DATA SHEET

TDA3607
Multiple voltage regulator with switch

Preliminary specification
File under Integrated Circuits, IC01

1997 May 05

Philips Semiconductors

PHILIPS

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 ≤ 10 minutes	–	–	30	V
	load dump protection	during 50 ms; t_r ≥ 2.5 ms	–	–	50	V
$I_{q(tot)}$	total quiescent current	standby mode	–	1	40	μA
T_j	junction temperature		–	–	150	°C
Voltage regulators						
V_{REG1}	output voltage regulator 1	0.5 mA ≤ I_{REG1} ≤ 1.3 A	8.55	9.0	9.45	V
V_{REG2}	output voltage regulator 2	0.5 mA ≤ I_{REG2} ≤ 150 mA; V_P = 14.4 V	4.75	5.0	5.25	V
V_{REG3}	output voltage regulator 3	0.5 mA ≤ I_{REG3} ≤ 400 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

BLOCK DIAGRAM

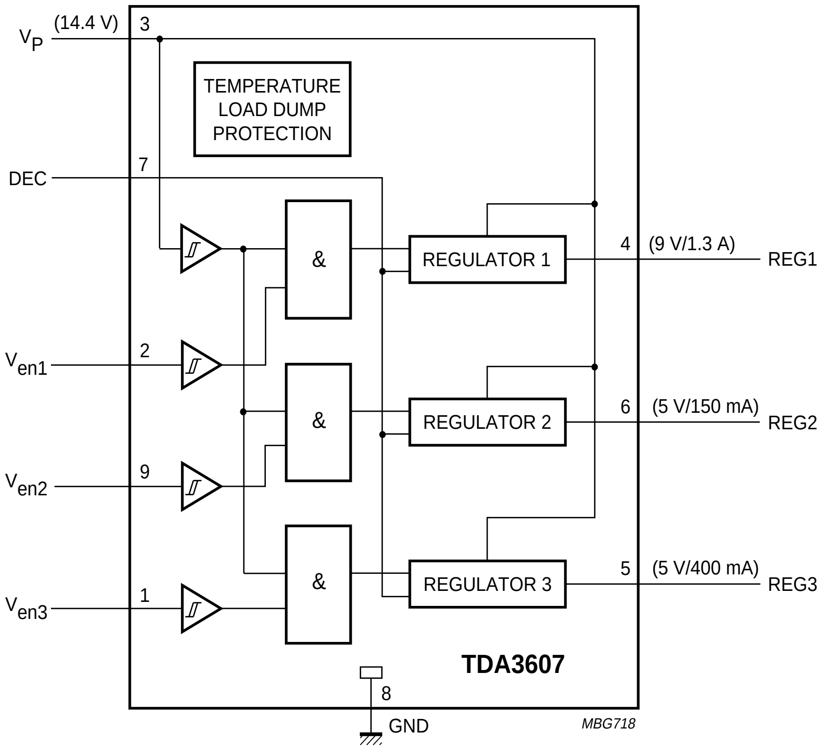


Fig.1 Block diagram.

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

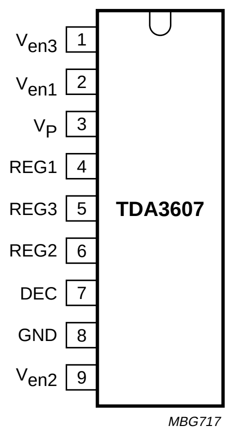


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA3607 is a multiple output voltage regulator with three independent switchable regulators. When the supply voltage (V_P > 4.5 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 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.

