

DATA SHEET

TDA3607

Multiple voltage regulator with
switch

Preliminary specification
File under Integrated Circuits, IC01

1997 May 05

Multiple voltage regulator with switch

TDA3607

FEATURES

- Three V_P -state controlled regulators (regulator 1, regulator 2 and regulator 3)
- Separate control pins for switching regulators 1, 2 and 3
- Supply voltage range from -18 to $+50$ V
- Low quiescent current (when regulators 1, 2 and 3 are switched off)
- High ripple rejection.

PROTECTIONS

- Reverse polarity safe (down to -18 V without high reverse current)
- Able to withstand voltages up to 18 V at the outputs (supply line may be short-circuited)
- ESD protected on all pins
- Thermal protection
- Load dump protection
- Foldback current limit protection for regulators 1, 2 and 3
- DC short-circuit safe to ground and V_P for all regulator outputs.

GENERAL DESCRIPTION

The TDA3607 is a multiple output voltage regulator with three independent regulators. It contains:

1. Three fixed voltage regulators with foldback current protection (regulators 1, 2 and 3)
2. A supply pin which can withstand load dump pulses and negative supply voltages
3. Independant enable inputs for regulators 1, 2 and 3
4. Local temperature protection for regulator 3.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage operating		11	14.4	18	V
	jump start	$t \leq 10$ minutes	–	–	30	V
	load dump protection	during 50 ms; $t_r \geq 2.5$ ms	–	–	50	V
$I_{q(\text{tot})}$	total quiescent current	standby mode	–	1	40	μA
T_j	junction temperature		–	–	150	$^{\circ}\text{C}$
Voltage regulators						
V_{REG1}	output voltage regulator 1	$0.5 \text{ mA} \leq I_{\text{REG1}} \leq 1.3 \text{ A}$	8.55	9.0	9.45	V
V_{REG2}	output voltage regulator 2	$0.5 \text{ mA} \leq I_{\text{REG2}} \leq 150 \text{ mA}$; $V_P = 14.4 \text{ V}$	4.75	5.0	5.25	V
V_{REG3}	output voltage regulator 3	$0.5 \text{ mA} \leq I_{\text{REG3}} \leq 400 \text{ mA}$	4.75	5.0	5.25	V

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA3607	SIL9P	plastic single in-line power package; 9 leads	SOT131-2

