

# DATA SHEET

**BFG540W**

**BFG540W/X; BFG540W/XR**

**NPN 9 GHz wideband transistor**

Product specification  
Supersedes data of 1997 Dec 04

2000 May 23

## NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR

## FEATURES

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

## APPLICATIONS

RF front end wideband applications in the GHz range, such as analog and digital cellular telephones, cordless telephones (CT2, CT3, PCN, DECT, etc.), radar detectors, pagers, satellite television tuners (SATV), MATV/CATV amplifiers and repeater amplifiers in fibre-optic systems.

## DESCRIPTION

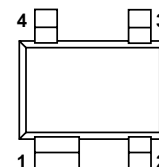
NPN silicon planar epitaxial transistors in 4-pin dual-emitter SOT343N and SOT343R plastic packages.

## MARKING

TYPE NUMBER	CODE
BFG540W	N9
BFG540W/X	N7
BFG540W/XR	N8

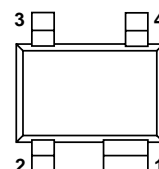
## PINNING

PIN	DESCRIPTION
<b>BFG540W</b> (see Fig.1)	
1	collector
2	base
3	emitter
4	emitter
<b>BFG540W/X</b> (see Fig.1)	
1	collector
2	emitter
3	base
4	emitter
<b>BFG540W/XR</b> (see Fig.2)	
1	collector
2	emitter
3	base
4	emitter



Top view MBK523

Fig.1 SOT343N.



Top view MSB842

Fig.2 SOT343R.

## 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
$I_C$	collector current (DC)		—	—	120	mA
$P_{tot}$	total power dissipation	$T_s \leq 85\text{ °C}$	—	—	500	mW
$h_{FE}$	DC current gain	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$	100	120	250	
$C_{re}$	feedback capacitance	$I_C = 0$ ; $V_{CB} = 8\text{ V}$ ; $f = 1\text{ MHz}$	—	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	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	—	16	—	dB
		$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 2\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$	—	10	—	dB
$ S_{21} ^2$	insertion power gain	$I_C = 40\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	14	15	—	dB
F	noise figure	$\Gamma_s = \Gamma_{opt}$ ; $I_C = 10\text{ mA}$ ; $V_{CE} = 8\text{ V}$ ; $f = 2\text{ GHz}$	—	2.1	—	dB

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LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V <sub>CBO</sub>	collector-base voltage	open emitter	–	20	V
V <sub>CES</sub>	collector-emitter voltage	R <sub>BE</sub> = 0	–	15	V
V <sub>EBO</sub>	emitter-base voltage	open collector	–	2.5	V
I <sub>C</sub>	collector current (DC)		–	120	mA
P <sub>tot</sub>	total power dissipation	T <sub>s</sub> ≤ 85 °C; see Fig.3; note 1	–	500	mW
T <sub>stg</sub>	storage temperature		–65	+150	°C
T <sub>j</sub>	junction temperature		–	175	°C

Note

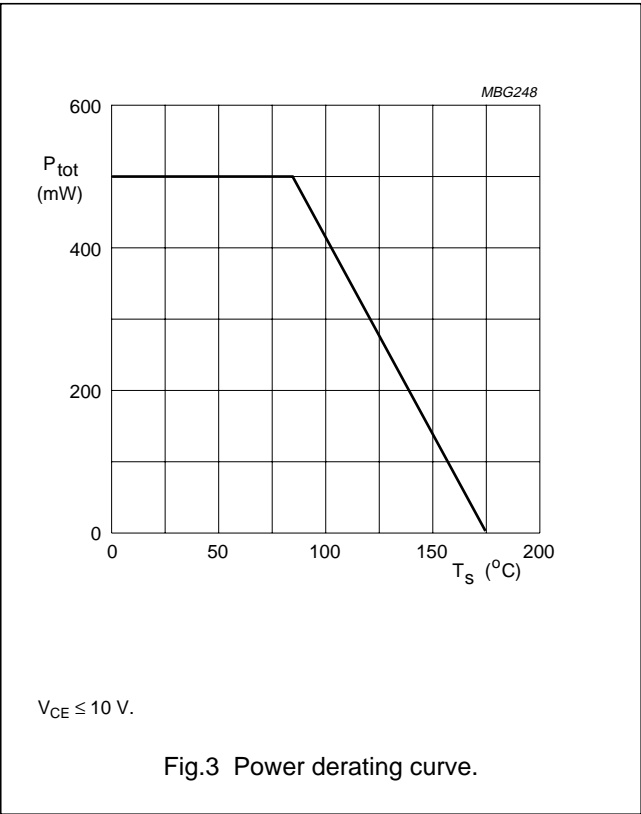
1. T<sub>s</sub> is the temperature at the soldering point of the collector pin.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
R <sub>th j-s</sub>	thermal resistance from junction to soldering point	T <sub>s</sub> ≤ 85 °C; note 1	180	K/W

Note

1. T<sub>s</sub> 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.

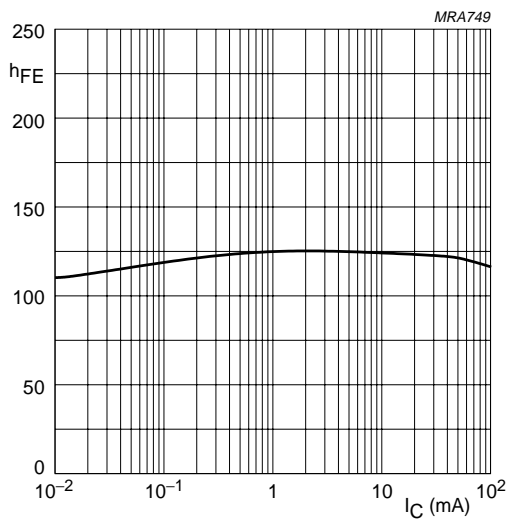
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V <sub>(BR)CBO</sub>	collector-base breakdown voltage	open emitter; I <sub>C</sub> = 10 µA; I <sub>E</sub> = 0	20	–	–	V
V <sub>(BR)CES</sub>	collector-emitter breakdown voltage	R <sub>BE</sub> = 0; I <sub>C</sub> = 40 µA	15	–	–	V
V <sub>(BR)EBO</sub>	emitter-base breakdown voltage	open collector; I <sub>E</sub> = 100 µA; I <sub>C</sub> = 0	2.5	–	–	V
I <sub>CBO</sub>	collector cut-off current	open emitter; V <sub>CB</sub> = 8 V; I <sub>E</sub> = 0	–	–	50	nA
h <sub>FE</sub>	DC current gain	I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V	100	120	250	
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
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>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>re</sub>	feedback capacitance	I <sub>C</sub> = 0; V <sub>CB</sub> = 8 V; f = 1 MHz	–	0.5	–	pF
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	–	16	–	dB
		I <sub>C</sub> = 40 mA; V <sub>CE</sub> = 8 V; f = 2 GHz; T <sub>amb</sub> = 25 °C	–	10	–	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	14	15	–	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	–	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	–	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	–	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; f = 900 MHz; R <sub>L</sub> = 50 Ω; 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.  $G_{UM} = 10 \log \frac{|s_{21}|^2}{(1 - |s_{11}|^2)(1 - |s_{22}|^2)}$  dB.
- I<sub>C</sub> = 40 mA; V<sub>CE</sub> = 8 V; 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 (DIN45004B); 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; R<sub>L</sub> = 75 Ω; V<sub>CE</sub> = 8 V; I<sub>C</sub> = 40 mA;
  - 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; R<sub>L</sub> = 75 Ω; 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.

