Magnatec

Certificate No. FS 36235

Magna Park, Coventry Road, Lutterworth
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MAGNA TEC

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

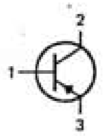
			BD646	648	650	652	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	80	100	120	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	80	100	120	V
Collector current (peak value)	$-I_{CM}$	max.		12			A
Total power dissipation up to $T_{mb} = 25\ ^oC$	P_{tot}	max.		62,5			W
Junction temperature	T_j	max.		150			^oC
D.C. current gain:							
$-I_C = 0,5$ A; $-V_{CE} = 3$ V	h_{FE}	typ.		2700			
$-I_C = 3,0$ A; $-V_{CE} = 3$ V	h_{FE}	>		750			
Cut-off frequency:							
$-I_C = 3$ A; $-V_{CE} = 3$ V	f_{hfe}	typ.		100			kHz

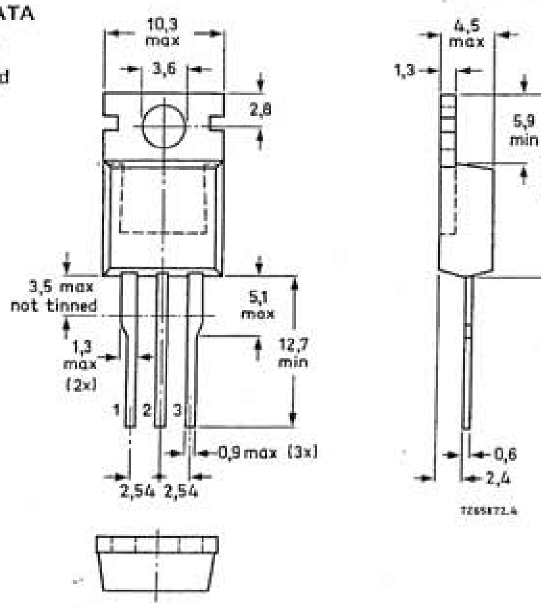
MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-220AB.

Collector connected to mounting base.





See also chapters Mounting Instructions and Accessories.

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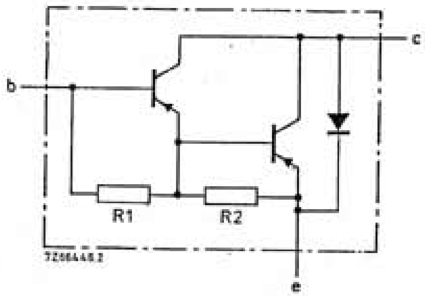

Fig. 2 Darlington circuit diagram.

R_1 typ. 4 kΩ
R_2 typ. 80 Ω

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 °C	P_{tot}	max.	62,5	W
Storage temperature	T_{stg}		−65 to + 150	°C
Junction temperature *	T_j		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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MAGNA TEC

Silicon Darlington power transistors

BD646;648
BD650; 652

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current			
$I_E = 0; -V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	0,2 mA
$I_E = 0$; BD646: $-V_{CB} = 40$ V; BD648: $-V_{CB} = 50$ V; BD650: $-V_{CB} = 60$ V; BD652: $-V_{CB} = 70$ V; $T_j = 150\ ^oC$	$-I_{CBO}$	<	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.	2700
$-I_C = 3$ A; $-V_{CE} = 3$ V	h_{FE}	>	750
$-I_C = 8$ A; $-V_{CE} = 3$ V	h_{FE}	typ.	200
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
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.	100 kHz
Small-signal current gain			
$-I_C = 3$ A; $-V_{CE} = 3$ V; f = 1 MHz	h_{fe}	>	10
Diode, forward voltage			
$I_F = 3$ A	V_F	typ.	1,8 V
Second-breakdown collector current			
$-V_{CE} = 50$ V; $t_p = 0,1$ s	$-I_{(SB)}$	>	1,25 A
Switching times (between 10% and 90% levels) (Fig. 3)			
$-I_{Con} = 3$ A; $-I_{Bon} = I_{Boff} = 12$ mA; $V_{CC} = -10$ V			
Turn-on time	t_{on}	typ.	1 μs
		<	2 μs
Turn-off time	t_{off}	typ.	5 μs
		<	10 μs

