BFP720F

SiGe:C Heterojunction Wideband RF Bipolar Transistor

Data Sheet

Revision 1.0, 2009-03-13

RF & Protection Devices

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BFP720F, SiGe:C Heterojunction Wideband RF Bipolar Transistor

Revision History: 2009-03-13, Revision 1.0

Previous Revision:

Page	Subjects (major changes since last revision)
	Converted to the new IFX Template.
	Business Unit, Infineon Logo and the Trademarks were changed.

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Last Trademarks Update 2009-10-19

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SiGe:C Heterojunction Wideband RF Bipolar Transistor

1   Features

Main features:

- High performance general purpose wideband LNA transistor
- 150 GHz fT-Silicon Germanium Carbon technology
- Enables Best-In-Class performance for wireless applications due to high dynamic range
- Transistor geometry optimized for low-current applications
- Operation voltage: 1.0 V to 4.0 V
- Very high gain at high frequencies and low current consumption
- 26.5 dB maximum stable gain at 1.9 GHz and only 13 mA
- 15 dB maximum available gain at 10 GHz and only 13 mA
- Ultra low noise figure from latest SiGe:C technology
- 0.7 dB minimum noise figure at 5.5 GHz and 1.0 dB at 10 GHz
- High linearity OP1dB = +7 dBm and OIP3 = +21 dBm at 5.5 GHz and low current consumption of 13 mA
- Pb-free (RoHS compliant) package
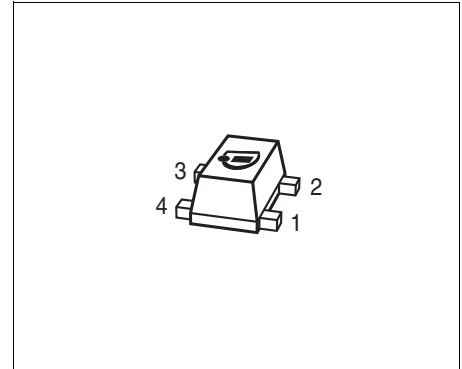
Applications

FM Radio, Mobile TV, RKE, AMR, Cellular, ZigBee, GPS, WiMAX, SDARs, Satellite Radio, Bluetooth, WiFi, Cordless phone, UMTS, WLAN, UWB, LNB.

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

Product Name	Package	Pin Configuration				Marking
BFP720F	TSFP-4	1 = B	2 = E	3 = C	4 = E	R9s

2 Product Brief

The BFP720F is a wideband Silicon Germanium Carbon (SiGe:C) NPN Heterojunction Bipolar Transistor (HBT) in a plastic 4-pin dual emitter TSFP-4 package. The device combines very high gain with lowest noise figure at low operating current for use in a wide range of wireless applications. The BFP720F is especially well-suited for portable battery-powered applications in which reduced power consumption is a key requirement. Collector design supports operation voltages from 1.0 V to 4.0 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	4.7	–	V	I_C = 1 mA, I_B = 0
Collector-base breakdown voltage	$V_{(BR)CBO}$	13	15	–	V	I_E = 0
Collector current	I_C	–	–	25	mA	–
Total power dissipation	P_{tot}	–	–	100	mW	$T_S \leq 109$ °C
DC current gain	h_{FE}	160	250	400		V_{CE} = 3 V, I_C = 13 mA

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 = 13 mA, f = 1 GHz
f = 2.4 GHz						
Maximum Power Gain		–		–	dB	
Low Noise Operation Point	G_{ms}		22			I_C = 5 mA
High Linearity Operation Point	G_{ms}		25.5			I_C = 13 mA
Transducer Gain		–		–	dB	$Z_S = Z_L$ = 50 Ω
Low Noise Operation Point	S_{21}		20.5			I_C = 5 mA
High Linearity Operation Point	S_{21}		23			I_C = 13 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			I_C = 5 mA
Linearity		–		–	dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}		6			I_C = 13 mA
3rd Order Intercept Point	OIP_3		21			I_C = 13 mA
f = 5.5 GHz						
Maximum Power Gain		–		–	dB	
Low Noise Operation Point	G_{ms}		19			I_C = 5 mA
High Linearity Operation Point	G_{ms}		21.5			I_C = 13 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}		16.5			I_C = 13 mA
Minimum Noise Figure		–		–	dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}		0.7			I_C = 5 mA
Associated Gain	G_{ass}		15			I_C = 5 mA
Linearity		–		–	dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}		7			I_C = 13 mA
3rd Order Intercept Point	OIP_3		21			I_C = 13 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}	–	4.0	V	
T_A = -55 °C		–	3.5		
Collector-emitter voltage	V_{CES}	–	13	V	
Collector-base voltage	V_{CBO}	–	13	V	
Emitter-base voltage	V_{EBO}	–	1.2	V	
Collector current	I_C	–	25	mA	
Base current	I_B	–	2	mA	
Total power dissipation[1]	P_{tot}	–	100	mW	
$T_S \leq$ 109 °C					
Operation junction temperature	T_{JOp}	-55	150	°C	
Storage temperature	T_{Stg}	-55	150	°C	

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

Note: Exceeding only one of the above maximum rating limits even for a short moment may cause permanent damage to the device. Even if the device continues to operate, its lifetime may be considerably shortened. Maximum ratings are stress ratings only and do not mean unaffected functional operation and lifetime at others than standard operation conditions.

4 Thermal Characteristics

Table 4 Thermal Resistance

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Junction - soldering point[1]	R_{thJS}	–	410	–	K/W	–

1) For calculation of R_{thJA} please refer to Application Note Thermal Resistance
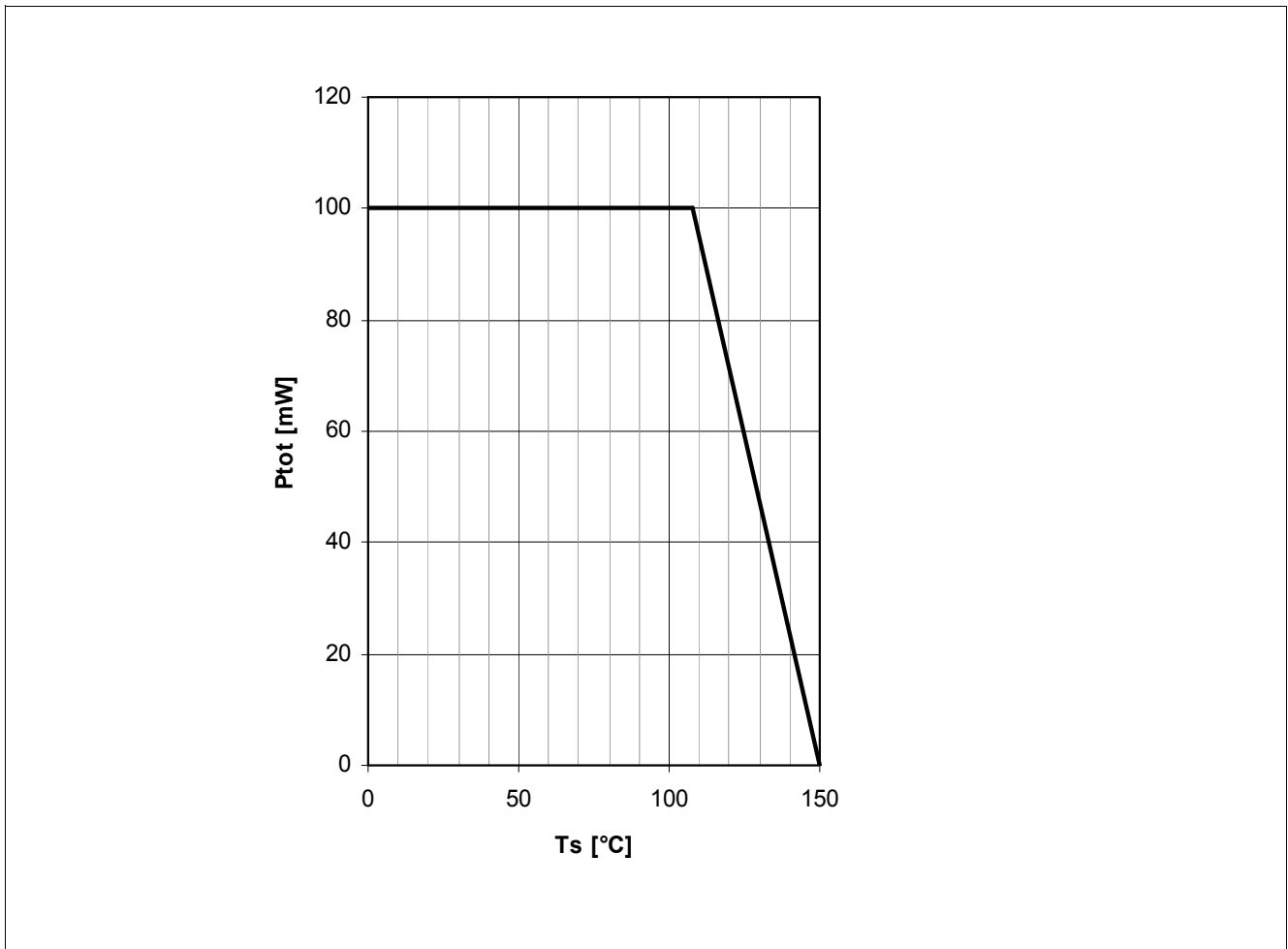
Figure 1 Total Power Dissipation $P_{tot} = f(T_s)$

