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BUK208-50Y; BUK213-50Y

Single channel high-side TOPFET™

Rev. 02 — 06 June 2002 Product data

1. Product profile

1.1 Description

Monolithic temperature and overload protected single high-side power switch based on TOPFET™ Trench technology in a 5-pin surface mount or leadform plastic package.

Product availability:

BUK208-50Y in SOT263B-01

BUK213-50Y in SOT426 (D^2-PAK).

1.2 Features

- Very low quiescent current
- Power TrenchMOS™
- Overtemperature protection
- Over and undervoltage protection
- Reverse battery protection
- Low charge pump noise
- Loss of ground protection
- CMOS logic capability
- Negative load clamping
- Overload protection
- ESD protection for all pins
- Diagnostic status indication
- Operating voltage down to 5.5 V
- Current limitation.

1.3 Applications

- 12 and 24V grounded loads
- Inductive loads
- High inrush current loads
- Replacement for relays and fuses.

1.4 Quick reference data

Table 1: Quick reference data

Symbol	Parameter	Min	Max	Unit
R_{BLon}	on-state resistance at 25 °C	-	100	mΩ
I_L	continuous load current	-	8.5	A
$I_{L(nom)}$	nominal load current (ISO)	3.6	-	A
$I_{L(lim)}$	limiting load current	12	24	A
V_{BG}	operating voltage	5.5	35	V

PHILIPS

2. Pinning information

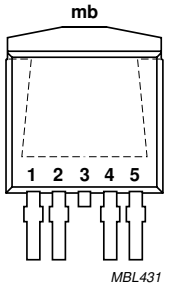


Fig 1. Pinning; SOT426 (D^2-PAK).

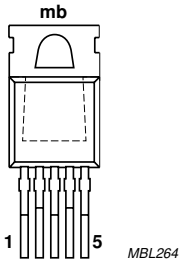


Fig 2. Pinning; SOT263B-01.

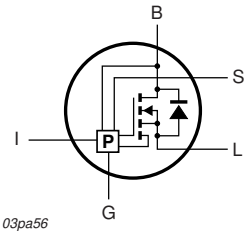


Fig 3. Symbol; (HSS) TOPFET™.

2.1 Pin description

Table 2: Pin description

Symbol	Pin	I/O		Description
G	1	-		circuit common ground
I	2	I		input
B	3	-	[1] [2]	battery
S	4	O		status
L	5	O		load
-	mb	-	[2]	mounting base

[1] It is not possible to make a connection to pin 3 of the SOT426 package.

[2] The battery is connected to the mounting base.

