DATA SHEET

TDA3682
Multiple voltage regulator with power switches

Product specification
Supersedes data of 2000 Nov 20

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Philips
Semiconductors

PHILIPS

Multiple voltage regulator with power switches

TDA3682

FEATURES

General

- Good stability for any regulator with almost any output capacitor
- Five voltage regulators (BU5V, illumination, AM, FM and audio)
- Mode selection by three enable control pins
- Low dropout voltage output stages (PNP output stage)
- High ripple rejection
- Low noise for all regulators
- Two power switches (power antenna and power control function).

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 protection of all pins
- Thermal protection to avoid thermal break down
- Load dump protection
- Regulator outputs are DC short-circuited safe to ground and supply voltage
- Foldback current limit protection for all regulators
- Loss of ground protection for power switches.

GENERAL DESCRIPTION

The TDA3682 is a multiple output voltage regulator with power switches, intended for use in car radios with or without a microprocessor.

The TDA3682 contains the following:

- Four switchable regulators and one permanent active regulator (BU5V)
- Two power switches with loss of ground protection
- Three enable control inputs for selecting the regulators (illumination, audio, AM or FM) and the power switches (PANT and PCON); the standby mode is selected with all enable control inputs at LOW level.

The quiescent current has a very low level of 120 μA (typical value) with the regulator 2 (BU5V) active.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA3682ST	RDBS13P	plastic rectangular-DIL-bent-SIL power package; 13 leads	SOT528-2

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{P2}	supply voltage	regulator 1 on	11.4	14.4	18	V
		regulators 3, 4 and 5 on	10	14.4	18	V
		regulator 2 on	4	–	–	V
		jump start for t ≤ 10 minutes	–	–	30	V
		load dump protection for $t \leq 50$ ms and $t_r \geq 2.5$ ms	–	–	50	V
		overvoltage for shut-down	20	–	–	V
$I_{q(tot)}$	total quiescent supply current	standby mode; V_{P2} = 14.4 V	–	120	150	μA
Voltage regulators						
$V_{o(REG1)}$	output voltage of regulator 1	0.5 mA ≤ I_o ≤ 250 mA	9.89	10.3	10.71	V
$V_{o(REG2)}$	output voltage of regulator 2	0.5 mA ≤ I_o ≤ 300 mA	4.8	5.0	5.2	V
$V_{o(REG3)}$	output voltage of regulator 3	0.5 mA ≤ I_o ≤ 200 mA	7.87	8.2	8.53	V
$V_{o(REG4)}$	output voltage of regulator 4	0.5 mA ≤ I_o ≤ 50 mA	7.87	8.2	8.53	V
$V_{o(REG5)}$	output voltage of regulator 5	0.5 mA ≤ I_o ≤ 50 mA	7.87	8.2	8.53	V
Power switches						
$V_{drop(SW1)}$	dropout voltage of switch 1	I_o = 200 mA	–	0.6	0.8	V
$V_{drop(SW2)}$	dropout voltage of switch 2	I_o = 200 mA	–	0.6	0.8	V
Enable control inputs						
V_{IL}	LOW-level input voltage		–0.2	–	+1.0	V
V_{IM}	MID-level input voltage	not valid for pin EN1	2	–	3	V
V_{IH}	HIGH-level input voltage		4	–	–	V
R_i	input resistance	0 V ≤ V_{EN} ≤ $V_{o(REG2)}$ + 0.3 V	50	–	–	kΩ

