

# DATA SHEET

**BFR93A**

**NPN 6 GHz wideband transistor**

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

1997 Oct 29

## NPN 6 GHz wideband transistor

## BFR93A

## FEATURES

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

## APPLICATIONS

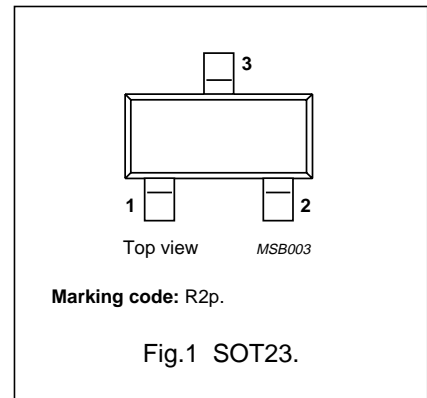
- RF wideband amplifiers and oscillators.

## DESCRIPTION

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

## PINNING

PIN	DESCRIPTION
1	base
2	emitter
3	collector



## 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	$T_s \leq 95\text{ }^\circ\text{C}$	–	300	mW
$C_{re}$	feedback capacitance	$I_C = 0$ ; $V_{CE} = 5\text{ V}$ ; $f = 1\text{ MHz}$	0.6	–	pF
$f_T$	transition frequency	$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $f = 500\text{ MHz}$	6	–	GHz
$G_{UM}$	maximum unilateral power gain	$I_C = 30\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	13	–	dB
		$I_C = 30\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	7	–	dB
F	noise figure	$I_C = 5\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 1\text{ GHz}$ ; $\Gamma_s = \Gamma_{opt}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$	1.9	–	dB
$V_O$	output voltage	$d_{im} = -60\text{ dB}$ ; $I_C = 30\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $R_L = 75\text{ }\Omega$ ; $T_{amb} = 25\text{ }^\circ\text{C}$ ; $f_p + f_q - f_r = 793.25\text{ MHz}$	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	$T_s \leq 95\text{ }^\circ\text{C}$ ; note 1	–	300	mW
$T_{stg}$	storage temperature		–65	+150	$^\circ\text{C}$
$T_j$	junction temperature		–	+175	$^\circ\text{C}$

## Note

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

## NPN 6 GHz wideband transistor

## BFR93A

## THERMAL CHARACTERISTICS

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

## Note

- $T_s$  is the temperature at the soldering point of the collector pin.

## CHARACTERISTICS

$T_j = 25\text{ °C}$  unless otherwise specified.

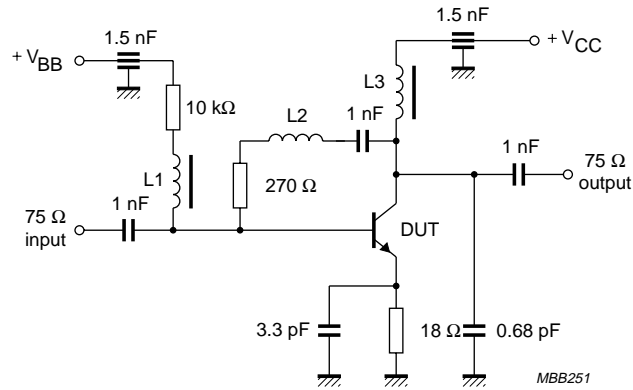
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{CBO}$	collector cut-off current	$I_E = 0$ ; $V_{CB} = 5\text{ V}$	–	–	50	nA
$h_{FE}$	DC current gain	$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$	40	90	–	
$C_c$	collector capacitance	$I_E = I_e = 0$ ; $V_{CB} = 5\text{ V}$ ; $f = 1\text{ MHz}$	–	0.7	–	pF
$C_e$	emitter capacitance	$I_C = I_c = 0$ ; $V_{EB} = 0.5\text{ V}$ ; $f = 1\text{ MHz}$	–	1.9	–	pF
$C_{re}$	feedback capacitance	$I_C = I_c = 0$ ; $V_{CE} = 5\text{ V}$ ; $f = 1\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	–	0.6	–	pF
$f_T$	transition frequency	$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$ ; $f = 500\text{ MHz}$	4.5	6	–	GHz
$G_{UM}$	maximum unilateral power gain (note 1)	$I_C = 30\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$	–	13	–	dB
		$I_C = 30\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$	–	7	–	dB
F	noise figure (note 2)	$I_C = 5\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 1\text{ GHz}$ ; $\Gamma_s = \Gamma_{opt}$ ; $T_{amb} = 25\text{ °C}$	–	1.9	–	dB
		$I_C = 5\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 2\text{ GHz}$ ; $\Gamma_s = \Gamma_{opt}$ ; $T_{amb} = 25\text{ °C}$	–	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

