

Logic level TOPFET D-PAK version of BUK117-50DL

BUK138-50DL

DESCRIPTION

Monolithic temperature and overload protected logic level power MOSFET in **TOPFET2** technology assembled in a 3 pin surface mount 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 | 8 | A |
| P_D | Total power dissipation | 40 | W |
| T_j | Continuous junction temperature | 150 | °C |
| $R_{DS(ON)}$ | Drain-source on-state resistance | 100 | $m\Omega$ |
| I_{ISL} | Input supply current $V_{IS} = 5$ V | 650 | μA |

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

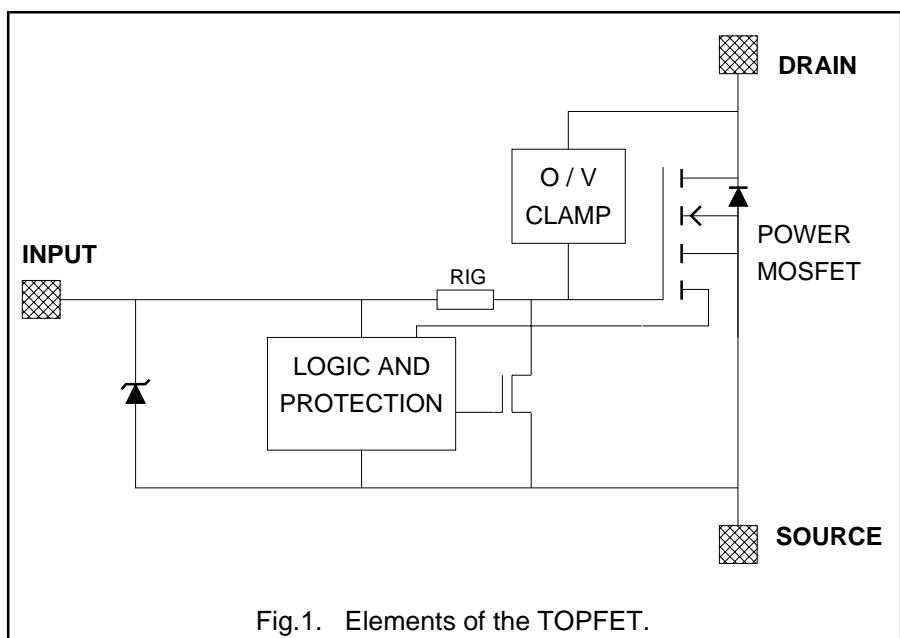
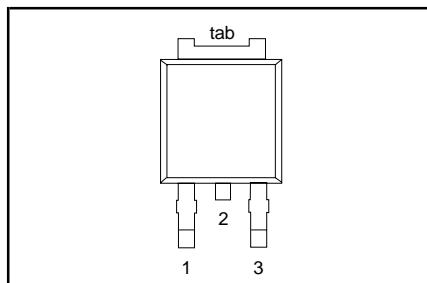


Fig.1. Elements of the TOPFET.

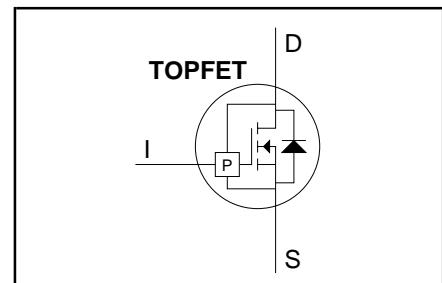
PINNING - SOT428

| 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 ¹ | - | - | 50 | V |
| I_D | Continuous drain current | $V_{IS} = 5 \text{ V}; T_{mb} = 25 \text{ }^\circ\text{C}$ | - | self - limited | A |
| I_D | Continuous drain current | $V_{IS} = 5 \text{ V}; T_{mb} \leq 110 \text{ }^\circ\text{C}$ | - | 8 | A |
| I_I | Continuous input current | - | -5 | 5 | mA |
| I_{IRM} | Non-repetitive peak input current | $t_p \leq 1 \text{ ms}$ | -10 | 10 | mA |
| P_D | Total power dissipation | $T_{mb} \leq 25 \text{ }^\circ\text{C}$ | - | 40 | W |
| T_{stg} | Storage temperature | - | -55 | 175 | $^\circ\text{C}$ |
| T_j | Continuous junction temperature ² | normal operation | - | 150 | $^\circ\text{C}$ |
| T_{sold} | Case temperature | during soldering | - | 260 | $^\circ\text{C}$ |

