

# Logic level TOPFET

PIP3115-B

## 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

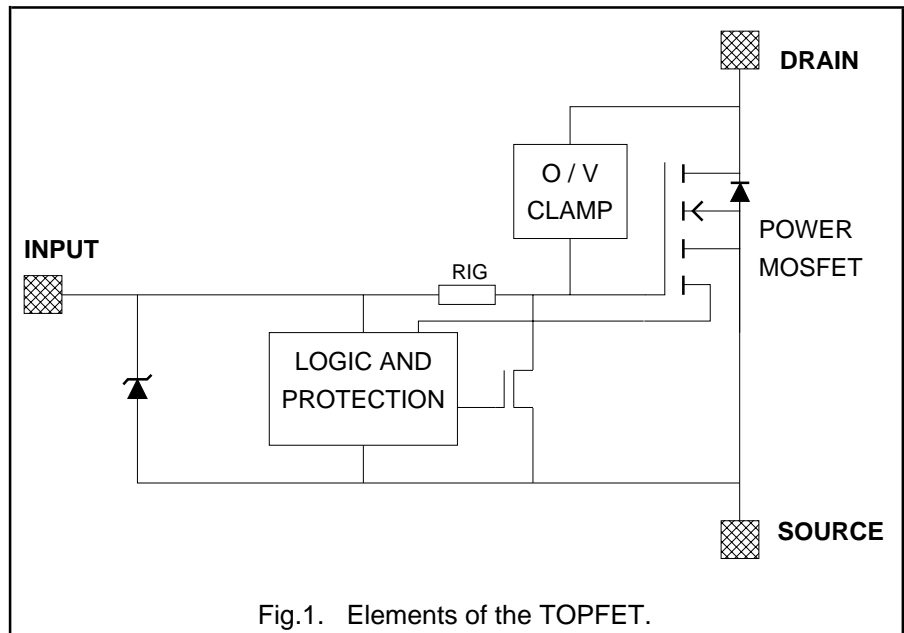
## FEATURES

- 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
- 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                   | 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  | mΩ   |
| $I_{ISL}$    | Input supply current $V_{IS} = 5\text{ V}$ | 650  | μA   |

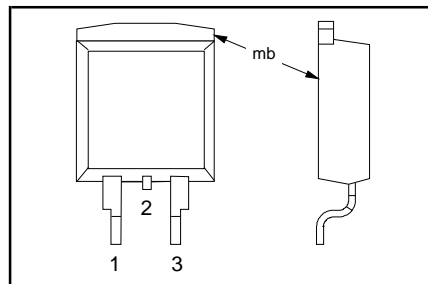
## FUNCTIONAL BLOCK DIAGRAM



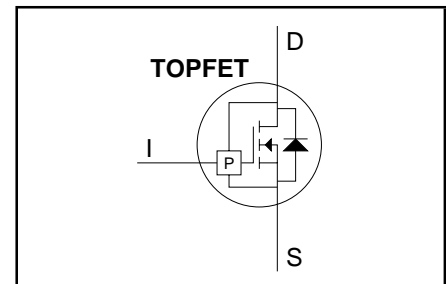
## PINNING - SOT404

| 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    |
| $I_D$      | Continuous drain current                     | $V_{IS} = 5\text{ V}; T_{mb} = 25\text{ °C}$     | -    | self - limited | A    |
| $I_D$      | Continuous drain current                     | $V_{IS} = 5\text{ V}; T_{mb} \leq 110\text{ °C}$ | -    | 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                      | $T_{mb} \leq 25\text{ °C}$                       | -    | 40             | W    |
| $T_{stg}$  | Storage temperature                          | -  | -55  | 175            | °C   |
| $T_j$      | Continuous junction temperature <sup>2</sup> | normal operation                                 | -    | 150            | °C   |
| $T_{sold}$ | Case 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 |
|-----------|--|--|------|------|------|
| $E_{DSM}$ | <b>Inductive load turn-off</b><br>Non-repetitive clamping energy | $I_{DM} = 8\text{ A}; V_{DD} \leq 20\text{ V}$<br>$T_{mb} \leq 25\text{ °C}$ | -    | 100  | mJ   |
| $E_{DRM}$ | Repetitive clamping energy                                       | $T_{mb} \leq 95\text{ °C}; f = 250\text{ Hz}$                                | -    | 20   | mJ   |

