TDA8931

Power comparator 1 × 20 W

Rev. 01 — 14 January 2004 Preliminary data sheet

1. General description

The TDA8931 is a switching power stage for high efficiency class-D audio power amplifier systems.

It contains a Single-Ended (SE) power stage, drive logic, protection control logic, a full differential input comparator and a HVP charger to charge the SE capacitor. With this amplifier a compact 1 × 20 W closed loop self-oscillating digital amplifier system can be built. The TDA8931 has a high efficiency so that a heat sink is not required up to 20 W (RMS). The system operates on an asymmetrical and a symmetrical supply voltage.

2. Features

- High efficiency
- Operating voltage asymmetrical from 12 V to 35 V
- Operating voltage symmetrical from ±6 V to ±17.5 V
- Thermally protected
- No heat sink required
- Charger for single-ended capacitor
- No pop sound

3. Applications

- Flat panel television sets
- Flat panel monitors
- Multimedia systems
- Wireless speakers
- Micro systems

4. Quick reference data

Table 1: Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
General						
V_P	operating supply voltage	asymmetrical	12	22	35	V
		symmetrical	±6	±11	±17.5	V
I_q	quiescent current	Operating mode; V_P = 22 V	-	20	30	mA
I_{stb}	standby current	Standby mode; V_P = 22 V	-	10	15	mA
I_{sleep}	sleep current	Sleep mode; V_P = 22 V	-	100	200	µA

PHILIPS

Table 1: Quick reference data *…continued*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
η	efficiency	P_o = 15 W; V_p = 30 V; R_L = 8 Ω	89	91	-	%
SE channel						
P_o	maximum output power	R_L = 4 Ω; THD = 10 %				
		V_P = 26 V	21	22	-	W
		V_P = 22 V	15	16	-	W
		R_L = 8 Ω; THD = 10 %				
		V_P = 30 V	15	16	-	W

5. Ordering information

Table 2: Ordering information

Type number	Package		
	Name	Description	Version
TDA8931T	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1

6. Block diagram

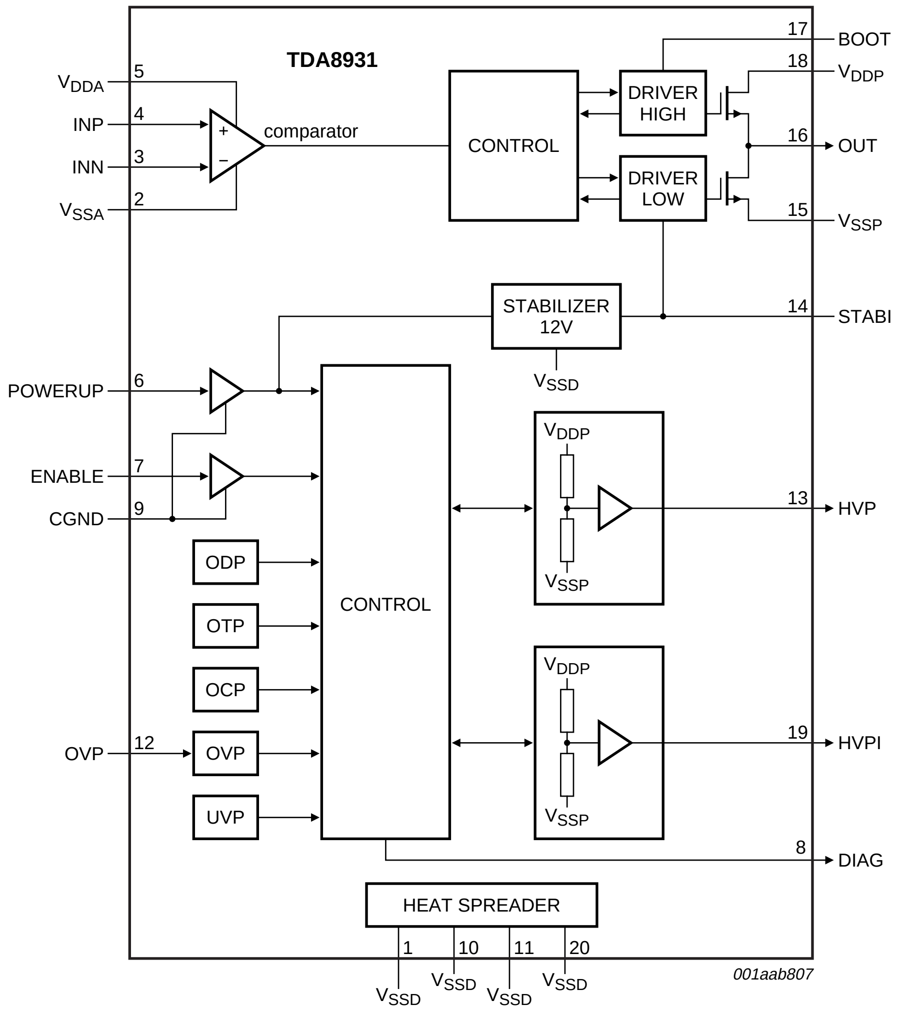


Fig 1. Block diagram

7. Pinning information

7.1 Pinning

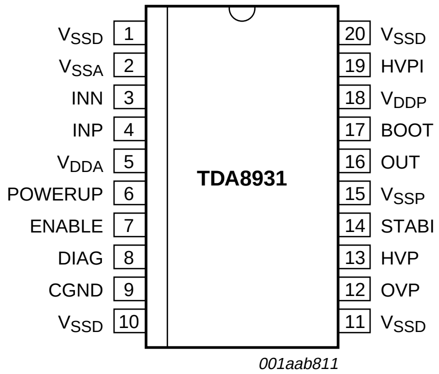


Fig 2. Pin configuration

7.2 Pin description

Table 3: Pin description

Symbol	Pin	Description
V_{SSD}	1	negative digital supply voltage; heat spreader
V_{SSA}	2	negative analog supply voltage
INN	3	inverting input
INP	4	non inverting input
V_{DDA}	5	positive analog supply voltage
POWERUP	6	power-up input
ENABLE	7	enable input
DIAG	8	diagnostic output
CGND	9	control ground; reference ground for pins POWERUP, ENABLE and DIAG
V_{SSD}	10	negative digital supply voltage; heat spreader
V_{SSD}	11	negative digital supply voltage; heat spreader
OVP	12	overvoltage protection reference input
HVP	13	half supply voltage output for charging SE capacitor
STABI	14	decoupling of internal stabilizer
V_{SSP}	15	negative power supply voltage
OUT	16	PWM output
BOOT	17	bootstrap capacitor connection
V_{DDP}	18	positive power supply voltage
HVPI	19	half supply voltage output for reference voltage of input circuitry
V_{SSD}	20	negative digital supply voltage; heat spreader

8. Functional description

8.1 General

The TDA8931 is a switching power stage for high efficiency class-D audio power amplifier systems. It contains a Single-Ended (SE) power stage, drive logic, protection control logic, a full differential input comparator and a HVP charger to charge the SE capacitor (see Figure 1). With this amplifier a compact 1 × 20 W closed loop self-oscillating digital amplifier system can be built. A second order low-pass filter converts the PWM output signal into an analog audio signal across the speaker.

8.2 Interfacing

The operating modes of the TDA8931 can be controlled by pins POWERUP and ENABLE. Both pins refer to pin CGND. The device has three modes:

- Sleep mode
- Standby mode
- Operating mode

When pin POWERUP = LOW, the power comparator is in Sleep mode, independent of the signal on pin ENABLE. In Sleep mode the SE capacitor charger will be discharged.

