DATA SHEET

TDA3604
Multiple voltage regulator with external reset delay and switch

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

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Philips Semiconductors

PHILIPS

Multiple voltage regulator with external reset delay and switch

TDA3604

FEATURES

- One V_P state controlled regulator (regulator 2)
- Regulator 2, reset and ignition buffer operates during load dump and thermal shutdown
- Separate control pins 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
- Reset delay time adjustable
- High ripple rejection
- Power switch
- Separate supply for the 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 TDA3604 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 an 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.

Both supply pins 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
TDA3604	DBS13P	plastic DIL-bent-SIL power package; 13 leads (lead length 12 mm)	SOT141-6

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	$I_{sw} = 0.5$ A; note 3	–	–	1.4	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 $V_{REG\ 1}$.
3. The drop-out voltage of the power switch is measured between V_P and V_{sw}.

BLOCK DIAGRAM

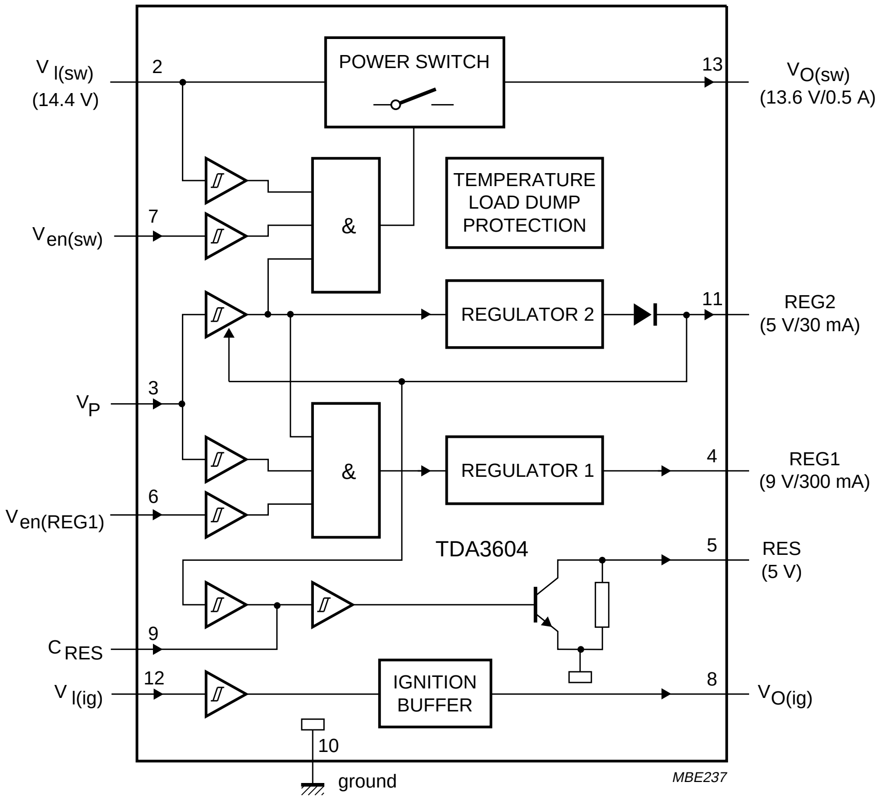


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
n.c.	1	not connected
$V_{I(sw)}$	2	power switch input voltage
V_P	3	supply voltage
REG1	4	regulator 1 output
RES	5	reset output voltage (+5 V)
$V_{en(REG1)}$	6	regulator 1 enable input
$V_{en(sw)}$	7	power switch enable input voltage
$V_{O(ig)}$	8	ignition output voltage
C_{RES}	9	reset capacitor
GND	10	ground (0 V)
REG2	11	regulator 2 output
$V_{I(ig)}$	12	ignition input voltage
$V_{O(sw)}$	13	power switch output voltage

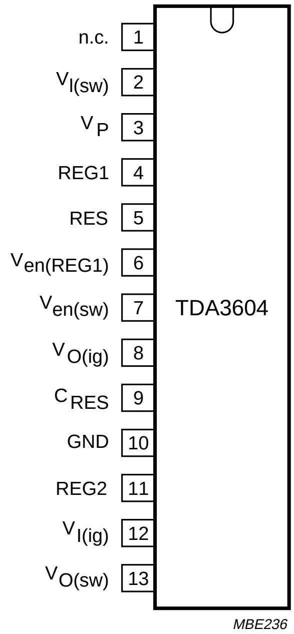


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA3604 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 pin 9). The above mentioned start-up feature is built in to secure 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 enable inputs (pins 6 and 7 respectively).

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.3.

