DATA SHEET

BFC520
NPN wideband cascode transistor

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

1997 Sep 10

Philips
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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 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

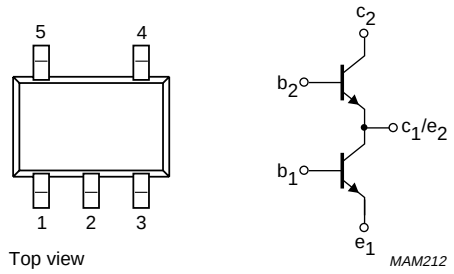


Fig.1 Simplified outline and symbol.

QUICK REFERENCE DATA

V_{C2-E1} = 3 V; I_C = 20 mA; V_{B2} = 2.1 V; 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}		–	–	10	fF
$\lvert s_{21}/s_{12}\rvert^2$	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

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
$R_{th\ j\text{-}s}$	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 = 20 mA; V_{CE} = 6 V	60	120	250	
AC characteristics of the cascode configuration						
f_T	transition frequency	I_C = 20 mA; $V_{C2\text{-}E1}$ = 3 V; f = 1 GHz	–	7	–	GHz
C_c	collector capacitance T2	$I_E = i_e$ = 0; $V_{C2\text{-}B2}$ = 1 V; f = 1 MHz	–	0.55	–	pF
C_{re2}	feedback capacitance T2	I_C = 0; $V_{C2\text{-}E1}$ = 3 V; f = 1 MHz	–	500	–	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 1	I_C = 20 mA; $V_{C2\text{-}E1}$ = 3 V; f = 900 MHz; T_{amb} = 25 °C	–	31	–	dB
		I_C = 20 mA; $V_{C2\text{-}E1}$ = 3 V; f = 2 GHz; T_{amb} = 25 °C	–	19	–	dB
$\lvert s_{21}\rvert^2$	insertion power gain	I_C = 20 mA; $V_{C2\text{-}E1}$ = 3 V; f = 900 MHz; T_{amb} = 25 °C	–	17	–	dB
		I_C = 20 mA; $V_{C2\text{-}E1}$ = 3 V; f = 2 GHz; T_{amb} = 25 °C	–	13	–	dB
$\lvert s_{21}/s_{12}\rvert^2$	maximum isolation; note 2	f = 900 MHz	–	63	–	dB
		f = 2 GHz	–	38	–	dB
F	noise figure	I_C = 5 mA; $V_{C2\text{-}E1}$ = 3 V; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.3	1.6	dB
IP_3	third order intercept point (input)	note 3	–	–18	–	dBm

Notes

1. MSG = $\lvert s_{12}/s_{21}\rvert \times \left(k - \sqrt{k^2 - 1}\right)$ $\quad k = \dfrac{1 + \lvert s_{11} \times s_{22} - s_{12} \times s_{21}\rvert^2 - \left(\lvert s_{11}\rvert^2 - \lvert s_{22}\rvert^2\right)}{2 \times \lvert s_{12} \times s_{21}\rvert}$
2. Maximum isolation is defined as the isolation when S_{21} 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.

