

Application Note No. 163

BGA728L7 Broadband Low Noise Amplifier for
Portable and Mobile TV Applications

RF & Protection Devices



Never stop thinking

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BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

Application Note No. 163

Revision History: 2008-12-18, Rev. 1.1

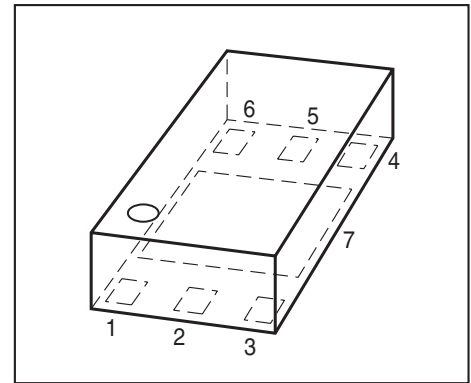
Previous Version: Rev. 1.0

Page	Subjects (major changes since last revision)
	Minor error corrections

1 Broadband Low Noise Amplifier for Portable and Mobile TV Applications

Features

- High gain mode: 15.8 dB gain
- Low gain mode: -5 dB gain
- Noise figure: 1.3 dB / 5.5 dB in high / low gain mode
- Power off function
- Operating frequency: 100 MHz - 1700 MHz
- Supply voltage: 1.5 V to 3.6 V
- Small leadless TSLP-7-1 package
- Output internally matched to 50 Ω
- Input pre-matched to 50 Ω
- Low external parts count
- Integrated ESD protection: 1 kV HBM
- Moisture sensitivity level: MSL 1
- RoHS compliant package



TSLP-7-1

Application

- Portable and mobile TV in VHFIII-, UHF- and L-bands
- ISM applications in 100 MHz - 1700 MHz
- RKE applications

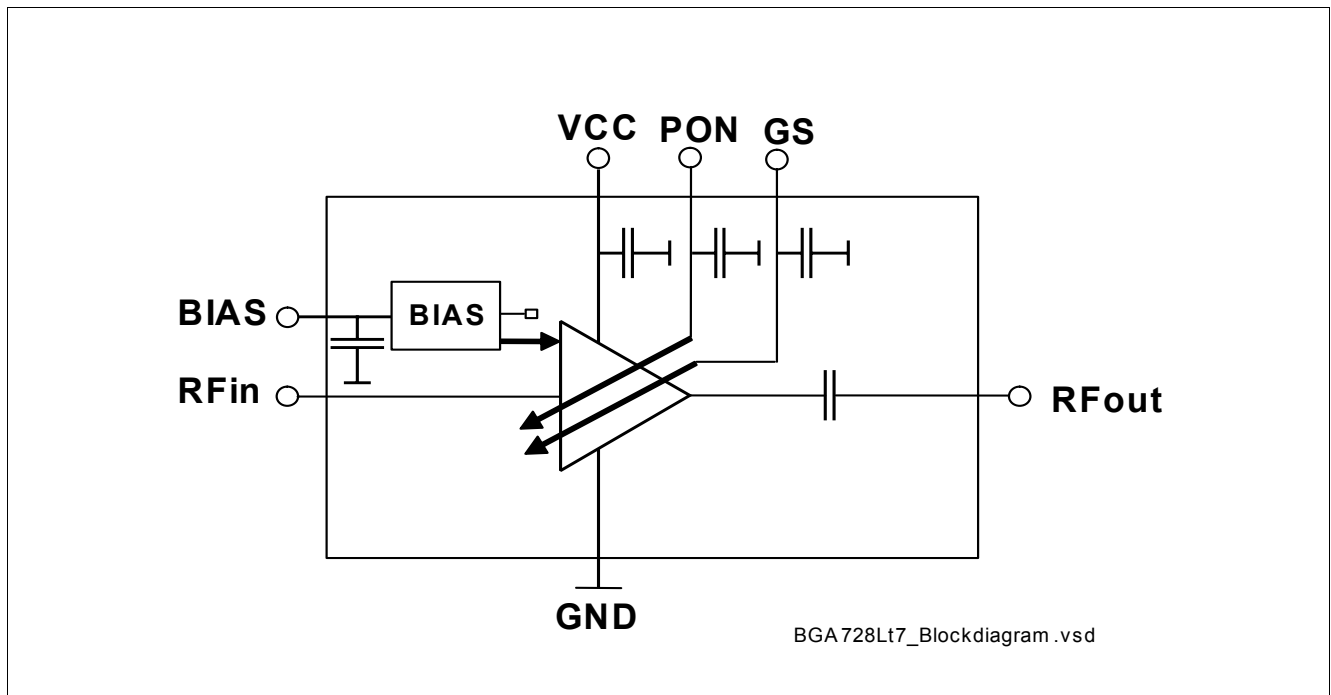


Figure 1 Equivalent circuit

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

1.1 Introduction

The new BGA728L7 is the first mobile TV LNA worldwide to support 1.8 V, 2.8 V and 3.3 V operations. It is optimized for a wide frequency range covering VHFIII, UHF and L bands, and one of the few mobile TV LNAs offering dual modes (high-gain mode and low gain mode). At high-gain mode BGA728L7 helps to improve reception sensitivity for weak signals through its best-in-class noise figure of 1.3 dB combined with 16 dB gain. For a strong input signal the BGA728L7 can be switched to a low-gain mode to offer higher linearity with low current consumption of only 0.5 mA.

Mobile TV is a key feature for next-generation high-end communication products, such as cellular phones, personal media players and portable devices including lap-tops. According to a report from the UK-based market research company Data monitor, mobile television is set to achieve massive growth over the next years with a global market for such services to reach about 155 million subscribers by the end of 2012, up from just 4.4 million in 2007. Asia Pacific markets will be the most accepting of mobile TV. In Japan, already more than 50 percent of the latest mobile phone models feature mobile TV capability.

The main challenges for mobile TV systems are to achieve a high dynamic range, enhance system sensitivity for in-door reception or tunnels, and to fulfill the stringent MBRAI (MultiBasic Rate Interface) requirements. The Infineon BGA728L7 supports various standards such as DVB-T, DVB-H, ISDB-T, MediaFLO, T-DMB, as well as the emerging Chinese standards including CMMB, TMMB or DMB-TH. With its high gain and excellent noise figure, the system sensitivity can be considerably improved. By switching to low-gain mode with input 1dB Compression Point of +3.5 dBm, the LNA can handle higher input power level and therefore increase the system's dynamic range by up to 20 dB. The fast switching time of 3.5 μ s also allows it to support time-slicing-based mobile TV systems.

1.1.1 Technical Features at a Glance

The BGA728L7 supports a broad supply voltage range from 1.5 V to 3.6 V. At high-gain mode, it consumes about 6mA current. The noise figure is as low as 1.3 dB and the gain is about 16 dB with minimum variation over the complete working frequency range. At low gain mode, input IP3 (Third Order Intercept Point) is +16 dBm at a current of only 0.5 mA. Due to the low voltage and low current capabilities, BGA728L7 allows higher energy efficiency for portable devices and extends their battery usage time. The on-chip 1 kV HBM ESD protection simplifies the system ESD protection effort and makes BGA728L7 very robust against ESD events during the assembly process.

BGA728L7 integrates not only a high performance SiGe bipolar transistor but also components such as active-biasing, feedback and input/output matching circuits. BGA728L7 needs only 3 external passive components compared to approximately 5 to 10 additional external components of current designs. As a result, system designers of mobile phones and portable devices can easily use BGA728L7 to realize a compact, low-power mobile TV design within short time.

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

1.2 Overview of RF Performance

The following tables show the typical RF performance of BGA728L7 in high-gain and low-gain mode. The different modes can be selected according to the table below.

Table 1 Truth table

Control Voltage V_{PON}	Control Voltage V_{GS}	Gain Mode
High	Low	High Gain
High	High	Low Gain
Low	High	Low Gain
Low	Low	OFF

Table 2 Typical RF Characteristics¹⁾ High-Gain Mode: $V_{CC} = 2.8\text{ V}$, $V_{PON} = 2.8\text{ V}$, $V_{GS} = 0\text{ V}$, $I_{CC} = 5.8\text{ mA}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Frequency Range	f_{BW}	170 ²⁾		1675	MHz	VHFIII/UHF/L-Band US/L-Band EU
Power Gain	$ S_{21} $		15.75		dB	$f = 470\text{ MHz}$
Power Gain Variation over Frequency	$\Delta S_{21} $		1		dB	$f = 170\text{ MHz}-1675\text{ MHz}$
Reverse Isolation	$1/ S_{12} $		>25		dB	
Noise figure	NF		1.3		dB	$f = 470\text{ MHz}$
Input return loss	$1/ S_{11} $		> 8		dB	50 Ω
Output return loss	$1/ S_{22} $		> 8		dB	50 Ω
Stability factor	k		>1.5			From 30 kHz to 6 GHz
Input 1 dB compression point	IP_{1dB}		-10		dBm	$f = 170\text{ MHz}$
			-10		dBm	$f = 470\text{ MHz}$
			-9		dBm	$f = 1500\text{ MHz}$
3rd order input intercept point	IIP_3		-7		dBm	$f = 170\text{ MHz}$; 1 MHz offset
			-7		dBm	$f = 470\text{ MHz}$; 1 MHz offset
			-3		dBm	$f = 1500\text{ MHz}$; 1 MHz offset
Settling time for Power On	t_{PON}		3.5		μs	
Settling time Power Off	t_{POFF}		2		μs	

1) Measured on application board including losses of both SMA connectors and PCB at 470 - 1675 MHz

2) 170 MHz to 240 MHz (VHF III) can be covered by adding external capacitor on input circuit

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

Table 3 Typical RF Characteristics¹⁾ Low-Gain Mode: $V_{CC} = 2.8\text{ V}$, $V_{PON} = 2.8\text{ V}$, $V_{GS} = 2.8\text{ V}$, $I_{CC} = 0.5\text{ mA}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Frequency Range	F_{PW}	170 ²⁾		1675	MHz	VHFIII/UHF/L-Band US/L-Band EU
Power Gain	$ S_{21} $		-5.2		dB	
Power Gain Variation over Frequency	$\Delta S_{21} $		2.1		dB	$f = 170\text{ MHz}-1675\text{ MHz}$
Noise figure	NF		5.5		dB	$f = 470\text{ MHz}$
Input return loss	$1/ S_{11} $		>8		dB	50 Ω
Output return loss	$1/ S_{22} $		>8		dB	50 Ω
Input compression point	IP_{1dB}		3		dBm	$f = 170\text{ MHz}$
			3.5		dBm	$f = 470\text{ MHz}$
			5		dBm	$f = 1500\text{ MHz}$
3rd order input intercept point	IIP_3		16		dBm	$f = 170\text{ MHz}$; 1 MHz offset
			16		dBm	$f = 470\text{ MHz}$; 1 MHz offset
			20		dBm	$f = 1500\text{ MHz}$; 1 MHz offset
Settling time GS ON	t_{GSON}		2		μs	
Settling time GS OFF	t_{GSOFF}		3.5		μs	

1) Measured on application board including losses of both SMA connectors and PCB at 470 - 1675 MHz

2) 170 MHz to 240 MHz (VHF III) can be covered by adding external capacitor on input circuit.

1.3 DC Characteristics

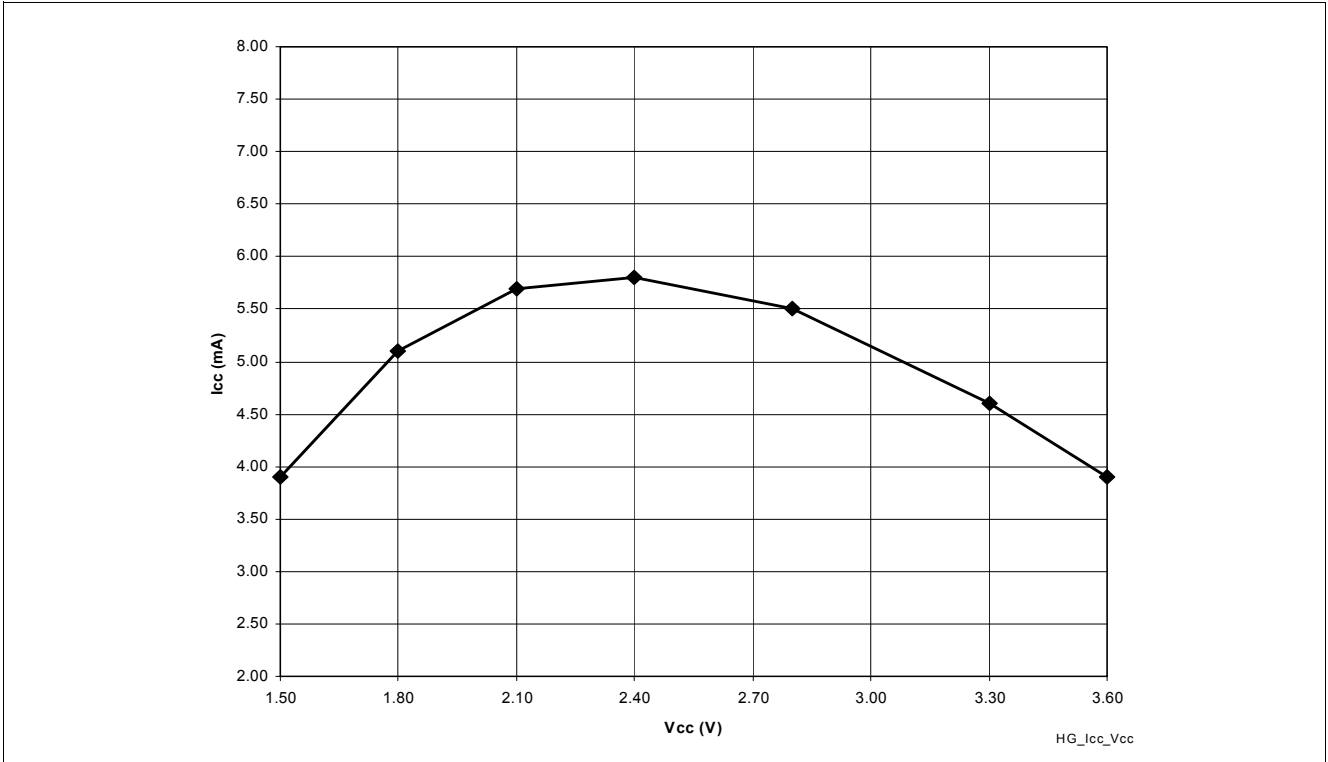


Figure 2 Current consumption in high-gain mode vs. Vcc

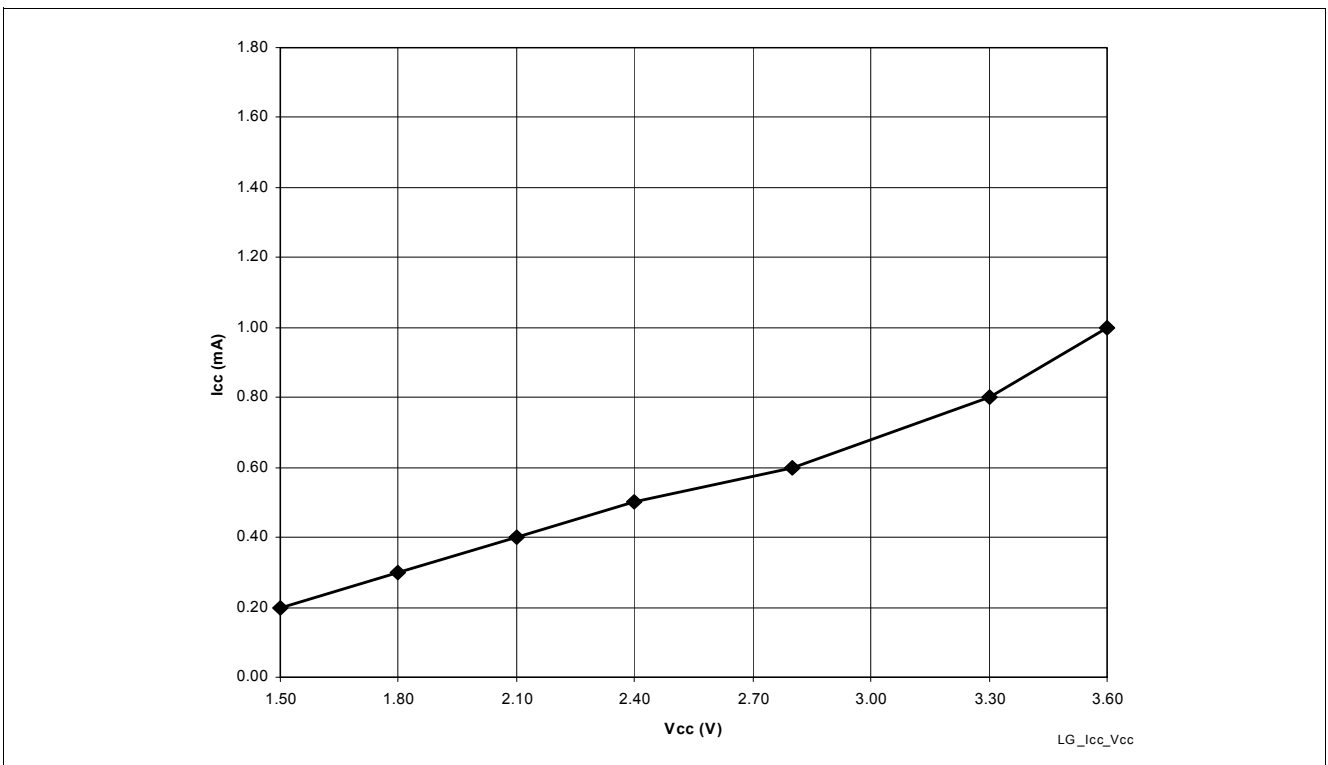


Figure 3 Current consumption in low-gain mode vs. Vcc

2 Application Circuit covering UHF- and L-Band

2.1 Schematic Diagram

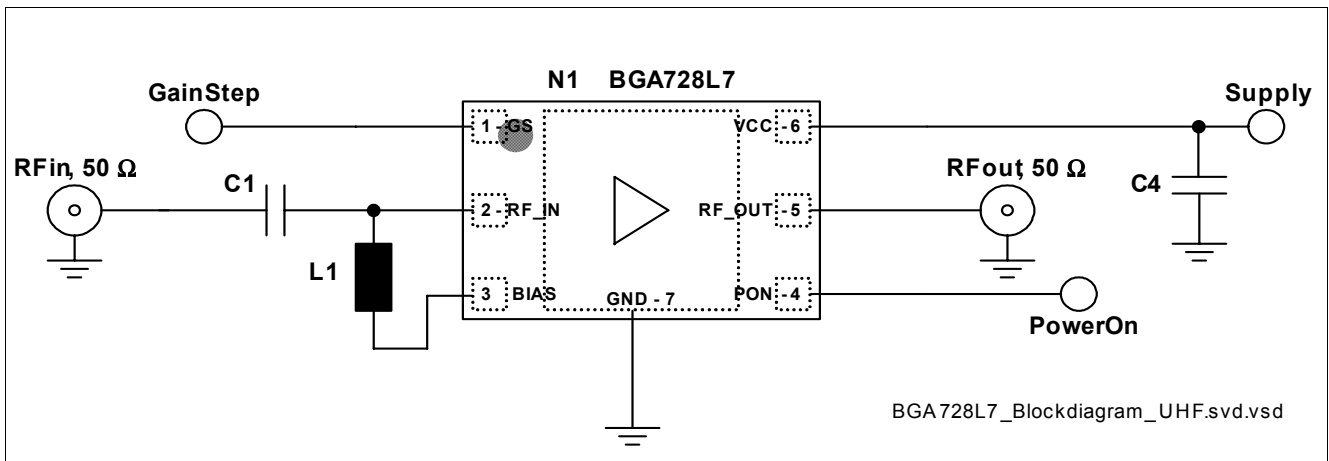


Figure 4 Schematic diagram UHF/L-Band

Table 4 Bill of Materials

Name	Value	Package	Manufacturer	Function
C1	56 pF	0402	Various	DC block
C4	1 nF	0402	Various	Supply voltage filtering
L1	75 nH	0402	Murata LQW15AN75NG00	Bias Feed
N1	BGA728L7		Infineon	SiGe LNA

