

# DATA SHEET

## **BFG410W** NPN 22 GHz wideband transistor

Product specification  
Supersedes data of 1997 Oct 29  
File under Discrete Semiconductors, SC14

1998 Mar 11

## NPN 22 GHz wideband transistor

BFG410W

## FEATURES

- Very high power gain
- Low noise figure
- High transition frequency
- Emitter is thermal lead
- Low feedback capacitance.

## APPLICATIONS

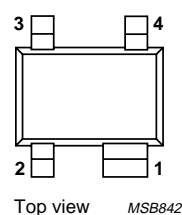
- RF front end
- Wideband applications, e.g. analog and digital cellular telephones, cordless telephones (PHS, DECT, etc.)
- Radar detectors
- Pagers
- Satellite television tuners (SATV)
- High frequency oscillators.

## DESCRIPTION

NPN double polysilicon wideband transistor with buried layer for low voltage applications in a plastic, 4-pin dual-emitter SOT343R package.

## PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	emitter
4	collector



Marking code: P4.

Fig.1 Simplified outline SOT343R.

## QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{CB0}$	collector-base voltage	open emitter	–	–	10	V
$V_{CEO}$	collector-emitter voltage	open base	–	–	4.5	V
$I_C$	collector current (DC)		–	10	12	mA
$P_{tot}$	total power dissipation	$T_s \leq 110\text{ }^\circ\text{C}$	–	–	54	mW
$h_{FE}$	DC current gain	$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}; T_j = 25\text{ }^\circ\text{C}$	50	80	120	
$C_{re}$	feedback capacitance	$I_C = 0; V_{CB} = 2\text{ V}; f = 1\text{ MHz}$	–	45	–	fF
$f_T$	transition frequency	$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz}; T_{amb} = 25\text{ }^\circ\text{C}$	–	22	–	GHz
$G_{max}$	maximum power gain	$I_C = 10\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz}; T_{amb} = 25\text{ }^\circ\text{C}$	–	21	–	dB
F	noise figure	$I_C = 1\text{ mA}; V_{CE} = 2\text{ V}; f = 2\text{ GHz}; \Gamma_S = \Gamma_{opt}$	–	1.2	–	dB

## CAUTION

This product is supplied in anti-static packing to prevent damage caused by electrostatic discharge during transport and handling. For further information, refer to Philips specs.: SNW-EQ-608, SNW-FQ-302A and SNW-FQ-302B.

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**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	–	10	V
V <sub>CEO</sub>	collector-emitter voltage	open base	–	4.5	V
V <sub>EBO</sub>	emitter-base voltage	open collector	–	1	V
I <sub>C</sub>	collector current (DC)		–	12	mA
P <sub>tot</sub>	total power dissipation	T <sub>s</sub> ≤ 110 °C; note 1; see Fig.2	–	54	mW
T <sub>stg</sub>	storage temperature		–65	+150	°C
T <sub>j</sub>	operating junction temperature		–	150	°C

**Note**

1. T<sub>s</sub> is the temperature at the soldering point of the emitter pins.

**THERMAL CHARACTERISTICS**

SYMBOL	PARAMETER	VALUE	UNIT
R <sub>th j-s</sub>	thermal resistance from junction to soldering point	750	K/W

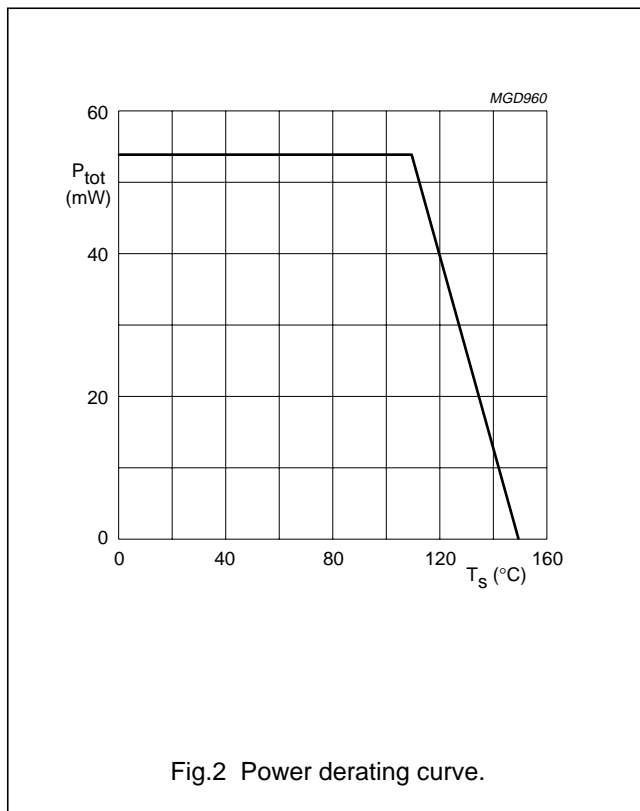


Fig.2 Power derating curve.

