

# 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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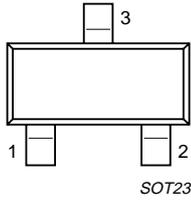
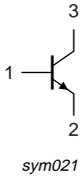
**Table 1: Quick reference data ...continued**

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<sub>j</sub> = 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	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $R_L = 50\ \Omega$ ; $T_{amb} = 25\text{ °C}$ ; $f = 900\text{ MHz}$	-	21	-	dBm
I <sub>TO</sub>	third order intercept point		[2]	34	-	dBm
$V_O$	output voltage	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $Z_L = Z_S = 75\ \Omega$ ; $T_{amb} = 25\text{ °C}$	[3]	550	-	mV

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

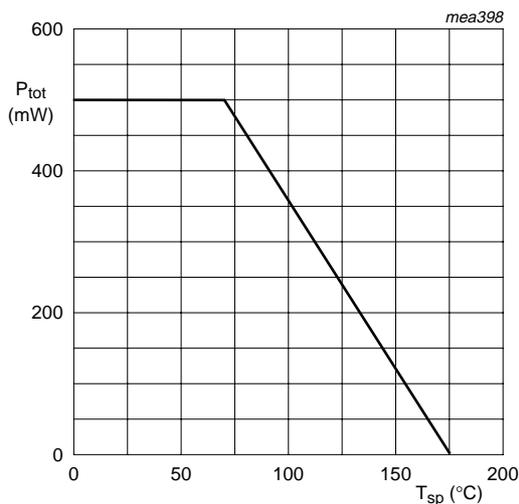
$$G_{UM} = 10 \log \frac{|s_{21}|^2}{(1 - |s_{11}|^2)(1 - |s_{22}|^2)} \text{ dB.}$$

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

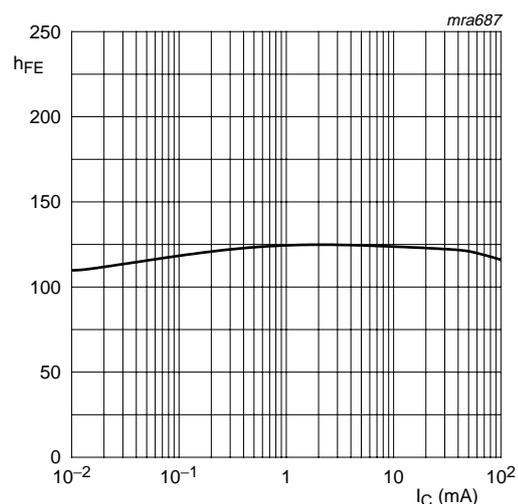
Measured at  $f_{(2p-q)} = 898\text{ MHz}$  and  $f_{(2q-p)} = 904\text{ MHz}$ .

