BFR840L3RHESD

Robust ultra low noise SiGe:C Bipolar RF Transistor in very small thin package

Data Sheet

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BFR840L3RHESD, Robust ultra low noise SiGe:C Bipolar RF Transistor in very small thin package

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Previous Revision: 1.0

Page	Subjects (major changes since last revision)

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1 Product Brief

The BFR840L3RHESD is a high performance HBT (Heterojunction Bipolar Transistor) specifically designed for 5-6 GHz WiFi applications. The device is based upon the reliable high volume SiGe:C technology of Infineon.

The BFR840L3RHESD provides inherently good input and output power match as well as inherently good noise match at 5-6 GHz. The simultaneous noise and power match without lossy external matching components at the input leads to a low external parts count, to a very good noise figure and to a very high transducer gain in the WiFi application. Integrated protection elements at in- and output make the device robust against ESD and excessive RF input power.

The device offers its high performance at low current and voltage and is especially well-suited for portable battery-powered applications in which energy efficiency is a key requirement. The device comes in a very small thin leadless package, ideal for modules.

Robust ultra low noise SiGe:C Bipolar RF Transistor in very small thin package **BFR840L3RHESD**

2 Features

- Robust ultra low noise amplifier based on Infineon´s reliable high volume SiGe:C bipolar technology
- Unique combination of high end RF performance and robustness: high maximum RF input power, 1.5 kV HBM ESD hardness
- Very high transition frequency f_T = 75 GHz enables best in class noise performance at high frequencies: NF_{min} = 0.65 dB at 5.5 GHz, 1.1 dB at 12 GHz, 1.8 V, 5 mA
- High gain $|S_{21}|^2$ = 19 dB @ 5.5 GHz, 10 mA, 1.8 V
- Ideal for low voltage applications e.g. V_{CC} = 1.2 V and 1.8 V (2.85 V, 3.3 V, 3.6 V requires corresponding collector resistor)
- Low power consumption, ideal for mobile applications
- Pb- and halogen free (RoHS compliant) very small thin leadless package (package height 0.31 mm, ideal for modules)

RoHS

Applications

As Low Noise Amplifier (LNA) in

- Mobile and fixed connectivity applications: WLAN 802.11, WiMAX and UWB
- Satellite communication systems: satellite radio (SDARs, DAB), navigation systems (e.g. GPS, Glonass) and C-band LNB (1st and 2nd stage LNA)
- Ku-band LNB front-end (2nd stage or 3rd stage LNA and active mixer)
- Ka-band oscillators (DROs)

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

Product Name	Package	Pin Configuration				Marking
BFR840L3RH ESD	TSLP-3-9	1 = B	2 = E	3 = C		T8

3 Maximum Ratings

Table 1 Maximum Ratings at T_A = 25°C (unless otherwise specified)

Parameter	Symbol	Values		Unit	Note / Test Condition
		Min.	Max.		
Collector emitter voltage	V_{CEO}	–	2.25 2.0	V	25°C -55°C Open base
Collector emitter voltage[1)]	V_{CES}	–	2.25 2.0	V	25°C -55°C E-B short circuited
Collector emitter voltage[2)]	V_{CB0}	–	2.9 2.6	V	25°C -55°C Open emitter
Base current	I_B	-5	3	mA	–
Collector current	I_C	–	35	mA	–
RF input power	P_{RFin}	–	tbd	dBm	–
ESD stress pulse	V_{ESD}	-1.5	1.5	kV	HBM, all pins, acc. to JESD22-A114
Total power dissipation[3)]	P_{tot}	–	75	mW	$T_S \leq 111$ °C
Junction temperature	T_J	–	150	°C	–
Storage temperature	T_{Stg}	-55	150	°C	–

1) V_{CES} is identical to V_{CEO} due to design
2) V_{CBO} is similar to V_{CEO} due to design
3) 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 2 Thermal Resistance

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Junction - soldering point[1)]	R_{thJS}	–	521	–	K/W	–

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

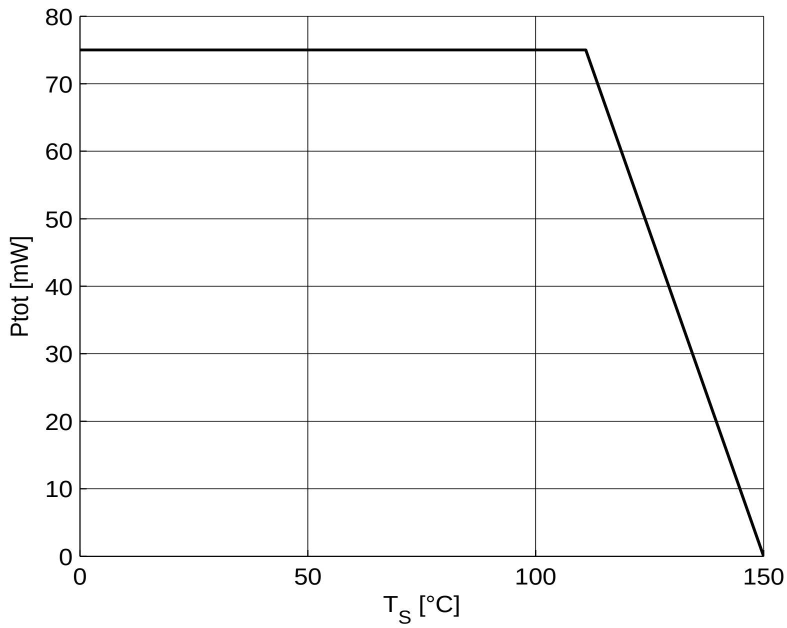

Figure 1 Total Power Dissipation $P_{tot} = f(T_s)$

5 Electrical Characteristics

5.1 DC Characteristics

Table 3 DC Characteristics at T_A = 25 °C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Collector emitter breakdown voltage	$V_{(BR)CEO}$	2.25	2.6	–	V	I_C = 1 mA, I_B = 0 Open base
Collector emitter leakage current	I_{CES}	–	–	400	nA	V_{CE} = 1.5 V, V_{BE} = 0 E - B short circuited
Collector base leakage current	I_{CBO}	–	–	400	nA	V_{CB} = 1.5 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}	150	260	450		V_{CE} = 1.8 V, I_C = 10 mA Pulse measured

5.2 General AC Characteristics

Table 4 General AC Characteristics at T_A = 25 °C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transition frequency	f_T	–	75	–	GHz	V_{CE} = 1.8 V, I_C = 25 mA f = 2 GHz
Collector base capacitance	C_{CB}	–	52	–	fF	V_{CB} = 1.8 V, V_{BE} = 0 f = 1 MHz Emitter grounded
Collector emitter capacitance	C_{CE}	–	0.34	–	pF	V_{CE} = 1.8 V, V_{BE} = 0 f = 1 MHz Base grounded
Emitter base capacitance	C_{EB}	–	0.34	–	pF	V_{EB} = 0.4 V, V_{CB} = 0 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

