NPN 5 GHz wideband transistor

BFR90A

FEATURES

- Low noise
- Low intermodulation distortion
- High power gain
- Gold metallization.

DESCRIPTION

NPN transistor in a plastic SOT37 envelope primarily intended for use in RF wideband amplifiers.

A SOT54 (TO-92) version (ref: ON4184) is available on request.

PNP complement is the BFQ51.

PINNING

PIN	DESCRIPTION
Code: BFR90A/02	
1	base
2	emitter
3	collector

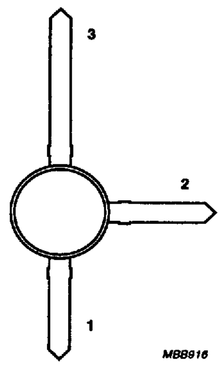


Fig.1 SOT37.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter	–	20	V
V_{CEO}	collector-emitter voltage	open base	–	15	V
I_C	DC collector current		–	25	mA
P_{tot}	total power dissipation	up to T_s = 155 °C (note 1)	–	300	mW
f_T	transition frequency	I_C = 14 mA; V_{CE} = 10 V; f = 500 MHz; T_j = 25 °C	5	–	GHz
C_{re}	feedback capacitance	I_C = 0; V_{CE} = 10 V; f = 1 MHz	0.35	–	pF
G_{UM}	maximum unilateral power gain	I_C = 14 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C	15.5	–	dB
F	noise figure	I_C = 4 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C; Z_S = 60 Ω	1.7	–	dB
V_O	output voltage	d_{im} = –60 dB; I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C; $f_{(p+q-r)}$ = 793.25 MHz	150	–	mV
P_{L1}	output power at 1 dB gain compression	I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C; measured at f = 800 MHz	8	–	dBm
ITO	third order intercept point	I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C	27	–	dBm

Note

1. T_s is the temperature at the soldering point of the collector lead.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter	–	20	V
V_{CEO}	collector-emitter voltage	open base	–	15	V
V_{EBO}	emitter-base voltage	open collector	–	2	V
I_C	DC collector current		–	25	mA
P_{tot}	total power dissipation	up to T_s = 155 °C (note 1)	–	300	mW
T_{stg}	storage temperature		–65	150	°C
T_j	junction temperature		–	175	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	CONDITIONS	THERMAL RESISTANCE
$R_{th\ j-s}$	thermal resistance from junction to soldering point	up to T_s = 155 °C (note 1)	65 K/W

Note

1. T_s is the temperature at the soldering point of the collector lead.

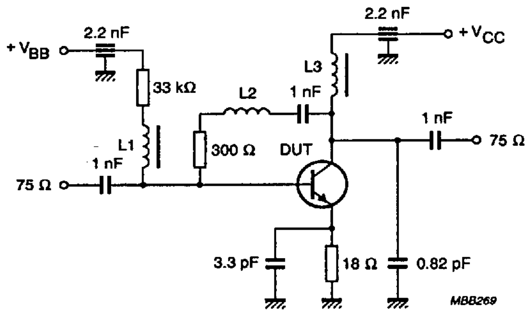
CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	I_E = 0; V_{CB} = 10 V	–	–	50	nA
h_{FE}	DC current gain	I_C = 14 mA; V_{CE} = 10 V	40	90	–	
f_T	transition frequency	I_C = 14 mA; V_{CE} = 10 V; f = 500 MHz	–	5	–	GHz
C_c	collector capacitance	$I_E = i_e$ = 0; V_{CB} = 10 V; f = 1 MHz	–	0.6	–	pF
C_e	emitter capacitance	$I_C = i_c$ = 0; V_{EB} = 0.5 V; f = 1 MHz	–	1.2	–	pF
C_{re}	feedback capacitance	I_C = 0; V_{CE} = 10 V; f = 1 MHz	–	0.35	–	pF
G_{UM}	maximum unilateral power gain (note 1)	I_C = 14 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C	–	15.5	–	dB
F	noise figure	I_C = 4 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C; Z_S = 60 Ω	–	1.7	–	dB
		I_C = 4 mA; V_{CE} = 10 V; f = 2 GHz; T_{amb} = 25 °C; Z_S = opt.	–	3.6	–	dB
d_2	second order intermodulation distortion	see Figs 2 and 8 and note 2	–	–50	–	dB
V_O	output voltage	see Figs 2 and 7 and note 3	–	150	–	mV
P_{L1}	output power at 1 dB gain compression (see Fig.2)	I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C; measured at f = 800 MHz	–	8	–	dBm
ITO	third order intercept point	see Fig.2 and note 4	–	27	–	dBm

