

# 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

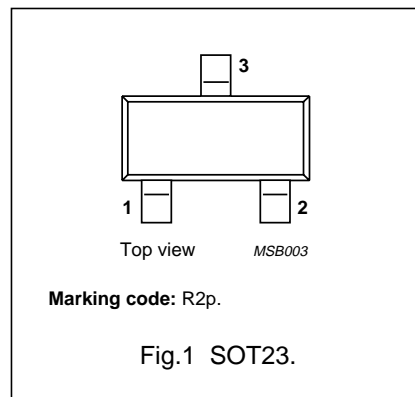
- RF wideband amplifiers and oscillators.

## 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.

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## 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.

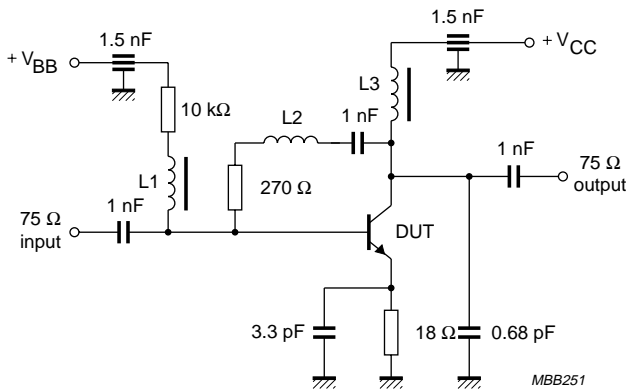
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{CBO}$	collector cut-off current	$I_E = 0$ ; $V_{CB} = 5\text{ V}$	—	—	50	nA
$h_{FE}$	DC current gain	$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$	40	90	—	
$C_c$	collector capacitance	$I_E = I_E = 0$ ; $V_{CB} = 5\text{ V}$ ; $f = 1\text{ MHz}$	—	0.7	—	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  $G_{UM} = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)} \text{ dB}$ .
- Measured on the same die in a SOT37 package (BFR91A).
- $d_{im} = -60\text{ dB}$  (DIN 45004B);  $I_C = 30\text{ mA}$ ;  $V_{CE} = 8\text{ V}$ ;  $R_L = 75\text{ }\Omega$ ;  $T_{amb} = 25\text{ °C}$ ;  
 $V_p = V_O$  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  $f_p + f_q - f_r = 793.25\text{ MHz}$ .
- $I_C = 30\text{ mA}$ ;  $V_{CE} = 8\text{ V}$ ;  $R_L = 75\text{ }\Omega$ ;  $T_{amb} = 25\text{ °C}$ ;  
 $V_p = 200\text{ mV}$  at  $f_p = 250\text{ MHz}$ ;  
 $V_q = 200\text{ mV}$  at  $f_q = 560\text{ MHz}$ ;  
measured at  $f_p + f_q = 810\text{ MHz}$ .

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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.

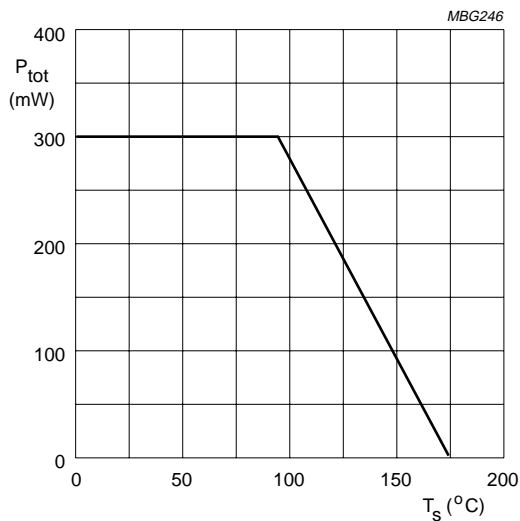
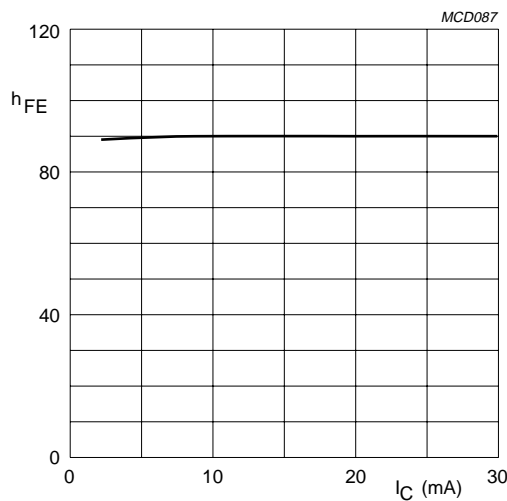


Fig.3 Power derating curve.

