# DATA SHEET

# BFR93AW
## NPN 5 GHz wideband transistor

Product specification
Supersedes data of November 1992
File under Discrete Semiconductors, SC14

1995 Sep 18

Philips
Semiconductors

PHILIPS

# NPN 5 GHz wideband transistor BFR93AW

## FEATURES

- High power gain
- Gold metallization ensures excellent reliability
- SOT323 (S-mini) package.

## APPLICATIONS

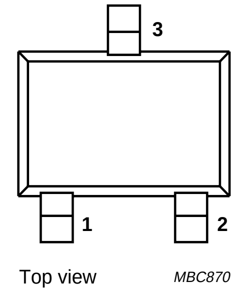
It is designed for use in RF amplifiers, mixers and oscillators with signal frequencies up to 1 GHz.

## DESCRIPTION

Silicon NPN transistor encapsulated in a plastic SOT323 (S-mini) package. The BFR93AW uses the same crystal as the SOT23 version, BFR93A.

## PINNING

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




**Marking code**: R2.

Fig.1 SOT323

## QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{CBO}$ | collector-base voltage | open emitter | – | – | 15 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | – | – | 12 | V |
| $I_C$ | collector current (DC) | | – | – | 35 | mA |
| $P_{tot}$ | total power dissipation | up to $T_s$ = 93 °C; note 1 | – | – | 300 | mW |
| $h_{FE}$ | DC current gain | $I_C$ = 30 mA; $V_{CE}$ = 5 V | 40 | 90 | – | |
| $C_{re}$ | feedback capacitance | $I_C$ = 0; $V_{CE}$ = 5 V; f = 1 MHz; $T_{amb}$ = 25 °C | – | 0.6 | – | pF |
| $f_T$ | transition frequency | $I_C$ = 30 mA; $V_{CE}$ = 5 V; f = 500 MHz | 4 | 5 | – | GHz |
| $G_{UM}$ | maximum unilateral power gain | $I_C$ = 30 mA; $V_{CE}$ = 8 V; f = 1 GHz; $T_{amb}$ = 25 °C | – | 13 | – | dB |
| | | $I_C$ = 30 mA; $V_{CE}$ = 8 V; f = 2 GHz; $T_{amb}$ = 25 °C | – | 8 | – | dB |
| F | noise figure | $I_C$ = 5 mA; $V_{CE}$ = 8 V; f = 1 GHz; $\Gamma_s = \Gamma_{opt}$ | – | 1.5 | – | dB |
| $T_j$ | junction temperature | | – | – | 150 | °C |

**Note**

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

## LIMITING VALUES

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

| SYMBOL | PARAMETER | CONDITION | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{CBO}$ | collector-base voltage | open emitter | – | 15 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | – | 12 | V |
| $V_{EBO}$ | emitter-base voltage | open collector | – | 2 | V |
| $I_C$ | collector current (DC) | | – | 35 | mA |
| $P_{tot}$ | total power dissipation | up to $T_s$ = 93 °C; see Fig.2; note 1 | – | 300 | mW |
| $T_{stg}$ | storage temperature | | –65 | +150 | °C |
| $T_j$ | junction temperature | | – | 150 | °C |

## THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITION | VALUE | UNIT |
|---|---|---|---|---|
| $R_{th\ j\text{-}s}$ | thermal resistance from junction to soldering point | up to $T_s$ = 93 °C; note 1 | 190 | K/W |

### Note to the Limiting values and Thermal characteristics

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

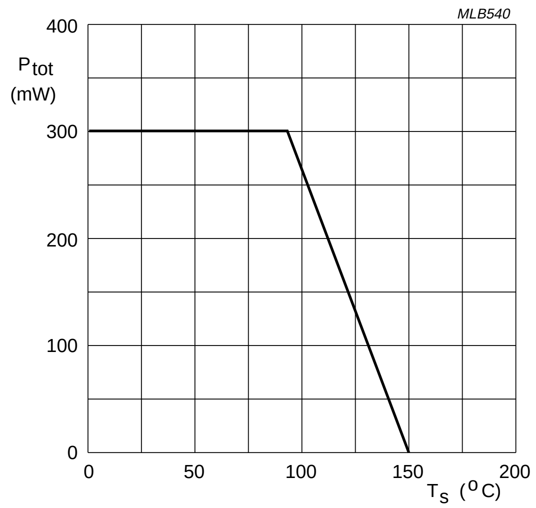



Fig.2 Power derating curve.

