



Certificate No. FS 36235

Magna Park, Coventry Road, Lutterworth
Leicestershire LE17 4JB, England
Sales telephone: 01455 554711
Admin telephone: 01455 552505
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BD646; 648
BD650; 652

SILICON DARLINGTON POWER TRANSISTORS

P-N-P epitaxial base transistors in monolithic Darlington circuit for audio output stages and general amplifier and switching applications; TO-220 plastic envelope. N-P-N complements are BD645, BD647, BD649 and BD651.

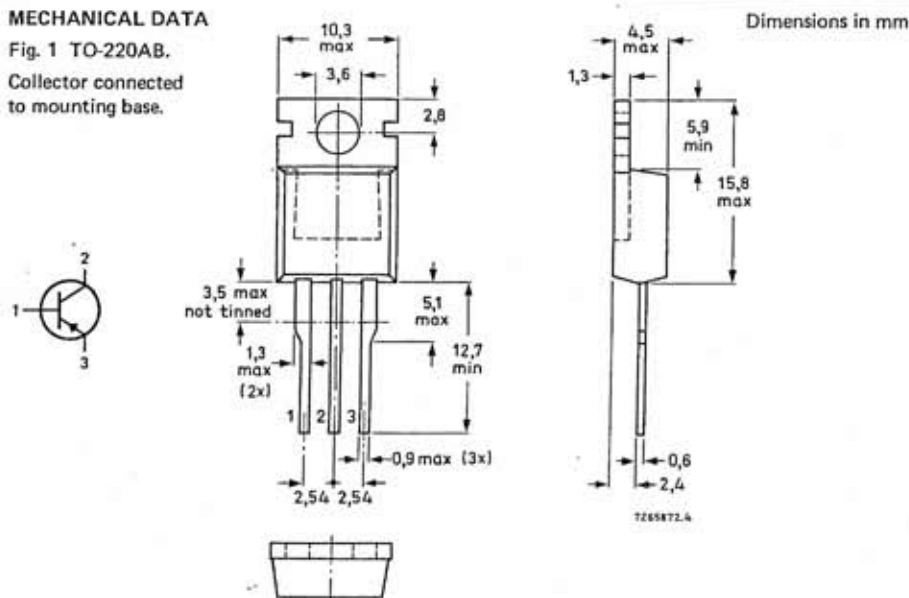
QUICK REFERENCE DATA

		BD646	648	650	652
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120 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.			2700	
$-I_C = 3,0\text{ A}; -V_{CE} = 3\text{ V}$	$h_{FE} >$			750	
Cut-off frequency:					
$-I_C = 3\text{ A}; -V_{CE} = 3\text{ V}$	f_{hfe} typ.			100	kHz

MECHANICAL DATA

Fig. 1 TO-220AB.

Collector connected
to mounting base.



See also chapters Mounting Instructions and Accessories.

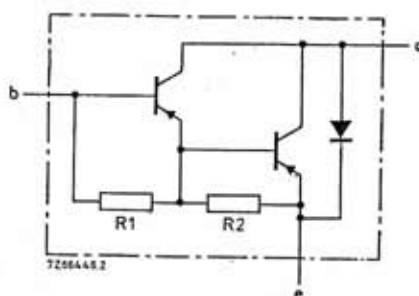


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R_1 typ. 4 k Ω
 R_2 typ. 80 Ω

Fig. 2 Darlington circuit diagram.

