

# AN11118

BFU725F/N1 1.5 GHz LNA evaluation board

Rev. 1.1 — 17 October 2011

Application note

## Document information

Info	Content
<b>Keywords</b>	LNA, 1.5 GHz, BFU725F, GPS
<b>Abstract</b>	This document explains the BFU725F 1.5 GHz LNA evaluation board



**Revision history**

<b>Rev</b>	<b>Date</b>	<b>Description</b>
1.1	20111017	Modified BOM for better stability.
1.0	20110921	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](mailto:salesaddresses@nxp.com)

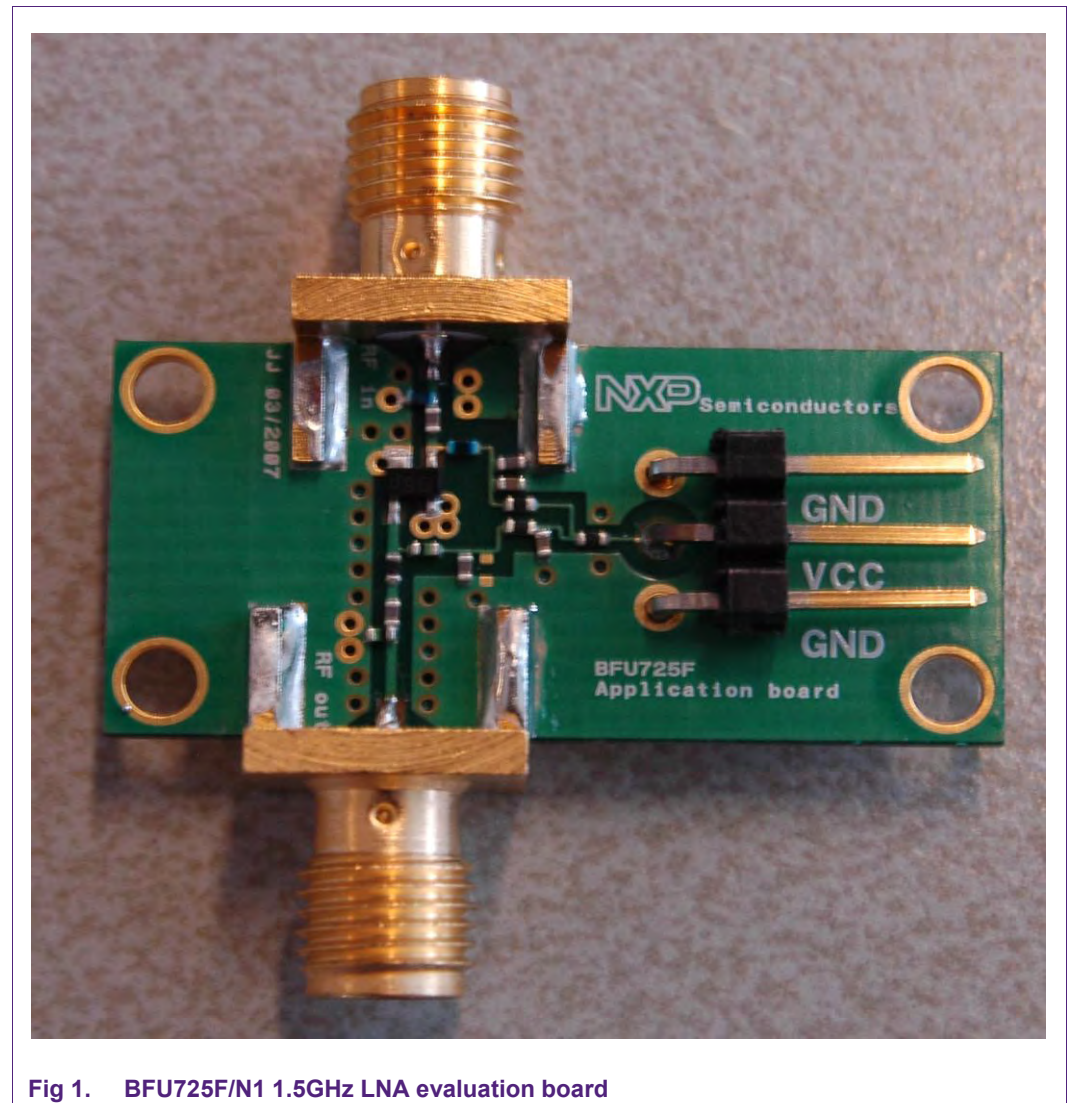
## 1. Introduction

The BFU725F/N1 is a wideband Silicon Germanium Amplifier transistor for high speed, low noise applications. It is designed to be used for LNA applications up to 15 GHz like GPS, Satellite radio, Cordless Phone, Wireless LAN and satellite LNB. The BFU725F/N1 comes in a SOT343F package that has 2-emitter pins to reduce emitter inductance (for maximum gain).

The BFU725F/N1 is ideal in all kind of applications where cost matters. It also gives the designer flexibility in his design work, like bias current, frequency of operation; optimize for the parameter of interest e.g. noise; gain; IP3 etc

The 1.5GHz LNA evaluation board (EVB) is designed to evaluate the performance of the BFU725F/N1 applied as a general ISM band LNA in the 1.5GHz range. In this document, the application diagram, board layout, bill of material, and some typical results are given.

Fig 1 shows the evaluation board.



## 2. General Description

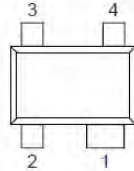
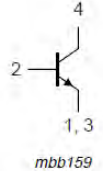
