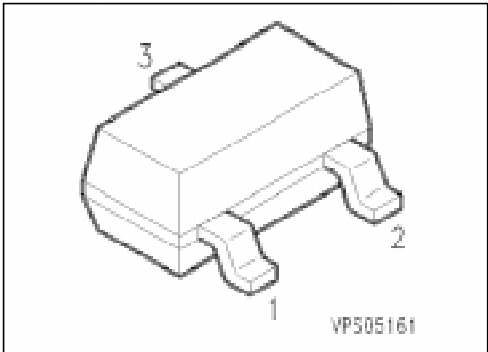


NPN Silicon Switching Transistor

SMBT 3904

- High DC current gain: 0.1 mA to 100 mA
- Low collector-emitter saturation voltage
- Complementary type: SMBT 3906 (PNP)



Type	Marking	Ordering Code (tape and reel)	Pin Configuration			Package ¹⁾
			1	2	3	
SMBT 3904	s1A	Q68000-A4416	B	E	C	SOT-23

Maximum Ratings

Parameter	Symbol	Values	Unit
Collector-emitter voltage	V_{CE0}	40	V
Collector-base voltage	V_{CB0}	60	
Emitter-base voltage	V_{EB0}	6	
Collector current	I_C	200	mA
Total power dissipation, $T_s = 69^\circ\text{C}$	P_{tot}	330	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_{stg}	- 65 ... + 150	

Thermal Resistance

Junction - ambient ²⁾	$R_{th JA}$	≤ 315	K/W
Junction - soldering point	$R_{th JS}$	≤ 245	

¹⁾ For detailed information see chapter Package Outlines.

²⁾ Package mounted on epoxy pcb 40 mm × 40 mm × 1.5 mm/6 cm² Cu.

Electrical Characteristics

at $T_A = 25\text{ }^{\circ}\text{C}$, unless otherwise specified.

Parameter	Symbol	Values			Unit
		min.	typ.	max.	

DC characteristics

Collector-emitter breakdown voltage $I_C = 1\text{ mA}$	$V_{(BR)CE0}$	40	—	—	V
Collector-base breakdown voltage $I_C = 10\text{ }\mu\text{A}$	$V_{(BR)CB0}$	60	—	—	
Emitter-base breakdown voltage $I_E = 10\text{ }\mu\text{A}$	$V_{(BR)EB0}$	6	—	—	
Collector-base cutoff current $V_{CB} = 30\text{ V}$	I_{CB0}	—	—	50	nA
DC current gain $I_C = 100\text{ }\mu\text{A}$, $V_{CE} = 1\text{ V}$ $I_C = 1\text{ mA}$, $V_{CE} = 1\text{ V}$ $I_C = 10\text{ mA}$, $V_{CE} = 1\text{ V}^{1)}$ $I_C = 50\text{ mA}$, $V_{CE} = 1\text{ V}^{1)}$ $I_C = 100\text{ mA}$, $V_{CE} = 1\text{ V}^{1)}$	h_{FE}	40 70 100 60 30	— — — — —	— — 300 — —	—
Collector-emitter saturation voltage ¹⁾ $I_C = 10\text{ mA}$, $I_B = 1\text{ mA}$ $I_C = 50\text{ mA}$, $I_B = 5\text{ mA}$	V_{CEsat}	— —	— —	0.2 0.3	V
Base-emitter saturation voltage ¹⁾ $I_C = 10\text{ mA}$, $I_B = 1\text{ mA}$ $I_C = 50\text{ mA}$, $I_B = 5\text{ mA}$	V_{BEsat}	0.65 —	— —	0.85 0.95	

¹⁾ Pulse test conditions: $t \leq 300\text{ }\mu\text{s}$, $D = 2\text{ }\%$.

Electrical Characteristics

at $T_A = 25\text{ }^{\circ}\text{C}$, unless otherwise specified.

