

TOFET dual high side switch

PIP3207-DC

DESCRIPTION

Monolithic dual channel high side protected power switch in TOPFET2 technology assembled in a 7 pin plastic surface mount package.

APPLICATIONS

General purpose switch for driving lamps, motors, solenoids, heaters.

FEATURES

- Vertical power TrenchMOS
- Low on-state resistance
- CMOS logic compatible
- Very low quiescent current
- Overtemperature protection
- Load current limiting
- Overload and short circuit protection
- Self resetting overcurrent protection
- Overvoltage and undervoltage shutdown with hysteresis
- Off-state open circuit load detection
- Diagnostic status indication
- Voltage clamping for turn off of inductive loads
- ESD protection on all pins
- Reverse battery, overvoltage and transient protection

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	UNIT
I_L	Nominal load current (ISO)	8	A
SYMBOL	PARAMETER	MAX.	UNIT
V_{BG}	Continuous off-state supply voltage	50	V
I_L	Continuous load current	16	A
T_j	Continuous junction temperature	150	°C
R_{ON}	On-state resistance, $T_j = 25^{\circ}\text{C}$	40	mΩ

FUNCTIONAL BLOCK DIAGRAM

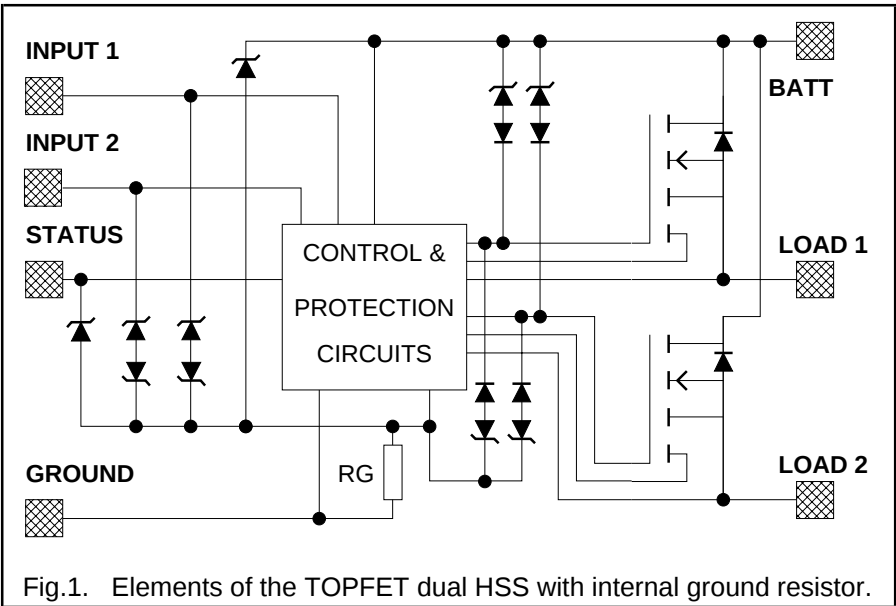


Fig.1. Elements of the TOPFET dual HSS with internal ground resistor.

PINNING - SOT427

PIN	DESCRIPTION
1	load 1
2	ground
3	input 1
4	connected to mb
5	status
6	input 2
7	load 2
mb	battery

PIN CONFIGURATION

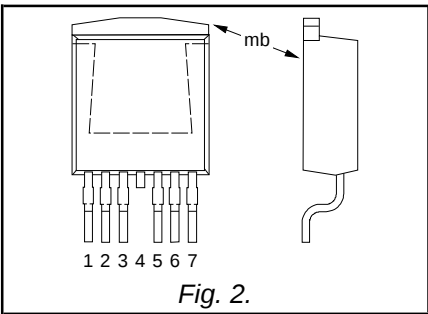


Fig. 2.

SYMBOL

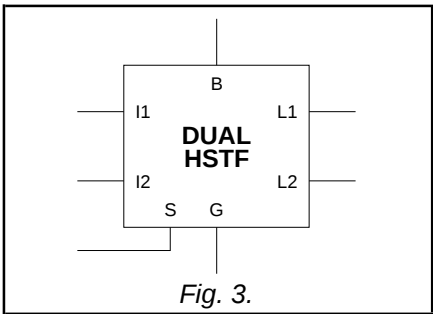


Fig. 3.

CONVENTION

Positive currents flow into pins, except for load and ground pins.

