

# BFP760

Low Noise Silicon Germanium Bipolar RF Transistor

## Data Sheet

Revision 1.1, 2013-08-05

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**BFP760, Low Noise Silicon Germanium Bipolar RF Transistor**

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Page	Subjects (major changes since last revision)
	This data sheet replaces the revision from 2012-12-04.
	Pages 14,15,16: Fig. 5-2, 5-4, 5-5, 5-6 corrected.
	Table 5-4: outlier value for OIP3 corrected.

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## Table of Contents

	<b>Table of Contents</b> .....	4
	<b>List of Figures</b> .....	5
	<b>List of Tables</b> .....	6
<b>1</b>	<b>Product Brief</b> .....	7
<b>2</b>	<b>Features</b> .....	8
<b>3</b>	<b>Maximum Ratings</b> .....	9
<b>4</b>	<b>Thermal Characteristics</b> .....	10
<b>5</b>	<b>Electrical Characteristics</b> .....	11
5.1	DC Characteristics .....	11
5.2	General AC Characteristics .....	11
5.3	Frequency Dependent AC Characteristics .....	12
5.4	Characteristic DC Diagrams .....	15
5.5	Characteristic AC Diagrams .....	18
<b>6</b>	<b>Simulation Data</b> .....	25
<b>7</b>	<b>Package Information SOT343</b> .....	26

## List of Figures

Figure 4-1	Total Power Dissipation $P_{tot} = f(T_s)$ .....	10
Figure 5-1	BFP760 Testing Circuit .....	12
Figure 5-2	Collector Current vs. Collector Emitter Voltage $I_C = f(V_{CE})$ , $I_B =$ Parameter in $\mu\text{A}$ . .....	15
Figure 5-3	DC Current Gain $h_{FE} = f(I_C)$ , $V_{CE} = 3\text{ V}$ .....	15
Figure 5-4	Collector Current vs. Base Emitter Voltage $I_C = f(V_{BE})$ , $V_{CE} = 2\text{ V}$ .....	16
Figure 5-5	Base Current vs. Base Emitter Forward Voltage $I_B = f(V_{BE})$ , $V_{CE} = 2\text{ V}$ .....	16
Figure 5-6	Base Current vs. Base Emitter Reverse Voltage $I_B = f(V_{EB})$ , $V_{CE} = 2\text{ V}$ .....	17
Figure 5-7	Transition Frequency $f_T = f(I_C)$ , $f = 1\text{ GHz}$ , $V_{CE} =$ Parameter in V .....	18
Figure 5-8	3rd Order Intercept Point $OIP_3 = f(I_C)$ , $Z_S = Z_L = 50\ \Omega$ , $V_{CE}$ , $f =$ Parameters .....	18
Figure 5-9	3rd Order Intercept Point at output $OIP_3$ [dBm] = $f(I_C, V_{CE})$ , $Z_S = Z_L = 50\ \Omega$ , $f = 5.5\text{ GHz}$ .....	19
Figure 5-10	Compression Point at output $OP_{1dB}$ [dBm] = $f(I_C, V_{CE})$ , $Z_S = Z_L = 50\ \Omega$ , $f = 5.5\text{ GHz}$ .....	19
Figure 5-11	Collector Base Capacitance $C_{CB} = f(V_{CB})$ , $f = 1\text{ MHz}$ .....	20
Figure 5-12	Gain $G_{ma}$ , $G_{ms}$ , $ S_{21} ^2 = f(f)$ , $V_{CE} = 3\text{ V}$ , $I_C = 30\text{ mA}$ .....	20
Figure 5-13	Maximum Power Gain $G_{max} = f(I_C)$ , $V_{CE} = 3\text{ V}$ , $f =$ Parameter in GHz .....	21
Figure 5-14	Maximum Power Gain $G_{max} = f(V_{CE})$ , $I_C = 30\text{ mA}$ , $f =$ Parameter in GHz .....	21
Figure 5-15	Input Reflection Coefficient $S_{11} = f(f)$ , $V_{CE} = 3\text{ V}$ , $I_C = 10 / 30\text{ mA}$ .....	22
Figure 5-16	Source Impedance for Minimum Noise Figure $Z_{opt} = f(f)$ , $V_{CE} = 3\text{ V}$ , $I_C = 10 / 30\text{ mA}$ .....	22
Figure 5-17	Output Reflection Coefficient $S_{22} = f(f)$ , $V_{CE} = 3\text{ V}$ , $I_C = 10 / 30\text{ mA}$ .....	23
Figure 5-18	Noise Figure $NF_{min} = f(f)$ , $V_{CE} = 3\text{ V}$ , $I_C = 10 / 30\text{ mA}$ , $Z_S = Z_{opt}$ .....	23
Figure 5-19	Noise Figure $NF_{min} = f(I_C)$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_{opt}$ , $f =$ Parameter in GHz .....	24
Figure 5-20	Noise Figure $NF_{50} = f(I_C)$ , $V_{CE} = 3\text{ V}$ , $Z_S = 50\ \Omega$ , $f =$ Parameter in GHz .....	24
Figure 7-1	Package Outline .....	26
Figure 7-2	Package Footprint .....	26
Figure 7-3	Marking Example (Marking BFP760: R6s) .....	26
Figure 7-4	Tape Dimensions .....	26

## List of Tables

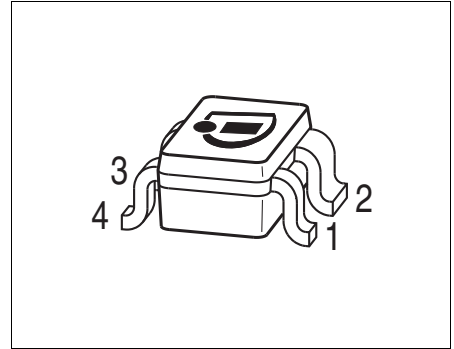
Table 3-1	Maximum Ratings at $T_A = 25\text{ °C}$ (unless otherwise specified) . . . . .	9
Table 4-1	Thermal Resistance . . . . .	10
Table 5-1	DC Characteristics at $T_A = 25\text{ °C}$ . . . . .	11
Table 5-2	General AC Characteristics at $T_A = 25\text{ °C}$ . . . . .	11
Table 5-3	AC Characteristics, $V_{CE} = 3\text{ V}$ , $f = 0.9\text{ GHz}$ . . . . .	13
Table 5-4	AC Characteristics, $V_{CE} = 3\text{ V}$ , $f = 1.8\text{ GHz}$ . . . . .	13
Table 5-5	AC Characteristics, $V_{CE} = 3\text{ V}$ , $f = 2.4\text{ GHz}$ . . . . .	13
Table 5-6	AC Characteristics, $V_{CE} = 3\text{ V}$ , $f = 3.5\text{ GHz}$ . . . . .	14
Table 5-7	AC Characteristics, $V_{CE} = 3\text{ V}$ , $f = 5.5\text{ GHz}$ . . . . .	14

## 1 Product Brief

The BFP760 is a linear and very low noise wideband NPN bipolar RF transistor. The device is based on Infineon's reliable high volume silicon germanium carbon (SiGe:C) heterojunction bipolar technology. The collector design supports voltages up to  $V_{CE0} = 4.0$  V and currents up to  $I_C = 70$  mA. With its high linearity at currents as low as 10 mA (see Fig. 5-8) the device supports energy efficient designs. The typical transition frequency is approximately 45 GHz, hence the device offers high power gain at frequencies up to 9 GHz in amplifier applications. The device is housed in an easy to use plastic package with visible leads.

## 2 Features

- Very low noise amplifier based on Infineon’s reliable, high volume SiGe:C technology
- High linearity  $OIP_3 = 27 \text{ dBm @ } 5.5 \text{ GHz, } 3 \text{ V, } 30 \text{ mA}$
- High transition frequency  $f_T = 45 \text{ GHz @ } 1 \text{ GHz, } 3 \text{ V, } 35\text{mA}$
- $NF_{\text{min}} = 0.95 \text{ dB @ } 5.5 \text{ GHz, } 3 \text{ V, } 10 \text{ mA}$
- Maximum power gain  $G_{\text{ms}} = 21.5 \text{ dB @ } 3.5 \text{ GHz, } 3 \text{ V, } 30 \text{ mA}$
- Low power consumption, ideal for mobile applications
- Easy to use Pb-free (RoHS compliant) and halogen-free standard package with visible leads
- Qualification report according to AEC-Q101 available



### Applications

As Low Noise Amplifier (LNA) in

- Mobile and fixed connectivity applications: WLAN 802.11a/b/g/n/ac, WiMAX 2.5/3.5 GHz, 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
- UMTS/LTE mobile phone applications
- ISM applications like RKE, AMR and Zigbee, as well as for emerging wireless applications

As discrete active mixer, buffer amplifier in VCOs

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

Product Name	Package	Pin Configuration				Marking
BFP760	SOT343	1 = B	2 = E	3 = C	4 = E	R6s



### 3 Maximum Ratings

Table 3-1 Maximum Ratings at  $T_A = 25\text{ °C}$  (unless otherwise specified)

Parameter	Symbol	Values		Unit	Note / Test Condition
		Min.	Max.		
Collector emitter voltage	$V_{CEO}$	– –	4.0 3.5	V	Open base $T_A = 25\text{ °C}$ $T_A = -55\text{ °C}$
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	$I_C$	–	70	mA	–
Base current	$I_B$	–	4	mA	–
Total power dissipation <sup>1)</sup>	$P_{tot}$	–	240	mW	$T_S \leq 95\text{ °C}$
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.**

## 4 Thermal Characteristics

Table 4-1 Thermal Resistance

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Junction - soldering point <sup>1)</sup>	$R_{thJS}$	–	230	–	K/W	–

