BFR840L3RHESD

SiGe:C NPN RF bipolar transistor

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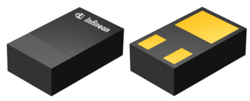
Product description

The BFR840L3RHESD is a dicrete RF heterojunction bipolar transistor (HBT) with an integrated ESD protection suitable for 5 GHz band applications.



Feature list

- Unique combination of high end RF performance and robustness: 20 dBm maximum RF input power, 1.5 kV HBM ESD hardness
- High transition frequency f_T = 75 GHz to enable 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 G_{ms} = 22 dB at 5.5 GHz, 1.8 V, 10 mA
- OIP_3 = 18 dBm at 5.5 GHz, 1.8 V, 10 mA
- 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 require a corresponding collector resistor)
- Low profile and small form factor leadless package

Product validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22.

Potential applications

- Wireless communications: WLAN 2.4 GHz and 5-6 GHz bands, WiMAX and UWB
- Satellite communication systems: satellite radio (SDARs, DAB), navigation systems (e.g. GPS, GLONASS, BeiDou, Galilleo)

Device information

Table 1 Part information

Product name / Ordering code	Package	Pin configuration			Marking	Pieces / Reel
BFR840L3RHESD / BFR840L3RHESDE6327XTSA1	TSLP-3-9	1 = B	2 = C	3 = E	T8	15000

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

Table of contents

1 Absolute maximum ratings

Table 2 Absolute maximum ratings at T_A = 25 °C (unless otherwise specified)

Parameter	Symbol	Values		Unit	Note or test condition
		Min.	Max.		
Collector emitter voltage	V_{CEO}	–	2.25	V	Open base
			2.0		T_A = -55 °C, open base
Collector base voltage [1]	V_{CBO}		2.9		Open emitter
			2.6		T_A = -55 °C, open emitter
Collector emitter voltage [2]	V_{CES}		2.25		E-B short circuited
			2.0		T_A = -55 °C, E-B short circuited
Base current	I_B	-5	3	mA	–
Collector current	I_C	–	35		
RF input power	P_{RFin}	–	20	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			

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.***

1 V_{CBO} is identical to V_{CEO} due to design.
2 V_{CES} is similar to V_{CEO} due to design.
3 T_S is the soldering point temperature. T_S is measured on the emitter lead at the soldering point of the PCB.

2 Thermal characteristics

Table 3 Thermal resistance

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Junction - soldering point	R_{thJS}	–	521	–	K/W	–

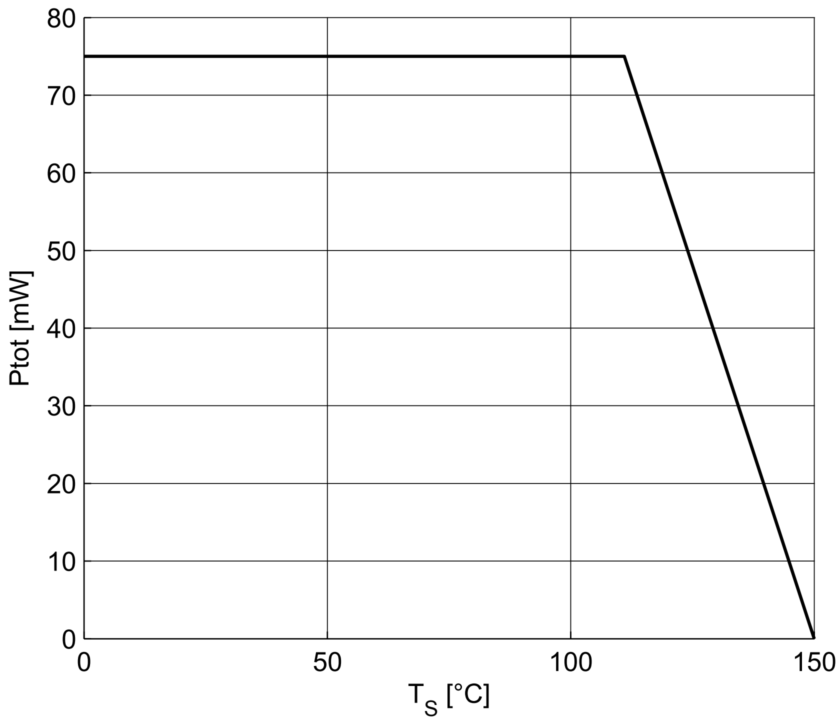


Figure 1 Total power dissipation P_{tot} = f(T_S)

3 Electrical characteristics

3.1 DC characteristics

Table 4 DC characteristics at T_A = 25 °C

Parameter	Symbol	Values			Unit	Note or 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 [1]	nA	V_{CE} = 1.5 V, V_{BE} = 0, E-B short circuited
Collector base leakage current	I_{CBO}			400 [1]		V_{CB} = 1.5 V, I_E = 0, open emitter
Emitter base leakage current	I_{EBO}			10 [1]	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

3.2 General AC characteristics

Table 5 General AC characteristics at T_A = 25 °C

Parameter	Symbol	Values			Unit	Note or 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			V_{EB} = 0.4 V, V_{CB} = 0, f = 1 MHz, collector grounded

1 Maximum values not limited by the device but by the short cycle time of the 100% test

3.3 Frequency dependent AC characteristics

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

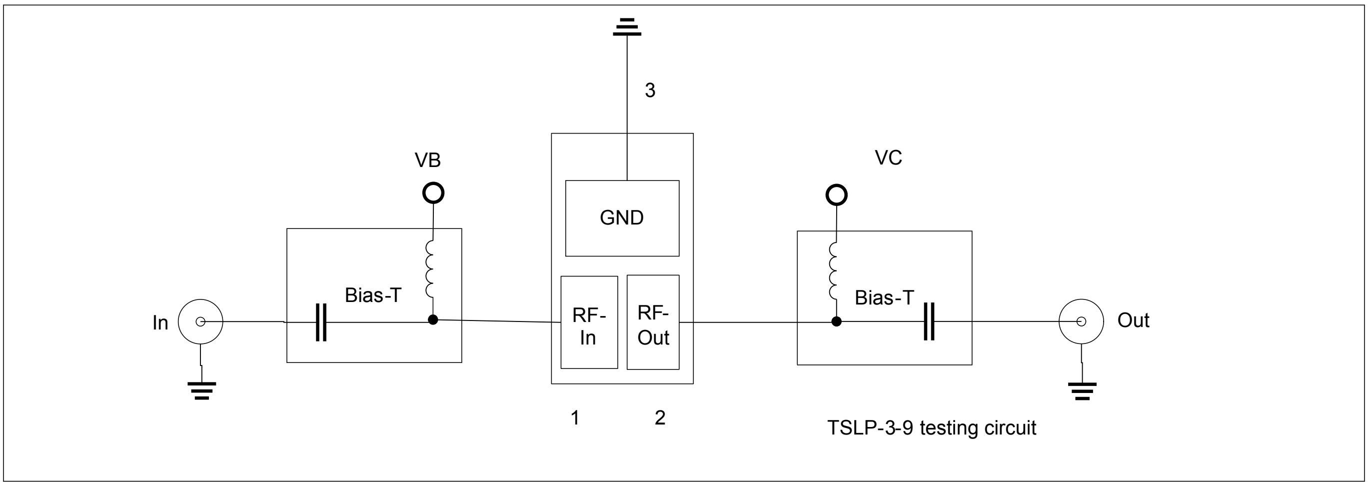


Figure 2 Testing circuit

Table 6 AC characteristics, V_{CE} = 1.8 V, f = 0.45 GHz

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

Table 7 AC characteristics, V_{CE} = 1.8 V, f = 0.9 GHz

Parameter	Symbol	Values			Unit	Note or 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			
Noise figure						
• Minimum noise figure	NF_{min}		0.55			I_C = 5 mA
• Associated gain	G_{ass}		26			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		18.5			$Z_S = Z_L$ = 50 Ω, I_C = 10 mA
• 1 dB gain compression point at output	OP_{1dB}		4			

