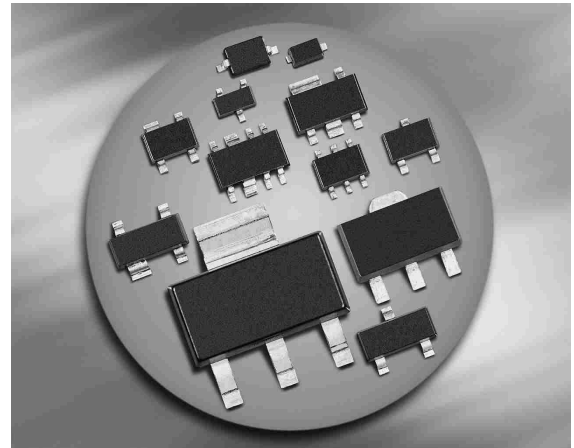


### NPN Silicon Switching Transistors

- High DC current gain: 0.1 mA to 100 mA
- Low collector-emitter saturation voltage
- For SMBT3904S:  
Two (galvanic) internal isolated transistors with good matching in one package
- Complementary types: SMBT3906... MMBT3906
- SMBT3904S: For orientation in reel  
see package information below
- Pb-free (RoHS compliant) package
- Qualified according AEC Q101



| Type              | Marking | Pin Configuration |      |      |      |      |      | Package |
|-------------------|---------|-------------------|------|------|------|------|------|---------|
| SMBT3904/MMBT3904 | s1A     | 1=B               | 2=E  | 3=C  | -    | -    | -    | SOT23   |
| SMBT3904S         | s1A     | 1=E1              | 2=B1 | 3=C2 | 4=E2 | 5=B2 | 6=C1 | SOT363  |

### Maximum Ratings

| Parameter                                                                                                                     | Symbol    | Value       | Unit |
|-------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|------|
| Collector-emitter voltage                                                                                                     | $V_{CEO}$ | 40          | V    |
| Collector-base voltage                                                                                                        | $V_{CBO}$ | 60          |      |
| Emitter-base voltage                                                                                                          | $V_{EBO}$ | 6           |      |
| Collector current                                                                                                             | $I_C$     | 200         | mA   |
| Total power dissipation-<br>$T_S \leq 71^\circ\text{C}$ , SOT23, SMBT3904<br>$T_S \leq 115^\circ\text{C}$ , SOT363, SMBT3904S | $P_{tot}$ | 330<br>250  | mW   |
| Junction temperature                                                                                                          | $T_j$     | 150         |      |
| Storage temperature                                                                                                           | $T_{stg}$ | -65 ... 150 | °C   |

### Thermal Resistance

| Parameter                                                                  | Symbol     | Value                    | Unit |
|----------------------------------------------------------------------------|------------|--------------------------|------|
| Junction - soldering point <sup>1)</sup><br>SMBT3904/MMBT3904<br>SMBT3904S | $R_{thJS}$ | $\leq 240$<br>$\leq 140$ | K/W  |

<sup>1)</sup>For calculation of  $R_{thJA}$  please refer to Application Note AN077 (Thermal Resistance Calculation)

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

| Parameter                                                                                                                                                                                                                                                                | Symbol        | Values                      |                       |                         | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------|-----------------------|-------------------------|------|
|                                                                                                                                                                                                                                                                          |               | min.                        | typ.                  | max.                    |      |
| DC Characteristics                                                                                                                                                                                                                                                       |               |                             |                       |                         |      |
| Collector-emitter breakdown voltage<br>$I_C = 1\text{ mA}, I_B = 0$                                                                                                                                                                                                      | $V_{(BR)CEO}$ | 40                          | -                     | -                       | V    |
| Collector-base breakdown voltage<br>$I_C = 10\text{ }\mu\text{A}, I_E = 0$                                                                                                                                                                                               | $V_{(BR)CBO}$ | 60                          | -                     | -                       |      |
| Emitter-base breakdown voltage<br>$I_E = 10\text{ }\mu\text{A}, I_C = 0$                                                                                                                                                                                                 | $V_{(BR)EBO}$ | 6                           | -                     | -                       |      |
| Collector-base cutoff current<br>$V_{CB} = 30\text{ V}, I_E = 0$                                                                                                                                                                                                         | $I_{CBO}$     | -                           | -                     | 50                      | nA   |
| DC current gain <sup>1)</sup><br>$I_C = 100\text{ }\mu\text{A}, V_{CE} = 1\text{ V}$<br>$I_C = 1\text{ mA}, V_{CE} = 1\text{ V}$<br>$I_C = 10\text{ mA}, V_{CE} = 1\text{ V}$<br>$I_C = 50\text{ mA}, V_{CE} = 1\text{ V}$<br>$I_C = 100\text{ mA}, V_{CE} = 1\text{ V}$ | $h_{FE}$      | 40<br>70<br>100<br>60<br>30 | -<br>-<br>-<br>-<br>- | -<br>-<br>300<br>-<br>- | -    |
| Collector-emitter saturation voltage <sup>1)</sup><br>$I_C = 10\text{ mA}, I_B = 1\text{ mA}$<br>$I_C = 50\text{ mA}, I_B = 5\text{ mA}$                                                                                                                                 | $V_{CEsat}$   | -<br>-                      | -<br>-                | 0.2<br>0.3              | V    |
| Base emitter saturation voltage <sup>1)</sup><br>$I_C = 10\text{ mA}, I_B = 1\text{ mA}$<br>$I_C = 50\text{ mA}, I_B = 5\text{ mA}$                                                                                                                                      | $V_{BEsat}$   | 0.65<br>-                   | -<br>-                | 0.85<br>0.95            |      |

