



BGU8009

SiGe:C low-noise amplifier MMIC for GPS, GLONASS, Galileo and COMPASS and LTE B32

Rev. 7.3 — 16 May 2019

Product data sheet

1 General description

The BGU8009 is, also known as the GPS1201M, a Low-Noise Amplifier (LNA) for GNSS receiver and LTE Band 32 down link applications. This BGU8009 is available in a small plastic 6-pin extremely thin leadless package. The BGU8009 requires one external matching inductor and one external decoupling capacitor.

The BGU8009 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 dB gain at a noise figure of 0.65 dB. 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

- Covers full GNSS L1 band, from 1559 MHz to 1610 MHz and LTE band 32 from 1452 MHz to 1496 MHz
- Optionally also the GNSS lower L-band can be covered (from 1164 MHz to 1299 MHz) by adding additional matching components as described in the application note AN11353.
- GNSS:
 - Noise figure = 0.65 dB
 - Gain 18 dB
 - High input 1 dB compression point of -7 dBm
 - High out of band IP_{3i} of 6 dBm
- LTE B32:
 - Noise figure = 0.65 dB
 - Gain 20 dB
 - High input 1 dB compression point of -8.5 dBm
- Supply voltage 1.5 V to 3.1 V
- Optimized performance at low supply current of 4.2 mA
- Power-down mode current consumption < 1 μA
- Integrated temperature stabilized bias for easy design.
- Requires only one input matching inductor and one supply decoupling capacitor
- Input and output DC decoupled
- ESD protection on all pins (HBM > 2 kV)
- Integrated matching for the output
- Available in a 6-pins leadless package 1.1 mm x 0.9 mm x 0.47 mm; 0.4 mm pitch: SOT1230
- 180 GHz transit frequency - SiGe:C technology
- Moisture sensitivity level 1



3 Applications

- Smart phones
- Feature phones
- Tablets
- Digital still cameras
- Digital video cameras
- RF front-end modules
- Complete GNSS modules
- Personal health applications

4 Quick reference data

Table 1. Quick reference data GNSS band L1

$f = 1575 \text{ MHz}$; $V_{CC} = 2.85 \text{ V}$; $P_i < -40 \text{ dBm}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; input matched to $50 \text{ } \Omega$ using a 5.6 nH inductor, see [Figure 34](#), unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage		1.5	-	3.1	V
I_{CC}	supply current	$V_{I(ENABLE)} \geq 0.8 \text{ V}$				
		• $P_i < -40 \text{ dBm}$	2.6	4.4	6.5	mA
		• $P_i = -20 \text{ dBm}$	-	9	-	mA
G_p	power gain	$P_i < -40 \text{ dBm}$	16	17.8	20	dB
		$P_i = -20 \text{ dBm}$	-	20.0	-	dB
NF	noise figure	$P_i < -40 \text{ dBm}$ ^[1]	-	0.65	1.2	dB
		$P_i < -40 \text{ dBm}$ ^[1]	-	0.70	1.25	dB
$P_{i(1dB)}$	input power at 1 dB gain compression	$V_{CC} = 1.8 \text{ V}$	-	-10	-	dBm
		$V_{CC} = 2.85 \text{ V}$	-12.5	-7	-	dBm
IP3 _i	input third-order intercept point	$V_{CC} = 1.8 \text{ V}$ ^[2]	-	3	-	dBm
		$V_{CC} = 2.85 \text{ V}$ ^[2]	-	6	-	dBm

[1] PCB losses are subtracted.

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

Table 2. Quick reference data LTE B32

$f = 1474 \text{ MHz}$; $V_{CC} = 2.8 \text{ V}$; $P_i = -30 \text{ dBm}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; input matched to $50 \text{ } \Omega$ using a 9.1 nH inductor, see [Figure 34](#), unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage		1.5	-	3.1	V
I_{CC}	supply current	$V_{I(ENABLE)} \geq 0.8 \text{ V}$	-	4.4	-	mA
G_p	power gain			20		dB
NF	noise figure	^[1]	-	0.65	-	dB
$P_{i(1dB)}$	input power at 1 dB gain compression	$V_{CC} = 1.8 \text{ V}$	-	-11	-	dBm
		$V_{CC} = 2.8 \text{ V}$	-	-8.5	-	dBm
IP3 _i	input third-order intercept point	$V_{CC} = 1.8 \text{ V}$ ^[2]	-	-7	-	dBm
		$V_{CC} = 2.8 \text{ V}$ ^[2]	-	-6	-	dBm

[1] PCB losses are subtracted.

[2] $\Delta f = 1 \text{ MHz}$; $P_i = -30 \text{ dBm}$ per carrier.

5 Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
BGU8009	XSON6	plastic very thin small outline package; no leads; 6 terminals; body 1.1 x 0.9 x 0.47 mm	SOT1230
OM7820	EVB	BGU8009 evaluation board, MMIC only	-
OM7824	EVB	BGU8009 evaluation board, front-end EVB	-
OM17066	EVB	BGU8009 evaluation board for LTE B32	

6 Marking

Table 4. Marking code

Type number	Marking code	Date code
BGU8009	A	YWW

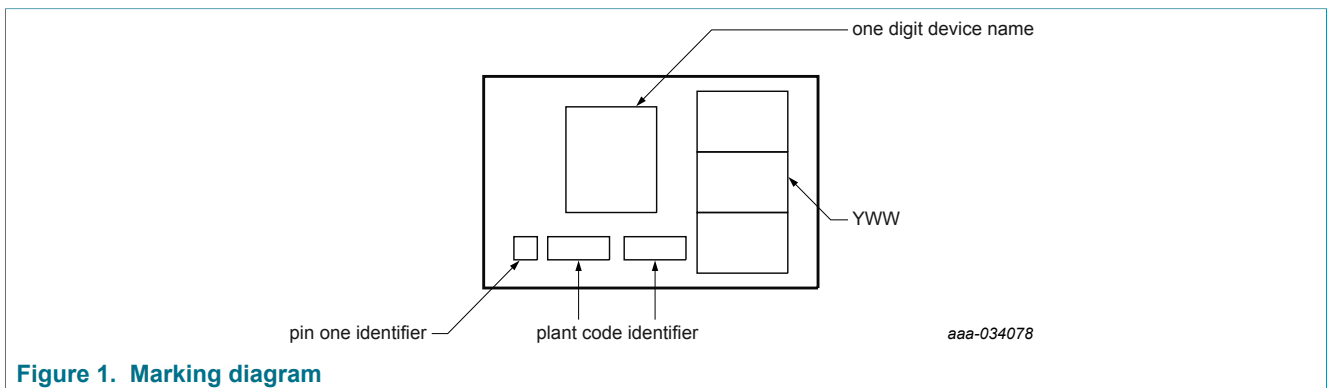


Figure 1. Marking diagram

7 Block diagram

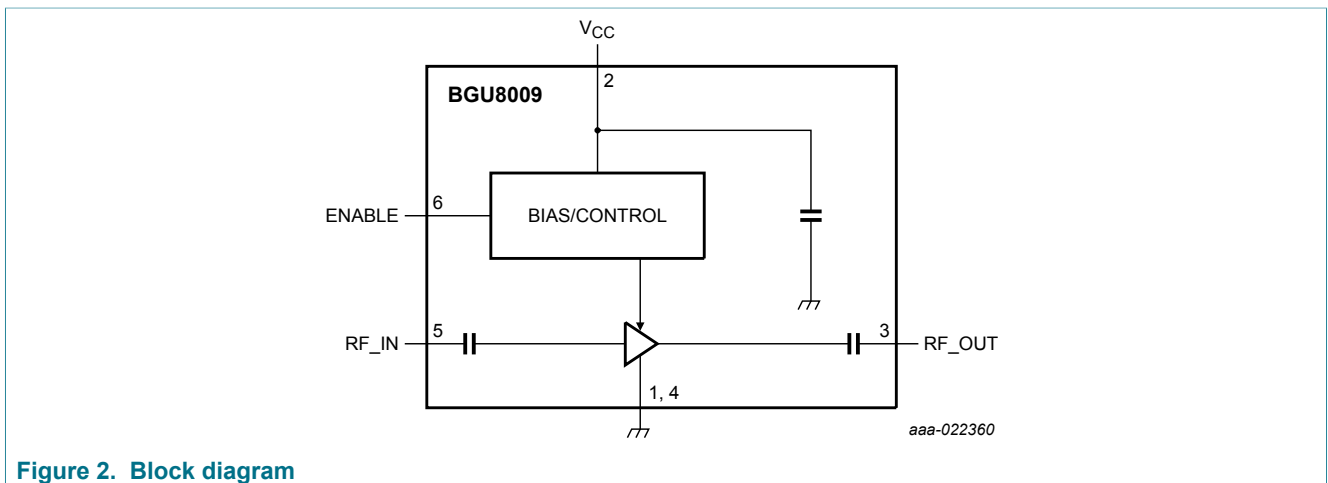
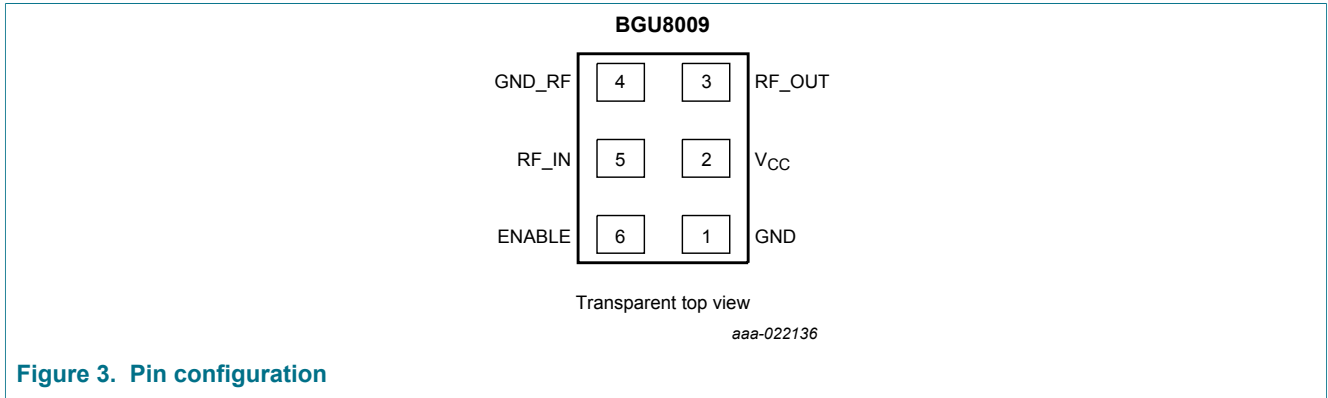


