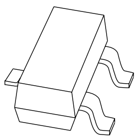


BFR540

NPN 9 GHz wideband transistor

Rev. 05 — 1 September 2004 **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

- 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

PHILIPS

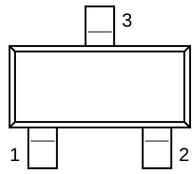
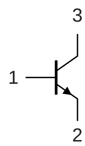
Table 1: Quick reference data *...continued*

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	 SOT23	 sym021
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
$R_{th(j\text{-}sp)}$	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.

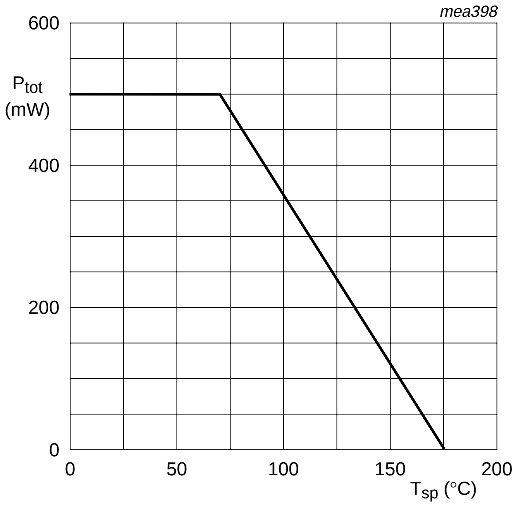
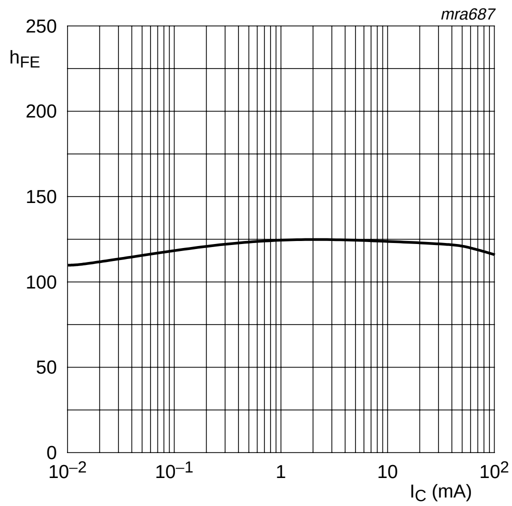
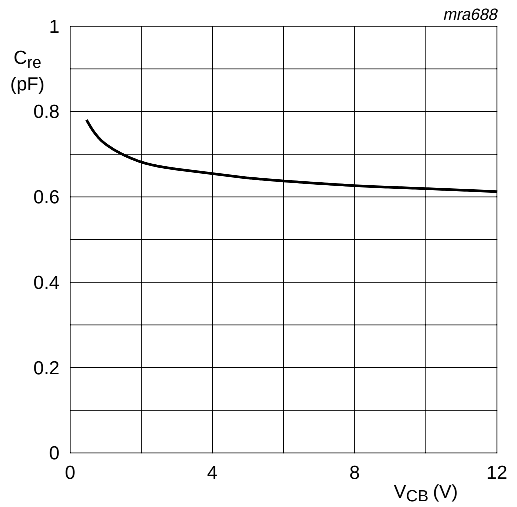


Fig 1. Power derating curve.



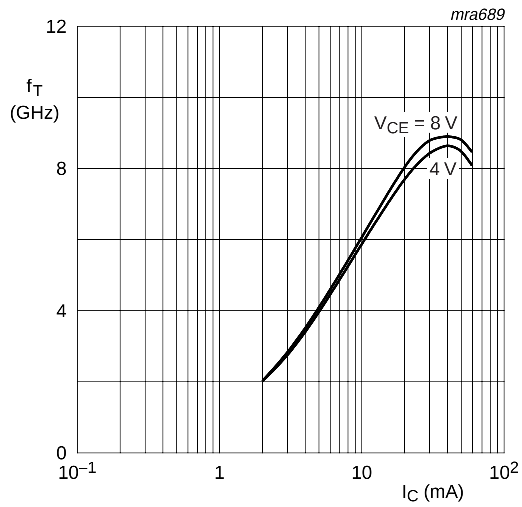
V_{CE} = 8 V.