3. Block diagram

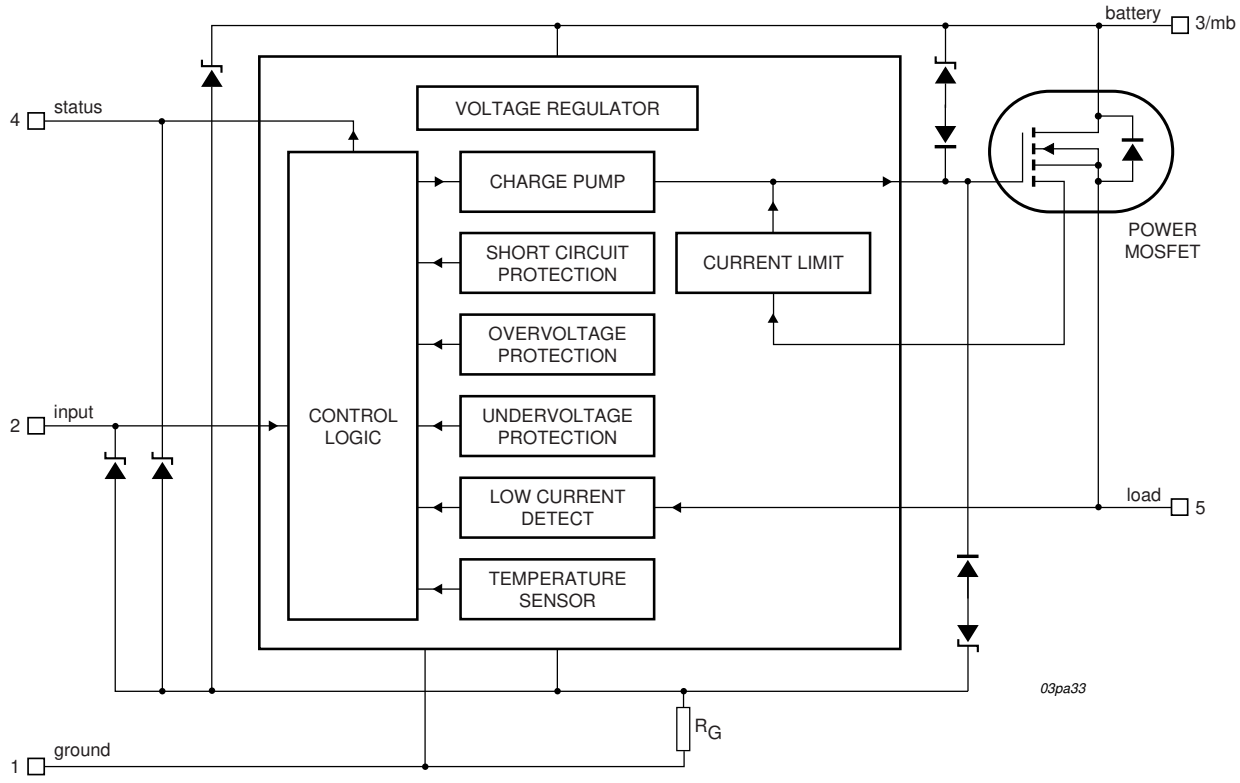


Fig 4. Elements of the high-side TOPFET switch.

4. Functional description

Table 3: Truth table

Abbreviations: L = logic LOW; H = logic HIGH; X = don't care; 0 = condition not present; 1 = condition present; UV = undervoltage; OV = overvoltage; LC = low current or open circuit load; SC = short circuit; OT = overtemperature [1].

Input	Supply		Load			Load output	Status	Operating mode
	UV	OV	LC	SC	OT			
L	X	X	X	X	X	OFF	H	off
H	0	0	0	0	0	ON	H	on & normal
H	0	0	1	0	0	ON	L	on & low current detect
H	1	0	X	X	X	OFF	H	supply undervoltage lockout
H	0	1	X	0	0	OFF	H	supply overvoltage shutdown
H	0	0	0	1	X	OFF	L	SC tripped
H	0	0	0	0	1	OFF	L	OT shutdown

[1] The status will continue to indicate OT (even if the input goes LOW) until the device cools below the reset threshold. See "Overtemperature protection" characteristics in Table 6.

5. Limiting values

Table 4: Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{BG}	continuous supply voltage			-	50	V
I_L	continuous load current	$T_{mb} \leq 112$ °C		-	8.5	A
P_{tot}	total power dissipation	$T_{mb} \leq 25$ °C		-	48	W
T_{stg}	storage temperature			–55	+175	°C
T_j	junction temperature			-	150	°C
T_{mb}	mounting base temperature	during soldering (≤ 10 s)		-	260	°C
Reverse battery voltage						
V_{BG}	continuous reverse voltage		[1]	-	16	V
V_{BG}	repetitive reverse voltage			-	32	V
External resistor						
R_I	external resistor		[2]	3.3	-	kΩ
R_S			[3]	3.3	-	kΩ
Input current						
I_I	continuous current			–5	+5	mA
I_I	repetitive peak current	$\delta \leq 0.1$; $t_p = 300$ µs		–50	+50	mA
Status current						
I_S	continuous current			–5	+5	mA
I_S	repetitive peak current	$\delta \leq 0.1$; $t_p = 300$ µs		–50	+50	mA
Inductive load clamping						
$E_{BL(CL)}$	non-repetitive clamping energy	$T_j = 150$ °C prior to turn-off; $I_L = 2$ A		-	100	mJ
Electrostatic discharge						
V_{esd}	electrostatic discharge voltage	Human body model; C = 100 pF; R = 1.5 kΩ		-	2	kV

[1] Reverse battery voltage is only allowed with external resistors to limit the input and status currents to a safe value. The connected load must limit the reverse current. The internal ground resistor limits the reverse battery ground current.

[2] To limit input current during reverse battery and transient overvoltages.

[3] To limit status current during reverse battery and transient overvoltages.

6. Thermal characteristics

Table 5: Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j\text{-}mb)}$	thermal resistance from junction to mounting base		-	2.1	2.6	K/W
$R_{th(j\text{-}a)}$	thermal resistance from junction to ambient	mounted on printed circuit board; minimum footprint; SOT426	-	-	50	K/W