Notes

1. G_{UM} is the maximum unilateral power gain, assuming S_{12} is zero and $G_{UM} = 10 \log \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$ dB.
2. I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; VSWR < 2; T_{amb} = 25 °C;
   V_p = 60 mV at f_p = 250 MHz;
   V_q = 60 mV at f_q = 560 MHz;
   measured at $f_{(p+q)}$ = 810 MHz.
3. d_{im} = –60 dB (DIN 45004B); I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; VSWR < 2; T_{amb} = 25 °C;
   $V_p = V_O$ at d_{im} = –60 dB; f_p = 795.25 MHz;
   $V_q = V_O$ –6 dB; f_q = 803.25 MHz;
   $V_r = V_O$ –6 dB; f_r = 805.25 MHz;
   measured at $f_{(p+q-r)}$ = 793.25 MHz.
4. I_C = 14 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C;
   P_p = ITO –6 dB; f_p = 800 MHz;
   P_q = ITO –6 dB; f_q = 801 MHz;
   measured at $f_{(2q-p)}$ = 802 MHz and $f_{(2p-q)}$ = 799 MHz.



L1 = L3 = 5 µH microchoke.

L2 = 3 turns 0.4 mm copper wire; winding pitch 1 mm; internal diameter 3 mm.

Fig.2 Intermodulation distortion and second order intermodulation distortion test circuit.

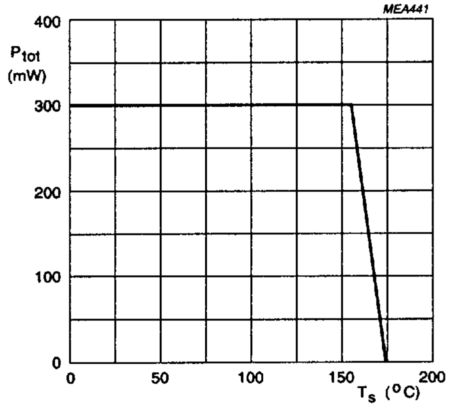
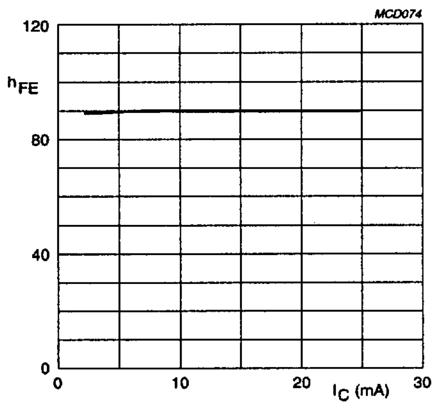
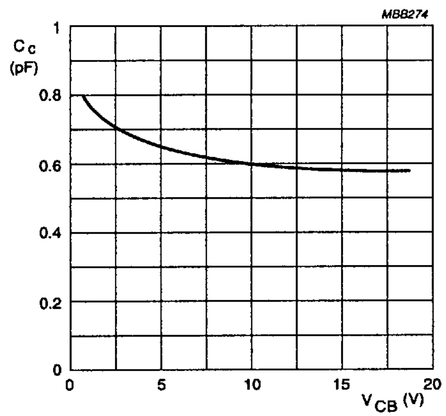


Fig.3 Power derating curve.



