

Silicon diffused power transistors

BUT11; BUT11A

High-voltage, high-speed, glass-passivated npn power transistors in a TO-220 envelope, intended for use in converters, inverters, switching regulators, motor control systems etc.

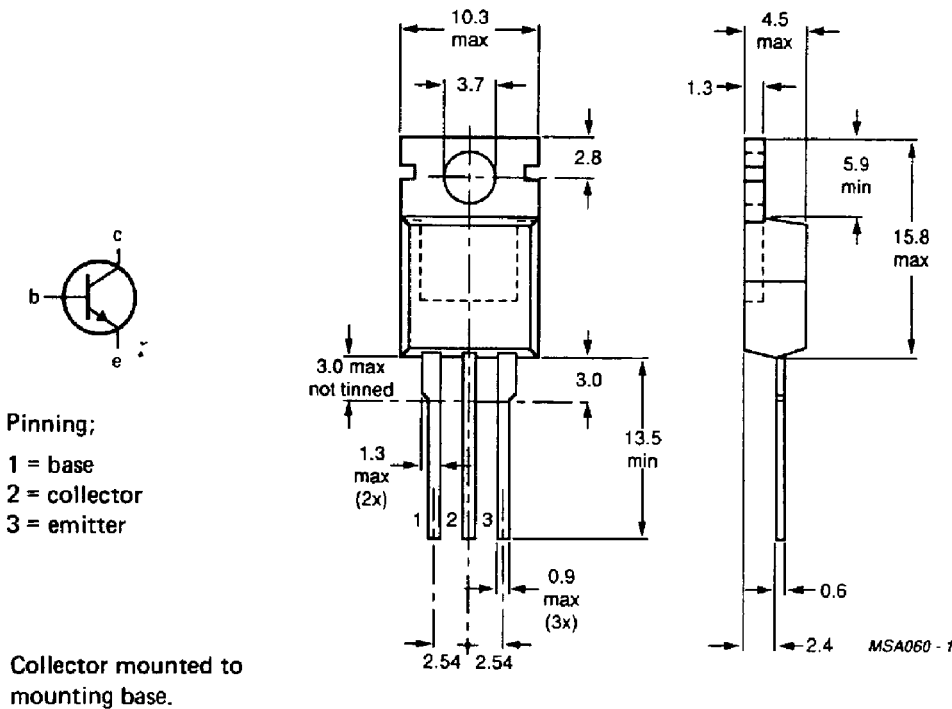
QUICK REFERENCE DATA

		BUT11	BUT11A
Collector-emitter voltage (peak value; $V_{BE} = 0$ )	$V_{CESM}$ max.	850	1000 V
Collector-emitter voltage (open base)	$V_{CEO}$ max.	400	450 V
Collector-emitter saturation voltage	$V_{CEsat}$ max.	1,5	V
Collector current (DC)	$I_C$ max.	5	A
Collector current (peak value)	$I_{CM}$ max.	10	A
Total power dissipation up to $T_{mb} = 25\text{ }^\circ\text{C}$	$P_{tot}$ max.	100	W
Fall time	$t_f$ max.	0,8	$\mu\text{s}$

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.



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## RATINGS

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

		BUT11	BUT11A
Collector-emitter voltage (peak value, $V_{BE} = 0$ )	$V_{CESM}$ max.	850	1000 V
Collector-emitter voltage (open base)	$V_{CEO}$ max.	400	450 V
Collector current (DC)	$I_C$ max.	5	A
Collector current (peak value) $t_p < 2$ ms	$I_{CM}$ max.	10	A
Base current (DC)	$I_B$ max.	2	A
Base current (peak value); $t_p < 2$ ms	$I_{BM}$ max.	4	A
Total power dissipation up to $T_{mb} = 25$ °C	$P_{tot}$ max.	100	W
Storage temperature range	$T_{stg}$	-65 to +150	°C
Junction temperature	$T_j$ max.	150	°C