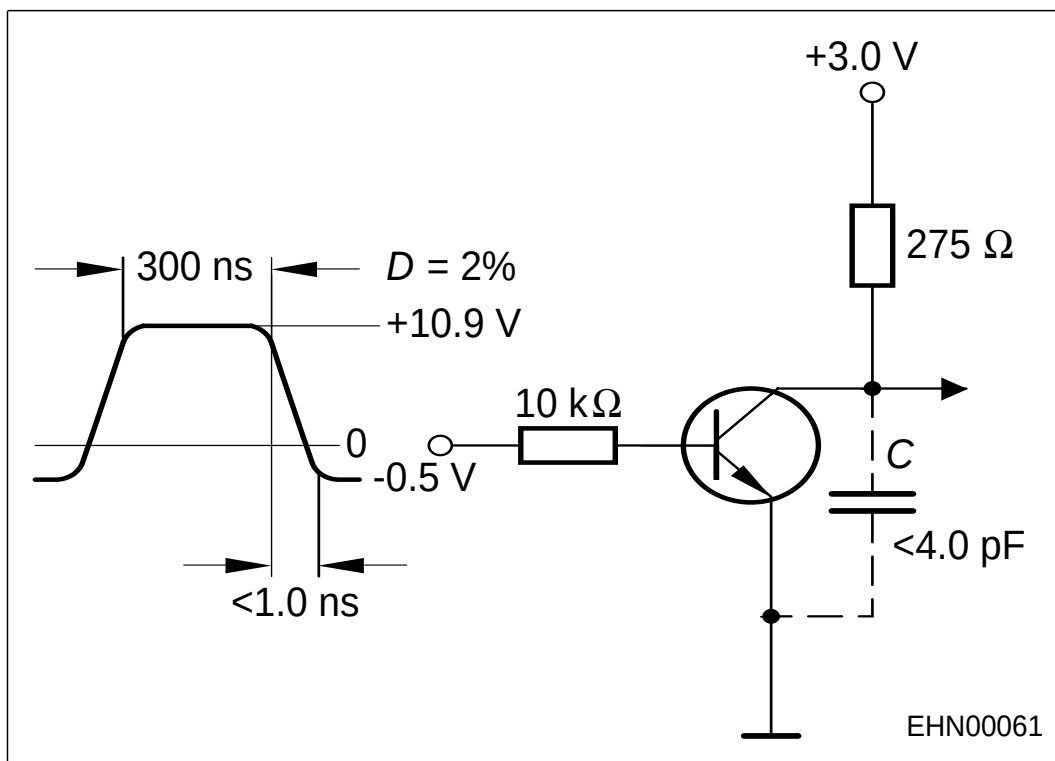
<sup>1)</sup>Pulse test:  $t < 300\mu\text{s}$ ;  $D < 2\%$