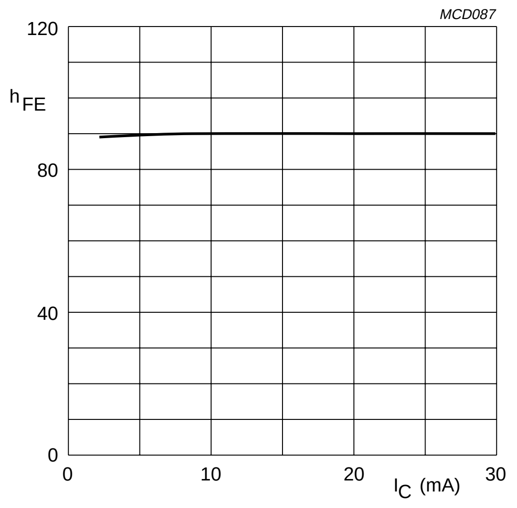
## CHARACTERISTICS

$T_j$ = 25 °C (unless otherwise specified).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $I_{CBO}$ | collector leakage current | $I_E$ = 0; $V_{CB}$ = 5 V | – | – | 50 | nA |
| $h_{FE}$ | DC current gain | $I_C$ = 30 mA; $V_{CE}$ = 5 V | 40 | 90 | – | |
| $C_c$ | collector capacitance | $I_E = i_e$ = 0; $V_{CB}$ = 5 V; f = 1 MHz | – | 0.7 | – | pF |
| $C_e$ | emitter capacitance | $I_C = i_c$ = 0; $V_{EB}$ = 0.5 V; f = 1 MHz | – | 2.3 | – | pF |
| $C_{re}$ | feedback capacitance | $I_C$ = 0; $V_{CE}$ = 5 V; f = 1 MHz | – | 0.6 | – | pF |
| $f_T$ | transition frequency | $I_C$ = 30 mA; $V_{CE}$ = 5 V; f = 500 MHz | 4 | 5 | – | GHz |
| $G_{UM}$ | maximum unilateral power gain; note 1 | $I_C$ = 30 mA; $V_{CE}$ = 8 V; f = 1 GHz; $T_{amb}$ = 25 °C | – | 13 | – | dB |
| | | $I_C$ = 30 mA; $V_{CE}$ = 8 V; f = 2 GHz; $T_{amb}$ = 25 °C | – | 8 | – | dB |
| F | noise figure | $I_C$ = 5 mA; $V_{CE}$ = 8 V; f = 1 GHz; $\Gamma_s = \Gamma_{opt}$ | – | 1.5 | – | dB |
| | | $I_C$ = 5 mA; $V_{CE}$ = 8 V; f = 2 GHz; $\Gamma_s = \Gamma_{opt}$ | – | 2.1 | – | dB |

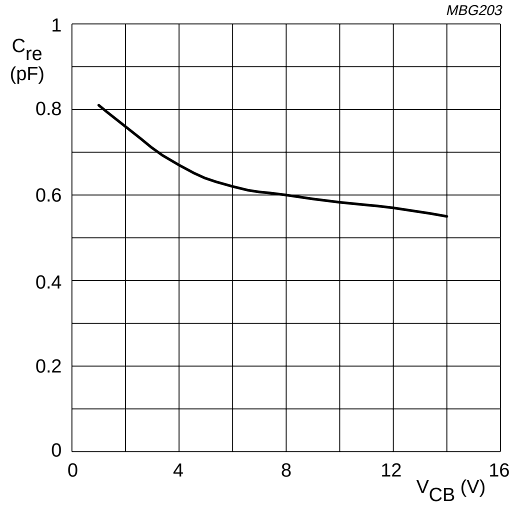
**Note**

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.



