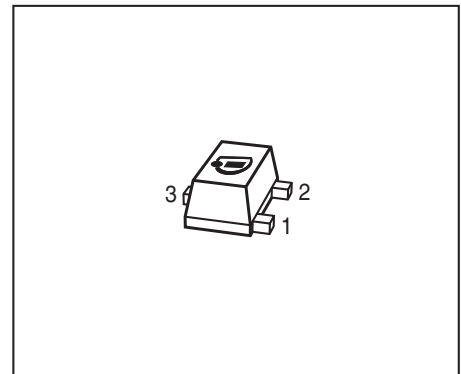


## Low Noise Silicon Bipolar RF Transistor

- Low noise amplifier for low current applications
- Collector design supports 5 V supply voltage
- For oscillators up to 3.5 GHz
- Low noise figure 1.0 dB at 1.8 GHz
- Pb-free (RoHS compliant) and halogen-free thin small flat package with visible leads
- Qualification report according to AEC-Q101 available



**ESD (Electrostatic discharge) sensitive device, observe handling precaution!**

| Type    | Marking | Pin Configuration |       |       | Package |
|---------|---------|-------------------|-------|-------|---------|
| BFR360F | FBs     | 1 = B             | 2 = E | 3 = C | TSFP-3  |

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

| Parameter                                                              | Symbol    | Value       | Unit               |
|------------------------------------------------------------------------|-----------|-------------|--------------------|
| Collector-emitter voltage                                              | $V_{CEO}$ | 6           | V                  |
| Collector-emitter voltage                                              | $V_{CES}$ | 15          |                    |
| Collector-base voltage                                                 | $V_{CBO}$ | 15          |                    |
| Emitter-base voltage                                                   | $V_{EBO}$ | 2           |                    |
| Collector current                                                      | $I_C$     | 35          | mA                 |
| Base current                                                           | $I_B$     | 4           |                    |
| Total power dissipation <sup>1)</sup><br>$T_S \leq 98^{\circ}\text{C}$ | $P_{tot}$ | 210         | mW                 |
| Junction temperature                                                   | $T_J$     | 150         | $^{\circ}\text{C}$ |
| Storage temperature                                                    | $T_{Stg}$ | -55 ... 150 |                    |

### Thermal Resistance

| Parameter                                | Symbol     | Value | Unit |
|------------------------------------------|------------|-------|------|
| Junction - soldering point <sup>2)</sup> | $R_{thJS}$ | 250   | K/W  |

<sup>1)</sup>  $T_S$  is measured on the collector lead at the soldering point to the pcb

<sup>2)</sup> For the definition of  $R_{thJS}$  please refer to Application Note AN077 (Thermal Resistance Calculation)

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

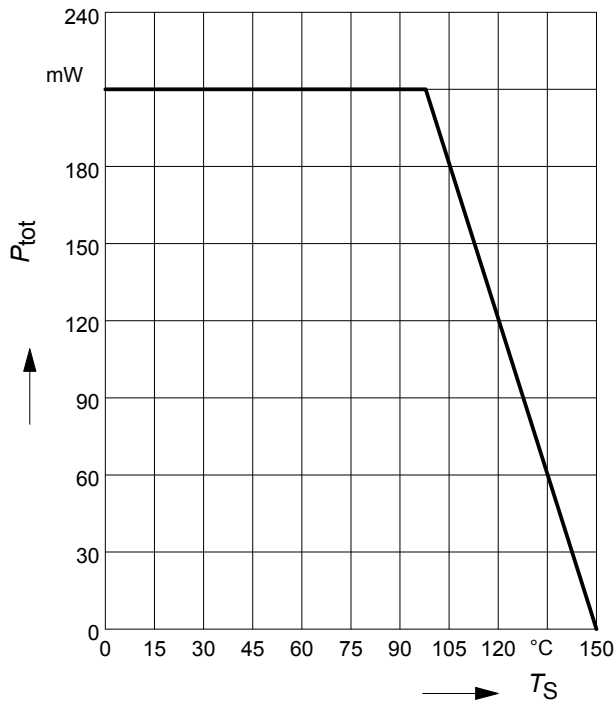
| Parameter                                                                                                                                                                     | Symbol        | Values |        |          | Unit |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------|--------|----------|------|
|                                                                                                                                                                               |               | min.   | typ.   | max.     |      |
| DC Characteristics                                                                                                                                                            |               |        |        |          |      |
| Collector-emitter breakdown voltage<br>$I_C = 1\text{ mA}$ , $I_B = 0$                                                                                                        | $V_{(BR)CEO}$ | 6      | 9      | -        | V    |
| Collector-emitter cutoff current<br>$V_{CE} = 4\text{ V}$ , $V_{BE} = 0$<br>$V_{CE} = 10\text{ V}$ , $V_{BE} = 0$ , $T_A = 85^{\circ}\text{C}$<br>Verified by random sampling | $I_{CES}$     | -<br>- | 1<br>2 | 30<br>50 | nA   |
| Collector-base cutoff current<br>$V_{CB} = 4\text{ V}$ , $I_E = 0$                                                                                                            | $I_{CBO}$     | -      | 1      | 30       |      |
| Emitter-base cutoff current<br>$V_{EB} = 1\text{ V}$ , $I_C = 0$                                                                                                              | $I_{EBO}$     | -      | 1      | 500      |      |
| DC current gain<br>$I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , pulse measured                                                                                              | $h_{FE}$      | 90     | 120    | 160      | -    |

