

# DATA SHEET

## **BFG540; BFG540/X; BFG540/XR** NPN 9 GHz wideband transistor

Product specification  
Supersedes data of 1997 Dec 03

2000 May 23

**NPN 9 GHz wideband transistor**

**BFG540; BFG540/X;  
BFG540/XR**

**FEATURES**

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

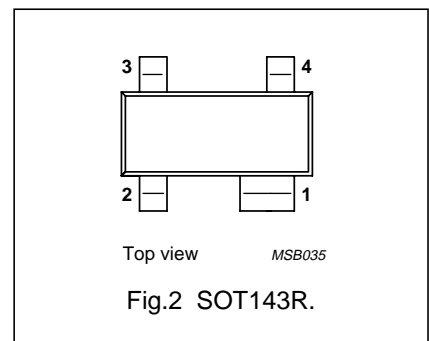
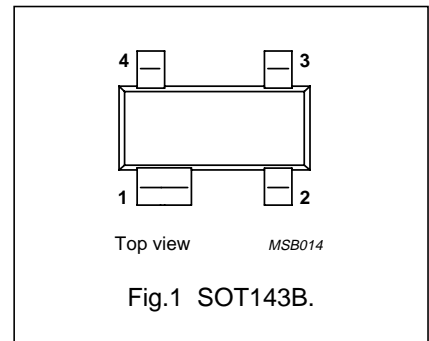
**DESCRIPTION**

NPN silicon planar epitaxial transistors, intended for wideband applications in the GHz range, such as analog and digital cellular telephones, cordless telephones (CT1, CT2, DECT, etc.), radar detectors, satellite TV tuners (SATV), MATV/CATV amplifiers and repeater amplifiers in fibre-optical systems.

The transistors are mounted in plastic SOT143B and SOT143R packages.

**PINNING**

PIN	DESCRIPTION
BFG540 (Fig.1) Code: N37	
1	collector
2	base
3	emitter
4	emitter
BFG540/X (Fig.1) Code: N43	
1	collector
2	emitter
3	base
4	emitter
BFG540/XR (Fig.2) Code: N49	
1	collector
2	emitter
3	base
4	emitter



## NPN 9 GHz wideband transistor

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## QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{CBO}$	collector-base voltage	open emitter	–	–	20	V
$V_{CES}$	collector-emitter voltage	$R_{BE} = 0$	–	–	15	V
$I_C$	DC collector current		–	–	120	mA
$P_{tot}$	total power dissipation	$T_s \leq 60\text{ °C}$ ; note 1	–	–	400	mW
$h_{FE}$	DC current gain	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $T_j = 25\text{ °C}$	100	120	250	
$C_{re}$	feedback capacitance	$I_C = 0$ ; $V_{CE} = 8\text{ V}$ ; $f = 1\text{ MHz}$	–	0.5	–	pF
$f_T$	transition frequency	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$	–	9	–	GHz
$G_{UM}$	maximum unilateral power gain	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	–	18	–	dB
		$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$	–	11	–	dB
$ S_{21} ^2$	insertion power gain	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	15	16	–	dB
F	noise figure	$\Gamma_s = \Gamma_{opt}$ ; $I_C = 10\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	–	1.3	1.8	dB
		$\Gamma_s = \Gamma_{opt}$ ; $I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	–	1.9	2.4	dB
		$\Gamma_s = \Gamma_{opt}$ ; $I_C = 10\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$	–	2.1	–	dB

## LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{CBO}$	collector-base voltage	open emitter	–	20	V
$V_{CES}$	collector-emitter voltage	$R_{BE} = 0$	–	15	V
$V_{EBO}$	emitter-base voltage	open collector	–	2.5	V
$I_C$	DC collector current		–	120	mA
$P_{tot}$	total power dissipation	$T_s \leq 60\text{ °C}$ ; note 1	–	400	mW
$T_{stg}$	storage temperature		–65	+150	°C
$T_j$	junction temperature		–	150	°C

## Note

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

## THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j-s}$	thermal resistance from junction to soldering point	$T_s \leq 60\text{ °C}$ ; note 1	290	K/W

## Note

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

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**CHARACTERISTICS**

T<sub>j</sub> = 25 °C unless otherwise specified.

