

AN11638

BGU7060 Evaluation board application note

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Application note

Document information

Info	Content
Keywords	BGU7060, LNA-VGA, IP3 _i , NF, PCB, P _{i(1dB)} , dynamic range.
Abstract	This application note describes the evaluation board (EVB) design and typical performance of the BGU7060. The BGU7060 is a fully integrated analog-controlled variable gain amplifier module. This EVB is supplied with all necessary connectors in order to enable ease of evaluation.
Ordering info	<u>Board number:OM7954, BGU7060</u> <u>12NC:934069583598</u>
Contact information	For more information, please visit: http://www.nxp.com



Revision history

Rev	Date	Description
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1. Introduction

This application note gives a description of the BGU7060 evaluation board.

This enables ease of evaluation; it provides the EVB circuit schematic, the bill of materials (BOM), PCB material information and artwork. It also provides a list of equipment for a typical evaluation set up, as well as typical test results of the BGU7060.

This fully supplied EVB can be ordered from the NXP website www.nxp.com

2. Product description

NXP semiconductors' BGU7060 is a fully integrated analog-controlled variable gain amplifier module. Its low noise and high linearity performance makes it ideal for sensitive receivers in cellular base station applications. The BGU7060 is operating in the 698 MHz to 748 MHz frequency range (LTE bands 12, 17, 28) and has a gain control range of 35 dB. At maximum gain the noise figure is 0.85 dB. The gain is analog-controlled having maximum gain at 0 V and minimum gain at 3.3 V. The LNA can be bypassed extending the dynamic range. The BGU7060 is internally matched to 50 Ohm, meaning no external matching is required, enabling ease of use. It is housed in a 16 pins 8x8x1.3mm leadless HLQFN16R package SOT1301. The BGU7060 can operate from 4.75V to 5.25 single supply and consumes about 220mA in high gain mode (LNA active) and about 190mA in the low gain mode (LNA bypassed)

BGU7060 is one of a series of LNA-VGA products for the different frequency bands intended for cellular base stations and its related applications.

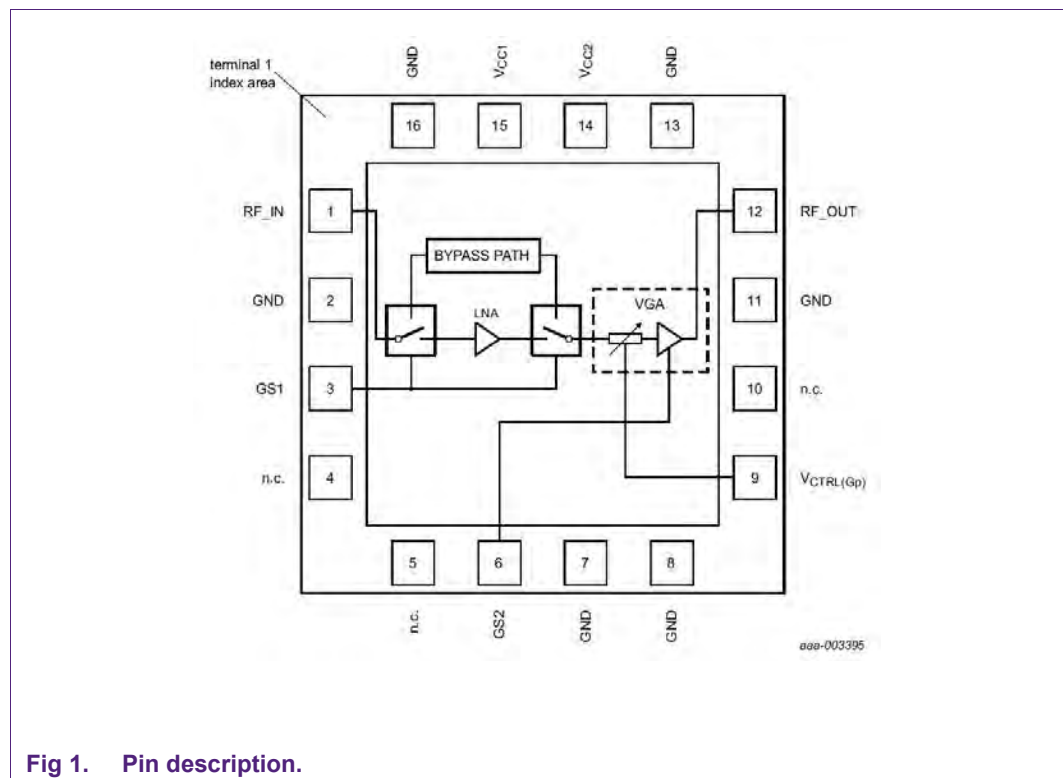


Fig 1. Pin description.

3. BGU7060 Evaluation board

The BGU7060 evaluation board, (see [Fig 2](#)) is fabricated on a 1mm thick 3 layer PCB that uses 0.5mm R4003C for the RF performance and 0.5mm Fr4 for the mechanical strength of the PCB. The board is fully assembled with the BGU7060, including the external components. The board is supplied with two SMA connectors for input and output connection to the RF test equipment.