7. Static characteristics

Table 6: Static characteristics

Limits are valid for −40 °C ≤ T_{mb} ≤ +150 °C and typical values for T_{mb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Clamping voltage							
V_{BG}	battery-ground voltage	I_G = 1 mA; Figure 6		50	55	65	V
V_{BL}	battery-load voltage	$I_L = I_G$ = 1 mA		50	55	65	V
V_{LG}	negative load-ground	I_L = 10 mA; Figure 12 and 14		−18	−23	−28	V
V_{LG}	negative load voltage	I_L = 2 A; t_p = 300 µs	[1]	−20	−25	−30	V
Supply voltage							
V_{BG}	operating range	battery-ground		5.5	-	35	V
Current							
I_B	quiescent current	V_{LG} = 0 V; Figure 10	[2]				
		T_{mb} = 150 °C		-	-	20	µA
		T_{mb} = 25 °C		-	0.1	2	µA
I_L	off-state load current	$V_{BL} = V_{BG}$					
		T_{mb} = 150 °C		-	-	20	µA
		T_{mb} = 25 °C		-	0.1	1	µA
I_G	operating current	Figure 6		-	2	4	mA
$I_{L(nom)}$	nominal load current (ISO)	V_{BL} = 0.5 V; T_{mb} = 85 °C	[3]	3.6	-	-	A
Resistance [4]							
R_{BLon}	on-state resistance	9 ≤ V_{BG} ≤ 35 V; I_L = 2 A; Figure 5					
		T_{mb} = 25 °C		-	80	100	mΩ
		T_{mb} = 150 °C		-	-	200	mΩ
		V_{BG} = 6 V; I_L = 2 A					
		T_{mb} = 25 °C		-	100	125	mΩ
		T_{mb} = 150 °C		-	-	250	mΩ
R_G	internal ground resistance	I_G = 10 mA		95	150	190	Ω
Input [5]							
I_I	input current	V_{IG} = 5 V		20	90	160	µA
V_{IG}	input clamping voltage	I_I = 200 µA		5.5	7	8.5	V
$V_{IG(ON)}$	input turn-on threshold voltage	Figure 9		-	2.4	3	V
$V_{IG(OFF)}$	input turn-off threshold voltage			1.5	2.1	-	V
ΔV_{IG}	input turn-on threshold hysteresis			-	0.3	-	V
$I_{I(ON)}$	input turn-on current	V_{IG} = 3 V		-	-	100	µA
$I_{I(OFF)}$	input turn-off current	V_{IG} = 1.5 V		10	-	-	µA
Low current detection [6][9]							
$I_{L(LC)}$	low current detection threshold	T_{mb} = −40 to +150 °C		90	-	600	mA
		T_{mb} = 25 °C; Figure 15		150	300	450	mA
$\Delta I_{L(LC)}$	hysteresis			-	60	-	mA
Undervoltage [9]							
$V_{BG(UV)}$	low supply threshold voltage		[7]	2	4.2	5.5	V

Table 6: Static characteristics...*continued*

Limits are valid for −40 °C ≤ T_{mb} ≤ +150 °C and typical values for T_{mb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$\Delta V_{BG(UV)}$	hysteresis			-	0.5	-	V
Overvoltage [9]							
$V_{BG(OV)}$	high supply threshold voltage		[8]	40	45	50	V
$\Delta V_{BG(OV)}$	hysteresis			-	1	-	V
Overload protection [9]							
$I_{L(lim)}$	limiting load current	$V_{BG} \geq 9$ V; $V_{BL} = V_{BG}$; Figure 8	[10]	12	18	24	A
Short circuit load protection [9][10]							
$V_{BL(TO)}$	battery load threshold voltage	V_{BG} = 16 V; Figure 11	[11]	8	10	12	V
		V_{BG} = 35 V		15	20	25	V
Overtemperature protection [9][10]							
$T_{j(TO)}$	threshold junction temperature		[12]	150	170	190	°C
$\Delta T_{j(TO)}$	hysteresis			-	10	-	°C
Status [5][9]							
V_{SG}	status clamping voltage	I_S = 100 µA		5.5	7	8.5	V
V_{SG}	status low voltage	I_S = 100 µA; Figure 7					
		T_{mb} = −40 °C		-	-	1	V
		T_{mb} = 25 °C		-	0.7	0.8	V
I_S	status leakage current	V_{SG} = 5 V					
		T_{mb} = 150 °C		-	-	15	µA
		T_{mb} = 25 °C		-	0.1	1	µA
R_S	external pull-up resistor	V_{SG} = 5 V	[13]	-	47	-	kΩ

[1] For a high-side switch, the load pin voltage goes negative with respect to ground during the turn-off of an inductive load.

[2] This is the current drawn from the supply when the input is LOW, and includes leakage current to the load.

[3] Defined as in ISO 10483-1. For comparison purposes only.

[4] The supply and input voltages for the R_{BLon} tests are continuous. The specified pulse duration is t_p = 300 µs, and refers only to the applied load current.

[5] 9 V ≤ V_{BG} ≤ 16 V

[6] 9 V ≤ V_{BG} ≤ 35 V. A low current load can be detected in the on-state.

[7] Undervoltage sensor causes the device to switch off and reset.

[8] Overvoltage sensor causes the device to switch off to protect the load.

