TDA3663

Very low dropout voltage/quiescent current 3.3 V voltage regulator

Rev. 05 — 13 June 2005 Product data sheet

1. General description

The TDA3663 is a fixed 3.3 V voltage regulator with a very low dropout voltage and quiescent current, which operates over a wide supply voltage range.

2. Features

- Fixed 3.3 V, 100 mA regulator
- Supply voltage range up to 45 V
- Very low quiescent current of 15 μA (typical value)
- Very low dropout voltage
- High ripple rejection
- Protections:
  - Reverse polarity safe (down to –25 V without high reverse current)
  - Negative transient of 50 V (R_S = 10 Ω, t < 100 ms)
  - Able to withstand voltages up to 18 V at the output (supply line may be short-circuited)
  - ESD protection on all pins
  - DC short-circuit safe to ground and V_P of the regulator output
  - Temperature protection (at T_j > 150 °C)

3. Quick reference data

Table 1: Quick reference data

T_{amb} = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Supply							
V_P	supply voltage	regulator operating	[1]	3	14.4	45	V
I_q	quiescent supply current	V_P = 14.4 V; I_{REG} = 0 mA		-	15	30	μA
Voltage regulator							
V_{REG}	output voltage	8 V ≤ V_P ≤ 22 V; I_{REG} = 0.5 mA		3.16	3.3	3.44	V
		6 V ≤ V_P ≤ 45 V; I_{REG} = 0.5 mA;		3.13	3.3	3.47	V
		0.5 mA ≤ I_{REG} ≤ 100 mA		3.13	3.3	3.47	V
$V_{REG(drop)}$	dropout voltage	V_P = 3.1 V; I_{REG} = 50 mA; T_{amb} ≤ 85 °C		-	0.18	0.3	V

[1] The regulator output will follow V_P if $V_P < V_{REG} + V_{REG(drop)}$.

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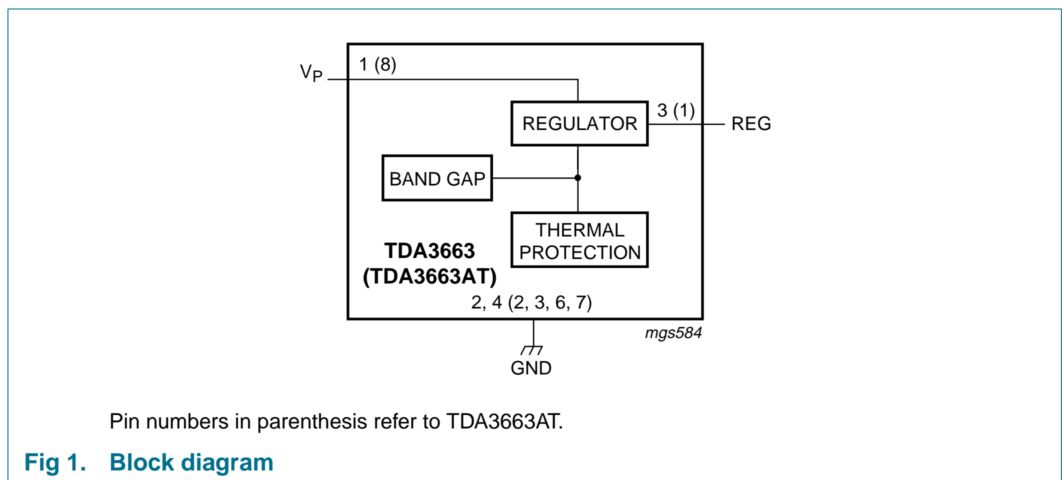
4. Ordering information

Table 2: Ordering information

Type number	Package		
	Name	Description	Version
TDA3663	SO4	plastic small outline package; 4 leads; body width 3.5 mm	SOT223-1
TDA3663AT	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

5. Block diagram



Pin numbers in parenthesis refer to TDA3663AT.