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

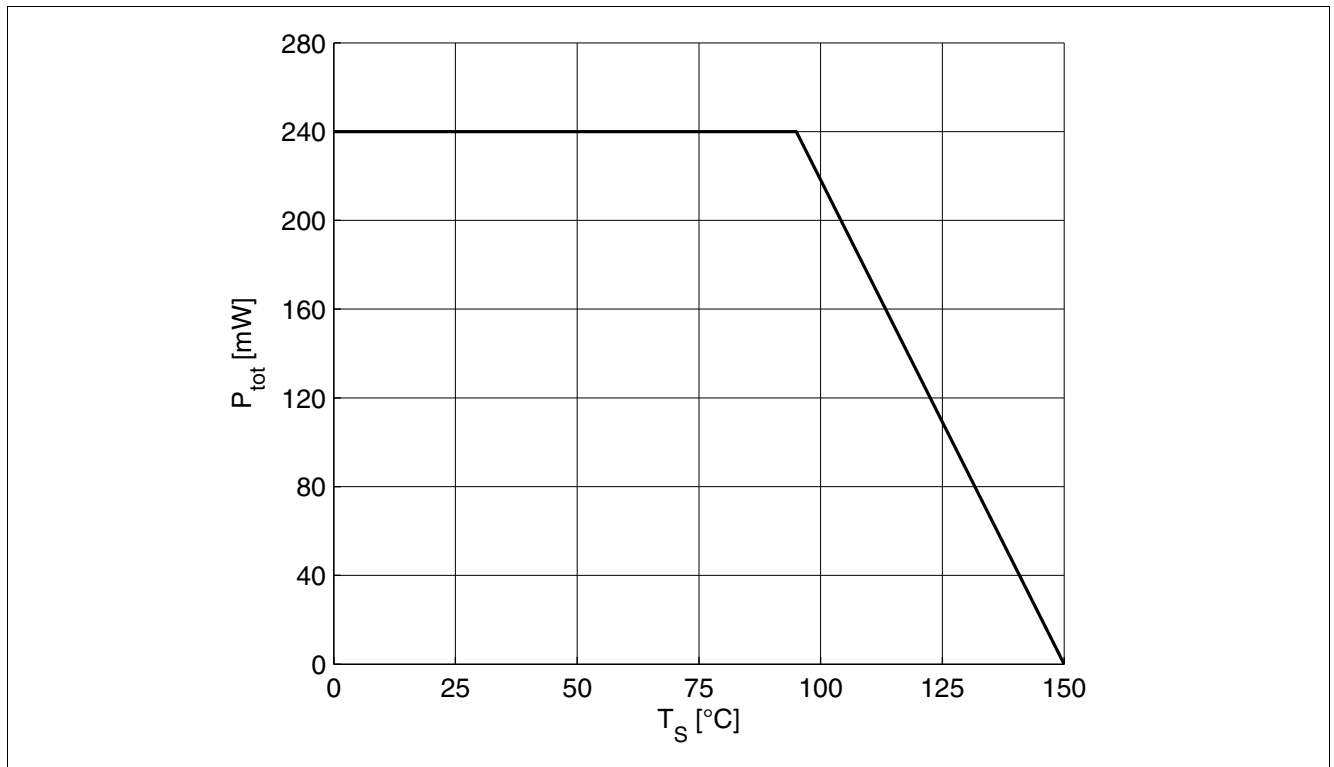


Figure 4-1 Total Power Dissipation  $P_{tot} = f(T_s)$

## 5 Electrical Characteristics

### 5.1 DC Characteristics

**Table 5-1 DC Characteristics at  $T_A = 25\text{ }^\circ\text{C}$** 

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Collector emitter breakdown voltage	$V_{(BR)CEO}$	4	4.7	–	V	$I_C = 1\text{ mA}$ , $I_B = 0$ Open base
Collector emitter leakage current	$I_{CES}$	–	10 1	400 <sup>1)</sup> 40 <sup>1)</sup>	nA	$V_{CE} = 13\text{ V}$ , $V_{BE} = 0$ $V_{CE} = 5\text{ V}$ , $V_{BE} = 0$ E-B short circuited
Collector base leakage current	$I_{CBO}$	–	1	40 <sup>1)</sup>	nA	$V_{CB} = 5\text{ V}$ , $I_E = 0$ Open emitter
Emitter base leakage current	$I_{EBO}$	–	1	40 <sup>1)</sup>	nA	$V_{EB} = 0.5\text{ V}$ , $I_C = 0$ Open collector
DC current gain	$h_{FE}$	160	250	400		$V_{CE} = 3\text{ V}$ , $I_C = 35\text{ mA}$ Pulse measured

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

### 5.2 General AC Characteristics

**Table 5-2 General AC Characteristics at  $T_A = 25\text{ }^\circ\text{C}$** 

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Transition frequency	$f_T$	–	45	–	GHz	$V_{CE} = 3\text{ V}$ , $I_C = 35\text{ mA}$ $f = 1\text{ GHz}$
Collector base capacitance	$C_{CB}$	–	0.13	0.2	pF	$V_{CB} = 3\text{ V}$ , $V_{BE} = 0$ $f = 1\text{ MHz}$ Emitter grounded
Collector emitter capacitance	$C_{CE}$	–	0.42	–	pF	$V_{CE} = 3\text{ V}$ , $V_{BE} = 0$ $f = 1\text{ MHz}$ Base grounded
Emitter base capacitance	$C_{EB}$	–	0.65	–	pF	$V_{EB} = 0.5\text{ V}$ , $V_{CB} = 0$ $f = 1\text{ MHz}$ Collector grounded

### 5.3 Frequency Dependent AC Characteristics

Measurement setup is a test fixture with Bias T's in a 50 Ω system,  $T_A = 25\text{ °C}$

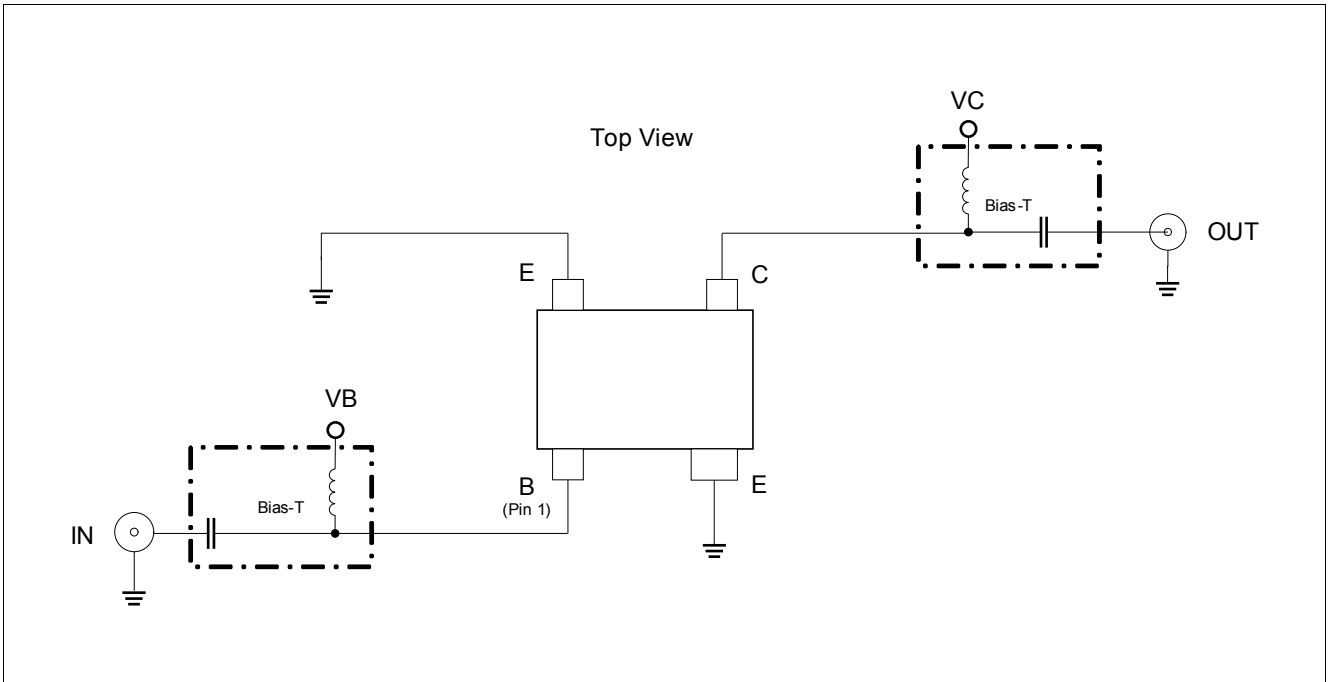


Figure 5-1 BFP760 Testing Circuit

Electrical Characteristics

**Table 5-3 AC Characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 0.9\text{ GHz}$**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
<b>Power gain</b>						
Maximum power gain	$G_{ms}$	–	29	–	dB	$I_C = 30\text{ mA}$
Transducer gain	$ S_{21} ^2$	–	28	–		$I_C = 30\text{ mA}$
<b>Minimum Noise Figure</b>						
Minimum noise figure	$NF_{min}$	–	0.5	–	dB	$I_C = 10\text{ mA}$
Associated gain	$G_{ass}$	–	25.5	–		$I_C = 10\text{ mA}$
<b>Linearity</b>						
1 dB compression point at output	$OP_{1dB}$	–	14	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 30\text{ mA}$
3rd order intercept point at output	$OIP_3$	–	27	–		$I_C = 30\text{ mA}$

**Table 5-4 AC Characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 1.8\text{ GHz}$**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
<b>Power gain</b>						
Maximum power gain	$G_{ms}$	–	25	–	dB	$I_C = 30\text{ mA}$
Transducer gain	$ S_{21} ^2$	–	22	–		$I_C = 30\text{ mA}$
<b>Minimum Noise Figure</b>						
Minimum noise figure	$NF_{min}$	–	0.55	–	dB	$I_C = 10\text{ mA}$
Associated gain	$G_{ass}$	–	20.5	–		$I_C = 10\text{ mA}$
<b>Linearity</b>						
1 dB compression point at output	$OP_{1dB}$	–	14.5	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 30\text{ mA}$
3rd order intercept point at output	$OIP_3$	–	28	–		$I_C = 30\text{ mA}$

**Table 5-5 AC Characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 2.4\text{ GHz}$**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
<b>Power gain</b>						
Maximum power gain	$G_{ms}$	–	23.5	–	dB	$I_C = 30\text{ mA}$
Transducer gain	$ S_{21} ^2$	–	20	–		$I_C = 30\text{ mA}$
<b>Minimum Noise Figure</b>						
Minimum noise figure	$NF_{min}$	–	0.6	–	dB	$I_C = 10\text{ mA}$
Associated gain	$G_{ass}$	–	19	–		$I_C = 10\text{ mA}$
<b>Linearity</b>						
1 dB compression point at output	$OP_{1dB}$	–	14	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 30\text{ mA}$
3rd order intercept point at output	$OIP_3$	–	28	–		$I_C = 30\text{ mA}$

**Table 5-6 AC Characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 3.5\text{ GHz}$** 

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
<b>Power gain</b>						
Maximum power gain	$G_{ms}$	–	21.5	–	dB	$I_C = 30\text{ mA}$
Transducer gain	$ S_{21} ^2$	–	16.5	–		$I_C = 30\text{ mA}$
<b>Minimum Noise Figure</b>						
Minimum noise figure	$NF_{min}$	–	0.7	–	dB	$I_C = 10\text{ mA}$
Associated gain	$G_{ass}$	–	16	–		$I_C = 10\text{ mA}$
<b>Linearity</b>						
1 dB compression point at output	$OP_{1dB}$	–	14.5	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 30\text{ mA}$
3rd order intercept point at output	$OIP_3$	–	28.5	–		$I_C = 30\text{ mA}$

**Table 5-7 AC Characteristics,  $V_{CE} = 3\text{ V}$ ,  $f = 5.5\text{ GHz}$** 

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
<b>Power gain</b>						
Maximum power gain	$G_{ms}$	–	16.5	–	dB	$I_C = 30\text{ mA}$
Transducer gain	$ S_{21} ^2$	–	12	–		$I_C = 30\text{ mA}$
<b>Minimum Noise Figure</b>						
Minimum noise figure	$NF_{min}$	–	0.95	–	dB	$I_C = 10\text{ mA}$
Associated gain	$G_{ass}$	–	12.5	–		$I_C = 10\text{ mA}$
<b>Linearity</b>						
1 dB compression point at output	$OP_{1dB}$	–	13	–	dBm	$Z_S = Z_L = 50\ \Omega$ $I_C = 30\text{ mA}$
3rd order intercept point at output	$OIP_3$	–	27	–		$I_C = 30\text{ mA}$

Note:  $OIP_3$  value depends on termination of all intermodulation frequency components. Termination used for this measurement is  $50\ \Omega$  from  $0.2\text{ MHz}$  to  $12\text{ GHz}$

