DATA SHEET

TDA8586
Power amplifier with load detection and auto BTL/SE selection

Preliminary specification
Supersedes data of 1998 May 25
File under Integrated Circuits, IC01

1999 Apr 08

Philips
Semiconductors

PHILIPS

Power amplifier with load detection and auto BTL/SE selection

TDA8586

FEATURES

General

- Operating voltage from 8 to 18 V
- Low distortion
- Few external components, fixed gain
- Automatic mode selection (SE or BTL) depending on connected ‘rear’ loads
- Can be used as a stereo amplifier in Bridge-Tied Load (BTL) or quad Single-Ended (SE) amplifiers
- Single-ended mode without loudspeaker capacitor
- Soft clipping, to guarantee good clip behaviour with inductive loads
- Mute and standby mode with one-pin operation
- Diagnostic information for Dynamic Distortion Detector (DDD), high temperature (140 °C) mode of operation and short-circuit
- No switch-on/off plops when switching between standby and mute and from mute to on
- Load detection on ‘rear’ channels when switching from standby to mute
- Fast mute on supply voltage drops (low V_P mute).

Protection

- Short-circuit proof to ground, positive supply voltage on all pins and across load
- ESD protected on all pins
- Thermal protection against temperatures exceeding 150 °C
- Load dump protection
- Overvoltage protection.

GENERAL DESCRIPTION

The IC incorporates the following functions:

1. 4×6 W SE amplifies without SE capacitor, because of the availability of 2 half supply voltage power buffers
2. 2×20 W BTL amplifiers
3. Automatic switching between 2 and 4 speaker operation. The mode of operation is determined during start-up.

This amplifier is protected for all general short-circuit conditions to battery or ground, overvoltage, 45 V load dump and short-circuits on the speaker outputs.

The IC is contained in a 20-pin power HSOP package, but is also available in a 17-pin SIL power package. When packaged in the 20-pin HSOP package additional functions are available:

1. DDD level selection between 2 and 10%
2. Overrule pin for changing mode of operation (from SE to BTL or from BTL to SE).

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA8586Q	DBS17P	plastic DIL-bent-SIL power package; 17 leads (lead length 12 mm)	SOT243-1
TDA8586TH	HSOP20	heatsink small outline package; 20 leads; low stand-off	SOT418-2

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	operating supply voltage		8.0	–	18	V
$I_{q(tot)}$	total quiescent current	V_P = 14.4 V, SE mode	–	140	170	mA
I_{stb}	standby supply current	V_P = 14.4 V	–	1	100	μA
G_v	voltage gain	SE mode	25	26	27	dB
		BTL mode	31	32	33	dB
Bridge-tied load application						
P_o	output power	V_P = 14.4 V; R_L = 4 Ω				
		THD = 0.5%	14	15	–	W
		THD = 10%	17	21	–	W
THD	total harmonic distortion	f_i = 1 kHz; P_o = 1 W; V_P = 14.4 V; R_L = 4 Ω	–	0.05	0.15	%
V_{OO}	DC output offset voltage	V_P = 14.4 V; R_L = 4 Ω; mute condition	–	10	20	mV
		V_P = 14.4 V; on condition	–	0	100	mV
$V_{n(o)}$	noise output voltage	R_s = 1 kΩ; V_P = 14.4 V	–	100	200	μV
Single-ended application						
P_o	output power	V_P = 14.4 V; R_L = 4 Ω				
		THD = 0.5%	4	4.5	–	W
		THD = 10%	5	6	–	W
THD	total harmonic distortion	f_i = 1 kHz; P_o = 1 W; V_P = 14.4 V; R_L = 4 Ω	–	0.08	0.15	%
V_{OO}	DC output offset voltage	V_P = 14.4 V; R_L = 4 Ω; mute condition	–	10	20	mV
		V_P = 14.4 V; on condition	–	0	100	mV
$V_{n(o)}$	noise output voltage	R_s = 1 kΩ; V_P = 14.4 V	–	80	150	μV

BLOCK DIAGRAM

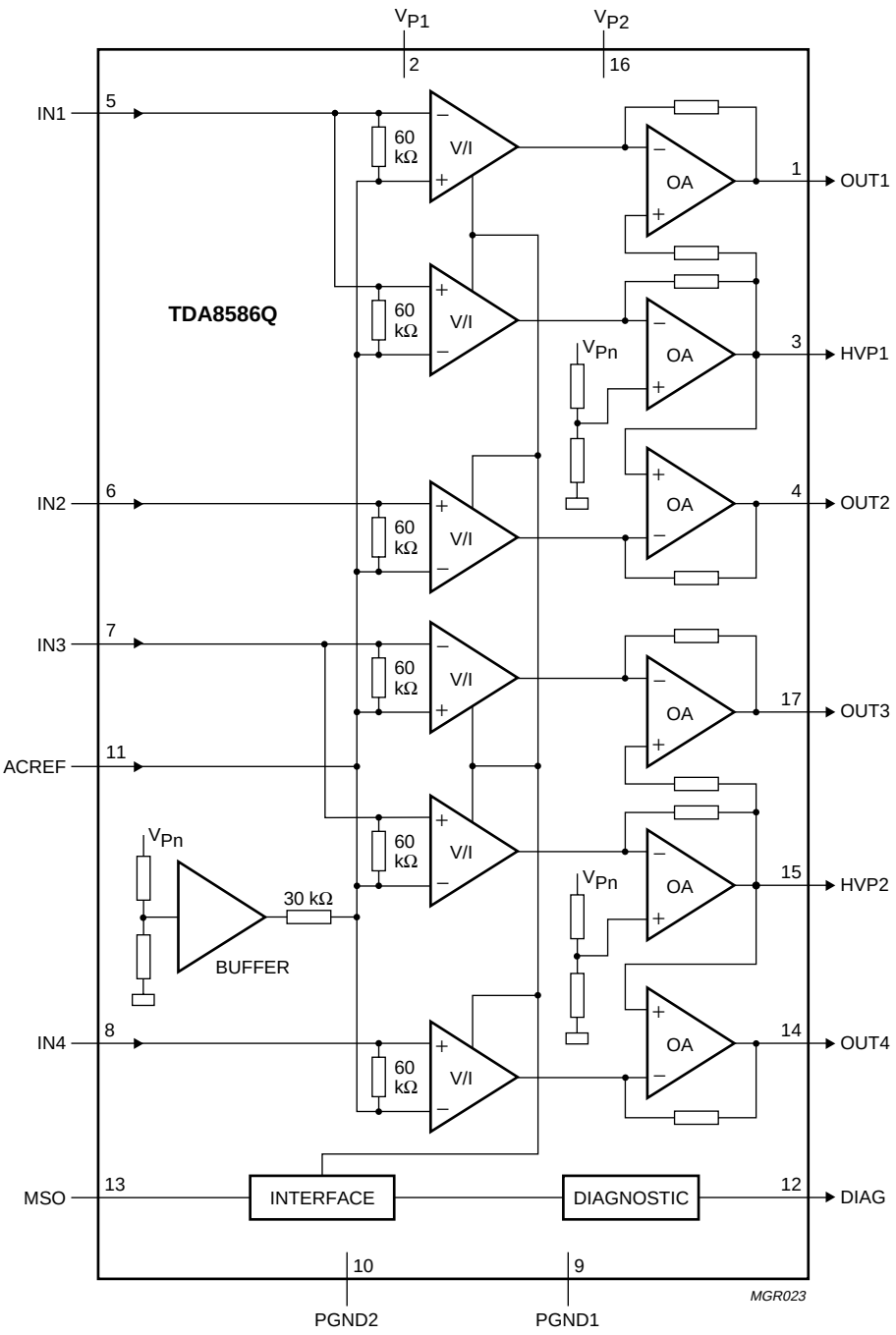


Fig.1 Block diagram SOT243-1.

