DATA SHEET

TDA3603

Multiple voltage regulator with switch

Preliminary specification
Supersedes data of 1995 Feb 16
File under Integrated Circuits, IC01

1995 Oct 04

Philips
Semiconductors

PHILIPS

Multiple voltage regulator with switch   TDA3603

FEATURES

- One V_P state controlled regulator (regulator 2)
- Regulator 2, reset and ignition buffer operates during load dump and thermal shutdown
- One control pin for switching regulator 1 and the power switch
- Supply voltage range of −18 to +50 V (operating from 9.75 V)
- Low reverse current of regulator 2
- Low quiescent current (when regulator 1 is switched off, standby)
- Ignition input/output
- Reset output
- High ripple rejection
- Power switch.

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 shortened)
- ESD protected on all pins
- Thermal protection
- Load dump protection
- Foldback current limit protection for regulators 1 and 2
- Delayed second current limit protection for the power switch
- The regulator outputs and the power switch are DC short-circuited safe to ground and V_P.

GENERAL DESCRIPTION

The TDA3603 is a multiple output voltage regulator with a power switch, intended for use in car radios with or without a microcontroller.

It contains one fixed voltage regulator with a foldback current protection (regulator 1) and one fixed voltage regulator (regulator 2), intended to supply a microcontroller, that also operates during load dump and thermal shutdown.

There is a power switch with protections, operated by the enable input.

The reset and ignition outputs can be used to interface by the microcontroller. The reset signal can be used to call up the microcontroller and the ignition output indicates ignition voltage available.

The supply pin can withstand load dump pulses and negative supply voltages.

Regulator 2 will be switched on at a supply voltage >6.5 V and off at a voltage of regulator 2 <1.9 V.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA3603	SIL9MPF	plastic single in-line medium power package with fin; 9 leads	SOT110-1
TDA3603P	HDIP18	plastic heat-dissipating dual in-line package; 18 leads	SOT398-1

Multiple voltage regulator with switch

TDA3603

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage					
	operating		9.75	14.4	25	V
	regulator 2 on	note 1	2.4	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	total quiescent current	standby mode	–	400	500	μA
T_{vj}	operating virtual junction temperature		–	–	150	°C
Voltage regulators						
V_{REG1}	output voltage regulator 1	0.5 mA $\leq I_{REG1} \leq 300$ mA	8.65	9.0	9.35	V
V_{REG2}	output voltage regulator 2	0.5 mA $\leq I_{REG2} \leq 30$ mA; $V_P = 14.4$ V	4.8	5.0	5.2	V
$V_{drop(REG1)}$	drop-out voltage	$I_{REG1} = 0.3$ A; note 2	–	–	0.5	V
Power switch						
$V_{drop(sw)}$	drop-out voltage	$I_{sw} = 0.3$ A; note 3	–	–	0.9	V
I_M	peak current	$t \leq 10$ ms	1.4	–	–	A

