

Philips Semiconductors B.V.

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900MHz LOW NOISE AMPLIFIER WITH THE BFG410W

Abstract:

This application note contains an example of a Low Noise Amplifier with the new BFG410W Double Poly RF-transistor. The LNA is designed for a frequency $f=900\text{MHz}$. The Noise Figure $NF\sim 1.4\text{dB}$ at $f=900\text{MHz}$ and the gain $S_{21}\sim 14\text{dB}$.

Appendix I: 900MHz LNA circuit

Appendix II: Printlayout and list of used components & materials

Appendix III: Results of simulations and measurements

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Introduction:

With the new Philips silicon bipolar double poly BFG400W series, it is possible to design low noise 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 a first study of such an amplifier will be given. This amplifier is designed for a working frequency of 900MHz.

Designing the circuit:

The circuit is designed to show the following performance:

transistor: BFG410W

$V_{ce}=2V$, $I_c=2mA$, $V_{SUP}\sim 3.3V$

freq=900MHz

Gain~15dB

NF<=1.3dB

VSWRi<1:2

VSWRo<1:2

In the simulations the effect of extra RF-noise caused by the SMA-connectors was omitted, so in the practical situation the NF is ~0.1dB higher. This LNA is not optimised for the highest IP3. The IP3 can be optimised by:

- I. an extra series RC-decoupling of the base to the ground
- II. increasing I_c

With the solution I. two extra components are necessary, and with solution II, the Noise Figure of the LNA increases and the optimum source impedance also.

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

Designing the layout:

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

Measurements:

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

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Appendix I: Schematic of the circuit

