AN11251

BGA7210 Operation Frequency Extension Down to 400 MHz

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Document information

Info	Content
Keywords	BGA7210, VGA, Frequency Extension, RF Choke, S-Parameters, Return Loss, OM7921/BGA7210 Customer Evaluation Kit
Abstract	The document provides the measurement results to show BGA7210 could operate well down to 400 MHz with good performance, by optimizing the RF Choke value.
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Contact information	For more information, please visit: http://www.nxp.com

Revision history

Rev	Date	Description
1	20120911	Initial document

1. Introduction

This document describes the testing results for the frequency down to 400 MHz by optimizing the RF Choke value, the testing items include S-Parameters, linearity performance, noise figure, and so on. Measurements shown compare the performance using the original external component list ***(without the shunt capacitor Csh = 0.68 pF)*** with the optimized RF Choke, which proves BGA7210's excellent performance down to 400 MHz, covering low CDMA band.

The BGA7210 MMIC is an extremely linear Variable Gain Amplifier (VGA), operating from 0.7 GHz (now it's 0.4 GHz) to 3.8 GHz. The maximum gain is 30 dB. It has an attenuation range of 31.5 dB. At its minimum attenuation setting it has a maximum power output of 21 dBm, an IP3o of 39 dBm and a noise figure of 6.5 dB.

The BGA7210 has been designed and qualified for the severe mission profile of cellular base stations, but its outstanding RF performance and digital SPI interfacing flexibility make it suitable for a wide variety of applications.

2. Schematic Description

Figure 1 shows the simplified schematic of BGA7210 evaluation board. With the current component values, the gain roll-off at low 400 MHz frequencies. To improve this, the RF choke L2 was changed from 22 nH to 47 nH (Murata LQW 18), other components remain the same as BOM listed in datasheet. From simulations done earlier, the RF choke show the biggest influence among the external components. The reason of choosing 47 nH is for better output RL at lower frequency. 56 nH is also possible, but that will result in too much performance roll-off at high frequency.

For all measurements described here, no output matching capacitor (Csh) was used.