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BLOCK DIAGRAM

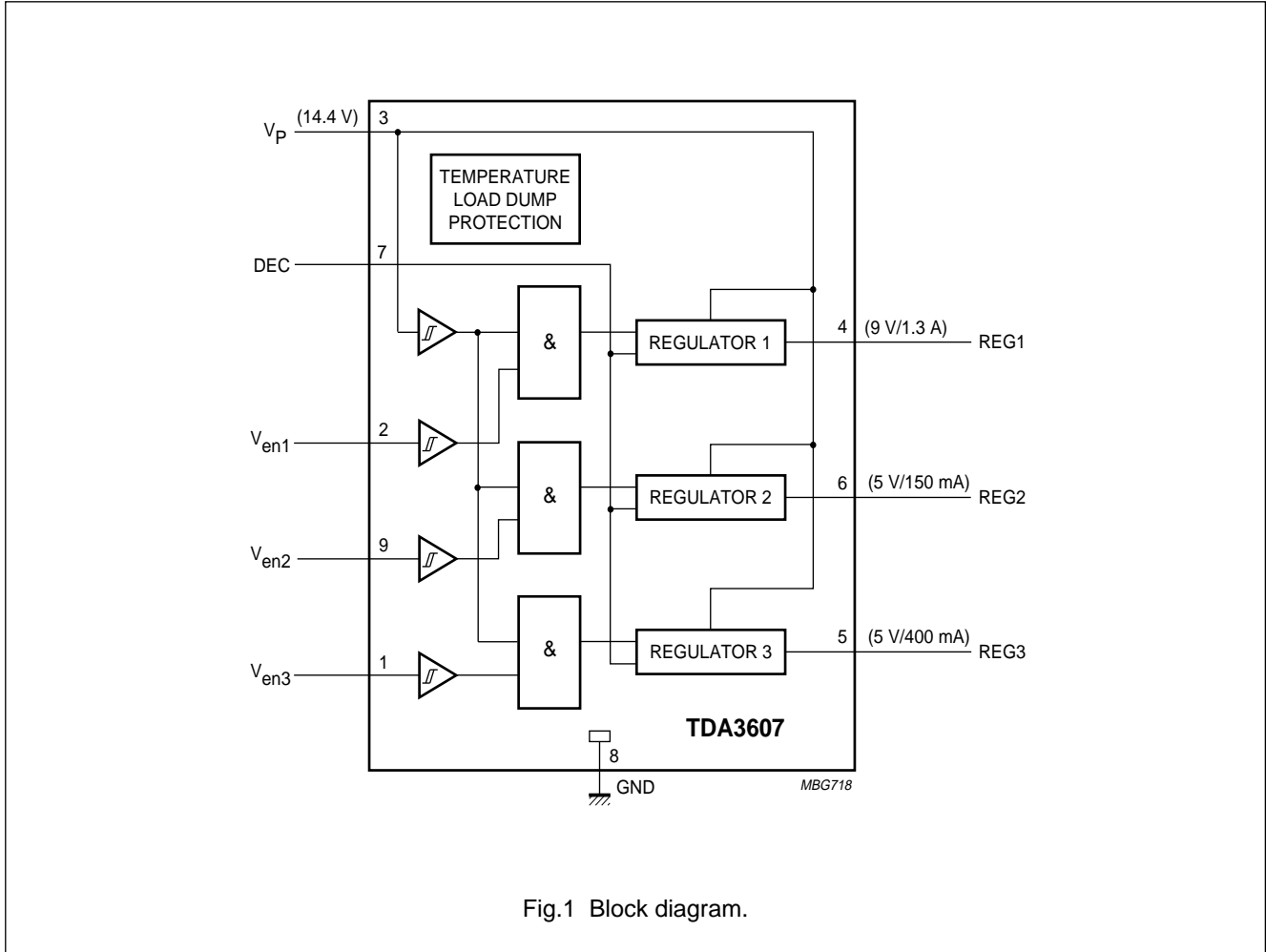


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
V _{en3}	1	enable input regulator 3
V _{en1}	2	enable input regulator 1
V _P	3	supply voltage
REG1	4	regulator 1 output
REG3	5	regulator 3 output
REG2	6	regulator 2 output
DEC	7	decoupling capacitor
GND	8	ground
V _{en2}	9	enable input regulator 2

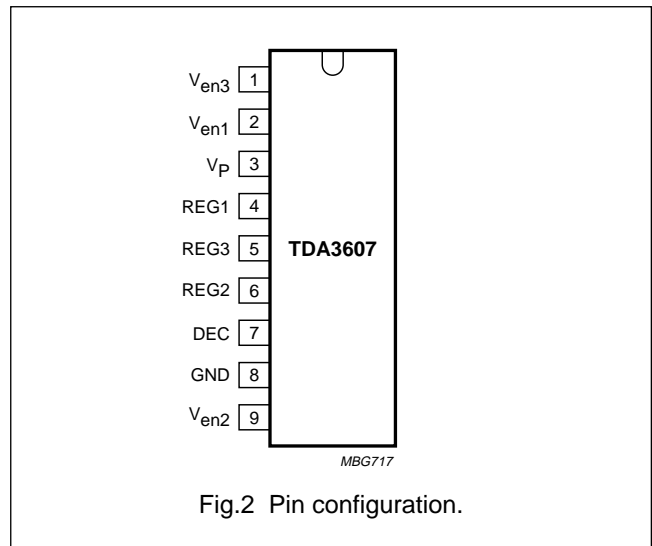


Fig.2 Pin configuration.

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FUNCTIONAL DESCRIPTION

The TDA3607 is a multiple output voltage regulator with three independent switchable regulators. When the supply voltage ($V_P > 4.5\text{ V}$) is available, regulators 1, 2 and 3 can be operated by means of 3 independent enable inputs.

Schmitt-trigger functions are included to switch-off the regulators at low battery voltage ($V_P < 4\text{ V}$). A hysteresis is included to avoid random switching.

All output pins are fully protected. The regulators are protected against load dump (regulators will switch-off at supply voltages higher than 20 V) and short-circuit (foldback current protection).

The total timing of a semi on/off logic set is shown in Fig.3.

