Silicon germanium low noise amplifier BGA5H1BN6

15 dB high gain low-noise amplifier for 5G band n78 (3300 MHz to 3800 MHz) application

About this document

This application note describes Infineon's LNA: BGA5H1BN6 as a high-gain Low-Noise Amplifier (LNA) for 5G band n78 (3300 MHz to 3800 MHz) applications with 0402 components for matching.

1. The BGA5H1BN6 is a broadband silicon germanium LNA supporting 3300 to 3800 MHz. It operates in both high-gain and bypass modes.
2. The target application is 5G band n78 (3300 to 3800 MHz) application.
3. In this report, the performance of BGA5H1BN6 is measured on a Rogers board. This device is matched with 0402 size external components.
4. Key performance parameters at 2.8 V, 3300 MHz (high-gain mode)
   Noise Figure (NF) = 1.02 dB
   Insertion gain = 15.5 dB
   Input return loss = 8.3 dB
   Output return loss = 10.5 dB
   Input P1dB = -11.0 dBm

   Key performance parameters at 2.8 V, 3550 MHz (high-gain mode)
   NF = 0.93 dB
   Insertion gain = 14.6 dB
   Input return loss = 8.3 dB
   Output return loss = 8.9 dB
   Input P1dB = -10.2dBm

   Key performance parameters at 2.8 V, 3800 MHz (high-gain mode)
   NF = 1.1 dB
   Insertion gain = 13.6 dB
   Input return loss = 8.0 dB
   Output return loss = 7.7 dB
   Input P1dB = -9.4 dBm

   Key performance parameters at 2.8 V, 3300 MHz (bypass mode)
   Insertion loss = 6.5 dB

   Key performance parameters at 2.8 V, 3550 MHz (bypass mode)
   Insertion loss = 5.6 dB

   Key performance parameters at 2.8 V, 3800 MHz (bypass mode)
   Insertion loss = 4.8 dB

Table of contents

List of figures[1]

List of tables

1) The graphs are generated with the simulation program AWR Microwave Office®.

1 Introduction of LTE and 5G applications

Mobile phones today represent the largest worldwide market in terms of both volume and number of applications on a single platform. More than 1.5 billion phones are shipped per year worldwide. The major wireless functions in a typical mobile phone include a 2G/3G/4G/5G (GSM/EDGE/CDMA/UMTS/WCDMA/LTE/LTE-A/TD-SCDMA/TD-LTE) cellular modem, and wireless connectivity systems such as Wireless Local Area Network (WLAN), Global Navigation Satellite System (GNSS), broadcasting receivers, and Near-Field Communication (NFC).

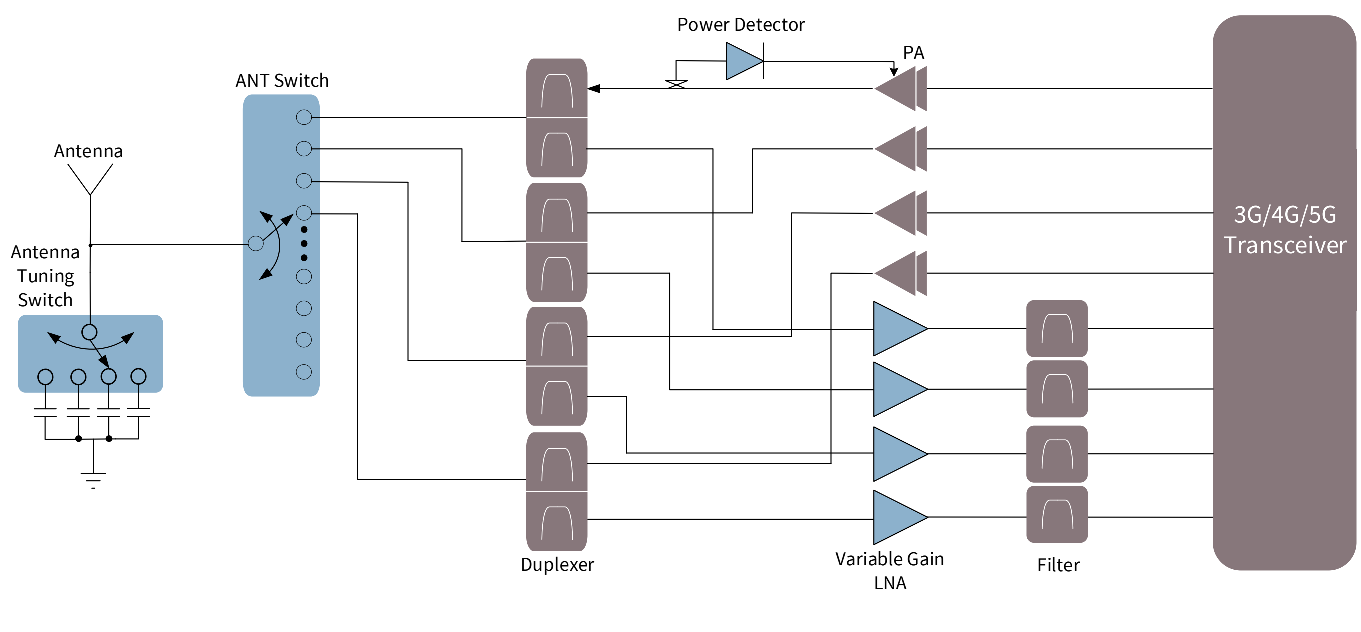

Figure 1 Block diagram of a 4G LTE/5G NR RF front-end

Moving toward 5G as well as 4G Long-Term Evolution-Advanced (LTE-A), the number of 5G and LTE bands has exploded in the last few years. Currently, there are more than 50 bands in use worldwide. The ability of 5G and 4G LTE-A to support bandwidth up to 100 MHz and to have more spectral efficiency by using high-order modulation schemes such as Quadrature Amplitude Modulation (QAM-64/256) is of particular importance as the demand for higher wireless data speeds continues to grow rapidly. LTE-A can aggregate up to five carriers (up to 100 MHz) to increase user data rates and capacity for high-speed applications. These new techniques for mobile high-data-rate communication and advanced wireless connectivity include:

- Inter-operation Frequency-Division Duplexing (FDD) and Time-Division Duplexing (TDD) systems
- Down-/uplink Carrier Aggregation (CA)
- LTE-U and LAA at 5 to 6 GHz using link aggregation or carrier aggregation
- Adaptive antenna systems
- Multiple-Input Multiple-Output (MIMO) for RF front-ends
- Device-to-Device (D2D) communication with LTE (LTE-D)
- High-speed wireline connection with USB 3.0, Bluetooth 4.0, etc.

The above-mentioned techniques drive the industry to develop new concepts for RF front-ends and the antenna system and digital interface protection. These require microwave semiconductor vendors to offer highly integrated and compact devices with lower loss rates, and more powerful linear performance. The key trends in RF components for mobile phone are:

- Microwave Monolithic Integrated Circuits (MMICs) with smaller form factors
- Higher levels of integration with control buses
- Higher RF power capability

- Ability to handle increased number of bands and operating modes
- Better immunity to interfering signals
- Frequency tuning ability
- Higher integration of various functions in single packages (modulization)

Table 1 LTE bands

Band no.	Band definition	Uplink frequency range	Downlink frequency range	FDD/TDD system	Comment
1	Mid-band	1920 to 1980 MHz	2110 to 2170 MHz	FDD	
2	Mid-band	1850 to 1910 MHz	1930 to 1990 MHz	FDD	
3	Mid-band	1710 to 1785 MHz	1805 to 1880 MHz	FDD	
4	Mid-band	1710 to 1755 MHz	2110 to 2155 MHz	FDD	
5	Low-band	824 to 849 MHz	869 to 894 MHz	FDD	
6	Low-band	830 to 840 MHz	875 to 885 MHz	FDD	
7	High-band	2500 to 2570 MHz	2620 to 2690 MHz	FDD	
8	Low-band	880 to 915 MHz	925 to 960 MHz	FDD	
9	Mid-band	1749.9 to 1784.9 MHz	1844.9 to 1879.9 MHz	FDD	
10	Mid-band	1710 to 1770 MHz	2110 to 2170 MHz	FDD	
11	Mid-band	1427.9 to 1452.9 MHz	1475.9 to 1500.9 MHz	FDD	
12	Low-band	698 to 716 MHz	728 to 746 MHz	FDD	
13	Low-band	777 to 787 MHz	746 to 756 MHz	FDD	
14	Low-band	788 to 798 MHz	758 to 768 MHz	FDD	
15		Reserved	Reserved	FDD	
16		Reserved	Reserved	FDD	
17	Low-band	704 to 716 MHz	734 to 746 MHz	FDD	
18	Low-band	815 to 830 MHz	860 to 875 MHz	FDD	
19	Low-band	830 to 845 MHz	875 to 890 MHz	FDD	
20	Low-band	832 to 862 MHz	791 to 821 MHz	FDD	
21	Mid-band	1447.9 to 1462.9 MHz	1495.9 to 1510.9 MHz	FDD	
22	High-band	3410 to 3500 MHz	3510 to 3600 MHz	FDD	
23	Mid-band	2000 to 2020 MHz	2180 to 2200 MHz	FDD	
24	Mid-band	1626.5 to 1660.5 MHz	1525 to 1559 MHz	FDD	
25	Mid-band	1850 to 1915 MHz	1930 to 1995 MHz	FDD	
26	Low-band	814 to 849 MHz	859 to 894 MHz	FDD	
27	Low-band	807 to 824 MHz	852 to 869 MHz	FDD	
28	Low-band	703 to 748 MHz	758 to 803 MHz	FDD	
29	Low-band	N/A	716 to 728 MHz	FDD	
30	High-band	2305 to 2315 MHz	2350 to 2360 MHz	FDD	
31	Low-band	452.5 to 457.5 MHz	462.5 to 467.5MHz	FDD	
32	Mid-band	N/A	1452 to 1496 MHz	FDD	
33	Mid-band	1900 to 1920 MHz		TDD	

Band no.	Band definition	Uplink frequency range	Downlink frequency range	FDD/TDD system	Comment
34	Mid-band	2010 to 2025 MHz		TDD	
35	Mid-band	1850 to 1910 MHz		TDD	
36	Mid-band	1930 to 1990 MHz		TDD	
37	Mid-band	1910 to 1930 MHz		TDD	
38	High-band	2570 to 2620 MHz		TDD	
39	Mid-band	1880 to 1920 MHz		TDD	
40	High-band	2300 to 2400 MHz		TDD	
41	High-band	2496 to 2690 MHz		TDD	
42	High-band	3400 to 3600 MHz		TDD	
43	High-band	3600 to 3800 MHz		TDD	
44	Low-band	703 to 803 MHz		TDD	
45	Mid-band	1447 to 1467 MHz		TDD	
46	Ultra -high-band	5150 to 5925 MHz		TDD	
…					
64		Reserved			
65	Mid-band	1920 to 2010 MHz	2110 to 2200 MHz	FDD	
66	Mid-band	1710 to 1780 MHz	2110 to 2200 MHz	FDD	
67	Low-band	N/A	738 to 758 MHz	FDD	
68	Low-band	698 to 728 MHz	753 to 783 MHz	FDD	

Note: FDD – Frequency Division Duplexing; TDD – Time Division Duplexing.

Table 2 5G bands

Band no.	Band definition	Uplink frequency range	Downlink frequency range	FDD/TDD system	Comment
n1	Mid-band	1920 to 1980 MHz	2110 to 2170 MHz	FDD	
n2	Mid-band	1850 to 1910 MHz	1930 to 1990 MHz	FDD	
n3	Mid-band	1710 to 1785 MHz	1805 to 1880 MHz	FDD	
n5	Mid-Band	824 to 849 MHz	869 to 894 MHz	FDD	
n7	High-band	2500 to 2570 MHz	2620 to 2690 MHz	FDD	
n8	Low-band	880 to 915 MHz	925 to 960 MHz	FDD	
n12	Low-band	699 to 716 MHz	729 to 746 MHz	FDD	
n20	Low-band	832 to 862 MHz	791 to 821 MHz	FDD	
n25	Mid-band	1850 to 1915 MHz	1930 to 1995 MHz	FDD	
n28	Low-band	703 to 748 MHz	758 to 803 MHz	FDD	
n34	Mid-band	2010 to 2025 MHz		TDD	
n38	High-band	2570 to 2620 MHz		TDD	
n39	Mid-band	1880 to 1920 MHz		TDD	
n40	High-band	2300 to 2400 MHz		TDD	
n41	High-band	2496 to 2690 MHz		TDD	
n50	Mid-band	1432 to 1517 MHz		TDD	
n66	Mid-band	1710 to 1780 MHz	2110 to 2200 MHz	FDD	
n70	Low-band	1695 to 1710 MHz	1995 to 2020 MHz	FDD	
n71	Mid-band	663 to 698 MHz	617 to 652 MHz	FDD	
n74	High-band	1427 to 1470 MHz	1475 to 1518 MHz	FDD	
n75	Mid-band	N/A	1432 to 1517 MHz	SDL	
n76	Mid-band	N/A	1427 to 1432 MHz	SDL	
n77	Mid-band	3300 to 4200 MHz		TDD	
n78	Low-band	3300 to 3800 MHz		TDD	
n79	Low-band	4400 to 5000 MHz		TDD	
n80	Mid-band	1710 to 1785 MHz	N/A	SUL	
n81	Low-band	880 to 915 MHz	N/A	SUL	
n82	Low-band	832 to 862 MHz	N/A	SUL	
n83	Low-band	703 to 748 MHz	N/A	SUL	
n84	Mid-band	1920 to 1980 MHz	N/A	SUL	
n86	Mid-band	1710 to 1780 MHz	N/A	SUL	

Note: FDD – Frequency Division Duplexing; TDD – Time Division Duplexing; SDL – Supplemental Downlink; SUL – Supplemental Uplink.