Table 8 **AC characteristics, V_{CE} = 1.8 V, f = 1.5 GHz**

Parameter	Symbol	Values			Unit	Note or 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			
Noise figure						
• Minimum noise figure	NF_{min}		0.55			I_C = 5 mA
• Associated gain	G_{ass}		24.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		17			$Z_S = Z_L$ = 50 Ω, I_C = 10 mA
• 1 dB gain compression point at output	OP_{1dB}		4			

Table 9 **AC characteristics, V_{CE} = 1.8 V, f = 1.9 GHz**

Parameter	Symbol	Values			Unit	Note or 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			
Noise figure						
• Minimum noise figure	NF_{min}		0.6			I_C = 5 mA
• Associated gain	G_{ass}		24			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		17			$Z_S = Z_L$ = 50 Ω, I_C = 10 mA
• 1 dB gain compression point at output	OP_{1dB}		4			

Table 10 **AC characteristics, V_{CE} = 1.8 V, f = 2.4 GHz**

Parameter	Symbol	Values			Unit	Note or 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			
Noise figure						
• Minimum noise figure	NF_{min}		0.6			I_C = 5 mA
• Associated gain	G_{ass}		22.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		17			$Z_S = Z_L$ = 50 Ω, I_C = 10 mA
• 1 dB gain compression point at output	OP_{1dB}		4			

Table 11 AC characteristics, V_{CE} = 1.8 V, f = 3.5 GHz

Parameter	Symbol	Values			Unit	Note or 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			
Noise figure						
• Minimum noise figure	NF_{min}		0.6			I_C = 5 mA
• Associated gain	G_{ass}		20			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		18			$Z_S = Z_L$ = 50 Ω, I_C = 10 mA
• 1 dB gain compression point at output	OP_{1dB}		4			

Table 12 AC characteristics, V_{CE} = 1.8 V, f = 5.5 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		22			I_C = 10 mA
• Transducer gain	$\|S_{21}\|^2$		19			
Noise figure						
• Minimum noise figure	NF_{min}		0.65			I_C = 5 mA
• Associated gain	G_{ass}		16.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		18			$Z_S = Z_L$ = 50 Ω, I_C = 10 mA
• 1 dB gain compression point at output	OP_{1dB}		4			

Table 13 AC characteristics, V_{CE} = 1.8 V, f = 10 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ma}		16			I_C = 10 mA
• Transducer gain	$\|S_{21}\|^2$		13			
Noise figure						
• Minimum noise figure	NF_{min}		0.9			I_C = 5 mA
• Associated gain	G_{ass}		11.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		17			$Z_S = Z_L$ = 50 Ω, I_C = 10 mA
• 1 dB gain compression point at output	OP_{1dB}		3			

Table 14 AC characteristics, V_{CE} = 1.8 V, f = 12 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ma}		13.5			I_C = 10 mA
• Transducer gain	$\|S_{21}\|^2$		10			
Noise figure						
• Minimum noise figure	NF_{min}		1.1			I_C = 5 mA
• Associated gain	G_{ass}		12			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		17			$Z_S = Z_L$ = 50 Ω, I_C = 10 mA
• 1 dB gain compression point at output	OP_{1dB}		3			

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 Ω from 0.2 MHz to 12 GHz.*

3.4 Characteristic DC diagrams

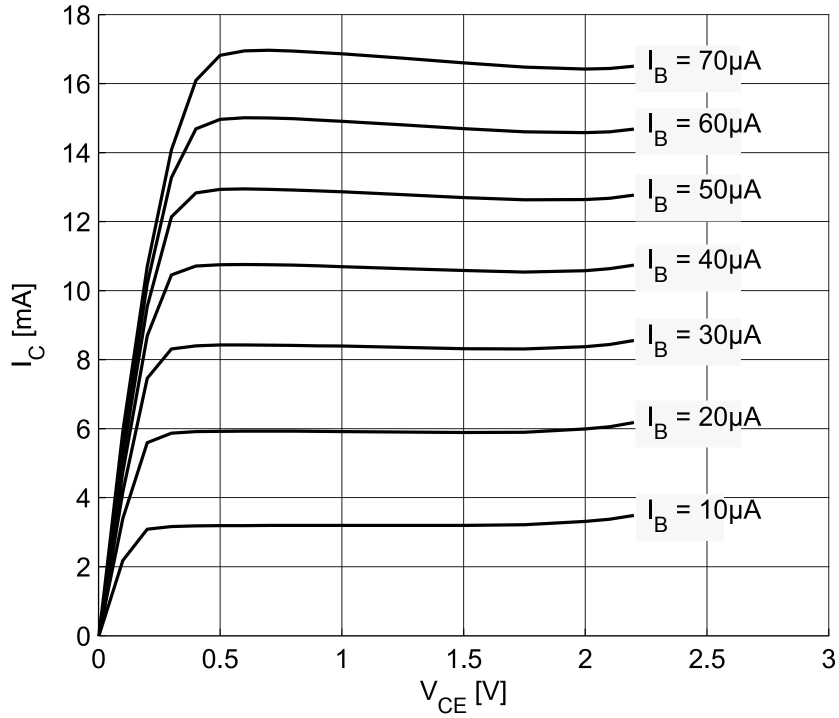


Figure 3 Collector current vs. collector emitter voltage $I_C = f(V_{CE})$, I_B = parameter

