

# DATA SHEET

## **BFG540W** **BFG540W/X; BFG540W/XR** NPN 9 GHz wideband transistor

Product specification  
Supersedes data of August 1995  
File under Discrete Semiconductors, SC14

1997 Dec 04

# 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

They are intended for applications in the RF front end, in 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

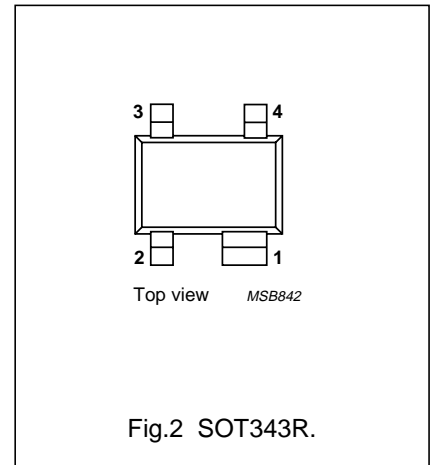
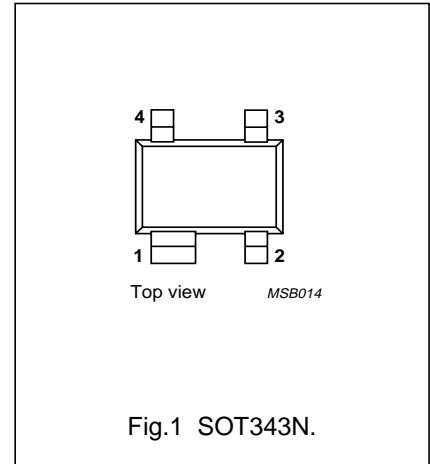
NPN silicon planar epitaxial transistors in plastic, 4-pin dual-emitter SOT343N and SOT343R packages.

### 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



### QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{CB0}$	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	up to $T_s = 85\text{ °C}$	–	–	500	mW
$h_{FE}$	DC current gain	$I_C = 40\text{ mA}; V_{CE} = 8\text{ V}$	60	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

NPN 9 GHz wideband transistor

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BFG540W/X; BFG540W/XR

**LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 134).

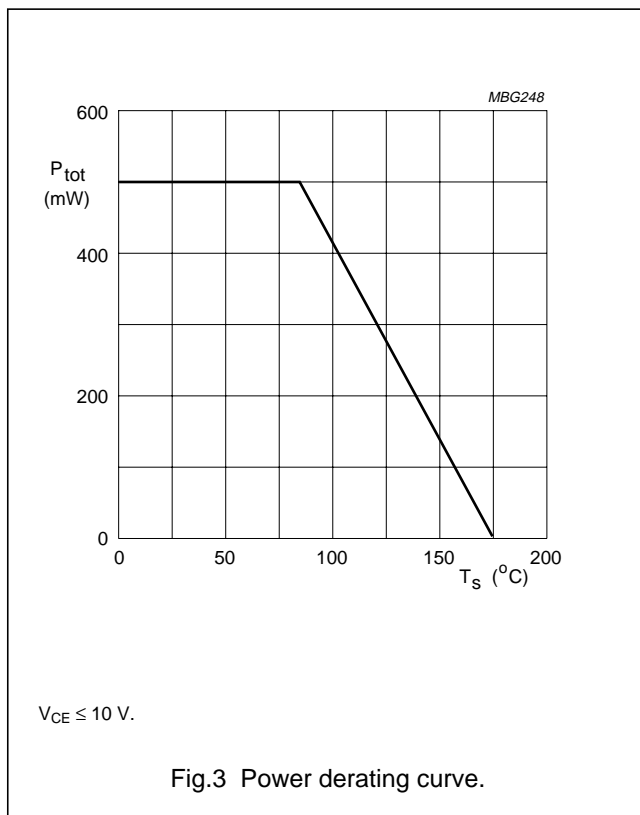
SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V <sub>CBO</sub>	collector-base voltage	open emitter	–	20	V
V <sub>CES</sub>	collector-emitter voltage	R <sub>BE</sub> = 0	–	15	V
V <sub>EBO</sub>	emitter-base voltage	open collector	–	2.5	V
I <sub>C</sub>	collector current (DC)		–	120	mA
P <sub>tot</sub>	total power dissipation	up to 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

**THERMAL CHARACTERISTICS**

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

**Note to the “Limiting values” and “Thermal characteristics”**

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).

