

AN11086

BGU7003 LNA application for GPS L2 band

Rev. 2 — 9 October 2012

Application note

Document information

Info	Content
Keywords	BGU7003, LNA, GPS L2 band.
Abstract	This application note provides circuit simulation, schematic, layout, BOM and typical EVB performance for GPS L2 LNA based on BGU7003.



Revision history

Rev	Date	Description
v.2	20121009	Correct mistakes
v.1	20120105	Initial version

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 BGU7003 is a wideband low noise amplifier in a plastic, leadless 6 pin extremely thin small outline SOT891 package. It can be used for various LNA applications up to 6 GHz such as GPS, satellite radio, cordless phone and E-metering.

The BGU7003 contains 1 RF stage and an internal bias that is temperature stabilized. It also contains an enable function to shut down the amplifier with a logic signal on the ENABLE pin.

The BGU7003 is ideal for use where size and low power are most critical. Typical usages are mobile phones, Personal Digital Assistants (PDA), Personal Navigation Devices (PND), E-metering and remote controllers.

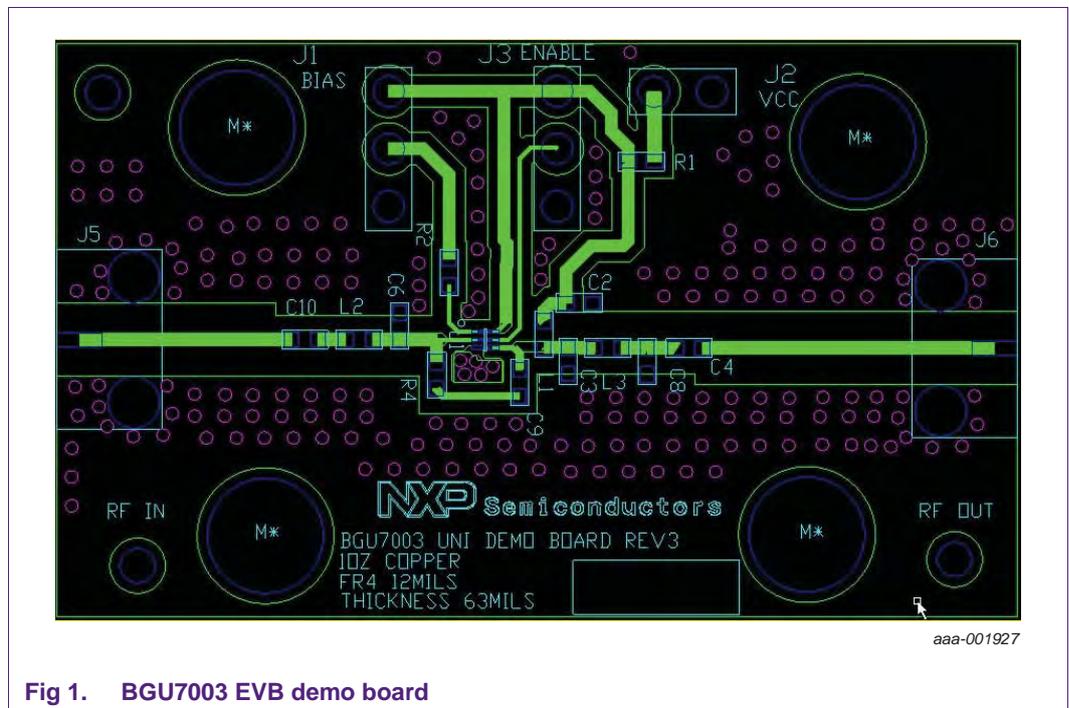


Fig 1. BGU7003 EVB demo board

2. General description

This universal LNA evaluation board (EVB) is optimized to evaluate the performance of the BGU7003 applied in multiband GPS L2 band. In this document, circuit simulations and result in ADS, the application schematic, board layout, bill of material, and typical test results are given.

Due to the flexibility of external matching, the BGU7003 can be retuned and optimized to meet LNA requirements of future navigation systems.

3. Application circuit simulation

3.1 BGU7003 GPS L2 band LNA simulation

Assumptions:

- 50 Ω termination at input and output
- 5 mA at 2.5 V S2P file is used
- 2.5 V supply voltage

