NPN 6 GHz wideband transistor

BFR91A

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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: ON4185) is available on request.

PNP complement is BFQ23.

PINNING

PIN	DESCRIPTION
Code: BFR91A/02	
1	base
2	emitter
3	collector

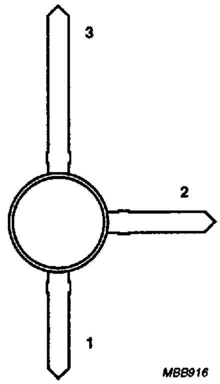


Fig.1 SOT37.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter	–	15	V
V_{CEO}	collector-emitter voltage	open base	–	12	V
I_C	DC collector current		–	35	mA
P_{tot}	total power dissipation	up to T_s = 155 °C (note 1)	–	300	mW
f_T	transition frequency	I_C = 30 mA; V_{CE} = 5 V; f = 500 MHz; T_j = 25 °C	6	–	GHz
C_{re}	feedback capacitance	I_C = 0; V_{CE} = 10 V; f = 1 MHz; T_{amb} = 25 °C	0.6	–	pF
G_{UM}	maximum unilateral power gain	I_C = 30 mA; V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C	14	–	dB
F	noise figure	I_C = 4 mA; V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C; Z_S = opt.	1.6	–	dB
V_O	output voltage	d_{im} = −60 dB; I_C = 30 mA; V_{CE} = 8 V; R_L = 75 Ω; T_{amb} = 25 °C; $f_{(p+q-r)}$ = 793.25 MHz	425	–	mV
P_{L1}	output power at 1 dB gain compression	I_C = 30 mA; V_{CE} = 8 V; R_L = 75 Ω; T_{amb} = 25 °C; measured at f = 800 MHz	17	–	dBm
ITO	third order intercept point	I_C = 30 mA; V_{CE} = 8 V; R_L = 75 Ω; T_{amb} = 25 °C	36	–	dBm

Note

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

NPN 6 GHz wideband transistor BFR91A

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter	–	15	V
V_{CEO}	collector-emitter voltage	open base	–	12	V
V_{EBO}	emitter-base voltage	open collector	–	2	V
I_C	DC collector current		–	35	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
$R_{th\ j\text{-}s}$	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.

NPN 6 GHz wideband transistor BFR91A

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

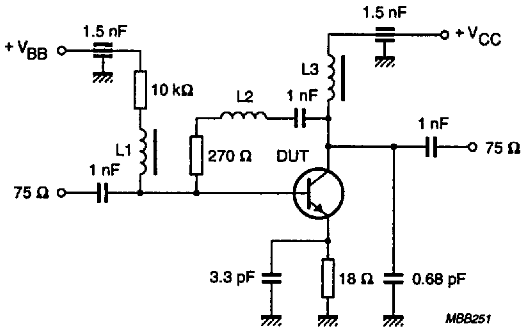
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	$I_E = 0$; $V_{CB} = 5$ V	–	–	50	nA
h_{FE}	DC current gain	$I_C = 30$ mA; $V_{CE} = 5$ V	40	90	–	
f_T	transition frequency	$I_C = 30$ mA; $V_{CE} = 5$ V; f = 500 MHz	–	6	–	GHz
C_c	collector capacitance	$I_E = i_e = 0$; $V_{CB} = 10$ V; f = 1 MHz	–	0.9	–	pF
C_e	emitter capacitance	$I_C = i_c = 0$; $V_{EB} = 0.5$ V; f = 1 MHz	–	2.5	–	pF
C_{re}	feedback capacitance	$I_C = 0$; $V_{CE} = 10$ V; f = 1 MHz; $T_{amb} = 25$ °C	–	0.6	–	pF
G_{UM}	maximum unilateral power gain (note 1)	$I_C = 30$ mA; $V_{CE} = 8$ V; f = 800 MHz; $T_{amb} = 25$ °C	–	14	–	dB
F	noise figure	$I_C = 4$ mA; $V_{CE} = 8$ V; f = 800 MHz; $T_{amb} = 25$ °C; Z_S = opt.	–	1.6	–	dB
		$I_C = 30$ mA; $V_{CE} = 8$ V; f = 2 GHz; $T_{amb} = 25$ °C; Z_S = opt.	–	2.3	–	dB
V_O	output voltage	see Figs 2 and 8 and note 2	–	425	–	mV
		see Figs 2 and 12 and note 3	–	200	–	mV
P_{L1}	output power at 1 dB gain compression (see Fig.2)	$I_C = 30$ mA; $V_{CE} = 8$ V; $R_L = 75\ \Omega$; $T_{amb} = 25$ °C; measured at f = 800 MHz	–	17	–	dBm
ITO	third order intercept point	see Fig.2 and note 4	–	36	–	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. $d_{im} = -60$ dB (DIN 45004B); $I_C = 30$ mA; $V_{CE} = 8$ V; $R_L = 75\ \Omega$; $T_{amb} = 25$ °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.
3. $d_2 = -50$ dB; $I_C = 30$ mA; $V_{CE} = 8$ V; $R_L = 75\ \Omega$; $T_{amb} = 25$ °C;
   $V_p = V_O$ at $d_2 = -50$ dB; $f_p = 250$ MHz;
   $V_q = V_O$ at $d_2 = -50$ dB; $f_p = 560$ MHz;
   measured at $f_{(p+q)} = 810$ MHz.
4. $I_C = 30$ mA; $V_{CE} = 8$ V; $R_L = 75\ \Omega$; $T_{amb} = 25$ °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.

