MAGNA TEC

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

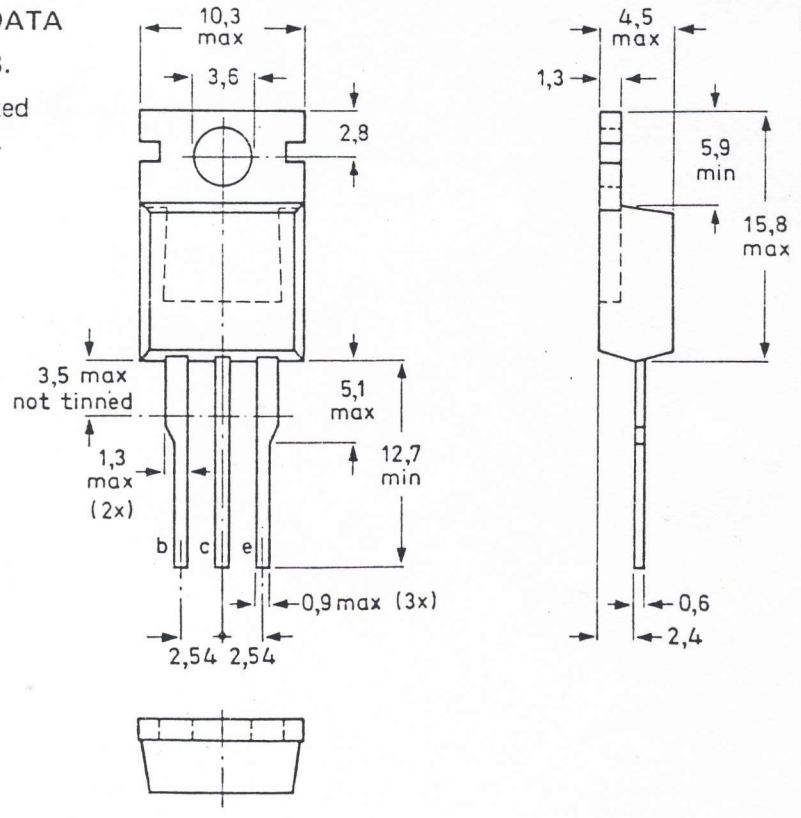
			BD645	647	649	651	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	100	120	140	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	80	100	120	V
Collector current (peak value)	I_{CM}	max.		12			A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.		62,5			W
Junction temperature	T_j	max.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

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.



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CIRCUIT DIAGRAM

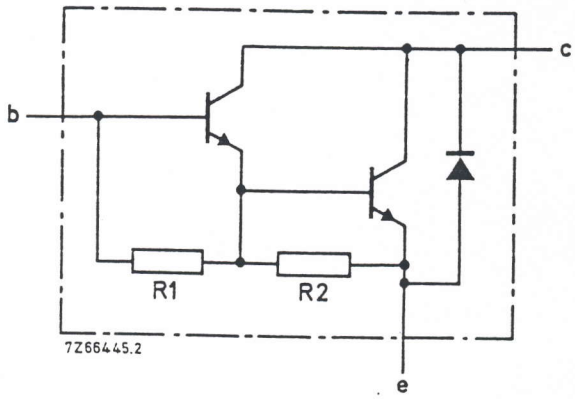

Fig. 2
R_1 typ. 4 kΩ
R_2 typ. 100 Ω

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	$R_{th\ j\text{-}mb}$	=	2	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	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 °C unless otherwise specified

