



BFR540

NPN 9 GHz wideband transistor

Rev. 05 — 1 September 2004

Product data sheet

1. Product profile

1.1 General description

The BFR540 is an NPN silicon planar epitaxial transistor in a SOT23 plastic package.

1.2 Features

- High power gain
- Low noise figure
- High transition frequency
- Gold metallization ensures excellent reliability.

1.3 Applications

- RF front end wideband applications in the GHz range
 - ◆ Analog and digital cellular telephones
 - ◆ Cordless telephones (CT1, CT2, DECT, etc.)
 - ◆ Radar detectors
 - ◆ Satellite TV tuners (SATV)
 - ◆ MATV/CATV amplifiers
 - ◆ Repeater amplifiers in fiber-optic systems.

1.4 Quick reference data

Table 1: Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CBO}	collector-base voltage	open emitter	-	-	20	V
V_{CES}	collector-emitter voltage	$R_{BE} = 0 \Omega$	-	-	15	V
I_C	collector current (DC)		-	-	120	mA
P_{tot}	total power dissipation	$T_{sp} \leq 70 \text{ }^\circ\text{C}$	[1]	-	500	mW
h_{FE}	DC current gain	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V}$	100	120	250	
C_{re}	feedback capacitance	$I_C = i_c = 0 \text{ A}; V_{CB} = 8 \text{ V}; f = 1 \text{ MHz}$	-	0.6	-	pF
f_T	transition frequency	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V}; f = 1 \text{ GHz}$	-	9	-	GHz
G_{UM}	maximum unilateral power gain	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$				
		$f = 900 \text{ MHz}$	-	14	-	dB
		$f = 2 \text{ GHz}$	-	7	-	dB

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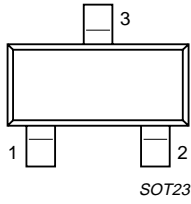
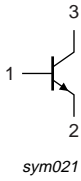
Table 1: Quick reference data ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$ s_{21} ^2$	insertion power gain	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V};$ $T_{amb} = 25 \text{ }^\circ\text{C};$ $f = 900 \text{ MHz}$	12	13	-	dB
NF	noise figure	$\Gamma_s = \Gamma_{opt}; V_{CE} = 8 \text{ V};$ $T_{amb} = 25 \text{ }^\circ\text{C}$				
		$I_C = 10 \text{ mA};$ $f = 900 \text{ MHz}$	-	1.3	1.8	dB
		$I_C = 40 \text{ mA};$ $f = 900 \text{ MHz}$	-	1.9	2.4	dB
		$I_C = 10 \text{ mA};$ $f = 2 \text{ GHz}$	-	2.1	-	dB

[1] T_{sp} is the temperature at the soldering point of the collector tab.

2. Pinning information

Table 2: Pinning

Pin	Description	Simplified outline	Symbol
1	base	 <p>SOT23</p>	 <p>sym021</p>
2	emitter		
3	collector		

3. Ordering information

Table 3: Ordering information

Type number	Package		
	Name	Description	Version
BFR540	-	plastic surface mounted package; 3 leads	SOT23

4. Marking

Table 4: Marking

Type number	Marking code [1]
BFR540	33*

[1] * = p: Made in Hong Kong
 * = t: Made in Malaysia
 * = 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	-	20	V
V_{CES}	collector-emitter voltage	$R_{BE} = 0 \Omega$	-	15	V
V_{EBO}	emitter-base voltage	open collector	-	2.5	V
I_C	collector current (DC)		-	120	mA
P_{tot}	total power dissipation	$T_{sp} \leq 70 \text{ }^\circ\text{C}$	[1]	500	mW
T_{stg}	storage temperature		-65	+150	$^\circ\text{C}$
T_j	junction temperature		-	175	$^\circ\text{C}$

[1] T_{sp} is the temperature at the soldering point of the collector tab.

6. Thermal characteristics

Table 6: Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-sp)}$	thermal resistance from junction to soldering point		[1]	260 K/W

[1] T_{sp} is the temperature at the soldering point of the collector tab.