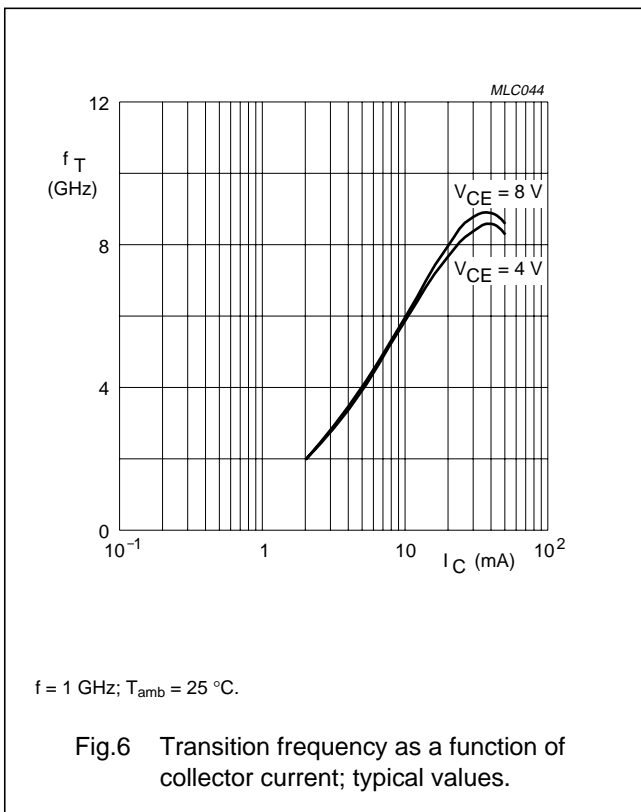
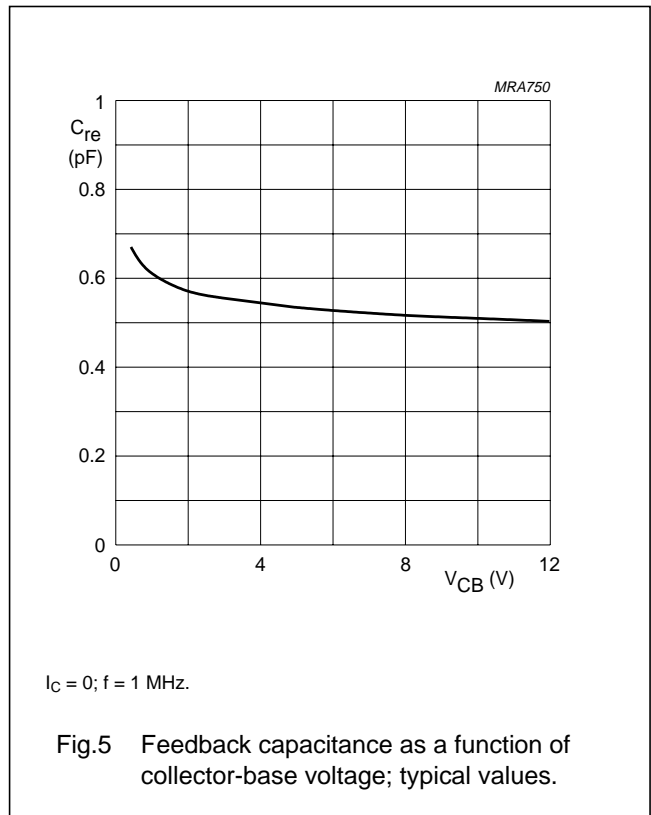
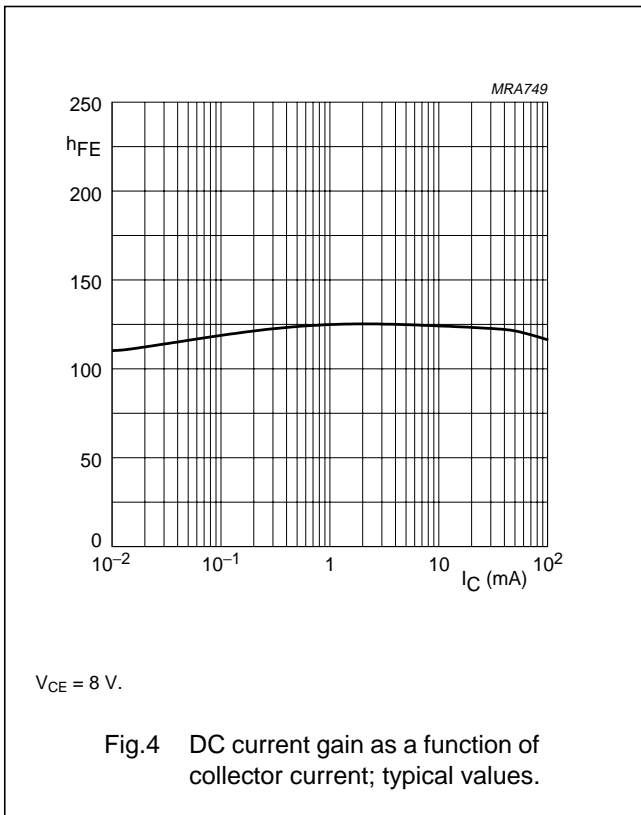
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V <sub>(BR)CBO</sub>	collector-base breakdown voltage	open emitter; I <sub>C</sub> = 10 μA; I <sub>E</sub> = 0	20	–	–	V
V <sub>(BR)CES</sub>	collector-emitter breakdown voltage	R <sub>BE</sub> = 0; I <sub>C</sub> = 40 μA	15	–	–	V
V <sub>(BR)EBO</sub>	emitter-base 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	60	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
PL <sub>1</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.

