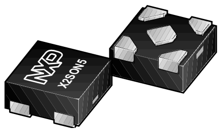


BGU8309

SiGe:C low-noise amplifier MMIC for GPS, GLONASS, Galileo and COMPASS

Rev. 4 — 18 January 2017 Product data sheet

1. General description

The BGU8309 is, also known as the GPS1401M, a low current Low Noise-Amplifier (LNA) for GNSS receiver applications. The BGU8309 is available in a small plastic 5-pin extremely thin leadless package. The BGU8309 requires only one external matching inductor and is optimized for higher $IP3_i$ performance.

The BGU8309 adapts itself to the changing environment resulting from co-habitation of different radio systems in modern cellular handsets. It has been designed for ultra low power consumption and optimal performance when jamming signals from co-existing cellular transmitters are present. At low jamming power levels, it delivers 17 dB gain at a noise figure of 0.65 dB and a supply current of 3.6 mA. During high jamming power levels, resulting for example from a cellular transmit burst, it temporarily increases its bias current to improve sensitivity.

2. Features and benefits

- Out of band $IP3_i$ of 5 dBm
- Optimized performance at a low supply current of 3.6 mA
- Covers full GNSS L1 band, from 1559 MHz to 1610 MHz
- Noise figure = 0.7 dB
- Gain 17 dB
- Input 1 dB compression point of –9 dBm
- Supply voltage 1.5 V to 3.1 V
- Integrated supply decoupling capacitor
- Power-down mode current consumption < 1 μA
- Integrated temperature stabilized bias for easy design
- Requires only one input matching inductor
- RF input and RF output are AC coupled through internal DC blocking caps
- ESD protection on all pins (HBM > 2 kV)
- Integrated matching for the output
- Available in a 5-pins leadless package 0.8 mm × 0.8 mm × 0.35 mm: SOT1226-2
- 180 GHz transit frequency - SiGe:C technology
- Moisture sensitivity level 1

3. Applications

- LNA for GPS, GLONASS
- Galileo and Compass (BeiDou) in smart phones
- Feature phones
- Tablet PCs
- Digital still cameras
- Digital video cameras
- RF front-end modules
- Complete GNSS modules
- Wearable applications

4. Quick reference data

Table 1. Quick reference data

f = 1575 MHz; V_{CC} = 1.8 V; $V_{I(ENABLE)} \geq 0.8$ V; $P_i < -40$ dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 6.8 nH inductor, see Figure 3. Unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CC}	supply voltage			1.5	-	3.1	V
I_{CC}	supply current	$P_i < -40$ dBm		1.6	3.6	5.6	mA
G_p	power gain	no jammer		15	17	19	dB
NF	noise figure	$P_i = -40$ dBm; no jammer	[1][2]	-	0.7	1.25	dB
$P_{i(1dB)}$	input power at 1 dB gain compression		[2]	–14	–9	-	dBm
$IP3_i$	input third-order intercept point		[2][3]	–1	5	-	dBm

[1] PCB losses are subtracted.

[2] Guaranteed by device design, but not tested in production.

[3] f_1 = 1713 MHz; f_2 = 1851 MHz; P_i = –20 dBm at f_1; P_i = –65 dBm at f_2.

5. Ordering information

Table 2. Ordering information

Type number	Package		
	Name	Description	Version
BGU8309	X2SON5	plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body 0.8 × 0.8 × 0.35 mm	SOT1226-2
OM17017	EVB	BGU8309; evaluation board, MMIC only	-

