

# BFP640FESD

## Low profile robust silicon NPN RF bipolar transistor



### Product description

The BFP640FESD is a RF bipolar transistor based on SiGe:C technology that is part of Infineon's established sixth generation transistor family. Its ESD structure, high RF gain and low noise figure characteristics make the device suitable for a wide range of wireless applications. It remains cost competitive without compromising on ease of use.



### Feature list

- Minimum noise figure  $NF_{min} = 0.75$  dB at 3.5 GHz, 3 V, 6 mA
- High gain  $G_{ma} = 21.5$  dB at 3.5 GHz, 3 V, 30 mA
- $OIP_3 = 26$  dBm at 3.5 GHz, 3 V, 30 mA
- High ESD robustness, typical 2 kV (HBM)

### Product validation

Qualified for industrial applications according to the relevant tests of JEDEC JESD47, JESD22, and J-STD-020. Qualified for industrial applications according to the relevant tests of AEC-Q 101.

### Potential applications

- Low noise amplifiers (LNAs) in GNSS receivers
- LNAs in satellite radio (SDARs, DAB) receivers
- LNAs in multimedia applications such as CATV and FM radio

### Device information

**Table 1** Part information

Product name / Ordering code	Package	Pin configuration				Marking	Pieces / Reel
BFP640FESD / BFP640FESDH6327XTSA1	TSFP-4-1	1 = B	2 = E	3 = C	4 = E	T4s	3000

**Attention:** *ESD (Electrostatic discharge) sensitive device, observe handling precautions*

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**Absolute maximum ratings**

**1 Absolute maximum ratings**

**Table 2 Absolute maximum ratings at  $T_A = 25\text{ °C}$  (unless otherwise specified)**

Parameter	Symbol	Values		Unit	Note or test condition
		Min.	Max.		
Collector emitter voltage	$V_{CEO}$	-	4.1	V	Open base
			3.6		$T_A = -55\text{ °C}$ , open base
Collector emitter voltage <sup>1)</sup>	$V_{CES}$		4.1		E-B short circuited
			3.6		$T_A = -55\text{ °C}$ , E-B short circuited
Collector base voltage <sup>2)</sup>	$V_{CBO}$		4.8		Open emitter
			4.3		$T_A = -55\text{ °C}$ , open emitter
Base current	$I_B$	-10	6	mA	-
Collector current	$I_C$	-	50		
RF input power	$P_{RFin}$		21	dBm	
ESD stress pulse	$V_{ESD}$	-2	2	kV	HBM, all pins, acc. to JESD22-A114
Total power dissipation <sup>3)</sup>	$P_{tot}$	-	200	mW	$T_S \leq 90\text{ °C}$
Junction temperature	$T_J$		150	°C	-
Storage temperature	$T_{Stg}$		-55		

**Attention:** *Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Exceeding only one of these values may cause irreversible damage to the integrated circuit.*

<sup>1</sup>  $V_{CES}$  is similar to  $V_{CEO}$  due to design.

<sup>2</sup>  $V_{CBO}$  is similar to  $V_{CEO}$  due to design.

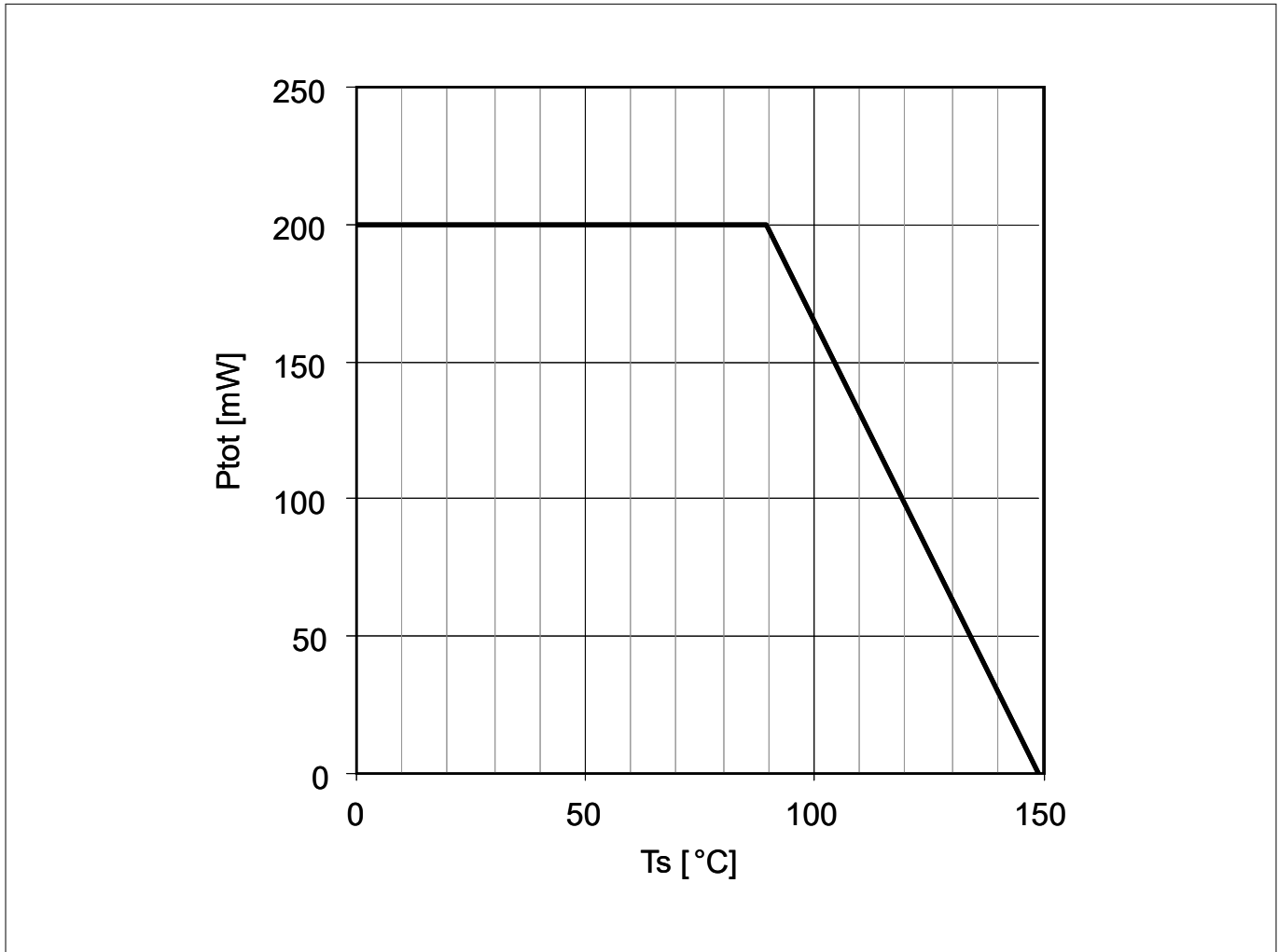
<sup>3</sup>  $T_S$  is the soldering point temperature.  $T_S$  is measured on the emitter lead at the soldering point of the PCB.

Thermal characteristics

## 2 Thermal characteristics

**Table 3 Thermal resistance**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Junction - soldering point	$R_{thJS}$	-	300	-	K/W	-



**Figure 1 Total power dissipation  $P_{tot} = f(T_s)$**

**Electrical characteristics**

### 3 Electrical characteristics

#### 3.1 DC characteristics

**Table 4** DC characteristics at  $T_A = 25\text{ °C}$

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Collector emitter breakdown voltage	$V_{(BR)CEO}$	4.1	4.7	–	V	$I_C = 1\text{ mA}$ , $I_B = 0$ , open base
Collector emitter leakage current	$I_{CES}$	–	–	500 <sup>4)</sup>	nA	$V_{CE} = 2\text{ V}$ , $V_{BE} = 0$ , E-B short circuited
Collector base leakage current	$I_{CBO}$			500 <sup>4)</sup>		$V_{CB} = 2\text{ V}$ , $I_E = 0$ , open emitter
Emitter base leakage current	$I_{EBO}$			10 <sup>4)</sup>	$\mu\text{A}$	$V_{EB} = 0.5\text{ V}$ , $I_C = 0$ , open collector
DC current gain	$h_{FE}$	110	180	270		$V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , pulse measured

#### 3.2 General AC characteristics

**Table 5** General AC characteristics at  $T_A = 25\text{ °C}$

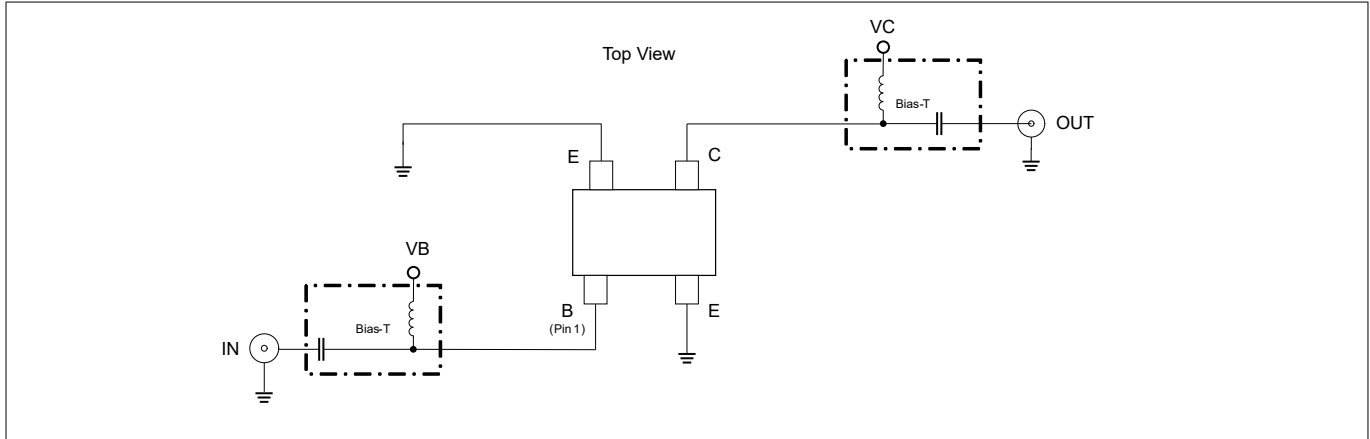
Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Transition frequency	$f_T$	–	46	–	GHz	$V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ , $f = 1\text{ GHz}$
Collector base capacitance	$C_{CB}$		0.08		pF	$V_{CB} = 3\text{ V}$ , $V_{BE} = 0$ , $f = 1\text{ MHz}$ , emitter grounded
Collector emitter capacitance	$C_{CE}$		0.35			$V_{CE} = 3\text{ V}$ , $V_{BE} = 0$ , $f = 1\text{ MHz}$ , base grounded
Emitter base capacitance	$C_{EB}$		0.6			$V_{EB} = 0.4\text{ V}$ , $V_{CB} = 0$ , $f = 1\text{ MHz}$ , collector grounded

<sup>4</sup> Maximum values not limited by the device but by the short cycle time of the 100% test.

