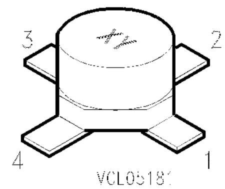
SIEMENS

NPN Silicon RF Transistor

BFQ 73S

- For low-noise, low-distortion broadband amplifiers in antenna and telecommunications systems up to 2 GHz at collector currents from 10 mA to 70 mA.
- Hermetically sealed ceramic package.
- HiRel/Mil screening available.
- CECC-type available: CECC 50002/261.



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

Type	Marking	Ordering Code (tape and reel)	Pin Configuration 1	2	3	4	Package[1)]
BFQ 73S	73S	Q62702-F1104	B	E	C	E	Cerec-X

Maximum Ratings

Parameter	Symbol	Values	Unit
Collector-emitter voltage	V_{CE0}	15	V
Collector-base voltage	V_{CB0}	20	
Emitter-base voltage	V_{EB0}	3	
Collector current	I_C	100	mA
Total power dissipation, $T_S \leq 110$ °C[3)]	P_{tot}	500	mW
Junction temperature	T_j	175	°C
Ambient temperature range	T_A	– 65 … + 175	
Storage temperature range	T_{stg}	– 65 … + 175	

Thermal Resistance

Parameter	Symbol	Values	Unit
Junction - ambient[2)]	$R_{th\ JA}$	≤ 210	K/W
Junction - soldering point[3)]	$R_{th\ JS}$	≤ 130	

1) For detailed information see chapter Package Outlines.
2) Package mounted on alumina 15 mm × 16.7 mm × 0.7 mm.
3) T_S is measured on the collector lead at the soldering point to the pcb.

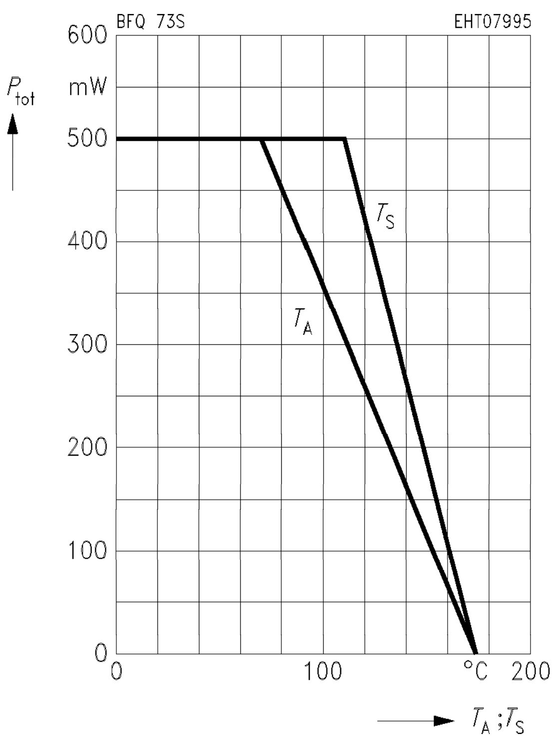
Electrical Characteristics
at T_A = 25 ˚C, unless otherwise specified.

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
DC Characteristics					
Collector-emitter breakdown voltage I_C = 1 mA, I_B = 0	$V_{(BR)CE0}$	15	–	–	V
Collector-base cutoff current V_{CB} = 10 V, I_E = 0	I_{CB0}	–	–	100	nA
Emitter-base cutoff current V_{EB} = 2 V, I_C = 0	I_{EB0}	–	–	10	µA
DC current gain I_C = 50 mA, V_{CE} = 5 V	h_{FE}	30	90	250	–
Collector-emitter saturation voltage I_C = 75 mA, I_B = 7.5 mA	V_{CEsat}	–	0.2	0.5	V

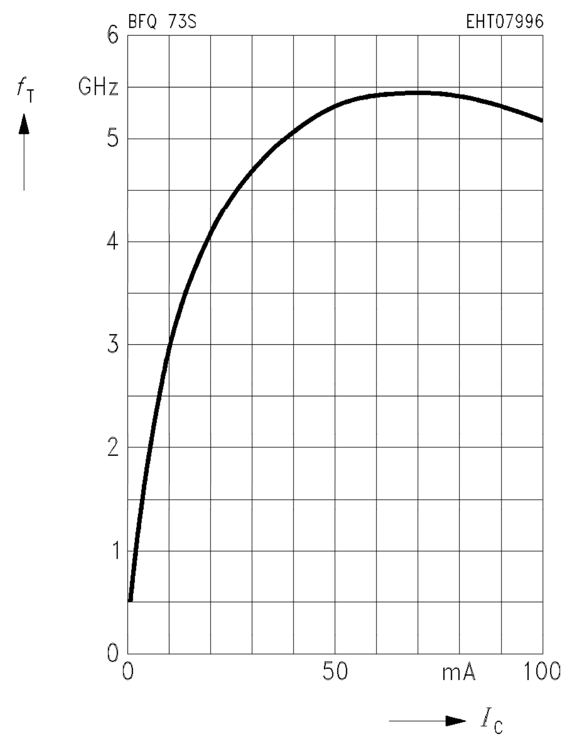
Electrical Characteristics
at T_A = 25 ˚C, unless otherwise specified.

