

**DISCRETE SEMICONDUCTORS**

# DATA SHEET

## **BFC505**

### **NPN wideband cascode transistor**

Product specification

1996 Oct 08

Supersedes data of 1995 Sep 01

File under Discrete Semiconductors, SC14

# NPN wideband cascode transistor

# BFC505

### 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

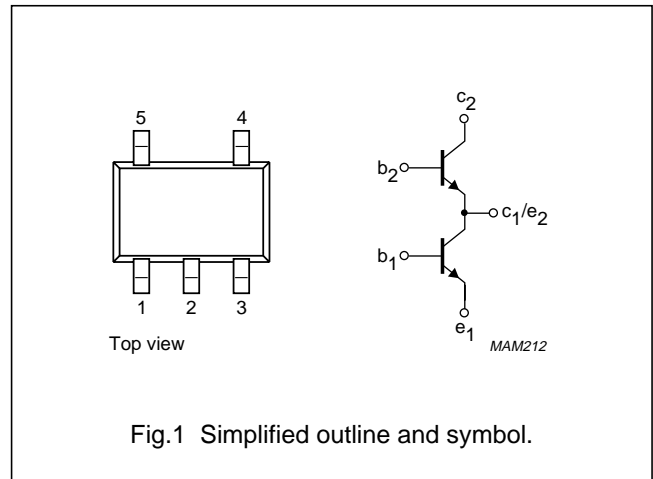
- Low voltage, low current, low noise and high gain amplifiers
- Oscillator buffer amplifiers
- Wideband voltage-to-current converters.

### 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 has a very low feedback capacitance resulting in high isolation.

### PINNING - SOT353

PIN	SYMBOL	DESCRIPTION
1	$b_2$	base 2
2	$e_1$	emitter 1
3	$b_1$	base 1
4	$c_1/e_2$	collector 1/emitter 2
5	$c_2$	collector 2



### QUICK REFERENCE DATA

$b_2$  connected to ground via 1 nF (0603) capacitor,  $e_1$  connected directly to ground.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$C_{re}$	feedback capacitance $C_{B1-C2}$	$I_e = 0$ ; $V_{C2-E1} = 0$ ; $f = 1\text{ MHz}$	–	–	10	fF
$ s_{21}/s_{12} ^2$	maximum isolation	$I_C = 5\text{ mA}$ ; $V_{C2} = V_{B2} = 3\text{ V}$ ; $f = 900\text{ MHz}$	60	–	–	dB
MSG	maximum stable power gain	$I_C = 0.5\text{ mA}$ ; $V_{C2} = V_{B2} = 1\text{ V}$ ; $f = 900\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$	–	22	–	dB
F	noise figure	$I_C = 0.5\text{ mA}$ ; $V_{C2-E1} = 1\text{ V}$ ; $f = 500\text{ MHz}$ ; $\Gamma_S = \Gamma_{opt}$	–	1.1	1.4	dB
		$I_C = 1\text{ mA}$ ; $V_{C2-E1} = 3\text{ V}$ ; $f = 900\text{ MHz}$ ; $\Gamma_S = \Gamma_{opt}$	–	1.8	2.1	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
<b>Any single transistor</b>					
$V_{CBO}$	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		–	18	mA
$P_{tot}$	total power dissipation	up to $T_s = 118\text{ °C}$ ; note 1	–	500	mW
$T_{stg}$	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 characteristics**