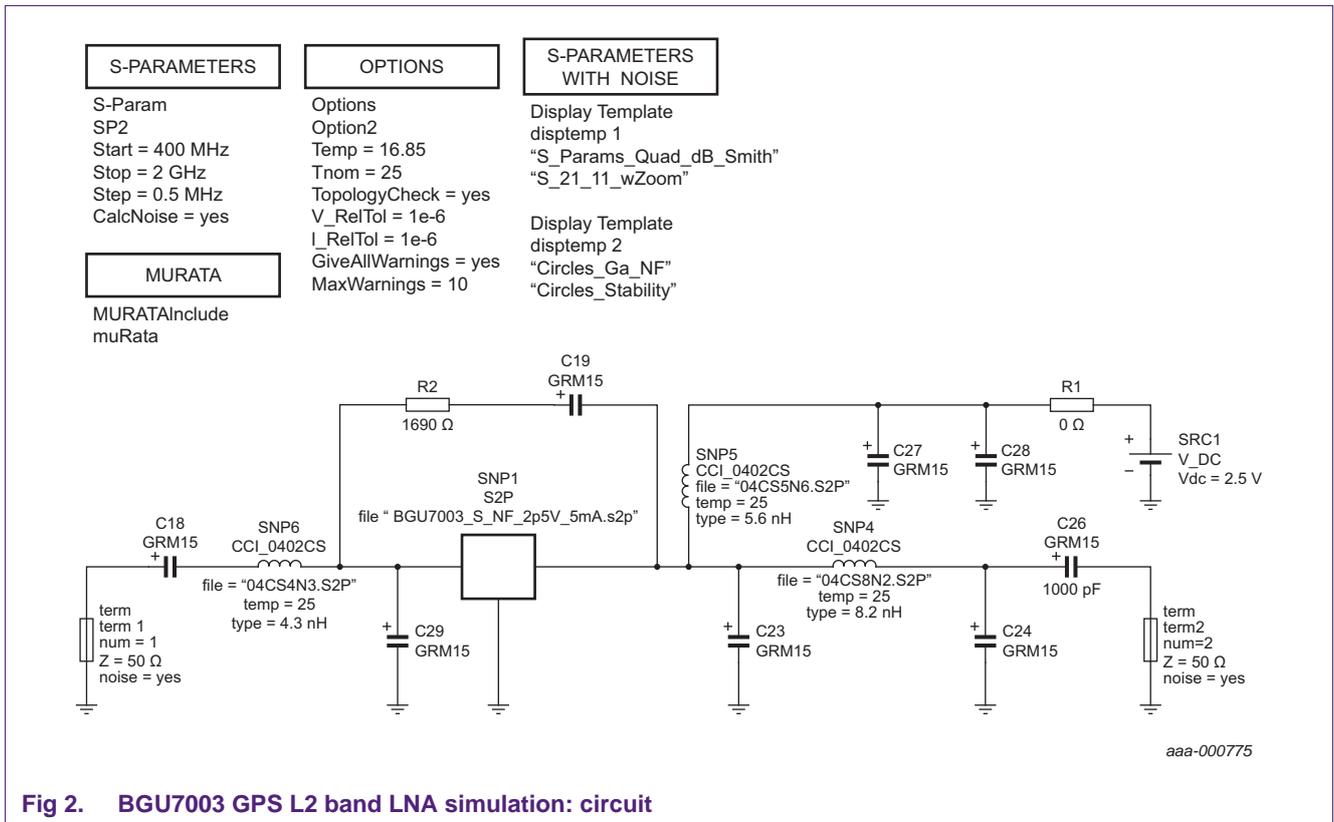


Fig 2. BGU7003 GPS L2 band LNA simulation: circuit

3.2 BGU7003 GPS L2 band LNA simulation result

3.2.1 Input and output match in GPS L2 band

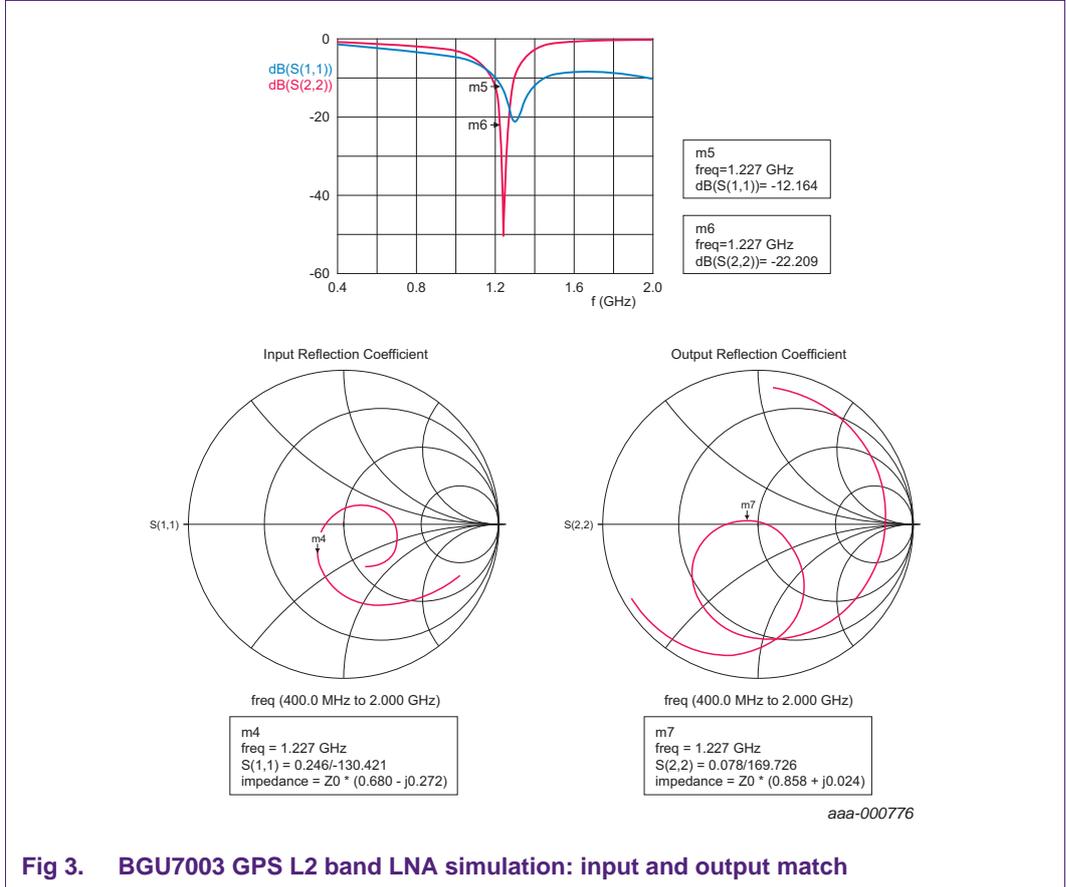


Fig 3. BGU7003 GPS L2 band LNA simulation: input and output match

3.2.2 Gain in GPS L2 band

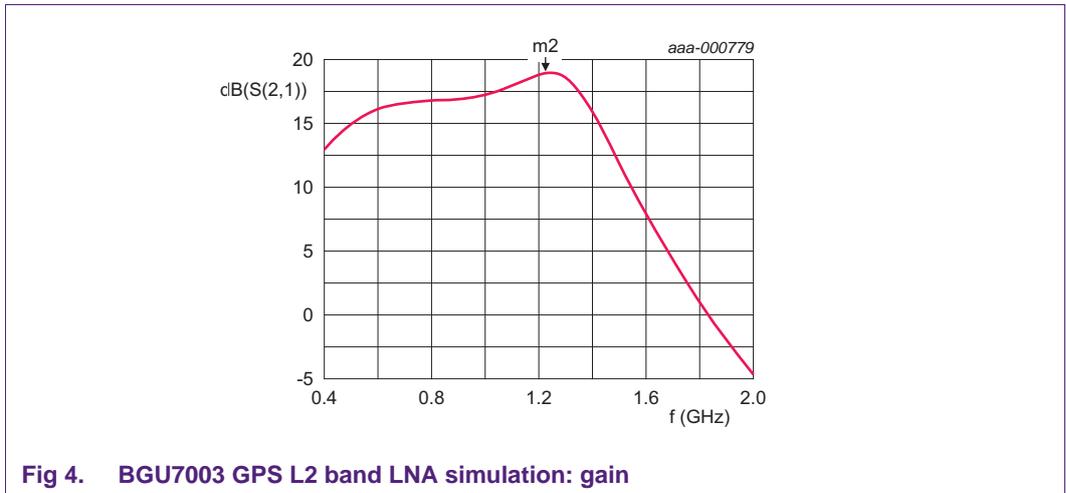


Fig 4. BGU7003 GPS L2 band LNA simulation: gain

3.2.3 Noise figure in GPS L2 band

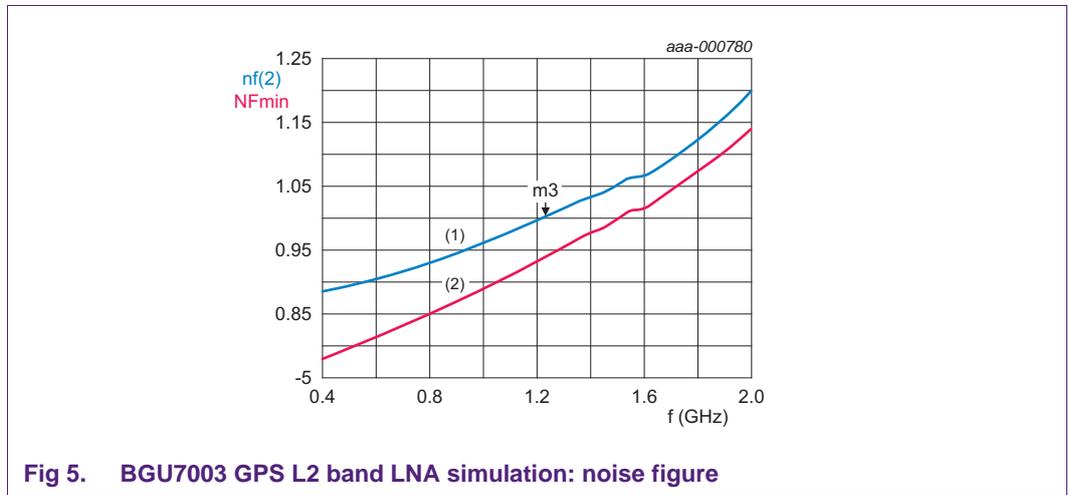