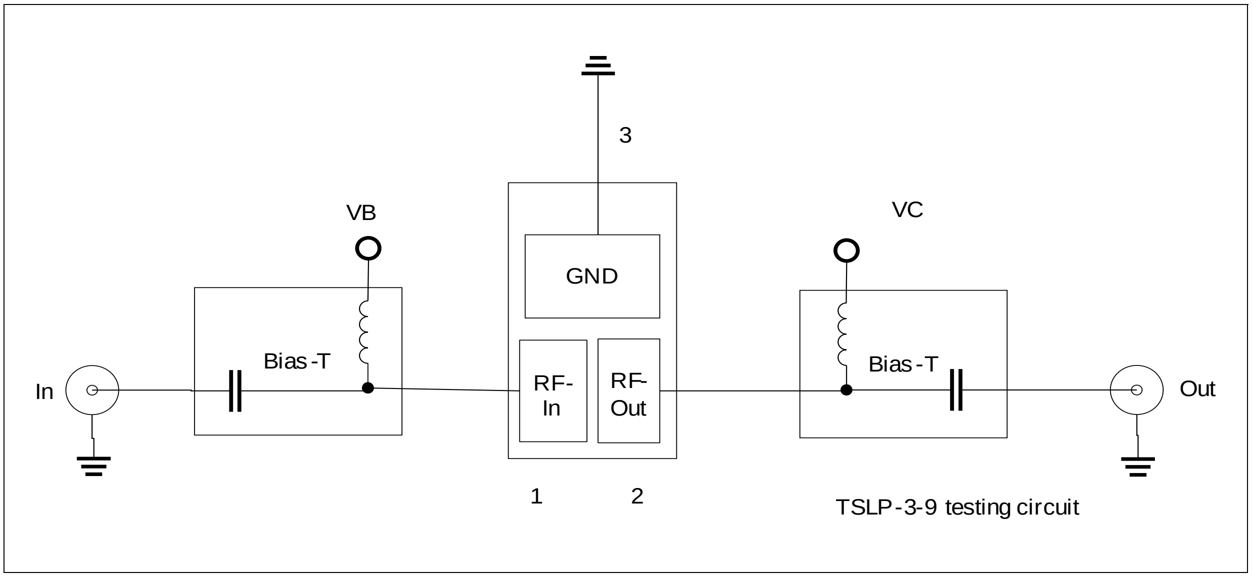

Figure 2 BFR840L3RHESD Testing Circuit

Table 5 AC Characteristics, V_{CE} = 1.8 V, f = 0.45 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ms}	–	31	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	27	–		I_C = 10 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.5	–		I_C = 5 mA
Associated gain	G_{ass}	–	27	–		I_C = 5 mA
Linearity					dBm	Z_S = Z_L = 50 Ω
1 dB compression point at output	OP_{1dB}	–	4	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	19.5	–		I_C = 10 mA

Table 6 AC Characteristics, V_{CE} = 1.8 V, f = 0.9 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ms}	–	29	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	26.5	–		I_C = 10 mA

Table 6 AC Characteristics, V_{CE} = 1.8 V, f = 0.9 GHz (cont'd)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.55	–		I_C = 5 mA
Associated gain	G_{ass}	–	26	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	4	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	19.5	–		I_C = 10 mA

Table 7 AC Characteristics, V_{CE} = 1.8 V, f = 1.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ms}	–	27	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	25.5	–		I_C = 10 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.55	–		I_C = 5 mA
Associated gain	G_{ass}	–	24.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	4.0	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	20	–		I_C = 10 mA

Table 8 AC Characteristics, V_{CE} = 1.8 V, f = 1.9 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ms}	–	26.5	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	25	–		I_C = 10 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.60	–		I_C = 5 mA
Associated gain	G_{ass}	–	24	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	4.5	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	21	–		I_C = 10 mA

Table 9 AC Characteristics, V_{CE} = 1.8 V, f = 2.4 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ms}	–	25.5	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	24	–		I_C = 10 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.6	–		I_C = 5 mA
Associated gain	G_{ass}	–	22.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	4	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	21	–		I_C = 10 mA

Table 10 AC Characteristics, V_{CE} = 1.8 V, f = 3.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ms}	–	23.5	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	22	–		I_C = 10 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.6	–		I_C = 5 mA
Associated gain	G_{ass}	–	20	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	5	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	22.5	–		I_C = 10 mA

Table 11 AC Characteristics, V_{CE} = 1.8 V, f = 5.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ma}	–	22	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	19	–		I_C = 10 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.65	–		I_C = 5 mA
Associated gain	G_{ass}	–	16.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	5	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	22	–		I_C = 10 mA

Table 12 AC Characteristics, V_{CE} = 1.8 V, f = 10 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ms}	–	16	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	13	–		I_C = 10 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.9	–		I_C = 5 mA
Associated gain	G_{ass}	–	11.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	3	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	19.5	–		I_C = 10 mA

Table 13 AC Characteristics, V_{CE} = 1.8 V, f = 12 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power gain					dB	
Maximum power gain	G_{ms}	–	13.5	–		I_C = 10 mA
Transducer gain	$\|S_{21}\|^2$	–	10	–		I_C = 10 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	1.1	–		I_C = 5 mA
Associated gain	G_{ass}	–	12	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	1.5	–		I_C = 10 mA
3rd order intercept point at output	OIP_3	–	18.5	–		I_C = 10 mA

Note:

1. *OIP_3 value depends on the termination of all intermodulation frequency components. The termination used for this measurement is 50 Ω from 0.2 MHz to 12 GHz.*

5.4 Characteristic DC Diagrams

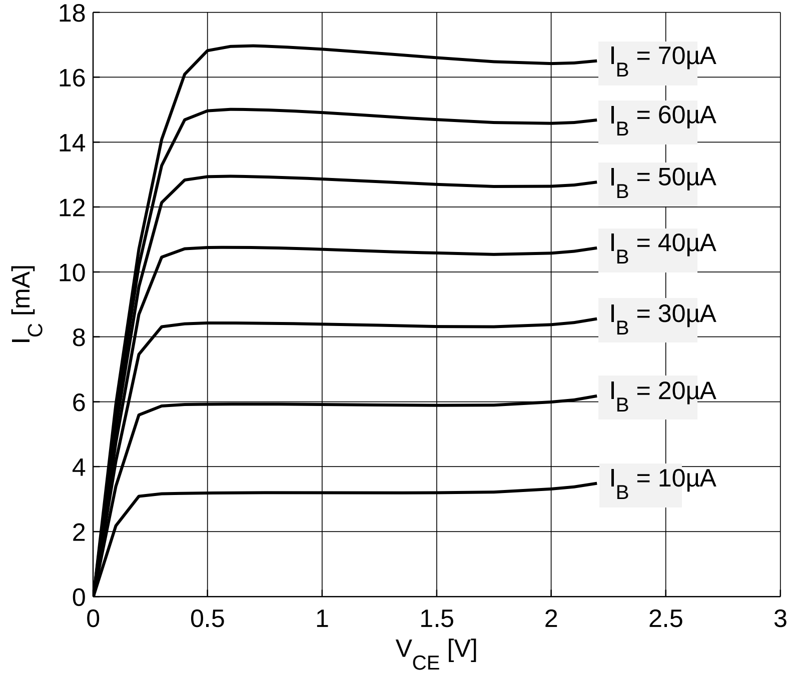

Figure 3 Collector Current vs. Collector Emitter Voltage $I_C = f(V_{CE})$, I_B = Parameter

