BGU7007

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

Rev. 3 — 29 March 2012 **Product data sheet**

1. Product profile

1.1 General description

The BGU7007 is a Low Noise Amplifier (LNA) for GNSS receiver applications in a plastic leadless 6-pin, extremely small SOT886 package. The BGU7007 requires only one external matching inductor and one external decoupling capacitor.

The BGU7007 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 0.85 dB. During high jamming power levels, resulting for example from a cellular transmit burst, it temporarily increases its bias current to improve sensitivity.

CAUTION

This device is sensitive to ElectroStatic Discharge (ESD). Therefore care should be taken during transport and handling.

1.2 Features and benefits

- Covers full GNSS L1 band, from 1559 MHz to 1610 MHz
- Noise figure (NF) = 0.85 dB
- Gain 18.5 dB
- High input1 dB compression point P_i (1dB) of –12 dBm
- High out of band $IP3_i$ of 4 dBm
- Supply voltage 1.5 V to 3.1 V
- Power-down mode current consumption < 1 μA
- Optimized performance at low supply current of 4.8 mA
- 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
- Small 6-pin leadless package 1 mm × 1.45 mm × 0.5 mm
- 110 GHz transit frequency - SiGe:C technology

1.3 Applications

- LNA for GPS, GLONASS, Galileo and Compass (BeiDou) in smart phones, feature phones, tablet PCs, Personal Navigation Devices, Digital Still Cameras, Digital Video Cameras, RF Front End modules, complete GPS chipset modules and theft protection (laptop, ATM)

1.4 Quick reference data

Table 1. Quick reference data

f = 1559 MHz to 1610 MHz; V_{CC} = 1.8 V; P_i < −40 dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 5.6 nH inductor; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CC}	supply voltage	RF input AC coupled		1.5	-	3.1	V
I_{CC}	supply current	V_{ENABLE} ≥ 0.8 V					
		P_i < −40 dBm		3.4	4.8	6.1	mA
		P_i = −20 dBm		8.9	12.8	15.9	mA
G_p	power gain	P_i < −40 dBm, no jammer		16.5	18.5	20.5	dB
		P_i = −20 dBm		17.5	19.5	21.5	dB
NF	noise figure	P_i < −40 dBm, no jammer	[1]	-	0.85	1.2	dB
		P_i < −40 dBm, no jammer	[2]	-	0.90	1.3	dB
		P_i = −20 dBm		-	1.2	1.6	dB
$P_{i(1dB)}$	input power at 1 dB gain compression	f = 1559 MHz to 1610 MHz					
		V_{CC} = 1.5 V		−16	−13	-	dBm
		V_{CC} = 1.8 V		−15	−12	-	dBm
		V_{CC} = 2.85 V		−14	−11	-	dBm
$IP3_i$	input third-order intercept point	f = 1.575 GHz					
		V_{CC} = 1.5 V	[3]	1	4	-	dBm
		V_{CC} = 1.8 V	[3]	1	4	-	dBm
		V_{CC} = 2.85 V	[3]	2	5	-	dBm

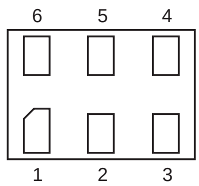
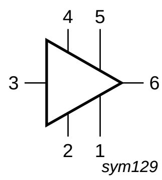
[1] PCB losses are subtracted.

[2] Including PCB losses.

[3] f_1 = 1713 MHz; f_2 = 1851 MHz; P_1 = P_2 = −30 dBm.

2. Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Graphic symbol
1	GND	 Transparent top view	
2	GND		
3	RF_IN		
4	V_{CC}		
5	ENABLE		
6	RF_OUT		

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BGU7007	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1.45 × 0.5 mm	SOT886

4. Marking

Table 4. Marking codes

Type number	Marking code
BGU7007	B6

5. Limiting values

Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage	RF input AC coupled		−0.5	+5.0	V
V_{ENABLE}	voltage on pin ENABLE	$V_{ENABLE} < V_{CC} + 0.6$	[2]	−0.5	+5.0	V
V_{RF_IN}	voltage on pin RF_IN	DC; $V_{RF\_IN} < V_{CC} + 0.6$	[2][3]	−0.5	+5.0	V
V_{RF_OUT}	voltage on pin RF_OUT	DC; $V_{RF\_OUT} < V_{CC} + 0.6$	[2][3]	−0.5	+5.0	V
P_i	input power			-	0	dBm
P_{tot}	total power dissipation	$T_{sp} \leq 130$ °C	[1]		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 JEDEC standard 22-A114E		-	4	kV
		Charged Device Model (CDM); According JEDEC standard 22-C101B		-	1	kV

[1] T_{sp} is the temperature at the soldering point of the emitter lead.

[2] Warning: due to internal ESD diode proctection, the applied DC voltage should not exceed V_{CC} + 0.6 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. Thermal characteristics

Table 6. Thermal characteristics

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

7. Characteristics

Table 7. Characteristics

f = 1559 MHz to 1610 MHz; V_{CC} = 1.8 V; V_{ENABLE} >= 0.8 V; P_i < –40 dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 5.6 nH inductor; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CC}	supply voltage	RF input AC coupled		1.5	-	3.1	V
I_{CC}	supply current	$V_{ENABLE} \geq 0.8$ V					
		$P_i < -40$ dBm		3.4	4.8	6.1	mA
		$P_i = -20$ dBm		8.9	12.8	15.9	mA
		$V_{ENABLE} \leq 0.35$ V		-	-	1	μA
T_{amb}	ambient temperature			–40	+25	+85	°C
G_p	power gain	T_{amb} = 25 °C					
		$P_i < -40$ dBm, no jammer		16.5	18.5	20.5	dB
		$P_i = -20$ dBm, no jammer		17.5	19.5	21.5	dB
		$P_{jam} = -20$ dBm; f_{jam} = 850 MHz		17.5	19.5	21.5	dB
		$P_{jam} = -20$ dBm; f_{jam} = 1850 MHz		17.5	19.5	21.5	dB
		–40 °C ≤ T_{amb} ≤ +85 °C					
		$P_i < -40$ dBm, no jammer		16	-	21	dB
		$P_i = -20$ dBm, no jammer		17	-	22	dB
		$P_{jam} = -20$ dBm; f_{jam} = 850 MHz		17	-	22	dB
		$P_{jam} = -20$ dBm; f_{jam} = 1850 MHz		17	-	22	dB
RL_{in}	input return loss	$P_i < -40$ dBm		5	7	-	dB
		$P_i = -20$ dBm		7	10	-	dB
RL_{out}	output return loss	$P_i < -40$ dBm		12	18	-	dB
		$P_i = -20$ dBm		15	24	-	dB
ISL	isolation			22	24	-	dB
NF	noise figure	T_{amb} = 25 °C					
		$P_i < -40$ dBm, no jammer	[1]	-	0.85	1.2	dB
		$P_i < -40$ dBm, no jammer	[2]	-	0.90	1.3	dB
		$P_i = -20$ dBm, no jammer		-	1.2	1.6	dB
		$P_{jam} = -20$ dBm; f_{jam} = 850 MHz		-	1.1	1.5	dB
		$P_{jam} = -20$ dBm; f_{jam} = 1850 MHz		-	1.3	1.7	dB
		–40 °C ≤ T_{amb} ≤ +85 °C					
		$P_i < -40$ dBm, no jammer		-	-	1.7	dB
		$P_i = -20$ dBm, no jammer		-	-	1.9	dB
		$P_{jam} = -20$ dBm; f_{jam} = 850 MHz		-	-	1.8	dB
		$P_{jam} = -20$ dBm; f_{jam} = 1850 MHz		-	-	2.0	dB