Collector cut-off current			
$I_E = 0$; $V_{CB} = V_{CEOmax}$	I_{CBO}	<	0,2 mA
$I_E = 0$; $V_{CB} = ½ V_{CBOmax}$; $T_j = 150$ °C	I_{CBO}	<	2 mA
$I_B = 0$; $V_{CE} = ½ V_{CEOmax}$	I_{CEO}	<	0,5 mA
Emitter cut-off current			
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	5 mA
D.C. current gain (note 1)			
$I_C = 0,5$ A; $V_{CE} = 3$ V	h_{FE}	typ.	1900
$I_C = 3$ A; $V_{CE} = 3$ V	h_{FE}	>	750
$I_C = 8$ A; $V_{CE} = 3$ V	h_{FE}	typ.	1800
Base-emitter voltage (notes 1 and 2)			
$I_C = 3$ A; $V_{CE} = 3$ V	V_{BE}	<	2,5 V
Saturation voltages (note 1)			
$I_C = 3$ A; $I_B = 12$ mA	V_{CEsat}	<	2 V
$I_C = 5$ A; $I_B = 50$ mA	V_{CEsat}	<	2,5 V
	V_{BEsat}	<	3 V
Diode forward voltage			
$I_F = 3$ A	V_F	typ.	1,2 V
Collector capacitance at f = 1 MHz			
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	75 pF
Cut-off frequency			
$I_C = 3$ A; $V_{CE} = 3$ V	f_{hfe}	typ.	50 kHz
Turn-off breakdown energy with inductive load			
$-I_{Boff} = 0$; $I_{CM} = 4,5$ A; $t_p = 1$ ms; T = 100 ms; see Fig. 3	$E_{(BR)}$	>	50 mJ
Small signal current gain			
$I_C = 3$ A; $V_{CE} = 3$ V; f = 1 MHz	$\lvert h_{fe} \rvert$	typ.	50
Second breakdown collector current			
$V_{CE} = 60$ V; $t_p = 0,1$ s	$I_{(SB)}$	>	1,04 A
Switching times (see Figs 4 and 5)			
$I_{Con} = 3$ A; $I_{Bon} = -I_{Boff} = 12$ mA			
turn-on time	t_{on}	typ.	1,0 µs
		<	2,5 µs
turn-off time	t_{off}	typ.	5 µs
		<	10 µs

Notes

1. Measured under pulse conditions: $t_p < 300$ µs, $\delta < 2\%$.
2. V_{BE} decreases by about 3,8 mV/K with increasing temperature.

BD645; 647
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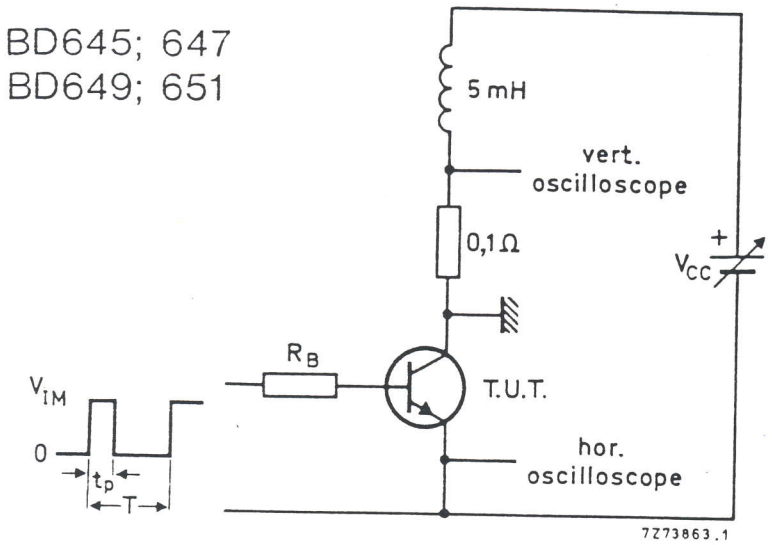


Fig. 3 Test circuit for turn-off breakdown energy.
V_{IM} = 12 V; R_B = 270 Ω;
t_p = 1 ms; δ = 1%.

