

# DATA SHEET

**BFR505**

**NPN 9 GHz wideband transistor**

Product specification  
File under Discrete Semiconductors, SC14

September 1995

NPN 9 GHz wideband transistor

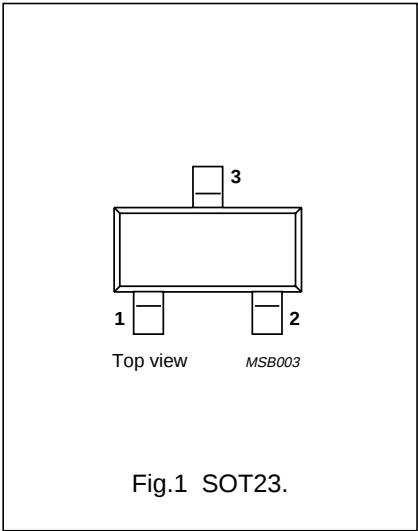
BFR505

FEATURES

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

PINNING

| PIN       | DESCRIPTION |
|-----------|-------------|
| Code: N30 |             |
| 1         | base        |
| 2         | emitter     |
| 3         | collector   |



DESCRIPTION

The BFR505 is an npn silicon planar epitaxial transistor, intended for applications in the RF frontend in wideband applications in the GHz range, such as analog and digital cellular telephones, cordless telephones (CT1, CT2, DECT, etc.), radar detectors, pagers and satellite TV tuners (SATV).

The transistor is encapsulated in a plastic SOT23 envelope.

QUICK REFERENCE DATA

| SYMBOL       | PARAMETER                     | CONDITIONS                                                                                                                                 | MIN. | TYP. | MAX. | UNIT |
|--------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $V_{CBO}$    | collector-base voltage        | open emitter                                                                                                                               | —    | —    | 20   | V    |
| $V_{CES}$    | collector-emitter voltage     | $R_{BE} = 0$                                                                                                                               | —    | —    | 15   | V    |
| $I_C$        | DC collector current          |                                                                                                                                            | —    | —    | 18   | mA   |
| $P_{tot}$    | total power dissipation       | up to $T_s = 135\text{ }^{\circ}\text{C}$ ; note 1                                                                                         | —    | —    | 150  | mW   |
| $h_{FE}$     | DC current gain               | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$                                                                                                | 60   | 120  | 250  |      |
| $C_{re}$     | feedback capacitance          | $I_C = i_c = 0$ ; $V_{CB} = 6\text{ V}$ ; $f = 1\text{ MHz}$                                                                               | —    | 0.3  | —    | pF   |
| $f_T$        | transition frequency          | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 1\text{ GHz}$                                                                           | —    | 9    | —    | GHz  |
| $G_{UM}$     | maximum unilateral power gain | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$                                | —    | 17   | —    | dB   |
|              |                               | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 2\text{ GHz}$                                  | —    | 10   | —    | dB   |
| $ S_{21} ^2$ | insertion power gain          | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$                                | 13   | 14   | —    | dB   |
| F            | noise figure                  | $\Gamma_s = \Gamma_{opt}$ ; $I_C = 1.25\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$ | —    | 1.2  | 1.7  | dB   |
|              |                               | $\Gamma_s = \Gamma_{opt}$ ; $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$    | —    | 1.6  | 2.1  | dB   |
|              |                               | $\Gamma_s = \Gamma_{opt}$ ; $I_C = 1.25\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 2\text{ GHz}$   | —    | 1.9  | —    | dB   |

Note

1.  $T_s$  is the temperature at the soldering point of the collector tab.

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**LIMITING VALUES**

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL    | PARAMETER                 | CONDITIONS                           | MIN. | MAX. | UNIT |
|-----------|---------------------------|--------------------------------------|------|------|------|
| $V_{CBO}$ | collector-base voltage    | open emitter                         | –    | 20   | V    |
| $V_{CES}$ | collector-emitter voltage | $R_{BE} = 0$                         | –    | 15   | V    |
| $V_{EBO}$ | emitter-base voltage      |                                      | –    | 2.5  | V    |
| $I_C$     | DC collector current      | continuous                           | –    | 18   | mA   |
| $P_{tot}$ | total power dissipation   | up to $T_s = 135\text{ °C}$ ; note 1 | –    | 150  | mW   |
| $T_{stg}$ | storage temperature       |                                      | –65  | 150  | °C   |
| $T_j$     | junction temperature      |                                      | –    | 175  | °C   |

**THERMAL RESISTANCE**

| SYMBOL        | PARAMETER                                 | THERMAL RESISTANCE |
|---------------|-------------------------------------------|--------------------|
| $R_{th\ j-s}$ | from junction to soldering point (note 1) | 260 K/W            |

**Note**

1.  $T_s$  is the temperature at the soldering point of the collector tab.