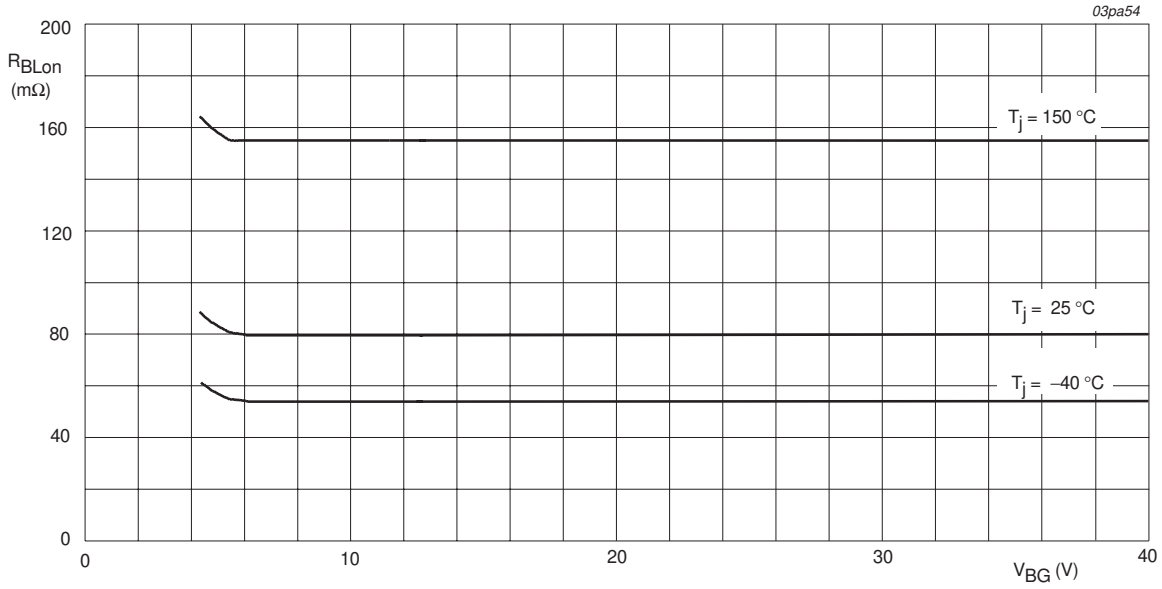
[9] See Table 3 “Truth table”

[10] 5.5 V ≤ V_{BG} ≤ 35 V

[11] The battery to load threshold voltage for short circuit is approximately proportional to the battery supply voltage.

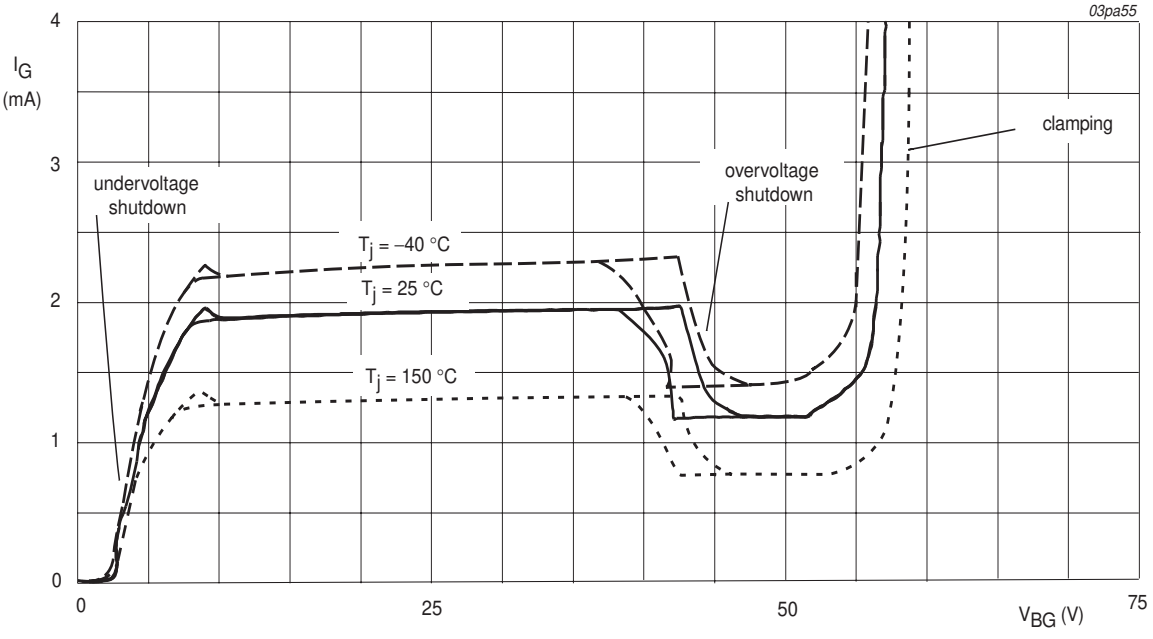
[12] After cooling below the reset temperature the switch will resume normal operation.