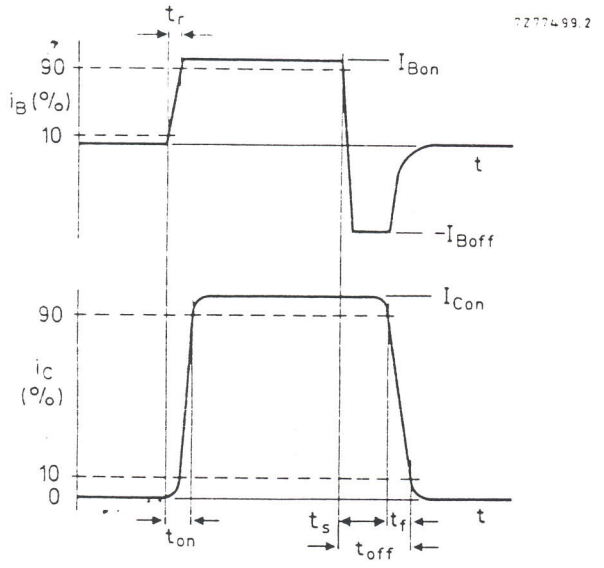
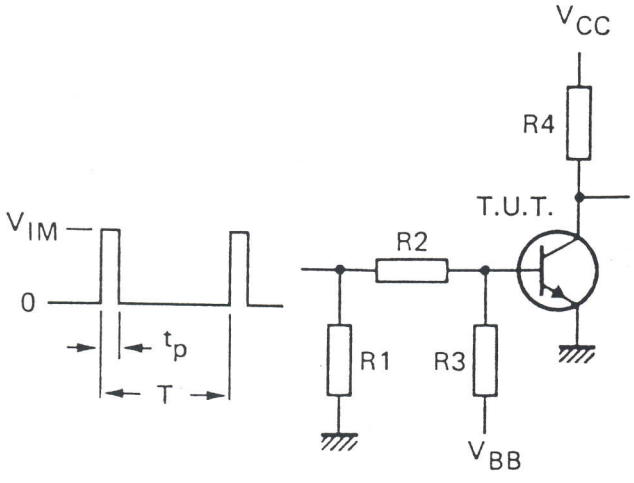


Fig. 4 Switching times waveforms.



V_{CC} = 10 V
V_{IM} = 10 V
$-V_{BB}$ = 4 V
R1 = 56 Ω
R2 = 410 Ω
R3 = 560 Ω
R4 = 3 Ω
$t_r = t_f$ = 15 ns
t_p = 10 μs
T = 500 μs

Fig. 5 Switching times test circuit.

BD645;
BD649;

