



# 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 IP<sub>3i</sub> 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 IP<sub>3i</sub> 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**

$f = 1575 \text{ MHz}$ ;  $V_{CC} = 1.8 \text{ V}$ ;  $V_{I(ENABLE)} \geq 0.8 \text{ V}$ ;  $P_i < -40 \text{ dBm}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ ; input matched to  $50 \text{ } \Omega$  using a  $6.8 \text{ nH}$  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	$P_i < -40 \text{ dBm}$	1.6	3.6	5.6	mA
$G_p$	power gain	no jammer	15	17	19	dB
NF	noise figure	$P_i = -40 \text{ dBm}$ ; 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]  $f_1 = 1713 \text{ MHz}$ ;  $f_2 = 1851 \text{ MHz}$ ;  $P_i = -20 \text{ dBm}$  at  $f_1$ ;  $P_i = -65 \text{ dBm}$  at  $f_2$ .

### 5. Ordering information

**Table 2. Ordering information**

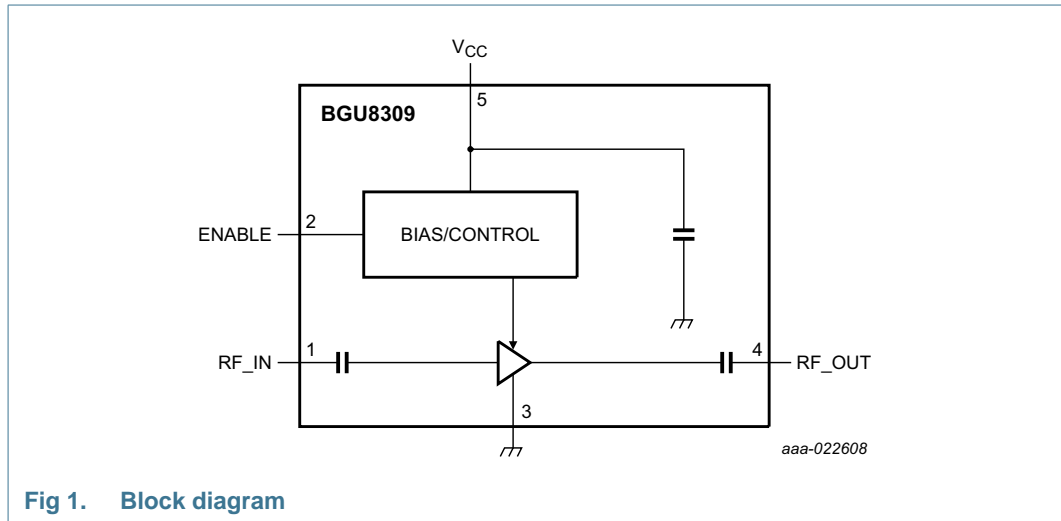
Type number	Package		Version
	Name	Description	
BGU8309	X2SON5	plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body $0.8 \times 0.8 \times 0.35 \text{ mm}$	SOT1226-2
OM17017	EVB	BGU8309; evaluation board, MMIC only	-

### 6. Marking

**Table 3. Marking codes**

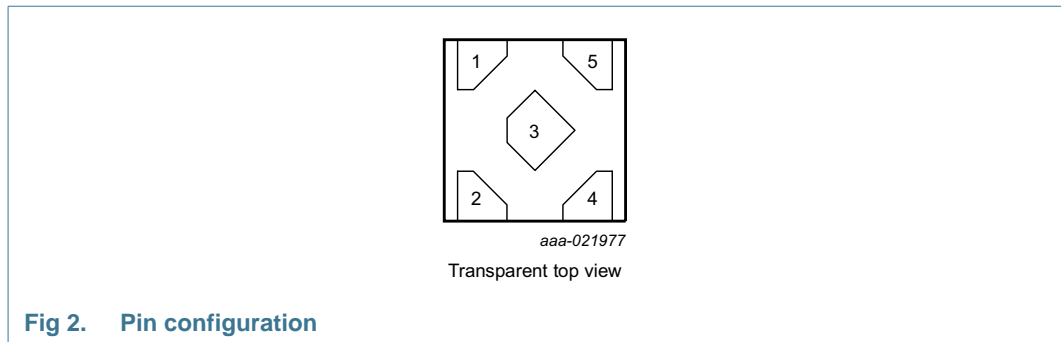
Type number	Marking code
BGU8309	A

## 7. Block diagram



## 8. Pinning information

### 8.1 Pinning



### 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 <sub>CC</sub>	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
$\Psi_{j-pcb}$	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  $V_{CC} = 1.8\text{ V}$**

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

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

[1] PCB losses are subtracted.

