# DATA SHEET

# BUW12F; BUW12AF
## Silicon diffused power transistors

Product specification
Supersedes data of February 1996
File under Discrete Semiconductors, SC06

1997 Aug 14

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# Silicon diffused power transistors BUW12F; BUW12AF

## DESCRIPTION

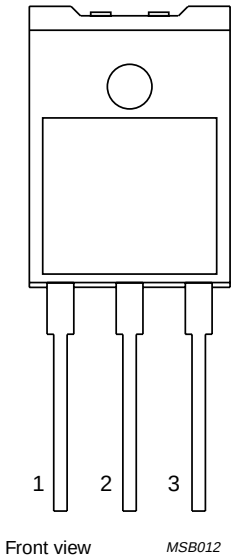
High-voltage, high-speed, glass-passivated NPN power transistor in a SOT199 package.

## APPLICATIONS

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

## PINNING

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



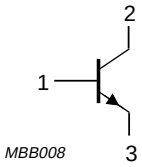




Fig.1 Simplified outline (SOT199) and symbol.

## QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MAX. | UNIT |
|---|---|---|---|---|
| $V_{CESM}$ | collector-emitter peak voltage | $V_{BE}$ = 0 | | |
| | BUW12F | | 850 | V |
| | BUW12AF | | 1000 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | | |
| | BUW12F | | 400 | V |
| | BUW12AF | | 450 | V |
| $V_{CEsat}$ | collector-emitter saturation voltage | see Figs 6 and 10 | 1.5 | V |
| $I_{Csat}$ | collector saturation current | | | |
| | BUW12F | | 6 | A |
| | BUW12AF | | 5 | A |
| $I_C$ | collector current (DC) | see Figs 2 and 5 | 8 | A |
| $I_{CM}$ | collector current (peak value) | see Fig 2 | 20 | A |
| $P_{tot}$ | total power dissipation | $T_h \leq 25$ °C; see Fig.4 | 34 | W |
| $t_f$ | fall time | resistive load; see Figs 12 and 13 | 0.8 | µs |

## THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---|---|---|---|---|
| $R_{th\ j\text{-}h}$ | thermal resistance from junction to external heatsink | note 1 | 3.7 | K/W |
| | | note 2 | 2.8 | K/W |
| $R_{th\ j\text{-}a}$ | thermal resistance from junction to ambient | | 35 | K/W |

**Notes**

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

## 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 | | | |
| | BUW12F | | – | 850 | V |
| | BUW12AF | | – | 1000 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | | | |
| | BUW12F | | – | 400 | V |
| | BUW12AF | | – | 450 | V |
| $I_{Csat}$ | collector saturation current | $V_{CE}$ = 1.5 V | | | |
| | BUW12F | | – | 6 | A |
| | BUW12AF | | – | 5 | A |
| $I_C$ | collector current (DC) | see Figs 2 and 5 | – | 8 | A |
| $I_{CM}$ | collector current (peak value) | see Fig 2 | – | 20 | A |
| $I_B$ | base current (DC) | | – | 4 | A |
| $I_{BM}$ | base current (peak value) | | – | 6 | A |
| $P_{tot}$ | total power dissipation | $T_h \leq 25$ °C; see Fig.4; note 1 | – | 34 | W |
| | | $T_h \leq 25$ °C; see Fig.4; note 2 | – | 45 | W |
| $T_{stg}$ | storage temperature | | –65 | +150 | °C |
| $T_j$ | junction temperature | | – | 150 | °C |

**Notes**

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

## ISOLATION CHARACTERISTICS

| SYMBOL | PARAMETER | 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 | 21 | pF |

