

AN11103

Externally-matched 900 MHz LNA using BGU7005

Rev. 1 — 7 December 2011

Application note

Document information

Info	Content
Keywords	BGU7005, LNA, externally matched
Abstract	This application note describes an evaluation board design using the BGU7005 for an externally-matched 900 MHz ISM band LNA. Board schematic, circuit simulation, layout, BOM and typical performance characteristics are provided.



Revision history

Rev	Date	Description
v.1	20111207	first issue

Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: salesaddresses@nxp.com

1. Introduction

The BGU7005 is a Low Noise Amplifier (LNA) for Global Positioning Systems (GPS) receiver applications in a plastic leadless 6-pin, extremely small SOT886 package. The BGU7005 requires only one external matching inductor and one external decoupling capacitor. The BGU7005 adapts itself to the changing environment resulting from co-habitation of different radio systems in modern cellular handsets. It is designed for low-power consumption and optimal jamming performance when signals from co-existing cellular transmitters are present. At low jamming power levels, it delivers 16.5 dB gain at a noise figure of 0.9 dB. During high jamming power levels, resulting, for example, from a cellular transmit burst, it temporarily increases its bias current to improve sensitivity.

The BGU7005 can be rematched externally to other frequency bands for suit various applications.

The evaluation board is tuned to achieve optimal performance in the 900 MHz Industrial, Scientific, Medical (ISM) band. It is suitable for evaluating various applications due to the low current, high gain and low noise figure of the BGU7005.

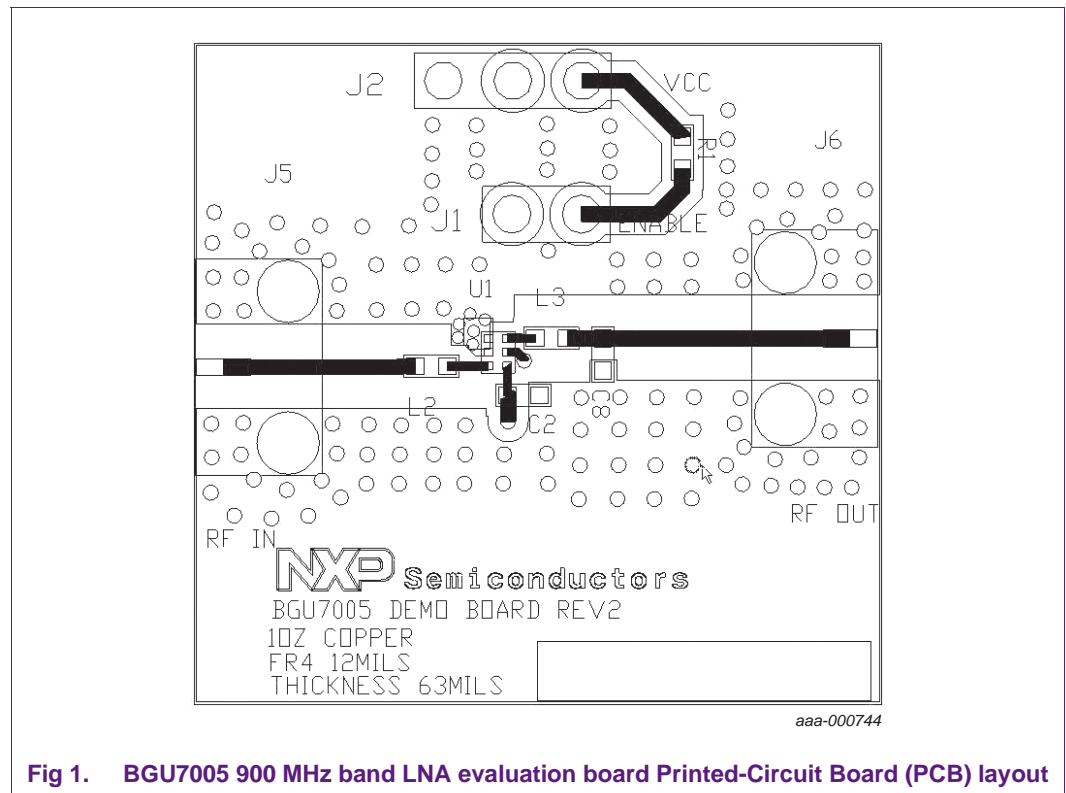


Fig 1. BGU7005 900 MHz band LNA evaluation board Printed-Circuit Board (PCB) layout

2. General description

The BGU7005 LNA evaluation board is optimized to evaluate the performance of the BGU7005 in a 900 MHz ISM band application. This document provides circuit simulations, Agilent Design System (ADS) results, application schematic, board layout, Bill Of Materials (BOM), and typical test results.

