

BD645; 647
BD649; 651

SILICON DARLINGTON POWER TRANSISTORS

N-P-N epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-220 plastic envelope. P-N-P complements are BD646, BD648, BD650 and BD652.

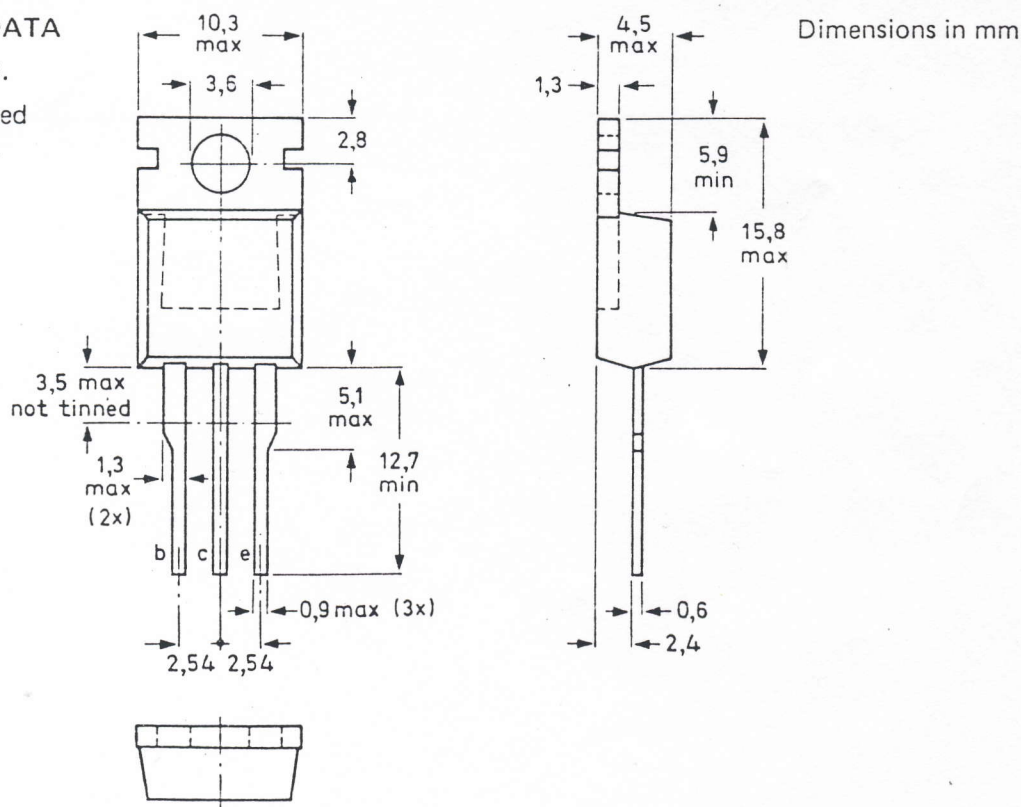
QUICK REFERENCE DATA

			BD645	647	649	651
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120 V
Collector current (peak value)	I_{CM}	max.		12		A
Total power dissipation up to $T_{mb} = 25^{\circ}\text{C}$	P_{tot}	max.		62,5		W
Junction temperature	T_j	max.		150		$^{\circ}\text{C}$
D.C. current gain:						
$I_C = 0,5 \text{ A}; V_{CE} = 3 \text{ V}$	h_{FE}	typ.		1900		
$I_C = 3,0 \text{ A}; V_{CE} = 3 \text{ V}$	h_{FE}	>		750		
Cut-off frequency: $I_C = 3 \text{ A}; V_{CE} = 3 \text{ V}$	f_{hfe}	typ.		50		kHz

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected to mounting base.



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CIRCUIT DIAGRAM

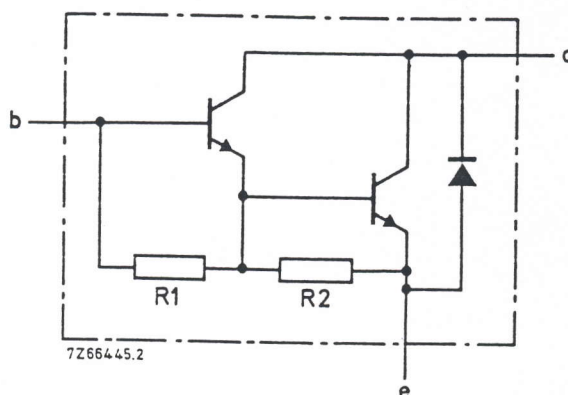


Fig. 2
R₁ typ. 4 kΩ
R₂ typ. 100 Ω

RATINGS

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

			BD645	647	649	651
Collector-base voltage (open emitter)	V _{CBO}	max.	80	100	120	140 V
Collector-emitter voltage (open base)	V _{CEO}	max.	60	80	100	120 V
Emitter-base voltage (open collector)	V _{EBO}	max.	5	5	5	5 V
Collector current (d.c.)	I _C	max.		8		A
Collector current (peak value)	I _{CM}	max.		12		A
Base current (d.c.)	I _B	max.		150		mA
Total power dissipation up to T _{mb} = 25.°C	P _{tot}	max.		62,5		W
Storage temperature	T _{stg}			-65 to + 150		°C
Junction temperature *	T _j	max.		150		°C

