

**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> $T_S \leq 98\text{ }^\circ\text{C}$	$P_{tot}$	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.	
<b>DC Characteristics</b>					
Collector-emitter breakdown voltage $I_C = 1\text{ mA}$ , $I_B = 0$	$V_{(BR)CEO}$	6	9	-	V
Collector-emitter cutoff current $V_{CE} = 4\text{ V}$ , $V_{BE} = 0$ $V_{CE} = 10\text{ V}$ , $V_{BE} = 0$ , $T_A = 85\text{ °C}$ Verified by random sampling	$I_{CES}$	-	1 2	30 50	nA
Collector-base cutoff current $V_{CB} = 4\text{ V}$ , $I_E = 0$	$I_{CBO}$	-	1	30	
Emitter-base cutoff current $V_{EB} = 1\text{ V}$ , $I_C = 0$	$I_{EBO}$	-	1	500	
DC current gain $I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , pulse measured	$h_{FE}$	90	120	160	-

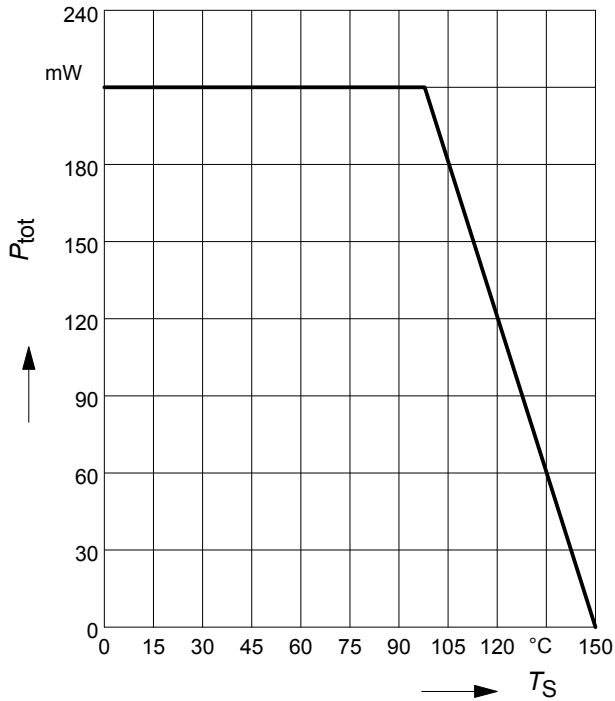
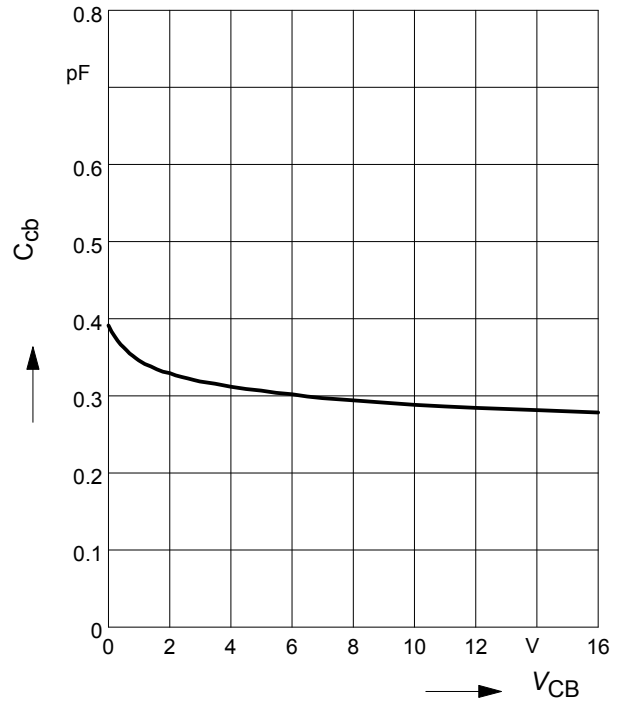
**Electrical Characteristics at  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise specified**

