

# DATA SHEET

**BFR92A**

**NPN 5 GHz wideband transistor**

Product specification  
Supersedes data of September 1995  
File under discrete semiconductors, SC14

1997 Oct 29

## NPN 5 GHz wideband transistor

## BFR92A

## FEATURES

- High power gain
- Low noise figure
- Low intermodulation distortion.

## APPLICATIONS

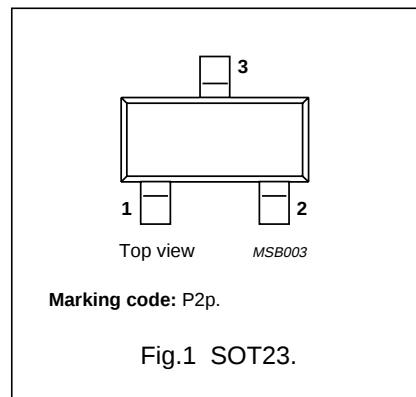
- RF wideband amplifiers and oscillators.

## DESCRIPTION

NPN wideband transistor in a plastic SOT23 package.  
PNP complement: BFT92.

## PINNING

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



## QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                     | CONDITIONS                                                                                                                                  | TYP. | MAX. | UNIT |
|-----------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|
| $V_{CBO}$ | collector-base voltage        |                                                                                                                                             | —    | 20   | V    |
| $V_{CEO}$ | collector-emitter voltage     |                                                                                                                                             | —    | 15   | V    |
| $I_C$     | collector current (DC)        |                                                                                                                                             | —    | 25   | mA   |
| $P_{tot}$ | total power dissipation       | $T_s \leq 95\text{ }^{\circ}\text{C}$                                                                                                       | —    | 300  | mW   |
| $C_{re}$  | feedback capacitance          | $I_C = i_c = 0$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ MHz}$                                                                               | 0.35 | —    | pF   |
| $f_T$     | transition frequency          | $I_C = 15\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 500\text{ MHz}$                                                                        | 5    | —    | GHz  |
| $G_{UM}$  | maximum unilateral power gain | $I_C = 15\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                 | 14   | —    | dB   |
|           |                               | $I_C = 15\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$                                 | 8    | —    | dB   |
| $F$       | noise figure                  | $I_C = 5\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $\Gamma_s = \Gamma_{opt}$ ; $T_{amb} = 25\text{ }^{\circ}\text{C}$      | 2.1  | —    | dB   |
| $V_O$     | output voltage                | $d_{im} = -60\text{ dB}$ ; $I_C = 14\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $R_L = 75\text{ }\Omega$ ; $f_p + f_q - f_r = 793.25\text{ MHz}$ | 150  | —    | mV   |

## LIMITING VALUES

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

| SYMBOL    | PARAMETER                 | CONDITIONS                                                | MIN. | MAX. | UNIT               |
|-----------|---------------------------|-----------------------------------------------------------|------|------|--------------------|
| $V_{CBO}$ | collector-base voltage    | open emitter                                              | —    | 20   | V                  |
| $V_{CEO}$ | collector-emitter voltage | open base                                                 | —    | 15   | V                  |
| $V_{EBO}$ | emitter-base voltage      | open collector                                            | —    | 2    | V                  |
| $I_C$     | collector current (DC)    |                                                           | —    | 25   | mA                 |
| $P_{tot}$ | total power dissipation   | $T_s \leq 95\text{ }^{\circ}\text{C}$ ; note 1; see Fig.3 | —    | 300  | mW                 |
| $T_{stg}$ | storage temperature       |                                                           | -65  | +150 | $^{\circ}\text{C}$ |
| $T_j$     | junction temperature      |                                                           | —    | 175  | $^{\circ}\text{C}$ |

## Note

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

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## THERMAL CHARACTERISTICS

| SYMBOL        | PARAMETER                                           | CONDITIONS                       | VALUE | UNIT |
|---------------|-----------------------------------------------------|----------------------------------|-------|------|
| $R_{th\ j-s}$ | thermal resistance from junction to soldering point | $T_s \leq 95\text{ °C}$ ; note 1 | 260   | K/W  |

