INTEGRATED CIRCUITS

DATA SHEET

TDA8925ST

Power stage 2 × 15 W class-D audio amplifier

Objective specification

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Philips Semiconductors

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CONTENTS

1 FEATURES
2 APPLICATIONS
3 GENERAL DESCRIPTION
4 QUICK REFERENCE DATA
5 ORDERING INFORMATION
6 BLOCK DIAGRAM
7 PINNING
8 FUNCTIONAL DESCRIPTION
8.1 Power stage
8.2 Protection
8.2.1 Overtemperature
8.2.2 Short-circuit across the loudspeaker terminals
8.3 BTL operation
9 LIMITING VALUES
10 THERMAL CHARACTERISTICS
11 QUALITY SPECIFICATION
12 DC CHARACTERISTICS
13 AC CHARACTERISTICS
14 SWITCHING CHARACTERISTICS
14.1 Duty factor
15 TEST AND APPLICATION INFORMATION
15.1 BTL application
15.2 Package ground connection
15.3 Output power
15.4 Reference design
15.5 Reference design bill of material
15.6 Curves measured in reference design
16 PACKAGE OUTLINE
17 SOLDERING
17.1 Introduction to soldering through-hole mount packages
17.2 Soldering by dipping or by solder wave
17.3 Manual soldering
17.4 Suitability of through-hole mount IC packages for dipping and wave soldering methods
18 DATA SHEET STATUS
19 DEFINITIONS
20 DISCLAIMERS

1 FEATURES

- High efficiency (>94%)
- Operating voltage from ±7.5 to ±30 V
- Very low quiescent current
- High output power
- Diagnostic output
- Usable as a stereo Single-Ended (SE) amplifier or as a mono amplifier in Bridge-Tied Load (BTL)
- Electrostatic discharge protection (pin to pin)

2 APPLICATIONS

- Television sets
- Home-sound sets
- Multimedia systems
- All mains fed audio systems

3 GENERAL DESCRIPTION

The TDA8925ST is a switching power stage for a high efficiency class-D audio power amplifier system.

With this powerstage a compact 2 × 15 W Self Oscilating Digital Aplifier system (SODA) can be built, operating with high efficiency and very low dissipation. No heatsink is required. The system operates over a wide supply voltage range from ±7.5 up to ±30 V and consumes a very low quiescent current.

4 QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
General; V_P = ±15 V						
V_P	supply voltage		±7.5	±15	±30	V
$I_{q(tot)}$	total quiescent current	no load connected	–	25	45	mA
η	efficiency	P_o = 15 W; R_L = 8 Ω	–	94	–	%
Stereo single-ended configuration						
P_o	output power	R_L = 8 Ω; THD = 10%; V_P = ±15 V	14	15	–	W
Mono bridge-tied load configuration						
P_o	output power	R_L = 16 Ω; THD = 10%; V_P = ±15 V	28	30	–	W

5 ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA8925ST	RDBS17P	plastic rectangular-DIL-bent-SIL power package; 17 leads	SOT577-2

6 BLOCK DIAGRAM

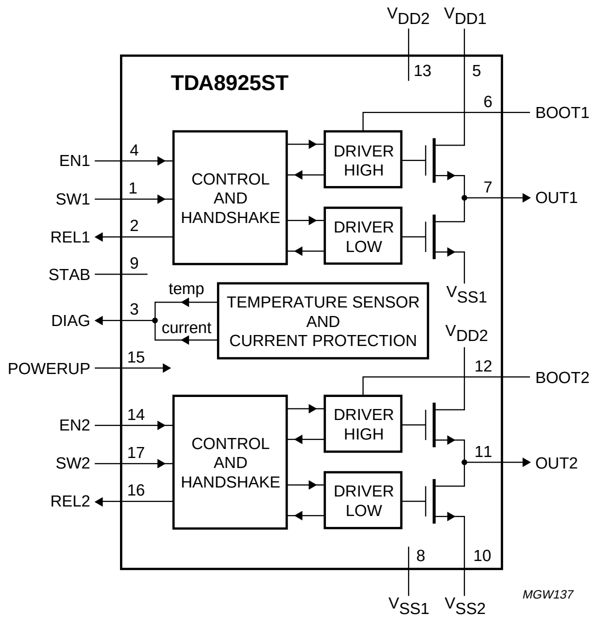


Fig.1 Block diagram.

