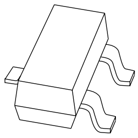

# BFR520

## NPN 9 GHz wideband transistor

Rev. 03 — 1 September 2004 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

- 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 $T_{sp} = 97$ °C | [1] | - | - | 300 | mW |
| $h_{FE}$ | DC current gain | $I_C = 20$ mA; $V_{CE} = 6$ V | | 60 | 120 | 250 | |
| $C_{re}$ | feedback capacitance | $I_C = i_c = 0$ A; $V_{CB} = 6$ V; f = 1 MHz | | - | 0.4 | - | pF |
| $f_T$ | transition frequency | $I_C = 20$ mA; $V_{CE} = 6$ V; f = 1 GHz | | - | 9 | - | GHz |
| $G_{UM}$ | maximum unilateral power gain | $I_C = 20$ mA; $V_{CE} = 6$ V; $T_{amb} = 25$ °C | | | | | |
| | | f = 900 MHz | | - | 15 | - | dB |
| | | f = 2 GHz | | - | 9 | - | dB |

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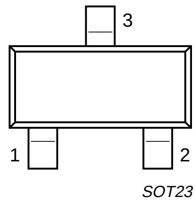
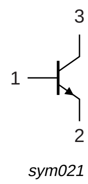
**Table 1: Quick reference data** *...continued*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $\lvert s_{21}\rvert^2$ | insertion power gain | $I_C$ = 20 mA; $V_{CE}$ = 6 V; $T_{amb}$ = 25 °C; f = 900 MHz | 13 | 14 | - | dB |
| NF | noise figure | $\Gamma_s = \Gamma_{opt}$; $T_{amb}$ = 25 °C | | | | |
| | | $I_C$ = 5 mA; $V_{CE}$ = 6 V; f = 900 MHz | - | 1.1 | 1.6 | dB |
| | | $I_C$ = 20 mA; $V_{CE}$ = 6 V; f = 900 MHz | - | 1.6 | 2.1 | dB |
| | | $I_C$ = 5 mA; $V_{CE}$ = 8 V; f = 2 GHz | - | 1.9 | - | 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 |   |   |
| 2 | emitter | | |
| 3 | collector | | |

## 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 [1] |
|---|---|
| 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 °C | [1] | - | 300 | mW |
| $T_{stg}$ | storage temperature | | | –65 | 150 | °C |
| $T_j$ | junction temperature | | | - | 175 | °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 |
|---|---|---|---|---|---|
| $R_{th(j\text{-}s)}$ | 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 °C unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{CBO}$ | collector cut-off current | $I_E$ = 0 A; $V_{CB}$ = 6 V | | - | - | 50 | nA |
| $h_{FE}$ | DC current gain | $I_C$ = 20 mA; $V_{CE}$ = 6 V | | 60 | 120 | 250 | |
| $C_e$ | emitter capacitance | $I_C = i_c$ = 0 A; $V_{EB}$ = 0.5 V; f = 1 MHz | | - | 1 | - | pF |
| $C_c$ | collector capacitance | $I_E = i_e$ = 0 A; $V_{CB}$ = 6 V; f = 1 MHz | | - | 0.5 | - | pF |
| $C_{re}$ | feedback capacitance | $I_C$ = 0 A; $V_{CB}$ = 6 V; f = 1 MHz | | - | 0.4 | - | pF |
| $f_T$ | transition frequency | $I_C$ = 20 mA; $V_{CE}$ = 6 V; f = 1 GHz | | - | 9 | - | GHz |
| $G_{UM}$ | maximum unilateral power gain | $I_C$ = 20 mA; $V_{CE}$ = 6 V; $T_{amb}$ = 25 °C | [1] | | | | |
| | | f = 900 MHz | | - | 15 | - | dB |
| | | f = 2 GHz | | - | 9 | - | dB |
| $\lvert s_{21}\rvert^2$ | insertion power gain | $I_C$ = 20 mA; $V_{CE}$ = 6 V; $T_{amb}$ = 25 °C; f = 900 MHz | | 13 | 14 | - | dB |

