

## 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 <sup>1)</sup>
			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, $T_s = 69\text{ °C}$	$P_{tot}$	330	mW
Junction temperature	$T_j$	150	°C
Storage temperature range	$T_{stg}$	- 65 ... + 150	

### Thermal Resistance

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

<sup>1)</sup> For detailed information see chapter Package Outlines.

<sup>2)</sup> Package mounted on epoxy pcb 40 mm × 40 mm × 1.5 mm/6 cm<sup>2</sup> Cu.

## Electrical Characteristics

at  $T_A = 25\text{ °C}$ , 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 <sup>1)</sup> $I_C = 10\text{ mA}, I_B = 1\text{ mA}$ $I_C = 50\text{ mA}, I_B = 5\text{ mA}$	$V_{CEsat}$	– –	– –	0.2 0.3	V
Base-emitter saturation voltage <sup>1)</sup> $I_C = 10\text{ mA}, I_B = 1\text{ mA}$ $I_C = 50\text{ mA}, I_B = 5\text{ mA}$	$V_{BEsat}$	0.65 –	– –	0.85 0.95	

<sup>1)</sup> 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.

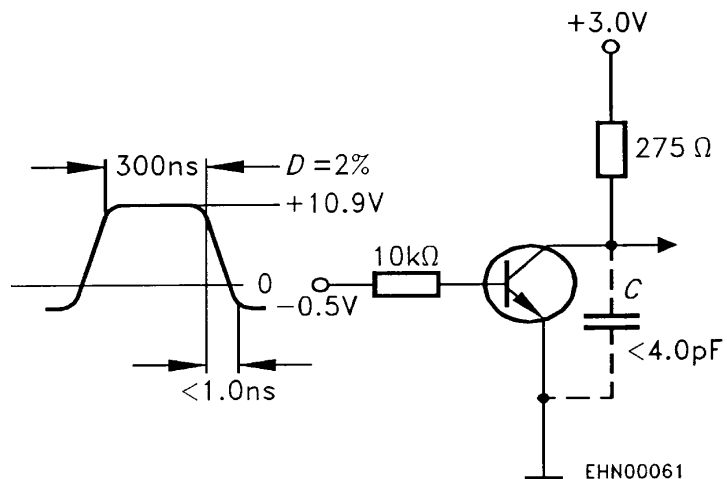
Parameter	Symbol	Values			Unit
		min.	typ.	max.	

**AC characteristics**

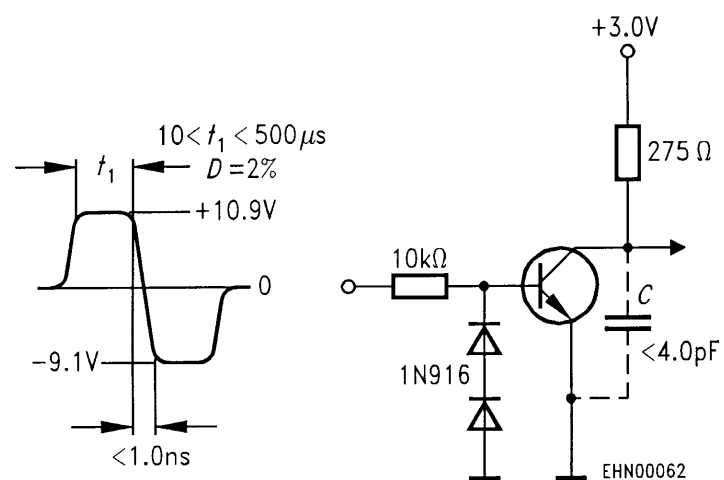
Transition frequency $I_C = 10\text{ mA}$ , $V_{CE} = 20\text{ V}$ , $f = 100\text{ MHz}$	$f_T$	300	–	–	MHz
Output capacitance $V_{CB} = 5\text{ V}$ , $f = 1\text{ MHz}$	$C_{obo}$	–	–	4	pF
Input capacitance $V_{EB} = 0.5\text{ V}$ , $f = 1\text{ MHz}$	$C_{ibo}$	–	–	8	
Input impedance $I_C = 1\text{ mA}$ , $V_{CE} = 10\text{ V}$ , $f = 1\text{ kHz}$	$h_{11e}$	1	–	10	k $\Omega$
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	$\mu\text{S}$
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