1.1 Key requirements for LNAs in LTE-A and 5G applications

5G and 4G LTE-A support data rates of up to 1 Gbps with advanced techniques such as MIMO and CA, etc. LTE-A can support up to five bands of CA by three component CA scenarios: intra-band contiguous, intra-band non-contiguous and inter-band non-contiguous aggregation. They present new challenges to RF front-end designers, such as interference from co-existing bands and harmonic generation. Smart LTE LNAs with the following features can address these requirements to achieve outstanding performance.

1.1.1 Low NF (NF)

An external LNA or LNA module boosts the sensitivity of the system by reducing the overall NF. In addition, due to the size constraint, the modem antenna and the receiver FE cannot always be placed close to the transceiver IC. The path loss in front of the integrated LNA on the transceiver IC increases the system NF significantly. An external LNA physically close to the antenna can help to eliminate the path loss and reduce the system NF. The sensitivity can be improved by several dB, which means a significant increase in the connectivity range.

1.1.2 High linearity (1-dB compression point P1dB and third-order intercept point IP3)

An increased number of bands at the receiver input create strong interference, leading to high requirements in linearity characteristics such as high input 1-dB compression point, second intermodulation (IMD2) products and input IP3 performance.

1.1.3 Low power consumption

Power consumption is even more important in today's smartphones. The latest LTE-A uses enhanced MIMO techniques with up to eight streams for downlink and four streams for uplink. Infineon's LNAs and LNA modules have low supply current and an integrated on/off feature that reduces power consumption and increases standby time for cellular handsets or other portable battery-operated wireless applications.

1.1.4 High integration and simple control interface

The demand for size and cost reduction and performance enhancement with ease of use and low parts count has become very important in existing and future generation smartphones. Our MMIC LNAs are highly integrated with input and output either matched or pre-matched, built-in temperature and supply voltage stabilization, and a fully ESD-protected circuit design to ensure stable operation and a simple control interface. More information on the LTE LNAs is available at: www.infineon.com/ltelna

More information on the mobile phone RF front-end and related Infineon product portfolio is available in the Application Guide Mobile Communication: www.infineon.com/appguide_rf_mobile.

2 BGA5H1BN6 overview

2.1 Features

- Operating frequencies: 2300 to 2690 MHz
- Insertion power gain: 18.1 dB
- Insertion loss in bypass mode: 5.2 dB
- Low NF: 0.7 dB
- Low current consumption: 8.5 mA
- Multi-state control: bypass and high-gain mode
- Supply voltage: 1.5 to 3.6 V
- Ultra-small TSNP-6-10 leadless package (footprint: 0.7 x 1.1 mm^2)
- B9HF silicon germanium technology
- RF output internally matched to 50 Ω
- Low external component count
- 2 kV HBM ESD protection (including AI-pin)
- Pb-free (RoHS compliant) package

RoHS

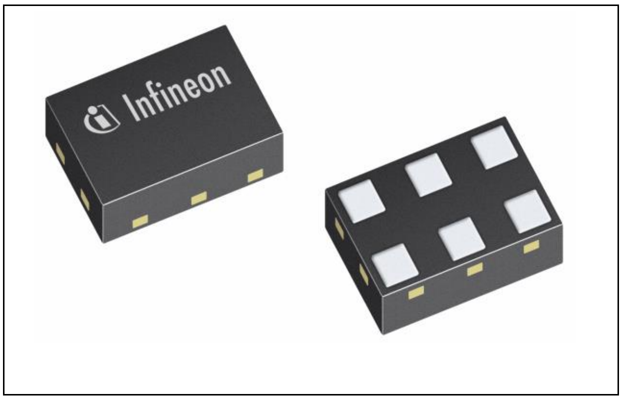

Figure 2 BGA5H1BN6

2.2 Description

The BGA5H1BN6 is a front-end LNA for LTE which covers a wide frequency range from 2300 to 2690 MHz. The LNA provides 18.1 dB gain and 0.7 dB NF at a current consumption of 8.5 mA in the application configuration described in Chapter 4. In bypass mode the LNA provides an insertion loss of 5.2 dB. The BGA5H1BN6 is based on Infineon Technologies' B9HF silicon germanium technology. It operates from 1.5 to 3.6 V supply voltage. The device features a single-line two-state control (bypass and high-gain mode). Off-state can be enabled by powering down V_{CC}.

Product name	Marking	Package
BGA5H1BN6	4	TSNP-6-10

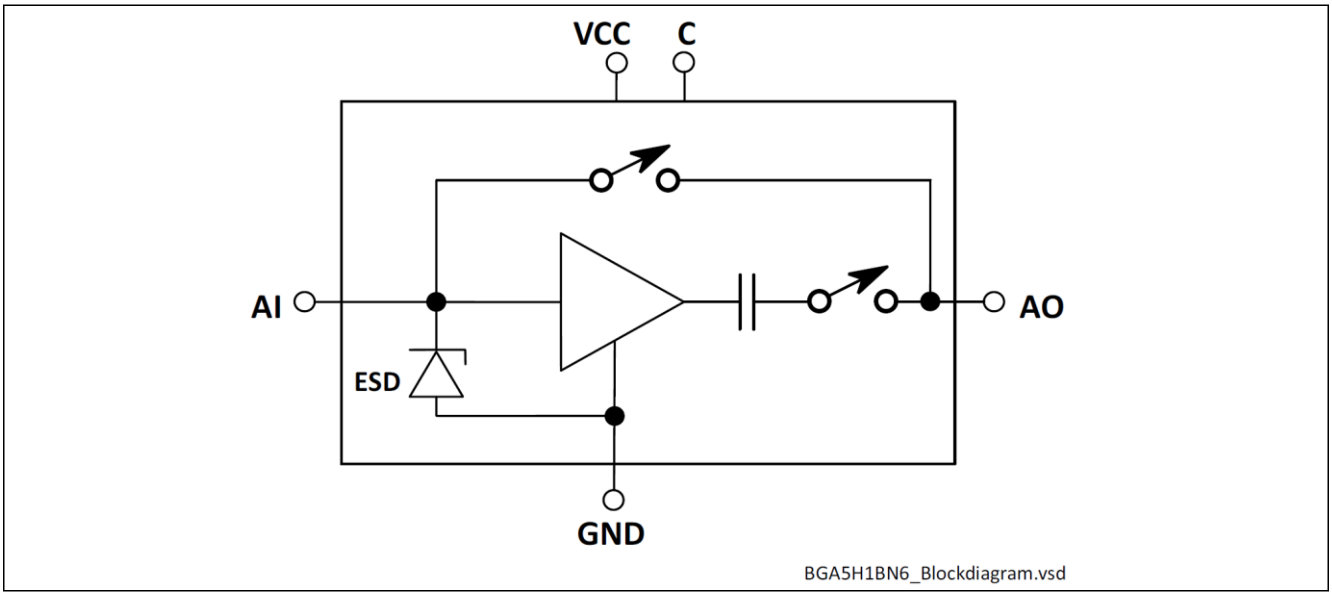

Figure 3 **Equivalent circuit of BGA5H1BN6**

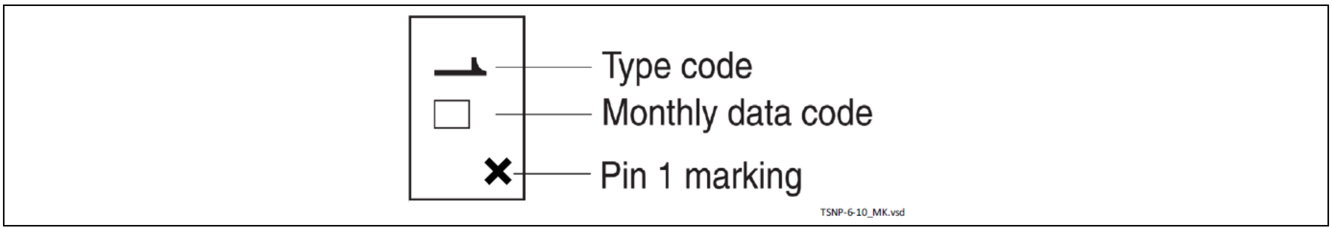

Figure 4 **Marking layout of TSNP-6-10**

Table 3 **Pin assignment of BGA5H1BN6**

Pin no.	Symbol	Function
1	GND	Ground
2	VCC	DC supply
3	AO	LNA output
4	GND	Ground
5	AI	LNA input
6	C	Control

3 Application circuit and performance overview

In this chapter the performance of the application circuit, the schematic and bill-on-materials are presented.

Device: BGA5H1BN6

Application: 15 dB high gain low-noise amplifier for 5G band n78 (3300 MHz to 3800 MHz) application (1800 to 2700 MHz) application

PCB Marking: BGA5X1BN6 V1.0

3.1 Summary of measurement results for band n78

Ther performance of BGA5H1BN6 for 5G Band n78 (3300 MHz – 3800 MHz) Application is summarized in the following table.

Table 4 Electrical characteristics of the BGA5H1BN6 (at room temperature) for 5G band n78 (3300 to 3800 MHz) in high gain mode

Parameter	Symbol	Value						Unit	Comment/Test Condition
DC Voltage	Vcc	1.8			2.8			V	
DC Current	Icc	8.8			9.2			mA	
Frequency Range	Freq	3300	3550	3800	3300	3550	3800	MHz	
Gain	G	15.3	14.4	13.4	15.5	14.6	13.6	dB	
Noise Figure	NF	1.02	0.93	1.1	1.02	0.93	1.1	dB	Loss of input line 0.2 dB deembedded
Input Return Loss	RLin	8.4	8.4	8.1	8.3	8.3	8.0	dB	
Output Return Loss	RLout	10.7	9.2	7.95	10.5	8.9	7.7	dB	
Reverse Isolation	IRev	32.0	31.5	30.9	31.9	31.2	30.8	dB	
Input P1dB	IP1dB	-12.0	-11.5	-10.5	-11.0	-10.2	-9.4	dBm	
Output P1dB	OP1dB	2.3	1.9	1.9	3.5	3.4	3.3	dBm	
Input IP3	IIP3	-0.8			-0.3			dBm	f_1 = 3549 MHz f_2 = 3551 MHz P_{in} = -30 dBm
Output IP3	OIP3	13.5			14.3			dBm	
Stability	k	>1						--	Unconditionally stable from 0 to 10 GHz

Table 5 Electrical characteristics of the BGA5H1BN6 (at room temperature) for 5G band n78 (3300 to 3800 MHz) in bypass mode

Parameter	Symbol	Value						Unit	Comment/Test Condition
DC Voltage	Vcc	1.8			2.8			V	
DC Current	Icc	84			87			uA	
Frequency Range	Freq	3300	3550	3800	3300	3550	3800	MHz	
Gain	G	-5.8	-6.4	-7.3	-5.8	-6.4	-7.2	dB	
Noise Figure	NF	4.6	5.1	6.7	3.8	5.0	6.4	dB	Loss of input line 0.2 dB deembedded
Input Return Loss	RLin	6.5	5.6	4.8	6.5	5.6	4.8	dB	
Output Return Loss	RLout	6.7	6.1	5.4	6.7	6.1	5.5	dB	
Reverse Isolation	IRev	5.8	6.4	7.2	5.8	6.4	7.3	dB	
Input P1dB	IP1dB	-6.8	-7.4	-8.3	-6.8	-7.4	-8.2	dBm	
Output P1dB	OP1dB	-13.7	-14.9	-16.6	-13.6	-14.8	-16.4	dBm	
Input IP3	IIP3	4.4			4.5			dBm	f_1 = 3549 MHz f_2 = 3551 MHz P_{in} = -10 dBm
Output IP3	OIP3	-1.8			-2.0			dBm	
Stability	k	>1						--	Unconditionally stable from 0 to 10 GHz

3.2 BGA5H1BN6 as 3300 MHz – 3800 MHz application low noise amplifier for 5G band n78 application

The BGA5H1BN6 is a silicon germanium LNA for 5G RF front-end in the range from 3300 to 3800 MHz. In this application note, the performance of BGA5H1BN6 for 5G band n78 (3300 to 3800 MHz) is investigated at 1.8 V and 2.8 V supply voltages. The circuit uses 0402 size components for matching.

At 1.8 V, high-gain mode, at 3300 MHz, the BGA5H1BN6 achieves a NF of about 1.02 dB and a gain of 15.3 dB. The input return loss is 8.4 dB and output return loss is 10.7 dB. It obtains an input 1 dB compression point (IP1dB) of -12.0 dBm.