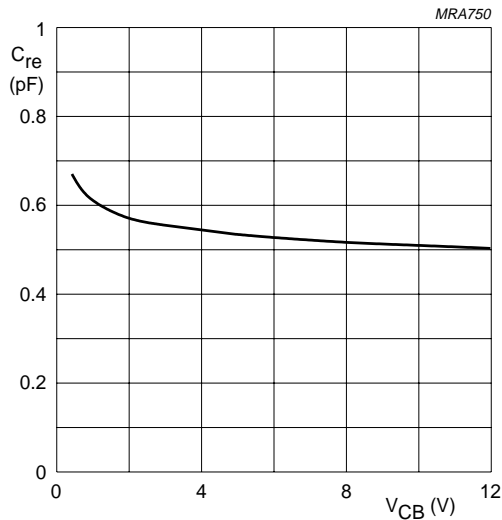
NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR



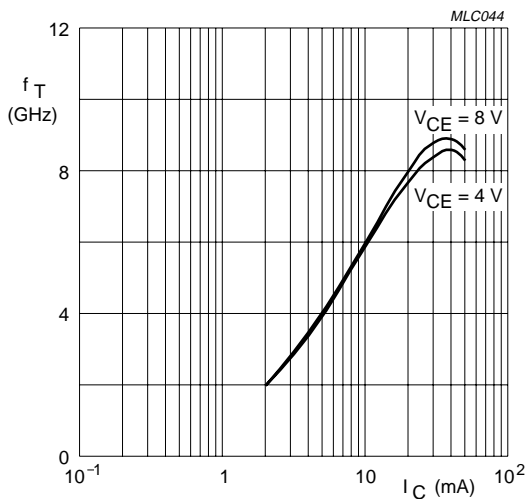
$V_{CE} = 8\text{ V}$ .

Fig.4 DC current gain as a function of collector current; typical values.



$I_C = 0$ ;  $f = 1\text{ MHz}$ .

Fig.5 Feedback capacitance as a function of collector-base voltage; typical values.

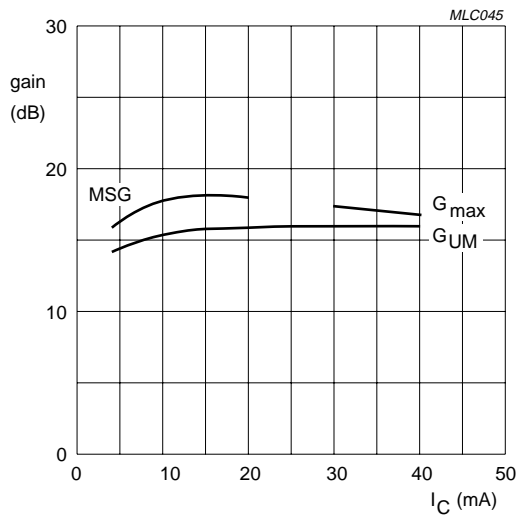


$f = 1\text{ GHz}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Fig.6 Transition frequency as a function of collector current; typical values.

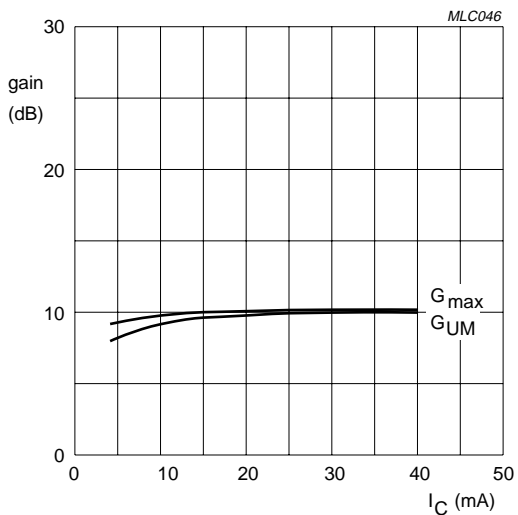
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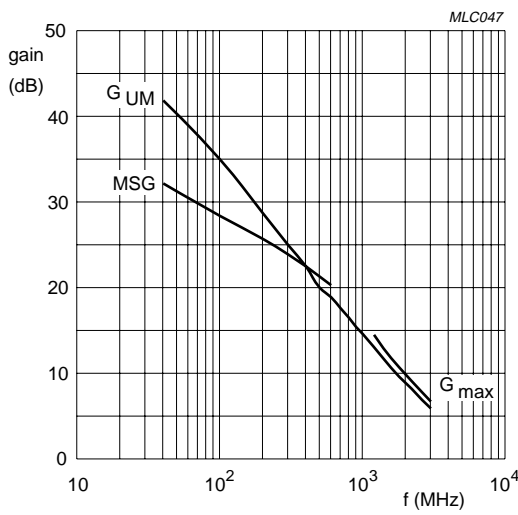
$f = 900 \text{ MHz}$ ;  $V_{CE} = 8 \text{ V}$ .

Fig.7 Gain as a function of collector current; typical values.



