# BFR94AW

## NPN 5 GHz wideband transistor

Rev. 2 — 2 October 2014 Product data sheet

## 1. Product profile

### 1.1 General description

Silicon NPN transistor encapsulated in a plastic SOT323 (S-mini) package. The BFR94AW uses the same crystal as the SOT23 version, BFR94A.

### 1.2 Features and benefits

- High power gain
- Gold metallization ensures excellent reliability
- AEC-Q101 qualified

### 1.3 Applications

- RF amplifiers, mixers and oscillators with signal frequencies up to 1 GHz

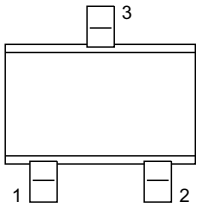
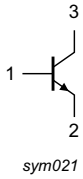
### 1.4 Quick reference data

**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CBO}$ | collector-base voltage | open emitter | - | - | 20 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | - | - | 15 | V |
| $I_C$ | collector current | | - | - | 25 | mA |
| $P_{tot}$ | total power dissipation | $T_{sp} \leq 93$ °C | - | - | 300 | mW |
| $h_{FE}$ | DC current gain | $I_C$ = 15 mA; $V_{CE}$ = 10 V | 65 | 90 | 135 | |
| $C_{re}$ | feedback capacitance | $I_C$ = 0 mA; $V_{CE}$ = 10 V; f = 1 MHz; $T_{amb}$ = 25 °C | - | 0.35 | - | pF |
| $f_T$ | transition frequency | $I_C$ = 15 mA; $V_{CE}$ = 10 V; f = 500 MHz | 3.5 | 5 | - | GHz |
| $G_{UM}$ | unilateral power gain | $I_C$ = 15 mA; $V_{CE}$ = 10 V; $T_{amb}$ = 25 °C | | | | |
| | | f = 1 GHz | - | 14 | - | dB |
| | | f = 2 GHz | - | 8 | - | dB |
| NF | noise figure | $I_C$ = 5 mA; $V_{CE}$ = 10 V; f = 1 GHz; $\Gamma_S = \Gamma_{opt}$ | - | 2 | - | dB |
| $T_j$ | junction temperature | | - | - | 150 | °C |

## 2. Pinning information

**Table 2. Pinning**

| Pin | Description | Simplified outline | Graphic symbol |
|---|---|---|---|
| 1 | base |  |  |
| 2 | emitter | | |
| 3 | collector | | |





## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BFR94AW | - | plastic surface-mounted package; 3 leads | SOT323 |

## 4. Marking

**Table 4. Marking**

| Type number | Marking code | Description |
|---|---|---|
| BFR94AW | XG* | * = p : made in Hong Kong |
| | | * = t : made in Malaysia |

## 5. Limiting values

**Table 5. Limiting values**

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

| | 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 | | - | 25 | mA |
| $P_{tot}$ | total power dissipation | $T_{sp} \leq 93$ °C; see Figure 1 [1] | - | 300 | mW |
| $T_{stg}$ | storage temperature | | −65 | +150 | °C |
| $T_j$ | junction temperature | | - | +150 | °C |

[1] $T_{sp}$ is the temperature at the solder point of the collector pin.

## 6. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | Typ | Unit |
|---|---|---|---|---|
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | $T_{sp} \leq 93$ °C [1] | 190 | K/W |

[1] $T_{sp}$ is the temperature at the solder point of the collector pin.