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LIMITING VALUES

Limiting values in accordance with the Absolute Maximum System (IEC 134)

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{BG}	Continuous supply voltage		0	50	V
I_L	Continuous load current per channel	$T_{mb} \leq 135^\circ\text{C}$	-	8	A
P_D	Total power dissipation	$T_{mb} \leq 25^\circ\text{C}$	-	83.3	W
T_{stg}	Storage temperature		-55	175	$^\circ\text{C}$
T_j	Continuous junction temperature ¹		-40	150	$^\circ\text{C}$
V_{GB}	Reverse battery voltages² Continuous reverse voltage		-	16	V
V_{GB}	Peak reverse voltage		-	32	V
	Application information				
R_I, R_S	External resistors ³	to limit input, status currents	3.2	-	$k\Omega$
	Input and status currents				
I_I	Continuous input current		-5	5	mA
I_S	Continuous status current		-5	5	mA
I_I	Repetitive peak input current	$\delta \leq 0.1, t_p = 300 \mu\text{s}$	-50	50	mA
I_S	Repetitive peak status current	$\delta \leq 0.1, t_p = 300 \mu\text{s}$	-50	50	mA
E_{BL}	Inductive load clamping Non-repetitive clamping energy (one channel)	$V_{BG} = 13 \text{ V}, I_L = 8 \text{ A}$ $T_j = 150^\circ\text{C}$ prior to turn-off	-	150	mJ

ESD LIMITING VALUE

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_C	Electrostatic discharge capacitor voltage	Human body model; $C = 250 \text{ pF}; R = 1.5 \text{ k}\Omega$	-	2	kV

1 For normal continuous operation. A higher T_j is allowed as an overload condition but at the threshold $T_{j(To)}$ the over temperature trip operates to protect the switch.

2 Reverse battery voltage is allowed only with external resistors to ensure that the input and status currents do not exceed the limiting values. The internal ground resistor limits the reverse battery ground current. The connected loads must limit the reverse load currents. Power is dissipated and the T_j rating must be observed.

3 To limit currents during reverse battery and transient overvoltages (positive or negative).

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THERMAL CHARACTERISTIC

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$R_{th\ j-mb}$	Thermal resistance ¹ Junction to mounting base	per channel	-	2.4	3	K/W
		both channels	-	1.2	1.5	K/W

STATIC CHARACTERISTICS

Limits are at $-40^{\circ}\text{C} \leq T_{mb} \leq 150^{\circ}\text{C}$ and typicals at $T_{mb} = 25^{\circ}\text{C}$ unless otherwise stated

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{BG} V_{BL} V_{GL}	Clamping voltages					
	Battery to ground	$I_G = 1\text{ mA}$	45	55	65	V
	Battery to load per channel	$I_L = I_G = 1\text{ mA}$	50	55	65	V
	Ground to load ²	$I_L = 10\text{ mA}$ $I_L = 10\text{ A}; t_p = 300\text{ }\mu\text{s}$	18 20	23 25	28 30	V
V_{BG}	Supply voltage Operating range ³	battery to ground -	5.5	-	35	V
I_B	Currents Total quiescent current ⁴	$9\text{ V} \leq V_{BG} \leq 35\text{ V}$ $V_{LG} = 0\text{ V}$ $T_{mb} = 25^{\circ}\text{C}$	-	-	20	μA
I_L	Off-state load current per channel	$V_{BL} = V_{BG}$ $T_{mb} = 25^{\circ}\text{C}$	-	0.1	1	μA
I_G	Operating current	one channel on both channels on	-	1.8 3.6	3 6	μA mA
I_L	Nominal load current ⁵	$V_{BL} = 0.5\text{ V}; T_{mb} = 85^{\circ}\text{C}$	8	-	-	A
R_G	Effective internal ground resistance ⁶	$I_G = -200\text{ mA}; t_p = 300\text{ }\mu\text{s}$	40	75	100	Ω
R_{ON} R_{ON}	Resistances per channel On-state resistance On-state resistance	V_{BG} 9 to 35 V				
		10 A				
		t_p ⁷ 300 μs				
		T_j 25 $^{\circ}\text{C}$ 150 $^{\circ}\text{C}$				
			-	30	40	m Ω
			-	60	80	m Ω
		5.5 V	-	50	60	m Ω
			-	100	120	m Ω

1 Of the output Power MOS transistors.

2 For a high side switch, the load pin voltage goes negative with respect to ground during the turn-off of an inductive load. This negative voltage is clamped by the device.

