



# BFR520

## NPN 9 GHz wideband transistor

Rev. 4 — 13 September 2011

Product data sheet

## 1. Product profile

### 1.1 General description

The BFR520 is an NPN silicon planar epitaxial transistor in a SOT23 plastic package.

### 1.2 Features and benefits

- 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
  - ◆ Pagers and satellite TV tuners (SATV)
  - ◆ 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		-	-	20	V
$V_{CES}$	collector-emitter voltage	$R_{BE} = 0 \Omega$	-	-	15	V
$I_C$	collector current (DC)		-	-	70	mA
$P_{tot}$	total power dissipation	up to $T_{sp} = 97 \text{ }^\circ\text{C}$	<a href="#">1</a> -	-	300	mW
$h_{FE}$	DC current gain	$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V}$	60	120	250	
$C_{re}$	feedback capacitance	$I_C = i_c = 0 \text{ A}; V_{CB} = 6 \text{ V}; f = 1 \text{ MHz}$	-	0.4	-	pF
$f_T$	transition frequency	$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V}; f = 1 \text{ GHz}$	-	9	-	GHz
$G_{UM}$	maximum unilateral power gain	$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$				
		$f = 900 \text{ MHz}$	-	15	-	dB
		$f = 2 \text{ GHz}$	-	9	-	dB



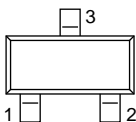
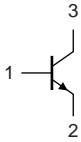
Table 1. Quick reference data ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$ s_{21} ^2$	insertion power gain	$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V};$ $T_{\text{amb}} = 25 \text{ }^\circ\text{C};$ $f = 900 \text{ MHz}$	13	14	-	dB
NF	noise figure	$\Gamma_s = \Gamma_{\text{opt}}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$				
		$I_C = 5 \text{ mA}; V_{CE} = 6 \text{ V};$ $f = 900 \text{ MHz}$	-	1.1	1.6	dB
		$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V};$ $f = 900 \text{ MHz}$	-	1.6	2.1	dB
		$I_C = 5 \text{ mA}; V_{CE} = 8 \text{ V};$ $f = 2 \text{ GHz}$	-	1.9	-	dB

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

## 2. Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Symbol
1	base		
2	emitter		
3	collector		

*sym021*

## 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BFR520	-	plastic surface mounted package; 3 leads	SOT23

## 4. Marking

Table 4. Marking

Type number	Marking code <sup>[1]</sup>
BFR520	32*

[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)		-	70	mA
$P_{tot}$	total power dissipation	up to $T_{sp} = 97 \text{ }^\circ\text{C}$ [1]	-	300	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
$R_{th(j-s)}$	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	$I_E = 0 \text{ A}; V_{CB} = 6 \text{ V}$	-	-	50	nA
$h_{FE}$	DC current gain	$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V}$	60	120	250	
$C_e$	emitter capacitance	$I_C = i_c = 0 \text{ A}; V_{EB} = 0.5 \text{ V};$ $f = 1 \text{ MHz}$	-	1	-	pF
$C_c$	collector capacitance	$I_E = i_e = 0 \text{ A}; V_{CB} = 6 \text{ V};$ $f = 1 \text{ MHz}$	-	0.5	-	pF
$C_{re}$	feedback capacitance	$I_C = 0 \text{ A}; V_{CB} = 6 \text{ V};$ $f = 1 \text{ MHz}$	-	0.4	-	pF
$f_T$	transition frequency	$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V};$ $f = 1 \text{ GHz}$	-	9	-	GHz
$G_{UM}$	maximum unilateral power gain	$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V};$ $T_{amb} = 25 \text{ }^\circ\text{C}$	[1]			
		$f = 900 \text{ MHz}$	-	15	-	dB
		$f = 2 \text{ GHz}$	-	9	-	dB
$ s_{21} ^2$	insertion power gain	$I_C = 20 \text{ mA}; V_{CE} = 6 \text{ V};$ $T_{amb} = 25 \text{ }^\circ\text{C}; f = 900 \text{ MHz}$	13	14	-	dB

