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# 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

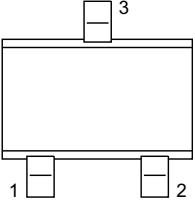
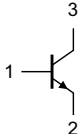
Table 1. Quick reference data

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	$T_{sp} \leq 93\text{ °C}$	-	-	300	mW
$h_{FE}$	DC current gain	$I_C = 15\text{ mA}; V_{CE} = 10\text{ V}$	65	90	135	
$C_{re}$	feedback capacitance	$I_C = 0\text{ mA}; V_{CE} = 10\text{ V};$ $f = 1\text{ MHz}; T_{amb} = 25\text{ °C}$	-	0.35	-	pF
$f_T$	transition frequency	$I_C = 15\text{ mA}; V_{CE} = 10\text{ V};$ $f = 500\text{ MHz}$	3.5	5	-	GHz
$G_{UM}$	unilateral power gain	$I_C = 15\text{ mA}; V_{CE} = 10\text{ V};$ $T_{amb} = 25\text{ °C}$				
		$f = 1\text{ GHz}$	-	14	-	dB
		$f = 2\text{ GHz}$	-	8	-	dB
NF	noise figure	$I_C = 5\text{ mA}; V_{CE} = 10\text{ V};$ $f = 1\text{ GHz}; \Gamma_S = \Gamma_{opt}$	-	2	-	dB
$T_j$	junction temperature		-	-	150	°C



## 2. Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Graphic symbol
1	base		 sym021
2	emitter		
3	collector		

## 3. Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
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	$T_{sp} \leq 93\text{ °C}$ ; see <a href="#">Figure 1</a> [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	$T_{sp} \leq 93\text{ °C}$	[1] 190	K/W

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

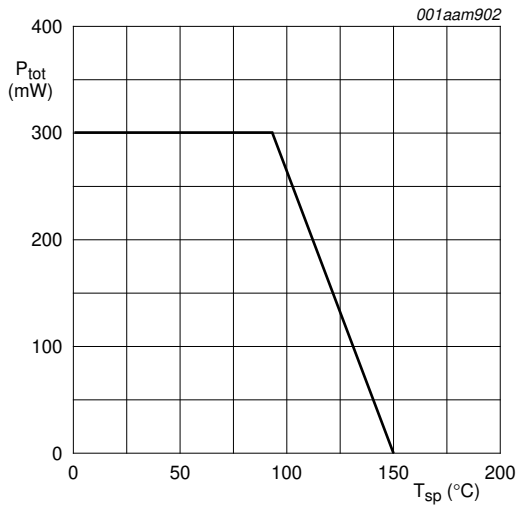
## 7. Characteristics

Table 7. Characteristics

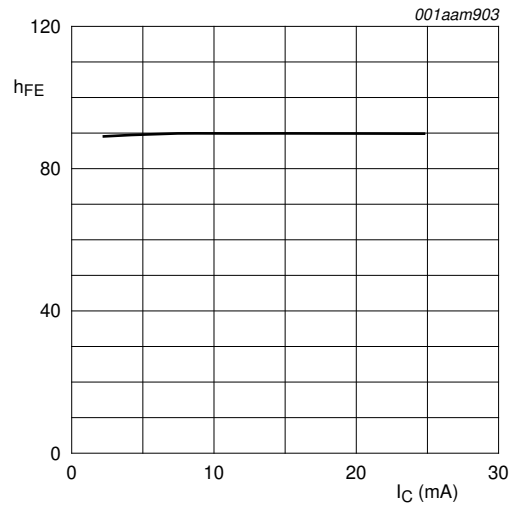
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CBO}$	collector-base cut-off current	$I_E = 0\text{ A}; V_{CB} = 10\text{ V}$	-	-	50	nA
$h_{FE}$	DC current gain	$I_C = 15\text{ mA}; V_{CE} = 10\text{ V}$	65	90	135	
$C_c$	collector capacitance	$I_E = i_e = 0\text{ A}; V_{CB} = 10\text{ V}; f = 1\text{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