6. Marking

Table 3. Marking codes

Type number	Marking code
BGU8309	A

7. Block diagram

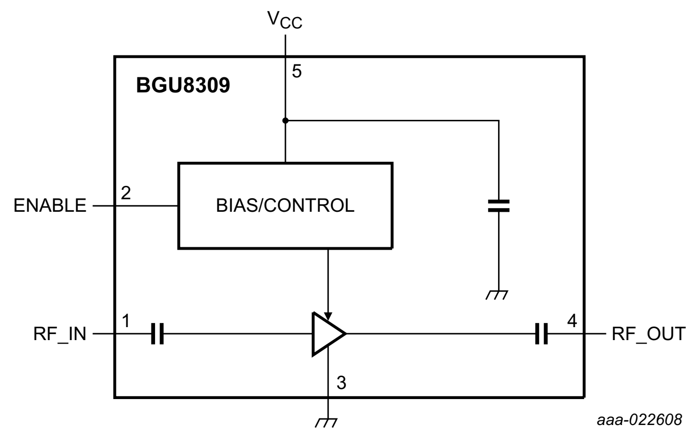


Fig 1. Block diagram

8. Pinning information

8.1 Pinning

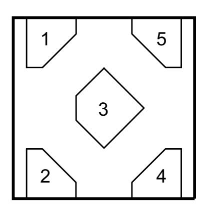


Fig 2. Pin configuration

8.2 Pin description

Table 4. Pin description

Symbol	Pin	Description
RF_IN	1	RF input
ENABLE	2	enable
GND	3	ground
RF_OUT	4	RF output
V_{CC}	5	supply voltage

9. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).
See Section 18.3 “Disclaimers”, paragraph “Limiting values”.

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage		[1]	–0.5	+5.0	V
$V_{I(ENABLE)}$	input voltage on pin ENABLE	$V_{I(ENABLE)} < V_{CC} + 0.6$ V	[1][2]	–0.5	+5.0	V
$V_{I(RF\_IN)}$	input voltage on pin RF_IN	DC; $V_{I(RF\_IN)} < V_{CC} + 0.6$ V	[1][2][3]	–0.5	+5.0	V
$V_{I(RF\_OUT)}$	input voltage on pin RF_OUT	DC; $V_{I(RF\_OUT)} < V_{CC} + 0.6$ V	[1][2][3]	–0.5	+5.0	V
P_i	input power		[1]	-	10	dBm
P_{tot}	total power dissipation	$T_{sp} \leq 130$ °C		-	55	mW
T_{stg}	storage temperature			–65	+150	°C
T_j	junction temperature			-	150	°C
V_{ESD}	electrostatic discharge voltage	Human Body Model (HBM) according to JEDEC standard JS-001-2010		-	±2	kV
		Charged Device Model (CDM) according to JEDEC standard JESD22-C101C		-	±1	kV

[1] Stressed with pulses of 200 ms in duration, with application circuit as in Figure 3.

[2] Warning: Due to internal ESD diode protection, to avoid excess current, the applied DC voltage must not exceed V_{CC} + 0.6 V or 5.0 V.

[3] The RF input and RF output are AC coupled through internal DC blocking capacitors.

10. Recommended operating conditions

Table 6. Operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage		1.5	-	3.1	V
T_{amb}	ambient temperature		–40	+25	+85	°C
$V_{I(ENABLE)}$	input voltage on pin ENABLE	OFF state	-	-	0.3	V
		ON state	0.8	-	-	V

11. Thermal characteristics

Table 7. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-bop)}$	thermal resistance from junction to bottom of package	in free air	[1]	192	K/W
$R_{th(j-pcb)}$	thermal resistance from junction to printed-circuit board	in free air	[2]	330	K/W
Ψ_{j-pcb}	thermal characterization parameter from junction to printed-circuit board	in free air	[2]	177	K/W

[1] Simulated using finite element method resembling device on NXP application board.

[2] Measured with device mounted on NXP application board.