- $T_s$  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	$I_C = 5\ \text{mA}; V_{CE} = 6\ \text{V}$	60	120	250	
<b>AC characteristics of the cascode configuration measured in test circuit (note 1)</b>						
$f_T$	transition frequency	$I_C = 5\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 1\ \text{GHz}$	–	7.3	–	GHz
$C_c$	collector capacitance T2	$I_E = i_e = 0; V_{C2-B2} = 0; f = 1\ \text{MHz}$	–	0.4	–	pF
$C_{re2}$	feedback capacitance T2	$I_C = 0; V_{C2-E1} = 3\ \text{V}; f = 1\ \text{MHz}$	–	250	–	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 2	$I_C = 0.25\ \text{mA}; V_{C2-E1} = 1\ \text{V}; f = 300\ \text{MHz}; T_{amb} = 25\text{ °C}$	–	25	–	dB
		$I_C = 0.5\ \text{mA}; V_{C2-E1} = 1\ \text{V}; f = 900\ \text{MHz}; T_{amb} = 25\text{ °C}$	–	22	–	dB
		$I_C = 5\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 2\ \text{GHz}; T_{amb} = 25\text{ °C}$	–	23	–	dB
$ s_{21} ^2$	insertion power gain	$I_C = 0.5\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 300\ \text{MHz}; T_{amb} = 25\text{ °C}$	–	21	–	dB
		$I_C = 5\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 900\ \text{MHz}; T_{amb} = 25\text{ °C}$	–	16	–	dB
		$I_C = 5\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 2\ \text{GHz}; T_{amb} = 25\text{ °C}$	–	11	–	dB
$ s_{21}/s_{12} ^2$	maximum isolation; note 3	$I_C = 0.5\ \text{mA}; V_{C2-E1} = 1\ \text{V}; f = 900\ \text{MHz}$	40	45	–	dB
		$I_C = 5\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 900\ \text{MHz}$	60	68	–	dB
		$I_C = 5\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 2\ \text{GHz}$	40	48	–	dB
F	noise figure	$I_C = 0.5\ \text{mA}; V_{C2-E1} = 1\ \text{V}; f = 500\ \text{MHz}; \Gamma_S = \Gamma_{opt}$	–	1.1	1.4	dB
		$I_C = 1\ \text{mA}; V_{C2-E1} = 3\ \text{V}; f = 900\ \text{MHz}; \Gamma_S = \Gamma_{opt}$	–	1.8	2.1	dB
		$I_C = 1\ \text{mA}; V_{C2-E1} = 1\ \text{V}; f = 2\ \text{GHz}; \Gamma_S = \Gamma_{opt}$	–	3.5	–	dB
$IP_3$	third order intercept point (input)	note 4	–	–20	–	dBm

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Notes

1.  $V_{B2} = V_{C2-E1}/2 + 0.6 \text{ V}$
2.  $MSG = |s_{12}/s_{21}| \times (k - \sqrt{k^2 - 1})$ ;  $k = \frac{1 + |s_{11} \times s_{22} - s_{12} \times s_{21}|^2 - (|s_{11}|^2 - |s_{22}|^2)}{2 \times |s_{12} \times s_{21}|}$
3. Maximum isolation is defined as the isolation when  $S_{21}$  of the amplifier is reduced to unity (buffer application).
4.  $I_C = 1 \text{ mA}$ ;  $V_{CE} = 3 \text{ V}$ ;  $R_S = 50 \Omega$ ;  $Z_L = \text{opt}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ ;  $f_p = 900 \text{ MHz}$ ;  $f_q = 902 \text{ MHz}$ ; measured at  $f_{(2p-q)} = 904 \text{ MHz}$ .