5.4 Characteristic DC Diagrams

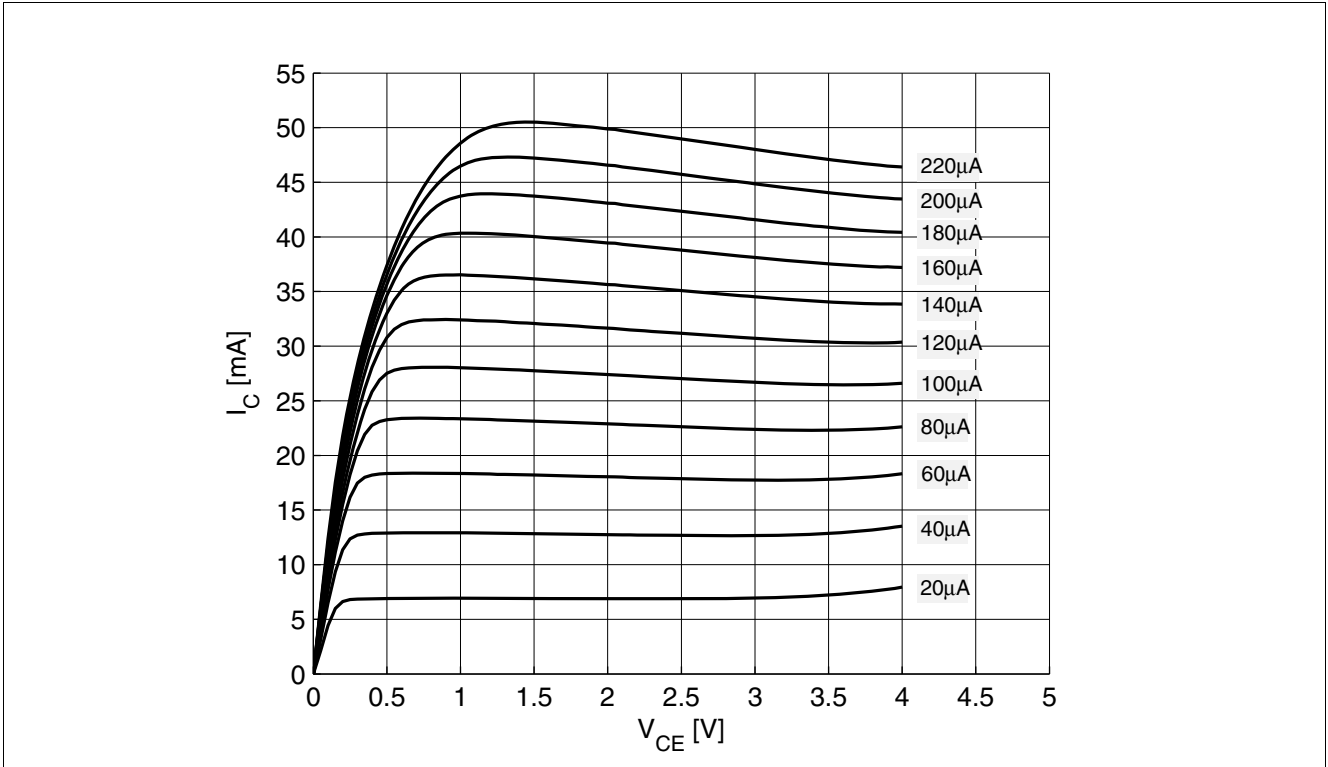


Figure 5-2 Collector Current vs. Collector Emitter Voltage  $I_C = f(V_{CE})$ ,  $I_B = \text{Parameter in } \mu A$

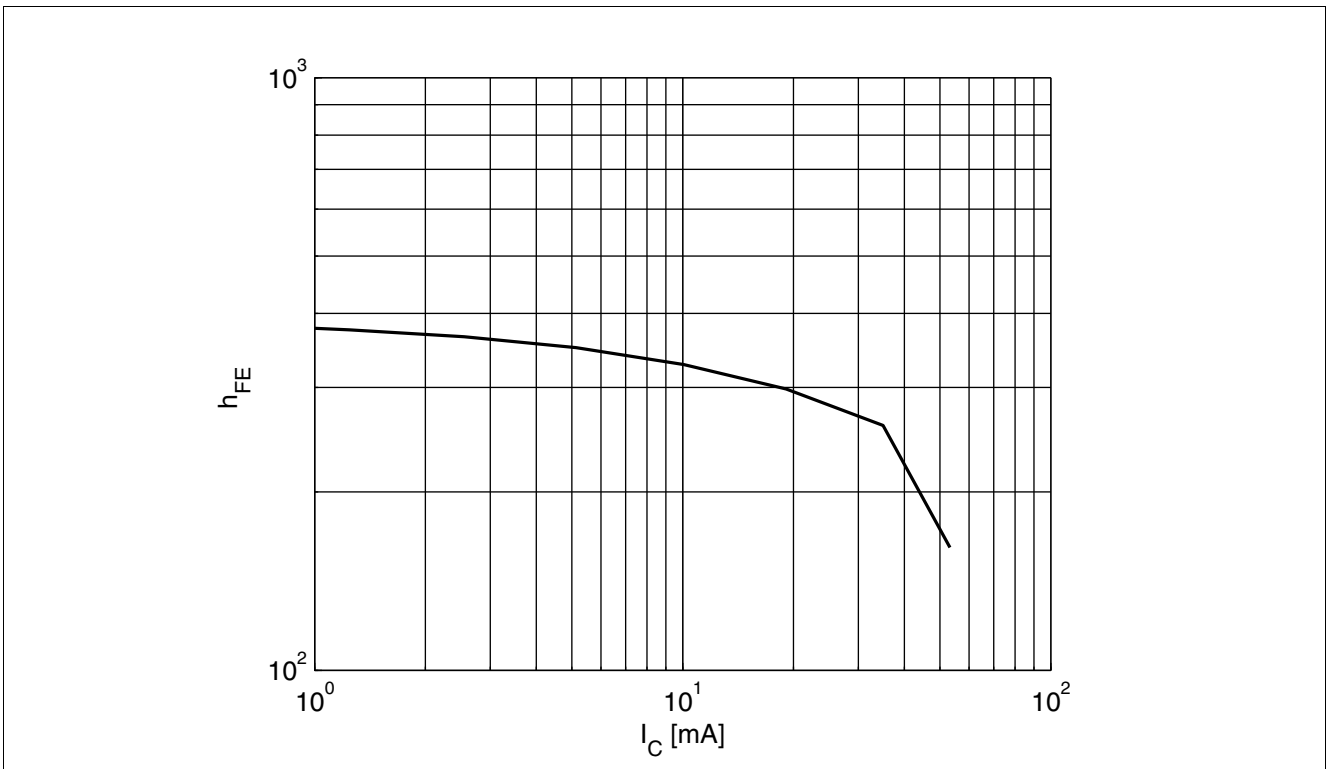


Figure 5-3 DC Current Gain  $h_{FE} = f(I_C)$ ,  $V_{CE} = 3 V$

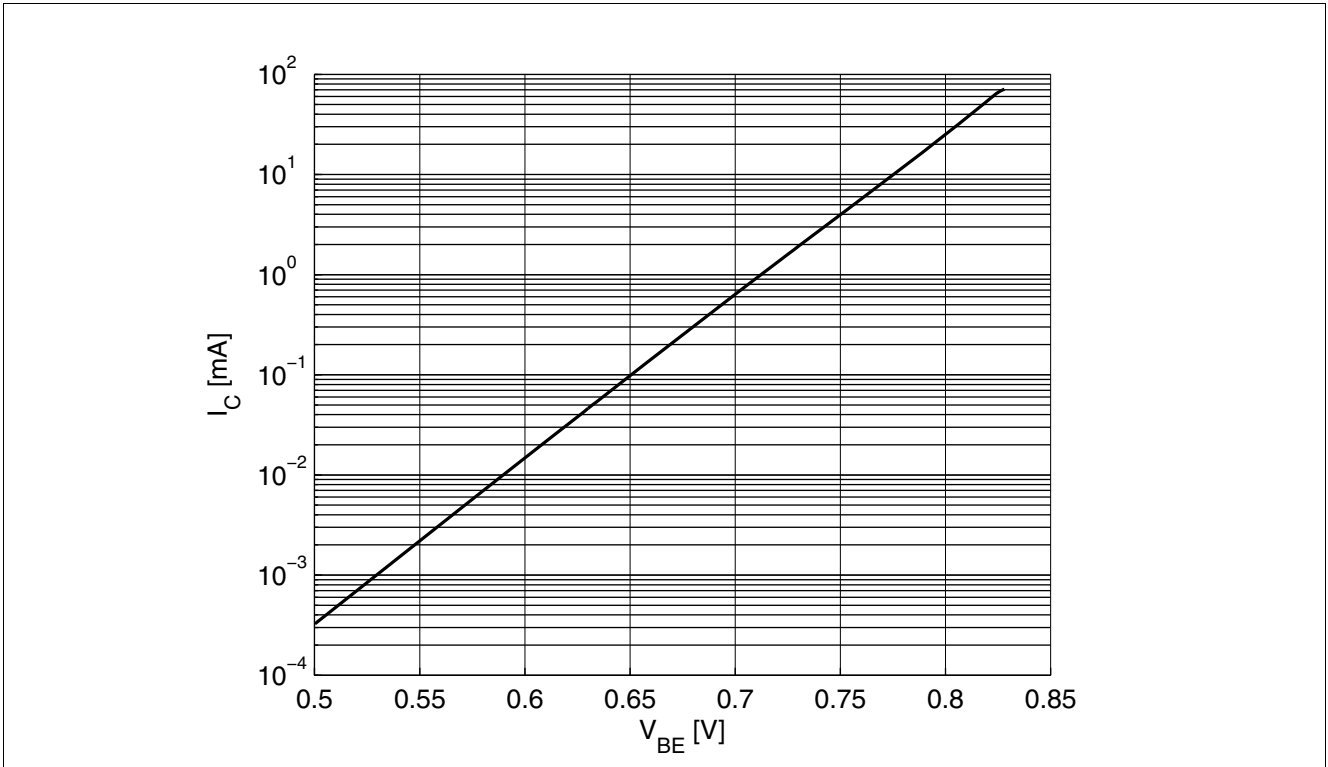


Figure 5-4 Collector Current vs. Base Emitter Voltage  $I_C = f(V_{BE})$ ,  $V_{CE} = 2\text{ V}$

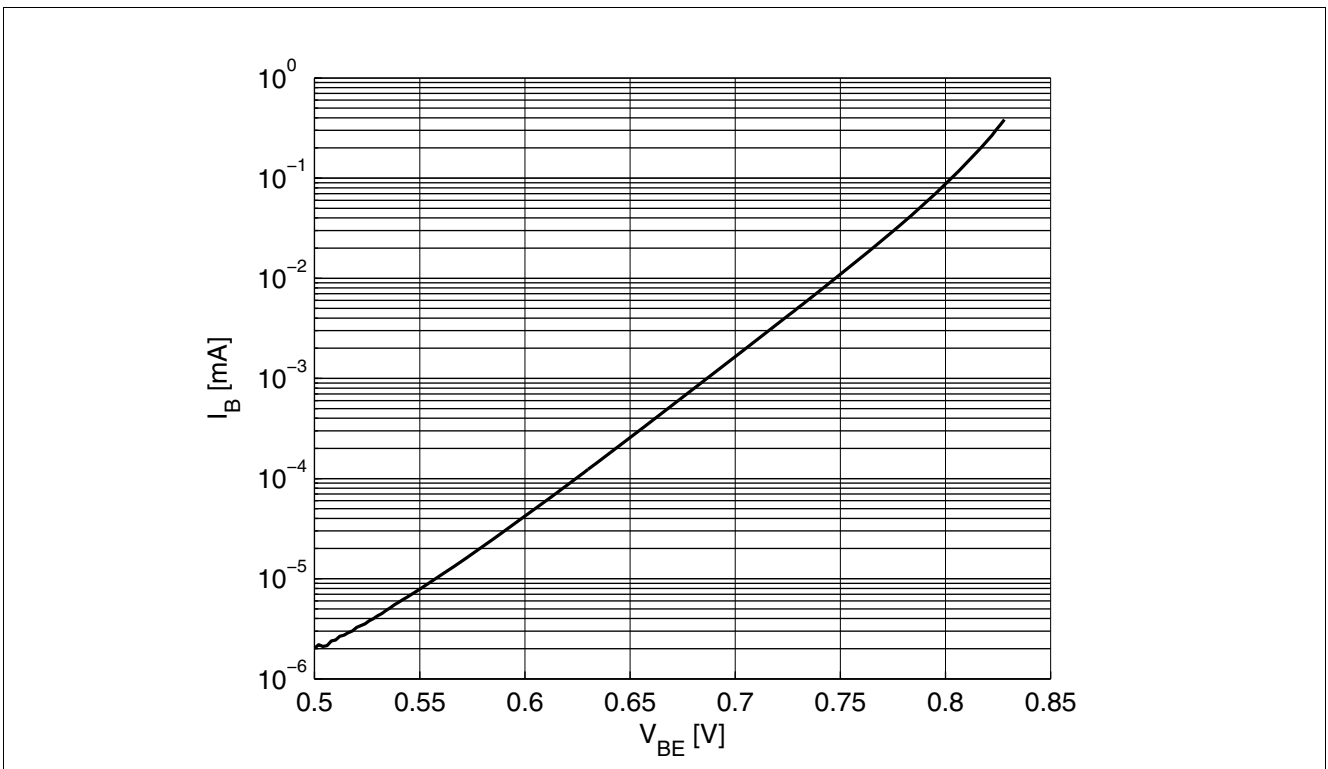


Figure 5-5 Base Current vs. Base Emitter Forward Voltage  $I_B = f(V_{BE})$ ,  $V_{CE} = 2\text{ V}$