- $G_{UM}$  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.
- Measured on the same die in a SOT37 package (BFR91A).
- $d_{im} = -60\text{ dB}$  (DIN 45004B);  $I_C = 30\text{ mA}$ ;  $V_{CE} = 8\text{ V}$ ;  $R_L = 75\ \Omega$ ;  $T_{amb} = 25\text{ °C}$ ;  
 $V_p = V_O$  at  $d_{im} = -60\text{ dB}$ ;  $f_p = 795.25\text{ MHz}$ ;  
 $V_q = V_O - 6\text{ dB}$  at  $f_q = 803.25\text{ MHz}$ ;  
 $V_r = V_O - 6\text{ dB}$  at  $f_r = 805.25\text{ MHz}$ ;  
measured at  $f_p + f_q - f_r = 793.25\text{ MHz}$ .
- $I_C = 30\text{ mA}$ ;  $V_{CE} = 8\text{ V}$ ;  $R_L = 75\ \Omega$ ;  $T_{amb} = 25\text{ °C}$ ;  
 $V_p = 200\text{ mV}$  at  $f_p = 250\text{ MHz}$ ;  
 $V_q = 200\text{ mV}$  at  $f_q = 560\text{ MHz}$ ;  
measured at  $f_p + f_q = 810\text{ MHz}$ .

NPN 6 GHz wideband transistor

BFR93A



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.

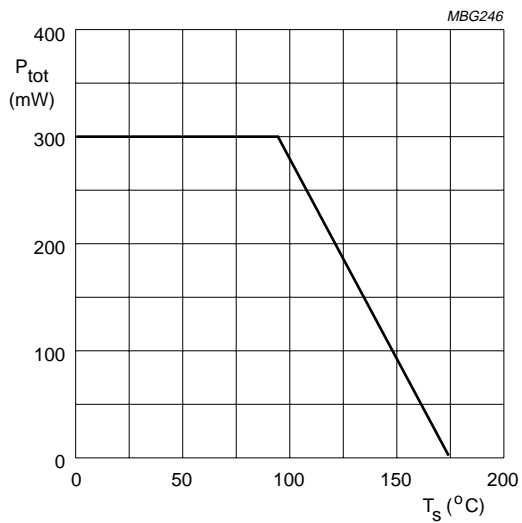
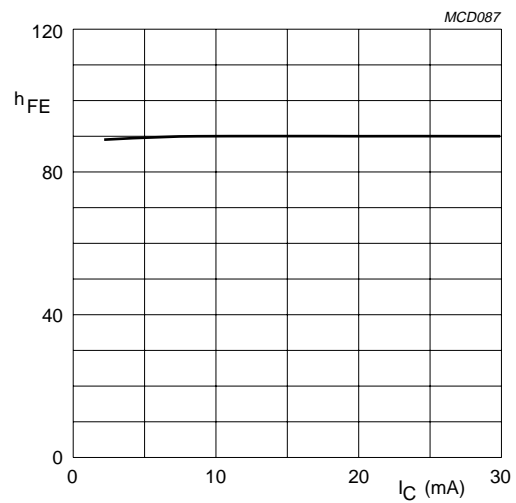


Fig.3 Power derating curve.

