BGU7062

Analog high linearity low noise variable gain amplifier

Rev. 1 — 10 August 2012 | Preliminary data sheet

1. Product profile

1.1 General description

The BGU7062 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 BGU7062 is operating in the 1710 MHz to 1785 MHz frequency range 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 BGU7062 is internally matched to 50 ohm, meaning no external matching is required, enabling ease of use. It is housed in a 16 pins 8 mm × 8 mm × 1.3 mm leadless HLQFN16R package SOT1301.

1.2 Features and benefits

- Input and output internally matched to 50 Ω
- Low noise figure of 0.85 dB
- High input IP3 of 0.8 dBm
- High $P_{i(1dB)}$ of −12.8 dBm
- Bypass mode of LNA giving high dynamic gain range
- Gain control range of 0 dB to 35 dB
- Single 5 V supply
- Single analog gain control of 0 V to 3.3 V
- Unconditionally stable up to 12.75 GHz
- Moisture sensitivity level 3
- ESD protection at all pins

1.3 Applications

- Cellular base stations, remote radio heads
- 3G, LTE infrastructure
- Low noise applications with variable gain and high linearity requirements
- Active antenna

1.4 Quick reference data

Table 1. Quick reference data

V_{CC1} = 5 V; V_{CC2} = 5 V; f = 1750 MHz; T_{amb} = 25 °C; input and output 50 Ω; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$I_{CC(tot)}$	total supply current	high gain mode	[1]	190	220	250	mA
		low gain mode	[2]	165	190	215	mA
NF	noise figure	$V_{ctrl(Gp)}$ = 0 V (maximum power gain)	[1]	-	0.85	-	dB
		G_p = 35 dB	[1]	-	0.95	1.1	dB
$IP3_I$	input third-order intercept point	G_p = 35 dB; 2-tone; tone-spacing = 1.0 MHz	[1]	0	0.8	-	dBm
$P_{i(1dB)}$	input power at 1 dB gain compression	G_p = 35 dB	[1]	−14	−12.8	-	dBm

[1] high gain mode: GS1 = LOW; GS2 = HIGH (see Table 9)

[2] low gain mode: GS1 = HIGH; GS2 = LOW (see Table 9)

2. Pinning information

2.1 Pinning

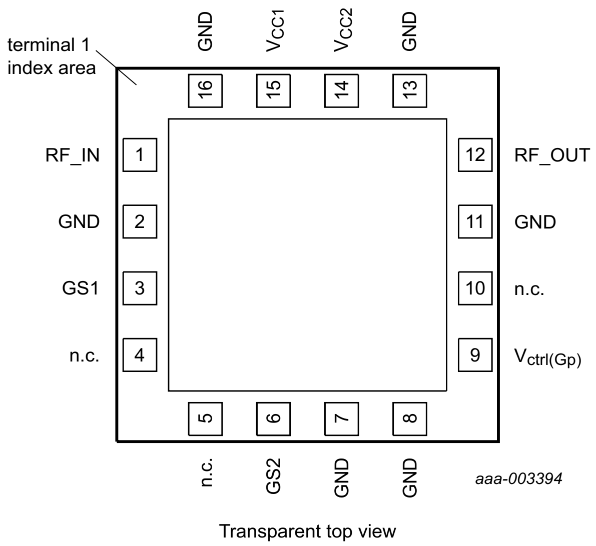


Fig 1. Pin configuration

2.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
RF_IN	1	RF input
GND	2, 7, 8, 11, 13, 16	ground
GS1	3	gain switch control 1
n.c.	4, 5, 10	not connected
GS2	6	gain switch control 2

Table 2. Pin description *...continued*

Symbol	Pin	Description
$V_{ctrl(Gp)}$	9	power gain control voltage
RF_OUT	12	RF output
V_{CC2}	14	supply voltage 2
V_{CC1}	15	supply voltage 1

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BGU7062	HLQFN16R	plastic thermal enhanced low quad flat package; no leads; 16 terminals; body 8 × 8 × 1.3 mm	SOT1301-1