## THERMAL RESISTANCE

From junction to mounting base	$R_{thj-mb} =$	1,25	K/W
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## CHARACTERISTICS

 $T_j = 25$  °C unless otherwise specified

Collector cut-off current \*

 $V_{CE} = V_{CESMmax}; V_{BE} = 0$  $I_{CES}$  max. 1 mA $V_{CE} = V_{CESMmax}; V_{BE} = 0; T_j = 125$  °C $I_{CES}$  max. 2 mA

Emitter cut-off current

 $I_C = 0; V_{EB} = 9$  V $I_{EBO}$  max. 10 mA

Saturation voltages

 $I_C = 3$  A;  $I_B = 0,6$  A $V_{CEsat}$  max. 1,5 V $V_{BEsat}$  max. 1,3 V $I_C = 2,5$  A;  $I_B = 0,5$  A $V_{CEsat}$  max. 1,5 V $V_{BEsat}$  max. 1,3 V

Collector-emitter sustaining voltage

 $I_C = 100$  mA;  $I_{Boff} = 0$ ;  $L = 25$  mH $V_{CEO_{sust}min.}$  400 450 V

DC current gain

 $I_C = 5$  mA;  $V_{CE} = 5$  V $h_{FE}$  min. 10 $h_{FE}$  typ. 18 $h_{FE}$  max. 35 $I_C = 500$  mA;  $V_{CE} = 5$  V $h_{FE}$  min. 10 $h_{FE}$  typ. 20 $h_{FE}$  max. 35

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

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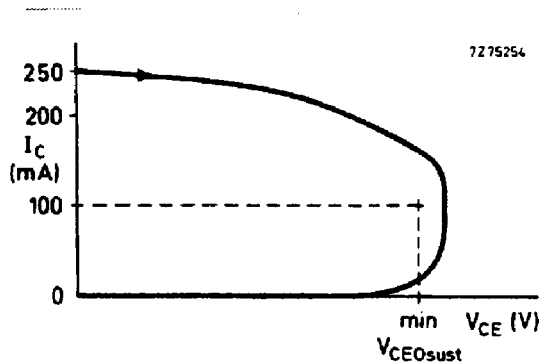


Fig. 2 Oscilloscope display for sustaining voltage.

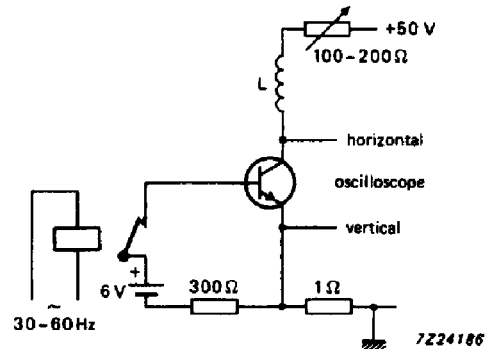


Fig. 3 Test circuit for  $V_{CE(sust)}$ .

Switching times resistive load (Figs 4 and 5)

$I_{Con} = 3\text{ A}; I_{Bon} = -I_{Boff} = 0,6\text{ A}$

Turn-on time

$t_{on}$

max.

1

—  $\mu\text{s}$

Turn-off: Storage time

$t_s$

max.

4

—  $\mu\text{s}$

Fall time

$t_f$

max.

0,8

—  $\mu\text{s}$

$I_{Con} = 2,5\text{ A}; I_{Bon} = -I_{Boff} = 0,5\text{ A}$

Turn-on time

$t_{on}$

max.

—

1  $\mu\text{s}$

Turn-off: Storage time

$t_s$

max.

—

4  $\mu\text{s}$

Fall time

$t_f$

max.

—

0,8  $\mu\text{s}$

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 3\text{ A}; I_B = 0,6\text{ A}$

Turn-off: Storage time

$t_s$

typ.

1,1

—  $\mu\text{s}$

Fall time

$t_f$

typ.

80

— ns

max.

