NPN 5 GHz wideband transistor — BFR96S

DESCRIPTION

NPN transistor in a plastic SOT37 envelope primarily intended for MATV applications. The device features excellent output voltage capabilities.

PNP complement is the BFQ32S.

PINNING

PIN	DESCRIPTION
Code: BFR96S/02	
1	base
2	emitter
3	collector

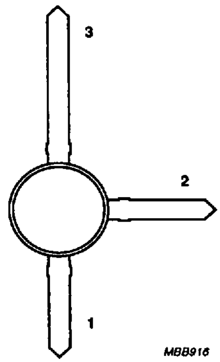

Fig.1 SOT37.

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		–	100	mA
P_{tot}	total power dissipation	up to T_s = 143 °C (note 1)	–	700	mW
f_T	transition frequency	I_C = 70 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	1	–	pF
G_{UM}	maximum unilateral power gain	I_C = 70 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C	11.5	–	dB
F	noise figure	I_C = 70 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C	4	–	dB
V_O	output voltage	d_{im} = –60 dB; I_C = 70 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C; $f_{(p+q-r)}$ = 793.25 MHz	700	–	mV
P_{L1}	output power at 1 dB gain compression	I_C = 70 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C; measured at f = 800 MHz	21	–	dBm
ITO	third order intercept point	I_C = 70 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C	40	–	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	–	3	V
I_C	DC collector current		–	100	mA
P_{tot}	total power dissipation	up to T_s = 143 °C (note 1)	–	700	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 = 143 °C (note 1)	45 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	–	–	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	–	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 = 800 MHz; $T_{amb} = 25$ °C	–	11.5	–	dB
F	noise figure	$I_C = 70$ mA; $V_{CE} = 10$ V; f = 800 MHz; $T_{amb} = 25$ °C	–	4	–	dB
d_2	second order intermodulation distortion	note 2	–	–52	–	dB
V_O	output voltage	note 3	–	700	–	mV
P_{L1}	output power at 1 dB gain compression	$I_C = 70$ mA; $V_{CE} = 10$ V; $R_L = 75\ \Omega$; $T_{amb} = 25$ °C; measured at f = 800 MHz	–	21	–	dBm
ITO	third order intercept point	note 4	–	40	–	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. $I_C = 70$ mA; $V_{CE} = 10$ V; $R_L = 75\ \Omega$; $T_{amb} = 25$ °C;
   $V_p = V_O = 316$ mV = 50 dBmV; $f_p = 250$ MHz;
   $V_q = V_O = 316$ mV = 50 dBmV; $f_q = 560$ MHz;
   measured at $f_{(p+q)} = 810$ MHz.
3. $d_{im} = -60$ dB (DIN 45004B); $I_C = 70$ mA; $V_{CE} = 10$ 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.
4. $I_C = 70$ mA; $V_{CE} = 10$ 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 $f_{(2p-q)} = 799$ MHz.

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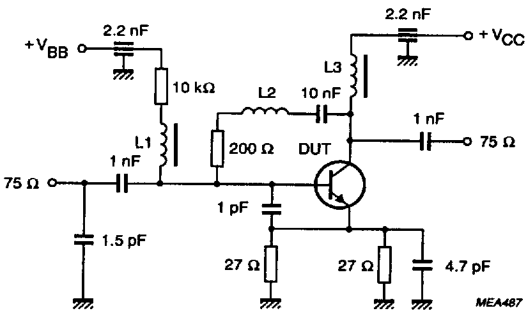


L1 = L3 = 5 μH microchoke.

L2 = 1.5 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.

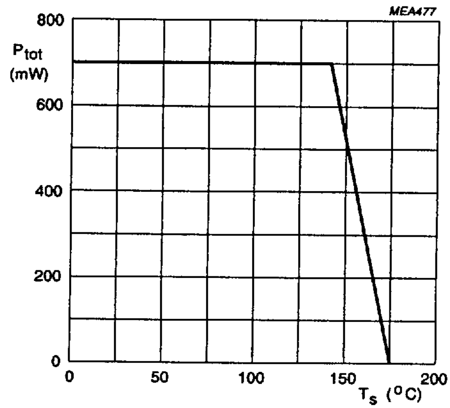
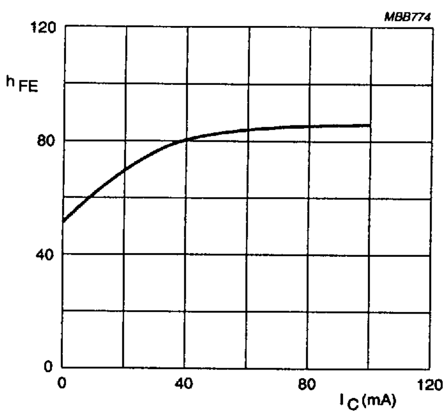
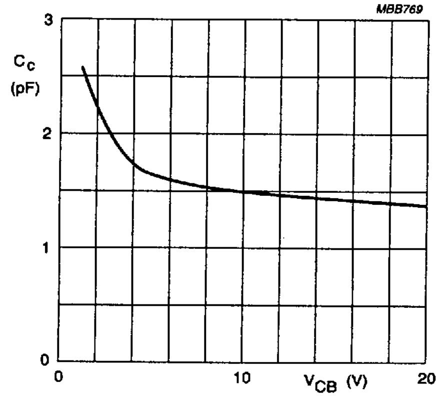


