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Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

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Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



BFP740ESD

Robust High Performance Low Noise Bipolar RF Transistor

Data Sheet

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BFP740ESD, Robust High Performance Low Noise Bipolar RF Transistor

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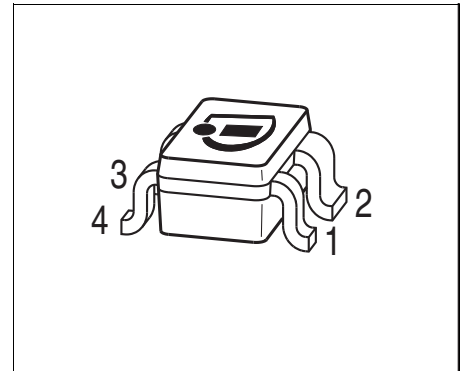
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1 Features

- Robust high performance low noise amplifier based on Infineon’s reliable, high volume SiGe:C wafer technology
- 2 kV ESD robustness (HBM) due to integrated protection circuits
- High maximum RF input power of 21 dBm
- 0.65 dB minimum noise figure typical at 2.4 GHz, 0.9 dB at 5.5 GHz, 6 mA
- 25.5 dB maximum gain (G_{ma} , G_{ms}) typical at 2.4 GHz, 18.5 dB at 5.5 GHz, 25 mA
- 24 dBm OIP_3 typical at 5.5 GHz, 25 mA
- Accurate SPICE GP model available to enable effective design in process (see chapter 6)
- Easy to use, Pb- and halogen free (RoHS compliant) standard package with visible leads



Applications

As Low Noise Amplifier (LNA) in

- Mobile, portable and fixed connectivity applications: WLAN 802.11a/b/g/n, WiMax 2.5/3.5/5 GHz, UWB, Bluetooth
- Satellite communication systems: Navigation systems (GPS, Glonass), satellite radio (SDARs, DAB) and C-band LNB
- Multimedia applications such as mobile/portable TV, CATV, FM Radio
- 3G/4G UMTS/LTE mobile phone applications
- ISM applications like RKE, AMR and Zigbee, as well as for emerging wireless applications

As discrete active mixer, amplifier in VCOs and buffer amplifier

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

Product Name	Package	Pin Configuration				Marking
BFP740ESD	SOT343	1 = B	2 = E	3 = C	4 = E	T7s

2 Product Brief

The BFP740ESD is a Silicon Germanium Carbon (SiGe:C) NPN Heterojunction wideband Bipolar RF Transistor (HBT) in a plastic dual emitter standard package with visible leads. The device is fitted with internal protection circuits, which enhance robustness against ESD and high RF input power strongly. The device combines robustness with very high RF gain and lowest noise figure at low operation current for use in a wide range of wireless applications.

The BFP740ESD is especially well-suited for portable battery-powered applications in which reduced power consumption is a key requirement. Device design supports collector voltages up to 4.2 V.

Table 1 Quick Reference DC Characteristics at $T_A = 25^\circ\text{C}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Collector emitter breakdown voltage	$V_{(BR)CEO}$	4.2	4.7	–	V	$I_C = 1 \text{ mA}$, $I_B = 0$ Open base
Collector base leakage current	I_{CBO}	–	–	400	nA	$V_{CB} = 2 \text{ V}$, $I_E = 0$ Open emitter
DC current gain	h_{FE}	160	250	400		$V_{CE} = 3 \text{ V}$, $I_C = 25 \text{ mA}$
Collector current	I_C	–	–	45	mA	
Total power dissipation	P_{tot}	–	–	160	mW	$T_S \leq 98^\circ\text{C}$

Table 2 Quick Reference AC Characteristics at $T_A = 25^\circ\text{C}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transition frequency	f_T	–	45	–	GHz	$V_{CE} = 3\text{ V}$, $I_C = 25\text{ mA}$ $f = 2\text{ GHz}$
$V_{CE} = 3\text{ V}$, $f = 2.4\text{ GHz}$						
Maximum power gain						
Low noise operation point	G_{ms}	–	22	–	dB	$I_C = 6\text{ mA}$
High linearity operation point	G_{ms}	–	25.5	–		$I_C = 25\text{ mA}$
Transducer gain						
Low noise operation point	S_{21}	–	19.5	–	dB	$Z_S = Z_L = 50\ \Omega$ $I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	22	–		$I_C = 25\text{ mA}$
Minimum noise figure						
Minimum noise figure	NF_{min}	–	0.65	–	dB	$Z_S = Z_{opt}$ $I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	20	–		$I_C = 6\text{ mA}$
Linearity						
1 dB gain compression point	OP_{1dB}	–	10.5	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	25	–		$I_C = 25\text{ mA}$
$V_{CE} = 3\text{ V}$, $f = 5.5\text{ GHz}$						
Maximum power gain						
Low noise operation point	G_{ms}	–	19	–	dB	$I_C = 6\text{ mA}$
High linearity operation point	G_{ma}	–	18.5	–		$I_C = 25\text{ mA}$
Transducer gain						
Low noise operation point	S_{21}	–	13	–	dB	$Z_S = Z_L = 50\ \Omega$ $I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	14.5	–		$I_C = 25\text{ mA}$
Minimum noise figure						
Minimum noise figure	NF_{min}	–	0.9	–	dB	$Z_S = Z_{opt}$ $I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	13.5	–		$I_C = 6\text{ mA}$
Linearity						
1 dB gain compression point	OP_{1dB}	–	10	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	24	–		$I_C = 25\text{ mA}$

3 Maximum Ratings

Table 3 Maximum Ratings at $T_A = 25^\circ\text{C}$ (unless otherwise specified)

Parameter	Symbol	Values		Unit	Note / Test Condition
		Min.	Max.		
Collector emitter voltage	V_{CEO}	–	4.2	V	Open base $T_A = 25^\circ\text{C}$
		–	3.7	V	$T_A = -55^\circ\text{C}$
Collector emitter voltage ¹⁾	V_{CBO}	–	4.9	V	Open emitter $T_A = 25^\circ\text{C}$
		–	4.4	V	$T_A = -55^\circ\text{C}$
Collector emitter voltage ²⁾	V_{CES}	–	4.2	V	Emitter / base shortened $T_A = 25^\circ\text{C}$
		–	3.7	V	$T_A = -55^\circ\text{C}$
Base current ³⁾	I_B	-10	5	mA	–
Collector current	I_C	–	45	mA	–
RF input power	P_{RFIn}	–	21	dBm	–
ESD stress pulse ⁴⁾	V_{ESD}	-2	2	kV	HBM, all pins, acc. to JESD22-A114
Total power dissipation ⁵⁾	P_{tot}	–	160	mW	$T_S \leq 98^\circ\text{C}$
Junction temperature	T_J	–	150	$^\circ\text{C}$	–
Storage temperature	T_{Stg}	-55	150	$^\circ\text{C}$	–

1) Low V_{CBO} due to integrated protection circuits

2) V_{CES} is identical to V_{CEO} due to integrated protection circuits.

3) Sustainable reverse bias current is high due to integrated protection circuits.

4) ESD robustness is high due to integrated protection circuits.

5) T_S is the soldering point temperature. T_S measured on the emitter lead at the soldering point of the pcb.

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. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

4 Thermal Characteristics

Table 4 Thermal Resistance

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Junction - soldering point ¹⁾	R_{thJS}	–	325	–	K/W	–

1) For calculation of R_{thJA} please refer to Application Note Thermal Resistance AN 077