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



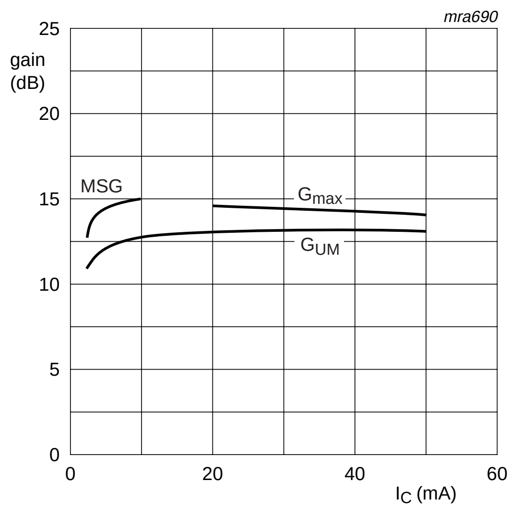
I_C = 0 A; f = 1 MHz.

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



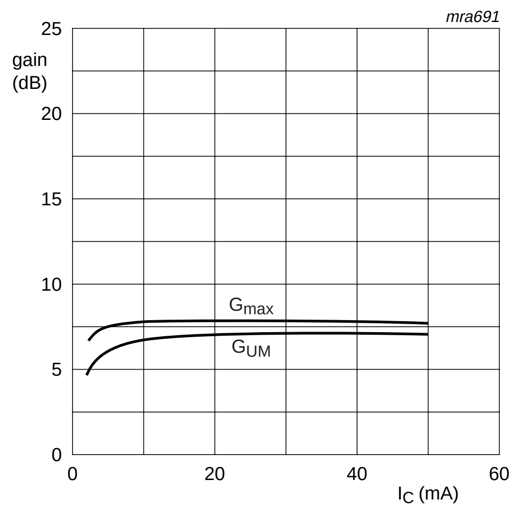
T_{amb} = 25 °C; f = 1 GHz.

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



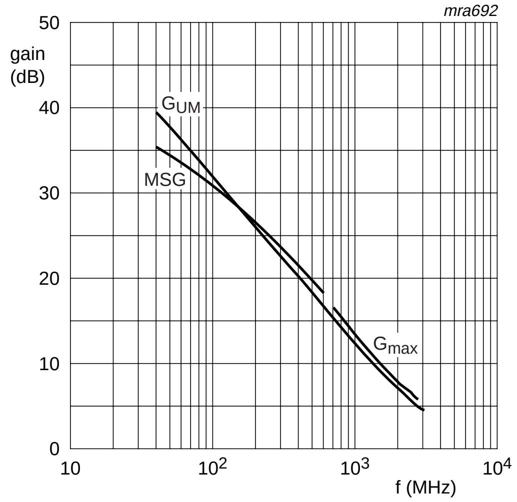
V_{CE} = 8 V; f = 900 MHz.

Fig 5. Gain as a function of collector current.



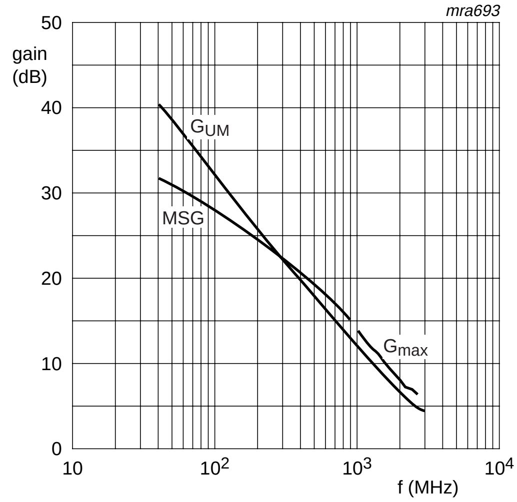
V_{CE} = 8 V; f = 2 GHz.

