Application Note No. 067

General Purpose Wide Band Driver Amplifier using BGA614

RF & Protection Devices

Never stop thinking

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Application Note No. 067

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Previous Version: 2000-02-03

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

Trademarks

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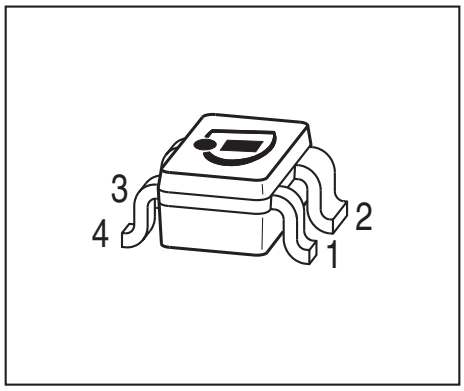
1 General Purpose Wide Band Driver Amplifier using BGA614

Features

- Easy to use, versatile, cascadable 50 Ω gain block - no external RF matching required
- Unconditionally stable
- Compression Point P_{1dB}: +12 dBm
- Exceptional noise figure for a low-cost, matched, broadband device: less than 2.4 dB at 2 GHz
- 70 GHz f_T SiGe technology

Applications

- RF amplifier for GSM, PCS, CDMA and UMTS basestations
- Broadband amplifier for SAT-TV, CATV and LNBs



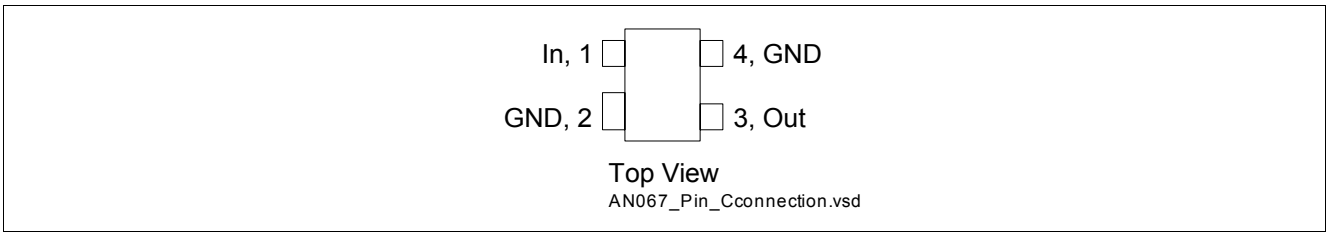


Figure 1 PIN configuration

1.1 Introduction

Infineon Technologies' BGA614 is a matched, general purpose broadband MMIC amplifier in a Darlington configuration. It is implemented in Infineon's high f_T, low noise B7HF Silicon Germanium technology.

The device's 3 dB bandwidth covers DC up to 2.7 GHz with a typical gain of 18.5 dB at 1 GHz. The BGA614 is matched to 50 Ω and is unconditionally stable over the entire frequency range. At a device current of 40 mA the MMIC has an output 1 dB compression point of +12 dBm. At this same DC operating point, the noise figure is only 2.3 dB at 2 GHz - a value previously unheard of in a low-cost, 50 Ω matched gain block. This exceptional performance, enabled by Infineon's 70 GHz B7HF Silicon Germanium process, combined with reduced external component count and ease of use make BGA614 an ideal choice for a wide variety of RF applications up to 2.5 GHz. The BGA614's simplicity, flexibility and ease of use streamlines the wireless design process and allows for shorter design cycles and fast to time-to-market in today's fast-paced, competitive business environment.

