BFP640

Surface mount high linearity silicon NPN RF bipolar transistor

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Product description

The BFP640 is a RF bipolar transistor based on SiGe:C technology that is part of Infineon's established sixth generation transistor family. Its transition frequency f_T of 42 GHz and high linearity characteristics at low currents make this device particularly suitable for energy efficiency designs at frequency as high as 8 GHz. It remains cost competitive without compromising on ease of use.

Feature list

- Minimum noise figure NF_{min} = 0.65 dB at 1.9 GHz, 3 V, 6 mA
- High gain G_{ma} = 24 dB at 1.9 GHz, 3 V, 25 mA
- OIP_3 = 26.5 dBm at 1.9 GHz, 3 V, 25 mA

Product validation

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

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
BFP640 / BFP640H6327XTSA1	SOT343	1 = B	2 = E	3 = C	4 = E	R4s	3000

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

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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}	–	4.1	V	Open base
			3.6		T_A = -55 °C, open base
Collector emitter voltage	V_{CES}		13		E-B short circuited
Collector base voltage	V_{CBO}		13		Open emitter
Emitter base voltage	V_{EBO}		1.2		Open collector
Base current	I_B		3	mA	–
Collector current	I_C		50		
Total power dissipation [1]	P_{tot}		200	mW	$T_S \leq 90$ °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 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}	–	300	–	K/W	–

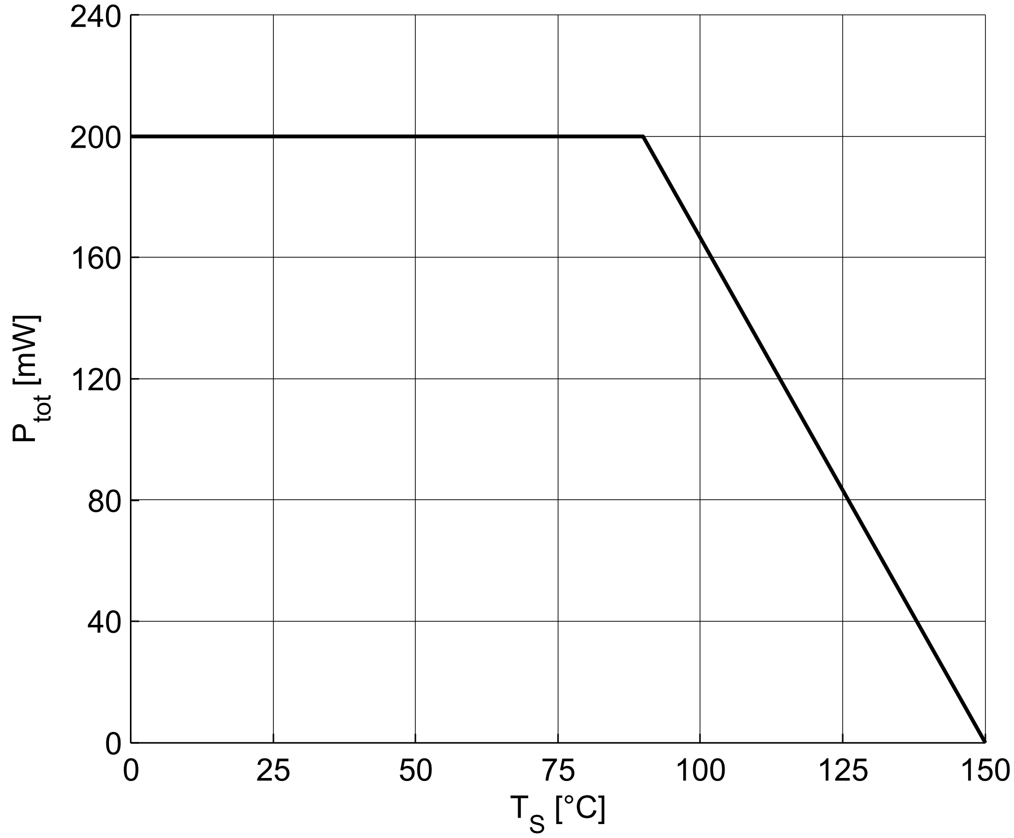

Figure 1 Total power dissipation P_{tot} = f(T_S)

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	$V_{(BR)CEO}$	4.1	4.7	–	V	$I_C = 1$ mA, $I_B = 0$, open base
Collector emitter leakage current	I_{CES}	–	1	400 [2]	nA	$V_{CE} = 13$ V, $V_{BE} = 0$, E-B short circuited
			1	40 [2]		$V_{CE} = 5$ V, $V_{BE} = 0$, E-B short circuited
Collector base leakage current	I_{CBO}		1	40 [2]		$V_{CB} = 5$ V, $I_E = 0$, open emitter
Emitter base leakage current	I_{EBO}		1	40 [2]		$V_{EB} = 0.5$ V, $I_C = 0$, open collector
DC current gain	h_{FE}	110	180	270		$V_{CE} = 3$ V, $I_C = 30$ 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	–	42	–	GHz	$V_{CE} = 3$ V, $I_C = 30$ mA, $f = 2$ GHz
Collector base capacitance	C_{CB}		0.08		pF	$V_{CB} = 3$ V, $V_{BE} = 0$, $f = 1$ MHz, emitter grounded
Collector emitter capacitance	C_{CE}		0.24			$V_{CE} = 3$ V, $V_{BE} = 0$, $f = 1$ MHz, base grounded
Emitter base capacitance	C_{EB}		0.51			$V_{EB} = 0.5$ V, $V_{CB} = 0$, $f = 1$ MHz, collector grounded

2 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.

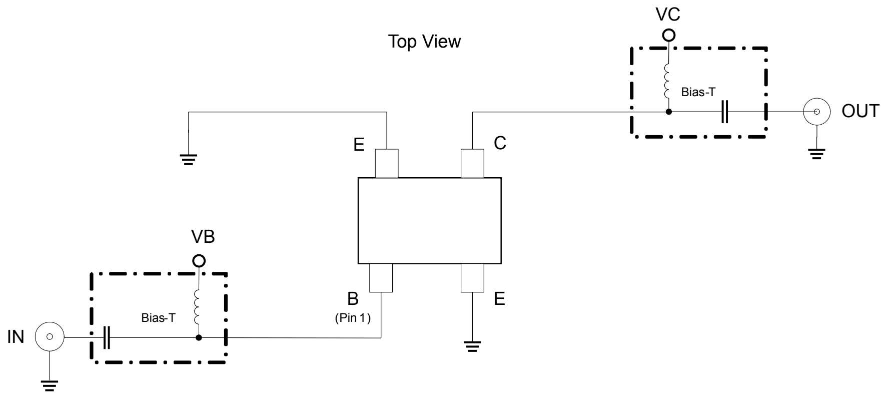

Figure 2 Testing circuit

Table 6 AC characteristics, V_{CE} = 3 V, f = 450 MHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain • Maximum power gain • Transducer gain	 G_{ms} $\|S_{21}\|^2$	–	 33 31.5	–	dB	I_C = 25 mA
Noise figure • Minimum noise figure • Associated gain	 NF_{min} G_{ass}		 0.55 26			I_C = 6 mA
Linearity • 3rd order intercept point at output • 1 dB gain compression point at output	 OIP_3 OP_{1dB}		 23.5 10.5		dBm	I_C = 25 mA, Z_S = Z_L = 50 Ω

Table 7 AC characteristics, V_{CE} = 3 V, f = 900 MHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain • Maximum power gain • Transducer gain	 G_{ms} $\|S_{21}\|^2$	–	 29 27.5	–	dB	I_C = 25 mA
Noise figure • Minimum noise figure • Associated gain	 NF_{min} G_{ass}		 0.6 24			I_C = 6 mA
Linearity • 3rd order intercept point at output • 1 dB gain compression point at output	 OIP_3 OP_{1dB}		 25.5 12		dBm	I_C = 25 mA, Z_S = Z_L = 50 Ω

Table 8 **AC characteristics, V_{CE} = 3 V, f = 1.5 GHz**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		25.5			I_C = 25 mA
• Transducer gain	$\|S_{21}\|^2$		23.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.6			I_C = 6 mA
• Associated gain	G_{ass}		21			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		25.5			I_C = 25 mA, Z_S = Z_L = 50 Ω
• 1 dB gain compression point at output	OP_{1dB}		11.5			

Table 9 **AC characteristics, V_{CE} = 3 V, f = 1.9 GHz**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		24			I_C = 25 mA
• Transducer gain	$\|S_{21}\|^2$		21.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.65			I_C = 6 mA
• Associated gain	G_{ass}		19.5			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		26.5			I_C = 25 mA, Z_S = Z_L = 50 Ω
• 1 dB gain compression point at output	OP_{1dB}		12.5			

Table 10 **AC characteristics, V_{CE} = 3 V, f = 2.4 GHz**

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ms}		22			I_C = 25 mA
• Transducer gain	$\|S_{21}\|^2$		19.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.7			I_C = 6 mA
• Associated gain	G_{ass}		18			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		27.5			I_C = 25 mA, Z_S = Z_L = 50 Ω
• 1 dB gain compression point at output	OP_{1dB}		12			

