DATA SHEET

BFG94
NPN 6 GHz wideband transistor

Product specification
File under Discrete Semiconductors, SC14

September 1995

Philips
Semiconductors

PHILIPS

NPN 6 GHz wideband transistor BFG94

FEATURES

- High power gain
- Low noise figure
- Low intermodulation distortion
- Gold metallization ensures excellent reliability.

DESCRIPTION

NPN transistor mounted in a plastic SOT223 envelope. It is primarily intended for use in communication and instrumentation systems.

PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	emitter
4	collector

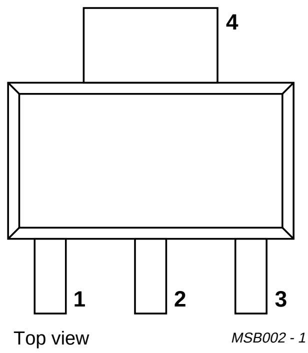


Fig.1 SOT223.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter	–	–	15	V
V_{CEO}	collector-emitter voltage	open base	–	–	12	V
I_C	DC collector current		–	–	60	mA
P_{tot}	total power dissipation	up to T_s = 140 °C (note 1)	–	–	700	mW
C_{re}	feedback capacitance	I_C = 0; V_{CE} = 10 V; f = 1 MHz	–	–	0.8	pF
f_T	transition frequency	I_C = 45 mA; V_{CE} = 10 V; f = 1 GHz; T_{amb} = 25 °C	4	6	–	GHz
G_{UM}	maximum unilateral power gain	I_C = 45 mA; V_{CE} = 10 V; f = 1 GHz; T_{amb} = 25 °C	11.5	13.5	–	dB
V_O	output voltage	I_C = 45 mA; V_{CE} = 10 V; d_{im} = –60 dB; R_L = 75 Ω; f = 800 MHz; T_{amb} = 25 °C	–	500	–	mV
P_{L1}	output power at 1 dB gain compression	I_C = 45 mA; V_{CE} = 10 V; f = 1 GHz; T_{amb} = 25 °C	–	21.5	–	dBm

Note

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

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		–	60	mA
P_{tot}	total power dissipation	up to T_s = 140 °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 = 140 °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.

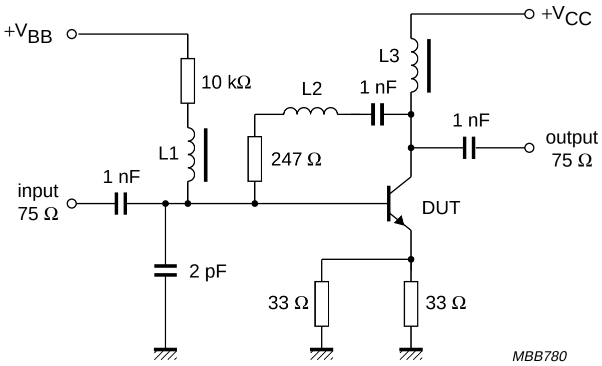
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	I_E = 0; V_{CB} = 10 V	–	–	100	nA
h_{FE}	DC current gain	I_C = 30 mA; V_{CE} = 5 V	45	90	–	
		I_C = 45 mA; V_{CE} = 10 V	–	100	–	
C_c	collector capacitance	$I_E = i_e$ = 0; V_{CB} = 10 V; f = 1 MHz	–	0.9	2	pF
C_e	emitter capacitance	$I_C = i_e$ = 0; V_{EB} = 0.5 V; f = 1 MHz	–	2.9	4.5	pF
C_{re}	feedback capacitance	$I_C = i_c$ = 0; V_{CE} = 10 V; f = 1 MHz	–	0.5	0.8	pF
f_T	transition frequency	I_C = 45 mA; V_{CE} = 10 V; f = 1 GHz; T_{amb} = 25 °C	4	–	–	GHz
		I_C = 30 mA; V_{CE} = 5 V; f = 1 GHz; T_{amb} = 25 °C	4	6	–	GHz
G_{UM}	maximum unilateral power gain (note1)	I_C = 45 mA; V_{CE} = 10 V; f = 1 GHz; T_{amb} = 25 °C	11.5	13.5	–	dB
F	minimum noise figure	$\Gamma_s = \Gamma_{opt}$; I_C = 45 mA; V_{CE} = 10 V; f = 500 MHz	–	2.7	–	dB
		$\Gamma_s = \Gamma_{opt}$; I_C = 45 mA; V_{CE} = 10 V; f = 1 GHz	–	3	–	dB
V_O	output voltage	note 2	–	500	–	mV
d_2	second order intermodulation distortion	note 3	–	–51	–	dB
P_{L1}	output power at 1 dB gain compression	I_C = 45 mA; V_{CE} = 10 V; R_L = 50 Ω; T_{amb} = 25 °C; measured at f = 1 GHz	–	21.5	–	dBm
ITO	third order intercept point	note 4	–	34	–	dBm