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

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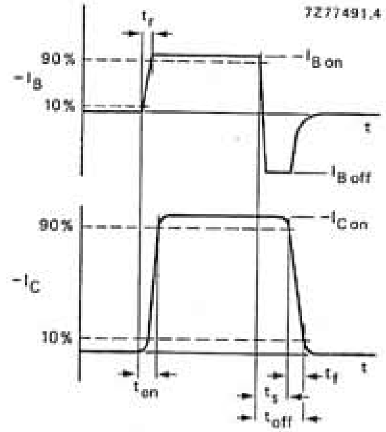
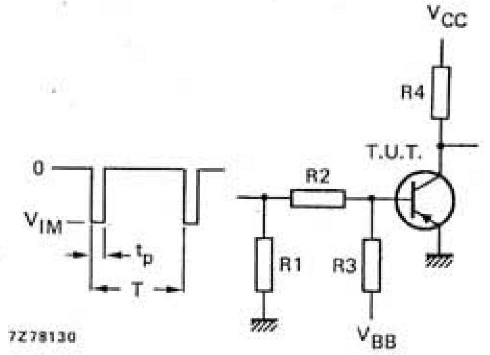


Fig. 3 Switching times waveforms.



$-V_{IM}$ = 10 V
$-V_{CC}$ = 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. 4 Switching times test circuit.

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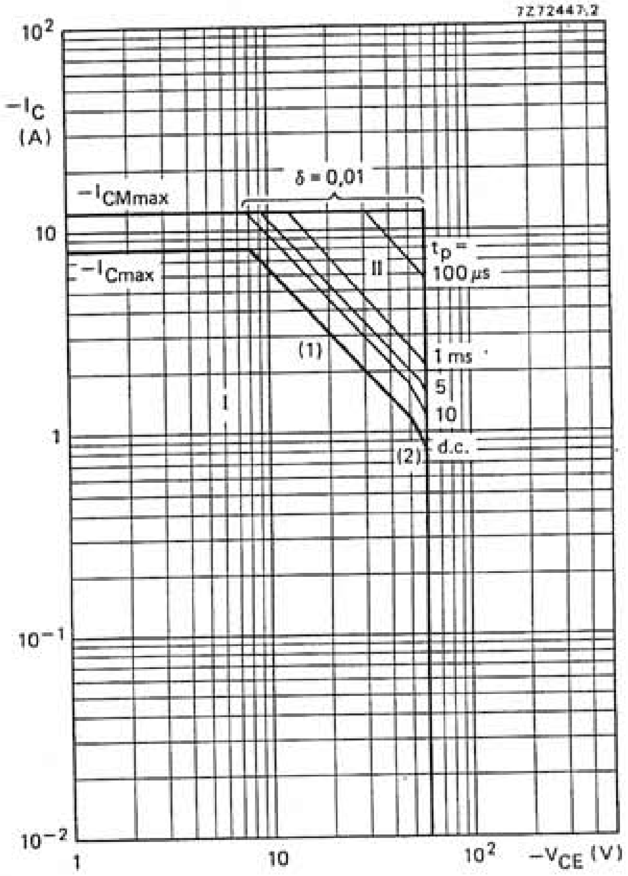

Fig. 5 Safe Operating ARea transistor BD646 at $T_{mb} = 25\ ^oC$.

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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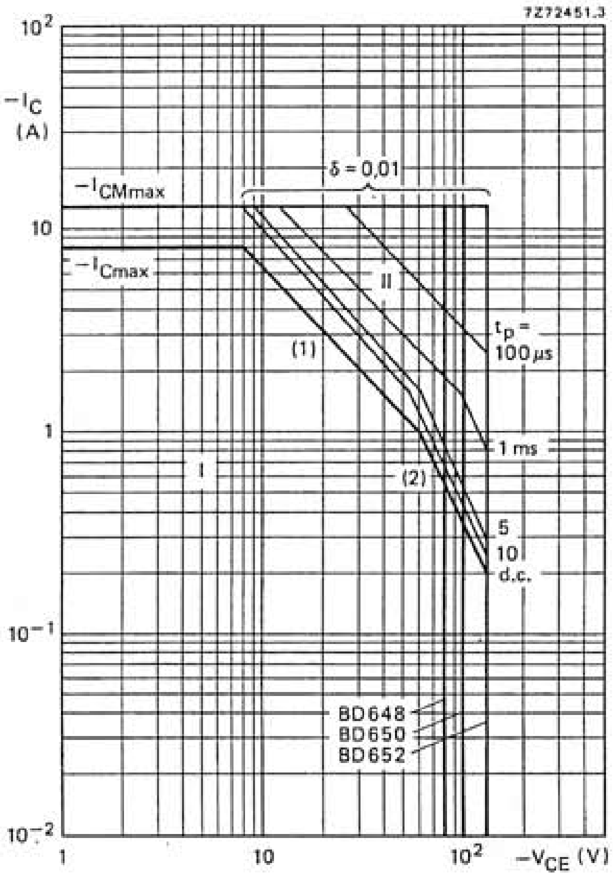

