

# DATA SHEET

## **BFG520W** **BFG520W/X; BFG520W/XR** NPN 9 GHz wideband transistor

Product specification  
File under Discrete Semiconductors, SC14

August 1995

**Philips Semiconductors**



**PHILIPS**

# NPN 9 GHz wideband transistor

# BFG520W BFG520W/X; BFG520W/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) and repeater amplifiers in fibre-optic systems.

## DESCRIPTION

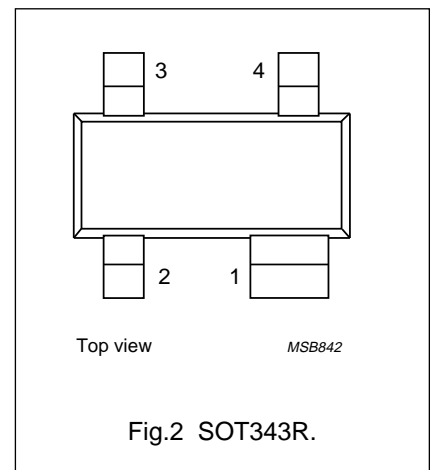
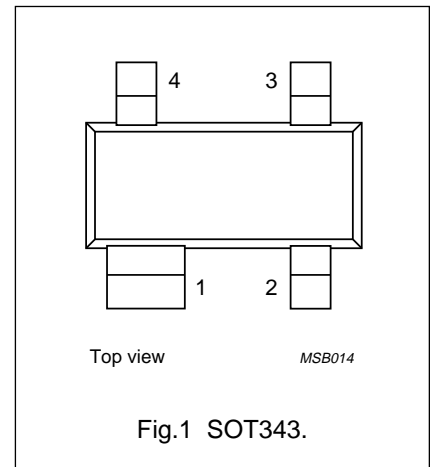
NPN silicon planar epitaxial transistors in plastic, 4-pin dual-emitter SOT343 and SOT343R packages.

## MARKING

TYPE NUMBER	CODE
BFG520W	N3
BFG520W/X	N4
BFG520W/XR	N5

## PINNING

PIN	DESCRIPTION
<b>BFG520W (see Fig.1)</b>	
1	collector
2	base
3	emitter
4	emitter
<b>BFG520W/X (see Fig.1)</b>	
1	collector
2	emitter
3	base
4	emitter
<b>BFG520W/XR (see Fig.2)</b>	
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
$V_{CEO}$	collector-emitter voltage	open base	–	–	15	V
$I_C$	collector current (DC)		–	–	70	mA
$P_{tot}$	total power dissipation	up to $T_s = 85\text{ °C}$	–	–	500	mW
$h_{FE}$	DC current gain	$I_C = 20\text{ mA}$ ; $V_{CE} = 6\text{ V}$	60	120	250	
$C_{re}$	feedback capacitance	$I_C = 0$ ; $V_{CB} = 6\text{ V}$ ; $f = 1\text{ MHz}$	–	0.35	–	pF
$f_T$	transition frequency	$I_C = 20\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 1\text{ GHz}$ ; $T_{amb} = 25\text{ °C}$	–	9	–	GHz
$G_{UM}$	maximum unilateral power gain	$I_C = 20\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	–	17	–	dB
$ S_{21} ^2$	insertion power gain	$I_C = 20\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	16	17	–	dB
F	noise figure	$\Gamma_s = \Gamma_{opt}$ ; $I_C = 5\text{ mA}$ ; $V_{CE} = 6\text{ V}$ ; $f = 900\text{ MHz}$	–	1.1	1.6	dB

NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR

**LIMITING VALUES**

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

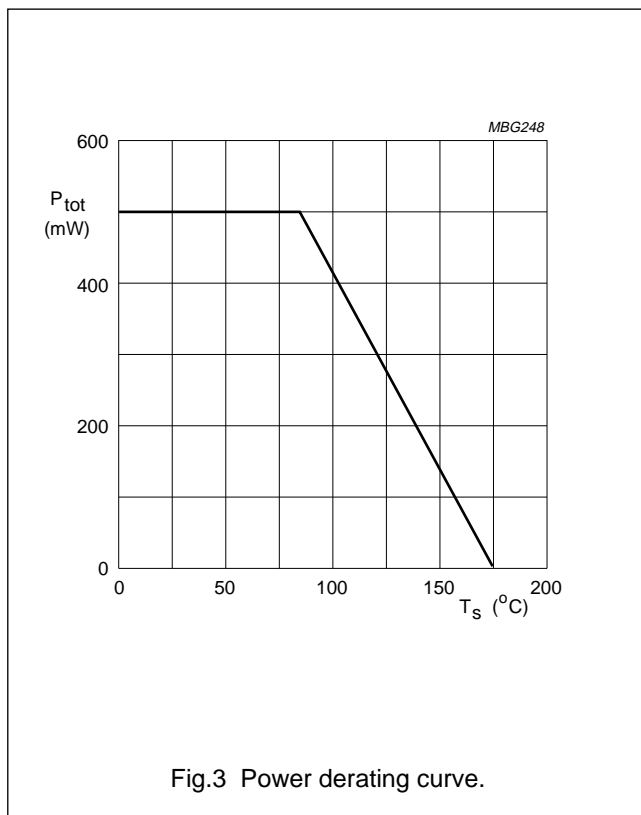
SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V <sub>CBO</sub>	collector-base voltage	open emitter	–	20	V
V <sub>CEO</sub>	collector-emitter voltage	open base	–	15	V
V <sub>EBO</sub>	emitter-base voltage	open collector	–	2.5	V
I <sub>C</sub>	collector current (DC)		–	70	mA
P <sub>tot</sub>	total power dissipation	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.



## NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR

## CHARACTERISTICS

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

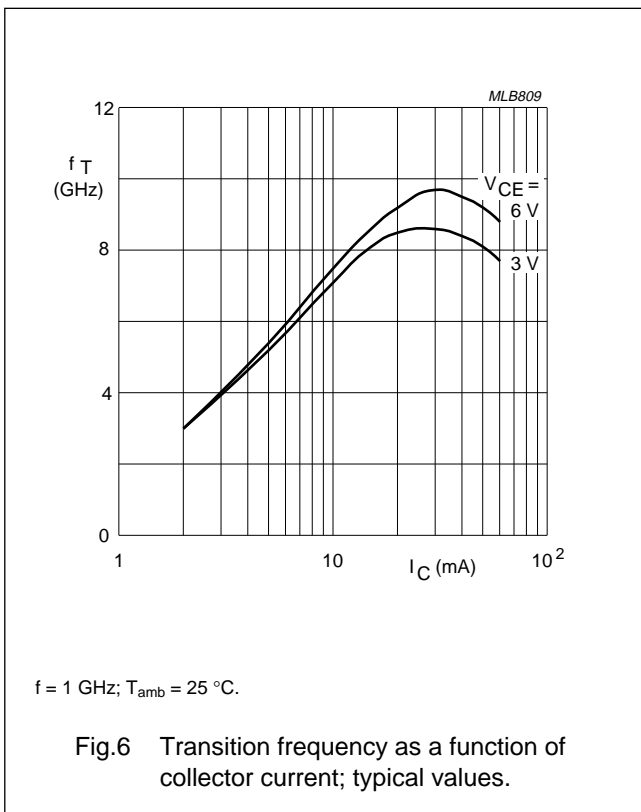
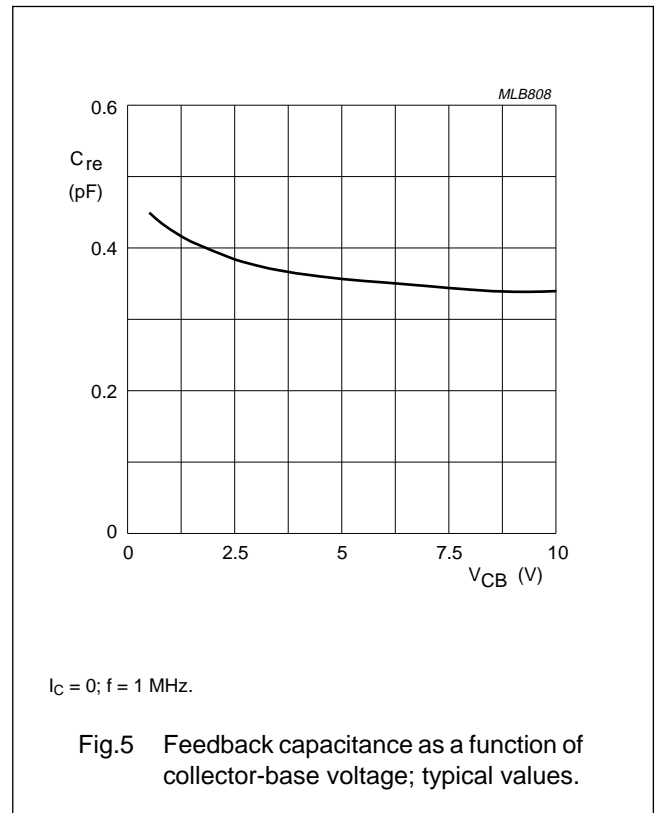
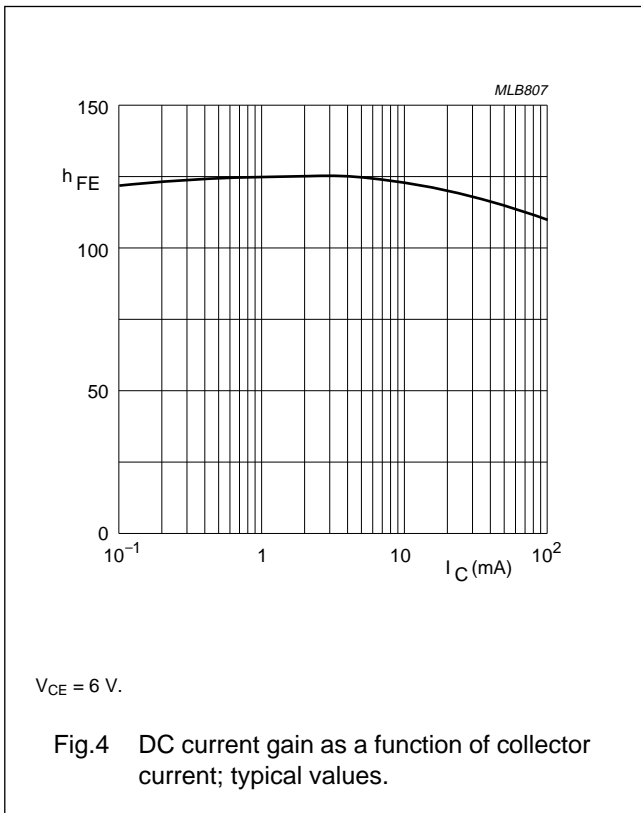
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V <sub>(BR)CBO</sub>	collector-base breakdown voltage	open emitter; I <sub>C</sub> = 0.01 mA; I <sub>E</sub> = 0	–	–	20	V
V <sub>(BR)CEO</sub>	collector-emitter breakdown voltage	open base; I <sub>C</sub> = 10 mA; I <sub>B</sub> = 0	–	–	15	V
V <sub>(BR)EBO</sub>	emitter-base breakdown voltage	open collector; I <sub>E</sub> = 0.01 mA; I <sub>C</sub> = 0	–	–	2.5	V
I <sub>CBO</sub>	collector cut-off current	open emitter; V <sub>CB</sub> = 6 V; I <sub>E</sub> = 0	–	–	50	nA
h <sub>FE</sub>	DC current gain	I <sub>C</sub> = 20 mA; V <sub>CE</sub> = 6 V	60	120	250	
C <sub>re</sub>	feedback capacitance	I <sub>C</sub> = 0; V <sub>CB</sub> = 6 V; f = 1 MHz	–	0.35	–	pF
f <sub>T</sub>	transition frequency	I <sub>C</sub> = 20 mA; V <sub>CE</sub> = 6 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> = 20 mA; V <sub>CE</sub> = 6 V; f = 900 MHz; T <sub>amb</sub> = 25 °C	–	17	–	dB
		I <sub>C</sub> = 20 mA; V <sub>CE</sub> = 6 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> = 20 mA; V <sub>CE</sub> = 6 V; f = 900 MHz; T <sub>amb</sub> = 25 °C	16	17	–	dB
F	noise figure	Γ <sub>s</sub> = Γ <sub>opt</sub> ; I <sub>C</sub> = 5 mA; V <sub>CE</sub> = 6 V; f = 900 MHz	–	1.1	1.6	dB
		Γ <sub>s</sub> = Γ <sub>opt</sub> ; I <sub>C</sub> = 20 mA; V <sub>CE</sub> = 6 V; f = 900 MHz	–	1.6	2.1	dB
		Γ <sub>s</sub> = Γ <sub>opt</sub> ; I <sub>C</sub> = 5 mA; V <sub>CE</sub> = 6 V; f = 2 GHz	–	1.85	–	dB
PL <sub>1</sub>	output power at 1 dB gain compression	I <sub>C</sub> = 20 mA; V <sub>CE</sub> = 6 V; f = 900 MHz; R <sub>L</sub> = 50 Ω; T <sub>amb</sub> = 25 °C	–	17	–	dBm
ITO	third order intercept point	note 2	–	26	–	dBm
V <sub>o</sub>	output voltage	note 3	–	275	–	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> = 20 mA; V<sub>CE</sub> = 6 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); I<sub>C</sub> = 20 mA; V<sub>CE</sub> = 6 V; 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;  
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> = 20 mA; V<sub>CE</sub> = 6 V; V<sub>o</sub> = 75 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.