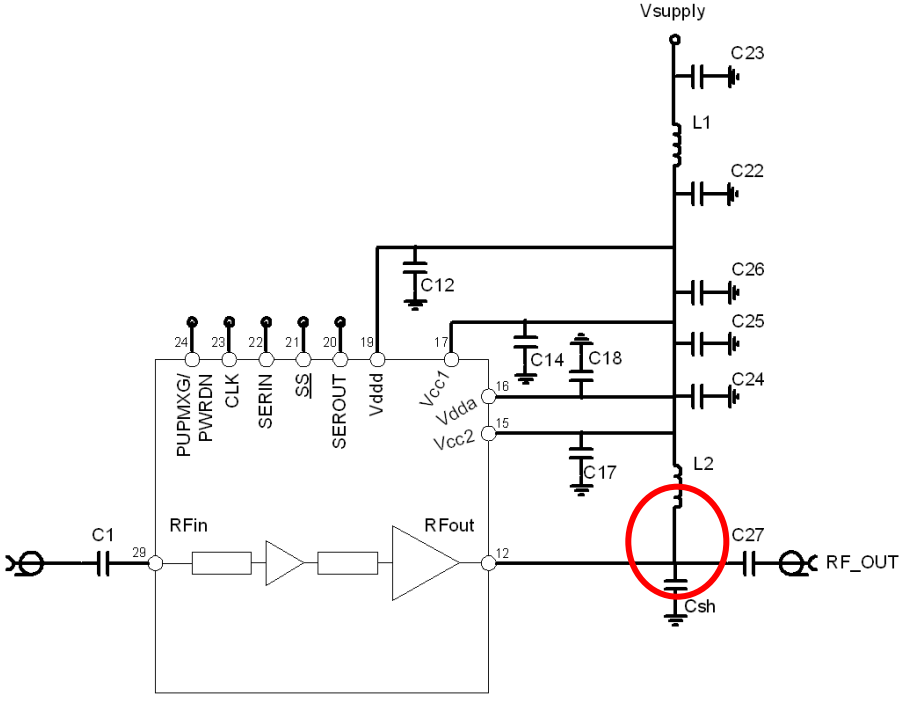


Fig 1. Simplified Schematic of BGA7210 Evaluation Board

3. Measurement Results

3.1 S-par Comparison

Figures 2 and 3 show the s-parameter for L2=22 nH (in blue) and L2=47 nH (in red), it's observed that