4. Functional diagram

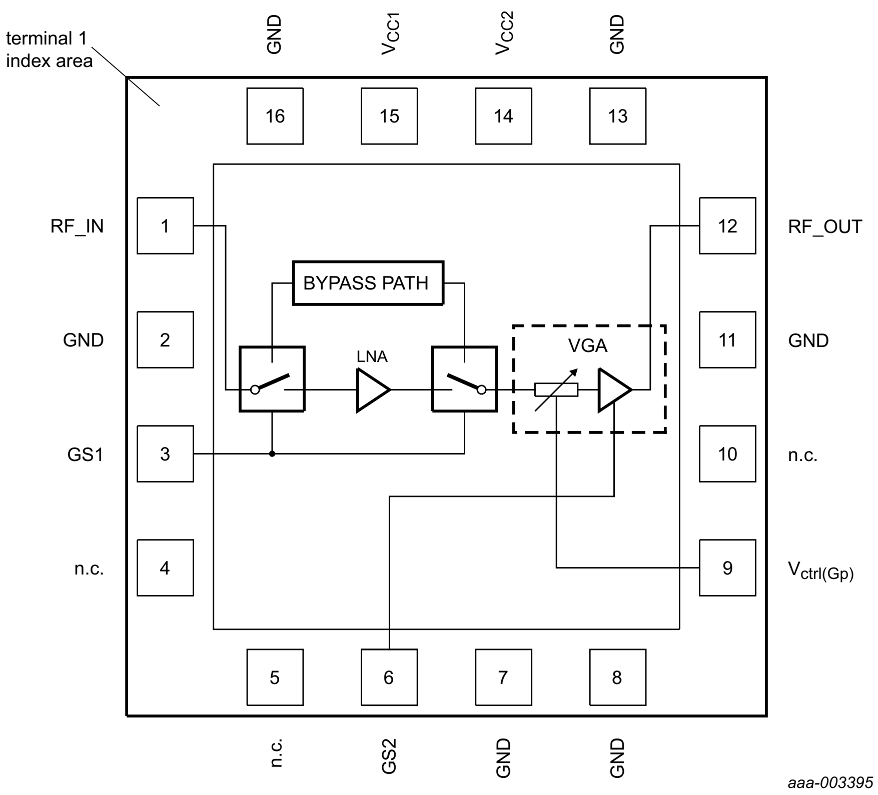


Fig 2. Functional diagram

5. Limiting values

Table 4. Limiting values
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage			0	6	V
$V_{ctrl(Gp)}$	power gain control voltage			–1	+3.6	V
$V_{I(GS1)}$	input voltage on pin GS1			–1	+3.6	V
$V_{I(GS2)}$	input voltage on pin GS2			–1	+3.6	V
$P_{i(RF)CW}$	continuous waveform RF input power	high gain mode; $V_{ctrl(Gp)}$ = 0 V	[1]	-	10	dBm
		low gain mode; $V_{ctrl(Gp)}$ = 0 V	[2]	-	15	dBm
T_j	junction temperature			-	150	°C
T_{stg}	storage temperature			–40	+150	°C
V_{ESD}	electrostatic discharge voltage	Human Body Model (HBM); according to ANSI/ESDA-JEDEC JS-001-2020-Device Testing, Human Body Model		-	±2	kV
		Charged Device Model (CDM); according to JEDEC standard 22-C101		-	±750	V

[1] high gain mode: GS1 = LOW; GS2 = HIGH (see Table 9)

[2] low gain mode: GS1 = HIGH; GS2 = LOW (see Table 9)

6. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC1}	supply voltage 1		4.75	5	5.25	V
V_{CC2}	supply voltage 2		4.75	5	5.25	V
$V_{ctrl(Gp)}$	power gain control voltage		0	-	3.3	V
$V_{I(GS1)}$	input voltage on pin GS1		0	-	3.3	V
$V_{I(GS2)}$	input voltage on pin GS2		0	-	3.3	V
Z_0	characteristic impedance		-	50	-	Ω
T_{case}	case temperature		–40	-	+85	°C

7. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-case)}$	thermal resistance from junction to case		[1]	42	K/W

[1] The case temperature is measured at the ground solder pad.

8. Characteristics

Table 7. Characteristics high gain mode

GS1 = LOW; GS2 = HIGH (see Table 9); V_{CC1} = 5 V; V_{CC2} = 5 V; f = 1750 MHz; T_{amb} = 25 °C; input and output 50 Ω; unless otherwise specified. All RF parameters have been characterized at the device RF input and RF output terminals.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC(tot)}$	total supply current		190	220	250	mA
$G_{p(min)}$	minimum power gain	$V_{ctrl(Gp)}$ = 3.3 V	-	13.5	-	dB
$G_{p(max)}$	maximum power gain	$V_{ctrl(Gp)}$ = 0 V	-	37	-	dB
$G_{p(flat)}$	power gain flatness	1710 MHz ≤ f ≤ 1785 MHz; 18 dB ≤ G_p ≤ 35 dB	-	0.3	-	dB
NF	noise figure	$V_{ctrl(Gp)}$ = 0 V (maximum power gain)	-	0.85	-	dB
		G_p = 35 dB	-	0.95	1.1	dB
		G_p = 18 dB	-	5.80	-	dB
$IP3_I$	input third-order intercept point	2-tone; tone-spacing = 1.0 MHz				
		G_p = 35 dB	0	0.8	-	dBm
		G_p = 30 dB	-	3.2	-	dBm
		G_p = 29 dB	-	3.5	-	dBm
		G_p = 18 dB	-	5.0	-	dBm
$P_{i(1dB)}$	input power at 1 dB gain compression	G_p = 35 dB	–14	–12.8	-	dBm
		G_p = 30 dB	-	–7.5	-	dBm
		G_p = 29 dB	-	–7.0	-	dBm
		G_p = 18 dB	-	–5.9	-	dBm
RL_{in}	input return loss	$V_{ctrl(Gp)}$ = 0 V (maximum power gain)	-	30	-	dB
		G_p = 35 dB	-	25	-	dB
RL_{out}	output return loss	$V_{ctrl(Gp)}$ = 0 V (maximum power gain)	-	17	-	dB
K	Rollett stability factor	0 GHz ≤ f ≤ 12.75 GHz	1	-	-	

