

PowerMOS transistor  
Logic level TOPFET

BUK108-50DL

DESCRIPTION

Monolithic temperature and overload protected logic level power MOSFET in a 3 pin plastic surface mount envelope, intended as a general purpose switch for automotive systems and other applications.

APPLICATIONS

- General controller for driving
- lamps
  - motors
  - solenoids
  - heaters

FEATURES

- Vertical power DMOS output stage
- Low on-state resistance
- Overload protection against over temperature
- Overload protection against short circuit load
- Latched overload protection reset by input
- 5 V logic compatible input level
- Control of power MOSFET and supply of overload protection circuits derived from input
- Lower operating input current permits direct drive by micro-controller
- ESD protection on input pin
- Overvoltage clamping for turn off of inductive loads

QUICK REFERENCE DATA

| SYMBOL       | PARAMETER                                  | MAX. | UNIT |
|--------------|--------------------------------------------|------|------|
| $V_{DS}$     | Continuous drain source voltage            | 50   | V    |
| $I_D$        | Continuous drain current                   | 13.5 | A    |
| $P_D$        | Total power dissipation                    | 40   | W    |
| $T_j$        | Continuous junction temperature            | 150  | °C   |
| $R_{DS(ON)}$ | Drain-source on-state resistance           | 125  | mΩ   |
| $I_{ISL}$    | Input supply current $V_{IS} = 5\text{ V}$ | 650  | μA   |

FUNCTIONAL BLOCK DIAGRAM

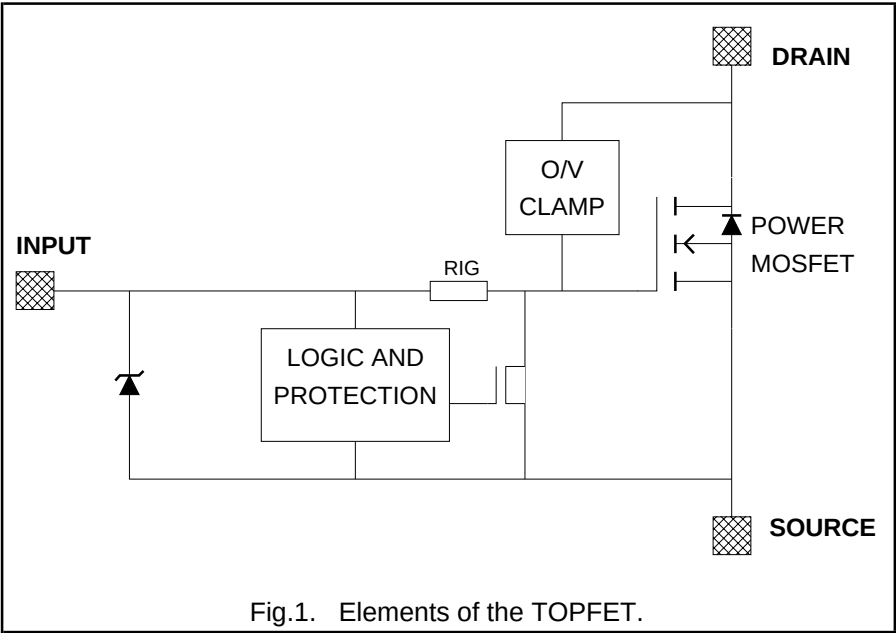
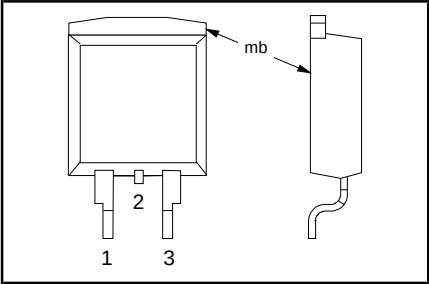


Fig.1. Elements of the TOPFET.

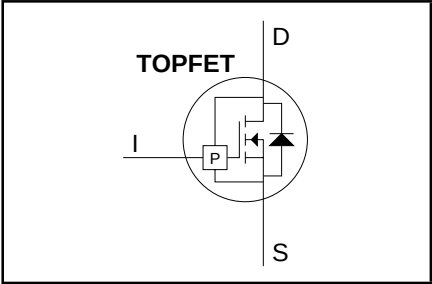
PINNING - SOT404

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | input       |
| 2   | drain       |
| 3   | source      |
| mb  | 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    |
| $V_{IS}$  | Continuous input voltage                     | -                                                | 0    | 6    | V    |
| $I_D$     | Continuous drain current                     | $T_{mb} \leq 25\text{ °C}; V_{IS} = 5\text{ V}$  | -    | 13.5 | A    |
| $I_D$     | Continuous drain current                     | $T_{mb} \leq 100\text{ °C}; V_{IS} = 5\text{ V}$ | -    | 8.5  | A    |
| $I_{DRM}$ | Repetitive peak on-state drain current       | $T_{mb} \leq 25\text{ °C}; V_{IS} = 5\text{ V}$  | -    | 54   | A    |
| $P_D$     | Total power dissipation                      | $T_{mb} \leq 25\text{ °C}$                       | -    | 40   | W    |
| $T_{stg}$ | Storage temperature                          | -                                                | -55  | 150  | °C   |
| $T_j$     | Continuous junction temperature <sup>2</sup> | normal operation                                 | -    | 150  | °C   |
| $T_{sld}$ | Lead temperature                             | during soldering                                 | -    | 250  | °C   |