**Electrical characteristics**

**3.3 Frequency dependent AC characteristics**

Measurement setup is a test fixture with Bias-T's in a 50 Ω system,  $T_A = 25\text{ °C}$ .



**Figure 2 Testing circuit**

**Table 6 AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 150\text{ MHz}$**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		-		-	dB	$I_C = 30\text{ mA}$
<ul style="list-style-type: none"> <li>Maximum power gain</li> <li>Transducer gain</li> </ul>	$G_{ms}$ $ S_{21} ^2$		40 35.5			
Noise figure						$I_C = 6\text{ mA}$
<ul style="list-style-type: none"> <li>Minimum noise figure</li> <li>Associated gain</li> </ul>	$NF_{min}$ $G_{ass}$		0.55 30.5			
Linearity					dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\text{ }\Omega$
<ul style="list-style-type: none"> <li>3rd order intercept point at output</li> <li>1 dB gain compression point at output</li> </ul>	$OIP_3$ $OP_{1dB}$	24.5 11				

**Table 7 AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 450\text{ MHz}$**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		-		-	dB	$I_C = 30\text{ mA}$
<ul style="list-style-type: none"> <li>Maximum power gain</li> <li>Transducer gain</li> </ul>	$G_{ms}$ $ S_{21} ^2$		35 33			
Noise figure						$I_C = 6\text{ mA}$
<ul style="list-style-type: none"> <li>Minimum noise figure</li> <li>Associated gain</li> </ul>	$NF_{min}$ $G_{ass}$		0.55 28.5			
Linearity					dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\text{ }\Omega$
<ul style="list-style-type: none"> <li>3rd order intercept point at output</li> <li>1 dB gain compression point at output</li> </ul>	$OIP_3$ $OP_{1dB}$	24.5 11				

**Electrical characteristics**

**Table 8 AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 900\text{ MHz}$**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain	$G_{ms}$ $ S_{21} ^2$	–	31.5	–	dB	$I_C = 30\text{ mA}$
• Maximum power gain			29.5			
• Transducer gain						
Noise figure	$NF_{min}$ $G_{ass}$		0.55			$I_C = 6\text{ mA}$
• Minimum noise figure			26			
• Associated gain						
Linearity	$OIP_3$ $OP_{1dB}$		25		dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\ \Omega$
• 3rd order intercept point at output			11			
• 1 dB gain compression point at output						

**Table 9 AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 1.5\text{ GHz}$**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain	$G_{ms}$ $ S_{21} ^2$	–	28.5	–	dB	$I_C = 30\text{ mA}$
• Maximum power gain			25.5			
• Transducer gain						
Noise figure	$NF_{min}$ $G_{ass}$		0.6			$I_C = 6\text{ mA}$
• Minimum noise figure			22.5			
• Associated gain						
Linearity	$OIP_3$ $OP_{1dB}$		25.5		dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\ \Omega$
• 3rd order intercept point at output			11.5			
• 1 dB gain compression point at output						

**Table 10 AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 1.9\text{ GHz}$**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain	$G_{ms}$ $ S_{21} ^2$	–	26.5	–	dB	$I_C = 30\text{ mA}$
• Maximum power gain			23.5			
• Transducer gain						
Noise figure	$NF_{min}$ $G_{ass}$		0.6			$I_C = 6\text{ mA}$
• Minimum noise figure			21			
• Associated gain						
Linearity	$OIP_3$ $OP_{1dB}$		26		dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\ \Omega$
• 3rd order intercept point at output			11.5			
• 1 dB gain compression point at output						

**Electrical characteristics**

**Table 11 AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 2.4\text{ GHz}$**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain	$G_{ms}$ $ S_{21} ^2$	–	25	–	dB	$I_C = 30\text{ mA}$
• Maximum power gain			21.5			
• Transducer gain						
Noise figure	$NF_{min}$ $G_{ass}$		0.65			$I_C = 6\text{ mA}$
• Minimum noise figure			19.5			
• Associated gain						
Linearity	$OIP_3$ $OP_{1dB}$		26		dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\ \Omega$
• 3rd order intercept point at output			11.5			
• 1 dB gain compression point at output						

**Table 12 AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 3.5\text{ GHz}$**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain	$G_{ma}$ $ S_{21} ^2$	–	21.5	–	dB	$I_C = 30\text{ mA}$
• Maximum power gain			18			
• Transducer gain						
Noise figure	$NF_{min}$ $G_{ass}$		0.75			$I_C = 6\text{ mA}$
• Minimum noise figure			15.5			
• Associated gain						
Linearity	$OIP_3$ $OP_{1dB}$		26		dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\ \Omega$
• 3rd order intercept point at output			11.5			
• 1 dB gain compression point at output						

**Table 13 AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 5.5\text{ GHz}$**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain	$G_{ma}$ $ S_{21} ^2$	–	16.5	–	dB	$I_C = 30\text{ mA}$
• Maximum power gain			14			
• Transducer gain						
Noise figure	$NF_{min}$ $G_{ass}$		0.95			$I_C = 6\text{ mA}$
• Minimum noise figure			13			
• Associated gain						
Linearity	$OIP_3$ $OP_{1dB}$		25.5		dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\ \Omega$
• 3rd order intercept point at output			11			
• 1 dB gain compression point at output						