Figure 2. Block diagram

8 Pinning information

8.1 Pinning



8.2 Pin description

Table 5. Pin description

Symbol	Pin	Description
GND	1	ground
V _{CC}	2	supply voltage
RF_OUT	3	RF output
GND_RF	4	RF ground
RF_IN	5	RF input
ENABLE	6	enable

9 Limiting values

Table 6. 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		[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	1575 MHz	[1] -	10	dBm
		1474 MHz	[1] -	10	dBm
P _{tot}	total power dissipation	T _{sp} ≤ 130 °C	-	55	mW

Symbol	Parameter	Conditions	Min	Max	Unit
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 34](#).

[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 to avoid excess current.

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

10 Recommended operating conditions

Table 7. 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 8. Thermal characteristics

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

12 Characteristics GNSS band L1

Table 9. Characteristics at V_{CC} = 1.8 V

f = 1575 MHz; V_{CC} = 1.8 V; V_{I(ENABLE)} ≥ 0.8 V; P_i < -40 dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 5.6 nH inductor, see Figure 34, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I _{CC}	supply current	V _{I(ENABLE)} ≥ 0.8 V	-	-	-	-
		P _i < -40 dBm	2.3	4.2	6.2	mA
		P _i = -20 dBm	-	9	-	mA
		V _{I(ENABLE)} ≤ 0.3 V	-	-	1	μA
G _p	power gain	no jammer	16	17.6	20	dB
		P _{jam} = -20 dBm; f _{jam} = 850 MHz	-	19.8	-	dB
		P _{jam} = -20 dBm; f _{jam} = 1850 MHz	-	20.0	-	dB
RL _{in}	input return loss	P _i < -40 dBm	-	9	-	dB
		P _i = -20 dBm	-	11	-	dB
RL _{out}	output return loss	P _i < -40 dBm	-	15	-	dB
		P _i = -20 dBm	-	15	-	dB
ISL	isolation		-	37	-	dB
NF	noise figure	P _i = -40 dBm; no jammer ^[1]	-	0.65	1.2	dB
		P _i = -40 dBm; no jammer ^{[2] [1]}	-	0.70	1.25	dB
		P _{jam} = -20 dBm; f _{jam} = 850 MHz ^[2]	-	0.9	-	dB
		P _{jam} = -20 dBm; f _{jam} = 1850 MHz ^[2]	-	1.2	-	dB
P _{i(1dB)}	input power at 1 dB gain compression		-	-10	-	dBm
IP3 _i	input third-order intercept point	^{[1] [3]}	-	3	-	dBm
		^{[1] [4]}	-	3	-	dBm
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] Guaranteed by device design; not tested in production.
 [2] Including PCB losses.
 [3] f₁ = 1713 MHz; f₂ = 1851 MHz, P_i = -20 dBm per carrier.
 [4] f₁ = 1713 MHz; f₂ = 1851 MHz, P_{i(1)} = -20 dBm, P_{i(2)} = -65 dBm.

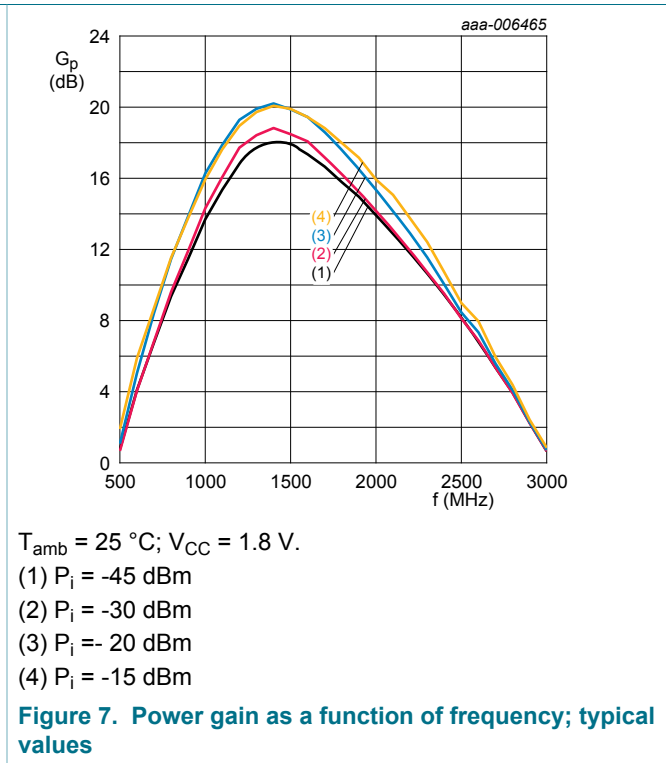
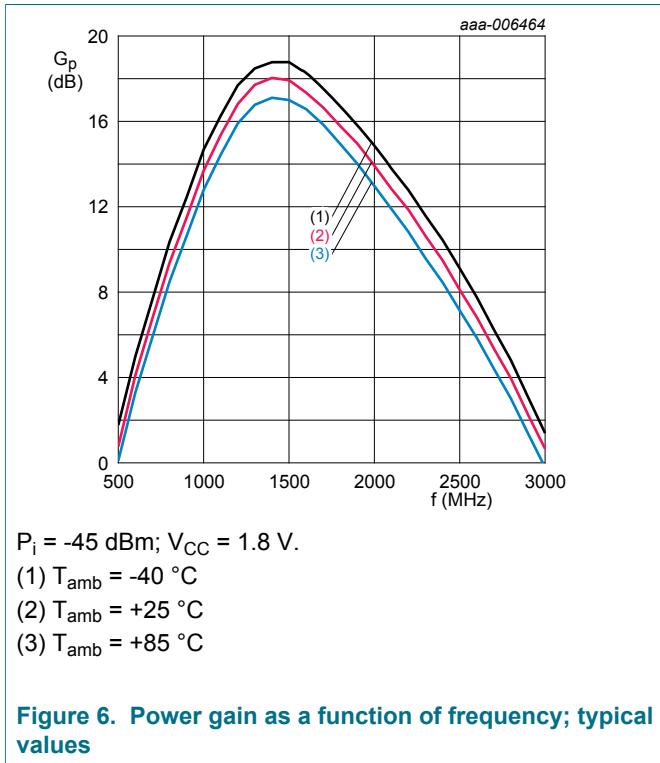
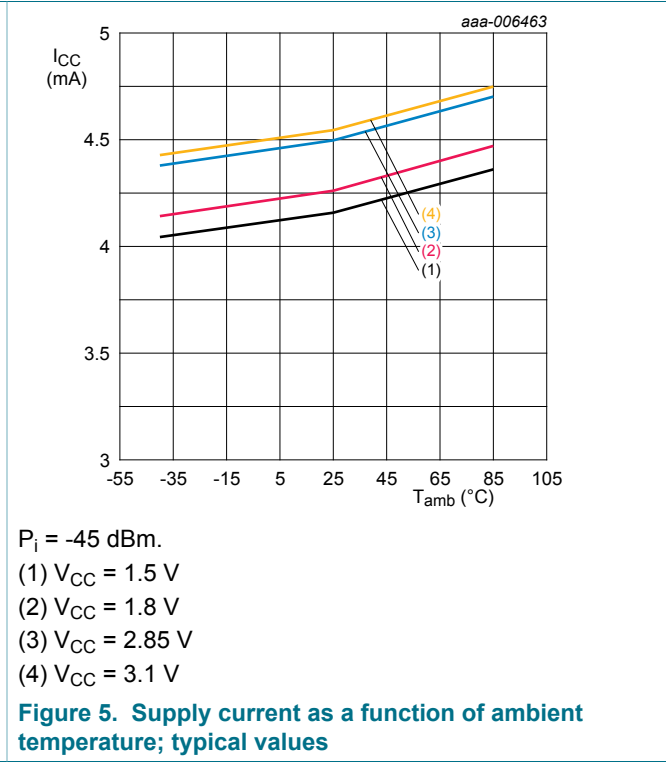
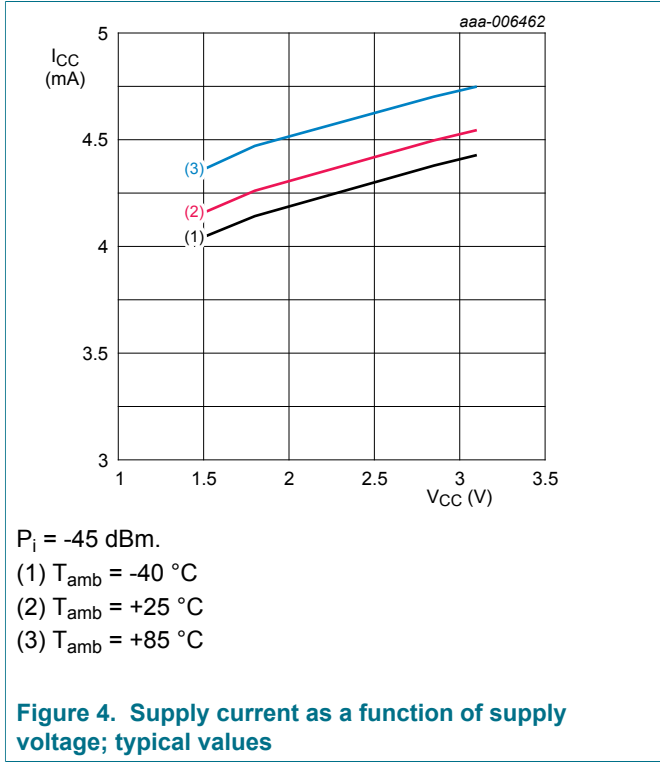
Table 10. Characteristics at Vcc = 2.85 V

