High-Band LNA Multiplexer Module: BGM15HA12

LTE LNA Multiplexer Module BGM15HA12 Supporting: Band-39 (1880-1920 MHz) and Band-41 (2496-2690 MHz)

Application Note AN409

About this document

Scope and purpose

This application note describes using Infineon's LTE LNA Multiplexer Module: BGM15HA12 to support not only LTE High-Band but also LTE Mid-Band.

1. This application note presents the measurement results of LNA Multiplexer Module design at Band-39 (1880-1920 MHz) and Band-41 (2496-2690 MHz).
2. The LNA Multiplexer Module design presented in this application note uses Infineon BGM15HA12 High-Band LNA Multiplexer Module.
3. The LNA Multiplexer Module is to be used in increasing Rx sensitivity in the diversity or main antenna paths. High-Band LNA Multiplexer Module can support all LTE High-Band, but it needs to support LTE Mid-Band due to some requirements of design.
4. High-Band LNA Multiplexer Module is thus carried out in this application note to fulfil the requirements of supporting LTE Band-39 and Band-41.
5. Key performance parameters achieved (@ Band-39):
    a. Noise figure = 1.35 dB,
    b. Gain = 16.5 dB,
    c. Input return loss = 9.8 dB,
    d. Output return loss = 11.4 dB.
6. Key performance parameters achieved (@ Band-41):
    a. Noise figure = 1.3 dB,
    b. Gain = 14.1 dB,
    c. Input return loss = 10.4 dB,
    d. Output return loss = 14.6 dB.

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

1 Introduction

1.1 Overview of 4G LTE and LTE-Advanced

The mobile technologies for smartphones have seen tremendous growth in recent years. The data rate required from mobile devices has increased significantly over the evolution modern mobile technologies starting from the first 3G/3.5G technologies (UMTS & WCDMA, HSPA & HSPA+) to the recently 4G LTE-Advanced. LTE-Advanced can support data rates of up to 1 Gbps.

Advanced technologies such as diversity Multiple Input Multiple Output (MIMO) and Carrier Aggregation (CA) are adopted to achieve such higher data rate requirements. MIMO technology, commonly referred as the diversity path in smartphones, has attracted attention for the significant increase in data throughput and link range without additional bandwidth or increased transmit power. The technology supports scalable channel bandwidth, between 1.4 and 20 MHz. The ability of 4G LTE to support bandwidths up to 20 MHz and to have more spectral efficiency by using high order modulation methods like QAM-64 is of particular importance as the demand for higher wireless data speeds continues to grow fast. Carrier aggregation used in LTE-Advanced combines up to 5 carriers and widens bandwidths up to 100 MHz to increase the user rates, across FDD and TDD.

Countries all over the world have released various frequencies bands for the 4G applications. **Table 1** shows the band assignment for the LTE bands worldwide.

Table 1 LTE Band Assignment

Band No.	Band Definition	Uplink Frequency Range	Downlink Frequency Range	FDD/TDD System	Comment
1	Mid-Band	1920-1980 MHz	2110-2170 MHz	FDD	
2	Mid-Band	1850-1910 MHz	1930-1990 MHz	FDD	
3	Mid-Band	1710-1785 MHz	1805-1880 MHz	FDD	
4	Mid-Band	1710-1755 MHz	2110-2155 MHz	FDD	

Table 1 LTE Band Assignment

Band No.	Band Definition	Uplink Frequency Range	Downlink Frequency Range	FDD/TDD System	Comment
5	Low-Band	824-849 MHz	869-894 MHz	FDD	
6	Low-Band	830-840 MHz	875-885 MHz	FDD	
7	High-Band	2500-2570 MHz	2620-2690 MHz	FDD	
8	Low-Band	880-915 MHz	925-960 MHz	FDD	
9	Mid-Band	1749.9-1784.9 MHz	1844.9-1879.9 MHz	FDD	
10	Mid-Band	1710-1770 MHz	2110-2170 MHz	FDD	
11		1427.9-1452.9 MHz	1475.9-1500.9 MHz	FDD	
12	Low-Band	698-716 MHz	728-746 MHz	FDD	
13	Low-Band	777-787 MHz	746-756 MHz	FDD	
14	Low-Band	788-798 MHz	758-768 MHz	FDD	
17	Low-Band	704-716 MHz	734-746 MHz	FDD	
18	Low-Band	815-830 MHz	860-875 MHz	FDD	
19	Low-Band	830-845 MHz	875-890 MHz	FDD	
20	Low-Band	832-862 MHz	791-821 MHz	FDD	
21		1447.9-1462.9 MHz	1495.9-1510.9 MHz	FDD	
22		3410-3500 MHz	3510-3600 MHz	FDD	
23	Mid-Band	2000-2020 MHz	2180-2200 MHz	FDD	
24		1626.5-1660.5 MHz	1525-1559 MHz	FDD	
25	Mid-Band	1850-1915 MHz	1930-1995 MHz	FDD	
26	Low-Band	814-849 MHz	859-894 MHz	FDD	
27	Low-Band	807-824 MHz	852-869 MHz	FDD	
28	Low-Band	703-748 MHz	758-803 MHz	FDD	
29	Low-Band	N/A	716-728 MHz	FDD	
33	Mid-Band	1900-1920 MHz		TDD	
34	Mid-Band	2010-2025 MHz		TDD	
35	Mid-Band	1850-1910 MHz		TDD	
36	Mid-Band	1930-1990 MHz		TDD	
37	Mid-Band	1910-1930 MHz		TDD	
38	High-Band	2570-2620 MHz		TDD	
39	Mid-Band	1880-1920 MHz		TDD	
40	High-Band	2300-2400 MHz		TDD	
41	High-Band	2496-2690 MHz		TDD	
42		3400-3600 MHz		TDD	
43		3600-3800 MHz		TDD	
44	Low-Band	703-803 MHz		TDD	

In order to cover all the bands from different countries in one single mobile device, mobile phones and data cards are usually equipped more and more bands and band combinations. Some typical examples are FDD quad-band combinations such as 1/2/5/8, 1/3/5/7 and 3/5/7/17. Furthermore, the frequency bands used by TD-LTE are 3.4-3.6 GHz in Australia and UK, 2.57-2.62 GHz in the US and China, 2.545-2.575 GHz in Japan, and 2.3-2.4 GHz in India and Australia are getting more focus. In high-end 4G smart phones, more mobile standards and frequency bands such as 5-Mode/10-Band (GMS/EDGE bands 2/3/8, WCDMA bands 1/2/5, TD-SCDMA bands 34/39, FDD-LTE Bands 3/7 and TD-LTE bands 38/39/40) or 5-Mode/13-Band (GMS/EDGE bands 2/3/5/8, WCDMA bands 1/2/5, TD-SCDMA bands 34/39, FDD-LTE Bands 3/7/13/17 and TD-LTE bands 38/39/40/41) are implemented in one phone to enable worldwide high speed internet roaming. In those phones, 2 or 3 antennas for main and diversity paths are separately used to implement the low-, mid- and high-band functions.

1.2 Infineon LNA Multiplexer Modules

With the increasing wireless data speed and with the extended link distance of mobile phones and 4G data cards, the requirements on the sensitivity are much higher. Infineon offers compact multiplexer modules including a CMOS SP5T switch and a SiGe BJT low noise amplifier (LNA) to support LTE or LTE-A smart phone designers to improve their system performance to meet the requirements coming from the networks/service providers.

Infineon Technologies is the leading company with broad product portfolio to offer high performance SiGe: C bipolar MMIC LNAs for mobile and wireless applications by using the industrial standard silicon process. Infineon MMIC LNAs deliver best-in-class noise figure, low current consumption and high linearity.

The major benefit to use external LNAs in equipment for LTE and LTE-Advanced applications in smart phones is to boost the sensitivity by reducing the system noise figure because an external LNA has lower noise figure than the integrated LNA on the transceiver IC. Furthermore, an external LNA enables flexible design to place the front-end components. Due to the size constraint, the antenna and the RF analogue front-end can often not be placed close to the transceiver IC. The losses introduced in front of the receive path on the transceiver IC impact dramatically the system sensitivity. An external LNA physically close to the antenna can help to eliminate the contribution of the losses to the system noise figure. Therefore the sensitivity can be improved by several dB.

In addition, in the modern smart phones the count of the bands is increasing dramatically up to more than ten bands. One another big challenge for the phone designers is the routing of RF signal lines in the front end, especially when the antenna and RF front-end is far away from the transceiver IC. The LNA multiplexer module helps designers to bundle the signals of those bands into three frequency ranges of 0.7 to 1 GHz (low-band), 1.8 to 2.2 GHz (mid-band) or 2.4 to 2.7 GHz (high-band) and forward them using a single low-loss transmission line to the transceiver IC.

By making use of 130nm RF bulk CMOS technology Infineon RF switches achieve overall better performance in integration, harmonic generation and heat dissipation as those with special technologies such as SOI and GaAs. The bulk CMOS technology ensures a safe delivery in high volume in cost effective single chip solution which turns to be the key factor for the high volume smart phone production.

Table 2 shows the product portfolio of Infineon multiplexer modules for the following three frequency ranges: the low-band (LB, 0.7 to 1.0 GHz), mid-band (MB, 1.8 to 2.2 GHz) and high-band (HB, 2.3 to 2.7 GHz). In these products, up to five bands can be bundled with one device.

Table 2 Infineon Product Portfolio of LNAs for 4G LTE and LTE-Advanced Applications

Frequency Range	728 MHz – 960 MHz	1805 MHz – 2200 MHz	2300 MHz – 2690 MHz	Comment
LNA Multiplexer Modules				
BGM15**L**A12	5x inputs, 1x output			
BGM15**M**A12		5x inputs, 1x output		
BGM15**H**A12			5x inputs, 1x output	

The Infineon´s LNA multiplexer modules are compatible with Mobile Industry Processor Interface (MIPI) Alliance Specification RF Front-End (RFFE) Control Interface, which provides a common and widespread method for controlling RF front-end devices. Nowadays, mobile phones evolve to a complex multi-radio systems comprised of different frequency bands, which implies the complexity of the RF front-end design. The RFFE bus provides the efficient operation in configurations from the simplest one Master component and one Slave component to, potentially, multi-Master configurations with tens of Slaves. The Infineon´s LNA Multiplexer Modules can be directly mapped to the selected band through MIPI RFFE. To support the carrier aggravation, two bands can be turned on at the same time.

1.3 Applications

Not only for the main paths, but also for the diversity paths, external LNAs are widely used to boost end user experience while using mobile devices for video and audio streaming.
Depending on the number of bands designed in a device, various numbers of LNAs where previously required in a system and with the requirement to place them very close to the diversity antenna also the number of 50 Ohm tracks need to be routed across the PCB causing space and cross talk problems. With the use of the BGM15XA12 family it can be limited to maximum three LNA's and three 50 Ohm lines supporting up to 15 Bands for the diversity receiver significantly simplifying the PCB design.

Figure 1 shows a block diagram example of the RX diversity front-end of a 4G modem. The Low-Bands (LB) and Mid-Bands (MB) use together one antenna while the High-Bands (HB) have their own antenna. A diplexer circuit separates the Mid-Band and Low-Band paths. Each path of LB, MB and HB has its own antenna switch followed by the band-selection SAW filters before the signal is forwarded to the LNA multiplexer modules. Taking the HB path as example, a SP5T switch connects the high band antenna with up to 5 diversity SAW filter for different 3G/4G bands. Every SAW is connected to the BGM15HA12 which multiplexes them into one high band LNA. The output of the BGM15HA12 LNA is connected to another SP5T de-multiplexing the bands to individual inputs of the receiver IC inputs. Between the BGMHA12 and the de-multiplexer RF switch might be a lengthy transmission line to cover the distance between the diversity antenna section and the RF compartment of the cellular phone. The use of the LNA multiplexer module BGM15HA12 ensures very good reference sensitivity as well as high data throughput. The higher line losses after the module can be compensated by the gain of the LNA so that it has very little impact on the signal-to-noise ratio. A similar structure is used for mid and low bands using BGM15MA12 and BGM15LA12, respectively. The only difference is a diplexer in front to connect both to one common antenna used for mid and low-band.

Furthermore, with the LNA multiplexer modules, phone designers are flexible to add or change the LTE bands required for various phone models so that the RF front-end design can be enhanced.

The advantages to use LNA multiplexer modules are:

- Excellent signal-to-noise ratio even with long distance between the antennas and the transceiver ICs
- Less routing of RF signal lines on PCB
- Flexible phone design to add/change the bands
- space saving and cost reduction

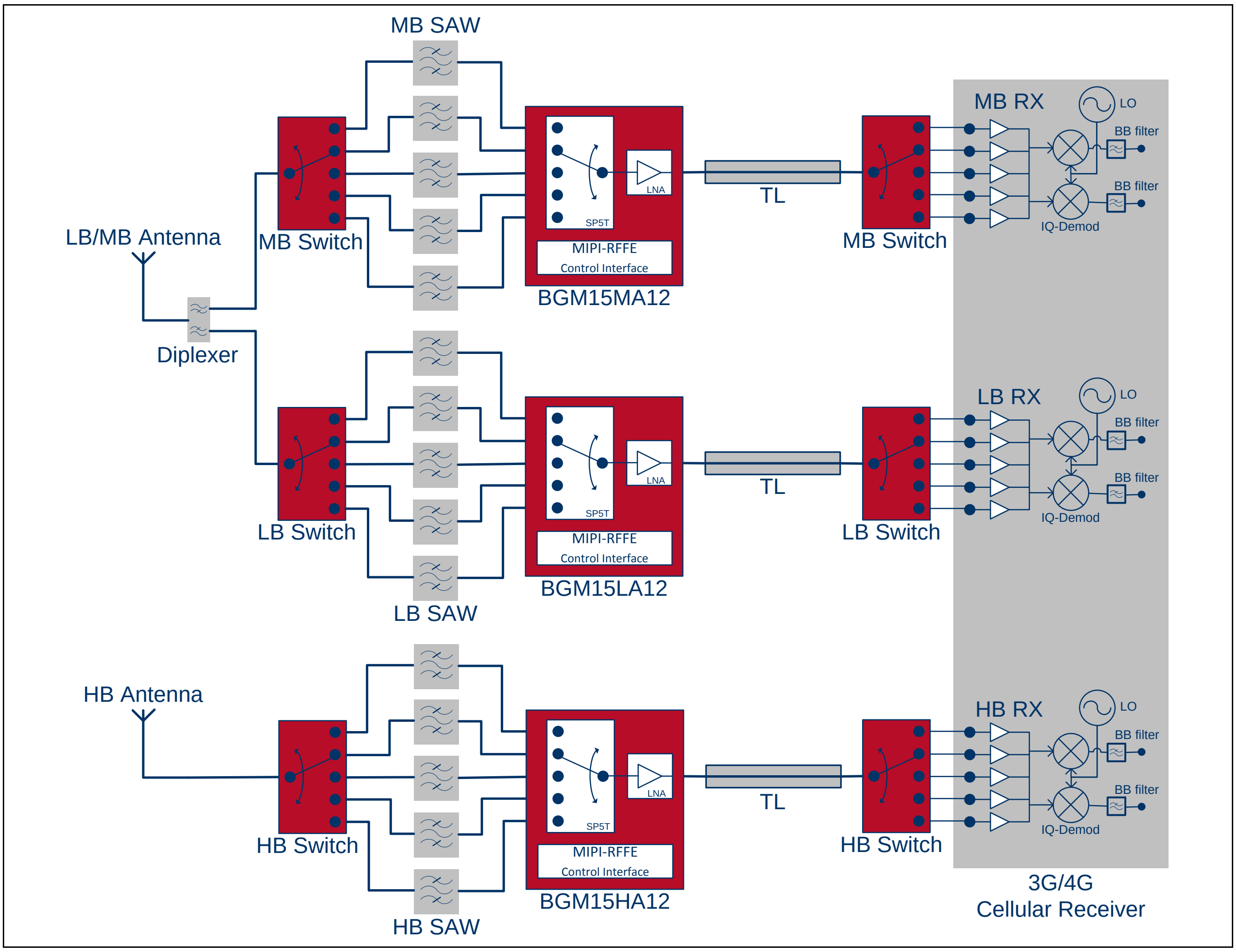

Figure 1 **Examples of Application Diagram of RF front-end for 4G LTE systems with LTE LNA multiplexer modules BGM15xA12.**

2 BGM15HA12 Overview

2.1 Features

- Power gain: 15.3 dB
- Low noise figure: 1.2 dB
- Low current consumption: 4.9 mA
- Frequency range from 2.3 to 2.7 GHz
- RF output internally matched to 50 Ω
- Low external component count
- High port-to-port-isolation
- Suitable for LTE / LTE-Advanced and 3G applications
- No decoupling capacitors required if no DC applied on RF lines
- On chip control logic including ESD protection
- Supply voltage: 2.2 to 3.3 V
- Integrated MIPI RFFE interface operating in 1.1 to 1.95 V voltage range
- Software programmable MIPI RFFE USID
- Small form factor 1.1 mm x 1.9 mm
- High EMI robustness
- RoHS and WEEE compliant package

RoHS

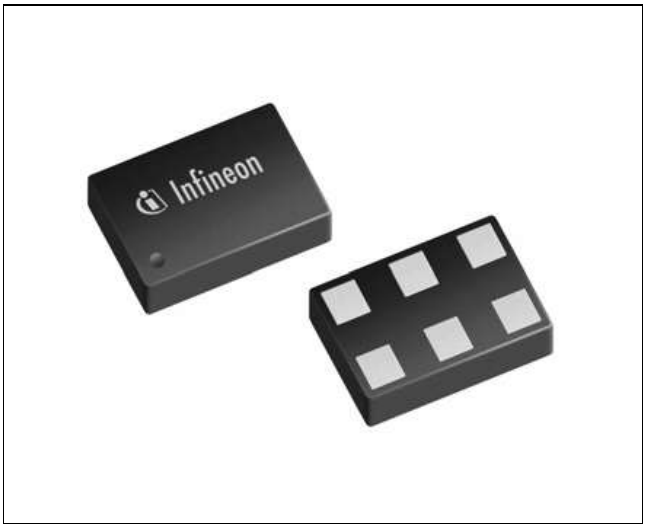

Figure 2 BGM15HA12 in ATSLP-12-3

2.2 Key Applications of BGM15HA12

As Low Noise Amplifier and Switch Module, to support 3G/4G/LTE/LTE-Advanced applications for mobile phones and data cards.

