BFR720L3RH

Low Noise Silicon Germanium Bipolar RF Transistor

Data Sheet

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	This data sheet replaces the revision from 2008-07-04. The production processes have not been changed and the typical device properties remain the same. Only the product description has been expanded and the characteristic curves taken with another test setup.

Table of Contents

	Table of Contents	4
	List of Figures	5
	List of Tables	6
1	**Product Brief**	7
2	**Features**	7
3	**Applications**	7
4	**Pin Configuration**	8
5	**Maximum Ratings**	9
6	**Thermal Characteristics**	10
7	**Electrical Characteristics**	11
7.1	DC Characteristics	11
7.2	General AC Characteristics	11
7.3	Frequency Dependent AC Characteristics	12
7.4	Characteristic DC Diagrams	16
7.5	Characteristic AC Diagrams	19
8	**Simulation Data**	26
9	**Package Information TSLP-3-9**	27

List of Figures

Figure 6-1 Total Power Dissipation $P_{tot} = f(T_S)$ . . . 10
Figure 7-1 Testing Circuit . . . 12
Figure 7-2 Collector Current vs. Collector Emitter Voltage $I_C = f(V_{CE})$, I_B = Parameter in µA . . . 16
Figure 7-3 DC Current Gain $h_{FE} = f(I_C)$, V_{CE} = 3 V . . . 16
Figure 7-4 Collector Current vs. Base Emitter Forward Voltage $I_C = f(V_{BE})$, V_{CE} = 2 V . . . 17
Figure 7-5 Base Current vs. Base Emitter Forward Voltage $I_B = f(V_{BE})$, V_{CE} = 2 V . . . 17
Figure 7-6 Base Current vs. Base Emitter Reverse Voltage $I_B = f(V_{EB})$, V_{CE} = 2 V . . . 18
Figure 7-7 Transition Frequency $f_T = f(I_C)$, f = 1 GHz, V_{CE} = Parameter in V . . . 19
Figure 7-8 3rd Order Intercept Point at Output $OIP_3 = f(I_C)$, $Z_S = Z_L$ = 50 Ω, $V_{CE,}$ f = Parameters . . . 19
Figure 7-9 3rd Order Intercept Point at Output OIP_3 [dBm] = $f(I_{C,}\ V_{CE})$, $Z_S = Z_L$ = 50 Ω, f = 5.5 GHz . . . 20
Figure 7-10 Compression Point at Output OP_{1dB} [dBm] = $f(I_{C,}\ V_{CE})$, $Z_S = Z_L$ = 50 Ω, f = 5.5 GHz . . . 20
Figure 7-11 Collector Base Capacitance $C_{CB} = f(V_{CB})$, f = 1 MHz . . . 21
Figure 7-12 Gain $G_{ma,}G_{ms,}$ $|S_{21}|^2 = f(f)$, V_{CE} = 3 V, I_C = 13 mA . . . 21
Figure 7-13 Maximum Power Gain $G_{max} = f(I_C)$, V_{CE}, f= 3 V, f = Parameter in GHz . . . 22
Figure 7-14 Maximum Power Gain $G_{max} = f(V_{CE})$, I_C = 13 mA, f = Parameter in GHz . . . 22
Figure 7-15 Input Matching $S_{11} = f(f)$, V_{CE} = 3 V, I_C = 4 / 13 mA . . . 23
Figure 7-16 Source Impedance for Minimum Noise Figure $Z_{opt} = f(f)$, V_{CE} = 3 V, I_C = 4 / 13 mA . . . 23
Figure 7-17 Output Matching $S_{22} = f(f)$, V_{CE} = 3 V, I_C = 4 / 13 mA . . . 24
Figure 7-18 Noise Figure $NF_{min} = f(f)$, V_{CE} = 3 V, I_C = 4 / 13 mA, $Z_S = Z_{opt}$ . . . 24
Figure 7-19 Noise Figure $NF_{min} = f(I_C)$, V_{CE} = 3 V, $Z_S = Z_{opt}$, f = Parameter in GHz . . . 25
Figure 7-20 Noise Figure $NF_{50} = f(I_C)$, V_{CE} = 3 V, Z_S = 50 Ω, f = Parameter in GHz . . . 25
Figure 9-1 Package Outline of TSLP-3-9 . . . 27
Figure 9-2 Footprint of TSLP-3-9 . . . 27
Figure 9-3 Marking Layout of TSLP-3-9 . . . 27
Figure 9-4 Tape of TSLP-3-9 . . . 27

List of Tables

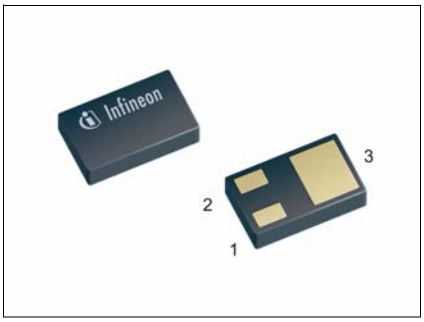
Table 5-1 Maximum Ratings at T_A = 25 °C (unless otherwise specified) 9
Table 6-1 Thermal Resistance 10
Table 7-1 DC Characteristics at T_A = 25 °C 11
Table 7-2 General AC Characteristics at T_A = 25 °C 11
Table 7-3 AC Characteristics, V_{CE} = 3 V, f = 150 MHz 12
Table 7-4 AC Characteristics, V_{CE} = 3 V, f = 0.45 GHz 12
Table 7-5 AC Characteristics, V_{CE} = 3 V, f = 0.9 GHz 13
Table 7-6 AC Characteristics, V_{CE} = 3 V, f = 1.5 GHz 13
Table 7-7 AC Characteristics, V_{CE} = 3 V, f = 1.9 GHz 13
Table 7-8 AC Characteristics, V_{CE} = 3 V, f = 2.4 GHz 14
Table 7-9 AC Characteristics, V_{CE} = 3 V, f = 3.5 GHz 14
Table 7-10 AC Characteristics, V_{CE} = 3 V, f = 5.5 GHz 14
Table 7-11 AC Characteristics, V_{CE} = 3 V, f = 10 GHz 15
Table 7-12 AC Characteristics, V_{CE} = 3 V, f = 12 GHz 15

1 Product Brief

The BFR720L3RH is a very low noise wideband NPN RF transistor. The device is based on Infineon's reliable high volume silicon germanium carbon (SiGe:C) heterojunction bipolar technology. The BFR720L3RH provides a transition frequency f_T of 43 GHz and is suited for low voltage applications ($V_{CEO,max}$ = 4 V) from VHF to 12 GHz. Due to its low power consumption the device is very energy efficient and well suited for mobile applications. The BFR720L3RH is housed in a very thin small leadless package ideal for modules.

2 Features

- Very low noise figure NF_{min} = 0.45 dB at 1.9 GHz, 0.65 dB at 5.5 GHz, 3 V, 4 mA
- High power gain G_{ms} = 21 dB at 5.5 GHz, 13 mA, 3 V
- Very thin small leadless package (height only 0.31 mm), hence ideal for modules with compact size and low profile height
- Pb-free (RoHS compliant) and halogen-free package
- Qualification report according to AEC-Q101 available



TSLP-3-9

RoHS

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

As discrete active mixer, amplifier in VCOs and buffer amplifier

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

4 Pin Configuration

Product Name	Package	Pin Configuration[1]			Marking
BFR720L3RH	TSLP-3-9	1 = B	2 = C	3 = E	R3

1) See **"Package Information TSLP-3-9" on Page 27**

5 Maximum Ratings

Table 5-1 Maximum Ratings at T_A = 25 °C (unless otherwise specified)

Parameter	Symbol	Values		Unit	Note / Test Condition
		Min.	Max.		
Collector emitter voltage	V_{CEO}	 – –	 4.0 3.5	V	Open base T_A = 25°C T_A = -55°C
Collector emitter voltage	V_{CES}	–	13	V	E-B short circuited
Collector base voltage	V_{CBO}	–	13	V	Open emitter
Emitter base voltage	V_{EBO}	–	1.2	V	Open collector
Collector current	I_C	–	30	mA	–
Base current	I_B	–	3	mA	–
Total power dissipation[1)]	P_{tot}	–	120	mW	$T_S \leq 103$ °C
Junction temperature	T_J	–	150	°C	–
Storage temperature	T_{Stg}	-55	150	°C	–

1) T_S is the soldering point temperature. T_S is 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.*

6 Thermal Characteristics

Table 6-1 Thermal Resistance

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Junction - soldering point[1)]	R_{thJS}	–	390	–	K/W	–

1)For the definition of R_{thJS} please refer to Application Note AN077 (Thermal Resistance Calculation)

