

## Logic level TOPFET

## BUK119-50DL

## DESCRIPTION

Monolithic temperature and overload protected logic level power MOSFET in **TOPFET2** technology assembled in a 3 pin plastic package.

## APPLICATIONS

General purpose switch for driving

- lamps
- motors
- solenoids
- heaters

in automotive systems and other applications.

## QUICK REFERENCE DATA

| SYMBOL       | PARAMETER                           | MAX. | UNIT      |
|--------------|-------------------------------------|------|-----------|
| $V_{DS}$     | Continuous drain source voltage     | 50   | V         |
| $I_D$        | Continuous drain current            | 20   | A         |
| $P_D$        | Total power dissipation             | 90   | W         |
| $T_j$        | Continuous junction temperature     | 150  | °C        |
| $R_{DS(ON)}$ | Drain-source on-state resistance    | 28   | $m\Omega$ |
| $I_{ISL}$    | Input supply current $V_{IS} = 5$ V | 650  | $\mu A$   |

## FEATURES

- TrenchMOS output stage
- Current limiting
- Overload protection
- Overtemperature protection
- Protection latched reset by input
- 5 V logic compatible input level
- Control of output stage and supply of overload protection circuits derived from input
- Low operating input current permits direct drive by micro-controller
- ESD protection on all pins
- Ovvoltage clamping for turn off of inductive loads

## FUNCTIONAL BLOCK DIAGRAM

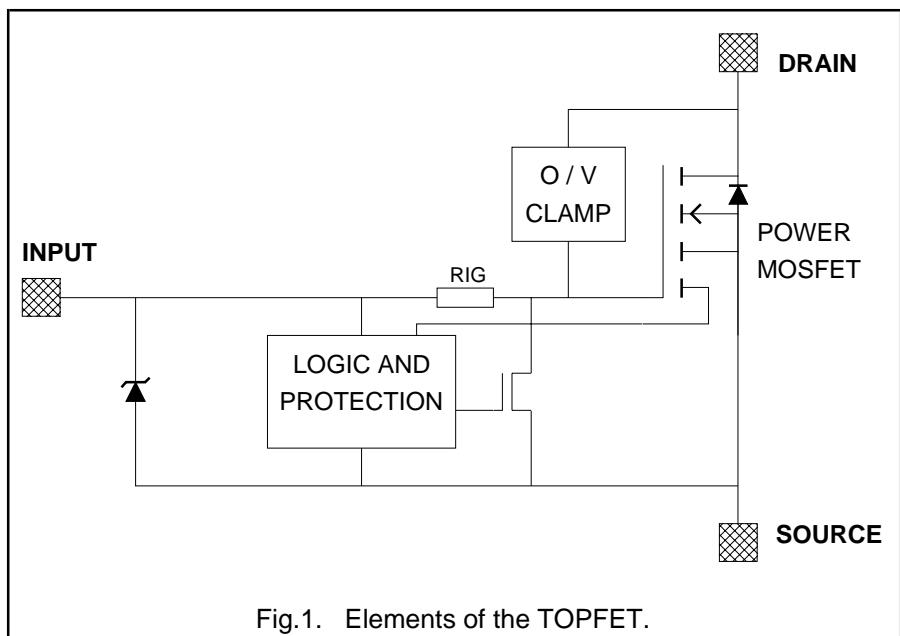
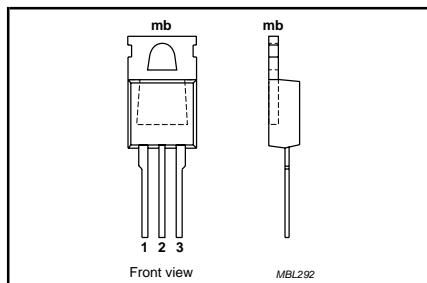


Fig.1. Elements of the TOPFET.