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

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

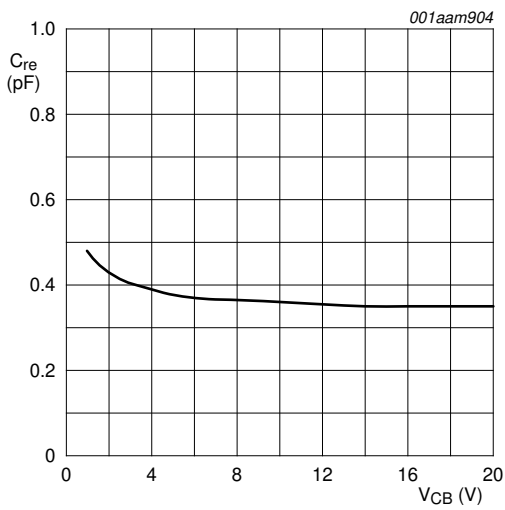


**Fig 1. Power derating curve**



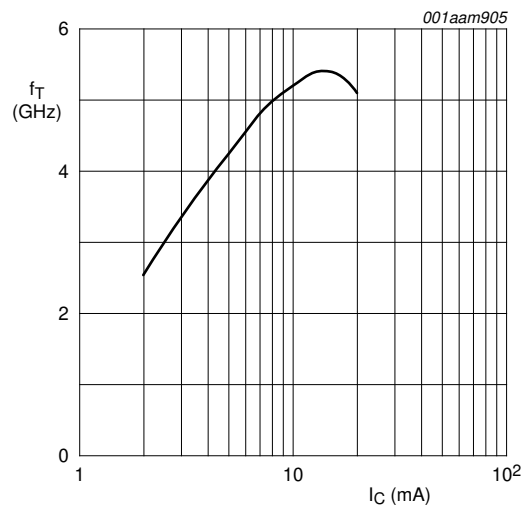
$V_{CE} = 10$  V.

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



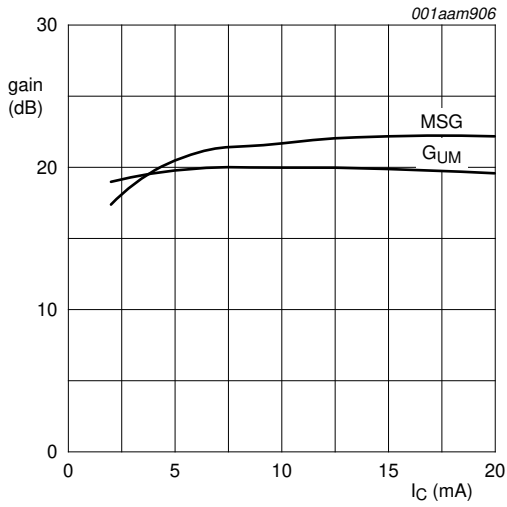
$I_C = 0$  mA;  $f = 1$  MHz.

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



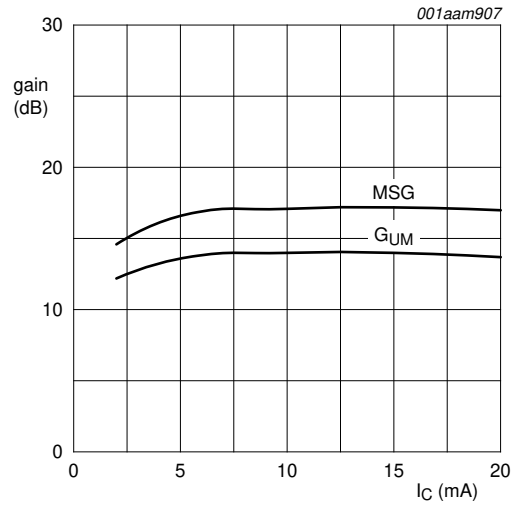
$V_{CE} = 5$  V;  $f = 500$  MHz;  $T_{amb} = 25$  °C.