THERMAL RESISTANCE *

From junction to mounting base	R _{th j-mb}	=	2	K/W
From junction to ambient in free air	R _{th j-a}	=	70	K/W

* Based on maximum average junction temperature in line with common industrial practice. The resulting higher junction temperature of the output transistor part is taken into account.

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CHARACTERISTICS

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

Collector cut-off current

$I_E = 0; V_{CBO} = V_{CEO\max}$

$I_E = 0; V_{CB} = \frac{1}{2} V_{CBO\max}; T_j = 150\text{ }^{\circ}\text{C}$

$I_B = 0; V_{CE} = \frac{1}{2} V_{CEO\max}$

Emitter cut-off current

$I_C = 0; V_{EB} = 5\text{ V}$

D.C. current gain (note 1)

$I_C = 0,5\text{ A}; V_{CE} = 3\text{ V}$

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

$I_C = 8\text{ A}; V_{CE} = 3\text{ V}$

Base-emitter voltage (notes 1 and 2)

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

Saturation voltages (note 1)

$I_C = 3\text{ A}; I_B = 12\text{ mA}$

$I_C = 5\text{ A}; I_B = 50\text{ mA}$

Diode forward voltage

$I_F = 3\text{ A}$

Collector capacitance at $f = 1\text{ MHz}$

$I_E = I_e = 0; V_{CB} = 10\text{ V}$

Cut-off frequency

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}$

Turn-off breakdown energy with inductive load

$-I_{Boff} = 0; I_{CM} = 4,5\text{ A}; t_p = 1\text{ ms};$

$T = 100\text{ ms};$ see Fig. 3

Small signal current gain

$I_C = 3\text{ A}; V_{CE} = 3\text{ V}; f = 1\text{ MHz}$

Second breakdown collector current

$V_{CE} = 60\text{ V}; t_p = 0,1\text{ s}$

Switching times (see Figs 4 and 5)