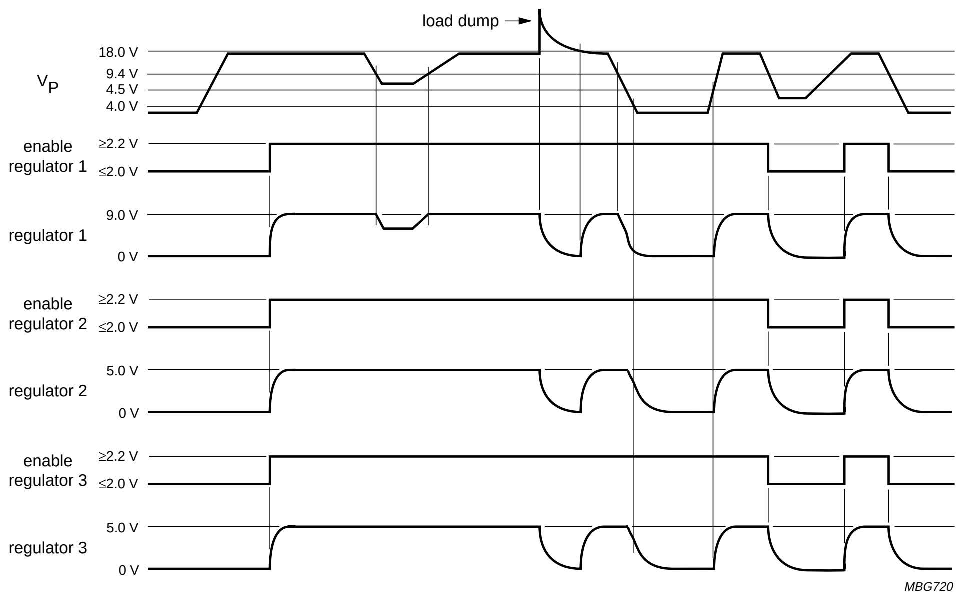


Fig.3 Timing diagrams.

LIMITING VALUES

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage				
	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
$R_{th\ j\text{-}c}$	thermal resistance from junction to case	regulator and switch-on	2	K/W
$R_{th\ j\text{-}a}$	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.

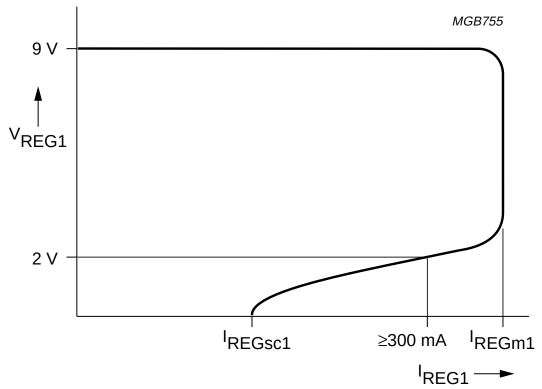
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies						
V_P	supply voltage					
	operating		11	14.4	18	V
	REGn on	note 1	6	14.4	18	V
	jump start	t ≤ 10 minutes	–	–	30	V
	load dump protection	during 50 ms; t_r ≥ 2.5 ms	–	–	50	V
I_q	quiescent current	V_P = 12.4 V; note 2	–	1	40	µA
		V_P = 14.4 V; 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

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 V	5	30	50	μA
Regulator 1 (I_{REG1} = 5 mA)						
$V_{REG1(off)}$	output voltage off		–	1	400	mV
V_{REG1}	output voltage	1 mA ≤ I_{REG1} ≤ 1.3 A	8.55	9.0	9.45	V
		10.5 V ≤ V_P ≤ 18 V	8.55	9.0	9.45	V
ΔV_{REG1}	line regulation	10.5 V ≤ V_P ≤ 18 V	–	–	50	mV
ΔV_{REGL1}	load regulation	1 mA ≤ I_{REG1} ≤ 1.3 A	–	–	100	mV
I_{qREG1}	quiescent current	I_{REG1} = 1.3 A	–	45	110	mA
SVRR1	supply voltage ripple rejection	f = 3 kHz; $V_{i(p-p)}$ = 2 V	60	70	–	dB
V_{REGd1}	drop-out voltage	I_{REG1} = 1.3 A; note 3	–	0.5	1.3	V
I_{REGm1}	current limit	V_{REG1} > 7.5 V; note 4	1.3	–	–	A
I_{REGsc1}	short-circuit current	R_L ≤ 0.5 Ω; note 5	250	900	–	mA
α_{ct}	cross talk noise	note 6	–	25	150	μV
Regulator 2 (I_{REG2} = 5 mA)						
$V_{REG2(off)}$	output voltage off		–	1	400	mV
V_{REG2}	output voltage	0.5 mA ≤ I_{REG2} ≤ 150 mA	4.75	5.0	5.25	V
		7 V ≤ V_P ≤ 18 V	4.75	5.0	5.25	V
ΔV_{REG2}	line regulation	7 V ≤ V_P ≤ 18 V	–	–	50	mV
ΔV_{REGL2}	load regulation	0.5 mA ≤ I_{REG2} ≤ 150 mA	–	–	50	mV
I_{qREG2}	quiescent current	I_{REG2} = 0.15 A	–	5	15	mA
SVRR2	supply voltage ripple rejection	f = 3 kHz; $V_{i(p-p)}$ = 2 V	60	70	–	dB
V_{REGd2}	drop-out voltage	I_{REG2} = 100 mA; V_P = 5 V; note 3	–	0.15	1.5	V
I_{REGm2}	current limit	V_{REG2} > 4 V; note 4	0.3	0.9	–	A
I_{REGsc2}	short-circuit current	R_L ≤ 0.5 Ω; note 5	20	250	–	mA
α_{ct}	cross talk noise	note 6	–	25	100	μV