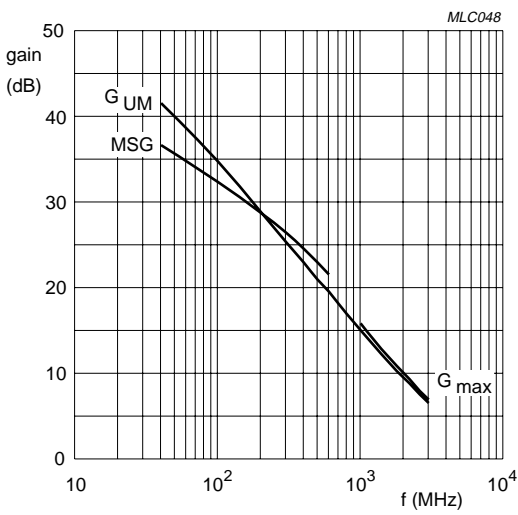
$f = 2 \text{ GHz}$ ;  $V_{CE} = 8 \text{ V}$ .

Fig.8 Gain as a function of collector current; typical values.



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

Fig.9 Gain as a function of frequency; typical values.

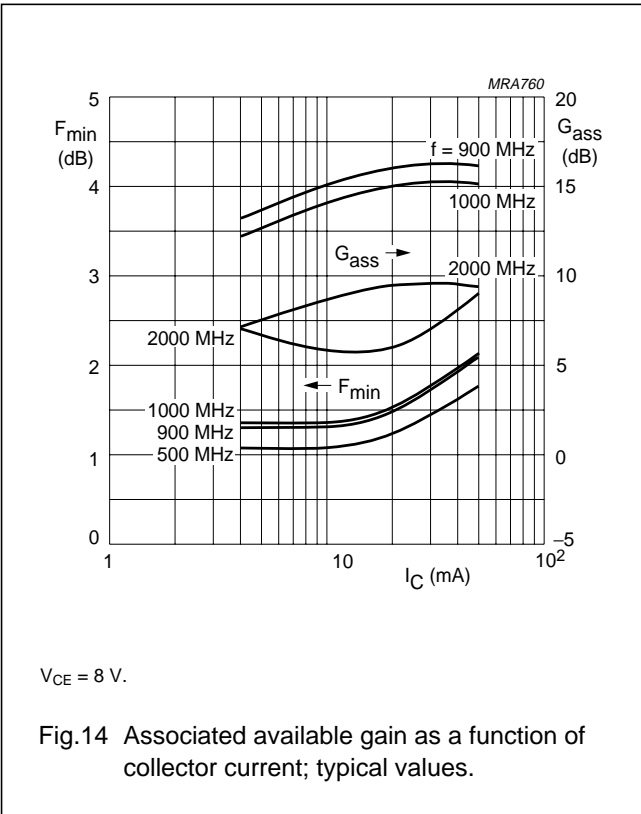
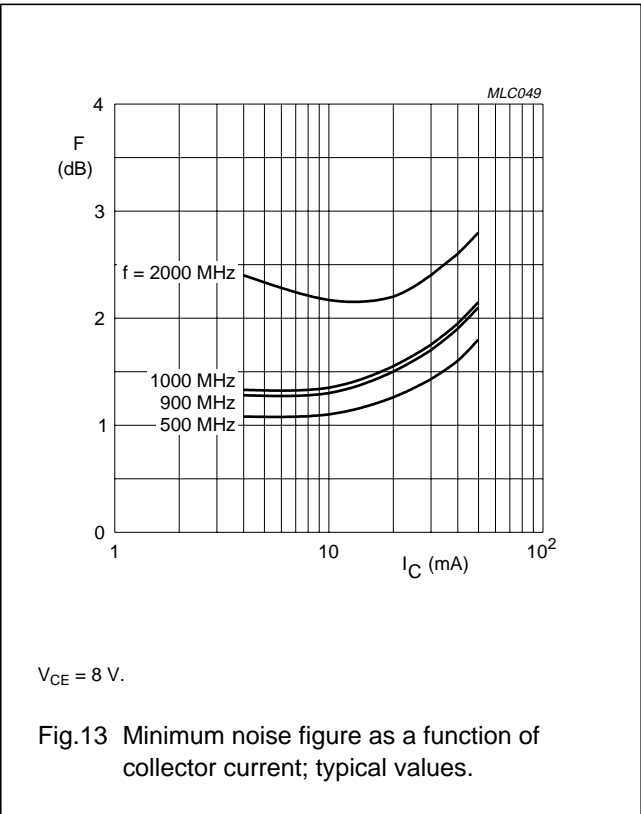
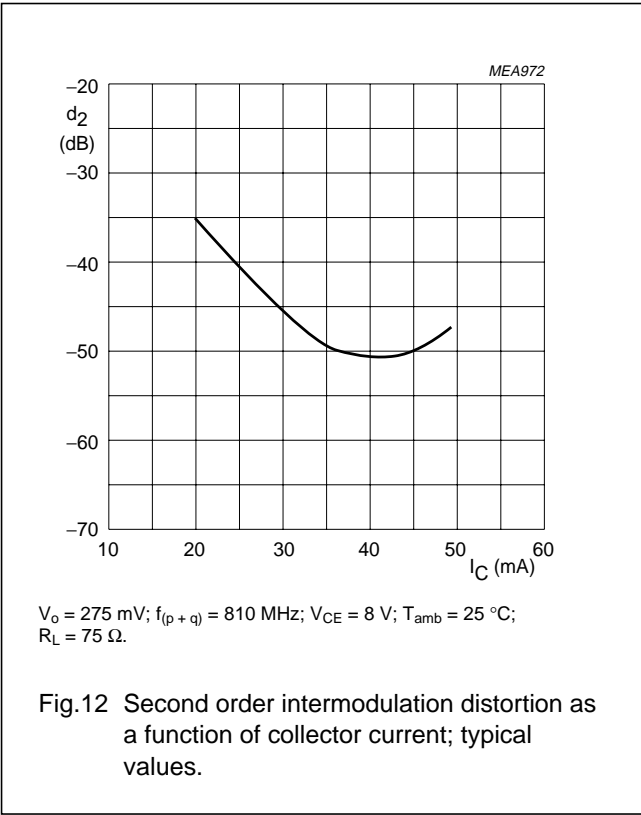
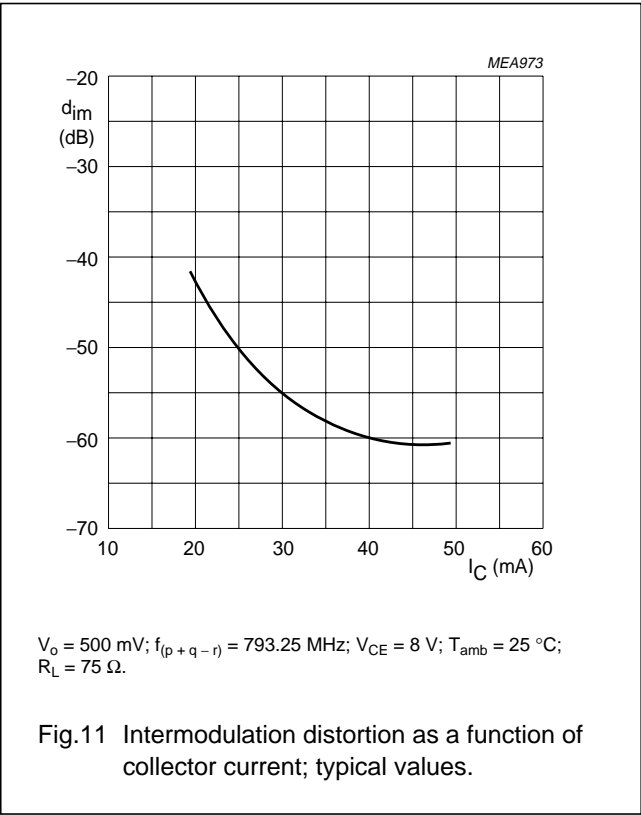


