BFP720FESD

Robust High Performance Low Noise Bipolar RF Transistor

Data Sheet

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RF & Protection Devices

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BFP720FESD, Robust High Performance Low Noise Bipolar RF Transistor

Revision History: 2010-06-29, Revision 1.1

Previous Revision 1.0:

Page	Subjects (major changes since last revision)
10	Icmax changed from 25mA to 30mA, PRFin value added
18-21	Characteristic DC diagrams and OIP3 diagram added

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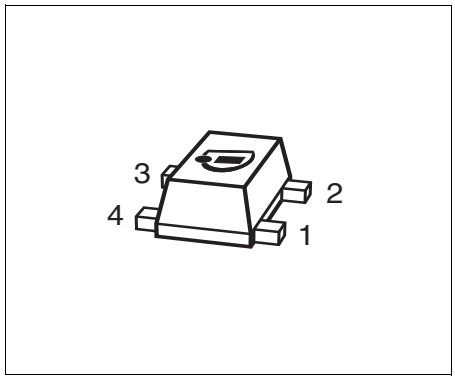
1 Features



- 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
- 0.6 dB minimum noise figure typical at 2.4 GHz, 0.8 dB at 10 GHz, 5 mA
- 26 dB maximum gain (G_{ms}) typical at 2.4 GHz, 22 dB at 5.5 GHz, 15 mA
- 21 dBm OIP3 typical at 5.5 GHz, 15 mA
- Accurate SPICE GP model available to enable effective design in process (see chapter 6)
- Thin, small, flat, Pb- and halogen free (RoHS compliant) package with visible leads

RoHS

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 (GPS, Glonass), satellite radio (SDARs, DAB) and LNB
- 3G/4G UMTS/LTE mobile phone applications
- Multimedia applications such as mobile/portable TV, CATV, FM Radio
- ISM applications like RKE, AMR and Zigbee, as well as for emerging wireless applications

As discrete active mixer, amplifier in VCO's and buffer amplifier.

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

Product Name	Package	Pin Configuration				Marking
BFP720FESD	TSFP-4-1	1 = B	2 = E	3 = C	4 = E	T3s

2 Product Brief

The BFP720FESD is a Silicon Germanium Carbon (SiGe:C) NPN Heterojunction wideband Bipolar RF Transistor (HBT) in a thin, small, flat, 4-pin dual emitter plastic 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 BFP720FESD 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°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 mA, I_B = 0 Open base
Collector base leakage current	I_{CBO}	–	–	400	nA	V_{CB} = 2 V, I_E = 0 Open emitter
DC current gain	h_{FE}	160	250	400		V_{CE} = 3 V, I_C = 15 mA
Collector current	I_C	–	–	30	mA	
Total power dissipation	P_{tot}	–	–	100	mW	$T_S \leq$ 109 °C

Table 2 Quick Reference AC Characteristics at T_A = 25°C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transition frequency	f_T	–	45	–	GHz	V_{CE} = 3 V, I_C = 15mA f = 1 GHz
V_{CE} = 3 V, f = 2.4 GHz						
Maximum Power Gain					dB	
Low noise operation point	G_{ms}	–	22.5	–		I_C = 5 mA
High linearity operation point	G_{ms}	–	26	–		I_C = 15 mA
Transducer Gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	20	–		I_C = 5 mA
High linearity operation point	S_{21}	–	23.5	–		I_C = 15 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.6	–		I_C = 5 mA
Associated gain	G_{ass}	–	21	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	7	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	22	–		I_C = 15 mA
V_{CE} = 3 V, f = 5.5 GHz						
Maximum Power Gain					dB	
Low noise operation point	G_{ms}	–	19.5	–		I_C = 5 mA
High linearity operation point	G_{ms}	–	22	–		I_C = 15 mA
Transducer Gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	15	–		I_C = 5 mA
High linearity operation point	S_{21}	–	17	–		I_C = 15 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.8	–		I_C = 5 mA
Associated gain	G_{ass}	–	16	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	7	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	21	–		I_C = 15 mA

3 Maximum Ratings

Table 3 Maximum Ratings at T_A = 25°C (unless otherwise specified)

Parameter	Symbol	Values		Unit	Note / Test Condition
		Min.	Max.		
Collector emitter voltage	V_{CEO}				Open base
		–	4.2	V	T_A = 25°C
		–	3.7	V	T_A = -55 °C
Collector base voltage[1]	V_{CBO}				Open emitter
		–	4.9	V	T_A = 25°C
		–	4.4	V	T_A = -55 °C
Collector emitter voltage[2]	V_{CES}				Emitter / base shortened
		–	4.2	V	T_A = 25°C
		–	3.7	V	T_A = -55 °C
Base current[3]	I_B	-10	3	mA	–
Collector current	I_C	–	30	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}	–	100	mW	$T_S \leq$ 109 °C
Junction temperature	T_J	–	150	°C	–
Storage temperature	T_{Stg}	-55	150	°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}	–	405	–	K/W	–