BLOCK DIAGRAM

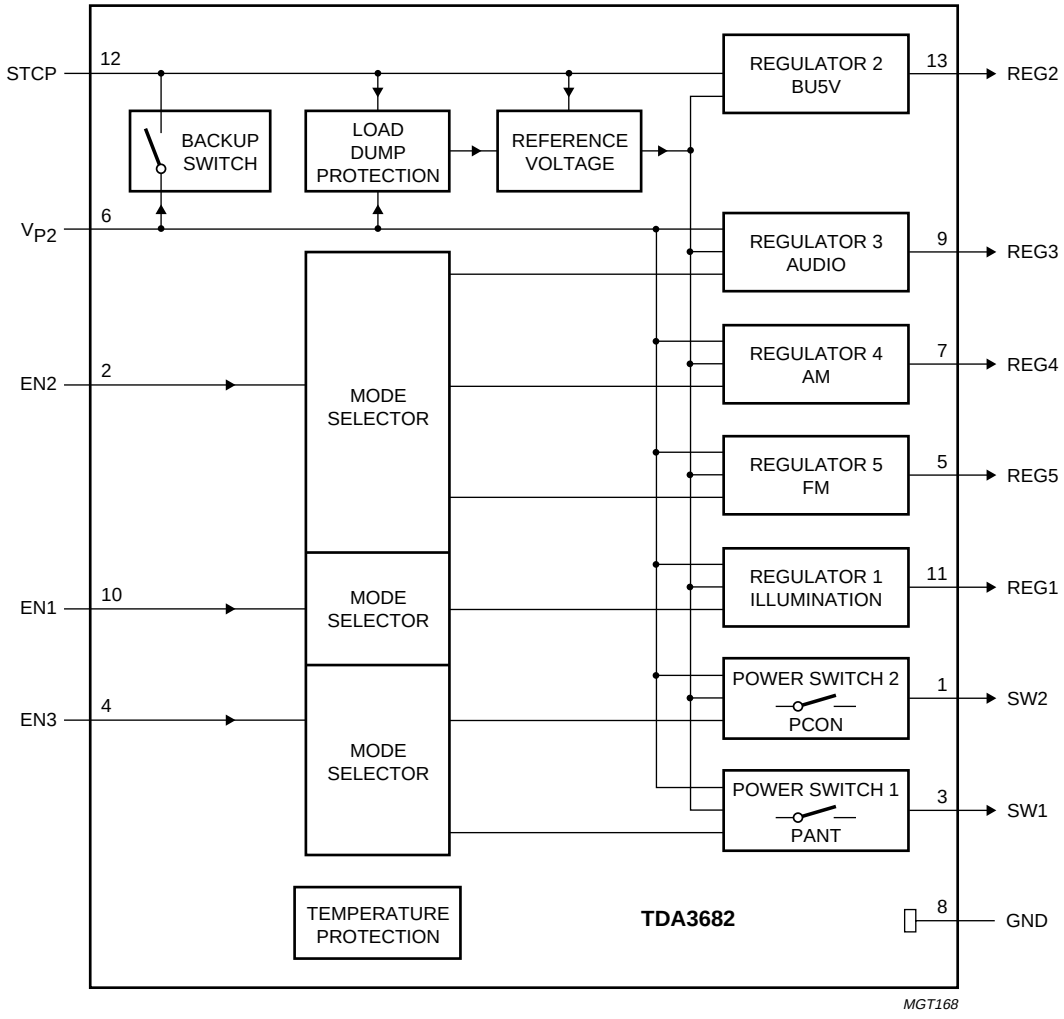


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
SW2	1	power control switch 2 (PCON) output
EN2	2	enable control input 2 for regulator 3 (audio), regulator 4 (AM) and regulator 5 (FM)
SW1	3	power antenna switch 1 (PANT) output
EN3	4	enable control input 3 for power switch 1 (PANT) and power switch 2 (PCON)
REG5	5	regulator 5 (FM) output
V_{P2}	6	supply voltage 2
REG4	7	regulator 4 (AM) output
GND	8	ground
REG3	9	regulator 3 (audio) output
EN1	10	enable control input 1 for regulator 1 (illumination)
REG1	11	regulator 1 (illumination) output
STCP	12	storage capacitor connection for supply voltage of regulator 2
REG2	13	permanent regulator 2 (BU5V) output

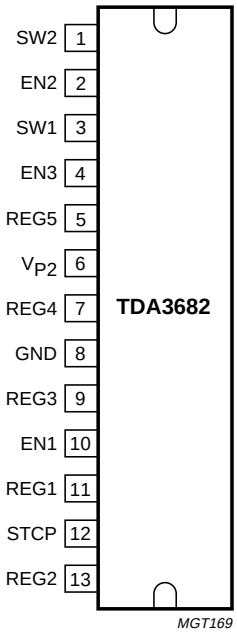


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA3682 is a multiple output voltage regulator with power switches, intended for use in car radios with or without a microprocessor.

It contains:

- Four switchable regulators and one permanent active regulator
- Two power switches with loss of ground protection
- Three enable control inputs EN1, EN2 and EN3.

The quiescent current has a very low level of 120 μA (typical value) with the regulator 2 (BU5V) active.

Because of low voltage operation of the application, low dropout voltage regulators are used in the TDA3682.

Output selection

Regulator 2 is always active and can not be controlled.

