

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

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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

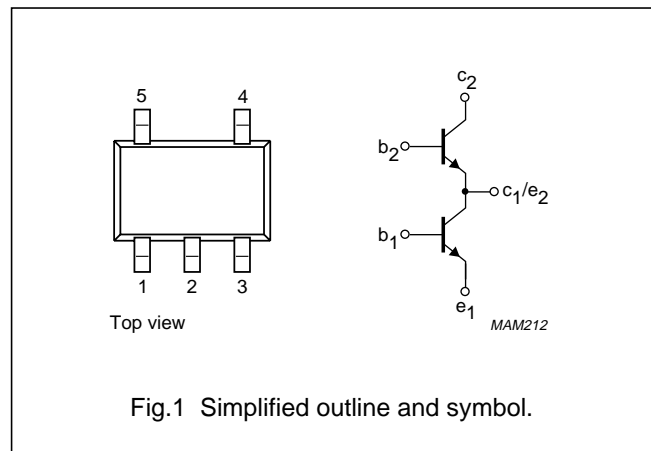
- Low noise, high gain amplifiers
- Oscillator buffer amplifiers
- Wideband voltage-to-current converters.

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 ₂	1	base 2
e ₁	2	emitter 1
b ₁	3	base 1
c ₁ /e ₂	4	collector 1/emitter 2
c ₂	5	collector 2



QUICK REFERENCE DATA

$V_{C2-E1} = 3\text{ V}$; $I_C = 20\text{ mA}$; $V_{B2} = 2.1\text{ V}$; b₂ connected to ground via 1 nF (0603) capacitor, e₁ connected directly to ground.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
C _{re}	feedback capacitance C _{B1-C2}		–	–	10	fF
$ S_{21}/S_{12} ^2$	maximum isolation	f = 900 MHz; T _{amb} = 25 °C	–	–63	–	dB
		f = 2 GHz; T _{amb} = 25 °C	–	–38	–	dB
MSG	maximum stable power gain (narrowband)	f = 900 MHz; T _{amb} = 25 °C	–	31	–	dB
		f = 2 GHz; T _{amb} = 25 °C	–	19	–	dB
F	noise figure	I _C = 5 mA; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.3	1.6	dB
R _{th j-s}	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
Any single transistor					
V _{CBO}	collector-base voltage	open emitter	–	20	V
V _{CEO}	collector-emitter voltage	open base	–	8	V
V _{EBO}	emitter-base voltage	open collector	–	2.5	V
I _C	DC collector current		–	70	mA
P _{tot}	total power dissipation	up to T _s = 60 °C; note 1	–	1	W
T _{stg}	storage temperature		–65	+175	°C
T _j	junction temperature		–	175	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
R _{th j-s}	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 characteristics1. T_s is the temperature at the soldering point of the collector pin.

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CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
DC characteristics of any single transistor						
V _{(BR)CBO}	collector-base breakdown voltage	I _C = 2.5 μA; I _E = 0	20	–	–	V
V _{(BR)CEO}	collector-emitter breakdown voltage	I _C = 10 μA; I _B = 0	8	–	–	V
V _{(BR)EBO}	emitter-base breakdown voltage	I _E = 2.5 μA; I _C = 0	2.5	–	–	V
I _{CBO}	collector-base leakage current	I _E = 0; V _{CB} = 6 V	–	–	50	nA
h _{FE}	DC current gain	I _C = 20 mA; V _{CE} = 6 V	60	120	250	
AC characteristics of the cascode configuration						
f _T	transition frequency	I _C = 20 mA; V _{C2-E1} = 3 V; f = 1 GHz	–	7	–	GHz
C _c	collector capacitance T2	I _E = i _e = 0; V _{C2-B2} = 1 V; f = 1 MHz	–	0.55	–	pF
C _{re2}	feedback capacitance T2	I _C = 0; V _{C2-E1} = 3 V; f = 1 MHz	–	500	–	fF
C _{re}	feedback capacitance	I _C = 0; V _{C2-E1} = 3 V; f = 1 MHz	–	–	10	fF
MSG	maximum stable power gain; note 1	I _C = 20 mA; V _{C2-E1} = 3 V; f = 900 MHz; T _{amb} = 25 °C	–	31	–	dB
		I _C = 20 mA; V _{C2-E1} = 3 V; f = 2 GHz; T _{amb} = 25 °C	–	19	–	dB
S ₂₁ ²	insertion power gain	I _C = 20 mA; V _{C2-E1} = 3 V; f = 900 MHz; T _{amb} = 25 °C	–	17	–	dB
		I _C = 20 mA; V _{C2-E1} = 3 V; f = 2 GHz; T _{amb} = 25 °C	–	13	–	dB
S ₂₁ /S ₁₂ ²	maximum isolation; note 2	f = 900 MHz	–	63	–	dB
		f = 2 GHz	–	38	–	dB
F	noise figure	I _C = 5 mA; V _{C2-E1} = 3 V; f = 900 MHz; Γ _S = Γ _{opt}	–	1.3	1.6	dB
IP ₃	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 S₂₁ of the amplifier is reduced to unity (buffer application).