**Table 7: Characteristics** *...continued*

*$T_j$ = 25 °C unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| NF | noise figure | $\Gamma_s = \Gamma_{opt}$; $V_{CE}$ = 6 V; $T_{amb}$ = 25 °C | | | | | |
| | | $I_C$ = 5 mA; f = 900 MHz | | - | 1.1 | 1.6 | dB |
| | | $I_C$ = 20 mA; f = 900 MHz | | - | 1.6 | 2.1 | dB |
| | | $I_C$ = 5 mA; f = 2 GHz | | - | 1.9 | - | dB |
| $P_{L(1dB)}$ | output power at 1 dB gain compression | $I_C$ = 20 mA; $V_{CE}$ = 6 V; $R_L$ = 50 Ω; $T_{amb}$ = 25 °C; f = 900 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

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

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

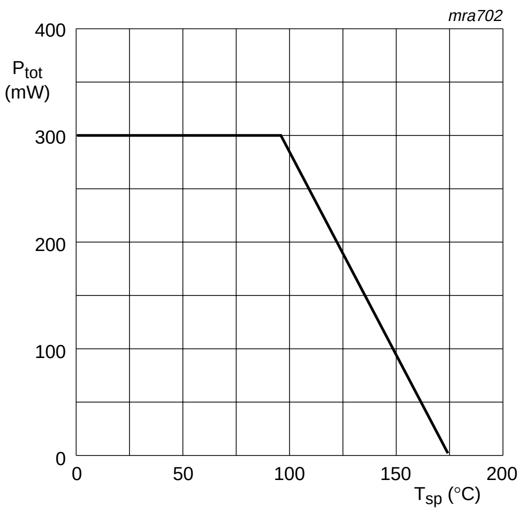
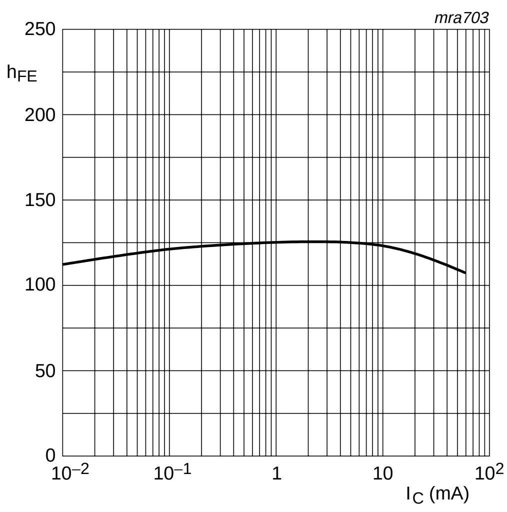
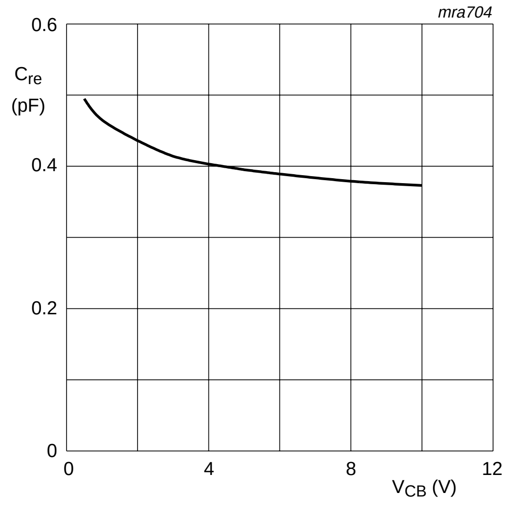



**Fig 1. Power derating curve.**



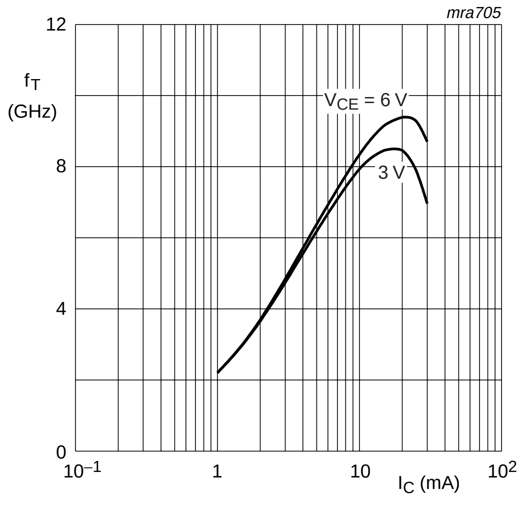

$V_{CE}$ = 6 V.

