

DATA SHEET

TDA3616

Multiple voltage regulator with
battery detection

Objective specification
Supersedes data of 1998 Jul 22
File under Integrated Circuits, IC01

2000 Jan 14

Multiple voltage regulator with battery detection

TDA3616

FEATURES

General

- One V_P -state controlled regulator
- Battery detection circuit
- Regulator, reset and battery outputs operate during load dump
- Supply voltage range from -18 to $+50$ V
- Low quiescent current (battery detection switched off)
- High ripple rejection
- Dual reset output
- Backup circuit
- Adjustable reset delay timer.

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
- The regulator output is DC short-circuited safe to ground and V_P .

GENERAL DESCRIPTION

The TDA3616 is a low power voltage regulator. It contains the following:

- One fixed voltage regulator with a foldback current protection, intended to supply a microprocessor, that also operates during load dump
- A provision for use of a reserve supply capacitor that will hold enough energy for the regulator to allow a microcontroller to prepare for loss of supply voltage
- Reset signals which can be used to interface with the microprocessor
- A supply pin that can withstand load dump pulses and negative supply voltages
- Defined start-up behaviour; regulator will be switched on at a supply voltage higher than 7.5 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 ≤ 10 minutes	–	–	30	V
	load dump protection	t ≤ 50 ms; t _r ≥ 2.5 ms	–	–	50	V
I _q	quiescent supply current	standby mode	–	95	125	μA
		standby mode; T _{amb} = 25 °C	–	95	120	μA
Regulator						
V _O	output voltage	0.5 mA ≤ I _{REG} ≤ 150 mA; 7 V ≤ V _P ≤ 18 V; T _{amb} = 25 °C	4.8	5.0	5.2	V
		0.5 mA ≤ I _{REG} ≤ 150 mA; 7 V ≤ V _P ≤ 18 V	4.75	5.0	5.25	V
		I _{REG} = 30 mA; 18 V ≤ V _P ≤ 50 V; load dump	4.75	5.0	5.25	V
V _{drop}	drop-out voltage	I _{REG} = 150 mA; V _P = 5 V; T _{amb} = 25 °C	–	0.6	1.0	V

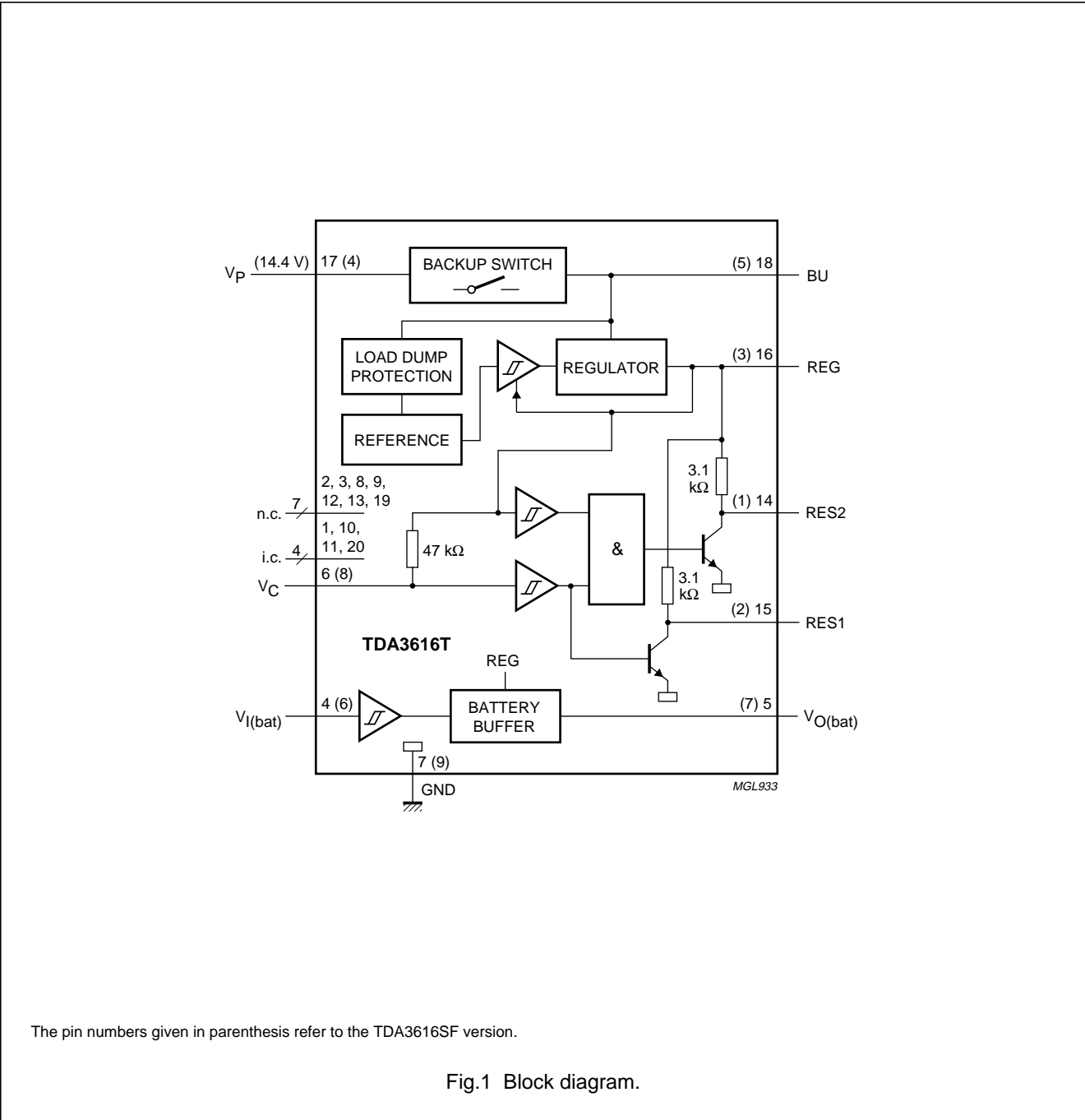
Multiple voltage regulator with battery detection