All the other regulators and both power switches can be controlled by using pins EN1, EN2 and EN3:

- Pin EN1 controls regulator 1 (illumination); see Table 1
- Pin EN2 selects regulator 3, 4 or 5 (audio, AM or FM); see Table 2
- Pin EN3 selects power switches 1 or 2 (PANT or PCON); see Table 3.

Pins EN2 and EN3 are three-state level control inputs:

- L means: $V_{EN} \leq 1$ V
- M means: $2 \text{ V} \leq V_{EN} \leq 3$ V
- H means: $V_{EN} \geq 4$ V.

Table 1 Enable control pin EN1

EN1	REGULATOR OUTPUT REG1
L	off
H	on

Table 2 Enable control pin EN2

EN2	REGULATOR OUTPUTS		
	REG3	REG4	REG5
L	off	off	off
M	on	off	on
H	on	on	off

Table 3 Enable control pin EN3

EN3	POWER SWITCHES	
	SW1	SW2
L	off	off
M	off	on
H	on	on

Protections

All output pins are fully protected against load dump and short-circuit (foldback current protection); see Fig.3. At load dump all regulator outputs will go low, except the output of regulator 2 (BU5V).

The power switches can withstand ‘loss of ground’. This means that the ground pin is disconnected and the switch output is connected to ground.

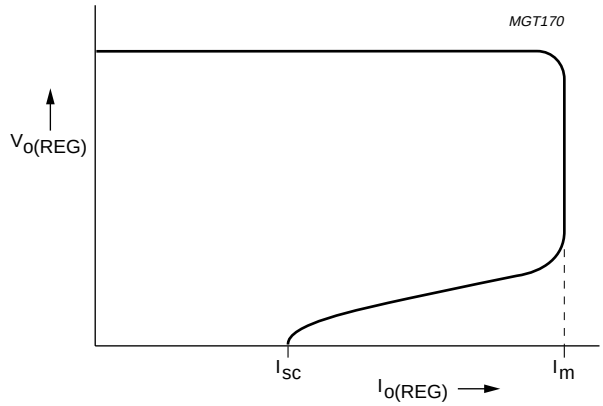


Fig.3 Foldback current protection.

Backup function

A backup function is present. This is realized by a switch function which acts like a sort of ideal diode between pins V_{P2} and STCP. The forward voltage of this ideal diode depends on the current flowing through this diode. This function makes it possible to supply regulator 2 (BU5V) when no supply voltage is present on pin V_{P2}. A special application can be made using a backup function by connecting a capacitor between pin STCP and ground. When the supply voltage is present on pin V_{P2} this capacitor will be charged to a level of $V_{P2} - 0.3$ V. This charge can now be used to supply regulator 2 for a short period of time when V_{P2} is switched to 0 V.

The delay time can be calculated using the formula:

$$t_{delay} = C_{backup} \times R_L \times \frac{V_{P2} - V_{REG2} - 0.5}{V_{REG2}}$$

Example: V_{P2} = 14.4 V, V_{REG2} = 5 V, R_L = 1 kΩ and C_{backup} = 100 μF results in a delay time of 177 ms.

When an overvoltage condition occurs, the voltage on pin STCP will be limited to approximately 18 V.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{P2}	supply voltage	regulators on	–	18	V
		reverse polarity; non-operating	–	18	V
		jump start for t ≤ 10 minutes	–	30	V
		load dump protection for t ≤ 50 ms and $t_r \geq 2.5$ ms	–	50	V
P_{tot}	total power dissipation	T_{amb} = 25 °C			
		infinite heatsink	–	17.8	W
		in free air	–	3.1	W
T_{stg}	storage temperature		–55	+150	°C
T_{amb}	ambient temperature		–40	+85	°C
T_j	junction temperature		–40	+150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th(j-c)}$	thermal resistance from junction to case	7	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	40	K/W

QUALITY SPECIFICATION

In accordance with *"SNW-FQ-611D"*.

CHARACTERISTICS

V_{P2} = 14.4 V; T_{amb} = 25 °C; measured in test circuit of Fig.7; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{P2}	supply voltage	regulator 1 on	11.4	14.4	18	V
		regulators 3, 4 and 5 on	10	14.4	18	V
		regulator 2				
		switched on	4	–	–	V
		in regulation	6.3	–	50	V
		overvoltage for shut-down	20	–	–	V
$I_{q(tot)}$	total quiescent supply current	standby mode; note 1	–	120	150	µA
Enable control inputs: pins EN1, EN2 and EN3						
V_{IL}	LOW-level input voltage		–0.2	–	+1.0	V
V_{IM}	MID-level input voltage	not valid for pin EN1	2	–	3	V
V_{IH}	HIGH-level input voltage		4	–	–	V
R_i	input resistance	$0 V \leq V_{EN} \leq V_{o(REG2)} + 0.3 V$	50	–	–	kΩ
		$V_{EN} > V_{o(REG2)} + 0.3 V$	2	3	–	kΩ