7. Characteristics

Table 7: Characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{CBO}	collector cut-off current	$I_E = 0 \text{ A}; V_{CB} = 8 \text{ V}$	-	-	50	nA
h_{FE}	DC current gain	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V}$	100	120	250	
C_e	emitter capacitance	$I_C = i_c = 0 \text{ A}; V_{EB} = 0.5 \text{ V};$ $f = 1 \text{ MHz}$	-	2	-	pF
C_c	collector capacitance	$I_E = i_e = 0 \text{ A}; V_{CB} = 8 \text{ V};$ $f = 1 \text{ MHz}$	-	0.9	-	pF
C_{re}	feedback capacitance	$I_C = 0 \text{ A}; V_{CB} = 8 \text{ V};$ $f = 1 \text{ MHz}$	-	0.6	-	pF
f_T	transition frequency	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V};$ $f = 1 \text{ GHz}$	-	9	-	GHz
G_{UM}	maximum unilateral power gain	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V};$ $T_{amb} = 25 \text{ }^\circ\text{C}$	[1]			
		$f = 900 \text{ MHz}$	-	14	-	dB
		$f = 2 \text{ GHz}$	-	7	-	dB
$ S_{21} ^2$	insertion power gain	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V};$ $T_{amb} = 25 \text{ }^\circ\text{C}; f = 900 \text{ MHz}$	12	13	-	dB

Table 7: Characteristics ...continued
T_j = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
NF	noise figure	$\Gamma_s = \Gamma_{opt}; V_{CE} = 8 \text{ V};$ $T_{amb} = 25 \text{ °C}$				
		$I_C = 10 \text{ mA}; f = 900 \text{ MHz}$	-	1.3	1.8	dB
		$I_C = 40 \text{ mA}; f = 900 \text{ MHz}$	-	1.9	2.4	dB
		$I_C = 10 \text{ mA}; f = 2 \text{ GHz}$	-	2.1	-	dB
$P_{L(1dB)}$	output power at 1 dB gain compression	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V};$ $R_L = 50 \text{ } \Omega; T_{amb} = 25 \text{ °C};$ $f = 900 \text{ MHz}$	-	21	-	dBm
ITO	third order intercept point		[2]	34	-	dBm
V_O	output voltage	$I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V};$ $Z_L = Z_S = 75 \text{ } \Omega;$ $T_{amb} = 25 \text{ °C}$	[3]	550	-	mV

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

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

[2] $I_C = 40 \text{ mA}; V_{CE} = 8 \text{ V}; R_L = 50 \text{ } \Omega; T_{amb} = 25 \text{ °C}; f = 900 \text{ MHz}; f_p = 900 \text{ MHz}; f_q = 902 \text{ MHz}.$

Measured at $f_{(2p-q)} = 898 \text{ MHz}$ and $f_{(2q-p)} = 904 \text{ MHz}.$

[3] $d_{im} = -60 \text{ dB (DIN 45004B)}; V_p = V_O; V_q = V_O - 6 \text{ dB}; f_p = 795.25 \text{ MHz}; V_R = V_O - 6 \text{ dB}; f_q = 803.25 \text{ MHz};$
 $f_r = 805.25 \text{ MHz}.$

Measured at $f_{(p+q-r)} = 793.25 \text{ MHz}.$

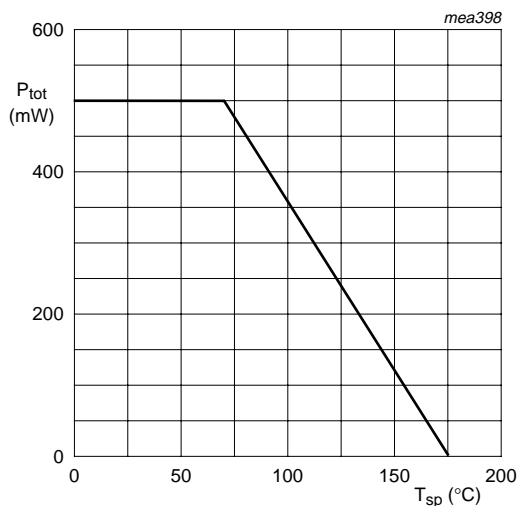
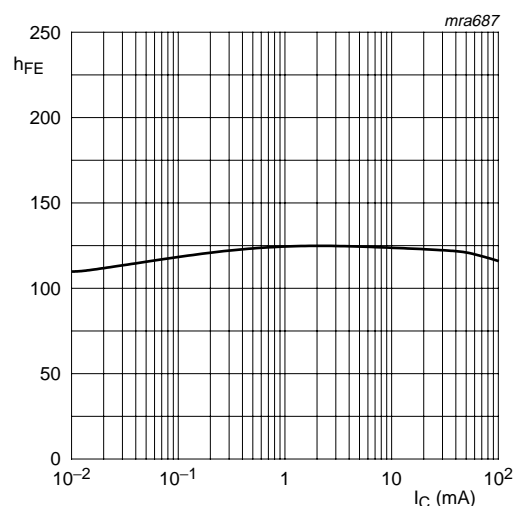
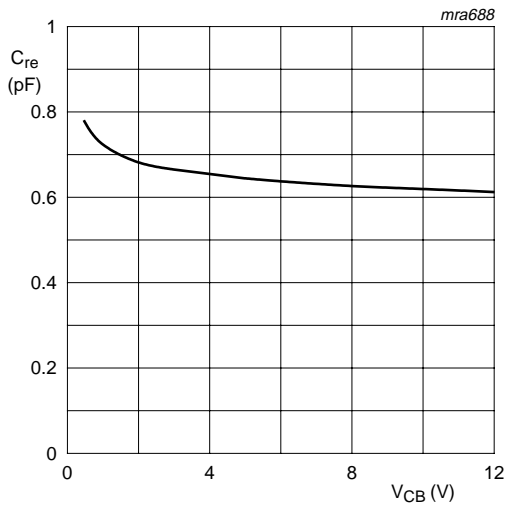


Fig 1. Power derating curve.