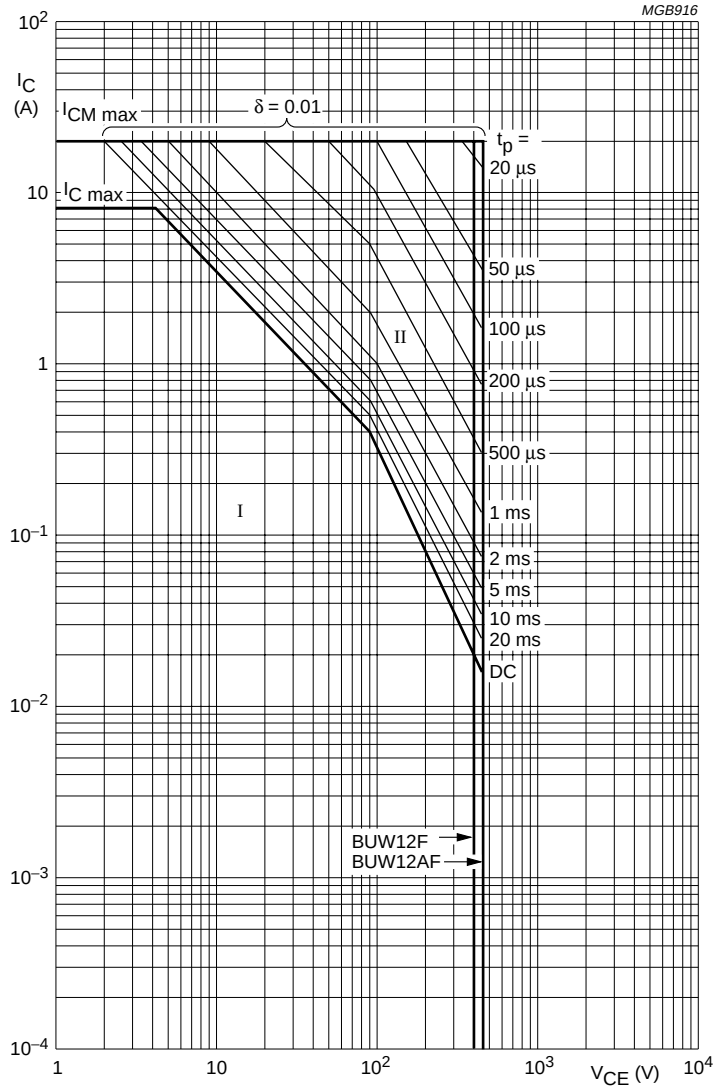
## CHARACTERISTICS

$T_j$ = 25 °C unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{CEOsust}$ | collector-emitter sustaining voltage | $I_C$ = 100 mA; $I_{Boff}$ = 0; L = 25 mH; see Figs 8 and 9 | | | | |
| | BUW12F | | 400 | – | – | V |
| | BUW12AF | | 450 | – | – | V |
| $V_{CEsat}$ | collector-emitter saturation voltage | | | | | |
| | BUW12F | $I_C$ = 6 A; $I_B$ = 1.2 A; see Figs 6 and 10 | – | – | 1.5 | V |
| | BUW12AF | $I_C$ = 5 A; $I_B$ = 1 A; see Figs 6 and 10 | – | – | 1.5 | V |
| $V_{BEsat}$ | base-emitter saturation voltage | | | | | |
| | BUW12F | $I_C$ = 6 A; $I_B$ = 1.2 A; see Fig.6 | – | – | 1.5 | V |
| | BUW12AF | $I_C$ = 5 A; $I_B$ = 1 A; see Fig.6 | – | – | 1.5 | V |
| $I_{CES}$ | collector-emitter cut-off current | $V_{CE}$ = $V_{CESMmax}$; $V_{BE}$ = 0; note 1 | – | – | 1 | mA |
| | | $V_{CE}$ = $V_{CESMmax}$; $V_{BE}$ = 0; $T_j$ = 125 °C; note 1 | – | – | 3 | mA |
| $I_{EBO}$ | emitter-base cut-off current | $V_{EB}$ = 9 V; $I_C$ = 0 | – | – | 10 | mA |
| $h_{FE}$ | DC current gain | $V_{CE}$ = 5 V; $I_C$ = 10 mA; see Fig.11 | 10 | 18 | 35 | |
| | | $V_{CE}$ = 5 V; $I_C$ = 1 A; see Fig.11 | 10 | 20 | 35 | |
| **Switching times resistive load** (see Figs 12 and 13) | | | | | | |
| $t_{on}$ | turn-on time | | | | | |
| | BUW12F | $I_{Con}$ = 6 A; $I_{Bon}$ = $I_{Boff}$ = 1.2 A | – | – | 1 | µs |
| | BUW12AF | $I_{Con}$ = 5 A; $I_{Bon}$ = $I_{Boff}$ = 1 A | – | – | 1 | µs |
| $t_s$ | storage time | | | | | |
| | BUW12F | $I_{Con}$ = 6 A; $I_{Bon}$ = $I_{Boff}$ = 1.2 A | – | – | 4 | µs |
| | BUW12AF | $I_{Con}$ = 5 A; $I_{Bon}$ = $I_{Boff}$ = 1 A | – | – | 4 | µs |
| $t_f$ | fall time | | | | | |
| | BUW12F | $I_{Con}$ = 6 A; $I_{Bon}$ = $I_{Boff}$ = 1.2 A | – | – | 0.8 | µs |
| | BUW12AF | $I_{Con}$ = 5 A; $I_{Bon}$ = $I_{Boff}$ = 1 A | – | – | 0.8 | µs |
| **Switching times inductive load** (see Figs 14 and 15) | | | | | | |
| $t_s$ | storage time | | | | | |
| | BUW12F | $I_{Con}$ = 6 A; $I_B$ = 1.2 A; $V_{CL}$ = 250 V; $T_c$ = 100 °C | – | 1.9 | 2.5 | µs |
| | BUW12AF | $I_{Con}$ = 5 A; $I_B$ = 1 A; $V_{CL}$ = 300 V; $T_c$ = 100 °C | – | 1.9 | 2.5 | µs |
| $t_f$ | fall time | | | | | |
| | BUW12F | $I_{Con}$ = 6 A; $I_B$ = 1.2 A; $V_{CL}$ = 250 V; $T_c$ = 100 °C | – | 200 | 300 | ns |
| | BUW12AF | $I_{Con}$ = 5 A; $I_B$ = 1 A; $V_{CL}$ = 300 V; $T_c$ = 100 °C | – | 200 | 300 | ns |

