BFR540

NPN 9 GHz wideband transistor

Rev. 6 — 13 September 2011 **Product data sheet**

1. Product profile

1.1 General description

The BFR540 is an NPN silicon planar epitaxial transistor in a SOT23 plastic package.

1.2 Features and benefits

- High power gain
- Low noise figure
- High transition frequency
- Gold metallization ensures excellent reliability.

1.3 Applications

- RF front end wideband applications in the GHz range
    - Analog and digital cellular telephones
    - Cordless telephones (CT1, CT2, DECT, etc.)
    - Radar detectors
    - Satellite TV tuners (SATV)
    - MATV/CATV amplifiers
    - Repeater amplifiers in fiber-optic systems.

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_{CES}	collector-emitter voltage	$R_{BE} = 0\ \Omega$		-	-	15	V
I_C	collector current (DC)			-	-	120	mA
P_{tot}	total power dissipation	$T_{sp} \leq 70\ °C$	[1]	-	-	500	mW
h_{FE}	DC current gain	$I_C = 40$ mA; $V_{CE} = 8$ V		100	120	250	
C_{re}	feedback capacitance	$I_C = i_c = 0$ A; $V_{CB} = 8$ V; f = 1 MHz		-	0.6	-	pF
f_T	transition frequency	$I_C = 40$ mA; $V_{CE} = 8$ V; f = 1 GHz		-	9	-	GHz
G_{UM}	maximum unilateral power gain	$I_C = 40$ mA; $V_{CE} = 8$ V; $T_{amb} = 25\ °C$					
		f = 900 MHz		-	14	-	dB
		f = 2 GHz		-	7	-	dB

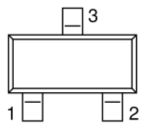
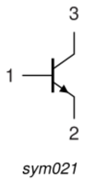
Table 1. Quick reference data *…continued*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\|s_{21}\|^2$	insertion power gain	I_C = 40 mA; V_{CE} = 8 V; T_{amb} = 25 °C; f = 900 MHz	12	13	-	dB
NF	noise figure	$\Gamma_s = \Gamma_{opt}$; V_{CE} = 8 V; T_{amb} = 25 °C				
		I_C = 10 mA; f = 900 MHz	-	1.3	1.8	dB
		I_C = 40 mA; f = 900 MHz	-	1.9	2.4	dB
		I_C = 10 mA; f = 2 GHz	-	2.1	-	dB

[1] T_{sp} is the temperature at the soldering point of the collector tab.

2. Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Symbol
1	base		
2	emitter		
3	collector		

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BFR540	-	plastic surface mounted package; 3 leads	SOT23

4. Marking

Table 4. Marking

Type number	Marking code[1]
BFR540	33*

[1] * = p: Made in Hong Kong

* = t: Made in Malaysia

* = W: Made in China.

5. Limiting values

Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CBO}	collector-base voltage	open emitter		-	20	V
V_{CES}	collector-emitter voltage	$R_{BE} = 0\ \Omega$		-	15	V
V_{EBO}	emitter-base voltage	open collector		-	2.5	V
I_C	collector current (DC)			-	120	mA
P_{tot}	total power dissipation	$T_{sp} \leq 70$ °C	[1]	-	500	mW
T_{stg}	storage temperature			–65	+150	°C
T_j	junction temperature			-	175	°C

[1] T_{sp} is the temperature at the soldering point of the collector tab.

6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-sp)}$	thermal resistance from junction to soldering point		[1]	260	K/W

[1] T_{sp} is the temperature at the soldering point of the collector tab.