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



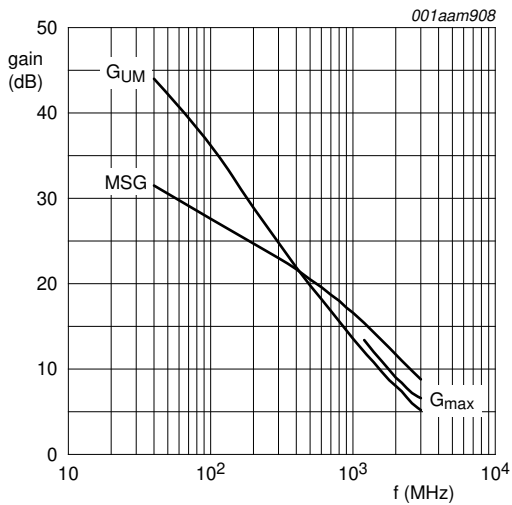
$V_{CE} = 10\text{ V}; f = 500\text{ MHz}.$

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



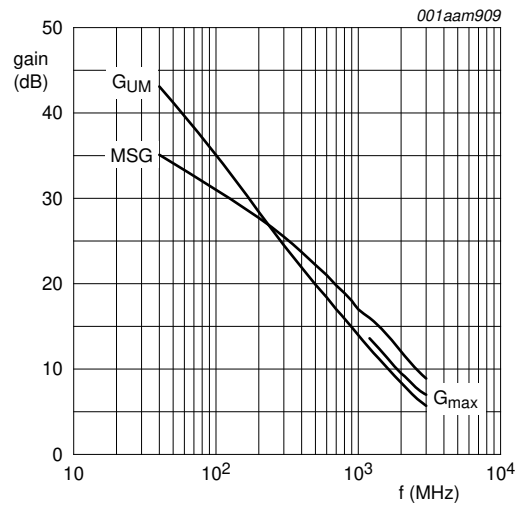
$V_{CE} = 10\text{ V}; f = 1\text{ GHz}.$

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



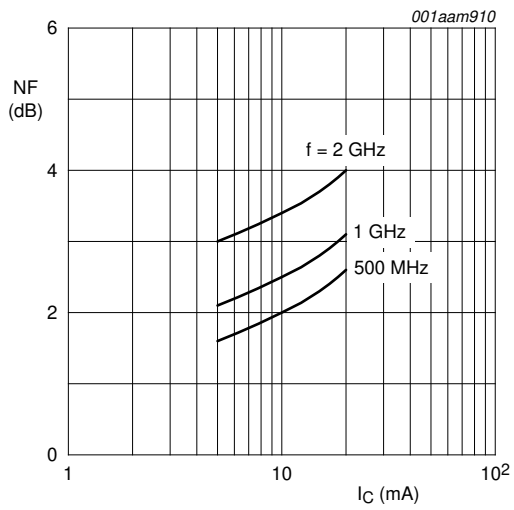
$V_{CE} = 10\text{ V}; I_C = 5\text{ mA}.$

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



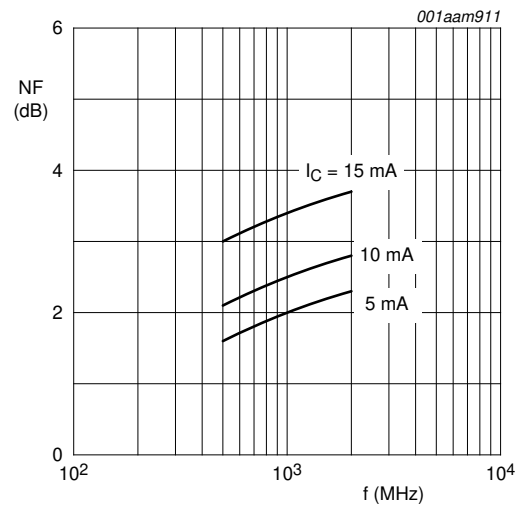
$V_{CE} = 10\text{ V}; I_C = 5\text{ mA}.$

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



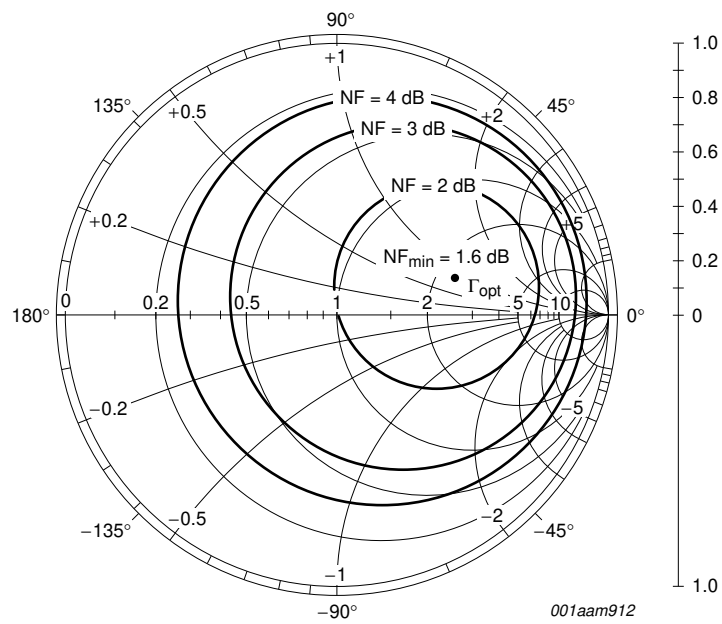
V<sub>CE</sub> = 10 V.

