UM10339

User Manual for the BGU7003 GPS LNA demo boards v2.0

Rev. 1 — 15 September 2011 User manual

Document information

Info	Content
Keywords	LNA, GPS, BGU7003
Abstract	This document explains the BGU7003 GPS LNA evaluation Board

Revision history

Rev	Date	Description
1	20110915	Initial document

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 Silicon Germanium Amplifier MMIC for high speed, low noise applications. It can be used mainly for LNA applications up to 6 GHz like GPS, satellite radio, cordless phone. The BGU7003 contains one RF stage and internal bias that is temperature stabilized. It also contains a power down function to shutdown the amplifier by means of a logic signal on the enable pin.

The BGU7003 is ideal for use in portable electronic devices, such as mobile phones, Personal Digital Assistants (PDAs), Personal Navigation Devices (PNDs) etc.

The GPS LNA EValuation Board (EVB) is designed to evaluate the performance of the BGU7003 applied as a GPS LNA. In this document, the application diagram, board layout, bill of material, and some typical results are given.

Figure Fig 1 shows the evaluation board.

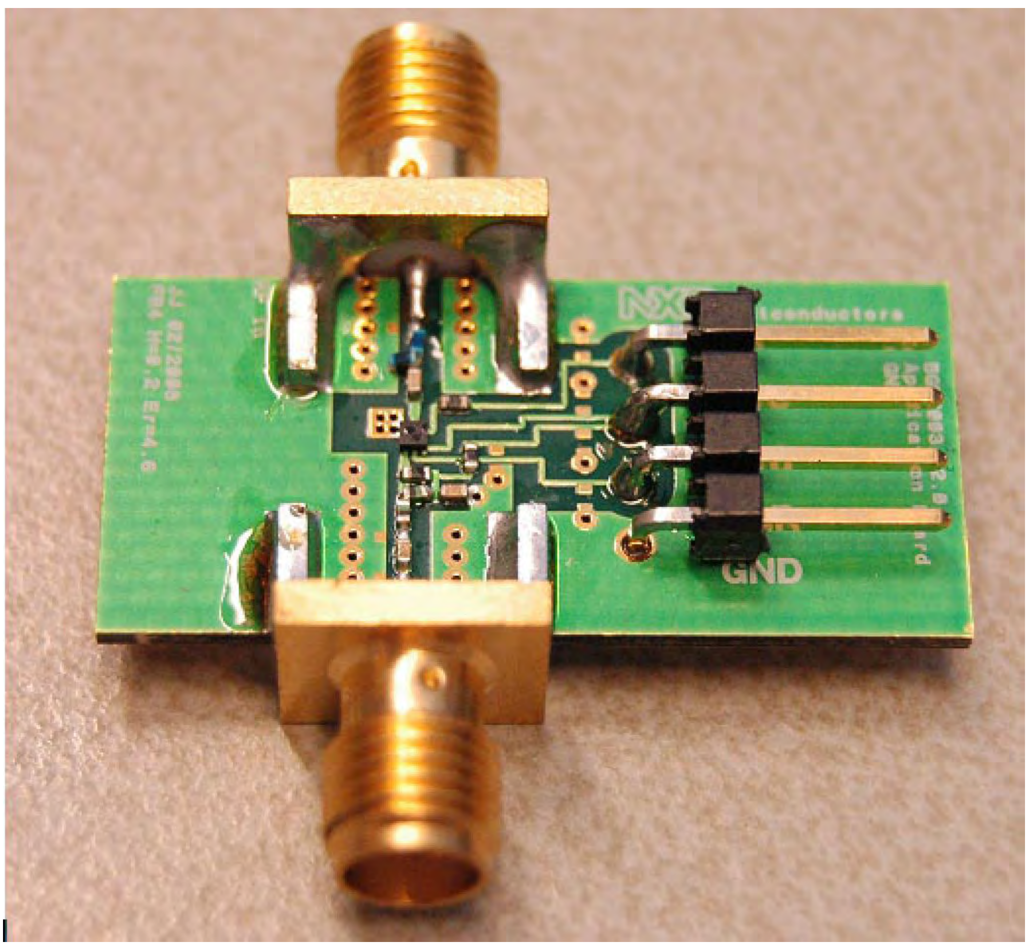

Fig 1. BGU7003_GPS LNA evaluation board

2. General description

