

# DATA SHEET

**BFR93A**

**NPN 6 GHz wideband transistor**

Product specification  
Supersedes data of September 1995

1997 Oct 29



# NPN 6 GHz wideband transistor

# BFR93A

### FEATURES

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

### APPLICATIONS

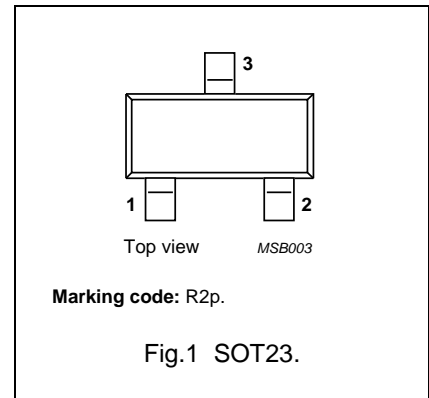
- RF wideband amplifiers and oscillators.

### 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.

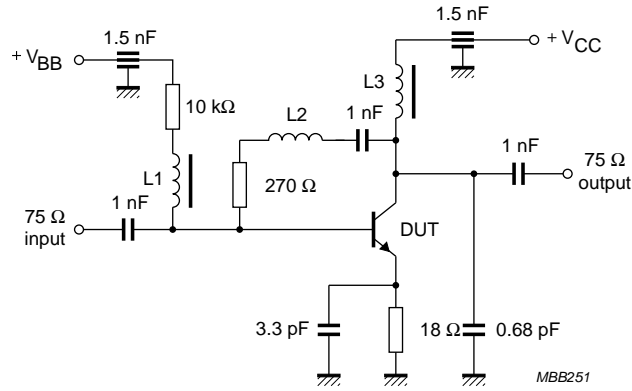
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{CBO}$	collector cut-off current	$I_E = 0$ ; $V_{CB} = 5\text{ V}$	–	–	50	nA
$h_{FE}$	DC current gain	$I_C = 30\text{ mA}$ ; $V_{CE} = 5\text{ V}$	40	90	–	
$C_c$	collector capacitance	$I_E = i_e = 0$ ; $V_{CB} = 5\text{ V}$ ; $f = 1\text{ MHz}$	–	0.7	–	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  $G_{UM} = 10 \log \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$  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  $f_p + f_q = 810\text{ MHz}$ .

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L1 = L3 = 5  $\mu$ H 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.

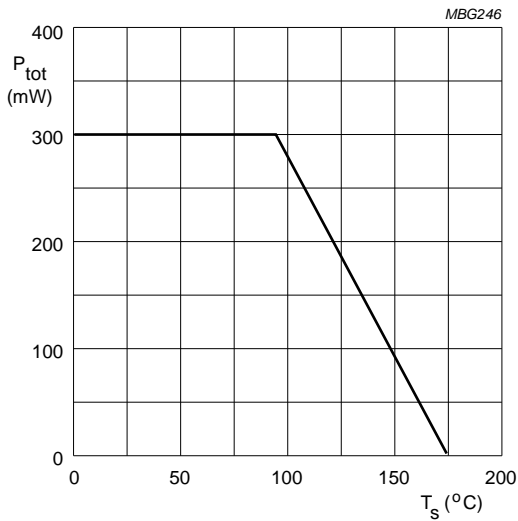
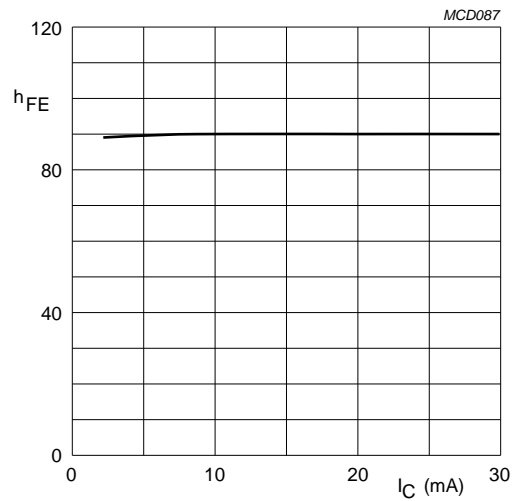


Fig.3 Power derating curve.