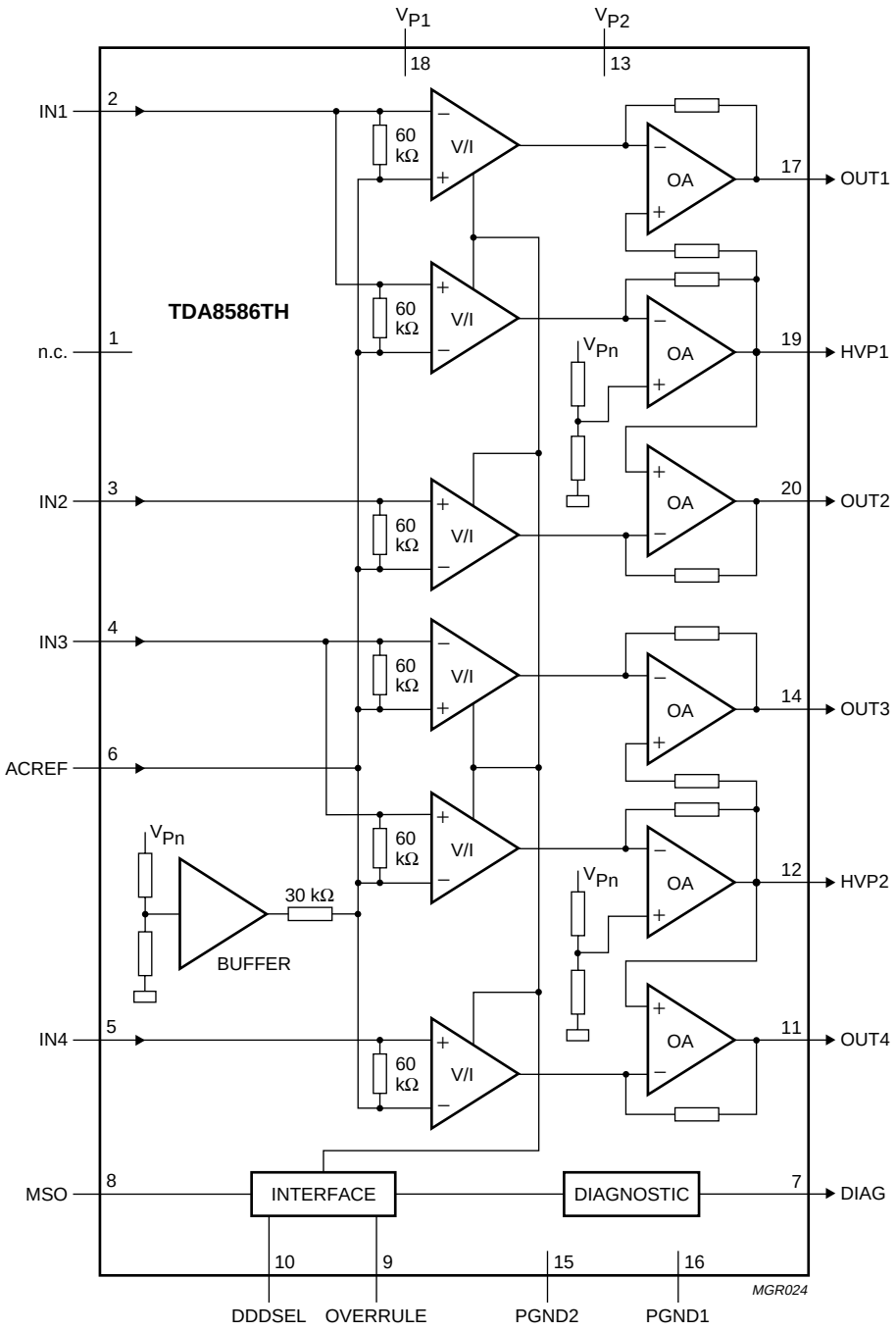


Fig.2 Block diagram SOT418-2 (HSOP20 heatsink up).

PINNING

SYMBOL	PIN SOT243	PIN SOT418	DESCRIPTION
n.c.	–	1	not connected
IN1	5	2	non-inverting input 1
IN2	6	3	inverting input 2
IN3	7	4	non inverting input 3
IN4	8	5	inverting input 4
ACREF	11	6	common signal input
DIAG	12	7	diagnostic output/mode fix
MSO	13	8	mode select mute, standby or on
OVERRULE	–	9	mode selection overrule
DDDSEL	–	10	2 or 10% dynamic distortion detection
OUT4	14	11	SE output 4 (negative)
HVP2	15	12	buffer output/BTL output 2 (negative)
V_{P2}	16	13	supply voltage 2
OUT3	17	14	SE output 3/BTL output 2 (positive)
PGND2	10	15	power ground 2
PGND1	9	16	power ground 1
OUT1	1	17	SE output 1/BTL output 1 (positive)
V_{P1}	2	18	supply voltage 1
HVP1	3	19	buffer output/BTL output 1 (negative)
OUT2	4	20	SE output 2 (negative)

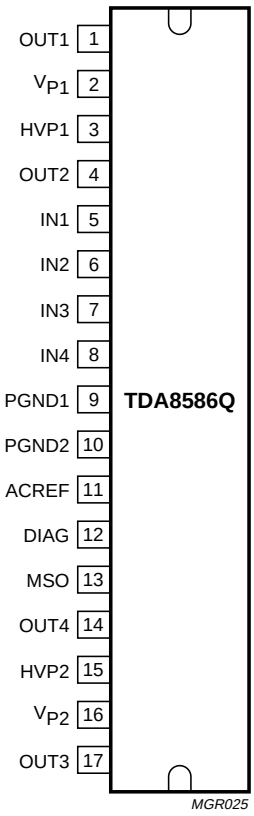


Fig.3 Pin configuration (SOT243-1).

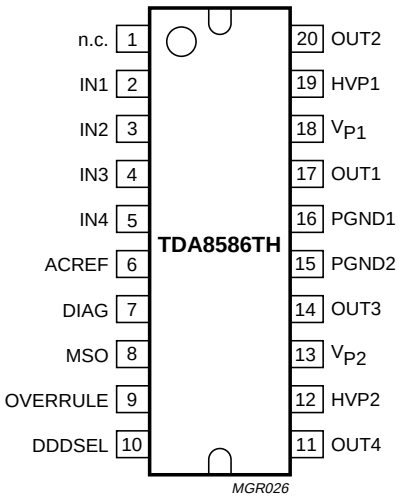


Fig.4 Pin configuration (SOT418-2).