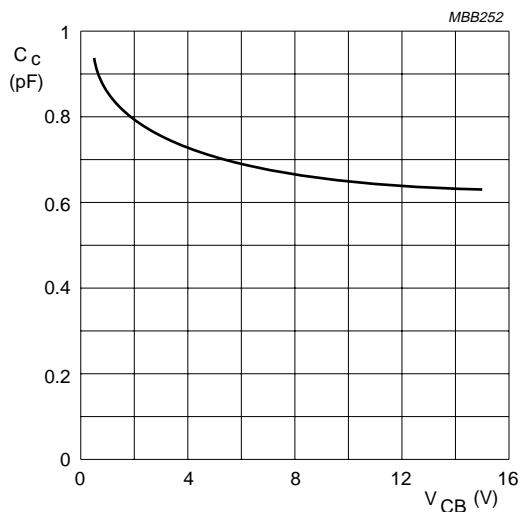


V<sub>CE</sub> = 5 V; T<sub>j</sub> = 25 °C.

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

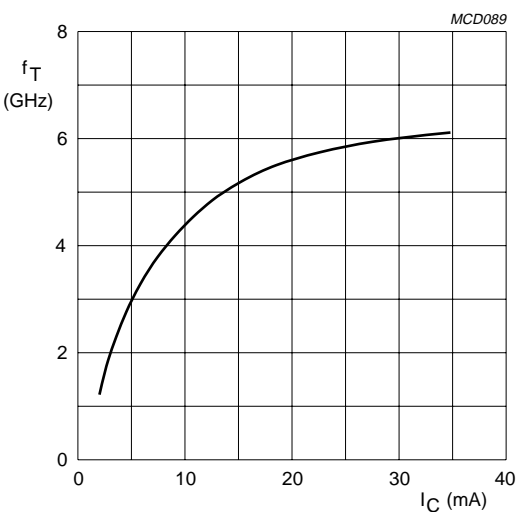
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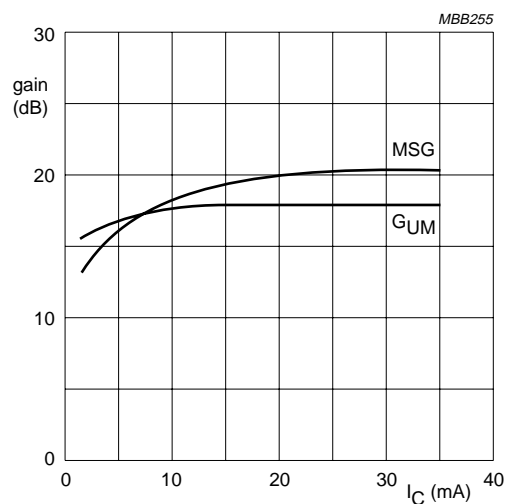
$I_E = i_b = 0$ ;  $f = 1$  MHz;  $T_j = 25$  °C.

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



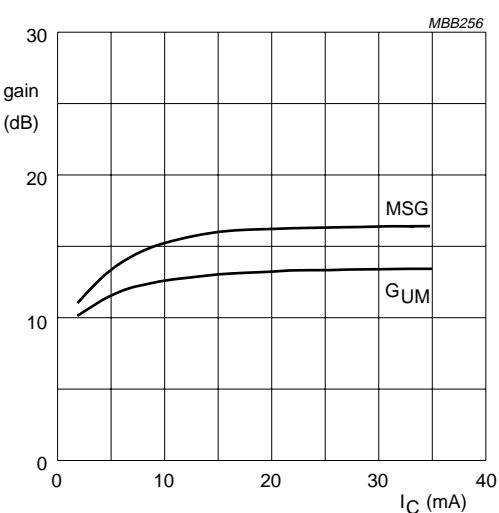
$V_{CE} = 5$  V;  $f = 500$  MHz;  $T_j = 25$  °C.