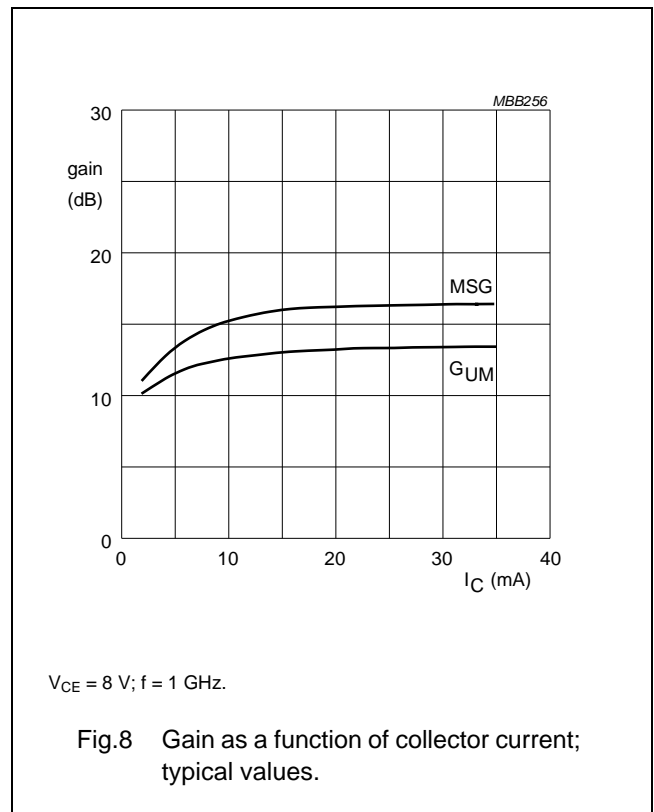
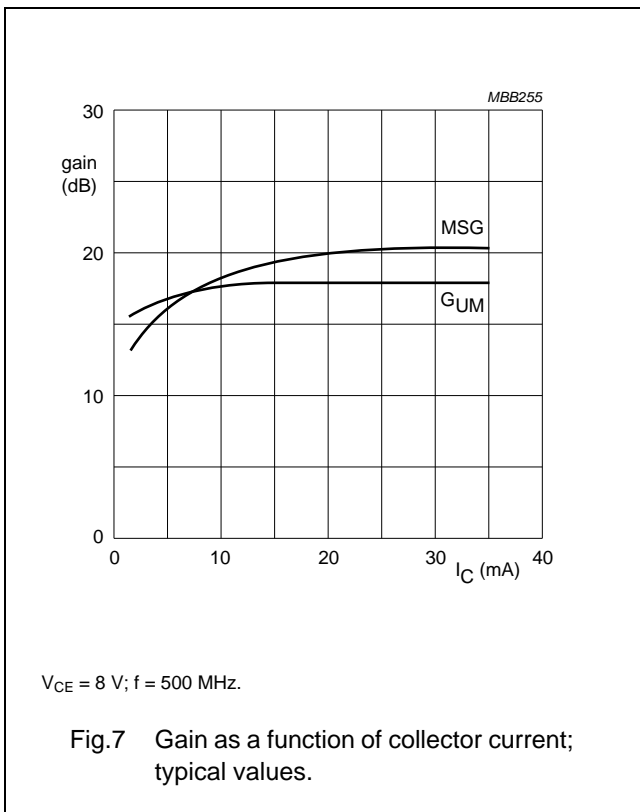
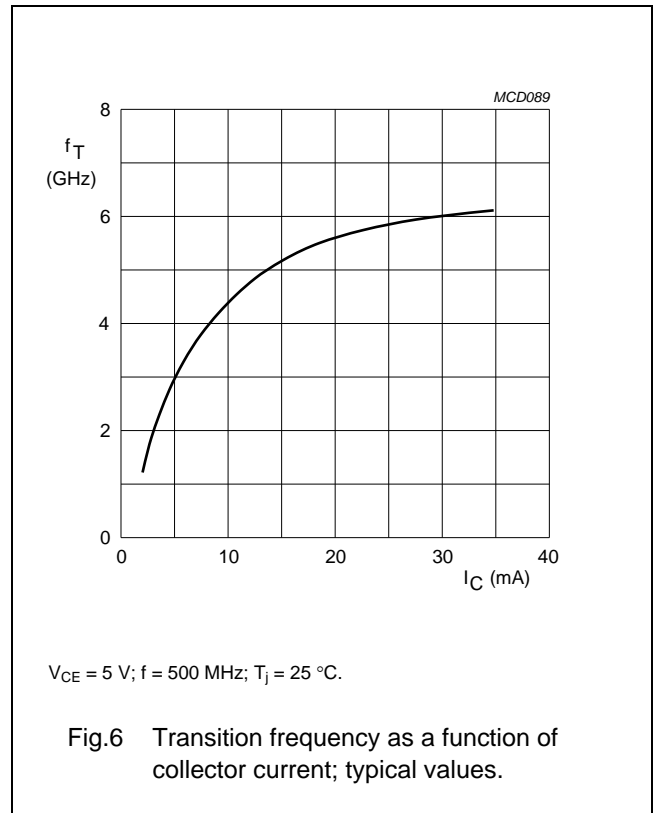
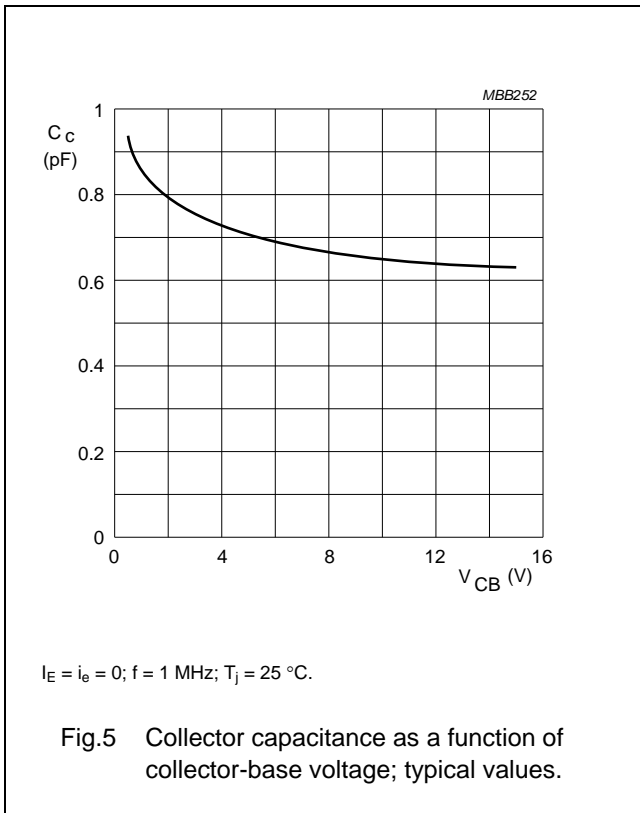