The BFU725F/N1 is the first discrete HBT produced in NXP's SiGeC QuBIC4x BiCmos process. SiGeC is a silicon germanium process with the addition of Carbon in the base layer of the NPN transistor. The presence of carbon in the base layer suppresses the boron diffusion during wafer processing that allows steeper and narrower SiGe HBT base and a heavier doped base, this results in lower base resistance, hence lower noise and higher cut off frequency (higher gain). In Table 1 a summary of the transistor performance in terms of noise and gain is shown.

**Table 1. BFU725F/N1 figures**

*Measured at 2V Vce and 5mA Ic*

Frequency [GHz]	Noise Figure [dB]	Associated gain [dB]
1.5	0.42	24
1.8	0.43	22
2.4	0.47	20
5.8	0.7	13.5
12	1.1	10

**Table 2. Pinning information of the BFU725F/N1**

Pin	Description	Simplified outline	Graphic symbol
1	Emitter		
2	Base		
3	Emitter		
4	Collector		

## 3. Application Board

The BFU725F/N1 1.5GHz EVB simplifies the evaluation of the BFU725F/N1 wideband transistor, for this frequency range. The EVB enables testing of the device performance and requires no additional support circuitry. The board is fully assembled with BFU725F/N1, including input- and output matching, to optimize the performance. For input matching a compromise has to be made for optimum noise/maximum gain/RL/usable bandwidth on the application and customer requirements. To prevent unwanted oscillations the stability factor (K) must be greater than 1. The stability factor can be increased at the cost of gain. The board is mounted with signal input and output SMA connectors for connection to RF test equipment.

### 3.1 Application Circuit

In Fig 2 the application diagram as supplied on the evaluation board is given.