When pin POWERUP = HIGH and pin ENABLE = LOW the device is in Standby mode. In Standby mode the device is DC biased and the SE capacitor will be charged and the output is floating.

When both pins POWERUP and ENABLE are HIGH, the device is in Operating mode. A level at pin POWERUP greater than 11 V can also enter the Operating mode, independent of the level on pin ENABLE (see Table 4).

Remark: The switch-on sequence is important. First pin POWERUP = HIGH, then pin ENABLE = HIGH.

Table 4: Interfacing

Voltage on pin		Mode
POWERUP	ENABLE	
< 0.8 V	-	Sleep
3 V to 7 V	< 0.8 V	Standby
	> 3 V	Operating
> 11 V	-	Operating

8.3 Input comparator

The input comparator has a full differential input and is optimized for low noise and low offset. This results in maximum flexibility in the application.

8.4 Half supply voltage input reference (pin HVPI)

When the device is in Standby mode, the external capacitor C6 (see Figure 5) will be charged until it reaches the half of the supply voltage. This pin charges capacitor C6 within 0.5 seconds.

Pin HVPI will be on its final level of $0.5V_P$ before the device starts switching. This results into a plop-noise free start-up behavior.

8.5 Half supply voltage capacitor charger (pin HVP)

When the device is in Standby mode, the SE capacitor C15 (see Figure 5) will be charged until it reaches the half of the supply voltage. This current charges capacitor C15 within 0.5 seconds when a capacitor of 1000 μF is used. When the voltage on pin HVP has reached the level of $0.5V_P$ it releases pin ENABLE for external use.

When the device is in Operating mode, pin HVP is switched to floating to minimize dissipation.

When the supply voltage drops, capacitor C15 is discharged and the device is switched off to avoid plop noise.

8.6 Protections

Overtemperature, overcurrent, overvoltage and undervoltage sensors are included in the TDA8931. When one of these sensors exceeds its threshold level the output power stage is switched off and the output stage becomes floating. After 1.5 μs the device will try to restart. When the fault condition is removed the output stage is switched on.

Table 5: Overview protections

Protection		Output pin DIAG	Remark
Symbol	Condition		
OTP	$T_j > 150$ °C	LOW [1]	self recovering when fault is removed
OCP	$I_O > I_{OCP}$		
OVP	$V_P > V_{P(OVP)fix}$		
UVP	$V_P < V_{P(UVP)}$		
ODP	$I_O > I_{OCP}$ and $T_j > 140$ °C	LOW	recovering by switching pin POWERUP: first to Sleep mode and then to Standby mode recovering by removing supply voltage

[1] Pin DIAG = LOW for minimal 1.5 μs.

8.6.1 Overtemperature protection (OTP)

If the junction temperature T_j exceeds the threshold level of approximately 150 °C then the device will shut down immediately. The device will start switching again when the temperature drops.

8.6.2 Overcurrent protection (OCP)

If the output current exceeds the maximum output current threshold level (e.g. when the loudspeaker terminals are short-circuited it will be detected by the current protection) the device will shut-down.

8.6.3 Overvoltage protection (OVP)

When the supply voltage applied to the TDA8931 exceeds the maximum supply voltage threshold level the device will shut down. The supply voltage on which the device stops operating is determined by two external resistors R1 and R2.

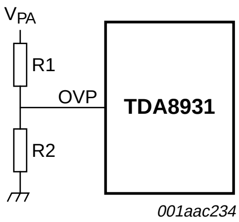


Fig 3. Overvoltage protection setting

The overvoltage protection level can be determined by the formula:

$$V_{P(OVP)} = \frac{R1 + R2}{R2} \times V_{OVP} \quad (1)$$

Where:

$V_{P(OVP)}$ = overvoltage protection level of supply voltage

R1 = external resistor

R2 = external resistor

V_{OVP} = 1.27 V reference voltage.

Example: The TDA8931 has to shut down at 24 V. When we choose R2 = 10 kΩ, then R1 has to be 178 kΩ and $V_{P(OVP)}$ becomes 24 V.

Remark: When pin OVP is connected to V_{SSD} the $V_{P(OVP)fix}$ level is used.

8.6.4 Undervoltage protection (UVP)

When the supply voltage applied to the TDA8931 drops below the minimum supply voltage threshold level the device is internally set to Standby mode.

8.6.5 Supply voltage drop protection

When the TDA8931T is switched off with the supply, it will be switched off before it reaches the voltage on pin HVP. This prevents switch-off pop noise. This function is not self recovering. The TDA8931T can be recovered by switching to Sleep mode or by removing the supply voltage.

8.6.6 Overdissipation protection (ODP)

In case of a short-circuit across the speaker the dissipation is minimized by the ODP. When the OCP and the OTP are on the same time activated, an over dissipation is defined. The device is set to Sleep mode and is not self-recovering. When pin POWERUP = 0 V or the supply voltage is removed, the device is recovered.

9. Internal circuitry

Table 6: Internal circuitry

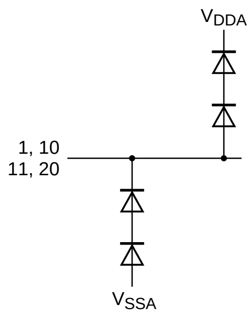
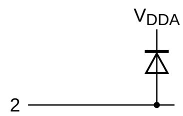
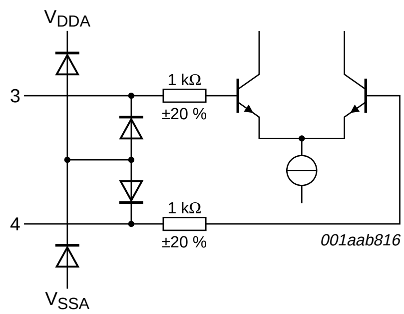
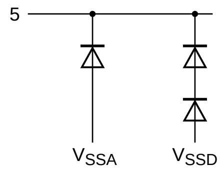
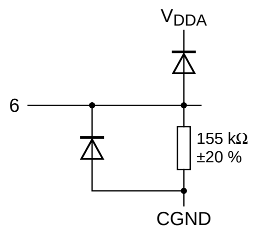
Pin	Symbol	Equivalent circuit
1, 10, 11, 20	V_{SSD}	 *001aab815*
2	V_{SSA}	 *001aab817*
3, 4	INN, INP	
5	V_{DDA}	 *001aab818*
6	POWERUP	 *001aab819*

Table 6: Internal circuitry *…continued*

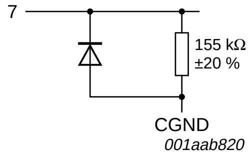
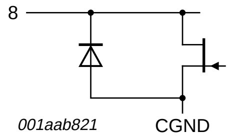
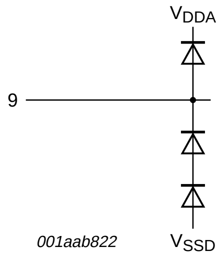
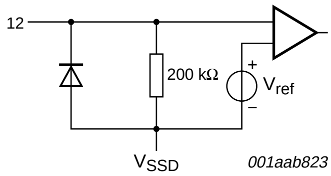
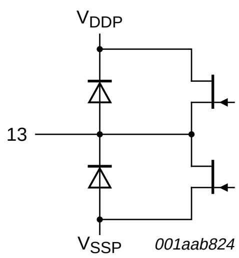
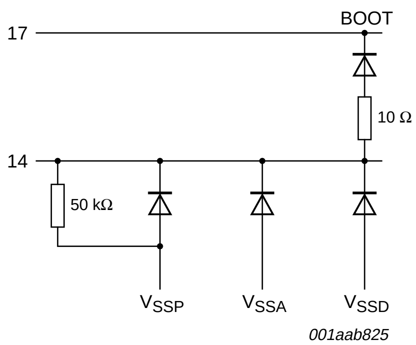
Pin	Symbol	Equivalent circuit
7	ENABLE	
8	DIAG	
9	CGND	
12	OVP	
13	HVP	
14	STABI	