### OVERLOAD PROTECTION LIMITING VALUES

With the protection supply provided via the input pin, TOPFET can protect itself from two types of overload.

| SYMBOL       | PARAMETER                                          | CONDITIONS              | MIN. | MAX. | UNIT |
|--------------|----------------------------------------------------|-------------------------|------|------|------|
| $V_{ISP}$    | Protection supply voltage <sup>3</sup>             | for valid protection    | 4    | -    | V    |
|              | <b>Over temperature protection</b>                 |                         |      |      |      |
| $V_{DDP(T)}$ | Protected drain source supply voltage              | $V_{IS} = 5\text{ V}$   | -    | 50   | V    |
|              | <b>Short circuit load protection<sup>4</sup></b>   |                         |      |      |      |
| $V_{DDP(P)}$ | Protected drain source supply voltage <sup>5</sup> | $V_{IS} = 5\text{ V}$   | -    | 24   | V    |
| $P_{DSM}$    | Instantaneous overload dissipation                 | $T_{mb} = 25\text{ °C}$ | -    | 0.6  | kW   |

### 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 |
|------------|----------------------------------|--------------------------------------------------------------------------------------------------|------|------|------|
| $I_{DROM}$ | Repetitive peak clamping current | $V_{IS} = 0\text{ V}$                                                                            | -    | 15   | A    |
| $E_{DSM}$  | Non-repetitive clamping energy   | $T_{mb} \leq 25\text{ °C}; I_{DM} = 15\text{ A};$<br>$V_{DD} \leq 20\text{ V};$ inductive load   | -    | 200  | mJ   |
| $E_{DRM}$  | Repetitive clamping energy       | $T_{mb} \leq 95\text{ °C}; I_{DM} = 8\text{ A};$<br>$V_{DD} \leq 20\text{ V}; f = 250\text{ Hz}$ | -    | 20   | mJ   |

### 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   |

<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> The input voltage for which the overload protection circuits are functional.

<sup>4</sup> For further information, refer to OVERLOAD PROTECTION CHARACTERISTICS.

<sup>5</sup> The short circuit load protection is able to save the device providing the instantaneous on-state dissipation is less than the limiting value for  $P_{DSM}$ , which is always the case when  $V_{DS}$  is less than  $V_{DDP(P)}$  maximum.

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### THERMAL CHARACTERISTICS

| SYMBOL         | PARAMETER                                       | CONDITIONS                                 | MIN. | TYP. | MAX. | UNIT |
|----------------|-------------------------------------------------|--------------------------------------------|------|------|------|------|
| $R_{th\ j-mb}$ | Thermal resistance<br>Junction to mounting base | -                                          | -    | 2.5  | 3.1  | K/W  |
| $R_{th\ j-a}$  | Thermal resistance<br>Junction to ambient       | minimum footprint FR4 PCB<br>(see fig. 23) | -    | 50   | -    | K/W  |

### STATIC CHARACTERISTICS

 $T_{mb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

| SYMBOL        | PARAMETER                                        | CONDITIONS                                                                                                  | MIN. | TYP. | MAX. | UNIT          |
|---------------|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $V_{(CL)DSS}$ | Drain-source clamping voltage                    | $V_{IS} = 0\text{ V}$ ; $I_D = 10\text{ mA}$                                                                | 50   | -    | -    | V             |
| $V_{(CL)DSS}$ | Drain-source clamping voltage                    | $V_{IS} = 0\text{ V}$ ; $I_{DM} = 1\text{ A}$ ; $t_p \leq 300\text{ }\mu\text{s}$ ;<br>$\delta \leq 0.01$   | -    | -    | 70   | V             |
| $I_{DSS}$     | Zero input voltage drain current                 | $V_{DS} = 12\text{ V}$ ; $V_{IS} = 0\text{ V}$                                                              | -    | 0.5  | 10   | $\mu\text{A}$ |
| $I_{DSS}$     | Zero input voltage drain current                 | $V_{DS} = 50\text{ V}$ ; $V_{IS} = 0\text{ V}$                                                              | -    | 1    | 20   | $\mu\text{A}$ |
| $I_{DSS}$     | Zero input voltage drain current                 | $V_{DS} = 40\text{ V}$ ; $V_{IS} = 0\text{ V}$ ; $T_j = 125\text{ }^{\circ}\text{C}$                        | -    | 10   | 100  | $\mu\text{A}$ |
| $R_{DS(ON)}$  | Drain-source on-state<br>resistance <sup>1</sup> | $V_{IS} = 5\text{ V}$ ; $I_{DM} = 7.5\text{ A}$ ; $t_p \leq 300\text{ }\mu\text{s}$ ;<br>$\delta \leq 0.01$ | -    | 85   | 125  | m $\Omega$    |

### OVERLOAD PROTECTION CHARACTERISTICS

TOPFET switches off when one of the overload thresholds is reached. It remains latched off until reset by the input.

