

DATA SHEET

TDA3664

Very low dropout voltage/quiescent current 5 V voltage regulator

Product specification
Supersedes data of 2000 Dec 08
File under Integrated Circuits, IC01

2000 Dec 14

Very low dropout voltage/quiescent current 5 V voltage regulator

TDA3664

FEATURES

General

- Fixed 5 V, 100 mA regulator
- Supply voltage range up to 45 V
- Very low quiescent current of 15 μ A (typical value)
- Very low dropout voltage
- High ripple rejection
- Very high stability:
 - Electrolytic capacitors: Equivalent Series Resistance (ESR) <22 Ω at worst-case condition
 - Other capacitors: 100 nF at $200 \mu\text{A} \leq I_{\text{REG}} \leq 100 \text{ mA}$.
- Pin compatible family TDA3662 up to TDA3666.

Protections

- Reverse polarity safe (down to -25 V without high reverse current)
- Negative transient of 50 V ($R_S = 10 \Omega$ and $t < 100 \text{ ms}$)

- 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 ($T_j > 150 \text{ }^\circ\text{C}$).

GENERAL DESCRIPTION

The TDA3664 is a fixed 5 V voltage regulator with very low dropout voltage/quiescent current, which operates over a wide supply voltage range.

The regulator is available as:

- TDA3664: SO4 package (automotive)
- TDA3664AT: SO8 package (automotive)
- TDA3664TT: TSSOP8 package (automotive).

Automotive: $V_P \leq 45 \text{ V}$ and $-40 \text{ }^\circ\text{C} \leq T_{\text{amb}} \leq +125 \text{ }^\circ\text{C}$.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage	regulator on	3	14.4	45	V
I_q	quiescent supply current	$V_P = 14.4 \text{ V}$; $I_{\text{REG}} = 0 \text{ mA}$	–	15	30	μA
Voltage regulator						
V_{REG}	regulator output voltage	$6 \text{ V} \leq V_P \leq 22 \text{ V}$; $I_{\text{REG}} = 0.5 \text{ mA}$	4.8	5.0	5.2	V
		$8 \text{ V} \leq V_P \leq 45 \text{ V}$; $I_{\text{REG}} = 0.5 \text{ mA}$	4.75	5.0	5.25	V
		$0.5 \text{ mA} \leq I_{\text{REG}} \leq 100 \text{ mA}$; $V_P = 14.4 \text{ V}$	4.75	5.0	5.25	V
$V_{\text{REG(drop)}}$	dropout voltage	$V_P = 4.5 \text{ V}$; $I_{\text{REG}} = 50 \text{ mA}$; $T_{\text{amb}} \leq 85 \text{ }^\circ\text{C}$	–	0.18	0.3	V

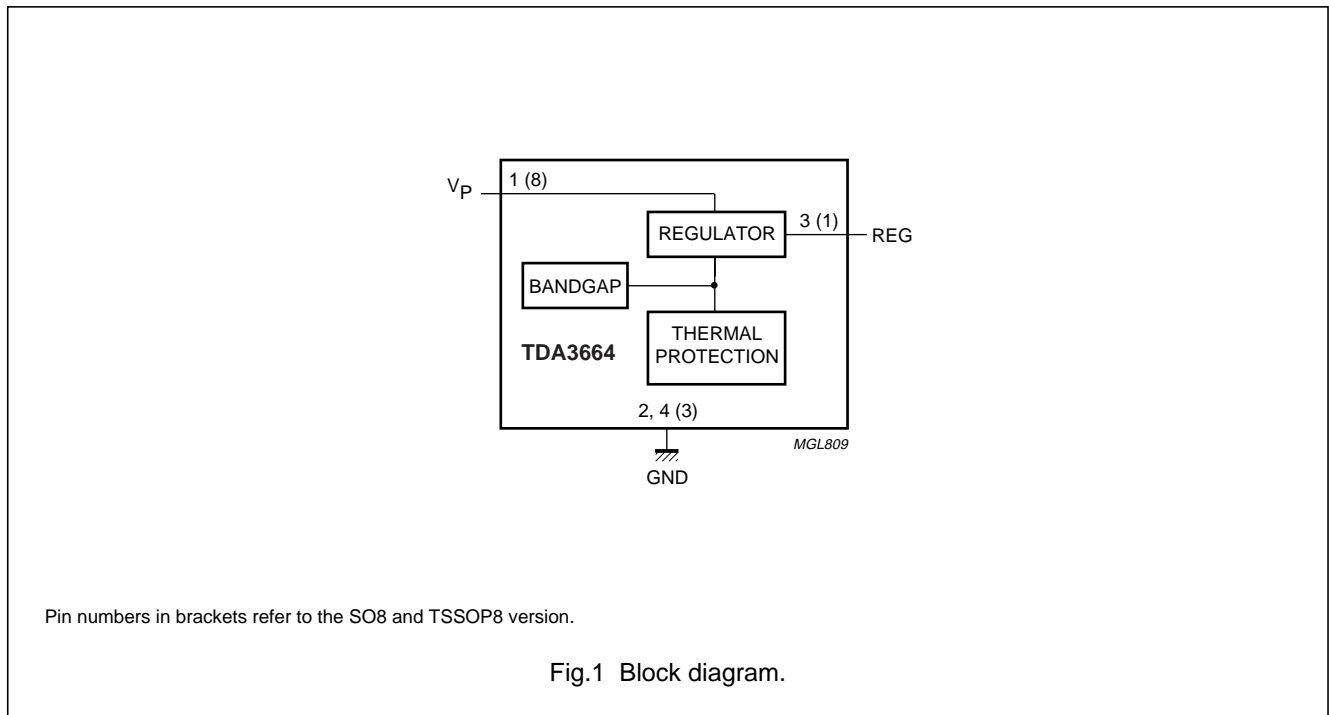
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ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA3664	SO4	plastic small outline package; 4 leads; body width 3.5 mm	SOT223-1
TDA3664AT	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
TDA3664TT	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm	SOT505-1

