Application Note No. 062

A Low Parts Count Low Noise Amplifier for GPS Applications using BGA428

RF & Protection Devices

Never stop thinking

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Page	Subjects (major changes since last revision)
All	Document layout change

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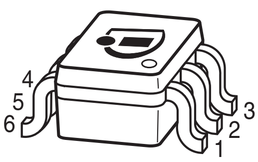
1 A Low Parts Count Low Noise Amplifier for GPS Applications using BGA428

Features

- Two-stage Low Noise Amplifier
- SIEGET^{R}45-Technology with 45 GHz f_T
- Small outline SOT363-Package
- Low Noise Figure: 1.4 dB at 1.575 GHz
- 22 dB Gain at 1.575 GHz
- Requires only 2 external matching elements at 1.575 GHz



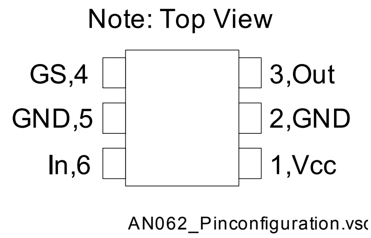


Figure 1 PIN configuration

1.1 Introduction

The Infineon BGA428 is a high performance two stage CE-CE transistor amplifier based on the BH6F-plus SIEGET®45-Technology.

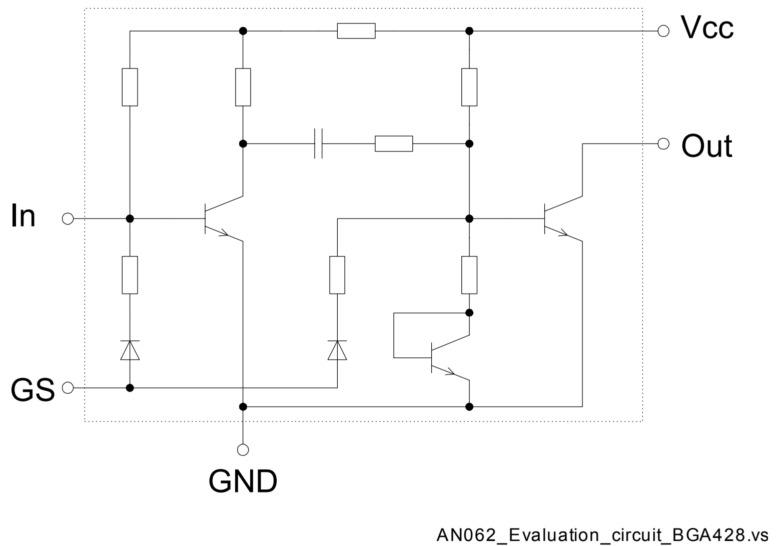


Figure 2 Equivalent Circuit of BGA428

High gain and low noise figure make it an ideal solution for Low Noise Amplifiers and receiver front end stages and other applications requiring moderate linearity up to 2 GHz. Internal prematching simplifies RF design effort and enables a simple, low-parts-count RF matching solution.

The BGA428's typical supply voltage range is 2.4 to 3.3 V. Gain may be reduced by approximately 32 dB in a single step by reducing V_{CC} to 0 V and applying 2.7 V to GS

Table 1 Performance Overview at 1.575 GHz

Parameter	Value	Unit
DC Voltage	3	V
DC Current	9.5	mA
Gain	22	dB
Noise Figure	1.4	dB
Input P_{1dB} Compression	-18.6	dBm
Input IP_3	-10	dBm
Input Return Loss	13	dB
Output Return Loss	12	dB
Reverse Isolation	34.2	dB

1.2 Description

The BGA428 is an integrated circuit consisting of two silicon bipolar transistor amplifier stages. Each transistor stage was optimized for overall device gain, linearity, noise figure and RF pre-matching. A reduced gain step is provided as well as a complete bias circuit.

The features of the BGA428 allow fast easy RF amplifier circuit designs requiring low component count and minimal printed circuit board area. DC power is provided by simply applying the proper voltage on the V_{CC} pin, although the circuit designer has the option of biasing each of the two stages separately. Internal prematching eases the external RF matching circuit can be combined with the coil that brings in DC bias.

The BGA428 is developed for use in battery powered equipment demanding high performance with low supply voltages. Typical applications for the device include low noise RF amplifiers, IF amplifiers and gain and buffer stages up to 2 GHz. The BGA428 is an excellent choice for use in cellular and cordless telephones and other commercial wireless equipment.