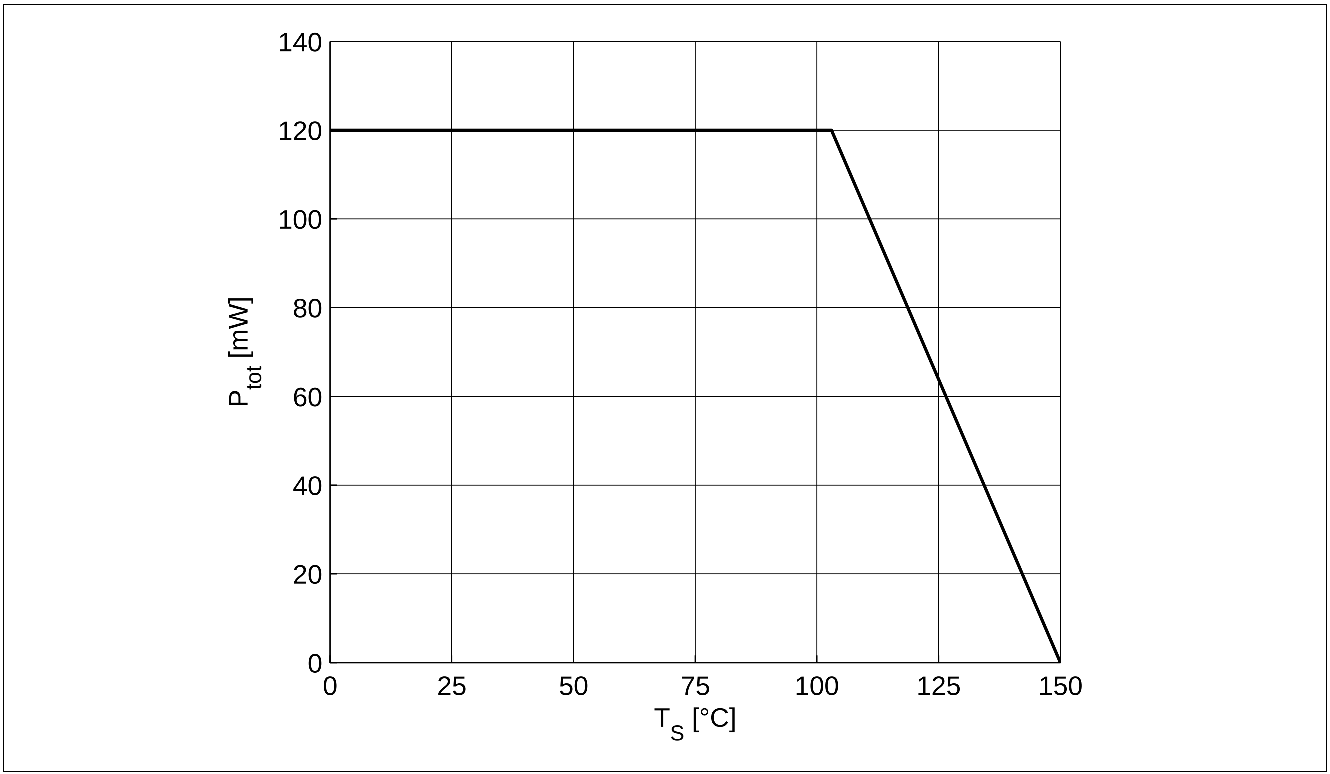


Figure 6-1 Total Power Dissipation $P_{tot} = f(T_S)$

7 Electrical Characteristics

7.1 DC Characteristics

Table 7-1 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 Open base
Collector emitter leakage current	I_{CES}	–	1 1	400 40	nA	V_{CE} = 13 V, V_{BE} = 0 V_{CE} = 5 V, V_{BE} = 0 E-B short circuited
Collector base leakage current	I_{CBO}	–	1	40	nA	V_{CB} = 5V, I_E = 0 Open emitter
Emitter base leakage current	I_{EBO}	–	1	40	nA	V_{EB} = 0.5V, I_C = 0 Open collector
DC current gain	h_{FE}	160	250	400		V_{CE} = 3 V, I_C = 13 mA Pulse measured

7.2 General AC Characteristics

Table 7-2 General AC Characteristics at T_A = 25 °C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transition frequency	f_T	–	43	–	GHz	V_{CE} = 3 V, I_C = 13 mA f = 2 GHz
Collector base capacitance	C_{CB}	–	0.07	0.10	pF	V_{CB} = 3 V, V_{BE} = 0 f = 1 MHz Emitter grounded
Collector emitter capacitance	C_{CE}	–	0.26	–	pF	V_{CE} = 3 V, V_{BE} = 0 f = 1 MHz Base grounded
Emitter base capacitance	C_{EB}	–	0.27	–	pF	V_{EB} = 0.5 V, V_{CB} = 0 f = 1 MHz Collector grounded

7.3 Frequency Dependent AC Characteristics

Measurement setup is a test fixture with Bias T´s in a 50 Ω system, T_A = 25 °C.

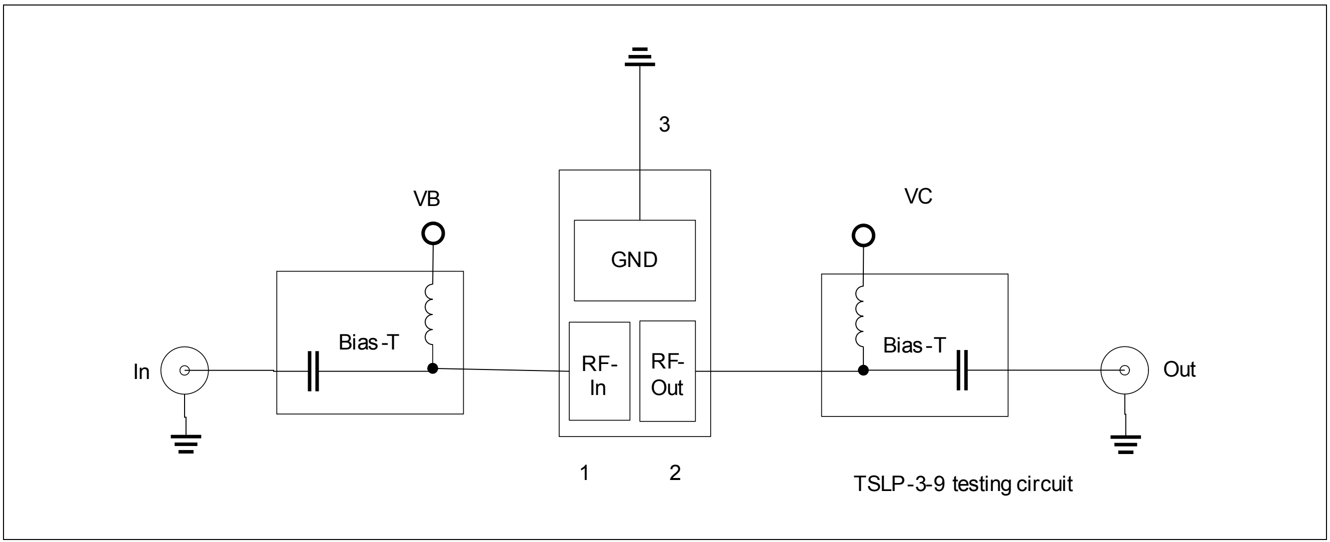


Figure 7-1 Testing Circuit

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ms}	–	36.5	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	28	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.45	–		I_C = 4 mA
Associated gain	G_{ass}	–	26.5	–		I_C = 4 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	5.5	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	19.5	–		I_C = 13 mA

Table 7-4 AC Characteristics, V_{CE} = 3 V, f = 0.45 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ms}	–	31.5	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	28	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.45	–		I_C = 4 mA
Associated gain	G_{ass}	–	25.5	–		I_C = 4 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	5.5	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	19.5	–		I_C = 13 mA

Table 7-5 AC Characteristics, V_{CE} = 3 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 = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	27	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.45	–		I_C = 4 mA
Associated gain	G_{ass}	–	24.5	–		I_C = 4 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	5.5	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	20	–		I_C = 13 mA

Table 7-6 AC Characteristics, V_{CE} = 3 V, f = 1.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ms}	–	26.5	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	25.5	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.45	–		I_C = 4 mA
Associated gain	G_{ass}	–	22.5	–		I_C = 4 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	5.5	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	20	–		I_C = 13 mA

Table 7-7 AC Characteristics, V_{CE} = 3 V, f = 1.9 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ms}	–	25.5	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	24	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.45	–		I_C = 4 mA
Associated gain	G_{ass}	–	21.5	–		I_C = 4 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	5.5	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	20.5	–		I_C = 13 mA