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

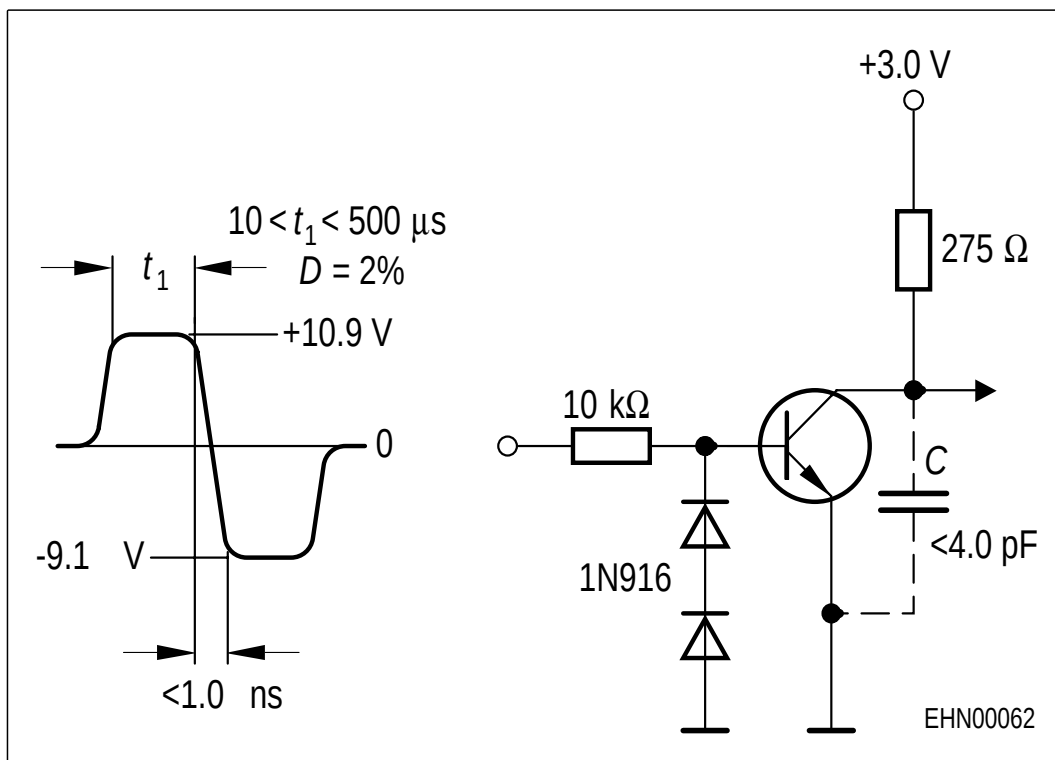
| Parameter                                                                                                                                              | Symbol    | Values |      |      | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------|------|------|------|
|                                                                                                                                                        |           | min.   | typ. | max. |      |
| AC Characteristics                                                                                                                                     |           |        |      |      |      |
| Transition frequency<br>$I_C = 10\text{ mA}$ , $V_{CE} = 20\text{ V}$ , $f = 100\text{ MHz}$                                                           | $f_T$     | 300    | -    | -    | MHz  |
| Collector-base capacitance<br>$V_{CB} = 5\text{ V}$ , $f = 1\text{ MHz}$                                                                               | $C_{cb}$  | -      | -    | 3.5  | pF   |
| Emitter-base capacitance<br>$V_{EB} = 0.5\text{ V}$ , $f = 1\text{ MHz}$                                                                               | $C_{eb}$  | -      | -    | 8    |      |
| Delay time<br>$V_{CC} = 3\text{ V}$ , $I_C = 10\text{ mA}$ , $I_{B1} = 1\text{ mA}$ ,<br>$V_{BE(off)} = 0.5\text{ V}$                                  | $t_d$     | -      | -    | 35   | ns   |
| Rise time<br>$V_{CC} = 3\text{ V}$ , $I_C = 10\text{ mA}$ , $I_{B1} = 1\text{ mA}$ ,<br>$V_{BE(off)} = 0.5\text{ V}$                                   | $t_r$     | -      | -    | 35   |      |
| Storage time<br>$V_{CC} = 3\text{ V}$ , $I_C = 10\text{ mA}$ , $I_{B1} = I_{B2} = 1\text{ mA}$                                                         | $t_{stg}$ | -      | -    | 200  |      |
| Fall time<br>$V_{CC} = 3\text{ V}$ , $I_C = 10\text{ mA}$ , $I_{B1} = I_{B2} = 1\text{ mA}$                                                            | $t_f$     | -      | -    | 50   |      |
| Noise figure<br>$I_C = 100\text{ }\mu\text{A}$ , $V_{CE} = 5\text{ V}$ , $f = 1\text{ kHz}$ ,<br>$\Delta f = 200\text{ Hz}$ , $R_S = 1\text{ k}\Omega$ | $F$       | -      | -    | 5    | dB   |