TDA3616

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA3616T	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1
TDA3616SF	SIL9MP	plastic single in-line medium power package with fin; 9 leads	SOT110-1

BLOCK DIAGRAM



Multiple voltage regulator with battery detection

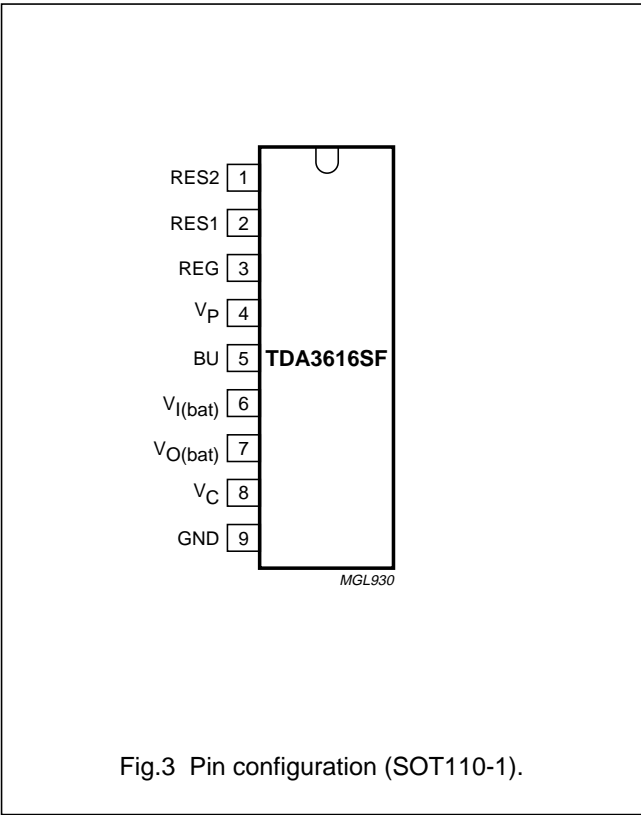
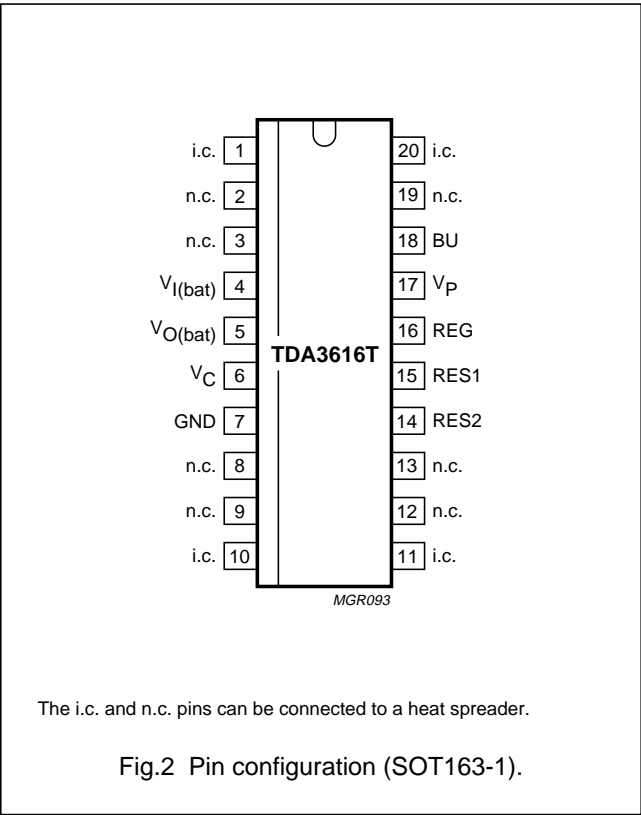
TDA3616

PINNING

SYMBOL	PIN		DESCRIPTION
	SOT163-1	SOT110-1	
i.c.	1, 10, 11, and 20	–	interconnected; heat spreader; note 1
n.c.	2, 3, 8, 9, 12, 13 and 19	–	not connected; heat spreader
$V_{I(bat)}$	4	6	battery input voltage
$V_{O(bat)}$	5	7	battery detection output voltage
V_C	6	8	reset delay capacitor
GND	7	9	ground (0 V)
RES2	14	1	reset 2 output
RES1	15	2	reset 1 output
REG	16	3	regulator output
V_P	17	4	supply voltage
BU	18	5	backup

Note

1. The i.c. pins are connected to each other by the leadframe and can be kept floating or can be connected to ground.



Multiple voltage regulator with battery detection

TDA3616

FUNCTIONAL DESCRIPTION

The TDA3616 (see Fig.1) 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.

This regulator will switch-on when the backup voltage (see Section "Backup circuit") 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.

Pin RES1 will go HIGH via an internal pull-up resistor of 3.1 k Ω , and is used to initialize the microprocessor. Pin 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.

