DATA SHEET

BFG410W
NPN 22 GHz wideband transistor

Product specification 1998 Mar 11
Supersedes data of 1997 Oct 29
File under Discrete Semiconductors, SC14

Philips Semiconductors

PHILIPS

FEATURES

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

APPLICATIONS

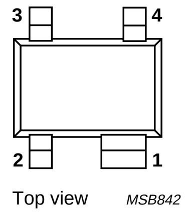
- RF front end
- Wideband applications, e.g. analog and digital cellular telephones, cordless telephones (PHS, DECT, etc.)
- Radar detectors
- Pagers
- Satellite television tuners (SATV)
- High frequency oscillators.

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_{CBO}	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	$T_s \leq 110$ °C	–	–	54	mW
h_{FE}	DC current gain	I_C = 10 mA; V_{CE} = 2 V; T_j = 25 °C	50	80	120	
C_{re}	feedback capacitance	I_C = 0; V_{CB} = 2 V; f = 1 MHz	–	45	–	fF
f_T	transition frequency	I_C = 10 mA; V_{CE} = 2 V; f = 2 GHz; T_{amb} = 25 °C	–	22	–	GHz
G_{max}	maximum power gain	I_C = 10 mA; V_{CE} = 2 V; f = 2 GHz; T_{amb} = 25 °C	–	21	–	dB
F	noise figure	I_C = 1 mA; V_{CE} = 2 V; f = 2 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.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter	–	10	V
V_{CEO}	collector-emitter voltage	open base	–	4.5	V
V_{EBO}	emitter-base voltage	open collector	–	1	V
I_C	collector current (DC)		–	12	mA
P_{tot}	total power dissipation	$T_s \leq 110$ °C; note 1; see Fig.2	–	54	mW
T_{stg}	storage temperature		–65	+150	°C
T_j	operating junction temperature		–	150	°C

Note

1. T_s is the temperature at the soldering point of the emitter pins.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}s}$	thermal resistance from junction to soldering point	750	K/W

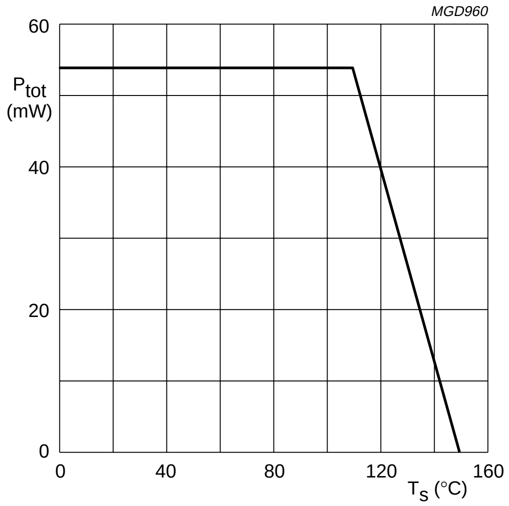


Fig.2 Power derating curve.

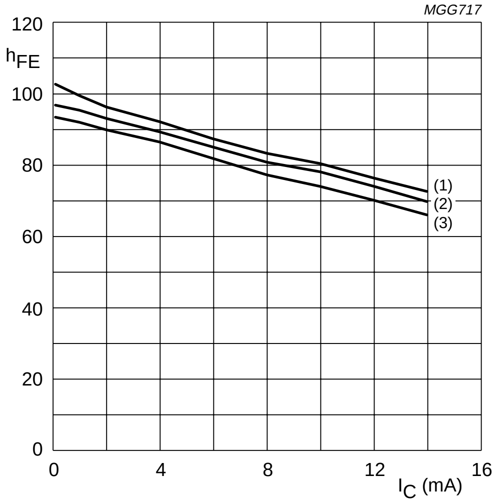
CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