3. Application circuit simulation

3.1 BGU7005 900 MHz band LNA simulation

Assumptions

- 50 Ω termination at input and output
- Data file for S-parameter and noise at 1.8 V used
- 1.8 V supply voltage

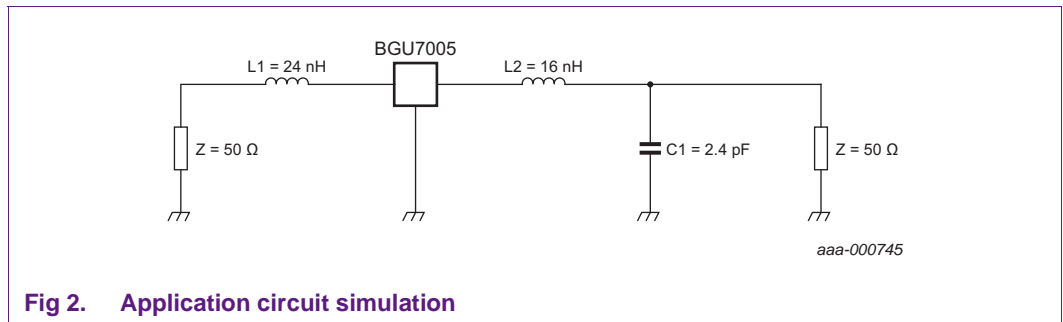


