

## Low noise, low current preamplifier for 1.9 GHz at 3 V

## Application report

In this short note some results of measurements are described performed on a LNA for the 1.8 - 2.0 GHz frequency range.

The amplifier is build with a low cost bipolar transistor on a low cost epoxy PCB.

The design was done at a DC voltage of 3 Volts, 2.5 mA.

Even under this low dissipation conditions an amplifier with low noise figure and associated high gain can be build while keeping the input impedance within reasonable limits from 50 Ohm.

Most low noise concepts give high mismatch at the input port. This design matches better than a 1:2 VSWR making it easier to connect to 50 Ohm designed bandpass filters or aerials.

### General characteristics:

|                |  |   |
|----------------|--|---|
| Supply voltage | 2.5 - 3.6 V                            |   |
| Gain           | > 10 dB typ. 11 dB                     |   |
| Noise Figure   | < 2.5dB typ. 2.4 dB                    | with PCB and cap. losses                    |
| Linearity      | IP3 > 7 dBm<br>typ. 9 dBm (output)     |   |
| VSWR           | input < 1:2 typ. 1.5<br>output < 1:2.5 |   |
| PCB material   | FR4 ( $\epsilon_r=4.7$ , $h=0.5$ mm)   | Epoxy                                       |
| Components     | BFG505<br>resistors<br>capacitors      | SOT143<br>Philips 0603/0805<br>Philips 0603 |

### Circuit diagram

The circuit diagram is straightforward.

Biasing is simply done by resistive feedback. The stabilisation factor might be too small to compensate for the HFE spread (or temperature) of the device, but since the supply dependency of gain is proven not to be very large (appendix C) this way of biasing is preferable because of reduced component count. The current setting can be lowered to about 1 mA while maintaining high gain and low noise figure.

The decoupling network (R1 - C3) might be omitted but serves to improve linearity.

The source and load match (S2, S3 resp. S4, S5) are designed to give a good compromise between noise, gain and matching performance. The matching striplines represent 70 Ohm transmission lines with S2 and S5 acting as short-circuited stubs with electrical length of ca.  $1/6\lambda$  and S3 and S4 even shorter.

---

## Low noise, low current preamplifier for 1.9 GHz at 3 V

---

## Application report

They can be replaced by any inductive element giving the same induction at the operation frequency.

Proper grounding is essential in GHz design. If no proper ground is available, an estimate of parasitic series induction must be made to take into account while designing.

The 10pF capacitors serve only as DC blocking capacitors and are not critical in value. They are at series resonance at about 2 GHz. No attempt has been made to make the circuit as small as possible, since it only represents a sub-circuit.

Reducing the size can be done by choosing narrower lines for S2, S5 so that they can become shorter and folded more.

Also a higher epsilon material can reduce the size.

### 900 MHz version

With the same transistor an amplifier at 900 MHz can be build.

Providing 50 Ohm input/output impedance, 1.3 dB Noise Figure, a Gain of over 10 dB and a current of only 1 mA it is very suitable for low power applications.

Observe the schematic diagram in appendix G, where the input impedance is realized through feedback in the emitter (L3).

The coils are made of closely wound enamelled Cu- wire,  $d=0.4$  mm; int. diam=1.6 mm. (at 900 MHz, coils are preferably used because of their small size)

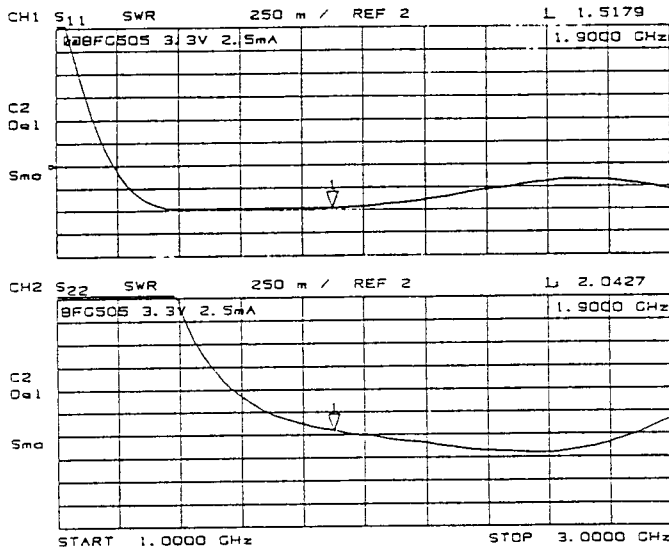
### Measurement results

- A: VSWR versus frequency**
- B: Gain/isolation versus frequency**
- C: Gain and current versus supply voltage**
- D: Intermodulation behaviour (IP3)**
- E+F: schematic diagram and layout**
- G: schematic diagram 900 MHz version**