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

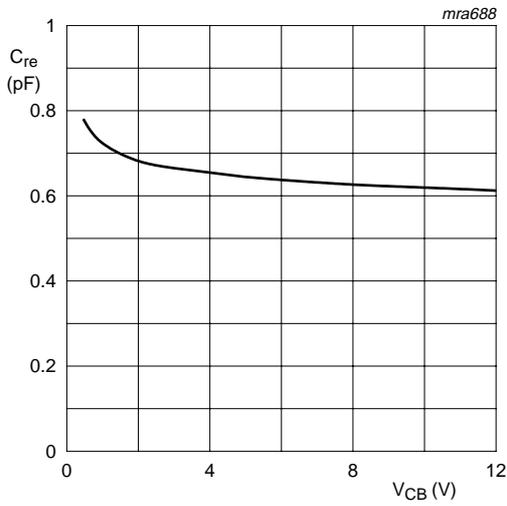


**Fig 1. Power derating curve.**



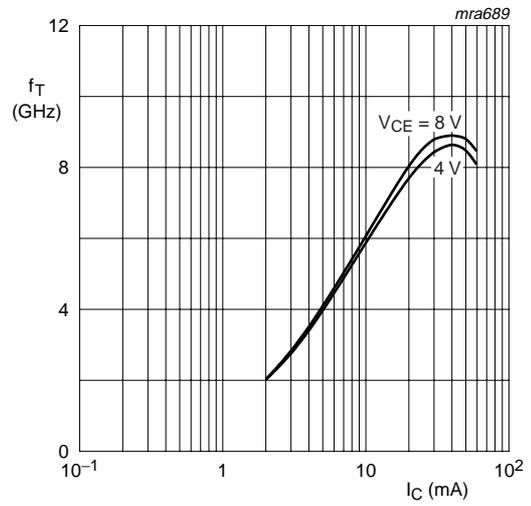
$V_{CE} = 8\text{ V}$ .

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



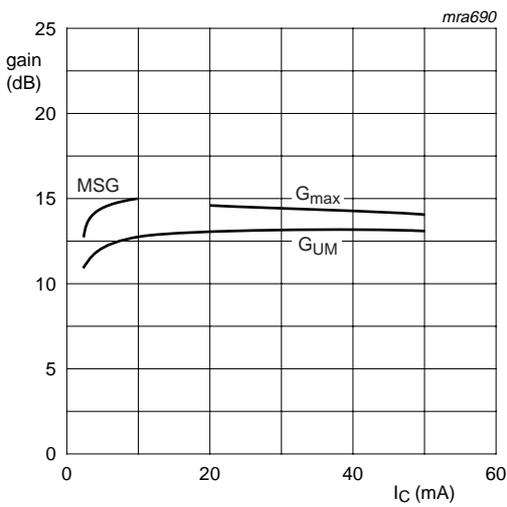
$I_C = 0$  A;  $f = 1$  MHz.

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



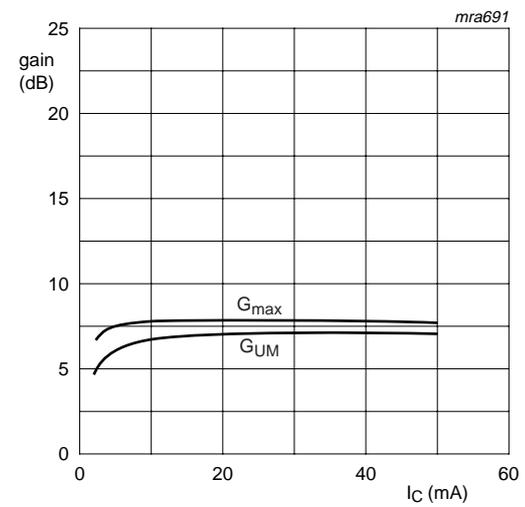
$T_{amb} = 25$  °C;  $f = 1$  GHz.

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



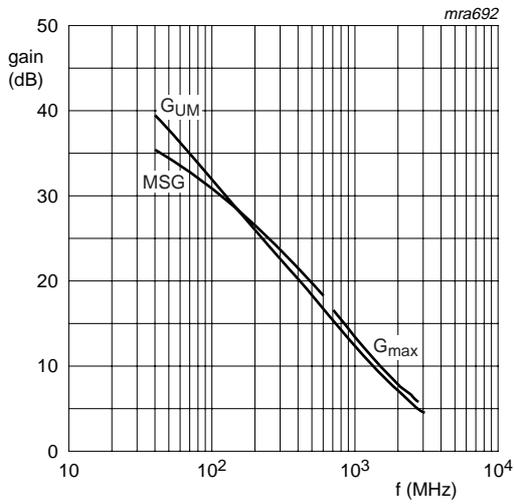
$V_{CE} = 8$  V;  $f = 900$  MHz.