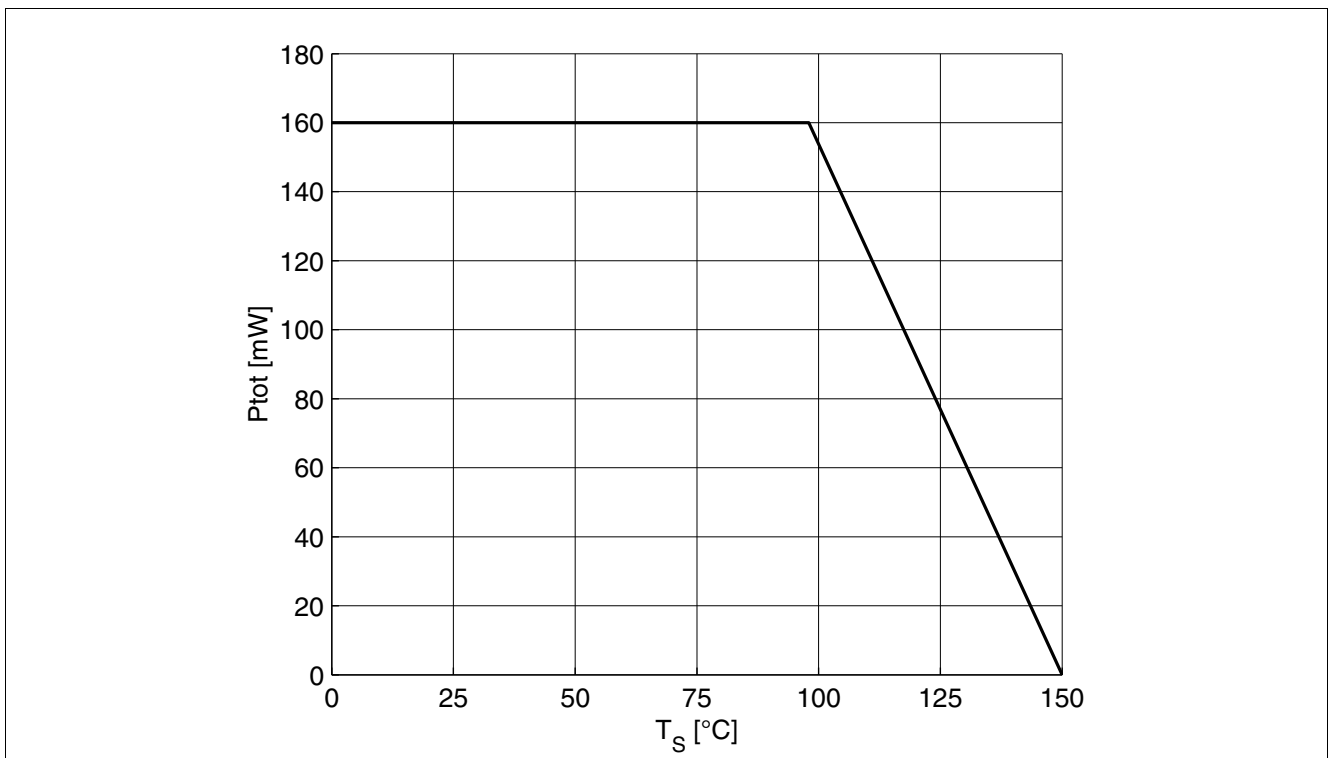


Figure 1 Total Power Dissipation $P_{tot} = f(T_s)$

5 Electrical Characteristics

5.1 DC Characteristics

Table 5 DC Characteristics at $T_A = 25\text{ °C}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Collector emitter breakdown voltage	$V_{(BR)CEO}$	4.2	4.7	–	V	$I_C = 1\text{ mA}$, $I_B = 0$ Open base
Collector emitter leakage current	I_{CES}	–	–	400	nA	$V_{CE} = 2\text{ V}$, $V_{BE} = 0$ Emitter/base shortened
Collector base leakage current	I_{CBO}	–	–	400	nA	$V_{CB} = 2\text{ V}$, $I_E = 0$ Open emitter
Emitter base leakage current	I_{EBO}	–	–	10	μA	$V_{EB} = 0.5\text{ V}$, $I_C = 0$ Open collector
DC current gain	h_{FE}	160	250	400		$V_{CE} = 3\text{ V}$, $I_C = 25\text{ mA}$ Pulse measured

5.2 General AC Characteristics

Table 6 General AC Characteristics at $T_A = 25\text{ °C}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transition frequency	f_T	–	45	–	GHz	$V_{CE} = 3\text{ V}$, $I_C = 25\text{ mA}$ $f = 2\text{ GHz}$
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}	–	0.45	–	pF	$V_{CE} = 3\text{ V}$, $V_{BE} = 0$ $f = 1\text{ MHz}$ Base grounded
Emitter base capacitance	C_{EB}	–	0.55	–	pF	$V_{EB} = 0.4\text{ V}$, $V_{CB} = 0$ $f = 1\text{ MHz}$ Collector grounded

5.3 Frequency Dependent AC Characteristics

Measurement setup is a test fixture with Bias T's in a $50\ \Omega$ system, $T_A = 25\ ^\circ\text{C}$

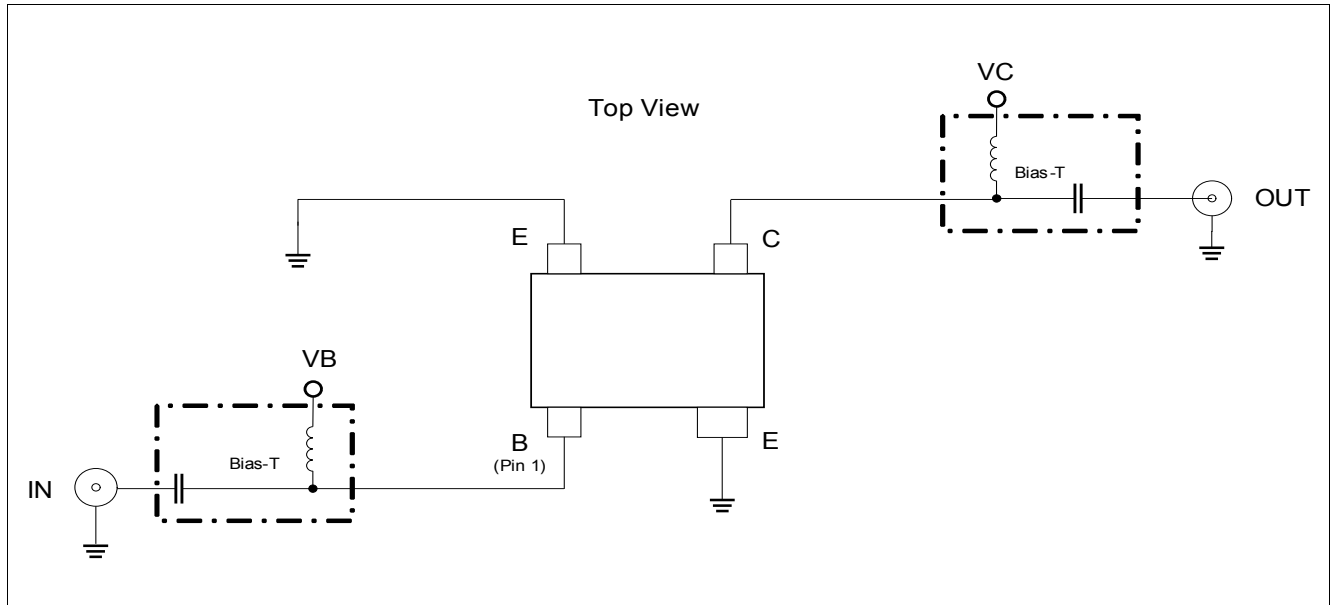


Figure 2 BFP740ESD Testing Circuit

Table 7 AC Characteristics, $V_{CE} = 3\ \text{V}$, $f = 150\ \text{MHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	34	–		$I_C = 6\ \text{mA}$
High linearity operation point	G_{ms}	–	38.5	–		$I_C = 25\ \text{mA}$
Transducer gain					dB	$Z_S = Z_L = 50\ \Omega$
Low noise operation point	S_{21}	–	25	–		$I_C = 6\ \text{mA}$
High linearity operation point	S_{21}	–	34	–		$I_C = 25\ \text{mA}$
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.55	–		$I_C = 6\ \text{mA}$
Associated gain	G_{ass}	–	30.5	–		$I_C = 6\ \text{mA}$
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB gain compression point	OP_{1dB}	–	9	–		$I_C = 25\ \text{mA}$
3rd order intercept point	OIP_3	–	23.5	–		$I_C = 25\ \text{mA}$

Electrical Characteristics
Table 8 AC Characteristics, $V_{CE} = 3\text{ V}$, $f = 450\text{ MHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain						
Low noise operation point	G_{ms}	–	29	–	dB	$I_C = 6\text{ mA}$
High linearity operation point	G_{ms}	–	33.5	–		$I_C = 25\text{ mA}$
Transducer gain						
Low noise operation point	S_{21}	–	24.5	–	dB	$Z_S = Z_L = 50\ \Omega$ $I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	32	–		$I_C = 25\text{ mA}$
Minimum noise figure						
Minimum noise figure	NF_{min}	–	0.55	–	dB	$Z_S = Z_{opt}$ $I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	28.5	–		$I_C = 6\text{ mA}$
Linearity						
1 dB gain compression point	OP_{1dB}	–	9.5	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	23.5	–		$I_C = 25\text{ mA}$

Table 9 AC Characteristics, $V_{CE} = 3\text{ V}$, $f = 900\text{ MHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain						
Low noise operation point	G_{ms}	–	26	–	dB	$I_C = 6\text{ mA}$
High linearity operation point	G_{ms}	–	30.5	–		$I_C = 25\text{ mA}$
Transducer gain						
Low noise operation point	S_{21}	–	23.5	–	dB	$Z_S = Z_L = 50\ \Omega$ $I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	29	–		$I_C = 25\text{ mA}$
Minimum noise figure						
Minimum noise figure	NF_{min}	–	0.55	–	dB	$Z_S = Z_{opt}$ $I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	25.5	–		$I_C = 6\text{ mA}$
Linearity						
1 dB gain compression point	OP_{1dB}	–	9.5	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	24	–		$I_C = 25\text{ mA}$

Electrical Characteristics
Table 10 AC Characteristics, $V_{CE} = 3\text{ V}$, $f = 1.5\text{ GHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	23.5	–		$I_C = 6\text{ mA}$
High linearity operation point	G_{ms}	–	28	–		$I_C = 25\text{ mA}$
Transducer gain					dB	$Z_S = Z_L = 50\ \Omega$
Low noise operation point	S_{21}	–	22	–		$I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	25.5	–		$I_C = 25\text{ mA}$
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.6	–		$I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	23	–		$I_C = 6\text{ mA}$
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB gain compression point	OP_{1dB}	–	10	–		$I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	24.5	–		$I_C = 25\text{ mA}$

