DATA SHEET

TDA3606
Multiple voltage regulator with battery detection

Product specification
Supersedes data of 1997 Jul 15
File under Integrated Circuits, IC01

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Philips
Semiconductors

PHILIPS

Multiple voltage regulator with battery detection

TDA3606

FEATURES

- One V_P-state controlled regulator
- Regulator and reset outputs operate during load dump
- Supply voltage range of –18 to +50 V
- Low quiescent current (battery detection switched off)
- High ripple rejection
- Dual reset output.

PROTECTIONS

- Reverse polarity safe (down to –18 V without high reverse current)
- Able to withstand voltages up to 18 V at the output (supply line may be short-circuited)
- ESD protected on all pins
- Load dump protection
- Foldback current limit protection for regulator
- DC short-circuit safe to ground and V_P of regulator output.

GENERAL DESCRIPTION

The TDA3606 is a low power voltage regulator. It contains:

1. One fixed voltage regulator with a foldback current protection, intended to supply a microprocessor that also operates during load dump
2. A reset-signal can be used to interface with the microprocessor
3. Supply pin can withstand load dump pulses and negative supply voltages
4. Defined start-up behaviour; regulator will be switched on at a supply voltage higher than 7.6 V and off when the output voltage of the regulator drops below 2.4 V.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage					
	operating	regulator on	5.6	14.4	25	V
	jump start	$t \leq 10$ minutes	–	–	30	V
	load dump protection	during 50 ms; $t_r \geq 2.5$ ms	–	–	50	V
$I_{q(tot)}$	total quiescent supply current	standby mode	–	95	120	μA
Voltage regulator						
V_{REG}	output voltage regulator	$7\ V \leq V_P \leq 18\ V$	4.85	5.0	5.15	V
		$0.5\ mA \leq I_{REG} \leq 50\ mA$	4.8	5.0	5.2	V
V_{REGd}	drop-out voltage	$I_{REG} = 50\ mA$	–	–	0.4	V

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA3606T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

BLOCK DIAGRAM

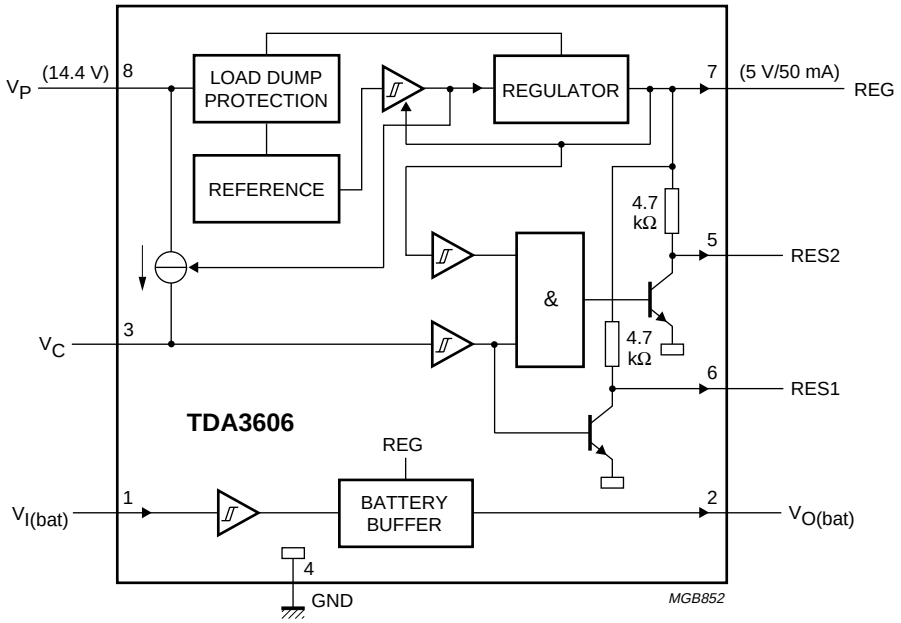


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
$V_{I(bat)}$	1	battery input voltage
$V_{O(bat)}$	2	battery detection output voltage
V_C	3	reset delay capacitor
GND	4	ground (0 V)
RES2	5	reset 2 output
RES1	6	reset 1 output
REG	7	regulator output
V_P	8	supply voltage

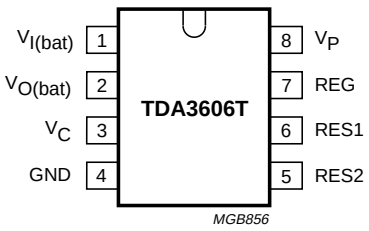


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA3606 is a voltage regulator intended to supply a microprocessor (e.g. in car radio applications). Because of low voltage operation of the application, a low-voltage drop regulator is used in the TDA3606.