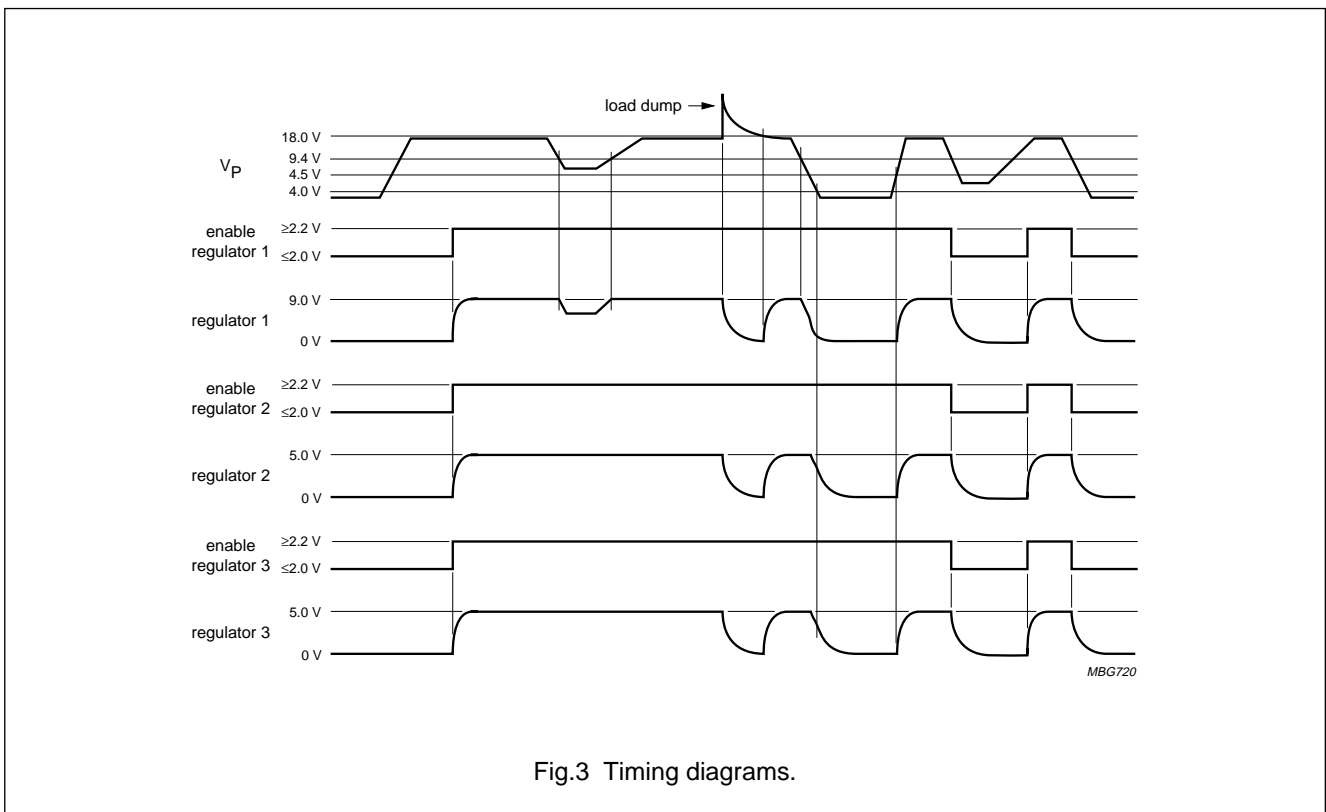


Fig.3 Timing diagrams.

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LIMITING VALUES

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V _P	supply voltage		–	18	V
	operating		–	18	V
	jump start	t ≤ 10 minutes	–	30	V
	load dump protection	during 50 ms; t _r ≥ 2.5 ms	–	50	V
V _P	reverse battery voltage	non-operating	–	–18	V
P _{tot}	total power dissipation		–	62	W
T _{stg}	storage temperature range	non-operating	–55	+150	°C
T _{amb}	ambient temperature range	operating	–40	+85	°C
T _j	junction temperature	operating	–	150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
R _{th j-c}	thermal resistance from junction to case	regulator and switch-on	2	K/W
R _{th j-a}	thermal resistance from junction to ambient in free air		50	K/W

QUALITY SPECIFICATION

In accordance with "SNW-FQ-611-E". 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; measured in test circuit of Fig.5; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies						
V _P	supply voltage					
	operating		11	14.4	18	V
	REGn on	note 1	6	14.4	18	V
	jump start	t ≤ 10 minutes	–	–	30	V
	load dump protection	during 50 ms; t _r ≥ 2.5 ms	–	–	50	V
I _q	quiescent current	V _P = 12.4 V; note 2	–	1	40	μA
		V _P = 14.4 V; note 2	–	1	–	μA
Schmitt-trigger power supply for regulators 1, 2 and 3						
V _{thr}	rising voltage threshold	V _{en} = 3 V	–	4.5	–	V
V _{thf}	falling voltage threshold	V _{en} = 3 V	–	4.1	–	V
V _{hys}	hysteresis		–	0.4	–	V