3 On-state resistance is increased if the supply voltage is less than 7 V.

4 This is the continuous current drawn from the battery when both inputs are low and includes leakage currents to the loads.

5 Per channel but with both channels conducting. Defined as in ISO 10483-1.

6 Equivalent of the parallel connected resistors for both channels.

7 The supply and input voltage for the R_{ON} tests are continuous. The specified pulse duration t_p refers only to the applied load current.

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INPUT CHARACTERISTICS

$5.5 \text{ V} \leq V_{BG} \leq 35 \text{ V}$. Limits are at $-40^\circ\text{C} \leq T_{mb} \leq 150^\circ\text{C}$ and typicals at $T_{mb} = 25^\circ\text{C}$ unless otherwise stated.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_I	Input current	$V_{IG} = 5 \text{ V}$	20	60	160	μA
V_{IG}	Input clamping voltage	$I_I = 200 \mu\text{A}$	5.5	7	8.5	V
$V_{IG(ON)}$	Input turn-on threshold voltage		-	2.1	3	V
$V_{IG(OFF)}$	Input turn-off threshold voltage		1.2	1.8	-	V
ΔV_{IG}	Input turn-on hysteresis		0.15	0.3	0.5	V
$I_{I(ON)}$	Input turn-on current	$V_{IG} = 3 \text{ V}$	-	-	100	μA
$I_{I(OFF)}$	Input turn-off current	$V_{IG} = 1.2 \text{ V}$	12	-	-	μA

OPEN CIRCUIT DETECTION CHARACTERISTICS

An open circuit load on either channel can be detected in the off-state. Refer to TRUTH TABLE.

This feature requires external load pull-up to a positive supply voltage via a suitable resistor.

Limits are at $-40^\circ\text{C} \leq T_{mb} \leq 150^\circ\text{C}$ and typical is at $T_{mb} = 25^\circ\text{C}$.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Open circuit detection						
$V_{LG(OC)}$	Load ground threshold voltage	$V_{BG} \geq 9 \text{ V}$	1.5	2.5	3.5	V
$I_{B(OC)}$	Supply quiescent current per OC channel	$V_{BG} = V_{LG} = 16 \text{ V}$ open circuit detected, other channel off	-	0.8	1.5	mA
$-I_{L(OC)}$	Load ground current per channel	$V_{LG} = 16 \text{ V}$ $V_{LG} = 3.5 \text{ V}$	-	200	300	μA
$t_{d(OC)}$	Status delay time	input low to status low	-	65	100	μs
Application information						
R_{ext}	External load pull-up resistance per channel	$V_{ext} = 5 \text{ V}$	-	10	-	k Ω

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UNDERVOLTAGE & OVERVOLTAGE CHARACTERISTICSLimits are at $-40^{\circ}\text{C} \leq T_{\text{mb}} \leq 150^{\circ}\text{C}$ and typicals at $T_{\text{mb}} = 25^{\circ}\text{C}$. Refer to TRUTH TABLE.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Undervoltage						
$V_{\text{BG(UV)}}$	Low supply threshold voltage ¹		2	4.2	5.3	V
$\Delta V_{\text{BG(UV)}}$	Hysteresis		0.1	0.5	1	V
Overvoltage						
$V_{\text{BG(OV)}}$	High supply threshold voltage ²		35	40	45	V
$\Delta V_{\text{BG(OV)}}$	Hysteresis		0.4	1	2	V
$I_{\text{BG(OV)}}$	Operating current per channel	$V_{\text{BG}} > V_{\text{BG(OV)}}$	-	1	2	mA

OVERLOAD PROTECTION CHARACTERISTICS

Independent protection per channel. Refer to TRUTH TABLE.