Table 11 AC characteristics, V_{CE} = 3 V, f = 3.5 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ma}		18			I_C = 25 mA
• Transducer gain	$\|S_{21}\|^2$		16.5			
Noise figure						
• Minimum noise figure	NF_{min}		0.85			I_C = 6 mA
• Associated gain	G_{ass}		15			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		27.5			I_C = 25 mA, Z_S = Z_L = 50 Ω
• 1 dB gain compression point at output	OP_{1dB}		12			

Table 12 AC characteristics, V_{CE} = 3 V, f = 5.5 GHz

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Power gain		–		–	dB	
• Maximum power gain	G_{ma}		14			I_C = 25 mA
• Transducer gain	$\|S_{21}\|^2$		12.5			
Noise figure						
• Minimum noise figure	NF_{min}		1.1			I_C = 6 mA
• Associated gain	G_{ass}		12			
Linearity					dBm	
• 3rd order intercept point at output	OIP_3		27.5			I_C = 25 mA, Z_S = Z_L = 50 Ω
• 1 dB gain compression point at output	OP_{1dB}		12.5			

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

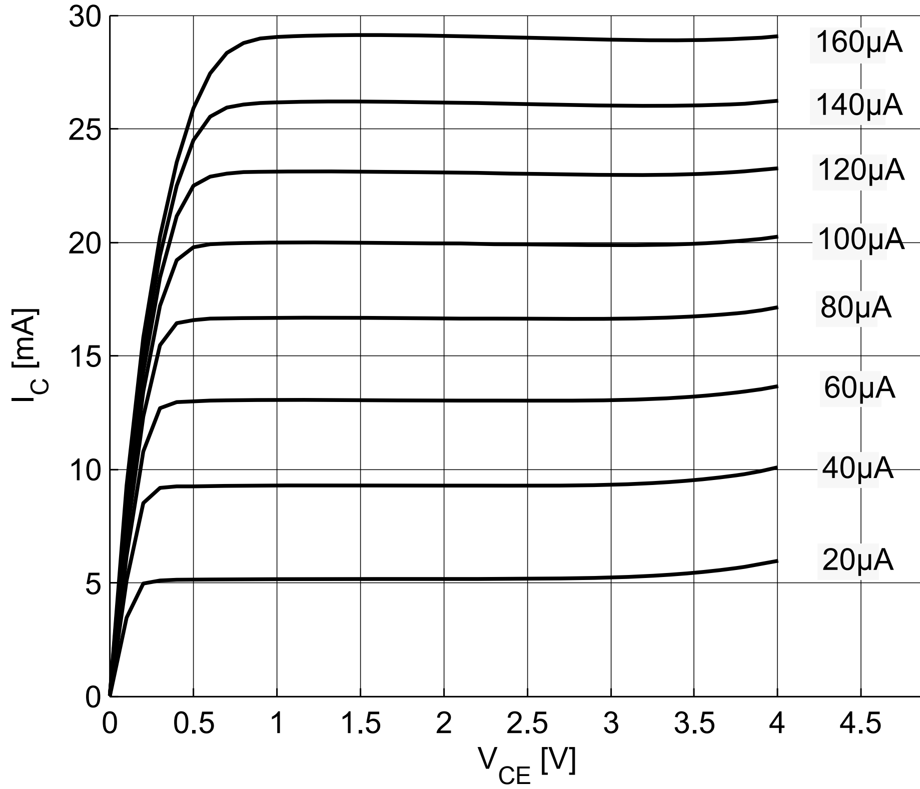

Figure 3 Collector current vs. collector emitter voltage $I_C = f(V_{CE})$, I_B = parameter

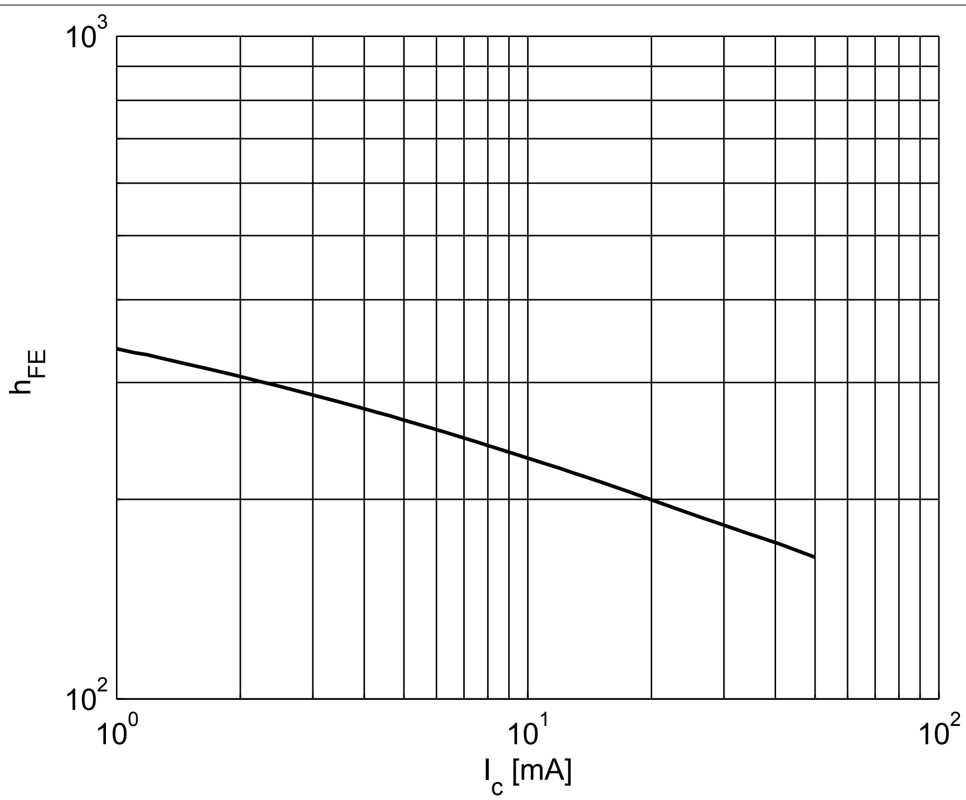

Figure 4 DC current gain $h_{FE} = f(I_C)$, V_{CE} = 3 V

Electrical characteristics

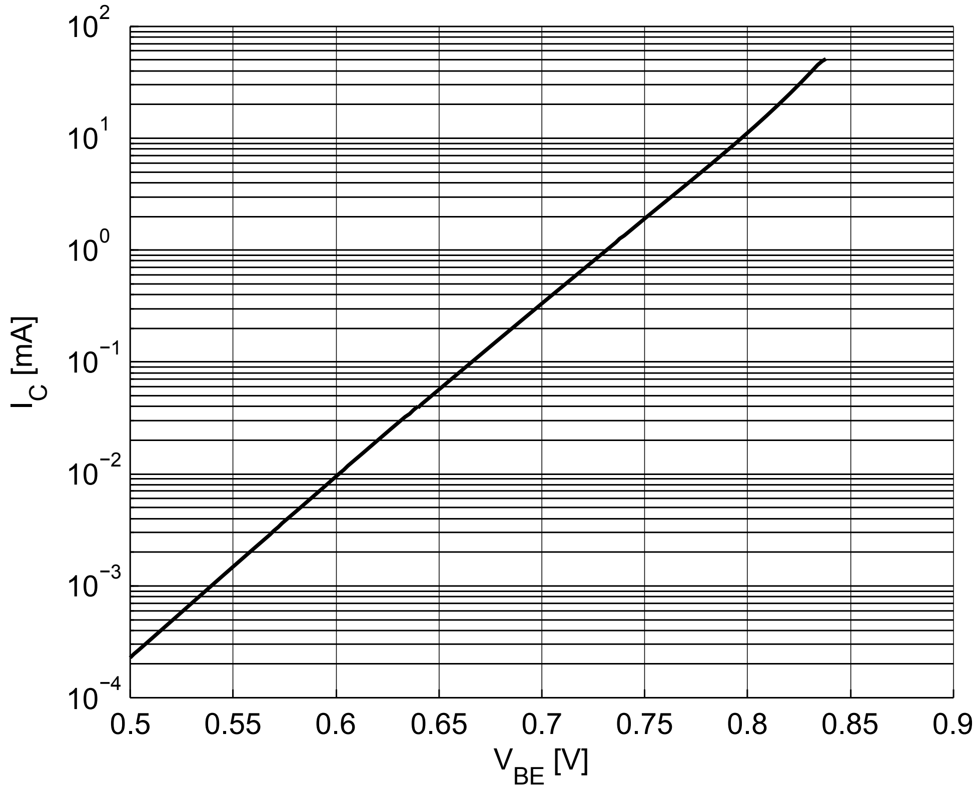

Figure 5 **Collector current vs. base emitter forward voltage $I_C = f(V_{BE})$, $V_{CE} = 2$ V**

