

# UM10339

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

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User manual

## Document information

Info	Content
<b>Keywords</b>	LNA, GPS, BGU7003
<b>Abstract</b>	This document explains the BGU7003 GPS LNA evaluation Board



**Revision history**

Rev	Date	Description
1	20110915	Initial document

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## 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.

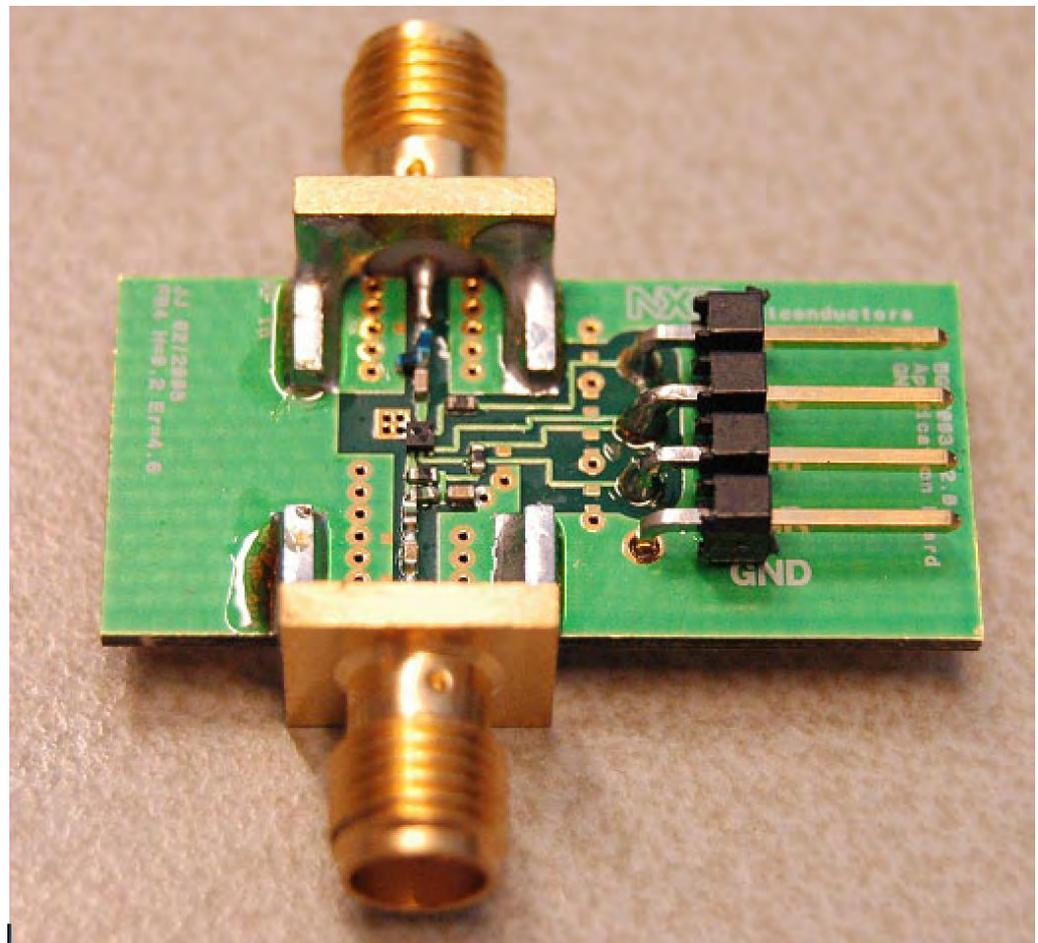


Fig 1. BGU7003\_GPS LNA evaluation board

## 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 resistor 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  $\mu$ A. In [Figure Fig 2](#) the simplified internal circuit of the BGU7003 is given.