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

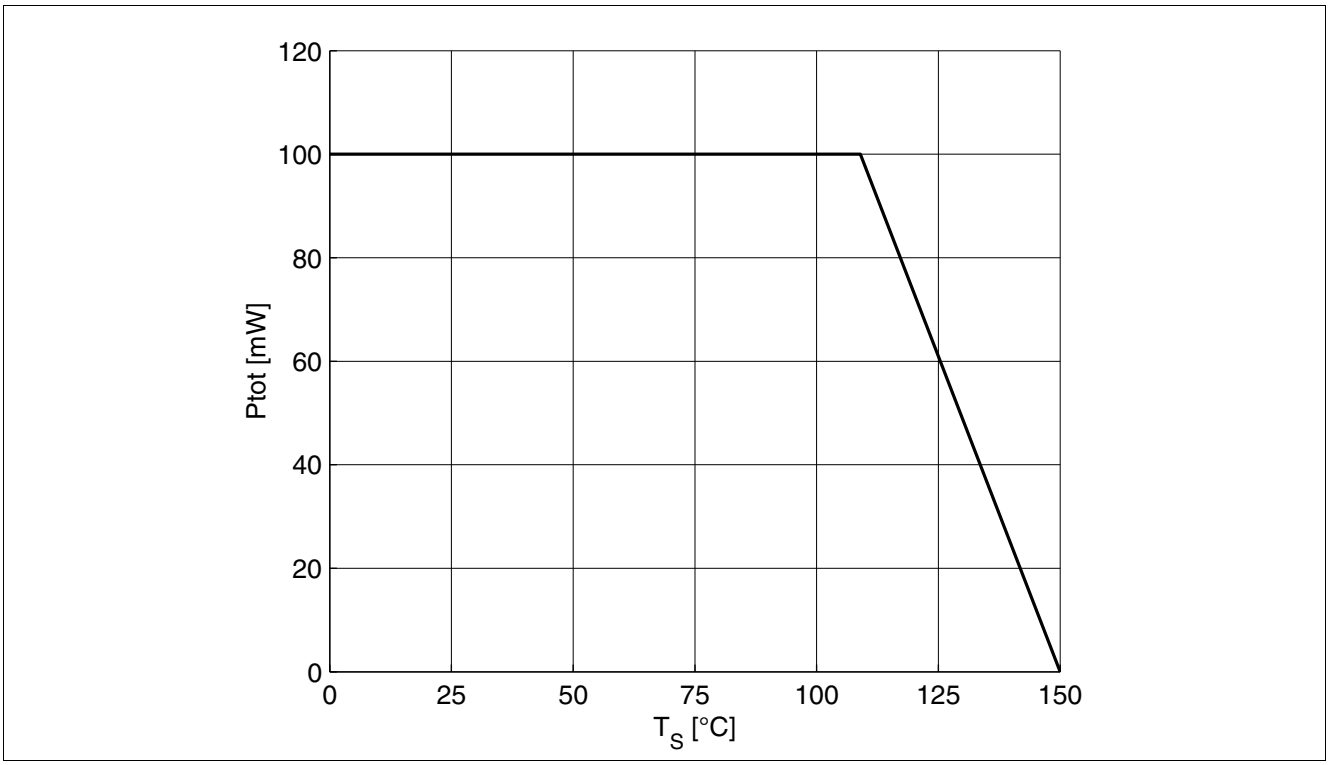


Figure 1 Total Power Dissipation $P_{tot} = f(T_s)$

5 Electrical Characteristics

5.1 DC Characteristics

Table 5 DC Characteristics at T_A = 25 °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 mA, I_B = 0 Open base
Collector emitter leakage current	I_{CES}	–	–	400	nA	V_{CE} = 2 V, V_{BE} = 0 Emitter/base shortened
Collector base leakage current	I_{CBO}	–	–	400	nA	V_{CB} = 2 V, I_E = 0 Open emitter
Emitter base leakage current	I_{EBO}	–	–	10	µA	V_{EB} = 0.5 V, I_C = 0 Open collector
DC current gain	h_{FE}	160	250	400		V_{CE} = 3 V, I_C = 15 mA Pulse measured

5.2 General AC Characteristics

Table 6 General AC Characteristics at T_A = 25 °C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transition frequency	f_T	–	45	–	GHz	V_{CE} = 3 V, I_C = 15 mA f = 1 GHz
Collector base capacitance	C_{CB}	–	0.05	–	pF	V_{CB} = 3 V, V_{BE} = 0 V f = 1 MHz Emitter grounded
Collector emitter capacitance	C_{CE}	–	0.35	–	pF	V_{CE} = 3 V, V_{BE} = 0 V f = 1 MHz Base grounded
Emitter base capacitance	C_{EB}	–	0.4	–	pF	V_{EB} = 0.4 V, V_{CB} = 0 V f = 1 MHz Collector grounded

5.3 Frequency Dependent AC Characteristics

Measurement setup is a test fixture with Bias T's in a 50 Ω system, T_A = 25 °C

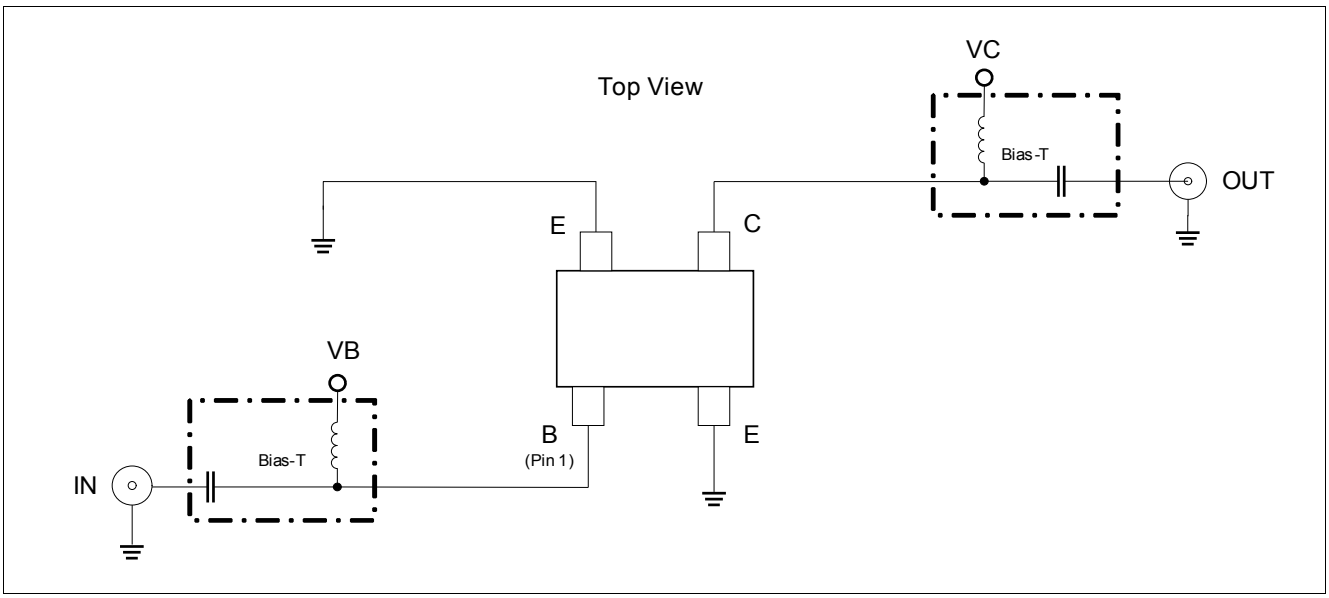


Figure 2 BFP720FESD Testing Circuit

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	34.5	–		I_C = 5 mA
High linearity operation point	G_{ms}	–	38.5	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	23.5	–		I_C = 5 mA
High linearity operation point	S_{21}	–	30.5	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.5	–		I_C = 5 mA
Associated gain	G_{ass}	–	29	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	6	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	21.5	–		I_C = 15 mA

Table 8 AC Characteristics, V_{CE} = 3 V, f = 450 MHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	30	–		I_C = 5 mA
High linearity operation point	G_{ms}	–	33.5	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	23	–		I_C = 5 mA
High linearity operation point	S_{21}	–	30	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.5	–		I_C = 5 mA
Associated gain	G_{ass}	–	27.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	6	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	21.5	–		I_C = 15 mA

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	26.5	–		I_C = 5 mA
High linearity operation point	G_{ms}	–	30.5	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	22.5	–		I_C = 5 mA
High linearity operation point	S_{21}	–	28.5	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.55	–		I_C = 5 mA
Associated gain	G_{ass}	–	25.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	6.5	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	22	–		I_C = 15 mA

Table 10 AC Characteristics, V_{CE} = 3 V, f = 1.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	24.5	–		I_C = 5 mA
High linearity operation point	G_{ms}	–	28	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	21.5	–		I_C = 5 mA
High linearity operation point	S_{21}	–	26	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.55	–		I_C = 5 mA
Associated gain	G_{ass}	–	23.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	7	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	22	–		I_C = 15 mA

Table 11 AC Characteristics, V_{CE} = 3 V, f = 1.9 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 = 5 mA
High linearity operation point	G_{ms}	–	27	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	21	–		I_C = 5 mA
High linearity operation point	S_{21}	–	25	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.55	–		I_C = 5 mA
Associated gain	G_{ass}	–	22.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	7	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	22	–		I_C = 15 mA

Table 12 AC Characteristics, V_{CE} = 3 V, f = 2.4 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 = 5 mA
High linearity operation point	G_{ms}	–	26	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	20	–		I_C = 5 mA
High linearity operation point	S_{21}	–	23.5	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.6	–		I_C = 5 mA
Associated gain	G_{ass}	–	21	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	7	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	22	–		I_C = 15 mA

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	21	–		I_C = 5 mA
High linearity operation point	G_{ms}	–	24.5	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	18	–		I_C = 5 mA
High linearity operation point	S_{21}	–	20.5	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.65	–		I_C = 5 mA
Associated gain	G_{ass}	–	19	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	7	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	21.5	–		I_C = 15 mA

Table 14 AC Characteristics, V_{CE} = 3 V, f = 5.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ms}	–	19.5	–		I_C = 5 mA
High linearity operation point	G_{ms}	–	22	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	15	–		I_C = 5 mA
High linearity operation point	S_{21}	–	17	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	0.8	–		I_C = 5 mA
Associated gain	G_{ass}	–	16	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	7	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	21	–		I_C = 15 mA