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## CHARACTERISTICS

$T_j = 25\text{ °C}$  unless otherwise specified.

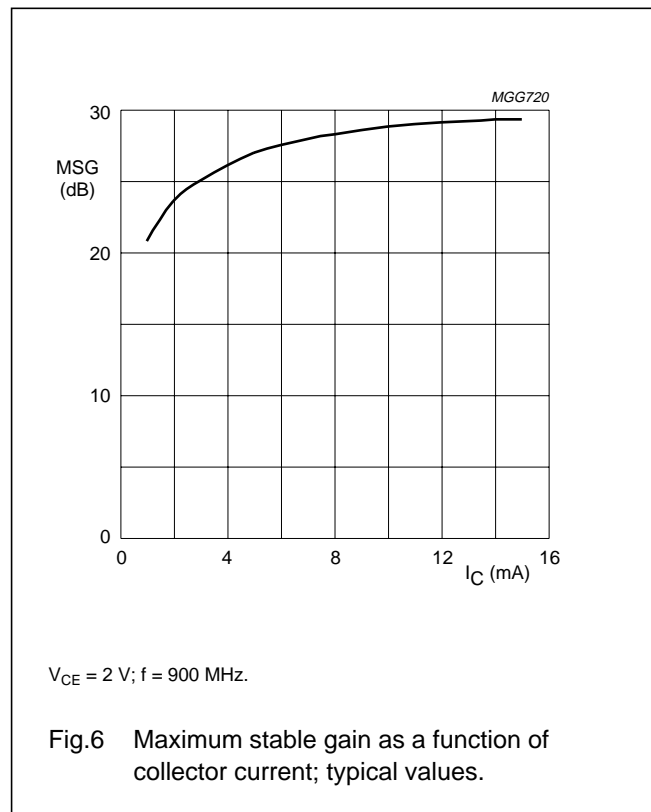
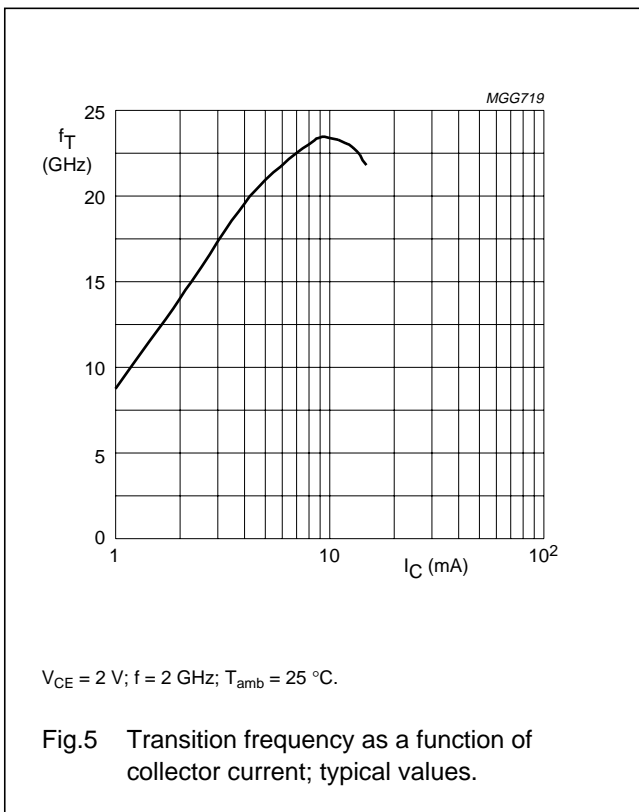
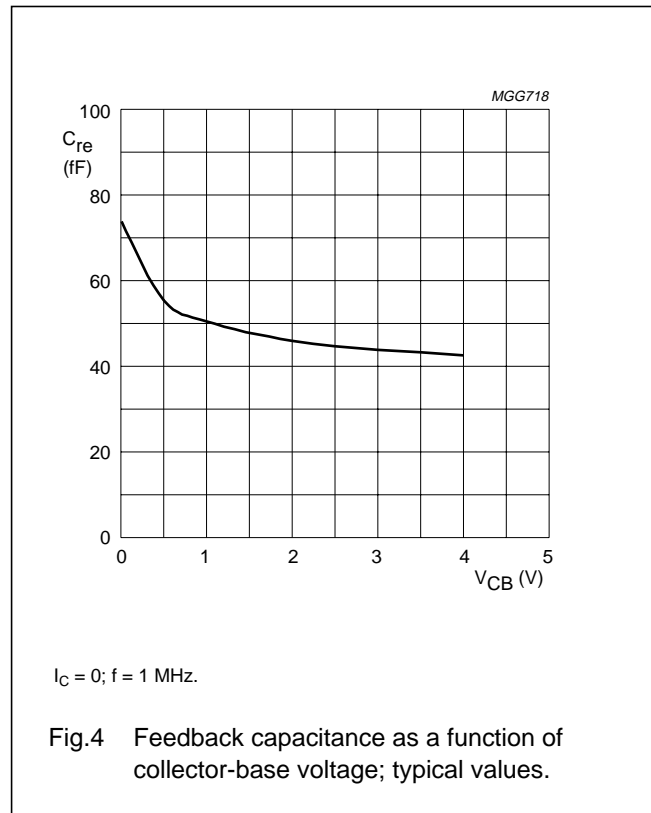
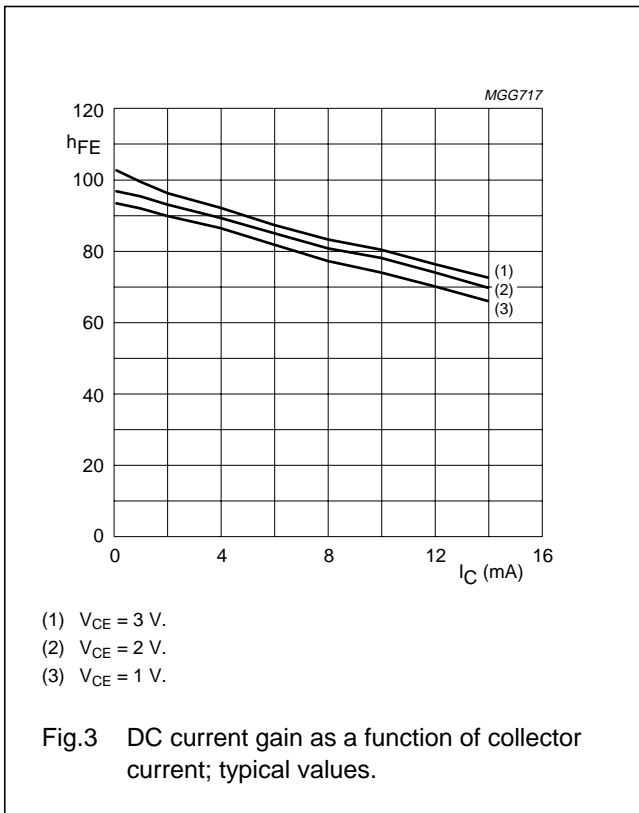
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{(BR)CBO}$	collector-base breakdown voltage	$I_C = 2.5\ \mu\text{A}; I_E = 0$	10	–	–	V
$V_{(BR)CEO}$	collector-emitter breakdown voltage	$I_C = 1\ \text{mA}; I_B = 0$	4.5	–	–	V
$V_{(BR)EBO}$	emitter-base breakdown voltage	$I_E = 2.5\ \mu\text{A}; I_C = 0$	1	–	–	V
$I_{CBO}$	collector-base leakage current	$I_E = 0; V_{CB} = 4.5\ \text{V}$	–	–	15	nA
$h_{FE}$	DC current gain	$I_C = 10\ \text{mA}; V_{CE} = 2\ \text{V};$ see Fig.3	50	80	120	
$C_c$	collector capacitance	$I_E = i_e = 0; V_{CB} = 2\ \text{V}; f = 1\ \text{MHz}$	–	220	–	fF
$C_e$	emitter capacitance	$I_C = i_c = 0; V_{EB} = 0.5\ \text{V}; f = 1\ \text{MHz}$	–	400	–	fF
$C_{re}$	feedback capacitance	$I_C = 0; V_{CB} = 2\ \text{V}; f = 1\ \text{MHz};$ see Fig.4	–	45	–	fF