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



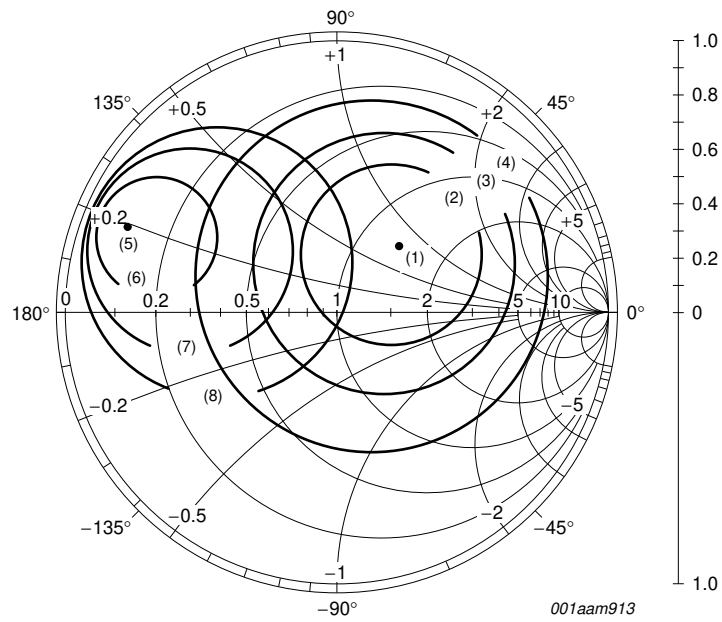
V<sub>CE</sub> = 10 V.

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



f = 500 MHz; V<sub>CE</sub> = 10 V; I<sub>C</sub> = 5 mA; Z<sub>O</sub> = 50 Ω.

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

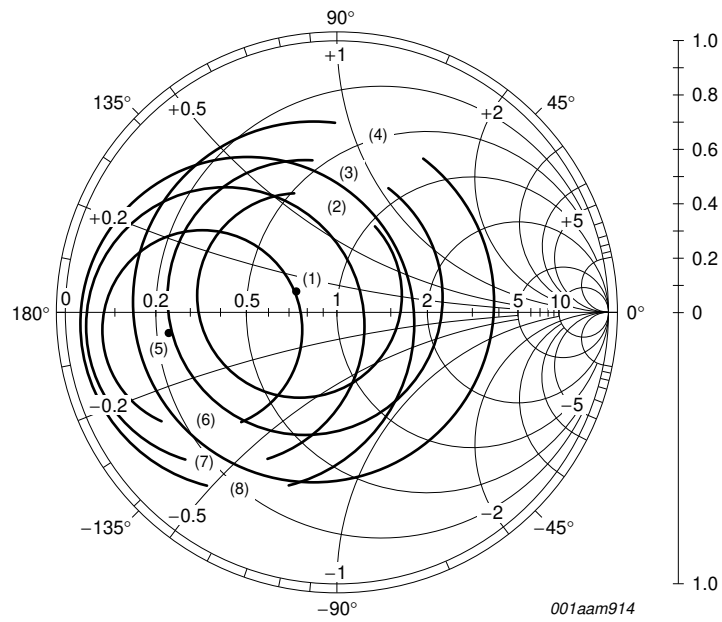


$f = 1 \text{ GHz}; V_{CE} = 10 \text{ V}; I_C = 5 \text{ mA}; Z_O = 50 \Omega.$

- (1)  $\Gamma_{opt}; NF_{min} = 2.1 \text{ dB}$
- (2)  $NF = 2.5 \text{ dB}$
- (3)  $NF = 3 \text{ dB}$
- (4)  $NF = 4 \text{ dB}$
- (5)  $\Gamma_{ms}; G_{max} = 15.7 \text{ dB}$
- (6)  $G = 15 \text{ dB}$
- (7)  $G = 14 \text{ dB}$
- (8)  $G = 13 \text{ dB}$