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.

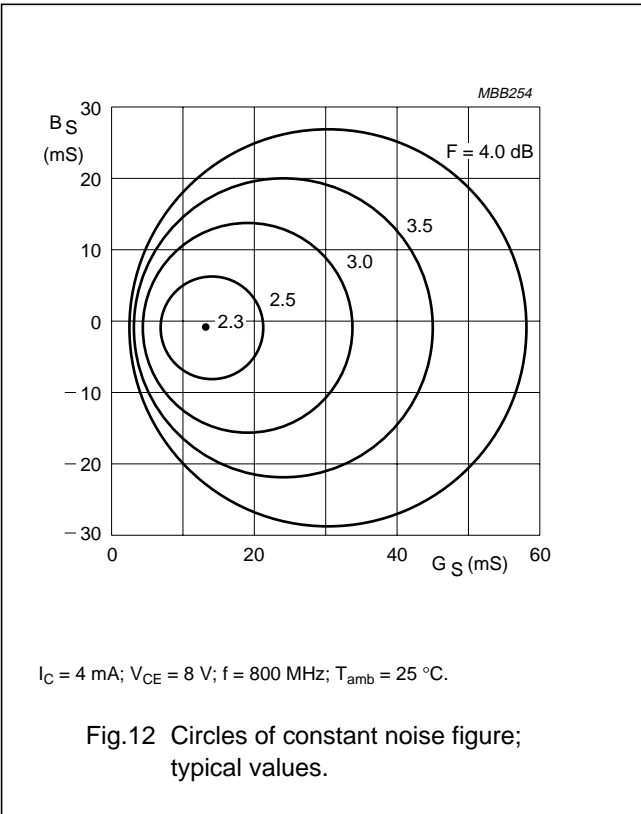