2.3 Description

The BGM15HA12 is a LNA multiplexer module that increases the data rate while keeping flexibility and low footprint. It is a perfect solution for multimode handsets based on LTE-Advanced and WCDMA. The device configuration is shown in **Figure 3.**

The BGM15HA12 is controlled via a MIPI RFFE controller. The on-chip controller allows power-supply voltages from 1.1 to 1.95 V.

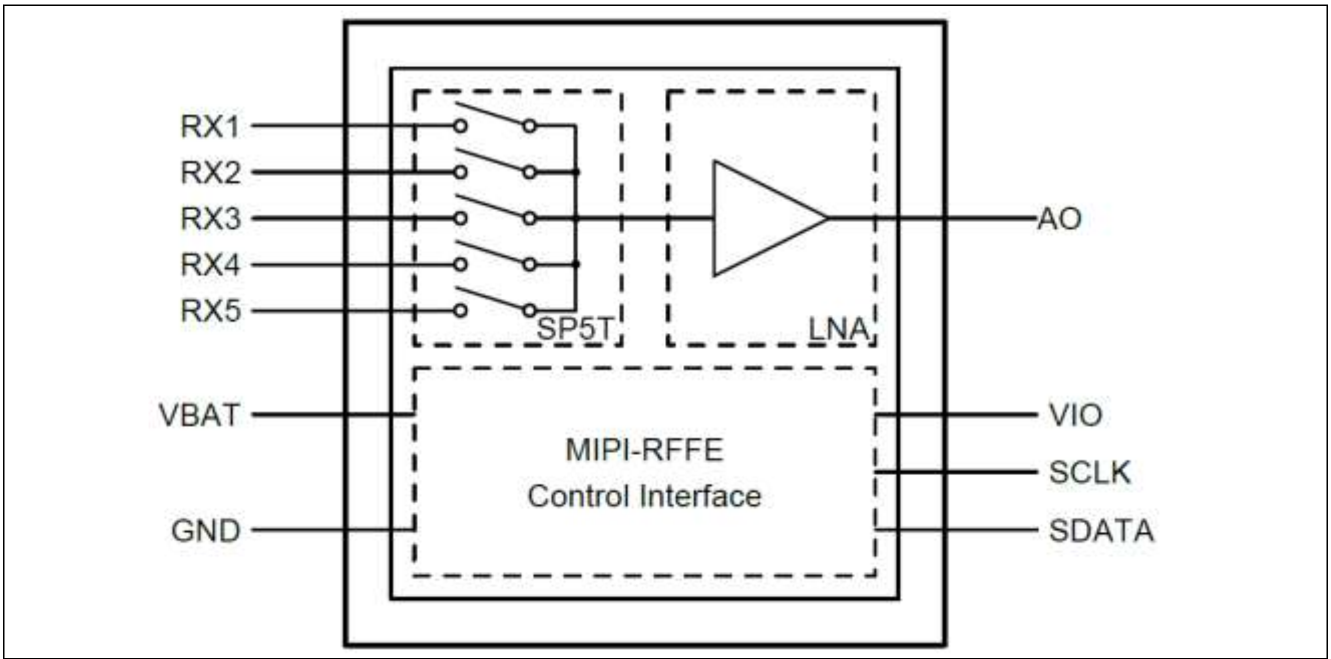

Figure 3 Block Diagram of BGM15HA12.

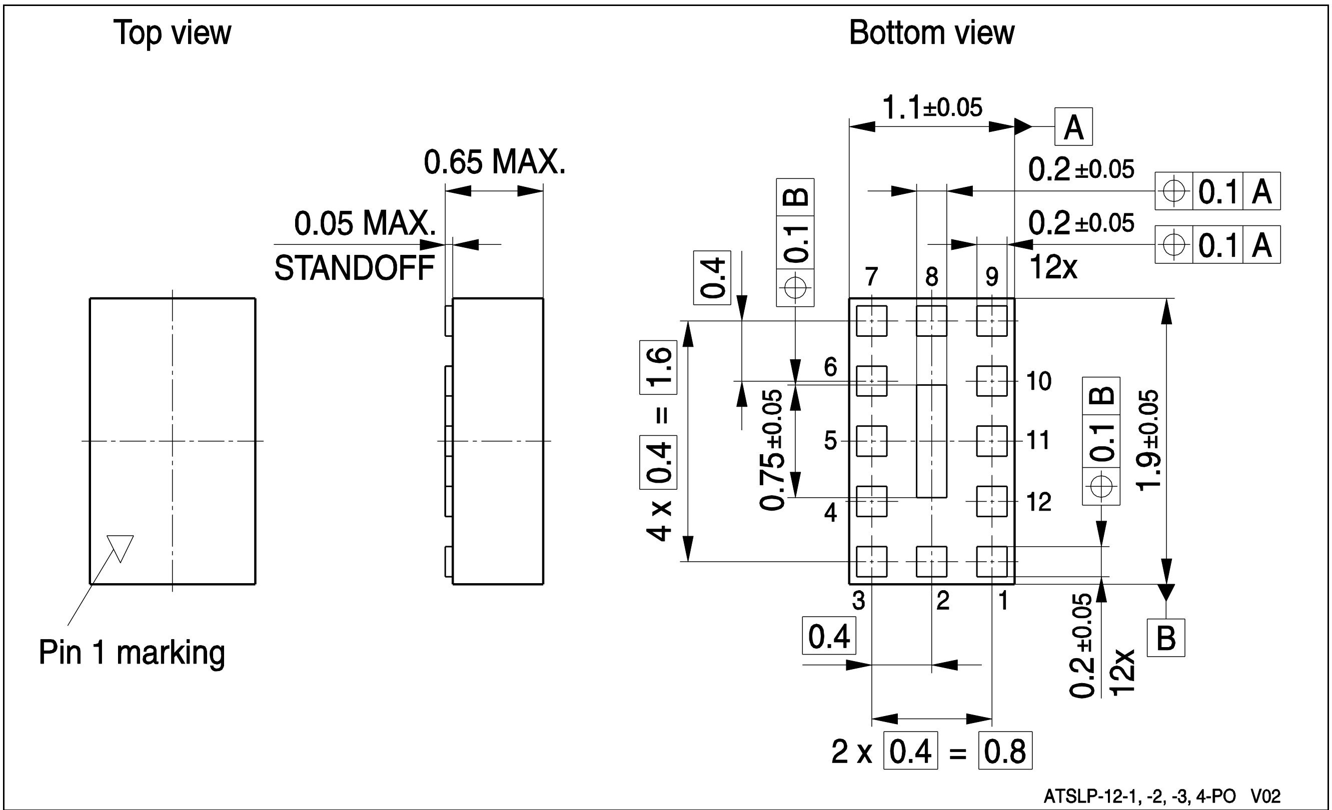

Figure 4 ATSLP-12-3 Package Outline (top, side and bottom views) BGM15HA12.

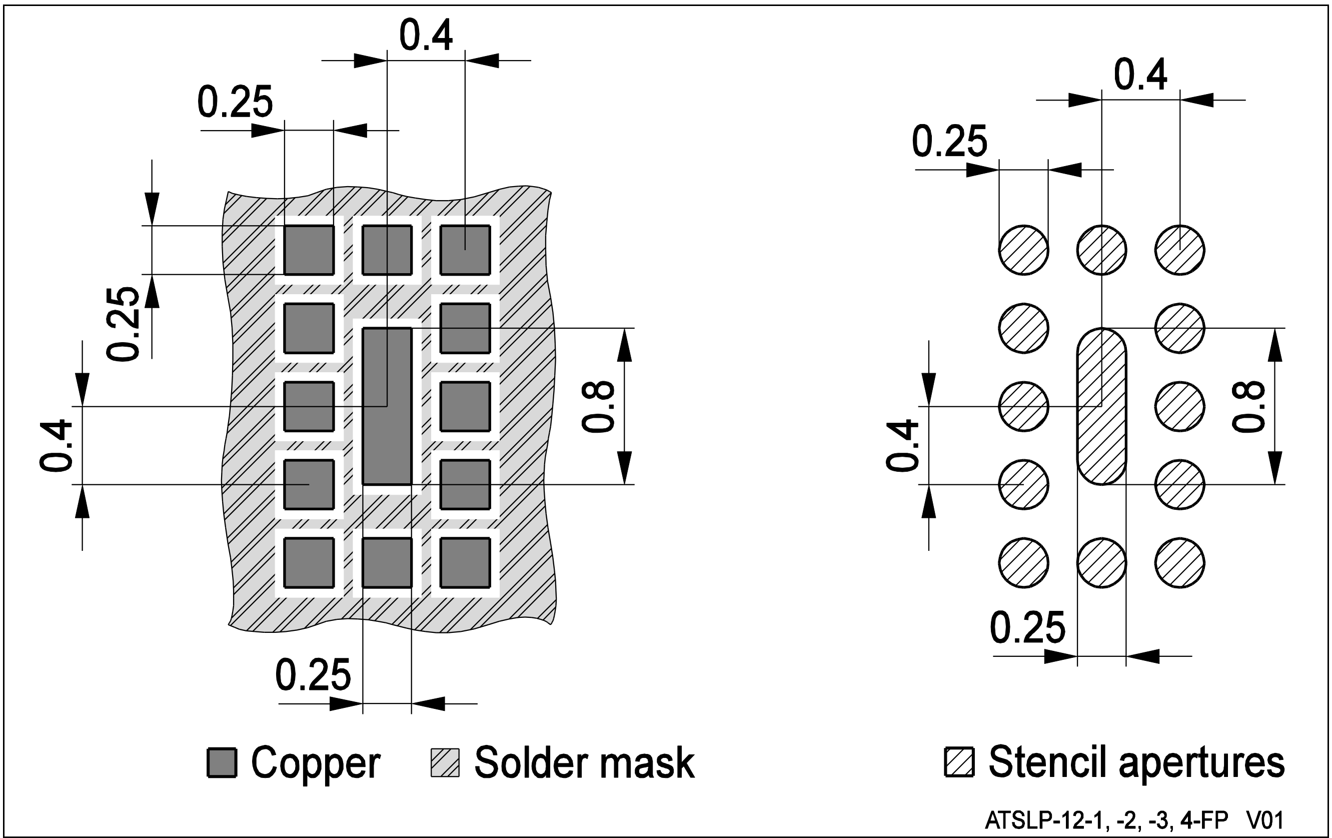

Figure 5 ATSLP-12-3 Foot Print of of BGM15HA12.

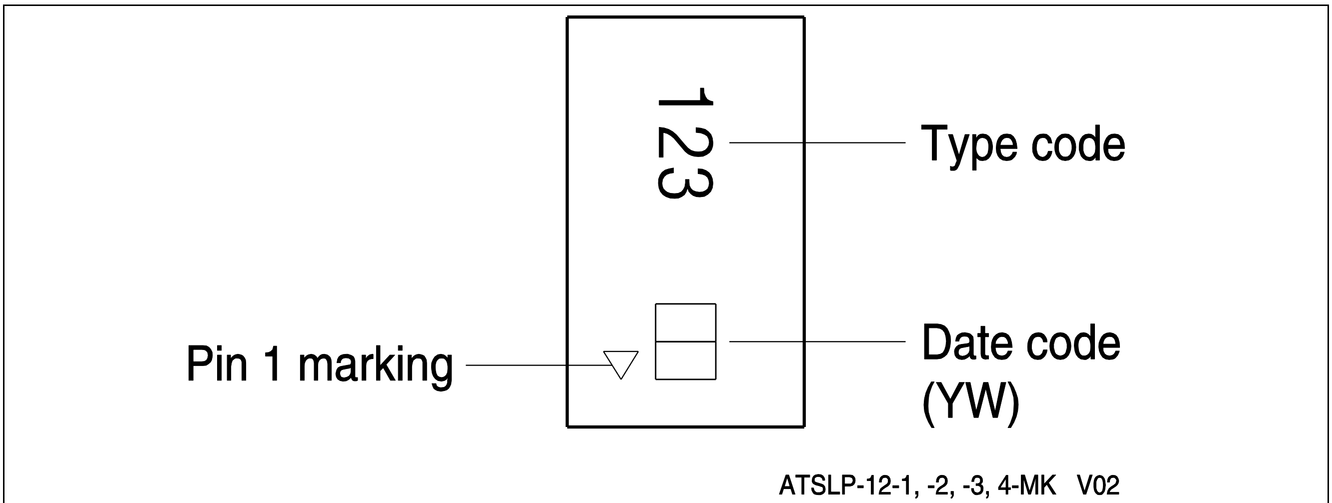

Figure 6 Marking Layout (top view) of BGM15HA12.

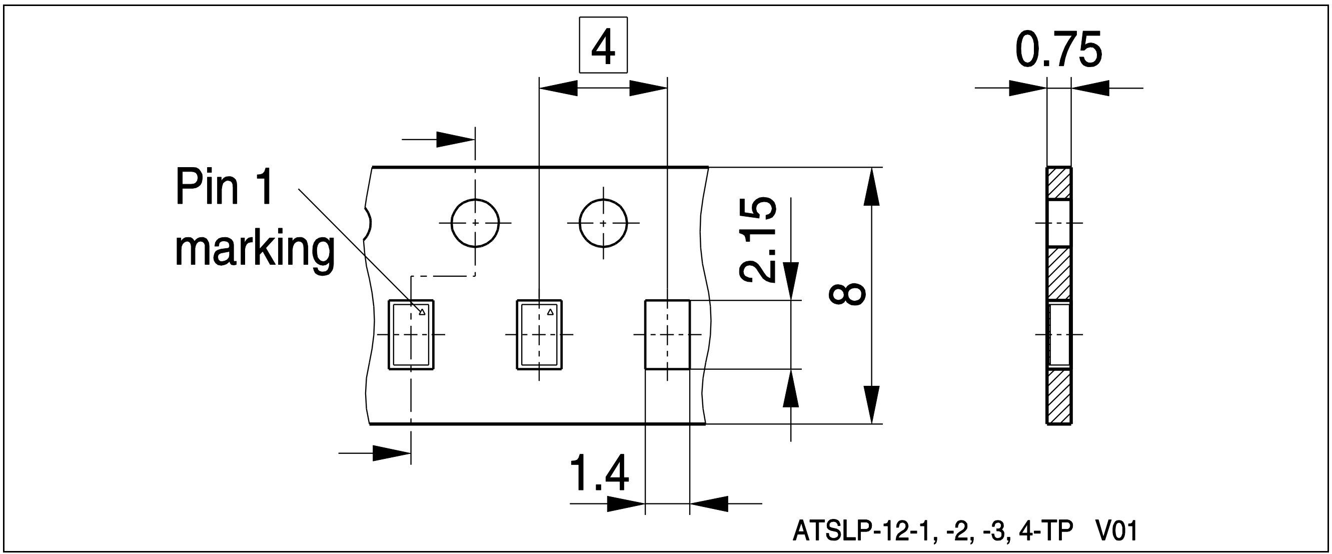

Figure 7 ATSLP-12-3 Carrier Tape for BGM15HA12.

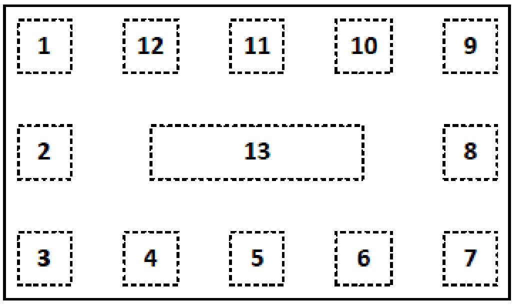

Figure 8 BGM15HA12 Pin Configuration (top view)

Table 3 Pin Definition and Function of Error! Unknown document property name.

