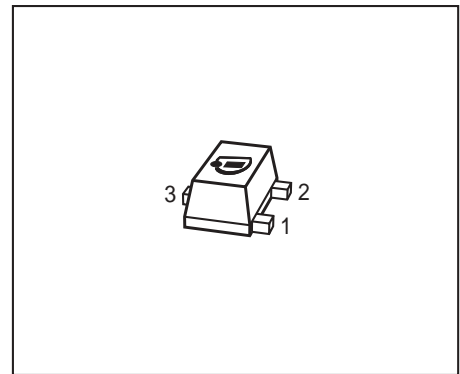


**NPN Silicon RF Transistor\***

- Low voltage/ low current operation
- For low noise amplifiers
- For Oscillators up to 3.5 GHz and Pout > 10 dBm
- Low noise figure: 1.0 dB at 1.8 GHz
- Pb-free (RoHS compliant) package<sup>1)</sup>
- Qualified according AEC Q101



\* Short term description



**ESD (Electrostatic discharge) sensitive device, observe handling precaution!**

Type	Marking	Pin Configuration			Package
BFR360F	FBs	1 = B	2 = E	3 = C	TSFP-3

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Collector-emitter voltage	$V_{CEO}$	6	V
Collector-emitter voltage	$V_{CES}$	15	
Collector-base voltage	$V_{CBO}$	15	
Emitter-base voltage	$V_{EBO}$	2	
Collector current	$I_C$	35	mA
Base current	$I_B$	4	
Total power dissipation <sup>2)</sup> $T_S \leq 98^\circ\text{C}$	$P_{tot}$	210	mW
Junction temperature	$T_j$	150	°C
Ambient temperature	$T_A$	-65 ... 150	
Storage temperature	$T_{stg}$	-65 ... 150	

**Thermal Resistance**

Parameter	Symbol	Value	Unit
Junction - soldering point <sup>3)</sup>	$R_{thJS}$	$\leq 250$	K/W

<sup>1)</sup>Pb-containing package may be available upon special request

<sup>2)</sup> $T_S$  is measured on the collector lead at the soldering point to the pcb

<sup>3)</sup>For calculation of  $R_{thJA}$  please refer to Application Note Thermal Resistance

**Electrical Characteristics** at  $T_A = 25^\circ\text{C}$ , unless otherwise specified

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>DC Characteristics</b>					
Collector-emitter breakdown voltage $I_C = 1 \text{ mA}, I_B = 0$	$V_{(BR)CEO}$	6	9	-	V
Collector-emitter cutoff current $V_{CE} = 15 \text{ V}, V_{BE} = 0$	$I_{CES}$	-	-	10	$\mu\text{A}$
Collector-base cutoff current $V_{CB} = 5 \text{ V}, I_E = 0$	$I_{CBO}$	-	-	100	nA
Emitter-base cutoff current $V_{EB} = 1 \text{ V}, I_C = 0$	$I_{EBO}$	-	-	1	$\mu\text{A}$
DC current gain- $I_C = 15 \text{ mA}, V_{CE} = 3 \text{ V}, \text{ pulse measured}$	$h_{FE}$	90	120	160	-