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

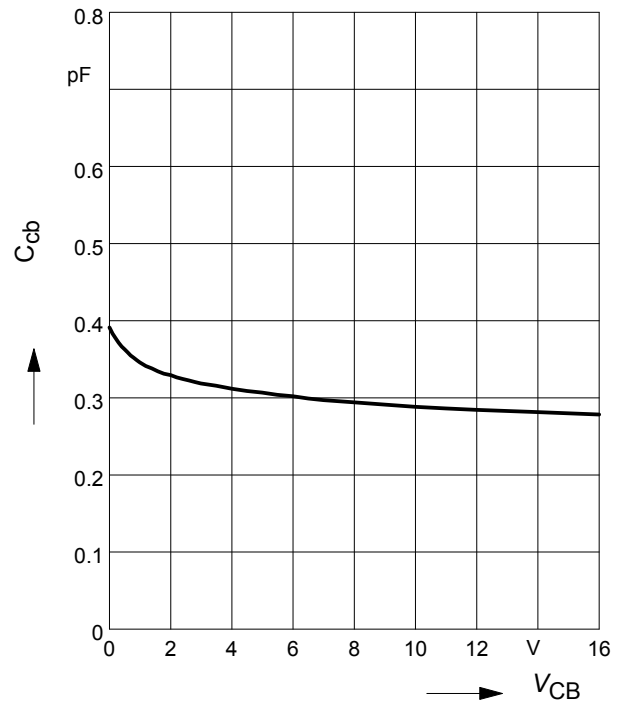
| Parameter                                                                                                                                                                         | Symbol        | Values |            |        | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------|------------|--------|------|
|                                                                                                                                                                                   |               | min.   | typ.       | max.   |      |
| AC Characteristics (verified by random sampling)                                                                                                                                  |               |        |            |        |      |
| Transition frequency<br>$I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $f = 1\text{ GHz}$                                                                                         | $f_T$         | 11     | 14         | -      | GHz  |
| Collector-base capacitance<br>$V_{CB} = 5\text{ V}$ , $f = 1\text{ MHz}$ , $V_{BE} = 0$ ,<br>emitter grounded                                                                     | $C_{cb}$      | -      | 0.32       | 0.5    | pF   |
| Collector emitter capacitance<br>$V_{CE} = 5\text{ V}$ , $f = 1\text{ MHz}$ , $V_{BE} = 0$ ,<br>base grounded                                                                     | $C_{ce}$      | -      | 0.2        | -      |      |
| Emitter-base capacitance<br>$V_{EB} = 0.5\text{ V}$ , $f = 1\text{ MHz}$ , $V_{CB} = 0$ ,<br>collector grounded                                                                   | $C_{eb}$      | -      | 0.4        | -      |      |
| Minimum noise figure<br>$I_C = 3\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_{Sopt}$ ,<br>$f = 1.8\text{ GHz}$                                                                  | $NF_{min}$    | -      | 1          | -      | dB   |
| Power gain, maximum available <sup>1)</sup><br>$I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_{Sopt}$ , $Z_L = Z_{Lopt}$ ,<br>$f = 1.8\text{ GHz}$<br>$f = 3\text{ GHz}$ | $G_{ma}$      | -<br>- | 15.5<br>11 | -<br>- |      |
| Transducer gain<br>$I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_L = 50\Omega$ ,<br>$f = 1.8\text{ GHz}$<br>$f = 3\text{ GHz}$                                          | $ S_{21e} ^2$ | -<br>- | 13<br>9    | -<br>- | dB   |
| Third order intercept point at output <sup>2)</sup><br>$V_{CE} = 3\text{ V}$ , $I_C = 15\text{ mA}$ , $f = 1.8\text{ GHz}$ ,<br>$Z_S = Z_L = 50\Omega$                            | $IP3$         | -      | 24         | -      | dBm  |
| 1dB compression point at output<br>$I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_L = 50\Omega$ ,<br>$f = 1.8\text{ GHz}$                                                | $P_{-1dB}$    | -      | 9          | -      |      |

