

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 automotive lamps, motors, solenoids, heaters.

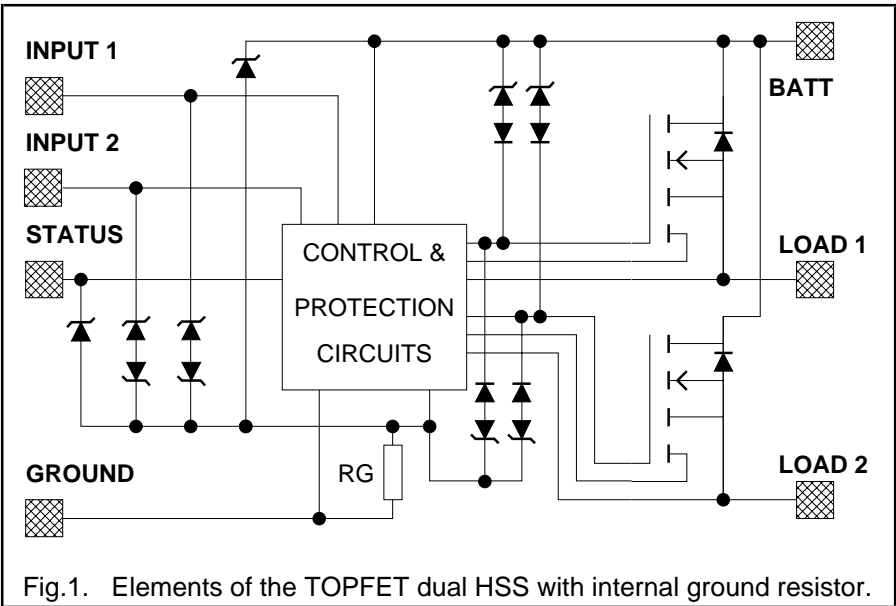
QUICK REFERENCE DATA

| 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 |

FEATURES

- Vertical power TrenchMOS
- Low on-state resistance
- CMOS logic compatible
- Very low quiescent current
- Overtemperature protection
- Load current limiting
- Latched overload and short circuit 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

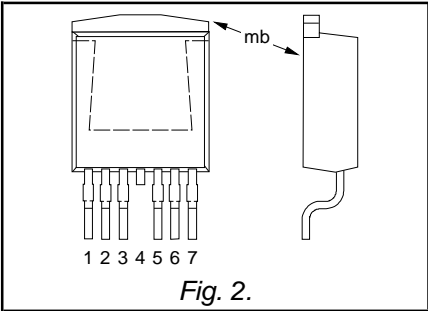
FUNCTIONAL BLOCK DIAGRAM



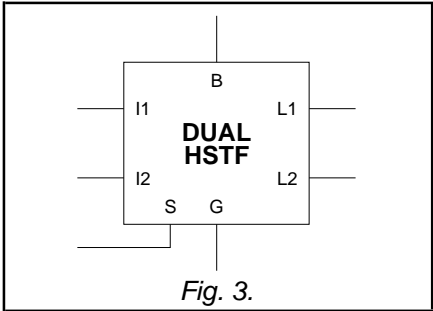
PINNING - SOT427

| 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



SYMBOL



CONVENTION

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

TOFET dual high side switch

BUK218-50DY

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 | $^\circ\text{C}$ |
| Reverse battery voltages² | | | | | |
| V_{GB} | 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 |
| Inductive load clamping | | | | | |
| E_{BL} | 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).

TOFET dual high side switch

BUK218-50DY

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 |
|-----------------|---------------------------------------------------|---------------------------------------------------|----------------|-----------------------------|----------------|------|------|------|------|
| | Clamping voltages | | | | | | | | |
| V _{BG} | Battery to ground | I _G = 1 mA | | | | 45 | 55 | 65 | V |
| V _{BL} | Battery to load per channel | I _L = I _G = 1 mA | | | | 50 | 55 | 65 | V |
| V _{GL} | Ground to load ² | I _L = 10 mA | | | | 18 | 23 | 28 | V |
| | | I _L = 10 A; t _p = 300 μs | | | | 20 | 25 | 30 | V |
| | Supply voltage | battery to ground | | | | | | | |
| V _{BG} | Operating range ³ | - | | | | 5.5 | - | 35 | V |
| | Currents | 9 V ≤ V _{BG} ≤ 35 V | | | | | | | |
| I _B | Total quiescent current ⁴ | V _{LG} = 0 V | | | | - | - | 20 | μA |
| | | T _{mb} = 25°C | | | | - | 0.1 | 1 | μA |
| I _L | Off-state load current per channel | V _{BL} = V _{BG} | | | | - | - | 10 | μA |
| | | T _{mb} = 25°C | | | | - | 0.1 | 1 | μA |
| I _G | Operating current | one channel on | | | | - | 1.8 | 3 | mA |
| | | both channels on | | | | - | 3.6 | 6 | mA |
| I _L | Nominal load current ⁵ | V _{BL} = 0.5 V; T _{mb} = 85°C | | | | 8 | - | - | A |
| R _G | Effective internal ground resistance ⁶ | I _G = -200 mA; t _p = 300 μs | | | | 40 | 75 | 100 | Ω |
| | Resistances per channel | V _{BG} | I _L | t _p ⁷ | T _j | | | | |
| R _{ON} | On-state resistance | 9 to 35 V | 10 A | 300 μs | 25°C | - | 30 | 40 | mΩ |
| | | | | | 150°C | - | 60 | 80 | mΩ |
| R _{ON} | On-state resistance | 5.5 V | 5 A | 300 μs | 25°C | - | 50 | 60 | mΩ |
| | | | | | 150°C | - | 100 | 120 | mΩ |

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.