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



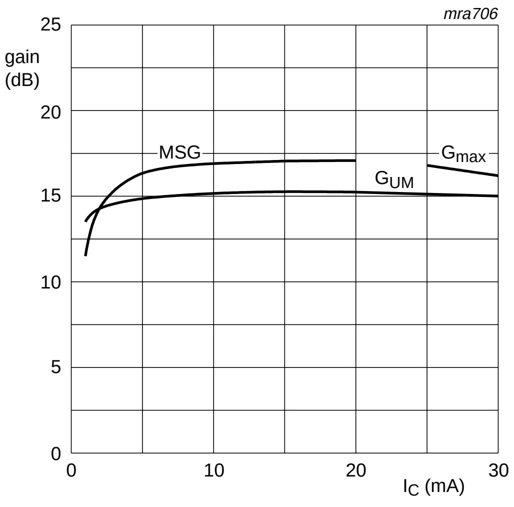

$I_C$ = 0 A; f = 1 MHz.

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



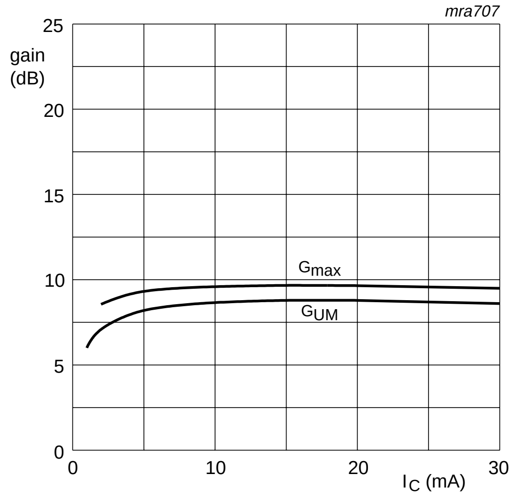

$T_{amb}$ = 25 °C; f = 1 GHz.

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



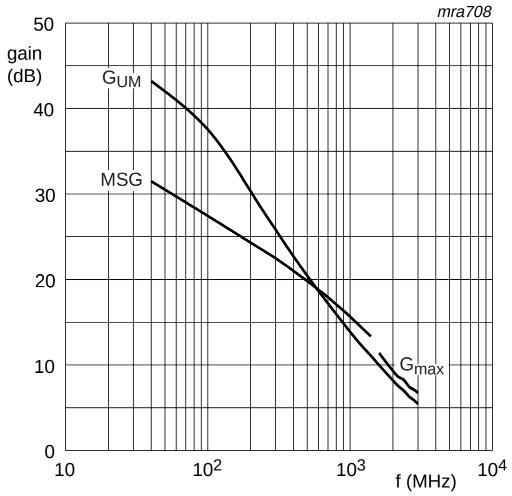

$V_{CE}$ = 6 V; f = 900 MHz.

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



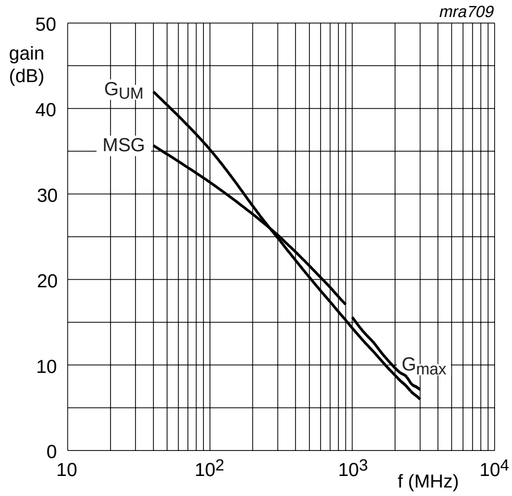

$V_{CE}$ = 6 V; f = 2 GHz.

