DATA SHEET

BFR93A
NPN 6 GHz wideband transistor

Product specification
Supersedes data of September 1995
File under discrete semiconductors, SC14

1997 Oct 29

Philips Semiconductors

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NPN 6 GHz wideband transistor BFR93A

FEATURES

- High power gain
- Low noise figure
- Very low intermodulation distortion.

APPLICATIONS

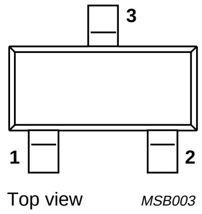
- RF wideband amplifiers and oscillators.

DESCRIPTION

NPN wideband transistor in a plastic SOT23 package.
PNP complement: BFT93.

PINNING

PIN	DESCRIPTION
1	base
2	emitter
3	collector



Marking code: R2p.

Fig.1 SOT23.

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	collector current (DC)		–	35	mA
P_{tot}	total power dissipation	$T_s \leq 95$ °C	–	300	mW
C_{re}	feedback capacitance	$I_C = 0$; $V_{CE} = 5$ V; f = 1 MHz	0.6	–	pF
f_T	transition frequency	$I_C = 30$ mA; $V_{CE} = 5$ V; f = 500 MHz	6	–	GHz
G_{UM}	maximum unilateral power gain	$I_C = 30$ mA; $V_{CE} = 8$ V; f = 1 GHz; $T_{amb} = 25$ °C	13	–	dB
		$I_C = 30$ mA; $V_{CE} = 8$ V; f = 2 GHz; $T_{amb} = 25$ °C	7	–	dB
F	noise figure	$I_C = 5$ mA; $V_{CE} = 8$ V; f = 1 GHz; $\Gamma_s = \Gamma_{opt}$; $T_{amb} = 25$ °C	1.9	–	dB
V_O	output voltage	$d_{im} = -60$ dB; $I_C = 30$ mA; $V_{CE} = 8$ V; $R_L = 75\ \Omega$; $T_{amb} = 25$ °C; $f_p + f_q - f_r = 793.25$ MHz	425	–	mV

LIMITING VALUES

In accordance with the Absolute Maximum Rating 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	collector current (DC)		–	35	mA
P_{tot}	total power dissipation	$T_s \leq 95$ °C; note 1	–	300	mW
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 pin.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}s}$	thermal resistance from junction to soldering point	$T_s \leq 95$ °C; note 1	260	K/W

Note

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

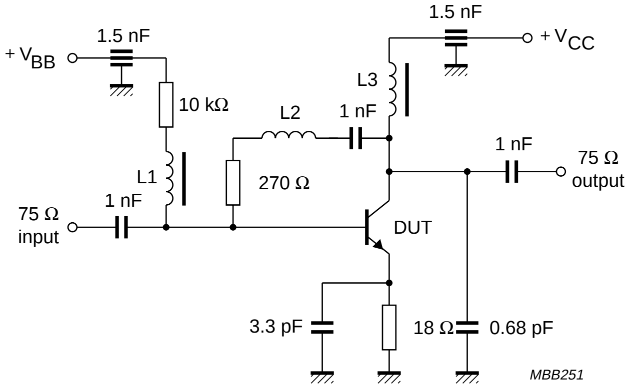
CHARACTERISTICS

$T_j = 25$ °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	–	
C_c	collector capacitance	$I_E = i_e = 0$; $V_{CB} = 5$ V; f = 1 MHz	–	0.7	–	pF
C_e	emitter capacitance	$I_C = i_c = 0$; $V_{EB} = 0.5$ V; f = 1 MHz	–	1.9	–	pF
C_{re}	feedback capacitance	$I_C = i_c = 0$; $V_{CE} = 5$ V; f = 1 MHz; $T_{amb} = 25$ °C	–	0.6	–	pF
f_T	transition frequency	$I_C = 30$ mA; $V_{CE} = 5$ V; f = 500 MHz	4.5	6	–	GHz
G_{UM}	maximum unilateral power gain (note 1)	$I_C = 30$ mA; $V_{CE} = 8$ V; f = 1 GHz; $T_{amb} = 25$ °C	–	13	–	dB
		$I_C = 30$ mA; $V_{CE} = 8$ V; f = 2 GHz; $T_{amb} = 25$ °C	–	7	–	dB
F	noise figure (note 2)	$I_C = 5$ mA; $V_{CE} = 8$ V; f = 1 GHz; $\Gamma_s = \Gamma_{opt}$; $T_{amb} = 25$ °C	–	1.9	–	dB
		$I_C = 5$ mA; $V_{CE} = 8$ V; f = 2 GHz; $\Gamma_s = \Gamma_{opt}$; $T_{amb} = 25$ °C	–	3	–	dB
V_O	output voltage	notes 2 and 3	–	425	–	mV
d_2	second order intermodulation distortion	notes 2 and 4	–	–50	–	dB