Notes

1. G_{UM} is the maximum unilateral power gain, assuming S_{12} is zero and

$$G_{UM} = 10\log\frac{|S_{21}|^2}{\left(1-|S_{11}|^2\right)\left(1-|S_{22}|^2\right)}\,\text{dB}.$$

2. d_{im} = –60 dB (DIN 45004B, par 6.3: 3-tone); I_C = 45 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C;
$V_p = V_O$ at d_{im} = –60 dB; f_p = 795.25 MHz;
$V_q = V_O$ –6 dB; $V_r = V_O$ –6 dB;
f_q = 803.25 MHz; f_r = 805.25 MHz;
measured at $f_{(p+q-r)}$ = 793.25 MHz.
3. I_C = 45 mA; V_{CE} = 10 V; R_L = 75 Ω; T_{amb} = 25 °C;
$V_q = V_O$ = 280 mV;
f_p = 250 MHz; f_q = 560 MHz;
measured at $f_{(p+q)}$ = 810 MHz.
4. I_C = 45 mA; V_{CE} = 10 V; R_L = 50 Ω; T_{amb} = 25 °C;
f_p = 1000 MHz; f_q = 1001 MHz;
measured at $f_{(2p-q)}$ and $f_{(2q-p)}$.



L1 = L3 = 5 μH micro-choke.

L2 = 1 turn copper wire (0.4 mm), internal diameter 4 mm.

Fig.2 Test circuit for second and third order intermodulation distortion.

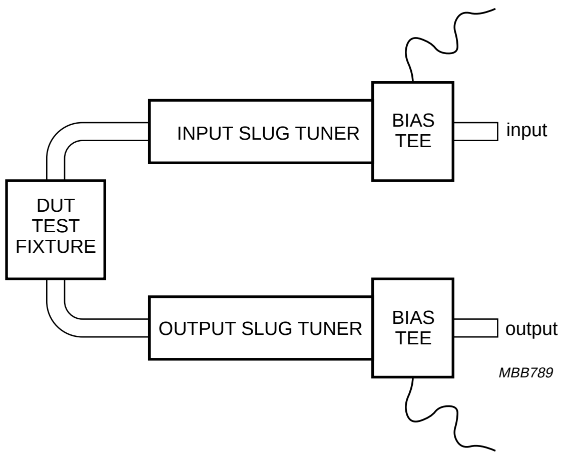


Fig.3 Measurement set-up for third order intercept point and 1 dB gain compression.