7 PINNING

SYMBOL	PIN	DESCRIPTION
SW1	1	digital switch input; channel 1
REL1	2	digital control output; channel 1
DIAG	3	digital open-drain output for overtemperature and overcurrent report
EN1	4	digital enable input; channel 1
V_{DD1}	5	positive power supply; channel 1
BOOT1	6	bootstrap capacitor; channel 1
OUT1	7	PWM output; channel 1
V_{SS1}	8	negative power supply; channel 1
STAB	9	decoupling internal stabilizer for logic supply
V_{SS2}	10	negative power supply; channel 2
OUT2	11	PWM output; channel 2
BOOT2	12	bootstrap capacitor; channel 2
V_{DD2}	13	positive power supply; channel 2
EN2	14	digital enable input; channel 2
POWERUP	15	enable input for switching on internal reference sources
REL2	16	digital control output; channel 2
SW2	17	digital switch input; channel 2

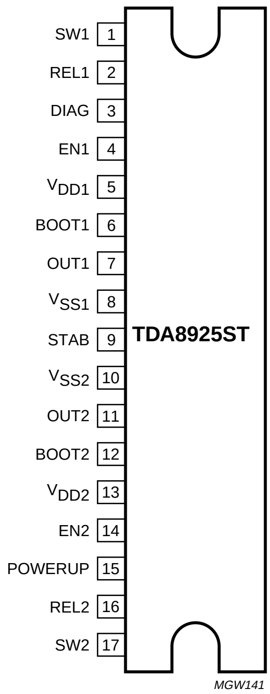


Fig.2 Pin configuration.

8 FUNCTIONAL DESCRIPTION

The TDA8925ST is a two-channel audio power amplifier system using the class-D technology (see Fig.3).

The power stage TDA8925ST is used for driving the low-pass filter and the loudspeaker load. It performs a level shift from the low-power digital PWM signal, at logic levels, to a high-power PWM signal that switches between the main supply lines. A 2nd-order low-pass filter converts the PWM signal into an analog audio signal across the loudspeaker.

8.1 Power stage

The power stage contains the high-power DMOS switches, the drivers, timing and handshaking between the power switches and some control logic. For protection, a temperature sensor and a maximum current detector are built-in on the chip.

For interfacing with the controller chip the following connections are used:

- Switch (pins SW1 and SW2): digital inputs; switching from V_{SS} to V_{SS} + 12 V and driving the power DMOS switches
- Release (pins REL1 and REL2): digital outputs; switching from V_{SS} to V_{SS} + 12 V; follow SW1 and SW2 with a small delay

  Note: for Self Oscillating applications this pin is not used.
- Enable (pins EN1 and EN2): digital inputs; at a level of V_{SS} the power DMOS switches are open and the PWM outputs are floating; at a level of V_{SS} + 12 V the power stage is operational and controlled by the switch pin if pin POWERUP is at V_{SS} + 12 V
- Power-up (pin POWERUP): must be connected to a continuous supply voltage of at least V_{SS} + 5 V with respect to V_{SS}
- Diagnostics (pin DIAG): digital open-drain output; pulled to V_{SS} if the temperature or maximum current is exceeded.

8.2 Protection

Temperature and short-circuit protection sensors are included in the TDA8925ST. In the event that the maximum current or maximum temperature is exceeded the diagnostic output is activated. Since the diagnostic is connected to the Enable pins in the application the system shuts down itsself.

8.2.1 OVERTEMPERATURE

If the junction temperature (T_j) exceeds 150 °C, then pin DIAG becomes LOW. The diagnostic pin is released if the temperature is dropped to approximately 130 °C, so there is a hysteresis of approximately 20 °C.