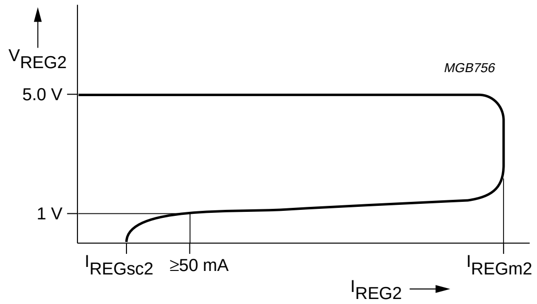
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Regulator 3 (I_{REG3} = 5 mA)						
$V_{REG3(off)}$	output voltage off		–	1	400	mV
V_{REG3}	output voltage	1 mA ≤ I_{REG3} ≤ 400 mA	4.75	5.0	5.25	V
		7 V ≤ V_P ≤ 18 V	4.75	5.0	5.25	V
ΔV_{REG3}	line regulation	7 V ≤ V_P ≤ 18 V	–	–	50	mV
ΔV_{REGL3}	load regulation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

Notes

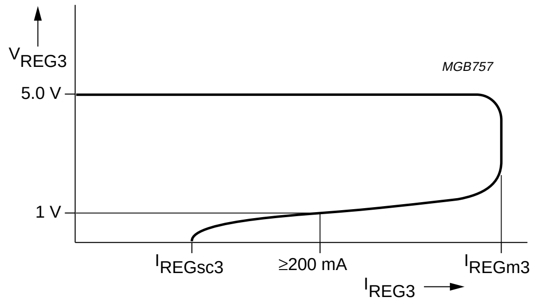
1. Minimum operating voltage, only if V_P has exceeded 4.5 V.
2. The quiescent current is measured in the standby mode. So, the enable inputs of regulator 1, 2 and 3 are LOW (V_{en} < 1 V).
3. The drop-out voltage of regulators 1, 2 and 3 is measured between V_P and V_{REGn}.
4. At current limit, I_{REGmn} 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.



a. Regulator 1.



b. Regulator 2.