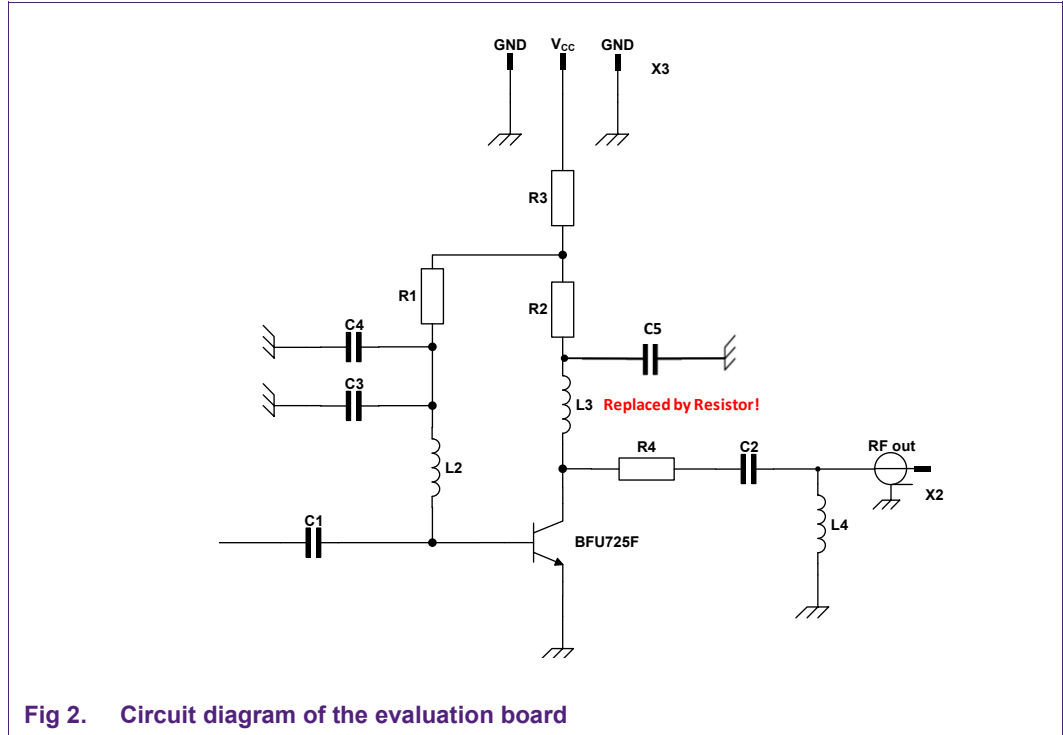


Fig 2. Circuit diagram of the evaluation board

### 3.2 Board Layout

Fig 3 shows the board layout with the components.

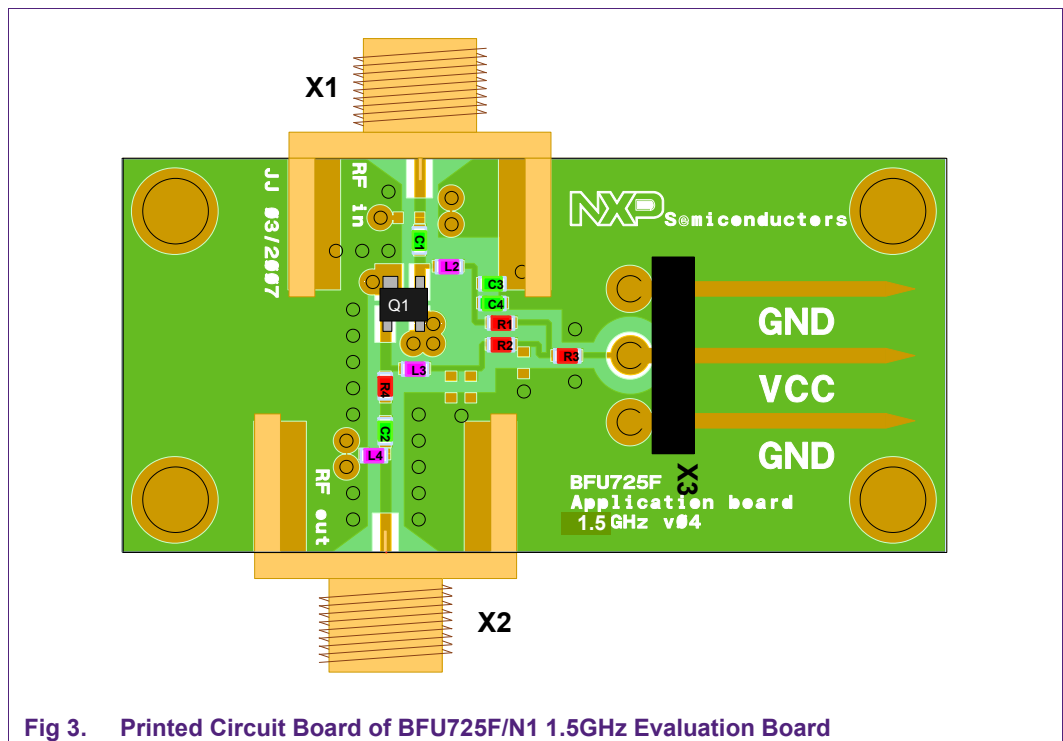
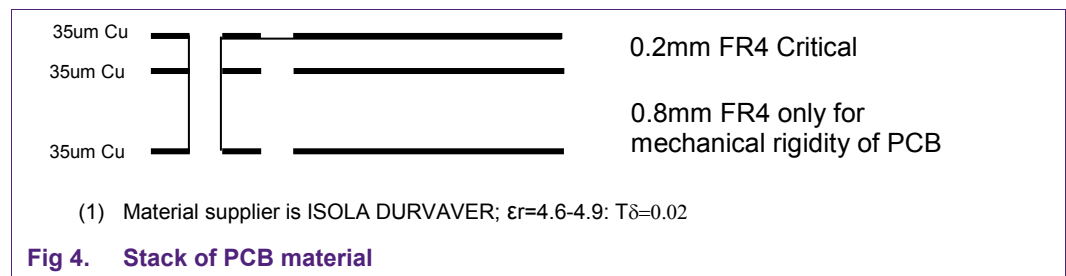


