

# DATA SHEET

**BFC520**

**NPN wideband cascode transistor**

Product specification  
Supersedes data of 1996 Oct 08  
File under Discrete Semiconductors, SC14

1997 Sep 10

# NPN wideband cascode transistor

# BFC520

### FEATURES

- Small size
- High power gain at low bias current and high frequencies
- High reverse isolation
- Low noise figure
- Gold metallization ensures excellent reliability
- Minimum operating voltage  $V_{C2-E1} = 1\text{ V}$ .

### APPLICATIONS

- Low noise, high gain amplifiers
- Oscillator buffer amplifiers
- Wideband voltage-to-current converters.

### DESCRIPTION

Cascode amplifier with two discrete dies in a surface mount, 5-pin SOT353 (S-mini) package. The amplifier is primarily intended for low power RF communications equipment, such as pagers and cordless phones and has a very low feedback capacitance resulting in high isolation.

### PINNING - SOT353

SYMBOL	PIN	DESCRIPTION
b <sub>2</sub>	1	base 2
e <sub>1</sub>	2	emitter 1
b <sub>1</sub>	3	base 1
c <sub>1</sub> /e <sub>2</sub>	4	collector 1/emitter 2
c <sub>2</sub>	5	collector 2

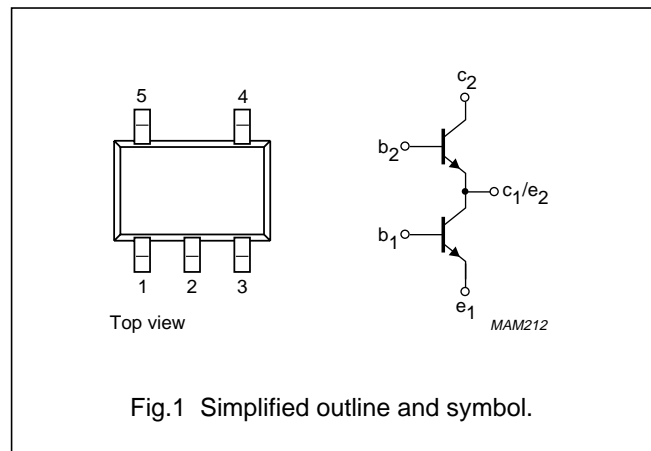


Fig.1 Simplified outline and symbol.

### QUICK REFERENCE DATA

$V_{C2-E1} = 3\text{ V}$ ;  $I_C = 20\text{ mA}$ ;  $V_{B2} = 2.1\text{ V}$ ; b<sub>2</sub> connected to ground via 1 nF (0603) capacitor, e<sub>1</sub> connected directly to ground.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
C <sub>re</sub>	feedback capacitance C <sub>B1-C2</sub>		–	–	10	fF
$ S_{21}/S_{12} ^2$	maximum isolation	f = 900 MHz; T <sub>amb</sub> = 25 °C	–	–63	–	dB
		f = 2 GHz; T <sub>amb</sub> = 25 °C	–	–38	–	dB
MSG	maximum stable power gain (narrowband)	f = 900 MHz; T <sub>amb</sub> = 25 °C	–	31	–	dB
		f = 2 GHz; T <sub>amb</sub> = 25 °C	–	19	–	dB
F	noise figure	I <sub>C</sub> = 5 mA; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.3	1.6	dB
R <sub>th j-s</sub>	thermal resistance from junction to soldering point	single loaded	–	–	230	K/W
		double loaded	–	–	115	K/W

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**LIMITING VALUES**

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
<b>Any single transistor</b>					
V <sub>CBO</sub>	collector-base voltage	open emitter	–	20	V
V <sub>CEO</sub>	collector-emitter voltage	open base	–	8	V
V <sub>EBO</sub>	emitter-base voltage	open collector	–	2.5	V
I <sub>C</sub>	DC collector current		–	70	mA
P <sub>tot</sub>	total power dissipation	up to T <sub>s</sub> = 60 °C; note 1	–	1	W
T <sub>stg</sub>	storage temperature		–65	+175	°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; note 1	single loaded	230	K/W
		double loaded	115	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