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

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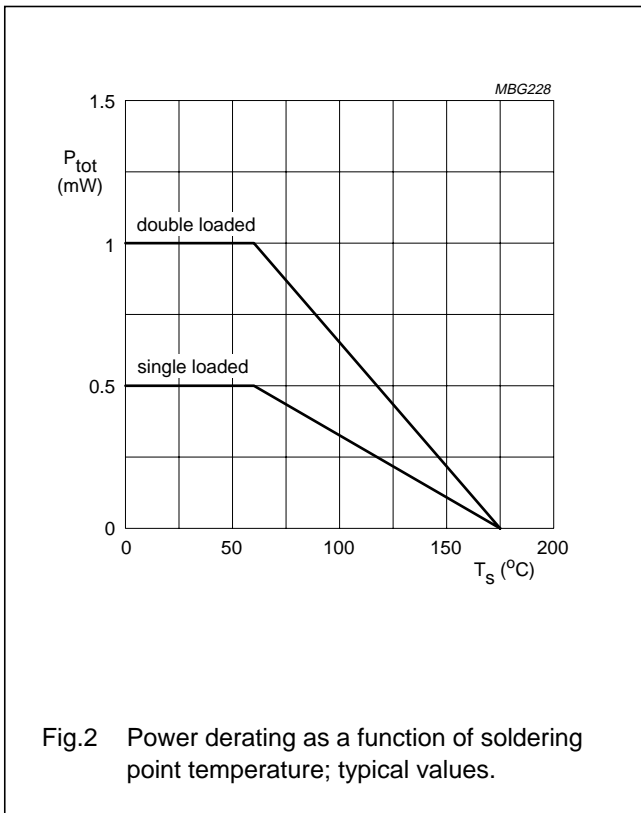
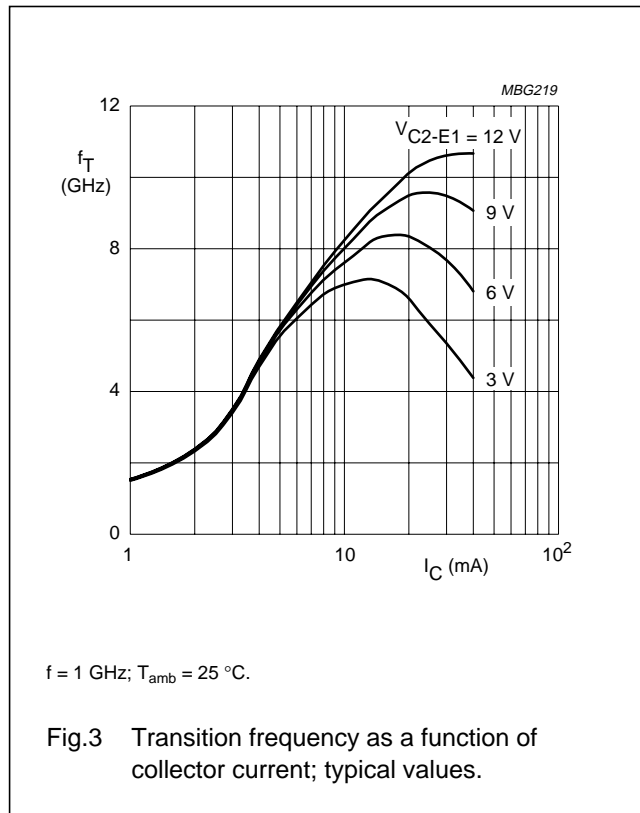
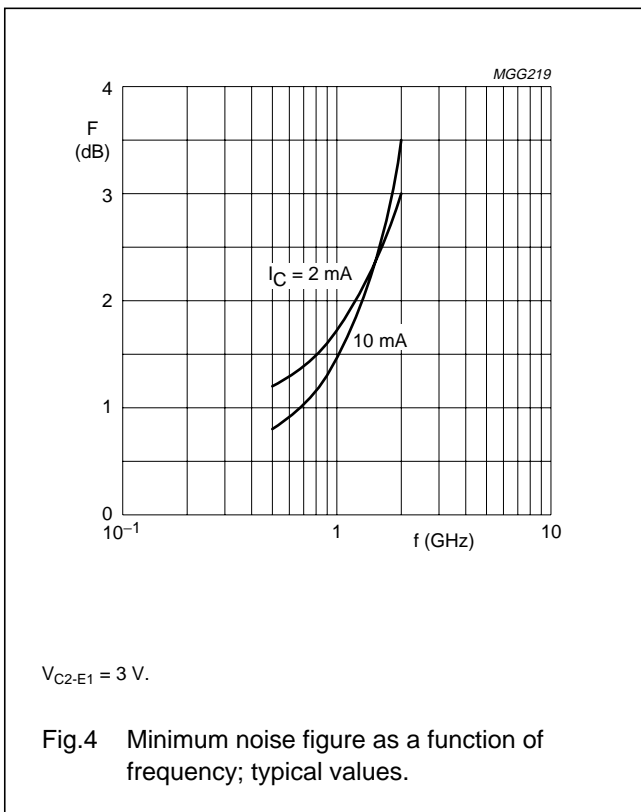