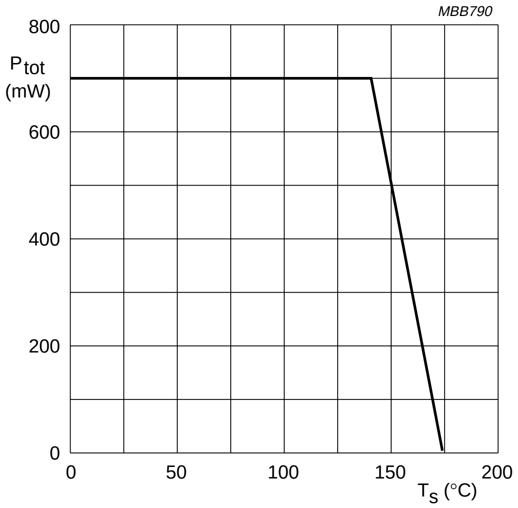
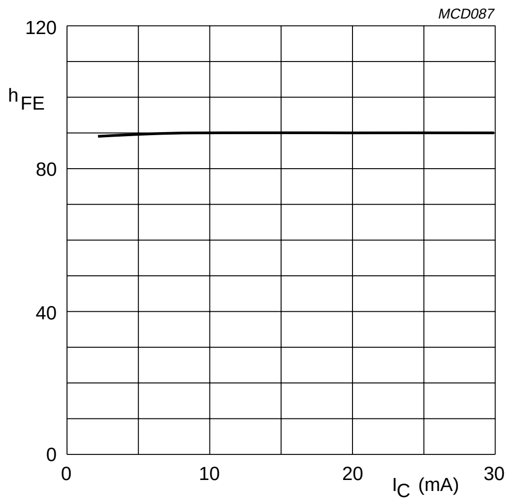
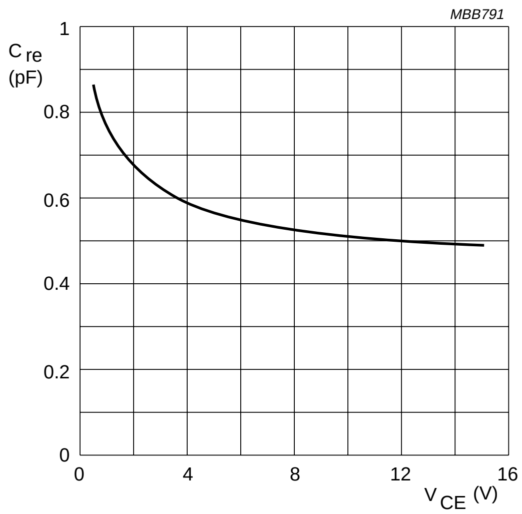


Fig.4 Power derating curve.



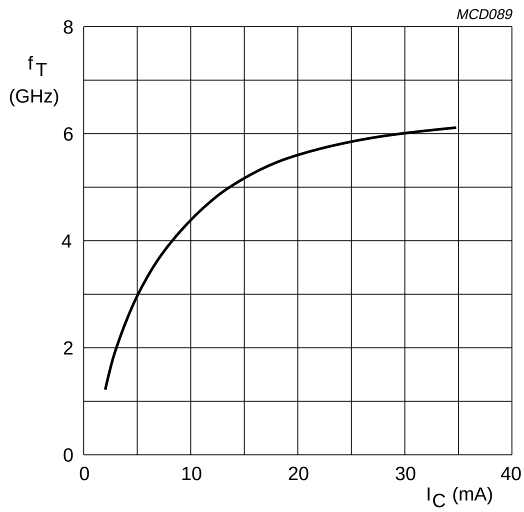
V_{CE} = 10 V; T_j = 25 °C

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



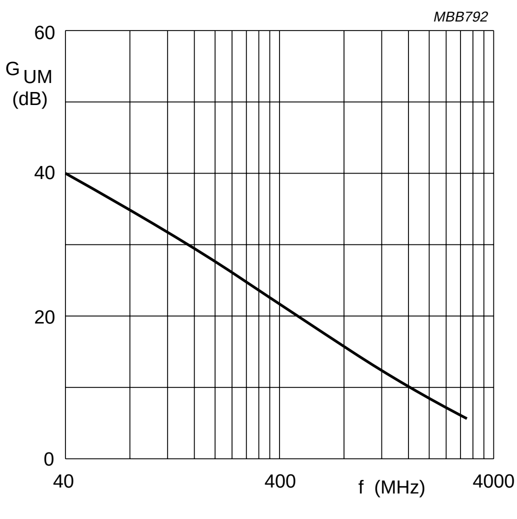
$I_C = i_c = 0$; f = 1 MHz.