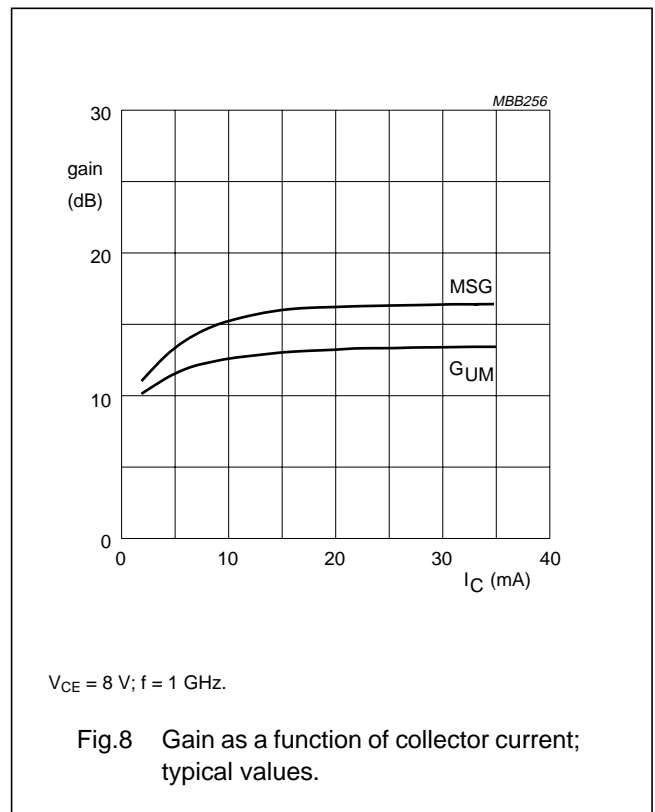
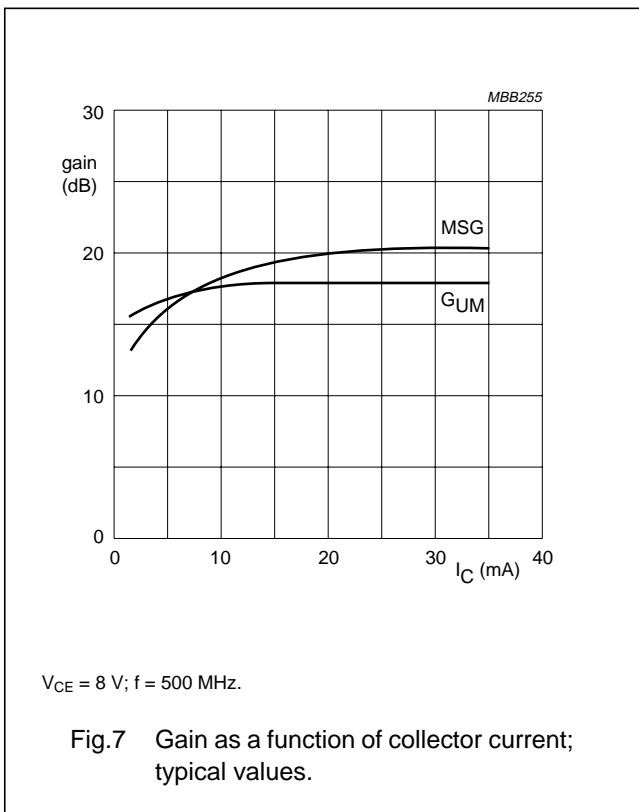
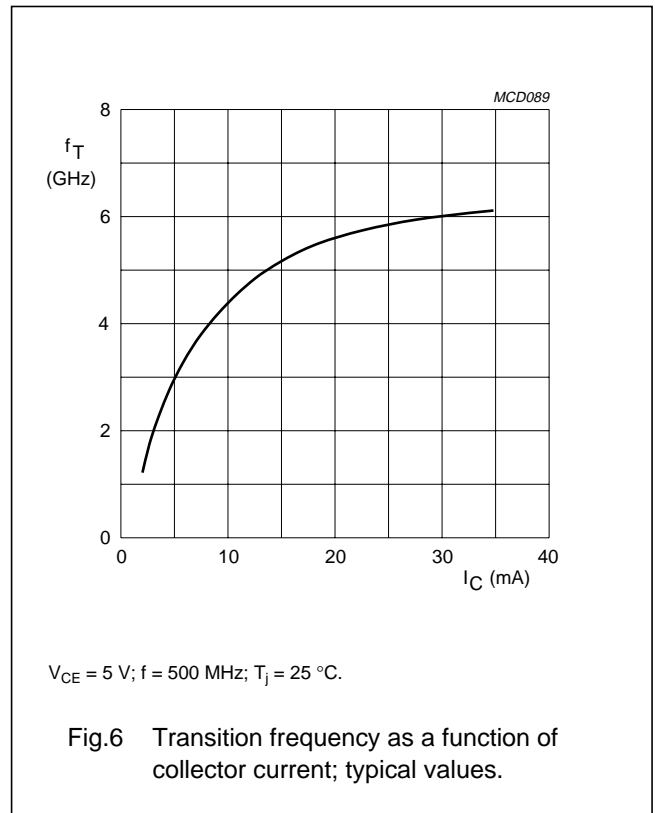