2.2 RF measurement results

2.2.1 High-gain mode

2.2.1.1 Narrow-band graphs

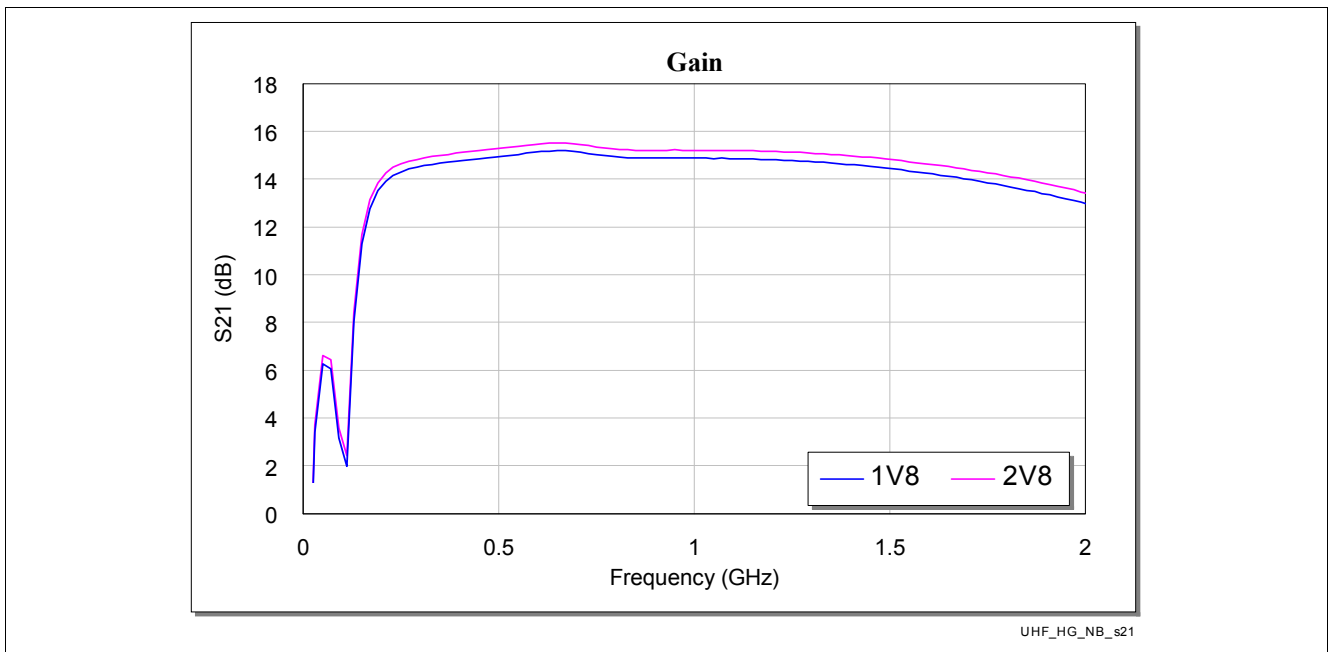


Figure 5 Gain (UHF, HG, NB)

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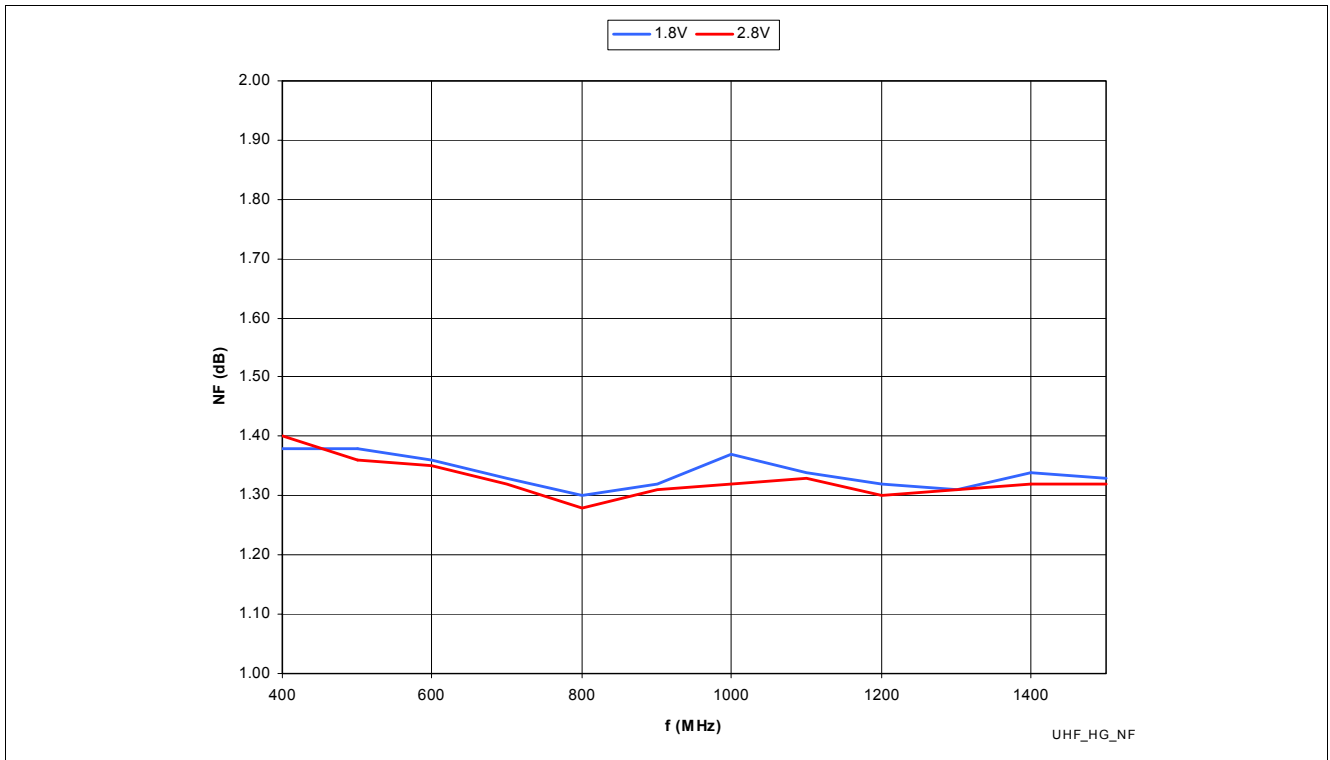


Figure 6 Noise Figure (UHF, HG, NB)

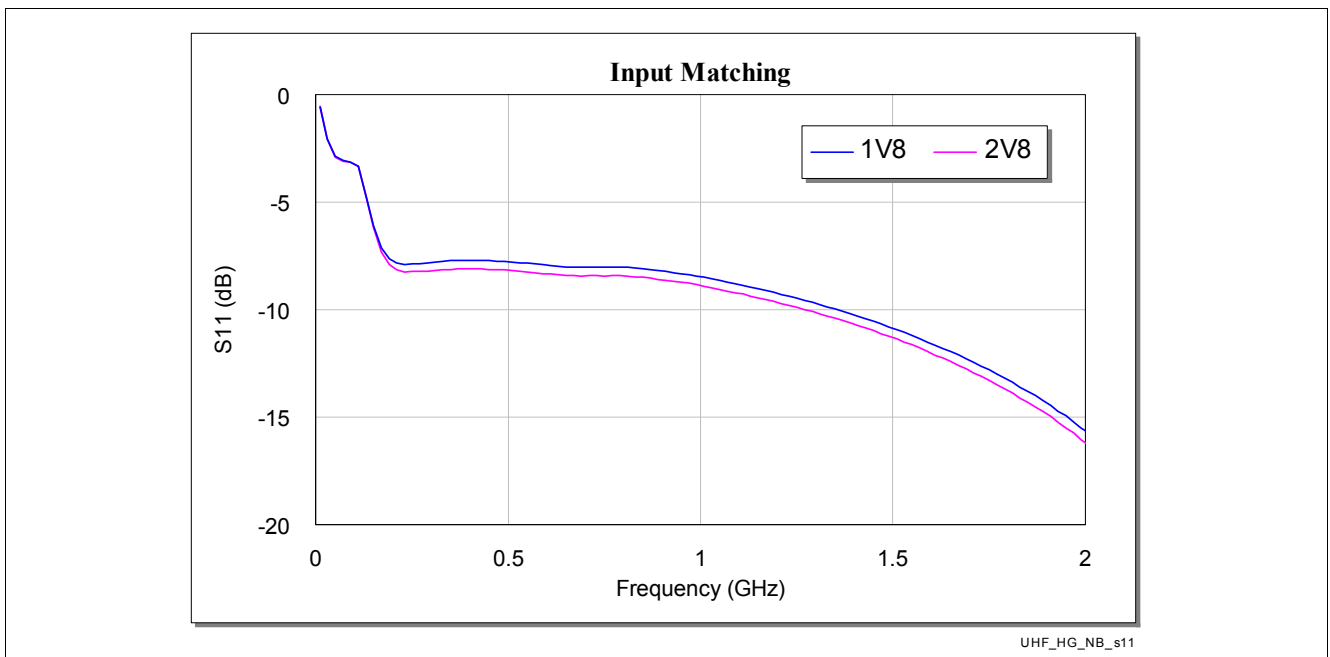


Figure 7 Input Matching (UHF, HG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

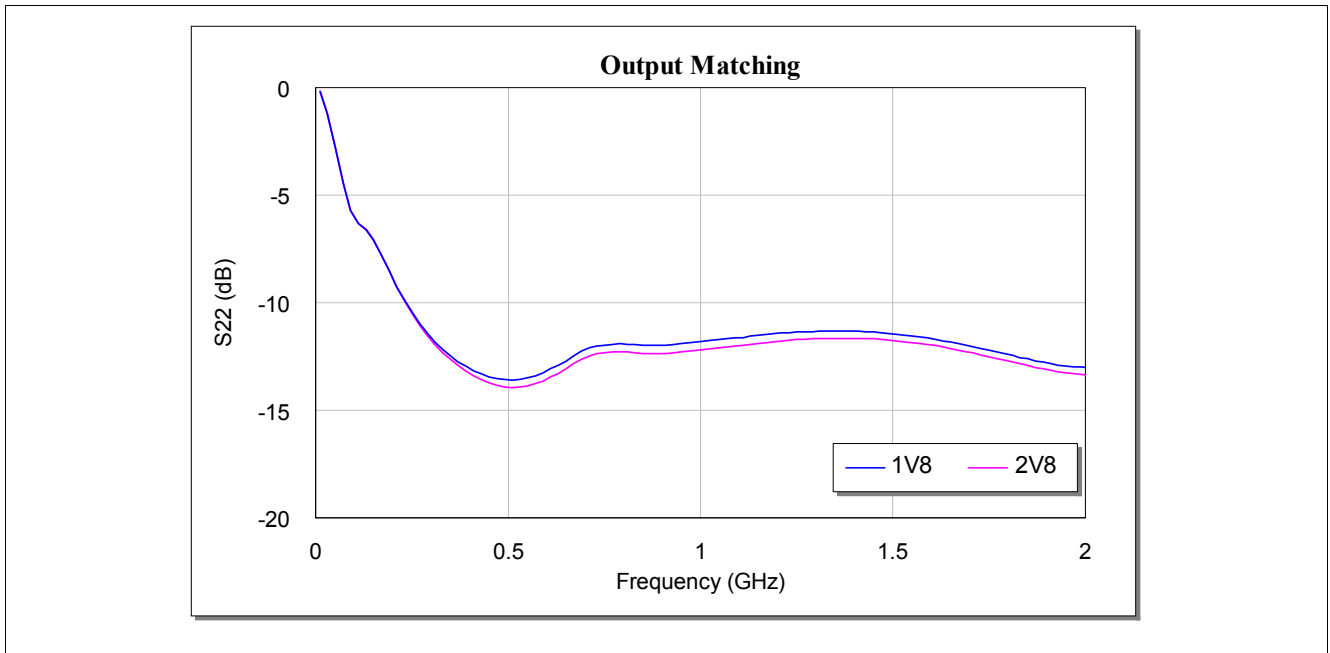


Figure 8 Output Matching (UHF, HG, NB)

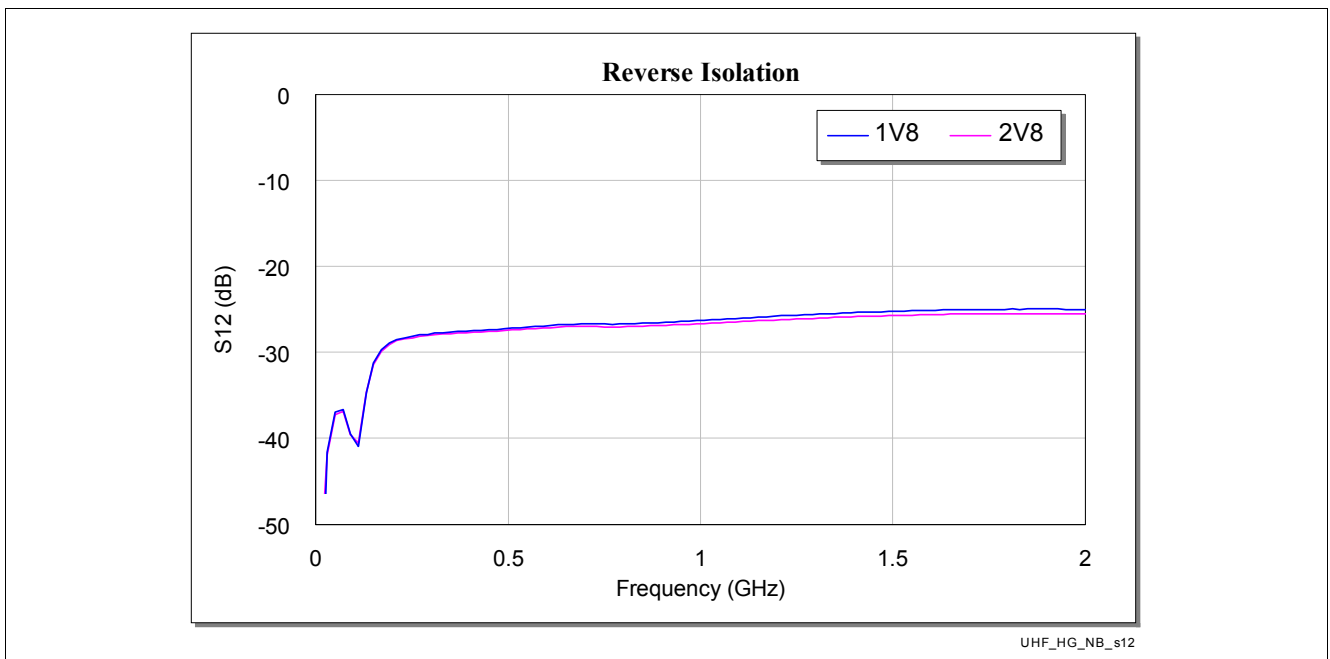


Figure 9 Reverse Isolation (UHF, HG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

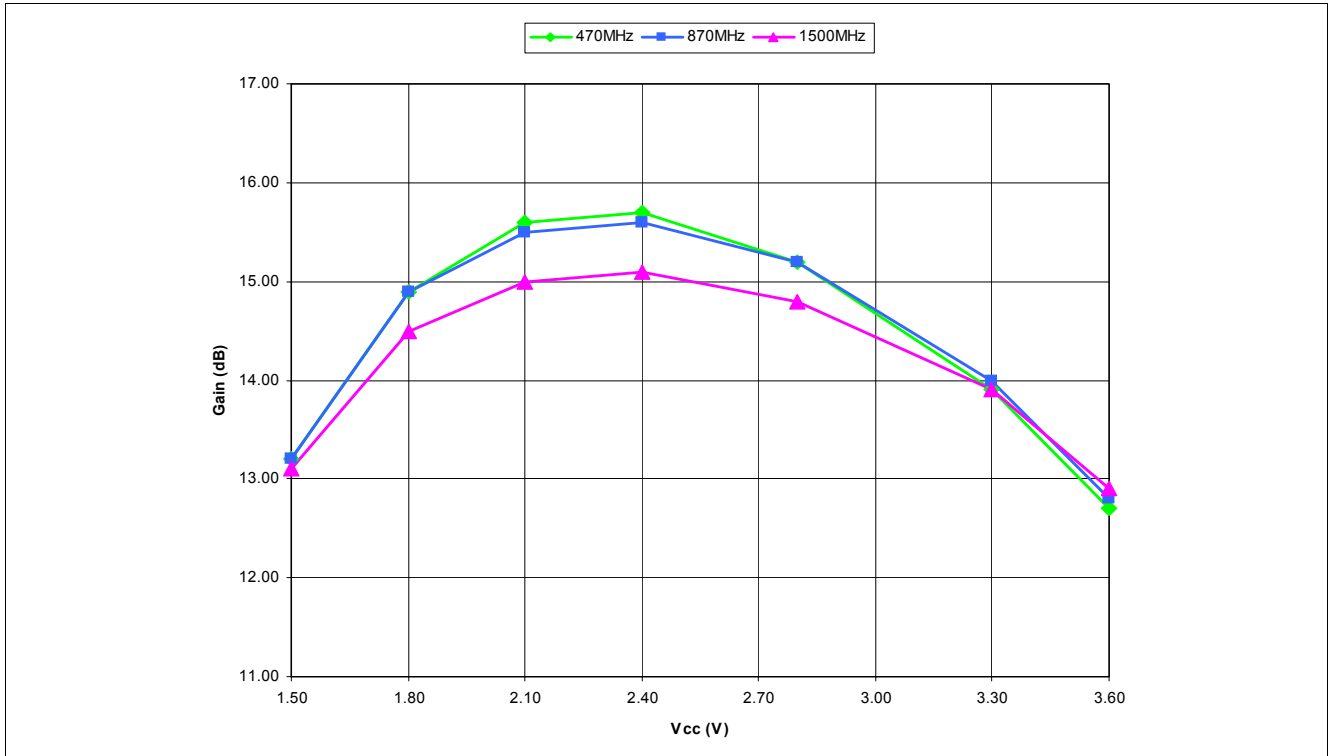


Figure 10 Gain vs. Vcc (UHF, HG, NB)