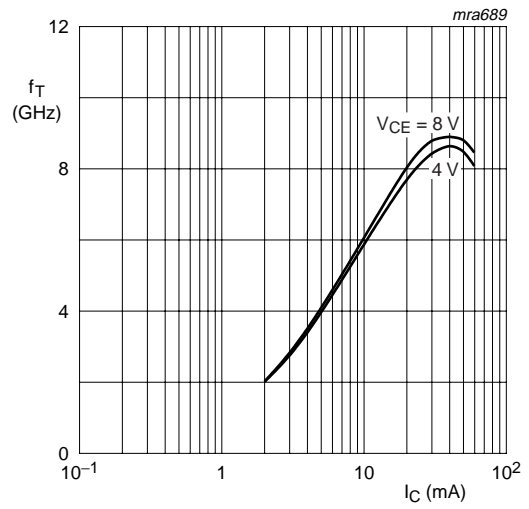
$V_{CE} = 8 \text{ V}.$

Fig 2. DC current gain as a function of collector current.



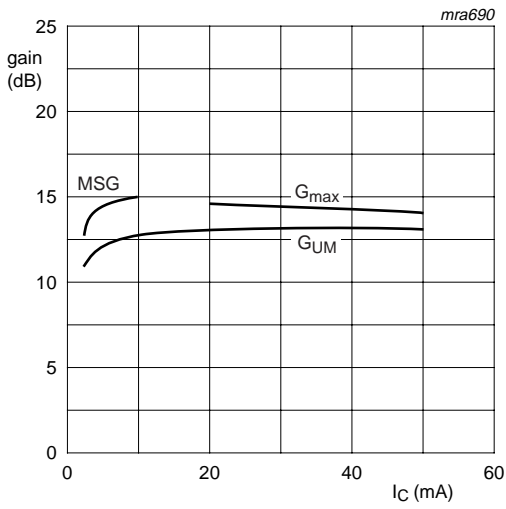
$I_C = 0$ A; $f = 1$ MHz.

Fig 3. Feedback capacitance as a function of collector-base voltage.



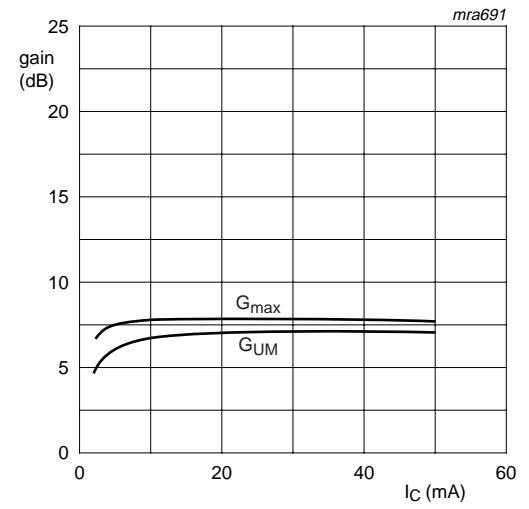
$T_{amb} = 25$ °C; $f = 1$ GHz.

Fig 4. Transition frequency as a function of collector current.



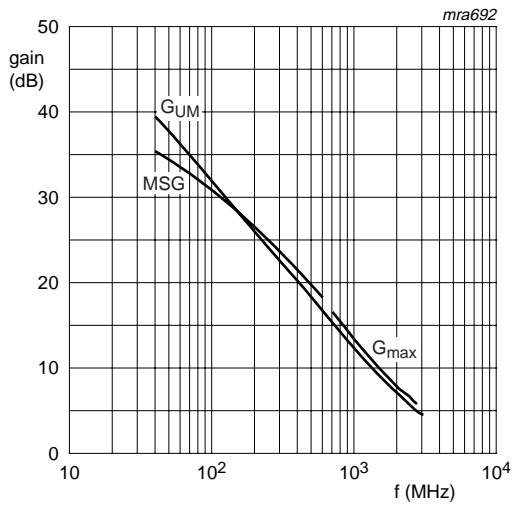
$V_{CE} = 8$ V; $f = 900$ MHz.

