

## Silicon Diffused Power Transistor

PHE13002AU

## GENERAL DESCRIPTION

High-voltage, high-speed planar-passivated npn power switching transistor in the SOT533 envelope intended for use in high frequency electronic lighting ballast applications, converters and inverters, etc.

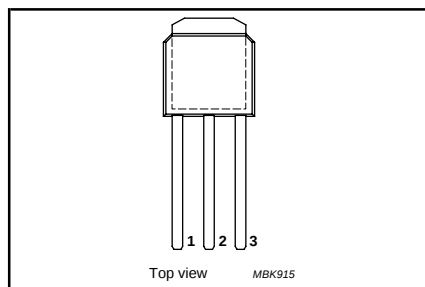
## QUICK REFERENCE DATA

| SYMBOL      | PARAMETER                             | CONDITIONS                                  | TYP. | MAX. | UNIT |
|-------------|---------------------------------------|---------------------------------------------|------|------|------|
| $V_{CESM}$  | Collector-emitter voltage peak value  | $V_{BE} = 0\text{ V}$                       | -    | 600  | V    |
| $V_{CBO}$   | Collector-Base voltage (open emitter) |                                             | -    | 600  | V    |
| $V_{CEO}$   | Collector-emitter voltage (open base) |                                             | -    | 300  | V    |
| $I_C$       | Collector current (DC)                |                                             | -    | 1.5  | A    |
| $I_{CM}$    | Collector current peak value          |                                             | -    | 3    | A    |
| $P_{tot}$   | Total power dissipation               | $T_{mb} \leq 25\text{ }^{\circ}\text{C}$    | -    | 50   | W    |
| $V_{CESat}$ | Collector-emitter saturation voltage  | $I_C = 1.0\text{ A}; I_B = 0.2\text{ A}$    | 0.27 | 1.0  | V    |
| $h_{FE}$    |                                       | $I_C = 1.0\text{ A}; V_{CE} = 5\text{ V}$   | 12   | 19   |      |
| $t_{fi}$    | Fall time (Inductive)                 | $I_C = 1.0\text{ A}; I_{B1} = 0.2\text{ A}$ | 56   | 76   | ns   |

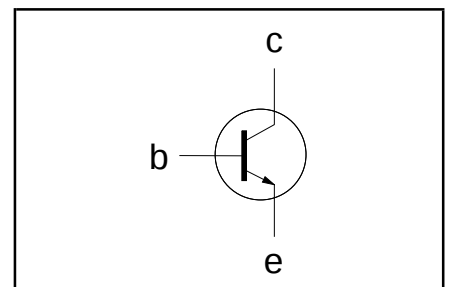
## PINNING - SOT533

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | base        |
| 2   | collector   |
| 3   | emitter     |
| tab | collector   |

## PIN CONFIGURATION



## SYMBOL



## LIMITING VALUES

Limiting values in accordance with the Absolute Maximum Rating System (IEC 134)

| SYMBOL     | PARAMETER                                | CONDITIONS                               | MIN. | MAX. | UNIT               |
|------------|------------------------------------------|------------------------------------------|------|------|--------------------|
| $V_{CESM}$ | Collector to emitter voltage             | $V_{BE} = 0\text{ V}$                    | -    | 600  | V                  |
| $V_{CEO}$  | Collector to emitter voltage (open base) |                                          | -    | 300  | V                  |
| $V_{CBO}$  | Collector to base voltage (open emitter) |                                          | -    | 600  | V                  |
| $I_C$      | Collector current (DC)                   |                                          | -    | 1.5  | A                  |
| $I_{CM}$   | Collector current peak value             |                                          | -    | 3    | A                  |
| $I_B$      | Base current (DC)                        |                                          | -    | 0.75 | A                  |
| $I_{BM}$   | Base current peak value                  |                                          | -    | 1.5  | A                  |
| $P_{tot}$  | Total power dissipation                  | $T_{mb} \leq 25\text{ }^{\circ}\text{C}$ | -    | 50   | W                  |
| $T_{stg}$  | Storage temperature                      |                                          | -65  | 150  | $^{\circ}\text{C}$ |
| $T_j$      | Junction temperature                     |                                          | -    | 150  | $^{\circ}\text{C}$ |

## THERMAL RESISTANCES

| SYMBOL         | PARAMETER                 | CONDITIONS  | TYP. | MAX. | UNIT |
|----------------|---------------------------|-------------|------|------|------|
| $R_{th\ j-mb}$ | Junction to mounting base |             | -    | 2.5  | K/W  |
| $R_{th\ j-a}$  | Junction to ambient       | in free air | 70   | -    | K/W  |