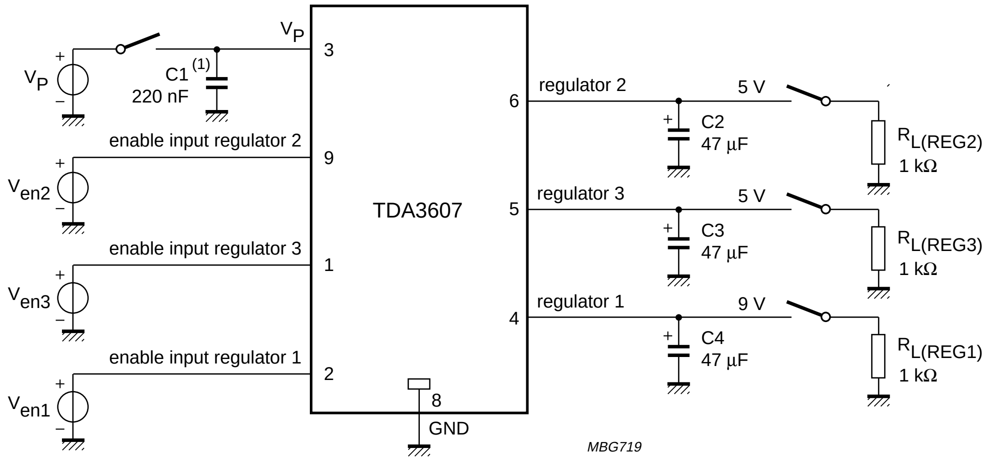


c. Regulator 3.

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

TEST AND APPLICATION INFORMATION

Test information



(1) Capacitor not required for stability.

Fig.5 Test circuit.

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.

Example 1

Regulator 1 is made stable with an electrolytic output capacitor of 68 µF (ESR = 0.5 Ω), at –30 °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 °C.

Example 2

Regulator 2 is made stable with a 10 µF electrolytic capacitor (ESR = 3.3 Ω), at –30 °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 °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.

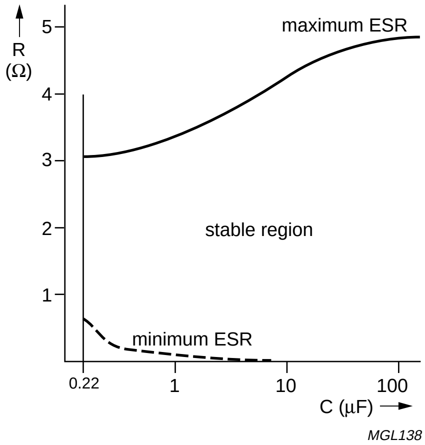


Fig.6 Curve for selecting the value of output capacitor for regulator 1.