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



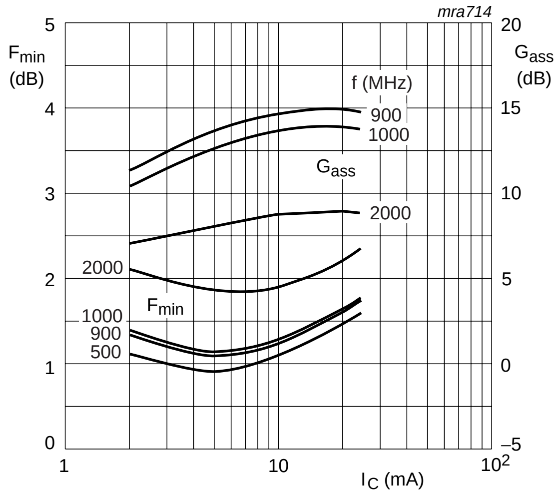

$V_{CE}$ = 6 V; $I_C$ = 5 mA.

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



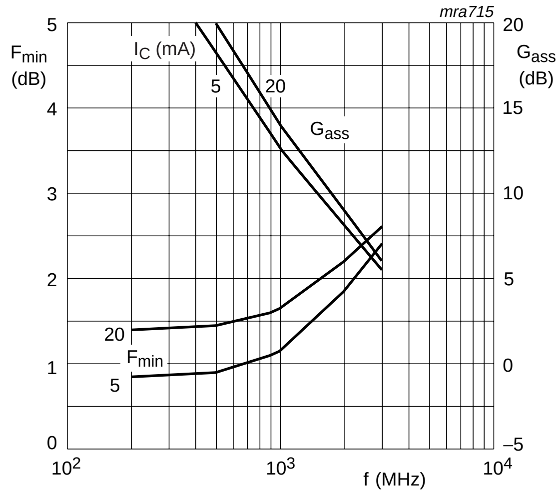

$V_{CE}$ = 6 V; $I_C$ = 20 mA.

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



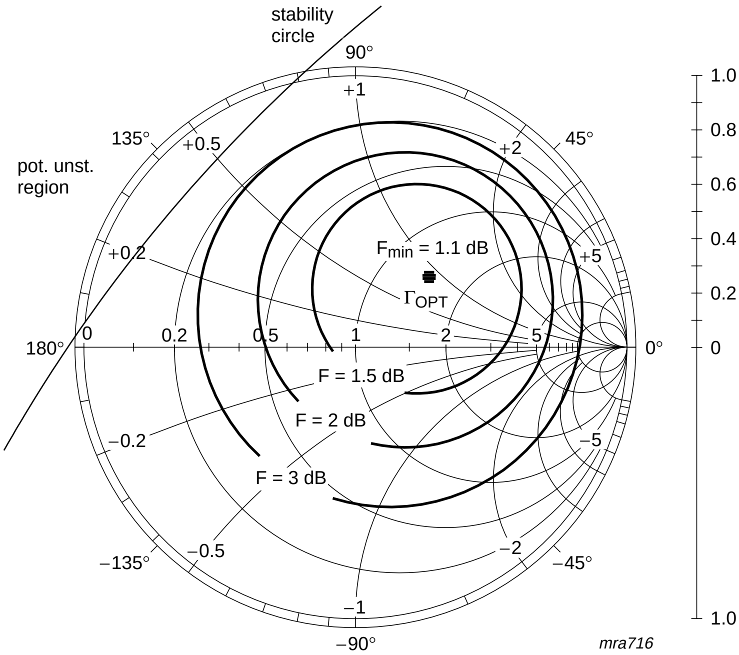

$V_{CE}$ = 6 V.