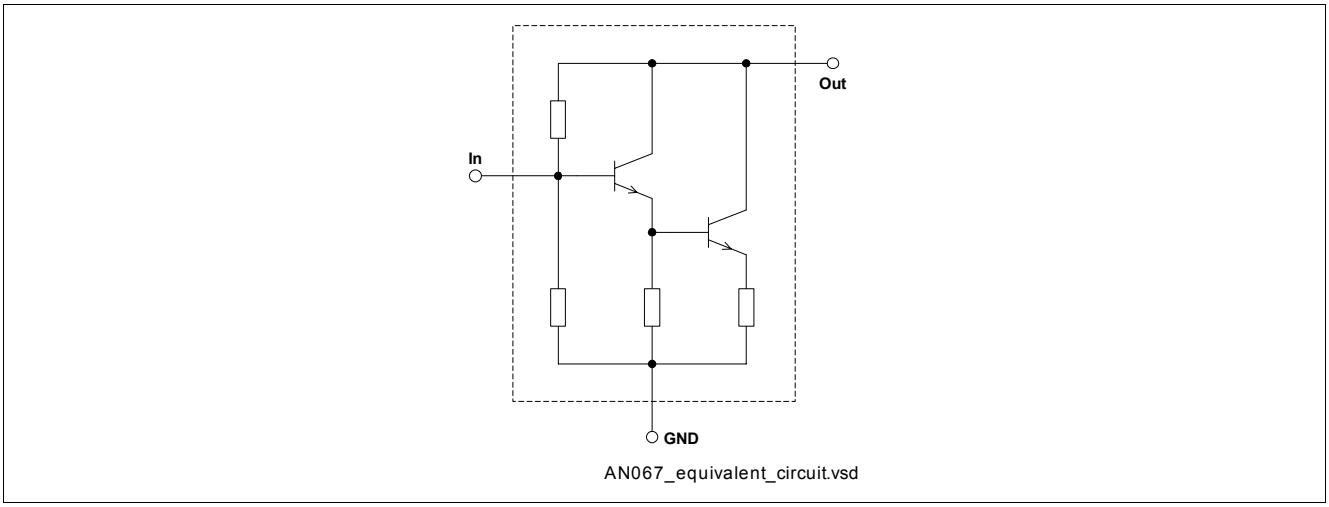


Figure 2 Equivalent Circuit of BGA614

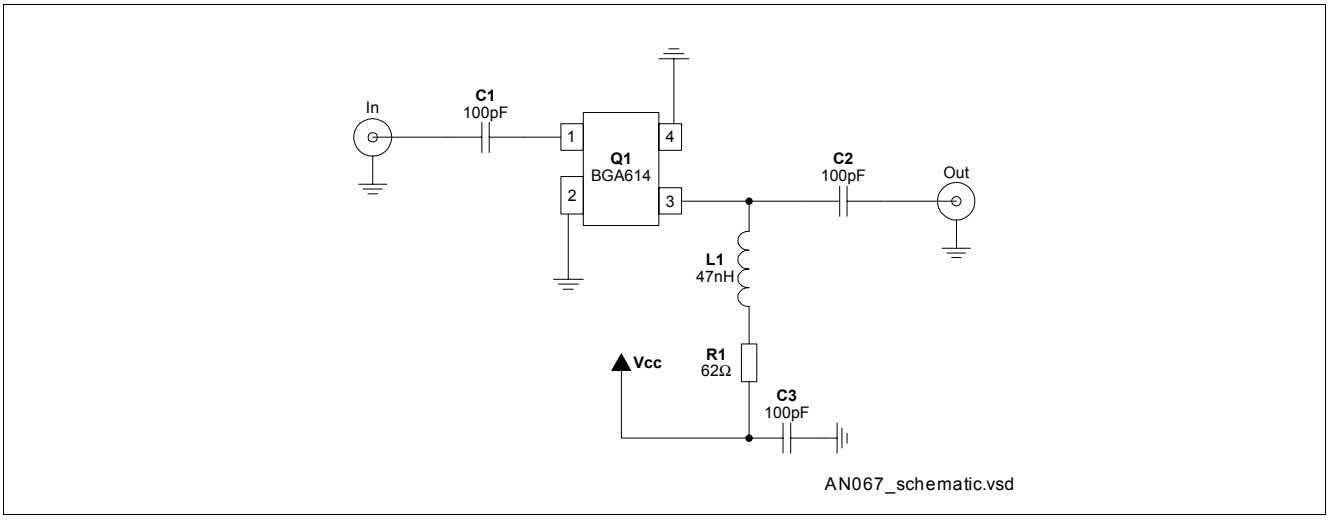


Figure 3 Schematic Diagram

Table 1 Bill of Materials

Name	Value	Unit	Size	Manufacturer	Function
C1	100	pF	0402	Various	DC block
C2	100	pF	0402	Various	DC block
C3	100	pF	0402	Various	RF bypass
L1	47	nH	0402	Toko LL 1005-FH	RF block
R1	62	Ω	0402	Various	Biasing
IC1	BGA614		SOT343	Infineon Technologies	SiGe MMIC