2.2.1.2 Wide-band graphs

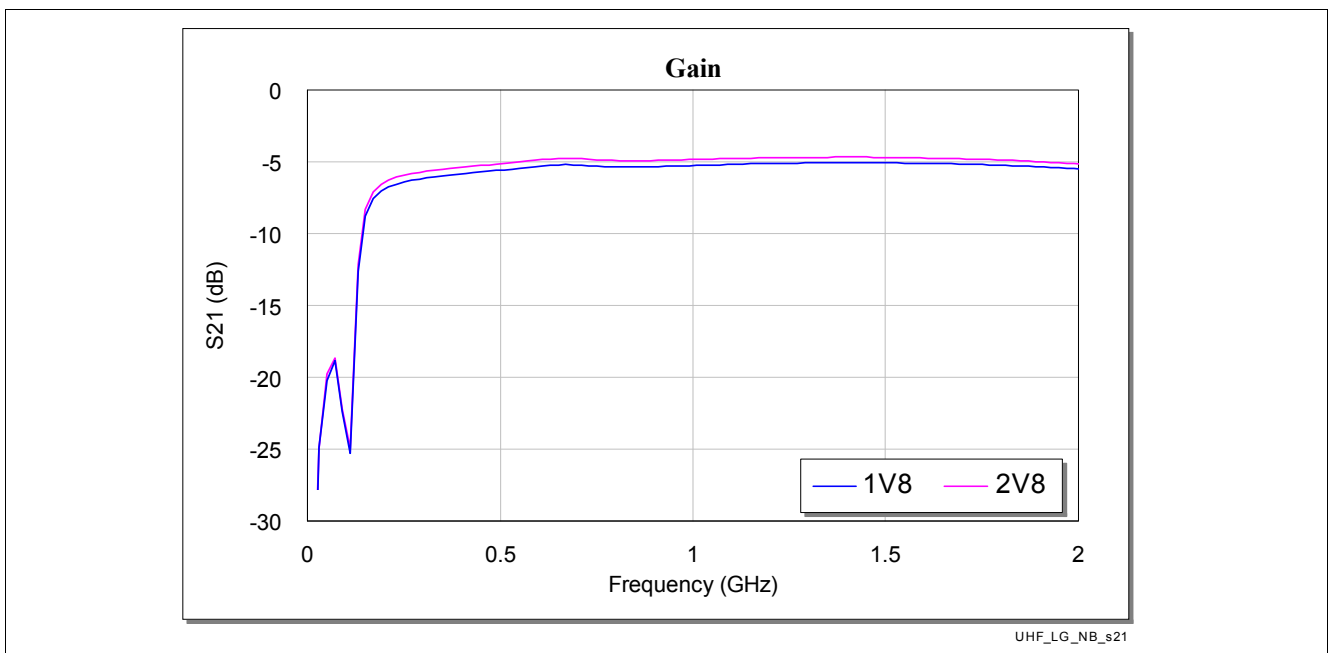


Figure 11 Gain (UHF, HG, WB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

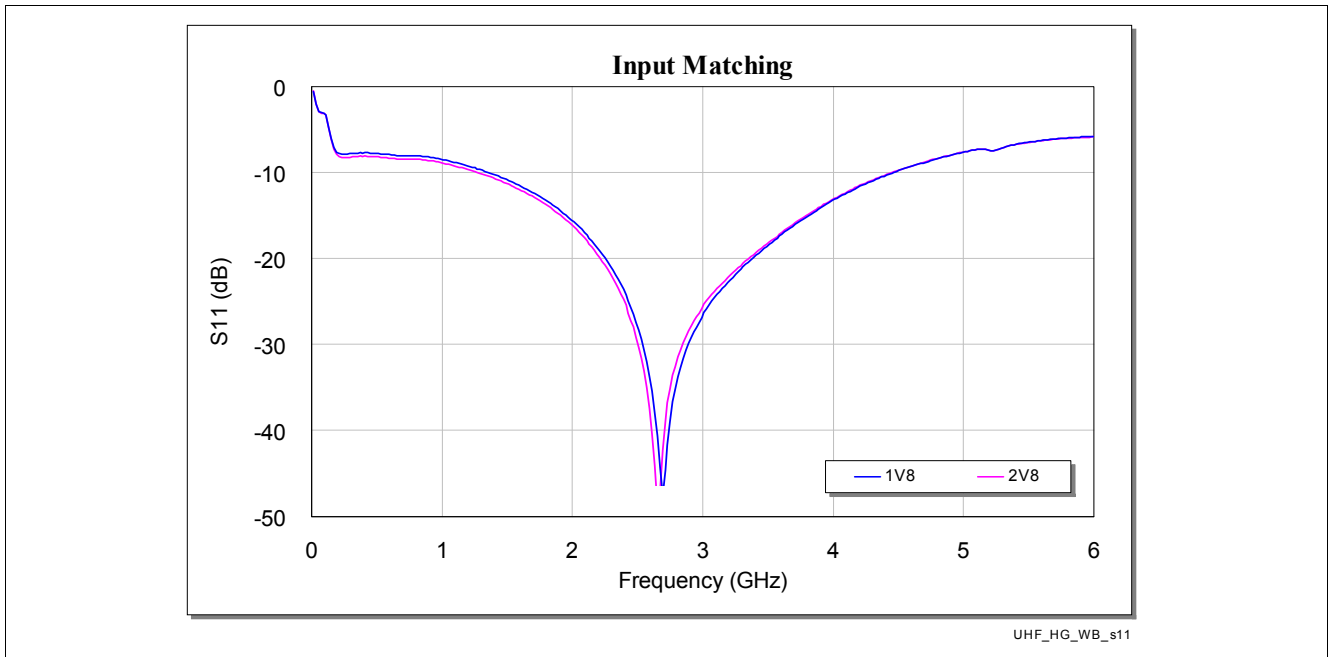


Figure 12 Input Matching (UHF, HG, WB)

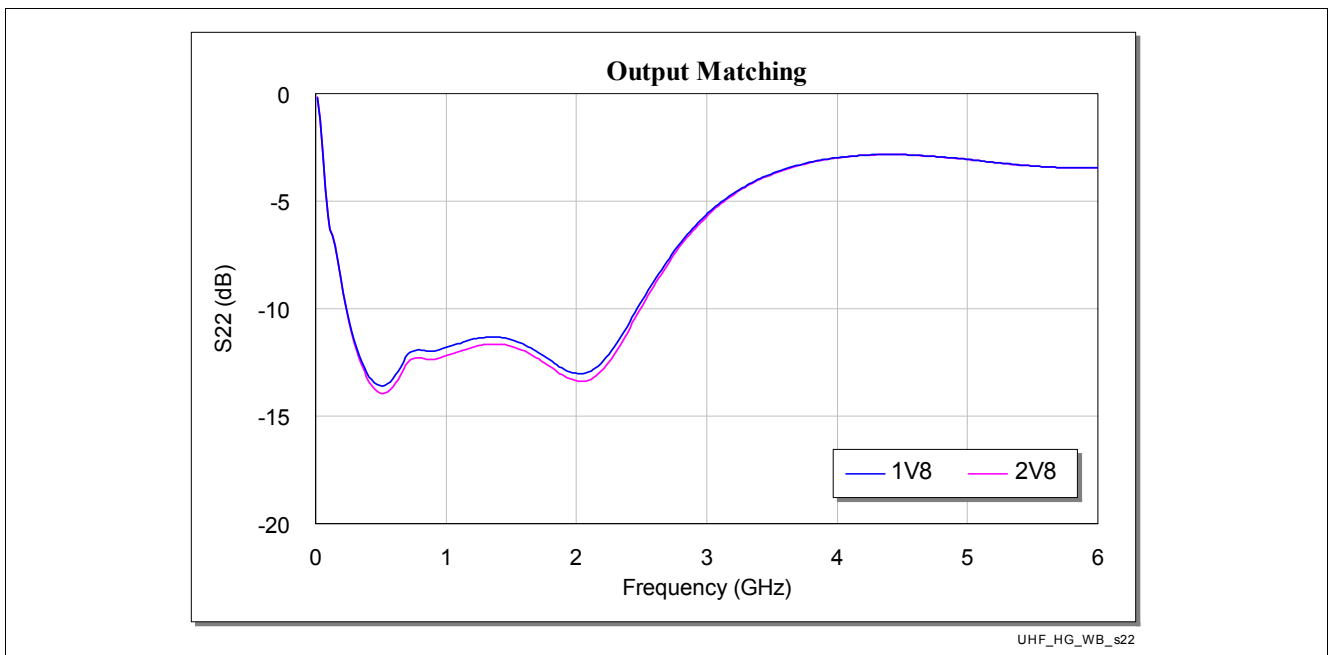


Figure 13 Output Matching (UHF, HG, WB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

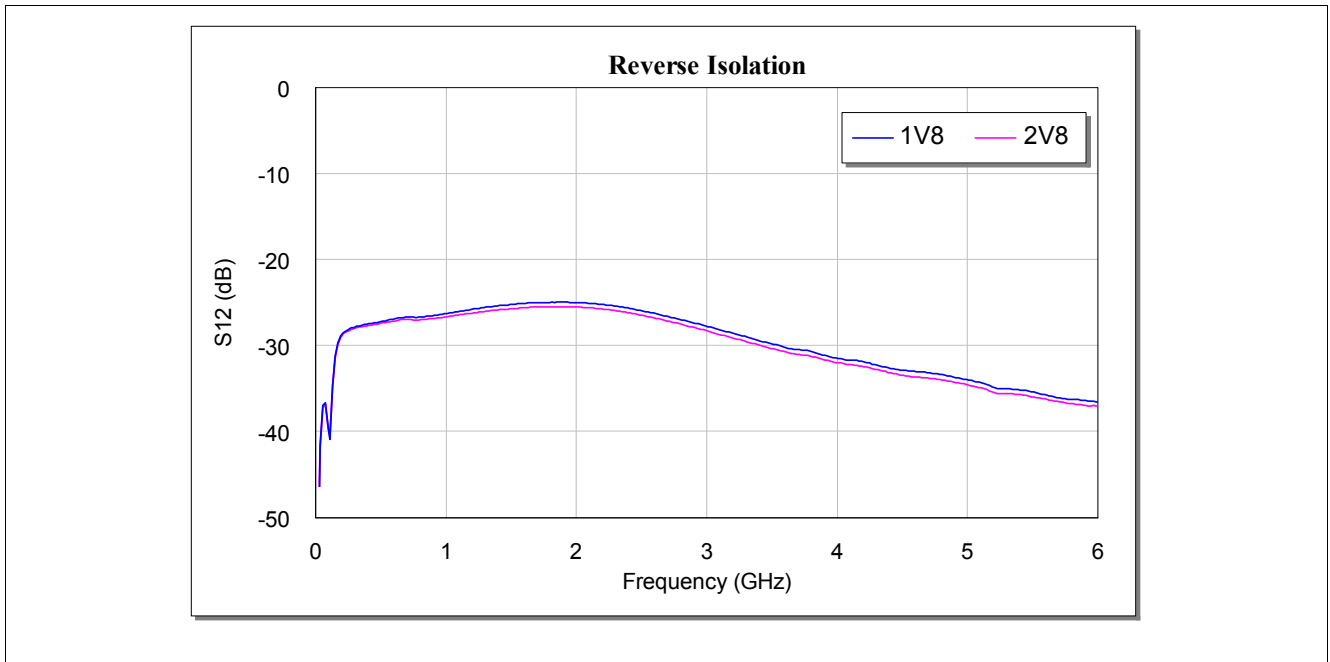


Figure 14 Reverse Isolation (UHF, HG, WB)

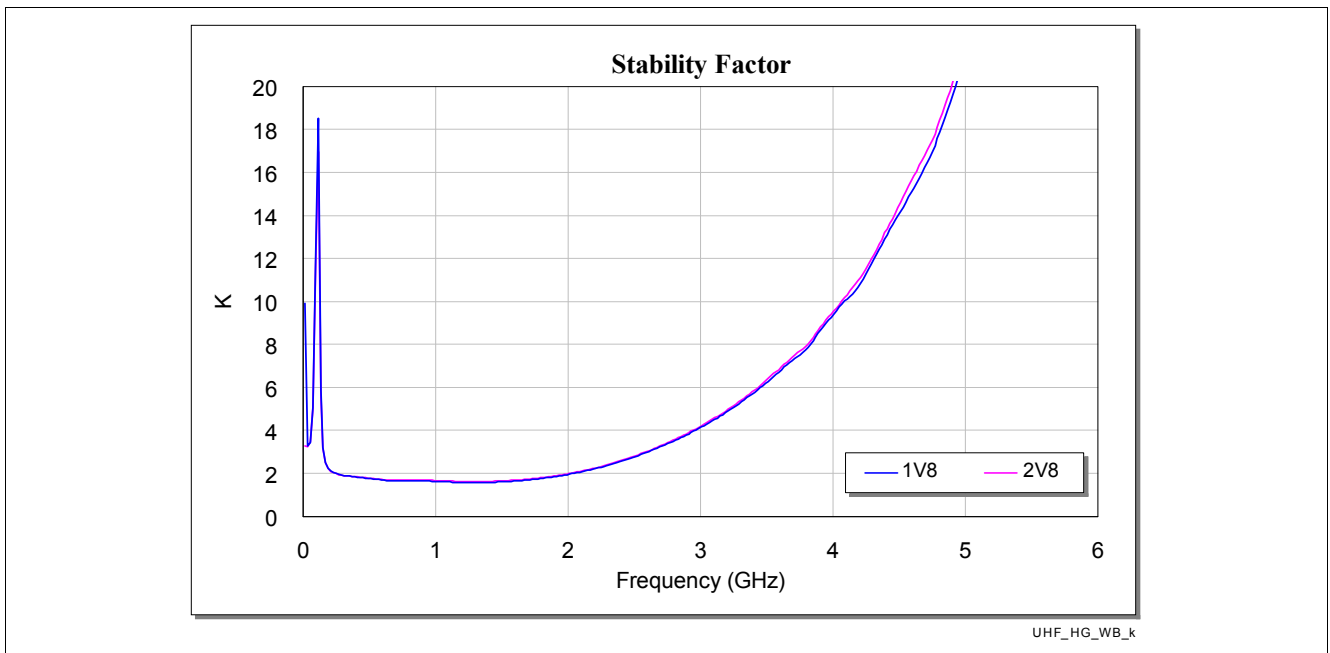


Figure 15 Stability Factor (UHF, HG, WB)

2.2.2 Low-gain mode

2.2.2.1 Narrow-band graphs

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

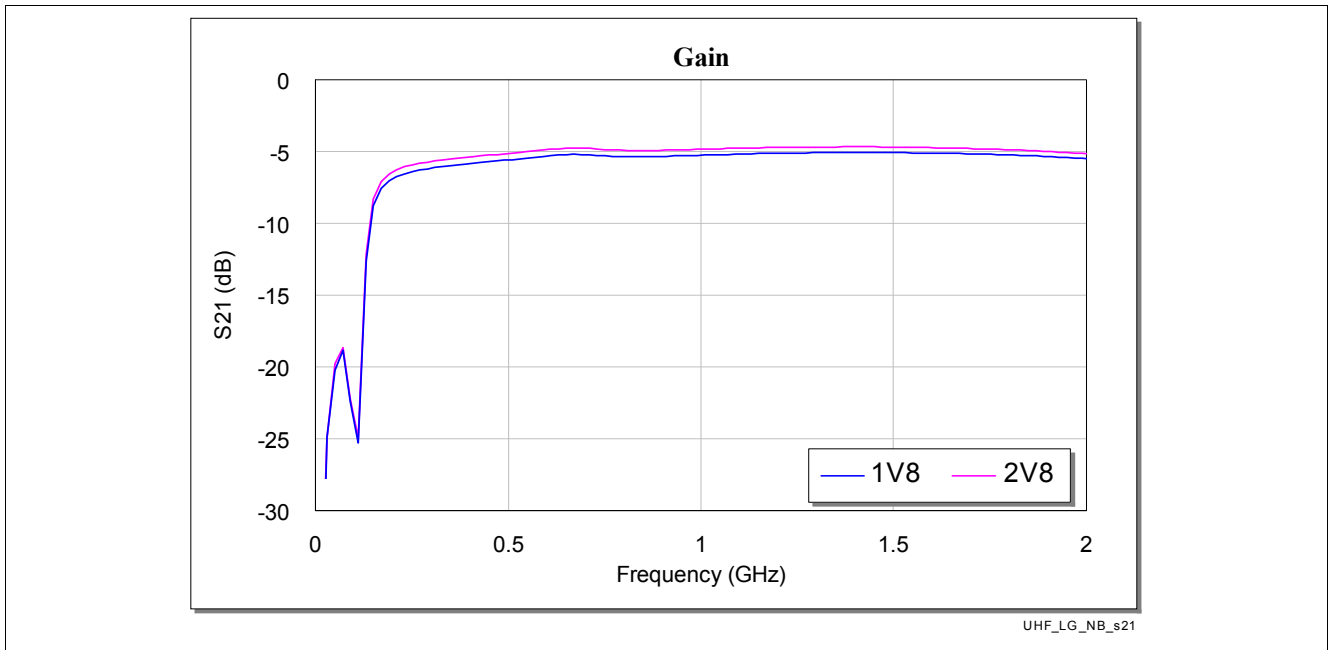


Figure 16 Gain (UHF, LG, NB)