**Fig 5. Gain as a function of collector current.**



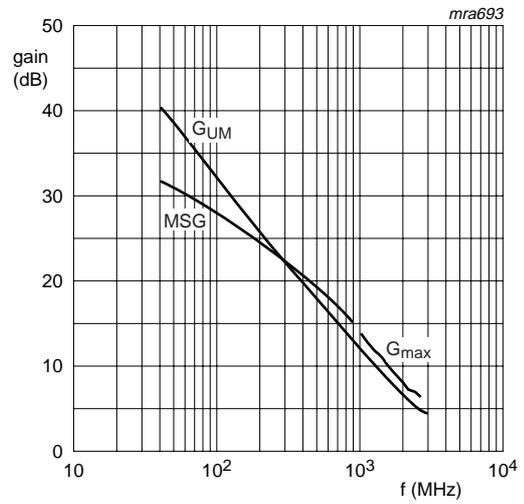
$V_{CE} = 8$  V;  $f = 2$  GHz.

**Fig 6. Gain as a function of collector current.**



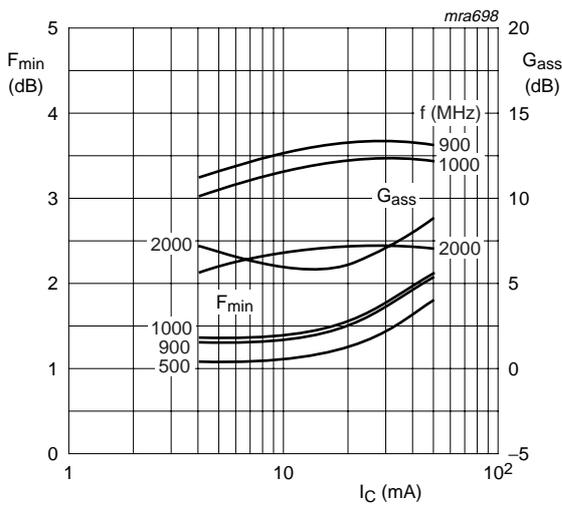
$V_{CE} = 8\text{ V}; I_C = 10\text{ mA}.$

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



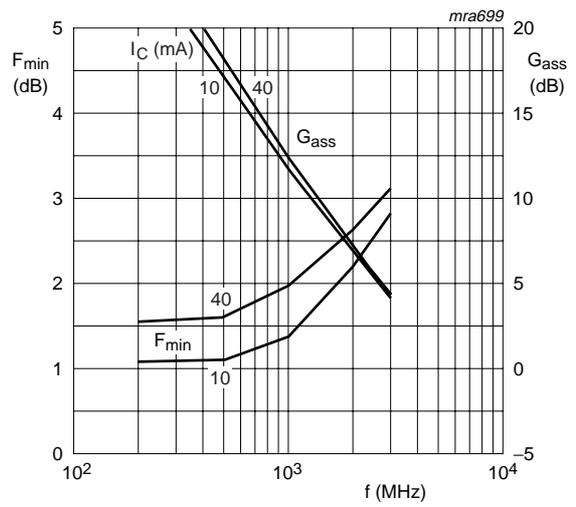
$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}.$