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



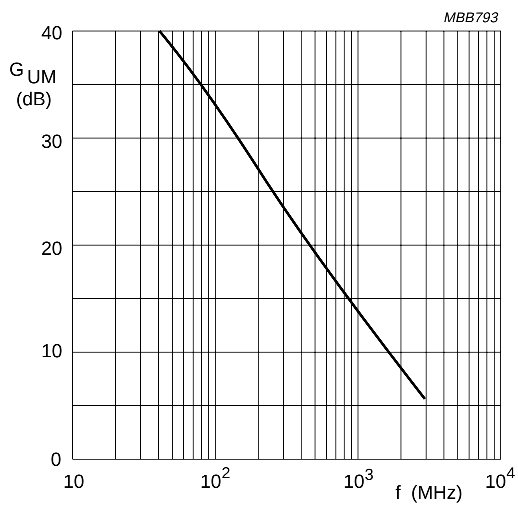
V_{CE} = 10 V; f = 1 GHz.

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



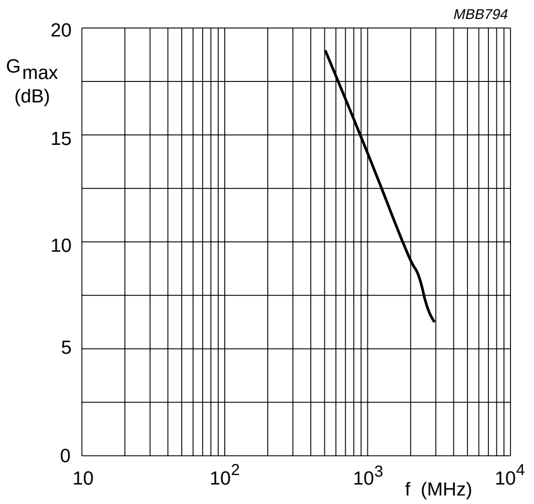
I_c = 45 mA; V_{CE} = 10 V.

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



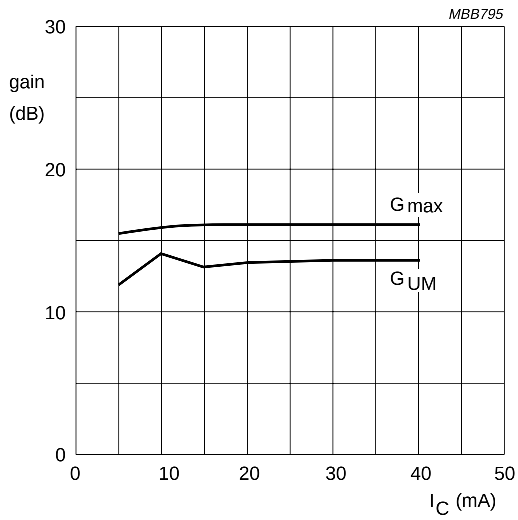
I_c = 20 mA; V_{CE} = 8 V.

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



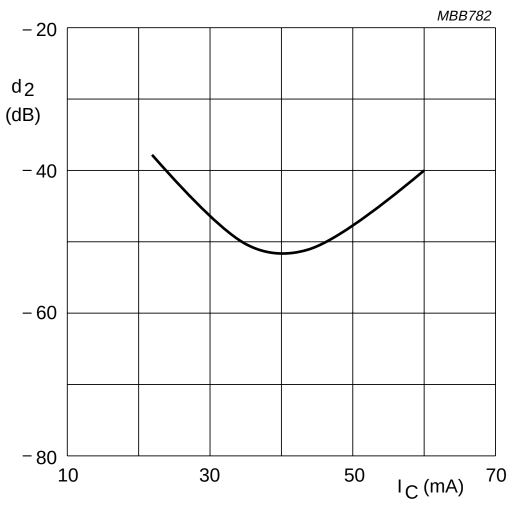
I_c = 20 mA; V_{CE} = 8 V.

Fig.10 Maximum available stable gain as a function of frequency.