The charge of the backup capacitor can be used to supply the regulator and logic circuits for a short period of time when the supply falls to 0 V (the time depends on the value of the storage capacitor). The regulator is switched off at a backup voltage of approximately 2.7 V. From this time onwards, the backup charge will only be used for maintaining reset functions. Due to this, the reset outputs will remain LOW until the output of the regulator is dropped to 0 V.

All output pins are fully protected. The regulator is protected against load dump and short-circuit (foldback current protection). At load dump, the battery detection circuit will remain operating.

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.

The timing diagrams are shown in Fig.4.

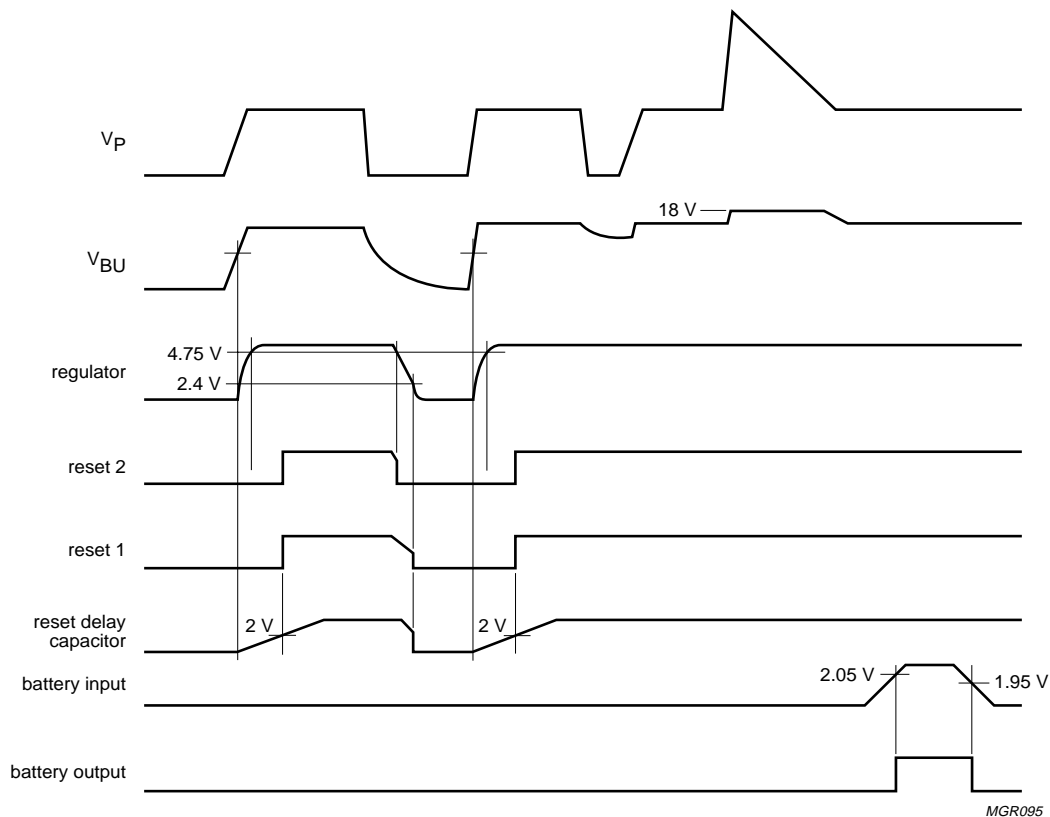


Fig.4 Timing diagrams.

Multiple voltage regulator with battery detection

TDA3616

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	$t \leq 50$ ms; $t_r \geq 2.5$ ms	–	50	V
V_{rp}	reverse polarity voltage	non-operating	–	–18	V
$V_{l(bat)p}$	positive pulse voltage at battery input	$V_P = 14.4$ V; $R_I = 5$ k Ω	–	50	V
$V_{l(bat)n}$	negative pulse voltage at battery input	$V_P = 14.4$ V; $R_I = 10$ k Ω ; $C_I = 1$ nF	–	–100	V
P_{tot}	total power dissipation	$V_P = 12.4$ V	–	2.5	W
T_{stg}	storage temperature	non-operating	–55	+150	°C
T_{amb}	ambient temperature	operating	–40	+105	°C
T_j	junction temperature	operating	–40	+150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-p)}$	thermal resistance from junction to pin/tab			
	TDA3616T		20	K/W
	TDA3616SF		12	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient			
	TDA3616T	10 cm ² 2-sided copper area connected to pins	50	K/W
	TDA3616SF	in free air	50	K/W

QUALITY SPECIFICATION

Quality specification in accordance with “SNW-FQ-611E”.