Table 7-8 AC Characteristics, V_{CE} = 3 V, f = 2.4 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ms}	–	24.5	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	23	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.5	–		I_C = 4 mA
Associated gain	G_{ass}	–	20	–		I_C = 4 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	6	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	21	–		I_C = 13 mA

Table 7-9 AC Characteristics, V_{CE} = 3 V, f = 3.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ms}	–	23	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	20	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.55	–		I_C = 4 mA
Associated gain	G_{ass}	–	17	–		I_C = 4 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	6.5	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	22.5	–		I_C = 13 mA

Table 7-10 AC Characteristics, V_{CE} = 3 V, f = 5.5 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ms}	–	21	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	16.5	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	0.65	–		I_C = 4 mA
Associated gain	G_{ass}	–	13.5	–		I_C = 4 mA
Linearity					dBm	$Z_S = Z_L$ = 50 Ω
1 dB compression point at output	OP_{1dB}	–	7.5	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	23	–		I_C = 13 mA

Table 7-11 AC Characteristics, V_{CE} = 3 V, f = 10 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ma}	–	14.5	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	11	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	1	–		I_C = 4 mA
Associated gain	G_{ass}	–	8.5	–		I_C = 4 mA
Linearity					dBm	Z_S = Z_L = 50 Ω
1 dB compression point at output	OP_{1dB}	–	7.5	–		I_C = 13 mA
3rd order intercept point at output	$OIP3$	–	22.5	–		I_C = 13 mA

Table 7-12 AC Characteristics, V_{CE} = 3 V, f = 12 GHz

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Power Gain					dB	
Maximum power gain	G_{ma}	–	12	–		I_C = 13 mA
Transducer gain	$\|S_{21}\|^2$	–	9	–		I_C = 13 mA
Minimum Noise Figure					dB	
Minimum noise figure	NF_{min}	–	1.1	–		I_C = 4 mA
Associated gain	G_{ass}	–	8	–		I_C = 4 mA
Linearity					dBm	Z_S = Z_L = 50 Ω
1 dB compression point at output	OP_{1dB}	–	6.5	–		I_C = 13 mA
3rd order intercept point at output	OIP_3	–	18.5	–		I_C = 13 mA

Note: 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.

7.4 Characteristic DC Diagrams

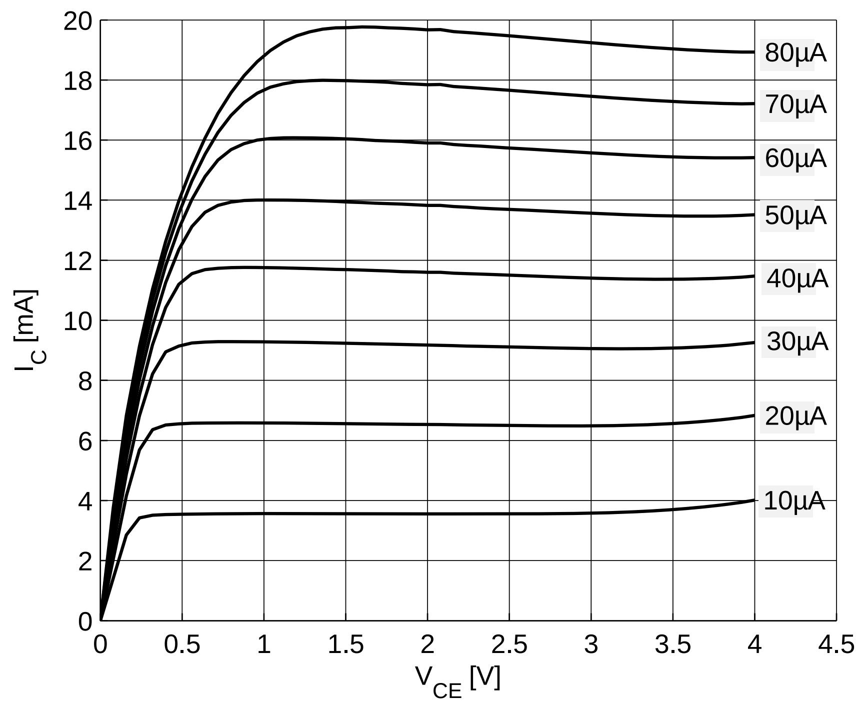


Figure 7-2 Collector Current vs. Collector Emitter Voltage $I_C = f(V_{CE})$, I_B = Parameter in µA

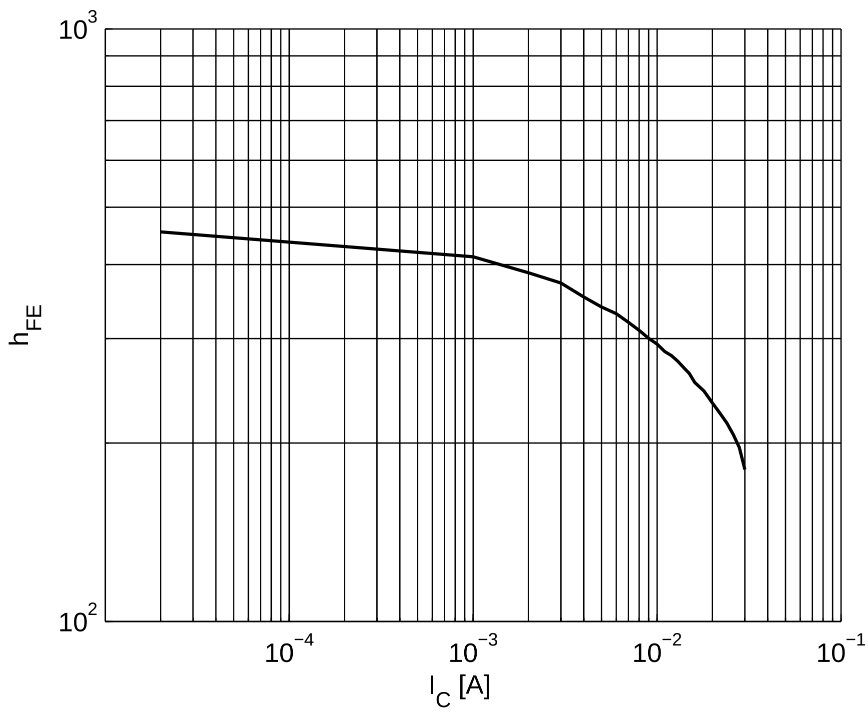


Figure 7-3 DC Current Gain $h_{FE} = f(I_C)$, V_{CE} = 3 V

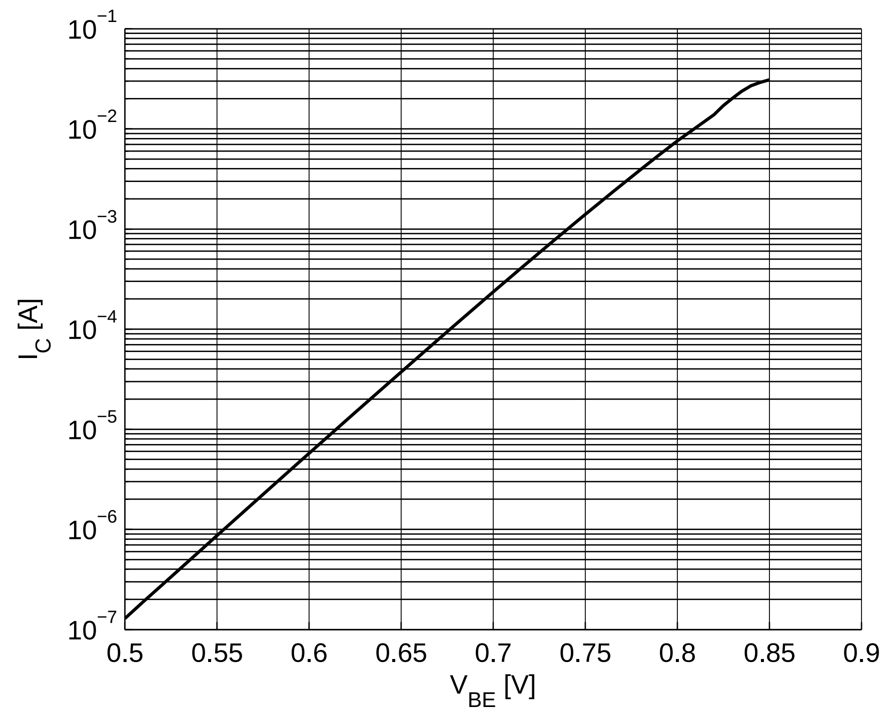


Figure 7-4 Collector Current vs. Base Emitter Forward Voltage $I_C = f(V_{BE})$, V_{CE} = 2 V

