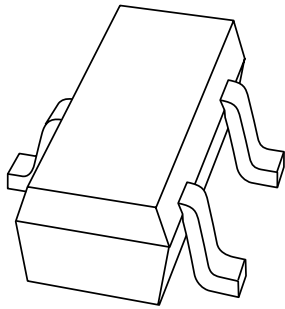


# DATA SHEET



**BFR505T**

**NPN 9 GHz wideband transistor**

Product specification  
Supersedes data of 2000 Mar 14

2000 May 17

## NPN 9 GHz wideband transistor

## BFR505T

## FEATURES

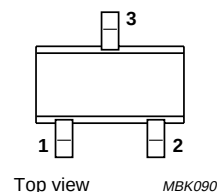
- Low current consumption
- High power gain
- Low noise figure
- High transition frequency
- Gold metallization ensures excellent reliability
- SOT416 (SC-75) package.

## DESCRIPTION

NPN transistor in a plastic SOT416 (SC-75) package.

## PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | base        |
| 2   | emitter     |
| 3   | collector   |



Marking code: N0.

Fig.1 SOT416.

## APPLICATIONS

Low power amplifiers, oscillators and mixers particularly in RF portable communication equipment (cellular phones, cordless phones and pagers) up to 2 GHz.

## 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       | $T_s \leq 75\text{ °C}$ ; note 1                                                                 | –    | –    | 150  | mW   |
| $h_{FE}$  | DC current gain               | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_j = 25\text{ °C}$                               | 60   | 120  | 250  |      |
| $f_T$     | transition frequency          | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$      | –    | 9    | –    | GHz  |
| $G_{UM}$  | maximum unilateral power gain | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$    | –    | 17   | –    | dB   |
| F         | noise figure                  | $I_C = 1.25\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$ | –    | 1.2  | 1.7  | dB   |

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 60134).

| SYMBOL    | PARAMETER                 | CONDITIONS                       | MIN. | MAX. | UNIT |
|-----------|---------------------------|----------------------------------|------|------|------|
| $V_{CBO}$ | collector-base voltage    | open emitter                     | –    | 20   | V    |
| $V_{CE}$  | collector-emitter voltage | $R_{BE} = 0$                     | –    | 15   | V    |
| $V_{EBO}$ | emitter-base voltage      | open collector                   | –    | 2.5  | V    |
| $I_C$     | DC collector current      |                                  | –    | 18   | mA   |
| $P_{tot}$ | total power dissipation   | $T_s \leq 75\text{ °C}$ ; note 1 | –    | 150  | mW   |
| $T_{stg}$ | storage temperature       |                                  | –65  | +150 | °C   |
| $T_j$     | junction temperature      |                                  | –    | 150  | °C   |

## Note

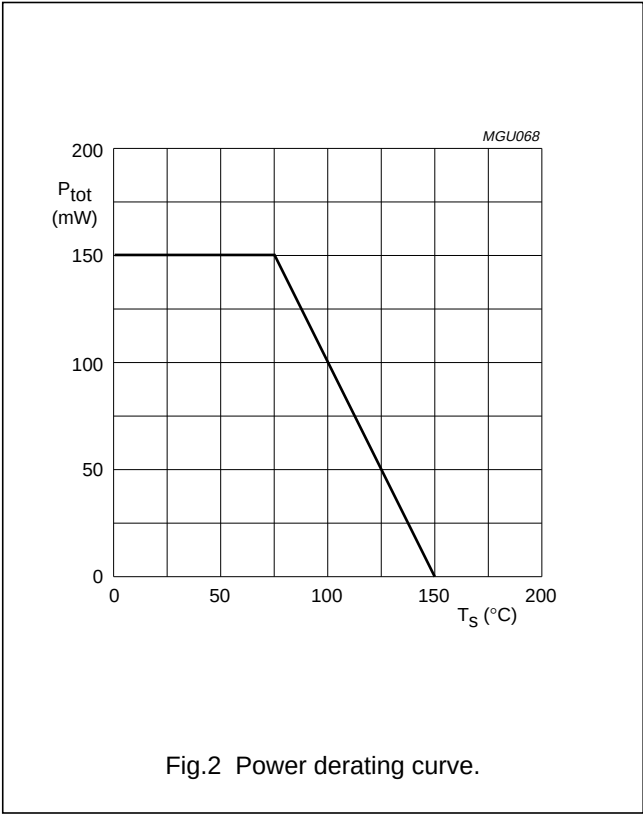
1.  $T_s$  is the temperature at the soldering point of the collector pin.