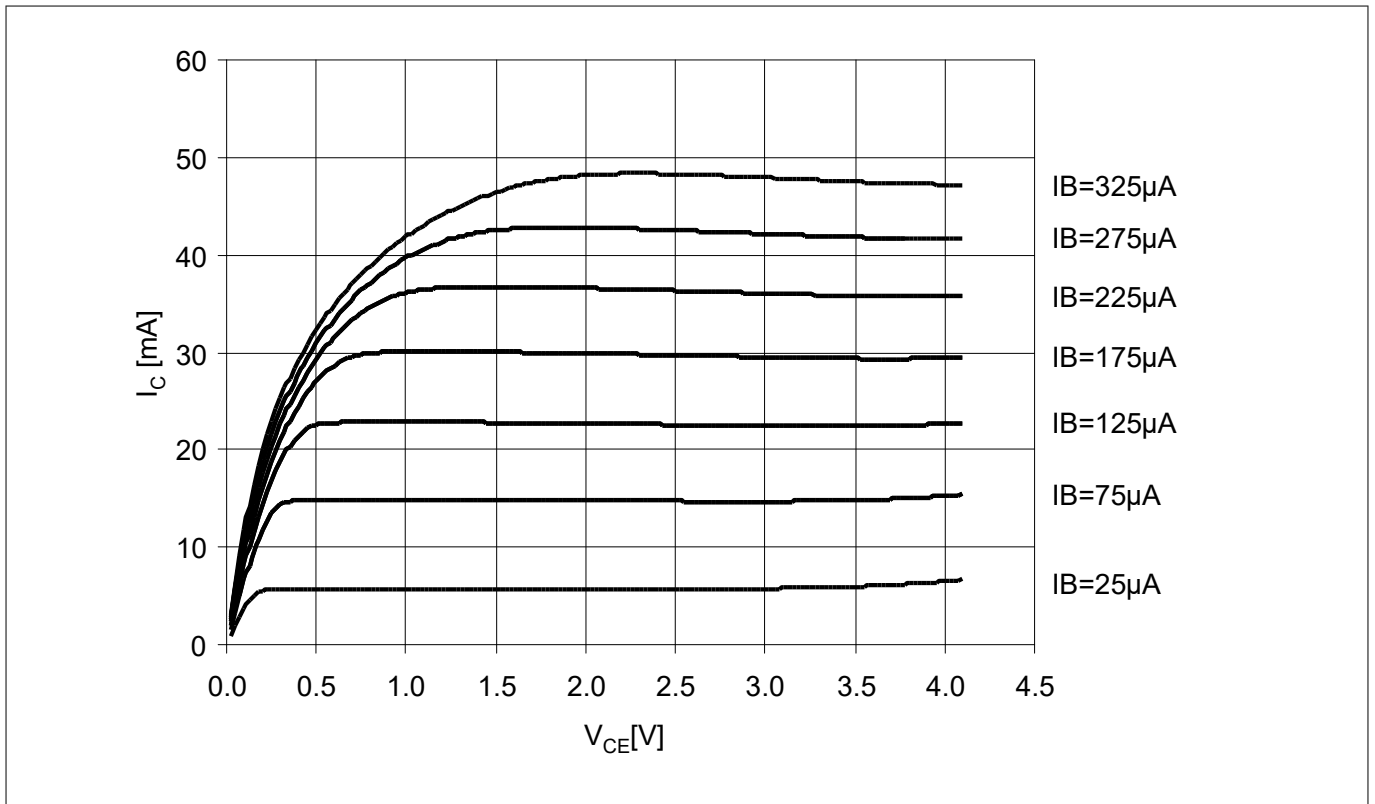
**Electrical characteristics**

**Table 14** AC characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 10\text{ GHz}$

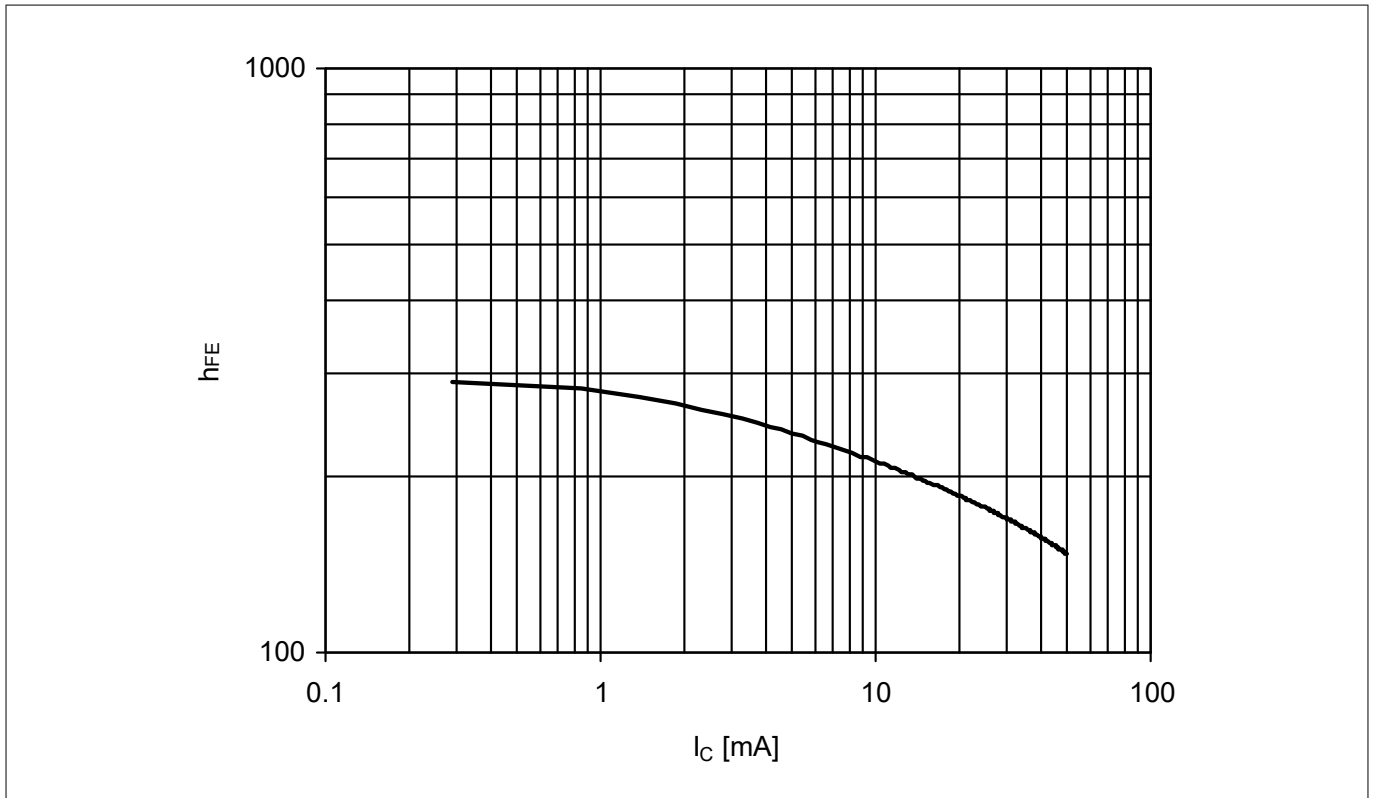
Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		-	11	-	dB	$I_C = 30\text{ mA}$
<ul style="list-style-type: none"> <li>Maximum power gain</li> <li>Transducer gain</li> </ul>	$G_{ma}$ $ S_{21} ^2$					
Noise figure		-	1.7	-	dB	$I_C = 6\text{ mA}$
<ul style="list-style-type: none"> <li>Minimum noise figure</li> <li>Associated gain</li> </ul>	$NF_{min}$ $G_{ass}$					
Linearity		-	24.5	-	dBm	$I_C = 30\text{ mA}$ , $Z_S = Z_L = 50\ \Omega$
<ul style="list-style-type: none"> <li>3rd order intercept point at output</li> <li>1 dB gain compression point at output</li> </ul>	$OIP_3$ $OP_{1dB}$					

**Note:**  $G_{ms} = |S_{21} / S_{12}|$  for  $k < 1$ ;  $G_{ma} = |S_{21} / S_{12}| (k - (k^2 - 1)^{1/2})$  for  $k > 1$ . In order to get the  $NF_{min}$  values stated in this chapter, the test fixture losses have been subtracted from all measured results.  $OIP_3$  value depends on termination of all intermodulation frequency components. Termination used for this measurement is  $50\ \Omega$  from 0.2 MHz to 12 GHz.