V<sub>CE</sub> = 5 V; T<sub>j</sub> = 25 °C.

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

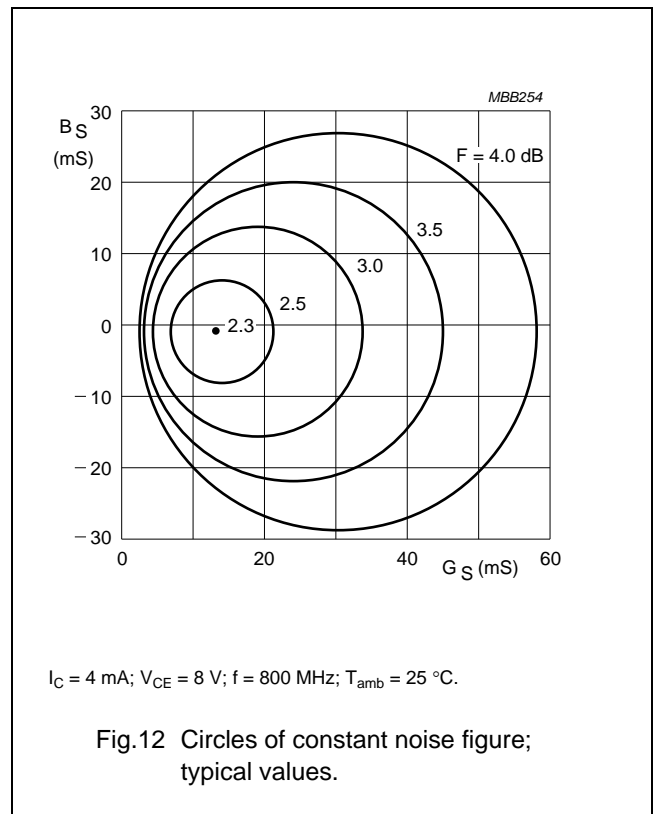
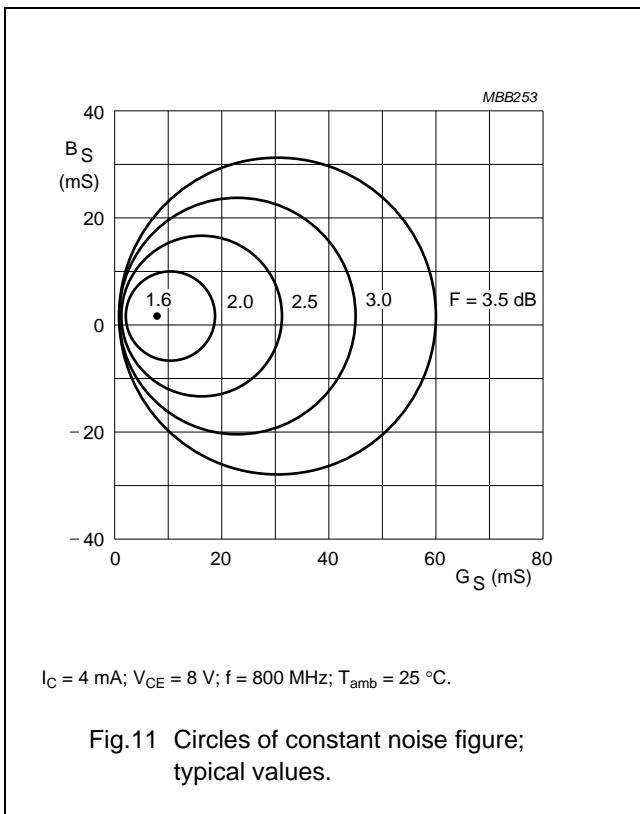
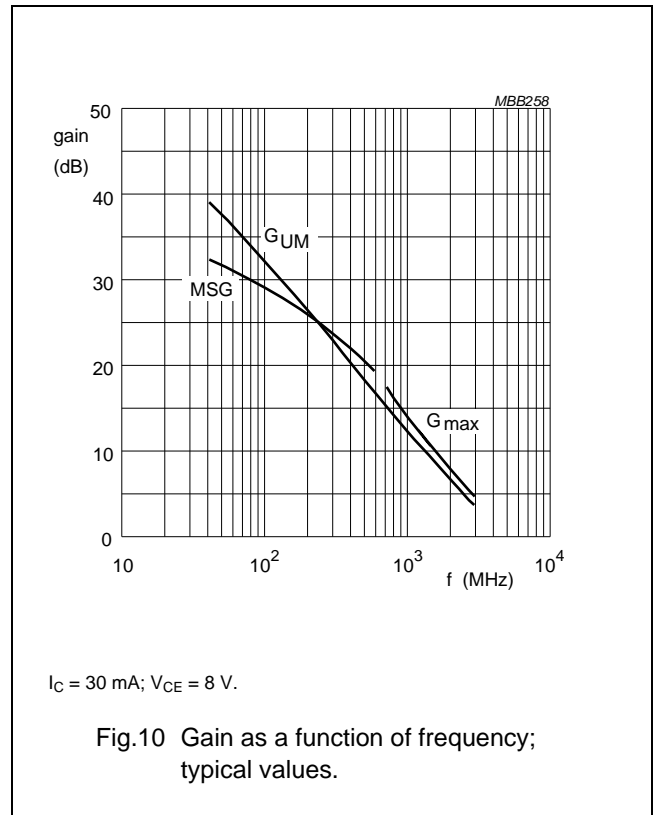
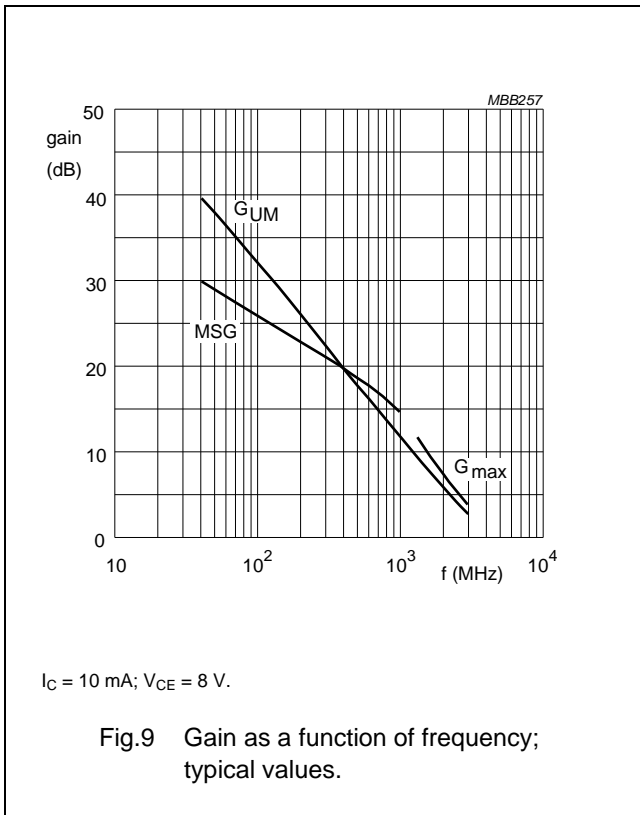