$f_T$	transition frequency	$I_C = 10\ \text{mA}; V_{CE} = 2\ \text{V}; f = 2\ \text{GHz};$ $T_{amb} = 25\text{ °C};$ see Fig.5	–	22	–	GHz
$G_{max}$	maximum power gain; note 1	$I_C = 10\ \text{mA}; V_{CE} = 2\ \text{V}; f = 2\ \text{GHz};$ $T_{amb} = 25\text{ °C};$ see Figs 7 and 8	–	21	–	dB
$ S_{21} ^2$	insertion power gain	$I_C = 10\ \text{mA}; V_{CE} = 2\ \text{V}; f = 2\ \text{GHz};$ $T_{amb} = 25\text{ °C};$ see Fig.8	–	18	–	dB
F	noise figure	$I_C = 1\ \text{mA}; V_{CE} = 2\ \text{V};$ $f = 900\ \text{MHz}; \Gamma_S = \Gamma_{opt};$ see Fig.13	–	0.9	–	dB
		$I_C = 1\ \text{mA}; V_{CE} = 2\ \text{V}; f = 2\ \text{GHz};$ $\Gamma_S = \Gamma_{opt};$ see Fig.13	–	1.2	–	dB
$P_{L1}$	output power at 1 dB gain compression	$I_C = 10\ \text{mA}; V_{CE} = 2\ \text{V}; f = 2\ \text{GHz};$ $Z_S = Z_{S\ opt}; Z_L = Z_{L\ opt};$ note 2	–	5	–	dBm
ITO	third order intercept point	$I_C = 10\ \text{mA}; V_{CE} = 2\ \text{V}; f = 2\ \text{GHz};$ $Z_S = Z_{S\ opt}; Z_L = Z_{L\ opt};$ note 2	–	15	–	dBm