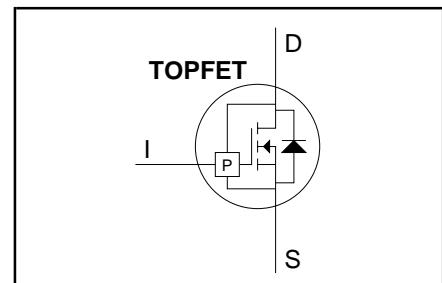
## PINNING - SOT78B

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | input       |
| 2   | drain       |
| 3   | source      |
| tab | drain       |

## PIN CONFIGURATION



## SYMBOL



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**LIMITING VALUES**

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

| SYMBOL     | PARAMETER                                    | CONDITIONS  | MIN. | MAX.           | UNIT |
|------------|--|---|------|----------------|------|
| $V_{DS}$   | Continuous drain source voltage <sup>1</sup> |   | -    | 50             | V    |
| $I_D$      | Continuous drain current                     | $V_{IS} = 5 \text{ V}; T_{mb} = 25^\circ\text{C}$     | -    | self - limited | A    |
| $I_D$      | Continuous drain current                     | $V_{IS} = 5 \text{ V}; T_{mb} \leq 121^\circ\text{C}$ | -    | 20             | A    |
| $I_I$      | Continuous input current                     |   | -5   | 5              | mA   |
| $I_{IRM}$  | Repetitive peak input current                | $\delta \leq 0.1, t_p = 300 \mu\text{s}$              | -50  | 50             | mA   |
| $P_D$      | Total power dissipation                      | $T_{mb} \leq 25^\circ\text{C}$                        | -    | 90             | W    |
| $T_{stg}$  | Storage temperature                          |   | -55  | 175            | °C   |
| $T_j$      | Continuous junction temperature <sup>2</sup> | normal operation                                      | -    | 150            | °C   |
| $T_{sold}$ | Lead temperature                             | during soldering                                      | -    | 260            | °C   |

**ESD LIMITING VALUE**

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

**OVERVOLTAGE CLAMPING LIMITING VALUES**

At a drain source voltage above 50 V the power MOSFET is actively turned on to clamp overvoltage transients.

| SYMBOL    | PARAMETER                      | CONDITIONS   | MIN. | MAX. | UNIT |
|-----------|--------------------------------|--|------|------|------|
| $E_{DSM}$ | Inductive load turn-off        | $I_{DM} = 20 \text{ A}; V_{DD} \leq 20 \text{ V}$  | -    | 350  | mJ   |
| $E_{DRM}$ | Non-repetitive clamping energy | $T_{mb} \leq 25^\circ\text{C}$                     | -    | 45   | mJ   |
|           | Repetitive clamping energy     | $T_{mb} \leq 95^\circ\text{C}; f = 250 \text{ Hz}$ |      |      |      |

**OVERLOAD PROTECTION LIMITING VALUE**

With an adequate protection supply provided via the input pin, TOPFET can protect itself from two types of overload - overtemperature and short circuit load.

| SYMBOL   | PARAMETER                         | REQUIRED CONDITION                           | MIN. | MAX. | UNIT |
|----------|-----------------------------------|--|------|------|------|
| $V_{DS}$ | Drain source voltage <sup>3</sup> | $4 \text{ V} \leq V_{IS} \leq 5.5 \text{ V}$ | 0    | 35   | V    |

**THERMAL CHARACTERISTIC**

| SYMBOL        | PARAMETER                                       | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---------------|---|------------|------|------|------|------|
| $R_{th,j-mb}$ | Thermal resistance<br>Junction to mounting base | -          | -    | 1.25 | 1.39 | K/W  |

<sup>1</sup> Prior to the onset of overvoltage clamping. For voltages above this value, safe operation is limited by the overvoltage clamping energy.<sup>2</sup> 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.<sup>3</sup> All control logic and protection functions are disabled during conduction of the source drain diode.

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BUK119-50DL

**OUTPUT CHARACTERISTICS**Limits are for  $-40^{\circ}\text{C} \leq T_{mb} \leq 150^{\circ}\text{C}$ ; typicals are for  $T_{mb} = 25^{\circ}\text{C}$  unless otherwise specified

| SYMBOL        | PARAMETER   | CONDITIONS   | MIN. | TYP. | MAX. | UNIT             |
|---------------|---|--|------|------|------|------------------|
| $V_{(CL)DSS}$ | <b>Off-state</b><br>Drain-source clamping voltage | $V_{IS} = 0 \text{ V}$<br>$I_D = 10 \text{ mA}$  | 50   | -    | -    | V                |
|               | Drain source leakage current                      | $I_{DM} = 4 \text{ A}; t_p \leq 300 \mu\text{s}; \delta \leq 0.01$<br>$V_{DS} = 40 \text{ V}$<br>$T_{mb} = 25^{\circ}\text{C}$ | 50   | 60   | 70   | V                |
| $I_{DSS}$     | <b>On-state</b><br>Drain-source resistance        | $V_{IS} \geq 4.4 \text{ V}; t_p \leq 300 \mu\text{s}; \delta \leq 0.01$<br>$I_{DM} = 10 \text{ A}$                             | -    | -    | 100  | $\mu\text{A}$    |
|               |   |  | -    | 0.1  | 10   | $\mu\text{A}$    |
| $R_{DS(ON)}$  |   | $T_{mb} = 25^{\circ}\text{C}$  | -    | 22   | 52   | $\text{m}\Omega$ |
|               |   |  | -    | 28   | 28   | $\text{m}\Omega$ |