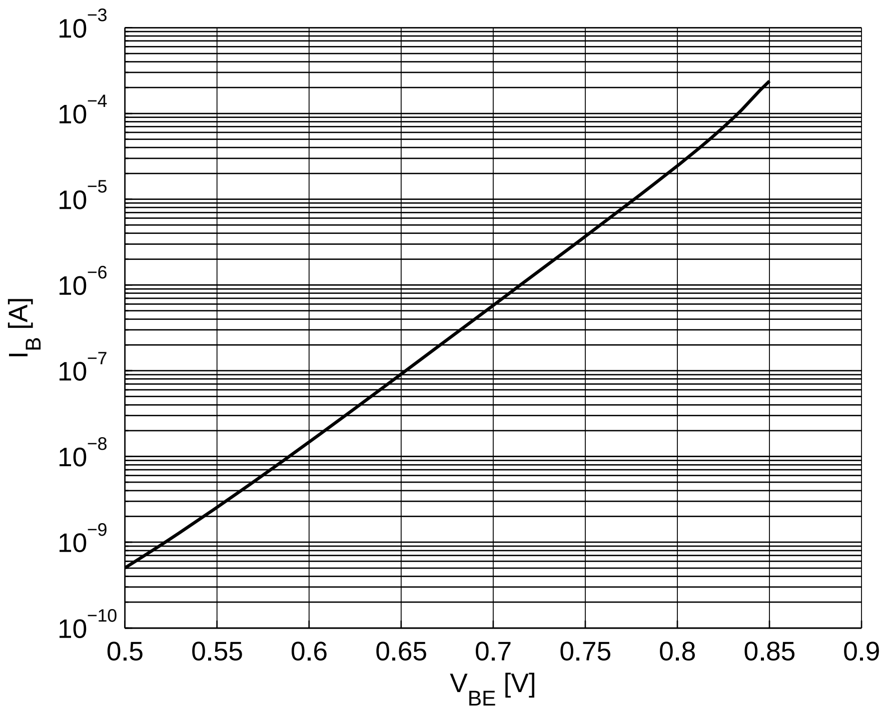


Figure 7-5 Base Current vs. Base Emitter Forward Voltage $I_B = f(V_{BE})$, V_{CE} = 2 V

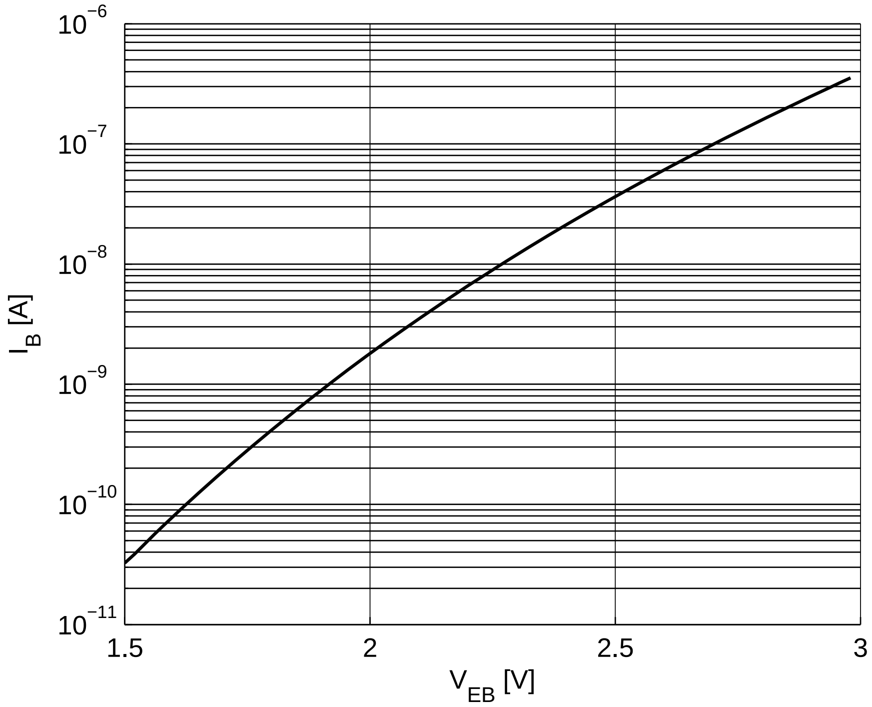


Figure 7-6 Base Current vs. Base Emitter Reverse Voltage $I_B = f(V_{EB})$, V_{CE} = 2 V

7.5 Characteristic AC Diagrams

Measurement setup is a test fixture with Bias-T´s in a 50 Ω system, T_A = 25 °C.

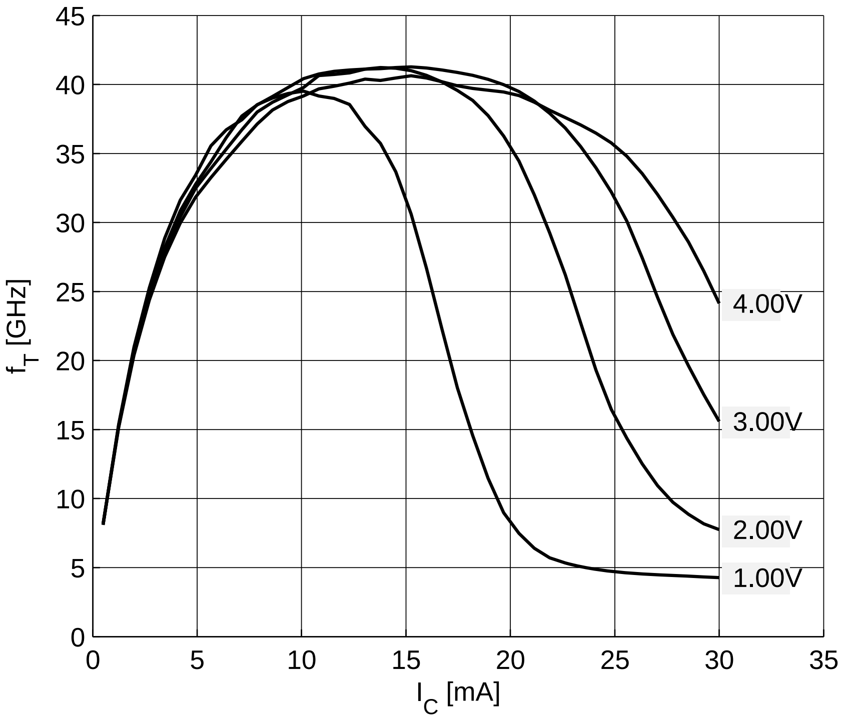


Figure 7-7 Transition Frequency $f_T = f(I_C)$, f = 1 GHz, V_{CE} = Parameter in V

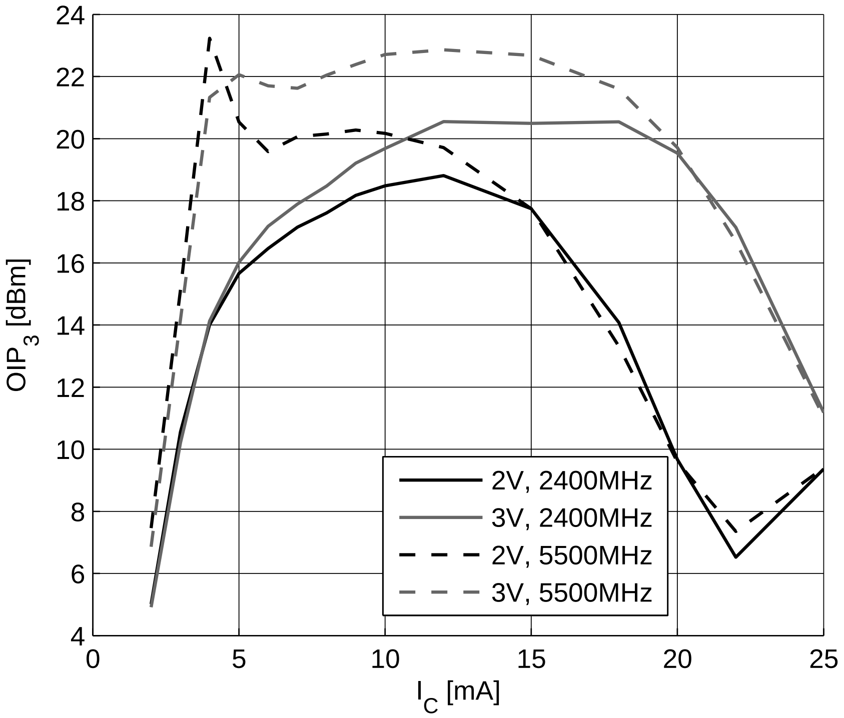


Figure 7-8 3rd Order Intercept Point at Output $OIP_3 = f(I_C)$, $Z_S = Z_L$ = 50 Ω, V_{CE}, f = Parameters