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## CHARACTERISTICS

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

| SYMBOL       | PARAMETER                              | CONDITIONS                                                                                                                                 | MIN. | TYP. | MAX. | UNIT |
|--------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{CBO}$    | collector cut-off current              | $I_E = 0$ ; $V_{CB} = 6\text{ V}$                                                                                                          | –    | –    | 50   | nA   |
| $h_{FE}$     | DC current gain                        | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$                                                                                                | 60   | 120  | 250  |      |
| $C_e$        | emitter capacitance                    | $I_C = I_{C0}$ ; $V_{EB} = 0.5\text{ V}$ ; $f = 1\text{ MHz}$                                                                              | –    | 0.4  | –    | pF   |
| $C_c$        | collector capacitance                  | $I_E = I_{E0}$ ; $V_{CB} = 6\text{ V}$ ; $f = 1\text{ MHz}$                                                                                | –    | 0.4  | –    | pF   |
| $C_{re}$     | feedback capacitance                   | $I_C = 0$ ; $V_{CB} = 6\text{ V}$ ; $f = 1\text{ MHz}$                                                                                     | –    | 0.3  | –    | pF   |
| $f_T$        | transition frequency                   | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 1\text{ GHz}$                                                                           | –    | 9    | –    | GHz  |
| $G_{UM}$     | maximum unilateral power gain (note 1) | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$                             | –    | 17   | –    | dB   |
|              |                                        | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 2\text{ GHz}$                               | –    | 10   | –    | dB   |
| $ S_{21} ^2$ | insertion power gain                   | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$                             | 13   | 14   | –    | dB   |
| F            | noise figure                           | $\Gamma_S = \Gamma_{opt}$ ; $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$ | –    | 1.2  | 1.7  | dB   |
|              |                                        | $\Gamma_S = \Gamma_{opt}$ ; $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$ | –    | 1.6  | 2.1  | dB   |
|              |                                        | $\Gamma_S = \Gamma_{opt}$ ; $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 2\text{ GHz}$   | –    | 1.9  | –    | dB   |
| $P_{L1}$     | output power at 1 dB gain compression  | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $R_L = 50\text{ }\Omega$ ;<br>$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; $f = 900\text{ MHz}$  | –    | 4    | –    | dBm  |
| ITO          | third order intercept point            | note 2                                                                                                                                     | –    | 10   | –    | dBm  |

## Notes

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

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

2.  $I_C = 5\text{ mA}$ ;  $V_{CE} = 6\text{ V}$ ;  $R_L = 50\text{ }\Omega$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  
 $f_p = 900\text{ MHz}$ ;  $f_q = 902\text{ MHz}$ ;  
 measured at  $f_{(2p-q)} = 898\text{ MHz}$  and  $f_{(2q-p)} = 904\text{ MHz}$ .

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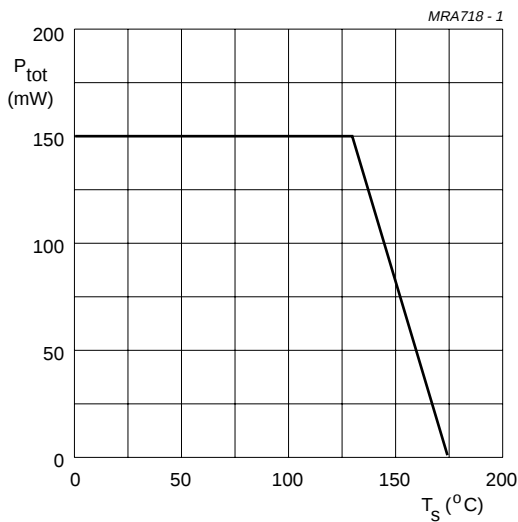
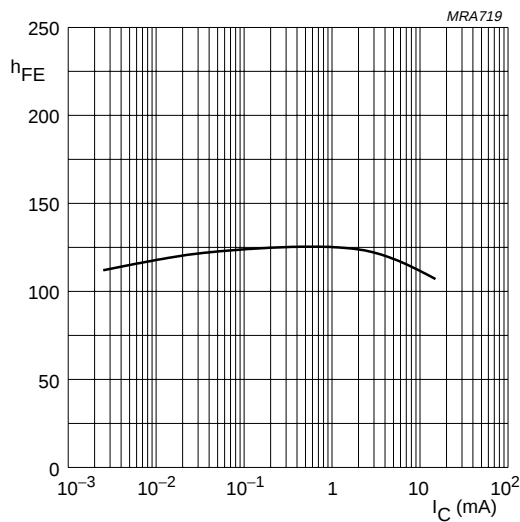
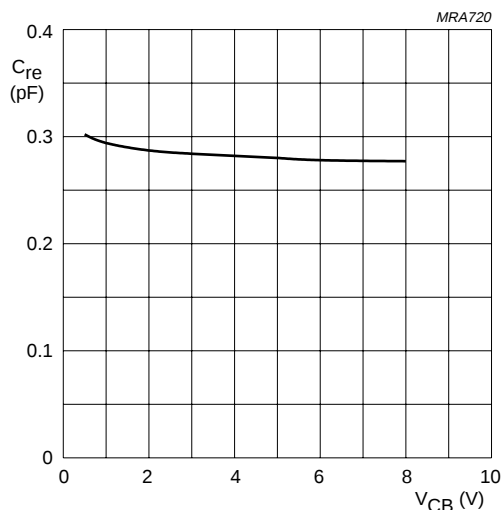


Fig.2 Power derating curve.



