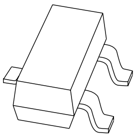


BFR93AR

NPN 6 GHz wideband transistor

Rev. 01 — 30 November 2006 | Product data sheet

1. Product profile

1.1 General description

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

1.2 Features

- Very high power gain
- Low noise figure
- Very low intermodulation distortion

1.3 Applications

- RF wideband amplifiers and oscillators

1.4 Quick reference data

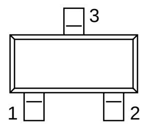
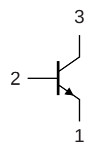
Table 1. Quick reference data

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	collector current		-	-	35	mA
P_{tot}	total power dissipation	$T_{sp} \leq 95$ °C	-	-	300	mW
C_{re}	feedback capacitance	I_C = 0 mA; 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}	unilateral power gain	I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C				
		f = 1 GHz	-	13	-	dB
		f = 2 GHz	-	7	-	dB
NF	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	IMD = –60 dB; I_C = 30 mA; V_{CE} = 8 V; R_L = 75 Ω; T_{amb} = 25 °C; $f_p + f_q - f_r$ = 793.25 MHz	-	425	-	mV

founded by Philips

2. Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Symbol
1	emitter		
2	base		
3	collector		

sym026

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BFR93AR	-	plastic surface-mounted package; 3 leads	SOT23

4. Marking

Table 4. Marking

Type number	Marking code	Description
BFR93AR	*R5	* = p : made in Hong Kong
		* = w : made in China

5. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

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			-	35	mA
P_{tot}	total power dissipation	$T_{sp} \leq 95$ °C; see Figure 2	[1]	-	300	mW
T_{stg}	storage temperature			–65	+150	°C
T_j	junction temperature			-	+175	°C

[1] T_{sp} is the temperature at the solder point of the collector pin.

6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j\text{-}sp)}$	thermal resistance from junction to solder point	$T_{sp} \leq 95$ °C	[1]	260	K/W

[1] T_{sp} is the temperature at the solder point of the collector pin.

7. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{CBO}	collector-base cut-off current	I_E = 0 A; V_{CB} = 5 V		-	-	50	nA
h_{FE}	DC current gain	I_C = 30 mA; V_{CE} = 5 V; see Figure 3		40	90	-	
C_c	collector capacitance	$I_E = i_e$ = 0 A; V_{CB} = 5 V; f = 1 MHz; see Figure 4		-	0.7	-	pF
C_e	emitter capacitance	$I_C = i_c$ = 0 A; V_{EB} = 0.5 V; f = 1 MHz		-	1.9	-	pF
C_{re}	feedback capacitance	$I_C = i_c$ = 0 A; 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; see Figure 5		4.5	6	-	GHz
G_{UM}	unilateral power gain	I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C; see Figure 6 to Figure 9	[1]				
		f = 1 GHz		-	13	-	dB
		f = 2 GHz		-	7	-	dB
NF	noise figure	I_C = 5 mA; V_{CE} = 8 V; $\Gamma_S = \Gamma_{opt}$; T_{amb} = 25 °C; see Figure 12 and Figure 13					
		f = 1 GHz		-	1.9	-	dB
		f = 2 GHz		-	3	-	dB
V_O	output voltage		[2][3]	-	425	-	mV
IMD2	second-order intermodulation distortion	see Figure 15	[2][4]	-	–50	-	dB

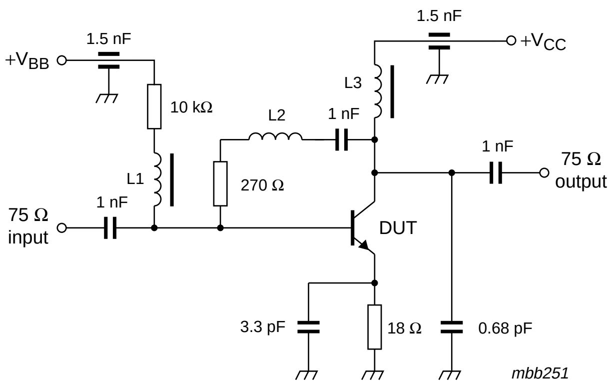
[1] G_{UM} is the maximum unilateral power gain, assuming S_{12} is zero and

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

[2] Measured on the same crystal in a SOT37 package (BFR91A).