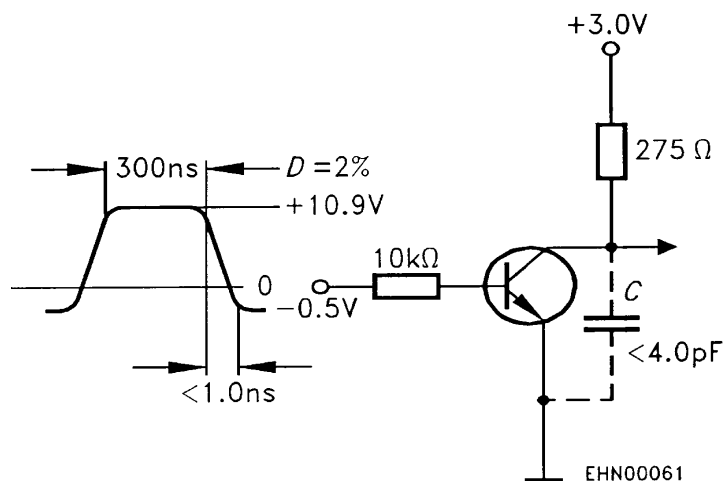
Parameter	Symbol	Values			Unit
		min.	typ.	max.	

AC characteristics

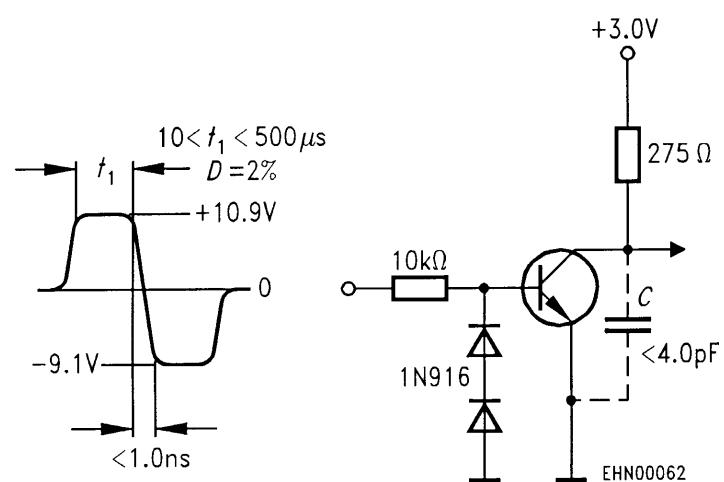
Transition frequency $I_C = 10\text{ mA}$, $V_{CE} = 20\text{ V}$, $f = 100\text{ MHz}$	f_T	300	—	—	MHz
Output capacitance $V_{CB} = 5\text{ V}$, $f = 1\text{ MHz}$	C_{obo}	—	—	4	pF
Input capacitance $V_{EB} = 0.5\text{ V}$, $f = 1\text{ MHz}$	C_{ibo}	—	—	8	
Input impedance $I_C = 1\text{ mA}$, $V_{CE} = 10\text{ V}$, $f = 1\text{ kHz}$	h_{11e}	1	—	10	k Ω
Open-circuit reverse voltage transfer ratio $I_C = 1\text{ mA}$, $V_{CE} = 10\text{ V}$, $f = 1\text{ kHz}$	h_{12e}	0.5	—	8	10^{-4}
Short-circuit forward current transfer ratio $I_C = 1\text{ mA}$, $V_{CE} = 10\text{ V}$, $f = 1\text{ kHz}$	h_{21e}	100	—	400	—
Open-circuit output admittance $I_C = 1\text{ mA}$, $V_{CE} = 10\text{ V}$, $f = 1\text{ kHz}$	h_{22e}	1	—	40	μS
Noise figure $I_C = 100\text{ }\mu\text{A}$, $V_{CE} = 5\text{ V}$, $R_S = 1\text{ k}\Omega$, $f = 1\text{ kHz}$	F	—	—	5	dB
$V_{CC} = 3\text{ V}$, $I_C = 10\text{ mA}$, $I_{B1} = 1\text{ mA}$ $V_{BE(off)} = 0.5\text{ V}$ Delay time	t_d	—	—	35	ns
Rise time	t_r	—	—	35	ns
$V_{CC} = 3\text{ V}$, $I_C = 10\text{ mA}$, $I_{B1} = I_{B2} = 1\text{ mA}$ Storage time	t_{stg}	—	—	200	ns
Fall time (see diagrams)	t_f	—	—	50	ns