8.2.2 SHORT-CIRCUIT ACROSS THE LOUDSPEAKER TERMINALS

When the loudspeaker terminals are short-circuited this will be detected by the current protection. If the output current exceeds the maximum output current of 3 A, then pin DIAG becomes LOW. Using the DIAG in combination with the Enable pins the system is shut down within 1 µs, and restarted again. During this time the dissipation is very low, therefore the average dissipation during a short circuit is practically zero.

Fig.3 Typical application schematic of the Self Oscillating class-Dsystem using the TDA8925ST.

8.3 BTL operation

BTL operation can be achieved by driving the audio input channels of the controller in the opposite phase and by connecting the loudspeaker with a BTL output filter between the two outputs (pins OUT1 and OUT2) of the power stage (see Fig.4).

In this way the system operates as a mono BTL amplifier and with the same loudspeaker impedance a four times higher output power can be obtained.

For more information see Chapter 15.

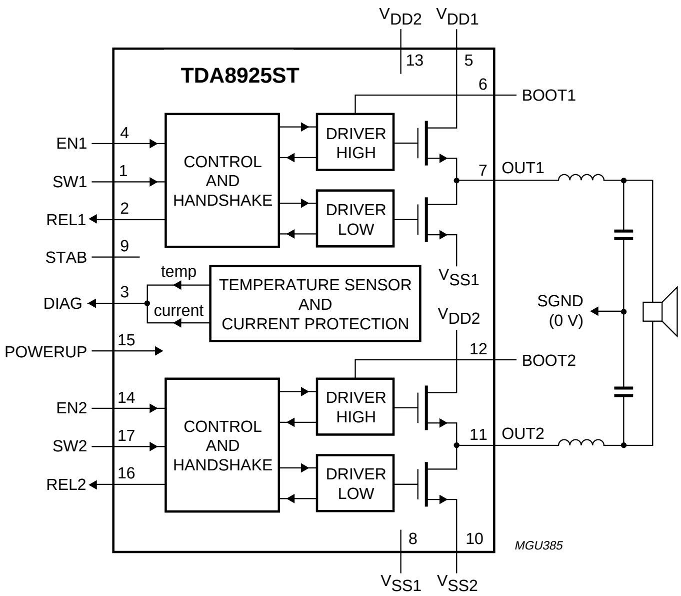


Fig.4 Mono BTL application.

9 LIMITING VALUES

In accordance with the Absolute Maximum Rate System (IEC 60134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage		–	±30	V
$V_{P(sc)}$	supply voltage for short-circuits across the load		–	±30	V
I_{ORM}	repetitive peak current in output pins		–	3	A
T_{stg}	storage temperature		–55	+150	°C
T_{amb}	ambient temperature		–40	+85	°C
T_{vj}	virtual junction temperature		–	150	°C
$V_{es(HBM)}$	electrostatic discharge voltage (HBM)	note 1			
$V_{es(MM)}$	electrostatic discharge voltage (MM)	note 2			

Notes

1. Human Body Model (HBM); R_s = 1500 Ω; C = 100 pF.
2. Machine Model (MM); R_s = 10 Ω; C = 200 pF; L = 0.75 μH.

10 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	in free air	1.5	K/W

11 QUALITY SPECIFICATION

In accordance with *“SNW-FQ611-part D”* if this device is used as an audio amplifier (except for ESD, see also Chapter 9).