## 7. Characteristics

**Table 7. Characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CBO}$ | collector-base cut-off current | $I_E = 0$ A; $V_{CB} = 10$ V | - | - | 50 | nA |
| $h_{FE}$ | DC current gain | $I_C = 15$ mA; $V_{CE} = 10$ V | 65 | 90 | 135 | |
| $C_c$ | collector capacitance | $I_E = i_e = 0$ A; $V_{CB} = 10$ V; f = 1 MHz | - | 0.6 | - | pF |
| $C_e$ | emitter capacitance | $I_C = i_c = 0$ A; $V_{EB} = 0.5$ V; f = 1 MHz | - | 0.9 | - | pF |
| $C_{re}$ | feedback capacitance | $I_C = 0$ mA; $V_{CE} = 10$ V; f = 1 MHz; $T_{amb} = 25$ °C | - | 0.35 | - | pF |
| $f_T$ | transition frequency | $I_C = 15$ mA; $V_{CE} = 10$ V; f = 500 MHz | 3.5 | 5 | - | GHz |
| $G_{UM}$ | unilateral power gain | $I_C = 15$ mA; $V_{CE} = 10$ V; $T_{amb} = 25$ °C [1] | | | | |
| | | f = 1 GHz | - | 14 | - | dB |
| | | f = 2 GHz | - | 8 | - | dB |
| NF | noise figure | $I_C = 5$ mA; $V_{CE} = 10$ V; $\Gamma_S = \Gamma_{opt}$ | | | | |
| | | f = 1 GHz | - | 2 | - | dB |
| | | f = 2 GHz | - | 3 | - | dB |

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

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

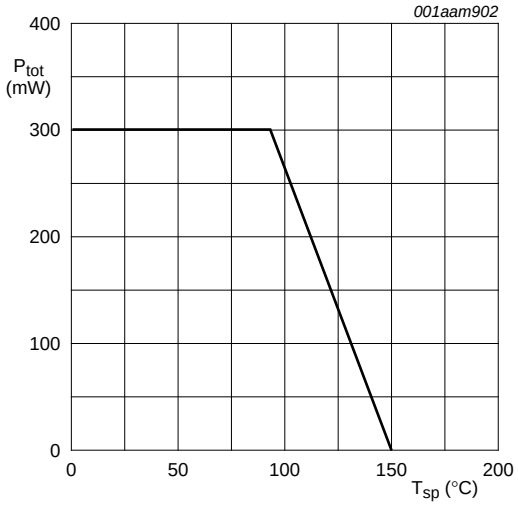
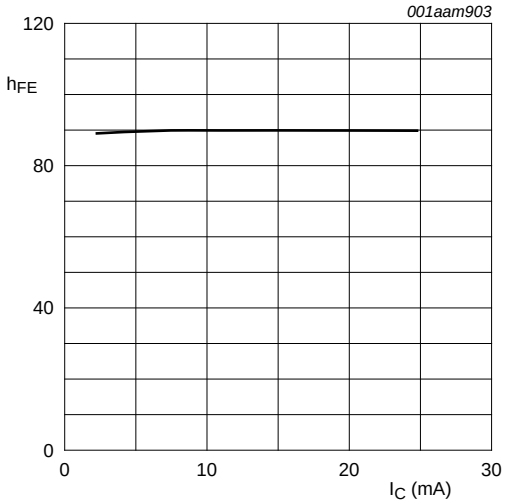
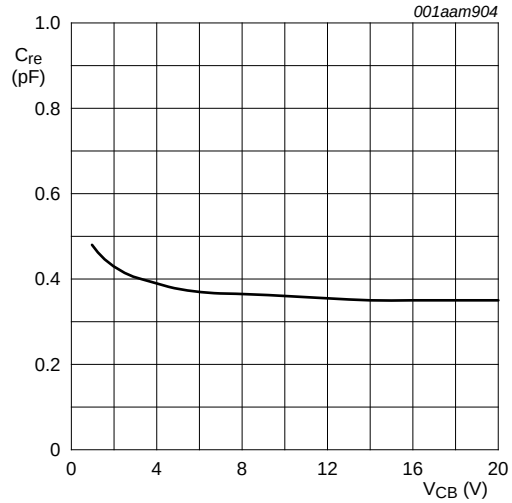



