APPLICATION INFORMATION

2 GHz buffer amplifier with the BFG410W

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ABSTRACT

- Description of the product

  The BFG410W, one of the Philips double polysilicon wideband transistors of the BFG400 series.
- Application area

  Low voltage high frequency wireless applications.
- Presented application

  A buffer amplifier for 2 GHz.
- Main results

  At a frequency of 2 GHz, the amplifier has a reverse insertion power attenuation of approximately 31 dB, an insertion power gain of approximately 11 dB and a noise figure of approximately 2.5 dB.

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INTRODUCTION

With the Philips double polysilicon wideband transistor BFG410W, it is possible to design buffer amplifiers for high frequency applications with a low current and a low supply voltage. These amplifiers are well suited for the new generation low voltage high frequency wireless applications. In this application note an example of a buffer amplifier with the BFG410W for a frequency of 2 GHz is given.

CIRCUIT DESCRIPTION

The following initial conditions apply for the amplifier design:

- $V_{supply} \approx 3$ V
- $V_{CE} = 2$ V
- $I_C \approx 5$ mA
- f = 2 GHz.

The circuit is designed to show the following performance:

- $s_{12} = -30$ dB
- $|s_{21}|^2 \approx 10$ dB
- $VSWR_{IN} < 2$
- $VSWR_{OUT} < 2$.

The input and output matching is realised with an RC-combination. Also extra emitter inductance on both emitter leads (micro striplines) is used to improve the matching.

CIRCUIT DIAGRAM

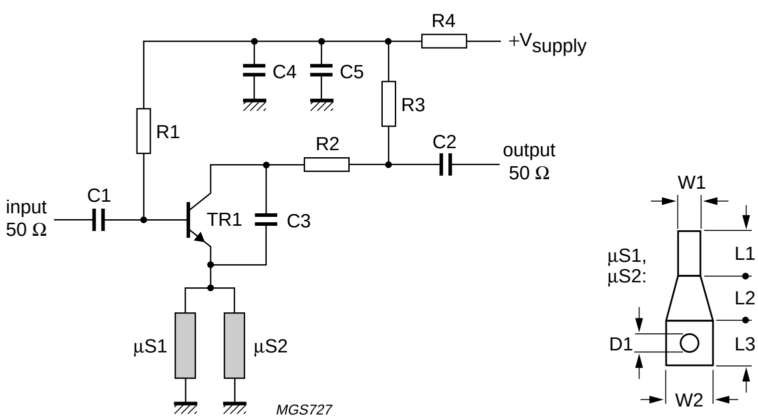

Fig.1 Circuit diagram.

2 GHz buffer amplifier with the BFG410W

COMPONENT LIST

Table 1 Component list for the 2 GHz buffer amplifier

COMPONENT	VALUE	UNIT	SIZE, MANUFACTURER	PURPOSE, COMMENT
TR1	BFG410W		SOT343R	RF transistor
R1	22	kΩ	0603 Philips	bias
R2	10	Ω	0603 Philips	improvement RF stability (K > 1)
R3	100	Ω	0603 Philips	RF block; levelling h_{FE} spread
R4	100	Ω	0603 Philips	RF block; levelling h_{FE} spread
R5	0	Ω	0603 Philips	or short-circuit wire (see note 1)
R6	0	Ω	0603 Philips	or short-circuit wire (see note 1)
C1	100	pF	0603 Philips	input match
C2	100	pF	0603 Philips	output match
C3	0.47	pF	0603 Philips	improvement RF stability (K > 1)
C4	5.6	pF	0603 Philips	2 GHz short
C5	1	nF	0603 Philips	RF short
µS1	see Table 2			emitter induction: micro stripline and via-hole
µS2	see Table 2			emitter induction: micro stripline and via-hole
PCB	FR4			$\varepsilon_r \approx 4.6$, d = 0.5 mm

Note

1. Adaptation of existing printed circuit board.

Table 2 Dimensions of the micro striplines µS1 and µS2 (see Fig.1)

COMPONENT	VALUE	UNIT	DESCRIPTION
L1	1.0	mm	length micro stripline; $Z_o \approx 48\ \Omega$
L2	1.0	mm	length interconnect micro stripline and via-hole area
L3	1.0	mm	length via-hole area
W1	0.5	mm	width micro stripline
W2	1.0	mm	width via-hole area
D1	0.4	mm	diameter of via-hole

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BOARD LAYOUT

The layout has been designed with the Hewlett Packard Microwave Design System (HP-MDS).

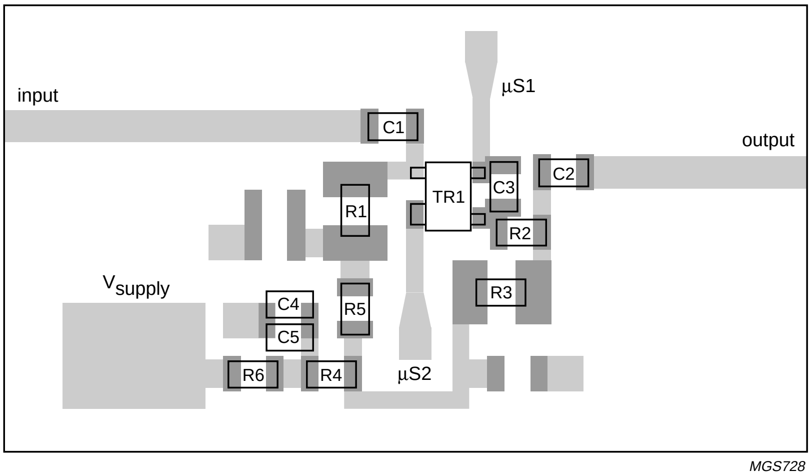

Fig.2 PCB layout.

MEASUREMENTS

Measurements have been done on a simulation model (with realistic RF models of all parts used) as well as on an actual printed circuit board. The measuring results of the simulation model are given in Table 3. The measuring results of the actual printed circuit board are given in Table 4.

The measurements have been done under the following conditions:

- supply voltage 3.0 V
- supply current approximately 5.5 mA
- collector-emitter voltage approximately 2 V
- frequency 2 GHz.

Table 3 Measuring results of the simulation model with HP-MDS

SYMBOL	PARAMETER	CONDITION	VALUE	UNIT
s_{12}	reverse transmission coefficient		–29.5	dB
$\lvert s_{21}\rvert^2$	insertion power gain		11.3	dB
$VSWR_{IN}$	input voltage standing wave ratio		2.6	
$VSWR_{OUT}$	output voltage standing wave ratio		2.2	
NF	noise figure	note 1	2.9	dB
$IP3_o$	third order intercept point	not measured	–	dB

Note

1. There is a difference in the values of the noise figure of the simulation model and the actual printed circuit board. This difference can be explained by the fact that the spice model is not optimized for noise.

Table 4 Measuring results of the actual printed circuit board

SYMBOL	PARAMETER	CONDITION	VALUE	UNIT
s_{12}	reverse transmission coefficient		–31.0	dB
$\lvert s_{21}\rvert^2$	insertion power gain		11.0	dB
$VSWR_{IN}$	input voltage standing wave ratio		2.6	
$VSWR_{OUT}$	output voltage standing wave ratio		2.2	
NF	noise figure	note 1	2.5	dB
$IP3_o$	third order intercept point	not measured	–	dB

Note

1. There is a difference in the values of the noise figure of the simulation model and the actual printed circuit board. This difference can be explained by the fact that the spice model is not optimized for noise.

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