration application PCB the $R_{th(j-a)} = 56\text{ K/W}$ for the SO20 plastic package. For a maximum ambient temperature of $T_{amb} = 50\text{ °C}$ the following calculation can be made for the maximum power

$$\text{dissipation: } \frac{(150\text{ K/W} - 50\text{ K/W})}{56\text{ K/W}} = 1.79\text{ W}$$

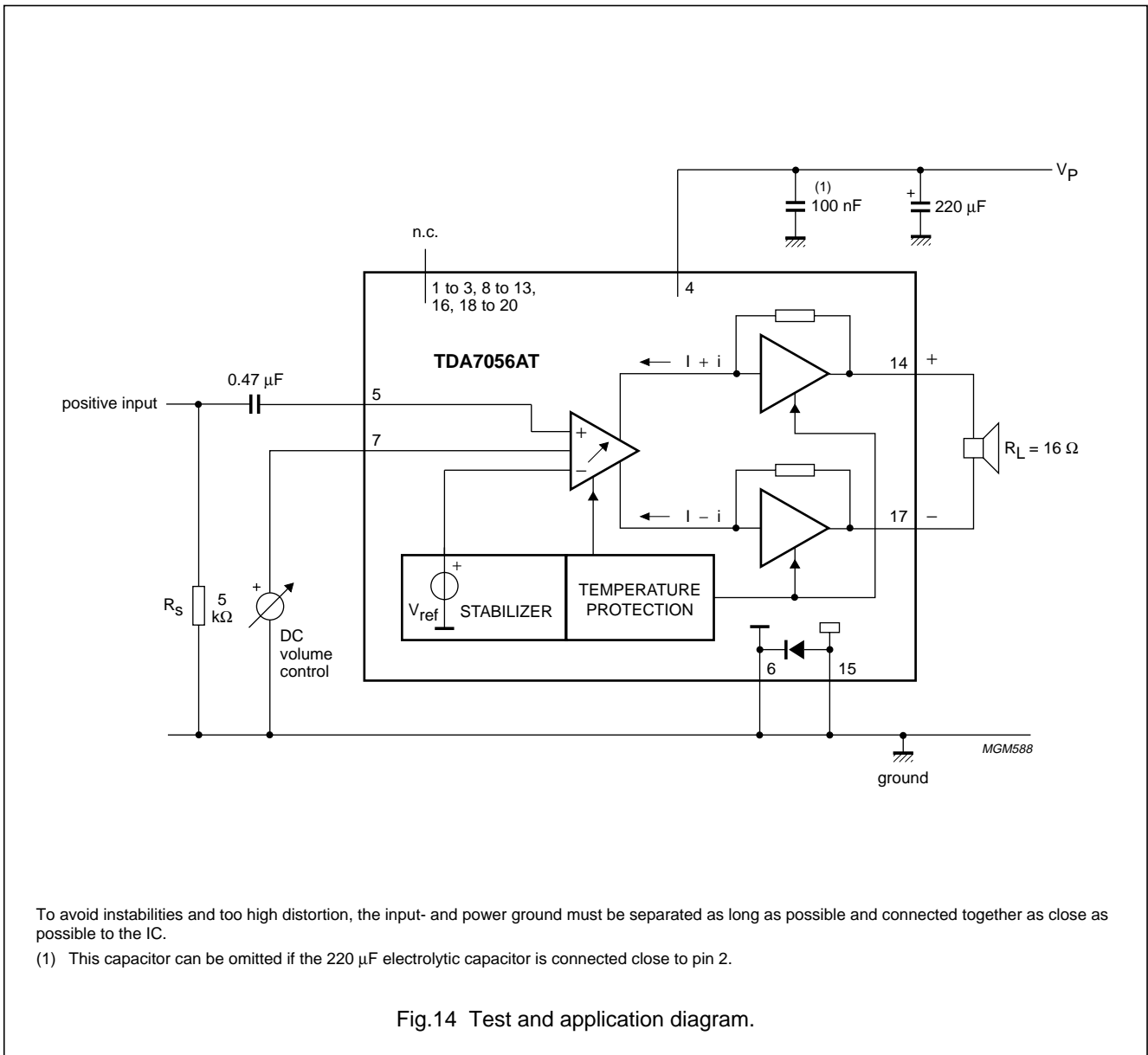
For the application at $V_P = 12\text{ V}$ and $R_L = 16\text{ }\Omega$ the worst case sine wave dissipation is 1.85 W. Because in practice the 'music-power' causes about the half of the sine wave dissipation, this application ($V_P = 12\text{ V}$; $R_L = 16\text{ }\Omega$) has been allowed.