**Fig 1. Power derating curve**



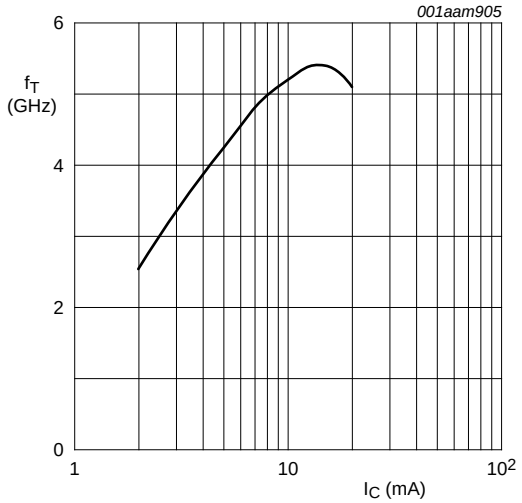

$V_{CE}$ = 10 V.

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



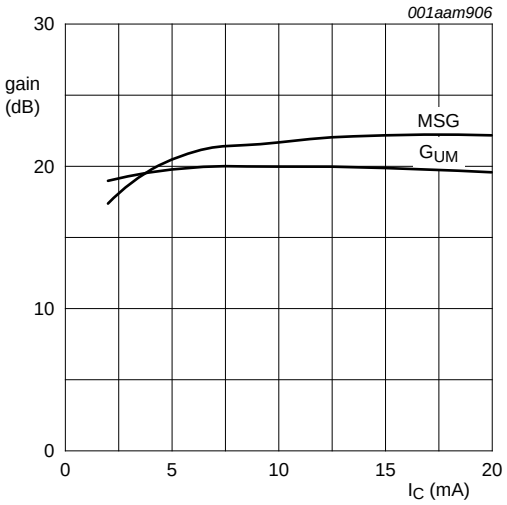

$I_C$ = 0 mA; f = 1 MHz.

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



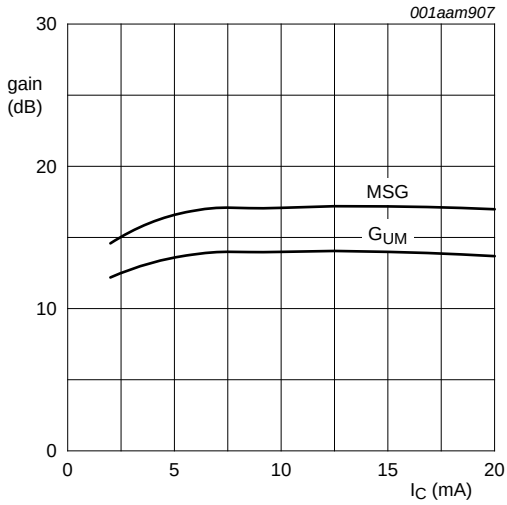

$V_{CE}$ = 5 V; f = 500 MHz; $T_{amb}$ = 25 °C.

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



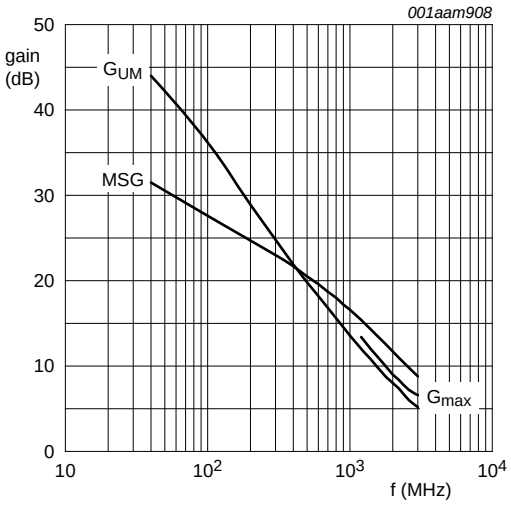

$V_{CE}$ = 10 V; f = 500 MHz.