[3] IMD = –60 dB (DIN 45004B); I_C = 30 mA; V_{CE} = 8 V; R_L = 75 Ω; T_{amb} = 25 °C;
$V_p = V_O$ at IMD = –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 Ω; T_{amb} = 25 °C;
V_p = 200 mV at f_p = 250 MHz;
V_q = 200 mV at f_p = 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 1. Intermodulation distortion and second harmonic MATV test circuit

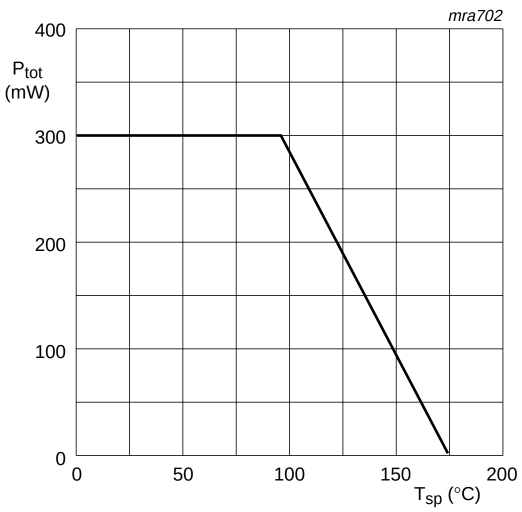
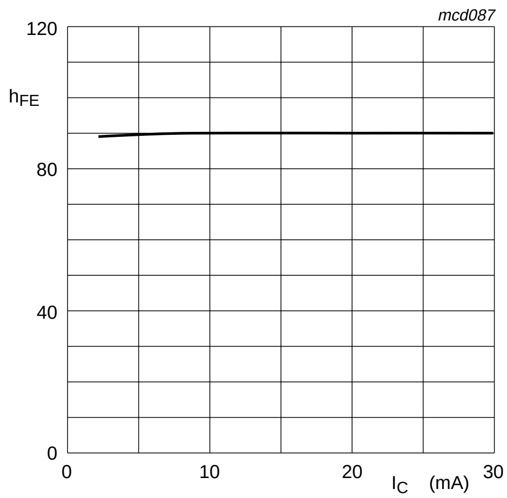
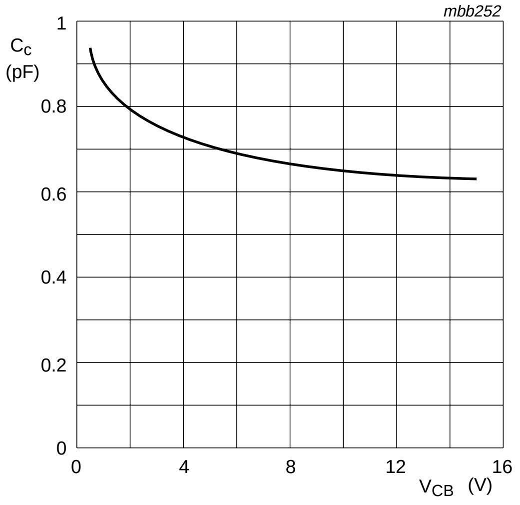


Fig 2. Power derating curve



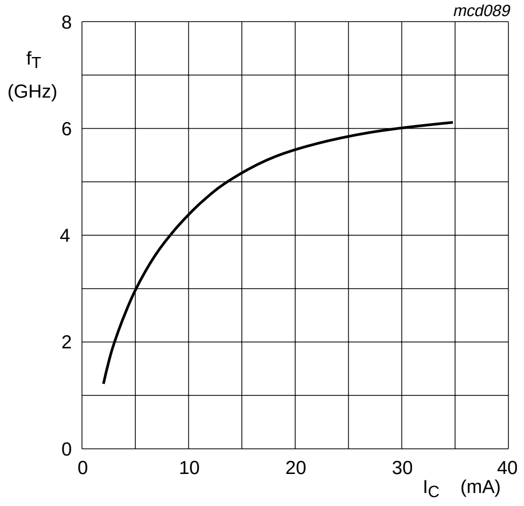
V_{CE} = 5 V; T_j = 25 °C.