BLOCK DIAGRAM

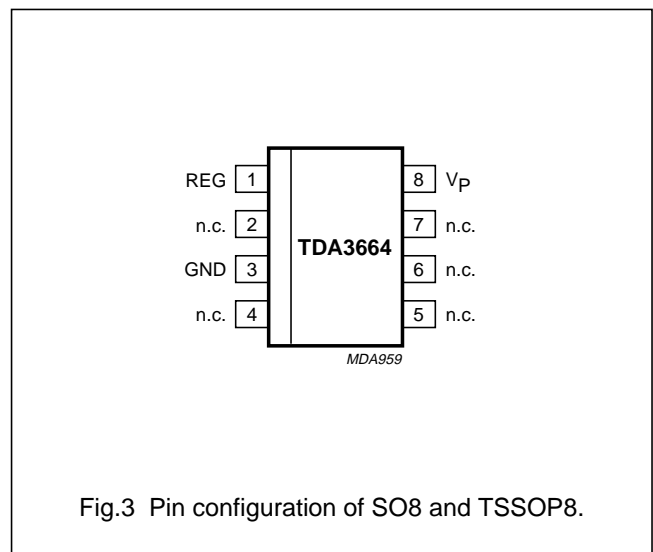
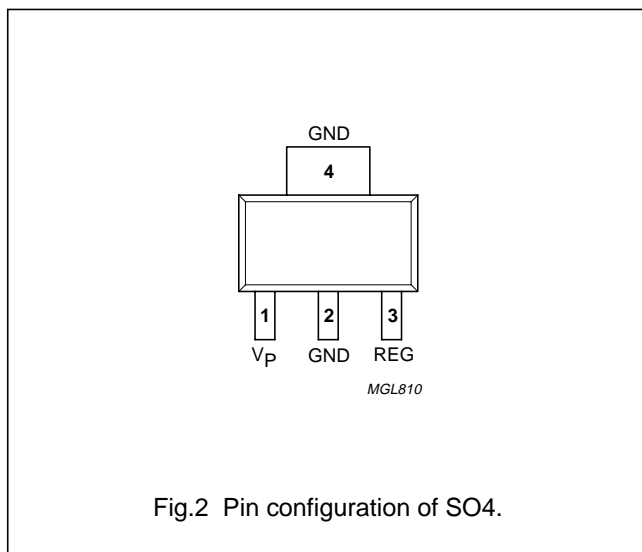


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PINNING

SYMBOL	PIN			DESCRIPTION
	SO4	SO8	TSSOP8	
V _P	1	8	8	supply voltage
GND	2 and 4	3	3	ground
REG	3	1	1	regulator output
n.c.	–	2, 4, 5, 6 and 7	2, 4, 5, 6 and 7	not connected



FUNCTIONAL DESCRIPTION

The TDA3664 is a fixed 5 V regulator which can deliver output currents up to 100 mA. The regulator is available in SO8, TSSOP8 and SO4 packages. The regulator is intended for portable, mains, telephone and automotive 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 regulator remains operational down to very low supply voltages, below which it switches off.

A temperature protection is included, which switches the regulator output off at IC temperatures above 150 °C.

A new output structure guarantees the stability of the regulator with an ESR (worst-case) up to 22 Ω, see Figs 5 and 6. This is very attractive as the ESR of an electrolytic capacitor increases strongly at low temperatures (no expensive tantalum capacitor required).

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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	temperature of copper area is 25 °C			
	TDA3664AT		–	0.8	W
	TDA3664TT		–	0.65	W
	TDA3664	–	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

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air; soldered in		
	SO8		155	K/W
	TSSOP8		220	K/W
	SO4		100	K/W
$R_{th(j-c)}$	thermal resistance from junction to case (SO4 only)	in free air	25	K/W

QUALITY SPECIFICATION

In accordance with “SNW-FQ-611E”.

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CHARACTERISTICS

$V_P = 14.4\text{ V}$; $T_{\text{amb}} = 25\text{ °C}$; measured in test circuit (see Fig.4); unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply voltage						
V_P	supply voltage	regulator operating; note 1	3	14.4	45	V
I_q	quiescent current	$V_P = 4.5\text{ V}$; $I_{\text{REG}} = 0\text{ mA}$	–	10	–	μA
		$V_P = 14.4\text{ V}$; $I_{\text{REG}} = 0\text{ mA}$	–	15	30	μA
		$6\text{ V} \leq V_P \leq 22\text{ V}$; $I_{\text{REG}} = 10\text{ mA}$	–	0.2	0.5	mA
		$6\text{ V} \leq V_P \leq 22\text{ V}$; $I_{\text{REG}} = 50\text{ mA}$; note 2	–	1.4	2.5	mA
Regulator output: pin REG						
V_{REG}	output voltage	$8\text{ V} \leq V_P \leq 22\text{ V}$; $I_{\text{REG}} = 0.5\text{ mA}$; $T_{\text{amb}} = 25\text{ °C}$	4.8	5.0	5.2	V
		$8\text{ V} \leq V_P \leq 22\text{ V}$; $I_{\text{REG}} = 0.5\text{ mA}$	4.75	5.0	5.25	V
		$0.5\text{ mA} \leq I_{\text{REG}} \leq 100\text{ mA}$; note 2	4.75	5.0	5.25	V
		$6\text{ V} \leq V_P \leq 45\text{ V}$	4.75	5.0	5.25	V
$\Delta V_{\text{REG}}(\text{line})$	line regulation voltage	$8\text{ V} \leq V_P \leq 16\text{ V}$; $I_{\text{REG}} = 0.5\text{ mA}$	–	1	10	mV
		$7\text{ V} \leq V_P \leq 22\text{ V}$; $I_{\text{REG}} = 0.5\text{ mA}$	–	1	30	mV
		$7\text{ V} \leq V_P \leq 45\text{ V}$; $I_{\text{REG}} = 0.5\text{ mA}$	–	1	50	mV
$\Delta V_{\text{REG}}(\text{load})$	load regulation voltage	$0.5\text{ mA} \leq I_{\text{REG}} \leq 50\text{ mA}$	–	10	50	mV
SVRR	supply voltage ripple rejection	$f_i = 120\text{ Hz}$; $V_{i(\text{ripple})} = 1\text{ V (RMS)}$; $I_{\text{REG}} = 0.5\text{ mA}$	50	60	–	dB
$V_{\text{REG}}(\text{drop})$	dropout voltage	$V_P = 4.5\text{ V}$; $I_{\text{REG}} = 50\text{ mA}$; $T_{\text{amb}} \leq 85\text{ °C}$	–	0.18	0.3	V
$I_{\text{REG}}(\text{crl})$	current limit	$V_{\text{REG}} > 4.5\text{ V}$	0.17	0.25	–	A
$V_{\text{REG}}(\text{stab})$	long-term stability		–	20	–	mV/1000 h
$I_{\text{LO}}(\text{rp})$	output leakage current at reverse polarity	$V_P = -15\text{ V}$, $V_{\text{REG}} \leq 0.3\text{ V}$	–	1	500	μA