Fig.3 Power derating curve.



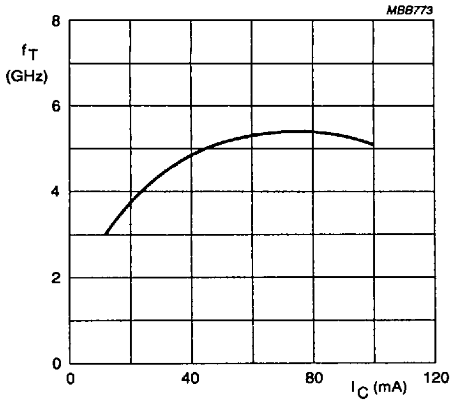
$V_{CE} = 10$ V; $T_j = 25$ °C.

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



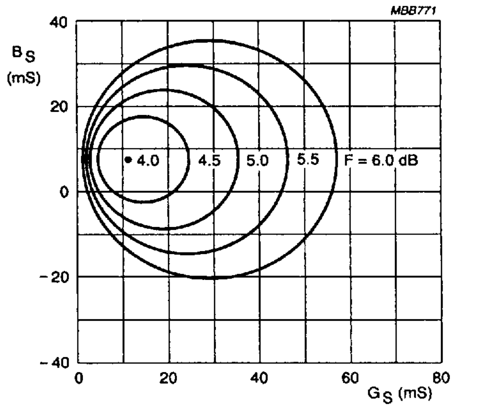
$I_E = i_e = 0$; f = 1 MHz; $T_j = 25$ °C.

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



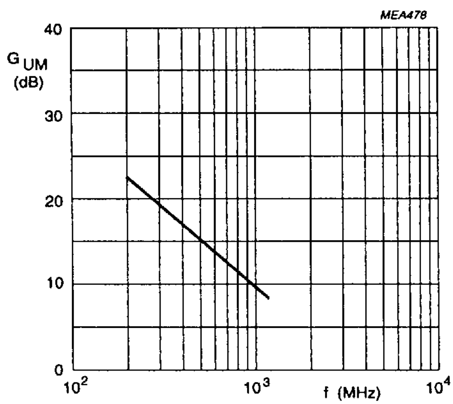
V_{CE} = 10 V; f = 500 MHz; T_j = 25 °C.

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



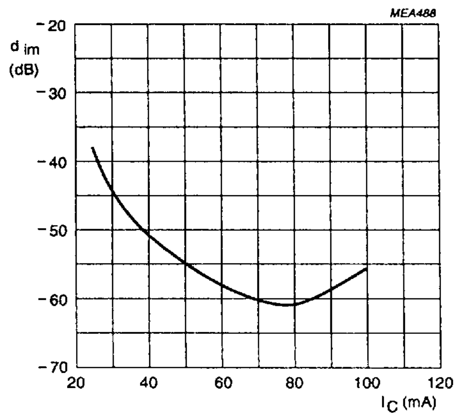
I_C = 70 mA; V_{CE} = 10 V; f = 800 MHz; T_{amb} = 25 °C.

Fig.7 Noise circle figure.



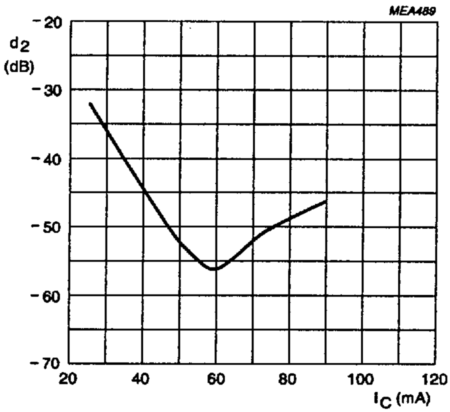
I_C = 70 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.8 Maximum unilateral power gain as a function of frequency.