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

[3] Including PCB losses.

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

**Table 9. Characteristics at  $V_{CC} = 2.85\text{ V}$**

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

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

**Table 9. Characteristics at  $V_{CC} = 2.85\text{ V}$  ...continued**

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

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

[1] PCB losses are subtracted.

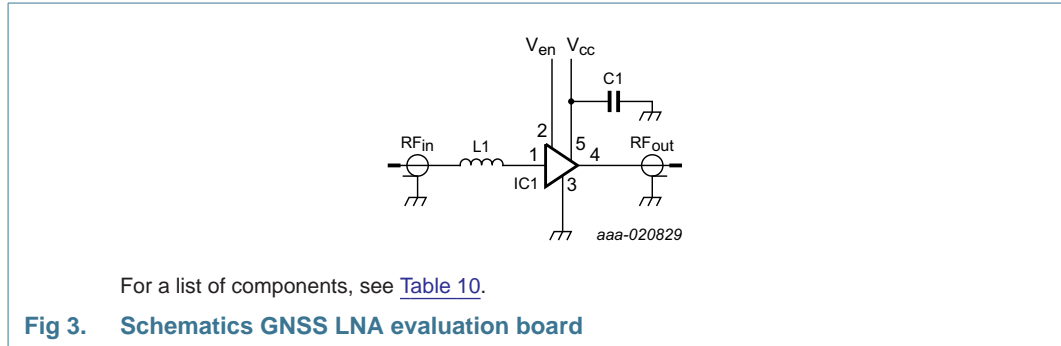
[2] Guaranteed by device design, but not tested in production.

[3] Including PCB losses.