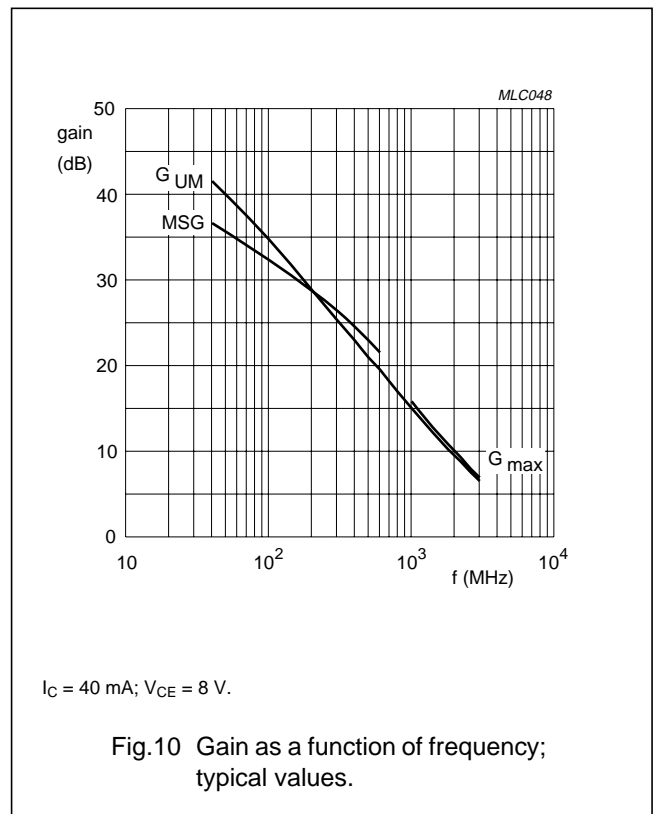
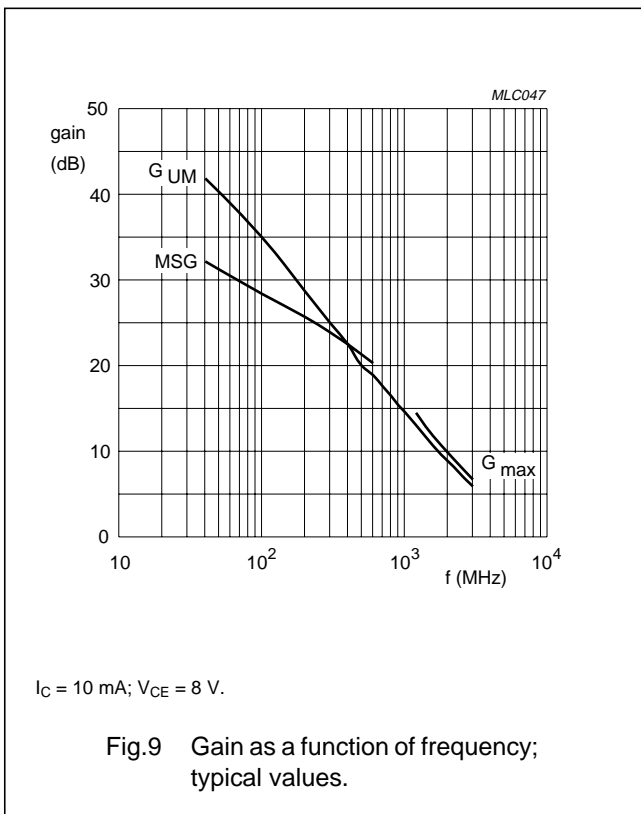
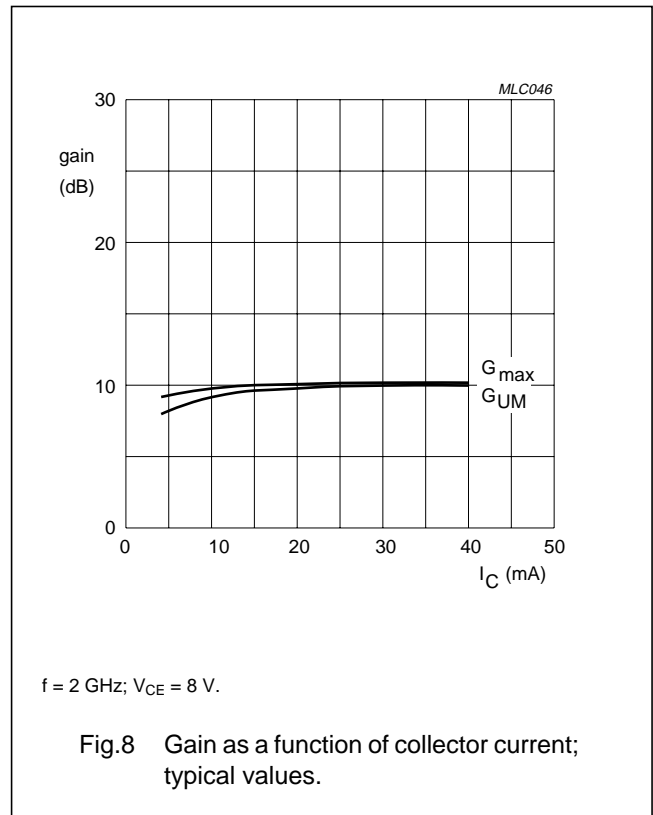
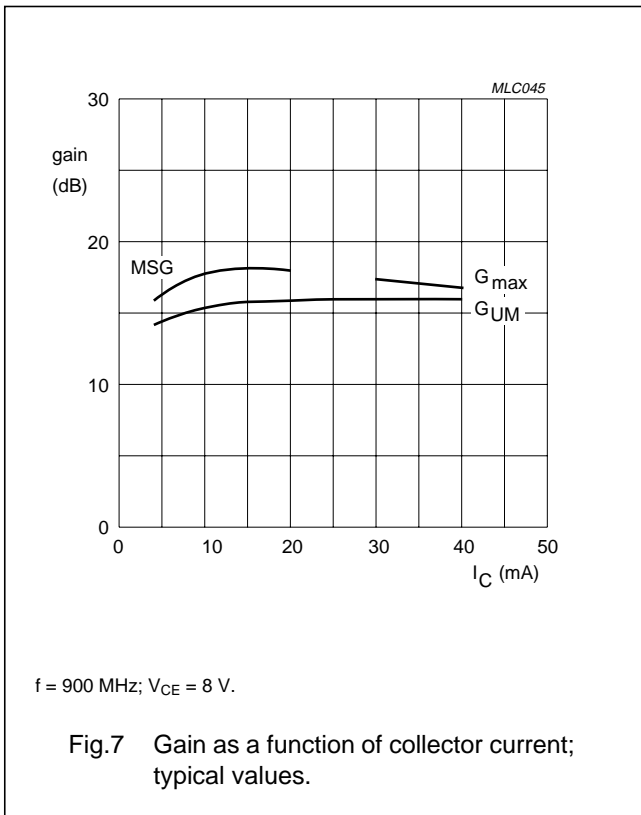
NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR