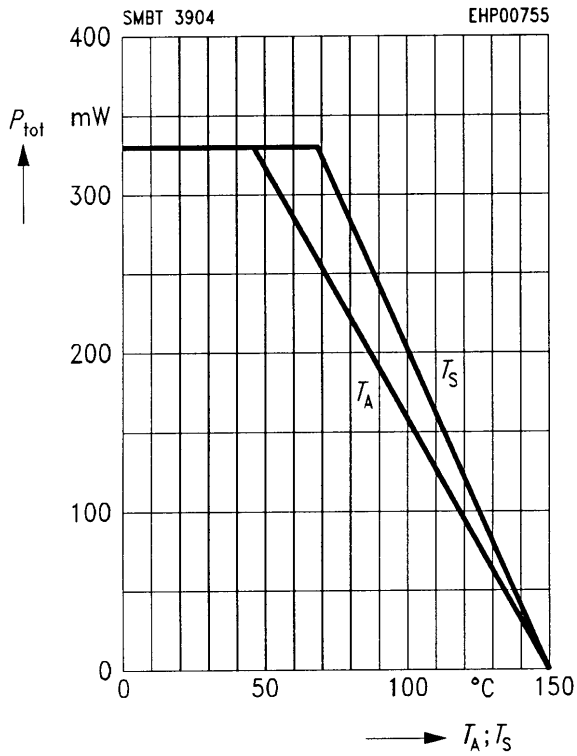


### Storage and fall time

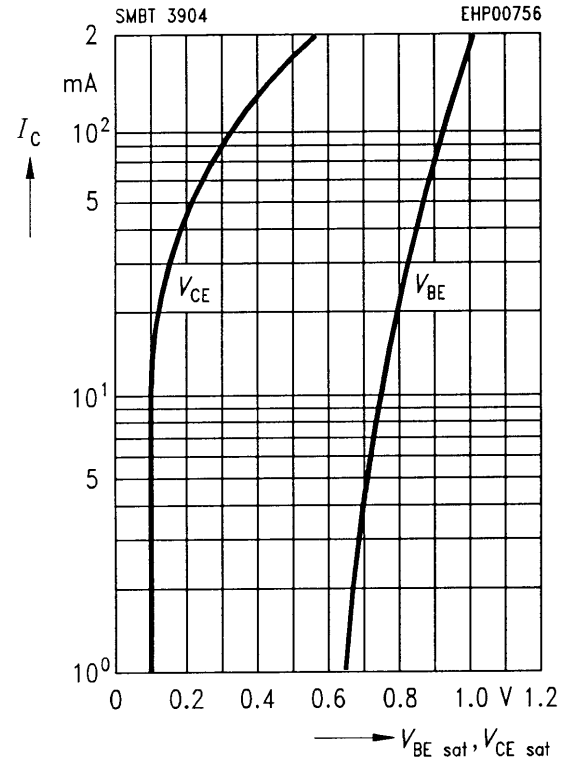


**Total power dissipation  $P_{tot} = f(T_A^*; T_S)$**

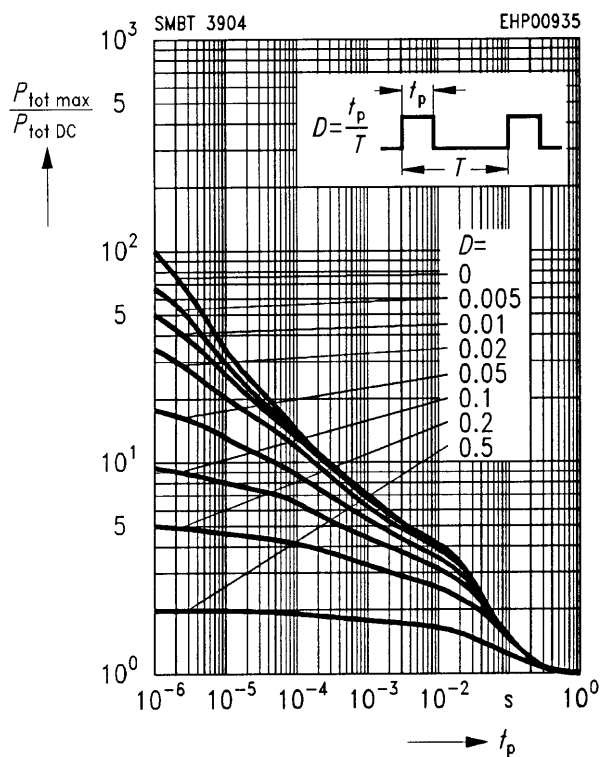
\* Package mounted on epoxy



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

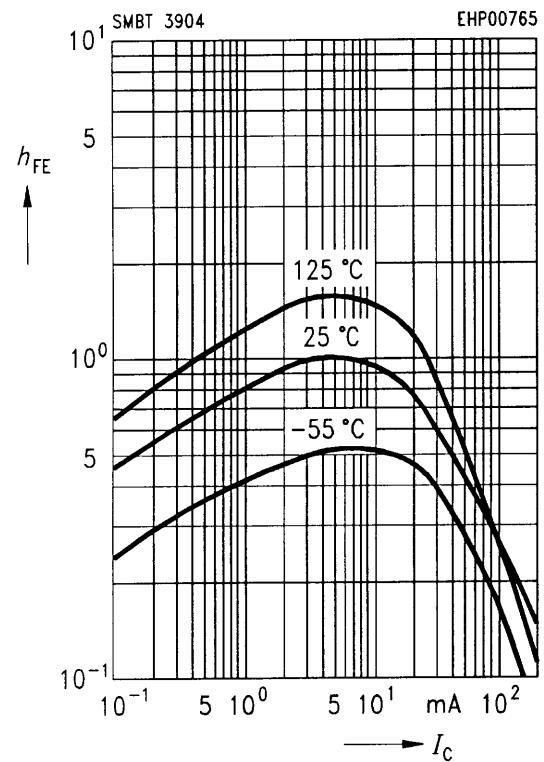