Pin No.	Name	Function
1	SLK	MIPI RFFE Clock
2	VIO	MIPI RFFE Power Supply
3	RX5	RF-Port RX No. 5
4	RX4	RF-Port RX No. 4
5	RX3	RF-Port RX No. 3
6	RX2	RF-Port RX No. 2
7	RX1	RF-Port RX No. 1
8	GND	Ground
9	GND	Ground
10	AO	RF-Output Port
11	VBAT	Power Supply
12	SDATA	MIPI RFFE Data IO
13	GND	Ground

Table 4 Modes of Operation (Truth Table, Register_0)

		REGISTER_0 Bits							
State	Mode	D7	D6	D5	D4	D3	D2	D1	D0
1	Isolation	x	x	x	0	0	0	0	0
2	RX1-AO	x	x	x	0	0	0	0	1
3	RX2-AO	x	x	x	0	0	0	1	0
4	RX3-AO	x	x	x	0	1	0	0	0
5	RX4-AO	x	x	x	0	0	1	0	0
6	RX5-AO	x	x	x	1	0	0	0	0
7	RX1&RX2-AO	x	x	x	0	0	0	1	1
8	RX2&RX3-AO	x	x	x	0	1	0	1	0
9	RX3&RX4-AO	x	x	x	0	1	1	0	0
10	RX4&RX5-AO	x	x	x	1	0	1	0	0
11	RX1&RX3-AO	x	x	x	0	1	0	0	1
12	RX2&RX4-AO	x	x	x	0	0	1	1	0
13	RX3&RX5-AO	x	x	x	1	1	0	0	0
14	RX1&RX4-AO	x	x	x	0	0	1	0	1
15	RX2&RX5-AO	x	x	x	1	0	0	1	0
16	RX1&RX5-AO	x	x	x	1	0	0	0	1

Note: Maximum two RX-ports can be activated at the same time to support carrier aggregation function.

3 Application Circuit and Performance Overview

BGM15HA12 not only can support LTE High-Bands from 2.3 GHz to 2.7GHz, but also need to support LTE Mid-Bands form 1.7 GHz to 2.2 GHz due to some requirements of design. In this application, the circuit examples of BGM15HA12 for Band-39 (Mid-Band) and Band-41 (High-Band) are presented.

Device: BGM15HA12

Application: LTE LNA Multiplexer Module BGM15HA12 Supporting: Band-39 (1880-1920 MHz) and Band-41 (2496-2690 MHz)

PCB Marking: BGM15 V1.1

3.1 Summary of Measurement Results

Table 5 **Electrical Characteristics at Room Temperature (T_A = 25 °C) for RX2-AO Band-39 (1880-1920 MHz), Register_0 State:XXX00010, with matching described in chapter 3.3 (C2= 3.3 nH, L2= 22 pF)**

Parameter	Symbol	Value			Unit	Comment/Test Condition
Parameters of the selected RX channel						
DC Voltage	V_{CC}	2.8			V	
DC Current	I_{CC}	5.5			mA	
Frequency Range	Freq	1880	1900	1920	MHz	
Gain	G	16.2	16.2	16.1	dB	
Noise Figure	NF	1.38	1.38	1.34	dB	Loss of SMA and line of 0.3 dB is subtracted
Input Return Loss	RL_{in}	10.5	10.6	10.6	dB	
Output Return Loss	RL_{out}	10.7	11.3	11.9	dB	
Reverse Isolation between selected RX Ports and AO	IRev	24.1	24.0	23.9	dB	
Input P1dB	IP1dB	-9.1			dBm	
Output P1dB	OP1dB	7.1			dBm	
Input IP3	IIP3	-9.2			dBm	Power @ Input: -30 dBm f_1=1900 MHz, f_2=1901 MHz
Output IP3	OIP3	7			dBm	
Stability	k	>1			--	Measured up to 10 GHz

Isolation of the non-selected channels

Table 5 **Electrical Characteristics at Room Temperature (T_A = 25 °C) for RX2-AO Band-39 (1880-1920 MHz), Register_0 State:XXX00010, with matching described in chapter 3.3 (C2= 3.3 nH, L2= 22 pF)**

Parameter	Symbol	Value	Unit	Comment/Test Condition
Isolation between selected and non-selected RX Ports	ISO	> 21.7	dB	
Isolation between non-selected RX Ports and AO	ISO	> 6.8	dB	Forward direction

Note: Please refer to ***chapter 4.1*** *for corresponding graphs of this band*

Table 6 **Electrical Characteristics at Room Temperature (T_A = 25 °C) for RX5-AO Band-41 (2496-2690 MHz), Register_0 State:XXX10000, with matching described in chapter 3.3 (C5= 0.8 pF, L5= 2.2 nH)**

Parameter	Symbol	Value			Unit	Comment/Test Condition
Parameters of the selected RX channel						
DC Voltage	V_{CC}	2.8			V	
DC Current	I_{CC}	4.8			mA	
Frequency Range	Freq	2496	2590	2690	MHz	
Gain	G	14.2	13.9	13.6	dB	
Noise Figure	NF	1.33	1.32	1.33	dB	Loss of SMA and line of 0.35 dB is subtracted
Input Return Loss	RL_{in}	9.7	10.4	11.2	dB	
Output Return Loss	RL_{out}	14.6	14.7	14.3	dB	
Reverse Isolation between selected RX Ports and AO	IRev	22.8	22.7	22.5	dB	
Input P1dB	IP1dB	-4.4			dBm	
Output P1dB	OP1dB	9.5			dBm	
Input IP3	IIP3	-3.1			dBm	Power @ Input: -30 dBm f_1=2590 MHz, f_2=2591 MHz
Output IP3	OIP3	10.8			dBm	
Stability	k	>1			--	Measured up to 10 GHz
Isolation of the non-selected channels						
Isolation between selected and non-selected RX Ports	ISO	> 24.2			dB	
Isolation between non-selected RX Ports and AO	ISO	> 13.3			dB	Forward direction

Note: Please refer to ***chapter 4.2*** *for corresponding graphs of this band*

3.2 BGM15HA12 as Low Noise Amplifier Module for LTE Single Band-39 (1880 – 1920 MHz) and Band-41(2496 –2690 MHz) Application

This application note focuses on the Infineon's Single-band LTE LNA BGA7M1N6 tuned for the band-7. It presents the performance of BGA7M1N6 with 1.8 V/2.8 V power supply and the operating current of 4.5 mA.

The application circuit requires only two 0201 passive component for each bands. The component value is fine tuned for optimal noise figure, gain, input and output matching. For Bnad 39 it has a gain of 16.1 dB. The circuit achieves input return loss better than 10.5 dB, as well as output return loss better than 10.7 dB. At room temperature the noise figure is 1.35 dB (SMA and PCB losses are subtracted). For Band 41 the circuit achieved gain 13.9 dB, NF 1.32 dB, input return loss 10.4 dB and output return loss of 14.7 dB

Furthermore, the circuit is measured unconditionally stable till 10 GHz. At band-39, using two tones spacing of 1 MHz, the output third order intercept point, OIP3 reaches 7.0 dBm and output P1dB reaches 7.1 dBm at 1900 MHz. At band-41, using two tones spacing of 1 MHz, the output third order intercept point, OIP3 reaches 10.8 dBm and output P1dB reaches 9.5 dBm at 2590 MHz. All the measurements are done with the standard evaluation board presented at the end of this application note.

3.3 Schematics and Bill-of-Materials

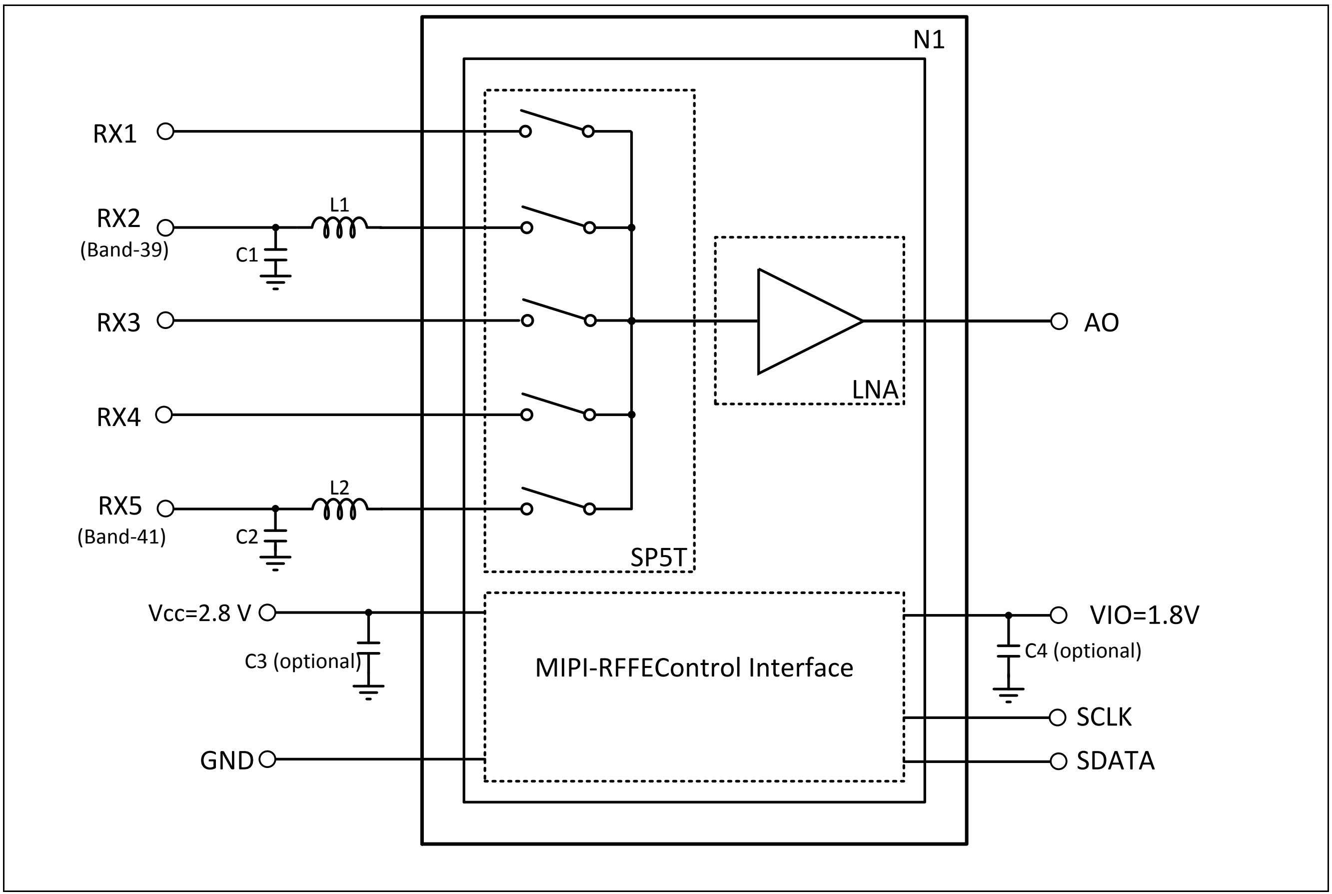

Figure 9 Schematics of the BGM15HA12 Application Circuit

Table 7 Bill-of-Materials

Symbol	Value	Unit	Size	Manufacturer	Comment
N1	BGM15HA12	ATSLP-12-3		Infineon	SiGe LNA
C1	3.3	nH	0201	Murata LQP series	Input matching for B-39
C2	0.8	pF	0201	Various	Input matching for B-41
C3	1	nF	0201	Various	RF bypass[1]
C4	1	nF	0201	Various	RF bypass[1]
L1	22	pF	0201	Various	Input matching for B-39
L2	2.2	nH	0201	Murata LQPseries	Input matching for B-41

Note: 1. The RF bypass bypass capacitor C3 and C4 at the DC power supply and VIO pin, can filter out the supply noise and stabilize the supply. The RF bypass capacitor C3 and C4 are not necessary if the clean and stable DC supply can be ensured.