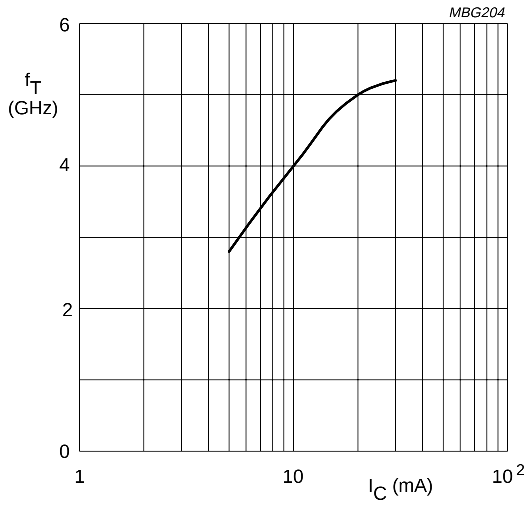

$V_{CE}$ = 5 V.

Fig.3 DC current gain as a function of collector current; typical values.



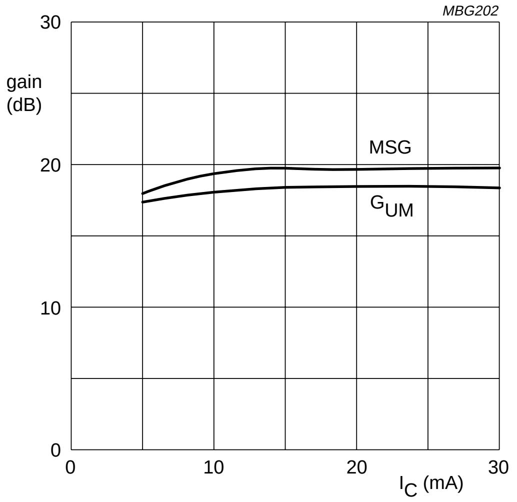

$I_C$ = 0; f = 1 MHz.

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



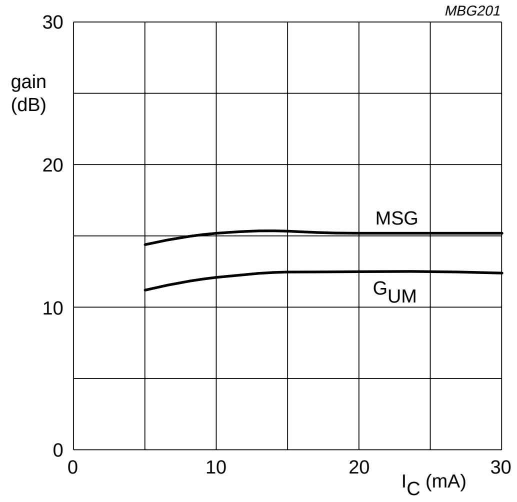

$V_{CE}$ = 5 V; f = 500 MHz; $T_{amb}$ = 25 °C.

Fig.5 Transition frequency as a function of collector current; typical values.



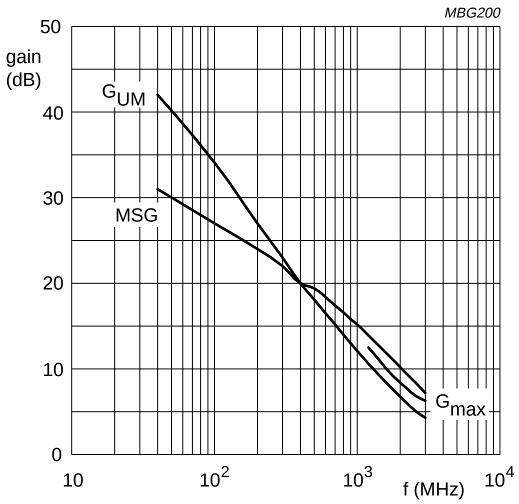

$V_{CE}$ = 8 V; f = 500 MHz.

Fig.6 Gain as a function of collector current; typical values.



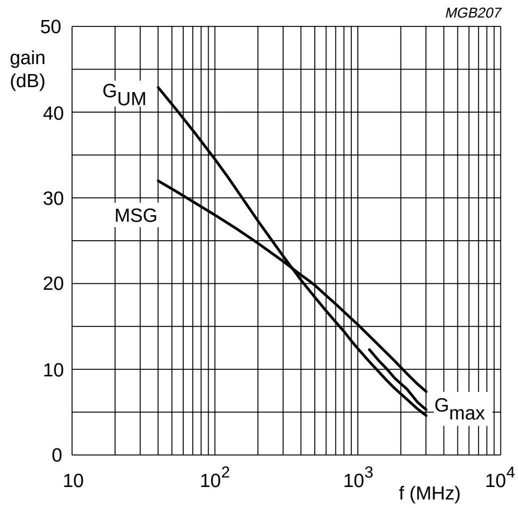

$V_{CE}$ = 8 V; f = 1 GHz.