Notes

1. G_{UM} is the maximum unilateral power gain, assuming S_{12} is zero and $G_{UM} = 10\log\dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}\,\text{dB}$.
2. Measured on the same die in a SOT37 package (BFR91A).
3. $d_{im} = -60$ 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 at $f_q = 803.25$ MHz;
   $V_r = V_O$ –6 dB at $f_r = 805.25$ MHz;
   measured at $f_p + f_q - f_r = 793.25$ MHz.
4. $I_C = 30$ mA; $V_{CE} = 8$ V; $R_L = 75\ \Omega$; $T_{amb} = 25$ °C;
   $V_p = 200$ mV at $f_p = 250$ MHz;
   $V_q = 200$ mV at $f_q = 560$ MHz;
   measured at $f_p + f_q = 810$ MHz.



L1 = L3 = 5 µH choke.

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

Fig.2 Intermodulation distortion and second harmonic distortion MATV test circuit.

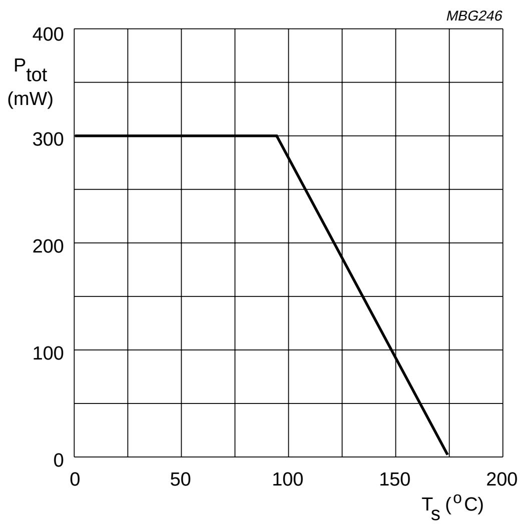
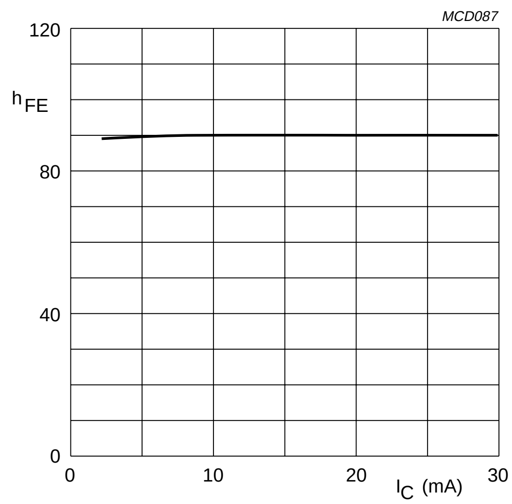


Fig.3 Power derating curve.



V_{CE} = 5 V; T_j = 25 °C.

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

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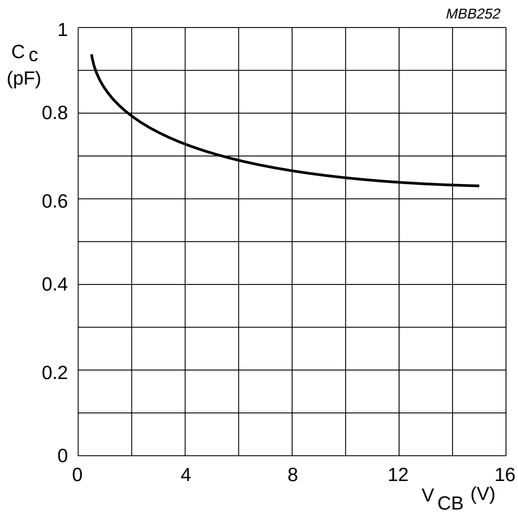
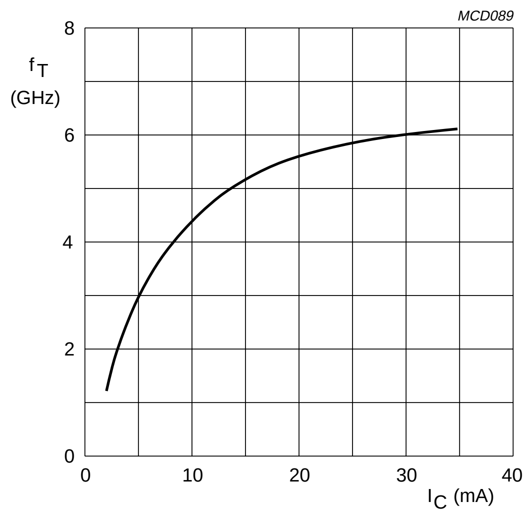


