



# BGU8019

SiGe:C Low Noise Amplifier MMIC for GPS, GLONASS,  
Galileo, and Compass

Rev. 5 — 21 May 2021

Product data sheet

## 1 Product profile

### 1.1 General description

The BGU8019 is, also known as the GPS1202M, a Low Noise Amplifier (LNA) for GNSS receiver applications, available in a small plastic 6-pin extremely thin leadless package. The BGU8019 requires one external matching inductor.

The BGU8019 adapts itself to the changing environment resulting from co-habitation of different radio systems in modern cellular handsets. It has been designed for low power consumption and optimal performance when jamming signals from co-existing cellular transmitters are present. At low jamming power levels it delivers 18.5 dB gain at a noise figure of 0.55 dB. During high jamming power levels, resulting for example from a cellular transmit burst, it temporarily increases its bias current to improve sensitivity.

### 1.2 Features and benefits

- Cover full GNSS L1 band, from 1559 MHz to 1610 MHz
- Noise figure (NF) = 0.55 dB
- Gain = 18.5 dB
- High input 1 dB compression point of -7 dBm
- High out of band IP<sub>3</sub> of 6 dBm
- Supply voltage 1.5 V to 3.1 V
- Self-shielding package concept
- Integrated supply decoupling capacitor
- Optimized performance at a supply current of 4.6 mA
- Power-down mode current consumption < 1  $\mu$ A
- Integrated temperature stabilized bias for easy design
- Require only one input matching inductor
- Input and output DC decoupled
- ESD protection on all pins (HBM > 2 kV)
- Integrated matching for the output
- Available in 6-pins leadless package 1.1 mm  $\times$  0.7 mm  $\times$  0.37 mm; 0.4 mm pitch: SOT1232
- 180 GHz transit frequency - SiGe:C technology
- Moisture sensitivity level of 1



**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
- personal health applications

**1.4 Quick reference data**

**Table 1. Quick reference data**

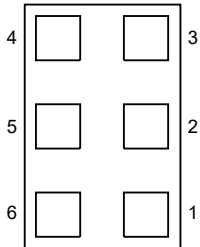
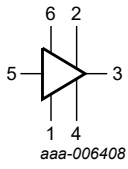
*f = 1575 MHz; V<sub>CC</sub> = 2.85 V; V<sub>I(ENABLE)</sub> ≥ 0.8 V; P<sub>i</sub> < -40 dBm; T<sub>amb</sub> = 25 °C; input matched to 50 Ω using a 6.8 nH inductor, see [Figure 1](#); unless otherwise specified.*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>CC</sub>	supply voltage		1.5	-	3.1	V
I <sub>CC</sub>	supply current		-	4.6	6.6	mA
G <sub>p</sub>	power gain	no jammer	16.5	18.5	20.5	dB
NF	noise figure	P <sub>i</sub> = -40 dBm, no jammer <sup>[1]</sup>	-	0.55	1.1	dB
P <sub>i(1dB)</sub>	input power at 1 dB gain compression		-11	-7	-	dBm
IP3 <sub>i</sub>	input third-order intercept point	<sup>[2]</sup>	0	6	-	dBm
		<sup>[3]</sup>	0	6	-	dBm

[1] PCB losses are subtracted.  
 [2] f<sub>1</sub> = 1713 MHz; f<sub>2</sub> = 1851 MHz; P<sub>i</sub> = -20 dBm per carrier  
 [3] f<sub>1</sub> = 1713 MHz, P<sub>i</sub> = -20 dBm; f<sub>2</sub> = 1850 MHz, P<sub>i</sub> = -65 dBm

## 2 Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Graphic symbol
1	GND	 <p>Transparent top view</p>	 <p>aaa-006408</p>
2	V <sub>CC</sub>		
3	RF_OUT		
4	GND_RF		
5	RF_IN		
6	ENABLE		

## 3 Ordering information

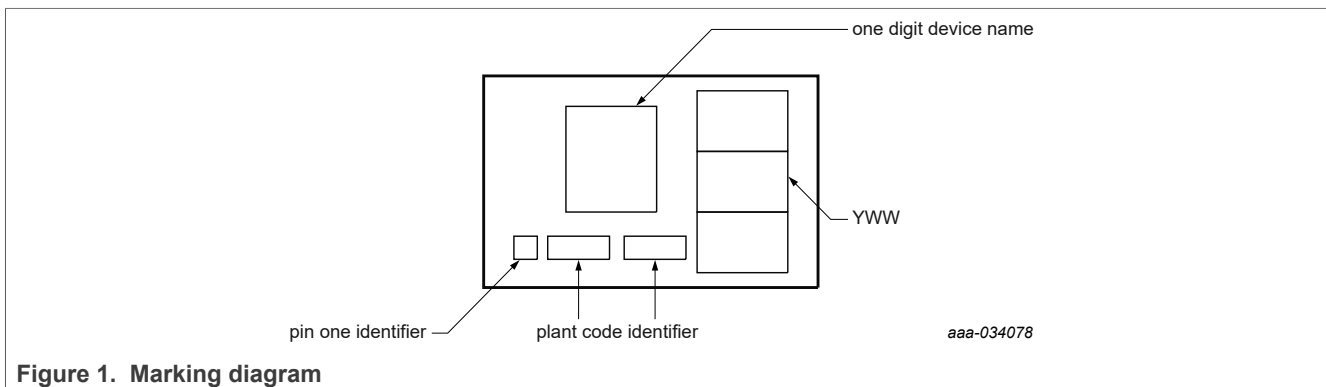
Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BGU8019	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1.1 × 0.7 × 0.37 mm	SOT1232
OM7848	EVB	BGU8019 evaluation board, MMIC only	-
OM7849	EVB	BGU8019 evaluation board, front-end EVB	-

## 4 Marking code

Table 4. Marking code

Type number	Marking code	Date code
BGU8019	A	YWW



## 5 Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

Absolute Maximum Ratings are given as Limiting Values of stress conditions during operation, that must not be exceeded under the worst probable conditions.

Symbol	Parameter	Conditions		Min	Max	Unit
$V_{CC}$	supply voltage	RF input AC coupled	[1]	-0.5	5	V
$V_{I(ENABLE)}$	input voltage on pin ENABLE	$V_{I(ENABLE)} < V_{CC} + 0.6$ V	[1][2]	-0.5	5	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	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	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 ANSI/ESDA/JEDEC standard JS-001		-	±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 1](#).

[2] Warning: due to internal ESD diode protection, the applied DC voltage shall not exceed  $V_{CC} + 0.6$  V and shall not exceed 5.0 V in order to avoid excess current.

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

## 6 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

## 7 Thermal characteristics

**Table 7. Thermal characteristics**

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point		225	K/W

## 8 Characteristics

**Table 8. Characteristics at  $V_{CC} = 1.8\text{ V}$**

$f = 1575\text{ MHz}$ ;  $V_{CC} = 1.8\text{ V}$ ;  $V_{I(ENABLE)} \geq 0.8\text{ V}$ ;  $P_i < -40\text{ dBm}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ ; input matched to  $50\text{ }\Omega$  using a  $6.8\text{ nH}$  inductor, see [Figure 1](#); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC}$	supply current	$V_{I(ENABLE)} \geq 0.8\text{ V}$				
		$P_i < -40\text{ dBm}$	-	4.4	6.4	mA
		$P_i = -20\text{ dBm}$	-	9	-	mA
		$V_{I(ENABLE)} \leq 0.3\text{ V}$	-	-	1	$\mu\text{A}$
$G_p$	power gain	no jammer	16	18	20	dB
		$P_{jam} = -20\text{ dBm}$ ; $f_{jam} = 850\text{ MHz}$	-	20	-	dB
		$P_{jam} = -20\text{ dBm}$ ; $f_{jam} = 1850\text{ MHz}$	-	20	-	dB
$RL_{in}$	input return loss	$P_i < -40\text{ dBm}$	9	12	-	dB
		$P_i = -20\text{ dBm}$	-	20	-	dB
$RL_{out}$	output return loss	$P_i < -40\text{ dBm}$	8	13	-	dB
		$P_i = -20\text{ dBm}$	-	12	-	dB
ISL	isolation		27	30	-	dB
NF	noise figure	$P_i = -40\text{ dBm}$ , no jammer <sup>[1]</sup>	-	0.55	1.1	dB
		$P_i = -40\text{ dBm}$ , no jammer <sup>[2]</sup>	-	0.60	1.15	dB
		$P_{jam} = -20\text{ dBm}$ ; $f_{jam} = 850\text{ MHz}$ <sup>[2]</sup>	-	0.9	-	dB
		$P_{jam} = -20\text{ dBm}$ ; $f_{jam} = 1850\text{ MHz}$ <sup>[2]</sup>	-	1.3	-	dB
$P_{i(1dB)}$	input power at 1 dB gain compression		-13	-10	-	dBm
IP <sub>3i</sub>	input third-order intercept point	<sup>[3]</sup>	-3	3	-	dBm
		<sup>[4]</sup>	-3	3	-	dBm
IMD <sub>3</sub>	third-order intermodulation distortion	measured at output pin <sup>[3]</sup>	-	-47	-	dBm
		measured at output pin <sup>[4]</sup>	-	-89	-	dBm
$t_{on}$	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] Including PCB losses