RATINGS

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

		BD646	648	650	652
Collector-base voltage (open emitter)	$-V_{CBO}$ max.	60	80	100	120 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 $T_{mb} = 25^\circ\text{C}$	P_{tot} max.		62,5		W
Storage temperature	T_{stg}	-65 to + 150			$^\circ\text{C}$
Junction temperature *	T_j	150			$^\circ\text{C}$

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

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

Collector cut-off current

$I_E = 0; -V_{CB} = -V_{CB0\text{max}}$

BD646: $-V_{CB} = 40\text{ V}$

BD648: $-V_{CB} = 50\text{ V}$

$I_E = 0; -V_{CB} = 60\text{ V}; T_j = 150^\circ\text{C}$

BD650: $-V_{CB} = 60\text{ V}$

BD652: $-V_{CB} = 70\text{ V}$

$I_B = 0; -V_{CE} = \frac{1}{2} V_{CE0\text{max}}$

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)

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

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

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

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

Cut-off frequency

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

Small-signal current gain

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

Diode, forward voltage

$I_F = 3\text{ A}$

Second-breakdown collector current

$-V_{CE} = 50\text{ V}; t_p = 0,1\text{ s}$

Switching times (between 10% and 90% levels) (Fig. 3)

$-I_{Con} = 3\text{ A}; -I_{Bon} = I_{Boff} = 12\text{ mA}; V_{CC} = -10\text{ V}$

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} typ. 2700

$h_{FE} > 750$

h_{FE} typ. 200

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

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

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

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

C_c typ. 75 pF

f_{hfe} typ. 100 kHz

$h_{fe} > 10$ ←

V_F typ. 1,8 V

$-I_{(SB)} > 1,25\text{ A}$

t_{on} typ. 1 μs

$t_{on} < 2\text{ $\mu\text{s}$$

t_{off} typ. 5 μs

$t_{off} < 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 mV/K with increasing temperature.



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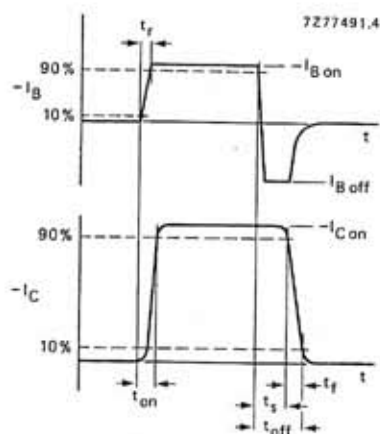


Fig. 3 Switching times waveforms.

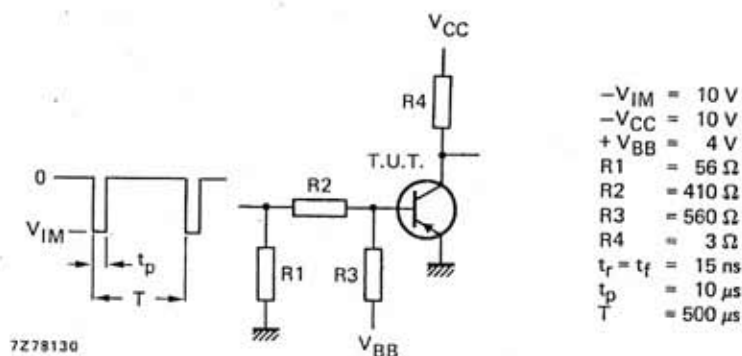


Fig. 4 Switching times test circuit.



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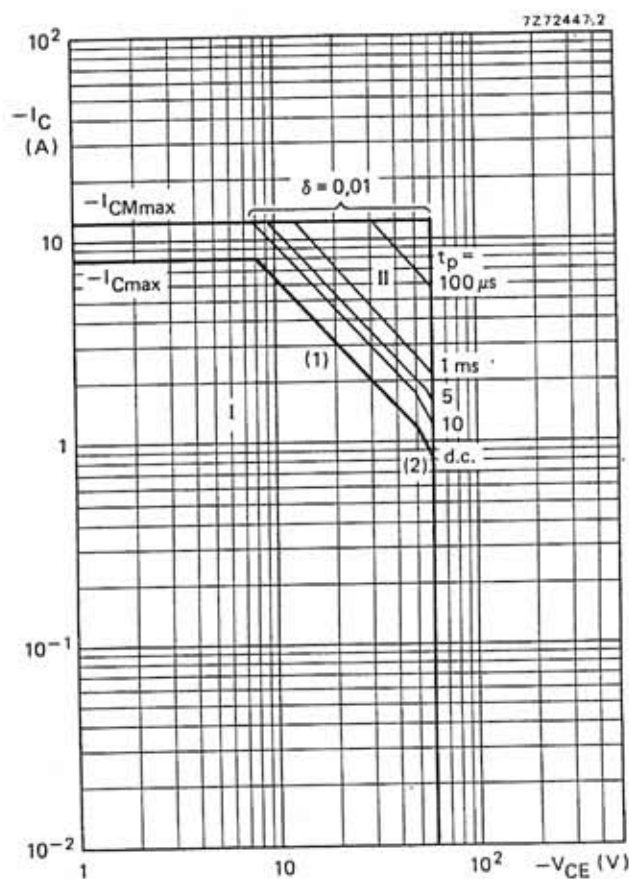