At 1.8 V, high-gain mode, at 3550 MHz, the BGA5H1BN6 achieves a NF of about 0.93 dB and a gain of 14.4 dB. The input return loss is 8.4 dB and output return loss is 9.2 dB. It obtains an input 1 dB compression point (IP1dB) of -11.5 dBm. Using two tones of -30 dBm spacing 2 MHz, the circuit achieves an IIP3 of -0.8 dBm.

At 1.8 V, high-gain mode, at 3800 MHz, the BGA5H1BN6 achieves a NF of about 1.10 dB and a gain of 13.4 dB. The input return loss is 8.1 dB and output return loss is 7.9 dB. It obtains an input 1 dB compression point (IP1dB) of -10.5 dBm.

At 2.8 V, high-gain mode, at 3300 MHz, the BGA5H1BN6 achieves a NF of about 1.02 dB and a gain of 15.5 dB. The input return loss is 8.3 dB and output return loss is 10.5 dB. It obtains an input 1 dB compression point (IP1dB) of -11.0 dBm.

At 2.8 V, high-gain mode, at 3550 MHz, the BGA5H1BN6 achieves a NF of about 0.93 dB and a gain of 14.6 dB. The input return loss is 8.3 dB and output return loss is 8.9 dB. It obtains an input 1 dB compression point (IP1dB) of -10.2 dBm. Using two tones of -30 dBm spacing 2 MHz, the circuit achieves an IIP3 of -0.3 dBm.

At 2.8 V, high-gain mode, at 3800 MHz, the BGA5H1BN6 achieves a NF of about 1.10 dB and a gain of 13.6 dB. The input return loss is 8.0 dB and output return loss is 7.7 dB. It obtains an input 1 dB compression point (IP1dB) of -9.4 dBm.

At 1.8 V, bypass mode, at 3300 MHz, the BGA5H1BN6 achieves a NF of about 4.6 dB and a gain of -5.8 dB. The input return loss is 6.5 dB and output return loss is 6.7 dB. It obtains an input 1 dB compression point (IP1dB) of -6.8 dBm.

At 1.8 V, bypass mode, at 3550 MHz, the BGA5H1BN6 achieves a NF of about 5.1 dB and a gain of -6.4 dB. The input return loss is 5.6 dB and output return loss is 6.1 dB. It obtains an input 1 dB compression point (IP1dB) of -7.4 dBm. Using two tones of -10 dBm spacing 2 MHz, the circuit achieves an IIP3 of 4.4 dBm.

At 1.8 V, bypass mode, at 3800 MHz, the BGA5H1BN6 achieves a NF of about 6.7 dB and a gain of -7.3 dB. The input return loss is 4.8 dB and output return loss is 5.4 dB. It obtains an input 1 dB compression point (IP1dB) of -8.3 dBm.

At 2.8 V, bypass mode, at 3300 MHz, the BGA5H1BN6 achieves a NF of about 3.8 dB and a gain of -5.8 dB. The input return loss is 6.5 dB and output return loss is 6.7 dB. It obtains an input 1 dB compression point (IP1dB) of -6.8 dBm.

At 2.8 V, bypass mode, at 3550 MHz, the BGA5H1BN6 achieves a NF of about 5.0 dB and a gain of -6.4 dB. The input return loss is 5.6 dB and output return loss is 6.1 dB. It obtains an input 1dB compression point (IP1dB) of -7.4 dBm. Using two tones of -10 dBm spacing 2 MHz, the circuit achieves an IIP3 of 4.5 dBm.

At 2.8 V, bypass mode, at 3800 MHz, the BGA5H1BN6 achieves a NF of about 6.4 dB and a gain of -7.2 dB. The input return loss is 4.8 dB and output return loss is 5.5 dB. It obtains an input 1 dB compression point (IP1dB) of -8.2 dBm.

The circuit is unconditionally stable up to 10 GHz.

3.3 Schematics and bill-of-materials

Ther schematic of BGA5H1BN6 for 5G Band n78 Application is presented in **Figure 5** and its bill-of-materials is shown in **Table 6**.

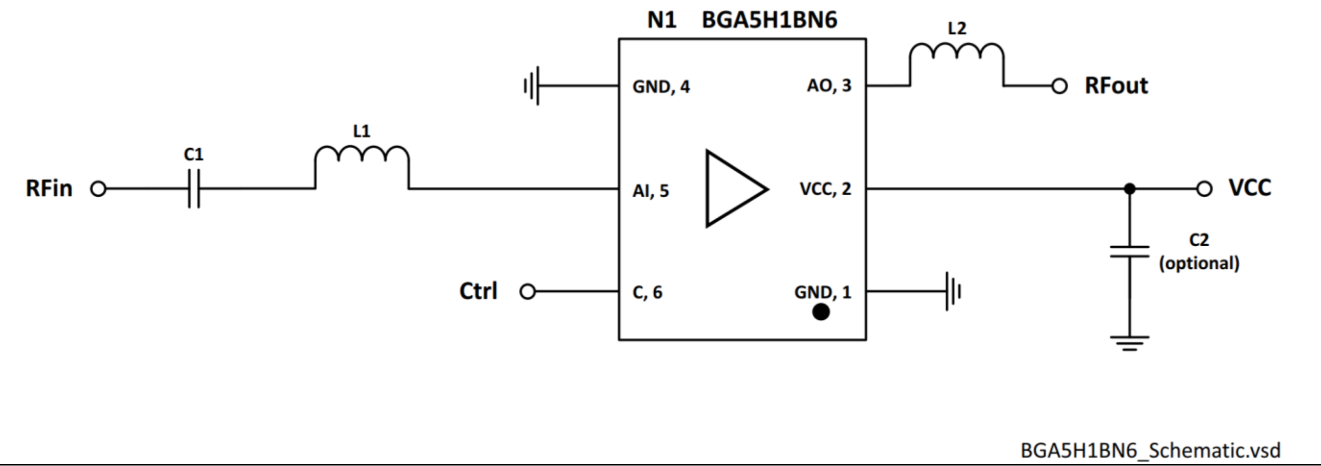

Figure 5 Schematics of the BGA5H1BN6 application circuit

Table 6 Bill-of-materials

Symbol	Value	Unit	Size	Manufacturer	Comment
C1	1	nF	0402	Various	DC block[1)]
C2	1	nF	0402	Various	RF bypass[2)]
L1	2.2	nH	0402	Murata LQW15 type	Input matching
L2	1.7	nH	0402	Murata LQW15 type	Input matching
N1	BGA5H1BN6		TSNP-6-10	Infineon Technologies	SiGe LNA

1) DC block function is NOT integrated at input of BGA5H1BN6. The DC block capacitor C1 is not necessary if the DC block function on the RF input line can be ensured by the previous stage.

2) RF bypass C2 is recommendend to mitigate power supply noise

4 Measurement graphs

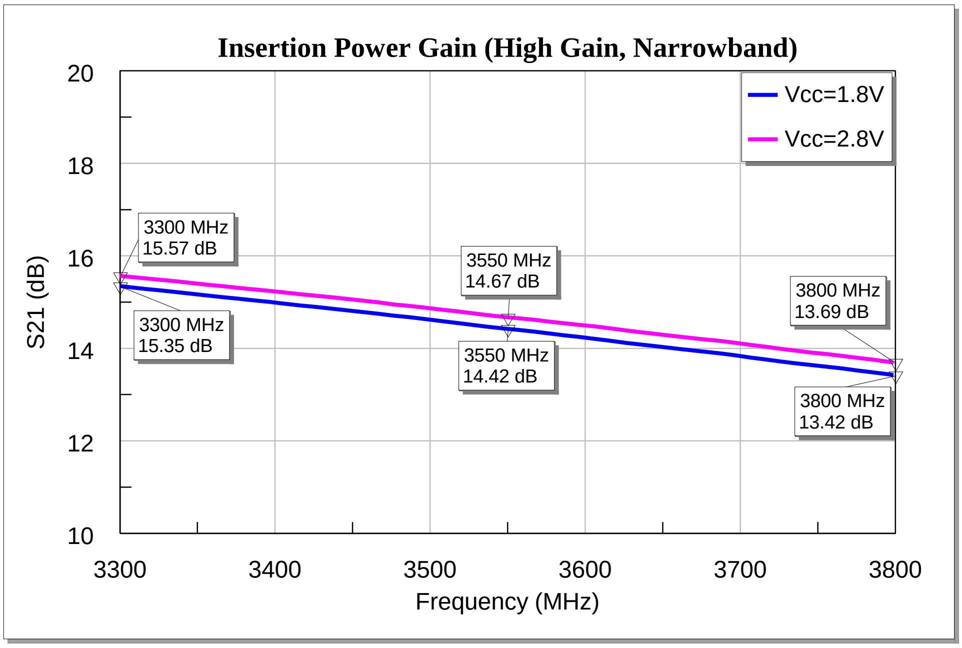

Figure 6 Insertion power gain (high gain, narrowband) of BGA5H1BN6 for band n78 applications

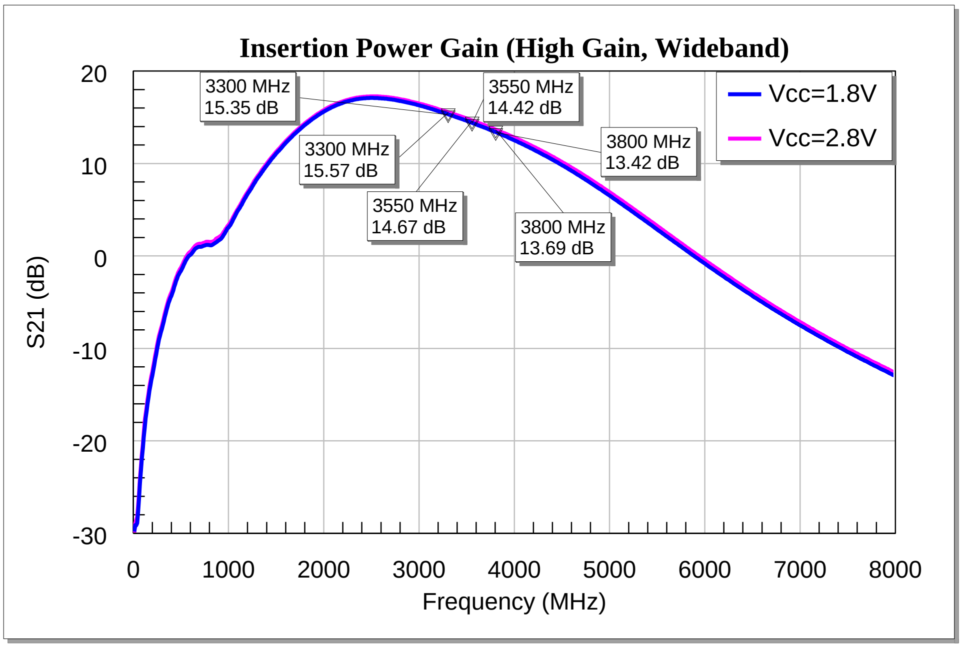

Figure 7 Insertion power gain (high gain, wideband) of BGA5H1BN6 for band n78 applications

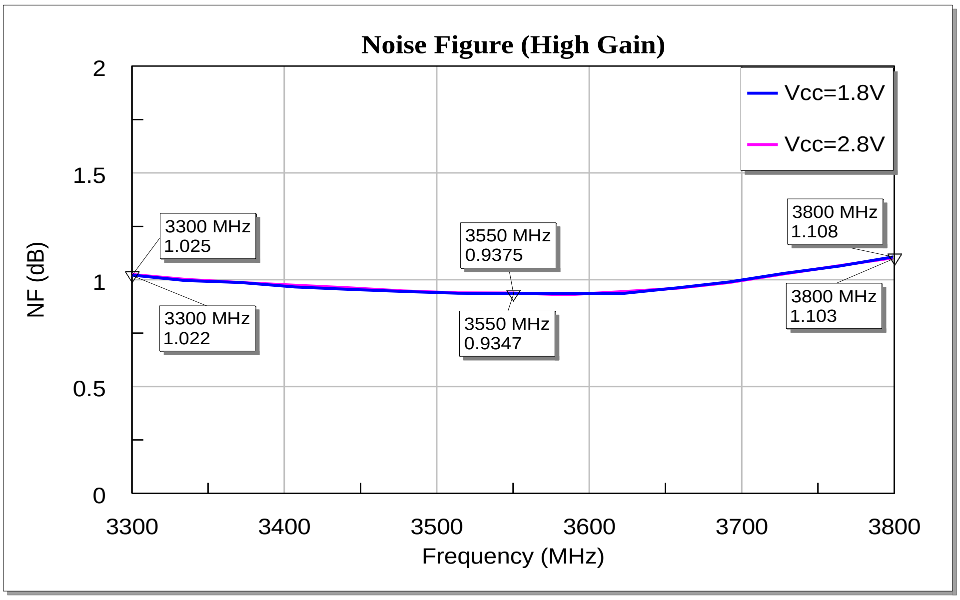

Figure 8 Noise figure (high gain) of BGA5H1BN6 for band n78 applications

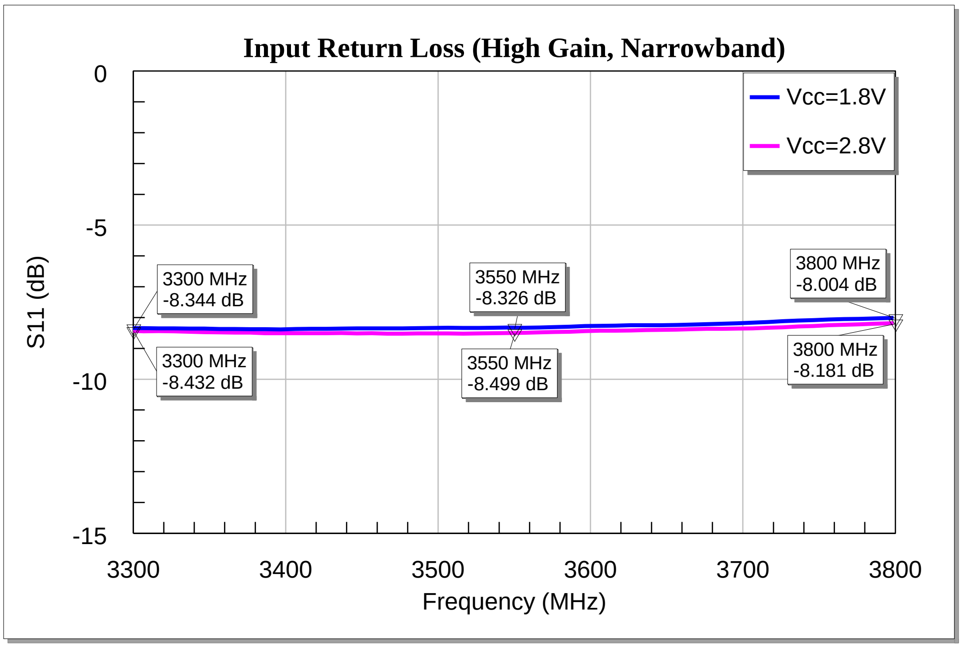

Figure 9 Input return loss (high gain, narrowband) of BGA5H1BN6 for band n78 applications