<sup>1)</sup>  $G_{ma} = |S_{21e}| / |S_{12e}| (k - (k^2 - 1)^{1/2})$ 
<sup>2)</sup>  $IP3$  value depends on termination of all intermodulation frequency components.  
Termination used for this measurement is  $50\Omega$  from 0.1 MHz to 6 GHz

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



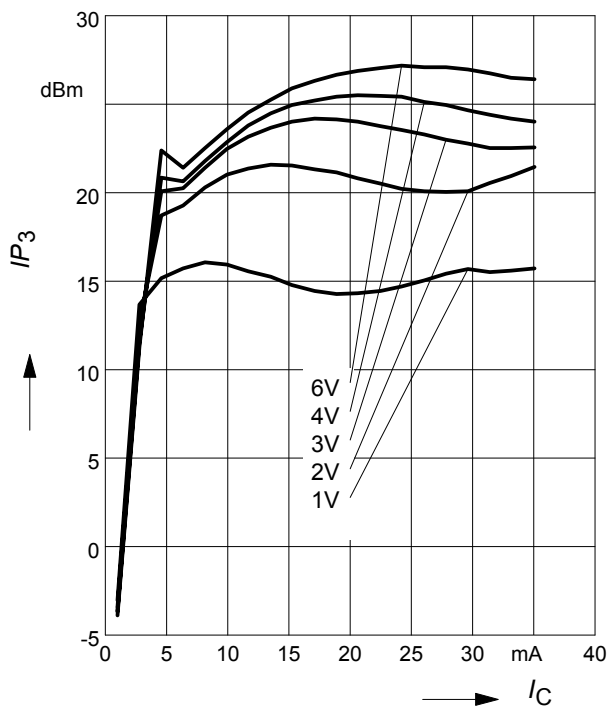
**Collector-base capacitance  $C_{\text{cb}} = f(V_{\text{CB}})$**   
 $f = 1\text{MHz}$



**Third order Intercept Point  $IP_3 = f(I_C)$**

(Output,  $Z_S = Z_L = 50\Omega$ )

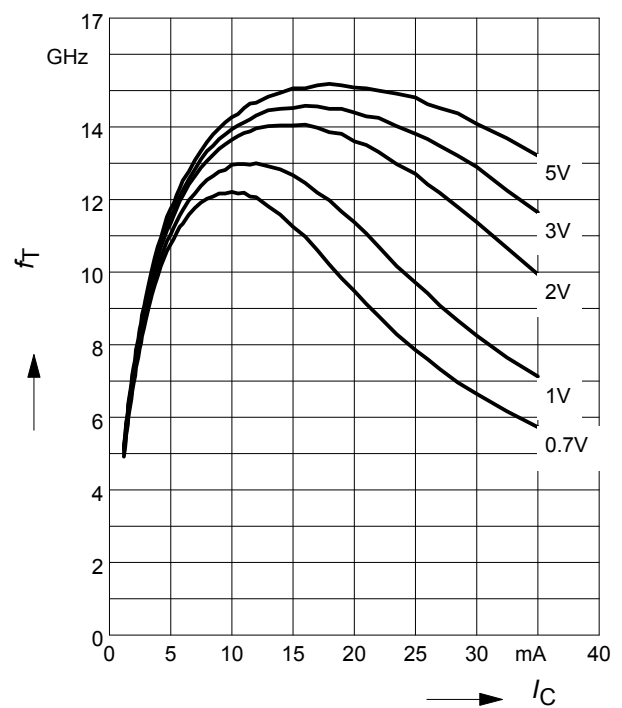
$V_{\text{CE}} = \text{parameter}, f = 1.8\text{GHz}$