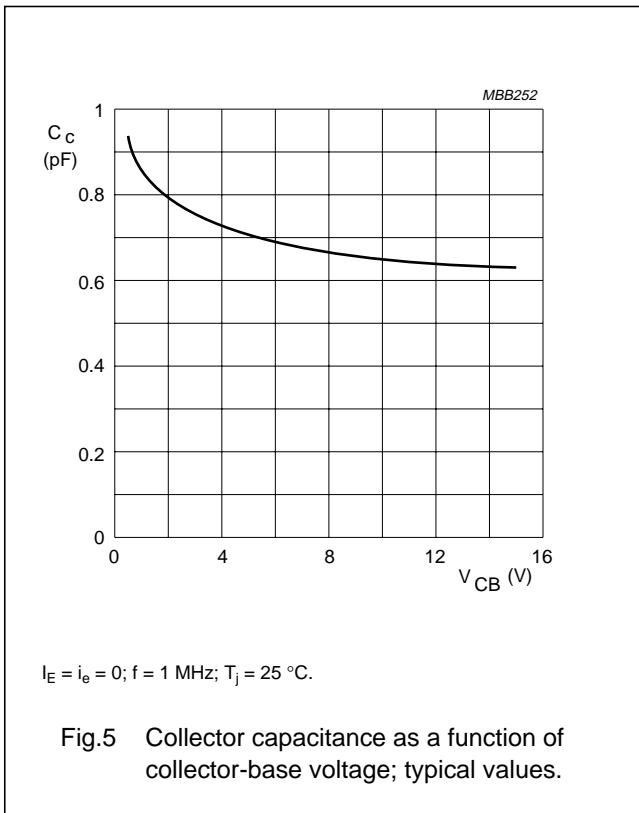


V<sub>CE</sub> = 5 V; T<sub>j</sub> = 25 °C.