**Electrical Characteristics** at  $T_A = 25^\circ\text{C}$ , unless otherwise specified

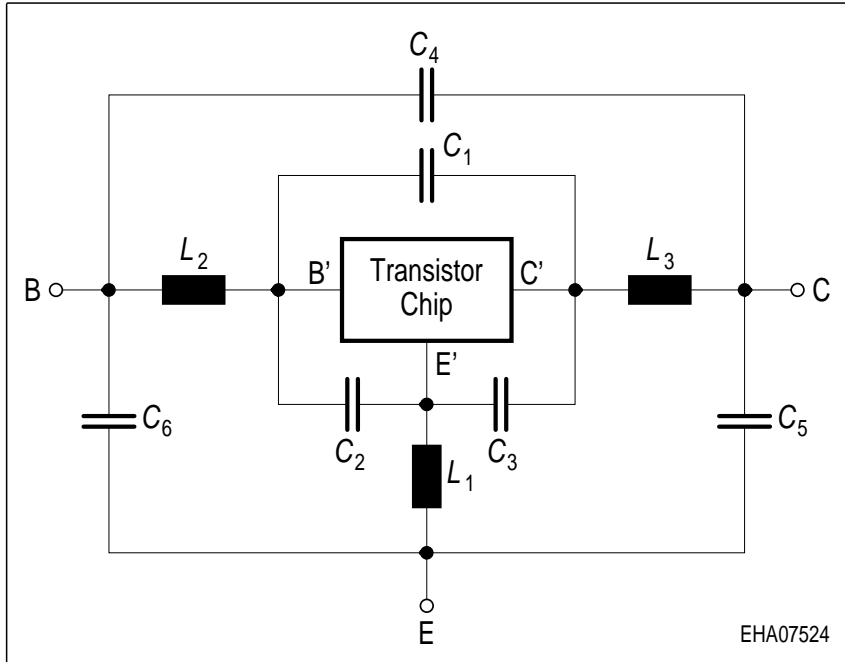
Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>AC Characteristics</b> (verified by random sampling)					
Transition frequency $I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $f = 1\text{ GHz}$	$f_T$	11	14	-	GHz
Collector-base capacitance $V_{CB} = 5\text{ V}$ , $f = 1\text{ MHz}$ , $V_{BE} = 0$ , emitter grounded	$C_{cb}$	-	0.32	0.5	pF
Collector emitter capacitance $V_{CE} = 5\text{ V}$ , $f = 1\text{ MHz}$ , $V_{BE} = 0$ , base grounded	$C_{ce}$	-	0.2	-	
Emitter-base capacitance $V_{EB} = 0.5\text{ V}$ , $f = 1\text{ MHz}$ , $V_{CB} = 0$ , collector grounded	$C_{eb}$	-	0.4	-	
Noise figure $I_C = 3\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_{Sopt}$ , $f = 1.8\text{ GHz}$	$F_{min}$	-	1	-	dB
Power gain, maximum available <sup>1)</sup> $I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_{Sopt}$ , $Z_L = Z_{Lopt}$ , $f = 1.8\text{ GHz}$ $f = 3\text{ GHz}$	$G_{ma}$	- -	15.5 11	- -	
Transducer gain $I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_L = 50\Omega$ , $f = 1.8\text{ GHz}$ $f = 3\text{ GHz}$	$ S_{21e} ^2$	- -	13 9	- -	dB
Third order intercept point at output <sup>2)</sup> $V_{CE} = 3\text{ V}$ , $I_C = 15\text{ mA}$ , $f = 1.8\text{ GHz}$ , $Z_S = Z_L = 50\Omega$	$IP_3$	-	24	-	dBm
1dB Compression point at output $I_C = 15\text{ mA}$ , $V_{CE} = 3\text{ V}$ , $Z_S = Z_L = 50\Omega$ , $f = 1.8\text{ GHz}$	$P_{-1dB}$	-	9	-	

<sup>1)</sup>  $G_{ma} = |S_{21e}| / |S_{12e}| (k - (k^2 - 1)^{1/2})$ 
<sup>2)</sup>  $IP_3$  value depends on termination of all intermodulation frequency components.  
Termination used for this measurement is  $50\Omega$  from 0.1 MHz to 6 GHz

**SPICE Parameter (Gummel-Poon Model, Berkley-SPICE 2G.6 Syntax):**
**Transistor Chip Data:**

IS =	0.0689	fA	BF =	147	-	NF =	1	-
VAF =	20	V	IKF =	77.28	mA	ISE =	150	fA
NE =	2.4	-	BR =	6	-	NR =	1	-
VAR =	60	V	IKR =	0.3	A	ISC =	20	fA
NC =	1.4	-	RB =	0.1	$\Omega$	IRB =	75	$\mu$ A
RBM =	7.31	$\Omega$	RE =	78.2	m $\Omega$	RC =	0.35	$\Omega$
CJE =	400	fF	VJE =	1.3	V	MJE =	0.5	-
TF =	9.219	ps	XTF =	0.115	-	VTF =	0.198	V
ITF =	1.336	mA	PTF =	0	deg	CJC =	473	fF
VJC =	0.864	V	MJC =	0.486	-	XCJC =	0.129	-
TR =	1.92	ns	CJS =	0	fF	VJS =	0.75	V
MJS =	0	-	XTB =	0	K	EG =	1.11	eV
XTI =	0	-	FC =	0.954	-	NK =	0.5	K
AF =	1	-	KF =	1E-14	-			

All parameters are ready to use, no scaling is necessary.