Multiple voltage regulator with battery detection

TDA3616

CHARACTERISTICS

$V_P = 14.4\text{ V}$; $I_{REG} = 0.5\text{ mA}$; $-40\text{ }^{\circ}\text{C} < T_{amb} < +105\text{ }^{\circ}\text{C}$; measurements taken in test circuit of Fig.7; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V _P	supply voltage	regulator on; note 1	5.6	14.4	25	V
	operating	t ≤ 10 minutes	–	–	30	V
	jump start	t ≤ 50 ms; t _r ≥ 2.5 ms	–	–	50	V
I _q	quiescent supply current	V _P = 12.4 V; T _{amb} = 25 °C; note 2	–	95	120	μA
		V _P = 12.4 V; note 2	–	95	125	μA
		V _P = 14.4 V; note 2	–	100	–	μA
		V _P = 50 V; load dump	–	5	20	mA
Schmitt trigger for regulator and reset 1						
V _{th(r)}	rising threshold voltage	R _{L(REG)} = 1 kΩ	6.2	7.5	8.1	V
V _{th(f)}	falling threshold voltage	I _{REG} = 5 mA	2.1	2.4	2.7	V
		I _{REG} = 30 mA	–	2.25	–	V
V _{hys}	hysteresis voltage		–	5.1	–	V
Schmitt trigger for battery detection						
V _{th(r)}	rising threshold voltage	T _{amb} = 25 °C	2.0	2.1	2.2	V
			2.0	2.1	2.25	V
V _{th(f)}	falling threshold voltage	T _{amb} = 25 °C	1.9	2.0	2.1	V
			1.9	2.0	2.15	V
V _{hys}	hysteresis voltage		–	0.1	–	V
Schmitt trigger for reset 2						
V _{th(r)}	rising threshold voltage	note 3	4.55	4.8	5.05	V
V _{th(f)}	falling threshold voltage	note 3	4.5	4.75	5.0	V
V _{hys}	hysteresis voltage		–	0.05	–	V
ΔV _{track}	voltage tracking with V _{REG}	I _{sink} = 0 mA; note 4	–65	0	+65	mV
Reset 1 and reset 2 buffers						
I _{sink(L)}	LOW-level sink current	V _{RES} ≤ 0.5 V; note 3	2	15	–	mA
R _{pu(int)}	internal pull-up resistance	T _{amb} = 25 °C	2.2	3.1	4.0	kΩ
			1.9	3.1	4.6	kΩ
Reset delay						
R _{pu(int)}	internal pull-up resistance	T _{amb} = 25 °C; note 5	–	47	–	kΩ
V _{th(r)}	rising threshold voltage		1.4	2.0	2.8	V
t _d	delay time	C _d = 100 nF; note 6; see Fig.9	–	2.6	–	ms
Battery buffer						
V _{OL}	LOW-level output voltage	I _I = 0 mA	0	0.05	0.5	V
V _{OH}	HIGH-level output voltage	I _o = 5 μA; note 7	–	5.0	5.2	V
I _{OL}	LOW-level output current	V _{OL} ≤ 0.5 V	0.2	0.5	–	mA
I _{OH}	HIGH-level output current	V _{OH} ≥ 4 V; see Fig.6	1	12	–	mA

Multiple voltage regulator with battery detection

TDA3616

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Regulator ($I_{REG} = 5 \text{ mA}$; unless otherwise specified)						
V_o	output voltage	$0.5 \text{ mA} \leq I_{REG} \leq 150 \text{ mA}$; $7 \text{ V} \leq V_P \leq 18 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$	4.8	5.0	5.2	V
		$0.5 \text{ mA} \leq I_{REG} \leq 150 \text{ mA}$; $7 \text{ V} \leq V_P \leq 18 \text{ V}$	4.75	5.0	5.25	V
		$I_{REG} = 30 \text{ mA}$; $18 \text{ V} \leq V_P \leq 50 \text{ V}$; load dump	4.75	5.0	5.25	V
I_o	output current	$V_P > 25 \text{ V}$; load dump	–	–	100	mA
ΔV_{LN}	line voltage regulation	$7 \text{ V} \leq V_P \leq 18 \text{ V}$	–	3	50	mV
ΔV_L	load voltage regulation	$0.5 \text{ mA} \leq I_{REG} \leq 150 \text{ mA}$; $T_{amb} = 25 \text{ }^\circ\text{C}$	–	–	70	mV
		$0.5 \text{ mA} \leq I_{REG} \leq 150 \text{ mA}$	–	–	85	mV
SVRR	supply voltage ripple rejection	$f_i = 200 \text{ Hz}$; $V_i = 2 \text{ V (p-p)}$; $I_o = 5 \text{ mA}$	55	60	–	dB
V_{drop}	drop-out voltage	$I_{REG} = 150 \text{ mA}$; $V_P = 5 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; note 8	–	0.6	1.0	V
		$I_{REG} = 150 \text{ mA}$; $V_P = 5.5 \text{ V}$; note 8	–	0.9	1.2	V
I_l	current limit	$V_{REG} > 4.5 \text{ V}$; $V_P > 10 \text{ V}$; note 9	0.25	0.6	1	A
I_{sc}	short-circuit current	$R_{L(REG)} \leq 0.5 \text{ } \Omega$; $T_{amb} = 25 \text{ }^\circ\text{C}$; note 10	40	80	–	mA
Backup switch						
I_{DC}	DC continuous current	$V_{BU} > 5 \text{ V}$; note 11	0.1	0.2	–	A
I_r	reverse current	$V_P = 0 \text{ V}$; $V_{BU} = 12.4 \text{ V}$	–	–	200	μA

Notes

- Minimum operating voltage, only if V_P has exceeded 7.5 V.
- The quiescent current is measured in standby mode. Therefore, the battery input is connected to a low voltage source and $R_{L(REG)} = \infty$.
- The voltage of the regulator sinks as a result of a supply voltage drop.
- Only one band gap circuit is used as a reference for both regulator and Schmitt trigger for reset. Due to this a tracking exists between the reset Schmitt trigger levels and the output voltage of the regulator.
- The temperature coefficient of the internal resistor is 0.2%/K.
- The delay time can be calculated with the following formula: $t_d = R_{pu(int)} \times C_d \times \ln\left(\frac{V_{REG}}{(V_{REG} - V_{thr})}\right)$
- The battery output voltage will be equal or less than the output voltage of the regulator.
- The drop-out voltage of the regulator is measured between V_P and V_{REG} .
- At current limit, I_l is held constant (behaviour according to dashed line in Fig.5).
- The foldback current protection limits the dissipated power at short-circuit (see Fig.5).
- The backup switch can deliver an additional current of 100 mA, guaranteed when the regulator is loaded with nominal loads ($I_{REG} \leq 150 \text{ mA}$).