150

— ns

$I_{Con} = 3\text{ A}; I_B = 0,6\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

$t_s$

typ.

1,2

—  $\mu\text{s}$

Fall time

$t_f$

max.

1,5

—  $\mu\text{s}$

typ.

140

— ns

max.

300

— ns

Switching times inductive load (Figs 6 and 7)

$I_{Con} = 2,5\text{ A}; I_B = 0,5\text{ A}$

Turn-off: Storage time

$t_s$

typ.

—

1,1  $\mu\text{s}$

Fall time

$t_f$

max.

—

1,4  $\mu\text{s}$

typ.

—

80 ns

max.

—

150 ns

$I_{Con} = 2,5\text{ A}; I_B = 0,5\text{ A}; T_j = 100\text{ }^\circ\text{C}$

Turn-off: Storage time

$t_s$

typ.

—

1,2  $\mu\text{s}$

Fall time

$t_f$

max.

—

1,5  $\mu\text{s}$

typ.

—

140 ns

max.

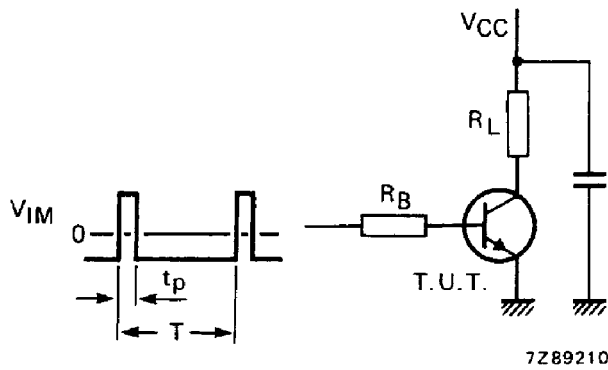
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300 ns

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$V_{CC} = 250 \text{ V}$   
 $V_{IM} = -6 \text{ to } +8 \text{ V}$   
 $\frac{t_p}{T} = 0,01$   
 $t_p = 20 \mu\text{s}$

The values of  $R_B$  and  $R_L$  are selected in accordance with  $I_{Con}$  and  $I_B$  requirements.

Fig. 4 Test circuit resistive load.

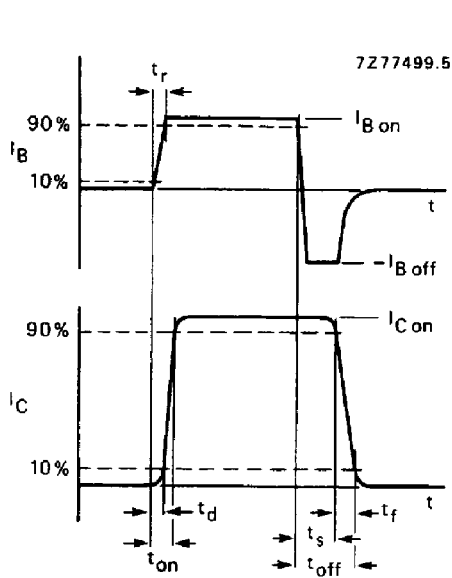


Fig. 5 Switching times waveforms with resistive load.