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Schmitt-trigger for enable input (regulators 1, 2 and 3)						
V_{thr}	rising voltage threshold		1.7	2.2	2.7	V
V_{thf}	falling voltage threshold		1.5	2.0	2.5	V
V_{hys}	hysteresis		0.1	0.2	0.5	V
I_{LI}	input leakage current	$V_{en} = 5\text{ V}$	5	30	50	μA
Regulator 1 ($I_{REG1} = 5\text{ mA}$)						
$V_{REG1(off)}$	output voltage off		–	1	400	mV
V_{REG1}	output voltage	$1\text{ mA} \leq I_{REG1} \leq 1.3\text{ A}$	8.55	9.0	9.45	V
		$10.5\text{ V} \leq V_P \leq 18\text{ V}$	8.55	9.0	9.45	V
ΔV_{REG1}	line regulation	$10.5\text{ V} \leq V_P \leq 18\text{ V}$	–	–	50	mV
ΔV_{REGL1}	load regulation	$1\text{ mA} \leq I_{REG1} \leq 1.3\text{ A}$	–	–	100	mV
I_{qREG1}	quiescent current	$I_{REG1} = 1.3\text{ A}$	–	45	110	mA
SVRR1	supply voltage ripple rejection	$f = 3\text{ kHz}; V_{i(p-p)} = 2\text{ V}$	60	70	–	dB
V_{REGd1}	drop-out voltage	$I_{REG1} = 1.3\text{ A}$; note 3	–	0.5	1.3	V
I_{REGm1}	current limit	$V_{REG1} > 7.5\text{ V}$; note 4	1.3	–	–	A
I_{REGsc1}	short-circuit current	$R_L \leq 0.5\ \Omega$; note 5	250	900	–	mA
α_{ct}	cross talk noise	note 6	–	25	150	μV
Regulator 2 ($I_{REG2} = 5\text{ mA}$)						
$V_{REG2(off)}$	output voltage off		–	1	400	mV
V_{REG2}	output voltage	$0.5\text{ mA} \leq I_{REG2} \leq 150\text{ mA}$	4.75	5.0	5.25	V
		$7\text{ V} \leq V_P \leq 18\text{ V}$	4.75	5.0	5.25	V
ΔV_{REG2}	line regulation	$7\text{ V} \leq V_P \leq 18\text{ V}$	–	–	50	mV
ΔV_{REGL2}	load regulation	$0.5\text{ mA} \leq I_{REG2} \leq 150\text{ mA}$	–	–	50	mV
I_{qREG2}	quiescent current	$I_{REG2} = 0.15\text{ A}$	–	5	15	mA
SVRR2	supply voltage ripple rejection	$f = 3\text{ kHz}; V_{i(p-p)} = 2\text{ V}$	60	70	–	dB
V_{REGd2}	drop-out voltage	$I_{REG2} = 100\text{ mA}; V_P = 5\text{ V}$; note 3	–	0.15	1.5	V
I_{REGm2}	current limit	$V_{REG2} > 4\text{ V}$; note 4	0.3	0.9	–	A
I_{REGsc2}	short-circuit current	$R_L \leq 0.5\ \Omega$; note 5	20	250	–	mA
α_{ct}	cross talk noise	note 6	–	25	100	μV

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Regulator 3 ($I_{REG3} = 5 \text{ mA}$)						
$V_{REG3(off)}$	output voltage off		–	1	400	mV
V_{REG3}	output voltage	$1 \text{ mA} \leq I_{REG3} \leq 400 \text{ mA}$	4.75	5.0	5.25	V
		$7 \text{ V} \leq V_P \leq 18 \text{ V}$	4.75	5.0	5.25	V
ΔV_{REG3}	line regulation	$7 \text{ V} \leq V_P \leq 18 \text{ V}$	–	–	50	mV
ΔV_{REGL3}	load regulation	$1 \text{ mA} \leq I_{REG3} \leq 400 \text{ mA}$	–	20	50	mV
I_{qREG3}	quiescent current	$I_{REG3} = 0.4 \text{ A}$	–	10	40	mA
SVRR3	supply voltage ripple rejection	$f = 3 \text{ kHz}; V_{i(p-p)} = 2 \text{ V}$	60	70	–	dB
V_{REGd3}	drop-out voltage	$I_{REG3} = 400 \text{ mA}; V_P = 9 \text{ V};$ note 3	–	0.45	1.5	V
I_{REGm3}	current limit	$V_{REG3} > 4 \text{ V};$ note 4	0.45	0.9	–	A
I_{REGsc3}	short circuit current	$R_L \leq 0.5 \Omega;$ note 5	100	300	–	mA
α_{ct}	cross talk noise	note 6	–	25	100	μV