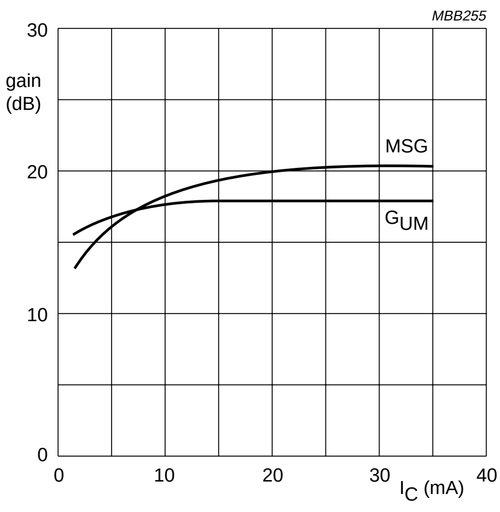
$I_E = i_e = 0$; f = 1 MHz; T_j = 25 °C.

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



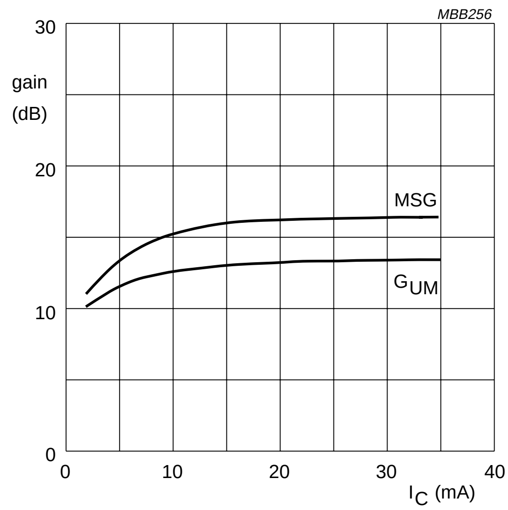
V_{CE} = 5 V; f = 500 MHz; T_j = 25 °C.

Fig.6 Transition frequency as a function of collector current; typical values.



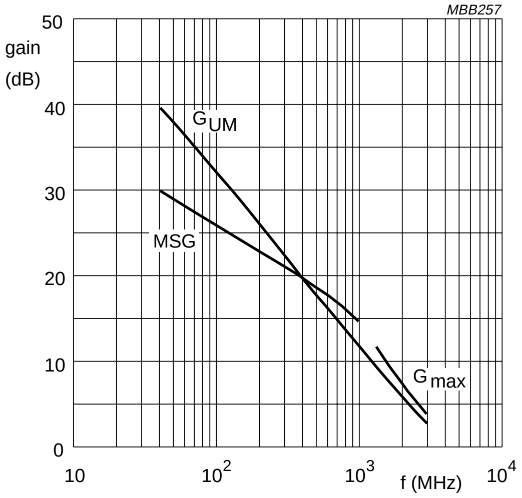
V_{CE} = 8 V; f = 500 MHz.

Fig.7 Gain as a function of collector current; typical values.