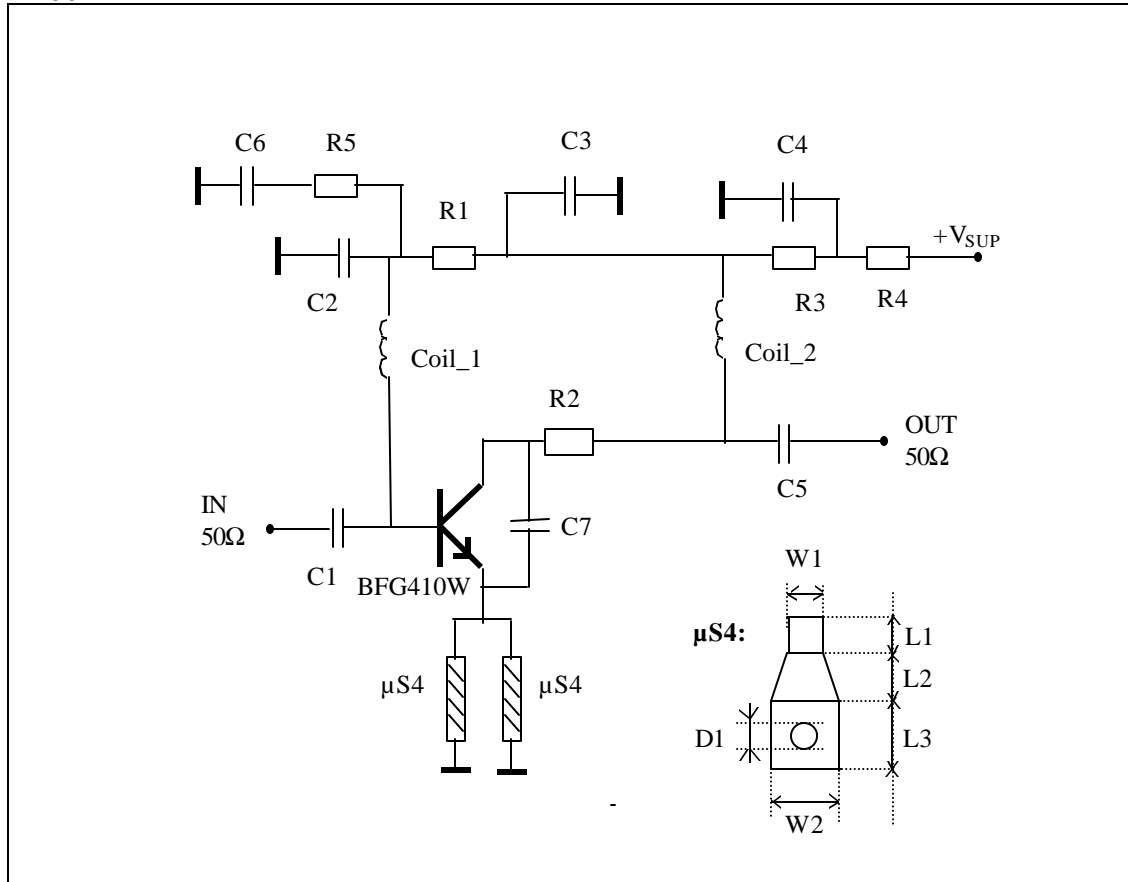


Figure 1: LNA circuit

900MHz LNA Component list:

Component:	Value:	Comment:
R1	47 KΩ	Bias.
R2	120 Ω	Better RF-stability ($K > 1$).
R3	22 Ω	RF-block.
R4	560 Ω	Cancelling H_{FE} -spread.
R5	100 Ω	To improve IP3-performance
C1	2.2 pF	Input match.
C2	27 pF	900MHz short.
C3	27 pF	900MHz short.
C4	1 nF	RF-short
C5	1.5 pF	Output match.
C6	100 nF	To improve IP3-performance
C7	0.47 pF	Better RF-stability ($K > 1$).
Coil_1	12 nH	Input match.
Coil_2	15 nH	Output match.
μs4	(next table)	Emitter induction: μ-stripline + via

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μ S4 Emitter induction (μ -stripline + via):

Name	Dimension	Description
L1	2.0mm	length μ -stripline; $Z_0 \sim 48\Omega$ (PCB: $\epsilon_r \sim 4.6$, $H=0.5\text{mm}$)
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

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Appendix II: Printlayout and list of used components & materials

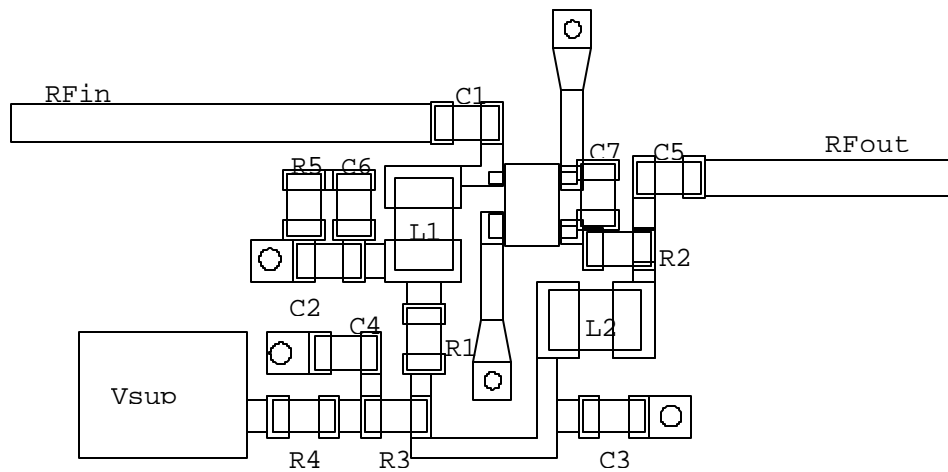


Figure 2: 900MHz LOW NOISE AMP. PRINT LAYOUT

Component list:

Component:	Value:	size:
R1	47 K Ω	0603 Philips
R2	120 Ω	0603 Philips
R3	22 Ω	0603 Philips
R4	560 Ω	0603 Philips
R5	100 Ω	0805 Philips
C1	2.2 pF	0603 Philips
C2	27 pF	0603 Philips
C3	27 pF	0603 Philips
C4	1 nF	0603 Philips
C5	1.5 pF	0603 Philips
C6	100 nF	0805 Philips
C7	0.47 pF	0603 Philips
L1	12 nH	0805CS Coilcraft
L2	15 nH	0805CS Coilcraft
PCB	$\epsilon_r \sim 4.6$, H=0.5mm	FR4