Short-circuit protection:

The output pins (pins 14 and 17) can be short-circuited to ground respectively to $+V_P$. The Missing Current Limiter (MCL) protection circuit will shut-off the amplifier. Removing the short-circuit will reset the amplifier automatically. Short-circuit across the load (pins 14 and 17) will activate the thermal protection circuit; this will result in reducing the short-circuit current.

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For single-end application the output peak current may not exceed 100 mA; at higher output currents the short circuit protection (MLC) will be activated.

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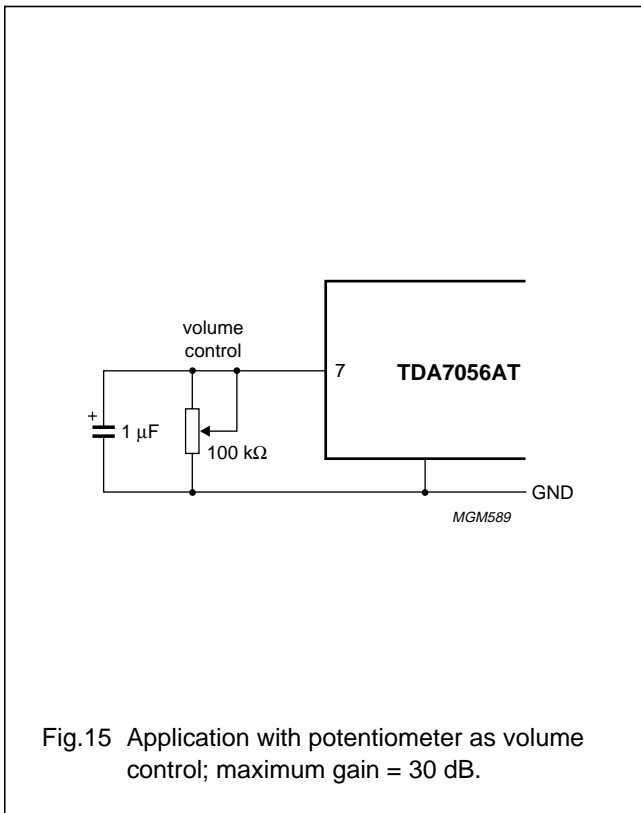


Fig.15 Application with potentiometer as volume control; maximum gain = 30 dB.

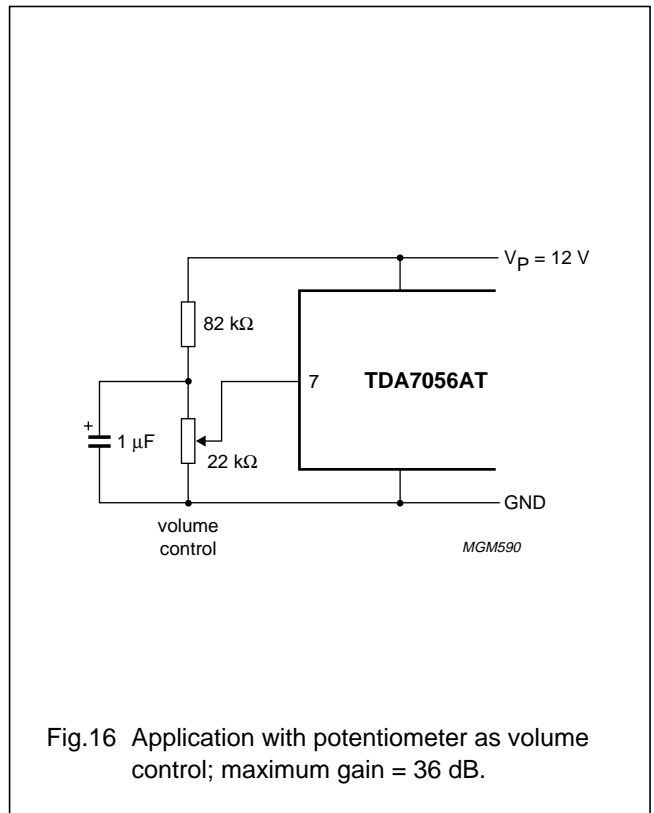


Fig.16 Application with potentiometer as volume control; maximum gain = 36 dB.