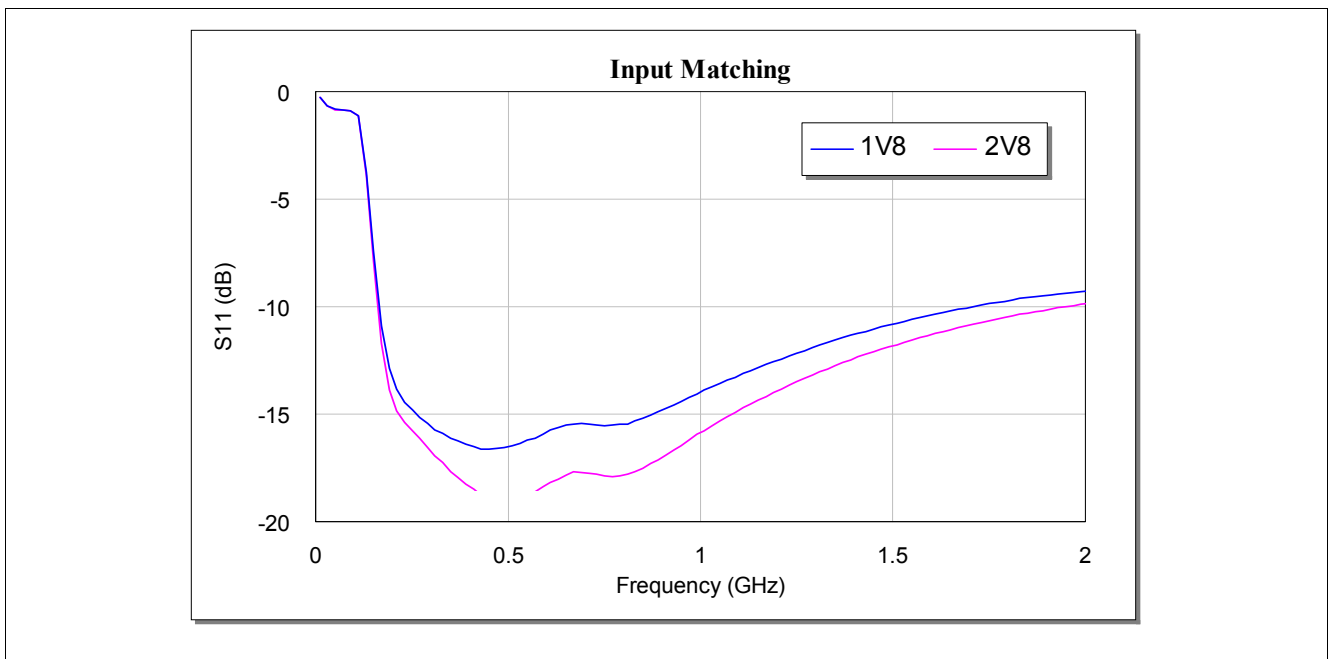


Figure 17 Input Matching (UHF, LG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

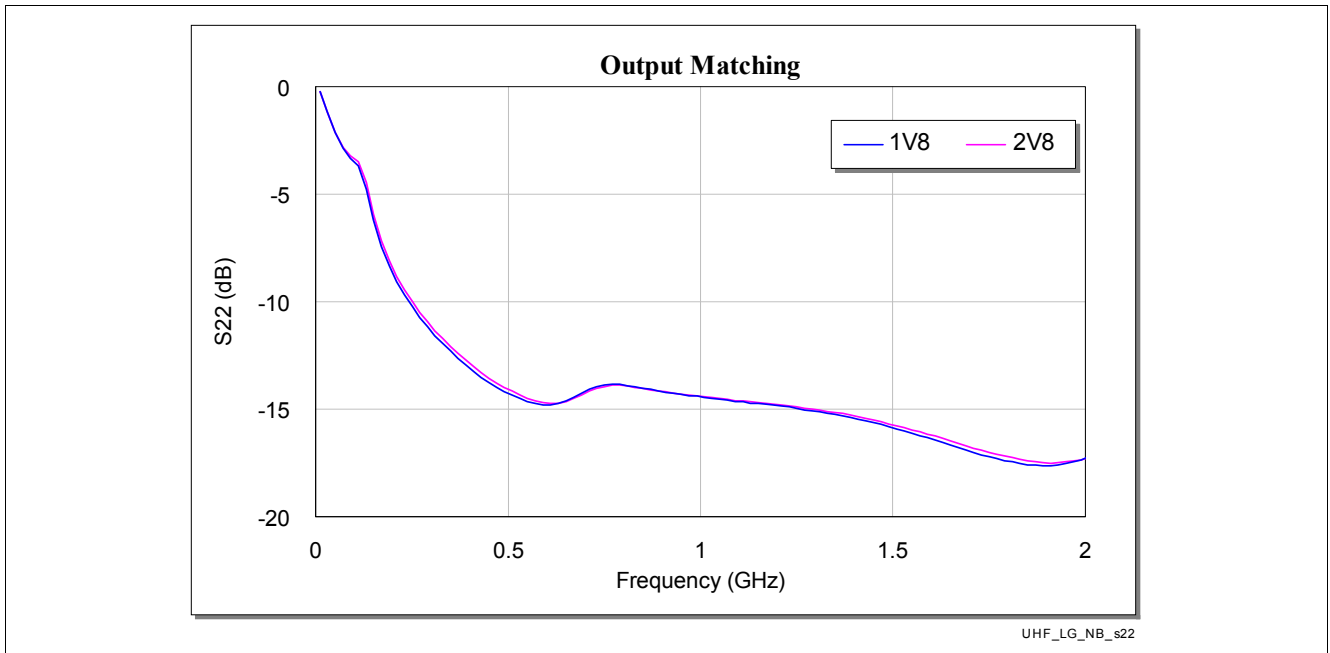


Figure 18 Output Matching (UHF, LG, NB)

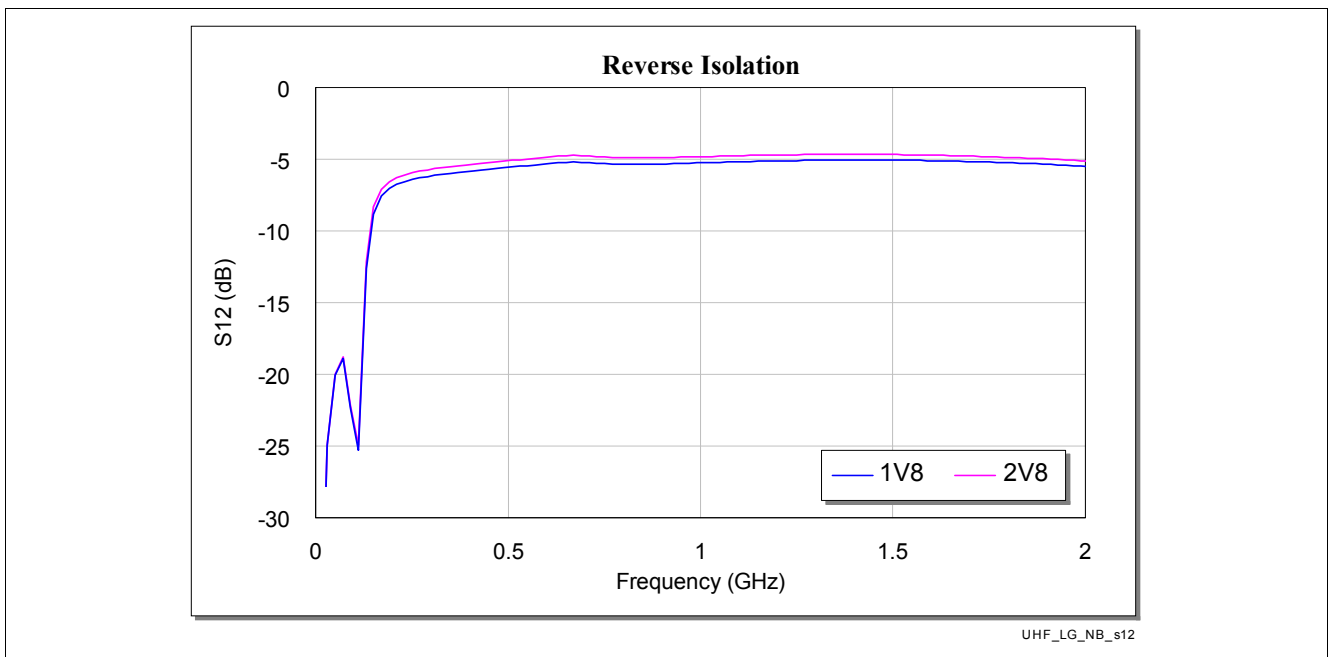


Figure 19 Reverse Isolation (UHF, LG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

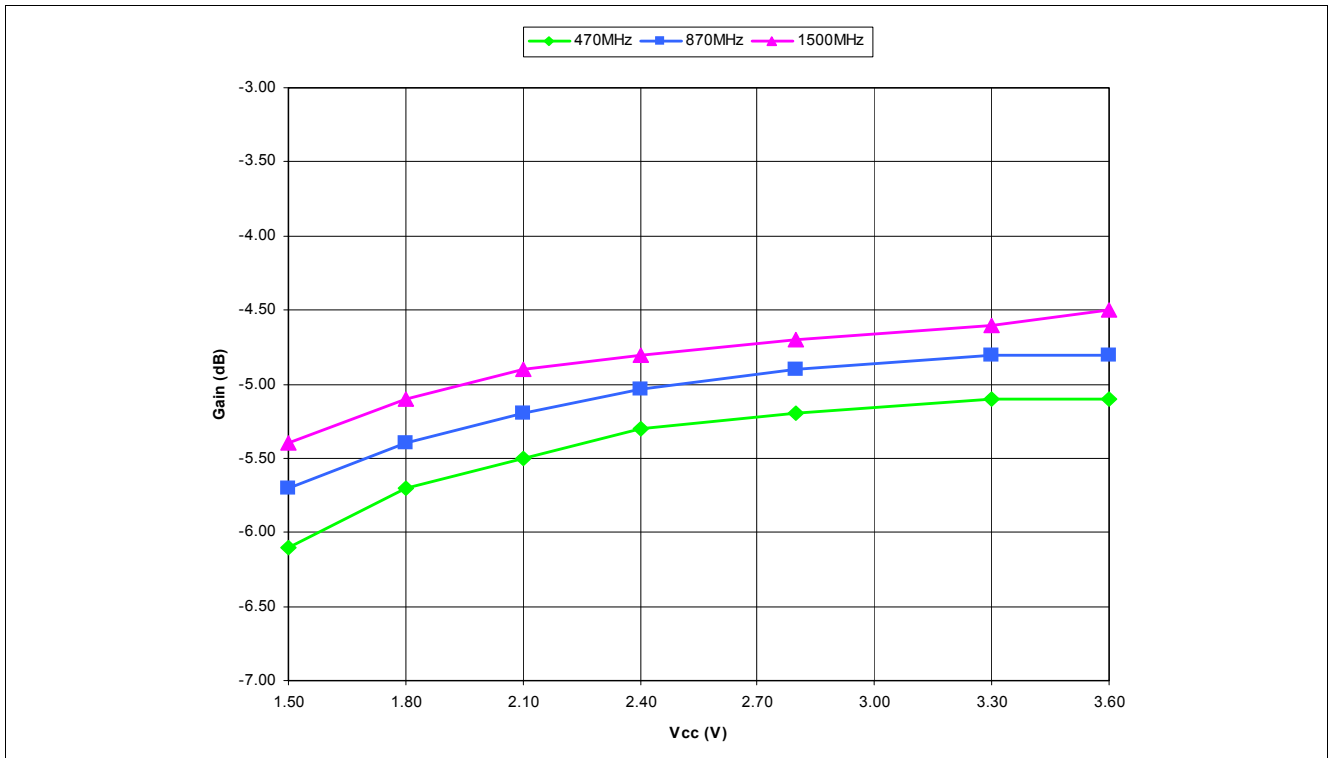


Figure 20 Gain vs. Vcc (UHF, LG, NB)

2.2.2.2 Wide-band graphs

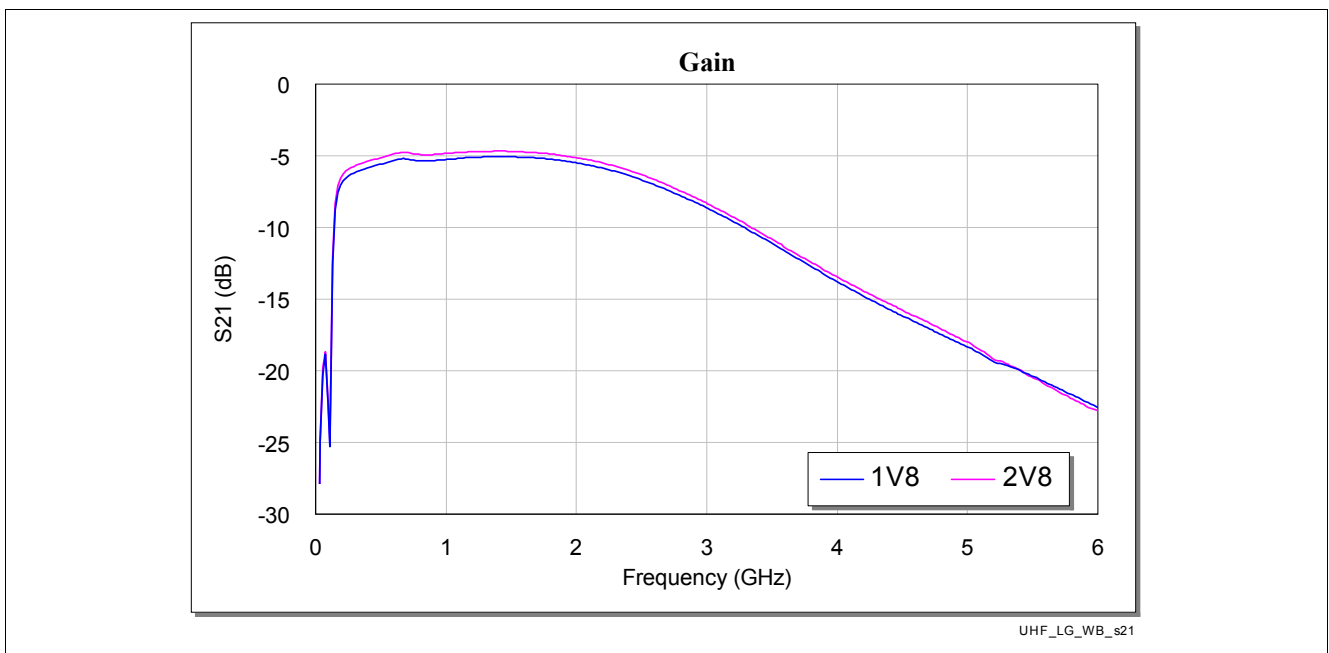


Figure 21 Gain (UHF, LG, WB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

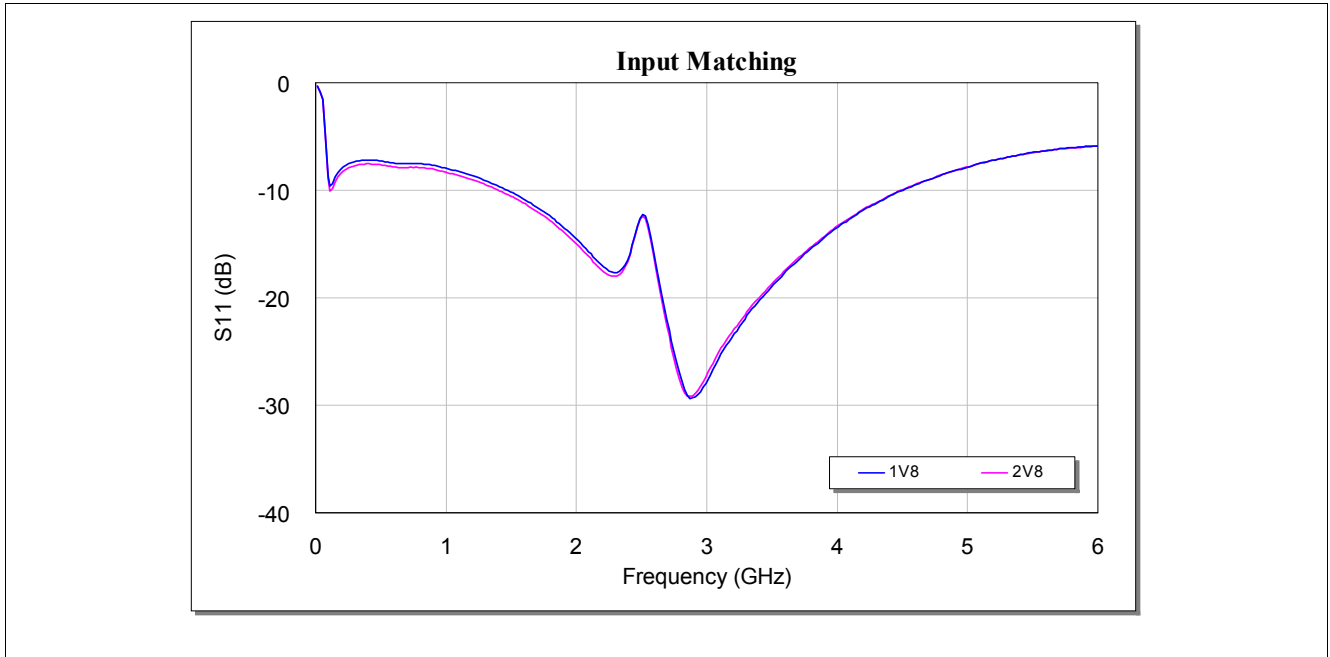


Figure 22 Input Matching (UHF, LG, WB)