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

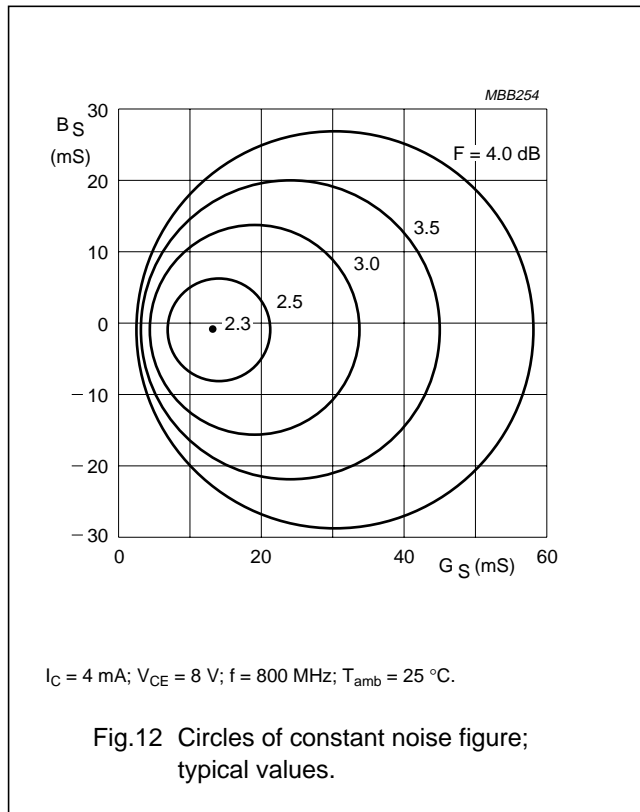
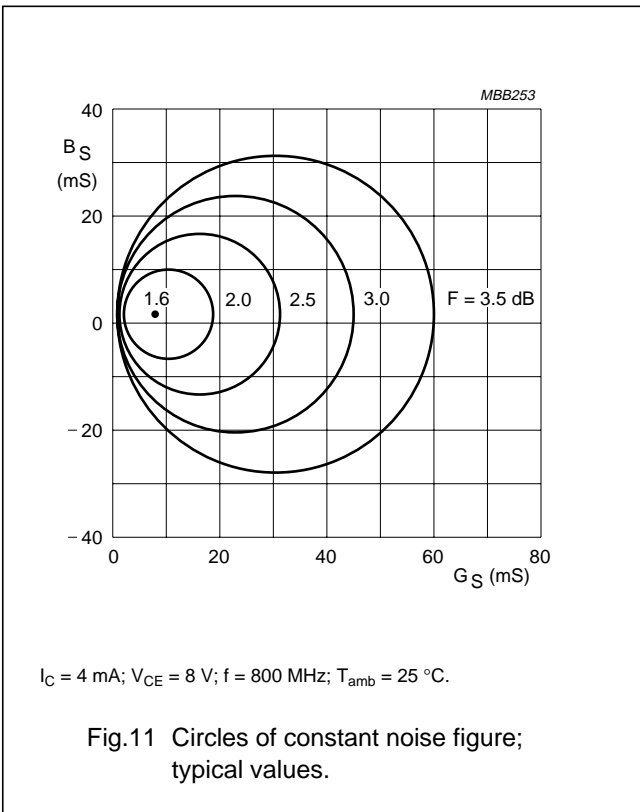
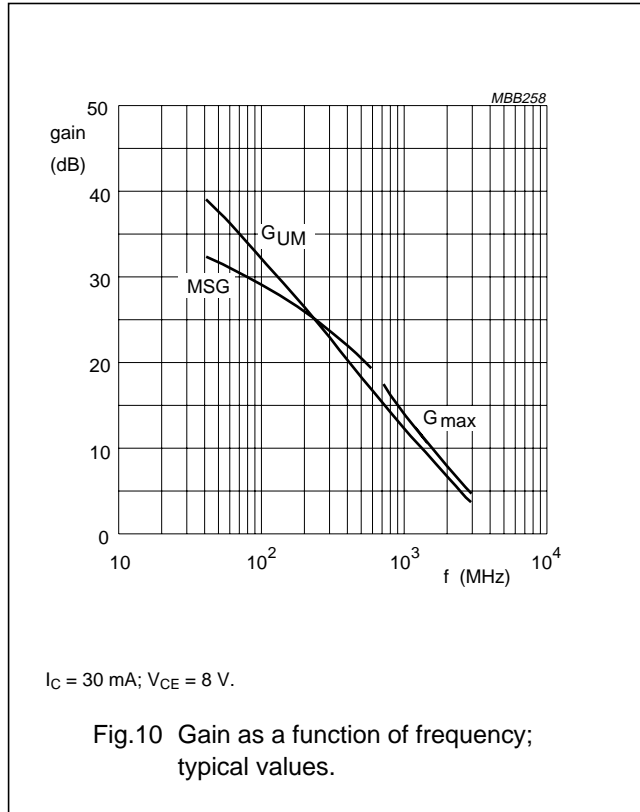
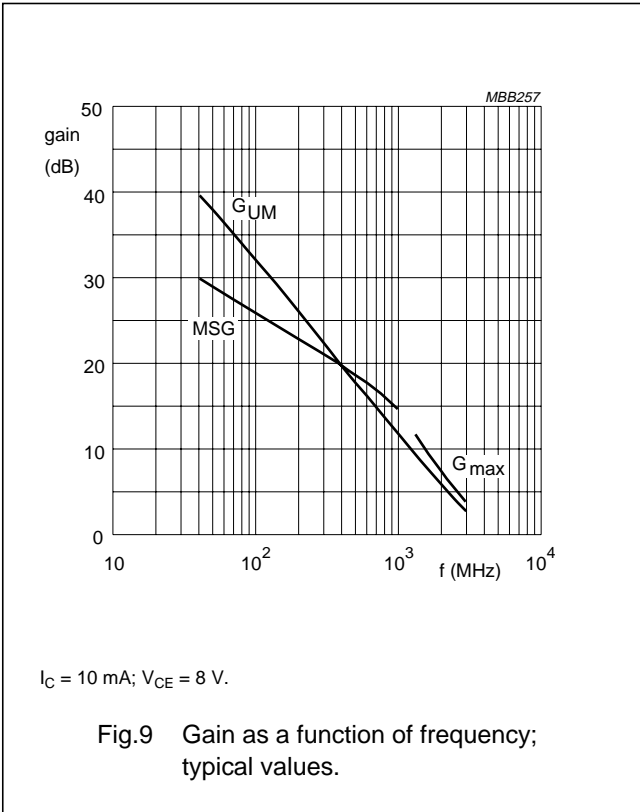
NPN 6 GHz wideband transistor