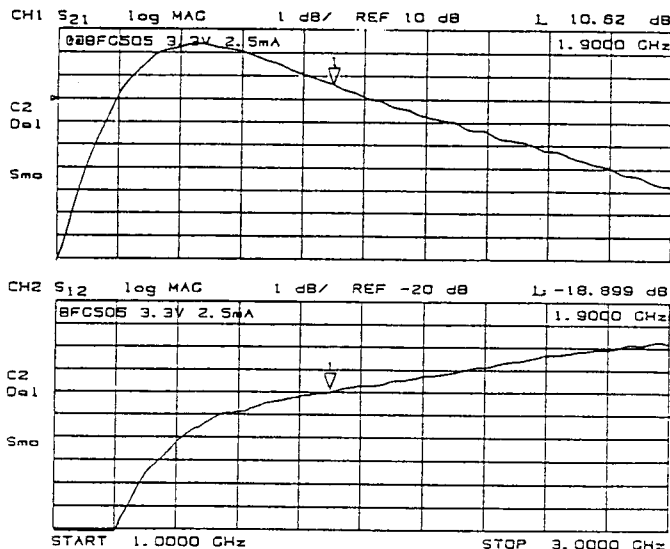
# Low noise, low current preamplifier for 1.9 GHz at 3 V

## Measurements

A



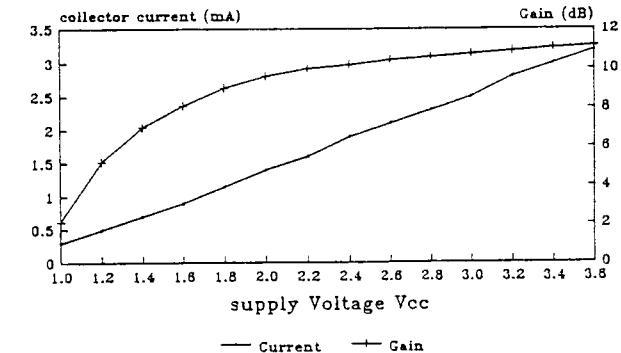
B



Low noise, low current preamplifier  
for 1.9 GHz at 3 V

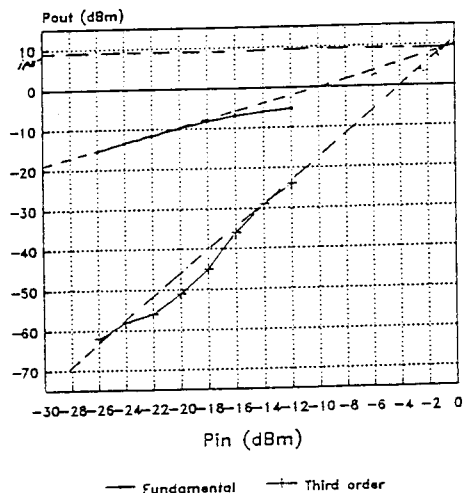
Application report

C Gain, current v. supply voltage  
Bias BFG505:  $R_b=82\text{ k}\Omega, R_c=240\text{ }\Omega$