Multiple voltage regulator with battery detection

TDA3616

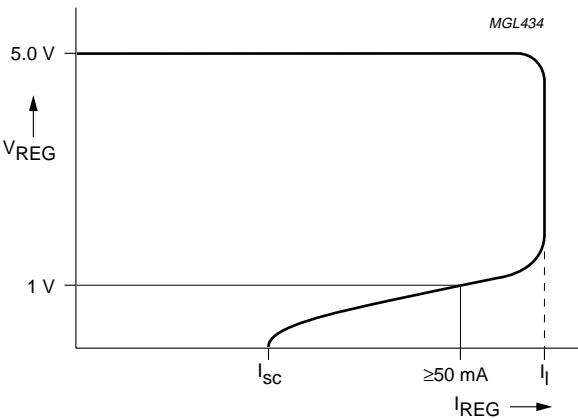
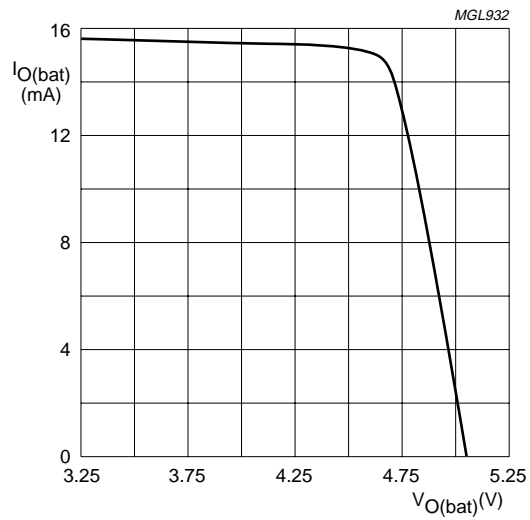


Fig.5 Foldback current protection.



$T_{amb} = 27^{\circ} \text{ C.}$

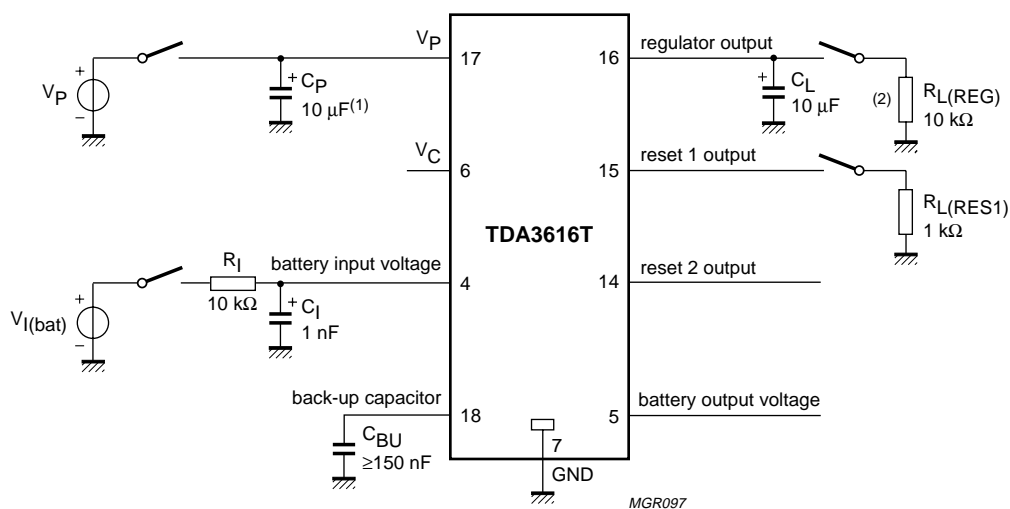
Fig.6 Battery buffer HIGH-level output current as a function of $V_{O(bat)}$.

Multiple voltage regulator with battery detection

TDA3616

TEST AND APPLICATION INFORMATION

Test information



(1) Capacitor not required for stability.

(2) $R_{L(REG)} = 0.5 \Omega$ at short-circuit.

Fig.7 Test circuit for TDA3616T.

Multiple voltage regulator with battery detection

TDA3616

Application information

NOISE

The noise at the output of the regulator depends on the bandwidth of the regulator, which can be adjusted by the output capacitor C_L . Table 1 shows the noise figures.

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

Table 1 Noise figures

I_o (mA)	NOISE FIGURE (μV) ⁽¹⁾		
	$C_L = 10\ \mu\text{F}$	$C_L = 47\ \mu\text{F}$	$C_L = 100\ \mu\text{F}$
0.5	58	50	45
50	250	200	180

Note

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

STABILITY

The regulator is stabilized by the output capacitor C_L . The value of the output capacitor can be selected using the diagram shown in Fig.8. The following two examples show the effects of the stabilization circuit using different values for the output capacitor.