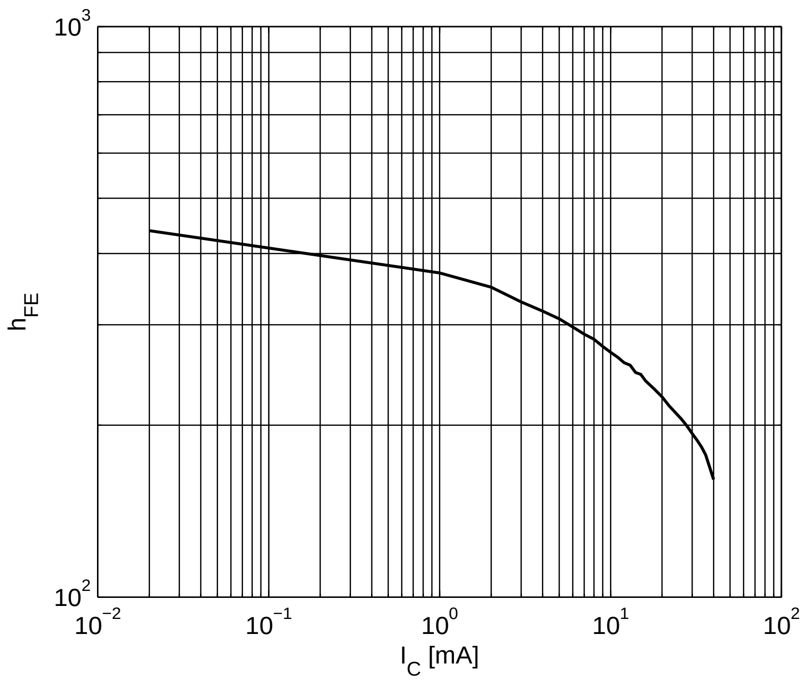

Figure 4 DC Current Gain $h_{FE} = f(I_C)$, V_{CE} = 1.8 V

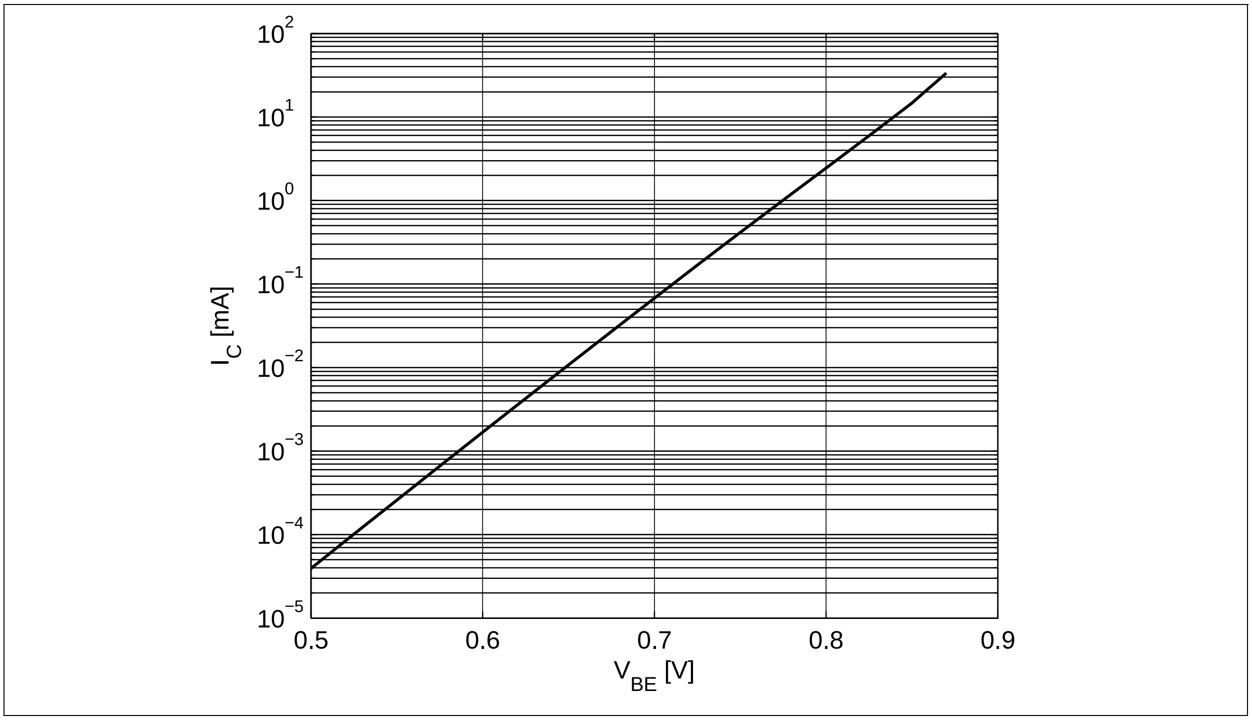

Figure 5 **Collector Current vs. Base Emitter Forward Voltage $I_C = f(V_{BE})$, V_{CE} = 1.8 V**

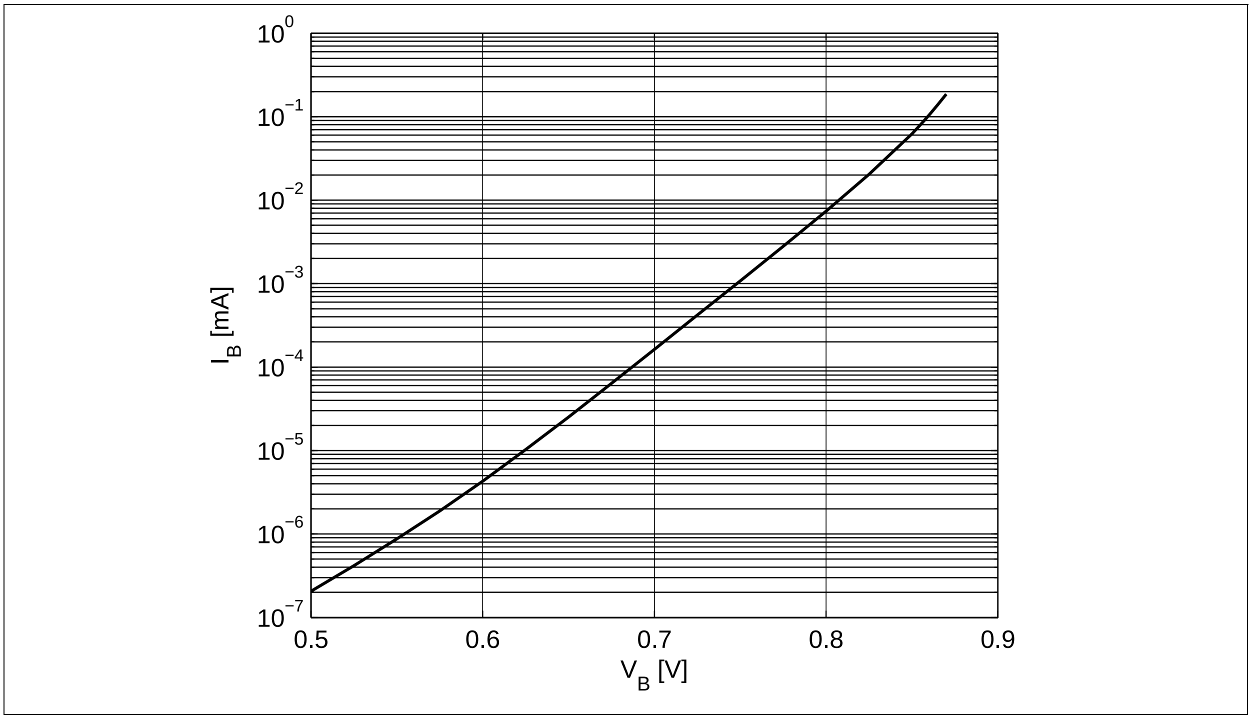

Figure 6 **Base Current vs. Base Emitter Forward Voltage $I_B = f(V_{BE})$, V_{CE} = 1.8 V**