**Permissible pulse load  $P_{tot max} / P_{tot DC} = f(t_p)$**



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

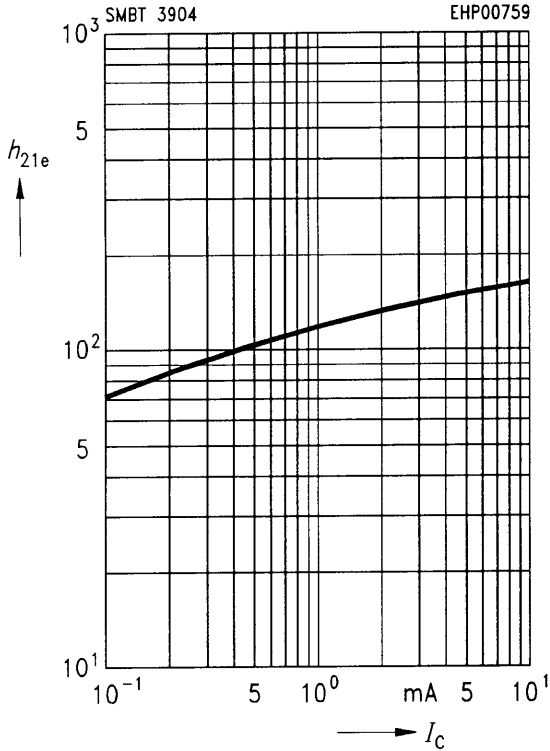
$V_{CE} = 10 V$ , normalized



**Short-circuit forward current**

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

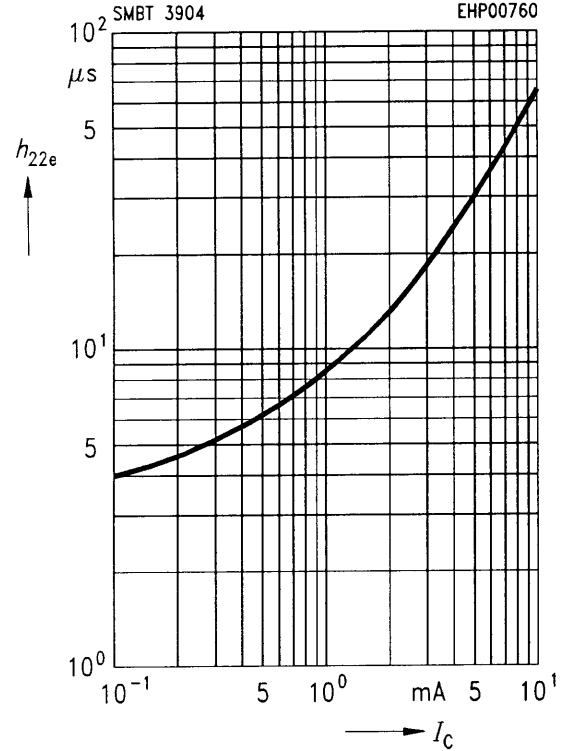
$V_{CE} = 10\text{ V}, f = 1\text{ MHz}$