Fig 1. Block diagram

6. Pinning information

6.1 Pinning

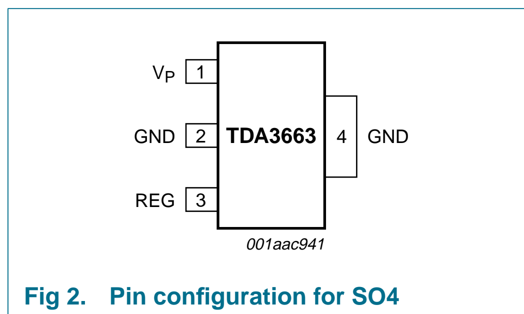


Fig 2. Pin configuration for SO4

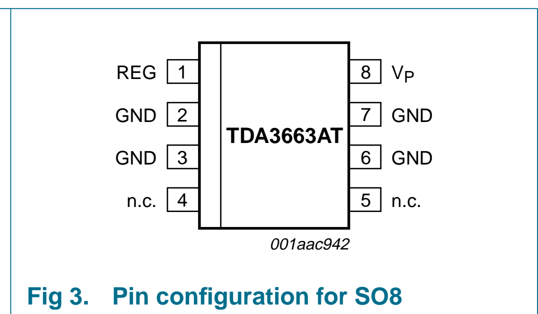


Fig 3. Pin configuration for SO8

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6.2 Pin description

Table 3: Pin description

Symbol	Pin		Description
	SO4	SO8	
V_P	1	8	supply voltage
GND	2 and 4	2, 3, 6 and 8	ground [1]
REG	3	1	regulator output
n.c.	-	4 and 5	not connected

[1] For he SO8 package all GND pins are connected to the lead frame and can also be used to reduce the total thermal resistance $R_{th(j-a)}$ by soldering these pins to a ground plane. The ground plane on the top side of the PCB acts like a heat spreader.

7. Functional description

The TDA3663 is a fixed 3.3 V regulator which can deliver output currents up to 100 mA. The regulator is available in SO8 and SO4 packages. The regulator is intended for portable, mains and telephone applications. To increase the lifetime of batteries, a specially built-in clamp circuit keeps the quiescent current of this regulator very low, also in dropout and full load conditions.

The device remains operational down to very low supply voltages and below this voltage it switches off.

A temperature protection circuit is included which switches off the regulator output at a junction temperature above 150 °C.

8. Limiting values

Table 4: Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
V_P	supply voltage		-	45	V
$V_{P(rp)}$	reverse polarity supply voltage	non-operating	-	–25	V
P_{tot}	total power dissipation				
	TDA3663	temperature of copper area is 25 °C	-	4.1	W
	TDA3663AT	T_{amb} = 25 °C	-	5	W
T_{stg}	storage temperature	non-operating	–55	+150	°C
T_{amb}	ambient temperature	operating	–40	+125	°C
T_j	junction temperature	operating	–40	+150	°C

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9. Thermal characteristics

Table 5: Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient			
	SO4	in free air; soldered	100	K/W
	SO8	in free air; soldered	155	K/W
$R_{th(j-c)}$	thermal resistance from junction to case			
	SO4	to center pins; soldered	25	K/W
	SO8	to center pins; soldered	30	K/W

10. Characteristics

Table 6: Characteristics

V_P = 14.4 V; T_{amb} = 25 °C; measured with test circuit of Figure 15; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Supply voltage: pin V_P							
V_P	supply voltage	regulator operating	[1]	3	14.4	45	V
I_q	quiescent supply current	V_P = 4.5 V; I_{REG} = 0 mA		-	10	-	µA
		V_P = 14.4 V; I_{REG} = 0 mA		-	15	30	µA
		6 V ≤ V_P ≤ 22 V; I_{REG} = 10 mA		-	0.2	0.5	mA
		6 V ≤ V_P ≤ 22 V; I_{REG} = 50 mA		-	1.4	2.5	mA
Regulator output: pin REG							
V_{REG}	output voltage	8 V ≤ V_P ≤ 22 V; I_{REG} = 0.5 mA		3.16	3.3	3.44	V
		0.5 mA ≤ I_{REG} ≤ 100 mA		3.13	3.3	3.47	V
		6 V ≤ V_P ≤ 45 V; I_{REG} = 0.5 mA		3.13	3.3	3.47	V
$V_{REG(drop)}$	dropout voltage	V_P = 3.1 V; T_{amb} ≤ 85 °C; I_{REG} = 50 mA		-	0.18	0.3	V
$V_{REG(stab)}$	output voltage long-term stability	per 1000 h		-	20	-	mV
$\Delta V_{REG(line)}$	line input regulation voltage	7 V ≤ V_P ≤ 22 V; I_{REG} = 0.5 mA		-	1	30	mV
		7 V ≤ V_P ≤ 45 V; I_{REG} = 0.5 mA		-	1	50	mV
$\Delta V_{REG(load)}$	load output regulation voltage	0.5 mA ≤ I_{REG} ≤ 50 mA		-	10	50	mV
SVRR	supply voltage ripple rejection	f_i = 120 Hz; $V_{i(ripple)}$ = 1 V (RMS); I_{REG} = 0.5 mA		50	60	-	dB
$I_{REG(crl)}$	output current limit	V_{REG} > 2.8 V		0.17	0.25	-	A
$I_{LO(rp)}$	output leakage current at reverse polarity	V_P = −15 V; V_{REG} ≤ 0.3 V		-	1	500	µA