Fig. 6 Safe Operating ARea. T_{mb} = 25 °C

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).

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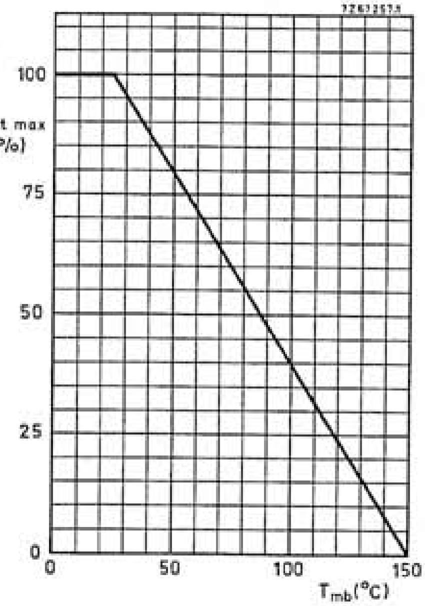

Fig. 7 Power derating curve.

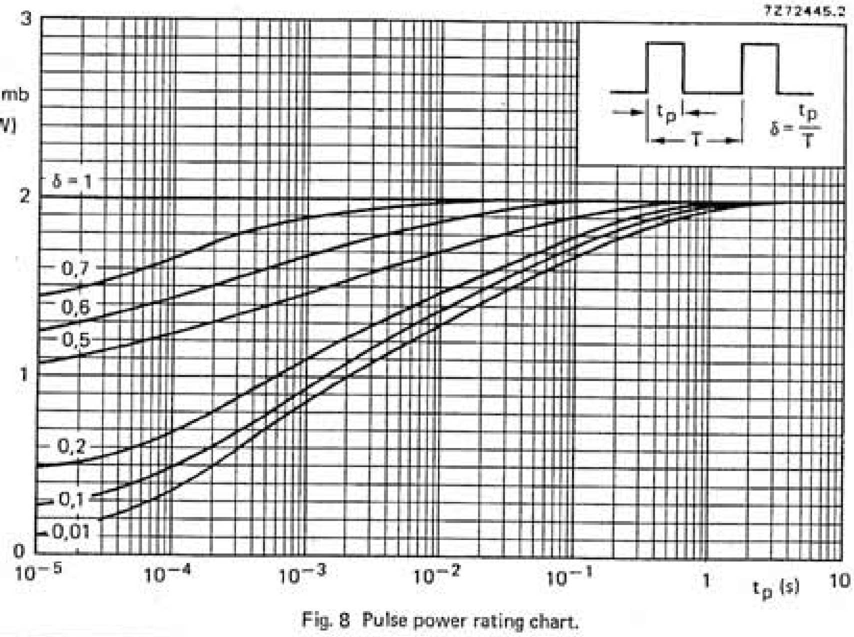

Fig. 8 Pulse power rating chart.