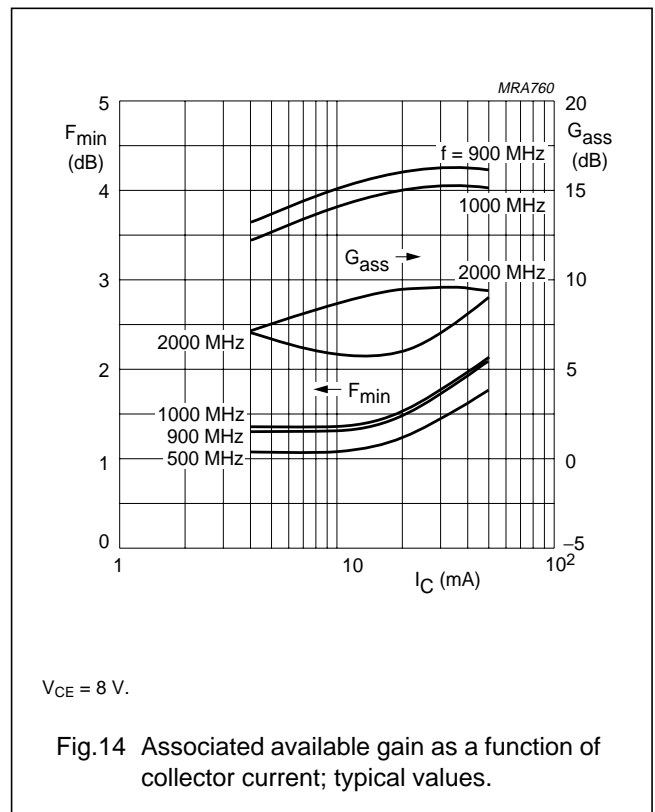
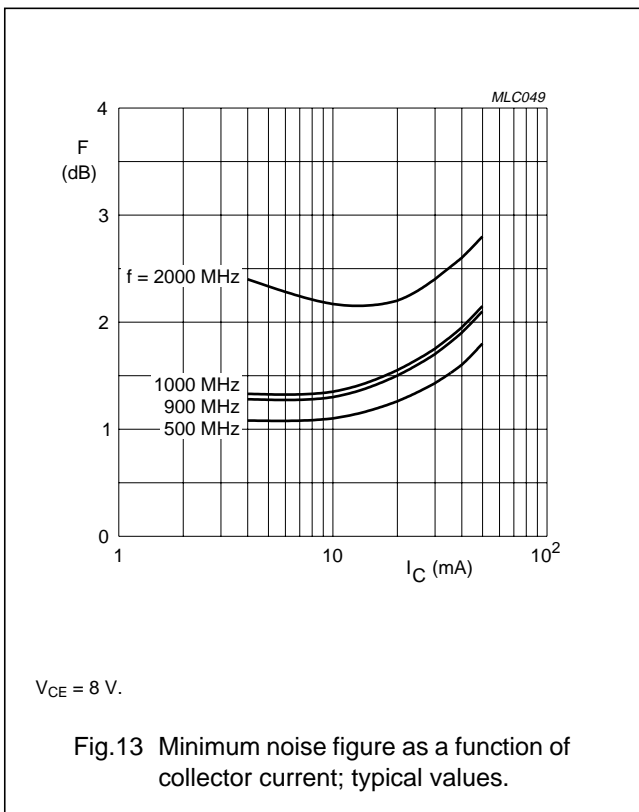
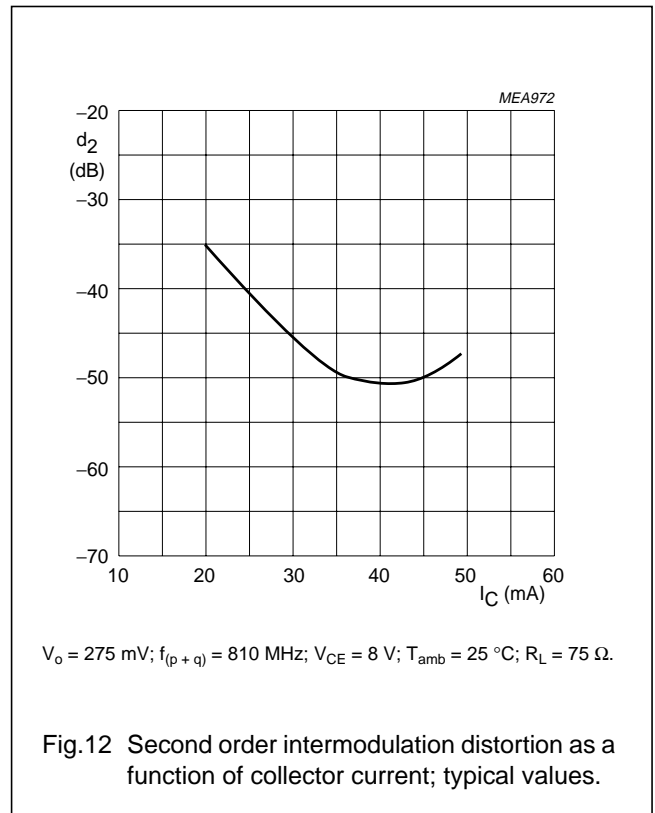
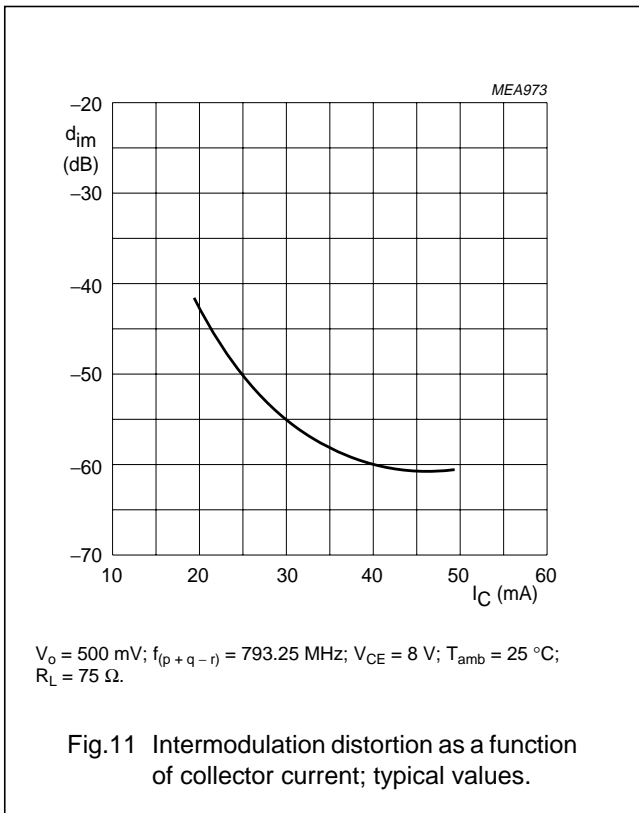
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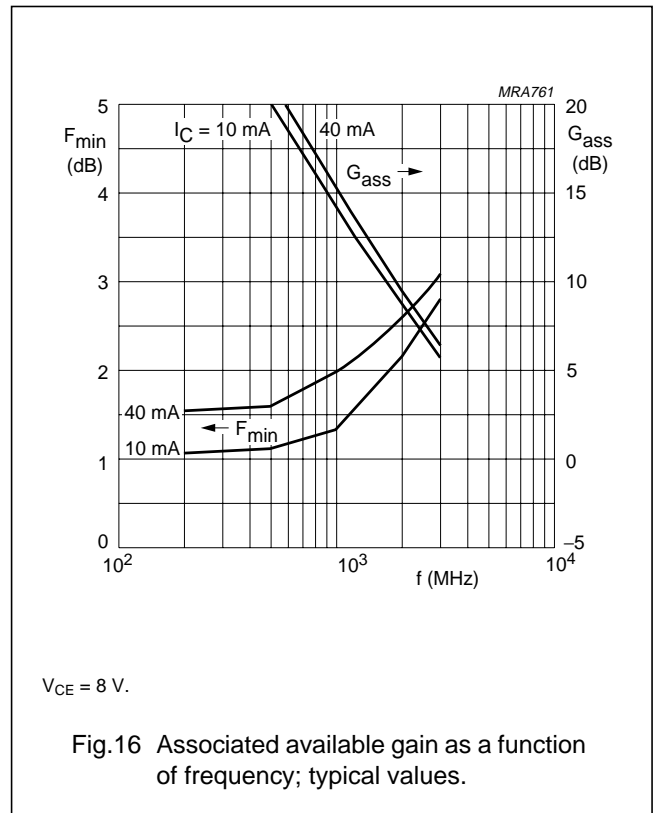
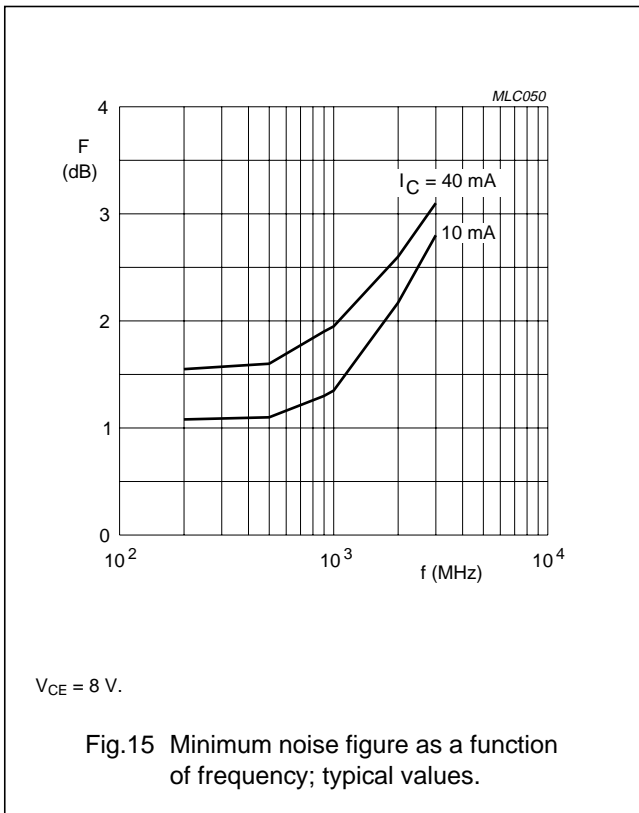
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NPN 9 GHz wideband transistor

