AN11091

High Ohmic FM LNA for embedded Antenna in Portable applications with BGU6102

Rev. 2.0 — December 7, 2016 **Application note**

Document information

Info	Content
Keywords	BGU6102, LNA, FM, embedded Antenna
Abstract	This document provides circuit, layout, BOM and performance information on FM band using BGU6102
Ordering info	BGU610x customer evaluation kit OM7810, 12nc 9340 661 94598
Contact information	For more information, please visit: http://www.nxp.com

Revision history

Rev	Date	Description
1.0	November 23, 2011	Initial document
2.0	December 7, 2016	Updated PCB

Contact information

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1. Introduction

“Music” as mobile value proposition has become increasingly popular in recent years. Transferring MP3 from the PC and playing on the mobile is now common, eased by decline in memory prices. This trend has re-ignited interest in FM Radio on Mobile as people want to keep up with the news, listen to new music, in addition to playing their MP3 collection.

With NXP’s FM LNA‟s consumers can listen to FM Radio on their mobile phone speaker. The LNA’s amplify the weak signal solving impedance mismatch between embedded antennas and the FM Radio receiver.

In this application note the FM band of 70 – 130 MHz is addressed. Key requirements for these applications are gain, noise figure, and input/output return loss.

The BGU6102 FM LNA is promoted with a full promotion package, called “customer evaluation kit”. The kit include a BGU6102 LNA evaluation board (see Fig 1) and loose BGU6102 MMIC samples. For other customer evaluation kit’s and application notes see www.nxp.com.

Table 1. Customer evaluation kit

Basic type	Customer Evaluation Kit
BGU6102	OM7810,customer evaluation kit for BGU6102 high ohmic FM LNA

The BGU610X LNA evaluation board simplifies the evaluation of the BGU6102 application. The evaluation board enables testing of the device performance and requires no additional support circuitry. The board is fully assembled with the BGU6102 MMIC, and the necessary matching and decoupling components for the associated frequency band.

The board is also supplied with two SMA connectors for input and output connection to RF test equipment. A 50 ohm “through line” is provided at the top of the evaluation board in case the user wishes to verify RF connector and grounded coplanar waveguide losses for de-embedding purposes.

Fig 1. BGU610X Evaluation Board

2. Design and Application

The BGU6102 MMIC is an unmatched wideband MMIC featuring an integrated bias, enable function and wide supply voltage range. BGU6102 is part of a family of three products (BGU6101, BGU6102 and BGU6104).

The application covers the FM band of 70 – 130 MHz.

Key Benefits:

- Supply voltage range from 1.5 V to 5 V
- NF_{min} of 0.7 dB
- Applicable between 70 MHz and 130 MHz
- Integrated temperature-stabilized bias for easy design
- Bias current configurable with external resistor
- Power-down mode current consumption < 6 μA
- ESD protection on all pins up to 3 kV HBM
- Small 6-pin leadless package 2.0 mm × 1.3 mm × 0.35 mm

2.1 Application Circuit Schematic

The PCB is designed to be adaptable for multiple bands and multiple configurations. This way, only some components need to be exchanged in order to adjust the board for another frequency band. In Fig 2 only the relevant components for this application are shown (5pcs external components). The associated Bill-Of-Material (BOM) is available and can be found in paragraph 2.3.

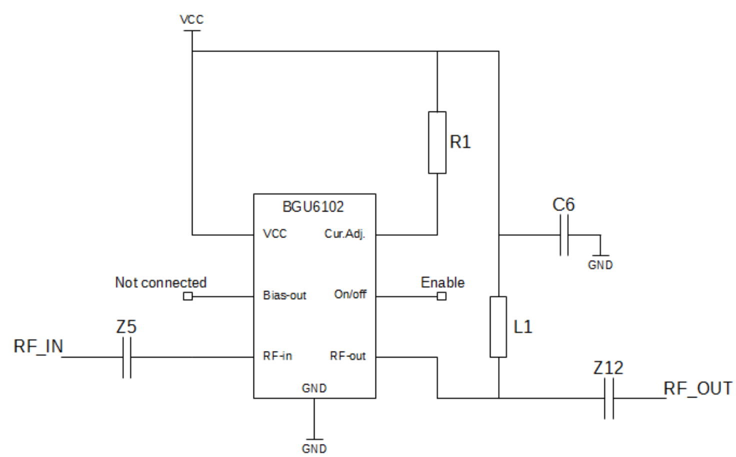

Fig 2. Schematic high ohmic version with relevant components only

At the position of L1 a resistor is placed. To accomplish a higher gain, one may replace this resistor by a coil with the result of a higher gain but a smaller useable bandwidth.