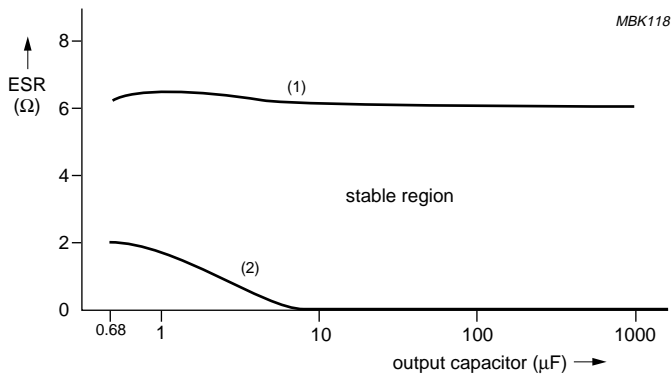
Remark: The behaviour of ESR as a function of the temperature must be known.

Example 1

The regulator is stabilized using an electrolytic output capacitor of 68 μF (ESR = 0.5 Ω). At $T_{\text{amb}} = -40\ ^\circ\text{C}$ 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 $T_{\text{amb}} = -40\ ^\circ\text{C}$.

Example 2

The regulator is stabilized using an electrolytic output capacitor of 10 μF (ESR = 3.3 Ω). At $T_{\text{amb}} = -40\ ^\circ\text{C}$ the capacitor value is decreased to 3 μF and the ESR is increased to 23.1 Ω . The regulator will be unstable at a temperature of $T_{\text{amb}} = -40\ ^\circ\text{C}$. This can be solved by using a tantalum capacitor of 10 μF .



- (1) Maximum Equivalent Series Resistance (ESR).
(2) Minimum ESR.

Fig.8 Curve for selecting the value of the output capacitor.

Multiple voltage regulator with battery detection

TDA3616

APPLICATION CIRCUIT

In Fig.9 the total quiescent current equals $I_q + I_{R_{divider}}$. The specified quiescent current equals I_q . When the supply voltage is connected, the regulator will switch-on when the supply voltage exceeds 7.5 V. With a timing capacitor connected to pin V_C 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:

$$I_{O(max)} = \frac{150 - T_{amb}}{R_{th(i-a)} \times (V_P - V_{REG})} = \frac{150 - T_{amb}}{50 \times (V_P - 5)} \text{ [mA]}$$

When $T_{\text{amb}} = 85^\circ\text{C}$ and $V_P = 16\text{ V}$, the maximum output current equals 118 mA. At lower ambient temperature ($T_{\text{amb}} < 0$) the maximum output current equals 250 mA.

For successful operation of the IC (maximum output current capability), special attention has to be paid to the copper area required as heatsink (connected to pins 1, 10, 11 and 20), the thermal capacity of the heatsink and its ability to transfer heat to the external environment.

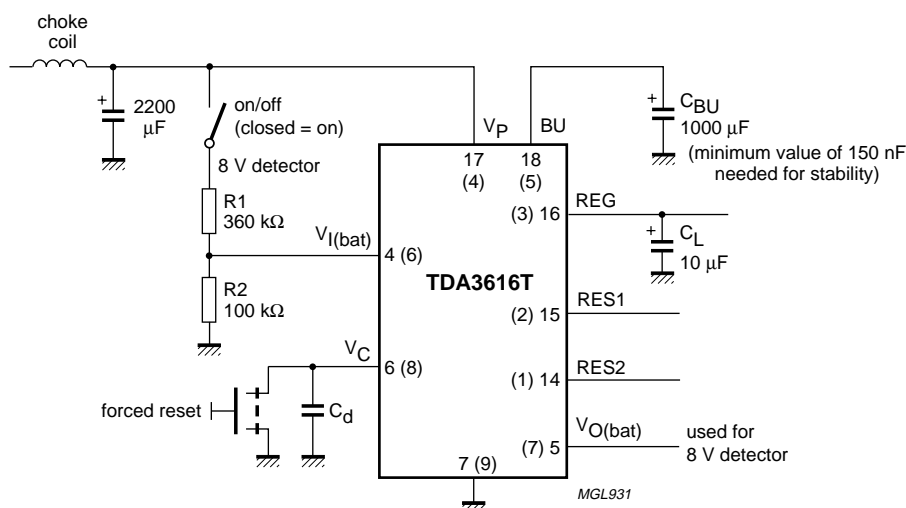
It is possible to reduce the total thermal resistance from 120 K/W to 50 K/W).

Backup circuit

The backup function is used for supplying the regulator and logic circuits (reset 1 and 2) when the supply voltage is disconnected. For stability **a minimum capacitor value of 150 nF** is needed.

With a supply voltage of 14.4 V the backup capacitor will be fully charged until approximately 14.2 V. At the moment the supply voltage is lower than the voltage on pin BU the backup switch will be opened (this backup switch acts like an ideal diode) and the charge of the backup capacitor is used for supplying the regulator and the logic circuits. The backup capacitor is mainly discharged by the load of the regulator. After a certain period of time the regulator output will be disabled and the backup capacitor will only be discharged by the quiescent current of the IC itself.

In combination with the battery detection Schmitt trigger, an early warning can be given to the microprocessor to indicate that the battery voltage has dropped down to an unacceptable low value, causing the microcontroller to run on backup charge. The early warning level can be programmed with resistors R1 and R2; see Fig.9.



The pin numbers given in parenthesis refer to the TDA3616SF version.

Fig.9 Typical application.