FUNCTIONAL DESCRIPTION

The TDA8586 is a multi-purpose power amplifier with four amplifiers and 2 buffer stages, which can be connected in the following configurations with high output power and low distortion:

- Dual Bridge-Tied Load (BTL) amplifiers
- Quad Single-Ended (SE) amplifiers.

In the BTL mode of operation, the 2 buffer amplifiers act as inverting amplifiers to complete the bridge across the 'front' amplifiers (OUT1 and OUT3) and the 'rear' outputs (OUT2 and OUT4) enter a high-impedance state.

In the SE mode of operation, the buffers act as an AC ground path thereby eliminating the need for series capacitors on the speaker outputs.

Diagnostics:
- While the IC is in the mute mode, the diagnostic output will signal the mode of operation when the IC is not overruled
- In the on mode the diagnostic output will signal any fault in the IC or if the output of any amplifier is clipping with a distortion of 10% (or 2% depending on selected clip-mode).

Special attention is given to the dynamic behaviour as follows:

- Noise suppression during engine start
- No plops when switching from standby to on
- Slow offset change between mute and on (controlled by MSO pin)
- Low noise levels, which are independent of the supply voltage.

Protections are included to avoid the IC being damaged at:

- Over temperature: T_j > 150 °C
- Short-circuit of the output pin(s) to ground or supply rail. When short-circuited, the power dissipation is limited
- ESD protection (Human Body Model 3000 V and Machine Model 300 V).

The presence of the load is measured after the transition between standby and mute. The IC will determine if there is an acceptable load on both outputs (OUT2 and OUT4). If both outputs are unloaded, the IC will switch to a 2 speaker mode of operation (BTL mode), unless it is overruled.

There are two options to overrule:
1. Before transition from mute to on, after a load detection, pulling the diagnostic output above 9.5 V will force the IC into 4 speaker mode
2. TDA8586TH: pulling the OVERRULE pin according pinning table.

Care should be taken with the OVERRULE function as it works during the on mode. If there is a 2 or 4 speaker mode change during the on mode a large 'plop' can be heard on the speakers.

The ACREF input (common signal input) acts with the four signal inputs (IN1 to IN4) to provide quasi differential inputs. A capacitor must be connected to this pin of which the ground pin should be connected to the ground at the signal source (usually the ground at the audio signal processor). This capacitor has a dual function. During the speaker detection, the signal ground capacitor is used to set the time constant of the measurement (and thus determines the minimum required switch-on time).
The capacitor on the MSO pin allows the integrate function to provide immunity to outside noises during load detection.

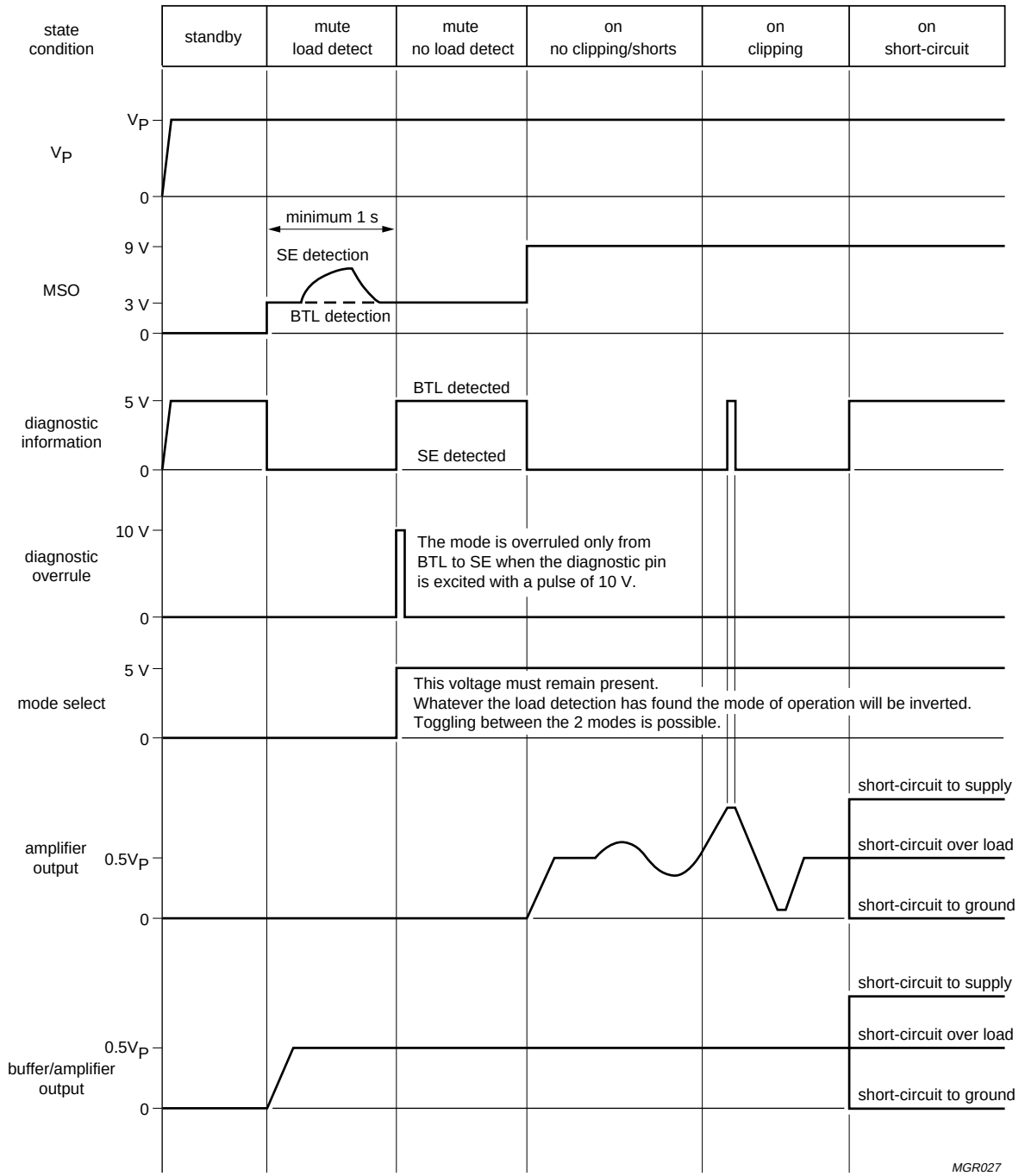


Fig.5 Timing diagram including diagnostics.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage	operating	8	18	V
		load dump protected; see Fig.6	–	45	V
V_{DIAG}	voltage on diagnostic pin		–	18	V
I_{OSM}	non-repetitive peak output current		–	6	A
I_{ORM}	repetitive peak output current		–	4	A
V_{rp}	reverse polarity voltage	note 1	–	6	V
V_{sc}	AC and DC short-circuit voltage of output pins across loads and to ground or supply pins		–	18	V
P_{tot}	total power dissipation		–	75	W
T_j	junction temperature		–	150	°C
T_{stg}	storage temperature		–55	+150	°C
T_{amb}	operating ambient temperature		–40	+150	°C

