Philips Semiconductors B.V.

Report nr. : RNR-45-98-B-0703
Author : T.F. Buss / J.Bouwman
Date : 28-10-1998
Department : Development DSC-N

900 MHz Driver with the BFG480W

Abstract:
This application note contains an example of a driver, designed for a frequency f=900MHz.
At f=900 MHz: The output power Pout≅11dBm, the Noise Figure NF≅3.2dB, the Gain S_{21} ≥ 16dB and the OIP3≅25dBm. VSWRin ≤ 1:2.0, VSWRout ≤ 1:1.4

DSCEN
winnen doen we samen

0. Introduction

With the new Philips silicon bipolar double poly BFG400W *5th generation* series, it is possible to design driver-amplifiers and PA's for high frequency applications with a low supply voltage. These amplifiers are well suited for the new generation low voltage high frequency wireless applications. In this note an example with the BFG480W driver amplifier will be given. This amplifier is designed for a working frequency of 900 MHz.

1. 900 MHz Driver with the BFG480W

Designing the circuit:

The circuit is designed to show the following performance:
transistor: BFG480W

V_{ce}~2V, I_c~60mA, V_{SUP}=3.0V
freq=900 MHz
Gain~16dB
VSWRi<1:2
VSWRo<1:2
OIP3>+20dBm

The outputmatching is realised with a LC-combination. Also extra emitter-inductance on both emitterleads (µ-strips) is used to improve the matching.
Figure 1 shows the Driver-circuit.

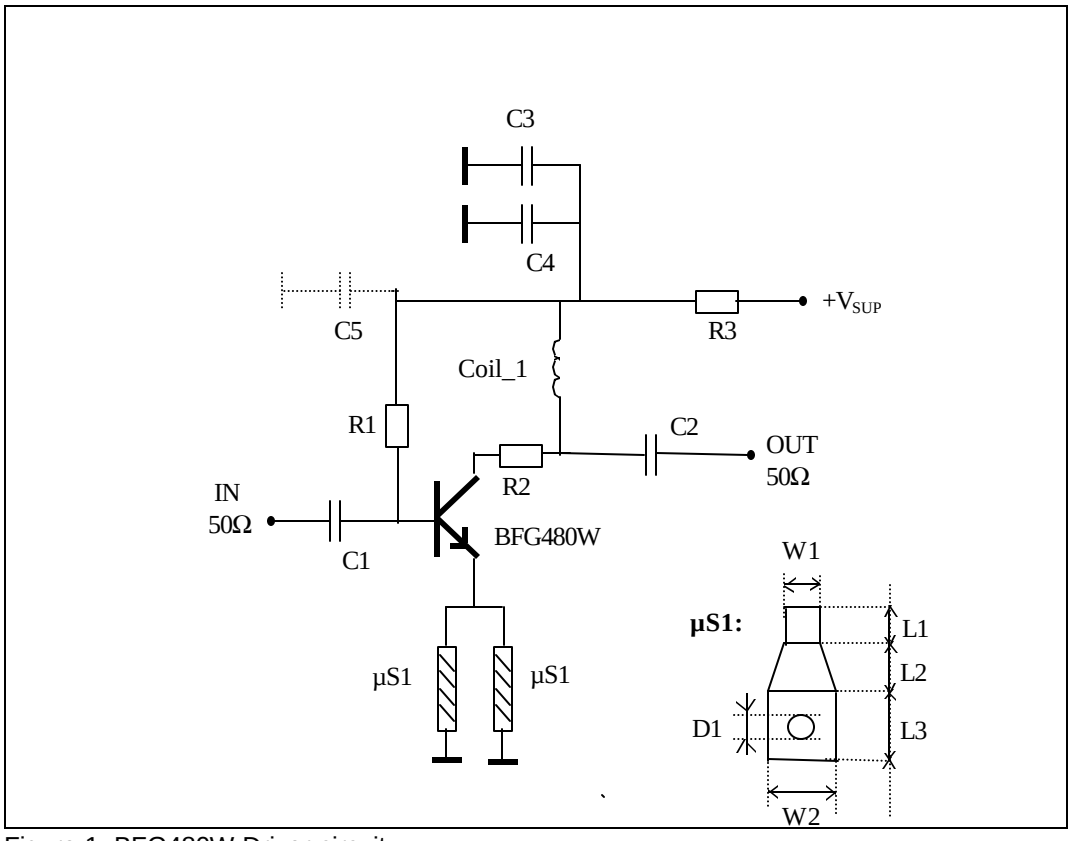


Figure 1: BFG480W Driver-circuit

Table 1 shows the components used for the BFG480W driver, table 2 shows the dimensions of the µ-stripline for the emitter-induction.