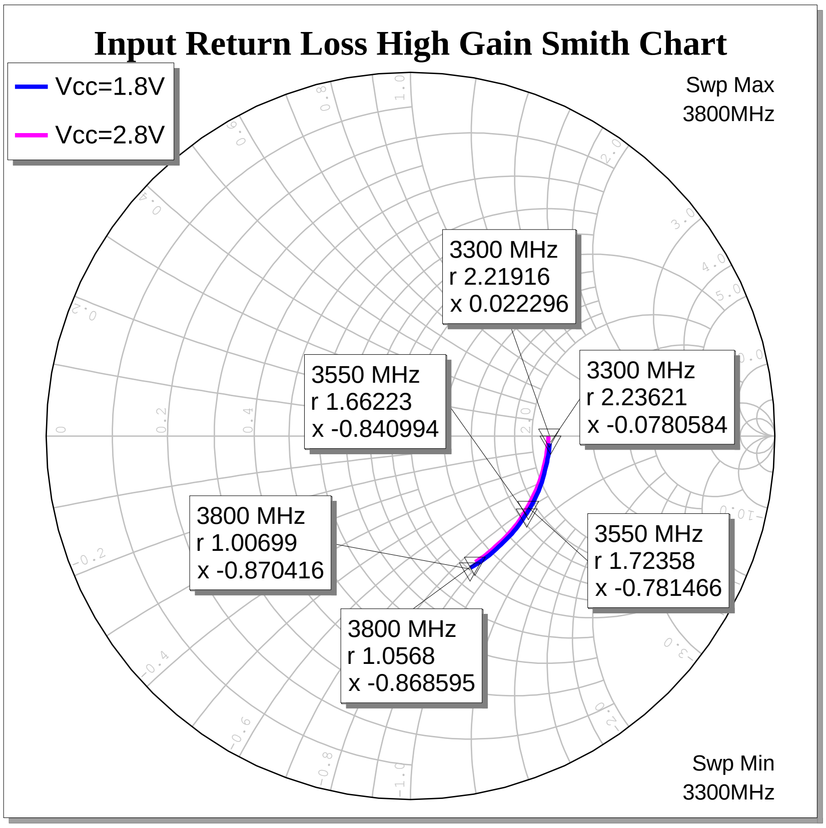

Figure 10 Input return loss (high gain, smith chart) of BGA5H1BN6 for band n78 applications

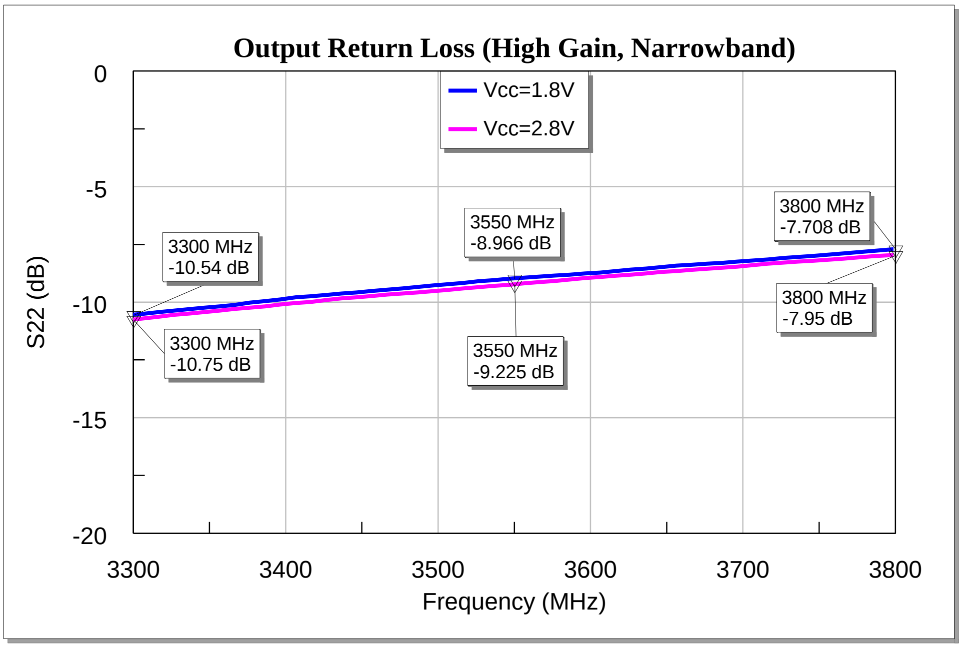

Figure 11 Output return loss (high gain, narrowband) of BGA5H1BN6 for band n78 applications

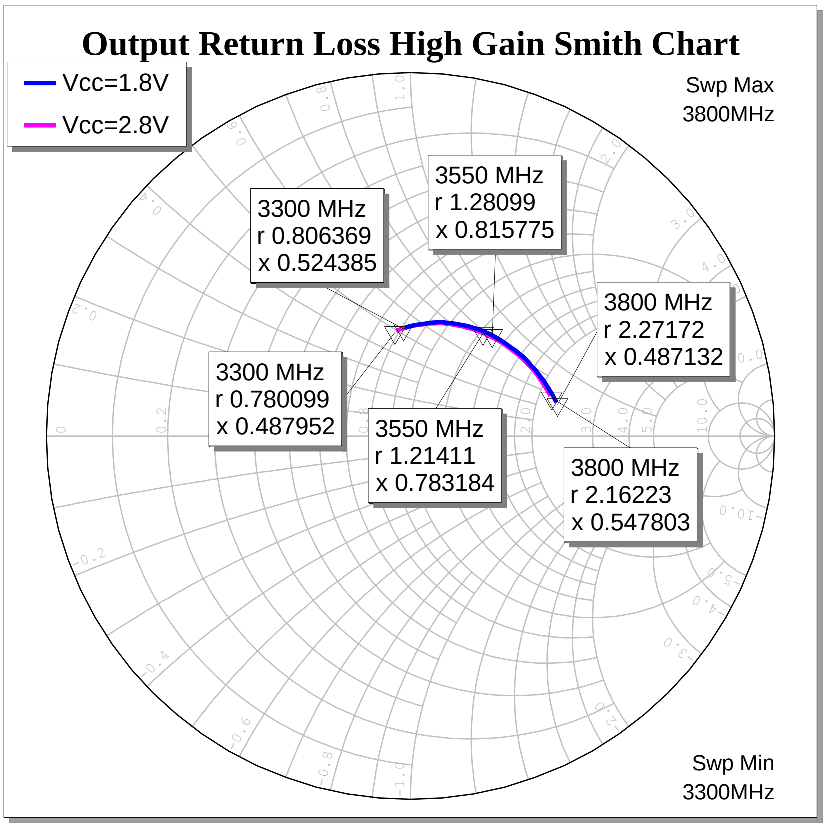

Figure 12 Output return loss (high gain, smith chart) of BGA5H1BN6 for band n78 applications

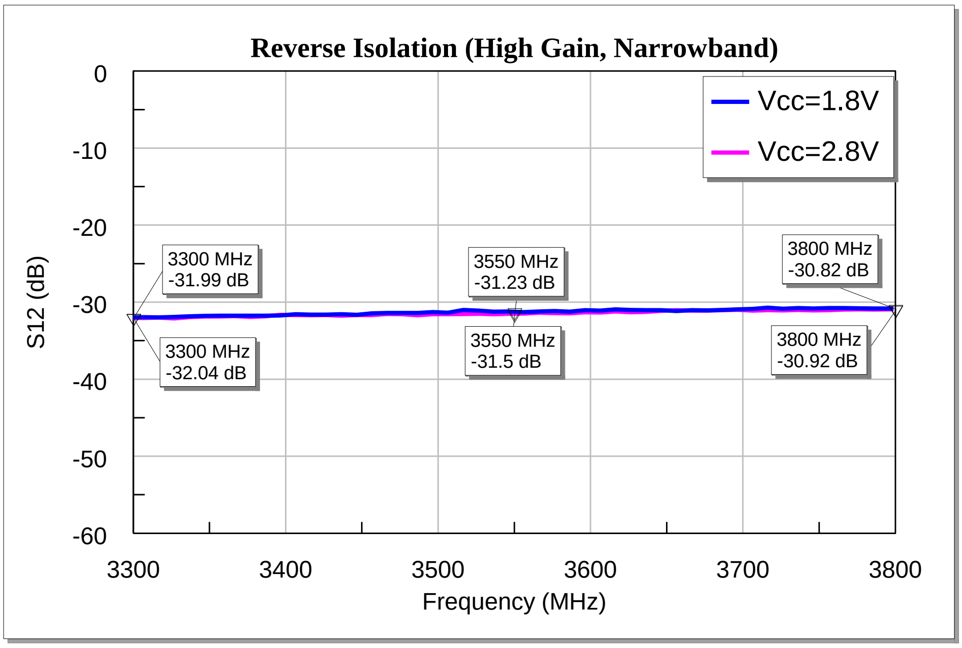

Figure 13 Reverse isolation (high gain, narrowband) of BGA5H1BN6 for band n78 applications

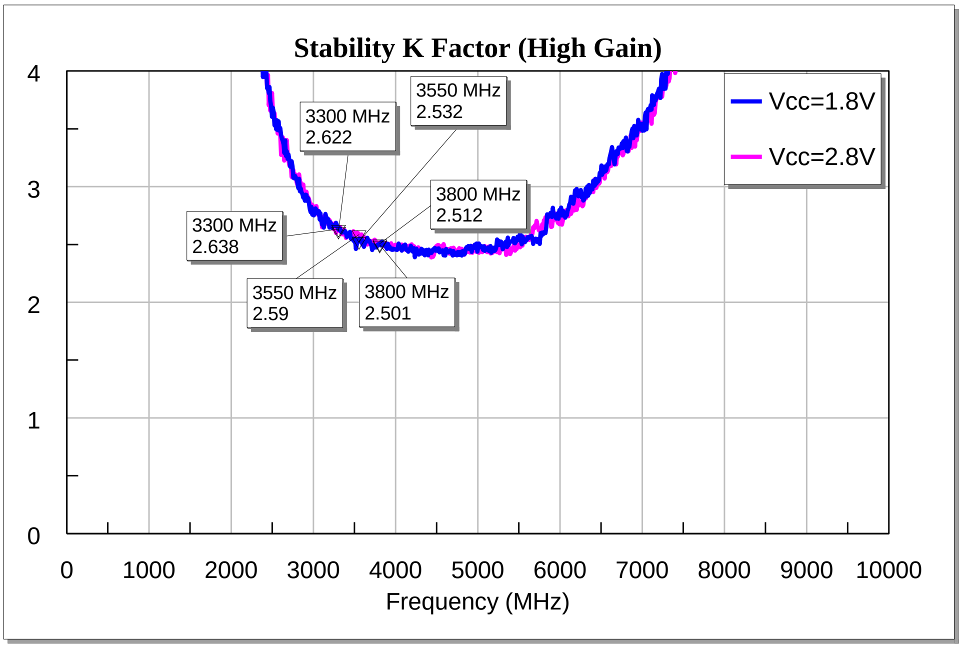

Figure 14 Stability K-factor (high gain) of BGA5H1BN6 for band n78 applications

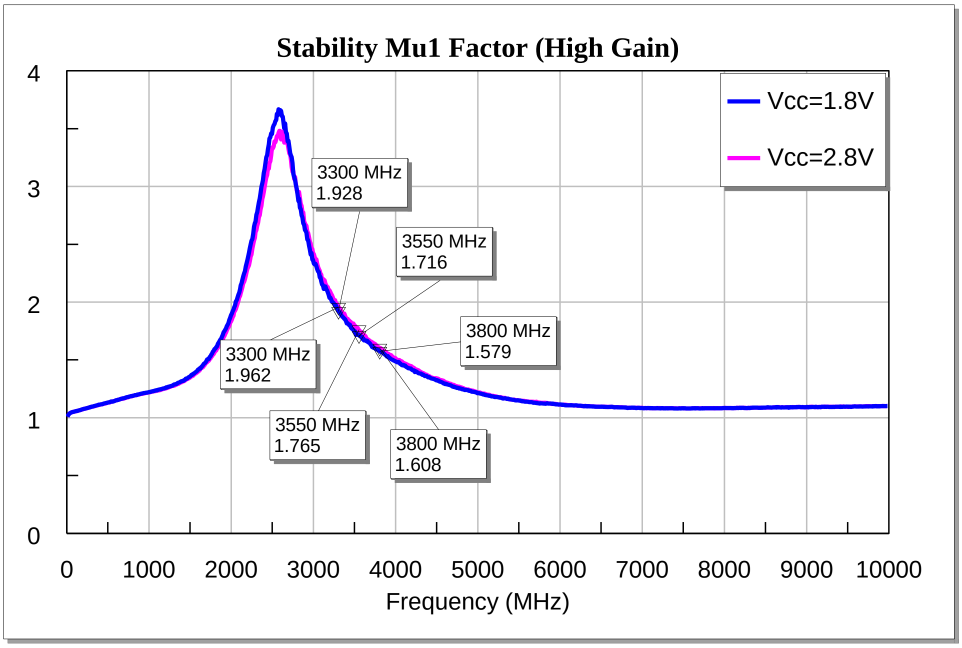

Figure 15 Stability Mu1-factor (high gain) of BGA5H1BN6 for band n78 applications