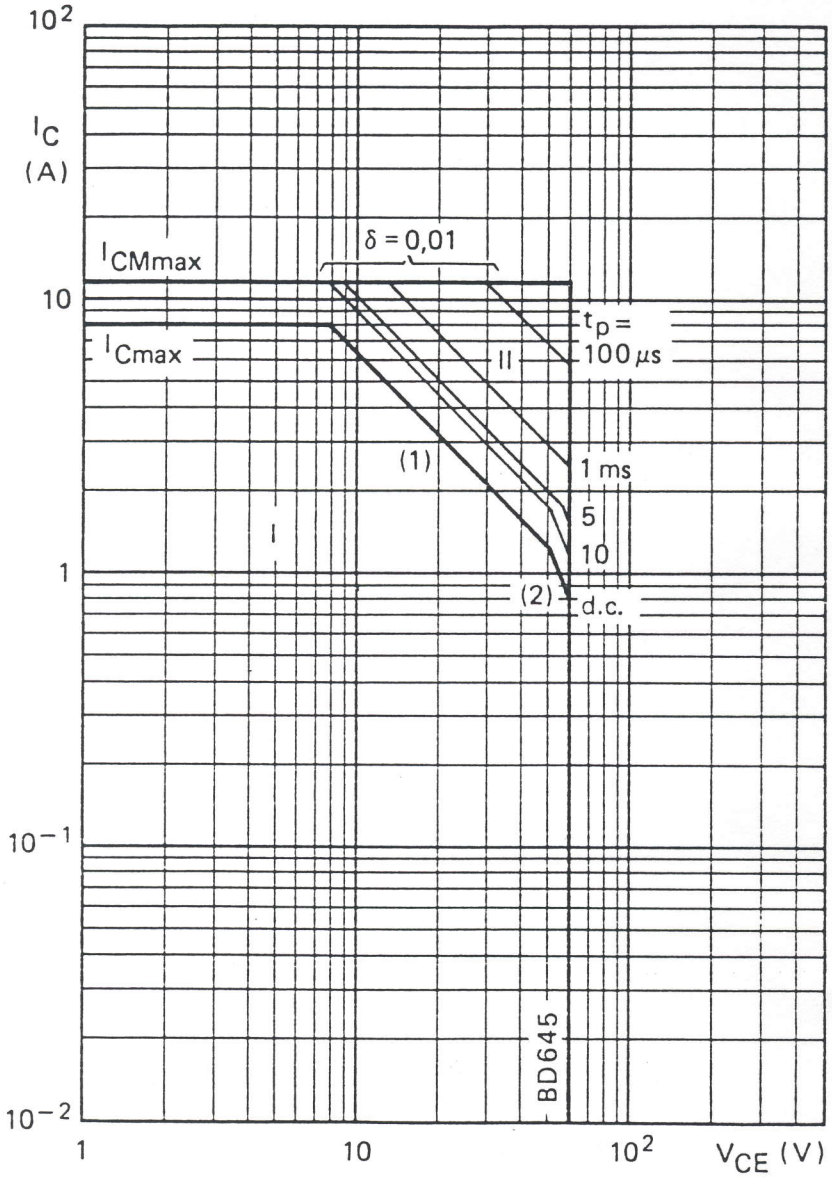


Fig. 6 Safe Operating ARea; T_{mb} = 25 °C

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).

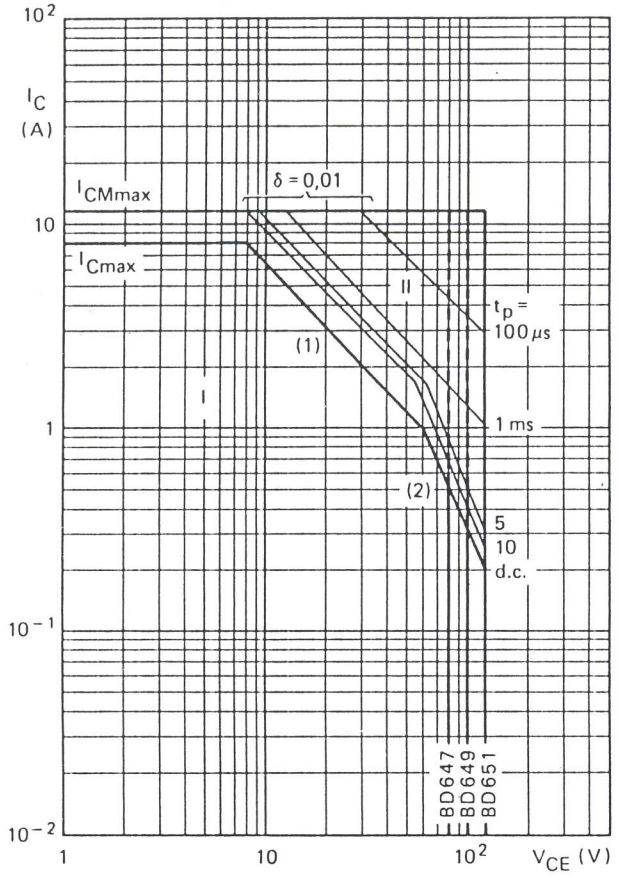


Fig. 7 Safe Operating ARea; T_{mb} = 25 °C.

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).

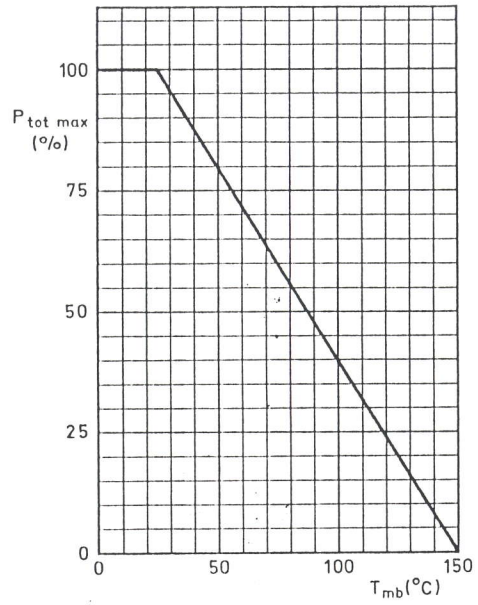


Fig. 8 Power derating curve.

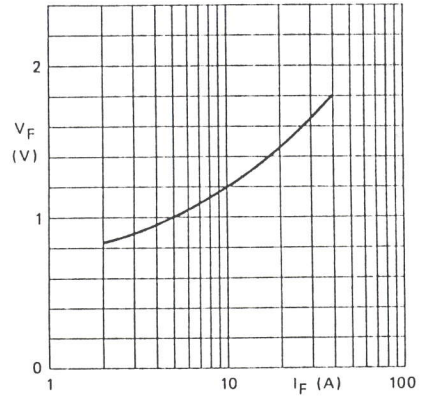


Fig. 8a Typical values forward voltage of collector-emitter diode (see Fig. 2) at T_j = 25 °C.