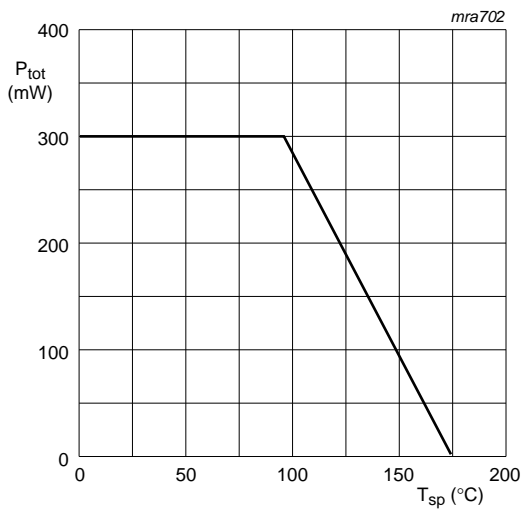
**Table 7. Characteristics ...continued**  
*T<sub>j</sub> = 25 °C unless otherwise specified.*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
NF	noise figure	$\Gamma_s = \Gamma_{opt}$ ; $V_{CE} = 6\text{ V}$ ; $T_{amb} = 25\text{ °C}$				
		$I_C = 5\text{ mA}$ ; $f = 900\text{ MHz}$	-	1.1	1.6	dB
		$I_C = 20\text{ mA}$ ; $f = 900\text{ MHz}$	-	1.6	2.1	dB
		$I_C = 5\text{ mA}$ ; $f = 2\text{ GHz}$	-	1.9	-	dB
$P_{L(1dB)}$	output power at 1 dB gain compression	$I_C = 20\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $R_L = 50\ \Omega$ ; $T_{amb} = 25\text{ °C}$ ; $f = 900\text{ MHz}$	-	17	-	dBm
ITO	third order intercept point		[2]	26	-	dBm

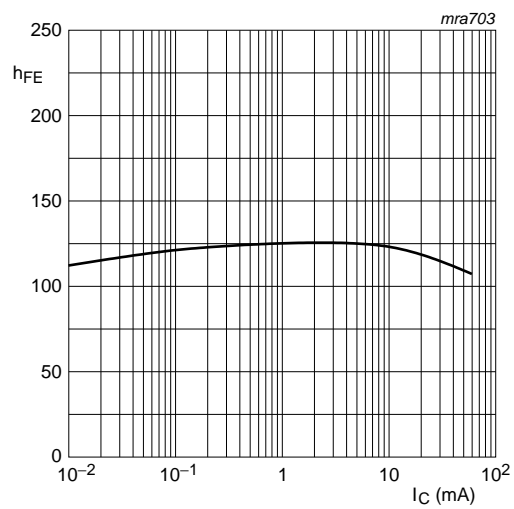
[1]  $G_{UM}$  is the maximum unilateral power gain, assuming  $s_{12}$  is zero and

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

[2]  $I_C = 20\text{ mA}$ ;  $V_{CE} = 6\text{ V}$ ;  $R_L = 50\ \Omega$ ;  $T_{amb} = 25\text{ °C}$ ;  $f_p = 900\text{ MHz}$ ;  $f_q = 902\text{ MHz}$   
 Measured at  $f_{(2p-q)} = 898\text{ MHz}$  and  $f_{(2q-p)} = 904\text{ MHz}$ .

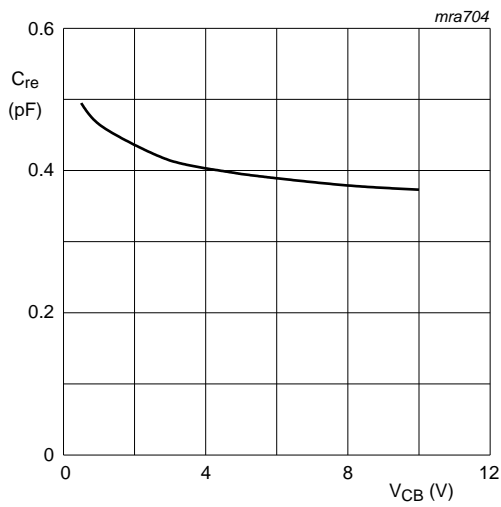


**Fig 1. Power derating curve.**



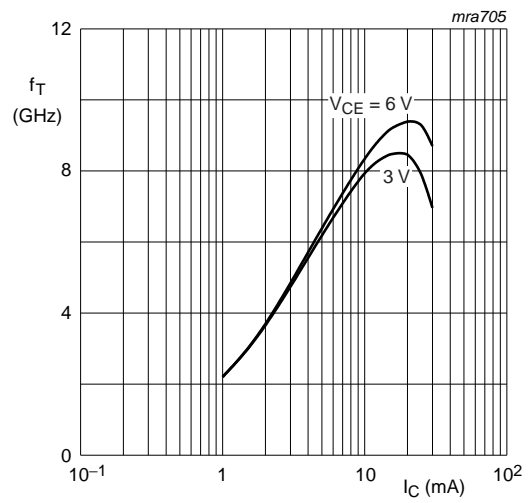
$V_{CE} = 6\text{ V}$ .

