DATA SHEET

BFC505
NPN wideband cascode transistor

Product specification
Supersedes data of 1995 Sep 01
File under Discrete Semiconductors, SC14

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Philips
Semiconductors

PHILIPS

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 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

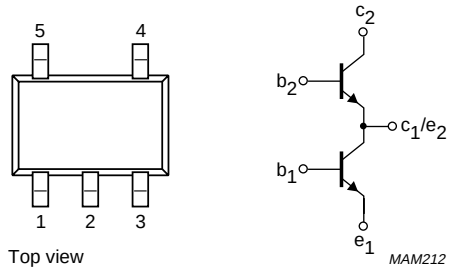


Fig.1 Simplified outline and symbol.

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 MHz	–	–	10	fF
$\lvert s_{21}/s_{12}\rvert^2$	maximum isolation	I_C = 5 mA; V_{C2} = V_{B2} = 3 V; f = 900 MHz	60	–	–	dB
MSG	maximum stable power gain	I_C = 0.5 mA; V_{C2} = V_{B2} = 1 V; f = 900 MHz; T_{amb} = 25 °C	–	22	–	dB
F	noise figure	I_C = 0.5 mA; V_{C2-E1} = 1 V; f = 500 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.1	1.4	dB
		I_C = 1 mA; V_{C2-E1} = 3 V; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.8	2.1	dB
$R_{th\ j\text{-}s}$	thermal resistance from junction to soldering point	single loaded	–	–	230	K/W
		double loaded	–	–	115	K/W

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		–	18	mA
P_{tot}	total power dissipation	up to T_s = 118 °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
$R_{th\ j\text{-}s}$	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

1. T_s is the temperature at the soldering point of the collector pin.

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 = 5 mA; V_{CE} = 6 V	60	120	250	
AC characteristics of the cascode configuration measured in test circuit (note 1)						
f_T	transition frequency	I_C = 5 mA; $V_{C2\text{-}E1}$ = 3 V; f = 1 GHz	–	7.3	–	GHz
C_c	collector capacitance T2	$I_E = i_e$ = 0; $V_{C2\text{-}B2}$ = 0; f = 1 MHz	–	0.4	–	pF
C_{re2}	feedback capacitance T2	I_C = 0; $V_{C2\text{-}E1}$ = 3 V; f = 1 MHz	–	250		fF
C_{re}	feedback capacitance	I_C = 0; $V_{C2\text{-}E1}$ = 3 V; f = 1 MHz	–	–	10	fF
MSG	maximum stable power gain; note 2	I_C = 0.25 mA; $V_{C2\text{-}E1}$ = 1 V; f = 300 MHz; T_{amb} = 25 °C	–	25	–	dB
		I_C = 0.5 mA; $V_{C2\text{-}E1}$ = 1 V; f = 900 MHz; T_{amb} = 25 °C	–	22	–	dB
		I_C = 5 mA; $V_{C2\text{-}E1}$ = 3 V; f = 2 GHz; T_{amb} = 25 °C	–	23	–	dB
$\lvert s_{21}\rvert^2$	insertion power gain	I_C = 0.5 mA; $V_{C2\text{-}E1}$ = 3 V; f = 300 MHz; T_{amb} = 25 °C	–	21	–	dB
		I_C = 5 mA; $V_{C2\text{-}E1}$ = 3 V; f = 900 MHz; T_{amb} = 25 °C	–	16	–	dB
		I_C = 5 mA; $V_{C2\text{-}E1}$ = 3 V; f = 2 GHz; T_{amb} = 25 °C	–	11	–	dB
$\lvert s_{21}/s_{12}\rvert^2$	maximum isolation; note 3	I_C = 0.5 mA; $V_{C2\text{-}E1}$ = 1 V; f = 900 MHz	40	45	–	dB
		I_C = 5 mA; $V_{C2\text{-}E1}$ = 3 V; f = 900 MHz	60	68	–	dB
		I_C = 5 mA; $V_{C2\text{-}E1}$ = 3 V; f = 2 GHz	40	48	–	dB
F	noise figure	I_C = 0.5 mA; $V_{C2\text{-}E1}$ = 1 V; f = 500 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.1	1.4	dB
		I_C = 1 mA; $V_{C2\text{-}E1}$ = 3 V; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.8	2.1	dB
		I_C = 1 mA; $V_{C2\text{-}E1}$ = 1 V; f = 2 GHz; $\Gamma_S = \Gamma_{opt}$	–	3.5	–	dB
IP_3	third order intercept point (input)	note 4	–	–20	–	dBm

Notes

1. $V_{B2} = V_{C2-E1}/2 + 0.6$ V
2. MSG = $\left|s_{12}/s_{21}\right| \times \left(k - \sqrt{k^2 - 1}\right)$; $k = \dfrac{1 + \left|s_{11} \times s_{22} - s_{12} \times s_{21}\right|^2 - \left(\left|s_{11}\right|^2 - \left|s_{22}\right|^2\right)}{2 \times \left|s_{12} \times s\sqrt{\ }_{21}\right|}$
3. Maximum isolation is defined as the isolation when S_{21} of the amplifier is reduced to unity (buffer application).
4. I_C = 1 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.