## Test circuits

### Delay and rise time

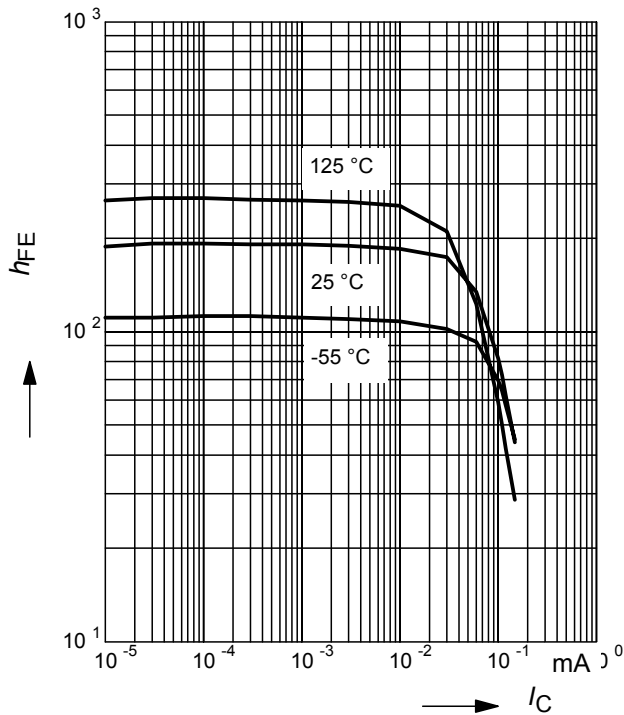


### Storage and fall time



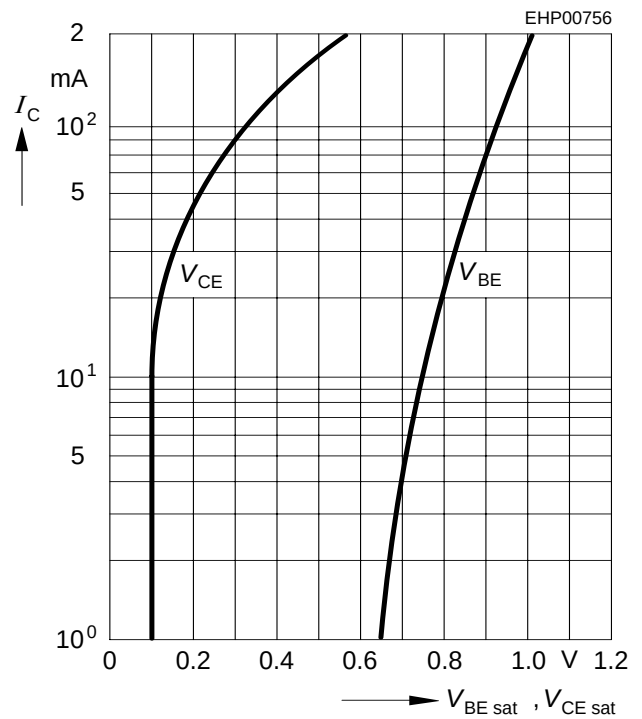
**DC current gain**  $h_{FE} = f(I_C)$

$V_{CE} = 1\text{ V}$ , normalized



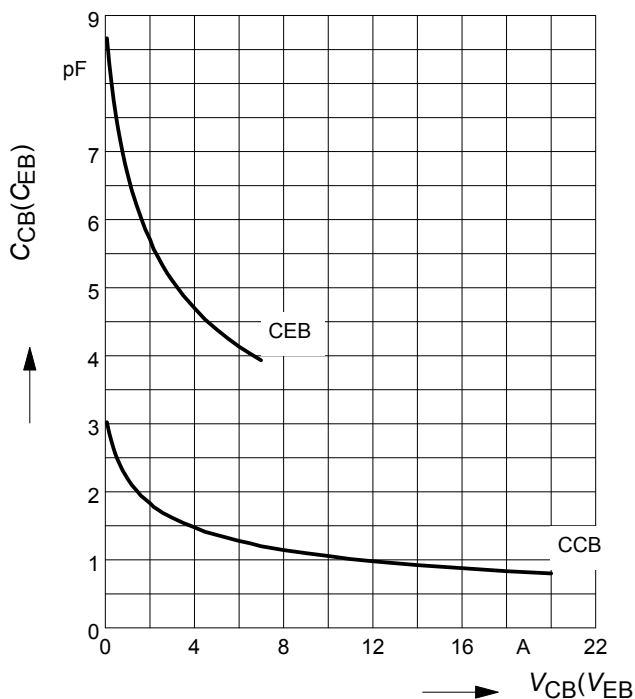
**Saturation voltage**  $I_C = f(V_{BEsat}; V_{CEsat})$

$h_{FE} = 10$



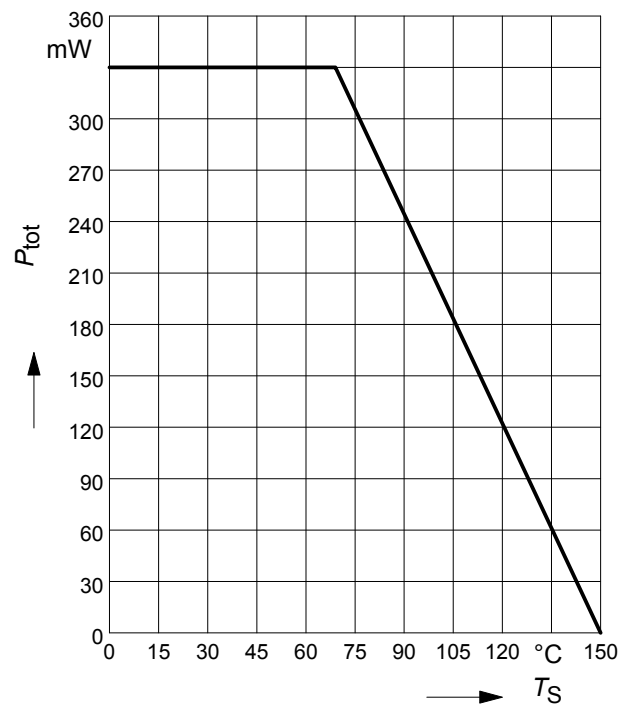
**Collector-base capacitance**  $C_{cb} = f(V_{CB})$