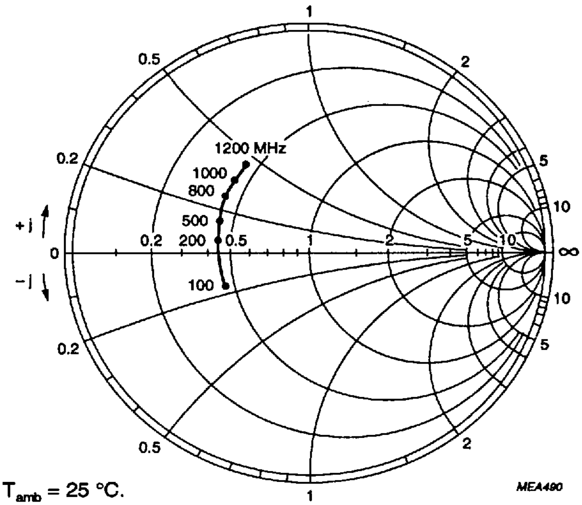
V_{CE} = 10 V; V_O = 700 mV = 56.9 dBmV;
T_{amb} = 25 °C; $f_{(p+q-r)}$ = 793.25 MHz;
measured in test circuit (see Fig.2).

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



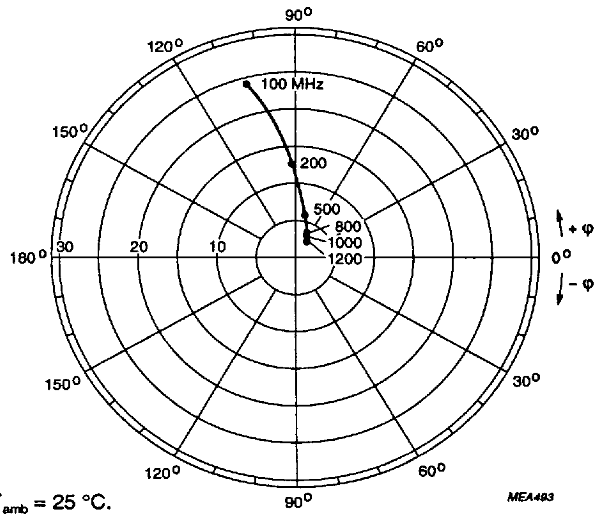
V_{CE} = 10 V; V_o = 316 mV = 50 dBmV;
T_{amb} = 25 °C; $f_{(p+q)}$ = 810 MHz;
measured in test circuit (see Fig.2).

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



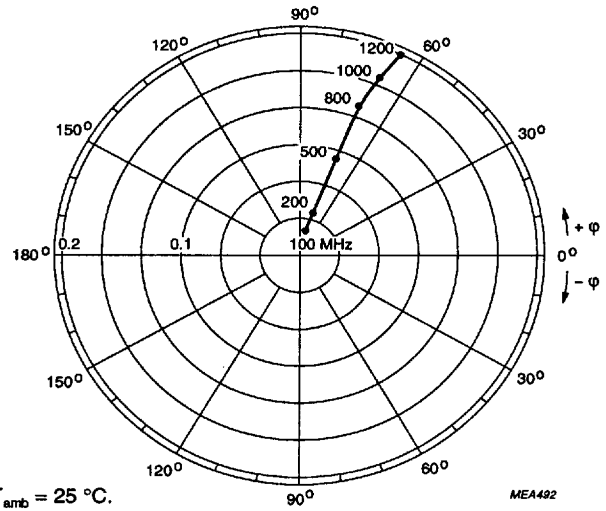
I_C = 70 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

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



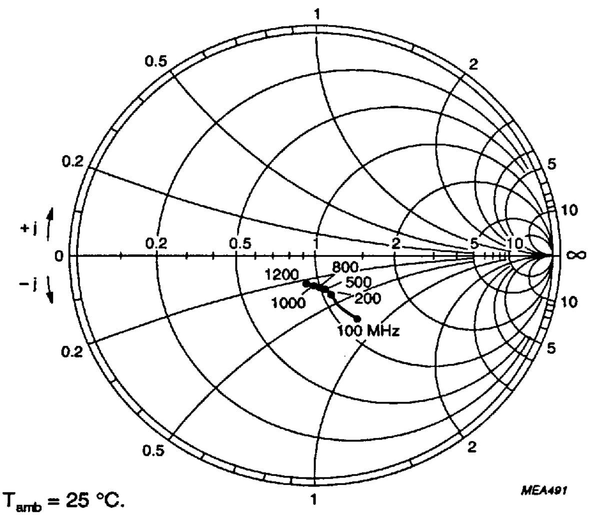
I_C = 70 mA; V_{CE} = 10 V; T_{amb} = 25 °C.