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

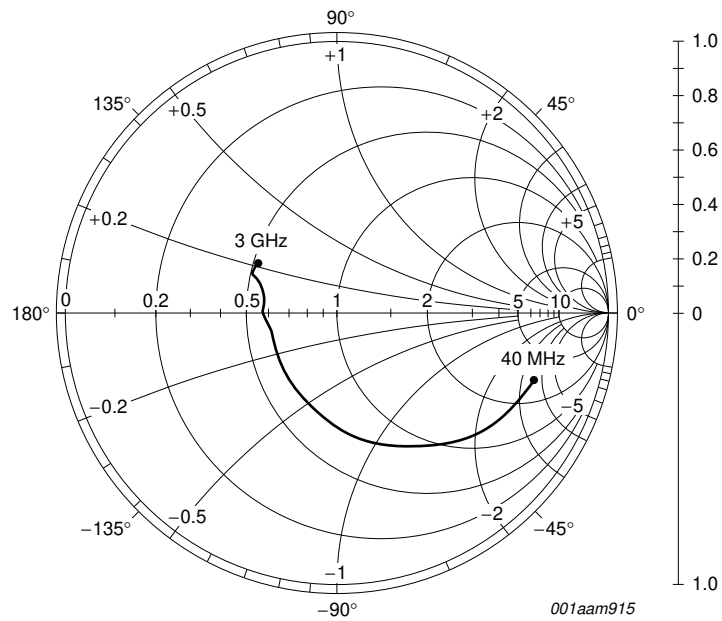




$f = 2 \text{ GHz}; V_{CE} = 10 \text{ V}; I_C = 5 \text{ mA}; Z_O = 50 \Omega.$

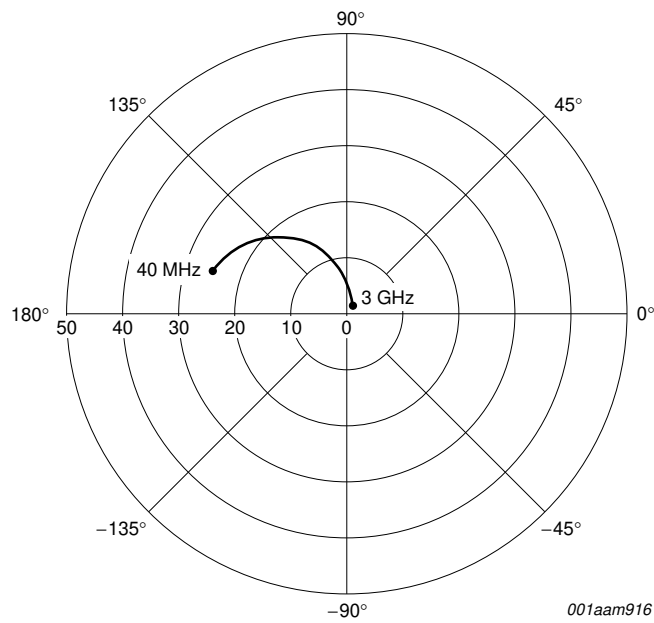
- (1)  $\Gamma_{opt}; NF_{min} = 3 \text{ dB}$
- (2)  $NF = 3.5 \text{ dB}$
- (3)  $NF = 4 \text{ dB}$
- (4)  $NF = 5 \text{ dB}$
- (5)  $\Gamma_{ms}; G_{max} = 9.1 \text{ dB}$
- (6)  $G = 8 \text{ dB}$
- (7)  $G = 7 \text{ dB}$
- (8)  $G = 6 \text{ dB}$