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



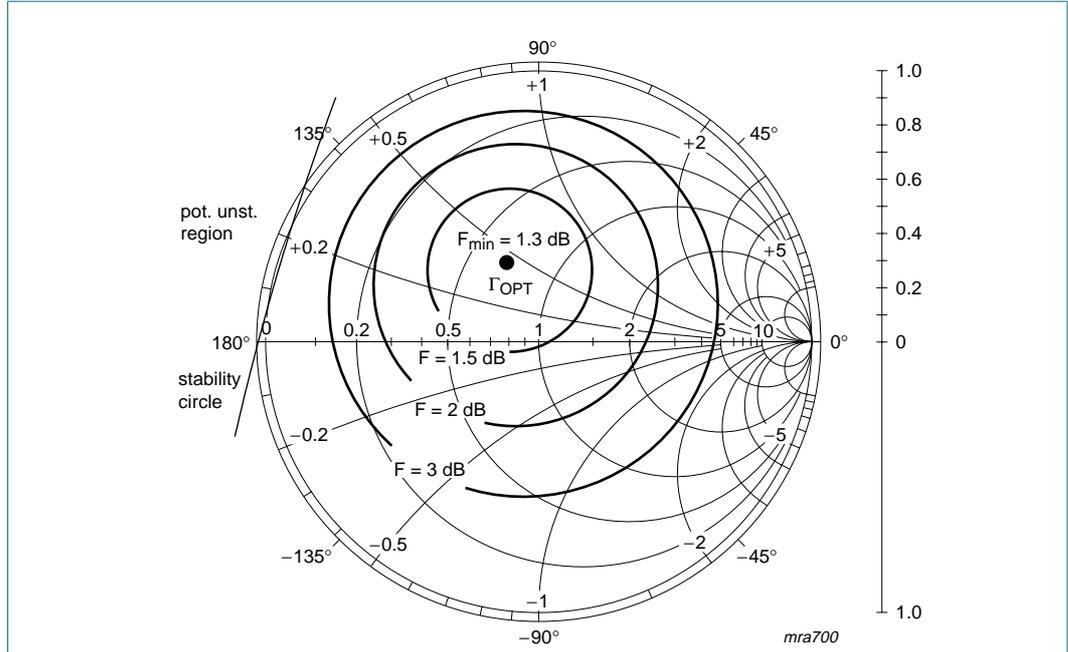
$V_{CE} = 8\text{ V}.$

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



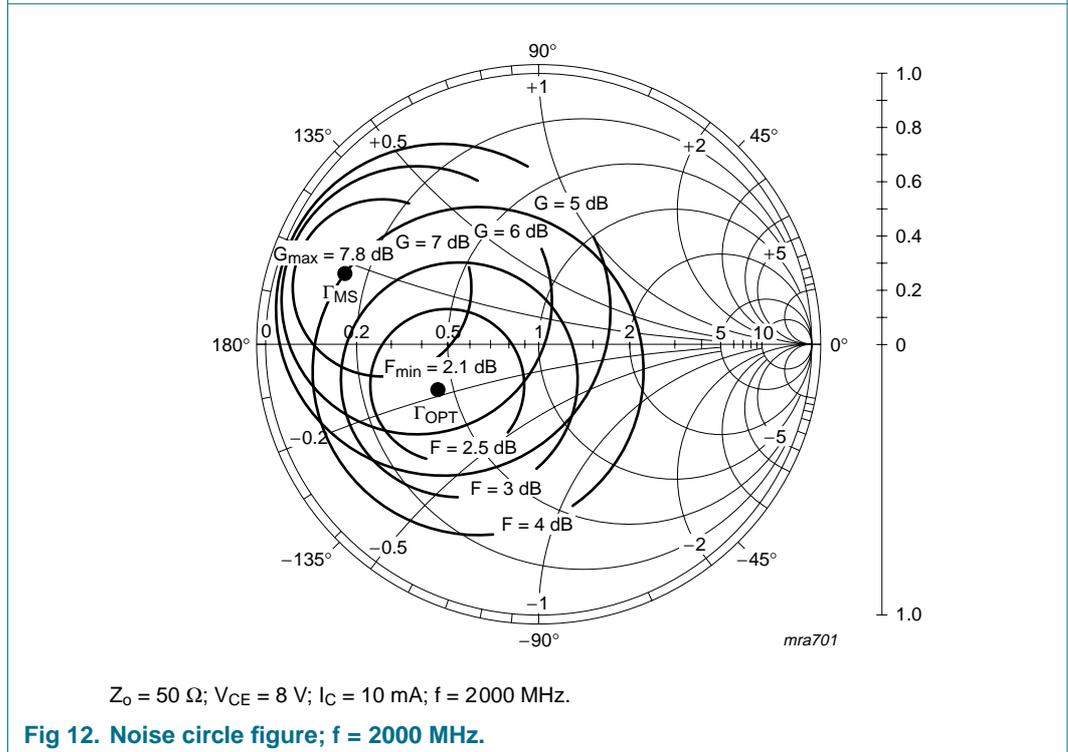