BFR93A



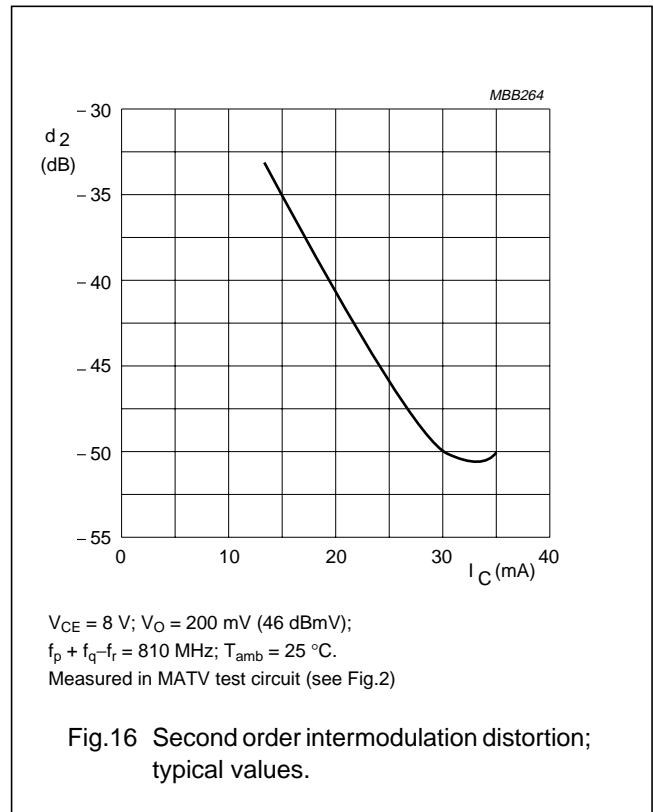
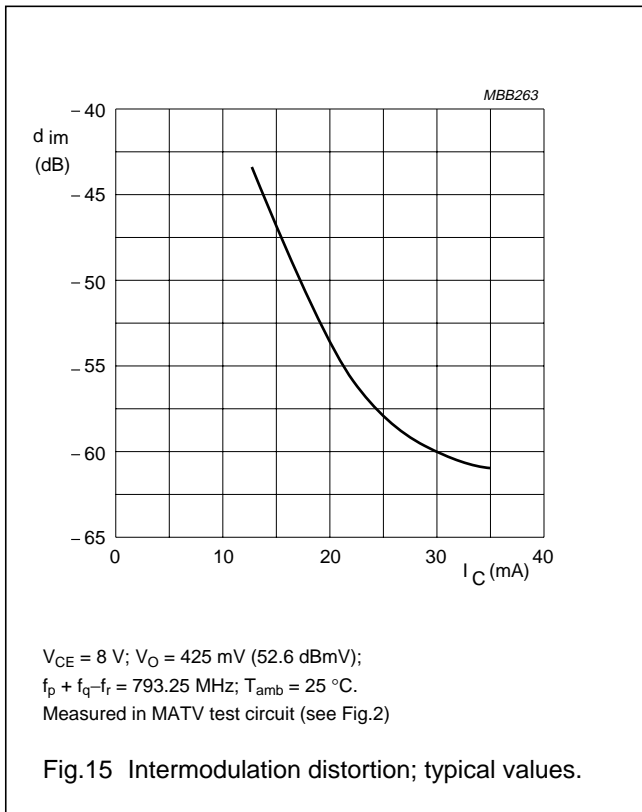
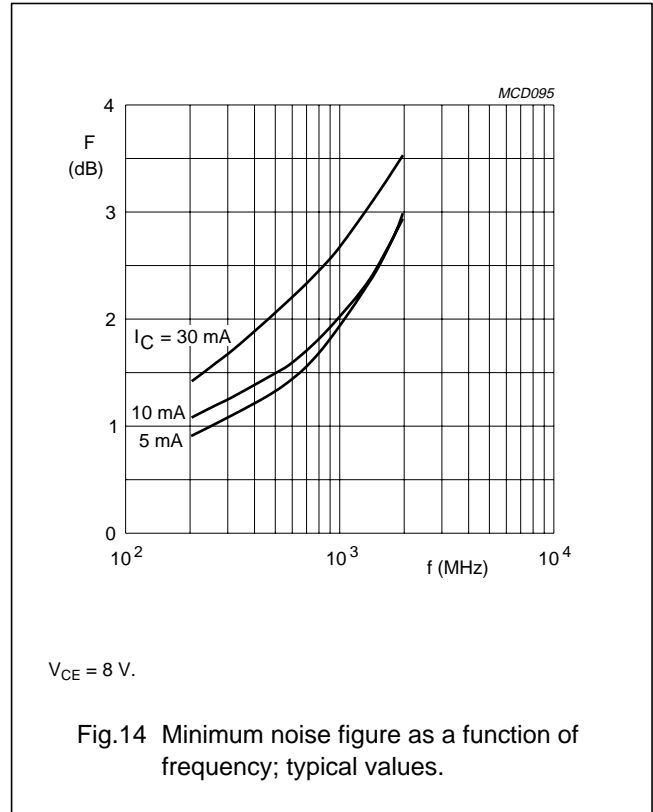
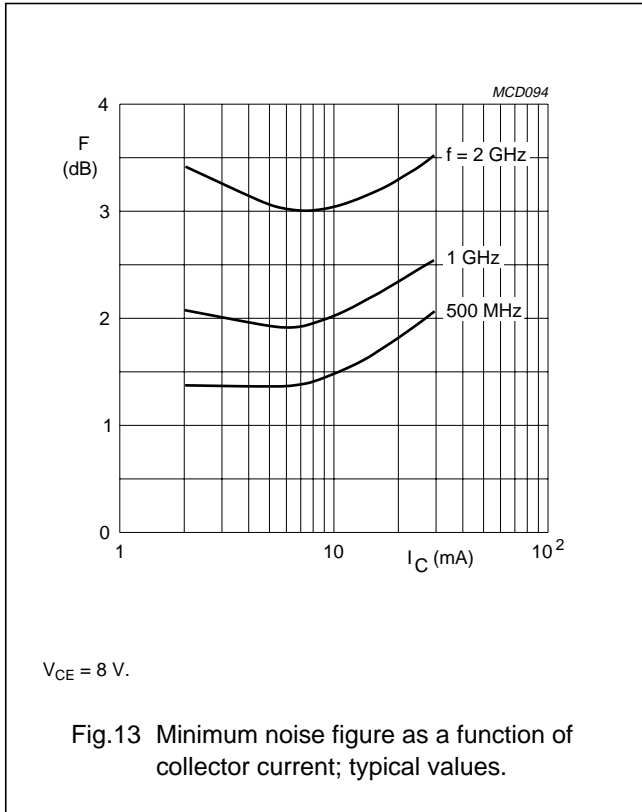
NPN 6 GHz wideband transistor