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum power gain					dB	
Low noise operation point	G_{ma}	–	14	–		I_C = 5 mA
High linearity operation point	G_{ma}	–	15	–		I_C = 15 mA
Transducer gain					dB	$Z_S = Z_L$ = 50 Ω
Low noise operation point	S_{21}	–	9	–		I_C = 5 mA
High linearity operation point	S_{21}	–	11	–		I_C = 15 mA
Minimum noise figure					dB	$Z_S = Z_{opt}$
Minimum noise figure	NF_{min}	–	1.3	–		I_C = 5 mA
Associated gain	G_{ass}	–	10	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB gain compression point	OP_{1dB}	–	6	–		I_C = 15 mA
3rd order intercept point	OIP_3	–	20	–		I_C = 15 mA

Note:

1. *$G_{ms} = |S_{21} / S_{12}|$ for k < 1; $G_{ma} = |S_{21} / S_{12}|(k-(k^2-1)^{1/2})$ for k > 1*
2. *In order to get the NF_{min} values stated in this chapter the test fixture losses have been subtracted from all measured results.*
3. *$OIP3_3$ value depends on termination of all intermodulation frequency components. Termination used for this measurement is 50 Ω from 0.2 MHz to 12 GHz.*

5.4 Characteristic DC Diagrams

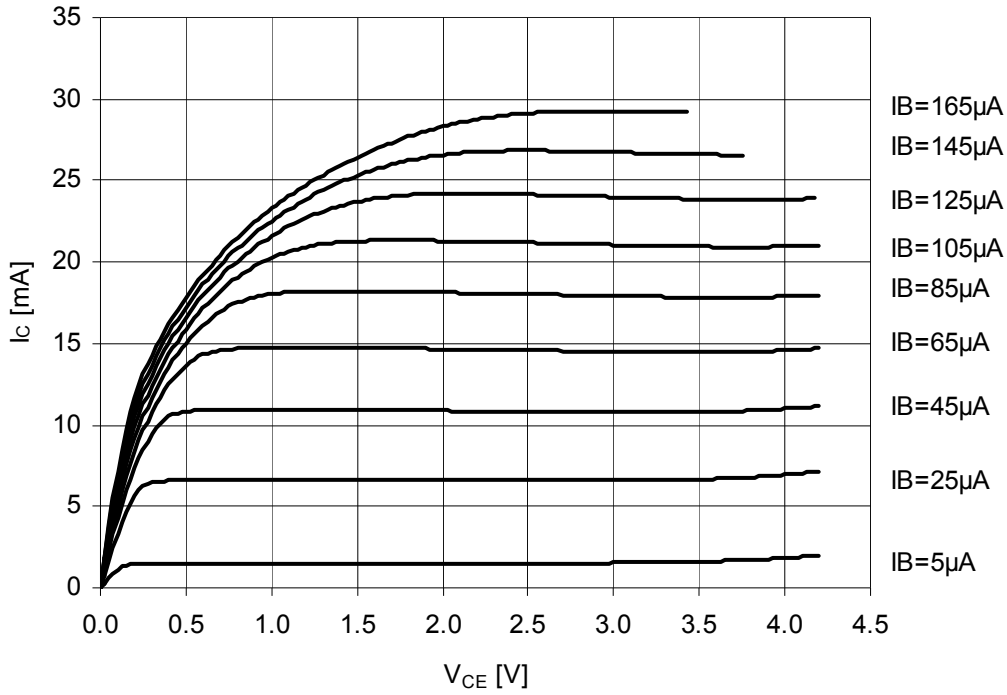


Figure 3 Collector Current vs. Collector Emitter Voltage $I_C = f(V_{CE})$, I_B = Parameter