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

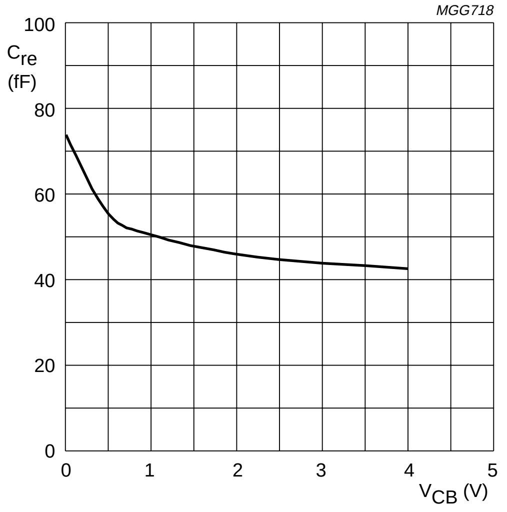
Notes

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



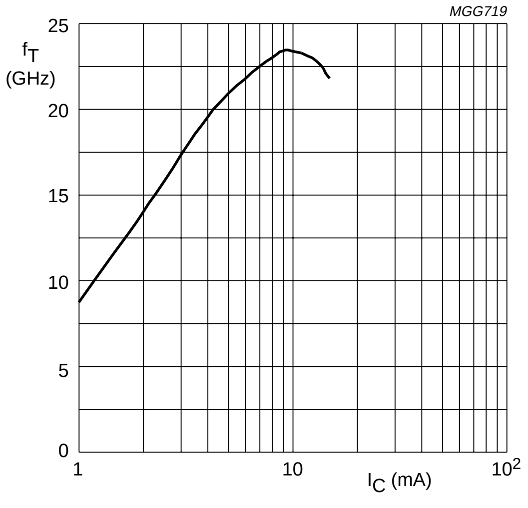
(1) V_{CE} = 3 V.
(2) V_{CE} = 2 V.
(3) V_{CE} = 1 V.

Fig.3 DC current gain as a function of collector current; typical values.



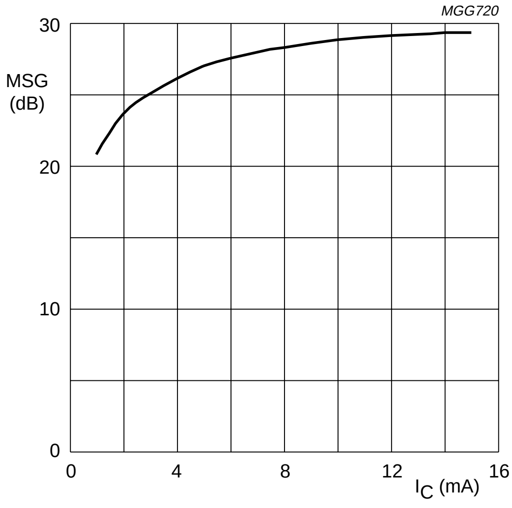
I_C = 0; f = 1 MHz.

Fig.4 Feedback capacitance as a function of collector-base voltage; typical values.



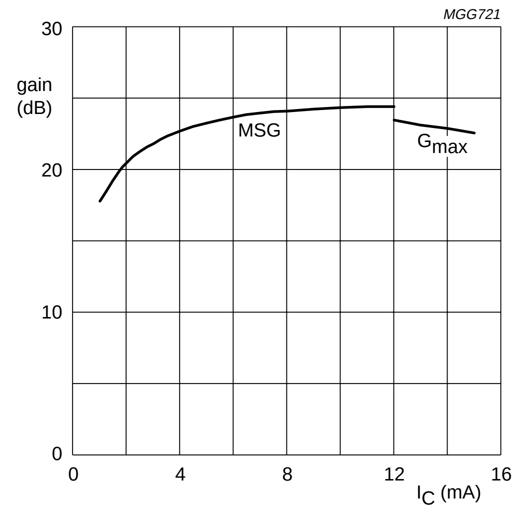
V_{CE} = 2 V; f = 2 GHz; T_{amb} = 25 °C.

Fig.5 Transition frequency as a function of collector current; typical values.



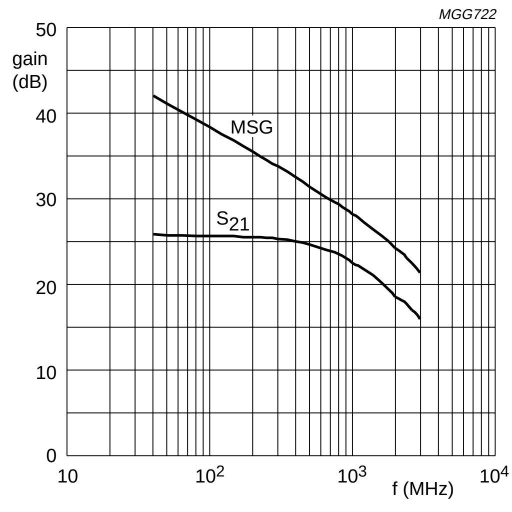
V_{CE} = 2 V; f = 900 MHz.

Fig.6 Maximum stable gain as a function of collector current; typical values.