**Transition frequency  $f_T = f(I_C)$**

$f = 1\text{GHz}$

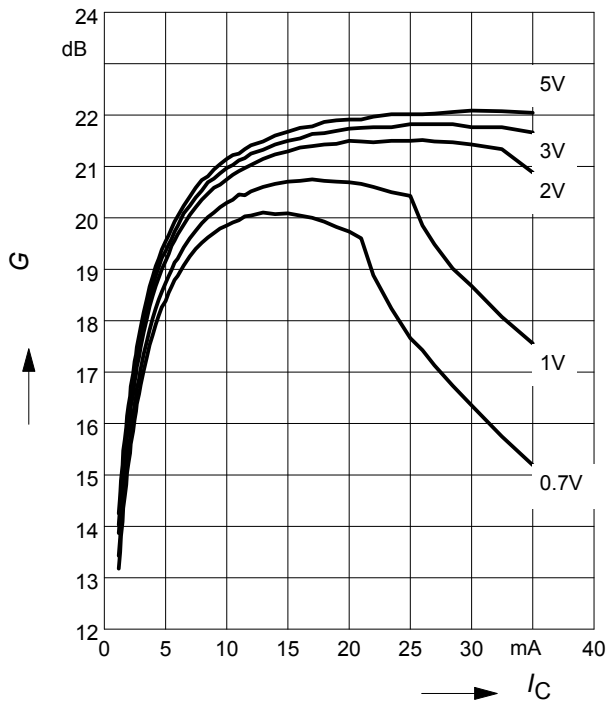
$V_{\text{CE}} = \text{parameter}$



**Power gain  $G_{ma}$ ,  $G_{ms} = f(I_C)$**

$f = 0.9\text{GHz}$

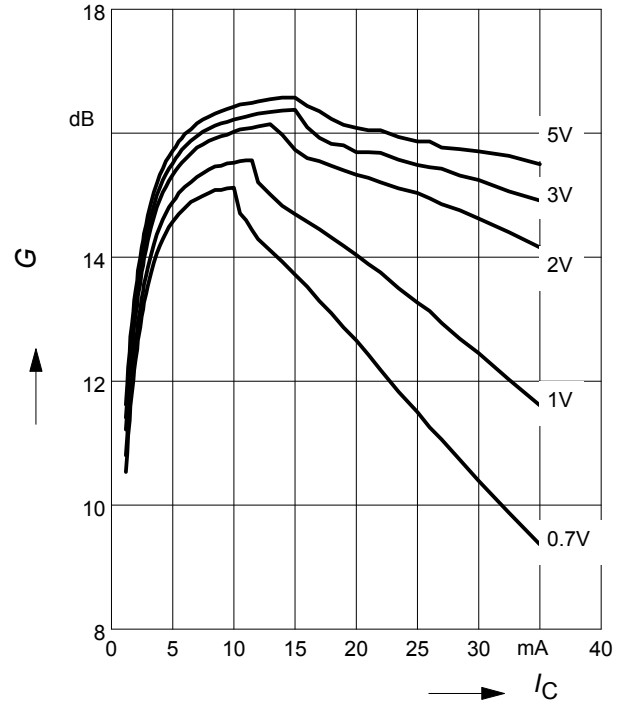
