BUK208-50Y; BUK213-50Y

Single channel high-side TOPFET™ Rev. 02 — 06 June 2002

Product data

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 (D2-PAK).

1.2 Features

- Very low guiescent 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

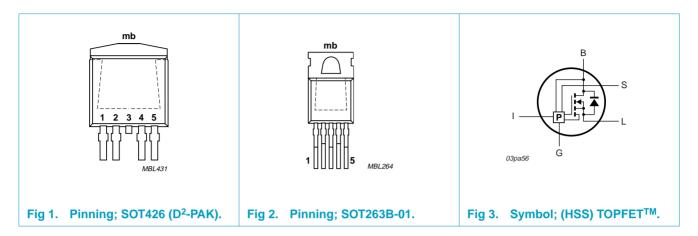
Table 1: **Quick reference data**

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





2. Pinning information



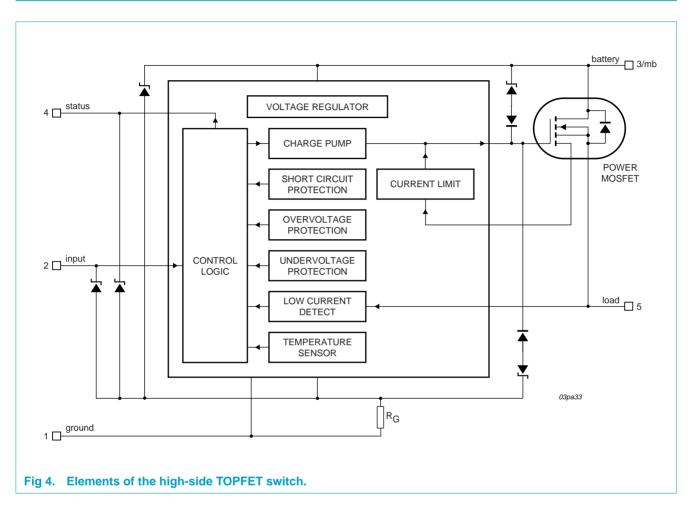
2.1 Pin description

Table 2: Pin description

Symbol	Pin	I/O		Description
G	1	-		circuit common ground
I	2	ı		input
В	3	-	[1] [2]	battery
S	4	0		status
L	5	0		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



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].

UV OV LC SC OT output L X X X X X X OFF H off H 0 0 0 0 ON H on & normal H 0 0 1 0 ON L on & low current detect H 1 0 X X X OFF H supply undervoltage lockout H 0 1 X 0 OFF H supply overvoltage shutdown H 0 0 0 1 X OFF L SC tripped	Input	Sup	ply		Load		Load	Status	Operating mode
H 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 OFF H supply overvoltage shutdown H 0 0 0 1 X OFF L SC tripped		UV	OV	LC	SC	OT	output		
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 OFF H supply overvoltage shutdown H 0 0 0 1 X OFF L SC tripped	L	Χ	X	X	X	X	OFF	Н	off
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 1 X OFF L SC tripped	Н	0	0	0	0	0	ON	Н	on & normal
H 0 1 X 0 0 OFF H supply overvoltage shutdown H 0 0 0 1 X OFF L SC tripped	Н	0	0	1	0	0	ON	L	on & low current detect
H 0 0 0 1 X OFF L SC tripped	Н	1	0	Х	Х	X	OFF	Н	supply undervoltage lockout
	Н	0	1	Х	0	0	OFF	Н	supply overvoltage shutdown
H 0 0 0 1 OFF I OT shutdown	Н	0	0	0	1	Х	OFF	L	SC tripped
11 0 0 0 1 OH E OF SHULLOWIT	Н	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).

in Max	I Init
50	V
8.5	Α
48	W
55 +175	5 °C
150	°C
260	°C
16	V
32	V
3 -	kΩ
3 -	kΩ
5 +5	mA
50 +50	mA
5 +5	mA
50 +50	mA
100	mJ
2	kV
	100

^[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.

6. Thermal characteristics

Table 5: Thermal characteristics

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

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

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

7. Static characteristics

Table 6: Static characteristics

Limits are valid for $-40 \,^{\circ}\text{C} \le T_{mb} \le +150 \,^{\circ}\text{C}$ and typical values for $T_{mb} = 25 \,^{\circ}\text{C}$ unless otherwise specified.