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Regulator 1: pin REG1 (I_o = 5 mA)						
$V_{o(REG1)}$	output voltage of regulator 1	0.5 mA ≤ I_o ≤ 250 mA	9.89	10.3	10.71	V
		12 V ≤ V_{P2} ≤ 18 V	9.89	10.3	10.71	V
ΔV_{line}	line regulation voltage	12 V ≤ V_{P2} ≤ 18 V	–	–	50	mV
ΔV_{load}	load regulation voltage	5 mA ≤ I_o ≤ 250 mA	–	–	100	mV
SVRR	supply voltage ripple rejection	f_i = 120 Hz; V_i = 2 V (p-p)	60	70	–	dB
V_{drop}	dropout voltage	V_{P2} = 10.0 V; I_o = 250 mA; note 2	–	0.4	0.7	V
I_m	current limit	V_o > 8.5 V	300	–	–	mA
I_{sc}	short-circuit current	R_L ≤ 0.5 Ω; note 3	50	–	–	mA
Regulator 2: pin REG2 (I_o = 5 mA)						
$V_{o(REG2)}$	output voltage of regulator 2	0.5 mA ≤ I_o ≤ 300 mA	4.8	5.0	5.2	V
		10 V ≤ V_{P2} ≤ 18 V	4.8	5.0	5.2	V
ΔV_{line}	line regulation	10 V ≤ V_{P2} ≤ 18 V	–	3	50	mV
ΔV_{load}	load regulation	0.5 mA ≤ I_o ≤ 300 mA	–	–	100	mV
SVRR	supply voltage ripple rejection	f_i = 120 Hz; V_i = 2 V (p-p)	60	70	–	dB
V_{drop}	dropout voltage	I_o = 300 mA				
		V_{STCP} = 5.5 V; note 4	–	0.7	0.9	V
		V_{P2} = 6 V; note 5	–	1.3	1.5	V
I_m	current limit	V_o > 4.5 V	350	–	–	mA
I_{sc}	short-circuit current	R_L ≤ 0.5 Ω; note 3	80	100	–	mA
Regulator 3: pin REG3 (I_o = 5 mA)						
$V_{o(REG3)}$	output voltage of regulator 3	0.5 mA ≤ I_o ≤ 200 mA	7.87	8.2	8.53	V
		10 V ≤ V_{P2} ≤ 18 V	7.87	8.2	8.53	V
ΔV_{line}	line regulation	10 V ≤ V_{P2} ≤ 18 V	–	3	50	mV
ΔV_{load}	load regulation	0.5 mA ≤ I_o ≤ 200 mA	–	–	100	mV
SVRR	supply voltage ripple rejection	f_i = 120 Hz; V_i = 2 V (p-p)	60	70	–	dB
V_{drop}	dropout voltage	V_{P2} = 8 V; I_o = 200 mA; note 2	–	0.2	0.4	V
I_m	current limit	V_o > 7 V	250	–	–	mA
I_{sc}	short-circuit current	R_L ≤ 0.5 Ω; note 3	40	–	–	mA
Regulator 4: pin REG4 (I_o = 5 mA)						
$V_{o(REG4)}$	output voltage of regulator 4	0.5 mA ≤ I_o ≤ 50 mA	7.87	8.2	8.53	V
		10 V ≤ V_{P2} ≤ 18 V	7.87	8.2	8.53	V
ΔV_{line}	line regulation	10 V ≤ V_{P2} ≤ 18 V	–	3	50	mV
ΔV_{load}	load regulation	0.5 mA ≤ I_o ≤ 50 mA	–	–	100	mV
SVRR	supply voltage ripple rejection	f_i = 120 Hz; V_i = 2 V (p-p)	65	70	–	dB
V_{drop}	dropout voltage	V_{P2} = 8 V; I_o = 50 mA; note 2	–	0.4	0.7	V
I_m	current limit	V_o > 7 V	75	–	–	mA
I_{sc}	short-circuit current	R_L ≤ 0.5 Ω; note 3	20	–	–	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Regulator 5: pin REG5 (I_o = 5 mA)						
$V_{o(REG5)}$	output voltage of regulator 5	0.5 mA ≤ I_o ≤ 50 mA	7.87	8.2	8.53	V
		10 V ≤ V_{P2} ≤ 18 V	7.87	8.2	8.53	V
ΔV_{line}	line regulation	10 V ≤ V_{P2} ≤ 18 V	–	3	50	mV
ΔV_{load}	load regulation	0.5 mA ≤ I_o ≤ 50 mA	–	–	100	mV
SVRR	supply voltage ripple rejection	f_i = 120 Hz; V_i = 2 V (p-p)	60	70	–	dB
V_{drop}	dropout voltage	V_{P2} = 8 V; I_o = 50 mA; note 2	–	0.2	0.4	V
I_m	current limit	V_o > 7 V	75	–	–	mA
I_{sc}	short-circuit current	R_L ≤ 0.5 Ω; note 3	20	–	–	mA
Power switch 1: pin SW1						
$V_{drop(SW1)}$	dropout voltage	I_o = 200 mA	–	0.6	0.8	V
I_m	current limit	V_o > 11.7 V	0.3	0.55	0.8	A
Power switch 2: pin SW2						
$V_{drop(SW2)}$	dropout voltage	I_o = 200 mA	–	0.6	0.8	V
I_m	current limit	V_o > 11.7 V	0.3	0.55	0.8	A