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>DC characteristics of any single transistor</b>						
$V_{(BR)CBO}$	collector-base breakdown voltage	$I_C = 2.5\ \mu\text{A}; I_E = 0$	20	–	–	V
$V_{(BR)CEO}$	collector-emitter breakdown voltage	$I_C = 10\ \mu\text{A}; I_B = 0$	8	–	–	V
$V_{(BR)EBO}$	emitter-base breakdown voltage	$I_E = 2.5\ \mu\text{A}; I_C = 0$	2.5	–	–	V
$I_{CBO}$	collector-base leakage current	$I_E = 0; V_{CB} = 6\ \text{V}$	–	–	50	nA
$h_{FE}$	DC current gain	$I_C = 20\ \text{mA}; V_{CE} = 6\ \text{V}$	60	120	250	
<b>AC characteristics of the cascode configuration</b>						
$f_T$	transition frequency	$I_C = 20\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 1\ \text{GHz}$	–	7	–	GHz
$C_c$	collector capacitance T2	$I_E = i_e = 0; V_{C2-B2} = 1\ \text{V}; f = 1\ \text{MHz}$	–	0.55	–	pF
$C_{re2}$	feedback capacitance T2	$I_C = 0; V_{C2-E1} = 3\ \text{V}; f = 1\ \text{MHz}$	–	500	–	fF
$C_{re}$	feedback capacitance	$I_C = 0; V_{C2-E1} = 3\ \text{V}; f = 1\ \text{MHz}$	–	–	10	fF
MSG	maximum stable power gain; note 1	$I_C = 20\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 900\ \text{MHz}; T_{amb} = 25\text{ °C}$	–	31	–	dB
		$I_C = 20\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 2\ \text{GHz}; T_{amb} = 25\text{ °C}$	–	19	–	dB
$ S_{21} ^2$	insertion power gain	$I_C = 20\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 900\ \text{MHz}; T_{amb} = 25\text{ °C}$	–	17	–	dB
		$I_C = 20\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 2\ \text{GHz}; T_{amb} = 25\text{ °C}$	–	13	–	dB
$ S_{21}/S_{12} ^2$	maximum isolation; note 2	$f = 900\ \text{MHz}$	–	63	–	dB
		$f = 2\ \text{GHz}$	–	38	–	dB
F	noise figure	$I_C = 5\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 900\ \text{MHz}; \Gamma_S = \Gamma_{opt}$	–	1.3	1.6	dB
IP <sub>3</sub>	third order intercept point (input)	note 3	–	–18	–	dBm

## Notes

$$1. \text{MSG} = |S_{12}/S_{21}| \times \left( k - \sqrt{k^2 - 1} \right) \quad k = \frac{1 + |S_{11} \times S_{22} - S_{12} \times S_{21}|^2 - (|S_{11}|^2 - |S_{22}|^2)}{2 \times |S_{12} \times S_{21}|}$$

2. Maximum isolation is defined as the isolation when  $S_{21}$  of the amplifier is reduced to unity (buffer application).

3.  $I_C = 5\ \text{mA}; V_{CE} = 3\ \text{V}; R_S = 50\ \Omega; Z_L = \text{opt}; T_{amb} = 25\text{ °C};$   
 $f_p = 900\ \text{MHz}; f_q = 902\ \text{MHz};$  measured at  $f_{(2p-q)} = 904\ \text{MHz}.$