**OVERLOAD CHARACTERISTICS** $V_{IS} = 5 \text{ V}; T_{mb} = 25^{\circ}\text{C}$  unless otherwise specified.

| SYMBOL                   | PARAMETER  | CONDITIONS   | MIN.       | TYP.       | MAX.       | UNIT               |
|--------------------------|--|--|------------|------------|------------|--------------------|
| $I_D$                    | <b>Short circuit load</b><br>Drain current limiting                              | $V_{DS} = 13 \text{ V}$<br>$4.4 \text{ V} \leq V_{IS} \leq 5.5 \text{ V};$<br>$-40^{\circ}\text{C} \leq T_{mb} \leq 150^{\circ}\text{C}$ | 28.5<br>21 | 43<br>-    | 57<br>65   | A<br>A             |
| $P_{D(TO)}$<br>$T_{DSC}$ | <b>Overload protection</b><br>Overload power threshold<br>Characteristic time    | device trips if $P_D > P_{D(TO)}$<br>which determines trip time <sup>1</sup>   | 75<br>200  | 185<br>380 | 250<br>600 | W<br>$\mu\text{s}$ |
| $T_{j(TO)}$              | <b>Overtemperature protection</b><br>Threshold junction temperature <sup>2</sup> |  | 150        | 170        | -          | $^{\circ}\text{C}$ |

<sup>1</sup> Trip time  $t_{dsc}$  varies with overload dissipation  $P_D$  according to the formula  $t_{dsc} \approx T_{DSC} / \ln[ P_D / P_{D(TO)} ]$ .<sup>2</sup> This is independent of the dV/dt of input voltage  $V_{IS}$ .

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BUK119-50DL

## INPUT CHARACTERISTICS

The supply for the logic and overload protection is taken from the input.

Limits are for  $-40^{\circ}\text{C} \leq T_{mb} \leq 150^{\circ}\text{C}$ ; typicals are for  $T_{mb} = 25^{\circ}\text{C}$  unless otherwise specified

| SYMBOL       | PARAMETER  | CONDITIONS   | MIN. | TYP. | MAX. | UNIT             |
|--------------|--|--|------|------|------|------------------|
| $V_{IS(TO)}$ | Input threshold voltage                                      | $V_{DS} = 5 \text{ V}$ ; $I_D = 1 \text{ mA}$<br>$T_{mb} = 25^{\circ}\text{C}$ | 0.6  | -    | 2.4  | V                |
| $I_{IS}$     | Input supply current   | normal operation; $V_{IS} = 5 \text{ V}$<br>$V_{IS} = 4 \text{ V}$             | 100  | 220  | 400  | $\mu\text{A}$    |
| $I_{ISL}$    | Input supply current   | protection latched; $V_{IS} = 5 \text{ V}$<br>$V_{IS} = 3 \text{ V}$           | 200  | 400  | 650  | $\mu\text{A}$    |
| $V_{ISR}$    | Protection reset voltage <sup>1</sup>                        | reset time $t_r \geq 100 \mu\text{s}$  | 1.5  | 2    | 2.9  | V                |
| $t_r$        | Latch reset time   | $V_{IS1} = 5 \text{ V}$ , $V_{IS2} < 1 \text{ V}$                              | 10   | 40   | 100  | $\mu\text{s}$    |
| $V_{(CL)IS}$ | Input clamping voltage                                       | $I_I = 1.5 \text{ mA}$   | 5.5  | -    | 8.5  | V                |
| $R_{IG}$     | Input series resistance <sup>2</sup> to gate of power MOSFET | $T_{mb} = 25^{\circ}\text{C}$  | -    | 33   | -    | $\text{k}\Omega$ |

## SWITCHING CHARACTERISTICS

$T_{mb} = 25^{\circ}\text{C}$ ;  $V_{DD} = 13 \text{ V}$ ; resistive load  $R_L = 4 \Omega$ . Refer to waveform figure and test circuit.