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THERMAL RESISTANCE

| SYMBOL        | PARAMETER                                           | VALUE | UNIT |
|---------------|-----------------------------------------------------|-------|------|
| $R_{th\,j-s}$ | thermal resistance from junction to soldering point | 500   | K/W  |



## NPN 9 GHz wideband transistor

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## CHARACTERISTICS

$T_j = 25\text{ °C}$ ; 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  |      |
| $C_c$        | collector capacitance                 | $I_E = I_e = 0$ ; $V_{CB} = 6\text{ V}$ ; $f = 1\text{ MHz}$                                                                 | –    | 0.4  | –    | pF   |
| $C_e$        | emitter capacitance                   | $I_C = I_c = 0$ ; $V_{EB} = 0.5\text{ V}$ ; $f = 1\text{ MHz}$                                                               | –    | 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                  | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$                                  | –    | 9    | –    | GHz  |
| $G_{UM}$     | maximum unilateral power gain; note 1 | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $T_{amb} = 25\text{ °C}$ ; $f = 900\text{ MHz}$                                | –    | 17   | –    | dB   |
|              |                                       | $f = 2\text{ GHz}$                                                                                                           | –    | 10   | –    | dB   |
| $ S_{21} ^2$ | insertion power gain                  | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$                                | 13   | 14   | –    | dB   |
| F            | noise figure                          | $\Gamma_s = \Gamma_{opt}$ ; $I_C = 1.25\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$ | –    | 1.2  | 1.7  | dB   |
|              |                                       | $\Gamma_s = \Gamma_{opt}$ ; $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$    | –    | 1.6  | 2.1  | dB   |
|              |                                       | $\Gamma_s = \Gamma_{opt}$ ; $I_C = 1.25\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$   | –    | 1.9  | –    | dB   |
| $P_{L1}$     | output power at 1 dB gain compression | $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $R_L = 50\text{ }\Omega$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$     | –    | 4    | –    | dBm  |
| ITO          | third-order intercept point           | note 2                                                                                                                       | –    | 10   | –    | dBm  |

## Notes

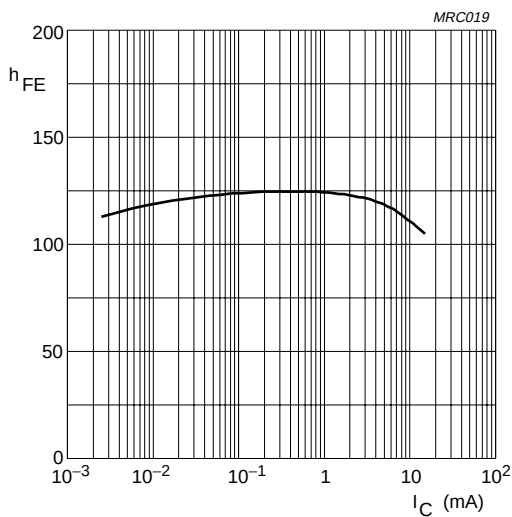
1.  $G_{UM}$  is the maximum unilateral power gain, assuming  $S_{12}$  is zero and