$V_{CE} = 8\text{ V}.$

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



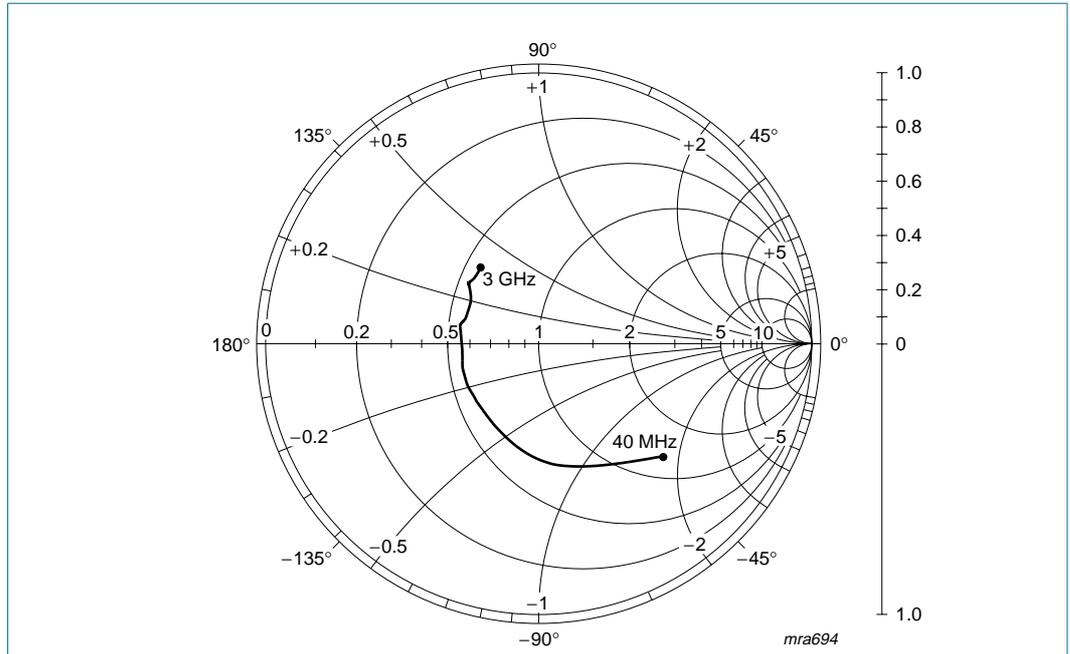
$Z_o = 50 \Omega$ ;  $V_{CE} = 8 \text{ V}$ ;  $I_C = 10 \text{ mA}$ ;  $f = 900 \text{ MHz}$ .