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



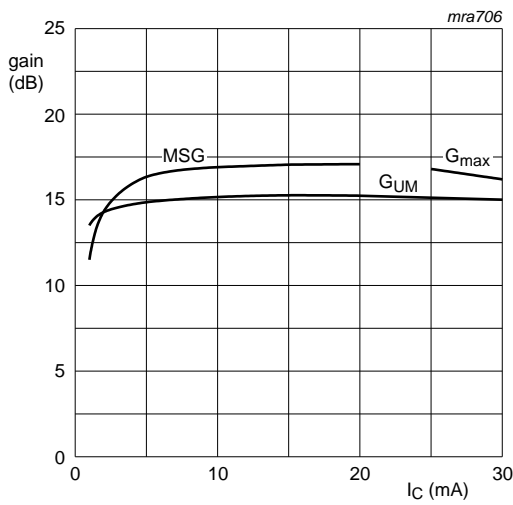
$I_C = 0$  A;  $f = 1$  MHz.

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



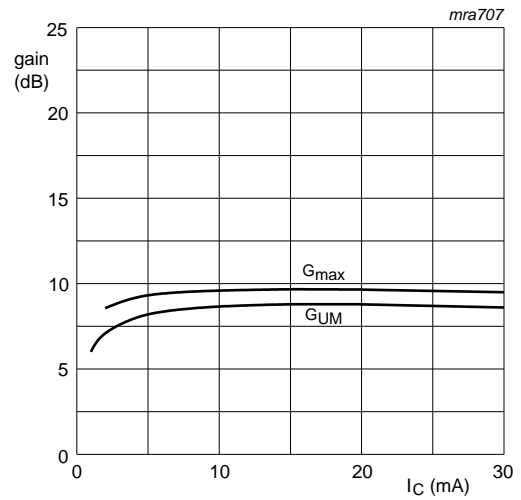
$T_{amb} = 25$  °C;  $f = 1$  GHz.

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



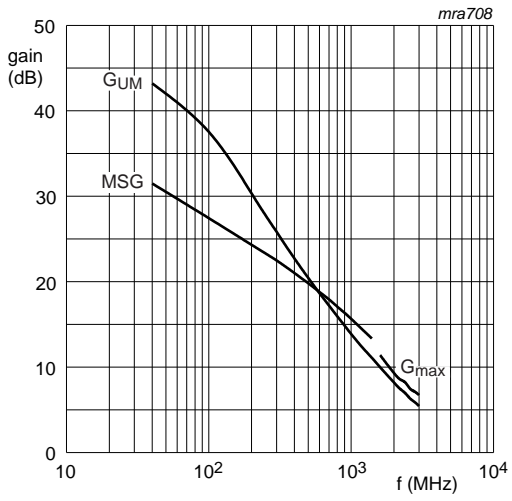
$V_{CE} = 6$  V;  $f = 900$  MHz.

**Fig 5. Gain as a function of collector current;  $f = 900$  MHz.**



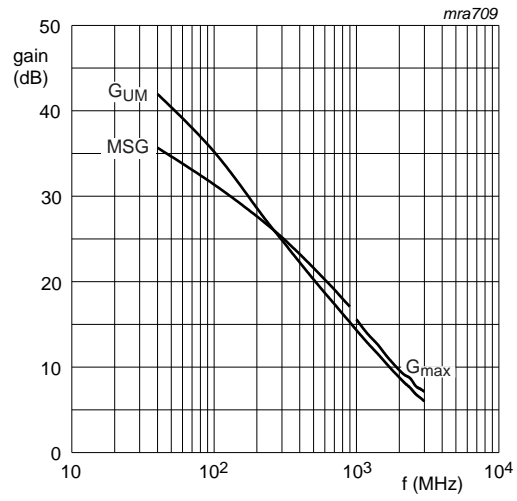
$V_{CE} = 6$  V;  $f = 2$  GHz.