Fig.2 Power derating as a function of soldering point temperature; typical values.



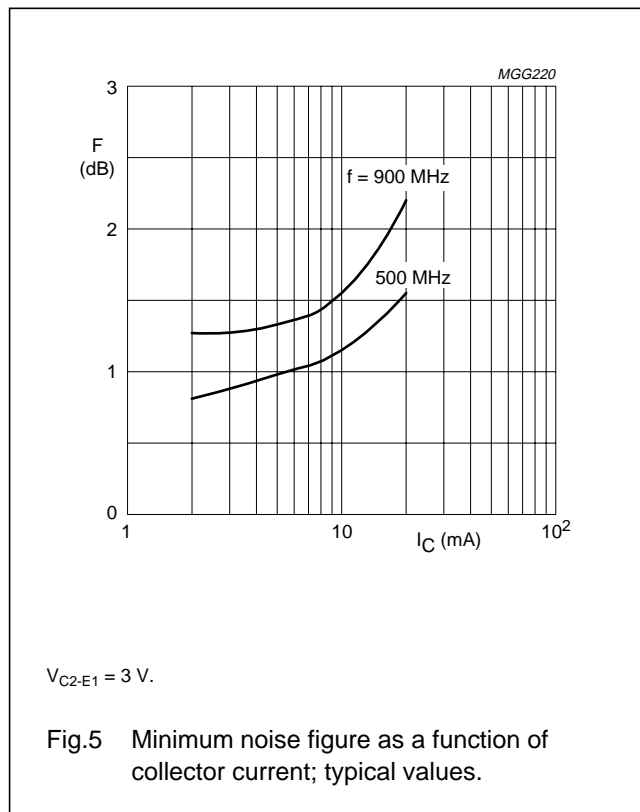
$f = 1 \text{ GHz}; T_{amb} = 25 \text{ }^\circ\text{C}.$