The PCB is capable to accommodate multiple circuit configurations with the BGU610x. Fig 3 shows the schematic of the PCB. The components that are not relevant for the application can be left unplaced or can be shorted by a zero ohms resistor.

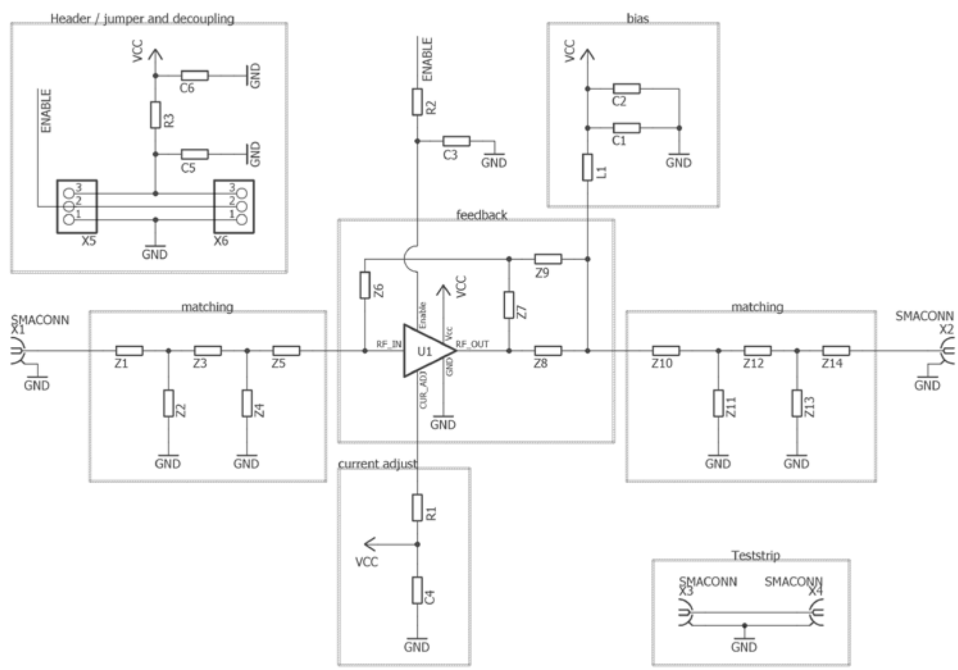

Fig 3. BGU610X Low Noise Amplifier evaluation PCB : Circuit schematic

2.2 Evaluation board Layout

Characteristics of the evaluation board (see figure 3):

- 3 layer PCB
- PCB material FR4 (ε_r=4.6)
- 20 x 35 mm
- RF layer thickness 0.254 mm (critical)
- Surface finish ENIG (Electroless Nickel Immersion Gold)
- Soldermask
- SMD components (0402 formfactor)