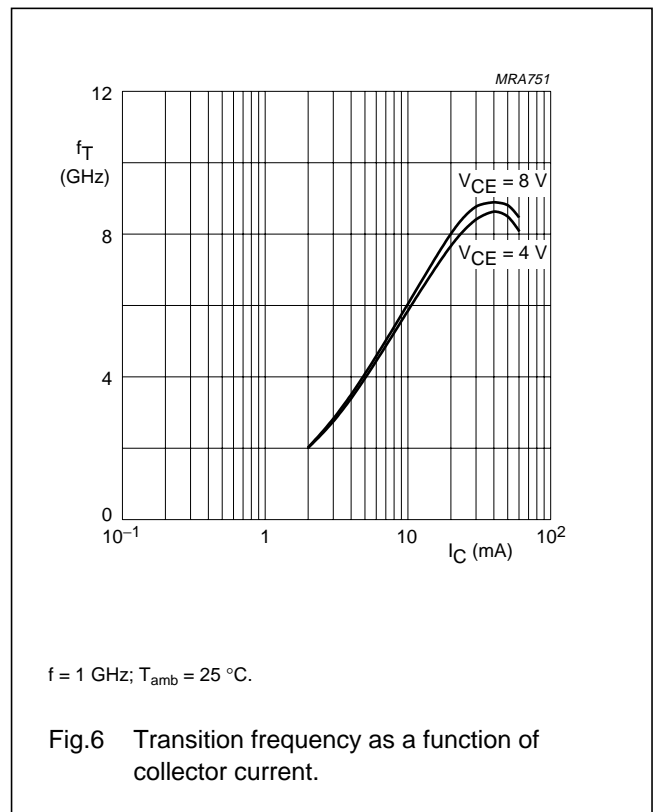
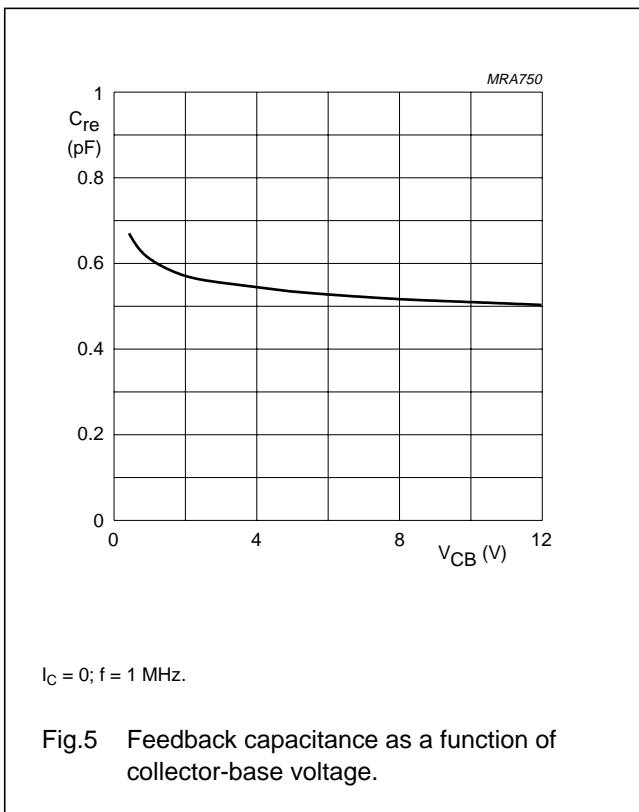
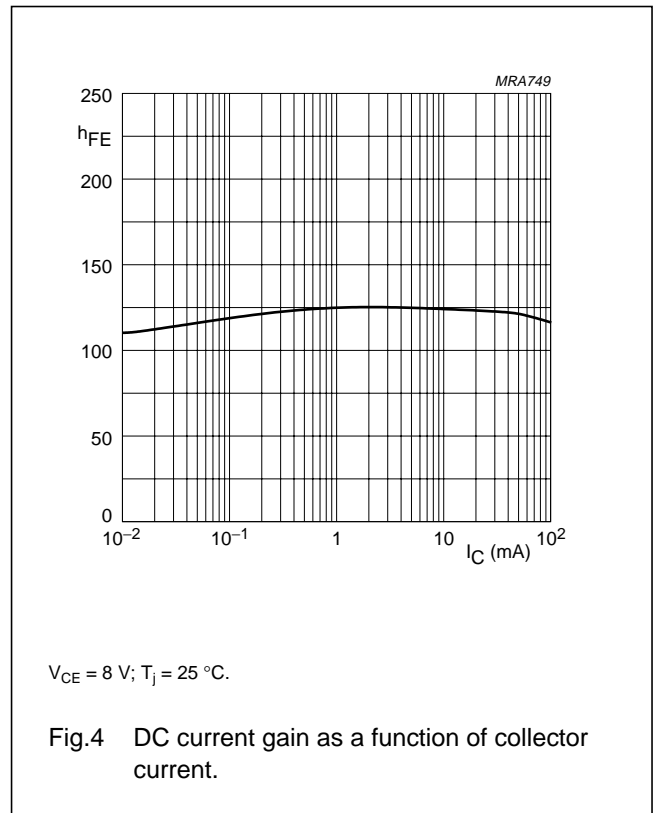
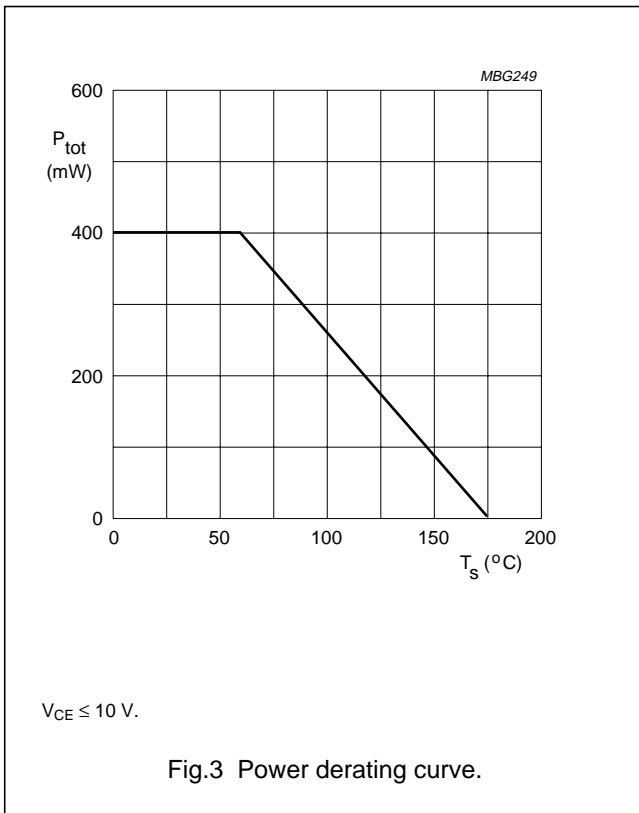
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I <sub>CBO</sub>	collector cut-off current	I <sub>E</sub> = 0; V <sub>CB</sub> = 8 V	–	–	50	nA
h <sub>FE</sub>	DC current gain	I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V	60	120	250	
C <sub>e</sub>	emitter capacitance	I <sub>C</sub> = I <sub>C</sub> = 0; V <sub>EB</sub> = 0.5 V; f = 1 MHz	–	2	–	pF
C <sub>c</sub>	collector capacitance	I <sub>E</sub> = I <sub>e</sub> = 0; V <sub>CB</sub> = 8 V; f = 1 MHz	–	0.9	–	pF
C <sub>re</sub>	feedback capacitance	I <sub>C</sub> = 0; V <sub>CB</sub> = 8 V; f = 1 MHz	–	0.5	–	pF
f <sub>T</sub>	transition frequency	I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V; f = 1 GHz; T <sub>amb</sub> = 25 °C	–	9	–	GHz
G <sub>UM</sub>	maximum unilateral power gain (note 1)	I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V; f = 900 MHz; T <sub>amb</sub> = 25 °C	–	18	–	dB
		I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V; f = 2 GHz; T <sub>amb</sub> = 25 °C	–	11	–	dB
S <sub>21</sub>   <sup>2</sup>	insertion power gain	I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V; f = 900 MHz; T <sub>amb</sub> = 25 °C	15	16	–	dB
F	noise figure	Γ <sub>s</sub> = Γ <sub>opt</sub> ; I <sub>C</sub> = 10 mA; V <sub>CE</sub> = 8 V; f = 900 MHz; T <sub>amb</sub> = 25 °C	–	1.3	1.8	dB
		Γ <sub>s</sub> = Γ <sub>opt</sub> ; I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V; f = 900 MHz; T <sub>amb</sub> = 25 °C	–	1.9	2.4	dB
		Γ <sub>s</sub> = Γ <sub>opt</sub> ; I <sub>C</sub> = 10 mA; V <sub>CE</sub> = 8 V; f = 2 GHz; T <sub>amb</sub> = 25 °C	–	2.1	–	dB
P <sub>L1</sub>	output power at 1 dB gain compression	I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V; R <sub>L</sub> = 50 Ω; f = 900 MHz; T <sub>amb</sub> = 25 °C	–	21	–	dBm
ITO	third order intercept point	note 2	–	34	–	dBm
V <sub>O</sub>	output voltage	note 3	–	500	–	mV
d <sub>2</sub>	second order intermodulation distortion	note 4	–	–50	–	dB