Notes

1. Minimum operating voltage, only if V_P has exceeded 4.5 V.
2. The quiescent current is measured in the standby mode. So, the enable inputs of regulator 1, 2 and 3 are LOW ($V_{en} < 1 \text{ V}$).
3. The drop-out voltage of regulators 1, 2 and 3 is measured between V_P and V_{REGn} .
4. At current limit, I_{REGmn} is held constant (see Fig.4 for behaviour of I_{REGmn}).
5. The foldback current protection limits the dissipated power at short-circuit (see Fig.4).
6. Perform the load regulation test with sine wave load of 10 kHz on the regulator output under test. Measure the RMS ripple voltage on each of the remaining regulator outputs, using a 80 kHz low-pass filter.

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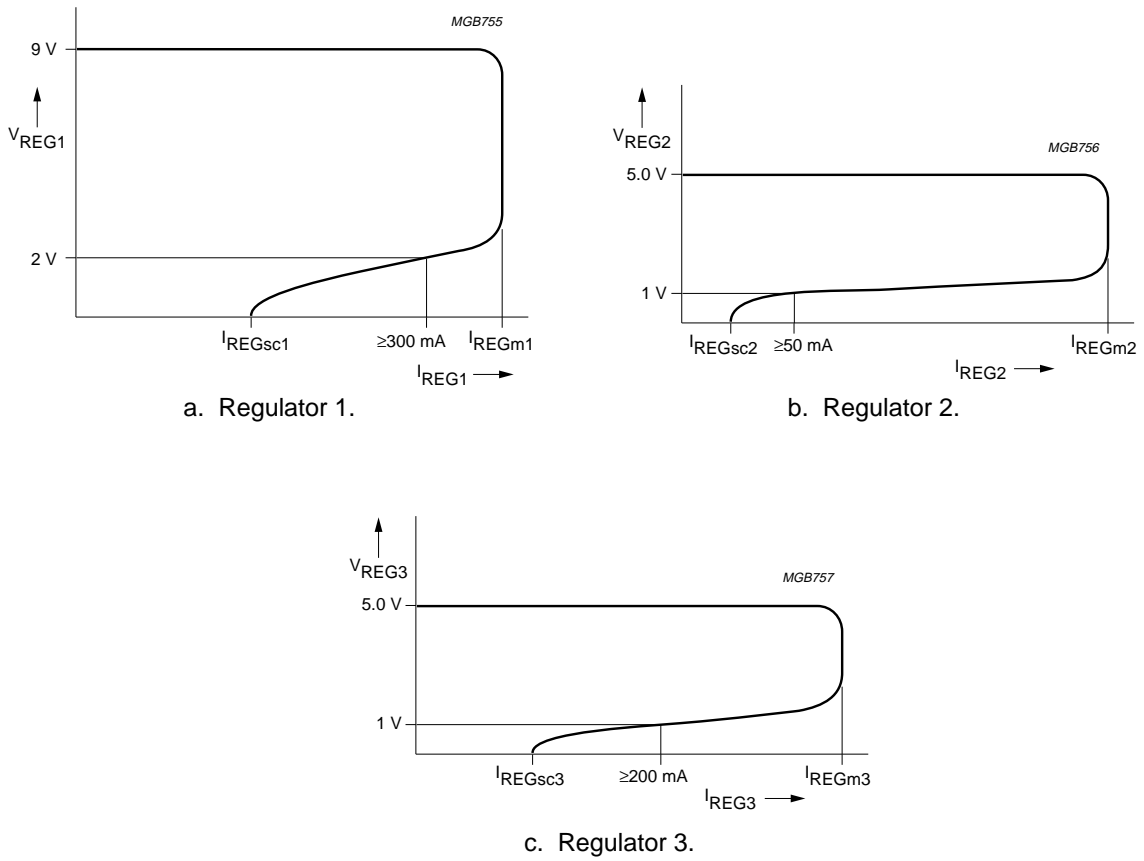