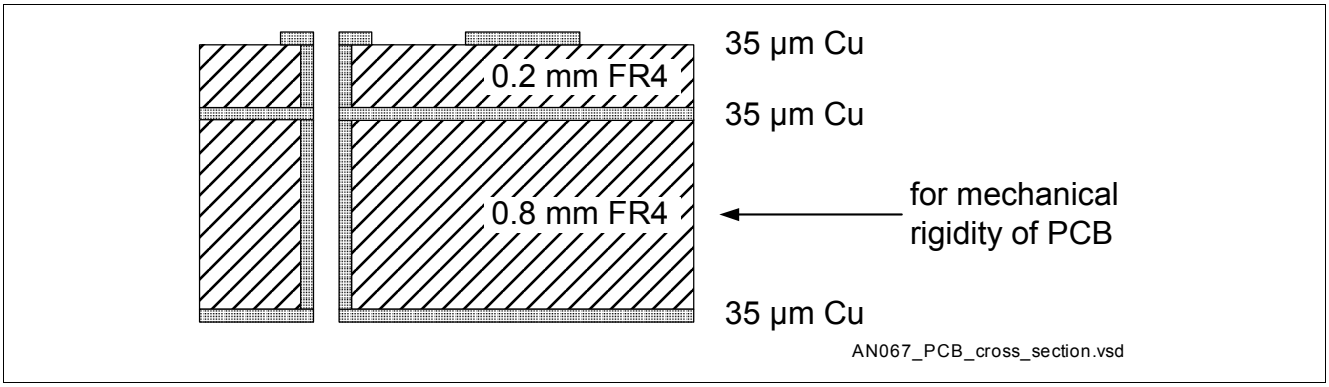


Figure 4 PCB Cross Section

Table 2 Performance Overview

Parameter	Value		
	1.7 GHz	**1.95 GHz**	**2.2 GHz**
Supply voltage V_{CC}	5 V	5 V	5 V
Supply current I_D	41.2 mA	41.2 mA	41.2 mA
Gain	17.0 dB	16.5 dB	15.9 dB
Noise figure	2.38 dB	2.35 dB	2.32 dB
Input return loss	15.5 dB	14.5 dB	13.7 dB
Output return loss	17.7 dB	16.8 dB	16.0 dB
Reverse Isolation	21.1 dB	20.9 dB	20.6 dB
Output P_{1dB}	12.6 dBm	12.2 dBm	12.6 dBm
Output IP_3 [1)]	23.6 dBm	21.0 dBm	20.8 dBm

1) Δf = 1 MHz; -20 dBm per tone

1.2 Circuit Design

This application note describes the design of a general purpose broadband driver amplifier for the frequency band between 1.7 GHz and 2.2 GHz using the BGA614. This band covers the Tx as well as Rx frequencies of various standards from GSM1800 or DCS1800, North America PCS band, up to W-CDMA.

Implementing an amplifier circuit using BGA614 is a simple, straightforward task. As both input and output are already matched to 50 Ω and BGA614 is an unconditionally stable device, there is no need to work on the RF portion of the amplifier design, leaving only DC biasing issues to contend with. The broadband 50 Ω match also eases and speeds integration of the MMIC with any external filters used.

Figure 5 shows the component placement on the application PCB. There are only five external components necessary for the complete amplifier circuit. The low external parts count simplifies manufacturing issues and reduces required PCB area and associated costs.