7. Characteristics

Table 7. Characteristics

T_j = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{CBO}	collector cut-off current	$I_E = 0$ A; $V_{CB} = 8$ V		-	-	50	nA
h_{FE}	DC current gain	$I_C = 40$ mA; $V_{CE} = 8$ V		100	120	250	
C_e	emitter capacitance	$I_C = i_c = 0$ A; $V_{EB} = 0.5$ V; f = 1 MHz		-	2	-	pF
C_c	collector capacitance	$I_E = i_e = 0$ A; $V_{CB} = 8$ V; f = 1 MHz		-	0.9	-	pF
C_{re}	feedback capacitance	$I_C = 0$ A; $V_{CB} = 8$ V; f = 1 MHz		-	0.6	-	pF
f_T	transition frequency	$I_C = 40$ mA; $V_{CE} = 8$ V; f = 1 GHz		-	9	-	GHz
G_{UM}	maximum unilateral power gain	$I_C = 40$ mA; $V_{CE} = 8$ V; $T_{amb} = 25$ °C	[1]				
		f = 900 MHz		-	14	-	dB
		f = 2 GHz		-	7	-	dB
$\|s_{21}\|^2$	insertion power gain	$I_C = 40$ mA; $V_{CE} = 8$ V; $T_{amb} = 25$ °C; f = 900 MHz		12	13	-	dB

Table 7. Characteristics *...continued*

T_j = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
NF	noise figure	$\Gamma_s = \Gamma_{opt}$; V_{CE} = 8 V; T_{amb} = 25 °C					
		I_C = 10 mA; f = 900 MHz		-	1.3	1.8	dB
		I_C = 40 mA; f = 900 MHz		-	1.9	2.4	dB
		I_C = 10 mA; f = 2 GHz		-	2.1	-	dB
$P_{L(1dB)}$	output power at 1 dB gain compression	I_C = 40 mA; V_{CE} = 8 V; R_L = 50 Ω; T_{amb} = 25 °C; f = 900 MHz		-	21	-	dBm
ITO	third order intercept point		[2]	-	34	-	dBm
V_O	output voltage	I_C = 40 mA; V_{CE} = 8 V; $Z_L = Z_S$ = 75 Ω; T_{amb} = 25 °C	[3]	-	550	-	mV

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

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

[2] I_C = 40 mA; V_{CE} = 8 V; R_L = 50 Ω; T_{amb} = 25 °C; f = 900 MHz; f_p = 900 MHz; f_q = 902 MHz.
Measured at $f_{(2p-q)}$ = 898 MHz and $f_{(2q-p)}$ = 904 MHz.

[3] d_{im} = –60 dB (DIN 45004B); $V_p = V_O$; $V_q = V_O$ – 6 dB; f_p = 795.25 MHz; $V_R = V_O$ – 6 dB; f_q = 803.25 MHz; f_r = 805.25 MHz.
Measured at $f_{(p+q-r)}$ = 793.25 MHz.