Figure 2   Permissible Pulse Load P_{tot_max} / P_{tot_DC} = f (t_p)

Figure 3   Permissible Pulse Load R_{thJS} = f (t_p)

5 Electrical Characteristics

5.1 DC Characteristics

Table 5   DC Characteristics at T_A = 25 °C

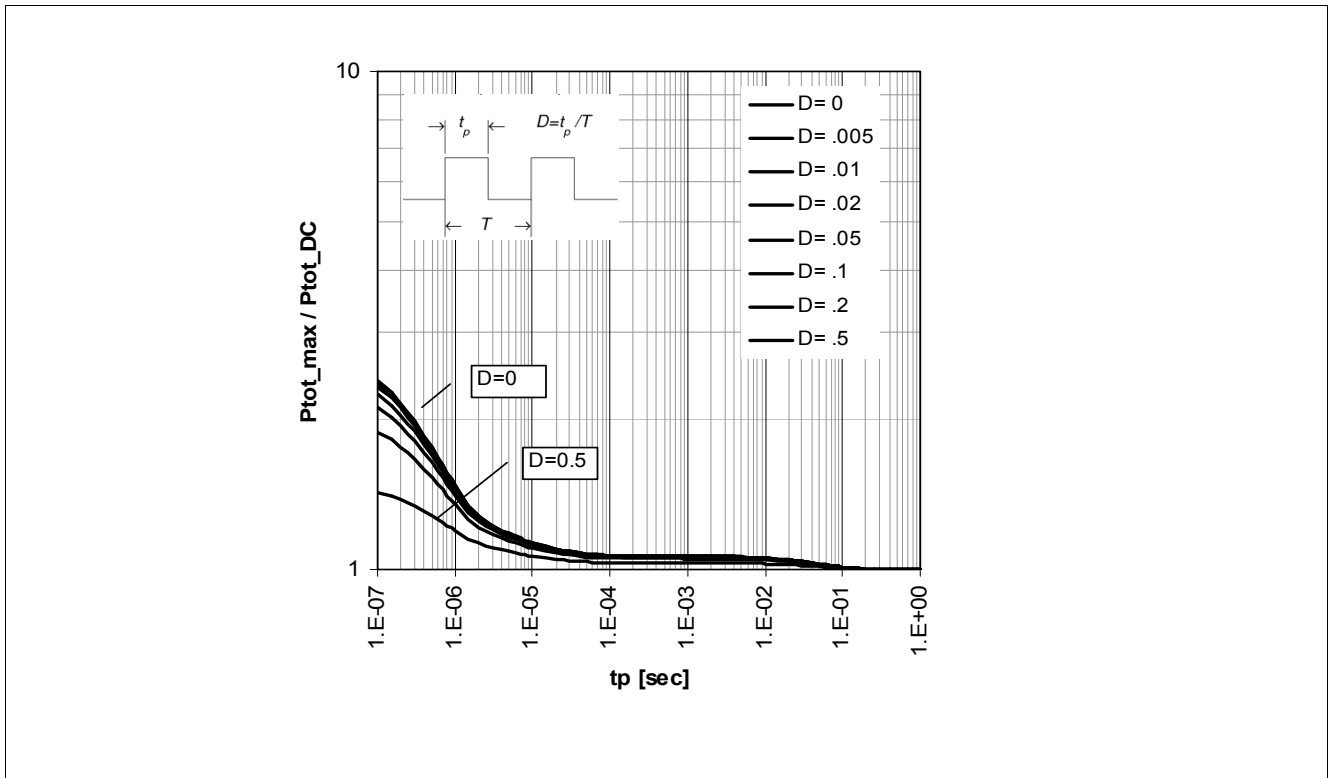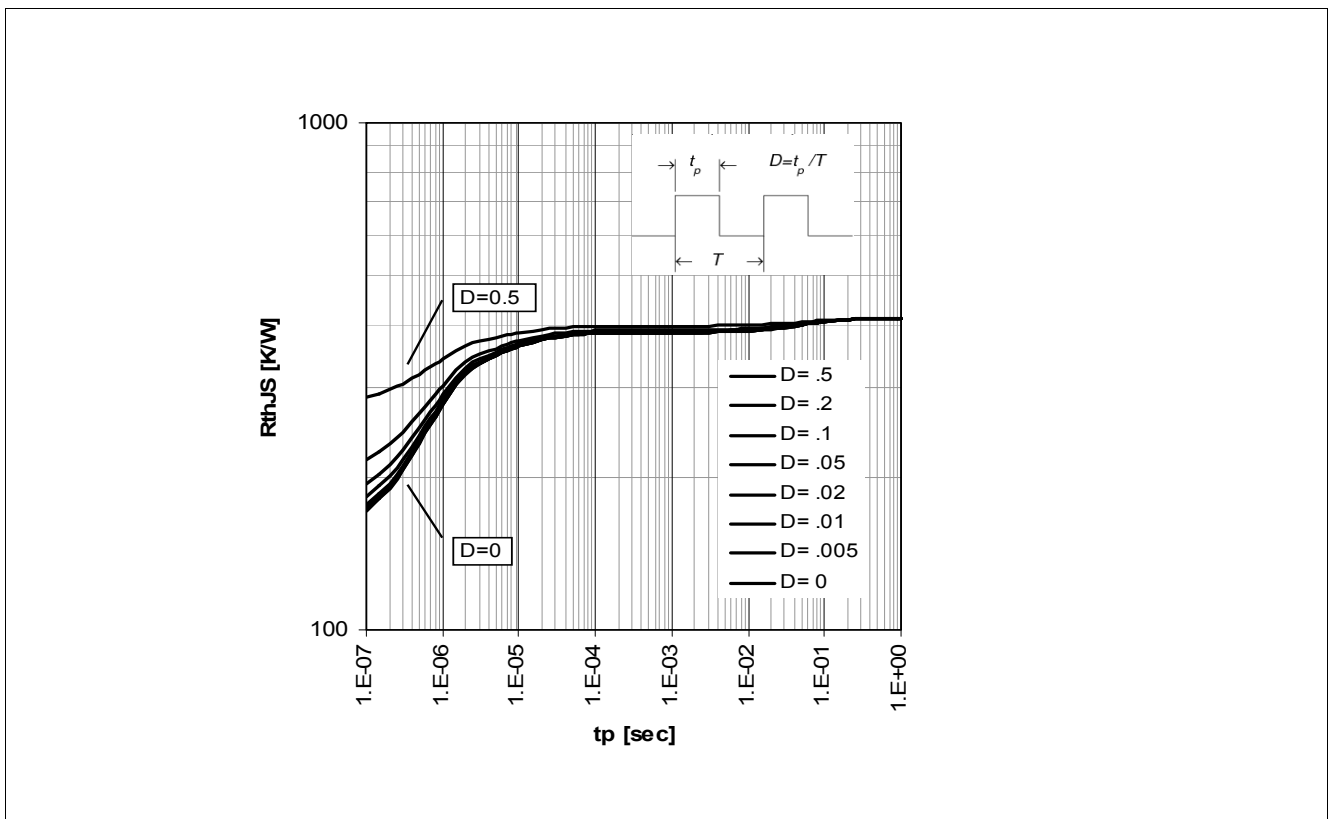| Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	**Typ.**	**Max.**		
Collector-emitter breakdown voltage	$V_{(BR)CEO}$	4	4.7	–	V	I_C = 1 mA, I_B = 0
Collector-emitter cutoff current	I_{CES}	–	–	30	μA	V_{CE} = 13 V, V_{BE} = 0 V
Collector-base cutoff current	I_{CBO}	–	–	100	nA	V_{CB} = 5 V, I_E = 0
Emitter-base cutoff current	I_{EBO}	–	–	2	μA	V_{EB} = 0.5 V, I_C = 0
DC current gain	h_{FE}	160	250	400		I_C = 13 mA, V_{CE} = 3 V pulse measured