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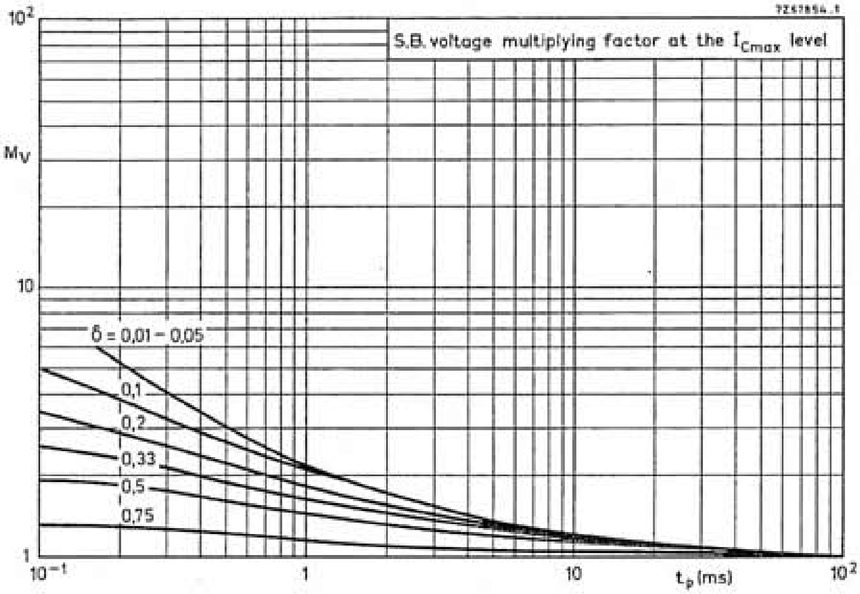

Fig. 9 S.B. voltage multiplying factor at the I_{Cmax} level.

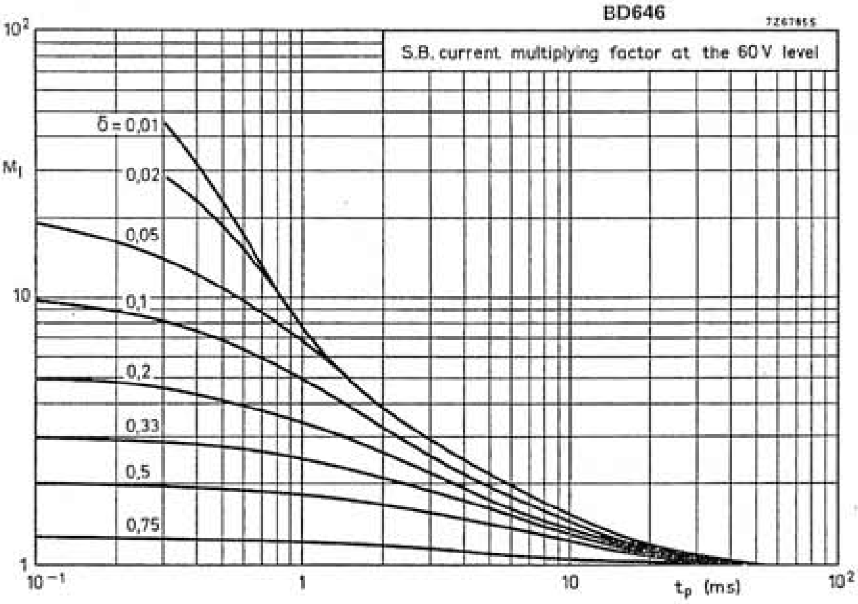

Fig. 10 S.B. current multiplying factor at 60 V level.

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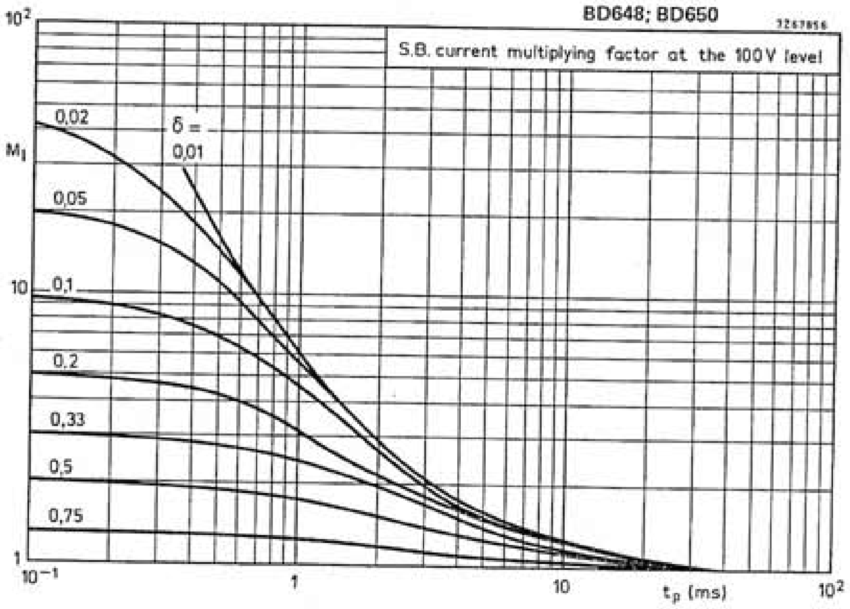

Fig. 11.