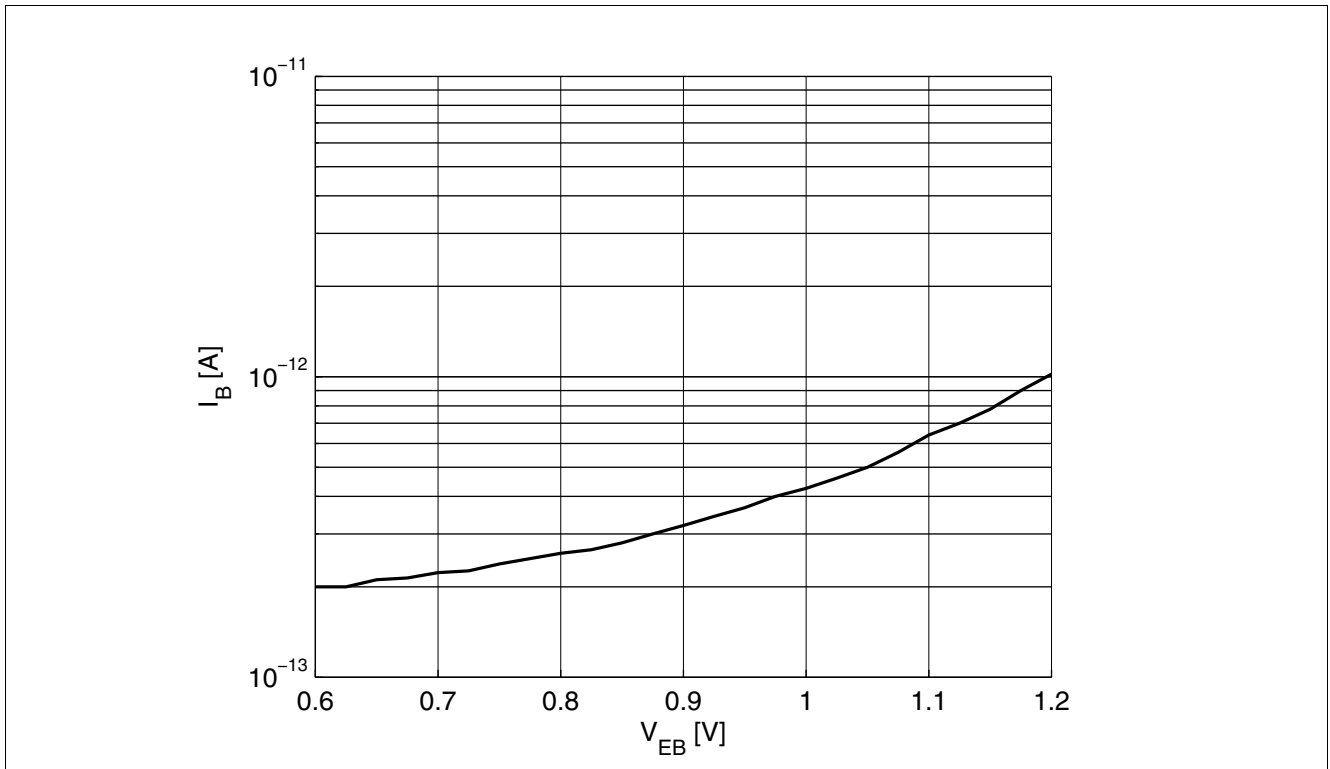


Figure 5-6 Base Current vs. Base Emitter Reverse Voltage  $I_B = f(V_{EB})$ ,  $V_{CE} = 2\text{ V}$

5.5 Characteristic AC Diagrams

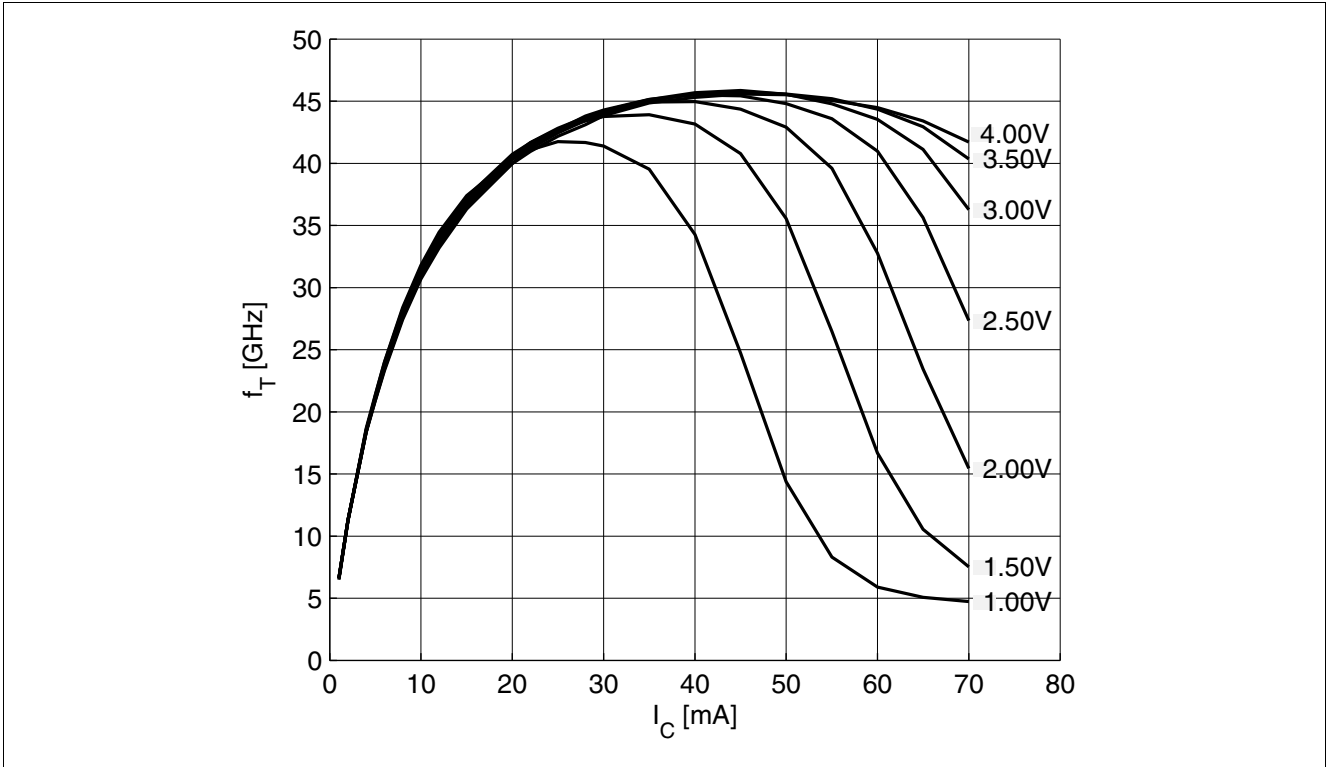


Figure 5-7 Transition Frequency  $f_T = f(I_C)$ ,  $f = 1$  GHz,  $V_{CE} =$  Parameter in V

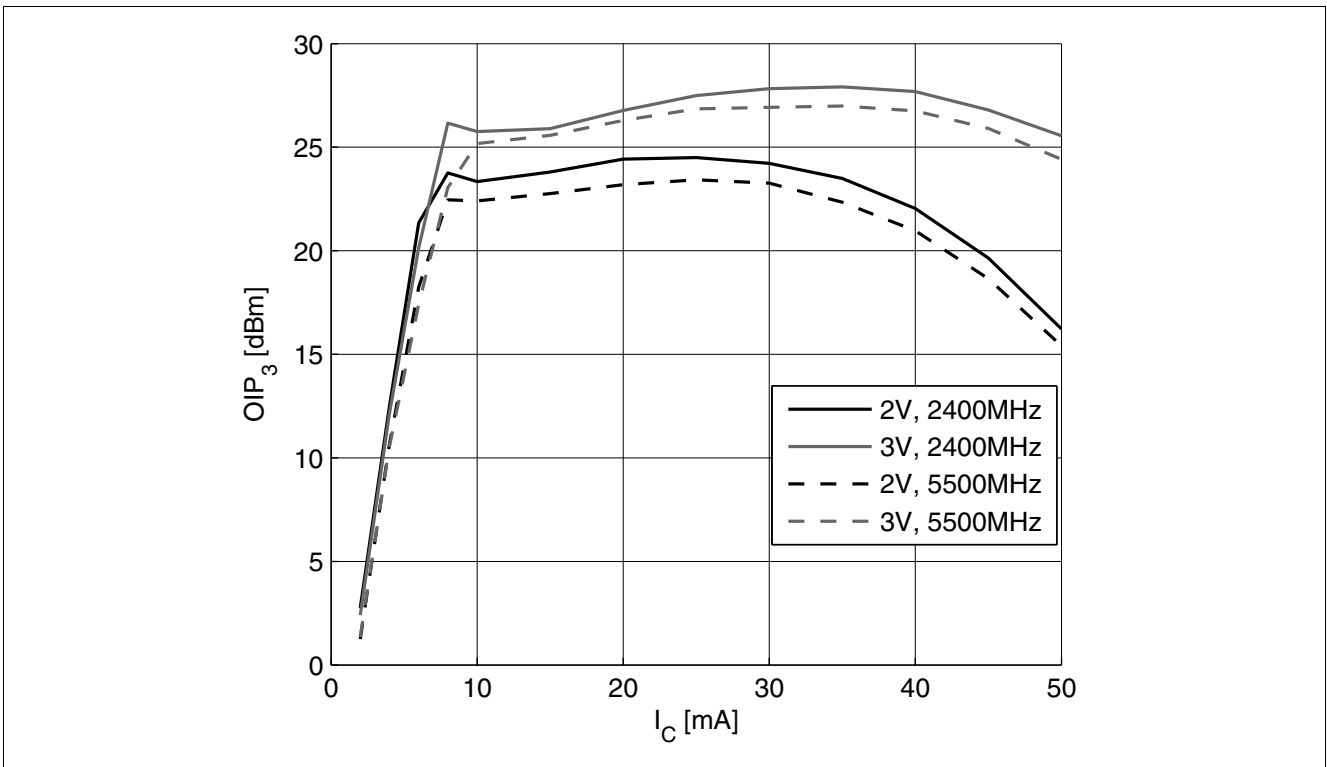


Figure 5-8 3rd Order Intercept Point  $OIP_3 = f(I_C)$ ,  $Z_S = Z_L = 50 \Omega$ ,  $V_{CE}, f =$  Parameters