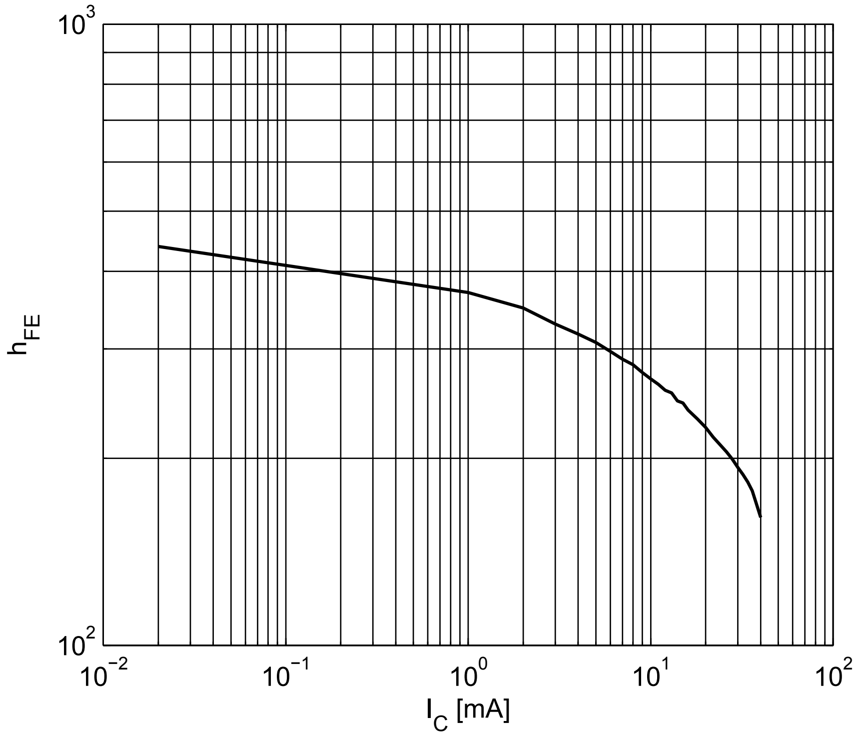


Figure 4 DC current gain $h_{FE} = f(I_C)$, V_{CE} = 1.8 V

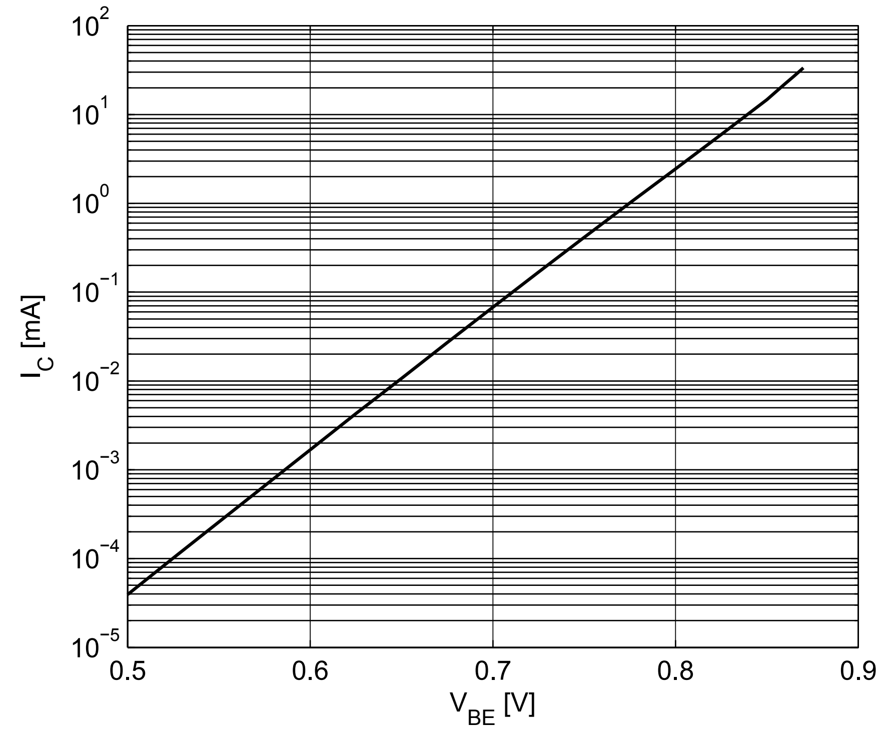


Figure 5 **Collector current vs. base emitter forward voltage $I_C = f(V_{BE})$, $V_{CE} = 1.8$ V**

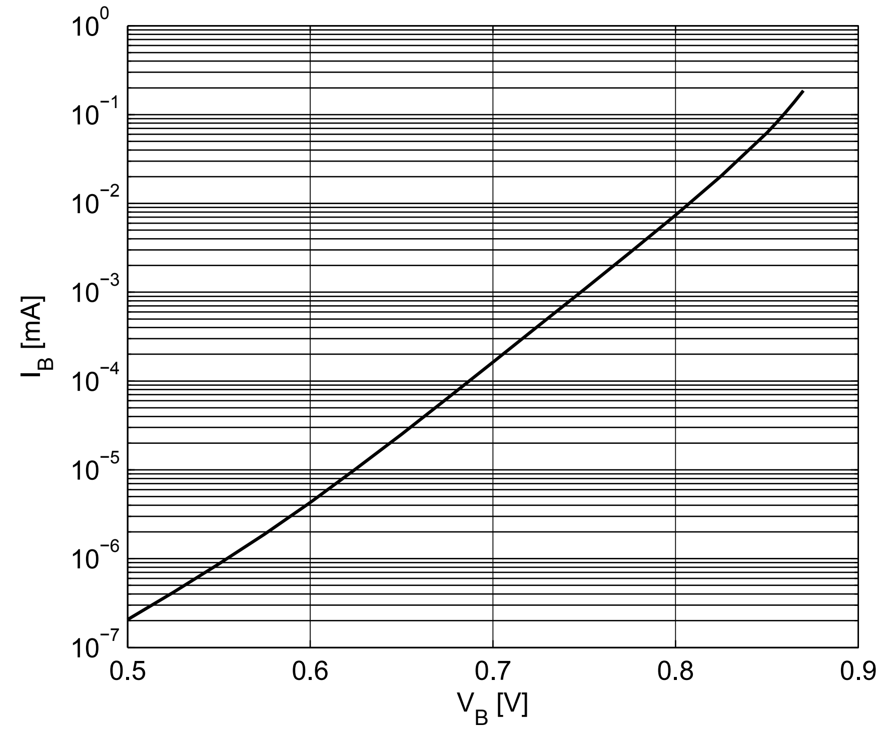


Figure 6 **Base current vs. base emitter forward voltage $I_B = f(V_{BE})$, $V_{CE} = 1.8$ V**

Electrical characteristics

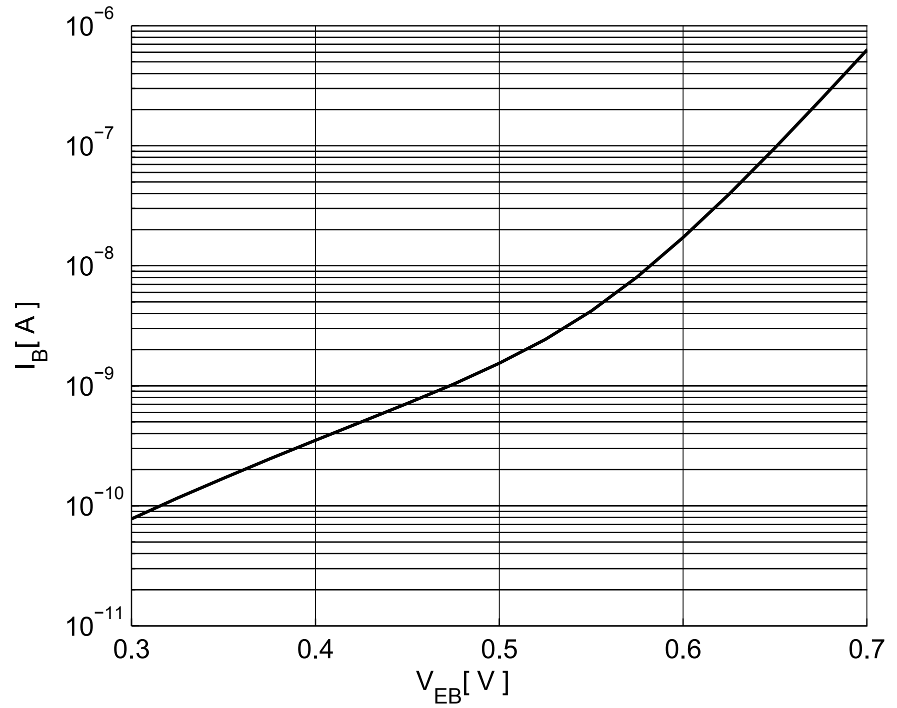


Figure 7 Base current vs. base emitter reverse voltage $I_B = f(V_{EB})$, $V_{CE} = 1.8$ V