**Fig 5. Gain as a function of collector current; typical values**



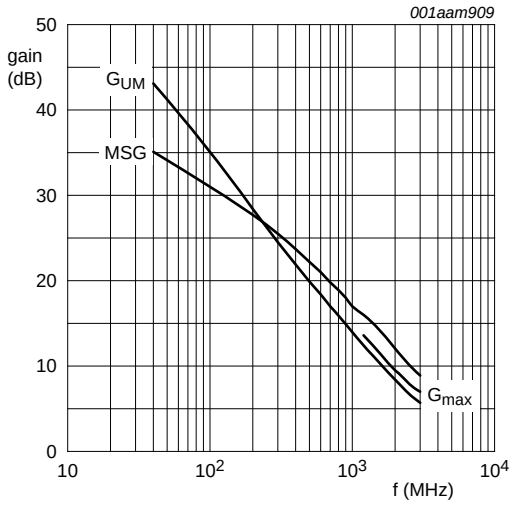

$V_{CE}$ = 10 V; f = 1 GHz.

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



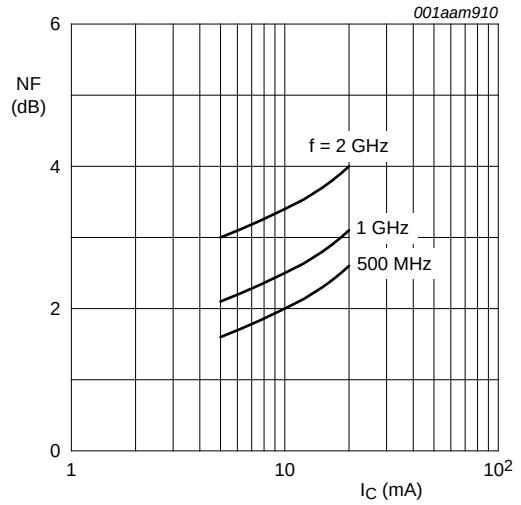

$V_{CE}$ = 10 V; $I_C$ = 5 mA.

**Fig 7. Gain as a function of frequency; typical values**



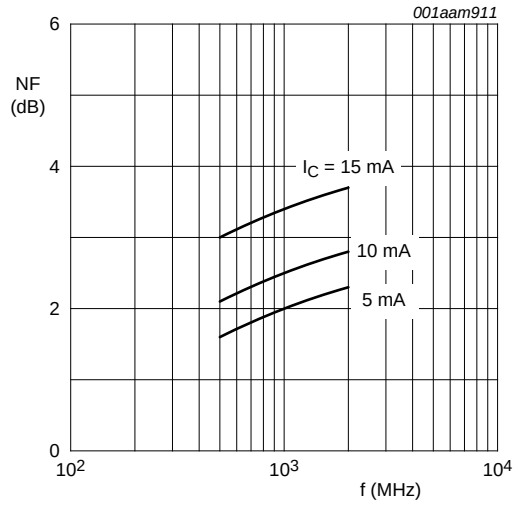

$V_{CE}$ = 10 V; $I_C$ = 5 mA.

