



# BGU8309

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

Rev. 4 — 18 January 2017

Product data sheet

## 1. General description

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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

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- 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  $\mu$ A
- 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  $\times$  0.8 mm  $\times$  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**

$f = 1575\text{ MHz}$ ;  $V_{CC} = 1.8\text{ V}$ ;  $V_{I(ENABLE)} \geq 0.8\text{ V}$ ;  $P_i < -40\text{ dBm}$ ;  $T_{amb} = 25\text{ °C}$ ; 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 <a href="#">[1][2]</a>	-	0.7	1.25	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][3]</a>	-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**

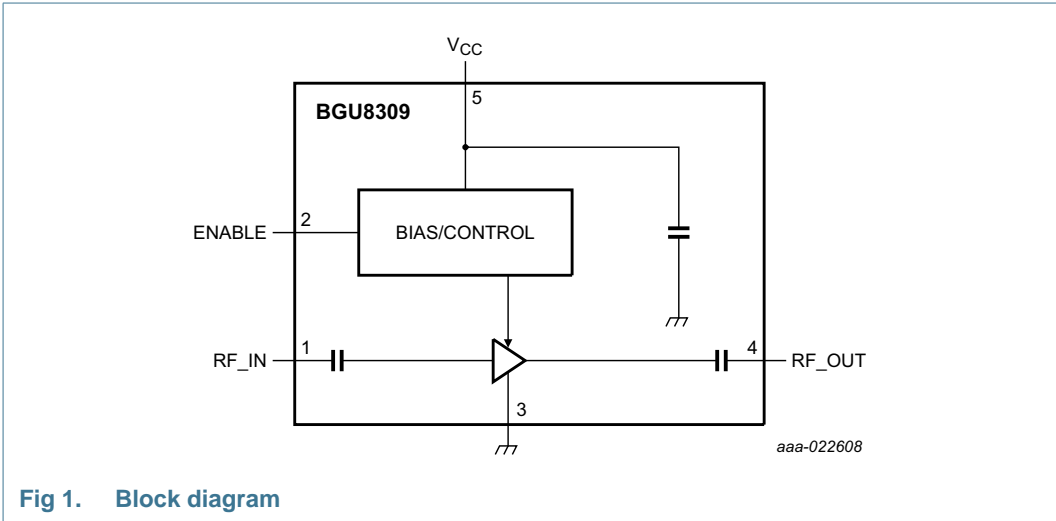
Type number	Package		
	Name	Description	Version
BGU8309	X2SON5	plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body $0.8 \times 0.8 \times 0.35\text{ mm}$	SOT1226-2
OM17017	EVB	BGU8309; evaluation board, MMIC only	-

### 6. Marking

**Table 3. Marking codes**

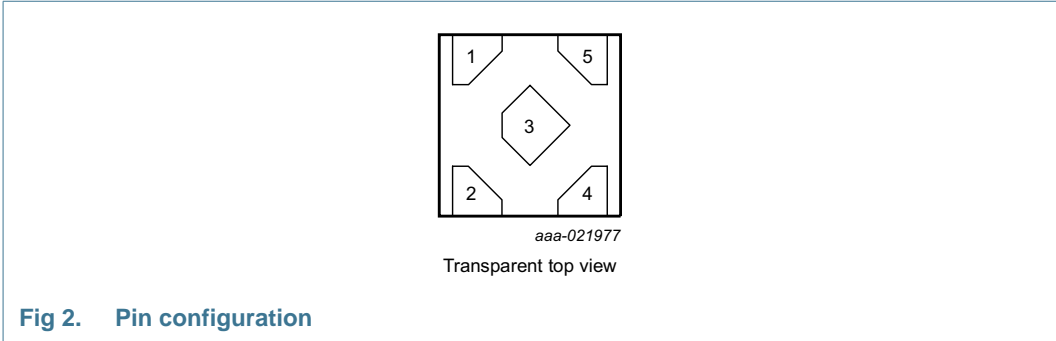
Type number	Marking code
BGU8309	A

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

$f = 1575\text{ MHz}$ ;  $V_{I(ENABLE)} \geq 0.8\text{ V}$ ;  $P_i < -40\text{ dBm}$ ;  $T_{amb} = 25^\circ\text{C}$ ; input matched to  $50\ \Omega$  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