Fig 5. Gain as a function of collector current.



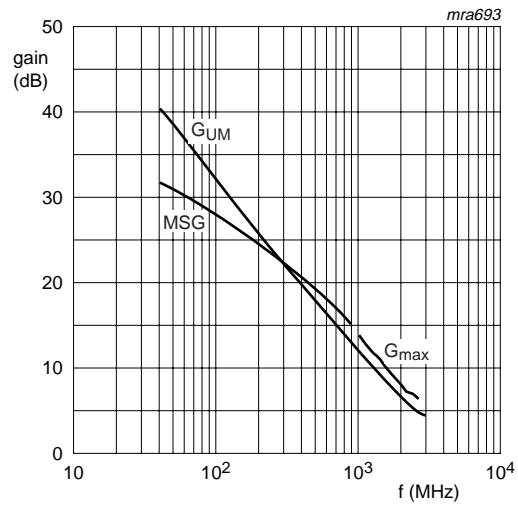
$V_{CE} = 8$ V; $f = 2$ GHz.

Fig 6. Gain as a function of collector current.



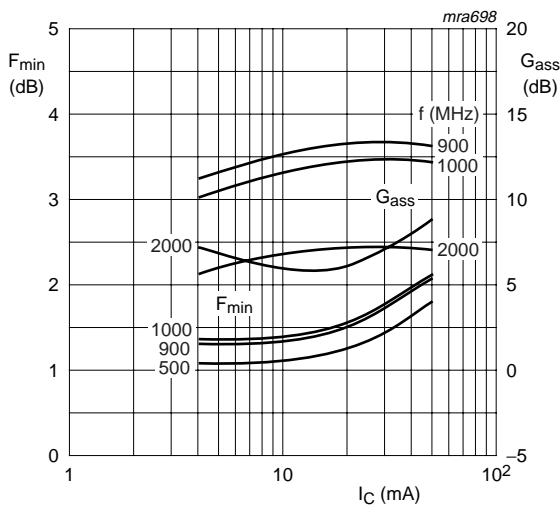
$V_{CE} = 8\text{ V}; I_C = 10\text{ mA}.$

Fig 7. Gain as a function of frequency; $I_C = 10\text{ mA}.$



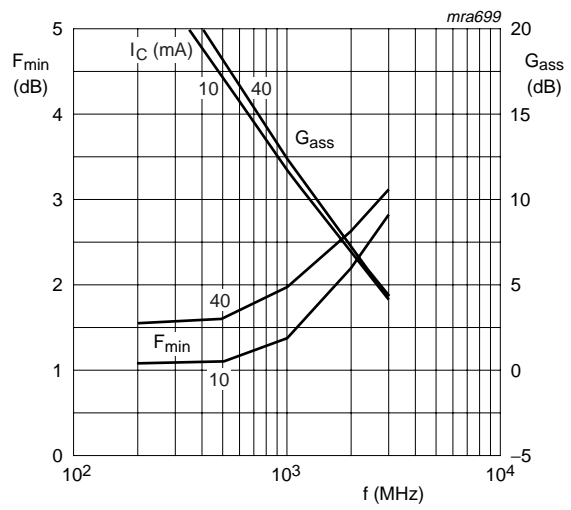
$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}.$