**Note**

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




Mounted **without** heatsink compound and 30 ±5 N force on centre of package.

$T_{mb}$ < 25 °C.

I - Region of permissible DC operation.

II - Permissible extension for repetitive pulse operation.

Fig.2 Forward bias SOAR.

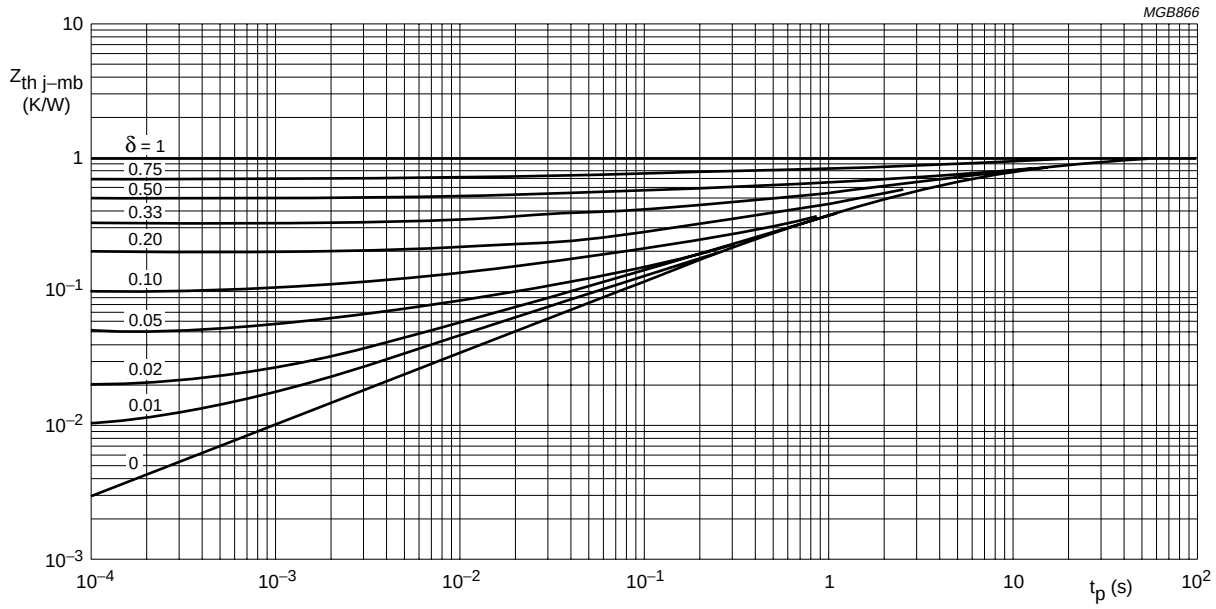



Fig.3 Transient thermal impedance.