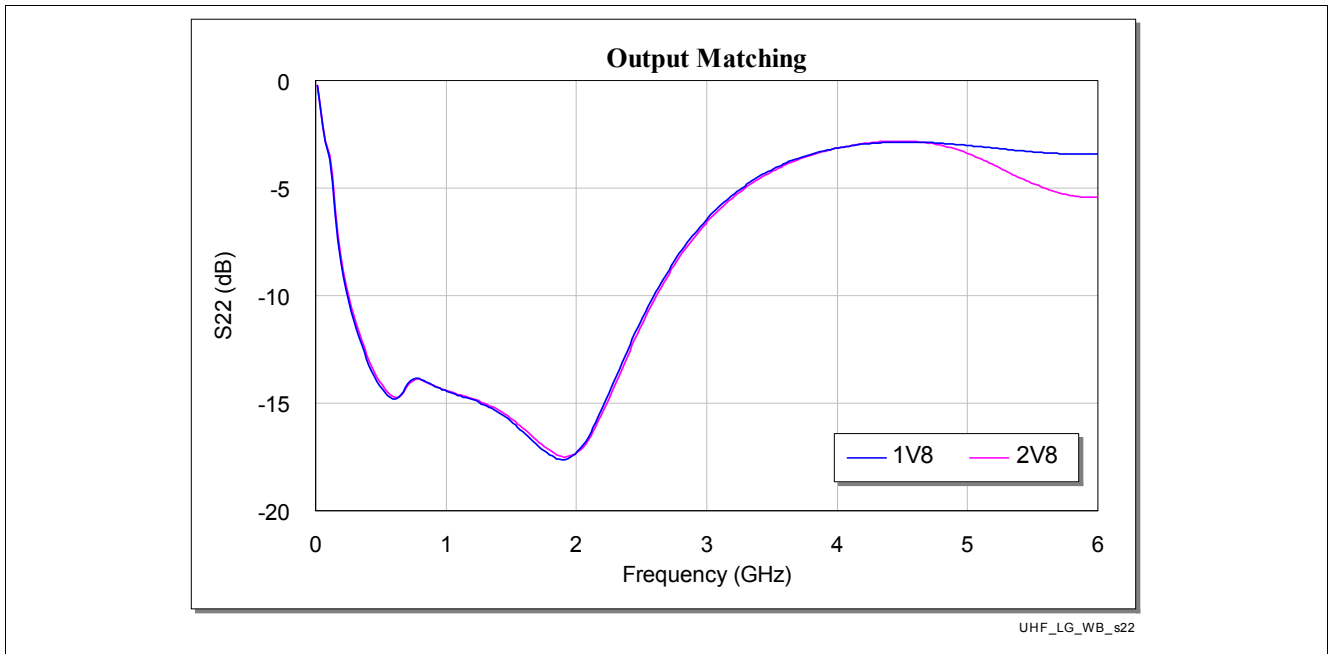


Figure 23 Output Matching (UHF, LG, WB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

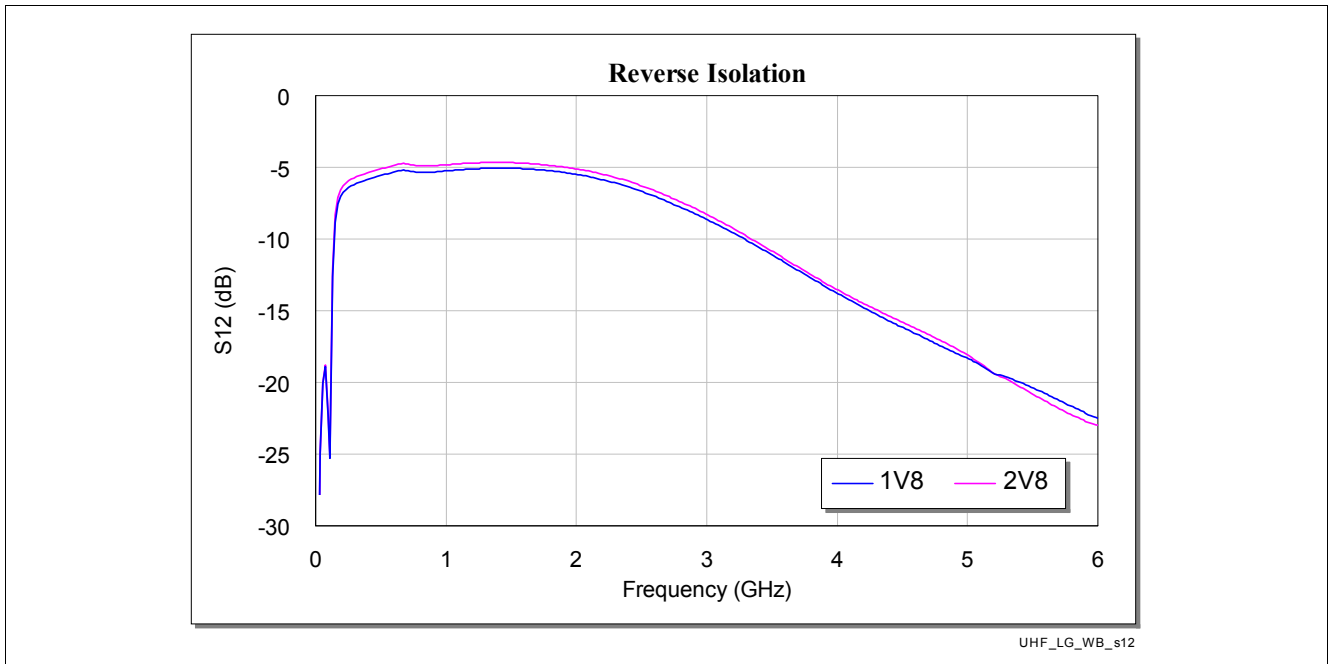


Figure 24 Reverse Isolation (UHF, LG, WB)

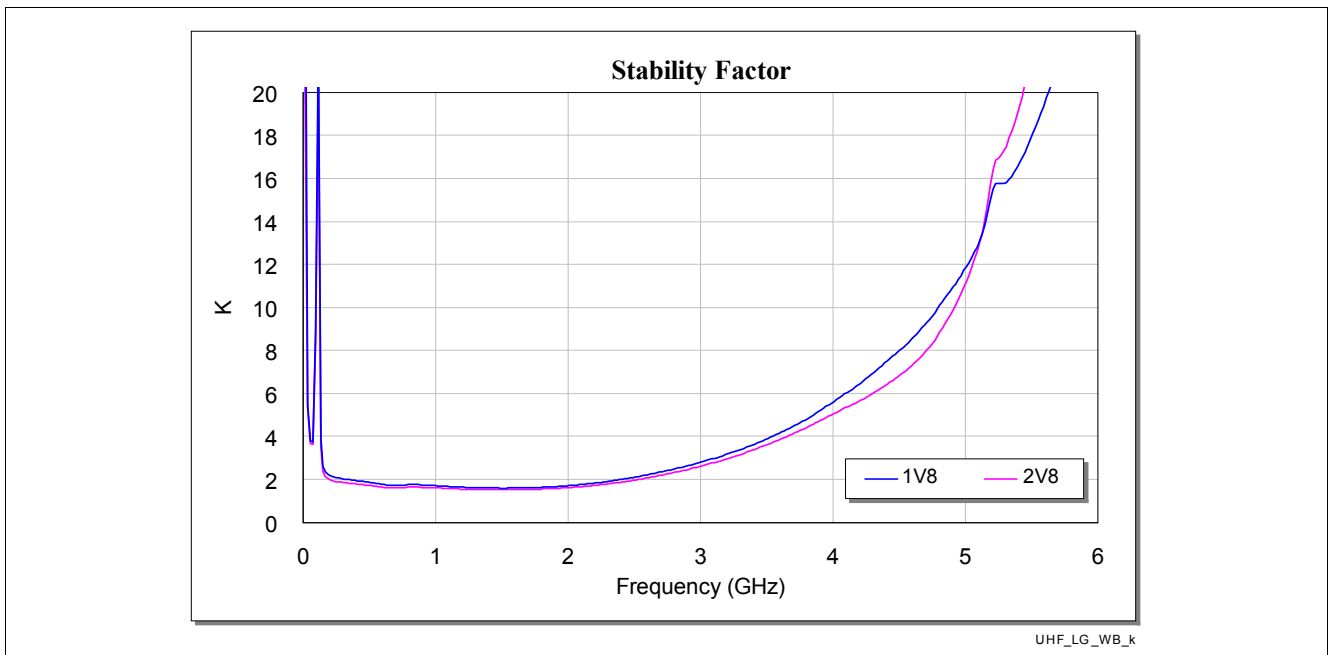


Figure 25 Stability Factor (UHF, LG, WB)

3 Application Circuit covering VHF III- UHF- and L-Band

3.1 Schematic Diagram

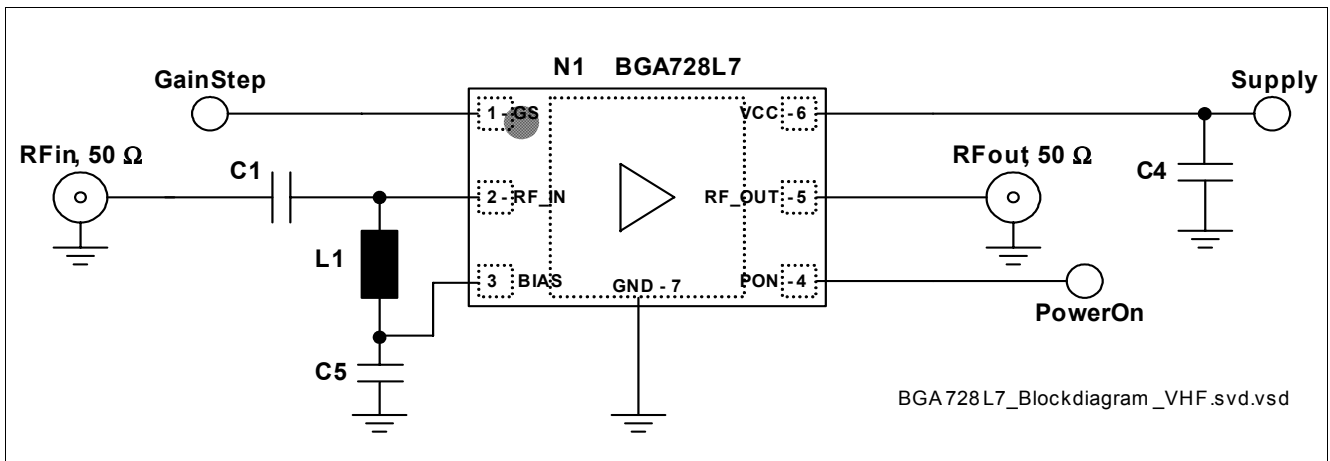


Figure 26 Schematic diagram VHF III / UHF/ L-Band

Table 5 Bill of Materials

Name	Value	Package	Manufacturer	Function
C1	56 pF	0402	Various	DC block
C4	1 nF	0402	Various	Supply voltage filtering
C5	1 nF	0402	Various	VHF III capability
L1	75 nH	0402	Murata LQW15AN75NG00	Bias Feed
N1	BGA728L7		Infineon	SiGe LNA

3.2 RF measurement results

3.2.1 High-gain mode

3.2.1.1 Narrow-band graphs

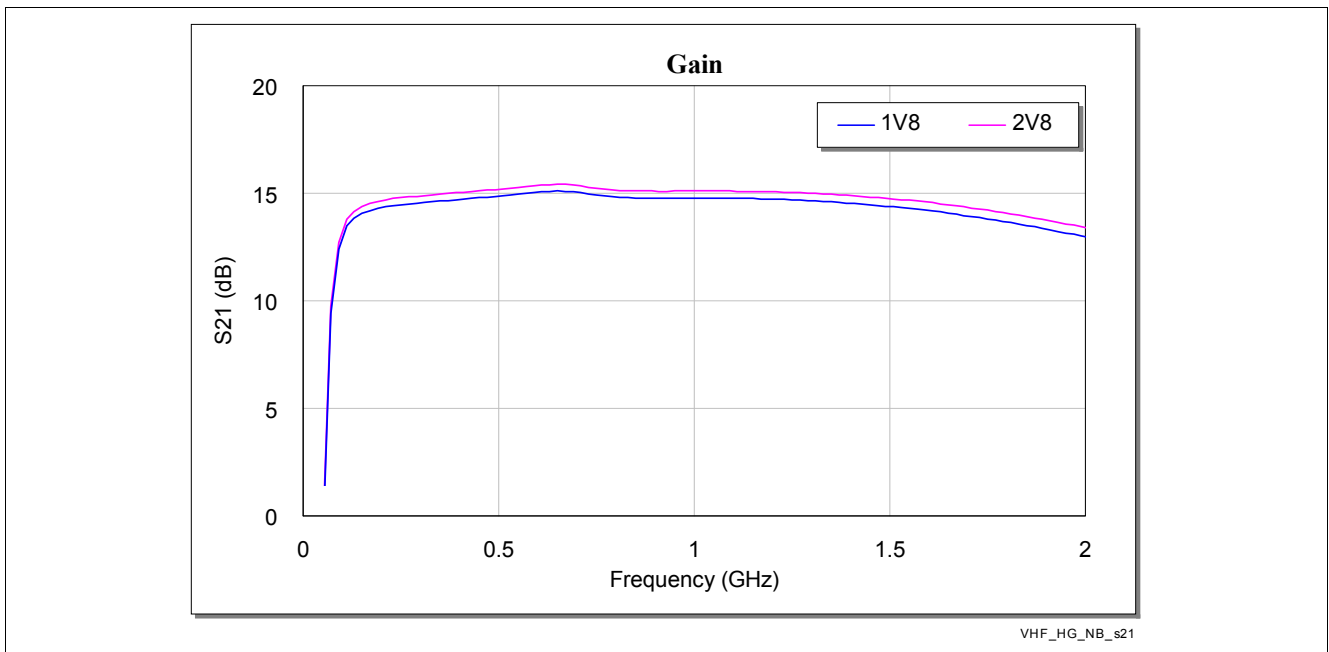


Figure 27 Gain (VHF, HG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

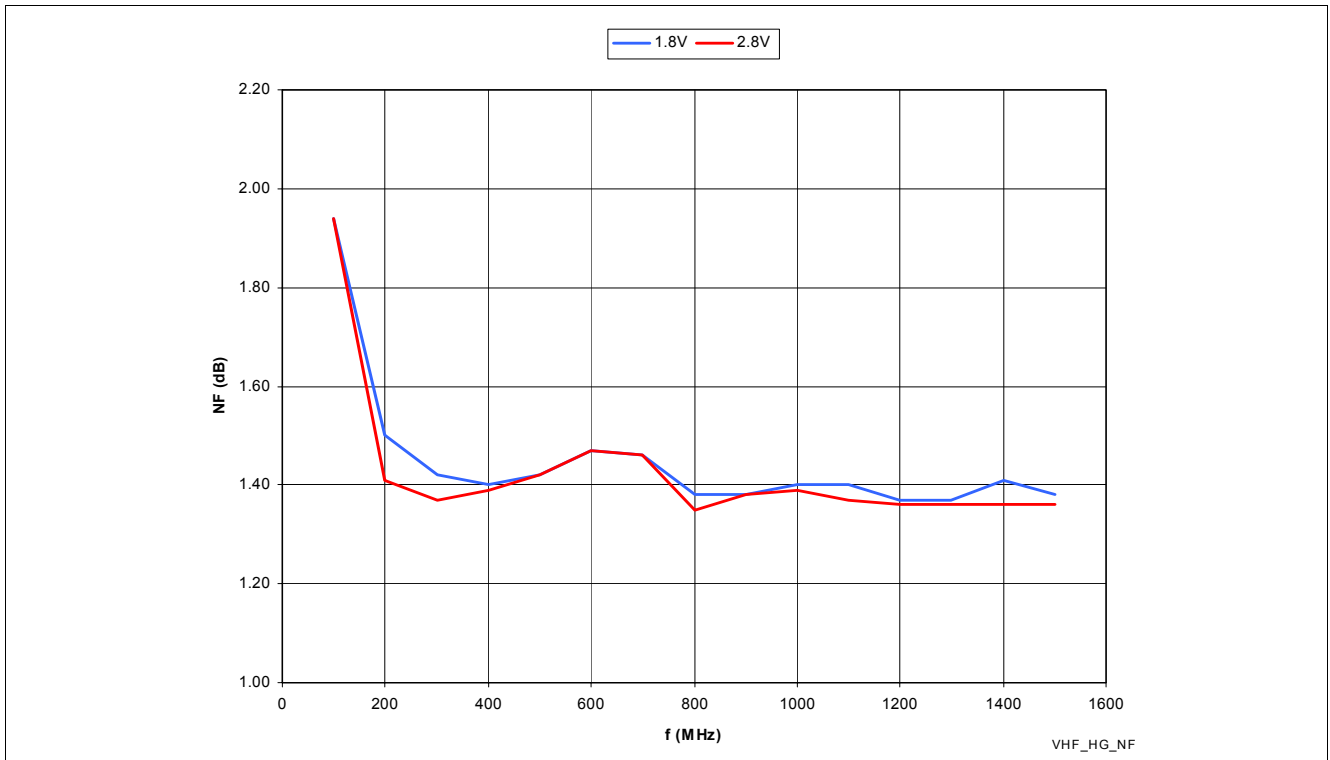


Figure 28 Noise Figure (VHF, HG, NB)

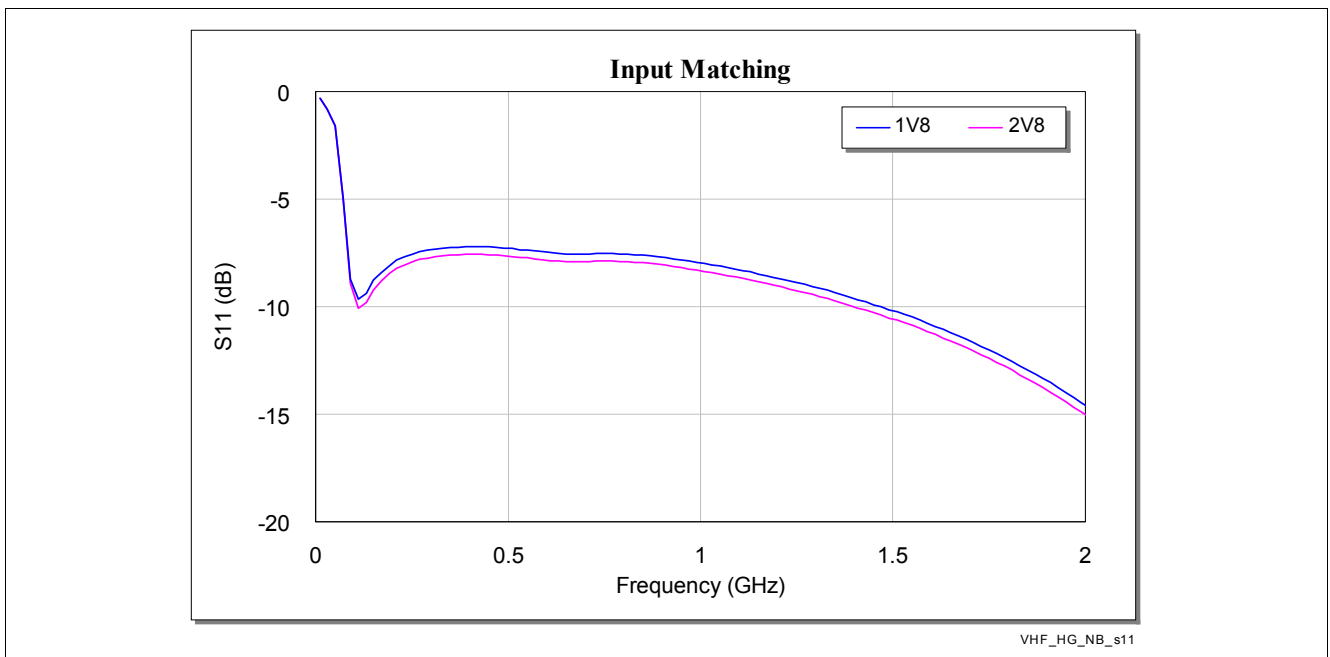


Figure 29 Input Matching (VHF, HG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

