NPN 5 GHz wideband transistor

BFG97

DESCRIPTION

NPN planar epitaxial transitor mounted in a plastic SOT223 envelope.
It features excellent output voltage capabilities, and is primarily intended for use in MATV applications.

PNP complement is the BFG31.

PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	emitter
4	collector

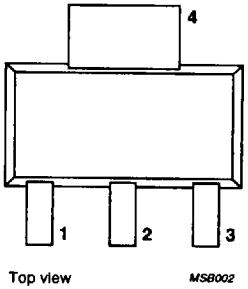


Fig.1 SOT223.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	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		–	–	100	mA
P_{tot}	total power dissipation	up to T_s = 125 °C (note 1)	–	–	1	W
h_{FE}	DC current gain	I_C = 70 mA; V_{CE} = 10 V; T_j = 25 °C	25	80	–	
f_T	transition frequency	I_C = 70 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	–	5.5	–	GHz
G_{UM}	maximum unilateral power gain	I_C = 70 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	–	16	–	dB
		I_C = 70 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C	–	12	–	dB
V_O	output voltage	I_C = 70 mA; V_{CE} = 10 V; d_{im} = –60 dB; R_L = 75 Ω; $f_{(p+q-r)}$ = 793.25 MHz; T_{amb} = 25 °C	–	700	–	mV

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	–	3	V
I_C	DC collector current		–	100	mA
P_{tot}	total power dissipation	up to T_s = 125 °C (note 1)	–	1	W
T_{stg}	storage temperature		–65	150	°C
T_j	junction temperature		–	175	°C

Note

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

THERMAL RESISTANCE

SYMBOL	PARAMETER	CONDITIONS	THERMAL RESISTANCE
$R_{th\ j\text{-}s}$	thermal resistance from junction to soldering point	up to T_s = 125 °C (note 1)	50 K/W

Note

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

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	–	–	100	nA
h_{FE}	DC current gain	I_C = 70 mA; V_{CE} = 10 V	25	80	–	
f_T	transition frequency	I_C = 70 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	–	5.5	–	GHz
C_c	collector capacitance	$I_E = i_e$ = 0; V_{CB} = 10 V; f = 1 MHz	–	1.5	–	pF
C_e	emitter capacitance	$I_C = i_c$ = 0; V_{EB} = 0.5 V; f = 1 MHz	–	6.5	–	pF
C_{re}	feedback capacitance	I_C = 0; V_{CE} = 10 V; f = 1 MHz	–	1	–	pF
G_{UM}	maximum unilateral power gain (note 1)	I_C = 70 mA; V_{CE} = 10 V; f = 500 MHz; T_{amb} = 25 °C	–	16	–	dB
		I_C = 70 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C	–	12	–	dB
V_O	output voltage	note 2	–	750	–	mV
		note 3	–	700	–	mV
d_2	second order intermodulation distortion	note 4	–	–56	–	dB
		note 5	–	–53	–	dB

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 = 70 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C
   $V_p = V_O$ at d_{im} = –60 dB;
   $V_q = V_O$ –6 dB; f_p = 445.25 MHz;
   $V_r = V_O$ –6 dB; f_q = 453.25 MHz; f_r = 455.25 MHz;
   measured at $f_{(p+q-r)}$ = 443.25 MHz.
3. d_{im} = –60 dB (DIN 45004B); I_C = 70 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C
   $V_p = V_O$ at d_{im} = –60 dB;
   $V_q = V_O$ –6 dB; f_p = 795.25 MHz;
   $V_r = V_O$ –6 dB; f_q = 803.25 MHz; f_r = 805.25 MHz;
   measured at $f_{(p+q-r)}$ = 793.25 MHz.
4. I_C = 70 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C;
   $V_p = V_q = V_O$ = 50 dBmV; $f_{(p+q)}$ = 410 MHz.
5. I_C = 70 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C;
   $V_p = V_q = V_O$ = 50 dBmV; $f_{(p+q)}$ = 810 MHz.