Table 6: Internal circuitry *...continued*

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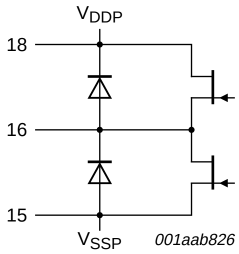
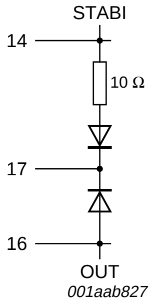
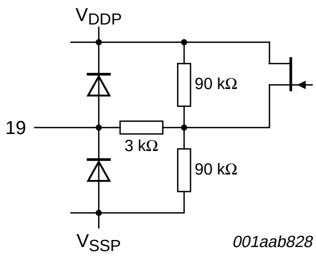
<tr><td>15</td><td>V_{SSP}</td><td rowspan="3">
</td></tr>
<tr><td>16</td><td>OUT</td></tr>
<tr><td>18</td><td>V_{DDP}</td></tr>
<tr><td>17</td><td>BOOT</td><td>
</td></tr>
<tr><td>19</td><td>HVPI</td><td>
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10. Limiting values

Table 7: Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
V_P	operating supply voltage	asymmetrical	12	40	V
		symmetrical	±6	±20	V
V_{ENABLE}	maximum voltage on pin ENABLE		-	14	V
V_{OVP}	maximum voltage on pin OVP		-	14	V
V_n	voltage on all other pins		$V_{SS} - 0.3$	$V_{DD} + 0.3$	V
I_{ORM}	repetitive peak output current		-	8	A
$P_{d(max)}$	maximum power dissipation		-	2.5	W
T_j	junction temperature		-	150	°C
T_{stg}	storage temperature		–55	+150	°C
T_{amb}	ambient temperature		–40	+85	°C

11. Thermal characteristics

Table 8: Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-a)}$	thermal resistance junction to ambient	in free air	[1]	24	K/W
$R_{th(j-p)}$	thermal resistance junction to pin	in free air	[2]	16	K/W
$R_{th(j-c)}$	thermal resistance junction to case	in free air	[3]	3	K/W

[1] Measured in the application board.

[2] V_p = 22 V; R_L = 4 Ω; V_{ripple} = 2 V (p-p); f_{ripple} = 100 Hz with feed-forward network (470 kΩ and 15 nF).

[3] Strongly depending on where you measure on the case.

12. Static characteristics

Table 9: Characteristics

V_P = 22 V; T_{amb} = 25 °C; $f_{carrier}$ = 290 kHz; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply voltage						
V_P	operating supply voltage	$V_P = V_{DDP} - V_{SSP}$				
		asymmetrical	12	22	35	V
		symmetrical	±6	±11	±17.5	V
I_q	quiescent current	with load; filter and snubbers connected	-	20	30	mA
I_{stb}	standby current	Standby mode; SE capacitor charged	-	10	15	mA
I_{sleep}	sleep current	Sleep mode	-	100	200	µA

Table 9: Characteristics *...continued*

V_P = 22 V; T_{amb} = 25 °C; $f_{carrier}$ = 290 kHz; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Power-up input: pin POWERUP							
V_{IL}	LOW-level input voltage	with respect to CGND		-	-	0.8	V
V_{IH}	HIGH-level input voltage	with respect to CGND					
		Standby mode		3	-	7	V
		Operating mode		11	-	V_P	V
V_{hys}	hysteresis voltage			-	0.5	-	V
I_I	input current	V_I = 5 V		-	30	40	μA
Enable input: pin ENABLE							
V_{IL}	LOW-level input voltage	with respect to CGND		-	-	0.8	V
V_{IH}	HIGH-level input voltage	with respect to CGND	[1]	3	-	12	V
V_{hys}	hysteresis voltage			-	0.3	-	V
I_I	input current	V_I = 5 V		-	30	40	μA
Internal stabilizer output: pin STABI							
V_O	output voltage	with respect to V_{SSD}		11	12	14	V
Comparator full differential input stage: pins INP and INN							
$V_{off(i)(eq)}$	equivalent input offset voltage			-	-	10	mV
$V_{n(i)(eq)}$	equivalent input RMS-noise voltage	20 Hz < f_i < 20 kHz		-	-	15	mV
$V_{i(cm)}$	common mode input voltage			V_{SSA} + 4	-	V_{DDA} – 5	V
$I_{i(bias)}$	bias input current			-	24	60	nA
Half supply voltage output for input circuitry: pin HVPI							
V_{HVPI}	output voltage on pin HVPI	Standby and Operating mode		$0.5V_P$ – 0.25	$0.5V_P$	$0.5V_P$ + 0.25	V
Half supply voltage output to charge SE capacitor: pin HVP							
V_{HVP}	output voltage on pin HVP	Standby mode		$0.5V_P$ – 0.25	$0.5V_P$	$0.5V_P$ + 0.25	V
I_{charge}	charge current of HVP capacitor			20	45	-	mA
Overtemperature protection (OTP)							
T_{OTP}	overtemperature protection level			150	155	-	°C
Overvoltage protection (OVP)							
$V_{P(OVP)fix}$	fixed OVP threshold level	level internal fixed		35	37.5	40	V
V_{OVP}	adjustable OVP level		[2]	1.19	1.27	1.35	V
Undervoltage protection (UVP)							
$V_{P(min)}$	protection level minimum supply voltage			10	11	12	V
Overcurrent protection (OCP)							
I_{OCP}	overcurrent protection level			3.3	4.0	-	A

[1] V_{IH} on pin ENABLE must not exceed V_{DDA}.

[2] The overvoltage protection can be controlled external (see Section 8.6.3).