Table 8. Characteristics low gain mode

GS1 = HIGH; GS2 = LOW (see Table 9); V_{CC1} = 5 V; V_{CC2} = 5 V; f = 1750 MHz; T_{amb} = 25 °C; input and output 50 Ω; unless otherwise specified. All RF parameters have been characterized at the device RF input and RF output terminals.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC(tot)}$	total supply current		165	190	215	mA
$G_{p(min)}$	minimum power gain	$V_{ctrl(Gp)}$ = 3.3 V	-	–6.6	-	dB
$G_{p(max)}$	maximum power gain	$V_{ctrl(Gp)}$ = 0 V	-	18.6	-	dB
$G_{p(flat)}$	power gain flatness	1710 MHz ≤ f ≤ 1785 MHz; 3 dB ≤ G_p ≤ 17 dB	-	0.1	-	dB
NF	noise figure	G_p = 17 dB	-	9.8	-	dB
		G_p = 3 dB	-	20.6	-	dB
$IP3_I$	input third-order intercept point	2-tone; tone-spacing = 1.0 MHz			-	
		G_p = 17 dB	-	20	-	dBm
		G_p = 12 dB	-	24	-	dBm
		G_p = 11 dB	-	25	-	dBm
		G_p = 3 dB	-	28	-	dBm

Table 8. Characteristics low gain mode *...continued*

GS1 = HIGH; GS2 = LOW (see Table 9); V_{CC1} = 5 V; V_{CC2} = 5 V; f = 1750 MHz; T_{amb} = 25 °C; input and output 50 Ω; unless otherwise specified. All RF parameters have been characterized at the device RF input and RF output terminals.

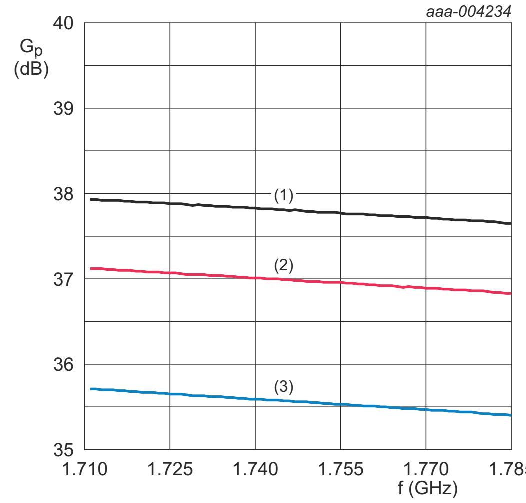
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{i(1dB)}$	input power at 1 dB gain compression	G_p = 17 dB	-	6.0	-	dBm
		G_p = 12 dB	-	10.0	-	dBm
		G_p = 11 dB	-	10.5	-	dBm
		G_p = 3 dB	-	10.5	-	dBm
RL_{in}	input return loss	$V_{ctrl(Gp)}$ = 0 V (maximum power gain)	-	30	-	dB
		G_p = 17 dB	-	25	-	dB
RL_{out}	output return loss	$V_{ctrl(Gp)}$ = 0 V (maximum power gain)	-	18	-	dB
K	Rollett stability factor	0 GHz ≤ f ≤ 12.75 GHz	1	-	-	

Table 9. Gain switch truth table

V_{CC1} = 5 V; V_{CC2} = 5 V; –10 °C ≤ T_{amb} ≤ +85 °C

Gain mode	GS1		GS2	
	logic	V_{GS1}	logic	V_{GS2}
high gain mode	LOW	0 V to 0.5 V	HIGH	2 V to 3.3 V
low gain mode	HIGH	2 V to 3.3 V	LOW	0 V to 0.5 V

8.1 Graphs



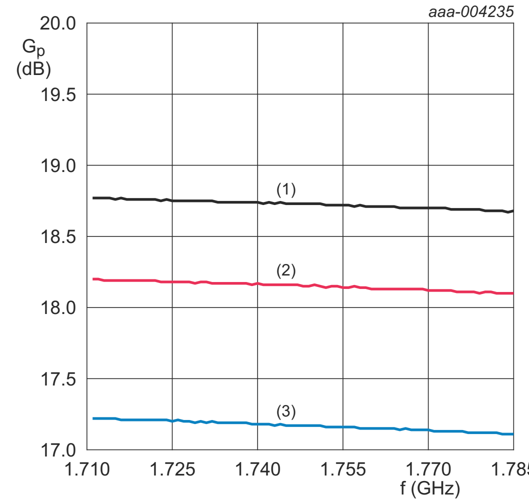
GS1 = LOW; GS2 = HIGH; V_{CC1} = 5 V; V_{CC2} = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) T_{amb} = –10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 3. Power gain as a function of frequency in high gain mode; typical values