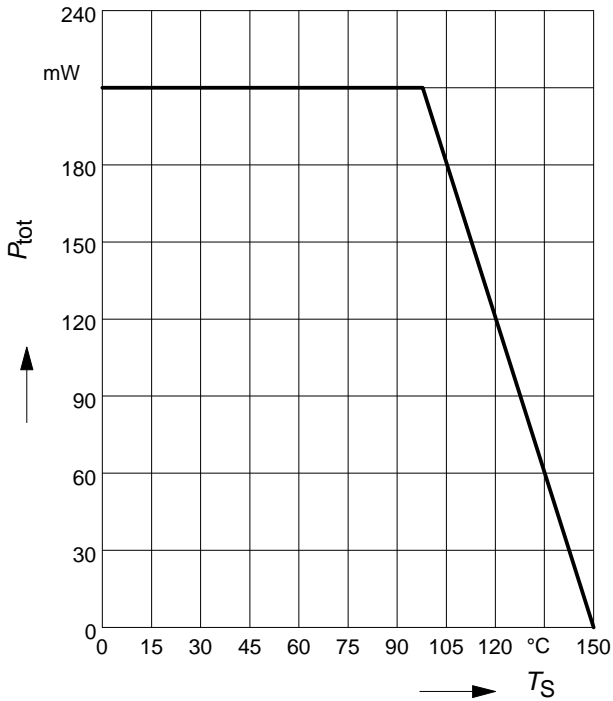
**Package Equivalent Circuit:**


$L_1 =$	0.556	nH
$L_2 =$	0.657	nH
$L_3 =$	0.381	nH
$C_1 =$	43	fF
$C_2 =$	123	fF
$C_3 =$	66	fF
$C_4 =$	10	fF
$C_5 =$	36	fF
$C_6 =$	47	fF

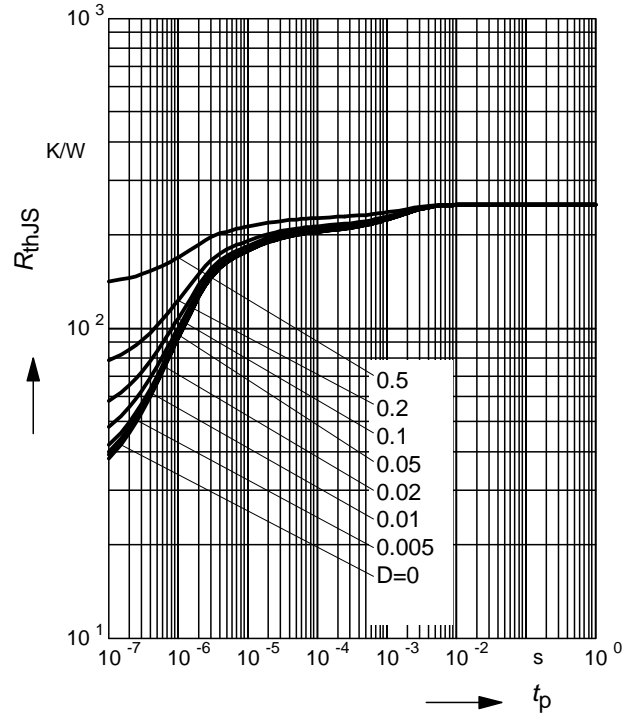
Valid up to 6GHz

For examples and ready to use parameters please contact your local Infineon Technologies distributor or sales office to obtain a Infineon Technologies CD-ROM or see Internet: <http://www.infineon.com>