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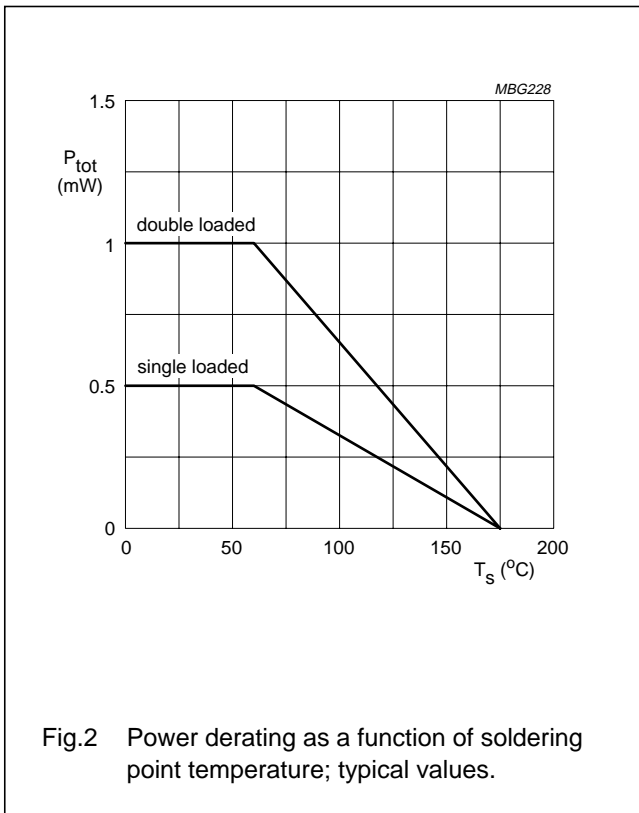
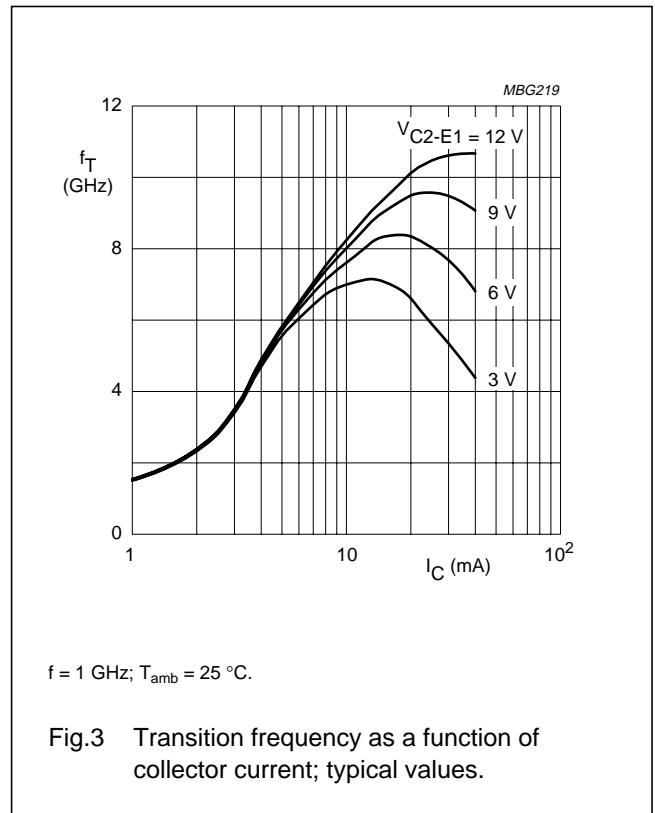
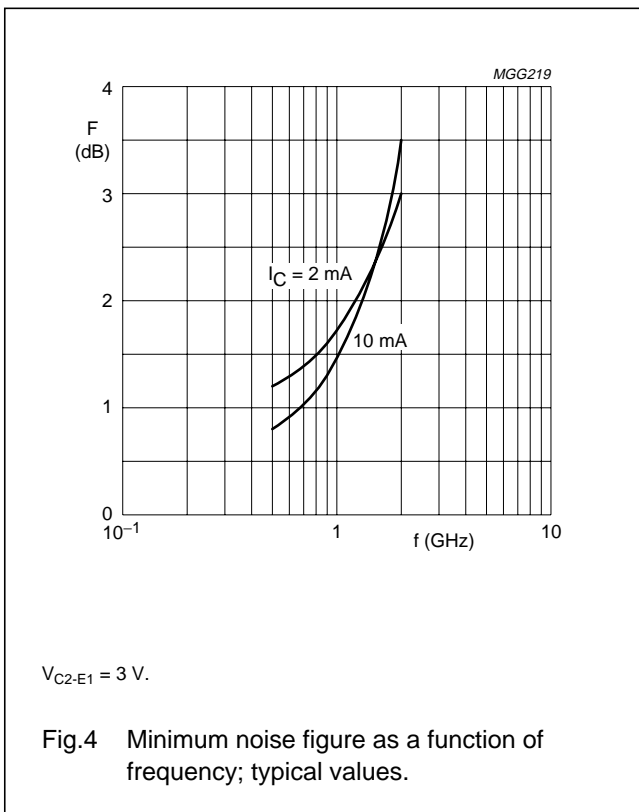


Fig.2 Power derating as a function of soldering point temperature; typical values.