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



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

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

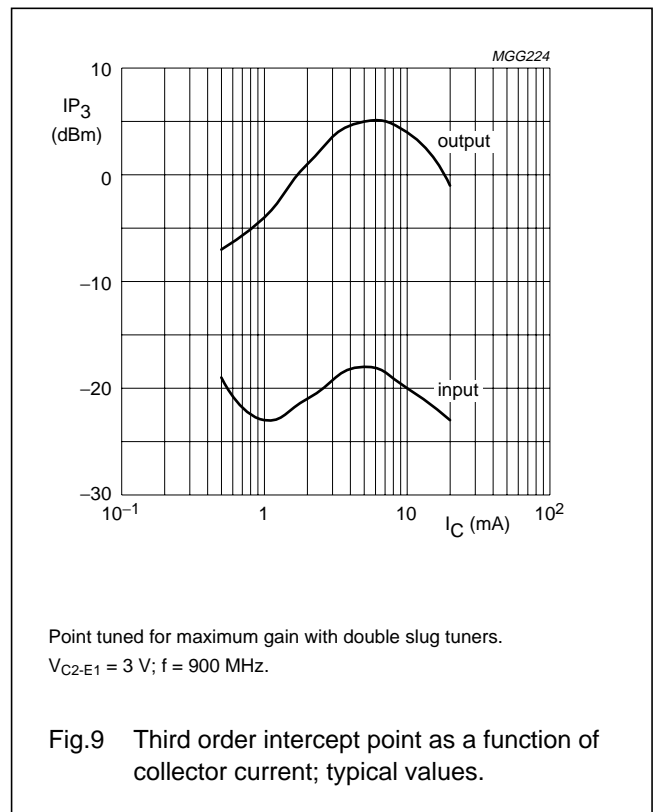
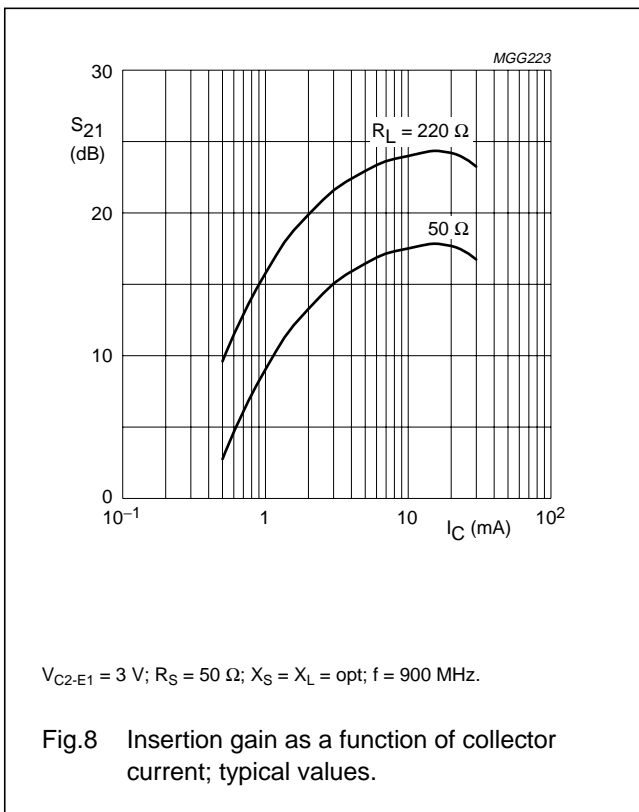
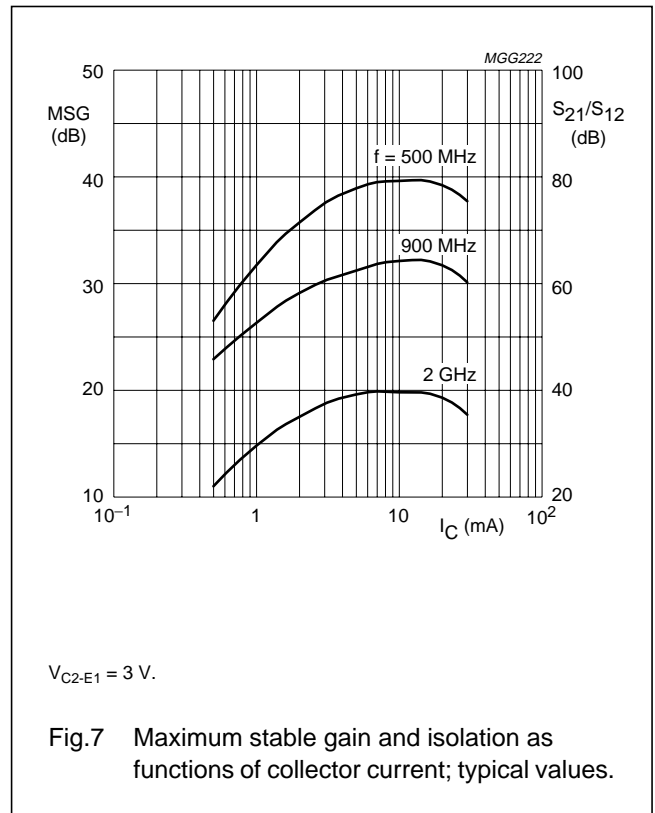
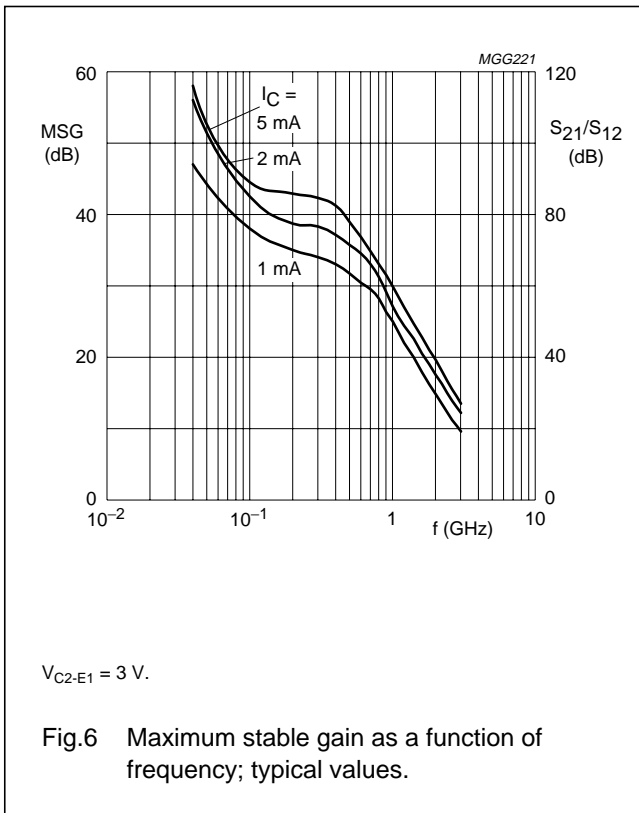