5.2 General AC Characteristics

Table 6   AC Characteristics at T_A = 25 °C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	**Typ.**	**Max.**		
Transition frequency	f_T	–	45	–	GHz	I_C = 13 mA, V_{CE} = 3 V f = 1 GHz
Collector-base capacitance	C_{cb}	–	0.06	–	pF	V_{CB} = 3 V, V_{BE} = 0 V f = 1 MHz emitter grounded
Collector-emitter capacitance	C_{ce}	–	0.3	–	pF	V_{CE} = 3 V, V_{BE} = 0 V f = 1 MHz base grounded
Emitter-base capacitance	C_{eb}	–	0.3	–	pF	V_{EB} = 0.5 V, V_{CB} = 0 V f = 1 MHz collector grounded

5.3 Frequency Dependent AC Characteristics

Measurement setup is a testfixture with Bias T's in a 50 Ω system, T_A = 25 °C
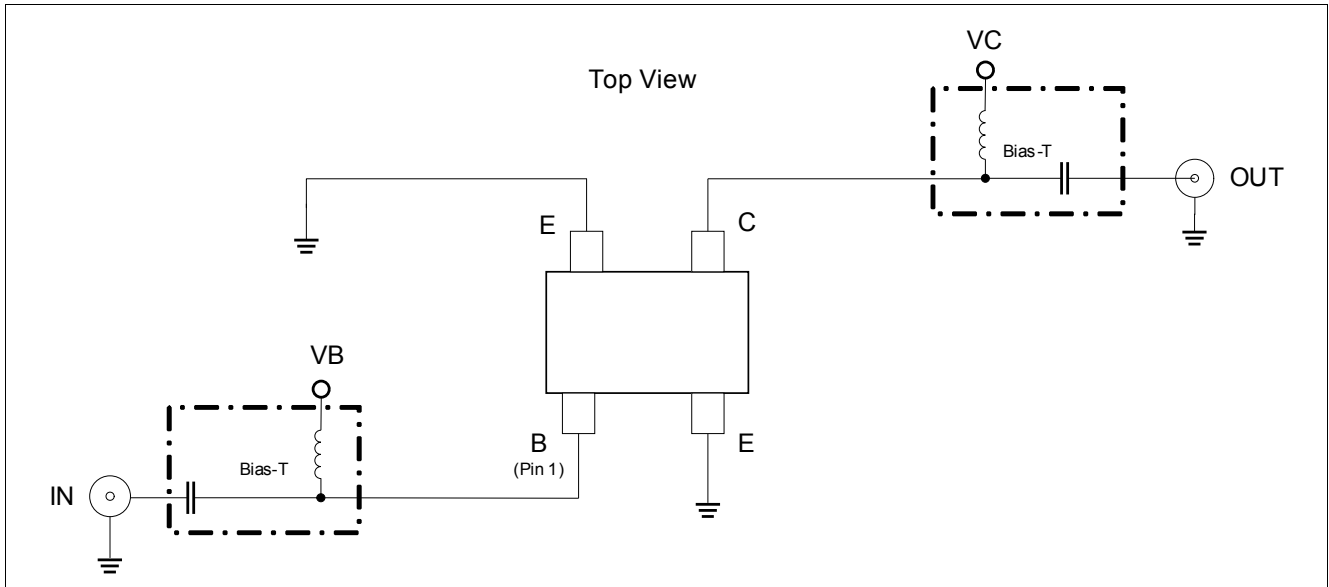
Figure 4   BFP720F Testing Circuit

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	–		I_C = 5 mA
High Linearity Operation Point	G_{ms}	–	37.5	–		I_C = 13 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}	–	29	–		I_C = 13 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}	–	0.4	–		I_C = 5 mA
Associated Gain	G_{ass}	–	28	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}	–	6	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	22.5	–		I_C = 13 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}	–	29	–		I_C = 5 mA
High Linearity Operation Point	G_{ms}	–	32.5	–		I_C = 13 mA

Table 8   AC Characteristics, V_{CE} = 3 V, f = 450 MHz (cont'd)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transducer Gain					dB	$Z_S = Z_L = 50\ \Omega$
Low Noise Operation Point	S_{21}	–	22.5	–		I_C = 5 mA
High Linearity Operation Point	S_{21}	–	28.5	–		I_C = 13 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}	–	0.4	–		I_C = 5 mA
Associated Gain	G_{ass}	–	27.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB Gain Compression Point	OP_{1dB}	–	5.5	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	21.5	–		I_C = 13 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}	–	29.5	–		I_C = 13 mA
Transducer Gain					dB	$Z_S = Z_L = 50\ \Omega$
Low Noise Operation Point	S_{21}	–	22.5	–		I_C = 5 mA
High Linearity Operation Point	S_{21}	–	27.5	–		I_C = 13 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}	–	0.45	–		I_C = 5 mA
Associated Gain	G_{ass}	–	25.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L = 50\ \Omega$
1 dB Gain Compression Point	OP_{1dB}	–	5.5	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	20.5	–		I_C = 13 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	–		I_C = 5 mA
High Linearity Operation Point	G_{ms}	–	27.5	–		I_C = 13 mA
Transducer Gain					dB	$Z_S = Z_L = 50\ \Omega$
Low Noise Operation Point	S_{21}	–	21.5	–		I_C = 5 mA
High Linearity Operation Point	S_{21}	–	26	–		I_C = 13 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}	–	0.45	–		I_C = 5 mA

Table 10   AC Characteristics, V_{CE} = 3 V, f = 1.5 GHz (cont'd)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Associated Gain	G_{ass}	–	24	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}	–	6	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	21	–		I_C = 13 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	–		I_C = 5 mA
High Linearity Operation Point	G_{ms}	–	26.5	–		I_C = 13 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}	–	24.5	–		I_C = 13 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}	–	0.5	–		I_C = 5 mA
Associated Gain	G_{ass}	–	23	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}	–	6.5	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	21	–		I_C = 13 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	–		I_C = 5 mA
High Linearity Operation Point	G_{ms}	–	25.5	–		I_C = 13 mA
Transducer Gain					dB	$Z_S = Z_L$ = 50 Ω
Low Noise Operation Point	S_{21}	–	20.5	–		I_C = 5 mA
High Linearity Operation Point	S_{21}	–	23	–		I_C = 13 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	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}	–	6	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	21	–		I_C = 13 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}	–	20.5	–		I_C = 5 mA
High Linearity Operation Point	G_{ms}	–	23.5	–		I_C = 13 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 = 13 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}	–	0.6	–		I_C = 5 mA
Associated Gain	G_{ass}	–	19.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}	–	6.5	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	21.5	–		I_C = 13 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	–		I_C = 5 mA
High Linearity Operation Point	G_{ms}	–	21.5	–		I_C = 13 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}	–	16.5	–		I_C = 13 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}	–	0.7	–		I_C = 5 mA
Associated Gain	G_{ass}	–	15	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}	–	7	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	21	–		I_C = 13 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 = 13 mA
Transducer Gain					dB	$Z_S = Z_L$ = 50 Ω
Low Noise Operation Point	S_{21}	–	9.5	–		I_C = 5 mA