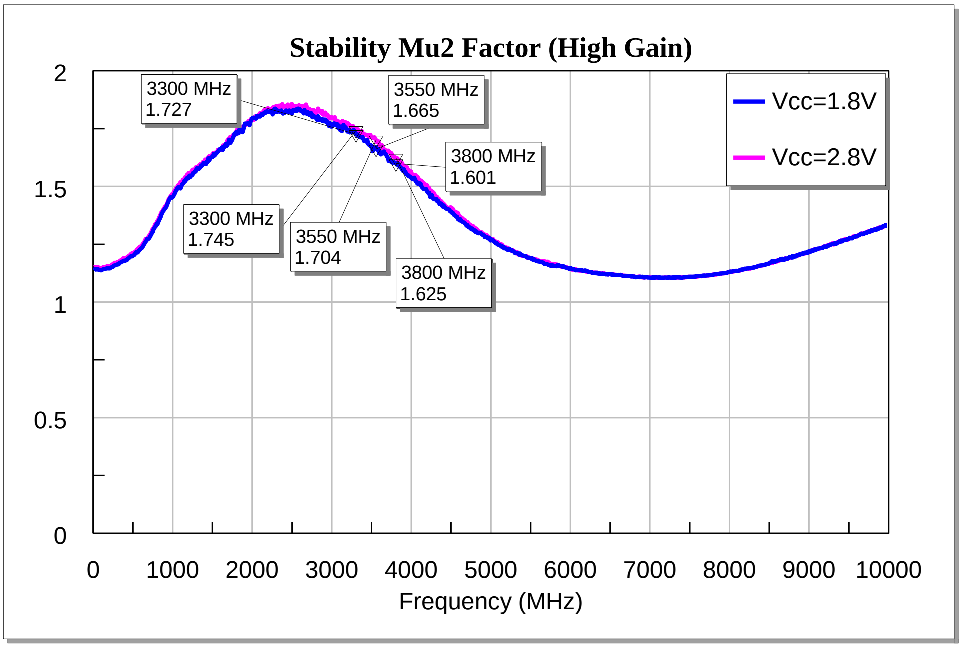

Figure 16 Stability Mu2-factor (high gain) of BGA5H1BN6 for band n78 applications

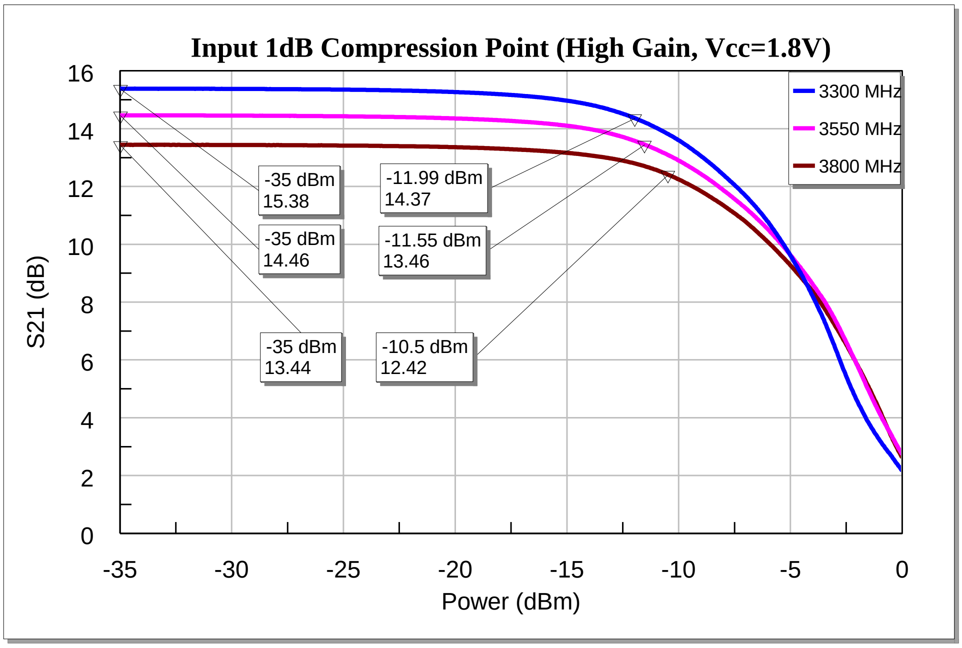

Figure 17 Input 1dB compression point (high gain, 1.8V) of BGA5H1BN6 for band n78 applications

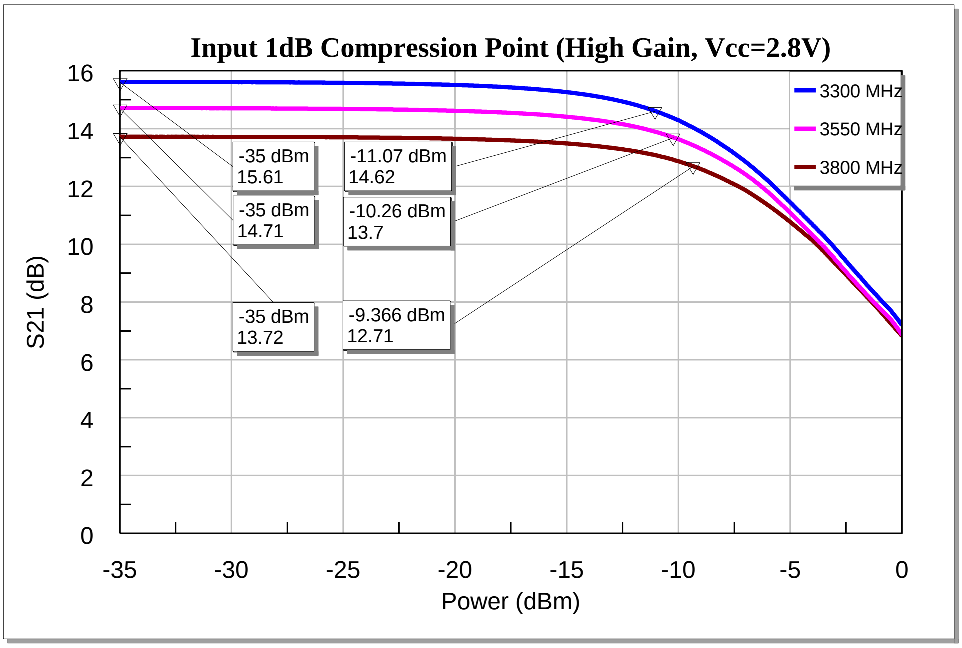

Figure 18 Input 1dB compression point (high gain, 2.8V) of BGA5H1BN6 for band n78 applications

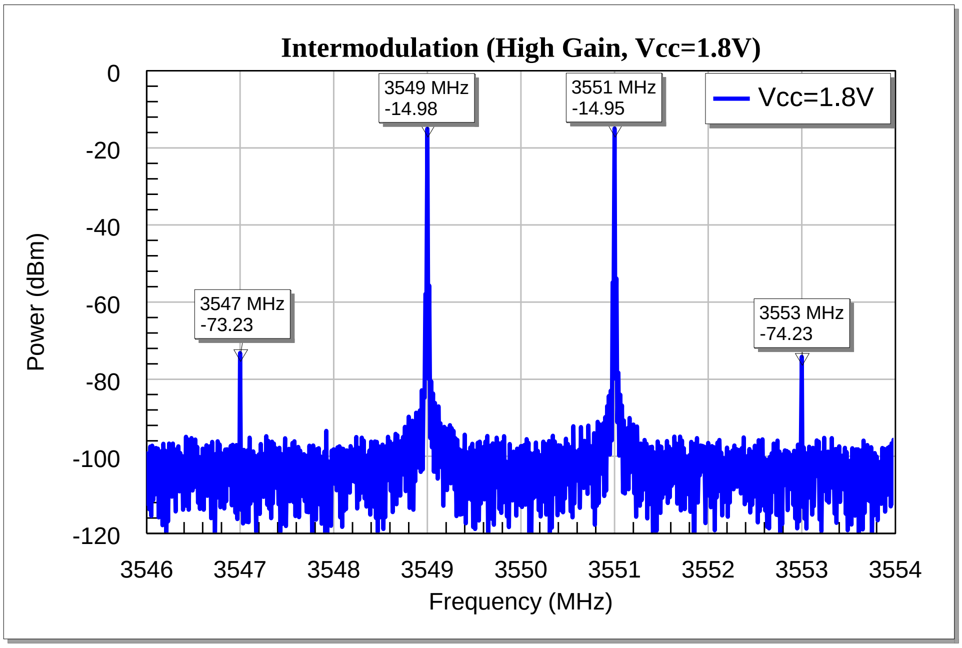

Figure 19 Third-order interception point (high gain, 1.8V) of BGA5H1BN6 for band n78 applications

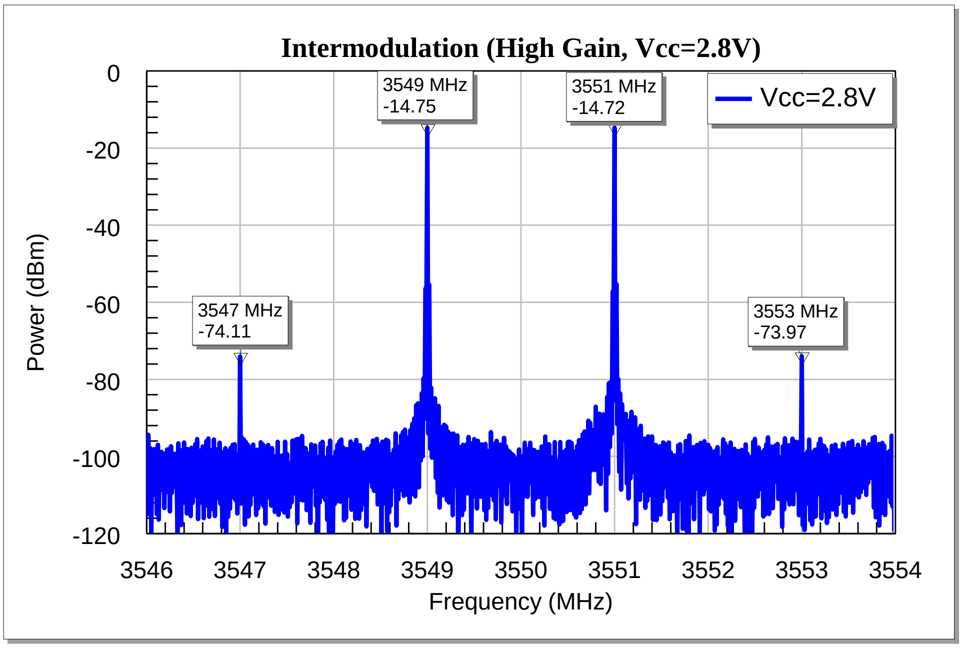

Figure 20 Third-order interception point (high gain, 2.8V) of BGA5H1BN6 for band n78 applications

