## NPN Silicon RF Transistor

* For low current applications
* For oscillators up to 12 GHz
* Noise figure F = 1.15 dB at 1.8 GHz
   outstanding G_{ms} = 22 dB at 1.8 GHz
* Transition frequency f_T = 25 GHz
* Gold metalization for high reliability
* **SIEGET $^®$ 25 - Line**
   Siemens **G**rounded **E**mitter **T**ransistor
   25 GHz f_T - **Line**

VPS05605
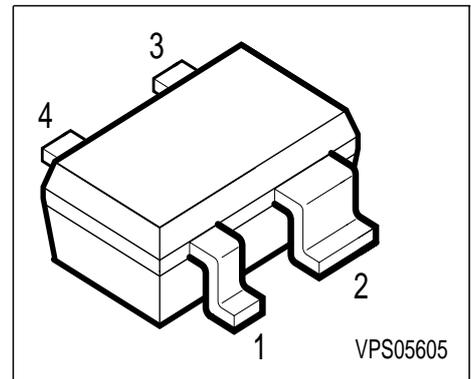
ESD: **E**lectro**s**tatic **d**ischarge sensitive device, observe handling precaution!

Type	Marking	Ordering Code	Pin Configuration				Package
BFP 405	ALs	Q62702-F1592	1 = B	2 = E	3 = C	4 = E	SOT-343

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CEO}	4.5	V
Collector-base voltage	V_{CBO}	15	
Emitter-base voltage	V_{EBO}	1.5	
Collector current	I_C	12	mA
Base current	I_B	1	
Total power dissipation, $T_S \leq 120\ °C$	P_{tot}	55	mW
Junction temperature	T_j	150	°C
Ambient temperature	T_A	-65 ...+150	
Storage temperature	T_{stg}	-65 ...+150	

Thermal Resistance

Junction - soldering point [1]	R_{thJS}	≤ 530	K/W

1) TS is measured on the collector lead at the soldering point to the pcb

Electrical Characteristics at $T_A = 25°C$, unless otherwise specified.

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
DC characteristics					
Collector-emitter breakdown voltage $I_C = 1$ mA, $I_B = 0$	$V_{(BR)CEO}$	4.5	5	6.5	V
Collector-base cutoff current $V_{CB} = 5$ V, $I_E = 0$	I_{CBO}	-	-	150	nA
Emitter-base cutoff current $V_{EB} = 1.5$ V, $I_C = 0$	I_{EBO}	-	-	15	µA
DC current gain $I_C = 5$ mA, $V_{CE} = 4$ V	h_{FE}	50	90	150	-
AC characteristics					
Transition frequency $I_C = 10$ mA, $V_{CE} = 3$ V, $f = 2$ GHz	f_T	20	25	-	GHz
Collector-base capacitance $V_{CB} = 2$ V, $f = 1$ MHz	C_{cb}	-	0.05	0.08	pF
Collector-emitter capacitance $V_{CE} = 2$ V, $f = 1$ MHz	C_{ce}	-	0.28	-	
Emitter-base capacitance $V_{EB} = 0.5$ V, $f = 1$ MHz	C_{eb}	-	0.29	-	
Noise figure $I_C = 2$ mA, $V_{CE} = 2$ V, $Z_S = Z_{Sopt}$, $f = 900$ MHz	F	-	1.15	1.4	dB
Power gain [1] $I_C = 5$ mA, $V_{CE} = 2$ V, $Z_S = Z_{Sopt}$, $Z_L = Z_{Lopt}$, $f = 1.8$ GHz	G_{ms}	-	22	-	
Insertion power gain $I_C = 5$ mA, $V_{CE} = 2$ V, $f = 1.8$ GHz, $Z_S = Z_L = 50Ω$	$|S_{21}|^2$	14	17	-	dB
Third order intersept point $I_C = 5$ mA, $V_{CE} = 2$ V, $Z_S = Z_{Sopt}$, $Z_L = Z_{Lopt}$, $f = 1.8$ GHz	IP_3	-	15	-	dBm
1dB Compression point $I_C = 5$ mA, $V_{CE} = 2$ V, $f = 1.8$ GHz, $Z_S = Z_{Sopt}$, $Z_L = Z_{Lopt}$	P_{-1dB}	-	5	-	