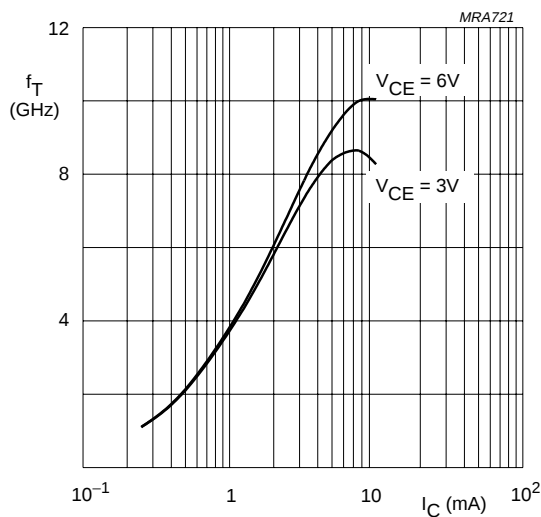
$V_{CE} = 6\text{ V}$ .

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



$I_c = 0$ ;  $f = 1\text{ MHz}$ .

Fig.4 Feedback capacitance as a function of collector-base voltage.

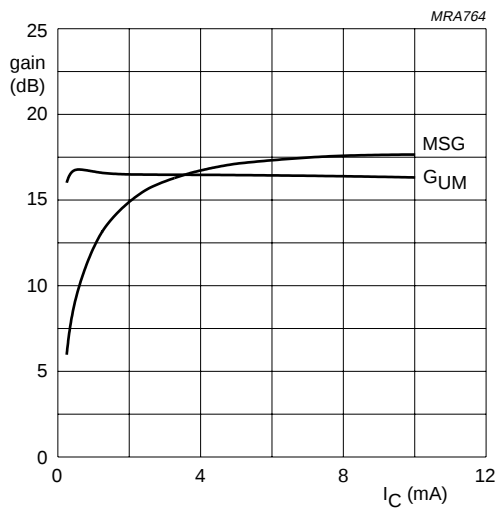


$T_{amb} = 25\text{ °C}$ ;  $f = 1\text{ GHz}$ .

Fig.5 Transition frequency as a function of collector current.

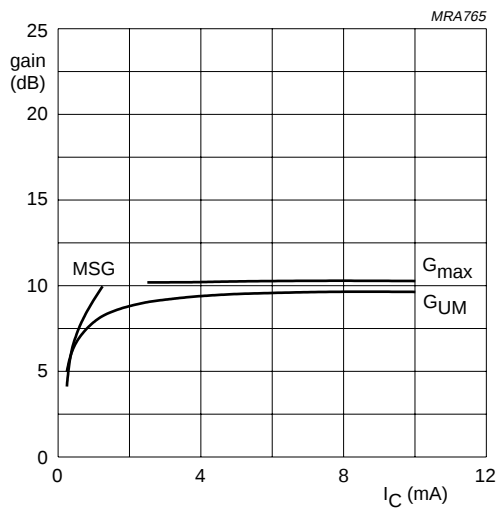
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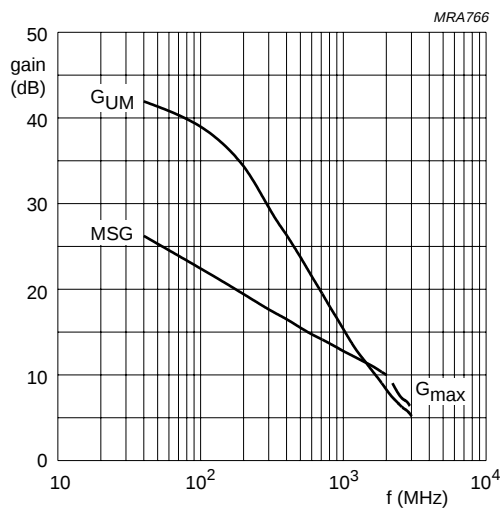
$V_{CE} = 6\text{ V}$ ;  $f = 900\text{ MHz}$ .

Fig.6 Gain as a function of collector current.



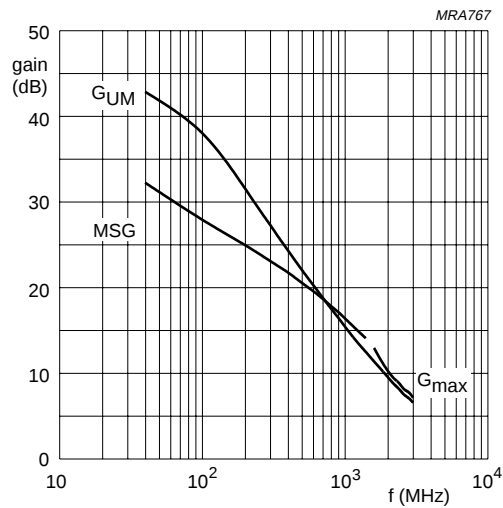
$V_{CE} = 6\text{ V}$ ;  $f = 2\text{ GHz}$ .