NPN 5 GHz wideband transistor BFG97

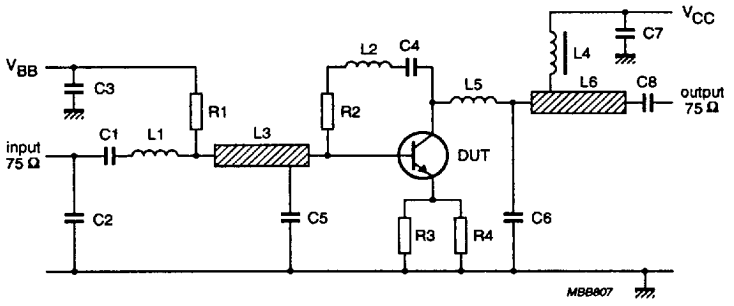


Fig.2 Intermodulation distortion and second order intermodulation distortion test circuit.

List of components (see test circuit)

DESIGNATION	DESCRIPTION	VALUE	DIMENSIONS	CATALOGUE NO.
C2, C3, C7, C8	multilayer ceramic capacitor	10 nF		2222 590 08627
C1, C4, C6	multilayer ceramic capacitor	1.2 pF		2222 851 12128
C5 (note 1)	miniature ceramic plate capacitor	10 nF		2222 629 08103
L1 (note 1)	0.5 turns 0.4 mm copper wire		int. dia. 3 mm	
L2	microstripline	75 Ω	length 14 mm; width 2.5 mm	
L3	microstripline	75 Ω	length 8 mm; width 2.5 mm	
L4, L5 (note 1)	1.5 turns 0.4 mm copper wire		int. dia. 3 mm; winding pitch 1 mm	
L6	microstripline	75 Ω	length 19 mm; width 2.5 mm	
L7	Ferroxcube choke	5 μH		3122 108 20153
R1	metal film resistor	10 kΩ		2322 180 73103
R2 (note 1)	metal film resistor	220 Ω		2322 180 73221
R3, R4	metal film resistor	30 Ω		2322 180 73309

Notes

The circuit has been built on a double copper-clad printed circuit board with PTFE dielectric ($\varepsilon_r = 2.2$); thickness 1/16 inch; thickness of copper sheet 2 x 35 μm.