Fig 6. Gain as a function of collector current.



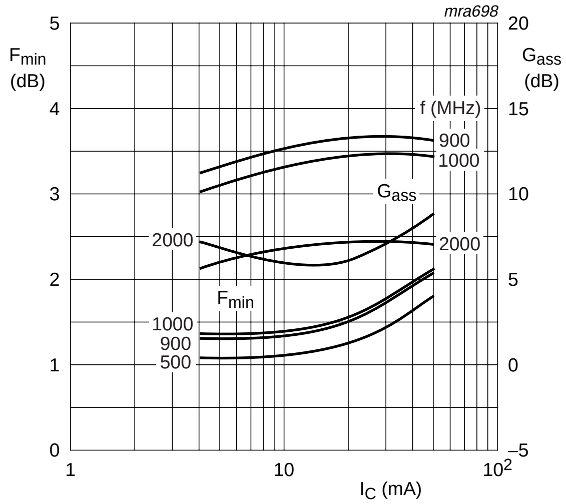
V_{CE} = 8 V; I_C = 10 mA.

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



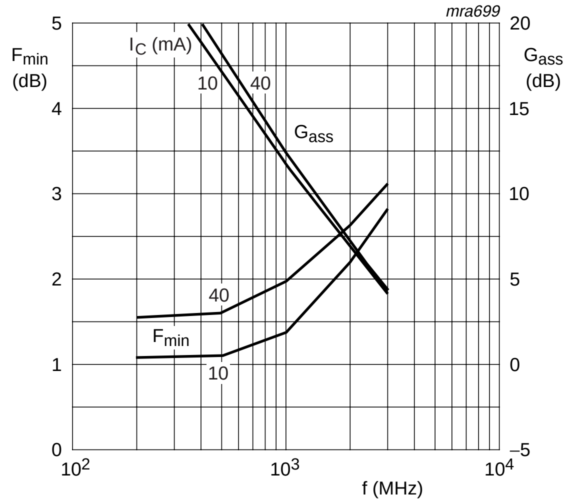
V_{CE} = 8 V; I_C = 40 mA.

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



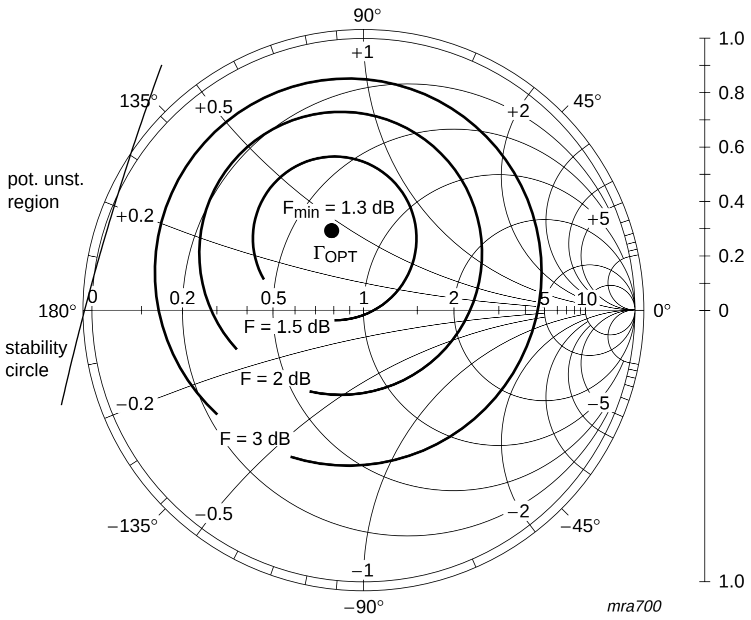
V_{CE} = 8 V.