This regulator will switch on when the supply voltage exceeds 7.5 V for the first time and will switch off again when the output voltage of the regulator drops below 2.4 V. When the regulator is switched on, the RES1 and RES2 outputs (RES2 can only be HIGH when RES1 is HIGH) will go HIGH after a fixed delay time (fixed by an external delay capacitor) to generate a reset to the microprocessor.

RES1 will go HIGH by an internal pull-up resistor of 4.7 kΩ, and is used to initialize the microprocessor. RES2 is used to indicate that the regulator output voltage is within its voltage range. This start-up feature is built-in to secure a smooth start-up of the microprocessor at first connection, without uncontrolled switching of the regulator during the start-up sequence.

All output pins are fully protected. The regulator is protected against load dump and short-circuit (foldback current protection).

Interfacing with the microprocessor can be accomplished by means of a battery Schmitt-trigger and output buffer (simple full/semi on/off logic applications). The battery output will go HIGH when the battery input voltage exceeds the HIGH threshold level.

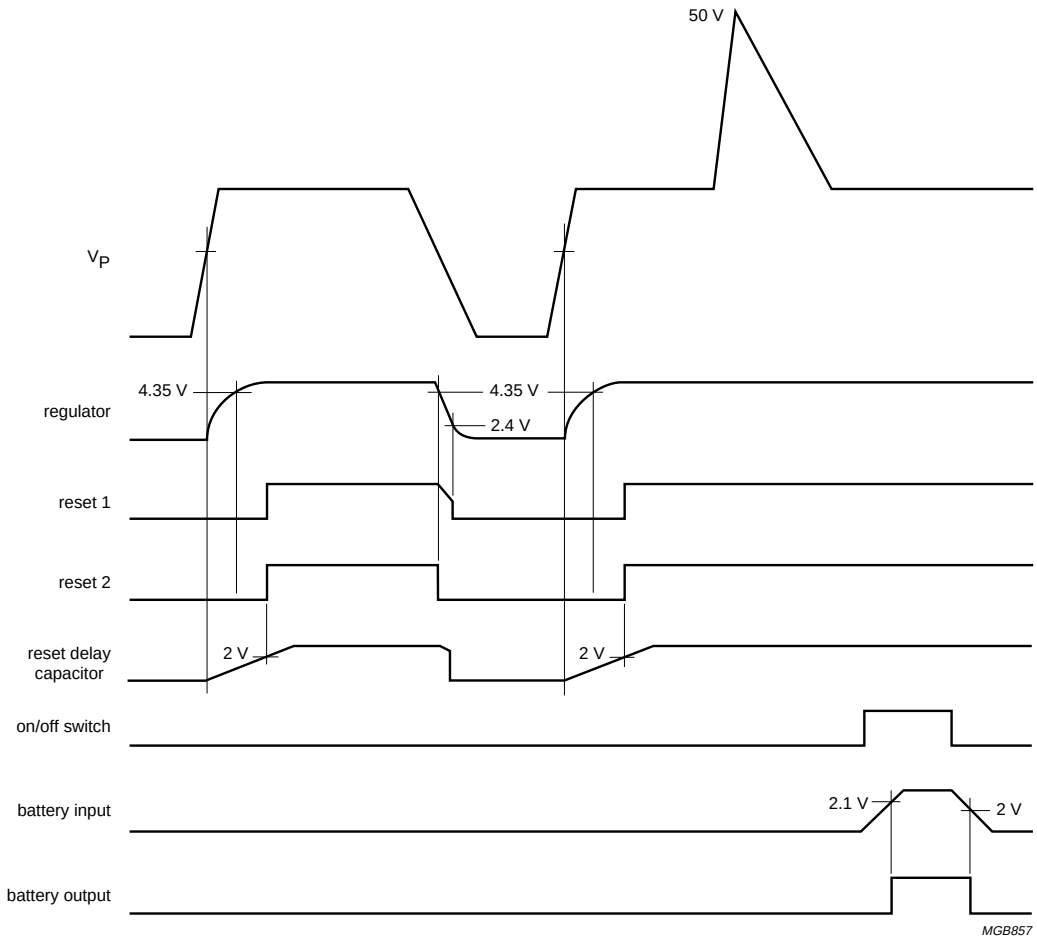


Fig.3 Timing diagrams.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage				
	operating	regulator on	–	25	V
	jump start	$t \leq 10$ minutes	–	30	V
	load dump protection	during 50 ms; $t_r \geq 2.5$ ms	–	50	V
V_P	reverse battery voltage	non-operating	–	–18	V
$V_{I(bat)p}$	positive pulse voltage at battery input	V_P = 14.4 V; R_I = 5 kΩ	–	50	V
$V_{I(bat)n}$	negative pulse voltage at battery input	V_P = 14.4 V; R_I = 5 kΩ	–	–100	V
P_{tot}	total power dissipation	T_{amb} = 25 °C	–	0.81	W
T_{stg}	storage temperature	non-operating	–55	+150	°C
T_{amb}	operating ambient temperature		–40	+85	°C
T_j	junction temperature	operating	–40	+150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient	in free air	155	K/W

QUALITY SPECIFICATION

In accordance with *"SNW-FQ-611E"*. The number of the quality specification can be found in the *"Quality Reference Handbook"*. The handbook can be ordered using the code 9397 750 00192.

CHARACTERISTICS