Top view Bottom view

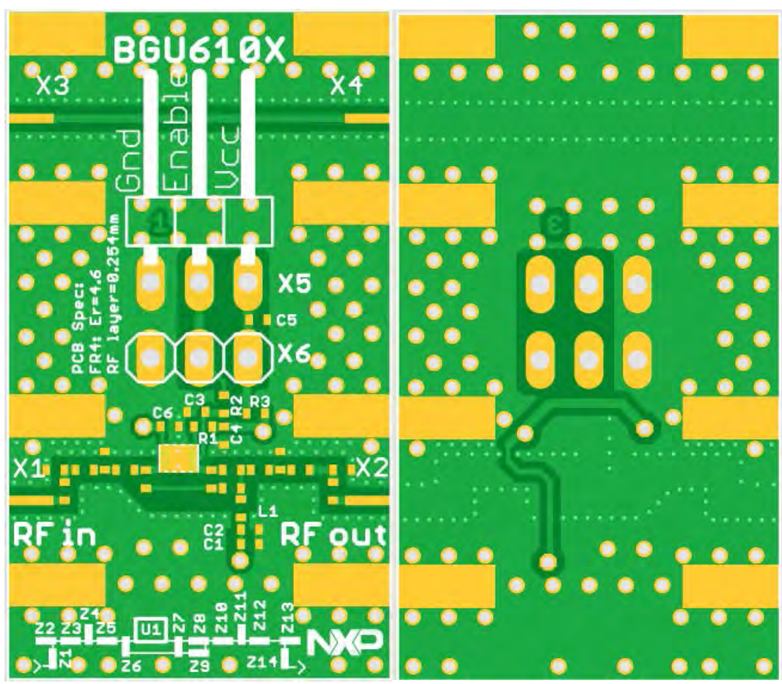

Fig 4. BGU610X Low Noise Amplifier evaluation board

Fig 5 shows the PCB stack-up. The PCB consists of 3 layers, where the first two, RF signal layer and RF ground are between a critical dielectric layer in order to ensure 50 ohm coplanar waveguide transmission lines. Through vias are used to connect the different layers.

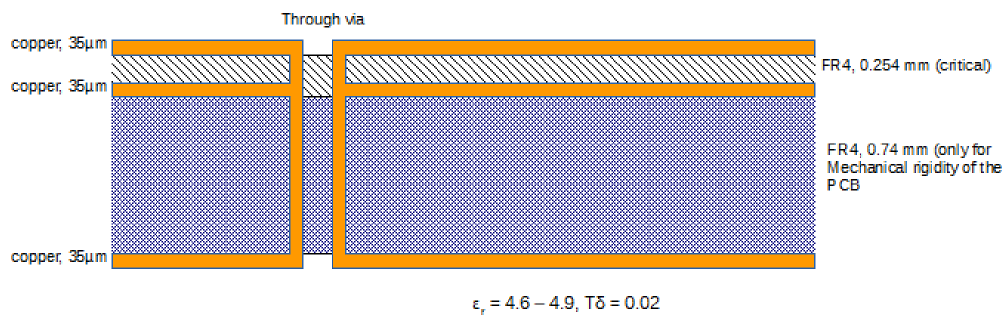

Fig 5. PCB Stack-up

2.3 Application board Bill-Of-Material

Table 2. Bill-Of-Material

Item	Quantity	Reference	Part Number	Value	Vendor
1	7	Z1,Z3,Z8,Z10,Z14,R2,R3	RC0402JR-070RL	0E	Phycomp
2	2	Z5,Z12	GRM155R71H331KA01D	330pF	Murata
3	1	C6	GRM155R71A473KA01D	47nF	Murata
4	1	R1	RC0402FR-0743KL	43k	Phycomp
5	1	L1 or R	2322 705 70569	56E	Yageo
6	1	U1	BGU6102	-	NXP
7	2	X1,X2	142-0701-841	SMA	Cinch Connectivity
8	1	X5	538-22-28-8030	header	Molex
9	1	X6	538-22-28-4030	header	Molex

Note: Customer can choose their preferred vendor but should be aware that the performance could be affected.

3. Measurement results

This section presents the results of the BGU6102 Low Noise Amplifier. Unless otherwise noted, all measurement references are at the SMA connectors on the evaluation board and are performed at an ambient temperature of 25 degrees Celsius. The circuit is biased with Vcc=3.0V, Icc=3.1mA.

Next measurements are performed:

- S-parameters
- Stability

3.1 S-Parameters

Fig 6 shows the measurement results of the S-parameter measurement. The measurements are performed up to 10GHz to calculate the stability factor. This stability factor is depicted in Fig 8.