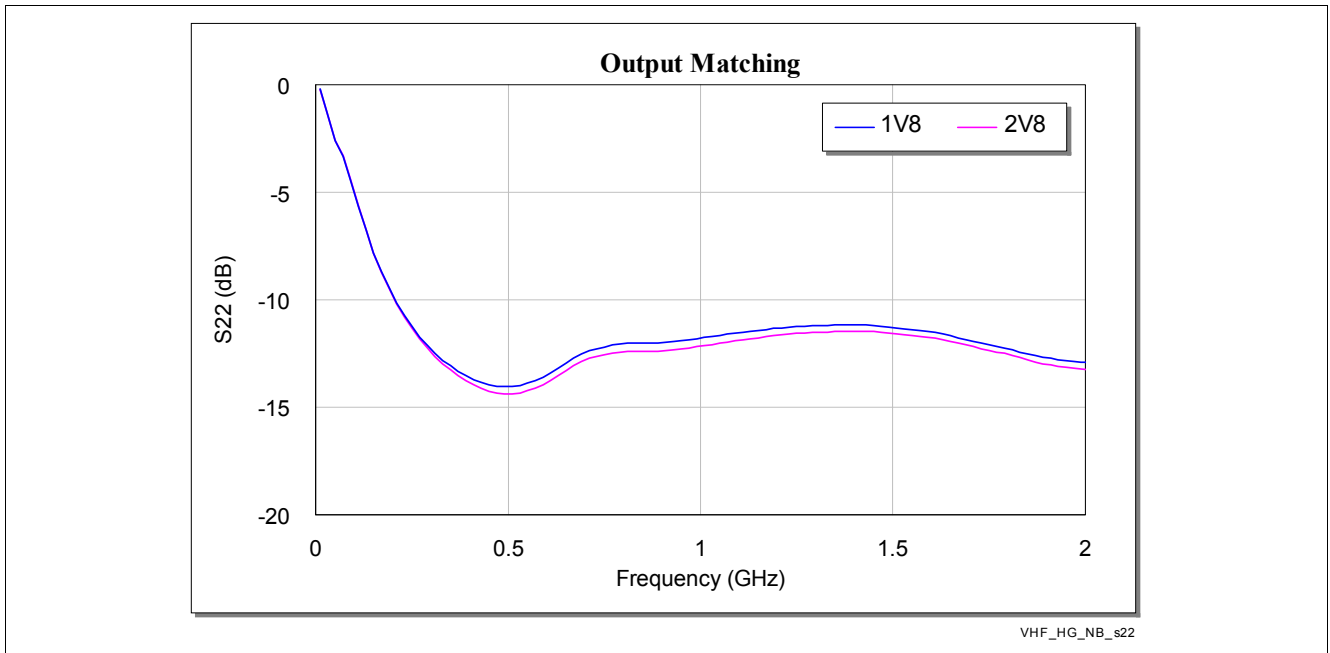


Figure 30 Output Matching (VHF, HG, NB)

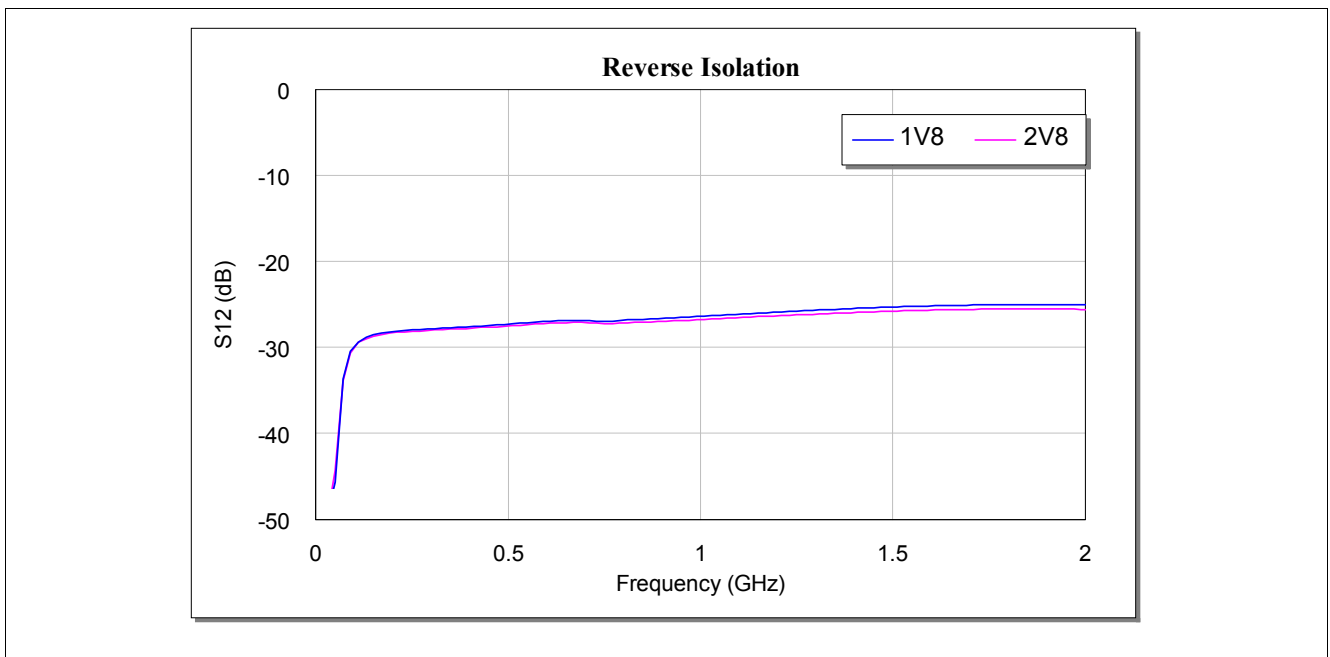


Figure 31 Reverse Isolation (VHF, HG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

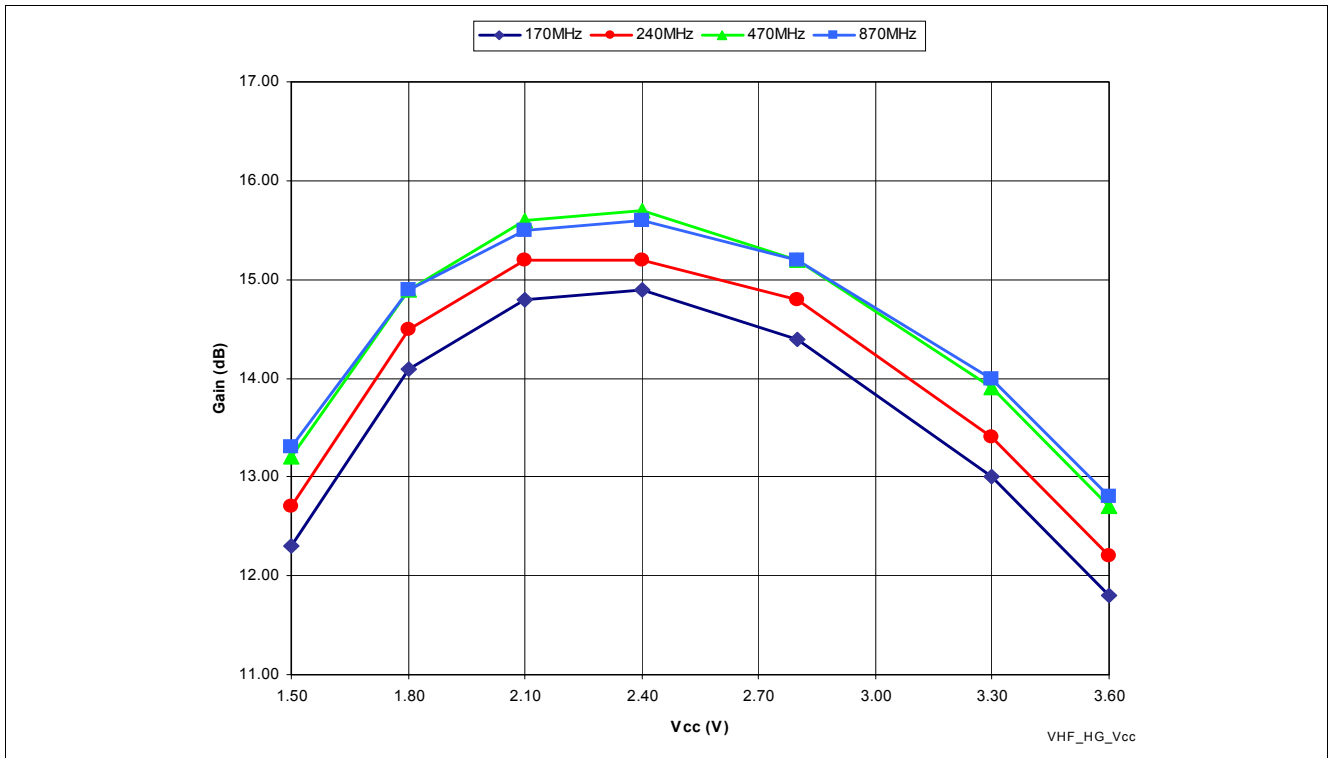


Figure 32 Gain vs. Vcc (VHF, HG, NB)

3.2.1.2 Wide-band graphs

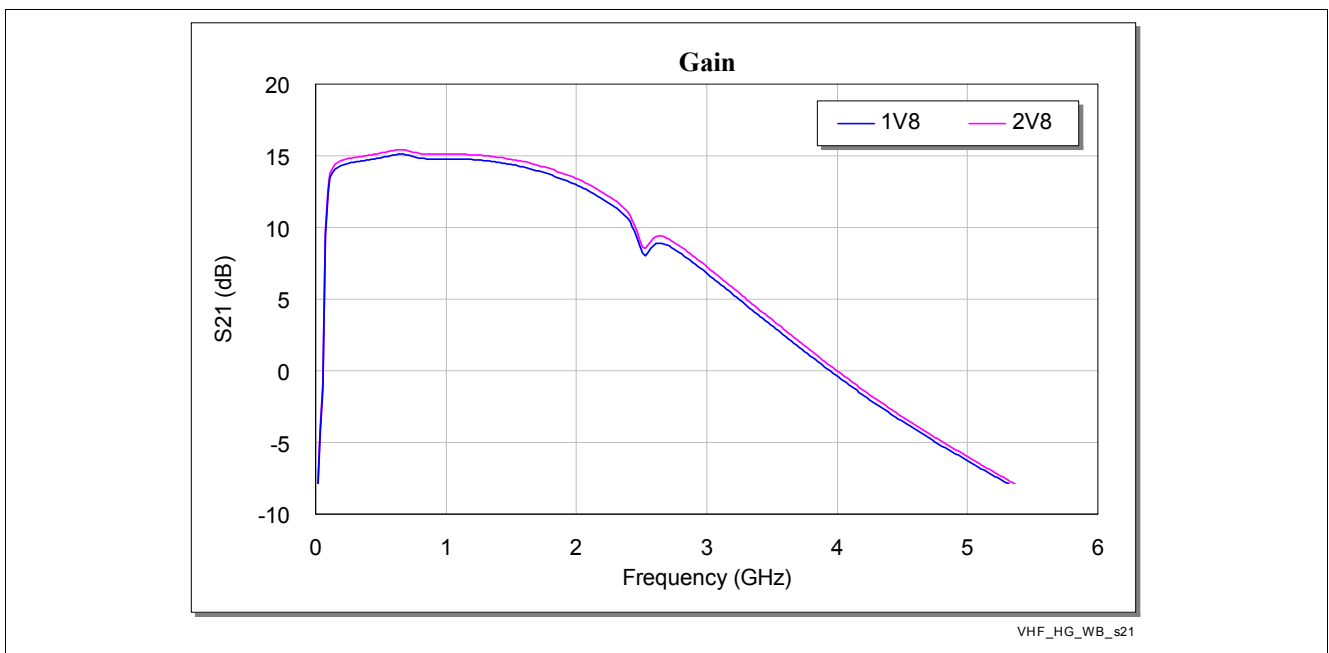


Figure 33 Gain (VHF, HG, WB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

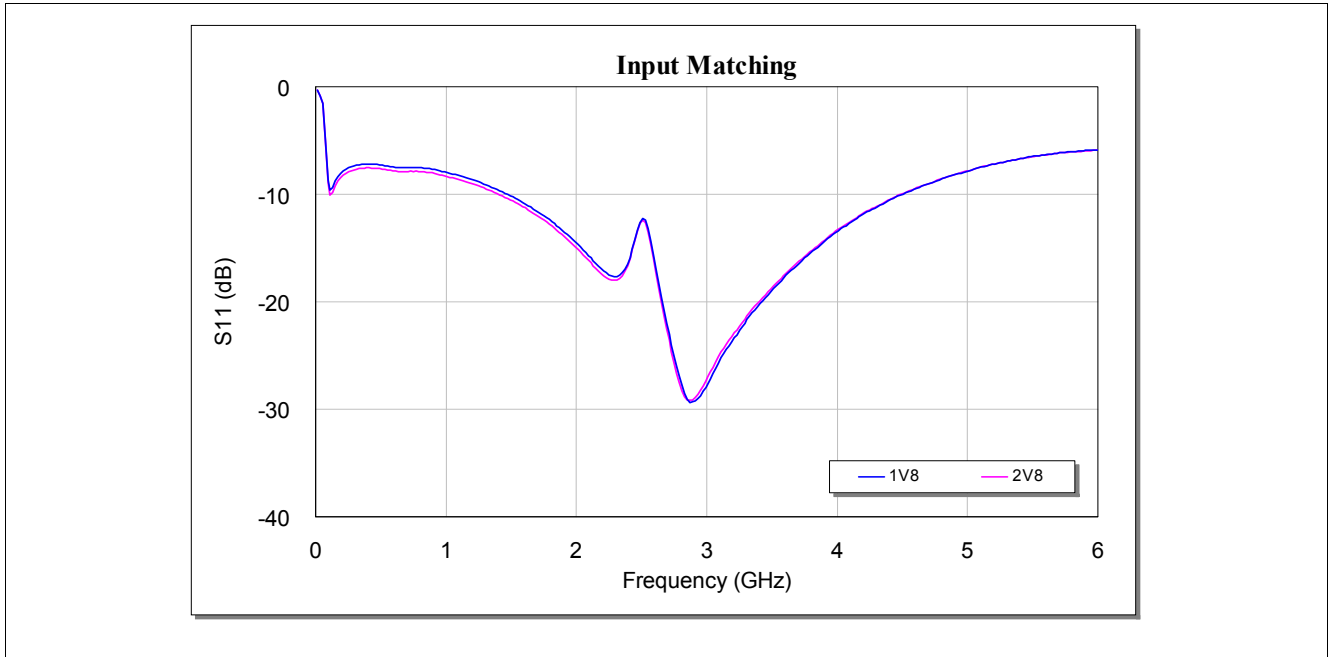


Figure 34 Input Matching (VHF, HG, WB)

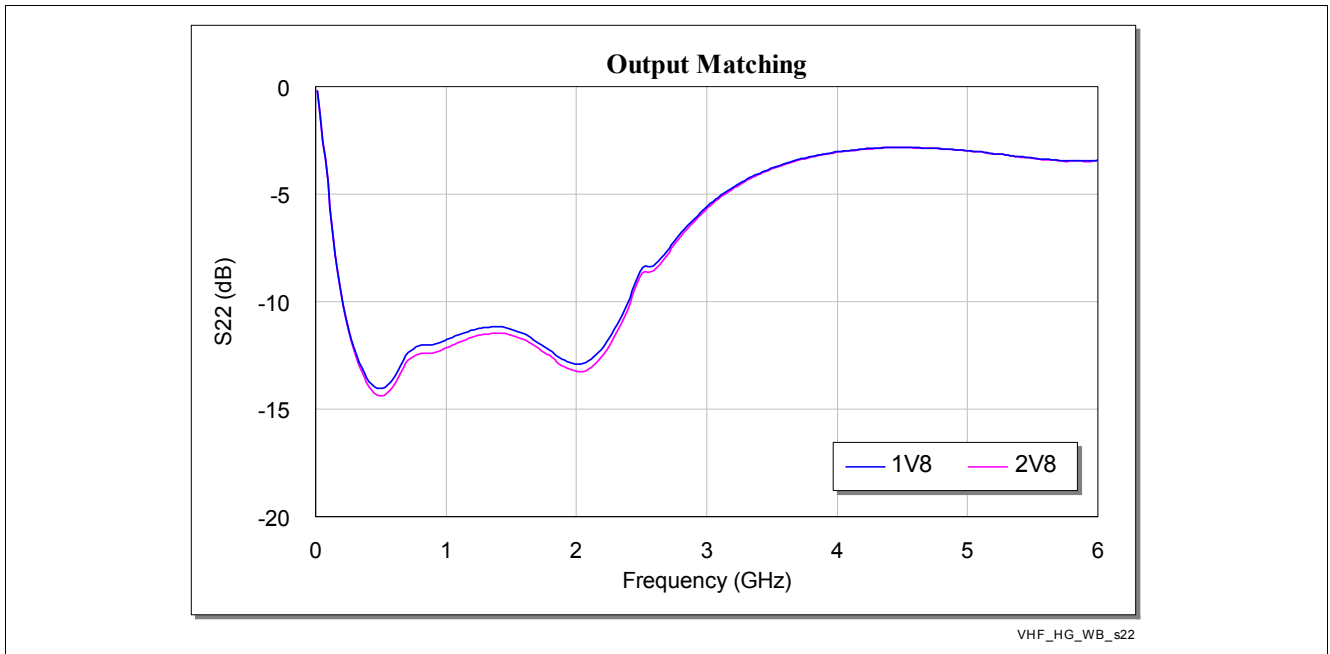


Figure 35 Output Matching (VHF, HG, WB)