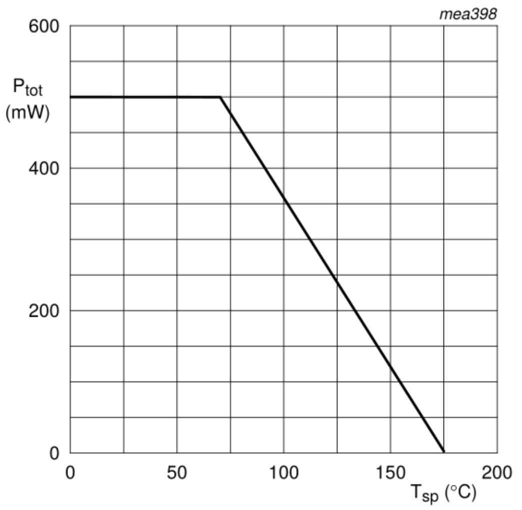
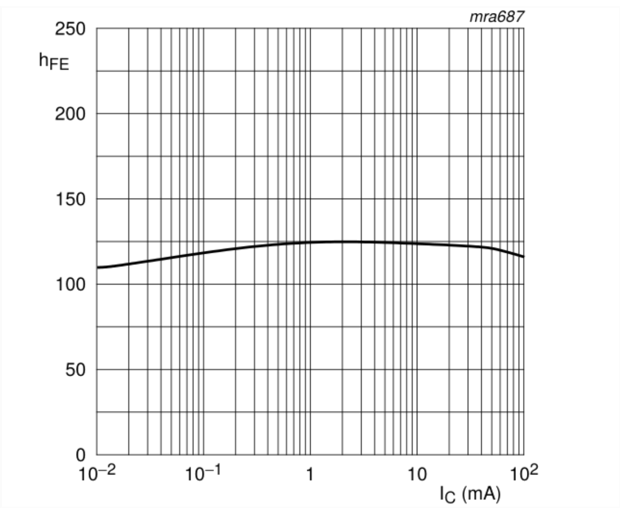
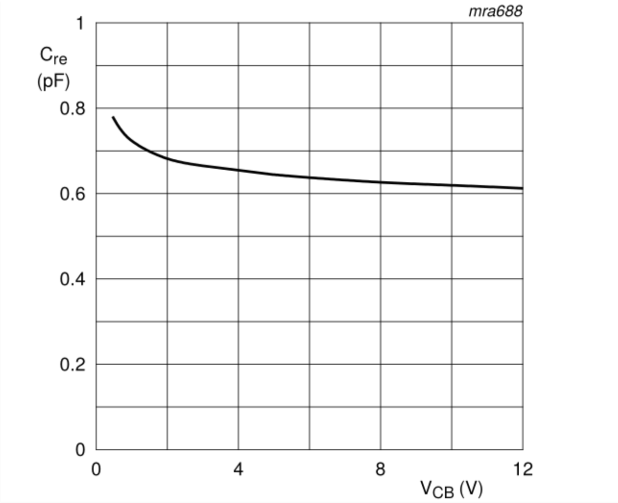


Fig 1. Power derating curve.



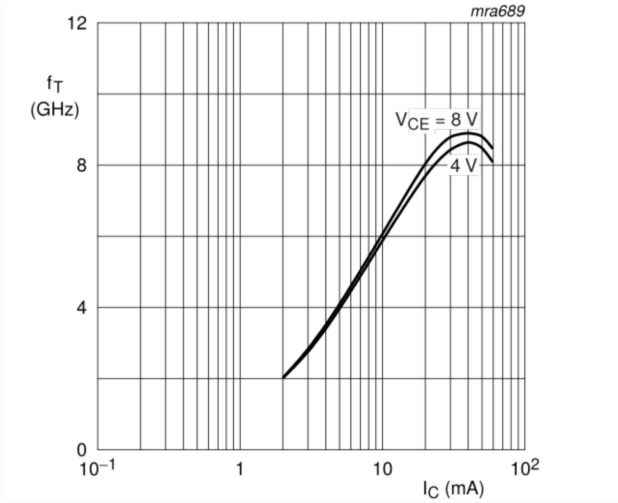
V_{CE} = 8 V.

Fig 2. DC current gain as a function of collector current.



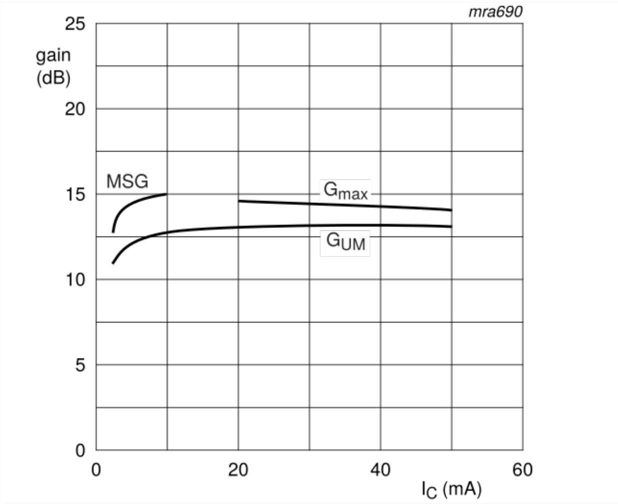
I_C = 0 A; f = 1 MHz.

Fig 3. Feedback capacitance as a function of collector-base voltage.