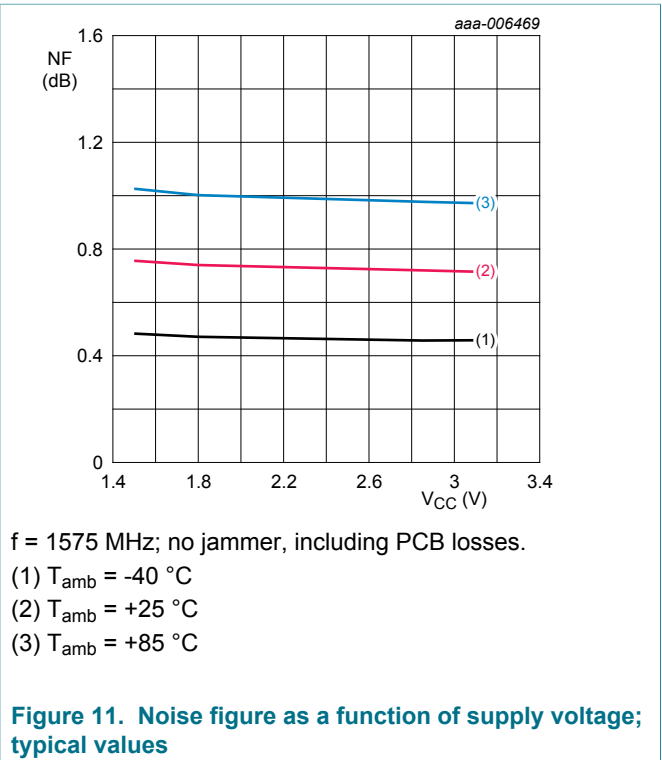
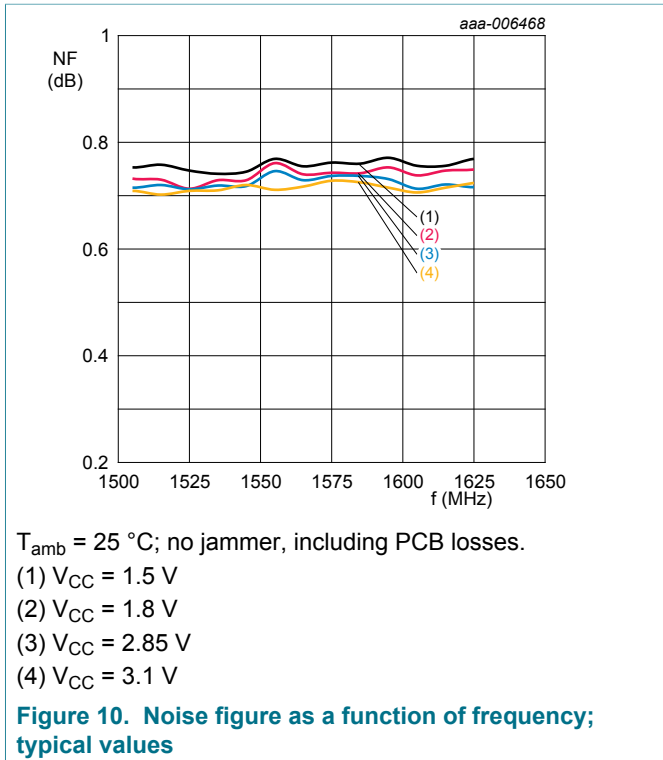
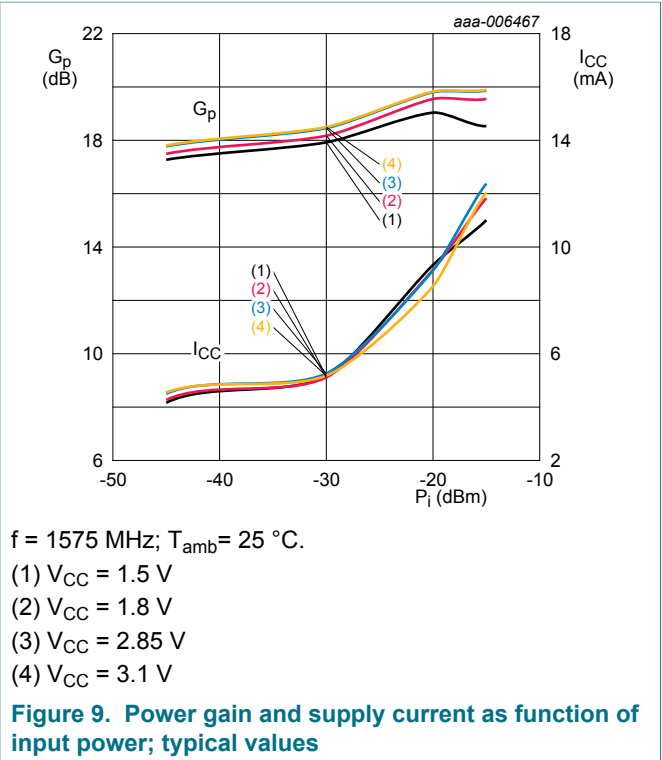
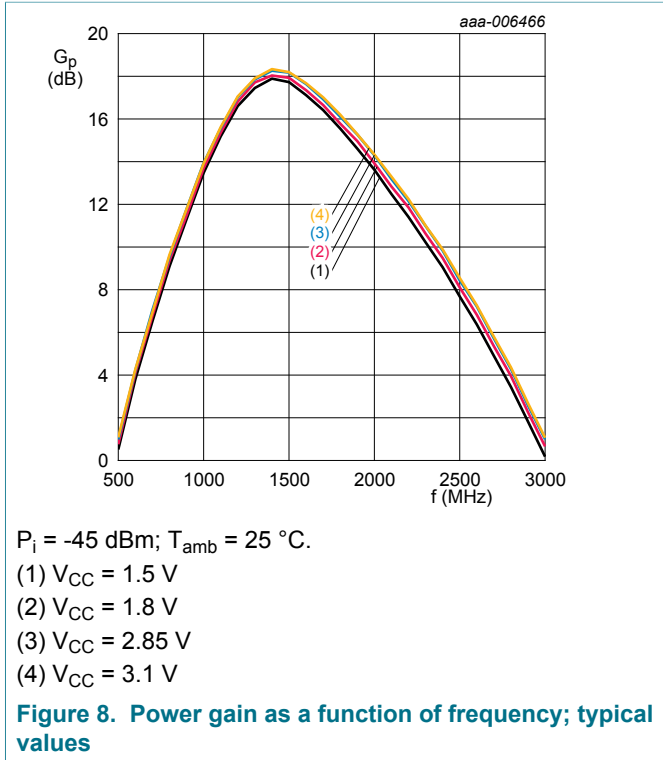
$f = 1575 \text{ MHz}$; $V_{CC} = 2.85 \text{ V}$; $V_{I(ENABLE)} \geq 0.8 \text{ V}$; $P_i < -40 \text{ dBm}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; input matched to $50 \text{ } \Omega$ using a 5.6 nH inductor, see [Figure 34](#), unless otherwise specified.