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

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

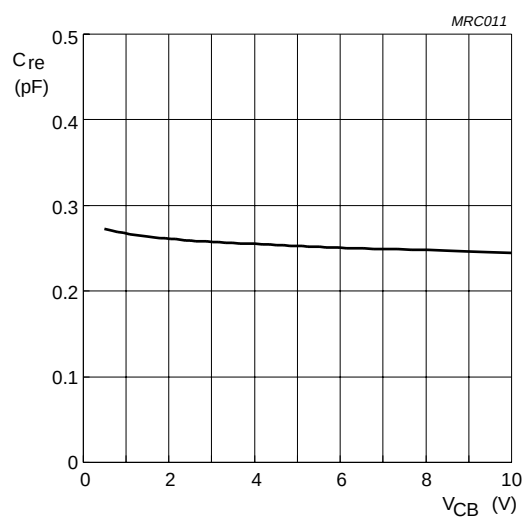
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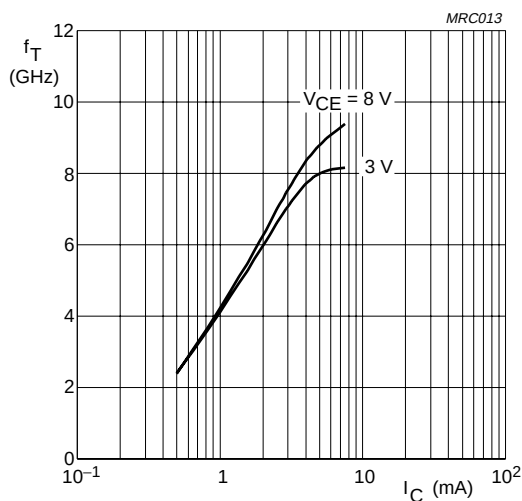
$V_{CE} = 6\text{ V}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ .

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.