3.5 Characteristic AC diagrams

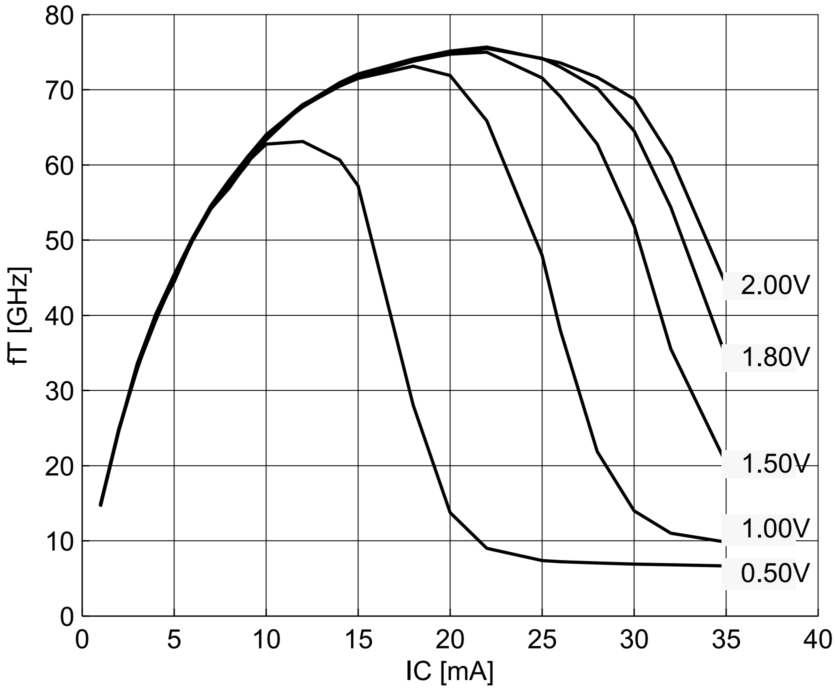


Figure 8 Transition frequency $f_T = f(I_C)$, $f = 2$ GHz, V_{CE} = parameter

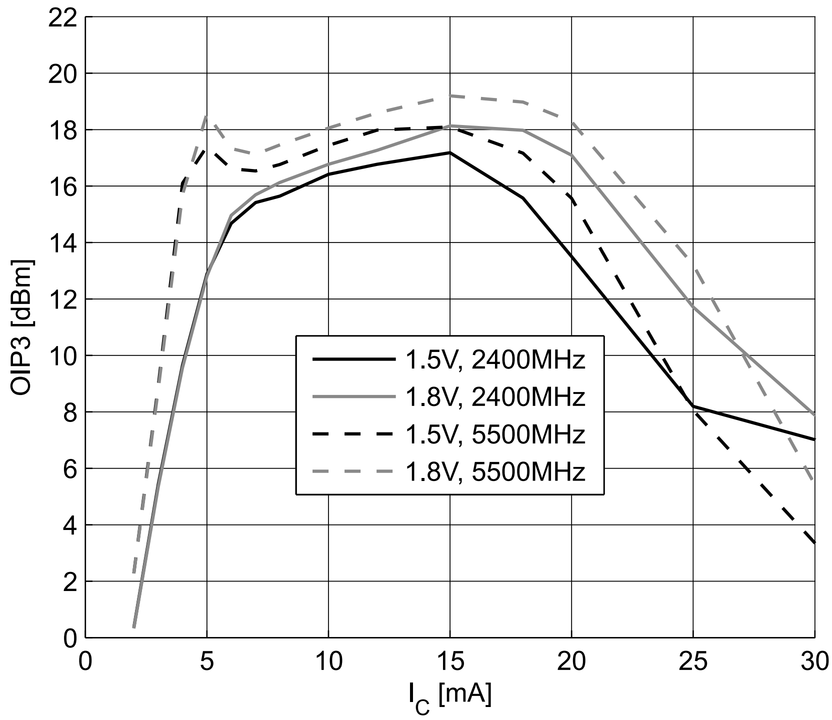


Figure 9 3rd order intercept point at output $OIP_3 = f(I_C)$, $Z_S = Z_L = 50\ \Omega$, V_{CE}, f = parameters

Electrical characteristics

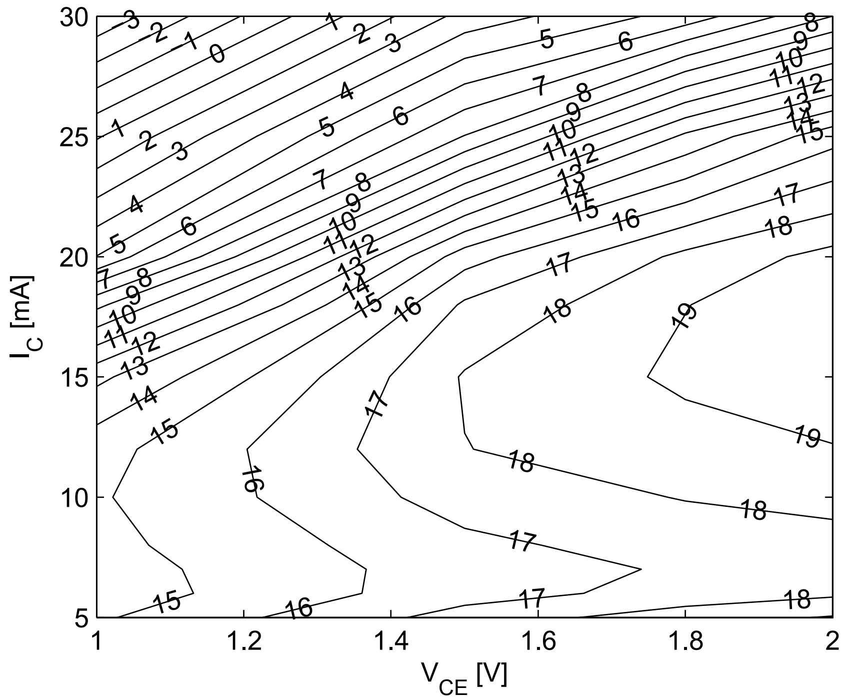


Figure 10 3rd order intercept point at output OIP_3 [dBm] = f(I_C, V_{CE}), Z_S = Z_L= 50 Ω, f = 5.5 GHz