12. Characteristics

Table 8. Characteristics at V_{CC} = 1.8 V

f = 1575 MHz; $V_{I(ENABLE)} \geq 0.8$ V; $P_i < -40$ dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 6.8 nH inductor, see Figure 3, unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{CC}	supply current	$V_{I(ENABLE)} \geq 0.8$ V					
		$P_i < -40$ dBm		1.6	3.6	5.6	mA
		$P_i = -20$ dBm		-	4.6	-	mA
		$V_{I(ENABLE)} \leq 0.3$ V		-	-	1	µA
G_p	power gain	no jammer		15	17	19	dB
		$P_{jam} = -20$ dBm; f_{jam} = 850 MHz		-	17	-	dB
		$P_{jam} = -20$ dBm; f_{jam} = 1850 MHz		-	17	-	dB
RL_{in}	input return loss	$P_i < -40$ dBm		-	12	-	dB
		$P_i = -20$ dBm		-	12	-	dB
RL_{out}	output return loss	$P_i < -40$ dBm		-	10	-	dB
		$P_i = -20$ dBm		-	10	-	dB
ISL	isolation			-	22	-	dB
NF	noise figure	$P_i = -40$ dBm; no jammer	[1][2]	-	0.7	1.25	dB
		$P_i = -40$ dBm; no jammer	[2][3]	-	0.8	1.35	dB
		$P_{jam} = -20$ dBm; f_{jam} = 850 MHz	[3]	-	1.0	-	dB
		$P_{jam} = -20$ dBm; f_{jam} = 1850 MHz	[3]	-	1.4	-	dB
$P_{i(1dB)}$	input power at 1 dB gain compression		[2]	–14	–9	-	dBm
$IP3_i$	input third-order intercept point		[2][4]	–1	5	-	dBm
IMD3	third-order intermodulation distortion	input	[4]	-	–98	-	dBm
K	Rollett stability factor			-	>1	-	-
t_{on}	turn-on time	time from $V_{I(ENABLE)}$ ON to 90 % of the gain		-	-	2	µs
t_{off}	turn-off time	time from $V_{I(ENABLE)}$ OFF to 10 % of the gain		-	-	1	µs

[1] PCB losses are subtracted.

[2] Guaranteed by device design, but not tested in production.

[3] Including PCB losses.

[4] f_1 = 1713 MHz; f_2 = 1851 MHz; $P_i = -20$ dBm at f_1; $P_i = -65$ dBm at f_2.

Table 9. Characteristics at V_{CC} = 2.85 V

f = 1575 MHz; $V_{I(ENABLE)} \geq 0.8$ V; $P_i < -40$ dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 6.8 nH inductor, see Figure 3; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{CC}	supply current	$V_{I(ENABLE)} \geq 0.8$ V				
		$P_i < -40$ dBm	1.6	3.6	5.6	mA
		$P_i = -20$ dBm	-	4.6	-	mA
		$V_{I(ENABLE)} \leq 0.3$ V	-	-	1	µA

Table 9. Characteristics at V_{CC} = 2.85 V *…continued*

f = 1575 MHz; $V_{I(ENABLE)} \geq 0.8$ V; $P_i < -40$ dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 6.8 nH inductor, see Figure 3; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
G_p	power gain	no jammer	15	17	19	dB
		P_{jam} = –20 dBm; f_{jam} = 850 MHz	-	17	-	dB
		P_{jam} = –20 dBm; f_{jam} = 1850 MHz	-	17	-	dB
RL_{in}	input return loss	P_i < –40 dBm	-	12	-	dB
		P_i = –20 dBm	-	12	-	dB
RL_{out}	output return loss	P_i < –40 dBm	-	10	-	dB
		P_i = –20 dBm	-	10	-	dB
ISL	isolation		-	22	-	dB
NF	noise figure	P_i = –40 dBm; no jammer [1][2]	-	0.7	1.25	dB
		P_i = –40 dBm; no jammer [2][3]	-	0.8	1.35	dB
		P_{jam} = –20 dBm; f_{jam} = 850 MHz [3]	-	1.0	-	dB
		P_{jam} = –20 dBm; f_{jam} = 1850 MHz [3]	-	1.4	-	dB
$P_{i(1dB)}$	input power at 1 dB gain compression	[2]	–14	–9	-	dBm
$IP3_i$	input third-order intercept point	[2][4]	–1	5	-	dBm
IMD3	third-order intermodulation distortion	input [4]	-	–98	-	dBm
K	Rollett stability factor		-	>1	-	-
t_{on}	turn-on time	time from $V_{I(ENABLE)}$ ON, to 90 % of the gain	-	-	2	µs
t_{off}	turn-off time	time from $V_{I(ENABLE)}$ OFF, to 10 % of the gain	-	-	1	µs

[1] PCB losses are subtracted.