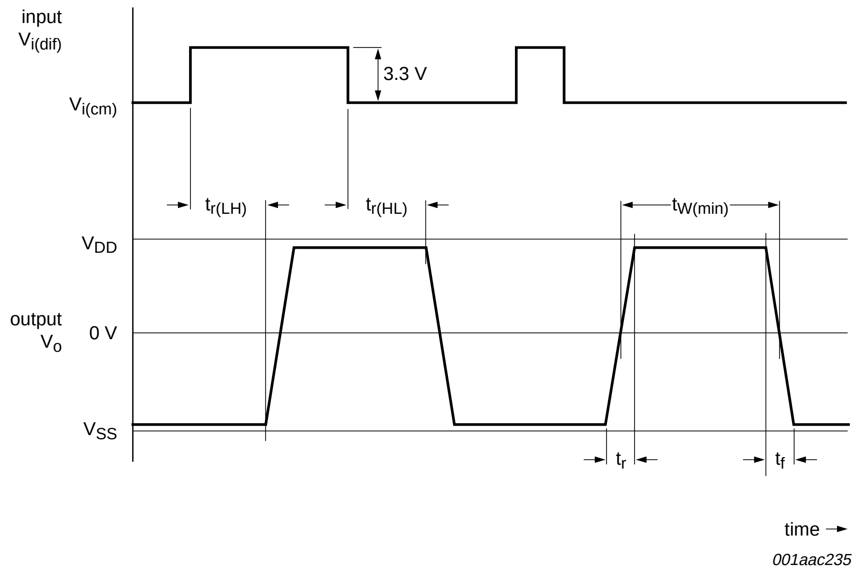
13. Dynamic characteristics

Table 10: Characteristics

V_P = 22 V; T_{amb} = 25 °C; R_L = 4 Ω; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Amplifier; SE channel							
$P_{o(max)}$	maximum output power	R_L = 4 Ω; THD = 10 %	[1]				
		V_P = 26 V		21	22	-	W
		V_P = 22 V		15	16	-	W
		R_L = 8 Ω; THD =10 %					
		V_P = 30 V		15	16	-	W
THD	total harmonic distortion	P_o = 1 W, f_i = 1 kHz	[1]	-	0.02	0.1	%
$V_{n(o)}$	noise output voltage	Operating mode; inputs shorted; gain = 20 dB, AES17 brick wall filter	[1]	-	128	150	μV
$G_{v(range)}$	gain adjust range		[1]	14	20	26	dB
η	efficiency	P_o = 15 W					
		V_p = 22 V; R_L = 4 Ω	[1]	87	89	-	%
		V_p = 30 V; R_L = 8 Ω	[1]	89	91	-	%
PWM output: pin OUT (see Figure 4)							
t_r	output voltage rise time			-	20	-	ns
t_f	output voltage fall time			-	20	-	ns
t_{dead}	dead time			-	0	-	ns
$t_{r(LH)}$	response time of transition from LOW-to-HIGH	$V_{i(dif)}$ = 70 mV		-	120	-	ns
		$V_{i(dif)}$ = 3.3 V		-	100	-	ns
$t_{r(HL)}$	response time of transition from HIGH-to-LOW	$V_{i(dif)}$ = 70 mV		-	120	-	ns
		$V_{i(dif)}$ = 3.3 V		-	100	-	ns
$t_{W(min)}$	minimum pulse width			-	150	-	ns
R_{DSon}	drain-source on-state resistance of output transistor			-	0.22	0.3	Ω

[1] Measured in the application board.



$V_{i(cm)}$ = (V_{SSA} + 4 V) to (V_{DDA} – 5 V).

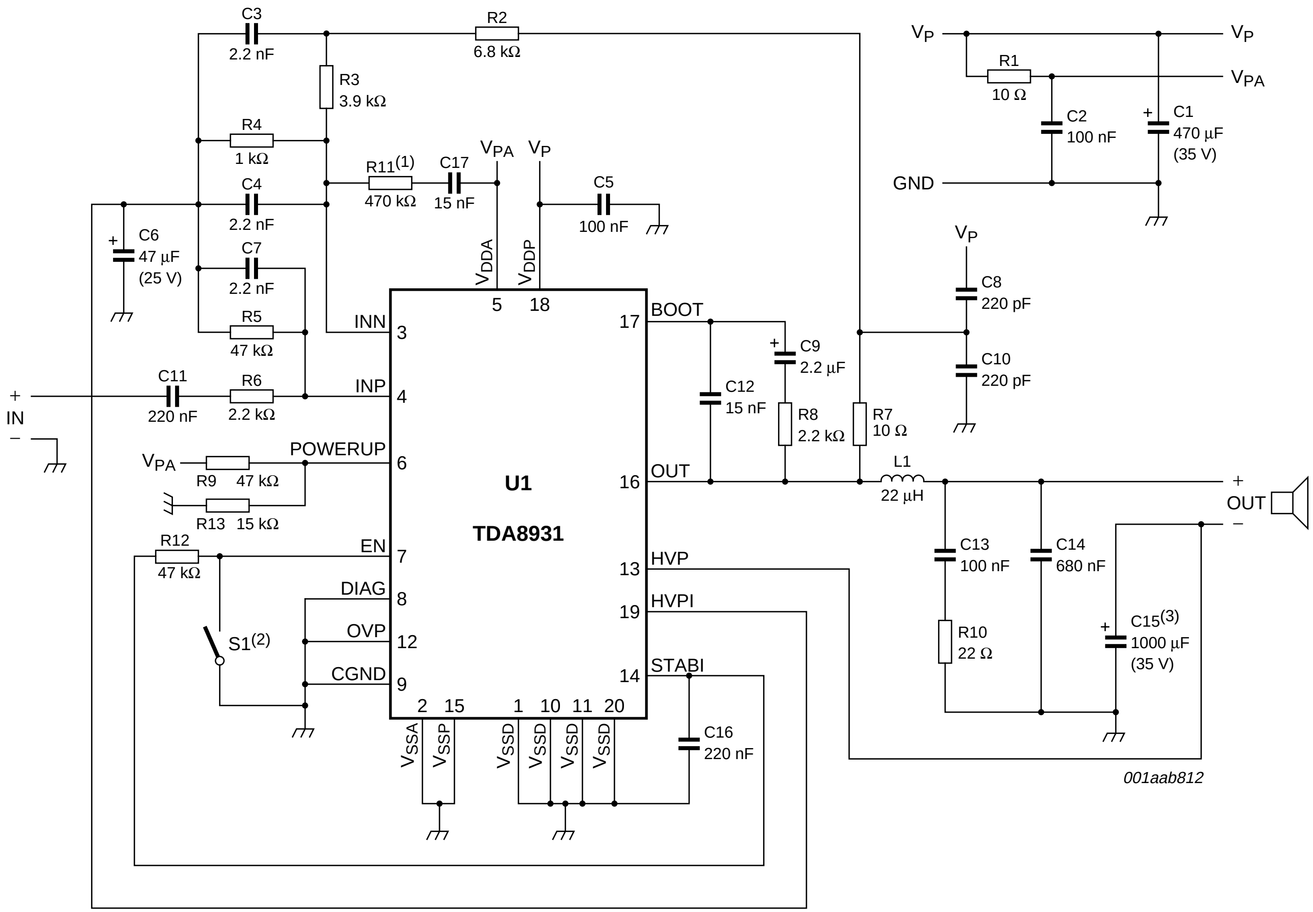
t_{dead} cannot be represented in the figure.

Response time depends on input signal amplitude.

The second input pulse is not reproduced with same pulse width by the output due to minimum pulse width limitation.

Fig 4. Timing diagram PWM output

14. Application information



(1) Optional feed forward network to improve SVRR.

(2) Standby mode: S1 = closed; Operating mode: S1 = open.

(3) The low frequency gain is determined by the capacitor in series with the speaker. The cut-off frequency with a 4 Ω speaker and C15 = 1000 µF is 40 Hz.