1.3 Design overview

This application note describes a low noise amplifier for 1.575 GHz. The schematic diagram is shown in **Figure 3**.

Amplifier design using BGA428 is no big effort.

Output matching is done by using a high-pass shunt L-series C (L1 and C6) matching circuit, as shown in **Figure 3**. In this configuration the inductor can be used for both the RF output match and the DC biasing of the second stage. The series C element serves both an RF matching and a DC blocking function.

There is no need for an input matching circuit. The BGA428's internal prematching offers a good trade-off between high gain and low noise figure with sufficient low return loss for most applications. The BGA428's input return loss values in the frequency band of interest are typically sightly better 10 dB. Capacitor C1 is only required if the amplifier is cascaded with stages that do not present a DC open circuit to the BGA428.

No stabilization measures have to be taken. Due its internal prematching, the BGA428 offers a high degree of stability sufficient for most applications.

In this application the gain step feature was not implemented to keep the parts count at minimum.

The following pages show the circuit diagram, bill of materials, PCB layout and measured data.

All parameters were measured at 25 °C and include the losses of the SMA connectors and microstrip lines on the PCB boards.

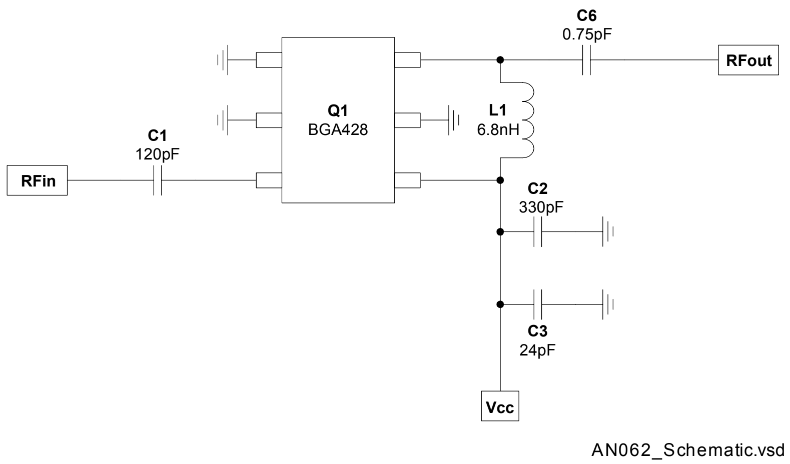


Figure 3 Schematic Diagram

Table 2 Bill of Material

Component	Value	Unit	Size	Manufacturer	Comment
C1	120	pF	0402	Various	DC block
C2	330	pF	0402	Various	RF bypass
C3	24	pF	0402	Various	RF bypass
C4	0.75	pF	0402	Various	Output match, DC block
L1	6.8	nH	0402	Toko LL 1005-FH	Output match, DC feed for 2nd stage
Q1			SOT363	Infineon Technologies	