1. Components C5, L1, L4, L5, and R2 are mounted on the underside of the PCB.

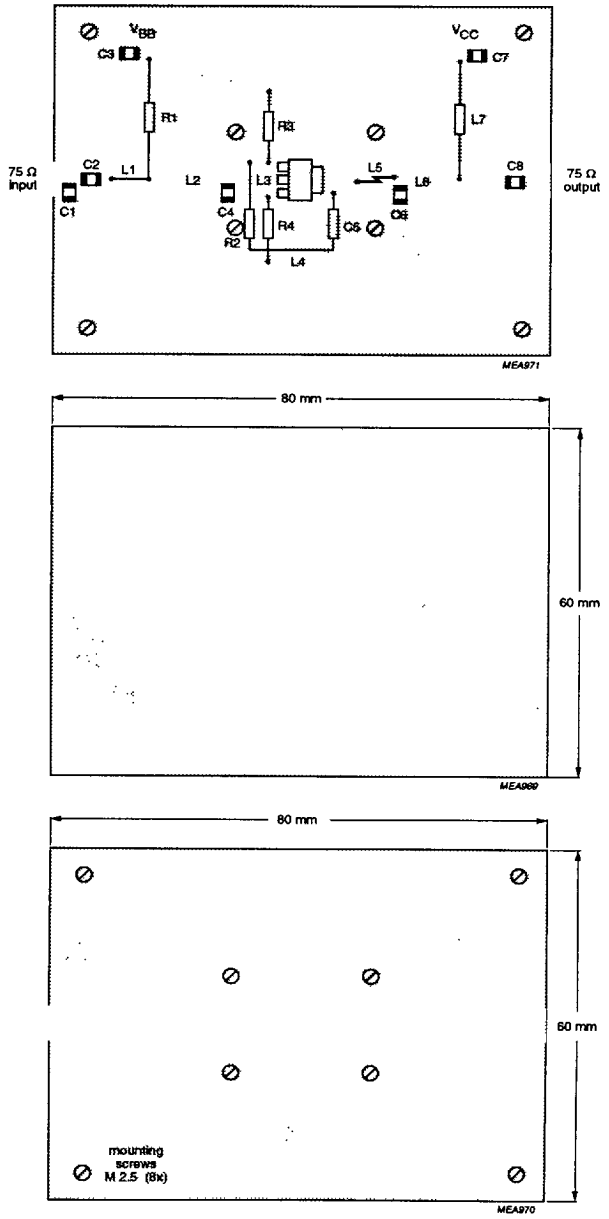


Fig.3 Intermodulation distortion and second order intermodulation distortion printed circuit board.

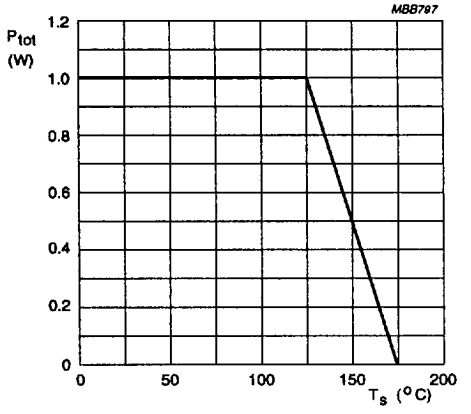
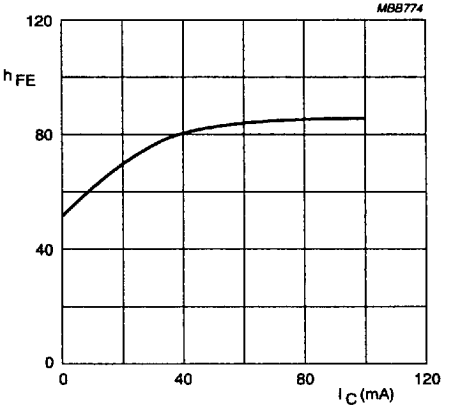
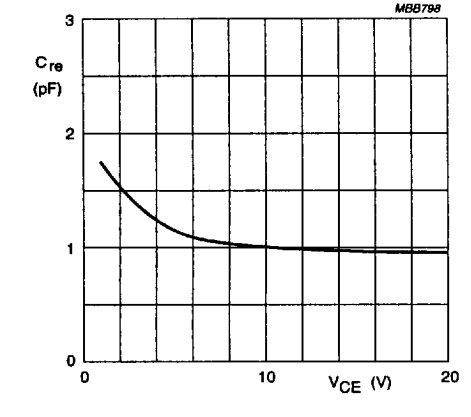


Fig.4 Power derating curve.



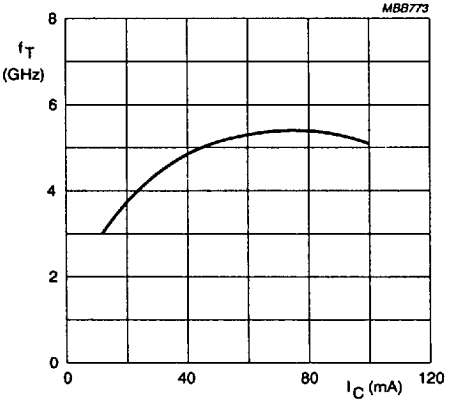
V_{CE} = 10 V; T_j = 25 °C.

Fig.5 DC current gain as a function of collector current.