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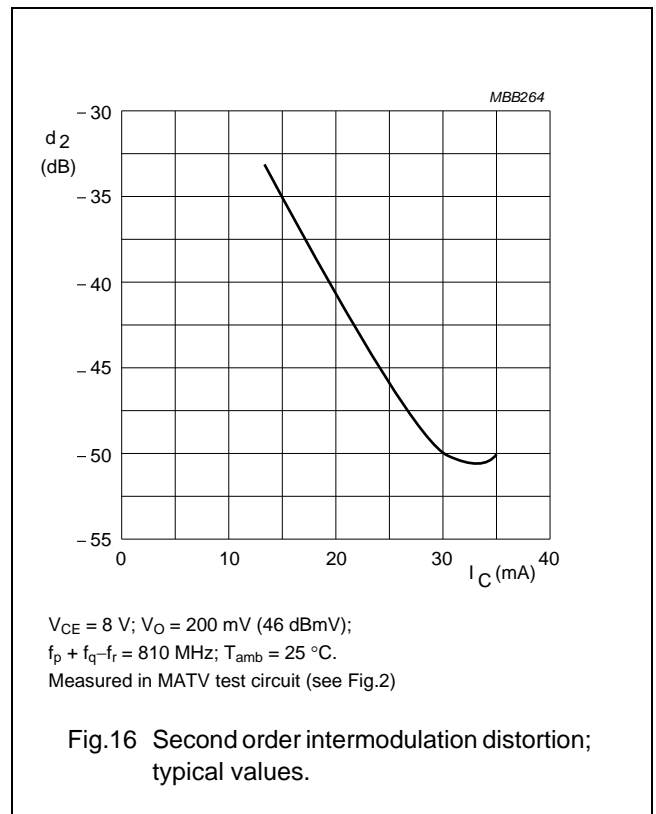
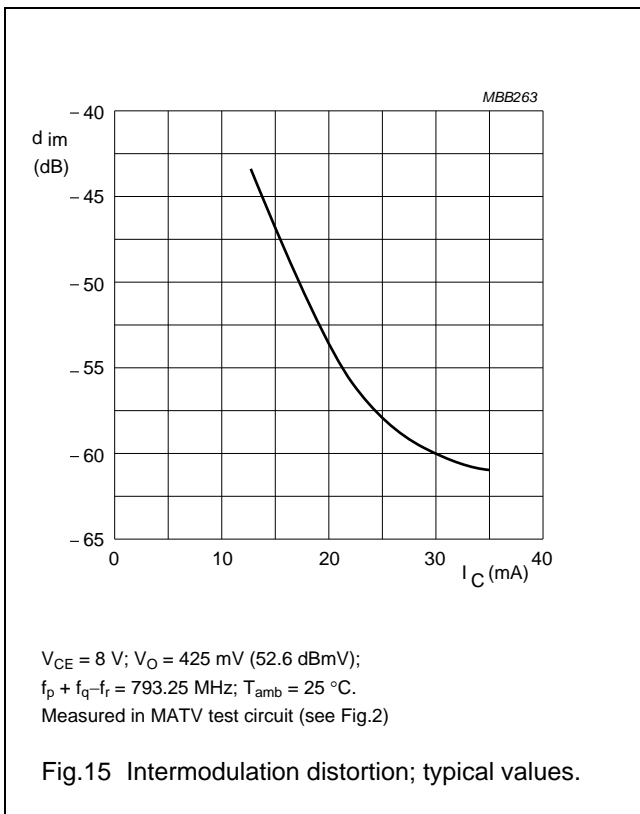
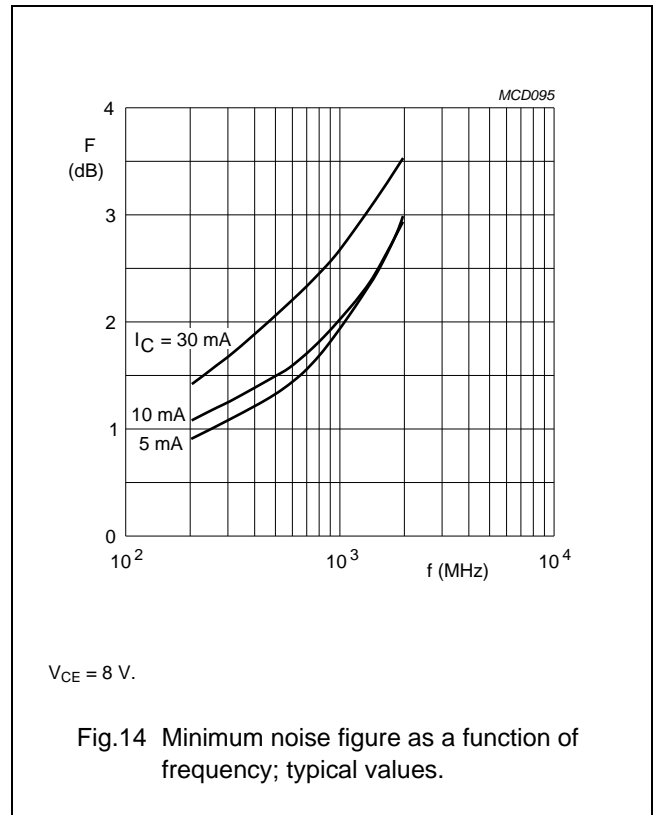
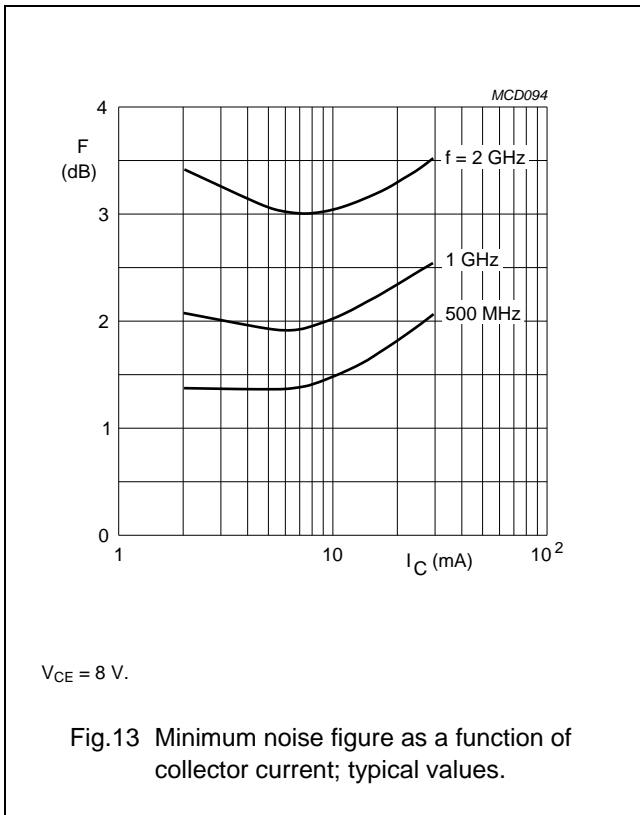
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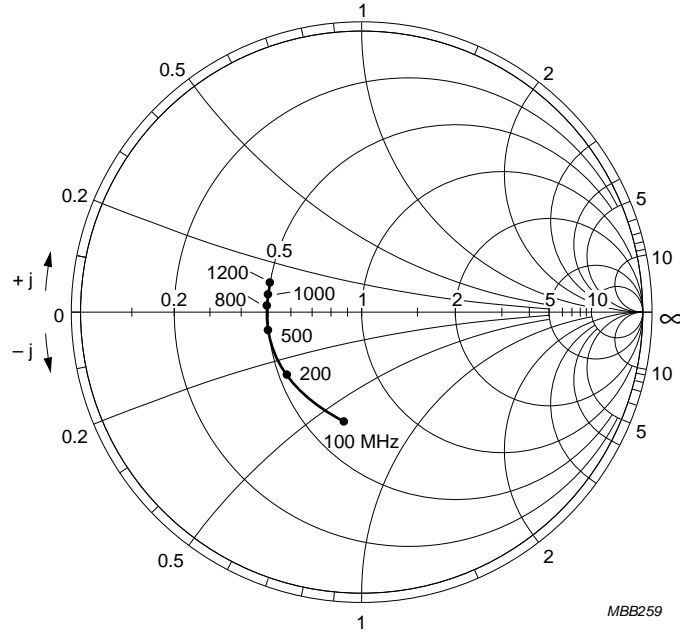