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



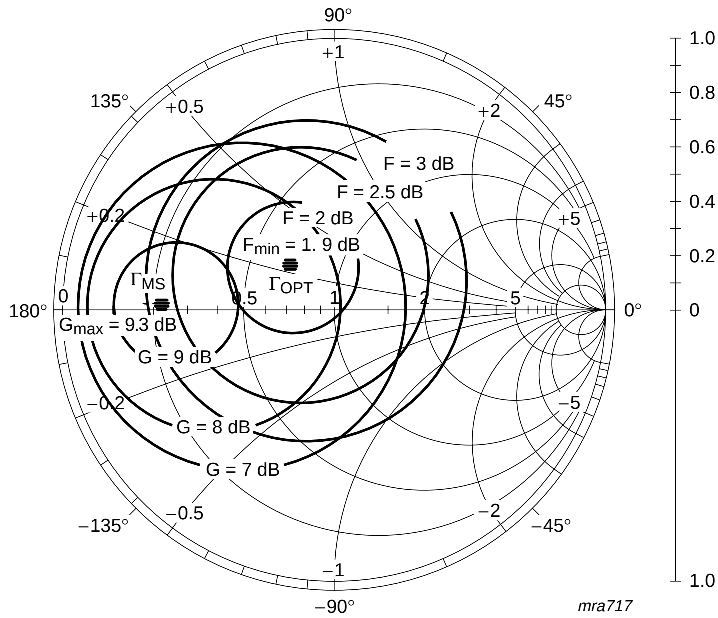

$V_{CE}$ = 6 V.

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



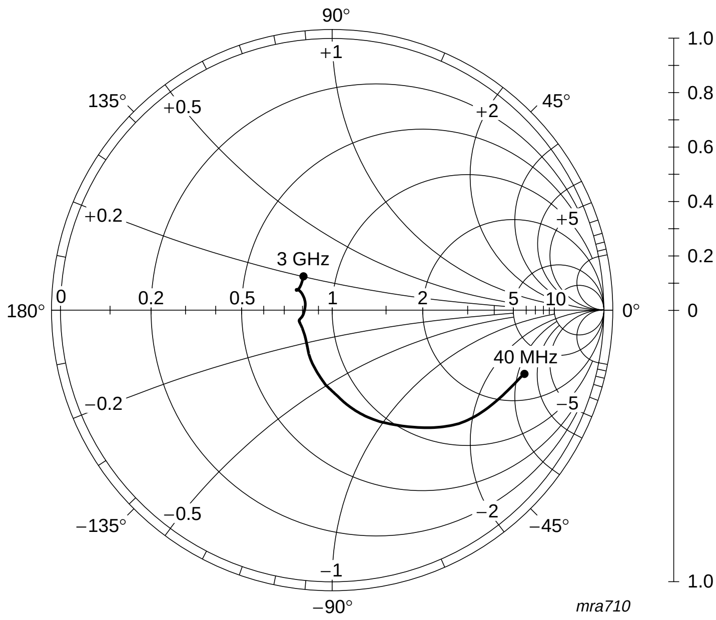

$Z_o$ = 50 Ω; $V_{CE}$ = 6 V; $I_C$ = 5 mA; f = 900 MHz.