$V_{CE} = \text{parameter}$



**Power gain  $G_{ma}$ ,  $G_{ms} = f(I_C)$**

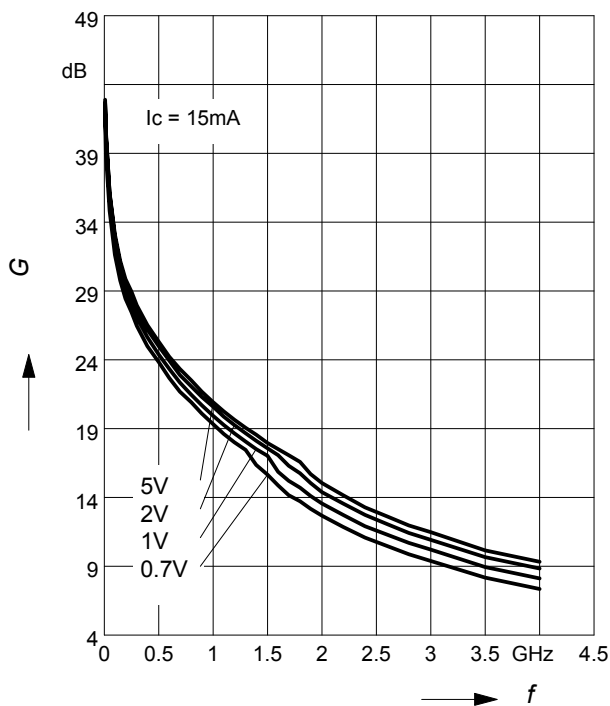
$f = 1.8\text{GHz}$

$V_{CE} = \text{parameter}$



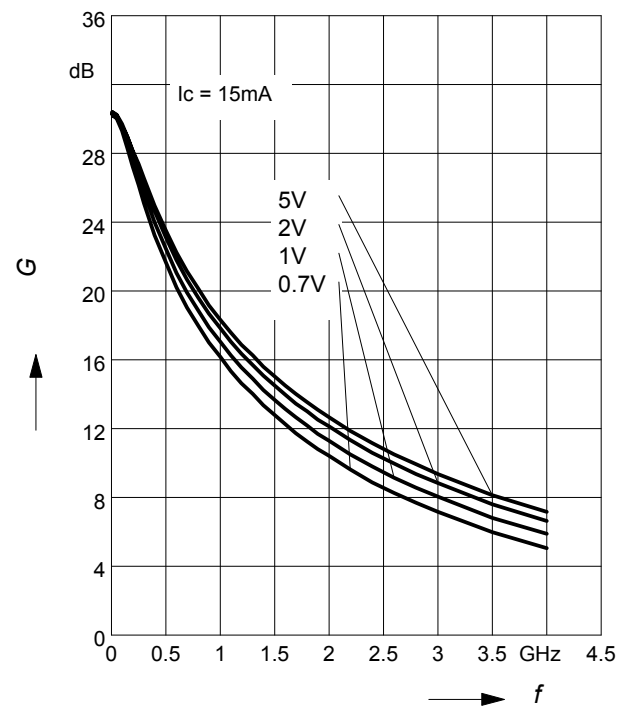
**Power Gain  $G_{ma}$ ,  $G_{ms} = f(f)$**