Fig 5. BGU7003 GPS L2 band LNA simulation: noise figure

3.2.4 Stability

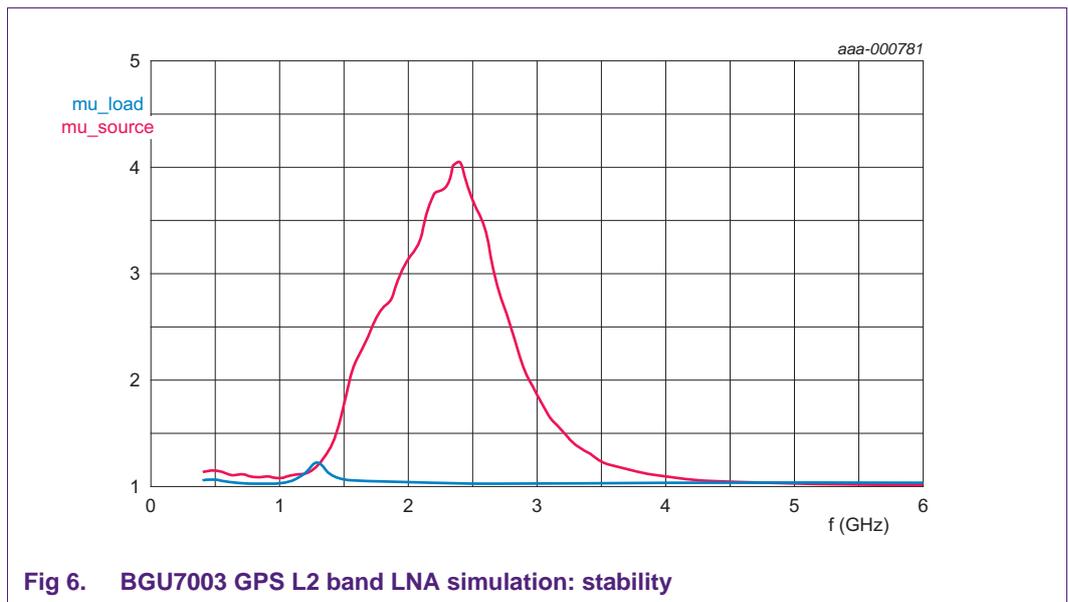


Fig 6. BGU7003 GPS L2 band LNA simulation: stability

4. Application board

The BGU7003 GPS L2 band LNA evaluation board simplifies the evaluation of the BGU7003 in the GPS application area. The evaluation board enables testing of the device performance and requires no additional support circuitry. The board is fully assembled with the BGU7003 IC, including input and output matching, to optimize the performance.

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

The BGU7003 is designed to operate at 2.5 V with optimal performance, and not to exceed 2.85 V. When it is used with varying supply voltages (3.3 V to 3.7 V for E-metering), the enable function is not used and LNA is always on. An ENABLE pin jumper is installed, which avoids the voltage on the V_{CC}, ENABLE and RF_OUT pins exceeding 2.85 V.