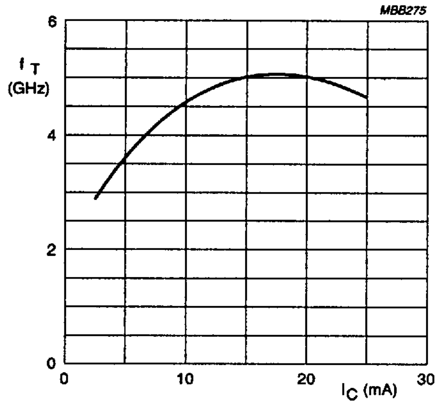
V_{CE} = 10 V; T_j = 25 °C.

Fig.4 DC current gain as a function of collector current.



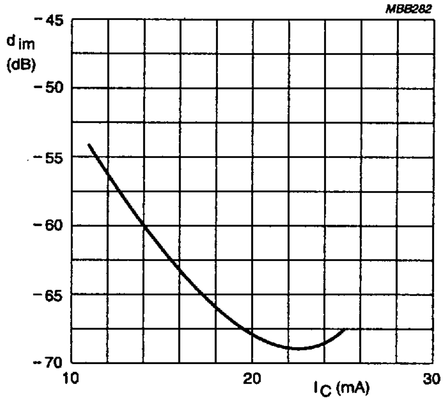
$I_E = i_e = 0$; f = 1 MHz; T_j = 25 °C.

Fig.5 Collector capacitance as a function of collector-base voltage.



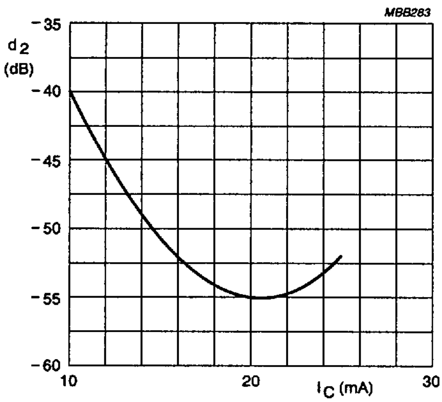
V_{CE} = 10 V; f = 500 MHz; T_j = 25 °C.

Fig.6 Transition frequency as a function of collector current.



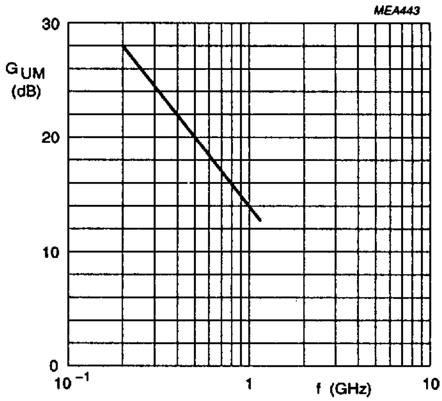
V_{CE} = 10 V; V_O = 43.5 dBmV = 150 mV;
$f_{(p+q-r)}$ = 793.25 MHz; T_{amb} = 25 °C;
measured in test circuit (see Fig.2).

Fig.7 Intermodulation distortion as a function of collector current.



V_{CE} = 10 V; V_O = 60 mV;
$f_{(p+q)}$ = 810 MHz; T_{amb} = 25 °C;
measured in test circuit (see Fig.2).

Fig.8 Second order intermodulation distortion as a function of collector current.



I_C = 14 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.9 Maximum unilateral power gain as a function of frequency.