### 3.4 Characteristic DC diagrams

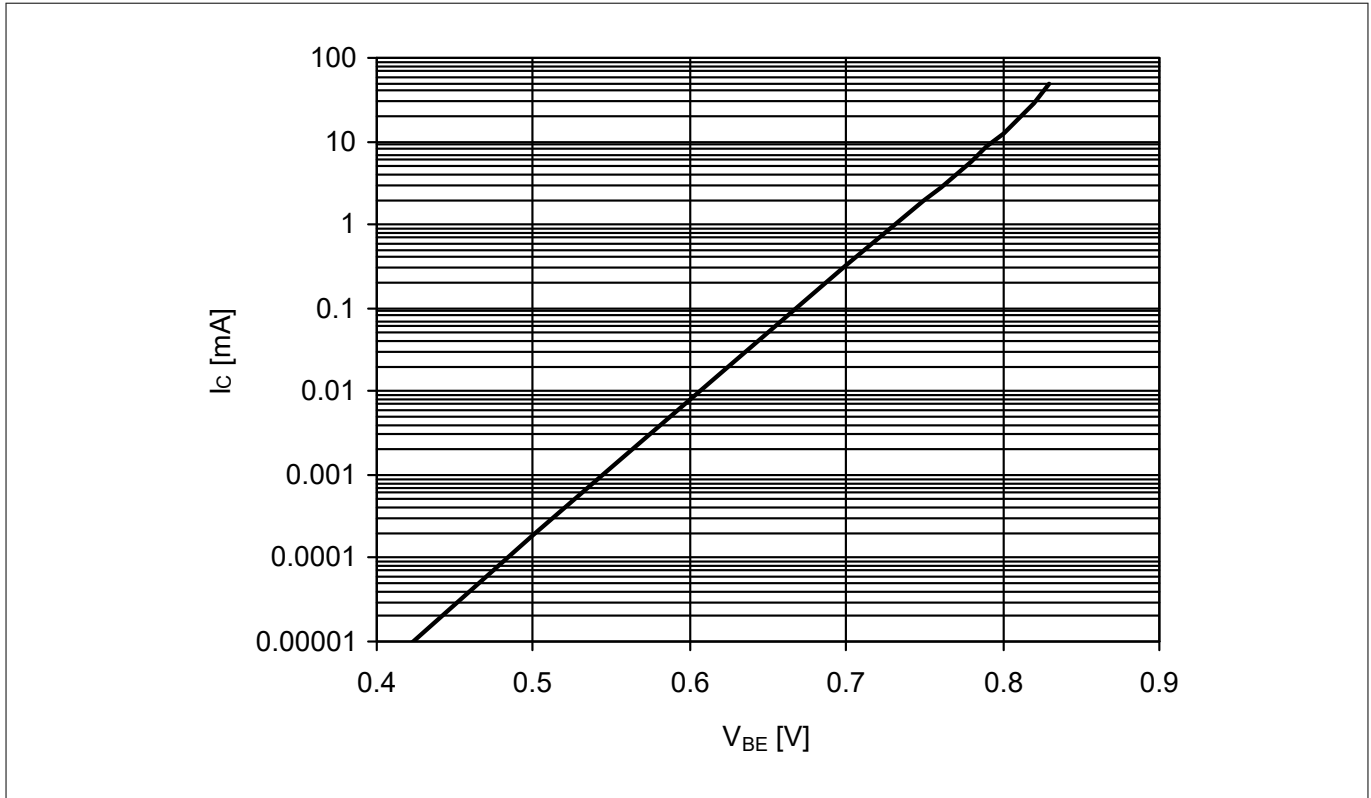


**Figure 3** Collector current vs. collector emitter voltage  $I_C = f(V_{CE})$ ,  $I_B = \text{parameter}$

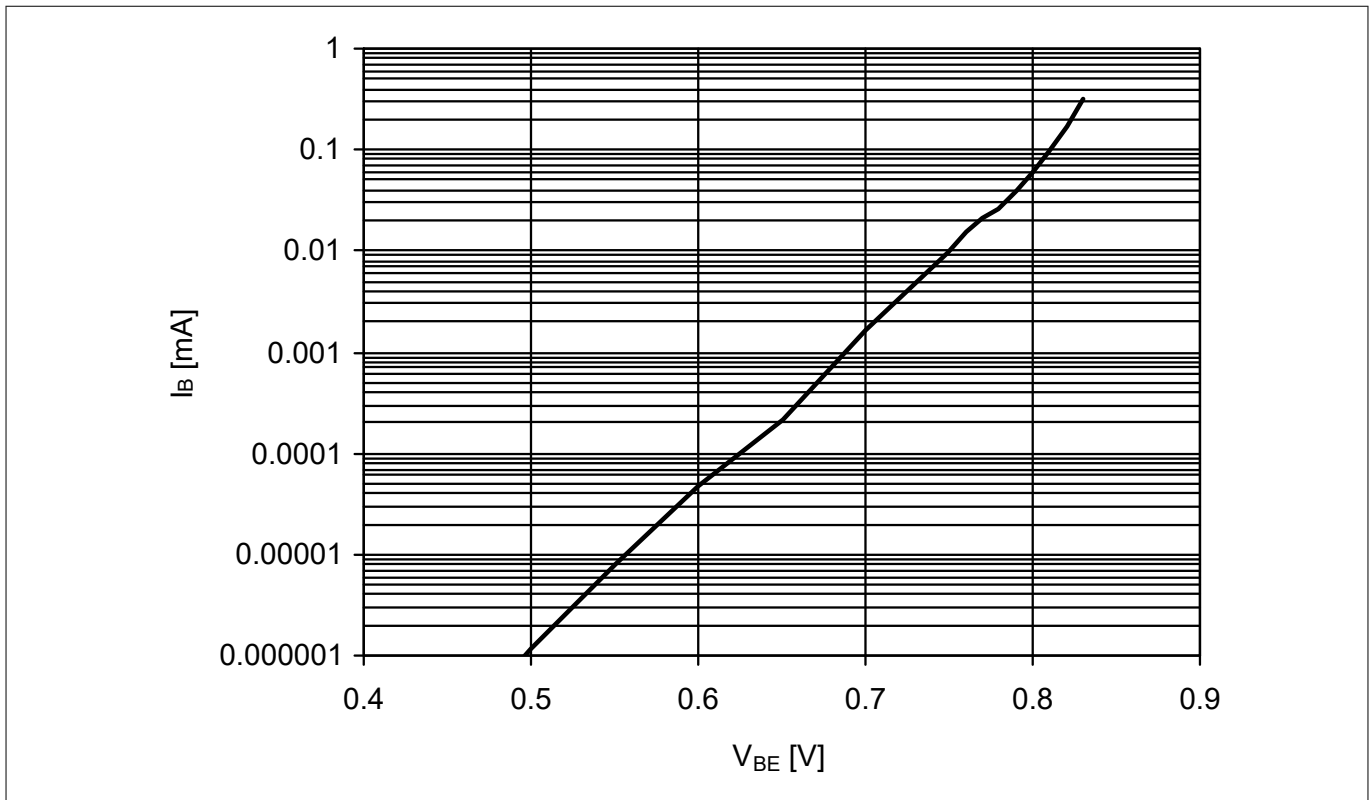


**Figure 4** DC current gain  $h_{FE} = f(I_C)$ ,  $V_{CE} = 3 \text{ V}$

**Electrical characteristics**

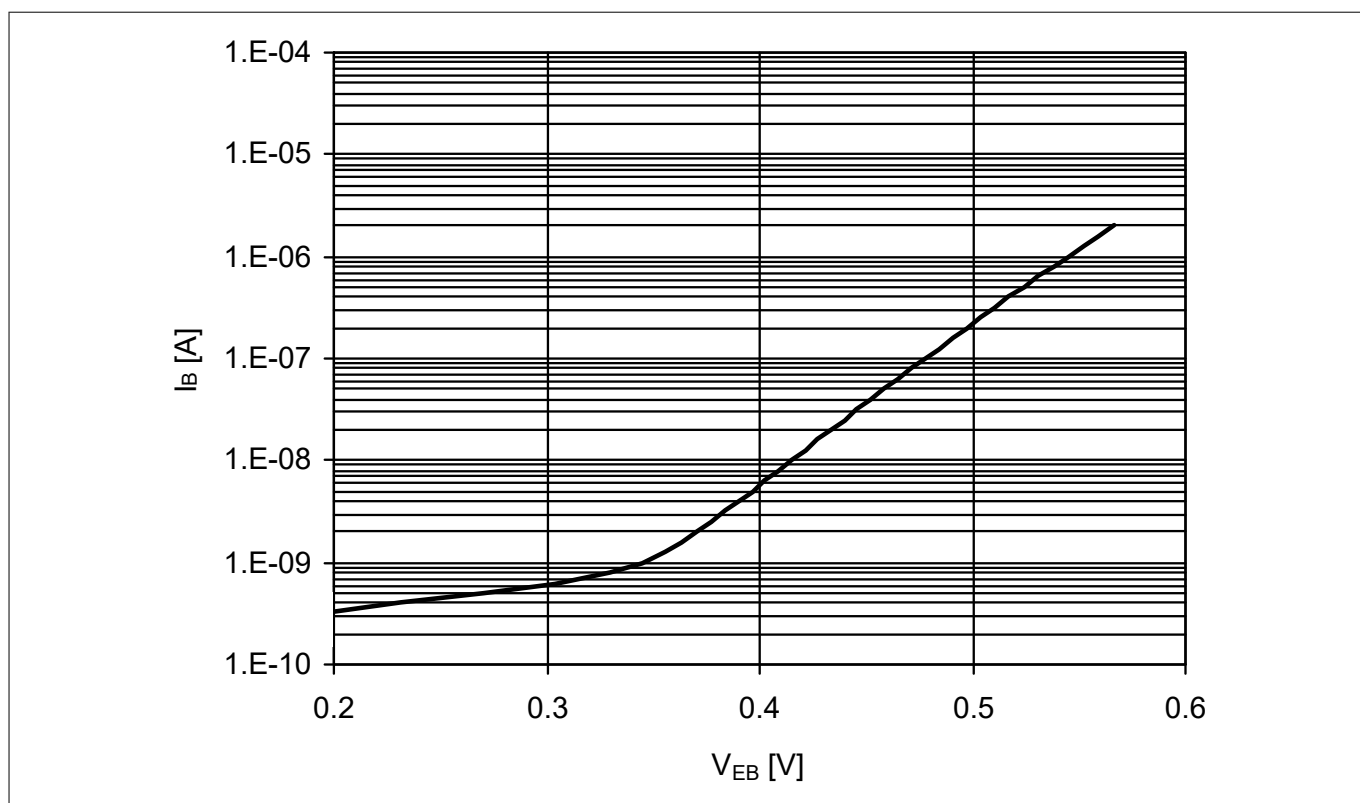


**Figure 5** Collector current vs. base emitter forward voltage  $I_C = f(V_{BE})$ ,  $V_{CE} = 2\text{ V}$



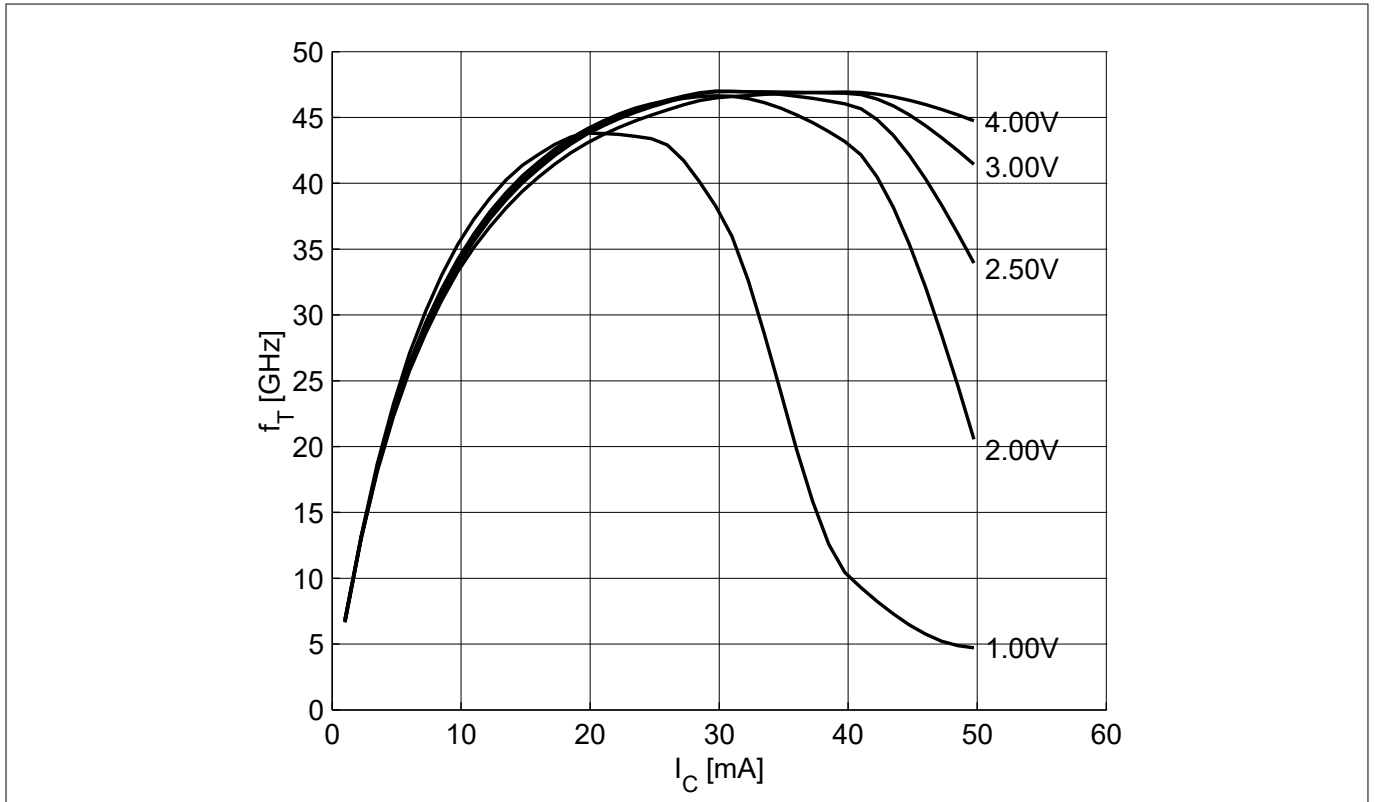
**Figure 6** Base current vs. base emitter forward voltage  $I_B = f(V_{BE})$ ,  $V_{CE} = 2\text{ V}$