12 DC CHARACTERISTICS

V_P = ±15 V; T_{amb} = 25 °C; measured in test diagram of Fig.6; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage	note 1	±7.5	±15	±30	V
$I_{q(tot)}$	total quiescent current	no load connected	–	25	45	mA
		outputs floating	–	5	10	mA
Internal stabilizer logic supply (pin STAB)						
$V_{O(STAB)}$	stabilizer output voltage	referenced to V_{SS}	11	13	15	V
Switch inputs (pins SW1 and SW2)						
V_{IH}	HIGH-level input voltage	referenced to V_{SS}	10	–	V_{STAB}	V
V_{IL}	LOW-level input voltage	referenced to V_{SS}	0	–	2	V
Control outputs (pins REL1 and REL2)						
V_{OH}	HIGH-level output voltage	referenced to V_{SS}	10	–	V_{STAB}	V
V_{OL}	LOW-level output voltage	referenced to V_{SS}	0	–	2	V
Diagnostic output (pin DIAG, open-drain)						
V_{OL}	LOW-level output voltage	I_{DIAG} = 1 mA; note 2	0	–	1.0	V
I_{LO}	output leakage current	no error condition	–	–	50	μA
Enable inputs (pins EN1 and EN2)						
V_{IH}	HIGH-level input voltage	referenced to V_{SS}	–	9	V_{STAB}	V
V_{IL}	LOW-level input voltage	referenced to V_{SS}	0	5	–	V
$V_{EN(hys)}$	hysteresis voltage		–	4	–	V
$I_{I(EN)}$	input current		–	–	300	μA
Switching-on input (pin POWERUP)						
$V_{POWERUP}$	operating voltage	referenced to V_{SS}	5	–	12	V
$I_{I(POWERUP)}$	input current	$V_{POWERUP}$ = 12 V	–	100	170	μA
Temperature protection						
T_{diag}	temperature activating diagnostic	$V_{DIAG} = V_{DIAG(LOW)}$	150	–	–	°C
T_{hys}	hysteresis on temperature diagnostic	$V_{DIAG} = V_{DIAG(LOW)}$	–	20	–	°C

Notes

1. The circuit is DC adjusted at V_P = ±15 to ±30 V.
2. Temperature sensor or maximum current sensor activated.

13 AC CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Single-ended application; note 1						
P_o	output power	R_L = 8 Ω; V_P = ±15 V				
		THD = 0.5%	10(2)	12	–	W
		THD = 10%	14(2)	15	–	W
THD	total harmonic distortion	P_o = 1 W; note 3				
		f_i = 1 kHz	–	0.05	0.1	%
		f_i = 10 kHz	–	0.2	–	%
η	efficiency	P_o = 30 W; f_i = 1 kHz; note 4	–	94	–	%
Mono BTL application; note 5						
P_o	output power	R_L = 16 Ω; THD = 0.5%	20(2)	24	–	W
		R_L = 16 Ω; THD = 10%	24(2)	30	–	W
THD	total harmonic distortion	P_o = 1 W; note 3				
		f_i = 1 kHz	–	0.05	0.1	%
		f_i = 10 kHz	–	0.2	–	%
η	efficiency	P_o = 30 W; f_i = 1 kHz; note 4	–	94	–	%

Notes

1. V_P = ±15 V; R_L = 8 Ω; f_i = 1 kHz; f_{osc} = 310 kHz; R_s = 0.1 Ω (series resistance of filter coil); T_{amb} = 25 °C; measured in reference design (SE application) shown in Fig.7; unless otherwise specified.
2. Indirectly measured; based on $R_{ds(on)}$ measurement.
3. Total Harmonic Distortion (THD) is measured in a bandwidth of 22 Hz to 22 kHz. When distortion is measured using a low-order low-pass filter a significantly higher value will be found, due to the switching frequency outside the audio band.
4. Efficiency for power stage; output power measured across the loudspeaker load.
5. V_P = ±15 V; R_L = 16 Ω; f_i = 1 kHz; f_{osc} = 310 kHz; R_s = 0.1 Ω (series resistance of filter coil); T_{amb} = 25 °C; measured in reference design (BTL application) shown in Fig.7; unless otherwise specified.