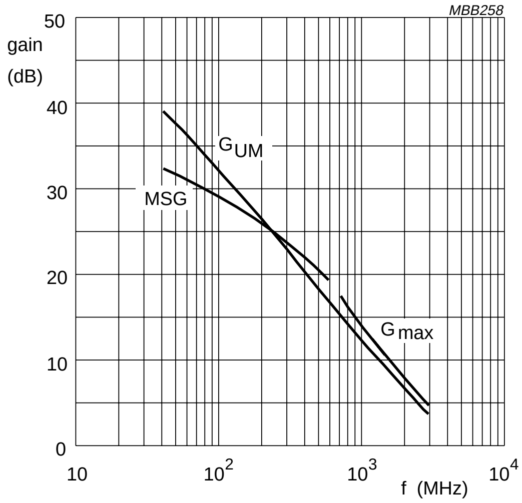
V_{CE} = 8 V; f = 1 GHz.

Fig.8 Gain as a function of collector current; typical values.



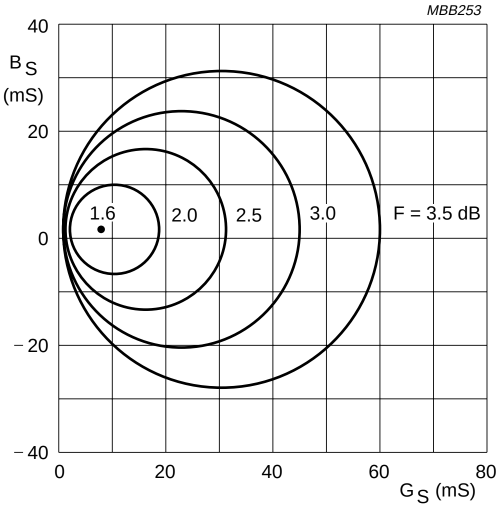
I_C = 10 mA; V_{CE} = 8 V.

Fig.9 Gain as a function of frequency; typical values.



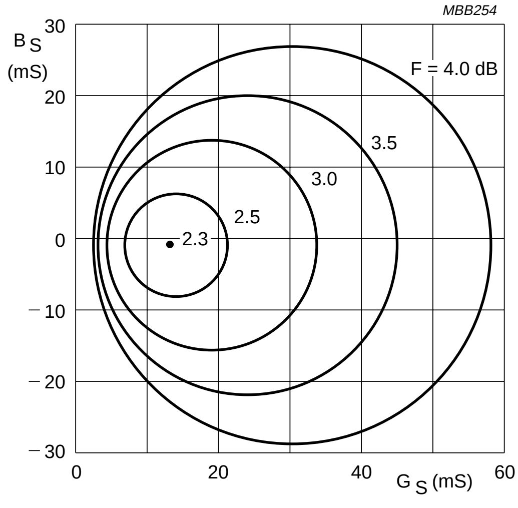
I_C = 30 mA; V_{CE} = 8 V.

Fig.10 Gain as a function of frequency; typical values.



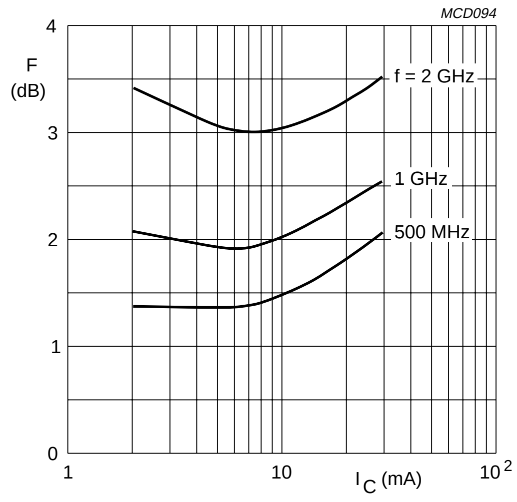
I_C = 4 mA; V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C.

Fig.11 Circles of constant noise figure; typical values.



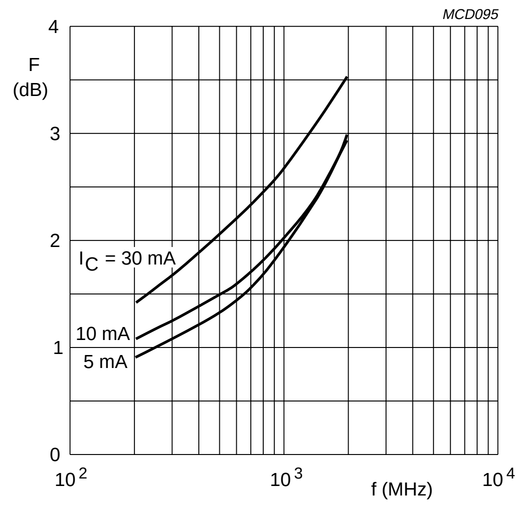
I_C = 4 mA; V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C.