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## STATIC CHARACTERISTICS

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

| SYMBOL                                  | PARAMETER                                                                                                 | CONDITIONS                                                                                                                                        | MIN.          | TYP.           | MAX.            | UNIT                                         |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------|-----------------|----------------------------------------------|
| $I_{CES}, I_{CBO}$<br>$I_{CES}$         | Collector cut-off current <sup>1</sup>                                                                    | $V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$<br>$V_{BE} = 0\text{ V}; V_{CE} = V_{CESMmax}$<br>$T_j = 125\text{ }^{\circ}\text{C}$                 | -<br>-        | 0.14<br>39     | 100<br>500      | $\mu\text{A}$<br>$\mu\text{A}$               |
| $I_{CEO}$<br>$I_{EBO}$<br>$V_{CEOsust}$ | Collector cut-off current <sup>1</sup><br>Emitter cut-off current<br>Collector-emitter sustaining voltage | $V_{CEO} = V_{CEOMmax} (300\text{V})$<br>$V_{EB} = 9\text{ V}; I_C = 0\text{ A}$<br>$I_B = 0\text{ A}; I_C = 10\text{ mA};$<br>$L = 25\text{ mH}$ | -<br>-<br>300 | 3.7<br>20<br>- | 100<br>100<br>- | $\mu\text{A}$<br>$\mu\text{A}$<br>$\text{V}$ |
| $V_{CESat}$<br>$V_{BESat}$              | Collector-emitter saturation voltage<br>Base-emitter saturation voltage                                   | $I_C = 1.0\text{ A}; I_B = 0.2\text{ A}$<br>$I_C = 1.0\text{ A}; I_B = 0.2\text{ A}$                                                              | -<br>-        | 0.27<br>1.03   | 1.0<br>1.3      | $\text{V}$<br>$\text{V}$                     |
| $h_{FE}$<br>$h_{FE}$<br>$h_{FE}$        | DC current gain                                                                                           | $I_C = 1\text{ mA}; V_{CE} = 5\text{ V}$<br>$I_C = 100\text{ mA}; V_{CE} = 5\text{ V}$<br>$I_C = 1.0\text{ A}; V_{CE} = 5\text{ V}$               | 17<br>19<br>9 | 23<br>30<br>12 | -<br>46<br>19   | $\text{V}$<br>$\text{V}$<br>$\text{V}$       |