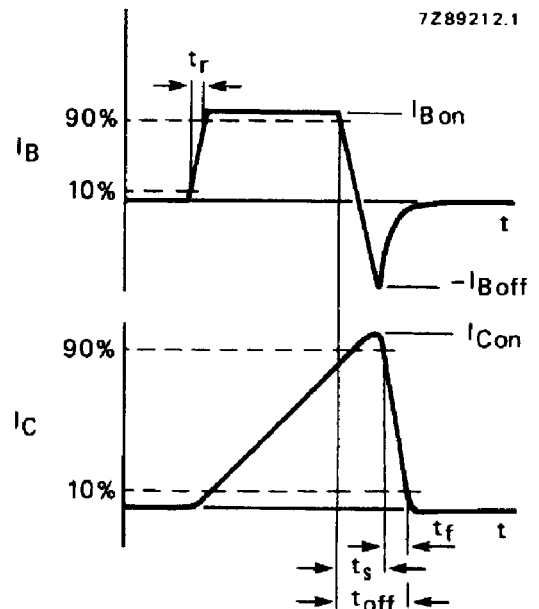
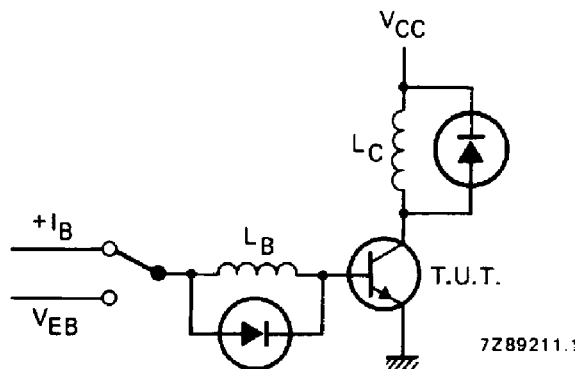


Fig. 6 Switching times waveforms with inductive load.



$V_{CC} = 300 \text{ V}$   
 $V_{EB} = 5 \text{ V}$   
 $L_B = 1 \mu\text{H}$

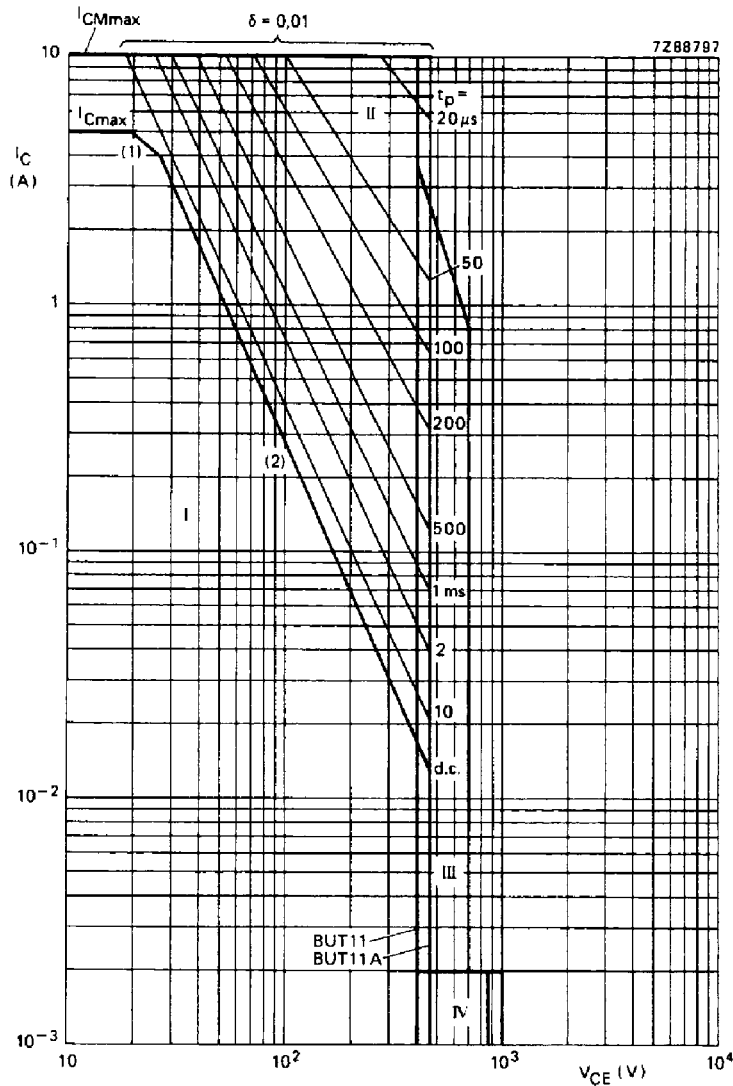
Fig. 7 Test circuit inductive load.