The BGU7003 design is a wideband Silicon Germanium (SiGe) transistor with internal bias circuit. This bias circuit is temperature stabilized, which keeps the current constant over temperature. The bias current for the RF stage can be set via an external bias resister in order to give the designer flexibility in choosing the bias current. The MMIC is also supplied with a power-down function that allows the designer to control the MMIC via a logic signal. This power-down mode only consumes 0.4 μA. In Figure Fig 2 the simplified internal circuit of the BGU7003 is given.

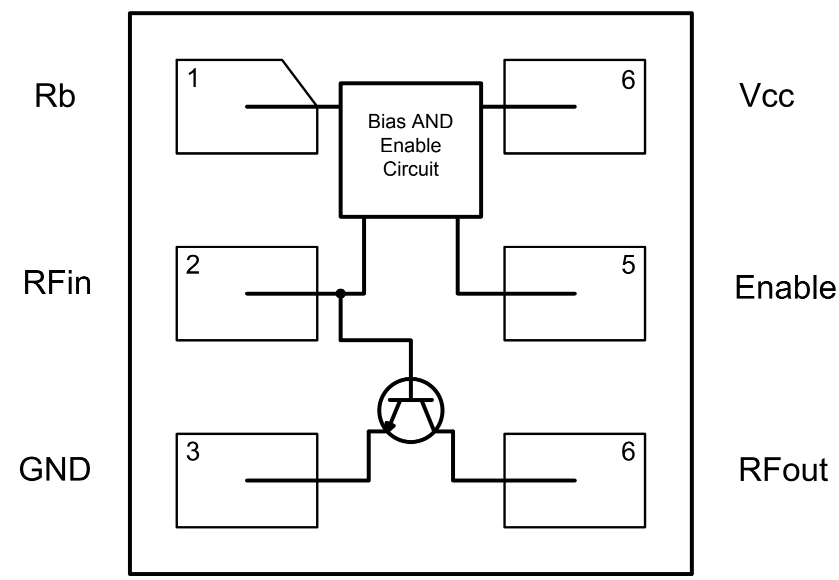

Fig 2. Simplified internal circuit of the BGU7003

The BGU7003 is not internally matched so for both input and output a matching circuit needs to be designed. The fact that no internal matching is available makes the product suitable for different application areas.

In the next paragraphs the BGU7003 applied as a GPS LNA is described.

3. Application board

The BGU7003 EVB simplifies the evaluation of the BGU7003 wideband amplifier MMIC, for the GPS application area. The EVB 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 connectorized with signal input and output SMA connectors for connection to RF test equipment.

3.1 Application circuit

In Figure Fig 3 the application diagram as supplied on the evaluation board is given.