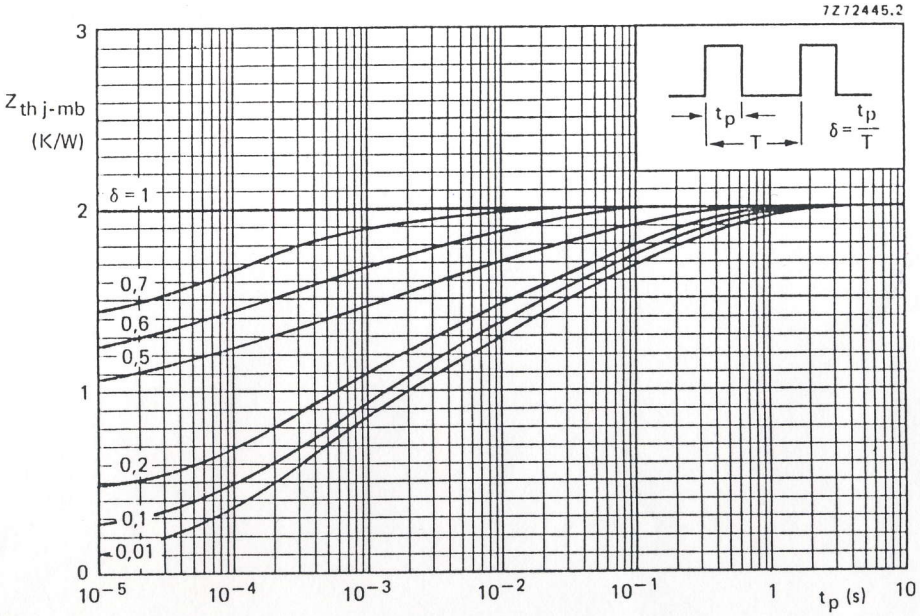


Fig. 9 Pulse power rating chart.

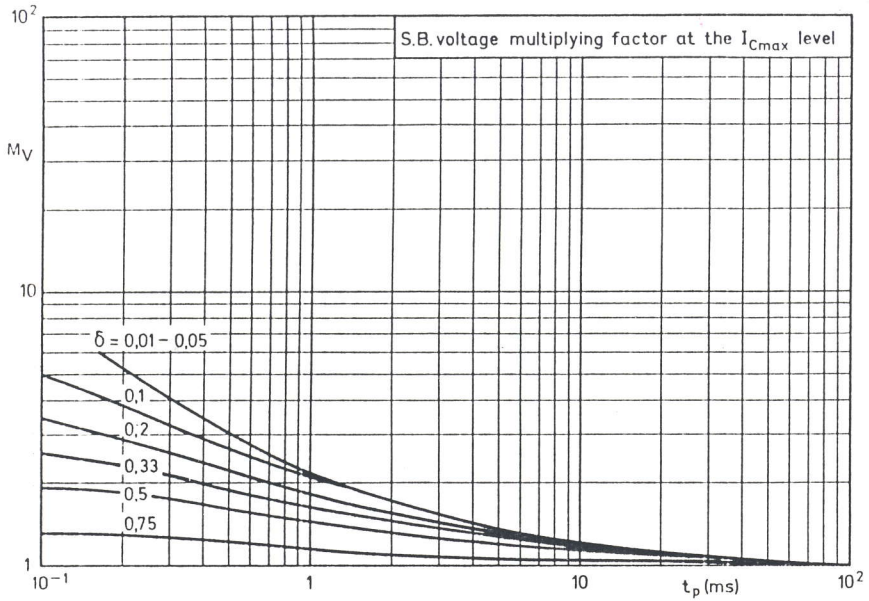


Fig. 10.

