

APPLICATION INFORMATION

2 GHz low noise amplifier with the BFG480W

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ABSTRACT

- Description of the product
The BFG480W, one of the Philips double polysilicon wideband transistors of the BFG400W series.
- Application area
Low voltage high frequency wireless applications.
- Presented application
A low noise amplifier for 2 GHz.
- Main results
At a frequency of 2 GHz, the amplifier has an insertion power gain of approximately 9.5 dB, a noise figure of approximately 2.2 dB, and a third order intercept point of approximately 10 dBm (measured at input).

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INTRODUCTION

With the Philips double polysilicon wideband transistor BFG480W, it is possible to design Low Noise Amplifiers (LNAs) 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. One feature of the BFG480W is that it has a good linearity performance. Therefore the BFG480W is well suited for LNAs with high linearity demands, such as Code Division Multiple Access (CDMA) applications. This application note gives an example of a 2 GHz LNA with the BFG480W.

CIRCUIT DESCRIPTION

The following initial conditions apply for the amplifier design:

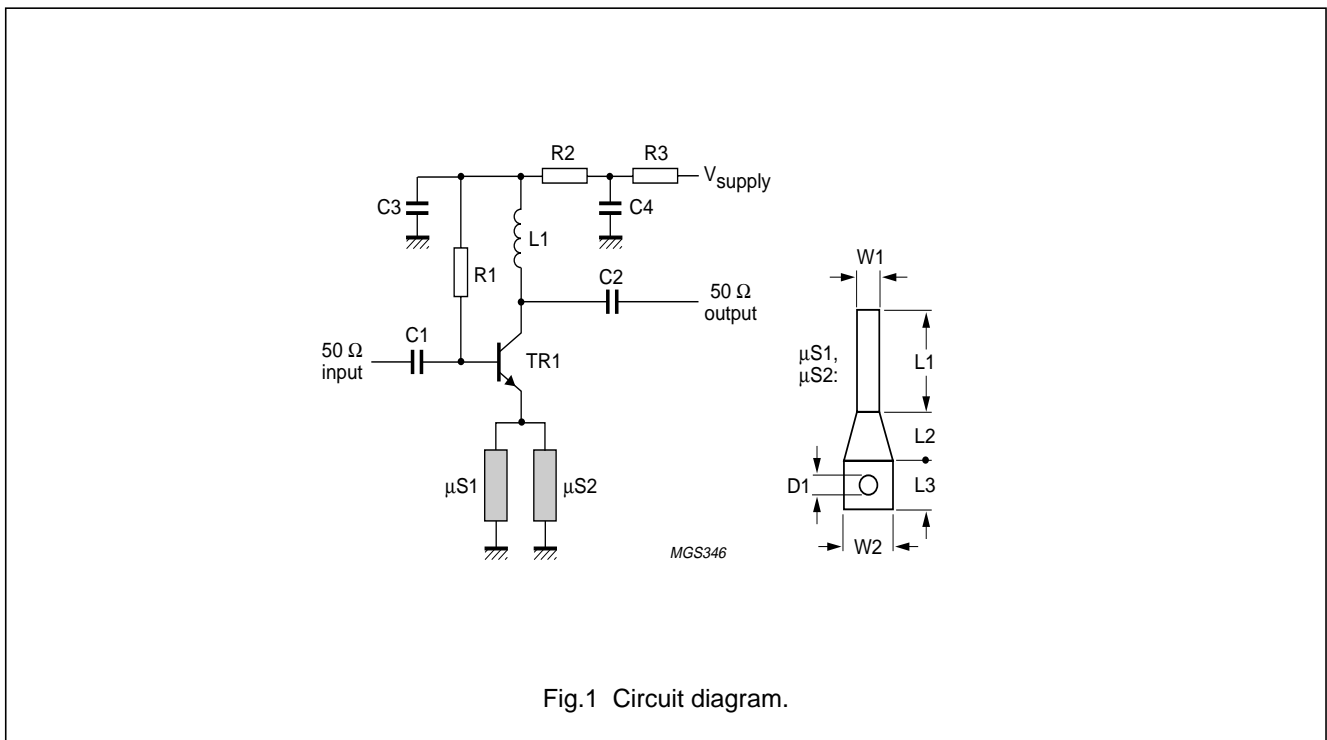
- $V_{\text{supply}} \approx 3.6 \text{ V}$
- $V_{\text{CE}} = 2 \text{ V}$
- $I_{\text{C}} = 21 \text{ mA}$
- $f = 2 \text{ GHz}$.