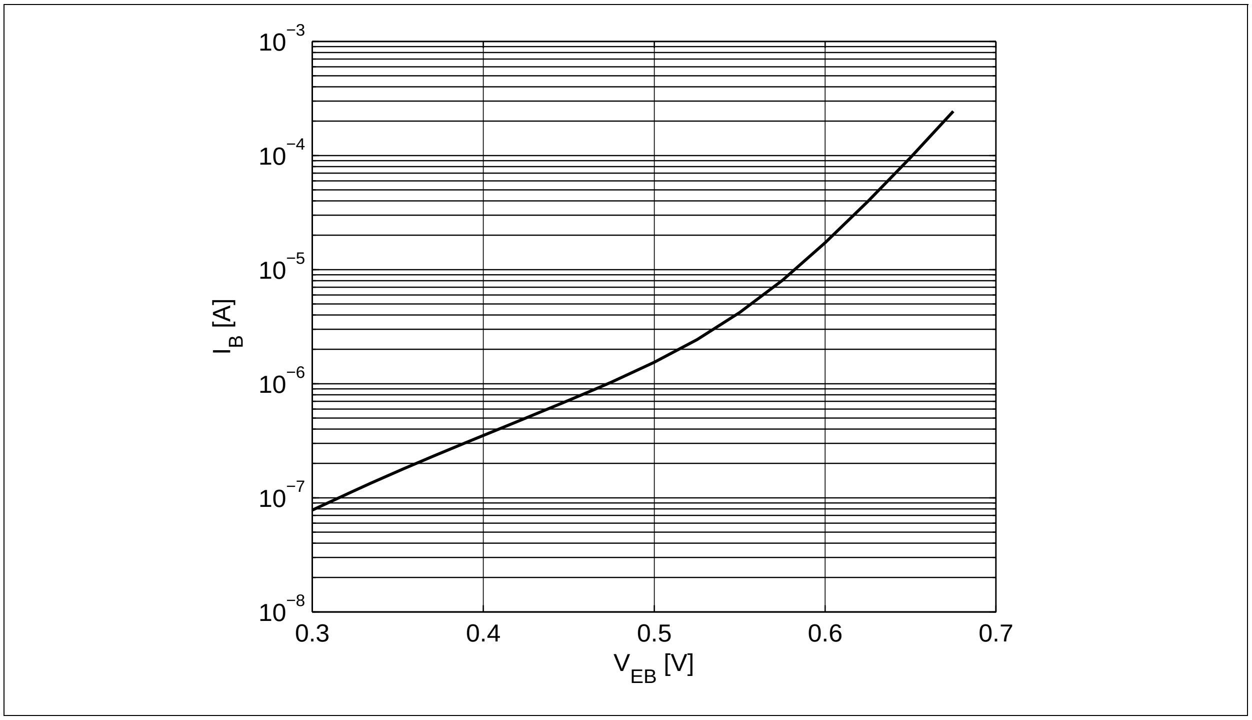

Figure 7 Base Current vs. Base Emitter Reverse Voltage $I_B = f(V_{EB})$, V_{CE} = 1.8 V

5.5 Characteristic AC Diagrams

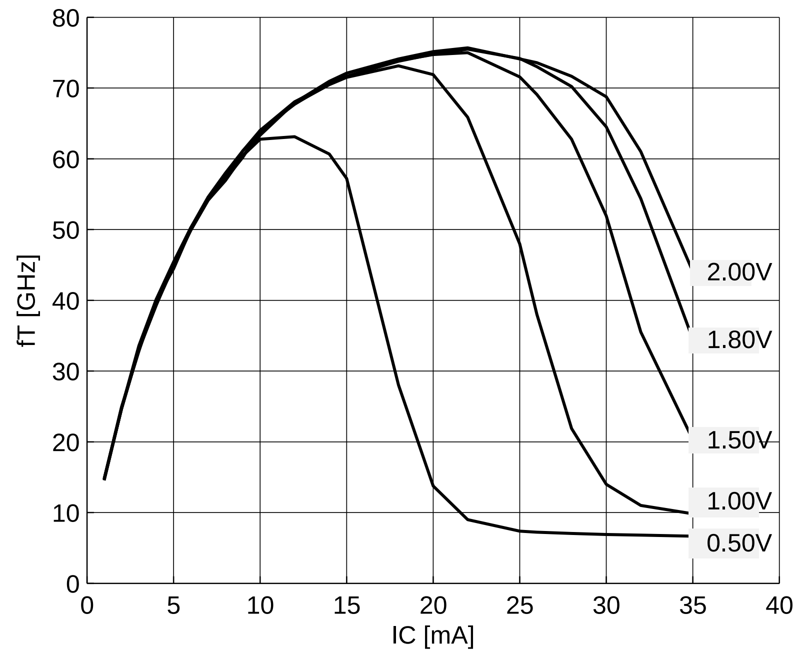

Figure 8 Transition Frequency $f_T = f(I_C)$, f = 2 GHz, V_{CE} = Parameter

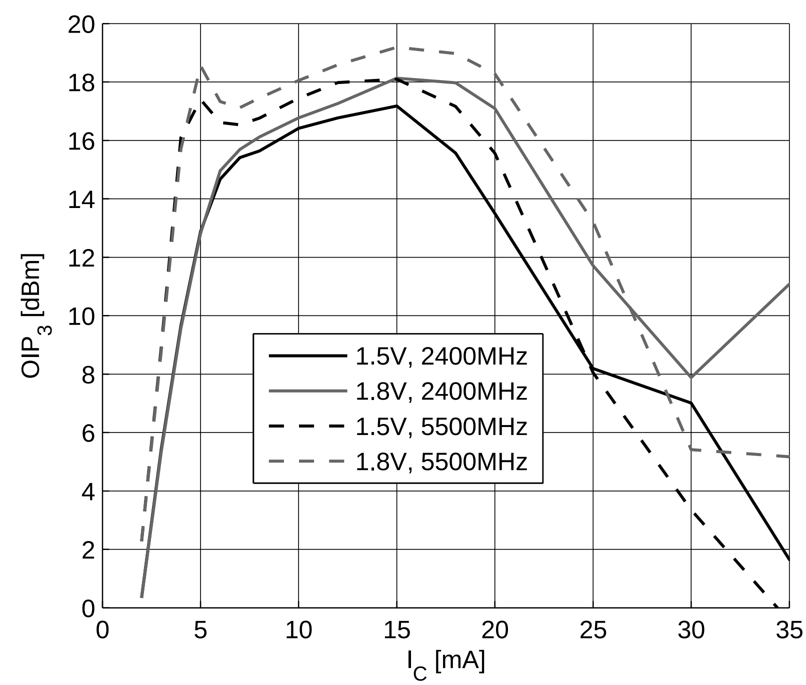

Figure 9 3rd Order Intercept Point at output $OIP_3 = f(I_C)$, $Z_S = Z_L$= 50 Ω, V_{CE}, f = Parameter

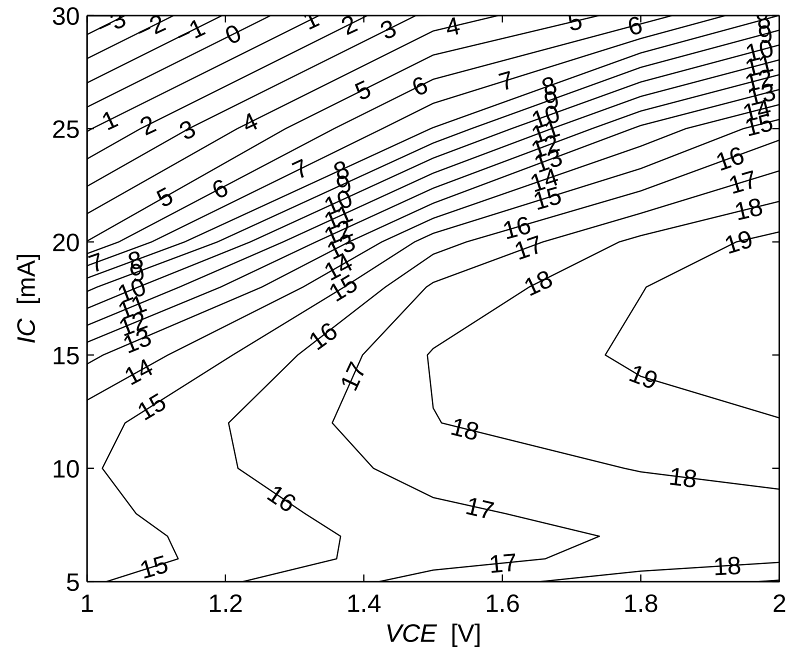

Figure 10 3rd Order Intercept Point at output OIP_3 [dBm] = f (I_C), Z_S = Z_L= 50 Ω, V_{CE}, f = Parameters