Fig 3. DC current gain as a function of collector current



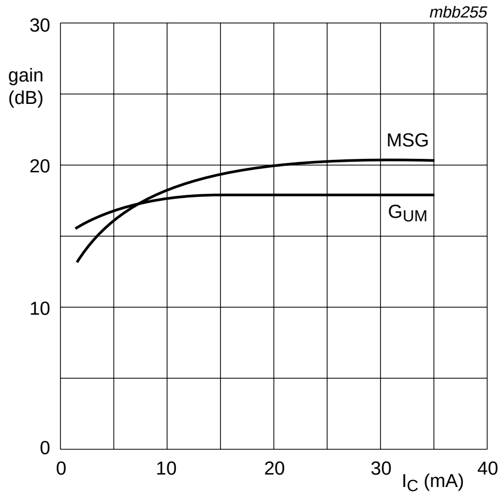
$I_E = i_e = 0$ mA; f = 1 MHz; $T_j = 25$ °C.

Fig 4. Collector capacitance as a function of collector-base voltage; typical values



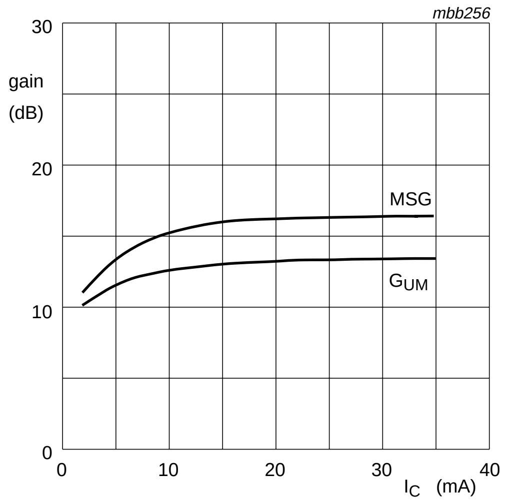
$V_{CE} = 2$ V; f = 500 MHz; $T_j = 25$ °C.

Fig 5. Transition frequency as a function of collector current; typical values



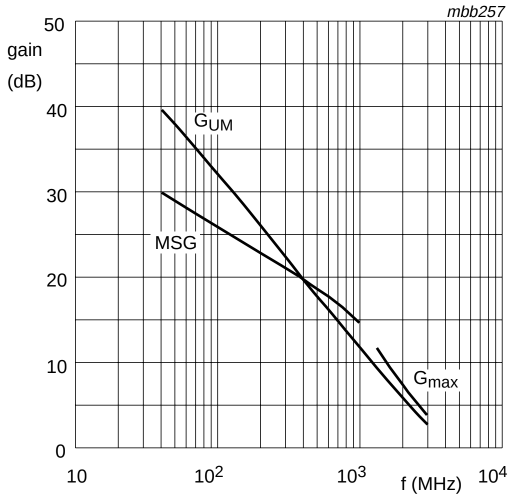
$V_{CE} = 8$ V; f = 500 MHz.

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



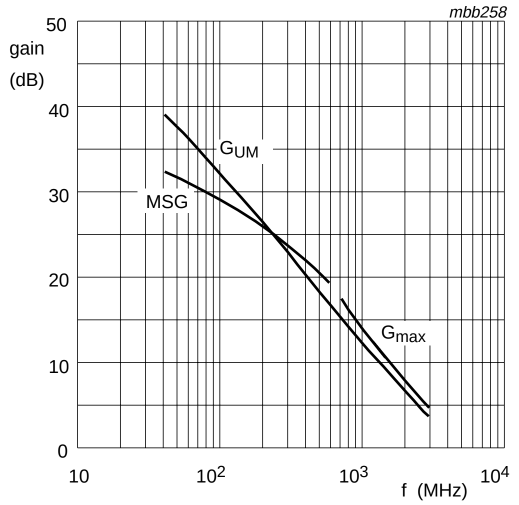
$V_{CE} = 8$ V; f = 1 GHz.