**Emitter-base capacitance**  $C_{eb} = f(V_{EB})$



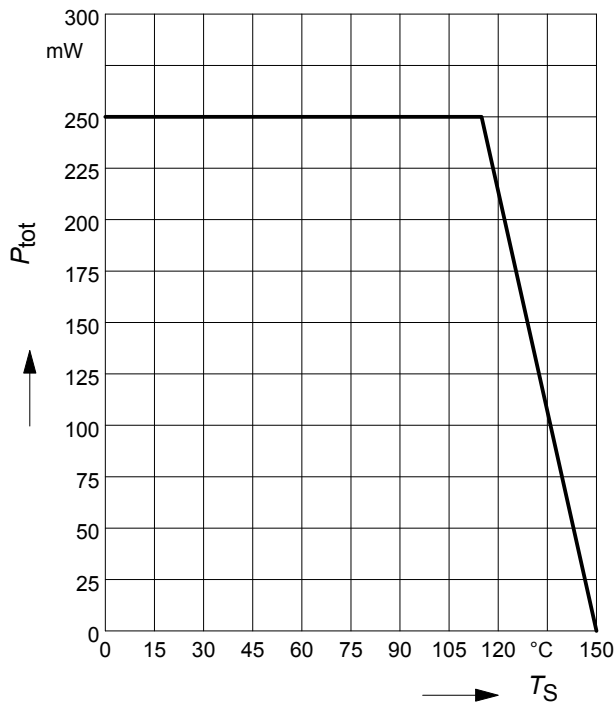
**Total power dissipation**  $P_{tot} = f(T_S)$

SMBT3904/MMBT3904



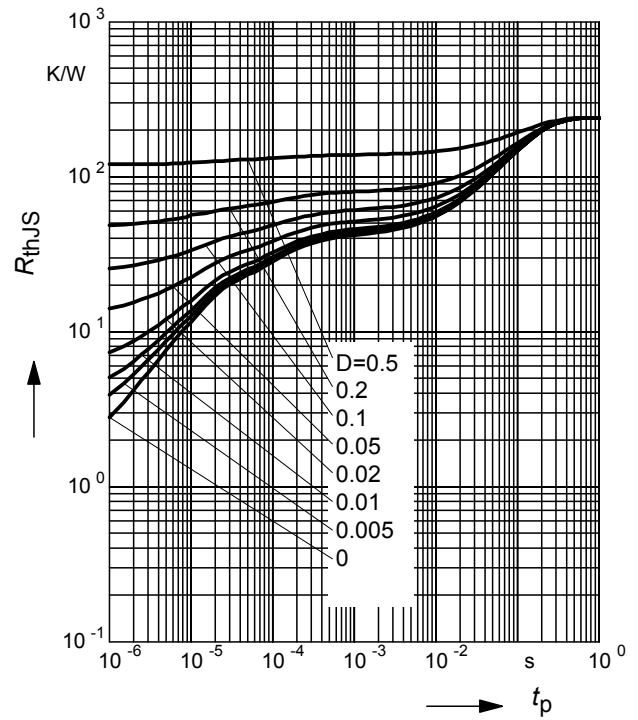
**Total power dissipation  $P_{\text{tot}} = f(T_S)$**