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

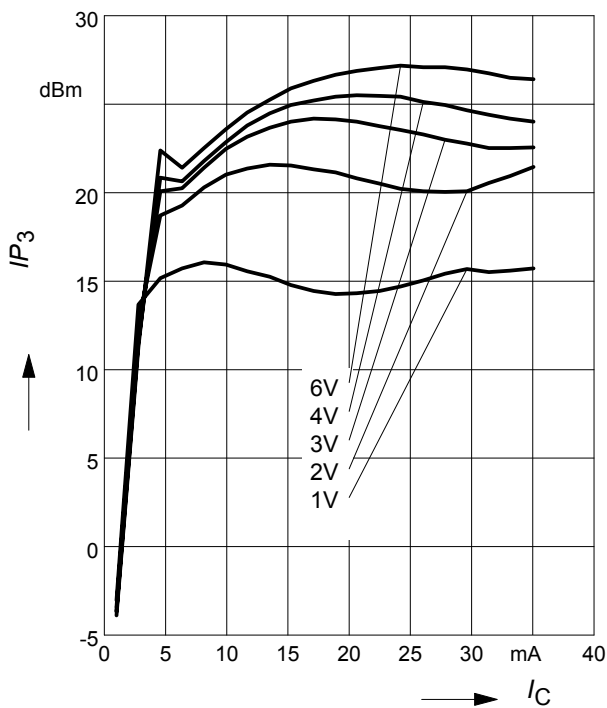
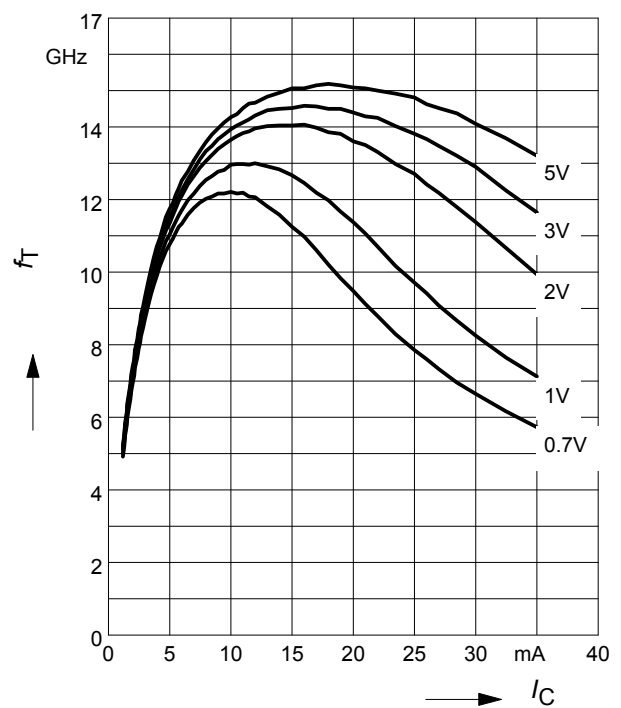
$$^1G_{ma} = |S_{21e} / S_{12e}| (k - (k^2 - 1)^{1/2})$$

<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  $P_{tot} = f(T_S)$** 

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

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

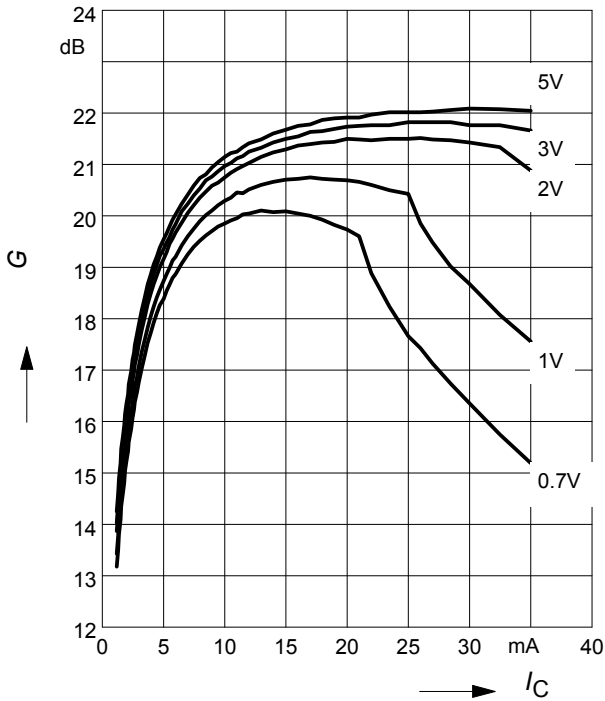
 (Output,  $Z_S = Z_L = 50\Omega$ )