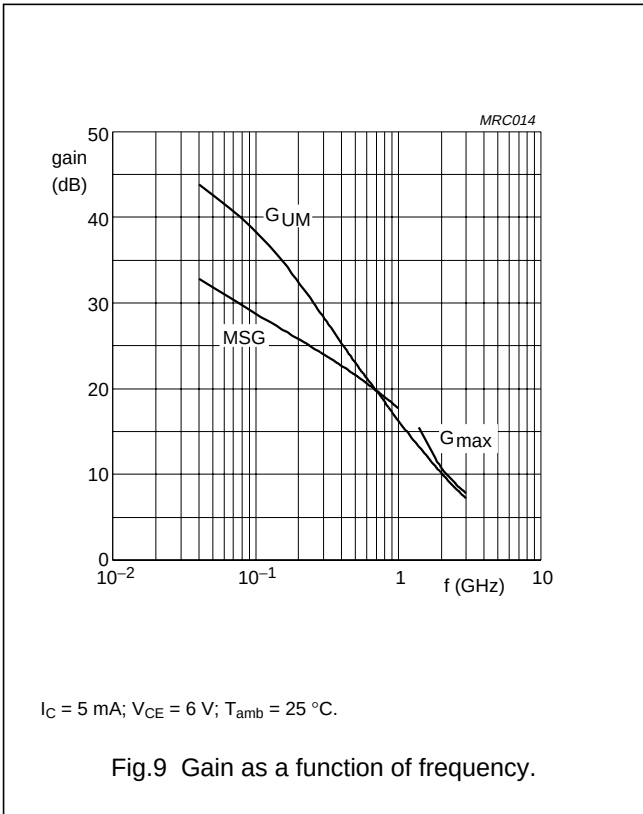
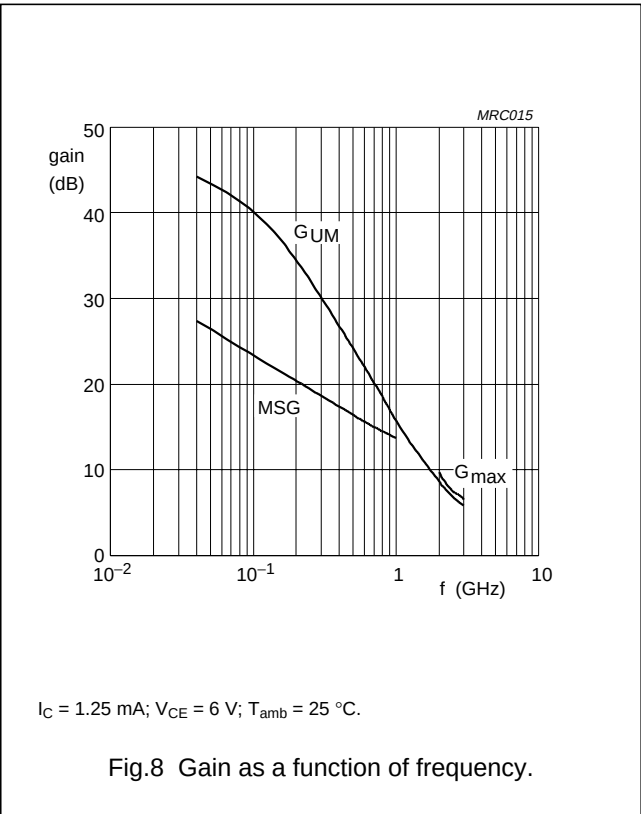
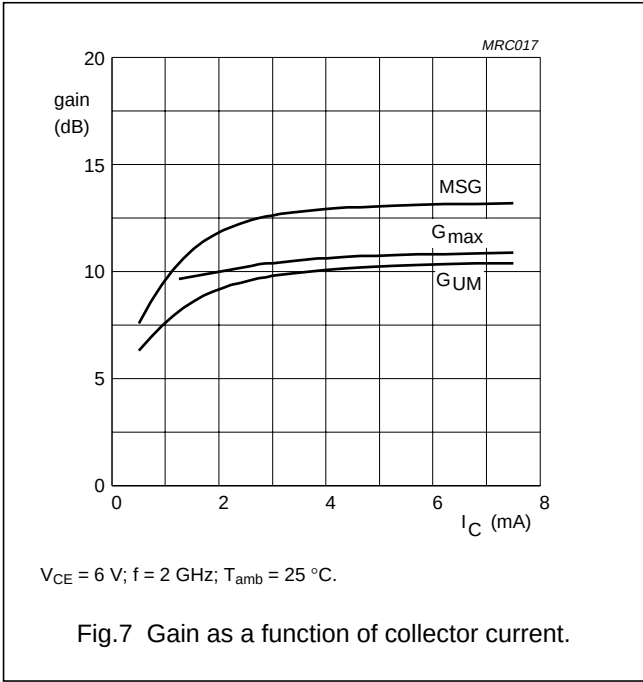
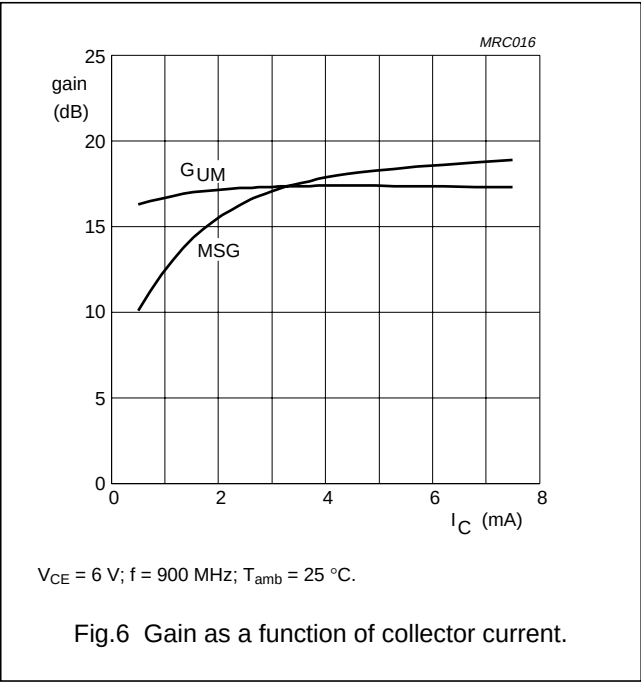
$f = 1\text{ GHz}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