[13] The status output is an open drain transistor and requires an external pull-up circuit to indicate a logic HIGH



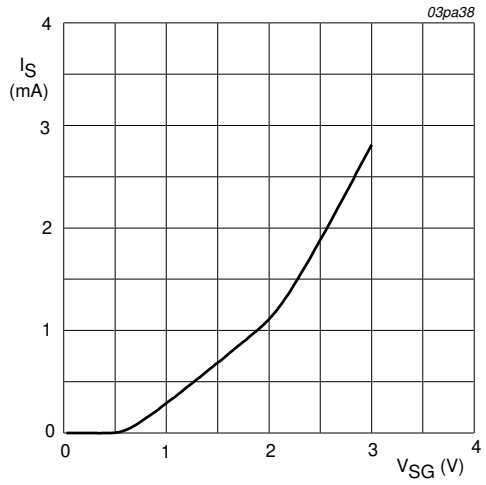
I_L = 2 A; V_{IG} = 5 V

Fig 5. Battery-load on-state resistance as a function of battery-ground voltage; typical values.



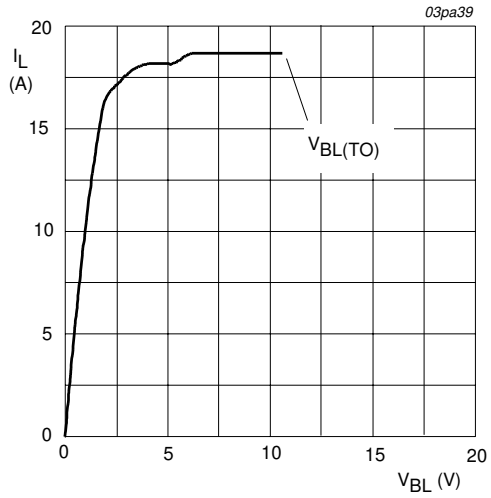
V_{IG} = 5 V

Fig 6. Supply current characteristics: battery-ground operating current as a function of battery-ground voltage; typical values.



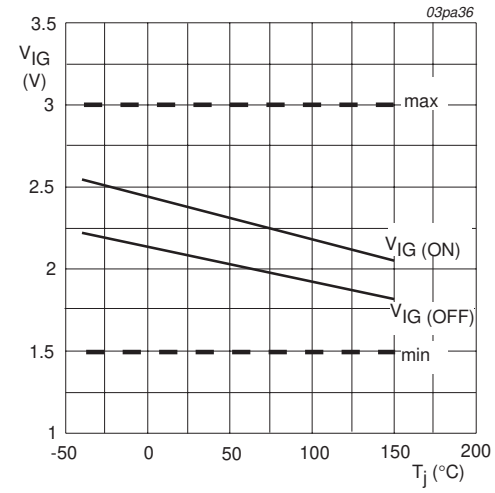
V_{BG} = 13 V; V_{IG} = 5 V; T_j = 25 °C

Fig 7. Status current as a function of status-ground voltage; typical values.



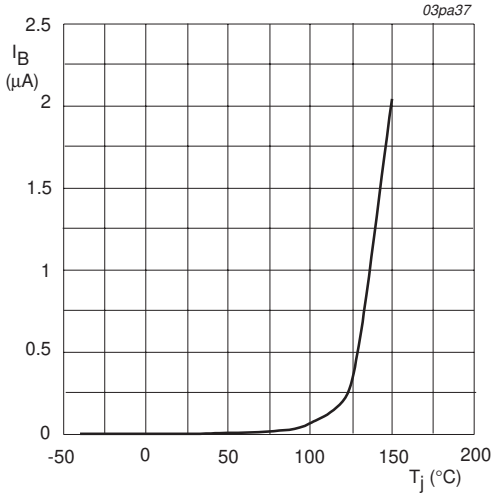
V_{BG} = 16 V; V_{IG} = 5 V; T_j = 25 °C (the device trips after ±200 µs, and the status goes LOW).

Fig 8. Load current limiting as a function of battery-load voltage; typical values.