S21 trace with 47 nH is moving to lower frequency area. At 400 MHz, S21 improves by 0.4 dB, S22 improves by 6.5 dB while S11 and S12 have no significant difference.

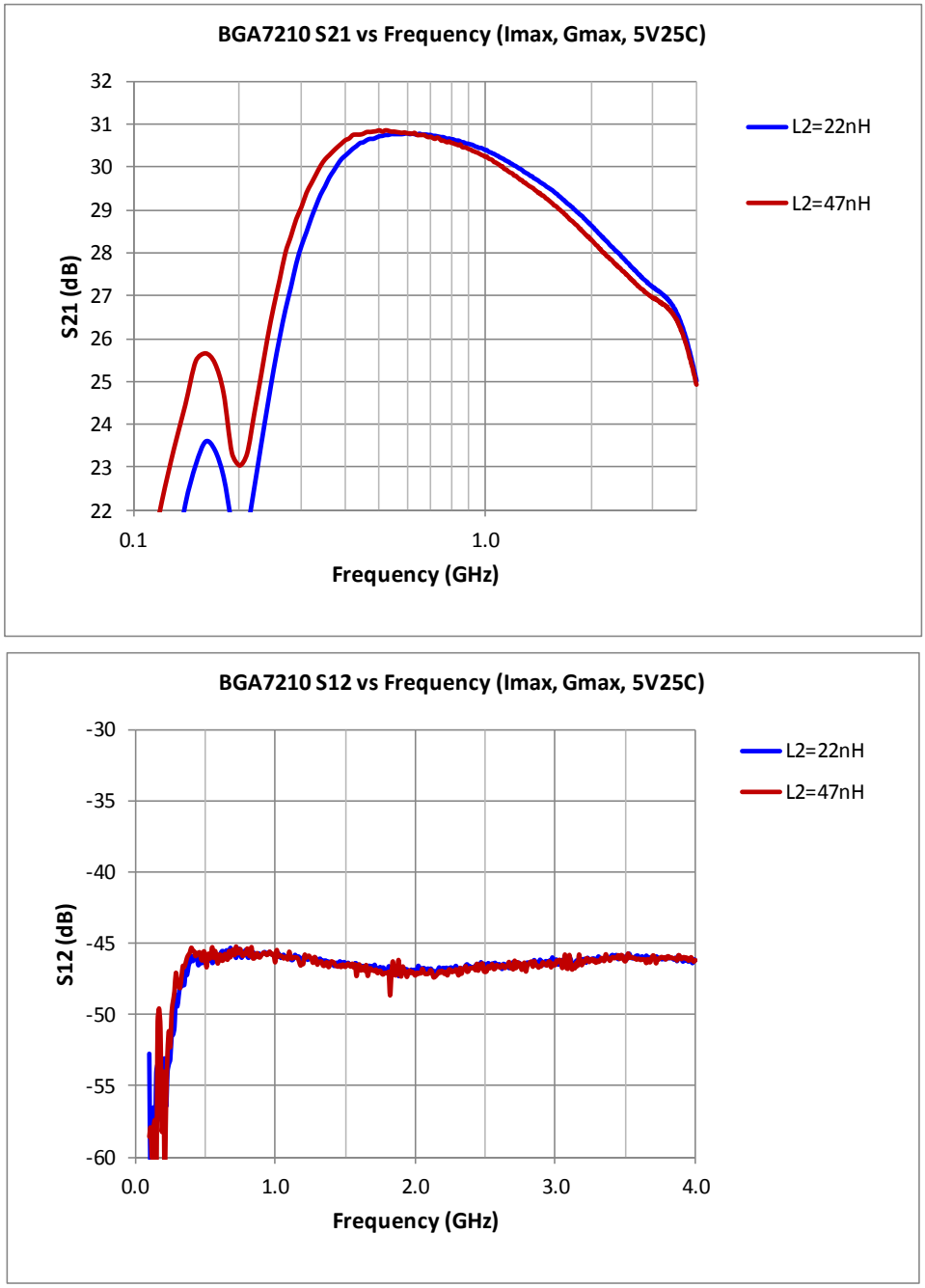
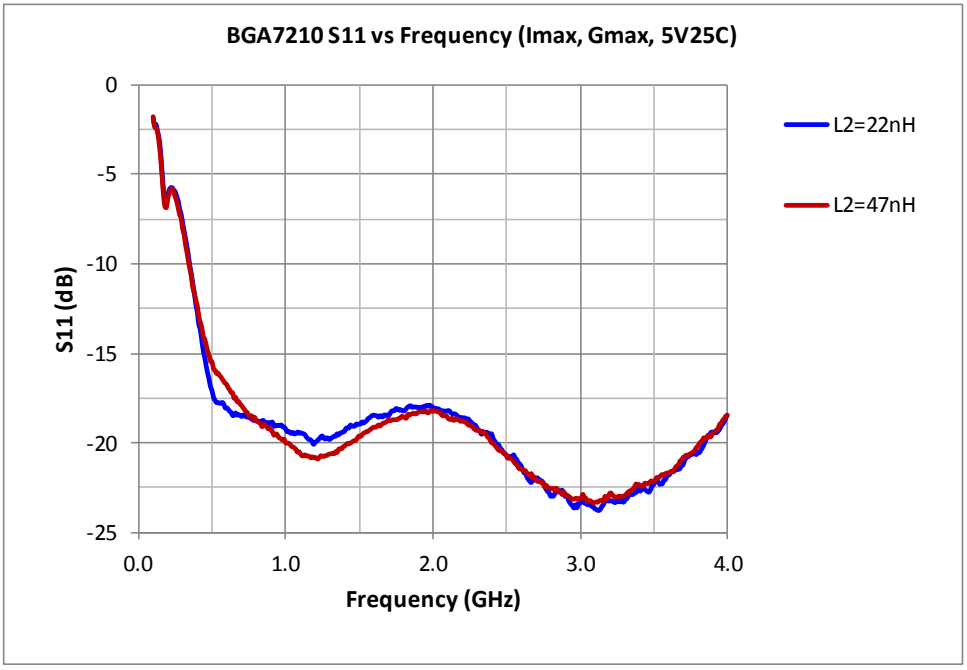