4.1 Application circuit schematic (GPS L2 band)

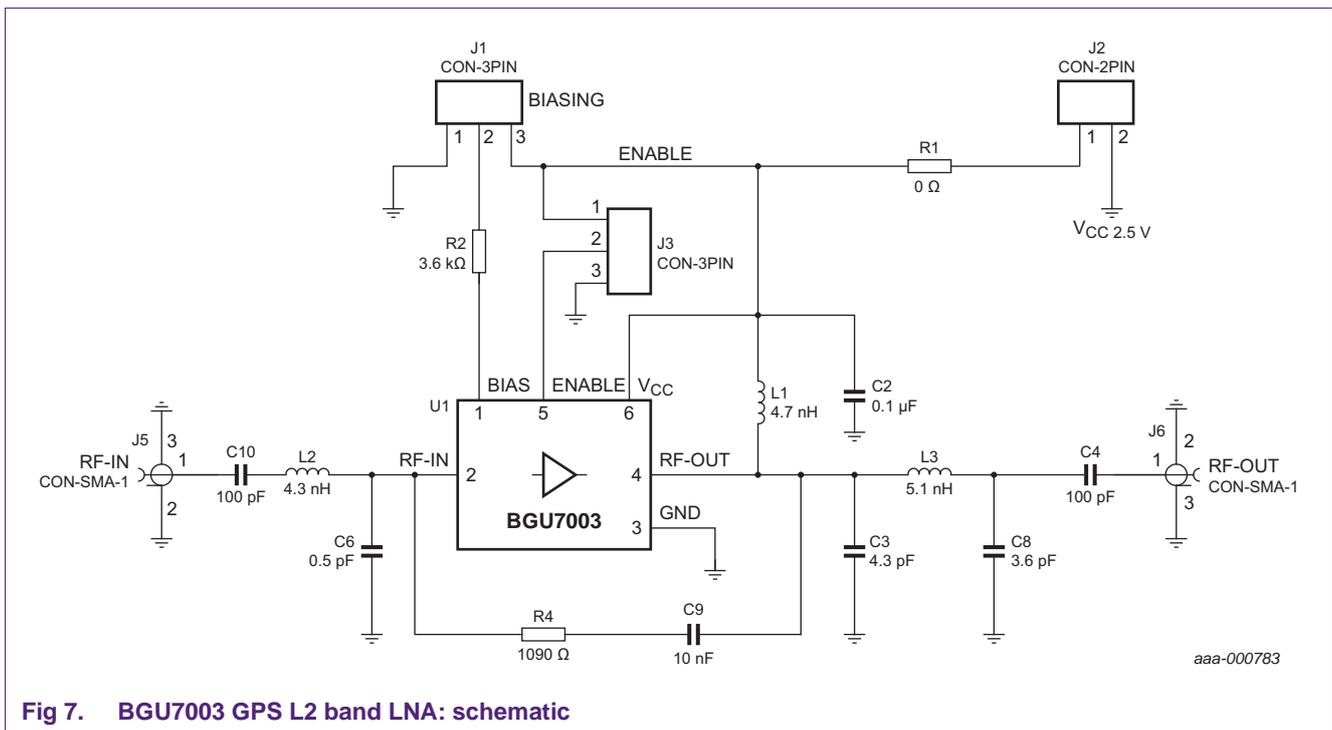


Fig 7. BGU7003 GPS L2 band LNA: schematic

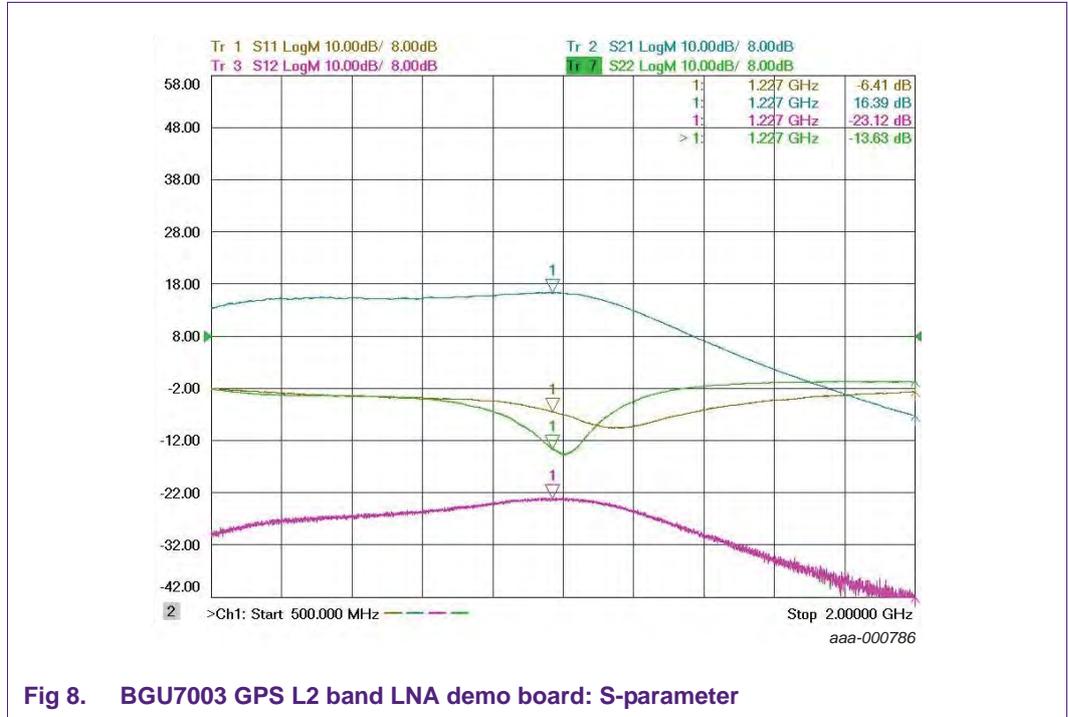
4.2 Application board Bill Of Materials BOM (GPS L2 band)

Table 1. BGU7003 LNA EVB for GPS L2 band parts List

Item	Quantity	Part reference	Part number	Vendor	Value
1	1	C2	GRM155R71C104KA88	Murata	0.1 pF
2	1	C3	GRM1555C1H4R3CZ01	Murata	4.3 pF
3	2	C4	GRM1555C1H101JZ01	Murata	100 pF
		C10	GRM1555C1H101JZ01	Murata	100 pF
4	1	C6	GRM1555C1HR50CZ01	Murata	0.5 pF
5	1	C8	GRM1555C1H3R6CZ01	Murata	3.6 pF
6	1	C9	GRM155R71C103KA01D	Murata	10 nF
7	2	J1	90120-0763	Molex	CON-3PIN
		J3	90120-0763	Molex	CON-3PIN
8	1	J2	90120-0762	Molex	CON-2PIN
9	2	J5	901-10110	Amphenol	CON-SMA-1
		J6	901-10110	Amphenol	CON-SMA-1
10	1	L1	0402CS-4N7X_LU	Coilcraft	4.7 nH
11	1	L2	0402CS-4N3X_LU	Coilcraft	4.3 nH
12	1	L3	0402CS-5N1X_LU	Coilcraft	5.1 nH
13	1	R1	CRCW04020000Z0ED	Vishay/Dale	0
14	1	R2	ERJ-2RKF3601X	Panasonic - ECG	3.6 k Ω
15	1	R4	ERJ-2RKF1691X	Panasonic - ECG	1.69 k Ω
16	1	U1	BGU7003	NXP	BGU7003