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



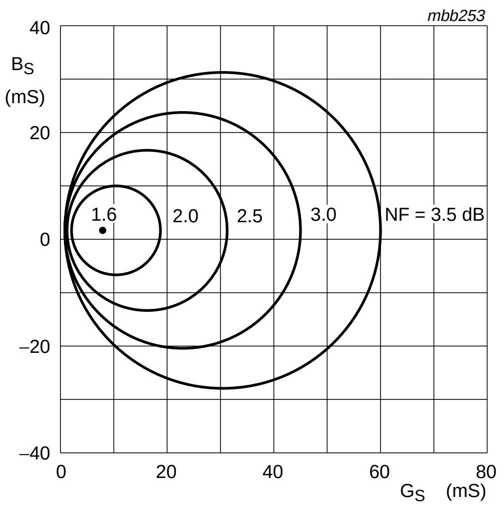
I_C = 10 mA; V_{CE} = 8 V.

Fig 8. Gain as a function of frequency; typical values



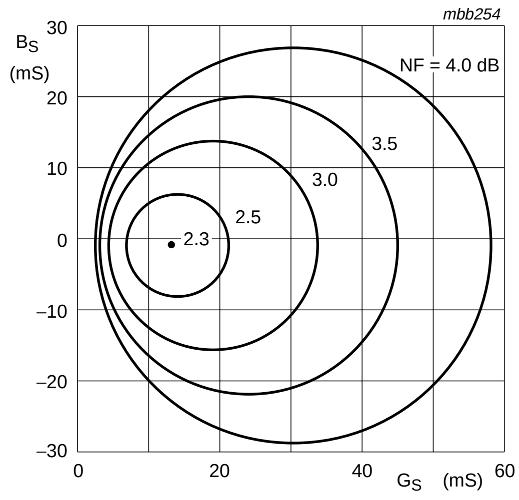
I_C = 30 mA; V_{CE} = 8 V.

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



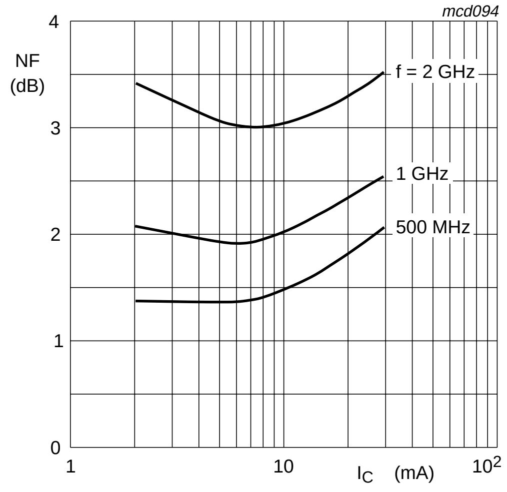
I_C = 4 mA; V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C.

Fig 10. Circles of constant noise figure; typical values



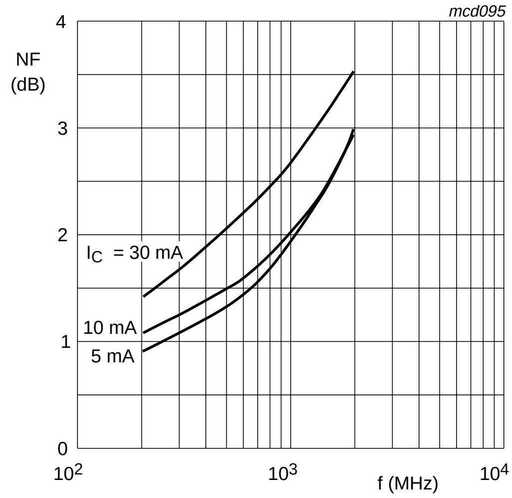
I_C = 4 mA; V_{CE} = 8 V; f = 800 MHz; T_{amb} = 25 °C.