## Note

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

## CHARACTERISTICS

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

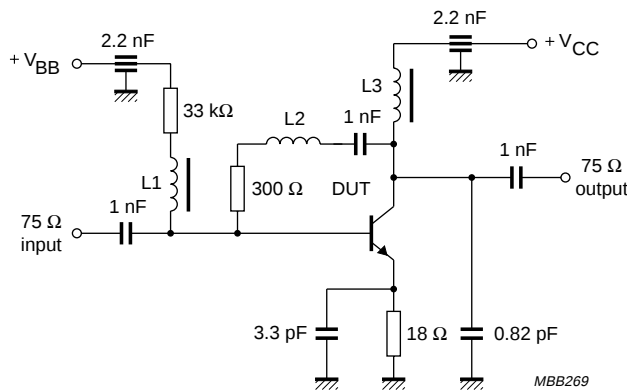
| SYMBOL    | PARAMETER                               | CONDITIONS                                                                                                                                    | MIN. | TYP. | MAX. | UNIT |
|-----------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{CBO}$ | collector leakage current               | $I_E = 0$ ; $V_{CB} = 10\text{ V}$                                                                                                            | –    | –    | 50   | nA   |
| $h_{FE}$  | DC current gain                         | $I_C = 15\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; see Fig.4                                                                                     | 40   | 90   | –    |      |
| $C_c$     | collector capacitance                   | $I_E = i_e = 0$ ; $V_{CB} = 10\text{ V}$ ; $f = 1\text{ MHz}$ ; see Fig.5                                                                     | –    | 0.6  | –    | pF   |
| $C_e$     | emitter capacitance                     | $I_C = i_c = 0$ ; $V_{EB} = 10\text{ V}$ ; $f = 1\text{ MHz}$                                                                                 | –    | 1.2  | –    | pF   |
| $C_{re}$  | feedback capacitance                    | $I_C = i_c = 0$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ MHz}$                                                                                 | –    | 0.35 | –    | pF   |
| $f_T$     | transition frequency                    | $I_C = 15\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 500\text{ MHz}$ ; see Fig.6                                                              | –    | 5    | –    | GHz  |
| $G_{UM}$  | maximum unilateral power gain (note 1)  | $I_C = 15\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$                                                 | –    | 14   | –    | dB   |
|           |                                         | $I_C = 15\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$                                                 | –    | 8    | –    | dB   |
| F         | noise figure                            | $I_C = 5\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 1\text{ GHz}$ ; $\Gamma_s = \Gamma_{opt}$ ; $T_{amb} = 25\text{ °C}$ ; see Figs 13 and 14 | –    | 2.1  | –    | dB   |
|           |                                         | $I_C = 5\text{ mA}$ ; $V_{CE} = 10\text{ V}$ ; $f = 2\text{ GHz}$ ; $\Gamma_s = \Gamma_{opt}$ ; $T_{amb} = 25\text{ °C}$ ; see Figs 13 and 14 | –    | 3    | –    | dB   |
| $V_O$     | output voltage                          | notes 2 and 3                                                                                                                                 | –    | 150  | –    | mV   |
| $d_2$     | second order intermodulation distortion | notes 2 and 4; see Fig.16                                                                                                                     | –    | –50  | –    | dB   |

## 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. Measured on the same die in a SOT37 package (BFR90A).
3.  $d_{im} = -60\text{ dB}$  (DIN 45004B);  $I_C = 14\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $R_L = 75\text{ }\Omega$ ;  $VSWR < 2$ ;  $T_{amb} = 25\text{ °C}$   
 $V_p = V_O$  at  $d_{im} = -60\text{ dB}$ ;  $f_p = 795.25\text{ MHz}$ ;  
 $V_q = V_O - 6\text{ dB}$ ;  $f_q = 803.25\text{ MHz}$ ;  
 $V_r = V_O - 6\text{ dB}$ ;  $f_r = 805.25\text{ MHz}$ ;  
measured at  $f_p + f_q - f_r = 793.25\text{ MHz}$ .
4.  $I_C = 14\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $R_L = 75\text{ }\Omega$ ;  $VSWR < 2$ ;  $T_{amb} = 25\text{ °C}$   
 $V_p = 60\text{ mV}$  at  $f_p = 250\text{ MHz}$ ;  
 $V_q = 60\text{ mV}$  at  $f_q = 560\text{ MHz}$ ;  
measured at  $f_p + f_q = 810\text{ MHz}$ .

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L1 = L3 = 5 μH choke.  
L2 = 3 turns 0.4 mm copper wire, internal diameter 3 mm, winding pitch 1 mm.

Fig.2 Intermodulation distortion and second harmonic distortion MATV test circuit.

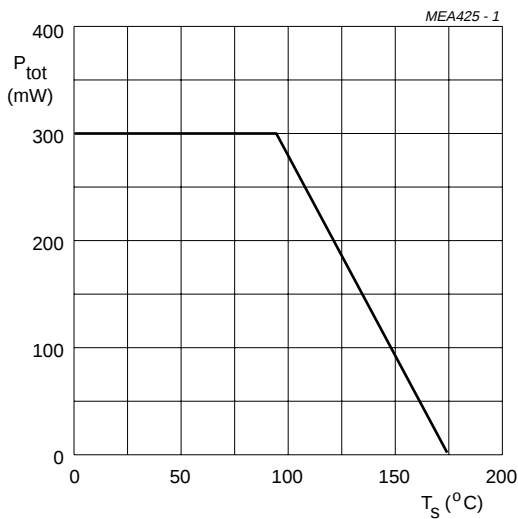
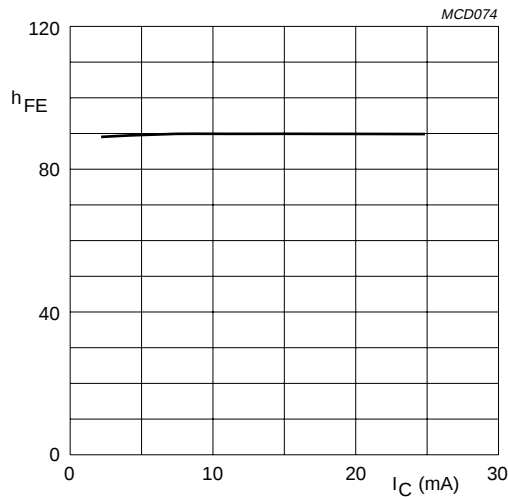