## DYNAMIC CHARACTERISTICS

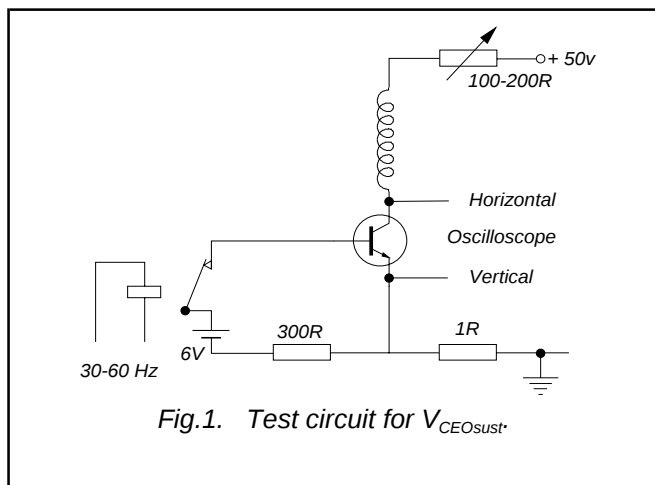
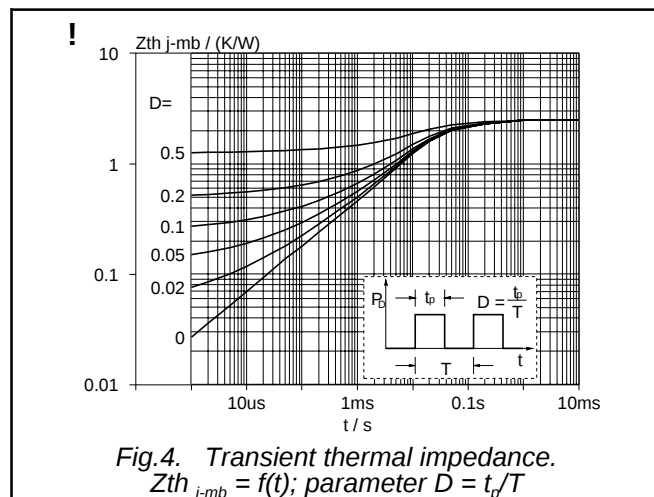
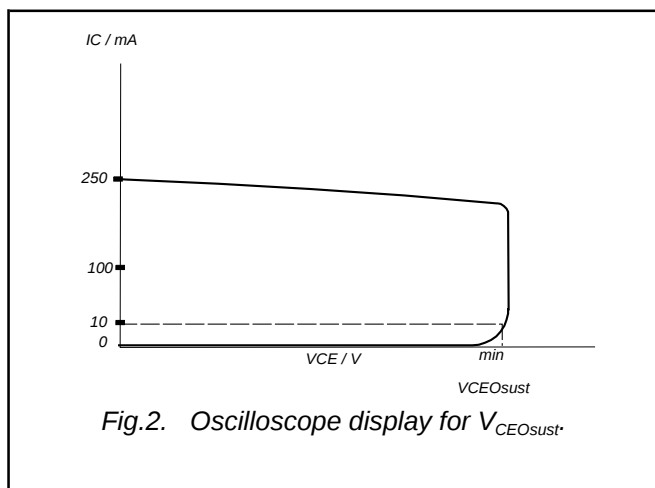
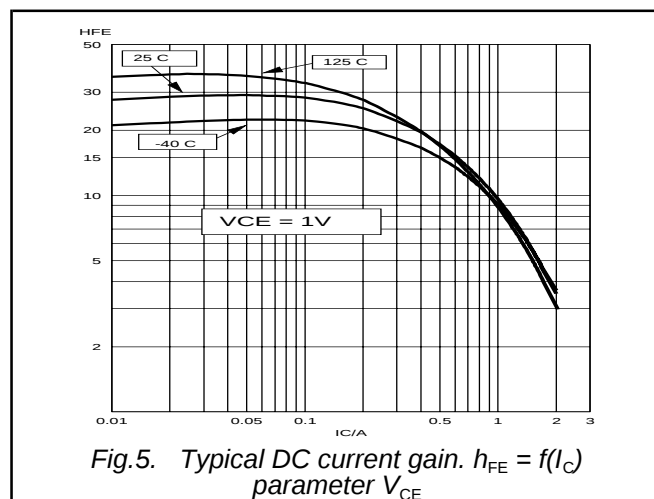
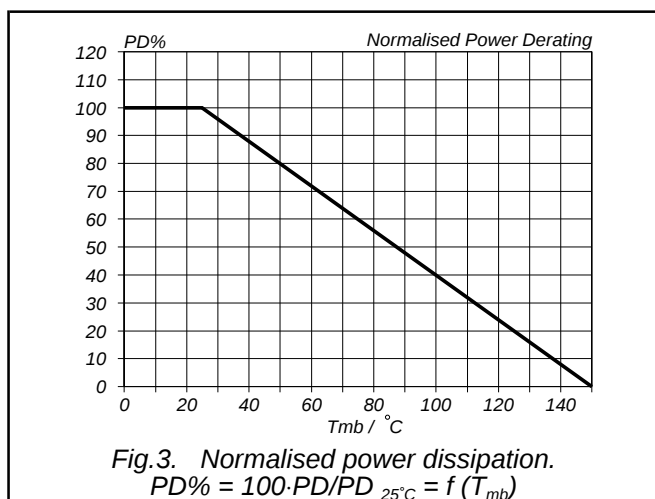
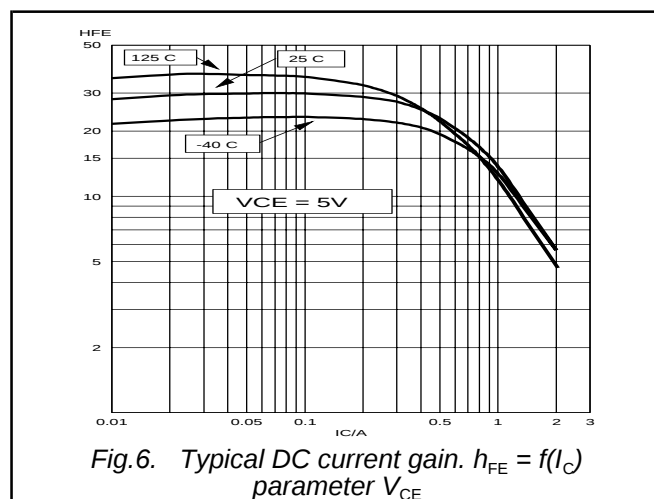
 $T_{mb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified

| SYMBOL                     | PARAMETER                                                                                       | CONDITIONS                                                                                                                                 | TYP.                 | MAX.                | UNIT                                            |
|----------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------|-------------------------------------------------|
| $t_{on}$<br>$t_s$<br>$t_f$ | Switching times (resistive load)<br>Turn-on time<br>Turn-off storage time<br>Turn-off fall time | $I_{Con} = 1.0\text{ A}; I_{Bon} = -I_{Boff} = 0.2\text{ A};$<br>$R_L = 75\text{ ohms}; V_{BB2} = 4\text{V};$                              | 0.78<br>0.91<br>0.25 | 1.0<br>1.22<br>0.34 | $\mu\text{s}$<br>$\mu\text{s}$<br>$\mu\text{s}$ |
| $t_{si}$<br>$t_{fi}$       | Switching times (inductive load)<br>Turn-off storage time<br>Turn-off fall time                 | $I_{Con} = 1.0\text{ A}; I_{Bon} = 0.2\text{ A}; L_B = 1\text{ }\mu\text{H};$<br>$-V_{BB} = 5\text{ V}$                                    | 0.55<br>56           | 0.74<br>76          | $\mu\text{s}$<br>$\text{ns}$                    |
| $t_{si}$<br>$t_{fi}$       | Switching times (inductive load)<br>Turn-off storage time<br>Turn-off fall time                 | $I_{Con} = 1.0\text{ A}; I_{Bon} = 0.2\text{ A}; L_B = 1\text{ }\mu\text{H};$<br>$-V_{BB} = 5\text{ V}; T_j = 100\text{ }^{\circ}\text{C}$ | -<br>-               | 1.5<br>140          | $\mu\text{s}$<br>$\text{ns}$                    |

<sup>1</sup> Measured with half sine-wave voltage (curve tracer).

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Fig.1. Test circuit for  $V_{CEOsust}$ .Fig.4. Transient thermal impedance.  
 $Z_{th j-mb} = f(t)$ ; parameter  $D = t_p/T$ Fig.2. Oscilloscope display for  $V_{CEOsust}$ .Fig.5. Typical DC current gain.  $h_{FE} = f(I_C)$   
parameter  $V_{CE}$ Fig.3. Normalised power dissipation.  
 $PD\% = 100 \cdot PD / PD_{25^\circ C} = f(T_{mb})$ Fig.6. Typical DC current gain.  $h_{FE} = f(I_C)$   
parameter  $V_{CE}$

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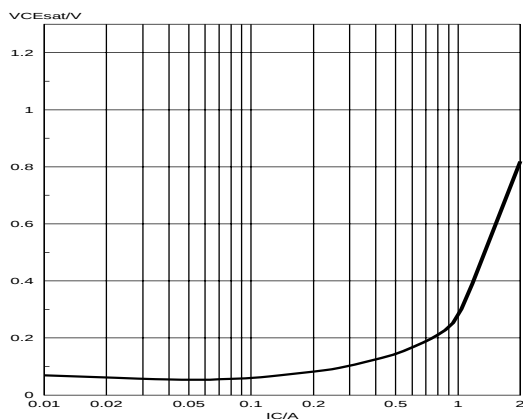


Fig. 7. Collector-Emitter saturation voltage.  
Solid Lines = typ values,  $I_C/I_B = 3$

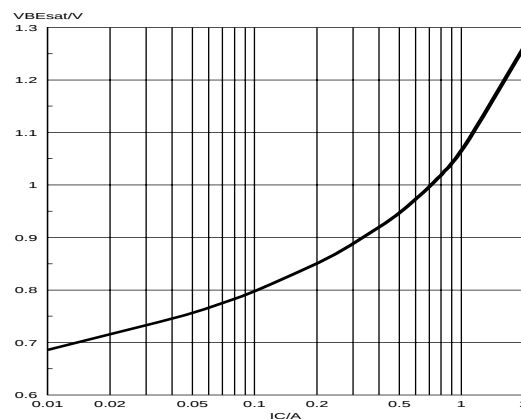


Fig. 8. Base-Emitter saturation voltage.  
Solid Lines = typ values,  $I_C/I_B = 3$