[1] The regulator output will follow V_P if $V_P < V_{REG} + V_{REG(drop)}$.

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11. Application information

11.1 Noise

The output noise is determined by the value of the output capacitor. The noise figure is measured at a bandwidth of 10 Hz to 100 kHz (see Table 7).

Table 7: Noise figures

Output current I_{REG} (mA)	Noise figure (µV)		
	C2 = 10 µF	C2 = 47 µF	C2 = 100 µF
0.5	550	320	300
50	650	400	400

11.2 Stability

For stable operation:

- The output capacitor ESR should not exceed 22 Ω (worst-case)
- A minimum ESR may be required; see Table 8
- It is recommended not to use below 1 mA output current because of reduced phase margin
- Use electrolytic capacitors for output capacity values of 1 µF and above

Table 8: Minimum ESR values required

I_{REG} (mA)	C2 = 100 nF	C2 = 1 µF	C2 = 10 µF	C2 = 100 µF
1	> 0 Ω	> 1.5 Ω	> 0 Ω	> 0 Ω
5	> 0 Ω	> 0 Ω	> 0 Ω	> 0 Ω
10	> 0 Ω	> 0 Ω	> 0 Ω	> 0 Ω
100	> 0 Ω	> 0 Ω	> 0 Ω	> 0 Ω

11.3 Application circuits

The maximum output current of the regulator equals:

$$I_{REG(max)} = \frac{150 - T_{amb}}{R_{th(j-a)} \times (V_P - V_{REG})} = \frac{150 - T_{amb}}{100 \times (V_P - 3.3)}(mA)$$

When T_{amb} = 21 °C and V_P = 14 V the maximum output current equals 116 mA.

The total thermal resistance of the TDA3663 can be decreased from 155 K/W to 30 K/W for the SO8 version. For the SO4 version it can be decreased from 100 K/W to 25 K/W when GND pins 2 and 4 of the package are soldered to the printed-circuit board.

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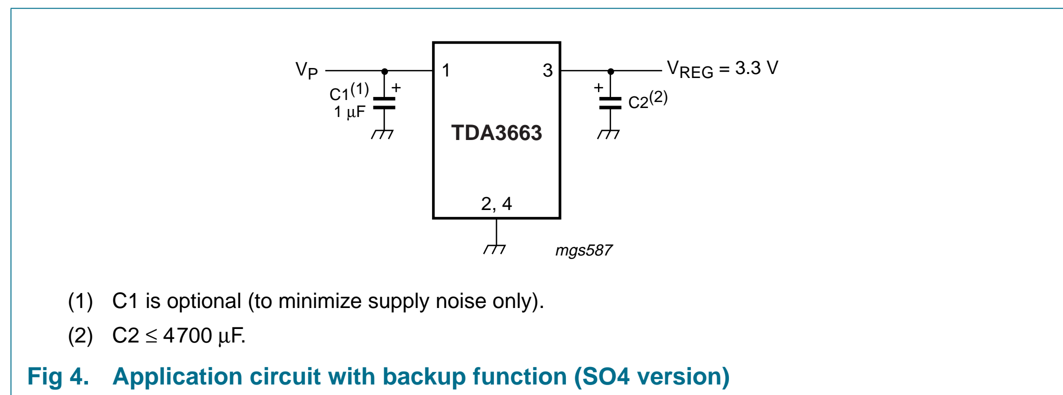
11.3.1 Application circuit with backup function

Sometimes a backup function is needed to supply, for example, a microcontroller for a short period of time when the supply voltage spikes to 0 V (or even –1 V).

This function can easily be built with the TDA3663 by using an output capacitor with a large value. When the supply voltage is 0 V (or –1 V), only a small current will flow into pin REG from this output capacitor (a few µA).

The application circuit is given in Figure 4.



(1) C1 is optional (to minimize supply noise only).