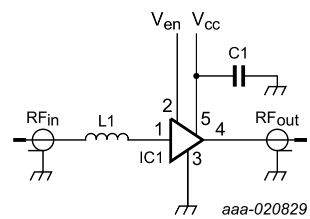
[2] Guaranteed by device design, but not tested in production.

[3] Including PCB losses.

[4] f_1 = 1713 MHz; f_2 = 1851 MHz; P_i = –20 dBm at f_1; P_i = –65 dBm at f_2.

13. Application information

13.1 GNSS LNA



For a list of components, see Table 10.

Fig 3. Schematics GNSS LNA evaluation board

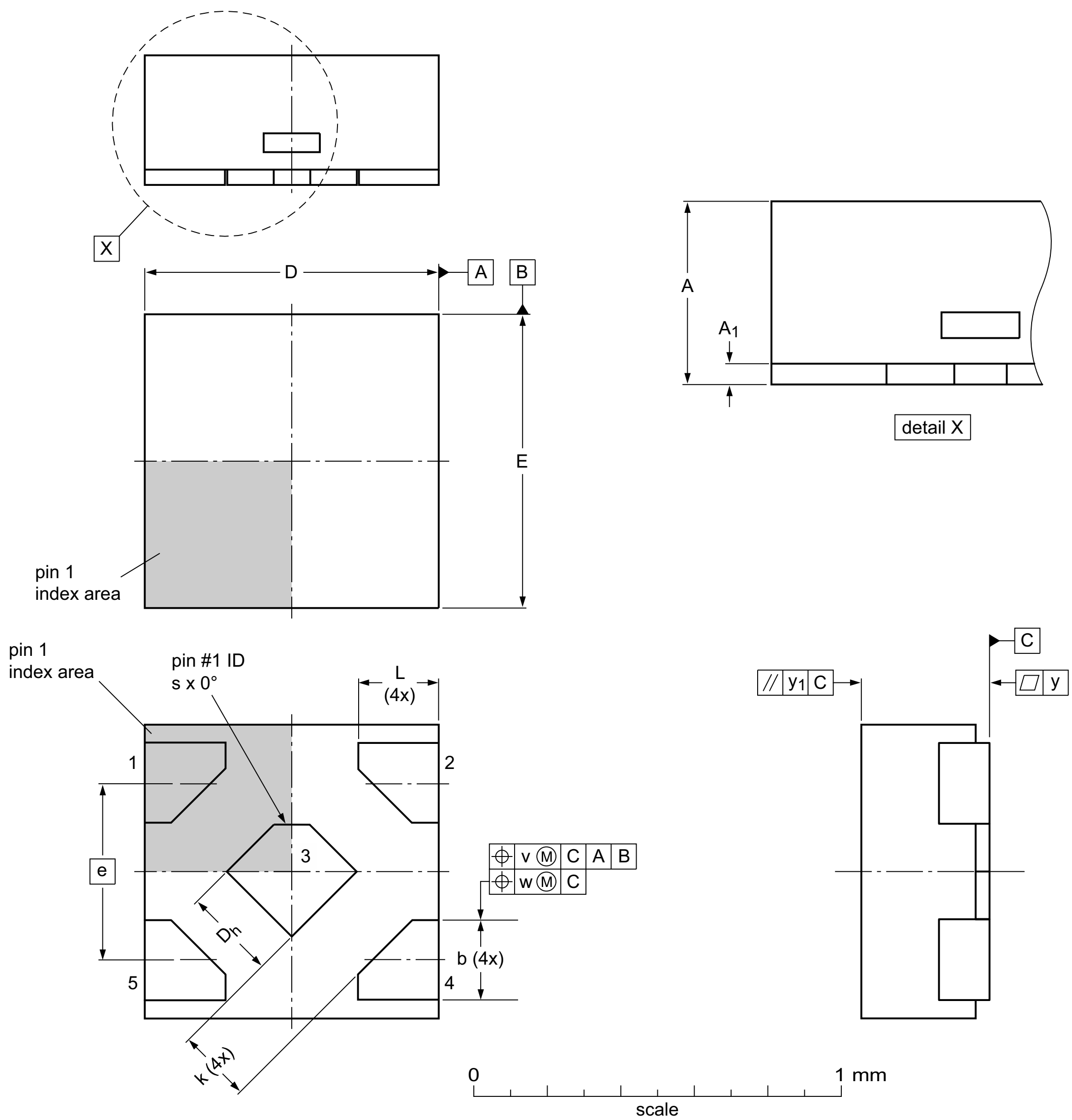
Table 10. List of components

For schematics, see Figure 3.