[3]  $f_1 = 1713\text{ MHz}$ ;  $f_2 = 1851\text{ MHz}$ ;  $P_i = -20\text{ dBm}$  per carrier

[4]  $f_1 = 1713\text{ MHz}$ ,  $P_i = -20\text{ dBm}$ ;  $f_2 = 1850\text{ MHz}$ ,  $P_i = -65\text{ dBm}$

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

$f = 1575\text{ MHz}$ ;  $V_{CC} = 2.85\text{ V}$ ;  $V_{I(ENABLE)} \geq 0.8\text{ V}$ ;  $P_i < -40\text{ dBm}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ ; input matched to  $50\text{ }\Omega$  using a  $6.8\text{ nH}$  inductor, see [Figure 1](#); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CC}$	supply current	$V_{I(ENABLE)} \geq 0.8\text{ V}$				
		$P_i < -40\text{ dBm}$	-	4.6	6.6	mA
		$P_i = -20\text{ dBm}$	-	10	-	mA
		$V_{I(ENABLE)} \leq 0.3\text{ V}$	-	-	1	$\mu\text{A}$
$G_p$	power gain	no jammer	16.5	18.5	20.5	dB
		$P_{jam} = -20\text{ dBm}$ ; $f_{jam} = 850\text{ MHz}$	-	20.0	-	dB
		$P_{jam} = -20\text{ dBm}$ ; $f_{jam} = 1850\text{ MHz}$	-	20.5	-	dB
$RL_{in}$	input return loss	$P_i < -40\text{ dBm}$	8	13	-	dB
		$P_i = -20\text{ dBm}$	-	22	-	dB
$RL_{out}$	output return loss	$P_i < -40\text{ dBm}$	8	13	-	dB
		$P_i = -20\text{ dBm}$	-	12	-	dB
ISL	isolation		27	30	-	dB
NF	noise figure	$P_i = -40\text{ dBm}$ , no jammer <sup>[1]</sup>	-	0.55	1.1	dB
		$P_i = -40\text{ dBm}$ , no jammer <sup>[2]</sup>	-	0.60	1.15	dB
		$P_{jam} = -20\text{ dBm}$ ; $f_{jam} = 850\text{ MHz}$ <sup>[2]</sup>	-	0.9	-	dB
		$P_{jam} = -20\text{ dBm}$ ; $f_{jam} = 1850\text{ MHz}$ <sup>[2]</sup>	-	1.3	-	dB
$P_{I(1dB)}$	input power at 1 dB gain compression		-11	-7	-	dBm
IP3 <sub>i</sub>	input third-order intercept point	<sup>[3]</sup>	0	6	-	dBm
		<sup>[4]</sup>	0	6	-	dBm
IMD3	third-order intermodulation distortion	measured at output pin <sup>[3]</sup>	-	-53	-	dBm
		measured at output pin <sup>[4]</sup>	-	-96	-	dBm
$t_{on}$	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] Including PCB losses

[3]  $f_1 = 1713\text{ MHz}$ ;  $f_2 = 1851\text{ MHz}$ ;  $P_i = -20\text{ dBm}$  per carrier

[4]  $f_1 = 1713\text{ MHz}$ ,  $P_i = -20\text{ dBm}$ ;  $f_2 = 1850\text{ MHz}$ ,  $P_i = -65\text{ dBm}$

9 Application information

9.1 GNSS application

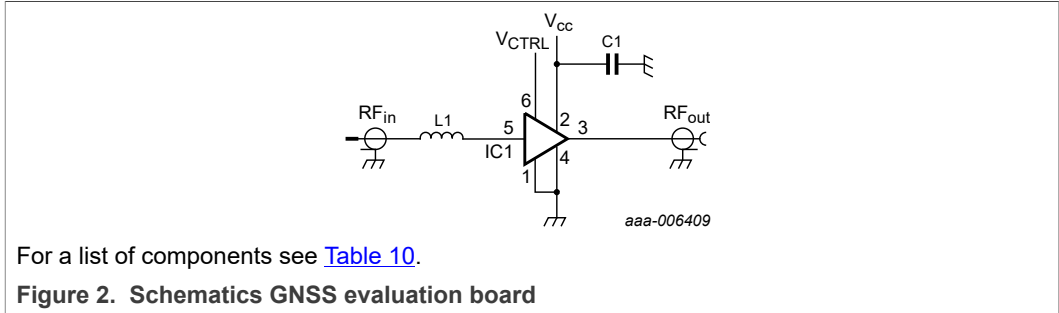
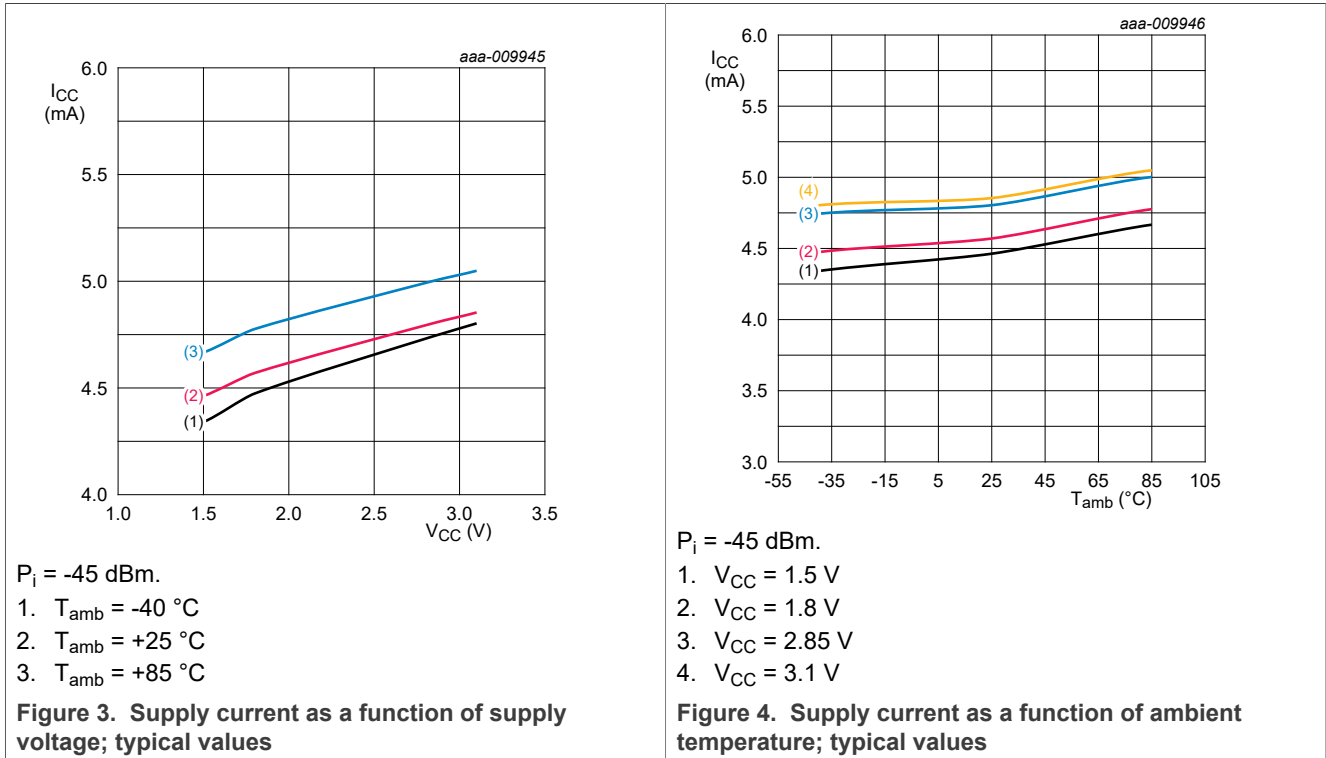


Table 10. List of components

For schematics see [Figure 1](#).