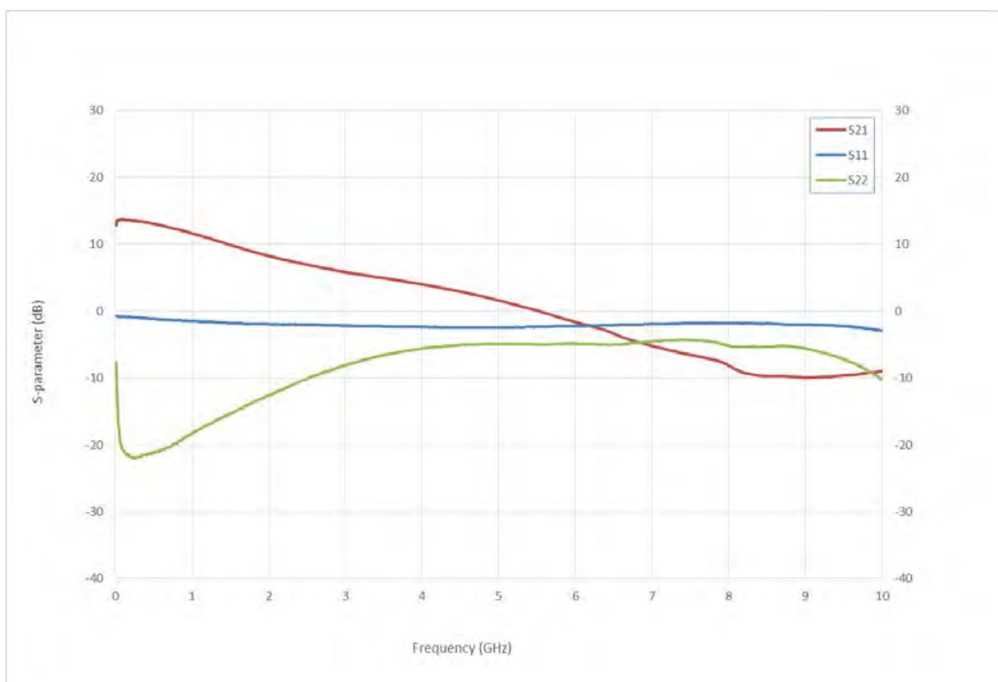

Fig 6. S-Parameters up to 10 GHz, Vcc=3.0V, Icc=3.1mA

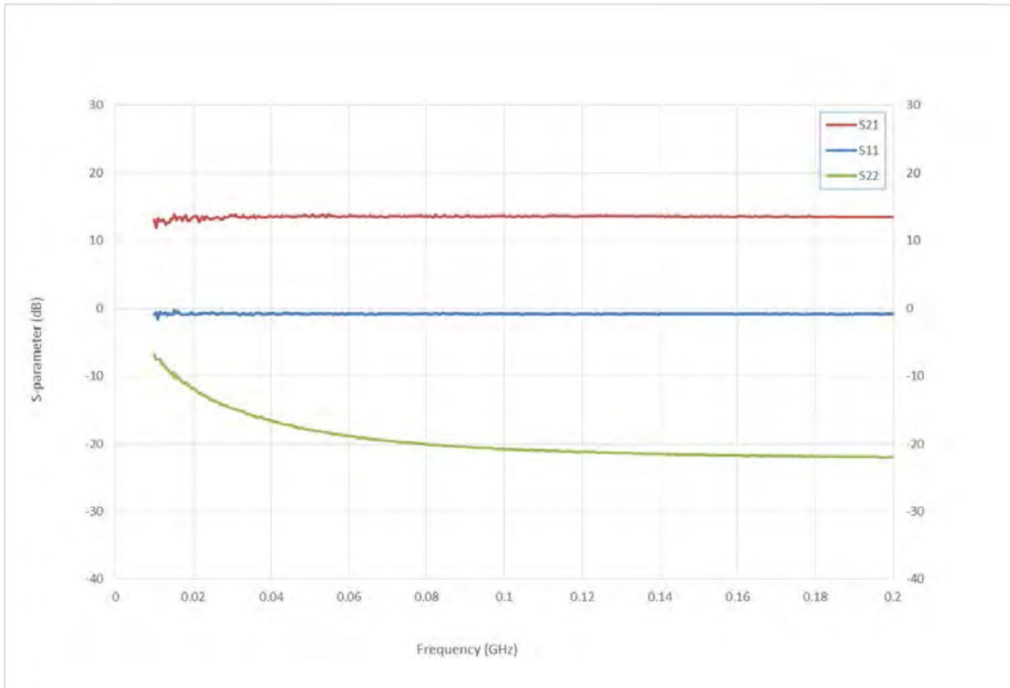

Fig 7. S-Parameters 10 – 200 MHz, Vcc=3.0V, Icc=3.1mA

3.2 Stability

The stability factor K is calculated from the measured S-parameters. To check for instabilities out of band, the S-parameters are measured over an extended frequency range.