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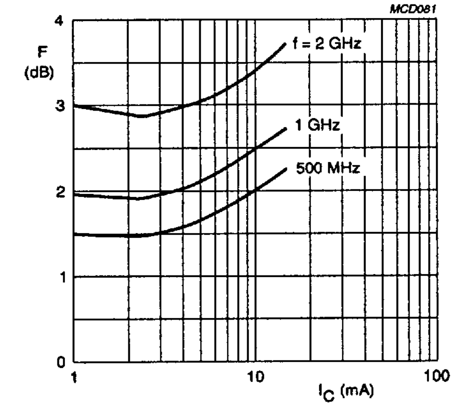
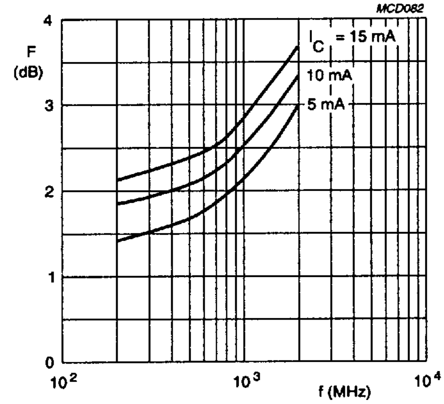


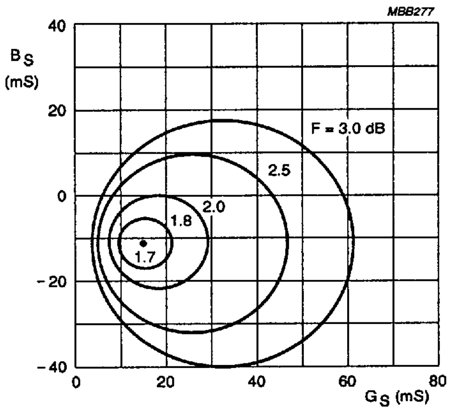
V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.10 Minimum noise figure as a function of collector current.



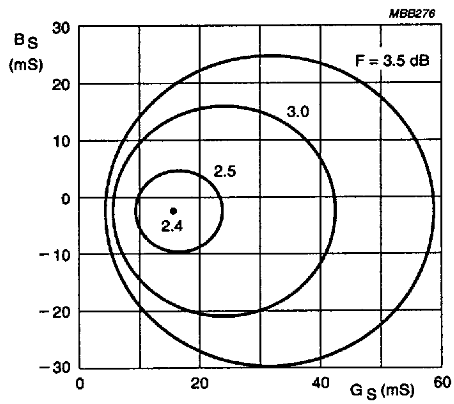
V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.11 Minimum noise figure as a function of frequency.



I_C = 4 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C.

Fig.12 Noise circle figure.



I_C = 14 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C.

Fig.13 Noise circle figure.

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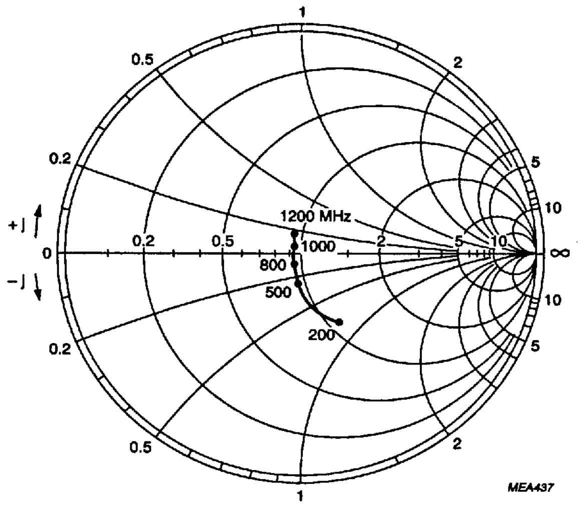
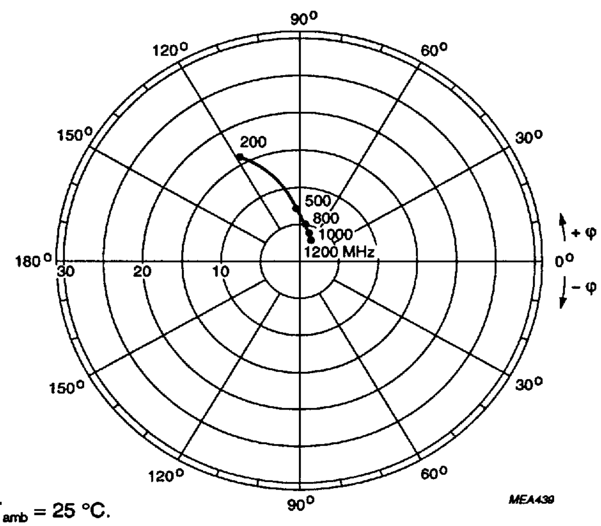


I_C = 14 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.14 Common emitter input reflection coefficient (S_{11}).