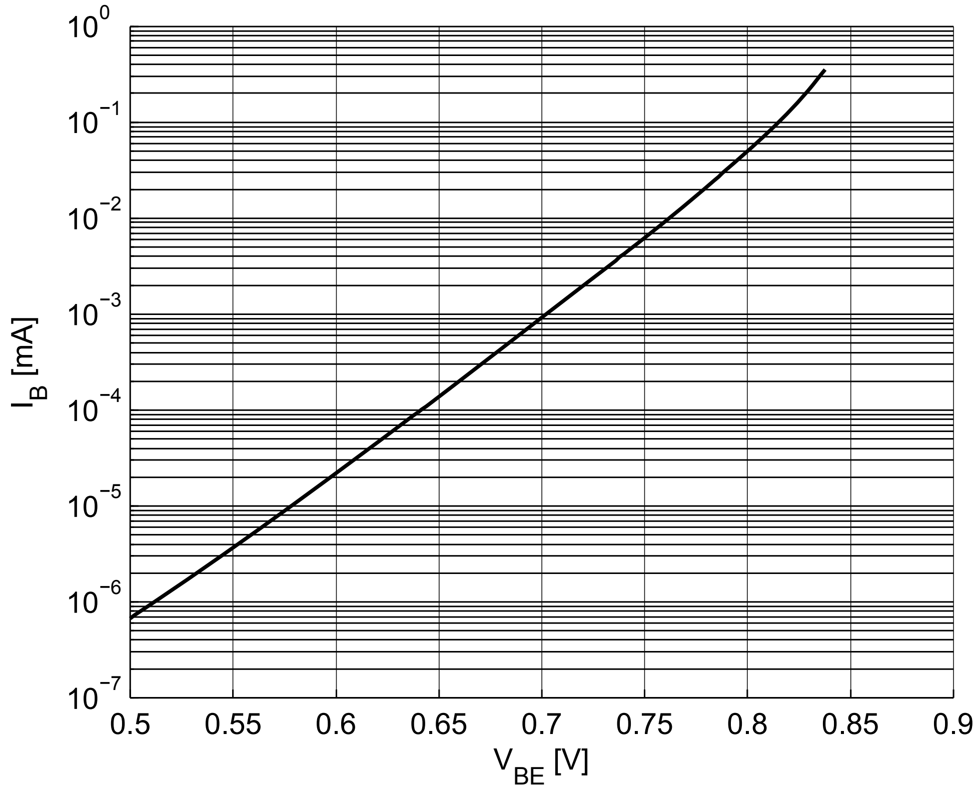

Figure 6 **Base current vs. base emitter forward voltage $I_B = f(V_{BE})$, $V_{CE} = 2$ V**

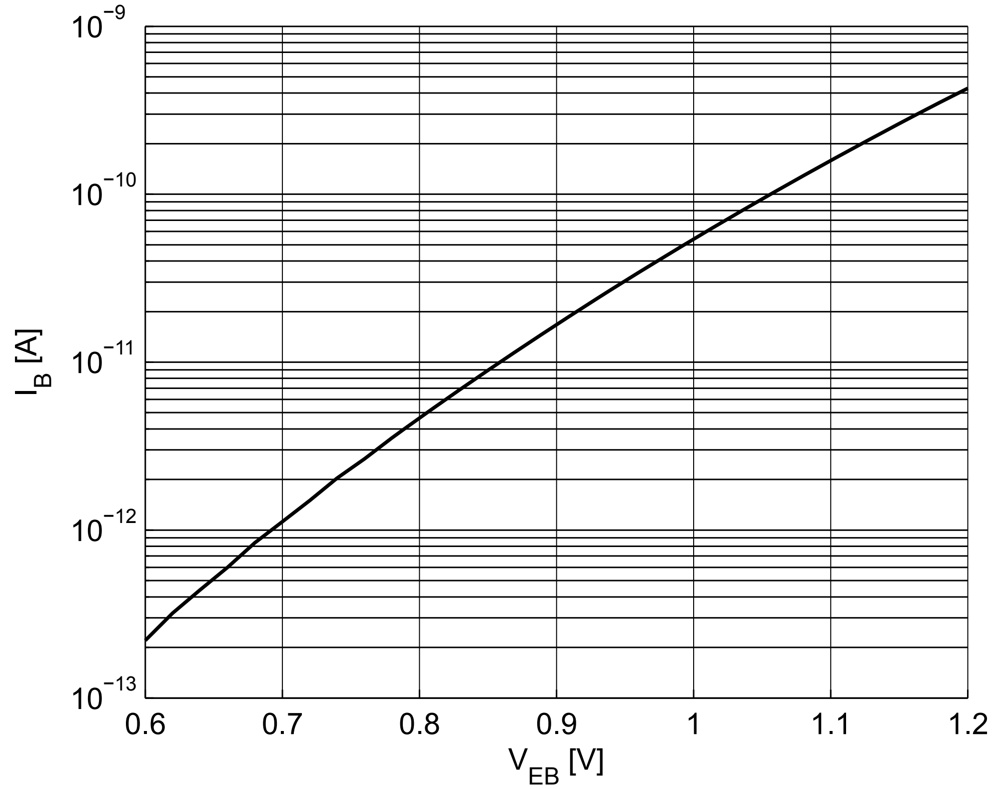

Figure 7 **Base current vs. base emitter reverse voltage I_B = f(V_{EB}), V_{CE} = 2 V**