NPN 6 GHz wideband transistor

BFR91A



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.

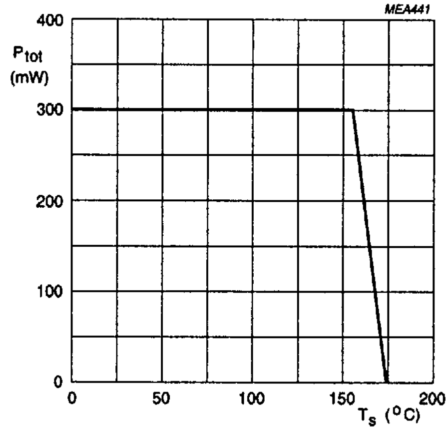
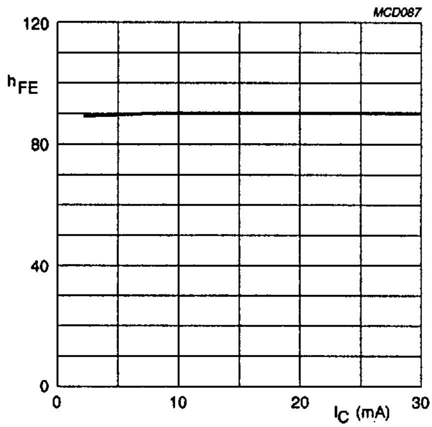
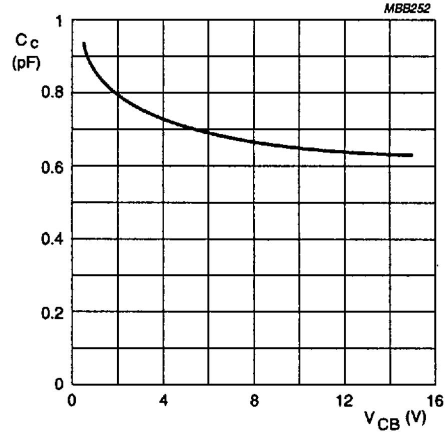


Fig.3 Power derating curve.



V_{CE} = 5 V; T_j = 25 °C.