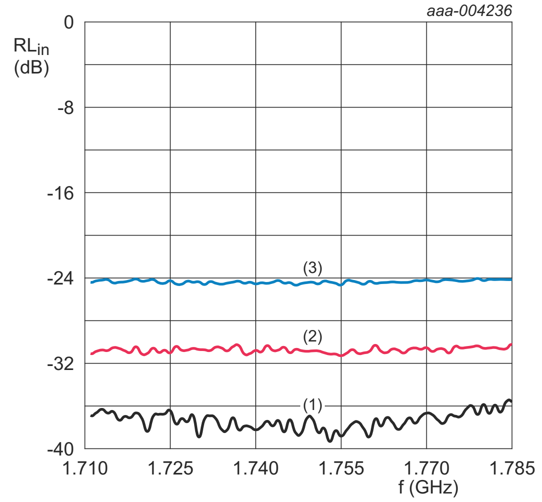
GS1 = HIGH; GS2 = LOW; V_{CC1} = 5 V; V_{CC2} = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) T_{amb} = –10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 4. Power gain as a function of frequency in low gain mode; typical values



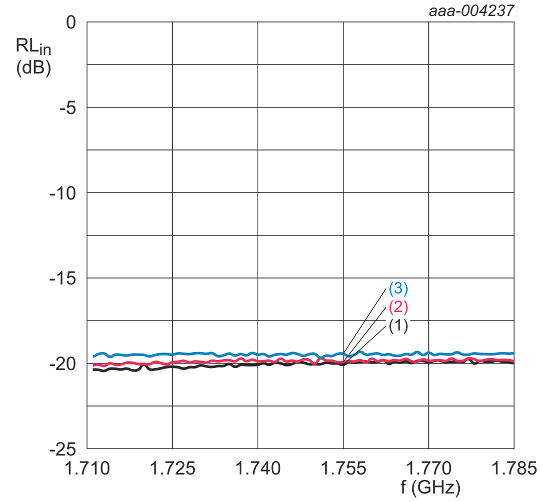
GS1 = LOW; GS2 = HIGH; V_{CC1} = 5 V; V_{CC2} = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 5. Input return loss as a function of frequency in high gain mode; typical values



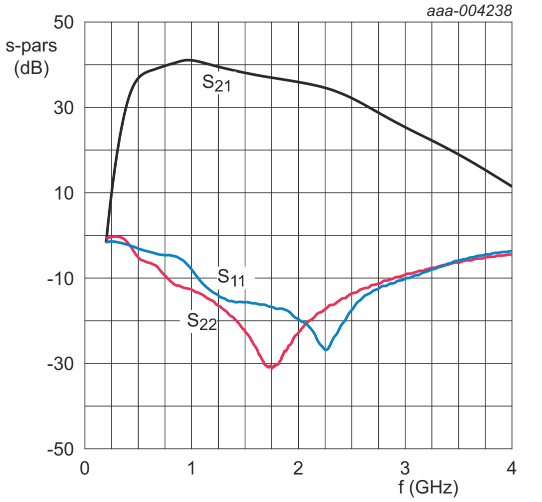
GS1 = HIGH; GS2 = LOW; V_{CC1} = 5 V; V_{CC2} = 5 V; $V_{ctrl(Gp)}$ = 0 V.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

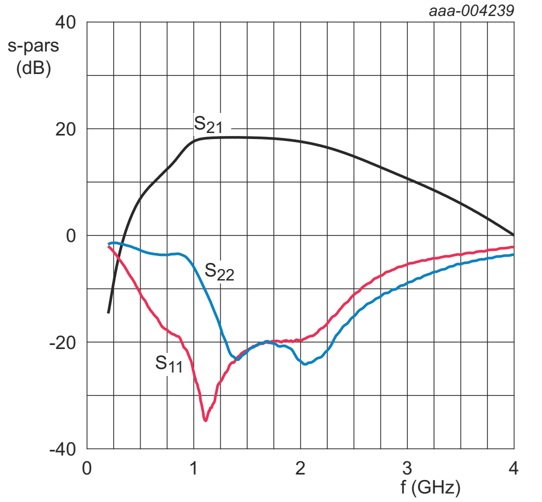
(3) T_{amb} = +85 °C

Fig 6. Input return loss as a function of frequency in low gain mode; typical values



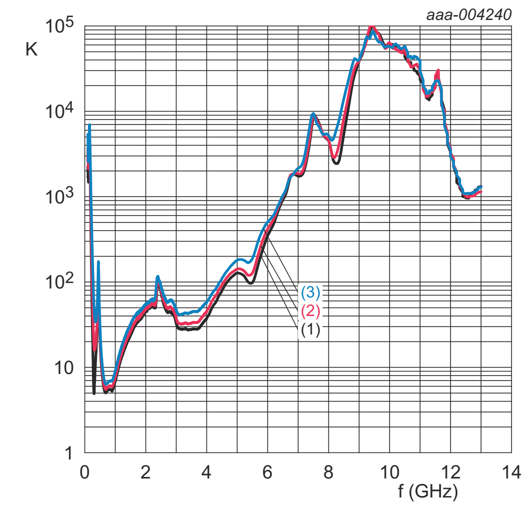
GS1 = LOW; GS2 = HIGH; V_{CC1} = 5 V; V_{CC2} = 5 V; $V_{ctrl(Gp)}$ = 0 V; T_{amb} = 25 °C.