Notes

1. The quiescent current is measured when $R_L = \infty$ and $V_{EN} \leq 0.8$ V.
2. The dropout voltage of a regulator is the voltage difference between V_{P2} and $V_{o(REG)}$.
3. The foldback current protection limits the dissipation power at short-circuit.
4. The dropout voltage of regulator 2 is the voltage difference between V_{STCP} and $V_{o(REG2)}$ and depends on the load current (see Fig.6).
5. The dropout voltage of regulator 2 is the voltage difference between V_{P2} and $V_{o(REG2)}$ and depends on the load current (see Fig.7).

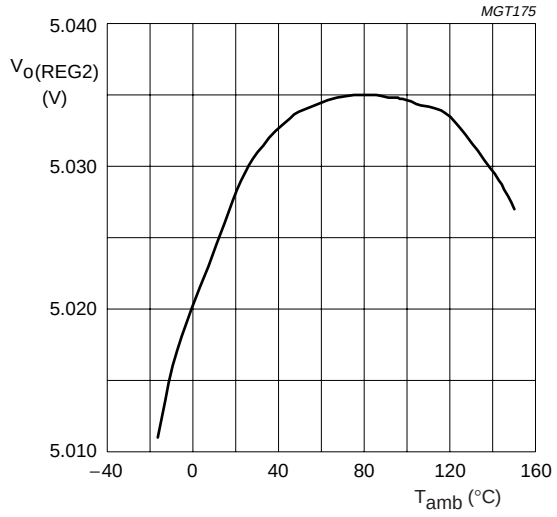


Fig.4 Output voltage of regulator 2 as a function of the ambient temperature.

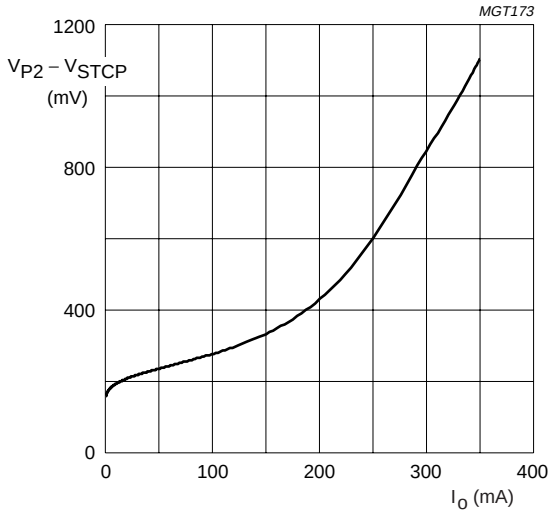


Fig.5 Voltage drop of V_{P2} as a function of the output current of regulator 2.