Fig.7 Gain as a function of collector current.



$V_{CE} = 6\text{ V}$ ;  $I_C = 1.25\text{ mA}$ .

Fig.8 Gain as a function of frequency.

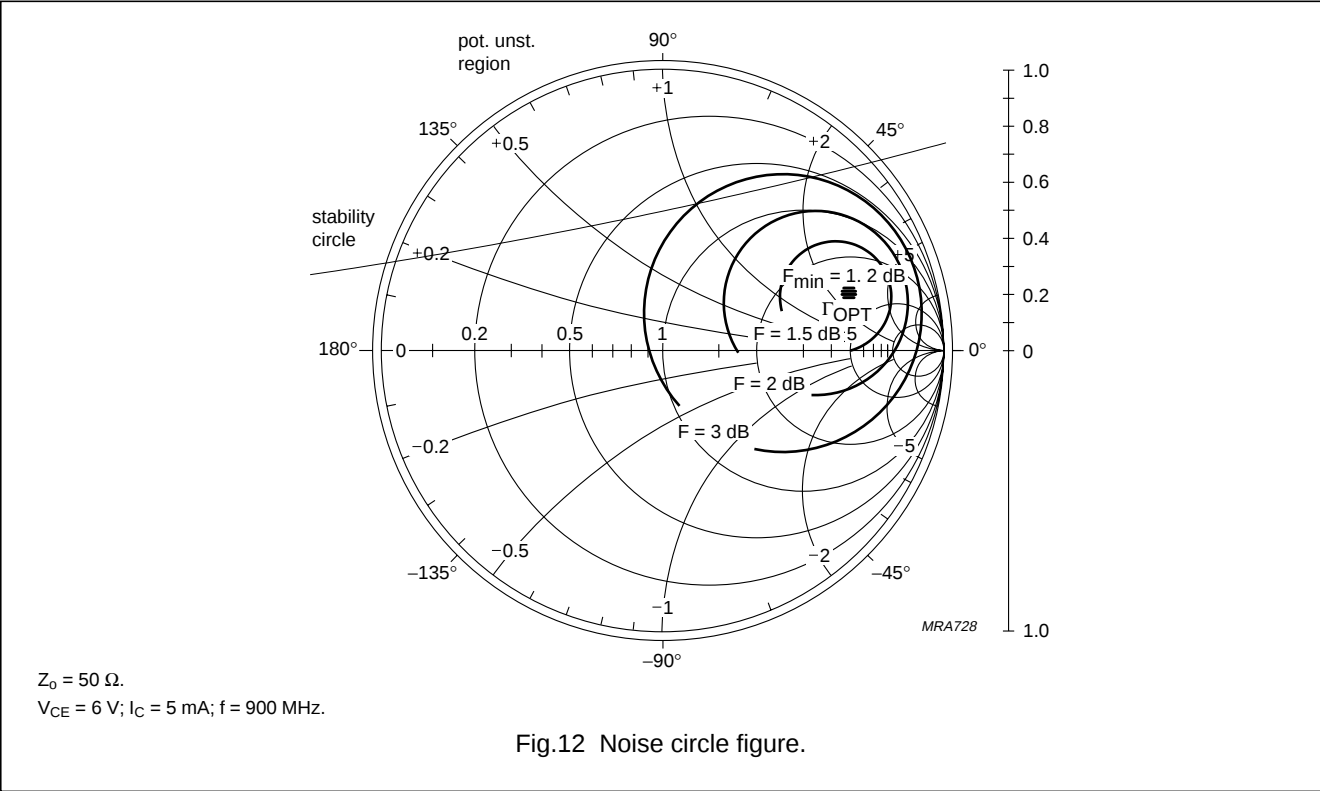
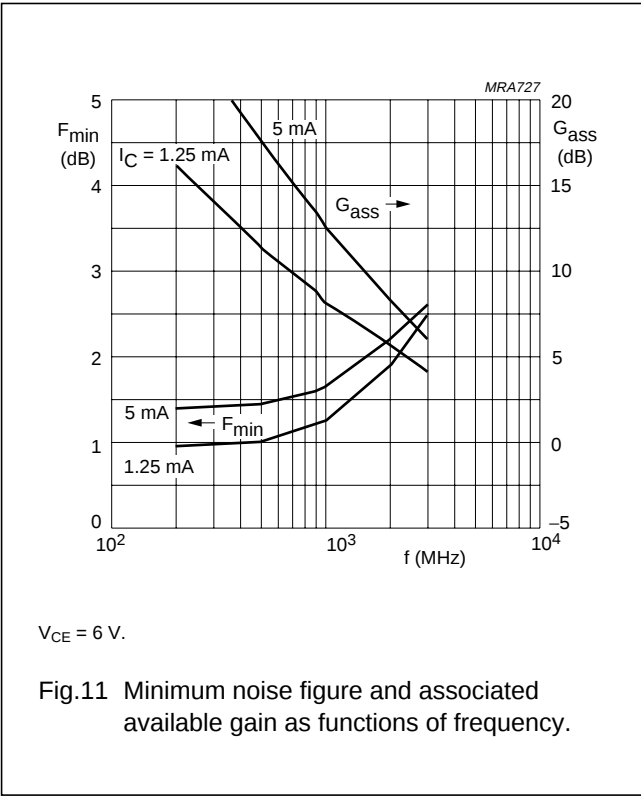
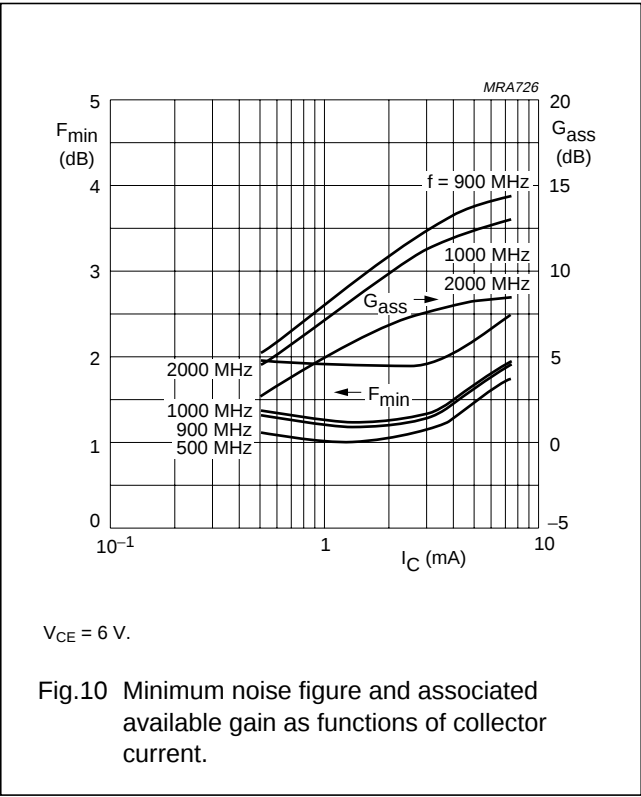