$I_{Con} = 3\text{ A}; I_{Bon} = -I_{Boff} = 12\text{ mA}$

turn-on time

turn-off time

$I_{CBO} < 0,2\text{ mA}$

$I_{CBO} < 2\text{ mA}$

$I_{CEO} < 0,5\text{ mA}$

$I_{EBO} < 5\text{ mA}$

$h_{FE} \text{ typ. } 1900$

$h_{FE} > 750$

$h_{FE} \text{ typ. } 1800$

$V_{BE} < 2,5\text{ V}$

$V_{CEsat} < 2\text{ V}$

$V_{CEsat} < 2,5\text{ V}$

$V_{BEsat} < 3\text{ V}$

$V_F \text{ typ. } 1,2\text{ V}$

$C_c \text{ typ. } 75\text{ pF}$

$f_{hfe} \text{ typ. } 50\text{ kHz}$

$E_{(BR)} > 50\text{ mJ}$

$|h_{fe}| \text{ typ. } 50$

$I_{(SB)} > 1,04\text{ A}$

$t_{on} \text{ typ. } 1,0\text{ }\mu\text{s}$
 $< 2,5\text{ }\mu\text{s}$

$t_{off} \text{ typ. } 5\text{ }\mu\text{s}$
 $< 10\text{ }\mu\text{s}$

Notes

1. Measured under pulse conditions: $t_p < 300\text{ }\mu\text{s}$, $\delta < 2\%$.

2. V_{BE} decreases by about $3,8\text{ mV/K}$ with increasing temperature.

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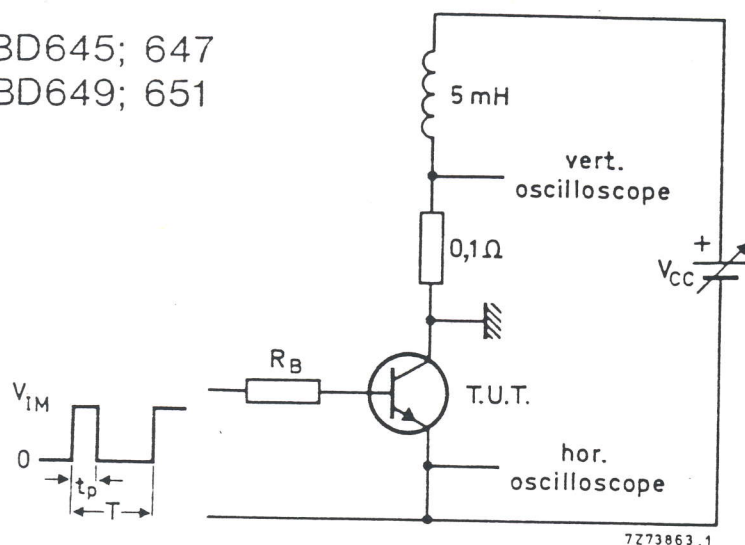


Fig. 3 Test circuit for turn-off breakdown energy.

$V_{IM} = 12 \text{ V}$; $R_B = 270 \Omega$;
 $t_p = 1 \text{ ms}$; $\delta = 1\%$.

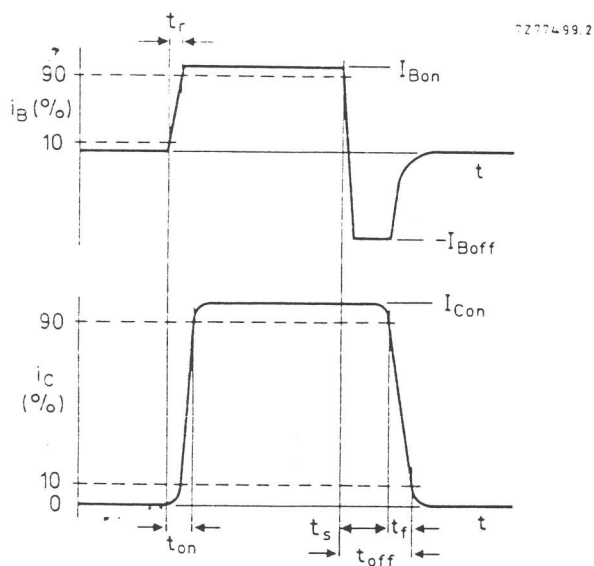
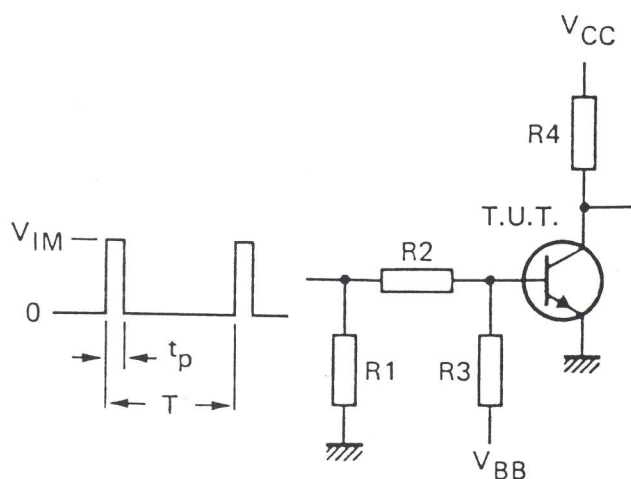


Fig. 4 Switching times waveforms.



$V_{CC} = 10 \text{ V}$
 $V_{IM} = 10 \text{ V}$
 $-V_{BB} = 4 \text{ V}$
 $R_1 = 56 \Omega$
 $R_2 = 410 \Omega$
 $R_3 = 560 \Omega$
 $R_4 = 3 \Omega$

$t_r = t_f = 15 \text{ ns}$
 $t_p = 10 \mu\text{s}$
 $T = 500 \mu\text{s}$

Fig. 5 Switching times test circuit.