3.5 Characteristic AC diagrams

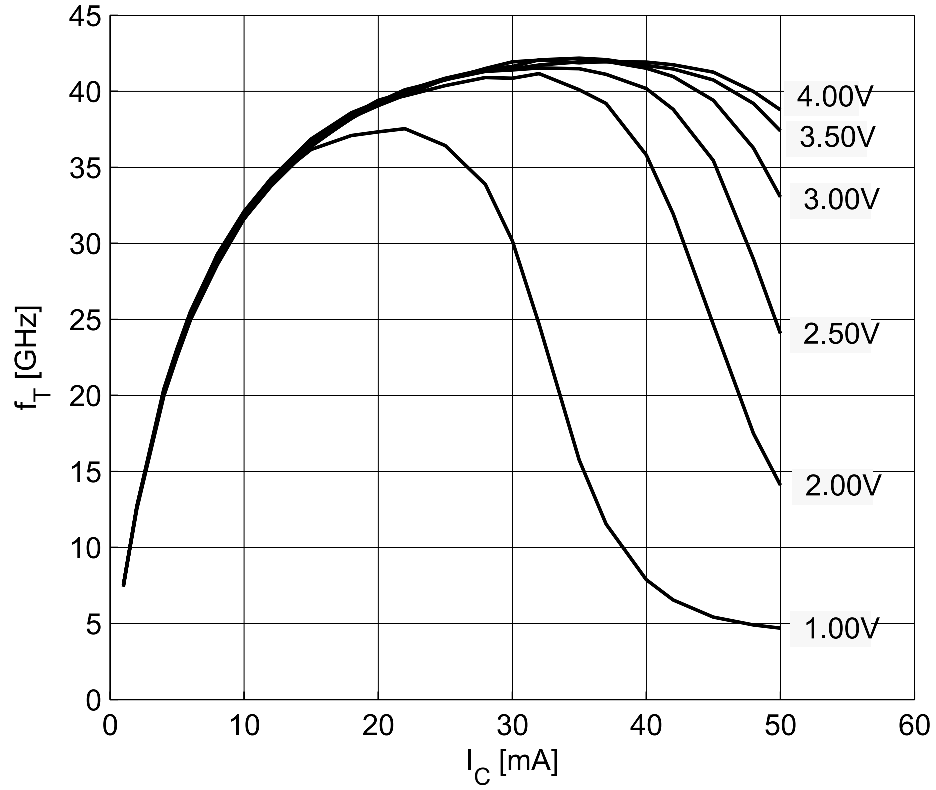

Figure 8 Transition frequency $f_T = f(I_C)$, f = 2 GHz, V_{CE} = parameter

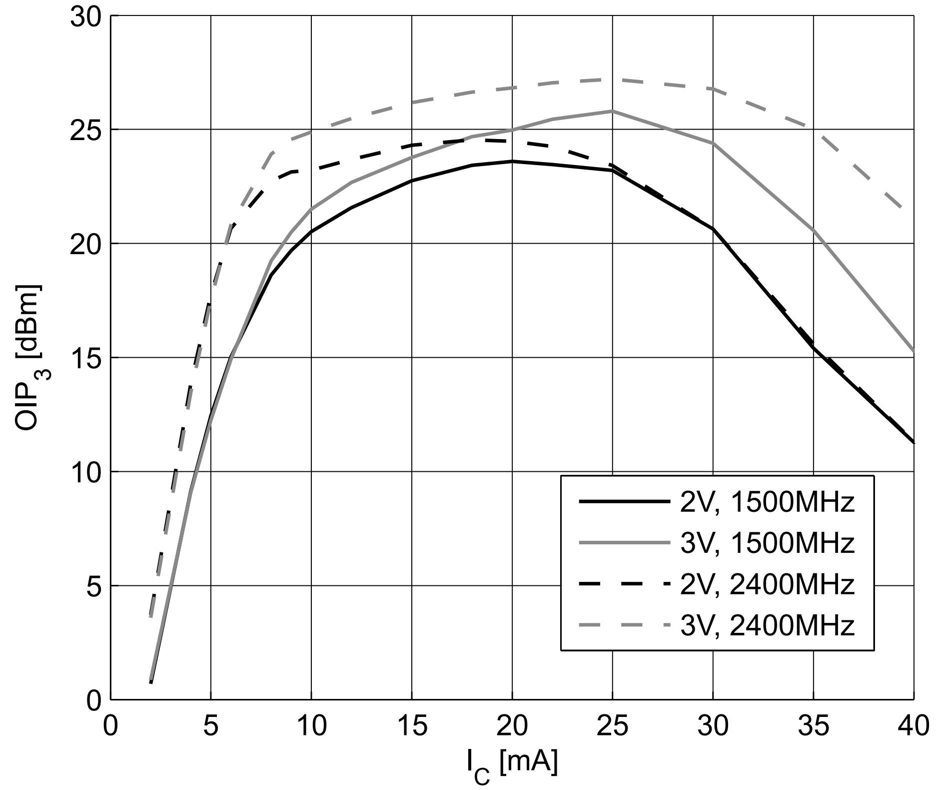

Figure 9 3rd order intercept point $OIP_3 = f(I_C)$, $Z_S = Z_L$ = 50 Ω, V_{CE}, f = parameters

Electrical characteristics

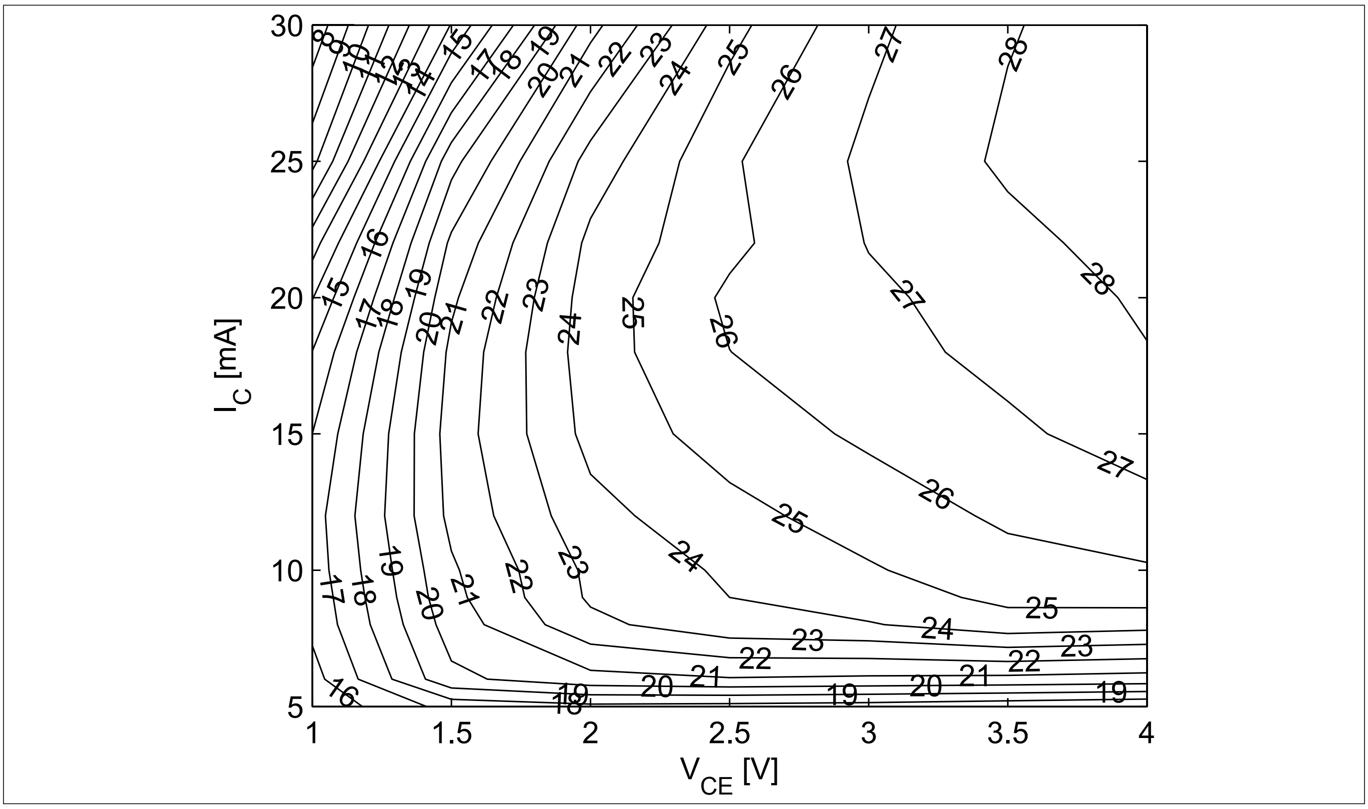

Figure 10 3rd order intercept point at output OIP_3 [dBm] = f(I_C , V_{CE}), Z_S = Z_L = 50 Ω, f = 2.4 GHz

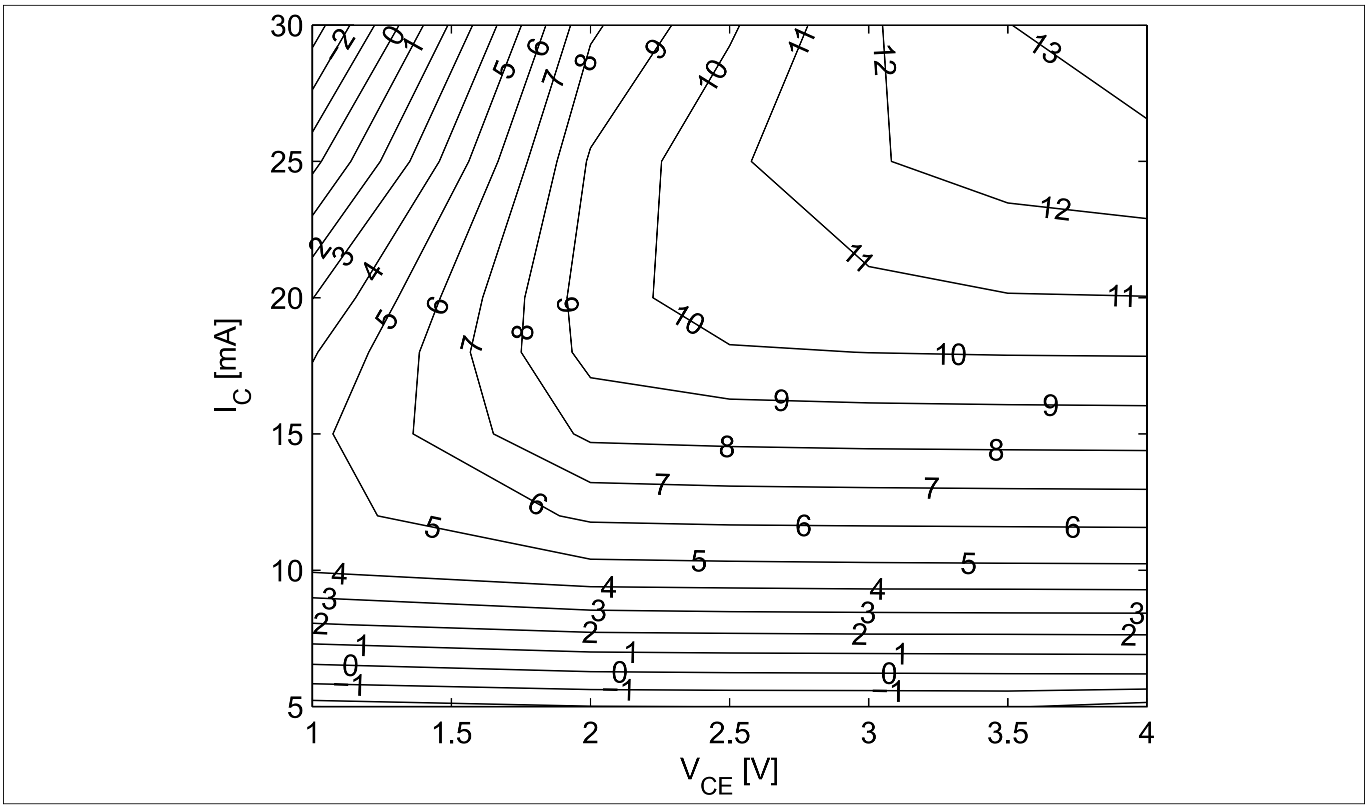

Figure 11 Compression point at output OP_{1dB} [dBm] = f(I_C, V_{CE}), Z_S = Z_L = 50 Ω, f = 2.4 GHz