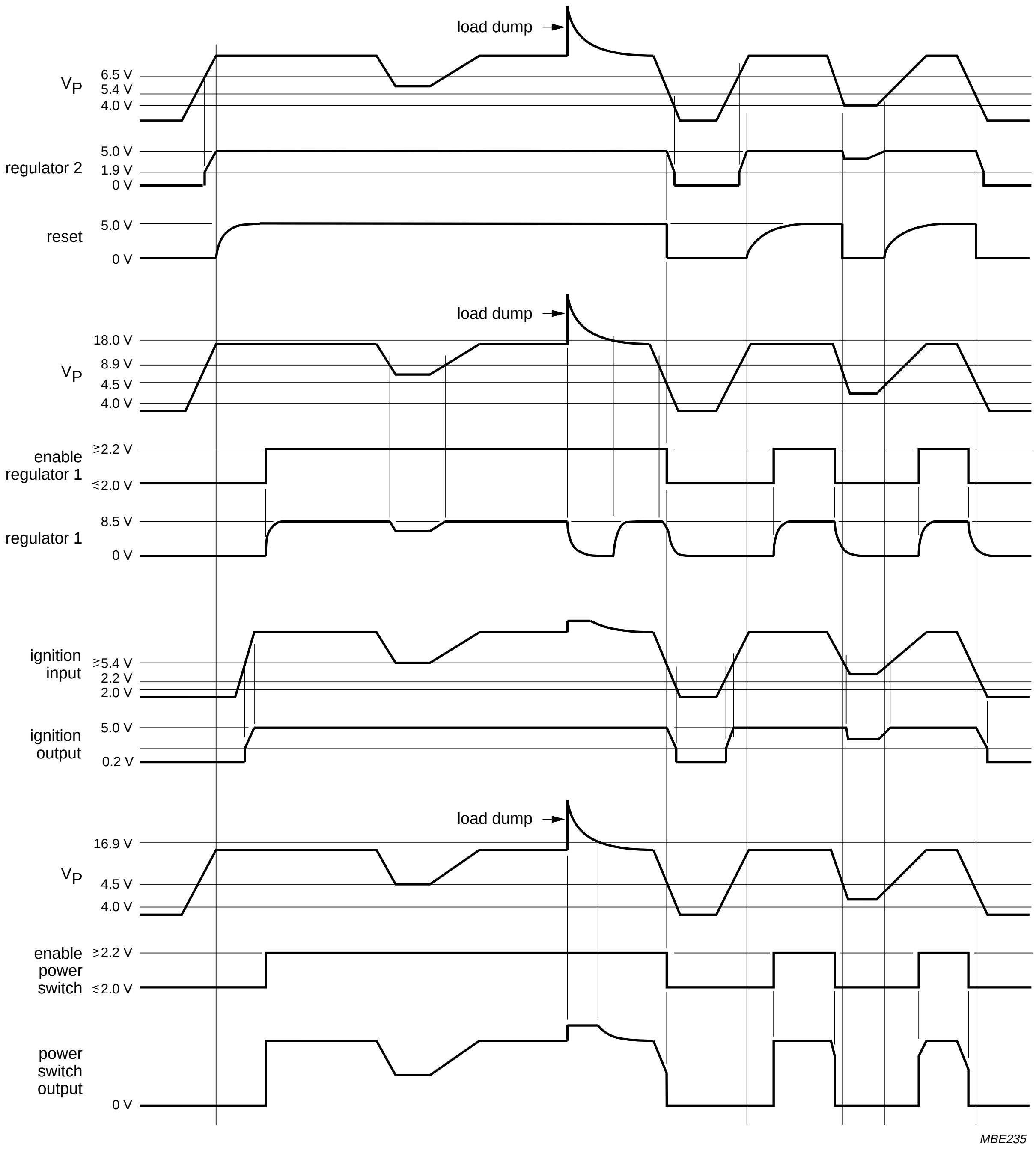


Fig.3 Timing diagram.

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	$V_P = 14.4$; $R_I = 1\ k\Omega$	–	50	V
V_{npi}	negative pulse voltage at ignition buffer	$V_P = 14.4$; $R_I = 1\ k\Omega$	–	–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		–	15.6	W

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}c}$	thermal resistance from junction to case	8	K/W
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient in free air	50	K/W

CHARACTERISTICS

$V_P = V_{Psw} = 14.4$ V; $T_{amb} = 25$ °C; see test Figs. 4 and 5 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 ≤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

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	$R_L \leq 0.5\ \Omega$; 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	$R_L \leq 0.5\ \Omega$; note 9	–	50	–	mA
α_{ct}	cross talk	note 13	–	50	–	dB
Power switch						
V_{swd}	drop-out voltage	I_{sw} = 0.4 A; note 14	–	0.8	1.4	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
Reset delay						
I_O	output current		–	3	–	μA
V_{thr}	rising voltage threshold		2.7	3.0	3.3	V
t_d	delay time	C_I = 47 nF; note 15	25	50	100	ms