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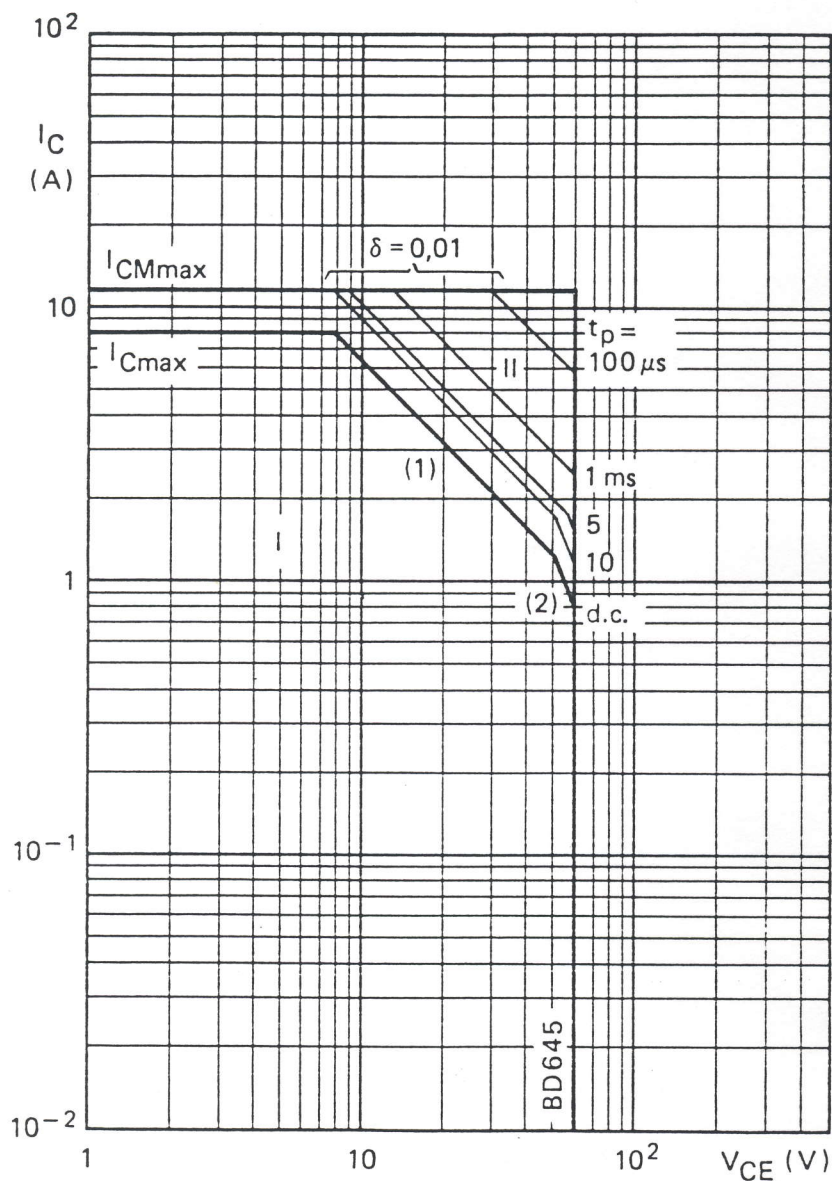


Fig. 6 Safe Operating ARea; $T_{mb} = 25\text{ }^{\circ}\text{C}$

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\text{ max}}$ and $P_{peak\text{ max}}$ lines.
- (2) Second-breakdown limits (independent of temperature).

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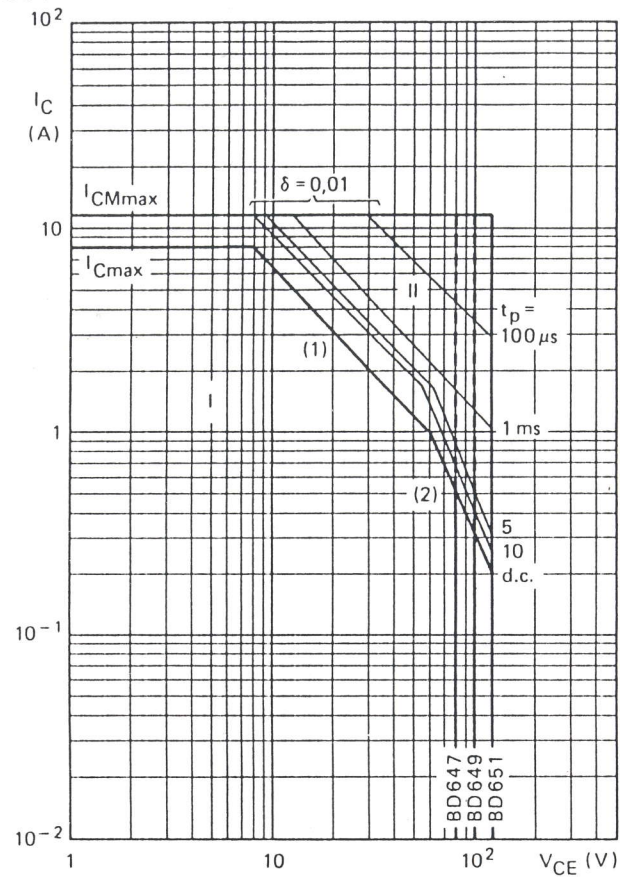


Fig. 7 Safe Operating Area; $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- I Region of permissible d.c. operation.
- II Permissible extension for repetitive pulse operation.
- (1) $P_{tot\ max}$ and $P_{peak\ max}$ lines.
- (2) Second-breakdown limits (independent of temperature).