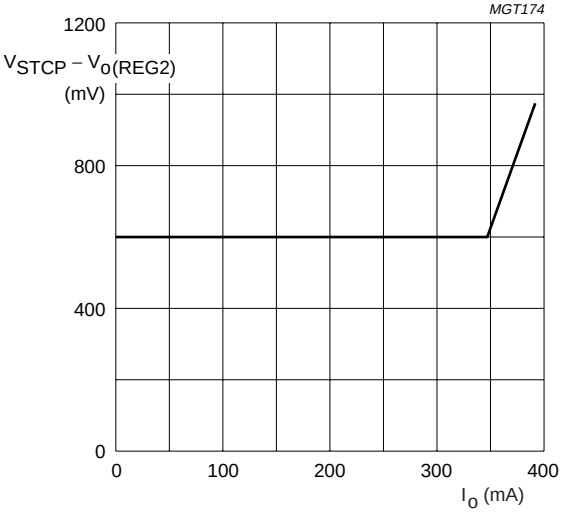


Fig.6 Dropout voltage of V_{STCP} as a function of the output current of regulator 2.

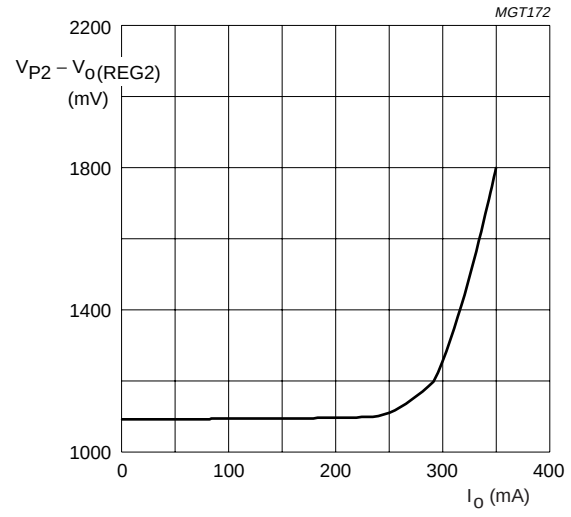
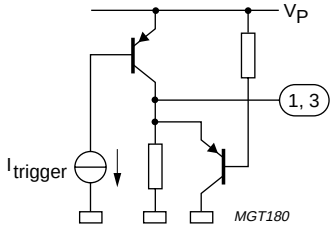
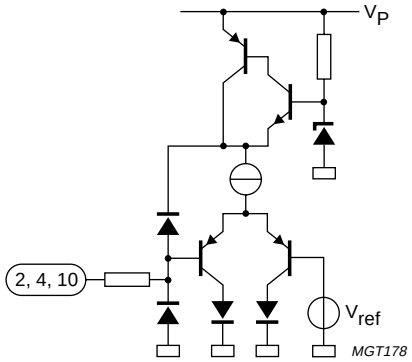
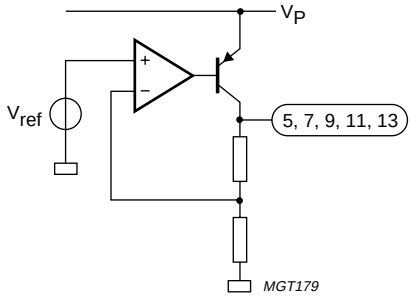
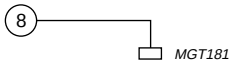


Fig.7 Dropout voltage of V_{P2} as a function of the output current of regulator 2.

INTERNAL PIN CONFIGURATION

PIN	SYMBOL	EQUIVALENT CIRCUIT
1	SW2	
3	SW1	
2	EN2	
4	EN3	
10	EN1	
5	REG5	
7	REG4	
9	REG3	
11	REG1	
13	REG2	
6	V_{P2}	
8	GND	
12	STCP	

TEST AND APPLICATION INFORMATION

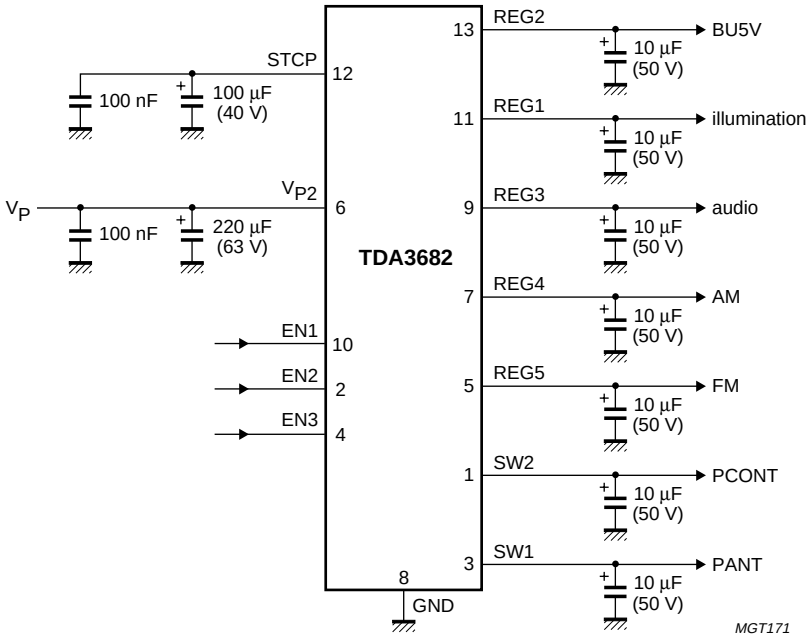


Fig.7 Test and application circuit.