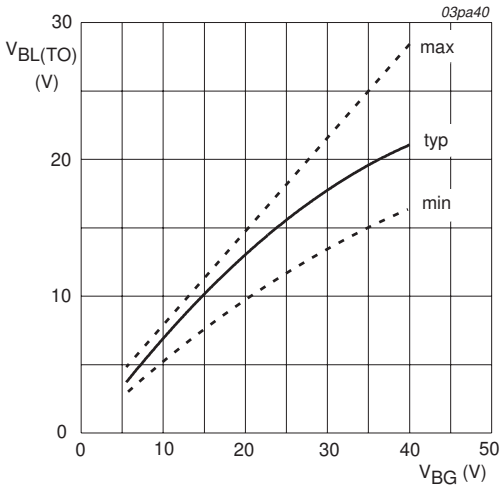
9 V ≤ V_{BG} ≤ 16 V

Fig 9. Input-source threshold voltage as a function of junction temperature.



V_{BG} = 16 V

Fig 10. Supply quiescent current as a function of junction temperature; typical values.



V_{IG} = 5 V; −40 °C ≤ T_j ≤ +150 °C

Fig 11. Battery-load threshold voltage as a function of battery-ground voltage.

8. Dynamic characteristics

Table 7: Switching characteristics

T_{mb} = 25 °C; V_{BG} = 13 V; resistive load R_L = 13 Ω. Figure 13

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Turn-on measured from the input going HIGH						
$t_{d(on)}$	turn-on delay time	to 10% V_L	-	50	80	µs
dV/dt_{on}	rising slew rate	30 to 70% V_L	-	0.5	1.0	V/µs
t_{on}	turn-on switching time	to 90% V_L	-	85	160	µs
Turn-off measured from the input going LOW						
$t_{d(off)}$	turn-off delay time	to 90% V_L	-	50	80	µs
dV/dt_{off}	falling slew rate	70 to 30% V_L	-	0.8	1.2	V/µs
t_{off}	turn-off switching time	to 10% V_L	-	70	120	µs

Table 8: Status response times

Limits are valid for −40 °C ≤ T_{mb} ≤ +150 °C and typical values for T_{mb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Measured from when the input goes HIGH						
$t_{d(sc)}$	short circuit response time	$V_{BL} > V_{BL(TO)}$; Figure 16	-	180	250	µs
$t_{d(lc)}$	low current detect response time	$I_L < I_{L(LC)}$; Figure 15	-	200	-	µs

Table 9: Capacitances

T_{mb} = 25 °C; f = 1 MHz; V_{IG} = 0 V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{ig}	input capacitance	V_{BG} = 13 V	-	15	20	pF
C_{bl}	output capacitance	V_{BL} = 13 V	-	130	185	pF
C_{sg}	status capacitance	V_{SG} = 5 V	-	11	15	pF

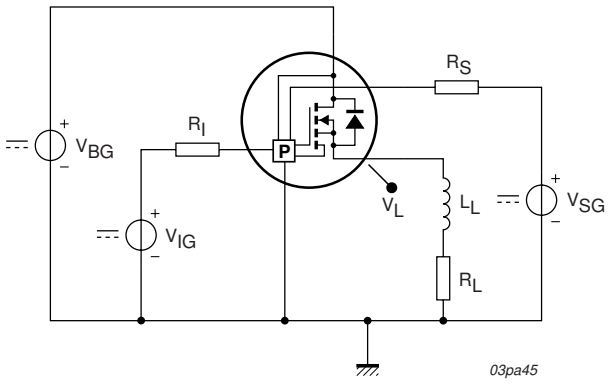
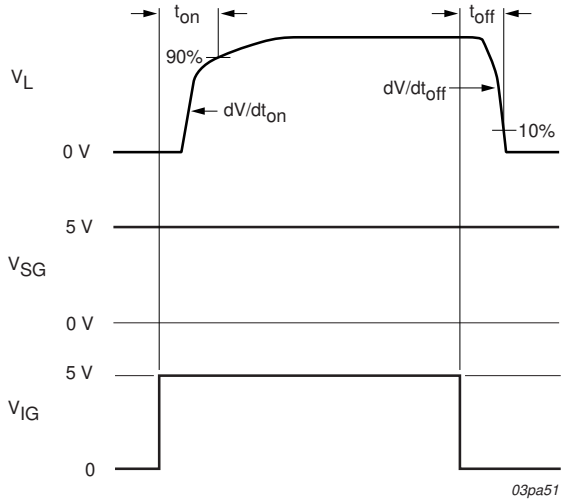


Fig 12. Schematic drawing of the switching circuit.



V_{BG} = 13 V; V_{IG} = 5 V and T_j = 25 °C

Fig 13. Resistive switching waveforms and definitions.