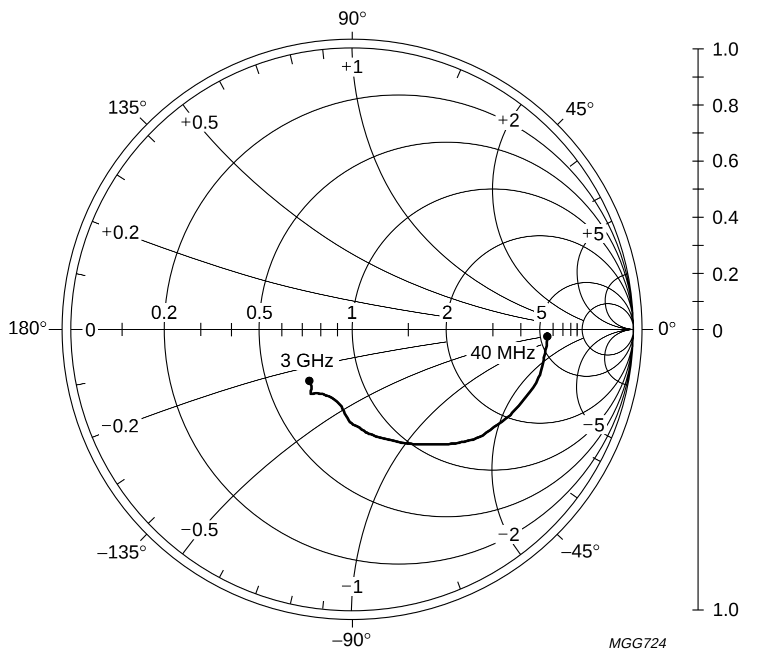
V_{CE} = 2 V; f = 2 GHz.

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



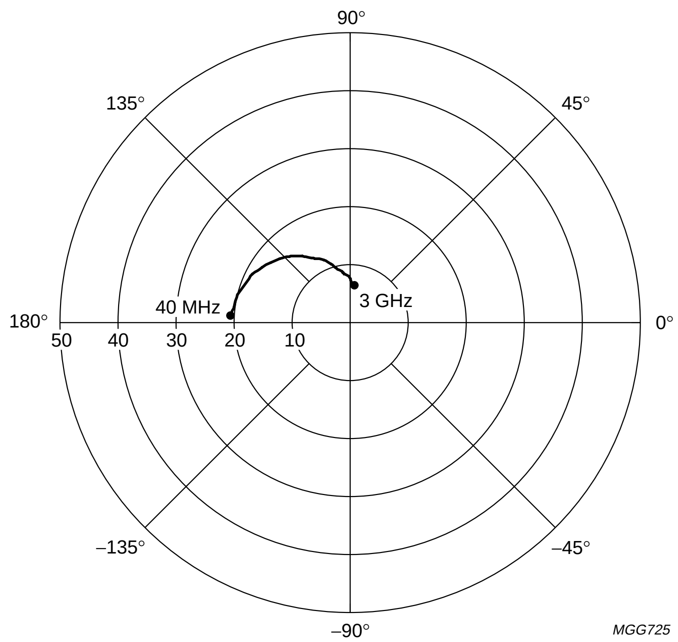
I_C = 10 mA; V_{CE} = 2 V.

Fig.8 Gain as a function of frequency; typical values.



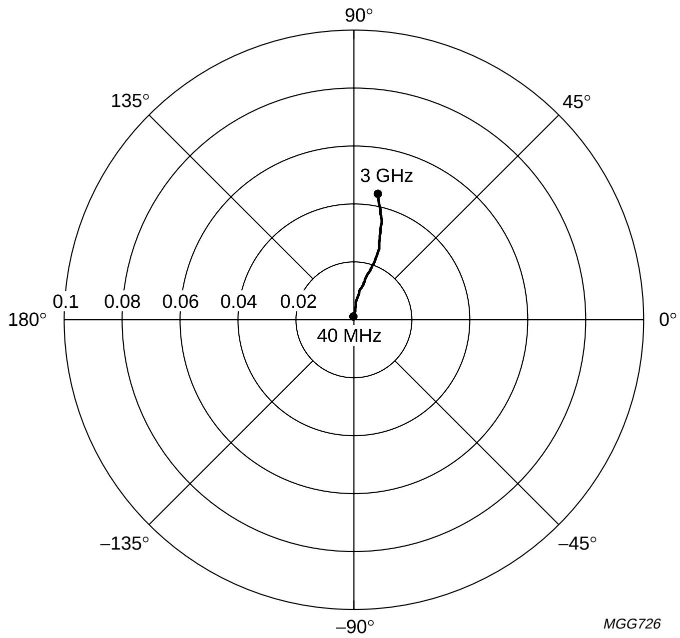
I_C = 10 mA; V_{CE} = 2 V; Z_o = 50 Ω.