(2) C2 ≤ 4700 µF.

Fig 4. Application circuit with backup function (SO4 version)

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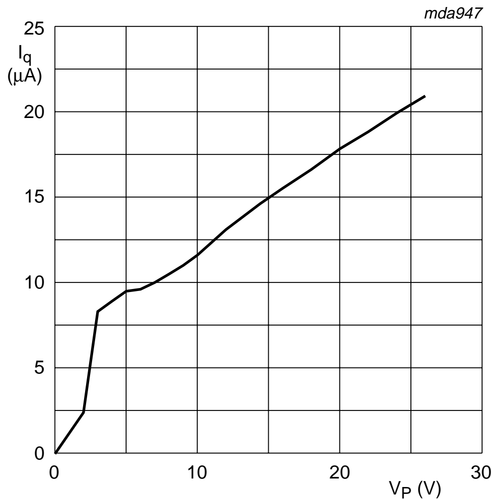
11.4 Additional application information

This section gives typical curves for various parameters measured on the TDA3663AT. Standard test conditions are: V_P = 14.4 V; T_{amb} = 25 °C.



I_{REG} = 0 mA.

Fig 5. Quiescent current as a function of the supply voltage

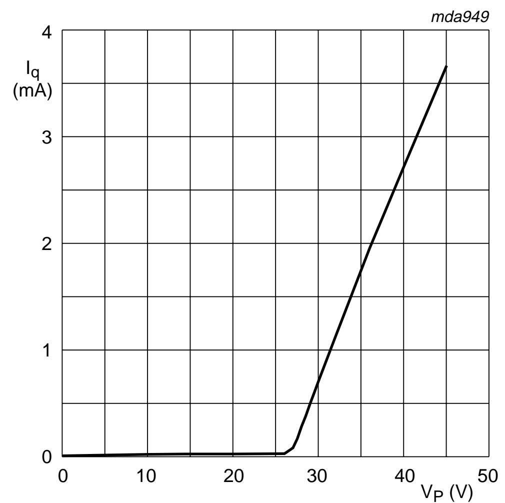
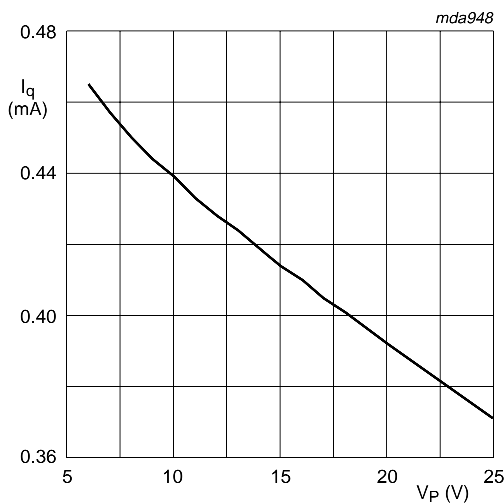
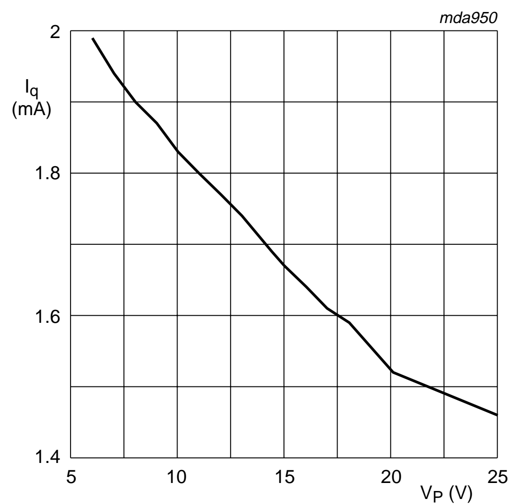


Fig 6. Quiescent current increase as a function of the high supply voltage



I_{REG} = 10 mA.

Fig 7. Quiescent current as a function of the supply voltage



I_{REG} = 50 mA.