Fig 2. Comparison S21 and S12 for Two RF Choke L2 Values (Imax, Gmax)



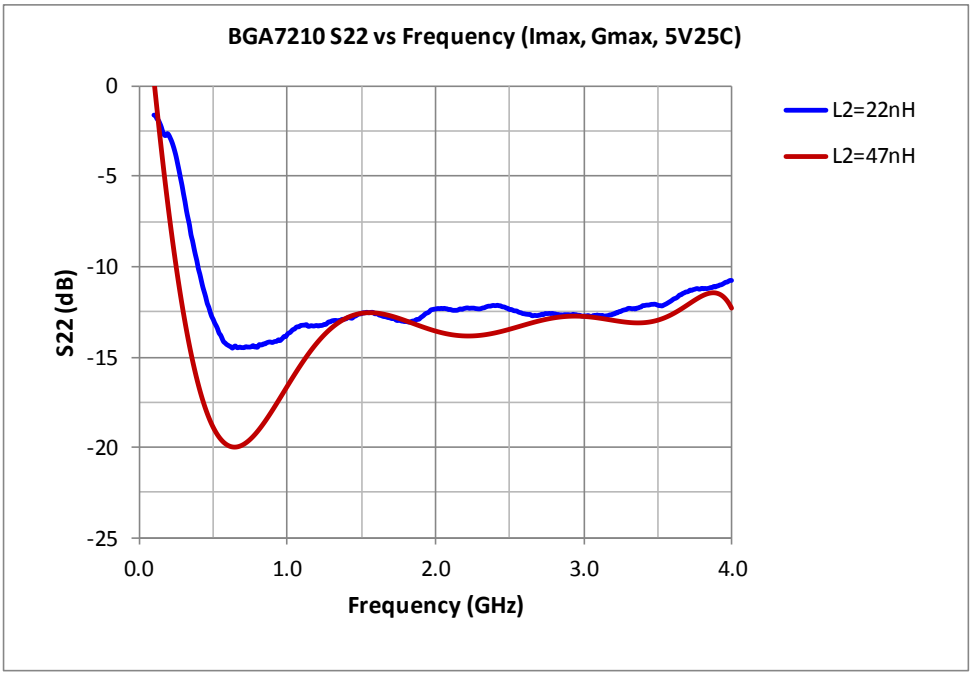


Fig 3. Comparison S11 and S22 for Two Different RF Choke Values (Imax, Gmax)