**Fig 6. Gain as a function of collector current;  $f = 2$  GHz.**



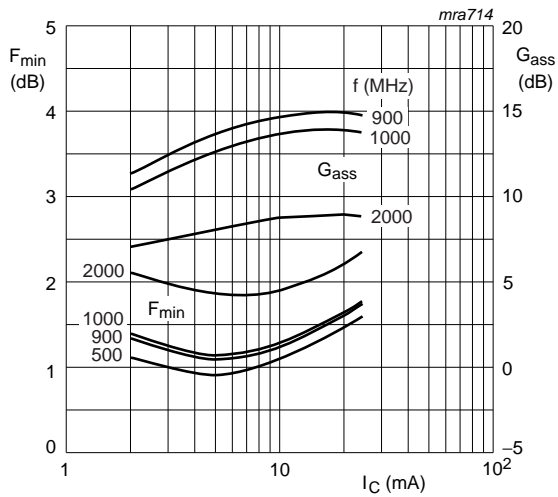
$V_{CE} = 6\text{ V}; I_C = 5\text{ mA}.$

**Fig 7. Gain as a function of frequency;  $I_C = 5\text{ mA}.$**



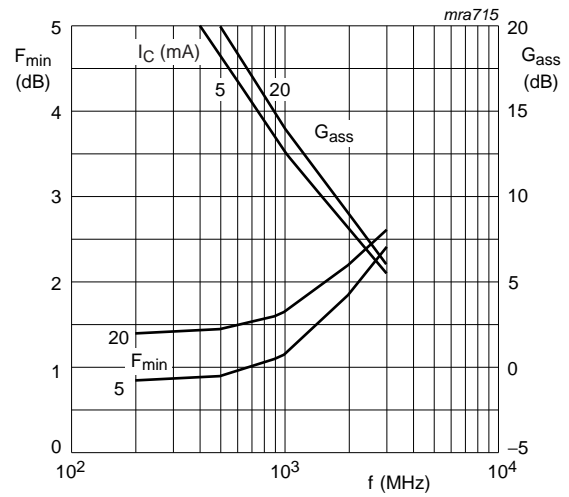
$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}.$

