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1.5GHz LOW NOISE AMPLIFIER WITH THE BFG425W

Abstract:
This application note contains an example of a Low Noise Amplifier with the new BFG425W Double Poly RF-transistor. The LNA is designed for a frequency f=1.5GHz, V_{SUP}~3.8V, I_{SUP}=5mA.
***Measured* performance at f=1.5GHz: Noise Figure NF~1.6dB, rf-Gain S_{21} ~14dB.**

Applications:
- Global Positioning Systems (GPS)
- Satellite Terminals.

Appendix I: 1.5GHz 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 an example of such an amplifier will be given. This amplifier is designed for a working frequency of 1.5GHz.

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

transistor: BFG425W

V_{ce}=3V, I_c=5mA, V_{SUP}~3.7V
freq=1.5GHz
Gain~14dB
NF<=1.6dB
VSWRi<1:2
VSWRo<1:2

The in- and outputmatching 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 al used parts) and measurements of the total circuit (epoxy PCB) are done (Appendix III).

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Appendix I: Schematic of the circuit

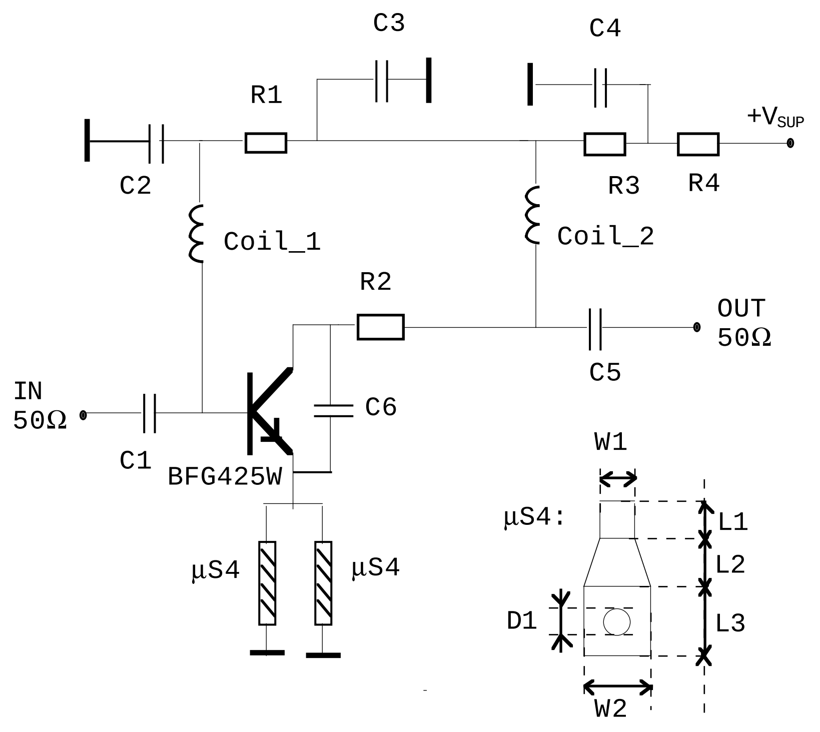

Figure 1: LNA circuit

1.5GHz LNA Component list: 1.5GHz LNA Component list:

Component	Value	Purpose, comment
R1	33 kΩ	Bias (coll.-base)
R2	10 Ω	in series with coll. for better S22, stability and reducing gain.
R3	22 Ω	RF blocking
R4	100 Ω	Bias, series with coll., cancelling hFE spread
C1	3.3 pF	Input match (input to base)
C2	8.2 pF	1.5GHz short (L1 to ground)
C3	8.2 pF	1.5GHz short (L2 to ground)
C4	1 nF	RF decoupling collector bias
C5	82 pF	Output match (collector to output)
C6	1 pF	Output match, stability (collector to emitter)
Coil_1	8.2 nH	Input match (base-bias)
Coil_2	8.2 nH	Output match (collector-bias)
µs4	(see next table)	µ-stripline Emitter-induction

μS4 Emitter inductance of μ-stripline and via-hole (see on former page: Schematic of the circuit):

Name	Dimension	Description
L1	**2.5mm**	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

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Appendix II: Printlayout and list of used components & materials

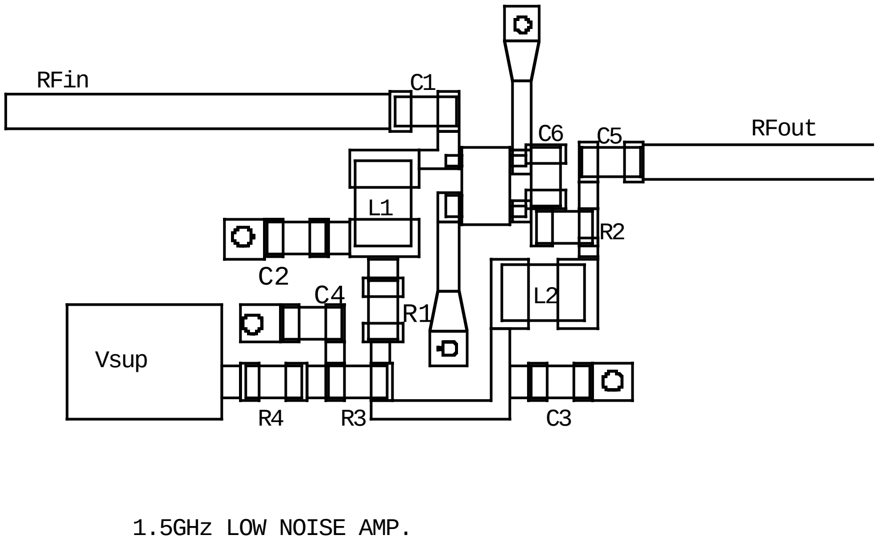

Figure 2: Printlayout

1.5GHz LNA Component list:

Component:	Value:	size:
PCB	FR4: ε_r ~4.6	H=0.5mm
R1	33 kΩ	0603 Philips
R2	10 Ω	0603 Philips
R3	22 Ω	0603 Philips
R4	100 Ω	0603 Philips
C1	3.3 pF	0603 Philips NPO
C2	8.2 pF	0603 Philips NPO
C3	8.2 pF	0603 Philips NPO
C4	1 nF	0805 Philips
C5	82 pF	0603 Philips NPO
C6	1 pF	0603 Philips NPO
L1	8.2 nH	0805CS Coilcraft
L2	8.2 nH	0805CS Coilcraft

Appendix III: Results of simulations and measurements

Conditions: V_{SUP}=3.7V, I_C=5mA, f=1.5GHz

	Simulation HP-MDS		Measured Perfomance	Comment:
f=1.5GHz	BFG425W SPICE model	S-param. model		
$\lvert S21\rvert^2$ [dB]	15.1	14.3	14.1	note 1
$\lvert S12\rvert^2$ [dB]	-25.5	-23.7	-25.0	note 1
VSWRi	1.6	1.7	2.2	note 1
VSWRo	1.8	2.4	2.5	note 1
Noise Figure [dB]	1.5	-	1.6	note 2

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<u>note 1:</u> Circuit is stable for all frequencies.
<u>note 2:</u> 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

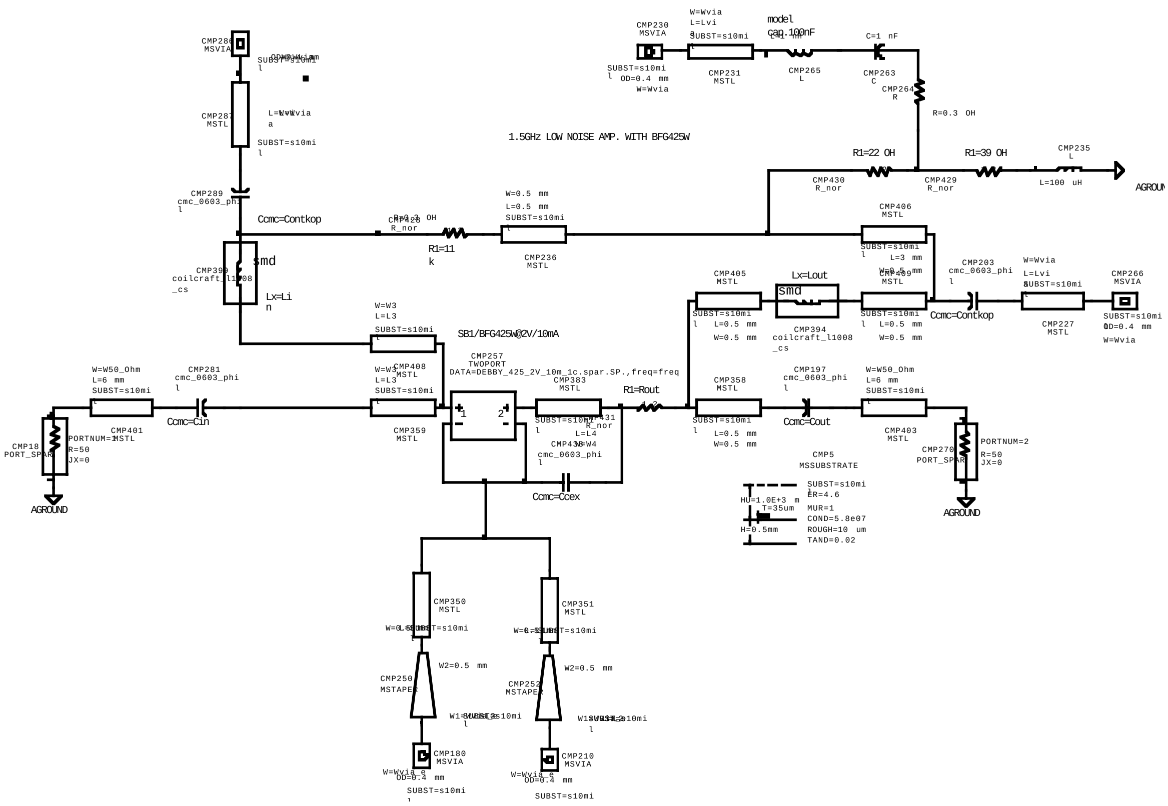

Figure 3: HP-MDS simulation circuit