APPLICATION INFORMATION

Demoboard for the BGA2001 (900 and 1800 MHz)

Application Note

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Application Note

SUMMARY

- **Description of products**
  BGA2001: RF transistor with internal bias circuit. Benefit is lower component count, internal compensation for temperature and current gain spread.
- **Application Area**
  Low noise amplifiers for systems like GSM, DECT, DCS with low component count.
- **Presented Applications**
  The applications present low noise amplifiers at 900 and 1800 MHz at 3 V supply voltage and 4.4 mA supply current with matching components.
- **Main results**
  An amplifier has been designed and tested with 16.6 dB gain, IIP3 = –7.4 dBm, $VSWR_{in}$ = 2.0, $VSWR_{out}$ = 2.1, 1.65 dB Noise Figure at 900 MHz, 3 V and 4.4 mA supply.
  An amplifier has been designed and tested with 13 dB gain, IIP3 = – 4.5 dBm, $VSWR_{in}$ = 1.3, $VSWR_{out}$ = 1.2, 1.6 dB Noise Figure at 1800 MHz, 3 V and 4.4 mA supply.

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THE BGA2001 MONOLITHIC MICROWAVE INTEGRATED CIRCUIT

For understanding of the behaviour of the Monolithic Microwave Integrated Circuit (MMIC), the internal circuit diagram is given in Fig.1.

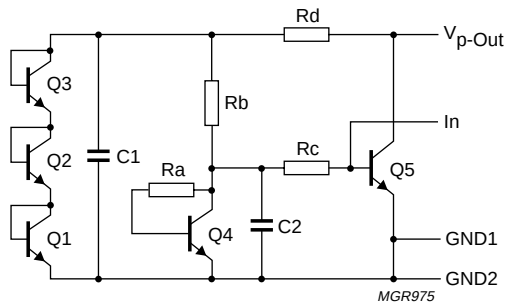

Fig.1 Internal circuit diagram.

Q5 is the main RF transistor. Q4 forms a current mirror with Q5. The input current of this current mirror is determined by the voltage on node $V_{p\text{-}Out}$ and resistors Ra, Rb and Rd. The voltage derived of $V_{p\text{-}Out}$ is stabilised by three stacked diodes made with transistors Q1, Q2 and Q3. R3 and C2 decouple the bias circuit from the RF input signal and C1 decouples the bias circuit from the RF output signal. On the Printed Circuit Board (PCB) an additional emitter inductance of about 0.8 nH was added, which is beneficial for achieving good noise match, for stability and easier impedance match. This inductance was made with a stripline (length 1 mm and width 0.5 mm).

Remarks

The input match on the 900 MHz application is not very good and can be improved by a larger emitter inductance, which reduces gain and increases the risk of instability. According to simulation the input and output match can be improved without these disadvantages by using an extra inductance in series with the input capacitor in the order of magnitude of 12 nH. This inductance can be also made by a stripline on the PCB, which is preventing the use of an extra relatively expensive component.

The PCB used for these application examples was designed for the BGA2003, which is the reason for the unused component position on the board. With the BGA2003 this is a control input, and with the BGA2001 this is the GND2 pin. This pin is not connected, only GND1 is connected to the circuit ground via a stripline.

The components used are equal as used in report *“RNR-T45-98-0260”*. The difference in the used MMIC BGA2001 is made with the final diffusion process. Comparing this report with the new results on both 900 and 1800 MHz show a minor degradation in input and output match, but improvement in gain and noise performance.

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APPLICATION 900 MHz WITH MINIMUM COMPONENTS

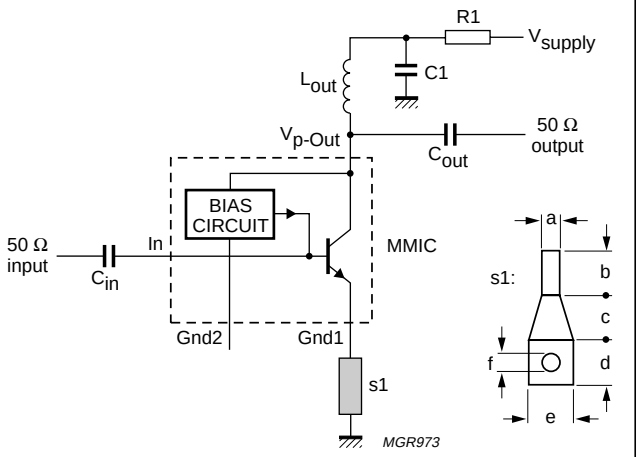

Fig.2 Schematic of the BGA2001 demoboard.