**Total power dissipation  $P_{tot} = f(T_S)$**

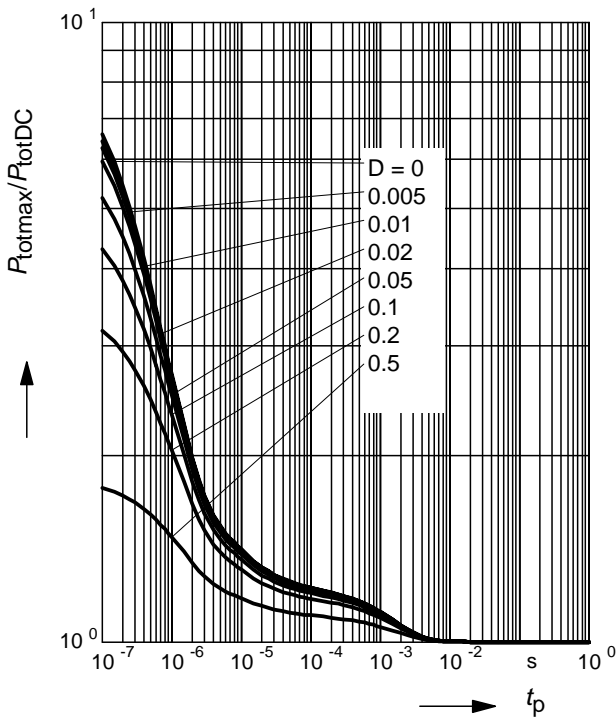


**Permissible Pulse Load  $R_{thJS} = f(t_p)$**



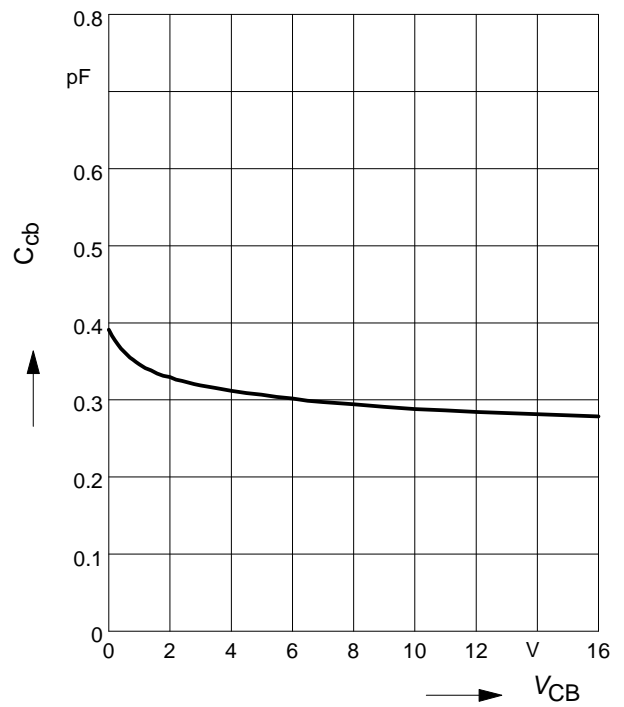
**Permissible Pulse Load**

$P_{totmax}/P_{totDC} = f(t_p)$



**Collector-base capacitance  $C_{cb} = f(V_{CB})$**

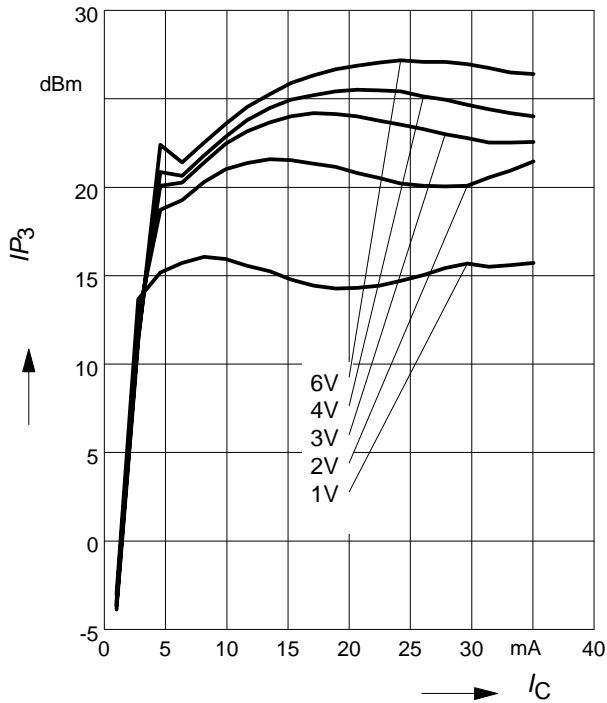
$f = 1\text{MHz}$



**Third order Intercept Point  $IP_3=f(I_C)$**

(Output,  $Z_S=Z_L=50\Omega$ )