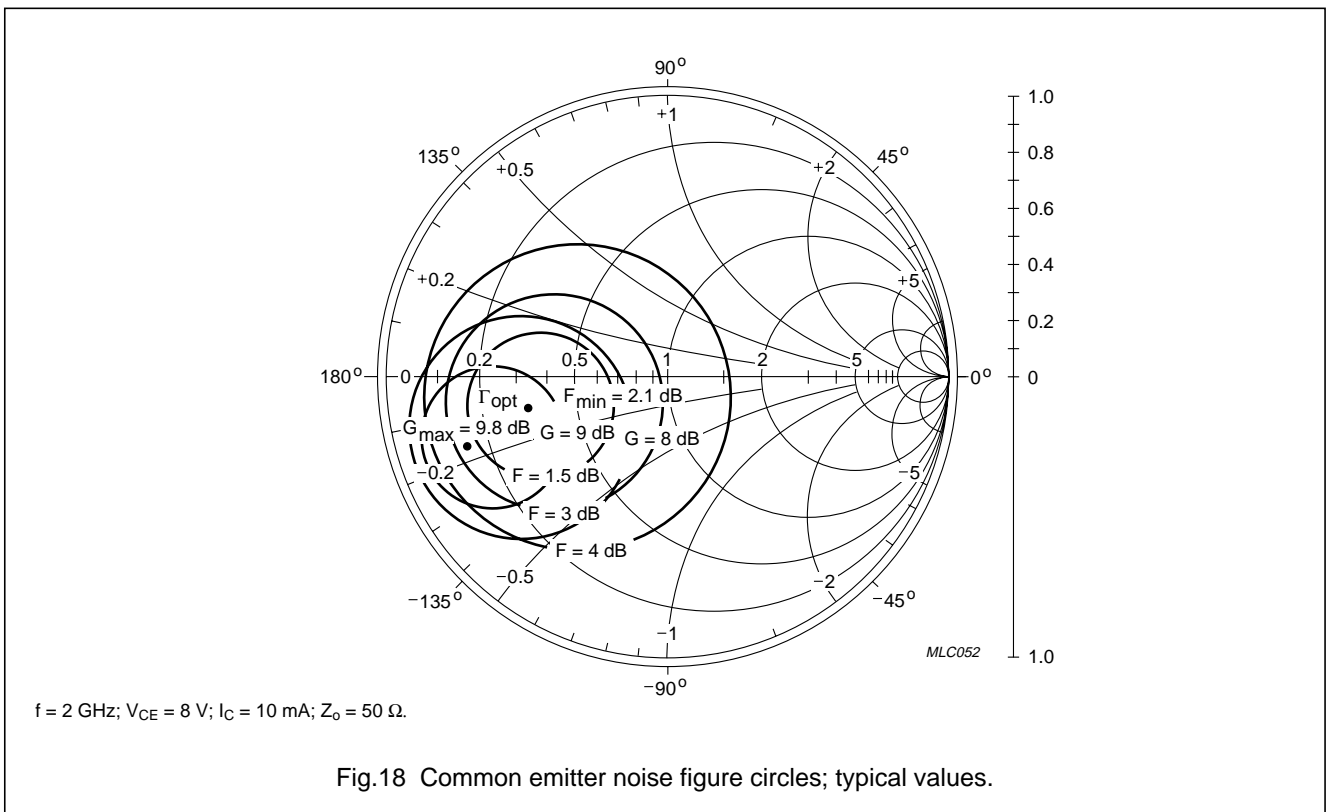
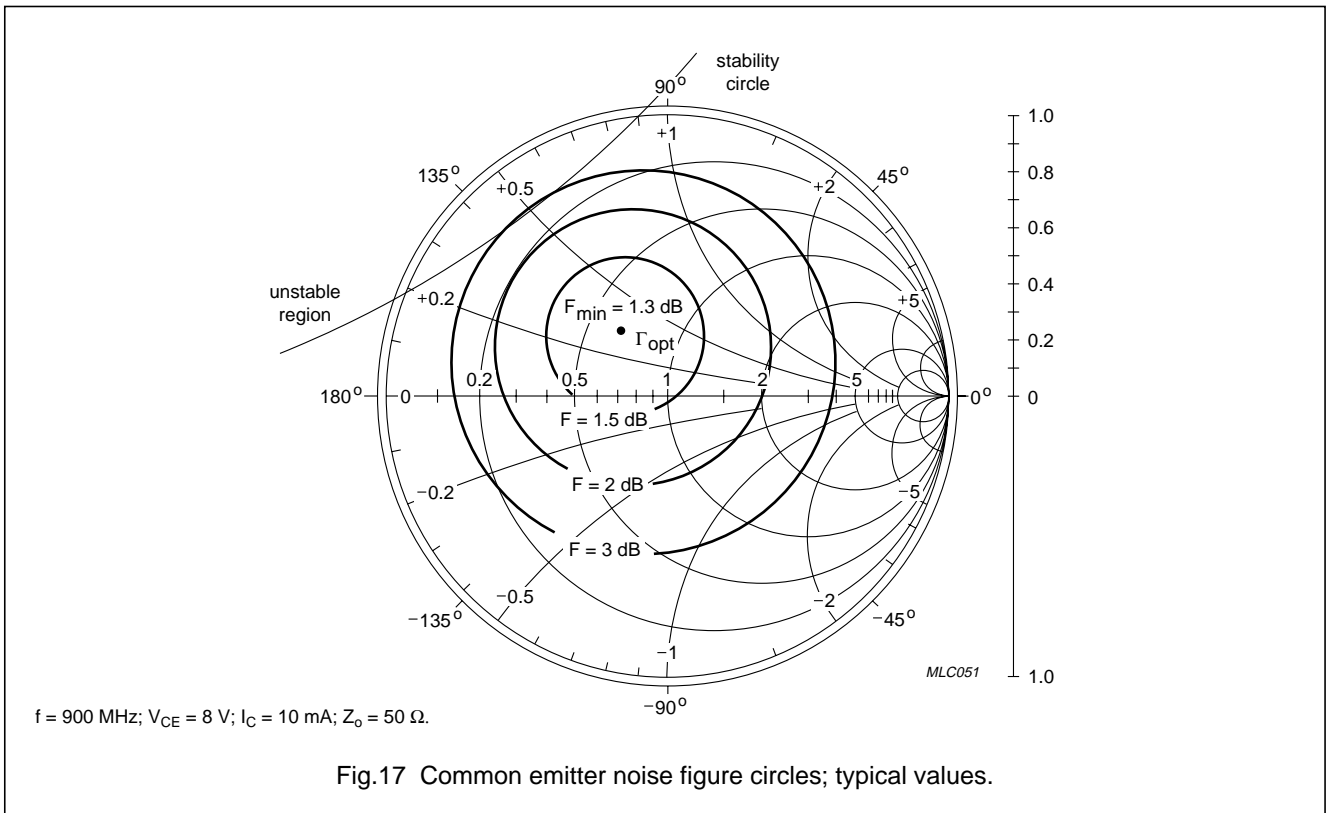
BFG540W  
BFG540W/X; BFG540W/XR





