

# DATA SHEET

## **BUT18F; BUT18AF** Silicon diffused power transistors

Product specification  
Supersedes data of 1997 Aug 13

1999 Jun 11

## Silicon diffused power transistors

## BUT18F; BUT18AF

## DESCRIPTION

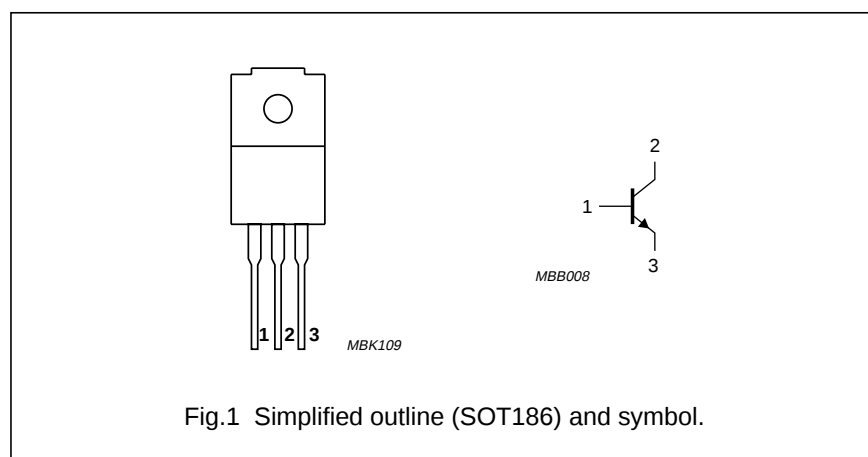
High-voltage, high-speed, glass-passivated NPN power transistor in a SOT186 package with electrically isolated mounting base.

## APPLICATIONS

- Converters
- Inverters
- Switching regulators
- Motor control systems.

## PINNING

| PIN | DESCRIPTION                                        |
|-----|----------------------------------------------------|
| 1   | base                                               |
| 2   | collector                                          |
| 3   | emitter                                            |
| mb  | mounting base; electrically isolated from all pins |



## QUICK REFERENCE DATA

| SYMBOL      | PARAMETER                                           | CONDITIONS                              | MAX.        | UNIT          |
|-------------|-----------------------------------------------------|-----------------------------------------|-------------|---------------|
| $V_{CESM}$  | collector-emitter peak voltage<br>BUT18F<br>BUT18AF | $V_{BE} = 0$                            | 850<br>1000 | V<br>V        |
| $V_{CEO}$   | collector-emitter voltage<br>BUT18F<br>BUT18AF      | open base                               | 400<br>450  | V<br>V        |
| $V_{CEsat}$ | collector-emitter saturation voltage                | see Fig.7                               | 1.5         | V             |
| $I_{Csat}$  | collector saturation current                        |                                         | 4           | A             |
| $I_C$       | collector current (DC)                              | see Fig.4                               | 6           | A             |
| $I_{CM}$    | collector current (peak value)                      | see Fig.4                               | 12          | A             |
| $P_{tot}$   | total power dissipation                             | $T_h \leq 25^\circ\text{C}$ ; see Fig.2 | 33          | W             |
| $t_f$       | fall time                                           | resistive load; see Figs 10 and 11      | 0.8         | $\mu\text{s}$ |

## THERMAL CHARACTERISTICS

| SYMBOL        | PARAMETER                                             | CONDITIONS | VALUE | UNIT |
|---------------|-------------------------------------------------------|------------|-------|------|
| $R_{th\ j-h}$ | thermal resistance from junction to external heatsink | note 1     | 6.15  | K/W  |
|               |                                                       | note 2     | 3.65  | K/W  |

## Notes

1. Mounted **without** heatsink compound and  $30 \pm 5$  N force on centre of package.
2. Mounted **with** heatsink compound and  $30 \pm 5$  N force on centre of package.