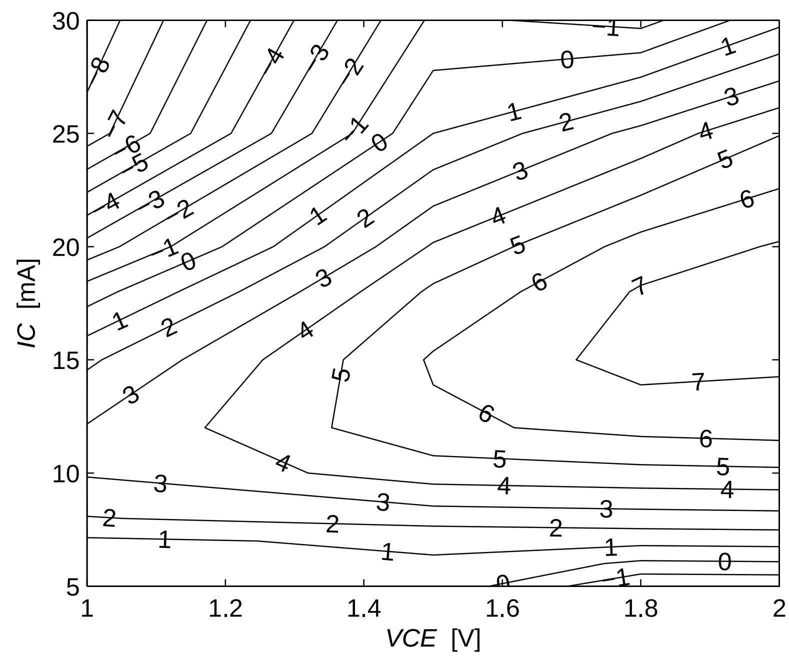

Figure 11 Compression Point at output OP_{1dB} [dBm] = f (I_C, V_{CE}), Z_S = Z_L= 50 Ω, f = 5.5 GHz

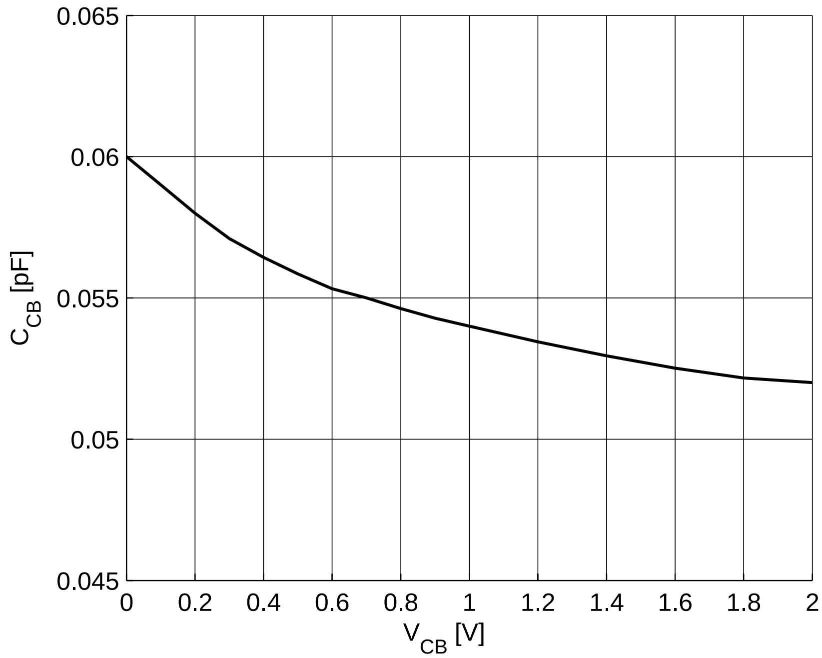

Figure 12 Collector Base Capacitance $C_{CB} = f(V_{CB})$, f = 1 MHz

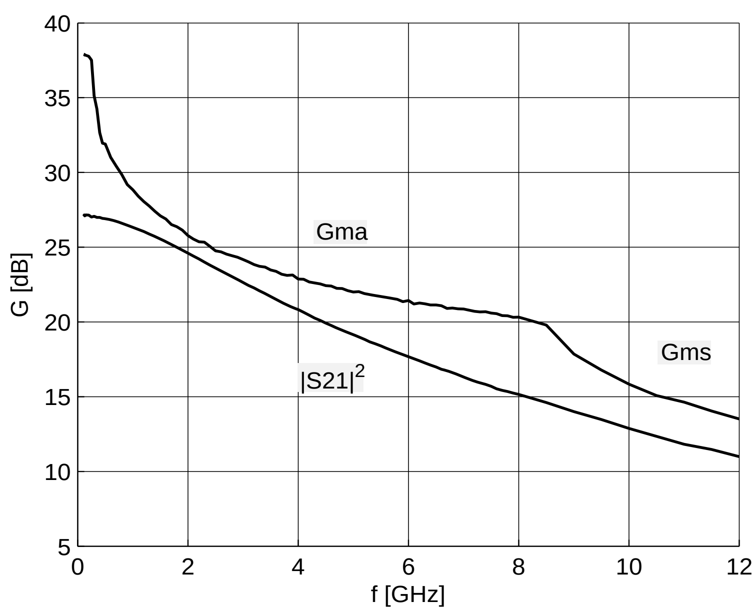

Figure 13 Gain G_{ma}, G_{ms}, $|S_{21}|^2 = f(f)$, V_{CE} = 1.8 V, I_C = 10 mA

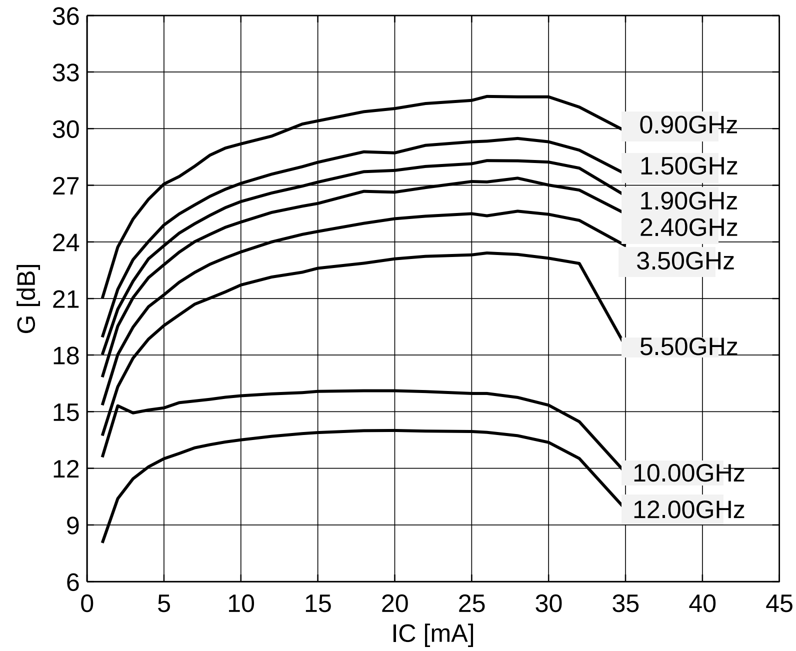

Figure 14 Maximum Power Gain G_{max} = f (I_C), V_{CE} = 1.8 V, f = Parameter in GHz