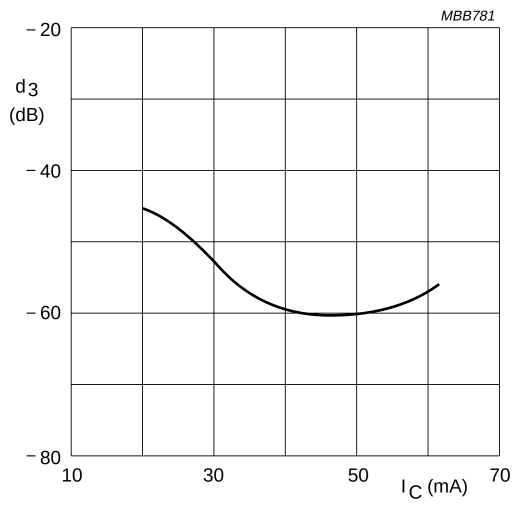
V_{CE} = 8 V; f = 1 GHz.
G_{max} = maximum available stable gain.
G_{UM} = maximum unilateral power gain.

Fig.11 Gain as a function of collector current.



I_c = 45 mA; V_{CE} = 10 V; $f_{(p+q)}$ = 810 MHz.
See test circuit, Fig.2

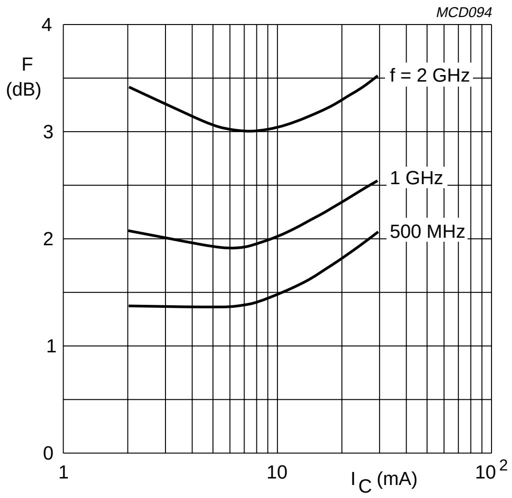
Fig.12 Second order intermodulation distortion as a function of collector current.



I_c = 45 mA; V_{CE} = 10 V; $f_{(p+q-r)}$ = 793.25 MHz.
See test circuit, Fig.2

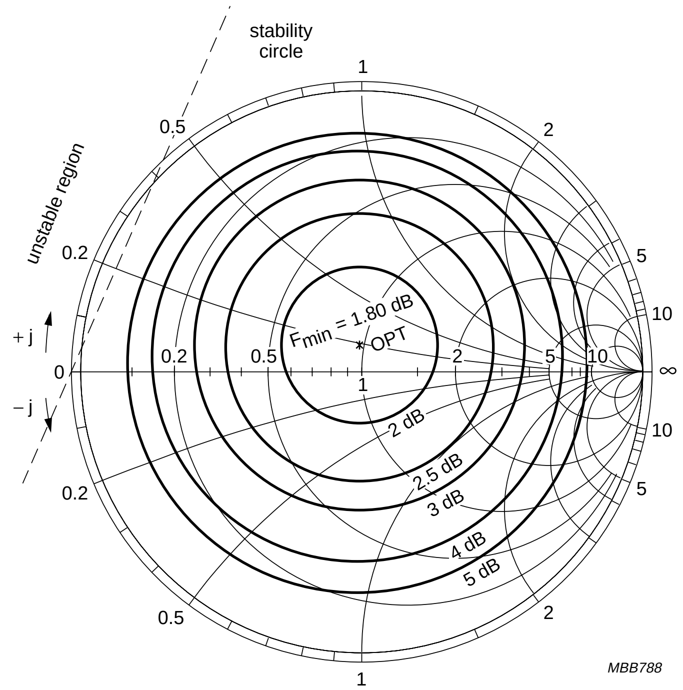
Fig.13 Third order intermodulation distortion as a function of collector current.