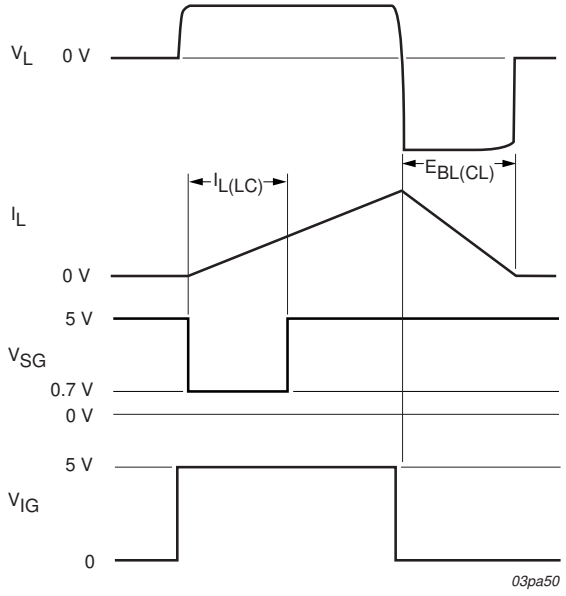


Fig 14. Switching a large inductive load.

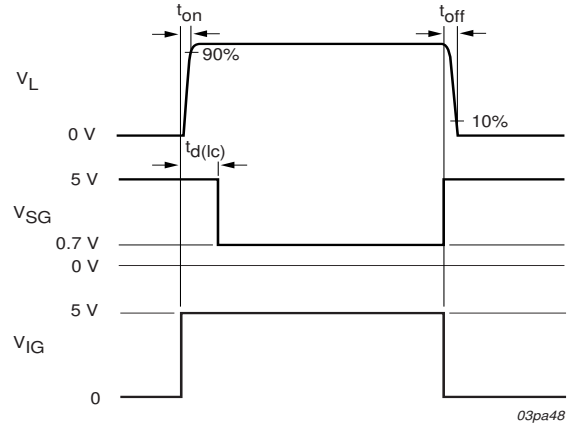
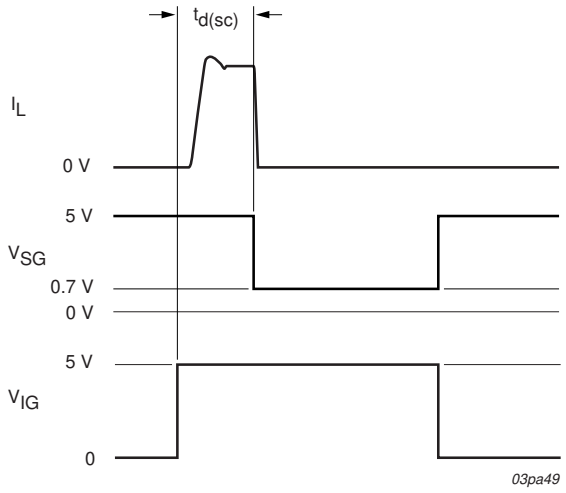


Fig 15. Low current detection waveforms.

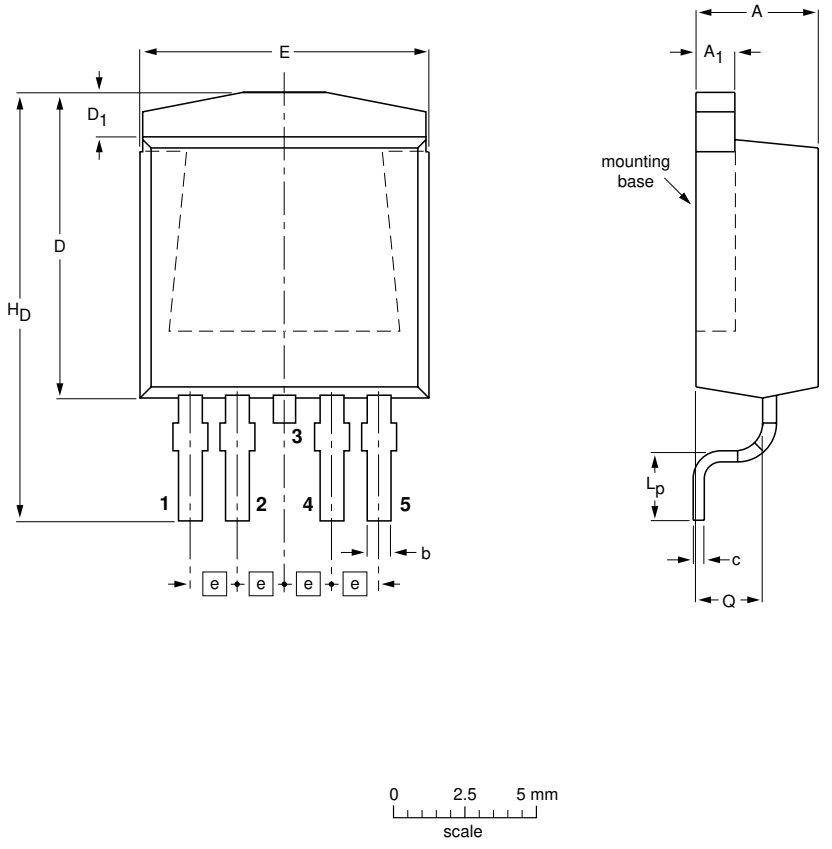


$V_{BL} \geq V_{BL(TO)}$

Fig 16. Short circuit protection waveforms.