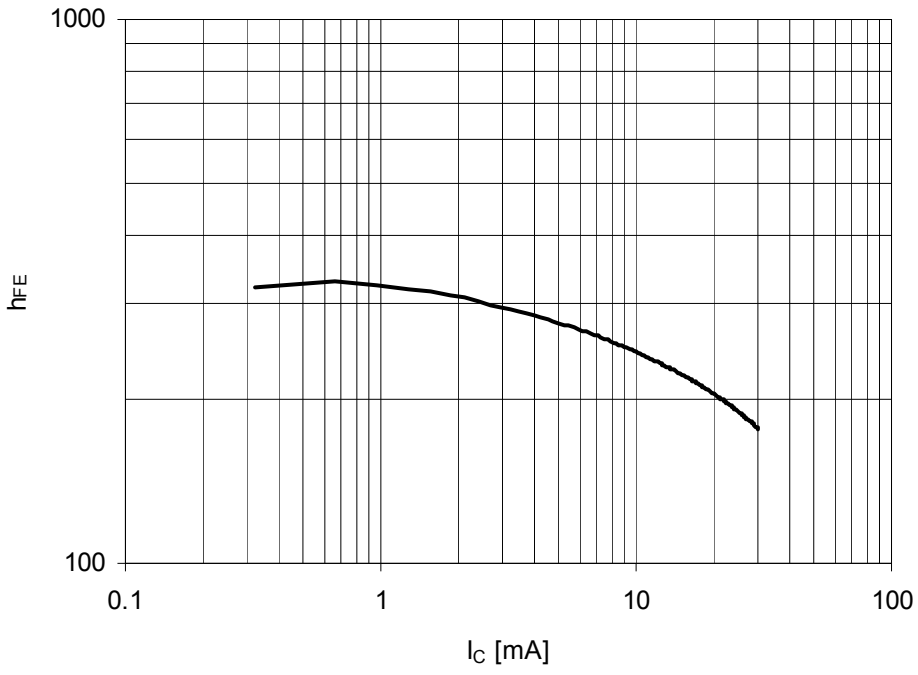


Figure 4 DC Current Gain $h_{FE} = f(I_C)$, V_{CE} = 3 V

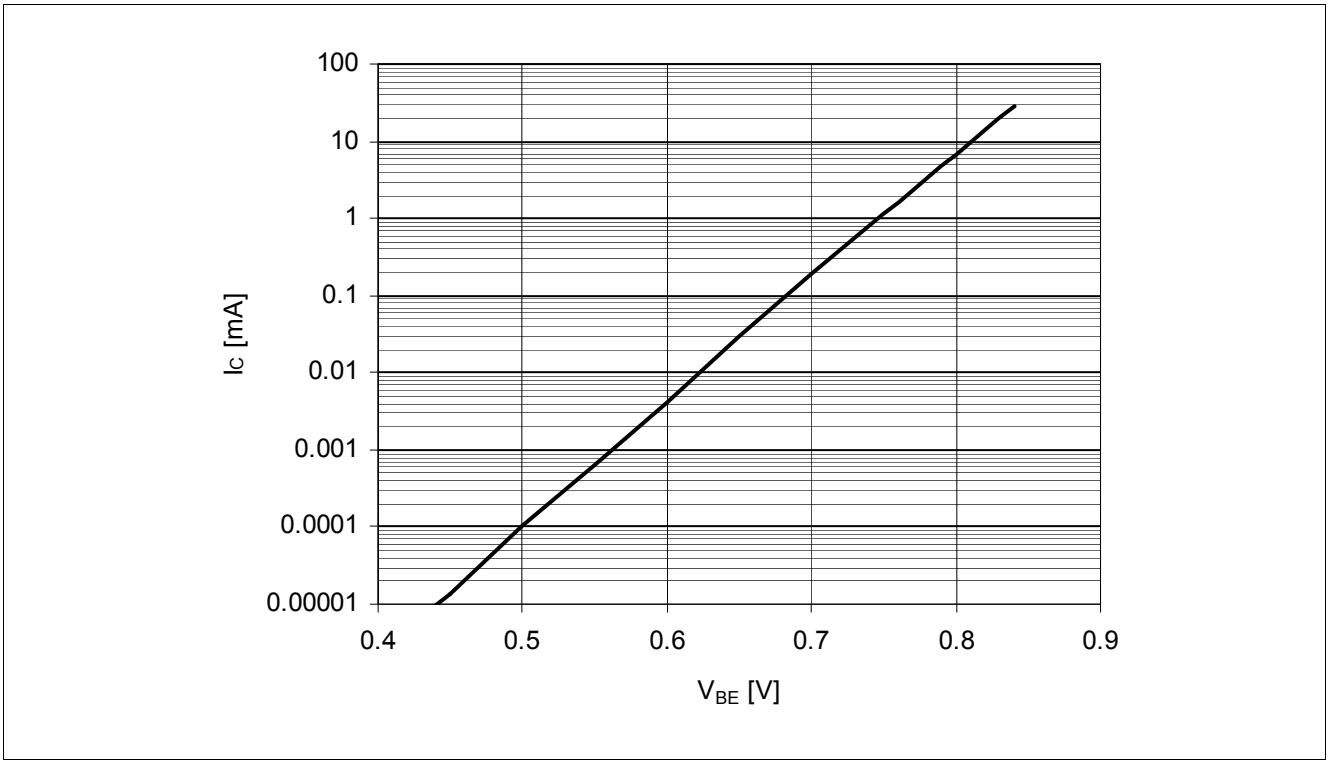


Figure 5 Collector Current vs. Base Emitter Voltage $I_C = f(V_{BE})$, V_{CE} = 2 V

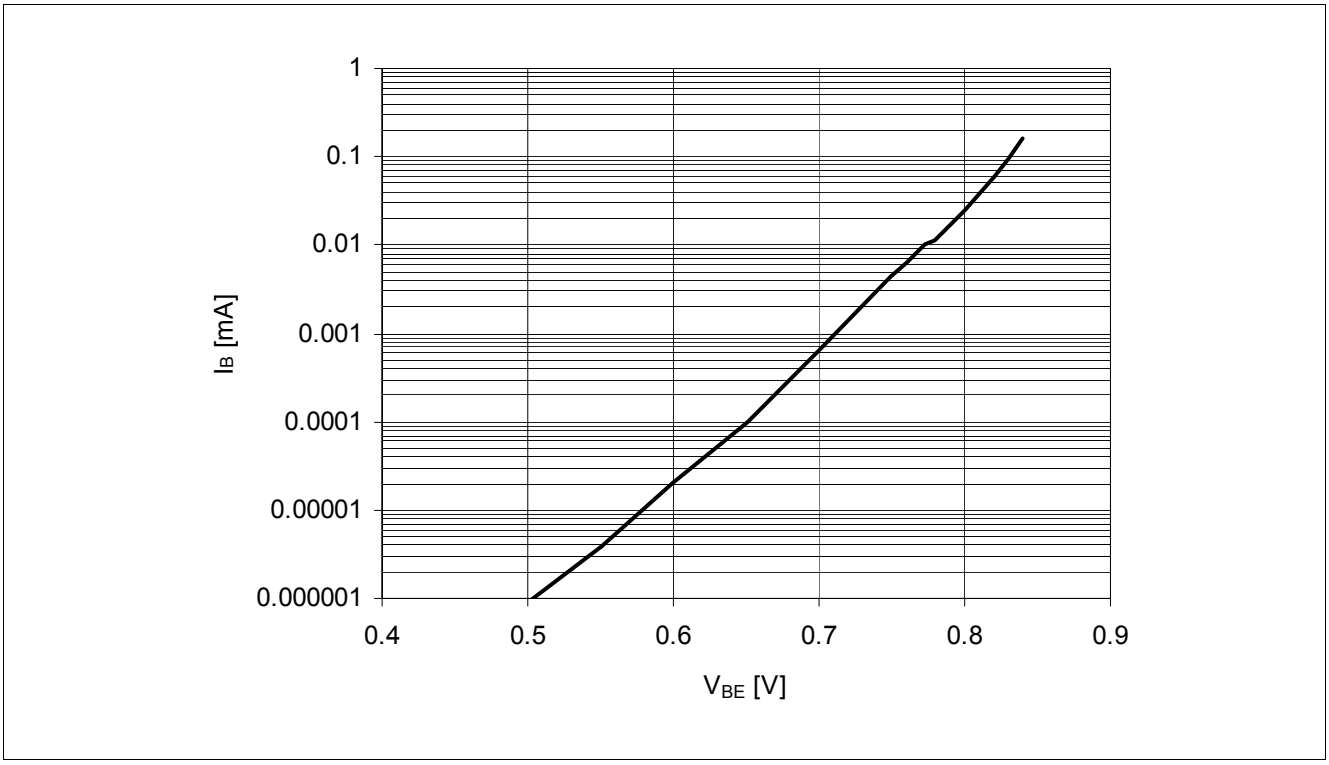


Figure 6 Base Current vs. Base Emitter Forward Voltage $I_B = f(V_{BE})$, V_{CE} = 2 V

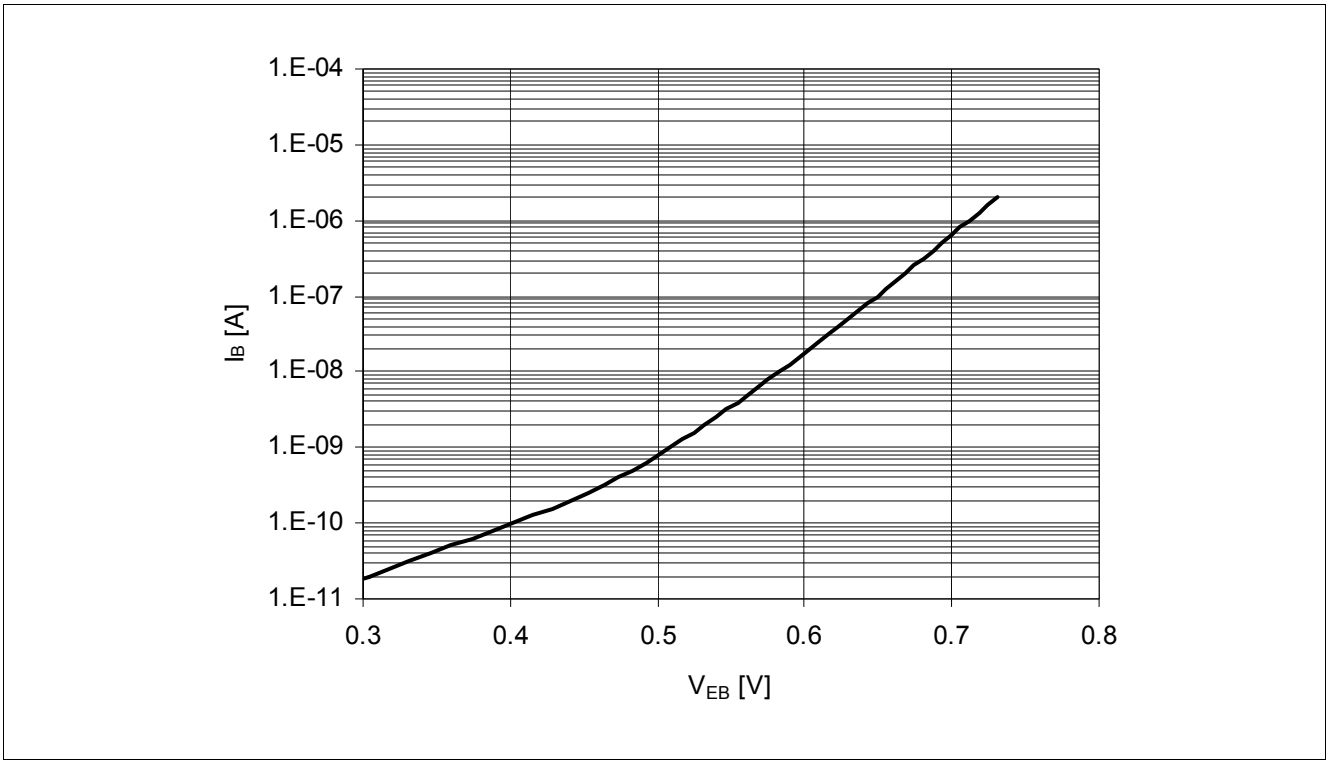


Figure 7 Base Current vs. Base Emitter Reverse Voltage $I_B = f(V_{EB})$, V_{CE} = 2 V