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



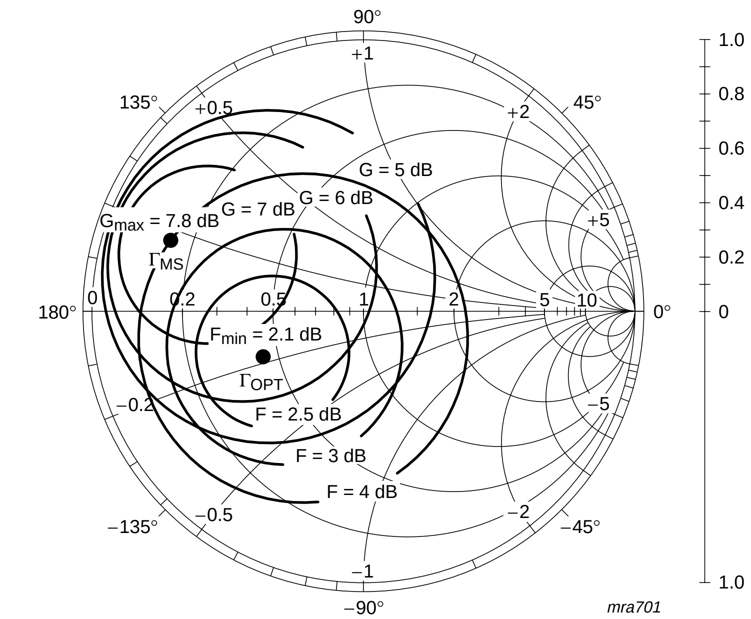
V_{CE} = 8 V.

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



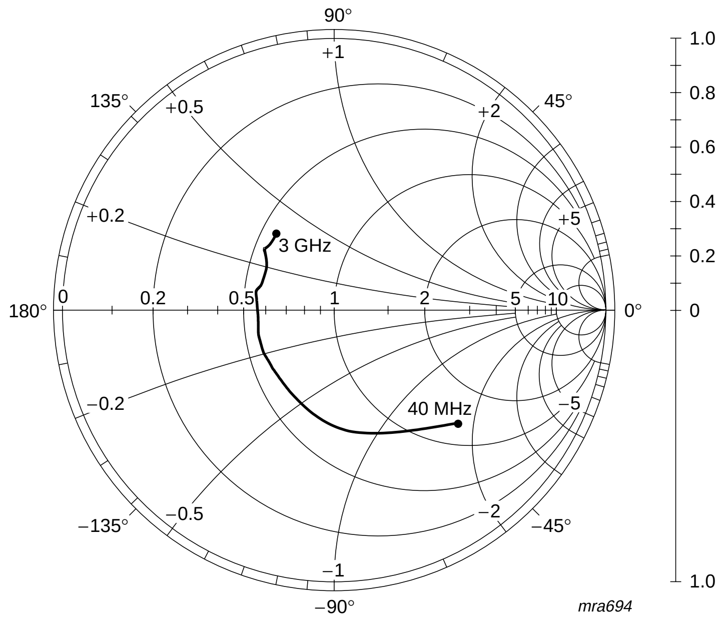
Z_o = 50 Ω; V_{CE} = 8 V; I_C = 10 mA; f = 900 MHz.

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



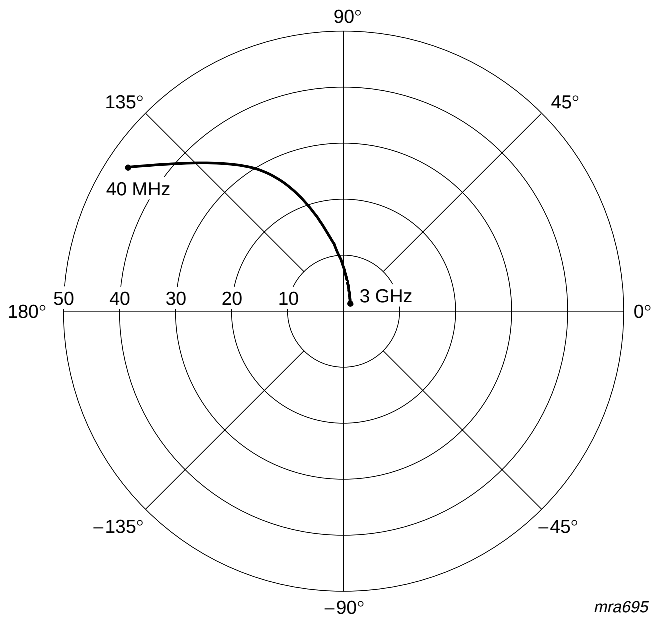
Z_o = 50 Ω; V_{CE} = 8 V; I_C = 10 mA; f = 2000 MHz.