Fig.3 Power derating curve.

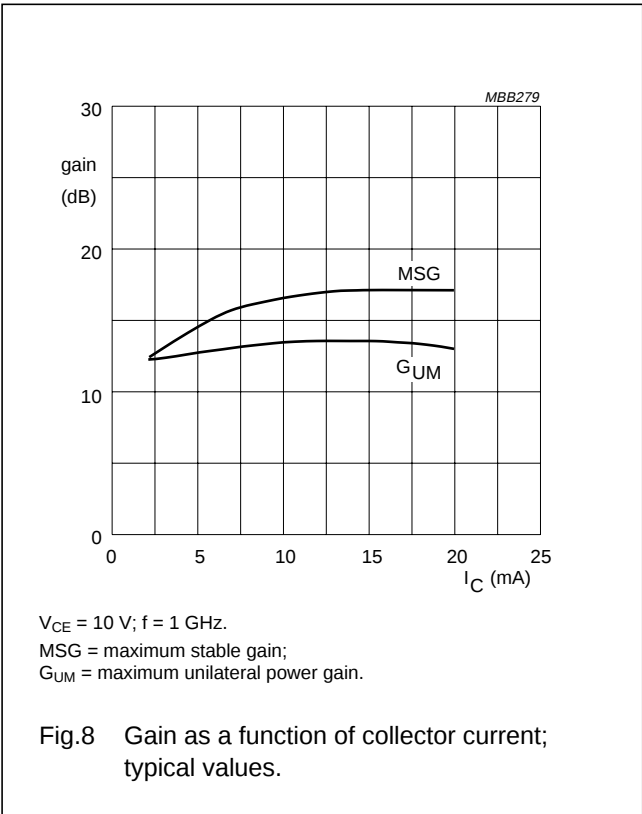
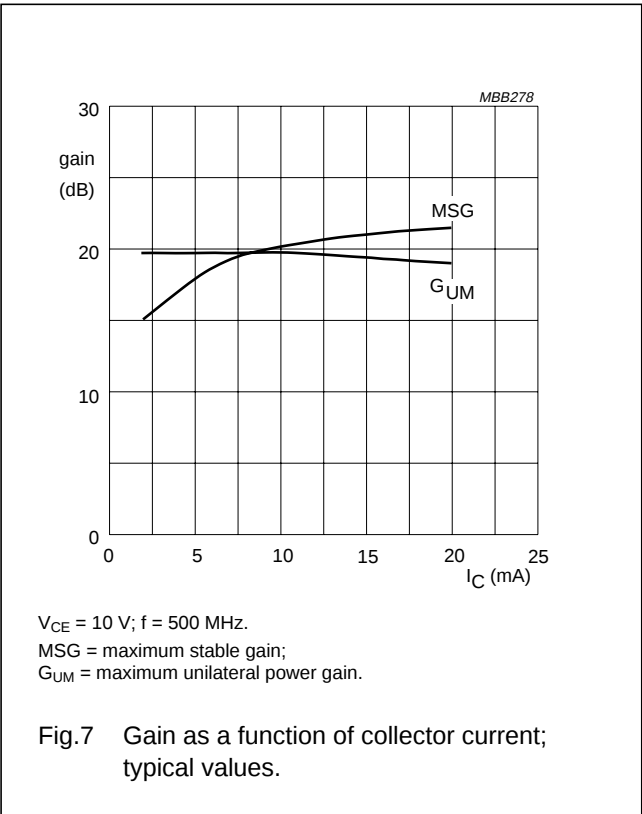
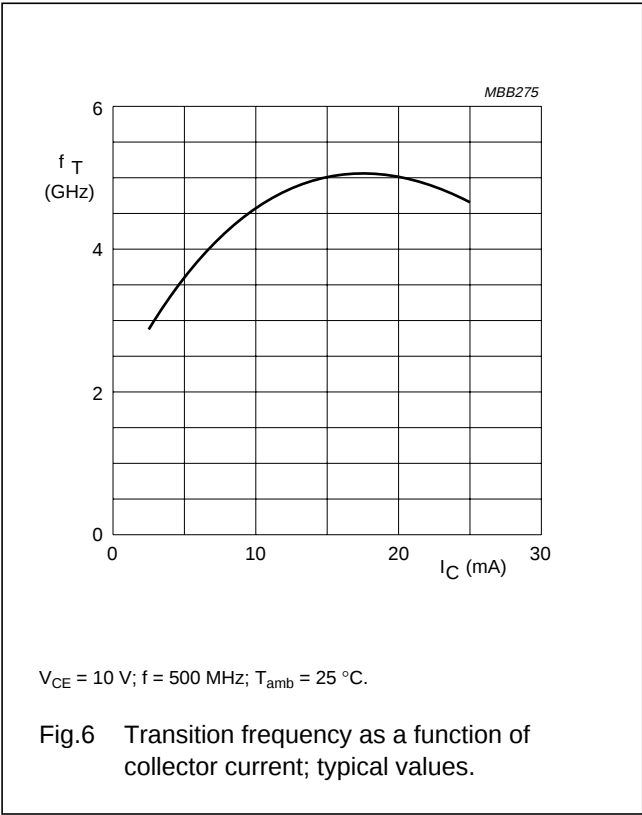
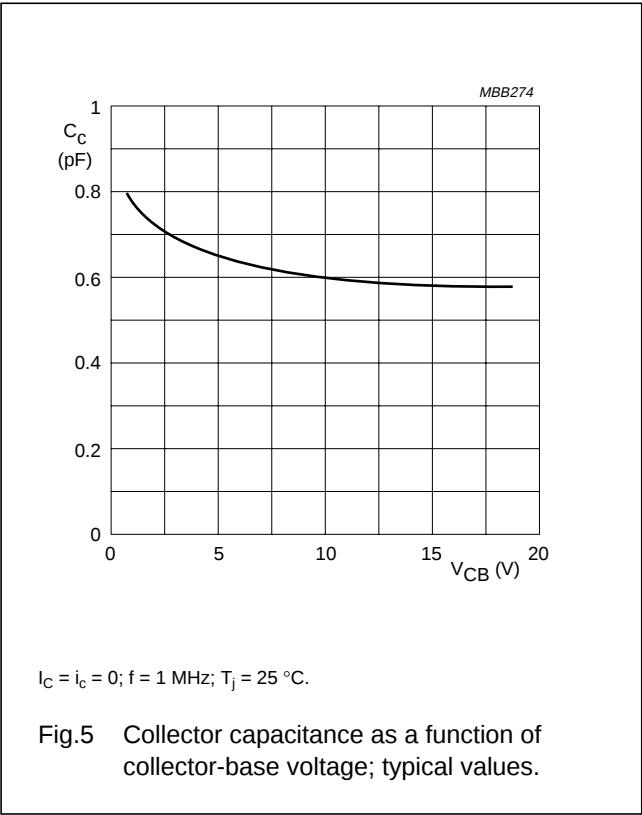