Fig.12 Circles of constant noise figure; typical values.



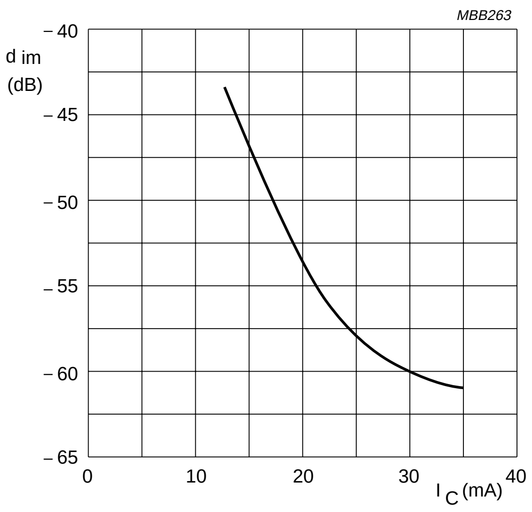
V_{CE} = 8 V.

Fig.13 Minimum noise figure as a function of collector current; typical values.



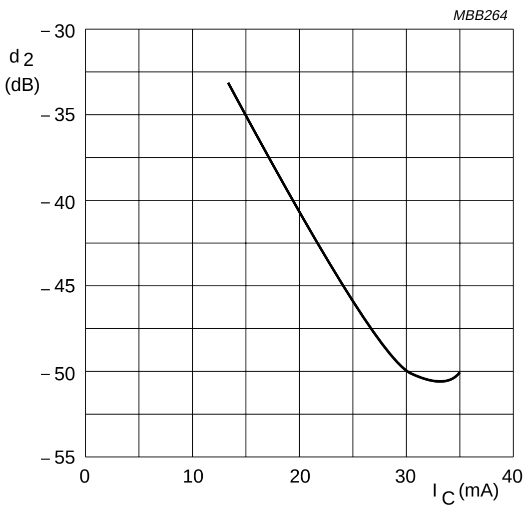
V_{CE} = 8 V.

Fig.14 Minimum noise figure as a function of frequency; typical values.



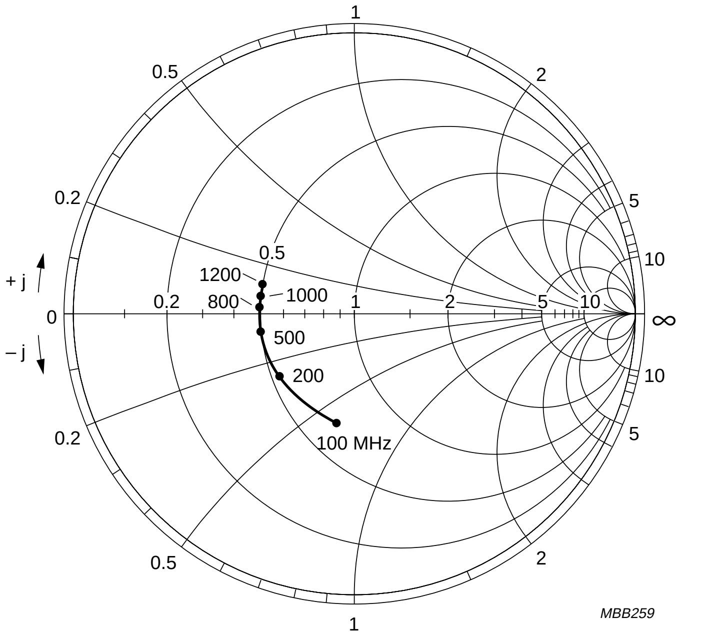
V_{CE} = 8 V; V_O = 425 mV (52.6 dBmV);
$f_p + f_q – f_r$ = 793.25 MHz; T_{amb} = 25 °C.
Measured in MATV test circuit (see Fig.2)

Fig.15 Intermodulation distortion; typical values.