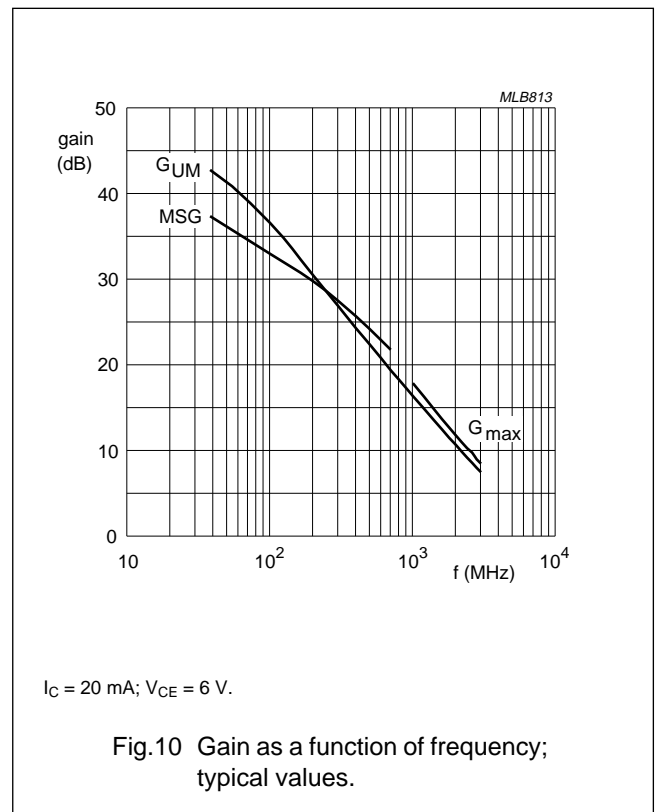
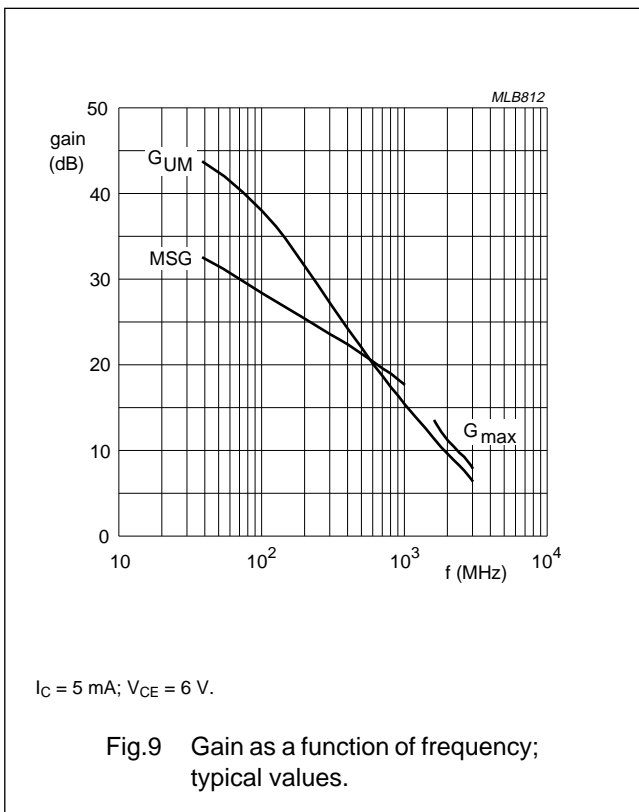
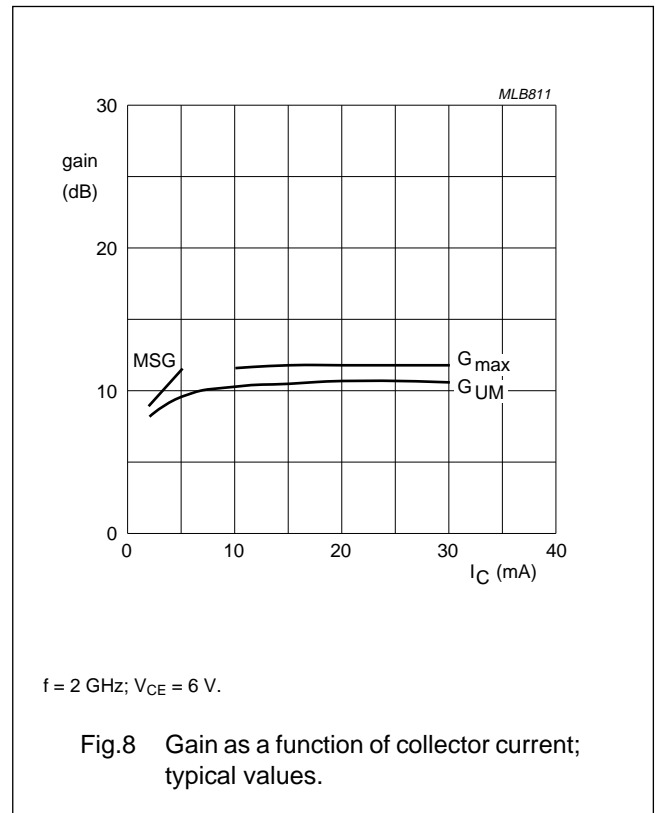
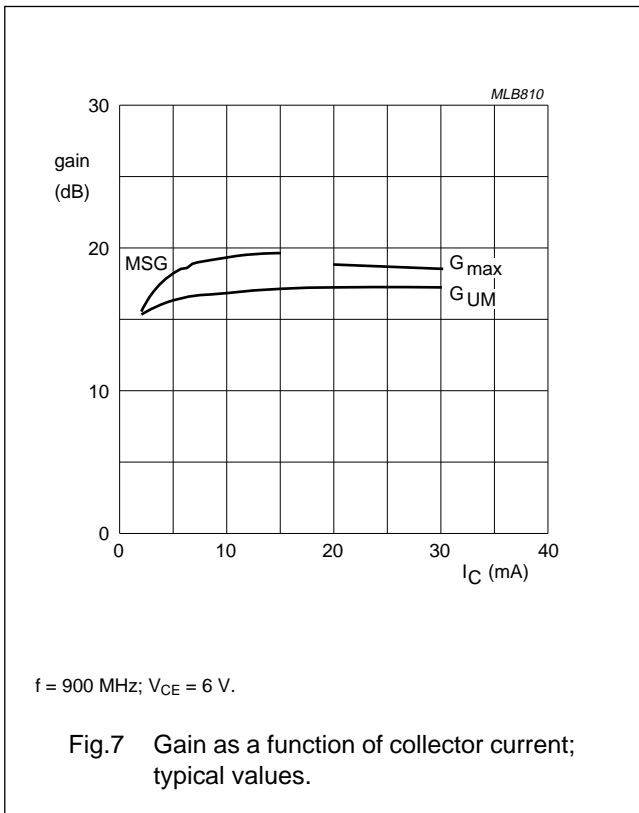
NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR



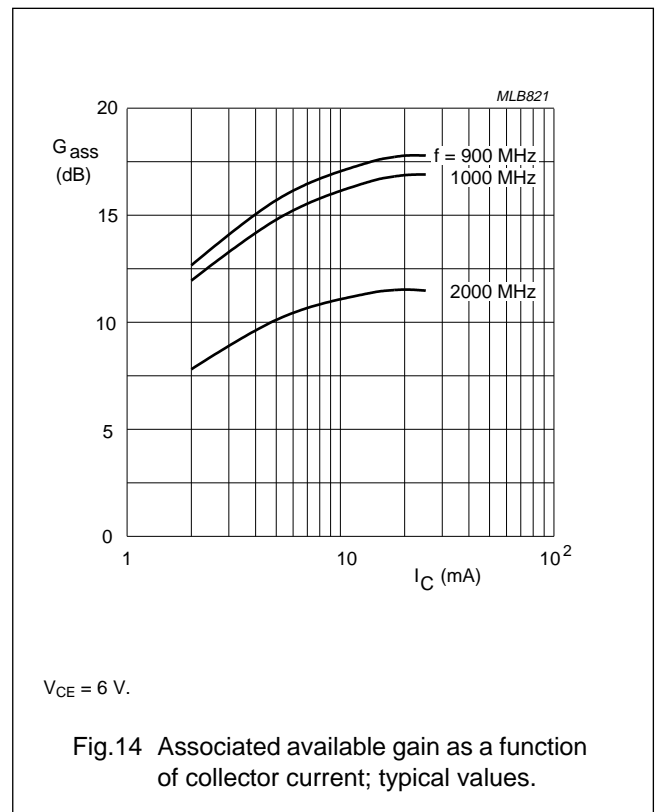
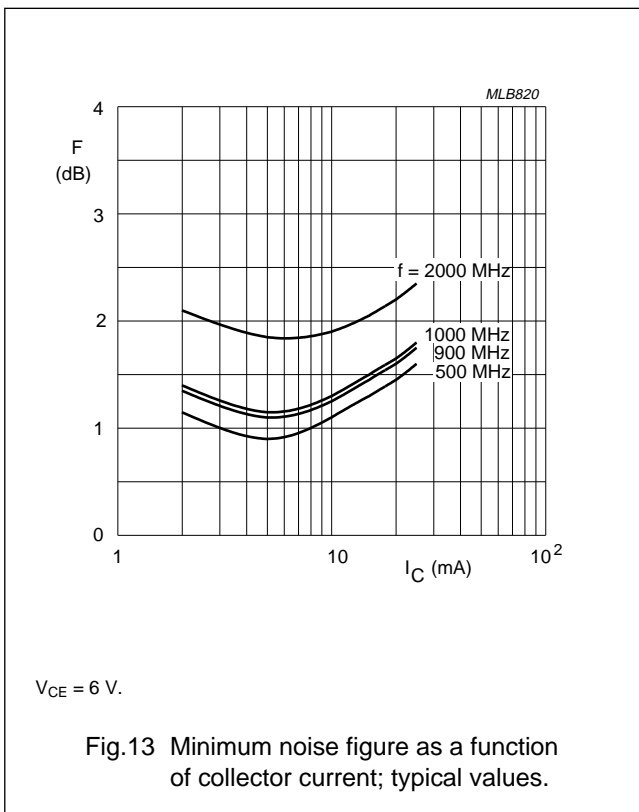
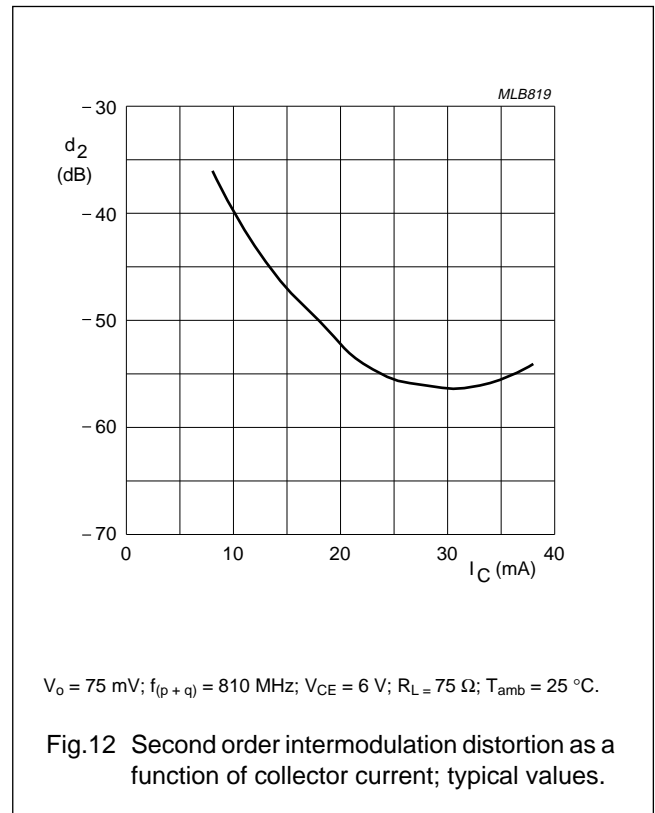
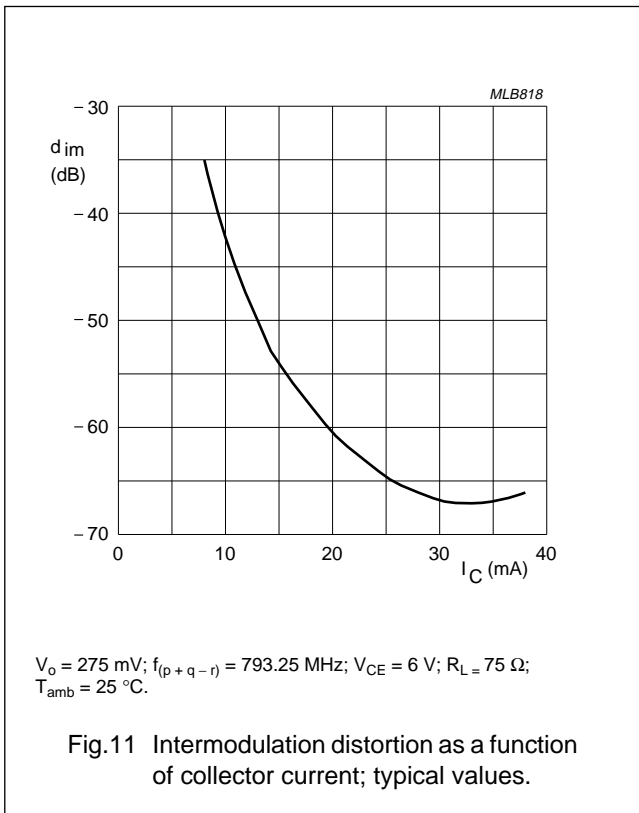
NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR



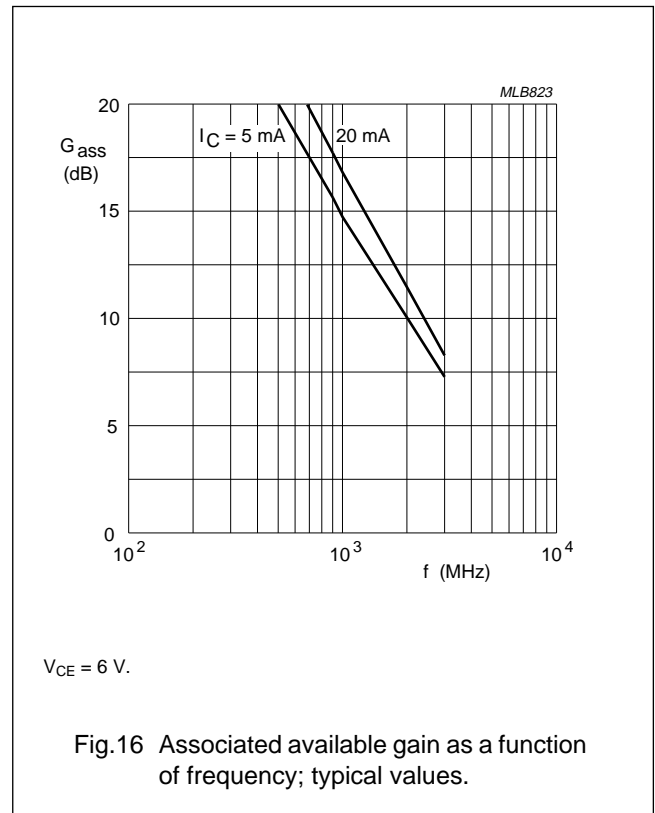
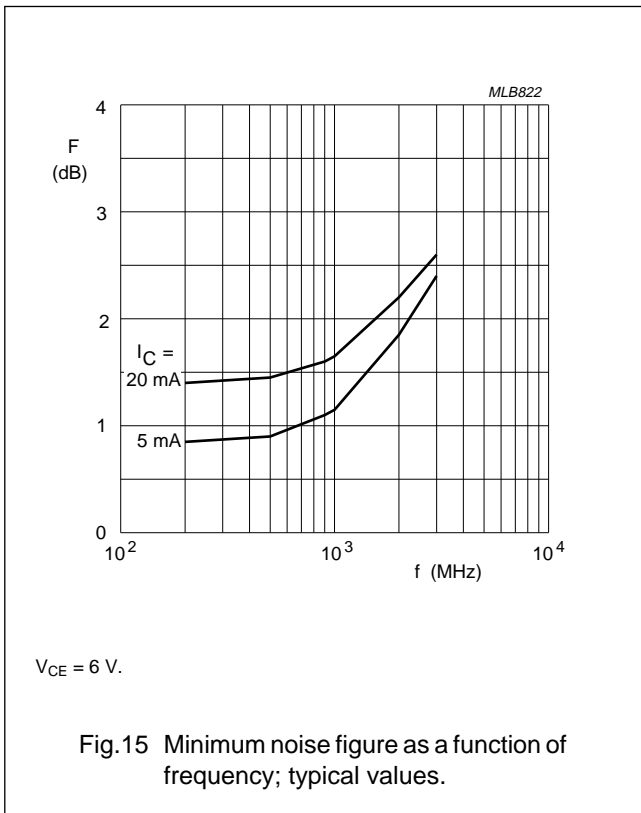
NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR



NPN 9 GHz wideband transistor

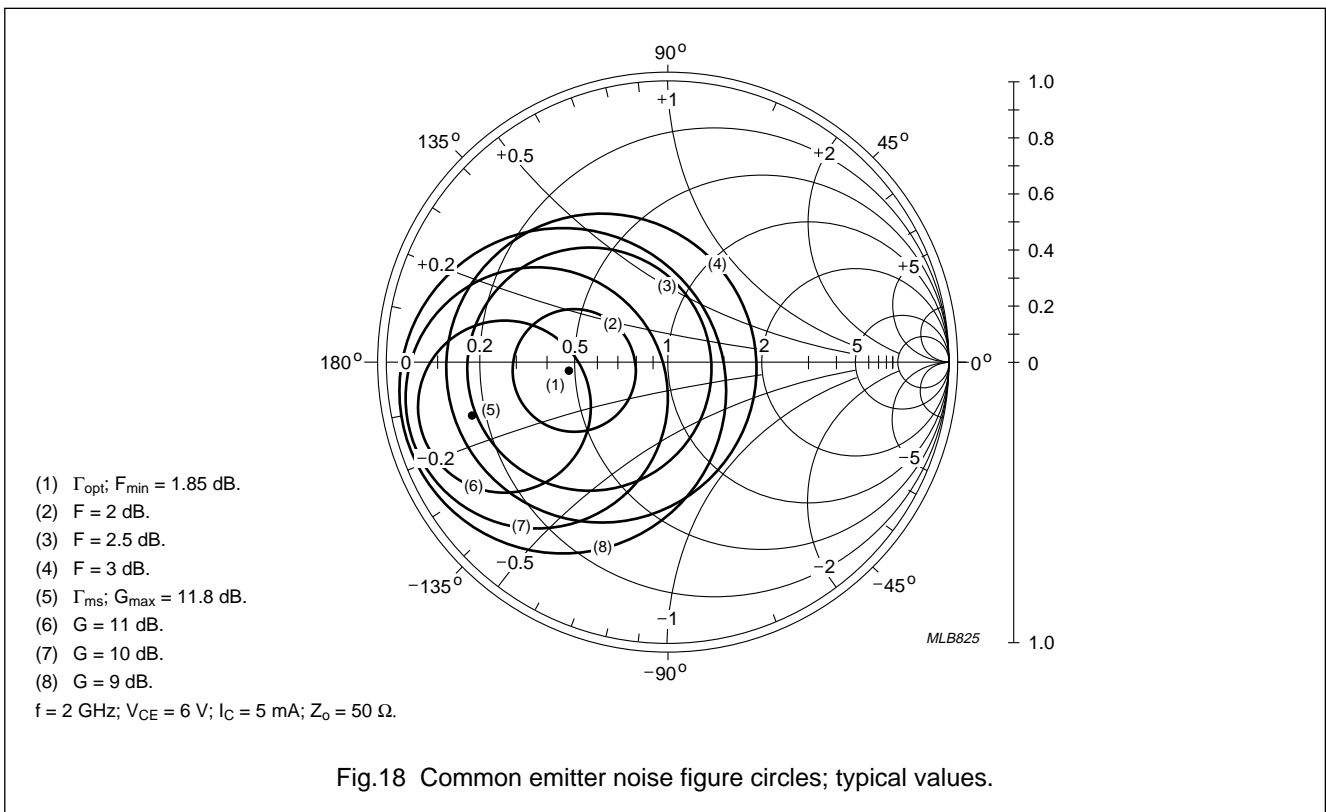
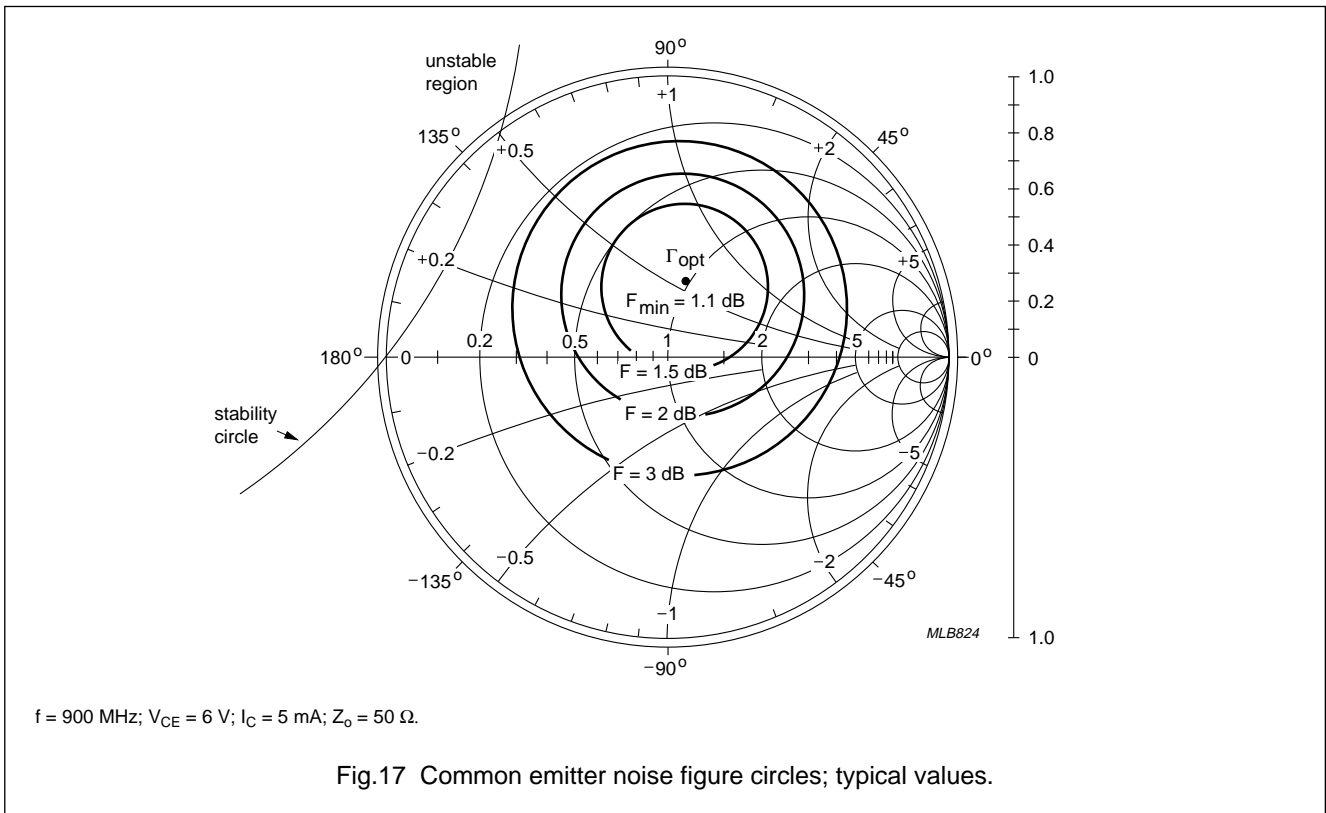
BFG520W  
BFG520W/X; BFG520W/XR