Electrical characteristics

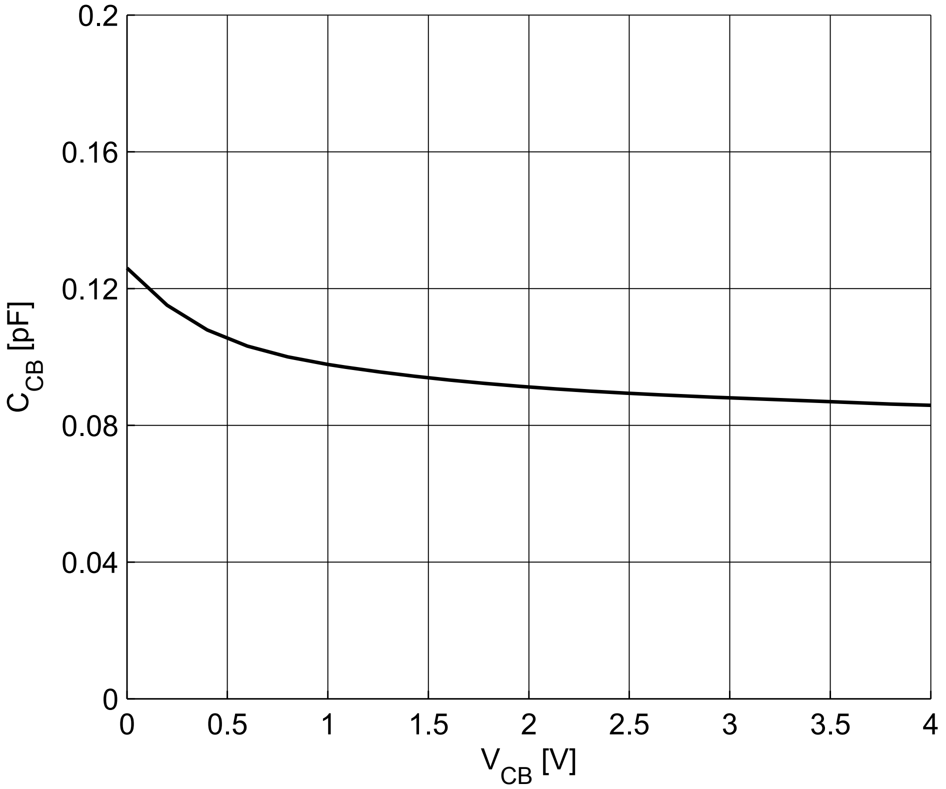

Figure 12 **Collector base capacitance $C_{CB} = f(V_{CB})$, f = 1 MHz**

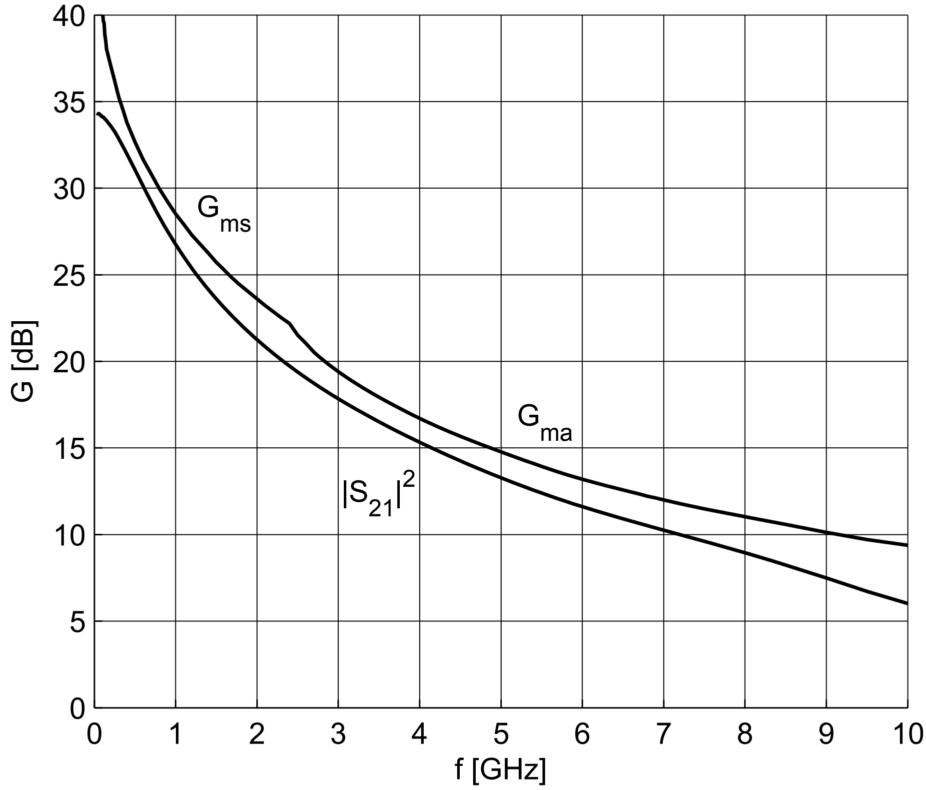

Figure 13 **Gain G_{ma}, G_{ms}, $|S_{21}|^2 = f(f)$, V_{CE} = 3 V, I_C = 25 mA**

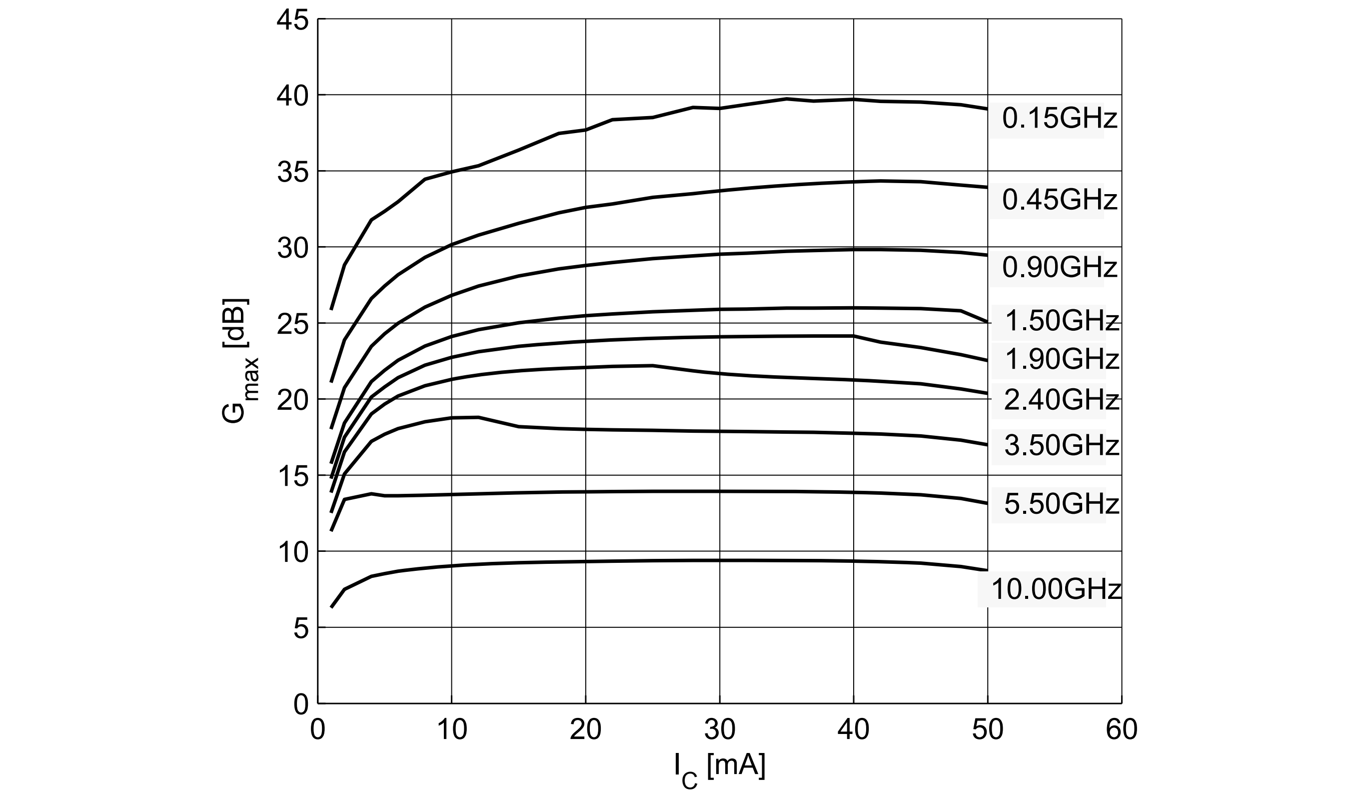

Figure 14 **Maximum power gain G_{max} = f(I_C), V_{CE} = 3 V, f = parameter in GHz**