Fig 2. Application circuit simulation

3.2 BGU7005 900 MHz band LNA simulation result

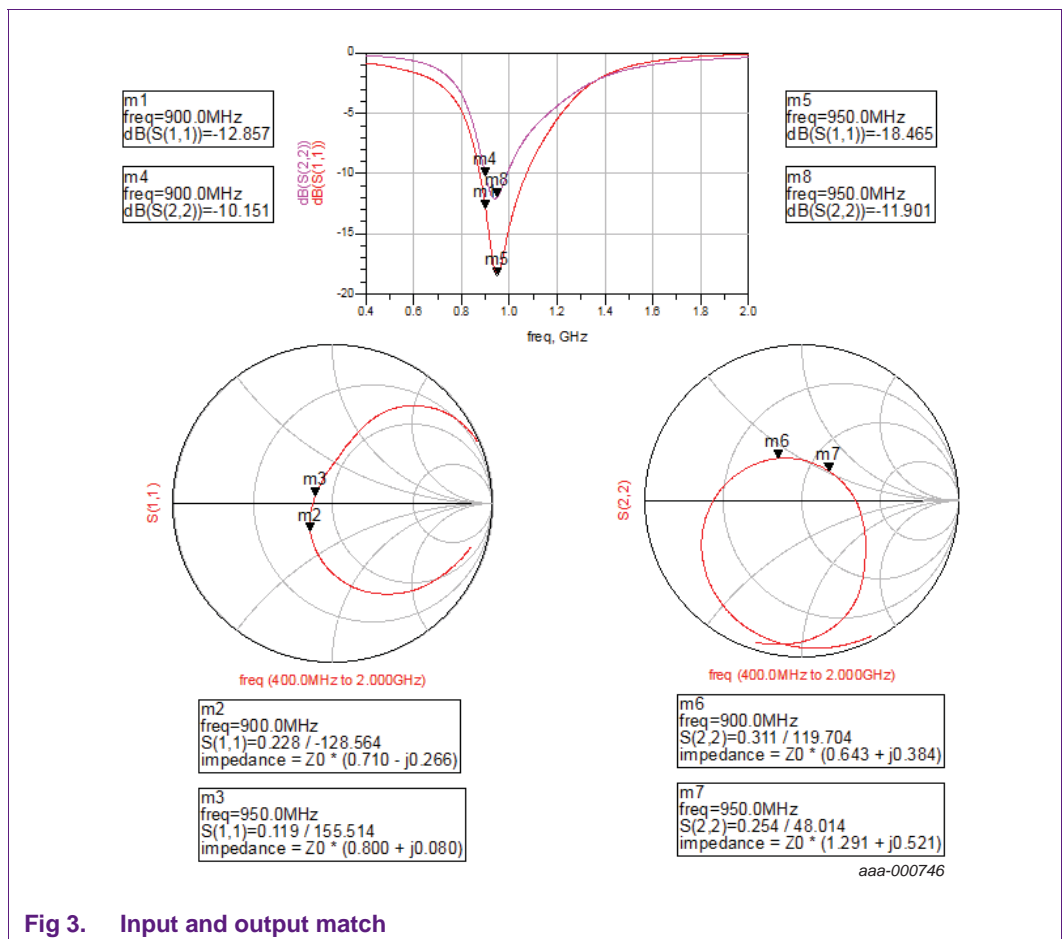
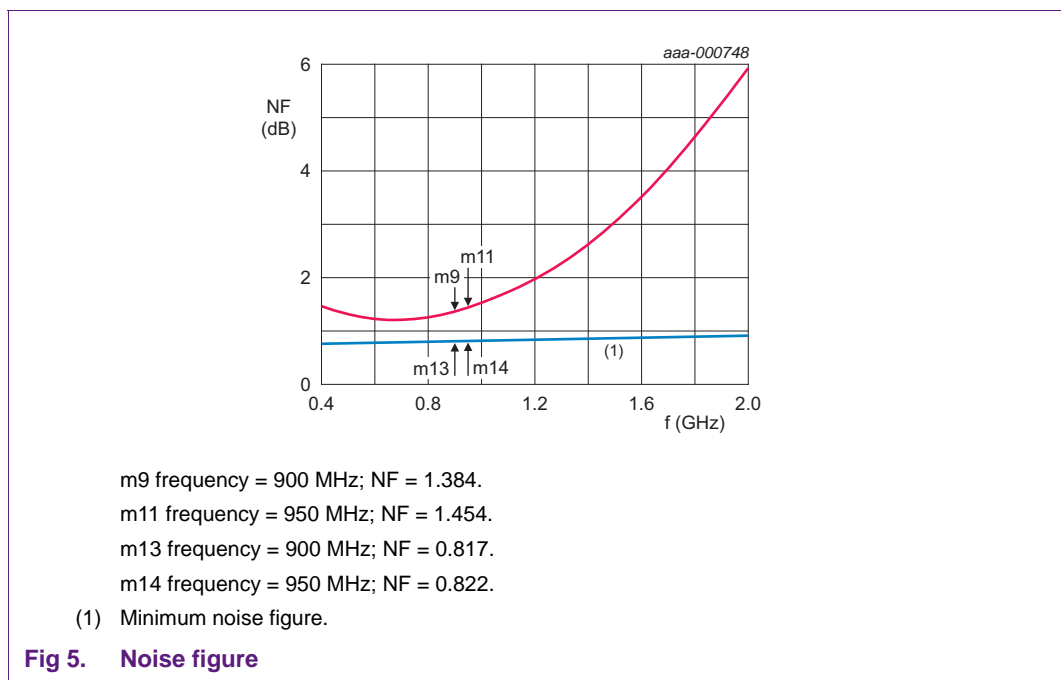
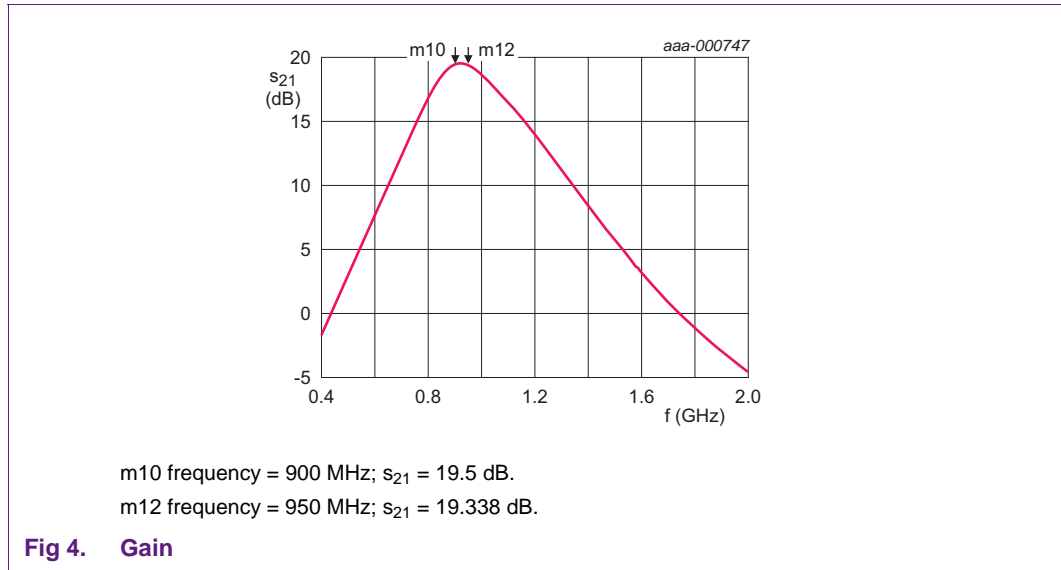