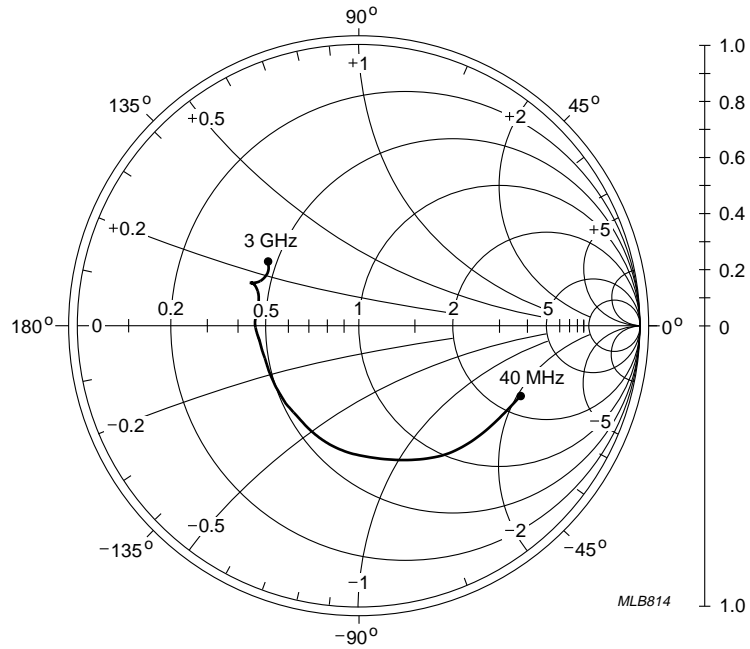
NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR



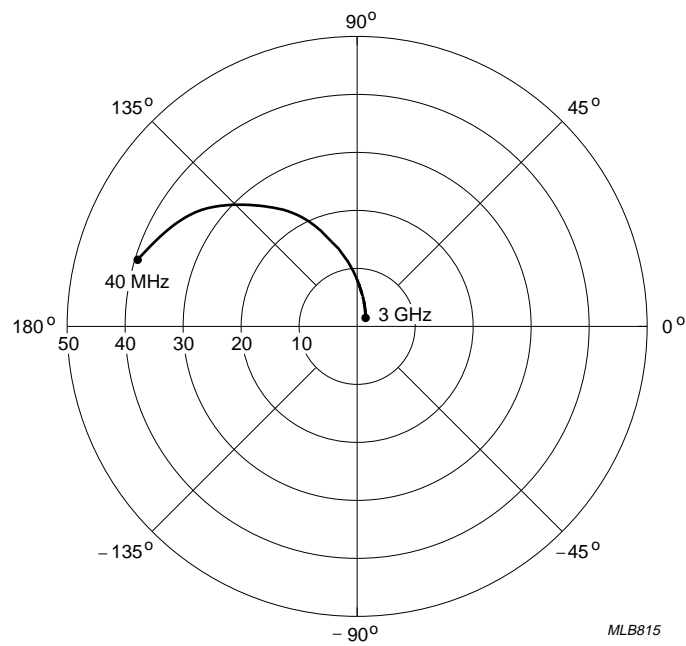
NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR



$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}; Z_o = 50\ \Omega.$

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

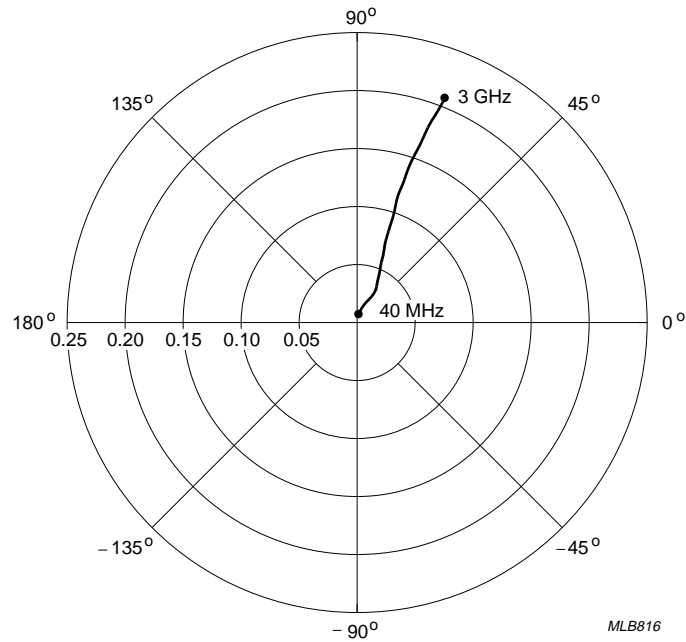


$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}.$

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

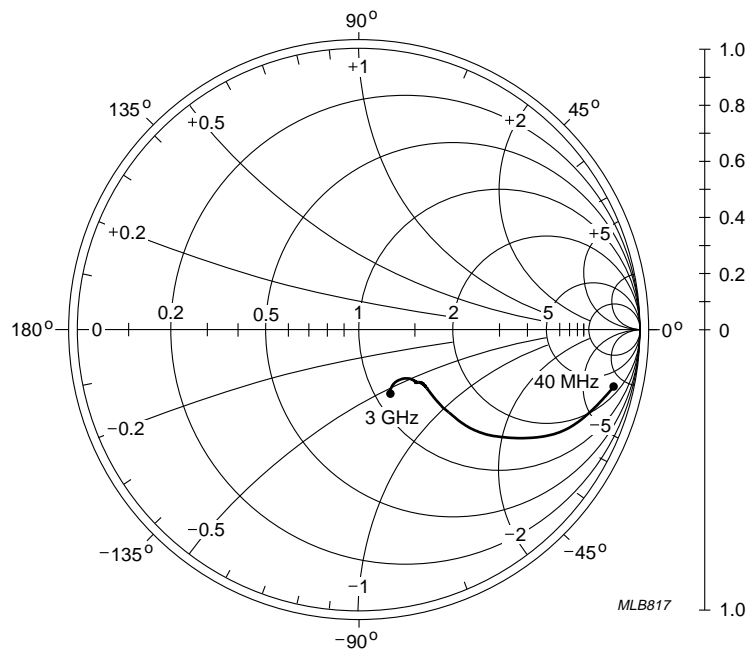
NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR



$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}$ .

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



$V_{CE} = 6\text{ V}; I_C = 20\text{ mA}; Z_0 = 50\ \Omega$ .

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

NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR

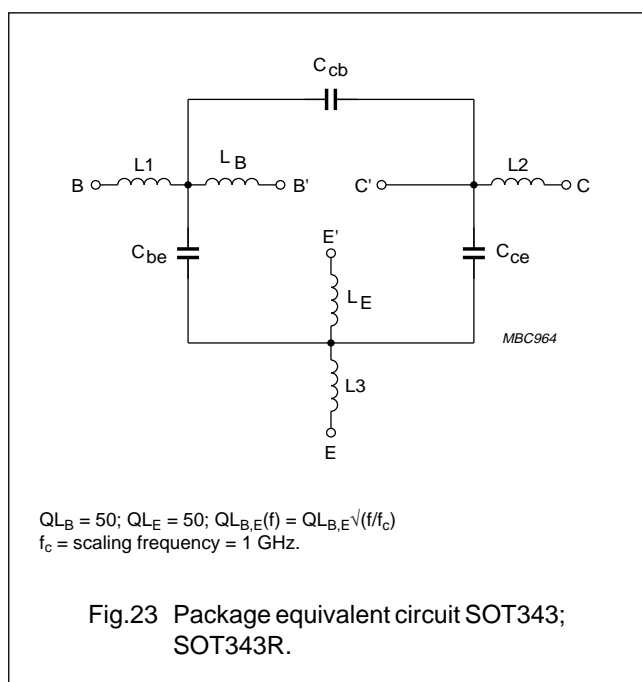
SPICE parameters for the BFG520W crystal