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 |

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 | $I_{DM} = 8 \text{ A}; V_{DD} \leq 20 \text{ V}$ | - | 100 | mJ |
| E_{DRM} | Non-repetitive clamping energy | $T_{mb} \leq 25 \text{ }^\circ\text{C}$ | - | 20 | mJ |
| | Repetitive clamping energy | $T_{mb} \leq 95 \text{ }^\circ\text{C}; f = 250 \text{ Hz}$ | - | | |

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 ³ | $4 \text{ V} \leq V_{IS} \leq 5.5 \text{ V}$ | 0 | 35 | V |

THERMAL CHARACTERISTIC

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---------------|---|---------------------------|------|------|------|------|
| $R_{th,j-mb}$ | Thermal resistance Junction to mounting base | - | - | 2.5 | 3.1 | K/W |
| $R_{th,j-a}$ | Junction to ambient | minimum footprint FR4 PCB | - | 71.4 | - | K/W |

¹ Prior to the onset of overvoltage clamping. For voltages above this value, safe operation is limited by the overvoltage clamping energy.

² 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.

³ All control logic and protection functions are disabled during conduction of the source drain diode.

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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 |
|---------------|---|--|------|------|------|---------------|
| $V_{(CL)DSS}$ | Off-state Drain-source clamping voltage | $V_{IS} = 0 \text{ V}$ $I_D = 10 \text{ mA}$ $I_{DM} = 1 \text{ A}; t_p \leq 300 \mu\text{s}; \delta \leq 0.01$ | 50 | - | - | V |
| | Drain source leakage current | $V_{DS} = 40 \text{ V}$ $T_{mb} = 25^{\circ}\text{C}$ | - | 60 | 70 | V |
| I_{DSS} | On-state Drain-source resistance | $I_{DM} = 3 \text{ A}; t_p \leq 300 \mu\text{s}; \delta \leq 0.01$ $V_{IS} \geq 4.4 \text{ V}$ $T_{mb} = 25^{\circ}\text{C}$ | - | - | 100 | μA |
| | | $V_{IS} \geq 4 \text{ V}$ $T_{mb} = 25^{\circ}\text{C}$ | - | 0.1 | 10 | μA |

OVERLOAD CHARACTERISTICS

$-40^{\circ}\text{C} \leq T_{mb} \leq 150^{\circ}\text{C}$ unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--------------------------|--|--|-----------|-----------|-----------|--------------------|
| I_D | Short circuit load Drain current limiting | $V_{DS} = 13 \text{ V}$ $V_{IS} = 5 \text{ V};$ $4.4 \text{ V} \leq V_{IS} \leq 5.5 \text{ V}$ $4 \text{ V} \leq V_{IS} \leq 5.5 \text{ V}$ | 8 | 12 | 16 | A |
| $P_{D(TO)}$ T_{DSC} | Overload protection Overload power threshold Characteristic time | $V_{IS} = 5 \text{ V};$ $T_{mb} = 25^{\circ}\text{C}$ device trips if $P_D > P_{D(TO)}$ which determines trip time ¹ | 20 200 | 55 350 | 80 600 | W μs |
| $T_{j(TO)}$ | Overtemperature protection Threshold junction temperature ² | | 150 | 170 | - | $^{\circ}\text{C}$ |

¹ Trip time t_{dsc} varies with overload dissipation P_D according to the formula $t_{dsc} \approx T_{DSC} / \ln[P_D / P_{D(TO)}]$.

² This is independent of the dV/dt of input voltage V_{IS} .

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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 | $V_{DS} = 5 \text{ V}$; $I_D = 1 \text{ mA}$ $T_{mb} = 25^{\circ}\text{C}$ | 0.6 | - | 2.4 | V |
| I_{IS} | Input supply current | normal operation; $V_{IS} = 5 \text{ V}$ $V_{IS} = 4 \text{ V}$ | 100 | 220 | 400 | μA |
| I_{ISL} | Input supply current | protection latched; $V_{IS} = 5 \text{ V}$ $V_{IS} = 3 \text{ V}$ | 200 | 400 | 650 | μA |
| V_{ISR} | Protection reset voltage ¹ | 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 | μs |
| $V_{(CL)IS}$ | Input clamping voltage | $I_I = 1.5 \text{ mA}$ | 5.5 | - | 8.5 | V |
| R_{IG} | Input series resistance ² 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 | $V_{IS} = 5 \text{ V}$ | - | 10 | 20 | μs |
| t_r | Rise time | | - | 20 | 40 | μs |
| $t_{d\ off}$ | Turn-off delay time | $V_{IS} = 0 \text{ V}$ | - | 30 | 60 | μs |
| t_f | Fall time | | - | 20 | 40 | μs |

¹ The input voltage below which the overload protection circuits will be reset.