VHF_HG_WB_s22

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

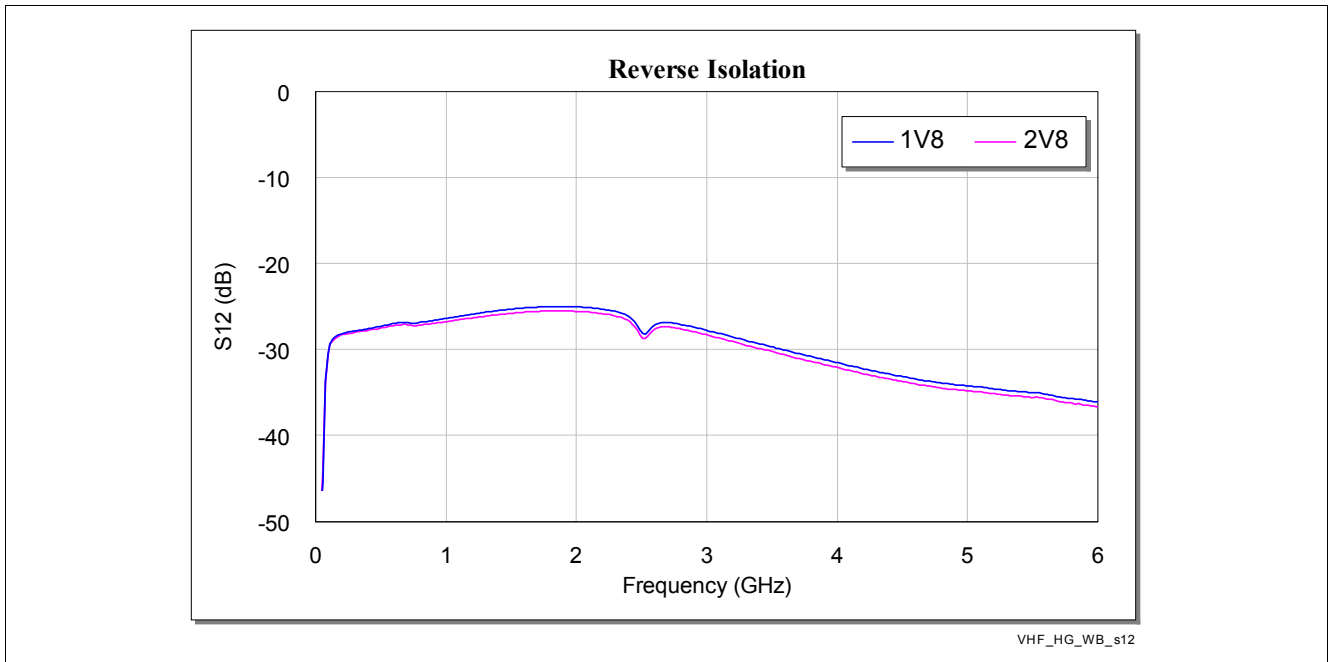


Figure 36 Reverse Isolation (VHF, HG, WB)

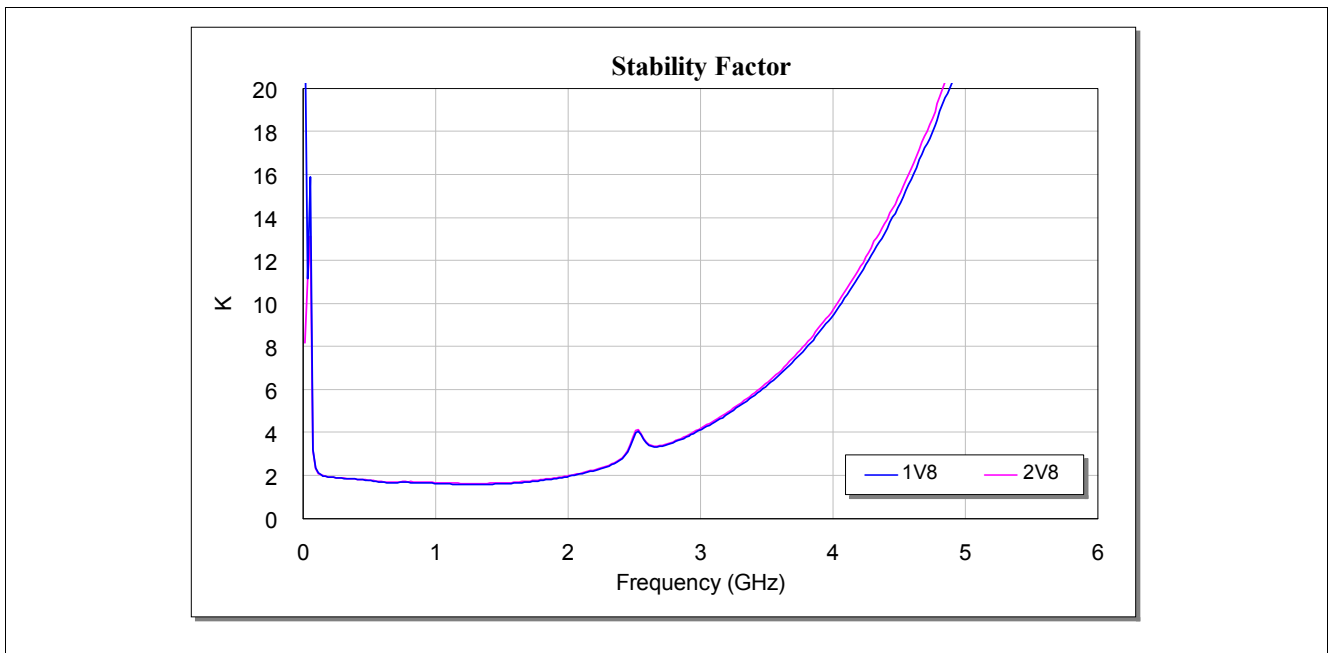


Figure 37 Stability Factor (VHF, HG, WB)

3.2.2 Low-gain mode

3.2.2.1 Narrow-band graphs

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

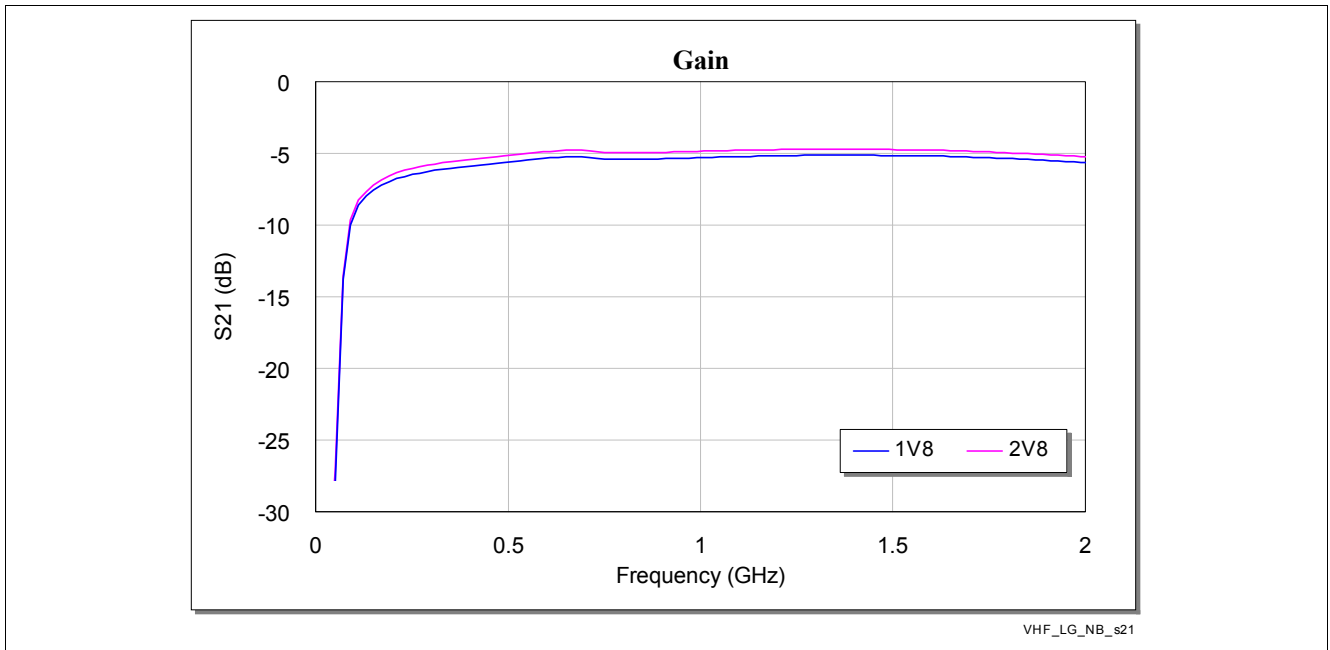


Figure 38 Gain (VHF, LG, NB)

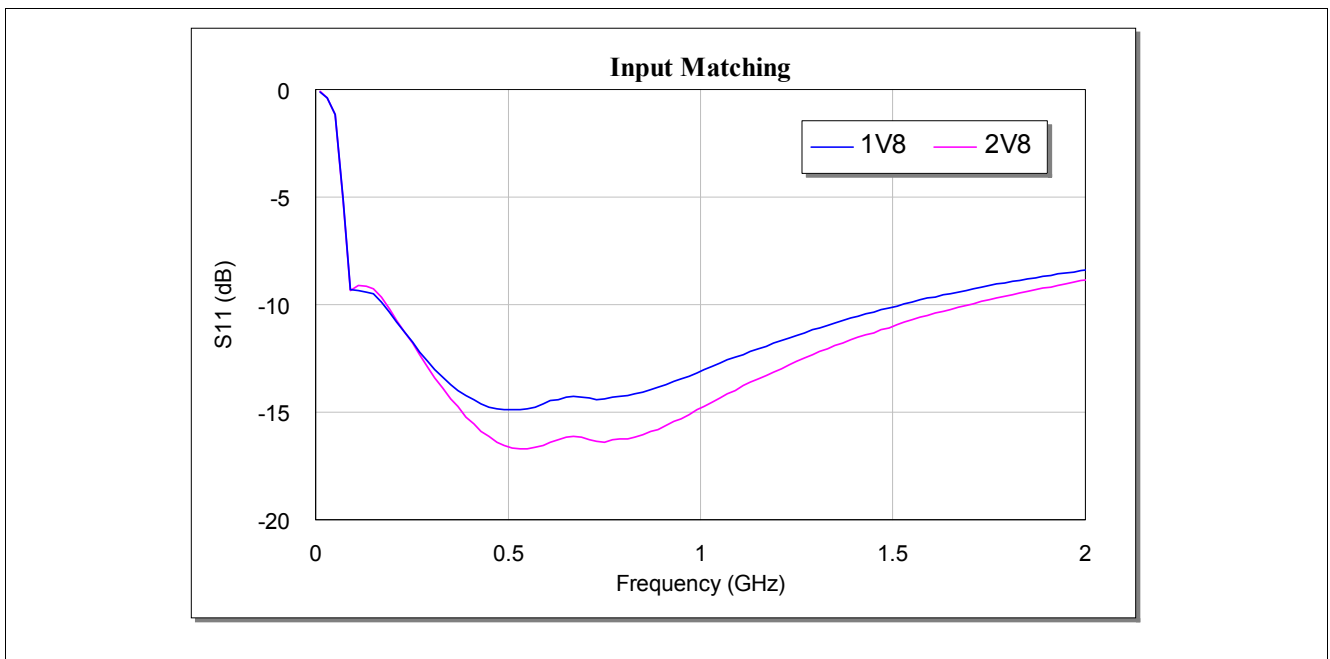


Figure 39 Input Matching (VHF, LG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

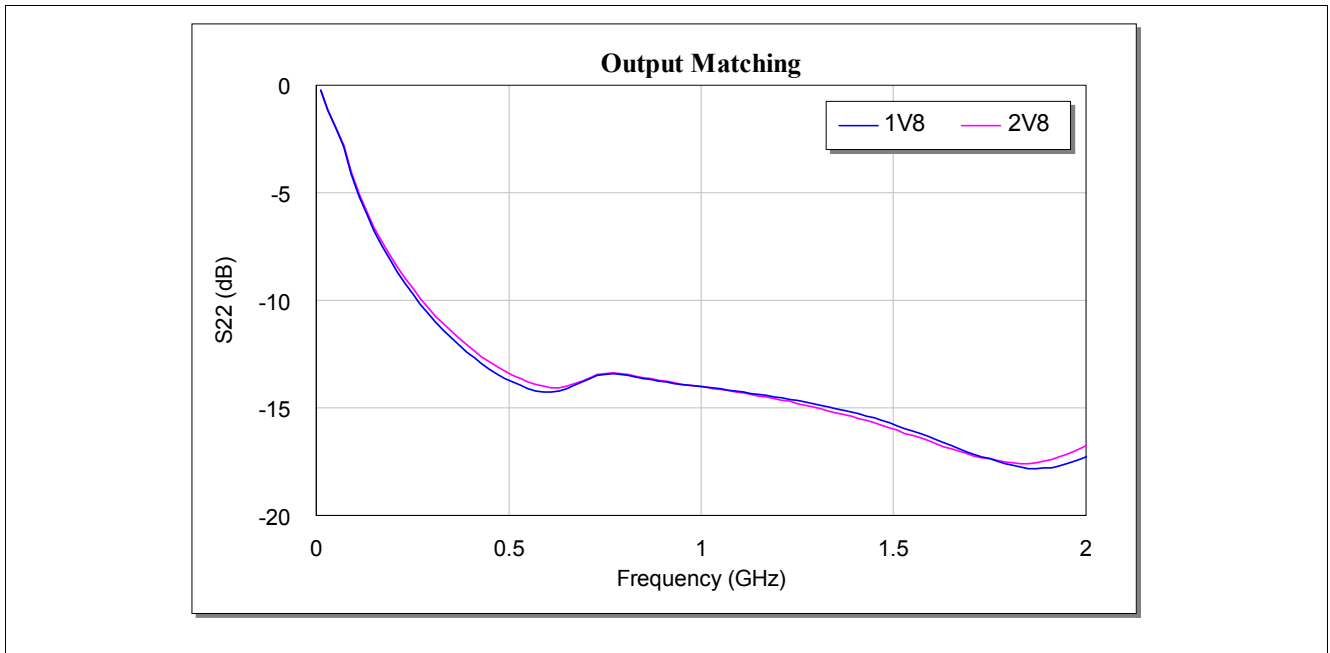


Figure 40 Output Matching (VHF, LG, NB)

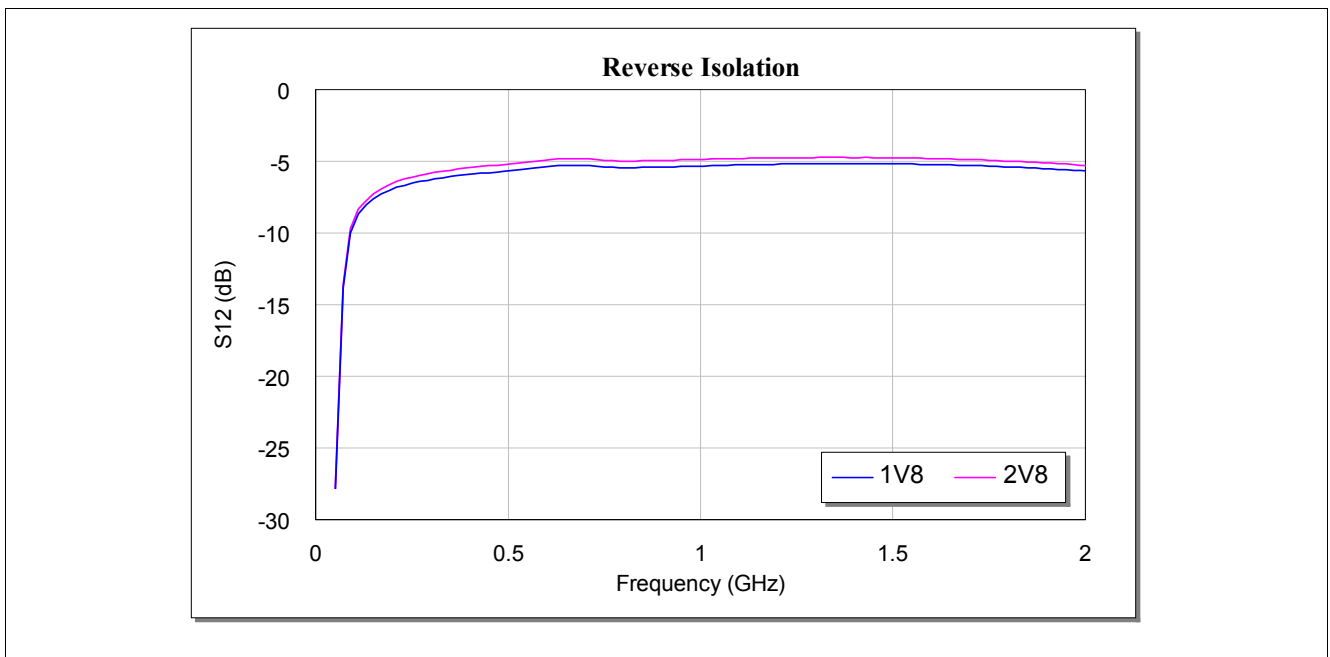


Figure 41 Reverse Isolation (VHF, LG, NB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

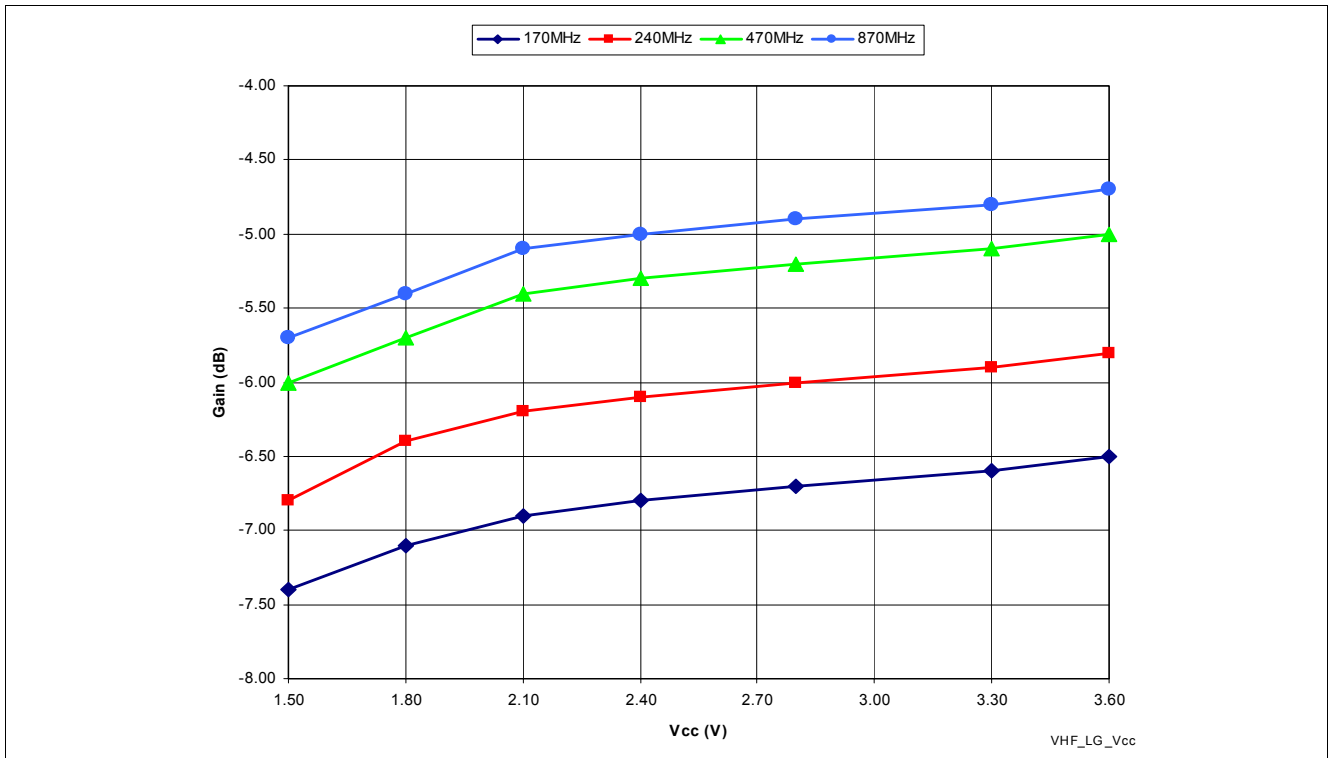


Figure 42 Gain vs. Vcc (VHF, LG, NB)