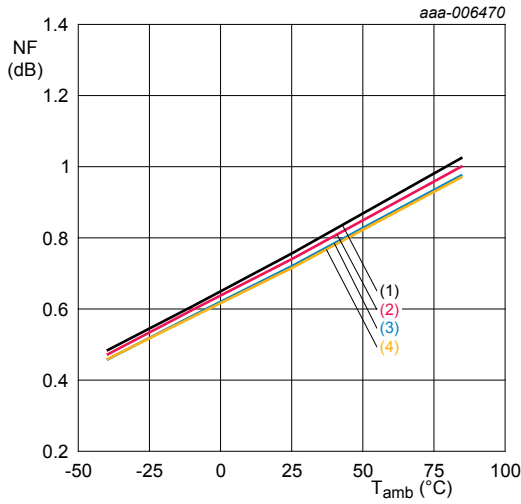
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I _{CC}	supply current	$V_{I(ENABLE)} \geq 0.8 \text{ V}$	-	-	-	-
		• $P_i < -40 \text{ dBm}$	2.6	4.4	6.5	mA
		• $P_i = -20 \text{ dBm}$	-	9	-	mA
		$V_{I(ENABLE)} \leq 0.3 \text{ V}$	-	-	1	μA
G _p	power gain	no jammer	16	17.8	20	dB
		• $P_{jam} = -20 \text{ dBm}$; $f_{jam} = 850 \text{ MHz}$	-	20.0	-	dB
		• $P_{jam} = -20 \text{ dBm}$; $f_{jam} = 1850 \text{ MHz}$	-	20.2	-	dB
RL _{in}	input return loss	$P_i < -40 \text{ dBm}$	-	9	-	dB
		$P_i = -20 \text{ dBm}$	-	11	-	dB
RL _{out}	output return loss	$P_i < -40 \text{ dBm}$	-	15	-	dB
		$P_i = -20 \text{ dBm}$	-	15	-	dB
ISL	isolation		-	37	-	dB
NF	noise figure	$P_i = -40 \text{ dBm}$; no jammer ^[1]	-	0.65	1.2	dB
		$P_i = -40 \text{ dBm}$; no jammer ^{[2] [1]}	-	0.70	1.25	dB
		$P_{jam} = -20 \text{ dBm}$; $f_{jam} = 850 \text{ MHz}$ ^[2]	-	0.9	-	dB
		$P_{jam} = -20 \text{ dBm}$; $f_{jam} = 1850 \text{ MHz}$ ^[2]	-	1.2	-	dB
P _{i(1dB)}	input power at 1 dB gain compression	^[1]	-12.5	-7	-	dBm
IP3 _i	input third-order intercept point	^{[1] [3]}	0	6	-	dBm
		^{[1] [4]}	0	6	-	dBm
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] Guaranteed by device design; not tested in production.
 [2] Including PCB losses.
 [3] $f_1 = 1713 \text{ MHz}$; $f_2 = 1851 \text{ MHz}$, $P_i = -20 \text{ dBm}$ per carrier.
 [4] $f_1 = 1713 \text{ MHz}$; $f_2 = 1851 \text{ MHz}$, $P_{i(1)} = -20 \text{ dBm}$, $P_{i(2)} = -65 \text{ dBm}$.

13 Graphs GNSS band L1



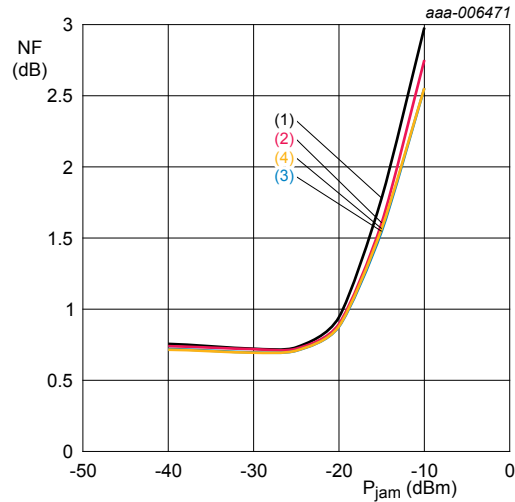




f = 1575 MHz; no jammer, including PCB losses.

- (1) V_{CC} = 1.5 V
- (2) V_{CC} = 1.8 V
- (3) V_{CC} = 2.85 V
- (4) V_{CC} = 3.1 V

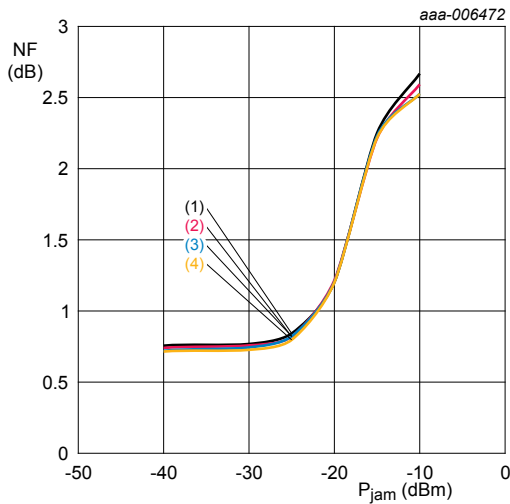
Figure 12. Noise figure as a function of ambient temperature; typical values



f_{jam} = 850 MHz; T_{amb} = 25 °C; f = 1575 MHz; including PCB losses.

- (1) V_{CC} = 1.5 V
- (2) V_{CC} = 1.8 V
- (3) V_{CC} = 2.85 V
- (4) V_{CC} = 3.1 V

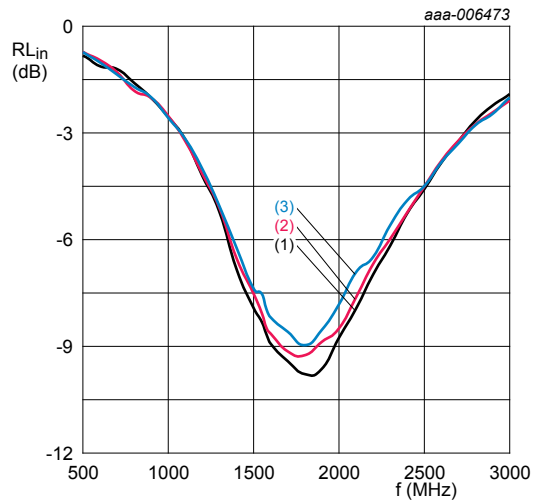
Figure 13. Noise figure as a function of jamming power; typical values



f_{jam} = 1850 MHz; T_{amb} = 25 °C; f = 1575 MHz; including PCB losses.