Fig 5. Typical application diagram with TDA8931 supplied from an asymmetrical supply

Table 11: Bill of material

Item	Part	Description
C1	470 µF/35 V	general purpose
C2	100 nF	SMD 0805
C3	2.2 nF	SMD 0805
C4	2.2 nF	SMD 0805
C5	100 nF	SMD 0805
C6	47 µF/25 V	general purpose
C7	2.2 nF	SMD 0805
C8	220 pF	SMD 0805
C9	2.2 µF/16 V	general purpose
C10	220 pF	SMD 0805
C11	220 nF	SMD 1206
C12	15 nF	SMD 0805
C13	100 nF	SMD 0805
C14	680 nF	MKT
C15	1000 µF/35 V	general purpose
C16	220 nF	SMD 1206
C17	15 nF	SMD 0805
R1	10 Ω	SMD 1206
R2	6.8 kΩ	SMD 0805
R3	3.9 kΩ	SMD 0805
R4	1 kΩ	SMD 0805
R5	47 kΩ	SMD 0805
R6	2.2 kΩ	SMD 0805
R7	10 Ω	SMD 1206
R8	2.2 kΩ	SMD 0805
R9	47 kΩ	SMD 0805
R10	22 Ω	SMD 2512
R11	470 kΩ	SMD 0805
R12	47 kΩ	SMD 0805
R13	15 kΩ	SMD 0805
L1	22 µH	TOKO 11RHBP A7503CY-220M
U1	TDA8931	SO20

14.1 Output power estimation

The output power, just before clipping, can be estimated using the following equation:

$$P_{o(1\%)} = \frac{\left(\frac{R_L}{R_L + R_{DSon} + R_{coil} + R_{ESR}} \times V_P\right)^2}{8 \times R_L} \quad (2)$$

Where:

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

R_L = load impedance

R_{DSon} = on-resistance power switch

R_{coil} = series resistance output coil

R_{ESR} = ESR of the single-ended capacitor

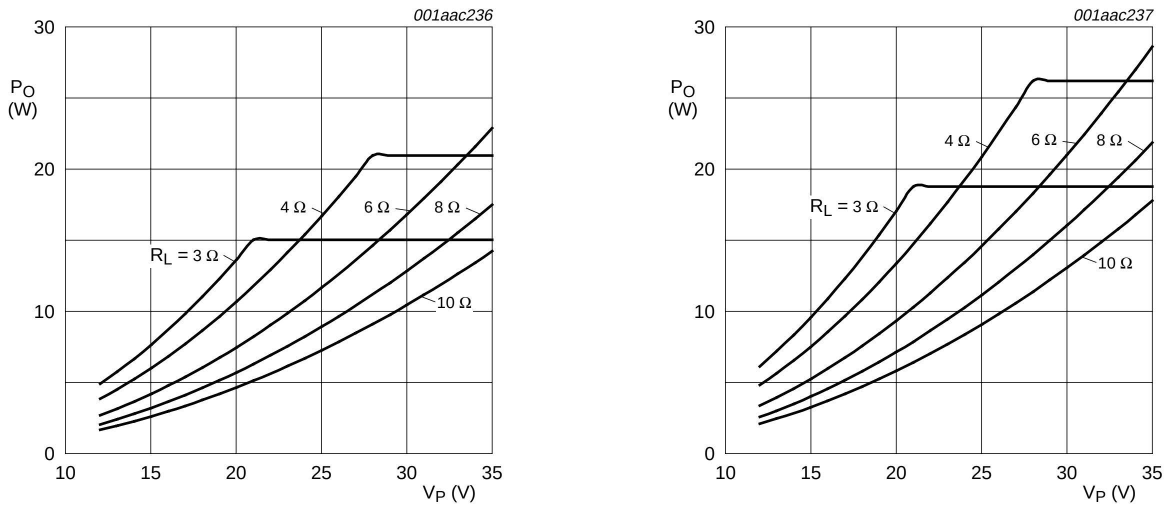
V_P = supply voltage ($V_{DDP} - V_{SSP}$)

Example: Substituting R_L = 4 Ω, R_{DSon} = 0.22 Ω (at T_j = 25 °C), R_{coil} = 0.045 Ω, R_{ESR} = 0.06 Ω and V_P = 22 V results in output power P_o = 12.9 W.

The output power at THD = 10 % can be estimated by:

$$P_{o(10\%)} = 1.25 \times P_{o(1\%)} \quad (3)$$

Figure 6 shows the estimated output power as a function of the supply voltage for different load impedances.



a. THD = 1 %.

b. THD = 10 %.

Fig 6. Output power as a function of supply voltage

14.2 Output current limiting

The output current is limited by the OCP with a threshold level of 3.3 A (minimum). During normal operation the output current should not exceed this threshold level, otherwise the output signal is distorted. The peak output current should stay below 3.3 A and can be estimated using the following equation:

$$I_O \le \frac{V_P}{2 \times (R_{DSon} + R_L + R_{coil} + R_{ESR})} \le 3.3 \qquad (4)$$

Where:

I_O = output current in the load in

V_P = supply voltage ($V_{DDP} - V_{SSP}$)

R_{DSon} = on-resistance power switch

R_L = load impedance

R_{coil} = series resistance output coil

R_{ESR} = ESR of the single-ended capacitor

Example: With a 4 Ω load the OCP will be triggered below a supply voltage of 28 V. This will result in an absolute maximum output power of P_o = 26 W at THD = 10 %.

14.3 Low pass filter considerations

For a flat frequency response (second order Butterworth filter) it is necessary to change the LC-filter components (L1 and C14) according to the speaker impedance. Table 12 shows the required components values in case of a 4 W, 6 W or 8 W speaker impedance.

Table 12: Filter components values

Speaker impedance (Ω)	L1 value (μH)	C14 value (nF)
4	22	680
6	33	470
8	47	330

14.4 Thermal behavior (printed-circuit board considerations)

The SO20 package of the TDA8931T has special thermal corner leads, significantly increasing the power capability (reducing R_{th}). The corner leads (pins 1, 10, 11 and 20) should be attached to a copper area (V_{SS}) on the PCB for cooling.

The typical thermal resistance $R_{th(j-a)}$ of the TDA8931T is 24 K/W (free air and natural convection) when soldered on a double sided FR4 PCB with 35 μm copper layer and cooling area of approximately of 28 cm^2.

14.4.1 Thermal layout including vias

The bottom side of the double-sided PCB is used to place the SMD components including the TDA8931T and the majority of the signal tracks. The topside is used to place the leaded components.

The remaining area on both top and bottom layer are filled with ground plane for a proper cooling. In this way it is possible to have a cooling area available of about:

- 40 % of the PCB area on the bottom (60 % for signal tracks and SMD components)
- 90 % of the PCB area on the top (10 % for signal tracks)

The PCB area required for a typical mono amplifier is 21.5 cm^2 resulting in a cooling area of about 28 cm^2. Thermal vias should be placed close to corner leads for a proper heat flow to the top layer of the PCB. Figure 7 is showing the thermal vias indicated as black dots and Figure 8 is showing the heat flow to the copper area on the top layer.

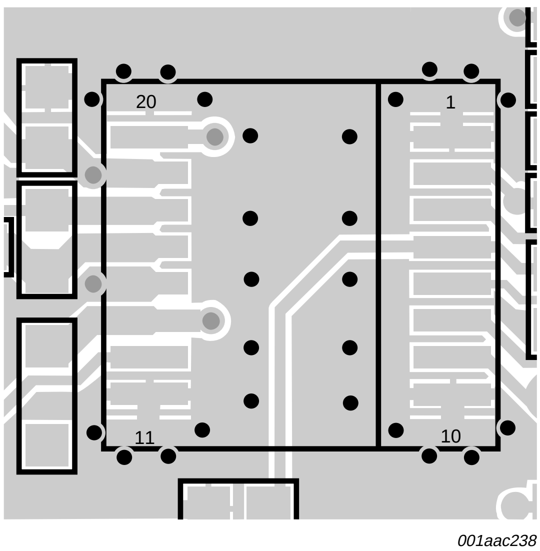


Fig 7. Thermal vias (top view)

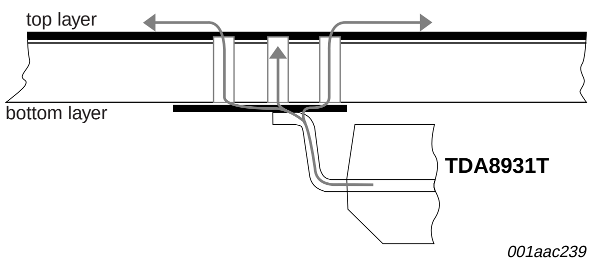


Fig 8. Heat flow (cross section view)

14.4.2 Thermal considerations

To estimate the maximum junction temperature, the following equation can be used:

$$T_{j(max)} = T_{amb} + R_{th(j-a)} \times P_d \qquad (5)$$

Where:

T_{amb} = ambient temperature

P_d = power dissipation in the TDA8931T

$R_{th(j-a)}$ = thermal resistance from junction to ambient (24 K/W)

To estimate the power dissipation, the following equation can be used:

$$P_d = P_o \times \left(\frac{1}{\eta} - 1\right) \quad (6)$$

Where:

P_d = power dissipation

P_o = RMS output power (W)

η = efficiency of total application (0.91 for R_L = 8 Ω and 0.89 for R_L = 4 Ω)

The derating curves of the dissipated power as a function of ambient temperature for several values of $R_{th(j-a)}$ are illustrated in Figure 9. A maximum junction temperature T_j = 150 °C is taken into account.