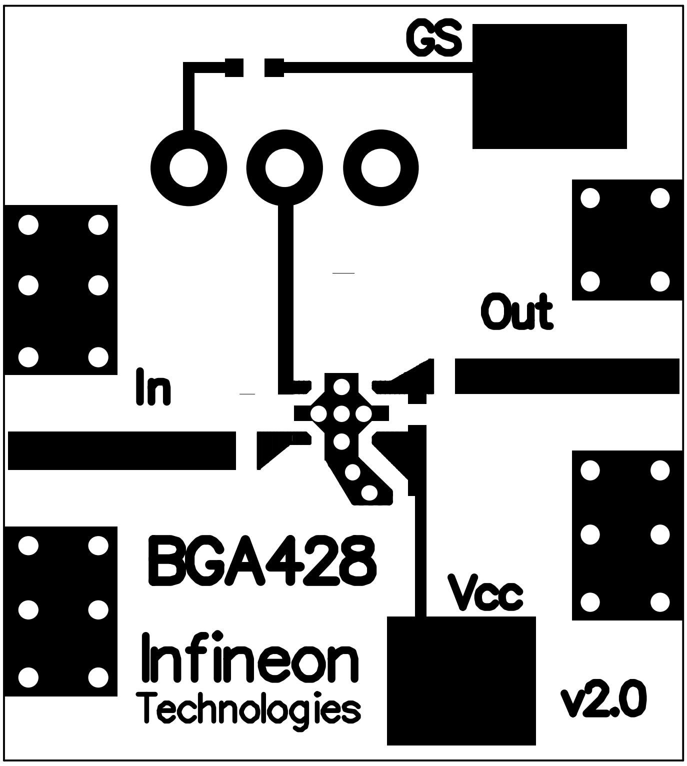


Figure 4 Application Board

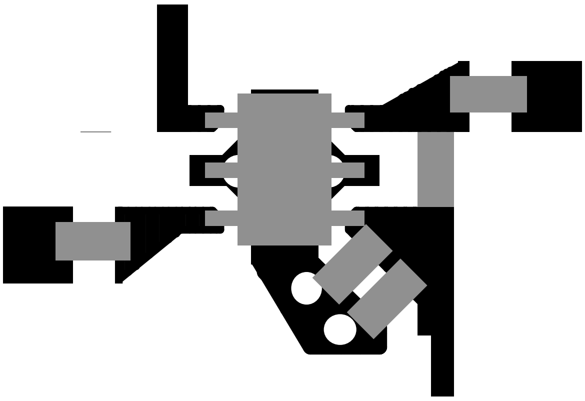


Figure 5 Component Placement

2 Measurement results

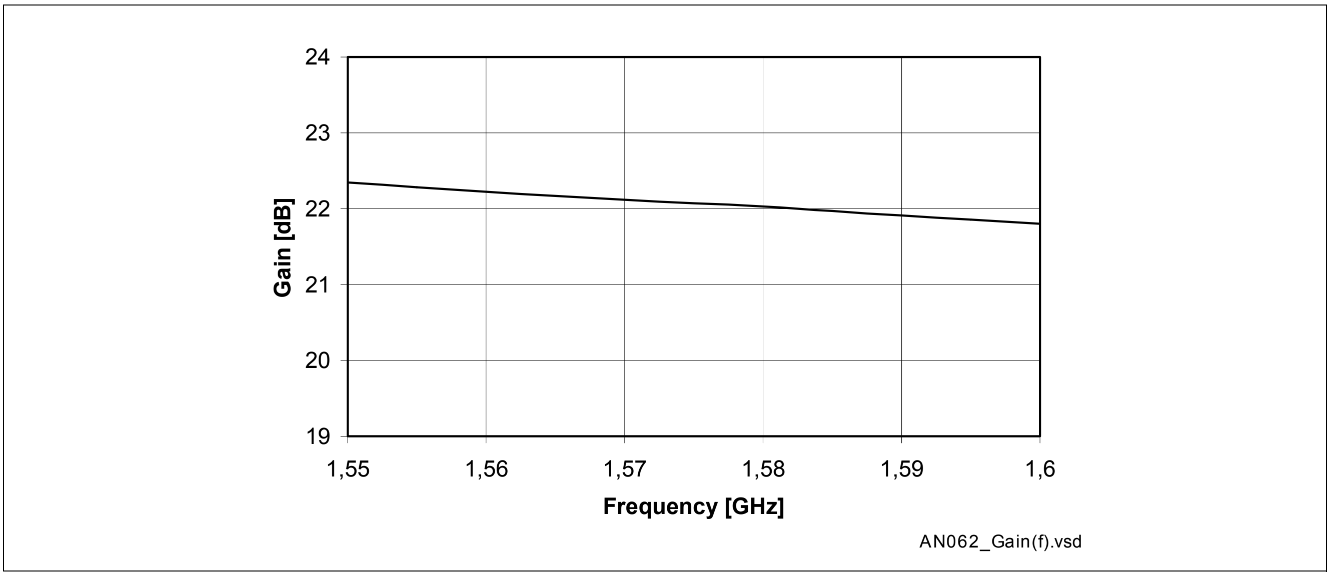


Figure 6 Measured Gain

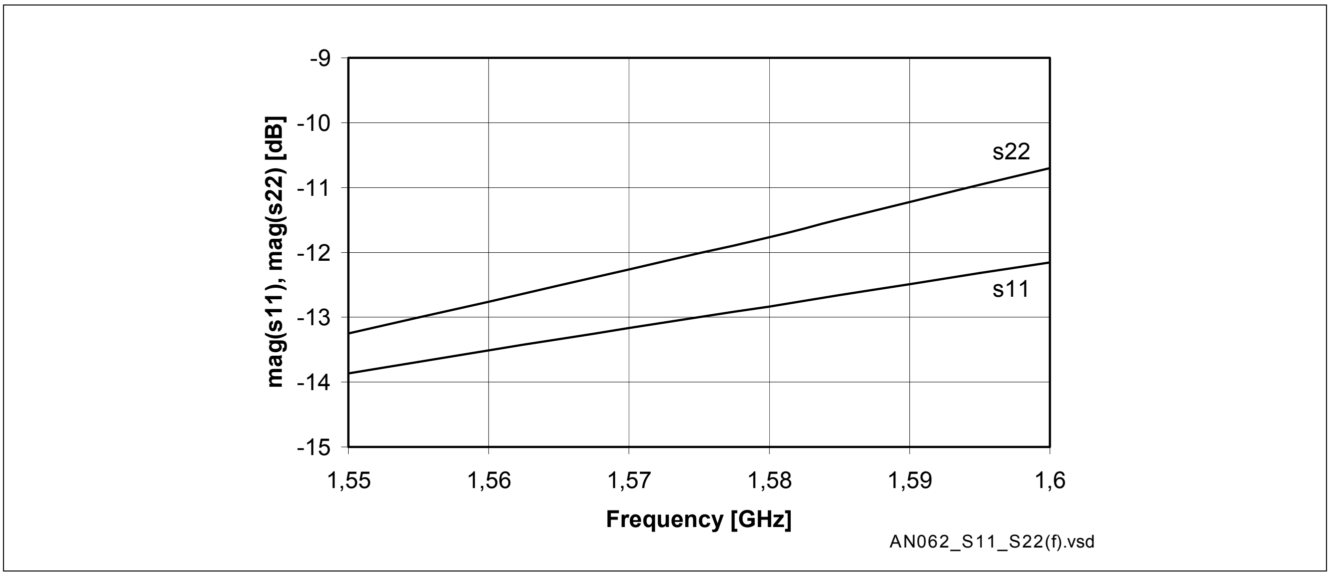