Fig 3. Input and output match



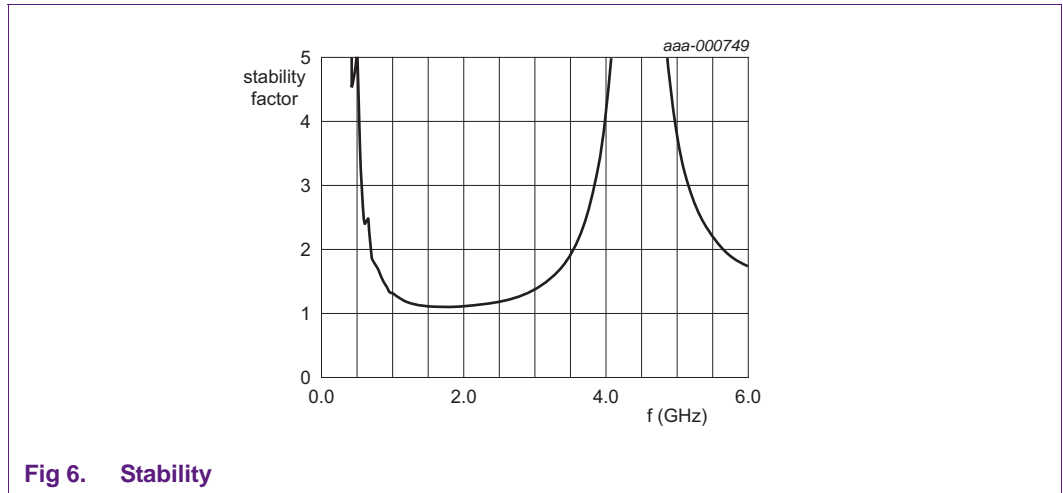


Fig 6. Stability

4. Evaluation board

The BGU7005 900 MHz band LNA evaluation board simplifies the evaluation of the BGU7005 application. The evaluation board enables device performance testing and requires no additional support circuitry. The board is fully assembled with the BGU7005 IC, including input and output matching for optimum performance.

The board is supplied with two SMA connectors for input and output connection to RF test equipment.

The BGU7005 is designed to operate at 1.8 V for optimal performance not exceeding 2.85 V. If the evaluation board is to be powered at a different supply voltage such as 3.3 V or 3.7 V, calculate the value of volt-drop resistor R1 and change it accordingly.