Table 7. Characteristics *...continued*

f = 1559 MHz to 1610 MHz; V_{CC} = 1.8 V; V_{ENABLE} >= 0.8 V; P_i < –40 dBm; T_{amb} = 25 °C; input matched to 50 Ω using a 5.6 nH inductor; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$P_{i(1dB)}$	input power at 1 dB gain compression	f = 1559 MHz to 1610 MHz					
		V_{CC} = 1.5 V		–16	–13	-	dBm
		V_{CC} = 1.8 V		–15	–12	-	dBm
		V_{CC} = 2.85 V		–14	–11	-	dBm
		f = 806 MHz to 928 MHz					
		V_{CC} = 1.5 V	[3]	–16	–13	-	dBm
		V_{CC} = 1.8 V	[3]	–15	–12	-	dBm
		V_{CC} = 2.85 V	[3]	–15	–12	-	dBm
		f = 1612 MHz to 1909 MHz					
		V_{CC} = 1.5 V	[3]	–14	–11	-	dBm
		V_{CC} = 1.8 V	[3]	–13	–10	-	dBm
		V_{CC} = 2.85 V	[3]	–11	–8	-	dBm
$IP3_i$	input third-order intercept point	f = 1.575 GHz					
		V_{CC} = 1.5 V	[4]	1	4	-	dBm
		V_{CC} = 1.8 V	[4]	1	4	-	dBm
		V_{CC} = 2.85 V	[4]	2	5	-	dBm
t_{on}	turn-on time		[5]	-	-	2	μs
t_{off}	turn-off time		[5]	-	-	1	μs
K	Rollett stability factor			1	-	-	

[1] PCB losses are subtracted.

[2] Including PCB losses.

[3] Out of band.

[4] f_1 = 1713 MHz; f_2 = 1851 MHz; $P_1 = P_2$ = –30 dBm.

[5] Within 10 % of the final gain.

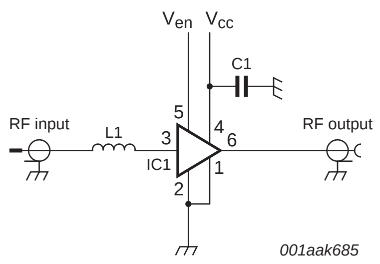
Table 8. ENABLE (pin 5)

–40 °C ≤ T_{amb} ≤ +85 °C; 1.5 V ≤ V_{CC} ≤ 3.1 V

V_{ENABLE} (V)	State
≤ 0.35	OFF
≥ 0.8	ON

8. Application information

8.1 GNSS LNA



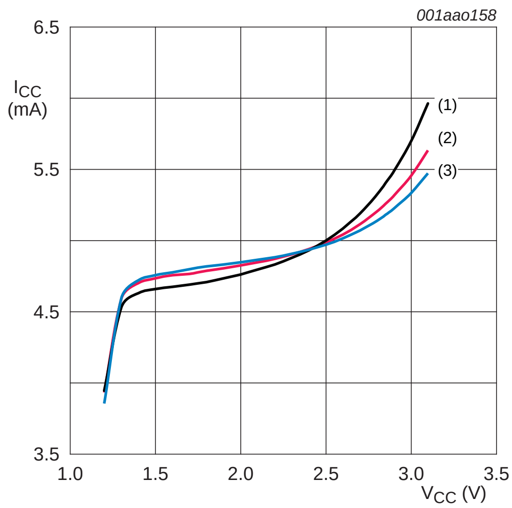
For a list of components see Table 9.

Fig 1. Schematics GNSS LNA evaluation board

Table 9. List of components

For schematics see Figure 1.