Fig 3. Printed Circuit Board of BFU725F/N1 1.5GHz Evaluation Board

### 3.3 PCB Layout

A good PCB Layout is an essential part of an RF circuit design. The EVB of the BFU725F/N1 can serve as a guideline for laying out a board using either the BFU725F/N1. 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 emitters is also essential for the performance. Either connect the emitters 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 Fig 4.



### 3.4 Bill of Materials

**Table 3. Bill of Materials**

Designator	Description	Footprint	Value	Supplier Name/type	Comment
C1	Capacitor	0402	1.5 pF	MurataGRM1555	DC blocking/ matching
C2	Capacitor	0402	6.8 pF	MurataGRM1555	DC blocking/ matching
C3,C5	Capacitor	0402	120 pF	MurataGRM1555	LF decoupling
C4	Capacitor	0402	100 nF	MurataGRM1555	LF decoupling
L2	Inductor	0402	5.1 nH	Murata/LQW15A High Q low Rs	Input matching
L3	<b>Resistor</b>	0402	100 $\Omega$	Various	Output matching
L4	NOT MOUNTED				
R1	Resistor	0402	22 k $\Omega$	Various	Bias setting
R2	Resistor	0402	0 $\Omega$	Various	Stability
R3	Resistor	0402	390 $\Omega$	Various	Bias setting
R4	Resistor	0402	33 $\Omega$	Various	Stability
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, 3 way 90121-0763	Bias connector

## 4. Required Equipment

---

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

- ✓ DC Power Supply up to 30 mA at 3V.
- ✓ An RF Signal generator capable of generating an RF signal at the operating frequency of 1.575 GHz.
- ✓ An RF spectrum analyzer that covers at least the operating frequency of 1.575 GHz 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.
- ✓ Amp meter to measure the supply current (optional).
- ✓ A Network analyzer for measuring gain, return loss and reverse Isolation.
- ✓ Noise figure analyzer.

## 5. Connections and Setup

---

The BFU725F/N1 1.5GHz 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 3V to the  $V_{CC}$  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 -45dBm output power at 1.575 GHz, set the spectrum analyzer on 1.575 GHz center frequency and a reference level of 0dBm.
3. Turn on the DC power supply and it should read approximately 5 mA.
4. Enable the RF output of the generator; the Spectrum analyzer displays a tone of 1.575 GHz at around -28.5 dBm.
5. 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
6. For Noise figure evaluation, either a Noise-figure analyzer or a spectrum analyzer with noise option can be used. The use of a 6 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.