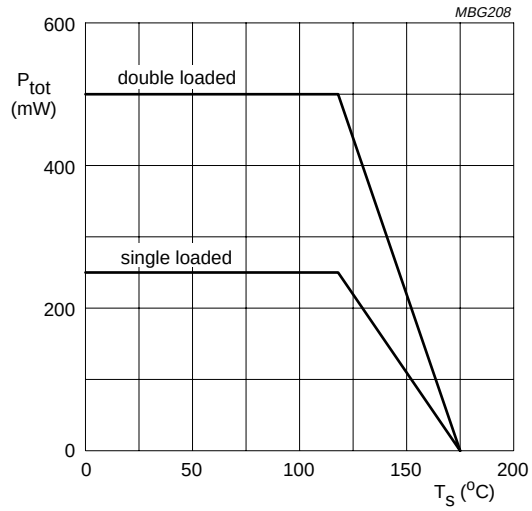
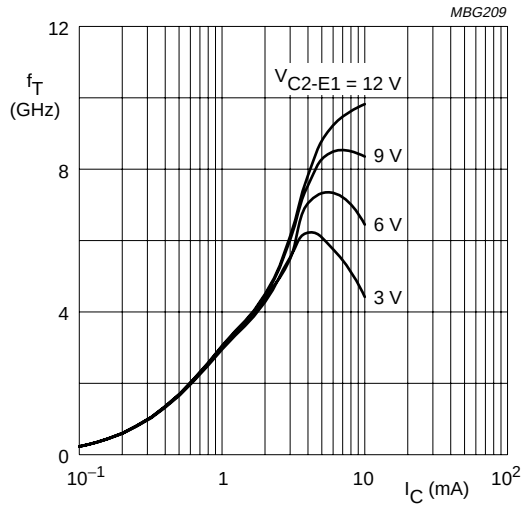
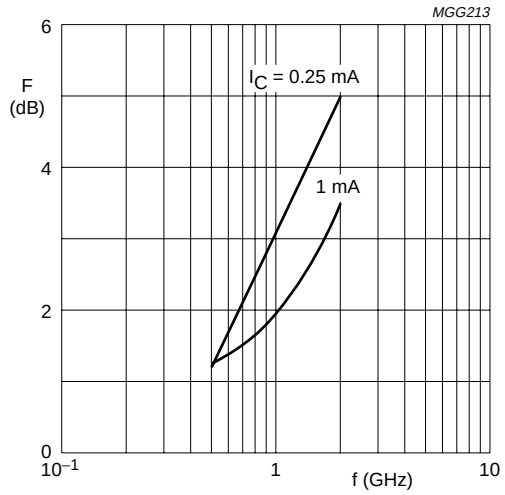


Fig.2 Power derating as a function of soldering point temperature; typical values.



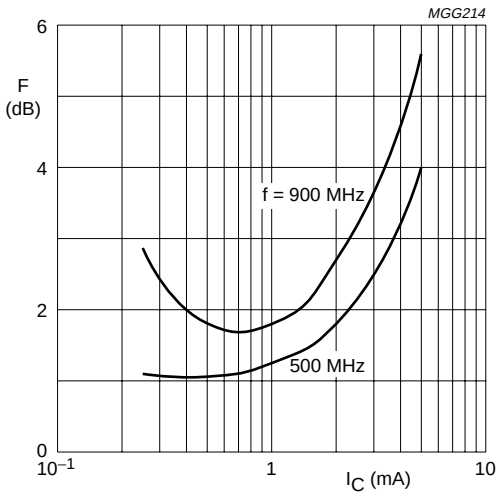
f = 1 GHz; T_{amb} = 25 °C.

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



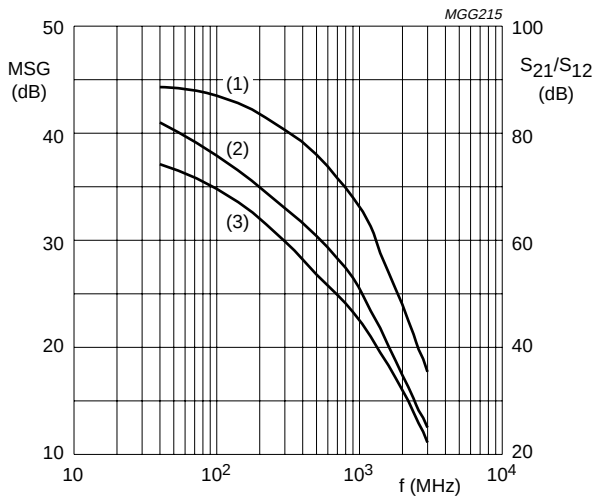
$V_{C2\text{-}E1}$ = 1 V.