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



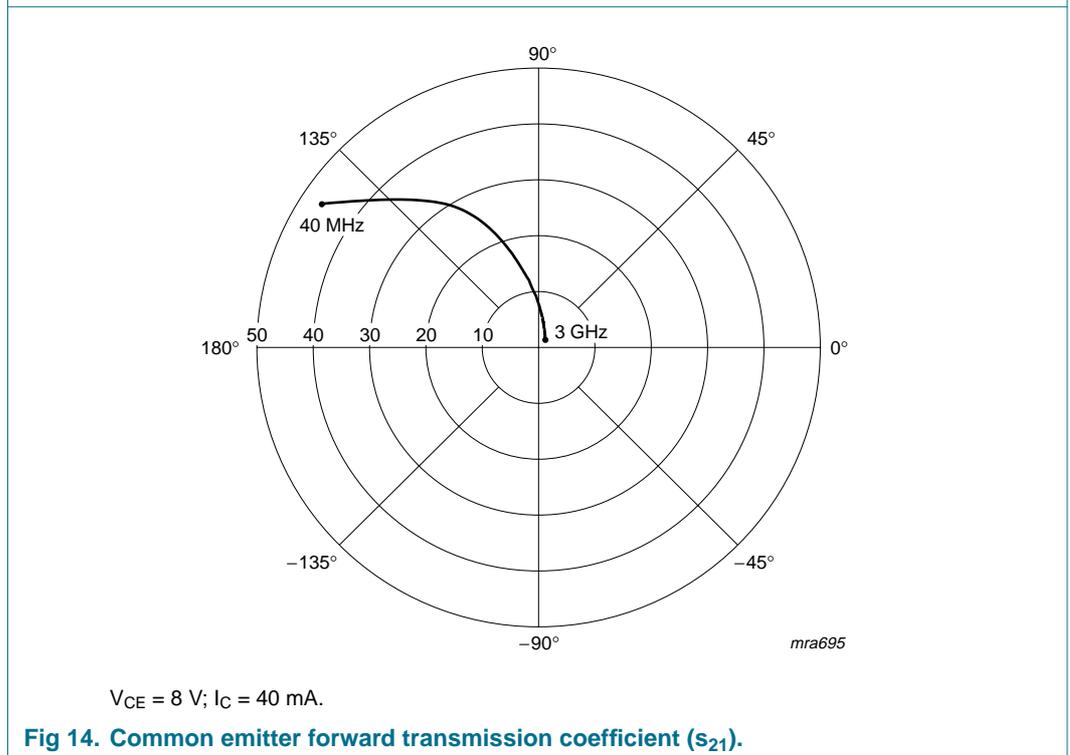
$Z_o = 50 \Omega$ ;  $V_{CE} = 8 \text{ V}$ ;  $I_C = 10 \text{ mA}$ ;  $f = 2000 \text{ MHz}$ .

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



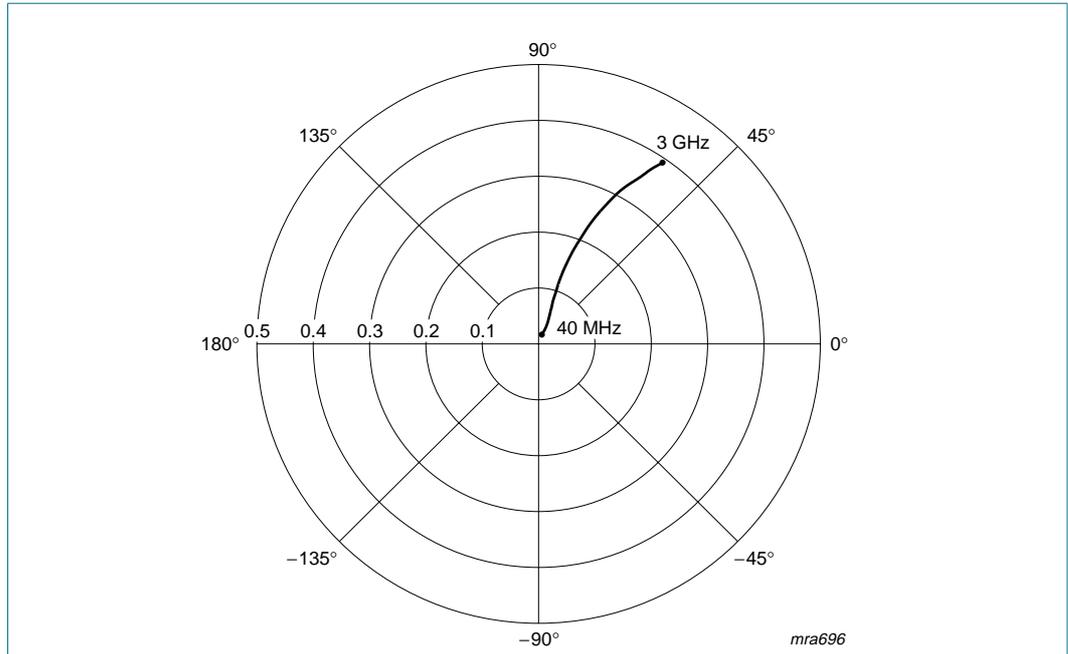
$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}; Z_o = 50\ \Omega.$