| SYMBOL       | PARAMETER           | CONDITIONS             | MIN. | TYP. | MAX. | UNIT          |
|--------------|---------------------|------------------------|------|------|------|---------------|
| $t_{d\ on}$  | Turn-on delay time  | $V_{IS} = 5 \text{ V}$ | -    | 25   | 50   | $\mu\text{s}$ |
| $t_r$        | Rise time           |                        | -    | 50   | 100  | $\mu\text{s}$ |
| $t_{d\ off}$ | Turn-off delay time | $V_{IS} = 0 \text{ V}$ | -    | 60   | 120  | $\mu\text{s}$ |
| $t_f$        | Fall time           |                        | -    | 50   | 100  | $\mu\text{s}$ |

<sup>1</sup> The input voltage below which the overload protection circuits will be reset.

<sup>2</sup> Not directly measurable from device terminals.

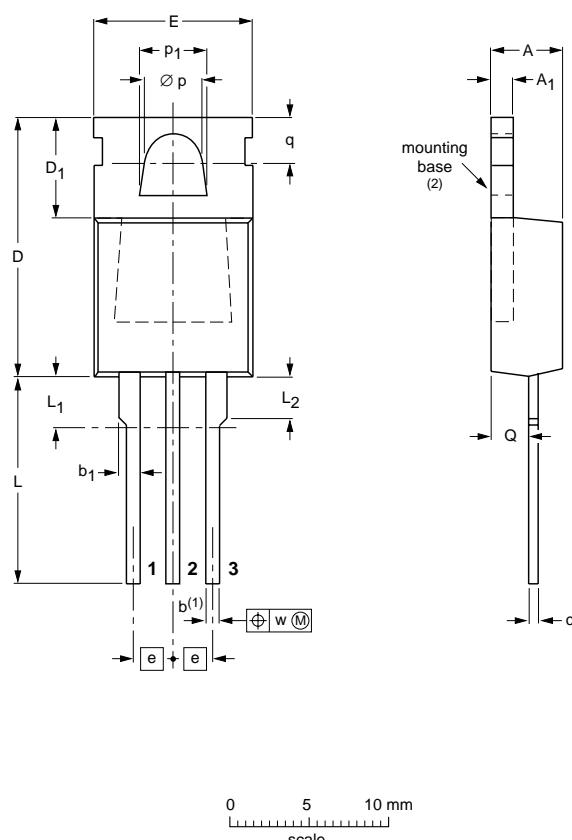
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## MECHANICAL DATA

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-leads

SOT78B



## DIMENSIONS (mm are the original dimensions)

| UNIT | A          | A <sub>1</sub> | b <sup>(1)</sup> | b <sub>1</sub> | c          | D            | D <sub>1</sub> | E           | e    | L            | L <sub>1</sub> | L <sub>2</sub> max. | Ø p        | p <sub>1</sub> | q          | Q          | w   |
|------|------------|----------------|------------------|----------------|------------|--------------|----------------|-------------|------|--------------|----------------|---------------------|------------|----------------|------------|------------|-----|
| mm   | 4.5<br>4.1 | 1.39<br>1.27   | 0.85<br>0.60     | 1.3<br>1.0     | 0.7<br>0.4 | 15.8<br>15.2 | 6.4<br>5.9     | 10.3<br>9.7 | 2.54 | 15.0<br>13.5 | 3.30<br>2.79   | 3.0                 | 3.8<br>3.6 | 4.3<br>4.1     | 3.0<br>2.7 | 2.6<br>2.2 | 0.4 |

## Notes

1. The positional accuracy of the terminals is controlled within zone L<sub>1</sub> max.
2. Mounting base configuration is not defined within the dimensions E and D

| OUTLINE VERSION | REFERENCES |       |      |  | EUROPEAN PROJECTION   | ISSUE DATE |
|-----------------|------------|-------|------|--|---|------------|
|                 | IEC        | JEDEC | EIAJ |  |   |            |
| SOT78B          |            |       |      |  |  | 01-02-22   |

Fig.2. SOT78B (TO220AB) package<sup>1</sup>, pin 2 connected to mounting base.

<sup>1</sup> Refer to mounting instructions for SOT78 (TO220) envelopes. Epoxy meets UL94 V0 at 1/8". Net mass: 2 g

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**DEFINITIONS**

| <b>DATA SHEET STATUS</b>   |                                   |   |
|--|-----------------------------------|---|
| <b>DATA SHEET STATUS<sup>1</sup></b>   | <b>PRODUCT STATUS<sup>2</sup></b> | <b>DEFINITIONS</b>  |
| 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  |
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