Fig.7 Gain as a function of collector current; typical values.



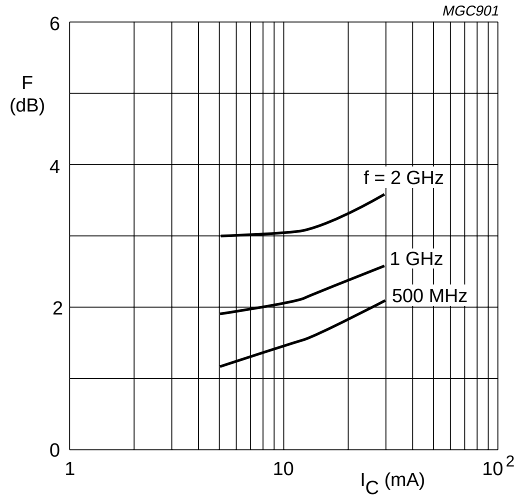

$V_{CE}$ = 8 V; $I_C$ = 10 mA.

Fig.8 Gain as a function of frequency; typical values.



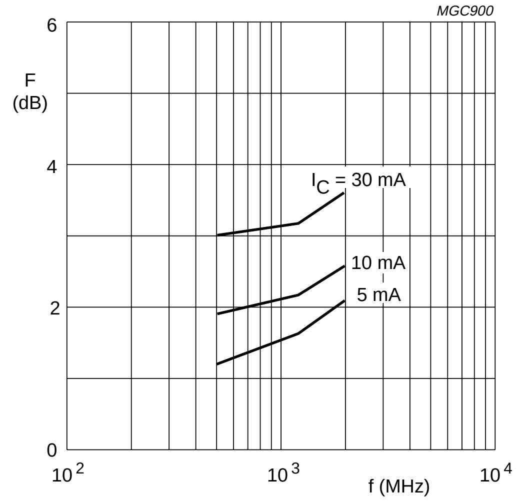

$V_{CE}$ = 8 V; $I_C$ = 30 mA.

Fig.9 Gain as a function of frequency; typical values.



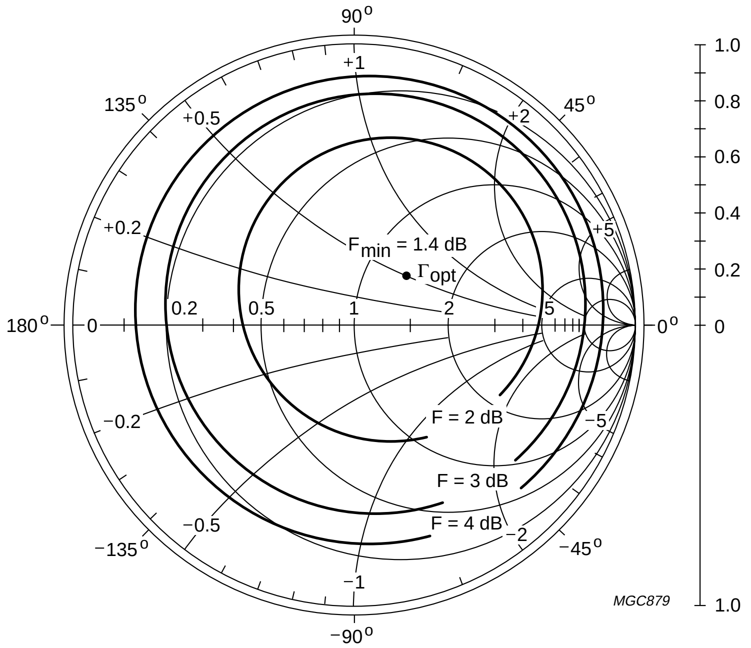

$V_{CE}$ = 8 V.