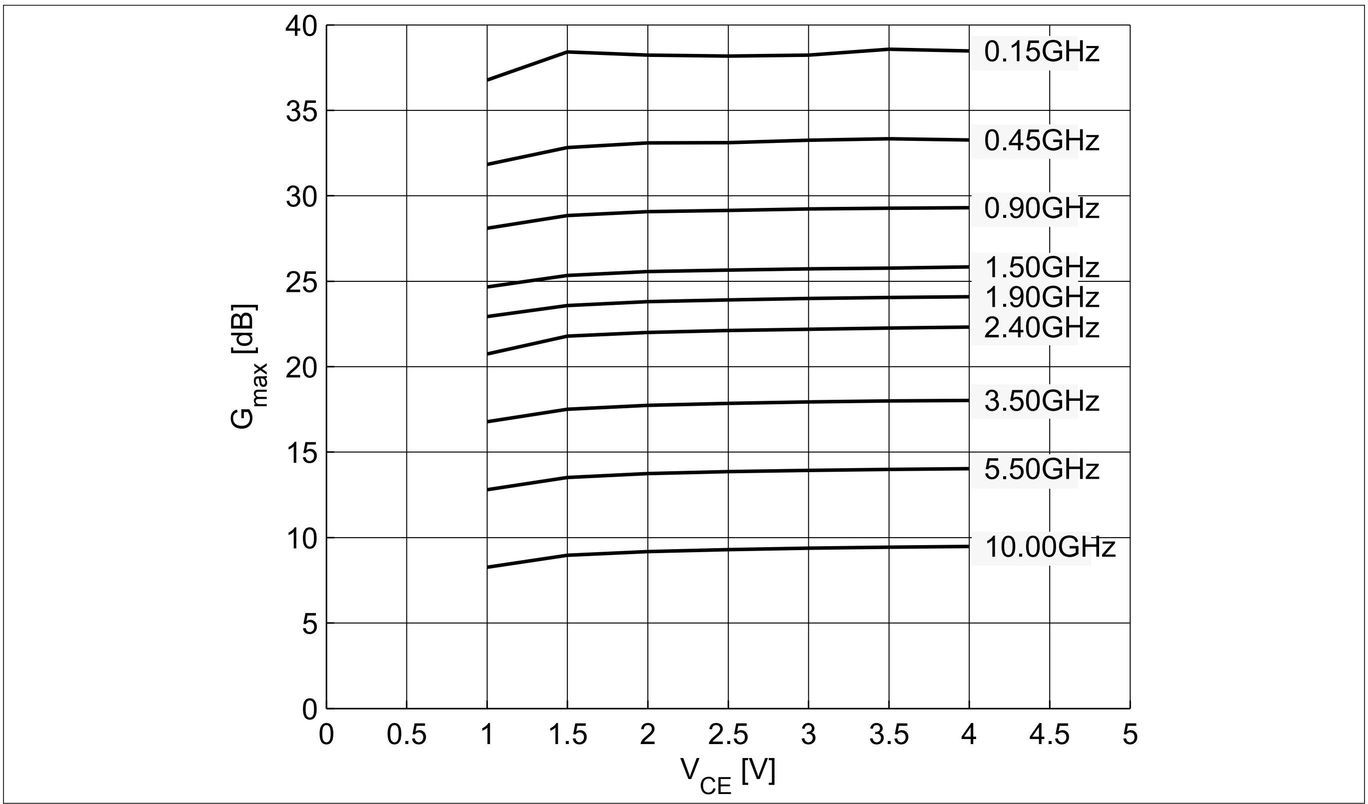

Figure 15 **Maximum power gain G_{max} = f(V_{CE}), I_C = 25 mA, f = parameter in GHz**

Electrical characteristics

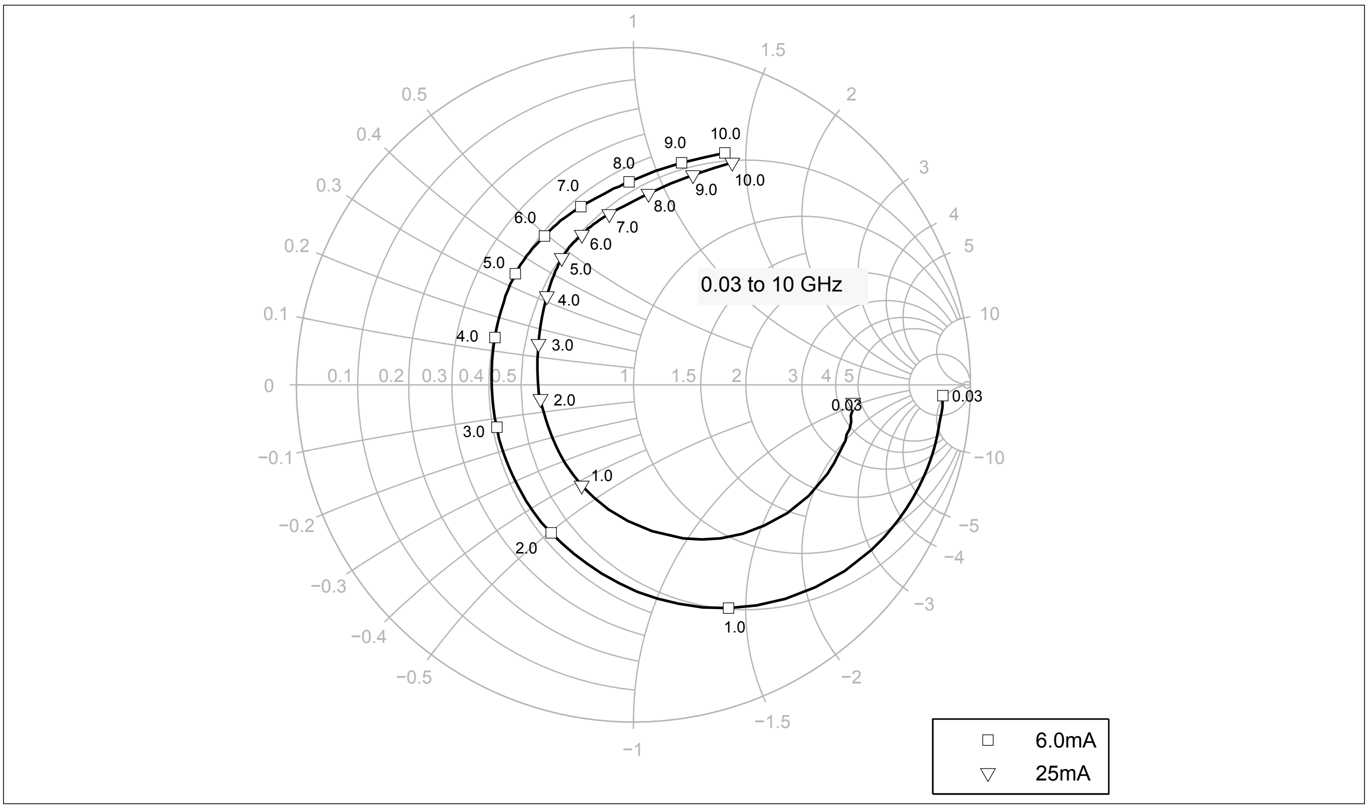

Figure 16 Input reflection coefficient $S_{11} = f(f)$, $V_{CE} = 3$ V, $I_C = 6$ / 25 mA