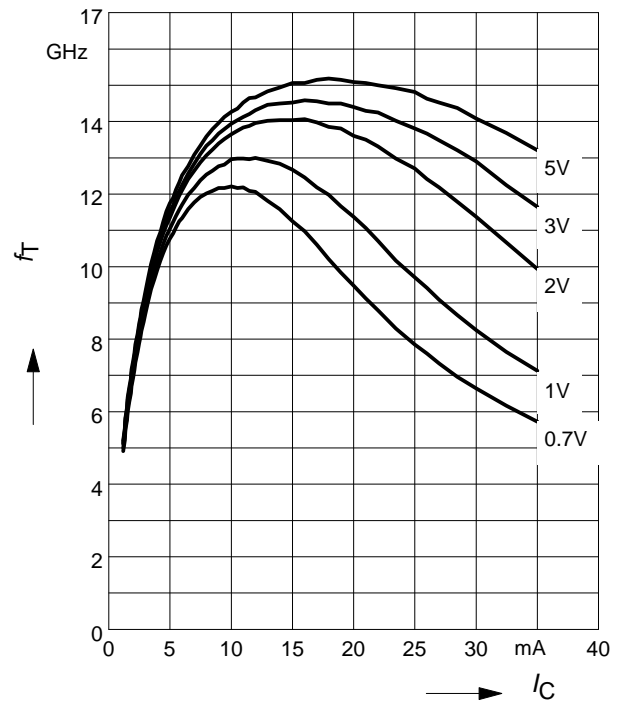
$V_{CE}$  = parameter,  $f = 1.8\text{GHz}$