1) $G_{ms} = |S_{21} / S_{12}|$

Common Emitter S-Parameters

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
V_{CE} = 2V, I_C = 5mA								
0.1	0.841	-5.2	13.52	174.9	0.0033	88.9	0.986	-2.5
0.5	0.791	-25.4	12.76	154.6	0.0161	77.5	0.956	-12.6
1	0.682	-48.7	11.25	133.3	0.0290	67.9	0.873	-22.7
2	0.449	-88.6	8.04	100.3	0.0479	55.4	0.709	-36.8
3	0.304	-126.1	5.91	77.4	0.0639	49.2	0.594	-44.7
4	0.239	-171.1	4.63	58.9	0.799	43.2	0.509	-55.5
6	0.303	129.3	3.13	28	0.1104	30.2	0.386	-73.5
8	0.464	91.4	2.22	-1.5	0.118	13.6	0.251	-92.2
9	0.549	77.9	1.93	-15.5	0.129	5.1	0.153	106.6
10	0.631	71	1.65	-27.5	0.136	-2.2	0.069	-166.6
11	0.666	67.6	1.47	-38.2	0.145	-8.5	0.127	137.2
12	0.693	63.4	1.23	-49.5	0.155	-15.3	0.187	75.6

Common Emitter Noise Parameters

f	F_{min} [1]	G_a [1]	Γ_{opt}		R_N	r_n	$F_{50\Omega}$ [2]	$|S_{21}|^2$ [2]
GHz	dB	dB	MAG	ANG	Ω	-	dB	dB
V_{CE} = 2V, I_C = 2mA								
0.9	0.9	21.2	0.54	14	21	0.42	1.8	16.1
1.8	1.15	18.2	0.46	27	19	0.38	1.8	15
2.4	1.35	15.5	0.41	38	18	0.36	1.8	14
3.0	1.46	14.5	0.34	55	17	0.34	1.8	12.9
4	1.62	11.9	0.26	80	12.5	0.25	1.8	11.3
5	1.75	9.3	0.17	117	11	0.22	1.9	9.7
6	2.15	8.1	0.13	180	14	0.28	2.2	8.2

1) Input matched for minimum noise figure, output for maximum gain   2) $Z_S = Z_L = 50\Omega$

For more and detailed S- and Noise-parameters please contact your local Siemens
distributor or sales office to obtain a Siemens Application Notes CD-ROM or see Internet:
http://www.siemens.de/Semiconductor/products/35/35.htm

SPICE Parameters (Gummel-Poon Model, Berkley-SPICE 2G.6 Syntax) :

Transistor Chip Data

IS =	0.21024	fA	BF =	83.23	-	NF =	1.0405	-
VAF =	39.251	V	IKF =	0.16493	A	ISE =	15.761	fA
NE =	1.7763	-	BR =	10.526	-	NR =	0.96647	-
VAR =	34.368	V	IKR =	0.25052	A	ISC =	0.037223	fA
NC =	1.3152	-	RB =	15	Ω	IRB =	0.21215	mA
RBM =	1.3491	Ω	RE =	1.9289		RC =	0.12691	Ω
CJE =	3.7265	fF	VJE =	0.70367	V	MJE =	0.37747	-
TF =	4.5899	ps	XTF =	0.3641	-	VTF =	0.19762	V
ITF =	1.3364	mA	PTF =	0	deg	CJC =	96.941	fF
VJC =	0.99532	V	MJC =	0.48652	-	XCJC =	0.08161	-
TR =	1.4935	ns	CJS =	0	fF	VJS =	0.75	V
MJS =	0	-	XTB =	0	-	EG =	1.11	eV
XTI =	3	-	FC =	0.99469	-	TNOM	300	K

C'-E'-Diode Data (Berkley-SPICE 2G.6 Syntax) :

IS =	2	fA	N =	1.02	-	RS =	20	Ω

All parameters are ready to use, no scalling is necessary

Package Equivalent Circuit:

L_{BI} =	0.47	nH
L_{BO} =	0.53	nH
L_{EI} =	0.23	nH
L_{EO} =	0.05	nH
L_{CI} =	0.56	nH
L_{CO} =	0.58	nH
C_{BE} =	136	fF
C_{CB} =	6.9	fF
C_{CE} =	134	fF
Valid up to 6GHz		
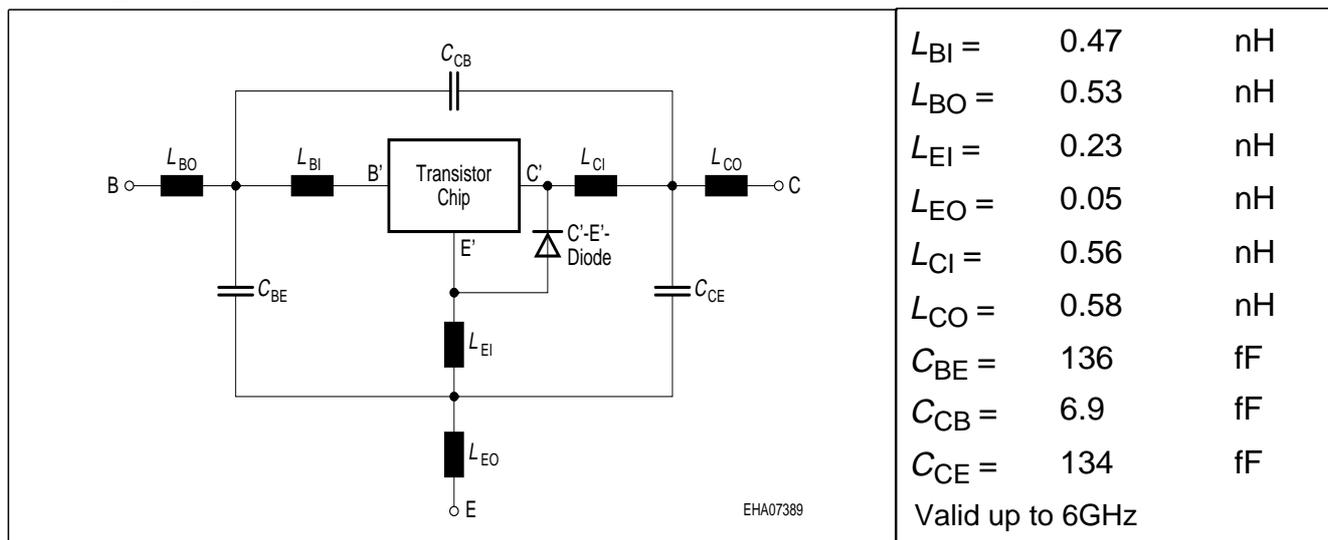
The SOT-343 package has two emitter leads. To avoid high complexity of the package equivalent circuit, both leads are combined in one electrical connection.

For examples and ready to use parameters please contact your local Siemens distributor or sales office to obtain a Siemens CD-ROM or see Internet: http://www.siemens.de/Semiconductor/products/35/35.htm

For non-linear simulation:

- Use transistor chip parameters in Berkeley SPICE 2G.6 syntax for all simulators.

- If you need simulation of thereverse characteristics, add the diode with the C'-E'- diode data between collector and emitter.

- Simulation of package is not necessary for frequenties < 100MHz.
  For higher frequencies add the wiring of package equivalent circuit around the non-linear transistor and diode model.

Note:

- This transistor is constructed in a common emitter configuration. This feature causes an additional reverse biased diode between emitter and collector, which does not effect normal operation.

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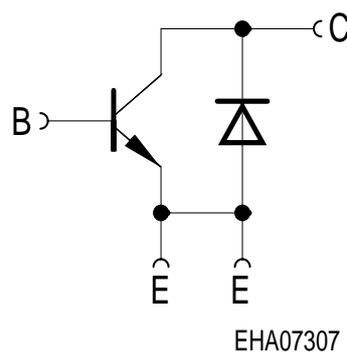
Transistor Schematic Diagram

The common emitter configuration shows the following advantages:

- Higher gain because of lower emitter inductance.
- Power is dissipated via the grounded emitter leads, because the chip is mounted on copper emitter leadframe.

Please note, that the broadest lead is the emitter lead.

The AC characteristics are verified by random sampling.