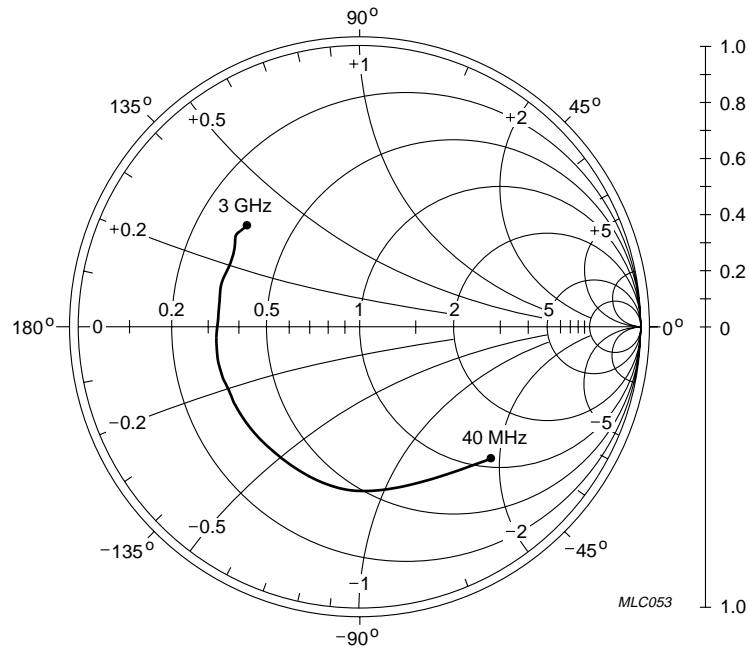
NPN 9 GHz wideband transistor

BFG540W  
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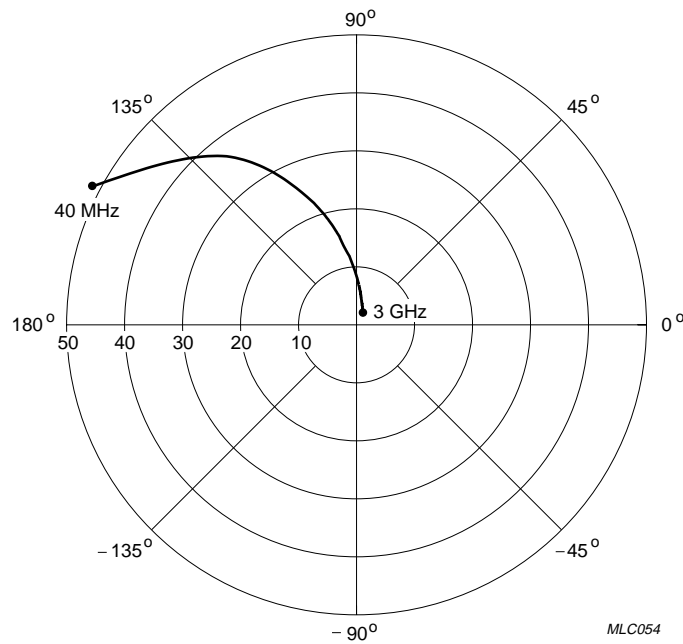
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$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}; Z_0 = 50\ \Omega.$

Fig.19 Common emitter input reflection coefficient ( $s_{11}$ ); typical values.