$V_{CE} = 6\text{ V}$ ;  $I_C = 5\text{ mA}$ .

Fig.9 Gain as a function of frequency.

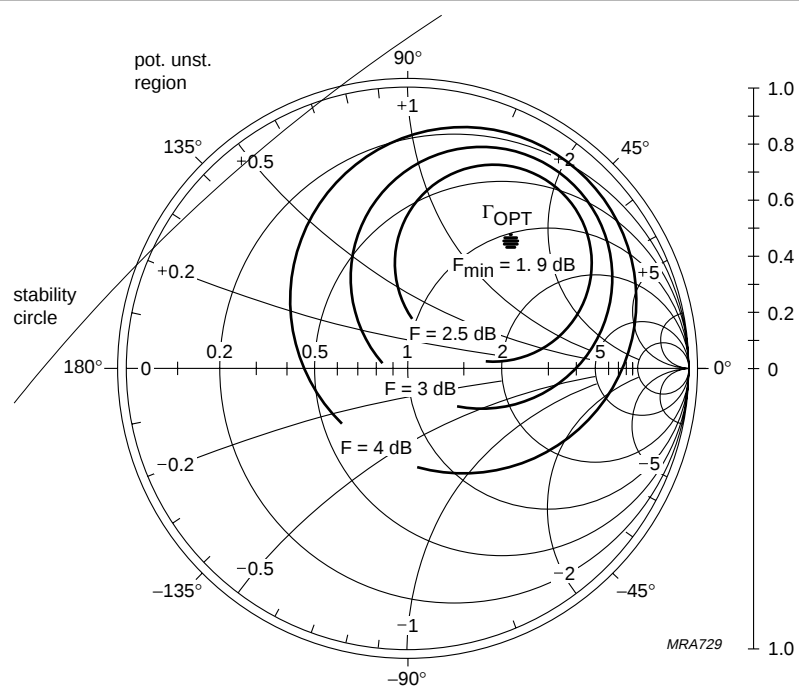
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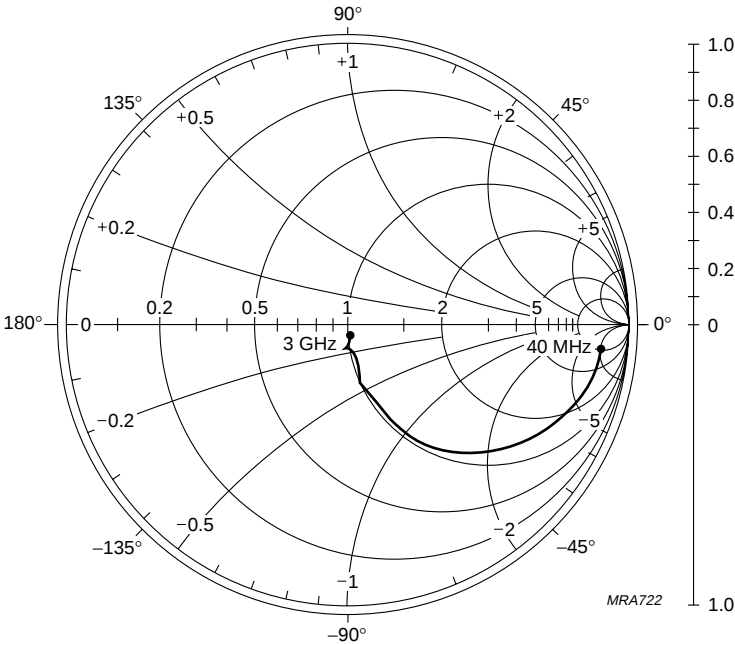
$Z_0 = 50 \Omega$ .