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

**Transition frequency  $f_T = f(I_C)$** 
 $f = 1\text{GHz}$ 
 $V_{CE} = \text{parameter}$ 


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

$f = 0.9\text{GHz}$

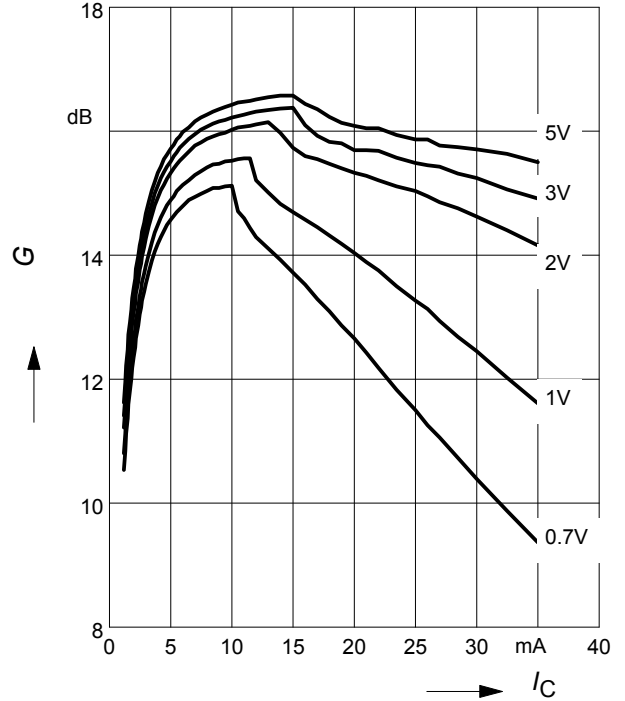
$V_{CE} = \text{parameter}$



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

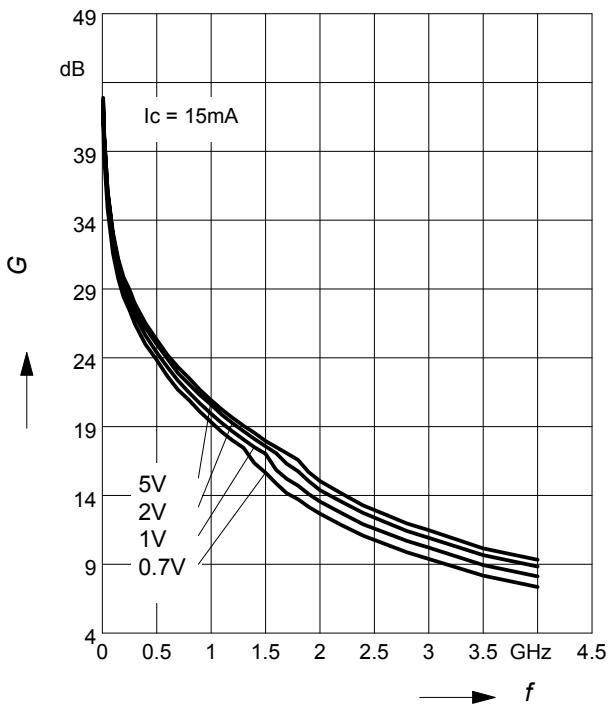
$f = 1.8\text{GHz}$

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



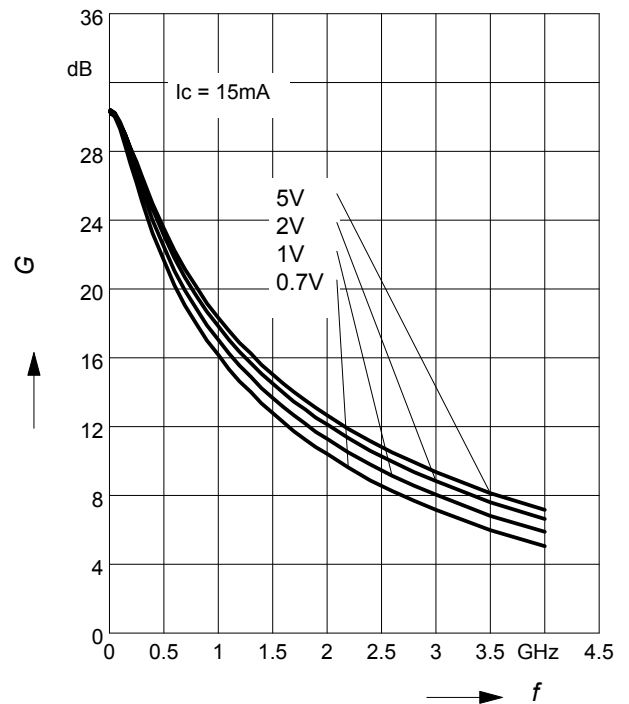
**Power Gain  $G_{ma}$ ,  $G_{ms} = f(f)$**