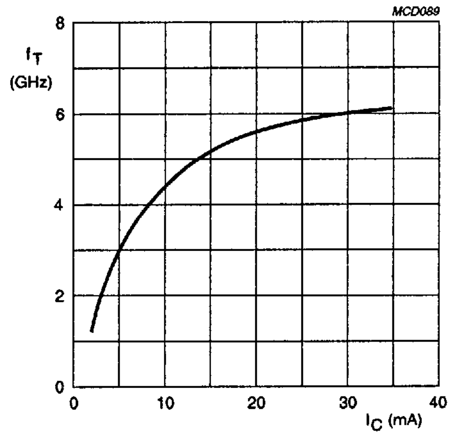
Fig.4 DC current gain as a function of collector current.



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

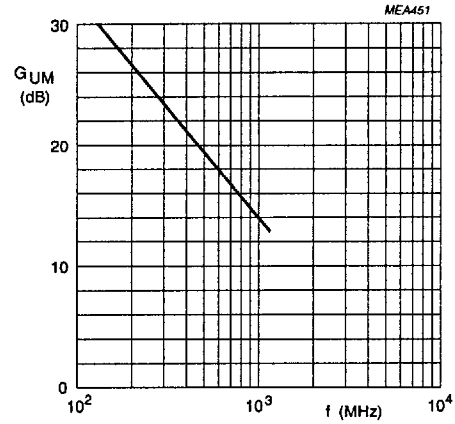
Fig.5 Collector capacitance as a function of collector-base voltage.

NPN 6 GHz wideband transistor BFR91A



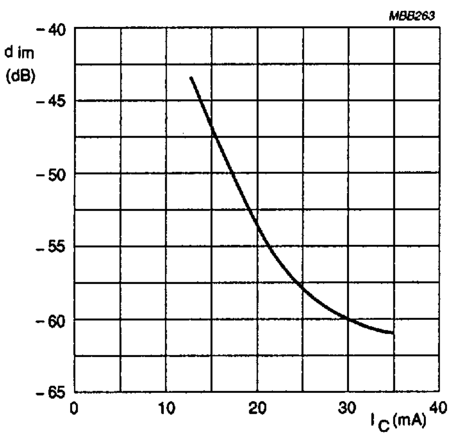
V_{CE} = 5 V; f = 500 MHz; T_j = 25 °C.

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



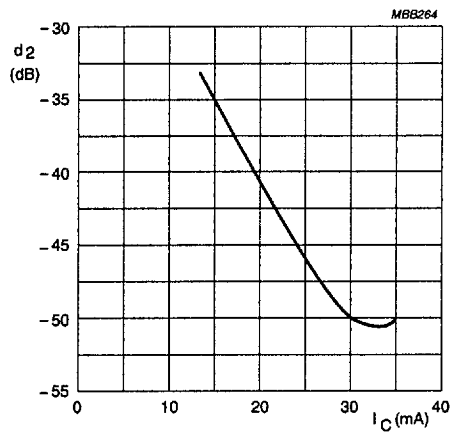
I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C.

Fig.7 Maximum unilateral power gain as a function of frequency.



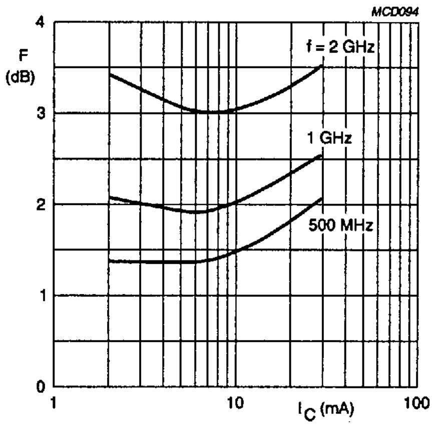
V_{CE} = 8 V; V_O = 425 mV = 52.60 dBmV;
$f_{(p+q-r)}$ = 793.25 MHz; T_{amb} = 25 °C;
measured in test circuit (see Fig.2).

Fig.8 Intermodulation distortion as a function of collector current.