5.5 Characteristic AC Diagrams

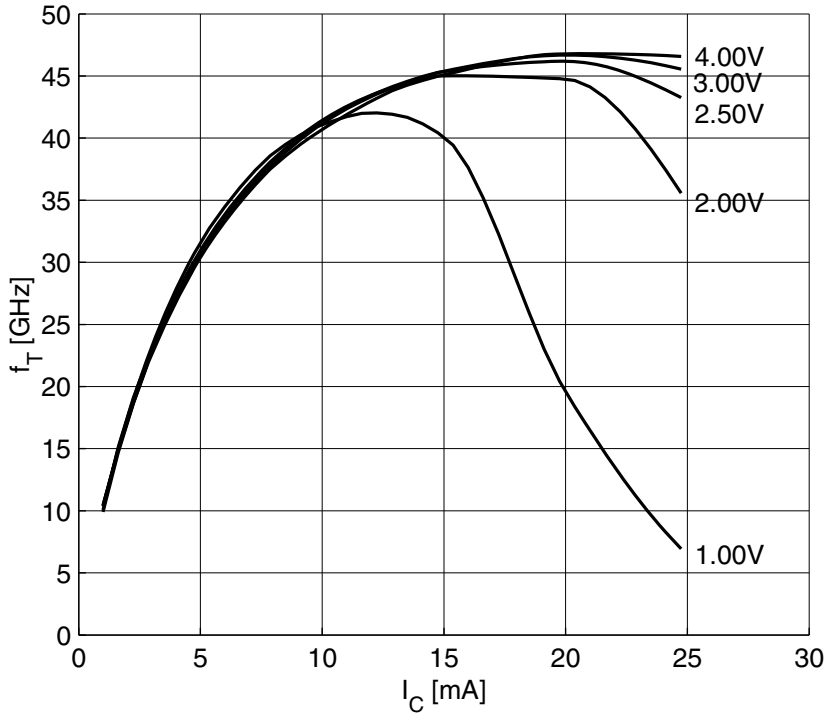


Figure 8 Transition Frequency $f_T = f(I_C), f$ = 1 GHz, V_{CE} = Parameter

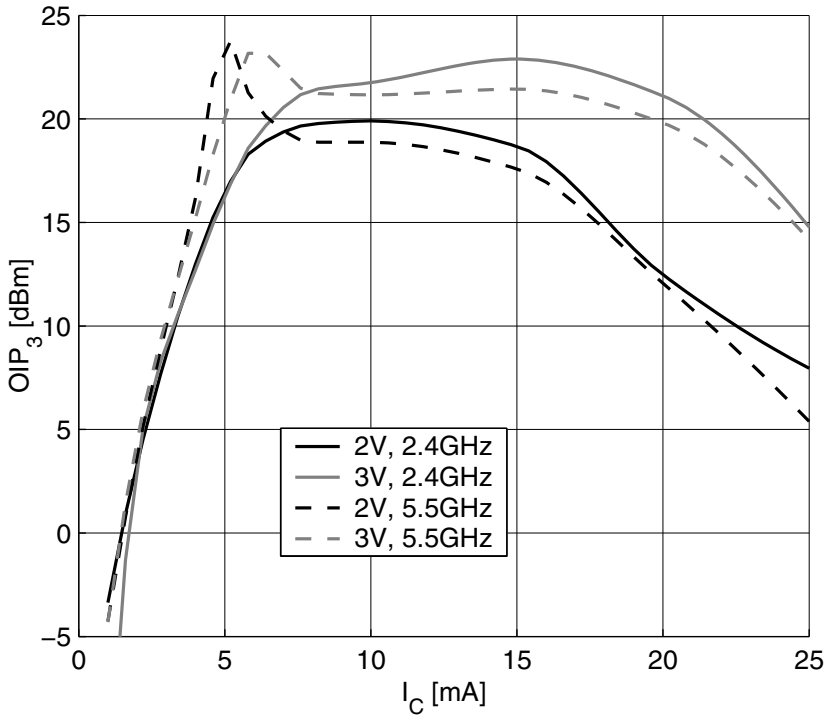


Figure 9 3rd Order Intercept Point $OIP_3 = f(I_C), Z_S = Z_L$= 50 Ω, V_{CE}, f = Parameters