Component	Description	Value	Remarks
C1	decoupling capacitor	1 nF	to suppress power supply noise
IC1	BGU8019	-	NXP
L1	high-quality matching inductor	6.8 nH	Murata LQW15A

9.2 Graphs



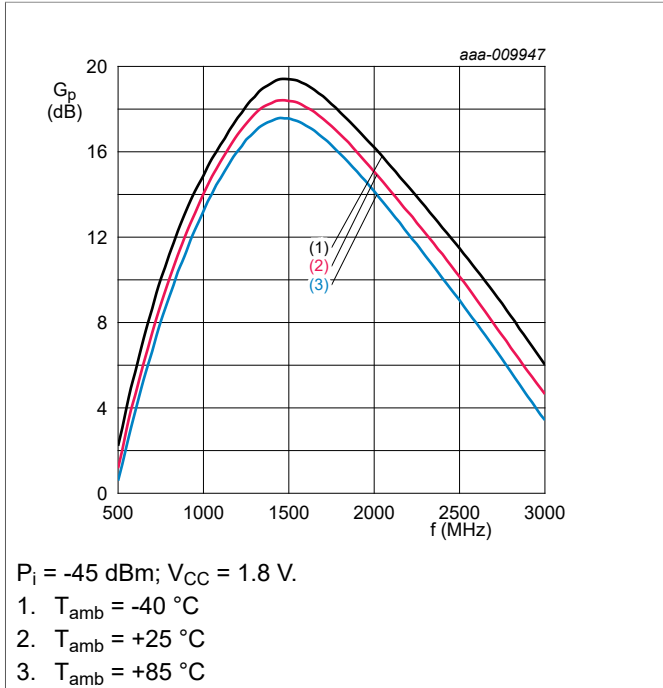


Figure 5. Power gain as a function of frequency; typical values

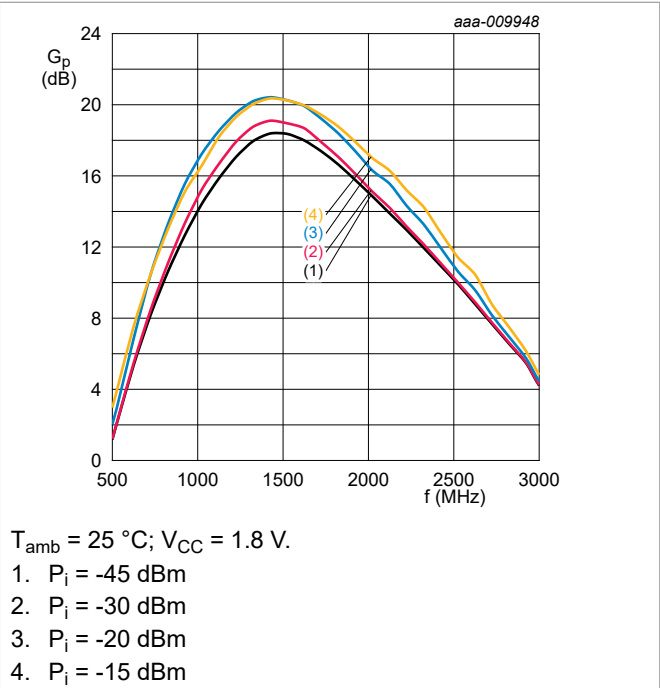


Figure 6. Power gain as a function of frequency; typical values

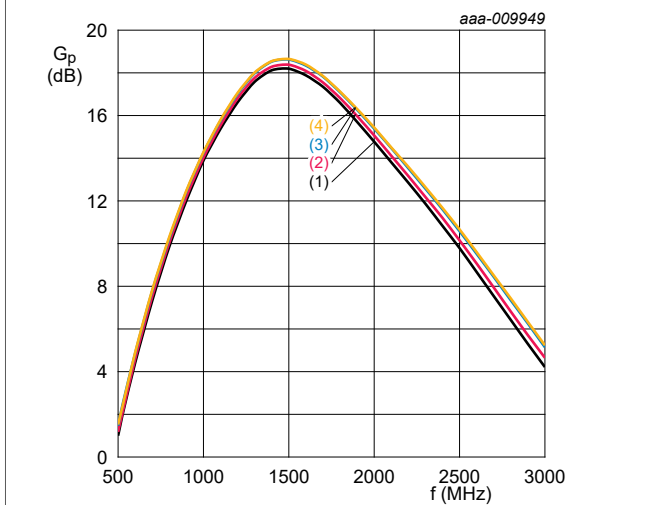


Figure 7. Power gain as a function of frequency; typical values

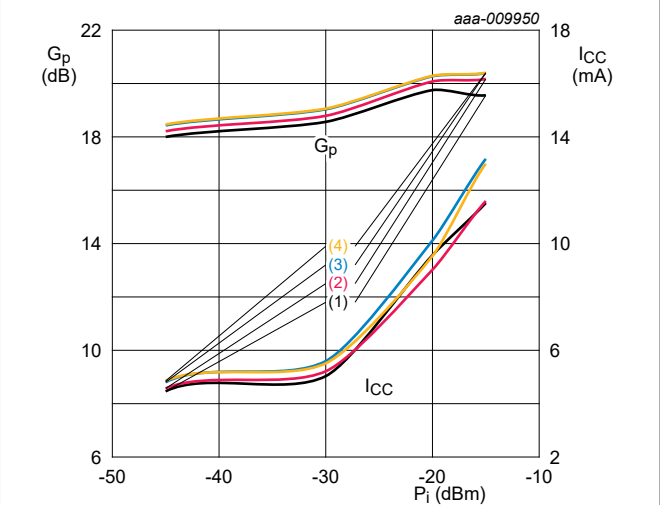
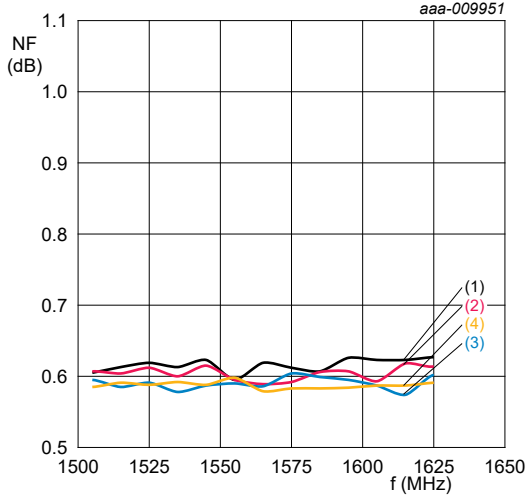


Figure 8. Power gain and supply current as function of input power; typical values

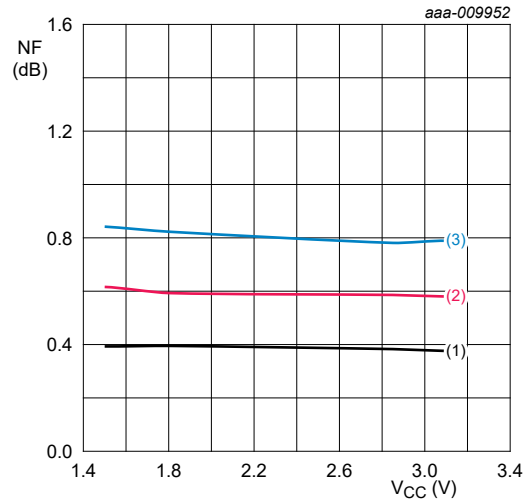




$T_{amb} = 25\text{ °C}$ ; no jammer, including PCB losses.