| SYMBOL       | PARAMETER                                                               | CONDITIONS                                                                                                                                           | MIN. | TYP. | MAX. | UNIT               |
|--------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|--------------------|
| $E_{DS(TO)}$ | Short circuit load protection <sup>2</sup><br>Overload threshold energy | $T_{mb} = 25\text{ }^{\circ}\text{C}$ ; $L \leq 10\text{ }\mu\text{H}$ ; $R_L = 10\text{ m}\Omega$<br>$V_{DD} = 13\text{ V}$ ; $V_{IS} = 5\text{ V}$ | -    | 0.2  | -    | J                  |
| $t_{d\ sc}$  | Response time                                                           | $V_{DD} = 13\text{ V}$ ; $V_{IS} = 5\text{ V}$                                                                                                       | -    | 0.8  | -    | ms                 |
| $I_{D(SC)}$  | Drain current <sup>3</sup>                                              | $V_{DD} = 13\text{ V}$ ; $V_{IS} = 5\text{ V}$                                                                                                       | -    | 25   | -    | A                  |
| $I_{DM(SC)}$ | Peak drain current <sup>4</sup>                                         | $V_{IS} = 5\text{ V}$ ; $V_{DD} = 13\text{ V}$                                                                                                       | -    | 60   | -    | A                  |
| $T_{j(TO)}$  | Over temperature protection<br>Threshold junction temperature           | $V_{IS} = 5\text{ V}$ ; from $I_D \geq 0.5\text{ A}$ <sup>5</sup>                                                                                    | 150  | -    | -    | $^{\circ}\text{C}$ |

### TRANSFER CHARACTERISTIC

 $T_{mb} = 25\text{ }^{\circ}\text{C}$ 

| SYMBOL   | PARAMETER                | CONDITIONS                                                                                                 | MIN. | TYP. | MAX. | UNIT |
|----------|--------------------------|------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $g_{fs}$ | Forward transconductance | $V_{DS} = 10\text{ V}$ ; $I_{DM} = 7.5\text{ A}$ $t_p \leq 300\text{ }\mu\text{s}$ ;<br>$\delta \leq 0.01$ | 5    | 9    | -    | S    |

<sup>1</sup> Continuous input voltage. The specified pulse width is for the drain current.

<sup>2</sup> Refer to OVERLOAD PROTECTION LIMITING VALUES.

<sup>3</sup> Continuous drain-source supply voltage. Pulsed input voltage.

<sup>4</sup> Continuous input voltage. Momentary short circuit load connection. (The higher peak current is due to the effect of capacitance Cgd).

<sup>5</sup> The over temperature protection feature requires a minimum on-state drain source voltage for correct operation. The specified minimum  $I_D$  ensures this condition.

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## INPUT CHARACTERISTICS

$T_{mb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified. The supply for the logic and overload protection is taken from the input.

| SYMBOL       | PARAMETER                                       | CONDITIONS                                  | MIN. | TYP. | MAX. | UNIT             |
|--------------|-------------------------------------------------|---------------------------------------------|------|------|------|------------------|
| $V_{IS(TO)}$ | Input threshold voltage                         | $V_{DS} = 5\text{ V}$ ; $I_D = 1\text{ mA}$ | 1.0  | 1.5  | 2.0  | V                |
| $I_{IS}$     | Input supply current                            | normal operation; $V_{IS} = 5\text{ V}$     | 100  | 200  | 350  | $\mu\text{A}$    |
|              |                                                 | $V_{IS} = 4\text{ V}$                       | -    | 160  | 270  | $\mu\text{A}$    |
| $V_{ISR}$    | Protection reset voltage <sup>1</sup>           | $T_j = 25\text{ }^{\circ}\text{C}$          | 2.0  | 2.6  | 3.5  | V                |
|              |                                                 | $T_j = 150\text{ }^{\circ}\text{C}$         | 1.0  | -    | -    |                  |
| $I_{ISL}$    | Input supply current                            | protection latched; $V_{IS} = 5\text{ V}$   | -    | 330  | 650  | $\mu\text{A}$    |
|              |                                                 | $V_{IS} = 3.5\text{ V}$                     | -    | 240  | 430  | $\mu\text{A}$    |
| $V_{(BR)IS}$ | Input breakdown voltage                         | $I_I = 10\text{ mA}$                        | 6    | -    | -    | V                |
| $R_{IG}$     | Input series resistance to gate of power MOSFET | $T_j = 25\text{ }^{\circ}\text{C}$          | -    | 33   | -    | $\text{k}\Omega$ |
|              |                                                 | $T_j = 150\text{ }^{\circ}\text{C}$         | -    | 50   | -    | $\text{k}\Omega$ |

## SWITCHING CHARACTERISTICS

$T_{mb} = 25\text{ }^{\circ}\text{C}$ .  $R_I = 50\text{ }\Omega$ . Refer to waveform figure and test circuit.

| SYMBOL     | PARAMETER           | CONDITIONS                                     | MIN. | TYP. | MAX. | UNIT          |
|------------|---------------------|------------------------------------------------|------|------|------|---------------|
| $t_{don}$  | Turn-on delay time  | $V_{DD} = 13\text{ V}$ ; $V_{IS} = 5\text{ V}$ | -    | 8    | -    | $\mu\text{s}$ |
| $t_r$      | Rise time           | resistive load $R_L = 4\text{ }\Omega$         | -    | 40   | -    | $\mu\text{s}$ |
| $t_{doff}$ | Turn-off delay time | $V_{DD} = 13\text{ V}$ ; $V_{IS} = 0\text{ V}$ | -    | 40   | -    | $\mu\text{s}$ |
| $t_f$      | Fall time           | resistive load $R_L = 4\text{ }\Omega$         | -    | 35   | -    | $\mu\text{s}$ |