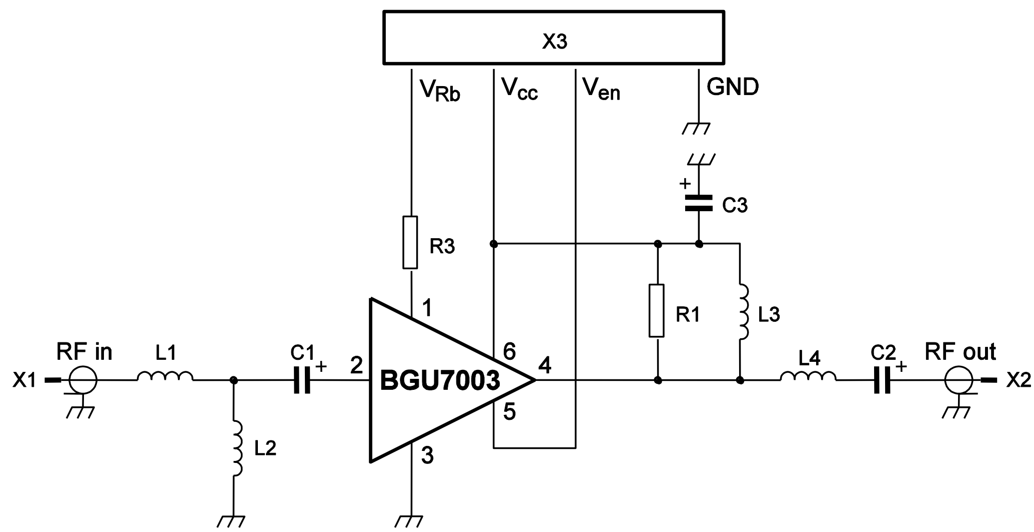

Fig 3. Circuit diagram of the evaluation board

3.2 Board layout

Figure Fig 4 shows the board layout with the component identifiers.

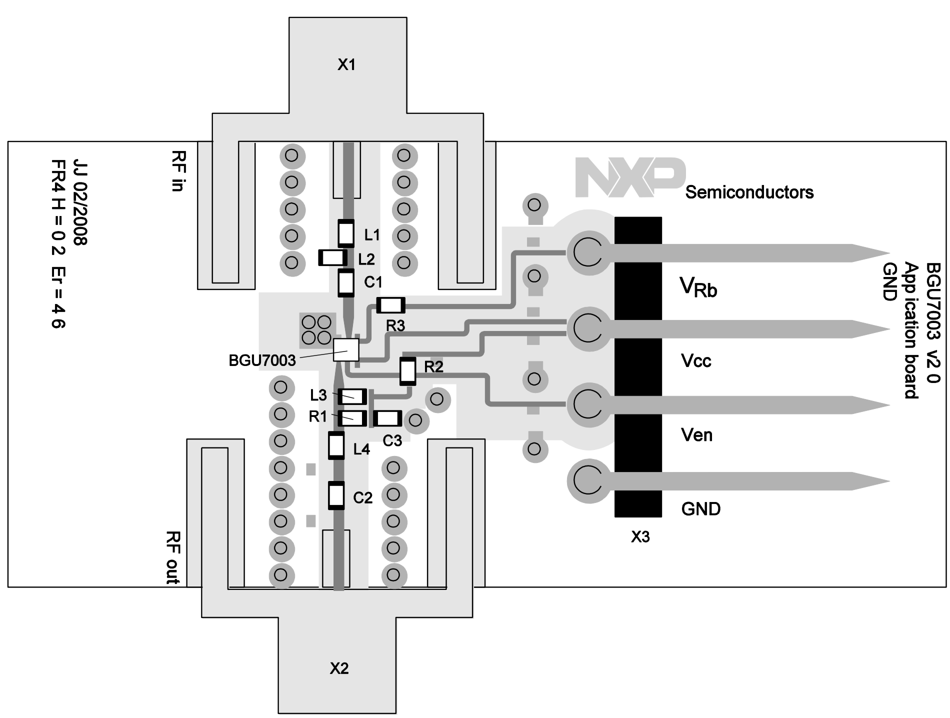

Fig 4. Printed-Circuit Board (PCB) of the BGU7003 evaluation board

3.3 PCB layout

A good PCB Layout is an essential part of an RF circuit design. The EVB of the BGU7003 can serve as a guideline for laying out a board using the BGU7003. Use controlled impedance lines for all high frequency inputs and outputs. Bypass V_{CC} with decoupling capacitors, preferable located as close as possible to the device. For long bias lines it may be necessary to add decoupling capacitors along the line further away from the device. Proper grounding the GND pin is also essential for the performance. Either connect the GND pin directly to the ground plane or through vias, or do both.

The material that has been used for the EVB is FR4 using the stack shown in figure Fig 5.