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



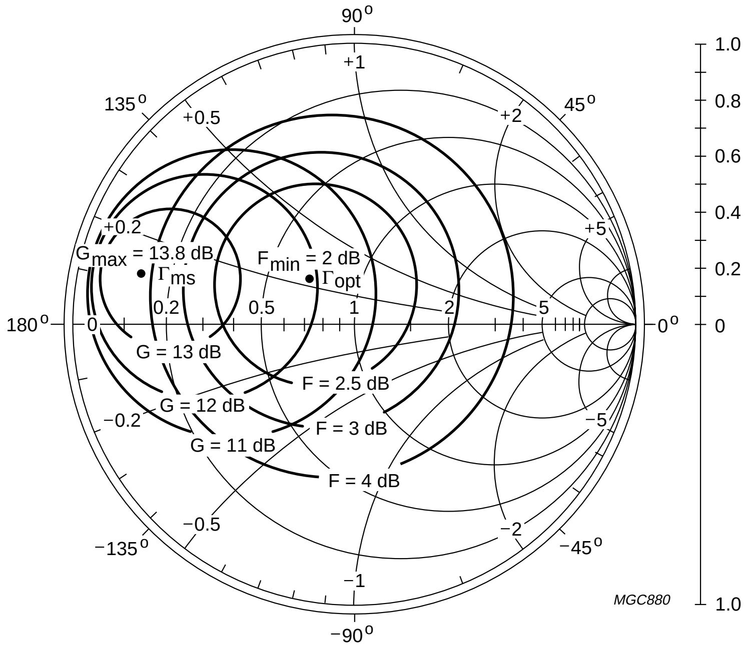

$V_{CE}$ = 8 V.

Fig.11 Minimum noise figure as a function of collector current; typical values.



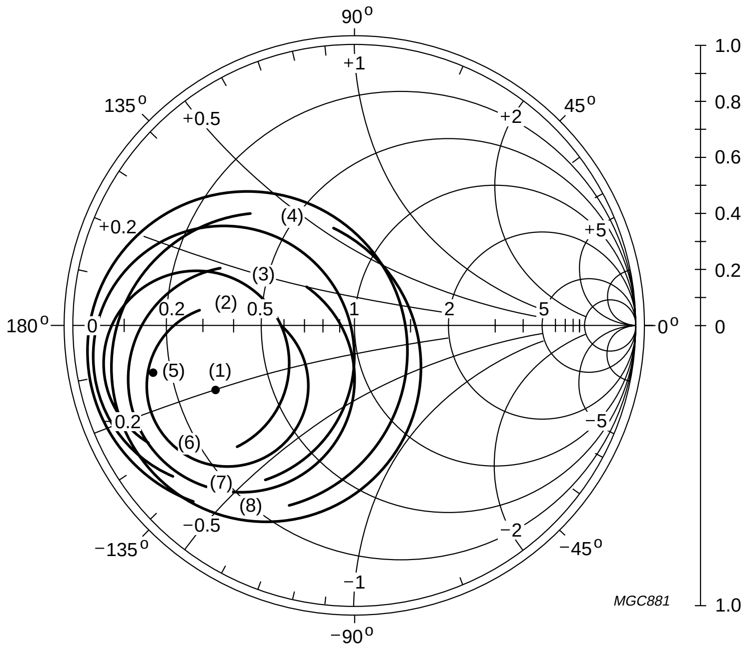

f = 500 MHz; $V_{CE}$ = 8 V; $I_C$ = 10 mA; $Z_o$ = 50 Ω.

Fig.12 Common emitter noise figure circles; typical values.