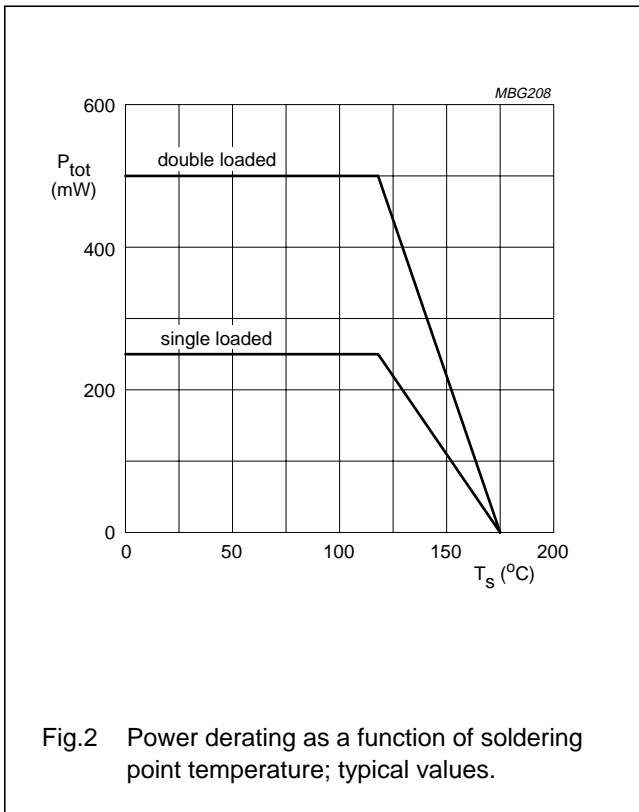
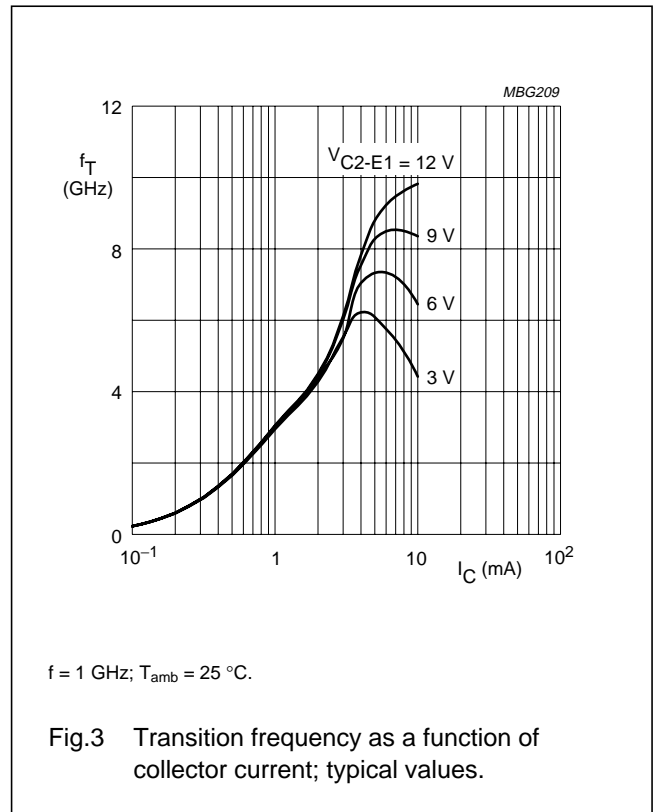


Fig.2 Power derating as a function of soldering point temperature; typical values.