Fig. 5 Safe Operating Area transistor BD646 at $T_{mb} = 25\text{ }^{\circ}\text{C}$.

- 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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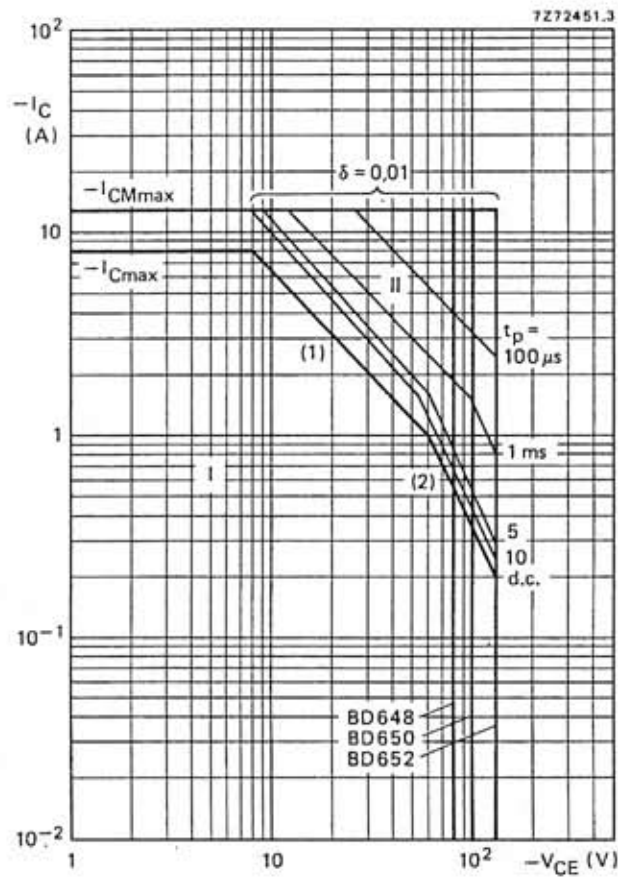


Fig. 6 Safe Operating Area. $T_{mb} = 25^\circ\text{C}$

- 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).



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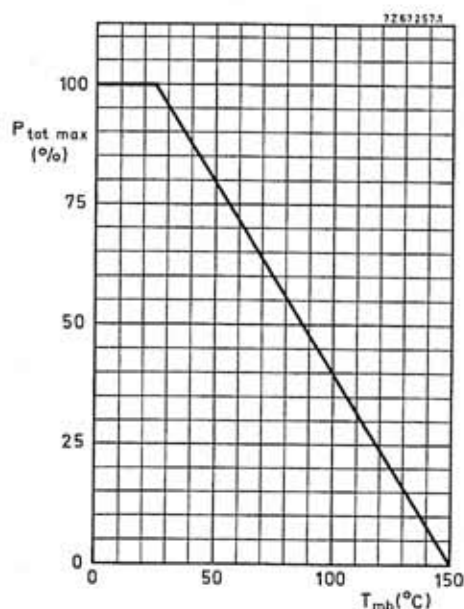


Fig. 7 Power derating curve.