V_P = 14.4 V; T_{amb} = 25 °C; see Fig.5; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies						
V_P	supply voltage					
	operating	regulator on; note 1	5.6	14.4	25	V
	jump start	t ≤ 10 minutes	–	–	30	V
	load dump protection	during 50 ms, $t_r \geq 2.5$ ms	–	–	50	V
I_q	quiescent current	V_P = 12.4 V; note 2	–	95	120	µA
		V_P = 14.4 V; note 2	–	100	–	µA
		load dump; V_P = 50 V	–	5	15	mA
Schmitt-trigger for regulator and reset 1						
V_{thr}	rising supply voltage threshold		6.2	7.5	8.2	V
V_{thf}	falling voltage of regulator threshold	I_{REG} = 5 mA	2.2	2.4	2.6	V
		I_{REG} = 30 mA	–	2.25	–	V
V_{hys}	hysteresis		–	5.1	–	V
Schmitt-trigger for battery detection						
V_{thr}	rising voltage threshold		1.95	2.05	2.15	V
V_{thf}	falling voltage threshold		1.85	1.95	2.05	V
V_{hys}	hysteresis		–	0.1	–	V
Schmitt-trigger for reset 2						
V_{thr}	rising voltage of regulator	note 3	4.3	4.45	4.6	V
V_{thf}	falling voltage of regulator	note 3	4.2	4.35	4.5	V
V_{hys}	hysteresis		–	0.1	–	V
Reset 1/2 buffer						
I_{sink}	LOW-level sink current	$V_{RES} \leq 0.8$ V; note 3	2	–	–	mA
R_{pu}	internal pull-up resistor		3.7	4.7	5.7	kΩ
Reset delay						
I_o	output current		–	0.75	–	µA
V_{thr}	rising voltage threshold		1.4	2.0	2.8	V
t_d	delay time	C_d = 47 nF; note 4	40	125	–	ms
Battery buffer						
V_{OL}	LOW-level output voltage	I_I = 0 mA	0	0.05	0.8	V
V_{OH}	HIGH-level output voltage	I_o = 5 µA; note 5	–	5.0	5.2	V
I_{OL}	LOW-level output current	$V_{OL} \leq 0.8$ V	0.2	0.5	–	mA
I_{OH}	HIGH-level output current	$V_{OH} \geq 3$ V	0.3	1.0	–	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Regulator (I_{REG} = 5 mA)						
V_o	output voltage	0.5 mA ≤ I_{REG} ≤ 50 mA	4.8	5.0	5.2	V
		7 V ≤ V_P ≤ 18 V	4.85	5.0	5.15	V
		18 V ≤ V_P ≤ 50 V; load dump; I_{REG} = 30 mA	4.75	5.0	5.25	V
I_o	output current	load dump; V_P > 25 V	–	–	45	mA
ΔV_{REG}	line regulation	7 V ≤ V_P ≤ 18 V	–	3	50	mV
ΔV_{REGL}	load regulation	0.5 mA ≤ I_{REG} ≤ 30 mA	–	–	50	mV
SVRR	supply voltage ripple rejection	f_i = 200 Hz; $V_{i(p-p)}$ = 2 V; I_o = 5 mA	55	60	–	dB
V_{REGd}	drop-out voltage	I_{REG} = 50 mA; V_P = 5 V; note 6	–	0.27	0.4	V
I_{clr}	current limit	V_{REG} > 4.5 V; note 7	0.1	0.27	0.6	A
I_{scr}	short-circuit current	R_L ≤ 0.5 Ω; note 8	15	60	–	mA