Fig 8. Quiescent current as a function of the supply voltage

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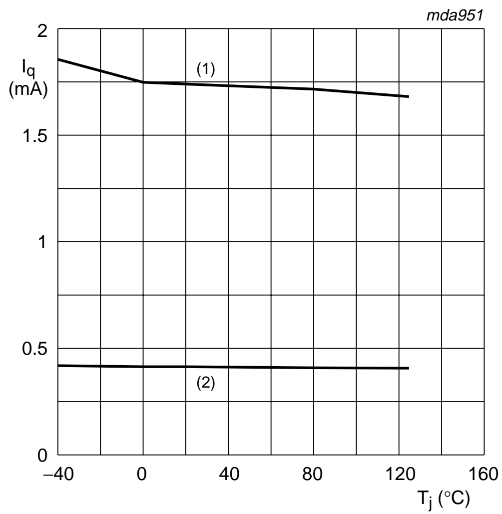


(1) I_q at 50 mA load.

(2) I_q at 10 mA load.

Fig 9. Quiescent current as a function of the junction temperature

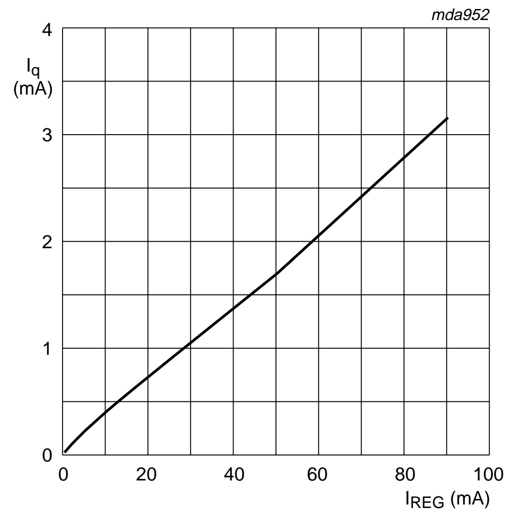
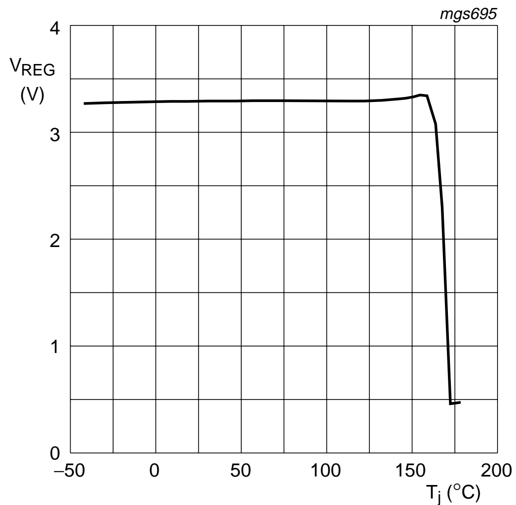


Fig 10. Quiescent current as a function of the output current



I_{REG} = 0 mA.

Fig 11. Output voltage thermal protection as a function of the junction temperature