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
AC Characteristics					
Transition frequency I_C = 50 mA, V_{CE} = 5 V, f = 200 MHz I_C = 75 mA, V_{CE} = 5 V, f = 200 MHz	f_T	 – –	 5.3 5.4	 – –	GHz
Collector-base capacitance V_{CB} = 10 V, V_{BE} = v_{be} = 0, f = 1 MHz	C_{cb}	–	0.9	–	pF
Collector-emitter capacitance V_{CE} = 10 V, V_{BE} = v_{be} = 0, f = 1 MHz	C_{ce}	–	0.4	–	
Input capacitance V_{EB} = 0.5 V, I_C = i_c = 0, f = 1 MHz	C_{ibo}	–	5	–	
Output capacitance V_{CE} = 10 V, V_{BE} = v_{be} = 0, f = 1 MHz	C_{obs}	–	1.3	–	
Noise figure I_C = 5 mA, V_{CE} = 10 V, f = 10 MHz, Z_S = 50 Ω I_C = 50 mA, V_{CE} = 5 V, f = 800 MHz, Z_S = Z_{Sopt}	F	 – –	 0.9 2.5	 – –	dB
Power gain I_C = 50 mA, V_{CE} = 5 V, f = 800 MHz, Z_S = Z_{Sopt}, Z_L = Z_{Lopt}	G_{pe}	–	15	–	
Transducer gain I_C = 50 mA, V_{CE} = 5 V, f = 1 GHz, Z_0 = 50 Ω	$\|S_{21e}\|^2$	–	10.5	–	
Linear output voltage two-tone intermodulation test I_C = 50 mA, V_{CE} = 10 V, d_{IM} = 60 dB f_1 = 806 MHz, f_2 = 810 MHz, Z_S = Z_L = 50 Ω	V_{o1} = V_{o2}	–	400	–	mV
Third order intercept point I_C = 50 mA, V_{CE} = 10 V, f = 800 MHz	IP_3	–	35	–	dBm

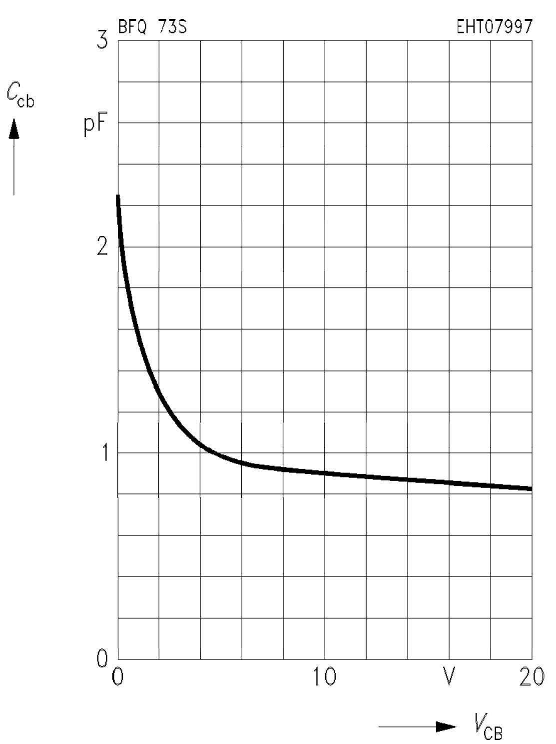
Total power dissipation $P_{tot} = f(T_A{}^*;\ T_S)$
* Package mounted on alumina



Transition frequency $f_T = f(I_C)$
V_{CE} = 5 V, f = 200 MHz



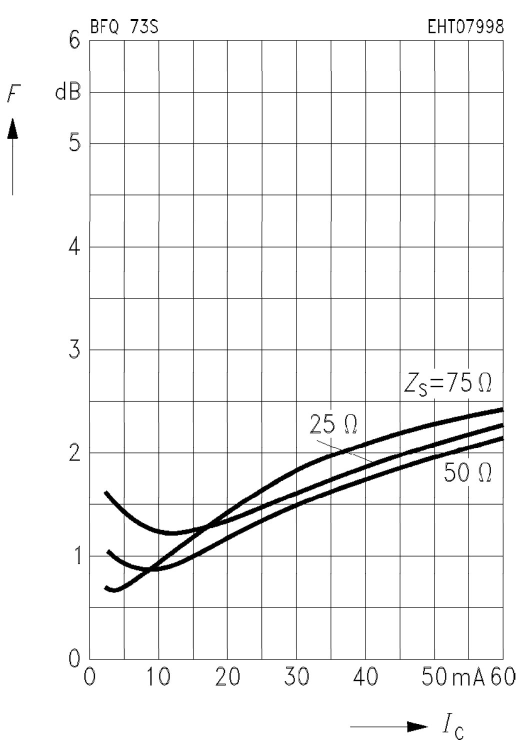
Collector-base capacitance $C_{cb} = f(V_{CB})$
$V_{BE} = v_{be}$ = 0, f = 1 MHz



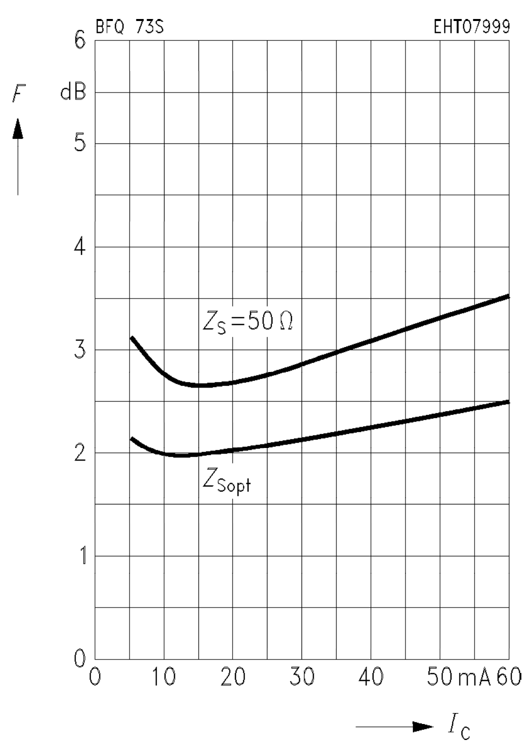
Common Emitter Noise Parameters

f	F_{min}	$G_p(F_{min})$	Γ_{opt}		R_N	N	$F_{50\,\Omega}$	$G_p(F_{50\Omega})$
GHz	dB	dB	MAG	ANG	Ω	–	dB	dB
I_C = 5 mA, V_{CE} = 5 V, Z_0 = 50 Ω								
0.01	0.9	–	(Z_S = 50 Ω)		–	–	–	–
I_C = 50 mA, V_{CE} = 5 V, Z_0 = 50 Ω								
0.01	2.0	–	(Z_S = 50 Ω)		–	–	–	–
0.8	2.5	14	0.41	163	9	0.39	3.8	–