Fig 11. Circles of constant noise figure; typical values



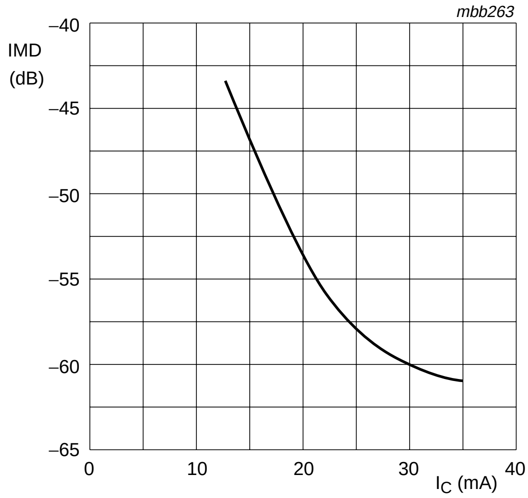
V_{CE} = 8 V.

Fig 12. Minimum noise figure as a function of collector current; typical values



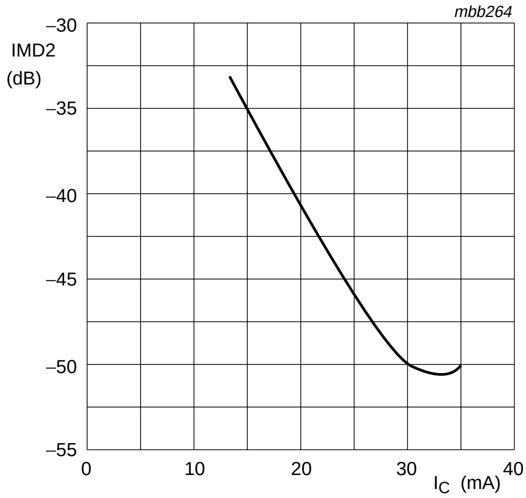
V_{CE} = 8 V.

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



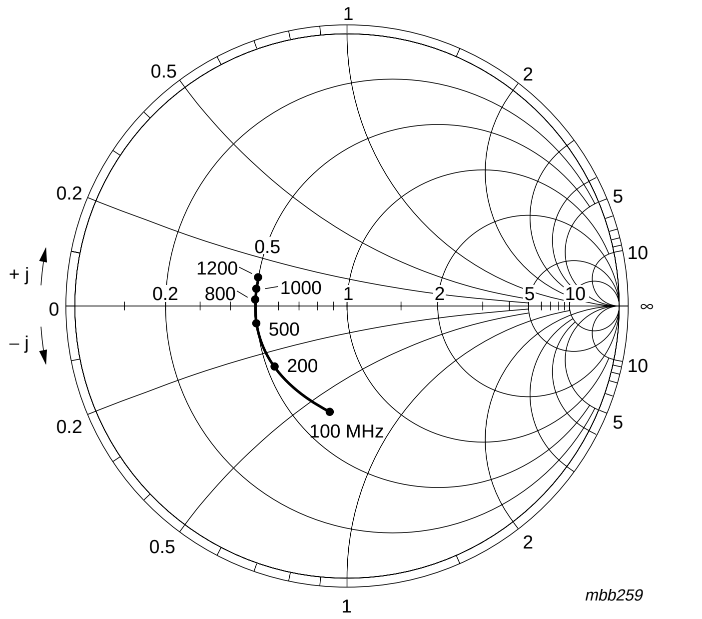
V_{CE} = 8 V; V_O = 425 mV (52.6 dBmV);
$f_p + f_q - f_r$ = 793.25 MHz; T_{amb} = 25 °C.
Measured in MATV test circuit; see Figure 1.