**Fig 8. Minimum noise figure as a function of frequency; typical values**



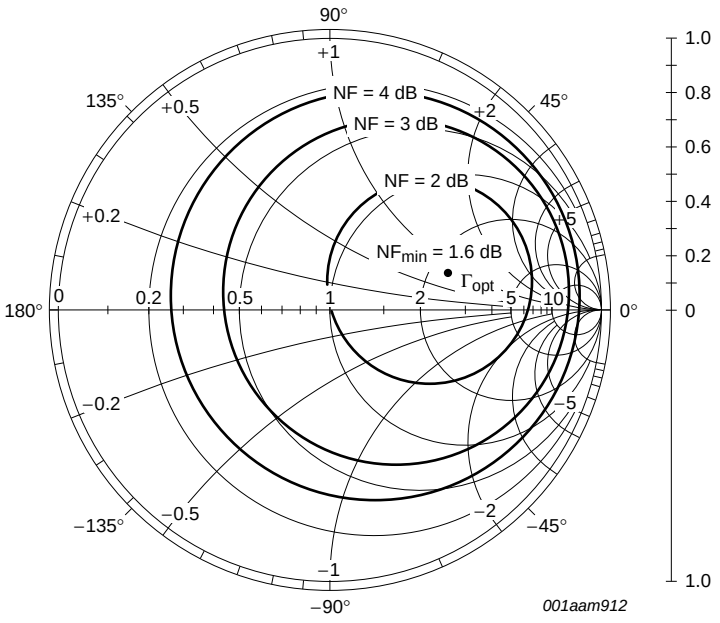

$V_{CE}$ = 10 V.

**Fig 9. Minimum noise figure as a function of collector current; typical values**



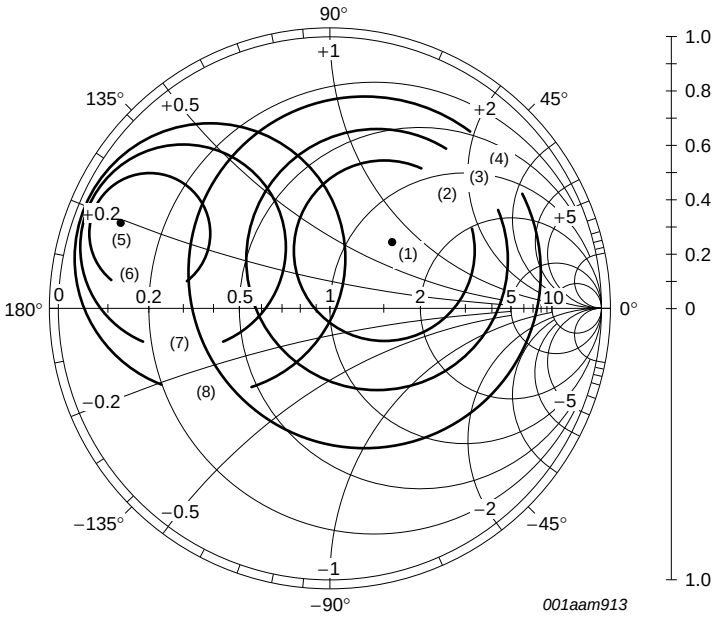

$V_{CE}$ = 10 V.

**Fig 10. Minimum noise figure as a function of frequency; typical values**




f = 500 MHz; $V_{CE}$ = 10 V; $I_C$ = 5 mA; $Z_O$ = 50 Ω.

**Fig 11. Common emitter noise figure circles; typical values**




f = 1 GHz; $V_{CE}$ = 10 V; $I_C$ = 5 mA; $Z_O$ = 50 Ω.