## INDUCTIVE SWITCHING

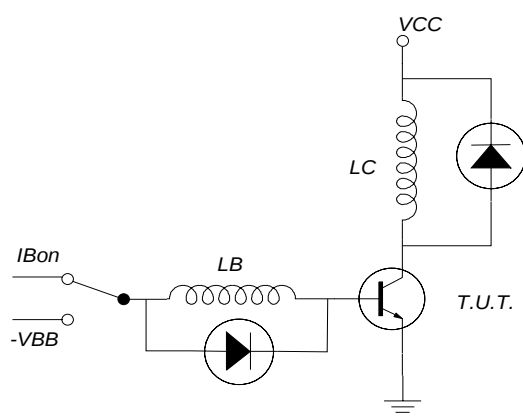


Fig. 9. Test circuit inductive load.  
 $V_{CC} = 300 \text{ V}$ ;  $-V_{BE} = 5 \text{ V}$ ,  $L_C = 200 \mu\text{H}$ ;  $L_B = 1 \mu\text{H}$

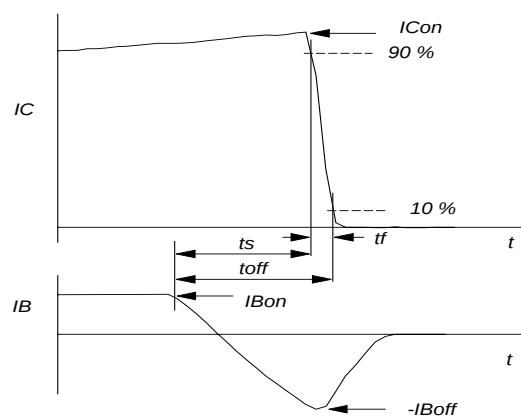


Fig. 10. Switching times waveforms with inductive load.

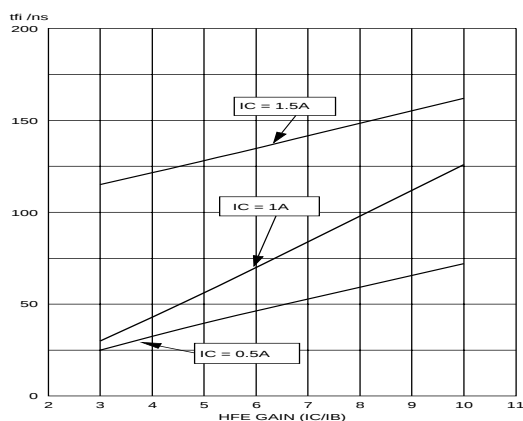


Fig. 11. Inductive switching.  
 $t_{ft} = f(h_{FE})$

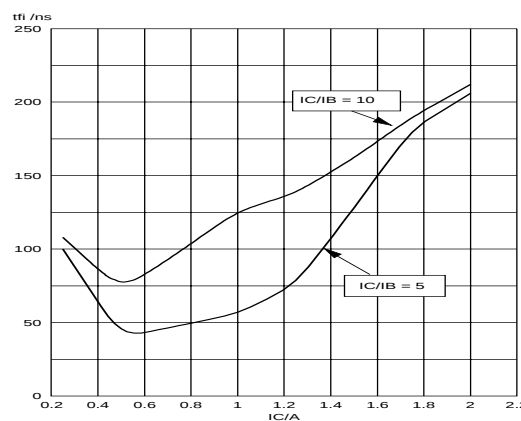


Fig. 12. Inductive switching.  
 $t_{ft} = f(I_C)$

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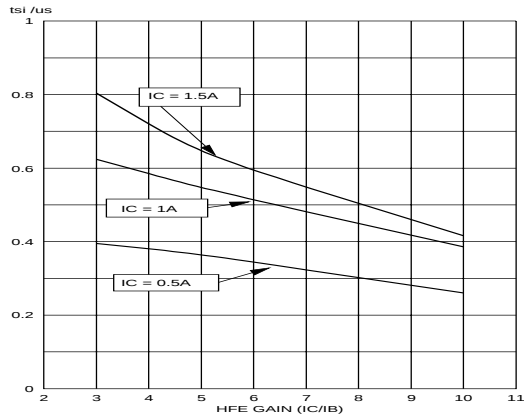