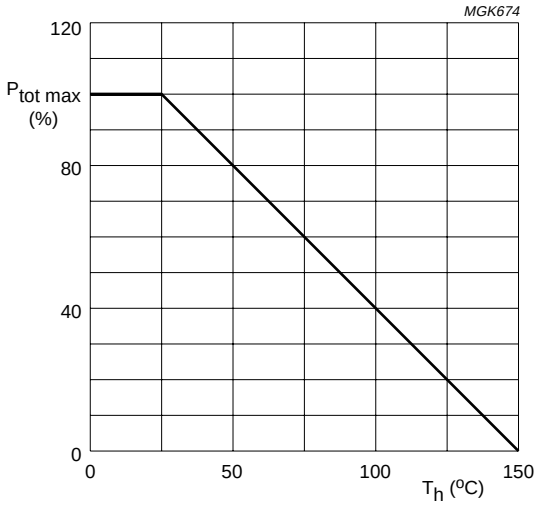
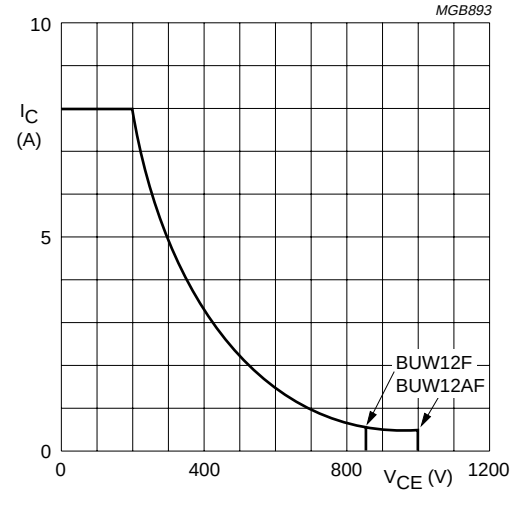
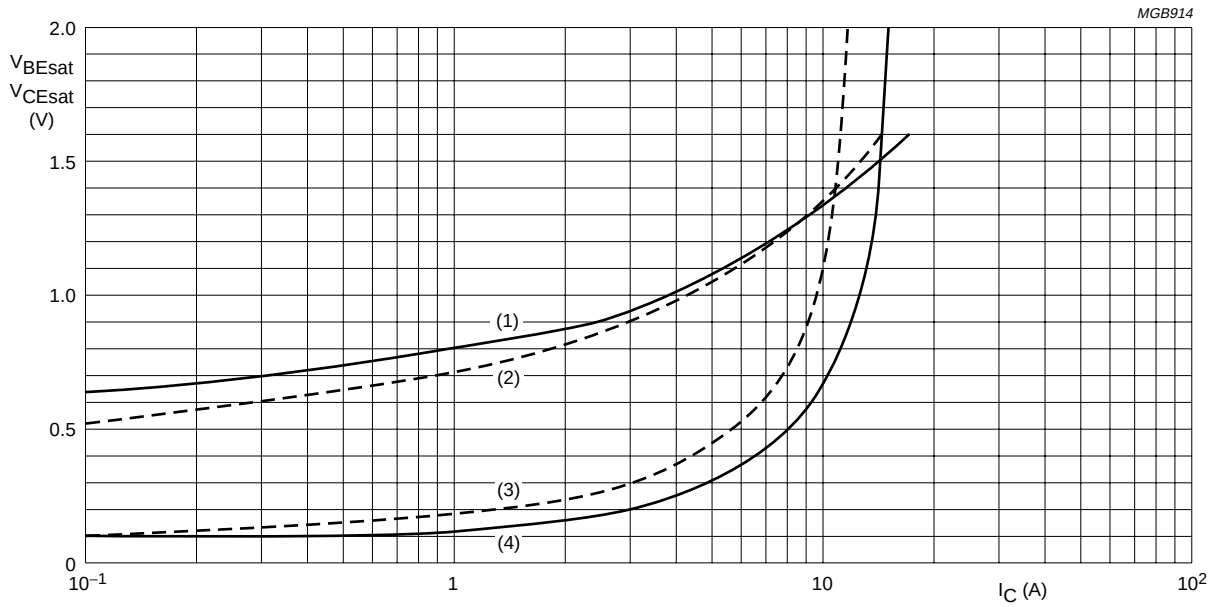



Fig.4 Power derating curve.




$T_c \leq 100$ °C; $V_{BE} = -1$ to $-5$ V.

Fig.5 Reverse bias SOAR.




$I_C/I_B$ = 5.