1.  $V_{CC} = 1.5\text{ V}$
2.  $V_{CC} = 1.8\text{ V}$
3.  $V_{CC} = 2.85\text{ V}$
4.  $V_{CC} = 3.1\text{ V}$

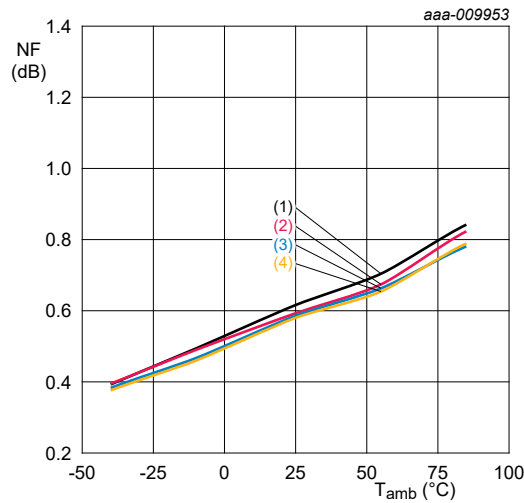
Figure 9. Noise figure as a function of frequency; typical values



$f = 1575\text{ MHz}$ ; no jammer, including PCB losses.

1.  $T_{amb} = -40\text{ °C}$
2.  $T_{amb} = +25\text{ °C}$
3.  $T_{amb} = +85\text{ °C}$

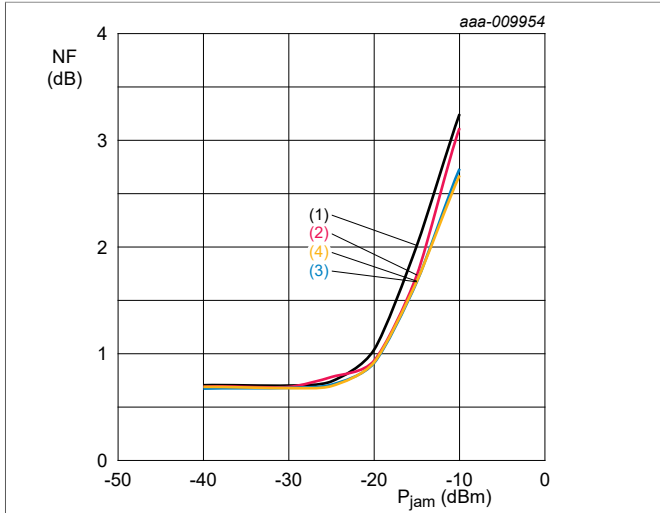
Figure 10. Noise figure as a function of supply voltage; typical values



$f = 1575\text{ MHz}$ ; no jammer, including PCB losses.

1.  $V_{CC} = 1.5\text{ V}$
2.  $V_{CC} = 1.8\text{ V}$
3.  $V_{CC} = 2.85\text{ V}$
4.  $V_{CC} = 3.1\text{ V}$

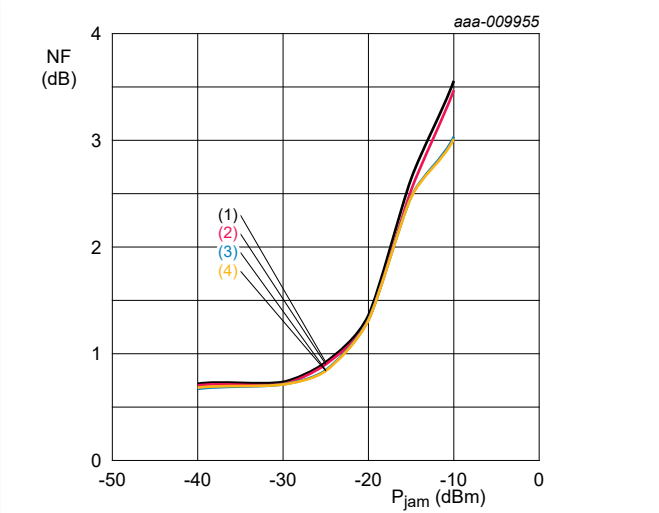
Figure 11. Noise figure as a function of ambient temperature; typical values



$f_{jam} = 850 \text{ MHz}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ ;  $f = 1575 \text{ MHz}$ ; including PCB losses.

1.  $V_{CC} = 1.5 \text{ V}$
2.  $V_{CC} = 1.8 \text{ V}$
3.  $V_{CC} = 2.85 \text{ V}$
4.  $V_{CC} = 3.1 \text{ V}$

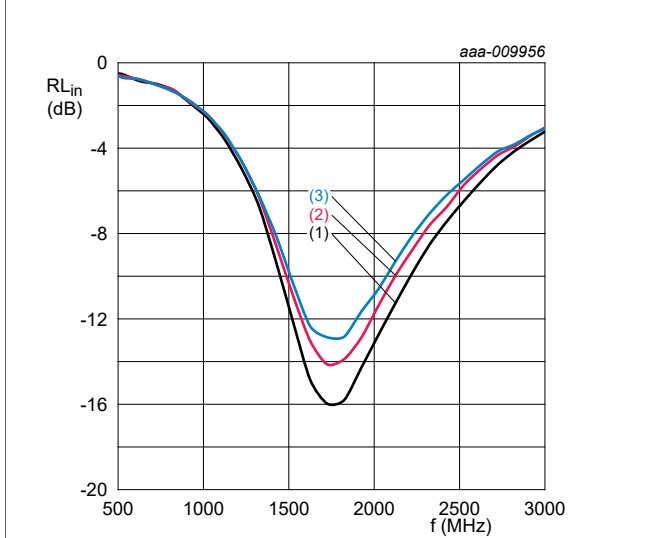
**Figure 12. Noise figure as a function of jamming power; typical values**



$f_{jam} = 1850 \text{ MHz}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$ ;  $f = 1575 \text{ MHz}$ ; including PCB losses.

1.  $V_{CC} = 1.5 \text{ V}$
2.  $V_{CC} = 1.8 \text{ V}$
3.  $V_{CC} = 2.85 \text{ V}$
4.  $V_{CC} = 3.1 \text{ V}$

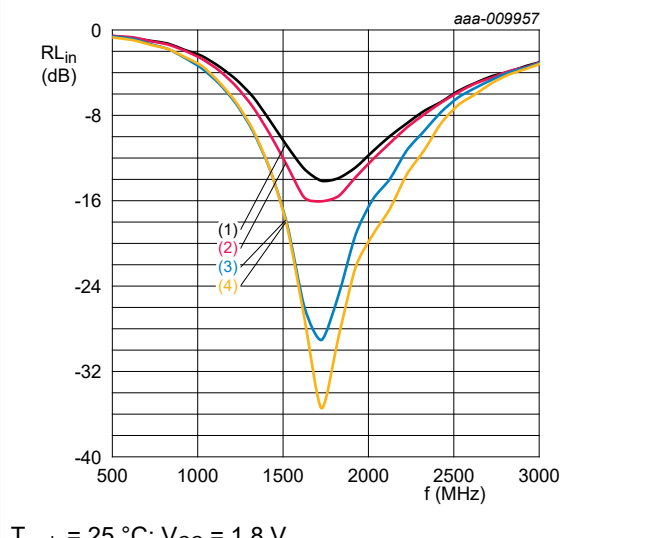
**Figure 13. Noise figure as a function of jamming power; typical values**



$P_i = -45 \text{ dBm}$ ;  $V_{CC} = 1.8 \text{ V}$ .