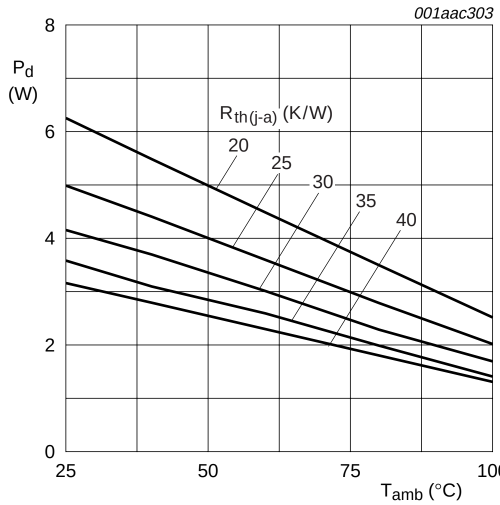


Fig 9. Derating curves for power dissipation as a function of maximum ambient temperature

Example: TDA8931T mono amplifier, with substituting P_o = 1 × 20 W, $R_{th(j-a)}$ = 24 K/W, P_d = 2.47 W results in a junction temperature $T_{j(max)}$ = 119 °C.

For this example the estimated maximum junction temperature at a high ambient temperature of 60 °C for a mono amplifier driving 4 Ω speaker impedance stays below the OTP threshold level of 150 °C.

14.5 Measured performance figures of mono amplifier with TDA8931

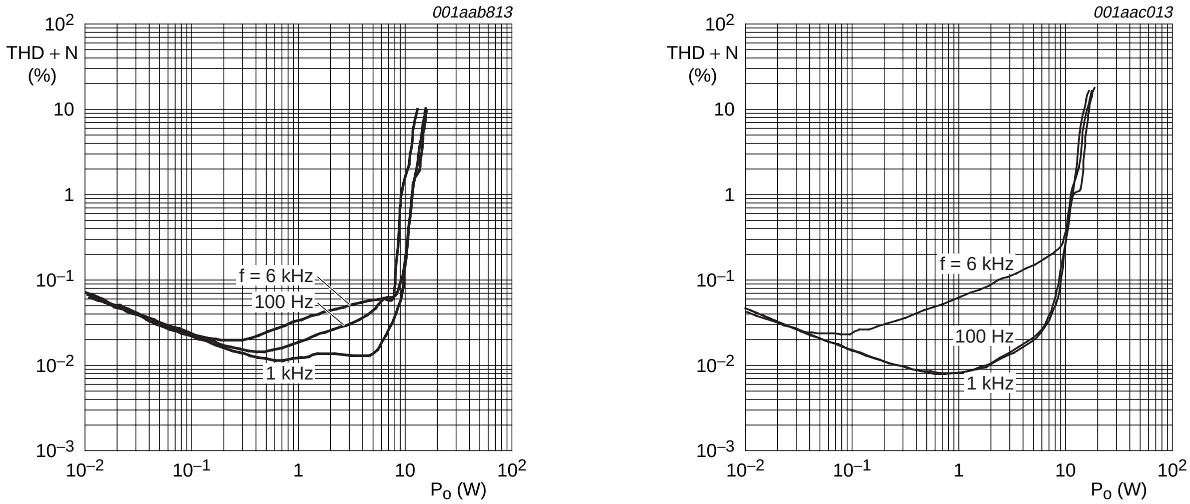
Table 13: Characteristics

V_P = 22 V; R_L = 4 Ω, f_i = 1 kHz; inverted input signal; T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_P	operating supply voltage		[1]	12	22	35	V
P_o	output power	V_P = 26 V; R_L = 4 Ω					
		THD+N = 10 %		-	22	-	W
		THD+N = 1 %		-	20	-	W
		V_P = 22 V; R_L = 4 Ω					
		THD+N = 10 %		-	16.0	-	W
		THD+N = 1 %		-	12.0	-	W
		V_P = 30 V; R_L = 8 Ω					
		THD+N = 10 %		-	16.0	-	W
		THD+N = 1 %		-	12.0	-	W
THD+N	total harmonic distortion-plus-noise	P_o = 1 W; AES17 brick wall filter					
		V_p = 22 V; R_L = 4 Ω		-	0.02	-	%
		V_p = 30 V; R_L = 8 Ω		-	0.02	-	%
η	efficiency	P_o = 15 W					
		V_p = 22 V; R_L = 4 Ω		-	89	-	%
		V_p = 30 V; R_L = 8 Ω		-	91	-	%
G_v	closed loop gain	V_i = 100 mV (RMS); f_i = 1 kHz		-	20	-	dB
$V_{n(o)}$	noise output voltage	inputs shorted; AES17 brick wall filter		-	128	-	µV
S/N	signal-to-noise ratio	unwanted; with respect to V_o = 10 V (RMS)		-	98	-	dB
B	band width	−3 dB low; LF cut-off point depends on value of SE capacitances		-	40	-	Hz
		−3 dB high		-	45000	-	Hz
SVRR	supply voltage ripple rejection	V_p = 22 V; R_L = 4 Ω; V_{ripple} = 2 V (p-p); f_{ripple} = 100 Hz with feed forward network (470 kΩ and 15 nF)		45	48	-	dB
f_c	idle carrier frequency			-	290	-	kHz

[1] Operates down to UVP threshold level and operates up to OVP threshold level.

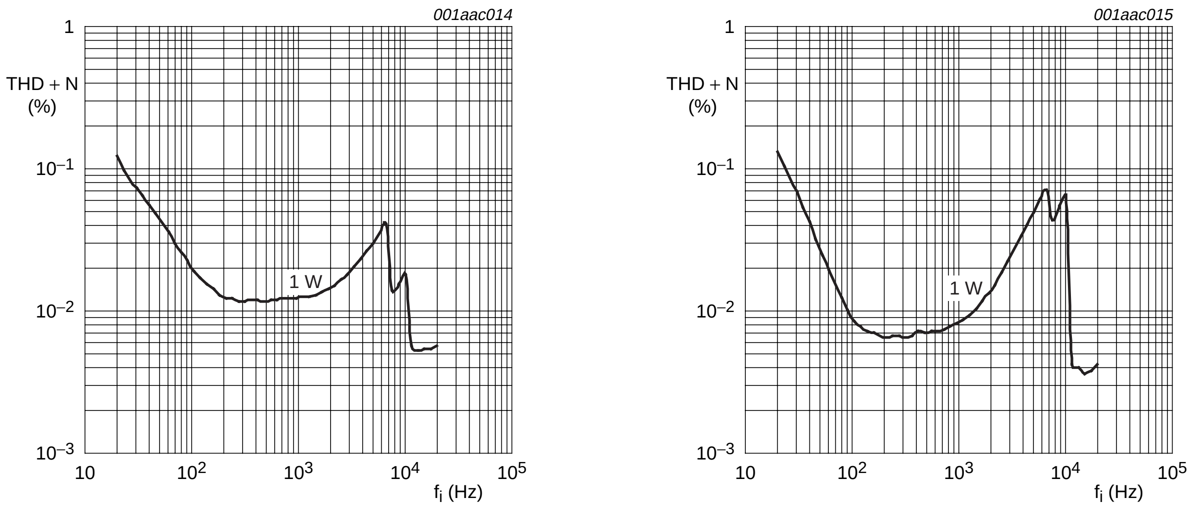
14.6 Curves measured in typical application



a. $V_P = 22$ V; $R_L = 4\ \Omega$.

b. $V_P = 30$ V; $R_L = 8\ \Omega$.