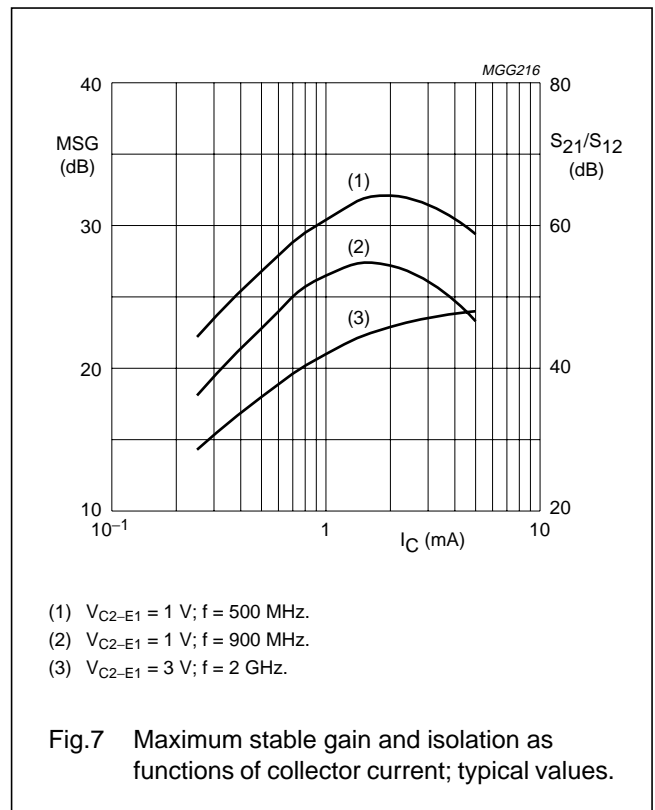
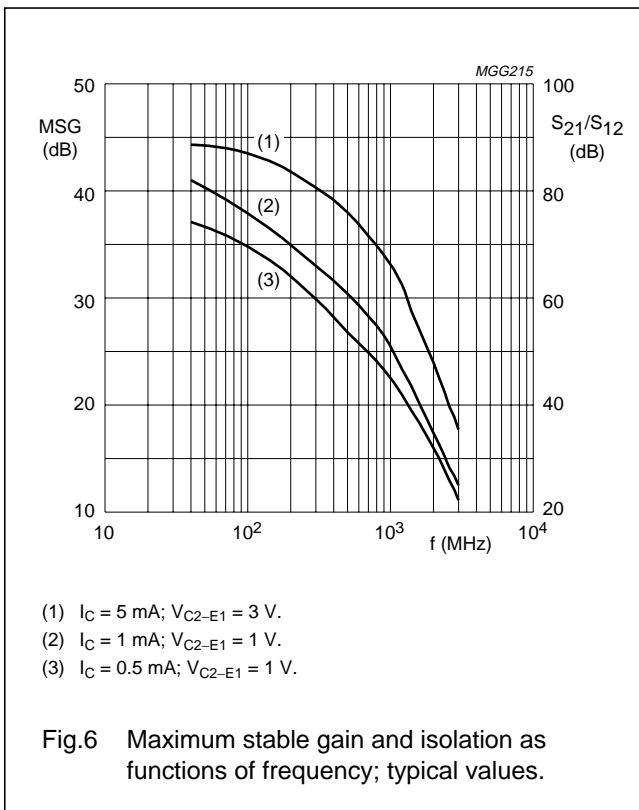
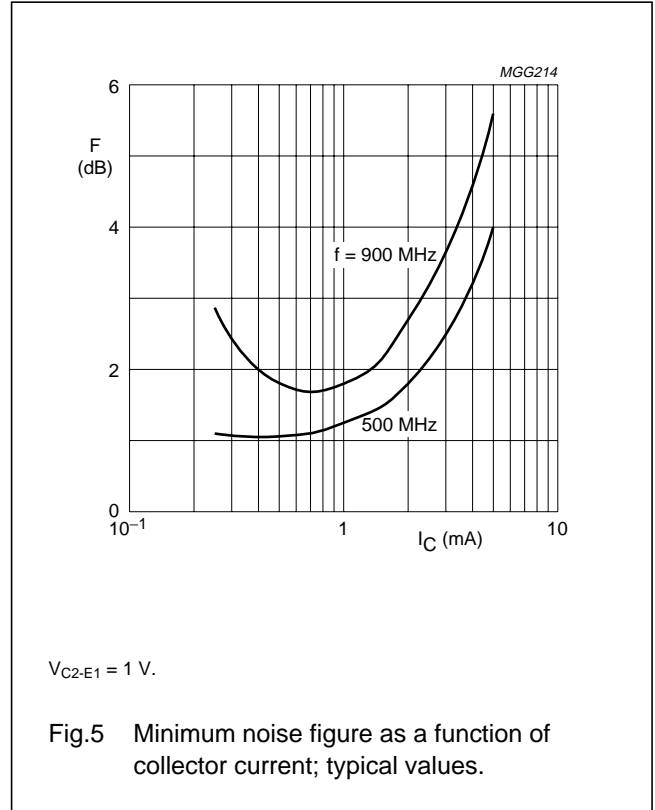
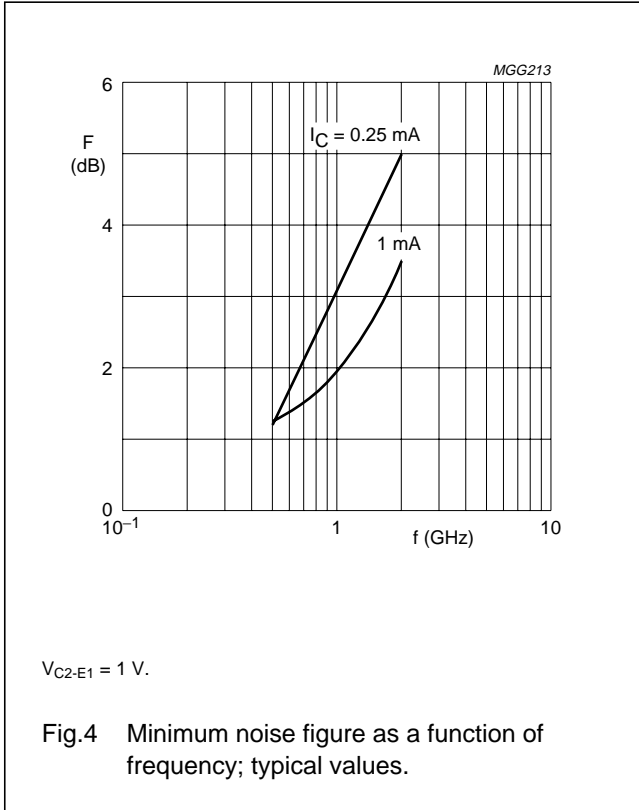