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

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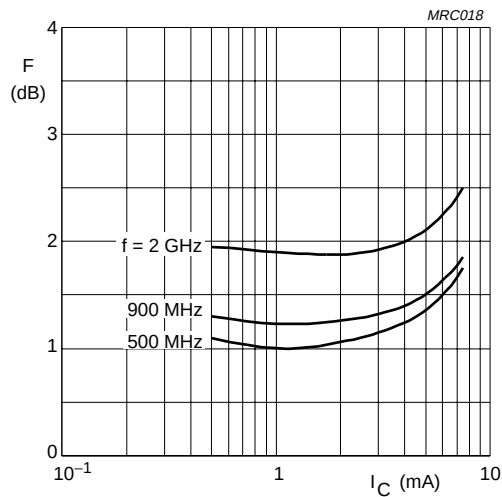
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In Figs 6 to 9,  $G_{UM}$  = maximum unilateral power gain;  
MSG = maximum stable gain;  $G_{max}$  = maximum available gain.



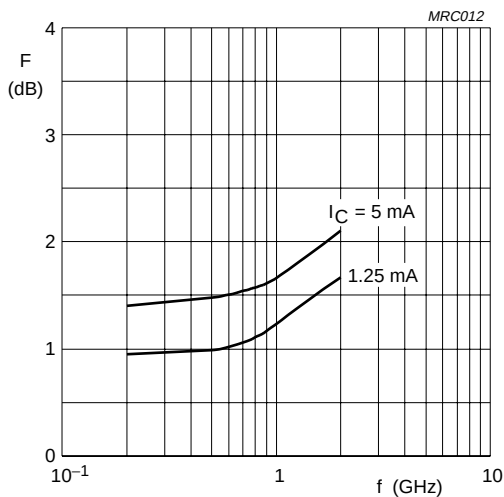
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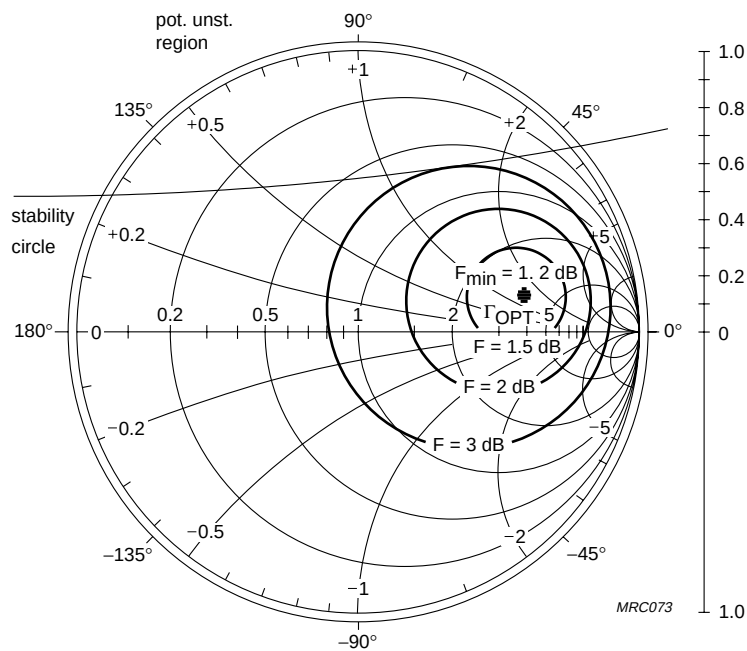
$V_{CE} = 6\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig.10 Minimum noise figure as a function of collector current.



$V_{CE} = 6\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig.11 Minimum noise figure as a function of frequency.



$I_C = 1.25\text{ mA}$ ;  $V_{CE} = 6\text{ V}$ ;  
 $f = 900\text{ MHz}$ ;  $Z_0 = 50\text{ }\Omega$ .

Fig.12 Noise circle.