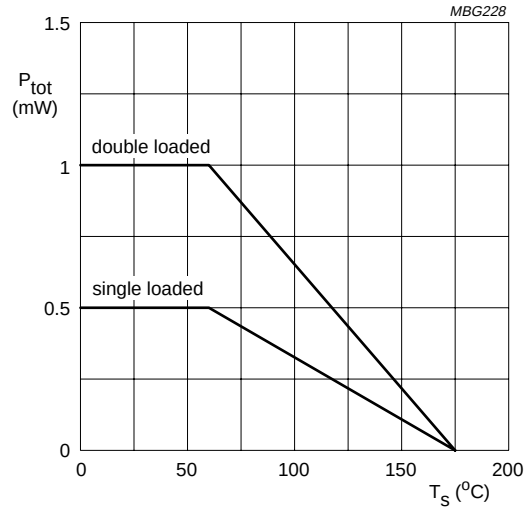
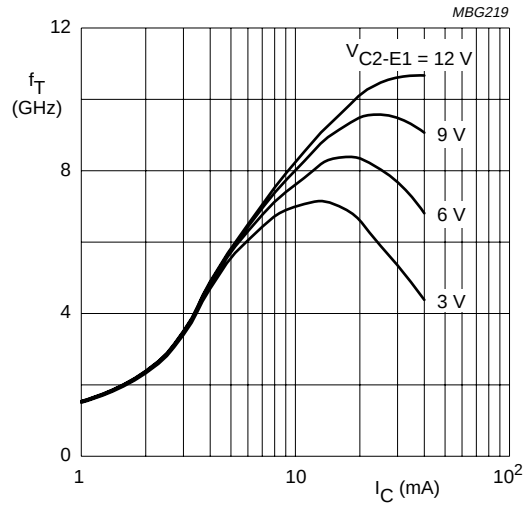
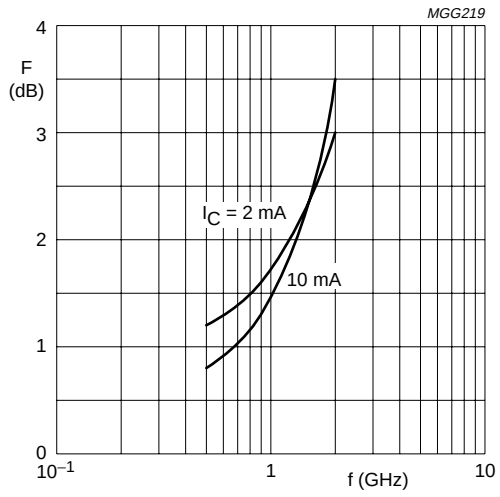


Fig.2 Power derating as a function of soldering point temperature; typical values.



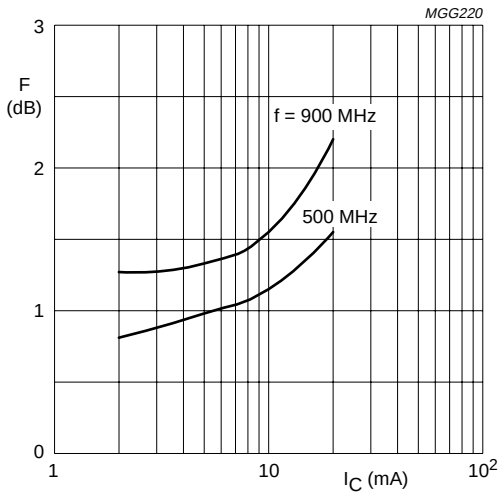
f = 1 GHz; T_{amb} = 25 °C.

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



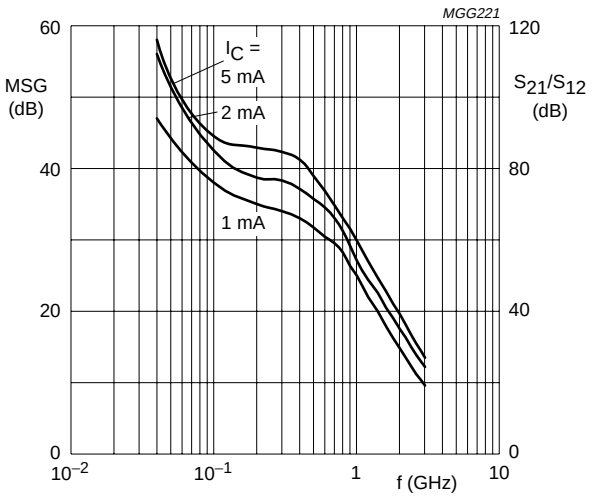
V_{C2-E1} = 3 V.

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



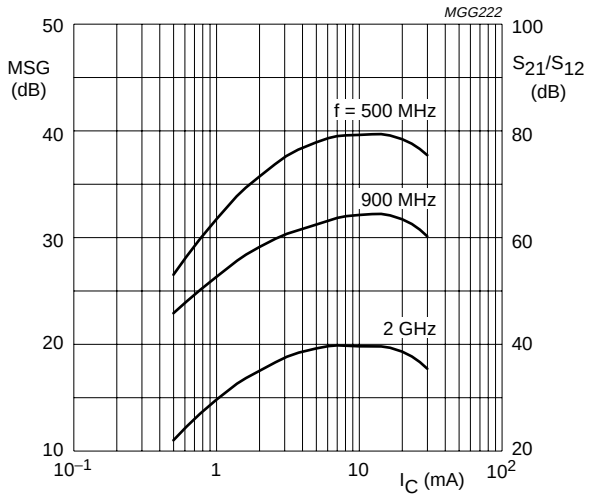
V_{C2-E1} = 3 V.