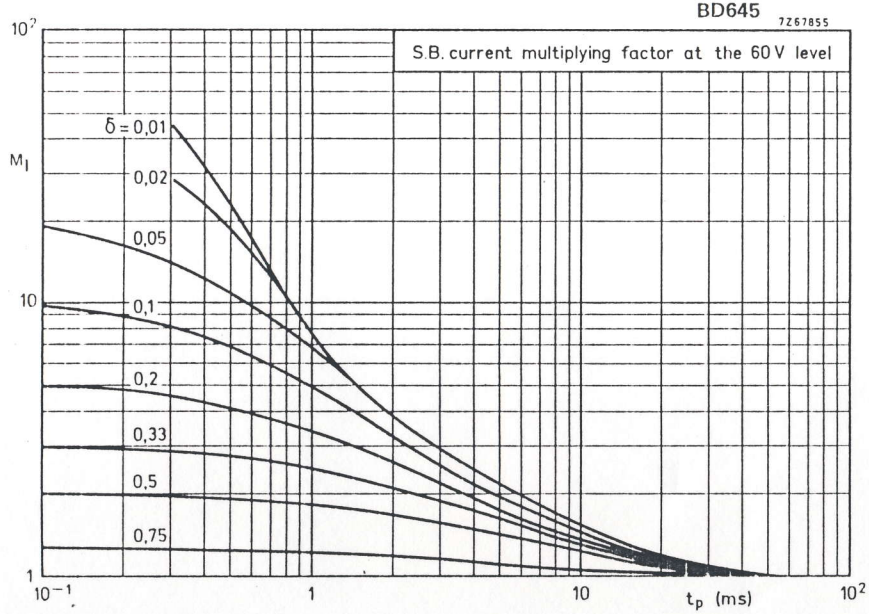


Fig. 11.

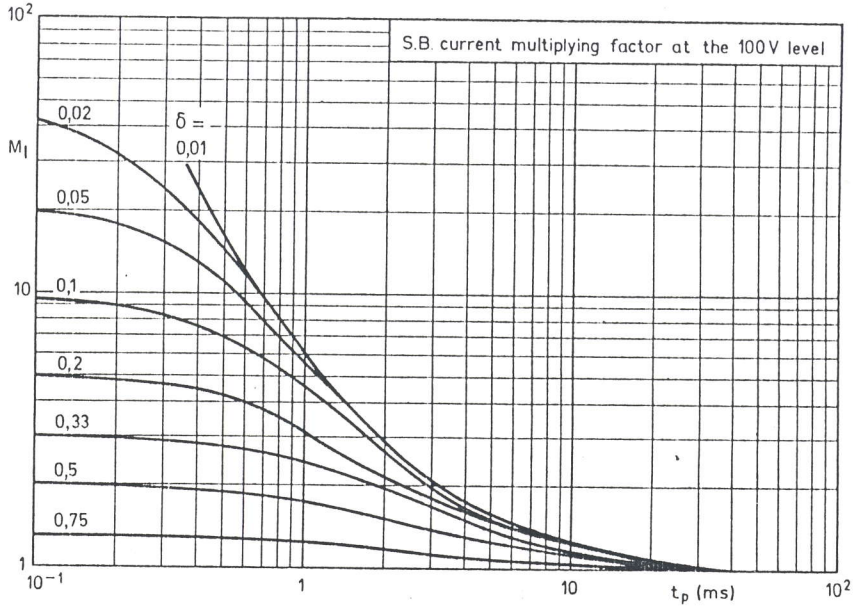


Fig. 12 Second breakdown current multiplying factor at the 100 V level.