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

* Package mounted on epoxy
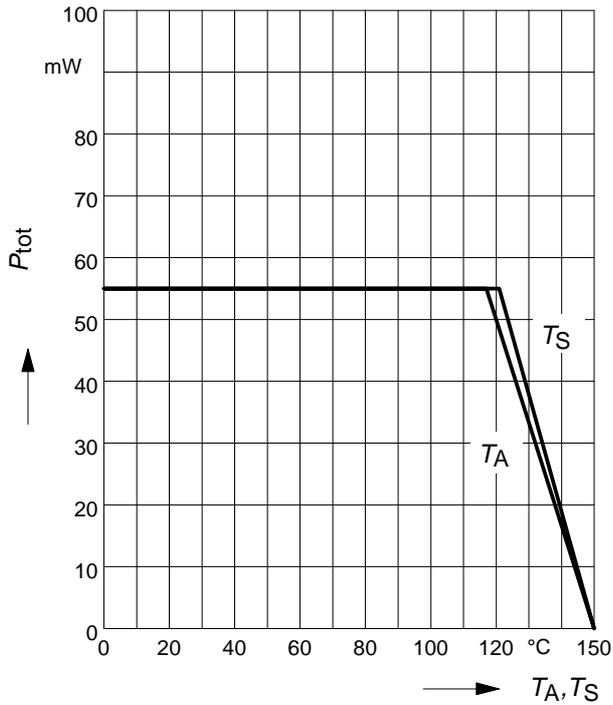
Transition frequency $f_T = f(I_C)$

f = 2 GHz

V_{CE} = parameter in V
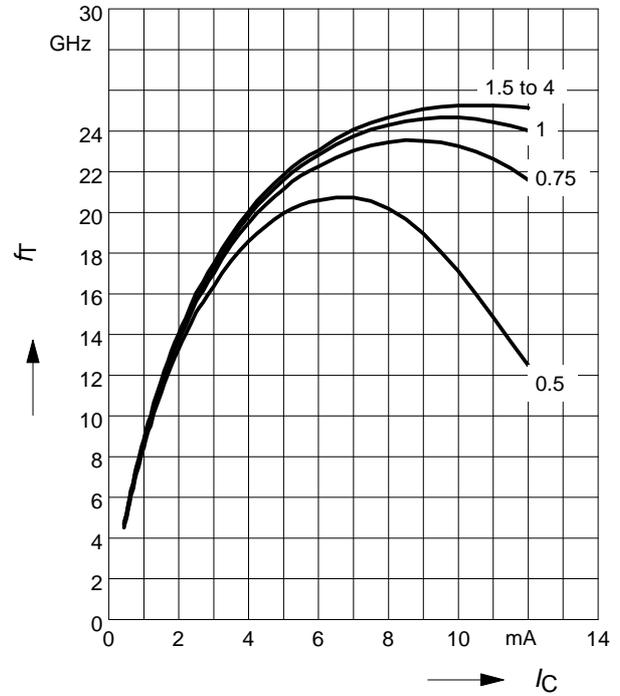

Permissible Pulse Load $R_{thJS} = f(t_p)$
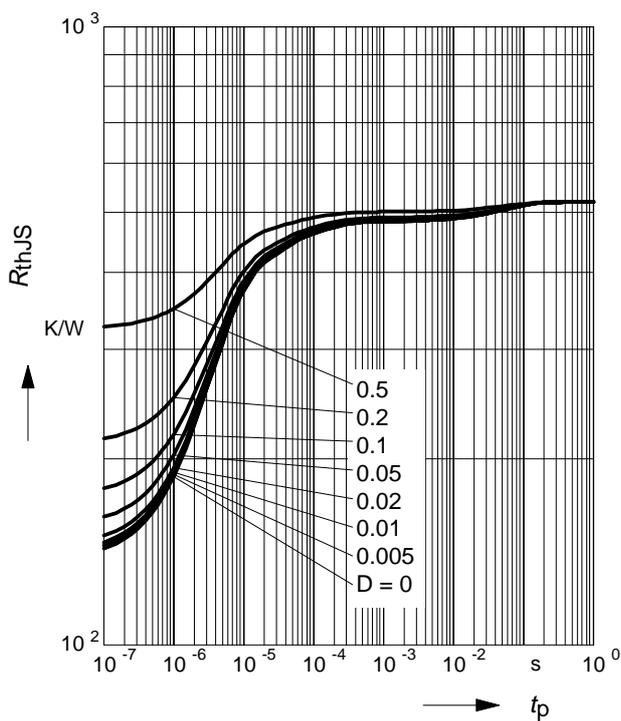
Permissible Pulse Load