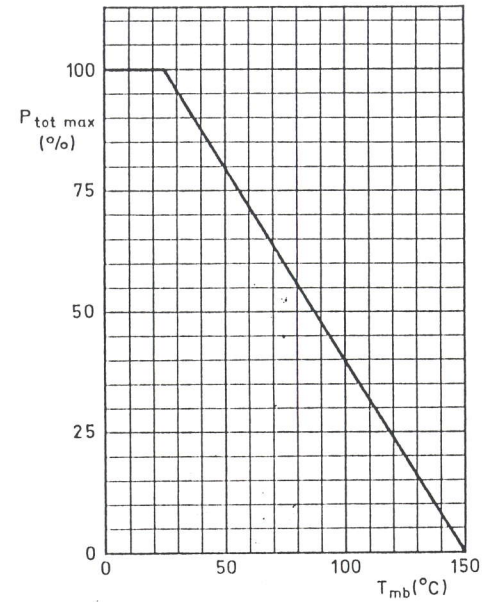


Fig. 8 Power derating curve.

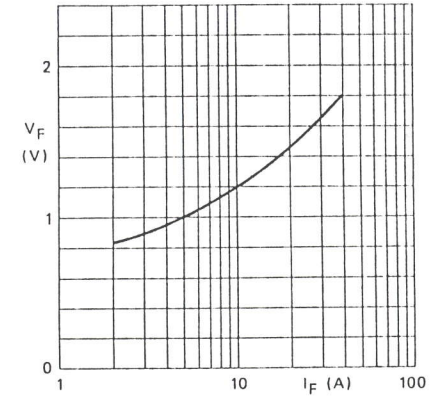


Fig. 8a Typical values forward voltage of collector-emitter diode (see Fig. 2) at $T_j = 25\text{ }^{\circ}\text{C}$.

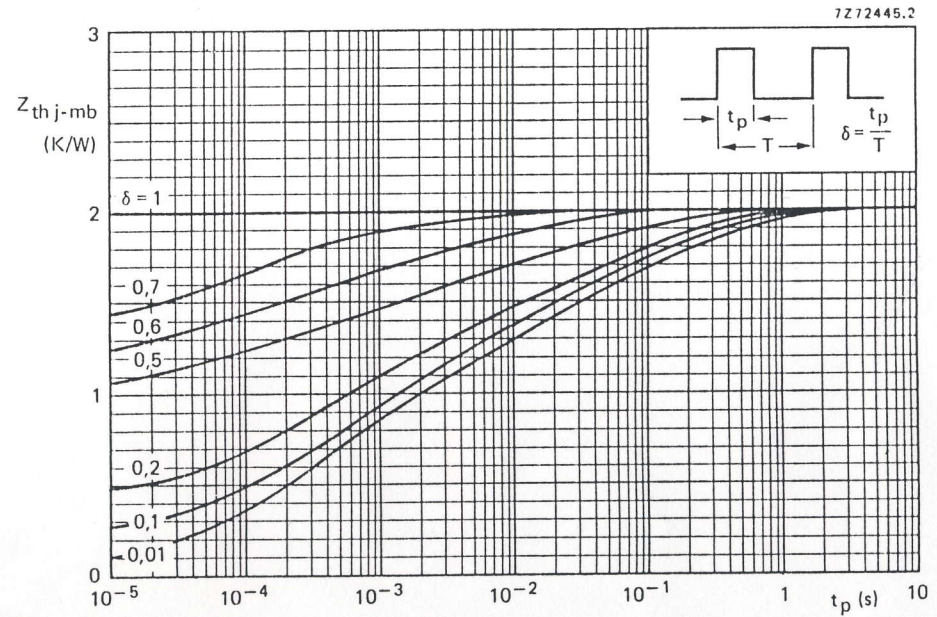


Fig. 9 Pulse power rating chart.