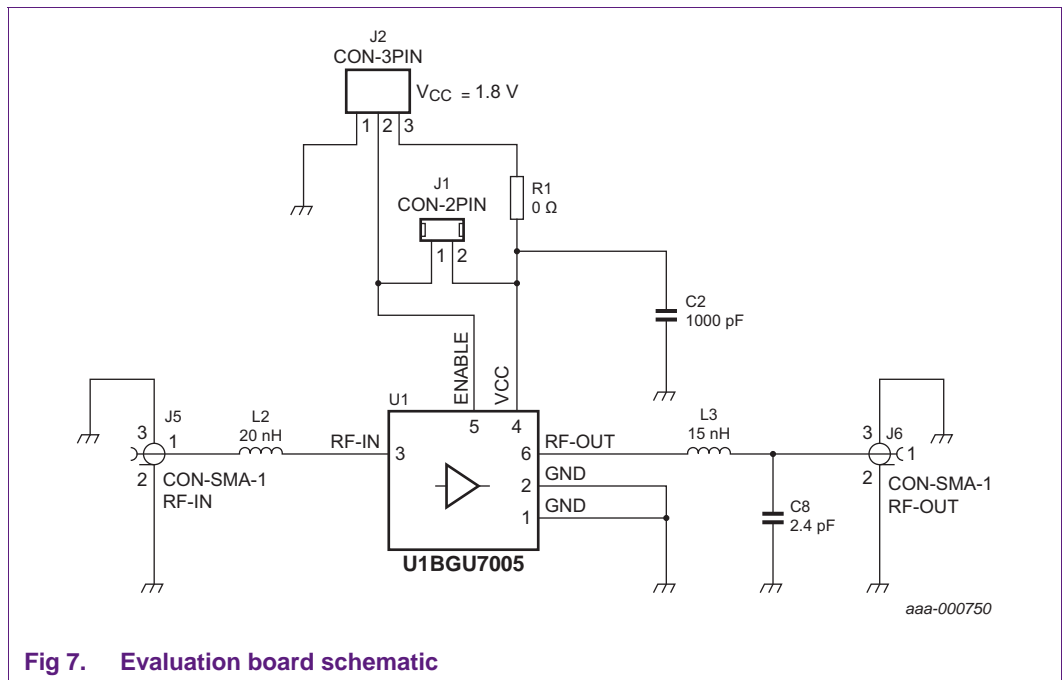


Fig 7. Evaluation board schematic

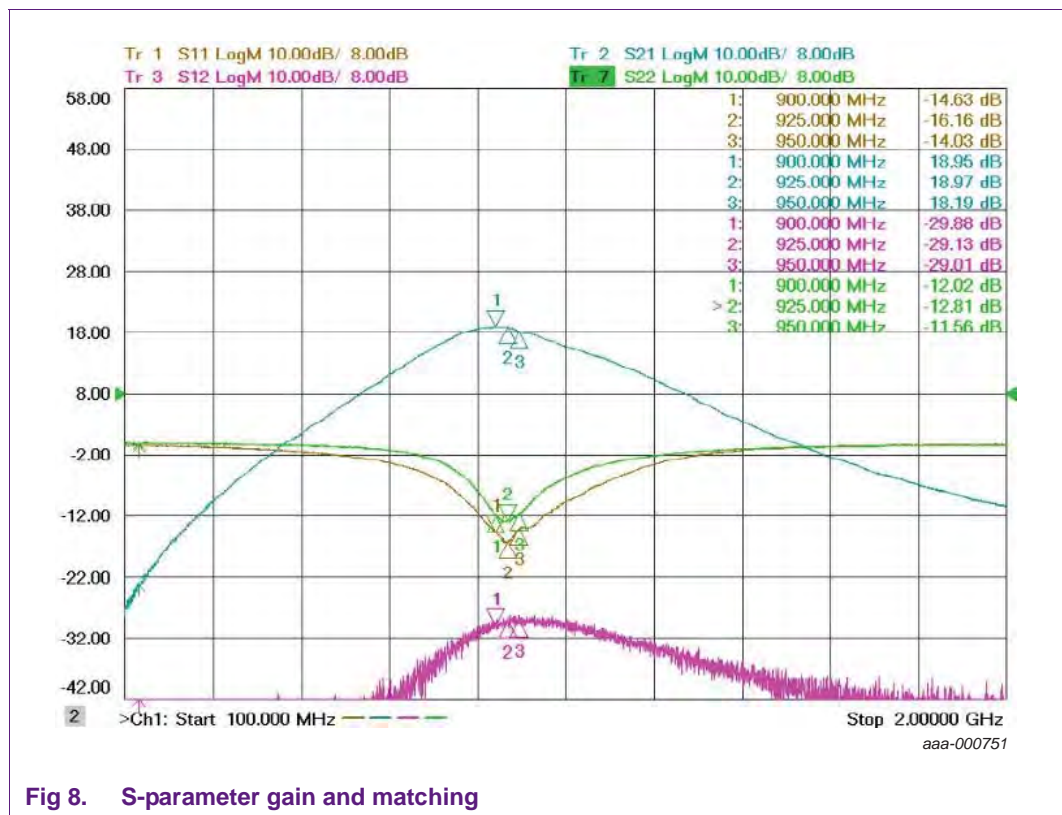
4.1 Bill of materials (900 MHz band)