Fig 8. Gain as a function of frequency; $I_C = 40\text{ mA}.$



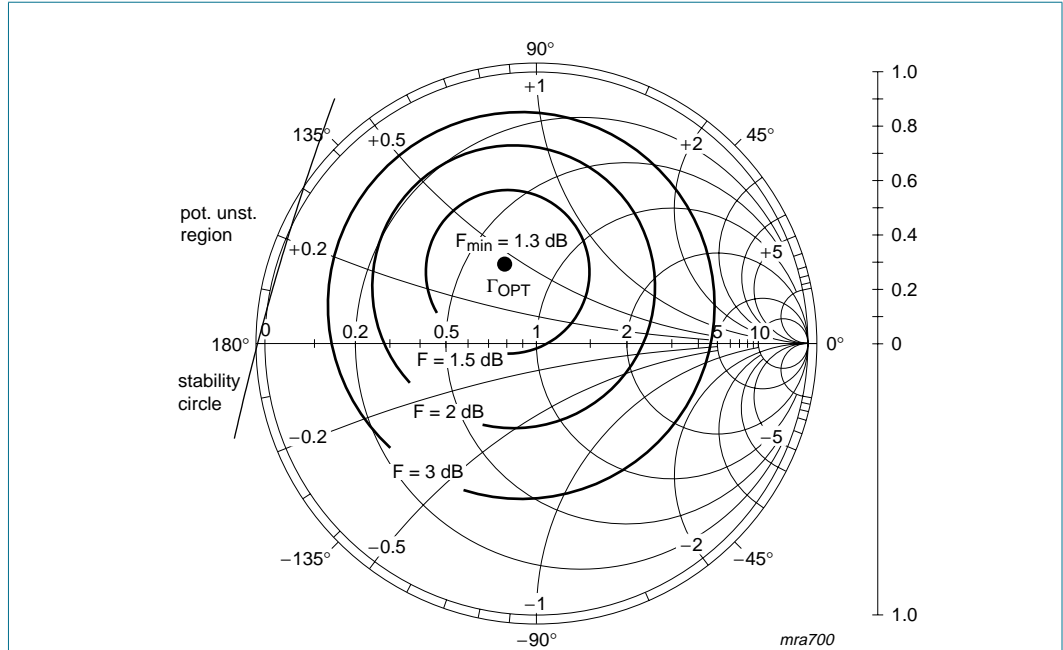
$V_{CE} = 8\text{ V}.$

Fig 9. Minimum noise figure and associated available gain as a function of collector current.



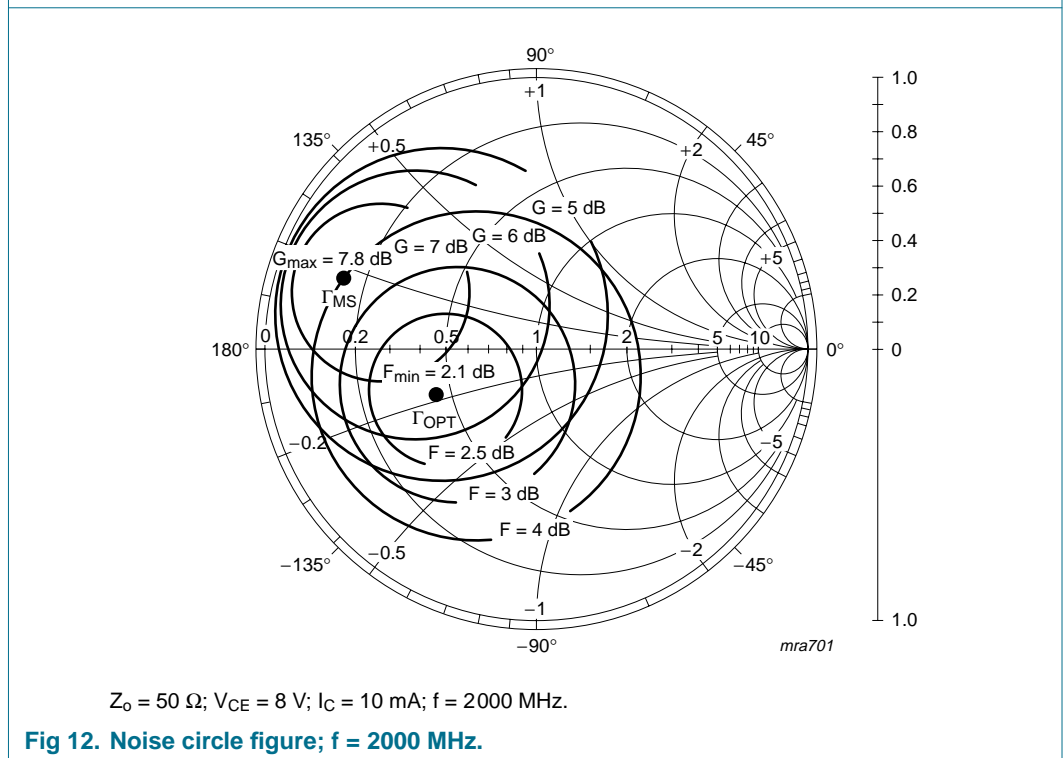
$V_{CE} = 8\text{ V}.$

Fig 10. Minimum noise figure and associated available gain as a function of frequency.