Table 11 AC Characteristics, $V_{CE} = 3\text{ V}$, $f = 1.9\text{ GHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	22.5	–		$I_C = 6\text{ mA}$
High linearity operation point	G_{ms}	–	26.5	–		$I_C = 25\text{ mA}$
Transducer gain					dB	$Z_S = Z_L = 50\ \Omega$
Low noise operation point	S_{21}	–	21	–		$I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	24	–		$I_C = 25\text{ mA}$
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.6	–		$I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	21	–		$I_C = 6\text{ mA}$
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB gain compression point	OP_{1dB}	–	10	–		$I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	25	–		$I_C = 25\text{ mA}$

Electrical Characteristics
Table 12 AC Characteristics, $V_{CE} = 3\text{ V}$, $f = 2.4\text{ GHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	22	–		$I_C = 6\text{ mA}$
High linearity operation point	G_{ms}	–	25.5	–		$I_C = 25\text{ mA}$
Transducer gain					dB	$Z_S = Z_L = 50\ \Omega$
Low noise operation point	S_{21}	–	19.5	–		$I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	22	–		$I_C = 25\text{ mA}$
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.65	–		$I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	20	–		$I_C = 6\text{ mA}$
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB gain compression point	OP_{1dB}	–	10.5	–		$I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	25	–		$I_C = 25\text{ mA}$

Table 13 AC Characteristics, $V_{CE} = 3\text{ V}$, $f = 3.5\text{ GHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	20.5	–		$I_C = 6\text{ mA}$
High linearity operation point	G_{ms}	–	23	–		$I_C = 25\text{ mA}$
Transducer gain					dB	$Z_S = Z_L = 50\ \Omega$
Low noise operation point	S_{21}	–	17	–		$I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	19	–		$I_C = 25\text{ mA}$
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.7	–		$I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	16.5	–		$I_C = 6\text{ mA}$
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB gain compression point	OP_{1dB}	–	10.5	–		$I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	24.5	–		$I_C = 25\text{ mA}$

Electrical Characteristics
Table 14 AC Characteristics, $V_{CE} = 3\text{ V}$, $f = 5.5\text{ GHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	19	–		$I_C = 6\text{ mA}$
High linearity operation point	G_{ma}	–	18.5	–		$I_C = 25\text{ mA}$
Transducer gain					dB	$Z_S = Z_L = 50\ \Omega$
Low noise operation point	S_{21}	–	13	–		$I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	14.5	–		$I_C = 25\text{ mA}$
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.9	–		$I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	13.5	–		$I_C = 6\text{ mA}$
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB gain compression point	OP_{1dB}	–	10	–		$I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	24	–		$I_C = 25\text{ mA}$

Table 15 AC Characteristics, $V_{CE} = 3\text{ V}$, $f = 10\text{ GHz}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	14.5	–		$I_C = 6\text{ mA}$
High linearity operation point	G_{ms}	–	14.5	–		$I_C = 25\text{ mA}$
Transducer gain					dB	$Z_S = Z_L = 50\ \Omega$
Low noise operation point	S_{21}	–	5.5	–		$I_C = 6\text{ mA}$
High linearity operation point	S_{21}	–	7.5	–		$I_C = 25\text{ mA}$
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	1.8	–		$I_C = 6\text{ mA}$
Associated gain	G_{ass}	–	8.5	–		$I_C = 6\text{ mA}$
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB gain compression point	OP_{1dB}	–	7.5	–		$I_C = 25\text{ mA}$
3rd order intercept point	OIP_3	–	21	–		$I_C = 25\text{ mA}$

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.

5.4 Characteristic DC Diagrams

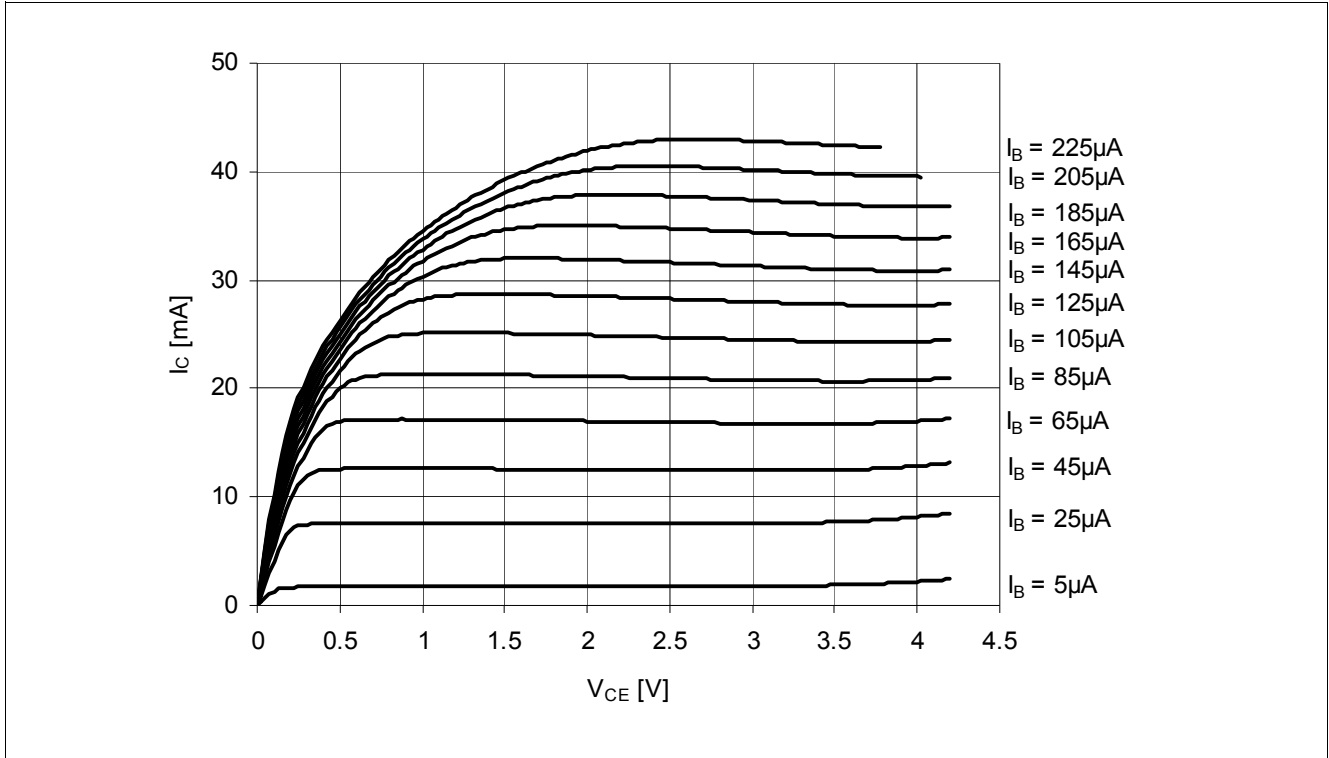


Figure 3 Collector Current vs. Collector Emitter Voltage $I_C = f(V_{CE})$, $I_B = \text{Parameter}$