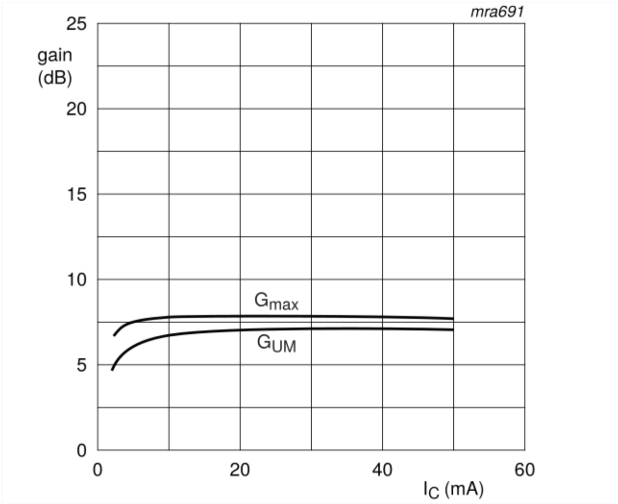
T_{amb} = 25 °C; f = 1 GHz.

Fig 4. Transition frequency as a function of collector current.



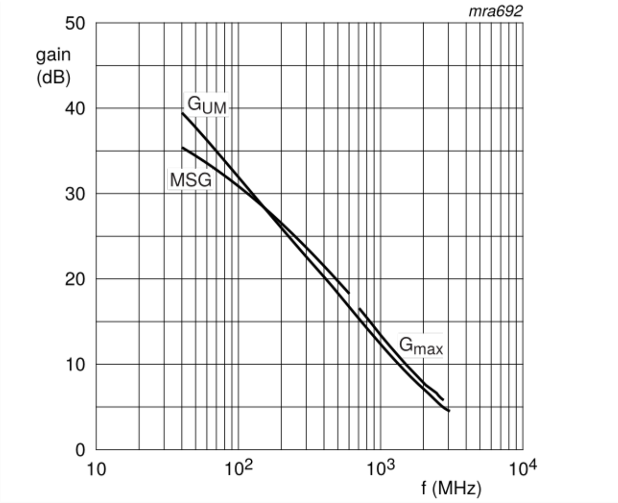
V_{CE} = 8 V; f = 900 MHz.

Fig 5. Gain as a function of collector current.



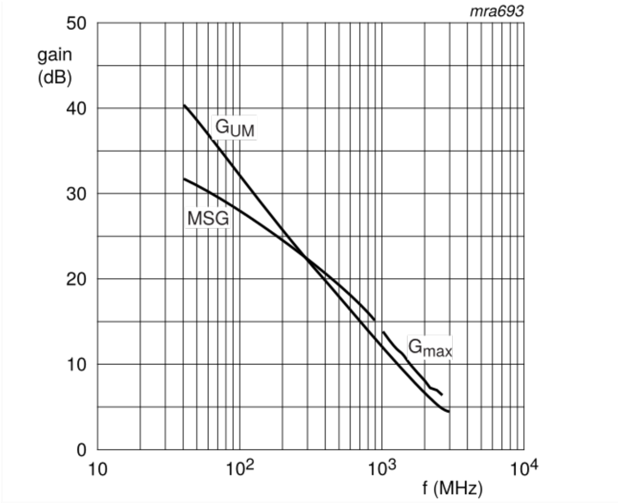
V_{CE} = 8 V; f = 2 GHz.

Fig 6. Gain as a function of collector current.



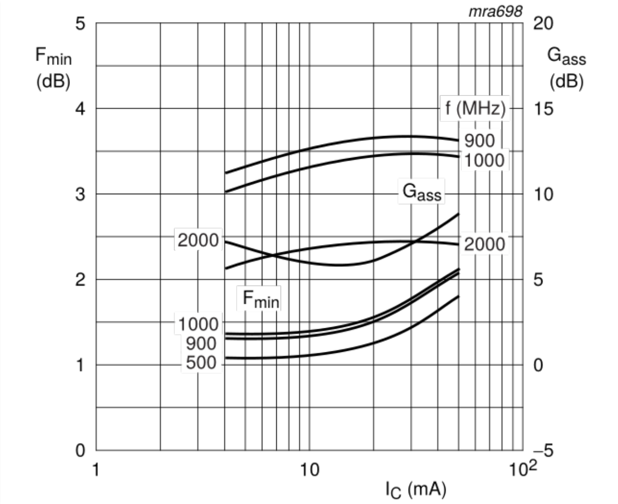
V_{CE} = 8 V; I_C = 10 mA.