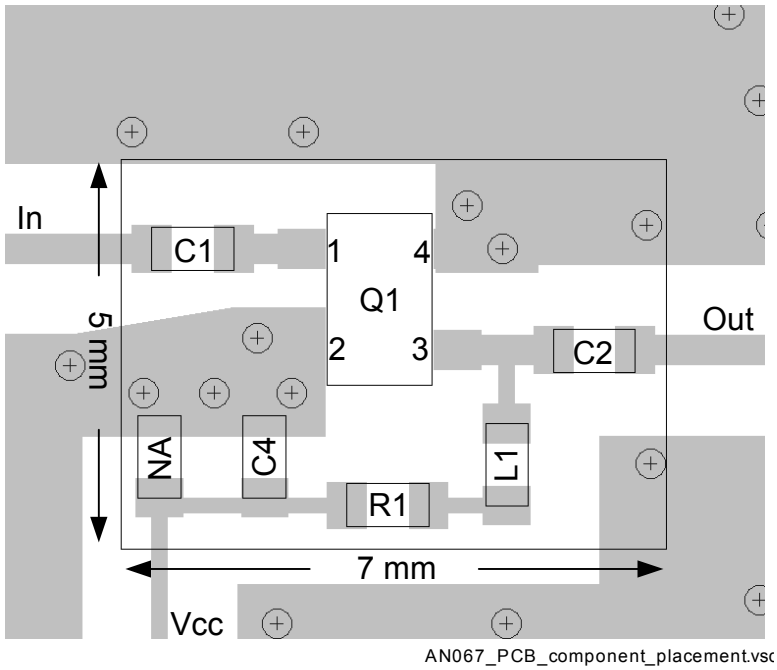


Figure 5 PCB: Component Placement

The BGA614 is biased via its RF output pin (Pin 3). **Figure 6** shows the dependence of the device current on the supply voltage for different values of the bias resistor R1. R1 stabilizes the supply current by using voltage feedback. In principle it is possible to bias BGA614 without an additional resistor. However, omitting R1 will lead to increased unit-to-unit variation in operating current due to the usual variation in the DC Beta (h_{FE}) of the internal transistor cells. It is therefore recommended that R1 be used in all cases.

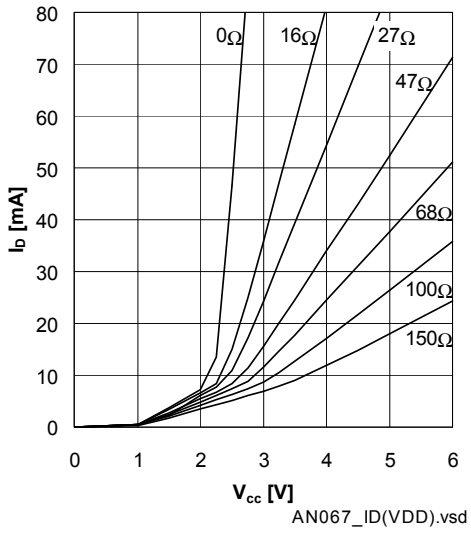


Figure 6 Device Current vs. Supply Voltage, Parameter is R1

The inductor L1 in series with resistor R1 is necessary for RF blocking. C4 serves as a RF bypass at the voltage supply.

The capacitors C1 and C2 are DC blocks as there is DC voltage present on Pin 1 as well as on Pin 3. These capacitors are needed only if there is no DC open circuit on the input and output of the amplifier. For example, if

a filter that presents a DC open circuit is used ahead of or after the BGA614, the corresponding DC blocking capacitor may be omitted.

1.3 Remarks

BGA614 is only one member of Infineon Technologies' broadband Darlingtion MMIC amplifier family. The complete family consists of BGA612, BGA614 and BGA616 to cover a wide range to typical supply currents.

BGA612 is designed for a typical supply current of 20 mA, BGA614 for 40 mA and the BGA616 for 60 mA.

The BGA614 application PCB can be used to evaluate BGA612 and BGA616 as well. It is only necessary to change the value of R1 to adjust the devices' supply current accordingly. Typical values of R1 are 135 Ω at V_{CC} = 5 V for BGA612 and 33 Ω at V_{CC} = 6 V for BGA616.