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



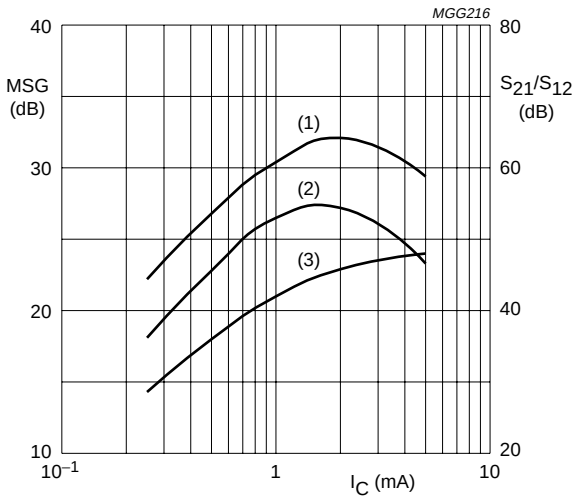
$V_{C2\text{-}E1}$ = 1 V.

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



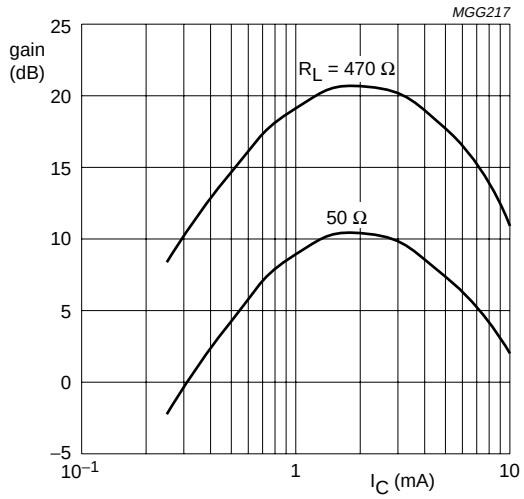
(1) I_C = 5 mA; $V_{C2\text{–}E1}$ = 3 V.
(2) I_C = 1 mA; $V_{C2\text{–}E1}$ = 1 V.
(3) I_C = 0.5 mA; $V_{C2\text{–}E1}$ = 1 V.

Fig.6 Maximum stable gain and isolation as functions of frequency; typical values.



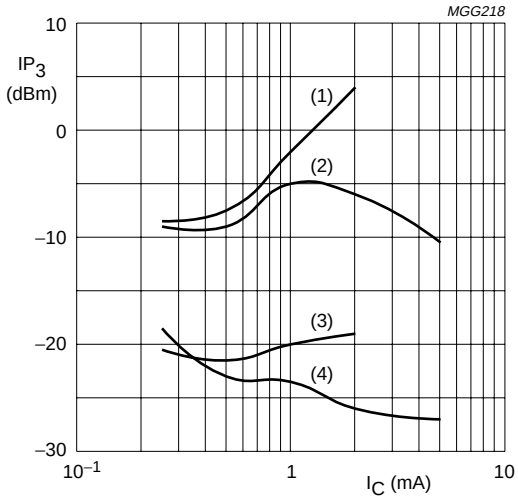
(1) $V_{C2\text{–}E1}$ = 1 V; f = 500 MHz.
(2) $V_{C2\text{–}E1}$ = 1 V; f = 900 MHz.
(3) $V_{C2\text{–}E1}$ = 3 V; f = 2 GHz.

Fig.7 Maximum stable gain and isolation as functions of collector current; typical values.



V_{CE} = 1 V; R_S = 50 Ω; X_S = X_L = opt; f = 900 MHz.

Fig.8 Transducer gain as a function of collector current; typical values.



Point tuned for maximum gain with double slug tuners; f = 900 MHz.
(1) IP_3 (output); $V_{C2\text{-}E1}$ = 3 V. (2) IP_3 (output); $V_{C2\text{-}E1}$ = 1 V.
(3) IP_3 (input); $V_{C2\text{-}E1}$ = 3 V. (4) IP_3 (input); $V_{C2\text{-}E1}$ = 1 V.

Fig.9 Third order intercept point as a function of collector current; typical values.