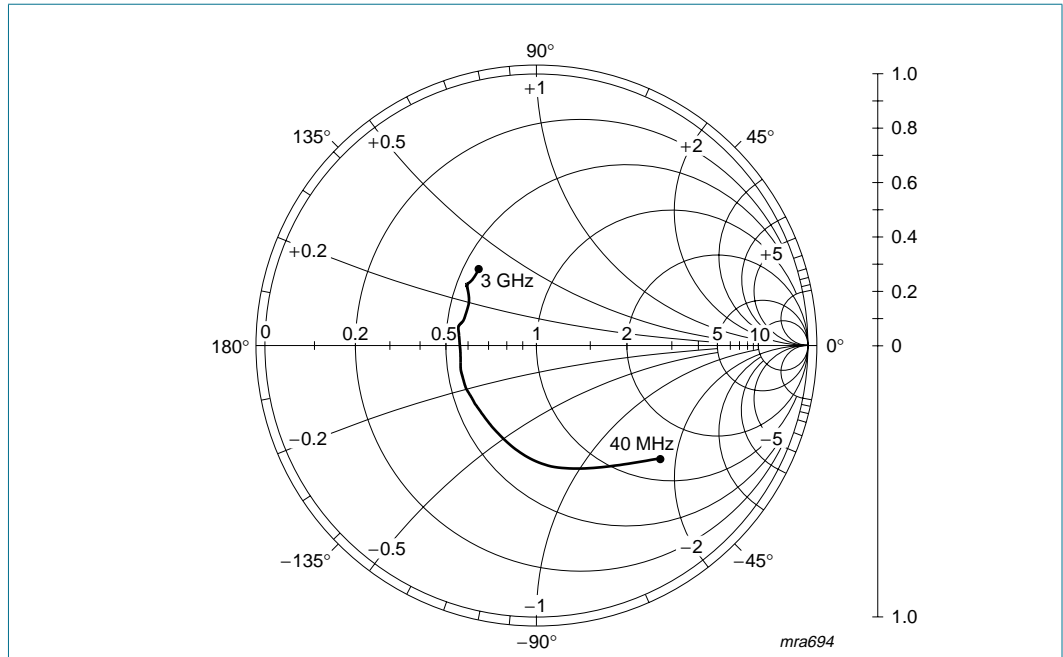
$Z_o = 50 \Omega$; $V_{CE} = 8 \text{ V}$; $I_C = 10 \text{ mA}$; $f = 900 \text{ MHz}$.

Fig 11. Noise circle figure; $f = 900 \text{ MHz}$.



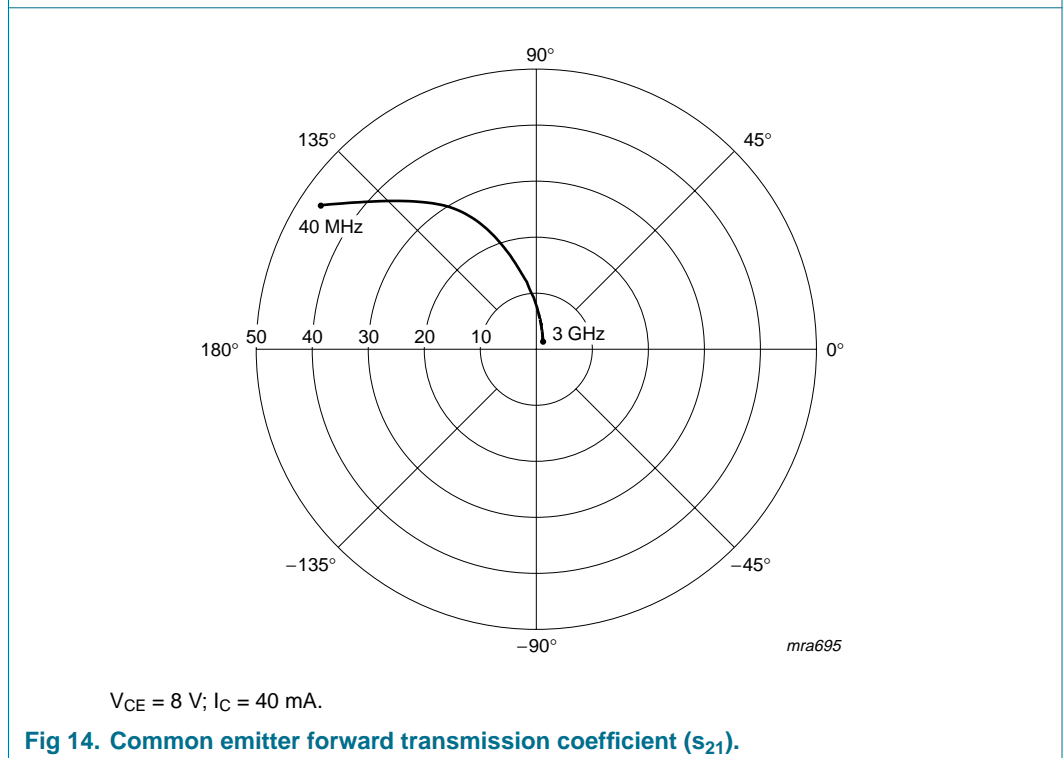
$Z_o = 50 \Omega$; $V_{CE} = 8 \text{ V}$; $I_C = 10 \text{ mA}$; $f = 2000 \text{ MHz}$.

Fig 12. Noise circle figure; $f = 2000 \text{ MHz}$.