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- (1)  $P_{tot\ max}$  and  $P_{tot\ peak\ max}$  lines.
- (2) Second-breakdown limits
- I Region of permissible DC operation
- II Permissible extension for repetitive pulse operation
- III Area of permissible operation during turn-on in single transistor converters, provided  $R_{BE} \leq 100\ \Omega$  and  $t_p \leq 0,6\ \mu s$ .
- IV Repetitive pulse operation in this region is permissible provided  $V_{BE} \leq 0$  and  $t_p \leq 5\ ms$ .

Fig. 8 Safe operating area at  $T_{mb} \leq 25\ ^\circ C$ .

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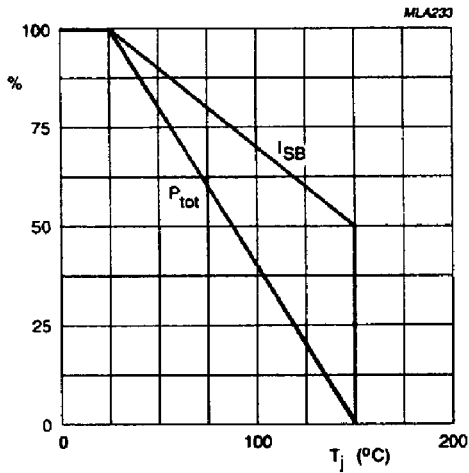


Fig. 9 Total power dissipation and second-breakdown current derating curve.

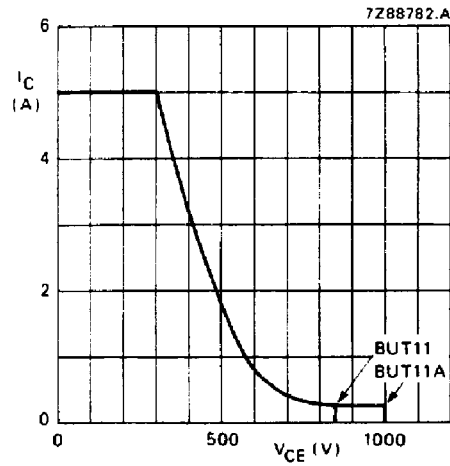


Fig. 10 Reverse bias SOAR.

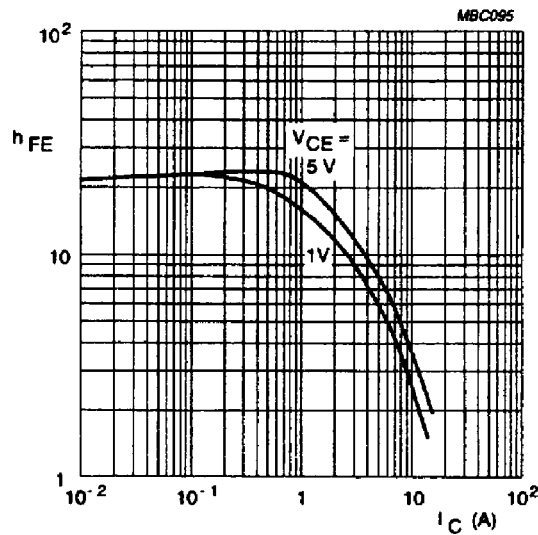


Fig.11 Typical DC current gain.