Note

1. A large reverse current will flow, therefore external protection is needed (fuse and reverse diode).

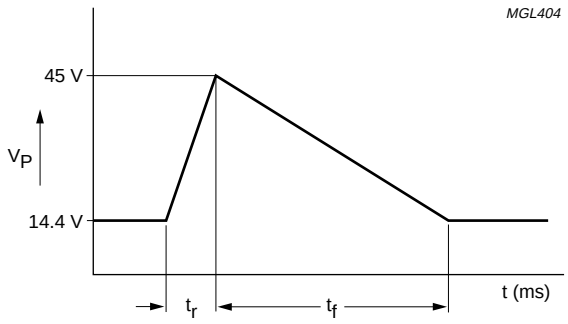


Fig.6 Load dump voltage waveform.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	40	K/W
$R_{th(j-c)}$	thermal resistance from junction to case		2	K/W

CHARACTERISTICS

V_P = 14.4 V; T_{amb} = 25 °C; f_i = 1 kHz; R_L = ∞; measured in test circuit of Fig.8; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies						
V_P	operating supply voltage		8.0	14.4	18	V
$I_{q(tot)}$	total quiescent current	SE mode	–	140	170	mA
I_{stb}	standby current		–	1	100	µA
V_O	DC output voltage	V_P = 14.4 V	–	7.0	–	V
$V_{P(mute)}$	low supply voltage mute		6.0	7.0	8.0	V
V_o	single-ended and bridge-tied load output voltage	V_P = 14.4 V; R_L = 4 Ω				
		mute condition	–	–	20	mV
		on condition	–	–	100	mV
V_I	DC input voltage	V_P = 14.4 V	–	4.0	–	V
PIN MSO						
V_{MSO}	voltage at pin MSO	standby condition	0	–	0.8	V
		mute condition; note 1	2.0	3.0	4	V
		on condition	8.0	–	10.5	V
I_{MSO}	input current	mute pin at standby condition; V_{MSO} < 0.8 V	–	5	40	µA
Diagnostic; output buffer (open-collector); see Figs 7 to 8						
$V_{DIAG(L)}$	diagnostic output voltage LOW	I_{sink} = 1 mA	–	0.3	0.8	V
I_{LI}	leakage current	V_{DIAG} = 14.4 V	–	–	1	µA
$V_{DIAG(or)}$	diagnostic override voltage	in mute mode after load detection	10.5	–	18	V
$V_{DIAG(4ch)}$	diagnostic 4 channel indication voltage	mute, after load detection with 4 speakers connected	–	0.3	0.8	V
CD2	clip detector LOW	THD mode; V_{DIAG} > 3 V; R = 10 kΩ	0.5	2	3.5	%
CD10	clip detector HIGH	THD mode (default); V_{DIAG} > 3 V; R = 10 kΩ	7	10	13	%
CLIP DETECT CONTROL PIN						
V_{DDDSEL}	voltage at DDD select pin to obtain:	10% DDD	0	–	1	V
		2% DDD	3	–	6	V
I_{DDDSEL}	Input current DDD select pin	V_{DDDSEL} = 5 V	15	–	140	µA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Stereo BTL application (see Fig.7)						
THD	total harmonic distortion	f_i = 1 kHz; P_o = 1 W; R_L = 4 Ω	–	0.05	0.15	%
		45 Hz < f_i < 10 kHz; P_o = 1 W; R_L = 4 Ω; filter: f < 30 kHz	–	0.3	–	%
P_o	output power	V_P = 14.4 V; R_L = 4 Ω; note 2				
		THD = 0.5%	14	15	–	W
		THD = 10%	17	21	–	W
G_v	voltage gain	$V_{i(rms)}$ = 15 mV	31	32	33	dB
ΔG_v	channel unbalance	$V_{i(rms)}$ = 15 mV	–0.7	0	+0.7	dB
α_{cs}	channel separation	P_o = 2 W; f_i = 1 kHz; R_L = 4 Ω	45	55	–	dB
V_{OO}	DC output offset voltage	V_P = 14.4 V; on condition	–	0	100	mV
		V_P = 14.4 V; R_L = 4 Ω; mute condition	–	10	20	mV
$V_{n(o)}$	noise output voltage on	R_s = 1 kΩ; V_P = 14.4 V; note 3	–	100	150	μV
$V_{n(o)(mute)}$	noise output voltage mute	note 3	–	0	20	μV
$V_{o(mute)}$	output voltage mute	$V_{i(rms)}$ = 1 V	–	3	500	μV
SVRR	supply voltage ripple rejection:	R_s = 0 Ω; f_i = 1 kHz; V_{ripple} = 2 V (p-p)				
		on condition	45	55	–	dB
		mute condition	55	70	–	dB
Z_i	input impedance	input referenced to ground	40	60	90	kΩ

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Quad SE application (see Fig.8)						
THD	total harmonic distortion	f_i = 1 kHz; P_o = 1 W; R_L = 4 Ω	–	0.05	0.15	%
		45 Hz < f_i < 10 kHz; P_o = 1 W; R_L = 4 Ω; filter: f < 30 kHz	–	0.5	–	%
P_o	output power	V_P = 14.4 V; R_L = 4 Ω; note 2				
		THD = 0.5%	4	4.5	–	W
		THD = 10%	5	6	–	W
G_v	voltage gain	$V_{i(rms)}$ = 15 mV	25	26	27	dB
ΔG_v	channel unbalance	$V_{i(rms)}$ = 15 mV	–0.7	0	+0.7	dB
α_{cs}	channel separation	P_o = 2 W; f_i = 1 kHz; R_L = 4 Ω	40	50	–	dB
V_{OO}	DC output offset voltage	V_P = 14.4 V; on condition	–	0	100	mV
		V_P = 14.4 V; R_L = 4 Ω; mute condition	–	10	20	mV
$V_{n(o)}$	noise output voltage on	R_s = 1 kΩ; V_P = 14.4 V; note 3	–	80	150	μV
$V_{n(o)(mute)}$	noise output voltage mute	note 3	–	0	20	μV
$V_{o(mute)}$	output voltage mute	$V_{i(rms)}$ = 1 V	–	3	500	μV
SVRR	supply voltage ripple rejection	R_s = 0 Ω; f_i = 1 kHz; V_{ripple} = 2 V (p-p)				
		on condition	43	47	–	dB
		mute condition	55	70	–	dB

Notes

1. Tolerances on the mute level is tight because of the usage of this pin for integration during load detection.
2. The output power is measured directly on the pins of the IC.
3. The noise output is measured in a bandwidth of 20 Hz to 20 kHz.