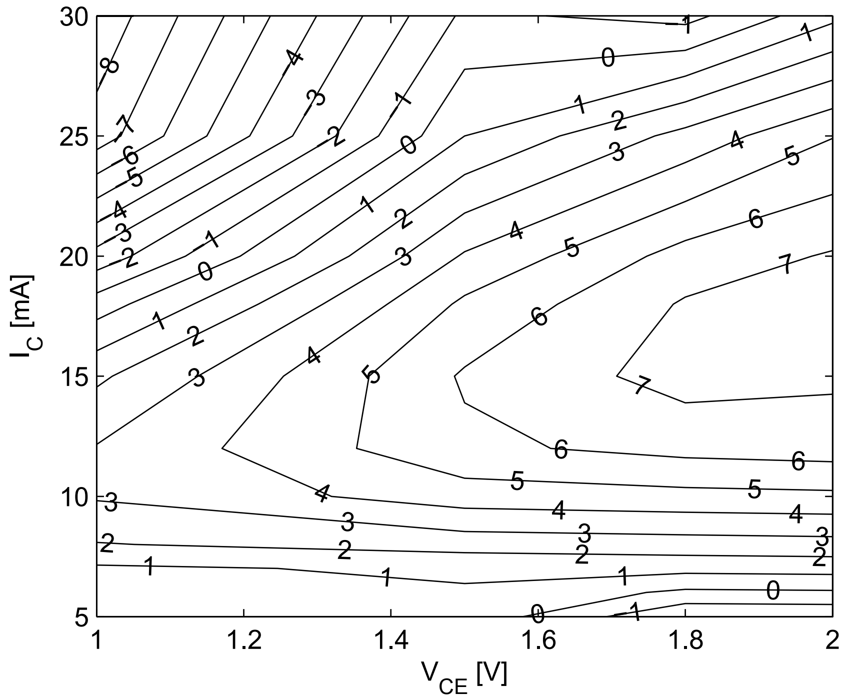


Figure 11 Compression point at output OP_{1dB} [dBm] = f(I_C, V_{CE}), Z_S = Z_L= 50 Ω, f = 5.5 GHz

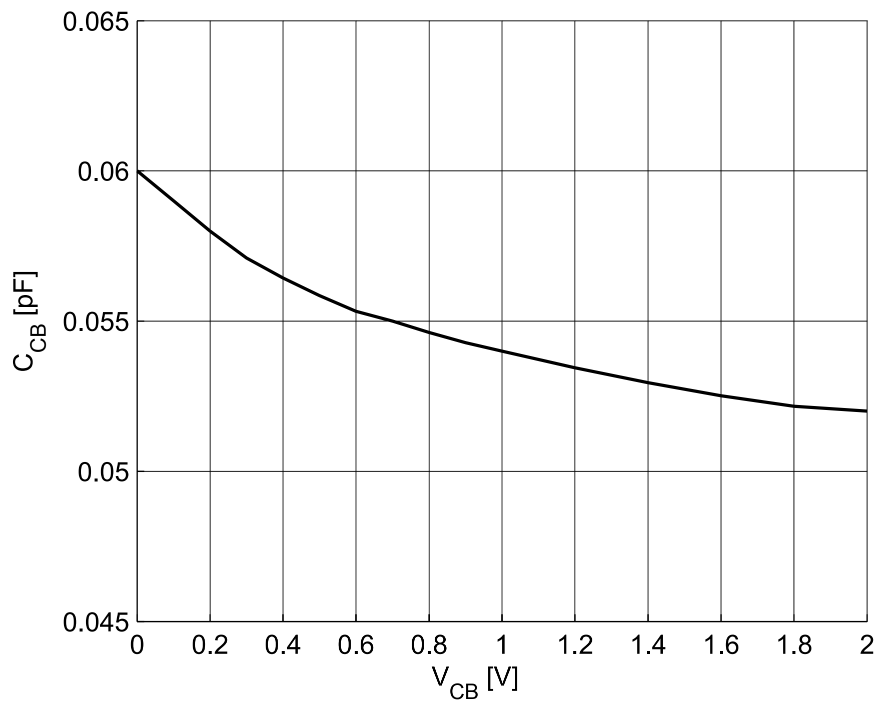


Figure 12 Collector base capacitance $C_{CB} = f(V_{CB})$, $f = 1$ MHz

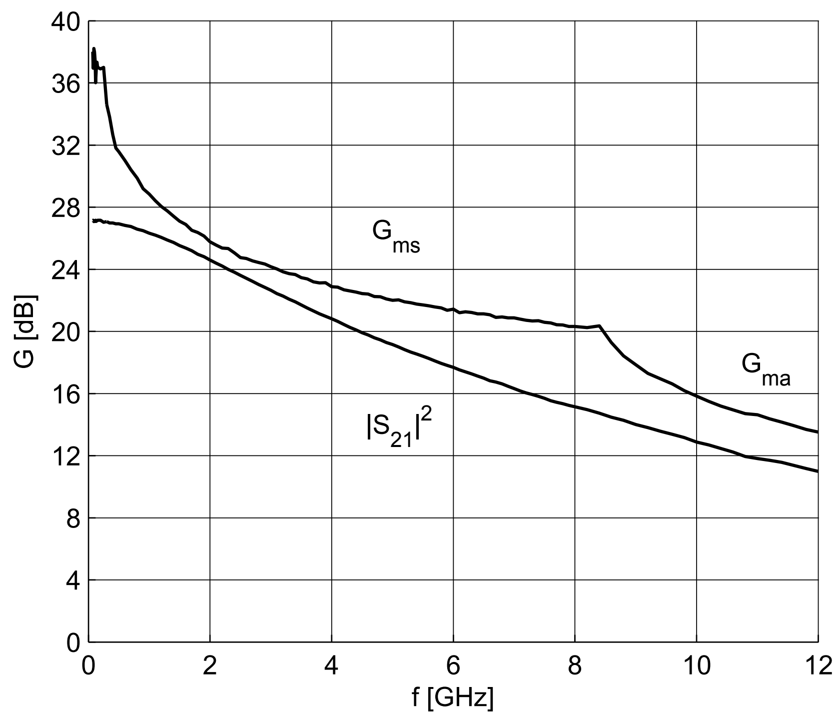


Figure 13 Gain G_{ma}, G_{ms}, $|S_{21}|^2 = f(f)$, $V_{CE} = 1.8$ V, $I_C = 10$ mA

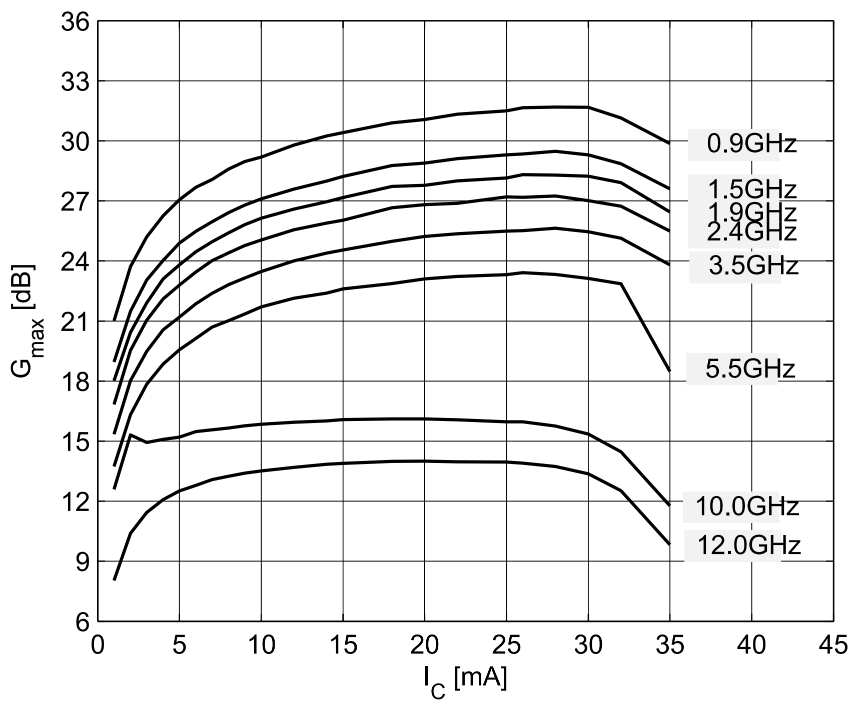


Figure 14 **Maximum power gain G_{max} = f(I_C), V_{CE} = 1.8 V, f = parameter in GHz**