- (1) V_{CC} = 1.5 V
- (2) V_{CC} = 1.8 V
- (3) V_{CC} = 2.85 V
- (4) V_{CC} = 3.1 V

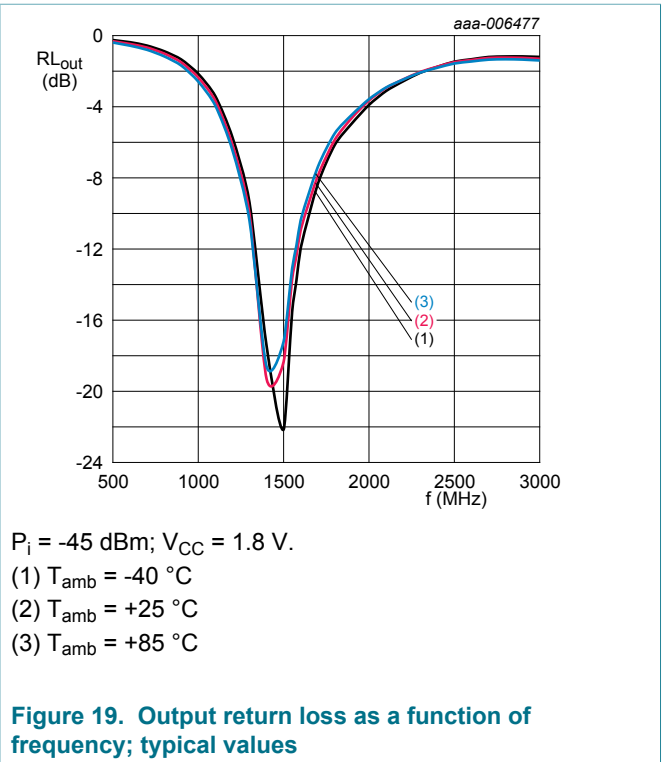
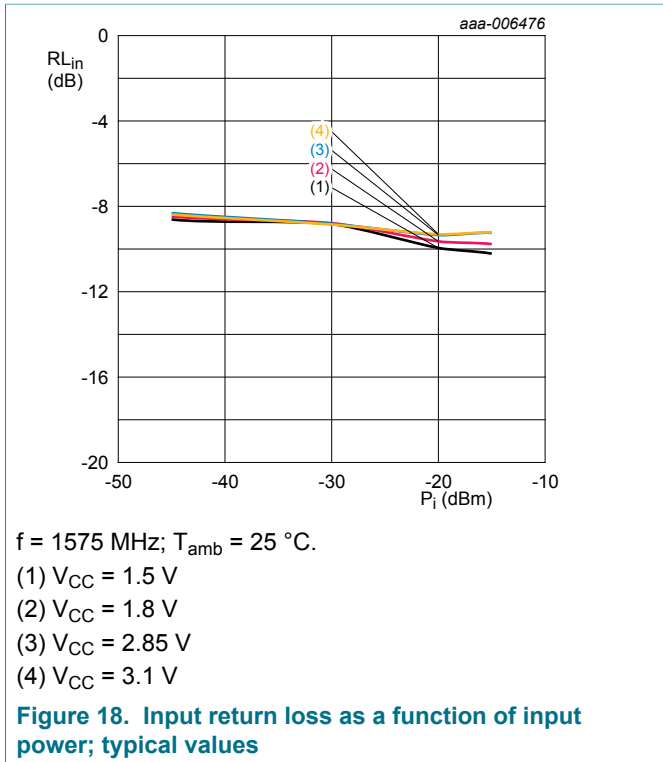
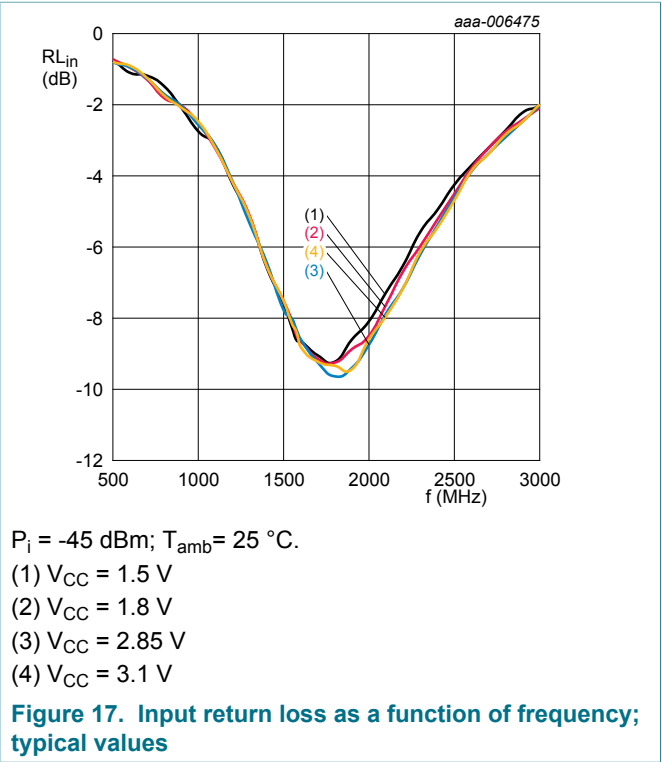
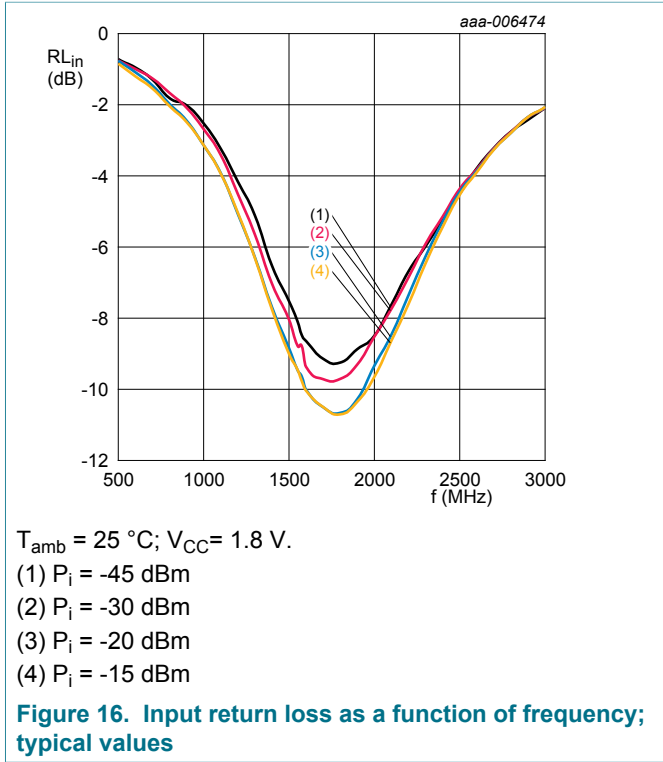
Figure 14. Noise figure as a function of jamming power; typical values

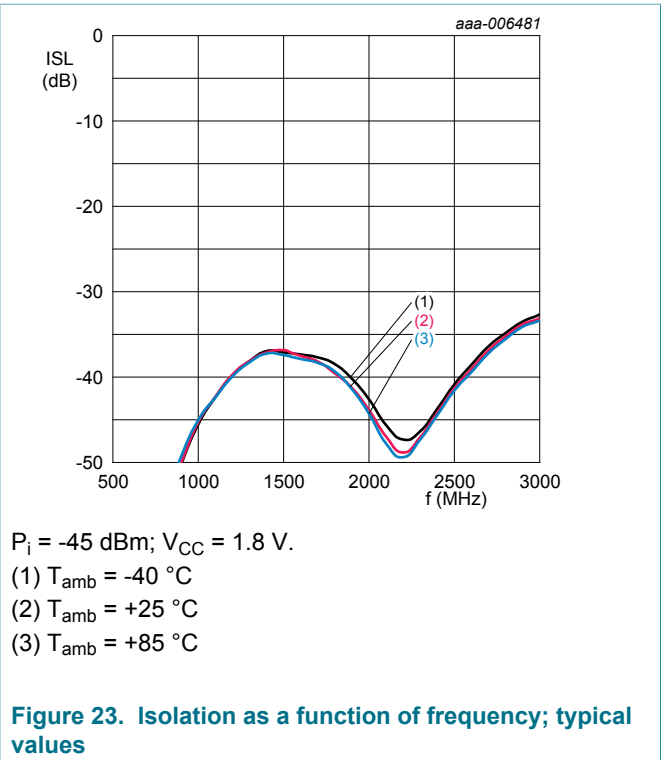
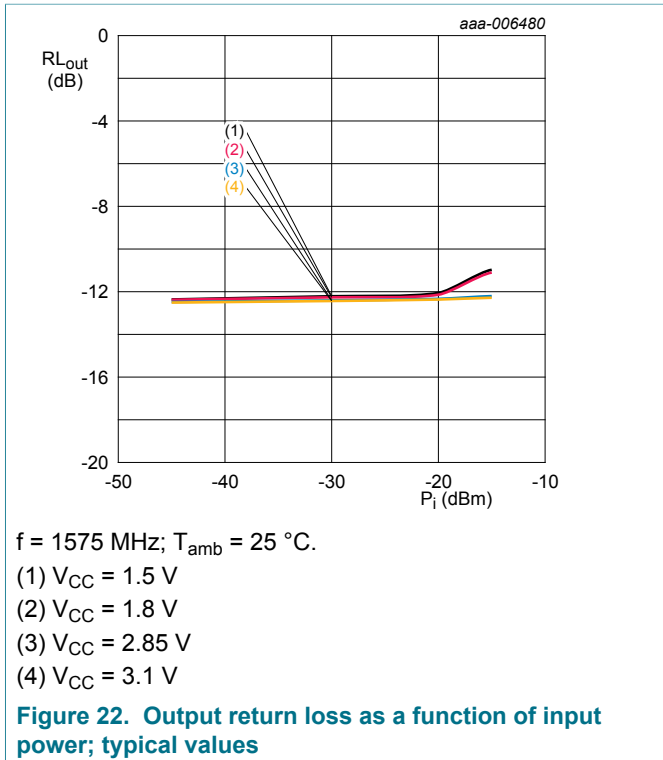
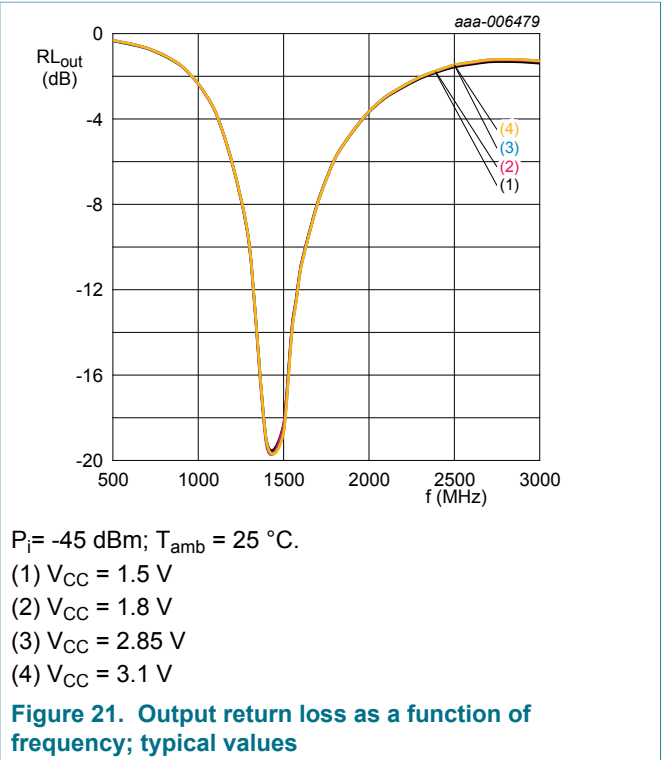
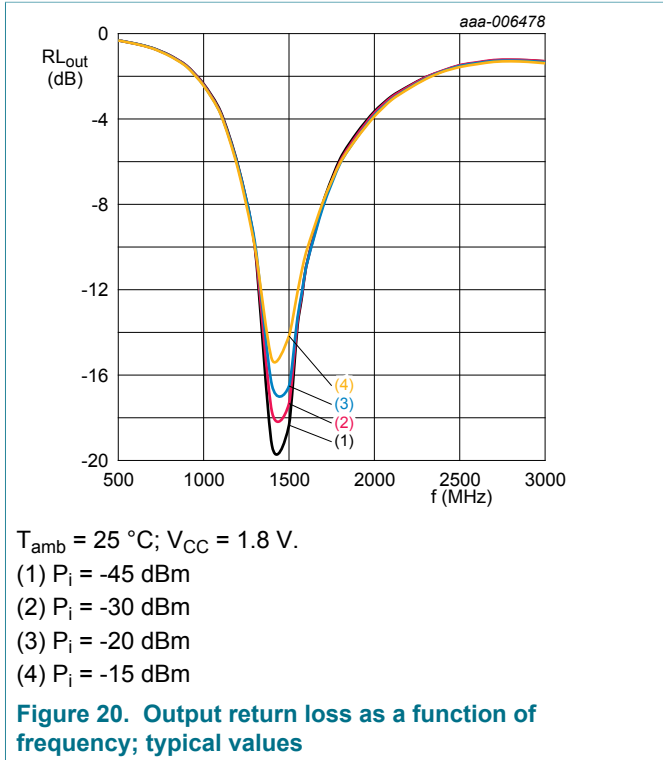