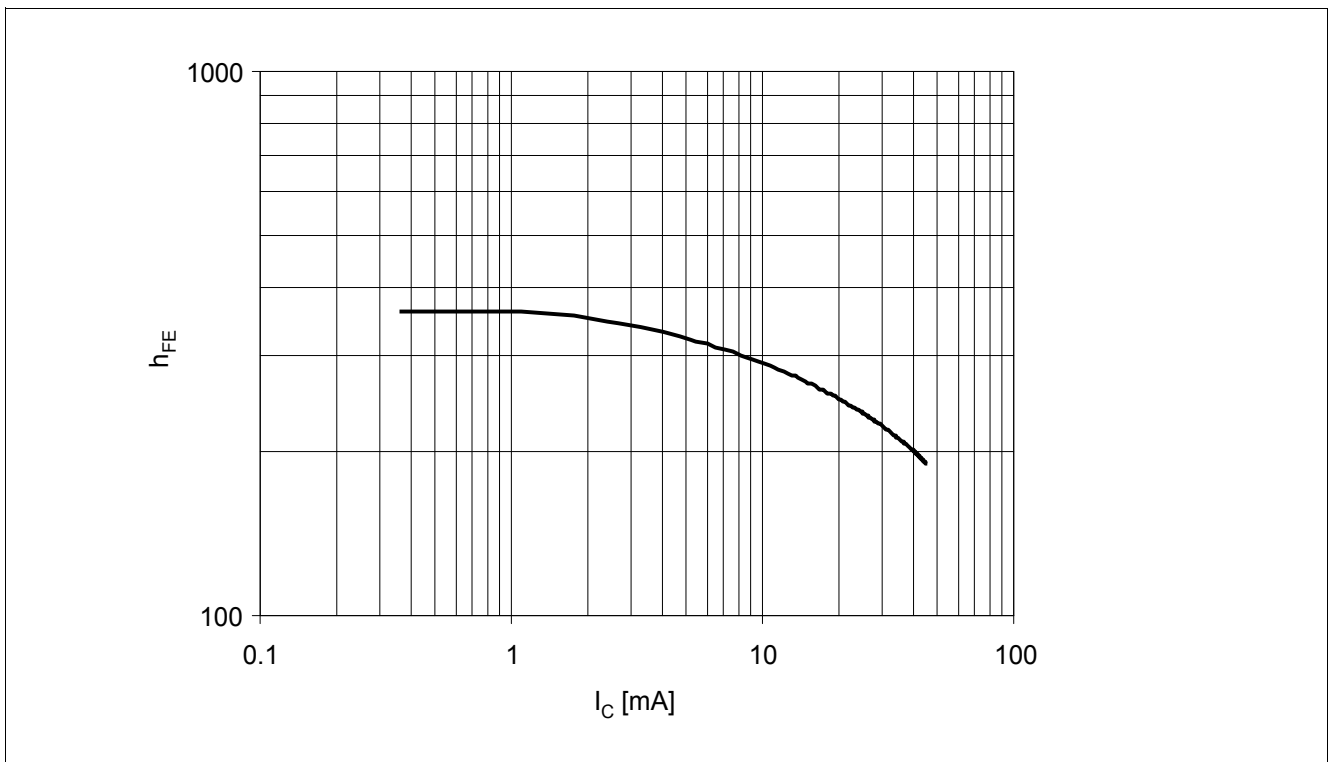


Figure 4 DC Current Gain $h_{FE} = f(I_C)$, $V_{CE} = 3 \text{ V}$

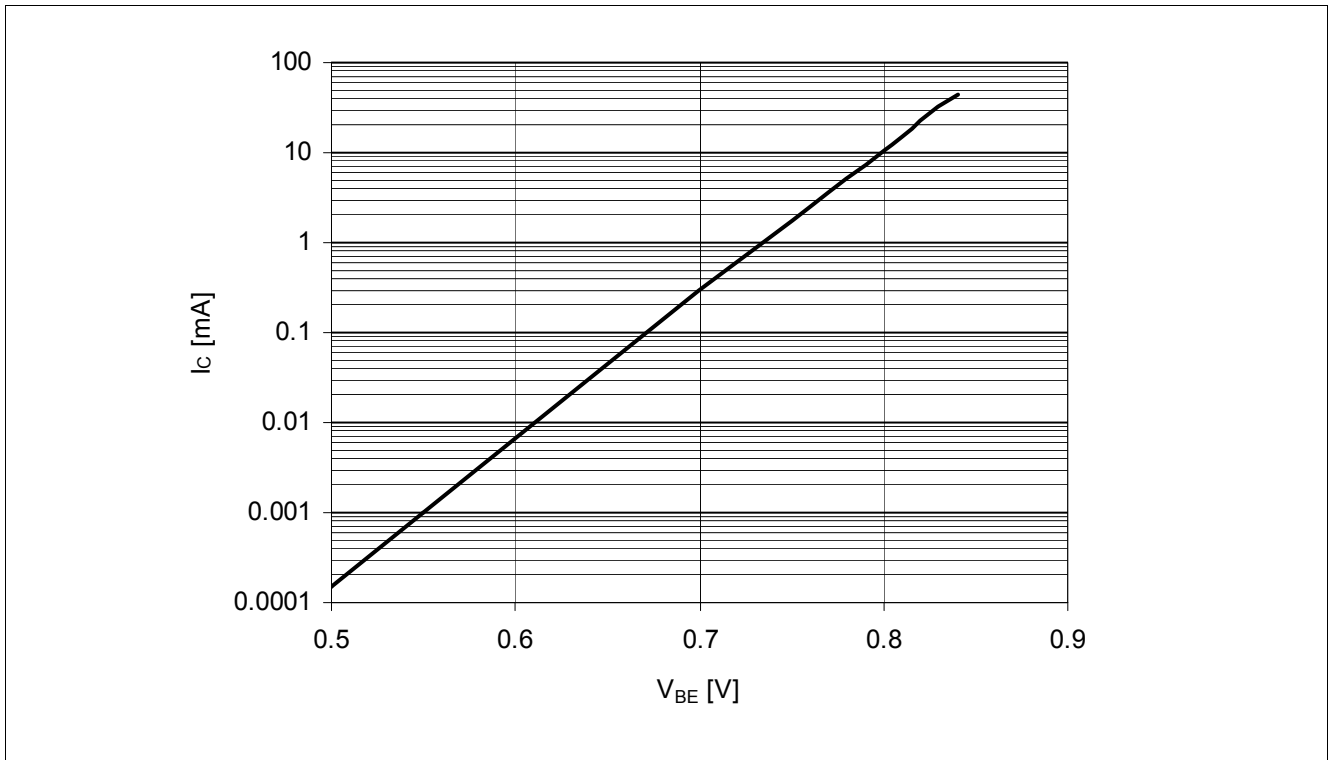


Figure 5 Collector Current vs. Base Emitter Voltage $I_C = f(V_{BE})$, $V_{CE} = 2\text{ V}$

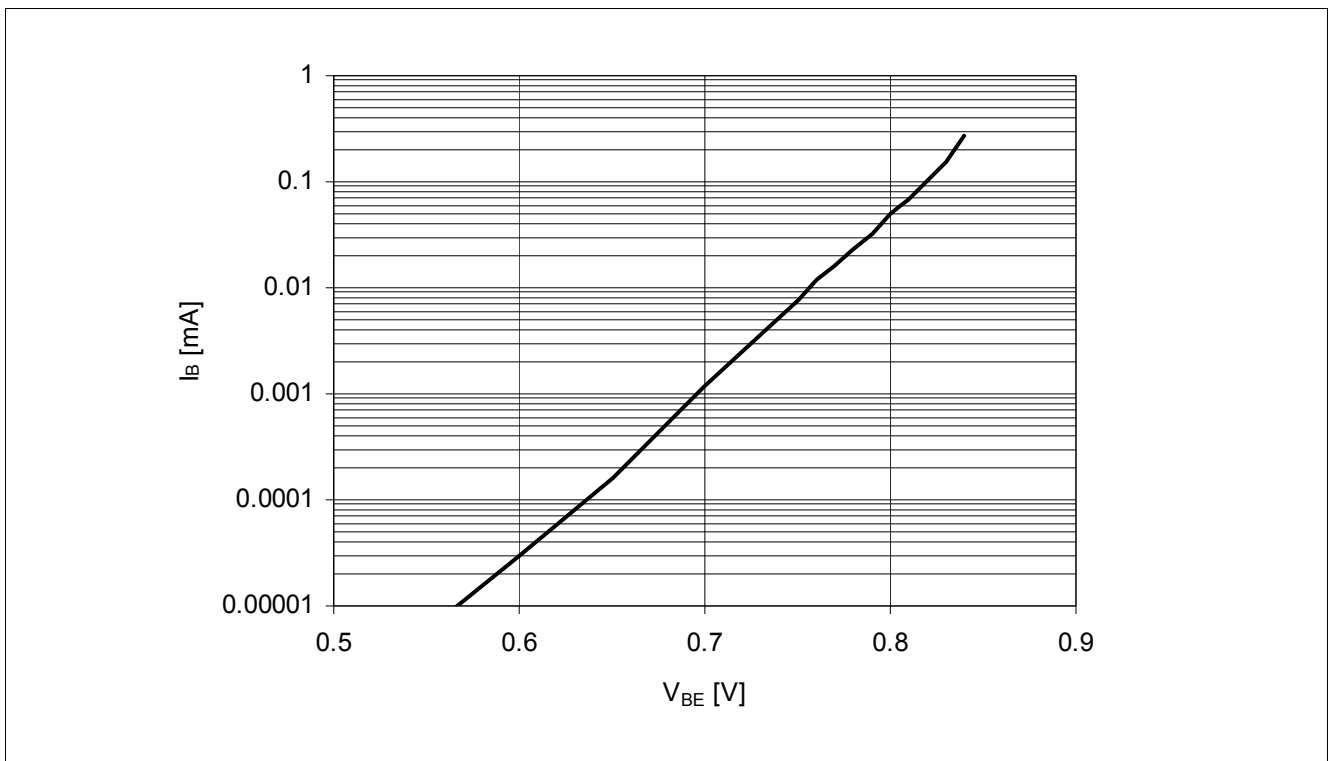


Figure 6 Base Current vs. Base Emitter Forward Voltage $I_B = f(V_{BE})$, $V_{CE} = 2\text{ V}$