## REVERSE DIODE LIMITING VALUE

| SYMBOL | PARAMETER                  | CONDITIONS                                                       | MIN. | MAX. | UNIT |
|--------|----------------------------|------------------------------------------------------------------|------|------|------|
| $I_S$  | Continuous forward current | $T_{mb} \leq 25\text{ }^{\circ}\text{C}$ ; $V_{IS} = 0\text{ V}$ | -    | 15   | A    |

## REVERSE DIODE CHARACTERISTICS

$T_{mb} = 25\text{ }^{\circ}\text{C}$

| SYMBOL    | PARAMETER             | CONDITIONS                                                                   | MIN. | TYP. | MAX. | UNIT |
|-----------|-----------------------|------------------------------------------------------------------------------|------|------|------|------|
| $V_{SDO}$ | Forward voltage       | $I_S = 15\text{ A}$ ; $V_{IS} = 0\text{ V}$ ; $t_p = 300\text{ }\mu\text{s}$ | -    | 1.0  | 1.5  | V    |
| $t_{rr}$  | Reverse recovery time | not applicable <sup>2</sup>                                                  | -    | -    | -    | -    |

## ENVELOPE CHARACTERISTICS

| SYMBOL | PARAMETER                  | CONDITIONS                                                   | MIN. | TYP. | MAX. | UNIT |
|--------|----------------------------|--------------------------------------------------------------|------|------|------|------|
| $L_d$  | Internal drain inductance  | Measured from upper edge of tab to centre of die             | -    | 2.5  | -    | nH   |
| $L_s$  | Internal source inductance | Measured from source lead soldering point to source bond pad | -    | 7.5  | -    | nH   |

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

<sup>2</sup> The reverse diode of this type is not intended for applications requiring fast reverse recovery.

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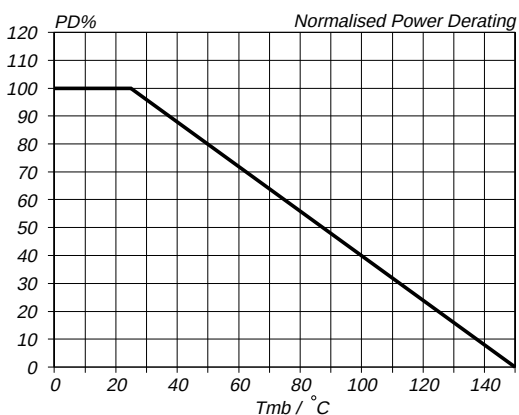


Fig.2. Normalised limiting power dissipation.  
 $P_D\% = 100 \cdot P_D / P_D(25^\circ\text{C}) = f(T_{mb})$

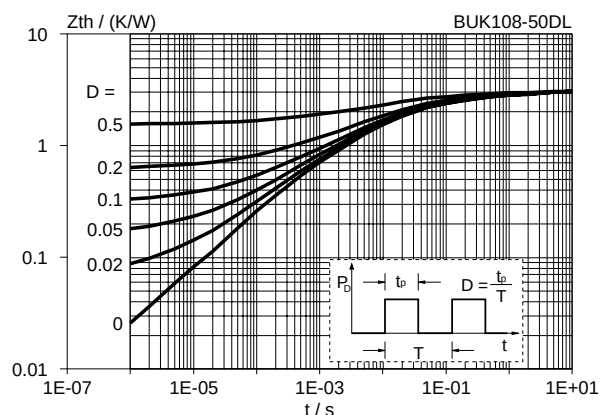


Fig.5. Transient thermal impedance.  
 $Z_{th\ j-mb} = f(t)$ ; parameter  $D = t_p/T$

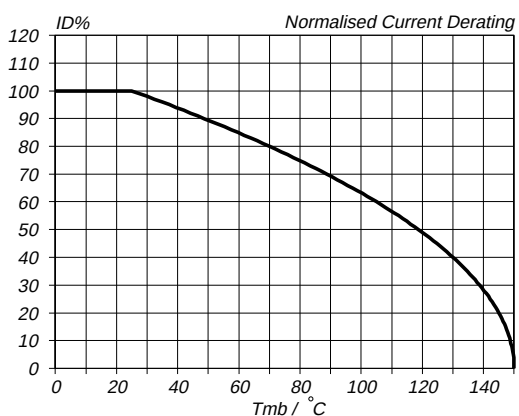


Fig.3. Normalised continuous drain current.  
 $I_D\% = 100 \cdot I_D / I_D(25^\circ\text{C}) = f(T_{mb})$ ; conditions:  $V_{IS} = 5\text{ V}$

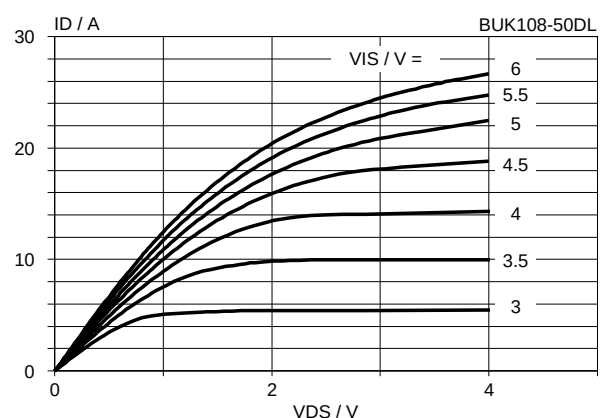


Fig.6. Typical on-state characteristics,  $T_j = 25^\circ\text{C}$ .  
 $I_D = f(V_{DS})$ ; parameter  $V_{IS}$ ;  $t_p = 2\text{ ms}$