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



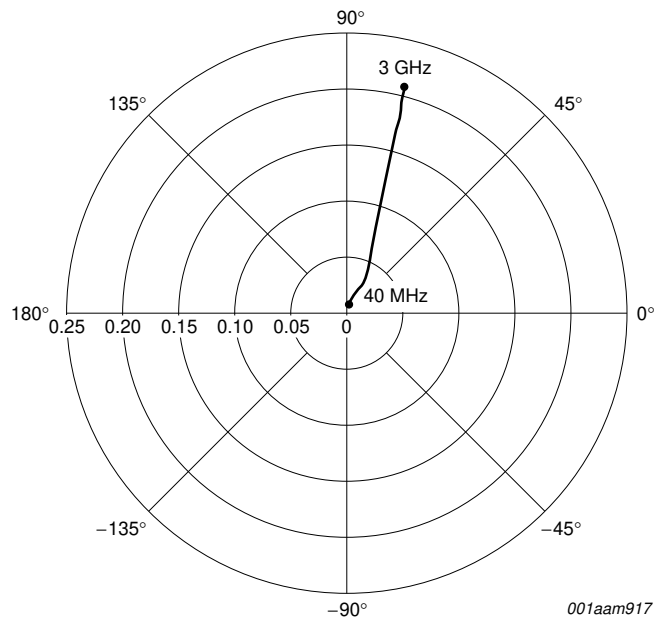
$V_{CE} = 10\text{ V}; I_C = 15\text{ mA}; Z_O = 50\ \Omega.$

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



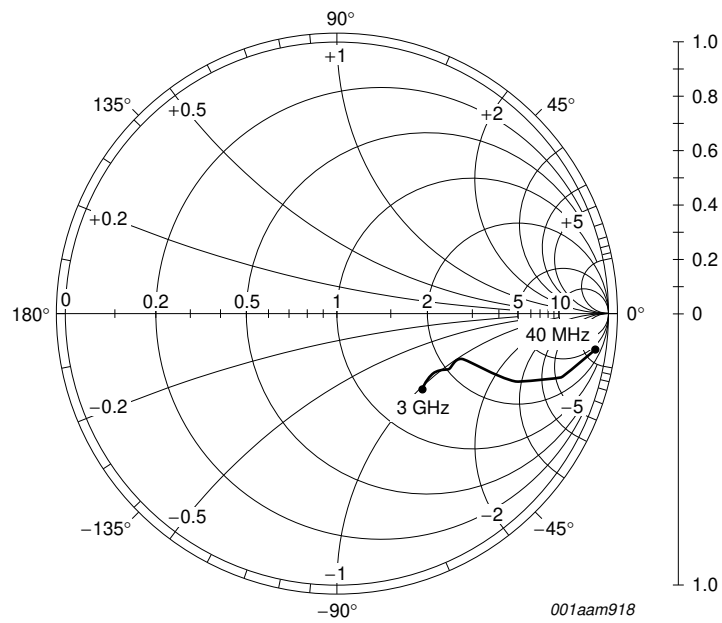
$V_{CE} = 10\text{ V}; I_C = 15\text{ mA}.$