3.2 Gain Parameters vs. Attenuation

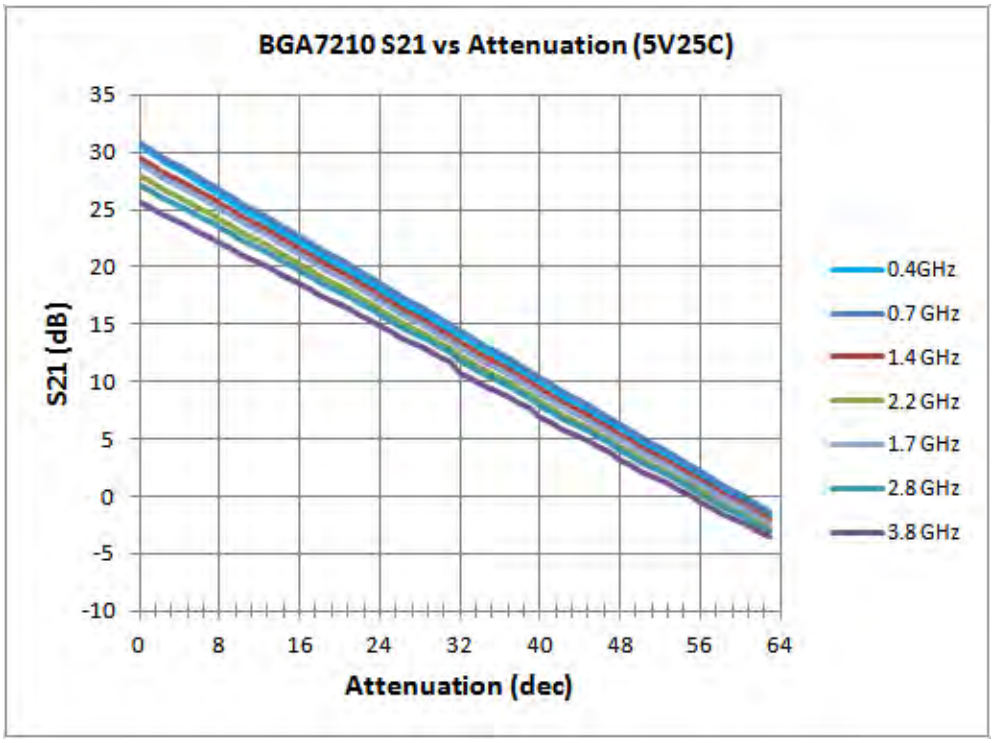


Fig 4. Gain vs. Attenuation Setting, L2=47 nH

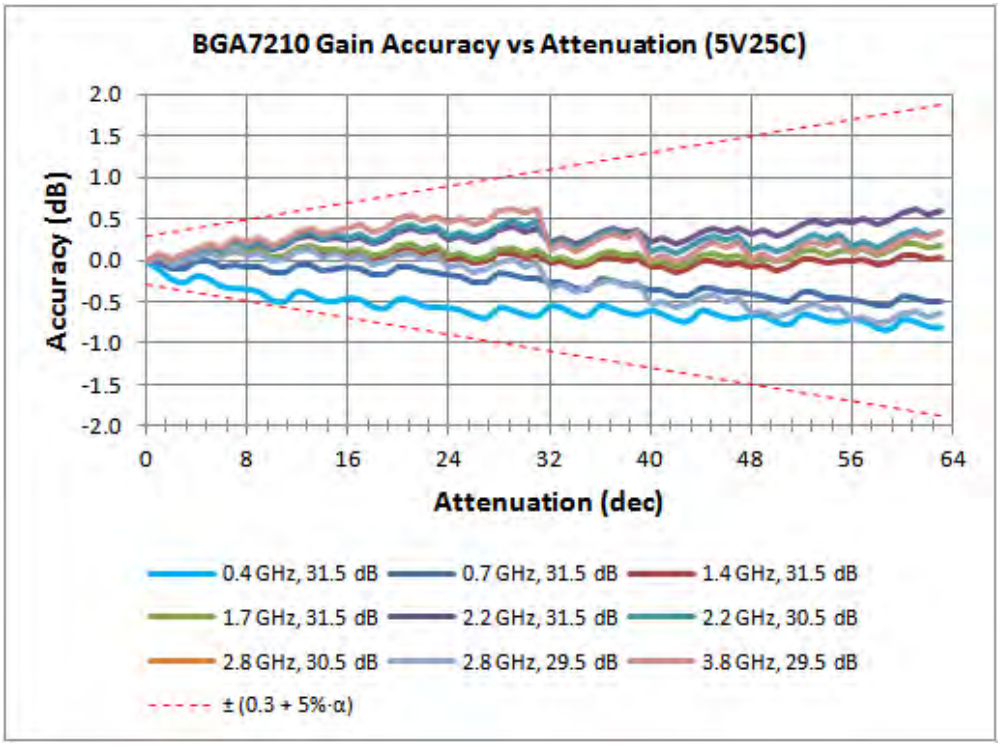


Fig 5. Gain Accuracy vs. Attenuation Setting, L2=47 nH

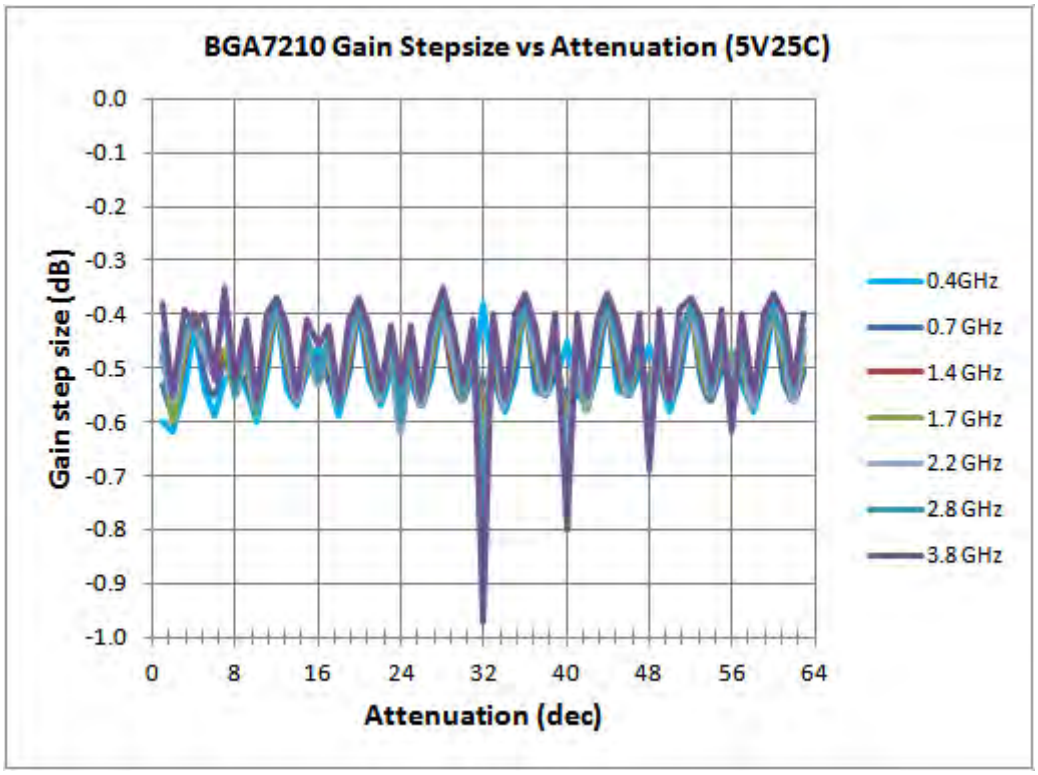


Fig 6. Gain Step Size vs. Attenuation Setting, L2=47 nH

With L2=47 nH S-parameter performance at 400 MHz of device complies with the current product specifications. No problem in monotonicity on all DSA (Digital