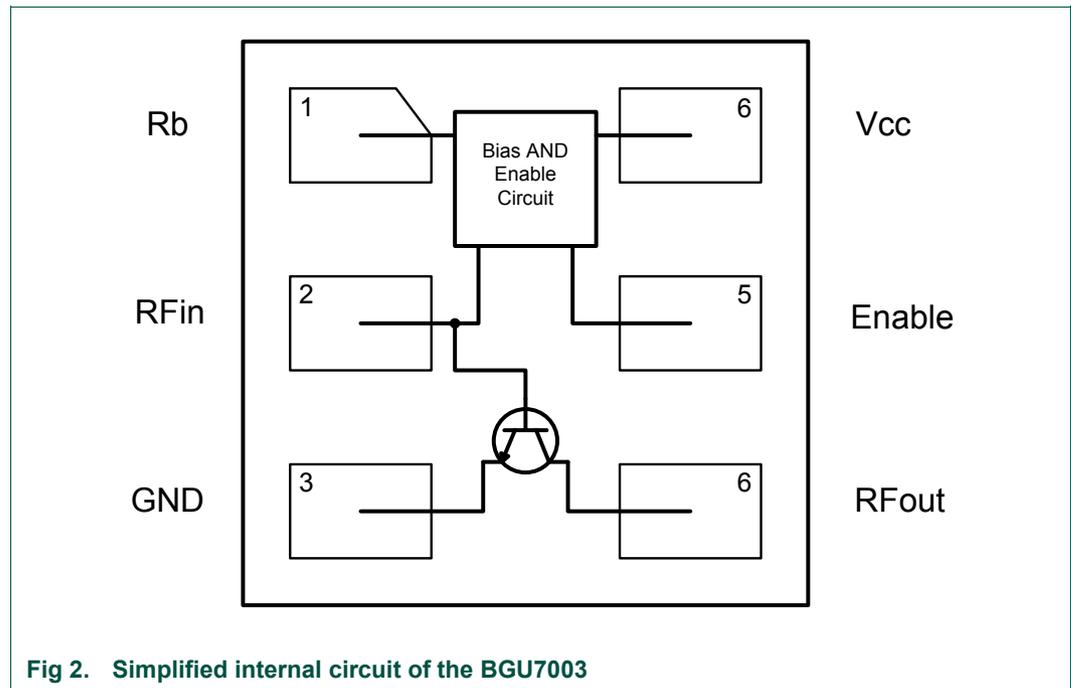


Fig 2. Simplified internal circuit of the BGU7003

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.