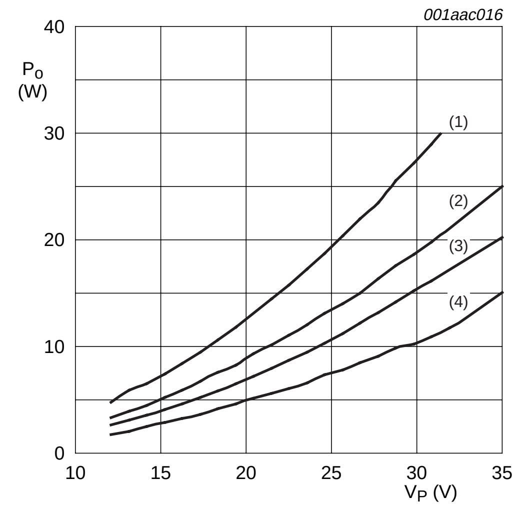
Fig 10. Total harmonic distortion-plus-noise as a function of output power



a. $V_P = 22$ V; $R_L = 4\ \Omega$; $P_o = 1$ W.

b. $V_P = 30$ V; $R_L = 8\ \Omega$; $P_o = 1$ W.

Fig 11. Total harmonic distortion-plus-noise as a function of frequency



(1) R_L = 4 Ω; THD = 10 %.

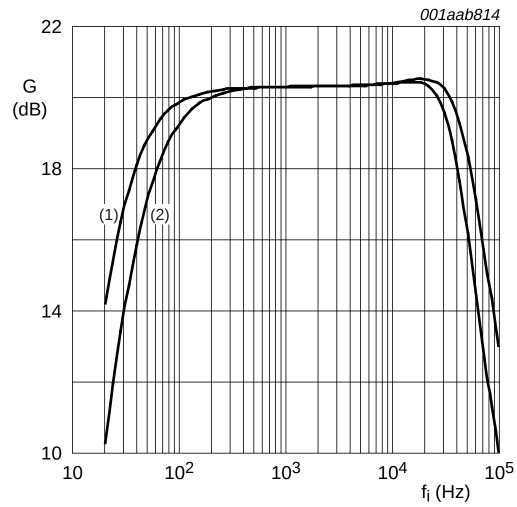
(2) R_L = 4 Ω; THD = 0.5 %.

(3) R_L = 8 Ω; THD = 10 %.

(4) R_L = 8 Ω; THD = 0.5 %.

Conditions: f_i = 1 kHz.

Fig 12. Output power as a function of supply voltage

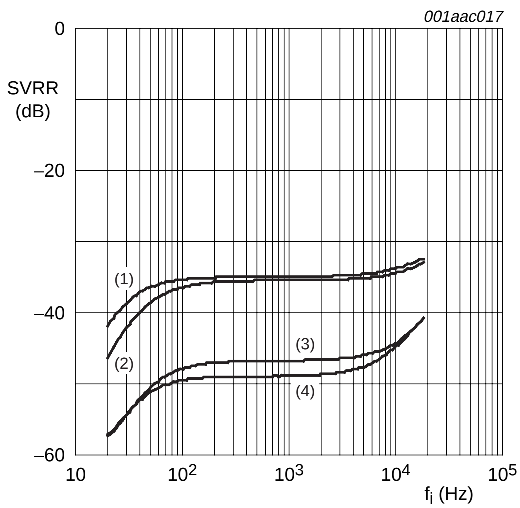


(1) R_L = 8 Ω.

(2) R_L = 4 Ω.

Conditions: V_P = 22 V; V_i = 100 mV.

Fig 13. Gain as a function of frequency



(1) R_L = 8 Ω.

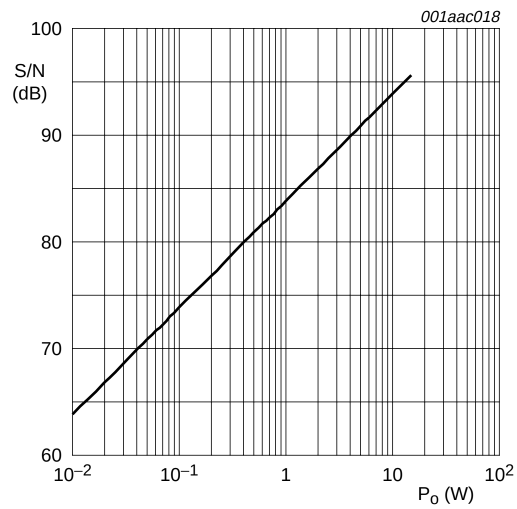
(2) R_L = 4 Ω.

(3) R_L = 4 Ω with feed forward network 470 kΩ /15 nF.

(4) R_L = 8 Ω with feed forward network 470 kΩ /15 nF.

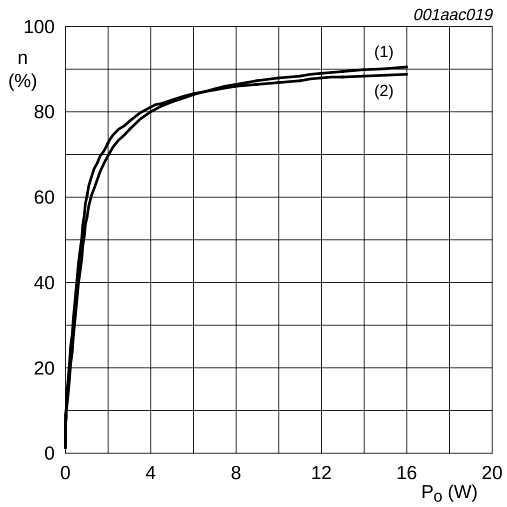
Conditions: V_{ripple} = 2 V (p-p).

Fig 14. SVRR as a function of frequency



Conditions: V_P = 22 V; R_L = 4 Ω; including AES 20 kHz filter.

Fig 15. Signal-to-noise ratio as a function of output power

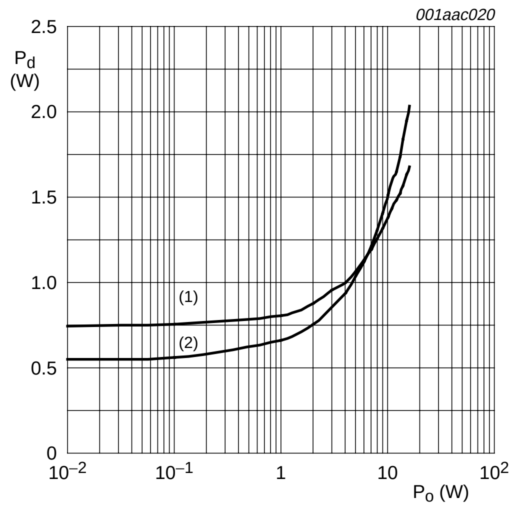


(1) V_P = 30 V; R_L = 8 Ω.