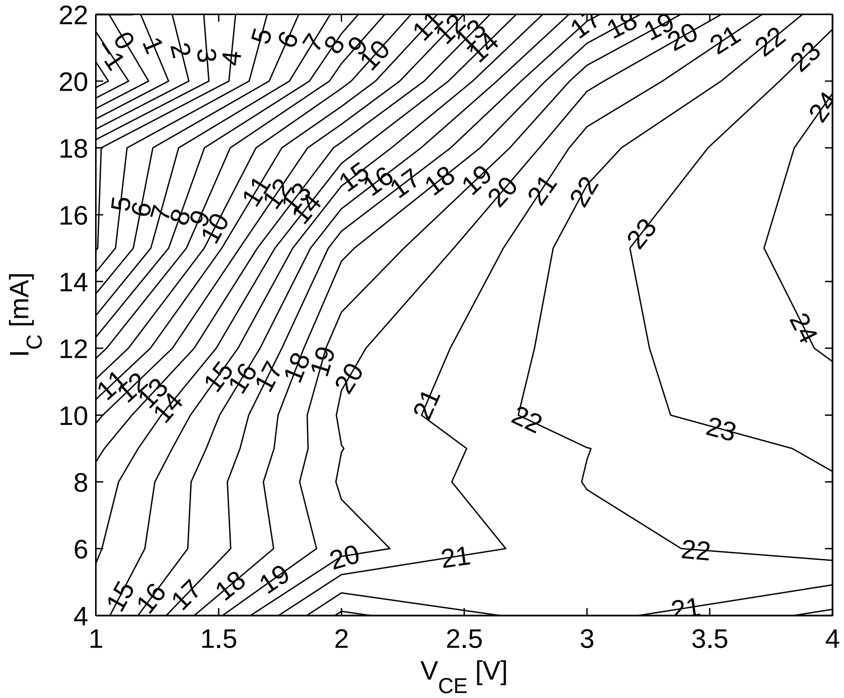


Figure 7-9 3rd Order Intercept Point at Output OIP_3 [dBm] = f (I_C, V_{CE}), Z_S = Z_L = 50 Ω, f = 5.5 GHz

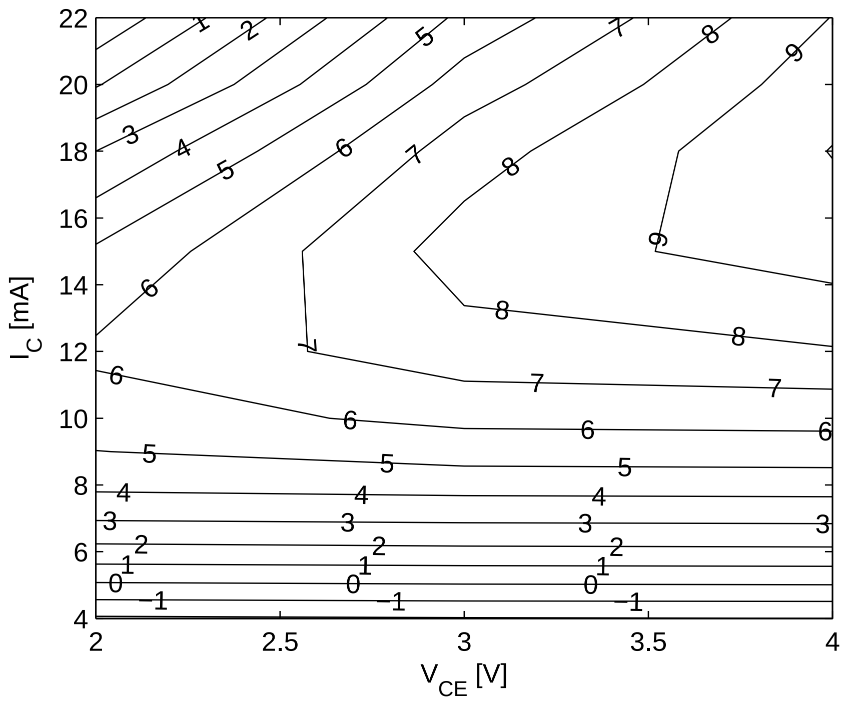


Figure 7-10 Compression Point at Output OP_{1dB} [dBm] = f (I_C, V_{CE}), Z_S = Z_L = 50 Ω, f = 5.5 GHz

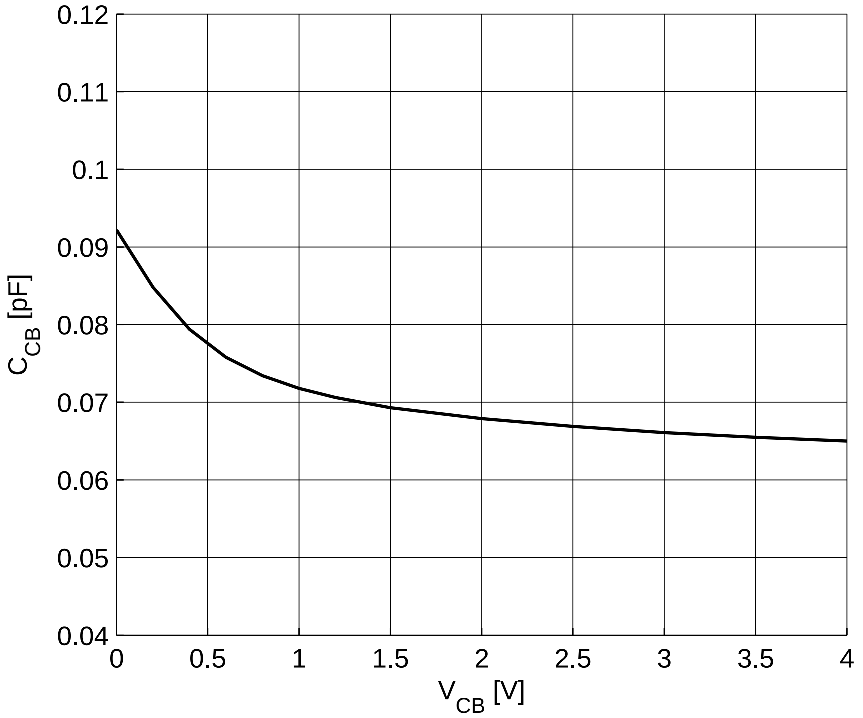


Figure 7-11 Collector Base Capacitance $C_{CB} = f\ (V_{CB})$, f = 1 MHz

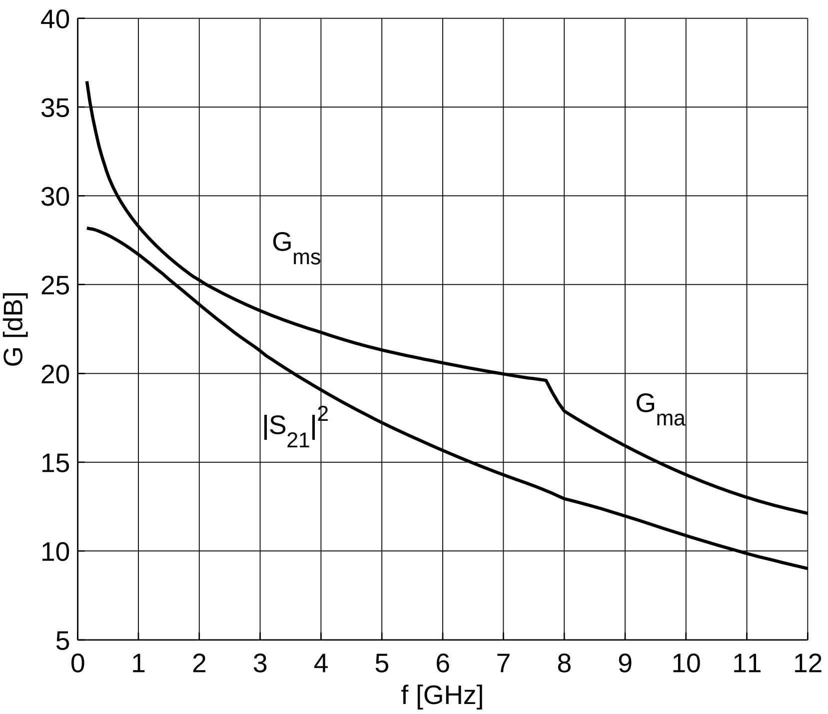


Figure 7-12 Gain G_{ma}, G_{ms}, $|S_{21}|^2 = f\ (f)$, V_{CE} = 3 V, I_C = 13 mA