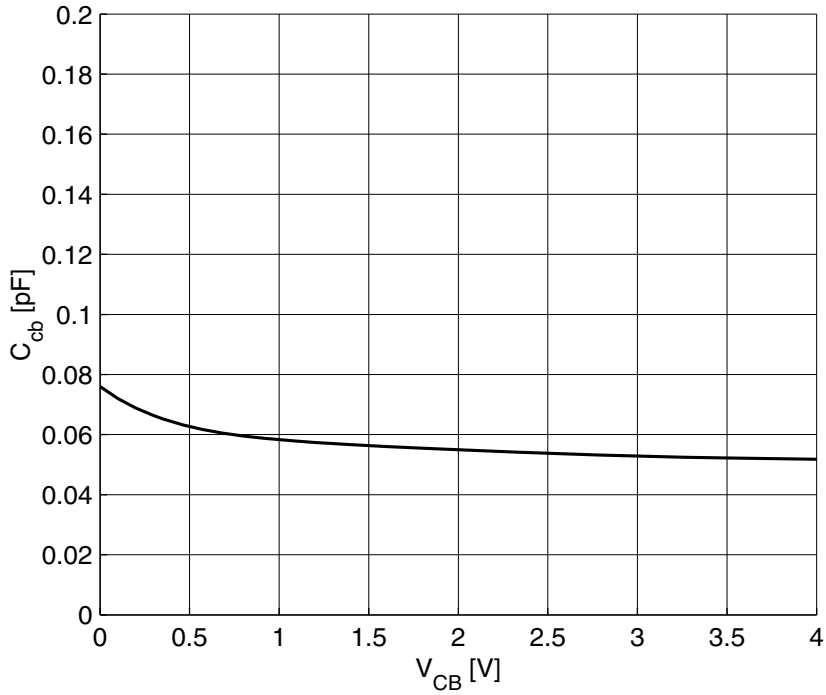


Figure 10 Collector Base Capacitance $C_{CB} = f(V_{CB})$, f = 1 MHz

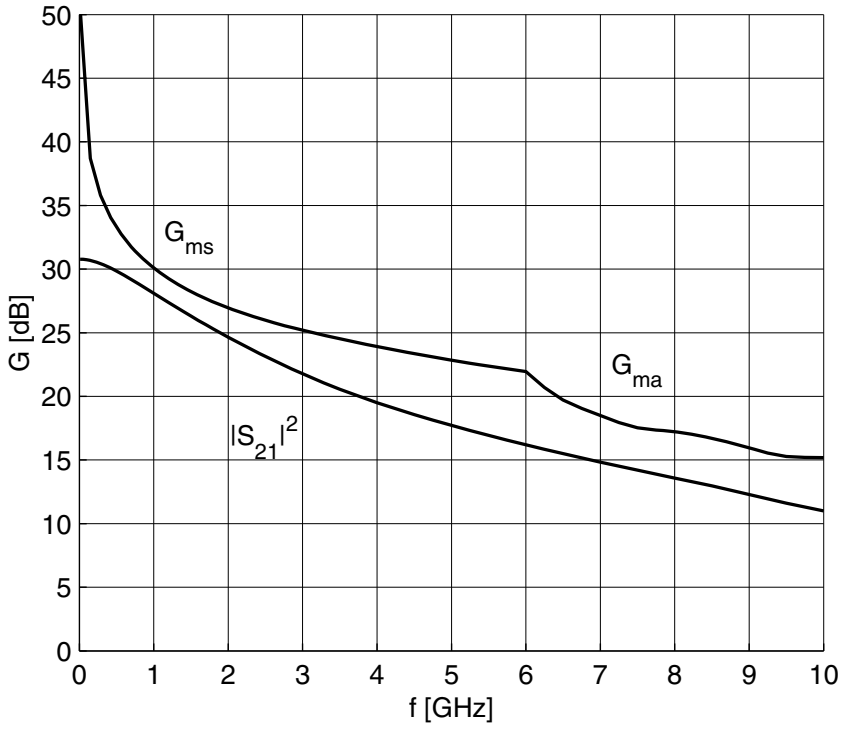


Figure 11 Gain G_{ma}, G_{ms}, $|S_{21}|^2 = f(f)$, V_{CE} = 3 V, I_C = 15 mA

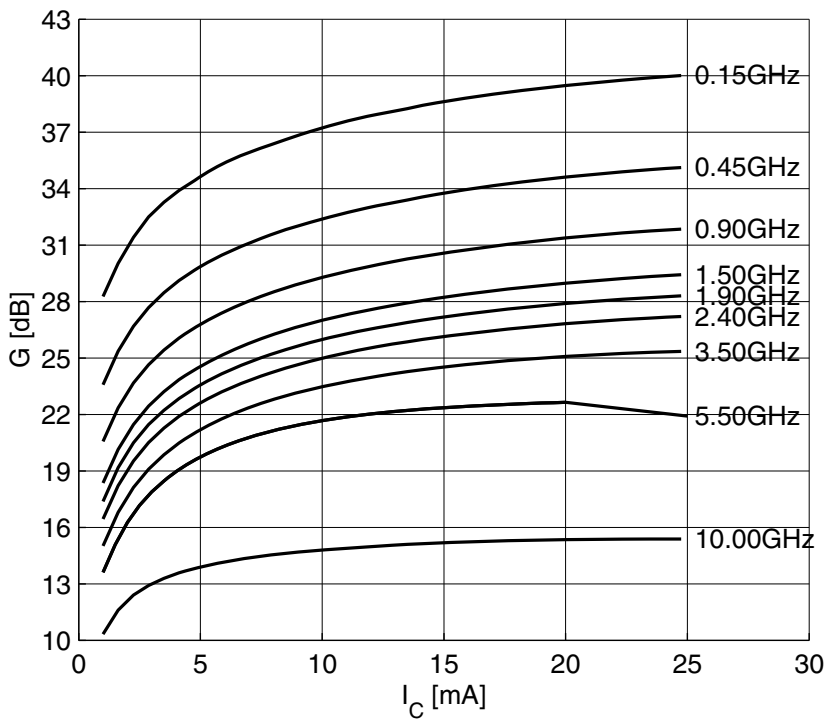


Figure 12 Maximum Power Gain $G_{max} = f(I_C)$, V_{CE} = 3 V, f = Parameter in GHz

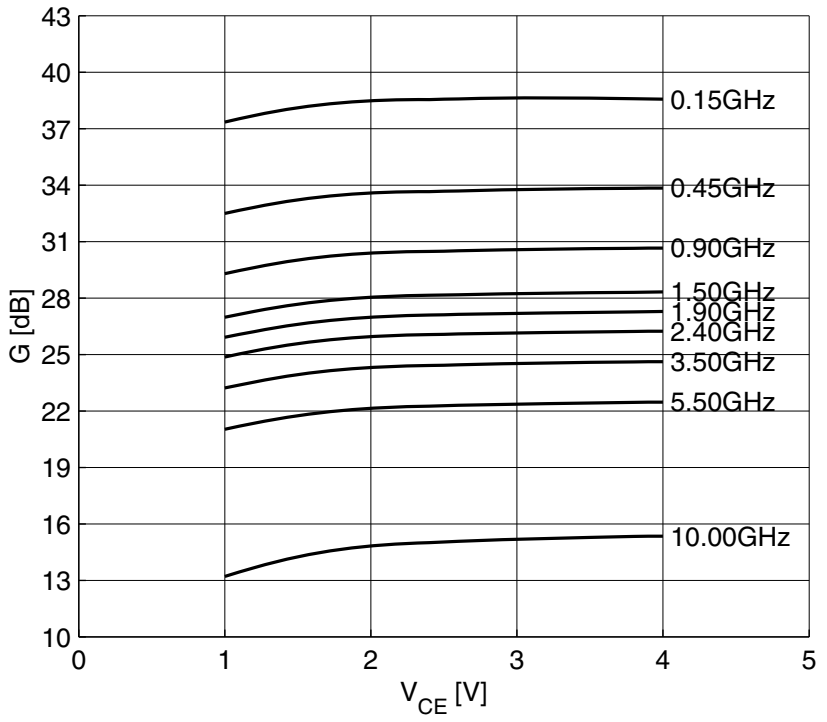


Figure 13 Maximum Power Gain $G_{max} = f(V_{CE})$, I_C = 15 mA, f = Parameter in GHz