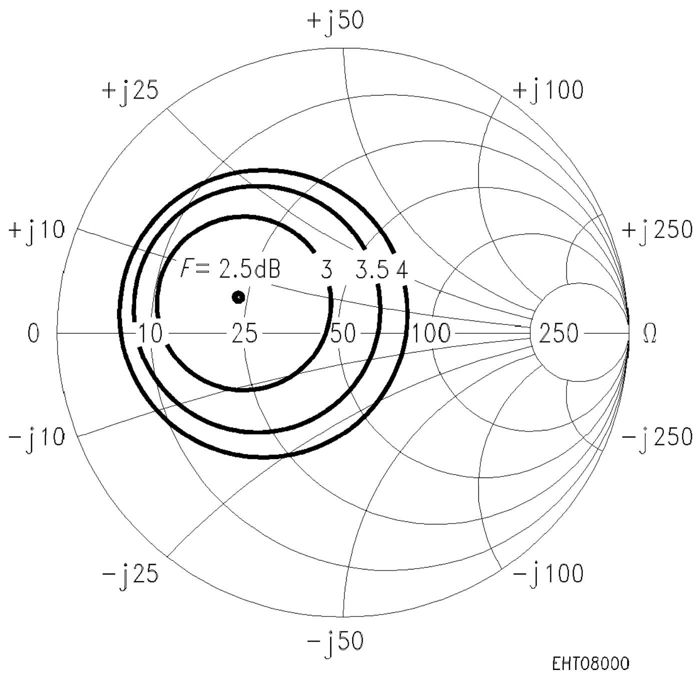
Noise figure $F = f(I_C)$
V_{CE} = 10 V, f = 10 MHz, Z_S = 50 Ω



Noise figure $F = f(I_C)$
V_{CE} = 5 V, f = 800 MHz

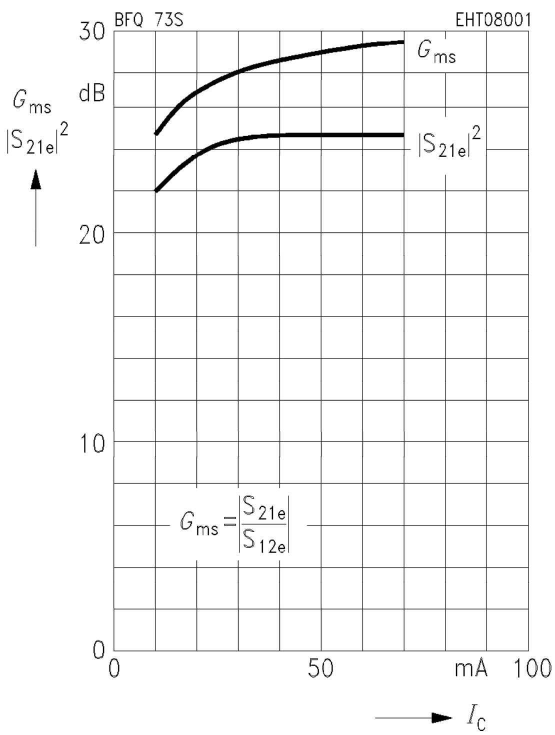


Circles of constant noise figure $F = f(Z_S)$ and available power gain $G_{av} = f(Z_S)$
I_C = 50 mA, V_{CE} = 5 V, f = 800 MHz,
Z_0 = 50 Ω