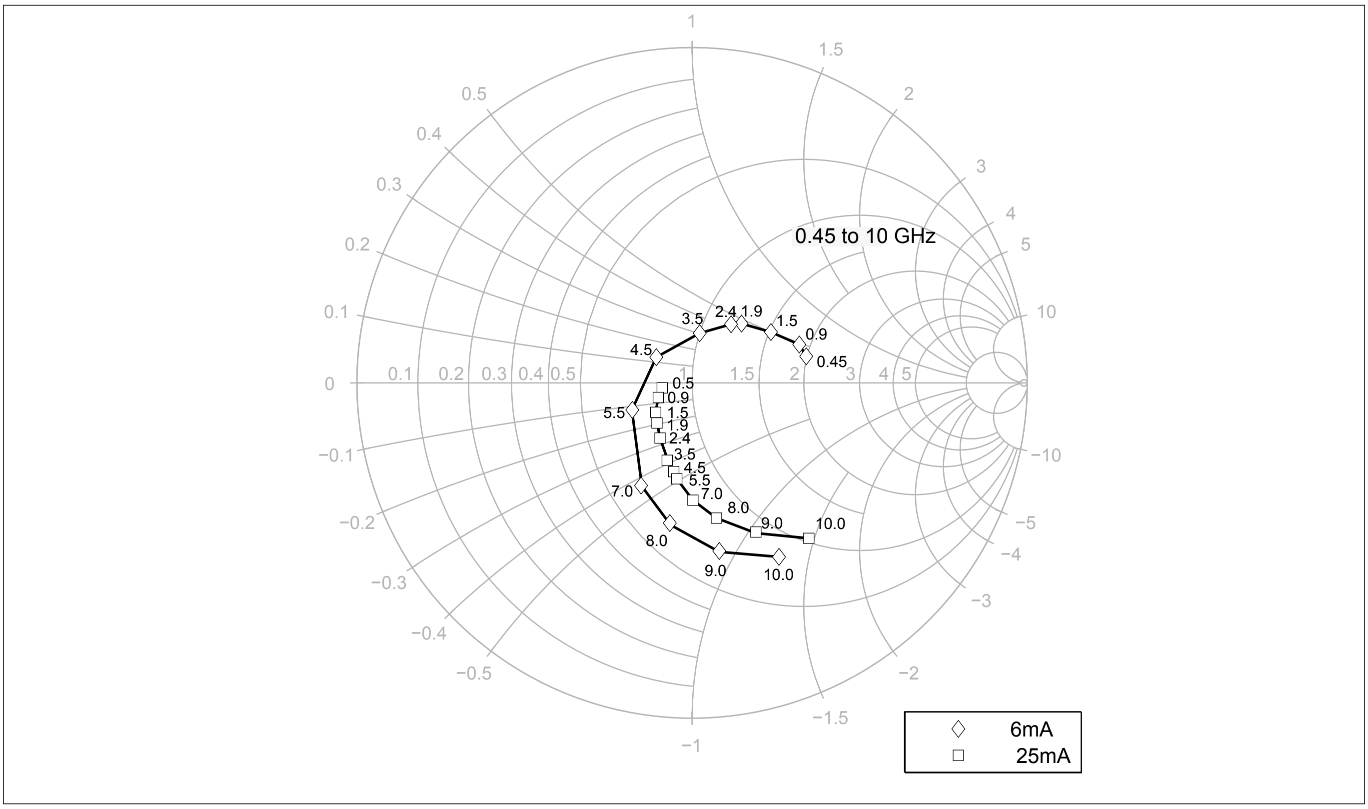

Figure 17 Source impedance for minimum noise figure $Z_{S,opt} = f(f)$, $V_{CE} = 3$ V, $I_C = 6$ / 25 mA

Electrical characteristics

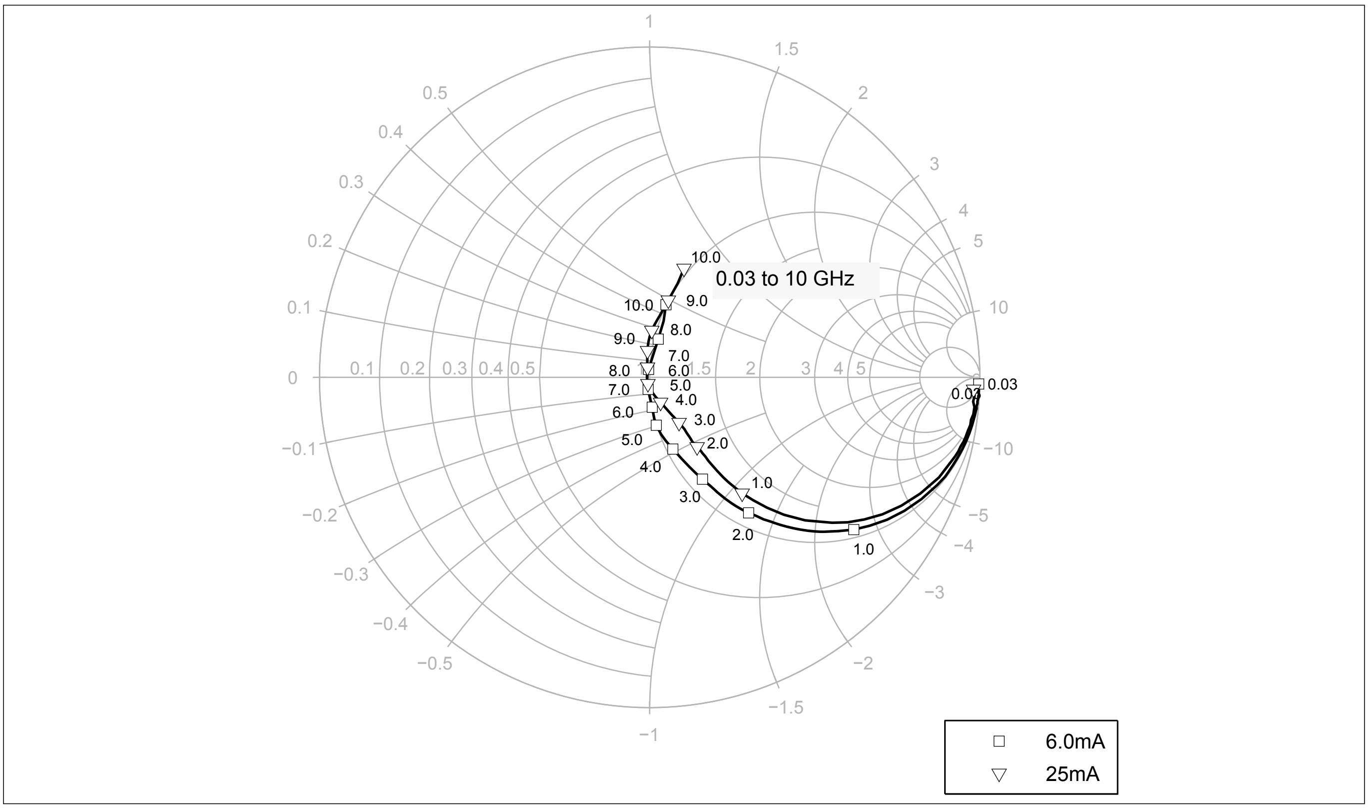

Figure 18 Output reflection coefficient S_{22} = f(f), V_{CE} = 3 V, I_C = 6 / 25 mA

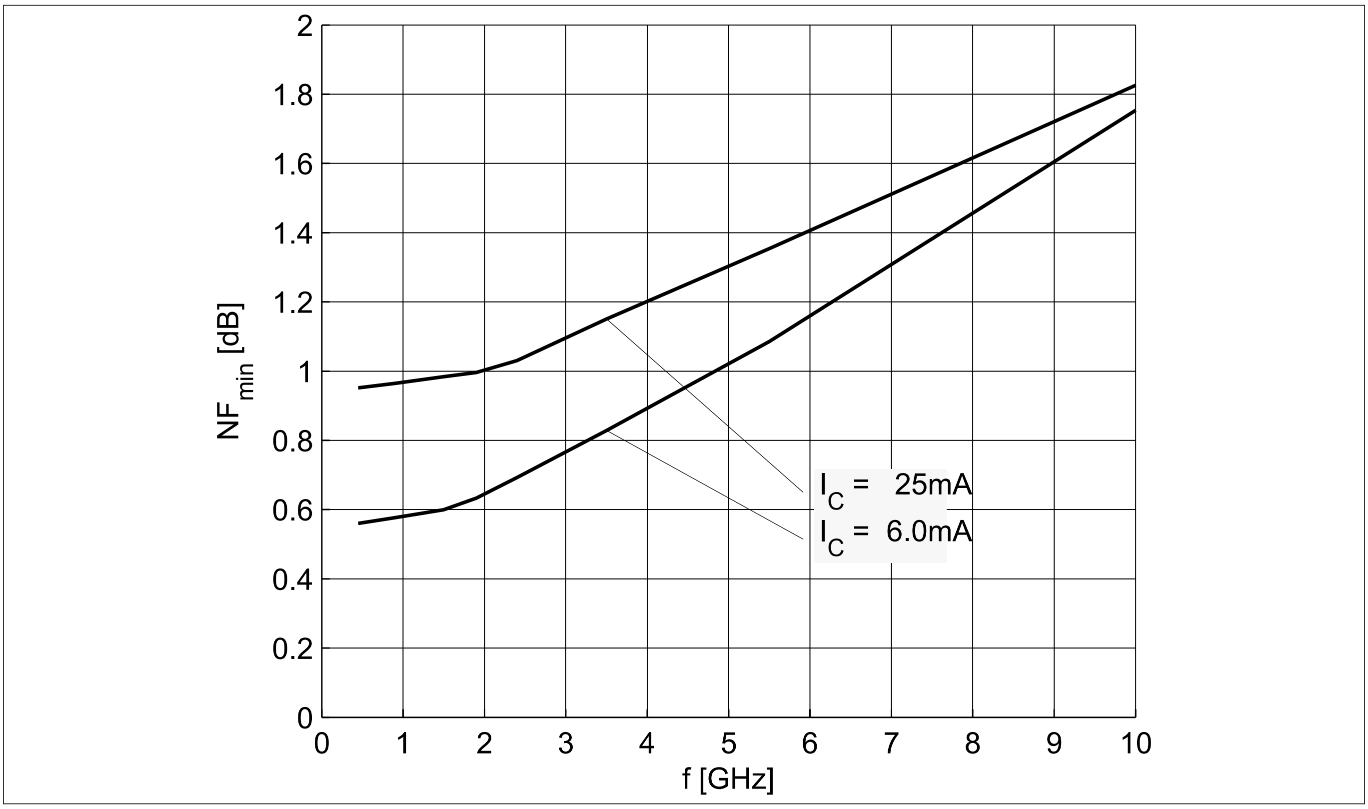

Figure 19 Noise figure NF_{min} = f(f), Z_S = $Z_{S,opt}$, V_{CE} = 3 V, I_C = 6 / 25 mA