Figure 7 Measured Input and Output Return Loss

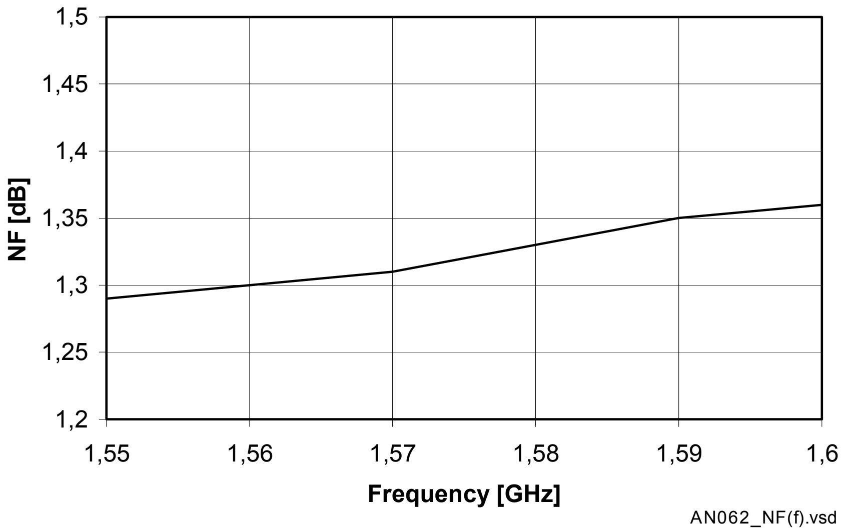


Figure 8 Measured Noise Figure

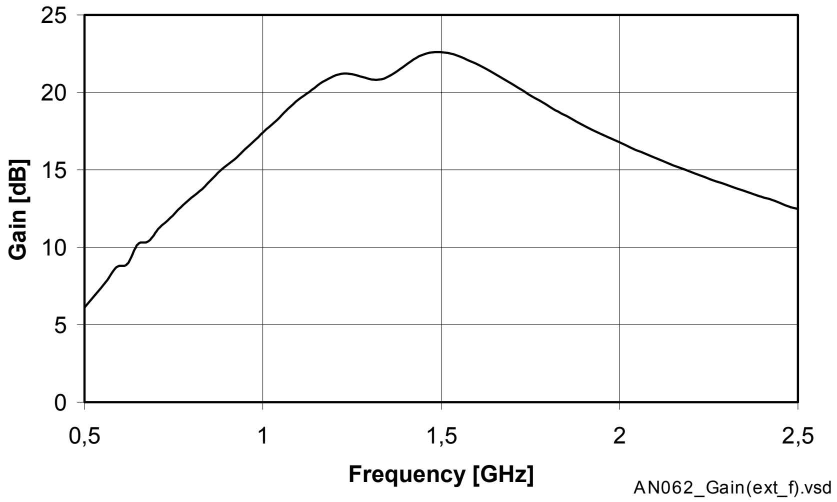


Figure 9 Measured Gain for Extended Frequency

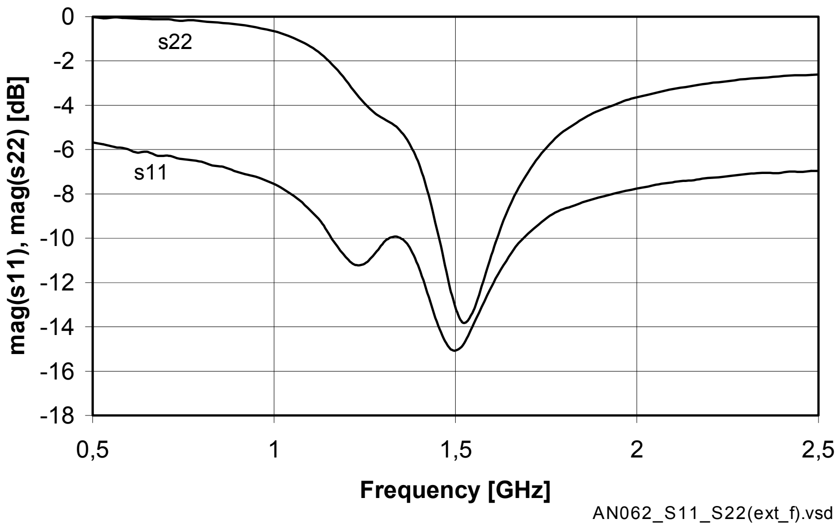