**Fig 8. Gain as a function of frequency;  $I_C = 20\text{ mA}.$**



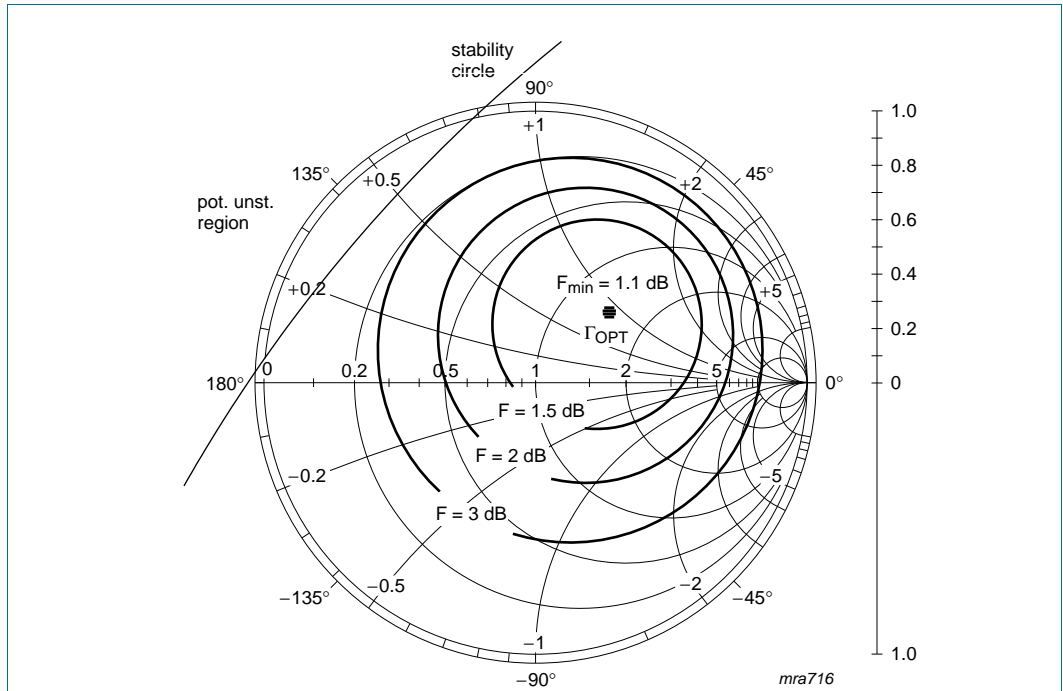
$V_{CE} = 6\text{ V}.$

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



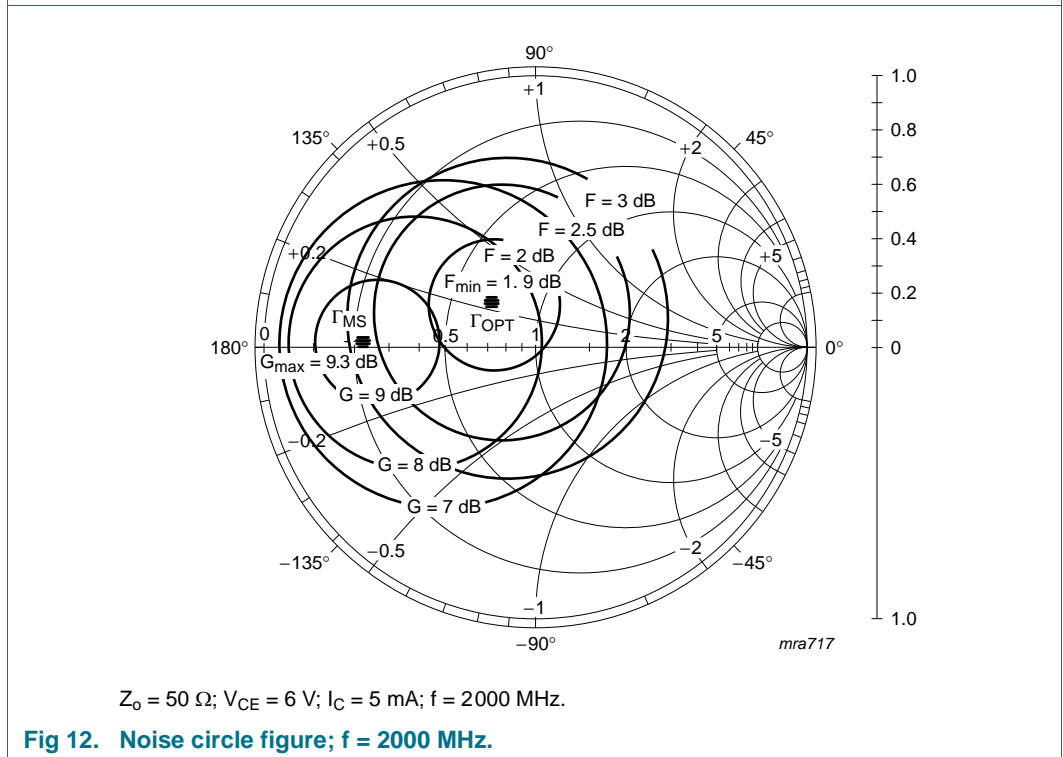
$V_{CE} = 6\text{ V}.$

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



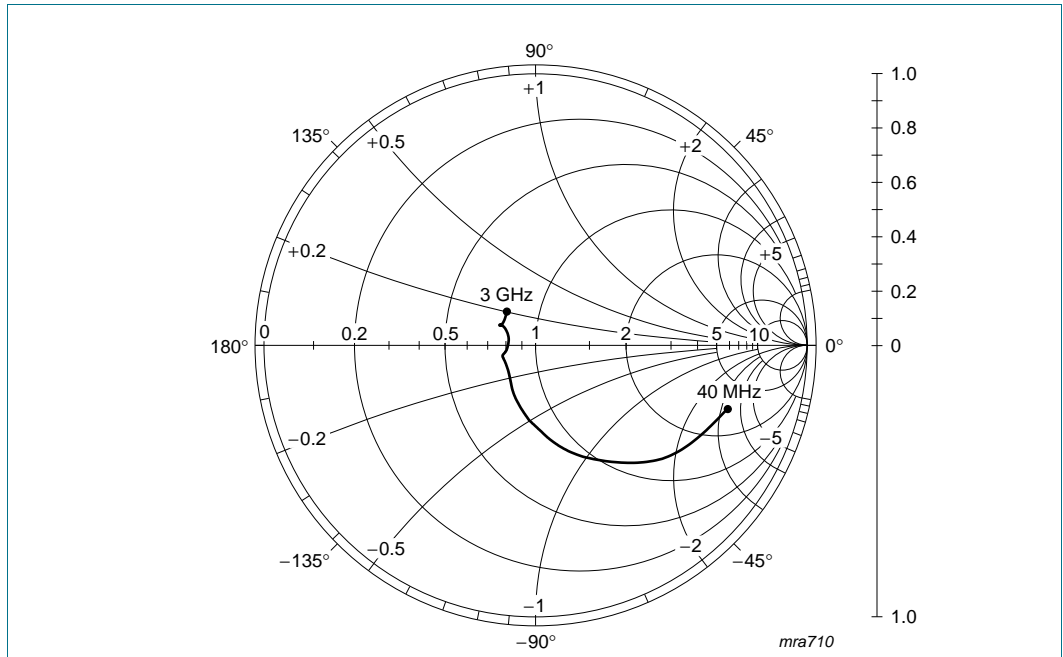
$Z_0 = 50 \Omega$ ;  $V_{CE} = 6 \text{ V}$ ;  $I_C = 5 \text{ mA}$ ;  $f = 900 \text{ MHz}$ .