Component	Value	Purpose, comment
R1	2.2 kΩ	Bias (coll.-base)
R2	10 Ω	Improve rf-stability
R3	10 Ω	DC-decoupling; cancelling h_{FE}-spread
C1	15 pF	Input match (input to base)
C2	15 pF	Output match (collector to output)
C3	27 pF	900MHz short (Coil_1 to ground)
C4	100 nF	Improving IP3 (by decoupling LF IP3 products)
C5	1 nF	RF decoupling collector bias (optional)
Coil_1	120 nH	Output match
µs1	(see next table)	µ-stripline Emitter-induction

Table 1: 900 MHz BFG480W Driver component list:

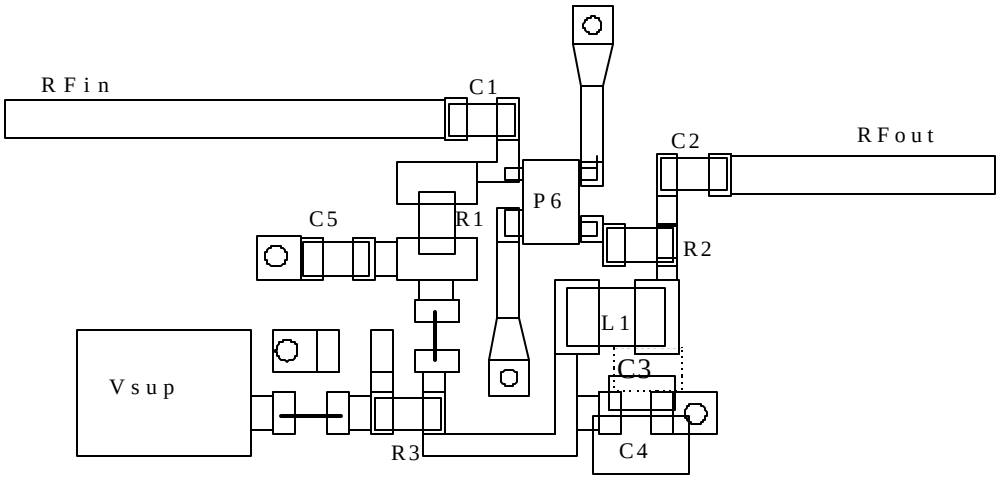
Name	Dimension	Description
L1	**1.5mm**	length µ-stripline; Z_0~48Ω (PCB: ε_r ~4.6, H=0.5mm)
L2	1.0mm	length interconnect stripline and via-hole area
L3	1.0mm	length via-hole area
W1	0.5mm	width µ-stripline
W2	1.0mm	width via-hole area
D1	0.4mm	diameter of via-hole

Table 2: µS1 Emitter inductance of µ-stripline and via-hole

(see on former page: Schematic of the circuit):

Designing the layout:

A lay-out has been designed with HP-MDS. Figure 4 shows the printlayout.



BFG480W 900MHz PA PRINT LAYOUT

Figure 2: BFG480W Driver-circuit layout

Component:	Value:	size:
P6	BFG480W	SOT343R2
R1	2.2 kΩ	0603 Philips
R2	10 Ω	0603 Philips
R3	10 Ω	0603 Philips
C1	15 pF	0603 Philips
C2	15 pF	0603 Philips
C3	27 pF	0603 Philips
C4	100 nF	0805 Philips
C5	1 nF	0603 Philips
L1	120 nH	0805CS Coilcraft
PCB	ε_r~4.6, H=0.5mm	FR4

Table 3: BFG480W 900 MHz Driver component list:

note 1:
The PCB of the Driver is adapted for this BFG480W application, therefore the shorts are used.