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



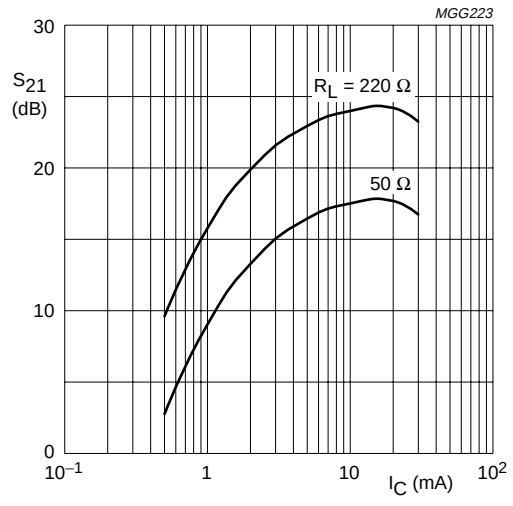
$V_{C2\text{-}E1}$ = 3 V.

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



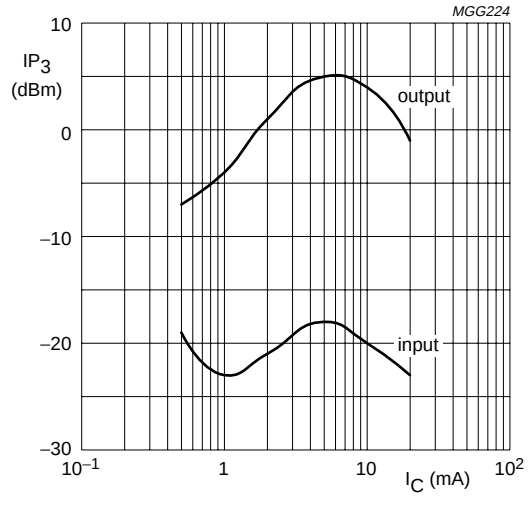
$V_{C2\text{-}E1}$ = 3 V.

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



$V_{C2\text{-}E1}$ = 3 V; R_S = 50 Ω; X_S = X_L = opt; f = 900 MHz.

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



Point tuned for maximum gain with double slug tuners.
$V_{C2\text{-}E1}$ = 3 V; f = 900 MHz.

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

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.

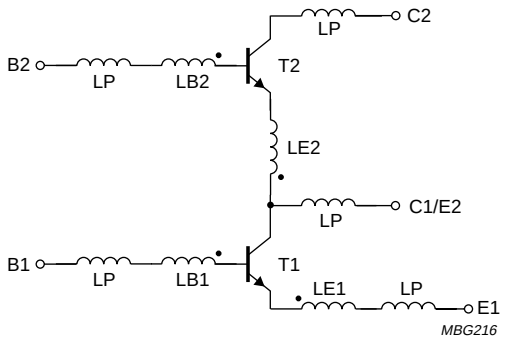


Fig.10 Package equivalent circuit SOT353A (inductance only).

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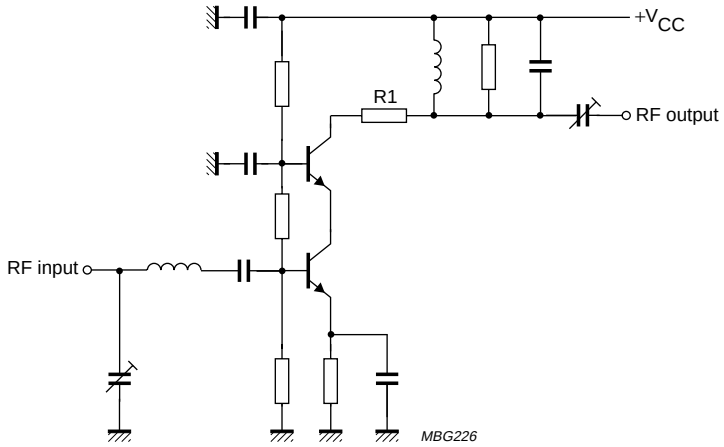
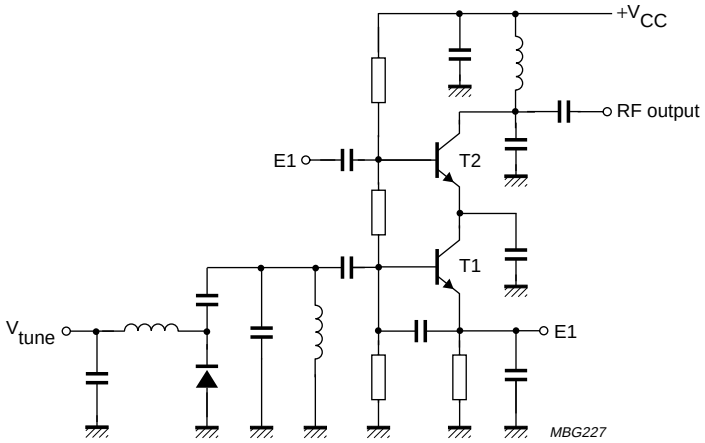
Fig.11 Package capacitance (fF) between indicated nodes.