Notes

1. Minimum operating voltage, only if V_P has exceeded 7.6 V.
2. The quiescent current is measured in stand-by mode. So, the battery input is connected to a low voltage source and $R_L = \infty$.
3. The voltage of regulator sinks as a result of a supply voltage drop.
4. The delay time can be calculated with the following formula: $t_d = \int \frac{C_d}{I_{ch}} dV_{thr} = \frac{C_d \times V_{thr}}{I_{ch}} (ms)$
5. Battery output voltage will be equal or less than the output voltage of regulator.
6. The drop-out voltage of regulator is measured between V_P and V_{REG}.
7. At current limit, I_{clr} is held constant (behaviour according to dashed line in Fig.4).
8. The foldback current protection limits the dissipated power at short-circuit (see Fig.4).

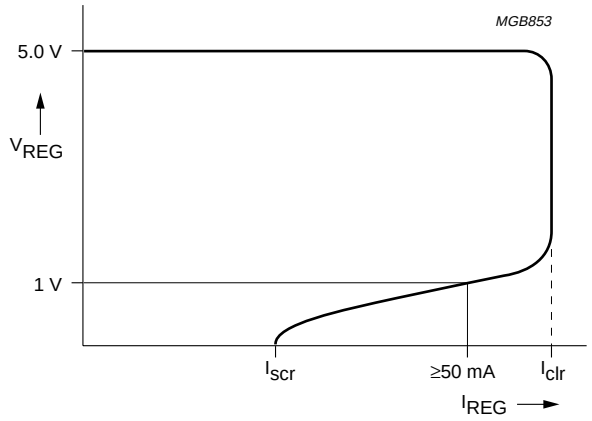
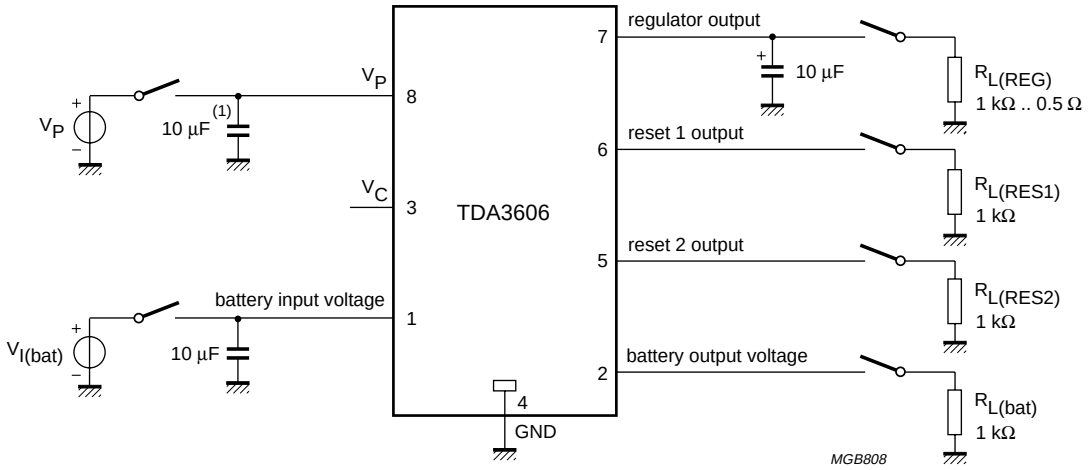


Fig.4 Foldback current protection.