4.3 Typical application board test result (GPS L2 band)

4.3.1 S-parameter gain and match



4.3.2 P1dB



4.3.3 Linearity/IP3

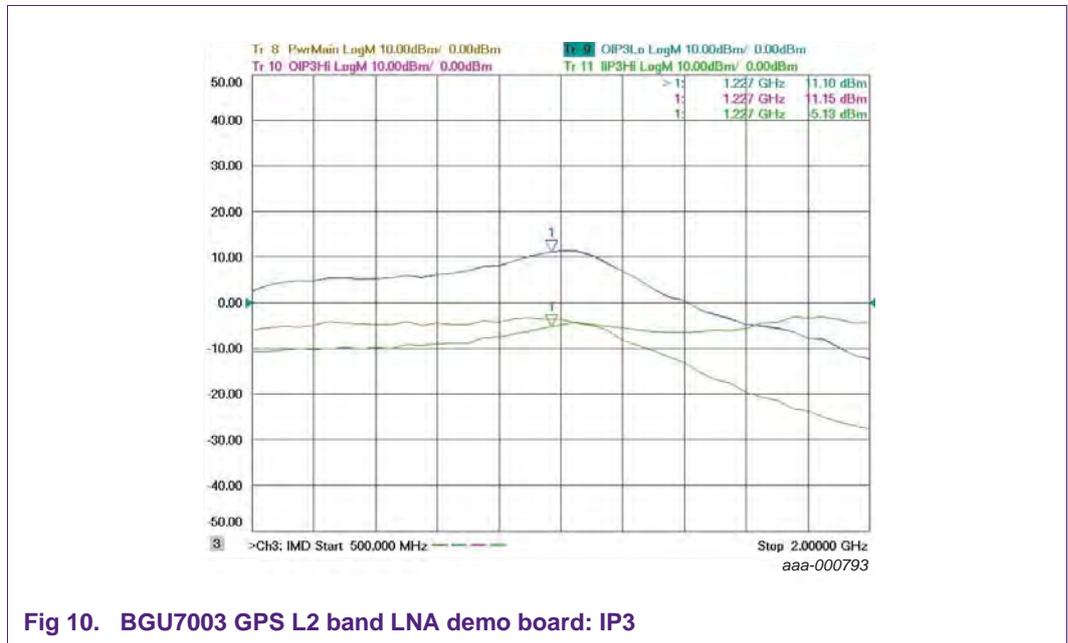


Fig 10. BGU7003 GPS L2 band LNA demo board: IP3

4.3.4 Stability

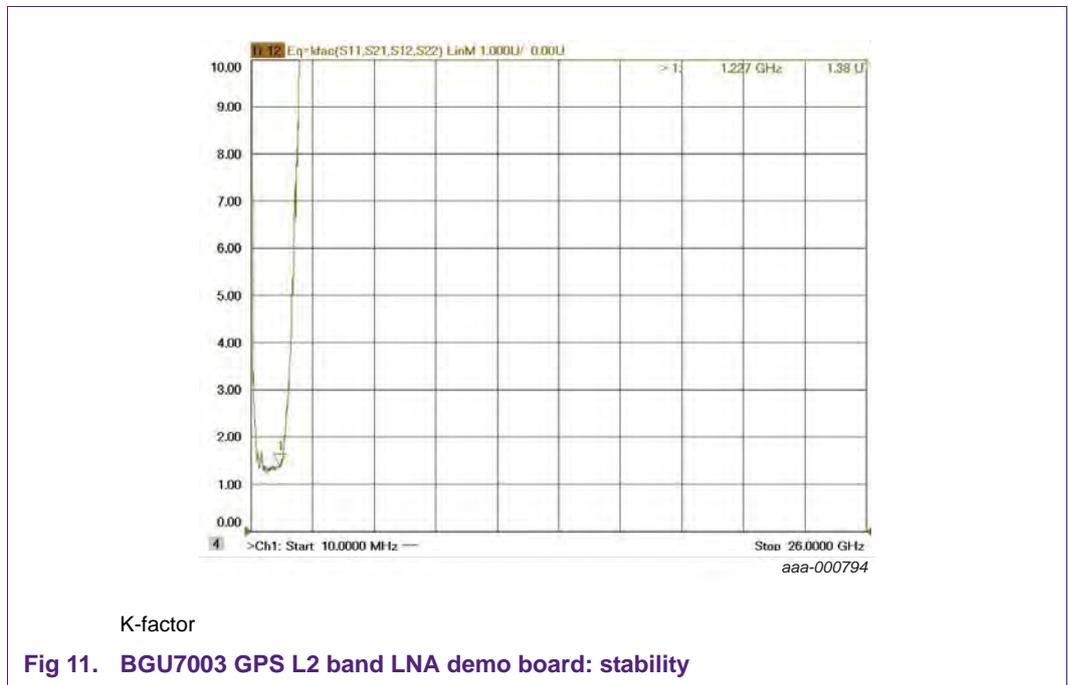


Fig 11. BGU7003 GPS L2 band LNA demo board: stability

4.3.5 Noise figure measurement

A 6 dB pad is inserted between the noise source and RF input to improve the NF measurement accuracy. The 6 dB pad is measured on a network analyzer to be 5.8 dB at 1.227 GHz.

A network analyzer is used to measure the loss between the connector and microstrip line which is shorted to ground before the first matching component. The measured return loss is 0.21 dB. Therefore, to obtain true noise, a 0.1 dB input loss is de-embedded.

Overall, a 5.9 dB loss at input and 0.1 dB loss at output are subtracted on the noise figure analyzer.