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



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

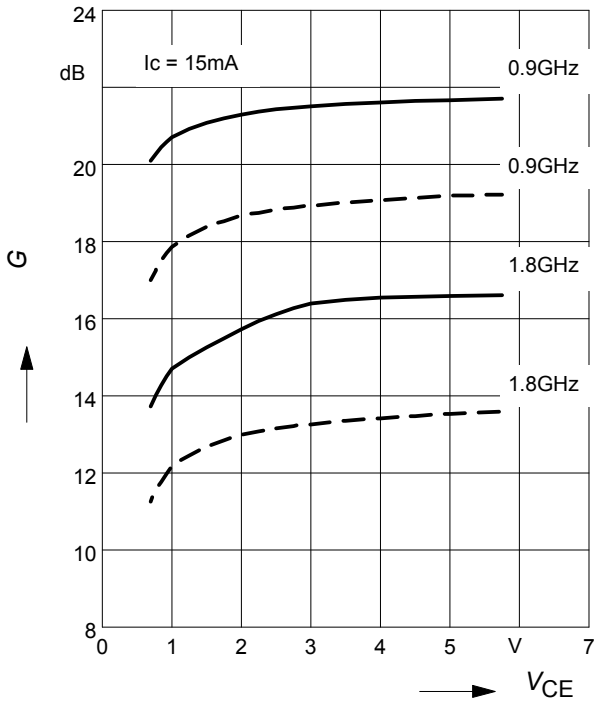
$V_{CE} = \text{parameter}$



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

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

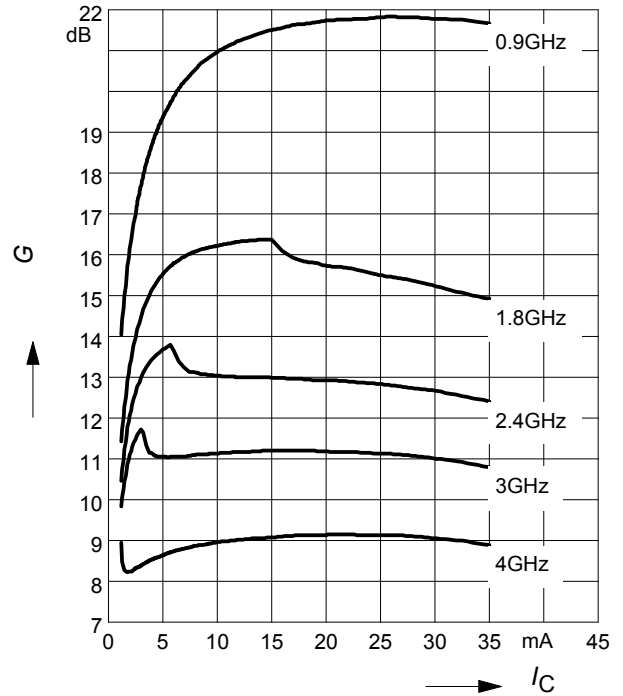
$f =$  parameter



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

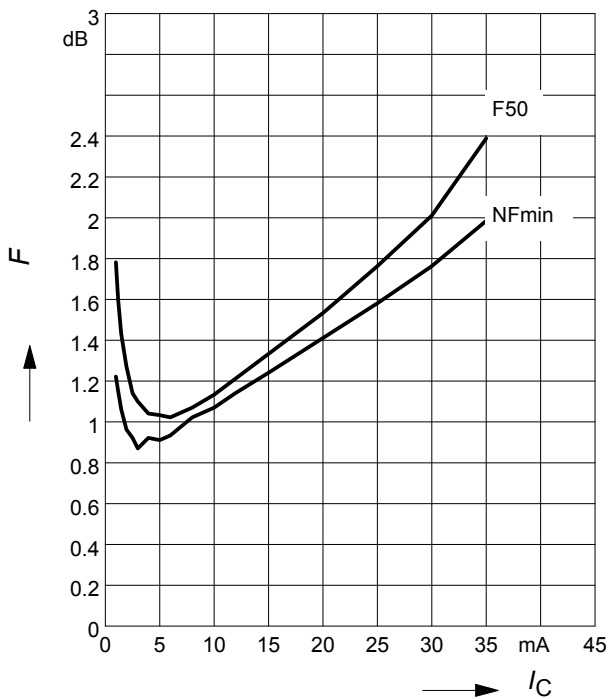
$V_{CE} = 3\text{V}$

$f =$  parameter



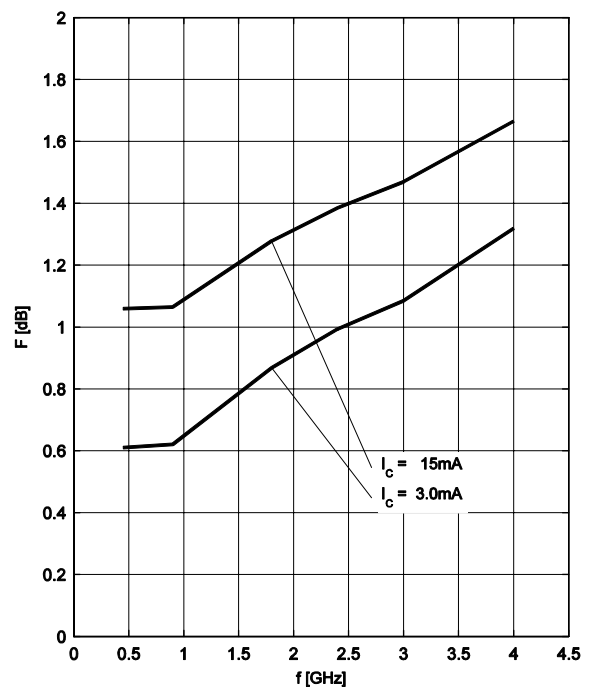
**Noise figure  $NF = f(I_C)$**

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