**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 |
|----------------|--|---------------------------|------|------|------|------|
| $R_{th\ j-mb}$ | <b>Thermal resistance</b><br>Junction to mounting base | -                         | -    | 2.5  | 3.1  | K/W  |
| $R_{th\ j-a}$  | Junction to ambient                                    | minimum footprint FR4 PCB | -    | 50   | -    | 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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**OUTPUT CHARACTERISTICS**Limits are for  $-40^{\circ}\text{C} \leq T_{\text{mb}} \leq 150^{\circ}\text{C}$ ; typicals are for  $T_{\text{mb}} = 25^{\circ}\text{C}$  unless otherwise specified

| SYMBOL                      | PARAMETER   | CONDITIONS   | MIN. | TYP. | MAX. | UNIT             |
|-----------------------------|---|--|------|------|------|------------------|
| $V_{(\text{CL})\text{DSS}}$ | <b>Off-state</b><br>Drain-source clamping voltage | $V_{\text{IS}} = 0 \text{ V}$  | 50   | -    | -    | V                |
|                             |   | $I_{\text{D}} = 10 \text{ mA}$<br>$I_{\text{DM}} = 1 \text{ A}; t_{\text{p}} \leq 300 \mu\text{s}; \delta \leq 0.01$ | 50   | 60   | 70   | V                |
| $I_{\text{DSS}}$            | Drain source leakage current                      | $V_{\text{DS}} = 40 \text{ V}$   | -    | -    | 100  | $\mu\text{A}$    |
|                             |   | $T_{\text{mb}} = 25^{\circ}\text{C}$   | -    | 0.1  | 10   | $\mu\text{A}$    |
| $R_{\text{DS(ON)}}$         | <b>On-state</b><br>Drain-source resistance        | $I_{\text{DM}} = 3 \text{ A}; t_{\text{p}} \leq 300 \mu\text{s}; \delta \leq 0.01$                                   | -    | -    | 190  | $\text{m}\Omega$ |
|                             |   | $V_{\text{IS}} \geq 4.4 \text{ V}$<br>$T_{\text{mb}} = 25^{\circ}\text{C}$   | -    | 68   | 100  | $\text{m}\Omega$ |
|                             |   | $V_{\text{IS}} \geq 4 \text{ V}$<br>$T_{\text{mb}} = 25^{\circ}\text{C}$   | -    | -    | 200  | $\text{m}\Omega$ |
|                             |   |  | -    | 72   | 105  | $\text{m}\Omega$ |

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

| SYMBOL                                 | PARAMETER  | CONDITIONS  | MIN. | TYP. | MAX. | UNIT               |
|--|--|---|------|------|------|--------------------|
| $I_{\text{D}}$                         | <b>Short circuit load</b><br>Drain current limiting                              | $V_{\text{DS}} = 13 \text{ V}$<br>$V_{\text{IS}} = 5 \text{ V}; T_{\text{mb}} = 25^{\circ}\text{C}$   | 8    | 12   | 16   | A                  |
|  |  | $4.4 \text{ V} \leq V_{\text{IS}} \leq 5.5 \text{ V}$   | 6    | -    | 18   | A                  |
|  |  | $4 \text{ V} \leq V_{\text{IS}} \leq 5.5 \text{ V}$   | 5    | -    | 18   | A                  |
| $P_{\text{D(TO)}}$<br>$T_{\text{DSC}}$ | <b>Overload protection</b><br>Overload power threshold<br>Characteristic time    | $V_{\text{IS}} = 5 \text{ V}; T_{\text{mb}} = 25^{\circ}\text{C}$<br>device trips if $P_{\text{D}} > P_{\text{D(TO)}}$<br>which determines trip time <sup>1</sup> | 20   | 55   | 80   | W                  |
|  |  |   | 200  | 350  | 600  | $\mu\text{s}$      |
| $T_{\text{j(TO)}}$                     | <b>Overtemperature protection</b><br>Threshold junction temperature <sup>2</sup> |   | 150  | 170  | -    | $^{\circ}\text{C}$ |

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

<sup>2</sup> This is independent of the  $dV/dt$  of input voltage  $V_{\text{IS}}$ .

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**INPUT CHARACTERISTICS**

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

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

| SYMBOL              | PARAMETER   | CONDITIONS  | MIN.                          | TYP. | MAX. | UNIT          |               |
|---------------------|---|---|-------------------------------|------|------|---------------|---------------|
| $V_{\text{IS(TO)}}$ | Input threshold voltage   | $V_{\text{DS}} = 5 \text{ V}$ ; $I_{\text{D}} = 1 \text{ mA}$<br>$T_{\text{mb}} = 25^{\circ}\text{C}$ | 0.6                           | -    | 2.4  | V             |               |
|                     |   |   | 1.1                           | 1.6  | 2.1  | V             |               |
| $I_{\text{IS}}$     | Input supply current  | normal operation;   | $V_{\text{IS}} = 5 \text{ V}$ | 100  | 220  | 400           | $\mu\text{A}$ |
|                     |   |   | $V_{\text{IS}} = 4 \text{ V}$ | 80   | 195  | 330           | $\mu\text{A}$ |
| $I_{\text{ISL}}$    | Input supply current  | protection latched;   | $V_{\text{IS}} = 5 \text{ V}$ | 200  | 400  | 650           | $\mu\text{A}$ |
|                     |   |   | $V_{\text{IS}} = 3 \text{ V}$ | 130  | 250  | 430           | $\mu\text{A}$ |
| $V_{\text{ISR}}$    | Protection reset voltage <sup>1</sup>                           | reset time $t_{\text{r}} \geq 100 \mu\text{s}$  | 1.5                           | 2    | 2.9  | V             |               |
| $t_{\text{lr}}$     | Latch reset time  | $V_{\text{IS1}} = 5 \text{ V}$ , $V_{\text{IS2}} < 1 \text{ V}$                                       | 10                            | 40   | 100  | $\mu\text{s}$ |               |
| $V_{\text{(CL)IS}}$ | Input clamping voltage  | $I_{\text{l}} = 1.5 \text{ mA}$   | 5.5                           | -    | 8.5  | V             |               |
| $R_{\text{IG}}$     | Input series resistance <sup>2</sup><br>to gate of power MOSFET | $T_{\text{mb}} = 25^{\circ}\text{C}$  | -                             | 33   | -    | k $\Omega$    |               |