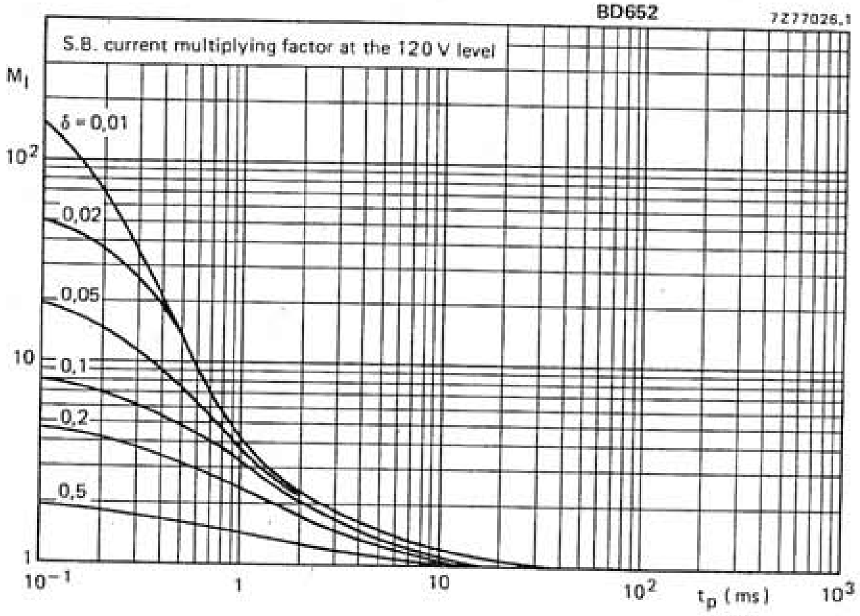

Fig. 12.

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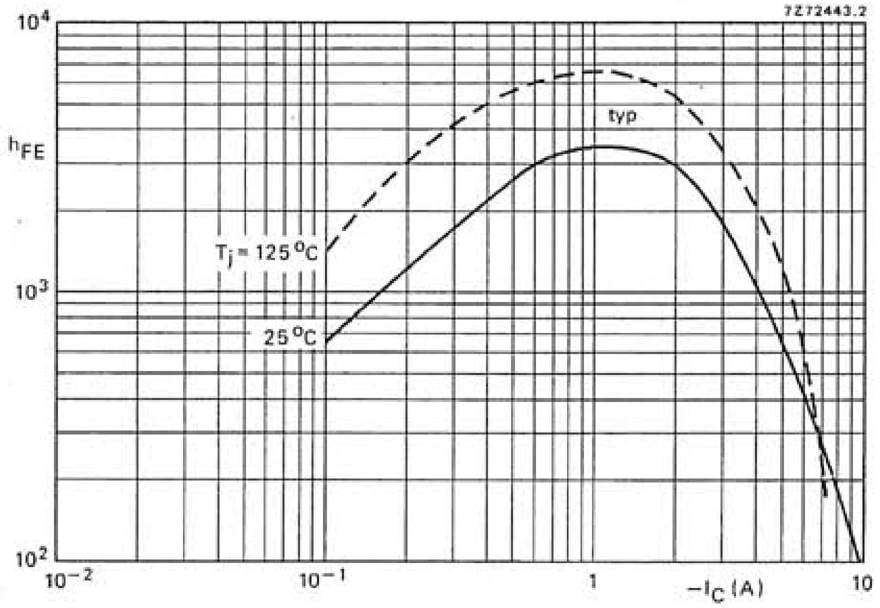

Fig. 13 D.C. current gain at $-V_{CE} = 3$ V.