Notes

1. Minimum operating voltage, only if V_P has exceeded 6.5 V.

2. The drop-out voltage of regulator 1 is measured between V_P and V_{REG1}.

3. The drop-out voltage of the power switch is measured between V_P and V_{sw}.

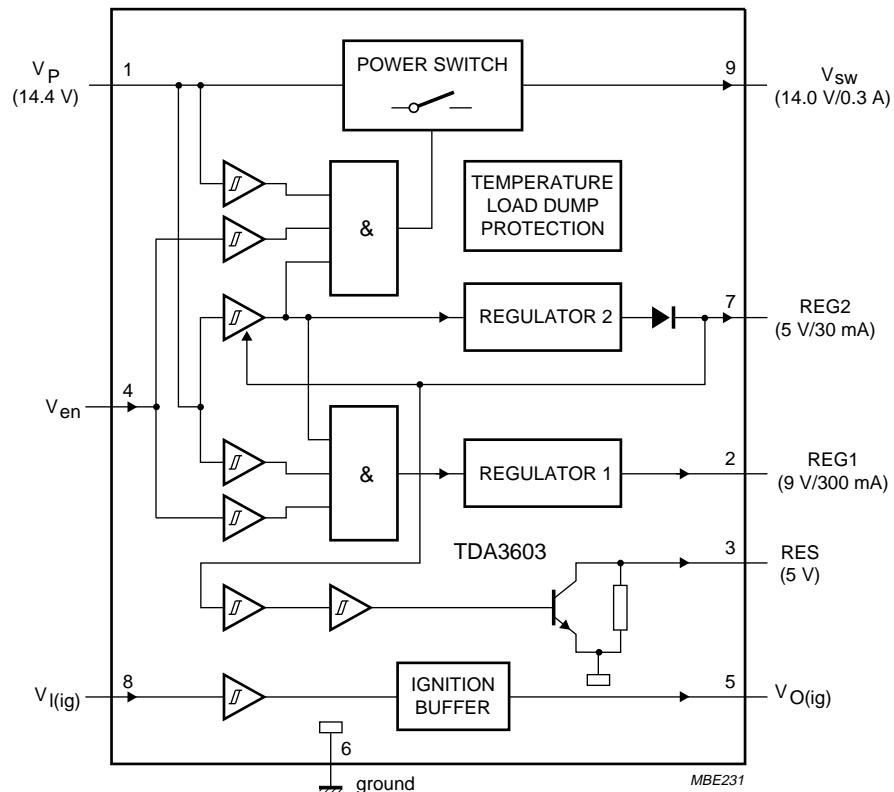## Multiple voltage regulator with switch

TDA3603

BLOCK DIAGRAM

Fig.1 Block diagram.

Multiple voltage regulator with switch

TDA3603

PINNING

SYMBOL	PIN		DESCRIPTION
	SOT110-1	SOT398-1	
V_P	1	1	supply voltage
REG1	2	2	regulator 1 output
RES	3	3	reset output voltage (+5 V)
V_{en}	4	4	enable input voltage
$V_{O(ig)}$	5	5	ignition output voltage
GND	6	6	ground (0 V)
REG2	7	7	regulator 2 output
$V_{I(ig)}$	8	8	ignition input voltage
V_{sw}	9	9	power switch output voltage
i.c.	–	10 to 18	can be connected to a heat spreader
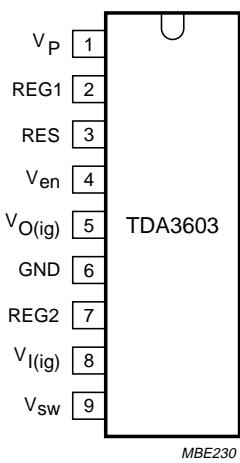
Fig.2 Pin configuration for SOT110-1.
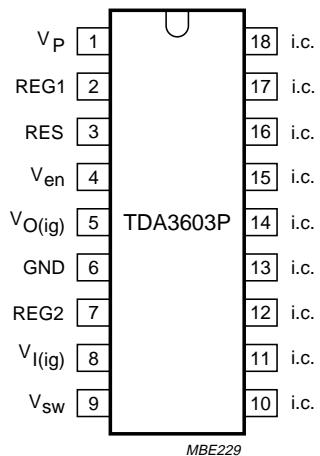
Pins 10 to 18 can be connected to a heat spreader.

Fig.3 Pin configuration for SOT398-1.

Multiple voltage regulator with switch

TDA3603

FUNCTIONAL DESCRIPTION

The TDA3603 is a multiple output voltage regulator with a power switch, intended for use in car radios with or without a microcontroller. Because of low-voltage operation of the car radio, low-voltage drop regulators are used.

Regulator 2 will switch on when the supply voltage exceeds 6.5 V for the first time and will switch off again when the output voltage of regulator 2 is below 1.9 V (this is below an engine start). When regulator 2 is switched on and the output voltage of this regulator is within its voltage range, the reset output will be enabled (reset will go HIGH via a pull-up resistor) to generate a reset to the microcontroller. The reset cycles can be extended by an external capacitor at the reset output (pin 3). The start-up feature is built-in to ensure a smooth start-up of the microcontroller at first connection, without uncontrolled switching of regulator 2 during the start-up sequence.

When both regulator 2 and the supply voltage (V_P > 4.5 V) are available, regulator 1 and the switch can be operated by an enable input (pin 4).

All output pins are fully protected. The regulators are protected against load dump (regulator 1 will switch off at supply voltages higher than 25 V) and short-circuit (foldback current protection).
The switch contains a current protection which is delayed for ≥10 ms (in short-circuit condition). During this time the current is limited to 1.4 A (V_P ≤ 18 V).