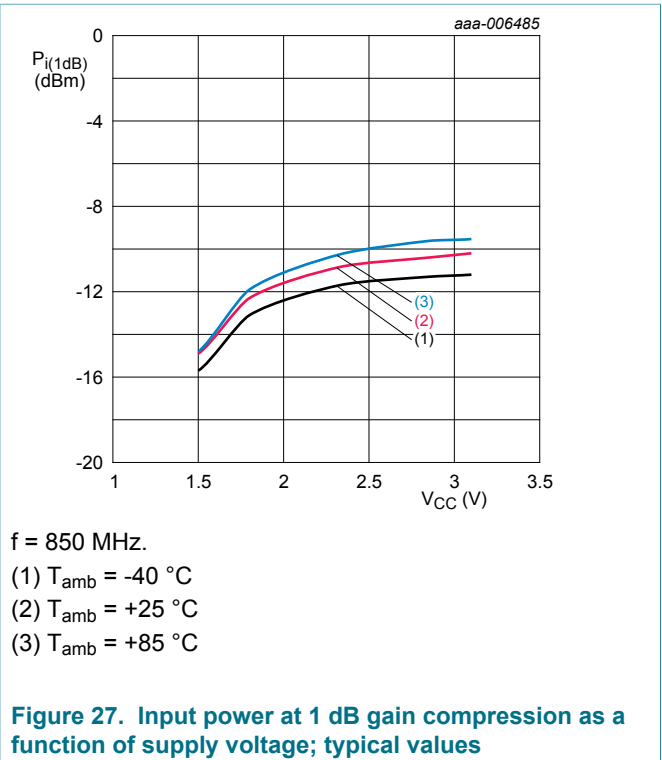
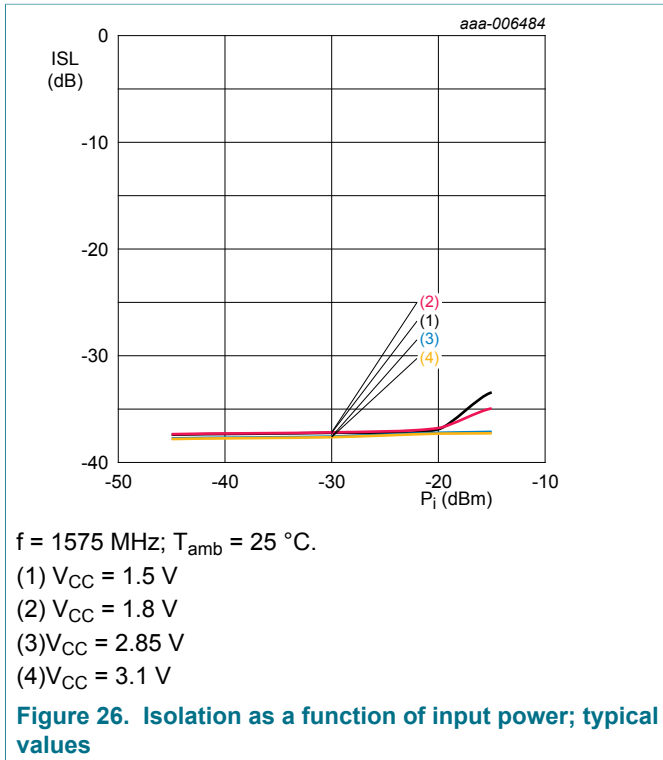
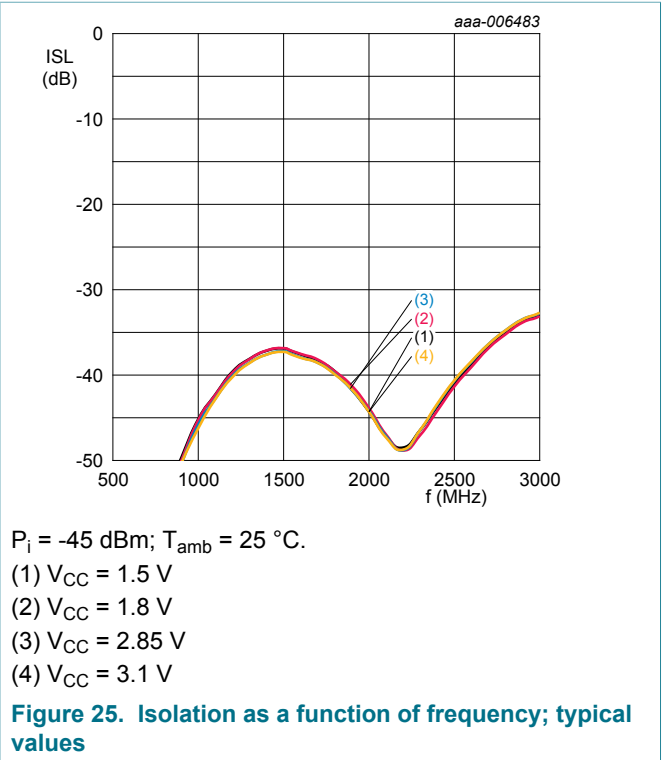
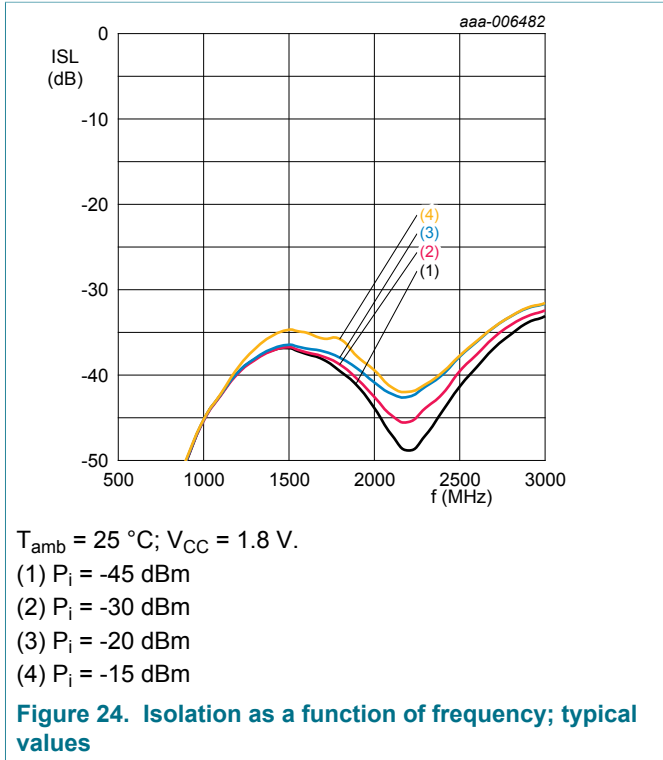
P_i = -45 dBm; V_{CC} = 1.8 V.