9. Package outline

Plastic single-ended surface mounted package (Philips version of D^2-PAK); 5 leads (one lead cropped) **SOT426**



DIMENSIONS (mm are the original dimensions)

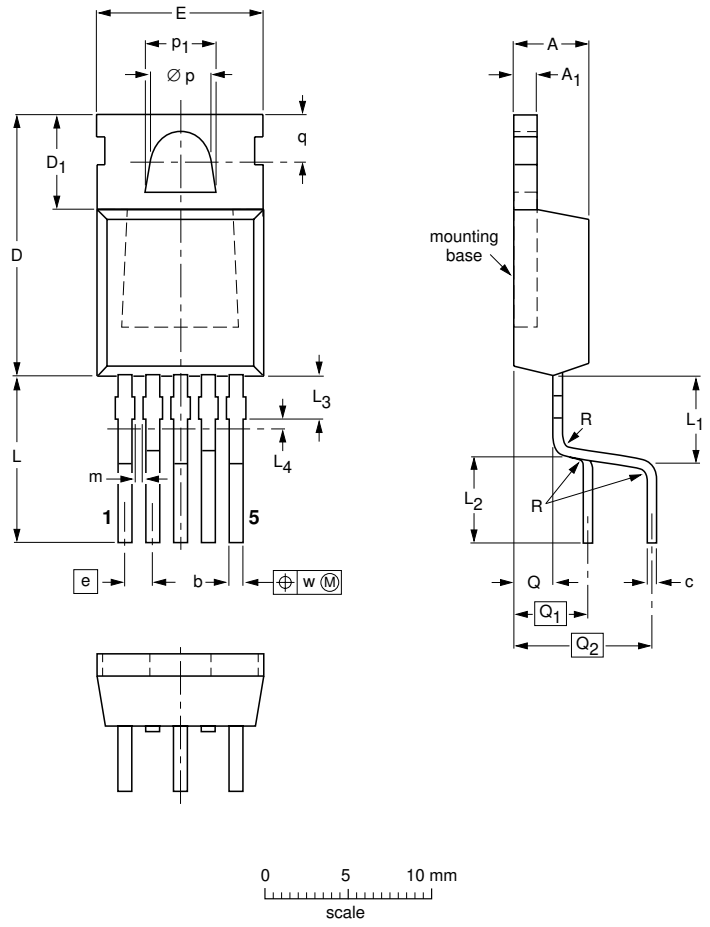
UNIT	A	A_1	b	c	D max.	D_1	E	e	L_p	H_D	Q
mm	4.50 4.10	1.40 1.27	0.85 0.60	0.64 0.46	11	1.60 1.20	10.30 9.70	1.70	2.90 2.10	15.80 14.80	2.60 2.20

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT426						~~98-12-14~~ 99-06-25

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

Fig 17. SOT426.

Plastic single-ended package; heatsink mounted; 1 mounting hole; 5-lead TO-220 lead form option **SOT263B-01**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b	c	D	D_1	E	e	L	L_1	L_2	L_3(1)	L_4(2) max.	m	∅ p	p_1	q	Q	Q_1	Q_2	R	w
mm	4.5 4.1	1.39 1.27	0.85 0.70	0.7 0.4	15.8 15.2	6.4 5.9	10.3 9.7	1.7	9.8 9.7	5.9 5.3	5.2 5.0	2.4 1.6	0.5	0.8 0.6	3.8 3.6	4.3 4.1	3.0 2.7	2.0	4.5	8.2	0.5	0.4

Notes

1. Terminal dimensions are uncontrolled in this zone.
2. Positional accuracy of the terminals is controlled in this zone.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT263B-01		5-lead (option) TO-220				01-01-11

Refer to mounting instructions for TO-220 packages. Epoxy meets UL94 VO at 1/8". Net mass: 2g

Fig 18. SOT263B-01.

10. Revision history

Table 10: Revision history

Rev	Date	CPCN	Description
02	20020606	-	**Product data (9397 750 09384); supersedes Product specification BUK208-50Y_1 (Rev 2.000) of March 2001 and Product specification BUK213-50Y_1 (Rev 2.000) of March 2001.** Modifications: • The format of this specification has been redesigned to comply with Philips Semiconductors new presentation and information standard.

11. Data sheet status

Data sheet status[1]	Product status[2]	Definition
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.

[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.

12. 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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