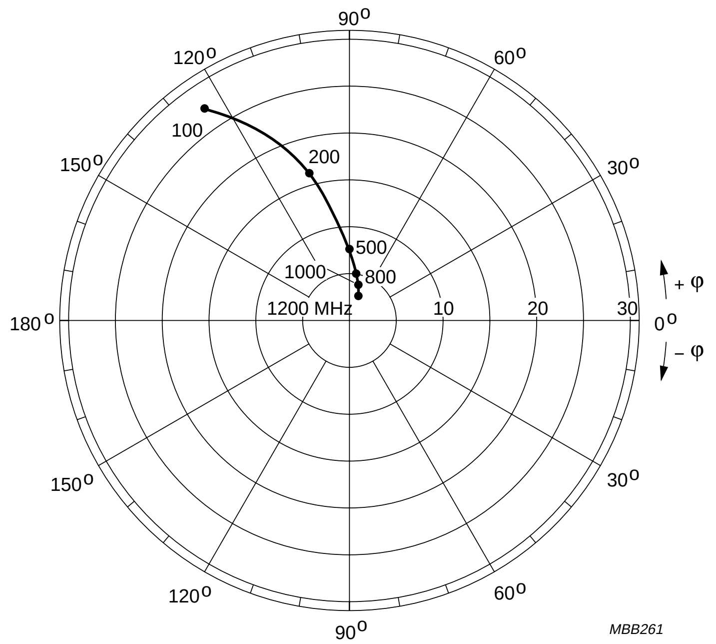
V_{CE} = 8 V; V_O = 200 mV (46 dBmV);
$f_p + f_q – f_r$ = 810 MHz; T_{amb} = 25 °C.
Measured in MATV test circuit (see Fig.2)

Fig.16 Second order intermodulation distortion; typical values.



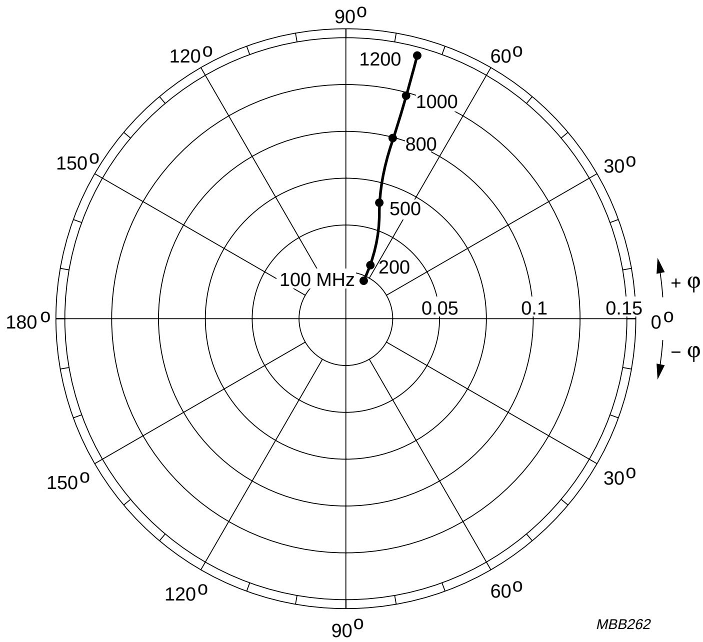
I_C = 30 mA; V_{CE} = 8 V; Z_o = 50 Ω; T_{amb} = 25 °C.

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



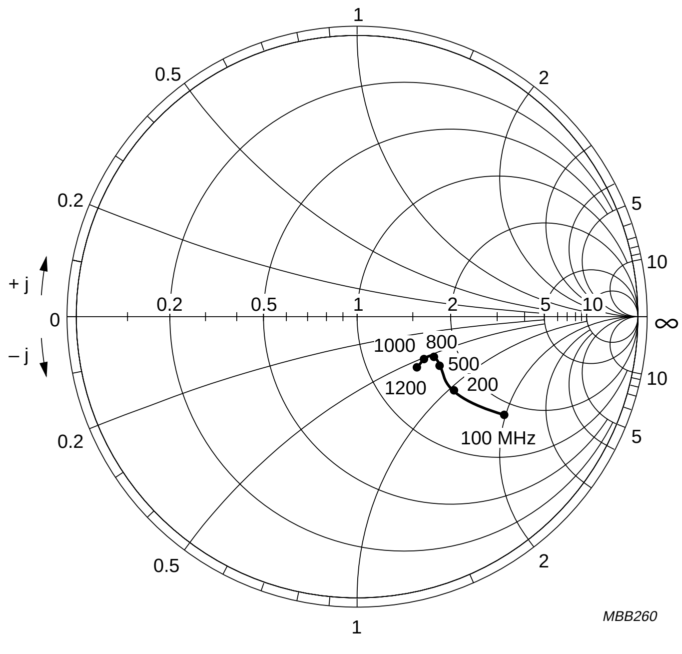
I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C.