Figure 10 Measured Input and Output Return Loss for Extended Frequency

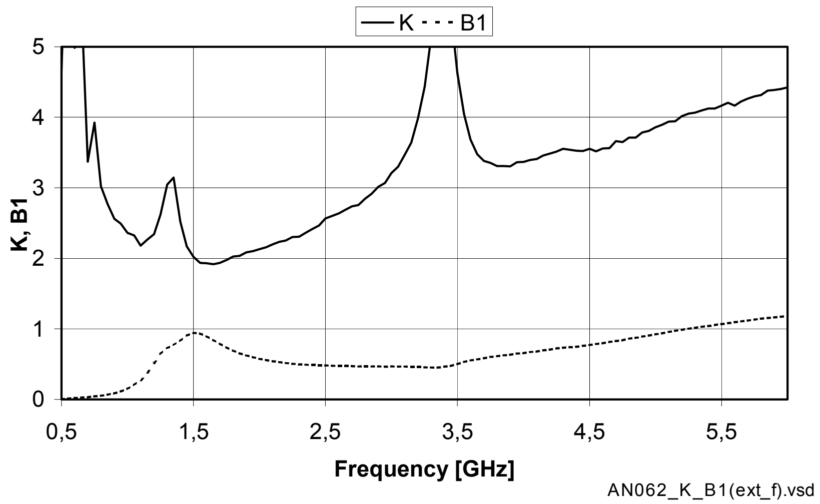


Figure 11 Measured Stability Factor K and Stability Measured B1

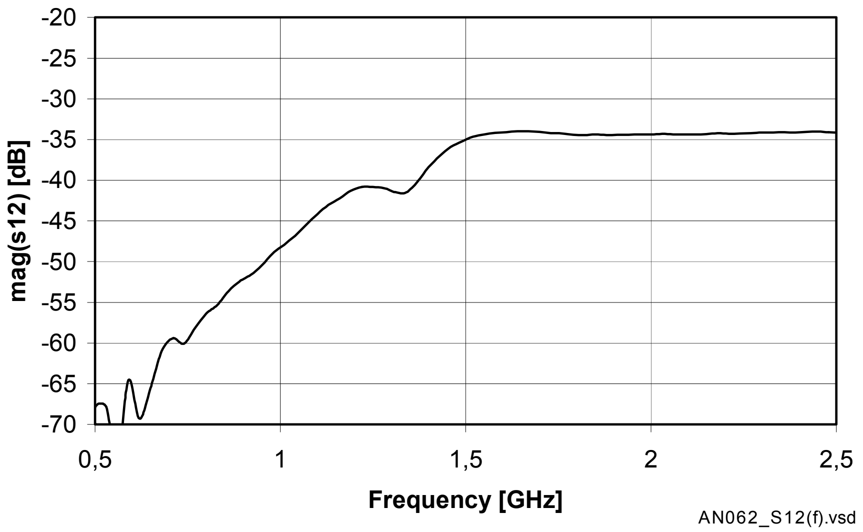


Figure 12 Measured Reverse Isolation