APPLICATION INFORMATION

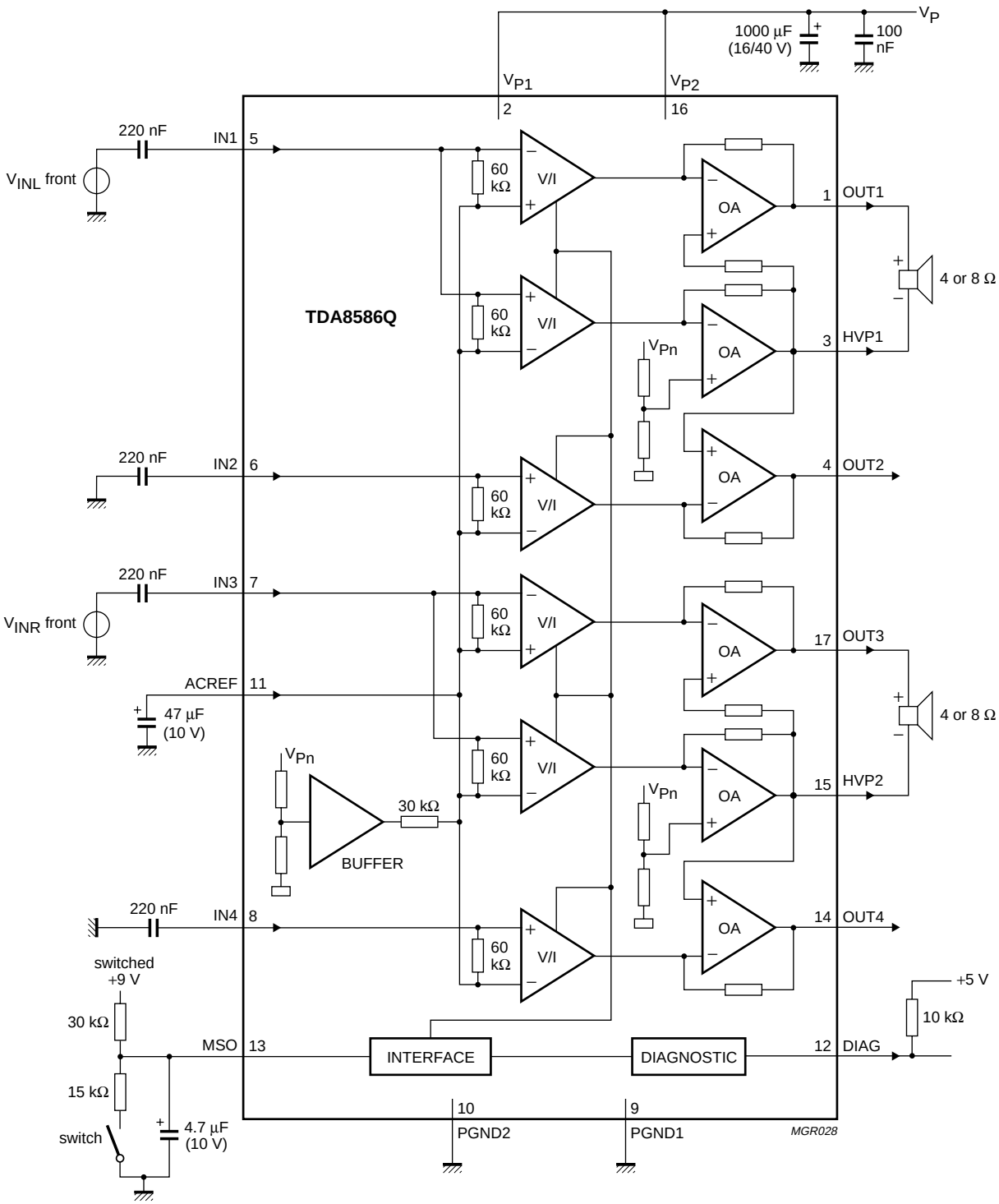


Fig.7 Stereo bridge-tied load application (SOT243-1).

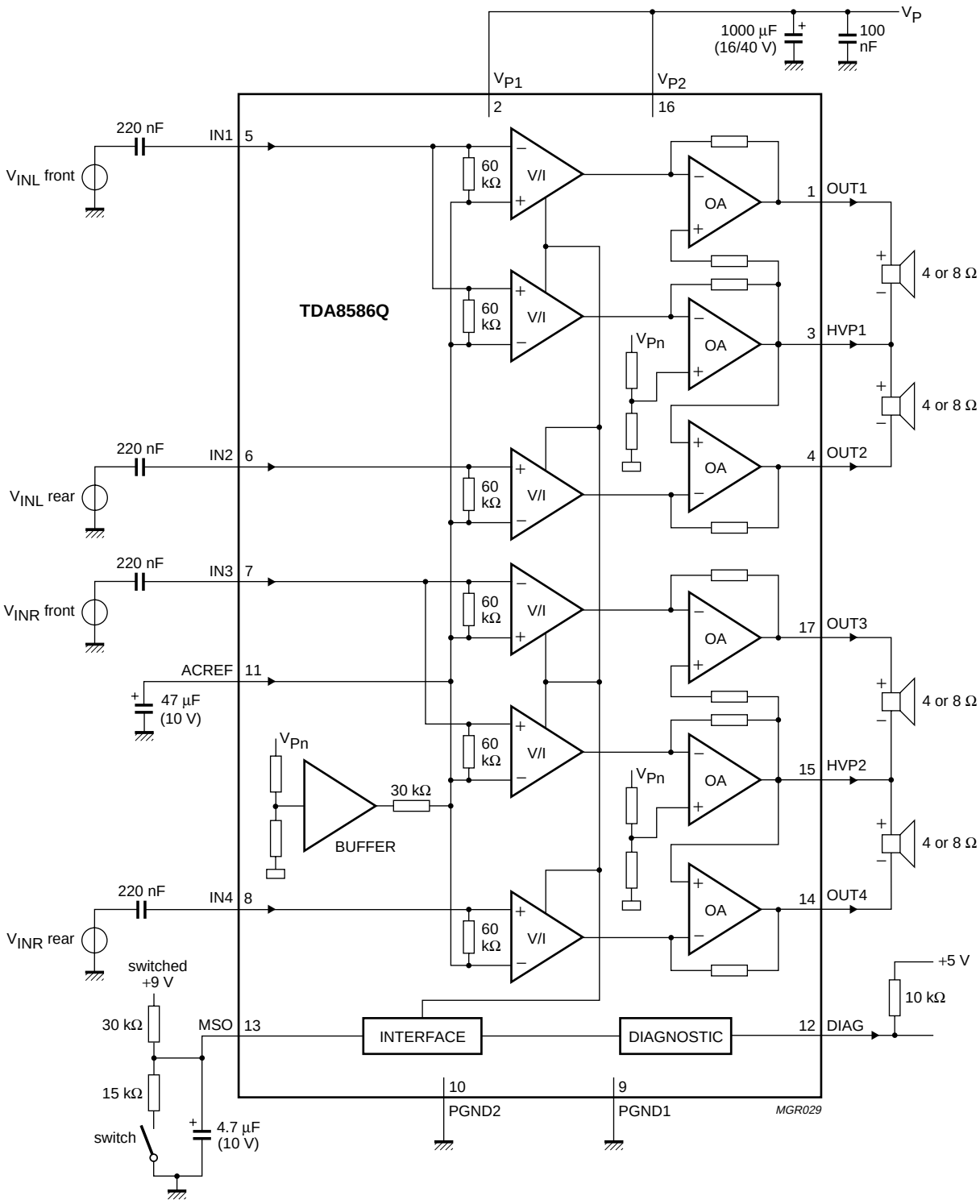


Fig.8 Quad single-ended application (SOT243-1).