Symbol	Parameter	Conditions		Min	Тур	Max	Unit
Clamping	yvoltage						
V_{BG}	battery-ground voltage	I _G = 1 mA; Figure 6		50	55	65	V
V_{BL}	battery-load voltage	$I_L = I_G = 1 \text{ mA}$		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 vo	oltage						
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	μΑ
		T _{mb} = 25 °C		-	0.1	2	μΑ
IL	off-state load current	$V_{BL} = V_{BG}$					
		T _{mb} = 150 °C		-	-	20	μΑ
		T _{mb} = 25 °C		-	0.1	1	μΑ
I _G	operating current	Figure 6		-	2	4	mA
I _{L(nom)}	nominal load current (ISO)	$V_{BL} = 0.5 \text{ V}; T_{mb} = 85 ^{\circ}\text{C}$	[3]	3.6	-	-	Α
Resistan	ce ^[4]						
R _{BLon}	on-state resistance	$9 \le V_{BG} \le 35 \text{ V}; I_L = 2 \text{ A}; Figure 5$					
		T _{mb} = 25 °C		-	80	100	$m\Omega$
		T _{mb} = 150 °C		-	-	200	mΩ
		V _{BG} = 6 V; I _L = 2 A					
		T _{mb} = 25 °C		-	100	125	$m\Omega$
		T _{mb} = 150 °C		-	-	250	$m\Omega$
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	μΑ
V_{IG}	input clamping voltage	Ι _Ι = 200 μΑ		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	μΑ
I _{I(OFF)}	input turn-off current	V _{IG} = 1.5 V		10	-	-	μΑ
	ent detection [6][9]						
I _{L(LC)}	low current detection threshold	$T_{mb} = -40 \text{ to } +150 ^{\circ}\text{C}$		90	-	600	mA
· - /		T _{mb} = 25 °C; Figure 15		150	300	450	mA
$\Delta I_{L(LC)}$	hysteresis	-		-	60	-	mA
Undervol	•						
V _{BG(UV)}	low supply threshold voltage		[7]	2	4.2	5.5	V

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Table 6: Static characteristics...continued

Limits are valid for $-40\,^{\circ}C \le T_{mb} \le +150\,^{\circ}C$ and typical values for $T_{mb} = 25\,^{\circ}C$ unless otherwise specified.

Symbol	Parameter	Conditions		Min	Тур	Max	Unit
$\Delta V_{BG(UV)}$	hysteresis			-	0.5	-	V
Overvolt	age ^[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	$V_{BG} \ge 9 \text{ V}; V_{BL} = V_{BG}; \text{ Figure 8}$	[10]	12	18	24	Α
Short cir	cuit 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
Overtem	perature 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	$I_{S} = 100 \mu A$		5.5	7	8.5	V
V_{SG}	status low voltage	$I_S = 100 \mu A$; Figure 7					
		$T_{mb} = -40 ^{\circ}C$		-	-	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	μΑ
		T _{mb} = 25 °C		-	0.1	1	μΑ
Rs	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 $t_p = 300 \,\mu s$, and refers only to the applied load current.
- [5] $9 \text{ V} \le \text{V}_{BG} \le 16 \text{ V}$
- [6] $9 \text{ V} \leq \text{V}_{BG} \leq 35 \text{ V}$. 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] $5.5 \text{ V} \le \text{V}_{BG} \le 35 \text{ V}$
- [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

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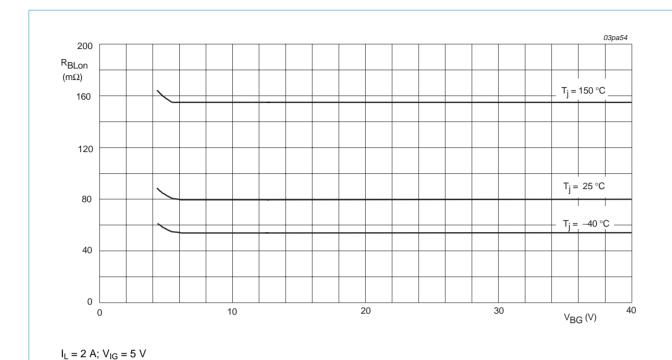


Fig 5. Battery-load on-state resistance as a function of battery-ground voltage; typical values.