$I_C = 40 \text{ mA}$ ;  $V_{CE} = 8 \text{ V}$ .

Fig.10 Gain as a function of frequency; typical values.

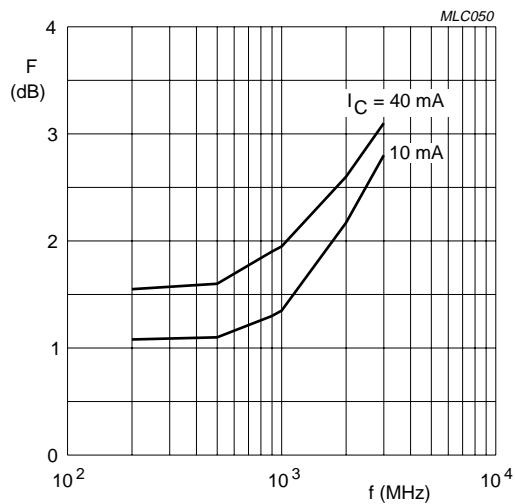
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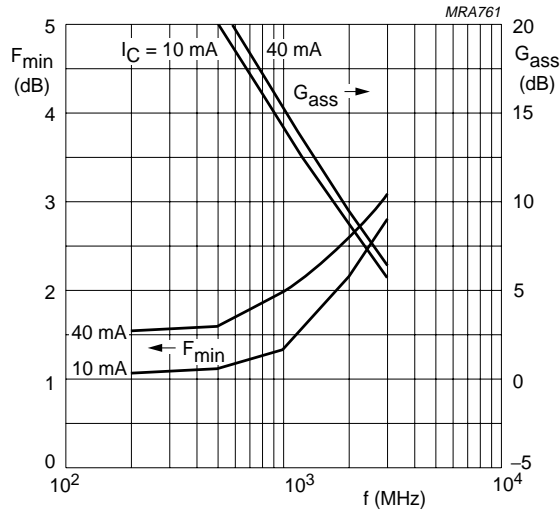
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V<sub>CE</sub> = 8 V.

Fig.15 Minimum noise figure as a function of frequency; typical values.



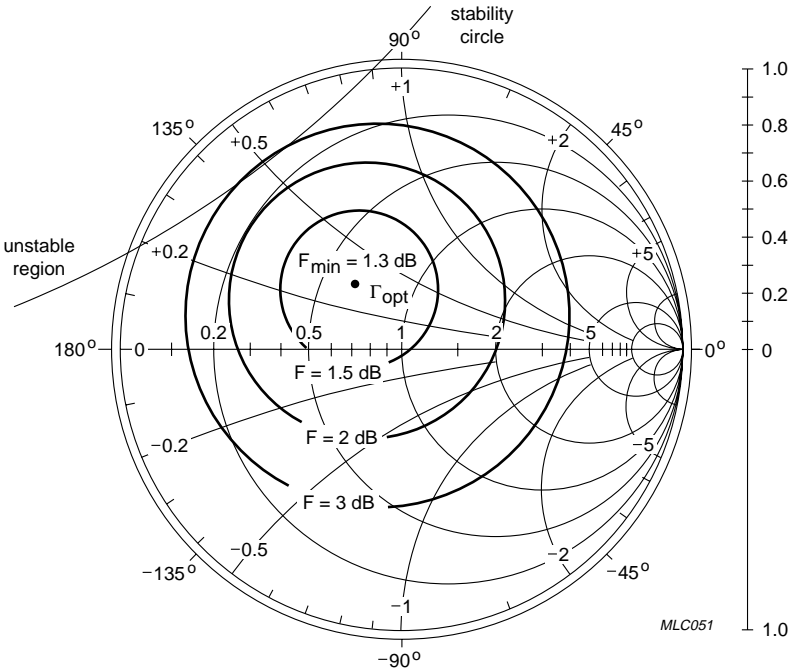
V<sub>CE</sub> = 8 V.

Fig.16 Associated available gain as a function of frequency; typical values.



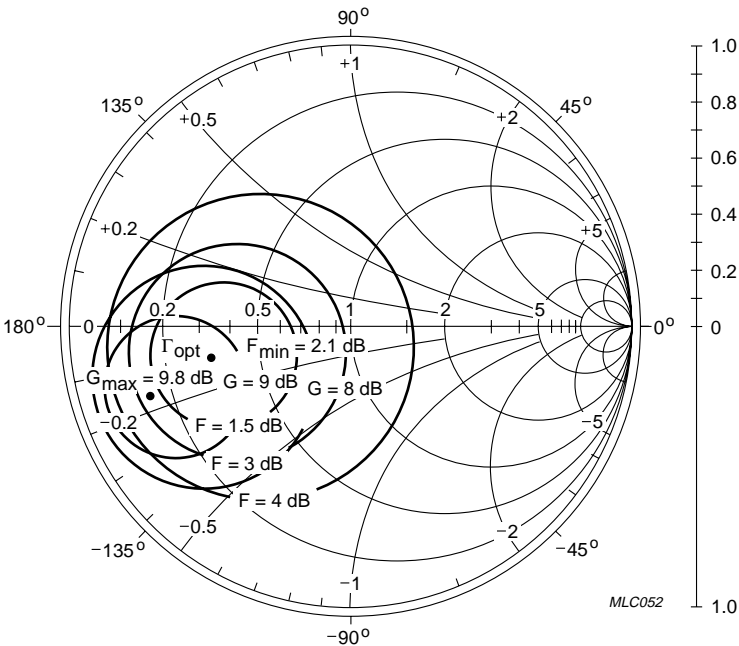
NPN 9 GHz wideband transistor

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f = 900 MHz; V<sub>CE</sub> = 8 V; I<sub>C</sub> = 10 mA; Z<sub>0</sub> = 50 Ω.