$V_{CE} = 10\text{ V}; T_J = 25\text{ °C}.$

Fig.4 DC current gain as a function of collector current; typical values.

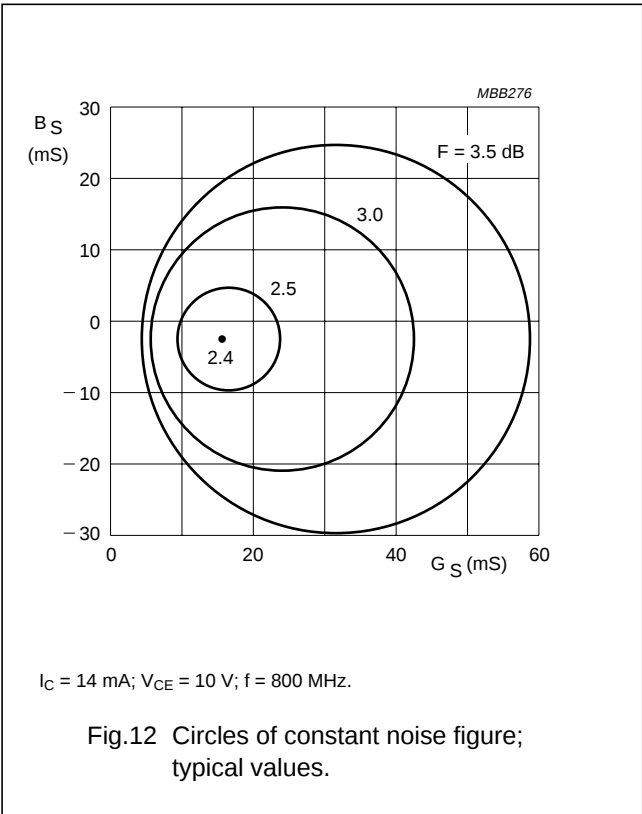
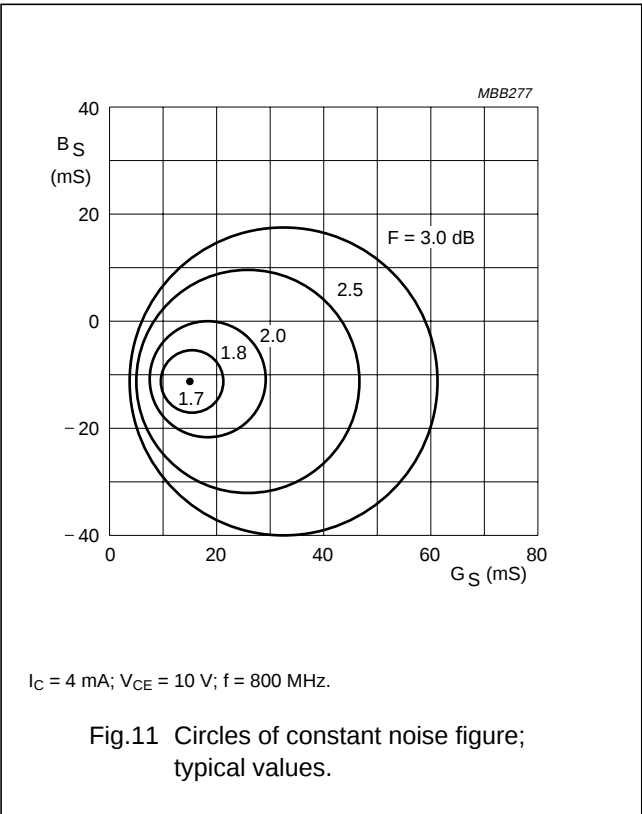