$V_{C2-E1} = 3 \text{ V}.$

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 ⁽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	0.071	–
33	XCJC	0.130	–
34	TR	543.7	ps
35 ⁽¹⁾	CJS	0.000	F
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.

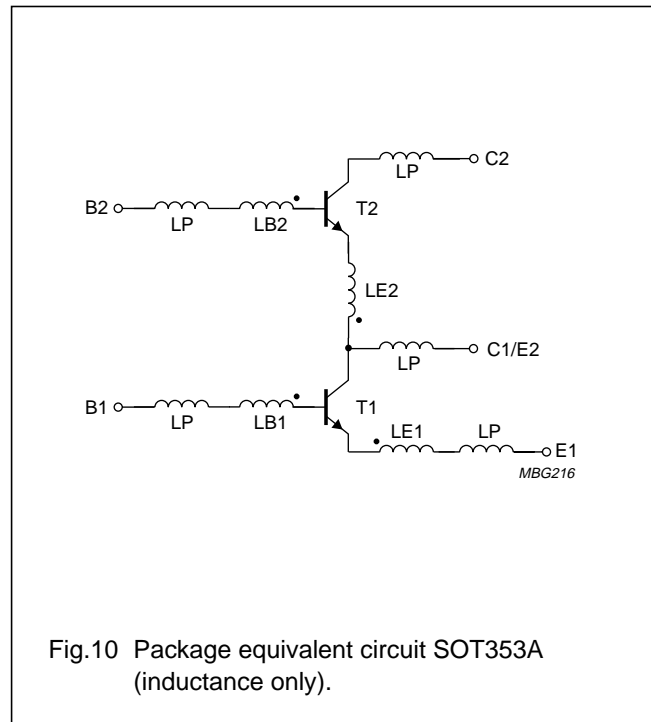


Fig.10 Package equivalent circuit SOT353A (inductance only).

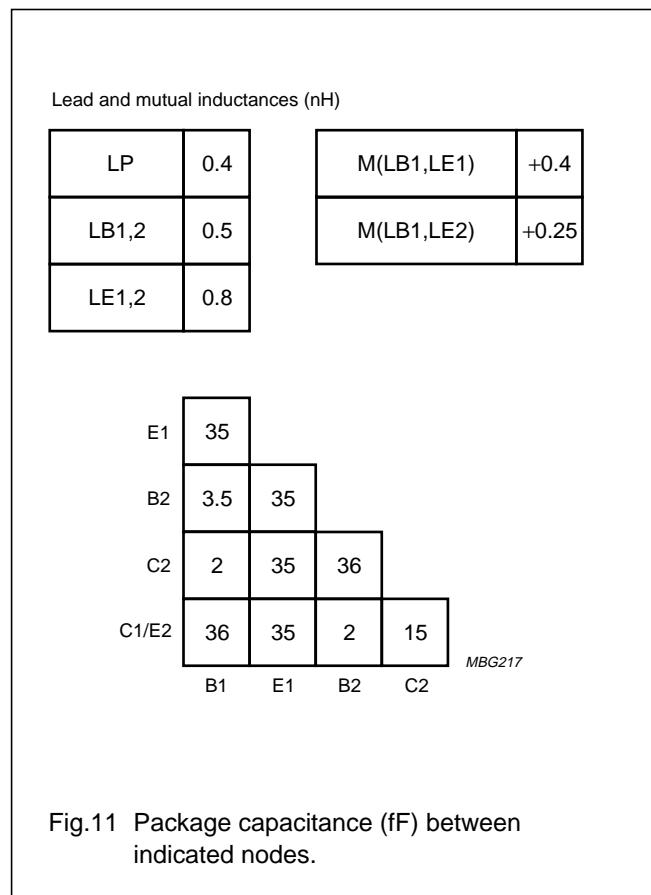
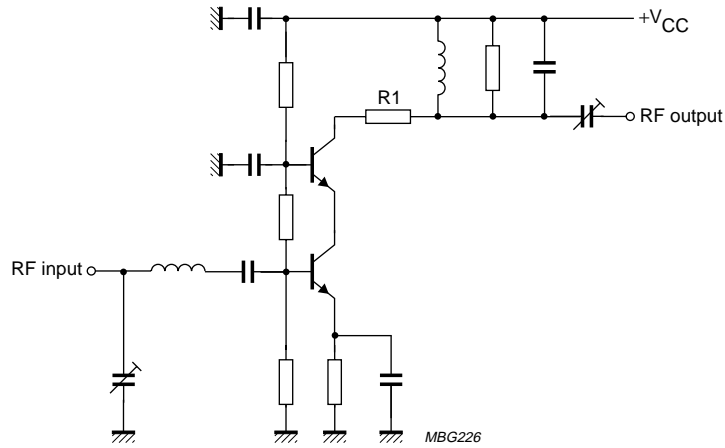


Fig.11 Package capacitance (fF) between indicated nodes.