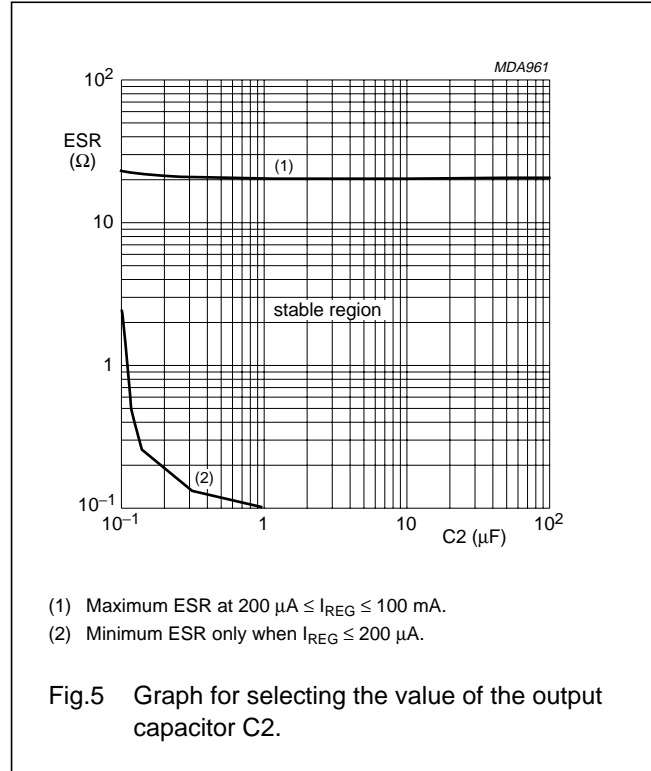
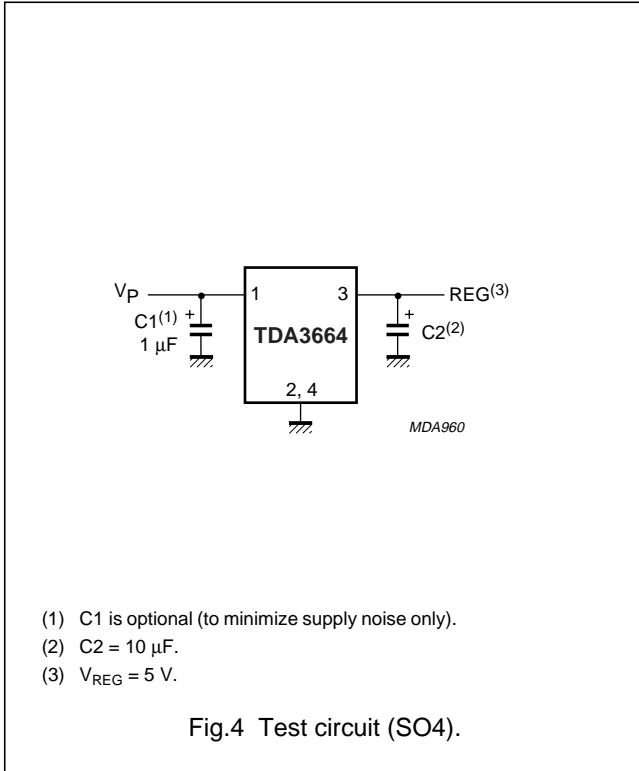
Notes

- The regulator output will follow V_P if $V_P < V_{\text{REG}} + V_{\text{REG}}(\text{drop})$.
- TDA3664TT: $I_{\text{REG}} \leq 15\text{ mA}$ at $T_{\text{amb}} \leq 125\text{ °C}$; $I_{\text{REG}} \leq 30\text{ mA}$ at $T_{\text{amb}} \leq 85\text{ °C}$.

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TEST AND APPLICATION INFORMATION



Noise

The output noise is determined by the value of the output capacitor (see Table 1).

Table 1 Noise figures

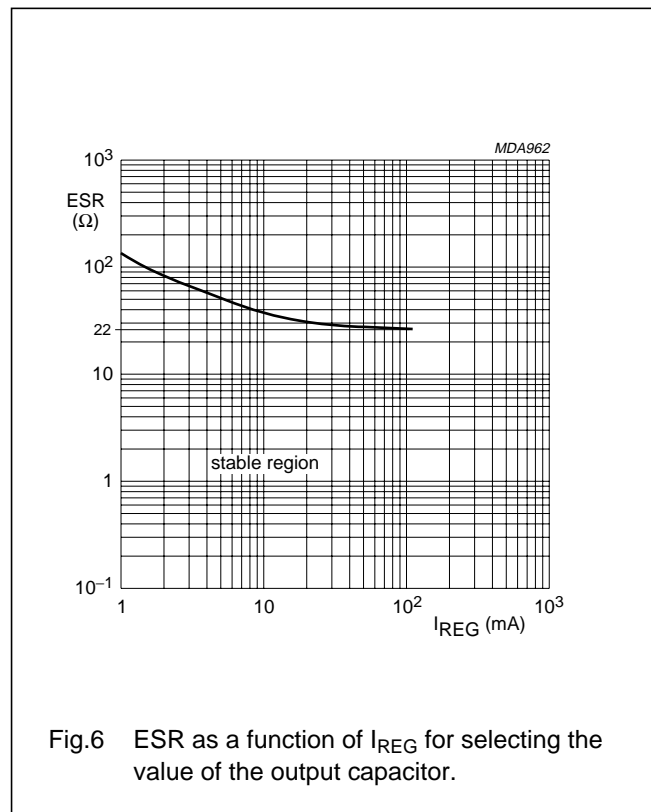
OUTPUT CURRENT I_O (mA)	NOISE FIGURE (μV) ⁽¹⁾		
	$C_O = 10 \mu F$	$C_O = 47 \mu F$	$C_O = 100 \mu F$
0.5	550	320	300
50	650	400	400

Note

1. Measured at a bandwidth of 10 Hz to 100 kHz.

Stability

The regulator is stabilized with an external capacitor on the output. The value of this capacitor can be selected using the diagrams shown in Figs 5 and 6. The four examples on the next page show the effects of the stabilization circuit using different values for the output capacitor.



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EXAMPLE 1

The regulator is stabilized with an electrolytic output capacitor of 68 μF (ESR = 0.5 Ω). At $-40\text{ }^\circ\text{C}$, the capacitor value is decreased to 22 μF and the ESR is increased to 3.5 Ω . The regulator will remain stable at a temperature of $-40\text{ }^\circ\text{C}$.

EXAMPLE 2

The regulator is stabilized with an electrolytic output capacitor of 10 μF (ESR = 3.3 Ω). At $-40\text{ }^\circ\text{C}$, the capacitor value is decreased to 3 μF and the ESR is increased to 20 Ω . The regulator will remain stable at a temperature of $-40\text{ }^\circ\text{C}$.

EXAMPLE 3

The regulator is stabilized with a 100 nF MKT capacitor on the output. Full stability is guaranteed when the output current is over 200 μA .

Because the thermal influence on this capacitor value is almost zero, the regulator will remain stable at a temperature of $-40\text{ }^\circ\text{C}$.