4 Measurement Graphs

4.1 Measurement Graphs Graphs for Band-39 (1880-1920 MHz), RX2-A0

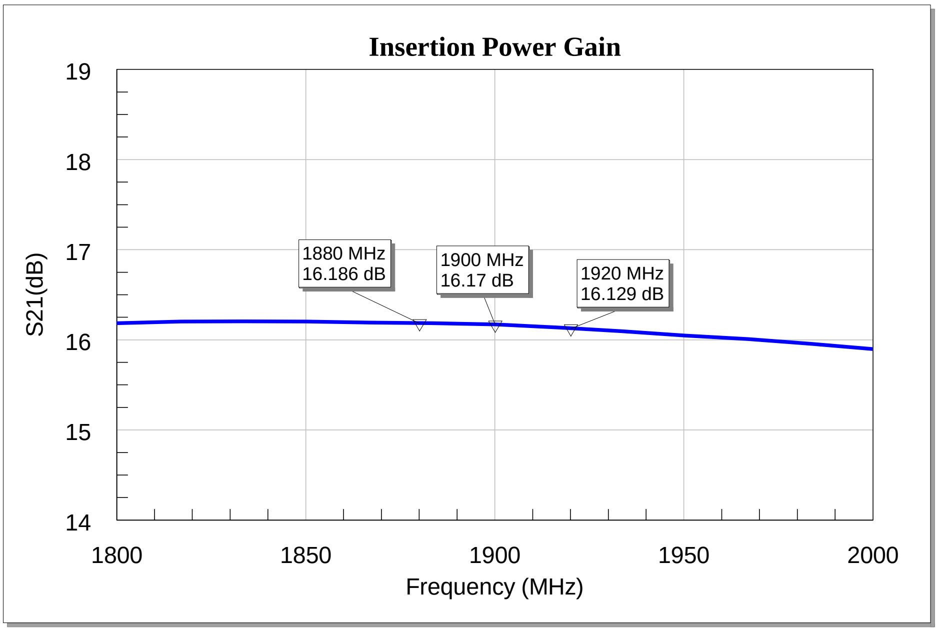

Figure 10 Insertion Power Gain of the BGM15HA12 for Band-39 Applications

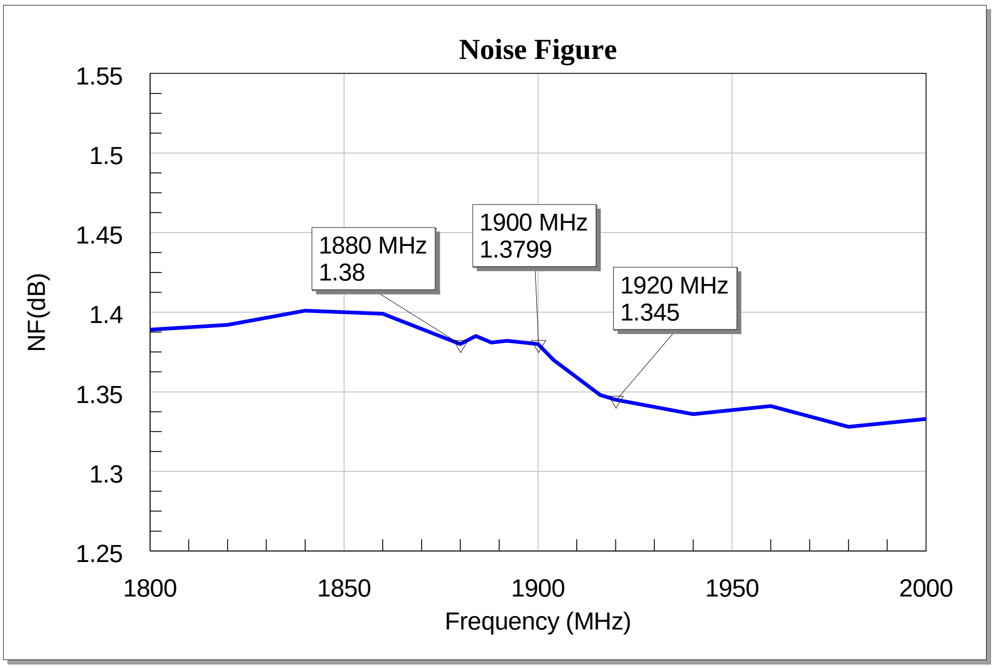

Figure 11 Noise Figure of BGM15HA12 for Band-39 Applications

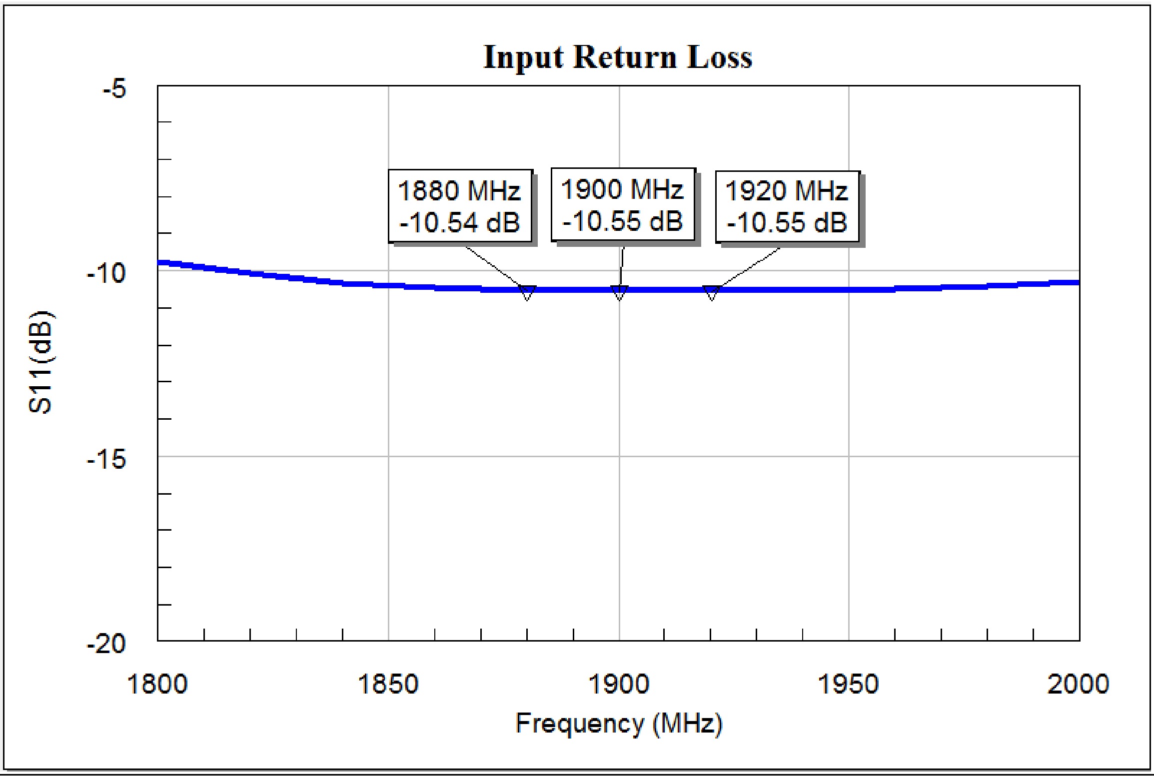

Figure 12 Input Matching of the BGM15HA12for Band-39 Applications

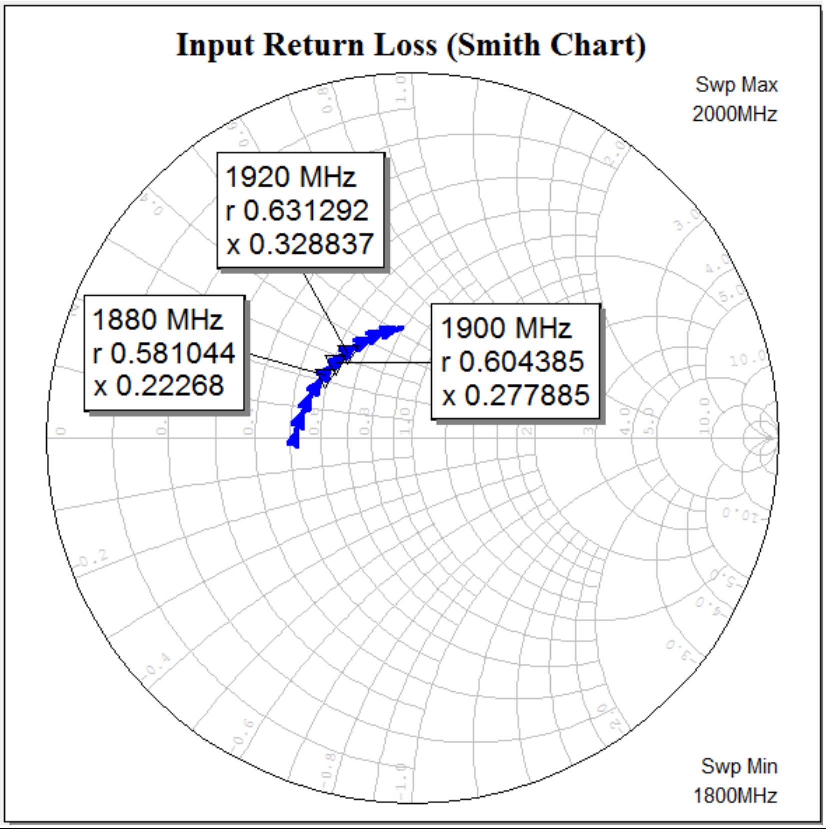

Figure 13 Input Matching (Smith Chart) of the BGM15HA12 for Band-39 Applications

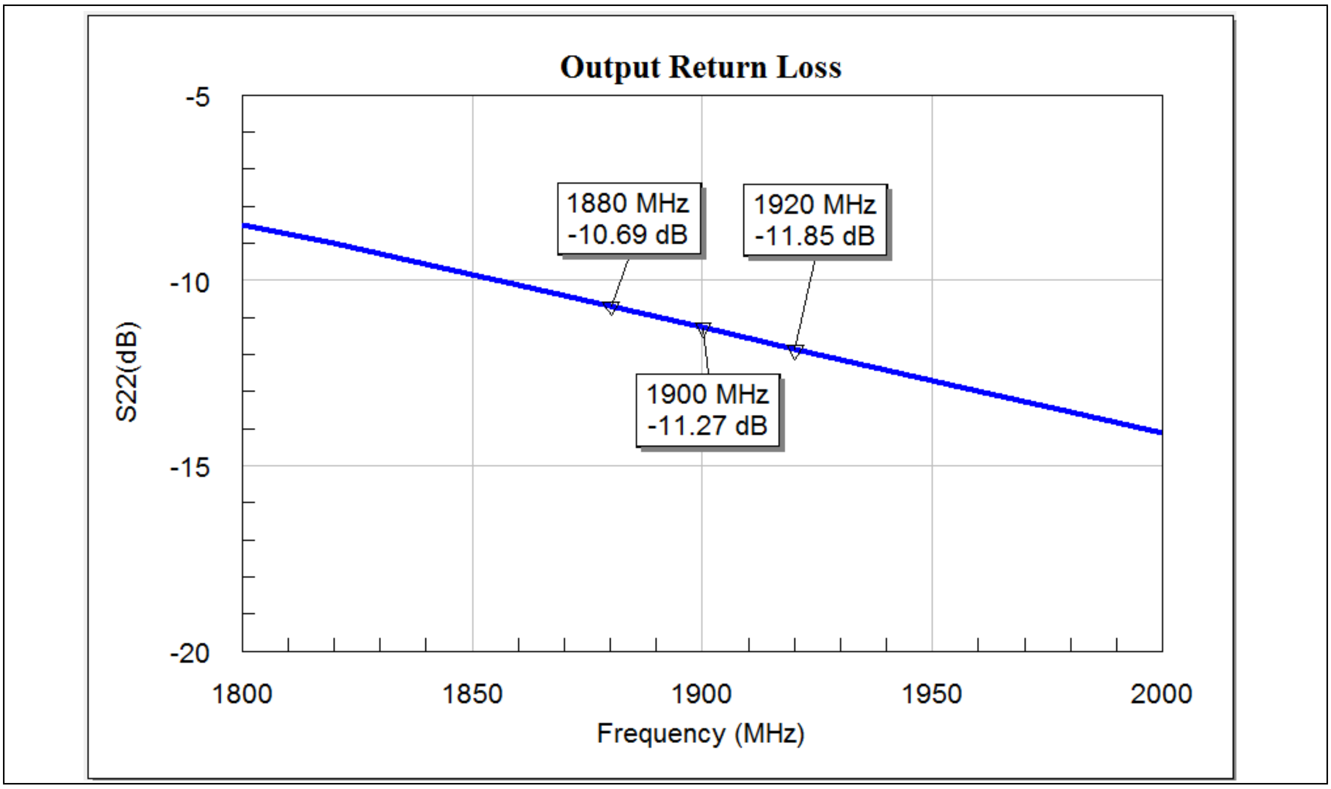

Figure 14 Output Matching of the BGM15HA12 for Band-39 Applications

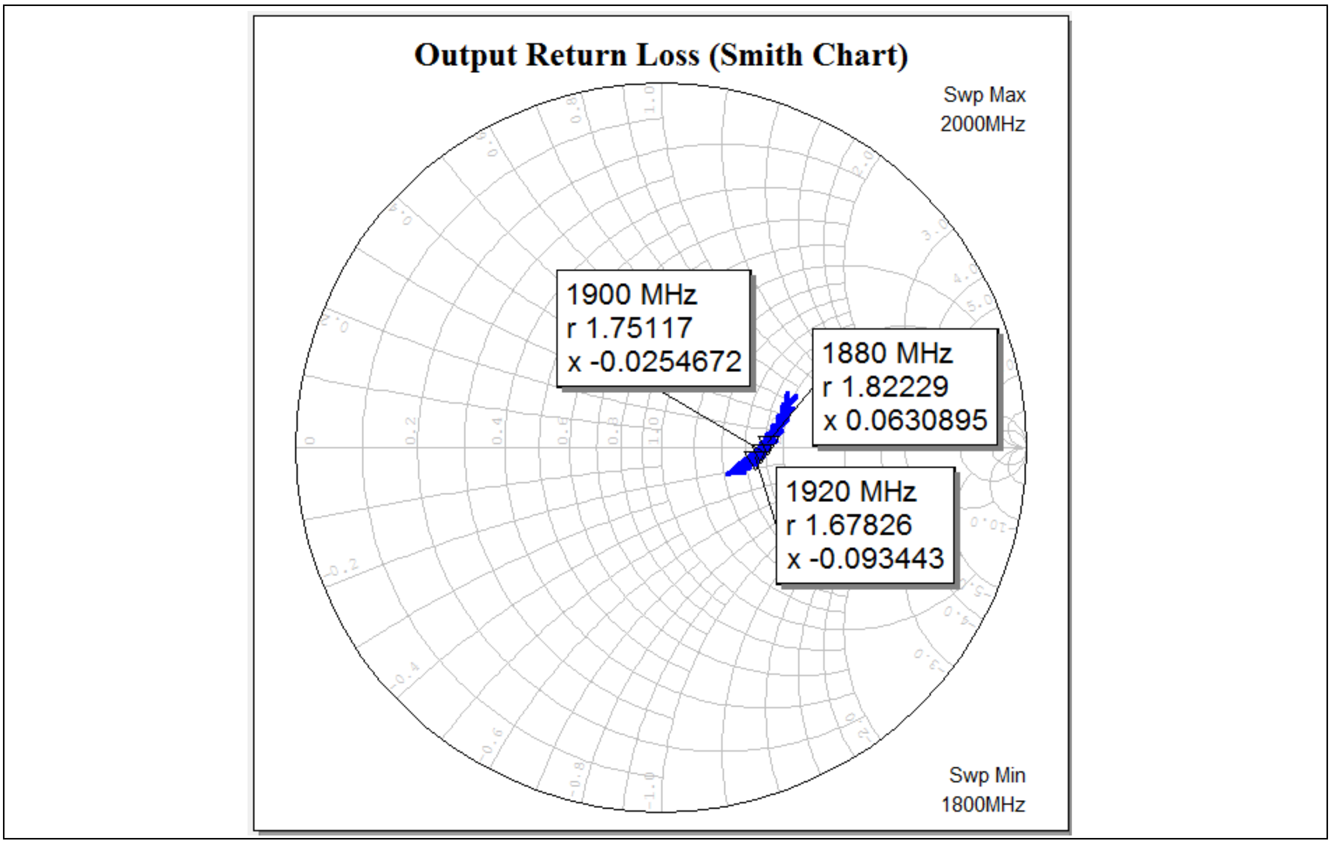

Figure 15 Output Matching (Smith Chart) of the BGM15HA12 for Band-39 Applications

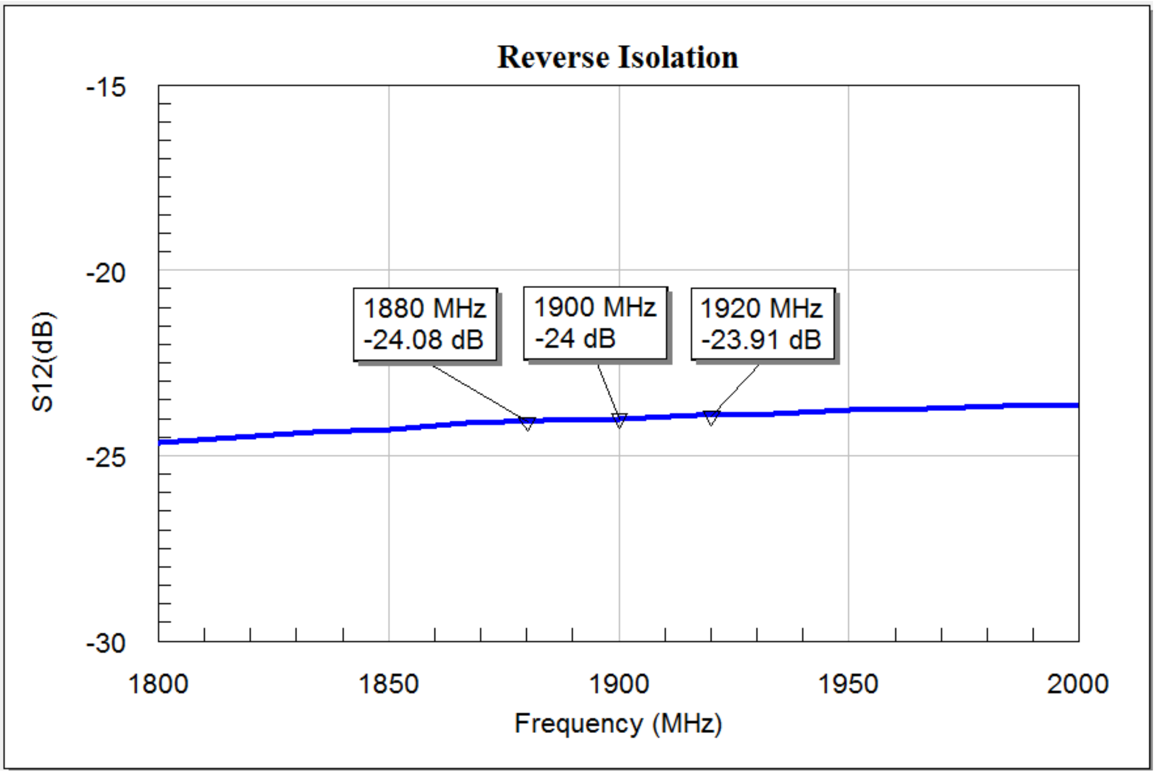

Figure 16 Reverse Isolation of the BGM15HA12 for Band-39 Applications

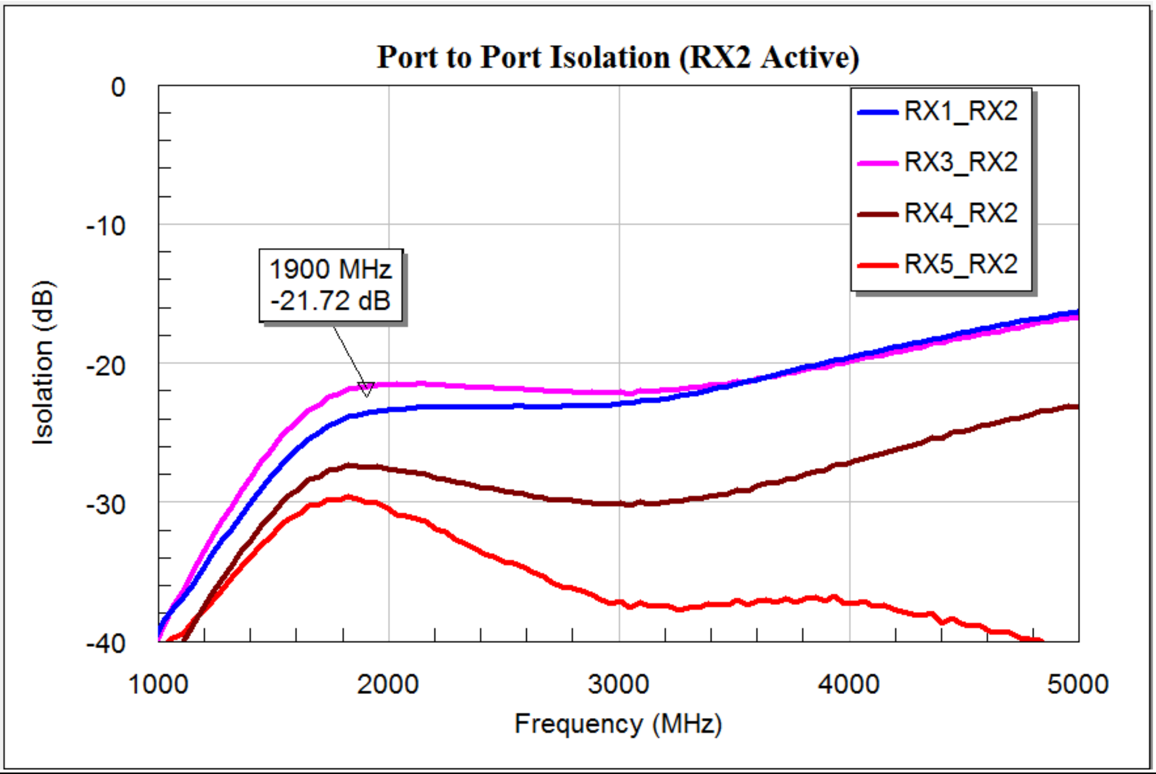

Figure 17 Isolation between RX2 and RX1/RX3/RX4/RX5, when RX2 is active of the BGM15HA12.