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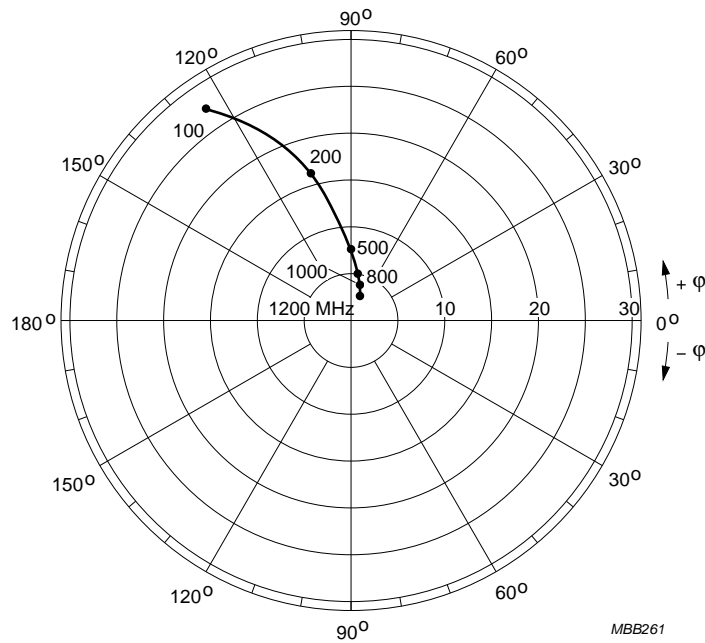
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$I_C = 30 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $Z_o = 50 \Omega$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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