Fig.13. Inductive switching.  
 $t_{si} = f(h_{FE})$

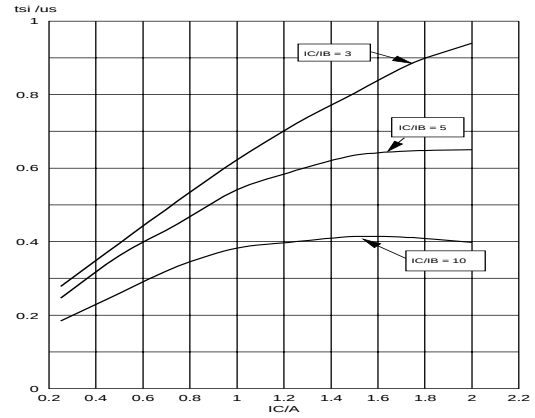


Fig.14. Inductive switching.  
 $t_{si} = f(I_C)$

## RESISTIVE SWITCHING

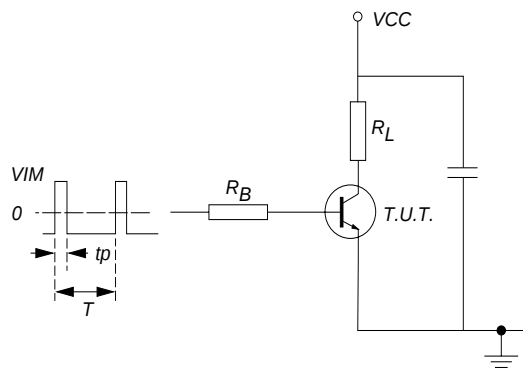


Fig.15. Test circuit resistive load.  $V_{IM} = -6$  to  $+8$  V  
 $V_{CC} = 250$  V;  $t_p = 20$   $\mu$ s;  $\delta = t_p / T = 0.01$ .  
 $R_B$  and  $R_L$  calculated from  $I_{Con}$  and  $I_{Bon}$  requirements.

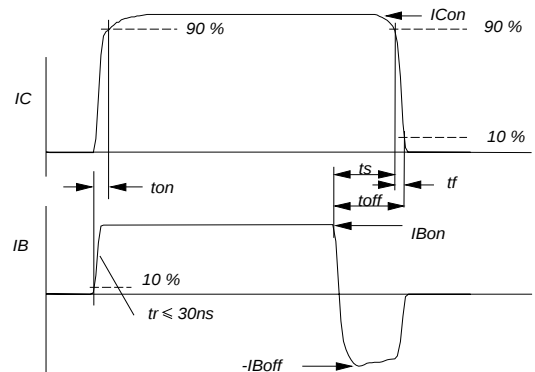


Fig.16. Switching times waveforms with resistive load.

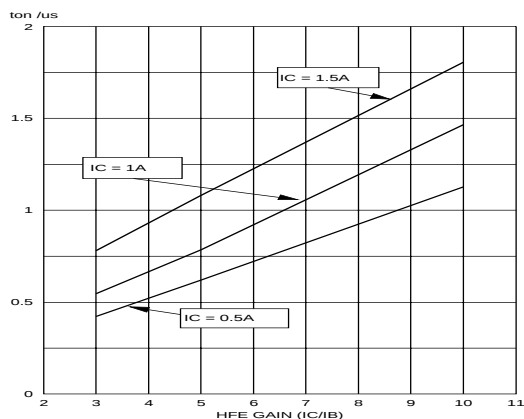


Fig.17. Resistive switching.  
 $t_{on} = f(h_{FE})$

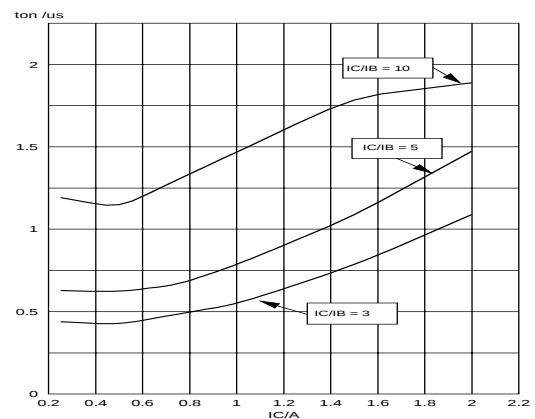


Fig.18. Resistive switching.  
 $t_{on} = f(I_C)$

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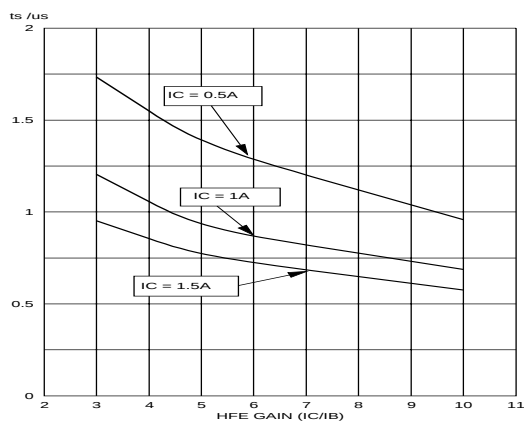