1.  $T_{amb} = -40 \text{ }^\circ\text{C}$
2.  $T_{amb} = +25 \text{ }^\circ\text{C}$
3.  $T_{amb} = +85 \text{ }^\circ\text{C}$

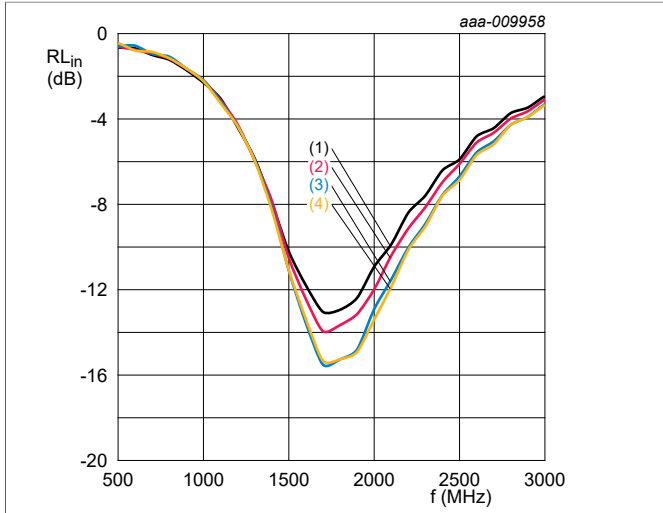
**Figure 14. Input return loss as a function of frequency; typical values**



$T_{amb} = 25 \text{ }^\circ\text{C}$ ;  $V_{CC} = 1.8 \text{ V}$ .

1.  $P_i = -45 \text{ dBm}$
2.  $P_i = -30 \text{ dBm}$
3.  $P_i = -20 \text{ dBm}$
4.  $P_i = -15 \text{ dBm}$

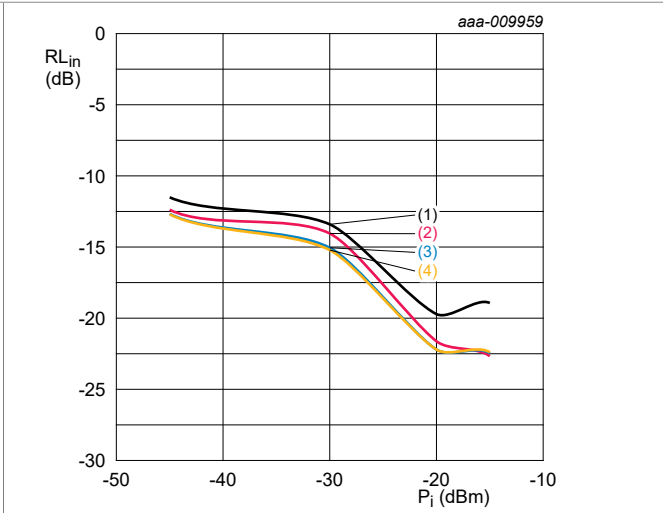
**Figure 15. Input return loss as a function of frequency; typical values**



$P_i = -45 \text{ dBm}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ .

1.  $V_{\text{CC}} = 1.5 \text{ V}$
2.  $V_{\text{CC}} = 1.8 \text{ V}$
3.  $V_{\text{CC}} = 2.85 \text{ V}$
4.  $V_{\text{CC}} = 3.1 \text{ V}$

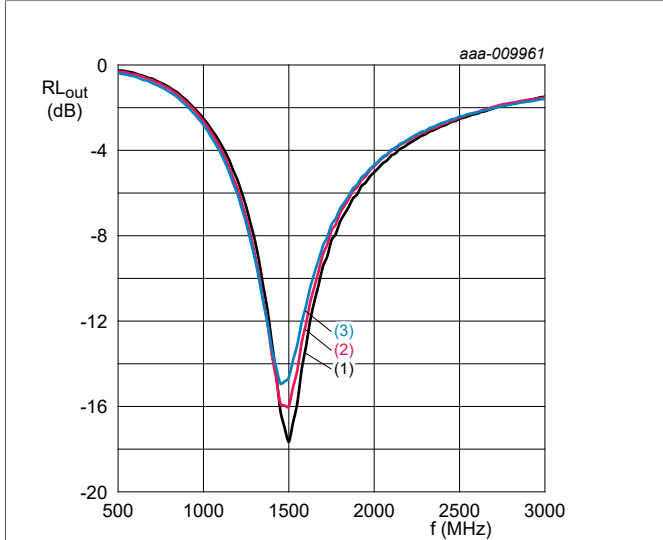
Figure 16. Input return loss as a function of frequency; typical values



$f = 1575 \text{ MHz}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ .

1.  $V_{\text{CC}} = 1.5 \text{ V}$
2.  $V_{\text{CC}} = 1.8 \text{ V}$
3.  $V_{\text{CC}} = 2.85 \text{ V}$
4.  $V_{\text{CC}} = 3.1 \text{ V}$

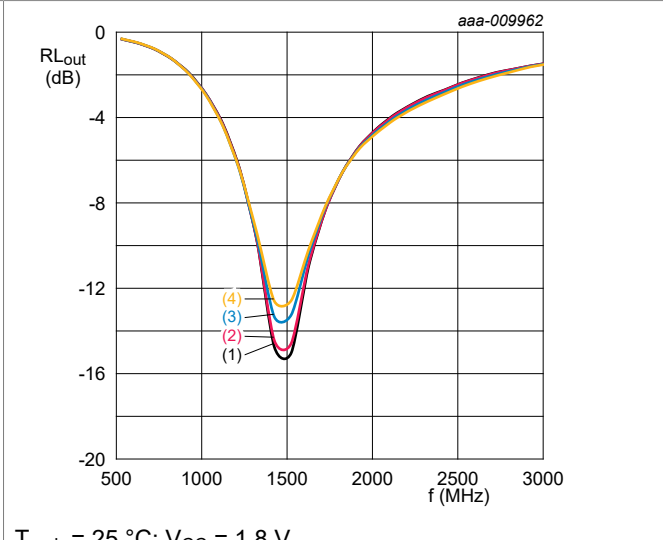
Figure 17. Input return loss as a function of input power; typical values



$P_i = -45 \text{ dBm}$ ;  $V_{\text{CC}} = 1.8 \text{ V}$ .

1.  $T_{\text{amb}} = -40 \text{ }^\circ\text{C}$
2.  $T_{\text{amb}} = +25 \text{ }^\circ\text{C}$
3.  $T_{\text{amb}} = +85 \text{ }^\circ\text{C}$

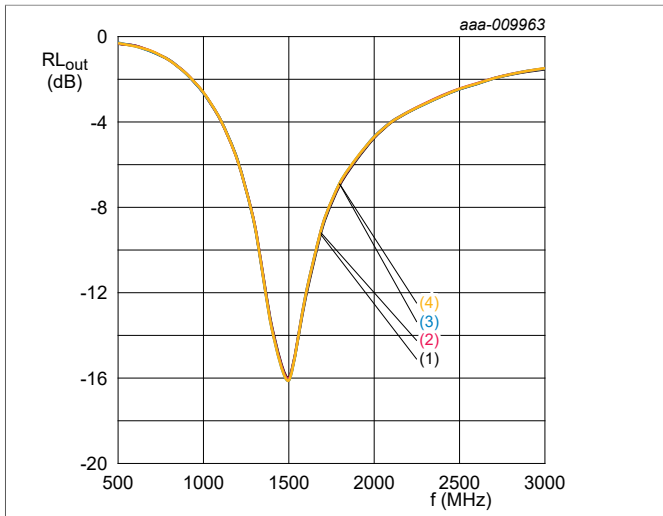
Figure 18. Output return loss as a function of frequency; typical values



$T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ ;  $V_{\text{CC}} = 1.8 \text{ V}$ .