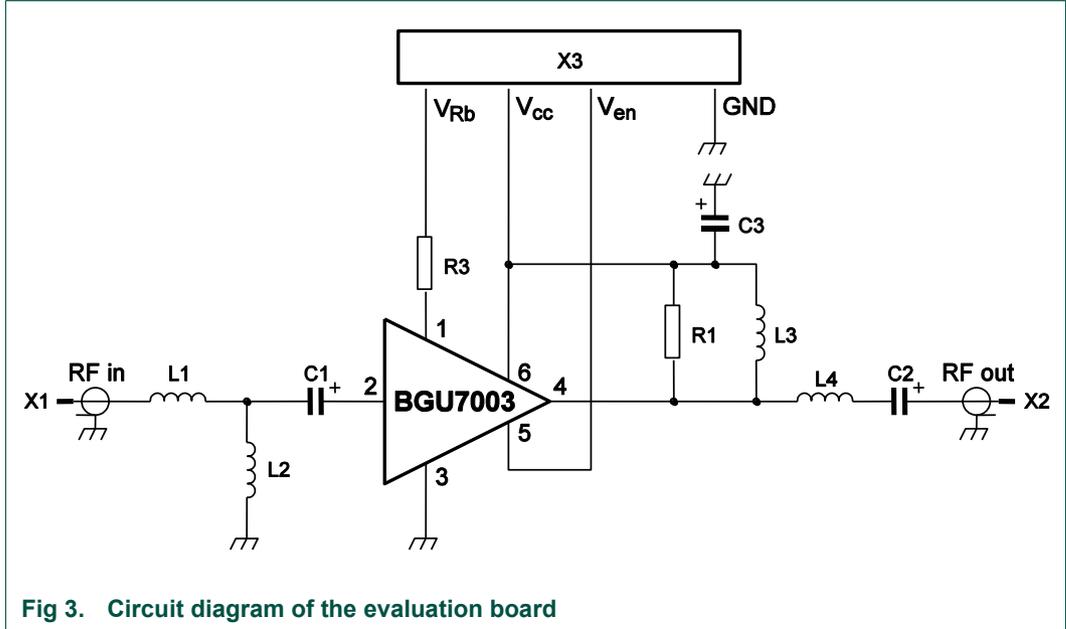


Fig 3. Circuit diagram of the evaluation board

### 3.2 Board layout

[Figure Fig 4](#) shows the board layout with the component identifiers.