## Notes

- $G_{max}$  is the maximum power gain, if  $K > 1$ . If  $K < 1$  then  $G_{max} = \text{MSG}$ ; see Figs 6, 7 and 8.
- $Z_S$  is optimized for noise;  $Z_L$  is optimized for gain.

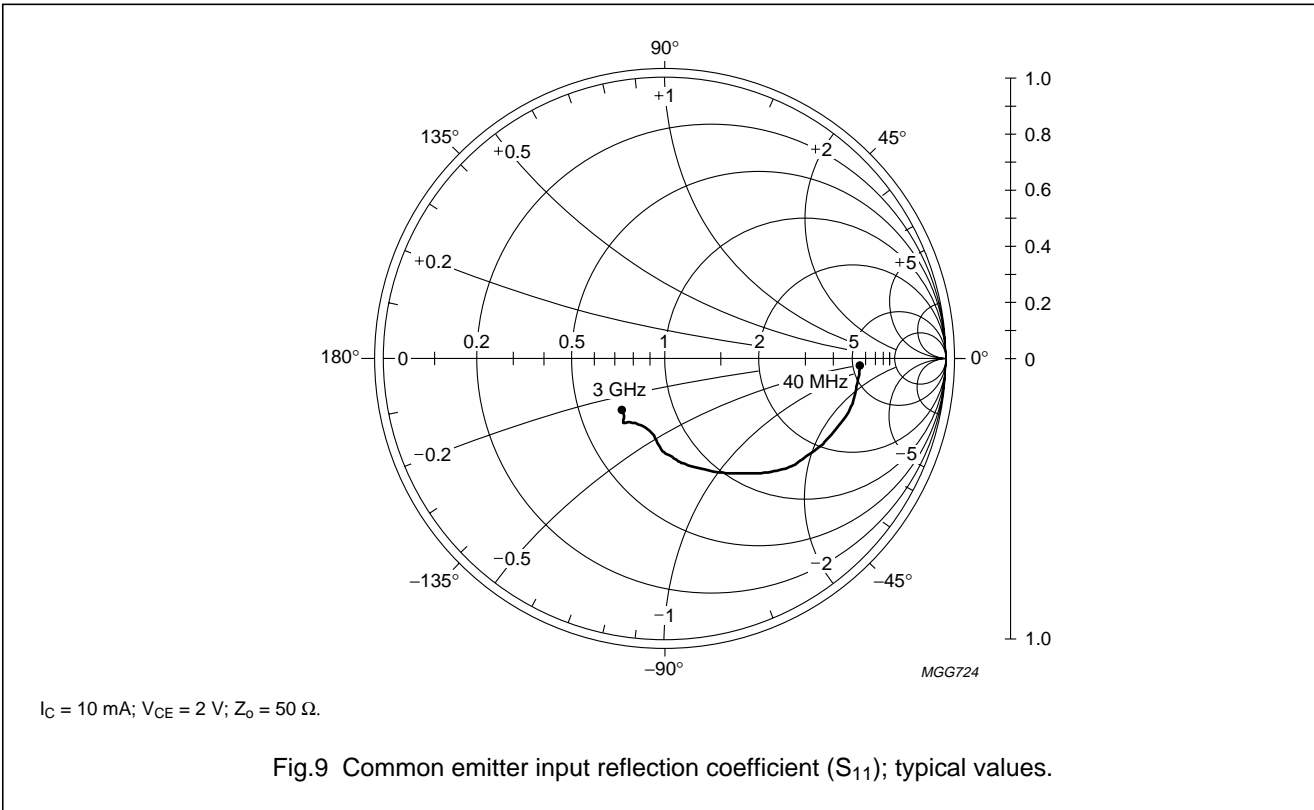
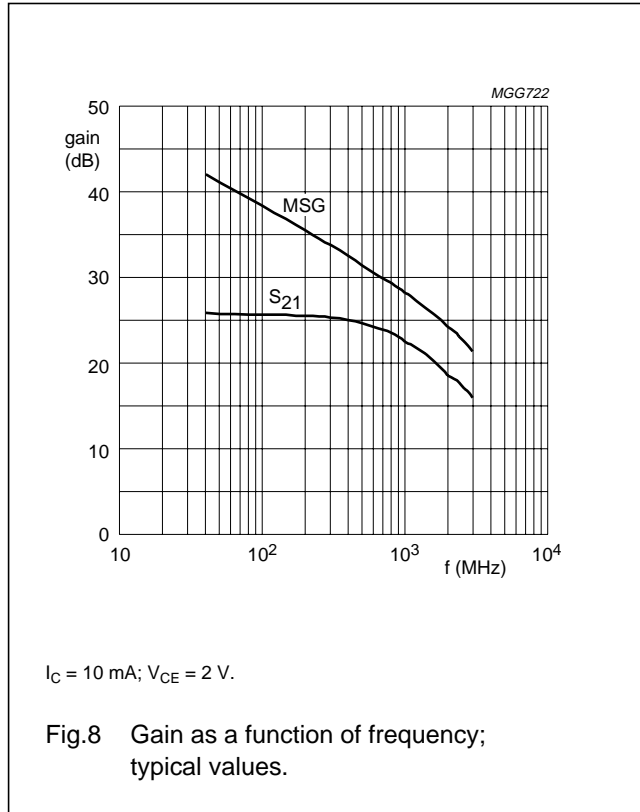
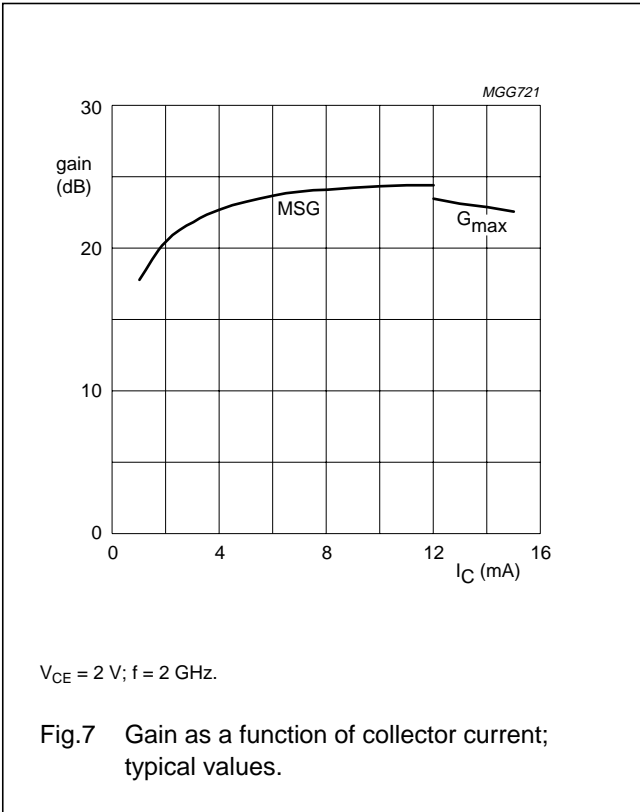