**Open-circuit output admittance**

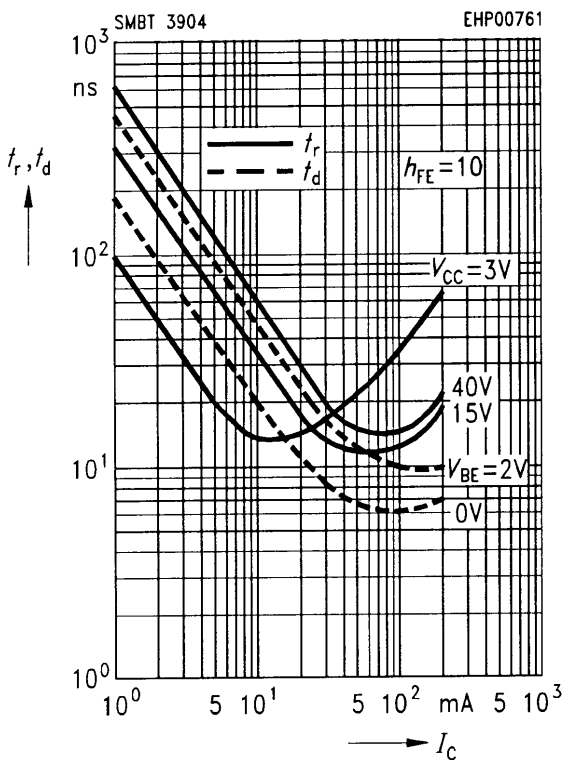
$h_{22e} = f(I_C)$

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

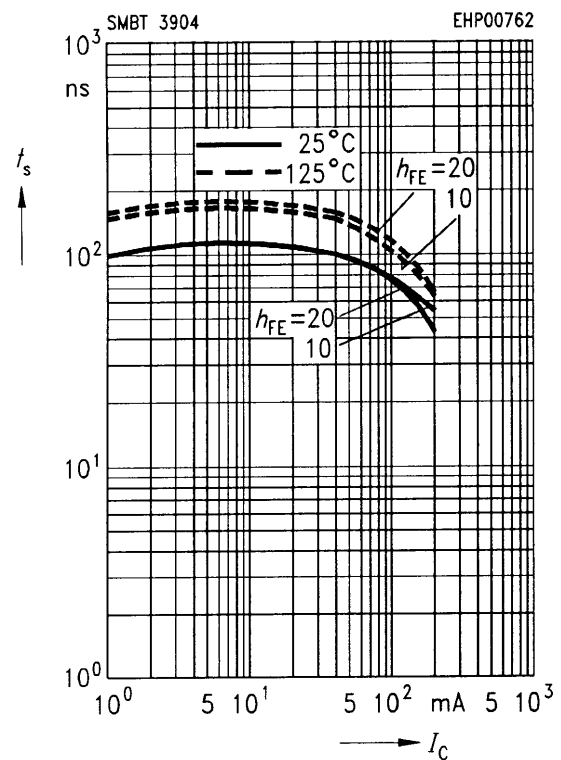


**Delay time  $t_d = f(I_C)$**

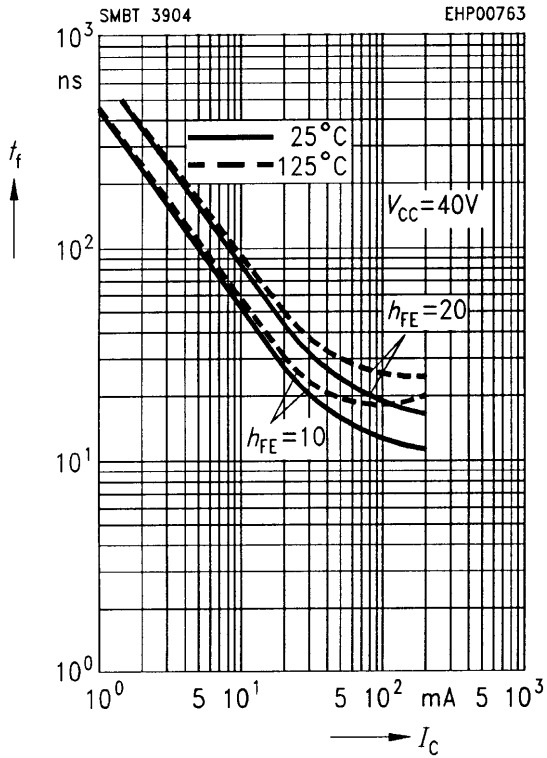
**Rise time  $t_r = f(I_C)$**



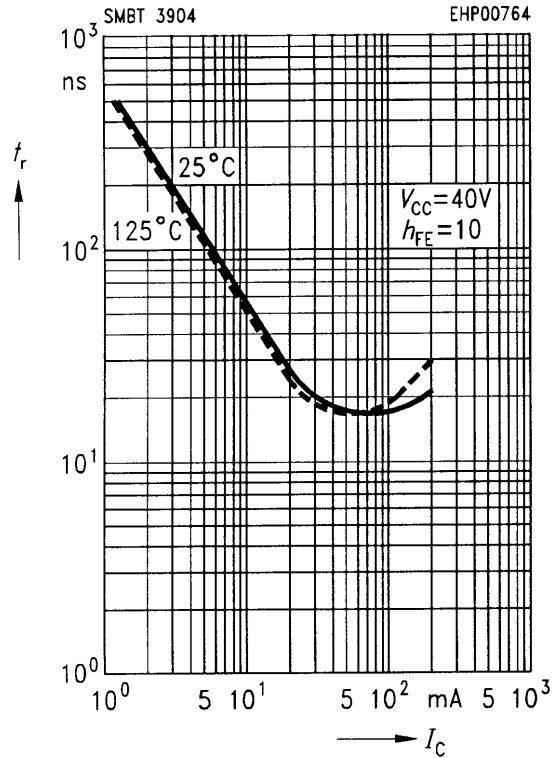