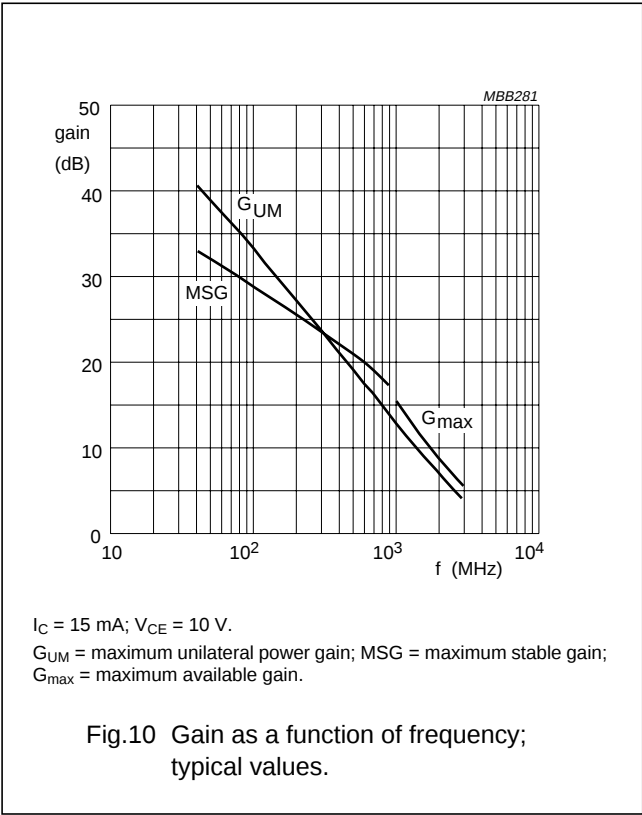
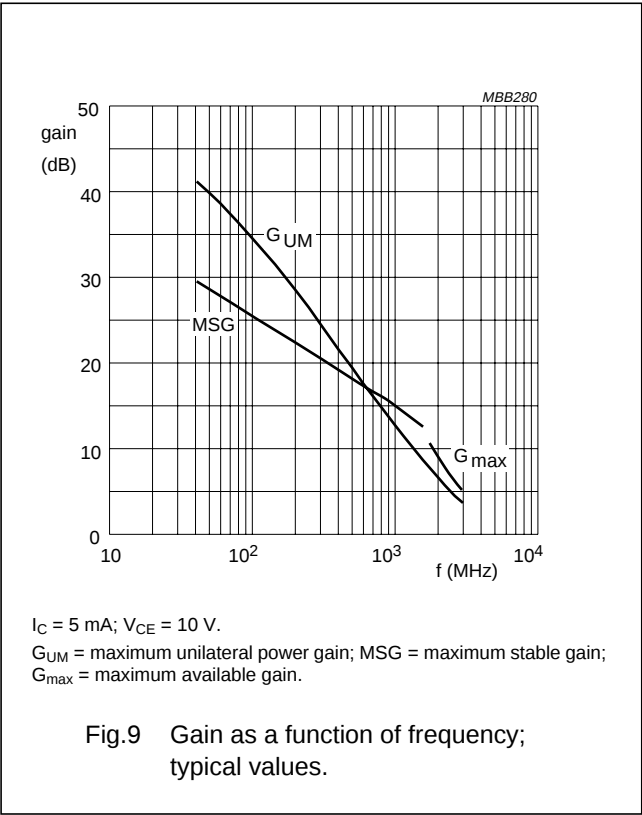
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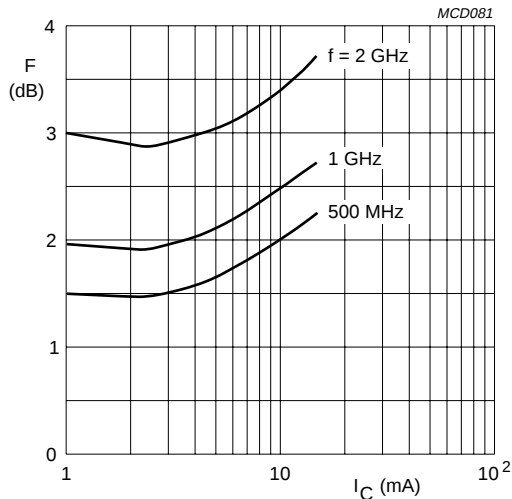
NPN 5 GHz wideband transistor

