## Philips Semiconductors B.V.


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# 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


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## 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.

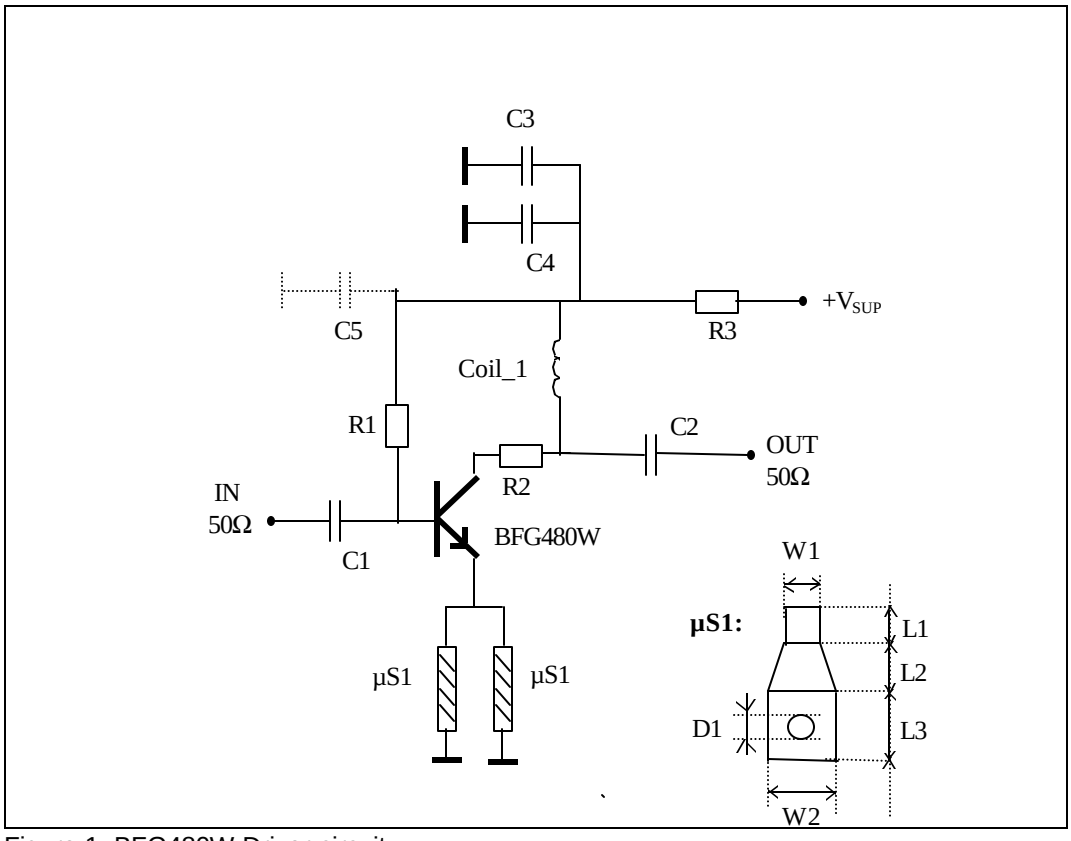



Figure 1: BFG480W Driver-circuit

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:

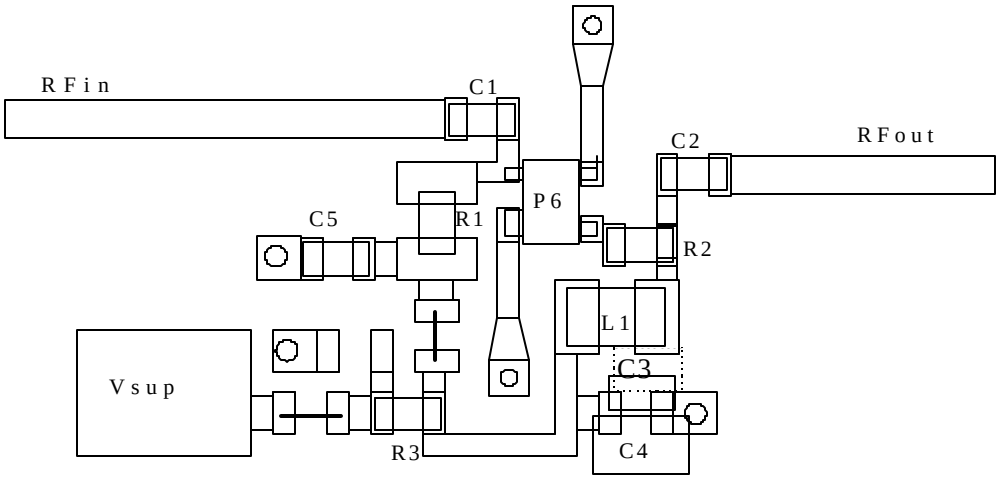
| Name | Dimension | Description |
|---|---|---|
| L1 | **1.5mm** | length µ-stripline; $Z_0$~48Ω (PCB: $\varepsilon_r$ ~4.6, H=0.5mm) |
| L2 | 1.0mm | length interconnect stripline and via-hole area |
| L3 | 1.0mm | length via-hole area |
| W1 | 0.5mm | width µ-stripline |
| W2 | 1.0mm | width via-hole 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 | $\varepsilon_r$~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, $\Delta$f=200 KHz |
| IP3 [dBm] (output) | 25.1 | $P_{IN}$=-20 dBm, $\Delta$f=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.