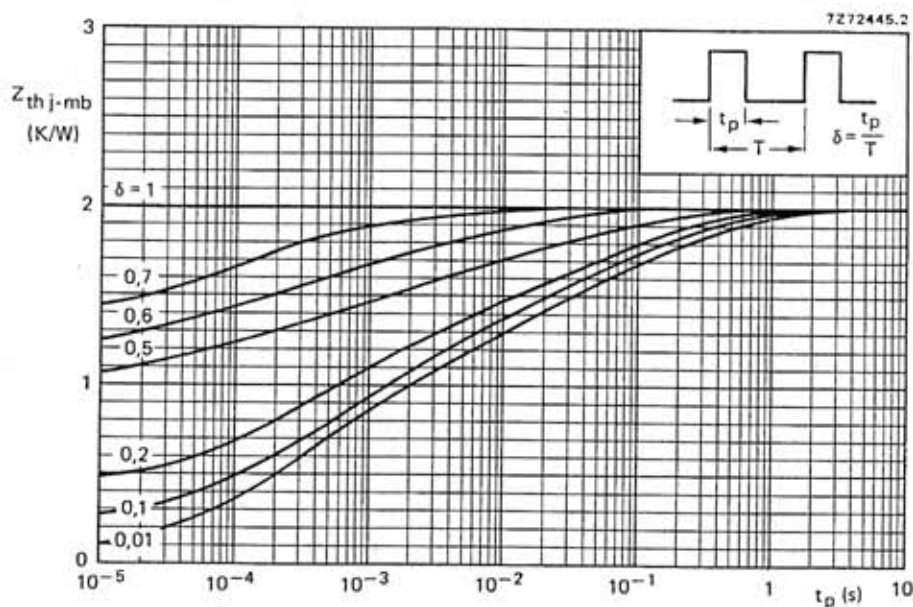


Fig. 8 Pulse power rating chart.



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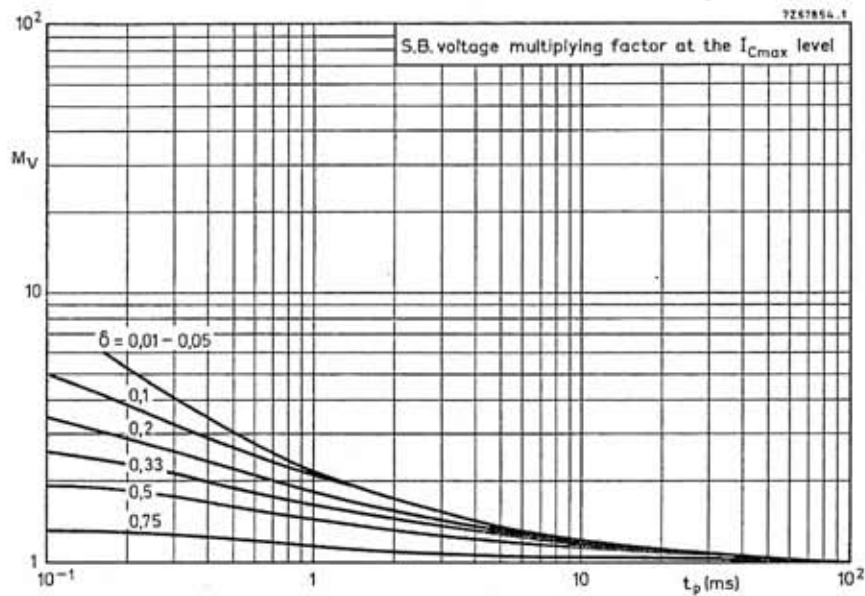


Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

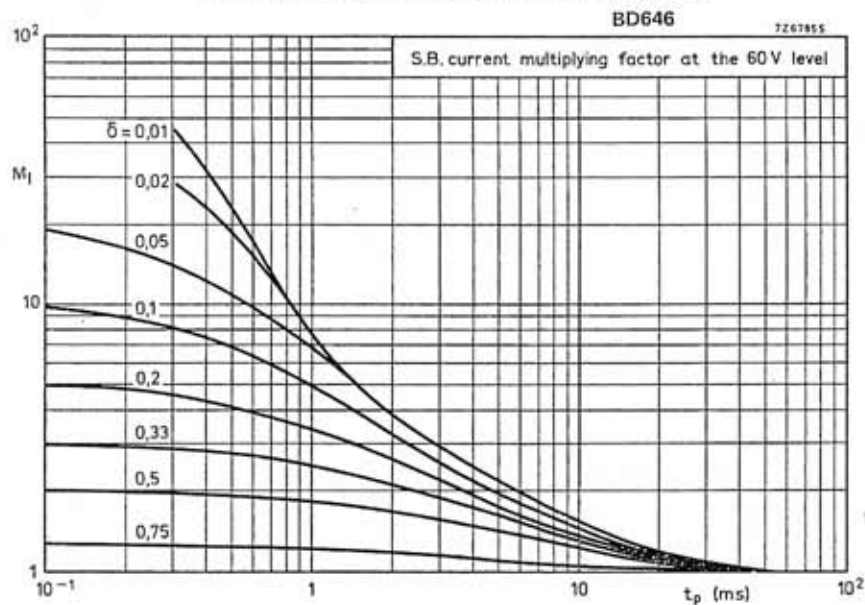


Fig. 10 S.B. current multiplying factor at 60 V level.