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

Fig.13 Noise circle figure.

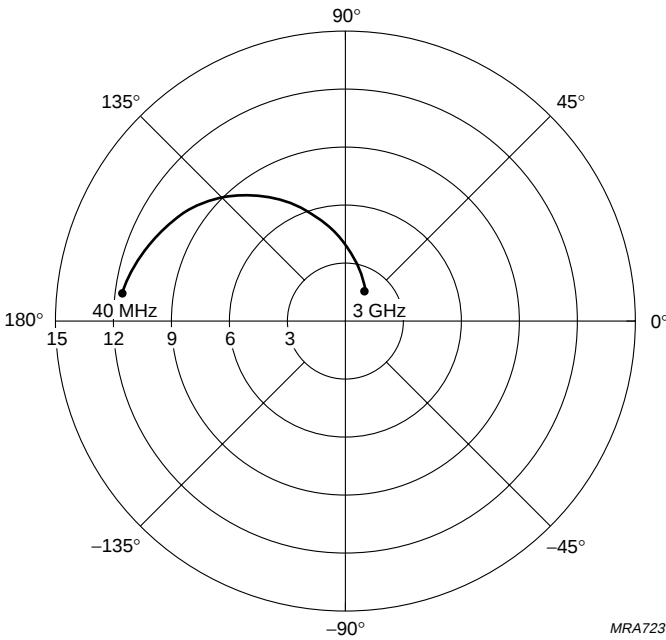
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$V_{CE} = 6\text{ V}$ ;  $I_C = 5\text{ mA}$ .  
 $Z_0 = 50\ \Omega$ .

Fig.14 Common emitter input reflection coefficient ( $S_{11}$ ).