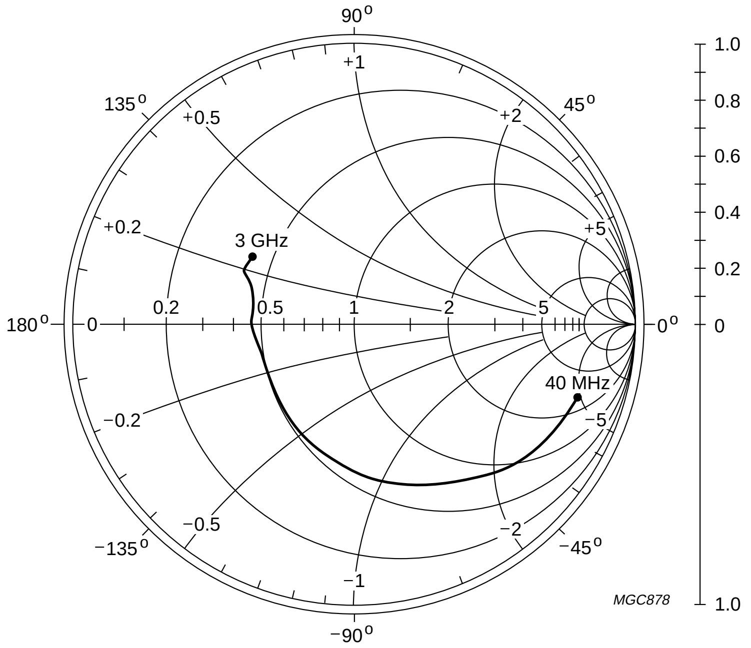

f = 1 GHz; $V_{CE}$ = 8 V; $I_C$ = 10 mA; $Z_o$ = 50 Ω.

Fig.13 Common emitter noise figure circles; typical values.



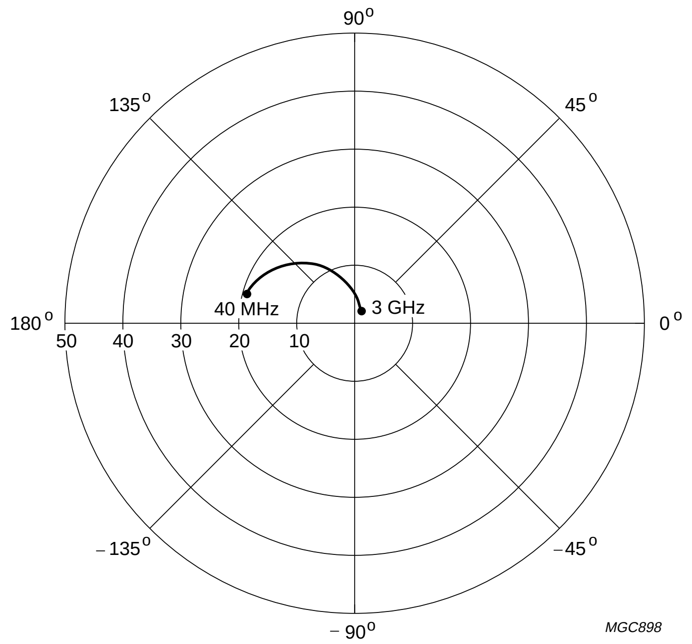

(1) $\Gamma_{opt}$; $F_{min}$ = 3 dB.
(2) F = 3.5 dB.
(3) F = 4 dB.
(4) F = 5 dB.
(5) $\Gamma_{ms}$; $G_{max}$ = 8.1 dB.
(6) G = 7 dB.
(7) G = 6 dB.
(8) G = 5 dB.
f = 2 GHz; $V_{CE}$ = 8 V; $I_C$ = 10 mA; $Z_o$ = 50 Ω.

Fig.14 Common emitter noise figure circles; typical values.



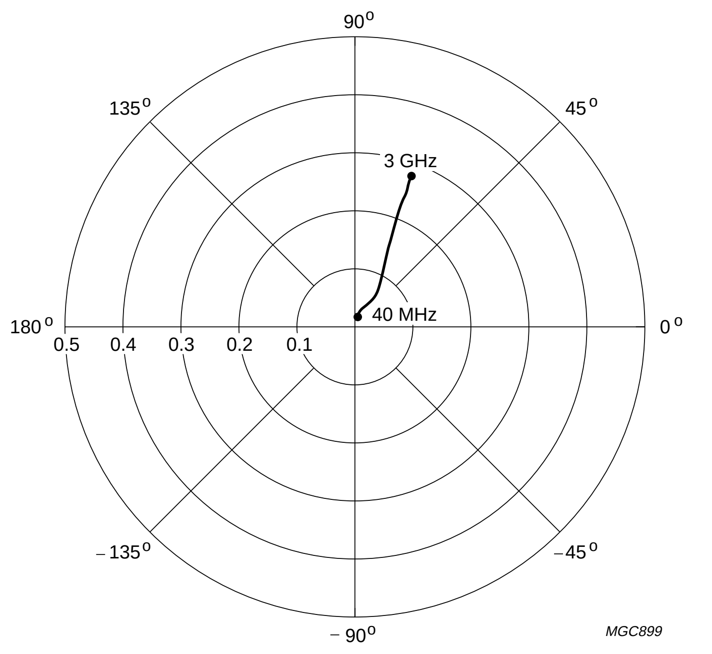

$V_{CE}$ = 8 V; $I_C$ = 30 mA; $Z_o$ = 50 Ω.