$P_{totmax}/P_{totDC} = f(t_p)$
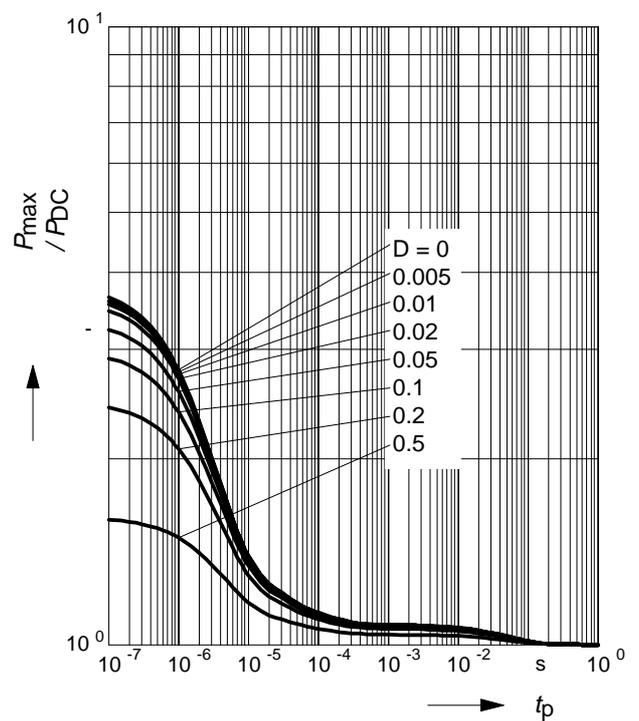
**Power gain** G_{ma}, G_{ms}, $|S_{21}|^2 = f(f)$

$V_{CE} = 2V$, $I_C = 5mA$
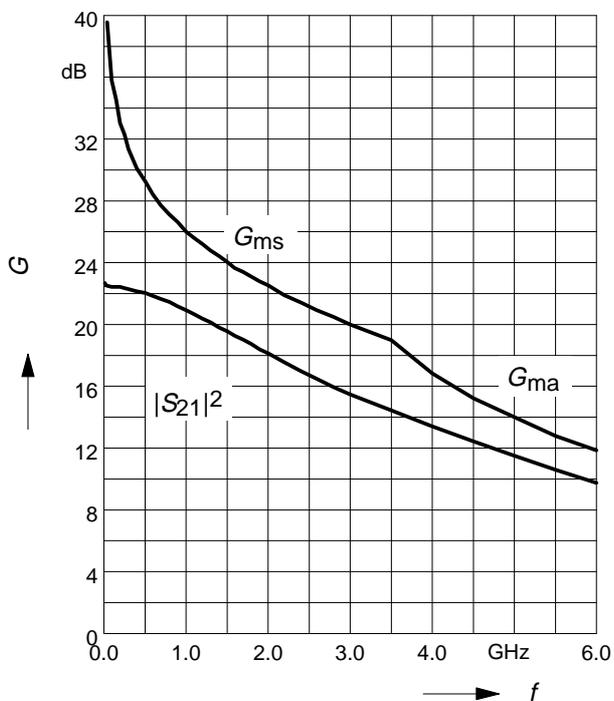
**Power gain** G_{ma}, $G_{ms} = f(I_C)$