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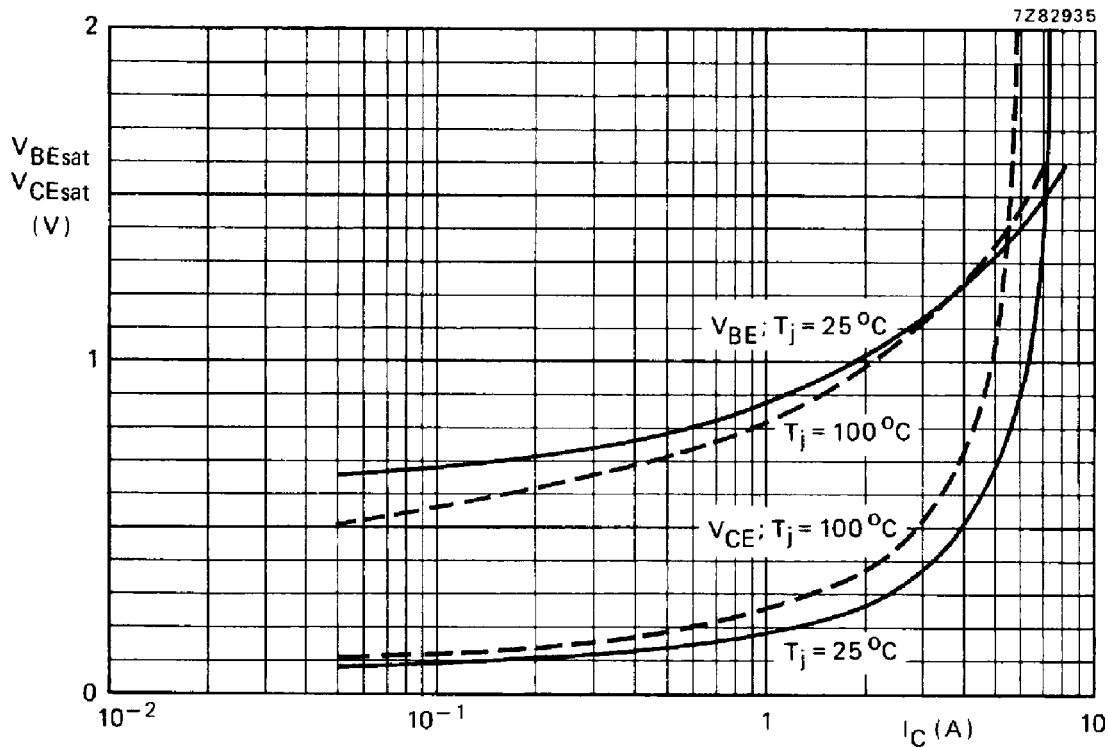


Fig. 12 Typical values base-emitter and collector-emitter voltage,  $I_C/I_B = 5$ .