At supply voltages over 16.9 V the switch is clamped at 15.0 V (to avoid externally connected circuitry being damaged by an overvoltage) and the switch will switch off at load dump.

Interfacing with the microcontroller can be accomplished by an ignition Schmitt-trigger and ignition output buffer, (simple full/semi on/off logic applications).

The total timing of a semi on/off logic set is shown Fig.4.
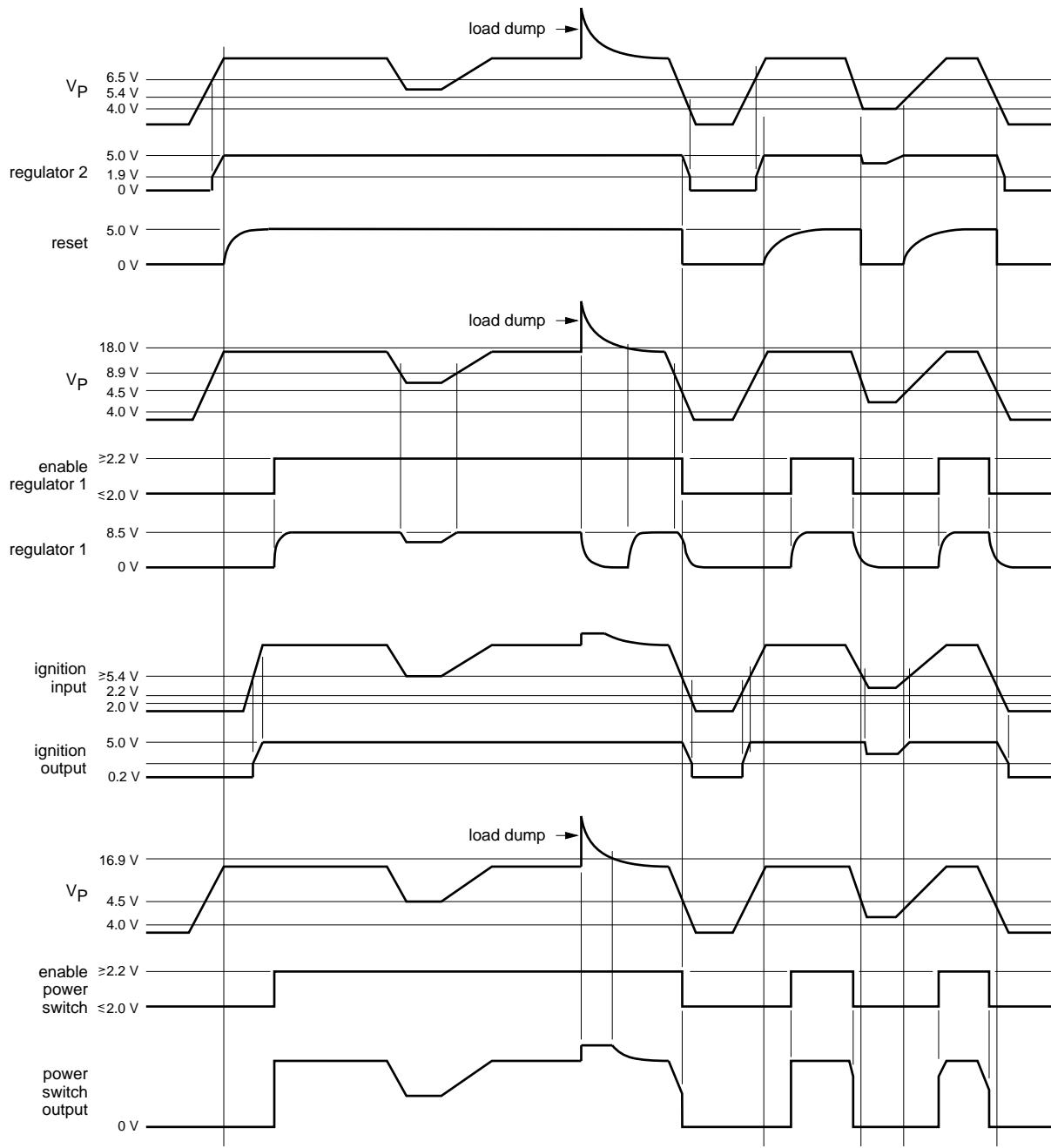
Multiple voltage regulator with switch

TDA3603

Fig.4 Timing diagram.