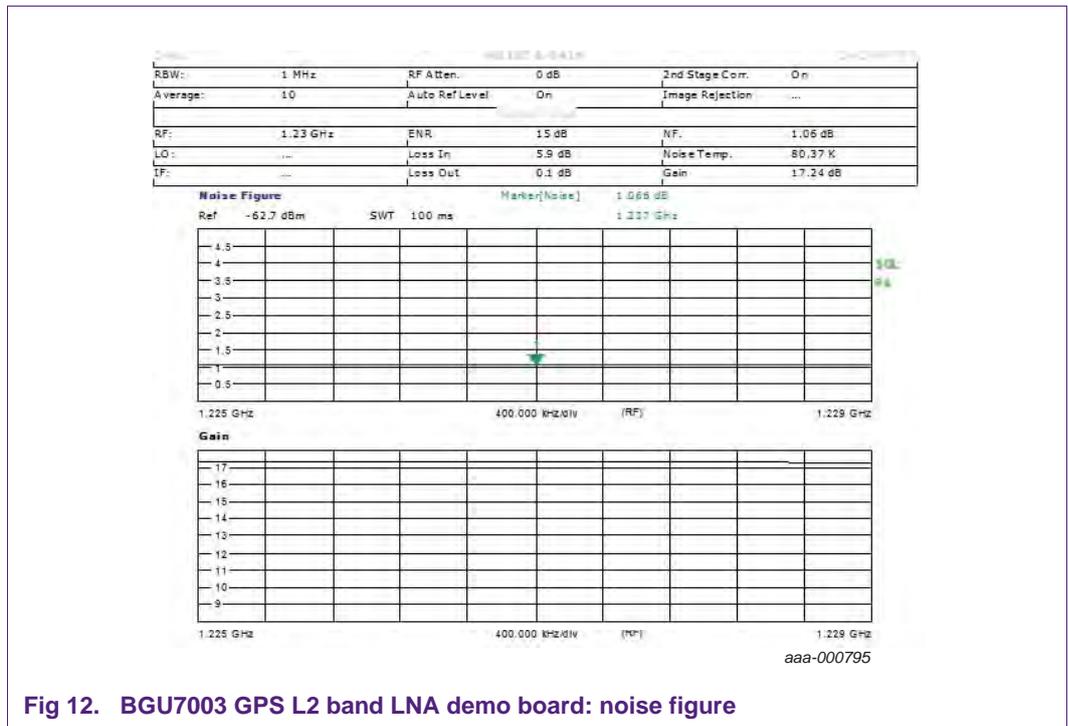
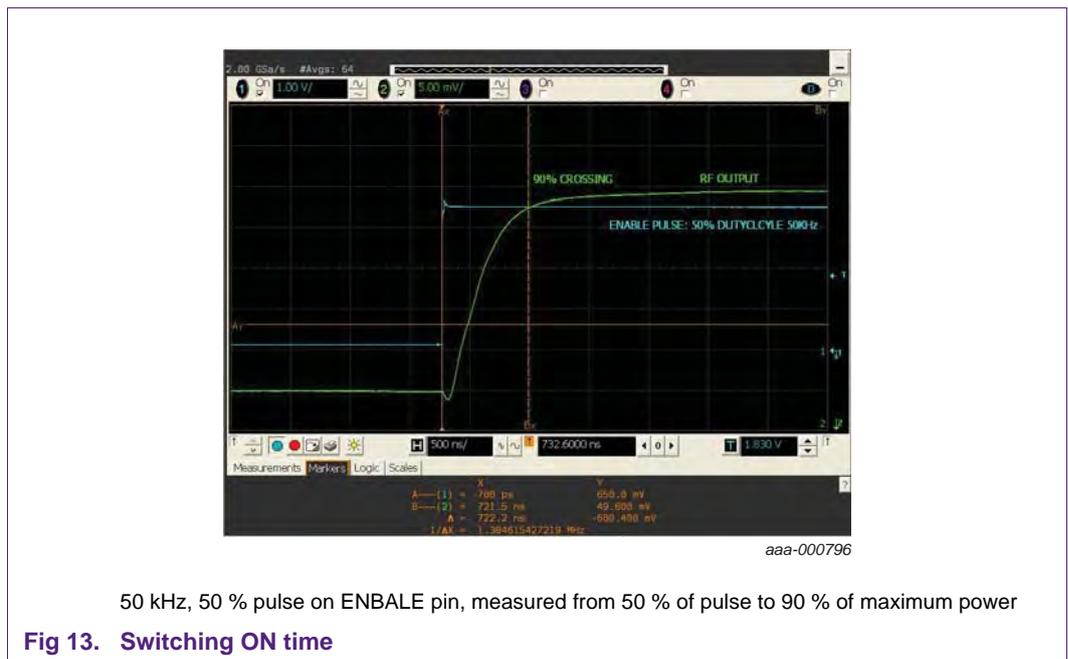