For further and more detailed dependencies of the devices' supply currents please refer to the appropriate data sheets where graphs like the one in **Figure 6** can be found for BGA612 and BGA616.

2 Measurement Results

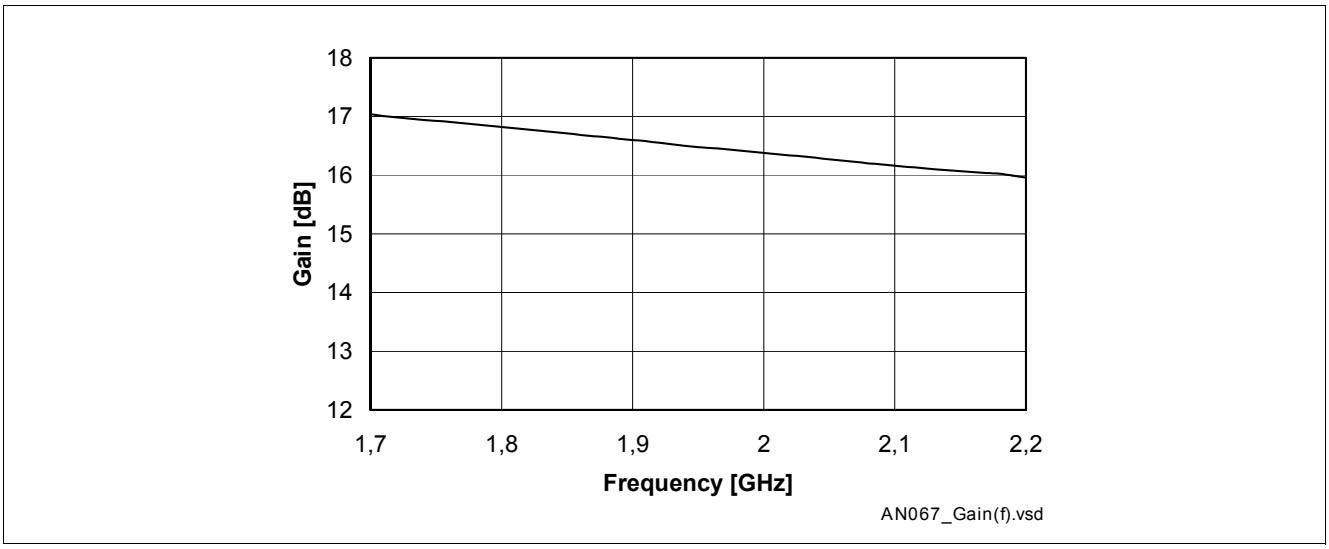