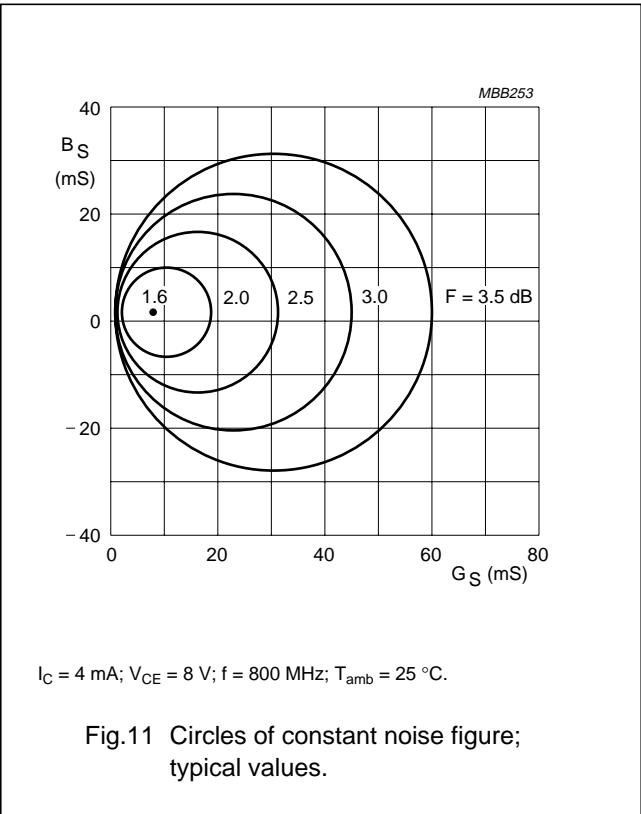
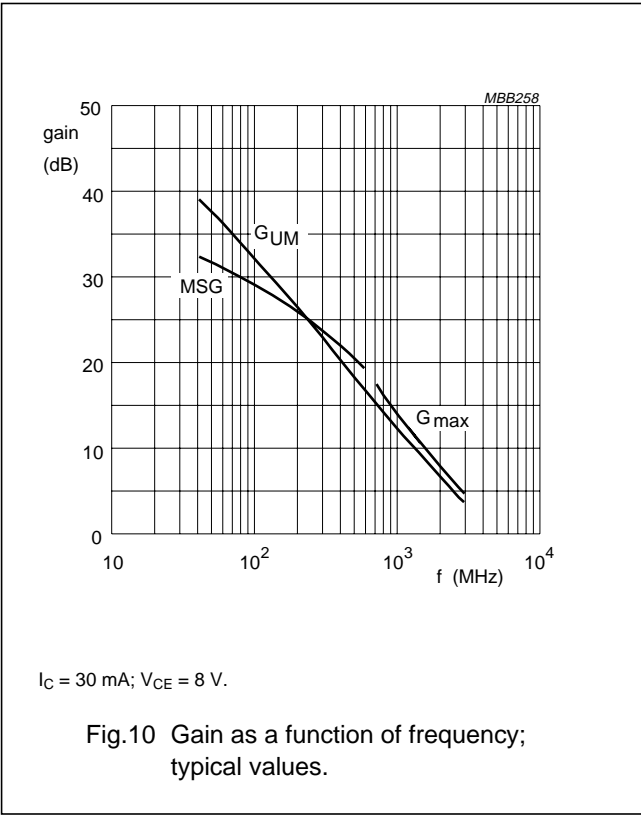
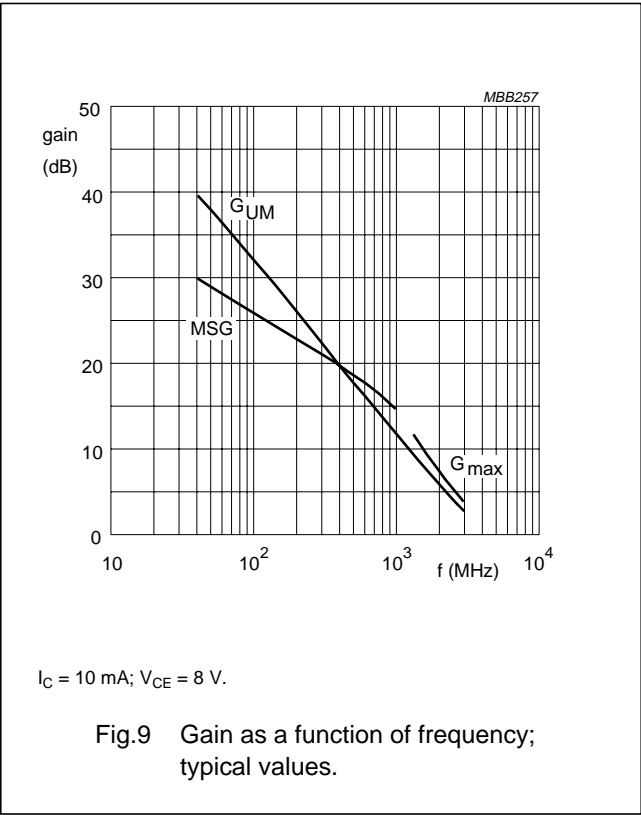