EXAMPLE 4

The regulator is stabilized with a 100 nF capacitor in parallel with a electrolytic capacitor of 10 μF on the output.

The regulator is now stable under all conditions and independent of:

- The ESR of the electrolytic capacitor
- The value of the electrolytic capacitor
- The output current.

Application circuits

The maximum output current of the regulator equals:

$$I_{\text{REG(max)}} = \frac{150 - T_{\text{amb}}}{R_{\text{th(j-a)}} \times (V_{\text{P}} - V_{\text{REG}})}$$

$$= \frac{150 - T_{\text{amb}}}{100 \times (V_{\text{P}} - 5)} \text{ (mA)}$$

When $T_{\text{amb}} = 21\text{ }^\circ\text{C}$, the maximum output current equals 140 mA at $V_{\text{P}} = 14\text{ V}$.

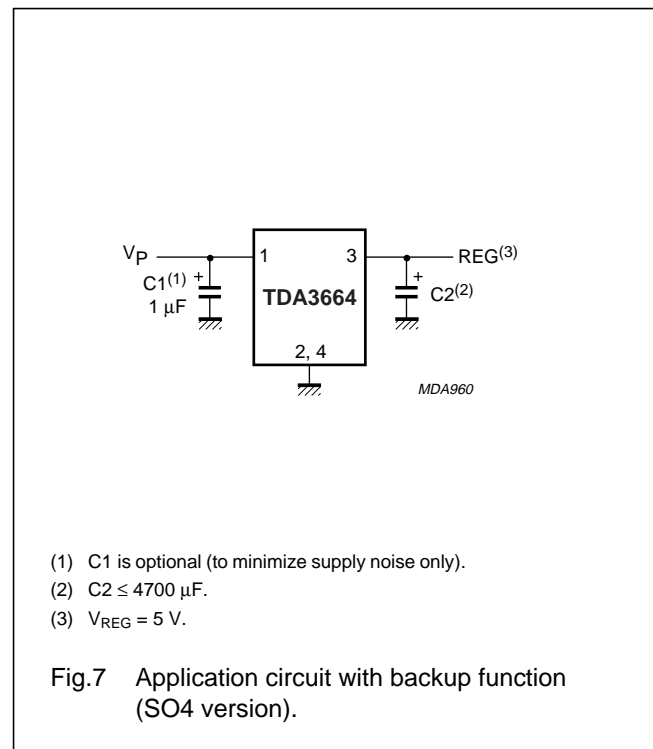
The total thermal resistance of the TDA3664 (SOT223-1 package) can be decreased to lower values when pin 4 and body of the package are soldered to the printed-circuit board.

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 be easily built with the TDA3664 by using a large output capacitor. When the supply voltage is 0 V (or -1 V), only a small current will flow into pin REG from this large output capacitor (a few μA).

The application circuit is given in Fig.7.

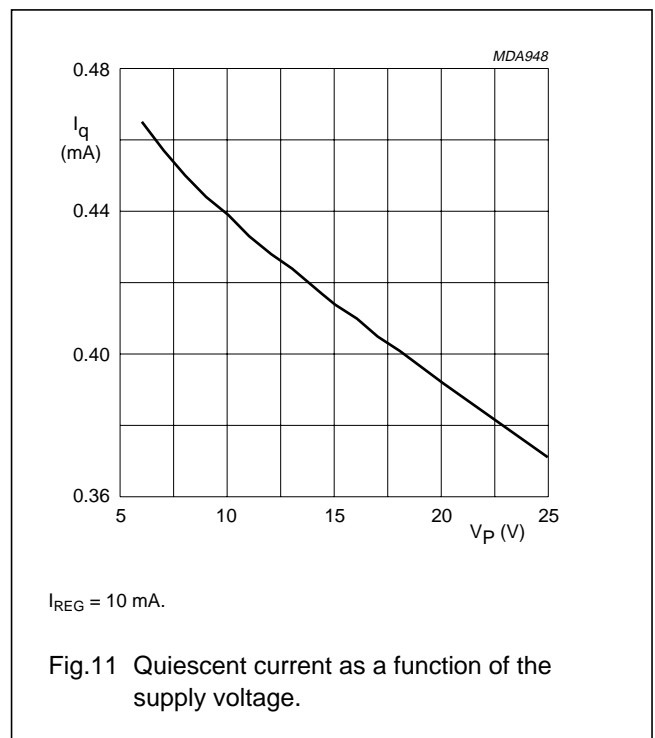
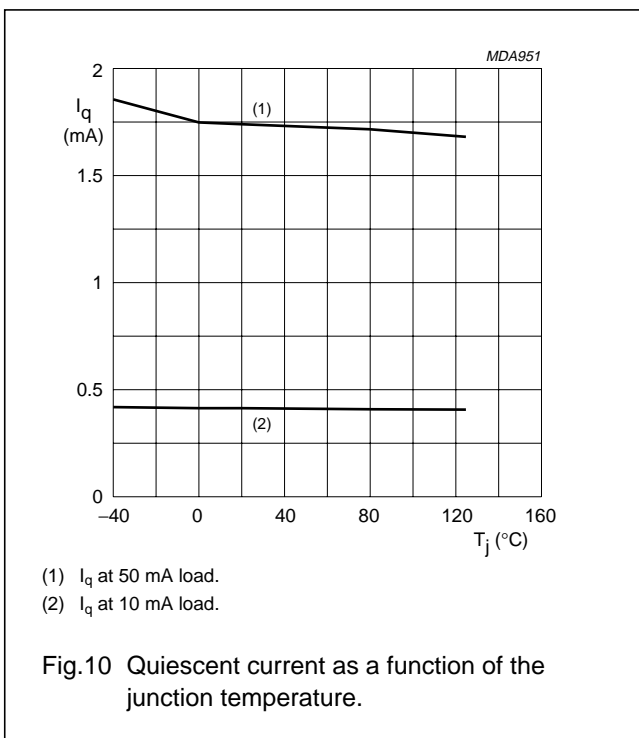
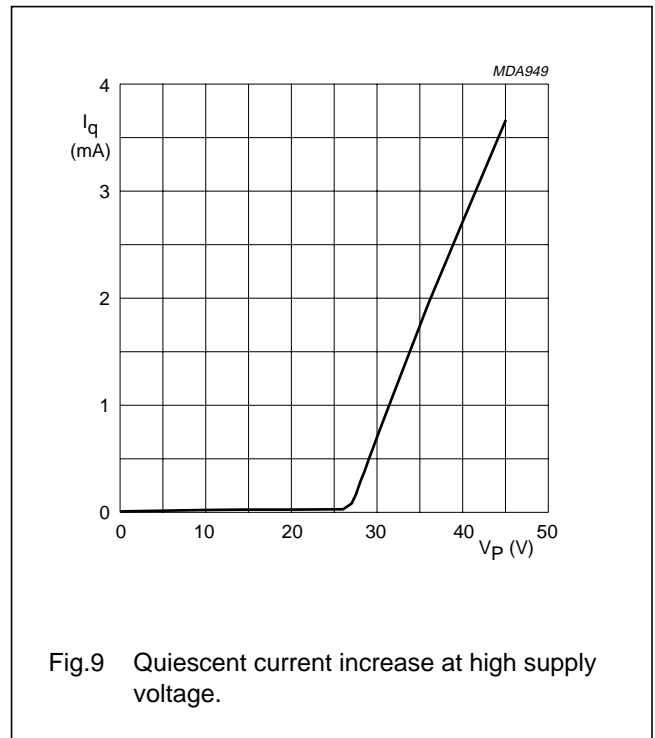
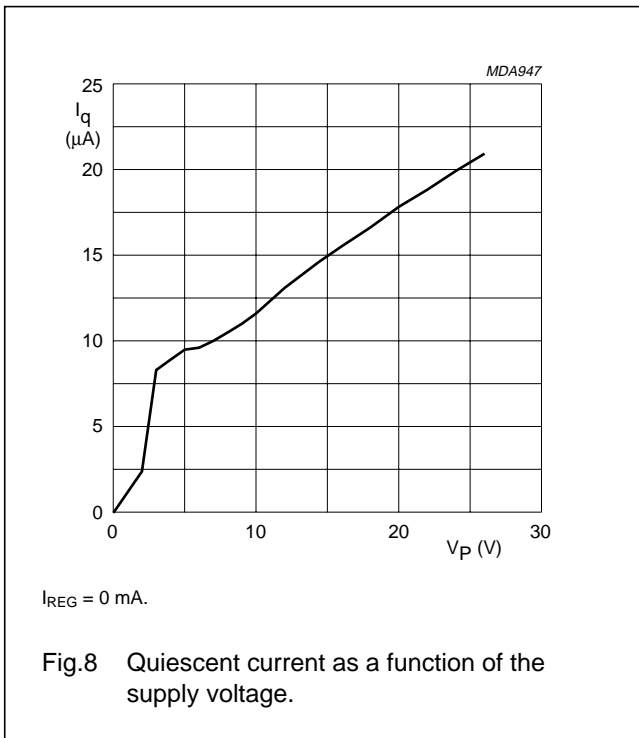