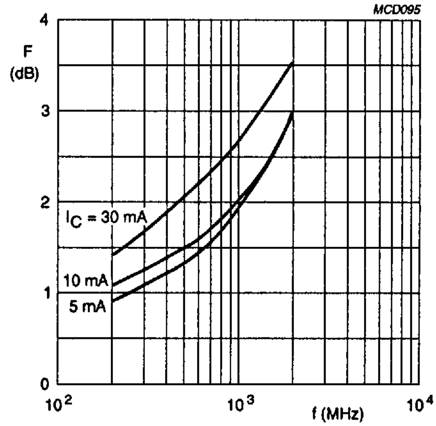
V_{CE} = 8 V; V_O = 200 mV = 46 dBmV;
$f_{(p+q)}$ = 810 MHz; T_{amb} = 25 °C;
measured in test circuit (see Fig.2).

Fig.9 Second order intermodulation distortion as a function of collector current.



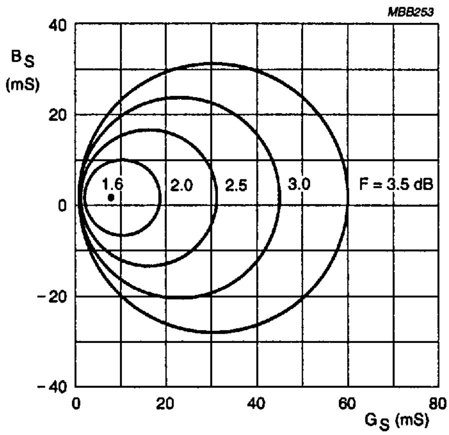
V_{CE} = 8 V; T_{amb} = 25 °C.

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



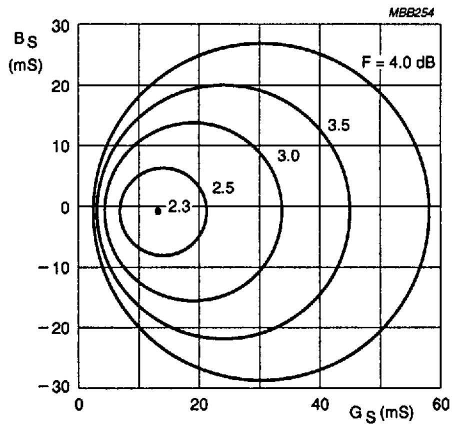
V_{CE} = 8 V; T_{amb} = 25 °C.

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



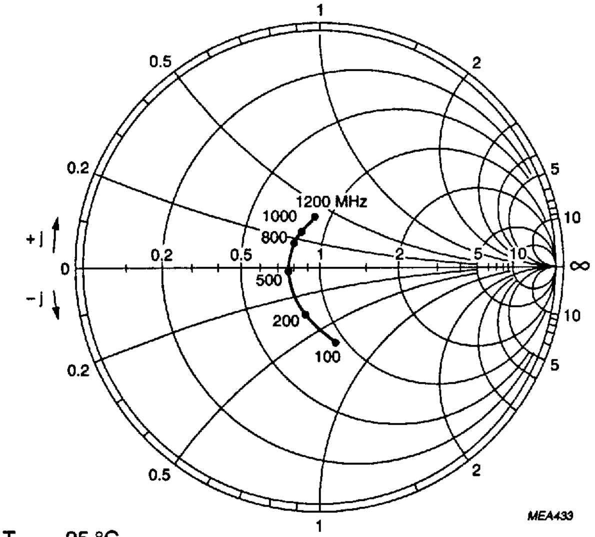
I_C = 4 mA; V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C.

Fig.12 Noise circle figure.



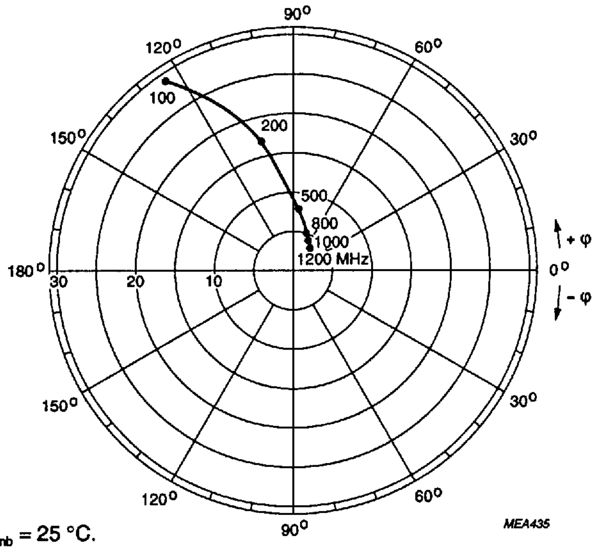
I_C = 30 mA; V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C.