$V_{CE} = \text{parameter}$



**Insertion Power Gain  $|S_{21}|^2 = f(f)$**

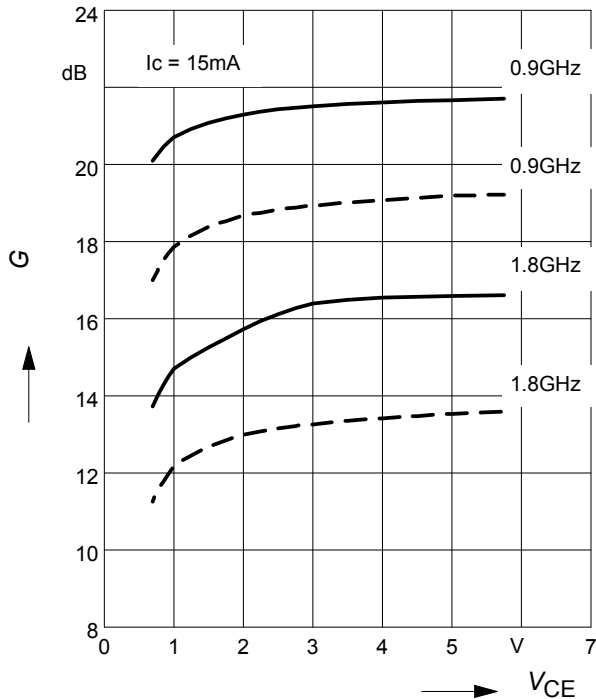
$V_{CE} = \text{parameter}$



**Power Gain  $G_{ma}$ ,  $G_{ms} = f(V_{CE})$ :** —

$|S_{21}|^2 = f(V_{CE})$ : - - - -

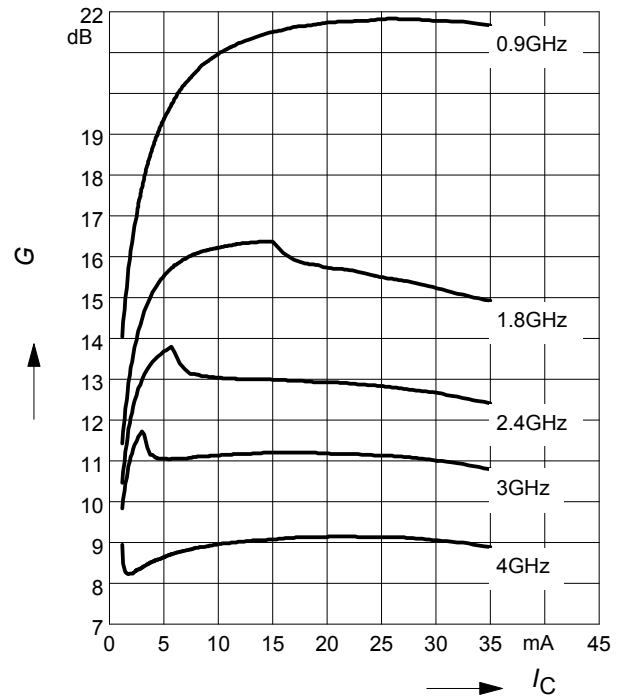
$f$  = parameter



**Power gain  $G_{ma}$ ,  $G_{ms} = f(I_C)$**

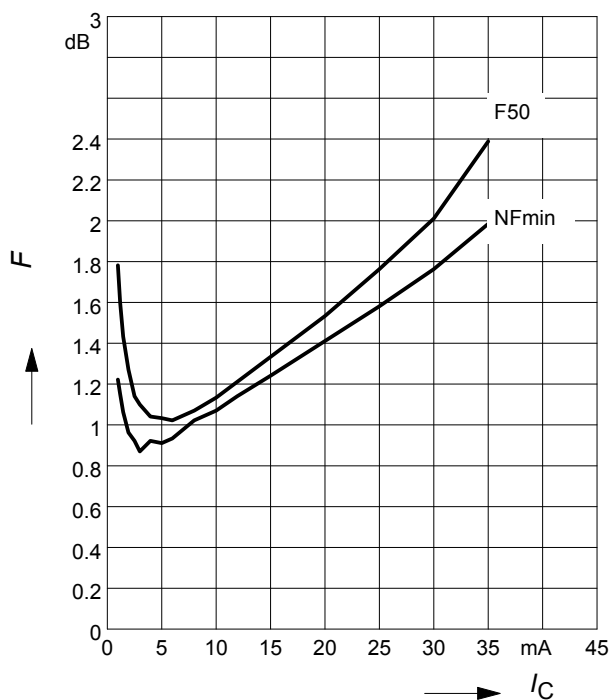
$V_{CE} = 3V$

$f$  = parameter



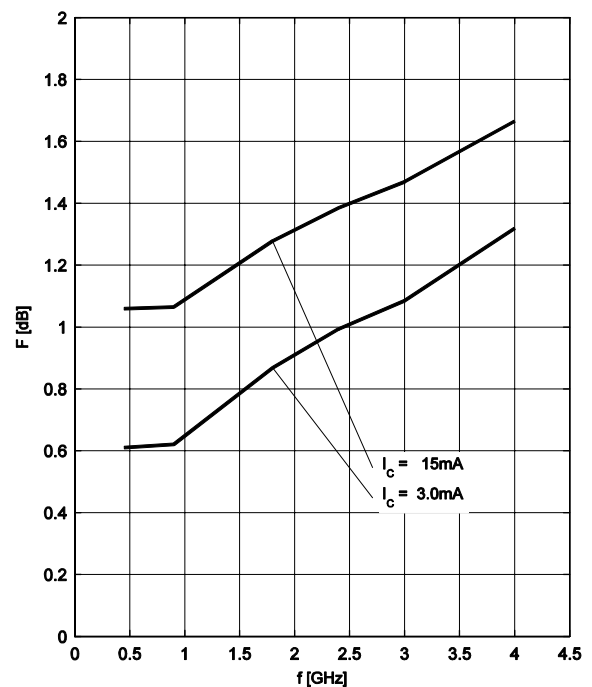
**Noise figure  $NF = f(I_C)$**

$V_{CE} = 3V$ ,  $f = 1,8 \text{ GHz}$