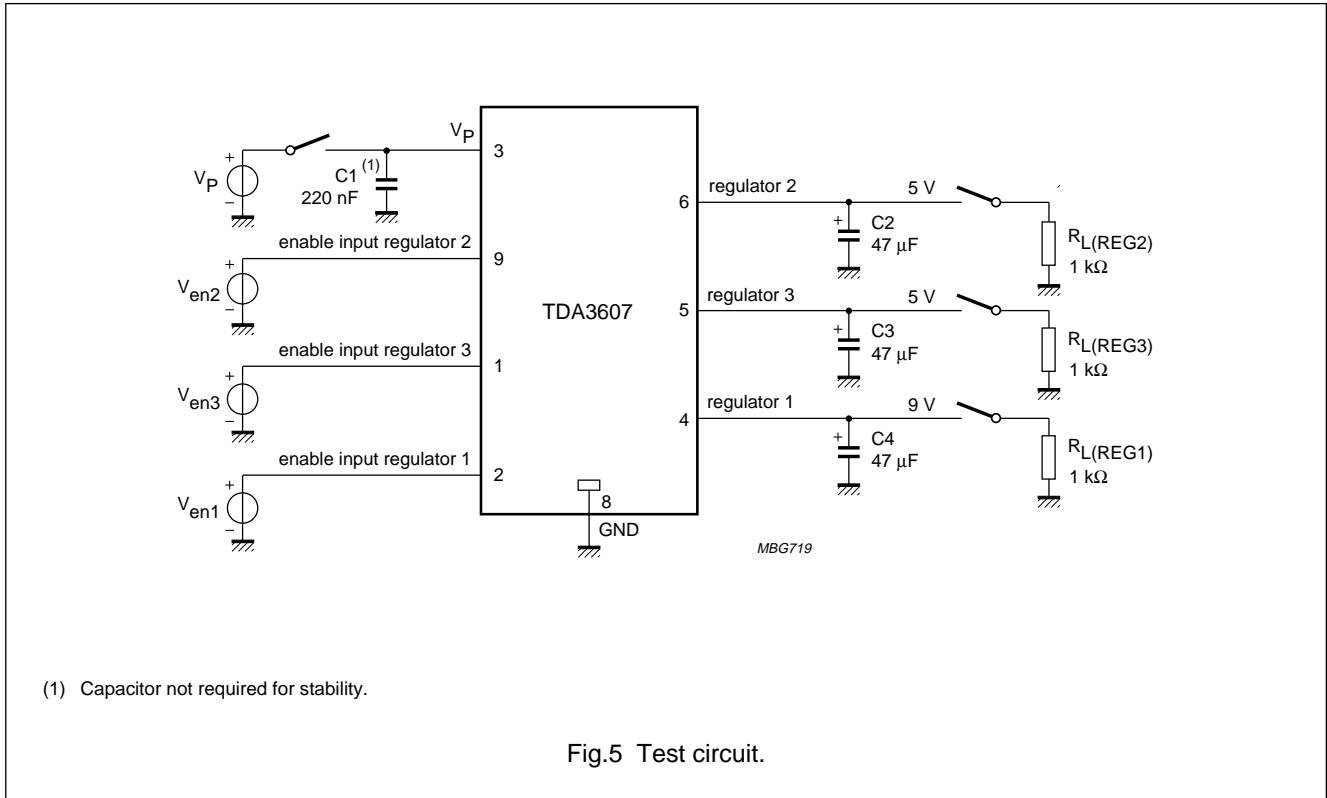
Fig.4 Foldback current protection for regulators 1, 2 and 3.

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TEST AND APPLICATION INFORMATION

Test information



Application information

NOISE

Table 1 Noise figures

REGULATOR	NOISE FIGURE (μV) ⁽¹⁾		
	at OUTPUT CAPACITOR (μF)		
	10	47	100
1	–	150	–
2	–	150	–
3	–	200	–

Note

1. Measured at a bandwidth of 200 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 regulators is translated into a current noise by means of the output capacitors).

When a high frequency capacitor of 220 nF in parallel with an electrolytic capacitor of 100 μF is connected directly to pins 3 and 8 (supply and ground) the noise is minimal.

STABILITY

The regulators are made stable with the externally connected output capacitors. The value of the output capacitors can be selected by referring to the graphs illustrated in Figs 6 and 7.

When an electrolytic capacitor is used the temperature behaviour of this output capacitor can cause oscillations at cold temperature.

The following two examples explain how an output capacitor value is selected.