Multiple voltage regulator with switch

TDA3603

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage				
	operating		–	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_{ppi}	positive pulse voltage at ignition buffer	$V_P = 14.4$; $R_l = 1$ kΩ	–	50	V
V_{npi}	negative pulse voltage at ignition buffer	$V_P = 14.4$; $R_l = 1$ kΩ	–	–100	V
T_{stg}	storage temperature	non-operating	–55	+150	°C
T_{vj}	operating virtual junction temperature		–40	+150	°C
P_{tot}	total power dissipation	SOT110-1	–	10.4	W
		SOT398-1	–	tbf	W

THERMAL CHARACTERISTICS

SYMBOL	TYPE NUMBER	PARAMETER	VALUE	UNIT
$R_{th\ j-c}$	TDA3603	thermal resistance from junction to case	12	K/W
$R_{th\ j-p}$	TDA3603P	thermal resistance from junction to pins	15	K/W

Multiple voltage regulator with switch

TDA3603

CHARACTERISTICS

V_P = 14.4 V; Tamb = 25 °C; see Figs 5 and 6; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage					
	operating		9.75	14.4	25	V
	regulator 2 on	note 1	2.4	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	quiescent current	V_P = 12.4 V; note 2	–	400	500	μA
		V_P = 14.4 V; note 2	–	420	–	μA
Schmitt-trigger power supply for the power switch						
V_{thr}	rising voltage threshold		4.0	4.5	5.0	V
V_{thf}	falling voltage threshold		3.5	4.0	4.5	V
V_{hys}	hysteresis		–	0.5	–	V
Schmitt-trigger power supply for regulator 1						
V_{thr}	rising voltage threshold		4.0	4.5	5.0	V
V_{thf}	falling voltage threshold		3.5	4.0	4.5	V
V_{hys}	hysteresis		–	0.5	–	V
Schmitt-trigger power supply for regulator 2						
V_{thr}	rising voltage threshold		6.0	6.5	7.1	V
V_{thf}	falling voltage threshold		1.7	1.9	2.2	V
V_{hys}	hysteresis		–	4.7	–	V
Schmitt-trigger for enable input						
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		–	0.2	–	V
Schmitt-trigger for reset buffer						
$V_{r(REG2)}$	rising voltage of regulator 2	note 3	–	$V_{REG2} - 0.15$	–	V
$V_{f(REG2)}$	falling voltage of regulator 2	note 3	–	$V_{REG2} - 0.25$	–	V
V_{spread}	voltage spread on tracking	note 4	–	10	–	mV
Schmitt-trigger for ignition buffer						
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		–	0.2	–	V
Reset buffer						
I_{sink}	LOW-level sink current	$V_{RES} \leq 0.8$ V	15	20	–	mA
I_{leak}	leakage current	V_P = 14.4 V; V_{RES} = 5 V	25	50	100	μA