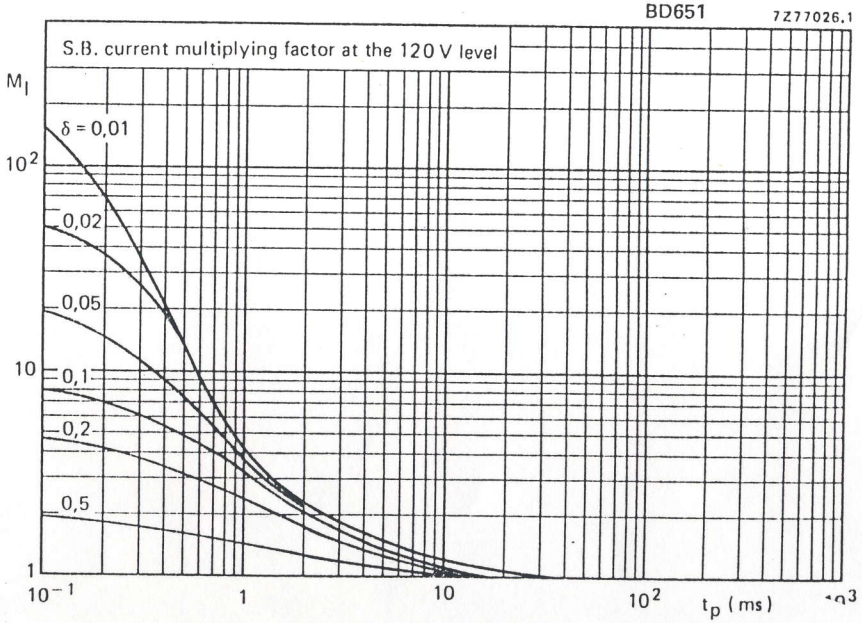


Fig. 13 Second breakdown current multiplying factor at the 120 V level.

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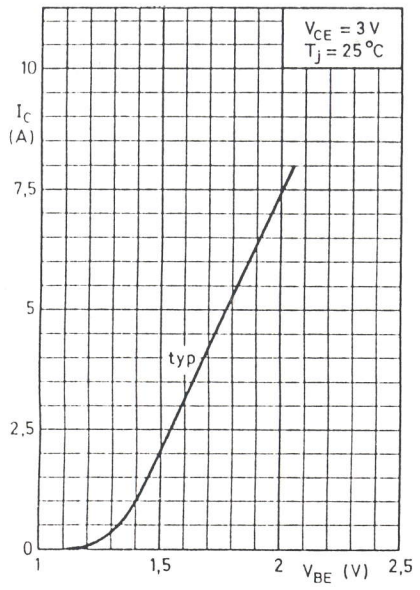

Fig. 14.

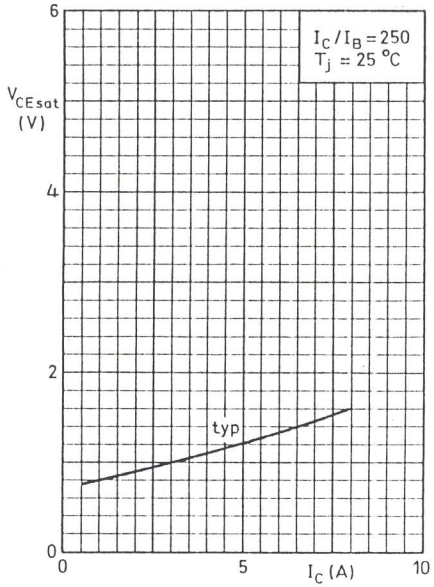

Fig. 15.

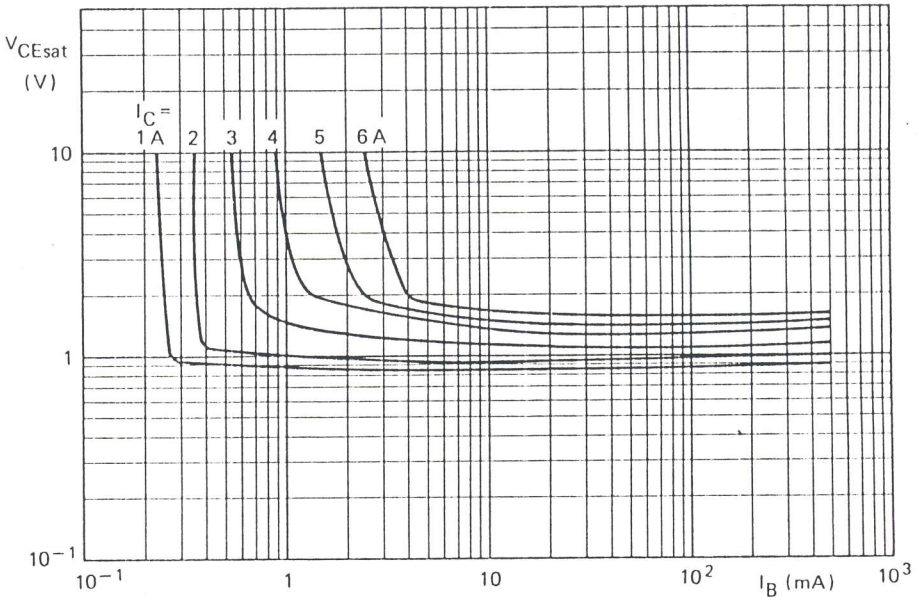

Fig. 17 Typical values collector-emitter saturation voltage. T_j = 25 °C.