**Notes**

- G<sub>UM</sub> is the maximum unilateral power gain, assuming s<sub>12</sub> is zero and  $G_{UM} = 10 \log \frac{|s_{21}|^2}{(1 - |s_{11}|^2)(1 - |s_{22}|^2)}$  dB.
- V<sub>CE</sub> = 8 V; I<sub>C</sub> = 40 mA; R<sub>L</sub> = 50 Ω; T<sub>amb</sub> = 25 °C;  
f<sub>p</sub> = 900 MHz; f<sub>q</sub> = 902 MHz;  
measured at f<sub>(2p-q)</sub> = 898 MHz and f<sub>(2q-p)</sub> = 904 MHz.
- d<sub>im</sub> = –60 dB (DIN 45004B); I<sub>C</sub> = 40 mA; V<sub>CE</sub> = 8 V; Z<sub>L</sub> = Z<sub>S</sub> = 75 Ω; T<sub>amb</sub> = 25 °C;  
V<sub>p</sub> = V<sub>O</sub>; V<sub>q</sub> = V<sub>O</sub> –6 dB; V<sub>r</sub> = V<sub>O</sub> –6 dB;  
f<sub>p</sub> = 795.25 MHz; f<sub>q</sub> = 803.25 MHz; f<sub>r</sub> = 805.25 MHz;  
measured at f<sub>(p+q-r)</sub> = 793.25 MHz.
- I<sub>C</sub> = 40 mA; V<sub>CE</sub> = 8 V; V<sub>O</sub> = 275 mV; T<sub>amb</sub> = 25 °C;  
f<sub>p</sub> = 250 MHz; f<sub>q</sub> = 560 MHz; measured at f<sub>(p+q)</sub> = 810 MHz.