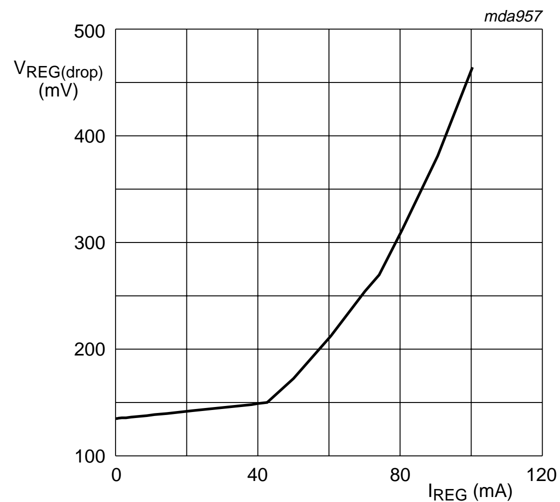


Fig 12. Dropout voltage as a function of the output current

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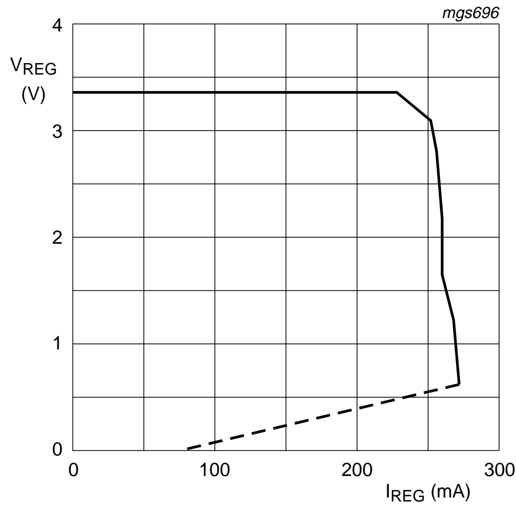
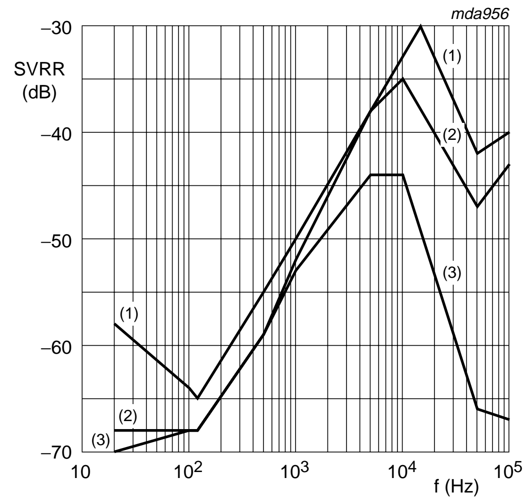


V_P = 8 V and pulsed load.

Fig 13. Fold back protection mode



I_{REG} = 10 mA; C2 = 10 μF.

(1) SVRR at R_L = 100 Ω.

(2) SVRR at R_L = 500 Ω.

(3) SVRR at R_L = 10 kΩ.

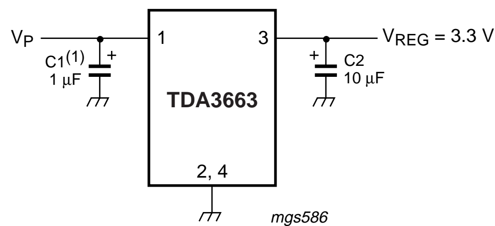
Fig 14. Supply voltage ripple rejection as a function of the ripple frequency

12. Test information

12.1 Quality information

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

12.2 Test circuit



(1) C1 is optional (to minimize supply noise only).

Fig 15. Test circuit (SO4)

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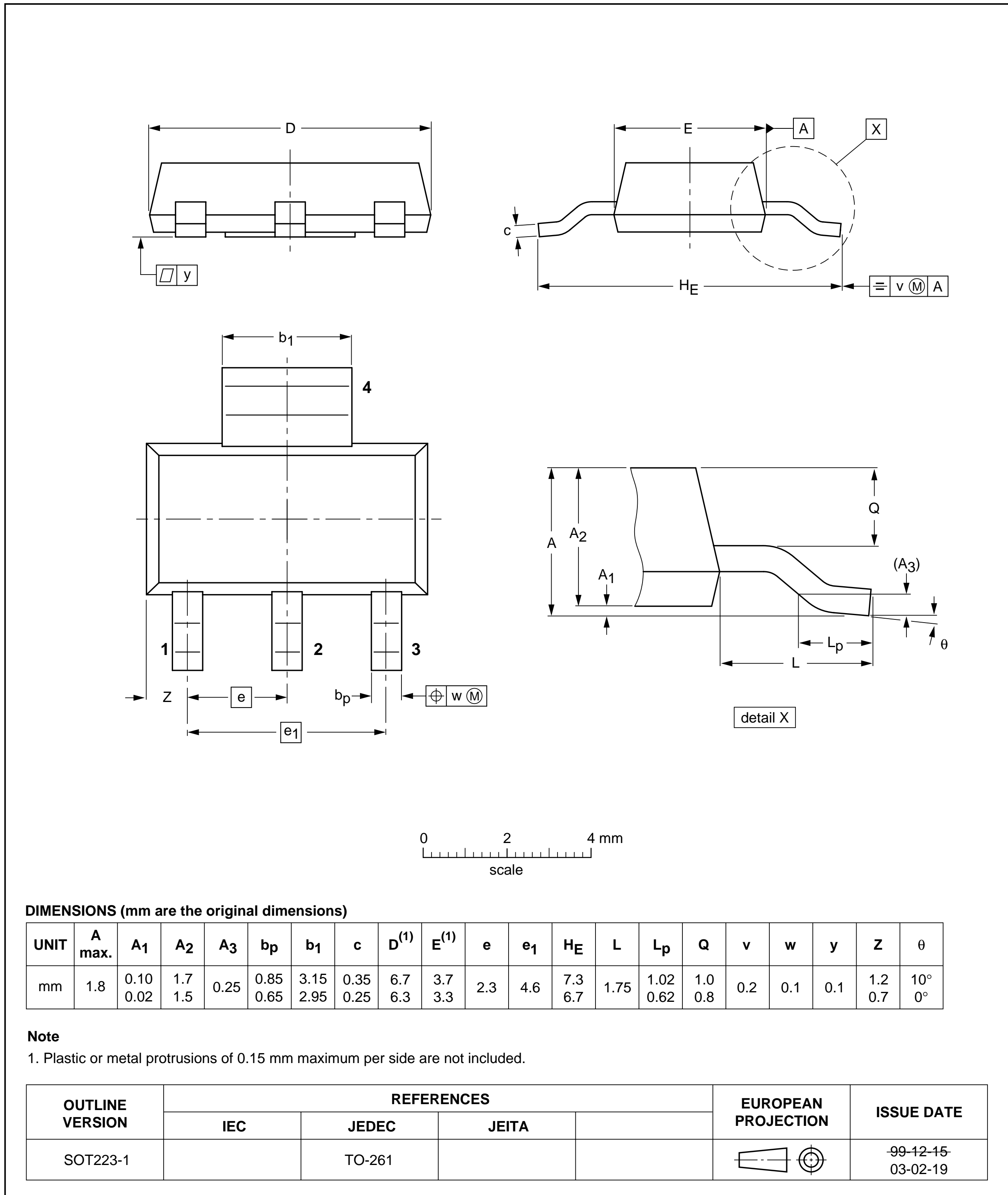
13. Package outline