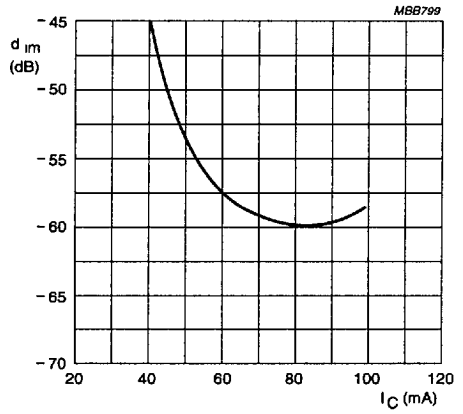
I_E = 0; f = 1 MHz; T_j = 25 °C.

Fig.6 Feedback capacitance as a function of collector-emitter voltage.



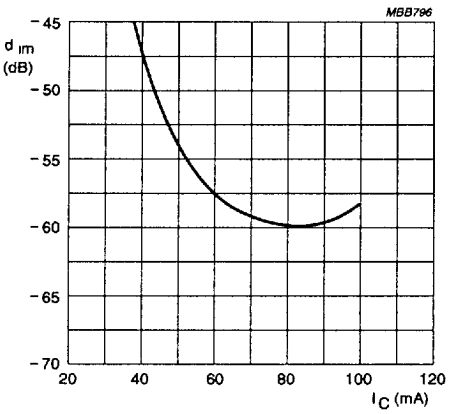
V_{CE} = 10 V; f = 500 MHz; T_j = 25 °C.

Fig.7 Transition frequency as a function of collector current.



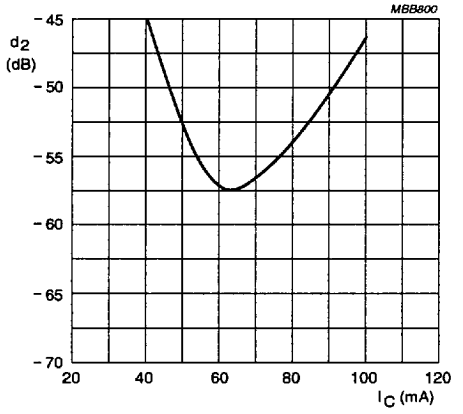
V_{CE} = 10 V; V_O = 750 mV; $f_{(p+q-r)}$ = 443.25 MHz; T_{amb} = 25 °C.

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



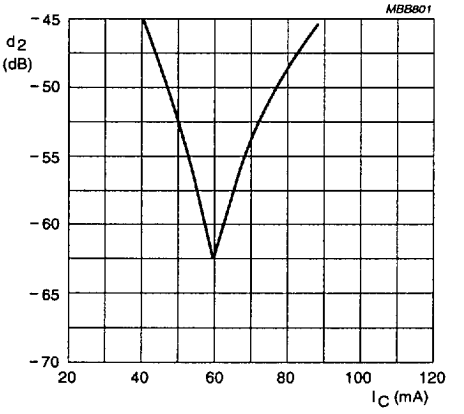
V_{CE} = 10 V; V_O = 700 mV; $f_{(p+q-r)}$ = 793.25 MHz; T_{amb} = 25 °C.

Fig.9 Intermodulation distortion as a function of collector current.



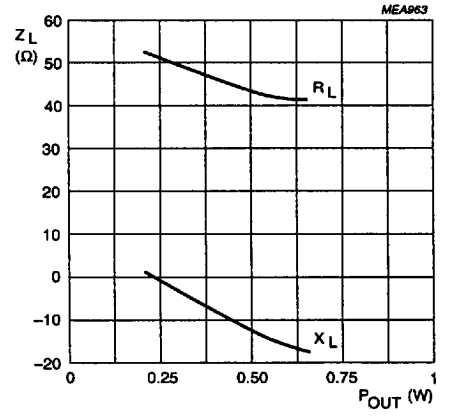
V_{CE} = 10 V; V_O = 50 dBmV; $f_{(p+q)}$ = 450 MHz; T_{amb} = 25 °C.

Fig.10 Second order intermodulation distortion as a function of collector current.