**Fig 11. Noise circle figure; f = 900 MHz.**



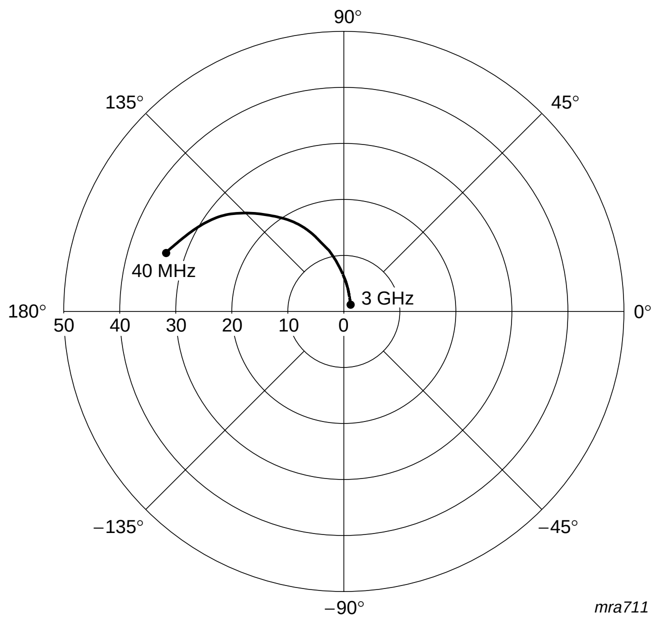

$Z_o$ = 50 Ω; $V_{CE}$ = 6 V; $I_C$ = 5 mA; f = 2000 MHz.

**Fig 12. Noise circle figure; f = 2000 MHz.**



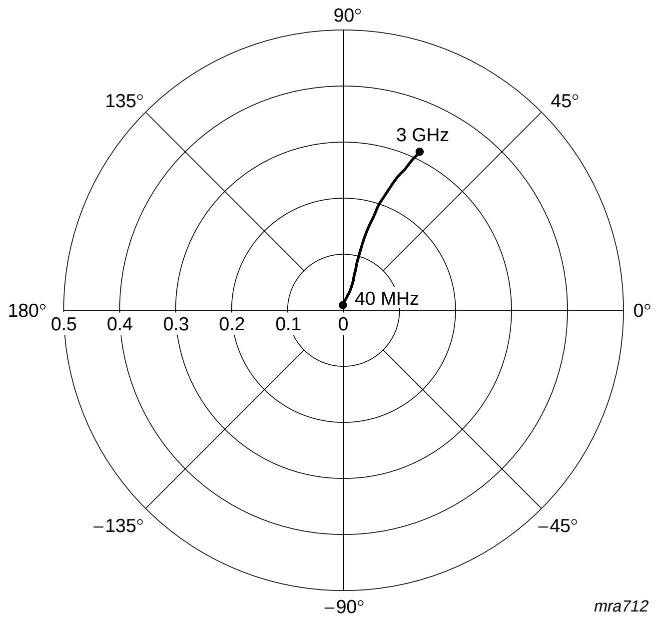

$V_{CE}$ = 6 V; $I_C$ = 20 mA; $Z_o$ = 50 Ω.

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



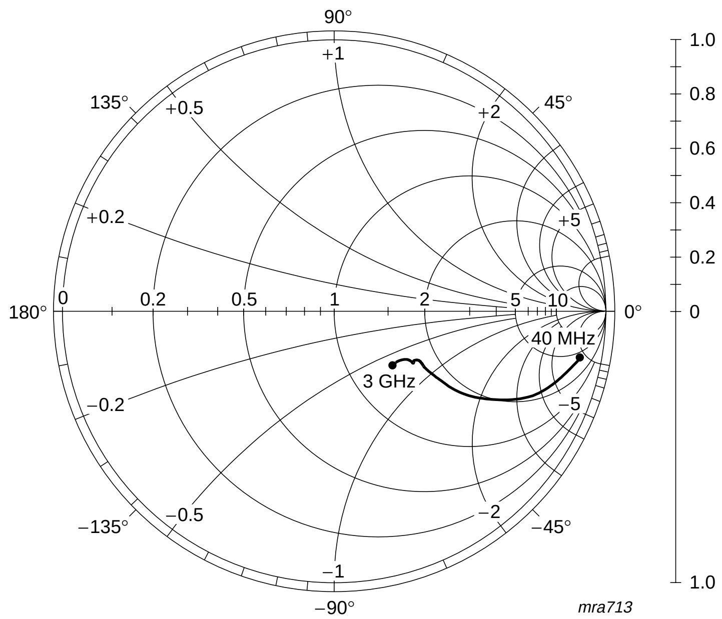

$V_{CE}$ = 6 V; $I_C$ = 20 mA.