$f = 1 \text{ GHz}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ .

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

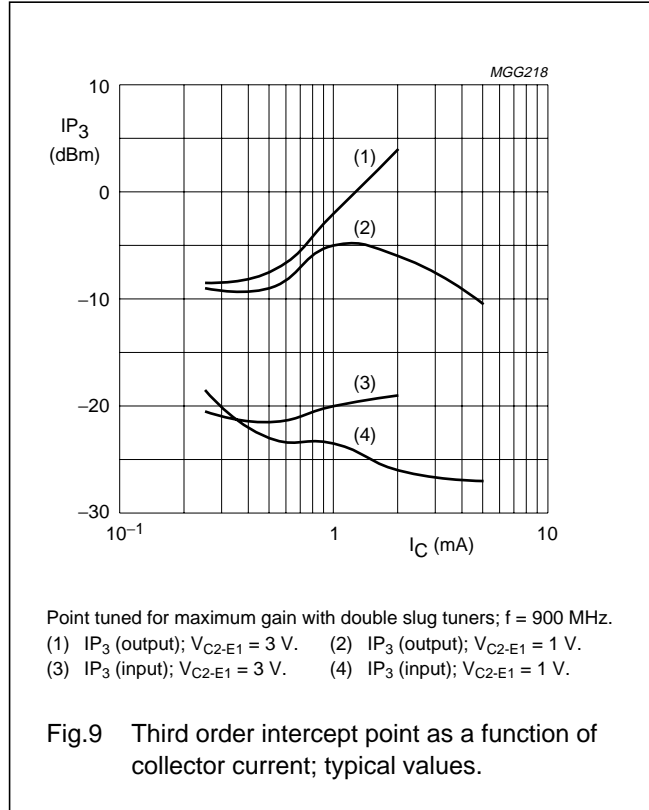
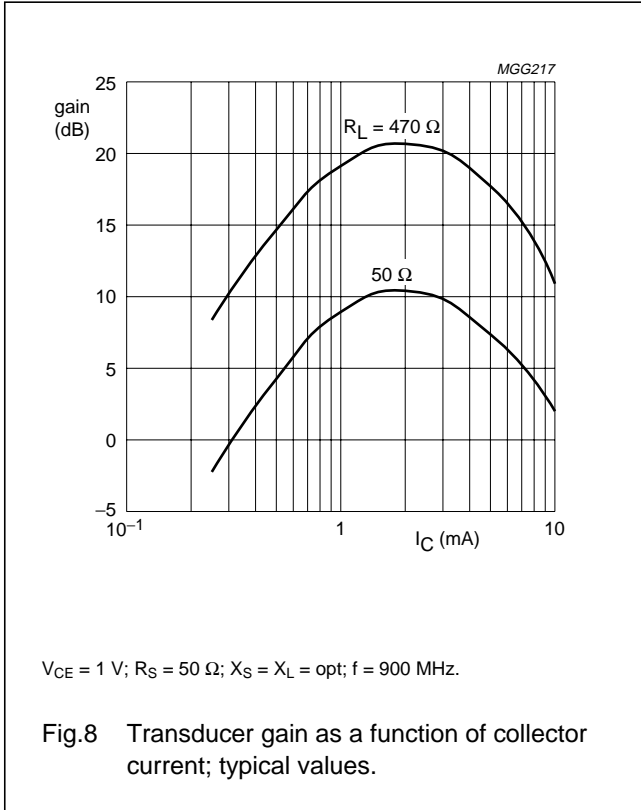
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APPLICATION INFORMATION