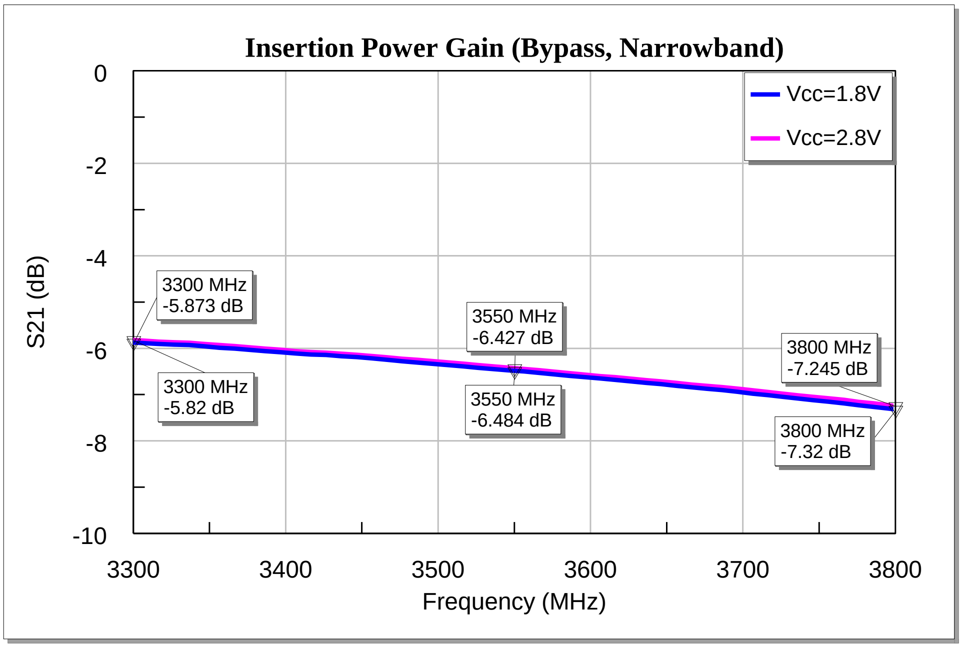

Figure 21 Insertion power gain (bypass, narrowband) of BGA5H1BN6 for band n78 applications

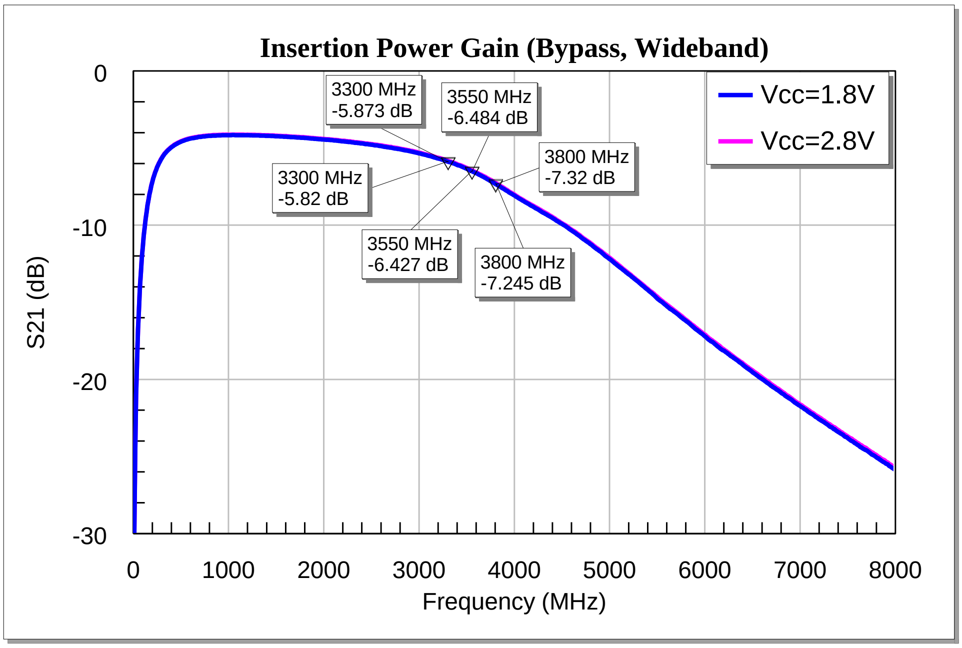

Figure 22 Insertion power gain (bypass, wideband) of BGA5H1BN6 for band n78 applications

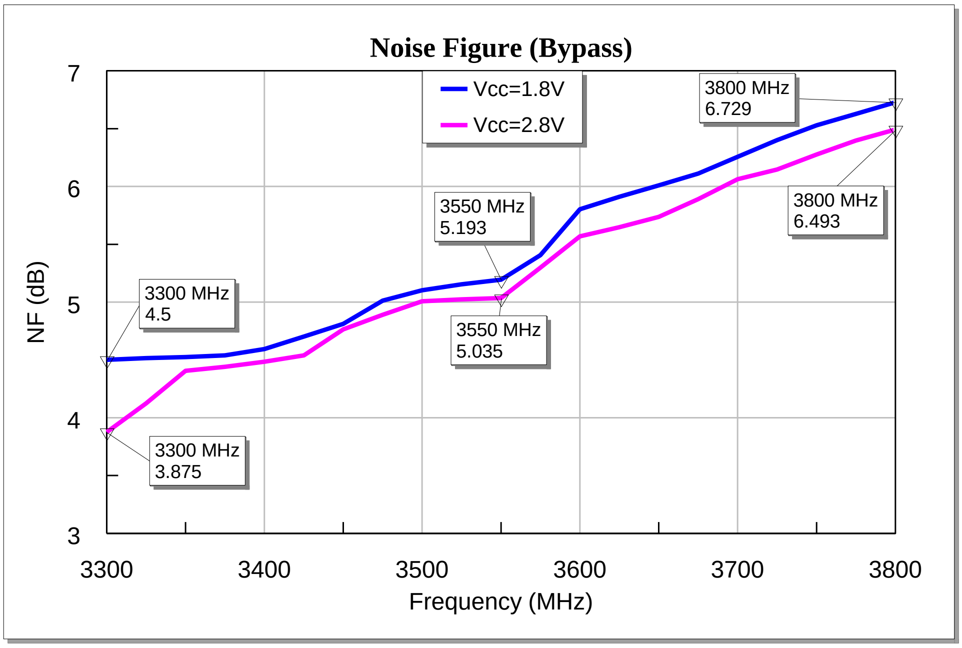

Figure 23 Noise figure (bypass) of BGA5H1BN6 for band n78 applications

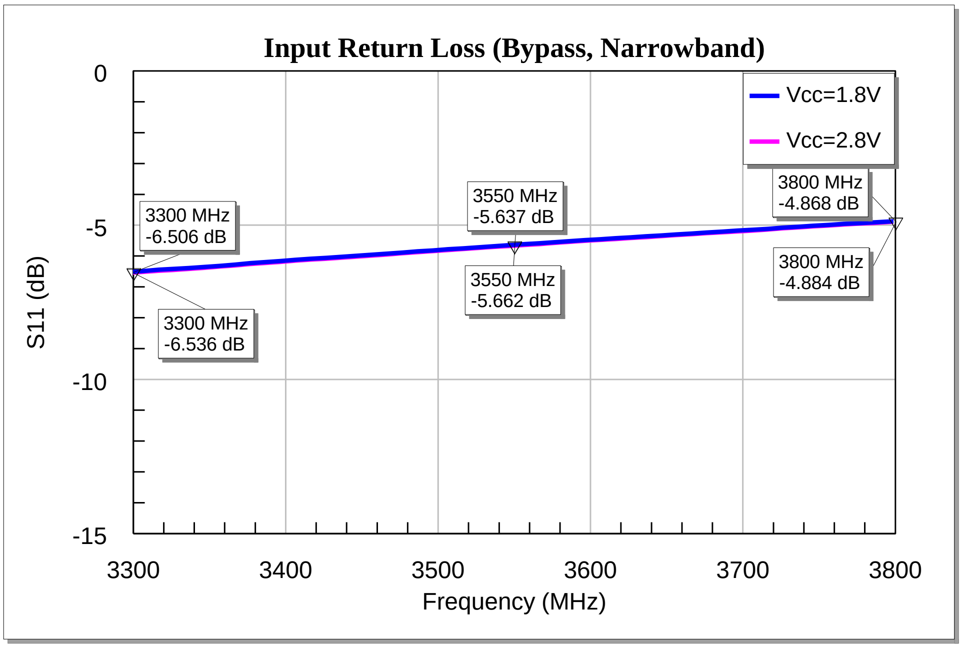

Figure 24 Input return loss (bypass, narrowband) of BGA5H1BN6 for band n78 applications

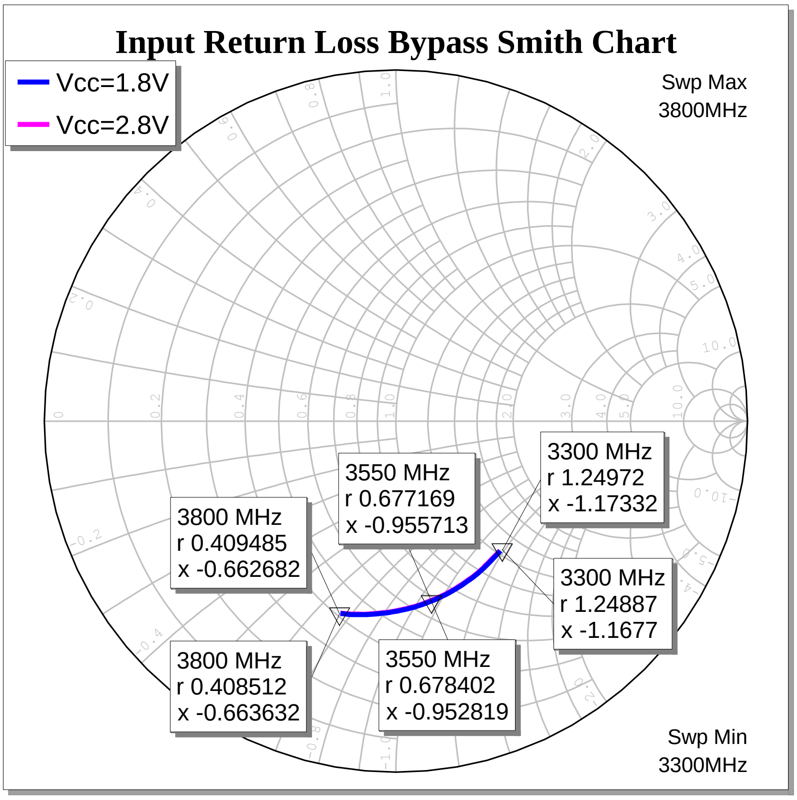

Figure 25 Input return loss (bypass, smith chart) of BGA5H1BN6 for band n78 applications

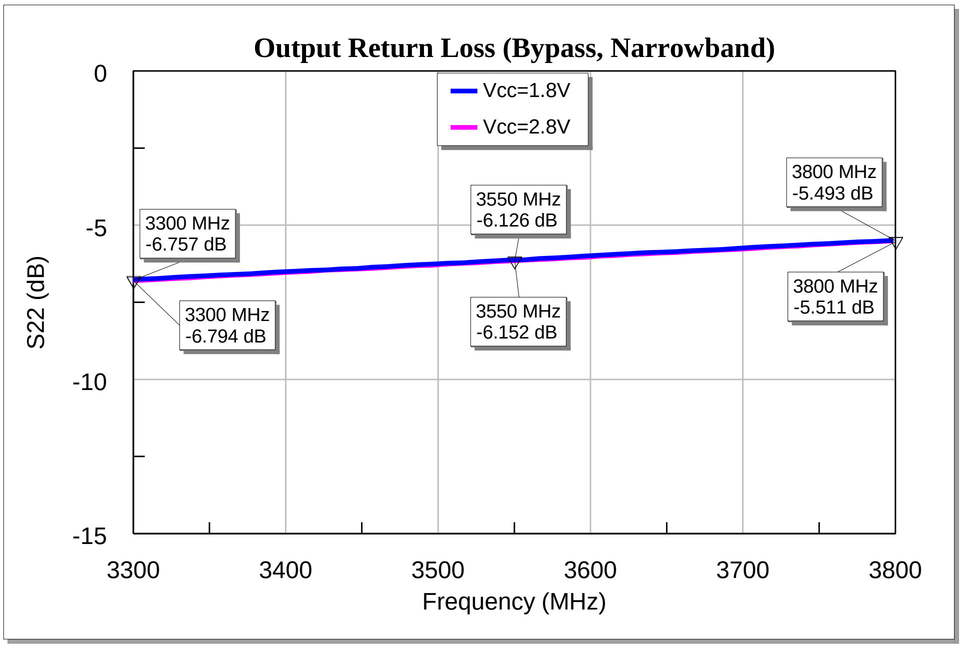

Figure 26 Output return loss (bypass, narrowband) of BGA5H1BN6 for band n78 applications