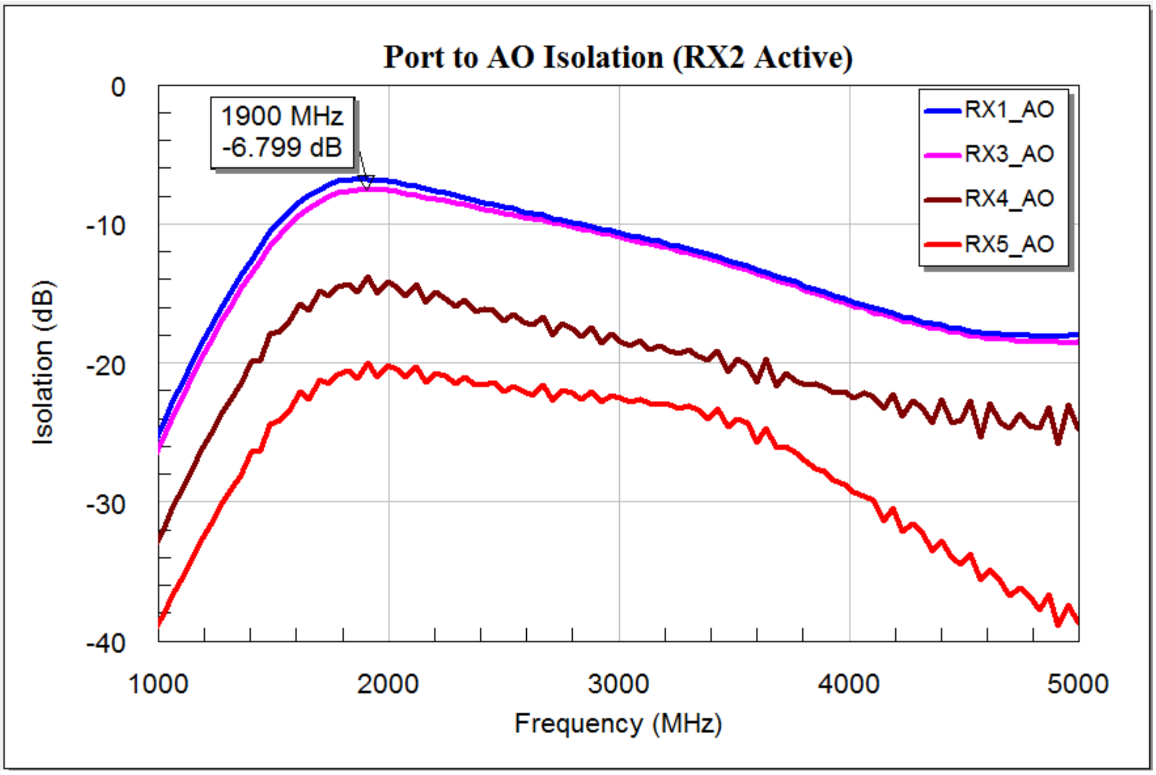

Figure 18 Isolation between AO and RX1/RX3/RX4/RX5, when RX2 is active of BGM15HA12