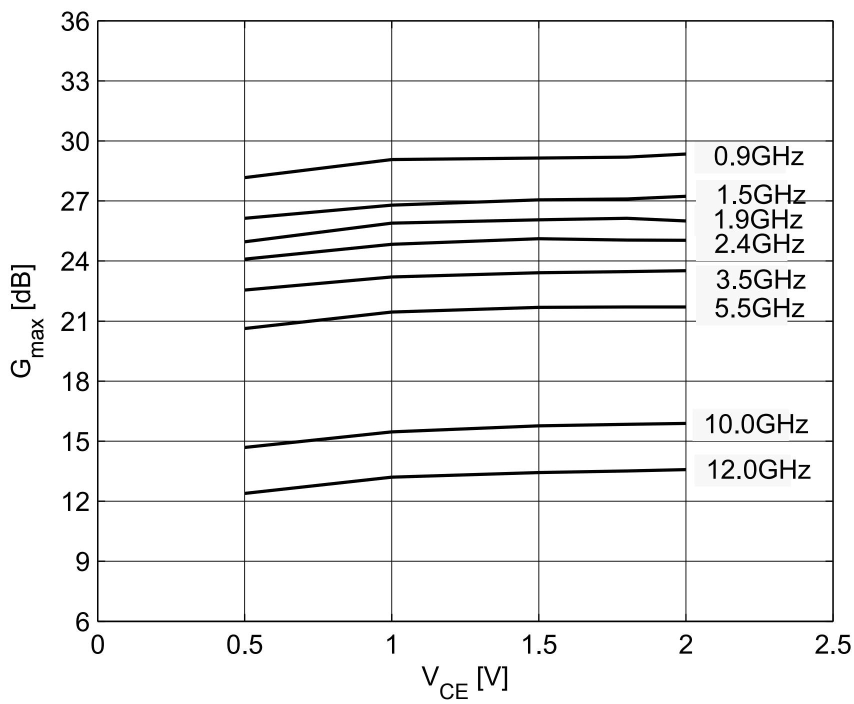


Figure 15 **Maximum power gain G_{max} = f(V_{CE}), I_C = 10 mA, f = parameter in GHz**

Electrical characteristics

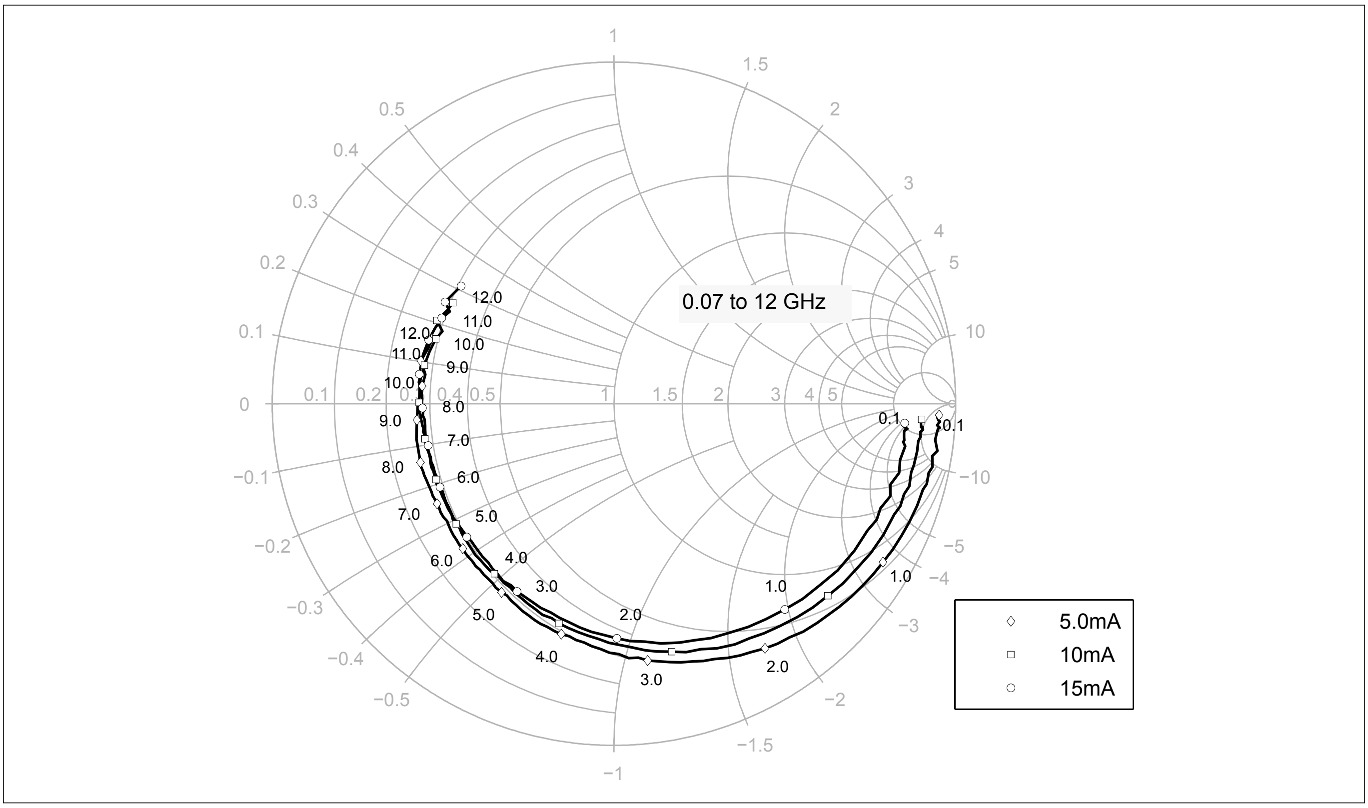


Figure 16 **Input reflection coefficient S_{11} = f(f), V_{CE} = 1.8 V, I_C = 5 / 10 / 15 mA**

