Philips Semiconductors B.V.

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2GHz BUFFER-AMPLIFIER WITH THE BFG410W

Abstract:
This application note contains an example of a Buffer-Amplifier with the new BFG410W Double Poly RF-transistor. The buffer is designed for a frequency f=2GHz. Performance at f=2GHz: Isolation S_{12}~-31dB, Gain S_{21} ~11dB and the Noise Figure NF~2.5dB.

Appendix I: Schematic of the circuit

Appendix II: Results of simulations and measurements

Appendix III: Printlayout and list of used components & materials

Introduction:

With the new Philips silicon bipolar double poly BFG400W series, 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 note an example of such an amplifier will be given. This buffer-amplifier is designed for a working frequency of 2GHz.

Designing the circuit:

The circuit is designed to show the following performance (target):

transistor: BFG410W

V_{ce}=2V, I_c~5mA, V_{SUP}~3V
freq=2GHz
Isolation S_{12}~-30dB
Gain: S_{21}~10dB
VSWRi<1:2
VSWRo<1:2

The in- and outputmatching is realised with a RC-combination. Also extra emitter-inductance on both emitter-leads (μ-strips) are used to improve the matching.

Designing the layout:

A lay-out has been designed with HP-MDS. Appendix III contains the printlayout.

Measurements:

Simulations (with realistic RF-models of al used parts) and measurements of the total circuit (epoxy PCB) are done (Appendix II).

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Appendix I: Schematic of the circuit

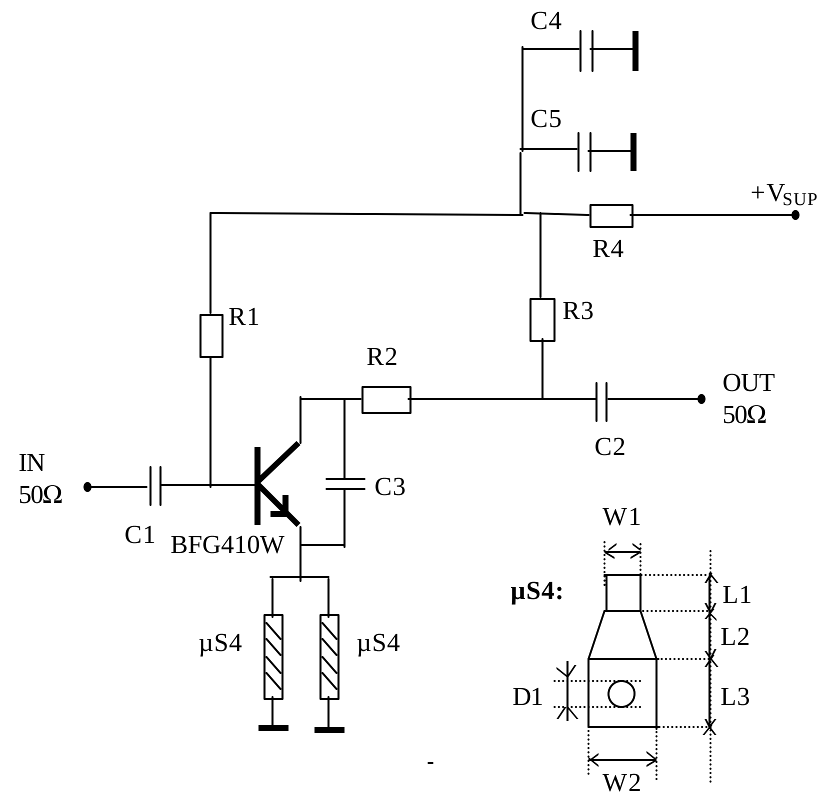

Figure 1: LNA circuit

2 GHz LNA Component list:

Component:	Value:	Comment:
R1	22 kΩ	Bias.
R2	10 Ω	Better RF-stability (K>1).
R3	100 Ω	RF-block/Cancelling H_{FE}-spread.
R4	100 Ω	RF-block/Cancelling H_{FE}-spread.
C1	100 pF	Input match.
C2	100 pF	Output match.
C3	0.47 pF	Better RF-stability (K>1).
C4	5.6 pF	2GHz short.
C5	1 nF	RF-short
µs4	(next table)	Emitter induction: µ-stripline + via

µS4 Emitter induction (µ-stripline + via):

Name	Dimension	Description
L1	1.0mm	length µ-stripline; Z_0~48Ω (PCB: ε_r ~4.6, H=0.5mm)
L2	1.0mm	length interconnect stripline and via-hole area
L3	1.0mm	length via-hole area
W1	0.5mm	width µ-stripline
W2	1.0mm	width via-hole area
D1	0.4mm	diameter of via-hole

Appendix II: Results of simulations and measurements:

BFG410W, V_{SUP}=3.0V, I_{SUP}~5.5mA, V_{CE}~2V:

	Simulation (HP-MDS):	**Measurements PCB:**	**Comment:**
f=2GHz			
$\|S_{12}\|^2$ [dB]	-29.5	-31.0	
$\|S_{21}\|^2$ [dB]	11.3	11.0	
VSWRi	2.6	2.6	
VSWRo	2.2	2.2	
Noise Figure [dB]	2.9 (Spice model)	2.5	note 1.
IP3 [dBm] (output)	-	-	not measured

note 1: There is a difference in Noise Figure between the Spice model simulations and the measured values. The difference in Noise Figure can be explained by the fact that the Spice model is not extracted for Noise.

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Appendix III: Printlayout and list of used components & materials

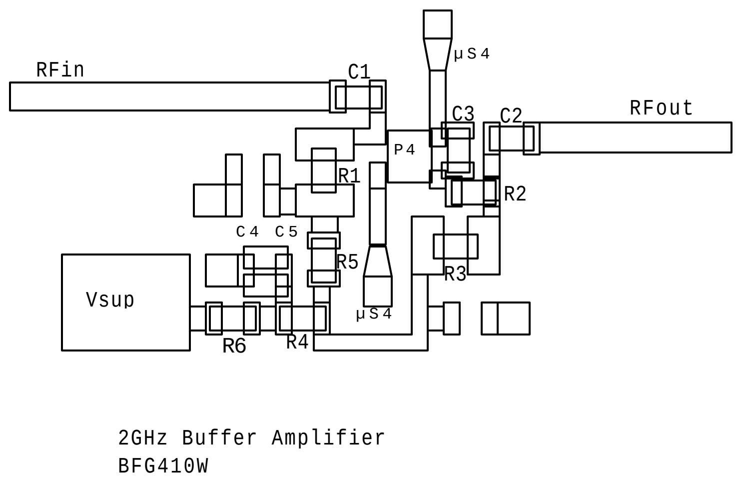

Figure 2: Printlayout

2GHz LNA Component list:

Component:	Value:	size:
R1	22 kΩ	0603 Philips
R2	10 Ω	0603 Philips
R3	100 Ω	0603 Philips
R4	100 Ω	0603 Philips
R5	0 Ω (note 1)	0603 Philips
R6	0 Ω (note 1)	0603 Philips
C1	100 pF	0603 Philips
C2	100 pF	0603 Philips
C3	0.47 pF	0603 Philips
C4	5.6 pF	0603 Philips
C5	1 nF	0603 Philips
PCB	ε_r ~4.6, H=0.5mm	FR4

<u>note 1:</u> The used PCB was designed for Low Noise Amplifier applications. R5 and R6 (shorts) are used to adapt the PCB for this buffer application.

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