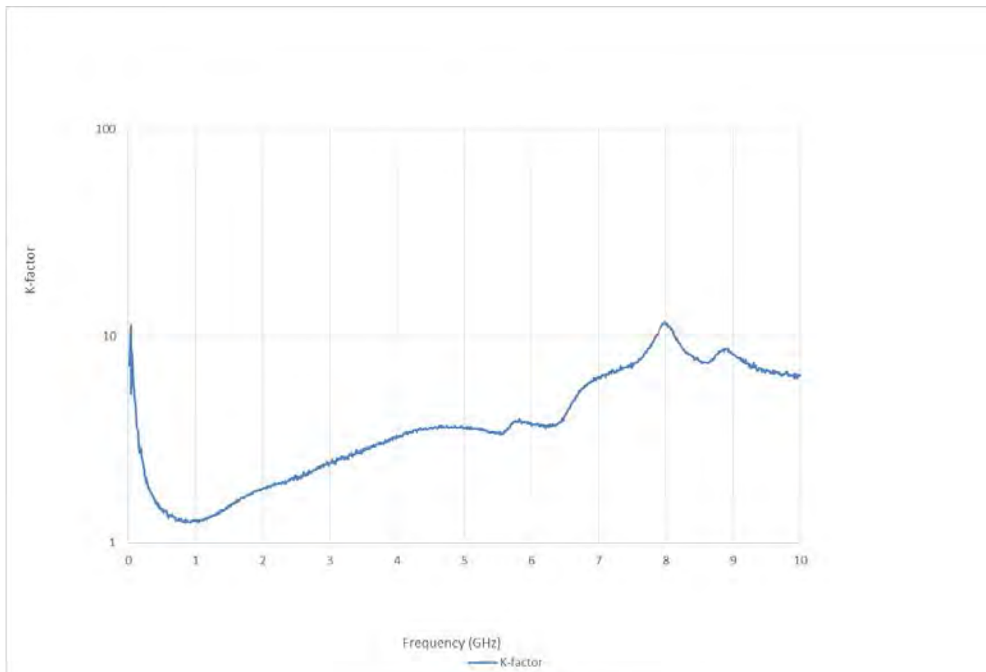

Fig 8. BGU6102 Low Noise Amplifier K Factor (Rollett Stability Factor)

4. Summary measurement results

Table 3. Typical measurements results measured on the evaluation board

Tamb = 25 °C; Vcc = Ven = 3.0 V; Icc(tot) = 3.1 mA[1]; f = 100 MHz; Z_S = Z_L = 50 Ω unless otherwise specified. All measurements are done with SMA-connectors as reference plane.

Parameter		Symbol	Value	Unit
Supply Voltage		Vcc	3.0	V
Supply Current		Icc	3.1	mA
Noise Figure [1]	@ 70 MHz	NF	1.0	dB
	@ 130 MHz	NF	1.0	dB
Power Gain	@ 70 MHz	Gp	13.8	dB
	@ 130 MHz	Gp	13.4	dB
Input Return Loss	@ 70 MHz	IRL	-0.6	dB
	@ 130 MHz	IRL	-1.0	dB
Output Return Loss	@ 70 MHz	ORL	-19.7	dB
	@ 130 MHz	ORL	-21.6	dB
Reverse Isolation	@ 70 MHz	ISLrev	-46.0	dB
	@ 130 MHz	ISLrev	-46.0	dB
Input 1dB Gain Compression Point		iP1dB	-22.2	dBm
Output 1dB Gain Compression Point		oP1dB	-9.6	dBm
Input Third Order Intercept Point [2]		iIP3	-15.7	dBm
Output Third Order Intercept Point [2]		oIP3	-2.1	dBm
Stability (100 MHz - 10 GHz)		K	>1	

[1] $I_{CC(tot)} = I_{CC} + I_{RF\_OUT} + I_{R\_BIAS}$

[2] The third order intercept point is measured at -30 dBm per tone at RF_IN (f_1 = 100 MHz; f_2 = 100.2 MHz)

5. Application recommendations

The BGU6102 can be used for other application than the applications mentioned in this application note. Only the matching components need to be changed (see schematic diagram of Fig 2). The biasing components can be changed to improve the linearity performance.

For other applications (customer evaluation kit's) using the BGU610X see www.nxp.com !

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