$V_{CE} = 8$  V;  $f = 1$  GHz.

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

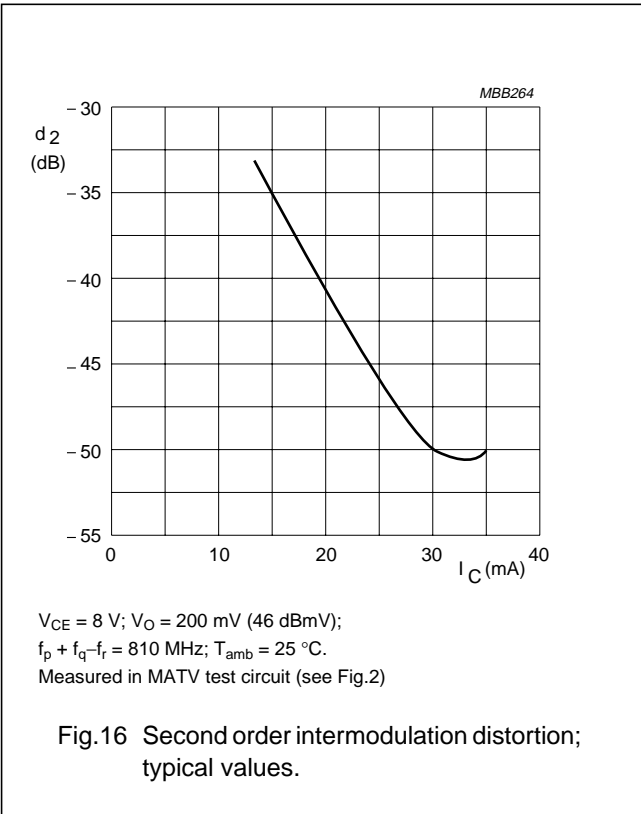
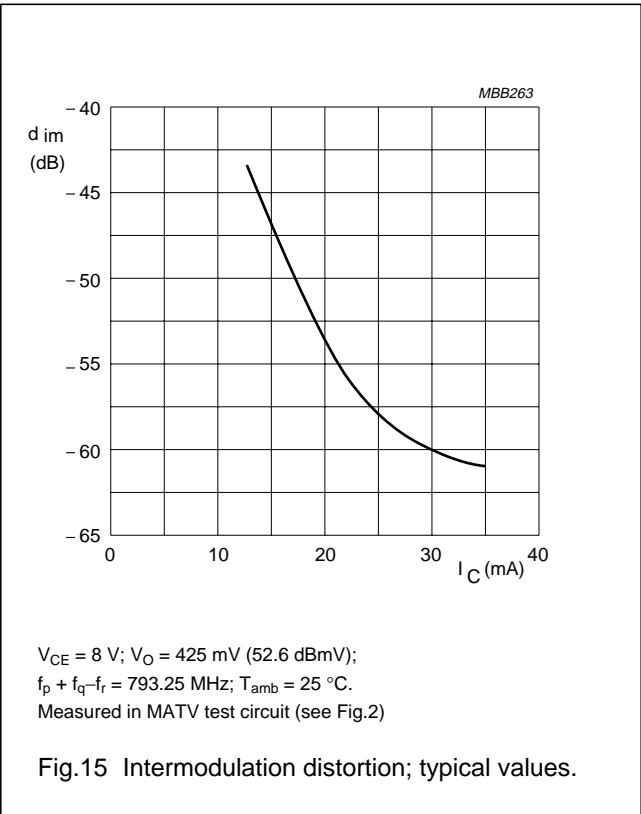
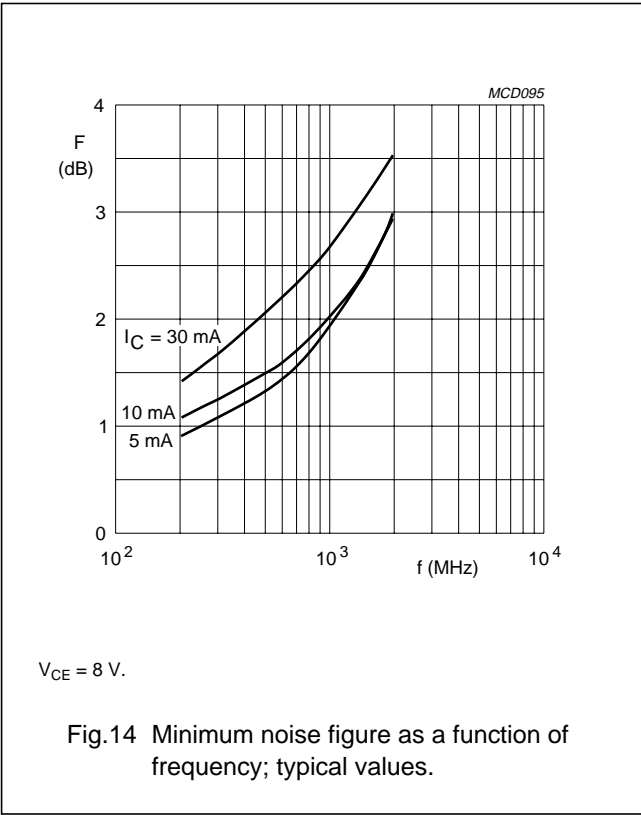
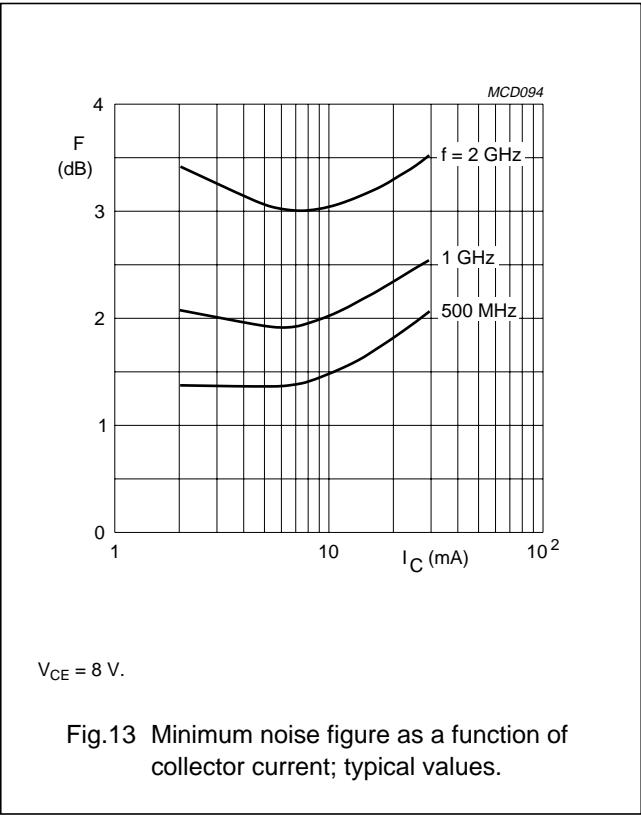
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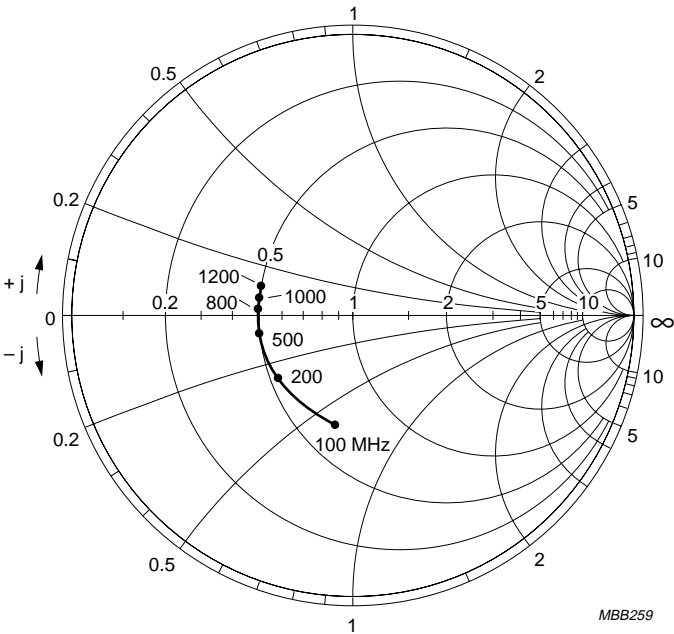