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



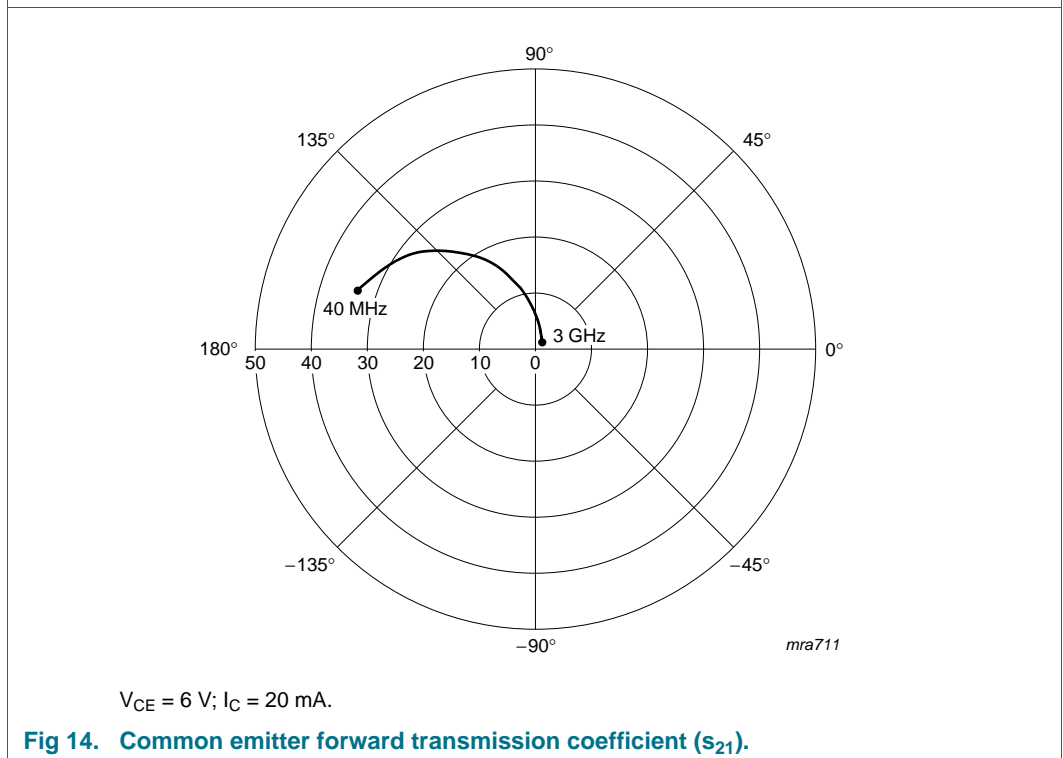
$Z_0 = 50 \Omega$ ;  $V_{CE} = 6 \text{ V}$ ;  $I_C = 5 \text{ mA}$ ;  $f = 2000 \text{ MHz}$ .