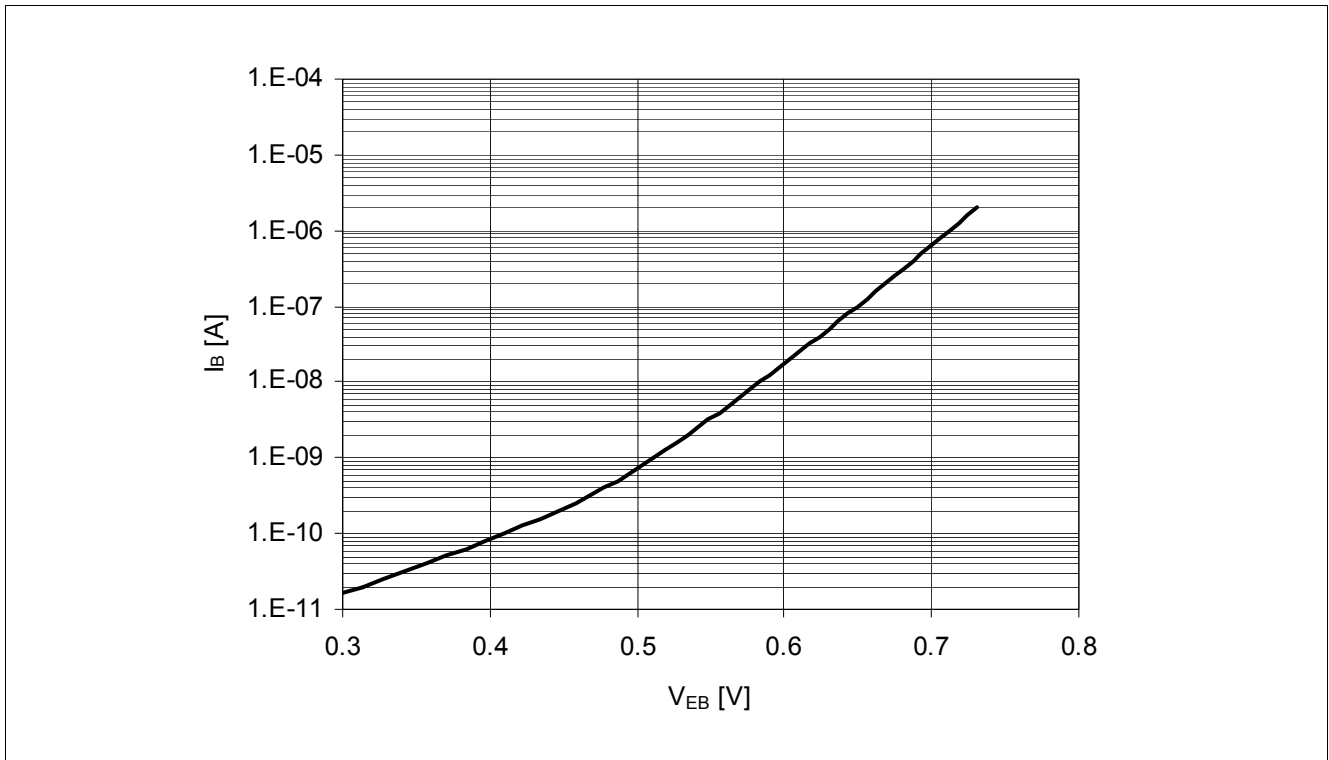


Figure 7 Base Current vs. Base Emitter Reverse Voltage $I_B = f(V_{EB}), V_{CE} = 2\text{ V}$

5.5 Characteristic AC Diagrams

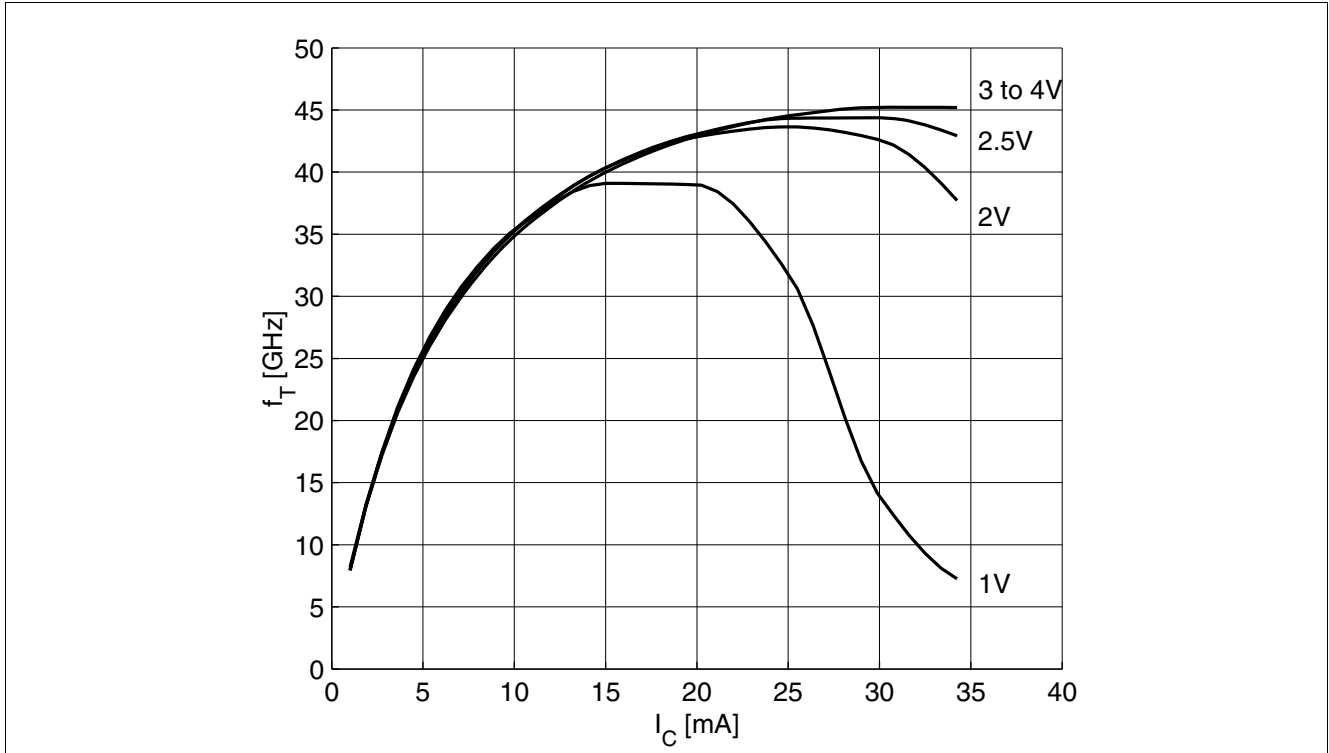


Figure 8 Transition Frequency $f_T = f(I_C)$, $f = 2$ GHz, $V_{CE} = \text{Parameter}$

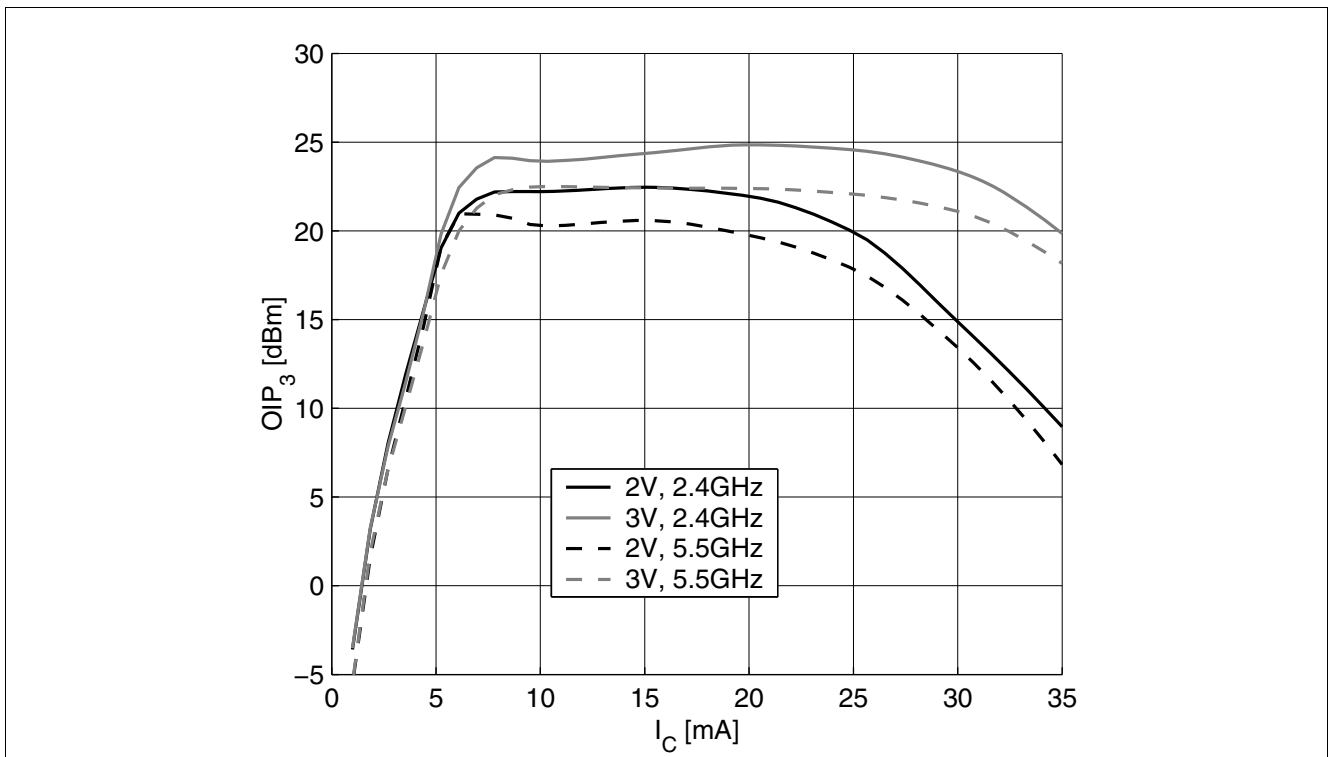


Figure 9 3rd Order Intercept Point $OIP_3 = f(I_C)$, $Z_S = Z_L = 50 \Omega$, $V_{CE}, f = \text{Parameters}$