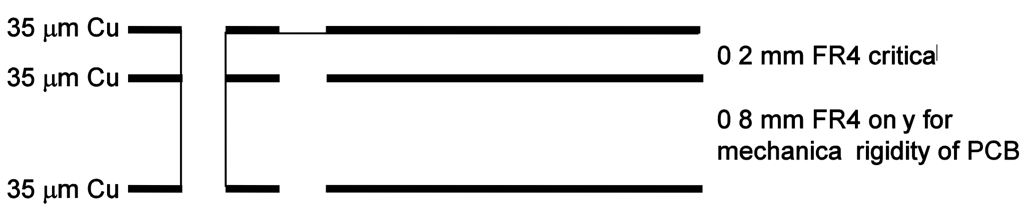

Fig 5. Stack of the PCB material

Material supplier is ISOLA DURAVER; ε_r = 4.6 to 4.9; tan δ = 0.02.

3.4 Bill of materials

Table 1. BOM of the BGU7003 evaluation board

Component	Description	Footprint	Value	Supplier name / type	Remarks
C1, C2	capacitor	0402	100 pF	MurataGRM1555	DC blocking
C3	capacitor	0402	180 pF	MurataGRM1555	decoupling
L1	inductor	0402	2.7 nH	Murata/LQW15A high quality factor, low series resistance	input matching
L2	inductor	0402	30 nH	Murata/LQW15A high quality factor, low series resistance	input matching
L3	inductor	0402	33 nH	Murata/LQG15HS	output matching / DC Bias
L4	inductor	0402	3.9 nH	Murata/LQG15HS	output matching
R1	resistor	0402	180 Ω		
R2	resistor	0402	0 Ω		bridge, proper routing makes it not necessary
R3	resistor	0402	3300 Ω		bias setting
X1, X2	SMA RF connector		-	Johnson, end launch SMA 142-0701-841	RF input / RF output
X3	DC header		-	Molex, PCB header, right angle, 1 row, 4 way 90121-0764	bias connector

4. Required equipment

In order to measure the evaluation board the following is necessary.

- A DC power supply up to 30 mA at 2 V to 2.8 V (up to 15V for bias control).
- An RF signal generator capable of generating an RF signal at the operating frequency of 1575.42 MHz.
- An RF spectrum analyzer that covers at least the operating frequency of 1575.42 MHz as well as a few of the harmonics, so up to 6 GHz should be sufficient. ”Optional” a version with the capability of measuring noise figure is convenient.
- An amp meter to measure the supply current (optional).
- A network analyzer for measuring gain, return loss and reverse isolation.
- A noise figure analyzer.

5. Connections and set_up

The BGU7003 EVB is fully assembled and tested. Please follow the steps below for a step-by-step guide to operate the EVB and testing the device functions.

1. Connect the DC power supply set to 2.5 V to the V_{CC}, V_{Rb} V_{en} and GND terminals.
2. Connect the RF signal generator and the spectrum analyzer to the RF input and the RF output of the EVB respectively. Do not turn on the RF output of the signal generator yet, set it to –40 dBm output power at 1575.42 MHz. Set the spectrum analyzer on 1575.42MHz center frequency and a reference level of 0 dBm.
3. Turn on the DC power supply and it should read approximately 5.1 mA.
4. Enable the RF output of the generator; the spectrum analyzer displays a tone of 1575.42 MHz at around –21 dBm.
5. In order to evaluate the board on different bias currents through RF stage of the MMIC the voltage on R3 (V_{Rb}) can be connected to a separate power supply. One is now able to control the bias current.
6. To evaluate the enable function the V_{en} terminal of the board can also be connected to a separate DC power supply that either gives a voltage > 0.6 V (amplifier on) or < 0.5 V (amplifier off).
7. Instead of using a signal generator and spectrum analyzer one can also use a network analyzer NWA in order to measure gain as well as in- and output return loss
8. For noise figure evaluation, either a noise figure analyzer or a spectrum analyzer with noise option can be used. The use of a 5 dB noise source, like the Agilent 364A is recommended. When measuring the noise figure of the evaluation board any kind of adaptors, cables etc between the noise source and the EVB should be avoided, since this affects the noise performance.