TEST AND APPLICATION INFORMATION

Test information



(1) Capacitor not required for stability.

Fig.5 Test circuit.

Application information

NOISE

The noise at the output of the regulator depends on the bandwidth of the regulator, which can be adjusted by means of the output capacitor. In Table 1 the noise figures are given.

Table 1 Noise figures

OUTPUT CURRENT I_O (mA)	NOISE FIGURE (µV)(1) AT OUTPUT CAPACITOR C_L (µF)		
	10	47	100
0.5	58	50	45
50	250	200	180

Note

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

The noise on the supply line depends on the value of the supply capacitor and is caused by a current noise (output noise of the regulator is translated into a current noise by means of the output capacitor). When a high frequency capacitor of 220 nF in parallel with an electrolytic capacitor of 100 µF is connected directly to pins 8 and 4 (supply and ground) the noise is minimized.

STABILITY

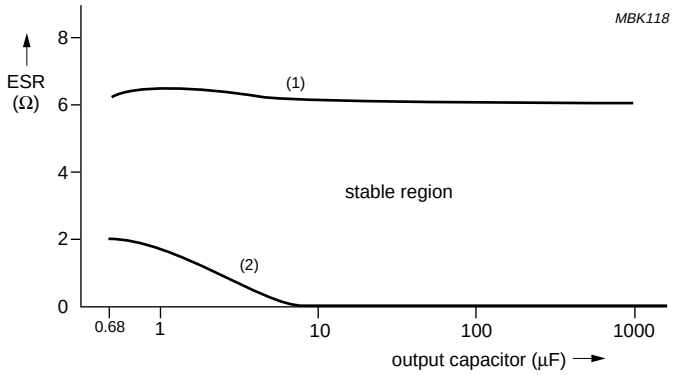
The regulator is stabilized by means of the output capacitor. The value of the output capacitor can be selected using the diagram shown in Fig.6. The following two examples show the effects of the stabilization circuit using different values for the output capacitor.

Example 1

The regulator is stabilized using an electrolytic output capacitor of 68 µF (ESR = 0.5 Ω). At –40 °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 °C.

Example 2

The regulator is stabilized using an electrolytic output capacitor of 10 µF (ESR = 3.3 Ω). At –40 °C the capacitor value is decreased to 3 µF and the ESR is increased to 23.1 Ω. The regulator will be instable at a temperature of –40 °C. This can be solved using a tantalum capacitor of 10 µF.



(1) Maximum ESR.
(2) Minimum ESR.

Fig.6 Curve for selecting the value of the output capacitor.

APPLICATION CIRCUITS

In Fig.7 the quiescent current equals $I_q + I_{Rdivider}$. The specified quiescent current equals I_q. When the supply voltage is connected, the regulator will switch on when the supply voltage exceeds 7.6 V. With the aid of a timing capacitor at pin 3 the reset can be delayed (the timer starts at the same moment as the regulator is switched on).

Forced reset can be accomplished by short-circuiting the timer capacitor by using the push button switch. When the push button is released again, the timer restarts (only when the regulator is on) causing a second reset on both RES1 and RES2.

The maximum output current of the regulator equals:

$$I_{max} = \frac{150 - T_{amb}}{R_{th\ j\text{-}a} \times (V_P - V_{REG})} = \frac{150 - T_{amb}}{155 \times (V_P - 5)} \quad (mA)$$

When T_{amb} = 85 °C, the maximum output current equals 45 mA. At lower ambient (T_{amb} < 0) temperature the maximum output current equals 100 mA.