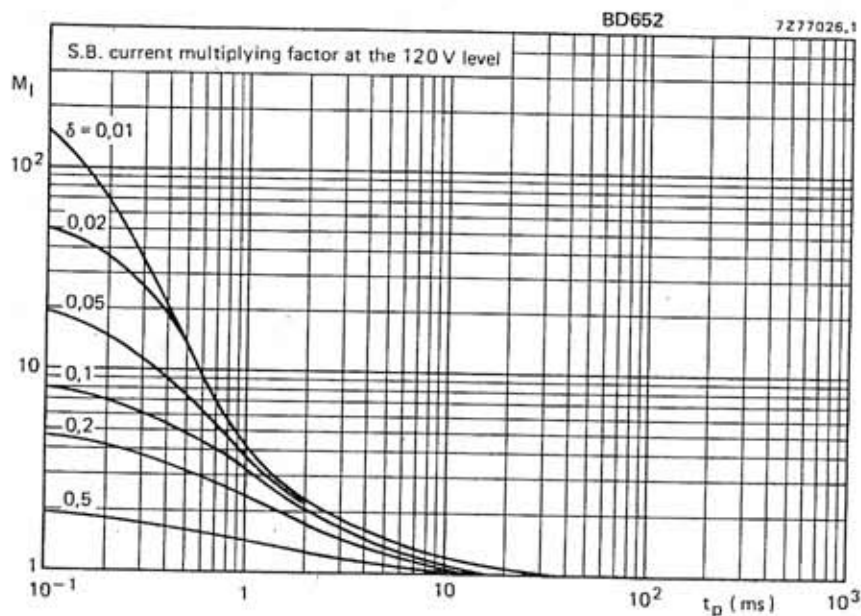
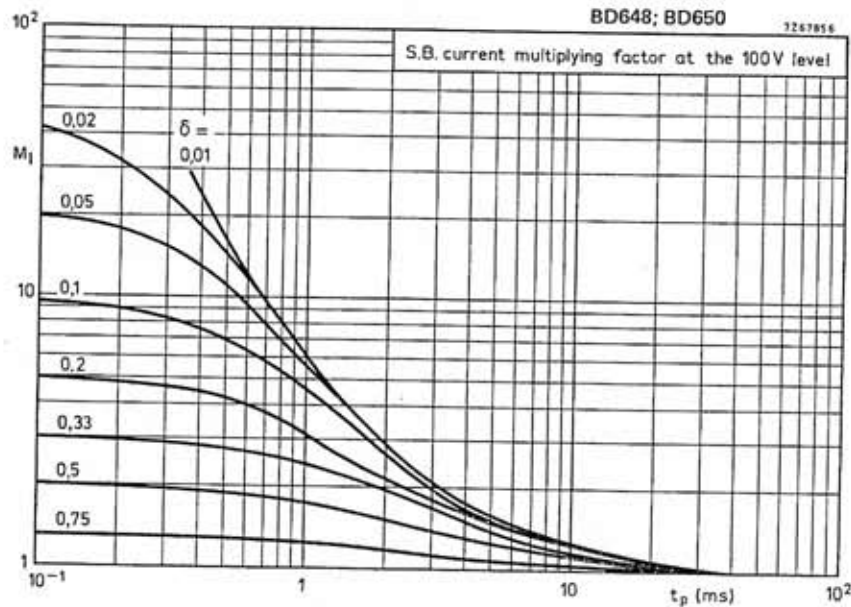
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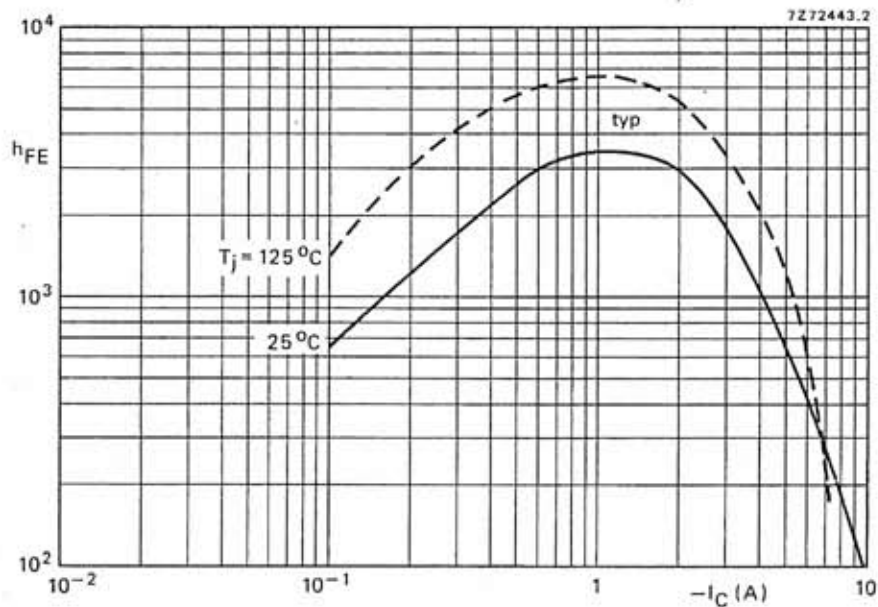


Fig. 13 D.C. current gain at $-V_{CE} = 3$ V.