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



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

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



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

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

**8. Package outline**

Plastic surface-mounted package; 3 leads

SOT323

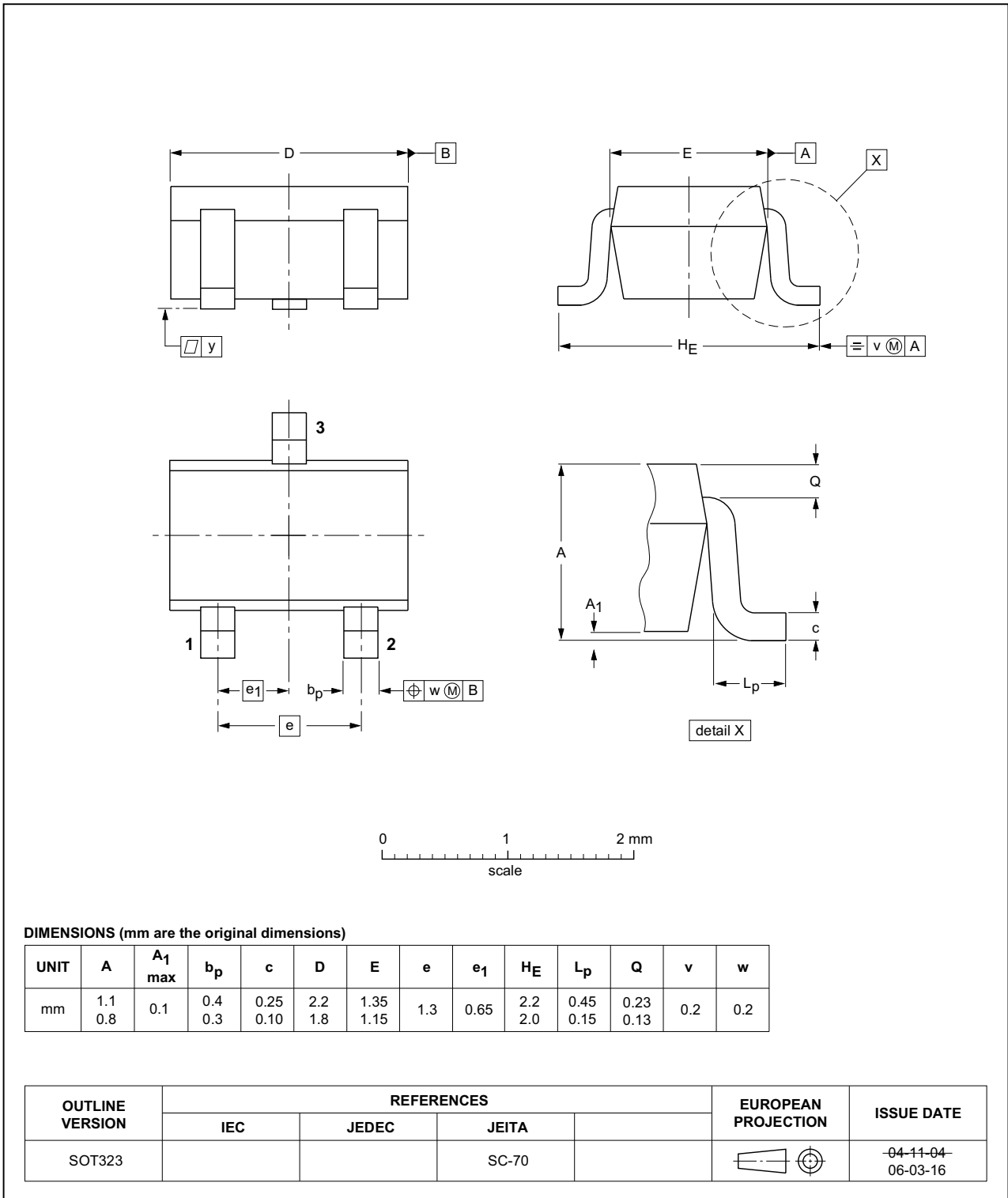


Fig 18. Package outline SOT323

## 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:	<ul style="list-style-type: none"><li>• <a href="#">Table 2 on page 2</a>: changed graphic symbol</li><li>• <a href="#">Figure 18 on page 11</a>: updated</li></ul>			
BFR94AW v.1	20101029	Product data sheet	-	-

## 11. Legal information

### 11.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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.

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

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## 13. Contents

<b>1</b>	<b>Product profile</b> . . . . .	<b>1</b>
1.1	General description . . . . .	1
1.2	Features and benefits . . . . .	1
1.3	Applications . . . . .	1
1.4	Quick reference data . . . . .	1
<b>2</b>	<b>Pinning information</b> . . . . .	<b>2</b>
<b>3</b>	<b>Ordering information</b> . . . . .	<b>2</b>
<b>4</b>	<b>Marking</b> . . . . .	<b>2</b>
<b>5</b>	<b>Limiting values</b> . . . . .	<b>2</b>
<b>6</b>	<b>Thermal characteristics</b> . . . . .	<b>3</b>
<b>7</b>	<b>Characteristics</b> . . . . .	<b>3</b>
<b>8</b>	<b>Package outline</b> . . . . .	<b>11</b>
<b>9</b>	<b>Abbreviations</b> . . . . .	<b>12</b>
<b>10</b>	<b>Revision history</b> . . . . .	<b>12</b>
<b>11</b>	<b>Legal information</b> . . . . .	<b>13</b>
11.1	Data sheet status . . . . .	13
11.2	Definitions . . . . .	13
11.3	Disclaimers . . . . .	13
11.4	Trademarks . . . . .	14
<b>12</b>	<b>Contact information</b> . . . . .	<b>14</b>
<b>13</b>	<b>Contents</b> . . . . .	<b>15</b>

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