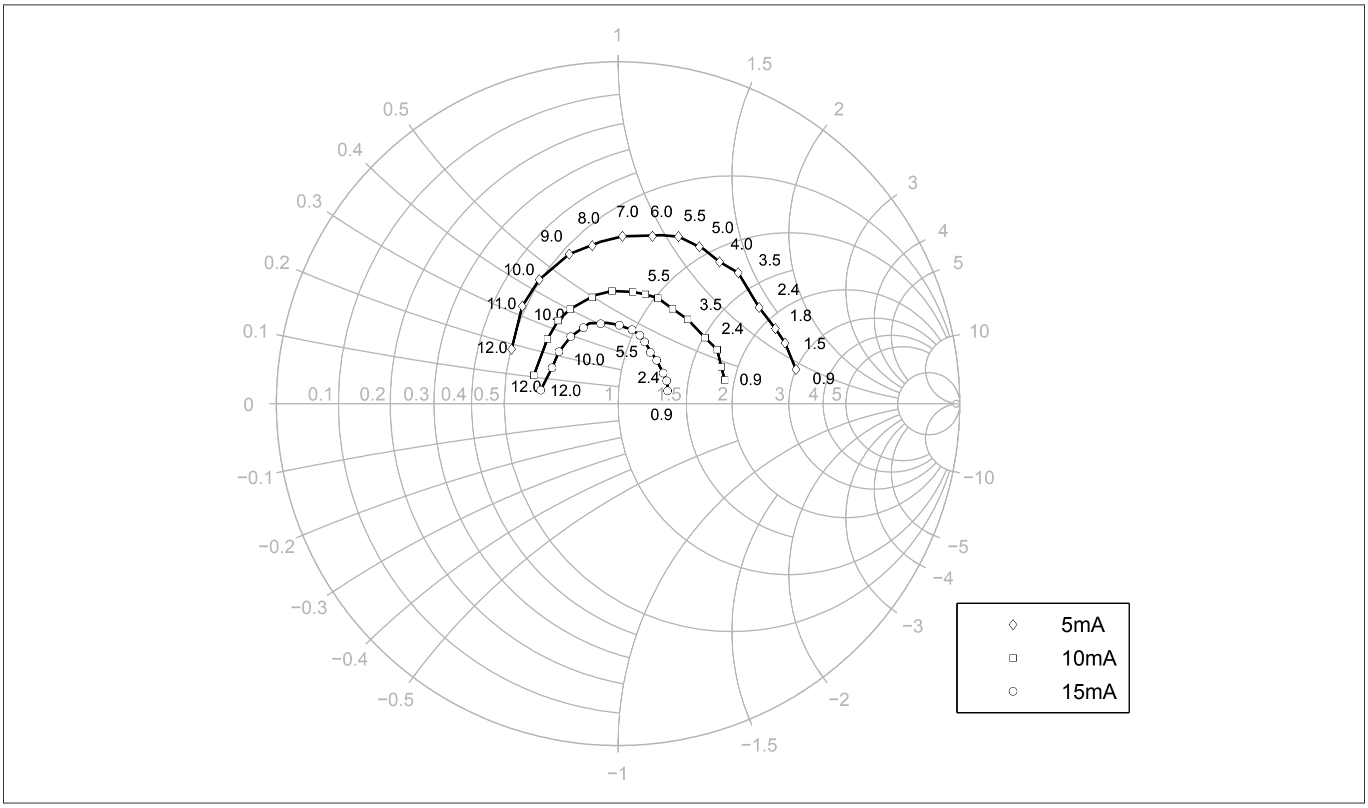


Figure 17 **Source impedance for minimum noise figure $Z_{S,opt}$ = f(f), V_{CE} = 1.8 V, I_C = 5 / 10 / 15 mA**

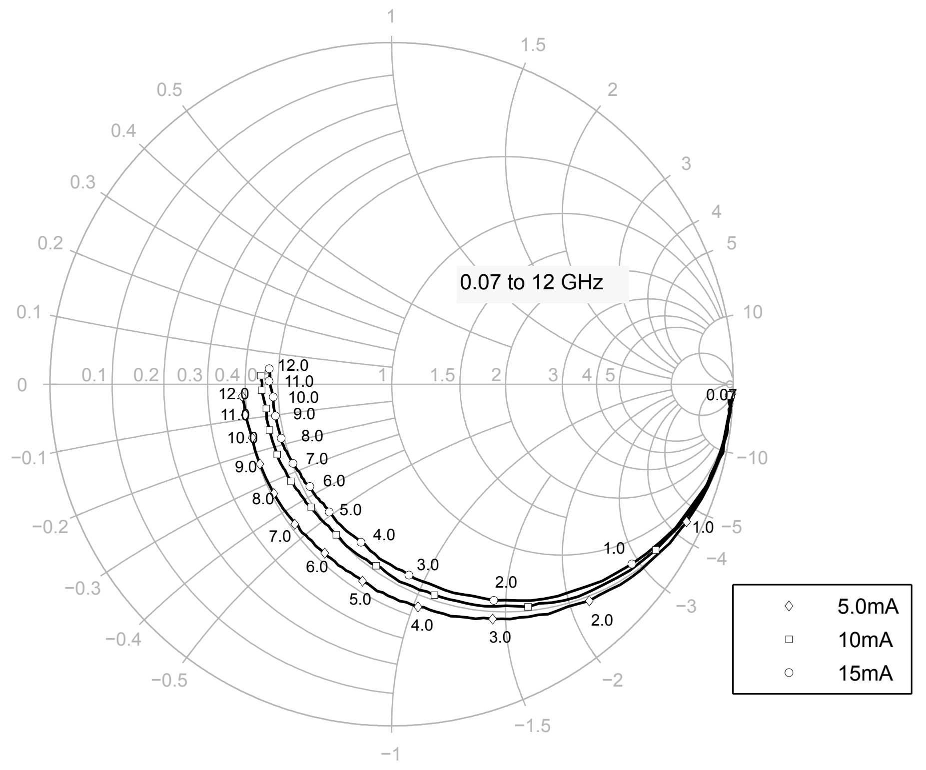


Figure 18 **Output reflection coefficient S_{22} = f(f), V_{CE} = 1.8 V, I_C = 5 / 10 / 15 mA**

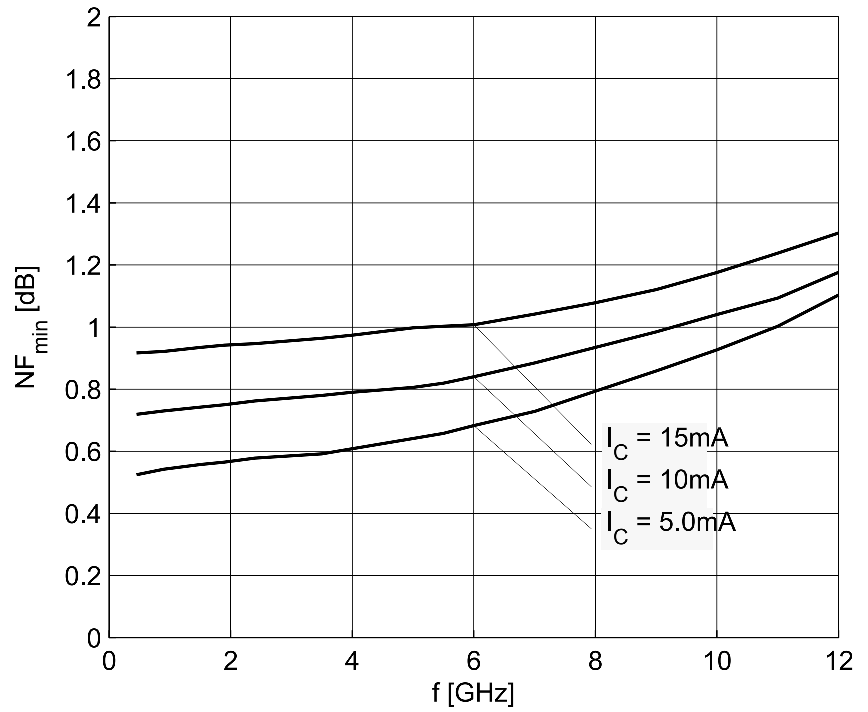


Figure 19 **Noise figure NF_{min} = f(f), V_{CE} = 1.8 V, Z_S = $Z_{S,opt}$, I_C = 5 / 10 / 15 mA**