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



$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}; Z_o = 50\ \Omega.$

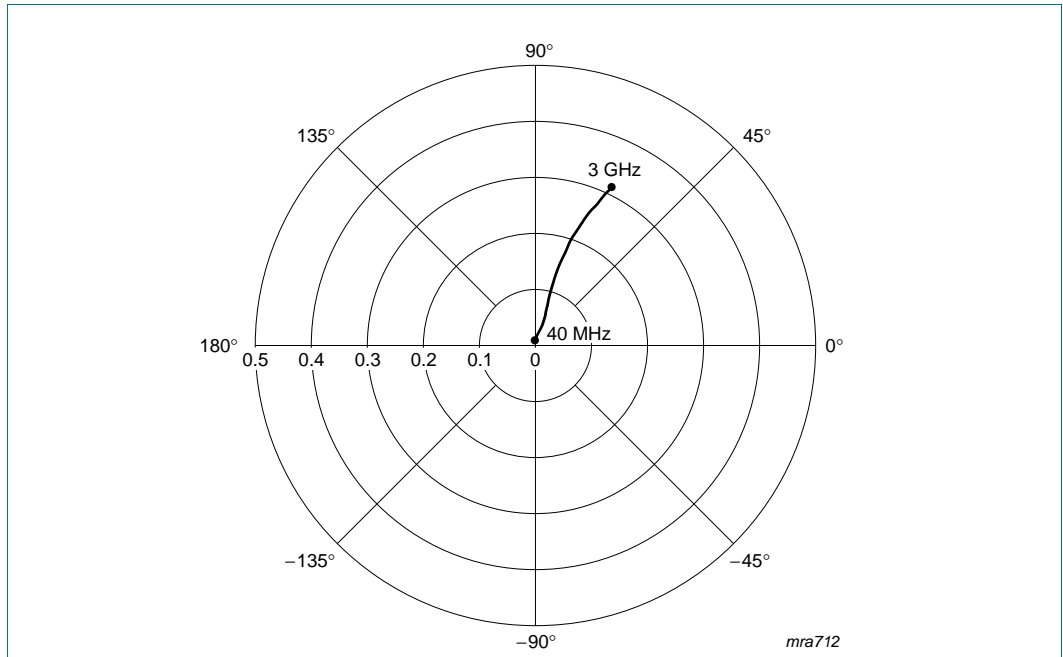
**Fig 13. Common emitter input reflection coefficient ( $s_{11}$ ).**



$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}.$

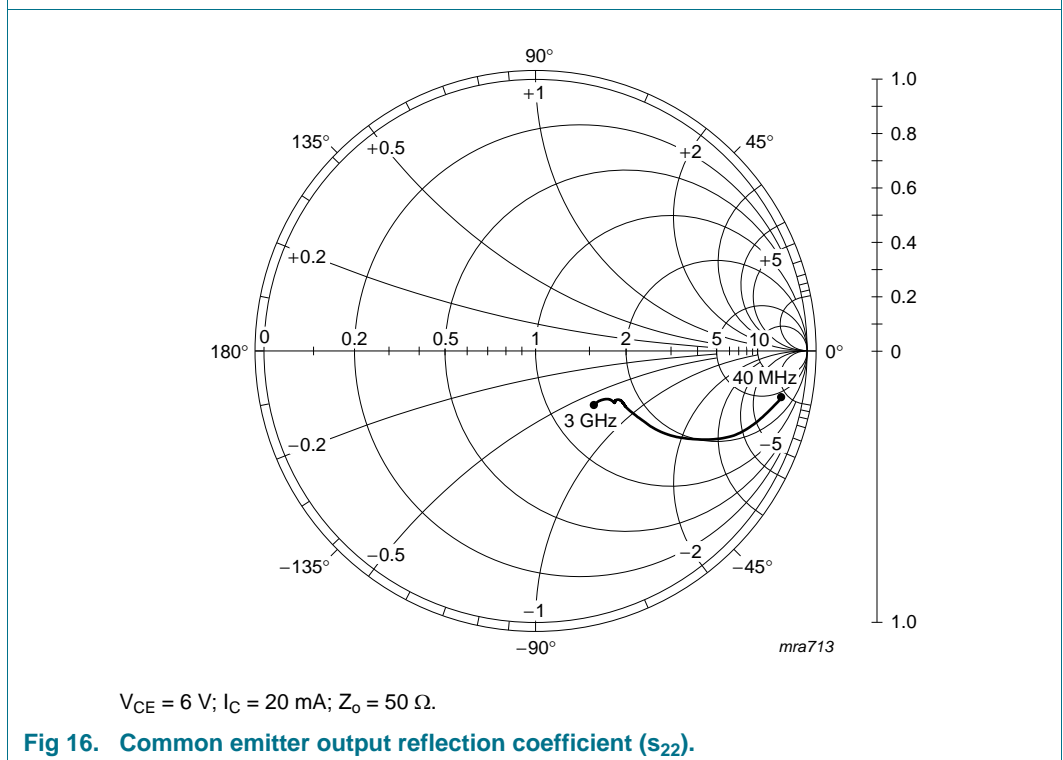
**Fig 14. Common emitter forward transmission coefficient ( $s_{21}$ ).**