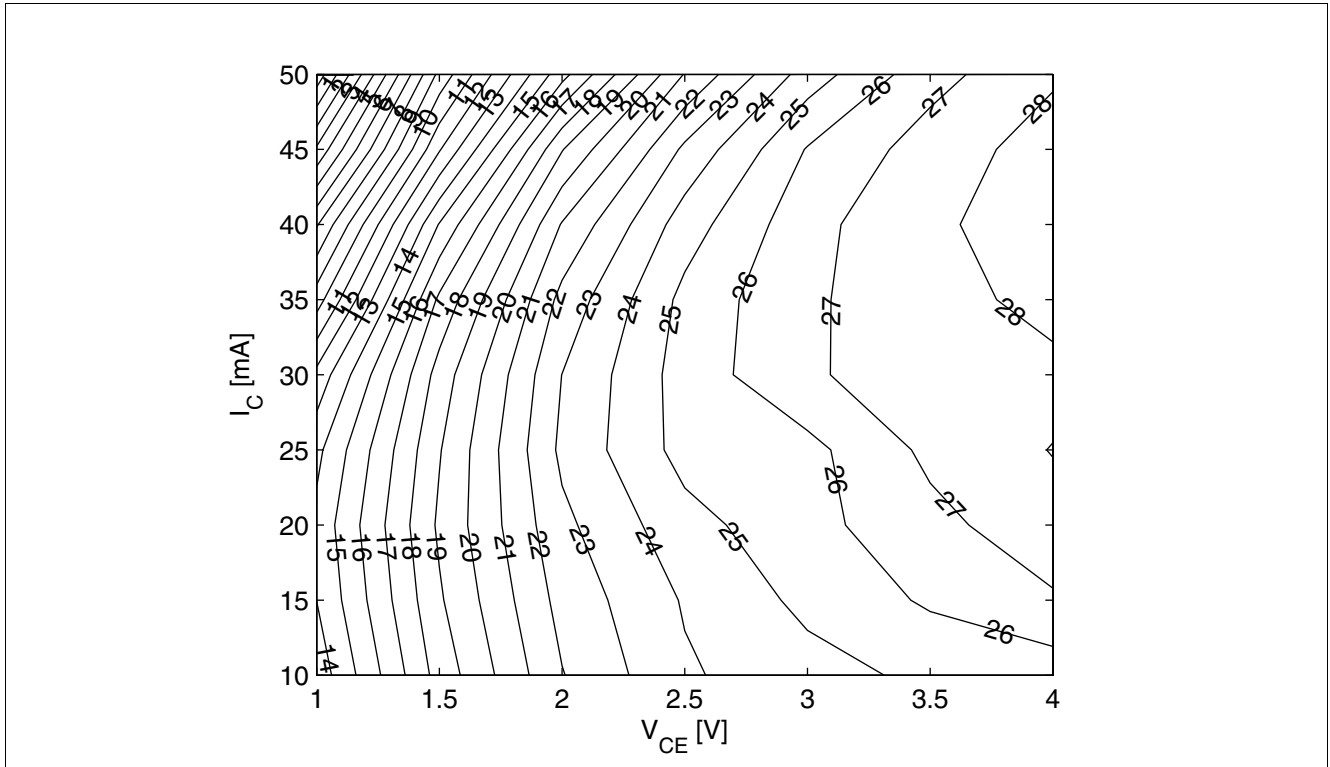


Figure 5-9 3rd Order Intercept Point at output  $OIP_3$  [dBm] =  $f(I_C, V_{CE})$ ,  $Z_S = Z_L = 50 \Omega$ ,  $f = 5.5$  GHz

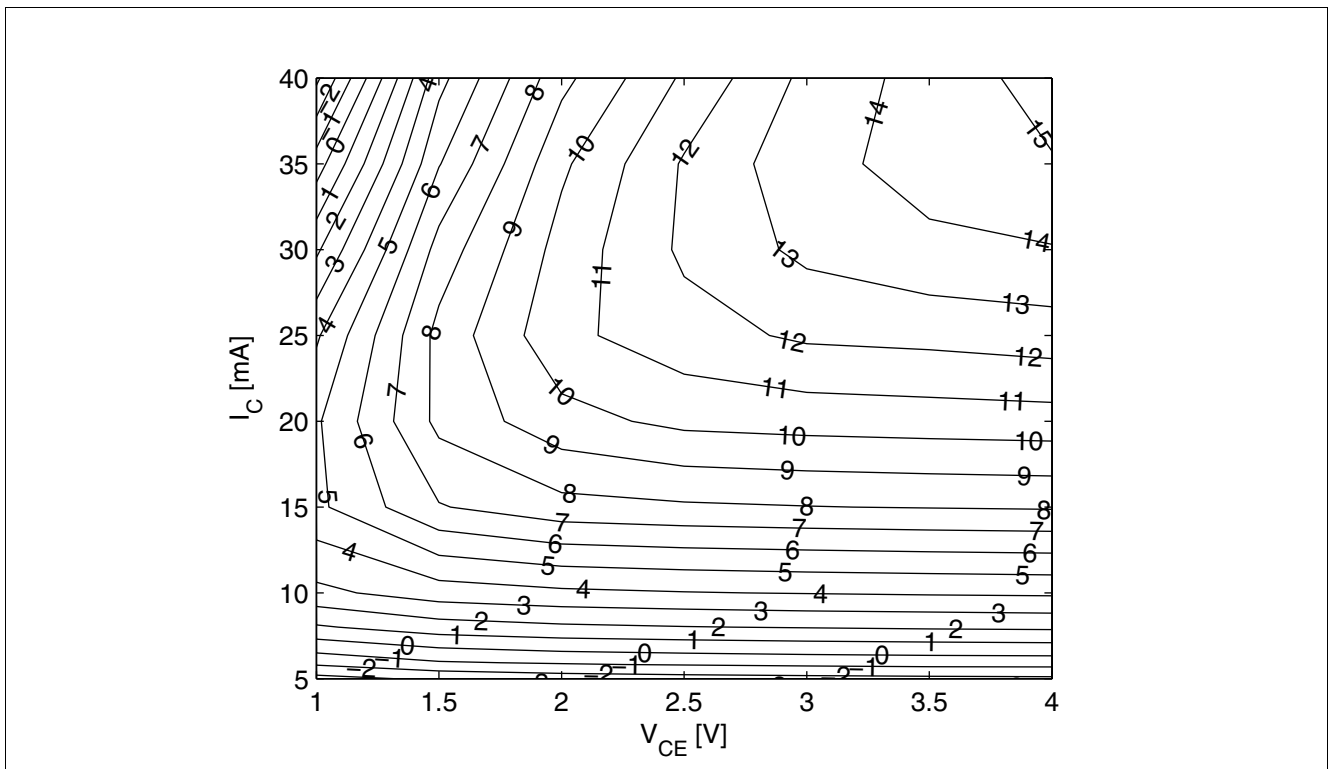


Figure 5-10 Compression Point at output  $OP_{1dB}$  [dBm] =  $f(I_C, V_{CE})$ ,  $Z_S = Z_L = 50 \Omega$ ,  $f = 5.5$  GHz

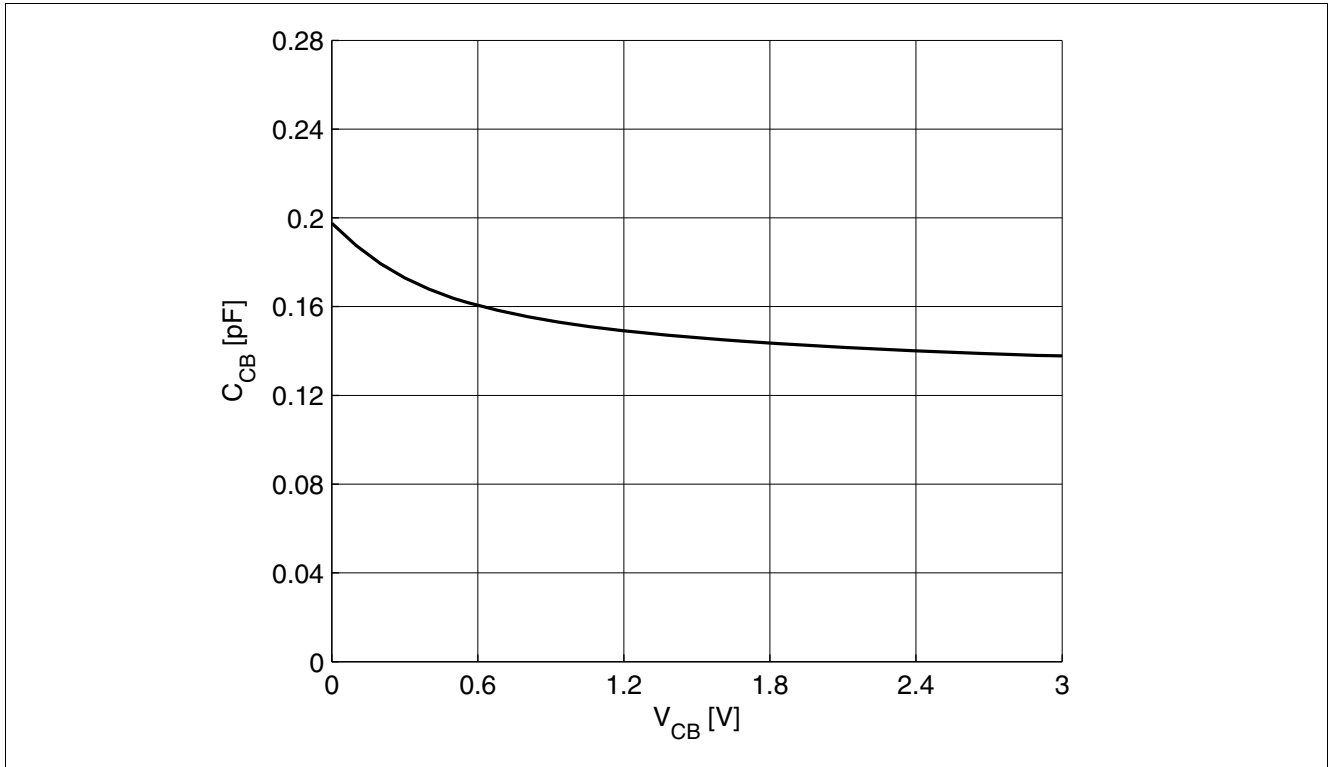


Figure 5-11 Collector Base Capacitance  $C_{CB} = f(V_{CB}), f = 1 \text{ MHz}$

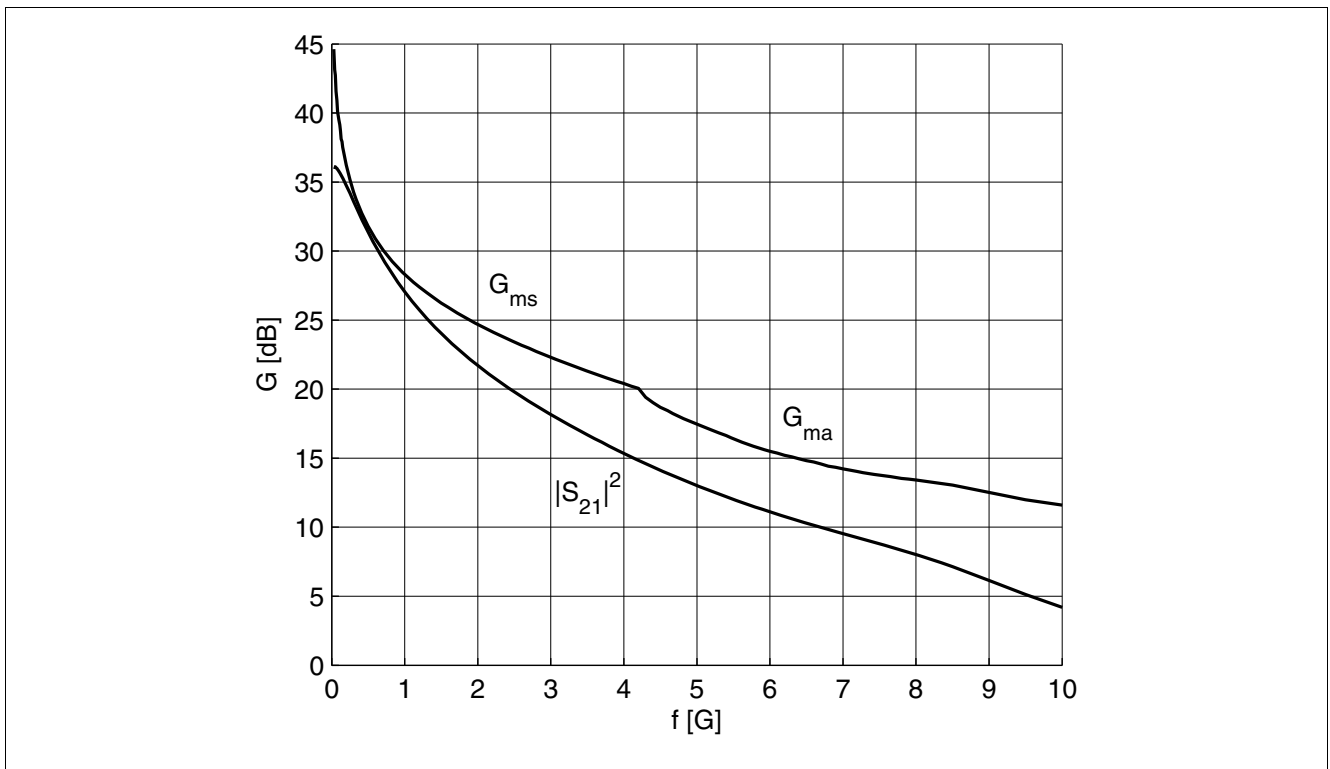


Figure 5-12 Gain  $G_{ma}$ ,  $G_{ms}$ ,  $|S_{21}|^2 = f(f), V_{CE} = 3 \text{ V}, I_C = 30 \text{ mA}$