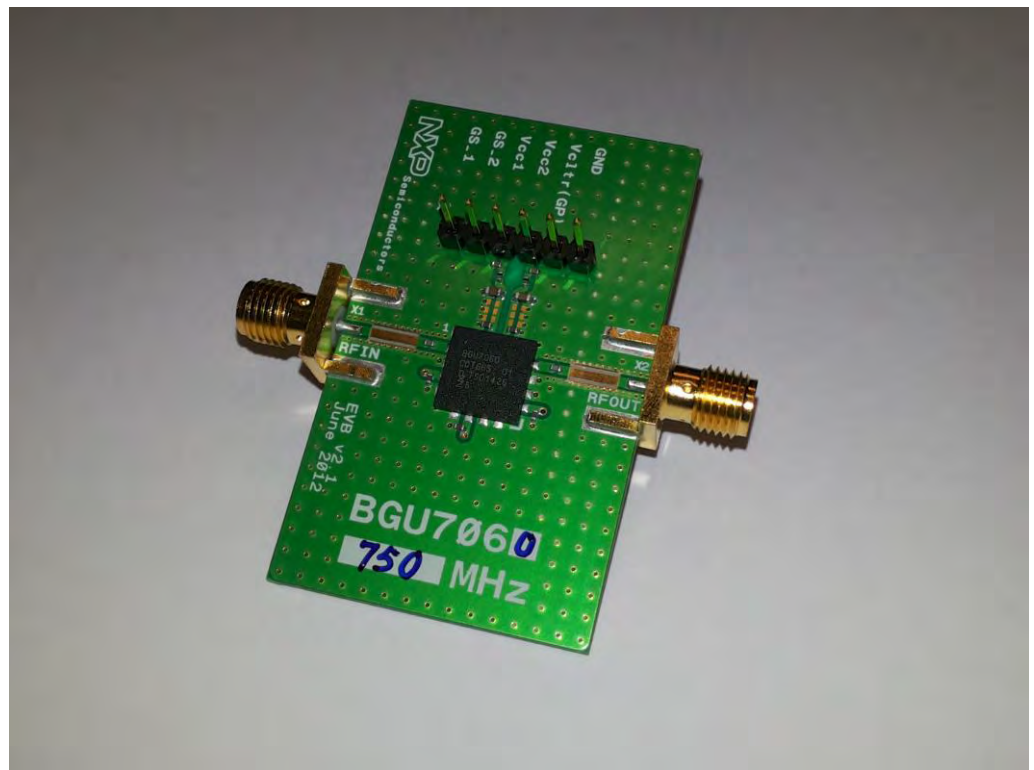


Fig 2. Evaluation Board

3.1 Application circuit

The circuit diagram of the evaluation board is shown in [Fig 3](#)

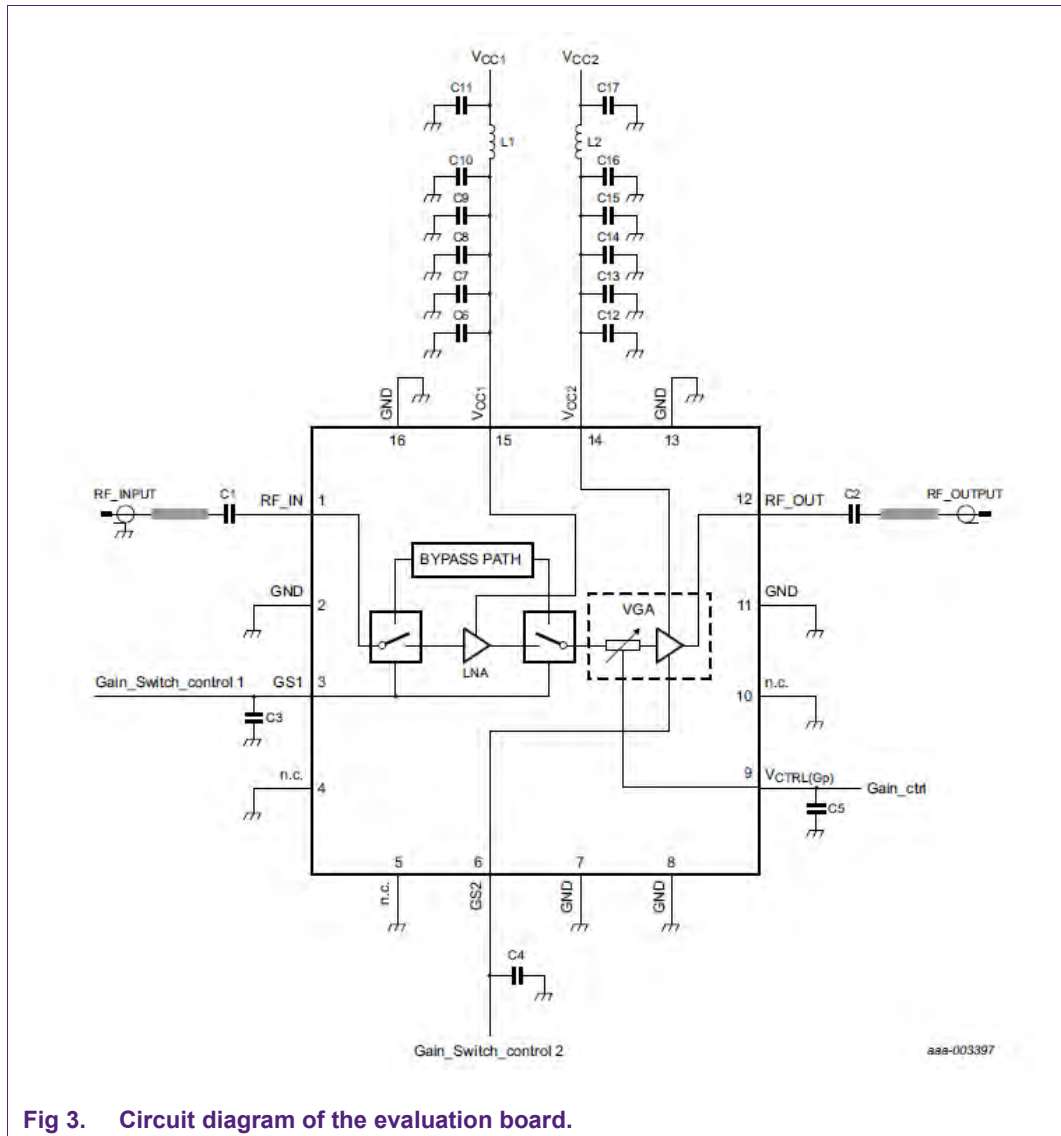


Fig 3. Circuit diagram of the evaluation board.

Since the BGU7060 is fully integrated the evaluation board only needs two AC coupling capacitors on the RF input and RF output, as well as bias decoupling circuits on Vcc1 and Vcc2, GS1, GS2, VCTRL(GP).

3.2 Decoupling structure.

Applying the BGU7060 in e.g. wireless base station BST, ask for careful Vcc decoupling in order to get the optimal and stable performance of the product especially on NF.