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



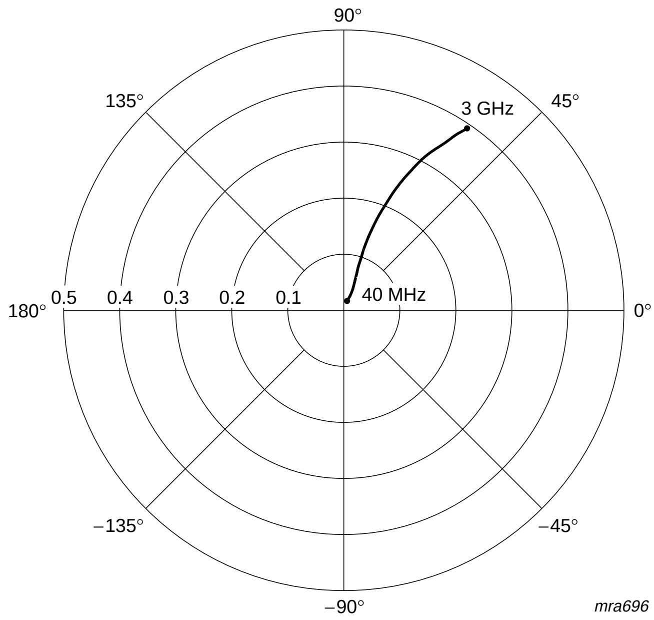
V_{CE} = 8 V; I_C = 40 mA; Z_o = 50 Ω.

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



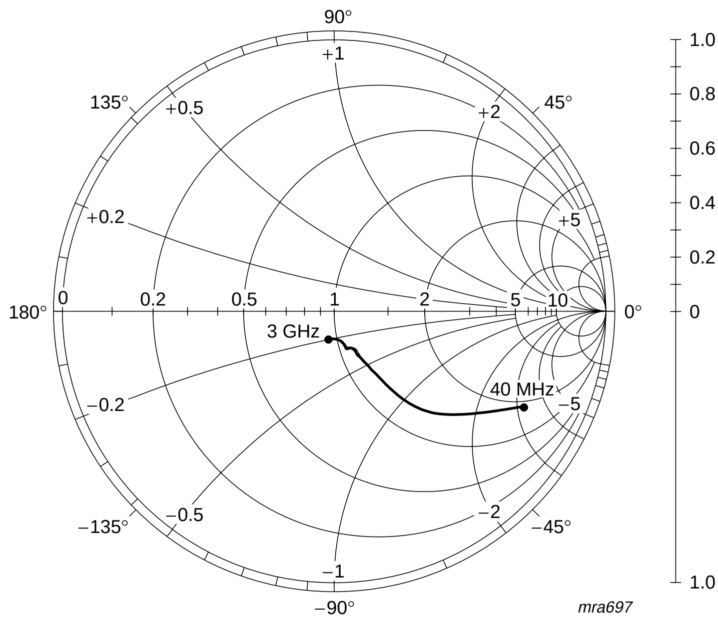
V_{CE} = 8 V; I_C = 40 mA.

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}).