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




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

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

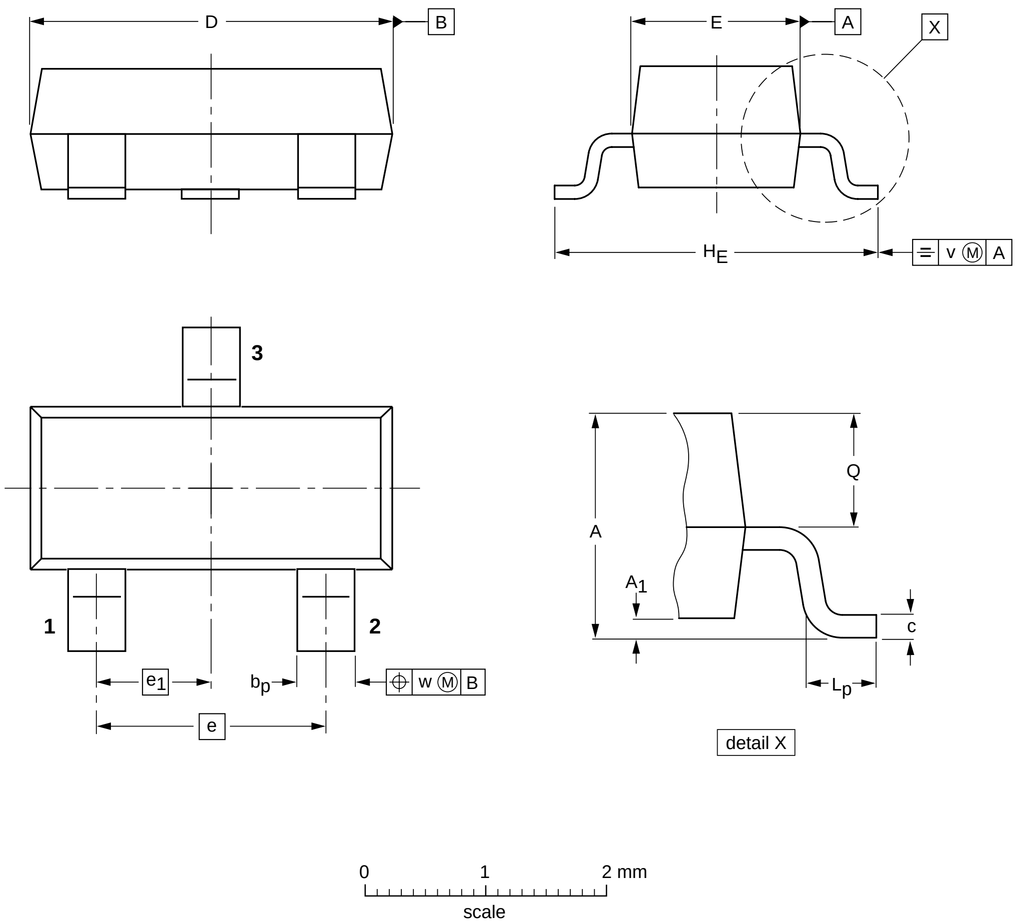



$V_{CE}$ = 6 V; $I_C$ = 20 mA; $Z_o$ = 50 Ω.

**Fig 16. 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<br>0.9 | 0.1 | 0.48<br>0.38 | 0.15<br>0.09 | 3.0<br>2.8 | 1.4<br>1.2 | 1.9 | 0.95 | 2.5<br>2.1 | 0.45<br>0.15 | 0.55<br>0.45 | 0.2 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT23 | | TO-236AB | | | | ~~97-02-28~~<br>99-09-13 |

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

## 9. Revision history

Table 8: Revision history

| Document ID | Release date | Data sheet status | Change notice | Doc. number | Supersedes |
|---|---|---|---|---|---|
| BFR520_3 | 20040901 | Product data sheet | - | 9397 750 13397 | BFR520_CNV_2 |
| Modifications: | • The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors.<br>• Table 4 “Marking”: Format of marking code changed. | | | | |
| BFR520_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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[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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For sales office addresses, send an email to: **sales.addresses@www.semiconductors.philips.com**

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