$V_{CE} = 2V$

f = parameter in GHz
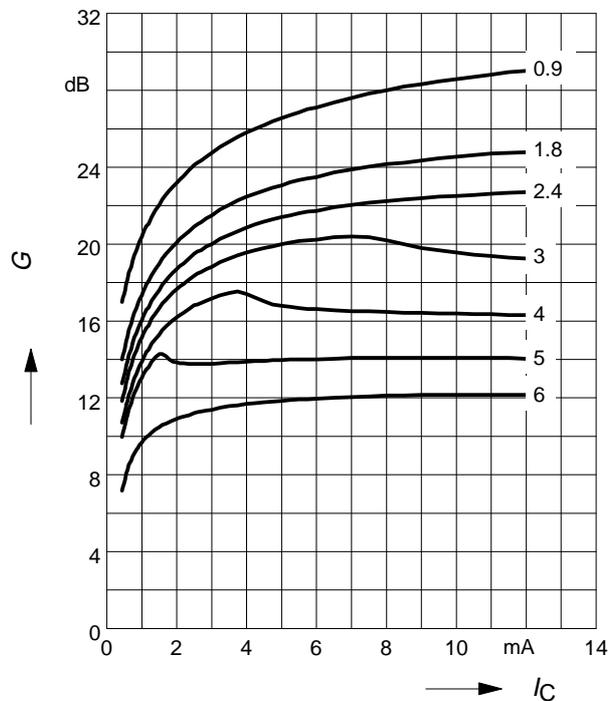
Power gain G_{ma}, $G_{ms} = f(V_{CE})$

$I_C = 5mA$

f = parameter in V
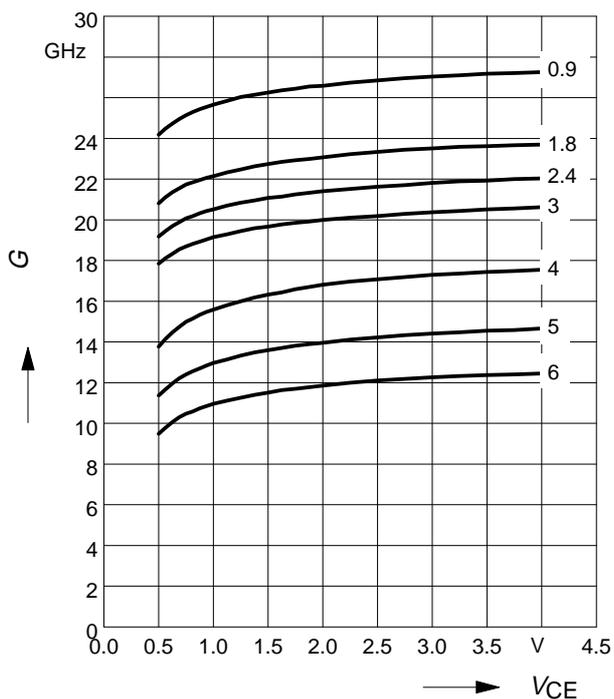
Collector-base capacitance $C_{cb} = f(V_{CB})$

$V_{BE} = 0$, $f = 1MHz$
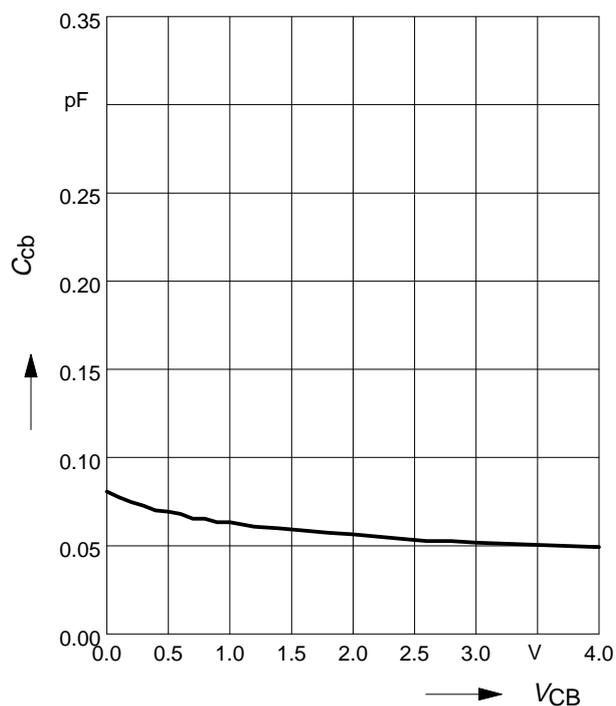
**Noise figure** $F = f(I_C)$