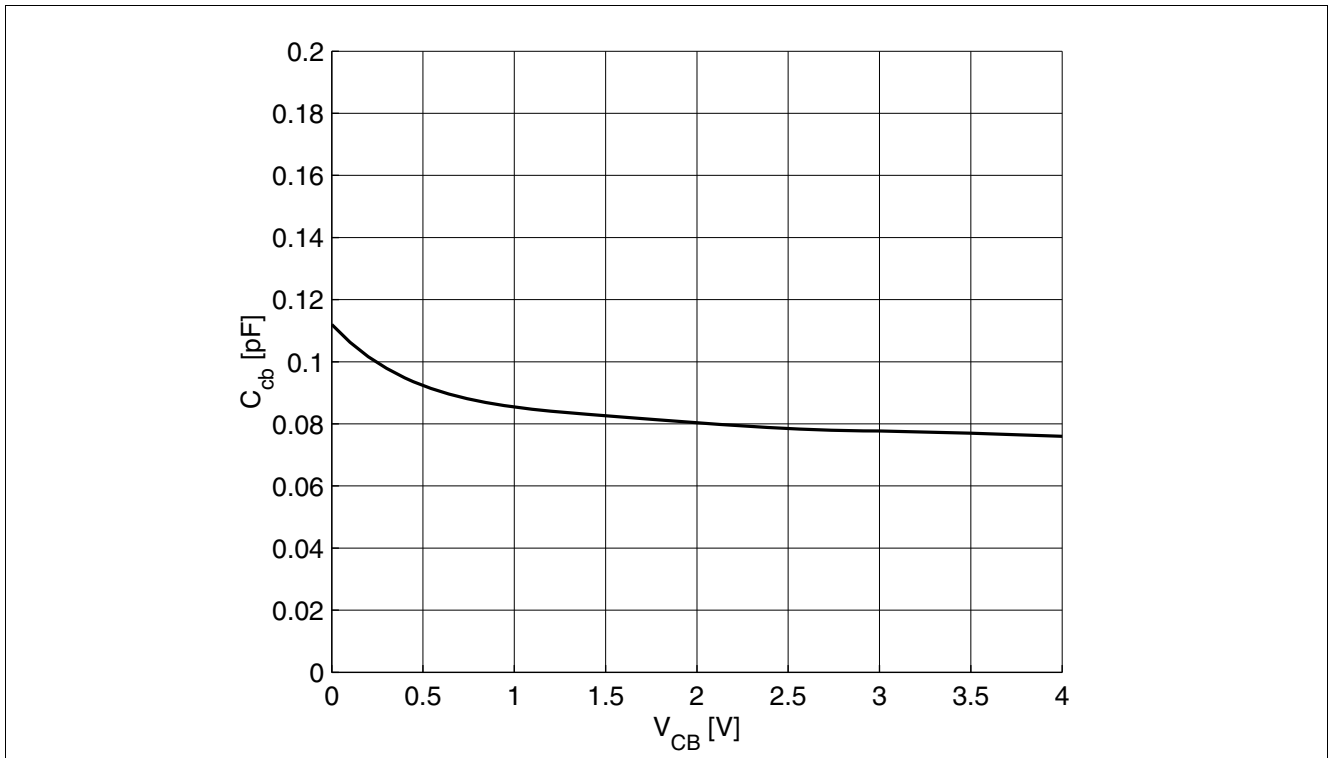


Figure 10 Collector Base Capacitance $C_{CB} = f(V_{CB})$, $f = 1$ MHz

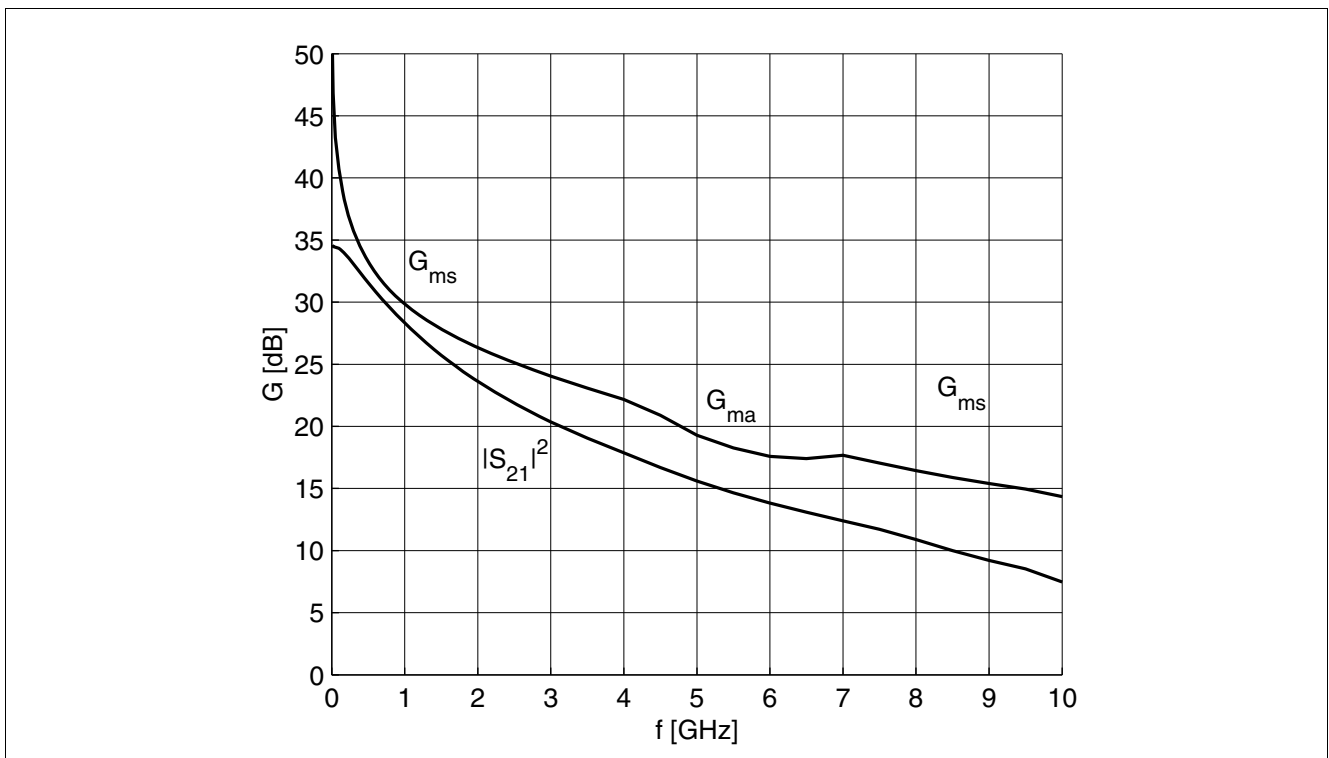


Figure 11 Gain G_{ma} , G_{ms} , $|S_{21}|^2 = f(f)$, $V_{CE} = 3$ V, $I_C = 25$ mA

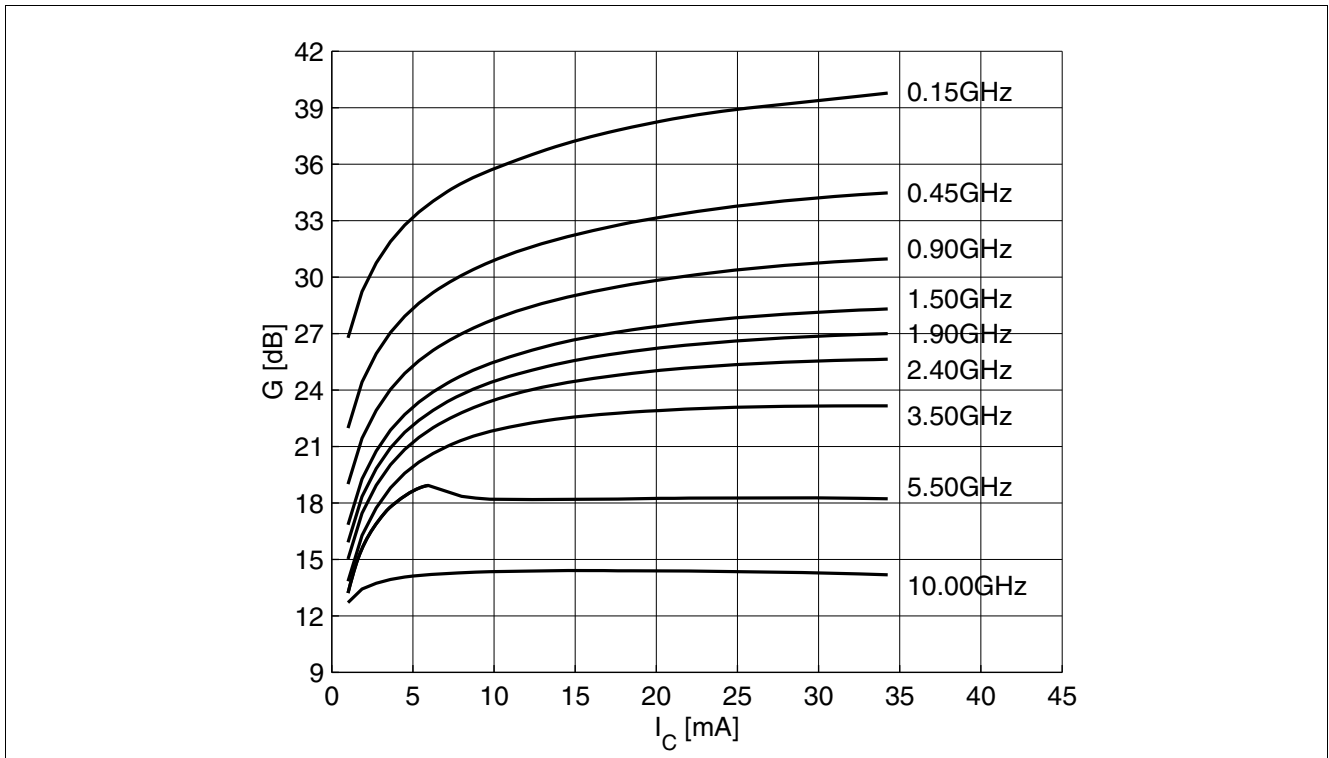


Figure 12 Maximum Power Gain $G_{max} = f(I_C)$, $V_{CE} = 3\text{ V}$, $f = \text{Parameter in GHz}$