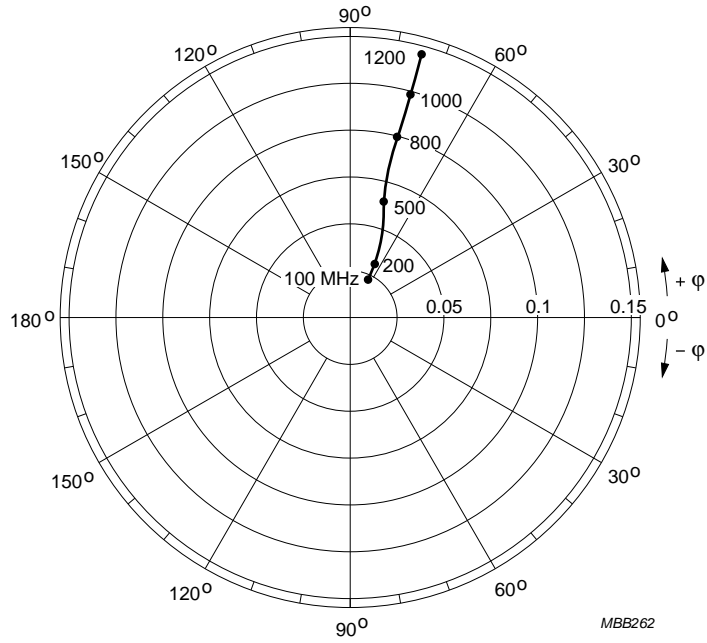
$I_C = 30 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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