Step Attenuator) settings and gain accuracy is within specification. No changes seen in performance at high frequencies compared to L2=22 nH.

3.3 Third Order Output Intercept Point (OIP3)

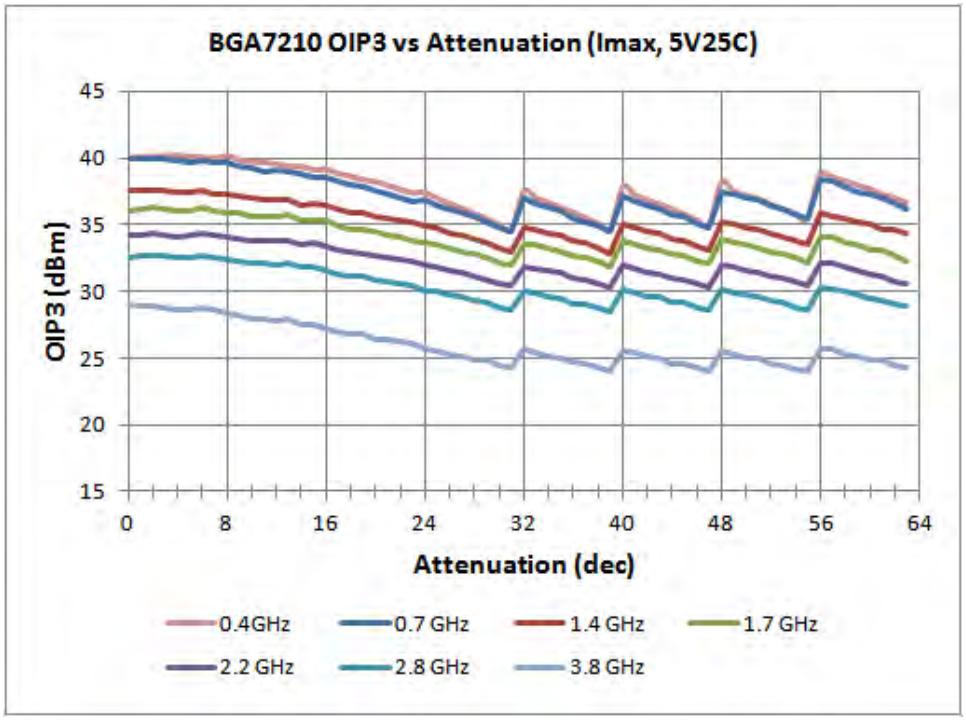


Fig 7. OIP3 vs. Attenuation Setting at Imax, Pin/tone-23 dBm, Fdelta=10 MHz, L2=47 nH

At 400 MHz, BGA7210 has the same OIP3 performance as 700 MHz. Compared to results of L2=22 nH, changing L2 to 47 nH has no effect on linearity performance.