**SWITCHING CHARACTERISTICS**

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

| SYMBOL            | PARAMETER           | CONDITIONS                    | MIN. | TYP. | MAX. | UNIT          |
|-------------------|---------------------|-------------------------------|------|------|------|---------------|
| $t_{\text{don}}$  | Turn-on delay time  | $V_{\text{IS}} = 5 \text{ V}$ | -    | 8    | 20   | $\mu\text{s}$ |
| $t_{\text{r}}$    | Rise time           |                               | -    | 20   | 50   | $\mu\text{s}$ |
| $t_{\text{doff}}$ | Turn-off delay time | $V_{\text{IS}} = 0 \text{ V}$ | -    | 25   | 70   | $\mu\text{s}$ |
| $t_{\text{f}}$    | Fall time           |                               | -    | 16   | 40   | $\mu\text{s}$ |

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

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

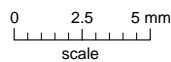
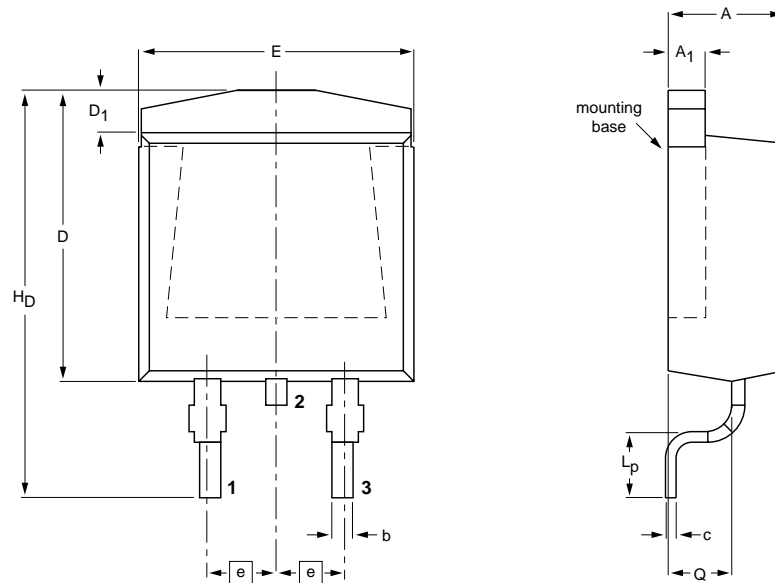
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MECHANICAL DATA

Plastic single-ended surface mounted package (Philips version of D<sup>2</sup>-PAK); 3 leads  
(one lead cropped)

SOT404



DIMENSIONS (mm are the original dimensions)

| UNIT | A            | A <sub>1</sub> | b            | c            | D max. | D <sub>1</sub> | E             | e    | L <sub>p</sub> | H <sub>D</sub> | Q            |
|------|--------------|----------------|--------------|--------------|--------|----------------|---------------|------|----------------|----------------|--------------|
| mm   | 4.50<br>4.10 | 1.40<br>1.27   | 0.85<br>0.60 | 0.64<br>0.46 | 11     | 1.60<br>1.20   | 10.30<br>9.70 | 2.54 | 2.90<br>2.10   | 15.40<br>14.80 | 2.60<br>2.20 |

| OUTLINE VERSION | REFERENCES |       |      | EUROPEAN PROJECTION | ISSUE DATE            |
|-----------------|------------|-------|------|---------------------|-----------------------|
|                 | IEC        | JEDEC | EIAJ |                     |                       |
| SOT404          |            |       |      |                     | -98-12-14<br>99-06-25 |

Fig.2. SOT404 surface mounting package<sup>1</sup>, centre pin connected to mounting base.

<sup>1</sup> Epoxy meets UL94 V0 at 1/8". Net mass: 1.4 g  
For soldering guidelines and SMD footprint design, please refer to Data Handbook SC18.

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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  |
| 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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| <b>Application information</b>   |                                   |   |
| Where application information is given, it is advisory and does not form part of the specification.  |                                   |   |
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