(1) $\Gamma_{opt}$; $NF_{min}$ = 2.1 dB

(2) NF = 2.5 dB

(3) NF = 3 dB

(4) NF = 4 dB

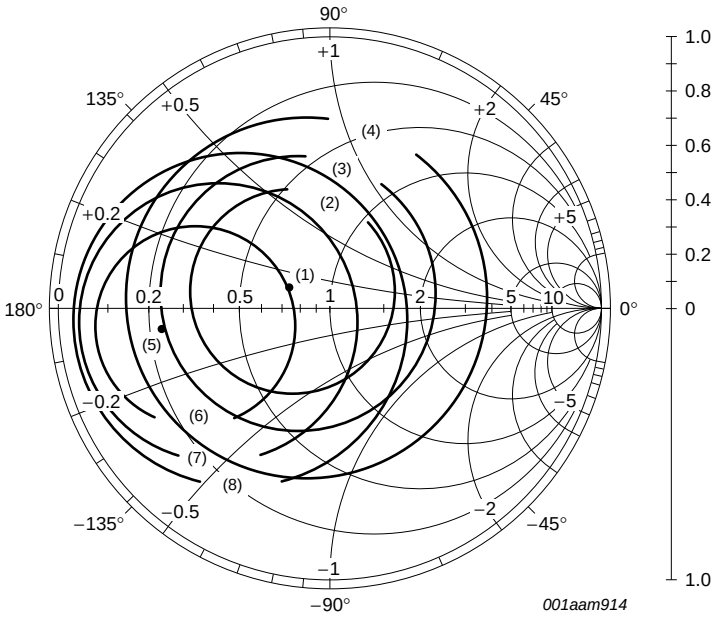
(5) $\Gamma_{ms}$; $G_{max}$ = 15.7 dB

(6) G = 15 dB

(7) G = 14 dB

(8) G = 13 dB

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




f = 2 GHz; $V_{CE}$ = 10 V; $I_C$ = 5 mA; $Z_O$ = 50 Ω.