I_C = 14 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.15 Common emitter forward transmission coefficient (S_{21}).

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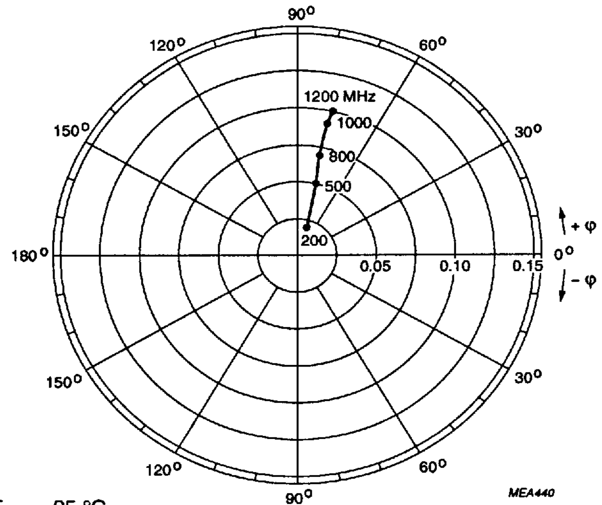
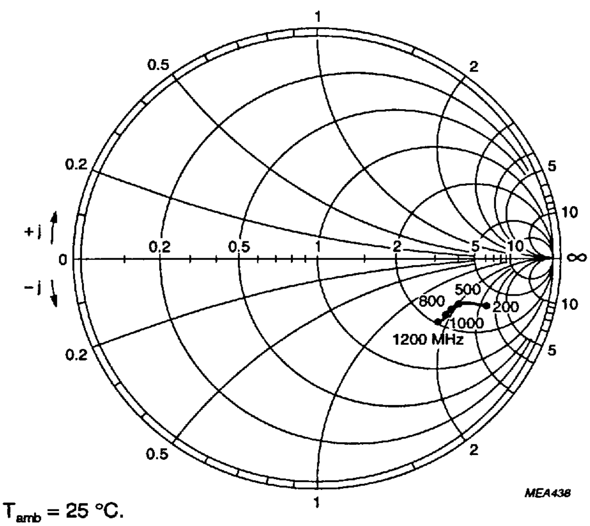


I_C = 14 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.16 Common emitter reverse transmission coefficient (S_{12}).



I_C = 14 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.17 Common emitter output reflection coefficient (S_{22}).