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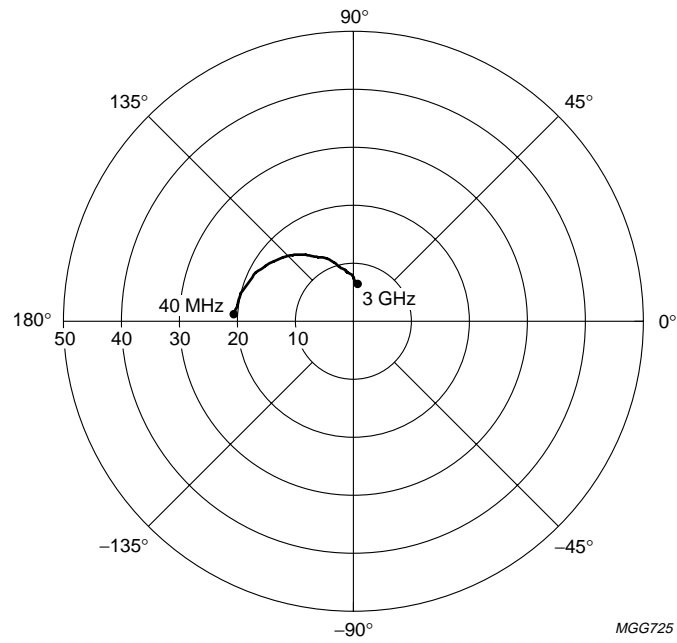
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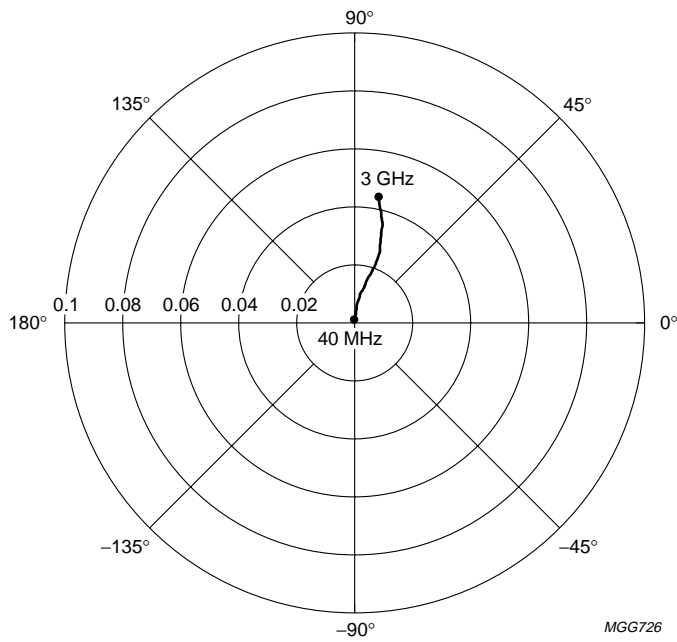
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$I_C = 10 \text{ mA}; V_{CE} = 2 \text{ V}.$