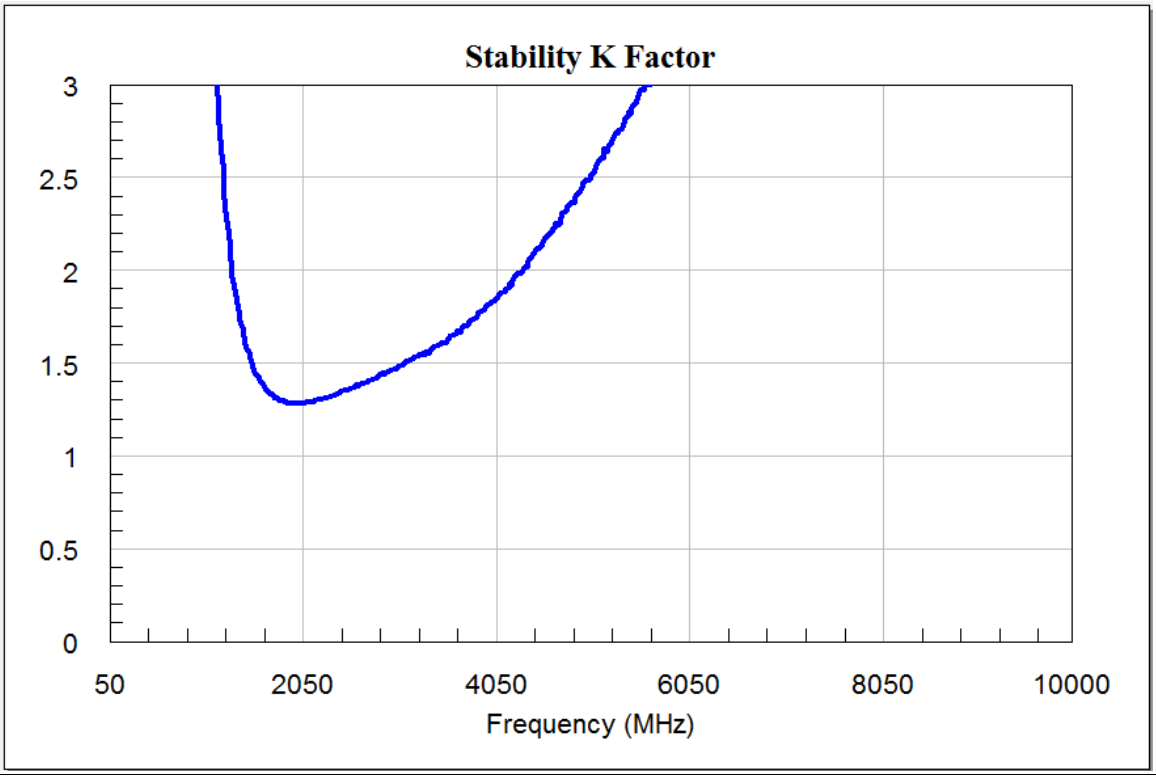

Figure 19 Stability K-factor of the BGM15HA12 for Band-39 Applications

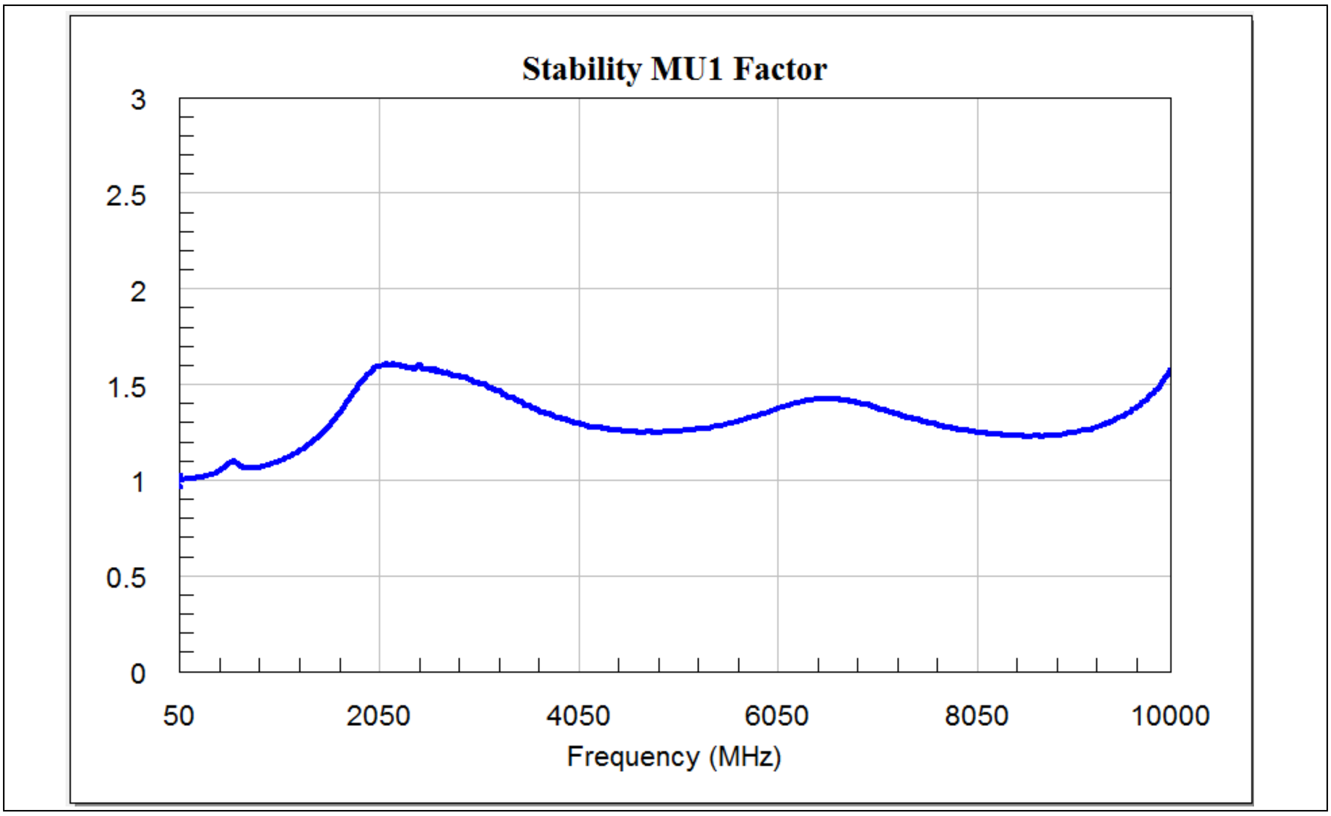

Figure 20 Stability Mu1-factor of the BGM15HA12 for Band-39 Applications

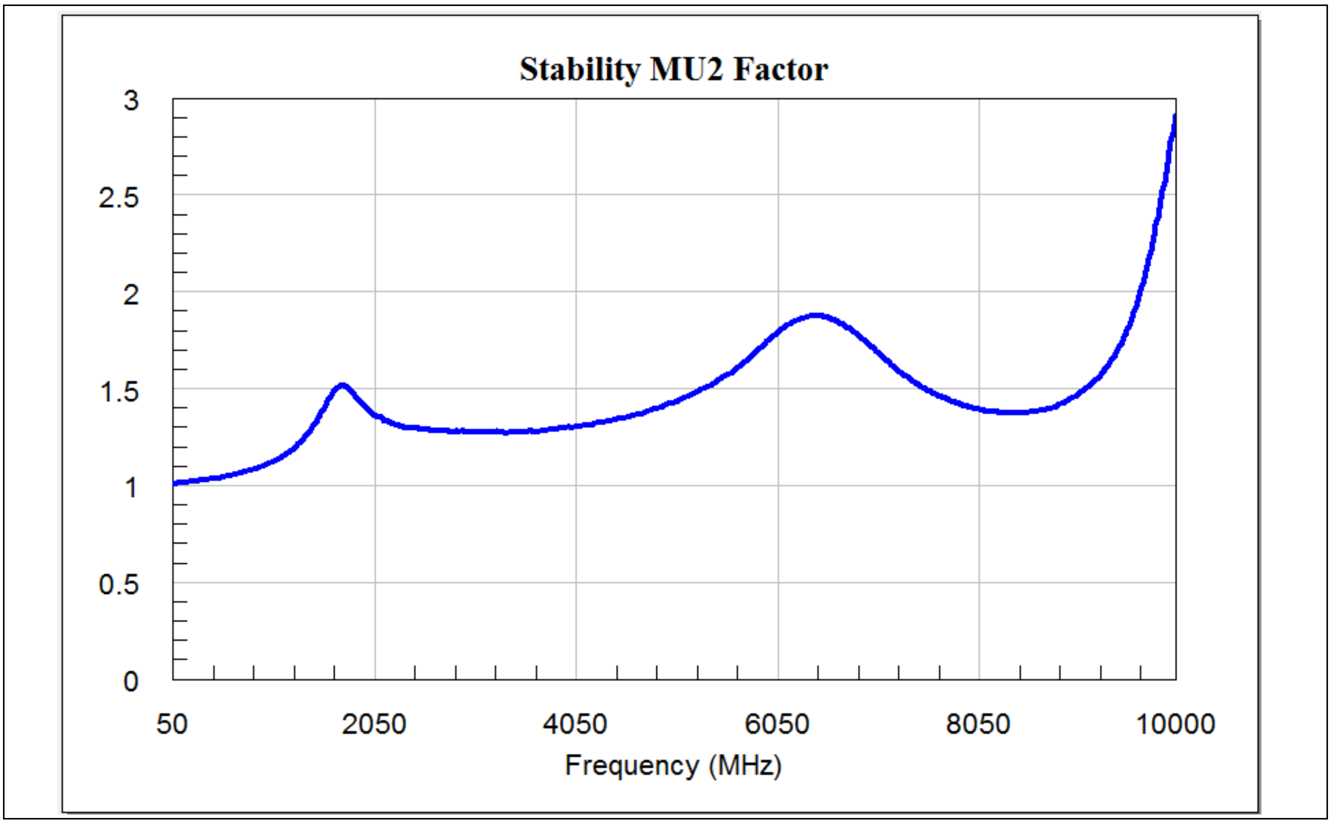

Figure 21 Stability Mu2-factor of the BGM15HA12 for Band-39 Applications

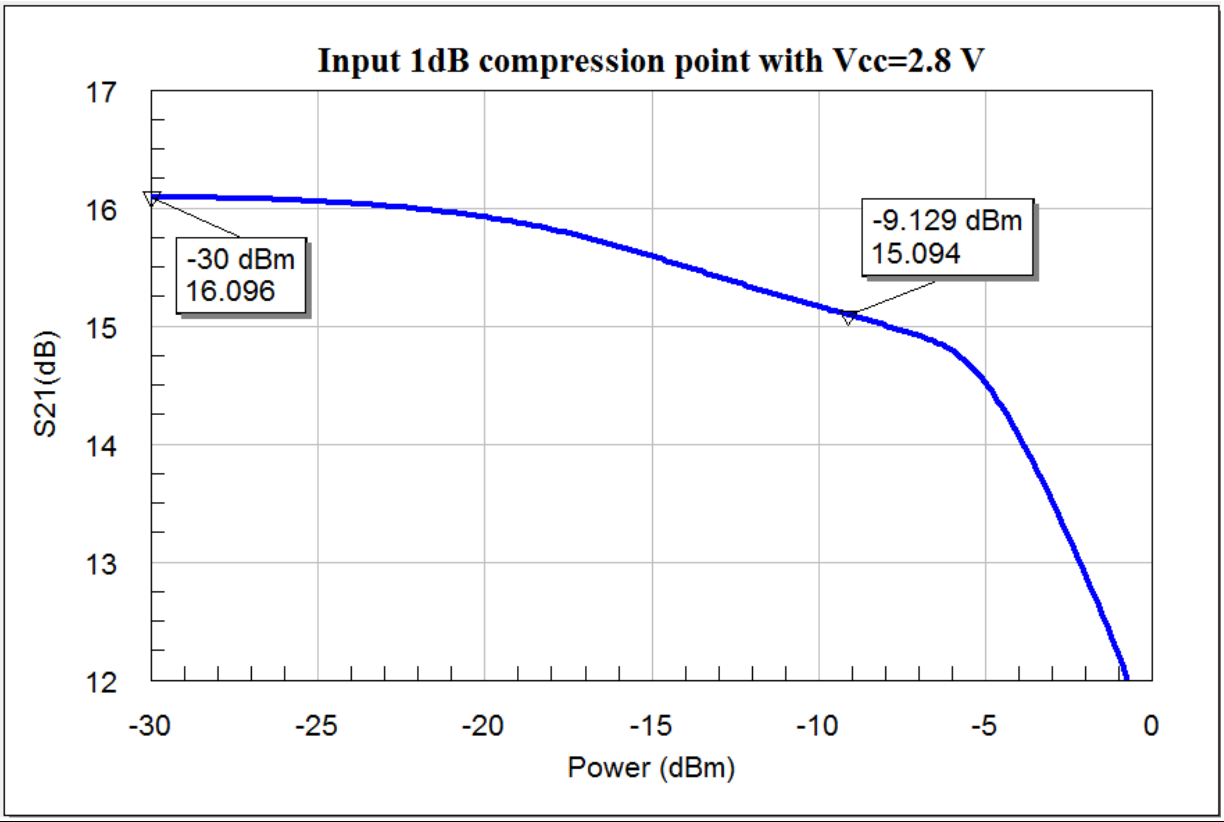

Figure 22 Input 1dB Compression Point of the BGM15HA12 for Band-39 Applications

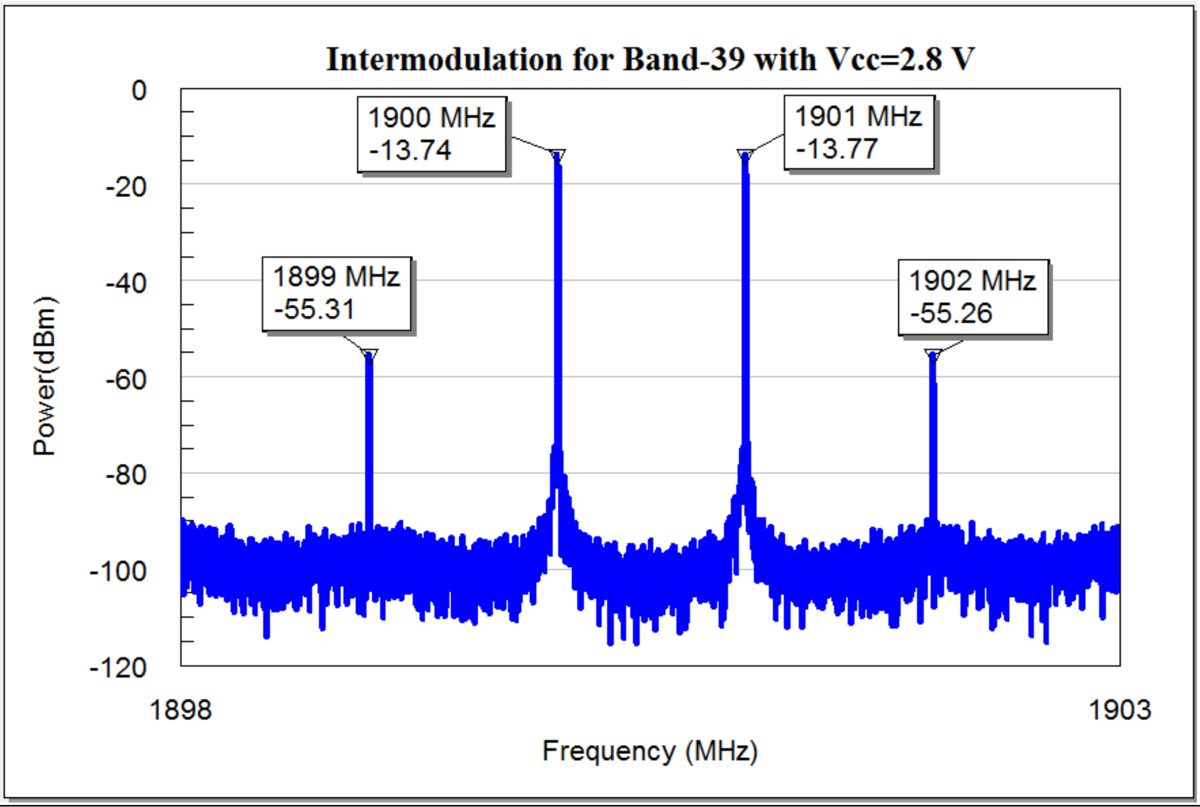

Figure 23 Input 3rd Intercept Point of BGM15HA12 for Band-39 Applications

4.2 Graphs for Band-41 (2496-2690 MHz); RX5-A0

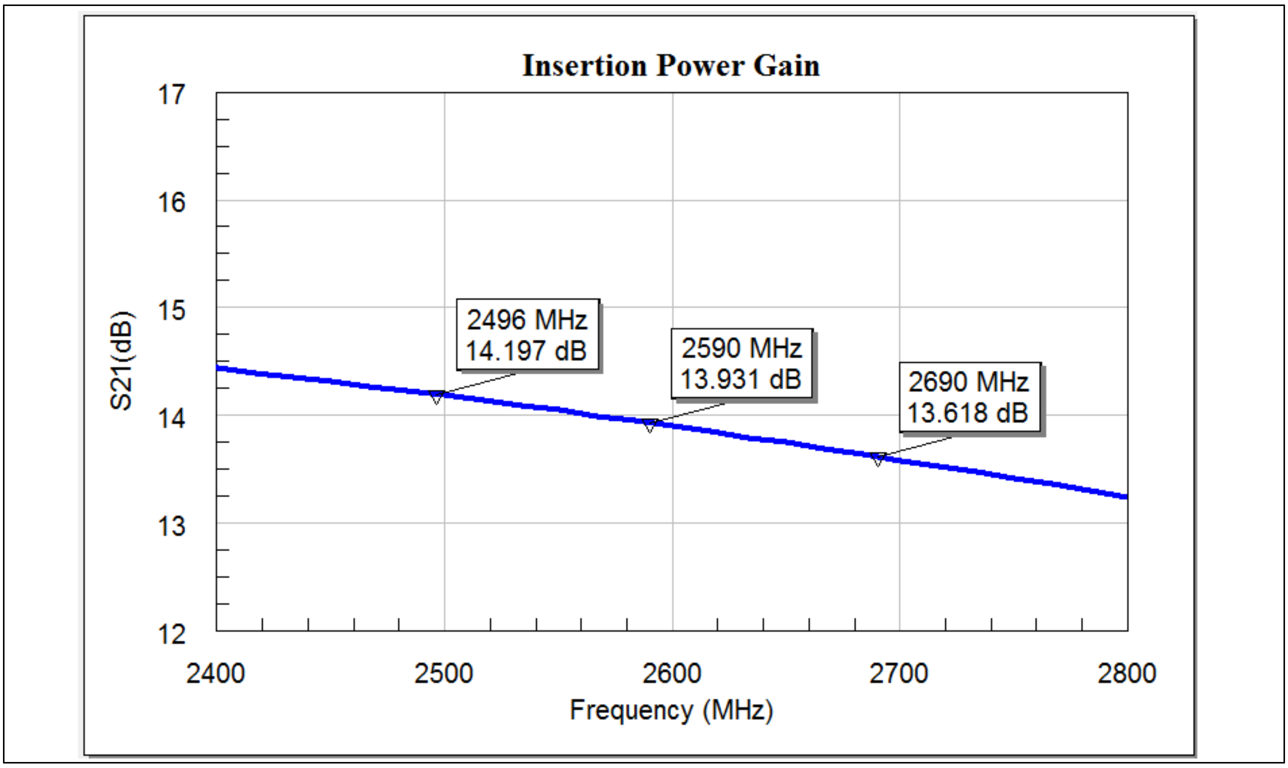

Figure 24 Insertion Power Gain of the BGM15HA12 for Band-41 Applications

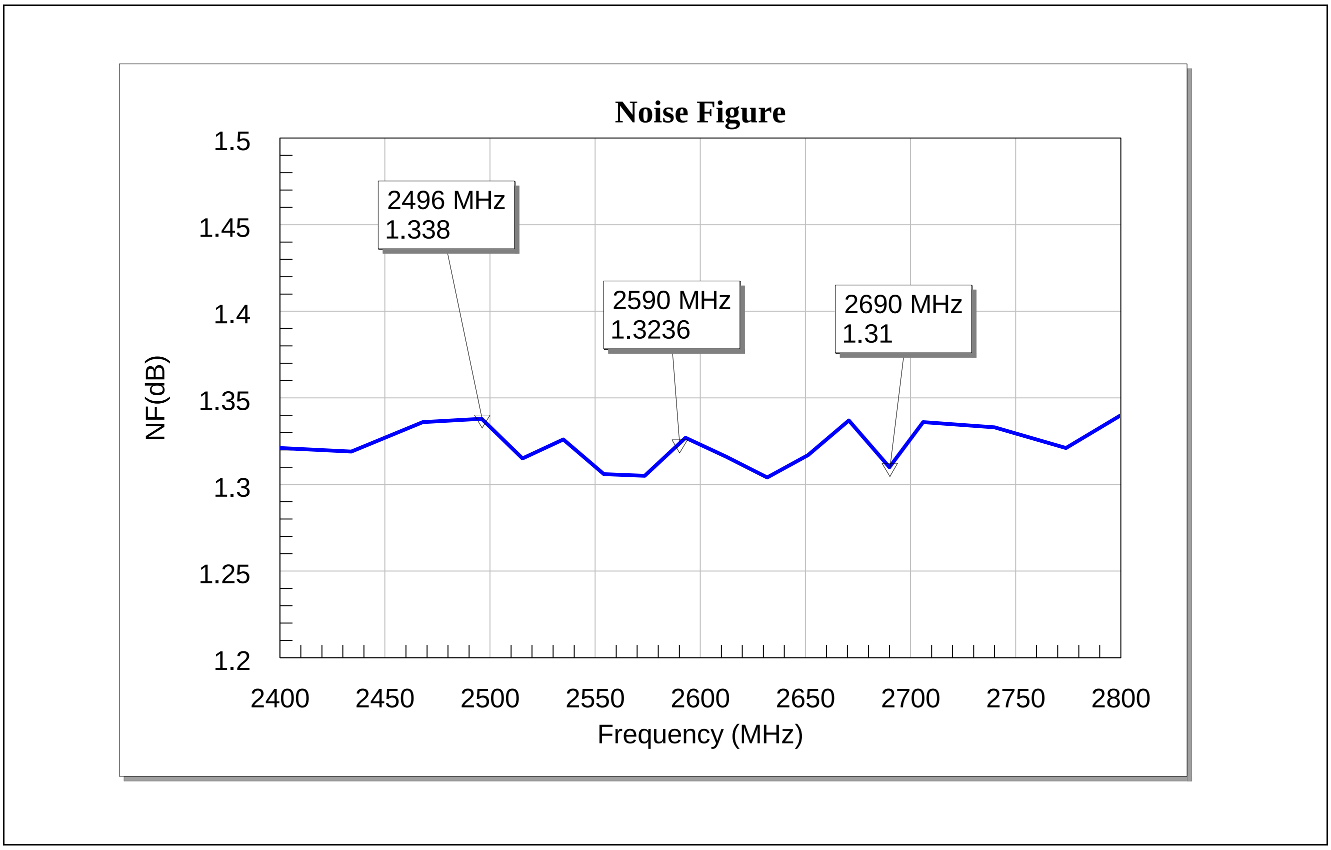

Figure 25 Noise Figure of the BGM15HA12 for Band-41 Applications

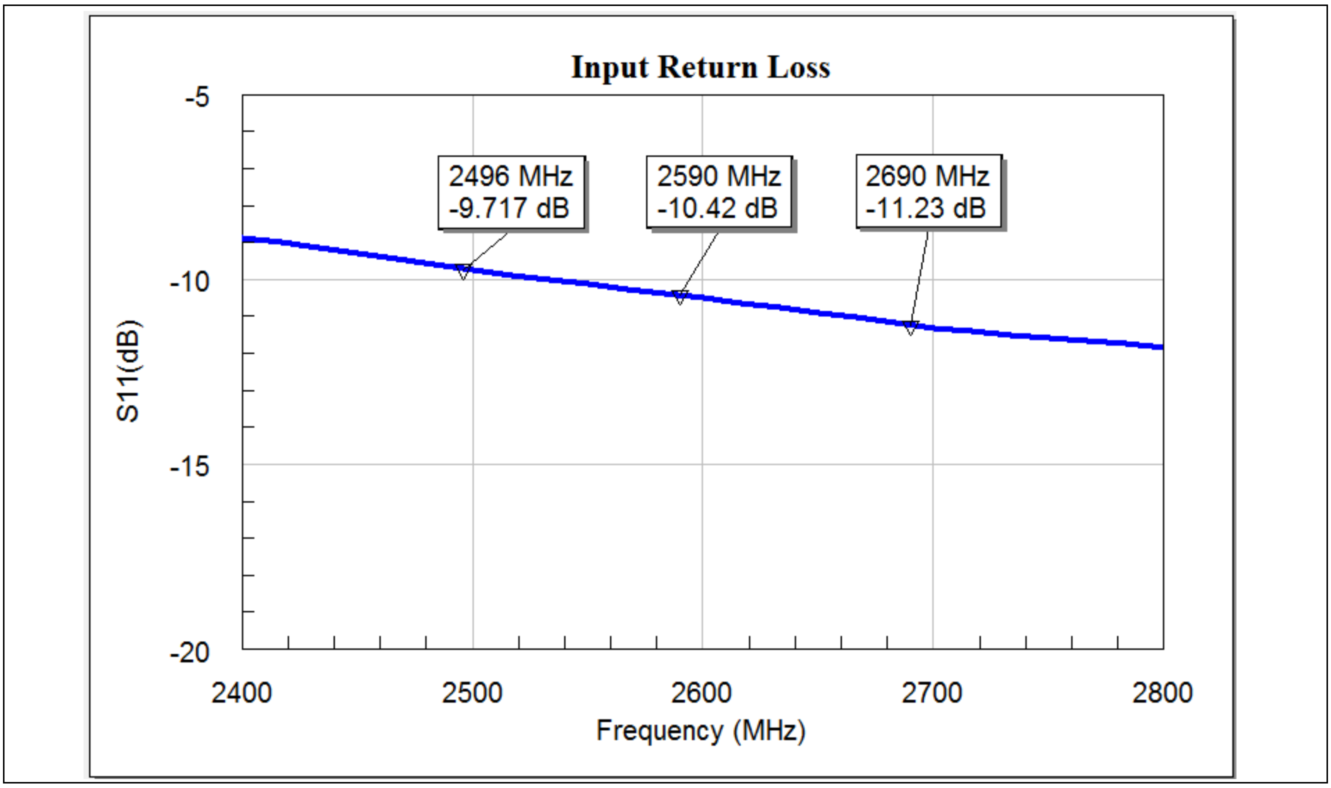

Figure 26 Input Matching of the BGM15HA12 for Band-41 Applications

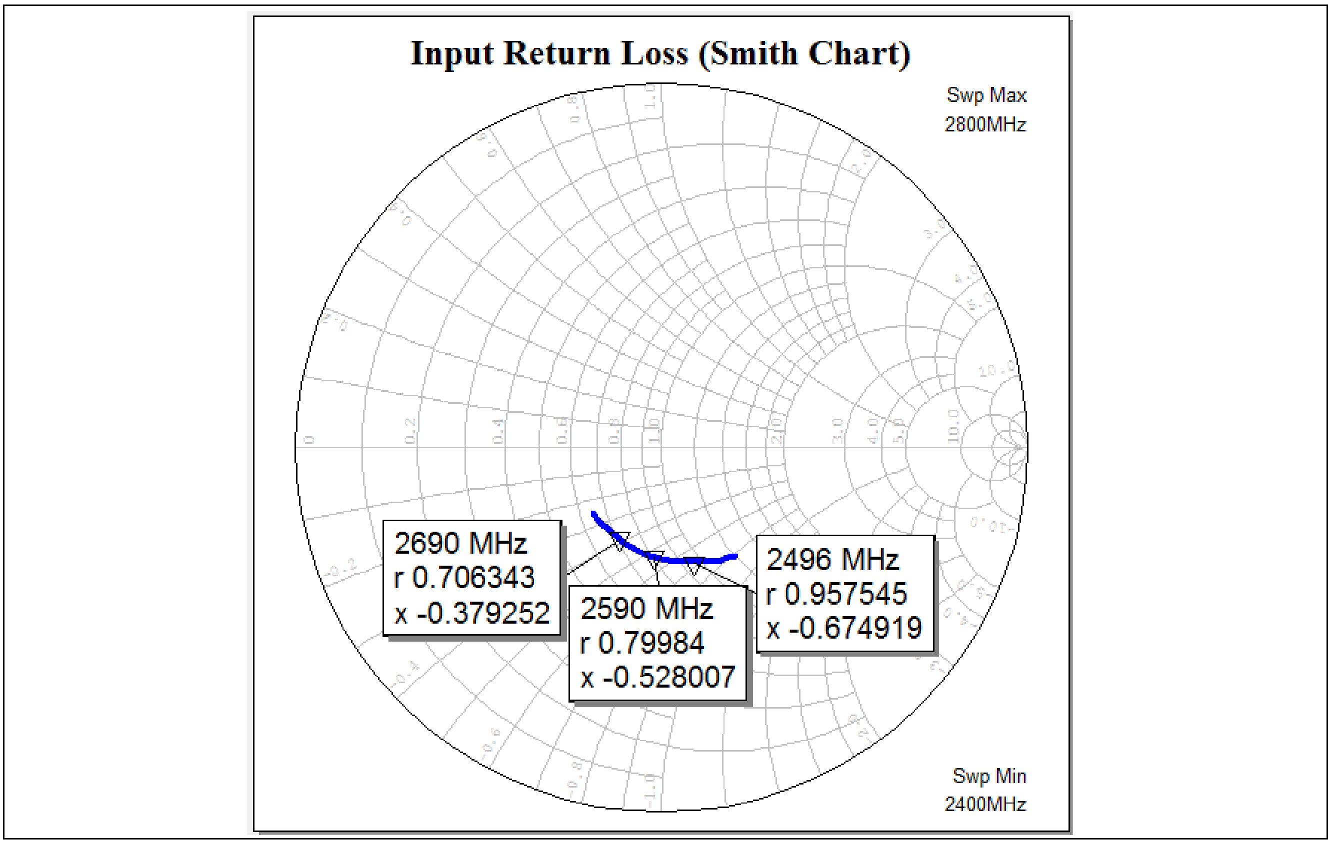