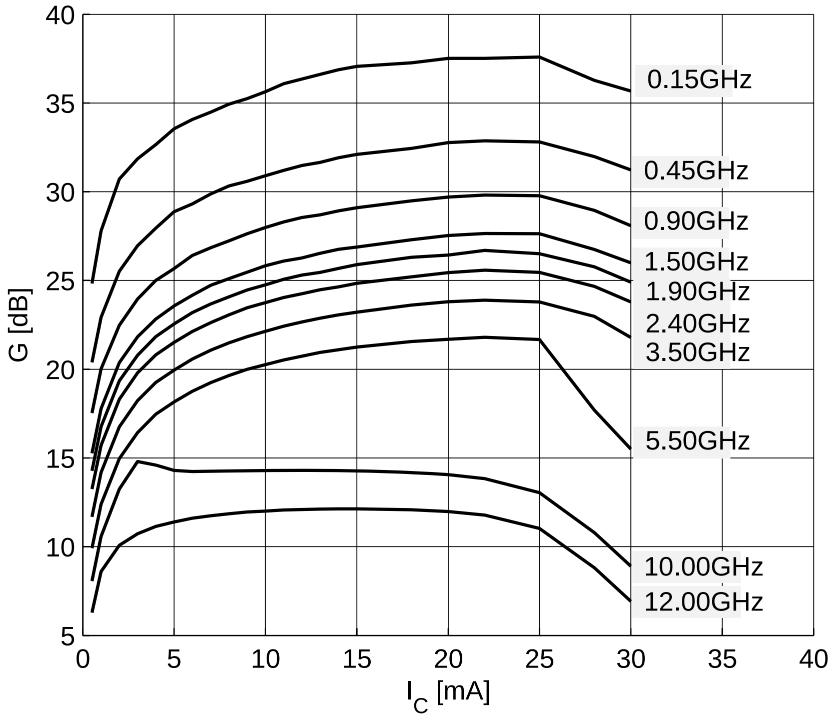


Figure 7-13 Maximum Power Gain G_{max} = f (I_C), V_{CE}, f= 3 V, f = Parameter in GHz

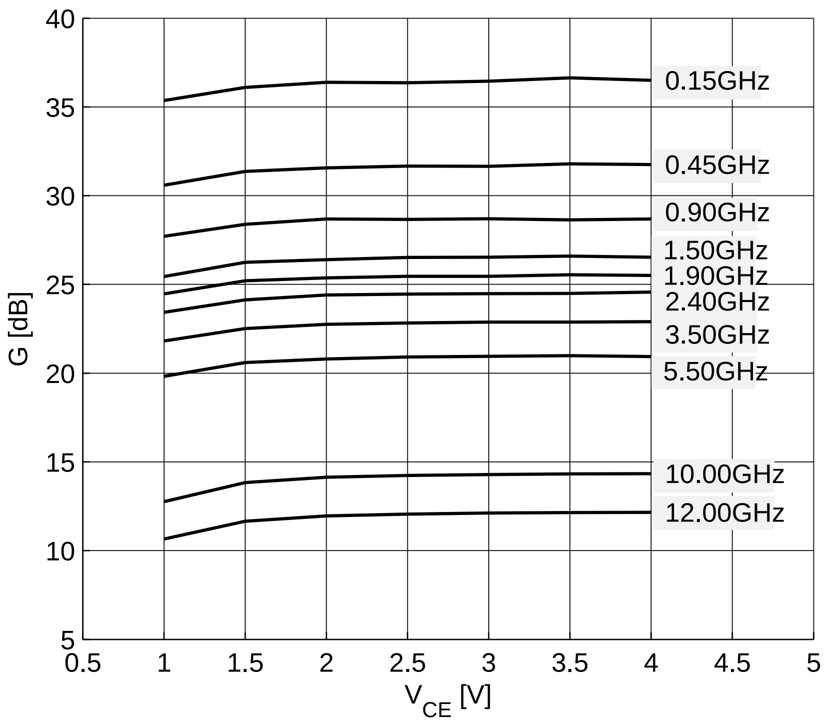


Figure 7-14 Maximum Power Gain G_{max} = f (V_{CE}), I_C = 13 mA, f = Parameter in GHz

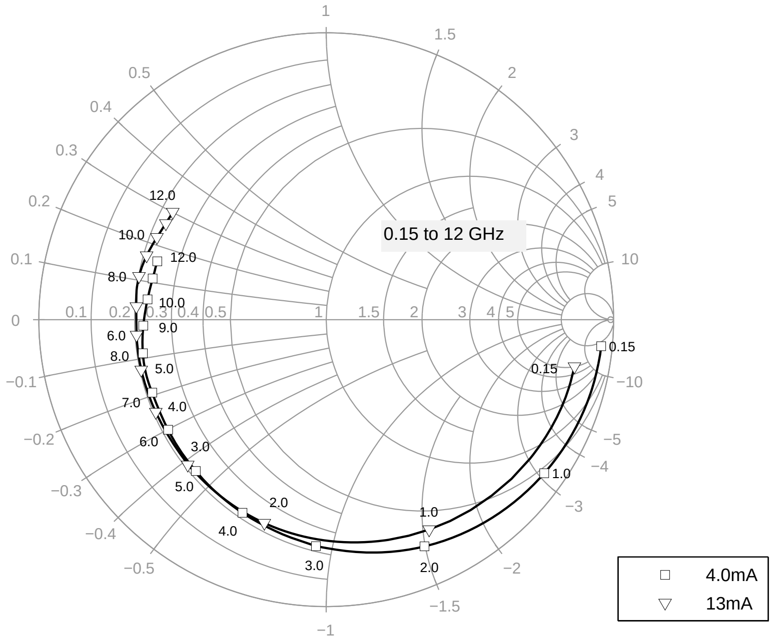


Figure 7-15 Input Matching S_{11} = f (f), V_{CE} = 3 V, I_C = 4 / 13 mA

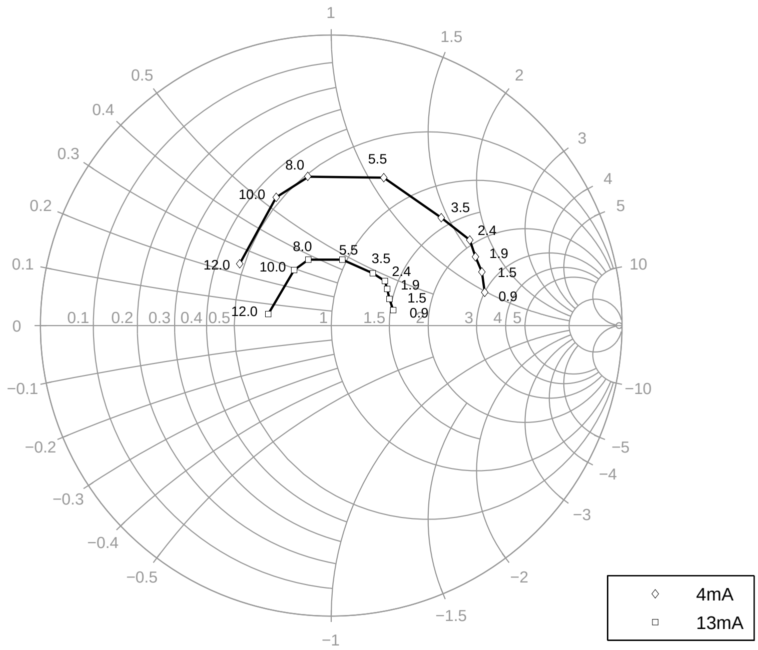


Figure 7-16 Source Impedance for Minimum Noise Figure Z_{opt} = f (f), V_{CE} = 3 V, I_C = 4 / 13 mA