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## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL     | PARAMETER                      | CONDITIONS                                  | MIN. | MAX. | UNIT |
|------------|--------------------------------|---------------------------------------------|------|------|------|
| $V_{CESM}$ | collector-emitter peak voltage | $V_{BE} = 0$                                |      |      |      |
|            | BUT18F                         |                                             | –    | 850  | V    |
|            | BUT18AF                        |                                             | –    | 1000 | V    |
| $V_{CEO}$  | collector-emitter voltage      | open base                                   |      |      |      |
|            | BUT18F                         |                                             | –    | 400  | V    |
|            | BUT18AF                        |                                             | –    | 450  | V    |
| $I_{CSat}$ | collector saturation current   |                                             | –    | 4    | A    |
| $I_C$      | collector current (DC)         | see Fig.4                                   | –    | 6    | A    |
| $I_{CM}$   | collector current (peak value) | see Fig.4                                   | –    | 12   | A    |
| $I_B$      | base current (DC)              |                                             | –    | 3    | A    |
| $I_{BM}$   | base current (peak value)      |                                             | –    | 6    | A    |
| $P_{tot}$  | total power dissipation        | $T_h \leq 25\text{ °C}$ ; see Fig.2; note 1 | –    | 20   | W    |
|            |                                | $T_h \leq 25\text{ °C}$ ; see Fig.2; note 2 | –    | 33   | W    |
| $T_{stg}$  | storage temperature            |                                             | –65  | +150 | °C   |
| $T_j$      | junction temperature           |                                             | –    | 150  | °C   |

## Notes

1. **Without** heatsink compound.
2. **With** heatsink compound.

## ISOLATION CHARACTERISTICS

| SYMBOL      | PARAMETER                                                              | TYP. | MAX. | UNIT |
|-------------|------------------------------------------------------------------------|------|------|------|
| $V_{isolM}$ | isolation voltage from all terminals to external heatsink (peak value) | –    | 1500 | V    |
| $C_{isol}$  | isolation capacitance from collector to external heatsink              | 12   | –    | pF   |

## CHARACTERISTICS

$T_j = 25\text{ °C}$  unless otherwise specified.

| SYMBOL        | PARAMETER                            | CONDITIONS                                                                        | MIN. | TYP. | MAX. | UNIT |
|---------------|--------------------------------------|-----------------------------------------------------------------------------------|------|------|------|------|
| $V_{CEOsust}$ | collector-emitter sustaining voltage | $I_C = 100\text{ mA}$ ; $I_{Boff} = 0$ ;<br>$L = 25\text{ mH}$ ; see Figs 3 and 6 |      |      |      |      |
|               | BUT18F                               |                                                                                   | 400  | –    | –    | V    |
|               | BUT18AF                              |                                                                                   | 450  | –    | –    | V    |
| $V_{CESat}$   | collector-emitter saturation voltage | $I_C = 4\text{ A}$ ; $I_B = 800\text{ mA}$ ; see Fig.7                            | –    | –    | 1.5  | V    |
| $V_{BEsat}$   | base-emitter saturation voltage      | $I_C = 4\text{ A}$ ; $I_B = 800\text{ mA}$ ; see Fig.8                            | –    | –    | 1.3  | V    |
| $I_{CES}$     | collector-emitter cut-off current    | $V_{CE} = V_{CESMmax}$ ; $V_{BE} = 0$ ;<br>note 1                                 | –    | –    | 1    | mA   |
|               |                                      | $V_{CE} = V_{CESMmax}$ ; $V_{BE} = 0$ ;<br>$T_j = 125\text{ °C}$ ; note 1         | –    | –    | 2    | mA   |
| $I_{EBO}$     | emitter-base cut-off current         | $V_{EB} = 9\text{ V}$ ; $I_C = 0$                                                 | –    | –    | 10   | mA   |