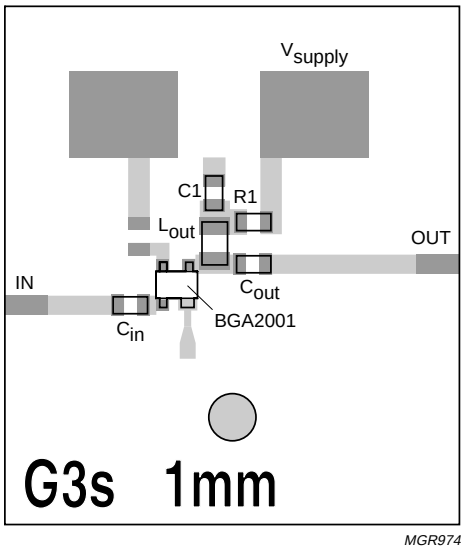

Fig.3 Amplifier Print Layout.

Table 1 Used components for the BGA2001, 900 MHz version of the demoboard

COMPONENT	VALUE	UNIT	SIZE - MANUFACTURER	PURPOSE, COMMENT
R1	120	Ω	0603 Philips	DC-bias
C1	47	pF	0603 Philips	RF-short to ground
C_{in}	470	pF	0603 Philips	DC-decoupling
L_{out}	15	nH	0603 TDK MLG1608	output match
C_{out}	1.8	pF	0603 Philips	output match
s1	–	–	PCB-stripline 50 Ω, via	a = 0.5 mm, b = c = d = e = 1 mm and f = 0.4 mm
MMIC	BGA2001	–	Philips SOT343R2	marking A1
PCB	–	–	FR4	ε_R ~ 4.6, H = 0.5 mm

Table 2 Measured values

V_{supply} = 3.0 V, I_{supply} = 4.38 mA.

S-PARAMETER	800 MHz	900 MHz	1000 MHz	UNIT
S_{11}	–6.123	–9.314	–11.109	dB
S_{21}	17.774	16.601	15.269	dB
S_{12}	–25.817	–25.432	–25.251	dB
S_{22}	–15.079	–8.879	–6.319	dB
NF	1.65	1.60	1.70	dB
IIP3; note 1	–	–7.4	–	dBm

Note

1. IIP3 measured at –28 dBm input level, Δf = 200 kHz.

APPLICATION 1.8 GHz WITH MINIMUM COMPONENTS

Table 3 Used components for the BGA2001, 1800 MHz version of the demoboard

COMPONENT	VALUE	UNIT	SIZE - MANUFACTURER	PURPOSE, COMMENT
R1	120	Ω	0603 Philips	DC-bias
C1	6.8	pF	0603 Philips	RF-short to ground
C_{in}	18	pF	0603 Philips	input match, DC-decoupling
L_{out}	5.6	nH	0603 TDK MLG1608	output match
C_{out}	1.2	pF	0603 Philips	output match
s1	–	–	PCB-stripline 50 Ω, via	a = 0.5 mm, b = c = d = e = 1 mm and f = 0.4 mm
MMIC	BGA2001	–	Philips SOT343R2	marking A1
PCB	–	–	FR4	ε_R ~ 4.6, H = 0.5 mm

Table 4 Measured values

V_{supply} = 3.0 V; I_{supply} = 4.45 mA.

S-PARAMETER	1.7 GHz	1.8 GHz	1.9 GHz	UNIT
S_{11}	–9.675	–11.974	–13.7	dB
S_{21}	12.066	11.244	10.9	dB
S_{12}	–18.735	–18.453	–17.8	dB
S_{22}	–15.805	–10.424	–9.3	dB
NF	1.47	1.48	1.62	dB
IIP3; note 1	–	–4.5	–	dBm

Note

1. IIP3 measured at –25 dBm input level, Δf = 200 kHz.

NOTES

NOTES

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