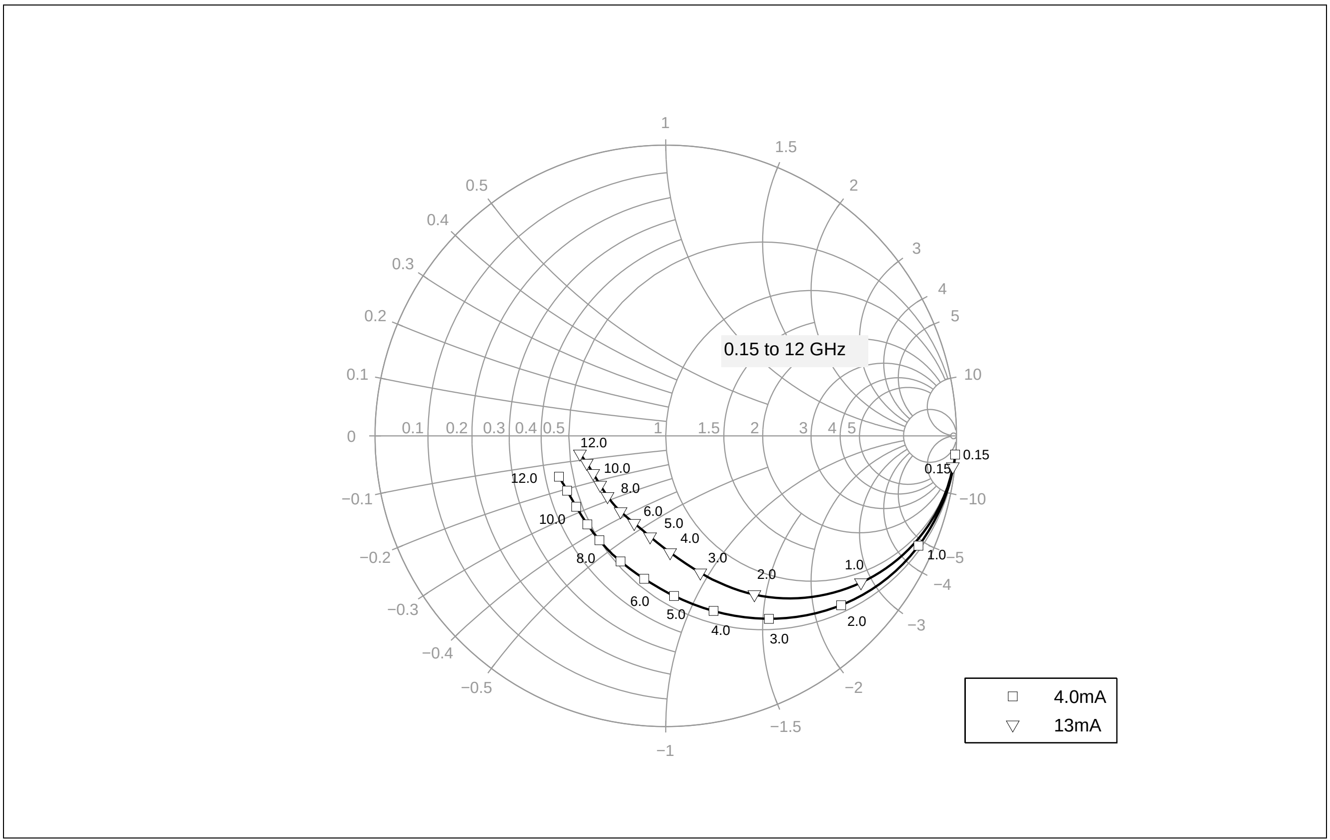


Figure 7-17 Output Matching $S_{22} = f\,(f)$, V_{CE} = 3 V, I_C = 4 / 13 mA

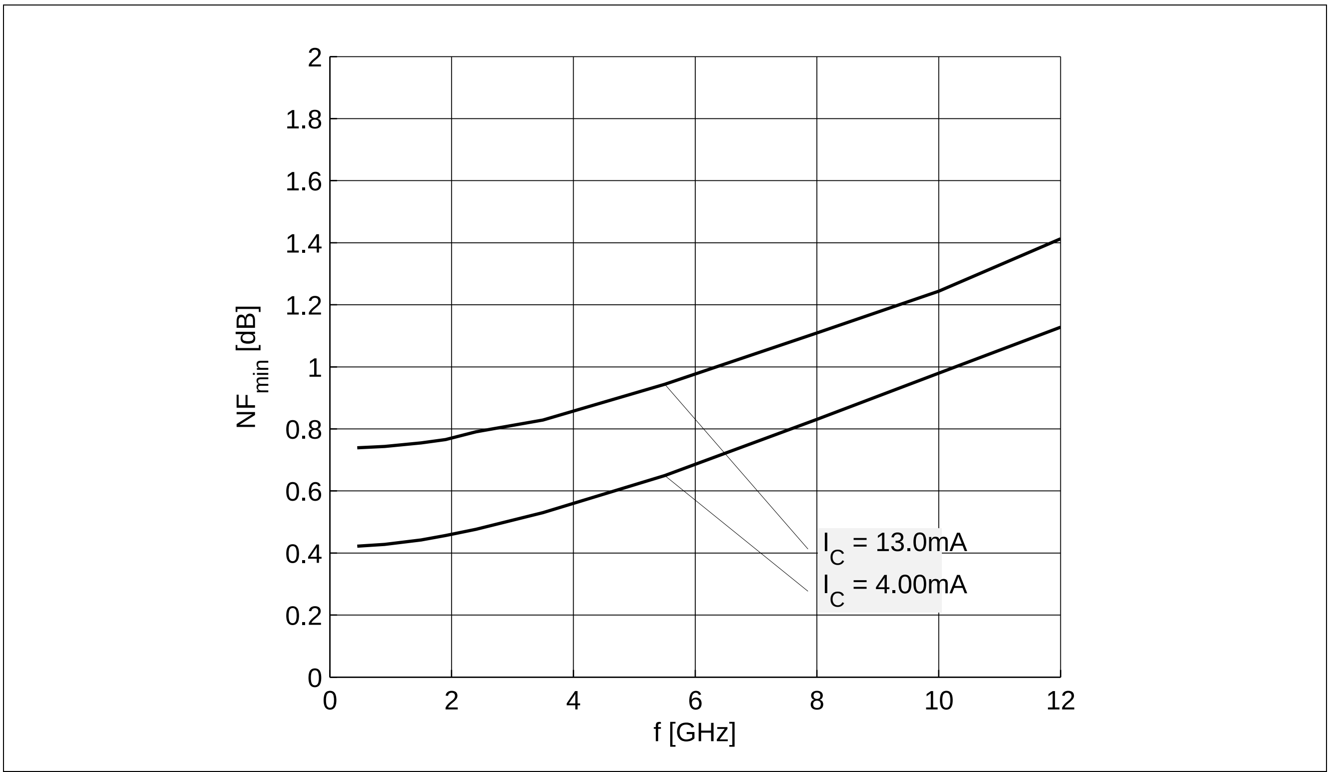


Figure 7-18 Noise Figure $NF_{min} = f\,(f)$, V_{CE} = 3 V, I_C = 4 / 13 mA, $Z_S = Z_{opt}$

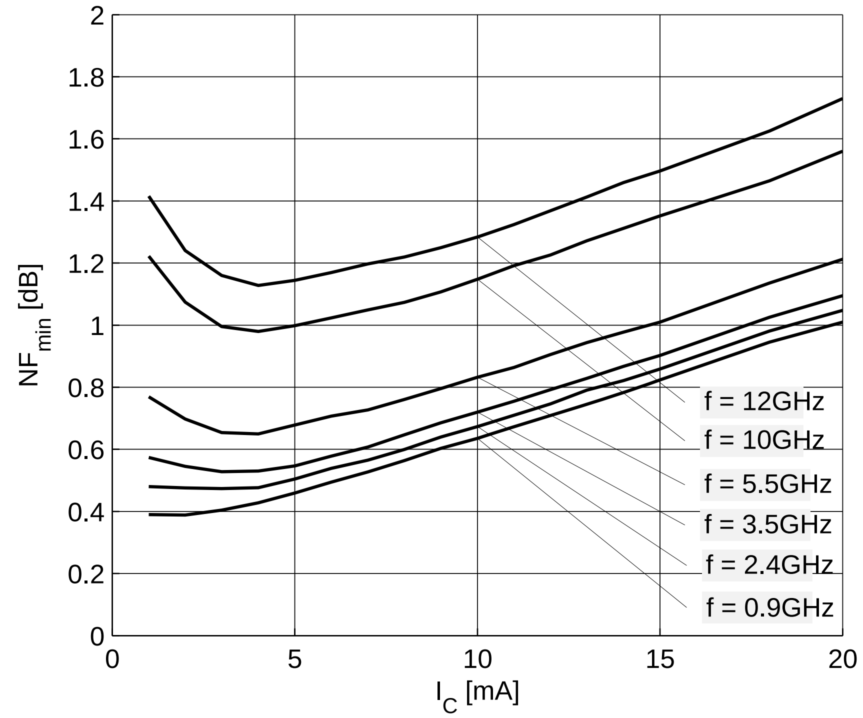


Figure 7-19 Noise Figure $NF_{min} = f(I_C)$, V_{CE} = 3 V, $Z_S = Z_{opt}$, f = Parameter in GHz

