DATA SHEET

BFE505
NPN wideband differential transistor

Product specification
Supersedes data of 1995 Sep 04
File under Discrete Semiconductors, SC14

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Philips
Semiconductors

PHILIPS

NPN wideband differential transistor BFE505

FEATURES

- Small size
- High power gain at low bias current and voltage
- Temperature matched
- Balanced configuration
- h_{FE} matched
- Continues to operate at V_{CE} < 1 V.

APPLICATIONS

- Single balanced mixers
- Balanced amplifiers
- Balanced oscillators.

DESCRIPTION

Emitter coupled dual NPN silicon RF transistor in a surface mount, 5-pin SOT353 (S-mini) package. The transistor is primarily intended for applications in the RF front end as a balanced mixer, a differential amplifier in analog and digital cellular phones, and in cordless phones, pagers and satellite TV-tuners.

PINNING - SOT353B

SYMBOL	PIN	DESCRIPTION
b_1	1	base 1
e	2	emitter
b_2	3	base 2
c_2	4	collector 2
c_1	5	collector 1

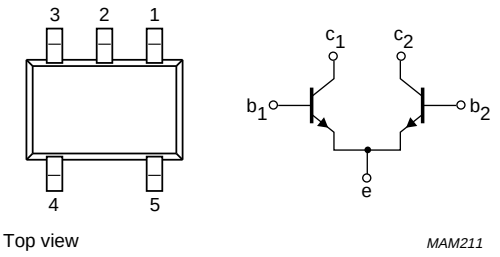

Fig.1 Simplified outline and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Any single transistor						
C_{re}	feedback capacitance C_{BC}	I_e = 0; V_{CB} = 3 V; f = 1 MHz	–	0.25	0.3	pF
MSG/G_{max}	maximum power gain	I_C = 5 mA; V_{CE} = 3 V; f = 900 MHz	–	17	–	dB
		I_C = 5 mA; V_{CE} = 3 V; f = 2 GHz	–	10	–	dB
F	noise figure	I_C = 2 mA; V_{CE} = 3 V; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.2	1.7	dB
		I_C = 3 mA; V_{CE} = 3 V; f = 2 GHz; $\Gamma_S = \Gamma_{opt}$	–	1.9	2.1	dB
h_{FE}	DC current gain	I_C = 5 mA; V_{CE} = 3 V	60	120	250	
$R_{th\ j\text{-}s}$	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	operating 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	
DC characteristics of the dual transistor						
Δh_{FE}	ratio of highest and lowest DC current gain	I_{C1} = I_{C2} = 5 mA; V_{CE1} = V_{CE2} = 6 V	1	1.2	–	
ΔV_{BEO}	difference between highest and lowest base-emitter voltage (offset voltage)	I_{E1} = I_{E2} = 10 mA; T_{amb} = 25 °C	0	1	–	mV
AC characteristics of any single transistor						
f_T	transition frequency	I_C = 5 mA; V_{CE} = 3 V; f = 1 GHz	–	9	–	GHz
C_c	collector capacitance	I_E = i_e = 0; V_{CB} = 3 V; f = 1 MHz	–	0.3	–	pF
C_{re}	feedback capacitance	I_C = 0; V_{CB} = 3 V; f = 1 MHz	–	0.25	–	pF
MSG/G_{max}	maximum power gain; note 1	I_C = 5 mA; V_{CE} = 3 V; f = 900 MHz; T_{amb} = 25 °C	–	17	–	dB
		I_C = 5 mA; V_{CE} = 3 V; f = 2 GHz; T_{amb} = 25 °C	–	10	–	dB
$\lvert s_{21}\rvert^2$	insertion power gain	I_C = 5 mA; V_{CE} = 3 V; f = 900 MHz; T_{amb} = 25 °C	–	13	–	dB
F	noise figure	I_C = 2 mA; V_{CE} = 3 V; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$	–	1.2	1.7	dB
		I_C = 3 mA; V_{CE} = 3 V; f = 2 GHz; $\Gamma_S = \Gamma_{opt}$	–	1.9	2.1	dB

Note

1. Maximum gain of the differential amplifier is higher because of internal emitter connection (see Fig.2).

APPLICATION INFORMATION

SPICE parameters for any single BFE505 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.