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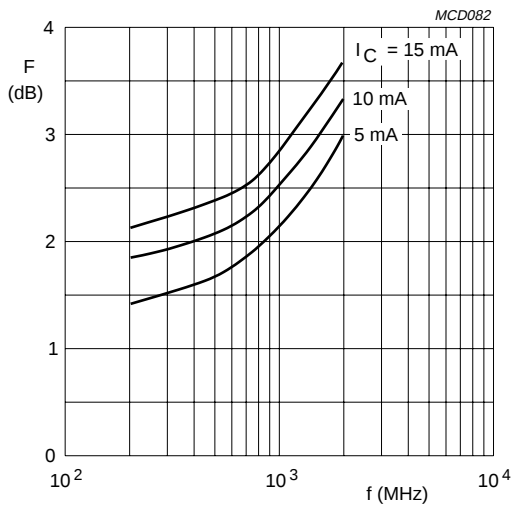
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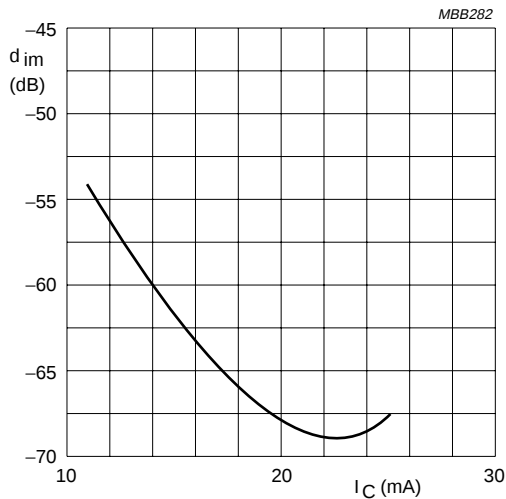
V<sub>CE</sub> = 10 V.

Fig.13 Minimum noise figure as a function of collector current; typical values.



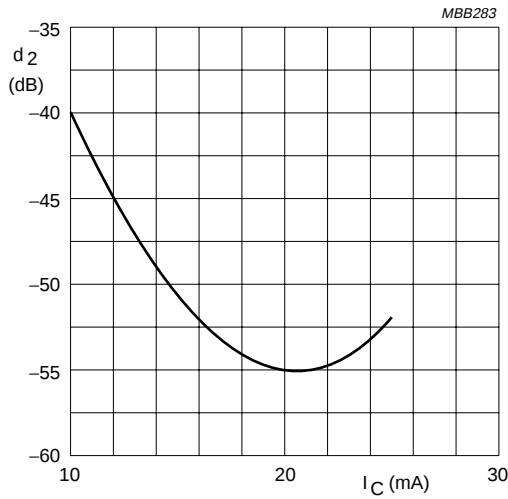
V<sub>CE</sub> = 10 V.

Fig.14 Minimum noise figure as a function of frequency; typical values.



V<sub>CE</sub> = 10 V; V<sub>O</sub> = 150 mV (43.5 dBmV);  
f<sub>p</sub> + f<sub>q</sub> - f<sub>r</sub> = 793.25 MHz; T<sub>amb</sub> = 25 °C.  
Measured in MATV test circuit (see Fig.2).

Fig.15 Intermodulation distortion; typical values.