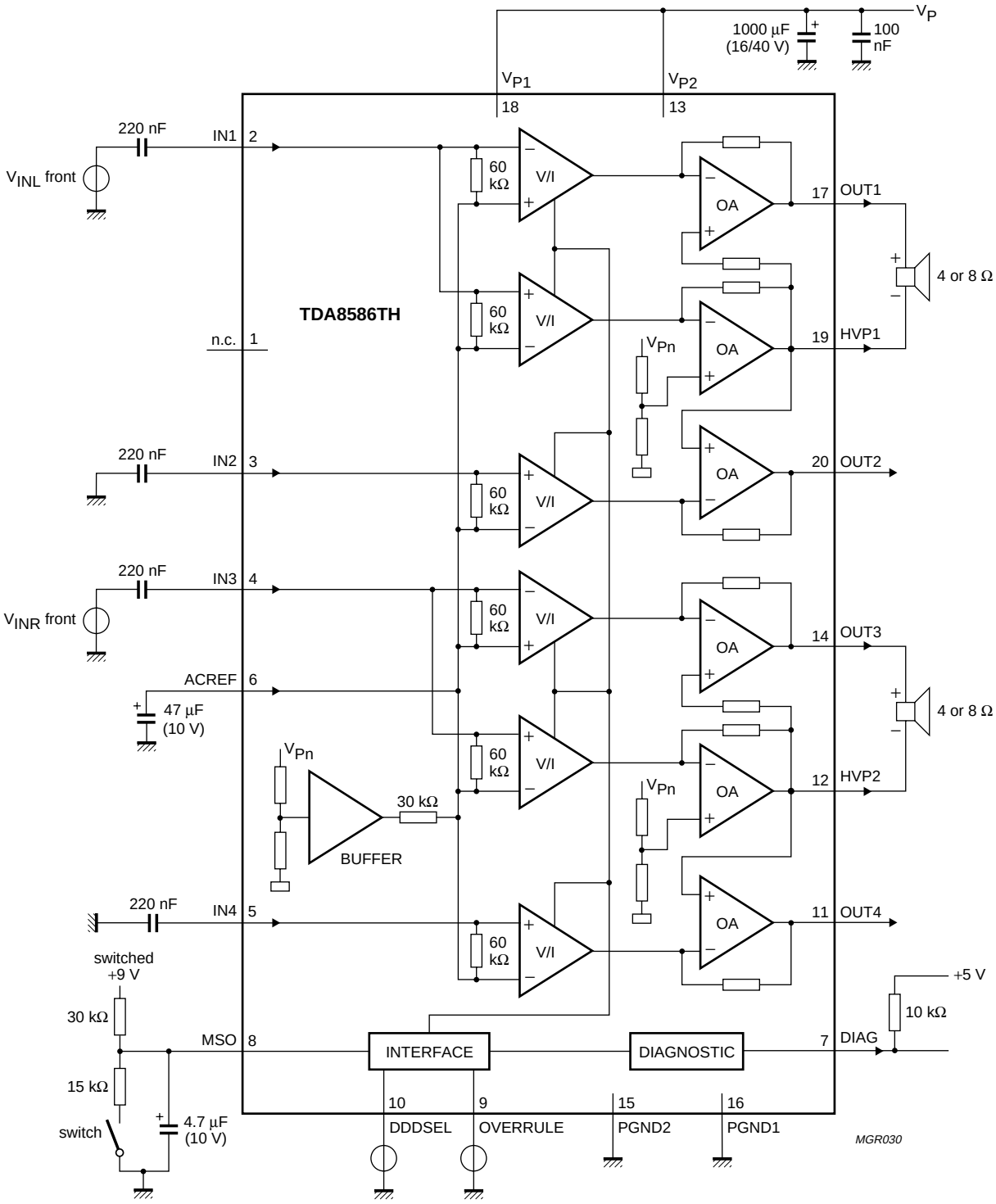


Fig.9 Stereo bridge-tied load application (SOT418-2).

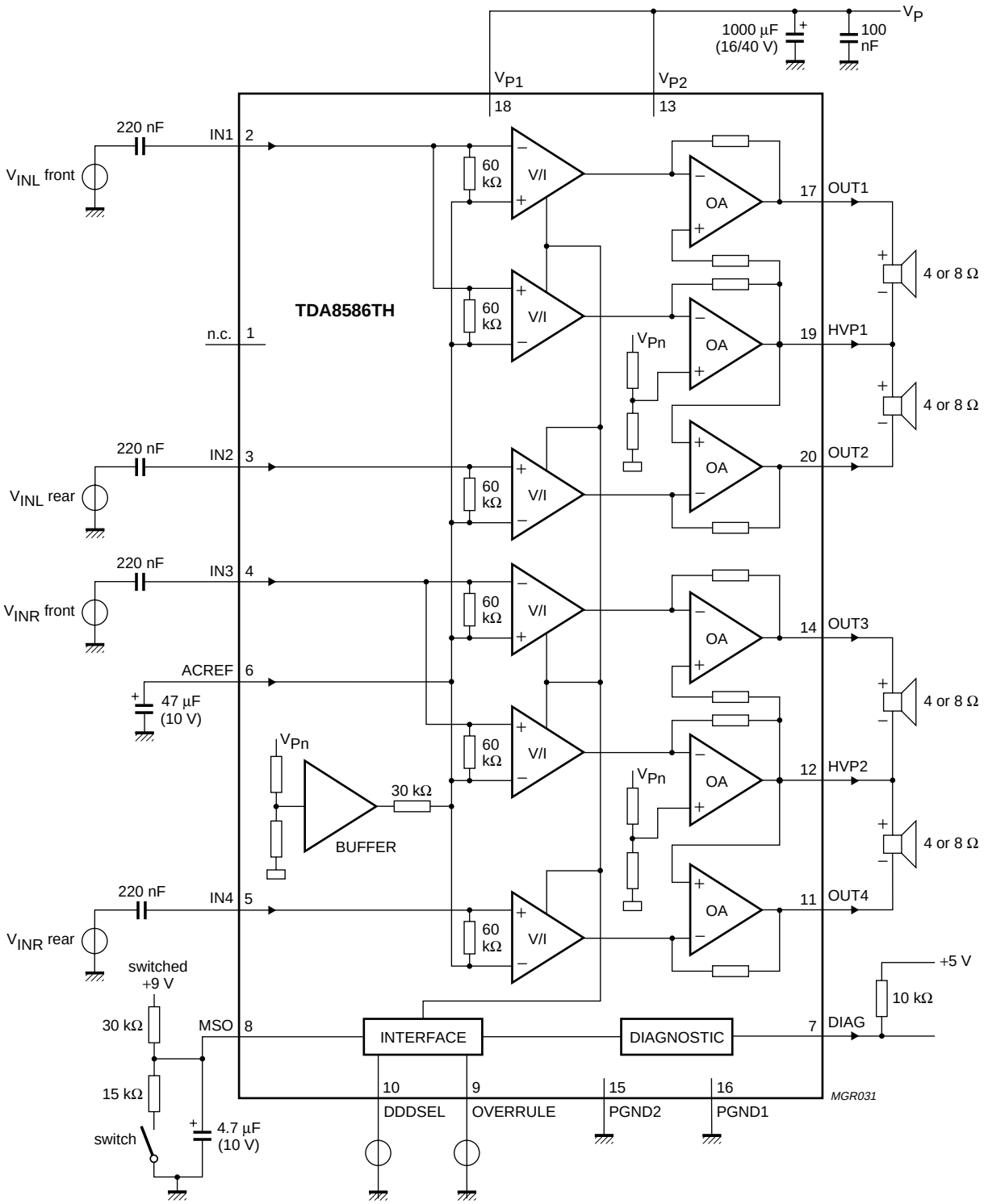
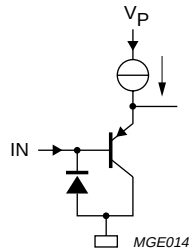
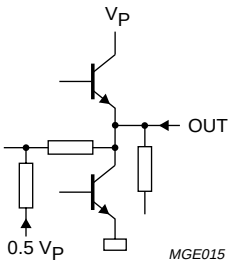
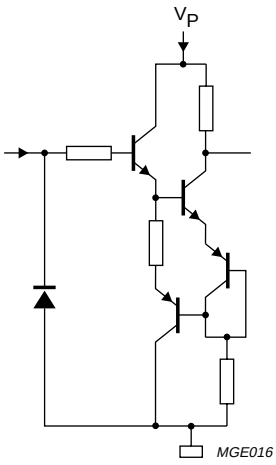