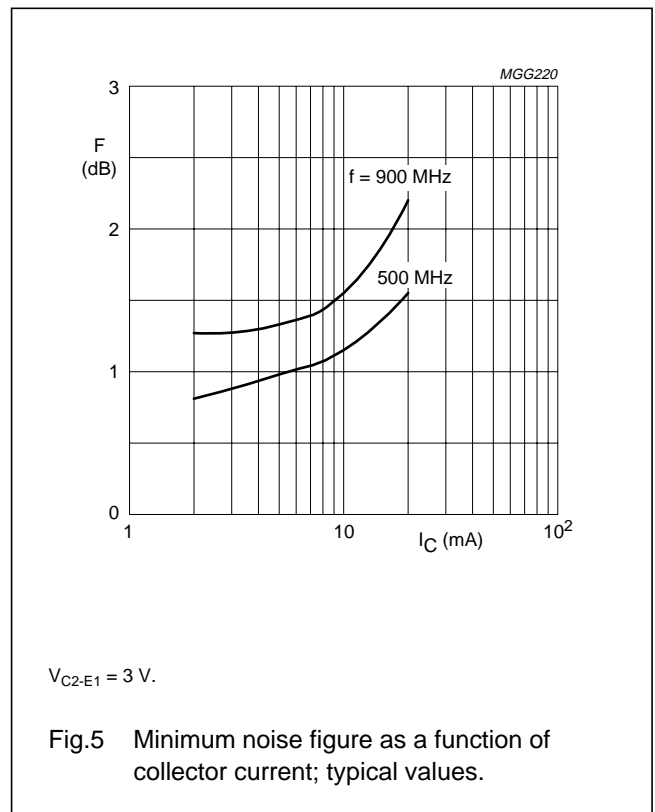
$f = 1$  GHz;  $T_{amb} = 25$  °C.

Fig.3 Transition frequency as a function of collector current; typical values.



$V_{C2-E1} = 3$  V.

Fig.4 Minimum noise figure as a function of frequency; typical values.