Fig.9 Common emitter input reflection coefficient (S_{11}); typical values.



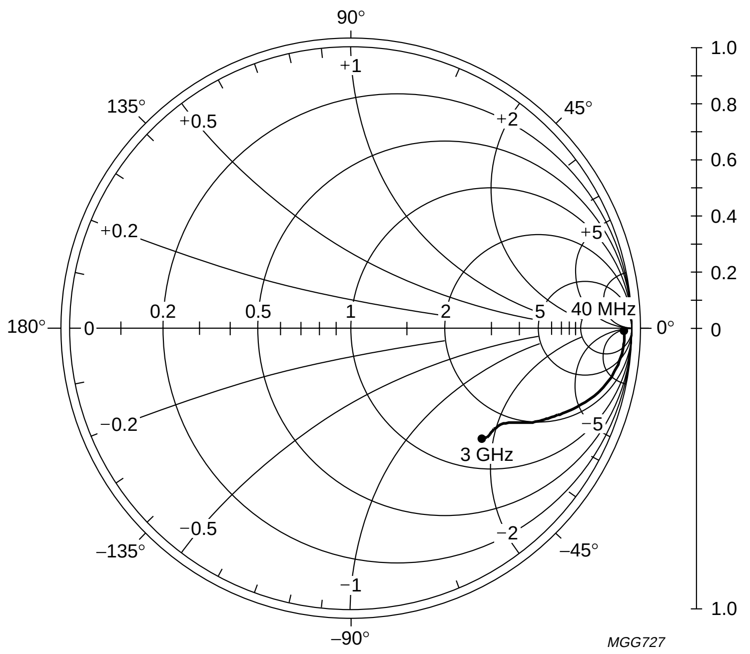
I_C = 10 mA; V_{CE} = 2 V.

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



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

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



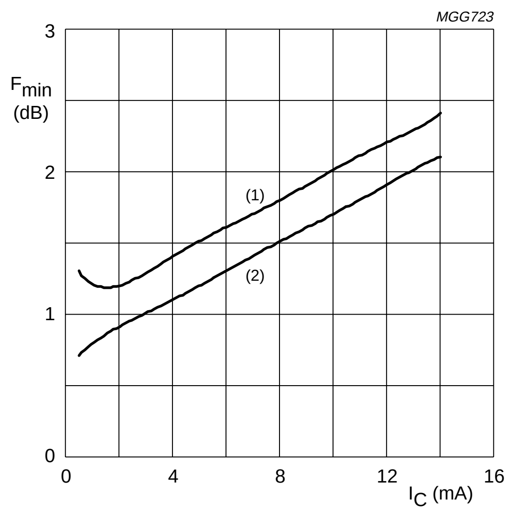
I_C = 10 mA; V_{CE} = 2 V; Z_o = 50 Ω.

Fig.12 Common emitter output reflection coefficient (S_{22}); typical values.

Noise data

V_{CE} = 2 V; typical values.

f (MHz)	I_C (mA)	F_{min} (dB)	Γ_{mag}	Γ_{angle}	r_n (Ω)
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



(1) f = 2 GHz; V_{CE} = 2 V.

(2) f = 900 MHz; V_{CE} = 2 V.

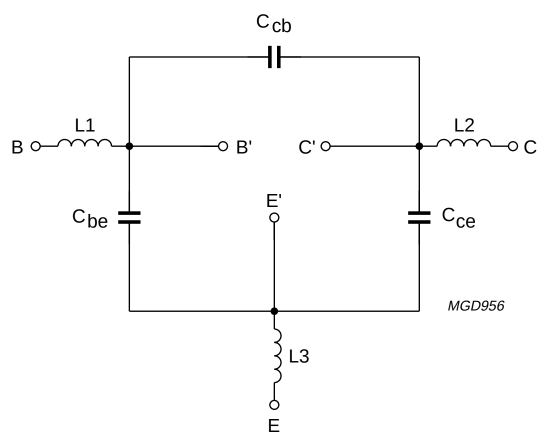
Fig.13 Minimum noise figure as a function of the collector current; typical values.

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	Ω
15	IRB	0.000	A
16	RBM	15.00	Ω
17	RE	432.0	mΩ
18	RC	4.324	Ω
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	–
39 (2)(3)	C_{bp}	145	fF
40 (2)	R_{sb1}	25	Ω
41 (3)	R_{sb2}	19	Ω

Notes

1. These parameters have not been extracted, the default values are shown.
2. Bonding pad capacity C_{bp} in series with substrate resistance R_{sb1} between B′ and E′.
3. Bonding pad capacity C_{bp} in series with substrate resistance R_{sb2} between C′ and E′.