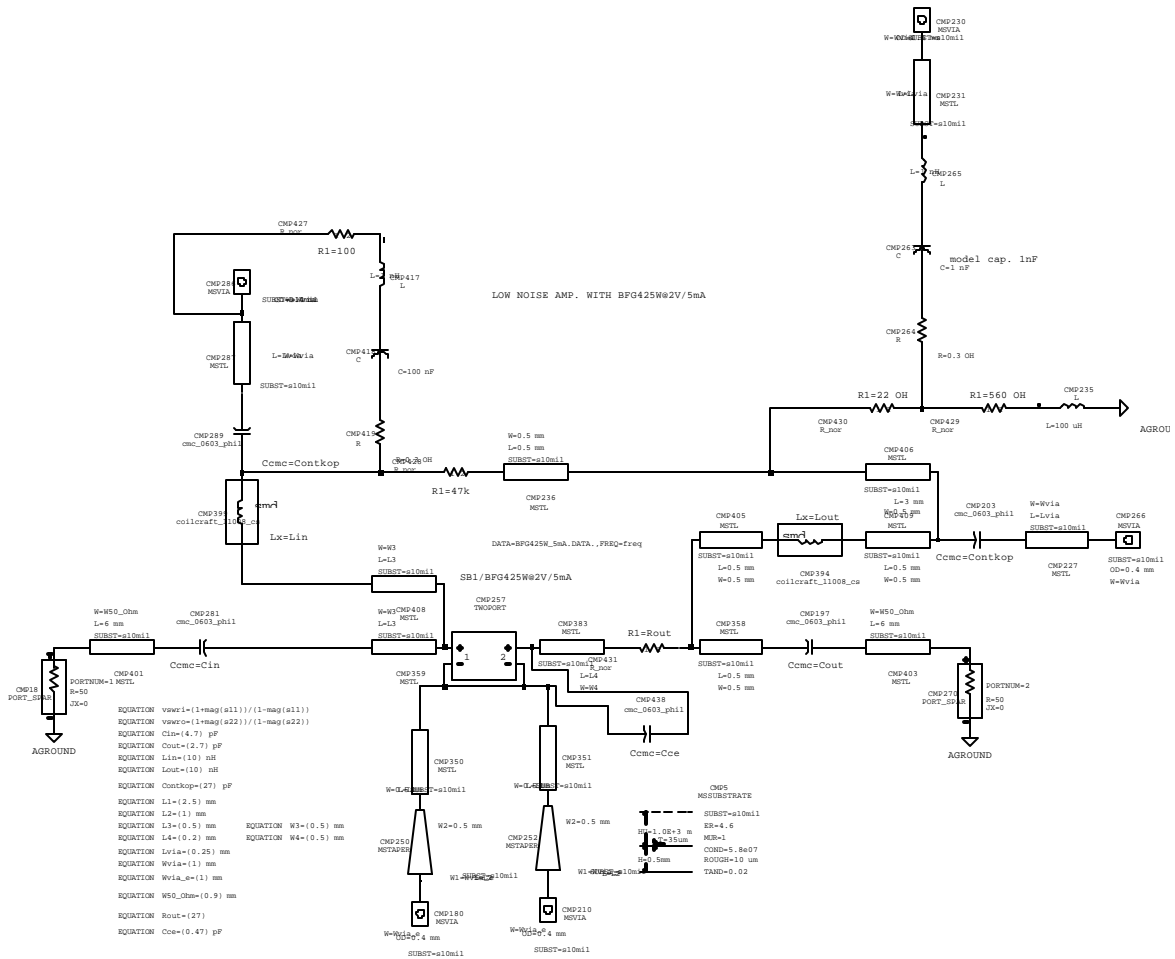
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Appendix III: Results of simulations en measurements

BFG410W, $V_{CE}=2V$, $I_C=2mA$:

	Simulation (HP-MDS):	Measurements PCB:	Comment:
$ S_{21} ^2$ [dB]	14.6	14.0	
VSWR _i	2.0	1.9	
VSWR _o	2.4	2.3	
Noise Figure [dB]	1.3	1.4 ^{*)}	
IP3 [dBm] (input)	-	-9	$\Delta f=100KHz$

^{*)}: The Noise Figure of the PCB is higher than the simulations (~0.1 dB). This is caused by the influence of the SMA-connectors and the microstrips on the epoxy PCB.



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