$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}.$

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



$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}; Z_o = 50\ \Omega.$

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

**8. Package outline**

Plastic surface-mounted package; 3 leads

SOT23

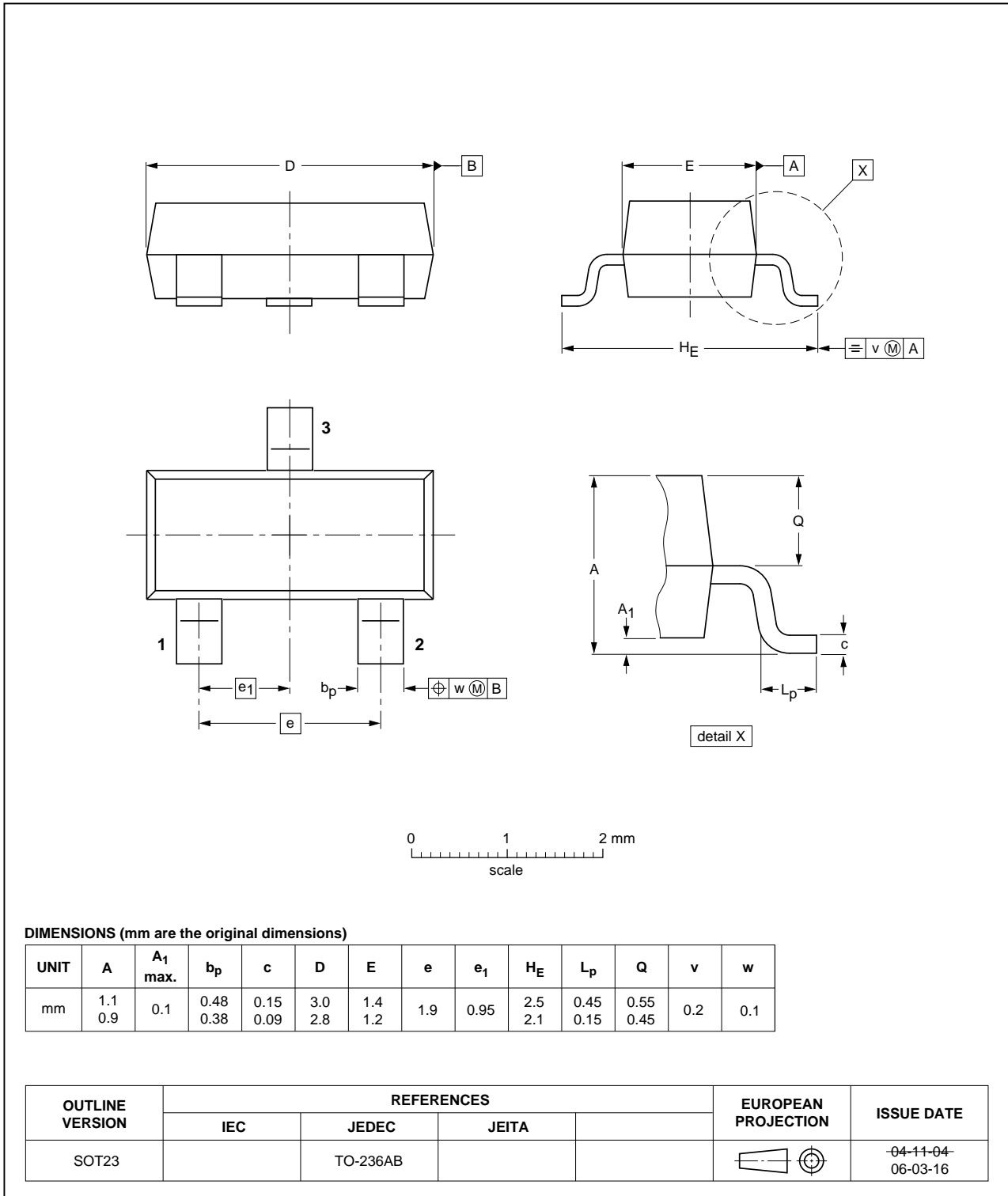


Fig 17. Package outline SOT23 (TO-236AB).

## 9. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BFR520 v.4	20110913	Product data sheet	-	BFR520 v.3
Modifications:		<ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li><li>• Package outline drawings have been updated to the latest version.</li></ul>		
BFR520 v.3 (9397 750 13397)	20040901	Product data sheet	-	BFR520_CNV v.2
BFR520_CNV v.2	19971204	Product specification	-	-

## 10. Legal information

### 10.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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