1.  $P_i = -45 \text{ dBm}$
2.  $P_i = -30 \text{ dBm}$
3.  $P_i = -20 \text{ dBm}$
4.  $P_i = -15 \text{ dBm}$

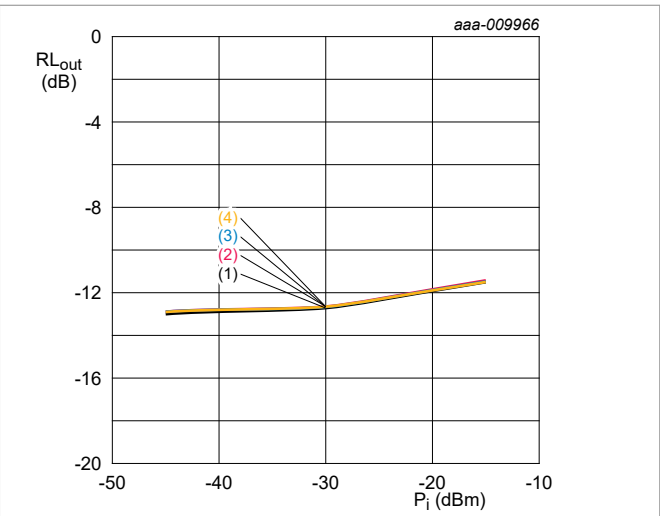
Figure 19. Output return loss as a function of frequency; typical values



$P_i = -45$  dBm;  $T_{amb} = 25$  °C.

1.  $V_{CC} = 1.5$  V
2.  $V_{CC} = 1.8$  V
3.  $V_{CC} = 2.85$  V
4.  $V_{CC} = 3.1$  V

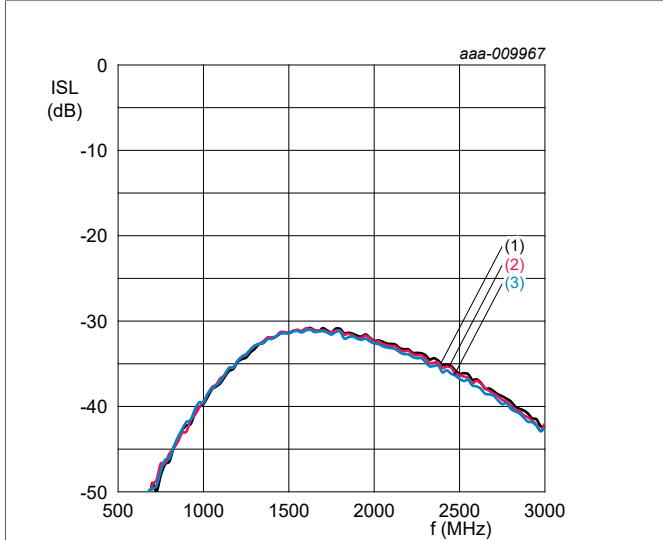
**Figure 20. Output return loss as a function of frequency; typical values**



$f = 1575$  MHz;  $T_{amb} = 25$  °C.

1.  $V_{CC} = 1.5$  V
2.  $V_{CC} = 1.8$  V
3.  $V_{CC} = 2.85$  V
4.  $V_{CC} = 3.1$  V

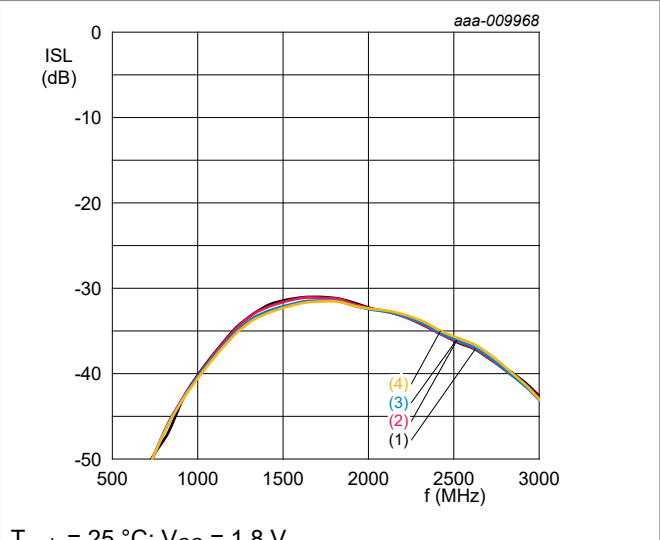
**Figure 21. Output return loss as a function of input power; typical values**



$P_i = -45$  dBm;  $V_{CC} = 1.8$  V.

1.  $T_{amb} = -40$  °C
2.  $T_{amb} = +25$  °C
3.  $T_{amb} = +85$  °C

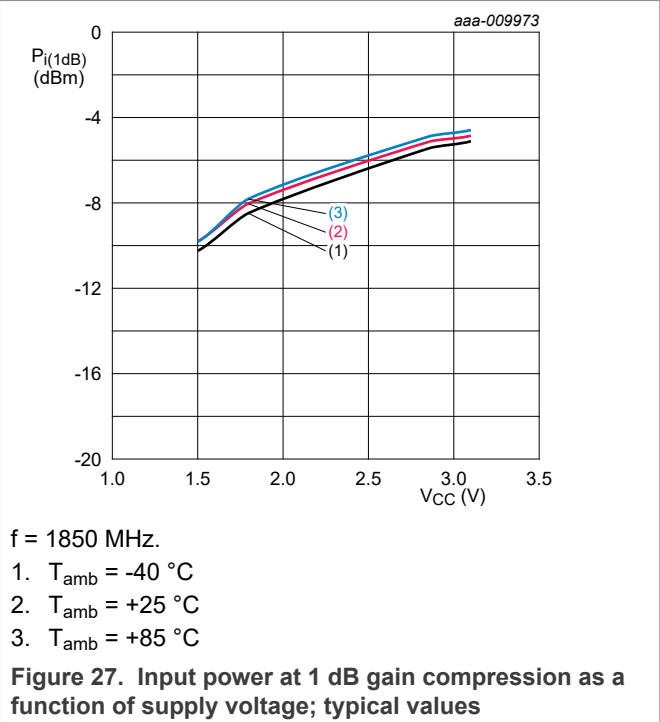
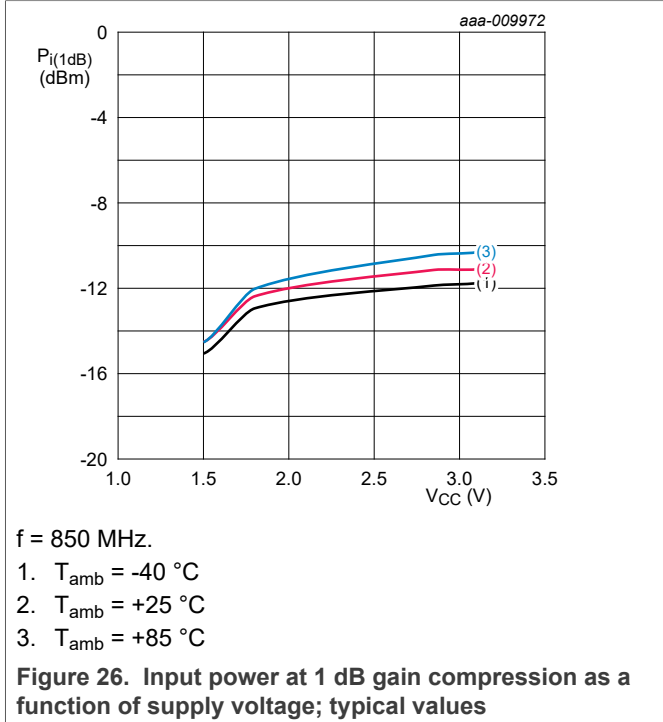
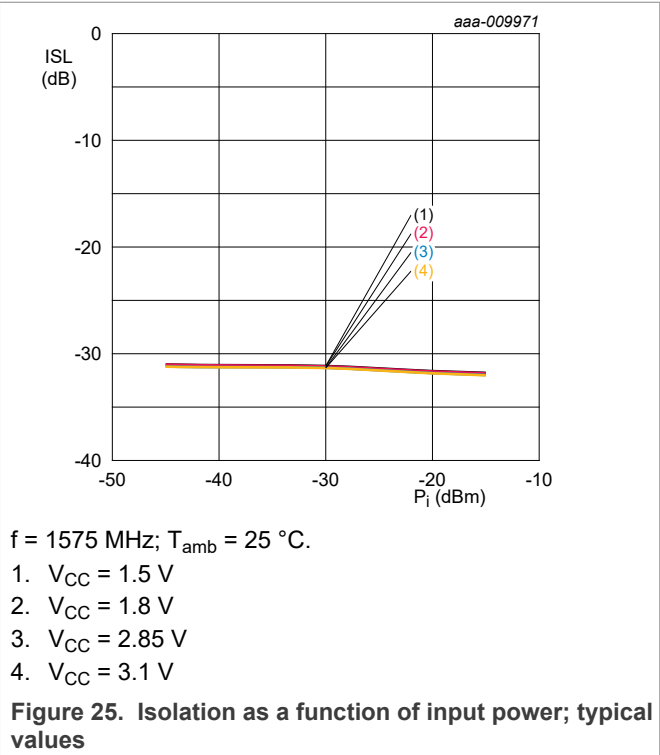
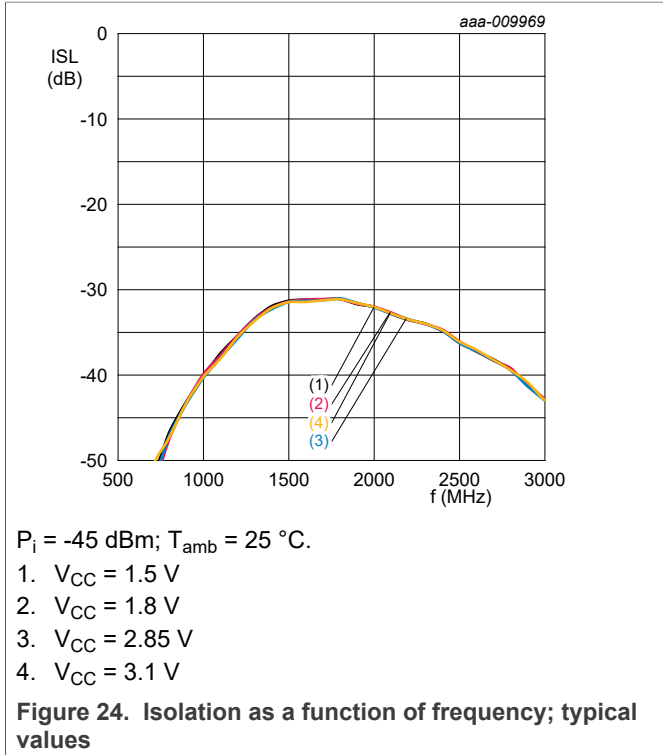
**Figure 22. Isolation as a function of frequency; typical values**