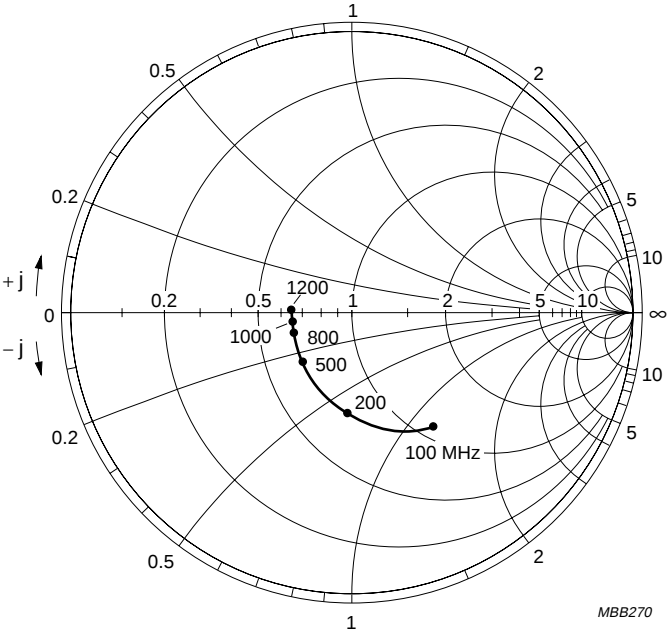


V<sub>CE</sub> = 10 V; V<sub>O</sub> = 60 mV; f<sub>p</sub> + f<sub>q</sub> - f<sub>r</sub> = 810 MHz; T<sub>amb</sub> = 25 °C.  
Measured in MATV test circuit (see Fig.2).

Fig.16 Second order intermodulation distortion; typical values.

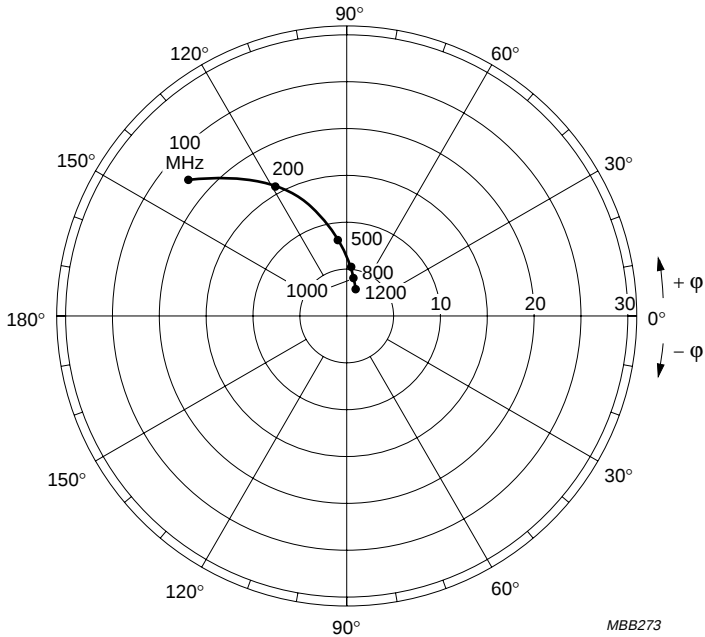
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$I_C = 14\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $Z_0 = 50\text{ }\Omega$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ .

Fig.17 Common emitter input reflection coefficient ( $S_{11}$ ); typical values.

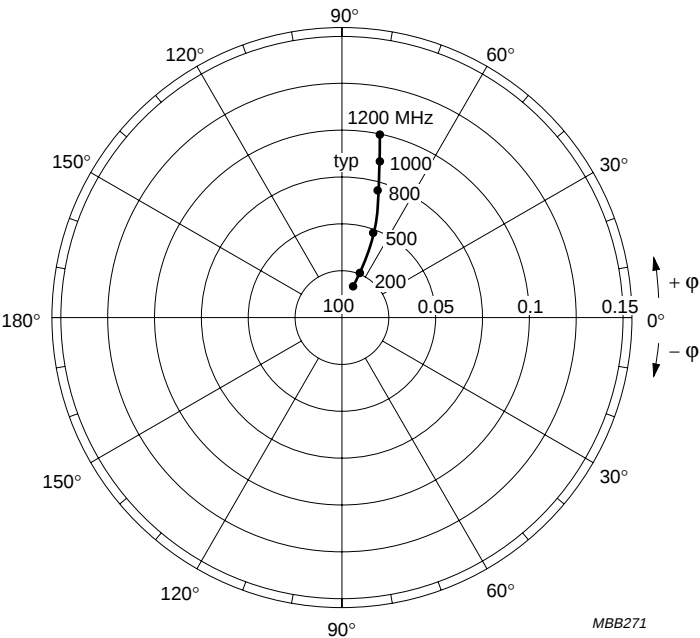


$I_C = 14\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ .

Fig.18 Common emitter forward transmission coefficient ( $S_{21}$ ); typical values.