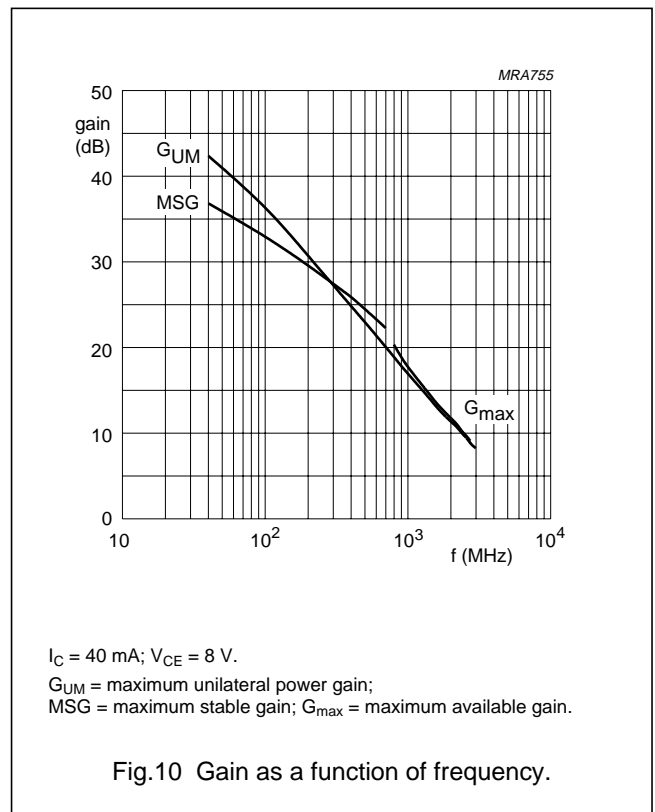
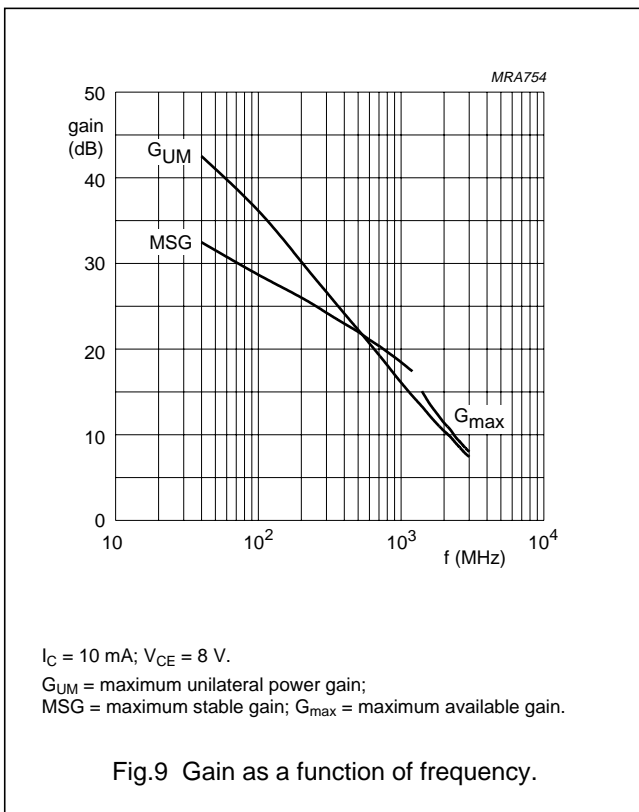
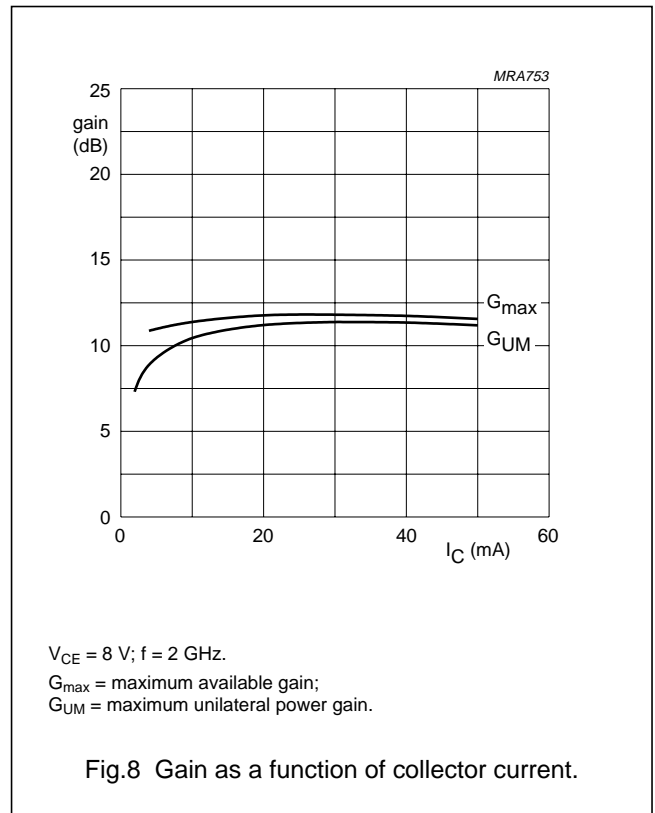
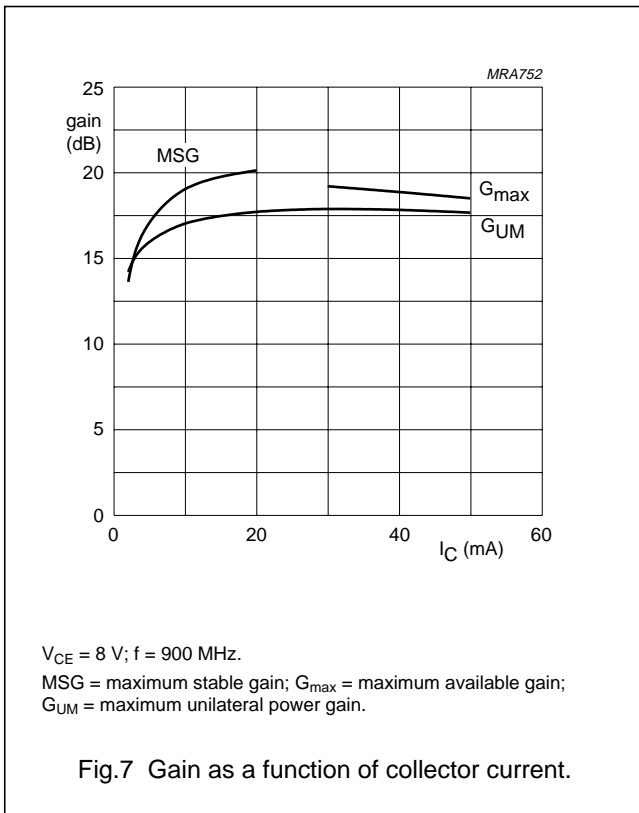
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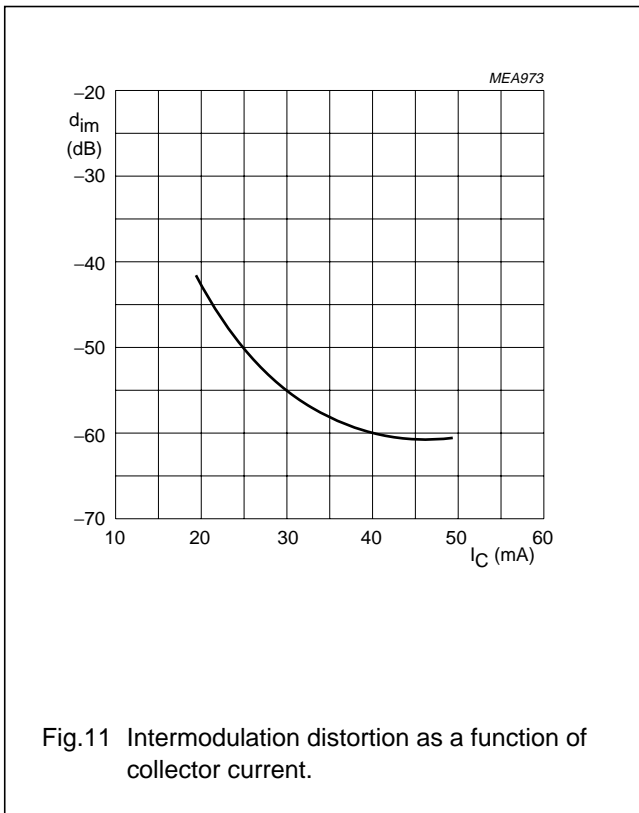


Fig.11 Intermodulation distortion as a function of collector current.