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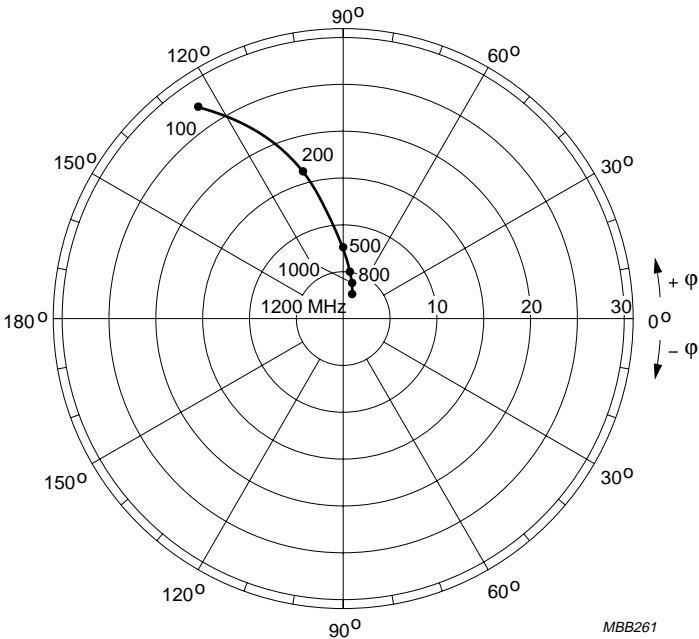
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$I_C = 30\text{ mA}$ ;  $V_{CE} = 8\text{ V}$ ;  $Z_o = 50\text{ }\Omega$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ .