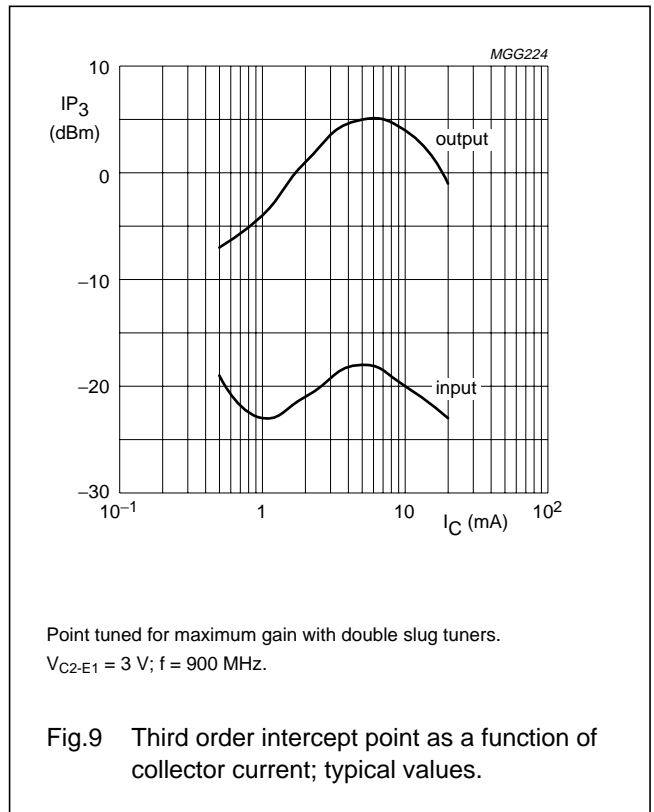
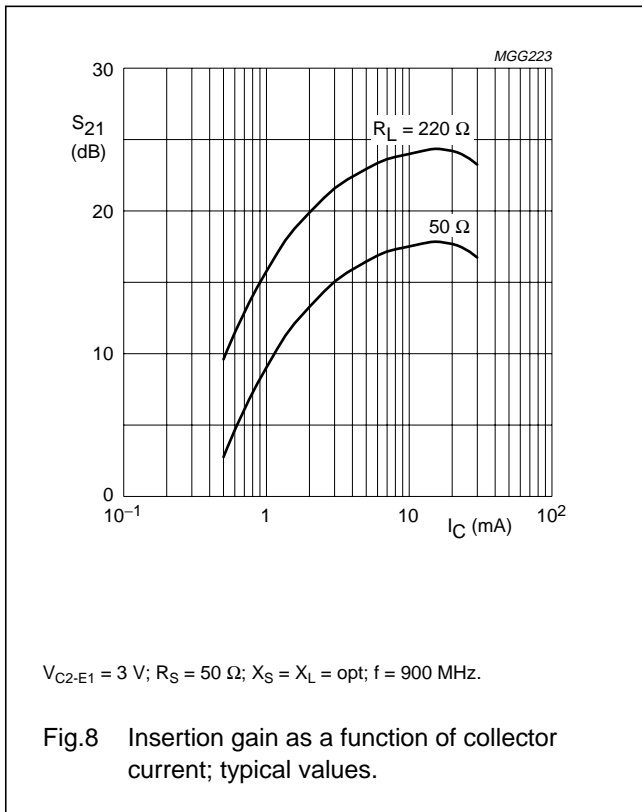
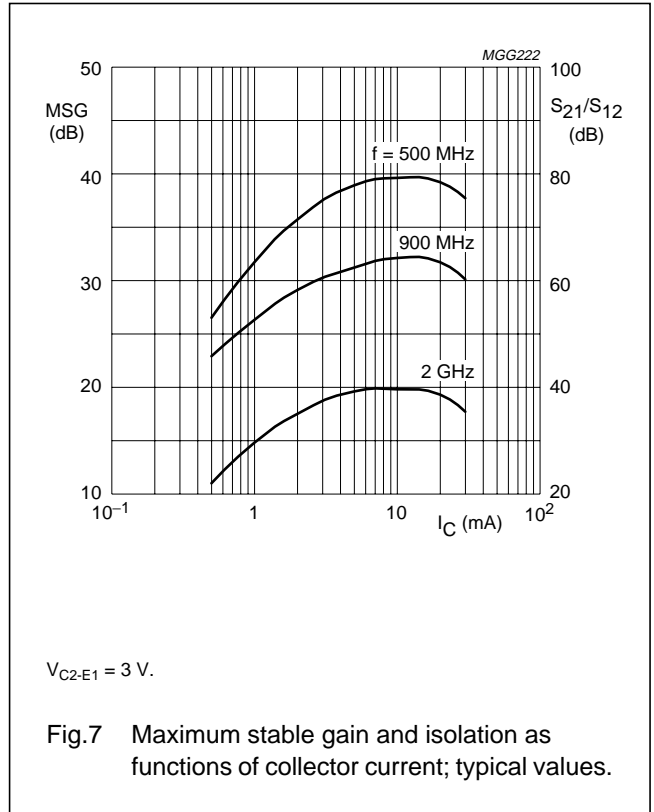
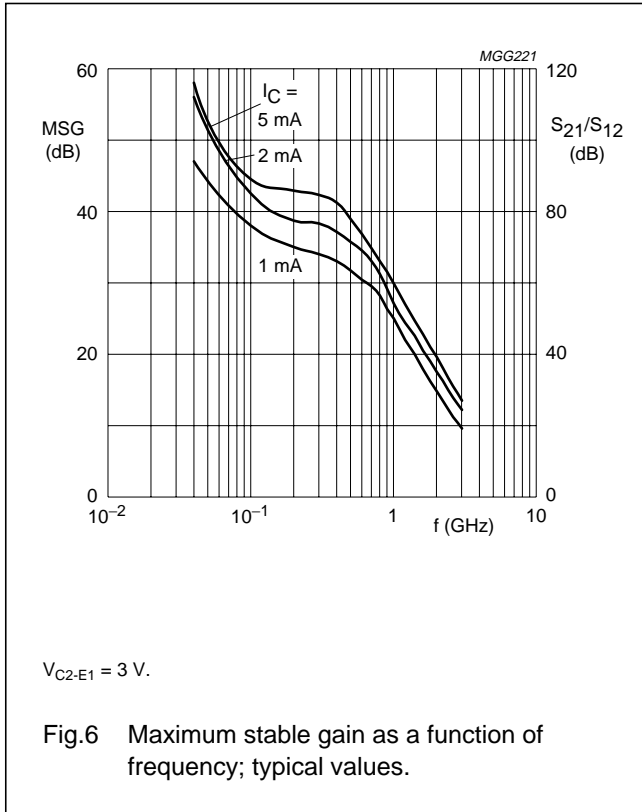