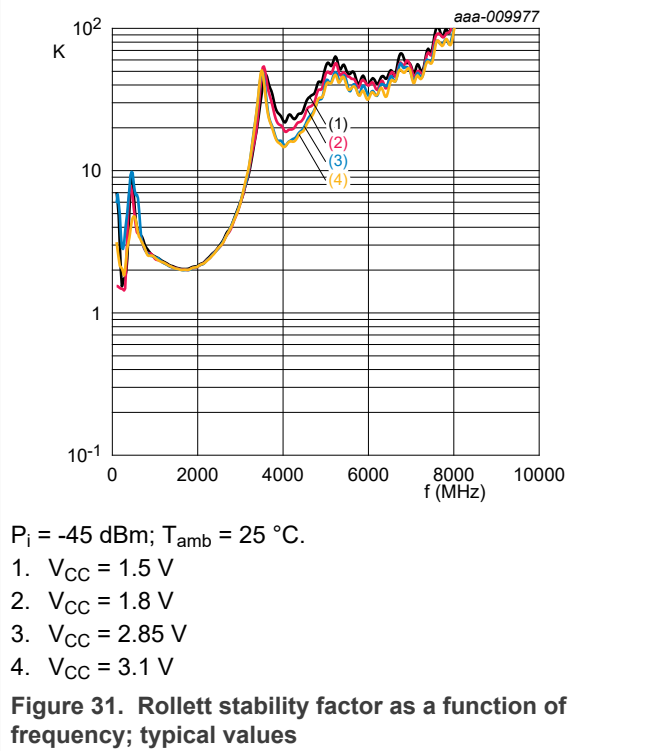
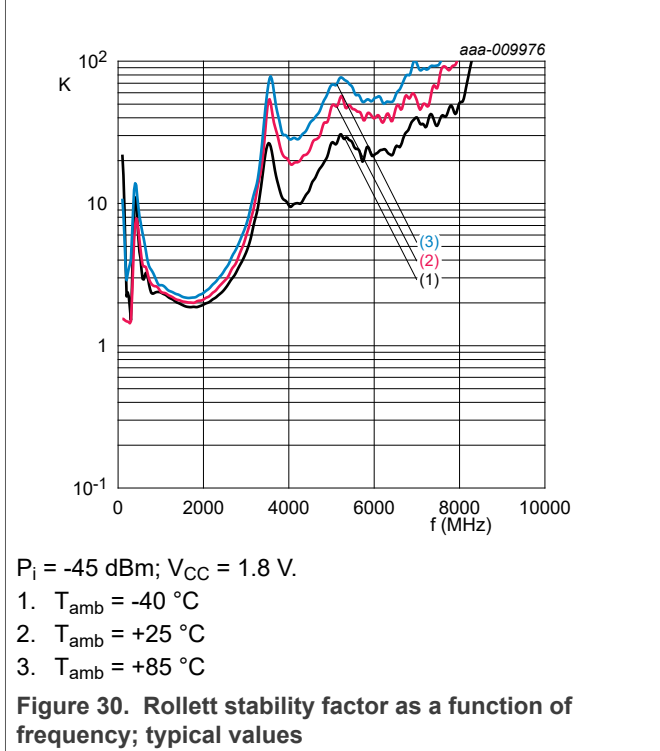
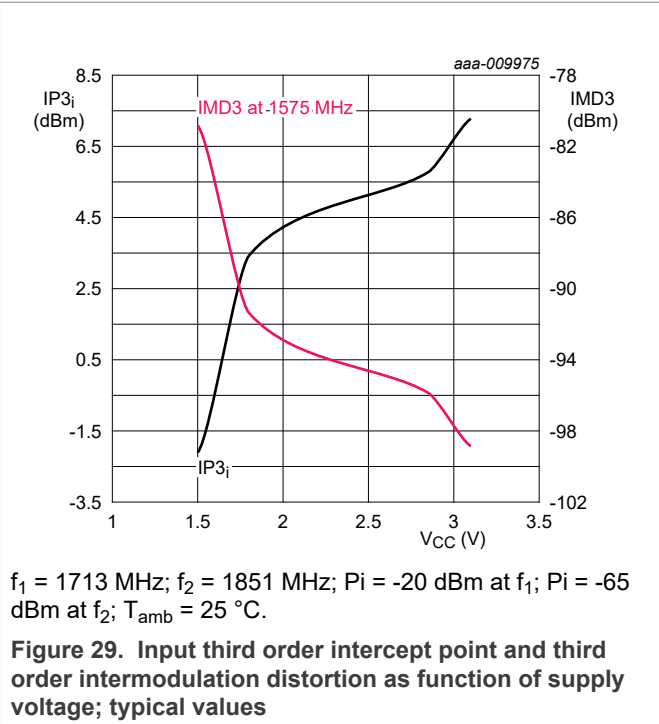
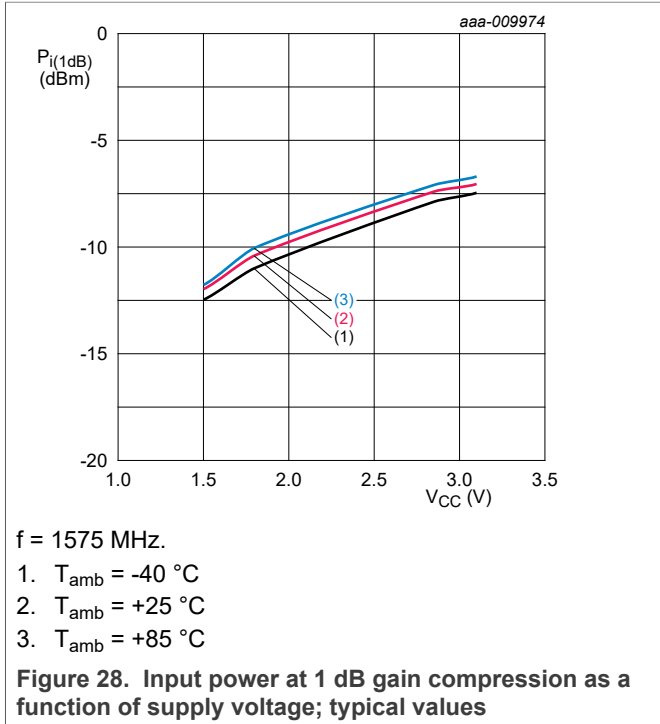


$T_{amb} = 25$  °C;  $V_{CC} = 1.8$  V.