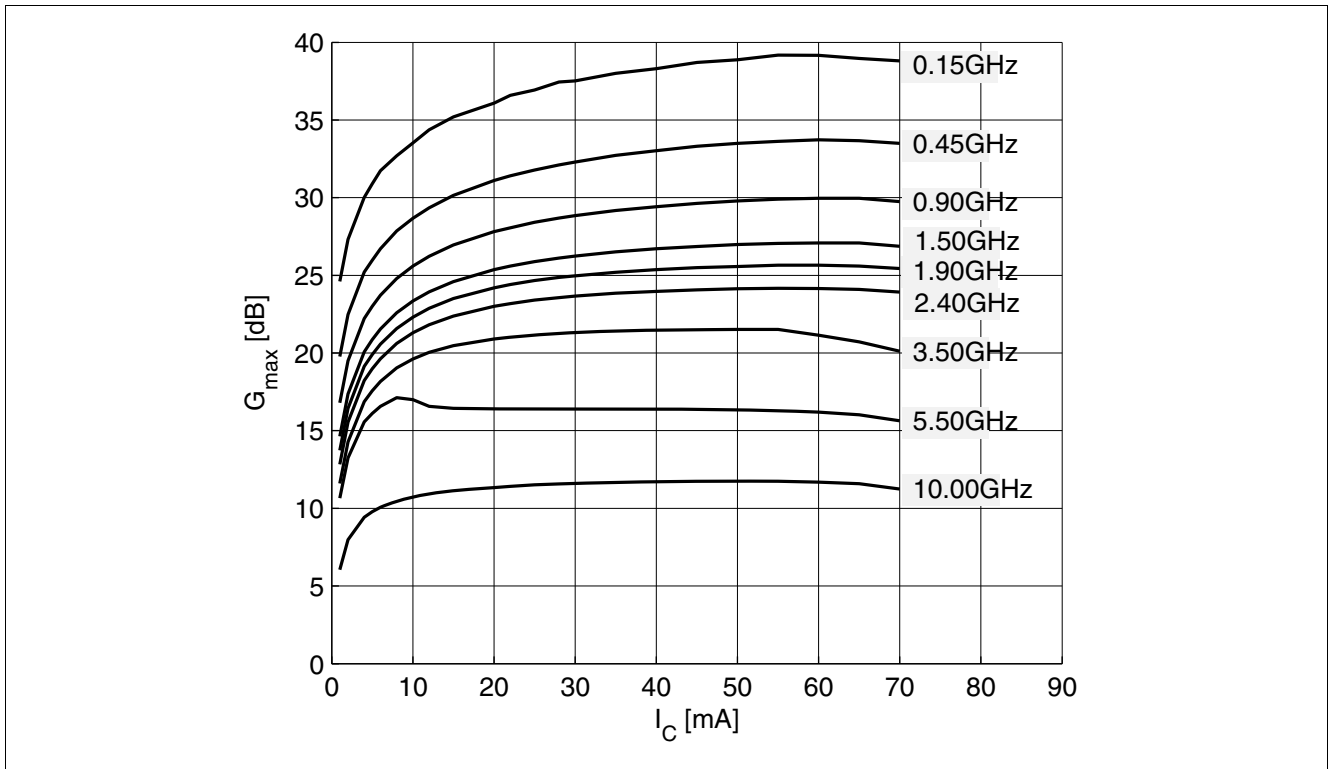


Figure 5-13 Maximum Power Gain  $G_{max} = f(I_C)$ ,  $V_{CE} = 3\text{ V}$ ,  $f = \text{Parameter in GHz}$

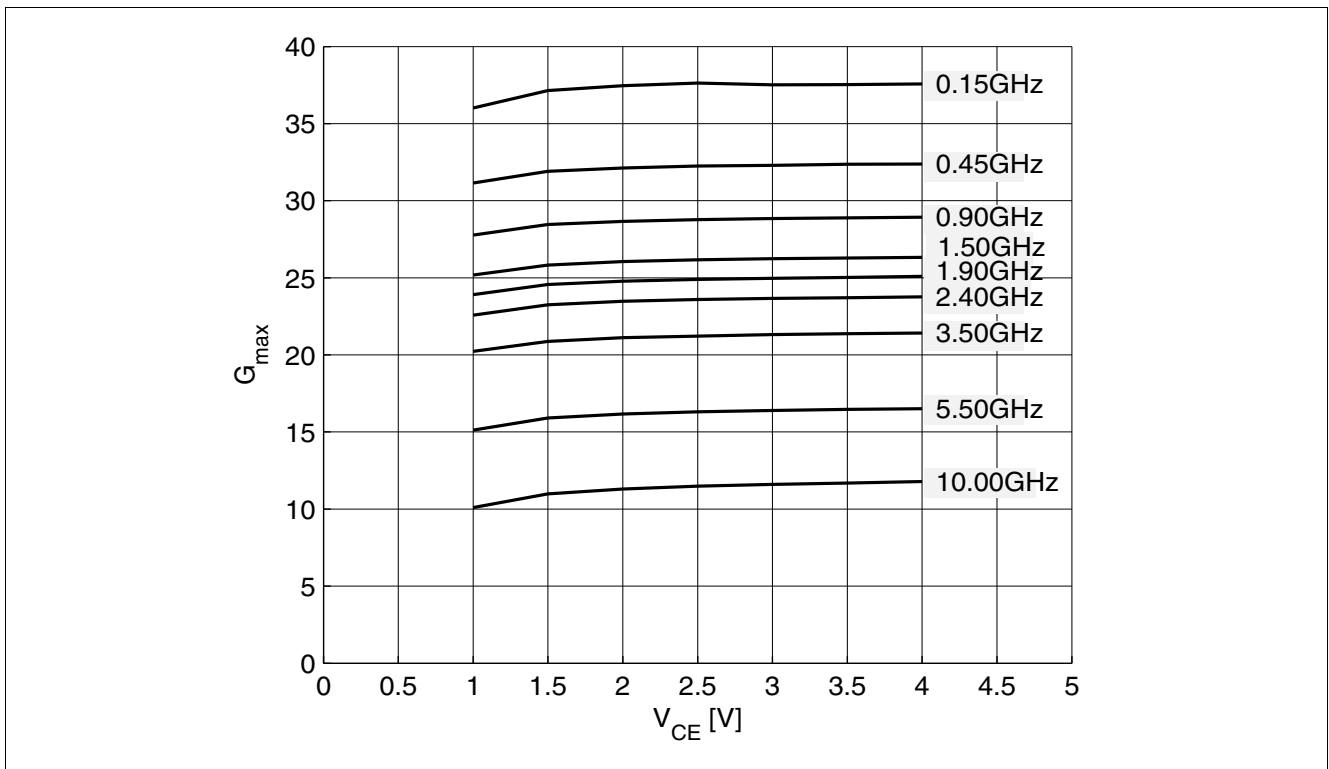


Figure 5-14 Maximum Power Gain  $G_{max} = f(V_{CE})$ ,  $I_C = 30\text{ mA}$ ,  $f = \text{Parameter in GHz}$

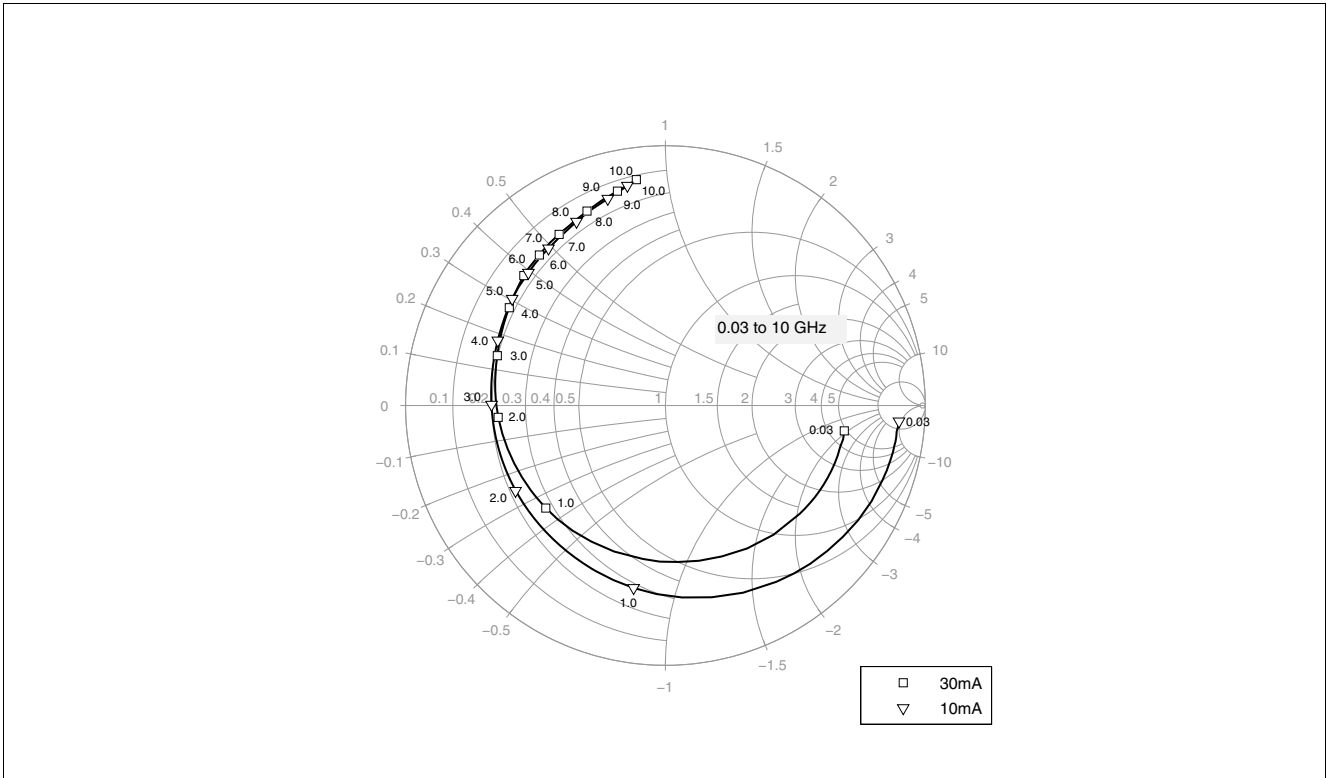


Figure 5-15 Input Reflection Coefficient  $S_{11} = f(f)$ ,  $V_{CE} = 3\text{ V}$ ,  $I_C = 10 / 30\text{ mA}$