SPICE parameters for any single BFC505 die

SEQUENCE No.	PARAMETER	VALUE	UNIT
1	IS	134.1	aA
2	BF	180.0	–
3	NF	0.988	–
4	VAF	38.34	V
5	IKF	150.0	mA
6	ISE	27.81	fA
7	NE	2.051	–
8	BR	55.19	–
9	NR	0.982	–
10	VAR	2.459	V
11	IKR	2.920	mA
12	ISC	17.45	aA
13	NC	1.062	–
14	RB	20.00	Ω
15	IRB	1.000	μA
16	RBM	20.00	Ω
17	RE	1.171	Ω
18	RC	4.350	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	284.7	fF
23	VJE	600.0	mV
24	MJE	0.303	–
25	TF	7.037	ps
26	XTF	12.34	–
27	VTF	1.701	V
28	ITF	30.64	mA
29	PTF	0.000	deg
30	CJC	242.4	fF
31	VJC	188.6	mV
32	MJC	0.041	–
33	XCJC	0.130	–
34	TR	1.332	ns
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	0.897	–

Note

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

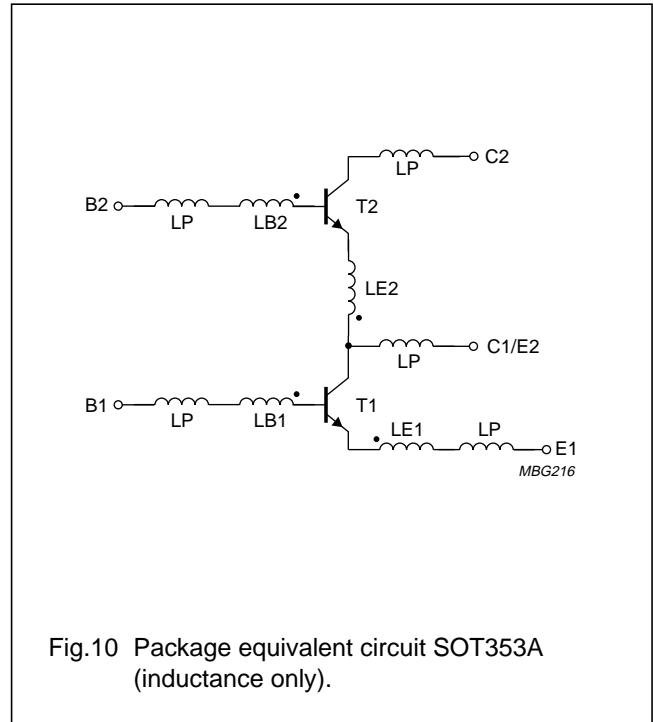


Fig.10 Package equivalent circuit SOT353A (inductance only).