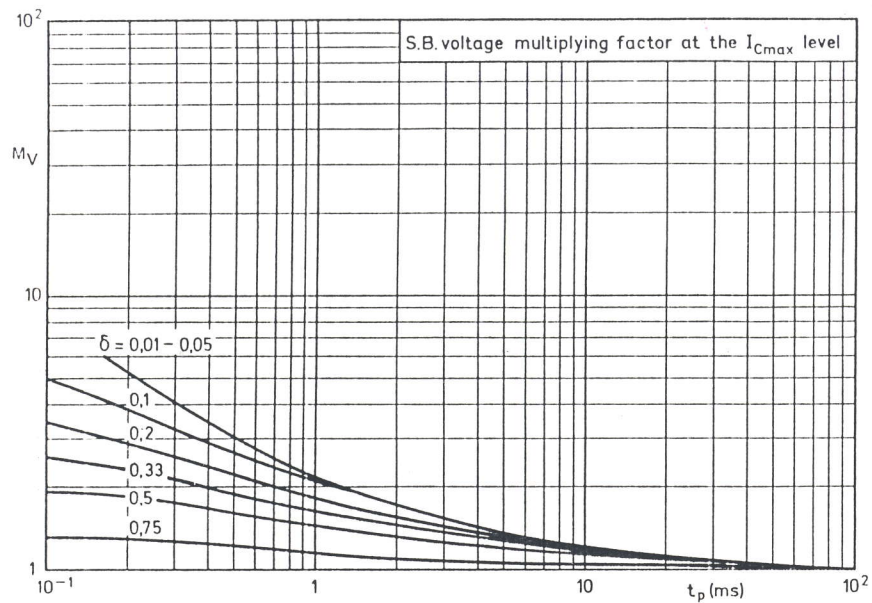


Fig. 10.

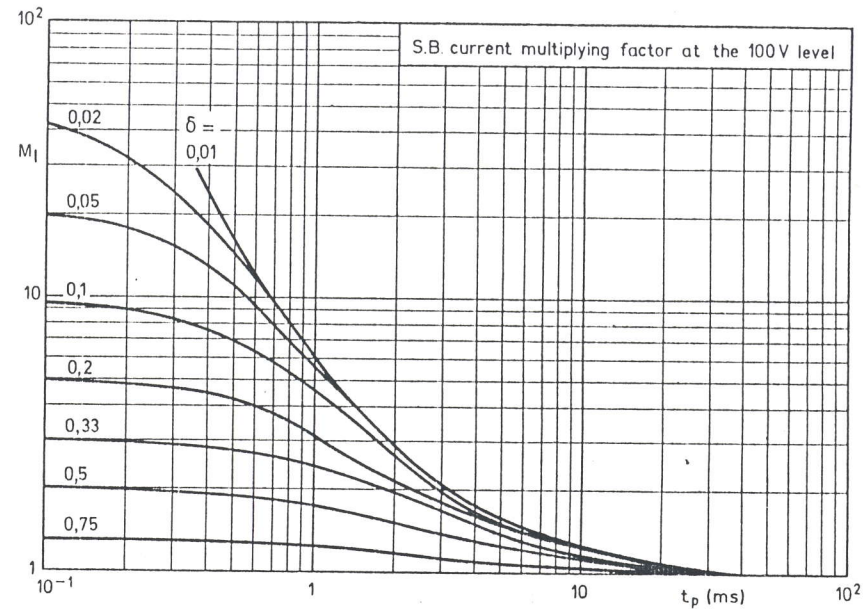


Fig. 12 Second breakdown current multiplying factor at the 100 V level.

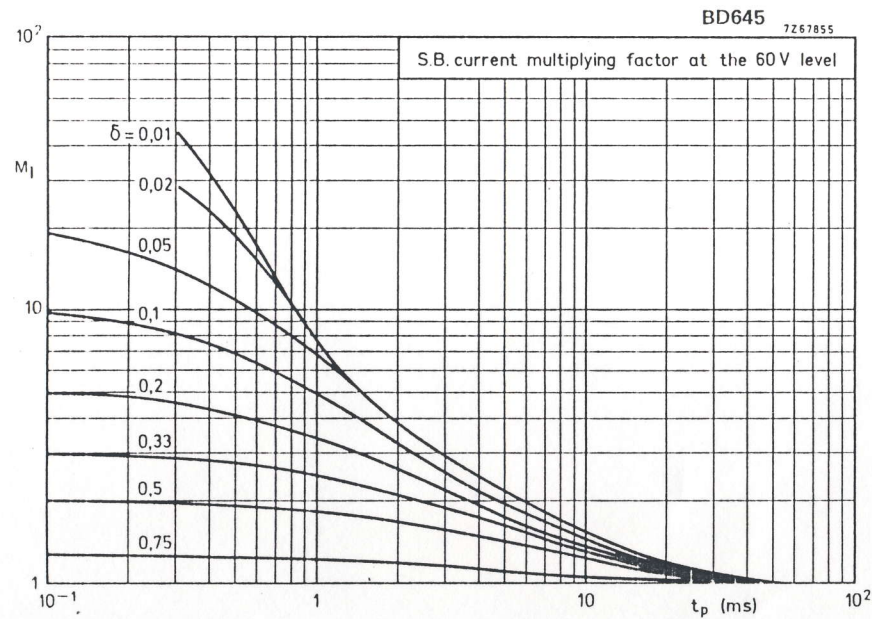


Fig. 11.