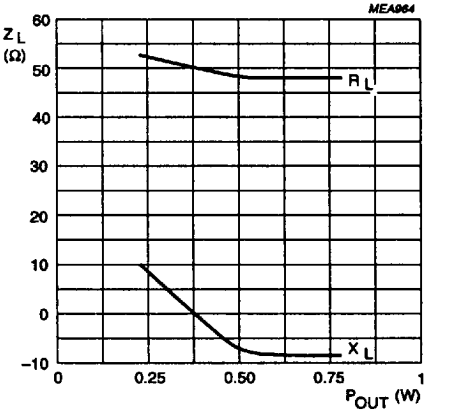
V_{CE} = 10 V; V_O = 50 dBmV; $f_{(p+q)}$ = 810 MHz; T_{amb} = 25 °C.

Fig.11 Second order intermodulation distortion as a function of collector current.



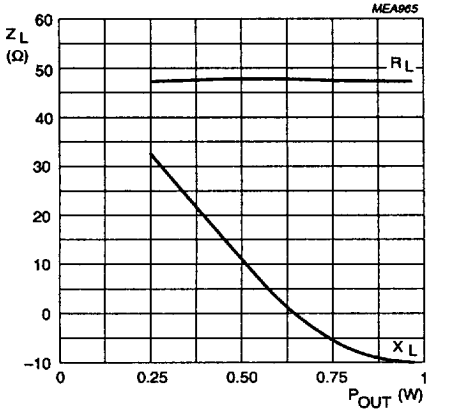
V_{CE} = 6 V; f = 900 MHz.

Fig.12 Load impedance as a function of output power.



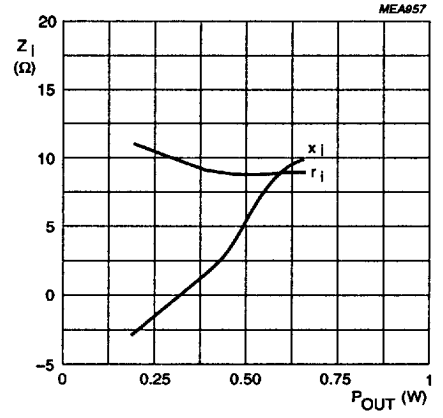
V_{CE} = 7.5 V; f = 900 MHz.

Fig.13 Load impedance as a function of output power.



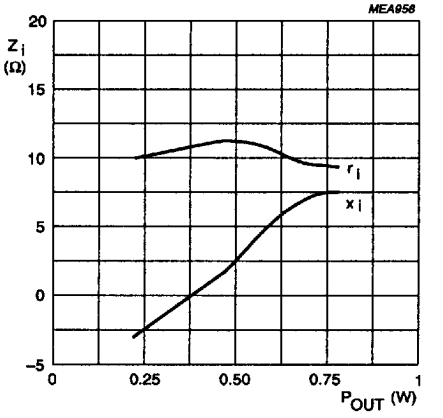
V_{CE} = 10 V; f = 900 MHz.

Fig.14 Load impedance as a function of output power.



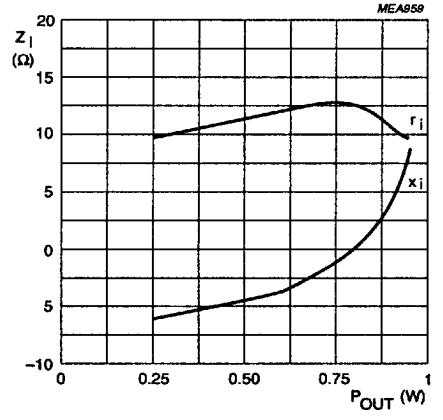
V_{CE} = 6 V; f = 900 MHz.

Fig.15 Input impedance as a function of output power.