Table 1. BGU7005 900 MHz band LNA evaluation board BOM

Item	Quantity	Part reference	Part number	Vendor ^[1]	Value
1	1	C2	GRM1555C1H102 JA01	Murata	1000 pF
2	1	C8	GRM1555C1H2R4 CZ01D	Murata	2.4 pF
3	1	J1	90120-0762	Molex	CON-2PIN
4	1	J2	90120-0763	Molex	CON-3PIN
5	2	J5, J6	901-10110	Amphenol	CON-SMA-1
6	1	L2	0402CS-20NX_LU	Coilcraft	20 nH
7	1	L3	0402CS-15NX	Coilcraft	15 nH
8	1	R1	CRCW04020000Z 0ED	Vishay/Dale	0 Ω
9	1	U1	BGU7005	NXP Semiconductors	BGU7005

[1] Sourcing materials from a different vendor may affect performance.

4.2 Typical evaluation board test results (900 MHz band)



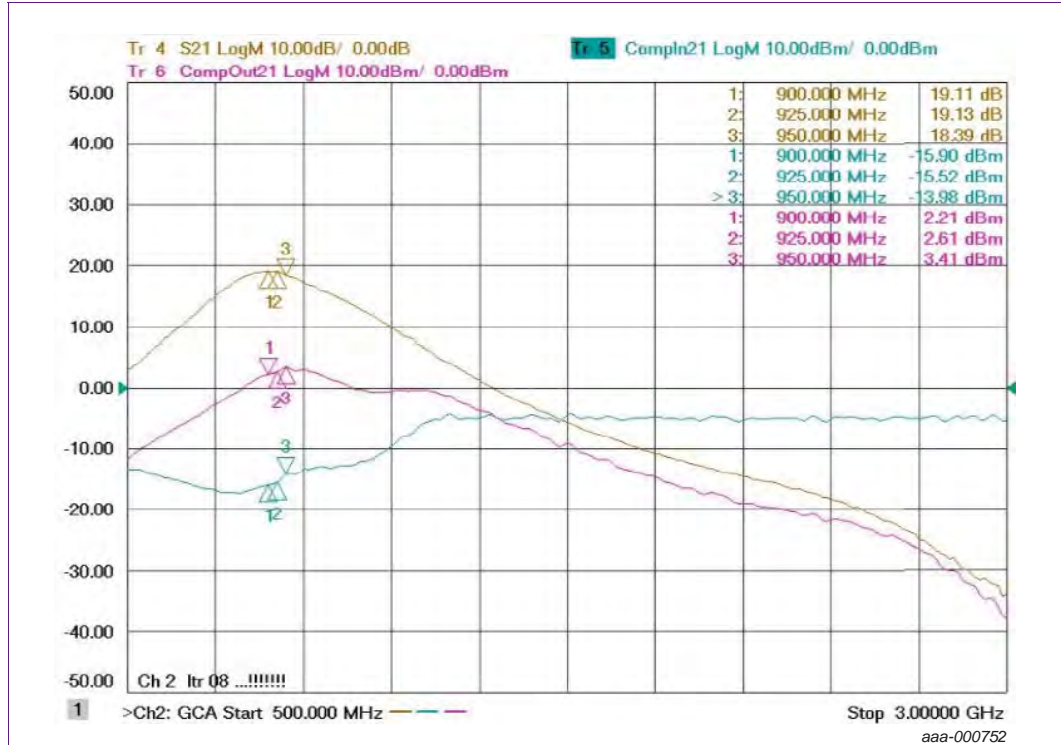
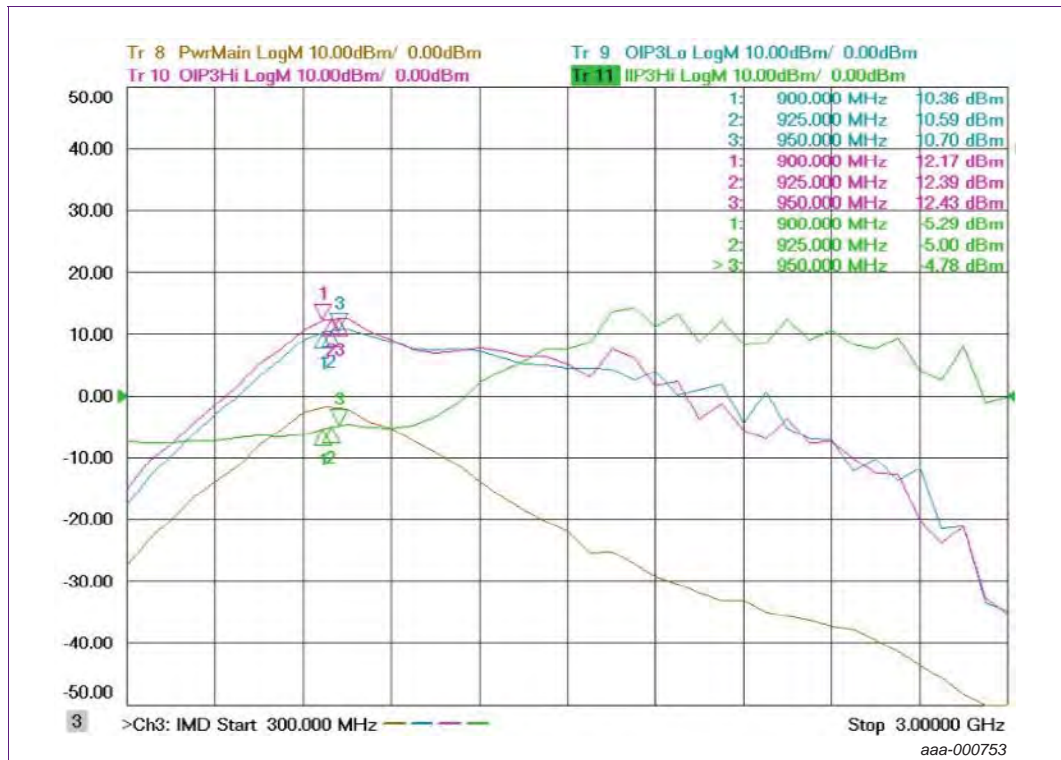