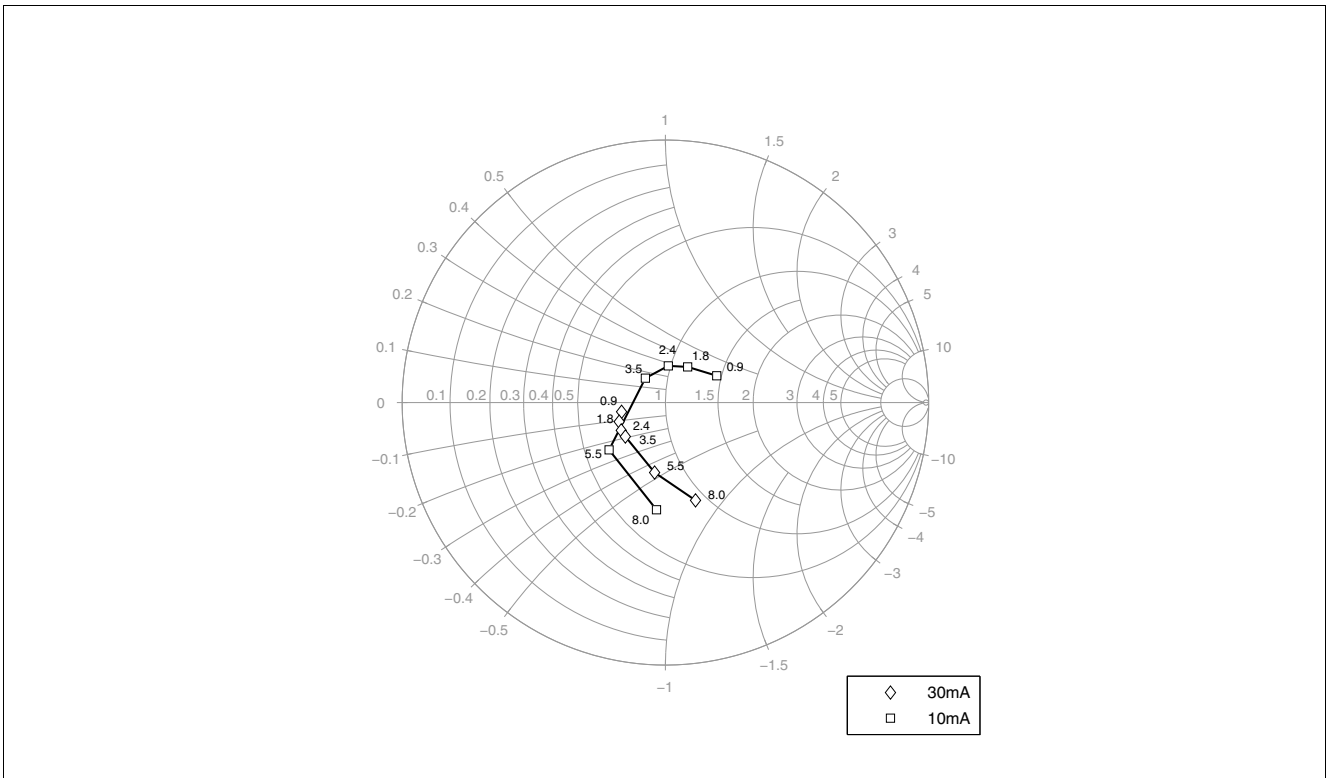


Figure 5-16 Source Impedance for Minimum Noise Figure  $Z_{opt} = f(f)$ ,  $V_{CE} = 3\text{ V}$ ,  $I_C = 10 / 30\text{ mA}$

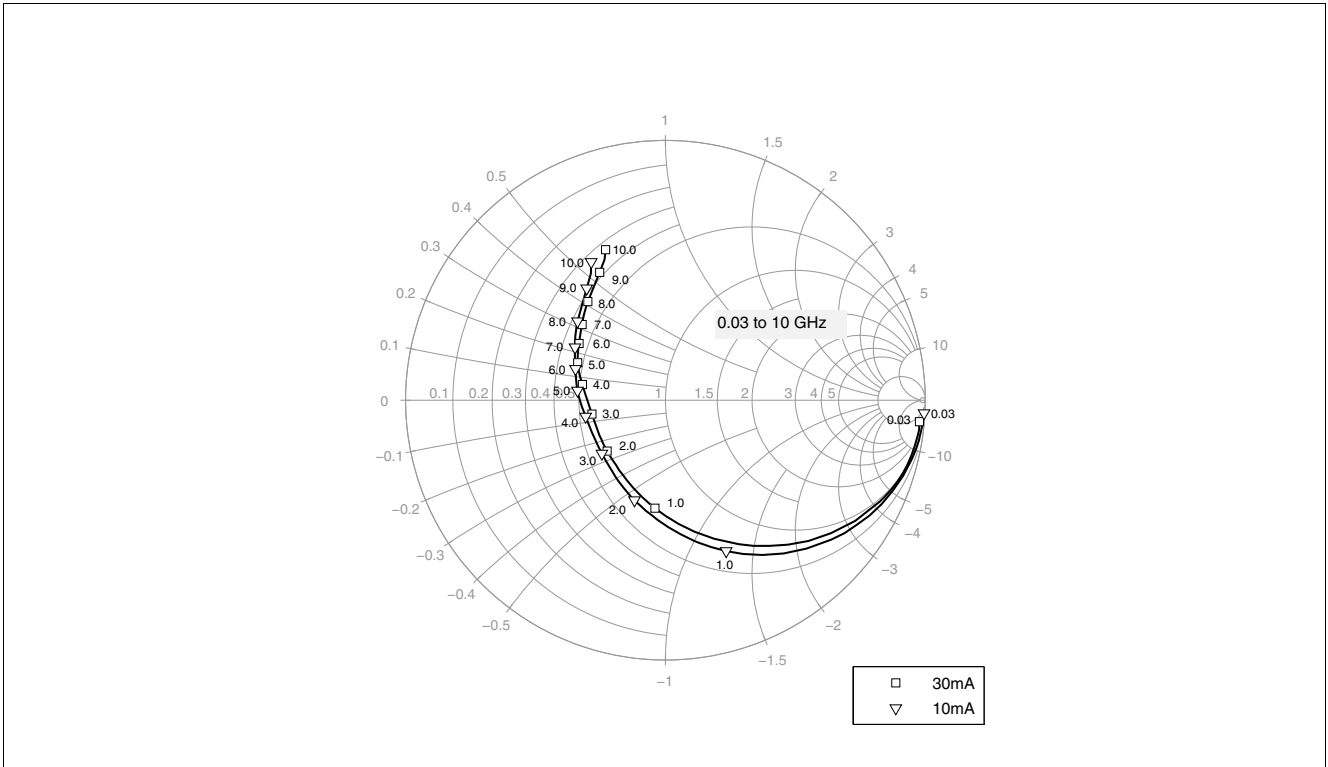


Figure 5-17 Output Reflection Coefficient  $S_{22} = f(f)$ ,  $V_{CE} = 3\text{ V}$ ,  $I_C = 10 / 30\text{ mA}$

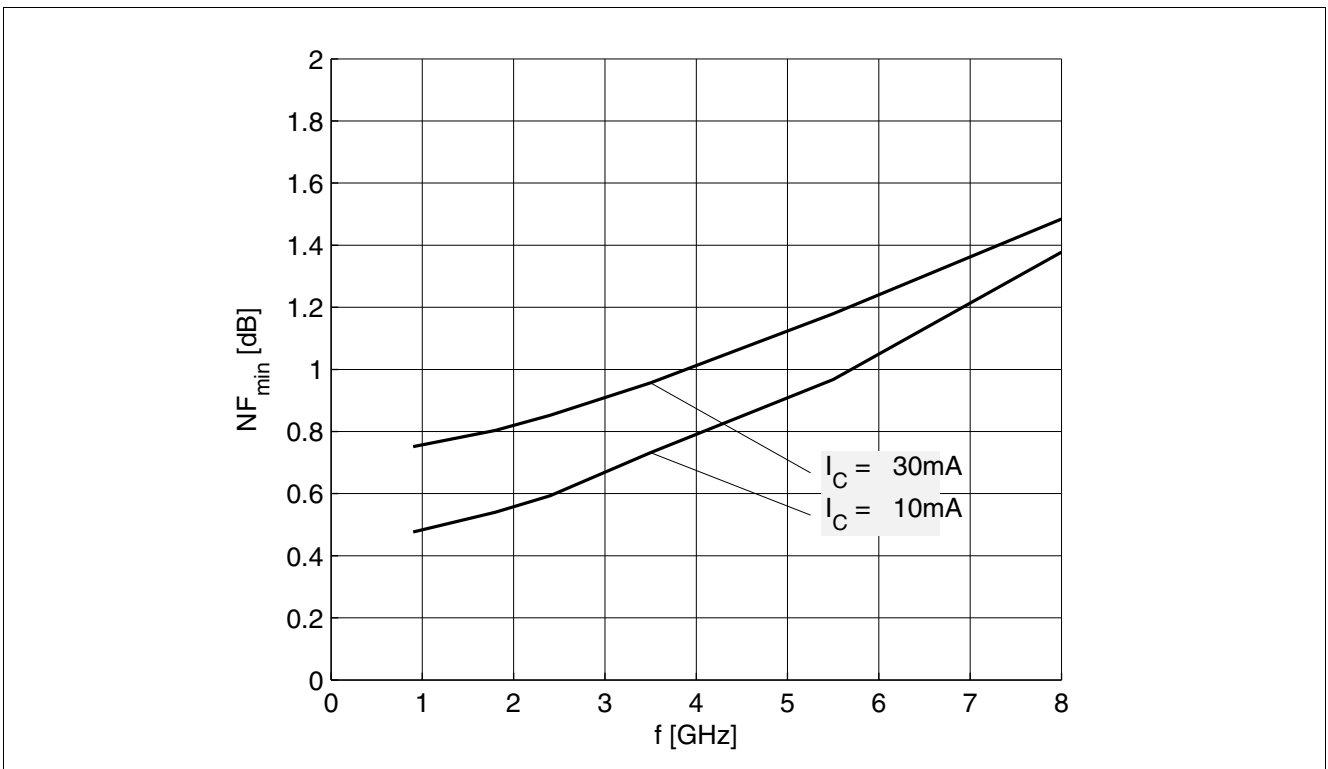


Figure 5-18 Noise Figure  $NF_{min} = f(f)$ ,  $V_{CE} = 3\text{ V}$ ,  $I_C = 10 / 30\text{ mA}$ ,  $Z_S = Z_{opt}$