Figure 27 Input Matching (Smith Chart) of the BGM15HA12 for Band-41 Applications

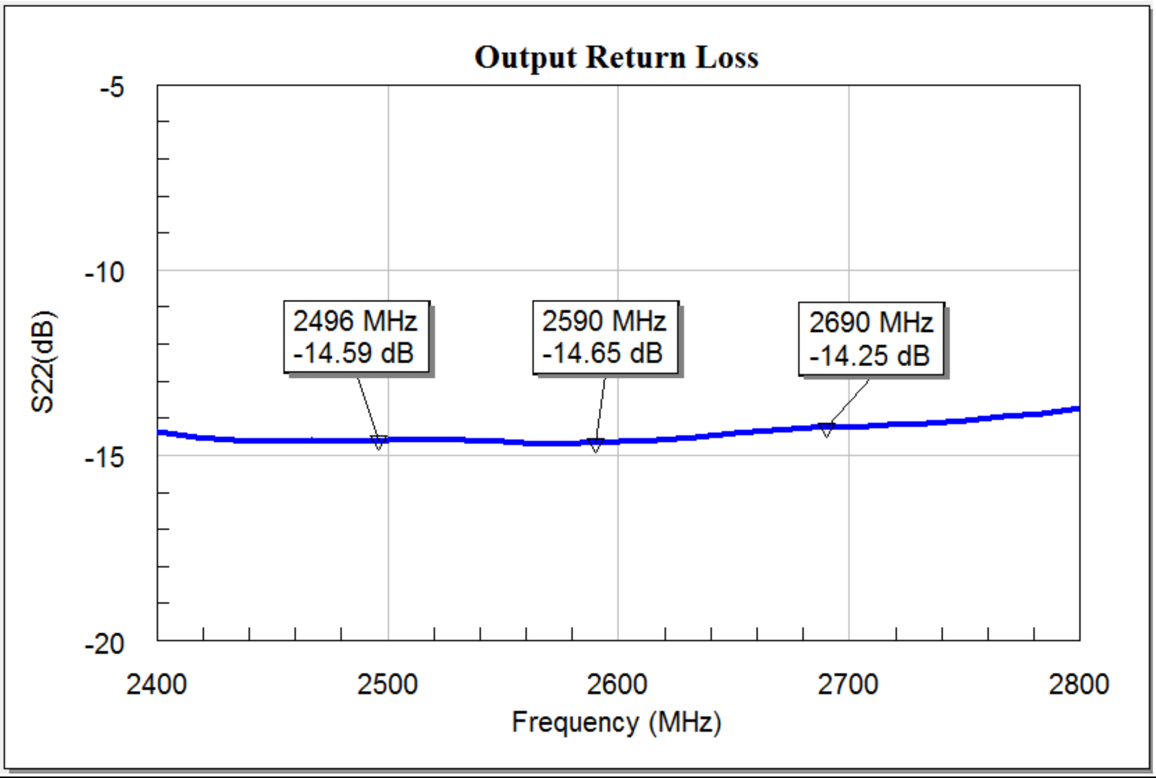

Figure 28 Output Matching of the BGM15HA12 for Band-41 Applications

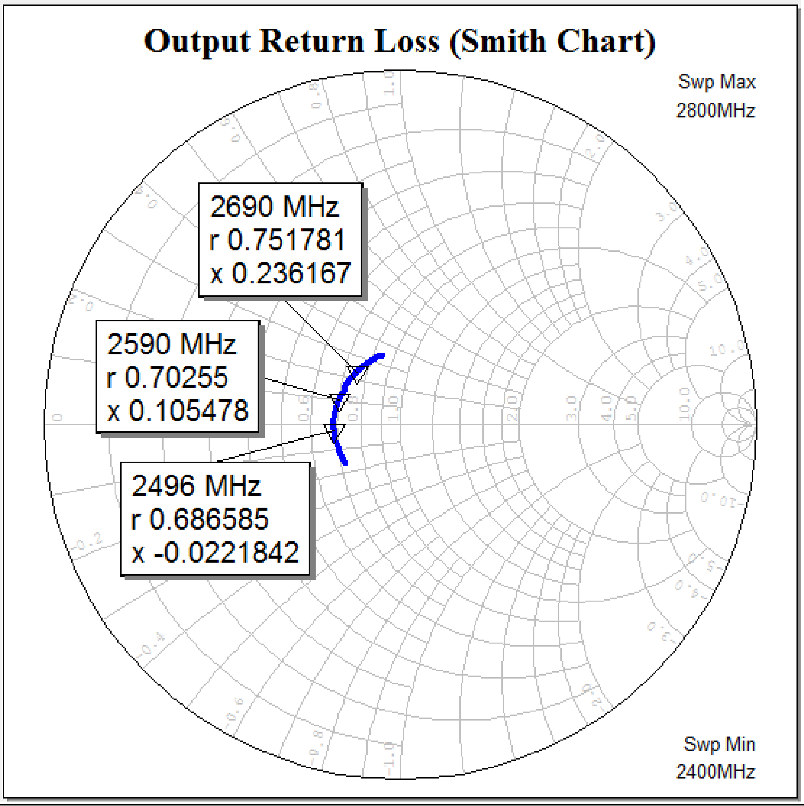

Figure 29 Output Matching (Smith Chart) of the BGM15HA12 for Band-41 Applications

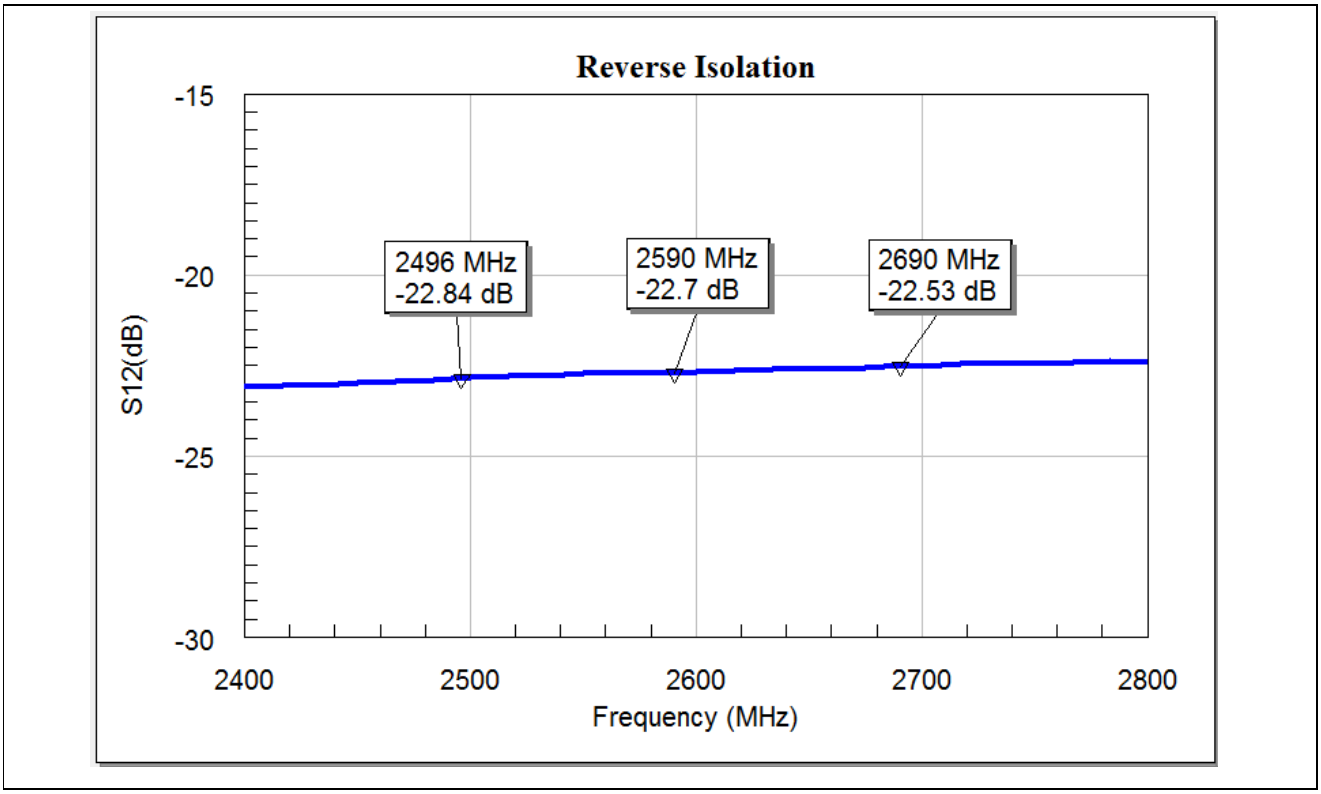

Figure 30 Reverse Isolation of the BGM15HA12 for Band-41 Applications

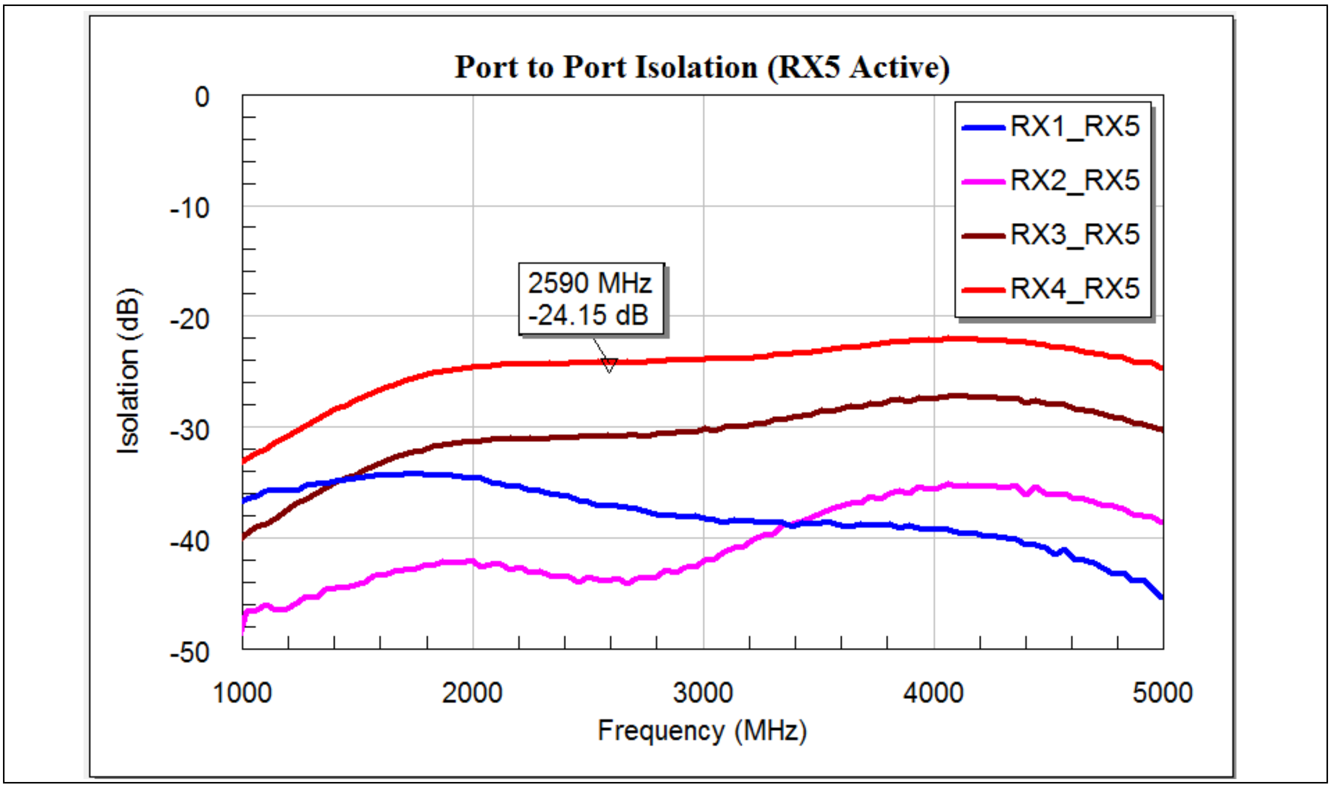

Figure 31 **Isolation between RX5 and RX1/RX2/RX3/RX4, when RX5 is active of the** Error! Unknown document property name.

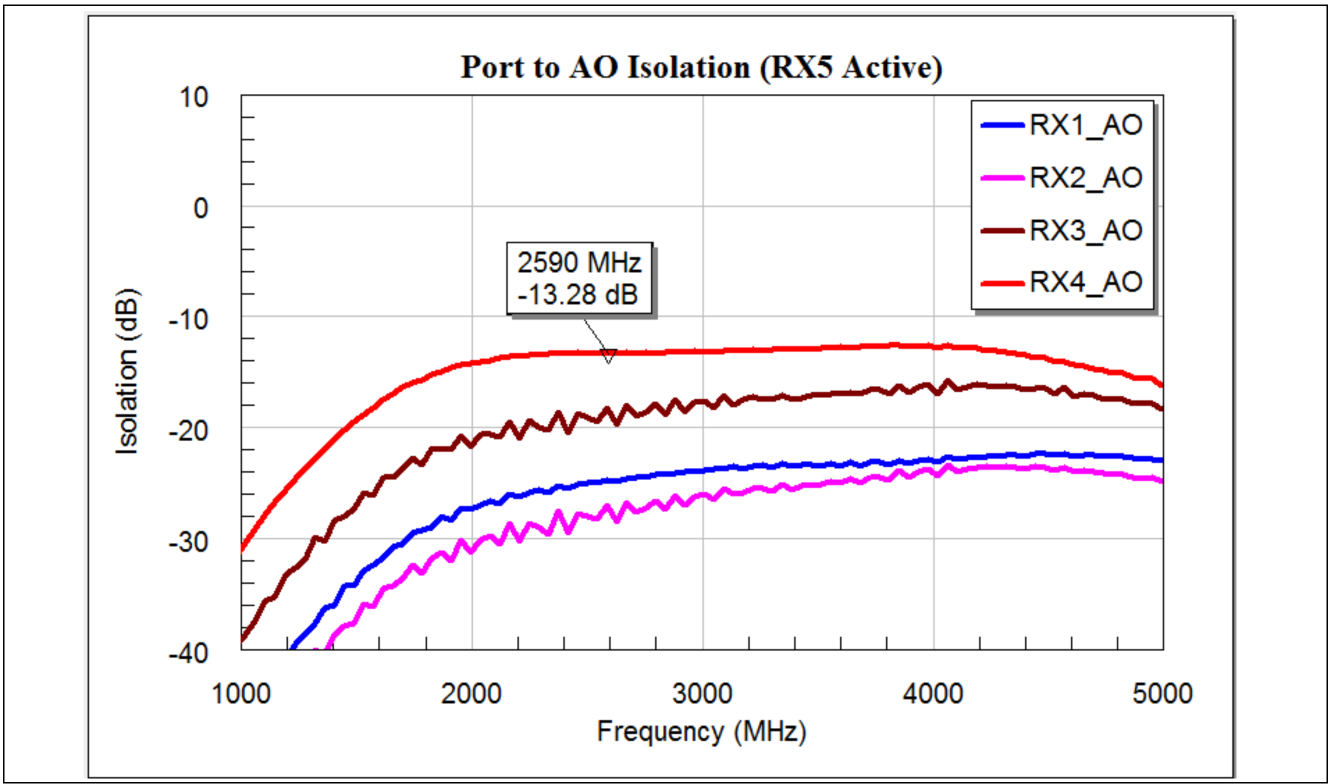

Figure 32 **Isolation between AO and RX1/RX2/RX3/RX4, when RX5 is active of the** Error! Unknown document property name.

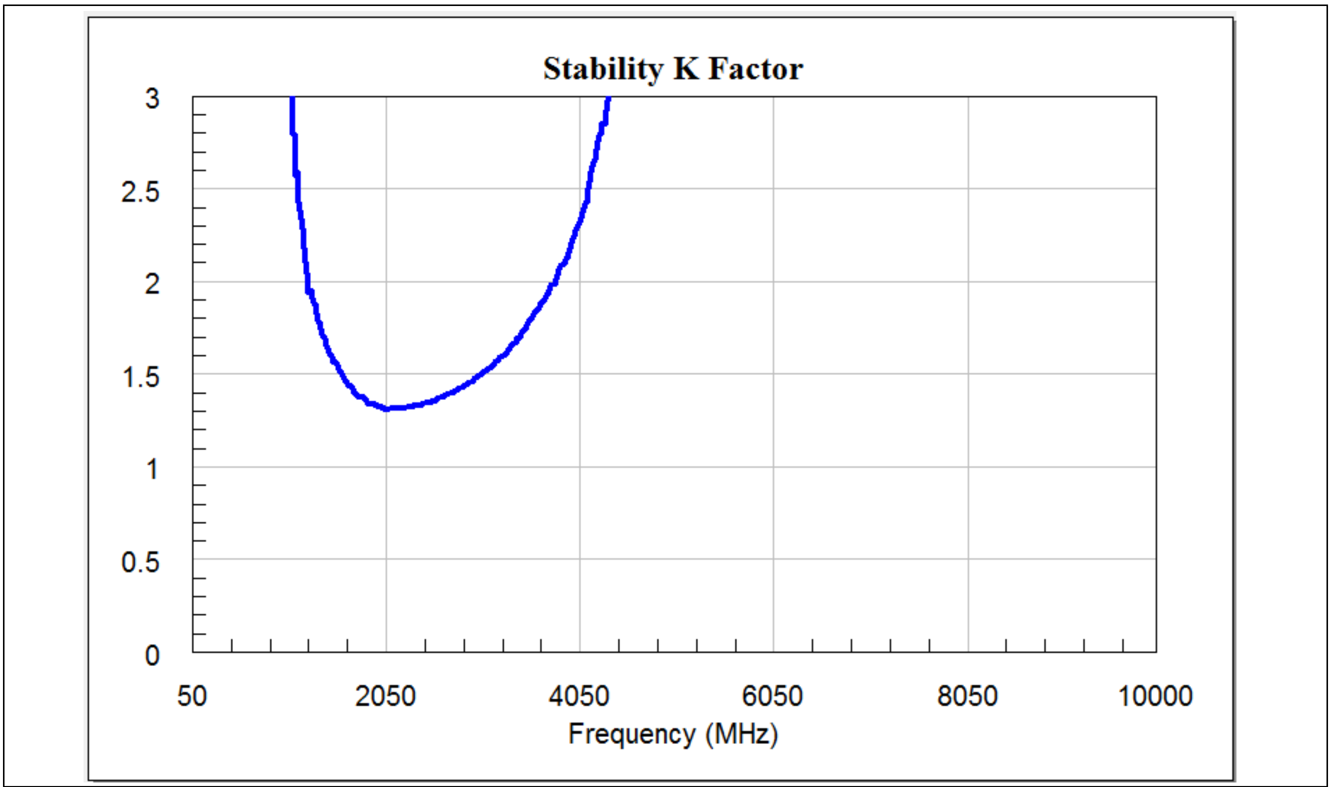

Figure 33 Stability K-factor of the BGM15HA12 for Band-41 Applications

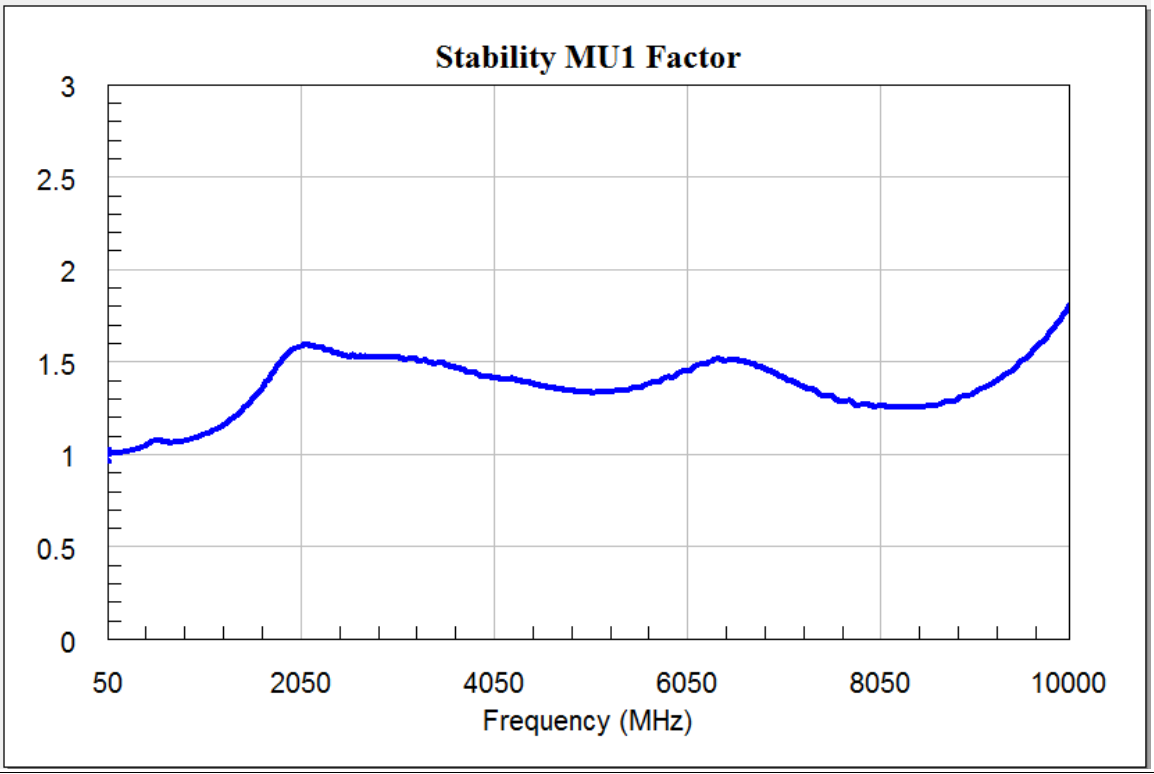

Figure 34 Stability Mu1-factor of the Error! Unknown document property name. **for Band-41 Applications**