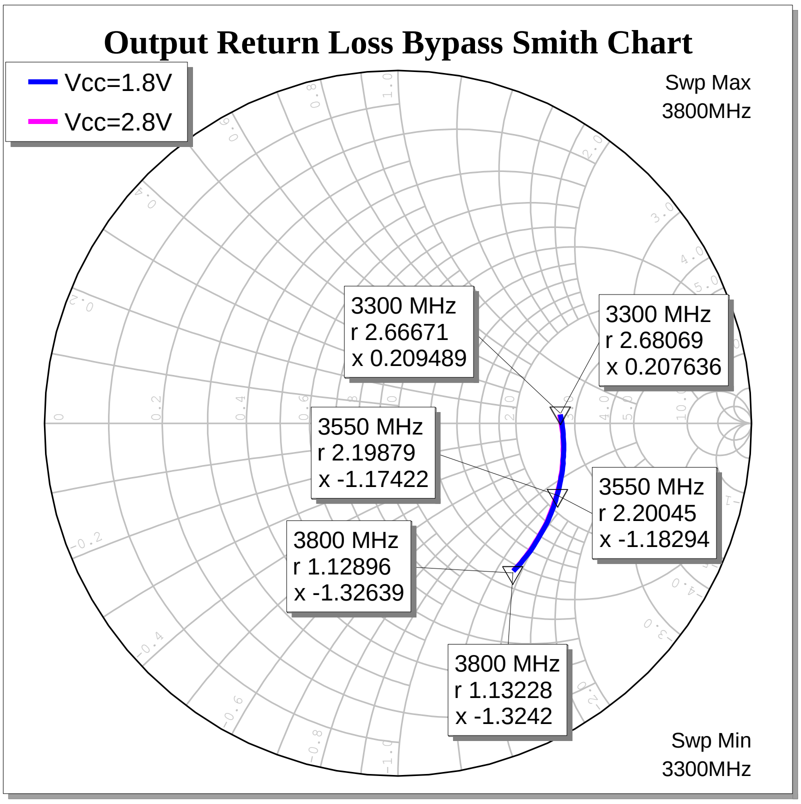

Figure 27 Output return loss (bypass, smith chart) of BGA5H1BN6 for band n78 applications

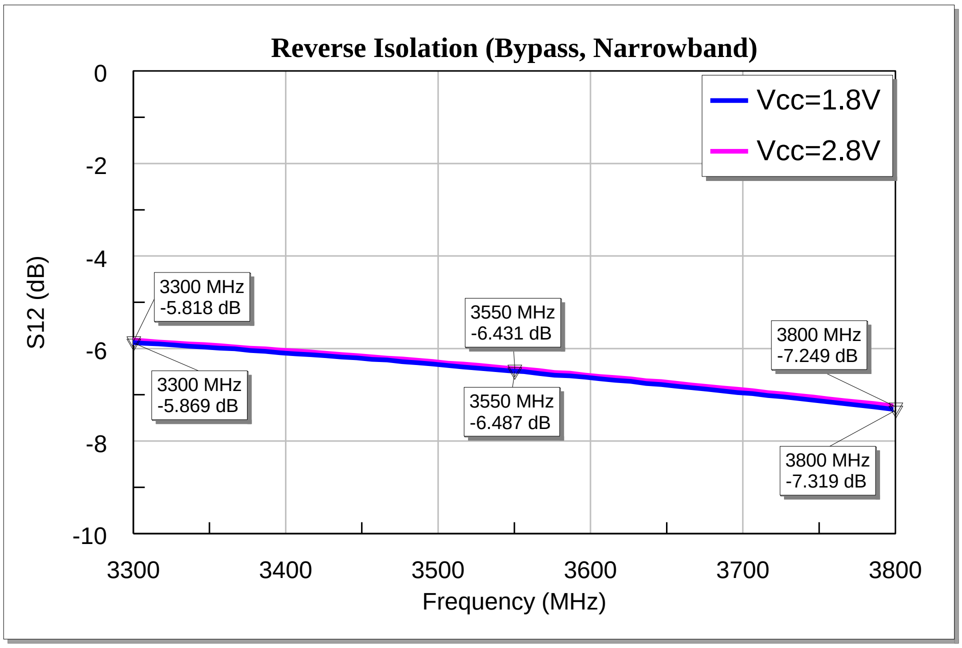

Figure 28 Reverse isolation (high gain, narrowband) of BGA5H1BN6 for band n78 applications

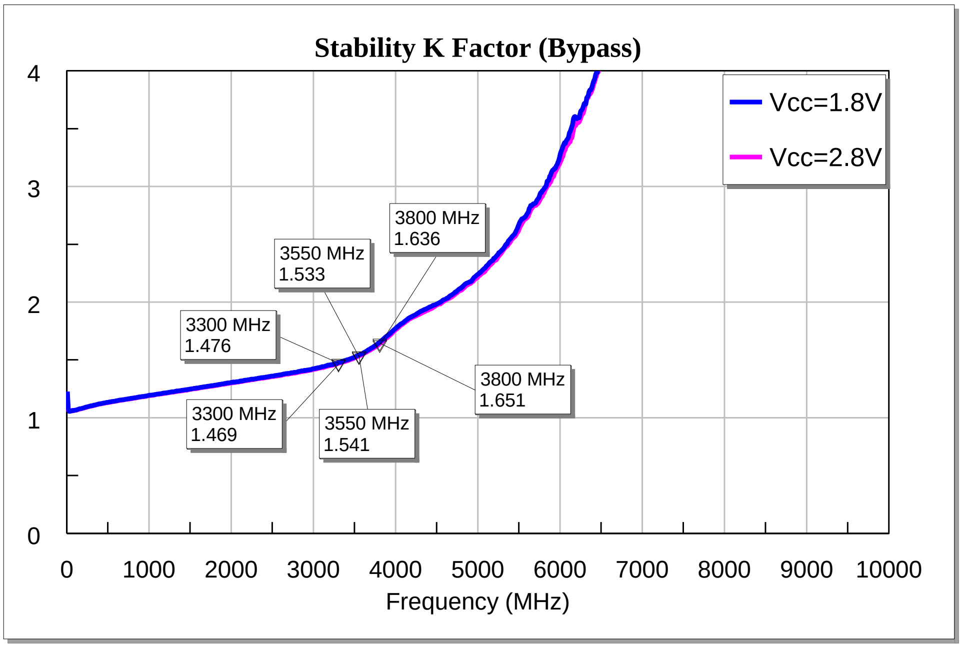

Figure 29 Stability K-factor (bypass) of BGA5H1BN6 for band n78 applications

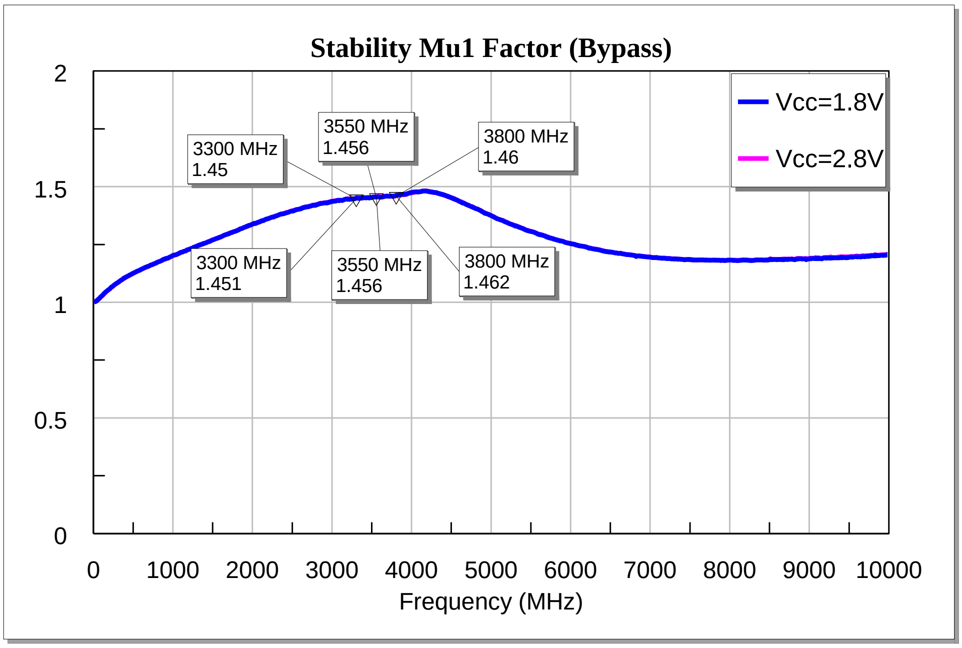

Figure 30 Stability Mu1-factor (bypass) of BGA5H1BN6 for band n78 applications

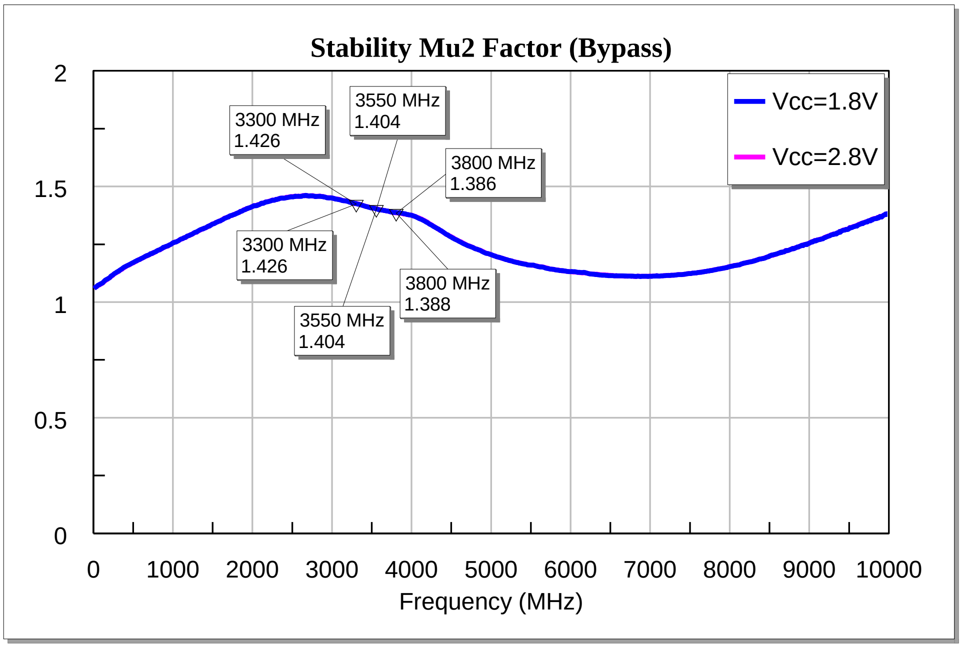

Figure 31 Stability Mu2-factor (bypass) of BGA5H1BN6 for band n78 applications

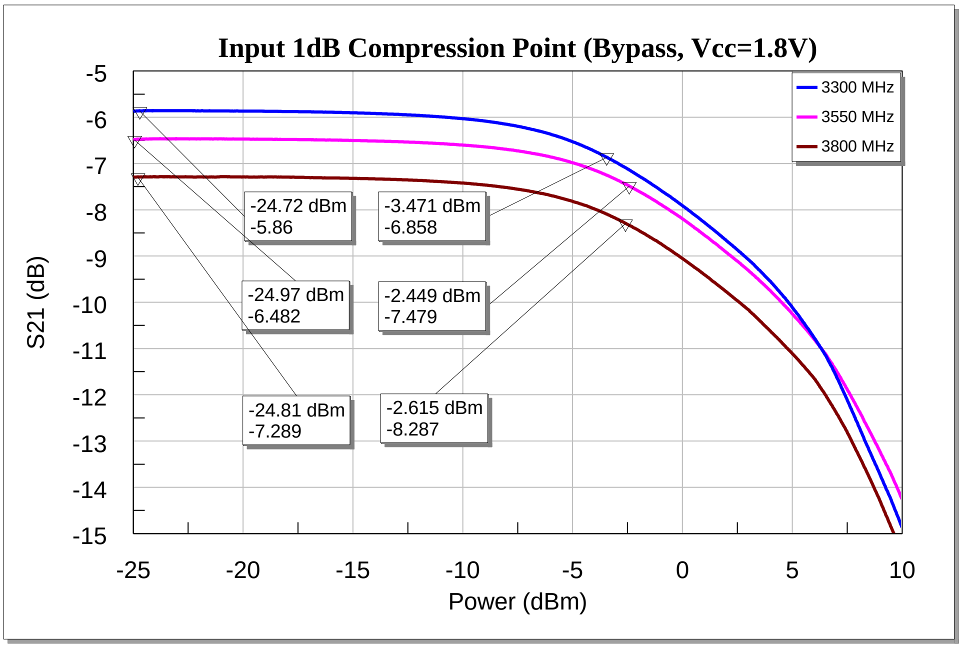

Figure 32 Input 1dB compression point (bypass, 1.8V) of BGA5H1BN6 for band n78 applications