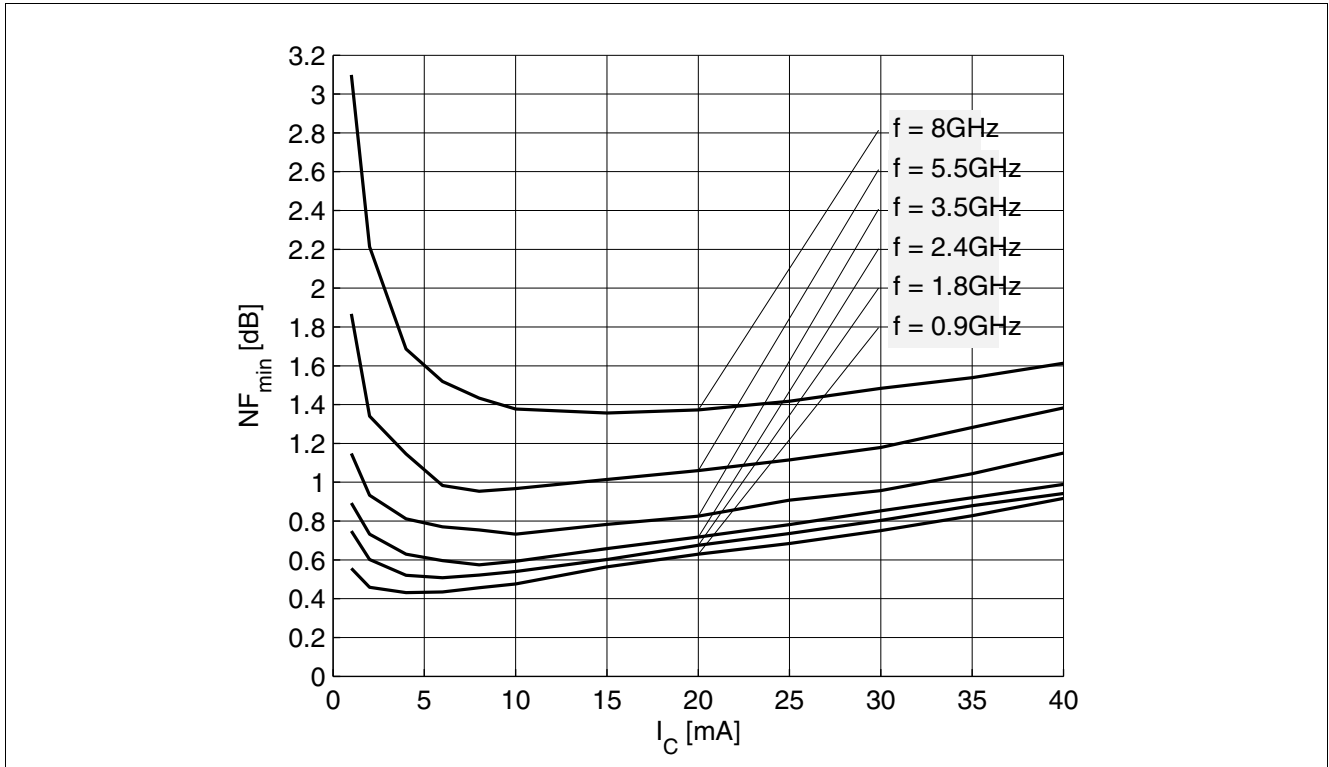


Figure 5-19 Noise Figure  $NF_{min} = f(I_C)$ ,  $V_{CE} = 3\text{ V}$ ,  $Z_S = Z_{opt}$ ,  $f = \text{Parameter in GHz}$

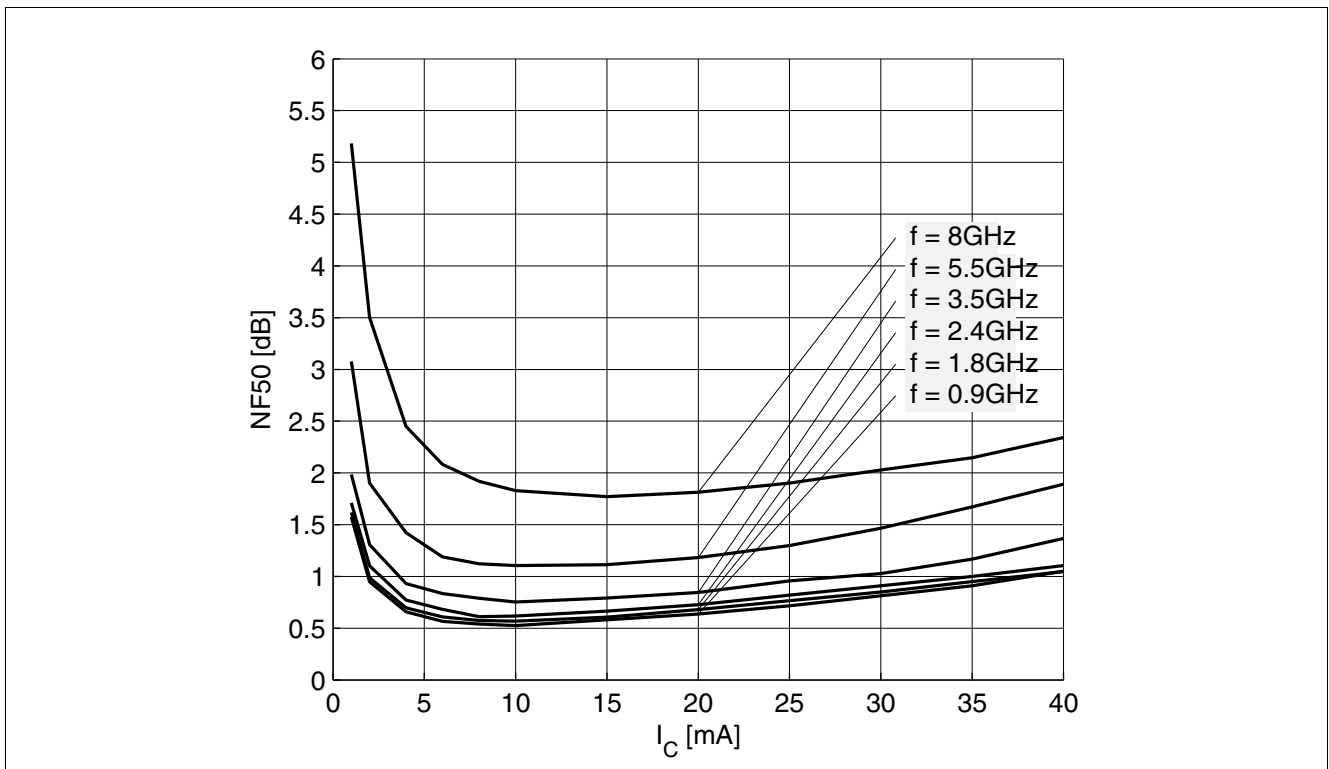


Figure 5-20 Noise Figure  $NF_{50} = f(I_C)$ ,  $V_{CE} = 3\text{ V}$ ,  $Z_S = 50\ \Omega$ ,  $f = \text{Parameter in GHz}$

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.  $T_A = 25\text{ }^\circ\text{C}$



## 6 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. Please consult our website and download the latest versions before actually starting your design.

You find the BFP760 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 BFP760 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.

## 7 Package Information SOT343

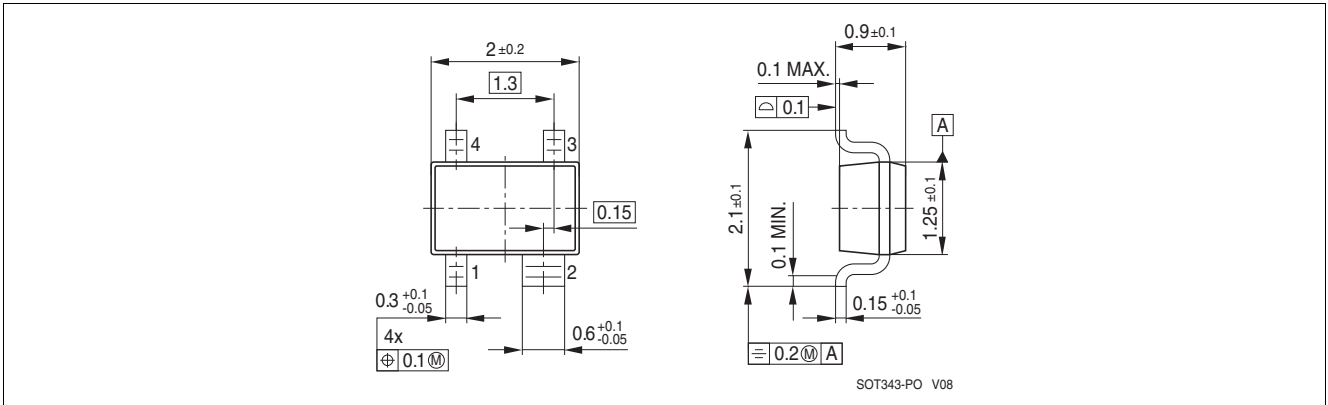


Figure 7-1 Package Outline

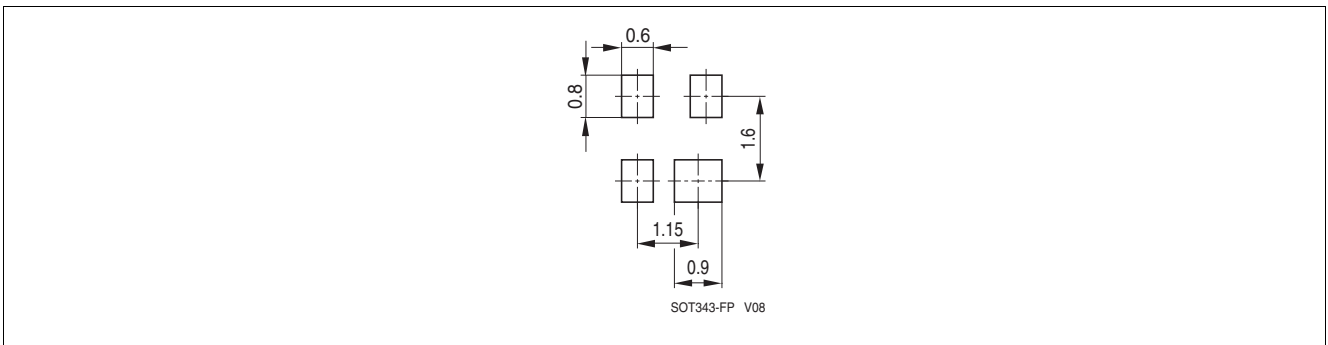


Figure 7-2 Package Footprint

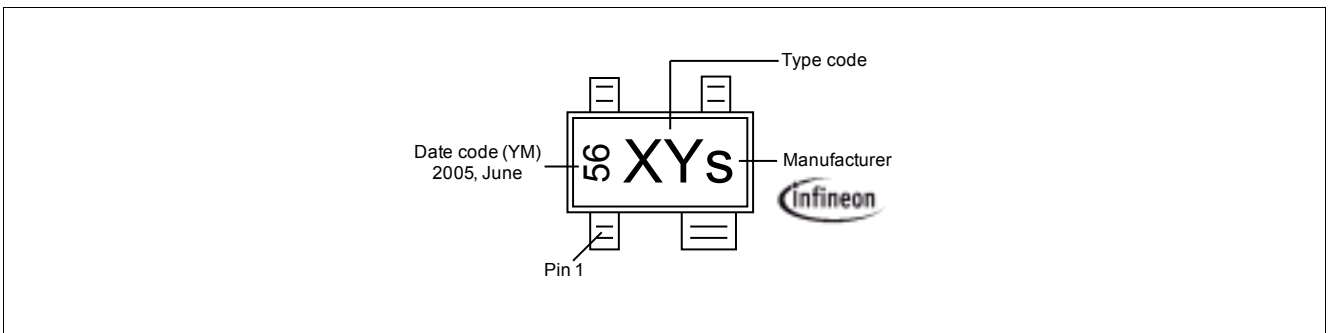


Figure 7-3 Marking Example (Marking BFP760: R6s)

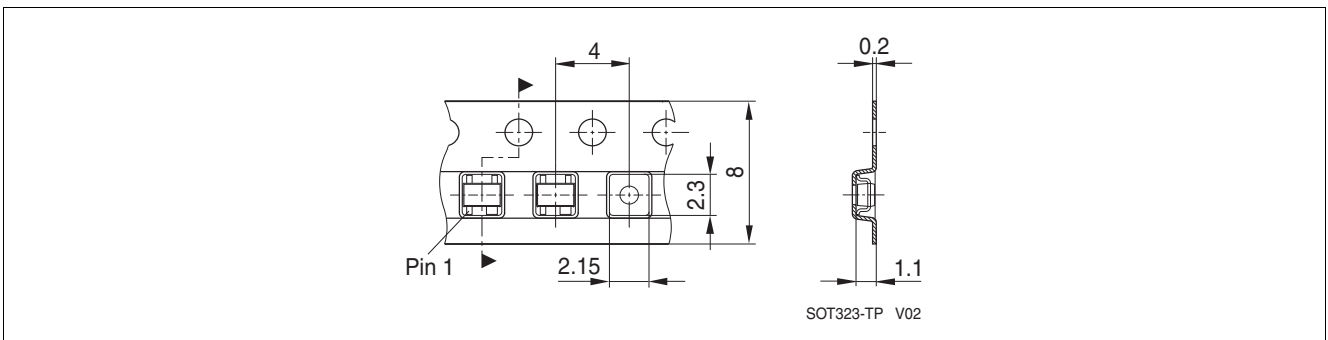


Figure 7-4 Tape Dimensions

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