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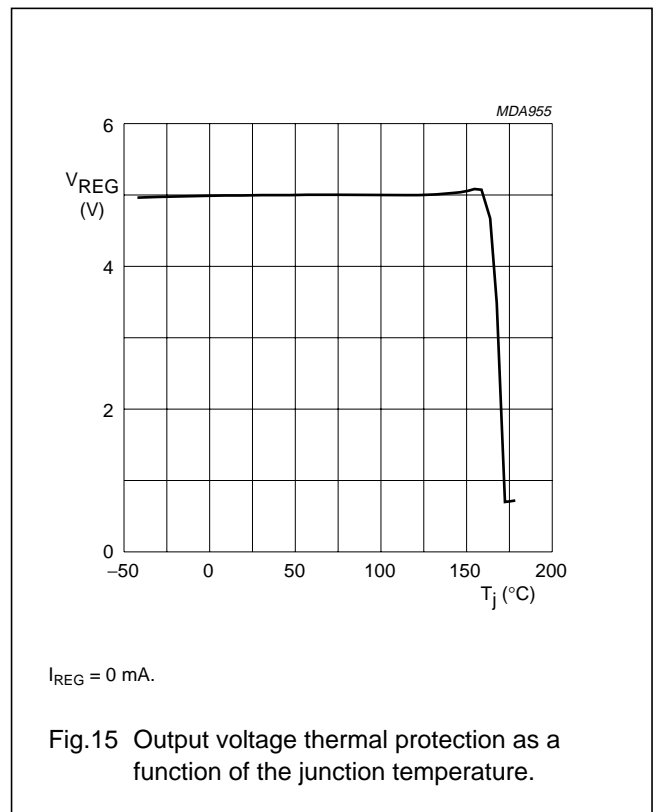
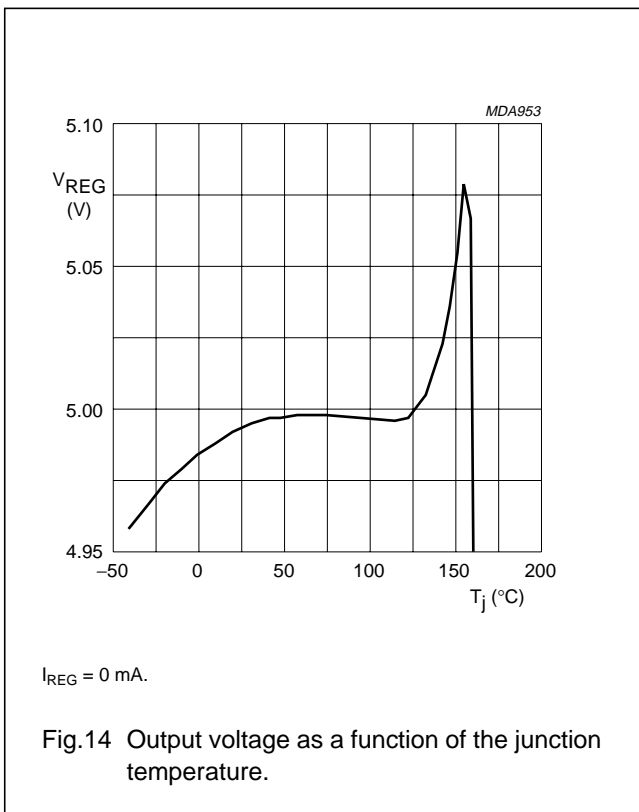
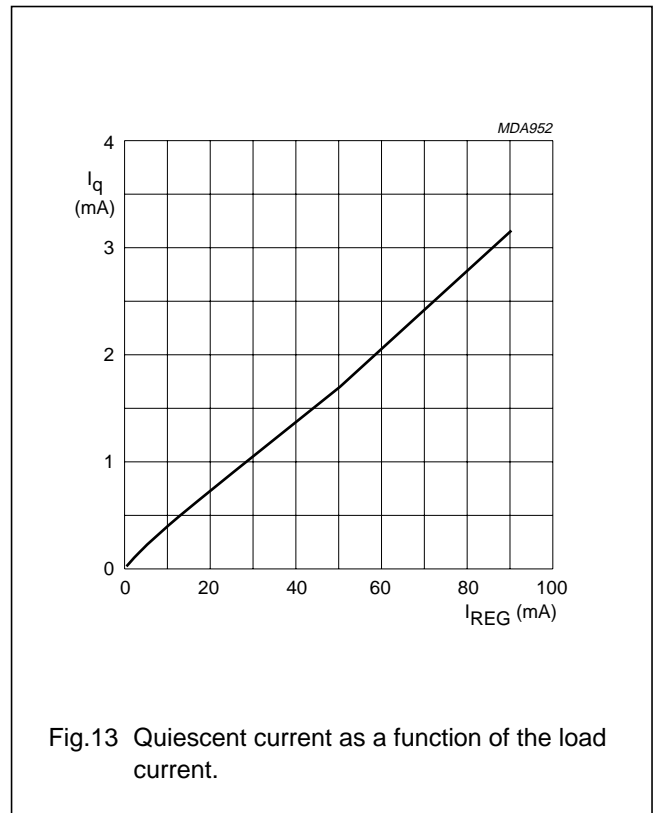
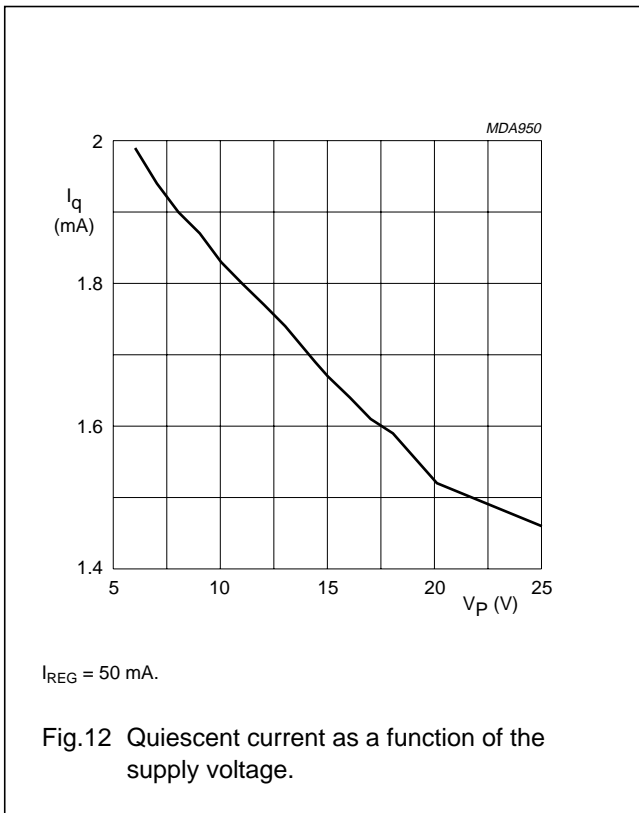
Additional application information