MGG725

Fig.10 Common emitter forward transmission coefficient ( $S_{21}$ ); typical values.



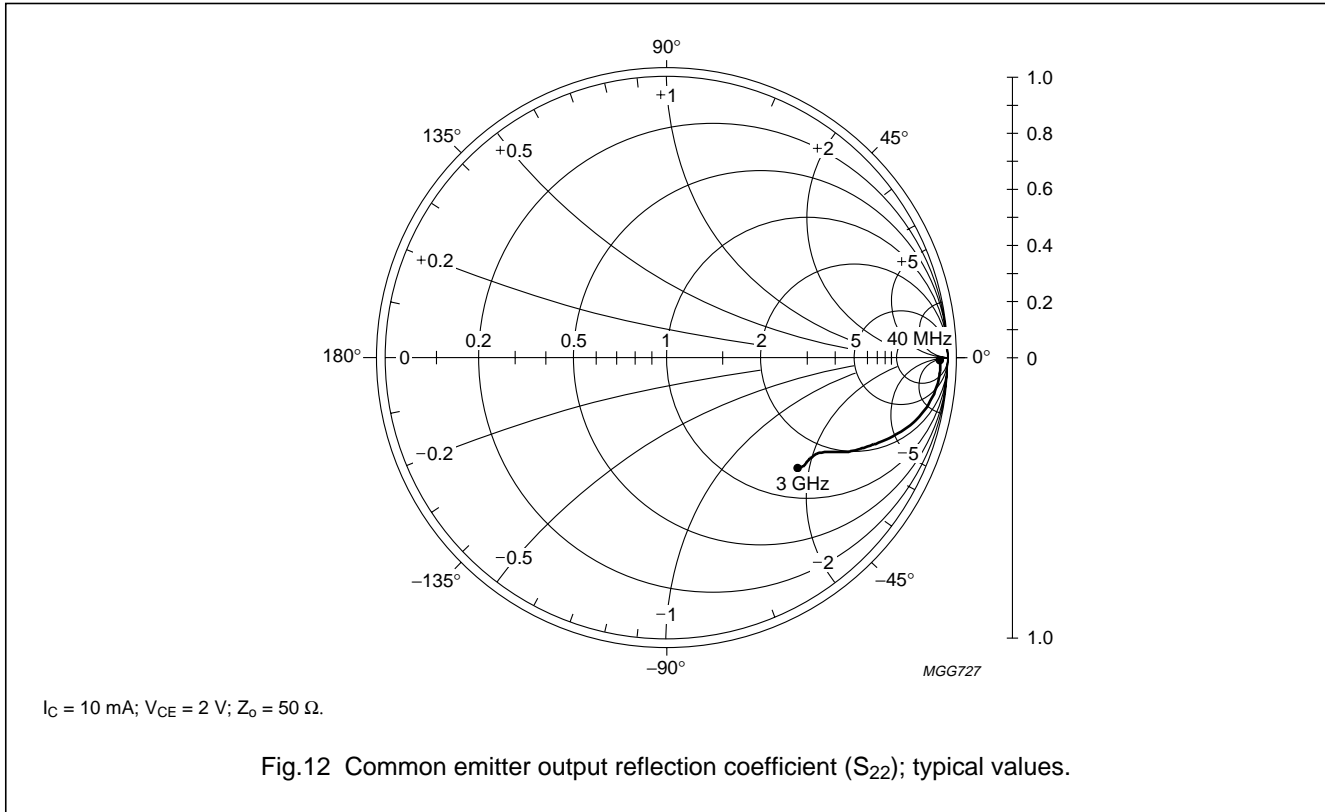
$I_C = 10 \text{ mA}; V_{CE} = 2 \text{ V}.$

MGG726

Fig.11 Common emitter reverse transmission coefficient ( $S_{12}$ ); typical values.