**Storage time  $t_{stg} = f(I_C)$**



**Fall time  $t_f = f(I_C)$**



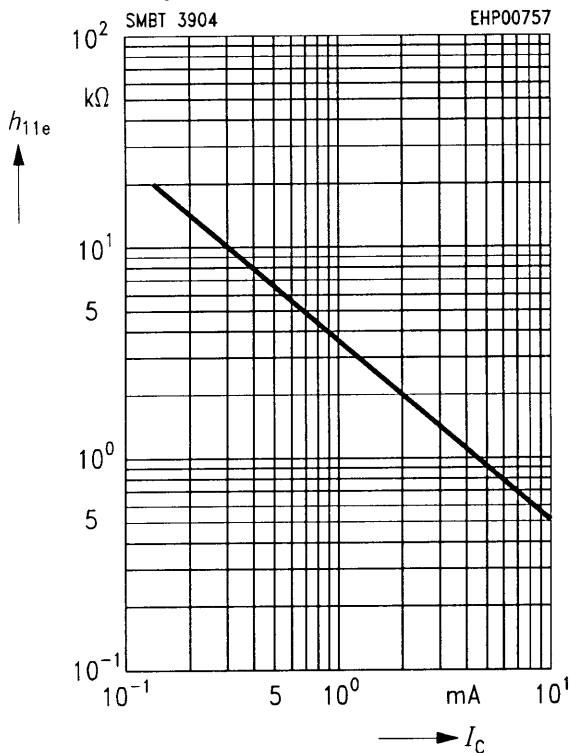
**Rise time  $t_r = f(I_C)$**



**Input impedance**

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

V<sub>CE</sub> = 10 V, f = 1 kHz



**Open-circuit reverse voltage**

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

V<sub>CE</sub> = 10 V, f = 1 kHz