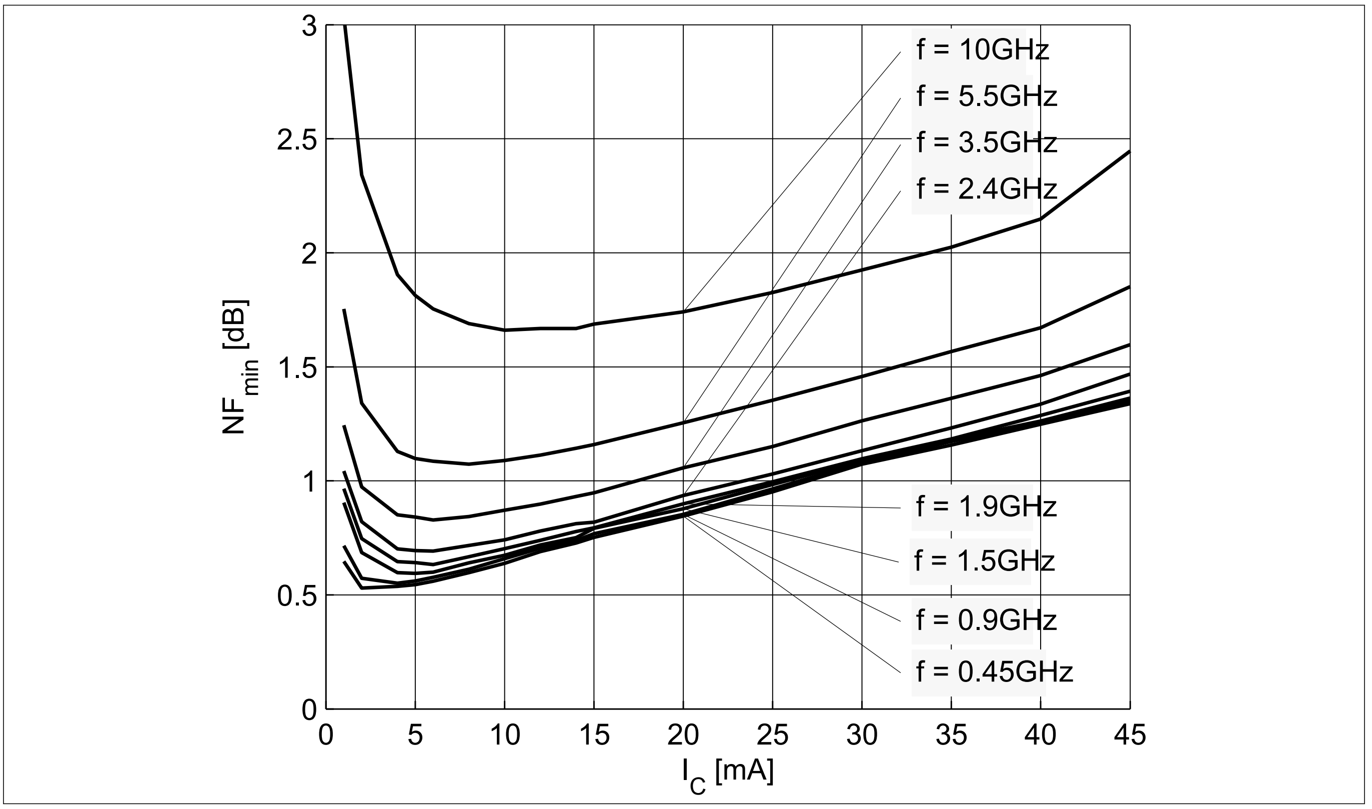

Figure 20 Noise figure NF_{min} = f(I_C), $Z_S = Z_{S,opt}$, V_{CE} = 3 V, f = parameter in GHz

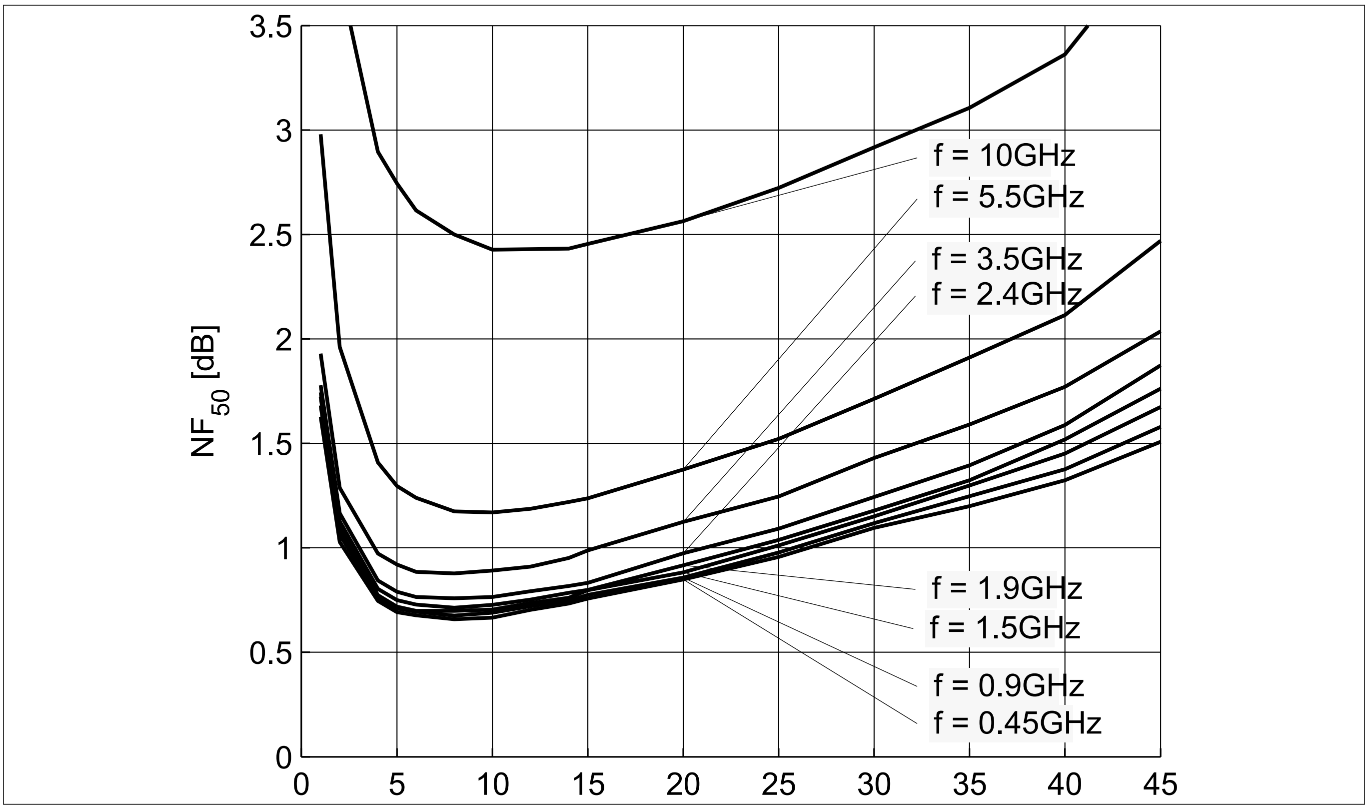

Figure 21 Noise figure NF_{50} = f(I_C), Z_S = 50 Ω, V_{CE} = 3 V, f = parameter in GHz

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 °C.*

4 Package information SOT343

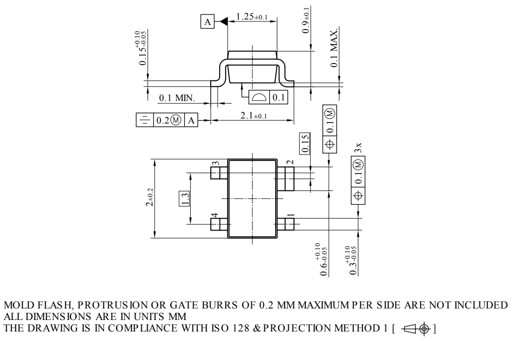

Figure 22 Package outline

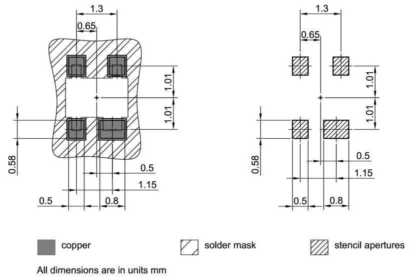

Figure 23 Foot print

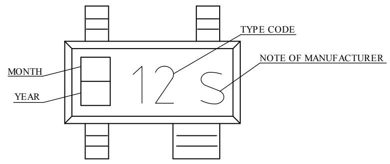

Figure 24 Marking layout example

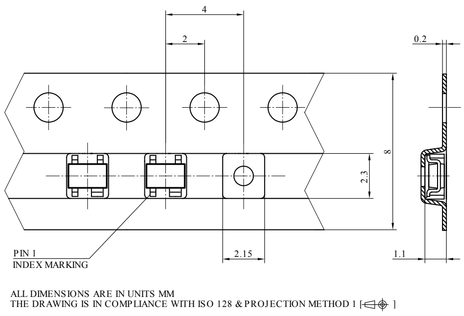

Figure 25 Tape dimensions

Revision history

Document version	Date of release	Description of changes
Revision 3.0	2019-01-25	New datasheet layout.

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