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

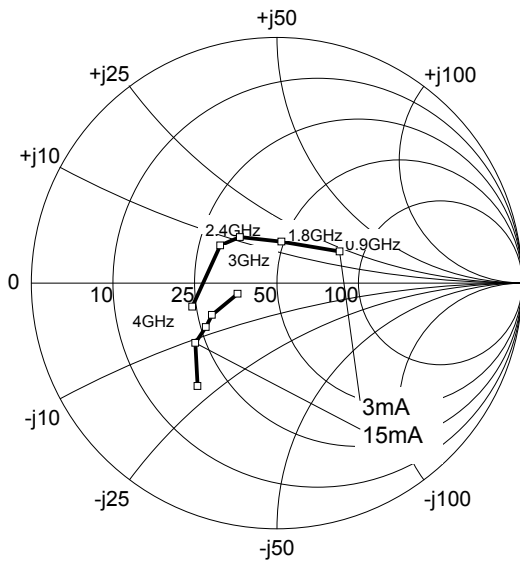
$V_{CE} = 3\text{V}$ ,  $Z_S = Z_{Sopt}$



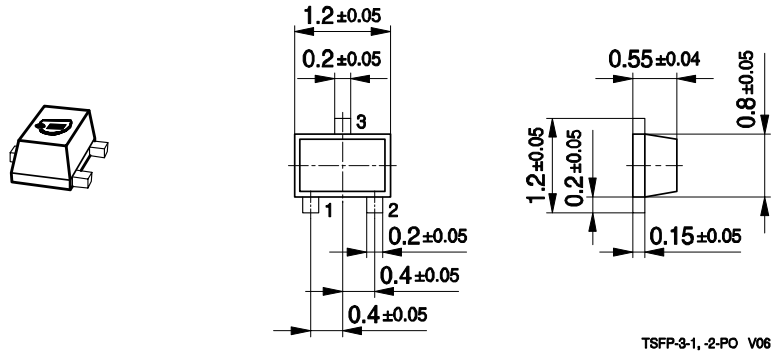
**Source impedance** for min.

noise figure vs. frequency

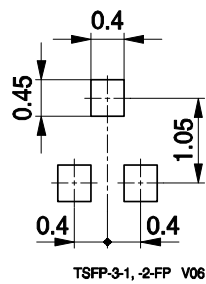
$V_{CE} = 3\text{ V}$



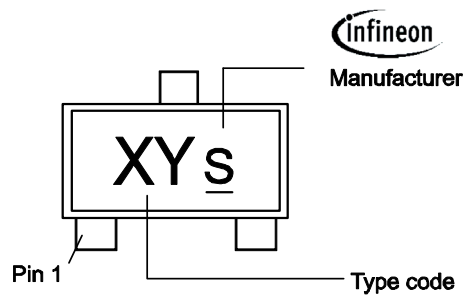
### Package Outline



### Foot Print



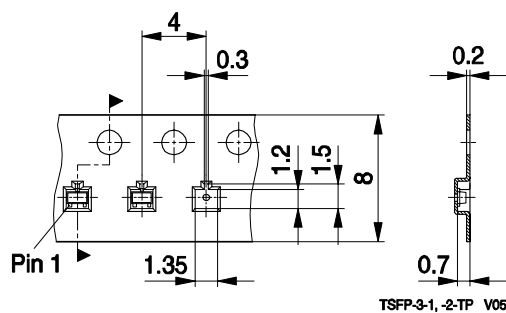
### Marking Layout (Example)



### Standard Packing

Reel Ø 180 mm = 3.000 Pieces/Reel

Reel Ø 330 mm = 10.000 Pieces/Reel





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