If the LNA_VGA module is supplied via supply rail that supplies more components, lack of decoupling can degrade the performance.

3.3 PCB Layout information

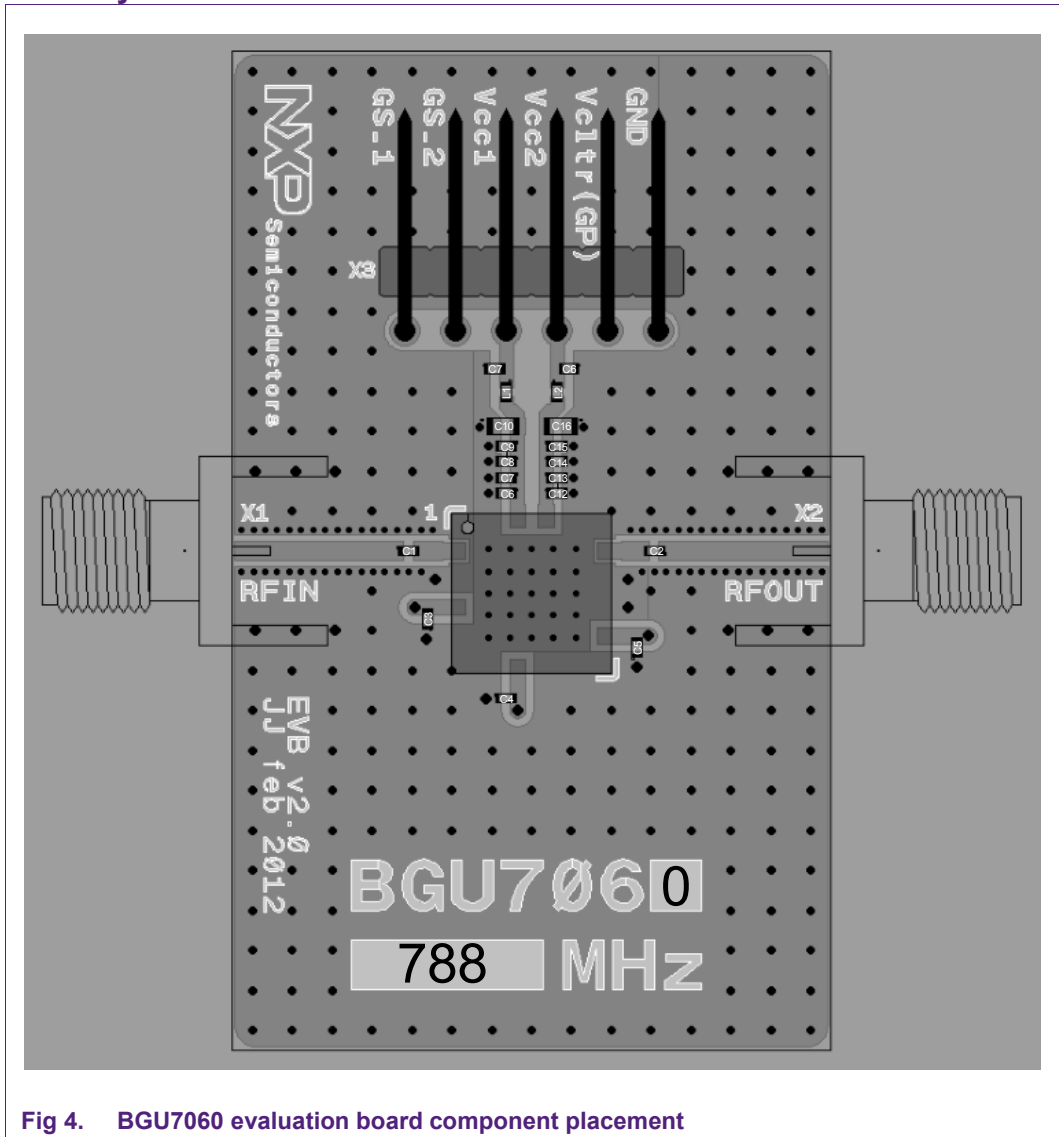


Fig 4. BGU7060 evaluation board component placement

Table 1. BOM of the BGU7060 evaluation board*Table description (optional)*

Designator	Description	Footprint	Value	Supplier Name/type	
U1	BGU7060	8x8x1.3mm 16 pins		HLQFN16R	
PCB		20x30mm		BGU706x EVB v2.1 June 2012	
C1,C2	Capacitor	0402	150pF	Murata GRM1555	AC coupling
C3-C5	Capacitor	0402	100pF	Murata GRM1555	Decoupling
C6,C12	Capacitor	0402	100pF	Murata GRM1555	Decoupling
C11,C17	Capacitor	0402	100nF	Murata GRM1555	Decoupling
C7-C10, C13-C16	-	-	-	-	Not assembled
L1,L2	Inductor	0402	10nH	Murata LQG15	Decoupling
X1,X2	SMA RF connector	-	-	Johnson, End launch SMA 142-0701-841	
X3	DC header	-	-	Molex, PCB header, right angle, 1 row 6 way 90121-0766	