The circuit is designed to show the following performance:

- $|S_{21}|^2 \approx 9 \text{ dB}$
- $\text{NF} \leq 2.5 \text{ dB}$
- $\text{VSWR}_{\text{IN}} < 2$
- $\text{VSWR}_{\text{OUT}} < 2$
- $\text{IP3}_i > 9 \text{ dBm}$.

The output matching is realised with an LC combination. Also an extra emitter inductance (micro stripline) is used on both emitter-leads to improve the matching and the noise figure.

CIRCUIT DIAGRAM



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COMPONENT LIST

Table 1 Component list for the 2 GHz LNA

COMPONENT	VALUE	UNIT	SIZE, MANUFACTURER	PURPOSE, COMMENT
TR1	BFG480W		SOT343R	RF amplifier
R1	5.6	k Ω	0603; Philips	collector to base bias
R2	22	Ω	0603; Philips	RF blocking
R3	47	Ω	0603; Philips	collector series bias; levelling h_{FE} spread
R4	0	Ω	0603; Philips	(or a short circuit wire)
R5	0	Ω	0603; Philips	(or a short circuit wire)
C1	4.7	pF	0603; Philips	input match (base coupling)
C2	150	pF	0603; Philips	output match (collector coupling)
C3	5.6	pF	0603; Philips	2 GHz short (L1 to ground)
C4	1	nF	0603; Philips	RF collector bias decoupling
L1	18	nH	0805CS; Coilcraft	output match
μ S1	see Table 2			emitter induction: micro stripline and via-hole
μ S2	see Table 2			emitter induction; micro stripline and via-hole
PCB	FR4			$\epsilon_r \approx 4.6$; $d = 0.5$ mm

Table 2 Dimensions of the micro striplines μ S1 and μ S2 (see Fig.1)

DIMENSION	VALUE	UNIT	DESCRIPTION
L1	2.5	mm	length micro stripline; $Z_0 \approx 48 \Omega$
L2	1.0	mm	length interconnect micro stripline and via-hole area
L3	1.0	mm	length via-hole
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).

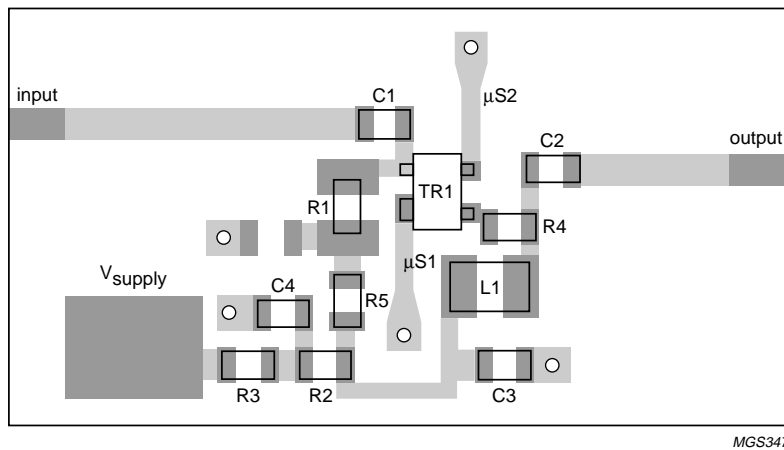


Fig.2 PCB layout.

MEASUREMENTS

The measurements have been done under the following conditions (unless otherwise specified):

- Supply voltage 3.6 V
- Supply current 21 mA
- Frequency 2 GHz.

Table 3 Measuring results of the 2 GHz LNA

SYMBOL	PARAMETER	CONDITION	VALUE	UNITS
$ S_{21} ^2$	insertion power gain		9.7	dB
$VSWR_{IN}$	input voltage standing wave ratio		1.9	
$VSWR_{OUT}$	output voltage standing wave ratio		1.2	
NF	noise figure		2.2	dB
$IP3_i$	third order intercept point	$\Delta f = 200$ kHz	10	dBm

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NOTES

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