Figure 7 Gain

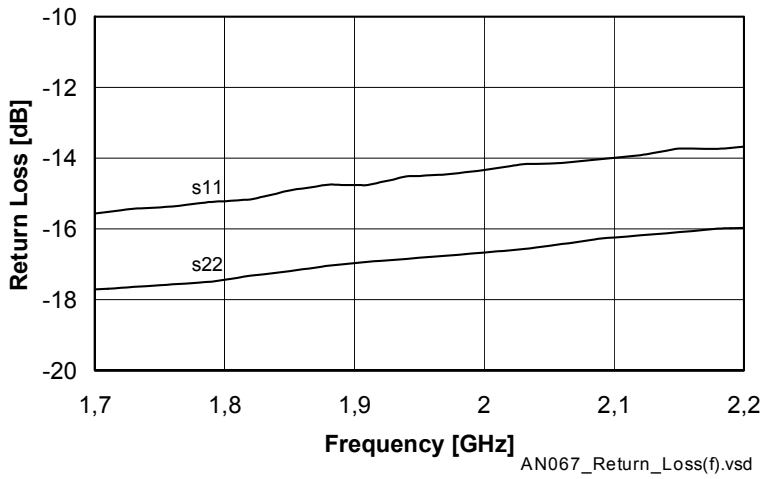


Figure 8 Matching

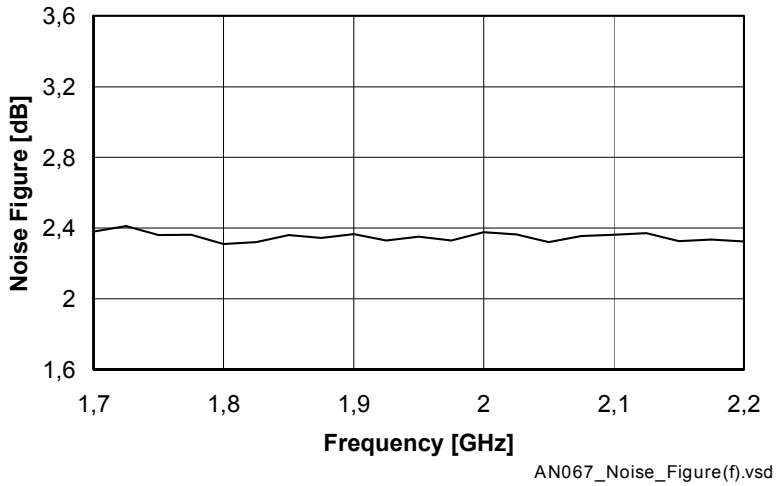


Figure 9 Noise Figure

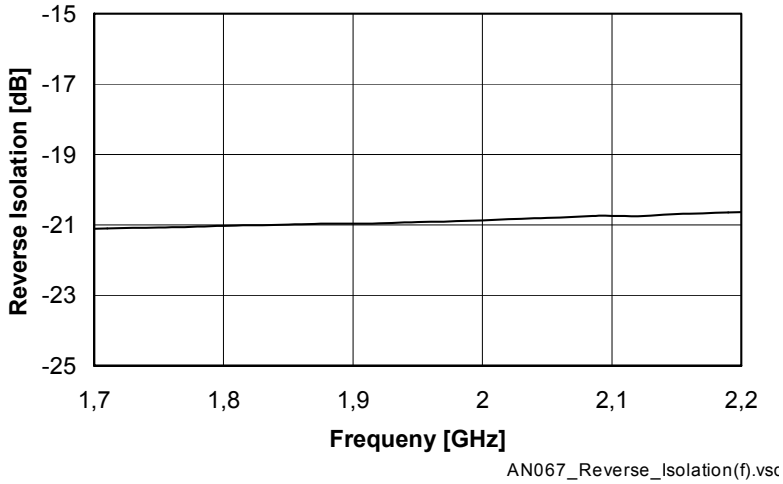


Figure 10 Reverse Isolation

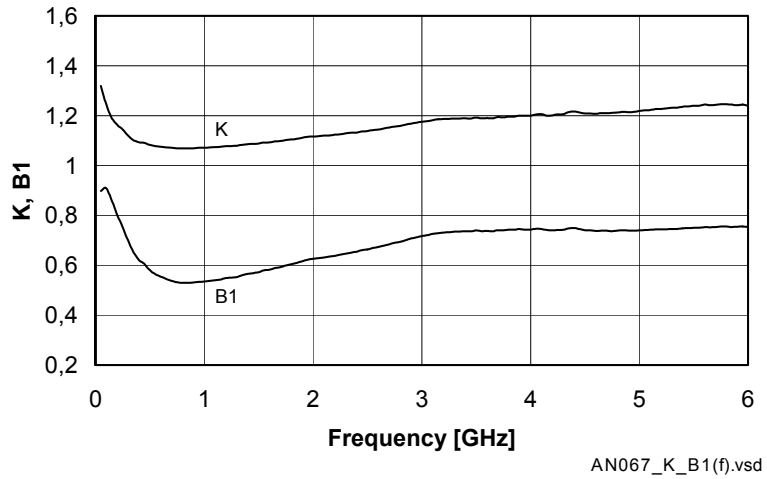