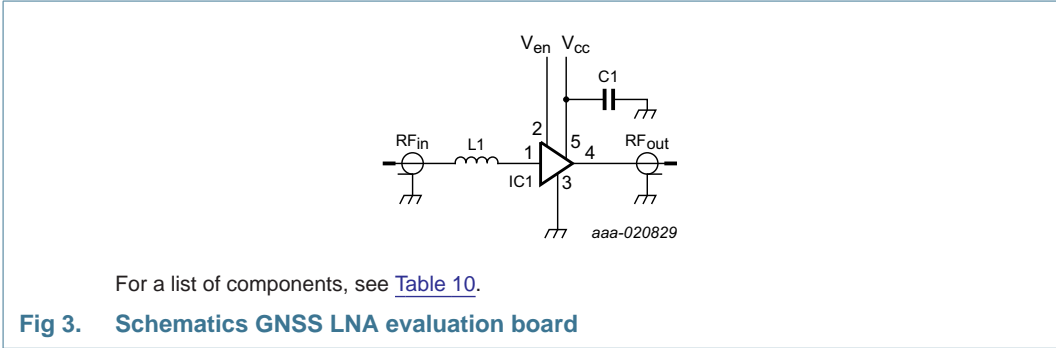


Table 10. List of components

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

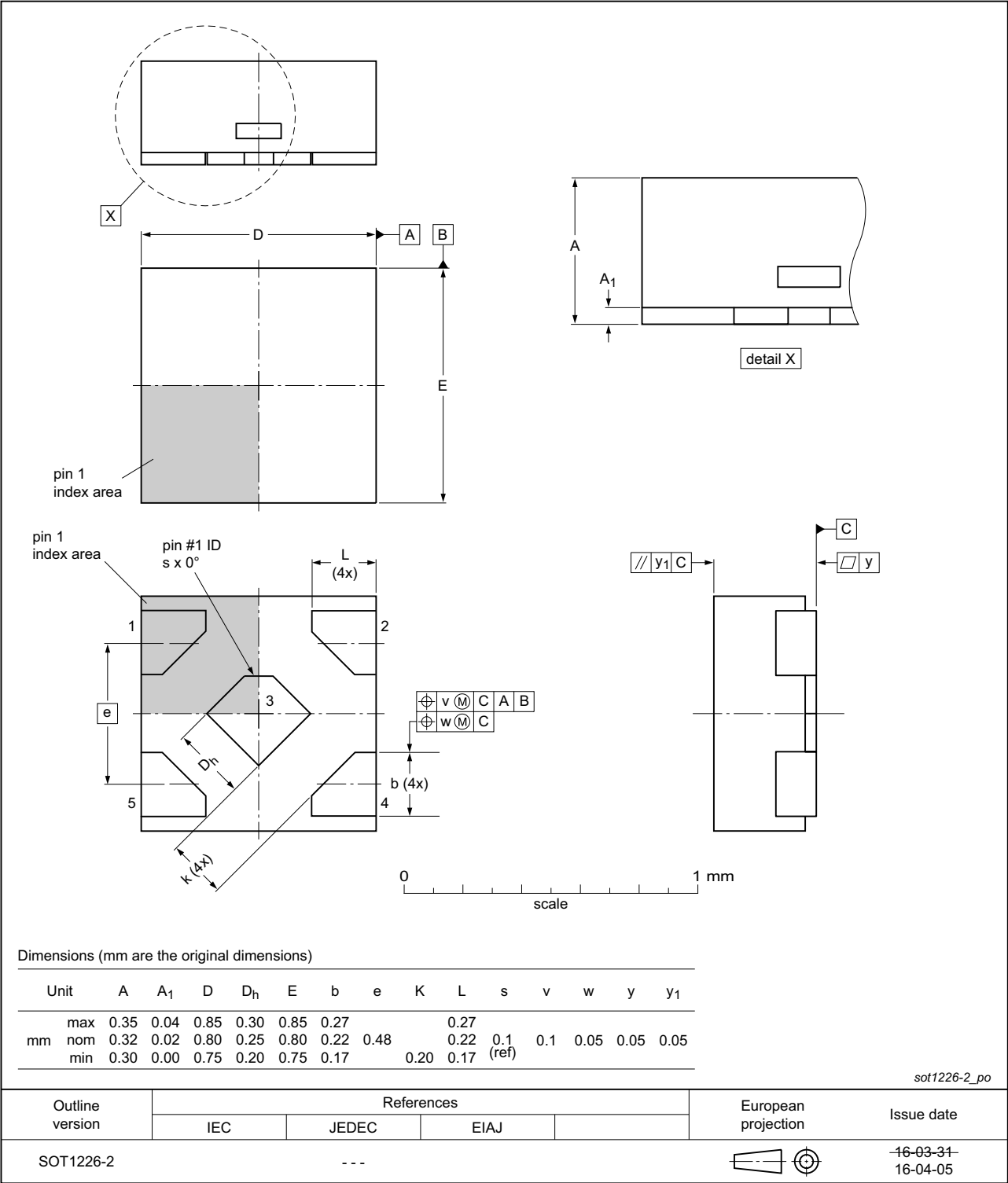


Fig 4. Package outline SOT1226-2(X2SON5)



## 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".

[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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