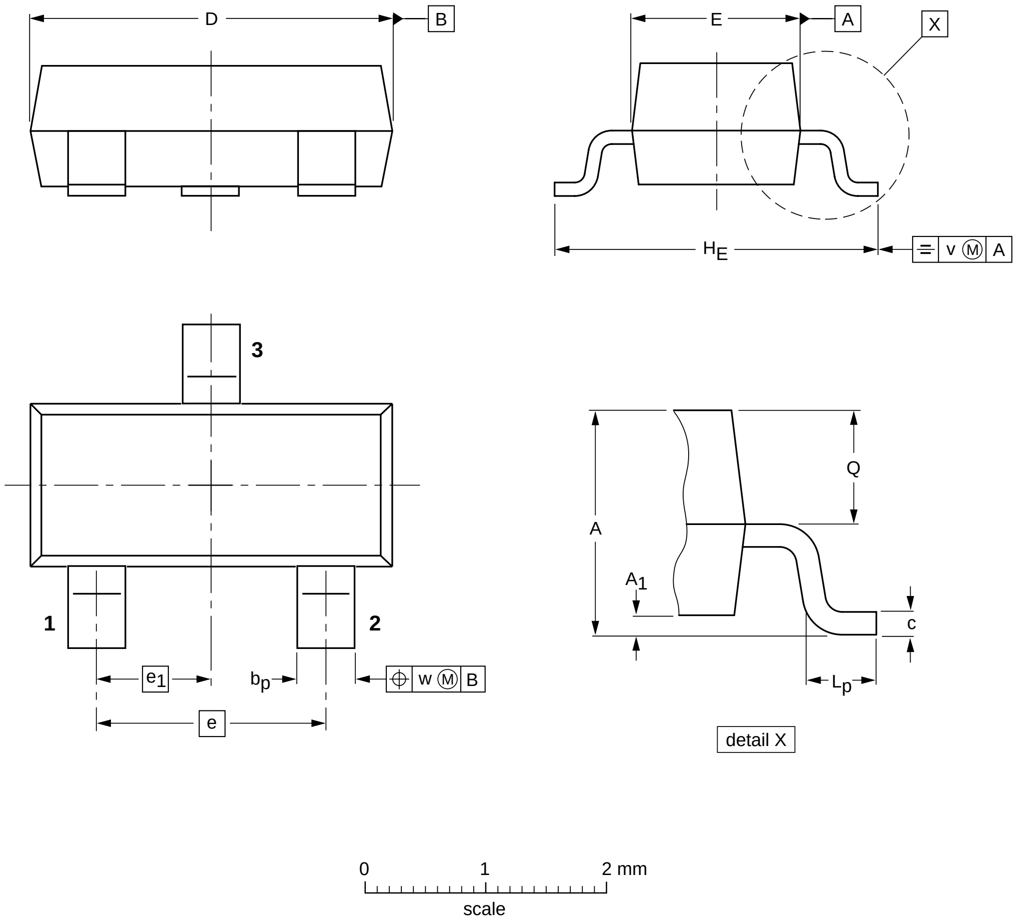


V_{CE} = 8 V; I_C = 40 mA; Z_o = 50 Ω.

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	EIAJ			
SOT23		TO-236AB				~~97-02-28~~ 99-09-13

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

9. Revision history

Table 8: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
BFR540_5	20040901	Product data sheet	-	9397 750 13398	BFR540_4
Modifications:	• The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors. • Table 4 "Marking": Format of marking code changed.				
BFR540_4	20000530	Product specification	-	9397 750 07062	BFR540_3
BFR540_3	19990823	Product specification	-	9397 750 06338	BFR540_CNV_2
BFR540_CNV_2	19971204	Product specification	-	not applicable	-

10. Data sheet status

Level	Data sheet status [1]	Product status [2] [3]	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

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

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

11. Definitions

Short-form specification — The data in a short-form 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.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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 — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

12. Disclaimers

Life support — These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips Semiconductors customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips Semiconductors for any damages resulting from such application.

Right to make changes — Philips Semiconductors reserves the right to make changes in the products - including circuits, standard cells, and/or software - described or contained herein in order to improve design and/or performance. When the product is in full production (status ‘Production’), relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN). Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no license or title under any patent, copyright, or mask work right to these products, and makes no representations or warranties that these products are free from patent, copyright, or mask work right infringement, unless otherwise specified.

13. Contact information

For additional information, please visit: **http://www.semiconductors.philips.com**

For sales office addresses, send an email to: **sales.addresses@www.semiconductors.philips.com**

14. Contents

Date of release: 1 September 2004
Document number: 9397 750 13398

Published in The Netherlands