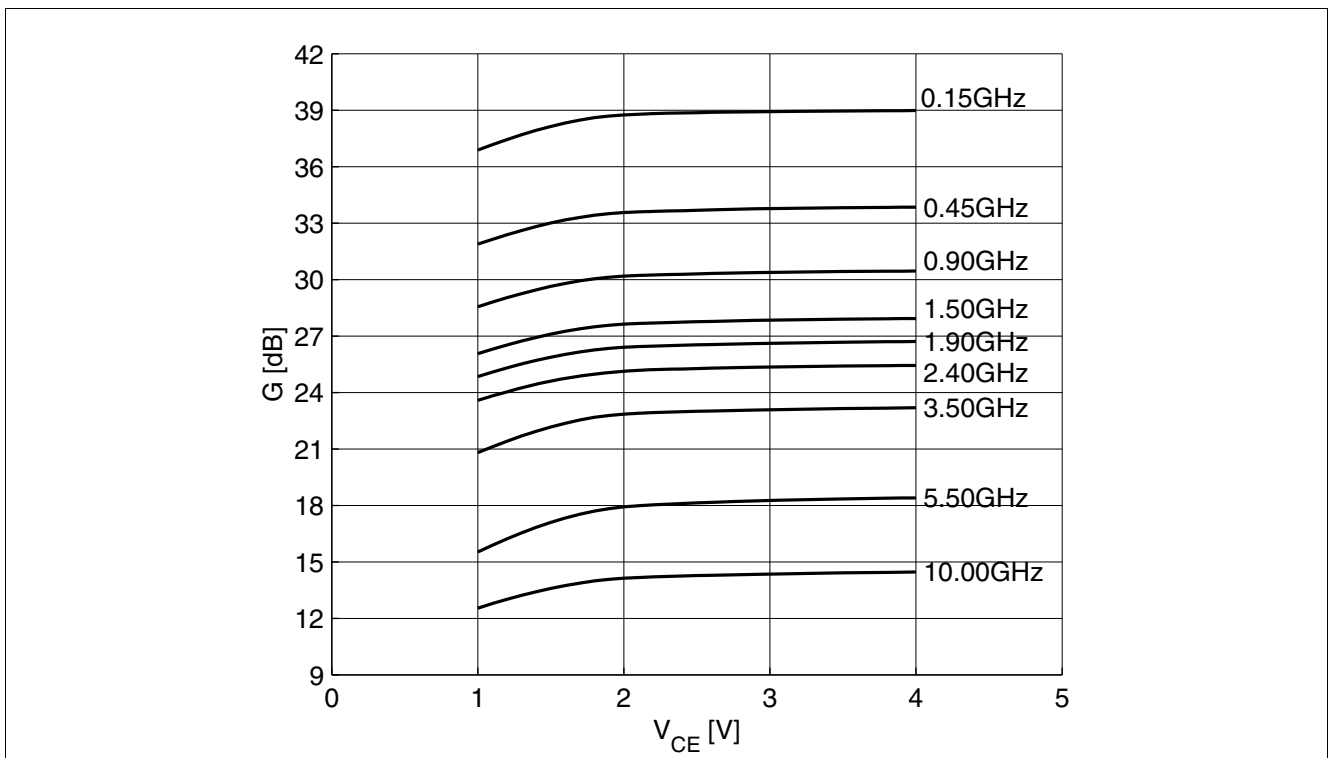


Figure 13 Maximum Power Gain $G_{max} = f(V_{CE})$, $I_C = 25\text{ mA}$, $f = \text{Parameter in GHz}$

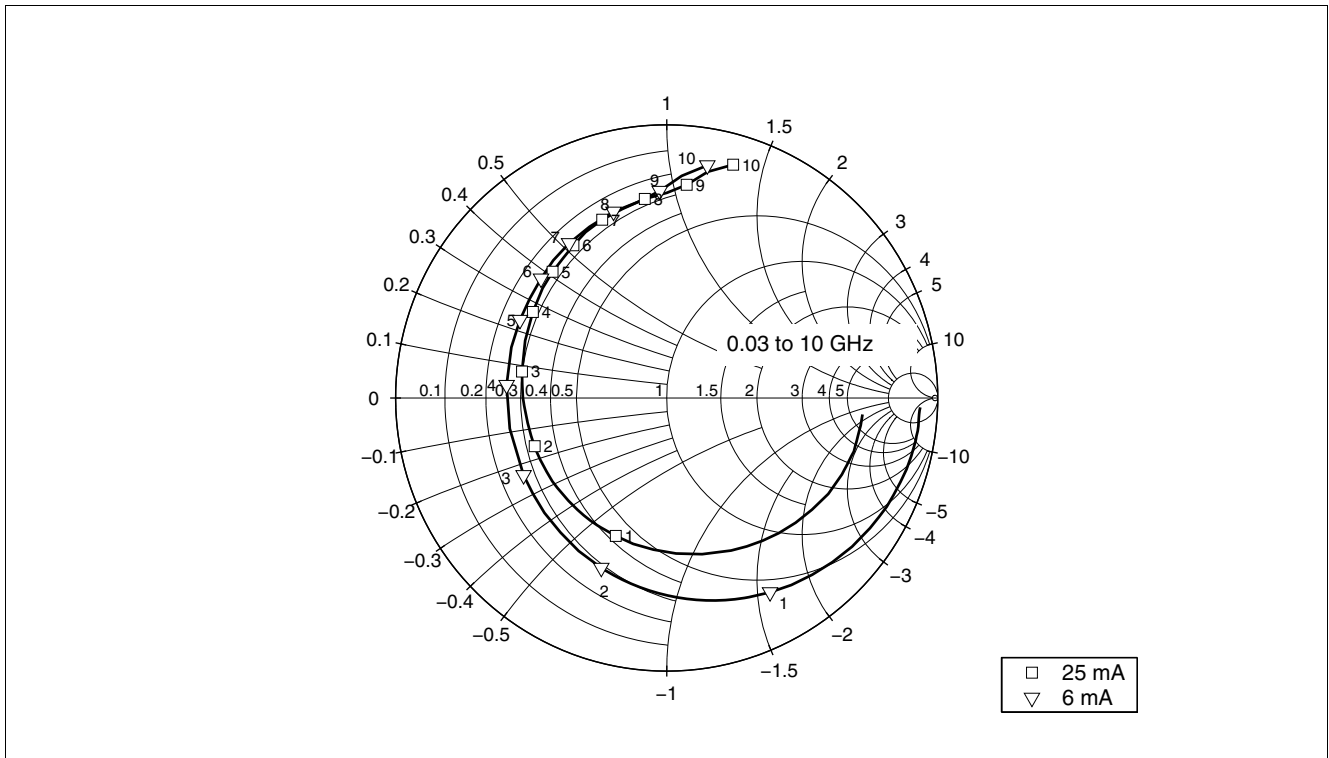


Figure 14 Input Matching $S_{11} = f(f)$, $V_{CE} = 3\text{ V}$, $I_C = 6 / 25\text{ mA}$