(1) $\Gamma_{opt}$; $NF_{min}$ = 3 dB

(2) NF = 3.5 dB

(3) NF = 4 dB

(4) NF = 5 dB

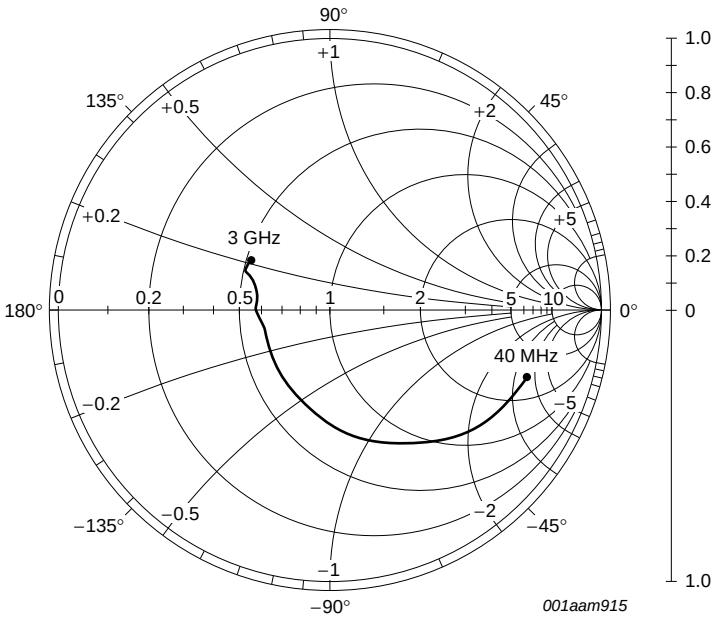
(5) $\Gamma_{ms}$; $G_{max}$ = 9.1 dB

(6) G = 8 dB

(7) G = 7 dB

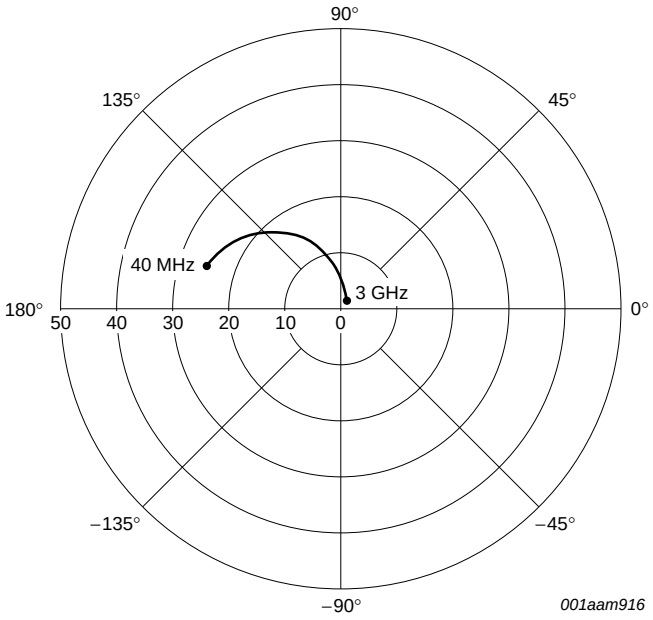
(8) G = 6 dB

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



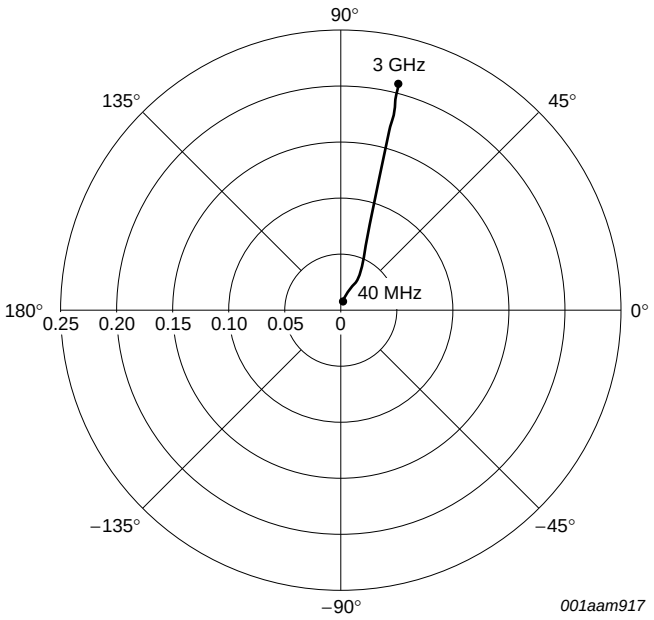

$V_{CE}$ = 10 V; $I_C$ = 15 mA; $Z_O$ = 50 Ω.

**Fig 14. Common emitter input reflection coefficient ($S_{11}$); typical values**



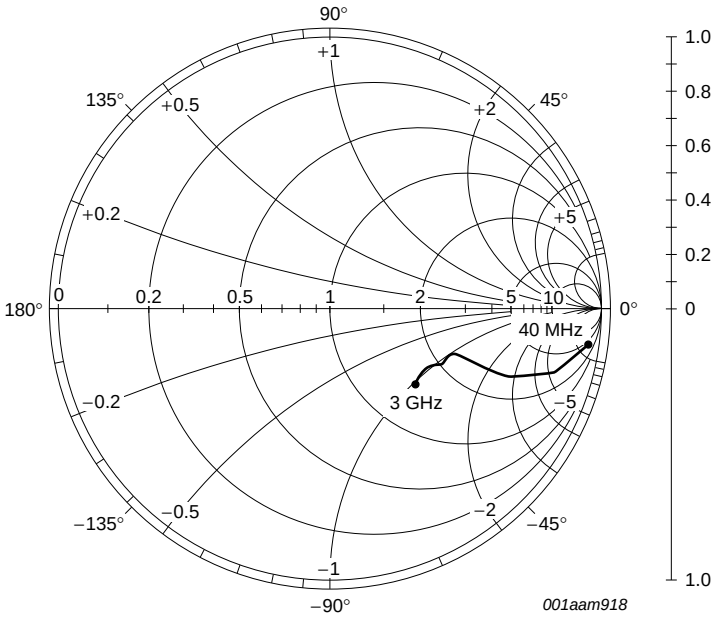

$V_{CE}$ = 10 V; $I_C$ = 15 mA.

**Fig 15. Common emitter forward transmission coefficient ($S_{21}$); typical values**




$V_{CE}$ = 10 V; $I_C$ = 15 mA.