Typical application circuits



R1 increases stability (10 to 47 Ω).

Fig.12 Narrowband amplifier.

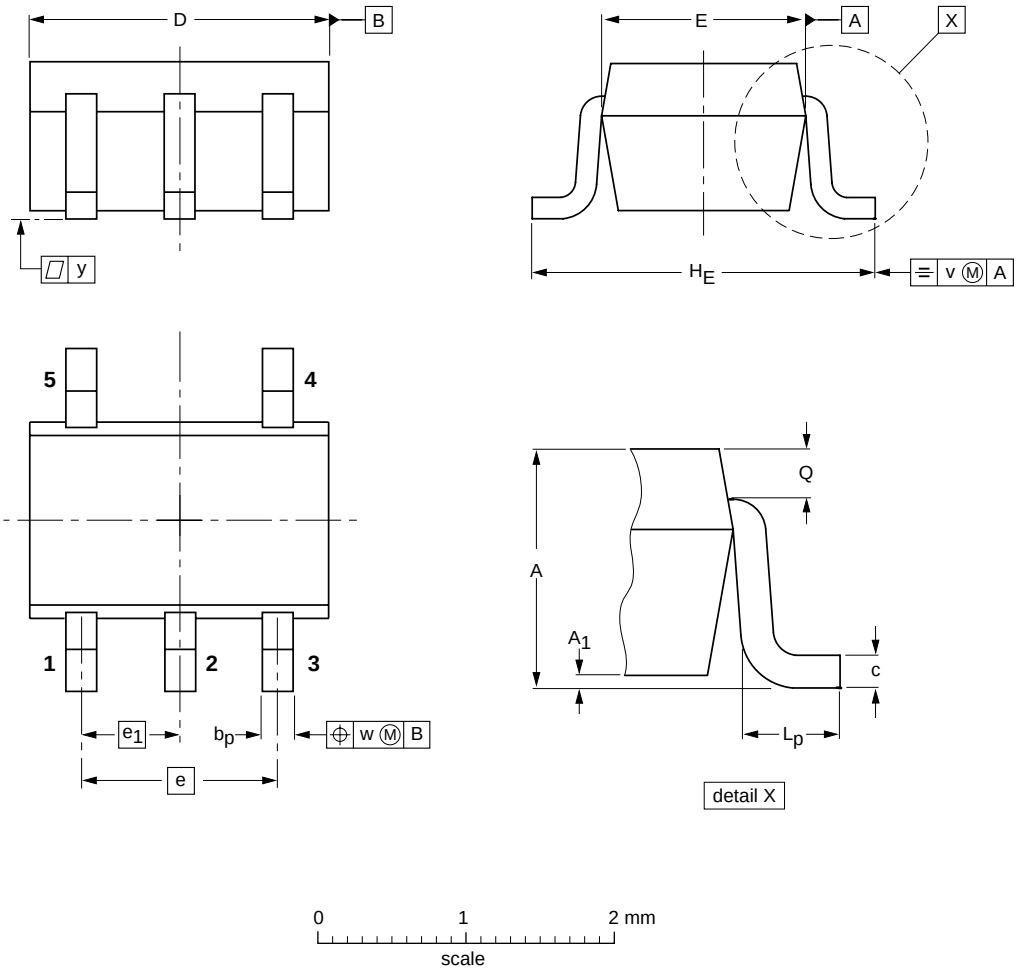


T1 forms a colpitts oscillator.
T2 acts as a buffer amplifier.

Fig.13 VCO/buffer combination.

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

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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Printed in The Netherlands 127127/00/03/pp12 Date of release: 1997 Sep 10 Document order number: 9397 750 02888

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