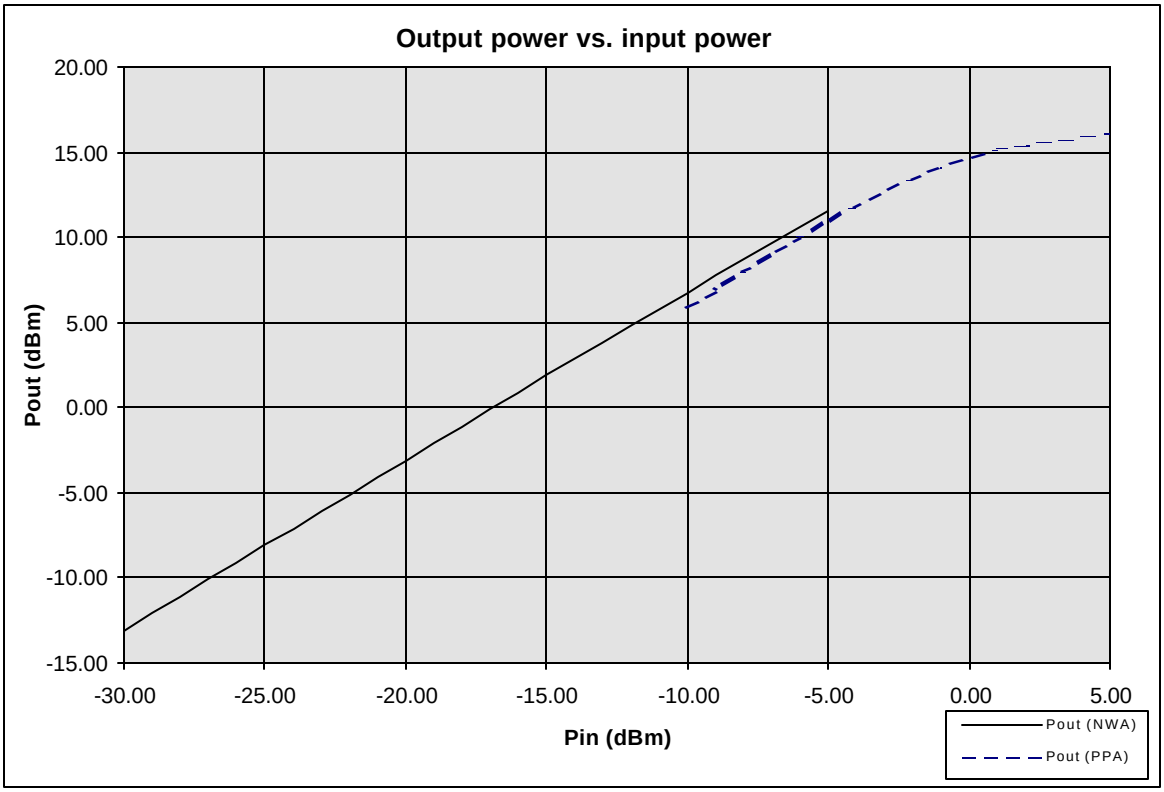



Figure 3: Output power vs. input power

PPA=Piek Power Analyzer
NWA=Network Analyzer