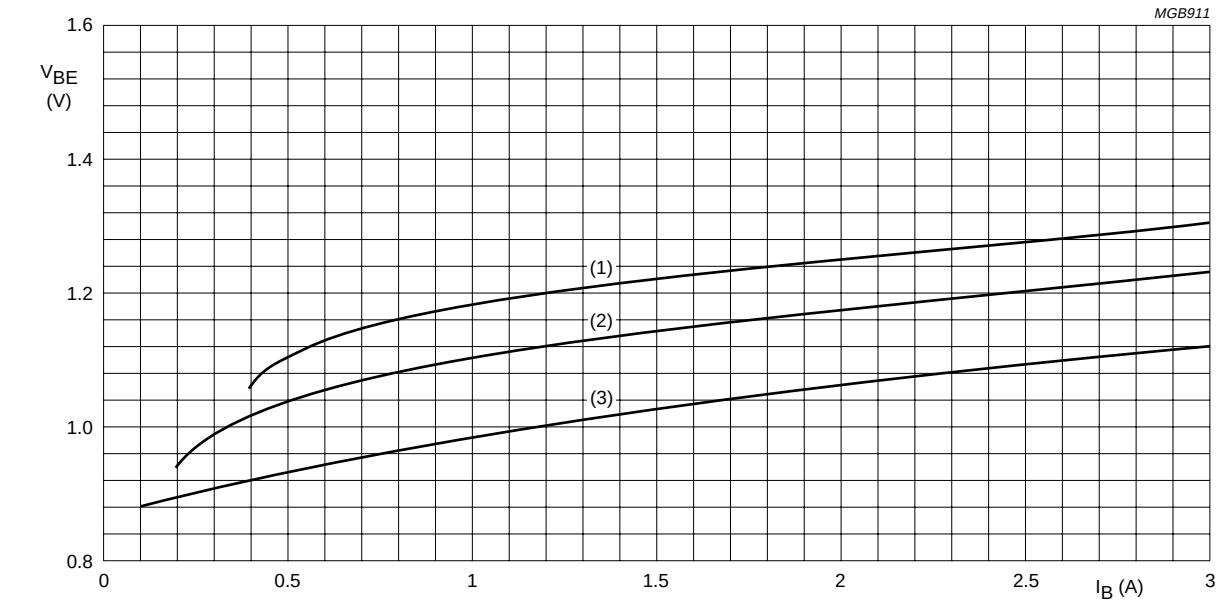
(1) $V_{BE}$; $T_j$ = 25 °C.

(2) $V_{BE}$; $T_j$ = 100 °C.

(3) $V_{CE}$; $T_j$ = 100 °C.

(4) $V_{CE}$; $T_j$ = 25 °C.

Fig.6 Base-emitter and collector-emitter saturation voltages as functions of collector current; typical values.




$T_j$ = 25 °C.

(1) $I_C$ = 8 A.

(2) $I_C$ = 6 A.

(3) $I_C$ = 3 A.

Fig.7 Base-emitter voltage as a function of base current; typical values.

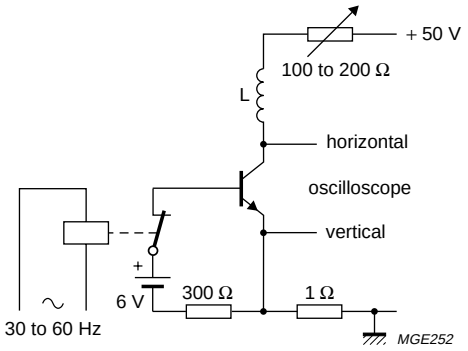



Fig.8 Test circuit for collector-emitter sustaining voltage.