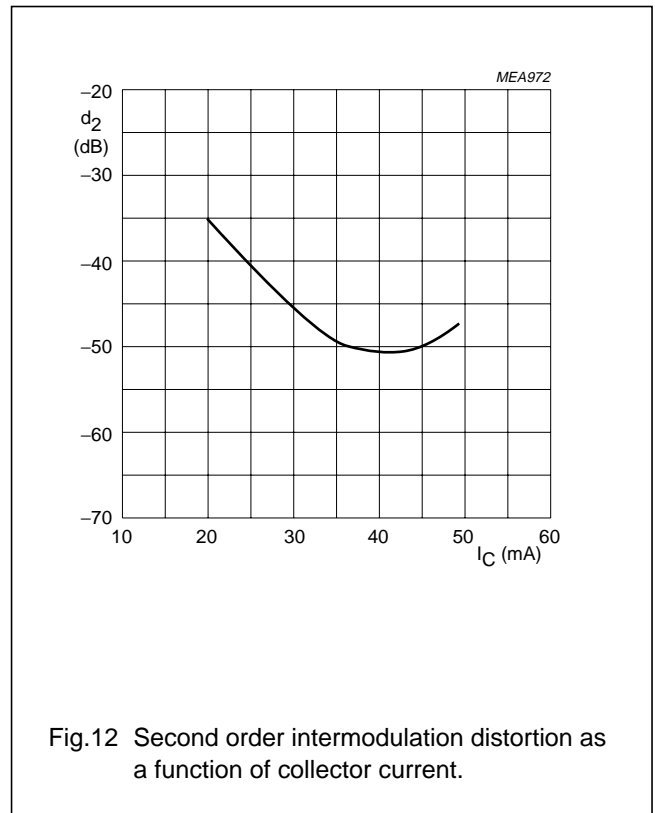
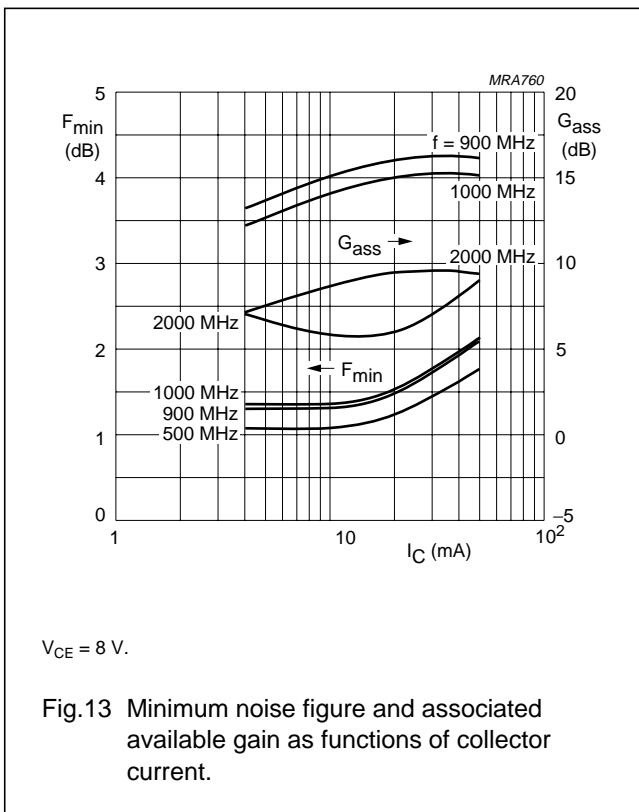
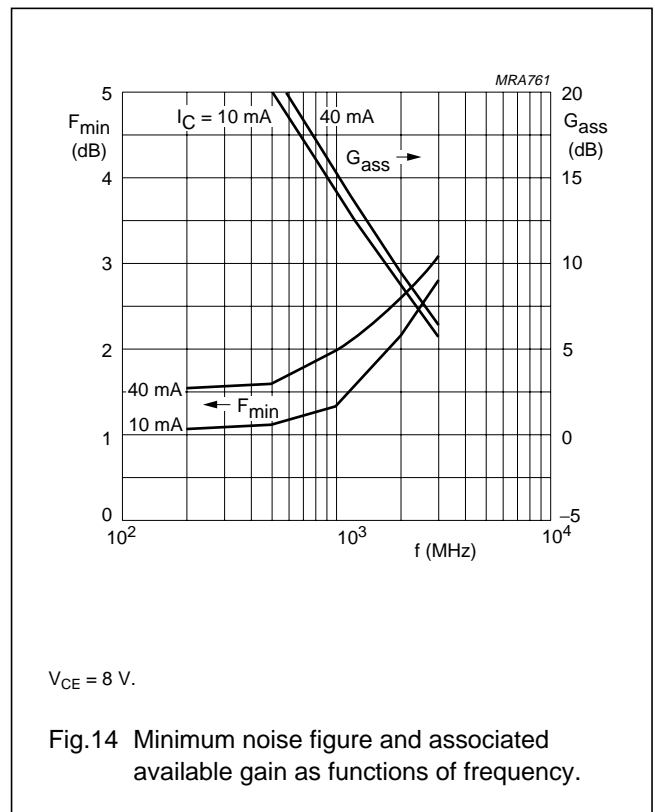


Fig.12 Second order intermodulation distortion as a function of collector current.



$V_{CE} = 8$  V.

Fig.13 Minimum noise figure and associated available gain as functions of collector current.