Fig.17 Common emitter noise figure circles; typical values.

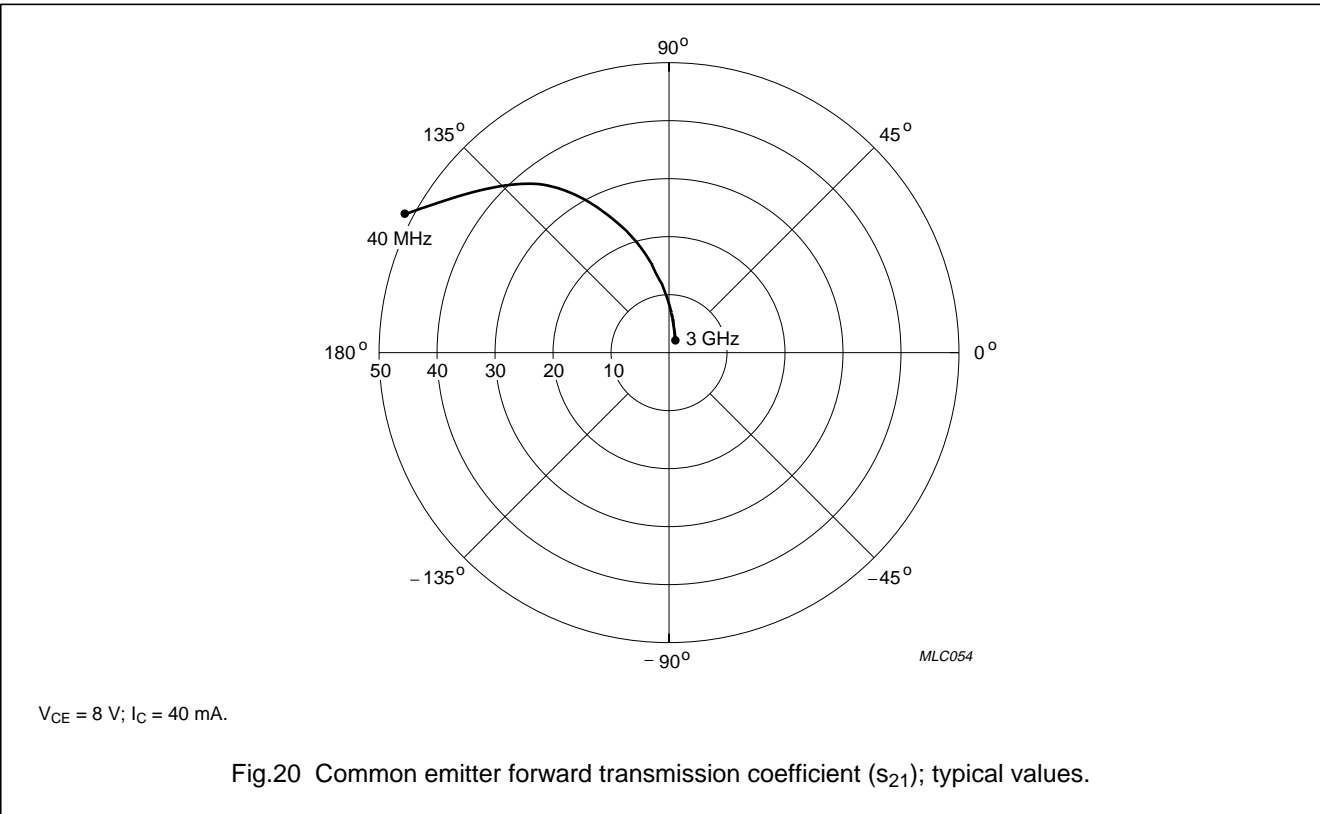
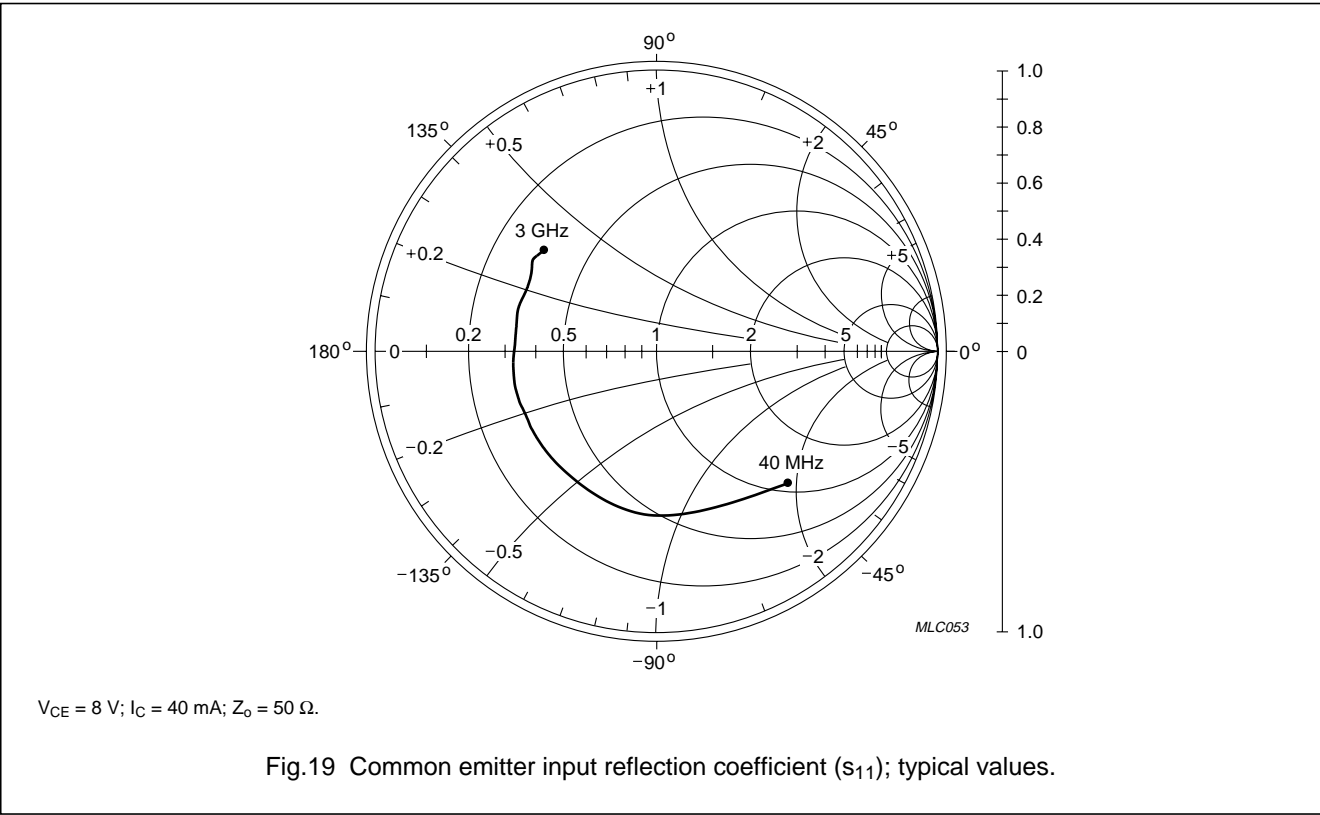