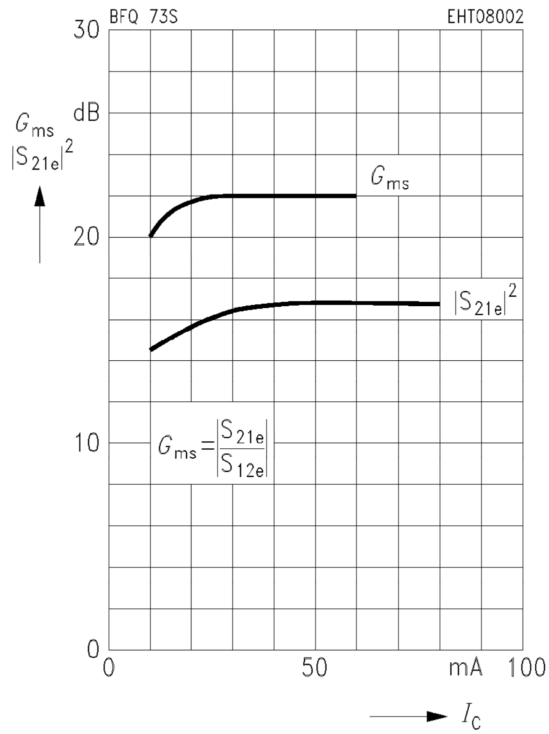


Common Emitter Power Gain

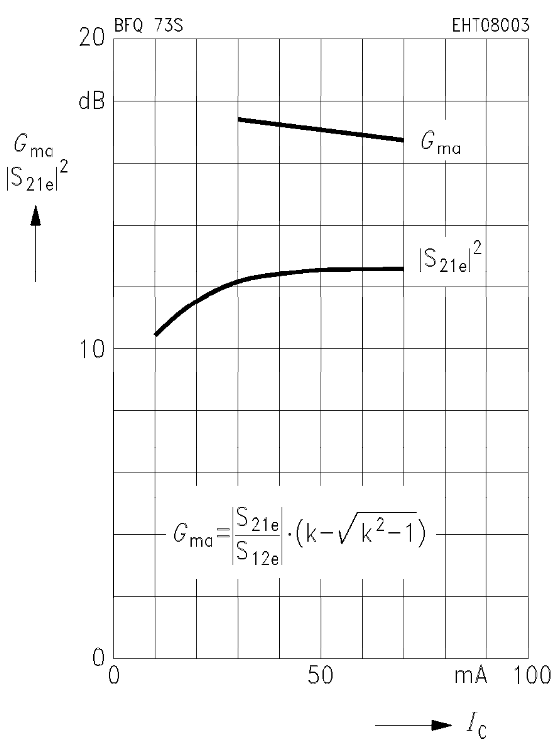
Power gain G_{ms}, $|S_{21e}|^2 = f(I_C)$
V_{CE} = 5 V, f = 200 MHz, Z_0 = 50 Ω



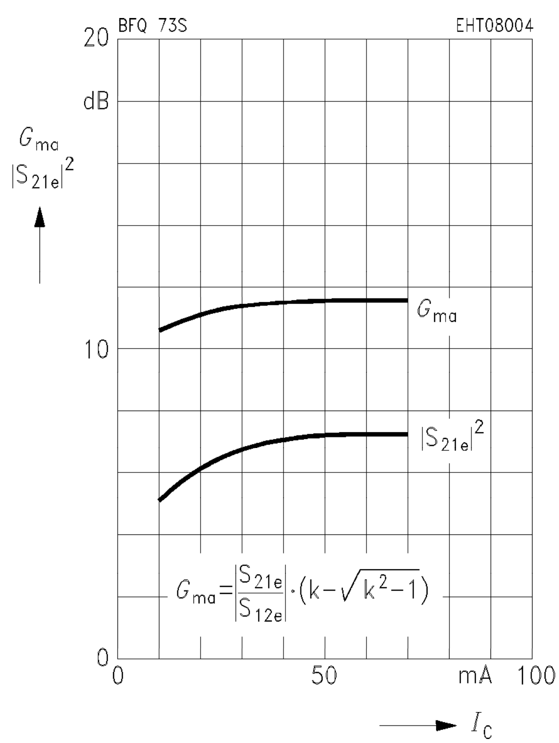
Power gain G_{ms}, $|S_{21e}|^2 = f(I_C)$
V_{CE} = 5 V, f = 500 MHz, Z_0 = 50 Ω



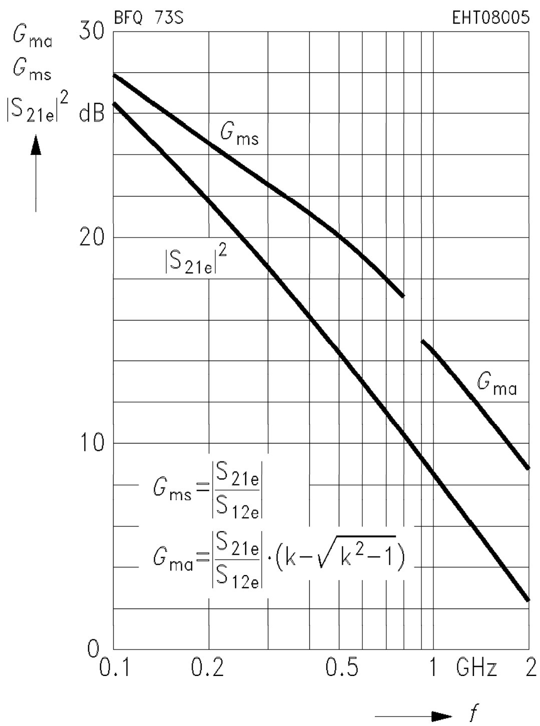
Power gain G_{ma}, $|S_{21e}|^2 = f(I_C)$
V_{CE} = 5 V, f = 800 MHz, Z_0 = 50 Ω



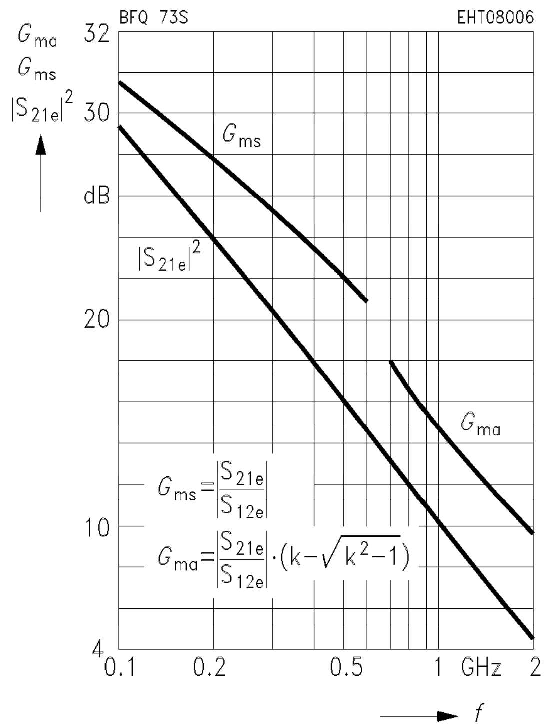
Power gain G_{ma}, $|S_{21e}|^2 = f(I_C)$
V_{CE} = 5 V, f = 1.5 GHz, Z_0 = 50 Ω