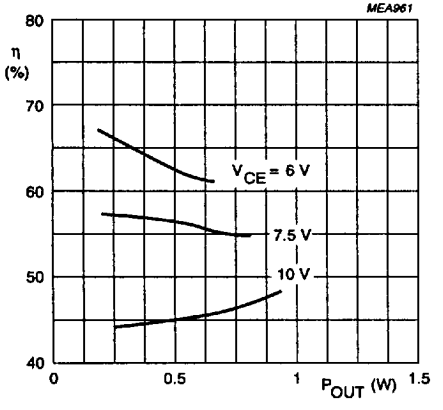
V_{CE} = 7.5 V; f = 900 MHz.

Fig.16 Input impedance as a function of output power.



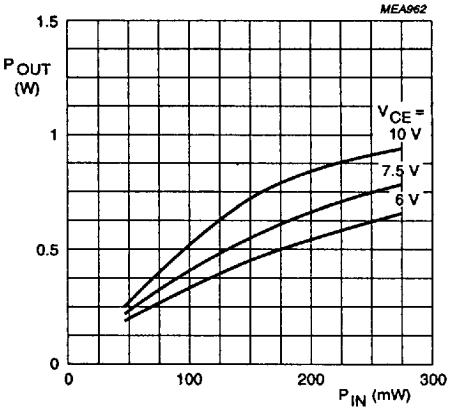
V_{CE} = 10 V; f = 900 MHz.

Fig.17 Input impedance as a function of output power.



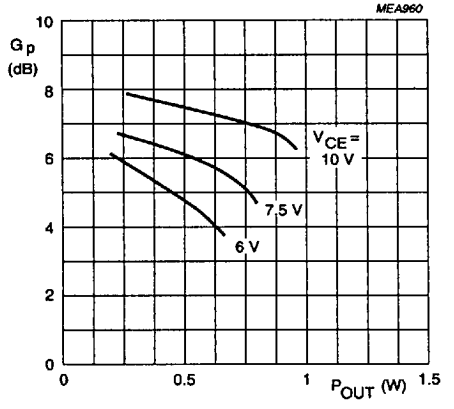
f = 900 MHz.

Fig.18 Efficiency as a function of output power.



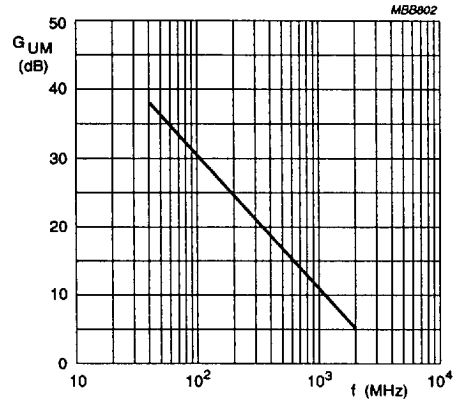
f = 900 MHz.

Fig.19 Output power as a function of input power.



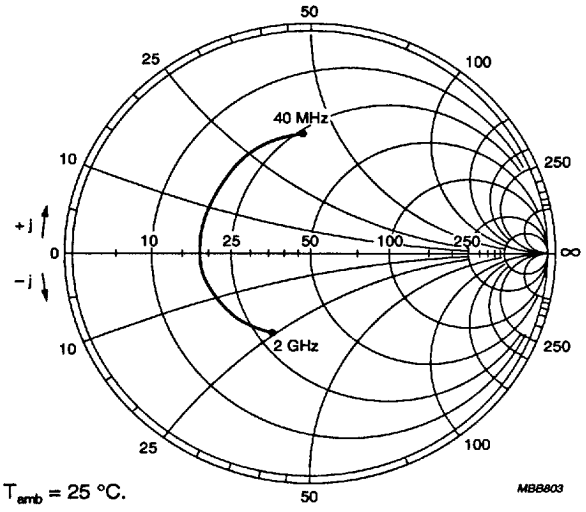
f = 900 MHz.

Fig.20 Power gain as a function of output power.