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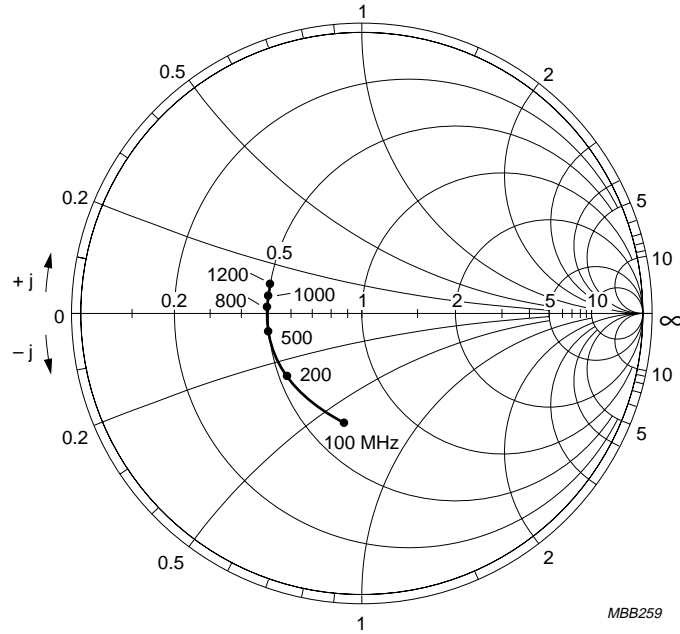
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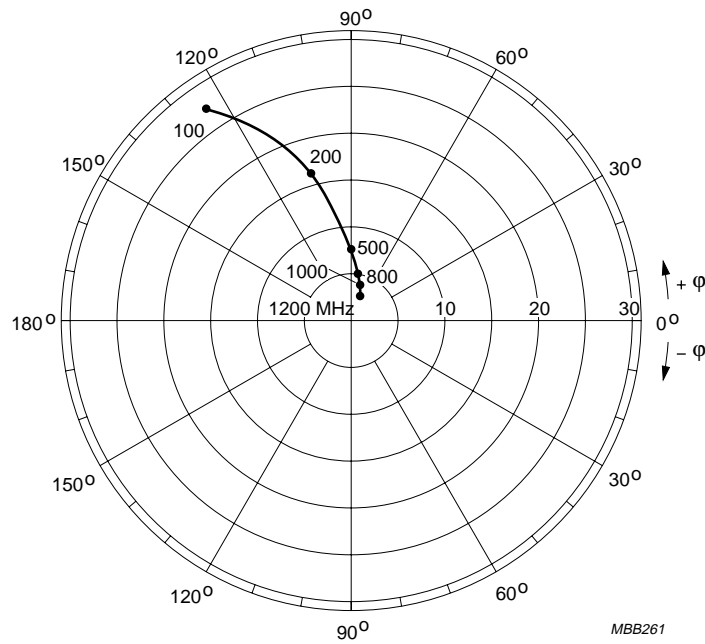
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BFR93A



$I_C = 30 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $Z_0 = 50 \Omega$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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



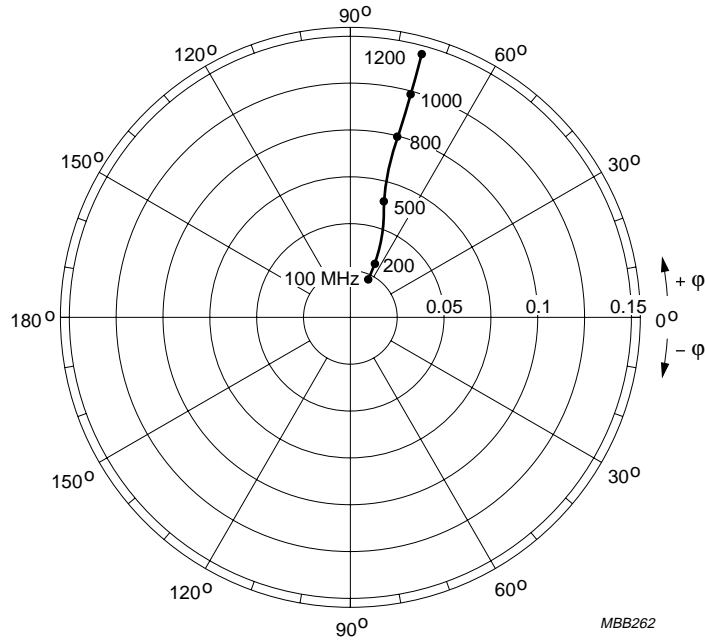
$I_C = 30 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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



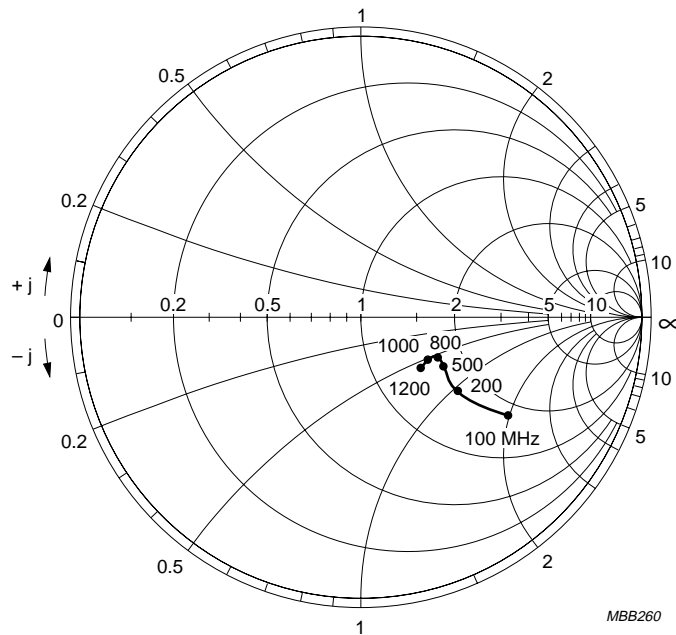
NPN 6 GHz wideband transistor

BFR93A



$I_C = 30 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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