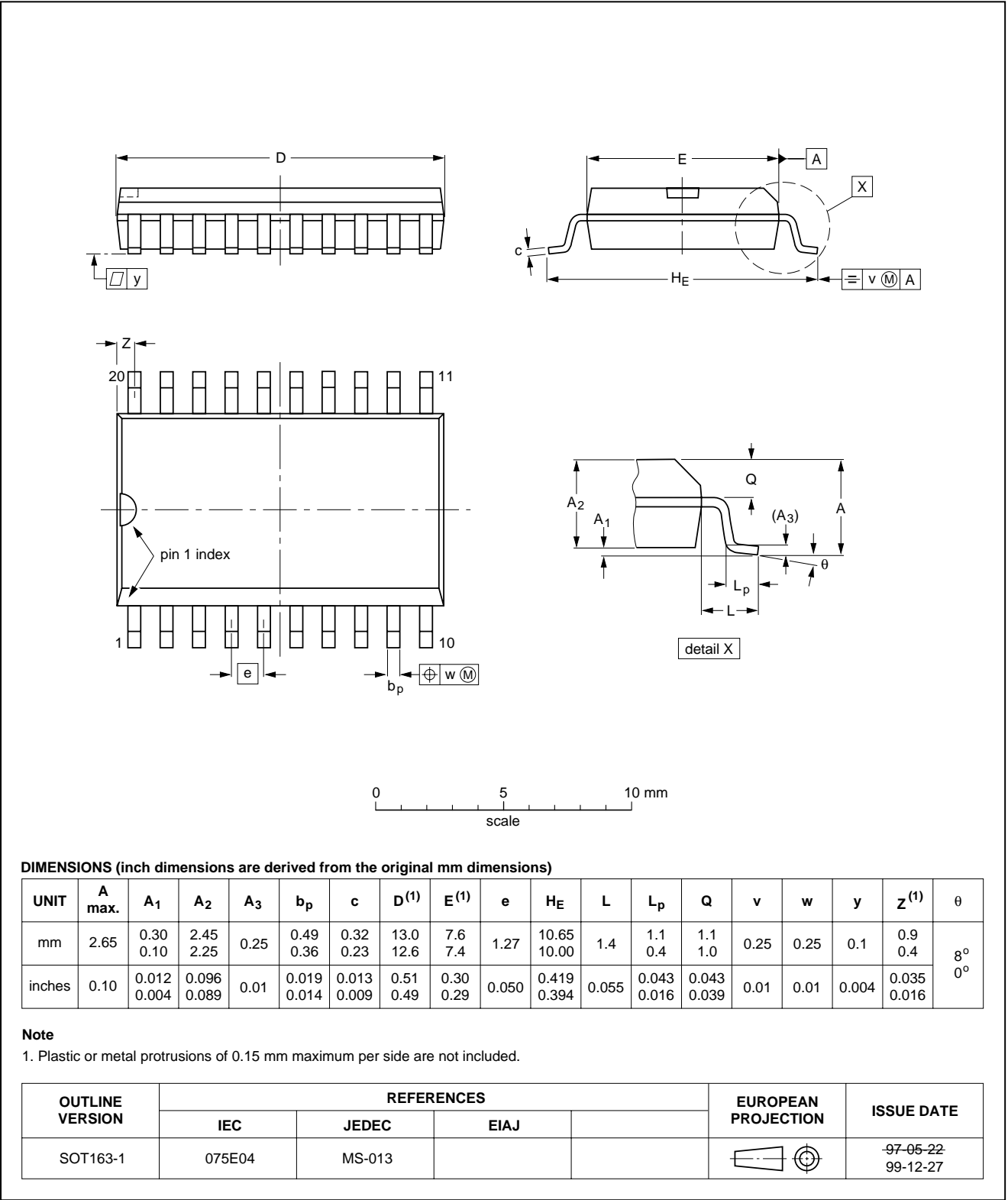
Multiple voltage regulator with battery detection