SO4: plastic small outline package; 4 leads; body width 3.5 mm **SOT223-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	b_1	c	D(1)	E(1)	e	e_1	H_E	L	L_p	Q	v	w	y	Z	θ
mm	1.8	0.10 0.02	1.7 1.5	0.25	0.85 0.65	3.15 2.95	0.35 0.25	6.7 6.3	3.7 3.3	2.3	4.6	7.3 6.7	1.75	1.02 0.62	1.0 0.8	0.2	0.1	0.1	1.2 0.7	10° 0°

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	JEITA			
SOT223-1		TO-261				~~99-12-15~~ 03-02-19

Fig 16. Package outline SOT223-1 (SO4)

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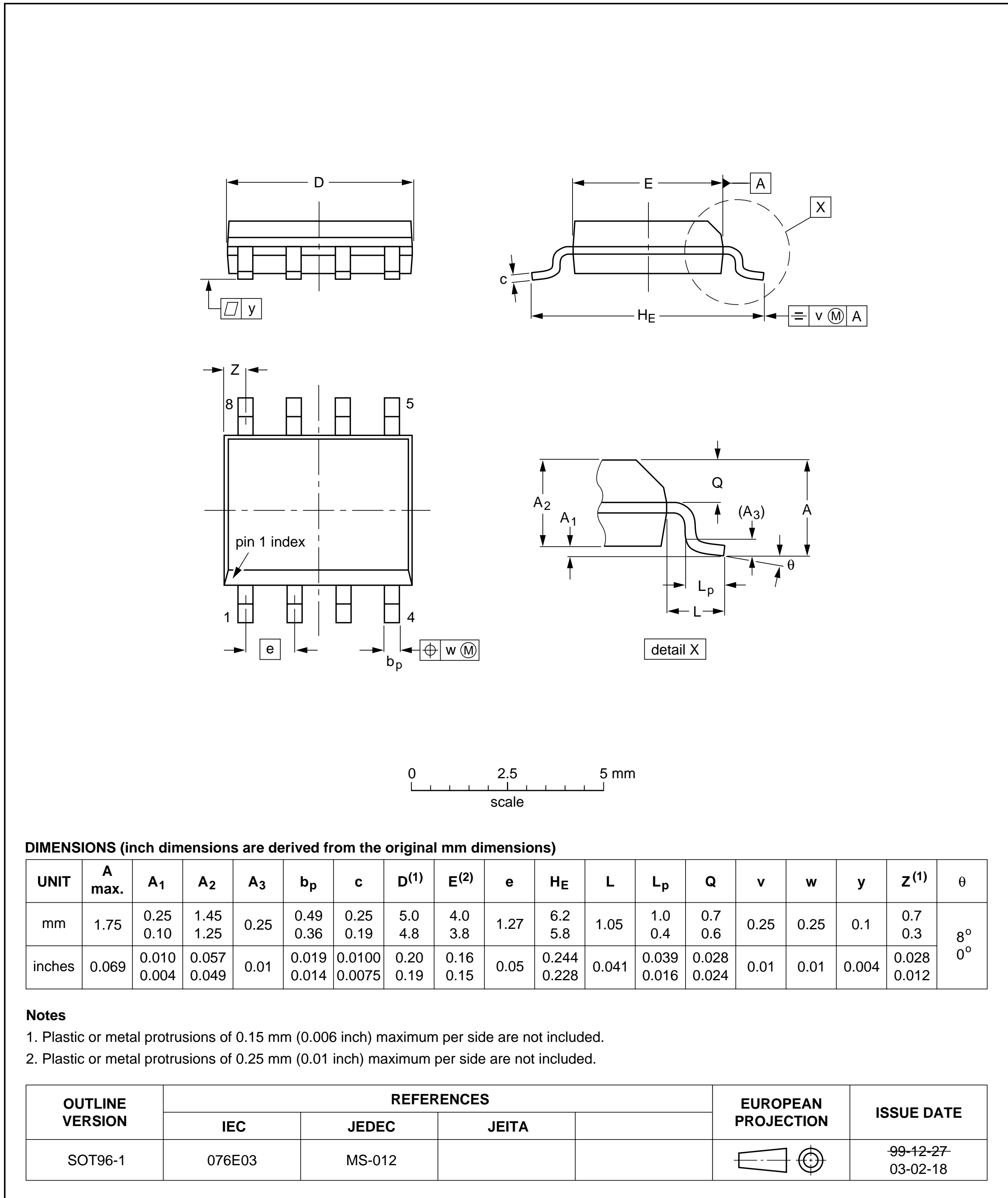
SO8: plastic small outline package; 8 leads; body width 3.9 mm **SOT96-1**