Test circuits

Delay and rise time

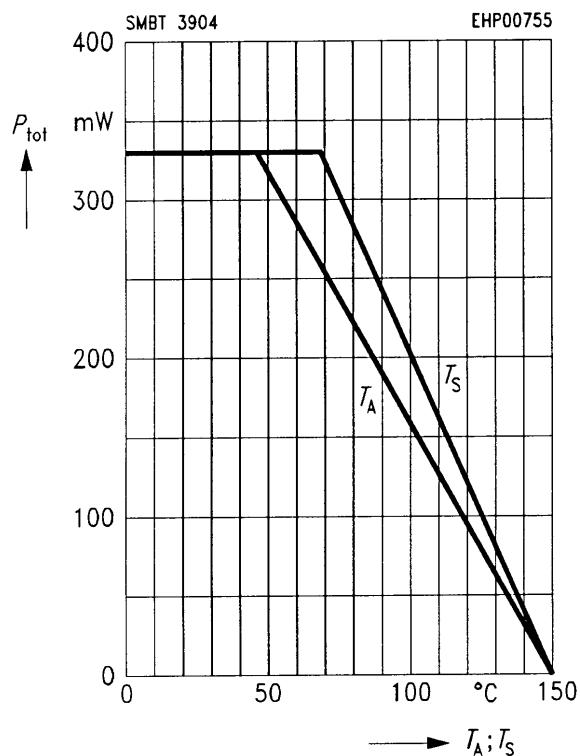


Storage and fall time

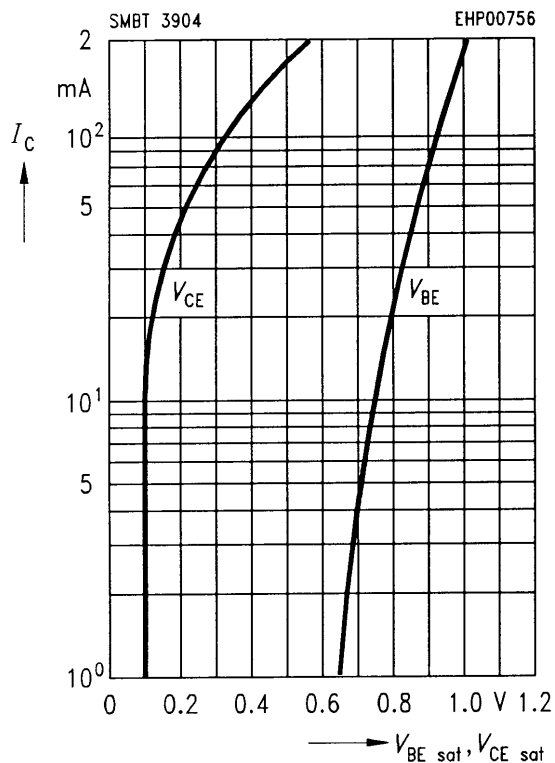


Total power dissipation $P_{\text{tot}} = f(T_A^*; T_S)$

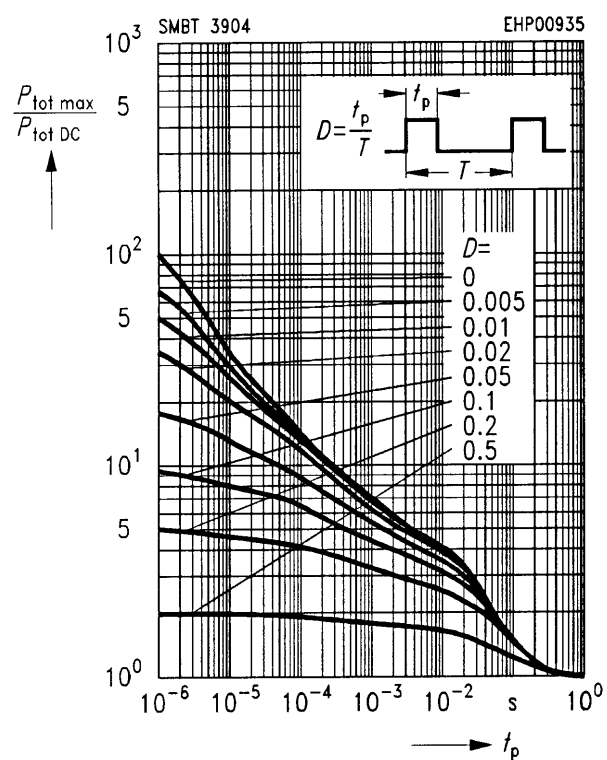
* Package mounted on epoxy



Saturation voltage $I_C = f(V_{\text{BE sat}}, V_{\text{CE sat}})$

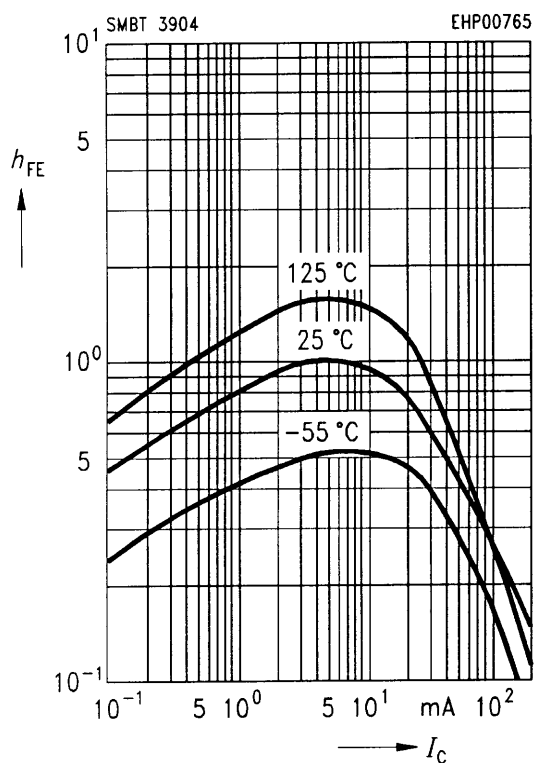