Fig.13 Noise circle figure.



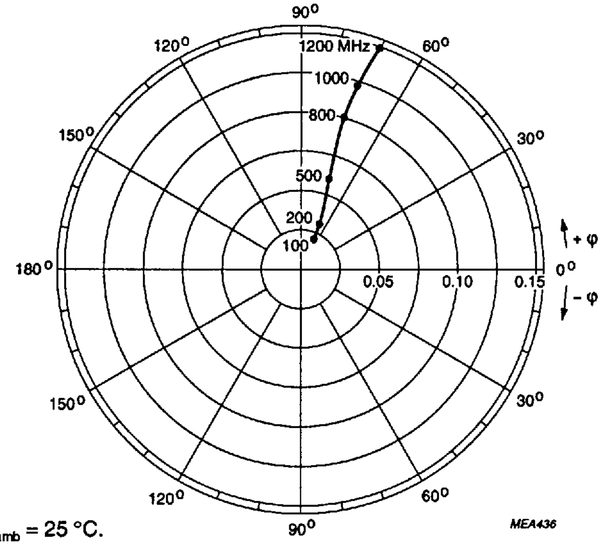
I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C.

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



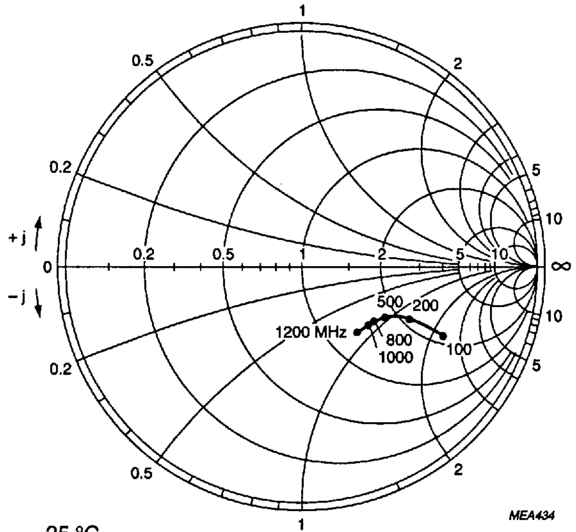
I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C.

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



I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C.

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



I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C.