**Fig 16. Common emitter reverse transmission coefficient ($S_{12}$); typical values**

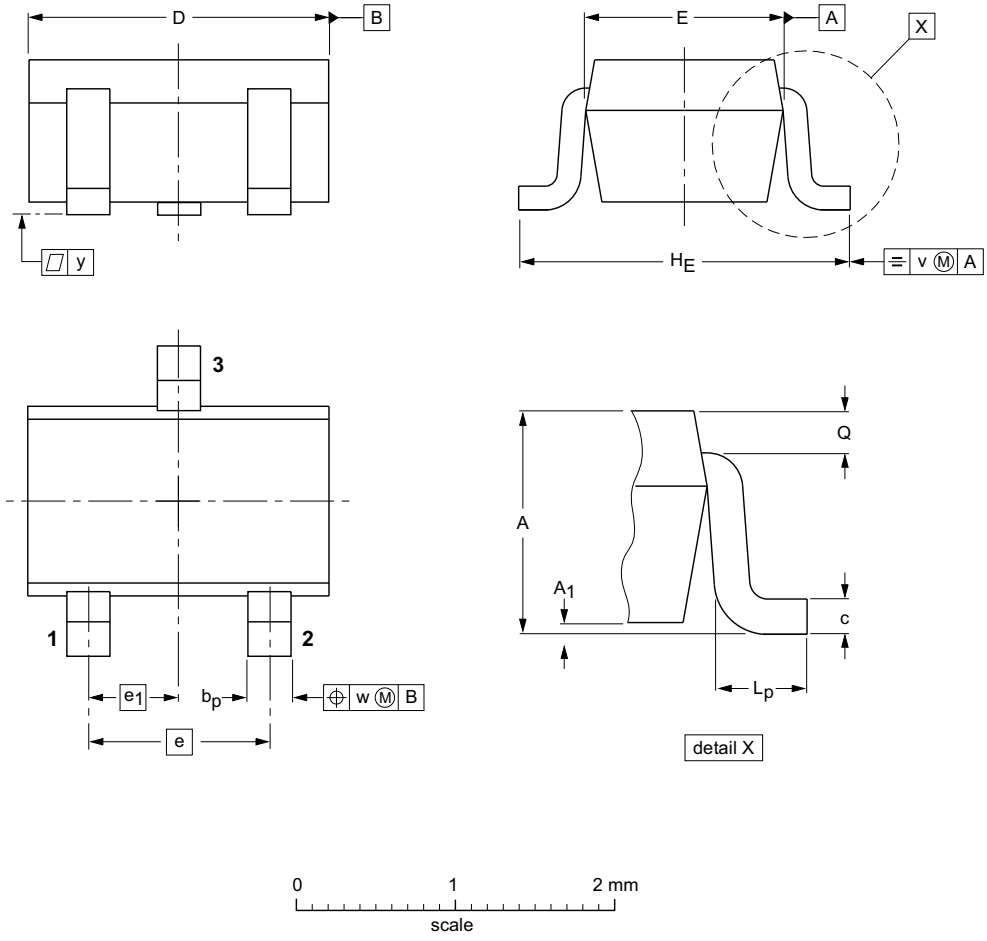



$V_{CE}$ = 10 V; $I_C$ = 15 mA.

**Fig 17. Common emitter output reflection coefficient ($S_{22}$); typical values**

## 8. Package outline

**Plastic surface-mounted package; 3 leads** **SOT323**




**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>0.8 | 0.1 | 0.4<br>0.3 | 0.25<br>0.10 | 2.2<br>1.8 | 1.35<br>1.15 | 1.3 | 0.65 | 2.2<br>2.0 | 0.45<br>0.15 | 0.23<br>0.13 | 0.2 | 0.2 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT323 | | | SC-70 | | | ~~04-11-04~~<br>06-03-16 |

**Fig 18. Package outline SOT323**

## 9. Abbreviations

**Table 8. Abbreviations**

| Acronym | Description |
|---|---|
| MSG | Maximum Stable Gain |
| NPN | Negative Positive Negative |
| RF | Radio Frequency |

## 10. Revision history

**Table 9. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| BFR94AW v.2 | 20141002 | Product data sheet | - | BFR94AW v.1 |
| Modifications: | • Table 2 on page 2: changed graphic symbol<br>• Figure 18 on page 11: updated | | | |
| BFR94AW v.1 | 20101029 | Product data sheet | - | - |

# 11. Legal information

## 11.1 Data sheet status

| Document status[1][2] | Product status[3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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