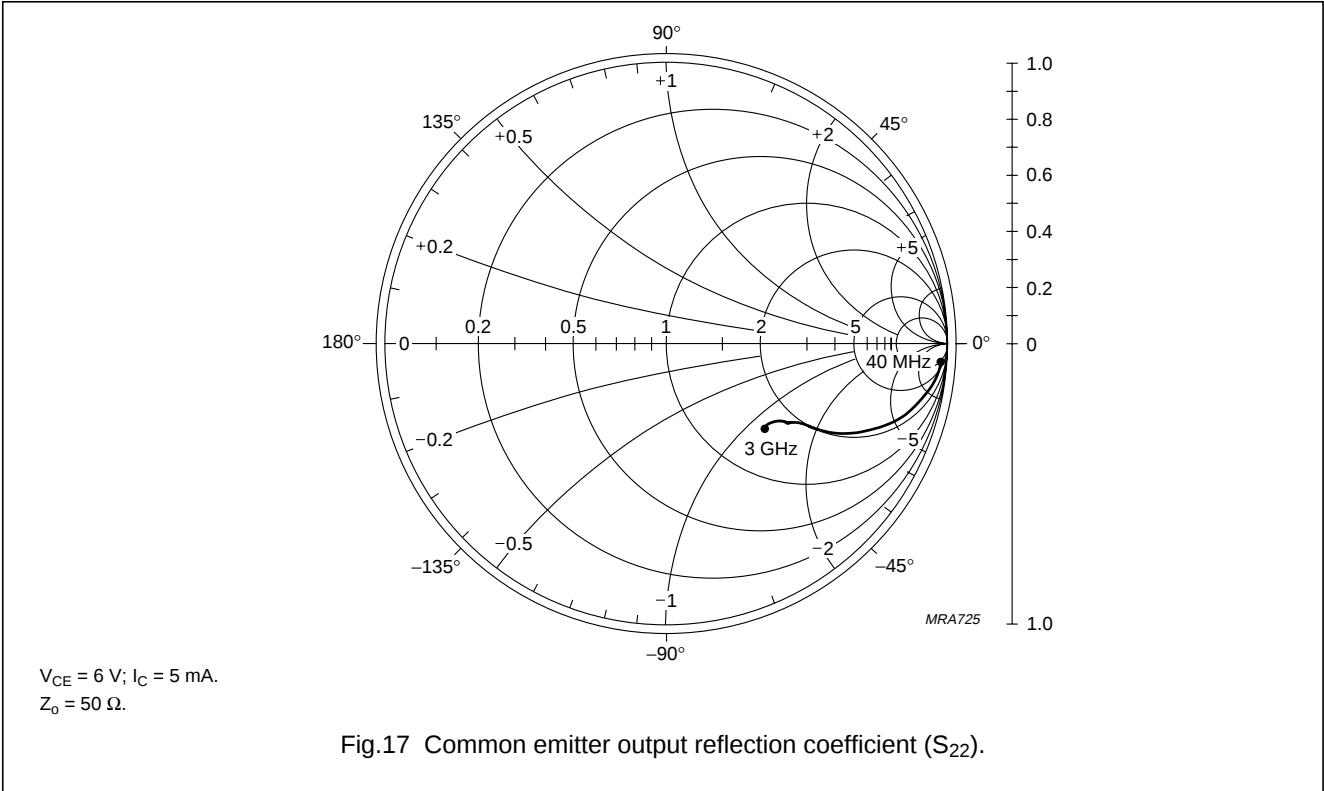
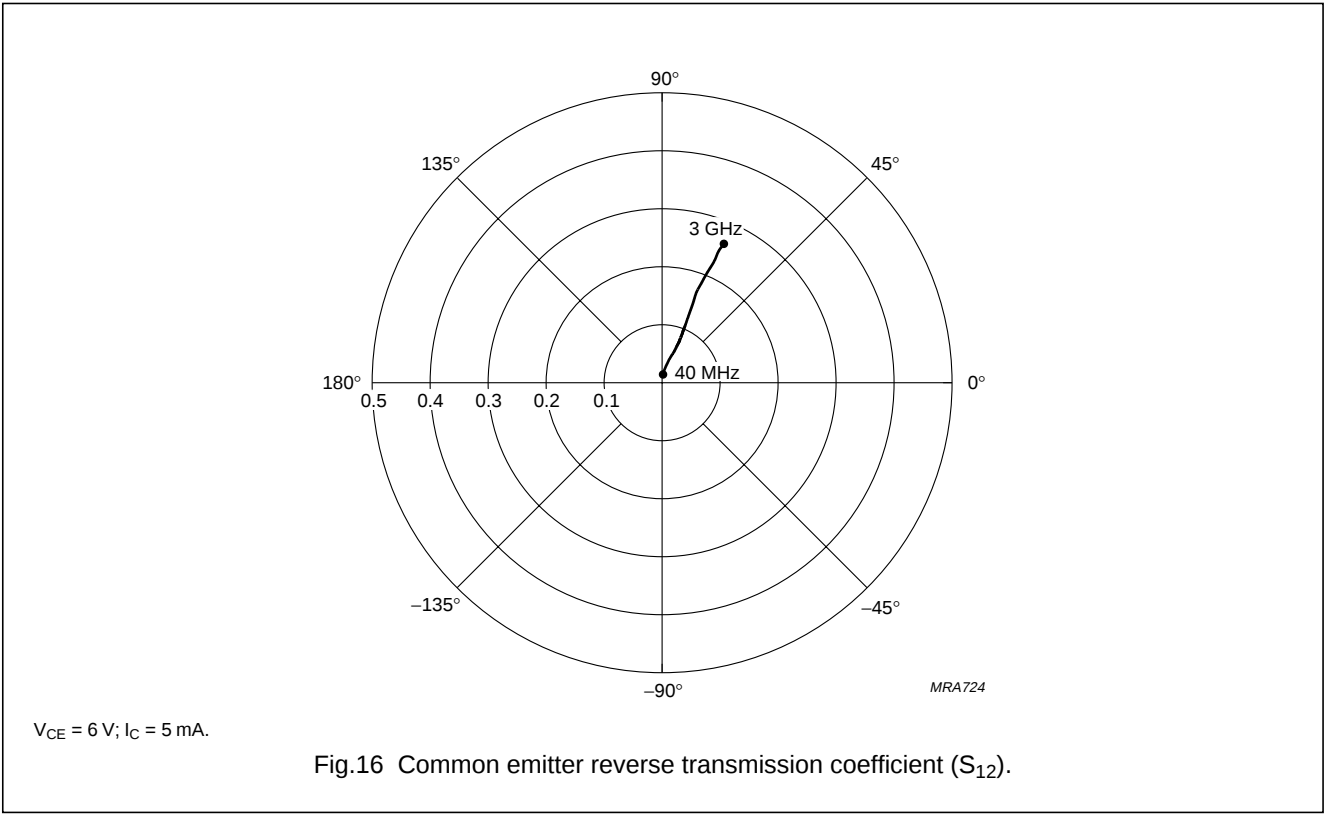


$V_{CE} = 6\text{ V}$ ;  $I_C = 5\text{ mA}$ .