Permissible pulse load $P_{\text{tot max}} / P_{\text{tot DC}} = f(t_p)$



DC current gain $h_{\text{FE}} = f(I_C)$

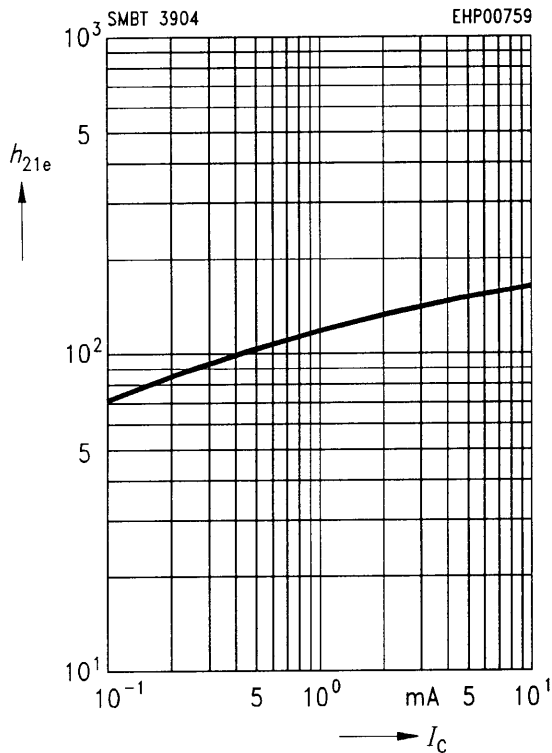
$V_{\text{CE}} = 10$ V, normalized



Short-circuit forward current

transfer ratio $h_{21e} = f(I_C)$

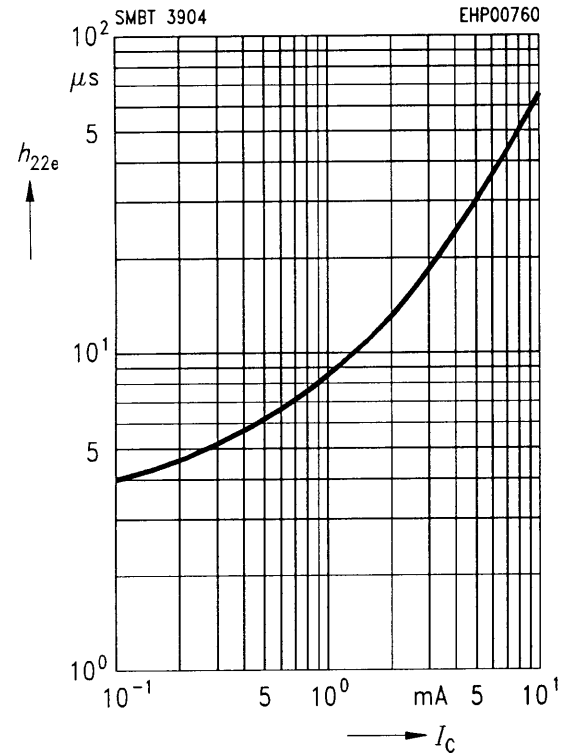
$V_{CE} = 10 \text{ V}, f = 1 \text{ MHz}$