Fig 7. S-parameters as a function of frequency in high gain mode; typical values



GS1 = HIGH; GS2 = LOW; V_{CC1} = 5 V; V_{CC2} = 5 V; $V_{ctrl(Gp)}$ = 0 V; T_{amb} = 25 °C.

Fig 8. S-parameters as a function of frequency in low gain mode; typical values



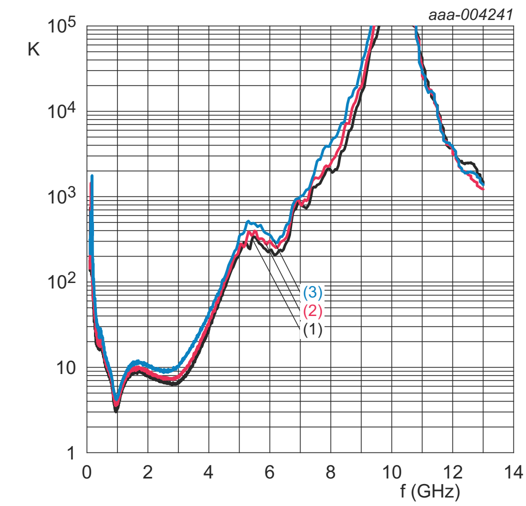
GS1 = LOW; GS2 = HIGH; V_{CC1} = 5 V; V_{CC2} = 5 V;
$V_{ctrl(Gp)}$ = 0 V.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 9. Rollet stability factor as a function of frequency in high gain mode; typical values



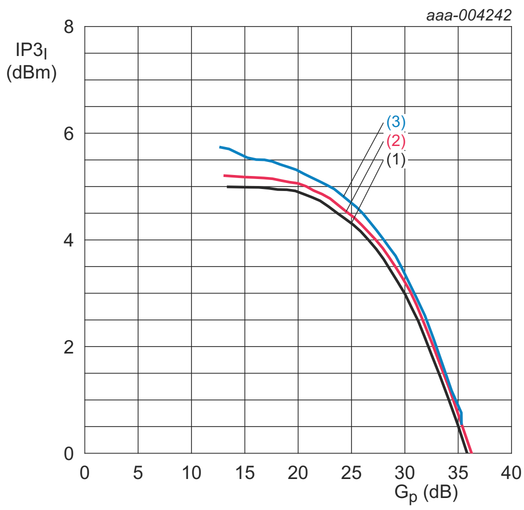
GS1 = HIGH; GS2 = LOW; V_{CC1} = 5 V; V_{CC2} = 5 V;
$V_{ctrl(Gp)}$ = 0 V.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 10. Rollet stability factor as a function of frequency in low gain mode; typical values



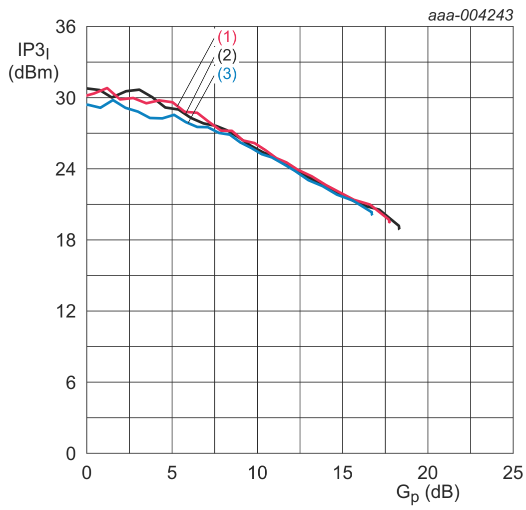
GS1 = LOW; GS2 = HIGH; V_{CC1} = 5 V; V_{CC2} = 5 V;
f = 1750 MHz.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 11. Input third-order intercept point as a function of power gain in high gain mode; typical values



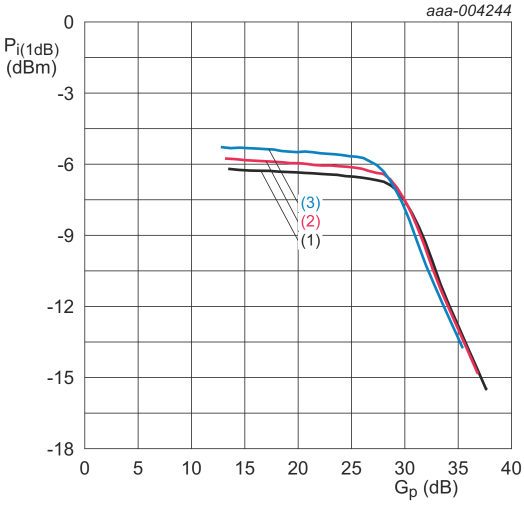
GS1 = HIGH; GS2 = LOW; V_{CC1} = 5 V; V_{CC2} = 5 V;
f = 1750 MHz.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 12. Input third-order intercept point as a function of power gain in low gain mode; typical values