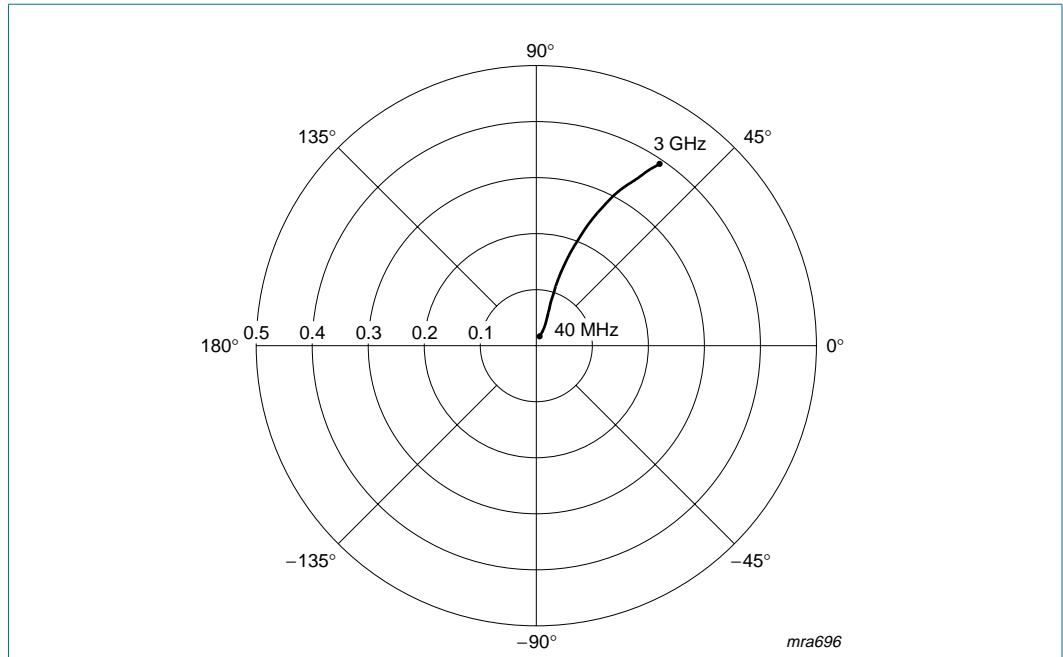
$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}; Z_o = 50\ \Omega.$

Fig 13. Common emitter input reflection coefficient (s_{11}).



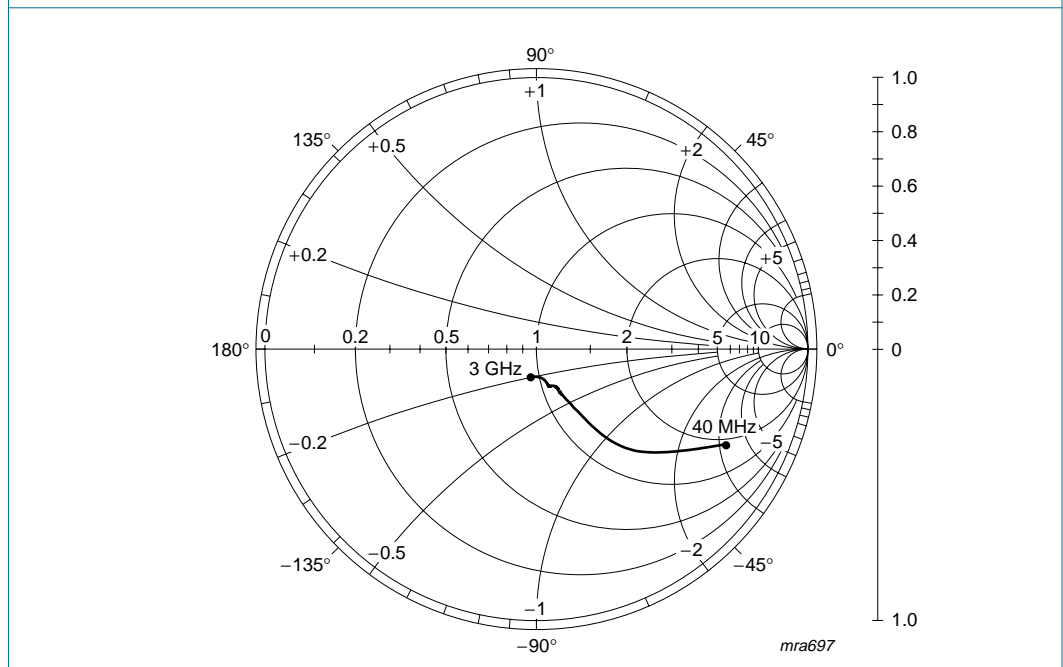
$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}.$

Fig 14. Common emitter forward transmission coefficient (s_{21}).



$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}$.

Fig 15. Common emitter reverse transmission coefficient (s_{12}).