Fig.12 Common emitter forward transmission coefficient (S_{21}).



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

Fig.13 Common emitter reverse transmission coefficient (S_{12}).



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

Fig.14 Common emitter output reflection coefficient (S_{22}).

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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	0.333	−96.0	49.624	130.8	0.012	70.5	0.648	−43.8	36.8
100	0.345	−144.7	25.627	107.3	0.023	67.5	0.348	−61.9	29.3
200	0.354	−168.9	13.375	94.2	0.041	73.3	0.208	−68.8	23.3
300	0.365	−179.7	9.016	87.9	0.058	74.3	0.165	−71.9	19.8
400	0.373	173.9	6.820	82.4	0.076	74.0	0.148	−76.4	17.4
500	0.380	166.6	5.483	78.7	0.092	73.3	0.143	−81.5	15.5
600	0.377	162.0	4.636	74.5	0.110	71.3	0.144	−85.9	14.1
700	0.377	158.1	3.983	71.4	0.128	70.5	0.146	−88.4	12.8
800	0.380	152.0	3.537	66.8	0.144	69.2	0.148	−91.5	11.7
900	0.375	145.1	3.151	63.9	0.160	67.9	0.151	−95.6	10.7
1000	0.376	141.4	2.846	61.3	0.175	66.4	0.151	−100.5	9.8
1200	0.422	131.9	2.411	55.0	0.206	63.4	0.156	−110.9	8.6
1400	0.424	123.3	2.097	47.8	0.233	60.2	0.173	−122.6	7.4
1600	0.452	117.1	1.869	42.5	0.261	58.0	0.192	−131.0	6.6
1800	0.448	112.1	1.707	37.0	0.288	53.6	0.213	−137.2	5.8
2000	0.488	100.5	1.556	33.1	0.311	51.0	0.221	−143.9	5.2
2200	0.506	94.5	1.483	28.3	0.333	48.3	0.232	−153.5	4.9
2400	0.524	88.7	1.351	22.5	0.355	46.6	0.251	−163.9	4.3
2600	0.560	86.2	1.262	19.6	0.379	43.0	0.282	−171.8	4.0
2800	0.547	78.5	1.183	14.6	0.387	39.7	0.313	−177.4	3.5
3000	0.563	71.9	1.114	10.6	0.406	38.5	0.330	177.4	3.1

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Table 2 Common emitter scattering parameters, $I_C = 70$ mA; $V_{CE} = 10$ 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	0.317	−109.4	52.636	127.2	0.011	66.9	0.596	−47.3	36.8
100	0.335	−151.1	26.034	105.0	0.023	70.4	0.306	−64.3	29.3
200	0.354	−172.6	13.450	92.9	0.041	73.9	0.184	−70.8	23.3
300	0.358	177.7	9.044	86.9	0.059	75.4	0.147	−74.5	19.8
400	0.368	173.9	6.852	82.0	0.075	75.2	0.135	−79.3	17.4
500	0.381	167.9	5.499	78.4	0.094	74.2	0.131	−84.4	15.6
600	0.373	160.3	4.641	74.2	0.111	71.7	0.135	−89.4	14.1
700	0.382	157.1	3.979	71.0	0.129	71.3	0.138	−92.1	12.8
800	0.377	151.7	3.551	66.7	0.145	69.6	0.139	−95.7	11.8
900	0.381	145.1	3.169	63.4	0.161	67.9	0.143	−99.2	10.8
1000	0.396	139.6	2.863	61.2	0.177	66.5	0.145	−103.8	10.0
1200	0.411	133.0	2.418	55.0	0.208	63.3	0.151	−114.5	8.6
1400	0.424	124.9	2.101	48.0	0.234	60.1	0.168	−126.8	7.4
1600	0.447	116.8	1.879	42.7	0.263	58.1	0.188	−134.4	6.6
1800	0.456	110.6	1.700	37.2	0.289	53.3	0.209	−140.5	5.8
2000	0.502	101.4	1.568	33.3	0.314	51.0	0.218	−147.2	5.4
2200	0.505	95.0	1.495	28.1	0.337	48.2	0.230	−156.3	5.0
2400	0.525	88.1	1.365	22.8	0.358	46.3	0.249	−166.9	4.4
2600	0.549	86.1	1.273	20.4	0.382	42.7	0.280	−174.6	4.0
2800	0.561	77.6	1.193	14.9	0.389	39.7	0.311	−179.7	3.6
3000	0.553	71.5	1.122	11.0	0.410	38.2	0.326	175.5	3.1