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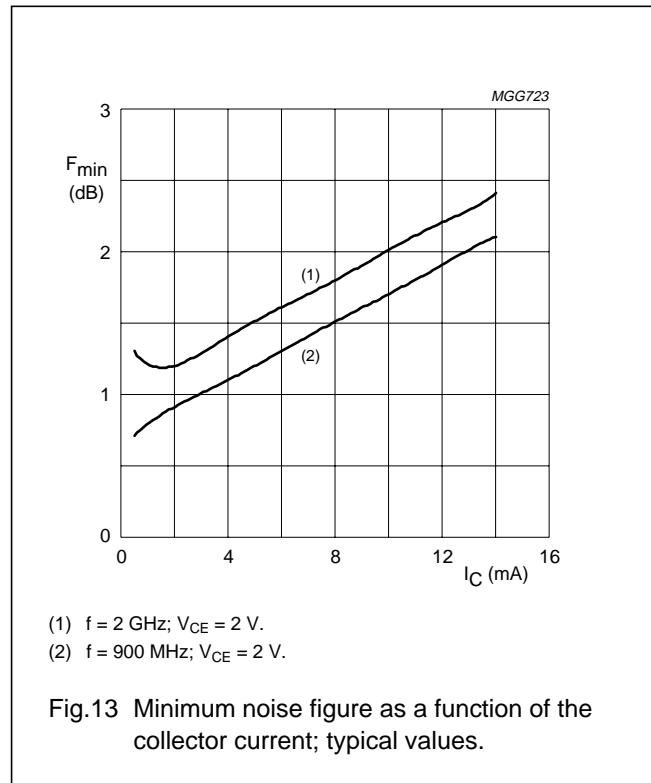
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Noise data

$V_{CE} = 2 \text{ V}$ ; typical values.

f (MHz)	$I_C$ (mA)	$F_{min}$ (dB)	$\Gamma_{mag}$	$\Gamma_{angle}$	$r_n$ ( $\Omega$ )
900	1	0.8	0.73	11.2	0.56
	2	0.9	0.58	10.1	0.43
	4	1.1	0.40	10.1	0.33
	6	1.3	0.28	11.0	0.30
	8	1.5	0.20	8.0	0.30
	10	1.7	0.14	10.5	0.27
	12	1.9	0.06	10.1	0.25
	14	2.1	0.05	14.2	0.26
2000	1	1.2	0.64	35.7	0.57
	2	1.2	0.50	35.8	0.44
	4	1.4	0.34	34.4	0.37
	6	1.6	0.25	33.7	0.34
	8	1.8	0.17	34.5	0.35
	10	2.0	0.12	35.8	0.34
	12	2.2	0.05	38.0	0.35
	14	2.4	0.03	44.8	0.34





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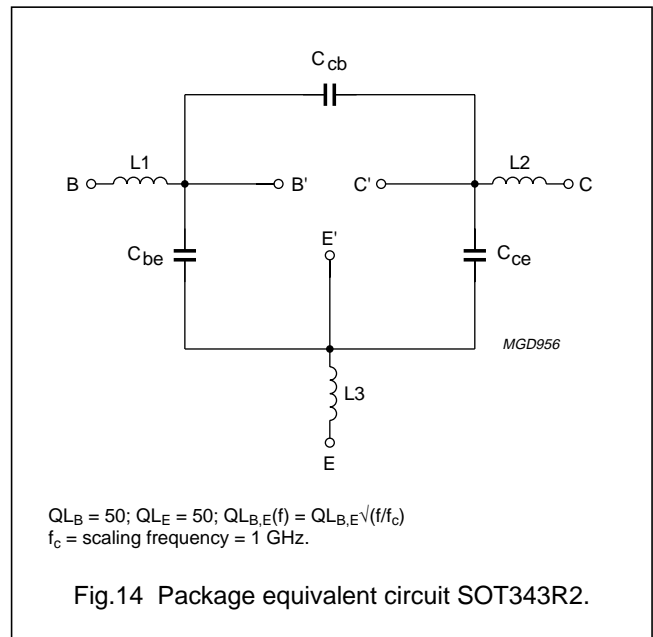
SPICE parameters for the BFG410W die