SMBT3904S



**Permissible Pulse Load  $R_{\text{thJS}} = f(t_p)$**

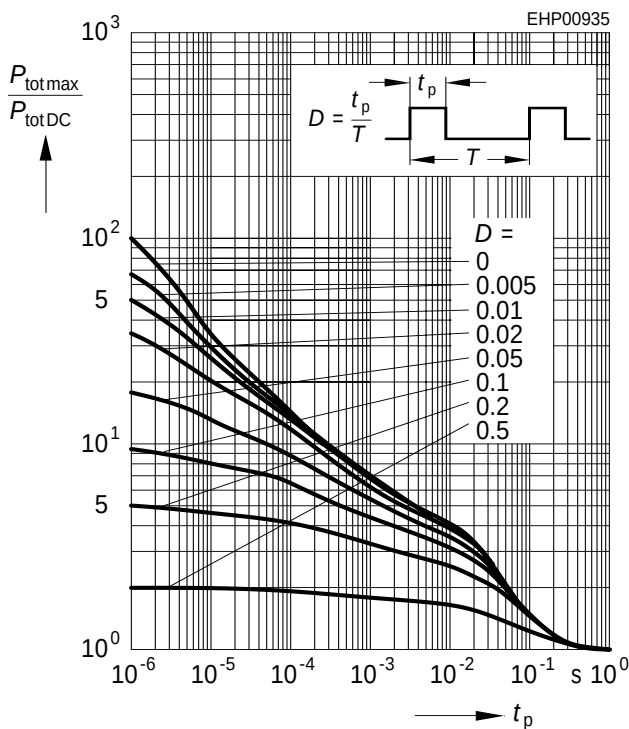
SMBT3904/ MMBT3904



**Permissible Pulse Load**

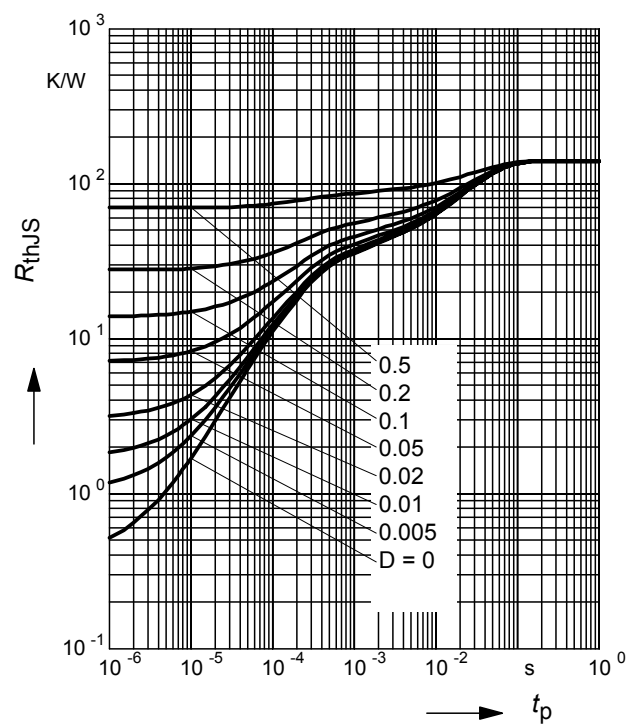
$P_{\text{totmax}}/P_{\text{totDC}} = f(t_p)$

SMBT3904/MMBT3904



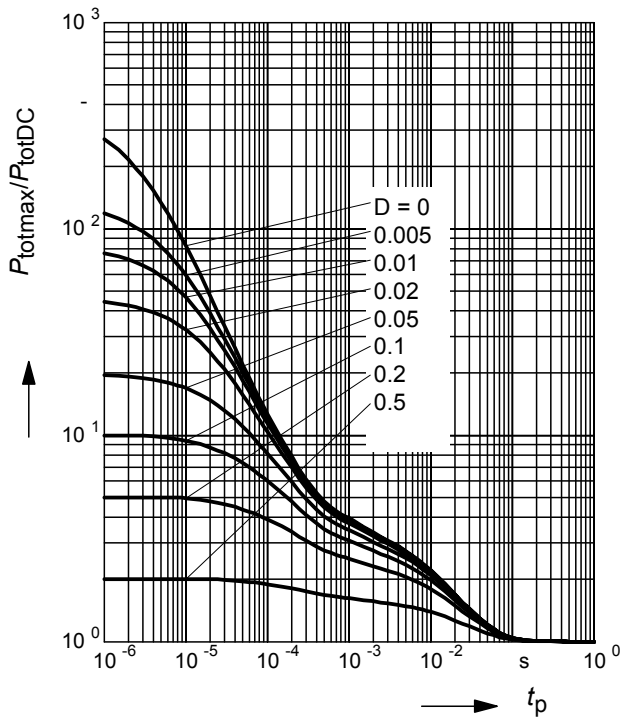
**Permissible Puls Load  $R_{\text{thJS}} = f(t_p)$**