3.2.2.2 Wide-band graphs

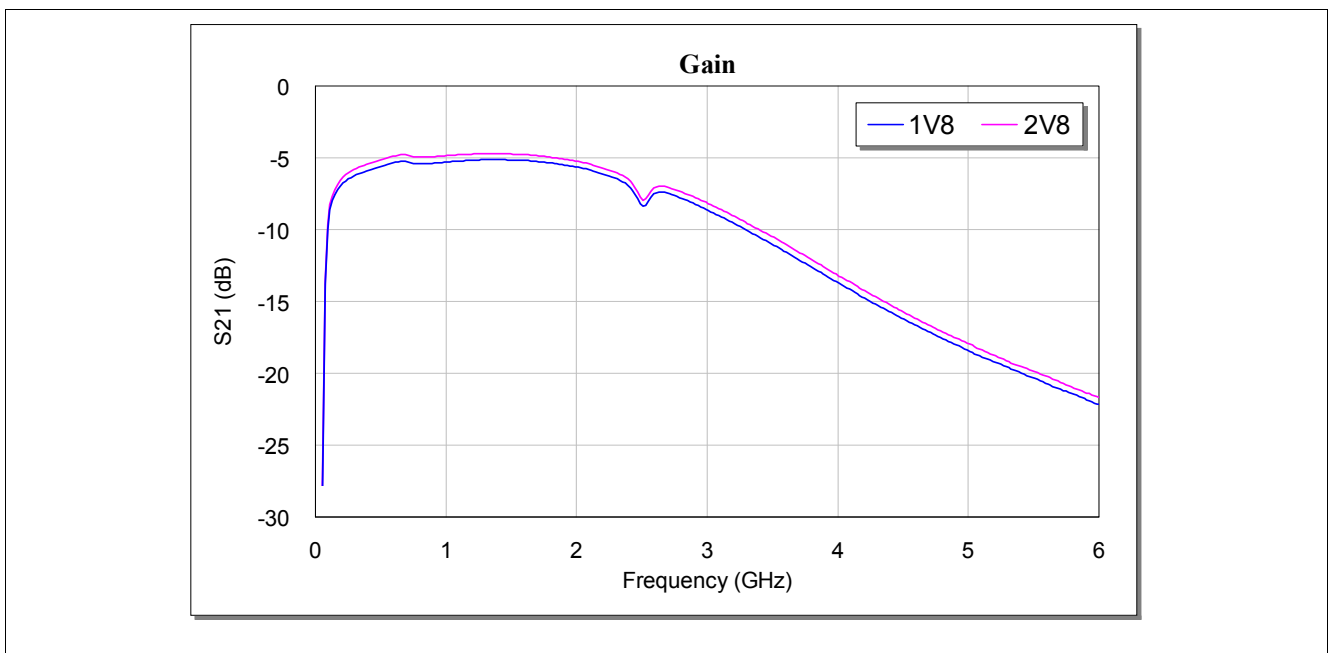


Figure 43 Gain (VHF, LG, WB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

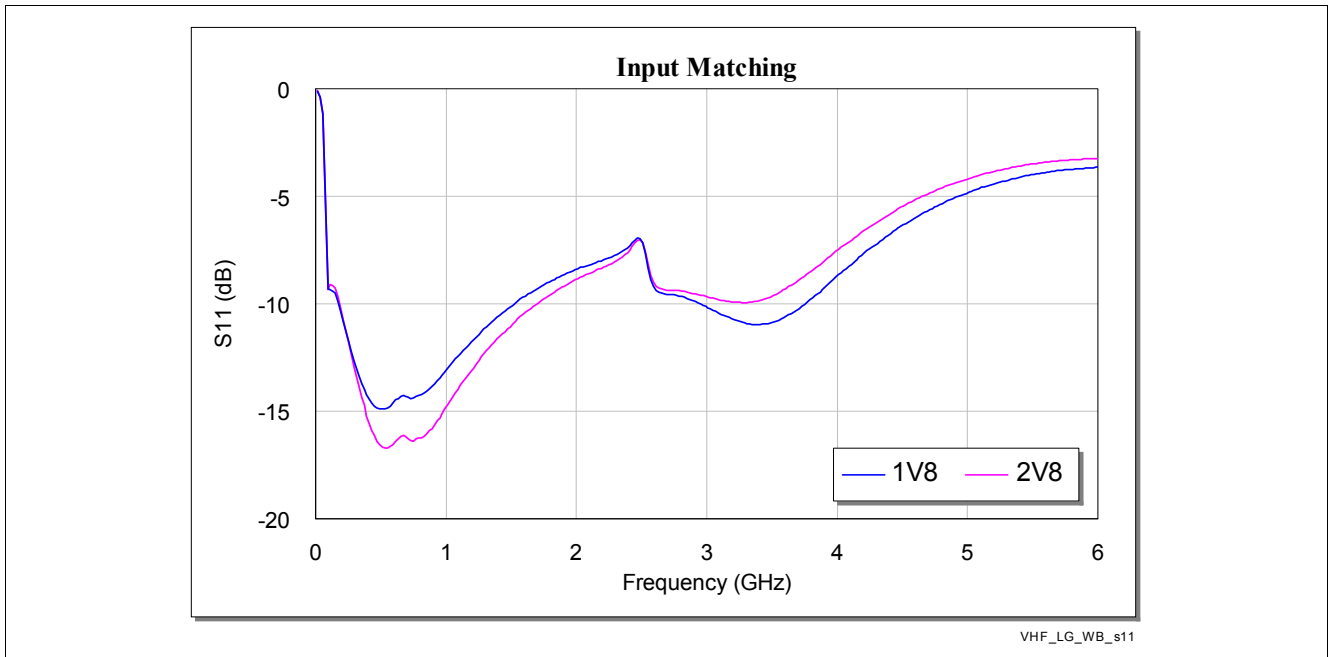


Figure 44 Input Matching (VHF, LG, WB)

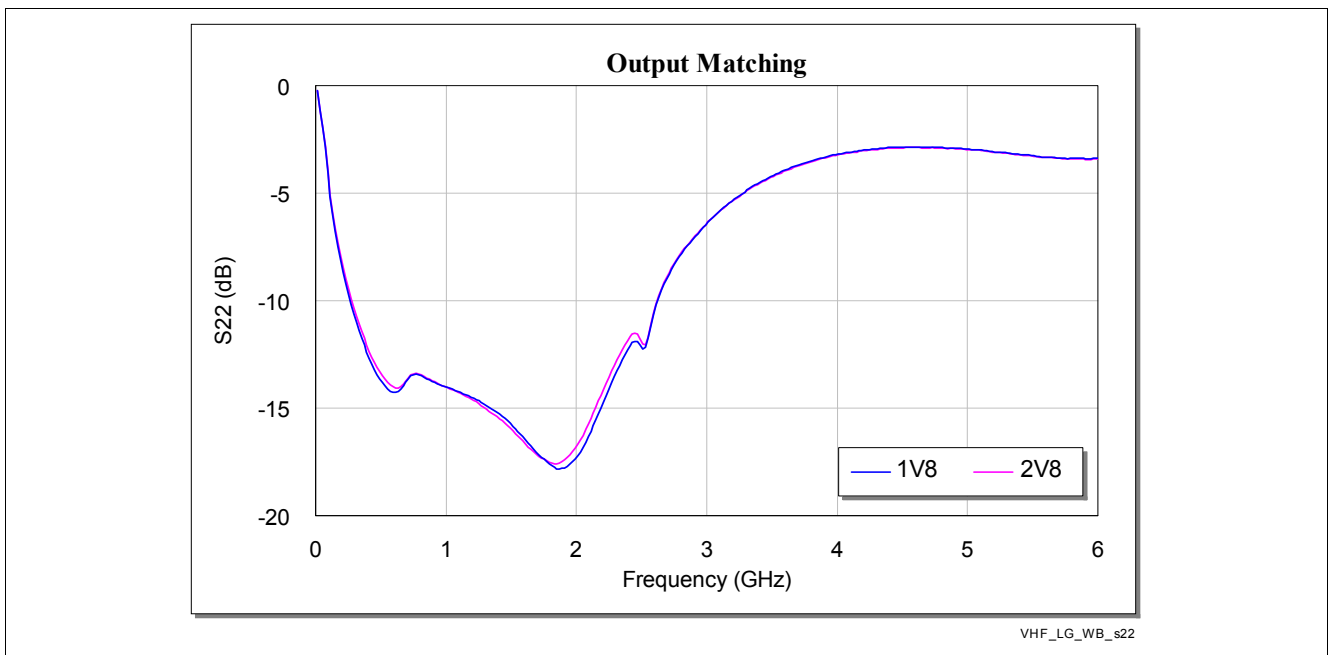


Figure 45 Output Matching (VHF, LG, WB)

BGA728L7 Broadband Low Noise Amplifier for Portable and Mobile TV

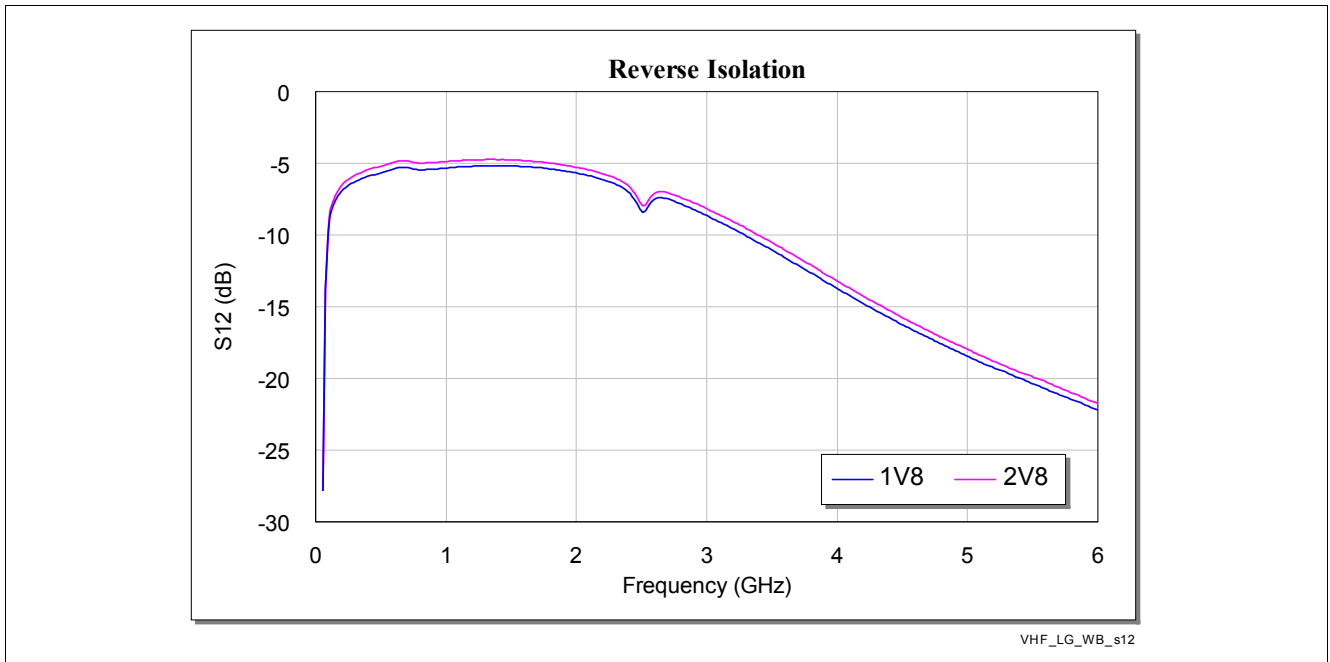


Figure 46 Reverse Isolation (VHF, LG, WB)

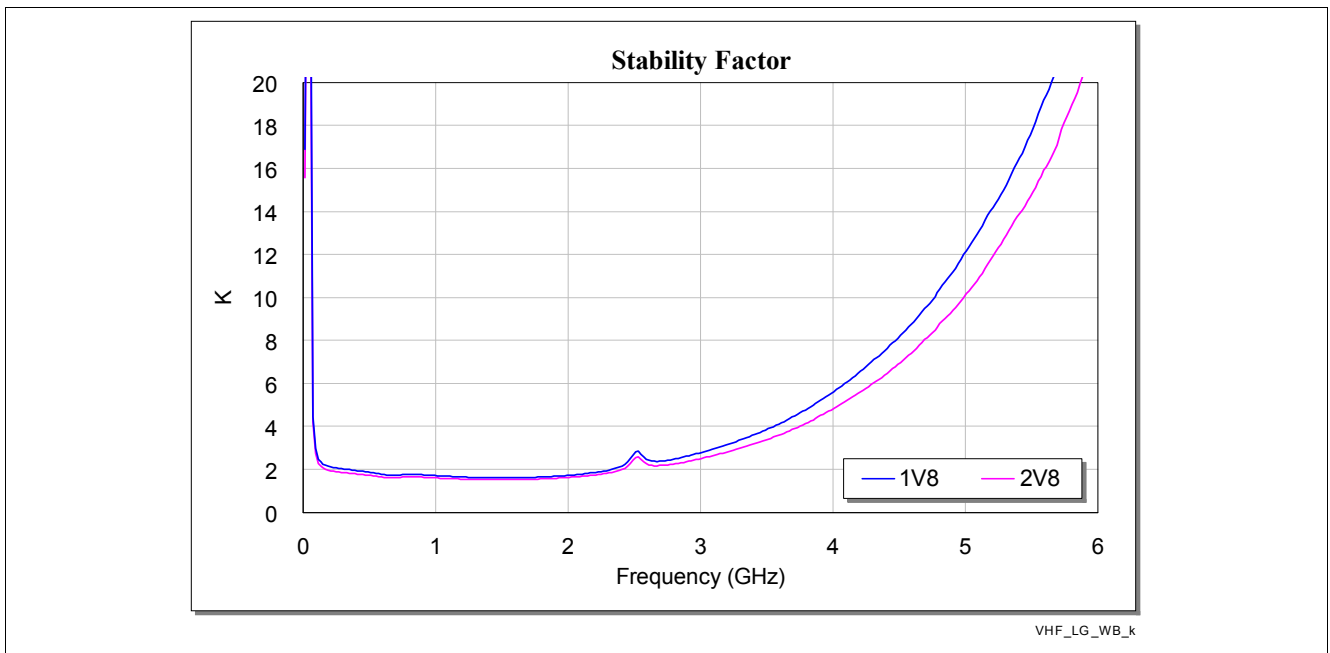


Figure 47 Stability Factor (VHF, LG, WB)

4 Evaluation Board

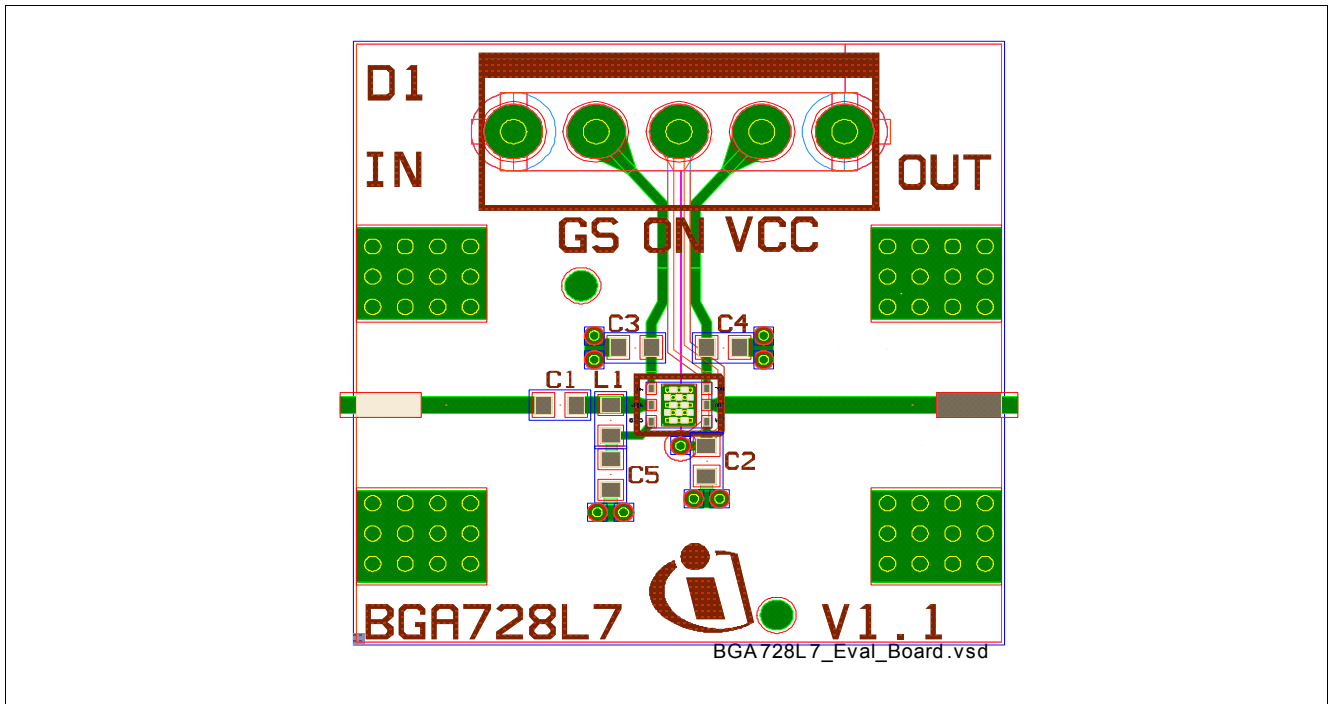


Figure 48 Layout of evaluation board