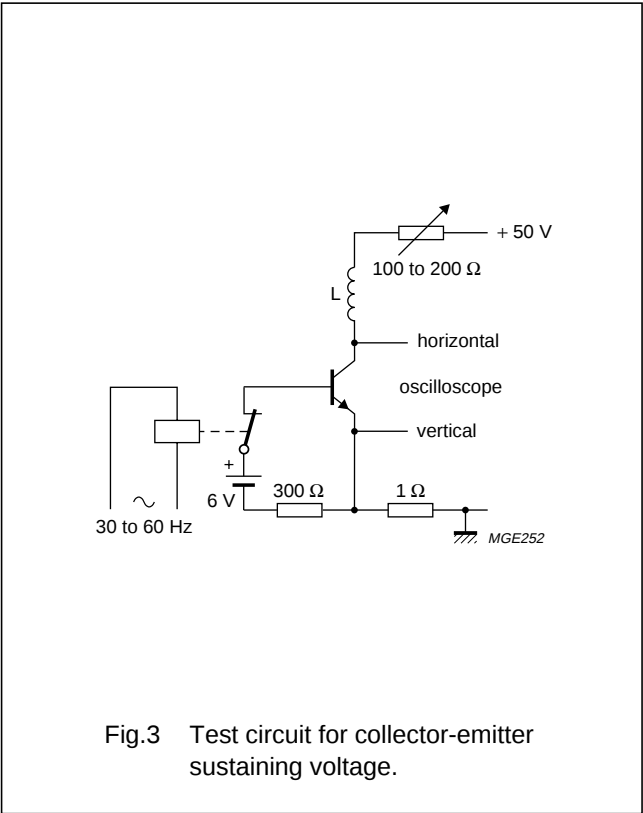
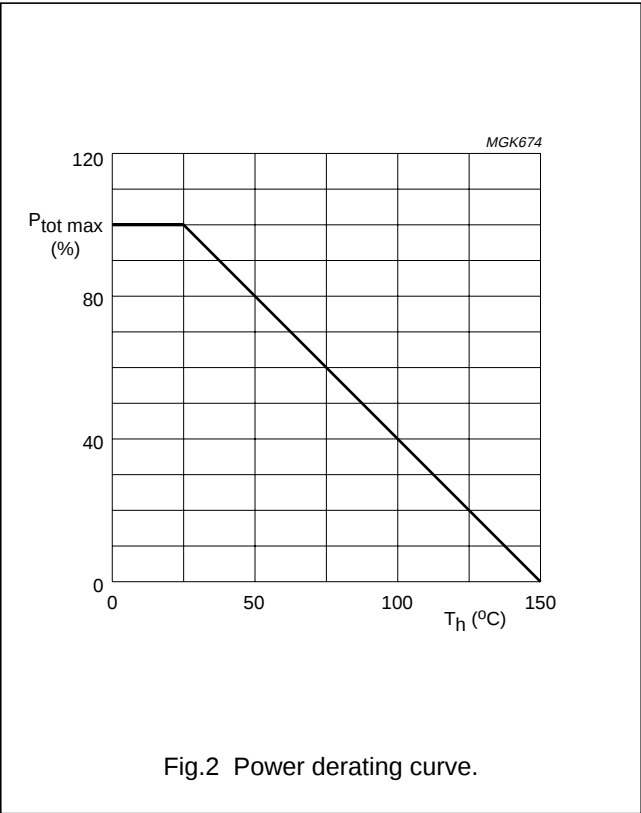
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| SYMBOL                                              | PARAMETER       | CONDITIONS                                                                | MIN. | TYP. | MAX. | UNIT |
|-----------------------------------------------------|-----------------|---------------------------------------------------------------------------|------|------|------|------|
| h <sub>FE</sub>                                     | DC current gain | V <sub>CE</sub> = 5 V; I <sub>C</sub> = 10 mA;<br>see Fig.9               | 10   | 18   | 35   |      |
|                                                     |                 | V <sub>CE</sub> = 5 V; I <sub>C</sub> = 1 A; see Fig.9                    | 10   | 20   | 35   |      |
| Switching times resistive load (see Figs 10 and 11) |                 |                                                                           |      |      |      |      |
| t <sub>on</sub>                                     | turn-on time    | I <sub>Con</sub> = 4 A;<br>I <sub>Bon</sub> = -I <sub>Boff</sub> = 800 mA | —    | —    | 1    | μs   |
| t <sub>s</sub>                                      | storage time    | I <sub>Con</sub> = 4 A;<br>I <sub>Bon</sub> = -I <sub>Boff</sub> = 800 mA | —    | —    | 4    | μs   |
| t <sub>f</sub>                                      | fall time       | I <sub>Con</sub> = 4 A;<br>I <sub>Bon</sub> = -I <sub>Boff</sub> = 800 mA | —    | —    | 0.8  | μs   |
| Switching times inductive load (see Figs 10 and 13) |                 |                                                                           |      |      |      |      |
| t <sub>s</sub>                                      | storage time    | I <sub>Con</sub> = 4 A; I <sub>Bon</sub> = 800 mA                         | —    | 1.6  | 2.5  | μs   |
| t <sub>f</sub>                                      | fall time       | I <sub>Con</sub> = 4 A; I <sub>Bon</sub> = 800 mA                         | —    | 150  | 400  | ns   |