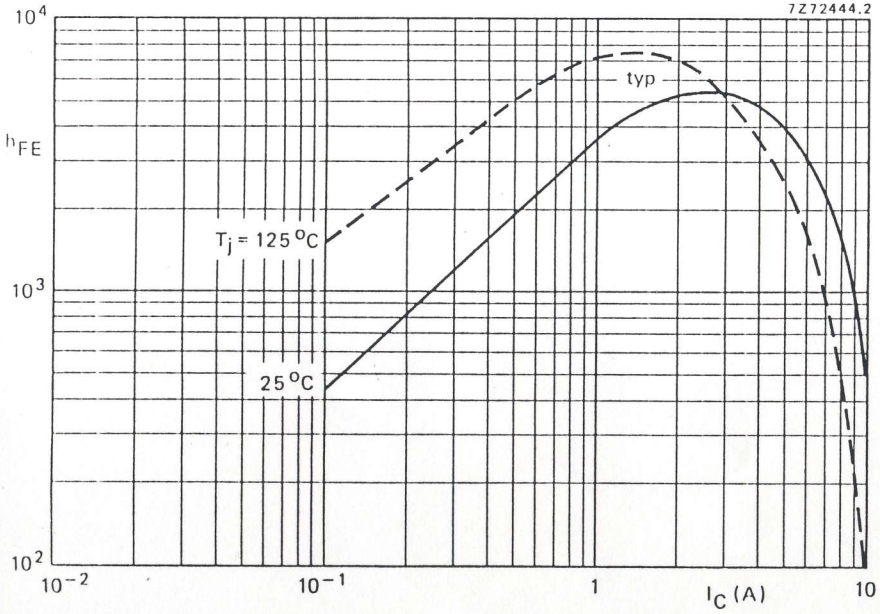

Fig. 16 Typical d.c. current gain. V_{CE} = 3 V.

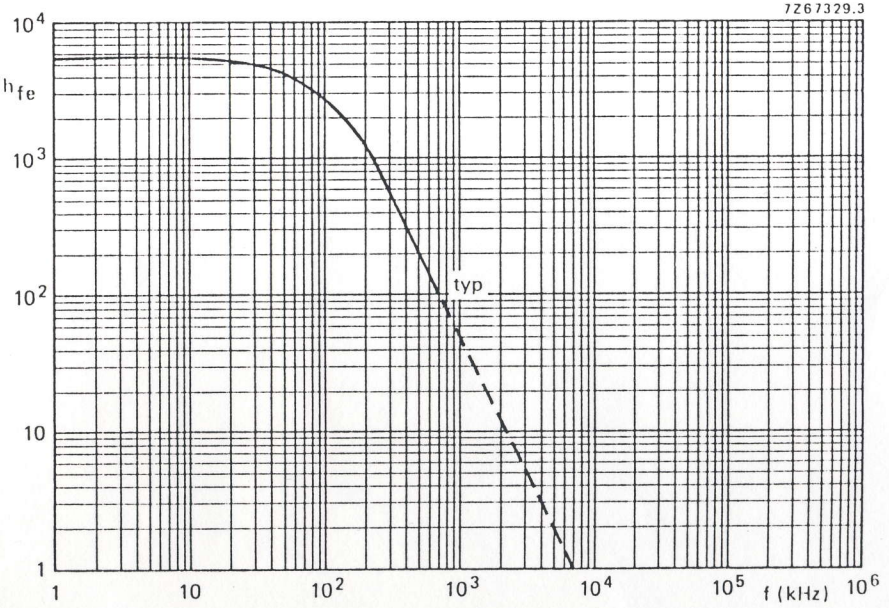

Fig. 18 Small signal current gain at I_C = 3 A; V_{CE} = 3 V.