Open-circuit output admittance

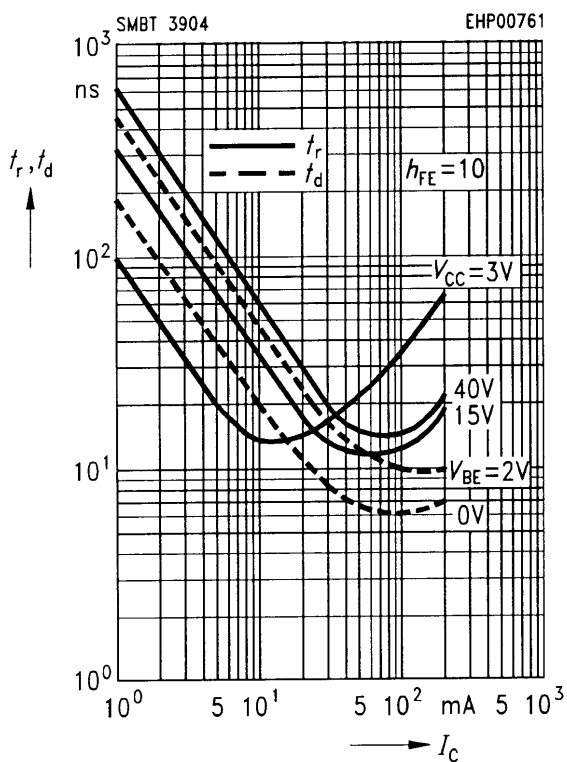
$h_{22e} = f(I_C)$

$V_{CE} = 10 \text{ V}, f = 1 \text{ MHz}$

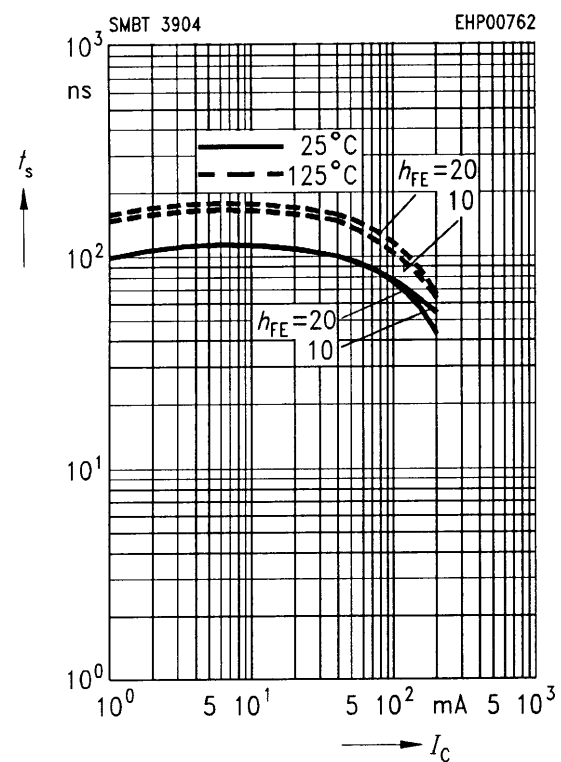


Delay time $t_d = f(I_C)$

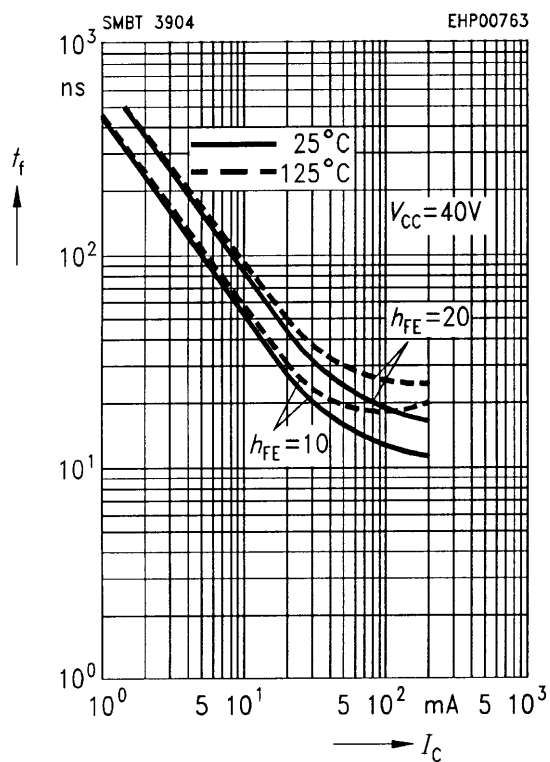
Rise time $t_r = f(I_C)$



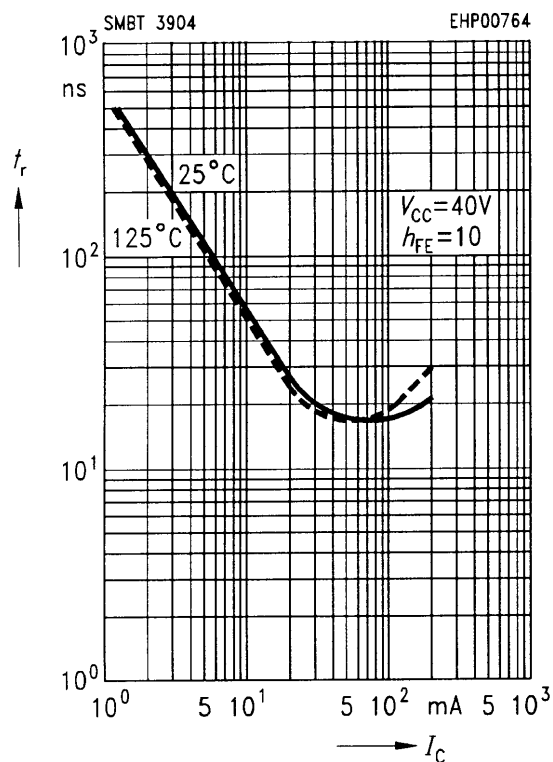