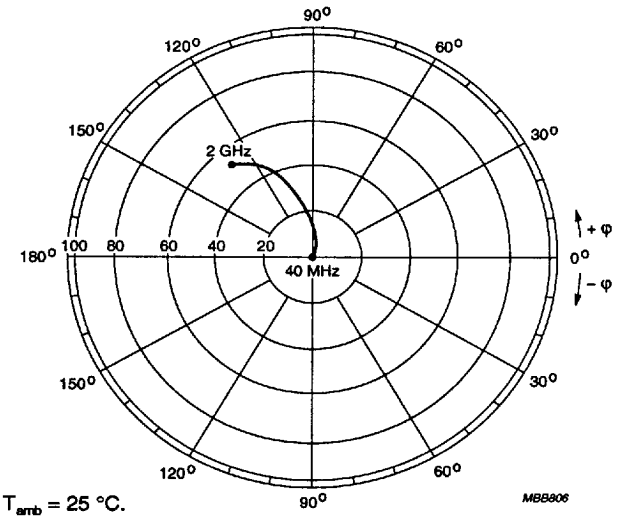
I_C = 70 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.21 Maximum unilateral power gain as a function of frequency.



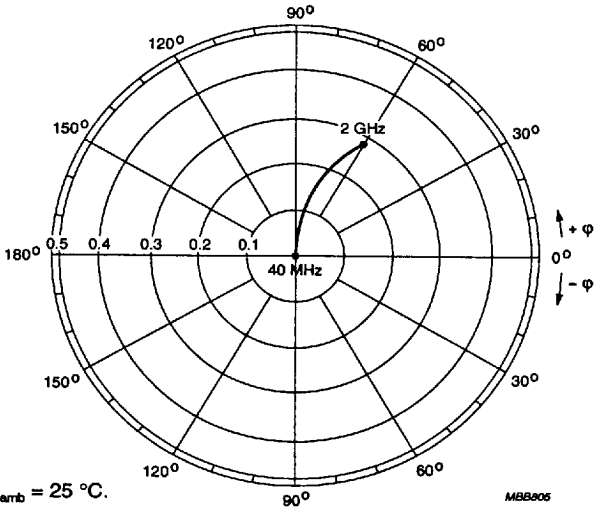
I_C = 70 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.22 Common emitter input reflection coefficient (S_{11}).



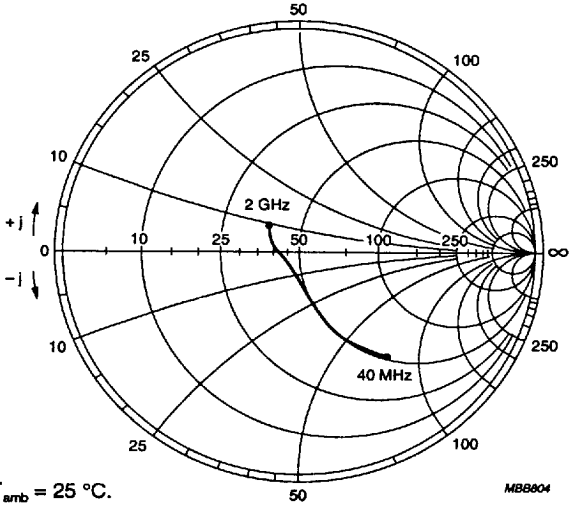
I_C = 70 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.23 Common emitter forward transmission coefficient (S_{21}).



I_C = 70 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.24 Common emitter reverse transmission coefficient (S_{12}).



I_C = 70 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.25 Common emitter output reflection coefficient (S_{22}).