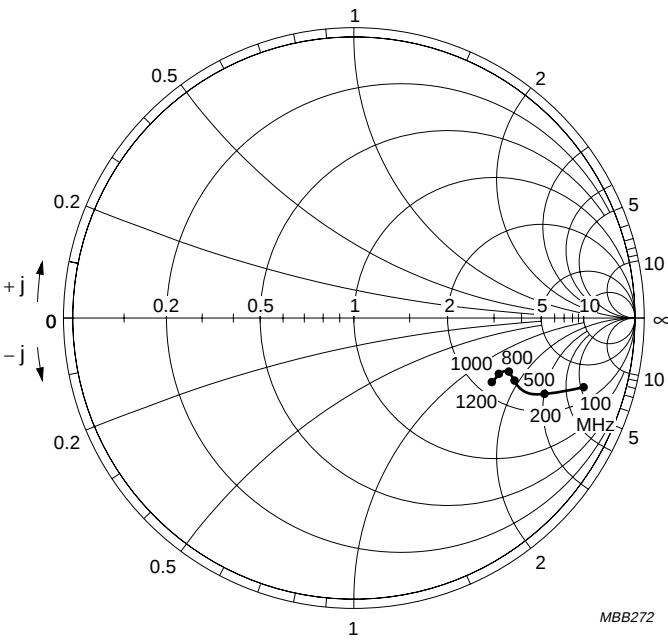
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$I_C = 14\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig.19 Common emitter reverse transmission coefficient ( $S_{12}$ ); typical values.



$I_C = 14\text{ mA}$ ;  $V_{CE} = 10\text{ V}$ ;  $Z_0 = 50\text{ }\Omega$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig.20 Common emitter output reflection coefficient ( $S_{22}$ ); typical values.

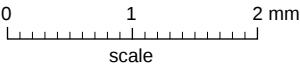
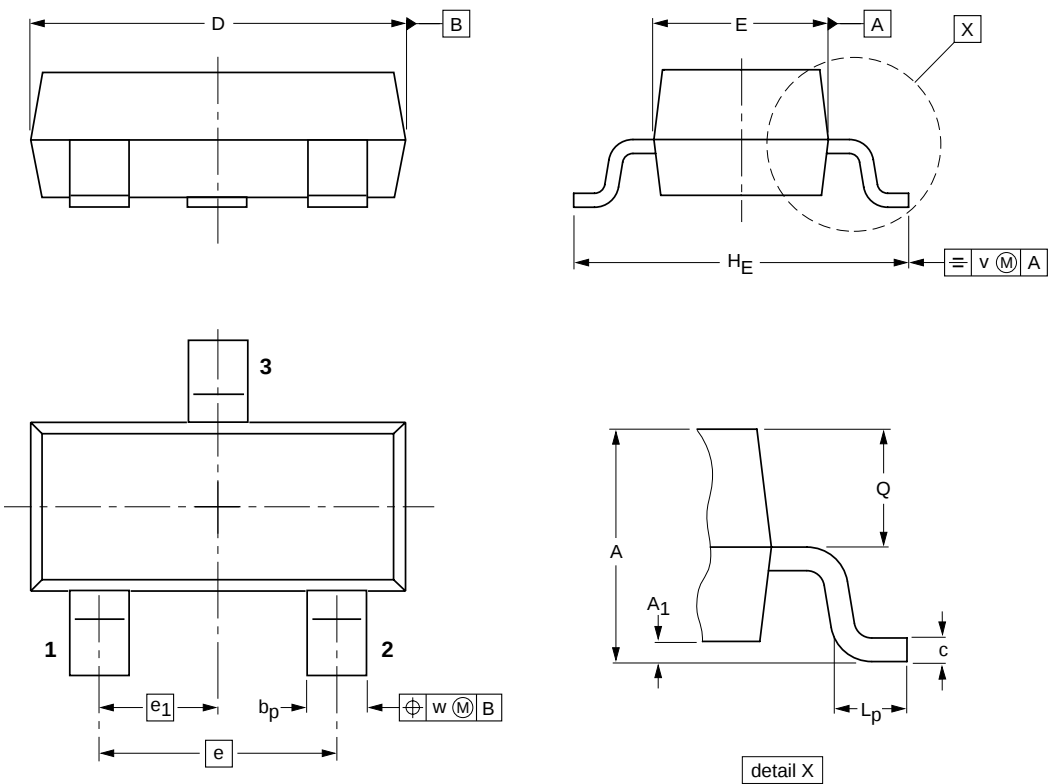
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PACKAGE OUTLINE

Plastic surface mounted package; 3 leads

SOT23



DIMENSIONS (mm are the original dimensions)

| UNIT | A          | A <sub>1</sub><br>max. | b <sub>p</sub> | c            | D          | E          | e   | e <sub>1</sub> | H <sub>E</sub> | L <sub>p</sub> | 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<br>VERSION | REFERENCES |       |      |  | EUROPEAN<br>PROJECTION | ISSUE DATE |
|--------------------|------------|-------|------|--|------------------------|------------|
|                    | IEC        | JEDEC | EIAJ |  |                        |            |
| SOT23              |            |       |      |  |                        | 97-02-28   |

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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.                                                                                                                         |
| Short-form specification                                                                                                                                                                                                                                                                                                                                                                                                                                  | The data in this 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. |
| <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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