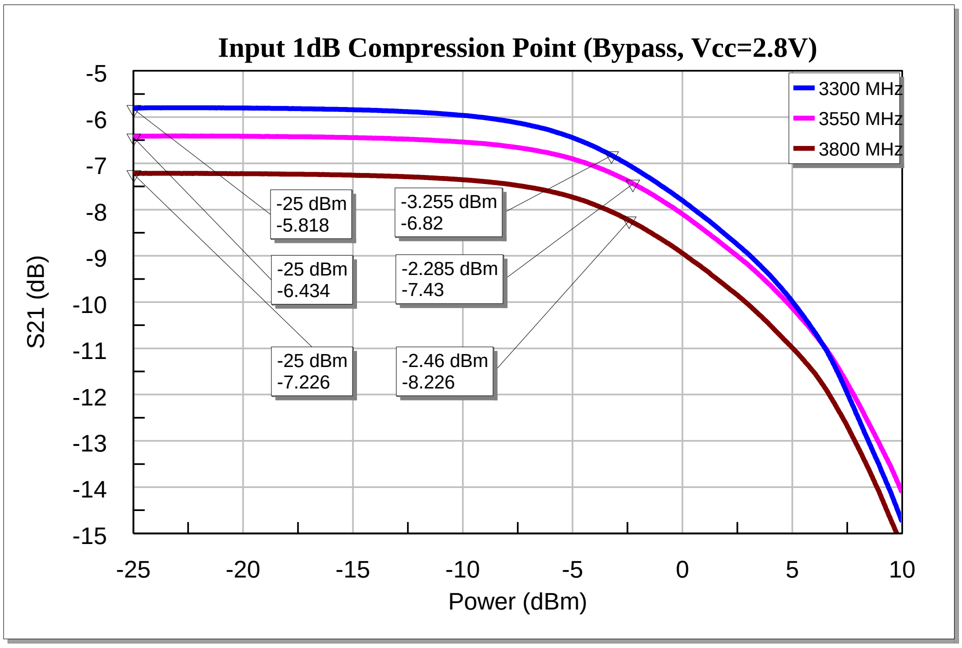

Figure 33 Input 1dB compression point (bypass, 2.8V) of BGA5H1BN6 for band n78 applications

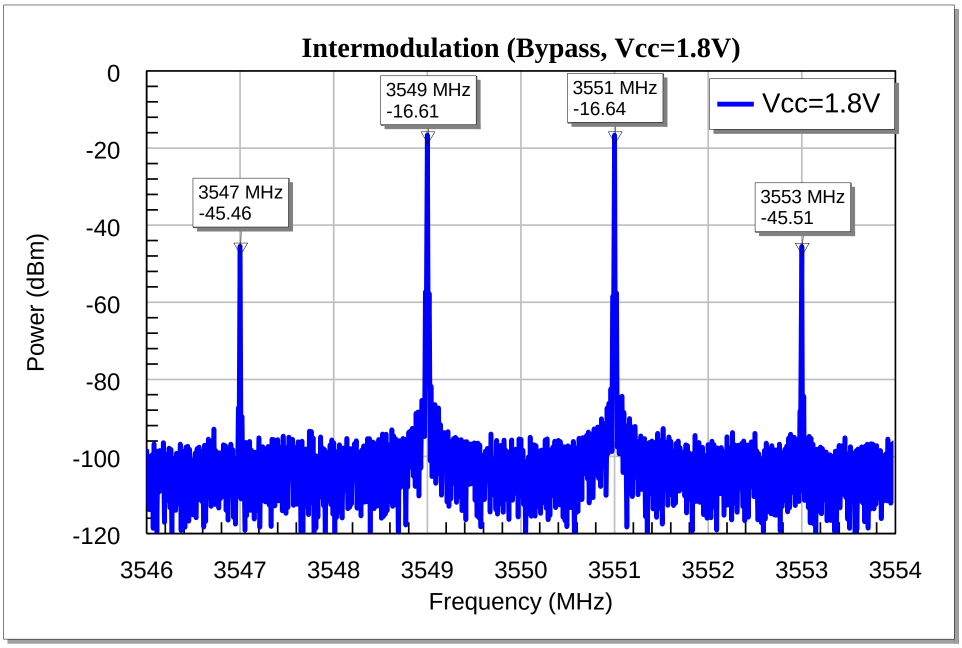

Figure 34 Third-order interception point (bypass, 1.8V) of BGA5H1BN6 for band n78 applications

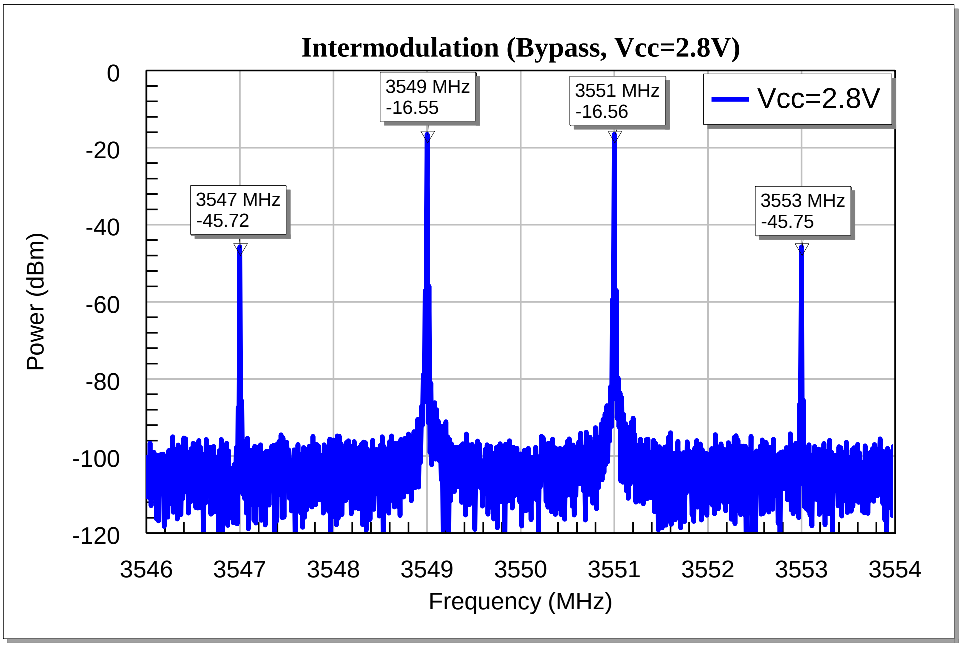

Figure 35 Third-order interception point (bypass, 2.8V) of BGA5H1BN6 for band n78 applications

5 Evaluation board and layout information

In this application note, the following PCB is used:

PCB Marking: **BGA5X1BN6 V1.0**

PCB material: **Nelco 4350**

ε_r of PCB material: **3.5**

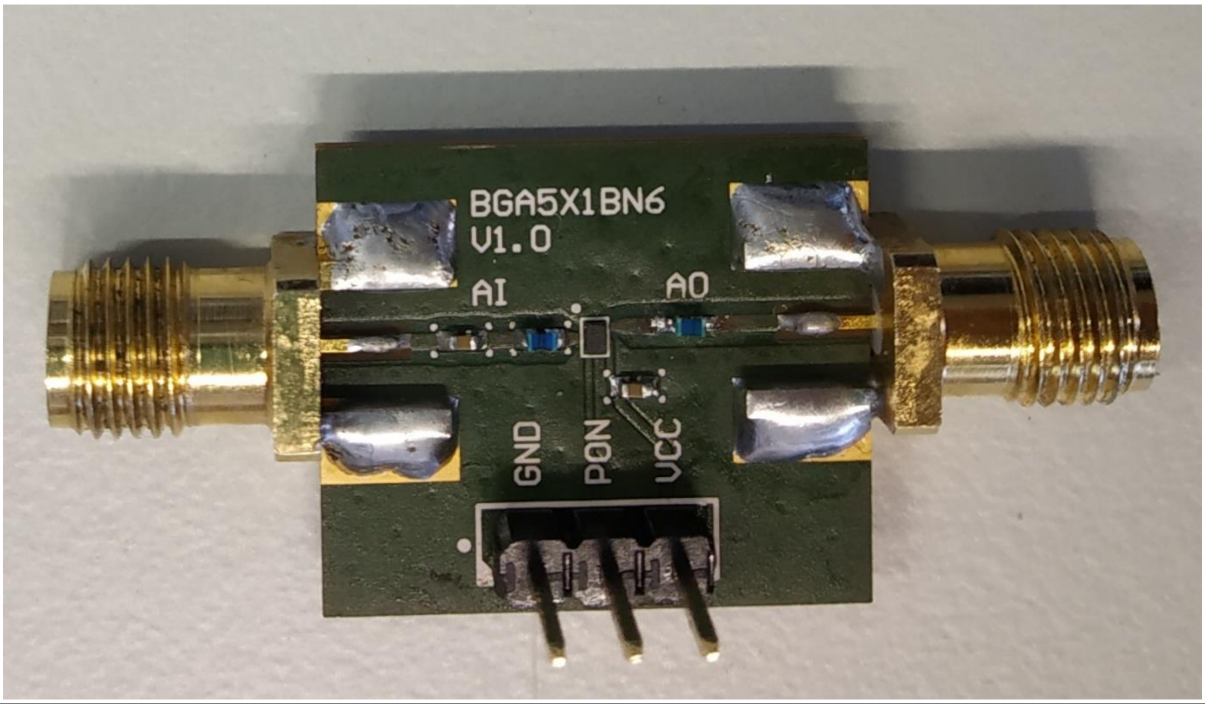

Figure 36 Photo picture of evaluation board (overview)

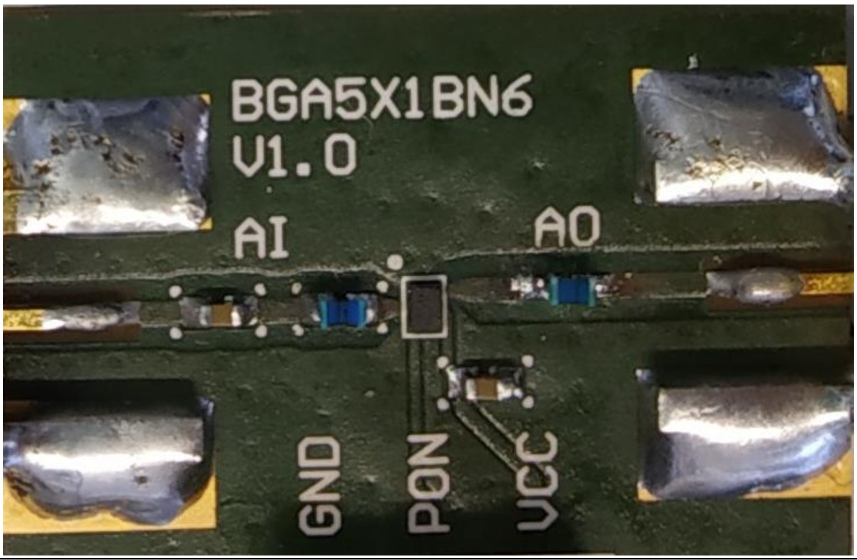

Figure 37 Photo picture of evaluation board (detailed view)

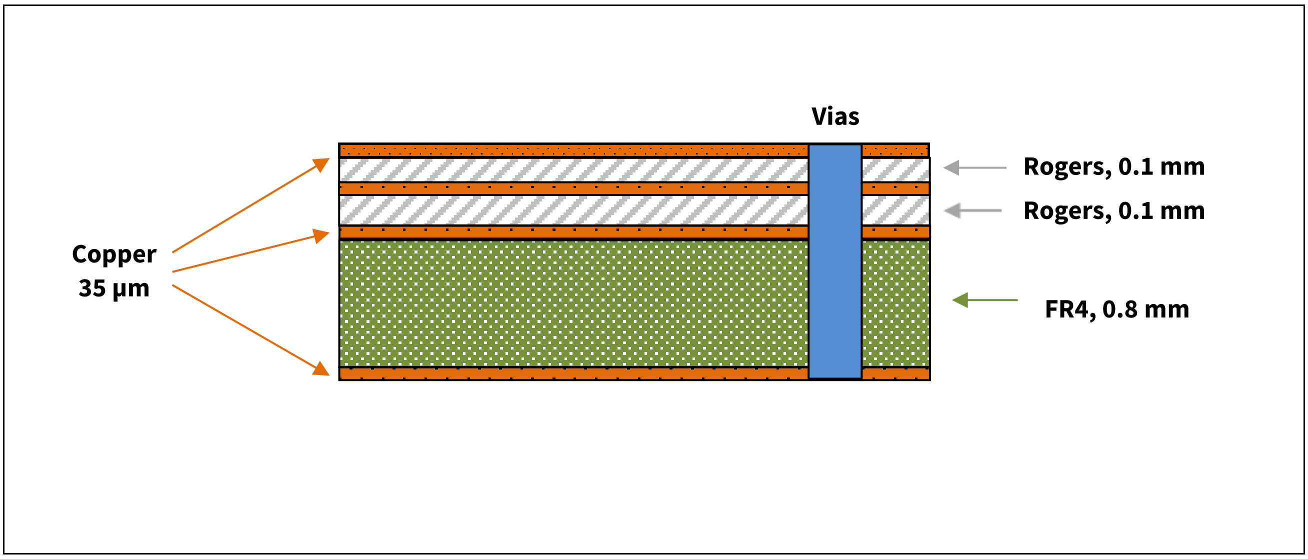

Figure 38 PCB layer information

6 Authors

Sergio Rosino Rincon, RF Application Engineer of Business Unit “Radio Frequency and Sensors”

Rauh Lukas, RF Application Engineer of Business Unit “Radio Frequency and Sensors”

Islam Mohammad Moakhkhrul, RF Application Engineer of Business Unit “Radio Frequency and Sensors”

7 Reference

[1] Application Guide for Mobile Communication 2015, Infineon Technologies, PMM RFS

Revision history

Major changes since the last revision

Page or reference	Description of change

Edition <>

Published by

Infineon Technologies AG

81726 Munich2019FORMAT 2019

Do you have a question about this document?

Email: erratum@infineon.com

Document reference

AN_1904_PL55_1904_114806