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

NPN 6 GHz wideband transistor

BFR91A

N AMER PHILIPS/DISCRETE 69E D -

Table 1 Common emitter scattering parameters, I_C = 20 mA; V_{CE} = 5 V

f (MHz)	S_{11} MAG. (RAT)	S_{11} ANG. (DEG)	S_{21} MAG. (RAT)	S_{21} ANG. (DEG)	S_{12} MAG. (RAT)	S_{12} ANG. (DEG)	S_{22} MAG. (RAT)	S_{22} ANG. (DEG)	G_{UM} (dB)
40	0.479	−33.9	36.860	152.9	0.010	78.4	0.894	−16.9	39.4
100	0.350	−71.5	26.190	127.3	0.020	70.2	0.683	−29.3	31.7
200	0.234	−109.6	15.844	107.9	0.034	70.3	0.501	−32.4	25.5
300	0.194	−136.0	11.107	98.3	0.046	72.0	0.429	−31.9	22.0
400	0.180	−154.6	8.502	91.9	0.059	73.3	0.396	−31.8	19.5
500	0.177	−168.1	6.879	87.2	0.072	73.4	0.377	−32.5	17.6
600	0.175	−179.6	5.792	83.4	0.085	73.2	0.367	−33.9	16.0
700	0.173	170.2	5.017	79.6	0.098	72.5	0.360	−35.5	14.7
800	0.174	160.3	4.427	76.2	0.110	71.7	0.355	−37.2	13.6
900	0.178	149.6	3.945	72.8	0.123	71.2	0.349	−38.8	12.6
1000	0.188	140.5	3.563	70.0	0.136	70.1	0.342	−40.6	11.7
1200	0.220	127.1	3.008	64.3	0.161	68.0	0.324	−45.4	10.3
1400	0.252	118.4	2.641	58.9	0.184	65.8	0.305	−51.6	9.1
1600	0.267	111.7	2.332	53.7	0.209	63.8	0.297	−58.9	8.1
1800	0.282	102.8	2.103	49.2	0.231	61.2	0.288	−65.6	7.2
2000	0.311	93.0	1.928	44.2	0.254	58.8	0.278	−71.3	6.5
2200	0.356	86.3	1.800	39.9	0.275	56.2	0.257	−77.9	6.0
2400	0.396	82.0	1.671	34.7	0.296	54.5	0.230	−87.8	5.4
2600	0.418	78.9	1.560	31.5	0.318	51.4	0.217	−100.5	4.9
2800	0.428	73.2	1.486	26.6	0.332	49.0	0.221	−112.7	4.5
3000	0.451	66.5	1.383	22.5	0.352	47.7	0.224	−121.9	4.0

NPN 6 GHz wideband transistor BFR91A

Table 2 Common emitter scattering parameters, I_C = 30 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	0.377	−40.1	43.686	148.7	0.009	77.3	0.858	−19.8	39.3
100	0.262	−81.4	28.795	122.5	0.019	72.9	0.621	−31.5	31.6
200	0.181	−120.9	16.681	104.7	0.032	74.4	0.452	−32.5	25.6
300	0.160	−147.3	11.556	96.0	0.046	74.9	0.391	−31.3	22.1
400	0.156	−164.4	8.808	90.3	0.059	76.0	0.364	−31.2	19.6
500	0.158	−176.4	7.109	86.0	0.073	75.7	0.348	−32.1	17.7
600	0.158	173.5	5.977	82.4	0.087	74.8	0.340	−33.6	16.2
700	0.158	164.1	5.171	78.9	0.100	74.0	0.334	−35.3	14.9
800	0.161	154.8	4.562	75.6	0.113	73.0	0.330	−37.2	13.8
900	0.166	144.6	4.065	72.3	0.127	72.1	0.325	−38.9	12.8
1000	0.178	135.7	3.670	69.6	0.140	70.8	0.318	−40.9	11.9
1200	0.209	123.8	3.097	64.2	0.165	68.3	0.300	−45.8	10.4
1400	0.242	115.9	2.718	58.9	0.190	66.0	0.281	−52.3	9.3
1600	0.257	109.9	2.399	53.9	0.215	63.8	0.273	−60.1	8.2
1800	0.272	101.3	2.164	49.5	0.237	60.9	0.264	−67.1	7.4
2000	0.301	91.6	1.982	44.6	0.261	58.4	0.254	−72.8	6.6
2200	0.346	85.2	1.849	40.3	0.281	55.8	0.233	−79.9	6.1
2400	0.386	81.2	1.717	35.2	0.302	53.9	0.206	−90.6	5.6
2600	0.407	78.4	1.604	31.9	0.325	50.6	0.194	−104.4	5.1
2800	0.419	73.0	1.524	27.2	0.338	48.2	0.200	−117.5	4.7
3000	0.442	66.3	1.422	23.1	0.358	46.7	0.203	−127.2	4.2