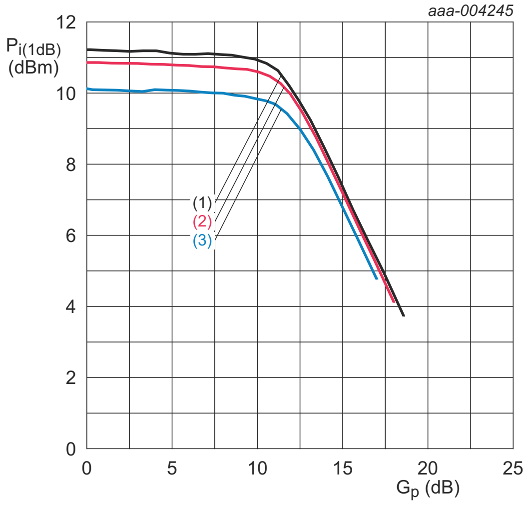
GS1 = LOW; GS2 = HIGH; V_{CC1} = 5 V; V_{CC2} = 5 V; f = 1750 MHz.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 13. Input power at 1 dB gain compression as a function of power gain in high gain mode; typical values



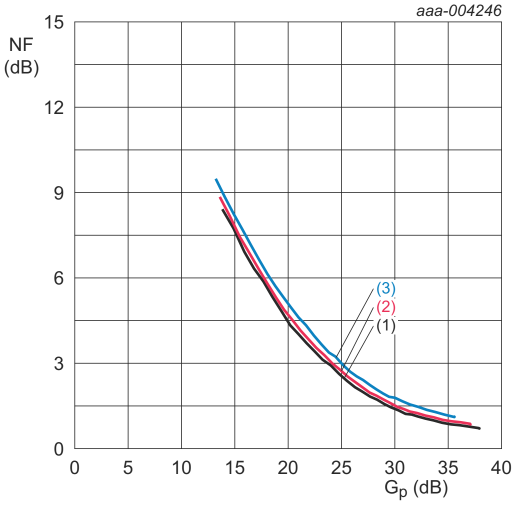
GS1 = HIGH; GS2 = LOW; V_{CC1} = 5 V; V_{CC2} = 5 V; f = 1750 MHz.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 14. Input power at 1 dB gain compression as a function of power gain in low gain mode; typical values



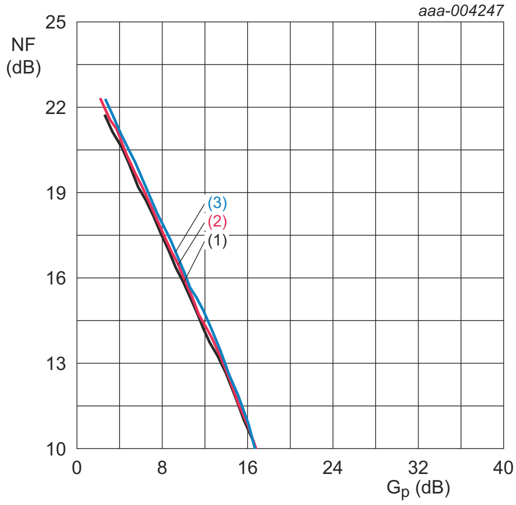
GS1 = LOW; GS2 = HIGH; V_{CC1} = 5 V; V_{CC2} = 5 V; f = 1750 MHz.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 15. Noise figure as a function of power gain in high gain mode; typical values



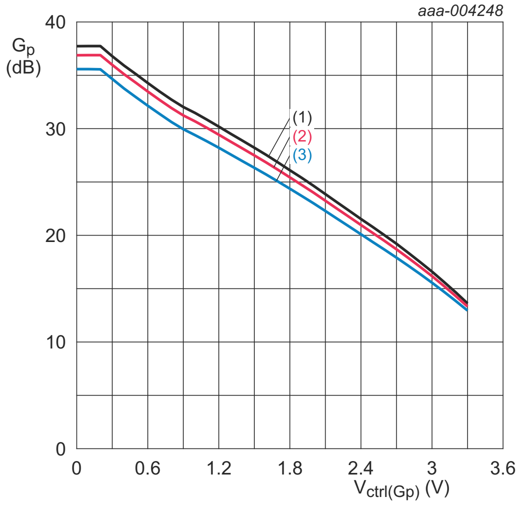
GS1 = HIGH; GS2 = LOW; V_{CC1} = 5 V; V_{CC2} = 5 V; f = 1750 MHz.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 16. Noise figure as a function of power gain in low gain mode; typical values



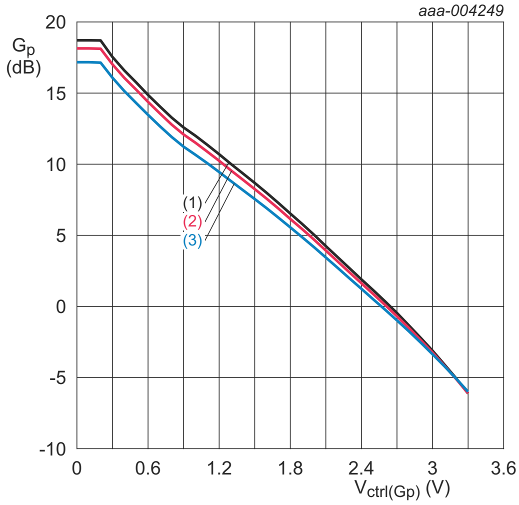
GS1 = LOW; GS2 = HIGH; V_{CC1} = 5 V; V_{CC2} = 5 V;
f = 1750 MHz.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 17. Power gain as a function of power gain control voltage in high gain mode; typical values



GS1 = HIGH; GS2 = LOW; V_{CC1} = 5 V; V_{CC2} = 5 V;
f = 1750 MHz.