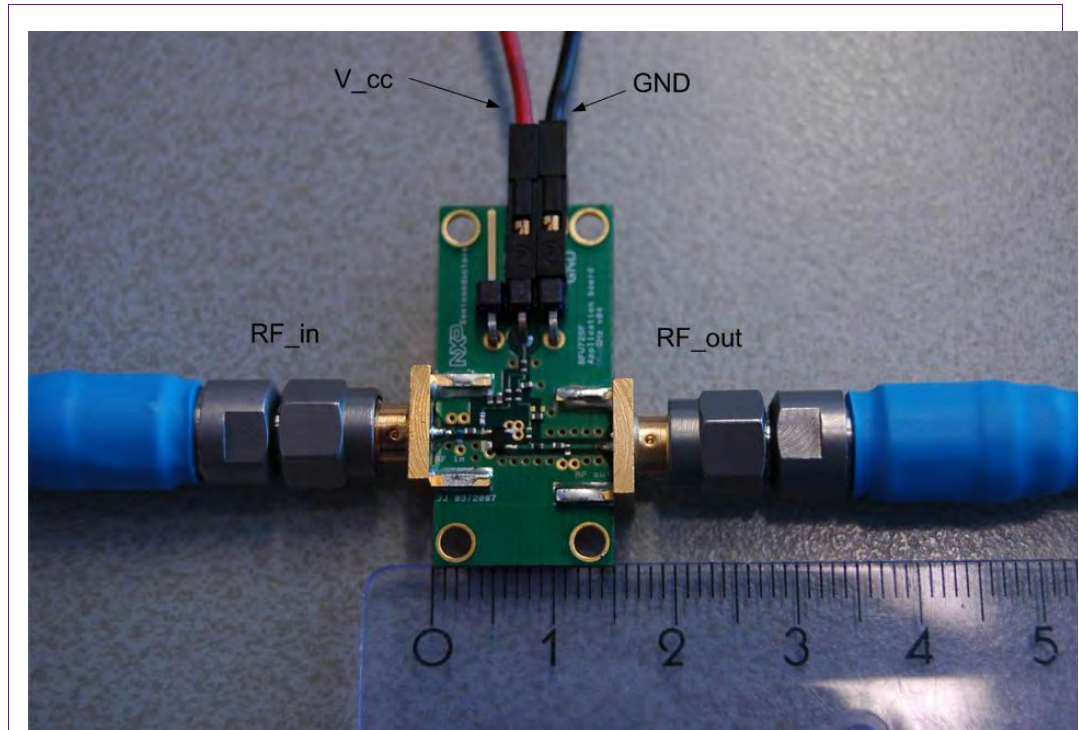


Fig 5. Evaluation board including its connections

## 6. Typical EVB Results

Table 4. Typical results measured on the evaluation board

Operating Frequency is  $f = 1575.42$  MHz unless otherwise specified;  $V_{cc} = 3$  V

Parameter	Symbol	BFU725F/N1 EVB	Unit	Comment
Supply Current	$I_{sup}$	4.8	mA	[1]
Noise Figure	NF	0.95	dB	[1]
Power Gain	$G_p$	15.7	dB	
Input Return Loss	IRL	4.7	dB	
Output Return Loss	ORL	9.5	dB	
Reverse Isolation	$ISO_{rev}$	27.8	dB	
Input 1dB Gain Compression	IP1dB	-22.8	dBm	
Output 1dB Gain Compression	OP1dB	-8.1	dBm	
Input third order intercept point	IIP3	-9.1	dBm	[2]
Output third order intercept point	OIP3	6.6	dBm	[2]

[1] The noise figure and gain figures are measured at the SMA connectors of the evaluation board. The losses of the connectors and the PCB of approximately 0.1 dB are not subtracted.