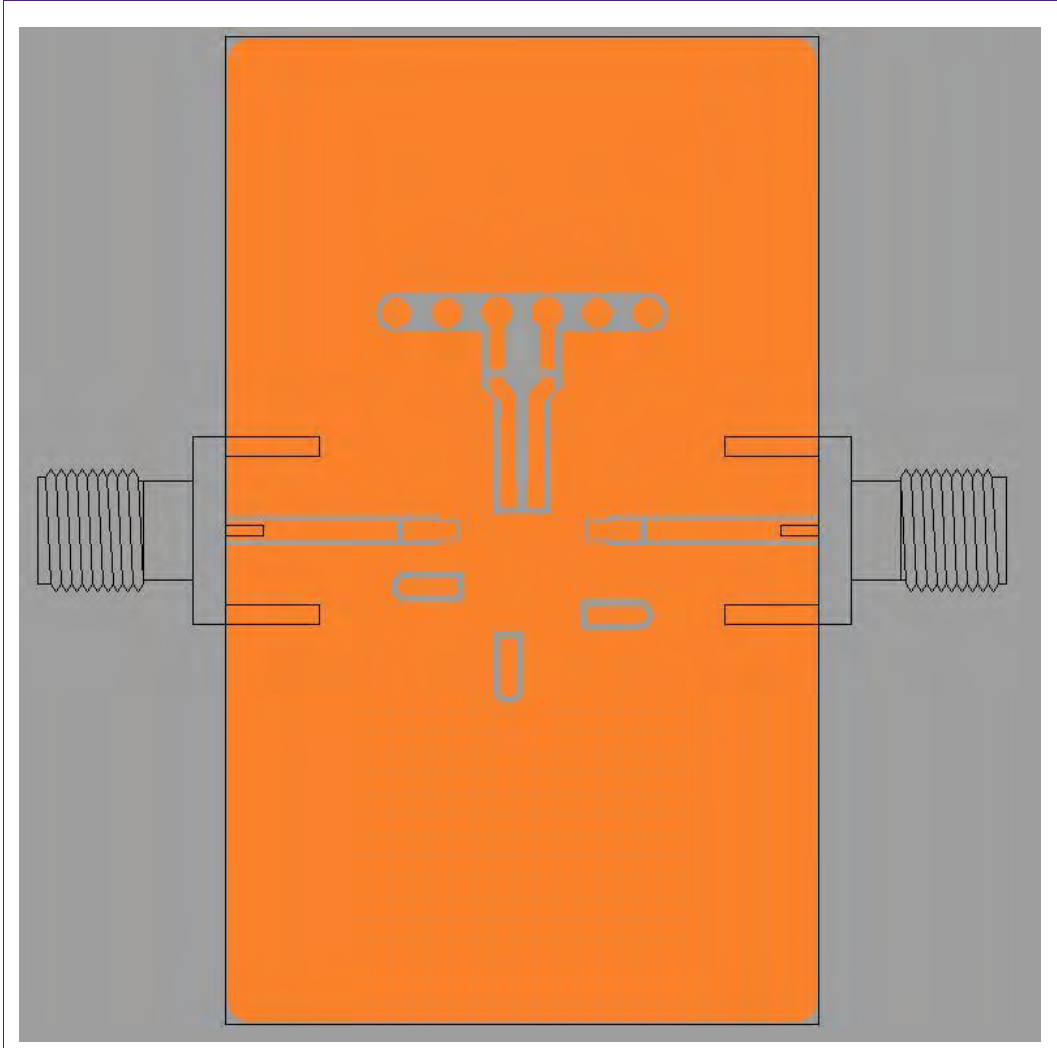


Fig 5. BGU706x Evaluation board Top layer PCB layout

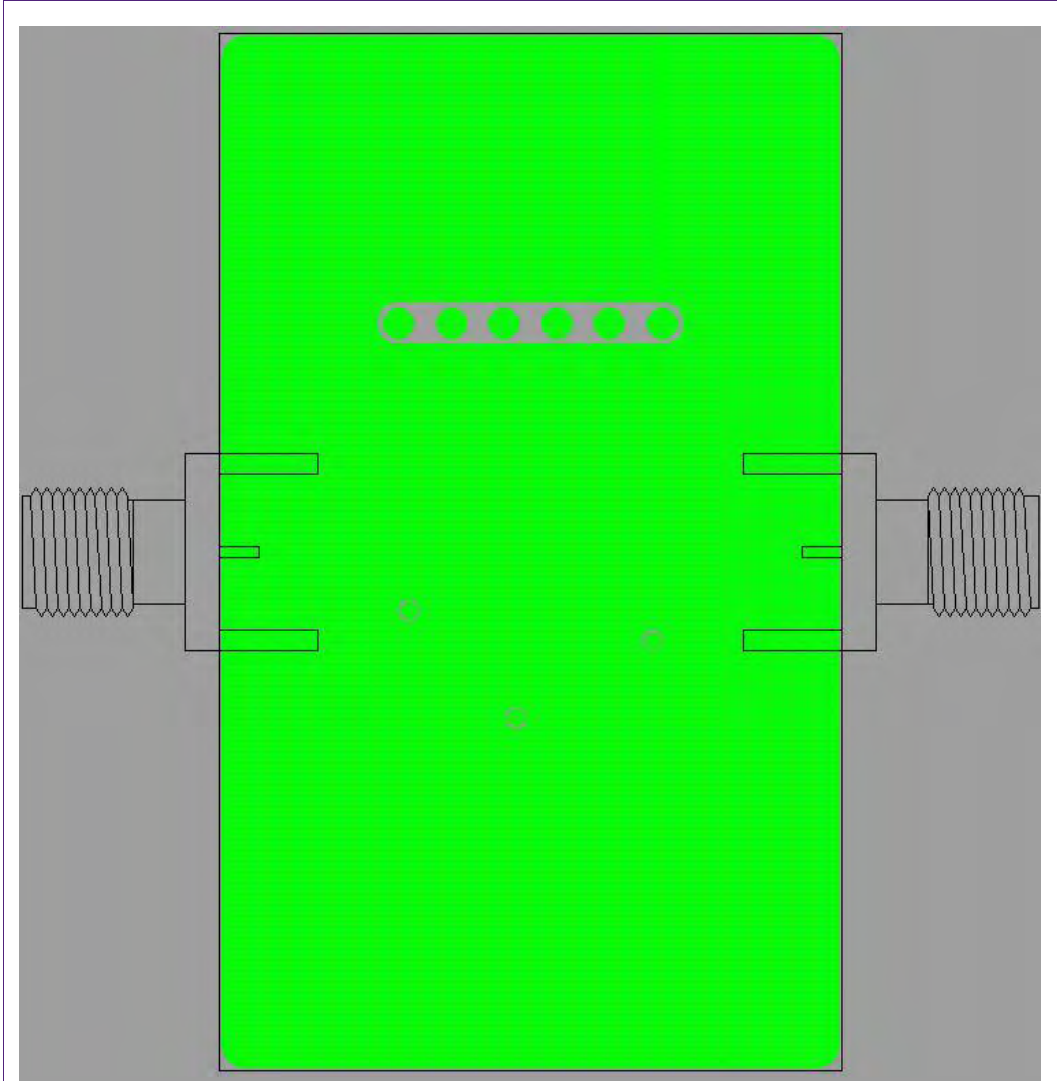


Fig 6. BGU706x Evaluation board inner layer PCB layout

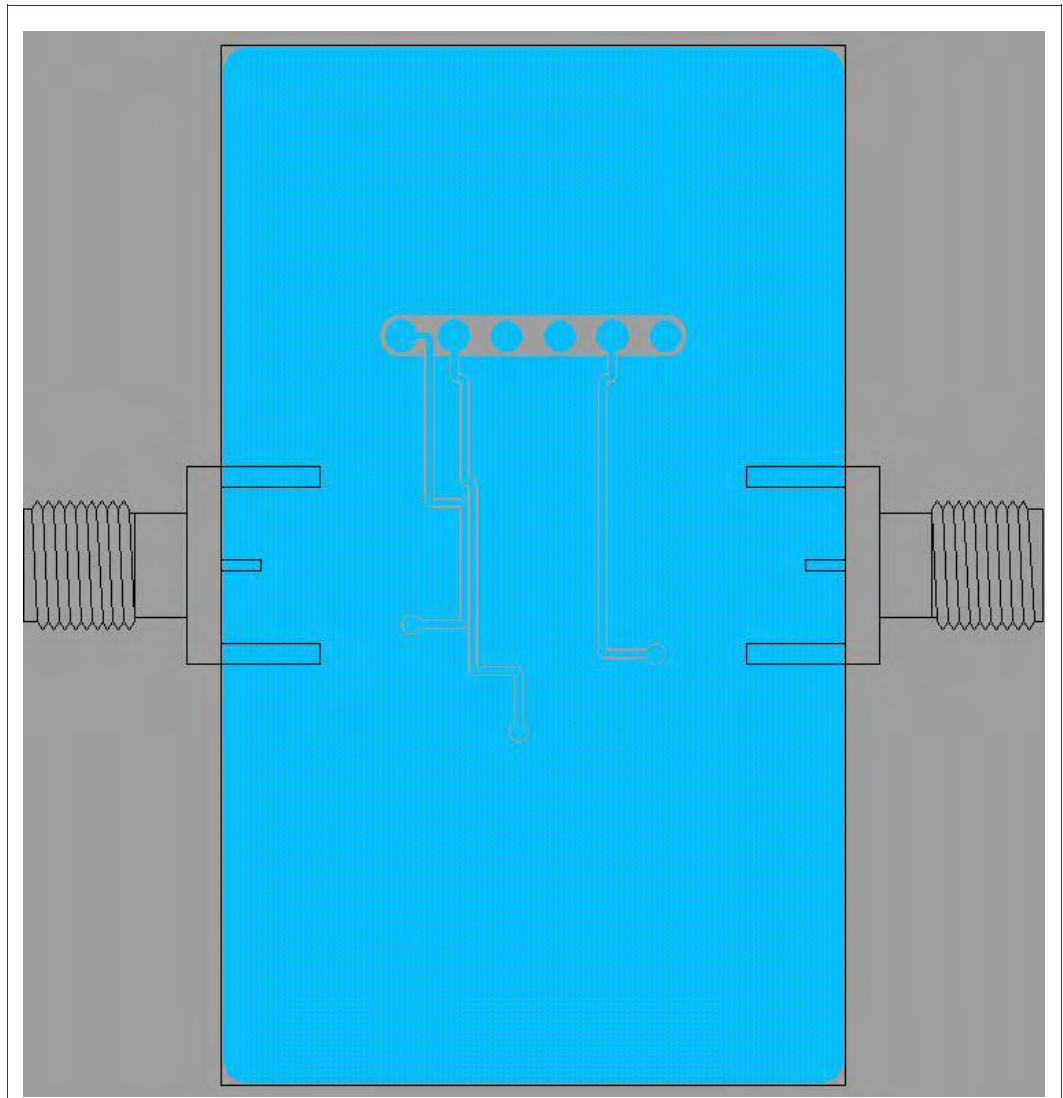


Fig 7. BGU706x Evaluation board bottom layer PCB layout

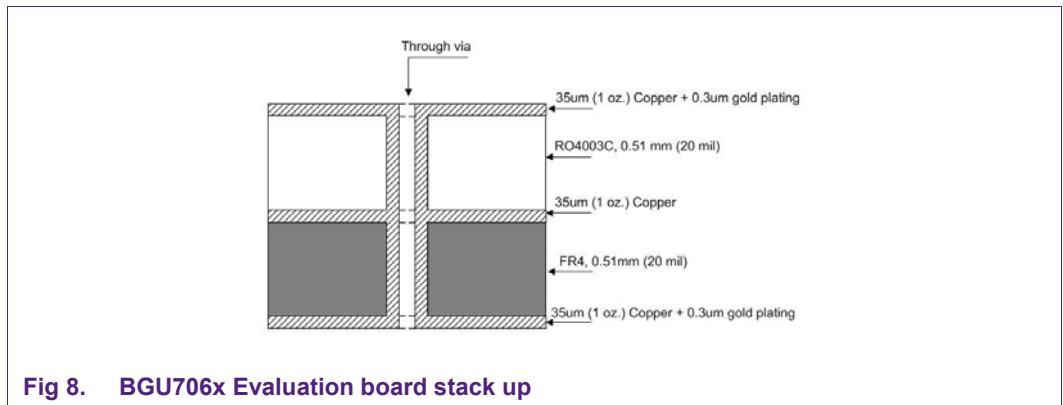


Fig 8. BGU706x Evaluation board stack up

3.4 Recommended footprint

A good PCB layout is an essential part of an RF circuit design. The BGU7060 evaluation board can serve as a guideline for laying out a board using the BGU7060. Both RF input and RF output lines are controlled impedance lines. Vcc1 and Vcc2 are decoupled by a Π filter decoupling. The recommended footprint for reflow soldering can be found in [Fig 9](#) as well as via this link [sot1301-1_fr.pdf](#).