Table 1 Common emitter scattering parameters, I_C = 50 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	0.437	−102.2	53.674	130.5	0.013	61.1	0.629	−49.8	37.7
100	0.474	−146.2	27.244	106.8	0.021	60.7	0.326	−76.3	30.3
200	0.482	−166.9	14.286	95.1	0.035	67.9	0.175	−95.5	24.4
300	0.496	−174.8	9.637	88.4	0.048	69.1	0.124	−110.5	21.0
400	0.505	179.5	7.339	82.9	0.062	69.9	0.103	−123.7	18.6
500	0.491	174.2	5.901	79.2	0.077	70.3	0.091	−133.9	16.7
600	0.511	169.7	4.931	75.9	0.090	69.9	0.085	−143.1	15.2
700	0.513	166.5	4.261	72.5	0.103	69.3	0.082	−152.8	13.9
800	0.519	163.6	3.772	69.2	0.117	67.9	0.077	−162.6	12.9
900	0.521	159.0	3.344	66.0	0.129	67.0	0.078	−172.4	11.9
1000	0.539	155.1	3.030	63.3	0.142	65.6	0.084	−179.9	11.2
1200	0.554	148.2	2.534	56.6	0.169	63.5	0.102	164.6	9.7
1400	0.571	143.4	2.259	51.3	0.187	60.3	0.122	157.5	8.9
1600	0.585	139.3	1.947	45.8	0.213	58.6	0.139	152.0	7.7
1800	0.592	130.7	1.767	39.1	0.237	53.9	0.157	145.6	6.9
2000	0.622	124.8	1.630	34.7	0.256	52.2	0.182	138.3	6.5
2200	0.649	118.4	1.474	29.5	0.275	49.4	0.213	132.7	5.9
2400	0.655	115.2	1.360	27.1	0.286	48.5	0.241	128.3	5.4
2600	0.674	111.2	1.285	21.2	0.312	44.2	0.266	123.5	5.1
2800	0.675	104.4	1.170	16.0	0.319	39.7	0.280	117.3	4.4
3000	0.698	97.2	1.130	12.1	0.335	38.1	0.302	109.8	4.4

Table 2 Common emitter scattering parameters, I_C = 70 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	0.421	−112.5	57.018	126.8	0.011	60.6	0.575	−54.9	37.7
100	0.470	−152.3	27.744	104.6	0.021	61.0	0.287	−81.8	30.3
200	0.483	−169.6	14.399	94.0	0.033	69.8	0.157	−103.7	24.4
300	0.490	−177.5	9.723	87.6	0.048	71.9	0.116	−120.3	21.0
400	0.490	178.8	7.379	82.3	0.063	71.2	0.101	−134.4	18.6
500	0.495	172.9	5.943	78.7	0.078	71.6	0.093	−145.7	16.7
600	0.507	169.7	4.950	75.6	0.091	70.7	0.089	−154.2	15.2
700	0.508	166.5	4.283	72.1	0.104	70.2	0.089	−163.4	14.0
800	0.506	164.4	3.784	69.2	0.118	68.3	0.086	−172.8	12.9
900	0.512	159.1	3.367	65.8	0.131	67.8	0.088	178.6	11.9
1000	0.535	155.0	3.038	63.1	0.144	65.7	0.094	171.6	11.2
1200	0.545	148.4	2.556	56.4	0.169	63.7	0.115	159.1	9.7
1400	0.577	142.1	2.270	51.5	0.190	60.2	0.138	153.0	9.0
1600	0.569	138.2	1.955	46.1	0.215	58.8	0.154	147.9	7.6
1800	0.592	131.6	1.767	38.9	0.239	54.3	0.171	141.3	6.9
2000	0.626	122.8	1.644	34.7	0.258	51.7	0.196	135.2	6.6
2200	0.641	118.2	1.483	29.7	0.276	49.4	0.226	129.6	5.9
2400	0.678	115.3	1.366	27.3	0.289	48.1	0.255	125.2	5.7
2600	0.684	110.5	1.284	21.1	0.314	44.0	0.277	120.7	5.3
2800	0.673	103.3	1.171	16.3	0.321	39.7	0.290	114.8	4.4
3000	0.702	97.1	1.140	12.1	0.336	38.0	0.313	107.2	4.5