Fig.15 Common emitter input reflection coefficient ($s_{11}$); typical values.



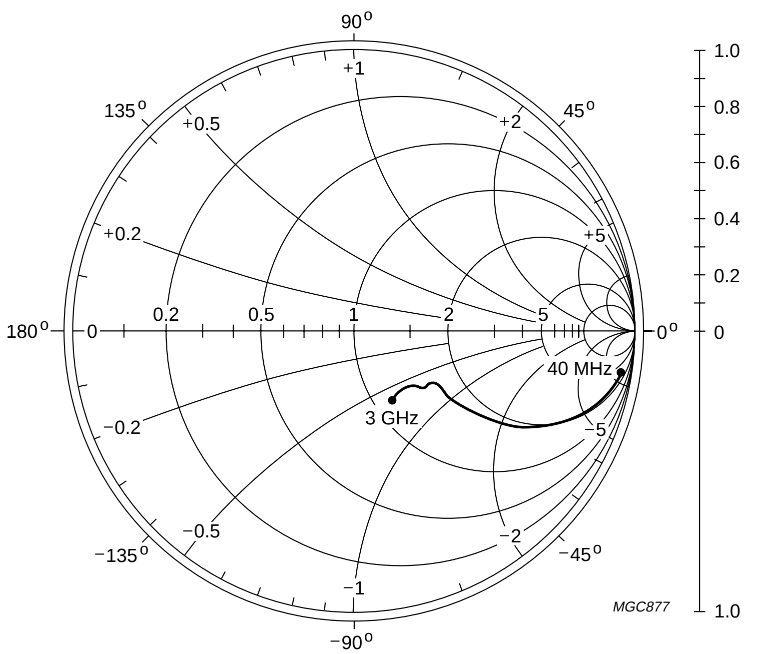

$V_{CE}$ = 8 V; $I_C$ = 30 mA.

Fig.16 Common emitter forward transmission coefficient ($s_{21}$); typical values.




$V_{CE}$ = 8 V; $I_C$ = 30 mA.

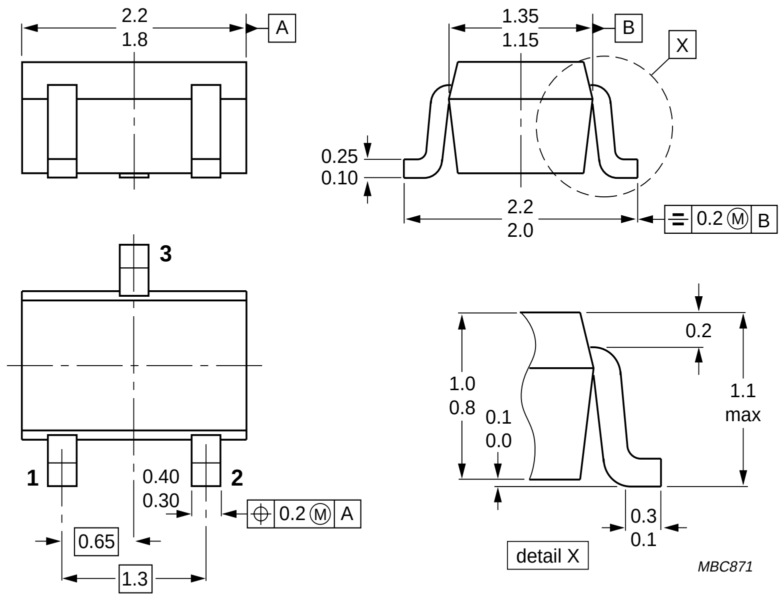
Fig.17 Common emitter reverse transmission coefficient ($s_{12}$); typical values.




$V_{CE}$ = 8 V; $I_C$ = 30 mA; $Z_o$ = 50 Ω.

Fig.18 Common emitter output reflection coefficient ($s_{22}$); typical values.

## PACKAGE OUTLINE




Dimensions in mm.

Fig.19 SOT323.

## DEFINITIONS

| Data sheet status | |
|---|---|
| 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. |
| **Limiting values** | |
| 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. | |
| **Application information** | |
| Where application information is given, it is advisory and does not form part of the specification. | |

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