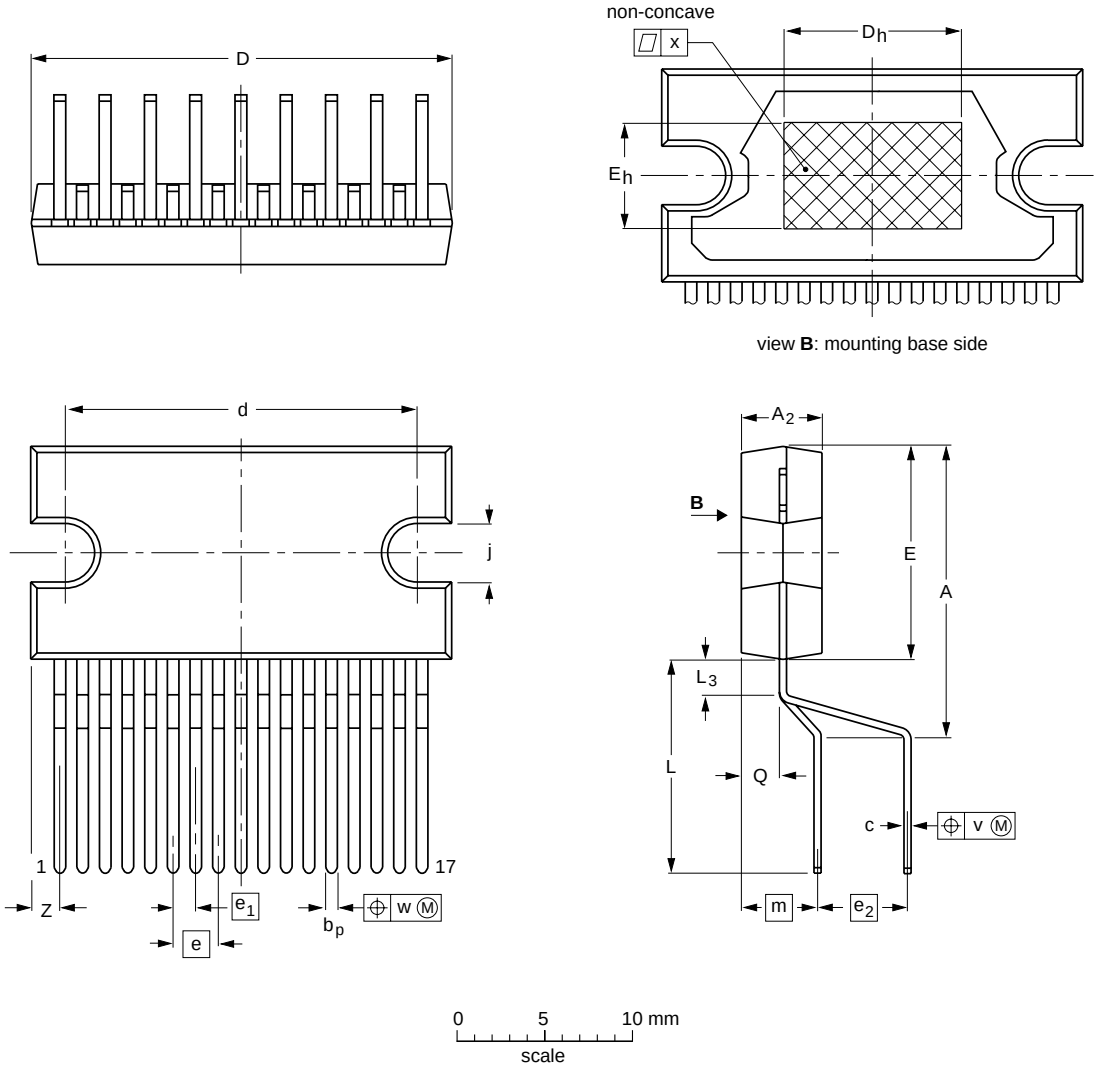
Fig.10 Quad single-ended application (SOT418-2).

INTERNAL PIN CONFIGURATION

PIN TDA8586TH	NAME	EQUIVALENT CIRCUIT
2, 3, 4, 5 and 6	inputs	
11, 12, 14, 17, 19 and 20	outputs	
8	mode select	

PACKAGE OUTLINES

DBS17P: plastic DIL-bent-SIL power package; 17 leads (lead length 12 mm) **SOT243-1**



DIMENSIONS (mm are the original dimensions)