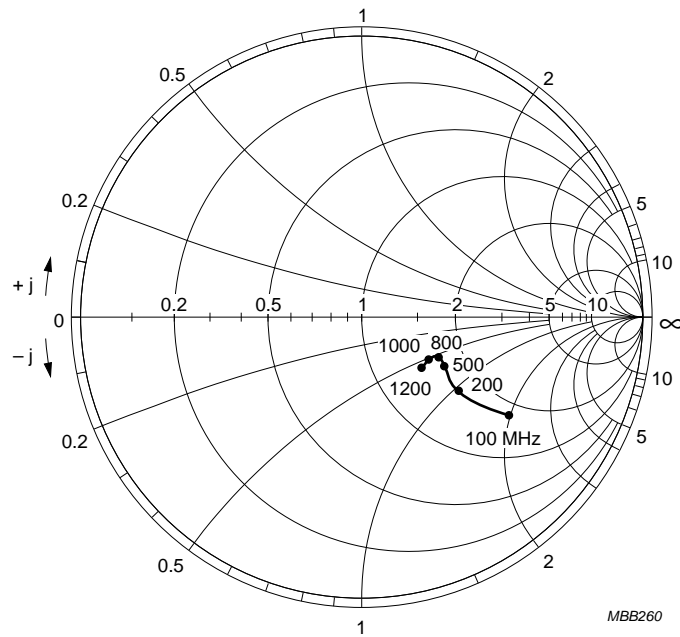
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$I_C = 30 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