This section gives typical curves for various parameters measured on the TDA3664AT. Standard test conditions are: $V_P = 14.4 \text{ V}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$.



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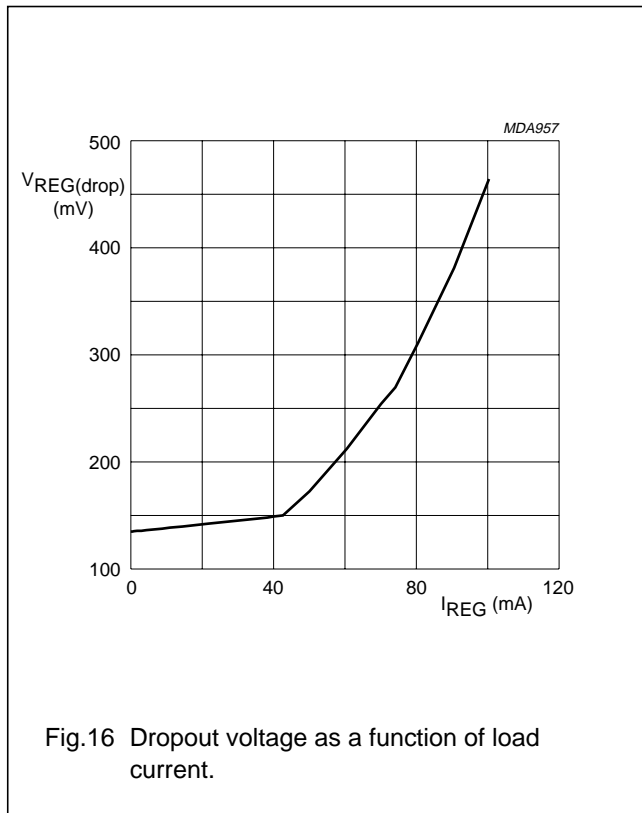
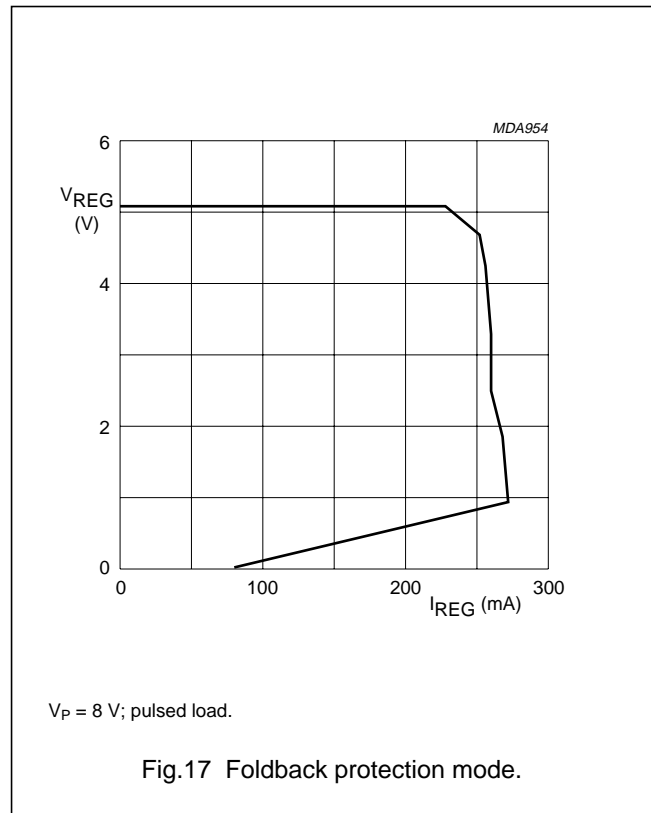
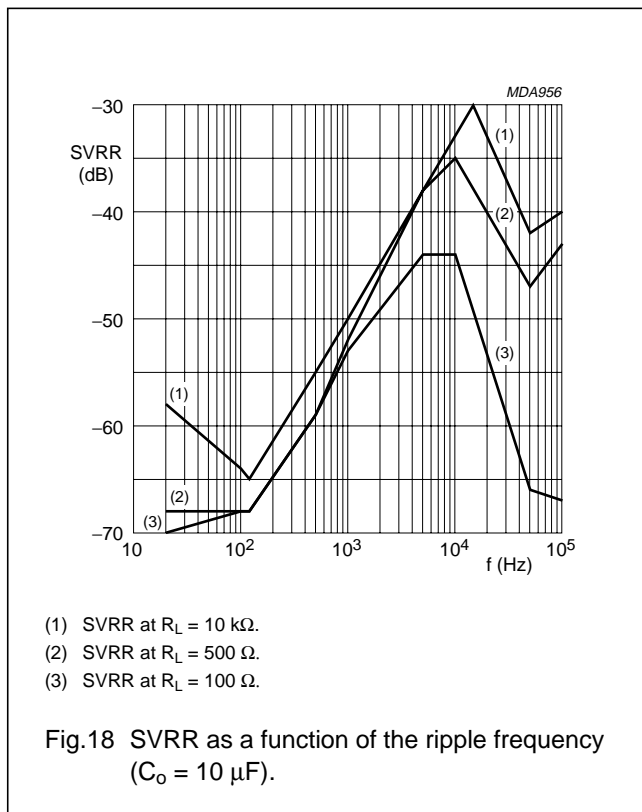