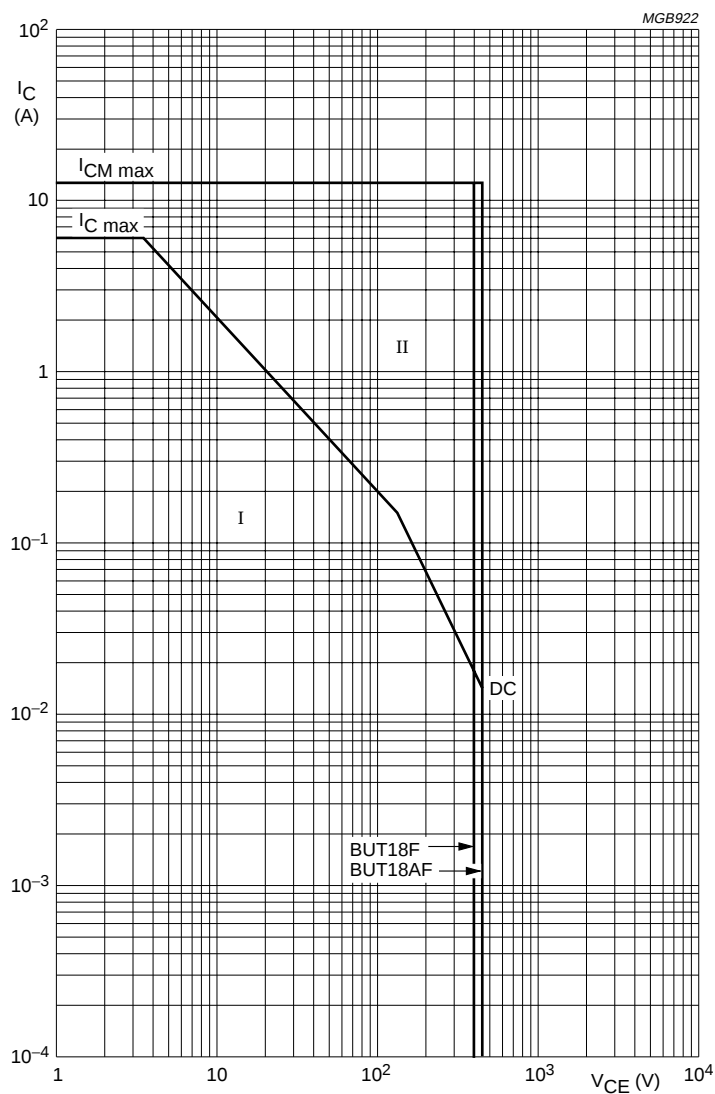
Note

1. Measured with a half-sinewave voltage (curve tracer).



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Mounted **without** heatsink compound and  $30 \pm 5$  N force on centre of package.

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

I - Region of permissible DC operation.

II - Permissible extension for repetitive pulse operation.

Fig.4 Forward bias SOAR.