Application information

NOISE

The outputs of regulators 1 to 5 are designed in such a way that the noise is very low and the stability is very good. The noise output voltage depends on output capacitor C_o. Table 4 shows the influence of the output capacitor on the noise figure.

Table 4 Noise figures

REGULATOR	NOISE FIGURE (μV)(1)		
	C_o = 10 μF	C_o = 47 μF	C_o = 100 μF
1	170	130	120
2	110	100	95
3	140	110	100
4	140	110	100
5	140	110	100

Note

1. Measured at a bandwidth from 20 Hz to 20 kHz.

STABILITY

The regulators are made stable with the externally connected output capacitors. The stability can be guaranteed with almost any output capacitor. When only an electrolytic capacitor is used, the temperature behaviour of this output capacitor can cause oscillations at extreme low temperature. The following two examples show how an output capacitor value is selected. Oscillation problems can be avoided by adding a 47 nF capacitor in parallel with the electrolytic capacitor.

Example 1 (regulator 2)

Regulator 2 (BU5V) is stabilized with an electrolytic output capacitor of 10 μF (ESR = 4 Ω). At T_{amb} = –30 °C the capacitor value is decreased to 3 μF and the ESR is increased to 28 Ω. As can be seen from Fig.8 the regulator will be instable at T_{amb} = –30 °C.

Solution: To avoid problems with stability at low temperatures, the use of tantalum capacitors is recommended. Use a tantalum capacitor with a value of 10 μF or an electrolytic capacitor with a higher value.

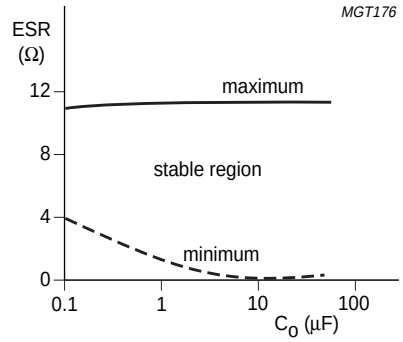


Fig.8 Curve for selecting the value of the output capacitor for regulator 2.

Example 2 (regulator 1)

Regulator 1 (illumination) is stabilized with an electrolytic capacitor of 2.2 μF (ESR = 8 Ω). At T_{amb} = – 30 °C the capacitor value is decreased to 0.8 μF and the ESR is increased to 56 Ω. As can be seen from Fig.9 the regulator will be stable at T_{amb} = –30 °C.

Even when only a small MKT capacitor of 47 nF is used as the output capacitor, regulator 1 will remain stable over the temperature range.