Fig.16 Dropout voltage as a function of load current.



$V_P = 8\text{ V}$; pulsed load.

Fig.17 Foldback protection mode.



- (1) SVRR at $R_L = 10\text{ k}\Omega$.
- (2) SVRR at $R_L = 500\ \Omega$.
- (3) SVRR at $R_L = 100\ \Omega$.

Fig.18 SVRR as a function of the ripple frequency ($C_o = 10\ \mu\text{F}$).

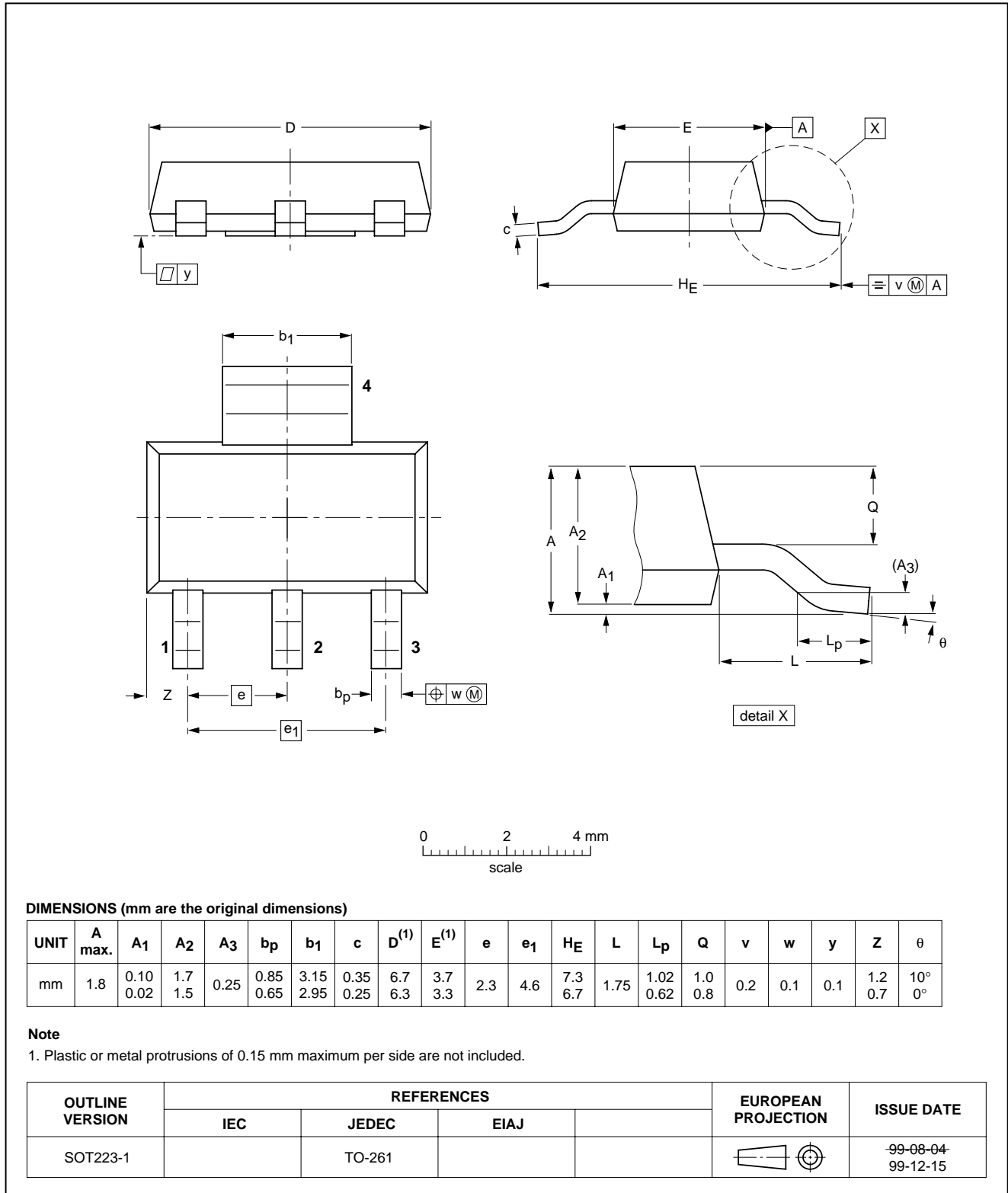
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PACKAGE OUTLINES