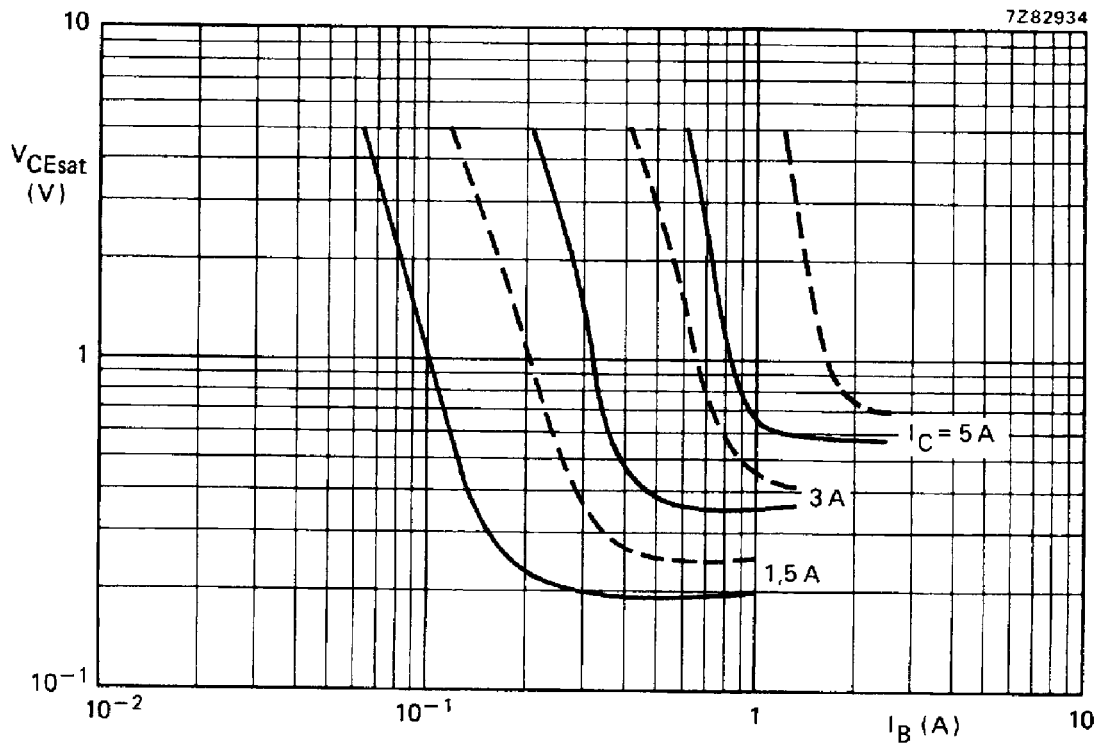


Fig. 13 Typ. (—) and max. (---) values collector-emitter saturation voltage at  $T_j = 25^\circ C$ .

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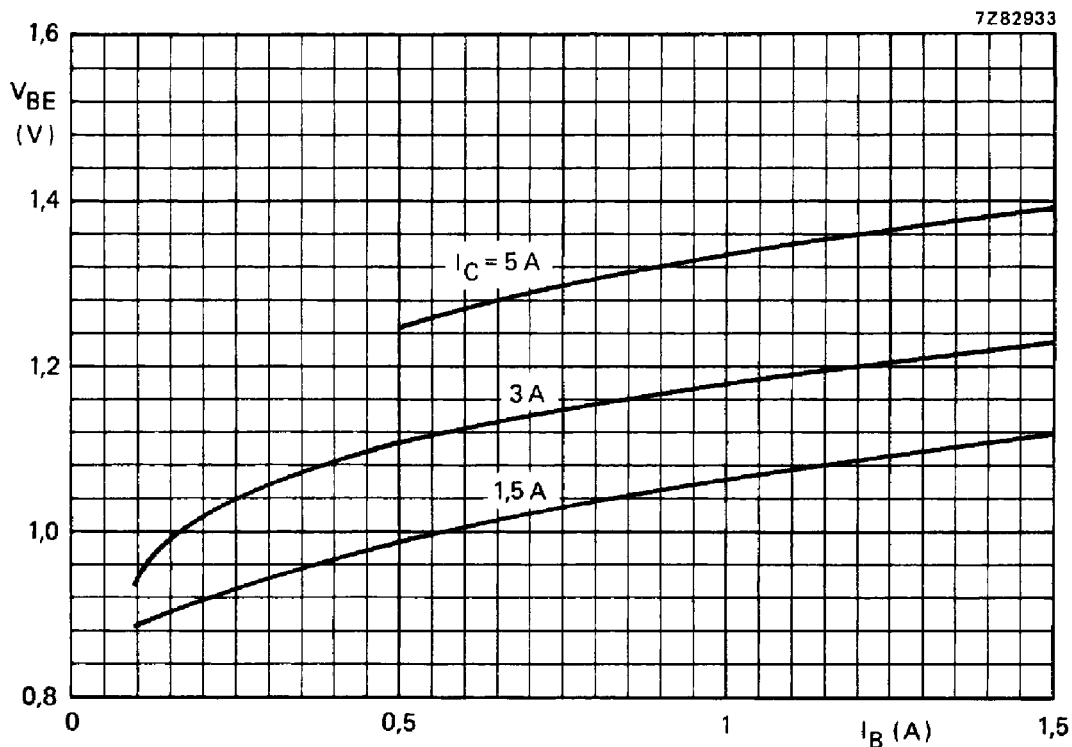


Fig. 14 Typical values at  $T_j = 25\text{ }^\circ\text{C}$ .

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