Storage time $t_{stg} = f(I_C)$



Fall time $t_f = f(I_C)$



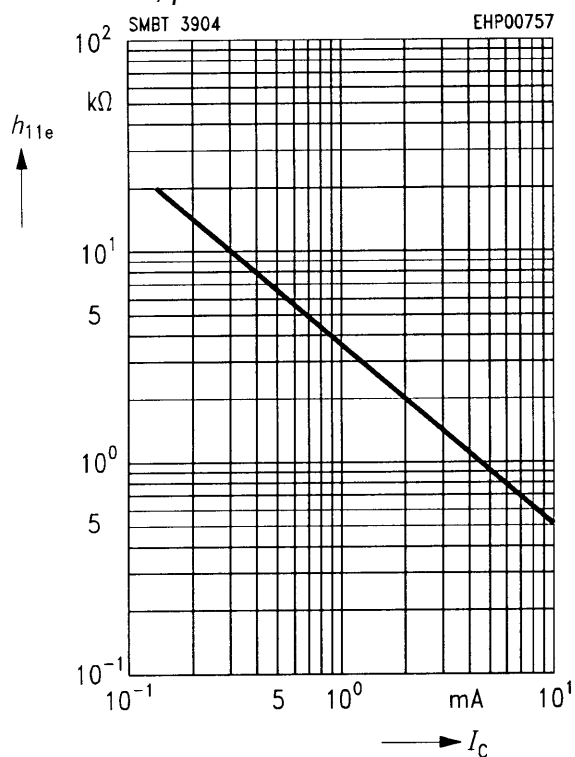
Rise time $t_r = f(I_C)$



Input impedance

$$h_{11e} = f(I_C)$$

$$V_{CE} = 10V, f = 1kHz$$



Open-circuit reverse voltage

$$\text{transfer ratio } h_{12e} = f(I_C)$$

$$V_{CE} = 10V, f = 1kHz$$