f = 2 GHz; V<sub>CE</sub> = 8 V; I<sub>C</sub> = 10 mA; Z<sub>0</sub> = 50 Ω.

Fig.18 Common emitter noise figure circles; typical values.

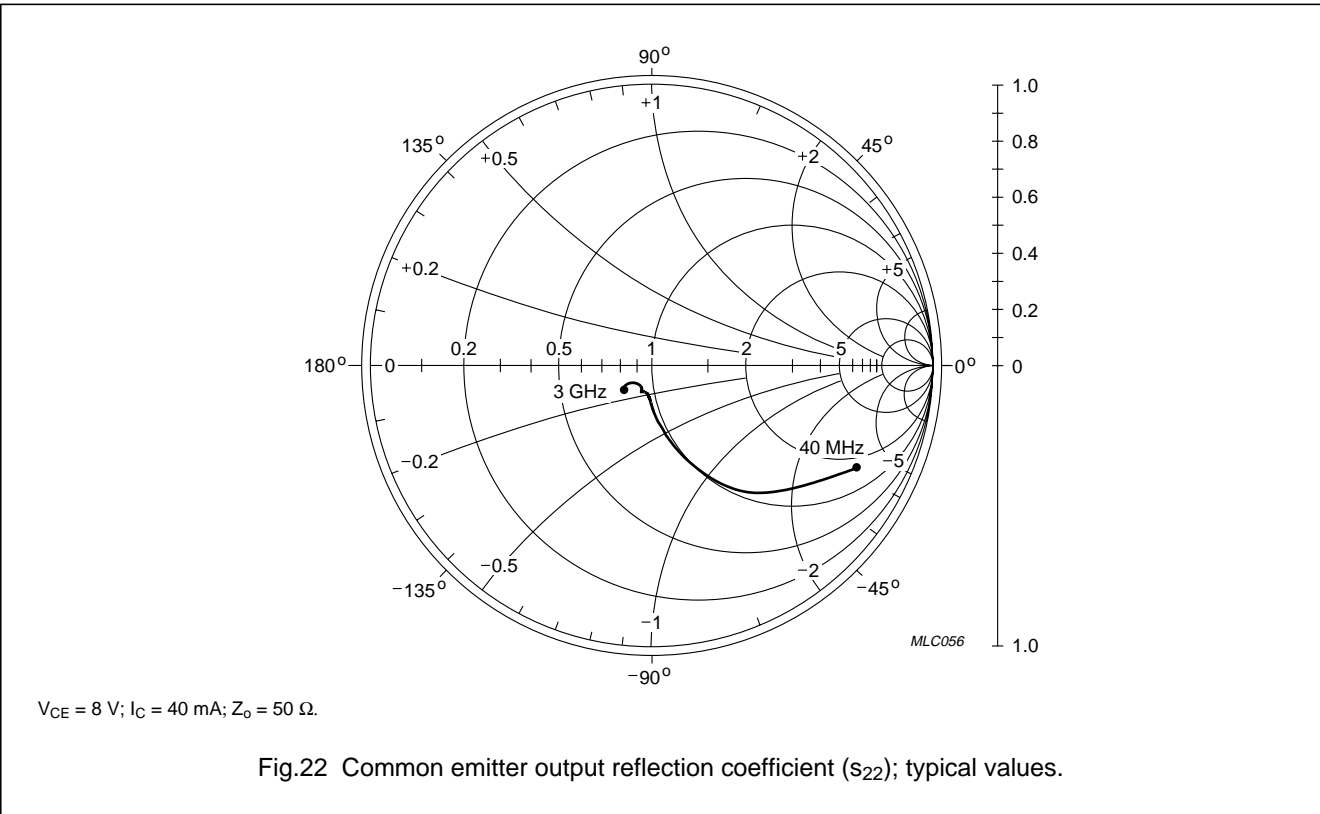
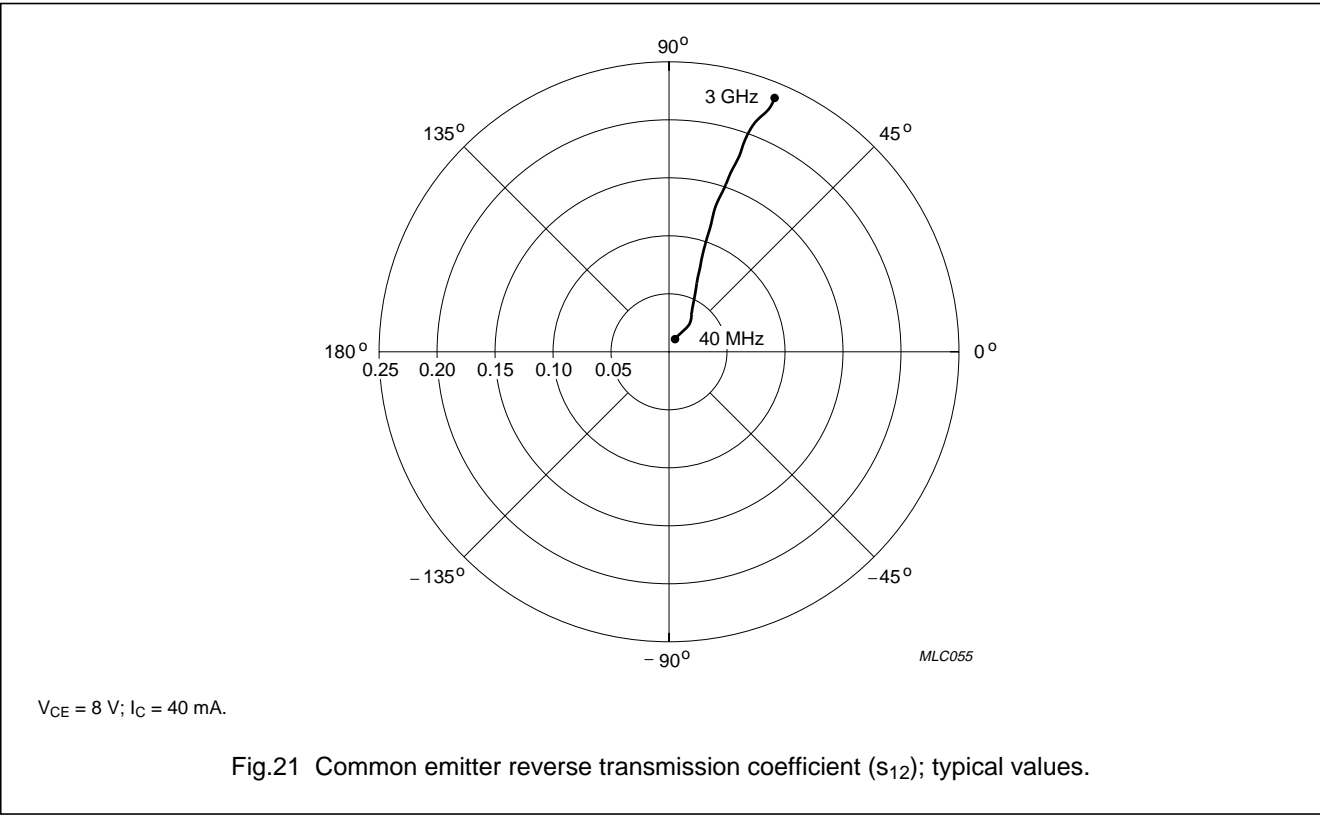
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NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR



## NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR

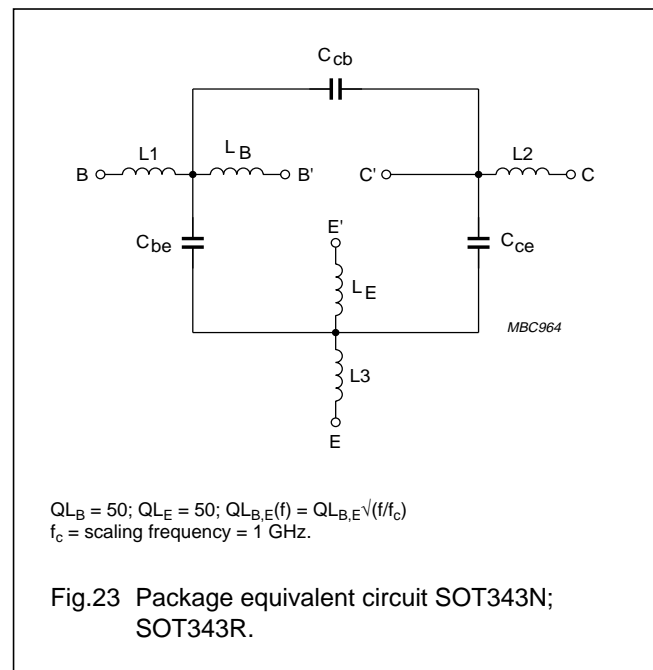
## SPICE parameters for the BFG540W crystal

SEQUENCE No.	PARAMETER	VALUE	UNIT
1	IS	1.045	fA
2	BF	184.3	–
3	NF	0.981	–
4	VAF	41.69	V
5	IKF	10.00	A
6	ISE	232.4	fA
7	NE	2.028	–
8	BR	43.99	–
9	NR	0.992	–
10	VAR	2.097	V
11	IKR	166.2	mA
12	ISC	129.8	aA
13	NC	1.064	–
14	RB	5.000	$\Omega$
15	IRB	1.000	$\mu$ A
16	RBM	5.000	$\Omega$
17	RE	353.5	m $\Omega$
18	RC	1.340	$\Omega$
19 (1)	XTB	0.000	–
20 (1)	EG	1.110	eV
21 (1)	XTI	3.000	–
22	CJE	1.978	pF
23	VJE	600.0	mV
24	MJE	0.332	–
25	TF	7.457	ps
26	XTF	11.40	–
27	VTF	3.158	V
28	ITF	156.9	mA
29	PTF	0.000	deg
30	CJC	793.7	fF
31	VJC	185.5	mV
32	MJC	0.084	–
33	XCJC	0.150	–
34	TR	1.598	ns
35 (1)	CJS	0.000	F

SEQUENCE No.	PARAMETER	VALUE	UNIT
36 (1)	VJS	750.0	mV
37 (1)	MJS	0.000	–
38	FC	0.814	–

**Note**

- These parameters have not been extracted, the default values are shown.

**List of components** (see Fig.23).

DESIGNATION	VALUE	UNIT
$C_{be}$	70	fF
$C_{cb}$	50	fF
$C_{ce}$	115	fF
L1	0.34	nH
L2	0.10	nH
L3	0.25	nH
$L_B$	0.40	nH
$L_E$	0.40	nH