SEQUENCE No.	PARAMETER	VALUE	UNIT
1	IS	1.016	fA
2	BF	220.1	–
3	NF	1.000	–
4	VAF	48.06	V
5	IKF	510	mA
6	ISE	283	fA
7	NE	2.035	–
8	BR	100.7	–
9	NR	0.988	–
10	VAR	1.692	V
11	IKR	2.352	mA
12	ISC	24.48	aA
13	NC	1.022	–
14	RB	10.00	Ω
15	IRB	1.000	μA
16	RBM	10.00	Ω
17	RE	775.3	mΩ
18	RC	2.210	Ω
19 (1)	XTB	0.000	–
20 (1)	EG	1.110	eV
21 (1)	XTI	3.000	–
22	CJE	1.245	pF
23	VJE	600.0	mV
24	MJE	0.258	–
25	TF	8.616	ps
26	XTF	6.788	–
27	VTF	1.414	V
28	ITF	110.3	mA
29	PTF	45.01	deg
30	CJC	447.6	fF
31	VJC	189.2	mV
32	MJC	0.070	–
33	XCJC	0.130	–
34	TR	543.7	ps
35 (1)	CJS	0.000	F

SEQUENCE No.	PARAMETER	VALUE	UNIT
36 (1)	VJS	750.0	mV
37 (1)	MJS	0.000	–
38	FC	0.780	–

Note

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



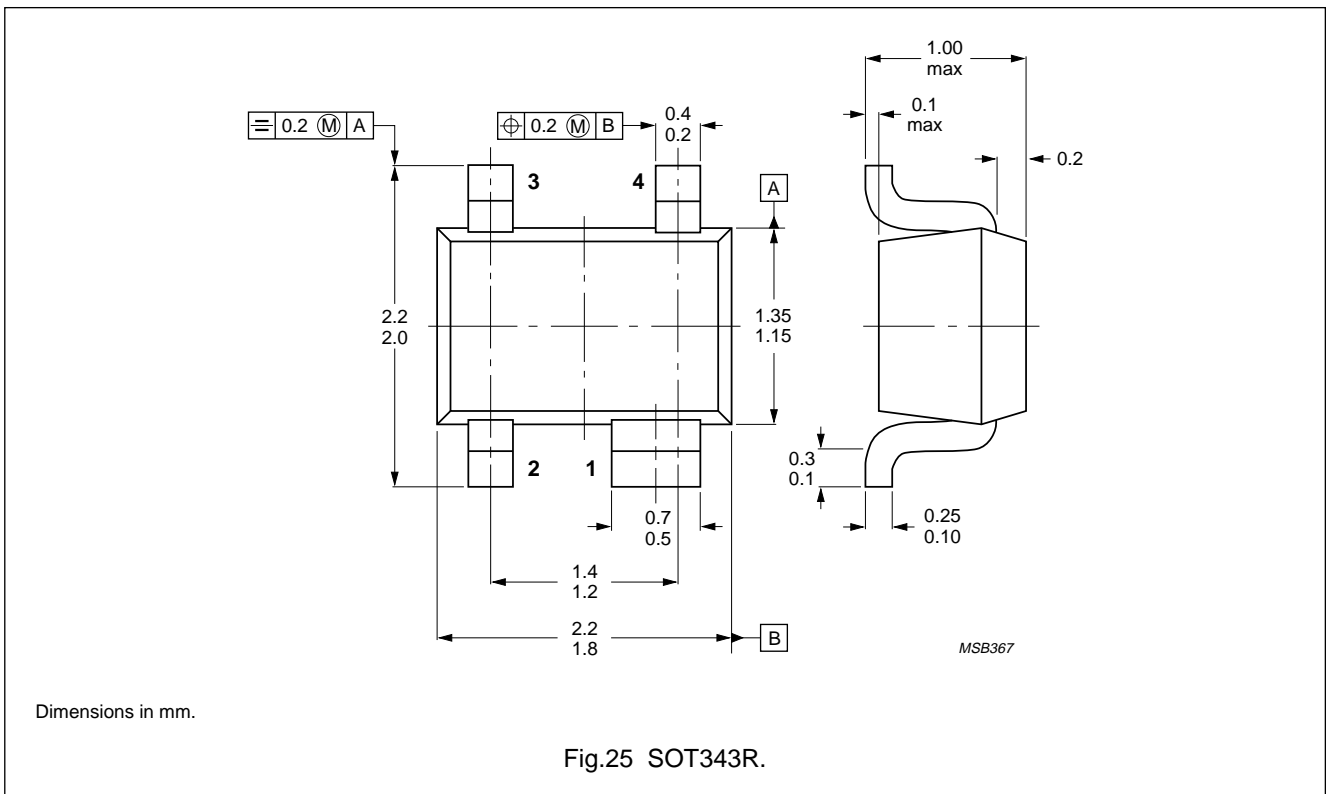
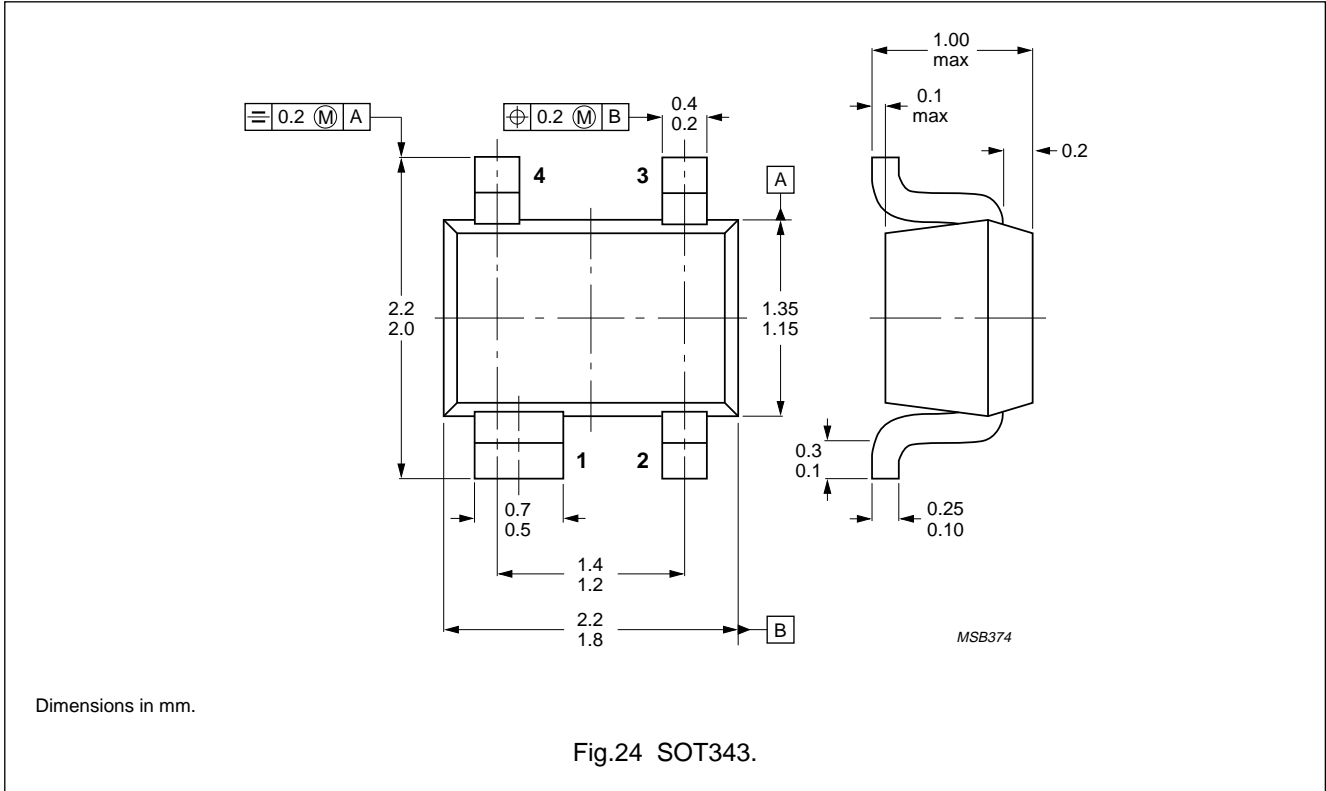
List of components (see Fig.23)