SMBT3904S



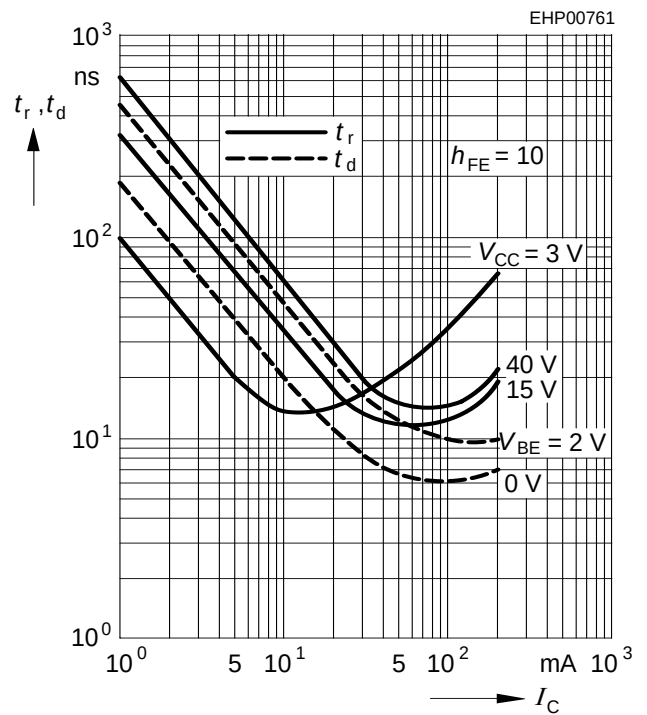
**Permissible Pulse Load**

$$P_{\text{totmax}}/P_{\text{totDC}} = f(t_p)$$

**SMBT3904S**


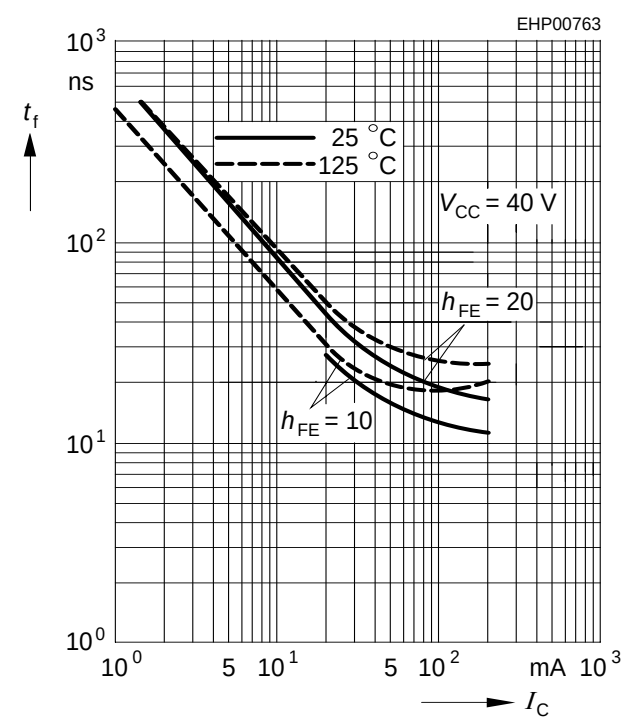
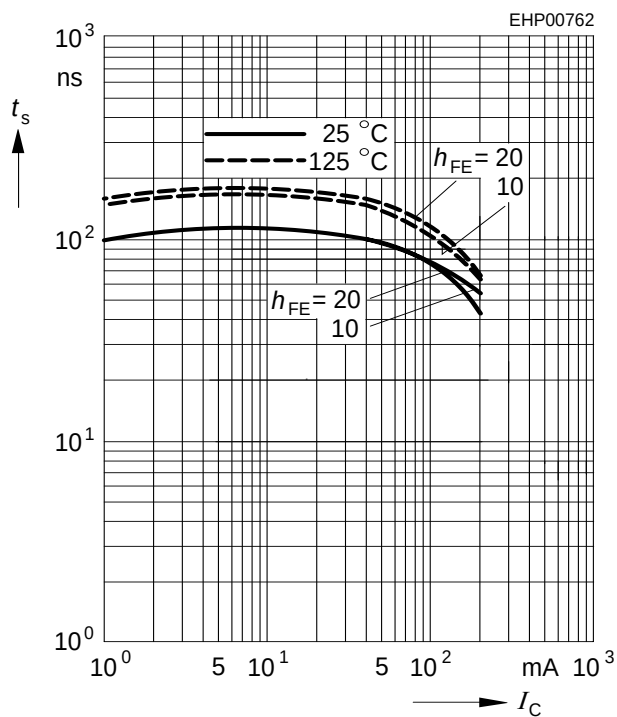
**Delay time  $t_d = f(I_C)$**