Results of PCB measurements (1):

BFG480W, f=900 MHz, V_{SUP} = 3.0 V, I_{SUP} ~ 50 mA @T = 25 °C

Pin (dBm)	Gp (dB)	Pout (dBm)	S11 (dB)	S22 (dB)
-30.00	16.91	-13.09	-9.76	-15.87
-25.00	16.91	-8.09	-9.74	-15.87
-20.00	16.89	-3.11	-9.74	-15.90
-15.00	16.87	1.87	-9.92	-15.82
-10.00	16.77	6.77	-9.80	-15.82
-5.00	16.54	11.54	-9.60	-15.84
-5.00	15.91	10.91	-9.10	-
0.00	14.70	14.70	-7.90	-
5.00	11.07	16.07	-5.60	-

Table 4: Results measurements BFG480W 900 MHz Driver amplifier

Comment:
First part is measured with a Network Analyzer, second part (-5 to +5 dBm) with a Peak Power Analyzer.

Results of PCB measurements (2):

BFG480W, f=900 Mhz, V_{SUP}=3.0V, I_{SUP}~50mA @T=25°C

Measurement	Value	Comment
Noise Figure [dB]	3.2	
IP3 [dBm] (input)	8.4	P_{IN}=-20 dBm, Δf=200 KHz
IP3 [dBm] (output)	25.1	P_{IN}=-20 dBm, Δf=200 KHz

Table 5: Results measurements BFG480W 900 MHz Driver amplifier

Figure 3 shows us the output power vs. input power -curve at 900 MHz. Measurements made with the Piek Power Analyzer (large signal) are displayed with the dashed line.

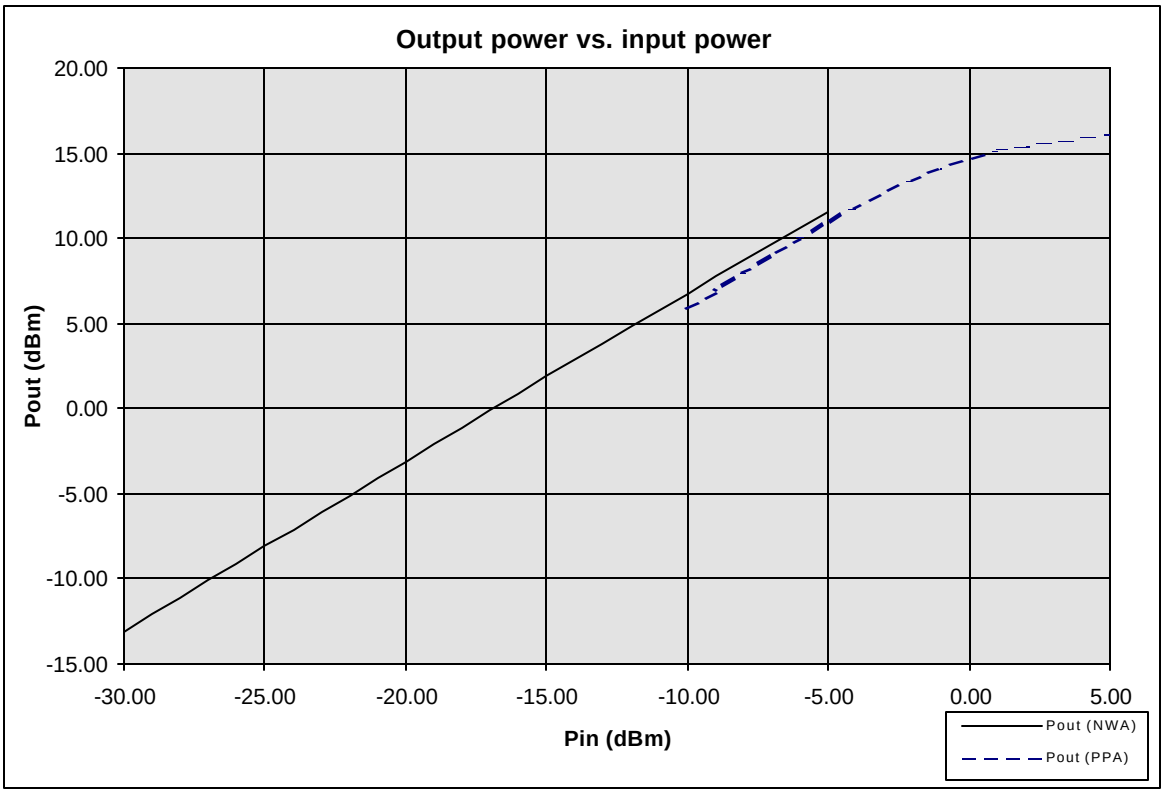


Figure 3: Output power vs. input power

PPA=Piek Power Analyzer
NWA=Network Analyzer