14 SWITCHING CHARACTERISTICS

$V_P = \pm15$ V; $T_{amb} = 25$ °C; measured in Fig.6; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
PWM outputs (pins OUT1 and OUT2); see Fig.5						
t_r	rise time		–	30	–	ns
t_f	fall time		–	30	–	ns
t_{blank}	blanking time		–	70	–	ns
t_{PD}	propagation delay	from pin SW1 (SW2) to pin OUT1 (OUT2)	–	20	–	ns
$t_{W(min)}$	minimum pulse width	note 1	–	220	270	ns
$R_{ds(on)}$	on-resistance of the output transistors		–	0.4	0.6	Ω

Note

1. When used in combination with controller TDA8929T, the effective minimum pulse width during clipping is $0.5t_{W(min)}$.

14.1 Duty factor

For the practical useable minimum and maximum duty factor (δ) which determines the maximum output power:

$$\frac{t_{W(min)} \times f_{osc}}{2} \times 100\% < \delta < \left(1 - \frac{t_{W(min)} \times f_{osc}}{2}\right) \times 100\%$$

Using the typical values: 3.5% < δ < 96.5%.

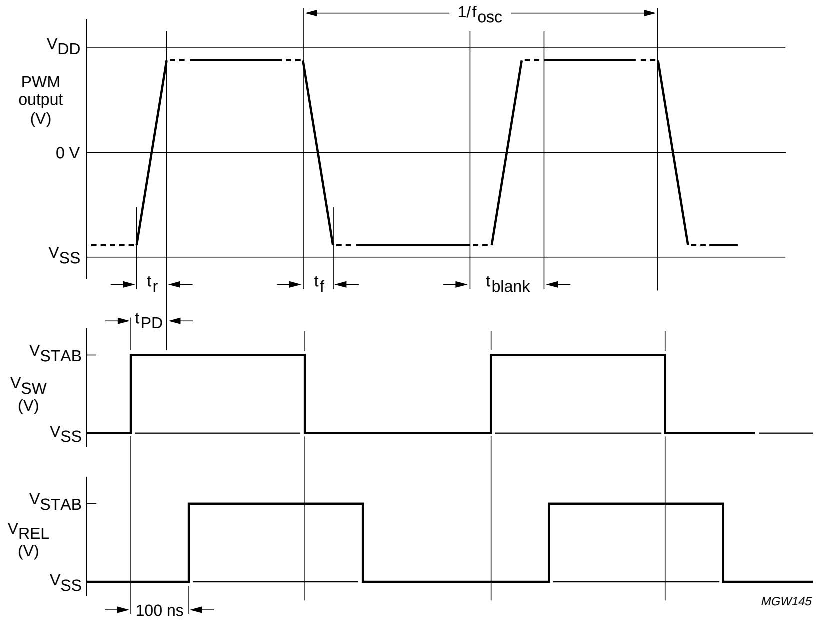


Fig.5 Timing diagram PWM output, switch and release signals.