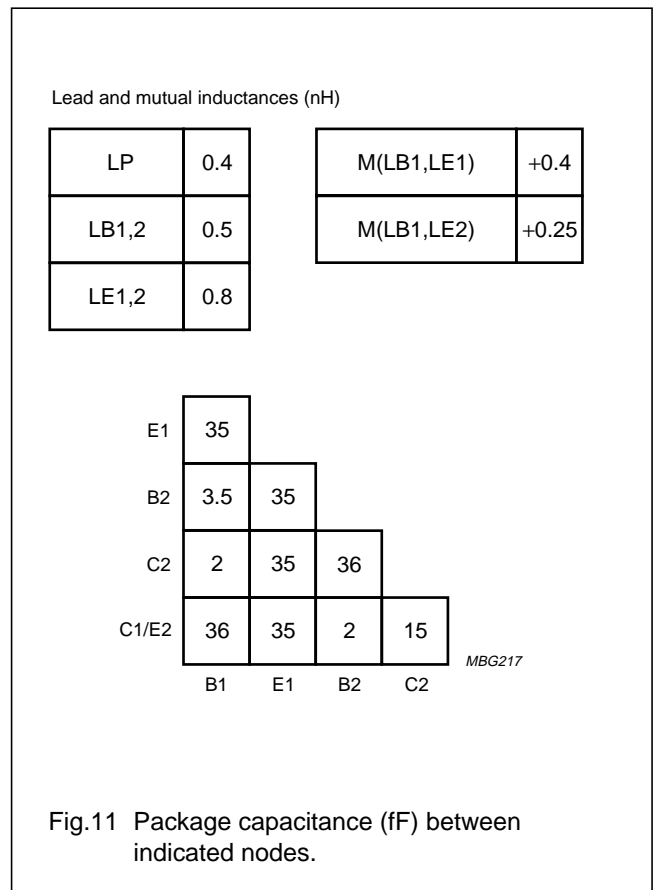


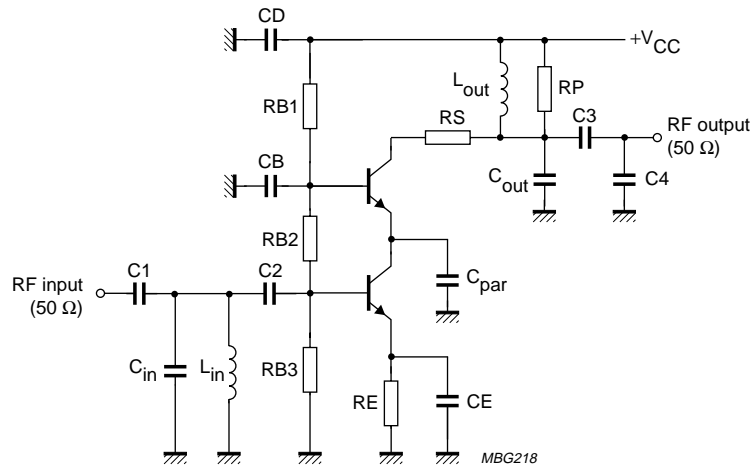
Fig.11 Package capacitance (fF) between indicated nodes.



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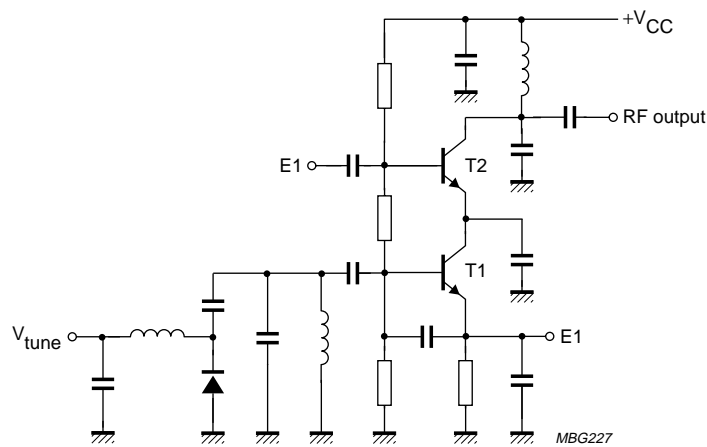
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Typical application circuits



RS increases stability.

Fig.12 Narrowband amplifier.



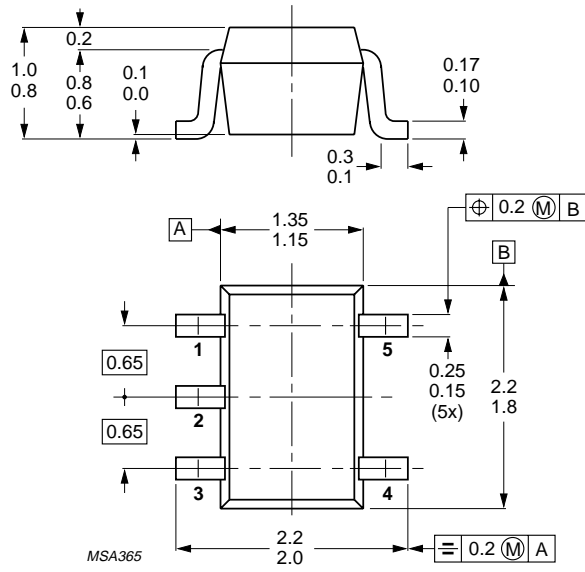
T1 forms a colpitts oscillator.  
T2 acts as a buffer amplifier.

Fig.13 VCO/buffer combination.

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PACKAGE OUTLINE



Dimensions in mm.

Fig.14 SOT353.

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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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