V_{CE} = 2 V, $Z_S = Z_{Sopt}$
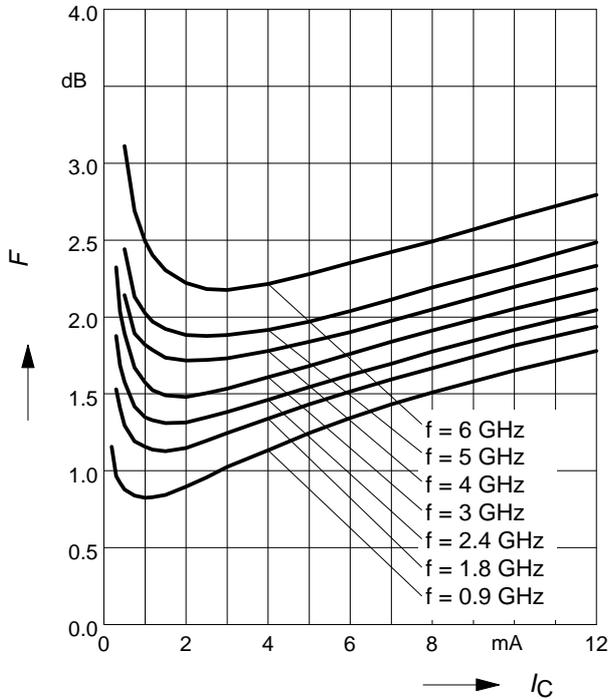
Noise figure $F = f(I_C)$

V_{CE} = 2 V, f = 1.8 GHz
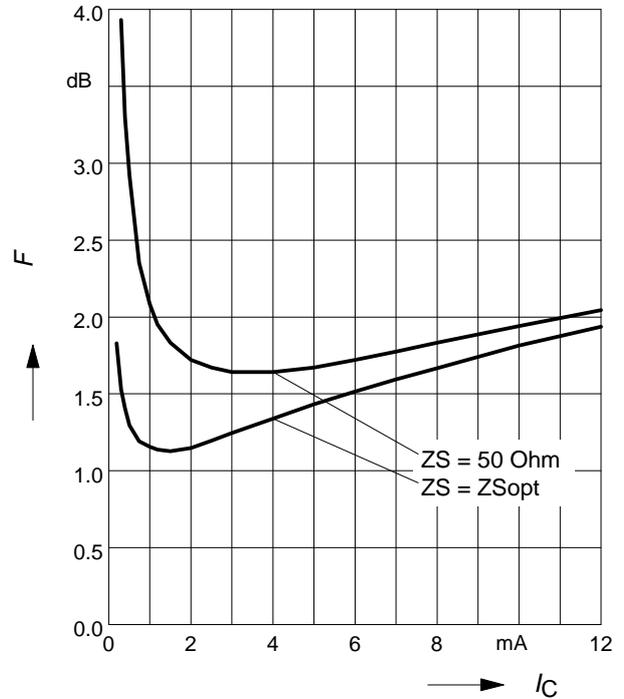
Noise figure $F = f(f)$

V_{CE} = 2 V, $Z_S = Z_{Sopt}$
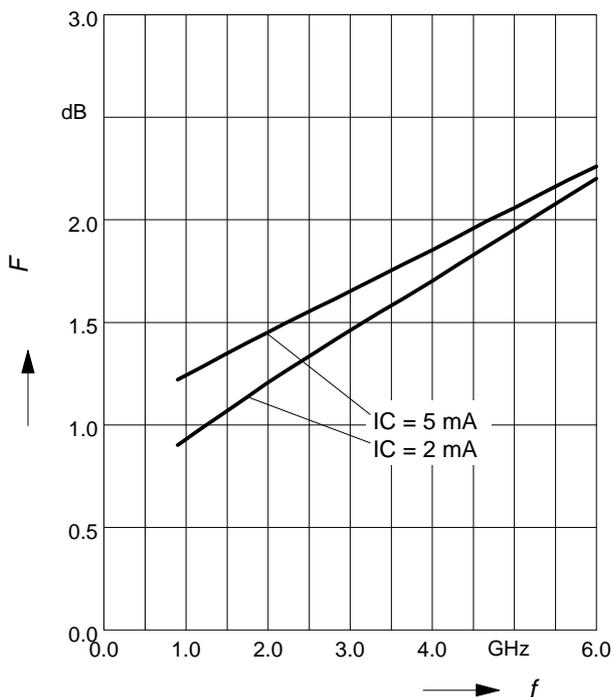
Source impedance for min.

Noise Figure versus Frequency

V_{CE} = 2V, I_C = 2mA / 5 mA