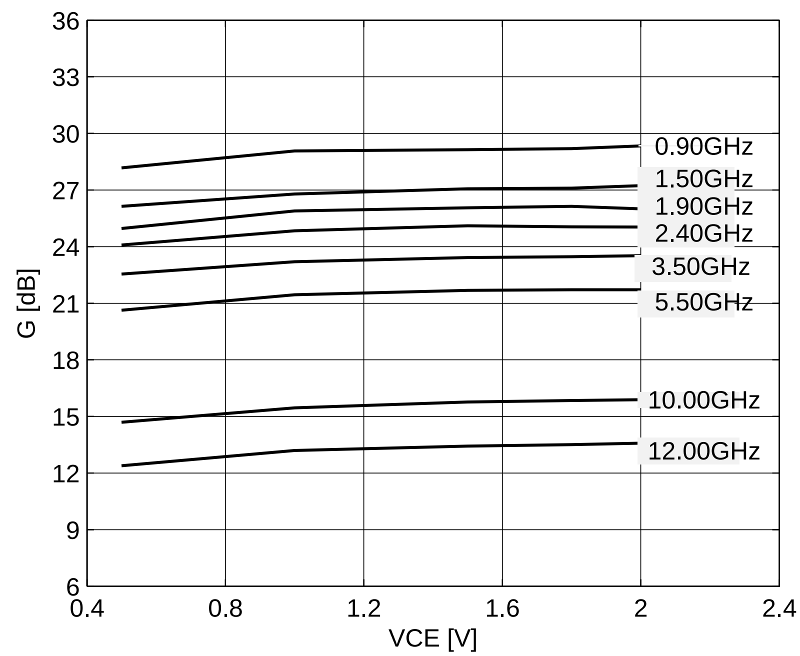

Figure 15 Maximum Power Gain G_{max} = f (V_{CE}), I_C = 10 mA, f = Parameter in GHz

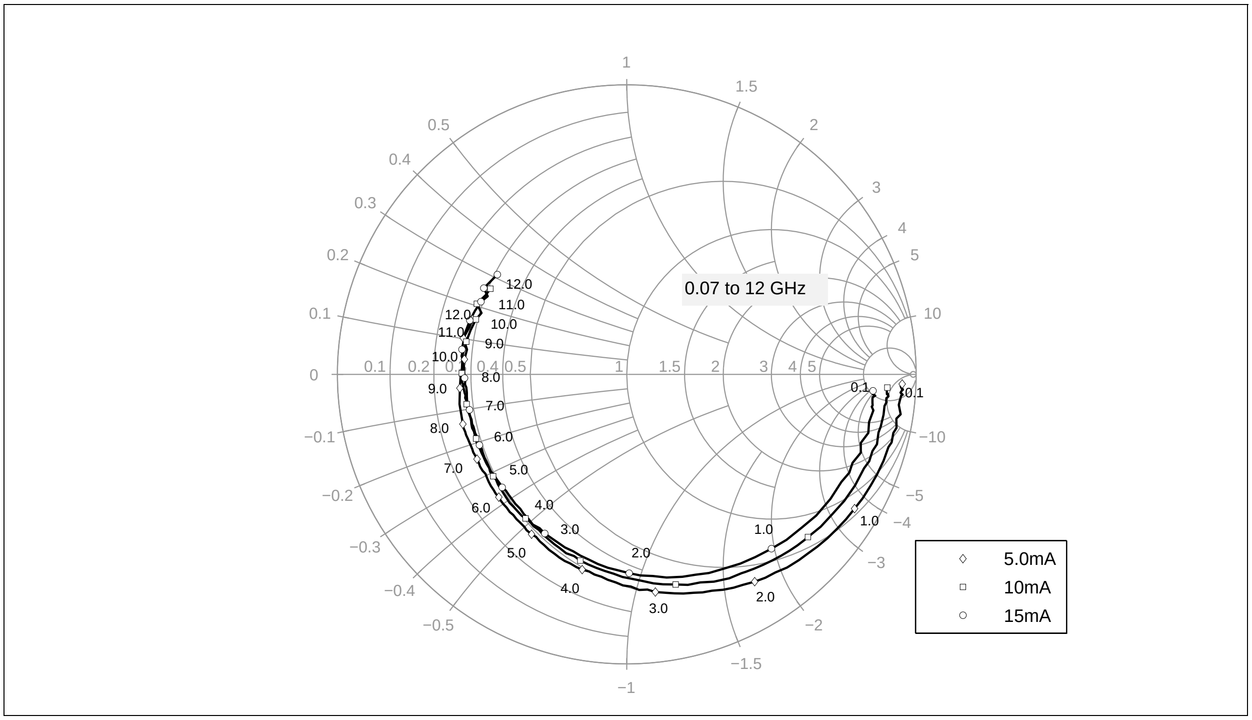

Figure 16 Input Matching $S_{11} = f\,(f)$, V_{CE} = 1.8 V, I_C = 5 / 10 / 15 mA

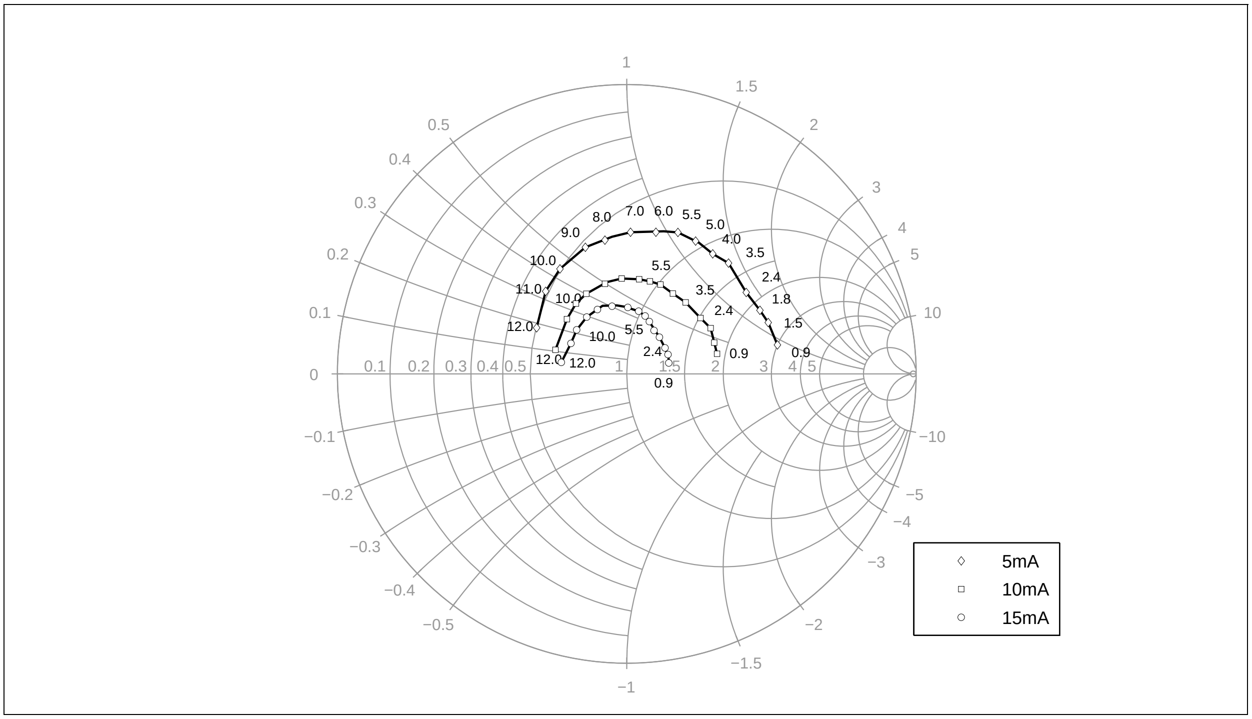

Figure 17 Source Impedance for Minimum Noise Figure $Z_{opt} = f\,(f)$, V_{CE} = 1.8 V, I_C = 5 / 10 / 15 mA