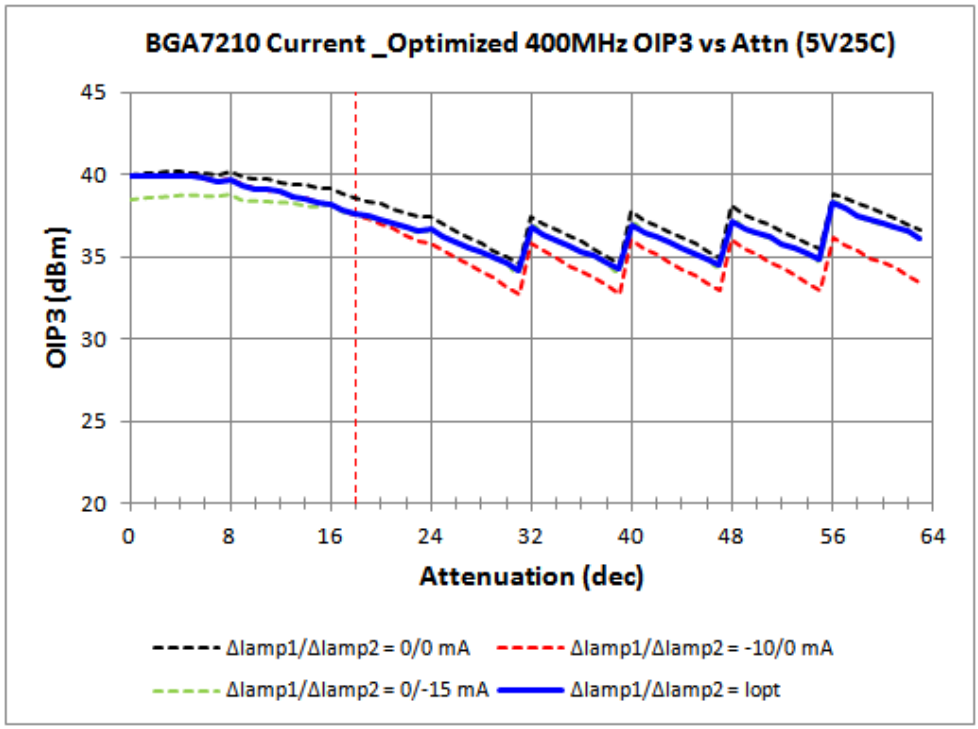


Fig 8. OIP3 vs. Attenuation Setting for Different Current Settings, L2=47 nH

Figure 8 shows that the current optimized OIP3 settings is also valid for 400 MHz. For DSA values between 0 and 17, ΔIamp1/ΔIamp2 =-10/0 mA was used and from DSA=18 to 63 ΔIamp1/ΔIamp2 =0/-15 mA was used.