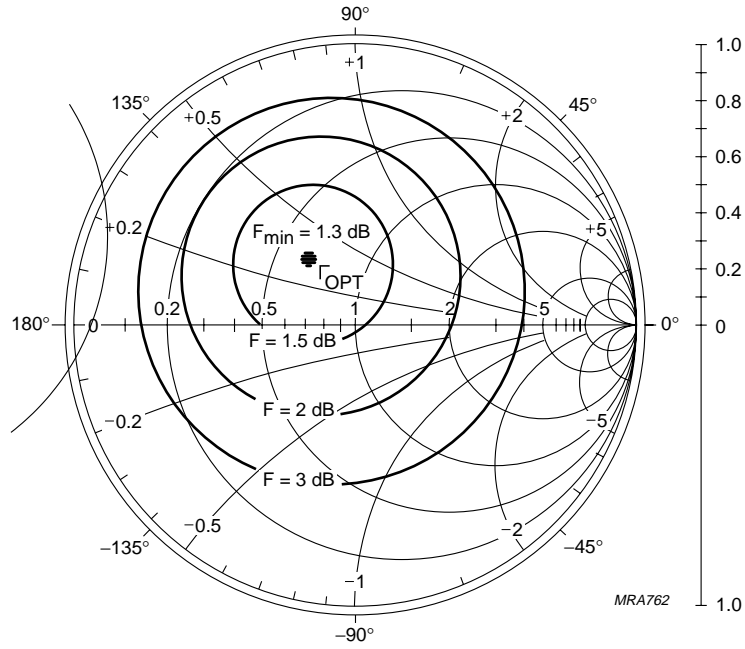


$V_{CE} = 8$  V.

Fig.14 Minimum noise figure and associated available gain as functions of frequency.

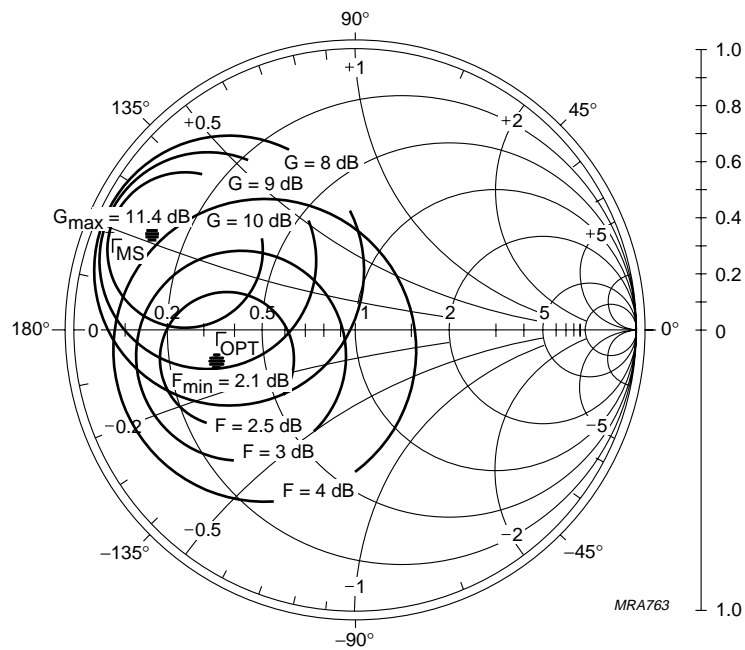
NPN 9 GHz wideband transistor

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BFG540/XR



$I_C = 10 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $Z_0 = 50 \Omega$ ;  $f = 900 \text{ MHz}$ .

Fig.15 Noise circle figure.



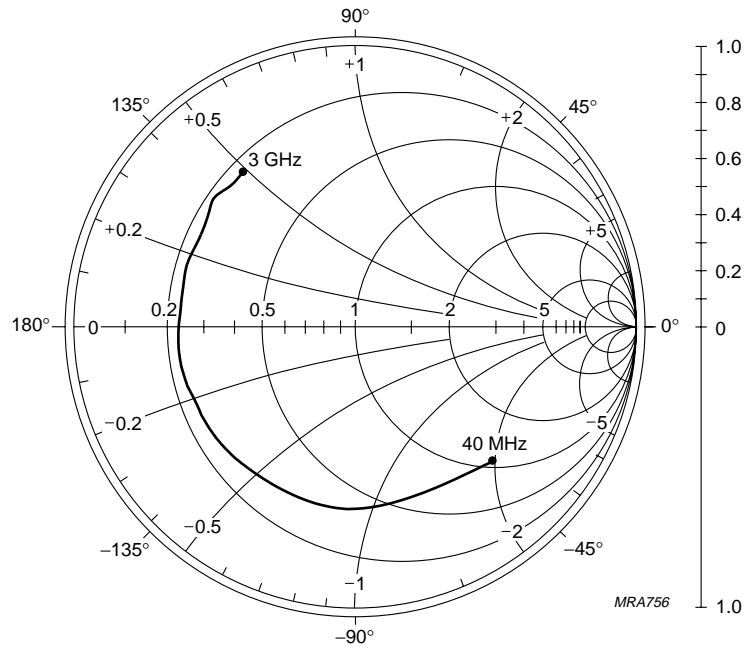
$I_C = 10 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $Z_0 = 50 \Omega$ ;  $f = 2 \text{ GHz}$ .

Fig.16 Noise circle figure.



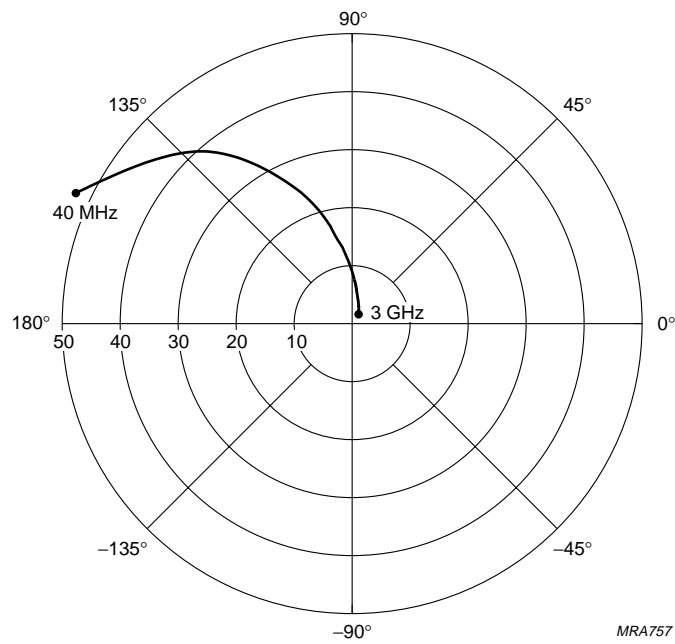
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BFG540/XR



$I_C = 40 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $Z_0 = 50 \Omega$ .