[2] Jammers at  $f_1=f+138$ MHz and  $f_2=f+276$ MHz, where  $f=1575.42$ MHz.  $P_{in}(f_1)=P_{in}(f_2)=-30$ dBm



## 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 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.

### 7.3 Trademarks

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

8. List of figures

Fig 1. BFU725F/N1 1.5GHz LNA evaluation board.....3  
Fig 2. Circuit diagram of the evaluation board .....5  
Fig 3. Printed Circuit Board of BFU725F/N1 1.5GHz  
Evaluation Board.....5  
Fig 4. Stack of PCB material .....6  
Fig 5. Evaluation board including its connections .....8

9. List of tables

---

Table 1. BFU725F/N1 figures .....4  
Table 2. Pinning information of the BFU725F/N1 .....4  
Table 3. Bill of Materials.....6  
Table 4. Typical results measured on the evaluation board.....8

## 10. Contents

---

<b>1.</b>	<b>Introduction .....</b>	<b>3</b>
<b>2.</b>	<b>General Description .....</b>	<b>4</b>
<b>3.</b>	<b>Application Board .....</b>	<b>4</b>
3.1	Application Circuit .....	5
3.2	Board Layout.....	5
3.3	PCB Layout.....	6
3.4	Bill of Materials.....	6
<b>4.</b>	<b>Required Equipment .....</b>	<b>7</b>
<b>5.</b>	<b>Connections and Setup .....</b>	<b>7</b>
<b>6.</b>	<b>Typical EVB Results.....</b>	<b>8</b>
<b>7.</b>	<b>Legal information .....</b>	<b>9</b>
7.1	Definitions .....	9
7.2	Disclaimers.....	9
7.3	Trademarks.....	9
<b>8.</b>	<b>List of figures.....</b>	<b>10</b>
<b>9.</b>	<b>List of tables .....</b>	<b>11</b>
<b>10.</b>	<b>Contents.....</b>	<b>12</b>

---

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

---

© NXP B.V. 2011.

All rights reserved.

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

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

Date of release: 17 October 2011

Document identifier: AN11118

## X-ON Electronics

Largest Supplier of Electrical and Electronic Components

*Click to view similar products for [RF Development Tools](#) category:*

*Click to view products by [NXP](#) manufacturer:*

Other Similar products are found below :

[MAAM-011117](#) [MAAP-015036-DIEEV2](#) [EV1HMC1113LP5](#) [EV1HMC6146BLC5A](#) [EV1HMC637ALP5](#) [EVAL-ADG919EBZ](#) [ADL5363-EVALZ](#) [LMV228SDEVAL](#) [SKYA21001-EVB](#) [SMP1331-085-EVB](#) [EV1HMC618ALP3](#) [EVAL01-HMC1041LC4](#) [MAAL-011111-000SMB](#) [MAAM-009633-001SMB](#) [MASW-000936-001SMB](#) [107712-HMC369LP3](#) [107780-HMC322ALP4](#) [SP000416870](#) [EV1HMC470ALP3](#) [EV1HMC520ALC4](#) [EV1HMC244AG16](#) [EV1HMC539ALP3](#) [EV1HMC6789BLC5A](#) [MAX2614EVKIT#](#) [124694-HMC742ALP5](#) [SC20ASATEA-8GB-STD](#) [MAX2837EVKIT+](#) [MAX2612EVKIT#](#) [MAX2692EVKIT#](#) [EV1HMC629ALP4E](#) [SKY12343-364LF-EVB](#) [108703-HMC452QS16G](#) [EV1HMC863ALC4](#) [EV1HMC427ALP3E](#) [119197-HMC658LP2](#) [EV1HMC647ALP6](#) [ADL5725-EVALZ](#) [MAX2371EVKIT#](#) [106815-HMC441LM1](#) [EV1HMC1018ALP4](#) [UXN14M9PE](#) [MAX2016EVKIT](#) [EV1HMC939ALP4](#) [MAX2410EVKIT](#) [MAX2204EVKIT+](#) [EV1HMC8073LP3D](#) [SIMSA868-DKL](#) [SIMSA868C-DKL](#) [SKY65806-636EK1](#) [SKY68020-11EK1](#)