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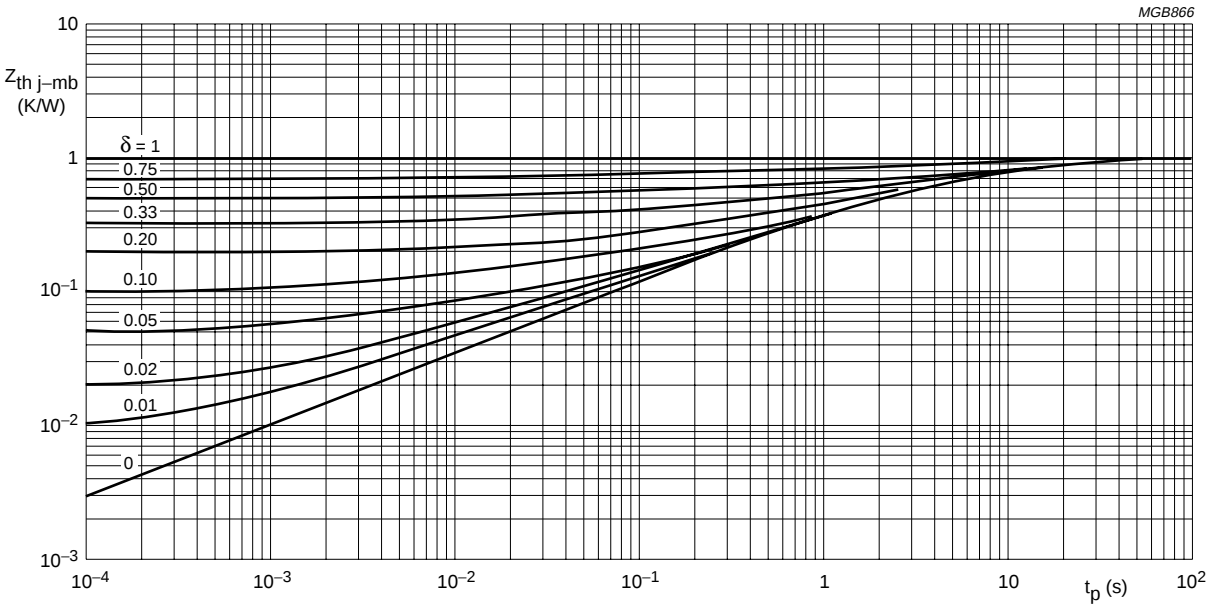


Fig.5 Transient thermal impedance.

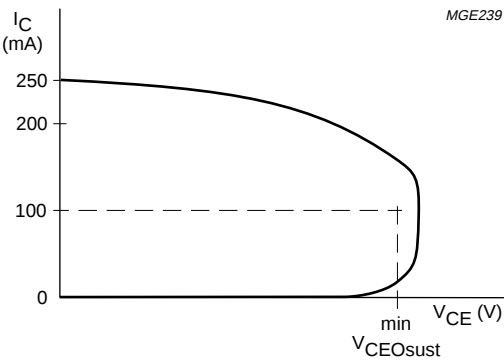
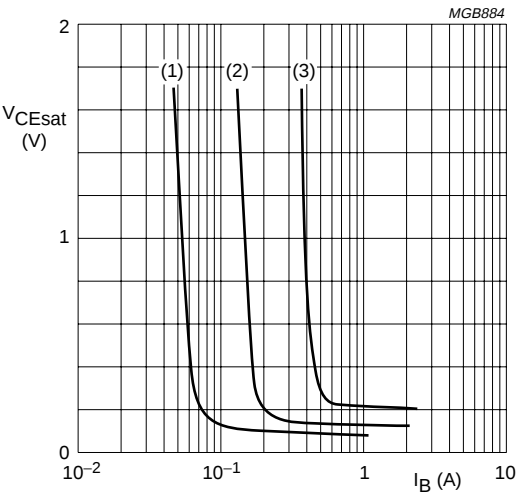


Fig.6 Oscilloscope display for collector-emitter sustaining voltage.