Fig 7. Gain as a function of frequency; I_C = 10 mA.



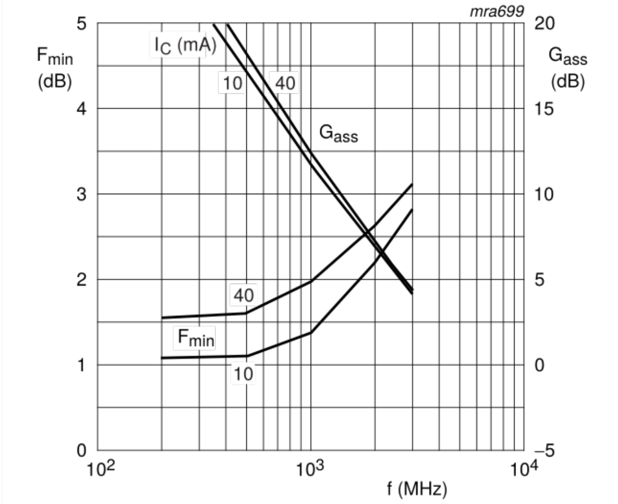
V_{CE} = 8 V; I_C = 40 mA.

Fig 8. Gain as a function of frequency; I_C = 40 mA.



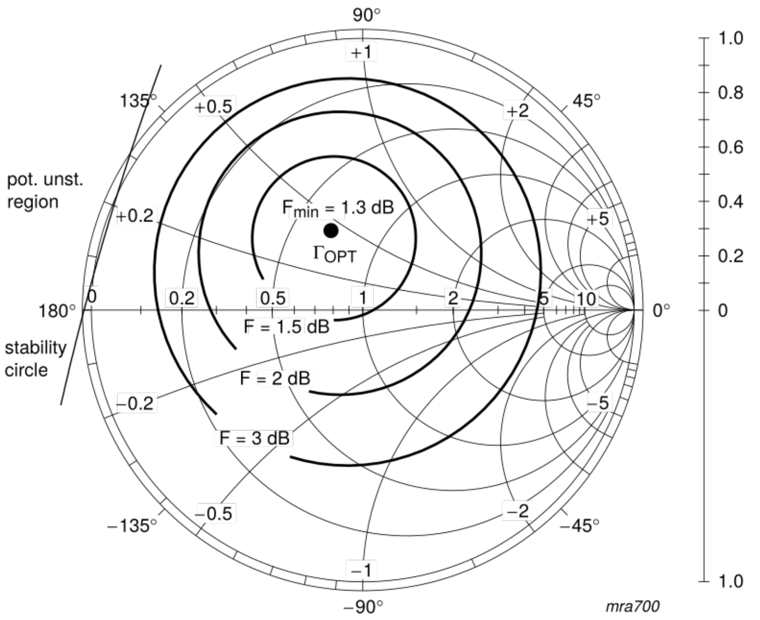
V_{CE} = 8 V.

Fig 9. Minimum noise figure and associated available gain as a function of collector current.