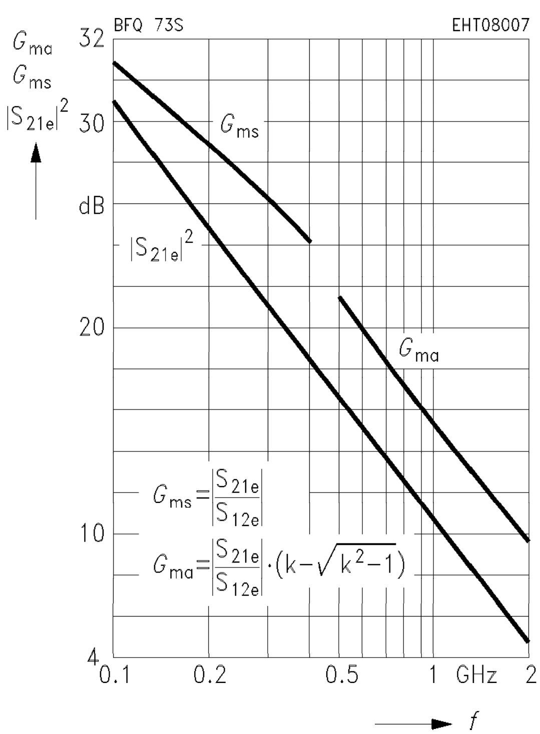
Power gain G_{ma}, G_{ms}, $|S_{21e}|^2 = f(f)$
I_C = 10 mA, V_{CE} = 5 V, Z_0 = 50 Ω



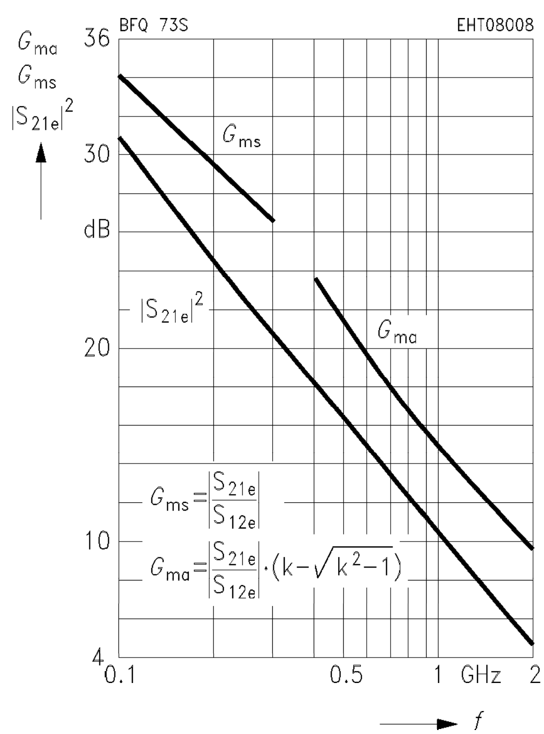
Power gain G_{ma}, G_{ms}, $|S_{21e}|^2 = f(f)$
I_C = 30 mA, V_{CE} = 5 V, Z_0 = 50 Ω



Power gain G_{ma}, G_{ms}, $|S_{21e}|^2 = f(f)$
I_C = 50 mA, V_{CE} = 5 V, Z_0 = 50 Ω



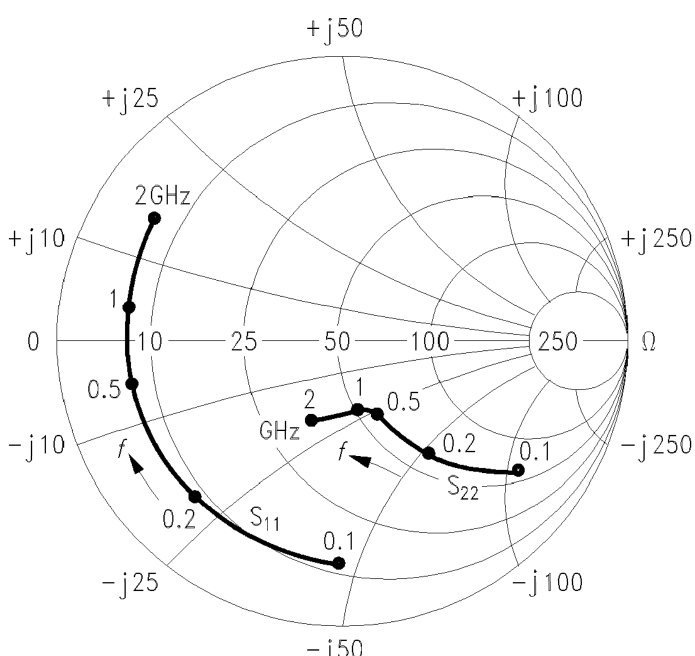
Power gain G_{ma}, G_{ms}, $|S_{21e}|^2 = f(f)$
I_C = 70 mA, V_{CE} = 5 V, Z_0 = 50 Ω