$V_{C2-E1} = 3$  V.

Fig.5 Minimum noise figure as a function of collector current; typical values.

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APPLICATION INFORMATION

SPICE parameters for any single BFC520 die

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	510.0	mA
6	ISE	283.0	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 <sup>(1)</sup>	XTB	0.000	–
20 <sup>(1)</sup>	EG	1.110	eV
21 <sup>(1)</sup>	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	0.071	–
33	XCJC	0.130	–
34	TR	543.7	ps
35 <sup>(1)</sup>	CJS	0.000	F
36 <sup>(1)</sup>	VJS	750.0	mV
37 <sup>(1)</sup>	MJS	0.000	–
38	FC	0.780	–

Note

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

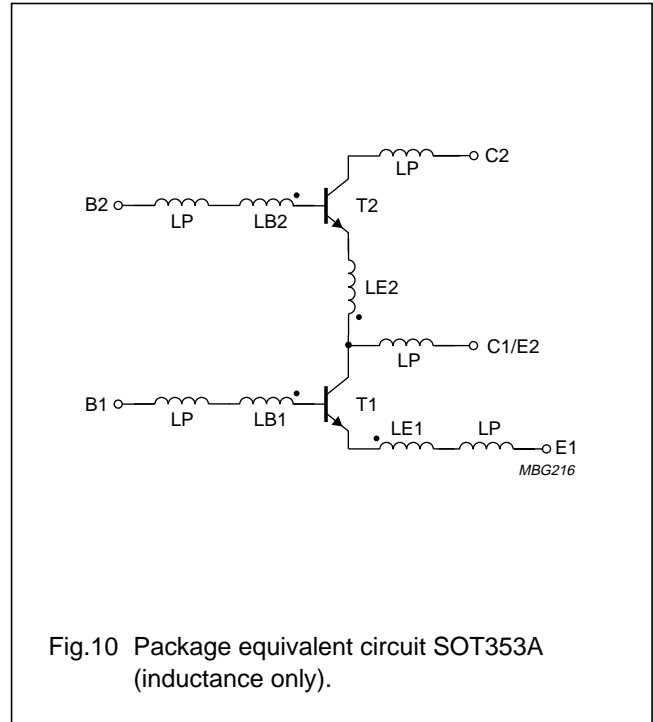


Fig.10 Package equivalent circuit SOT353A (inductance only).