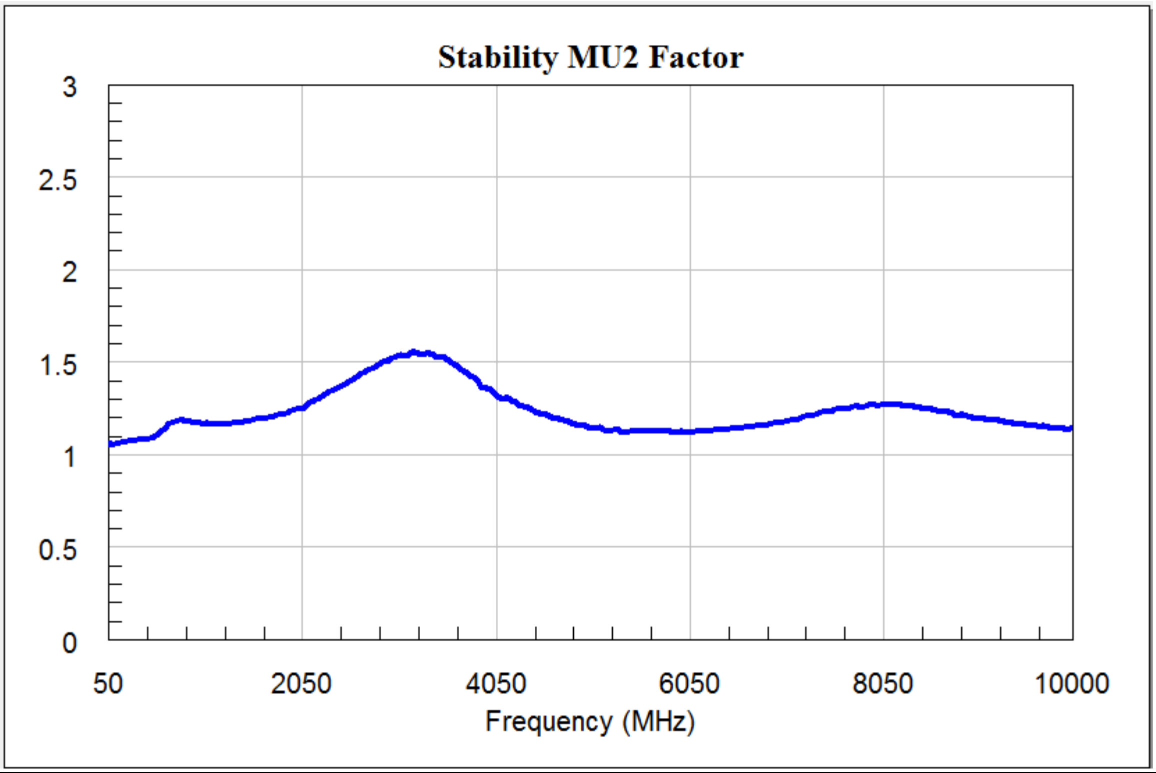

Figure 35 Stability Mu2-factor of the BGM15HA12 for Band-41 Applications

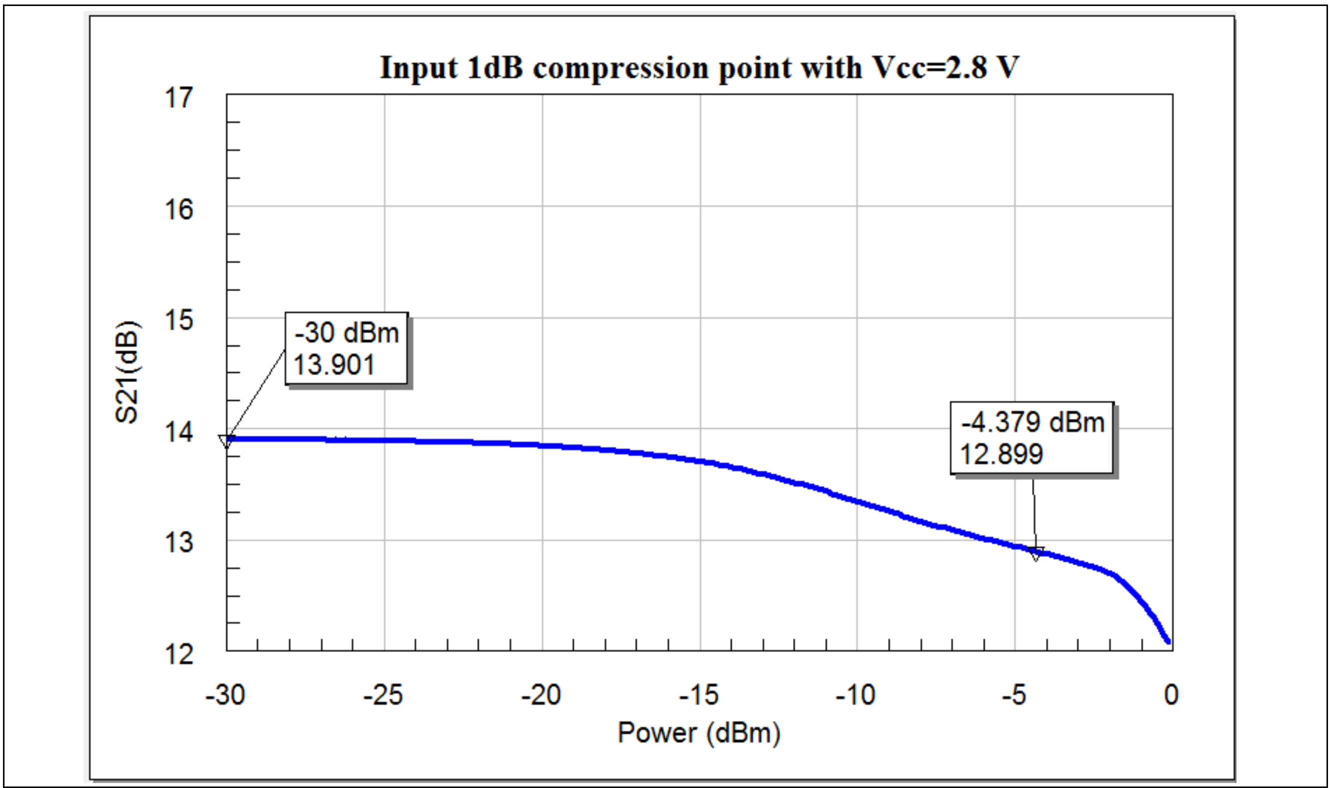

Figure 36 Input 1dB Compression Point of the BGM15HA12 for Band-41 Applications

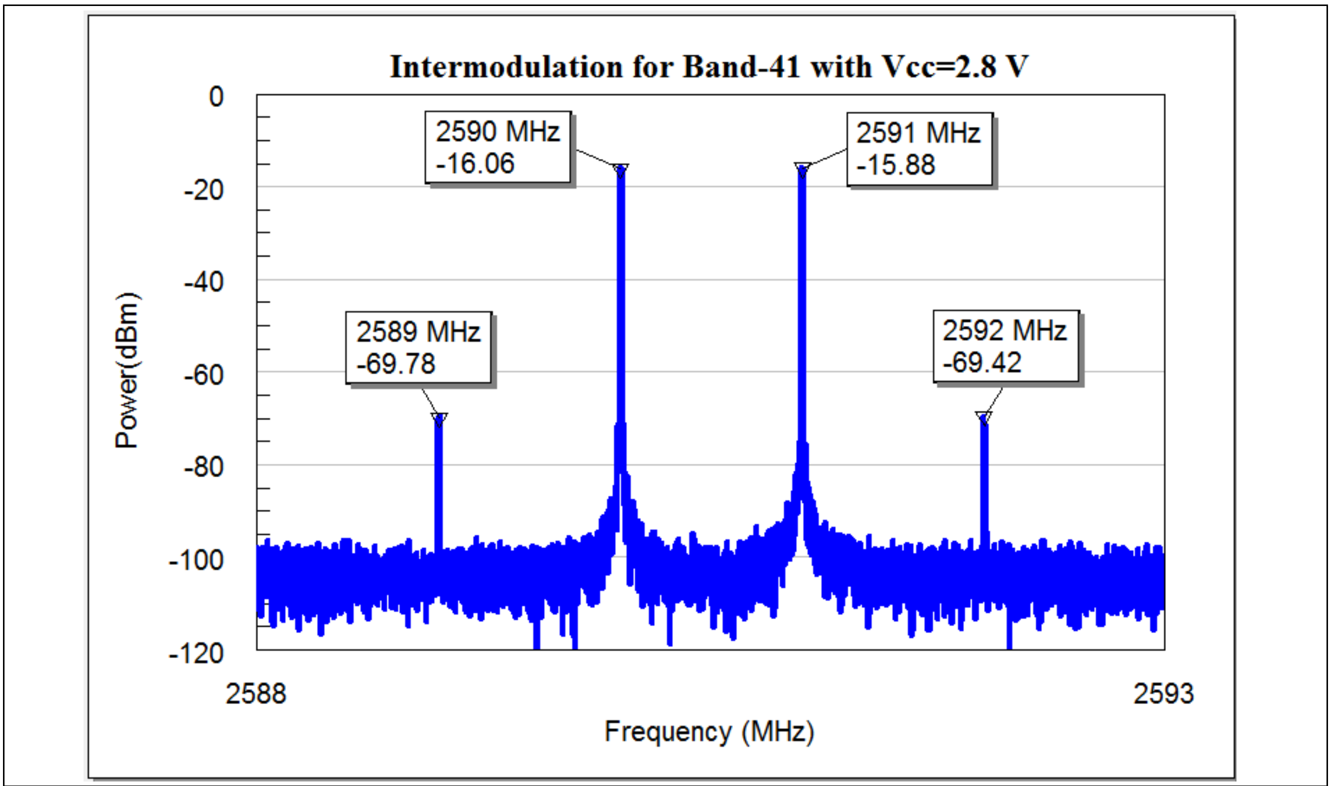

Figure 37 Input 3rd Intercept Point of the BGM15HA12 for Band-41 Applications

5 Evaluation Board and Layout Information

In this application note, the following PCB is used:

PCB Marking: **BGM15 V1.1**

PCB material: **Rogers4003**

ε_r of PCB material: **3.6**

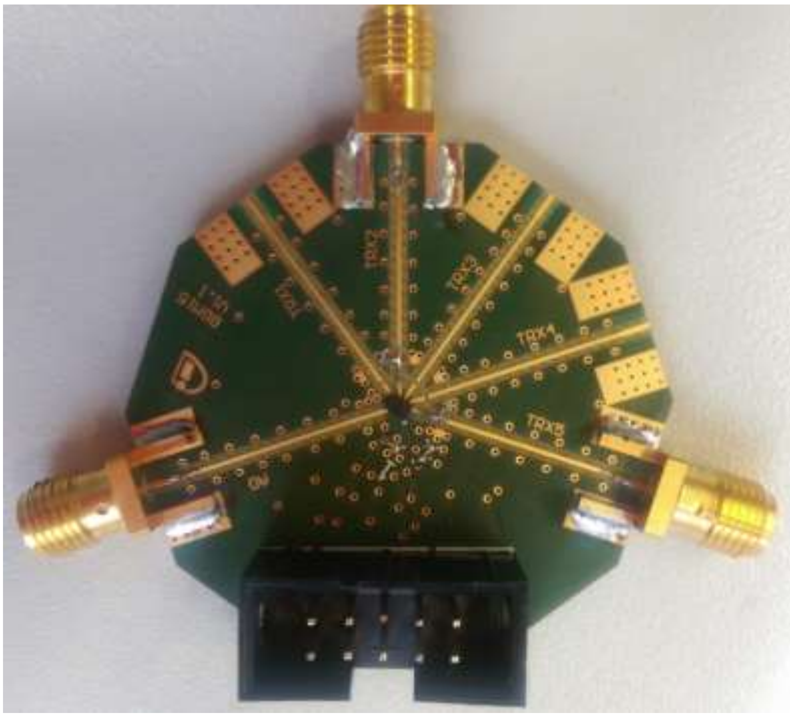

Figure 38 Photo of Evaluation Board (overview) PCB Marking BGM15 V1.1

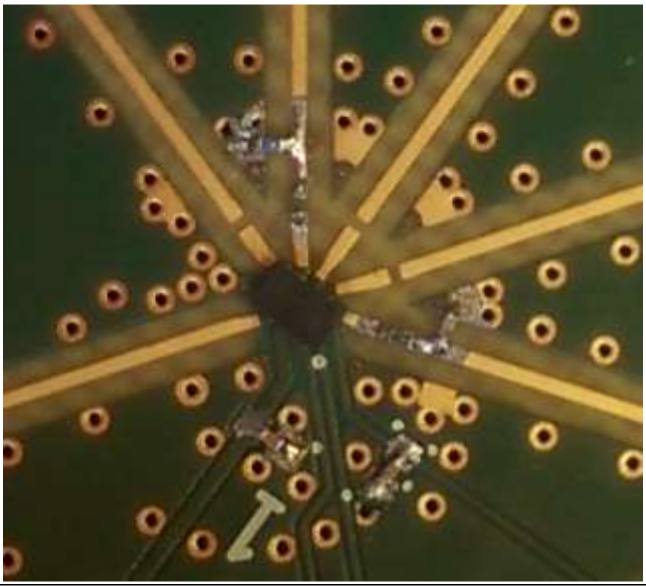

Figure 39 Photo of Evaluation Board (detailed view)

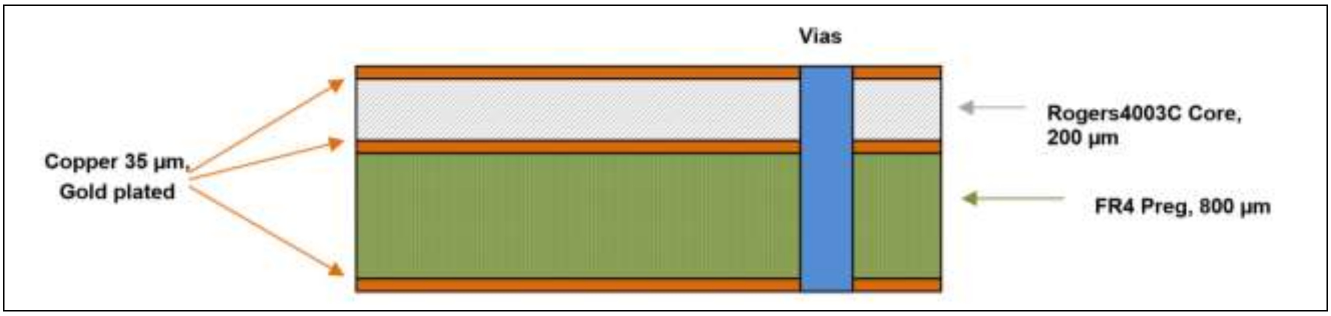

Figure 40 PCB Layer Information

6 Authors

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Moakhkhrul Islam, Application Engineer of Business Unit “RF and Protection Devices”.

7 Reference

[1] A Reference. See the code examples at www.infineon.com

Revision History

Major changes since the last revision

Page or Reference	Description of change

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