Fig.17 Common emitter input reflection coefficient ( $s_{11}$ ).

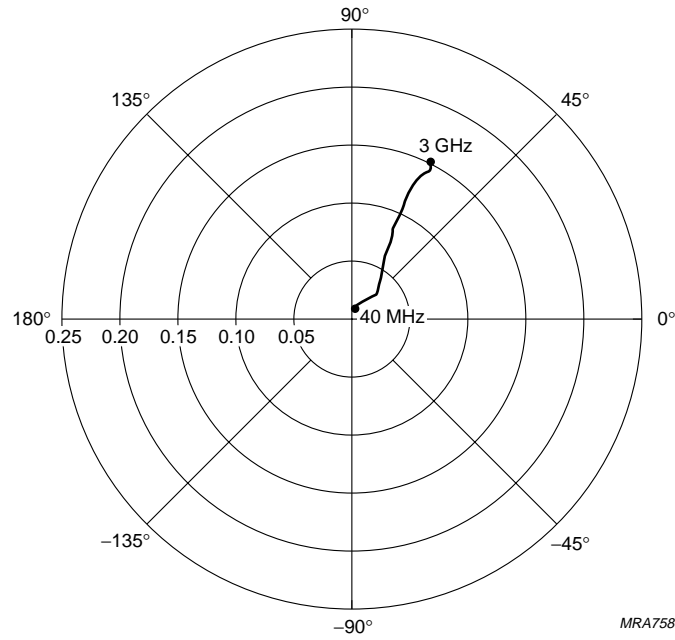


$I_C = 40 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ .

Fig.18 Common emitter forward transmission coefficient ( $s_{21}$ ).

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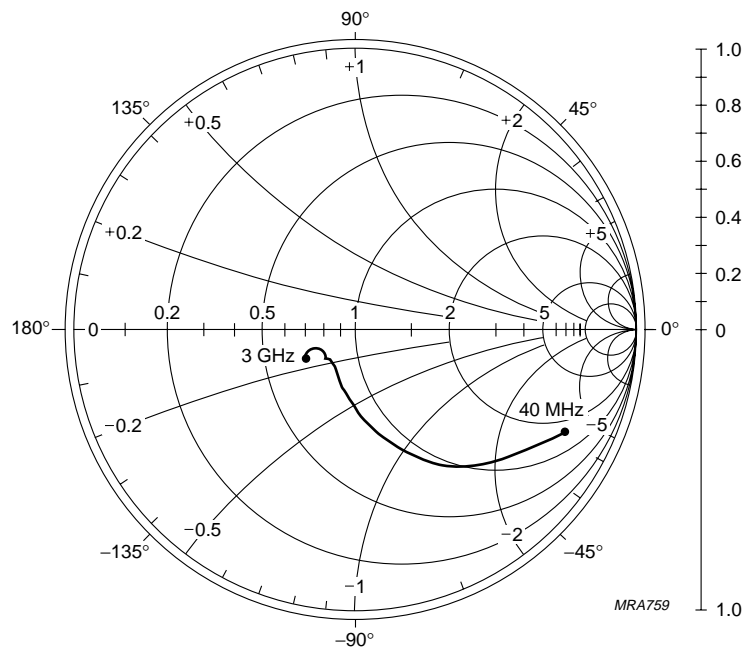
BFG540; BFG540/X;  
BFG540/XR



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

MRA758

Fig.19 Common emitter reverse transmission coefficient ( $s_{12}$ ).



$I_C = 40 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ ;  $Z_0 = 50 \Omega$ .

MRA759

Fig.20 Common emitter output reflection coefficient ( $s_{22}$ ).

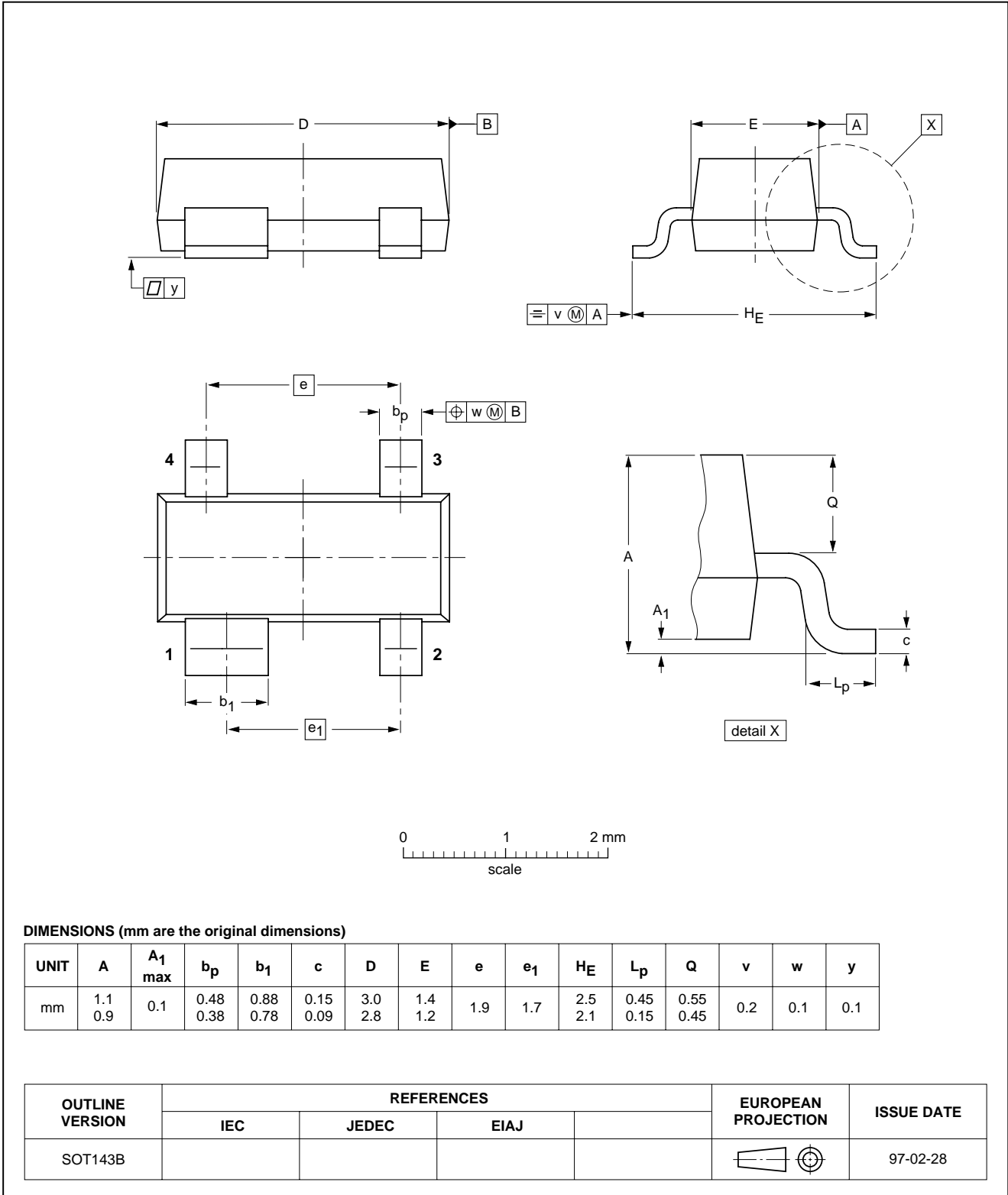
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BFG540; BFG540/X;  
BFG540/XR