## NPN 9 GHz wideband transistor

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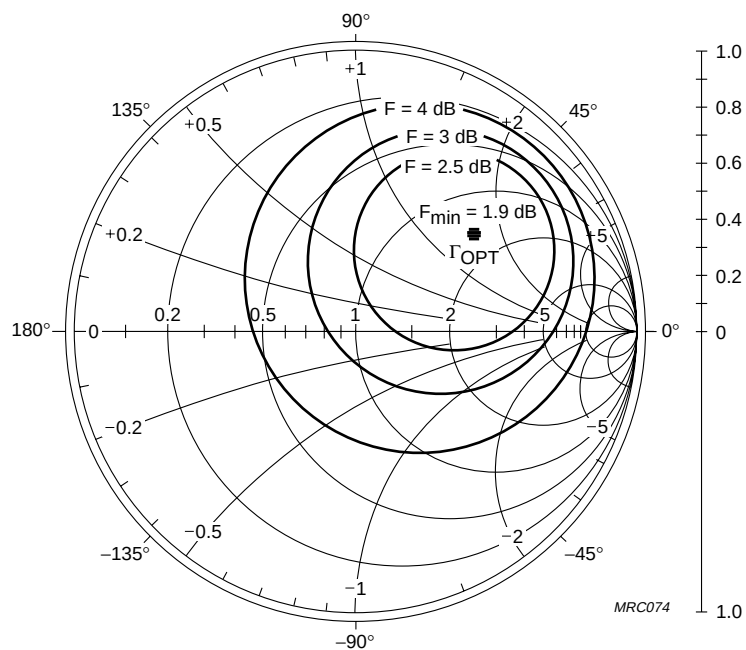
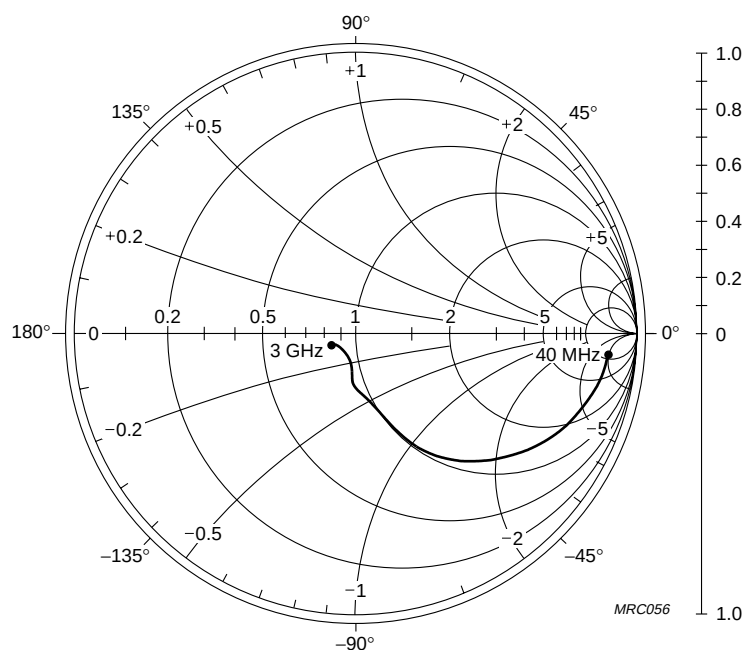


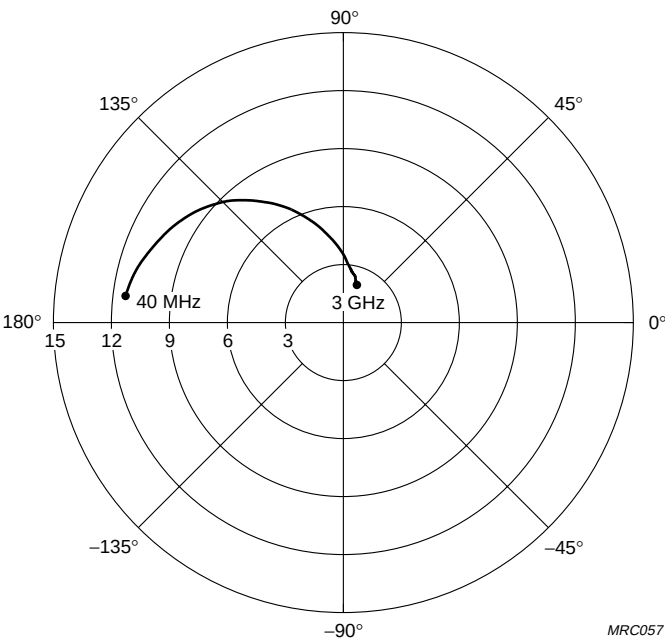
Fig.13 Noise circle.