15 TEST AND APPLICATION INFORMATION

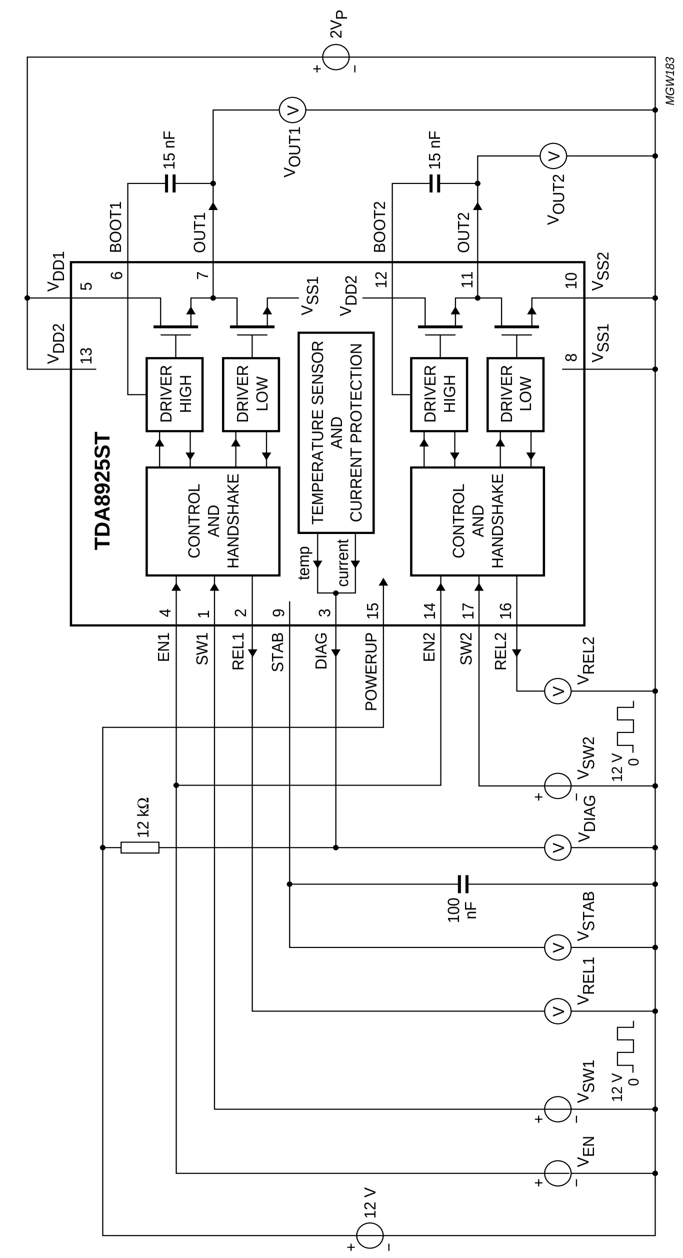


Fig.6 Test diagram.

15.1 BTL application

When using the system in a mono BTL application (for more output power), the inputs of both channels of the PWM modulator must be connected in parallel; the phase of one of the inputs must be inverted. In principle the loudspeaker can be connected between the outputs of the two single-ended demodulation filters.

15.2 Package ground connection

The heatsink of the TDA8925ST is connected internally to V_{SS}.

15.3 Output power

The output power in single-ended Self Oscillating class-D applications can be estimated using the formula

$$P_{o(1\%)} = \frac{\left[\frac{R_L}{(R_L + R_{ds(on)} + R_s)} \times V_P\right]^2}{2 \times R_L}$$

The maximum current $I_{O(max)} = \frac{[V_P]}{R_L + R_{ds(on)} + R_s}$ should not exceed 3 A.

The output power in BTL applications can be estimated using the formula

$$P_{o(1\%)} = \frac{\left[\frac{R_L}{R_L + 2 \times (R_{ds(on)} + R_s)} \times 2V_P\right]^2}{2 \times R_L}$$

The maximum current $I_{O(max)} = \frac{[2V_P]}{R_L + 2 \times (R_{ds(on)} + R_s)}$ should not exceed 3 A.

Where:

R_L = load impedance

R_s = series resistance of filter coil

$P_{o(1\%)}$ = output power just at clipping

The output power at THD = 10%: $P_{o(10\%)} = 1.25 \times P_{o(1\%)}$.

15.4 Reference design

The reference design for a Self Oscillating class-D system for the TDA8925ST is shown in Fig.7. The Printed-Circuit Board (PCB) layout is shown in Fig.8. The bill of materials is given in Table 1.