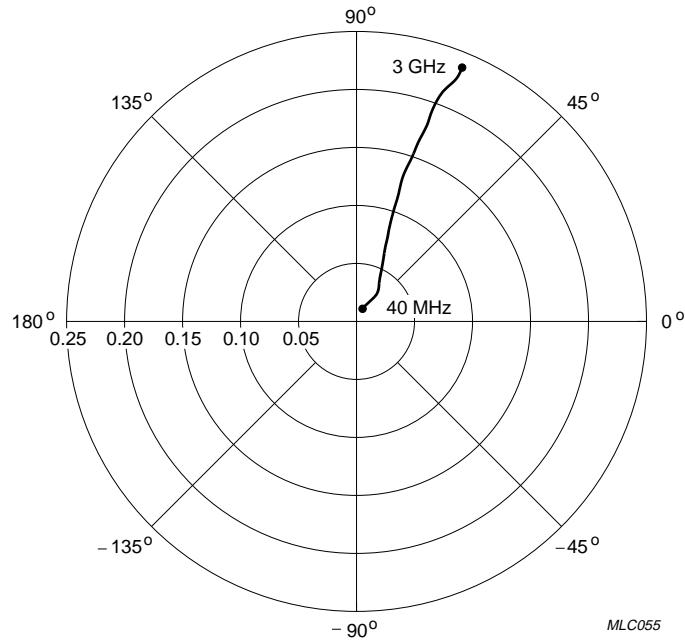


$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}.$

Fig.20 Common emitter forward transmission coefficient ( $s_{21}$ ); typical values.

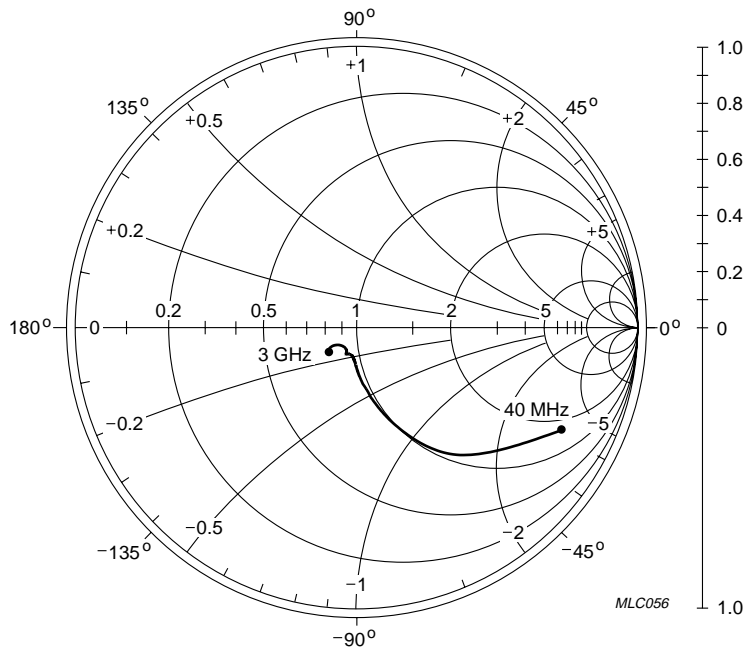
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$V_{CE} = 8\text{ V}; I_C = 40\text{ mA}$ .

Fig.21 Common emitter reverse transmission coefficient ( $s_{12}$ ); typical values.



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

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

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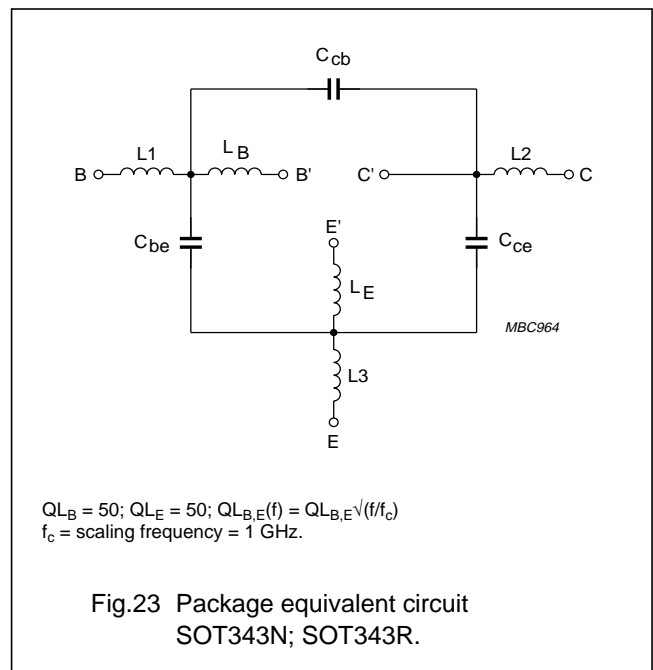
SPICE parameters for the BFG540W crystal

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	Ω
15	IRB	1.000	μA
16	RBM	5.000	Ω
17	RE	353.5	mΩ
18	RC	1.340	Ω
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

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



List of components (see Fig.23).

DESIGNATION	VALUE	UNIT
C <sub>be</sub>	70	fF
C <sub>cb</sub>	50	fF
C <sub>ce</sub>	115	fF
L1	0.34	nH
L2	0.10	nH
L3	0.25	nH
L <sub>B</sub>	0.40	nH
L <sub>E</sub>	0.40	nH