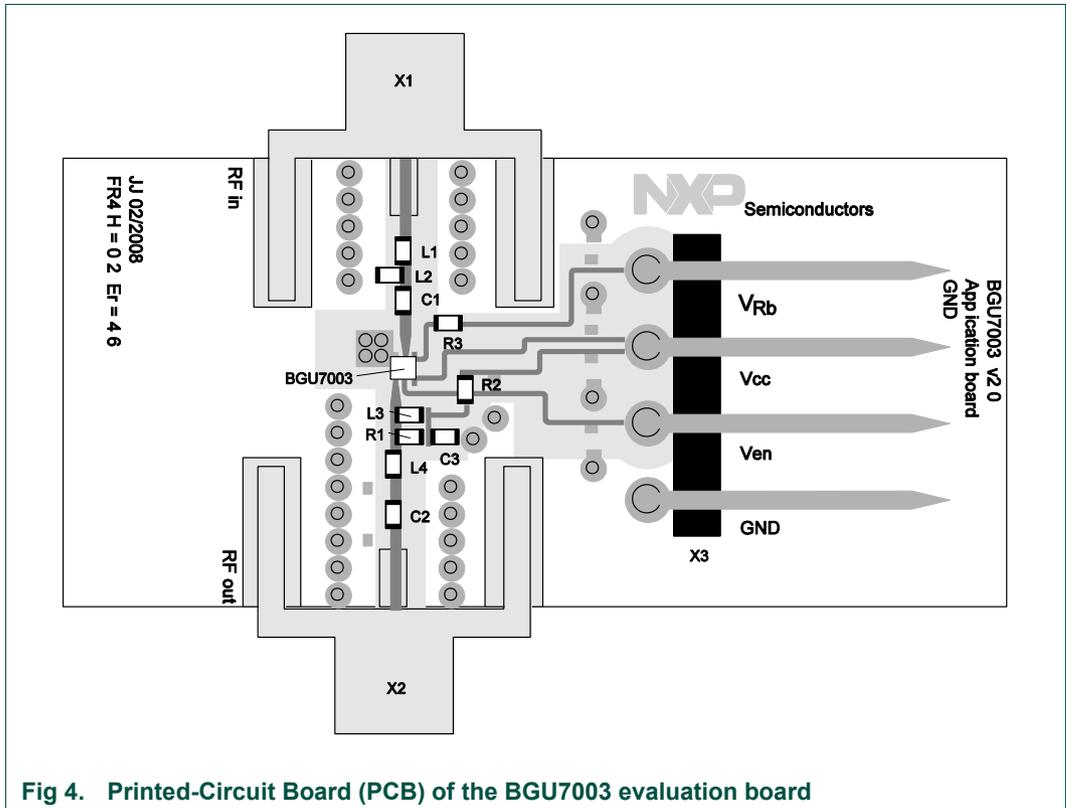


Fig 4. Printed-Circuit Board (PCB) of the BGU7003 evaluation board

### 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](#).

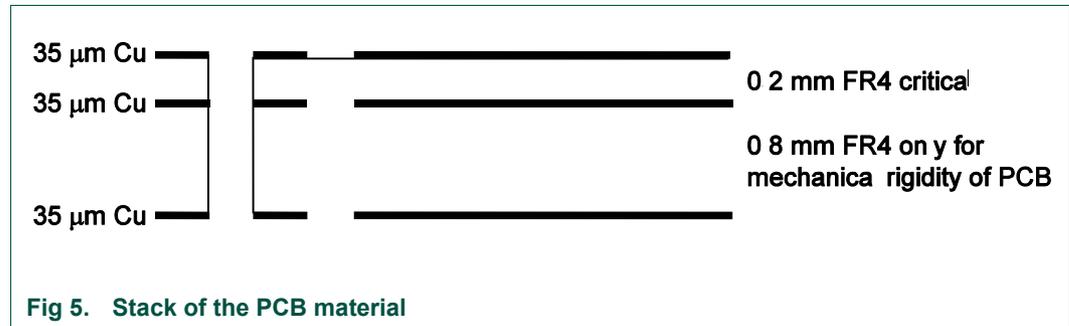


Fig 5. Stack of the PCB material

Material supplier is ISOLA DURAVER;  $\epsilon_r = 4.6$  to  $4.9$ ;  $\tan \delta = 0.02$ .

### 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 $\Omega$		
R2	resistor	0402	0 $\Omega$		bridge, proper routing makes it not necessary
R3	resistor	0402	3300 $\Omega$		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

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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

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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.

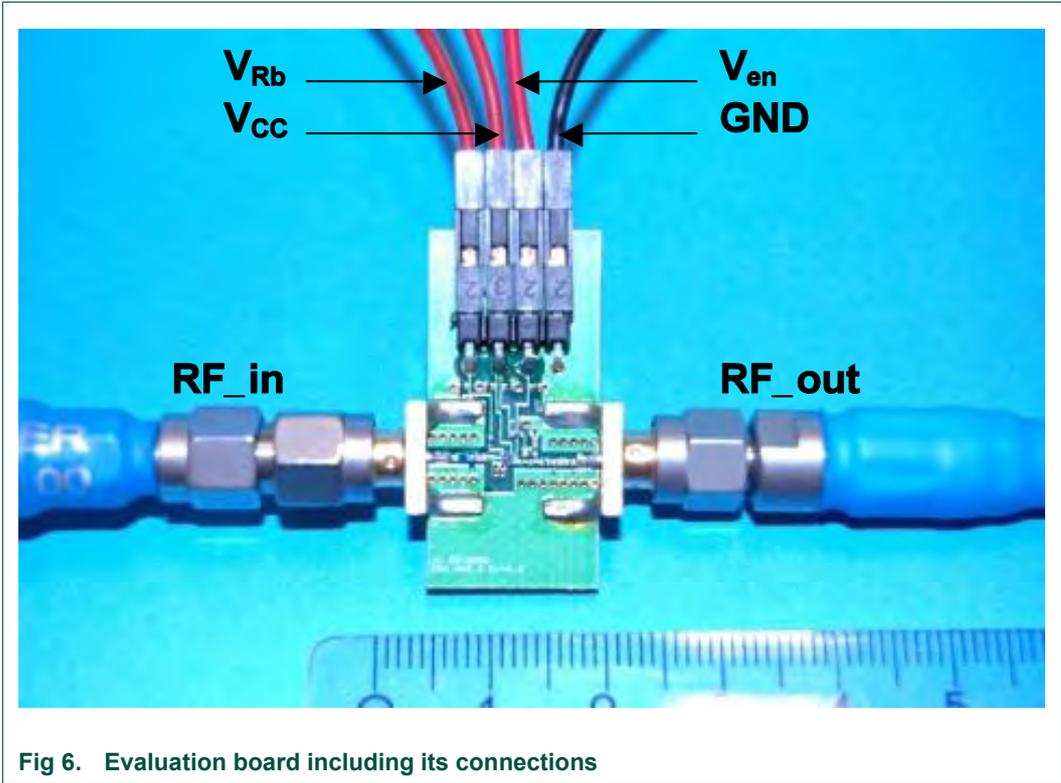


Fig 6. Evaluation board including its connections

## 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	<a href="#">[1]</a> 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 $\mu$ s	

[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.

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