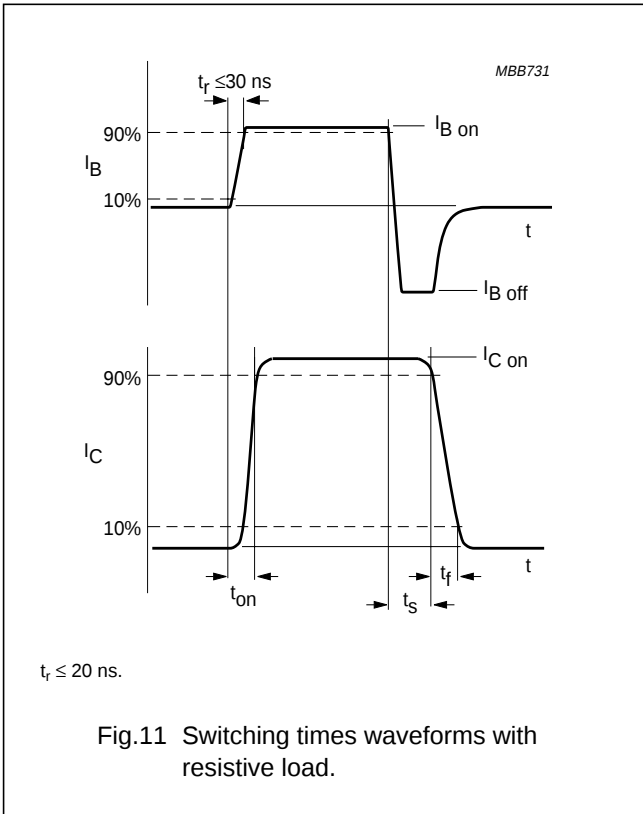
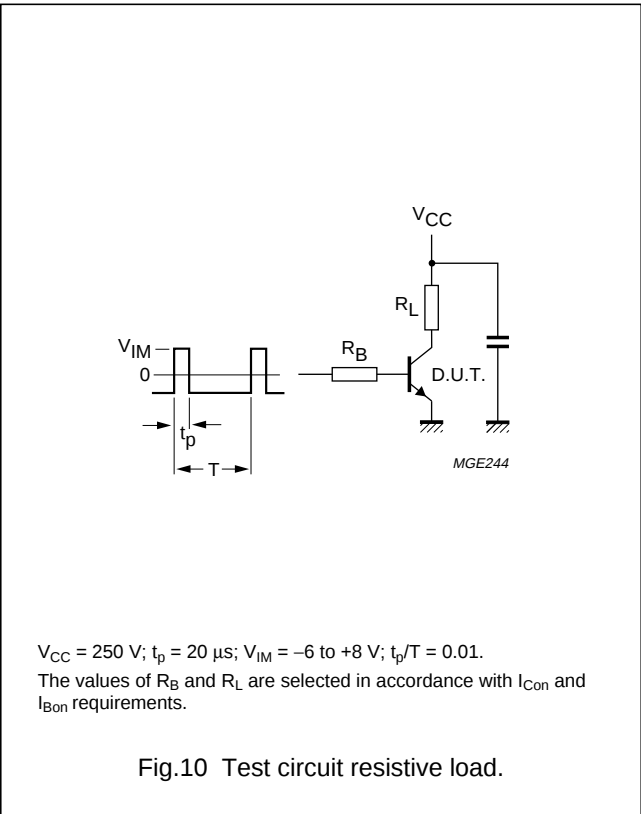
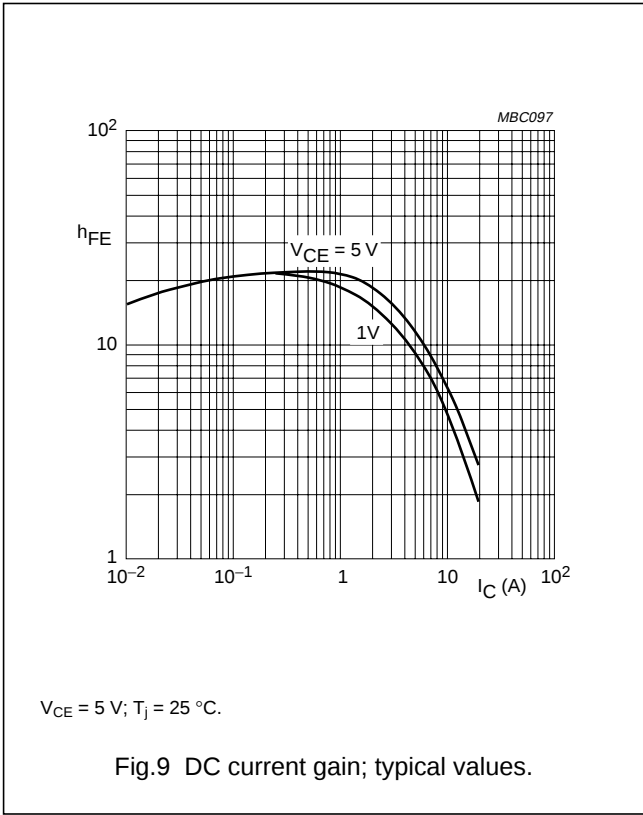
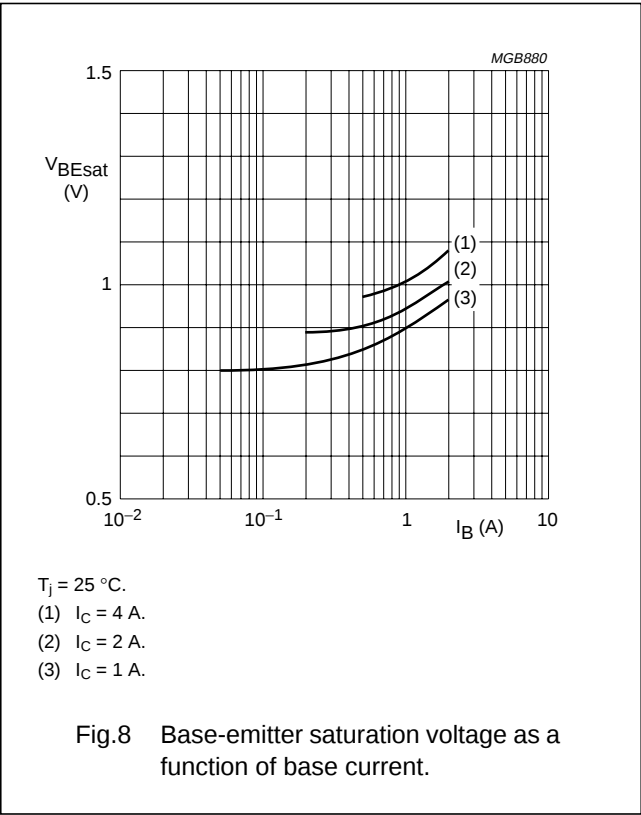