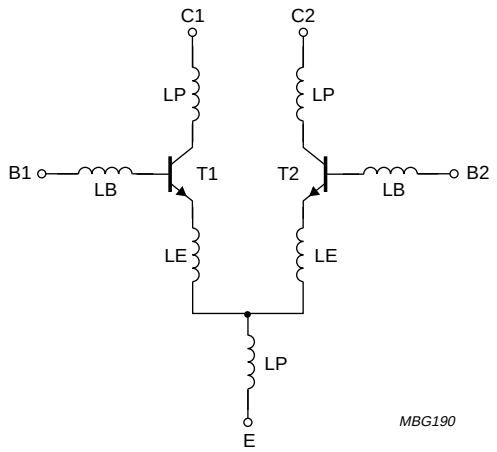

Fig.2 Package equivalent circuit SOT353B (inductance only).

Lead inductances (nH)

LP	0.4
LB	0.8
LE	0.6

	B1	E	B2	C2
E	35			
B2	3.5	35		
C2	2	35	36	
C1	36	35	2	15

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Fig.3 Package capacitance (fF) between indicated nodes.

Typical application circuit

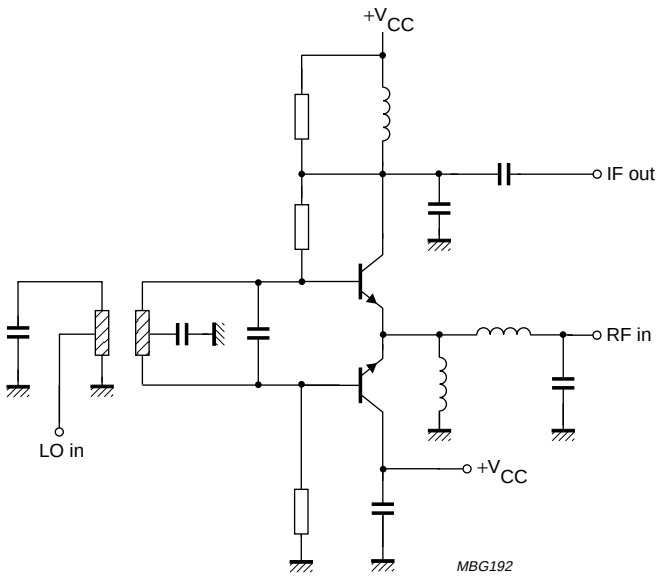
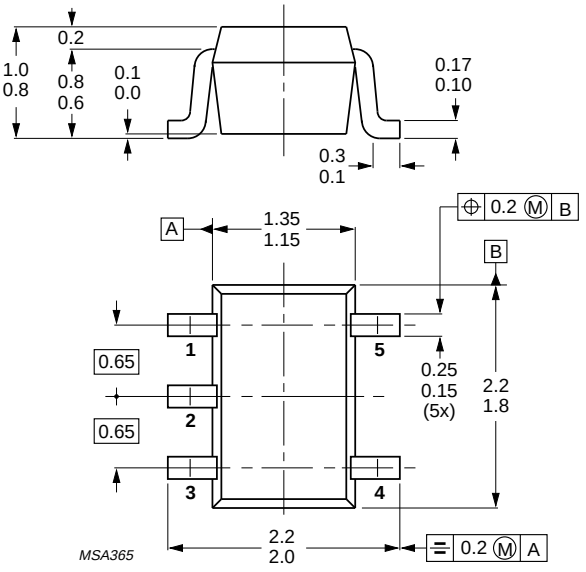


Fig.4 Single balanced switching mixer amplifier, featuring high LO↔RF isolation and linearity.

PACKAGE OUTLINE



Dimensions in mm.

Fig.5 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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