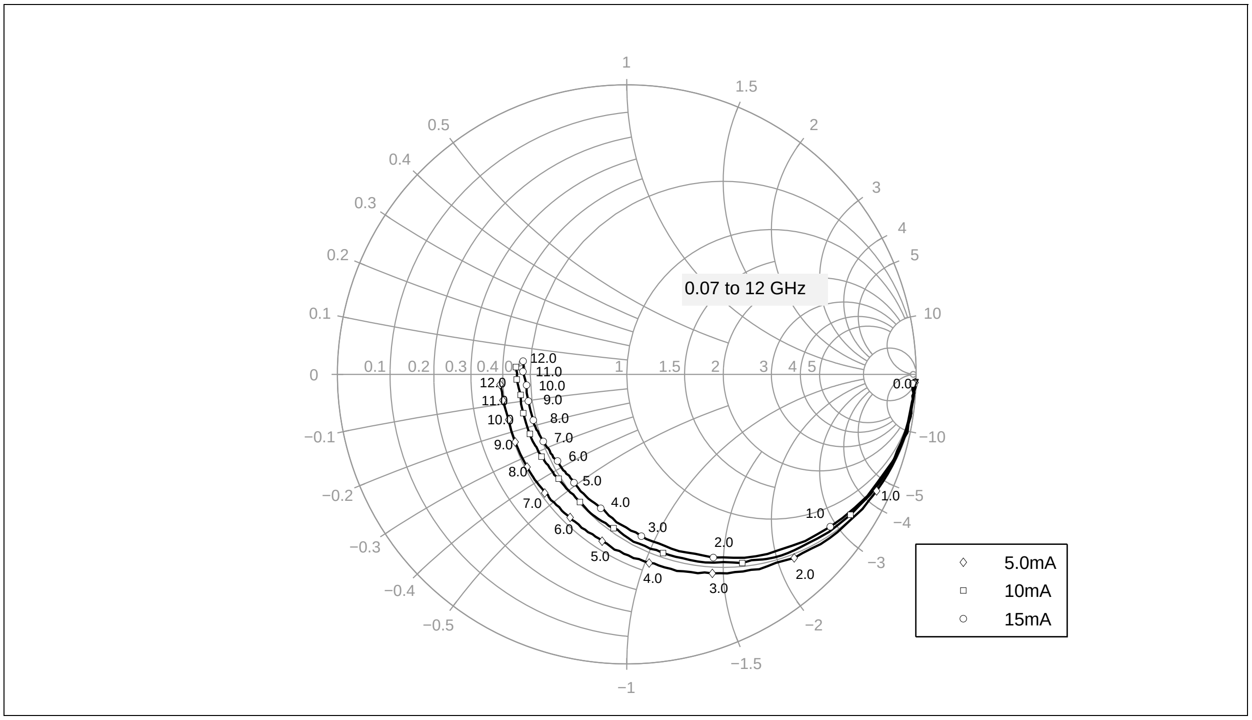

Figure 18 Output Matching $S_{22} = f(f)$, V_{CE} = 1.8 V, I_C = 5 / 10 / 15 mA

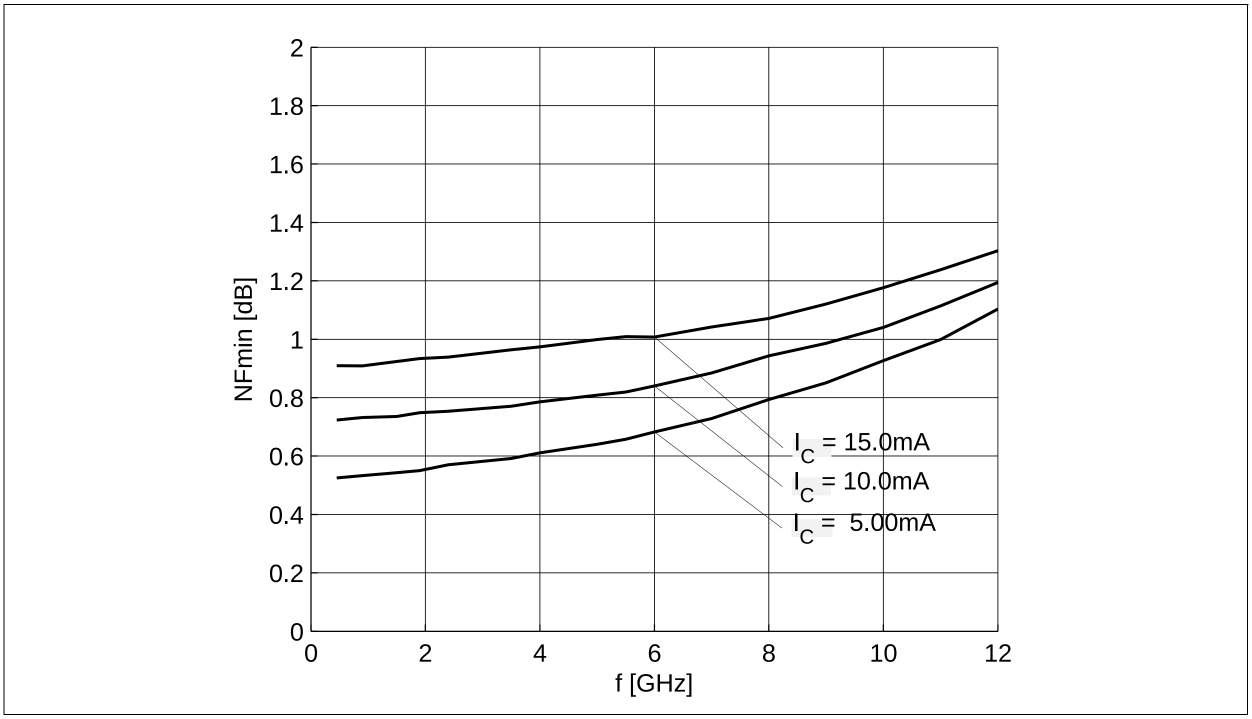

Figure 19 Noise Figure $NF_{min} = f(f)$, V_{CE} = 1.8 V, I_C = 5 / 10 / 15 mA, $Z_S = Z_{opt}$