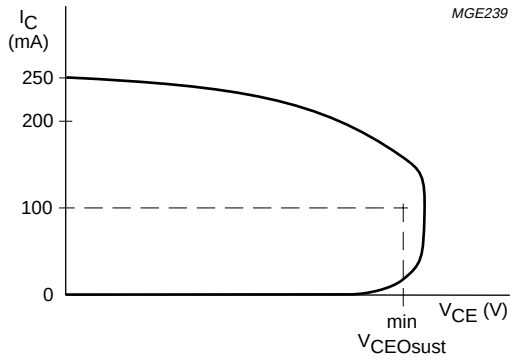
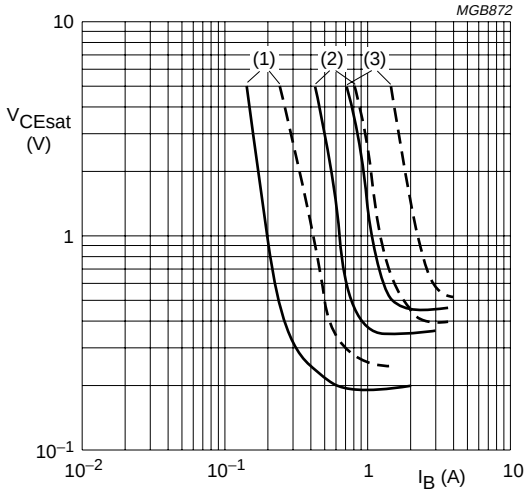
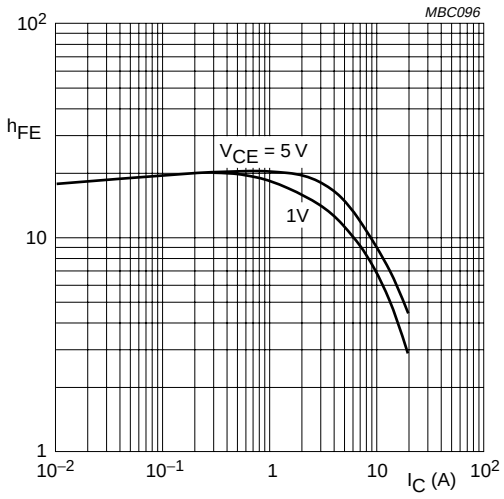



Fig.9 Oscilloscope display for collector-emitter sustaining voltage.



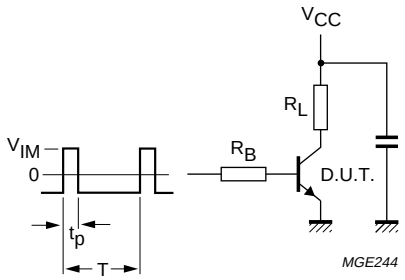

$T_j$ = 25 °C.
(1) $I_C$ = 3 A.
(2) $I_C$ = 6 A.
(3) $I_C$ = 8 A.

Fig.10 Collector-emitter saturation voltage as a function of base current.



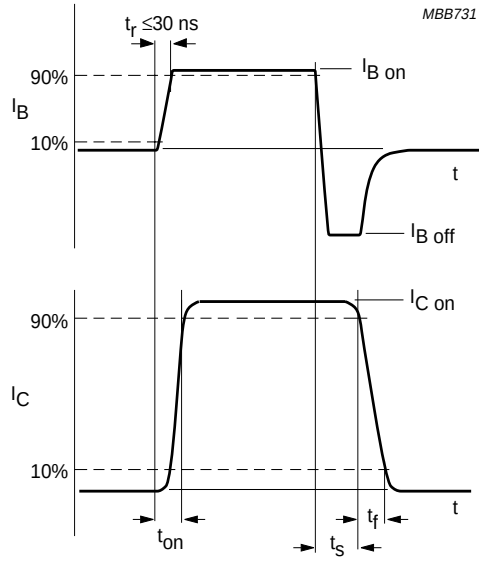

$T_j$ = 125 °C.

Fig.11 DC current gain; typical values.



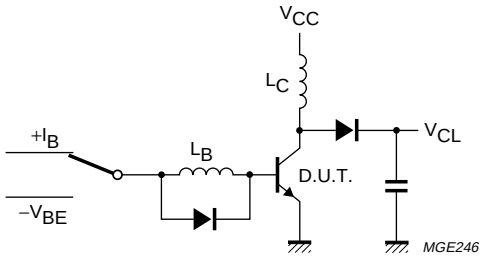

$V_{CC}$ = 250 V; $t_p$ = 20 μs; $V_{IM}$ = −6 to +8 V; $t_p/T$ = 0.01.
The values of $R_B$ and $R_L$ are selected in accordance with $I_{Con}$ and $I_{Bon}$ requirements.

Fig.12 Test circuit resistive load.




$t_r \leq 20$ ns.

Fig.13 Switching time waveforms with resistive load.




$V_{CL}$ = up to 1000 V; $V_{CC}$ = 30 V; $V_{BE}$ = −1 V to −5 V; $L_B$ = 1 μH; $L_C$ = 200 μH.