Table 15   AC Characteristics, V_{CE} = 3 V, f = 10 GHz (cont'd)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
High Linearity Operation Point	S_{21}	–	10.5	–		I_C = 13 mA
Minimum Noise Figure					dB	$Z_S = Z_{opt}$
Minimum Noise Figure	NF_{min}	–	1.0	–		I_C = 5 mA
Associated Gain	G_{ass}	–	10.5	–		I_C = 5 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB Gain Compression Point	OP_{1dB}	–	8	–		I_C = 13 mA
3rd Order Intercept Point	OIP_3	–	19.5	–		I_C = 13 mA

Note:

1. $G_{ms} = |S_{21} / S1_2|$ 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

5.4 Characteristic Curves
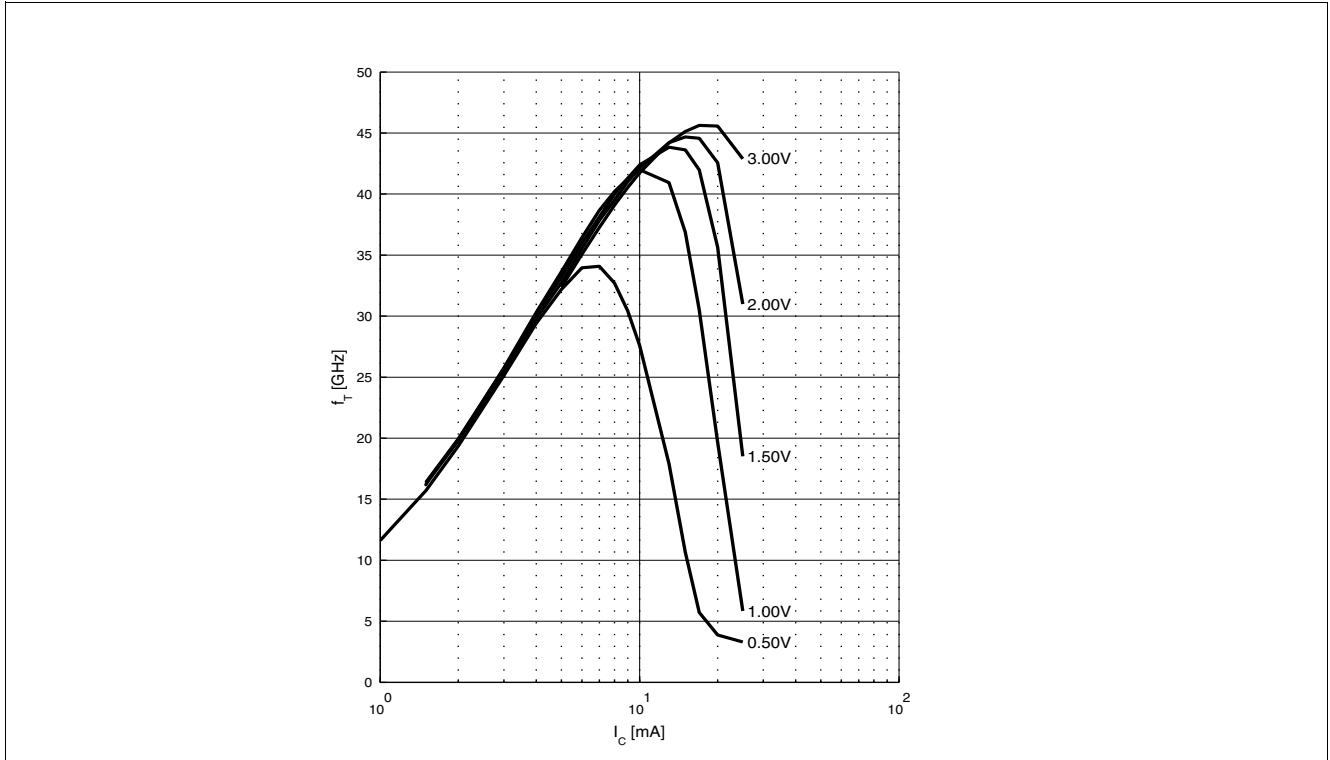
Figure 5 Transition Frequency $f_T = f(I_C, V_{CE})$, f = 1 GHz, V_{CE} Parameter in V
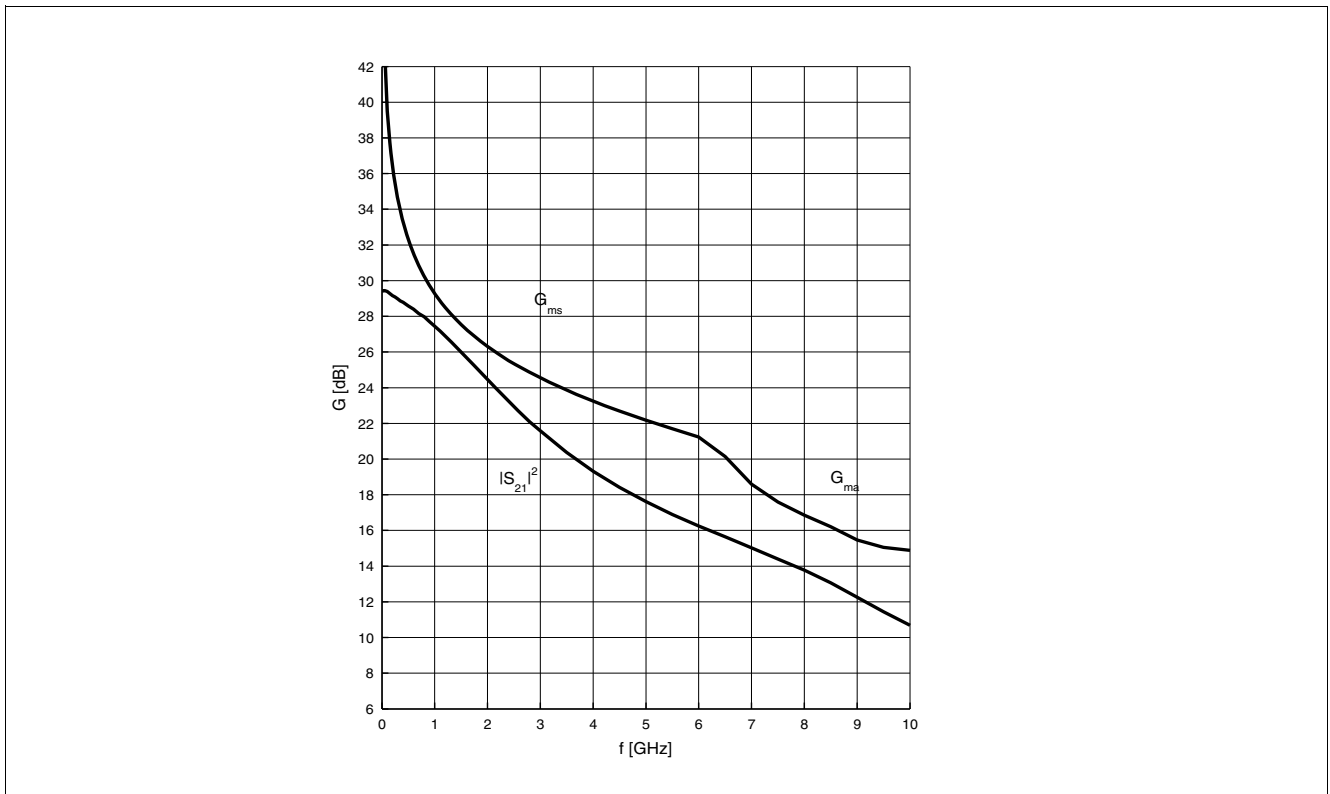
Figure 6 Power Gain G_{ma}, G_{ms}, $|S_{21}|^2 = f$ (freq), V_{CE} = 3 V, I_C = 13 mA
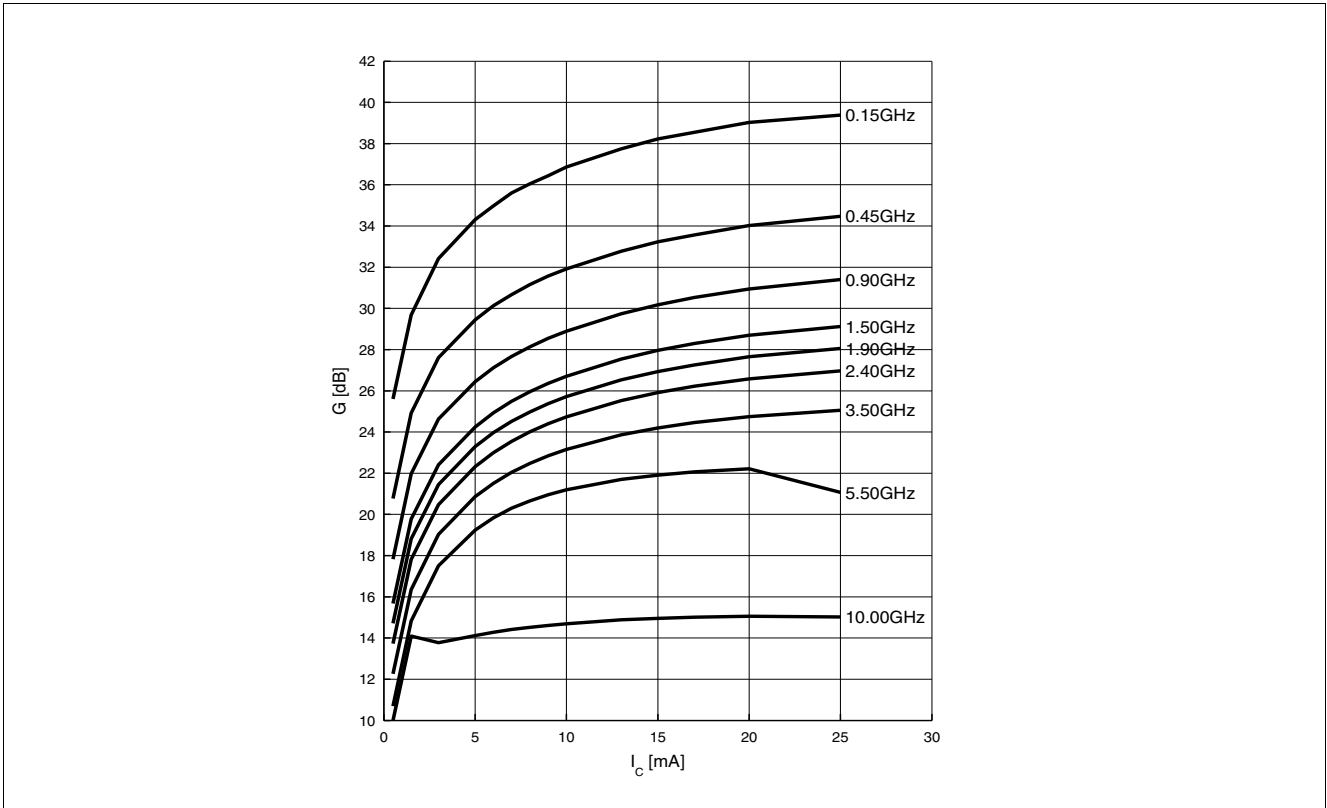
Figure 7   Power Gain G_{ma}, $G_{ms} = f(I_C)$, V_{CE} = 3 V, f = Parameter in GHz
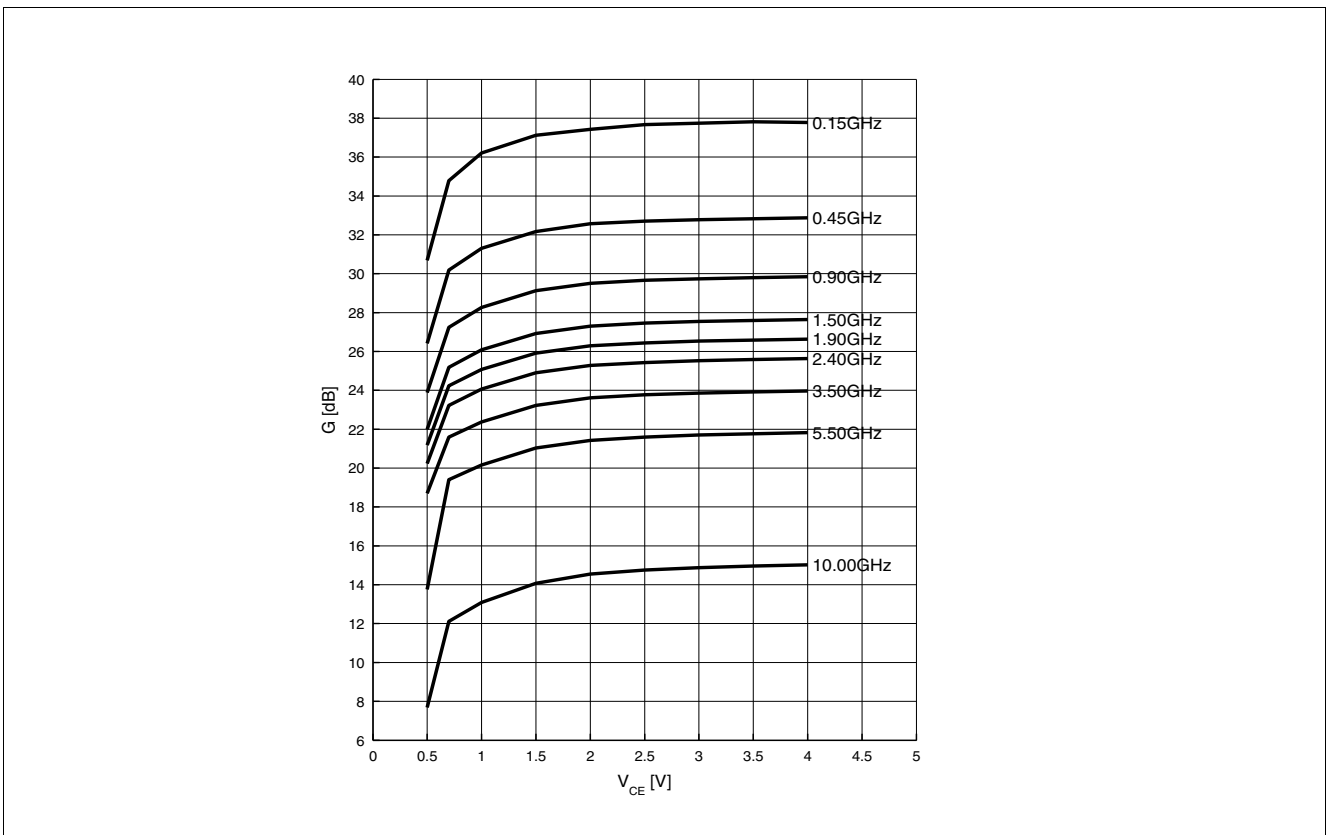
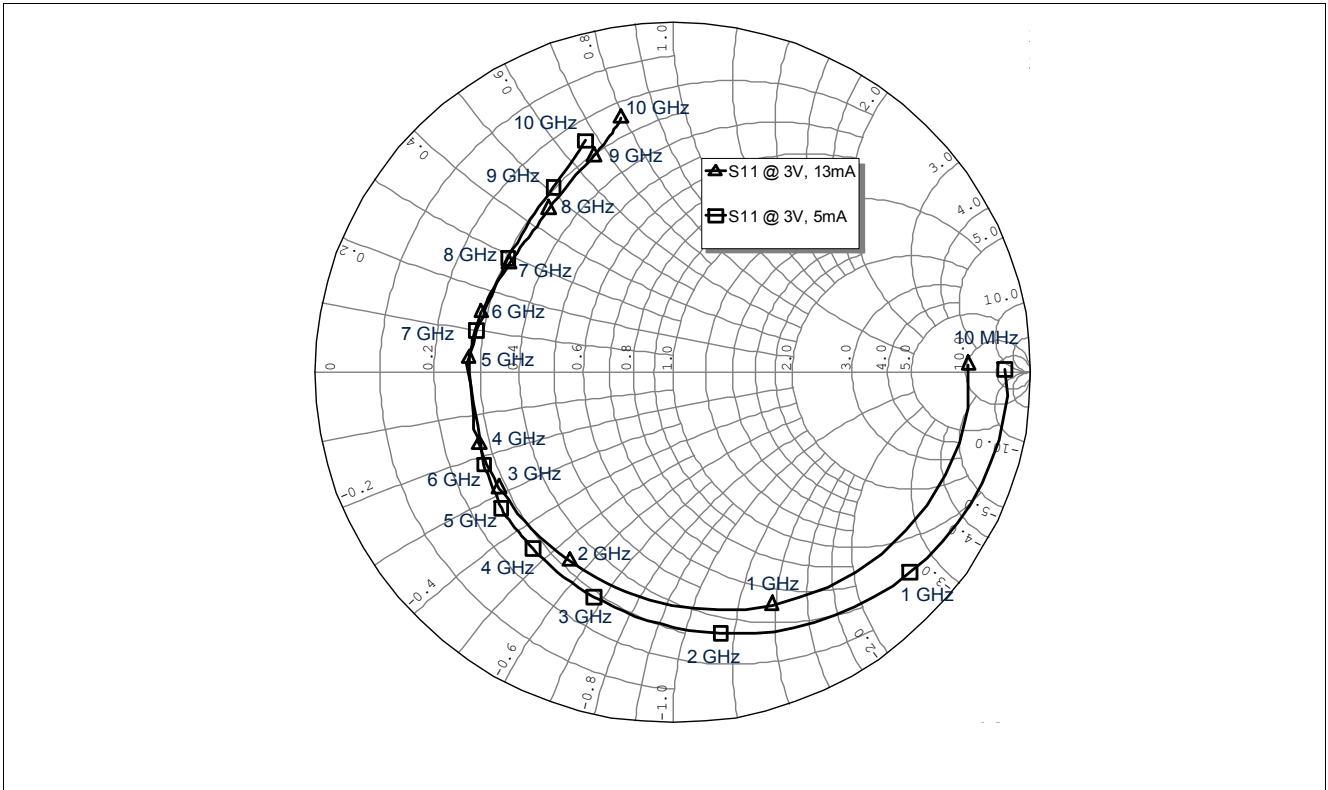Figure 8   Power Gain G_{ma}, $G_{ms} = f(V_{CE})$, I_C = 13 mA, f = Parameter in GHz