 $5.5\text{ V} \leq V_{\text{BG}} \leq 35\text{ V}$, limits are at $-40^{\circ}\text{C} \leq T_{\text{mb}} \leq 150^{\circ}\text{C}$ and typicals at $T_{\text{mb}} = 25^{\circ}\text{C}$ unless otherwise stated.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I _{L(lim)}	Overload protection	V _{BL} = V _{BG} ; t _p = 300 μs				
	Load current limiting	V _{BG} ≥ 8 V	18	30	42	A
		V _{BG} = 5.5 V	15	27	42	A
P _{D(TO)}	Short circuit load protection	T _{mb} ≤ 125°C prior to overload ³				
	Overload power threshold	for protection ⁴	100	150	200	W
T _{DSC}	Characteristic time	which determines trip time ⁵	-	200	500	μs
	Overtemperature protection					
T _{j(TO)}	Threshold junction temperature		150	170	190	°C
ΔT _{j(TO)}	Hysteresis ⁶		3	10	20	°C

¹ Undervoltage sensors causes each channel to switch off and reset.² Overvoltage sensors causes each output channel to switch off to protect its load.³ Above this temperature measurement of these parameters is prevented because OT protection may occur prior to SC protection.⁴ Normal operation will be resumed when $P_{\text{D}} < P_{\text{D(TO)}}$ and $T_{\text{j}} < T_{\text{j(TO)}}$.⁵ Trip time $t_{\text{d sc}}$ varies with overload dissipation P_{D} according to the *exponential model* formula $t_{\text{d sc}} \approx T_{\text{DSC}} / \text{LN}[P_{\text{D}} / P_{\text{D(TO)}}]$.⁶ After cooling below the reset temperature the channel will resume normal operation.

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STATUS CHARACTERISTICS

The status output is an open drain transistor, and requires an external pull-up circuit to indicate a logic high. Limits are at $-40^{\circ}\text{C} \leq T_{\text{mb}} \leq 150^{\circ}\text{C}$ and typicals at $T_{\text{mb}} = 25^{\circ}\text{C}$ unless otherwise stated. Refer to TRUTH TABLE.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{SG}	Status clamping voltage	$I_{\text{S}} = 100\ \mu\text{A}$	5.5	7	8.5	V
$V_{\text{SG(LO)}}$	Status low voltage	$I_{\text{S}} = 100\ \mu\text{A}$	-	0.7	0.9	V
I_{S}	Status leakage current	$I_{\text{S}} = 250\ \mu\text{A}$	-	-	1.1	V
		$V_{\text{SG}} = 5\ \text{V}$	-	-	10	μA
		$T_{\text{mb}} = 25^{\circ}\text{C}$	-	0.1	1	μA
$I_{\text{S(SAT)}}$	Status saturation current ¹	$V_{\text{SG}} = 5\ \text{V}$	5	10	15	mA
Application information						
R_{S}	External pull-up resistor		-	47	-	k Ω

TRUTH TABLE

INPUT		ABNORMAL CONDITIONS DETECTED								LOAD OUTPUT		STATUS	DESCRIPTION
		SUPPLY		LOAD 1			LOAD 2						
1	2	UV	OV	OC	SC	OT	OC	SC	OT	1	2		
L	L	0	X	0	X	X	0	X	X	OFF	OFF	H	both off & normal
L	L	0	X	1	X	X	X	X	X	OFF	OFF	L	both off, one/both OC or short to V+
L	H	0	X	1	X	X	0	0	0	OFF	ON	L	one off & OC, other on & normal
H	L	0	0	0	0	0	0	0	0	ON	OFF	H	one on & normal, other off & normal
H	H	0	0	0	0	0	0	0	0	ON	ON	H	both on & normal
H	X	1	0	X	X	X	0	X	X	OFF	OFF	H	supply undervoltage lockout
H	X	0	1	X	0	0	X	0	0	OFF	OFF	H	supply overvoltage shutdown
H	X	0	0	0	1	X	X	X	X	OFF	X	L	one SC shutdown
H	L	0	0	0	1	X	0	0	X	OFF	OFF	L	one SC shutdown, other off & normal
H	H	0	0	0	1	X	0	0	0	OFF	ON	L	one SC shutdown, other on & normal
H	X	0	0	0	0	1	X	X	X	OFF	X	L	one OT shutdown
H	L	0	0	0	0	1	0	0	X	OFF	OFF	L	one OT shutdown, other off & normal
H	H	0	0	0	0	1	0	0	0	OFF	ON	L	one OT shutdown, other on & normal

KEY TO ABBREVIATIONS

L	logic low	UV	undervoltage
H	logic high	OV	overvoltage
X	don't care	OC	open circuit
0	condition not present	SC	short circuit
1	condition present	OT	overtemperature

¹ For example with the pull-up resistor short circuited while the status transistor is conducting. This condition should be avoided in order to prevent possible interference with normal operation of the device.