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



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

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



I_C = 30 mA; V_{CE} = 8 V; Z_o = 50 Ω; T_{amb} = 25 °C.

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

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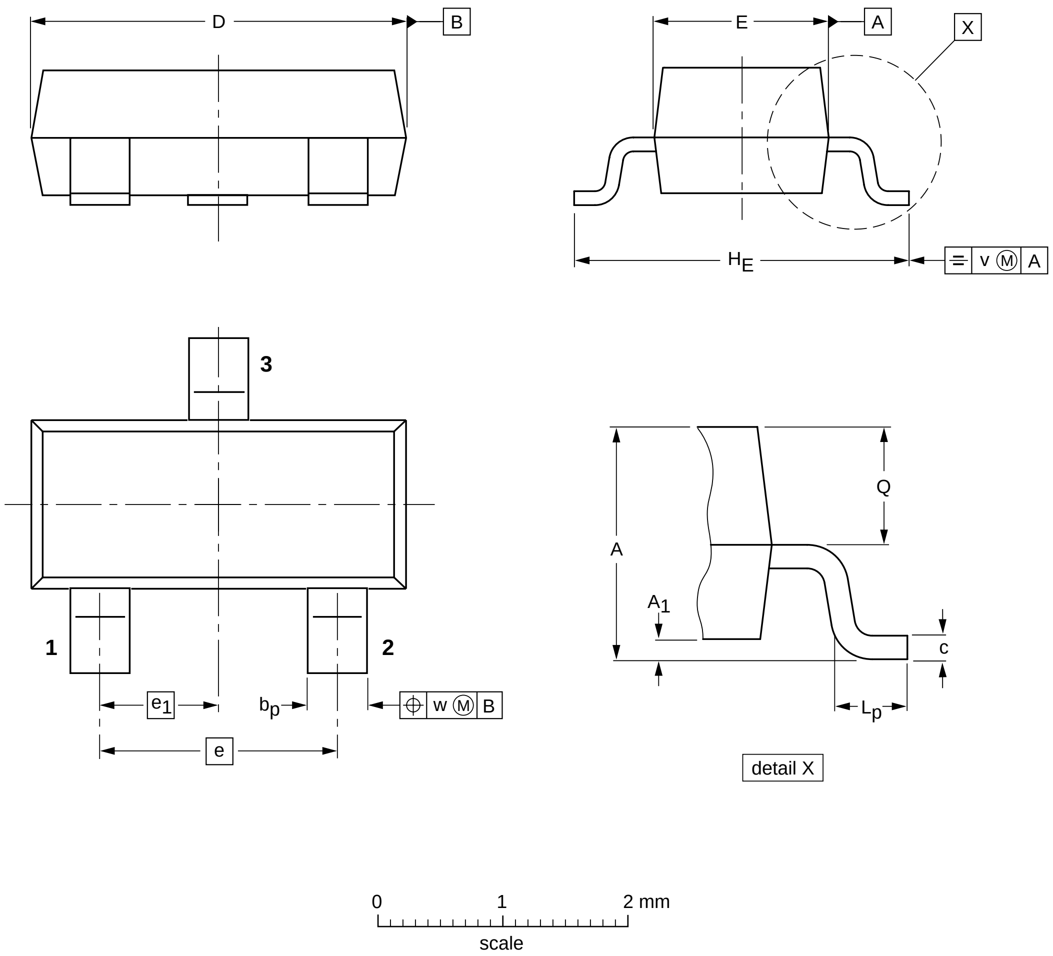
PACKAGE OUTLINE

Plastic surface mounted package; 3 leads **SOT23**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max.	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w
mm	1.1 0.9	0.1	0.48 0.38	0.15 0.09	3.0 2.8	1.4 1.2	1.9	0.95	2.5 2.1	0.45 0.15	0.55 0.45	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT23						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.	

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Printed in The Netherlands 127127/00/02/pp12 Date of release: 1997 Oct 29 Document order number: 9397 750 02764