**Transition frequency  $f_T=f(I_C)$**

$f = 1\text{GHz}$

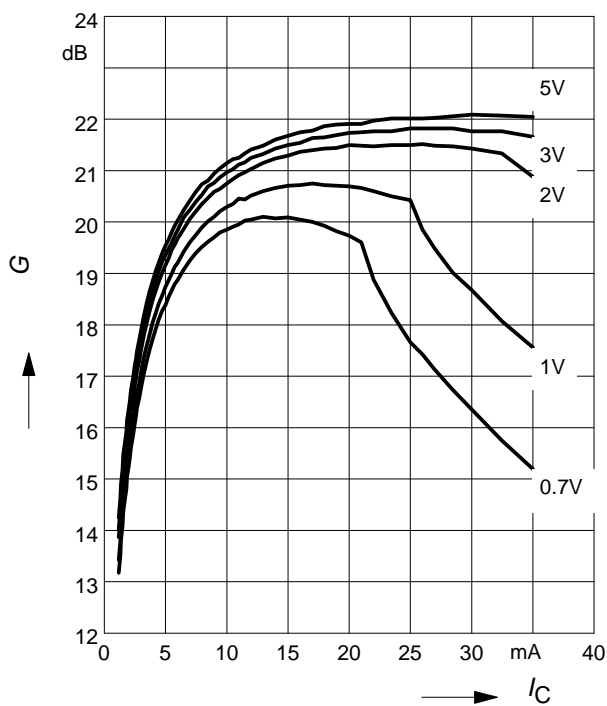
$V_{CE}$  = parameter



**Power gain  $G_{ma}, G_{ms} = f(I_C)$**

$f = 0.9\text{GHz}$

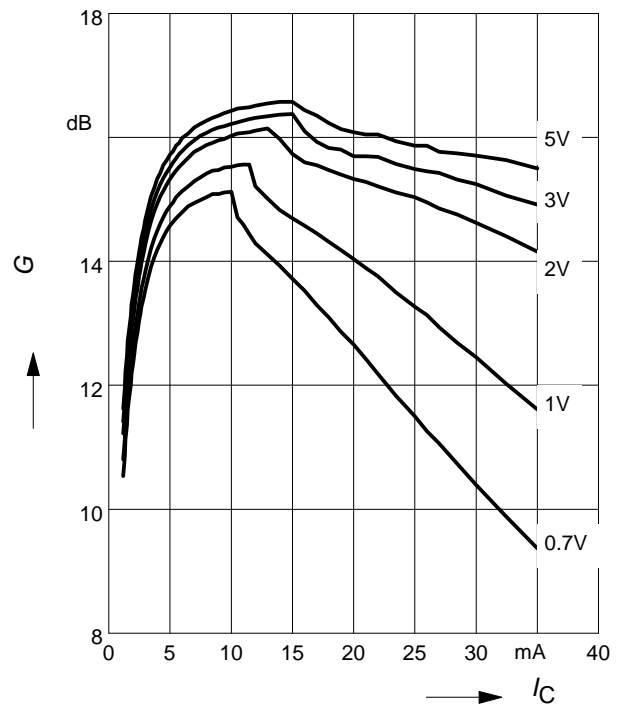
$V_{CE}$  = parameter



**Power gain  $G_{ma}, G_{ms} = f(I_C)$**

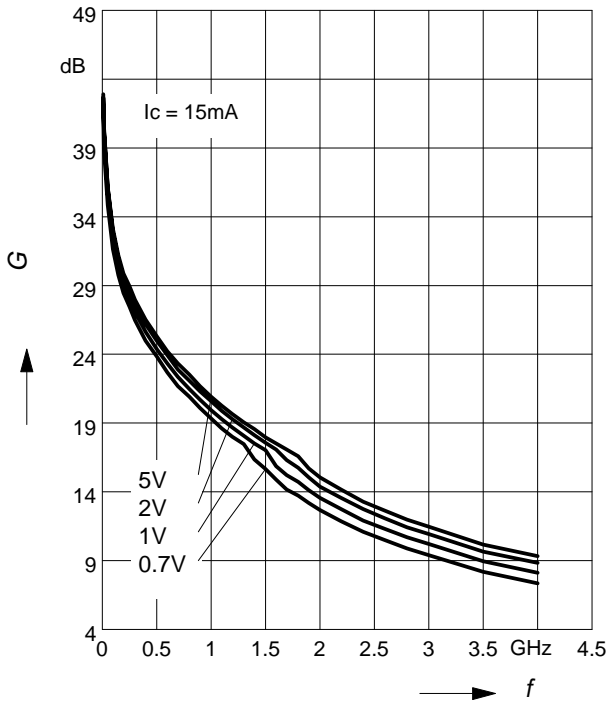
$f = 1.8\text{GHz}$

$V_{CE}$  = parameter



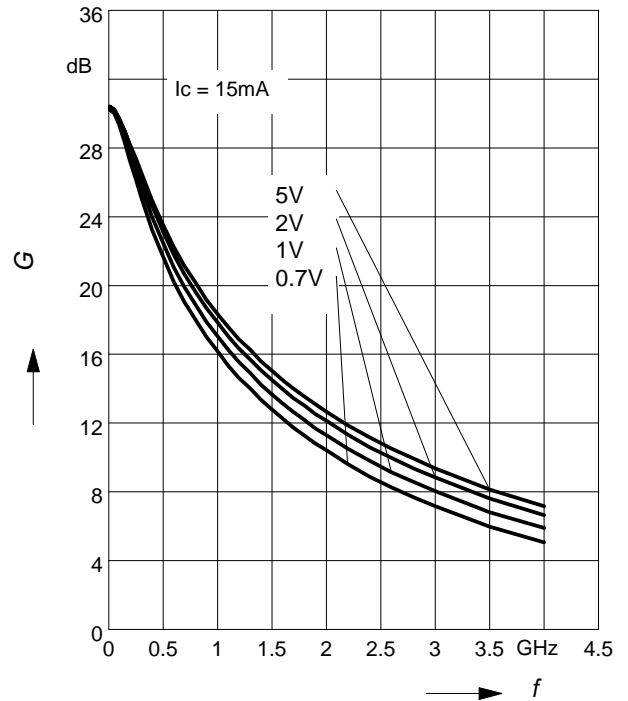
**Power Gain  $G_{ma}$ ,  $G_{ms} = f(f)$**