3.4 Noise Figure

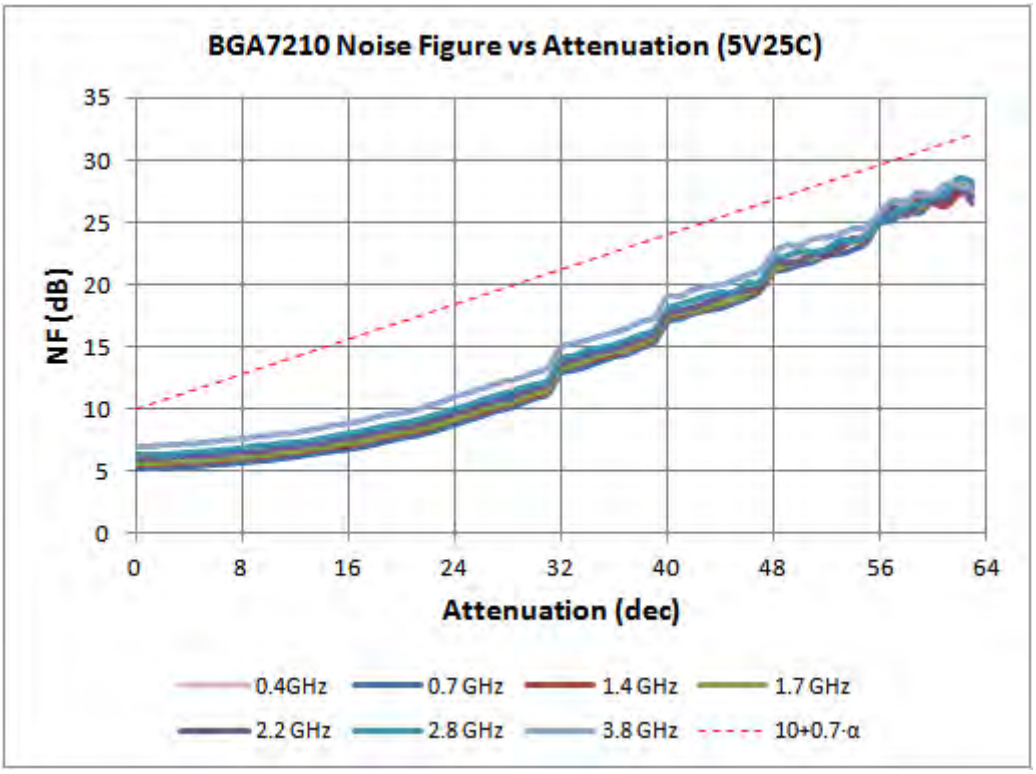


Fig 9. Noise Figure as Function of DSA Setting, L2=47 nH

Noise Figure at 400 MHz is the same as 700 MHz with 47 nH configuration.

3.5 Performance Summary

The table below shows the summary of the device performance at 400 MHz with L2=47 nH, and make comparison to the specification whose frequency range is from 700 … 1400 MHz.

Table 1. BGA7210 400 MHz Performance Summary L2=47 nH

Parameter	Conditions	Specification			Measurement
		Min	Typical	Max	5V_25C
Power Gain G_p	DSA=0 Iamp1=Iamp2=0	26.0	30.0	33.0	30.6
Attenuation Range α_{max}	Iamp1=Iamp2=0	28.0	31.5	35	32.3

Parameter	Conditions	Specification			Measurement
Attenuation Step Size $\Delta\alpha$	Iamp1=Iamp2=0	0.0	0.5	1.0	0.4 / 0.5 / 0.6
Input Return Loss RL_{in}	0 ≤ DSA ≤ 63 Iamp1=Iamp2=0		10		9.5
Output Return Loss RL_{Out}	0 ≤ DSA ≤ 63 Iamp1=Iamp2=0		7		14.1
Noise Figure	DSA=0 Iamp1=Iamp2=0	-	6.5	8.5	5.1
	DSA=63 Iamp1=Iamp2=0	-	27.5	30.5	27.7
3^{rd} order Output Intercept Point $IP3_O$	DSA=0 Iamp1=Iamp2=0	34	39	-	40.0
	DSA=63 Iamp1=Iamp2=0	-	35	-	36.6
Output Power at 1dB Compression $P_{L(1dB)}$	DSA=0 Iamp1=Iamp2=0	18	21		22.6

4. Conclusion

BGA7210 operation frequency range could easily extend down to 400 MHz, by replacing the RF choke L2 from original 22 nH to 47 nH. According to the measurement results, all concerned product performance (such as S-parameters, linearity, noise figure and so on) at 400 MHz is even slightly better than the performance from 700 … 1400MHz, as described in the Data Sheet. Therefore, this will make BGA7210 suitable for 400 MHz application.

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