(1) T_{amb} = −10 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 18. Power gain as a function of power gain control voltage in low gain mode; typical values

9. Application information

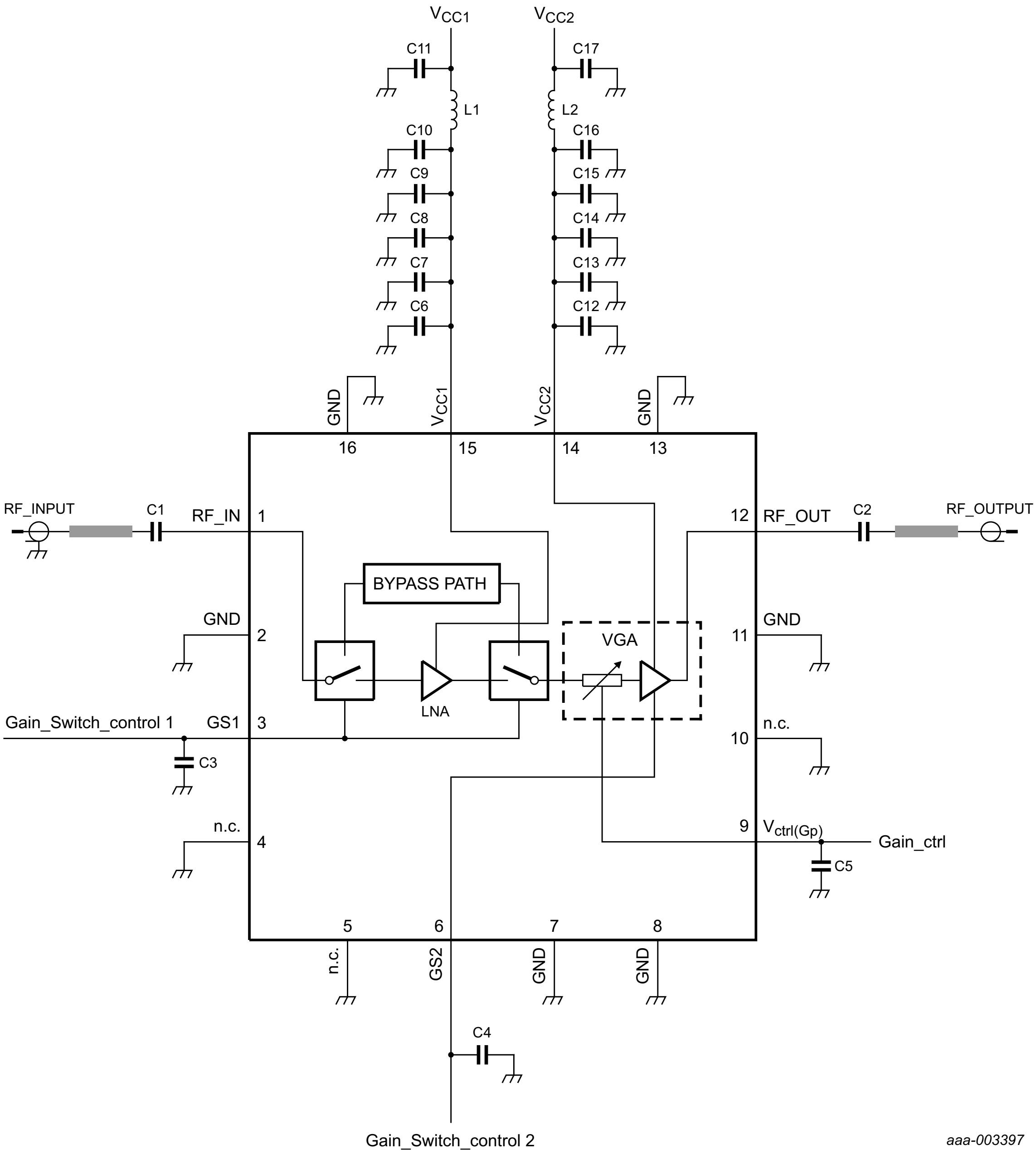
Table 10. List of components

For application circuit see Figure 19.

Component	Description	Value		Remarks
C1, C2	capacitor	1 nF	[1]	0402
C3, C4, C5, C6, C12	capacitor	100 pF	[1]	0402
C7, C8, C9, C10,	capacitor	optional		
C11, C17	capacitor	100 nF	[1]	0402
C13, C14, C15, C16	capacitor	optional		
L1, L2	inductor	10 nH	[2]	0402

[1] Murata GRM1555 series.