Table 1 Common emitter scattering parameters, I_C = 10 mA; V_{CE} = 5 V

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}		G_{UM} (dB)
	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	
40	0.754	−15.0	24.542	163.3	0.007	81.6	0.971	−7.0	43.9
100	0.646	−33.3	20.969	142.8	0.017	74.2	0.881	−15.3	35.3
200	0.451	−52.5	15.098	120.9	0.029	69.2	0.745	−20.7	28.1
300	0.325	−63.8	11.337	107.9	0.038	68.2	0.669	−22.2	24.1
400	0.251	−70.9	8.979	99.3	0.048	68.2	0.631	−23.2	21.5
500	0.195	−76.6	7.417	92.4	0.058	68.4	0.607	−24.7	19.6
600	0.154	−80.3	6.306	87.1	0.067	67.5	0.596	−26.0	18.0
700	0.121	−80.6	5.431	82.0	0.077	67.0	0.587	−27.5	16.6
800	0.094	−80.6	4.808	78.3	0.086	66.3	0.582	−28.8	15.5
900	0.073	−79.9	4.306	74.1	0.095	65.1	0.574	−30.2	14.4
1000	0.046	−80.3	3.908	70.1	0.105	64.0	0.567	−31.5	13.5
1200	0.004	54.5	3.357	62.5	0.124	60.9	0.545	−35.4	12.1
1400	0.042	88.7	2.912	55.7	0.143	57.4	0.521	−40.4	10.7
1600	0.067	84.8	2.587	49.7	0.161	55.3	0.515	−46.0	9.6
1800	0.085	79.8	2.379	43.7	0.181	52.5	0.513	−51.1	8.9
2000	0.122	72.5	2.177	37.4	0.197	48.9	0.506	−55.1	8.1
2200	0.162	70.3	1.996	31.4	0.214	45.9	0.484	−58.7	7.3
2400	0.196	71.5	1.890	26.3	0.230	43.0	0.456	−64.6	6.7
2600	0.225	71.2	1.812	20.0	0.249	39.3	0.437	−72.3	6.3
2800	0.245	65.8	1.705	13.8	0.266	36.0	0.434	−79.4	5.8
3000	0.263	60.7	1.622	9.7	0.282	33.6	0.437	−84.2	5.4

Table 2 Common emitter scattering parameters, I_C = 15 mA; V_{CE} = 5 V

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}		G_{UM} (dB)
	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	
40	0.664	−18.4	32.077	158.9	0.007	82.3	0.944	−9.2	42.3
100	0.525	−38.8	25.368	136.2	0.015	75.0	0.822	−17.1	34.4
200	0.342	−56.1	16.776	115.8	0.026	73.6	0.685	−20.2	27.8
300	0.238	−64.7	12.160	105.1	0.036	73.8	0.623	−20.5	24.1
400	0.178	−70.2	9.445	98.2	0.046	75.0	0.592	−20.9	21.5
500	0.141	−73.6	7.695	93.3	0.055	75.6	0.574	−21.9	19.5
600	0.111	−75.6	6.508	89.5	0.065	75.3	0.565	−23.1	18.0
700	0.088	−74.2	5.656	86.0	0.076	75.3	0.559	−24.5	16.7
800	0.067	−70.6	5.004	82.7	0.085	74.8	0.554	−26.0	15.6
900	0.047	−60.8	4.462	79.3	0.095	74.3	0.549	−27.4	14.6
1000	0.028	−38.4	4.021	76.6	0.105	73.7	0.542	−29.0	13.6
1200	0.026	59.7	3.404	71.5	0.124	72.1	0.527	−32.6	12.1
1400	0.056	86.0	3.016	66.7	0.144	70.7	0.511	−36.9	10.9
1600	0.072	86.1	2.668	61.8	0.162	69.1	0.503	−41.9	9.8
1800	0.092	78.3	2.404	58.3	0.180	67.8	0.494	−46.5	8.9
2000	0.126	71.3	2.200	53.5	0.198	66.0	0.486	−50.3	8.1
2200	0.171	71.0	2.060	49.9	0.215	64.1	0.466	−54.4	7.5
2400	0.207	73.1	1.931	44.0	0.233	62.6	0.437	−59.7	6.8
2600	0.226	74.3	1.786	41.4	0.251	60.3	0.416	−66.5	6.1
2800	0.241	70.3	1.755	37.1	0.266	58.9	0.412	−73.8	6.0
3000	0.268	63.9	1.633	32.6	0.284	57.9	0.411	−79.8	5.4