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 ( $S_{21}$ ).



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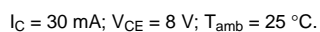


Fig.19 Common emitter reverse transmission coefficient ( $S_{12}$ ).

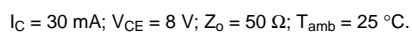


Fig.20 Common emitter output reflection coefficient ( $S_{22}$ ).

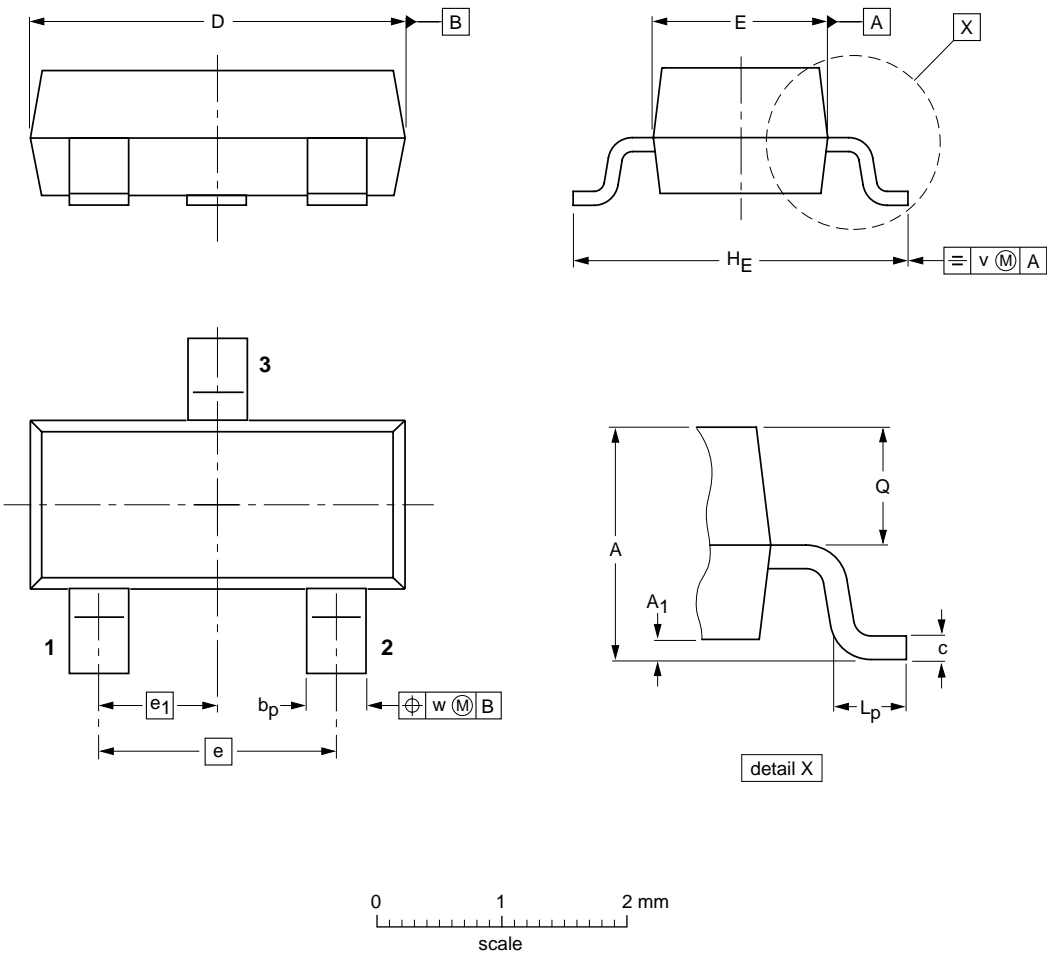
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PACKAGE OUTLINE

Plastic surface mounted package; 3 leads

SOT23



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <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

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Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
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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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