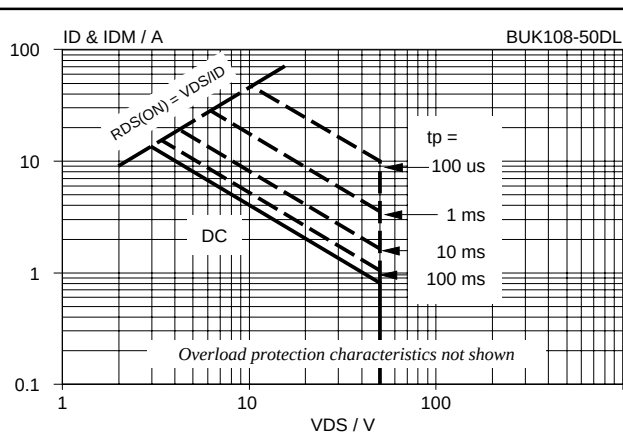


Fig.4. Safe operating area.  $T_{mb} = 25^\circ\text{C}$   
 $I_D$  &  $I_{DM} = f(V_{DS})$ ;  $I_{DM}$  single pulse; parameter  $t_p$

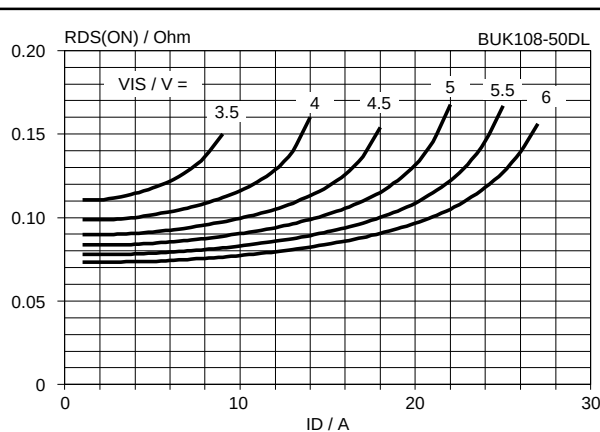


Fig.7. Typical on-state resistance,  $T_j = 25^\circ\text{C}$ .  
 $R_{DS(ON)} = f(I_D)$ ; parameter  $V_{IS}$ ;  $t_p = 2\text{ ms}$

# PowerMOS transistor

## Logic level TOPFET

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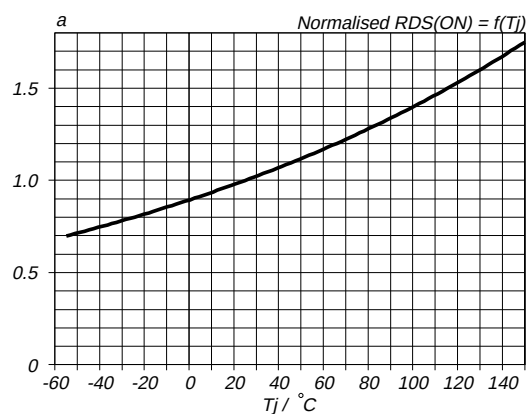


Fig.8. Normalised drain-source on-state resistance.  
 $a = R_{DS(ON)} / R_{DS(ON)}(25^\circ\text{C}) = f(T_j)$ ;  $I_D = 7.5\text{ A}$ ;  $V_{IS} = 5\text{ V}$

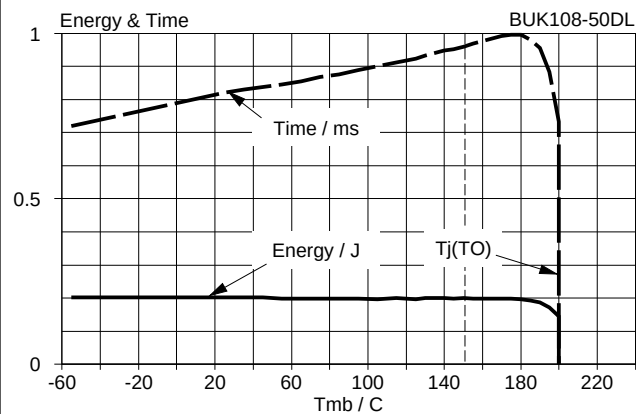


Fig.11. Typical overload protection characteristics.  
 Conditions:  $V_{DD} = 13\text{ V}$ ;  $V_{IS} = 5\text{ V}$ ; SC load =  $30\text{ m}\Omega$

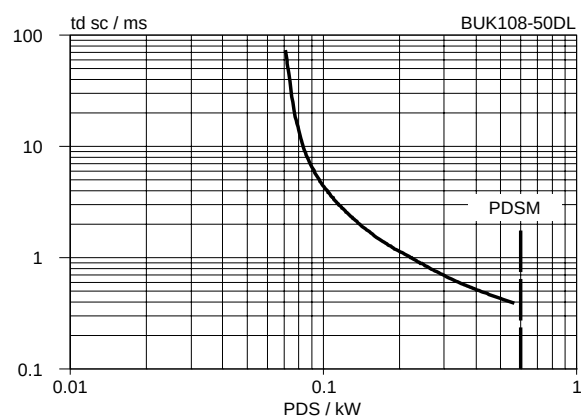


Fig.9. Typical overload protection characteristics.  
 $t_{dsc} = f(P_{DS})$ ; conditions:  $V_{IS} = 4\text{ V}$ ;  $T_j = 25^\circ\text{C}$ .