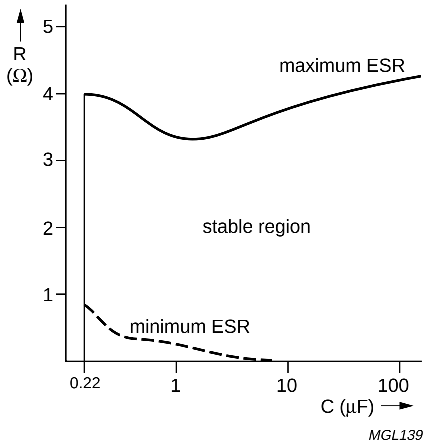
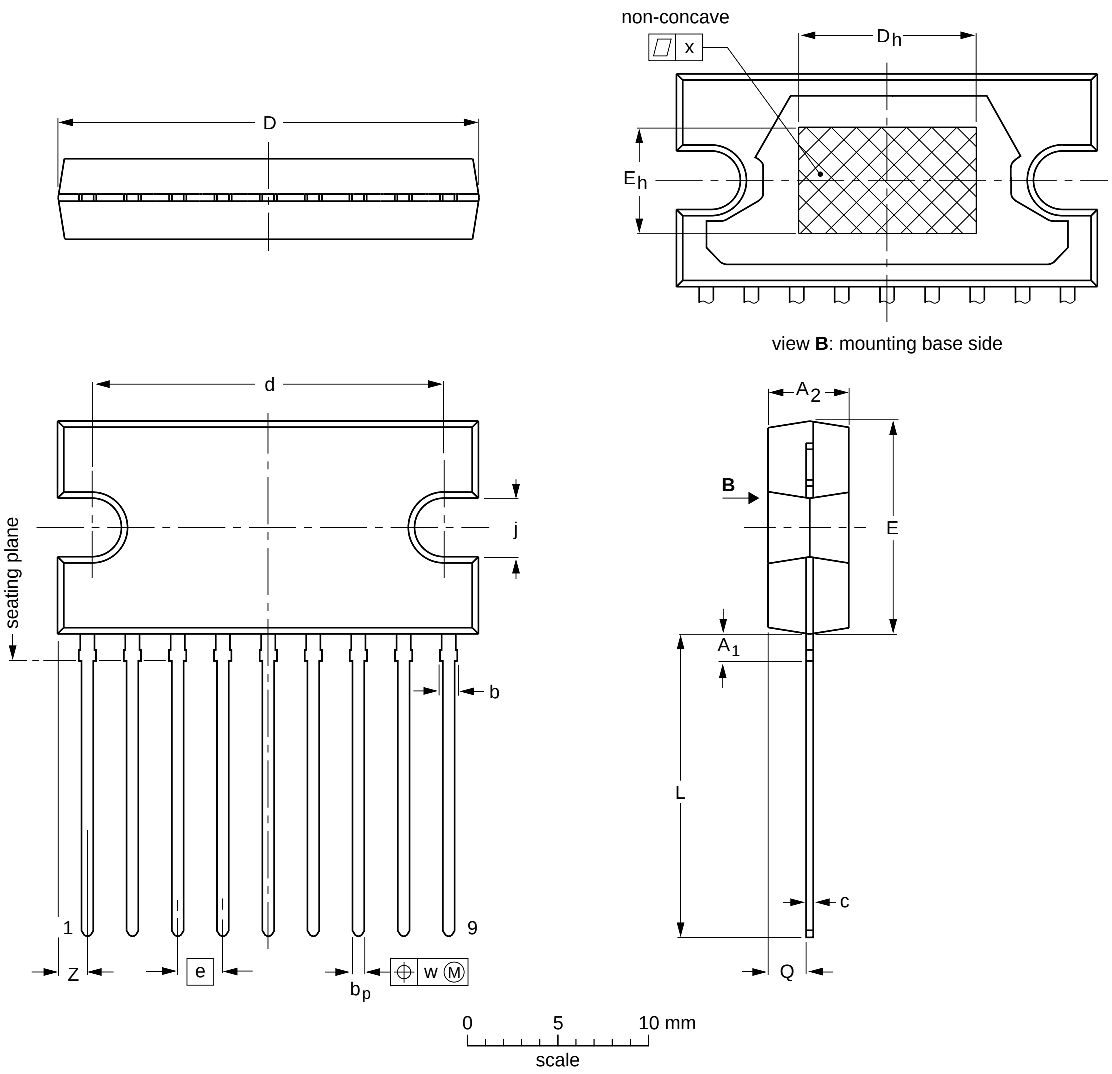


Fig.7 Curve for selecting the value of output capacitor for regulators 2 and 3.

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

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.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

NOTES

NOTES

NOTES

Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTH RYDE, NSW 2113,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213,
Tel. +43 1 60 101, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 689 211, Fax. +359 2 689 102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,
Tel. +45 32 88 2636, Fax. +45 31 57 0044

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615800, Fax. +358 9 61580920

France: 4 Rue du Port-aux-Vins, BP317, 92156 SURESNES Cedex,
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +30 1 4894 339/239, Fax. +30 1 4814 240

Hungary: see Austria

India: Philips INDIA Ltd, Shivsagar Estate, A Block, Dr. Annie Besant Rd.
Worli, MUMBAI 400 018, Tel. +91 22 4938 541, Fax. +91 22 4938 722

Indonesia: see Singapore

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,
Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZAWA,
Tel. +48 22 612 2831, Fax. +48 22 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 1231,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

South America: Rua do Rocio 220, 5th floor, Suite 51,
04552-903 São Paulo, SÃO PAULO - SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 829 1849

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 3 301 6312, Fax. +34 3 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 632 2000, Fax. +46 8 632 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2686, Fax. +41 1 481 7730

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2865, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 625 344, Fax.+381 11 635 777

For all other countries apply to: Philips Semiconductors, Marketing & Sales Communications,
Building BE-p, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

Internet: http://www.semiconductors.philips.com

Printed in The Netherlands 547027/1200/01/pp16 Date of release: 1997 May 05 Document order number: 9397 750 02272

Let's make things better.

Philips Semiconductors

PHILIPS