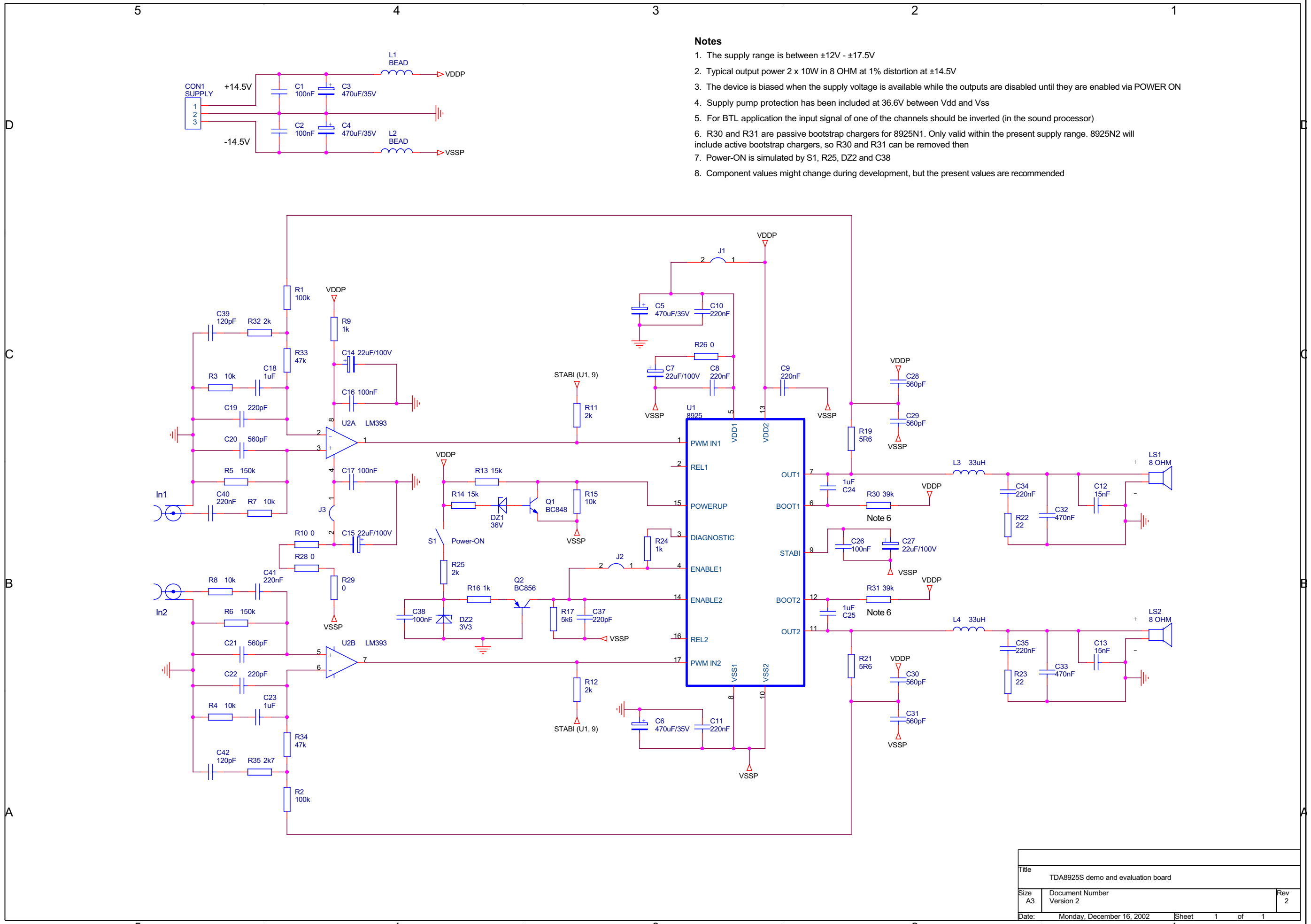


Fig.7 Self Oscillating class-D system application diagram for TDA8925ST.

Fig.8 Printed-circuit board layout for TDA8925ST.

15.5 Reference design bill of material

Table 1 Self Oscillating class-D system audio amplifierTDA8925ST (see Figs 7 and 8)