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



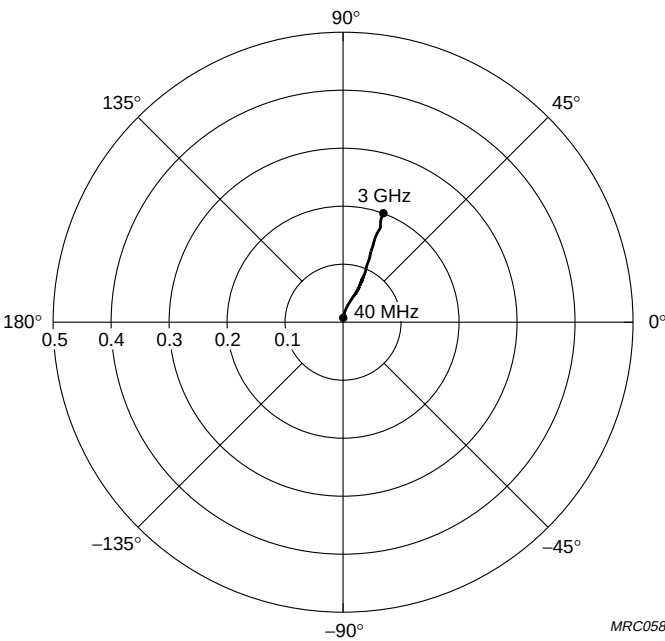
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$I_C = 5\text{ mA}$ ;  $V_{CE} = 6\text{ V}$ .

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

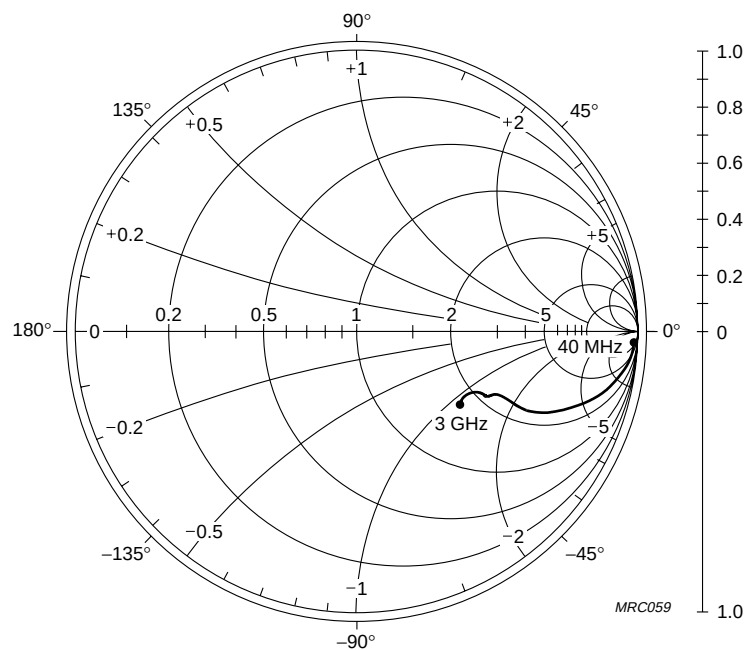


$I_C = 5\text{ mA}$ ;  $V_{CE} = 6\text{ V}$ .

Fig.16 Common emitter reverse transmission coefficient ( $S_{12}$ ).

## NPN 9 GHz wideband transistor

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

Fig.17 Common emitter output reflection coefficient ( $S_{22}$ ).