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

BFG520W  
BFG520W/X; BFG520W/XR

PACKAGE OUTLINES



## NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/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.

---

NPN 9 GHz wideband transistor

BFG520W  
BFG520W/X; BFG520W/XR

---

**NOTES**

## Philips Semiconductors – a worldwide company

**Argentina:** IEROD, Av. Juramento 1992 - 14.b, (1428)  
BUENOS AIRES, Tel. (541)786 7633, Fax. (541)786 9367

**Australia:** 34 Waterloo Road, NORTH RYDE, NSW 2113,  
Tel. (02)805 4455, Fax. (02)805 4466

**Austria:** Triester Str. 64, A-1101 WIEN, P.O. Box 213,  
Tel. (01)60 101-1236, Fax. (01)60 101-1211

**Belgium:** Postbus 90050, 5600 PB EINDHOVEN, The Netherlands,  
Tel. (31)40 783 749, Fax. (31)40 788 399

**Brazil:** Rua do Rocio 220 - 5<sup>th</sup> floor, Suite 51,  
CEP: 04552-903-SÃO PAULO-SP, Brazil.  
P.O. Box 7383 (01064-970).

Tel. (011)821-2333, Fax. (011)829-1849

**Canada:** PHILIPS SEMICONDUCTORS/COMPONENTS:  
Tel. (800) 234-7381, Fax. (708) 296-8556

**Chile:** Av. Santa Maria 0760, SANTIAGO,  
Tel. (02)773 816, Fax. (02)777 6730

**Colombia:** IPRELENTO LTDA, Carrera 21 No. 56-17,  
77621 BOGOTA, Tel. (571)249 7624/(571)217 4609,  
Fax. (571)217 4549

**Denmark:** Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,  
Tel. (032)88 2636, Fax. (031)57 1949

**Finland:** Sinikalliontie 3, FIN-02630 ESPOO,  
Tel. (9)0-50261, Fax. (9)0-520971

**France:** 4 Rue du Port-aux-Vins, BP317,  
92156 SURESNES Cedex,  
Tel. (01)4099 6161, Fax. (01)4099 6427

**Germany:** PHILIPS COMPONENTS UB der Philips G.m.b.H.,  
P.O. Box 10 63 23, 20043 HAMBURG,  
Tel. (040)3296-0, Fax. (040)3296 213.

**Greece:** No. 15, 25th March Street, GR 17778 TAVROS,  
Tel. (01)4894 339/4894 911, Fax. (01)4814 240

**Hong Kong:** PHILIPS HONG KONG Ltd., Components Div.,  
6/F Philips Ind. Bldg., 24-28 Kung Yip St., KWAI CHUNG, N.T.,  
Tel. (852)424 5121, Fax. (852)428 6729

**India:** Philips INDIA Ltd, Components Dept,  
Shivsagar Estate, A Block,  
Dr. Annie Besant Rd. Worli, Bombay 400 018  
Tel. (022)4938 541, Fax. (022)4938 722

**Indonesia:** Philips House, Jalan H.R. Rasuna Said Kav. 3-4,  
P.O. Box 4252, JAKARTA 12950,  
Tel. (021)5201 122, Fax. (021)5205 189

**Ireland:** Newstead, Clonskeagh, DUBLIN 14,  
Tel. (01)640 000, Fax. (01)640 200

**Italy:** PHILIPS COMPONENTS S.r.l.,  
Viale F. Testi, 327, 20162 MILANO,  
Tel. (02)6752.3302, Fax. (02)6752 3300.

**Japan:** Philips Bldg 13-37, Kohnan2-chome, Minato-ku, TOKYO 108,  
Tel. (03)3740 5028, Fax. (03)3740 0580

**Korea:** (Republic of) Philips House, 260-199 Itaewon-dong,  
Yongsan-ku, SEOUL, Tel. (02)794-5011, Fax. (02)798-8022

**Malaysia:** No. 76 Jalan Universiti, 46200 PETALING JAYA,  
SELANGOR, Tel. (03)750 5214, Fax. (03)757 4880

**Mexico:** Philips Components, 5900 Gateway East, Suite 200,  
EL PASO, TX 79905, Tel. 9-5(800)234-7381, Fax. (708)296-8556

**Netherlands:** Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB  
Tel. (040)783749, Fax. (040)788399

**New Zealand:** 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,  
Tel. (09)849-4160, Fax. (09)849-7811

**Norway:** Box 1, Manglerud 0612, OSLO,  
Tel. (022)74 8000, Fax. (022)74 8341

**Pakistan:** Philips Electrical Industries of Pakistan Ltd.,  
Exchange Bldg. ST-2/A, Block 9, KDA Scheme 5, Clifton,  
KARACHI 75600, Tel. (021)587 4641-49,  
Fax. (021)577035/5874546.

**Philippines:** PHILIPS SEMICONDUCTORS PHILIPPINES Inc,  
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,  
Metro MANILA, Tel. (02)810 0161, Fax. (02)817 3474

**Portugal:** PHILIPS PORTUGUESA, S.A.,  
Rua dr. António Loureiro Borges 5, Arquiparque - Miraflores,  
Apartado 300, 2795 LINDA-A-VELHA,  
Tel. (01)14163160/4163333, Fax. (01)14163174/4163366.

**Singapore:** Lorong 1, Toa Payoh, SINGAPORE 1231,  
Tel. (65)350 2000, Fax. (65)251 6500

**South Africa:** S.A. PHILIPS Pty Ltd., Components Division,  
195-215 Main Road Martindale, 2092 JOHANNESBURG,  
P.O. Box 7430 Johannesburg 2000,  
Tel. (011)470-5911, Fax. (011)470-5494.

**Spain:** Balmes 22, 08007 BARCELONA,  
Tel. (03)301 6312, Fax. (03)301 42 43

**Sweden:** Kottbygatan 7, Akalla. S-164 85 STOCKHOLM,  
Tel. (0)8-632 2000, Fax. (0)8-632 2745

**Switzerland:** Allmendstrasse 140, CH-8027 ZÜRICH,  
Tel. (01)488 2211, Fax. (01)481 77 30

**Taiwan:** PHILIPS TAIWAN Ltd., 23-30F, 66, Chung Hsiao West  
Road, Sec. 1. Taipei, Taiwan ROC, P.O. Box 22978,  
TAIPEI 100, Tel. (02)388 7666, Fax. (02)382 4382.

**Thailand:** PHILIPS ELECTRONICS (THAILAND) Ltd.,  
209/2 Sanpavuth-Bangna Road Prakanong,  
Bangkok 10260, THAILAND,  
Tel. (662)398-0141, Fax. (662)398-3319.

**Turkey:** Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,  
Tel. (0212)279 2770, Fax. (0212)269 3094

**United Kingdom:** Philips Semiconductors LTD.,  
276 Bath road, Hayes, MIDDLESEX UB3 5BX,  
Tel. (081)73050000, Fax. (081)7548421

**United States:** 811 East Arques Avenue, SUNNYVALE,  
CA 94088-3409, Tel. (800)234-7381, Fax. (708)296-8556

**Uruguay:** Coronel Mora 433, MONTEVIDEO,  
Tel. (02)70-4044, Fax. (02)92 0601

**For all other countries apply to:** Philips Semiconductors,  
International Marketing and Sales, Building BE-p,  
P.O. Box 218, 5600 MD, EINDHOVEN, The Netherlands,  
Telex 35000 phtcnl, Fax. +31-40-724825

SCD33 © Philips Electronics N.V. 1994

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands

123065/1500/01/pp16  
Document order number:

Date of release: August 1995  
9397 738 10011

# Philips Semiconductors



# PHILIPS