(2) V_P = 22 V; R_L = 4 Ω.

Conditions: f_i = 1 kHz.

Fig 16. Efficiency as a function of total output power



(1) V_P = 30 V; R_L = 8 Ω.

(2) V_P = 22 V; R_L = 4 Ω.

Conditions: f_i = 1 kHz.

Fig 17. Power dissipation as a function of total output power

15. Test information

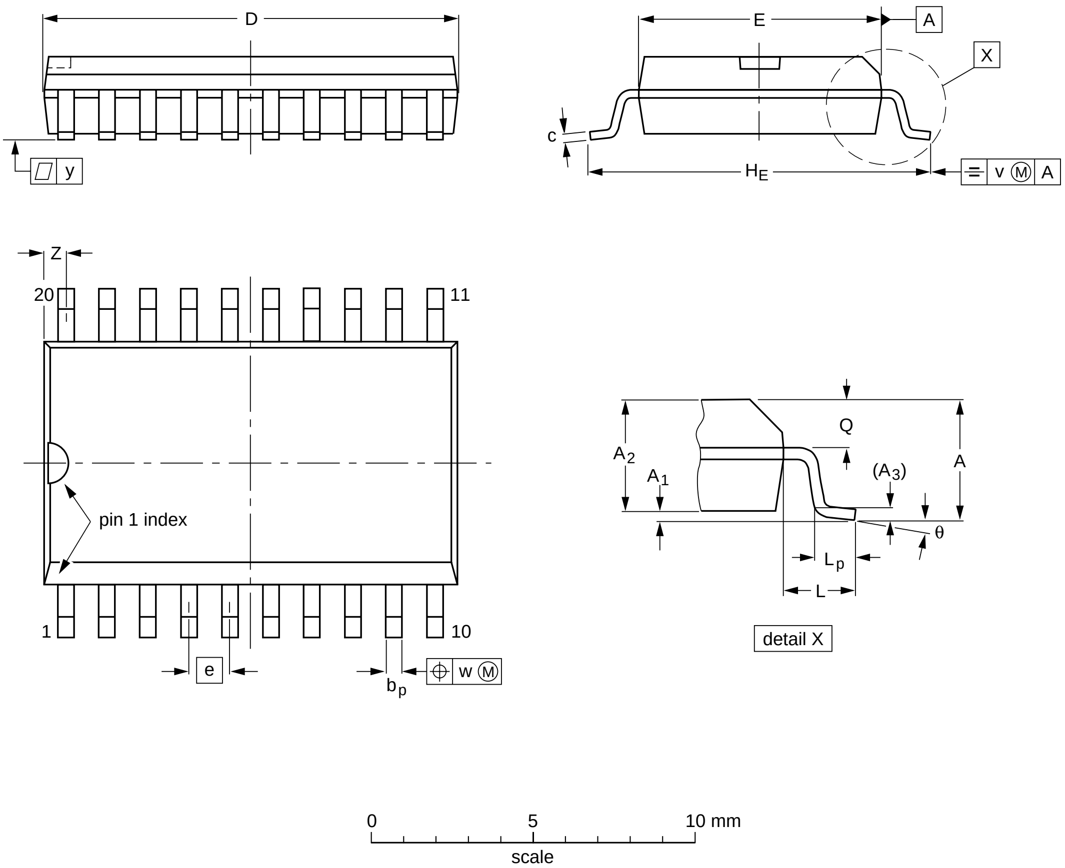
Remark: Only valid if the TDA8931 is used as an audio amplifier.

15.1 Quality information

The *General Quality Specification for Integrated Circuits, SNW-FQ-611* is applicable.

16. 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	0.3 0.1	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	0.1	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	0.05	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 (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT163-1	075E04	MS-013				~~99-12-27~~ 03-02-19

Fig 18. Package outline SOT163-1 (SO20)

17. Soldering

17.1 Introduction to soldering surface mount packages

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 surface mount IC packages. Wave soldering can still be used for certain surface mount ICs, but it is not suitable for fine pitch SMDs. In these situations reflow soldering is recommended.

17.2 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. Driven by legislation and environmental forces the worldwide use of lead-free solder pastes is increasing.

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

Typical reflow peak temperatures range from 215 °C to 270 °C depending on solder paste material. The top-surface temperature of the packages should preferably be kept:

- below 225 °C (SnPb process) or below 245 °C (Pb-free process)
  - for all BGA, HTSSON..T and SSOP..T packages
  - for packages with a thickness ≥ 2.5 mm
  - for packages with a thickness < 2.5 mm and a volume ≥ 350 mm^3 so called thick/large packages.
- below 240 °C (SnPb process) or below 260 °C (Pb-free process) for packages with a thickness < 2.5 mm and a volume < 350 mm^3 so called small/thin packages.

Moisture sensitivity precautions, as indicated on packing, must be respected at all times.

17.3 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 of the leads in the wave ranges from 3 seconds to 4 seconds at 250 °C or 265 °C, depending on solder material applied, SnPb or Pb-free respectively.

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

17.4 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 seconds to 5 seconds between 270 °C and 320 °C.

17.5 Package related soldering information

Table 14: Suitability of surface mount IC packages for wave and reflow soldering methods

Package [1]	Soldering method	
	Wave	Reflow [2]
BGA, HTSSON..T [3], LBGA, LFBGA, SQFP, SSOP..T [3], TFBGA, VFBGA, XSON	not suitable	suitable
DHVQFN, HBCC, HBGA, HLQFP, HSO, HSOP, HSQFP, HSSON, HTQFP, HTSSOP, HVQFN, HVSON, SMS	not suitable [4]	suitable
PLCC [5], SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended [5] [6]	suitable
SSOP, TSSOP, VSO, VSSOP	not recommended [7]	suitable
CWQCCN..L [8], PMFP [9], WQCCN..L [8]	not suitable	not suitable

[1] For more detailed information on the BGA packages refer to the *(LF)BGA Application Note* (AN01026); order a copy from your Philips Semiconductors sales office.

[2] 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*.

[3] These transparent plastic packages are extremely sensitive to reflow soldering conditions and must on no account be processed through more than one soldering cycle or subjected to infrared reflow soldering with peak temperature exceeding 217 °C ± 10 °C measured in the atmosphere of the reflow oven. The package body peak temperature must be kept as low as possible.

[4] These packages are not suitable for wave soldering. On versions with the heatsink on the bottom side, the solder cannot penetrate between the printed-circuit board and the heatsink. On versions with the heatsink on the top side, the solder might be deposited on the heatsink surface.

[5] 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.

[6] Wave soldering is suitable for LQFP, QFP and TQFP packages with a pitch (e) larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.

[7] Wave soldering is suitable for SSOP, TSSOP, VSO and VSSOP 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.

[8] Image sensor packages in principle should not be soldered. They are mounted in sockets or delivered pre-mounted on flex foil. However, the image sensor package can be mounted by the client on a flex foil by using a hot bar soldering process. The appropriate soldering profile can be provided on request.

[9] Hot bar soldering or manual soldering is suitable for PMFP packages.

18. Revision history

Table 15: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
TDA8931_1	20050114	Preliminary data sheet	-	9397 750 13847	-

19. 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).

[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.

20. 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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23. Contents

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