NPN 6 GHz wideband transistor BFG94



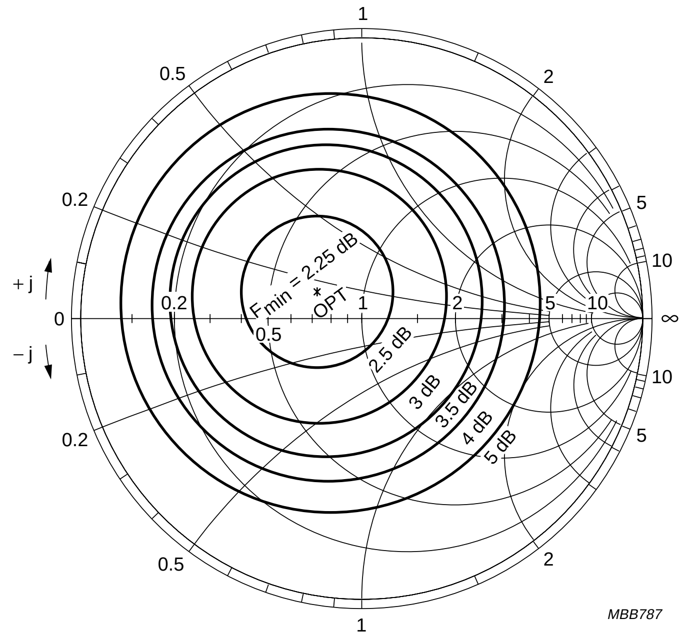
V_{CE} = 8 V.

Fig.14 Minimum noise figure as a function of collector current.



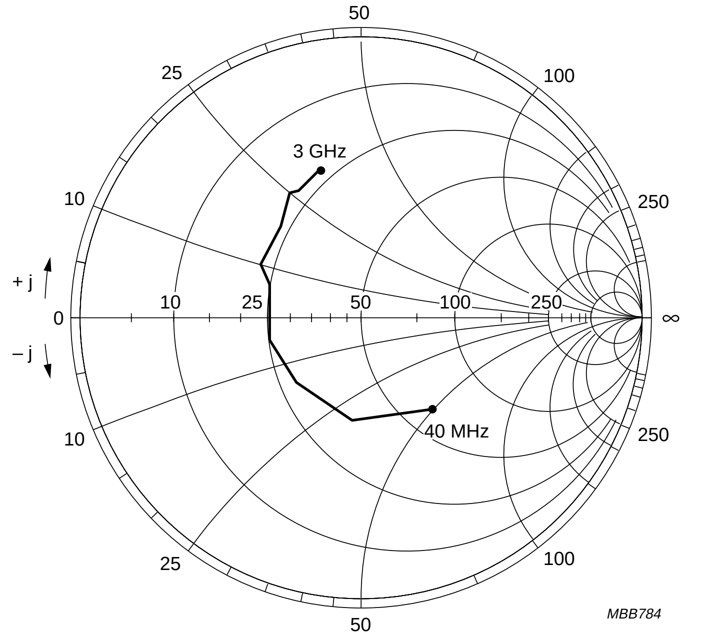
I_c = 15 mA; V_{CE} = 10 V; f = 500 MHz.

Fig.15 Noise circle.



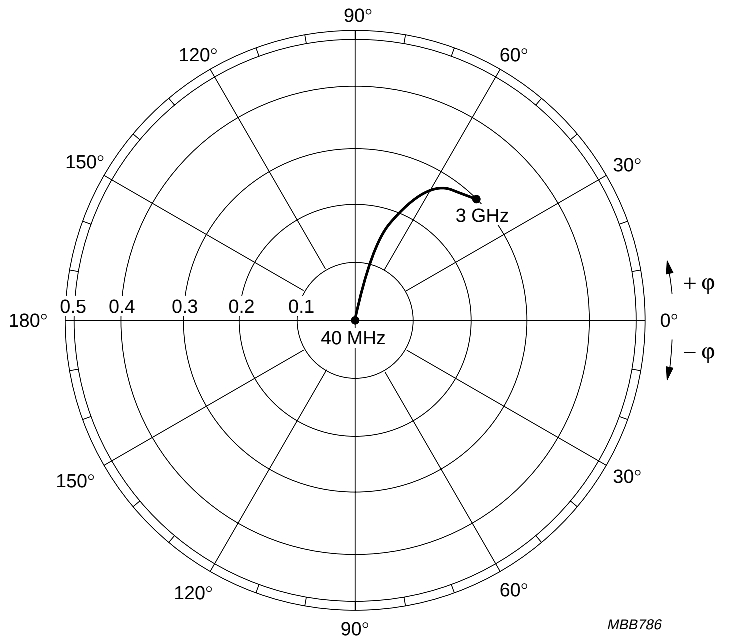
I_c = 15 mA; V_{CE} = 10 V; f =1 GHz.