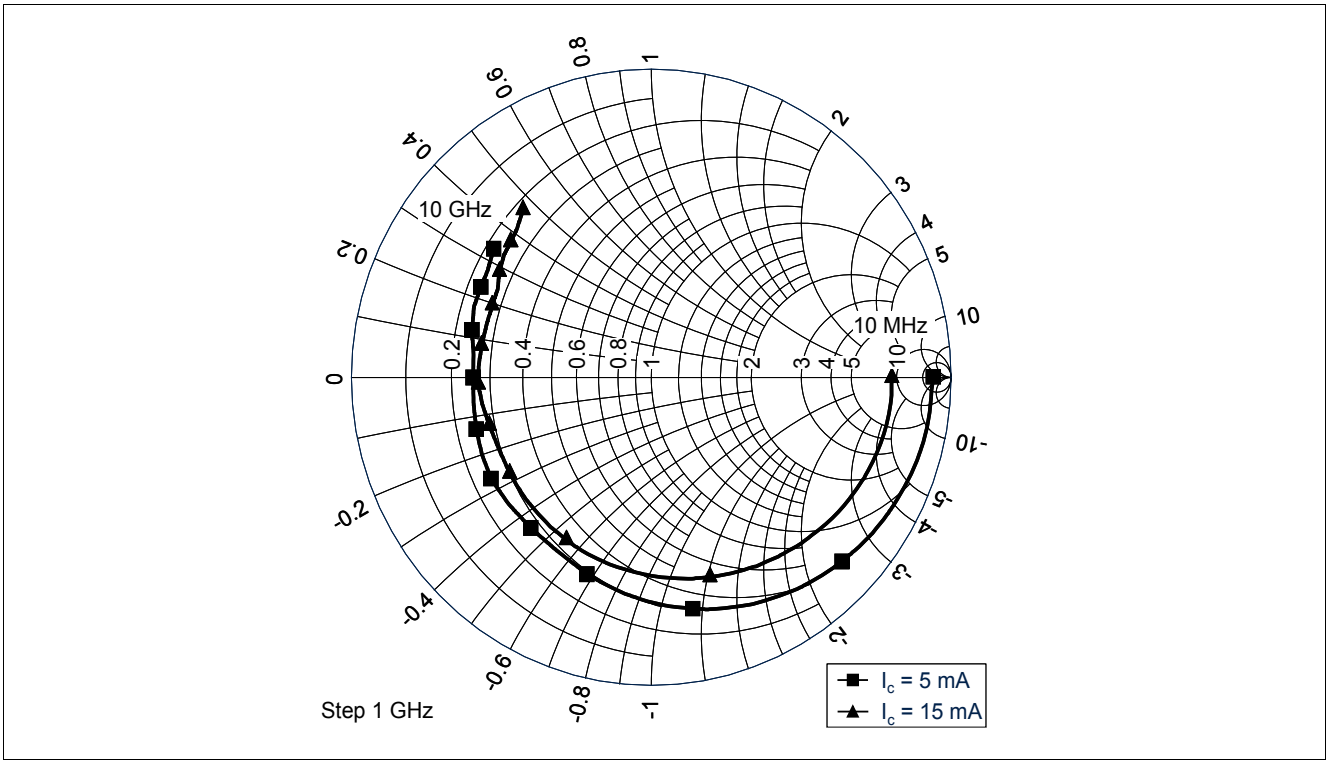


Figure 14 Input Matching $S_{11} = f(f)$, V_{CE} = 3 V, I_C = 5 / 15 mA

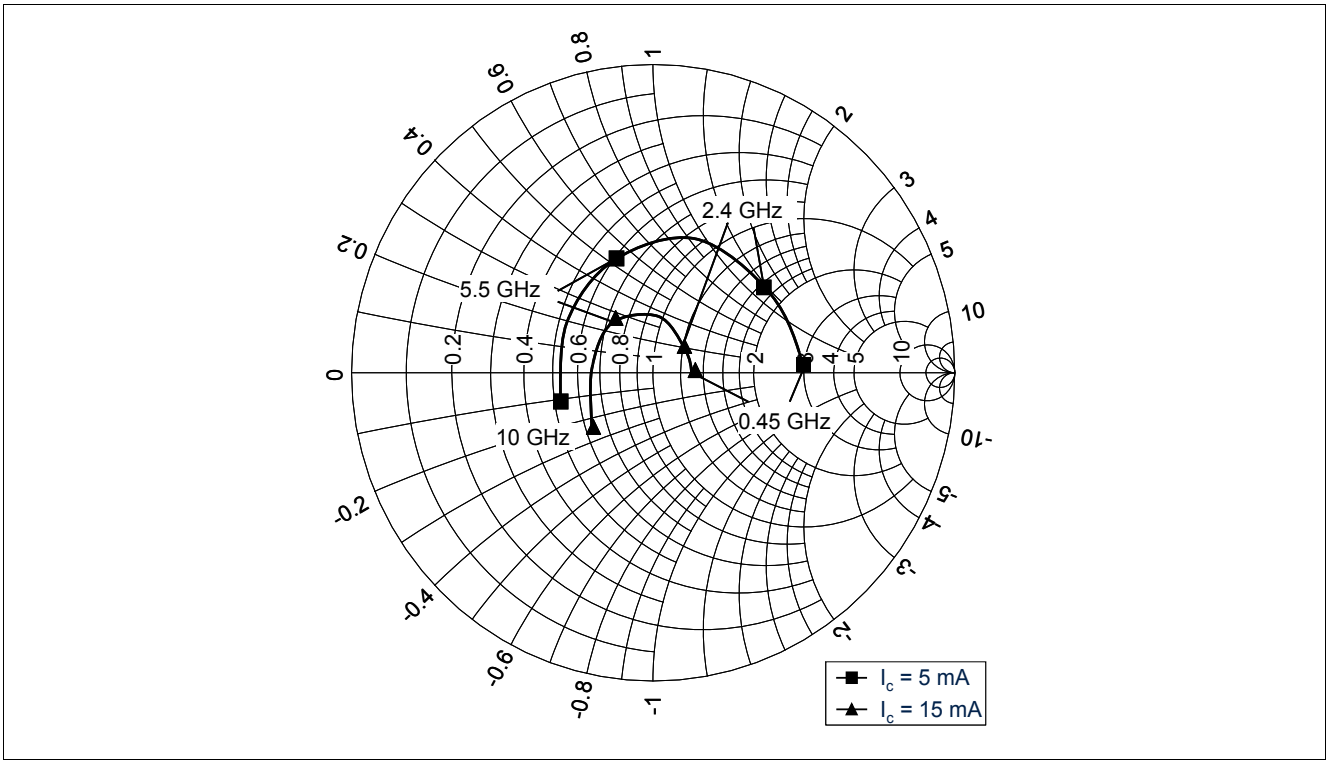


Figure 15 Source Impedance for Minimum Noise Figure $Z_{opt} = f(f)$, V_{CE} = 3 V, I_C = 5 / 15 mA

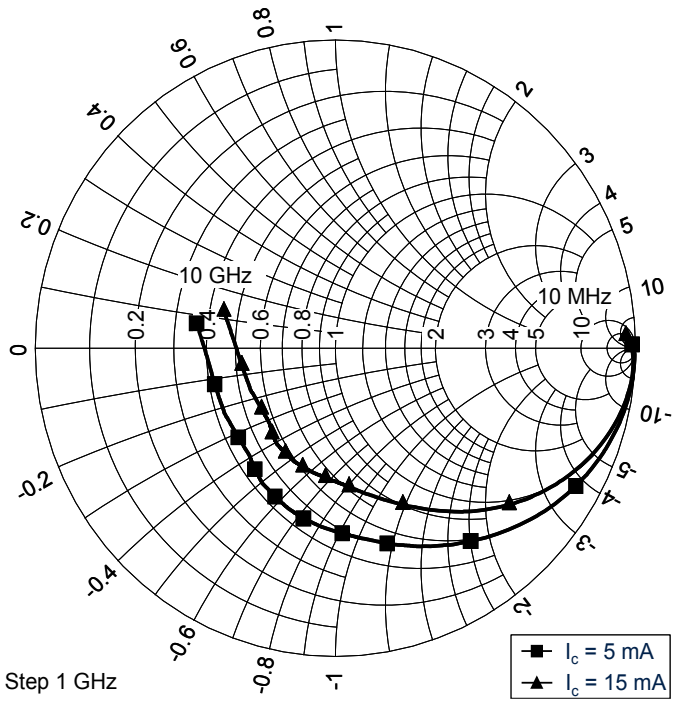


Figure 16 Output Matching $S_{22} = f(f)$, V_{CE} = 3 V, I_C = 5 / 15 mA

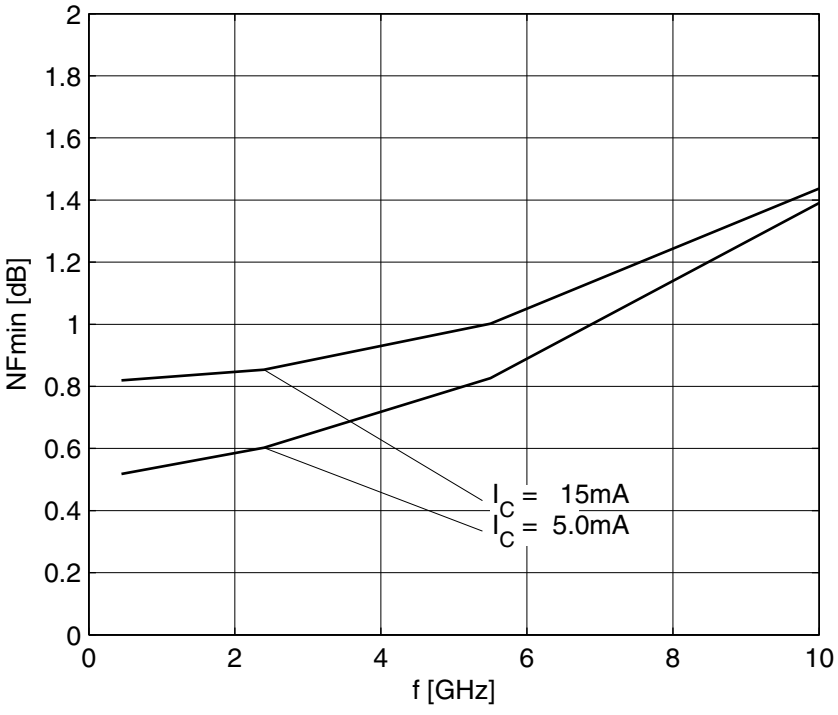


Figure 17 Noise Figure $NF_{min} = f(f)$, V_{CE} = 3 V, I_C = 5 / 15 mA, $Z_S = Z_{opt}$