Fig.19. Resistive switching.  
 $ts = f(h_{FE})$

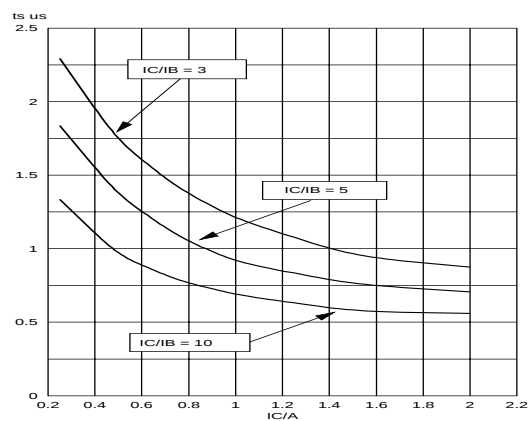


Fig.20. Resistive switching.  
 $ts = f(I_C)$

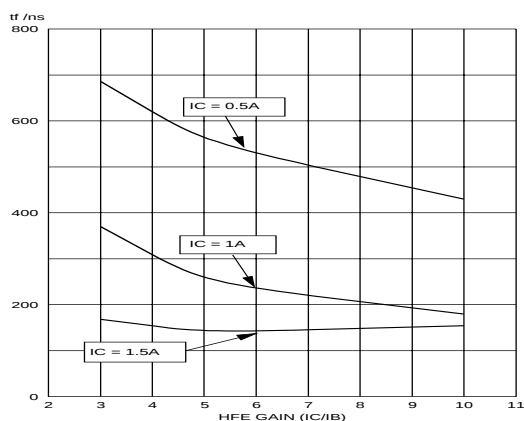


Fig.21. Resistive switching.  
 $tf = f(h_{FE})$

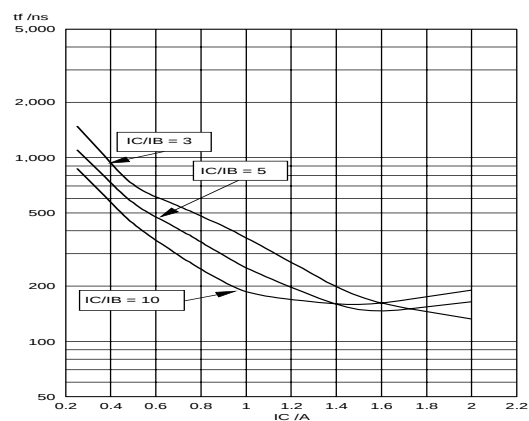


Fig.22. Resistive switching.  
 $tf = f(I_C)$

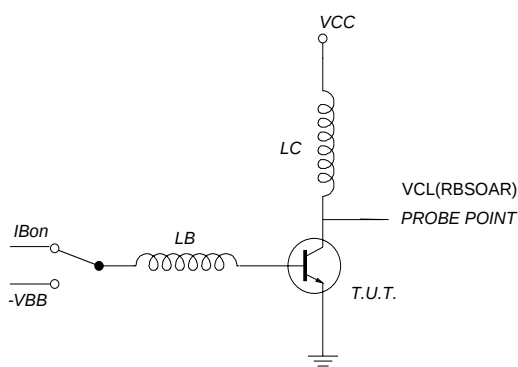


Fig.23. Test Circuit for the RBSOA test.  
 $V_{cl} \leq 600V$ ;  $V_{cc} = 150V$ ;  $L_B = 1\mu H$ ;  $L_c = 200\mu H$