TDA3616

PACKAGE OUTLINES

SO20: plastic small outline package; 20 leads; body width 7.5 mm

SOT163-1

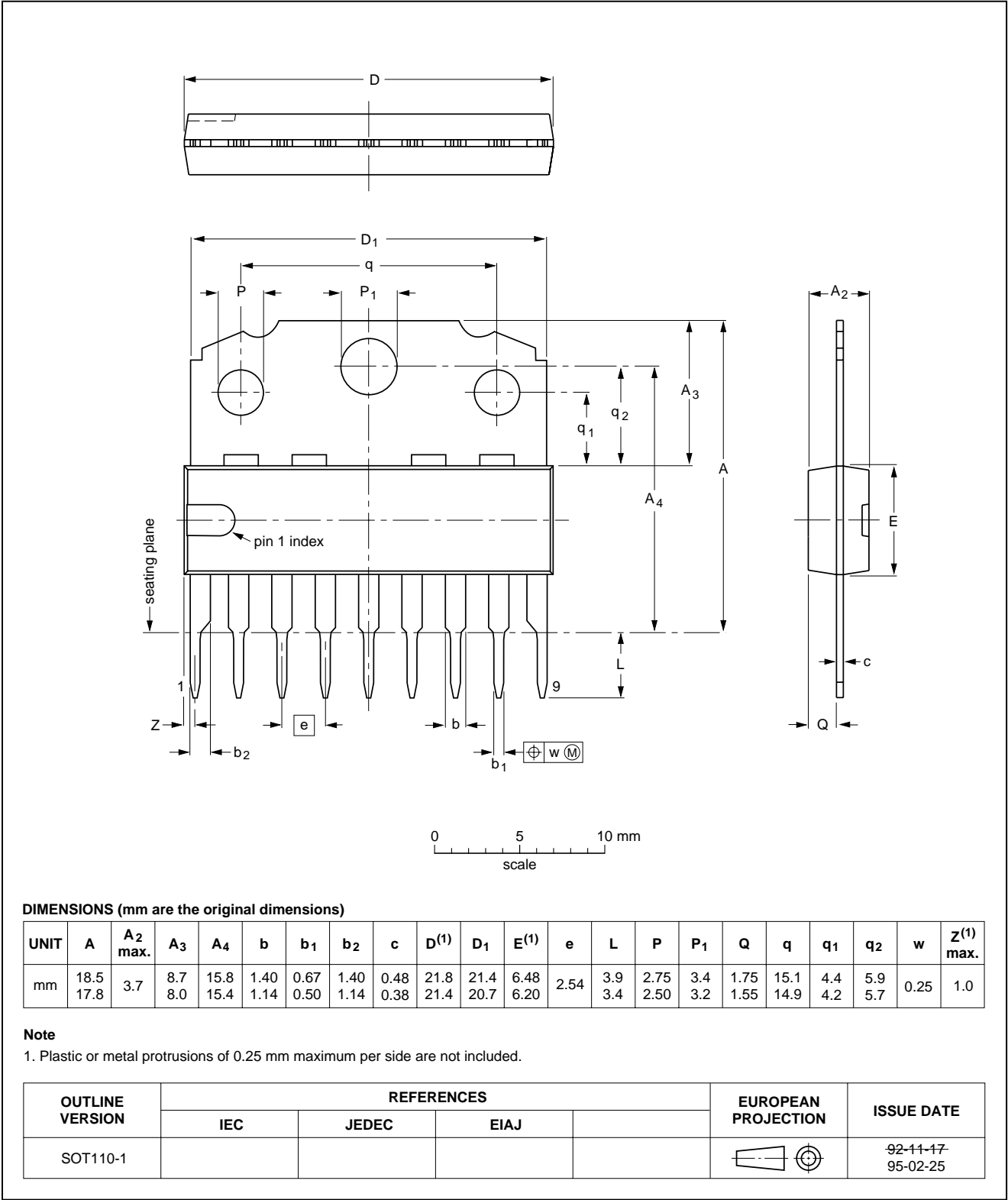


Multiple voltage regulator with battery detection

TDA3616

SIL9MPF: plastic single in-line medium power package with fin; 9 leads

SOT110-1



Multiple voltage regulator with battery detection

TDA3616

SOLDERING

Introduction

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 IC packages. Wave soldering is often preferred when through-hole and surface mount components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Through-hole mount packages

SOLDERING BY DIPPING OR BY SOLDER WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joints 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.

MANUAL SOLDERING

Apply the soldering iron (24 V or less) to the lead(s) of the package, either 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.

Surface mount packages

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, infrared/convection 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 230 °C.

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.

Multiple voltage regulator with battery detection

TDA3616

Suitability of IC packages for wave, reflow and dipping soldering methods

MOUNTING	PACKAGE	SOLDERING METHOD		
		WAVE	REFLOW ⁽¹⁾	DIPPING
Through-hole mount	DBS, DIP, HDIP, SDIP, SIL	suitable ⁽²⁾	–	suitable
Surface mount	BGA, LFBGA, SQFP, TFBGA	not suitable	suitable	–
	HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable ⁽³⁾	suitable	–
	PLCC ⁽⁴⁾ , SO, SOJ	suitable	suitable	–
	LQFP, QFP, TQFP	not recommended ⁽⁴⁾⁽⁵⁾	suitable	–
	SSOP, TSSOP, VSO	not recommended ⁽⁶⁾	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. For SDIP packages, the longitudinal axis must be parallel to the transport direction of the printed-circuit board.
3. 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).
4. 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.
5. Wave soldering is only suitable for LQFP, QFP and TQFP 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.
6. 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.

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

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Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 3 Figtree Drive, HOMEBUSH, NSW 2140,
Tel. +61 2 9704 8141, Fax. +61 2 9704 8139

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213,
Tel. +43 1 60 101 1248, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 20 0733, Fax. +375 172 20 0773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 68 9211, Fax. +359 2 68 9102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

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: Sydhavnsgade 23, 1780 COPENHAGEN V,
Tel. +45 33 29 3333, Fax. +45 33 29 3905

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615 800, Fax. +358 9 6158 0920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 4099 6161, Fax. +33 1 4099 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 2353 60, Fax. +49 40 2353 6300

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: PT Philips Development Corporation, Semiconductors Division,
Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510,
Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

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, Via Casati, 23 - 20052 MONZA (MI),
Tel. +39 039 203 6838, Fax +39 039 203 6800

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku,
TOKYO 108-8507, Tel. +81 3 3740 5130, Fax. +81 3 3740 5057

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, Fax +9-5 800 943 0087

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

Pakistan: see Singapore

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: Al.Jerozolimskie 195 B, 02-222 WARSAW,
Tel. +48 22 5710 000, Fax. +48 22 5710 001

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 319762,
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 58088 Newville 2114,
Tel. +27 11 471 5401, Fax. +27 11 471 5398

South America: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 93 301 6312, Fax. +34 93 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2741 Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2886, 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: Yukari Dudullu, Org. San. Blg., 2.Cad. Nr. 28 81260 Umraniye,
ISTANBUL, Tel. +90 216 522 1500, Fax. +90 216 522 1813

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. +44 208 730 5000, Fax. +44 208 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 3341 299, Fax.+381 11 3342 553

For all other countries apply to: Philips Semiconductors,
International 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>

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SCA 69

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