$V_{CE} =$  parameter



**Insertion Power Gain  $|S_{21}|^2 = f(f)$**

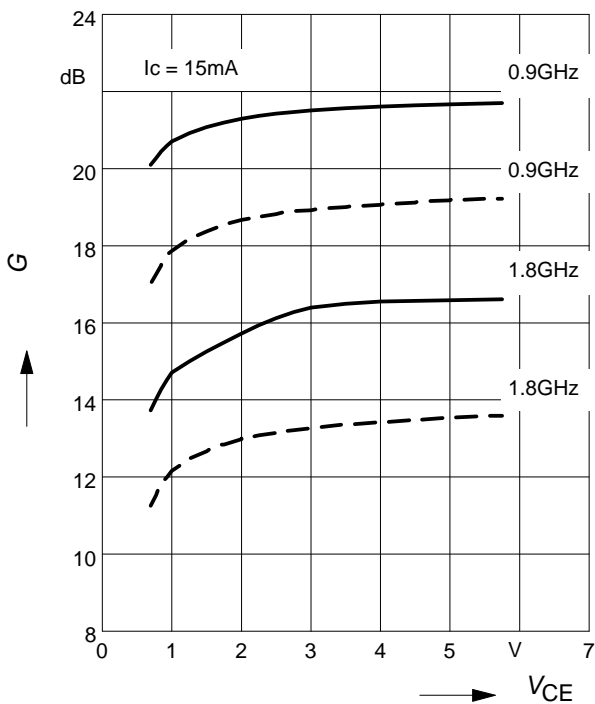
$V_{CE} =$  parameter



**Power Gain  $G_{ma}$ ,  $G_{ms} = f(V_{CE})$ : —**

$|S_{21}|^2 = f(V_{CE})$ : - - - -

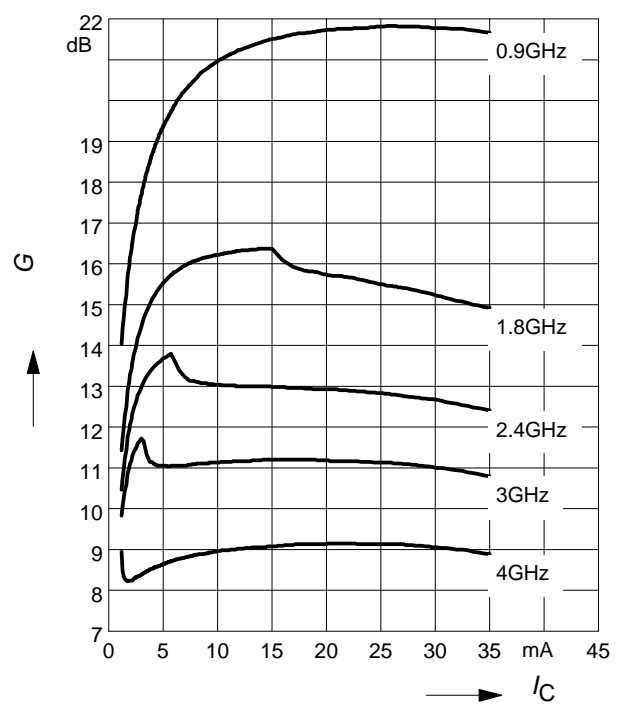
$f =$  parameter



**Power gain  $G_{ma}$ ,  $G_{ms} = f(I_C)$**

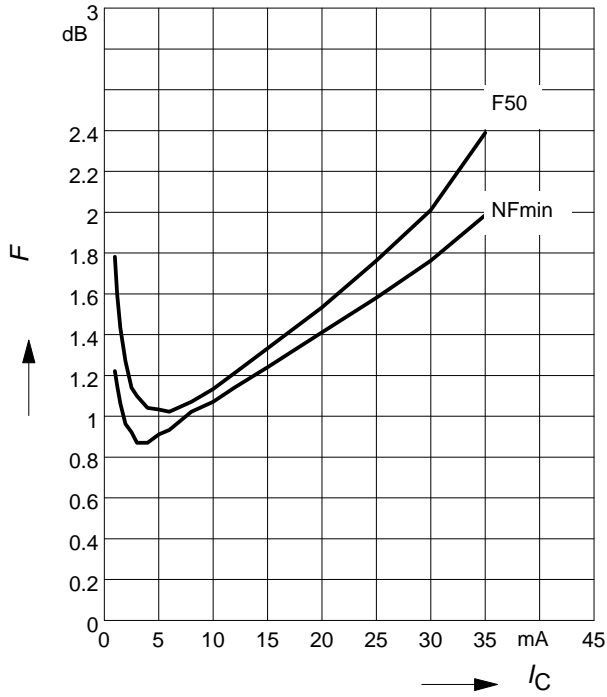
$V_{CE} = 3V$

$f =$  parameter



**Noise figure  $NF = f(I_C)$**

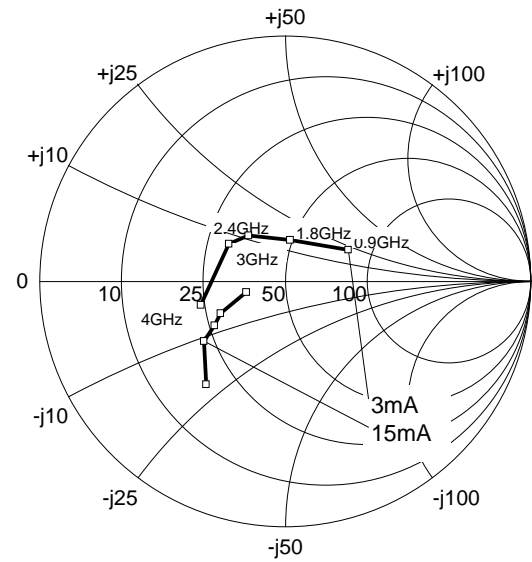