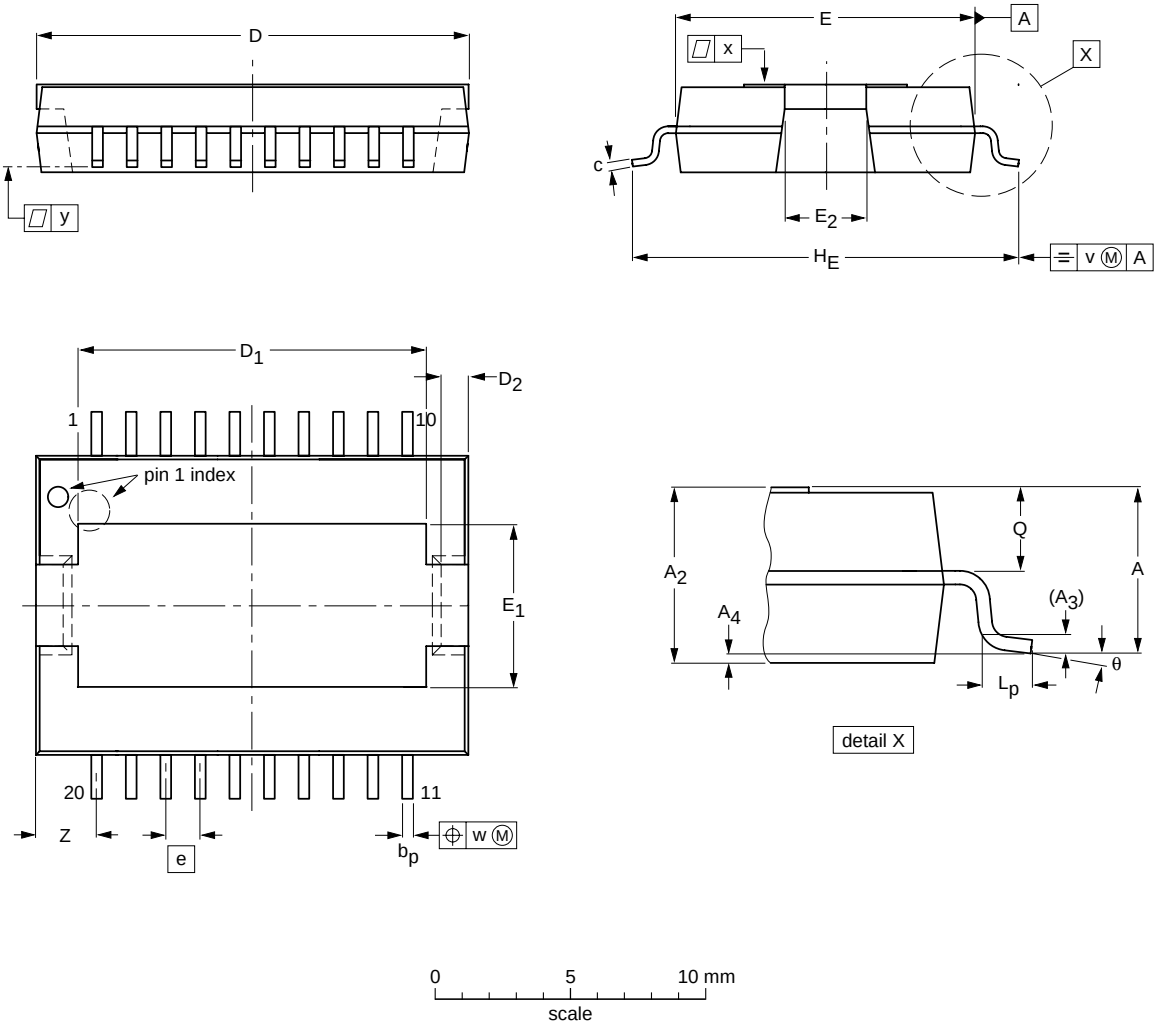
UNIT	A	A_2	b_p	c	$D^{(1)}$	d	D_h	$E^{(1)}$	e	e_1	e_2	E_h	j	L	L_3	m	Q	v	w	x	$Z^{(1)}$
mm	17.0 15.5	4.6 4.2	0.75 0.60	0.48 0.38	24.0 23.6	20.0 19.6	10	12.2 11.8	2.54	1.27	5.08	6	3.4 3.1	12.4 11.0	2.4 1.6	4.3	2.1 1.8	0.8	0.4	0.03	2.00 1.45

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT243-1						~~95-03-11~~ 97-12-16

HSOP20: heatsink small outline package; 20 leads; low stand-off **SOT418-2**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_2	A_3	A_4(1)	b_p	c	D(2)	D_1	D_2	E(2)	E_1	E_2	e	H_E	L_p	Q	v	w	x	y	Z	θ
mm	3.5	3.5 3.2	0.35	+0.12 −0.02	0.53 0.40	0.32 0.23	16.0 15.8	13.0 12.6	1.1 0.9	11.1 10.9	6.2 5.8	2.9 2.5	1.27	14.5 13.9	1.1 0.8	1.7 1.5	0.25	0.25	0.03	0.07	2.5 2.0	8° 0°

Note

1. Limits per individual lead.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT418-2						~~97-10-29~~ 98-02-25

SOLDERING

Introduction

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

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

Through-hole mount packages

SOLDERING BY DIPPING OR BY SOLDER WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joints for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg(max)}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

MANUAL SOLDERING

Apply the soldering iron (24 V or less) to the lead(s) of the package, either below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

Surface mount packages

REFLOW SOLDERING

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 methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferable be kept below 230 °C.

WAVE SOLDERING

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

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.

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.

MANUAL SOLDERING

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron 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.

Suitability of IC packages for wave, reflow and dipping soldering methods

MOUNTING	PACKAGE	SOLDERING METHOD		
		WAVE	REFLOW(1)	DIPPING
Through-hole mount	DBS, DIP, HDIP, SDIP, SIL	suitable(2)	–	suitable
Surface mount	BGA, SQFP	not suitable	suitable	–
	HLQFP, HSQFP, HSOP, HTSSOP, SMS	not suitable(3)	suitable	–
	PLCC(4), SO, SOJ	suitable	suitable	–
	LQFP, QFP, TQFP	not recommended(4)(5)	suitable	–
	SSOP, TSSOP, VSO	not recommended(6)	suitable	–

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
2. For SDIP packages, the longitudinal axis must be parallel to the transport direction of the printed-circuit board.
3. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
4. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
5. Wave soldering is only suitable for LQFP, QFP and TQFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
6. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

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.

NOTES

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 1 60 101 1248, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 20 0733, Fax. +375 172 20 0773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 68 9211, Fax. +359 2 68 9102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

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: Sydhavnsgade 23, 1780 COPENHAGEN V,
Tel. +45 33 29 3333, Fax. +45 33 29 3905

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615 800, Fax. +358 9 6158 0920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 4099 6161, Fax. +33 1 4099 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 2353 60, Fax. +49 40 2353 6300

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: PT Philips Development Corporation, Semiconductors Division,
Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510,
Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

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 108-8507, 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, Fax +9-5 800 943 0087

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

Pakistan: see Singapore

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 319762,
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 93 301 6312, Fax. +34 93 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2741 Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2886, 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, Fax. +1 800 943 0087

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 62 5344, Fax.+381 11 63 5777

For all other countries apply to: Philips Semiconductors,
International Marketing & Sales Communications, Building BE-p, P.O. Box 218,
5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

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

© Philips Electronics N.V. 1999 SCA63

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands 545002/750/02/pp24 Date of release: 1999 Apr 08 Document order number: 9397 750 05483

Let's make things better.

Philips Semiconductors

PHILIPS