$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}; Z_o = 50\ \Omega$.

Fig 16. Common emitter output reflection coefficient (s_{22}).

8. Package outline

Plastic surface mounted package; 3 leads

SOT23

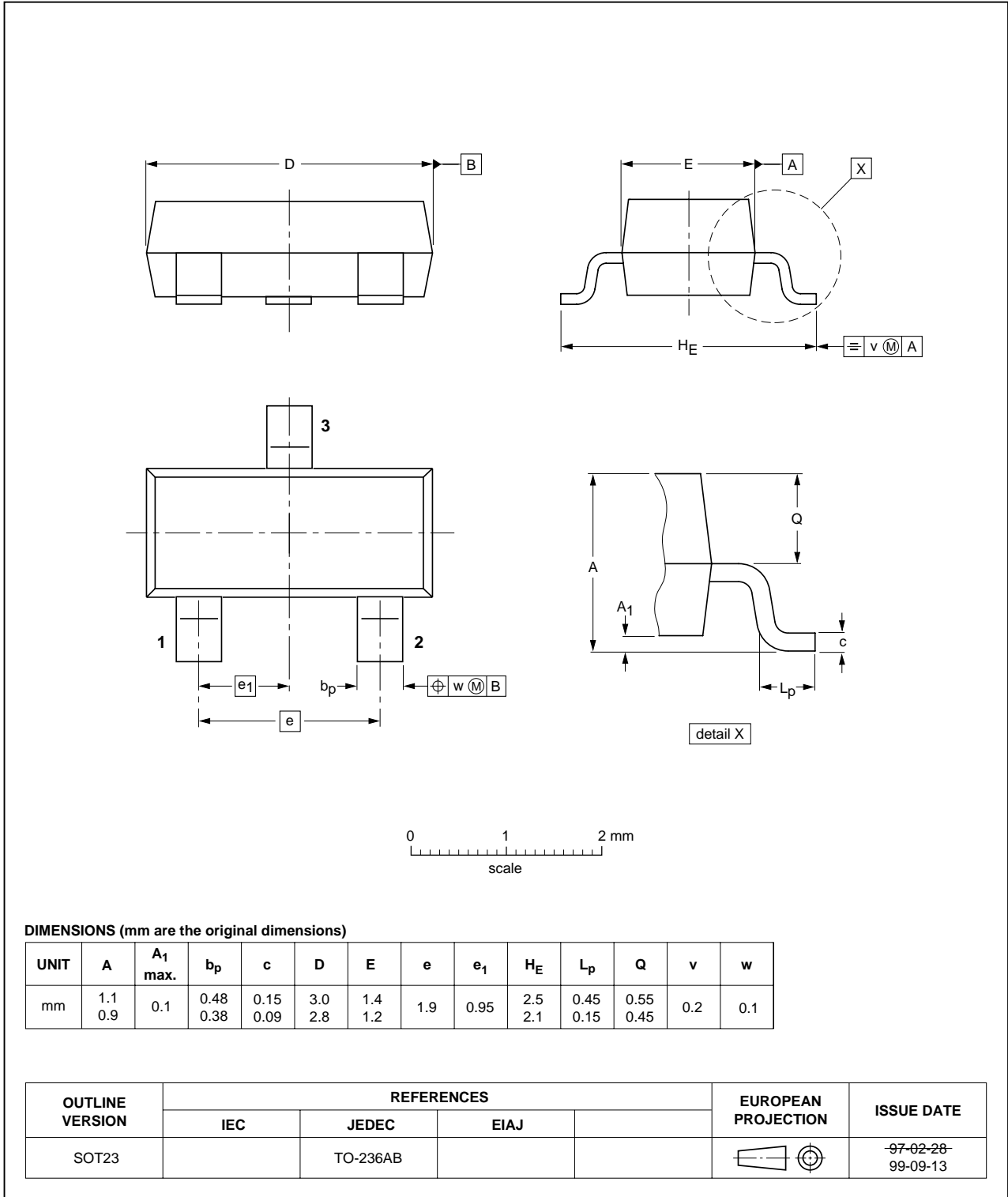


Fig 17. Package outline SOT23 (T0-236AB).

9. Revision history

Table 8: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
BFR540_5	20040901	Product data sheet	-	9397 750 13398	BFR540_4
Modifications:			<ul style="list-style-type: none">The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors.Table 4 "Marking": Format of marking code changed.		
BFR540_4	20000530	Product specification	-	9397 750 07062	BFR540_3
BFR540_3	19990823	Product specification	-	9397 750 06338	BFR540_CNV_2
BFR540_CNV_2	19971204	Product specification	-	not applicable	-

10. Data sheet status

Level	Data sheet status ^[1]	Product status ^[2] ^[3]	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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.

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