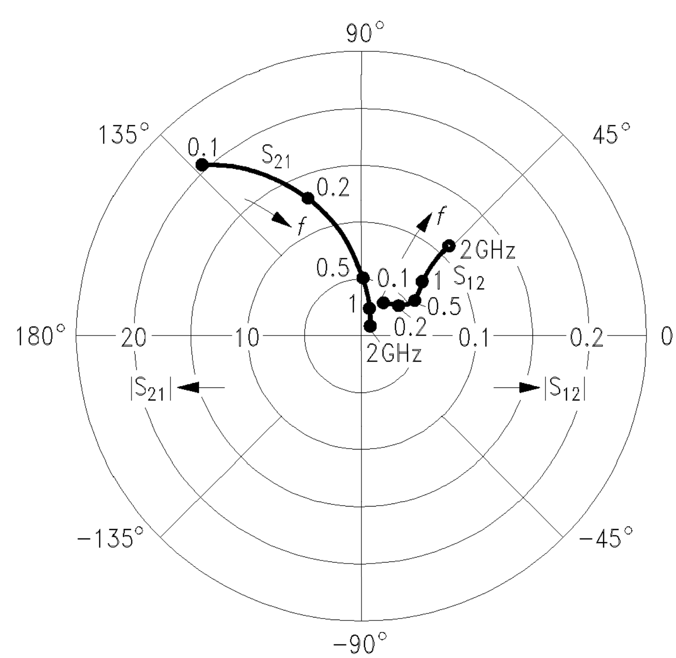
Common Emitter S Parameters

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
I_C = 10 mA, V_{CE} = 5 V, Z_0 = 50 Ω								
0.1	0.78	– 92	20.39	132	0.034	48	0.71	– 39
0.3	0.75	– 152	8.63	97	0.047	30	0.34	– 57
0.5	0.75	– 169	5.27	84	0.053	31	0.26	– 61
0.8	0.75	177	3.29	71	0.060	35	0.23	– 68
1.0	0.76	171	2.63	63	0.066	39	0.22	– 73
1.2	0.77	165	2.21	57	0.073	42	0.22	– 79
1.4	0.77	159	1.91	50	0.081	43	0.23	– 84
1.6	0.77	155	1.68	44	0.089	45	0.24	– 91
1.8	0.78	151	1.49	38	0.098	45	0.25	– 98
2.0	0.79	147	1.34	32	0.107	46	0.26	– 106

S_{11}, S_{22} = f (f)
I_C = 10 mA, V_{CE} = 5 V, Z_0 = 50 Ω



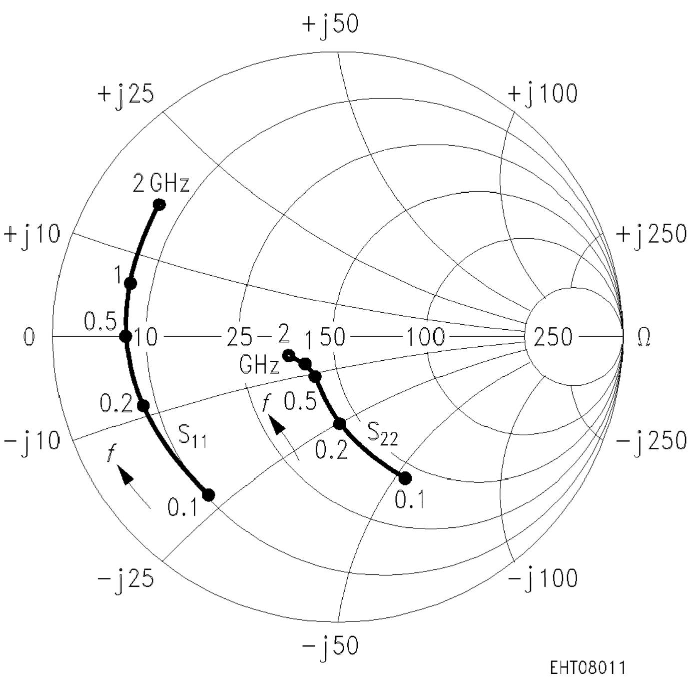
S_{12}, S_{21} = f (f)
I_C = 10 mA, V_{CE} = 5 V, Z_0 = 50 Ω



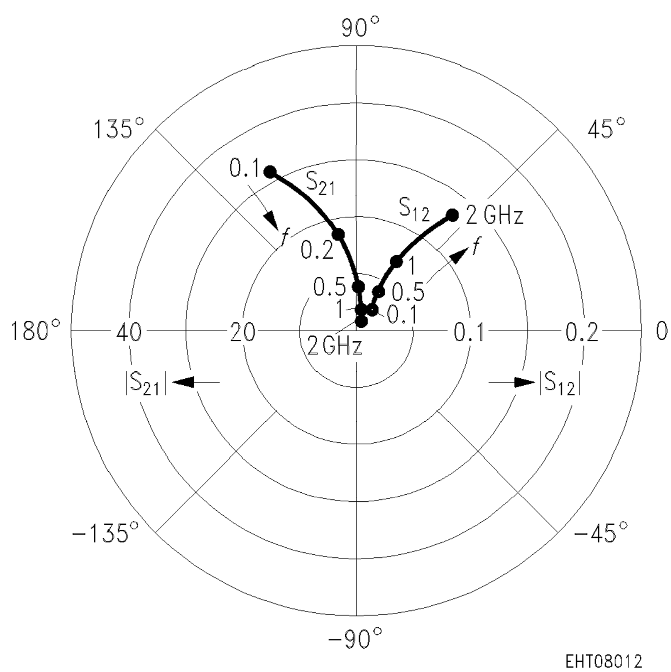
Common Emitter S Parameters (continued)

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
I_C = 30 mA, V_{CE} = 5 V, Z_0 = 50 Ω								
0.1	0.72	– 30	31.12	117	0.022	44	0.49	– 66
0.3	0.73	– 168	11.01	91	0.029	45	0.20	– 103
0.5	0.74	– 179	6.61	82	0.040	51	0.15	– 119
0.8	0.73	170	4.10	71	0.056	55	0.14	– 132
1.0	0.75	166	3.27	64	0.067	56	0.13	– 139
1.2	0.75	161	2.75	59	0.079	56	0.13	– 144
1.4	0.76	156	2.38	53	0.090	55	0.14	– 146
1.6	0.75	152	2.09	47	0.102	54	0.14	– 148
1.8	0.76	149	1.85	41	0.113	52	0.16	– 152
2.0	0.78	145	1.67	36	0.123	51	0.17	– 157