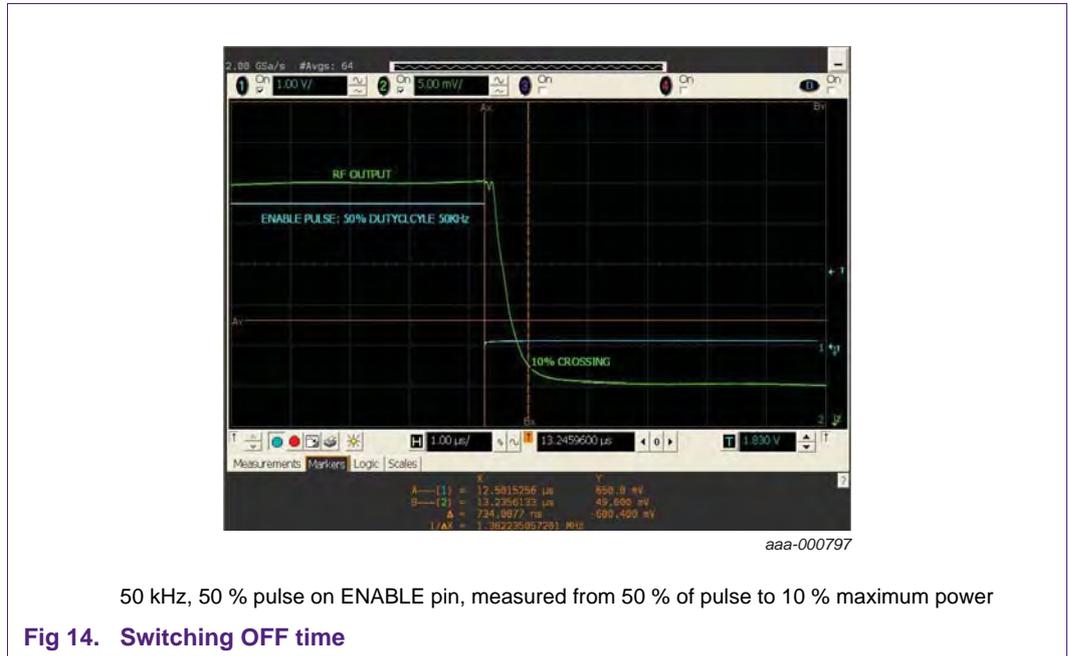
Fig 12. BGU7003 GPS L2 band LNA demo board: noise figure

4.3.6 ON/OFF switching time



50 kHz, 50 % pulse on ENBALE pin, measured from 50 % of pulse to 90 % of maximum power

Fig 13. Switching ON time



4.3.7 Summary of typical evaluation board test results

Table 2. Typical results measured on the GPS L2 band evaluation board
Operating frequency 1.227 GHz, unless otherwise specified, Temp = 25 °C

Symbol	Description	Conditions	Value	Unit
V _{CC}	supply voltage	-	2.5	V
I _{CC}	supply current	-	4.9	mA
NF	noise figure	-	1.01	dB
G _p	power gain	1.227 GHz	16.4	dB
RL _{in}	input return loss	-	6.4	dB
RL _{out}	output return loss	-	13.6	dB
α _{isol(r)}	reverse isolation	-	23.1	dB
P _{i(1dB)}	input power at 1 dB gain compression	-	-16.67	dBm
P _{L(1dB)}	output power at 1 dB gain compression	-	-0.68	dBm
IP3 _i	input third-order intercept point	-	-5.13	dBm
IP3 _O	output third-order intercept point	-	11.15	dBm
K	Rollett stability factor	0 to 26 GHz	>1	-
t _{sw}	switching time	ON	722	nS
		OFF	734	nS

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. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

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 and its suppliers accept 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.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

5.3 Trademarks

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

6. Tables

Table 1. BGU7003 400 MHz band LNA EVB parts List . . .8	evaluation board 12
Table 2. Typical results measured on the 400 MHz band	

7. Figures

Fig 1. BGU7003 EVB demo board.3
Fig 2. BGU7003 GPS L2 band LNA simulation: circuit4
Fig 3. BGU7003 GPS L2 band LNA simulation: input and output match5
Fig 4. BGU7003 GPS L2 band LNA simulation: gain5
Fig 5. BGU7003 GPS L2 band LNA simulation: noise figure6
Fig 6. BGU7003 GPS L2 band LNA simulation: stability6
Fig 7. BGU7003 GPS L2 band LNA: schematic7
Fig 8. BGU7003 GPS L2 band LNA demo board: S-parameter.9
Fig 9. BGU7003 GPS L2 band LNA demo board: P1dB9
Fig 10. BGU7003 GPS L2 band LNA demo board: IP310
Fig 11. BGU7003 GPS L2 band LNA demo board: stability10
Fig 12. BGU7003 GPS L2 band LNA demo board: noise figure11
Fig 13. Switching ON time11
Fig 14. Switching OFF time12

8. Contents

1	Introduction	3
2	General description	3
3	Application circuit simulation	4
3.1	BGU7003 GPS L2 band LNA simulation	4
3.2	BGU7003 GPS L2 band LNA simulation result	5
3.2.1	Input and output match in GPS L2 band	5
3.2.2	Gain in GPS L2 band	5
3.2.3	Noise figure in GPS L2 band	6
3.2.4	Stability	6
4	Application board	7
4.1	Application circuit schematic (GPS L2 band) ..	7
4.2	Application board Bill Of Materials BOM (GPS L2 band)	8
4.3	Typical application board test result (GPS L2 band)	9
4.3.1	S-parameter gain and match	9
4.3.2	P1dB	9
4.3.3	Linearity/IP3	10
4.3.4	Stability	10
4.3.5	Noise figure measurement	10
4.3.6	ON/OFF switching time	11
4.3.7	Summary of typical evaluation board test results	12
5	Legal information	13
5.1	Definitions	13
5.2	Disclaimers	13
5.3	Trademarks	13
6	Tables	14
7	Figures	14
8	Contents	15

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. 2012.

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: 9 October 2012

Document identifier: AN11086_2