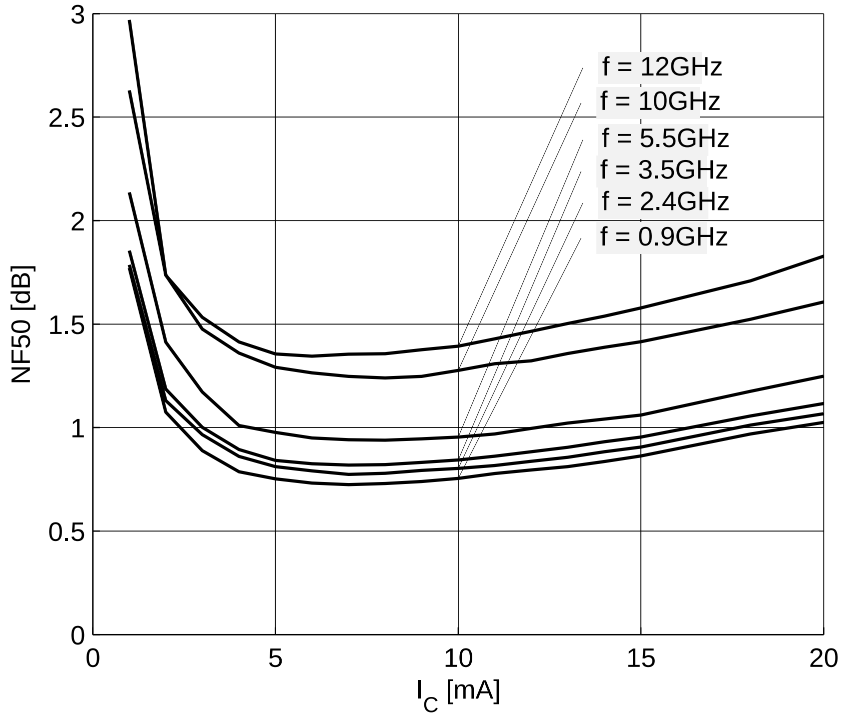


Figure 7-20 Noise Figure $NF_{50} = f(I_C)$, V_{CE} = 3 V, Z_S = 50 Ω, f = Parameter in GHz

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.

8 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 BFR720L3RH 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 BFR720L3RH 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.

9 Package Information TSLP-3-9

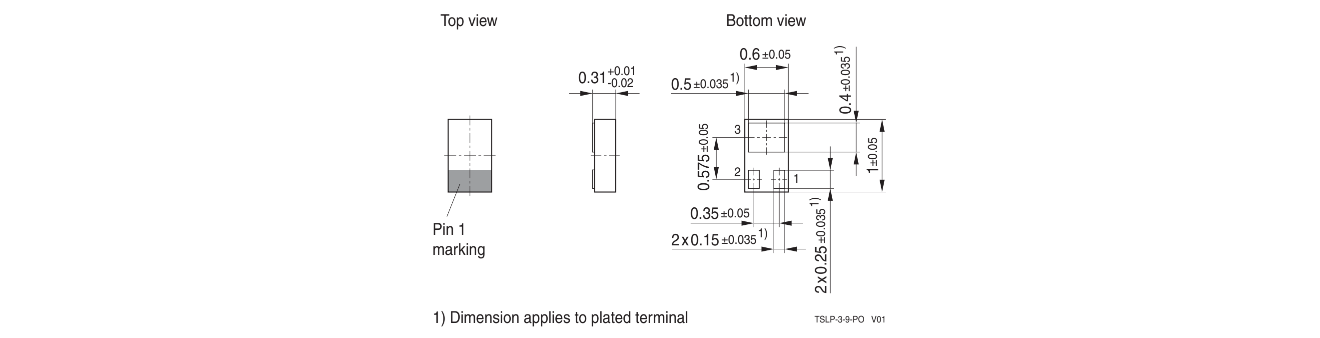


Figure 9-1 Package Outline of TSLP-3-9

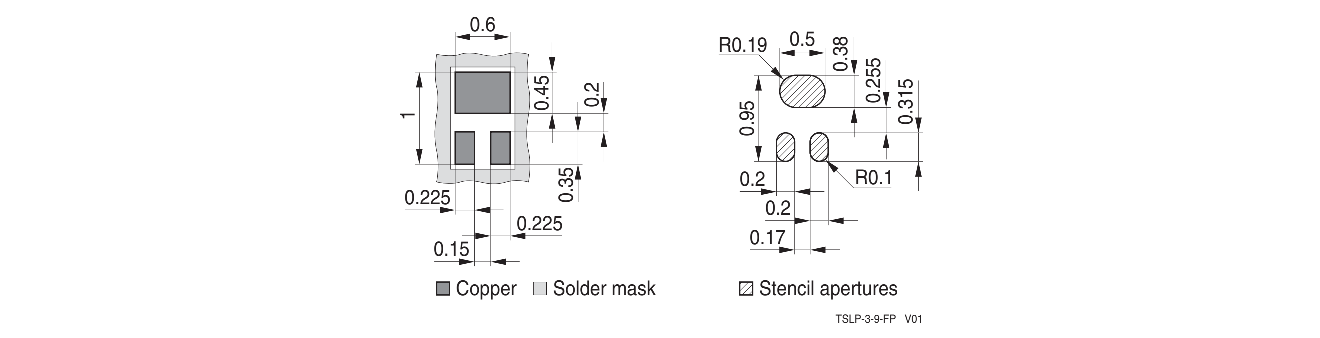


Figure 9-2 Footprint of TSLP-3-9

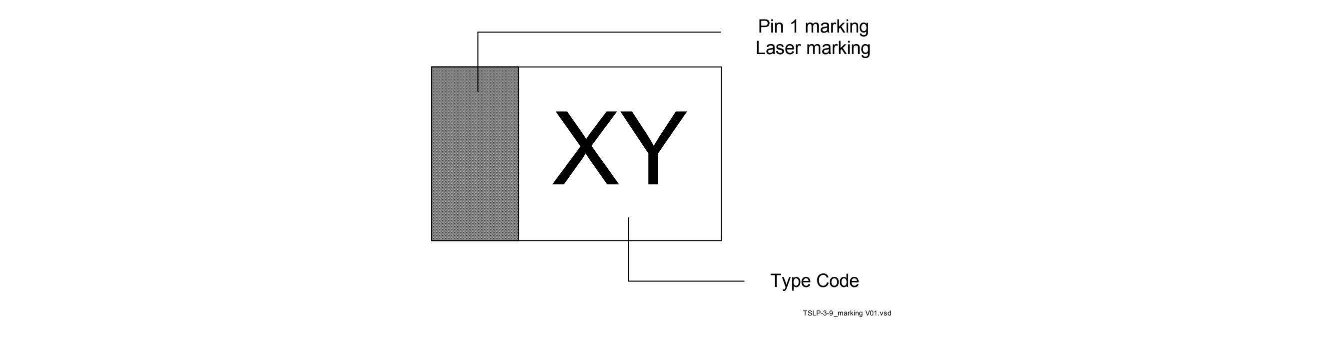


Figure 9-3 Marking Layout of TSLP-3-9

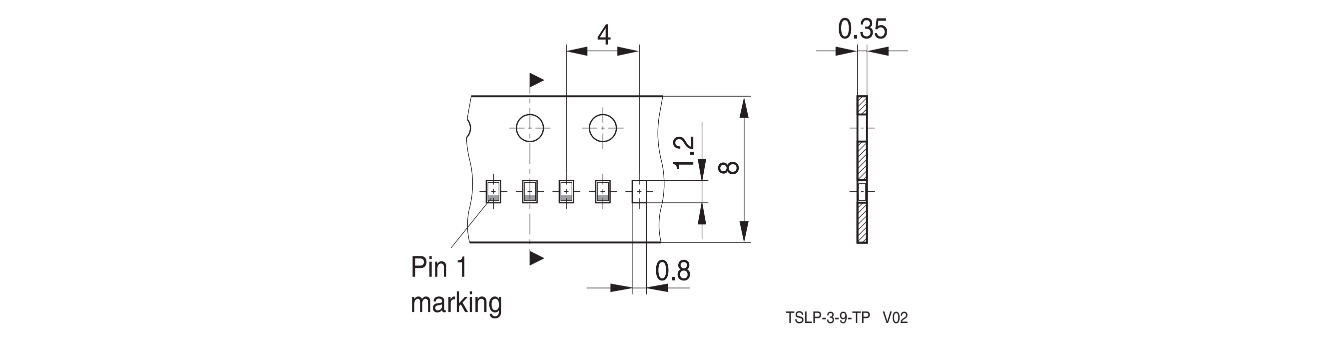


Figure 9-4 Tape of TSLP-3-9

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