Table 3 Common emitter scattering parameters, I_C = 20 mA; V_{CE} = 8 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	0.506	−31.1	37.283	153.0	0.009	78.6	0.902	−15.6	40.0
100	0.364	−64.6	26.682	127.0	0.019	70.0	0.701	−27.0	32.1
200	0.225	−99.3	16.147	106.7	0.033	69.9	0.528	−29.5	25.8
300	0.170	−125.8	11.336	96.4	0.045	70.4	0.461	−29.2	22.3
400	0.151	−143.9	8.697	89.5	0.058	70.3	0.430	−29.4	19.8
500	0.138	−159.6	7.070	83.7	0.071	70.0	0.414	−30.9	17.9
600	0.138	−173.7	5.958	78.9	0.083	68.9	0.406	−32.5	16.4
700	0.131	173.4	5.122	74.5	0.096	67.7	0.402	−34.1	15.0
800	0.132	161.9	4.530	70.7	0.109	66.3	0.398	−35.9	13.9
900	0.136	150.8	4.039	66.6	0.121	64.5	0.393	−37.3	12.9
1000	0.150	141.8	3.665	63.0	0.133	63.0	0.386	−38.9	12.1
1200	0.178	124.3	3.117	55.5	0.158	59.2	0.362	−43.4	10.6
1400	0.215	116.2	2.709	48.8	0.181	55.3	0.337	−50.1	9.4
1600	0.236	108.2	2.408	42.2	0.205	51.9	0.329	−58.4	8.4
1800	0.247	99.7	2.211	35.5	0.229	48.2	0.329	−65.3	7.7
2000	0.283	91.4	2.018	29.1	0.251	43.8	0.317	−70.5	6.9
2200	0.318	85.1	1.855	23.1	0.271	40.1	0.293	−76.0	6.2
2400	0.362	80.5	1.750	17.8	0.292	36.4	0.265	−85.4	5.8
2600	0.388	76.7	1.661	11.2	0.312	32.4	0.250	−97.8	5.4
2800	0.407	70.0	1.562	5.0	0.332	28.3	0.251	−108.8	4.9
3000	0.426	64.3	1.474	0.0	0.349	24.8	0.253	−116.4	4.5

Table 4 Common emitter scattering parameters, $I_C = 30$ mA; $V_{CE} = 8$ 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	0.414	−36.1	44.351	148.8	0.009	77.3	0.867	−18.2	39.8
100	0.279	−71.3	29.406	122.0	0.018	71.7	0.641	−28.7	32.0
200	0.167	−106.9	17.042	103.4	0.032	73.3	0.482	−29.1	25.9
300	0.131	−134.2	11.814	94.1	0.045	73.4	0.426	−28.3	22.4
400	0.120	−152.4	9.011	87.8	0.058	73.0	0.399	−28.7	19.9
500	0.114	−167.4	7.315	82.5	0.072	72.0	0.388	−30.1	18.0
600	0.118	178.3	6.152	77.9	0.085	70.6	0.382	−31.9	16.5
700	0.115	166.1	5.295	73.6	0.099	68.8	0.378	−34.0	15.2
800	0.117	155.2	4.665	70.1	0.111	67.3	0.374	−35.7	14.1
900	0.121	145.0	4.162	66.1	0.124	65.4	0.370	−37.3	13.1
1000	0.135	136.8	3.770	62.6	0.137	63.7	0.363	−38.8	12.2
1200	0.167	121.0	3.213	55.6	0.162	59.3	0.341	−43.5	10.8
1400	0.203	113.0	2.789	48.8	0.187	55.5	0.316	−50.5	9.5
1600	0.223	106.7	2.478	42.4	0.211	51.6	0.306	−59.0	8.5
1800	0.236	98.2	2.277	35.9	0.235	47.7	0.305	−66.4	7.8
2000	0.266	90.1	2.073	29.6	0.257	43.4	0.294	−71.5	7.0
2200	0.309	83.4	1.913	23.4	0.278	39.5	0.269	−77.2	6.4
2400	0.347	79.5	1.802	18.0	0.298	35.8	0.241	−87.0	5.9
2600	0.381	76.0	1.706	11.8	0.319	31.5	0.227	−100.4	5.6
2800	0.397	70.2	1.606	5.3	0.337	27.3	0.228	−112.0	5.1
3000	0.420	64.7	1.528	0.6	0.355	23.7	0.230	−119.8	4.8