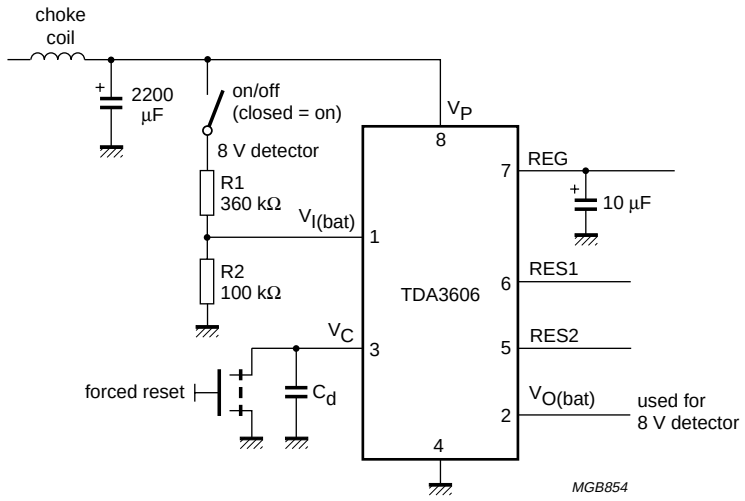
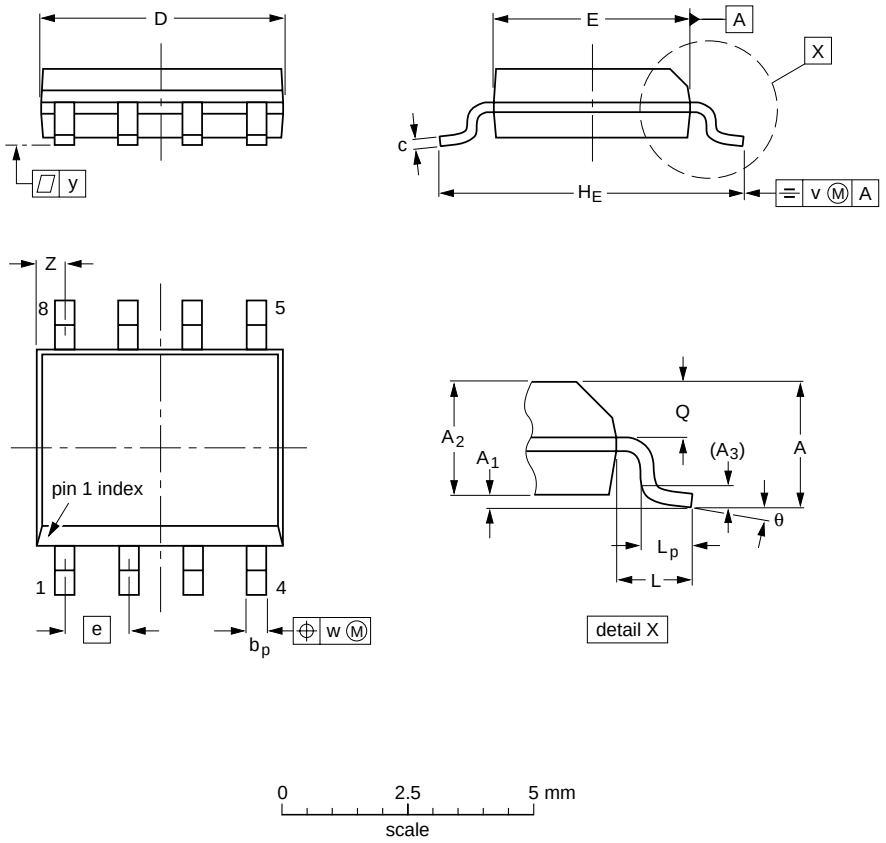


Fig.7 Typical application.

PACKAGE OUTLINE

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^o 0^o
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	0.050	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 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			
SOT96-1	076E03S	MS-012AA				~~95-02-04~~ 97-05-22

SOLDERING

Introduction

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

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"* (order code 9398 652 90011).

Reflow soldering

Reflow soldering techniques are suitable for all SO packages.

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 techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

Wave soldering

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

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.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. 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.

Repairing soldered joints

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

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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NOTES

NOTES

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