[2] Murata LQG15 series.

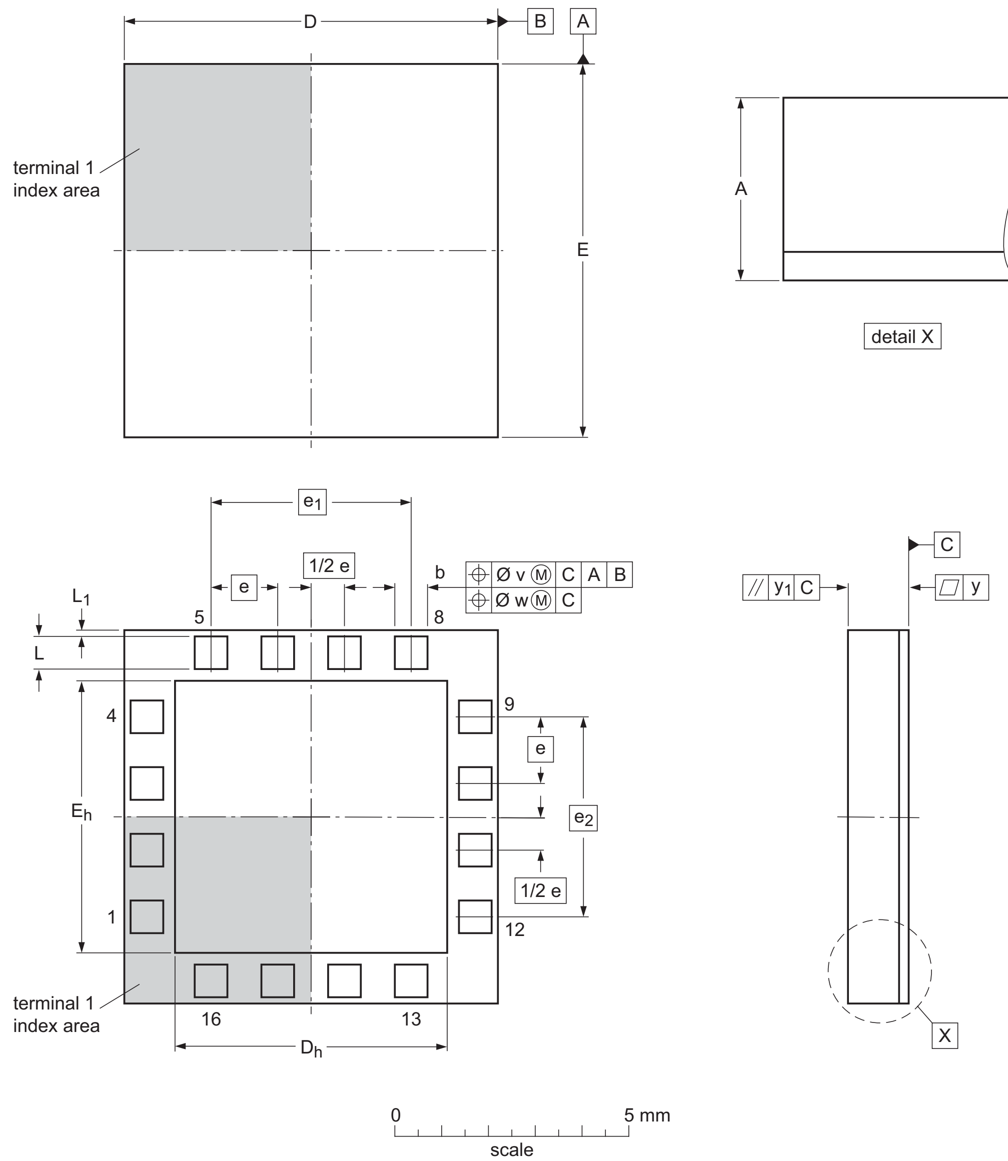


See Table 10 for a list of components.

Fig 19. Schematic layout for application circuit

10. Package outline

HLQFN16R: plastic thermal enhanced low profile quad flat package; no leads; 16 terminals; body 8 x 8 x 1.3 mm **SOT1301-1**



Dimensions

Unit		A	b	D	D_h	E	E_h	e	e_1	e_2	L	L_1	v	w	y	y_1
mm	max	1.40	0.75	8.1	5.85	8.1	5.85				0.75	0.15				
	nom	1.30	0.70	8.0	5.80	8.0	5.80	1.42	4.26	4.26	0.70	0.10	0.1	0.05	0.08	0.1
	min	1.25	0.65	7.9	5.75	7.9	5.75				0.65	0.05				

sot1301-1_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1301-1						~~11-08-23~~ 11-08-29

Fig 20. Package outline SOT1301-1 (HLQFN16R)

11. Abbreviations

Table 11. Abbreviations

Acronym	Description
3G	3rd Generation
ESD	ElectroStatic Discharge
LNA	Low Noise Amplifier
LTE	Long Term Evolution

12. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGU7062 v.1	20120810	Preliminary data sheet	-	-

13. Legal information

13.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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For sales office addresses, please send an email to: **salesaddresses@nxp.com**

15. Contents

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