Figure 9   Input Matching $S_{11} = f$ (freq), V_{CE} = 3 V, I_C = 5 mA / 13 mA
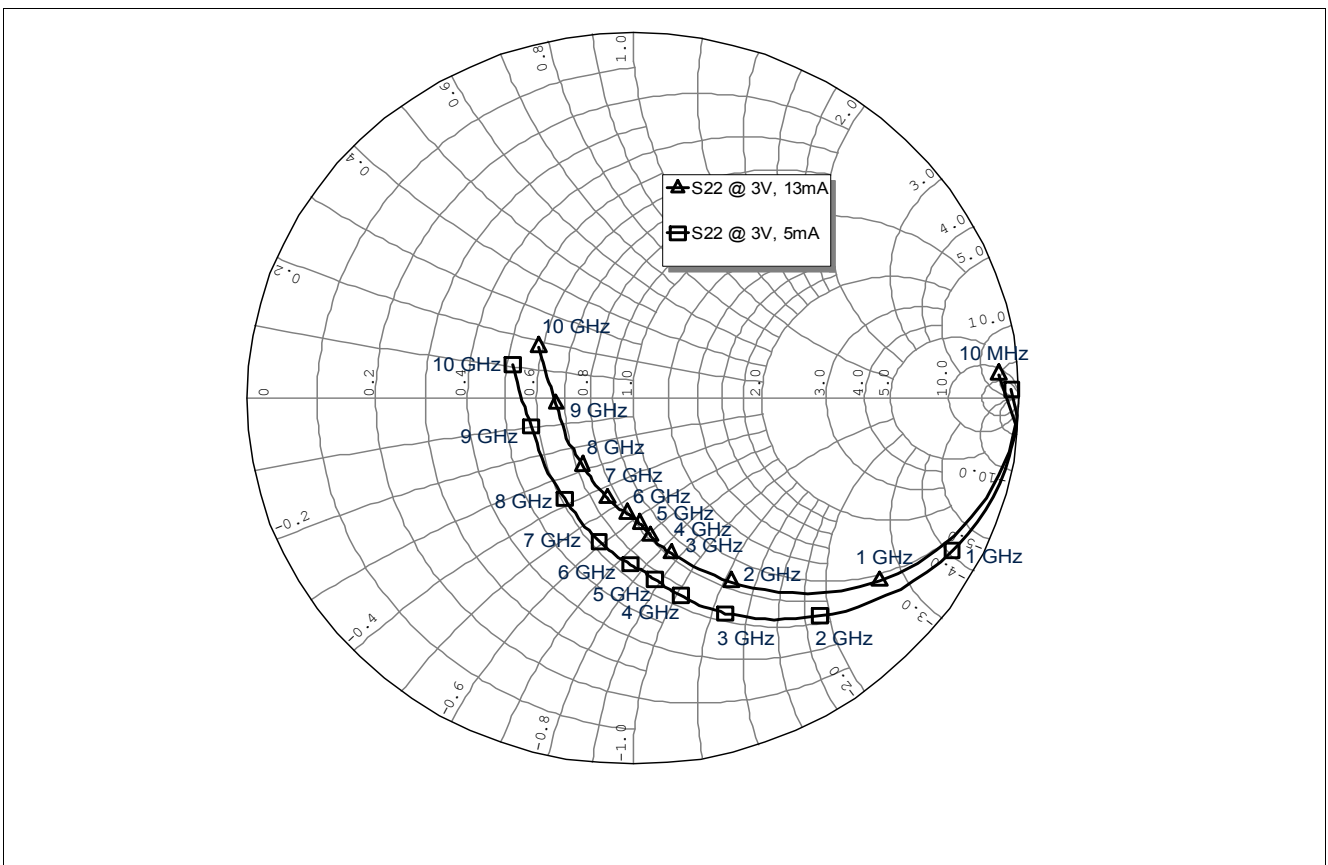
Figure 10   Output Matching $S_{22} = f$ (freq), V_{CE} = 3 V, I_C = 5 mA / 13 mA
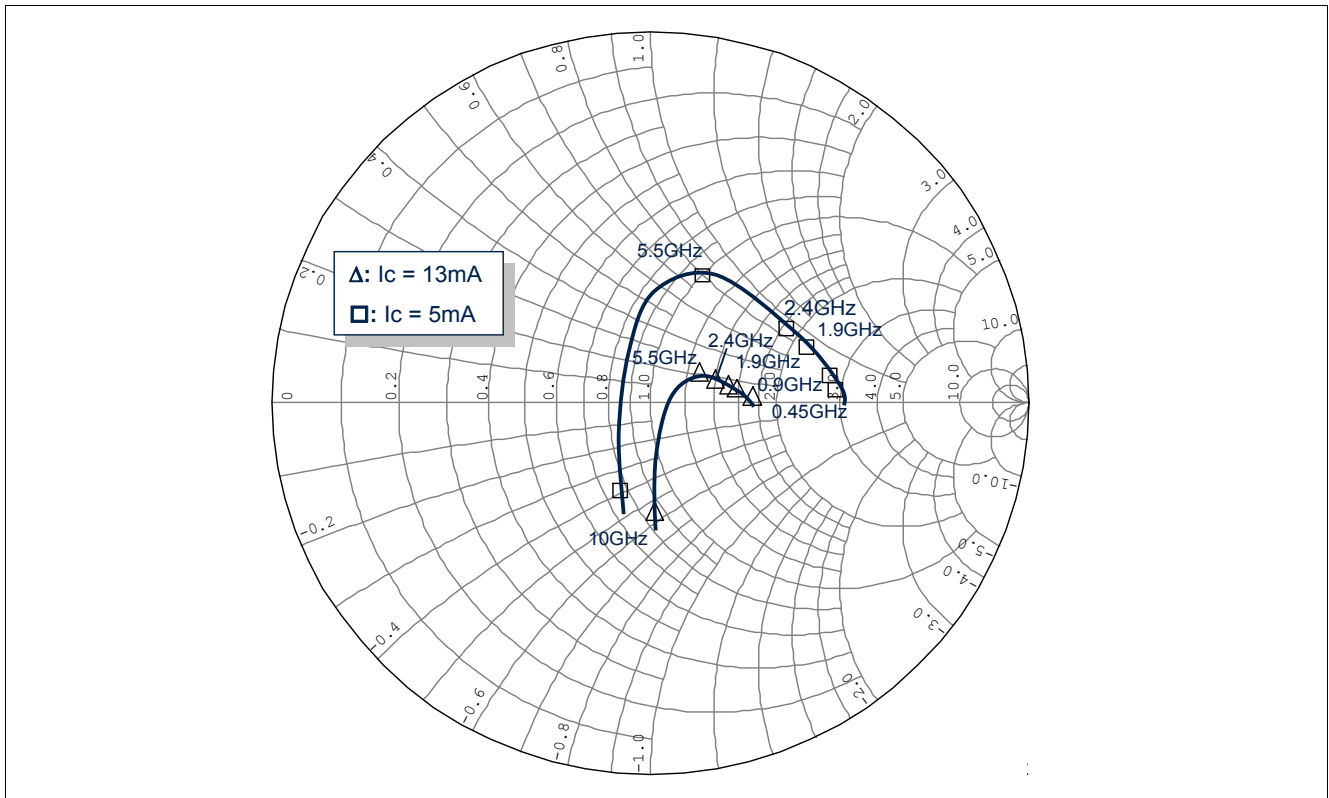
Figure 11   Source Impedance Z_{opt} for