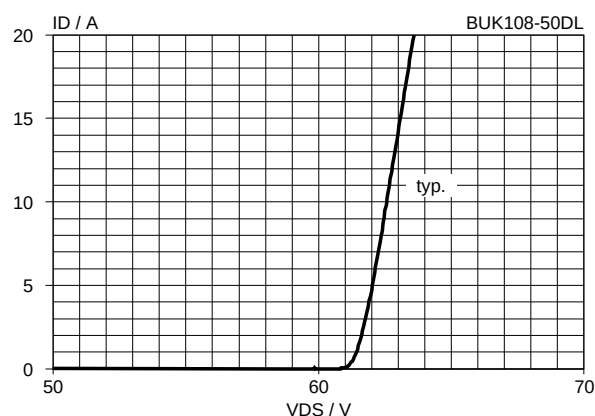


Fig.12. Typical clamping characteristics,  $25^\circ\text{C}$ .  
 $I_D = f(V_{DS})$ ; conditions:  $V_{IS} = 0\text{ V}$ ;  $t_p \leq 50\text{ }\mu\text{s}$

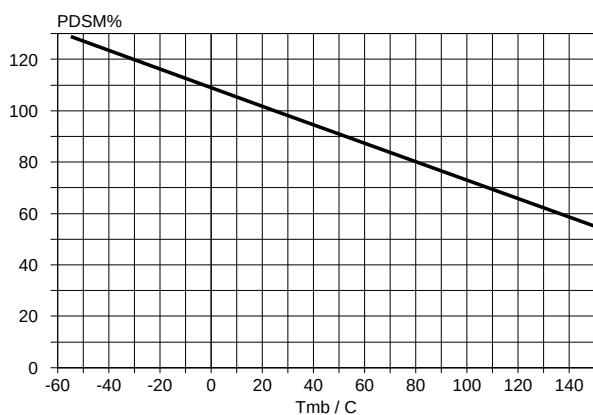


Fig.10. Normalised limiting overload dissipation.  
 $P_{DSM}\% = 100 \cdot P_{DSM} / P_{DSM}(25^\circ\text{C}) = f(T_{mb})$