Multiple voltage regulator with switch

TDA3603

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Ignition buffer						
V_{OL}	LOW-level output voltage	I_{OL} = 0 mA	0	0.2	0.8	V
V_{OH}	HIGH-level output voltage	note 5	–	5.0	5.2	V
I_{OL}	LOW-level output current	$V_{OL} \leq 0.8$ V	0.3	0.8	–	mA
I_{OH}	HIGH-level output current	$V_{OH} \geq 3$ V	0.3	2.0	–	mA
Regulator 1 (note 6)						
V_{REG1}	output voltage off		–	1	400	mV
V_{REG1}	output voltage	0.5 mA $\leq I_{REG1} \leq$ 300 mA	8.65	9.0	9.35	V
		10 V $\leq V_P \leq$ 18 V	8.65	9.0	9.35	V
ΔV_{REG1}	line regulation	10 V $\leq V_P \leq$ 18 V	–	–	50	mV
ΔV_{REGL1}	load regulation	0.5 mA $\leq I_{REG1} \leq$ 300 mA	–	–	70	mV
SVRR1	supply voltage ripple rejection	f_i = 200 Hz; V_I = 2 V (p-p)	60	–	–	dB
V_{REGd1}	drop-out voltage	I_{REG1} = 300 mA; note 7	–	0.4	0.5	V
I_{REGm1}	current limit	$V_{REG1} >$ 7 V; note 8	0.45	-	1.2	A
I_{REGsc1}	short-circuit current	$R_L \leq 0.5$ Ω; note 9	50	300	–	mA
α_{ct}	cross talk	note 10	–	50	–	dB
Regulator 2 (note 11)						
V_{REG2}	output voltage	0.5 mA $\leq I_{REG2} \leq$ 30 mA	4.8	5.0	5.2	V
		7 V $\leq V_P \leq$ 18 V	4.8	5.0	5.2	V
		18 V $\leq V_P \leq$ 50 V	4.75	5.0	5.25	V
ΔV_{REG2}	line regulation	7 V $\leq V_P \leq$ 18 V	–	–	50	mV
ΔV_{REGL2}	load regulation	0.5 mA $\leq I_{REG1} \leq$ 30 mA	–	–	50	mV
SVRR2	supply voltage ripple rejection	f_i = 200 Hz; V_I = 2 V (p-p)	60	–	–	dB
V_{REGd2}	drop-out voltage	I_{REG2} = 30 mA; note 12	–	0.3	0.4	V
I_{REGm2}	current limit	$V_{REG2} >$ 4.5 V; note 8	0.1	-	0.5	A
I_{REGsc2}	short-circuit current	$R_L \leq 0.5$ Ω; note 9	–	50	–	mA
α_{ct}	cross talk	note 13	–	50	–	dB
Power switch						
V_{swd}	drop-out voltage	I_{sw} = 0.3 A; note 14	–	0.4	0.9	V
I_{swcc}	continuous current		0.5	–	–	A
V_{swcl}	clamping voltage	$V_P \geq$ 16.9 V	–	15.0	16.2	V
I_M	peak current	$t \leq$ 10 ms	1.4	–	–	A
V_{swfb}	fly back voltage behaviour	I_{sw} = −200 mA	–	–	20	V
$I_{lim(sw)}$	current limit	V_P = 14.4 V; V_{sw} = 10 V; note 8	0.6	–	1.0	A

Multiple voltage regulator with switch   TDA3603

Notes to the characteristics

1. Minimum operating voltage, only if V_P has exceeded 6.5 V.

2. Enable and ignition inputs are low and regulator 2 is unloaded.

3. Voltage drop due to load condition.

4. The spread on tracking is one sigma value.

5. Ignition output voltage will be less than or equal to the output voltage of regulator 2.

6. I_{REG1} = 5 mA.

7. The drop-out voltage of regulator 1 is measured between V_P and V_{REG1}.

8. At current limit, I_{REGm} is held constant (behaviour in accordance with the broken line in Fig.5).

9. The foldback current protection limits the dissipated power at short-circuit (see Figs 5 and 6).

10. The cross talk of regulator 1 is measured with an I_{REG2} = 0.5 mA up to 30 mA with an input frequency of f_i = 100 kHz.

11. I_{REG2} = 5 mA.

12. The drop-out voltage of regulator 2 is measured between V_P and V_{REG2}.

13. The cross talk of regulator 2 is measured with an I_{REG1} = 0.5 mA up to 100 mA with an input frequency of f_i = 100 kHz.

14. The drop-out voltage of the power switch is measured between V_P and V_{sw}.
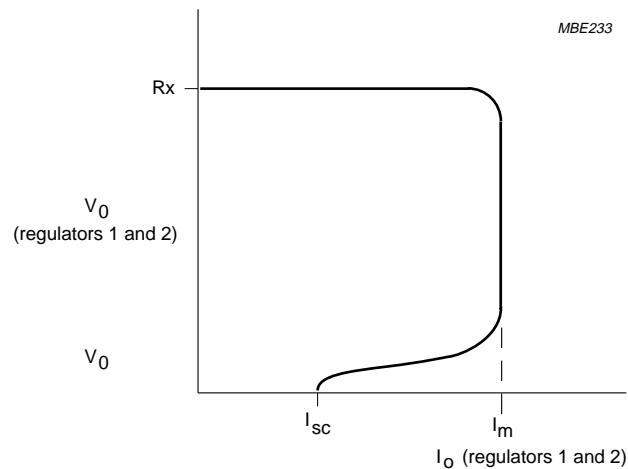
MBE233