QL_B = 50; QL_E = 50; $QL_{B,E}(f) = QL_{B,E}\sqrt{(f/f_c)}$
f_c = scaling frequency = 1 GHz.

Fig.14 Package equivalent circuit SOT343R2.

List of components (see Fig.14)

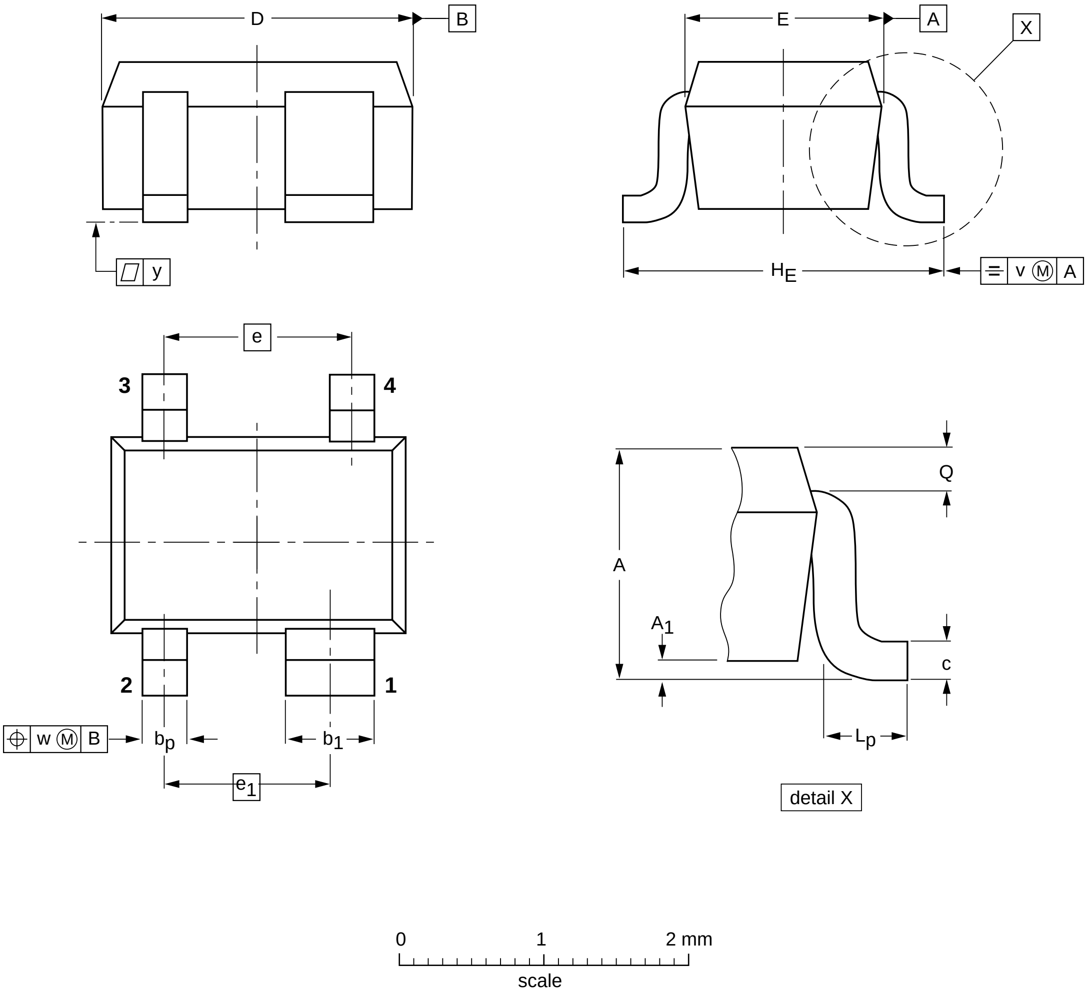
DESIGNATION	VALUE	UNIT
C_{be}	80	fF
C_{cb}	2	fF
C_{ce}	80	fF
L1	1.1	nH
L2	1.1	nH
L3 (note 1)	0.25	nH

Note

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

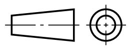
PACKAGE OUTLINE

Plastic surface mounted package; reverse pinning; 4 leads **SOT343R**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max	b_p	b_1	c	D	E	e	e_1	H_E	L_p	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

DEFINITIONS

Data Sheet Status	
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.
Limiting values	
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.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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