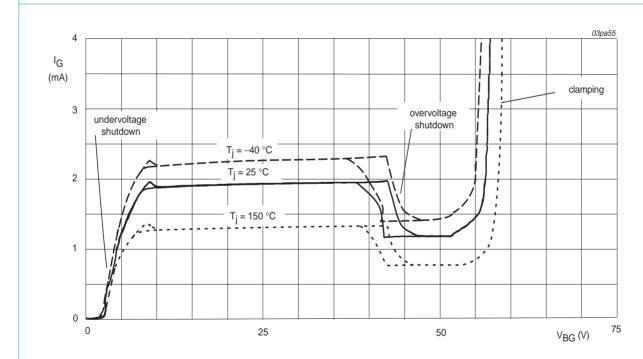
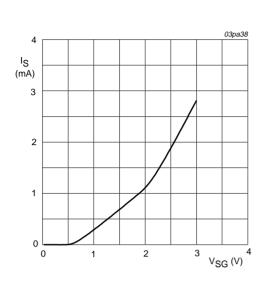


Fig 6. Supply current characteristics: battery-ground operating current as a function of battery-ground voltage; typical values.

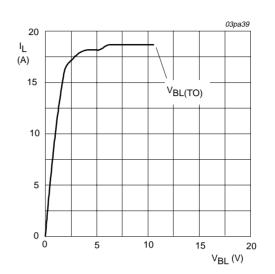
 $V_{IG} = 5 V$

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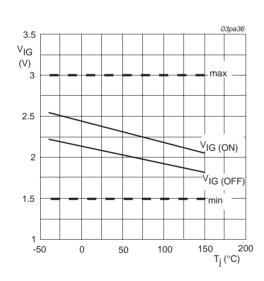
 $V_{BG} = 13 \text{ V}; V_{IG} = 5 \text{ V}; T_i = 25 ^{\circ}\text{C}$

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



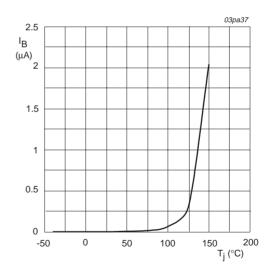
 V_{BG} = 16 V; V_{IG} = 5 V; T_{J} = 25 °C (the device trips after ±200 μ s, and the status goes LOW).

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



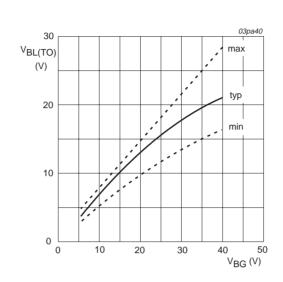
 $9 \text{ V} \leq \text{V}_{BG} \leq 16 \text{ V}$

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



 $V_{BG} = 16 \text{ V}$

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



 V_{IG} = 5 V; -40 °C \leq T $_{i}$ \leq +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	Тур	Max	Unit					
Turn-on i	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	neasured from the input going LC	ow .									
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 $-40^{\circ}C \le T_{mb} \le +150^{\circ}C$ and typical values for $T_{mb} = 25^{\circ}C$ unless otherwise specified.

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
Measure	d from when the input goes HIGH					
t _{d(sc)}	short circuit response time	V _{BL} > V _{BL(TO)} ; Figure 16	-	180	250	μs
$t_{d(Ic)}$	low current detect response time	I _L < I _{L(LC)} ; Figure 15	-	200	-	μs

Table 9: Capacitances

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

Symbol	Parameter	Conditions	Min	Тур	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

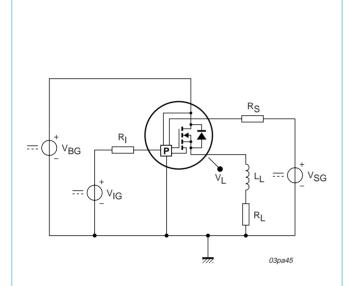
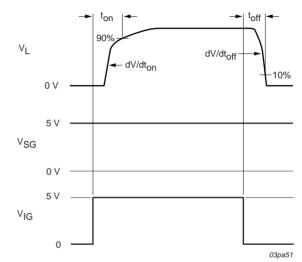


Fig 12. Schematic drawing of the switching circuit.



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

Fig 13. Resistive switching waveforms and definitions.

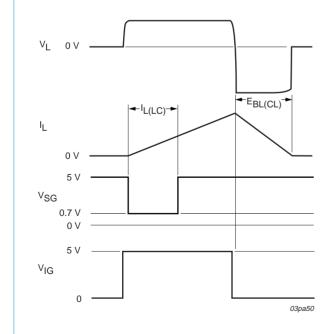


Fig 14. Switching a large inductive load.