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Example 1

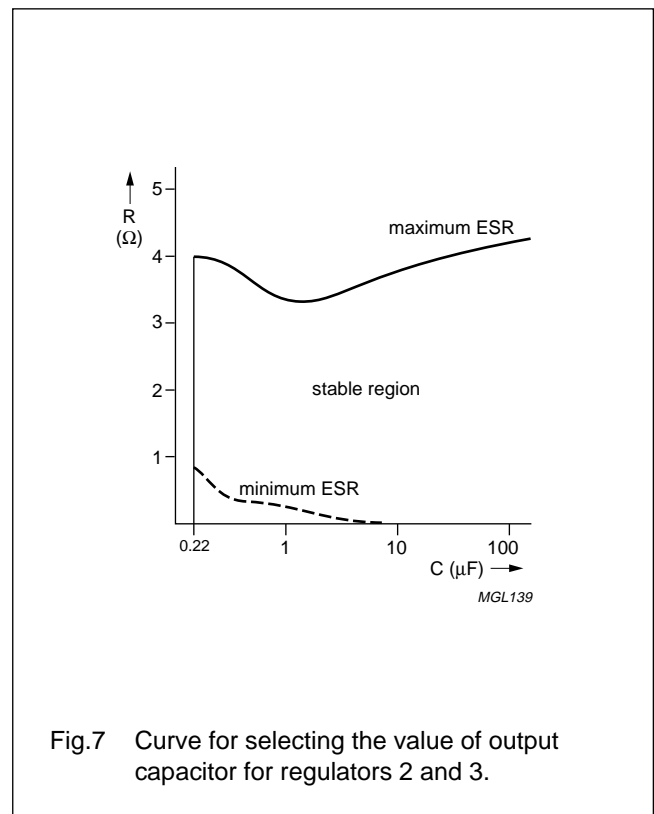
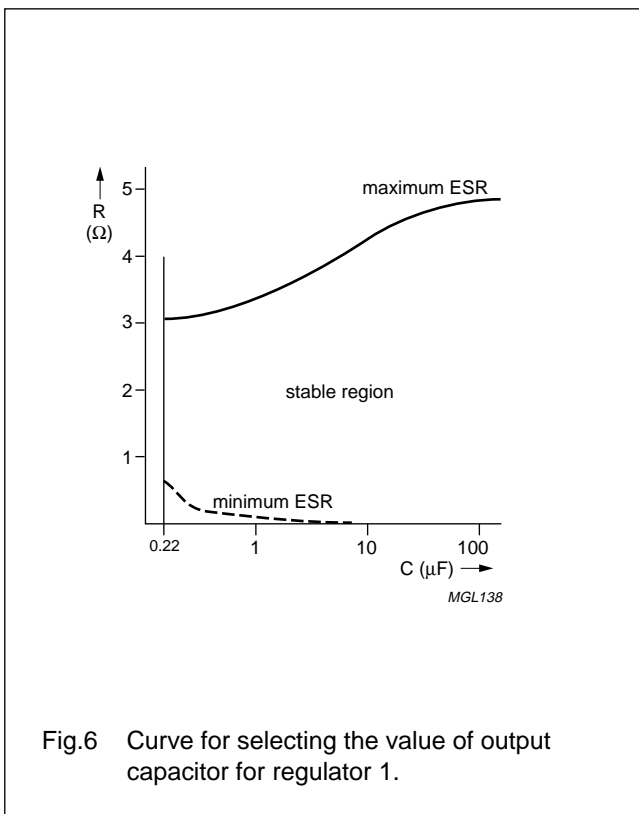
Regulator 1 is made stable with an electrolytic output capacitor of 68 μF (ESR = 0.5 Ω), at $-30\text{ }^\circ\text{C}$ the capacitor value is decreased to 22 μF and the ESR is increased to 3.5 Ω . The regulator will remain stable at $-30\text{ }^\circ\text{C}$.

Example 2

Regulator 2 is made stable with a 10 μF electrolytic capacitor (ESR = 3.3 Ω), at $-30\text{ }^\circ\text{C}$ the capacitor value is decreased to 3 μF and the ESR is increased to 23.1 Ω . The regulator will be unstable at $-30\text{ }^\circ\text{C}$ (see Fig.7).

Solution

Use a tantalum capacitor of 10 μF or a large electrolytic capacitor. The use tantalum capacitors is recommended to avoid problems with stability at cold temperatures.