**Noise figure  $F = f(f)$**

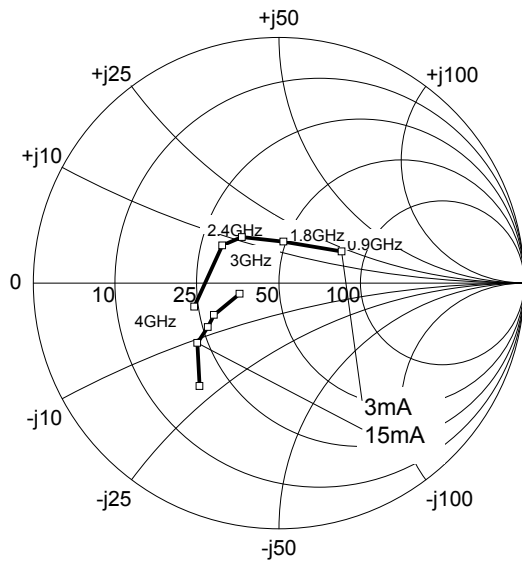
$V_{CE} = 3V$ ,  $Z_S = Z_{Sopt}$



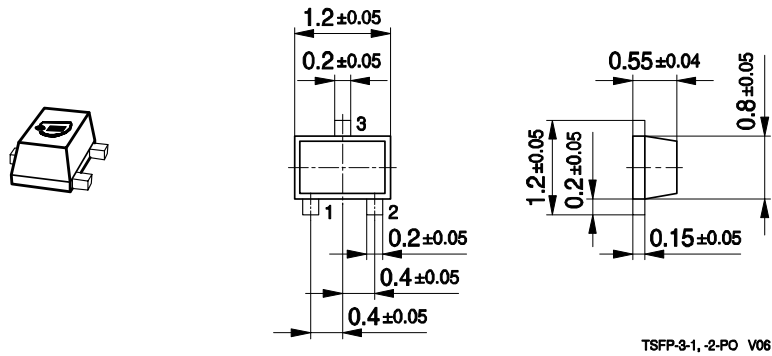
**Source impedance** for min.

noise figure vs. frequency

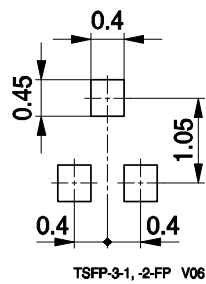
$V_{CE} = 3\text{ V}$



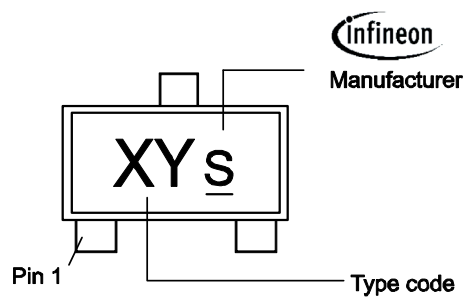
## Package Outline



## Foot Print



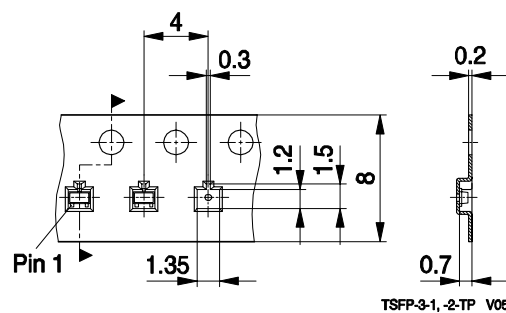
## Marking Layout (Example)



## Standard Packing

Reel Ø 180 mm = 3.000 Pieces/Reel

Reel Ø 330 mm = 10.000 Pieces/Reel



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