$T_j = 25\text{ }^{\circ}\text{C}$ .  
(1)  $I_C = 1\text{ A}$ .  
(2)  $I_C = 2\text{ A}$ .  
(3)  $I_C = 4\text{ A}$ .

Fig.7 Collector-emitter saturation voltage as a function of base current.

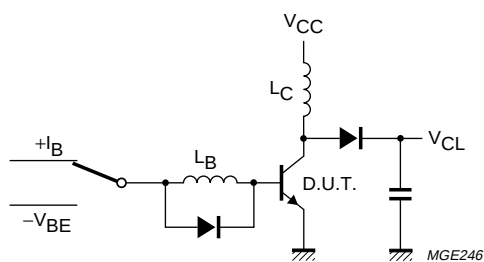
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$V_{CL} = 300\text{ V}$ ;  $V_{CC} = 30\text{ V}$ ;  $V_{BE} = -5\text{ V}$ ;  $L_B = 1\text{ }\mu\text{H}$ ;  $L_C = 200\text{ }\mu\text{H}$ .

Fig.12 Test circuit inductive load.

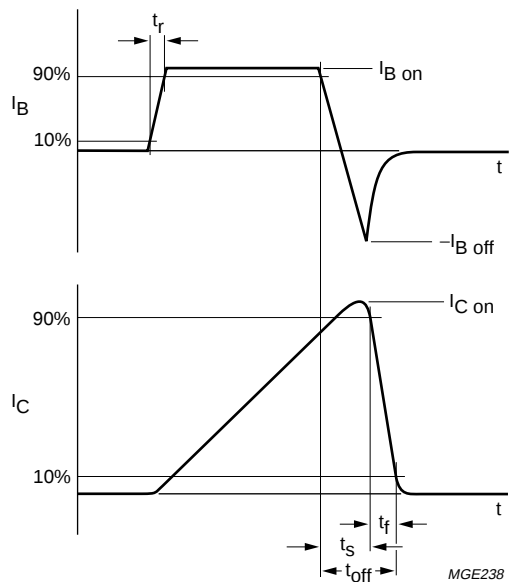


Fig.13 Switching time waveforms with inductive load.