Fig.16 Noise circle.



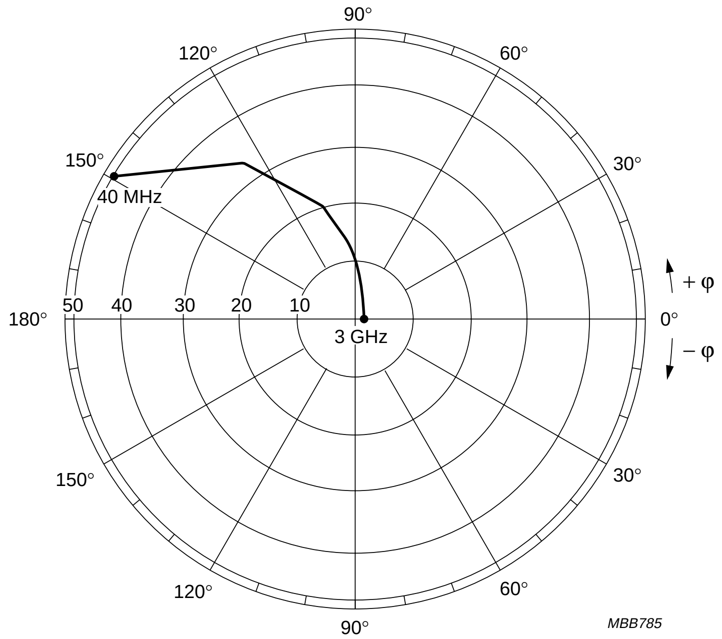
I_C = 45 mA; V_{CE} = 10 V.
Z_O = 50 Ω.

Fig.17 Common emitter input reflection coefficient (S_{11}).



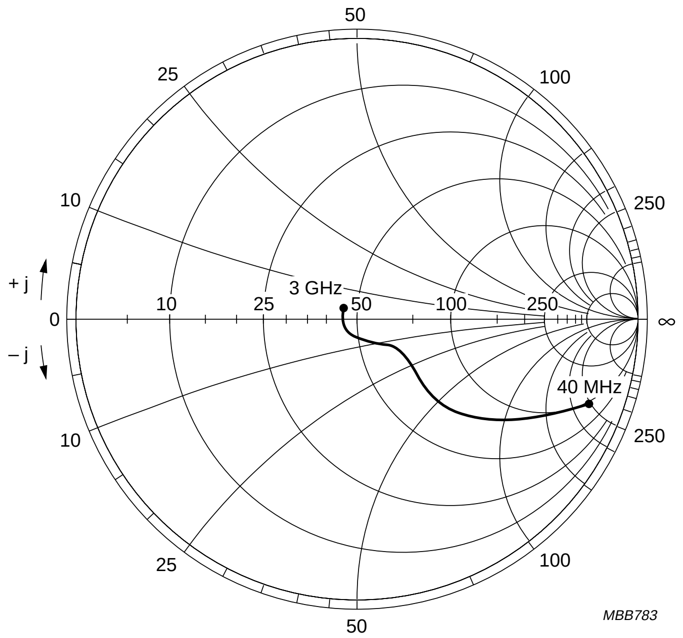
I_C = 45 mA; V_{CE} = 10 V.

Fig.18 Common emitter forward transmission coefficient (S_{21}).



I_C = 45 mA; V_{CE} = 10 V.

Fig.19 Common emitter reverse transmission coefficient (S_{12}).