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(1)	XTB	0.000	–
20(1)	EG	1.110	eV
21(1)	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(1)	CJS	0.000	F
36(1)	VJS	750.0	mV
37(1)	MJS	0.000	–
38	FC	0.897	–

Note

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

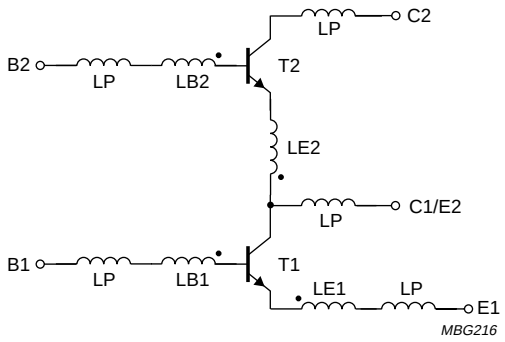


Fig.10 Package equivalent circuit SOT353A (inductance only).

Lead and mutual inductances (nH)

LP	0.4
LB1,2	0.5
LE1,2	0.8

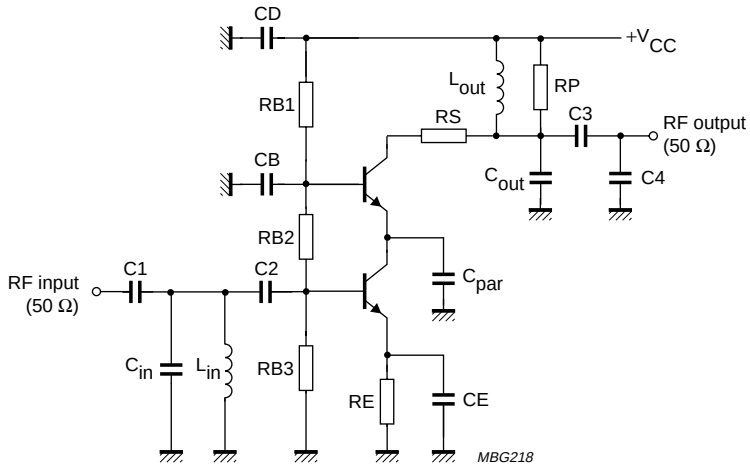
M(LB1,LE1)	+0.4
M(LB1,LE2)	+0.25

	B1	E1	B2	C2
E1	35			
B2	3.5	35		
C2	2	35	36	
C1/E2	36	35	2	15

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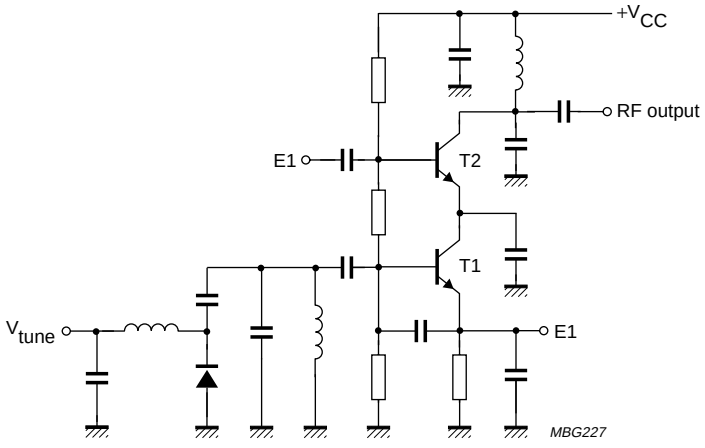
Fig.11 Package capacitance (fF) between indicated nodes.

Typical application circuits



RS increases stability.

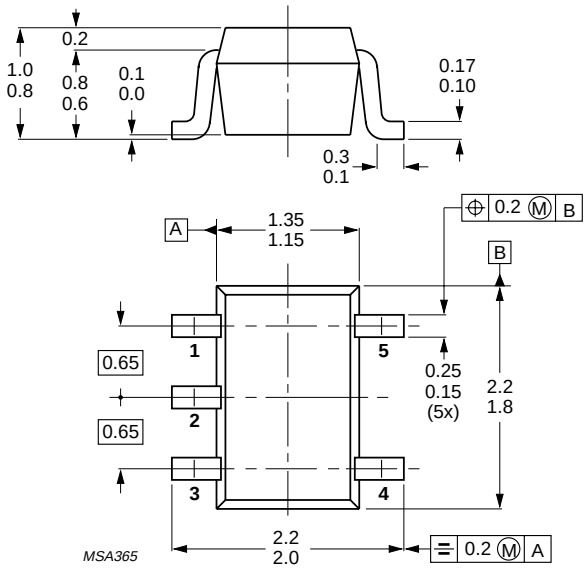
Fig.12 Narrowband amplifier.



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

Fig.13 VCO/buffer combination.

PACKAGE OUTLINE



Dimensions in mm.

Fig.14 SOT353.

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.	

LIFE SUPPORT APPLICATIONS

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