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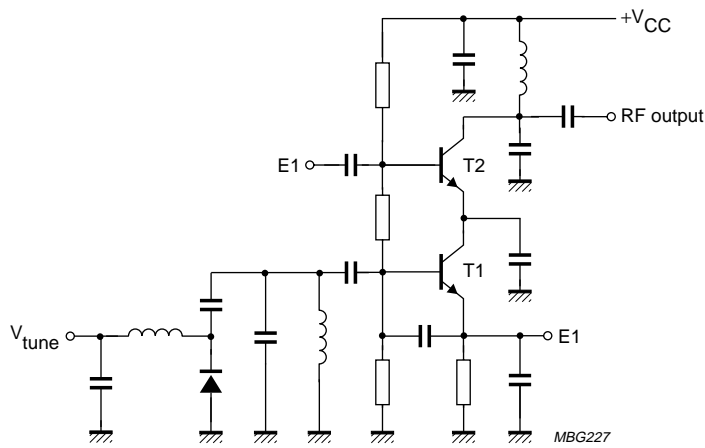
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Typical application circuits



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.

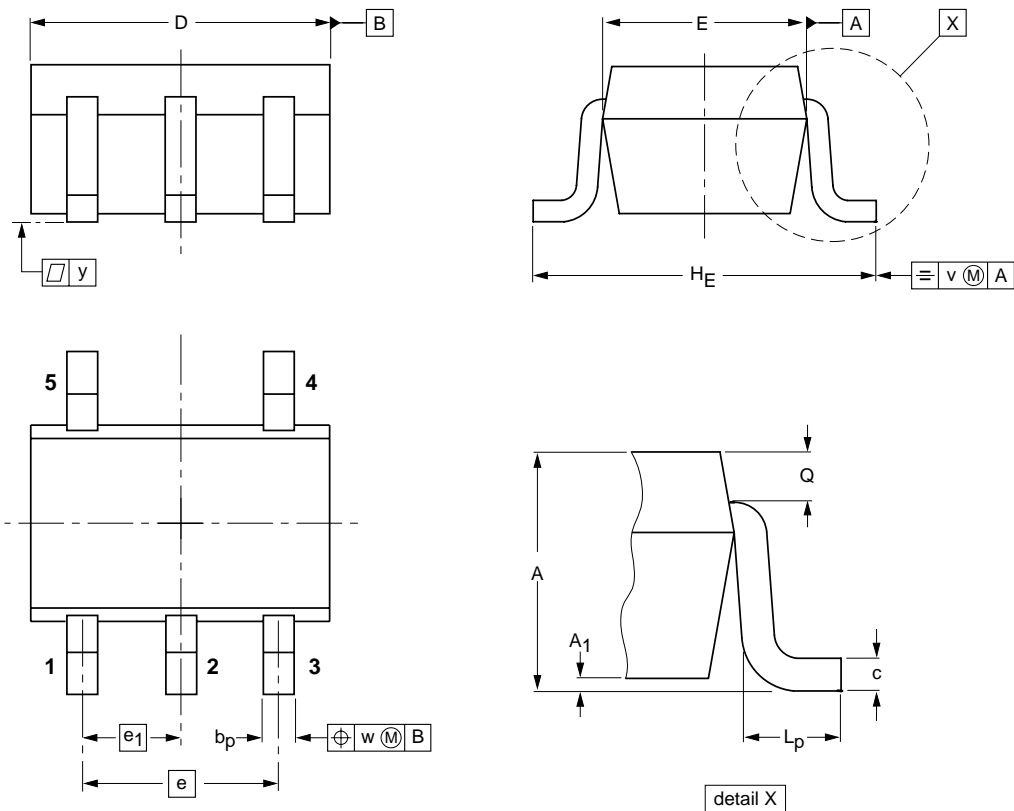
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PACKAGE OUTLINE

Plastic surface mounted package; 5 leads

SOT353



DIMENSIONS (mm are the original dimensions)

UNIT	A	A ₁ max	b _p	c	D	E ⁽²⁾	e	e ₁	H _E	L _p	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

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.
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.
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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