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



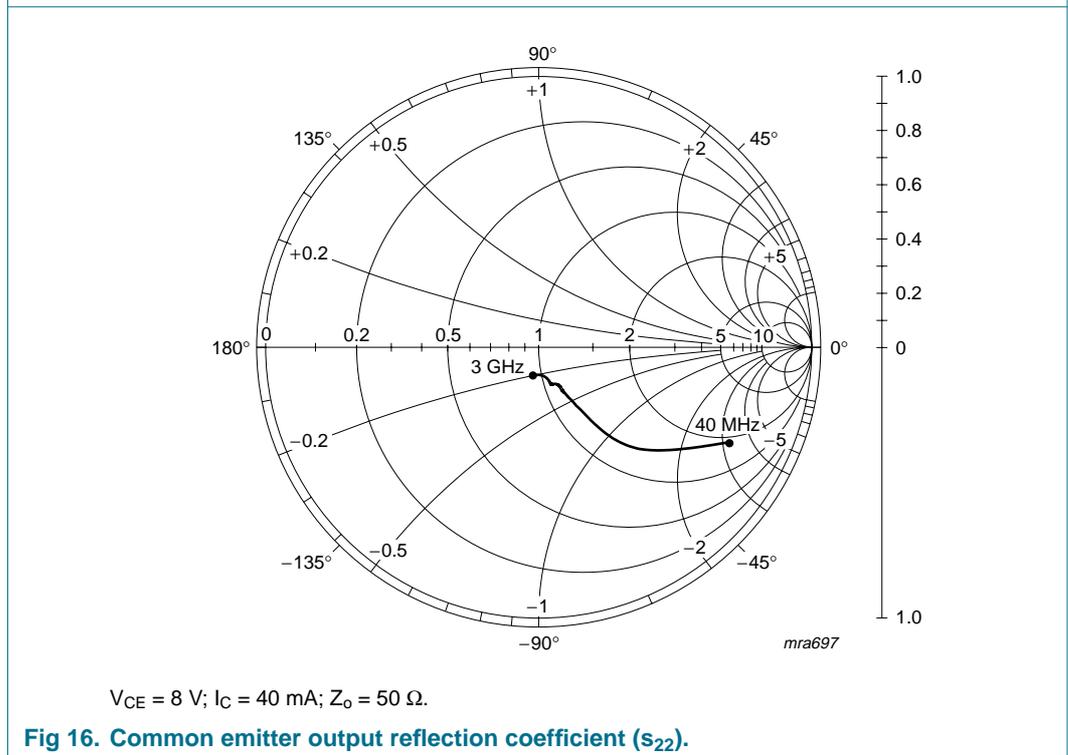
$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}.$