² Not directly measurable from device terminals.

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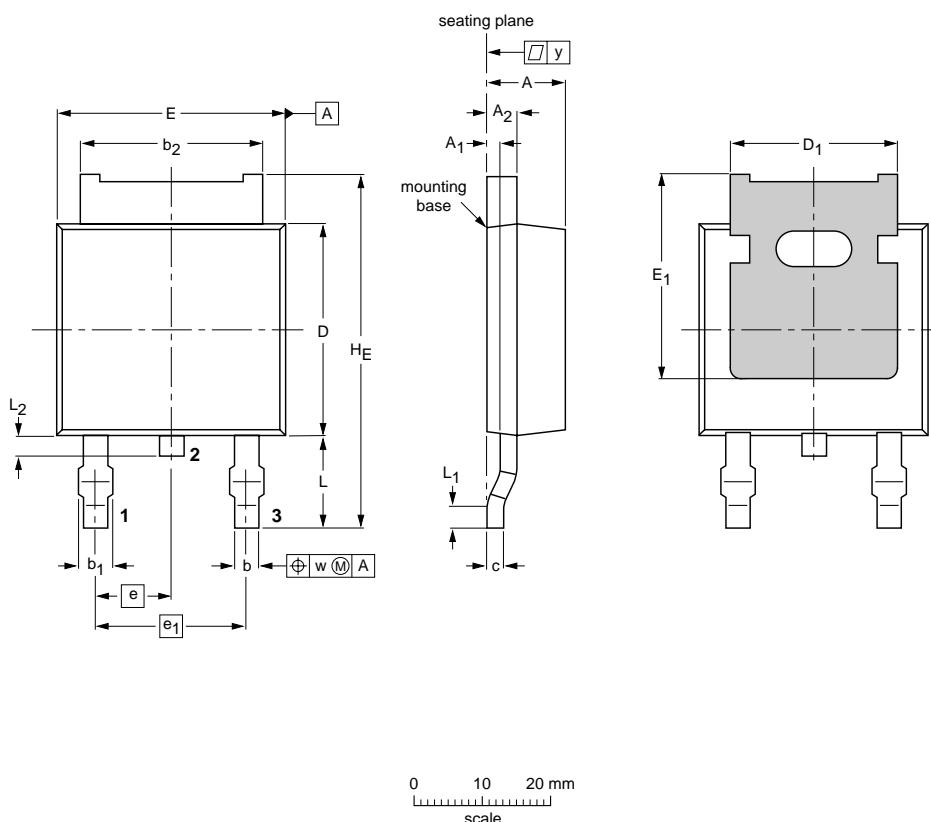
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MECHANICAL DATA

Plastic single-ended surface mounted package (Philips version of D-PAK); 3 leads
(one lead cropped)

SOT428



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ ⁽¹⁾ | A ₂ | b | b ₁ max. | b ₂ | c | D max. | D ₁ max. | E max. | E ₁ min. | e | e ₁ | H _E max. | L | L ₁ min. | L ₂ | w | y max. |
|------|--------------|-------------------------------|----------------|--------------|------------------------|----------------|------------|--------------|------------------------|--------------|------------------------|---------------|----------------|------------------------|--------------|------------------------|----------------|-----|------------|
| mm | 2.38 2.22 | 0.65 0.45 | 0.89 0.71 | 0.89 0.71 | 1.1 0.9 | 5.36 5.26 | 0.4 0.2 | 6.22 5.98 | 4.81 4.45 | 6.73 6.47 | 4.0 | 2.285 4.57 | 4.57 9.6 | 10.4 2.95 | 2.95 2.55 | 0.5 | 0.7 0.5 | 0.2 | 0.2 0.2 |

Note

1. Measured from heatsink back to lead.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|--------------------|------------|-------|------|--|------------------------|------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT428 | | | | | | 98-04-07 |

Fig.2. SOT428 surface mounting package¹, centre pin connected to mounting base.

¹ Epoxy meets UL94 V0 at 1/8". Net mass: 1.1 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 |
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| 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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