**Electrical characteristics**

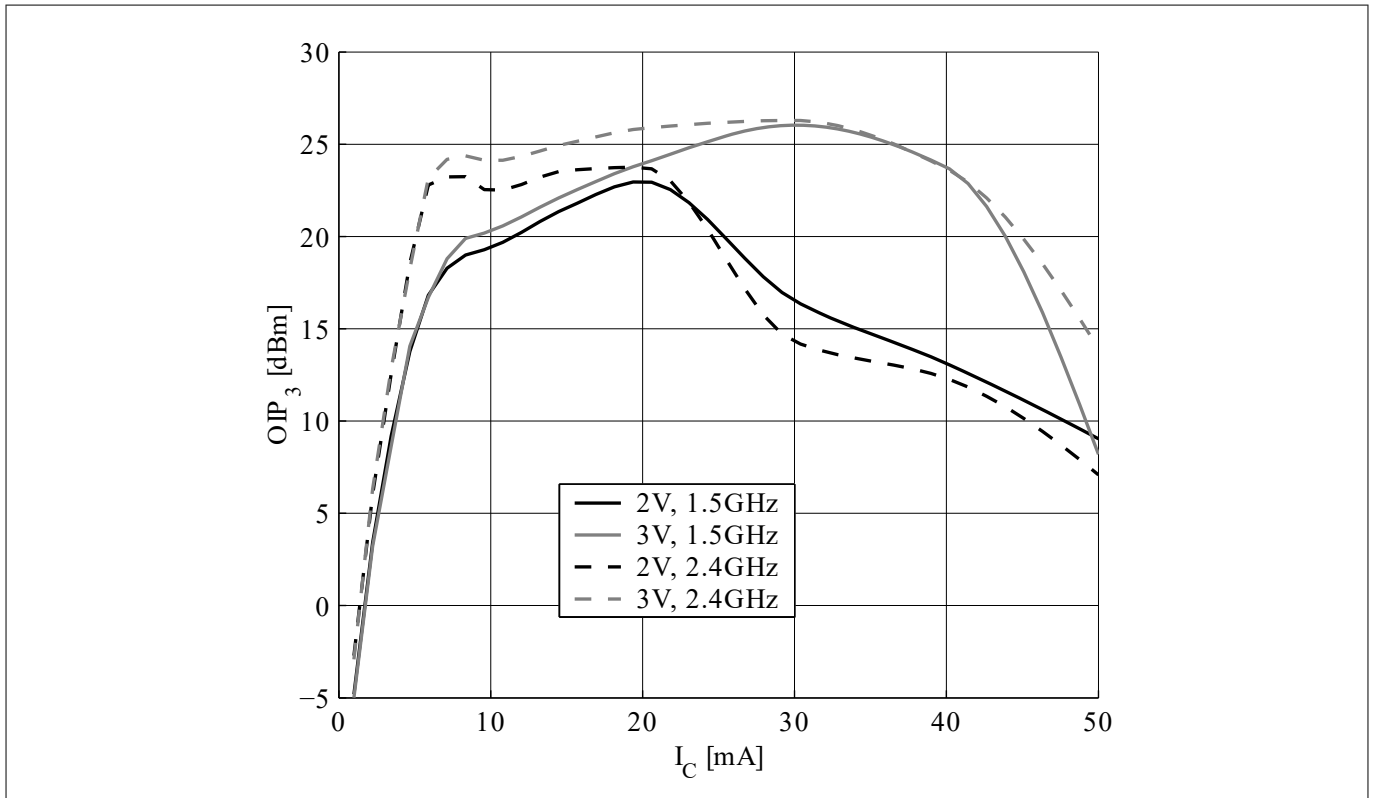


**Figure 7** Base current vs. base emitter reverse voltage  $I_B = f(V_{EB}), V_{CE} = 2 \text{ V}$

### 3.5 Characteristic AC diagrams

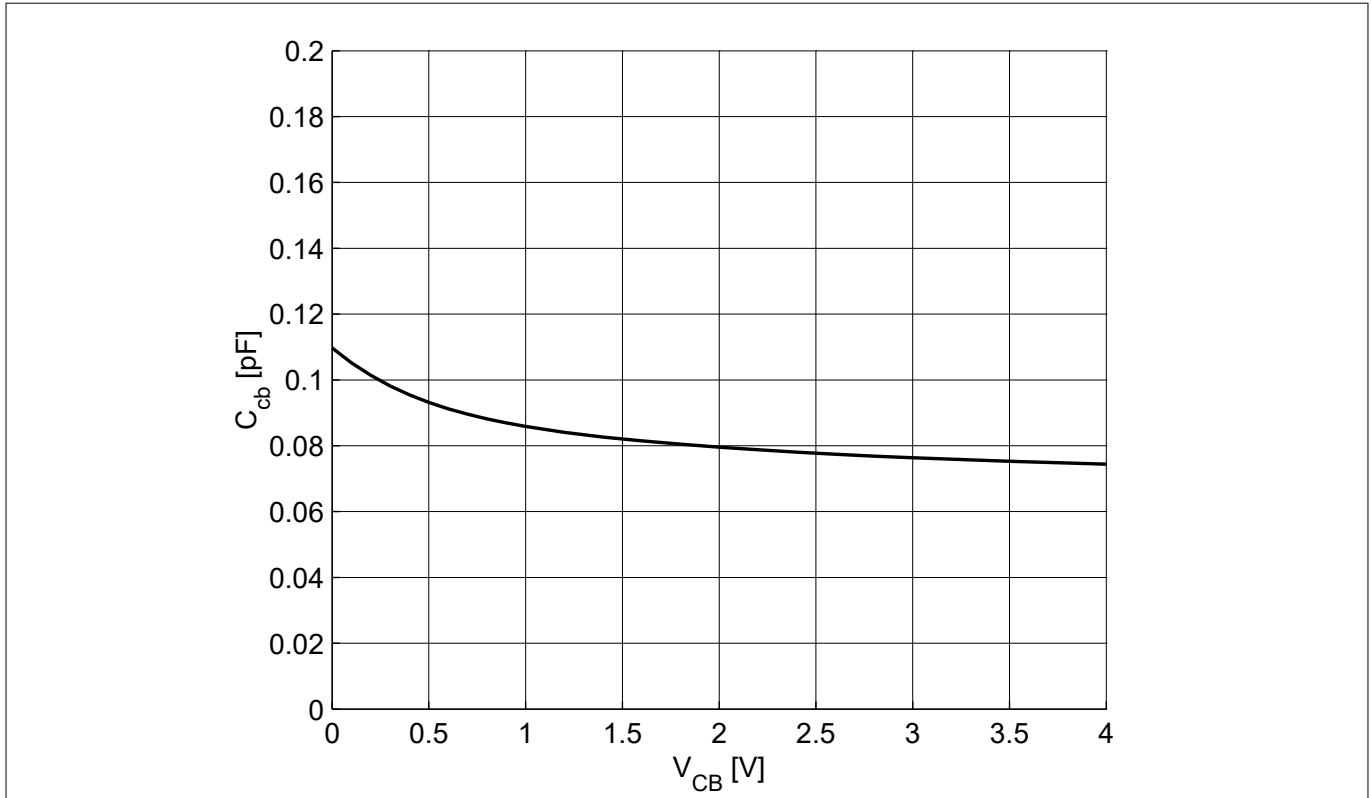


**Figure 8** Transition frequency  $f_T = f(I_C)$ ,  $f = 1$  GHz,  $V_{CE} = \text{parameter}$

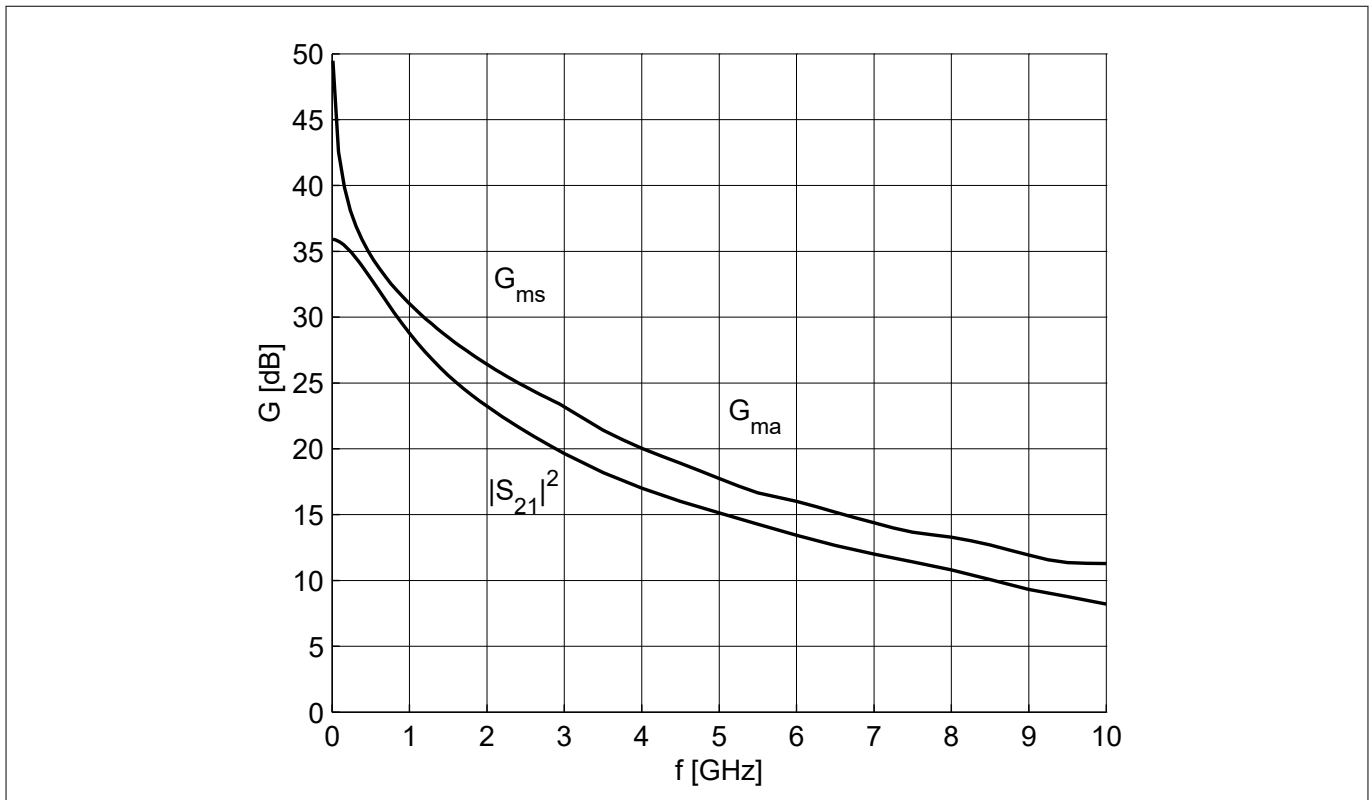


**Figure 9** 3rd order intercept point  $OIP_3 = f(I_C)$ ,  $Z_S = Z_L = 50 \Omega$ ,  $V_{CE}$ ,  $f = \text{parameters}$