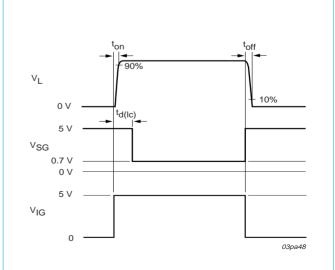
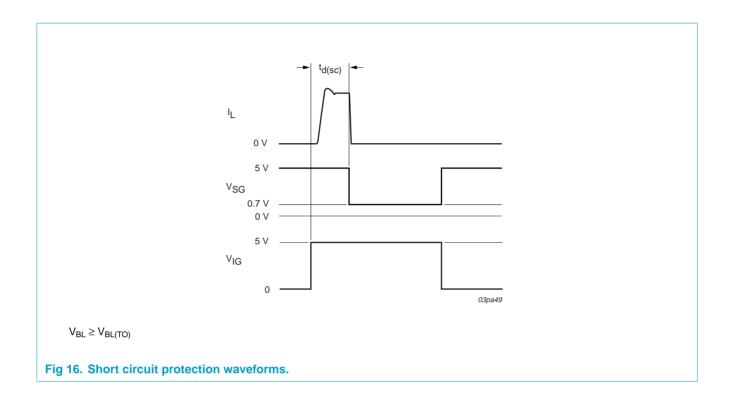
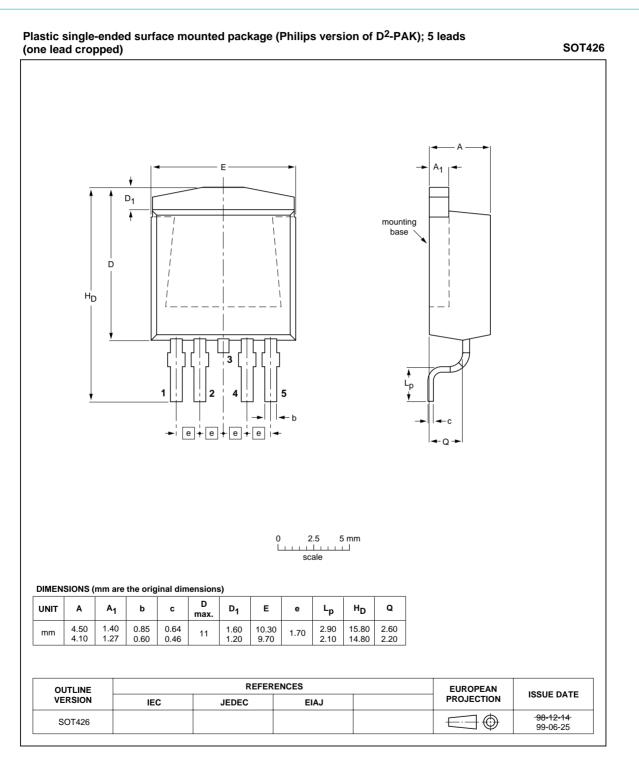


Fig 15. Low current detection waveforms.



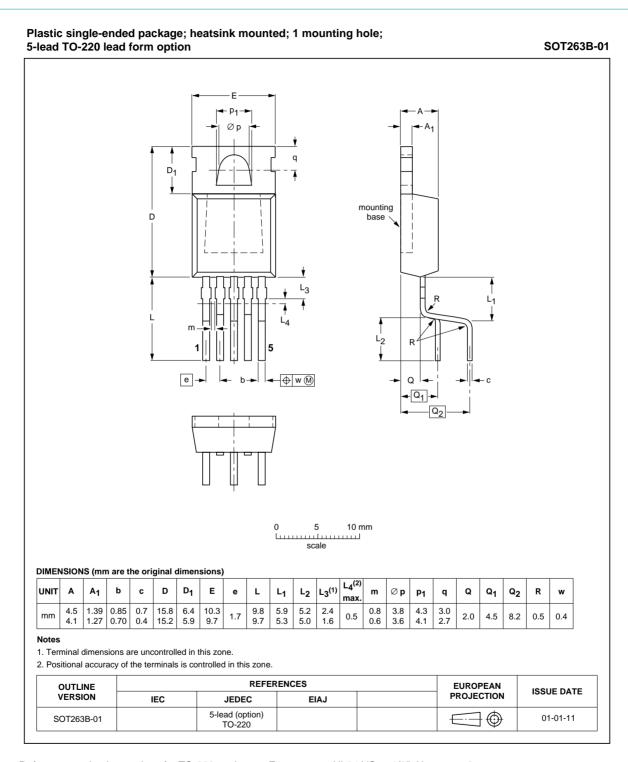
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9. Package outline



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.



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

Fig 18. SOT263B-01.

BUK208-50Y; BUK213-50Y

Single channel high-side TOPFET™

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.

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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^[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.

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