Fig.14 Test circuit inductive load and reverse bias SOAR.

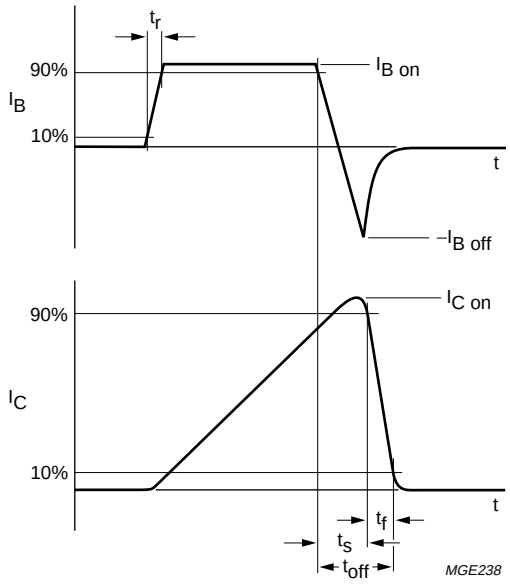
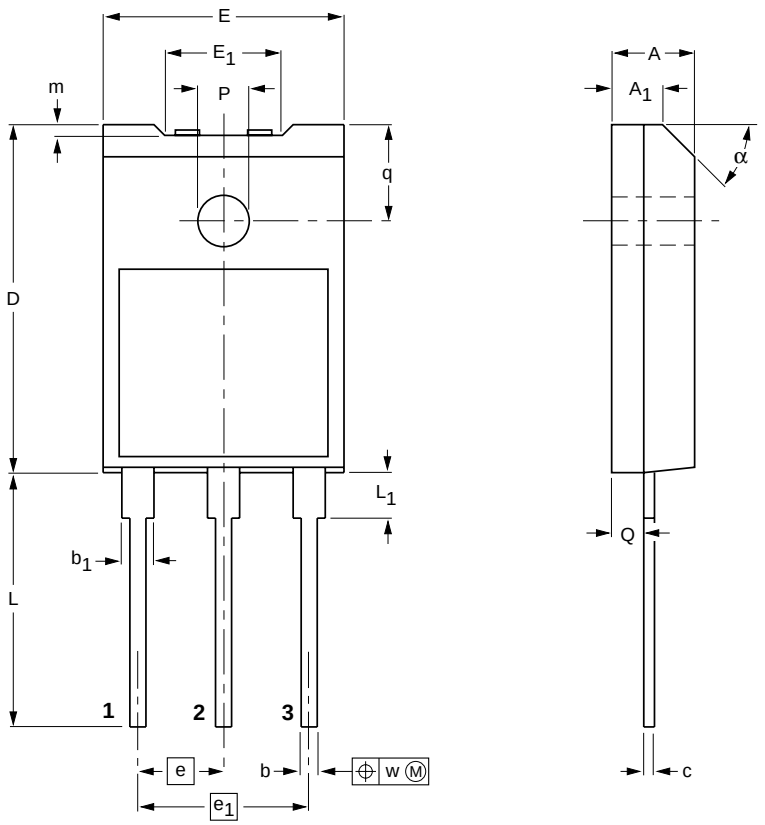
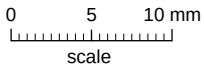



Fig.15 Switching time waveforms with inductive load.

## PACKAGE OUTLINE

**Plastic single-ended package; heatsink mounted; 1 mounting hole; 3 leads (in-line)** **SOT199**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ | b | $b_1$ | c | D | E | $E_1$ | e | $e_1$ | L | $L_1$ (1) | m | P | Q | q | w | α |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 5.2<br>4.8 | 3.4<br>3.0 | 1.2<br>1.0 | 2.1<br>1.9 | 0.6<br>0.5 | 21.5<br>20.5 | 15.3<br>14.7 | 7.8<br>6.8 | 5.45 | 10.9 | 16.5<br>15.7 | 3.7<br>3.3 | 0.8<br>0.6 | 3.3<br>3.1 | 2.1<br>1.9 | 6.2<br>5.8 | 0.4 | 45° |

**Note**

1. Terminals in this zone are not tinned.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT199 | | | | | | 97-06-27 |

## DEFINITIONS

| **Data sheet status** | |
|---|---|
| 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. |
| **Limiting values** | |
| 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. | |
| **Application information** | |
| Where application information is given, it is advisory and does not form part of the specification. | |

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