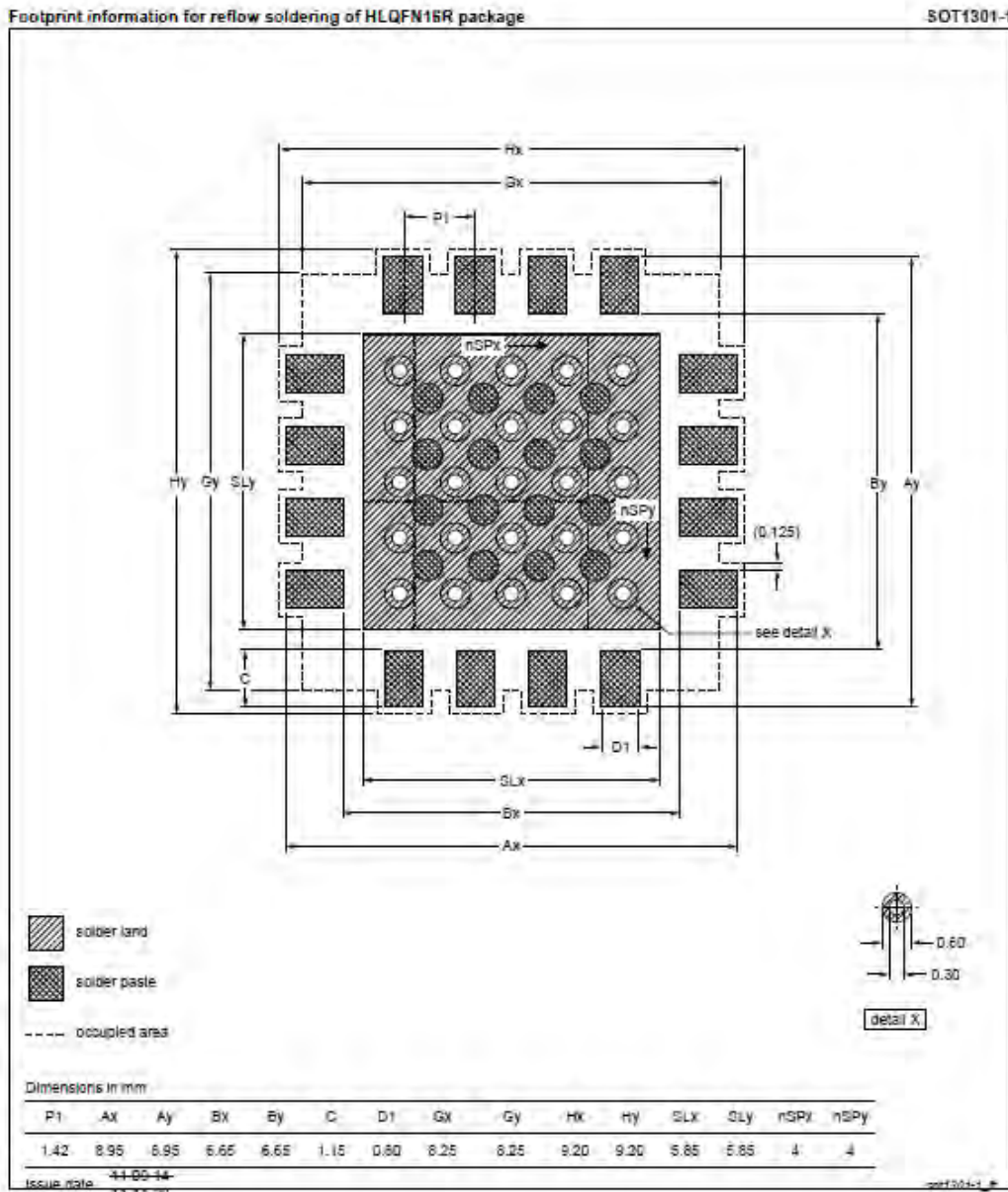


Fig 9. Recommended footprint specification for the HLQFV16R

4. Test Setup

4.1 S_Parameter, 1dB compression, IIP3, measurement setup

The BGU7060 EVB is fully assembled and tested.

Fig 10 Shows the measurements setup that is used to evaluate the BGU7060 EVB for S_parameters Gain, IRL ORL Reverse Isolation), 1dB gain compression as well as IIP3. It is intended as a guide only, substitutions are possible. The 10dB attenuator in the output path is recommended in order to avoid overdriving the analyzers receiver port when measuring 1 dB gain compression. Especially in the high gain mode of the BGU7060, this is needed.