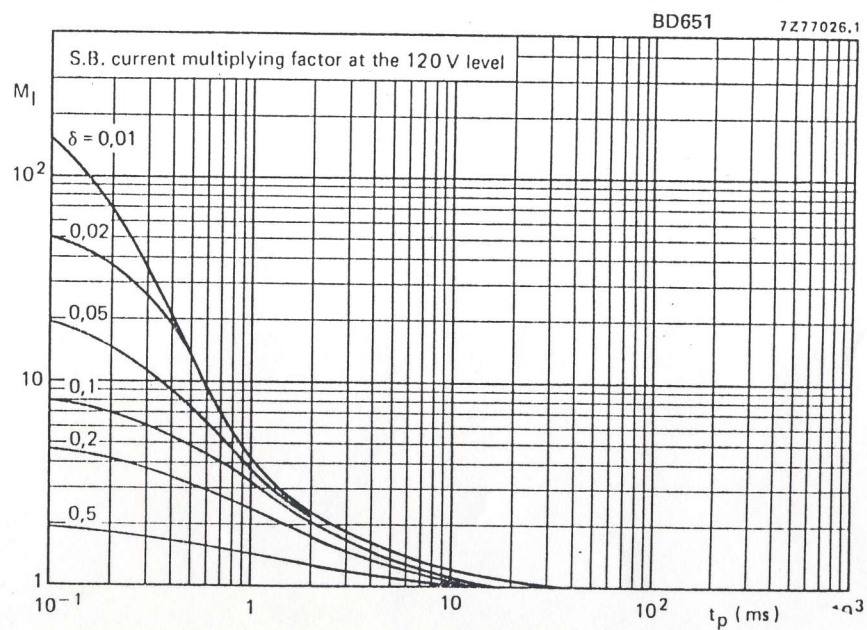


Fig. 13 Second breakdown current multiplying factor at the 120 V level.

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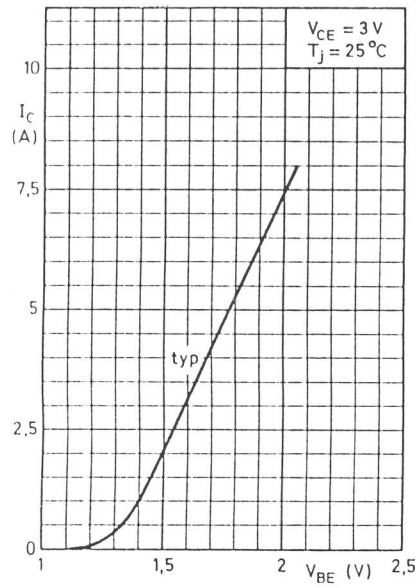


Fig. 14.

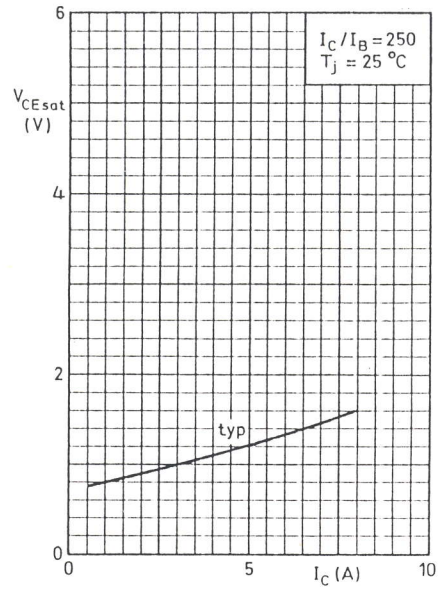


Fig. 15.