Electrical characteristics

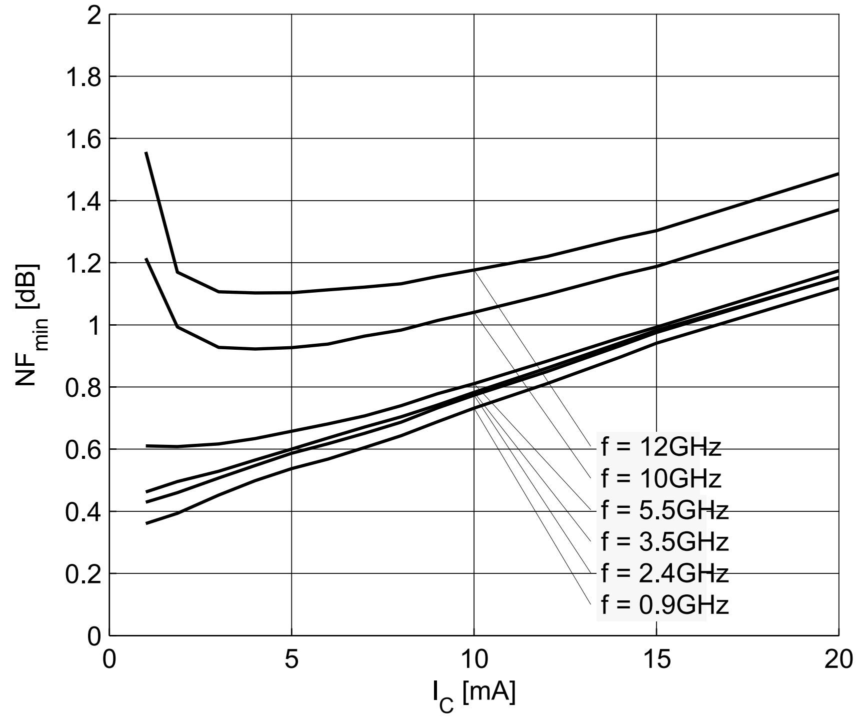


Figure 20 **Noise figure NF_{min} = f(I_C), V_{CE} = 1.8 V, Z_S = $Z_{S,opt}$, f = parameter in GHz**

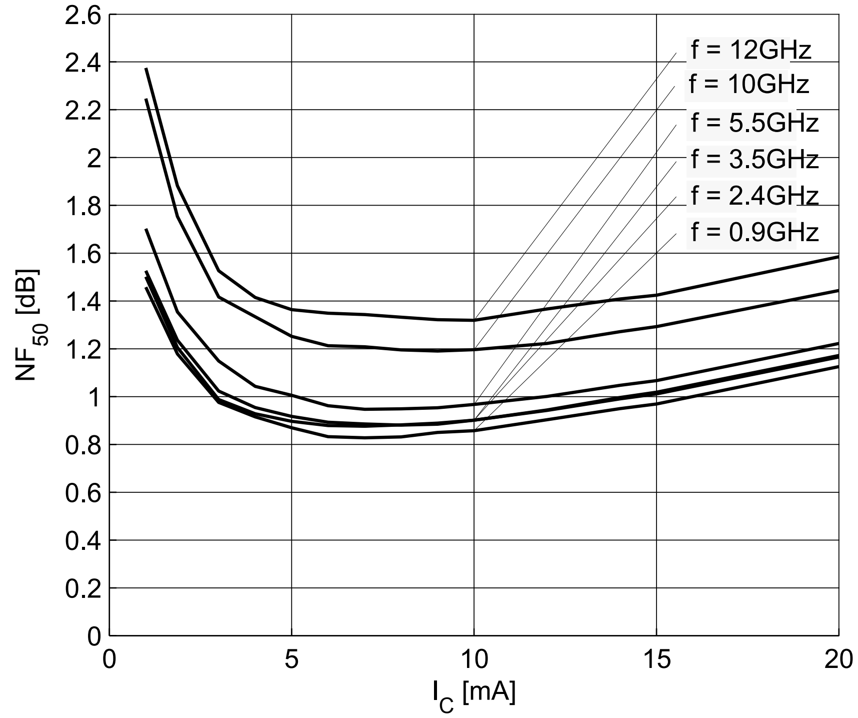


Figure 21 **Noise figure NF_{50} = f(I_C), V_{CE} = 1.8 V, Z_S = 50 Ω, f = parameter in GHz**

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.

4 Package information TSLP-3-9

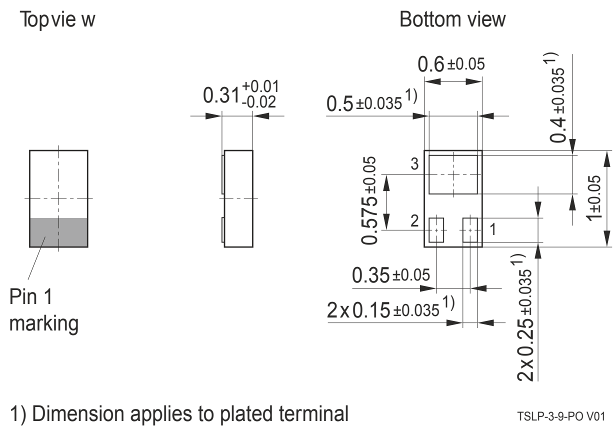


Figure 22 Package outline (dimension in mm)

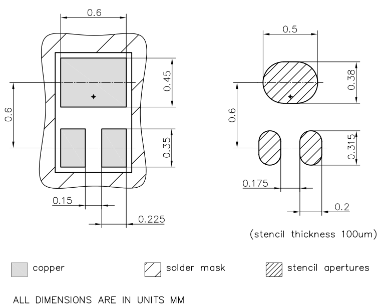


Figure 23 Foot print

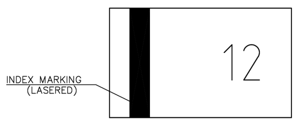


Figure 24 Marking layout example

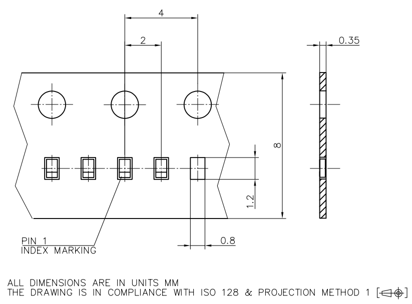


Figure 25 Tape dimensions

Note: *See our* ***Recommendations for Printed Circuit Board Assembly of TSLP/TSSLP/TSNP Packages*** *.*
The marking layout is an example. For the real marking code refer to the device information on the first page. The number of characters shown in the layout example is not necessarily the real one. The marking layout can consist of less characters.

Revision history

Document version	Date of release	Description of changes
2.0	2018-09-26	New datasheet layout.

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