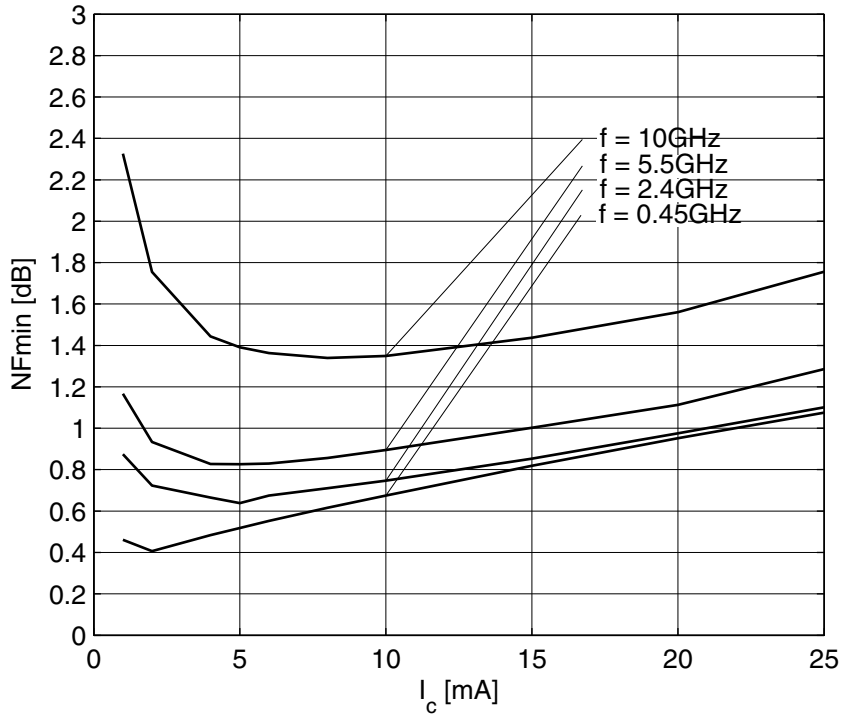


Figure 18 Noise Figure $NF_{min} = f(I_C)$, V_{CE} = 3 V, $Z_S = Z_{opt}$, f = Parameter in GHz

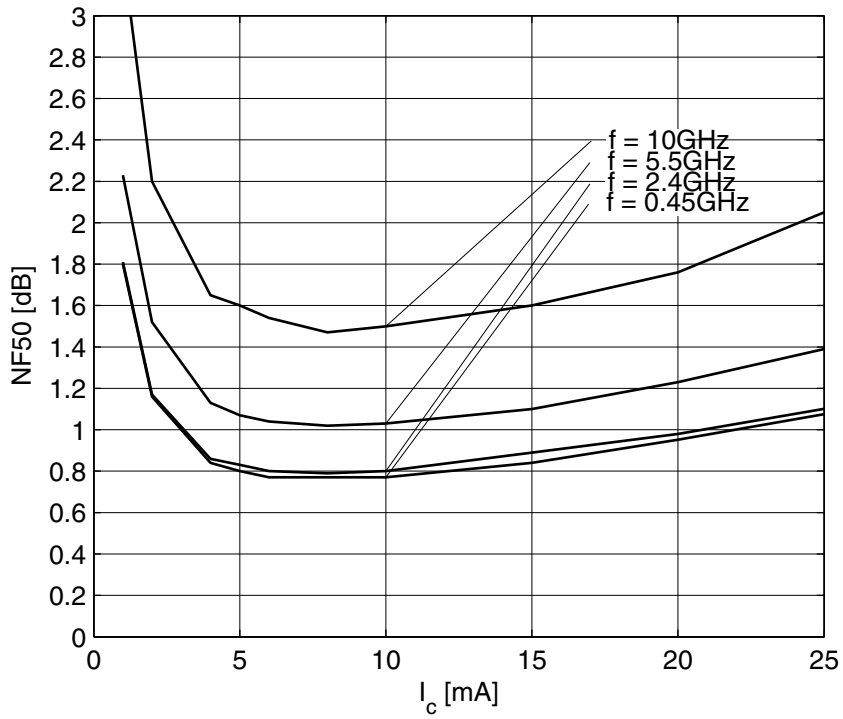


Figure 19 Noise Figure $NF_{50} = f(I_C)$, V_{CE} = 3 V, Z_S = 50 Ω, f = Parameter in GHz

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 °C

6 Simulation Data

For the SPICE Gummel Poon (GP) model as well as for the S-parameters (including noise parameters) please refer to our internet website: **www.infineon.com/rf.models**. Please consult our website and download the latest versions before actually starting your design.

You find the BFP720FESD SPICE GP model in the internet in MWO- and ADS-format, which you can import into these circuit simulation tools very quickly and conveniently. The model already contains the package parasitics and is ready to use for DC- and high frequency simulations. The terminals of the model circuit correspond to the pin configuration of the device.

The model parameters have been extracted and verified up to 10 GHz using typical devices. The BFP720FESD SPICE GP model reflects the typical DC- and RF-performance within the limitations which are given by the SPICE GP model itself. Besides the DC characteristics all S-parameters in magnitude and phase, as well as noise figure (including optimum source impedance, equivalent noise resistance and flicker noise) and intermodulation have been extracted.

7 Package Information TSFP-4-1

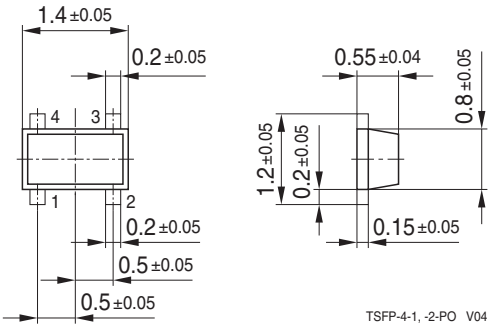


Figure 20 Package Outline

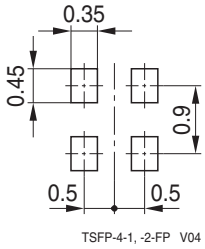


Figure 21 Package Foot Print

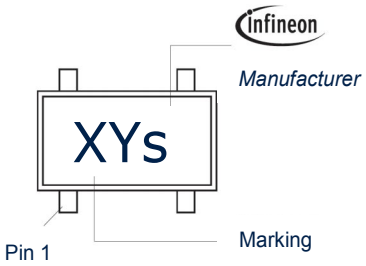


Figure 22 Marking Description (Marking BFP720FESD: T3s)

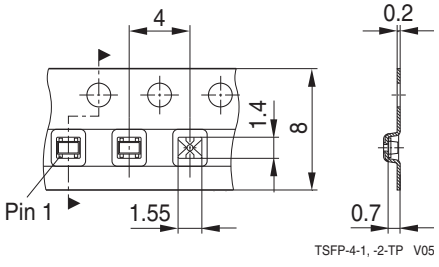


Figure 23 Tape Dimensions

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