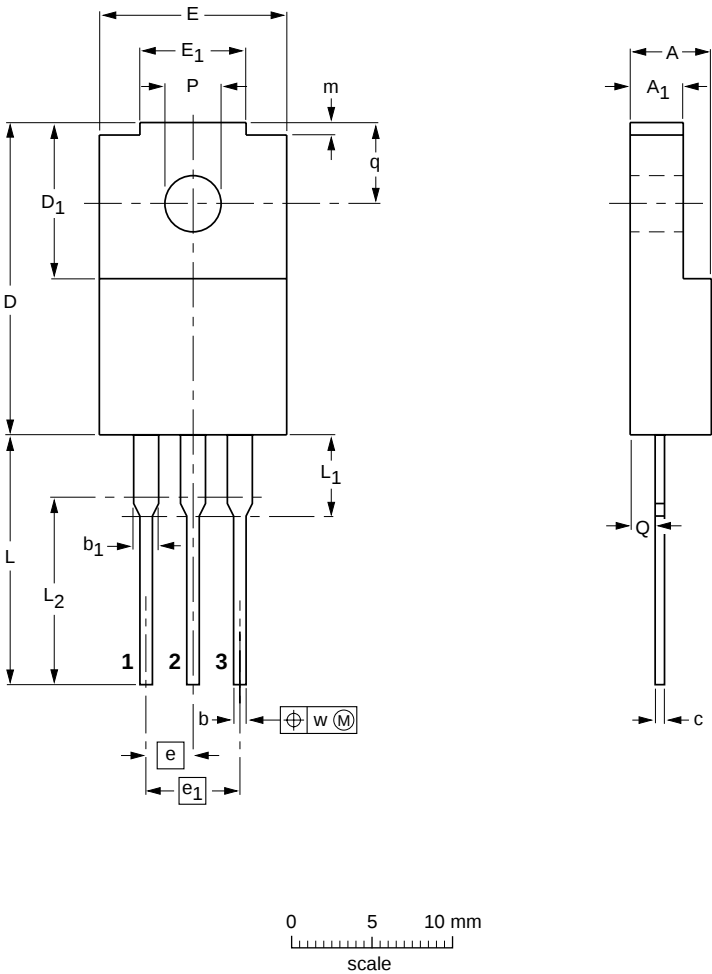
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PACKAGE OUTLINE

Plastic single-ended package; isolated heatsink mounted;  
1 mounting hole; 3 lead TO-220 exposed tabs

SOT186

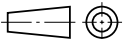


DIMENSIONS (mm are the original dimensions)

| UNIT | A          | A <sub>1</sub> | b          | b <sub>1</sub> | c            | D            | D <sub>1</sub> | E           | E <sub>1</sub> | e    | e <sub>1</sub> | L            | L <sub>1</sub> <sup>(1)</sup> | L <sub>2</sub> | m          | P          | Q          | q          | w   |
|------|------------|----------------|------------|----------------|--------------|--------------|----------------|-------------|----------------|------|----------------|--------------|-------------------------------|----------------|------------|------------|------------|------------|-----|
| mm   | 4.4<br>4.0 | 2.9<br>2.5     | 0.9<br>0.7 | 1.5<br>1.3     | 0.55<br>0.38 | 17.0<br>16.4 | 7.9<br>7.5     | 10.2<br>9.6 | 5.7<br>5.3     | 2.54 | 5.08           | 14.3<br>13.5 | 4.8<br>4.0                    | 10             | 0.9<br>0.5 | 3.2<br>3.0 | 1.4<br>1.2 | 4.4<br>4.0 | 0.4 |

Note

1. Terminal dimensions within this zone are uncontrolled. Terminals in this zone are not tinned.

| OUTLINE<br>VERSION | REFERENCES |        |      |  | EUROPEAN<br>PROJECTION                                                                | ISSUE DATE |
|--------------------|------------|--------|------|--|---------------------------------------------------------------------------------------|------------|
|                    | IEC        | JEDEC  | EIAJ |  |                                                                                       |            |
| SOT186             |            | TO-220 |      |  |  | 97-06-11   |

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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 given are 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 the 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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