frequency=1.9GHz

D IP3 preamp BFG505  
3.3V 2.5 mA

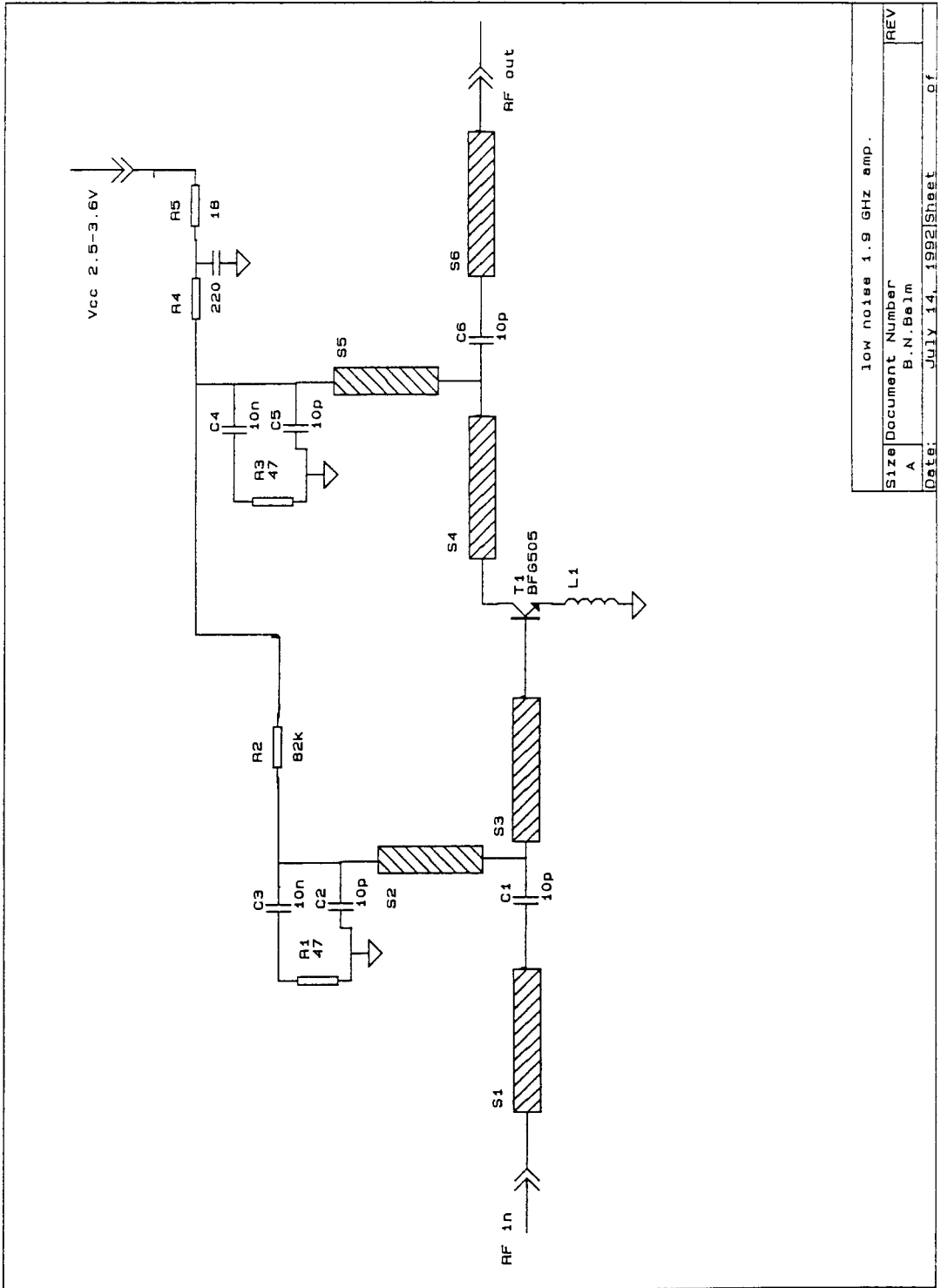


f=1.9 GHz

# Low noise, low current preamplifier for 1.9 GHz at 3 V

## Application report

E



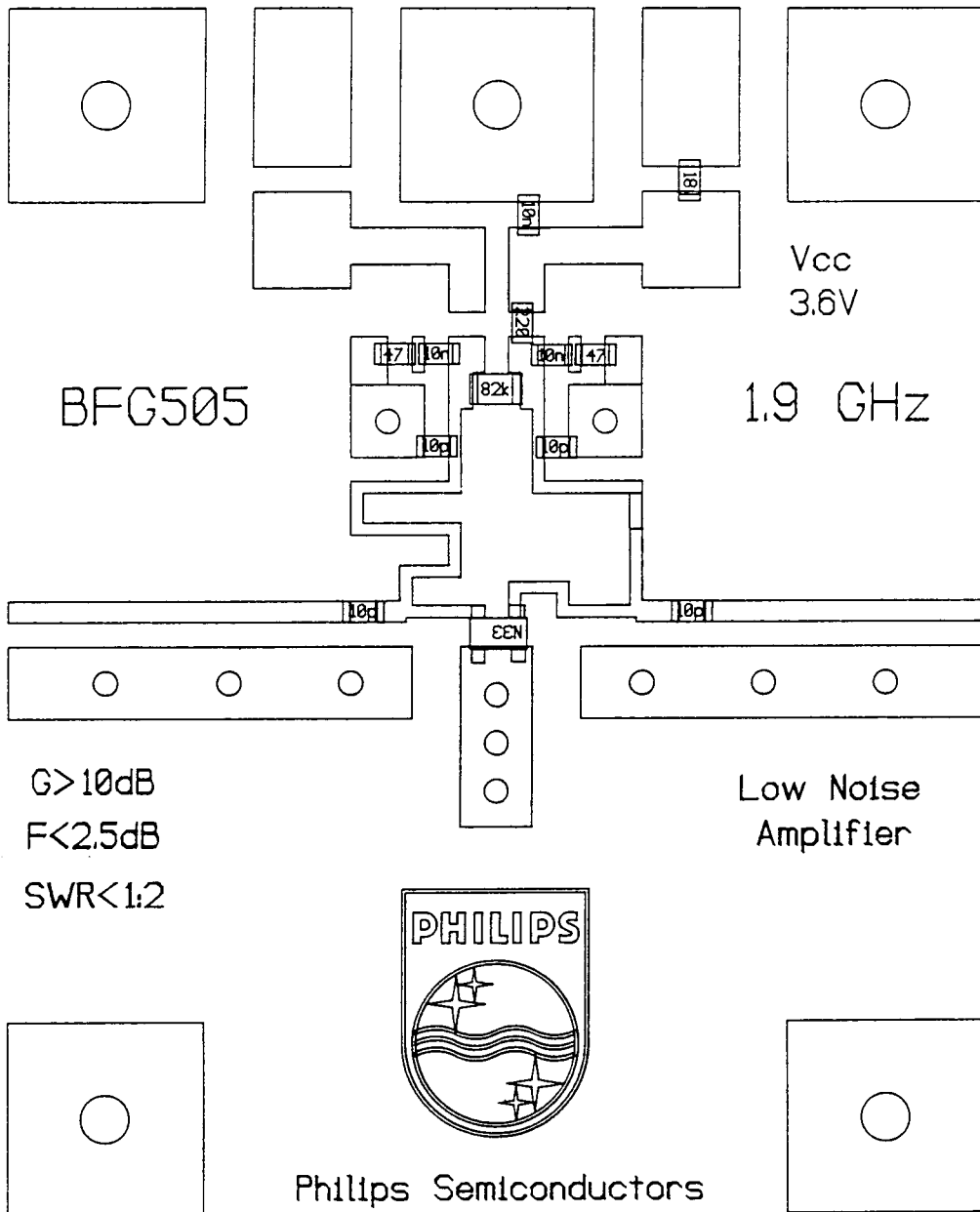
low noise 1.9 GHz amp.

|       |                 |          |
|-------|-----------------|----------|
| Size  | Document Number | REV      |
| A     | B.N.Belm        |          |
| Date: | July 14, 1992   | Sheet of |

Low noise, low current preamplifier  
for 1.9 GHz at 3 V

Application report

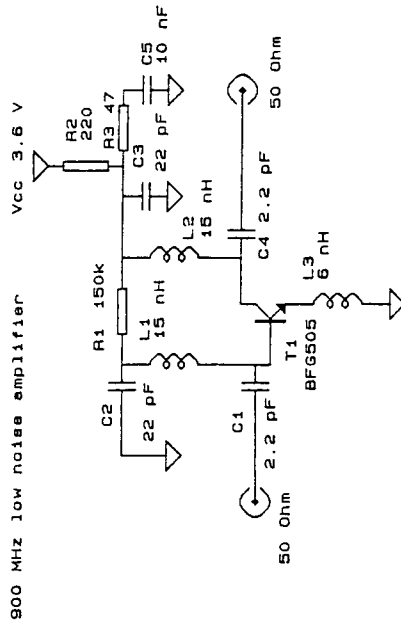
F



Low noise, low current preamplifier  
for 1.9 GHz at 3 V

Application report

G



L1-L2- 3 TURNS  
L3- 1 TURN

|                        |                 |
|------------------------|-----------------|
| 900 MHz low noise amp. |                 |
| Size                   | Document Number |
| A                      |                 |
| Date:                  | August 19, 1952 |
| Sheet                  | of              |
|                        |                 |