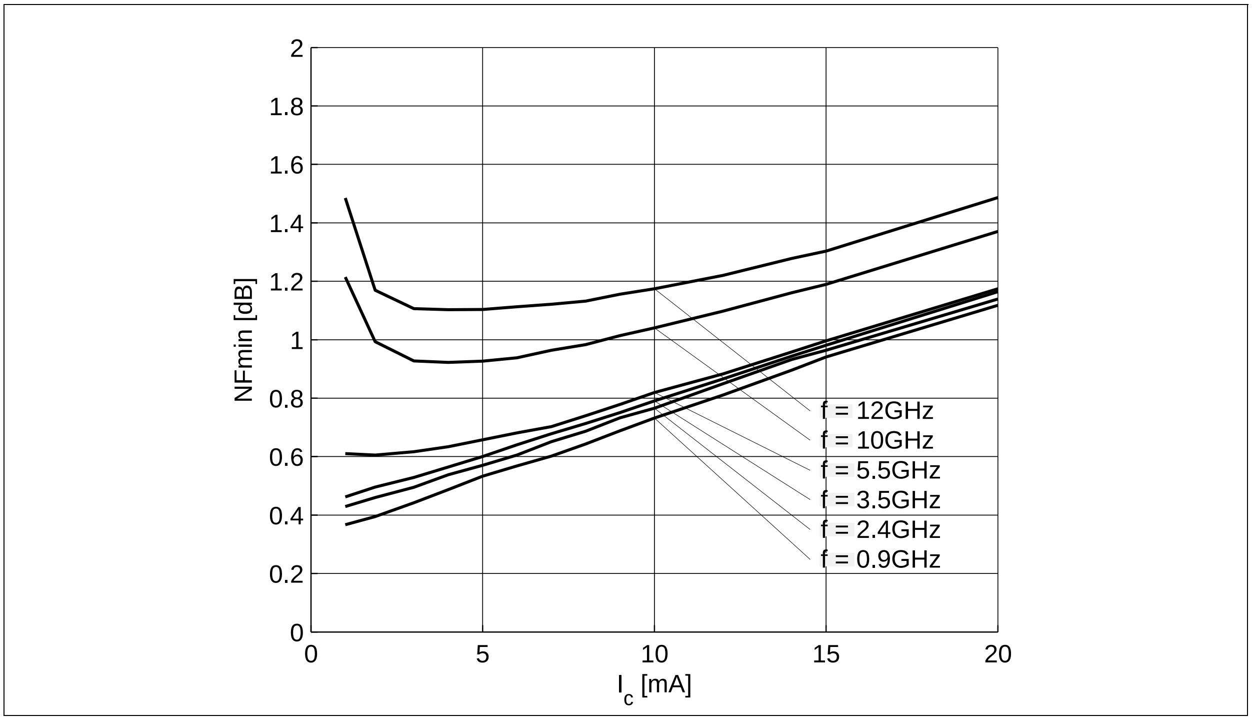

Figure 20 Noise Figure $NF_{min} = f(I_C)$, V_{CE} = 1.8 V, $Z_S = Z_{opt}$, f = Parameter in GHz

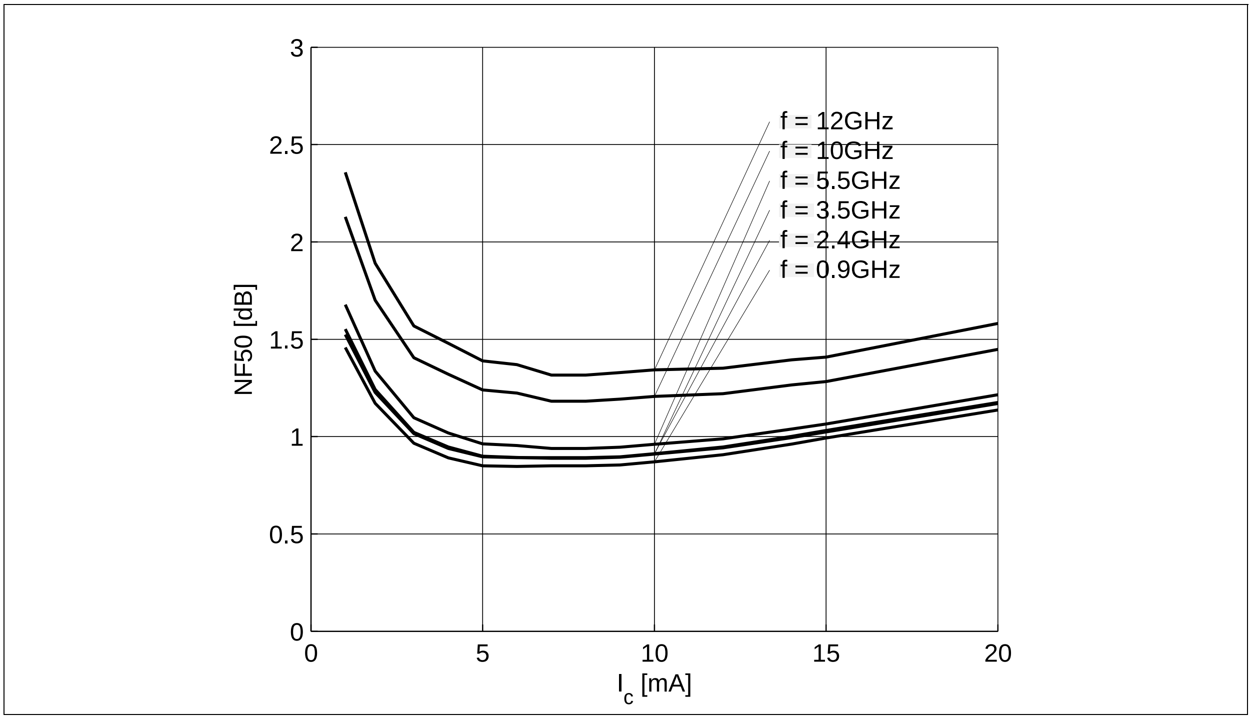

Figure 21 Noise Figure $NF_{50} = f(I_C)$, V_{CE} = 1.8 V, Z_S = 50 Ω, f = Parameter in GHz

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 Package Information TSLP-3-9

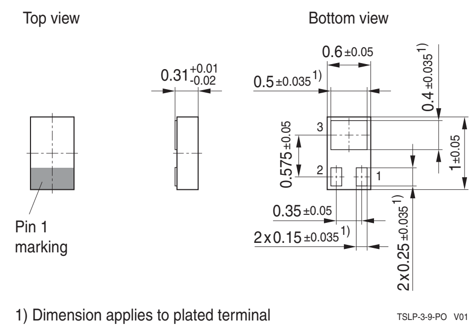

Figure 22 Package Outline

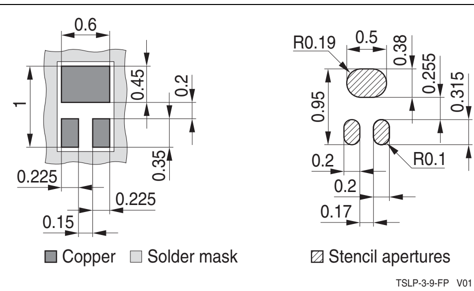

Figure 23 Package Foot Print

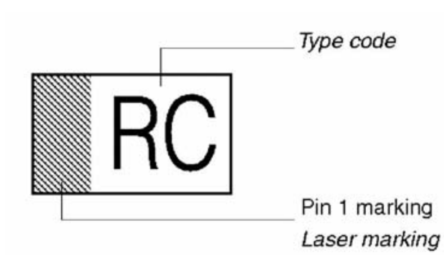

Figure 24 Marking Example (Marking BFR840L3RHESD: T8)

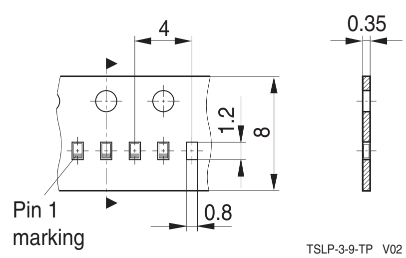

Figure 25 Tape Dimensions

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