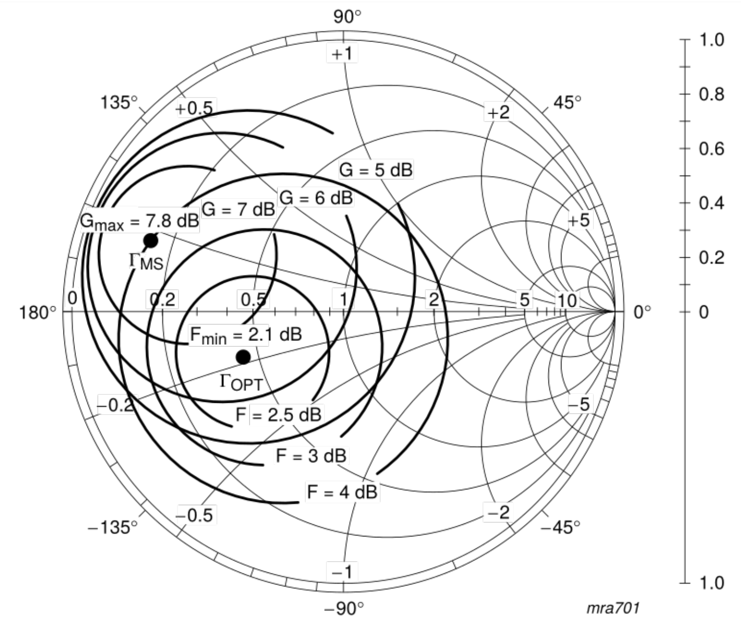
V_{CE} = 8 V.

Fig 10. Minimum noise figure and associated available gain as a function of frequency.



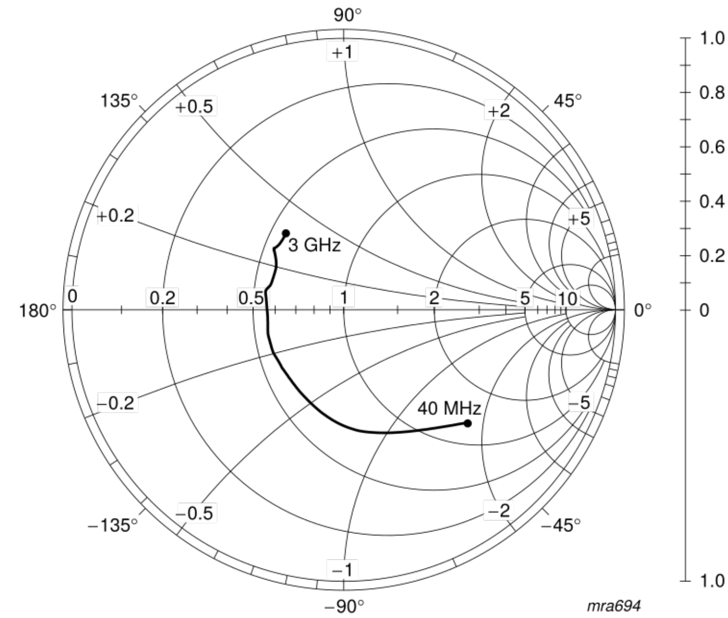
Z_o = 50 Ω; V_{CE} = 8 V; I_C = 10 mA; f = 900 MHz.

Fig 11. Noise circle figure; f = 900 MHz.



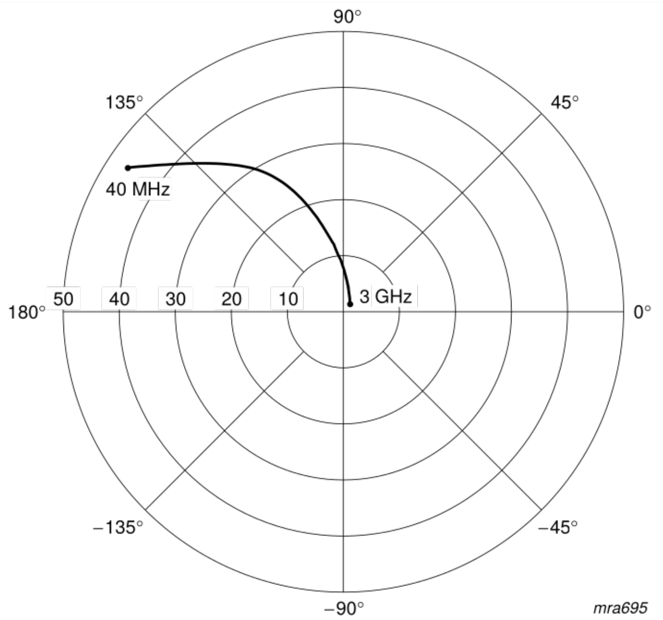
Z_o = 50 Ω; V_{CE} = 8 V; I_C = 10 mA; f = 2000 MHz.