Component	Description	Value	Remarks
C1	decoupling capacitor	1 nF	to suppress power supply noise
IC1	BGU8309	-	NXP Semiconductors
L1	high-quality matching inductor	6.8 nH	Murata LQW15A

14. Package outline

X2SON5: plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body 0.8 x 0.8 x 0.32 mm **SOT1226-2**



Dimensions (mm are the original dimensions)

Unit		A	A_1	D	D_h	E	b	e	K	L	s	v	w	y	y_1
mm	max	0.35	0.04	0.85	0.30	0.85	0.27			0.27					
	nom	0.32	0.02	0.80	0.25	0.80	0.22	0.48		0.22	0.1 (ref)	0.1	0.05	0.05	0.05
	min	0.30	0.00	0.75	0.20	0.75	0.17		0.20	0.17					

sot1226-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	EIAJ			
SOT1226-2		- - -				~~16-03-31~~ 16-04-05

Fig 4. Package outline SOT1226-2(X2SON5)

15. Handling information

CAUTION	
	This device is sensitive to ElectroStatic Discharge (ESD). Observe precautions for handling electrostatic sensitive devices. Such precautions are described in the *ANSI/ESD S20.20*, *IEC/ST 61340-5*, *JESD625-A* or equivalent standards.

16. Abbreviations

Table 11. Abbreviations

Acronym	Description
ESD	ElectroStatic Discharge
HBM	Human Body Model
GLONASS	Globalnaya Navigazionnaya Sputnikovaya Sistema
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
LNA	Low-Noise Amplifier
RF	Radio Frequency
TDD	Time-Division Duplexing

17. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGU8309 v.4	20170118	Product data sheet	-	BGU8309 v.3
Modifications:	Section 1: added GPS1401M according to our new naming convention			
BGU8309 v.3	20161102	Product data sheet	-	BGU8309 v.2
Modification:	• Table 8 on page 5: the minimum value for I_{CC}, P_i < –40 dBm has been changed to 1.6 • Table 8 on page 5; the maximum value for I_{CC}, P_i < –40 dBm has been changed to 5.6 • Table 8 on page 5: the minimum value for G_p, no jammer has been changed to 15 • Table 8 on page 5: the maximum value for G_p, no jammer has been changed to 19 • Table 8 on page 5: the maximum value for NF, P_i = –40 dBm; no jammer has been changed to 1.25 • Table 8 on page 5: the maximum value for NF, P_i = –40 dBm; no jammer has been changed to 1.35 • Table 8 on page 5: the minimum value for $P_{i(1dB)}$ has been changed to –14 • Table 8 on page 5: the minimum value for $IP3_i$ has been changed to –1 • Table 9 on page 5: the minimum value for I_{CC}, P_i < –40 dBm has been changed to 1.6 • Table 9 on page 5; the maximum value for I_{CC}, P_i < –40 dBm has been changed to 5.6 • Table 9 on page 5: the minimum value for G_p, no jammer has been changed to 15 • Table 9 on page 5: the maximum value for G_p, no jammer has been changed to 19 • Table 9 on page 5: the maximum value for NF, P_i = –40 dBm; no jammer has been changed to 1.25 • Table 9 on page 5: the maximum value for NF, P_i = –40 dBm; no jammer has been changed to 1.35 • Table 9 on page 5: the minimum value for $P_{i(1dB)}$ has been changed to –14 • Table 9 on page 5: the minimum value for $IP3_i$ has been changed to –1			
BGU8309 v.2	20160808	Product data sheet	-	BGU8309 v.1
Modification:	• Status changed from objective to product.			
BGU8309 v.1	20160718	Objective data sheet	-	-

18. Legal information

18.1 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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20. Contents

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Date of release: 18 January 2017

Document identifier: BGU8309