S_{11}, S_{22} = f (f)
I_C = 30 mA, V_{CE} = 5 V, Z_0 = 50 Ω



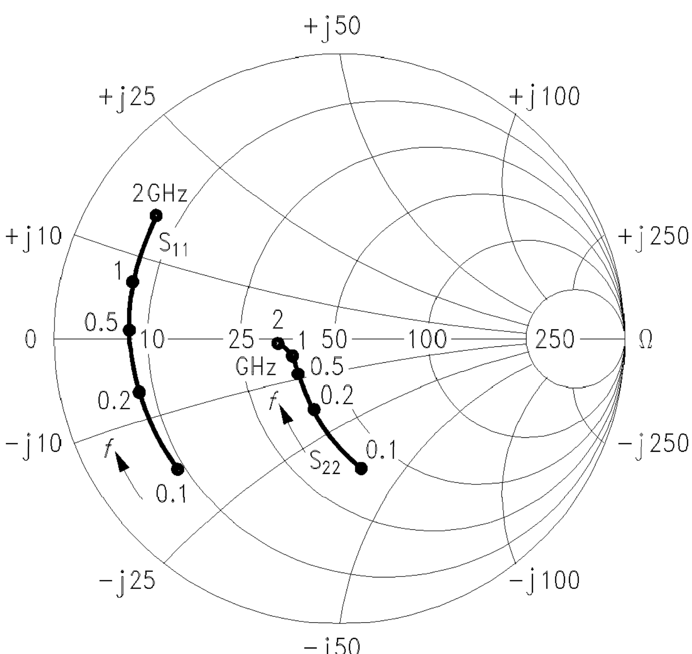
S_{12}, S_{21} = f (f)
I_C = 30 mA, V_{CE} = 5 V, Z_0 = 50 Ω



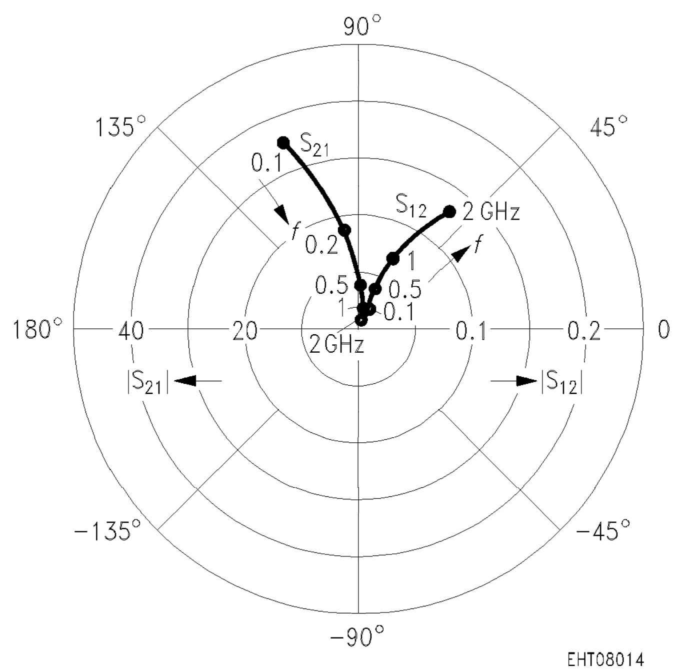
Common Emitter S Parameters (continued)

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
I_C = 50 mA, V_{CE} = 5 V, Z_0 = 50 Ω								
0.1	0.72	– 142	33.86	111	0.018	43	0.42	– 79
0.3	0.73	– 173	11.49	90	0.027	52	0.19	– 122
0.5	0.73	177	6.87	81	0.038	58	0.16	– 139
0.8	0.73	169	4.25	70	0.056	60	0.15	– 152
1.0	0.75	165	3.39	64	0.068	60	0.15	– 158
1.2	0.75	160	2.85	59	0.080	59	0.15	– 162
1.4	0.75	155	2.46	53	0.092	58	0.15	– 165
1.6	0.75	152	2.16	48	0.105	56	0.16	– 166
1.8	0.75	148	1.92	42	0.116	53	0.17	– 169
2.0	0.78	144	1.72	37	0.126	52	0.18	– 172

$S_{11}, S_{22} = f(f)$
I_C = 50 mA, V_{CE} = 5 V, Z_0 = 50 Ω



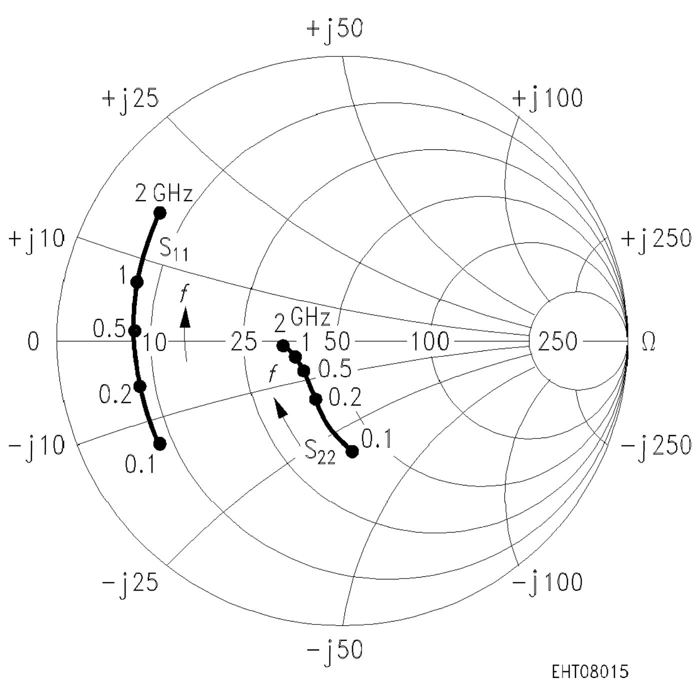
$S_{12}, S_{21} = f(f)$
I_C = 50 mA, V_{CE} = 5 V, Z_0 = 50 Ω