1.  $P_i = -45$  dBm
2.  $P_i = -30$  dBm
3.  $P_i = -20$  dBm
4.  $P_i = -15$  dBm

**Figure 23. Isolation as a function of frequency; typical values**





10 Package outline

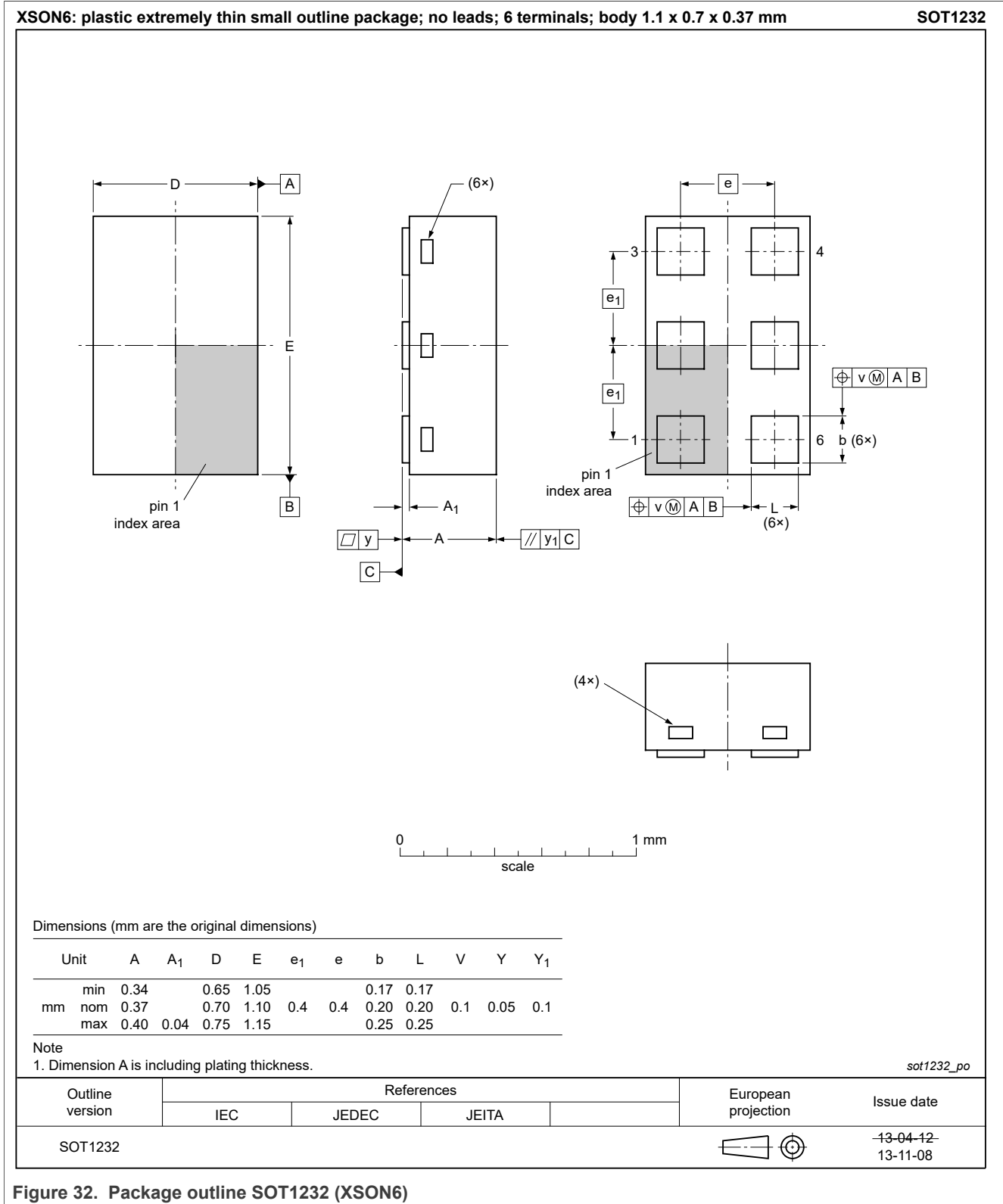



Figure 32. Package outline SOT1232 (XSON6)

## 11 Handling information

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

## 12 Abbreviations

Table 11. Abbreviations

Acronym	Description
ESD	electrostatic discharge
GLONASS	global navigation satellite system
GNSS	global navigation satellite system
GPS	global positioning system
HBM	human body model
MMIC	monolithic microwave-integrated circuit
PCB	printed circuit board
SiGe:C	silicon germanium carbon

## 13 Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGU8019 v.5	20210521	Product data sheet	2021050321	BGU8019 v.4.2
Modifications:	<ul style="list-style-type: none"> <li>added Min, and or Max values to some characteristics at 2.85 V</li> <li>changed conditions, footnotes, and Minimum, and Typical values on IP<sub>3i</sub></li> <li>added extra Typical value, and footnote to IMD3</li> </ul>			
BGU8019 v.4.2	20190516	Product data sheet	-	BGU8019 v.4.1
Modifications:	<ul style="list-style-type: none"> <li>added general Marking diagram</li> </ul>			
BGU8019 v.4.1	20190510	Product data sheet	-	BGU8019 v.4
Modifications:	<ul style="list-style-type: none"> <li>adapted date code notation to the Marking code table</li> </ul>			
BGU8019 v.4	20181123	Product data sheet	-	BGU8019 v.3
Modifications:	<ul style="list-style-type: none"> <li>adapted different min and max values in the characteristics</li> <li>adapted in band, and out of band condition to IP<sub>3i</sub> parameter</li> <li>changed the name of the application into GNSS application</li> </ul>			
BGU8019 v.3	20170118	Product data sheet	-	BGU8019 v.2
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Section 1</a>: added GPS1202M according to our new naming convention</li> </ul>			
BGU8019 v.2	20140603	Product data sheet	-	BGU8019 v.1
BGU8019 v.1	20131112	Preliminary data sheet	-	-



## 14 Legal information

### 14.1 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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## Contents

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<b>1</b>	<b>Product profile .....</b>	<b>1</b>
1.1	General description .....	1
1.2	Features and benefits .....	1
1.3	Applications .....	2
1.4	Quick reference data .....	2
<b>2</b>	<b>Pinning information .....</b>	<b>3</b>
<b>3</b>	<b>Ordering information .....</b>	<b>3</b>
<b>4</b>	<b>Marking code .....</b>	<b>3</b>
<b>5</b>	<b>Limiting values .....</b>	<b>4</b>
<b>6</b>	<b>Recommended operating conditions .....</b>	<b>4</b>
<b>7</b>	<b>Thermal characteristics .....</b>	<b>4</b>
<b>8</b>	<b>Characteristics .....</b>	<b>5</b>
<b>9</b>	<b>Application information .....</b>	<b>7</b>
9.1	GNSS application .....	7
9.2	Graphs .....	7
<b>10</b>	<b>Package outline .....</b>	<b>15</b>
<b>11</b>	<b>Handling information .....</b>	<b>16</b>
<b>12</b>	<b>Abbreviations .....</b>	<b>16</b>
<b>13</b>	<b>Revision history .....</b>	<b>16</b>
<b>14</b>	<b>Legal information .....</b>	<b>17</b>

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