NF_{min} vs. Frequency, V_{CE} = 3 V, I_C = 5 mA / 13 mA
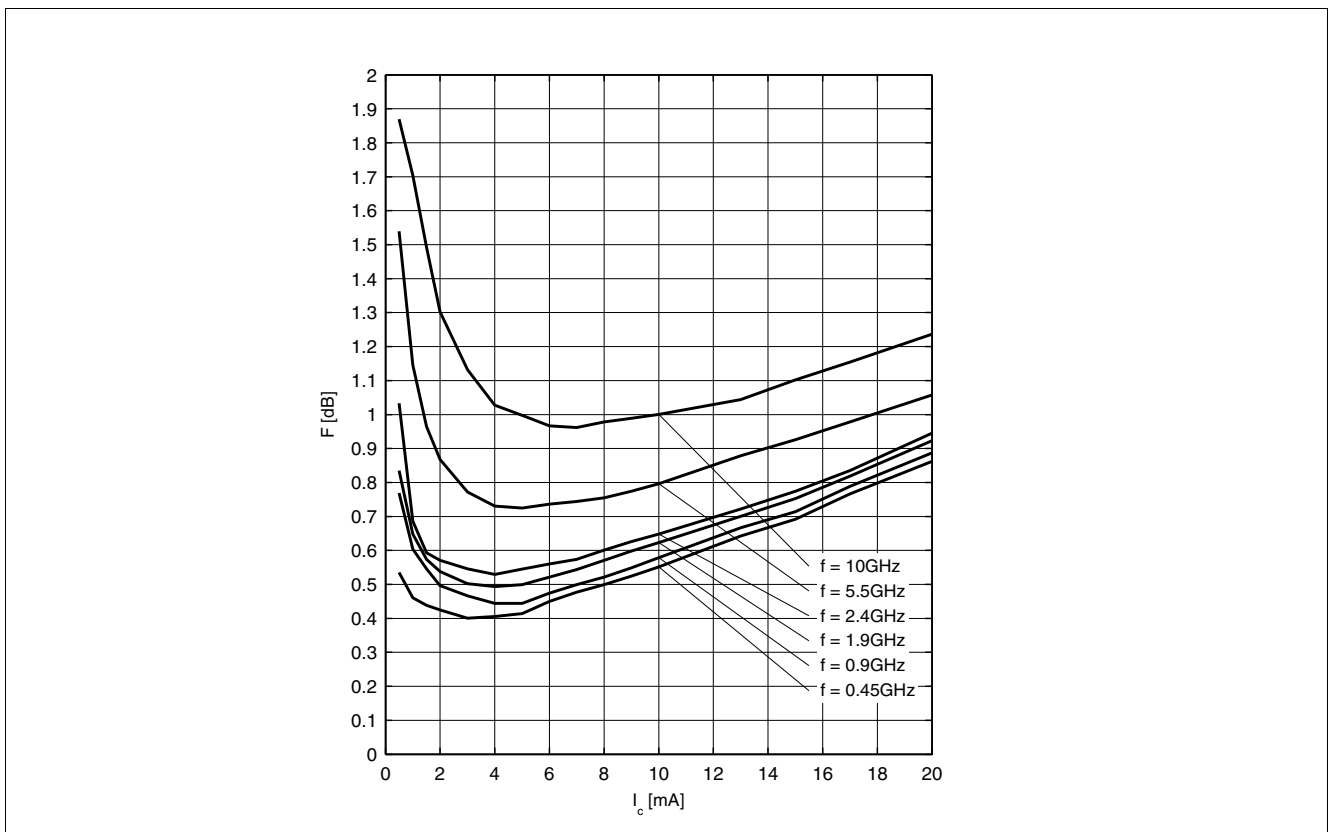
Figure 12   Noise Figure $NF_{min} = f(I_C)$, V_{CE} = 3 V, $Z_S = Z_{opt}$
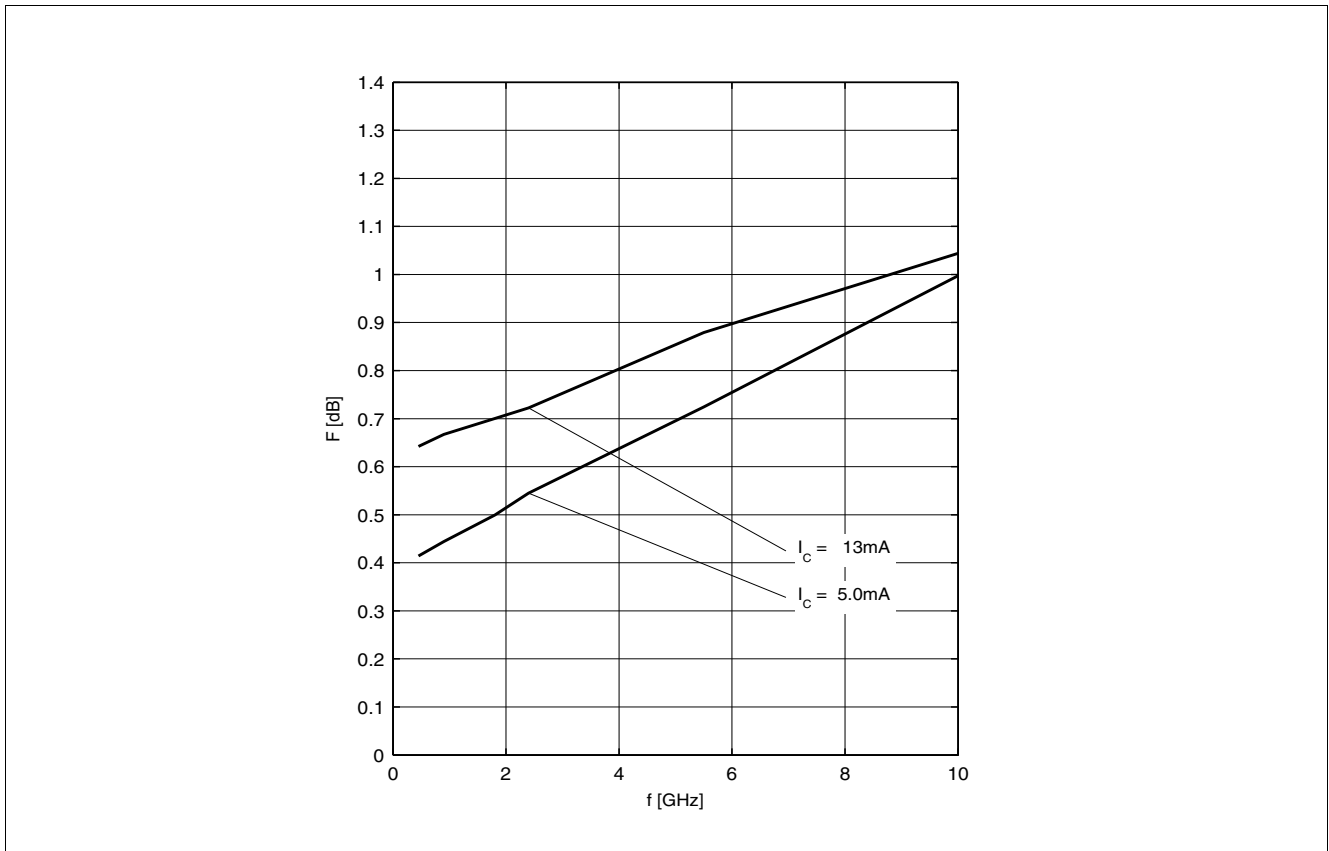
Figure 13   Noise Figure NF_{min} **=** f **(freq),** V_{CE} **= 3 V,** Z_S **=** Z_{opt}