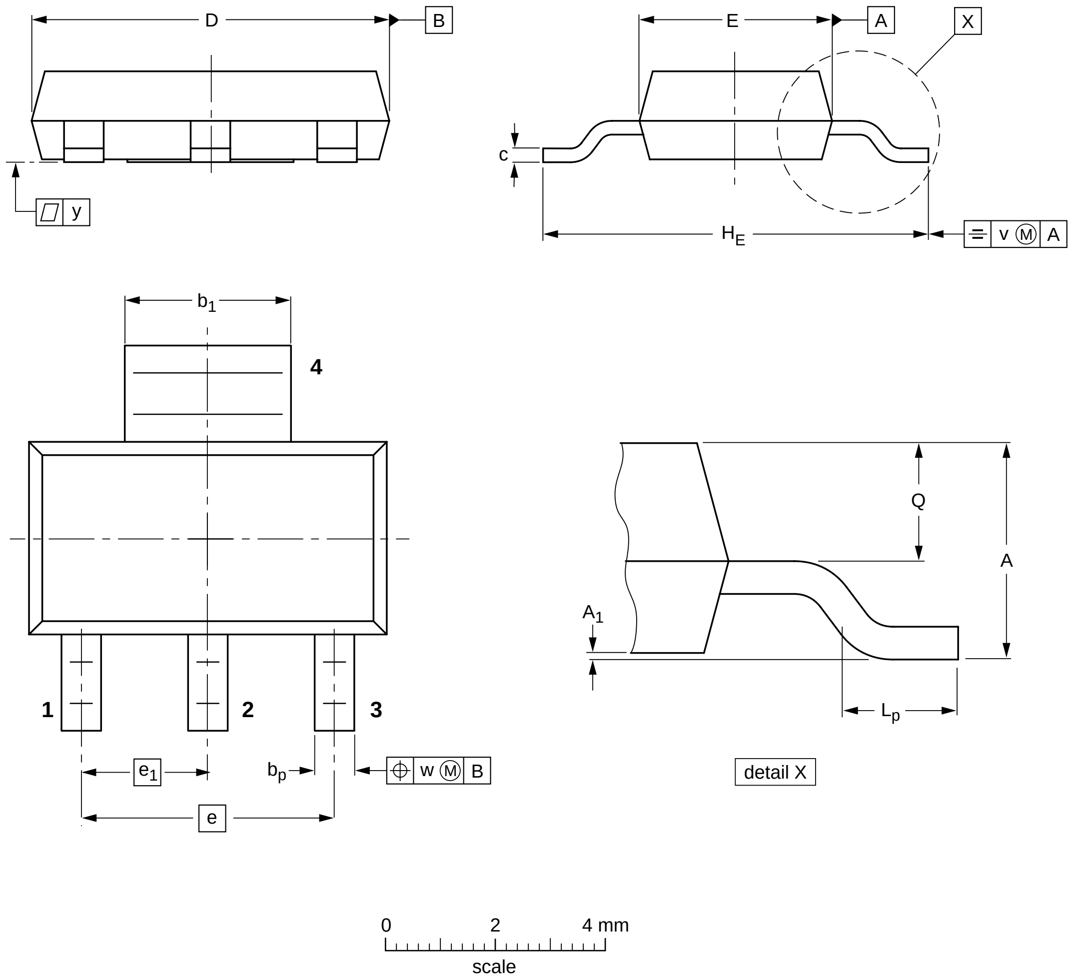


I_C = 45 mA; V_{CE} = 10 V.
Z_O = 50 Ω.

Fig.20 Common emitter output reflection coefficient (S_{22}).

PACKAGE OUTLINE

Plastic surface mounted package; collector pad for good heat transfer; 4 leads **SOT223**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b_p	b_1	c	D	E	e	e_1	H_E	L_p	Q	v	w	y
mm	1.8 1.5	0.10 0.01	0.80 0.60	3.1 2.9	0.32 0.22	6.7 6.3	3.7 3.3	4.6	2.3	7.3 6.7	1.1 0.7	0.95 0.85	0.2	0.1	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT223						~~96-11-11~~ 97-02-28

DEFINITIONS

Data Sheet Status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.