Fig 14. Intermodulation distortion; typical values



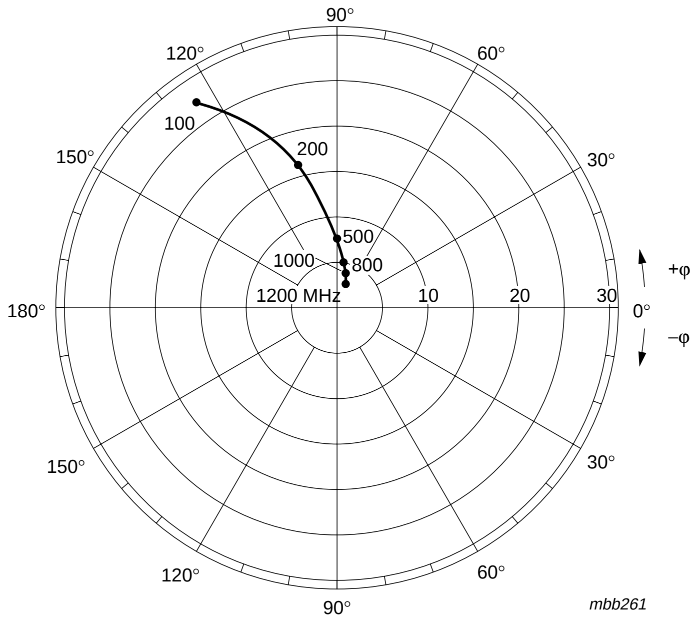
V_{CE} = 8 V; V_O = 200 mV (46 dBmV);
$f_p + f_q - f_r$ = 810 MHz; T_{amb} = 25 °C.
Measured in MATV test circuit; see Figure 1.

Fig 15. Second order intermodulation distortion; typical values



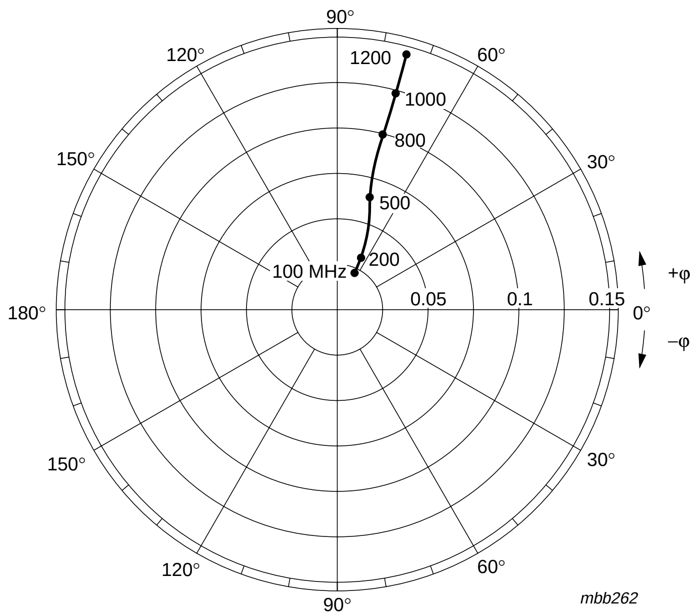
I_C = 30 mA; V_{CE} = 8 V; Z_O = 50 Ω;T_{amb} = 25 °C.

Fig 16. Common emitter input reflection coefficient (S_{11})



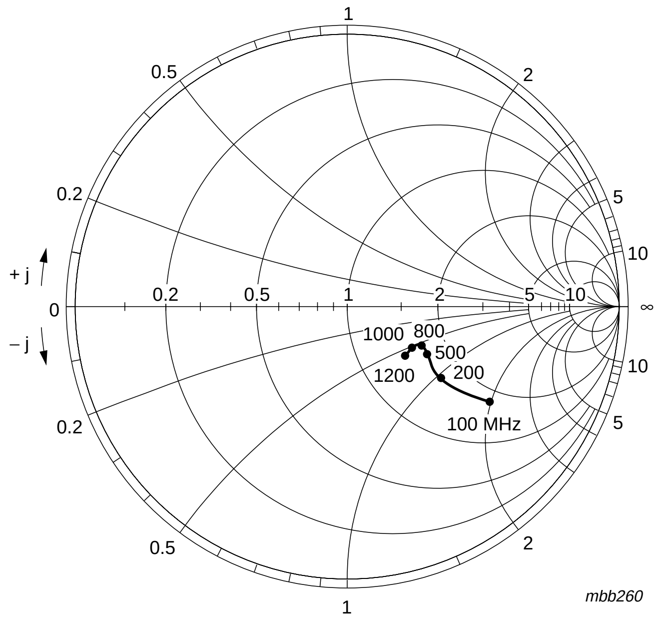
I_C = 30 mA; V_{CE} = 8 V; T_{amb} = 25 °C.