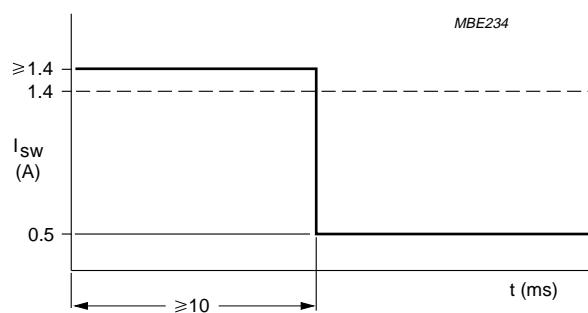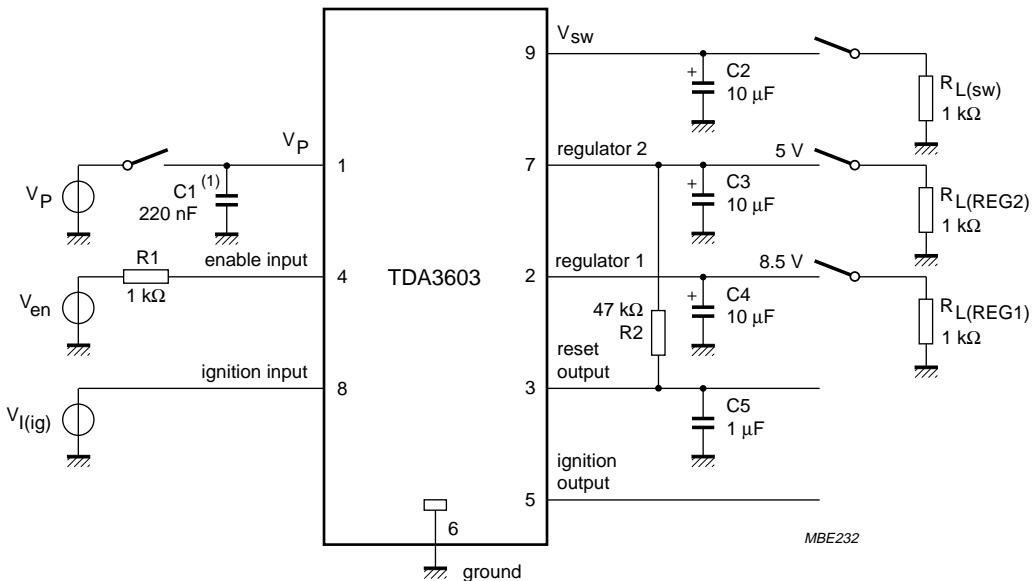Fig.5 Foldback current protection of the regulators.

MBE234

Fig.6 Foldback current protection of the power switch.

Multiple voltage regulator with switch

TDA3603

TEST AND APPLICATION INFORMATION

(1) Capacitor not required for stability.

Fig.7 Test circuit.

Noise information

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

Although stability is guaranteed when C_L is higher than 10 μF (over temperature range) with tan (ϕ) = 1 in the frequency range 1 to 10 kHz, however, for low noise, a 47 μF load capacitor is required.

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 the output capacitors). When a high frequency capacitor of 220 nF with an electrolytic capacitor of 100 μF in parallel is placed directly over pins 1 and 6 (supply and ground) the noise is minimized.

Table 1 Noise figures

REGULATOR	NOISE (μV)[1]	OUTPUT CAPACITOR (μF)
1	tbf	10
	150	47
	tbf	100
	tbf	220
2	tbf	10
	100	47
	tbf	100
	tbf	220