Table 3 Common emitter scattering parameters, I_C = 10 mA; V_{CE} = 10 V

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}		G_{UM} (dB)
	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	
40	0.779	−13.9	24.287	163.6	0.007	82.5	0.974	−6.4	44.7
100	0.672	−31.2	20.893	143.5	0.016	74.2	0.889	−14.2	35.8
200	0.481	−49.2	15.178	121.7	0.027	69.8	0.763	−19.2	28.6
300	0.351	−59.1	11.458	108.7	0.036	68.7	0.690	−20.9	24.6
400	0.272	−65.2	9.092	100.1	0.046	68.7	0.653	−21.9	21.9
500	0.217	−68.9	7.510	93.3	0.055	68.6	0.631	−23.4	19.9
600	0.176	−71.4	6.391	87.8	0.063	68.1	0.620	−24.9	18.4
700	0.146	−70.5	5.514	82.9	0.073	67.5	0.611	−26.2	17.0
800	0.121	−67.6	4.885	79.0	0.082	66.7	0.606	−27.6	15.8
900	0.100	−65.5	4.373	74.9	0.091	65.5	0.601	−28.9	14.8
1000	0.072	−63.1	3.967	71.2	0.100	64.3	0.593	−30.3	13.9
1200	0.033	−38.7	3.408	63.5	0.118	61.3	0.573	−34.2	12.4
1400	0.025	47.3	2.963	56.8	0.136	58.1	0.548	−39.1	11.0
1600	0.046	62.7	2.629	50.6	0.154	56.0	0.542	−44.3	9.9
1800	0.061	62.7	2.422	44.9	0.172	53.3	0.542	−49.3	9.2
2000	0.099	64.7	2.214	38.6	0.187	49.9	0.533	−53.1	8.4
2200	0.131	65.8	2.023	32.7	0.203	47.1	0.511	−56.8	7.5
2400	0.171	69.8	1.922	27.5	0.219	44.1	0.486	−62.3	7.0
2600	0.200	70.2	1.843	21.4	0.237	40.5	0.469	−69.7	6.6
2800	0.220	64.5	1.735	14.7	0.253	37.3	0.464	−76.6	6.1
3000	0.236	60.5	1.653	10.7	0.268	35.1	0.469	−81.2	5.7

Table 4 Common emitter scattering parameters, I_C = 15 mA; V_{CE} = 10 V

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}		G_{UM} (dB)
	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	MAG. (RAT)	ANG. (DEG)	
40	0.708	−16.9	31.405	159.6	0.006	81.6	0.948	−8.4	42.9
100	0.570	−36.0	25.156	137.4	0.014	75.1	0.836	−15.9	34.9
200	0.381	−51.8	16.853	117.0	0.025	73.3	0.706	−19.0	28.2
300	0.273	−58.8	12.283	106.1	0.035	73.8	0.645	−19.5	24.5
400	0.209	−62.5	9.559	99.1	0.044	75.2	0.615	−20.0	21.9
500	0.170	−64.6	7.798	94.2	0.054	75.6	0.598	−21.0	19.9
600	0.140	−64.8	6.603	90.4	0.063	75.2	0.589	−22.2	18.3
700	0.117	−63.2	5.742	86.9	0.072	75.2	0.583	−23.5	17.0
800	0.098	−59.4	5.081	83.6	0.082	74.8	0.578	−25.0	15.9
900	0.080	−52.1	4.531	80.2	0.091	74.4	0.573	−26.4	14.9
1000	0.062	−42.1	4.085	77.5	0.101	73.7	0.567	−27.9	13.9
1200	0.035	−5.5	3.457	72.5	0.119	72.4	0.552	−31.5	12.4
1400	0.036	50.4	3.070	67.7	0.138	71.0	0.536	−35.7	11.2
1600	0.049	65.0	2.718	62.9	0.156	69.6	0.528	−40.5	10.1
1800	0.068	63.4	2.445	59.4	0.172	68.3	0.520	−45.0	9.2
2000	0.104	62.2	2.239	54.7	0.189	66.7	0.512	−48.7	8.4
2200	0.145	66.5	2.098	51.2	0.206	65.1	0.493	−52.6	7.7
2400	0.181	70.8	1.970	45.1	0.223	63.4	0.464	−57.7	7.1
2600	0.199	72.8	1.821	42.6	0.240	61.3	0.444	−64.2	6.3
2800	0.213	69.4	1.793	38.4	0.255	59.9	0.441	−71.2	6.2
3000	0.241	62.8	1.670	33.8	0.272	59.1	0.440	−76.7	5.6