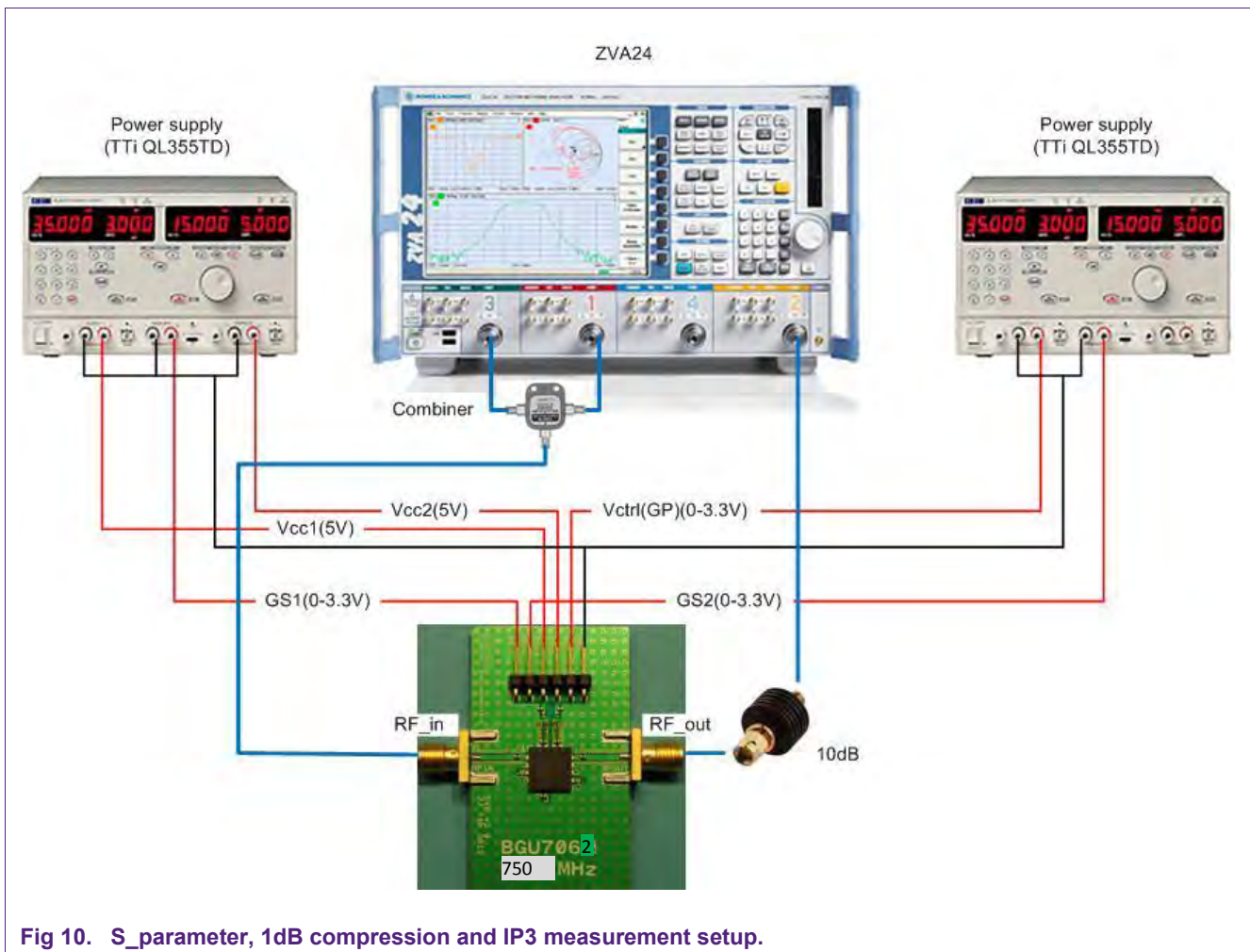


Fig 10. S_parameter, 1dB compression and IP3 measurement setup.

4.2 Noise figure measurement setup

In Fig 11 the noise figure measurement set-up is shown, this is also intended as a guide only, substitutions can be made. For the High gain mode of the BGU7060 it is recommended to use a 5dB ENR noise source, for the Low gain a 15 dB ENR noise source recommended. To achieve to lowest possible setup noise figure an external pre amplifier might be necessary, but since this will make the total gain in the highest gain setting of the BGU7060 to high a 6dB attenuator is needed to avoid overdriving the input of the spectrum analyzer.

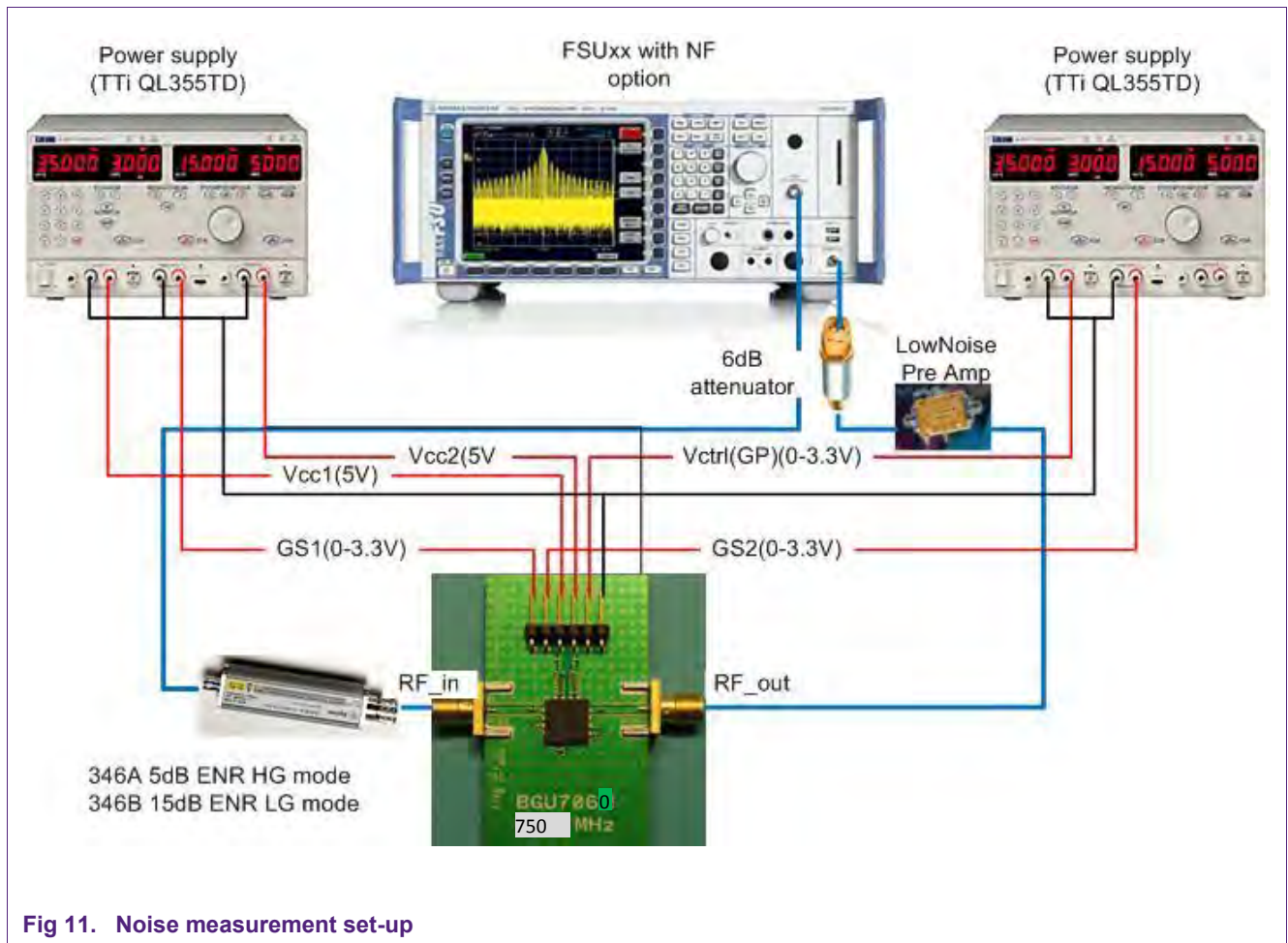


Fig 11. Noise measurement set-up

5. Typical operating performance.

A detailed overview of the performance of the BGU7060 can be found in de [Datasheet](#).