Notes to the characteristics

1. Minimum operating voltage, only if V_P has exceeded 6.5 V.
2. Enable inputs of regulator 1, ignition and switch are low. 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. 4.
9. The foldback current protection limits the dissipated power at short circuit (see Figs 4 and 5).
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}.
15. The delay time depends on the value of the capacitor

$$t_d = \frac{C}{I} \times V_{thrC} = C \times 2.5 \times 10^6$$

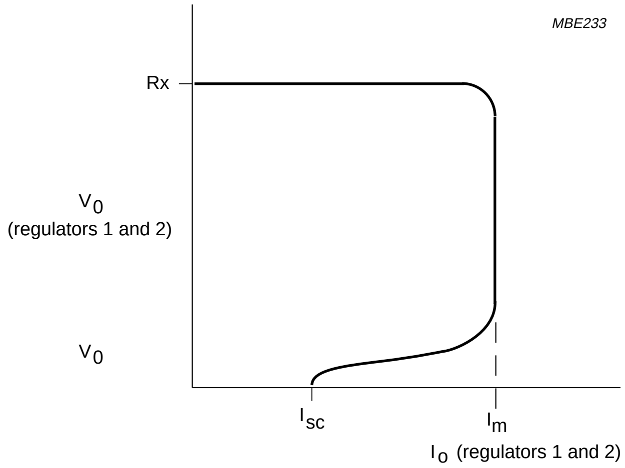


Fig.4 Foldback current protection of the regulators.

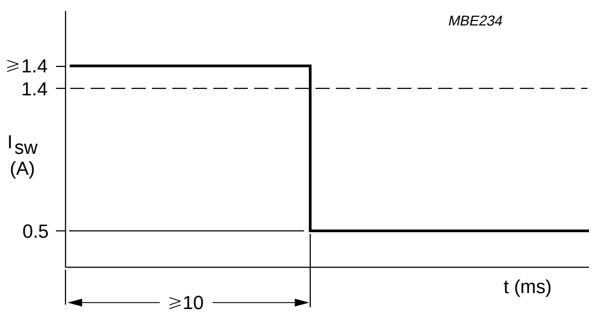
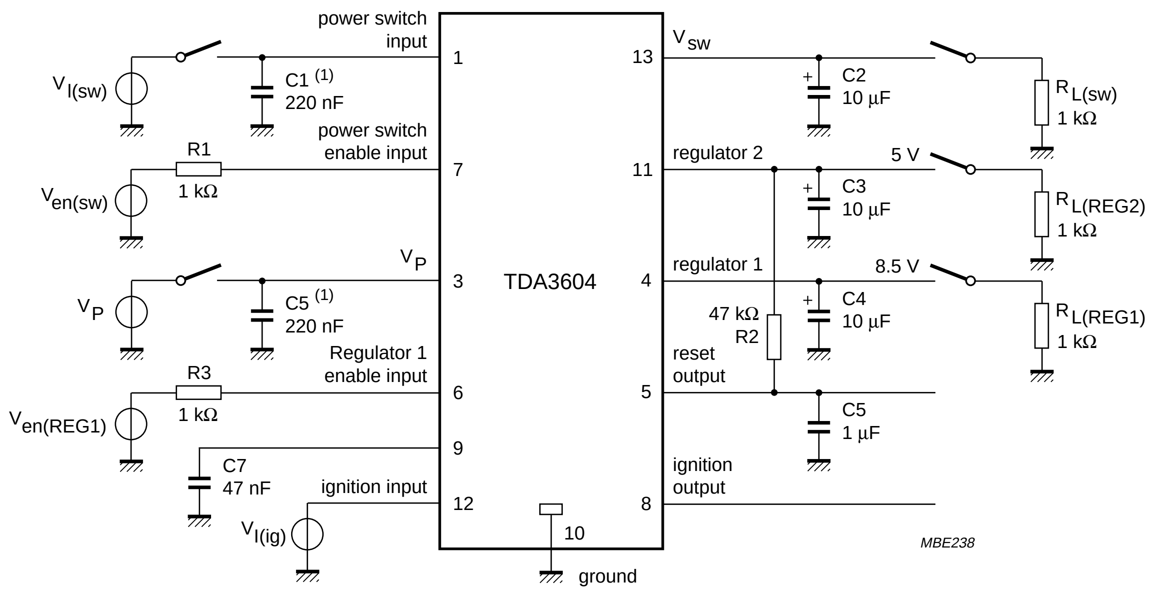


Fig.5 Foldback current protection of the power switch.

TEST AND APPLICATION INFORMATION



(1) Capacitor not required for stability.

Fig.6 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 3 and 10 (supply and ground) the noise is minimized.