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



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

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

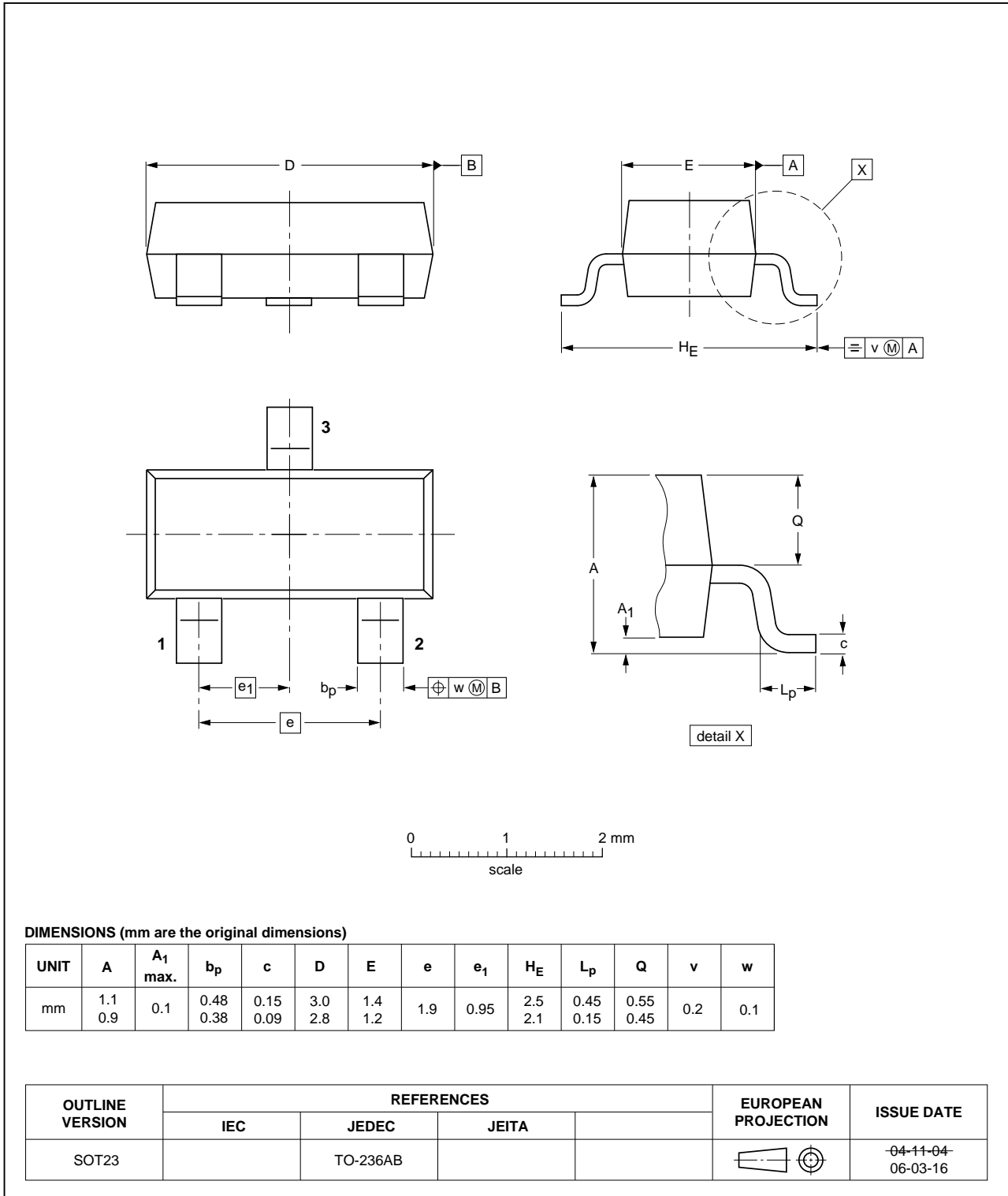
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PACKAGE OUTLINE

Plastic surface-mounted package; 3 leads

SOT23



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## DATA SHEET STATUS

DOCUMENT STATUS <sup>(1)</sup>	PRODUCT STATUS <sup>(2)</sup>	DEFINITION
Objective data sheet	Development	This document contains data from the objective specification for product development.
Preliminary data sheet	Qualification	This document contains data from the preliminary specification.
Product data sheet	Production	This document contains the product specification.

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