**Electrical characteristics**

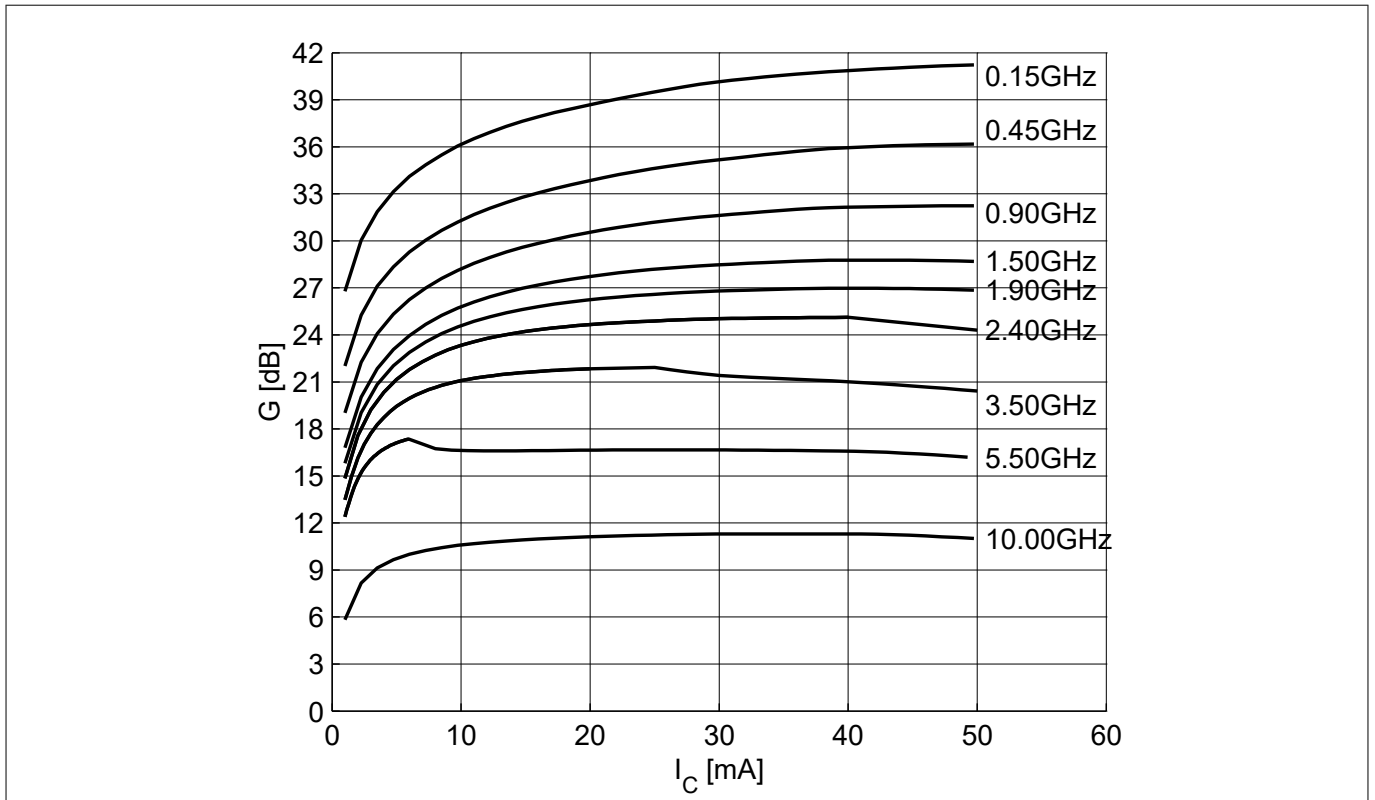


**Figure 10** Collector base capacitance  $C_{CB} = f(V_{CB}), f = 1 \text{ MHz}$

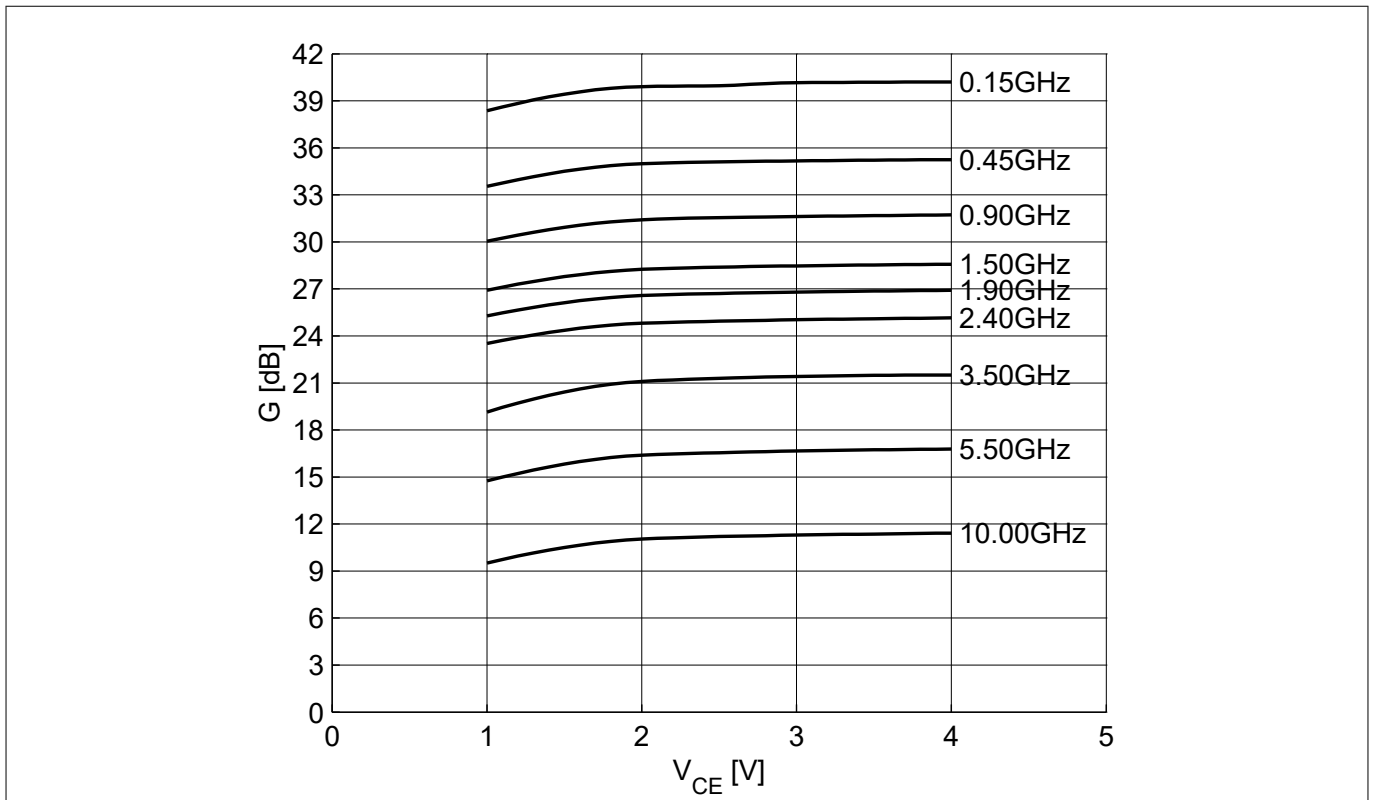


**Figure 11** Gain  $G_{ma}, G_{ms}, |S_{21}|^2 = f(f), V_{CE} = 3 \text{ V}, I_C = 30 \text{ mA}$

**Electrical characteristics**

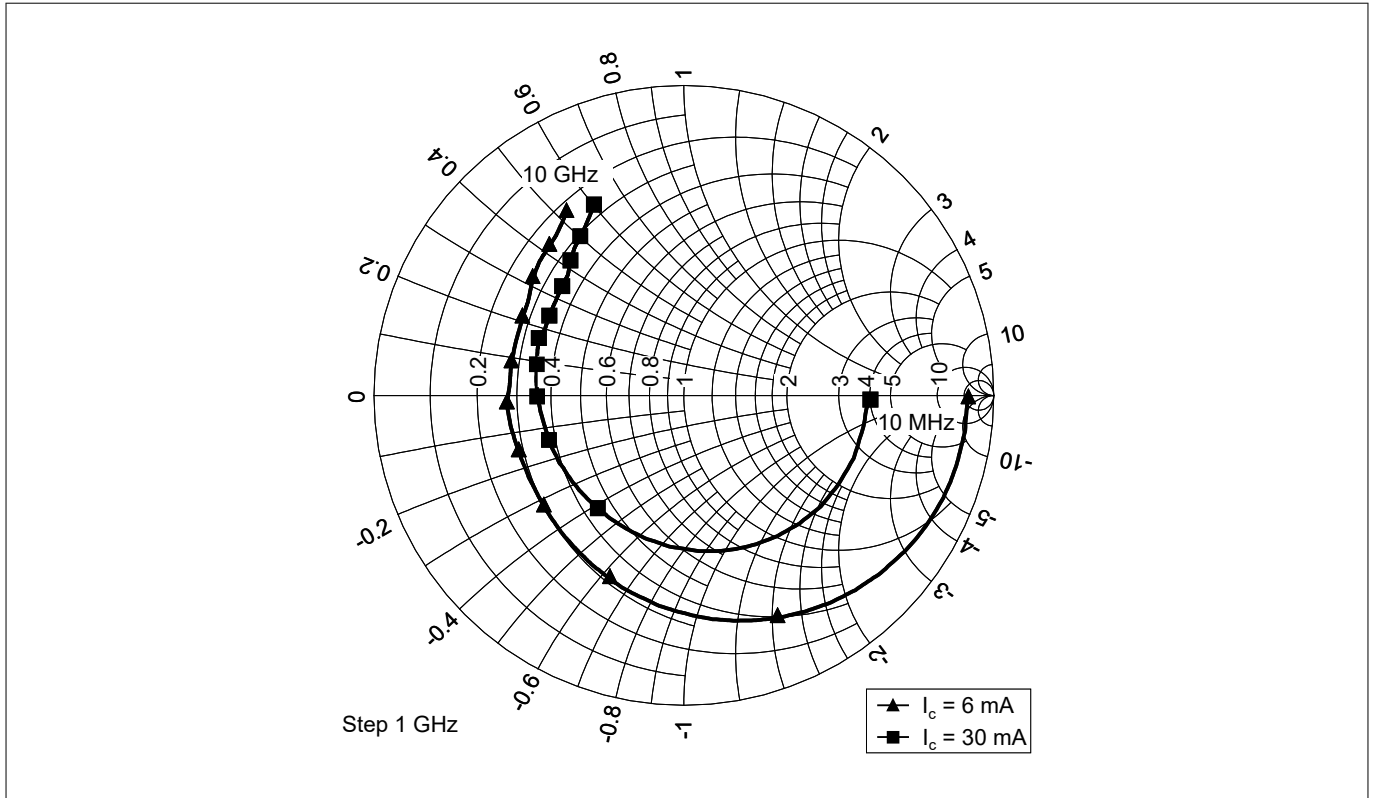


**Figure 12** Maximum power gain  $G_{\max} = f(I_C)$ ,  $V_{CE} = 3\text{ V}$ ,  $f = \text{parameter in GHz}$

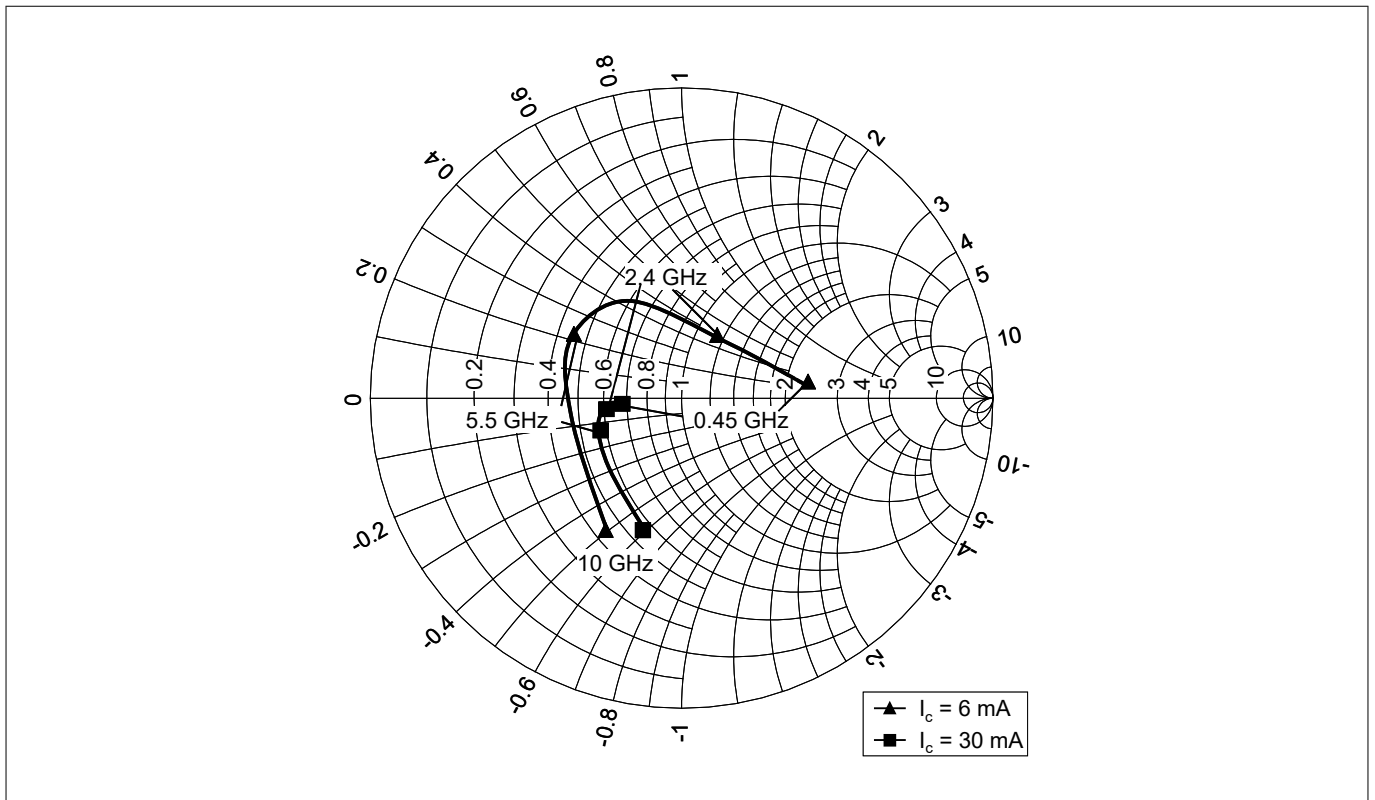