Fig 12. Noise circle figure; f = 2000 MHz.



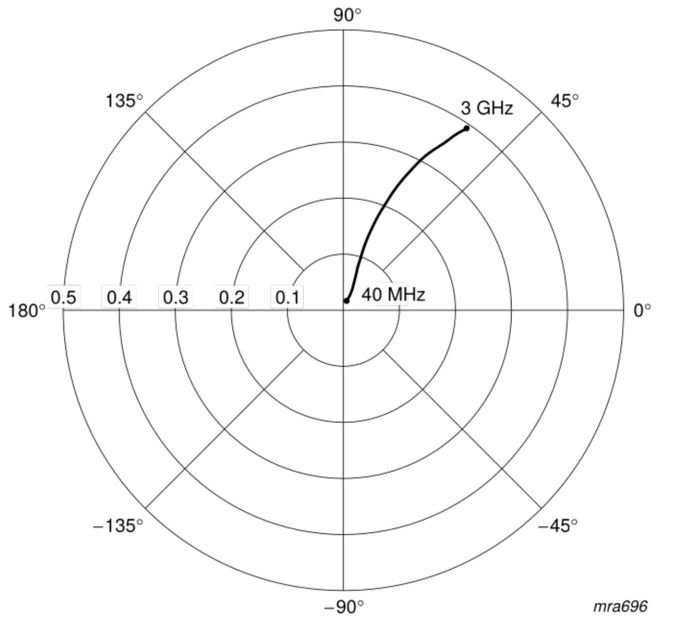
V_{CE} = 8 V; I_C = 40 mA; Z_o = 50 Ω.

Fig 13. Common emitter input reflection coefficient (s_{11}).



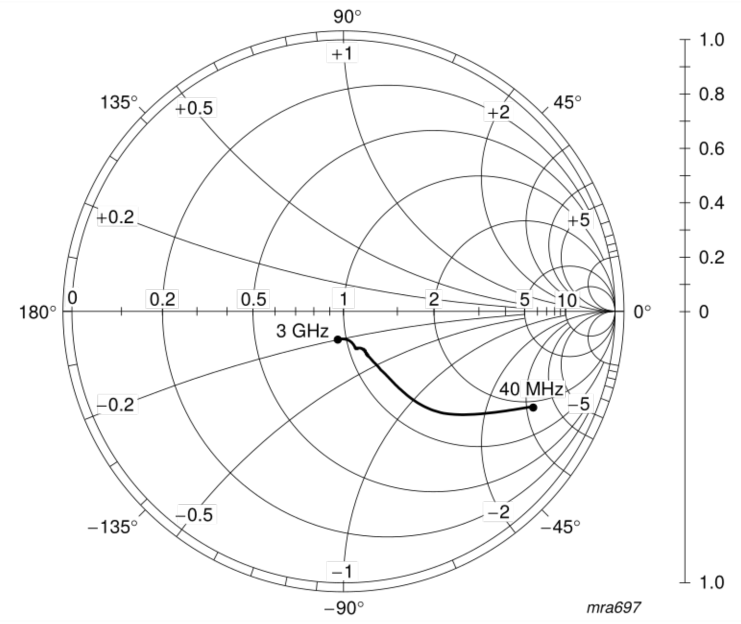
V_{CE} = 8 V; I_C = 40 mA.

Fig 14. Common emitter forward transmission coefficient (s_{21}).



V_{CE} = 8 V; I_C = 40 mA.

Fig 15. Common emitter reverse transmission coefficient (s_{12}).