SEQUENCE No.	PARAMETER	VALUE	UNIT
1	IS	19.42	aA
2	BF	145.0	–
3	NF	0.993	–
4	VAF	31.12	V
5	IKF	125.0	mA
6	ISE	123.6	fA
7	NE	3.000	–
8	BR	11.37	–
9	NR	0.985	–
10	VAR	1.874	V
11	IKR	50.00	mA
12	ISC	199.6	aA
13	NC	1.546	–
14	RB	35.00	$\Omega$
15	IRB	0.000	A
16	RBM	15.00	$\Omega$
17	RE	432.0	m $\Omega$
18	RC	4.324	$\Omega$
19 (1)	XTB	1.500	–
20 (1)	EG	1.110	eV
21 (1)	XTI	3.000	–
22	CJE	128.0	fF
23	VJE	900.0	mV
24	MJE	0.346	–
25	TF	4.122	ps
26	XTF	68.20	–
27	VTF	2.004	V
28	ITF	0.627	A
29	PTF	0.000	deg
30	CJC	56.68	fF
31	VJC	556.9	mV
32	MJC	0.207	–
33	XCJC	0.500	–
34 (1)	TR	0.000	ns
35 (1)	CJS	274.8	fF
36 (1)	VJS	418.3	mV
37 (1)	MJS	0.239	–
38	FC	0.550	–

SEQUENCE No.	PARAMETER	VALUE	UNIT
39 (2)(3)	C <sub>bp</sub>	145	fF
40 (2)	R <sub>sb1</sub>	25	$\Omega$
41 (3)	R <sub>sb2</sub>	19	$\Omega$

Notes

1. These parameters have not been extracted, the default values are shown.
2. Bonding pad capacity C<sub>bp</sub> in series with substrate resistance R<sub>sb1</sub> between B' and E'.
3. Bonding pad capacity C<sub>bp</sub> in series with substrate resistance R<sub>sb2</sub> between C' and E'.



List of components (see Fig.14)

DESIGNATION	VALUE	UNIT
C <sub>be</sub>	80	fF
C <sub>cb</sub>	2	fF
C <sub>ce</sub>	80	fF
L1	1.1	nH
L2	1.1	nH
L3 (note 1)	0.25	nH

Note

1. External emitter inductance to be added separately due to the influence of the printed-circuit board.

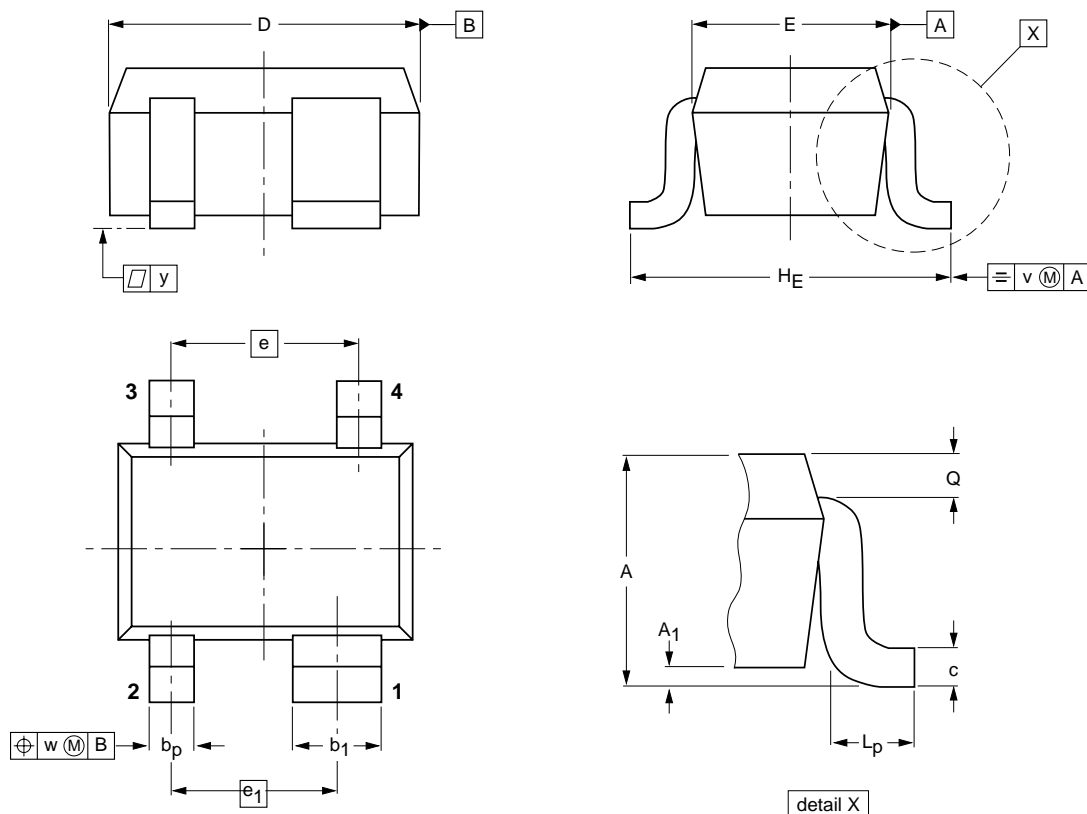
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PACKAGE OUTLINE

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 22 GHz wideband transistor

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**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.	

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