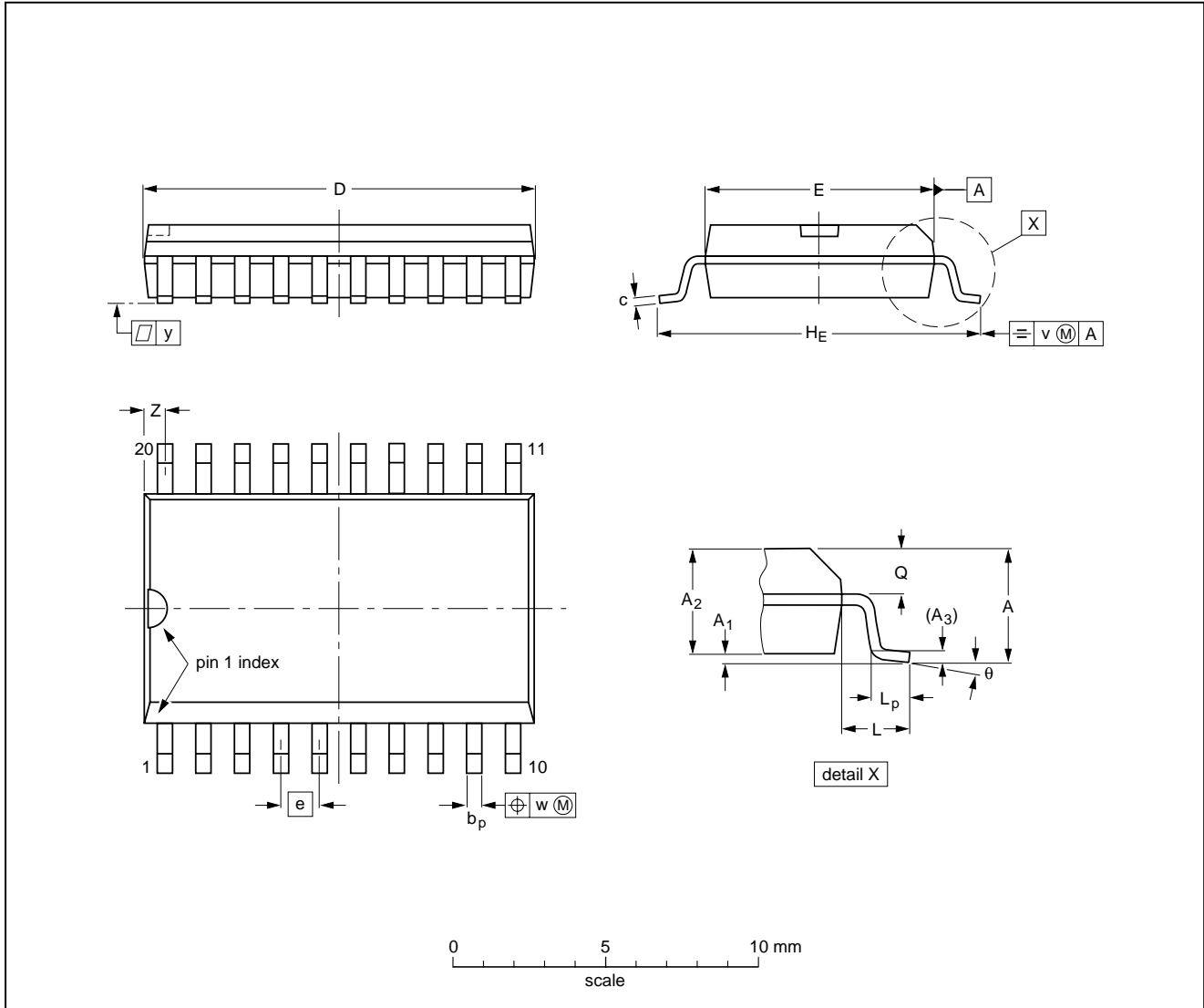
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PACKAGE OUTLINE

SO20: plastic small outline package; 20 leads; body width 7.5 mm

SOT163-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	z ⁽¹⁾	θ
mm	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	13.0 12.6	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8° 0°
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.51 0.49	0.30 0.29	0.050	0.419 0.394	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT163-1	075E04	MS-013AC				95-01-24 97-05-22

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SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "*IC Package Databook*" (order code 9398 652 90011).

Reflow soldering

Reflow soldering techniques are suitable for all SO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

Wave soldering

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

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DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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NOTES

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Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTH RYDE, NSW 2113,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213, Tel. +43 160 1010,
Fax. +43 160 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 689 211, Fax. +359 2 689 102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,
Tel. +45 32 88 2636, Fax. +45 31 57 0044

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615800, Fax. +358 9 61580920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +30 1 4894 339/239, Fax. +30 1 4814 240

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: see Singapore

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,
Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZAWA,
Tel. +48 22 612 2831, Fax. +48 22 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 1231,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

South America: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 3 301 6312, Fax. +34 3 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 632 2000, Fax. +46 8 632 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2686, Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2865, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381

Uruguay: see South America

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Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 625 344, Fax. +381 11 635 777

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Internet: <http://www.semiconductors.philips.com>

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Printed in The Netherlands

545102/25/01/pp20

Date of release: 1998 Feb 23

Document order number: 9397 750 03253

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