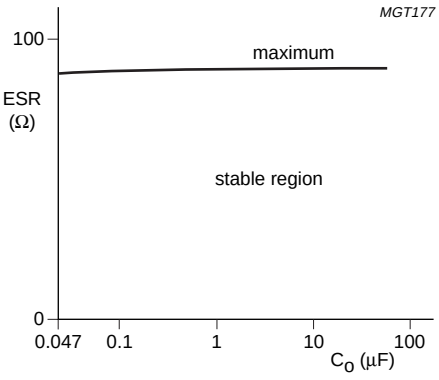
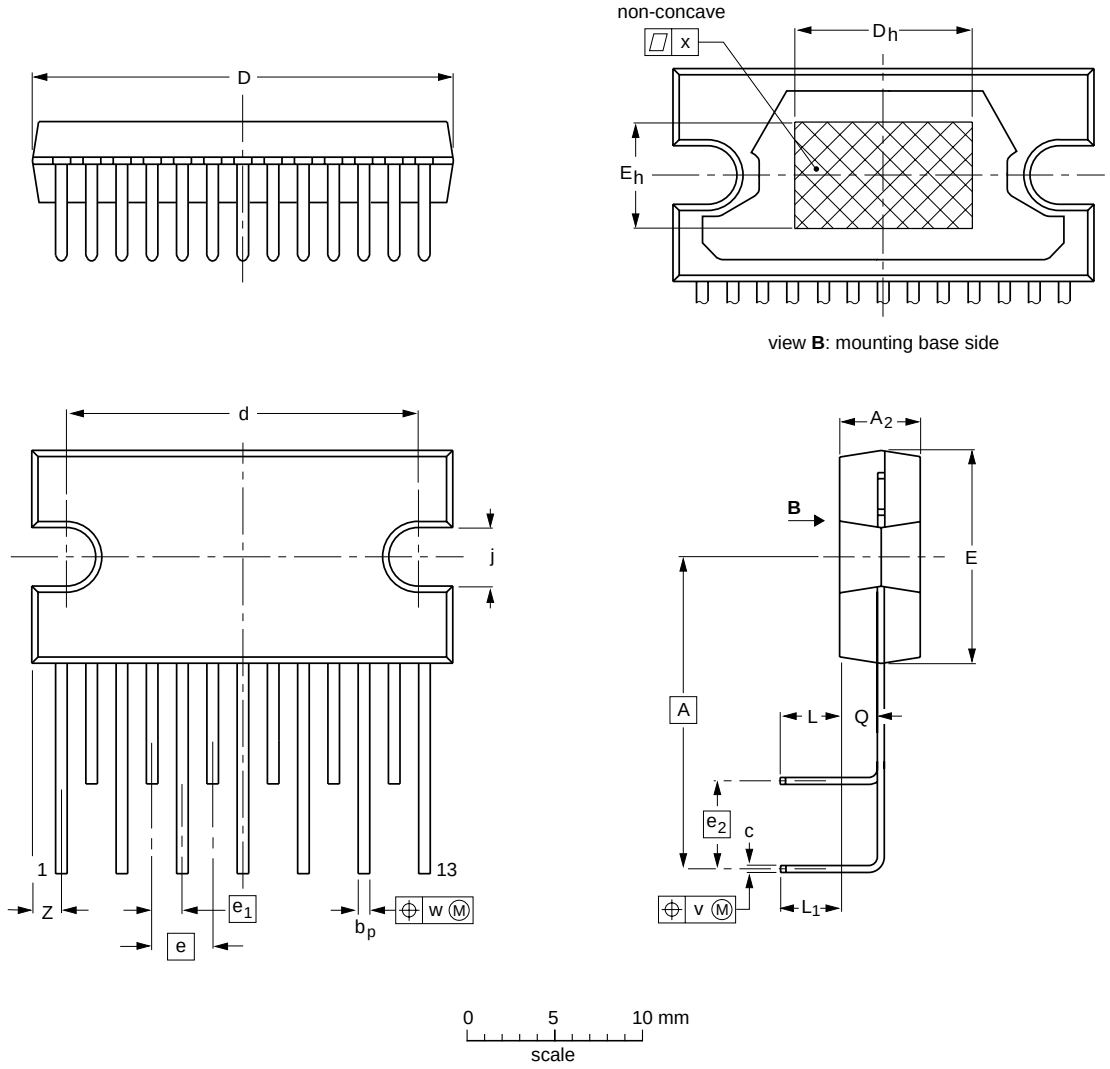


Fig.9 Curve for selecting the value of the output capacitor for regulators 1, 3, 4 and 5.

PACKAGE OUTLINE

RDBS13P: plastic rectangular-DIL-bent-SIL power package; 13 leads **SOT528-2**



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_1	Q	v	w	x	$Z^{(1)}$
mm	17.7	4.6 4.4	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	3.75 3.15	3.75 3.15	2.1 1.8	0.6	0.4	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			
SOT528-2						00-10-19

SOLDERING

Introduction to soldering through-hole mount packages

This text gives a brief insight to wave, dip and manual soldering. 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).

Wave soldering is the preferred method for mounting of through-hole mount IC packages on a printed-circuit board.

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.

Suitability of through-hole mount IC packages for dipping and wave soldering methods

PACKAGE	SOLDERING METHOD	
	DIPPING	WAVE
DBS, DIP, HDIP, SDIP, SIL	suitable	suitable[1]

Note

1. For SDIP packages, the longitudinal axis must be parallel to the transport direction of the printed-circuit board.

DATA SHEET STATUS

DATA SHEET STATUS[1]	PRODUCT STATUS[2]	DEFINITIONS
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A.

Notes

1. Please consult the most recently issued data sheet before initiating or completing a design.
2. The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.

DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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.

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