In [Table 2](#) and [Table 3](#) the typical performance at 725 MHz in High- and Low-gain is given.

Table 2. Typical performance high gain mode

GS1=LOW; GS2=HIGH; Vcc1=5V; Vcc2=5V; f=725MHz; Tamb=25°C; input and output 50Ω; unless otherwise specified.

Symbol	Parameter	Conditions	Typ	Unit
I _{CC(tot)}	total supply current		224	mA
G _{p(min)}	minimum power gain	V _{ctrl(Gp)} = 3.3 V	11.8	dB
G _{p(max)}	maximum power gain	V _{ctrl(Gp)} = 0 V	36.4	dB
G _{p(flat)}	power gain flatness	1920 MHz ≤ f ≤ 1980 MHz 18 dB ≤ G _p ≤ 35 dB	0.3	dB
NF	noise figure	V _{ctrl(Gp)} = 0 V (maximum power gain)	0.71	dB
		G _p = 35 dB	0.84	dB
		G _p = 18 dB	6.11	dB
IP _{3I}	input third-order intercept point	2-tone; tone-spacing = 1.0 MHz		
		G _p = 35 dB	1.0	dBm
		G _p = 30 dB	3.7	dBm
		G _p = 29 dB	4.0	dBm
P _{I(1dB)}	input power at 1 dB gain compression	G _p = 35 dB	-12.6	dBm
		G _p = 30 dB	-7.9	dBm
		G _p = 29 dB	-7.2	dBm
		G _p = 18 dB	-5.5	dBm
RL _{in}	input return loss	V _{ctrl(Gp)} = 0 V (maximum power gain)	27.3	dB
		G _p = 35 dB	54.4	dB
RL _{out}	output return loss	V _{ctrl(Gp)} = 0 V (maximum power gain)	18.3	dB
K	Rollett stability factor	0 GHz ≤ f ≤ 12.75 GHz	>1	

Table 3. Typical performance low gain mode

GS1=HIGH; GS2=LOW; Vcc1=5V; Vcc2=5V; f=725MHz; Tamb=25°C; input and output 50Ω; unless otherwise specified.

Symbol	Parameter	Conditions	Typ	Unit
I _{CC(tot)}	total supply current		194	mA
G _{p(min)}	minimum power gain	V _{ctrl(Gp)} = 3.3 V	-6.2	dB
G _{p(max)}	maximum power gain	V _{ctrl(Gp)} = 0 V	18.8	dB
G _{p(flat)}	power gain flatness	1920 MHz ≤ f ≤ 1980 MHz 3 dB ≤ G _p ≤ 17 dB	0.2	dB
NF	noise figure	G _p = 17 dB	10.5	dB
		G _p = 3 dB	22.4	dB
IP _{3I}	input third-order intercept point	2-tone; tone-spacing = 1.0 MHz		
		G _p = 17 dB	20.5	dBm
		G _p = 12 dB	25.5	dBm
		G _p = 11 dB	26.4	dBm
P _{i(1dB)}	input power at 1 dB gain compression	G _p = 17 dB	5.6	dBm
		G _p = 12 dB	10.0	dBm
		G _p = 11 dB	10.7	dBm
		G _p = 3 dB	10.9	dBm
RL _{in}	input return loss	V _{ctrl(Gp)} = 0 V (maximum power gain)	28.4	dB
		G _p = 17 dB	28.2	dB
RL _{out}	output return loss	V _{ctrl(Gp)} = 0 V (maximum power gain)	24.3	dB
K	Rollett stability factor	0 GHz ≤ f ≤ 12.75 GHz	>1	

6. Customer Evaluation Kit

The Evaluation Kit will come in an ESD shielded back label like below

It will include 1 EVB.



Fig 12. BGU7060 Customer evaluation kit.

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8. List of figures

Fig 1.	Pin description.	3
Fig 2.	Evaluation Board.....	4
Fig 3.	Circuit diagram of the evaluation board.	5
Fig 4.	BGU7060 evaluation board component placement	6
Fig 5.	BGU706x Evaluation board Top layer PCB layout	8
Fig 6.	BGU706x Evaluation board inner layer PCB layout	9
Fig 7.	BGU706x Evaluation board bottom layer PCB layout	10
Fig 8.	BGU706x Evaluation board stack up	10
Fig 9.	Recommended footprint specification for the HLQFV16R	11
Fig 10.	S ₁₁ parameter, 1dB compression and IP3 measurement setup.	12
Fig 11.	Noise measurement set-up	13
Fig 12.	BGU7060 Customer evaluation kit.	15

9. List of tables

Table 1. BOM of the BGU7060 evaluation board..... 7
Table 2. Typical performance high gain mode 14
Table 3. Typical performance low gain mode 15

10. Contents

1.	Introduction	3
2.	Product description	3
3.	BGU7060 Evaluation board	4
3.1	Application circuit	5
3.2	Decoupling structure	5
3.3	PCB Layout information	6
3.4	Recommended footprint	11
4.	Test Setup	12
4.1	S_Parameter, 1dB compression, IIP3, measurement setup	12
4.2	Noise figure measurement setup	12
5.	Typical operating performance	14
6.	Customer Evaluation Kit	15
7.	Legal information	16
7.1	Definitions	16
7.2	Disclaimers	16
7.3	Licenses	16
7.4	Patents	16
7.5	Trademarks	16
8.	List of figures	17
9.	List of tables	18
10.	Contents	19

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