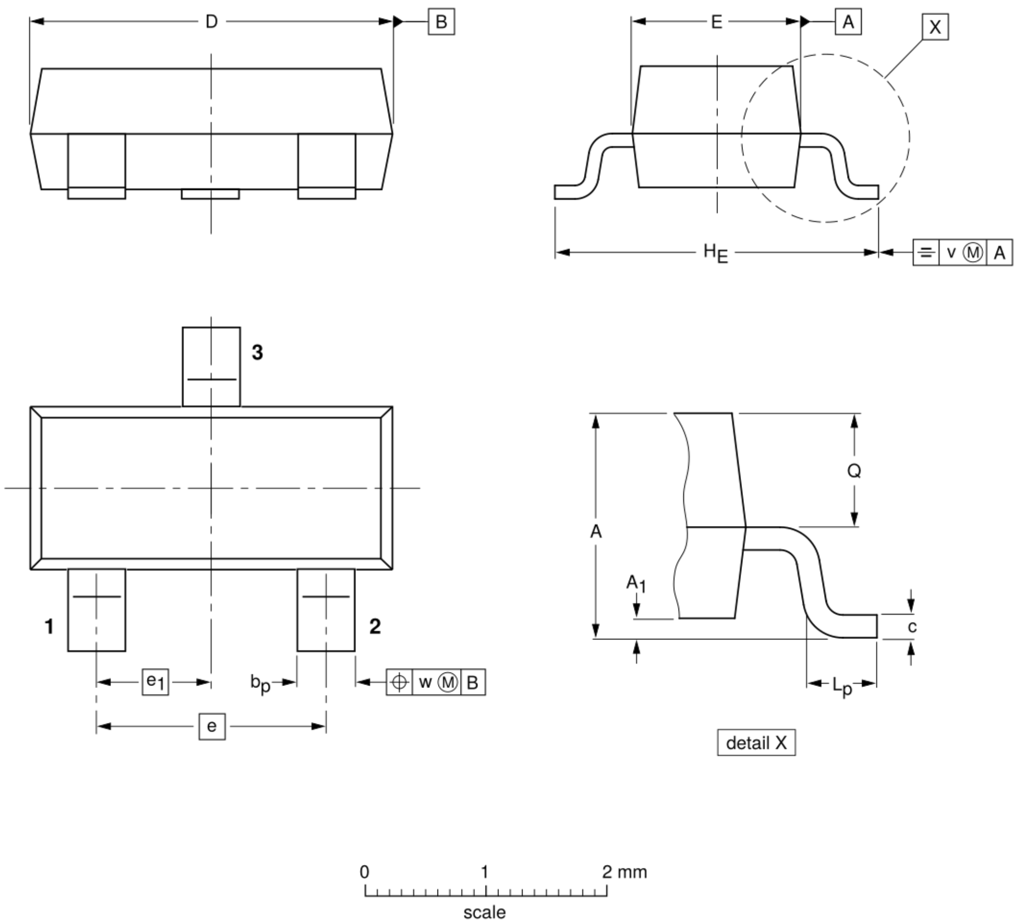


V_{CE} = 8 V; I_C = 40 mA; Z_o = 50 Ω.

Fig 16. Common emitter output reflection coefficient (s_{22}).

8. Package outline

Plastic surface-mounted package; 3 leads **SOT23**



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 0.9	0.1	0.48 0.38	0.15 0.09	3.0 2.8	1.4 1.2	1.9	0.95	2.5 2.1	0.45 0.15	0.55 0.45	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT23		TO-236AB				~~04-11-04~~ 06-03-16

Fig 17. Package outline SOT23 (T0-236AB).

9. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BFR540 v.6	20110913	Product data sheet	-	BFR540 v.5
Modifications:	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate. • Package outline drawings have been updated to the latest version.			
BFR540 v.5 (9397 750 13398)	20040901	Product data sheet	-	BFR540 v.4
BFR540 v.4 (9397 750 07062)	20000530	Product specification	-	BFR540 v.3
BFR540 v.3 (9397 750 06338)	19990823	Product specification	-	BFR540_CNV v.2
BFR540_CNV v.2	19971204	Product specification	-	-

10. Legal information

10.1 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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11. Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

12. Contents

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