Fig 9. P1 dB



Tone spacing = 1 MHz.

Fig 10. Linearity (IP3)



Fig 11. Stability (K factor)

4.2.1 Noise figure measurement

A 6 dB pad is placed between the noise source and RF input to improve the noise figure measurement accuracy. A network analyzer shows that the 6 dB pad is 5.9 dB at 900 MHz.

A network analyzer is used to measure the loss between the connector to the first matching component of the device. The measured return loss is 0.2 dB, therefore a 0.1 dB input loss must be taken into account to get the true noise figure.

Overall 6 dB loss at input and 0.1 dB loss at output are subtracted from the noise figure analyzer measurement.

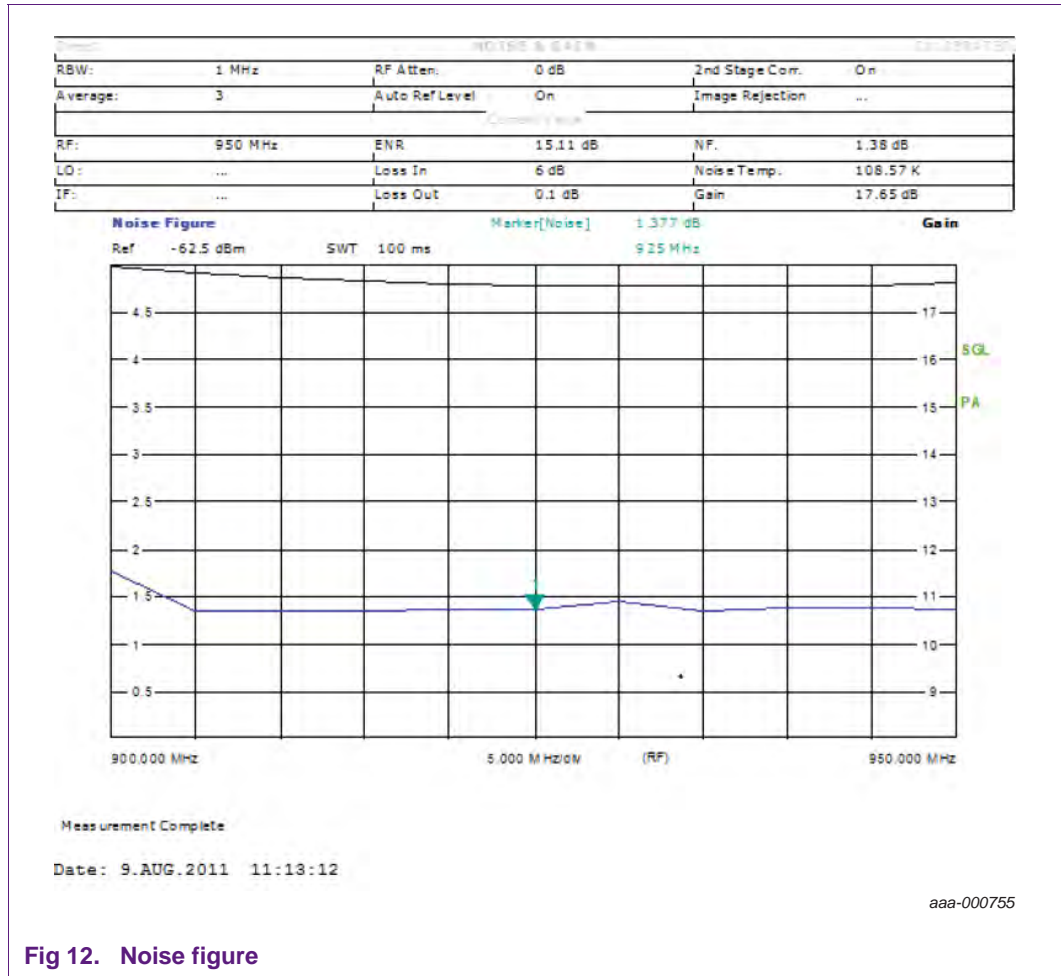


Fig 12. Noise figure

4.2.2 Typical evaluation board test results summary

Table 2. Typical results measured on the BGU7005 900 MHz band evaluation board

Parameter	Symbol	Value	Unit
Supply voltage	V_{CC}	1.8	V
Supply current	I_{CC}	4.16	mA
Noise figure	NF	1.38	dB
Power gain	G_P	18.97	dB
Input return loss	RL_{in}	16.1	dB
Output return loss	RL_{out}	12.8	dB
Reverse isolation	$\alpha_{isol(r)}$	29.1	dB
input power at 1 dB gain compression	$P_{i(1dB)}$	-15.52	dBm
output power at 1 dB gain compression	$PL_{(1dB)}$	2.61	dBm
Input third-order intercept point	$IP3_I$	-5.0	dBm
Output third-order intercept point	$IP3_O$	12.39	dBm
Rollett stability factor (0 GHz to 26 GHz)	K	>1	

5. Legal information

5.1 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

5.2 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors accepts no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product

design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Evaluation products — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer.

In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out of the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages.

Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US\$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

5.3 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

6. Contents

1	Introduction	3
2	General description	3
3	Application circuit simulation	4
3.1	BGU7005 900 MHz band LNA simulation	4
3.2	BGU7005 900 MHz band LNA simulation result	4
4	Evaluation board	6
4.1	Bill of materials (900 MHz band)	7
4.2	Typical evaluation board test results (900 MHz band)	7
4.2.1	Noise figure measurement	9
4.2.2	Typical evaluation board test results summary	10
5	Legal information	11
5.1	Definitions	11
5.2	Disclaimers	11
5.3	Trademarks	11
6	Contents	12

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP B.V. 2011.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 7 December 2011

Document identifier: AN11103