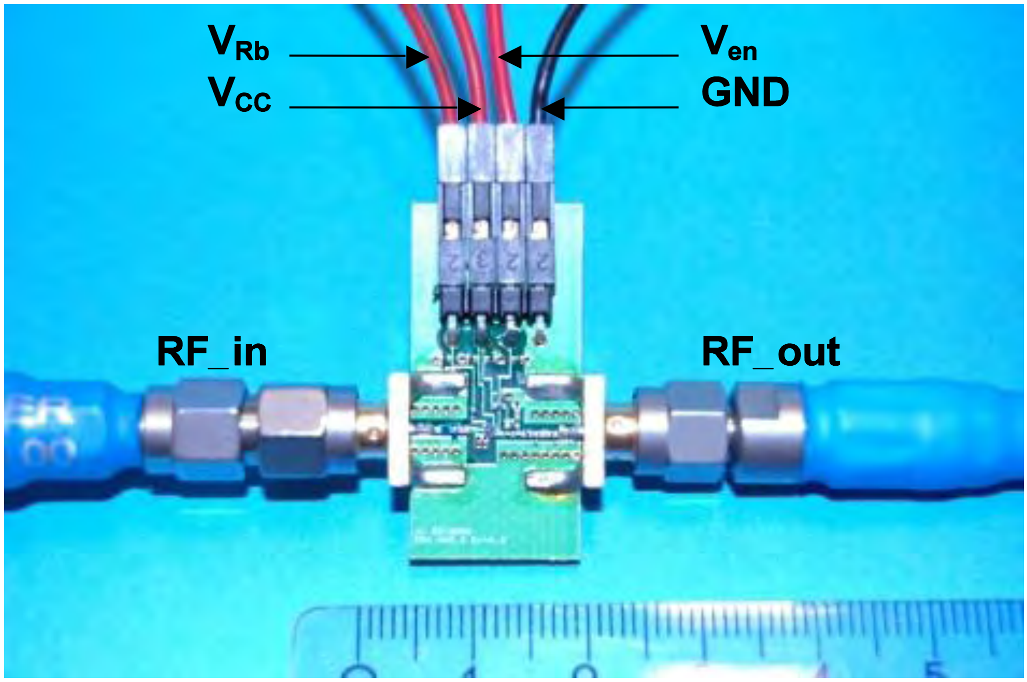

Fig 6. Evaluation board including its connections

6. Typical EVB results

Table 2. Typical results measured on the evaluation boards

Operating frequency is 1575.42 MHz; V_{CC}, V_{Rb} and V_{en} = 2.5 V; I_{CC} = 5 mA; T_{amb} = 25 °C; unless otherwise specified.

Symbol	Parameter	Value	Remarks
NF	noise figure [1]	0.85 dB	
G_p	power gain	18.2 dB	
RL_{in}	input return loss	5.6 dB	
RL_{out}	output return loss	18 dB	
ISL_{rev}	reverse isolation	24 dB	
$P_{i(1dB)}$	input power at 1 dB gain compression	−19 dBm	
$P_{o(1dB)}$	output power at 1 dB gain compression	−2 dBm	
$IP3_I$	input third-order intercept point	−6 dBm	
$IP3_O$	output third-order intercept point	10.5 dBm	on/off switching
t_{sw}	switching time	0.7 μs	

[1] The NF and G_p figures are measured at the SMA connectors of the EVB, so the losses of the connectors and the PCB are not subtracted. If you do so the NF will improve approximately 0.1 dB.

7. Legal information

7.1 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.

7.2 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 national 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 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.

7.3 Trademarks

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

8. List of figures

9. List of tables

10. Contents

Date of release: 15 September 2011

Document identifier: UM10339