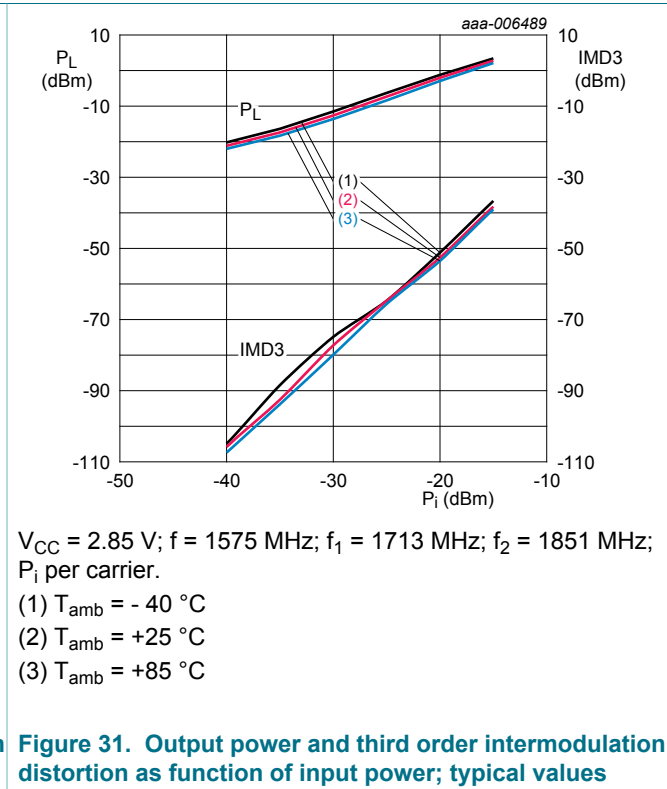
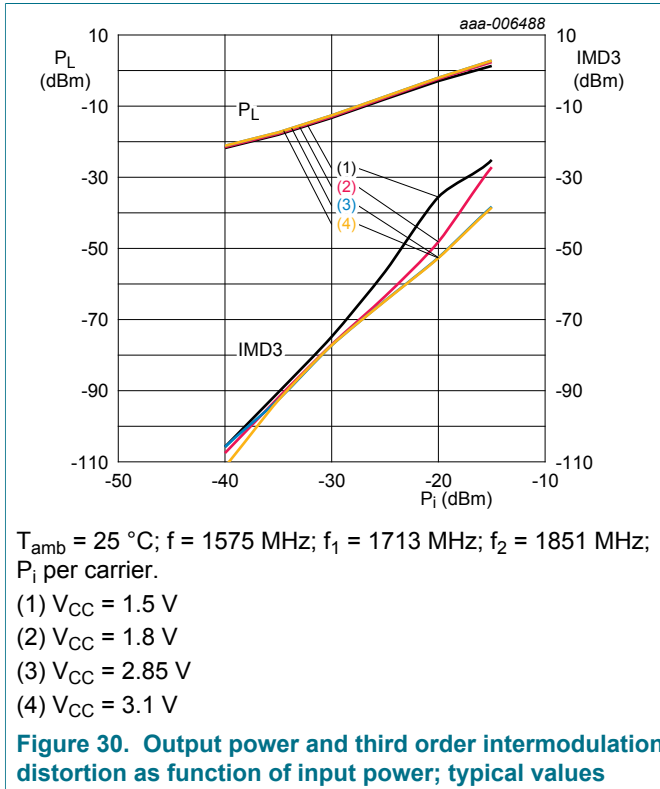
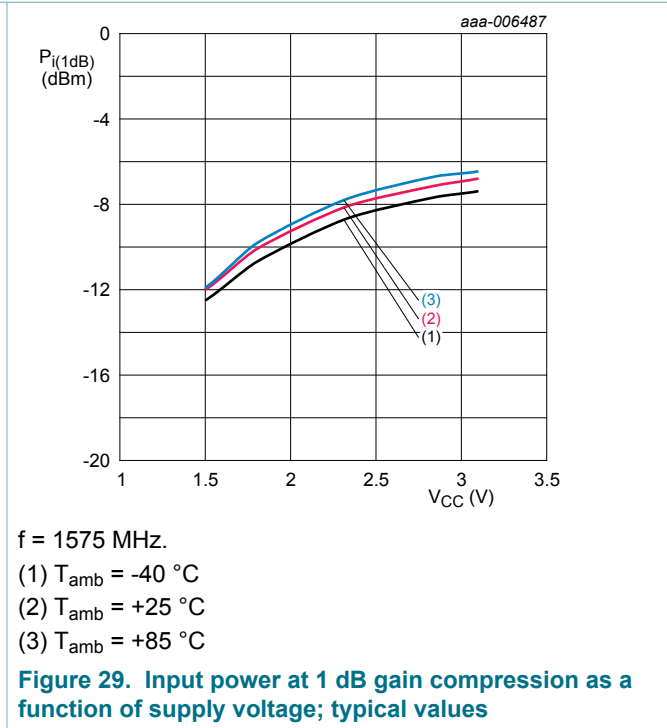
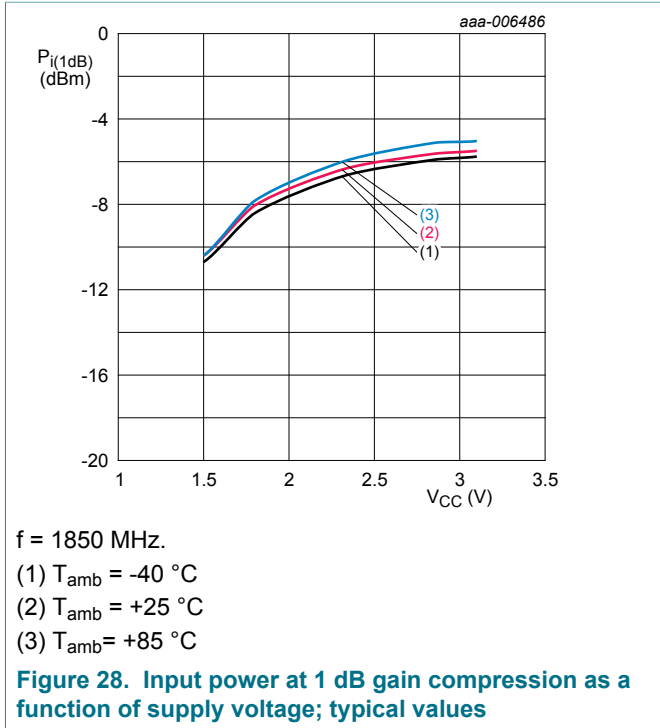
- (1) T_{amb} = -40 °C
- (2) T_{amb} = +25 °C
- (3) T_{amb} = +85 °C

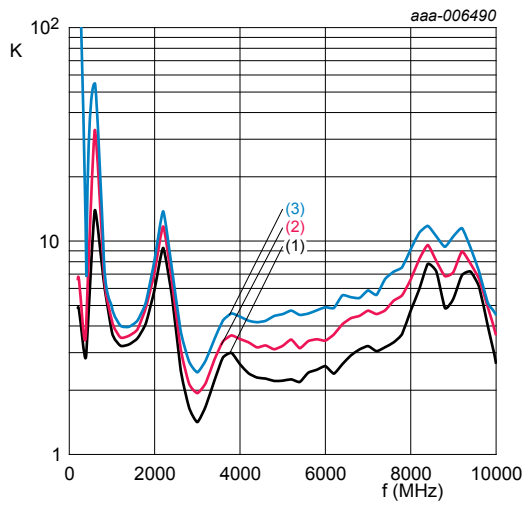
Figure 15. Input return loss as a function of frequency; typical values







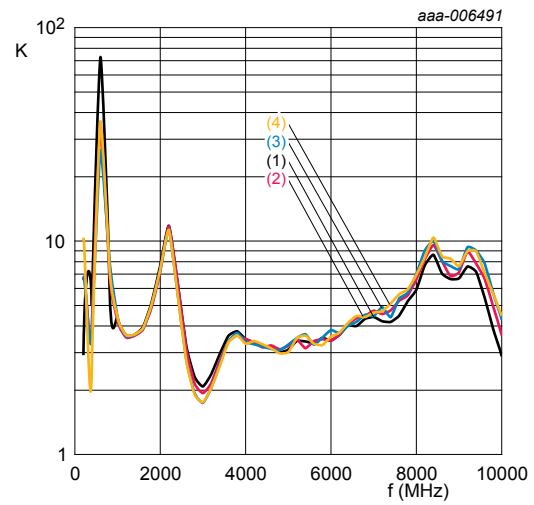




$V_{CC} = 1.8 \text{ V}$; $P_i = -45 \text{ dBm}$.

- (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 32. Rollett stability factor as a function of frequency; typical values



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

- (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 33. Rollett stability factor as a function of frequency; typical values

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Table 11. Characteristics

1474 MHz; $V_{CC} = 1.8\text{ V}$; $P_i = -30\text{ dBm}$; $T_{amb} = 25\text{ °C}$; input matched 50 Ω using application diagram from [Figure 34](#) and component values as in [Table 14](#). Unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Gain Mode						
I_{CC}	supply current	$V_{I(ENABLE)} \geq 0.8\text{ V}$	-	4.4	-	mA
G_p	power gain		-	20	-	dB
RL_{in}	input return loss		-	17.5	-	dB
RL_{out}	output return loss		-	23.5	-	dB
ISL	isolation		-	36	-	dB
NF	noise figure		[1] [2]	0.65	-	dBm
$P_{i(1dB)}$	input power at 1 dB gain compression		[2]	-11	-	dBm
$IP3_i$	input third-order intercept point	$\Delta f = 1\text{ MHz}$, $P_i = -30\text{ dBm}$	[2] [3]	-7	-	dBm
t_{on}	turn-on time	Time from $V_{I(CTRL)}$ ON to 90 % of the gain	-	-	2	μs
t_{off}	turn-off time	Time from $V_{I(CTRL)}$ OFF to 10 % of the gain	-	-	1	μs
K	Rollett stability factor		1	-	-	-

[1] PCB losses are subtracted.