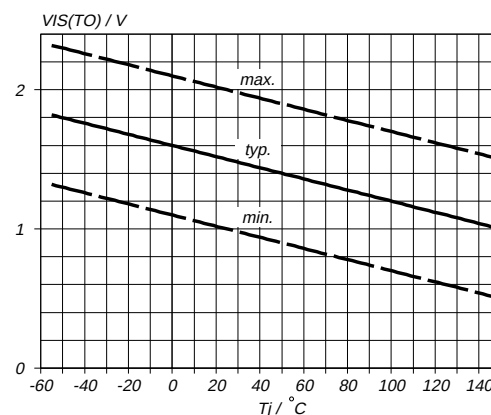
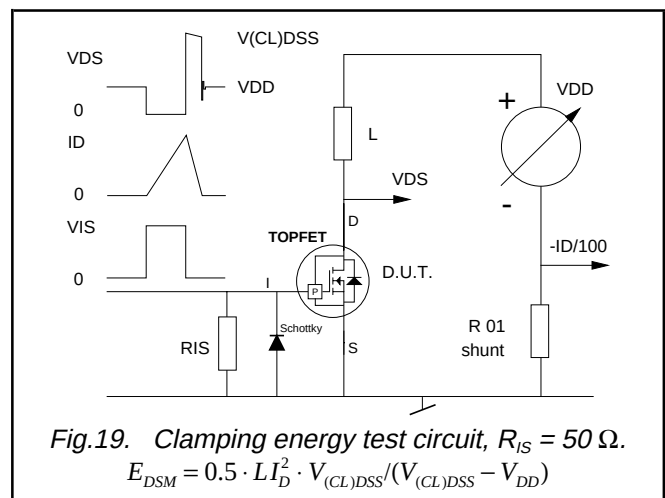
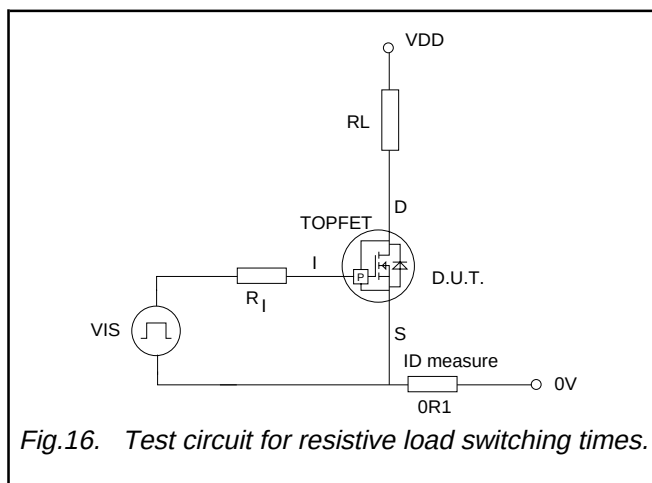
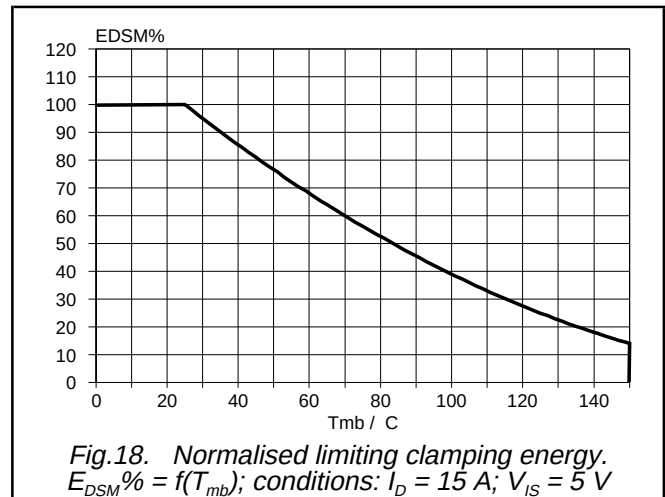
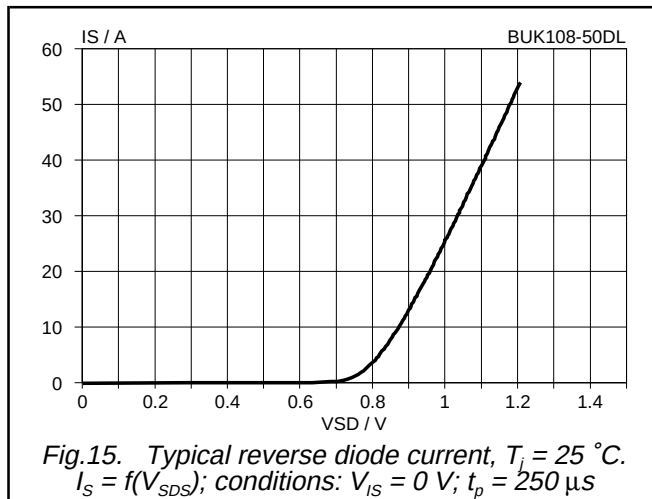
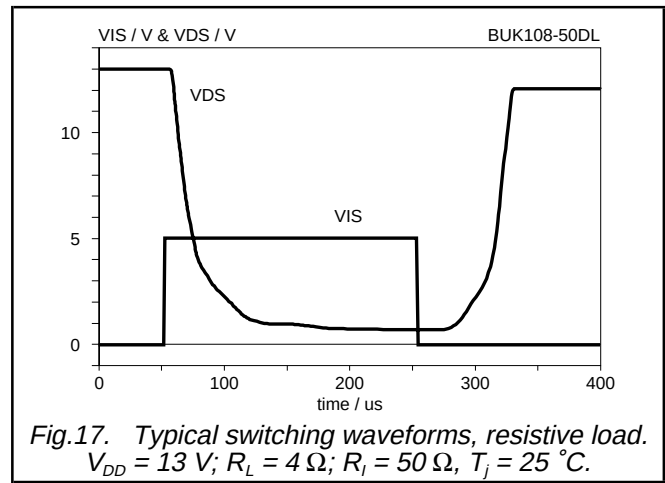
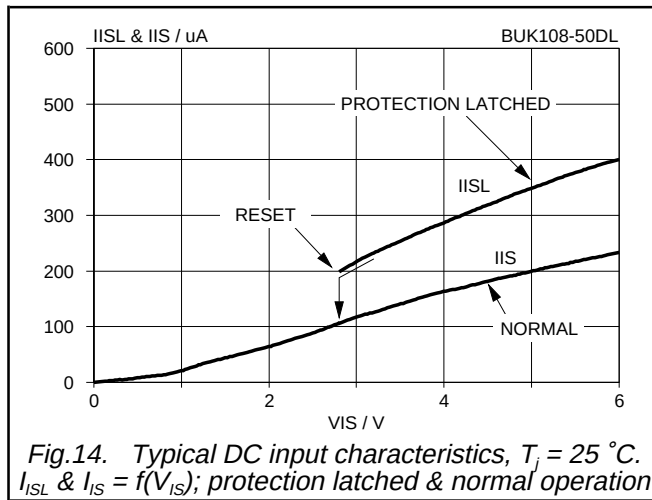


Fig.13. Input threshold voltage.  
 $V_{IS(TO)} = f(T_j)$ ; conditions:  $I_D = 1\text{ mA}$ ;  $V_{DS} = 5\text{ V}$