PACKAGE OUTLINES

Plastic surface mounted package; 4 leads

SOT143B

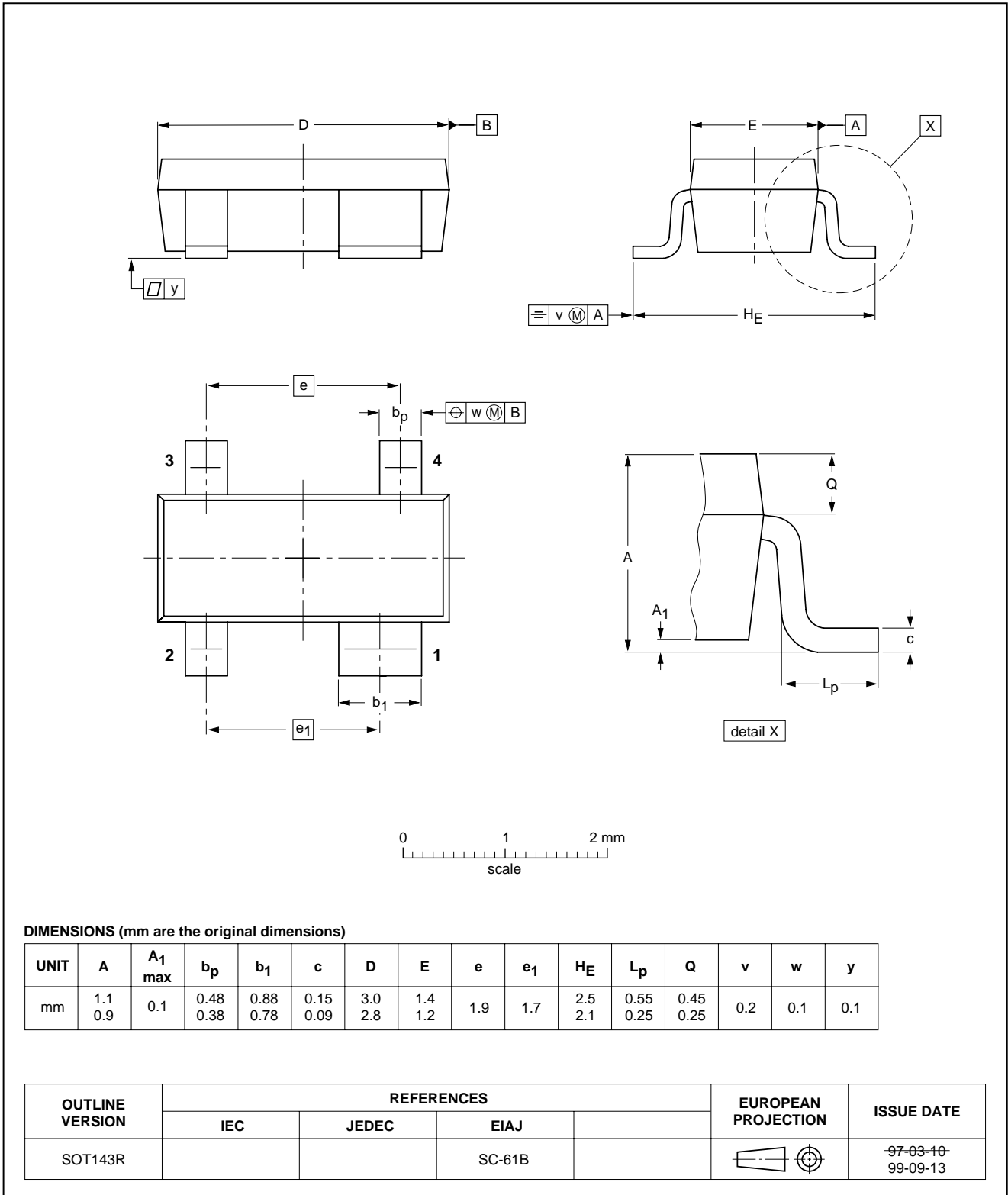


NPN 9 GHz wideband transistor

BFG540; BFG540/X;  
BFG540/XR

Plastic surface mounted package; reverse pinning; 4 leads

SOT143R



## NPN 9 GHz wideband transistor

BFG540; BFG540/X;  
BFG540/XR

## DATA SHEET STATUS

DATA SHEET STATUS	PRODUCT STATUS	DEFINITIONS <sup>(1)</sup>
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

## Note

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

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**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.

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**NOTES**

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**NOTES**

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