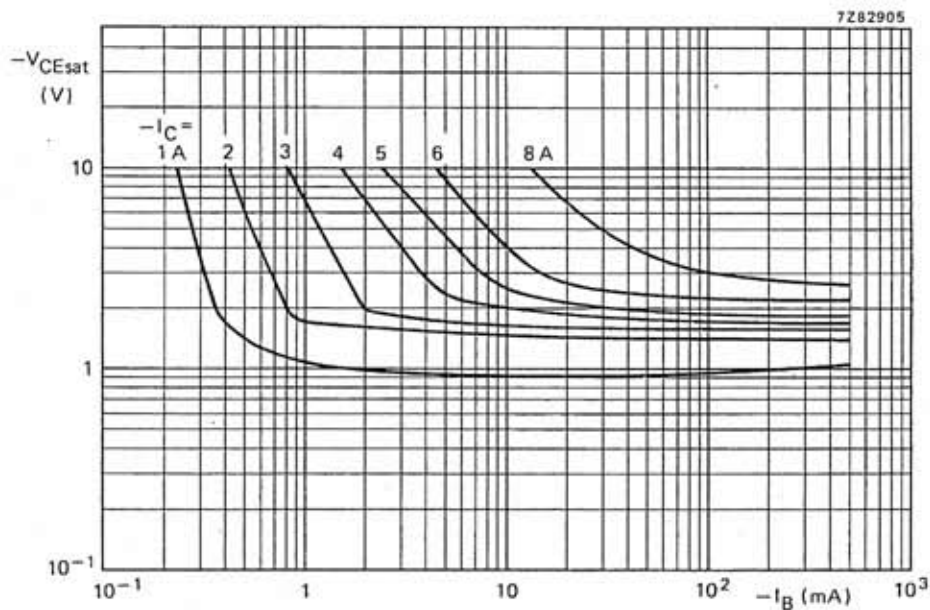


Fig. 14 Typical collector-emitter saturation voltage at $T_j = 25^\circ\text{C}$.



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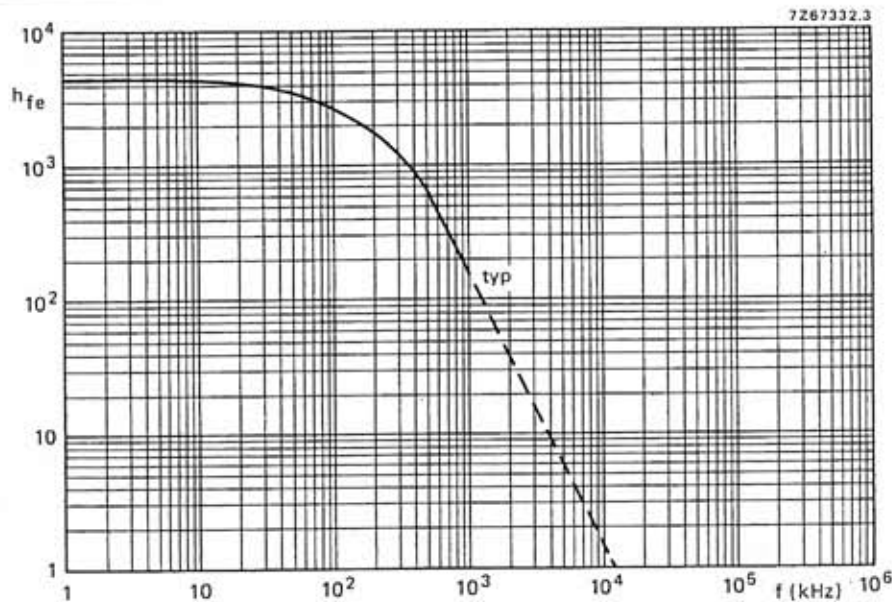


Fig. 15 Small signal current gain at $-I_C = 3\text{ A}$; $-V_{CE} = 3\text{ V}$.

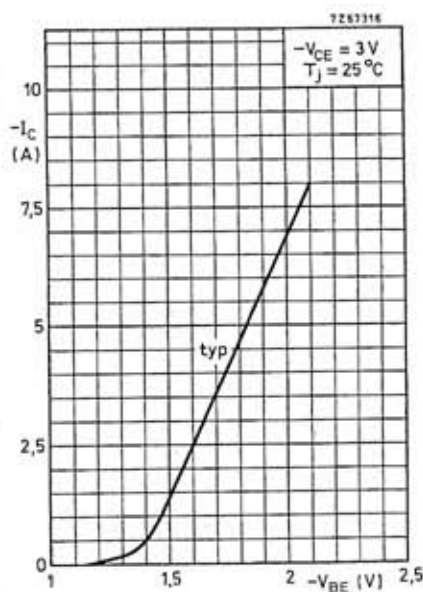


Fig. 16 Collector current.