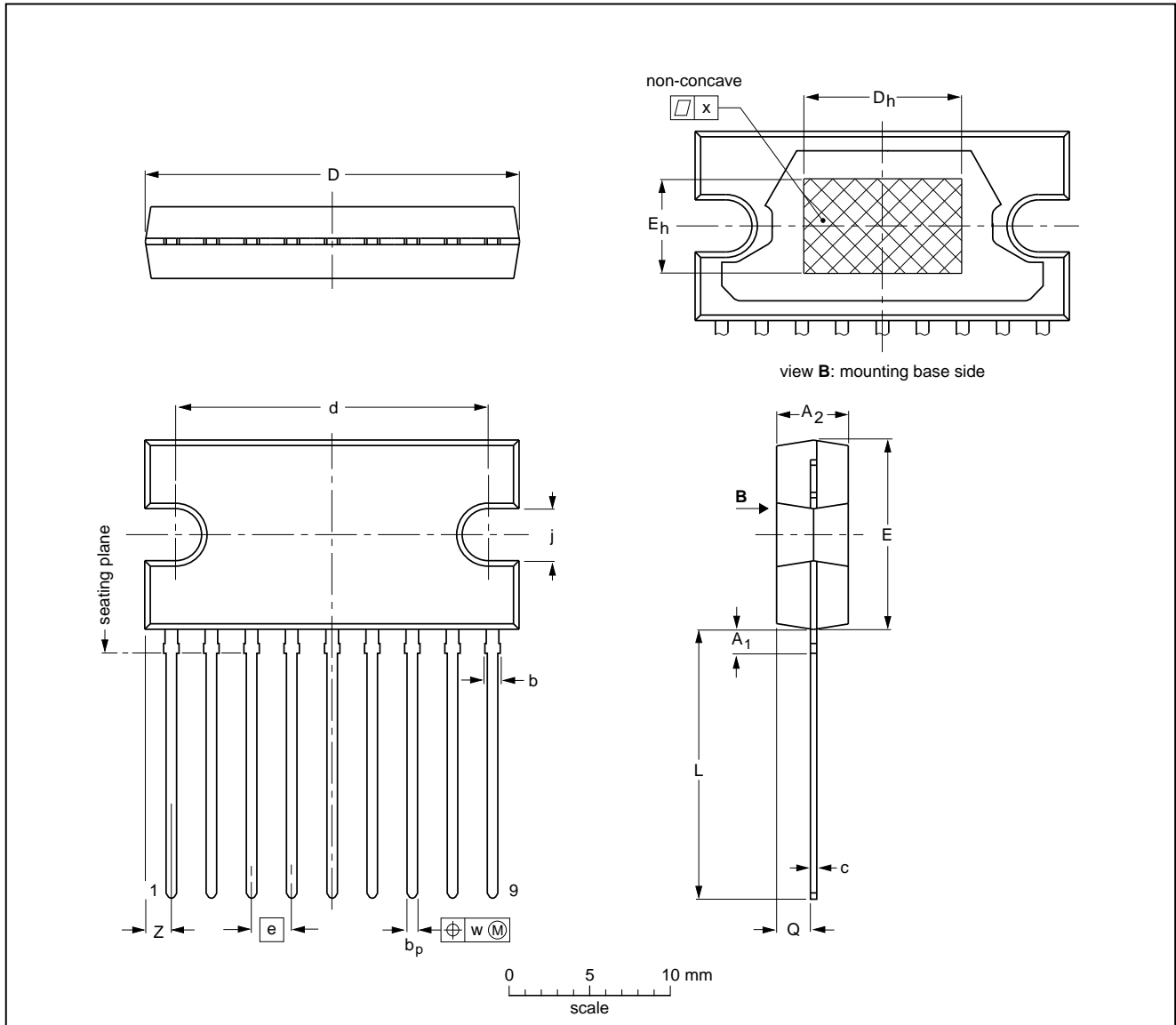
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PACKAGE OUTLINE

SIL9P: plastic single in-line power package; 9 leads

SOT131-2



DIMENSIONS (mm are the original dimensions)

UNIT	A ₁ max.	A ₂	b max.	b _p	c	D ⁽¹⁾	d	D _h	E ⁽¹⁾	e	E _h	j	L	Q	w	x	z ⁽¹⁾
mm	2.0	4.6 4.2	1.1	0.75 0.60	0.48 0.38	24.0 23.6	20.0 19.6	10	12.2 11.8	2.54	6	3.4 3.1	17.2 16.5	2.1 1.8	0.25	0.03	2.00 1.45

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT131-2						92-11-17 95-03-11

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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 "IC Package Databook" (order code 9398 652 90011).

Soldering by dipping or by wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

Repairing soldered joints

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

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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Printed in The Netherlands

547027/1200/01/pp16

Date of release: 1997 May 05

Document order number: 9397 750 02272

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