SO4: plastic small outline package; 4 leads; body width 3.5 mm

SOT223-1

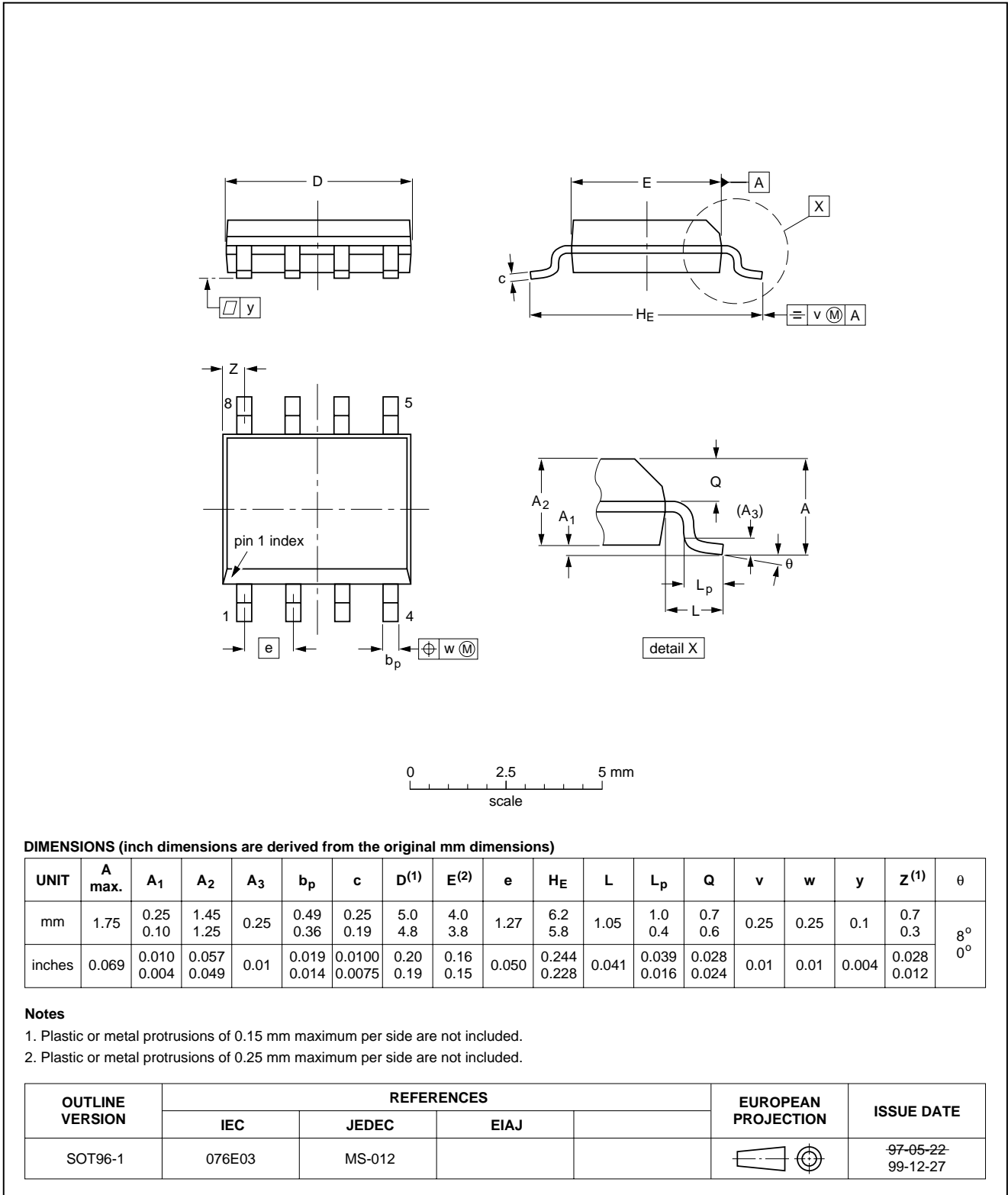


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SO8: plastic small outline package; 8 leads; body width 3.9 mm

SOT96-1

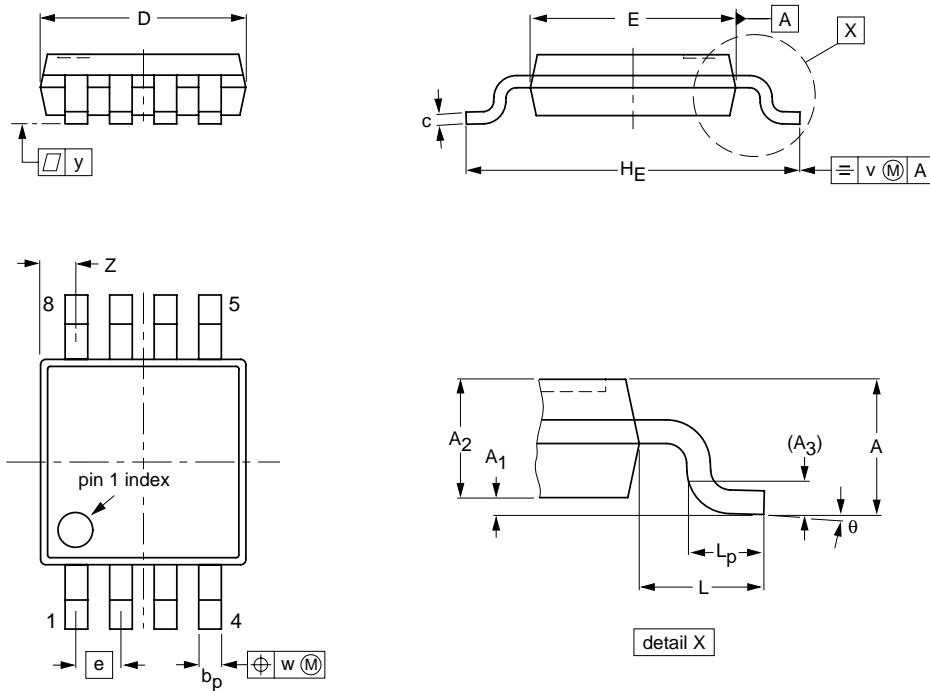


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TSSOP8: plastic thin shrink small outline package; 8 leads; body width 3 mm

SOT505-1



DIMENSIONS (mm are the original dimensions)

UNIT	A _{max.}	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	v	w	y	z ⁽¹⁾	θ
mm	1.10	0.15 0.05	0.95 0.80	0.25	0.45 0.25	0.28 0.15	3.10 2.90	3.10 2.90	0.65	5.10 4.70	0.94	0.70 0.40	0.1	0.1	0.1	0.70 0.35	6° 0°

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
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			
SOT505-1						99-04-09

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SOLDERING

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.

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, convection or convection/infrared 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 preferably be kept below 220 °C for thick/large packages, and below 235 °C for small/thin packages.

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.

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

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW ⁽¹⁾
BGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable ⁽²⁾	suitable
PLCC ⁽³⁾ , SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended ⁽³⁾⁽⁴⁾	suitable
SSOP, TSSOP, VSO	not recommended ⁽⁵⁾	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. 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).
3. 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.
4. Wave soldering is only suitable for LQFP, TQFP and QFP 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.
5. 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.

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DATA SHEET STATUS

DATA SHEET STATUS	PRODUCT STATUS	DEFINITIONS ⁽¹⁾
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

Note

1. Please consult the most recently issued data sheet before initiating or completing a design.

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.

Application information — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

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NOTES

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NOTES

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Printed in The Netherlands

753503/05/pp20

Date of release: 2000 Dec 14

Document order number: 9397 750 07866

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