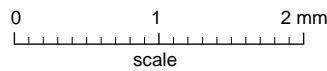
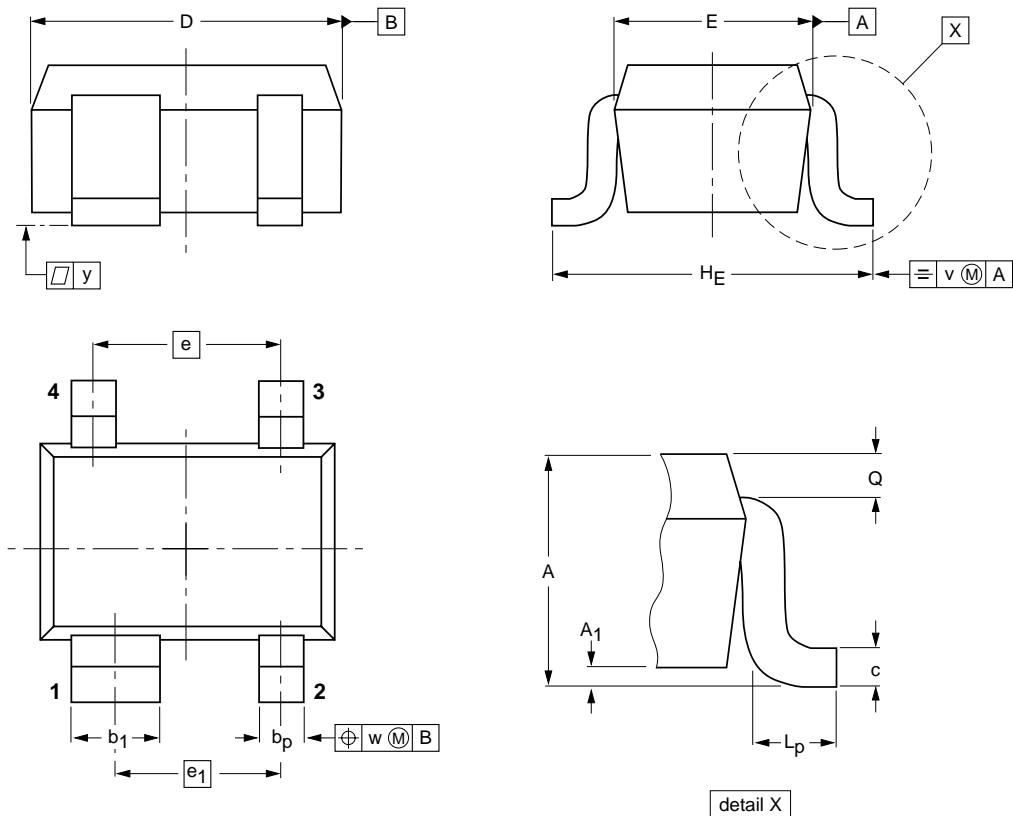
NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR

PACKAGE OUTLINES

Plastic surface mounted package; 4 leads

SOT343N



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub> max	b <sub>p</sub>	b <sub>1</sub>	c	D	E	e	e <sub>1</sub>	H <sub>E</sub>	L <sub>p</sub>	Q	v	w	y
mm	1.1 0.8	0.1	0.4 0.3	0.7 0.5	0.25 0.10	2.2 1.8	1.35 1.15	1.3	1.15	2.2 2.0	0.45 0.15	0.23 0.13	0.2	0.2	0.1

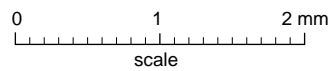
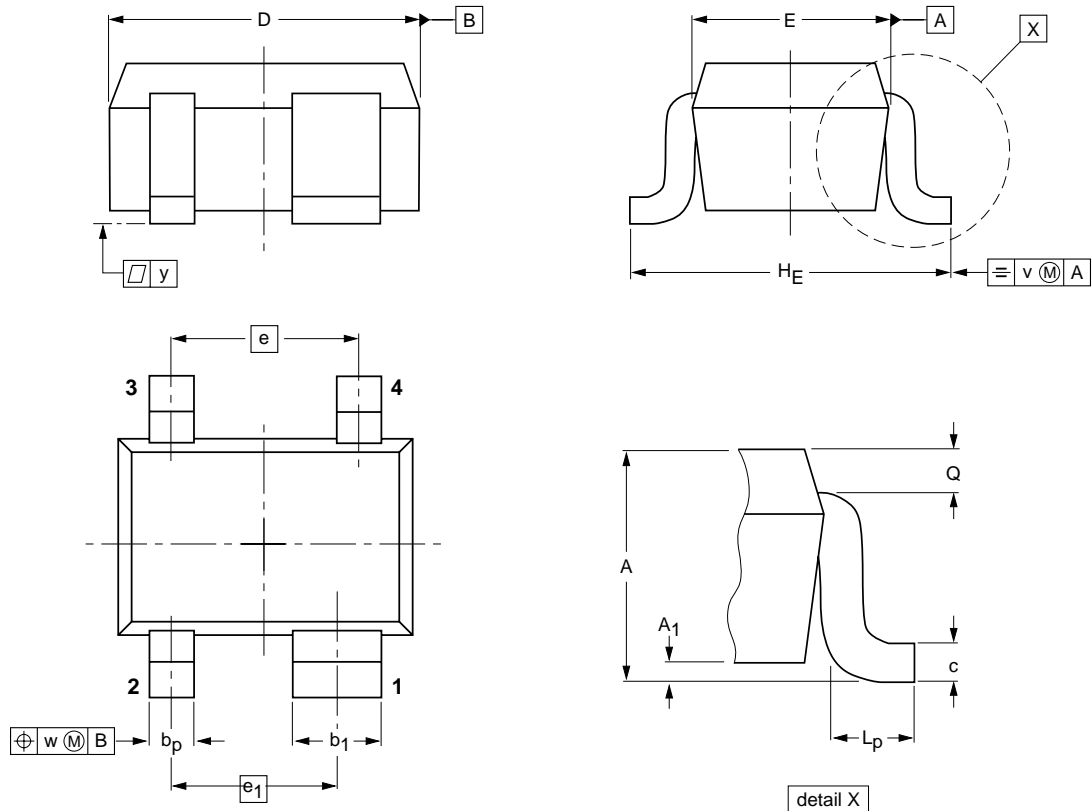
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT343N						97-05-21

NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR

Plastic surface mounted package; reverse pinning; 4 leads

SOT343R



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub> max	b <sub>p</sub>	b <sub>1</sub>	c	D	E	e	e <sub>1</sub>	H <sub>E</sub>	L <sub>p</sub>	Q	v	w	y
mm	1.1 0.8	0.1	0.4 0.3	0.7 0.5	0.25 0.10	2.2 1.8	1.35 1.15	1.3	1.15	2.2 2.0	0.45 0.15	0.23 0.13	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT343R						97-05-21

## NPN 9 GHz wideband transistor

BFG540W  
BFG540W/X; BFG540W/XR**DEFINITIONS**

<b>Data Sheet Status</b>	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
<b>Limiting values</b>	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). 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.	
<b>Application information</b>	
Where application information is given, it is advisory and does not form part of the specification.	

**LIFE SUPPORT APPLICATIONS**

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 customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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