$V_{CE} = 3V, f = 1,8 \text{ GHz}$



**Source impedance for min.**

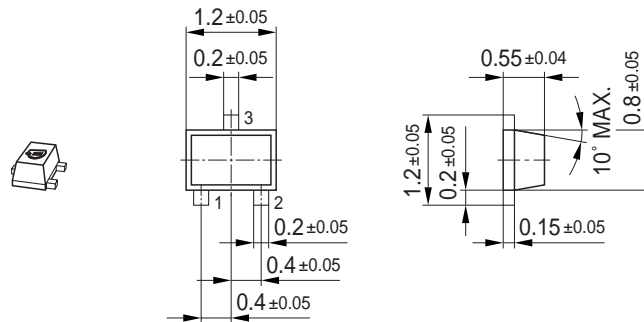
noise figure vs. frequency

$V_{CE} = 3 \text{ V}$

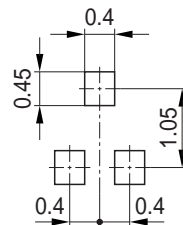




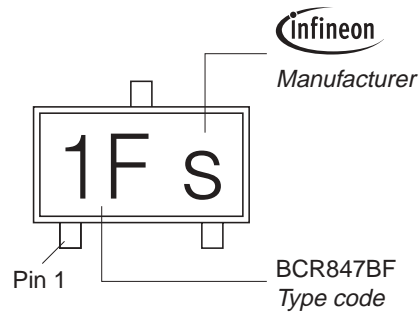
Package Outline



Foot Print

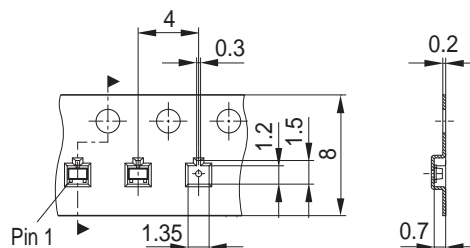


Marking Layout (Example)



Standard Packing

Reel  $\varnothing$ 180 mm = 3.000 Pieces/Reel  
 Reel  $\varnothing$ 330 mm = 10.000 Pieces/Reel



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