Fig 17. Common emitter forward transmission coefficient (S_{21})



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

Fig 18. Common emitter reverse transmission coefficient (S_{12})

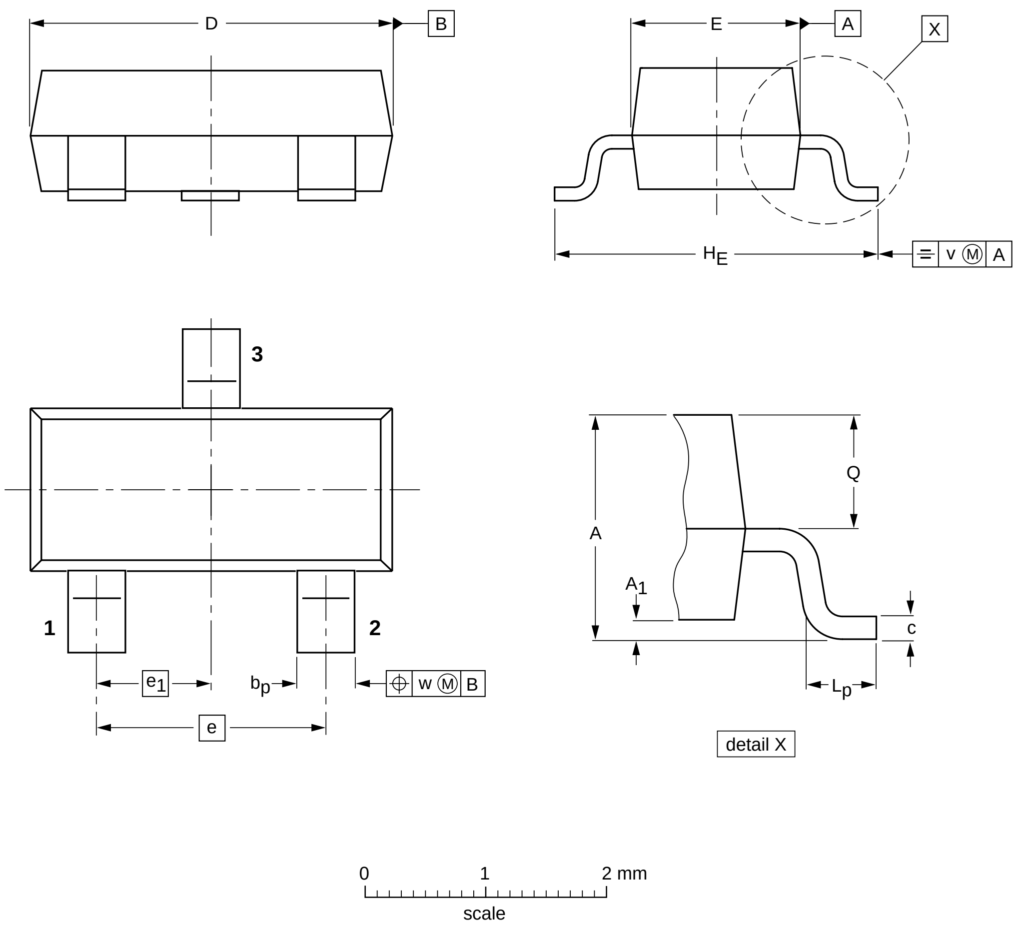


I_C = 30 mA; V_{CE} = 8 V; Z_O = 50 Ω;T_{amb} = 25 °C.

Fig 19. Common emitter output reflection coefficient (S_{22})

8. 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	JEITA			
SOT23		TO-236AB				~~04-11-04~~ 06-03-16

Fig 20. Package outline SOT23

9. Abbreviations

Table 8. Abbreviations

Acronym	Description
NPN	Negative Positive Negative
PNP	Positive Negative Positive
RF	Radio Frequency
MATV	Master Antenna Television

10. Revision history

Table 9. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BFR93AR_1	20061130	Product data sheet	-	-

11. Legal information

11.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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13. Contents

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Document identifier: BFR93AR_1