Figure 11 Stability Factor

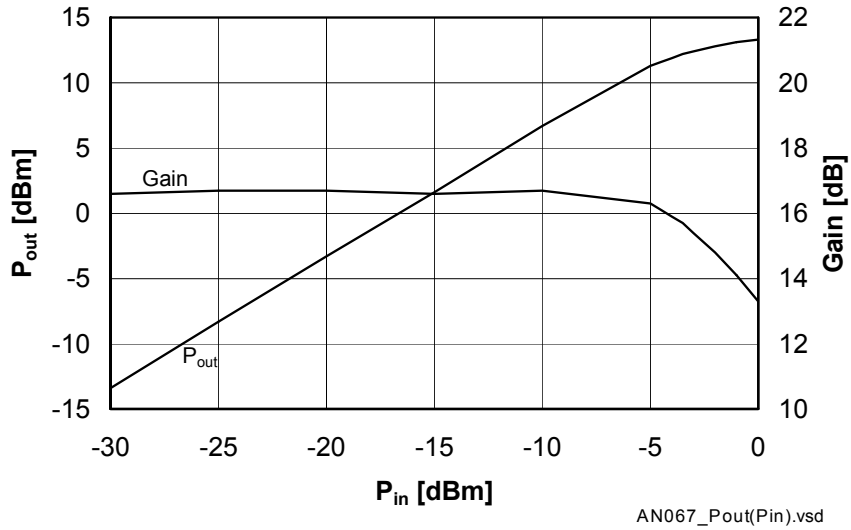


Figure 12 Gain Compression

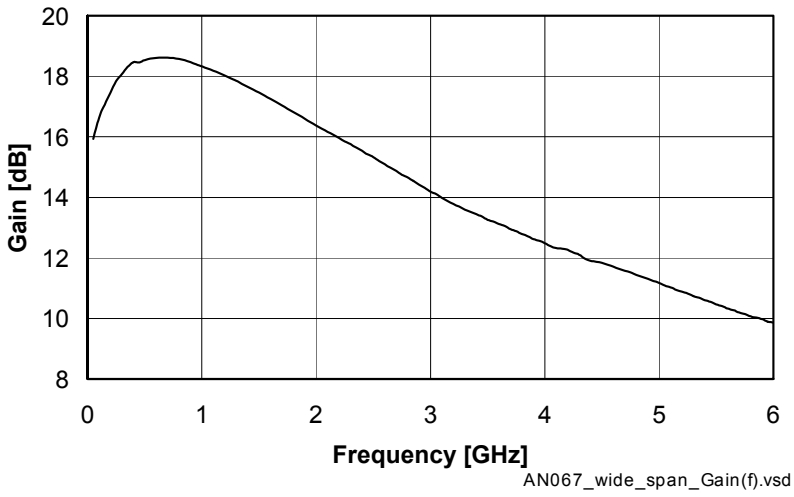


Figure 13 Gain, wide span

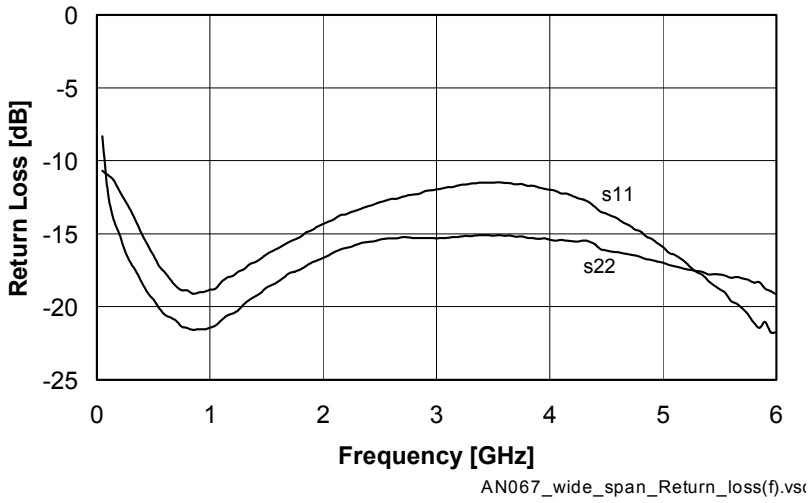


Figure 14 Matching, wide span