SUNSTAR 商斯达实业集团是集研发、生产、工程、销售、代理经销、技术咨询、信息服务等为一体的高科技企业，是专业高科技电子产品生产厂家，是具有 10 多年历史的专业电子元器件供应商，是中国最早和最大的仓储式连锁规模经营大型综合电子零部件代理分销商之一，是一家专业代理和分销世界各大品牌 IC 芯片和电子元器件的连锁经营综合性国际公司，专业经营进口、国产名厂名牌电子元件，型号、种类齐全。在香港、北京、深圳、上海、西安、成都等全国主要电子市场设有直属分公司和产品展示展销窗口门市部专卖店及代理分销商，已在全国范围内建成强大统一的供货和代理分销网络。我们专业代理经销、开发生产电子元器件、集成电路、传感器、微波光电元器件、工控机/DOC/DOM 电子盘、专用电路、单片机开发、MCU/DSP/ARM/FPGA 软件硬件、二极管、三极管、模块等，是您可靠的一站式现货配套供应商、方案提供商、部件功能模块开发配套商。商斯达实业公司拥有庞大的资料库，有数位毕业于著名高校——有中国电子工业摇篮之称的西安电子科技大学（西军电）并长期从事国防尖端科技研究的高级工程师为您精挑细选、量身订做各种高科技电子元器件，并解决各种技术问题。

微波光电部专业代理经销高频、微波、光纤、光电元器件、组件、部件、模块、整机；电磁兼容元器件、材料、设备；微波 CAD、EDA 软件、开发测试仿真工具；微波、光纤仪器仪表。欢迎国外高科技微波、光纤厂商将优秀产品介绍到中国、共同开拓市场。长期大量现货专业批发高频、微波、卫星、光纤、电视、CATV 器件：晶振、VCO、连接器、PIN 开关、变容二极管、开关二极管、低噪晶体管、功率电阻及电容、放大器、功率管、MMIC、混频器、耦合器、功分器、振荡器、合成器、衰减器、滤波器、隔离器、环行器、移相器、调制解调器；光电子器件和组件：红外发射管、红外接收管、光电开关、光敏管、发光二极管和发光二极管组件、半导体激光二极管和激光器组件、光电探测器和光接收组件、光发射接收模块、光纤激光器和光放大器、光调制器、光开关、DWDM 用光发射和接收器件、用户接入系统光收发器件与模块、光纤连接器、光纤跳线/尾纤、光衰减器、光纤适配器、光隔离器、光耦合器、光环行器、光复用器/转换器；无线收发芯片和模组、蓝牙芯片和模组。

更多产品请看本公司产品专用销售网站：

商斯达中国传感器科技信息网：<http://www.sensor-ic.com/>

商斯达工控安防网：<http://www.pc-ps.net/>

商斯达电子元器件网：<http://www.sunstare.com/>

商斯达微波光电产品网：[HTTP://www.rfoe.net/](http://www.rfoe.net/)

商斯达消费电子产品网：<http://www.icasic.com/>

商斯达实业科技产品网：<http://www.sunstars.cn/> 微波元器件销售热线：

地址：深圳市福田区福华路福庆街鸿图大厦 1602 室

电话：0755-82884100 83397033 83396822 83398585

传真：0755-83376182 (0) 13823648918 MSN: SUNS8888@hotmail.com

邮编：518033 E-mail:[szss20@163.com](mailto:szss20@163.com) QQ: 195847376

深圳赛格展销部：深圳华强北路赛格电子市场 2583 号 电话：0755-83665529 25059422

技术支持：0755-83394033 13501568376

欢迎索取免费详细资料、设计指南和光盘；产品凡多，未能尽录，欢迎来电查询。

北京分公司：北京海淀区知春路 132 号中发电子大厦 3097 号

TEL: 010-81159046 82615020 13501189838 FAX: 010-62543996

上海分公司：上海市北京东路 668 号上海赛格电子市场 D125 号

TEL: 021-28311762 56703037 13701955389 FAX: 021-56703037

西安分公司：西安高新开发区 20 所(中国电子科技集团导航技术研究所)

西安劳动南路 88 号电子商城二楼 D23 号

TEL: 029-81022619 13072977981 FAX:029-88789382