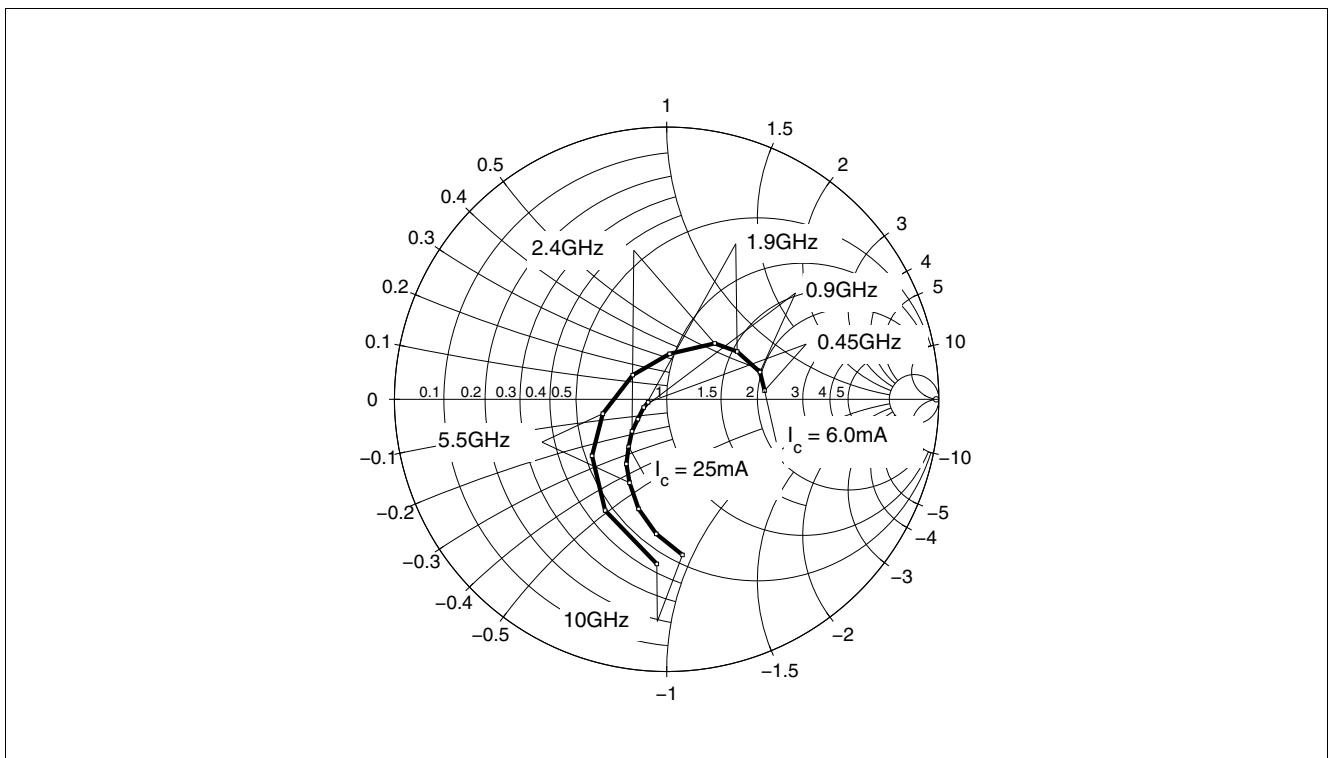


Figure 15 Source Impedance for Minimum Noise Figure $Z_{opt} = f(f)$, $V_{CE} = 3\text{ V}$, $I_C = 6 / 25\text{ mA}$

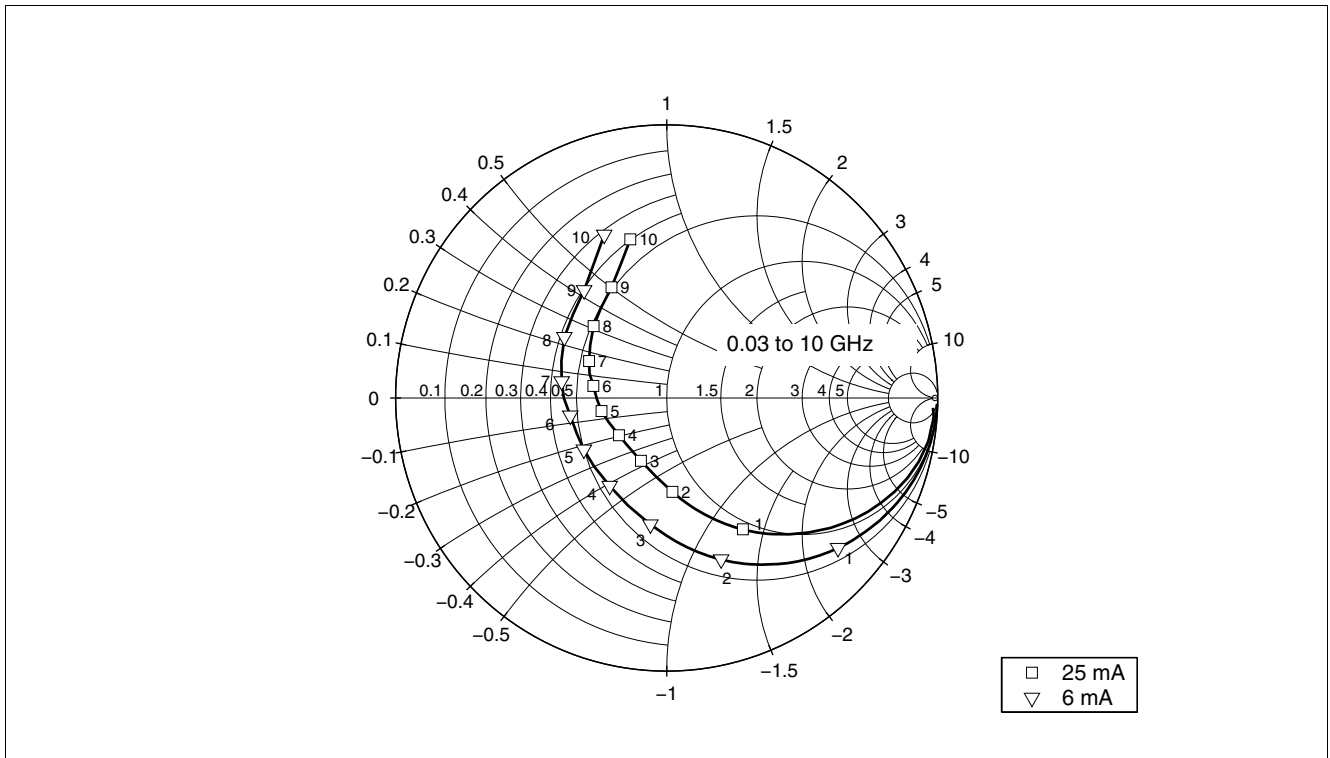


Figure 16 Output Matching $S_{22} = f(f)$, $V_{CE} = 3 \text{ V}$, $I_C = 6 / 25 \text{ mA}$

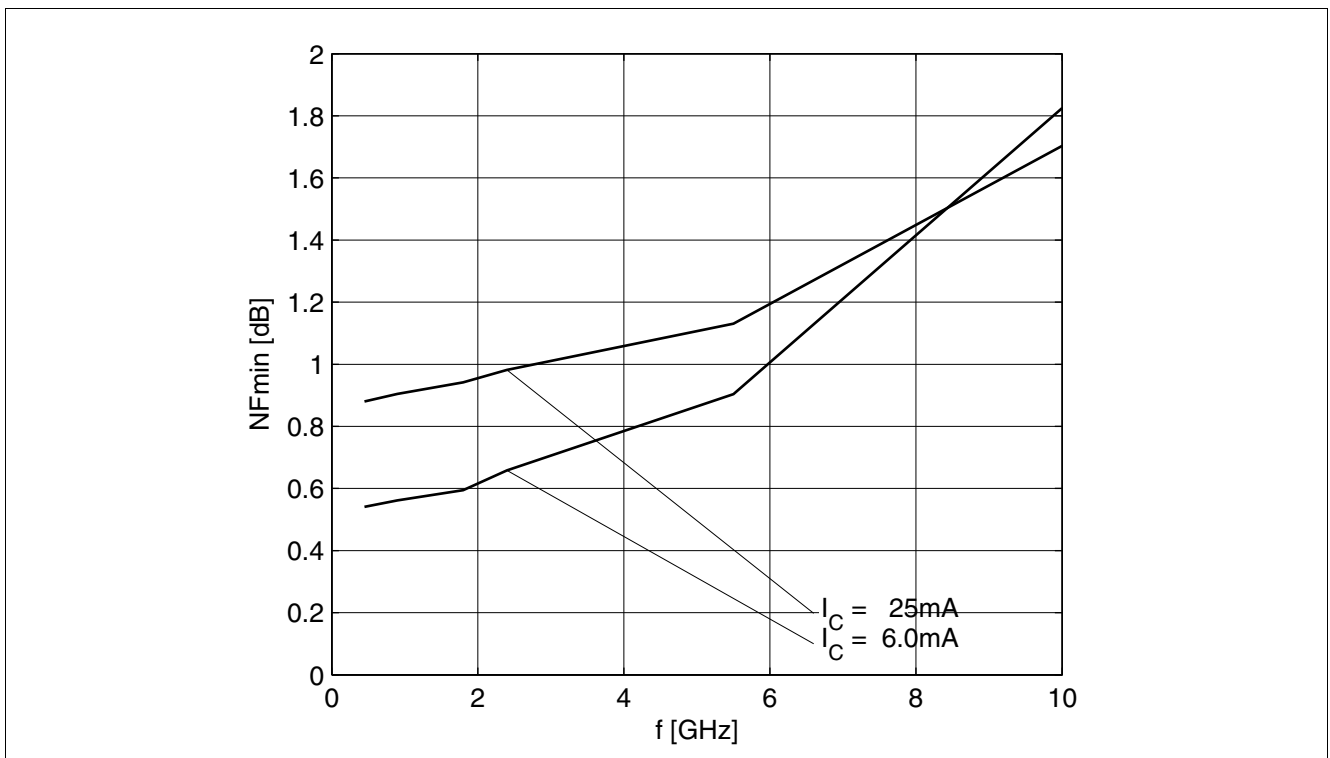


Figure 17 Noise Figure $NF_{min} = f(f)$, $V_{CE} = 3 \text{ V}$, $I_C = 6 / 25 \text{ mA}$, $Z_S = Z_{opt}$