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(2)	e	H_E	L	L_p	Q	v	w	y	Z(1)	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Notes

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT96-1	076E03	MS-012				~~99-12-27~~ 03-02-18

Fig 17. Package outline SOT96-1 (SO8)

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14. Soldering

14.1 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.

14.2 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.

14.3 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;

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– 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.

14.4 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.

14.5 Package related soldering information

Table 9: 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.

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[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.

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15. Revision history

Table 10: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
TDA3663_5	20050613	Product data	-	9397 750 15047	TDA3663_4
Modifications:	• The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors. • Section 1 “General description”: Removed automotive reference • Section 2 “Features”: Removed stability capacitor values and pin compatible products • Section 3 “Quick reference data”: Added V_P = 3.1 V to the $V_{REG(drop)}$ conditions • Section 7 “Functional description”: Removed automotive reference and details on stability capacitors • Section 11.2 “Stability”: Removed two figures and examples; added a new stability description • Section 11.4 “Additional application information”: Changed Figure 13 and removed former Figure 14				
TDA3663_4	20001214	Product specification	-	9397 750 07864	TDA3663_3
TDA3663_3	20001208	Preliminary specification	-	9397 750 07555	TDA3663_2
TDA3663_2	20000201	Preliminary specification	-	9397 750 06798	TDA3663_1
TDA3663_1	19990929	Preliminary specification	-	9397 750 06068	-

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16. Data sheet status

Level	Data sheet status [1]	Product status [2] [3]	Definition
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[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

17. Definitions

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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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21. Contents

1	**General description**	**1**
2	**Features**	**1**
3	**Quick reference data**	**1**
4	**Ordering information**	**2**
5	**Block diagram**	**2**
6	**Pinning information**	**2**
6.1	Pinning	2
6.2	Pin description	3
7	**Functional description**	**3**
8	**Limiting values**	**3**
9	**Thermal characteristics**	**4**
10	**Characteristics**	**4**
11	**Application information**	**5**
11.1	Noise	5
11.2	Stability	5
11.3	Application circuits	5
11.3.1	Application circuit with backup function	6
11.4	Additional application information	7
12	**Test information**	**9**
12.1	Quality information	9
12.2	Test circuit	9
13	**Package outline**	**10**
14	**Soldering**	**12**
14.1	Introduction to soldering surface mount packages	12
14.2	Reflow soldering	12
14.3	Wave soldering	12
14.4	Manual soldering	13
14.5	Package related soldering information	13
15	**Revision history**	**15**
16	**Data sheet status**	**16**
17	**Definitions**	**16**
18	**Disclaimers**	**16**
19	**Trademarks**	**16**
20	**Contact information**	**16**

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