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

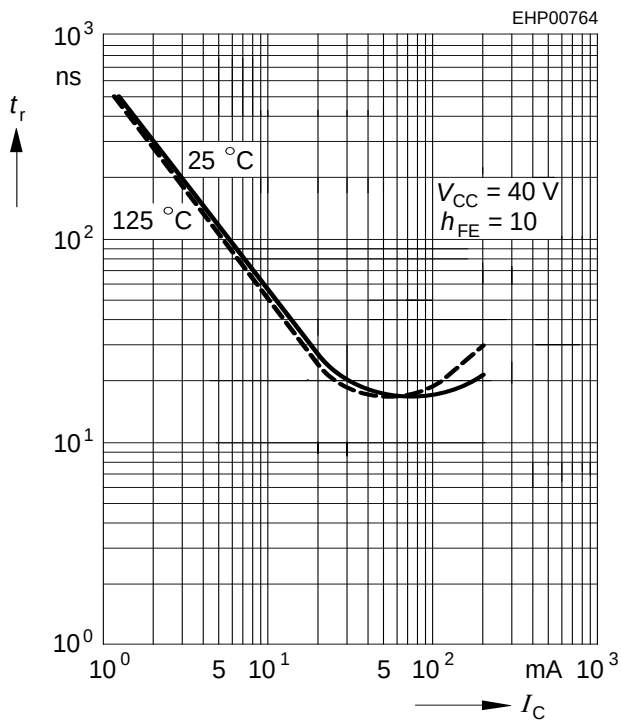


**Storage time  $t_{\text{stg}} = f(I_C)$**

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

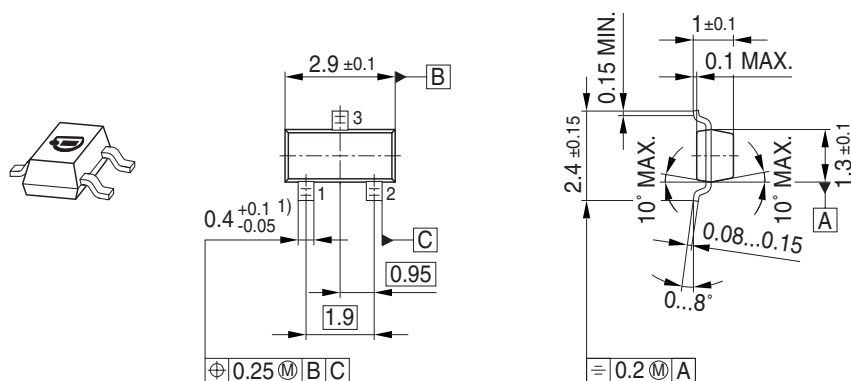


Rise time  $t_r = f(I_C)$



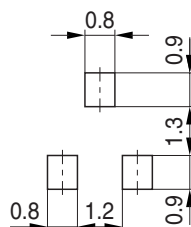


## Package Outline

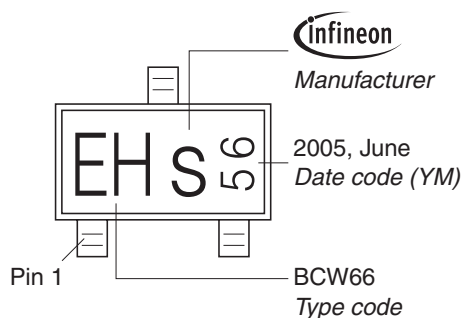


1) Lead width can be 0.6 max. in dambar area

## Foot Print

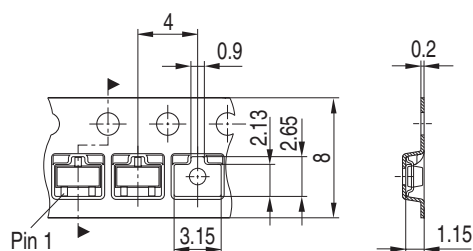


## Marking Layout (Example)

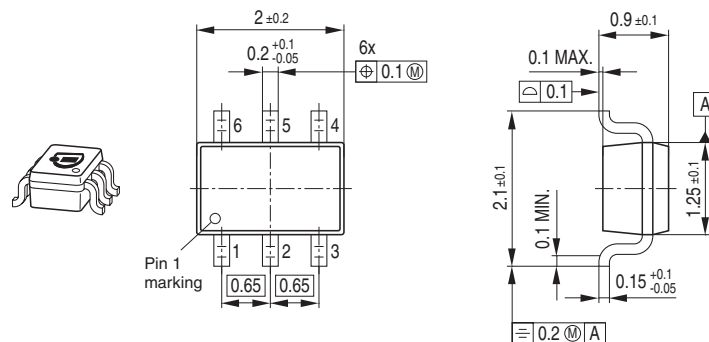


## Standard Packing

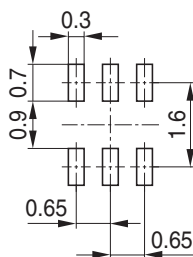
Reel ø180 mm = 3.000 Pieces/Reel  
Reel ø330 mm = 10.000 Pieces/Reel



## Package Outline

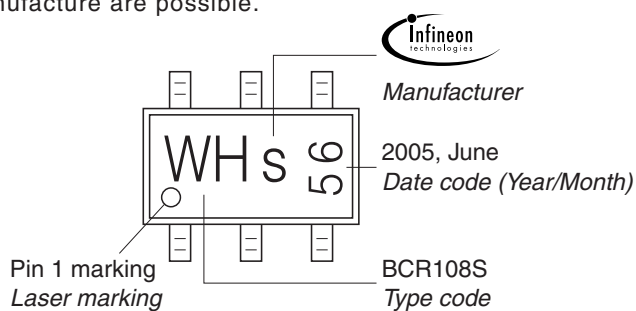


## Foot Print



## Marking Layout (Example)

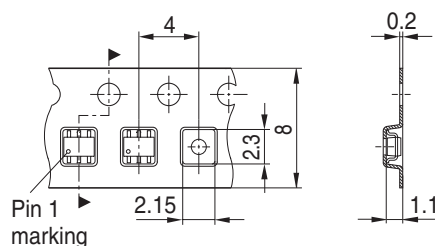
Small variations in positioning of  
Date code, Type code and Manufacture are possible.



## Standard Packing

Reel  $\varnothing 180$  mm = 3.000 Pieces/Reel  
Reel  $\varnothing 330$  mm = 10.000 Pieces/Reel

For symmetric types no defined Pin 1 orientation in reel.



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