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.

6 Simulation Data

For SPICE-model as well as for 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.

The simulation data have been generated and verified using typical devices. The BFP720F nonlinear SPICE-model reflects the typical DC- and RF-device performance with high accuracy.
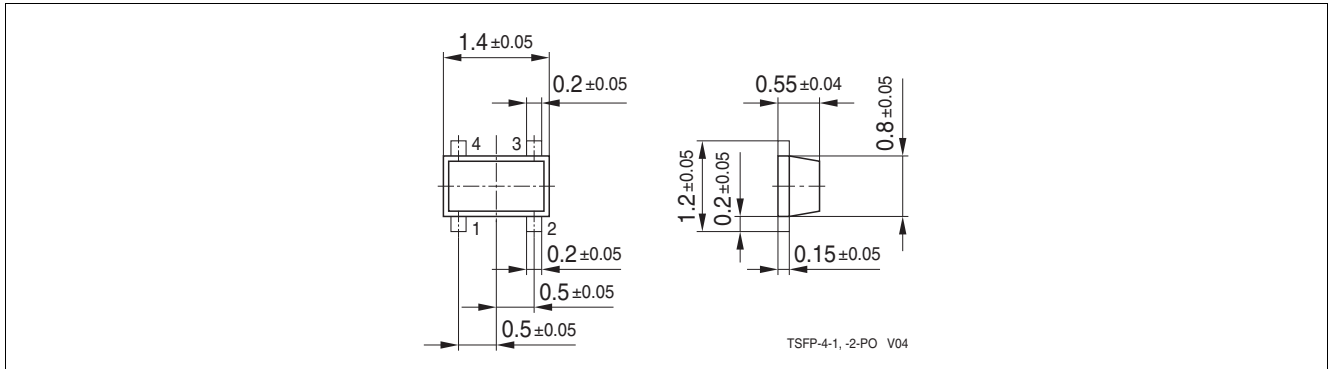
7 Package Information

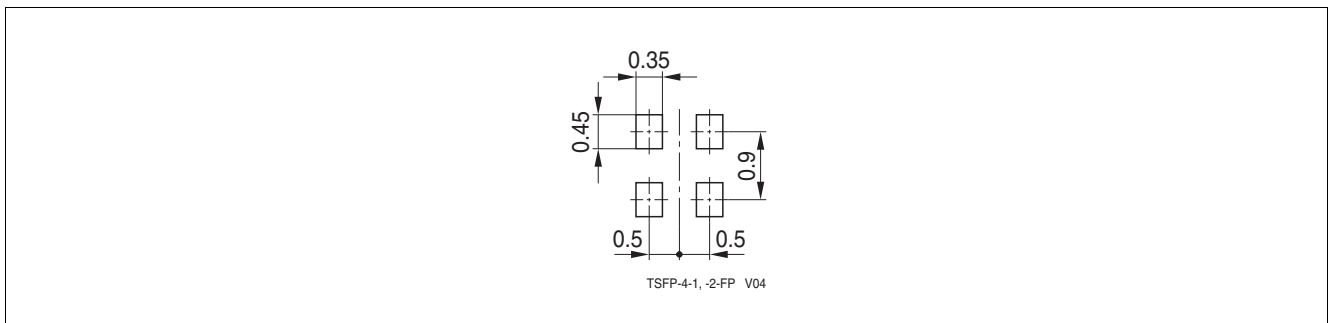**Figure 14   Package Outline TSFP-4(top / side view)**
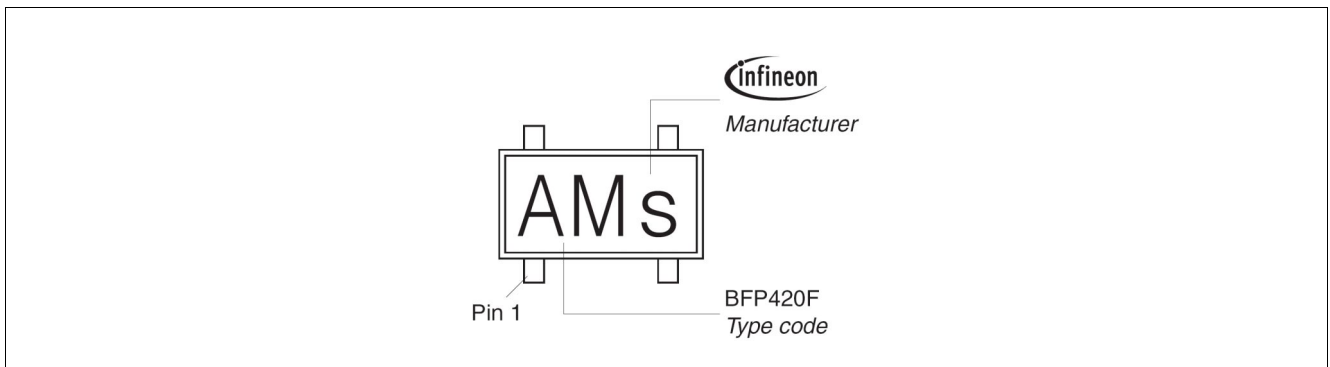

Figure 15   Footprint
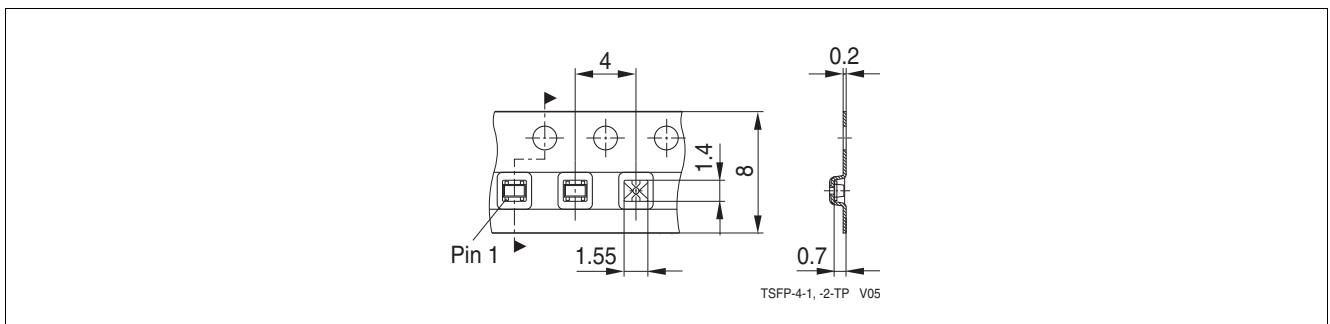

Figure 16   Marking Example (Marking BFP720F: R9s)

Figure 17   Tape Dimensions

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