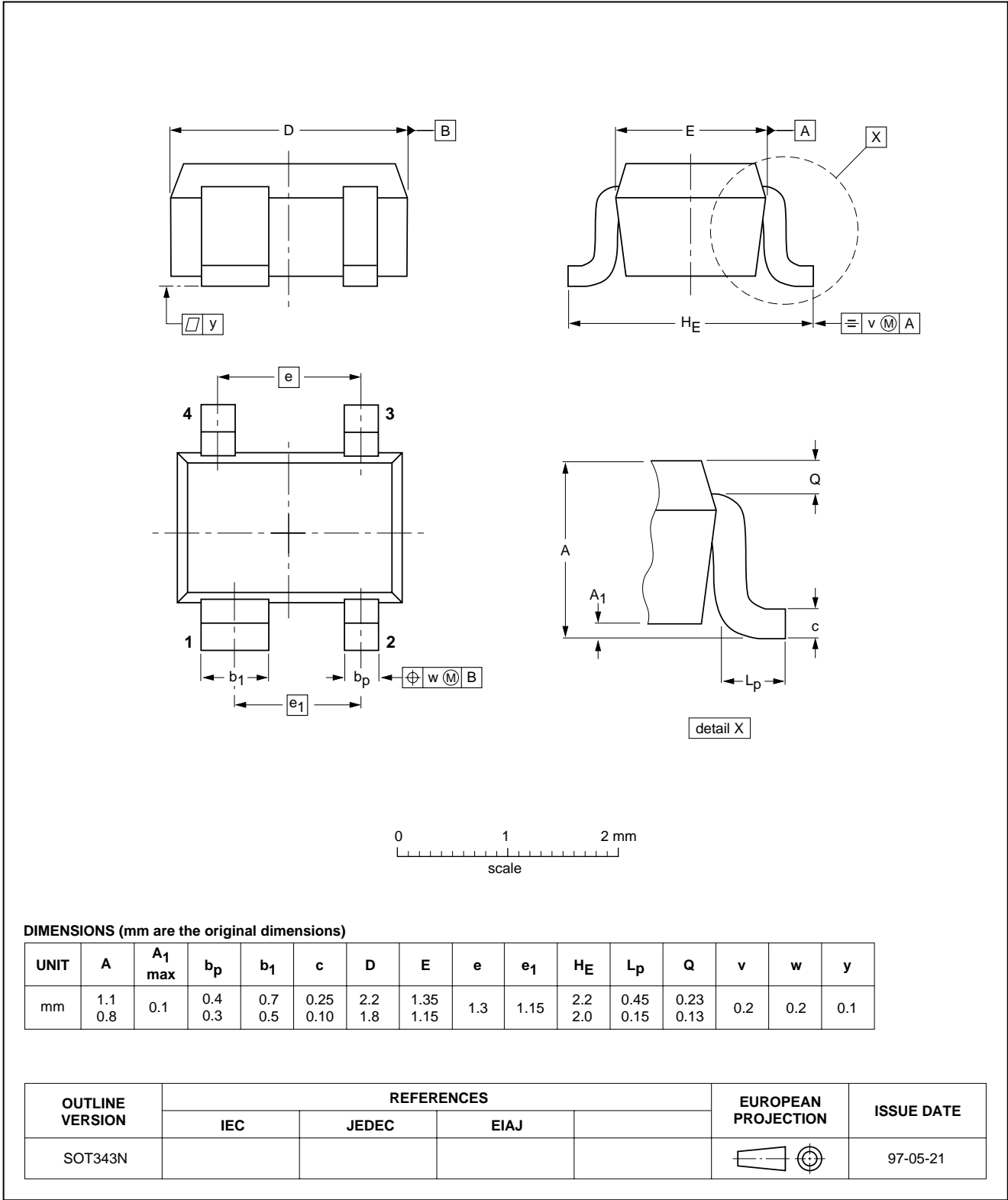
NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR

PACKAGE OUTLINES

Plastic surface mounted package; 4 leads

SOT343N

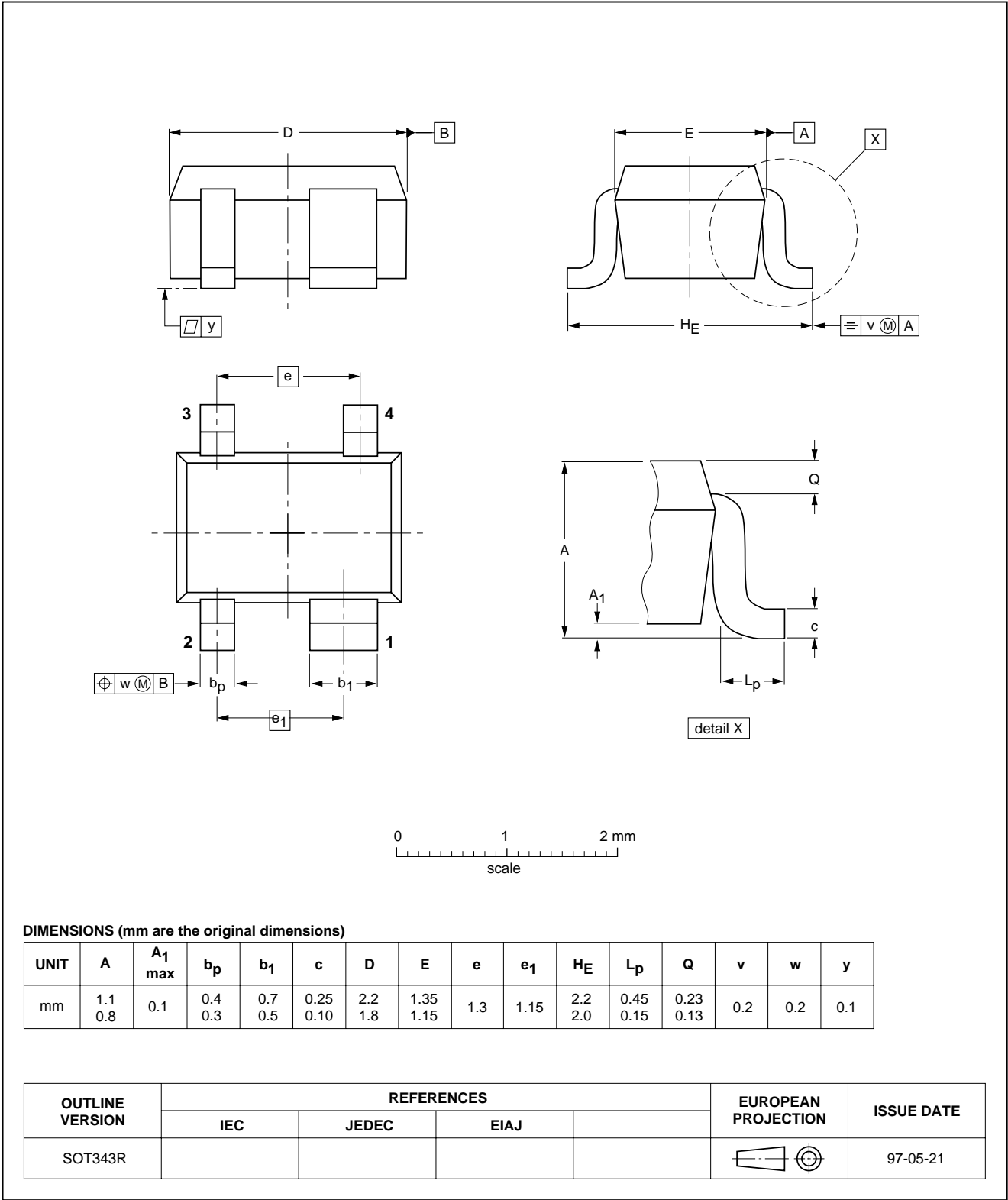


NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR

Plastic surface mounted package; reverse pinning; 4 leads

SOT343R



## NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/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.

## 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.

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