**Figure 13** Maximum power gain  $G_{\max} = f(V_{CE})$ ,  $I_C = 30\text{ mA}$ ,  $f = \text{parameter in GHz}$

**Electrical characteristics**



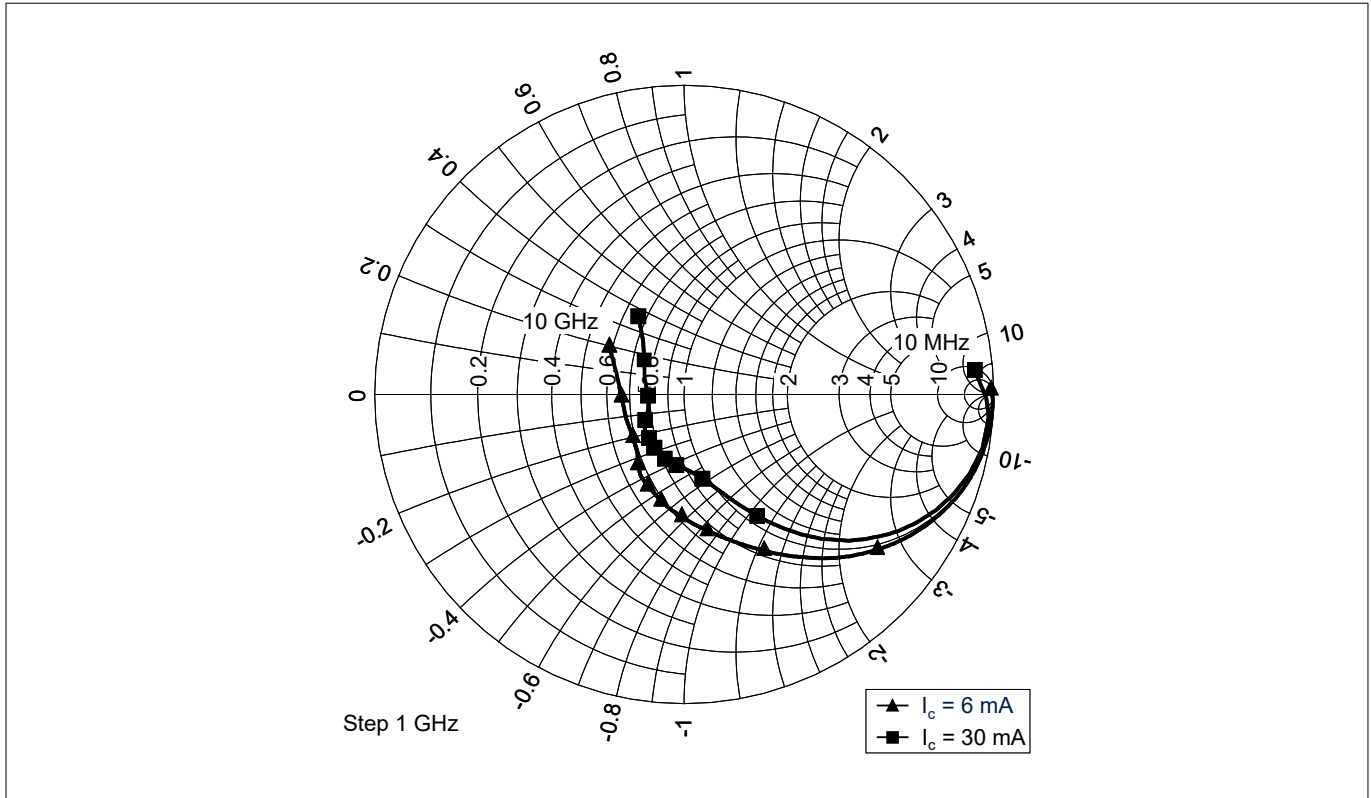
**Figure 14** Input reflection coefficient  $S_{11} = f(f)$ ,  $V_{CE} = 3$  V,  $I_C = 6 / 30$  mA



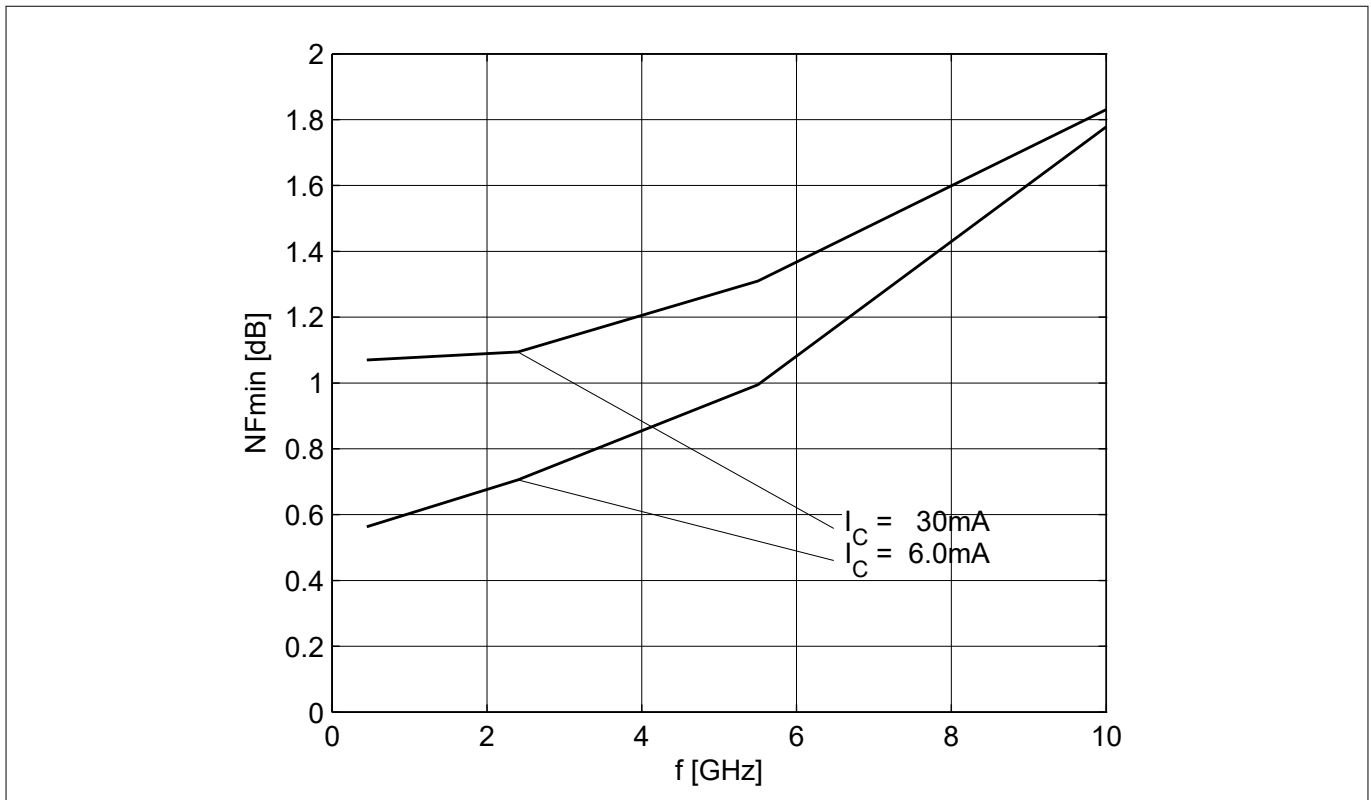
**Figure 15** Source impedance for minimum noise figure  $Z_{S,opt} = f(f)$ ,  $V_{CE} = 3$  V,  $I_C = 6 / 30$  mA