Table 1 Noise figures

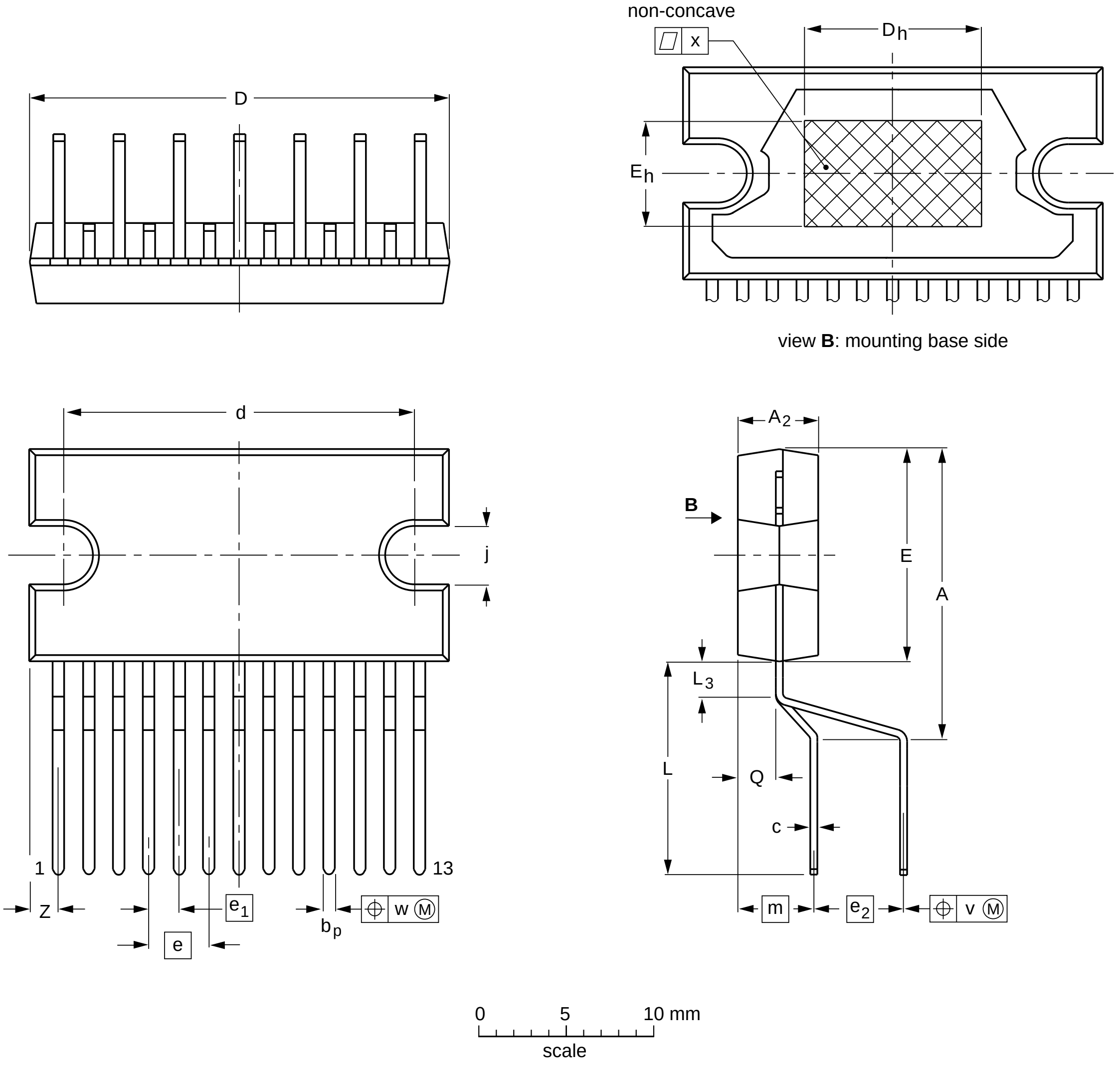
REGULATOR	NOISE (µV)[1]	OUTPUT CAPACITOR (µF)
1	tbf	10
	150	47
	tbf	100
	tbf	220
2	tbf	10
	100	47
	tbf	100
	tbf	220

Note

1. Bandwidth of 100 kHz.

PACKAGE OUTLINE

DBS13P: plastic DIL-bent-SIL power package; 13 leads (lead length 12 mm) **SOT141-6**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_2	b_p	c	$D^{(1)}$	d	D_h	$E^{(1)}$	e	e_1	e_2	E_h	j	L	L_3	m	Q	v	w	x	$Z^{(1)}$
mm	17.0 15.5	4.6 4.2	0.75 0.60	0.48 0.38	24.0 23.6	20.0 19.6	10	12.2 11.8	3.4	1.7	5.08	6	3.4 3.1	12.4 11.0	2.4 1.6	4.3	2.1 1.8	0.8	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			
SOT141-6						~~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.

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