COMPONENT	DESCRIPTION	VALUE	COMMENTS
1	power stage IC	TDA8925ST	RDBS17P package

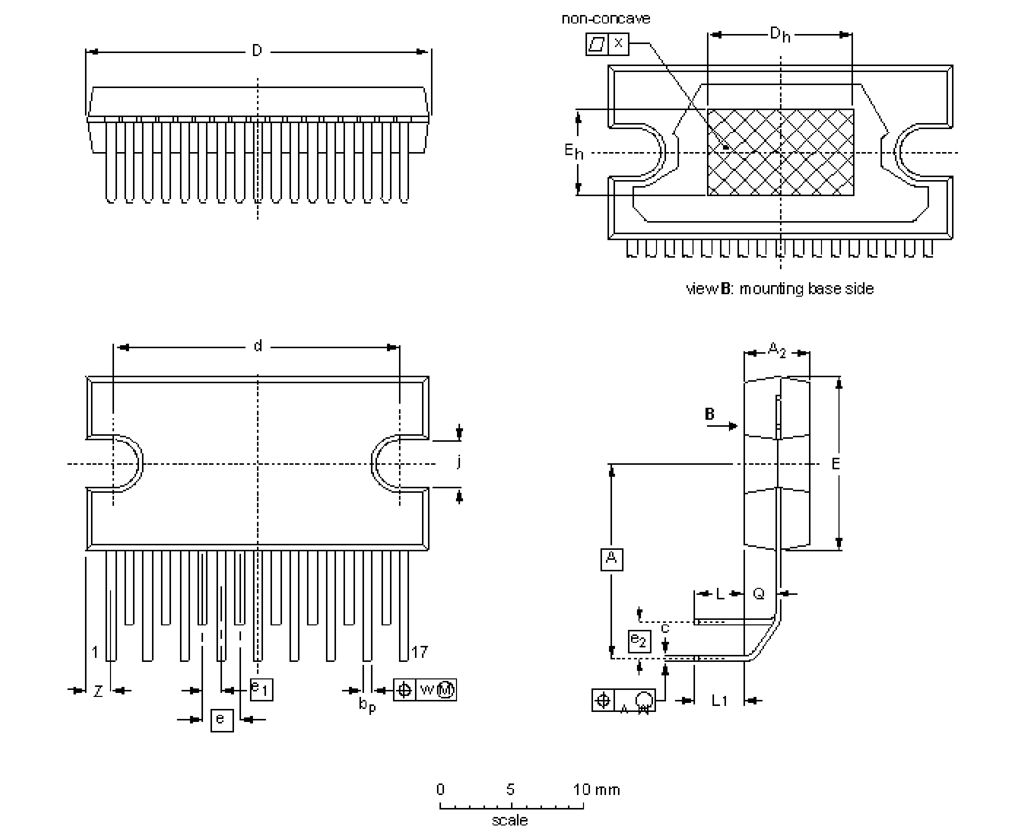
COMPONENT	DESCRIPTION	VALUE	COMMENTS

15.6 Curves measured in reference design

t

16 PACKAGE OUTLINE

RDBS17P: plastic rectangular-DIL-bent-SIL power package; 17 leads (row spacing 2.54 mm) **SOT577-2**



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_1	Q	v	w	x	Z[(1)]
mm	13.5	4.6 4.4	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	2.54	6	3.4 3.1	3.75 3.15	3.75 3.15	2.1 1.8	0.6	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			
SOT577-2						01-01-05

17 SOLDERING

17.1 Introduction to soldering through-hole mount packages

This text gives a brief insight to wave, dip and manual soldering. 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).

Wave soldering is the preferred method for mounting of through-hole mount IC packages on a printed-circuit board.

17.2 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.

17.3 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.

17.4 Suitability of through-hole mount IC packages for dipping and wave soldering methods

PACKAGE	SOLDERING METHOD	
	DIPPING	WAVE
DBS, DIP, HDIP, SDIP, SIL	suitable	suitable(1)

Note

1. For SDIP packages, the longitudinal axis must be parallel to the transport direction of the printed-circuit board.

18 DATA SHEET STATUS

LEVEL	DATA SHEET STATUS(1)	PRODUCT STATUS(2)(3)	DEFINITION
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

Notes

1. Please consult the most recently issued data sheet before initiating or completing a design.
2. The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.
3. For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

19 DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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.

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20 DISCLAIMERS

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Contact information

For additional information please visit **http://www.semiconductors.philips.com**. Fax: **+31 40 27 24825**
For sales offices addresses send e-mail to: **sales.addresses@www.semiconductors.philips.com**.

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