Note

1. Bandwidth of 100 kHz.

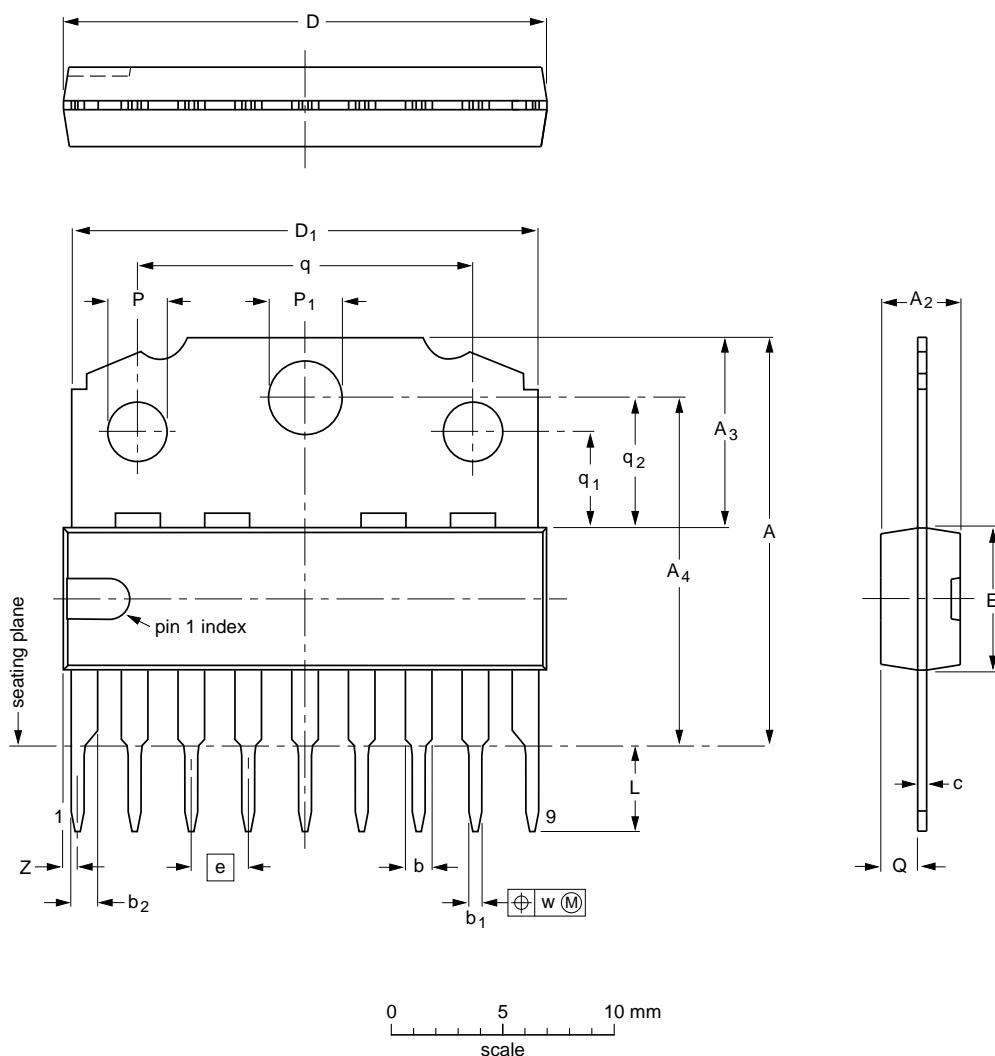# Multiple voltage regulator with switch

TDA3603

PACKAGE OUTLINES

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

SOT110-1

0   5   10 mm
scale

DIMENSIONS (mm are the original dimensions)

UNIT	A	A$_2$ max.	A$_3$	A$_4$	b	b$_1$	b$_2$	c	D$^{(1)}$	D$_1$	E$^{(1)}$	e	L	P	P$_1$	Q	q	q$_1$	q$_2$	w	Z$^{(1)}$ max.
mm	18.5 17.8	3.7	8.7 8.0	15.8 15.4	1.40 1.14	0.67 0.50	1.40 1.14	0.48 0.38	21.8 21.4	21.4 20.7	6.48 6.20	2.54	3.9 3.4	2.75 2.50	3.4 3.2	1.75 1.55	15.1 14.9	4.4 4.2	5.9 5.7	0.25	1.0

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			
SOT110-1						~~92-11-17~~ 95-02-25