# PowerMOS transistor

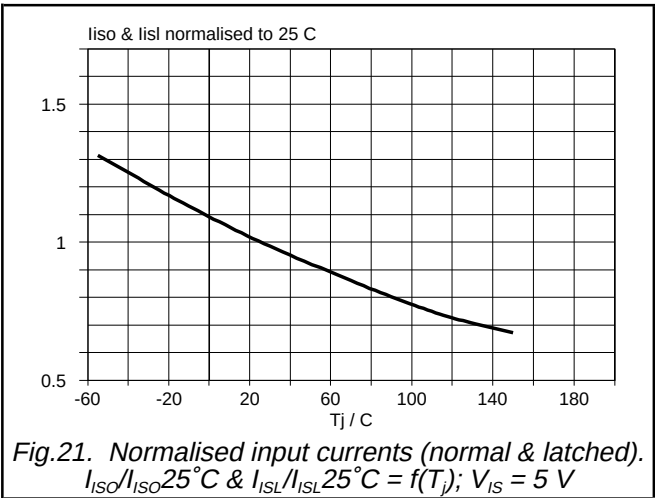
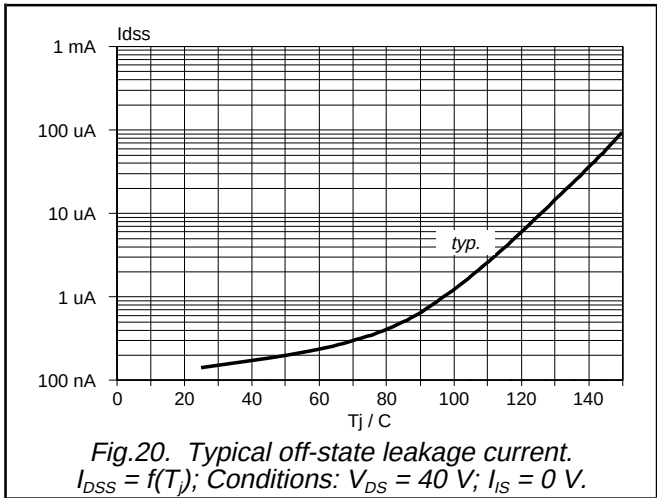
## Logic level TOPFET

### BUK108-50DL



PowerMOS transistor  
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# PowerMOS transistor Logic level TOPFET

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### MECHANICAL DATA

*Dimensions in mm*

*Net Mass: 1.4 g*

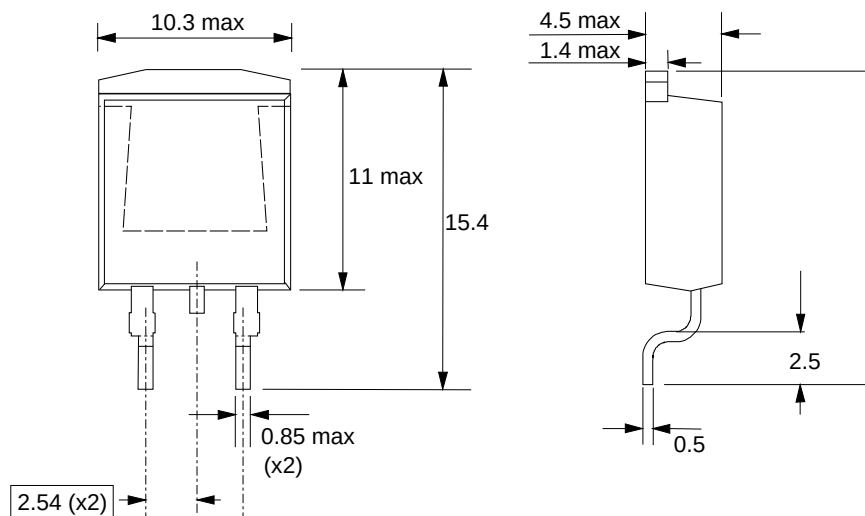


Fig.22. SOT404 : centre pin connected to mounting base.

#### Notes

1. Epoxy meets UL94 V0 at 1/8".

### MOUNTING INSTRUCTIONS

*Dimensions in mm*

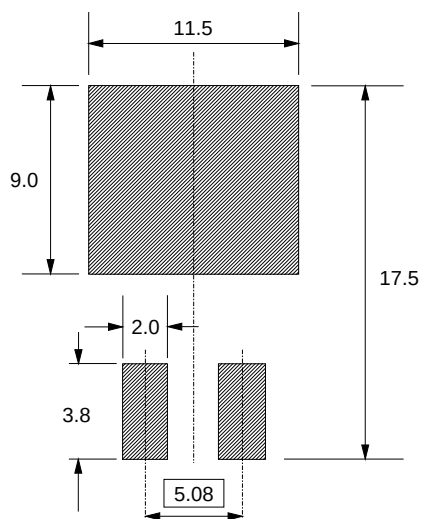


Fig.23. SOT404 : minimum pad sizes for surface mounting.

#### Notes

1. Plastic meets UL94 V0 at 1/8".

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**DEFINITIONS**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Data sheet status</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                       |
| Objective specification                                                                                                                                                                                                                                                                                                                                                                                                                                    | This data sheet contains target or goal specifications for product development.       |
| Preliminary specification                                                                                                                                                                                                                                                                                                                                                                                                                                  | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification                                                                                                                                                                                                                                                                                                                                                                                                                                      | This data sheet contains final product specifications.                                |
| <b>Limiting values</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                       |
| 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. |                                                                                       |
| <b>Application information</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                       |
| Where application information is given, it is advisory and does not form part of the specification.                                                                                                                                                                                                                                                                                                                                                        |                                                                                       |
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**LIFE SUPPORT APPLICATIONS**

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