$I_C = 30 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $Z_0 = 50 \text{ } \Omega$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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

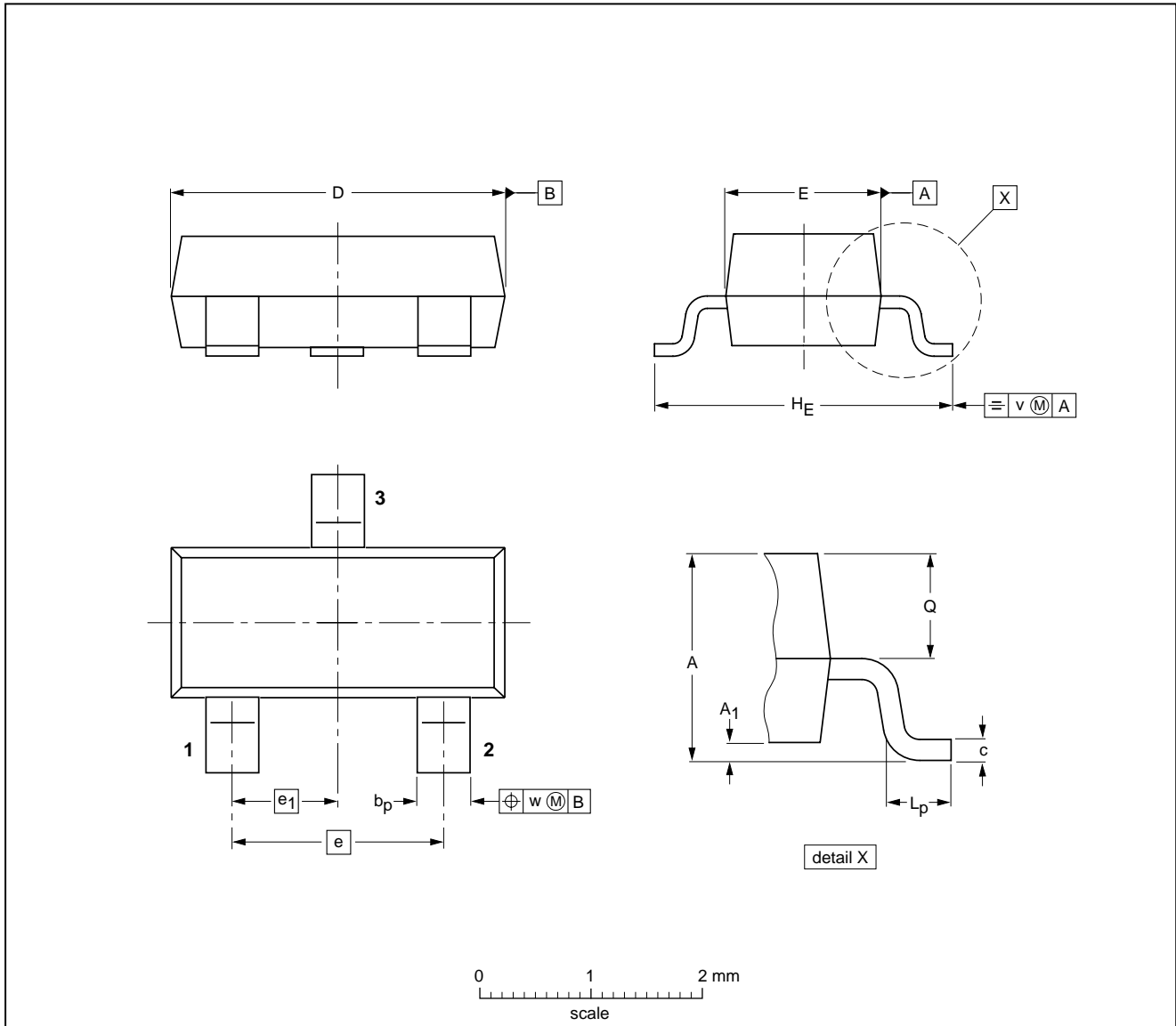
NPN 6 GHz wideband transistor

BFR93A

PACKAGE OUTLINE

Plastic surface mounted package; 3 leads

SOT23



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub> max.	b <sub>p</sub>	c	D	E	e	e <sub>1</sub>	H <sub>E</sub>	L <sub>p</sub>	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

## NPN 6 GHz wideband transistor

BFR93A

**DEFINITIONS**

<b>Data sheet status</b>	
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.
<b>Limiting values</b>	
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.	
<b>Application information</b>	
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Printed in The Netherlands

127127/00/02/pp12

Date of release: 1997 Oct 29

Document order number: 9397 750 02764

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