Multiple voltage regulator with switch

TDA3603

HDIP18: plastic heat-dissipating dual in-line package; 18 leads

SOT398-1

0   5   10 mm
scale
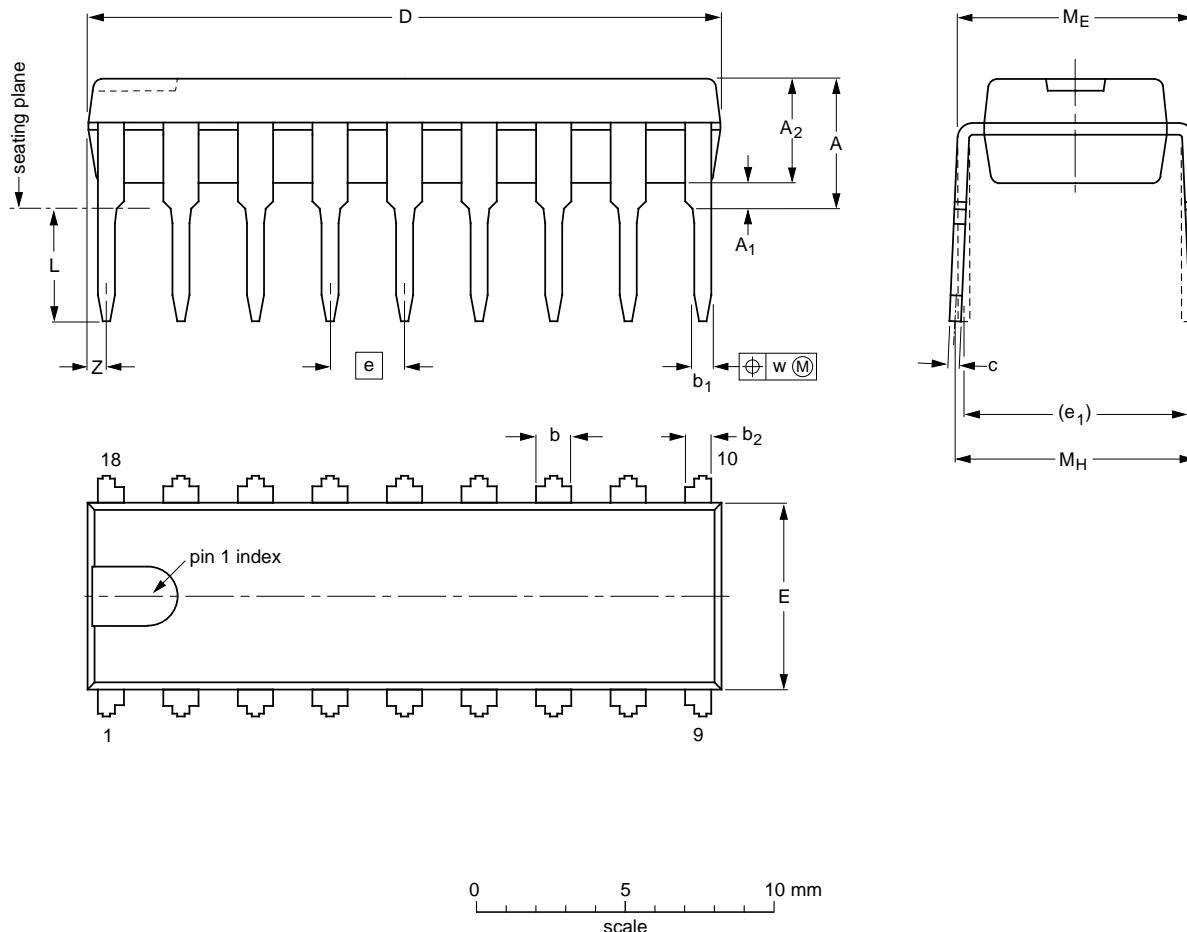
DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	$D^{(1)}$	$E^{(1)}$	e	e_1	L	M_E	M_H	w	$Z^{(1)}$ max.
mm	4.7	0.51	3.7	1.40 1.14	0.67 0.50	1.05 0.75	0.47 0.38	21.85 21.35	6.5 6.2	2.54	7.62	3.9 3.1	8.32 8.02	8.7 7.7	0.25	1.0
inches	0.19	0.02	0.15	0.06 0.04	0.03 0.02	0.04 0.03	0.02 0.01	0.87 0.84	0.26 0.24	0.10	0.30	0.15 0.12	0.33 0.32	0.34 0.30	0.01	0.04

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			
SOT398-1						~~94-04-13~~ 95-01-25

Multiple voltage regulator with switch

TDA3603

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.

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