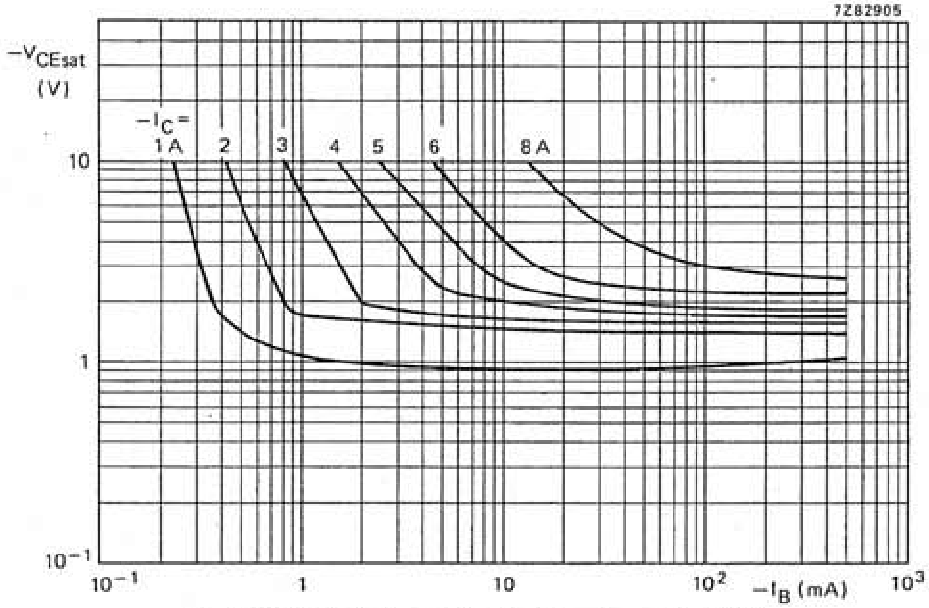

Fig. 14 Typical collector-emitter saturation voltage at $T_j = 25\,^oC$.

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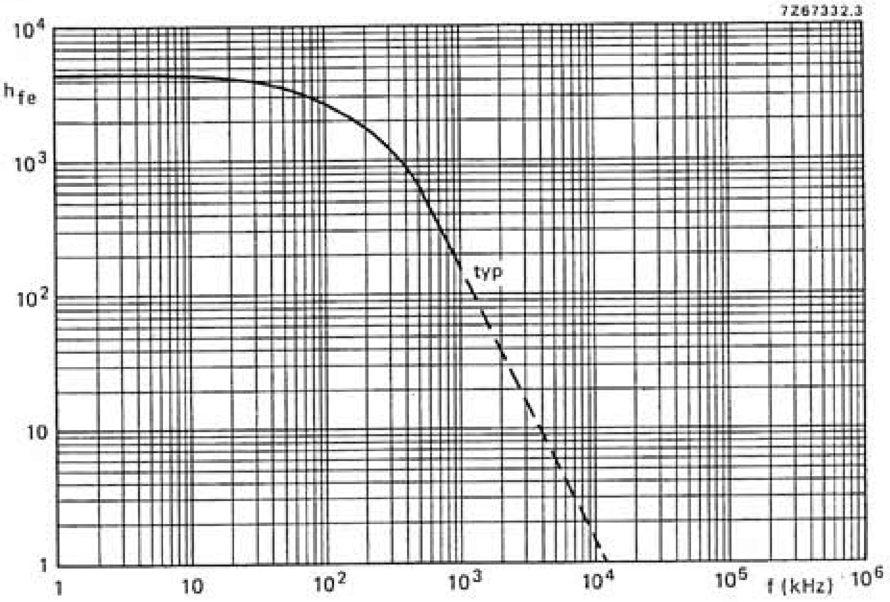

Fig. 15 Small signal current gain at $-I_C = 3$ A; $-V_{CE} = 3$ V.

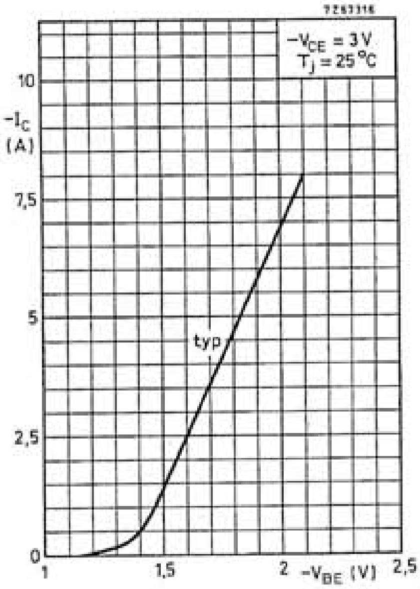

Fig. 16 Collector current.