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

[3] $f_1 = 1474\text{ MHz}$, $f_2 = 1475\text{ MHz}$

Table 12. Characteristics

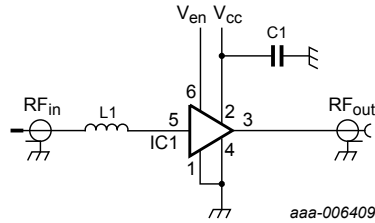
1474 MHz; $V_{CC} = 2.8\text{ V}$; $P_i = -30\text{ dBm}$; $T_{amb} = 25\text{ °C}$; input matched 50 Ω using application diagram from [Figure 34](#) and component values as in [Table 14](#). Unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Gain Mode						
I_{CC}	supply current	$V_{I(ENABLE)} \geq 0.8\text{ V}$	-	4.6	-	mA
G_p	power gain		-	20	-	dB
RL_{in}	input return loss		-	17.5	-	dB
RL_{out}	output return loss		-	23.5	-	dB
ISL	isolation		-	36	-	dB
NF	noise figure		[1] [2]	0.65	-	dB
$P_{i(1dB)}$	input power at 1 dB gain compression		[2]	-8.5	-	dBm
$IP3_i$	input third-order intercept point	$\Delta f = 1\text{ MHz}$, $P_i = -30\text{ dBm}$	[2] [3]	-6	-	dBm
t_{on}	turn-on time	Time from $V_{I(CTRL)}$ ON to 90 % of the gain	-	-	2	μs
t_{off}	turn-off time	Time from $V_{I(CTRL)}$ OFF to 10 % of the gain	-	-	1	μs
K	Rollett stability factor		1	-	-	-

- [1] PCB losses are subtracted.
- [2] Guaranteed by device design; not tested in production.
- [3] $f_1 = 1474$ MHz, $f_2 = 1475$ MHz

15 Application information

15.1 GNSS and LTE B32 LNA



For a list of components, see [Table 13](#) (GNSS) and [Table 14](#) (LTE B32).

Figure 34. Schematics GNSS LNA and LTE B32 evaluation board

Table 13. List of components for GNSS applications

See [Figure 34](#) for schematics.

Component	Description	Value	Remarks
EVB	Evaluation Board	SOT1230 - EVB	EVB for GNSS application, NXP Semiconductors
C1	decoupling capacitor	1 nF	
IC1	BGU8009	-	NXP Semiconductors
L1	high-quality matching inductor	5.6 nH	GNSS band L1: $1559 < f < 1610$ MHz Murata LQW15A

Table 14. List of components for LTE B32 applications

See [Figure 34](#) for schematics.

Component	Description	Value	Remarks
EVB	Evaluation Board	OM17025 (SOT1230, SOT1232)	EVB for LTE application, NXP Semiconductors
C1	decoupling capacitor	1 nF	
IC1	BGU8009	-	NXP Semiconductors
L1	high-quality matching inductor	9.1 nH	LTE band 32 L1: 1452 < f < 1496 MHz Murata LQW15A

GNSS: See application note AN11288 for details. LTE B32: See application note AN11986.

16 Package outline

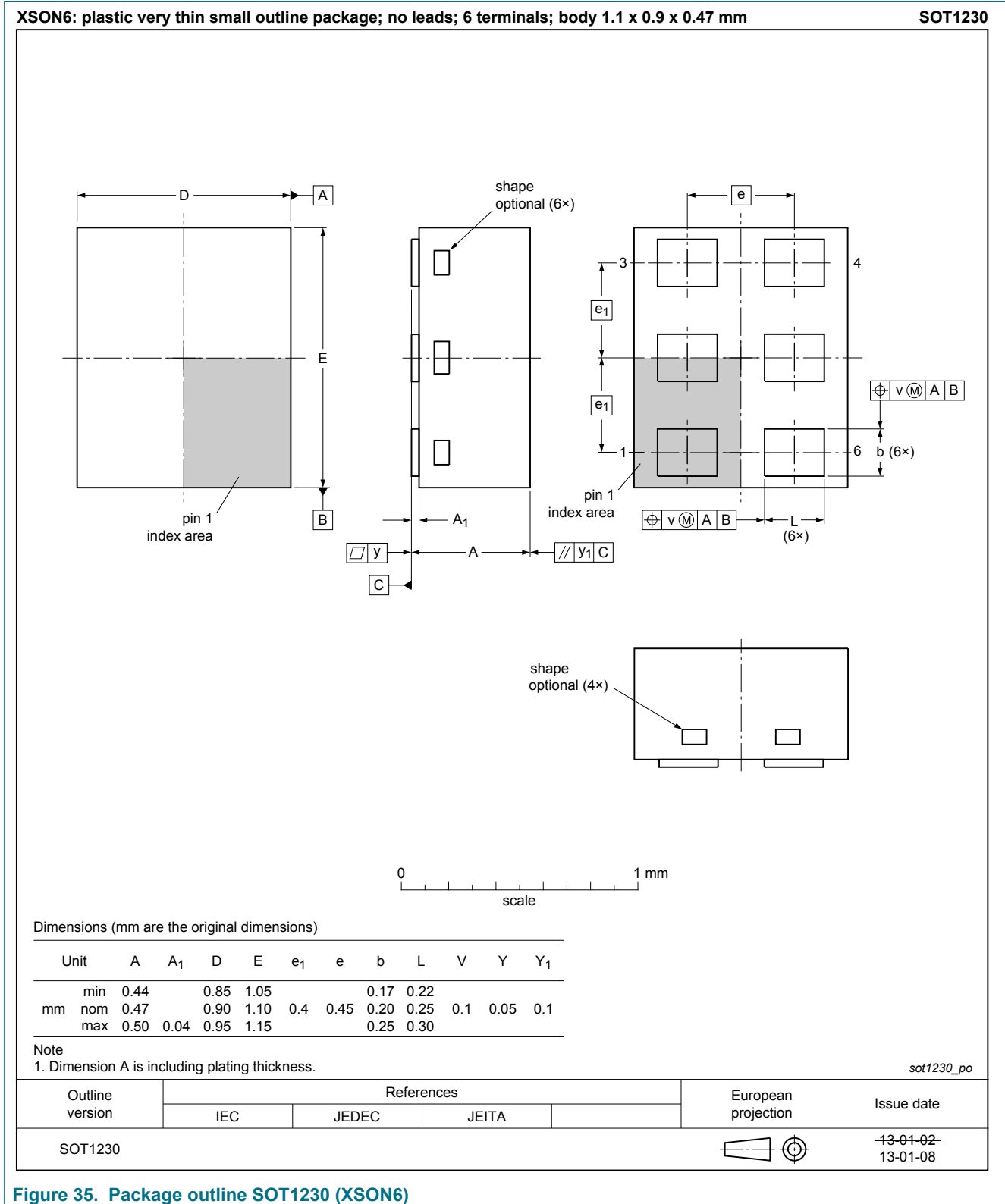


Figure 35. Package outline SOT1230 (XSON6)

17 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.

18 Abbreviations

Table 15. Abbreviations

Acronym	Description
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

19 Revision history

Table 16. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGU8009 v.7.3	20190516	Product data sheet	-	BGU8009 v.7.2
Modifications:	<ul style="list-style-type: none"> added general Marking diagram 			
BGU8009 v.7.2	20190510	Product data sheet	-	BGU8009 v.7.1
Modifications:	<ul style="list-style-type: none"> removed incorrect marking code description adapted date code notation to the Marking code table 			
BGU8009 v.7.1	20180416	Product data sheet	-	BGU8009 v.7
Modifications:	<ul style="list-style-type: none"> adapted the data sheet to the new look and feel 			
BGU8009 v.7	20170720	Product data sheet	-	BGU8009 v.6
Modifications:	<ul style="list-style-type: none"> Section 1 "General description" on page 1: added GPS1201M according to our new naming convention Section 2 "Features and benefits" on page 1: added LTE B32 characteristics Section 14 "Characteristics LTE B32" on page 17 added Table 13 added EVB 			
BGU8009 v.6	20170118	Product data sheet	-	BGU8009 v.5
Modifications:	<ul style="list-style-type: none"> Section 1: added GPS1201M according to our new naming convention 			
BGU8009 v.5	20160405	Product data sheet	-	BGU8009 v.4
Modifications:	<ul style="list-style-type: none"> updated Figure 2 			
BGU8009 v.4	20160316	Product data sheet	-	BGU8009 v.3

Document ID	Release date	Data sheet status	Change notice	Supersedes
Modifications:	• updated Table 8 and Table 9 on page 6			
BGU8009 v.3	20141001	Product data sheet	-	BGU8009 v.2
Modifications:	• Section 6.1 on page 3: Section has been added.			
BGU8009 v.2	20130619	Product data sheet	-	BGU8009 v.1
BGU8009 v.1	20130201	Product data sheet	-	-

20 Legal information

20.1 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".

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