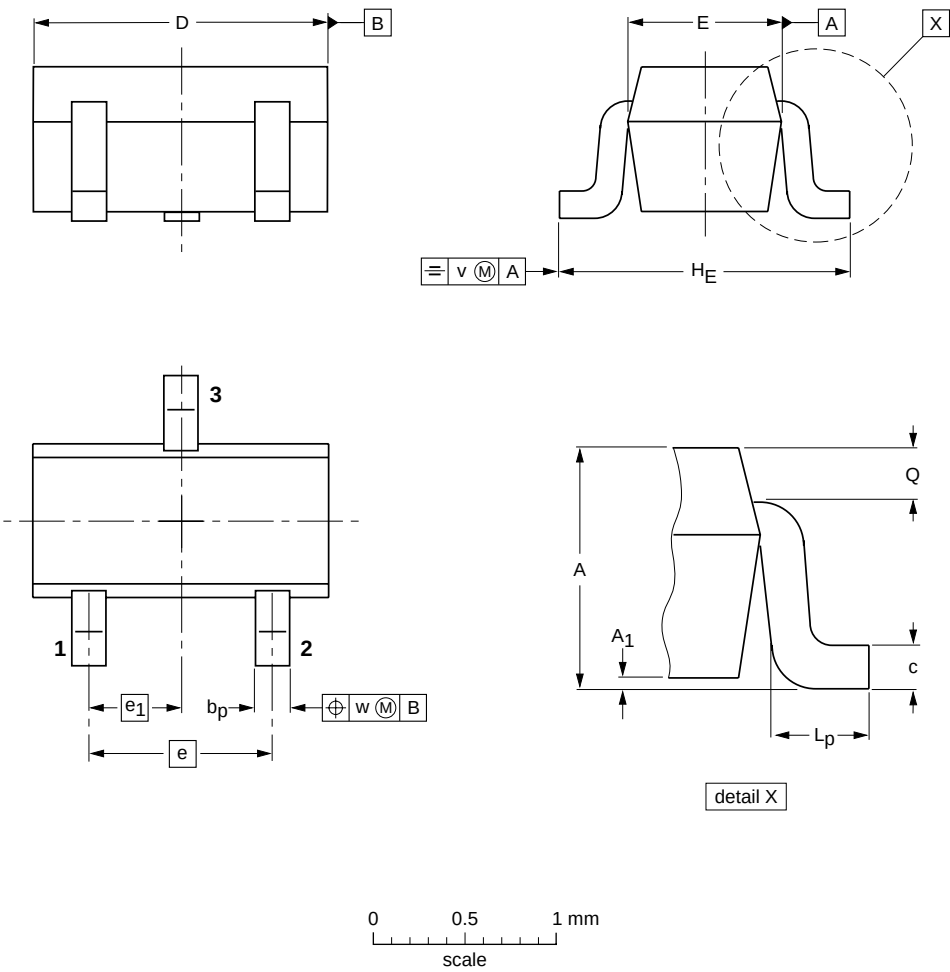
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PACKAGE OUTLINE

Plastic surface mounted package; 3 leads

SOT416



DIMENSIONS (mm are the original dimensions)

| UNIT | A            | A1<br>max | bp           | c            | D          | E          | e | e1  | HE           | Lp           | Q            | v   | w   |
|------|--------------|-----------|--------------|--------------|------------|------------|---|-----|--------------|--------------|--------------|-----|-----|
| mm   | 0.95<br>0.60 | 0.1       | 0.30<br>0.15 | 0.25<br>0.10 | 1.8<br>1.4 | 0.9<br>0.7 | 1 | 0.5 | 1.75<br>1.45 | 0.45<br>0.15 | 0.23<br>0.13 | 0.2 | 0.2 |

| OUTLINE<br>VERSION | REFERENCES |       |       |  | EUROPEAN<br>PROJECTION | ISSUE DATE |
|--------------------|------------|-------|-------|--|------------------------|------------|
|                    | IEC        | JEDEC | EIAJ  |  |                        |            |
| SOT416             |            |       | SC-75 |  |                        | 97-02-28   |

## NPN 9 GHz wideband transistor

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## DATA SHEET STATUS

| DATA SHEET STATUS         | PRODUCT STATUS | DEFINITIONS <sup>(1)</sup>                                                                                                                                                                                                                                 |
|---------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Objective specification   | Development    | This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.                                                                                                          |
| Preliminary specification | Qualification  | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
| Product specification     | Production     | This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.                                                       |

## Note

1. Please consult the most recently issued data sheet before initiating or completing a design.

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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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