**Electrical characteristics**

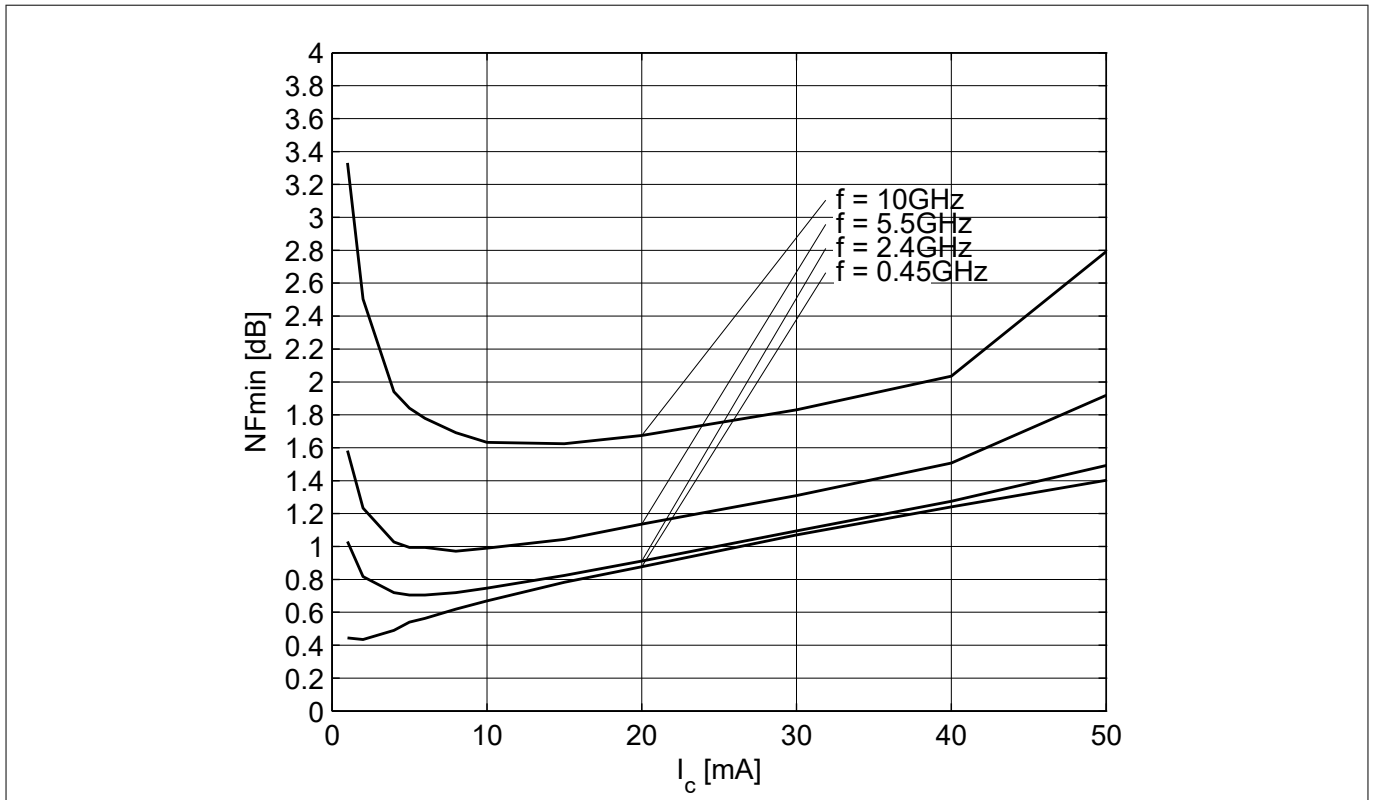


**Figure 16** Output reflection coefficient  $S_{22} = f(f)$ ,  $V_{CE} = 3 \text{ V}$ ,  $I_C = 6 / 30 \text{ mA}$

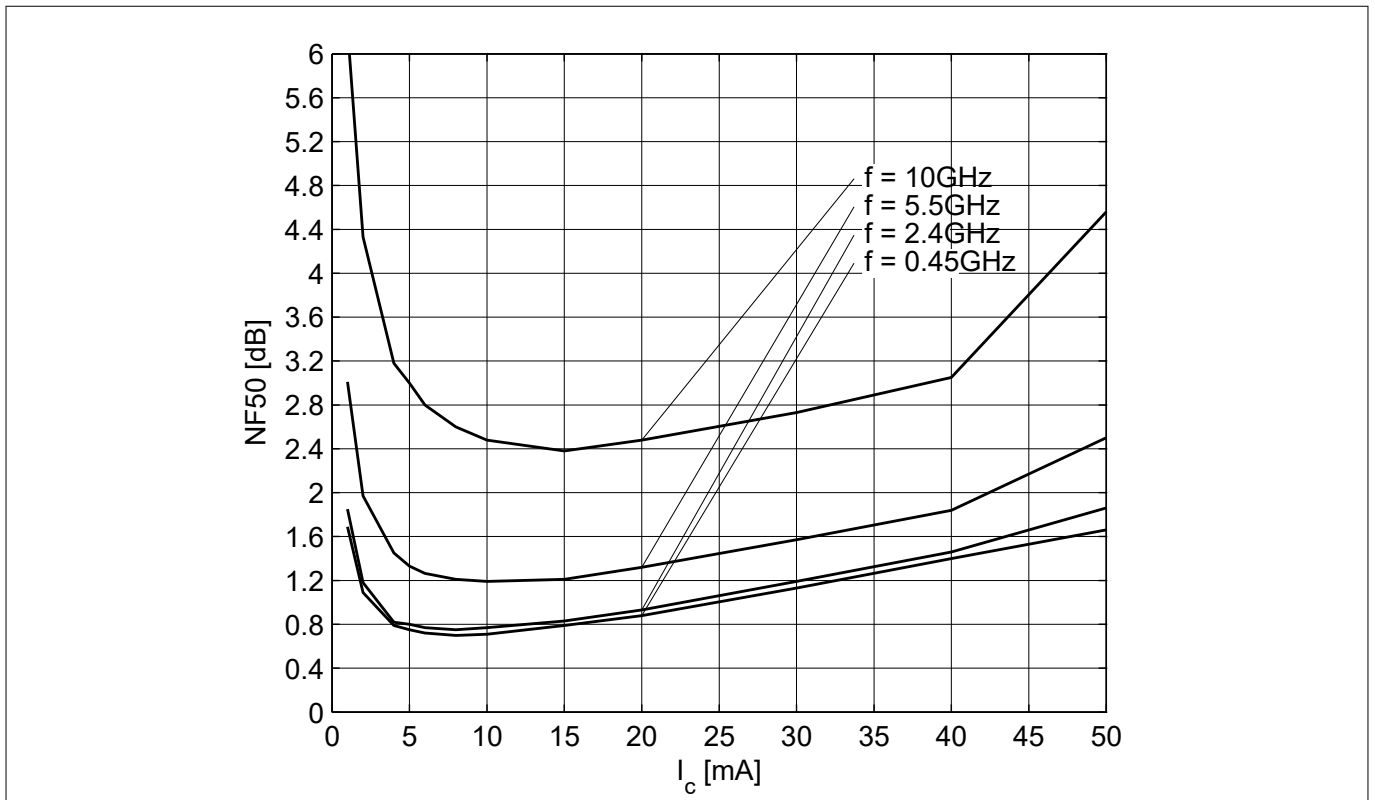


**Figure 17** Noise figure  $NF_{min} = f(f)$ ,  $Z_S = Z_{S,opt}$ ,  $V_{CE} = 3 \text{ V}$ ,  $I_C = 6 / 30 \text{ mA}$

**Electrical characteristics**



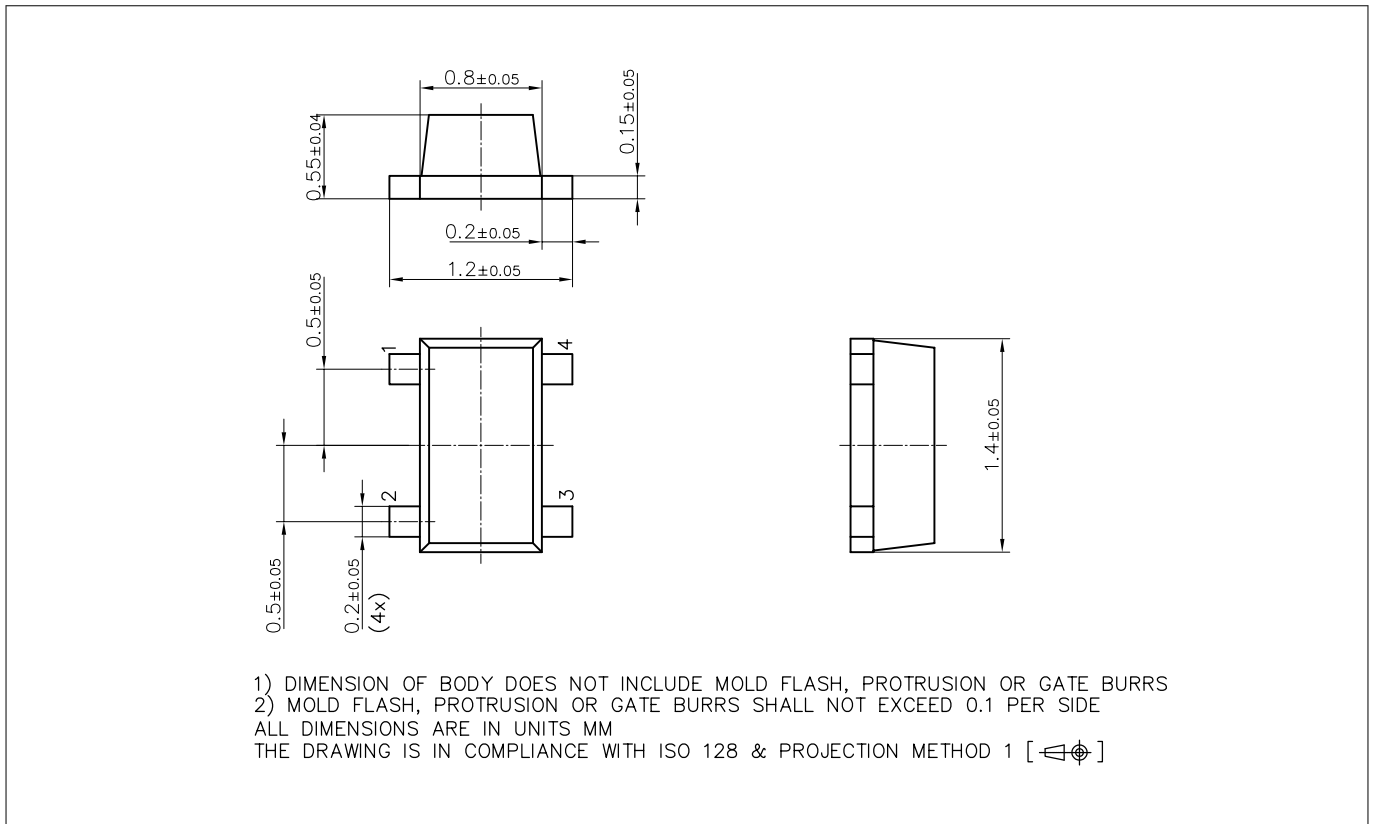
**Figure 18** Noise figure  $NF_{min} = f(I_C)$ ,  $Z_S = Z_{S,opt}$ ,  $V_{CE} = 3\text{ V}$ ,  $f =$  parameter in GHz



**Figure 19** Noise figure  $NF_{50} = f(I_C)$ ,  $Z_S = 50\ \Omega$ ,  $V_{CE} = 3\text{ V}$ ,  $f =$  parameter in GHz

**Note:** The curves shown in this chapter have been generated using typical devices but shall not be considered as a guarantee that all devices have identical characteristic curves.  $T_A = 25\text{ }^\circ\text{C}$ .

## 4 Package information TSFP-4-1



**Figure 20** TSFP-4-1 package

**Note:** For package information including footprint, packing and assembly recommendation refer to:

<https://www.infineon.com/packages/TSFP-4-1/>

**Revision history**

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**Revision history**

<b>Document version</b>	<b>Date of release</b>	<b>Description of changes</b>
Revision 2.0	2019-01-25	New datasheet layout.
Revision 3.0	2024-07-01	Updated product validation

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