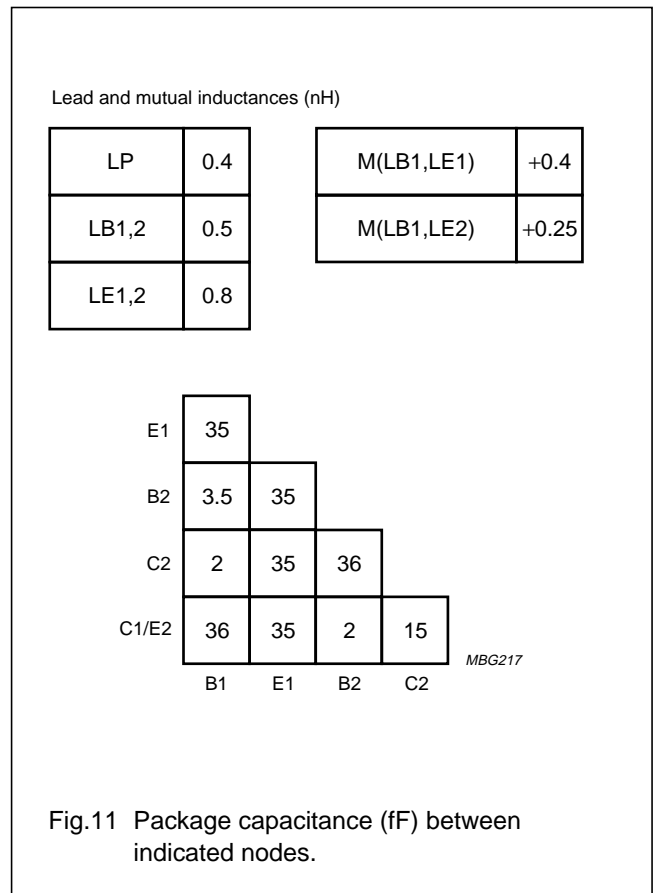
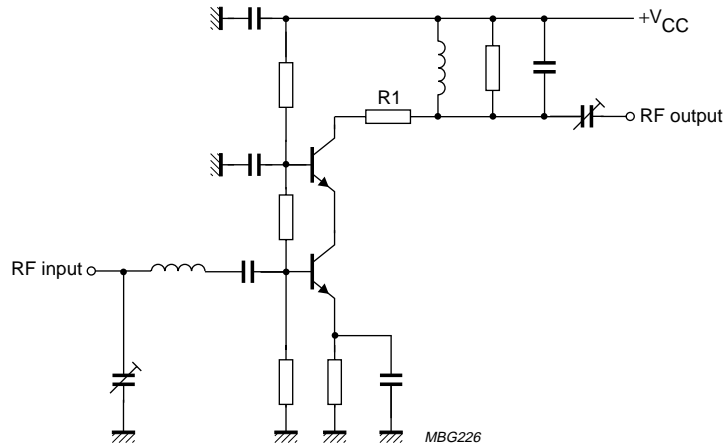


Fig.11 Package capacitance (fF) between indicated nodes.

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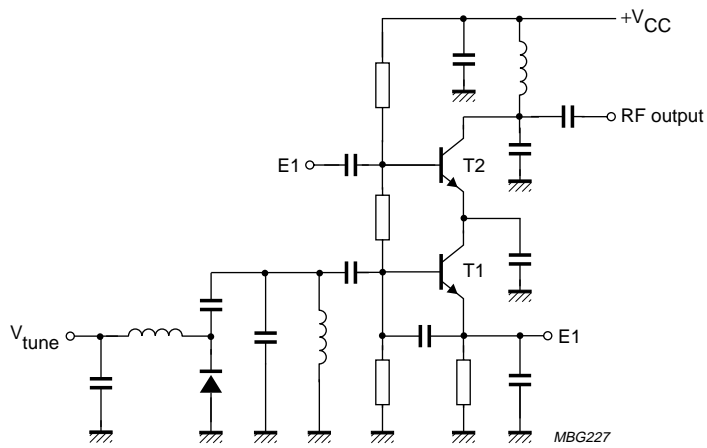
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Typical application circuits



R1 increases stability (10 to 47 Ω).

Fig.12 Narrowband amplifier.



T1 forms a colpitts oscillator.  
T2 acts as a buffer amplifier.

Fig.13 VCO/buffer combination.