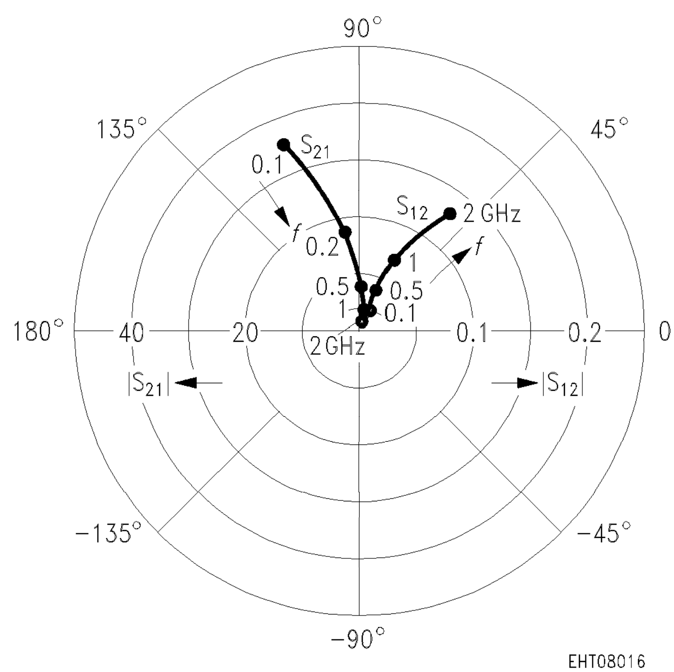
Common Emitter S Parameters (continued)

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	**MAG**	**ANG**	**MAG**	**ANG**	**MAG**	**ANG**	**MAG**	**ANG**
I_C = 70 mA, V_{CE} = 5 V, Z_0 = 50 Ω								
0.1	0.72	– 149	34.51	108	0.014	42	0.37	– 87
0.3	0.73	– 175	11.47	89	0.025	56	0.18	– 130
0.5	0.73	176	6.84	80	0.037	62	0.16	– 146
0.8	0.74	168	4.24	70	0.056	63	0.16	– 157
1.0	0.75	164	3.38	64	0.069	62	0.16	– 163
1.2	0.75	159	2.84	59	0.081	61	0.16	– 167
1.4	0.76	155	2.45	53	0.093	59	0.16	– 170
1.6	0.75	151	2.15	48	0.105	57	0.16	– 171
1.8	0.77	148	1.91	42	0.177	54	0.17	– 173
2.0	0.78	144	1.71	38	0.127	52	0.18	– 177

S_{11}, S_{22} = *f* (*f*)
I_C = 70 mA, V_{CE} = 5 V, Z_0 = 50 Ω

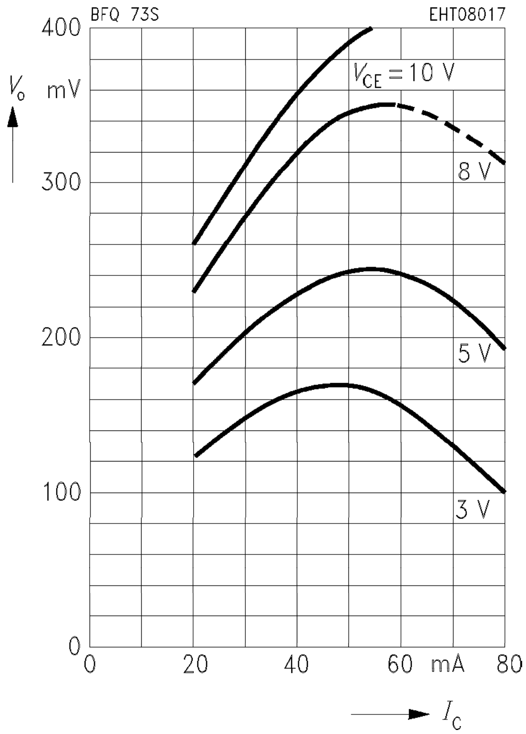


S_{12}, S_{21} = *f* (*f*)
I_C = 70 mA, V_{CE} = 5 V, Z_0 = 50 Ω



Common Emitter Large Signal Parameters

Linear output voltage $V_O = f(I_C)$
d_{IM} = 60 dB, f_1 = 806 MHz,
f_2 = 810 MHz, $Z_S = Z_L$ = 50 Ω



Note:

The transistor is driven by 2 adjacent signals f_1, f_2 with equal <u>output</u> power levels P_o for each carrier.

The distance d_{IM} between P_o and the third order intermodulation products P_{IM} ($2f_1 - f_2$ or $2f_2 - f_1$) is:

$d_{IM} = P_o - P_{IM}$
where $P_o = 10 \log (V_o^2 \ / (50\ \Omega \cdot 1 \text{mW}))$ (dBm)
and V_o = linear <u>output</u> voltage of each carrier.

The 3rd order intercept point IP_3 will be found by extrapolation to the point where P_{IM} would be identical to P_o:

IP_3 (output) = $P_o + d_{IM}/2$.

Linear output voltages for other d_{IM} (e.g. 50 dB) can be calculated thereby.