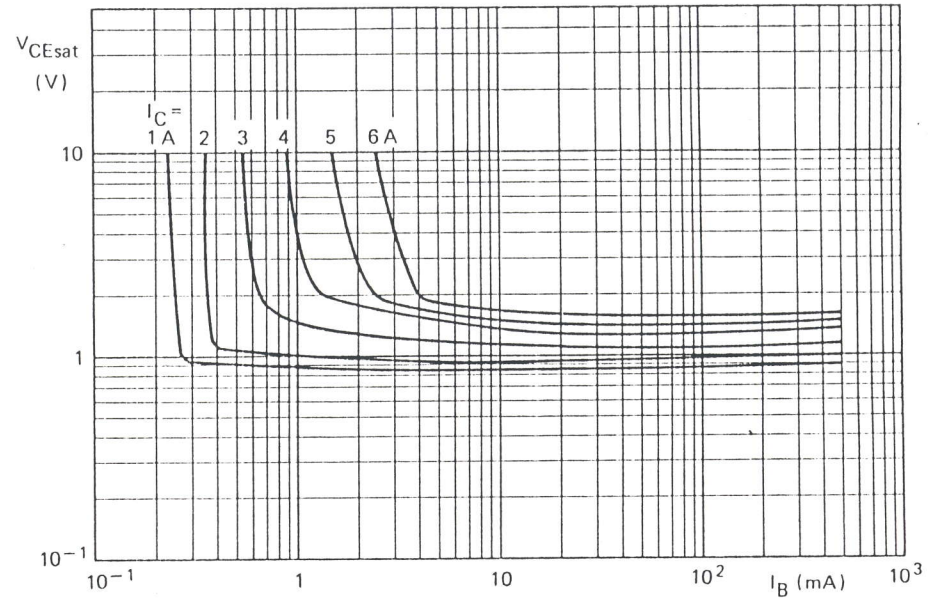


Fig. 17 Typical values collector-emitter saturation voltage. $T_j = 25\text{ }^{\circ}\text{C}$.

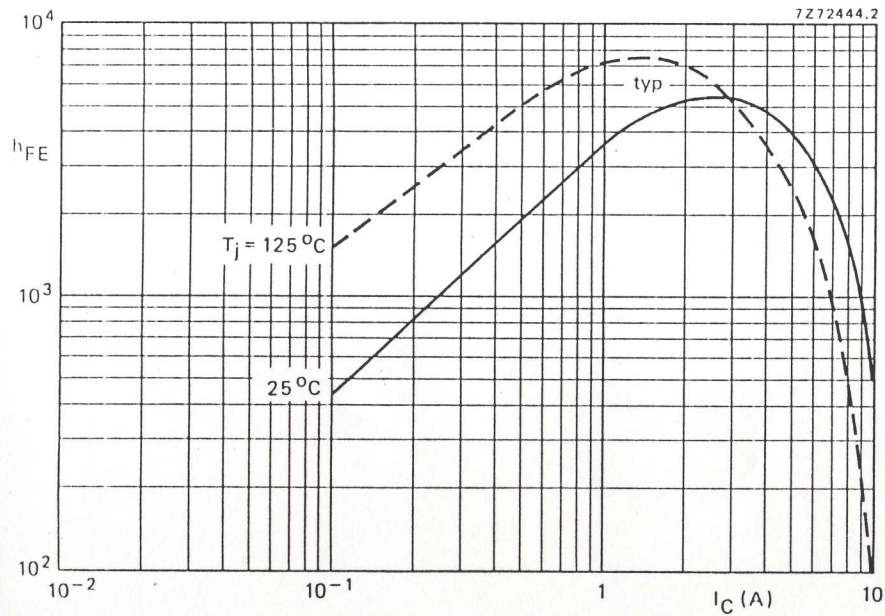


Fig. 16 Typical d.c. current gain. $V_{CE} = 3\text{ V}$.

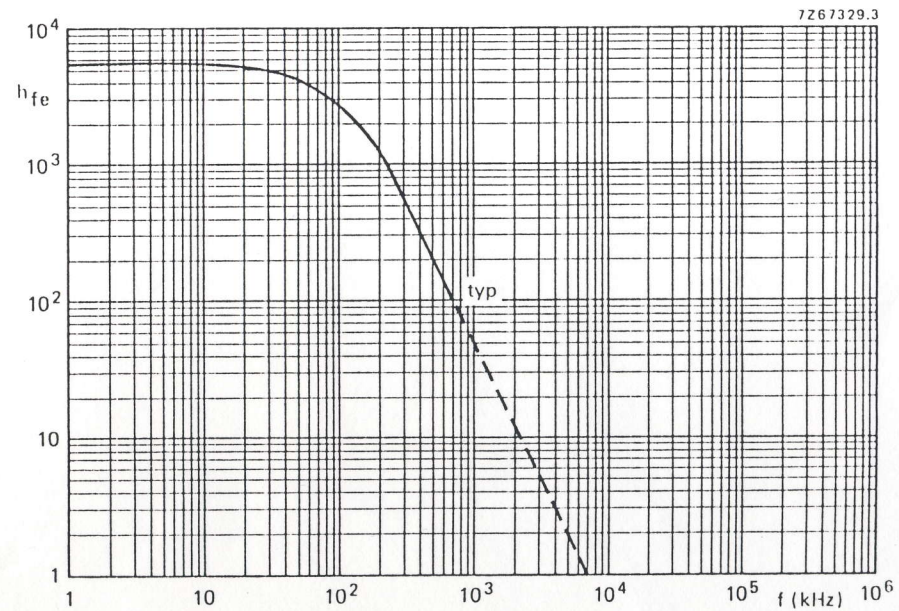


Fig. 18 Small signal current gain at $I_C = 3\text{ A}$; $V_{CE} = 3\text{ V}$.