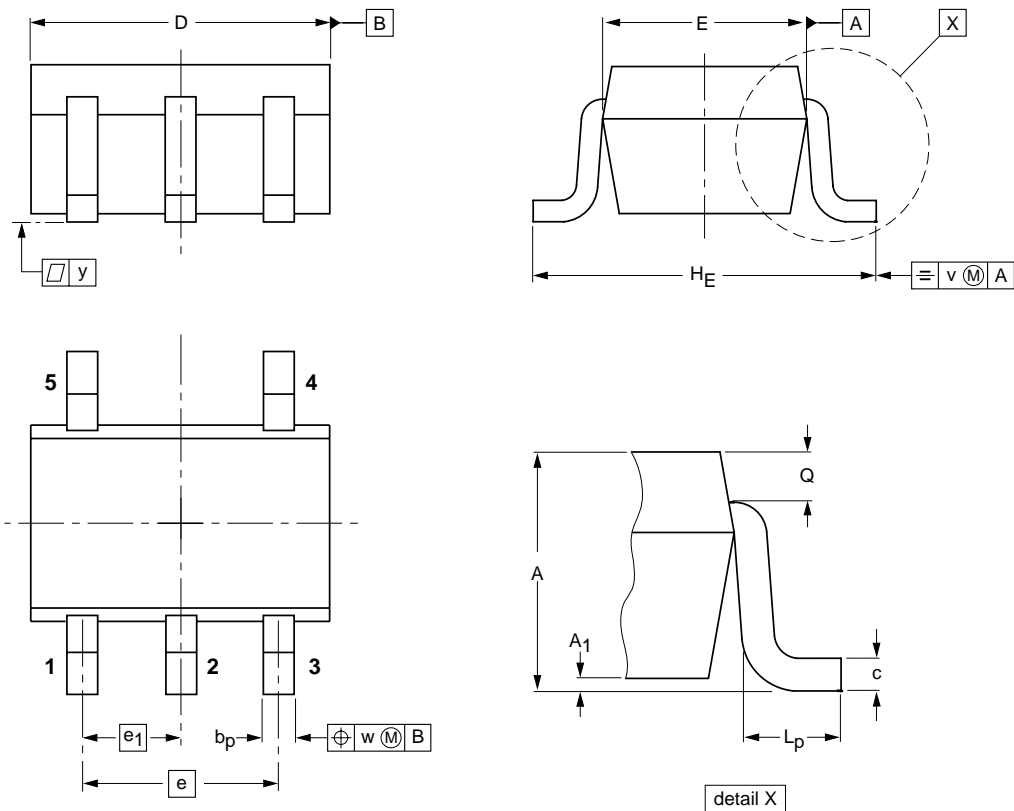
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PACKAGE OUTLINE

Plastic surface mounted package; 5 leads

SOT353



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub> max	b <sub>p</sub>	c	D	E <sup>(2)</sup>	e	e <sub>1</sub>	H <sub>E</sub>	L <sub>p</sub>	Q	v	w	y
mm	1.1 0.8	0.1	0.30 0.20	0.25 0.10	2.2 1.8	1.35 1.15	1.3	0.65	2.2 2.0	0.45 0.15	0.25 0.15	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT353			SC-88A			97-02-28

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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.
Short-form specification	The data in this 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.
<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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Fax. +43 160 101 1210

**Belarus:** Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,  
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**Hungary:** see Austria

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**Israel:** RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,  
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

**Italy:** PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,  
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

**Japan:** Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,  
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**Mexico:** 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,  
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**Middle East:** see Italy

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**New Zealand:** 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,  
Tel. +64 9 849 4160, Fax. +64 9 849 7811

**Norway:** Box 1, Manglerud 0612, OSLO,  
Tel. +47 22 74 8000, Fax. +47 22 74 8341

**Philippines:** Philips Semiconductors Philippines Inc.,  
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,  
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

**Poland:** Ul. Lukiska 10, PL 04-123 WARSZAWA,  
Tel. +48 22 612 2831, Fax. +48 22 612 2327

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**South America:** Rua do Rocio 220, 5th floor, Suite 51,  
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**Spain:** Balmes 22, 08007 BARCELONA,  
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**Taiwan:** Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,  
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**United Kingdom:** Philips Semiconductors Ltd., 276 Bath Road, Hayes,  
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

**United States:** 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,  
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