TOPFET dual high side switch

BUK218-50DY

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 |

TOPFET dual high side switch

BUK218-50DY

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 | $V_{\text{BG}} = 45 \text{ V}$ | - | 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 | | | | |
| T _{DSC} | Overload power threshold | for latched protection ⁴ | 100 | 150 | 200 | W |
| | Characteristic time | which determines trip time ⁵ | - | 200 | 500 | μs |
| T _{j(TO)} | Overtemperature protection | | | | | |
| | 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 SC protection for $P_{\text{D}} > P_{\text{D(TO)}}$ is latched. Normal operation may only be resumed after the input is toggled low then high again. Normal operation is maintained as long as $P_{\text{D}} < P_{\text{D(TO)}}$ 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.

TOPFET dual high side switch

BUK218-50DY

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 tripped |
| H | L | 0 | 0 | 0 | 1 | X | 0 | 0 | X | OFF | OFF | L | one SC tripped, other off & normal |
| H | H | 0 | 0 | 0 | 1 | X | 0 | 0 | 0 | OFF | ON | L | one SC tripped, 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
H logic high
X don't care
0 condition not present
1 condition present

UV undervoltage
OV overvoltage
OC open circuit
SC short circuit
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.

TOPFET dual high side switch

BUK218-50DY

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 |
| | per channel | | | | | |
| C_{ig} | Input capacitance | $V_{BG} = 13\text{ V}$ | - | 15 | 20 | pF |
| C_{bl} | Output capacitance | $V_{BL} = 13\text{ V}$ | - | 265 | 375 | pF |

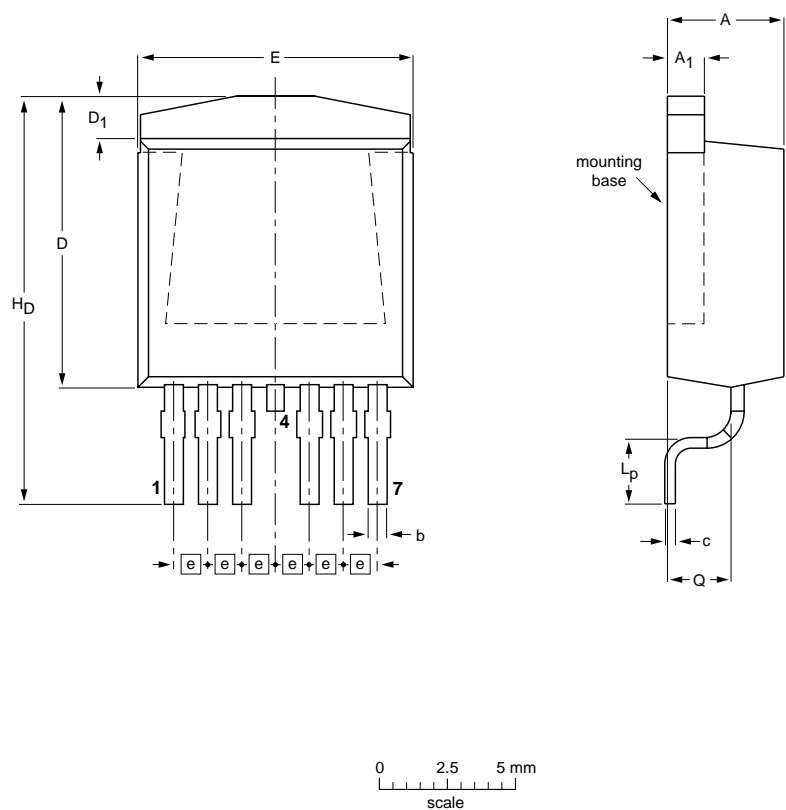
TOPFET dual high side switch

BUK218-50DY

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.

TOPFET dual high side switch

BUK218-50DY

DEFINITIONS

| 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 |
| 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. | | |
| © Philips Electronics N.V. 2001 | | |
| All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner. | | |
| The information presented in this document does not form part of any quotation or contract, it is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent or other industrial or intellectual property rights. | | |

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices or systems where malfunction of these products can be reasonably 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.

¹ Please consult the most recently issued datasheet before initiating or completing a design.

² The product status of the device(s) described in this datasheet may have changed since this datasheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.