Fig.15 Common emitter forward transmission coefficient ( $S_{21}$ ).

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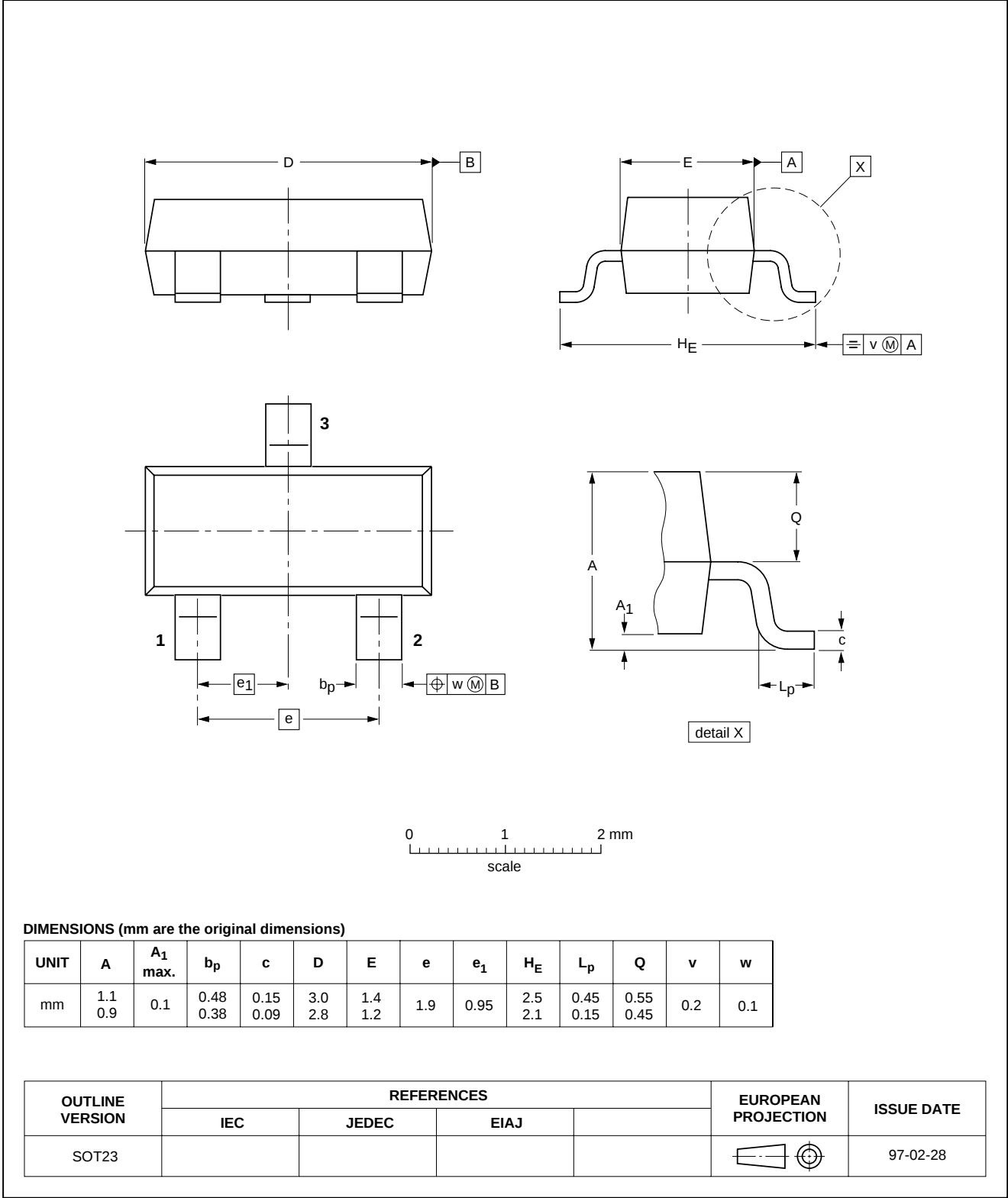
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PACKAGE OUTLINE

Plastic surface mounted package; 3 leads

SOT23



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**DEFINITIONS**

| <b>Data Sheet Status</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Objective specification                                                                                                                                                                                                                                                                                                                                                                                                                                   | This data sheet contains target or goal specifications for product development.       |
| Preliminary specification                                                                                                                                                                                                                                                                                                                                                                                                                                 | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification                                                                                                                                                                                                                                                                                                                                                                                                                                     | This data sheet contains final product specifications.                                |
| <b>Limiting values</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                       |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). 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. |                                                                                       |
| <b>Application information</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                       |
| Where application information is given, it is advisory and does not form part of the specification.                                                                                                                                                                                                                                                                                                                                                       |                                                                                       |

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