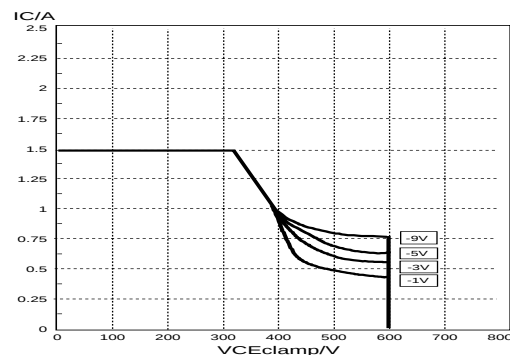
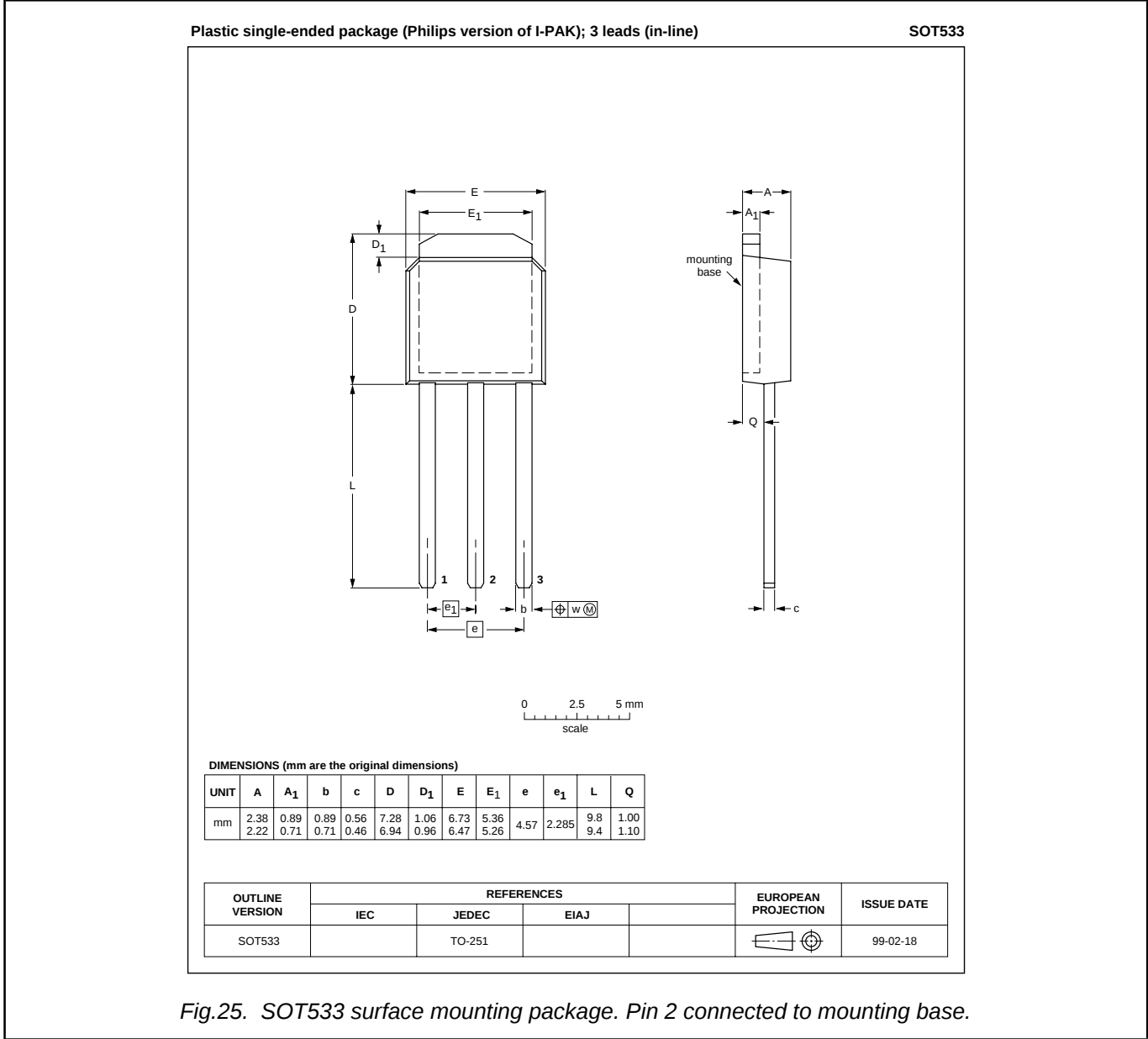


Fig.24. Reverse bias safe operating area  $T_j \leq T_{jmax}$   
for  $-V_{BE} = 9V, 5V, 3V \text{ \& } 1V$

Silicon Diffused Power Transistor

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MECHANICAL DATA



## Silicon Diffused Power Transistor

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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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