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SWITCHING CHARACTERISTICS
 $T_{mb} = 25\text{ }^{\circ}\text{C}$, $V_{BG} = 13\text{ V}$, for resistive load $R_L = 13\text{ }\Omega$ per channel.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
t_{don}	During turn-on Delay time	from input going high to 10% V_L	-	30	-	μs
dV/dt_{on}	Rate of rise of load voltage	30% to 70% V_L	0.5	1	2	$\text{V}/\mu\text{s}$
t_{on}	Total switching time	to 90% V_L	-	100	400	μs
t_{doff}	During turn-off Delay time	from input going low to 90% V_L	-	20	-	μs
dV/dt_{off}	Rate of fall of load voltage	70% to 30% V_L	0.5	1	2	$\text{V}/\mu\text{s}$
t_{off}	Total switching time	to 10% V_L	-	40	200	μs

CAPACITANCES
 $T_{mb} = 25\text{ }^{\circ}\text{C}$; $f = 1\text{ MHz}$; $V_{IG} = 0\text{ V}$

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
C_{sg}	Status capacitance	$V_{SG} = 5\text{ V}$	-	11	15	pF
C_{ig}	per channel Input capacitance	$V_{BG} = 13\text{ V}$	-	15	20	pF
C_{bl}	Output capacitance	$V_{BL} = 13\text{ V}$	-	265	375	pF

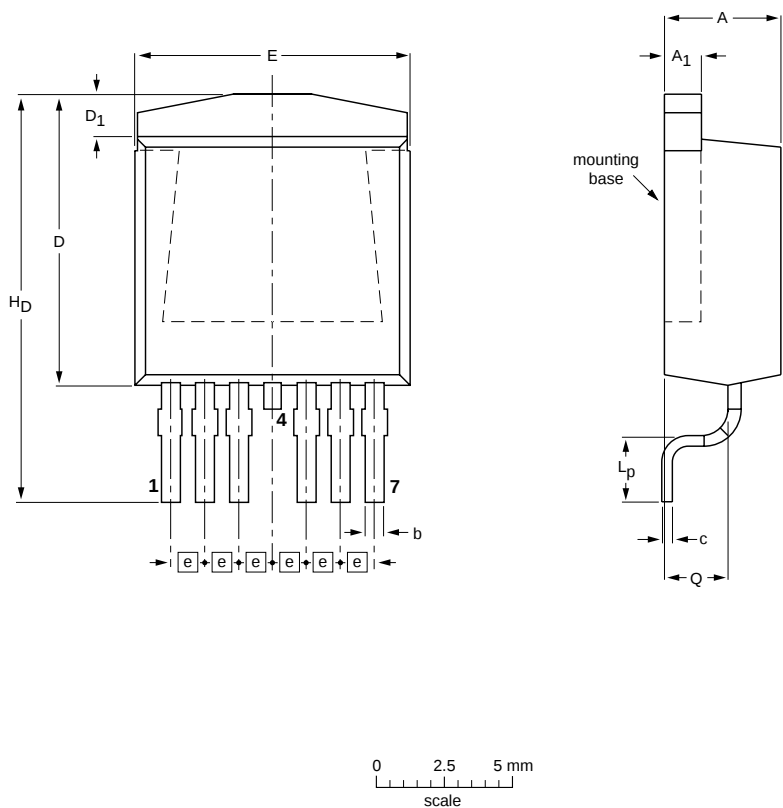
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MECHANICAL DATA

Plastic single-ended surface mounted package (Philips version of D²-PAK);
7 leads (one lead cropped)

SOT427



DIMENSIONS (mm are the original dimensions)

UNIT	A	A ₁	b	c	D max.	D ₁	E	e	L _p	H _D	Q
mm	4.50 4.10	1.40 1.27	0.85 0.60	0.64 0.46	11	1.60 1.20	10.30 9.70	1.27	2.90 2.10	15.80 14.80	2.60 2.20

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT427						99-06-25 01-04-18

Fig.4. SOT427 surface mounting package¹, centre pin connected to mounting base.

¹ Epoxy meets UL94 V0 at 1/8". Net mass: 1.5 g.
For soldering guidelines and SMD footprint design, please refer to Data Handbook SC18.

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DEFINITIONS

DATA SHEET STATUS		
DATA SHEET STATUS¹	PRODUCT STATUS²	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
Limiting values		
Limiting values are given 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 this 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.		
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