**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

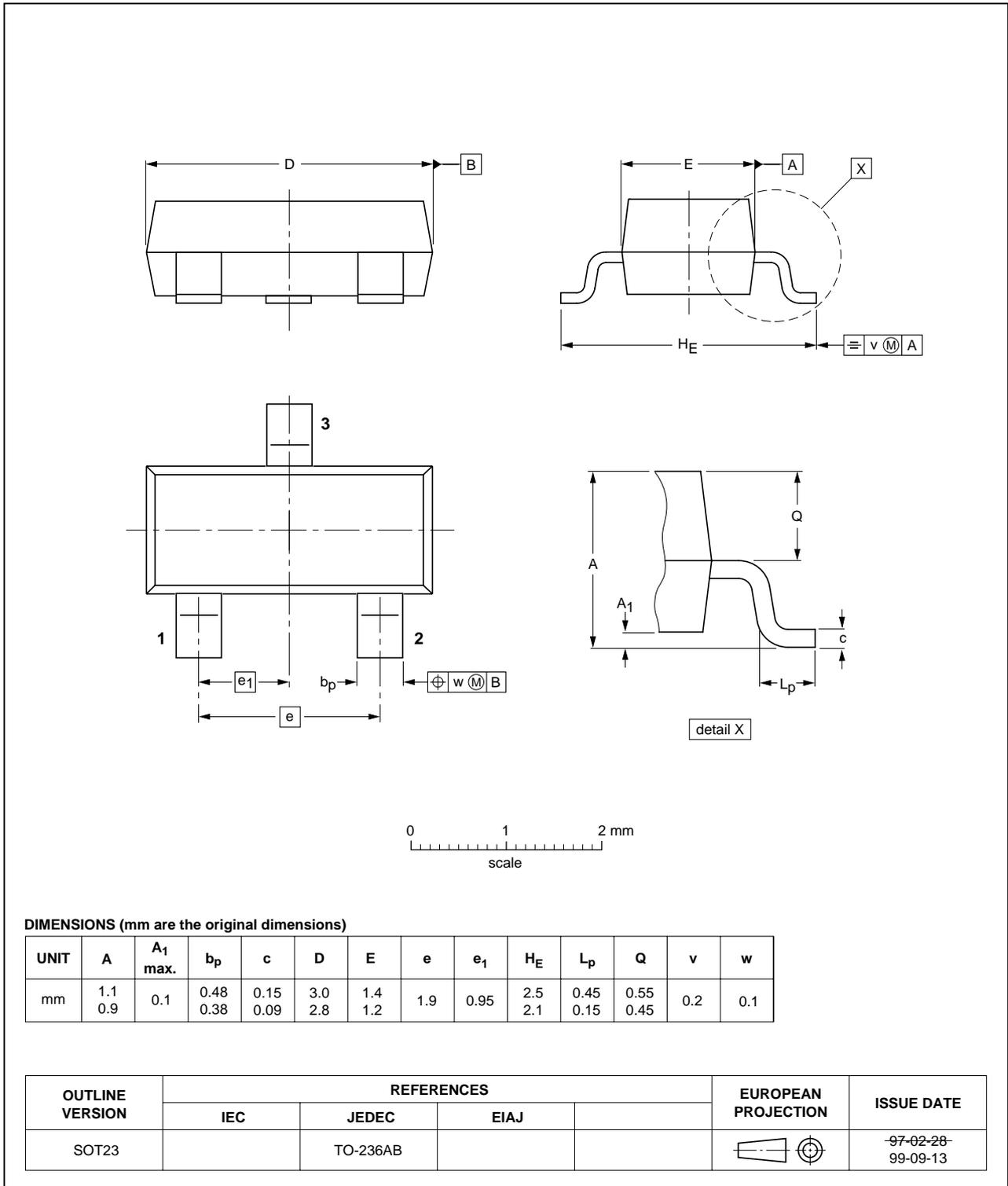


Fig 17. Package outline SOT23 (T0-236AB).

## 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"><li>The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors.</li><li><a href="#">Table 4 "Marking"</a>: Format of marking code changed.</li></ul>		
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 <sup>[1]</sup>	Product status <sup>[2]</sup> <sup>[3]</sup>	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.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

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[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

## 11. Definitions

**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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## 14. Contents

<b>1</b>	<b>Product profile</b> .....	<b>1</b>
1.1	General description .....	1
1.2	Features .....	1
1.3	Applications .....	1
1.4	Quick reference data .....	1
<b>2</b>	<b>Pinning information</b> .....	<b>2</b>
<b>3</b>	<b>Ordering information</b> .....	<b>2</b>
<b>4</b>	<b>Marking</b> .....	<b>2</b>
<b>5</b>	<b>Limiting values</b> .....	<b>3</b>
<b>6</b>	<b>Thermal characteristics</b> .....	<b>3</b>
<b>7</b>	<b>Characteristics</b> .....	<b>3</b>
<b>8</b>	<b>Package outline</b> .....	<b>10</b>
<b>9</b>	<b>Revision history</b> .....	<b>11</b>
<b>10</b>	<b>Data sheet status</b> .....	<b>12</b>
<b>11</b>	<b>Definitions</b> .....	<b>12</b>
<b>12</b>	<b>Disclaimers</b> .....	<b>12</b>
<b>13</b>	<b>Contact information</b> .....	<b>12</b>



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