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

### 13. Application information

#### 13.1 GNSS LNA



**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

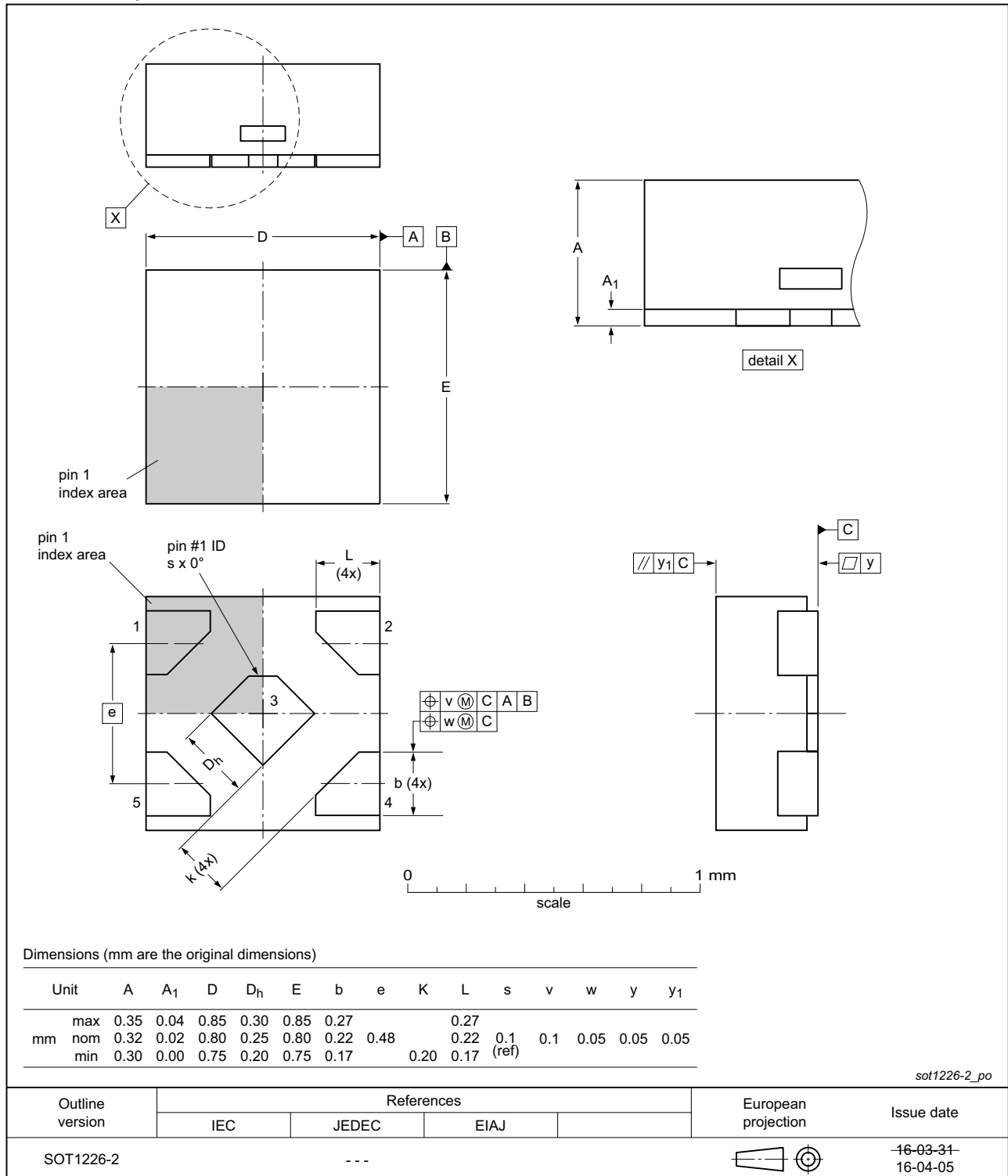


Fig 4. Package outline SOT1226-2(X2SON5)



## 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:	<a href="#">Section 1</a> : added GPS1401M according to our new naming convention			
BGU8309 v.3	20161102	Product data sheet	-	BGU8309 v.2
Modification:	<ul style="list-style-type: none"> <li>• <a href="#">Table 8 on page 5</a>: the minimum value for <math>I_{CC}</math>, <math>P_i &lt; -40</math> dBm has been changed to 1.6</li> <li>• <a href="#">Table 8 on page 5</a>: the maximum value for <math>I_{CC}</math>, <math>P_i &lt; -40</math> dBm has been changed to 5.6</li> <li>• <a href="#">Table 8 on page 5</a>: the minimum value for <math>G_p</math>, no jammer has been changed to 15</li> <li>• <a href="#">Table 8 on page 5</a>: the maximum value for <math>G_p</math>, no jammer has been changed to 19</li> <li>• <a href="#">Table 8 on page 5</a>: the maximum value for NF, <math>P_i = -40</math> dBm; no jammer has been changed to 1.25</li> <li>• <a href="#">Table 8 on page 5</a>: the maximum value for NF, <math>P_i = -40</math> dBm; no jammer has been changed to 1.35</li> <li>• <a href="#">Table 8 on page 5</a>: the minimum value for <math>P_{i(1dB)}</math> has been changed to -14</li> <li>• <a href="#">Table 8 on page 5</a>: the minimum value for <math>IP3_i</math> has been changed to -1</li> <li>• <a href="#">Table 9 on page 5</a>: the minimum value for <math>I_{CC}</math>, <math>P_i &lt; -40</math> dBm has been changed to 1.6</li> <li>• <a href="#">Table 9 on page 5</a>: the maximum value for <math>I_{CC}</math>, <math>P_i &lt; -40</math> dBm has been changed to 5.6</li> <li>• <a href="#">Table 9 on page 5</a>: the minimum value for <math>G_p</math>, no jammer has been changed to 15</li> <li>• <a href="#">Table 9 on page 5</a>: the maximum value for <math>G_p</math>, no jammer has been changed to 19</li> <li>• <a href="#">Table 9 on page 5</a>: the maximum value for NF, <math>P_i = -40</math> dBm; no jammer has been changed to 1.25</li> <li>• <a href="#">Table 9 on page 5</a>: the maximum value for NF, <math>P_i = -40</math> dBm; no jammer has been changed to 1.35</li> <li>• <a href="#">Table 9 on page 5</a>: the minimum value for <math>P_{i(1dB)}</math> has been changed to -14</li> <li>• <a href="#">Table 9 on page 5</a>: the minimum value for <math>IP3_i</math> has been changed to -1</li> </ul>			
BGU8309 v.2	20160808	Product data sheet	-	BGU8309 v.1
Modification:	<ul style="list-style-type: none"> <li>• Status changed from objective to product.</li> </ul>			
BGU8309 v.1	20160718	Objective data sheet	-	-

## 18. Legal information

### 18.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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".

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