Component	Description	Value	Supplier	Remarks
C1	decoupling capacitor	1 nF	various	
IC1	BGU7007	-	NXP	
L1	high quality matching inductor	5.6 nH	Murata LQW15A	



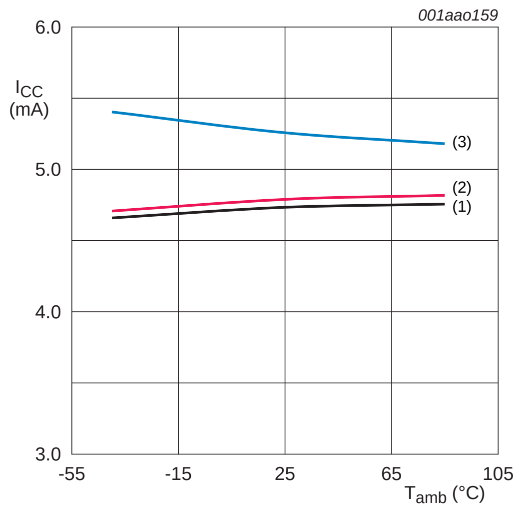
P_i = –45 dBm.

(1) T_{amb} = –40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 2. Supply current as a function of supply voltage; typical values



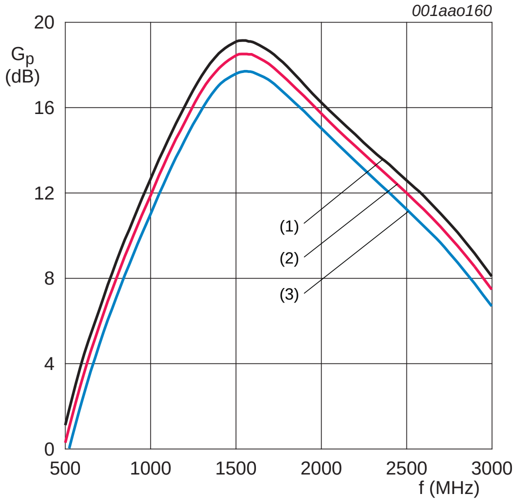
P_i = –45 dBm.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

Fig 3. Supply current as a function of ambient temperature; typical values



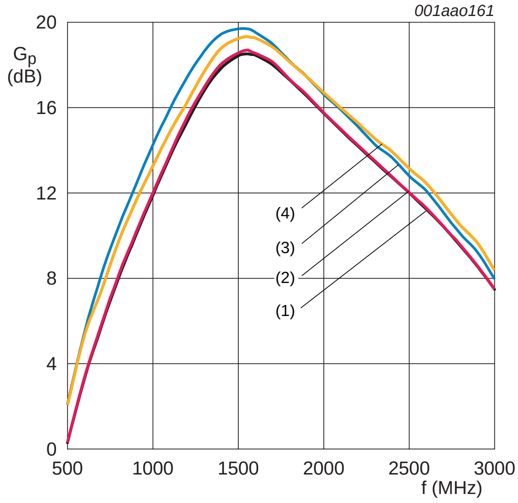
V_{CC} = 1.8 V; P_i = –45 dBm.

(1) T_{amb} = –40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 4. Power gain as a function of frequency; typical values



V_{CC} = 1.8 V; T_{amb} = 25 °C.

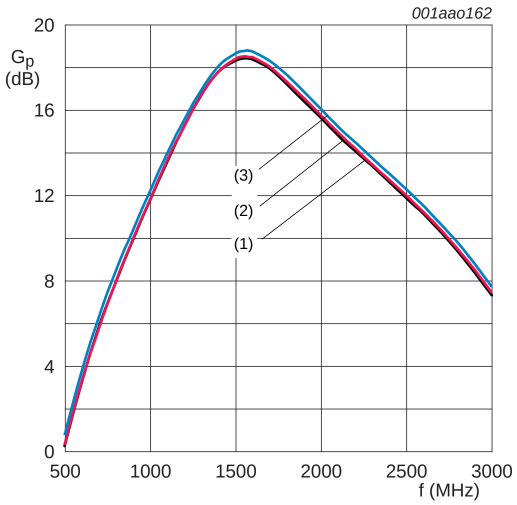
(1) P_i = –45 dBm

(2) P_i = –30 dBm

(3) P_i = –20 dBm

(4) P_i = –15 dBm

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



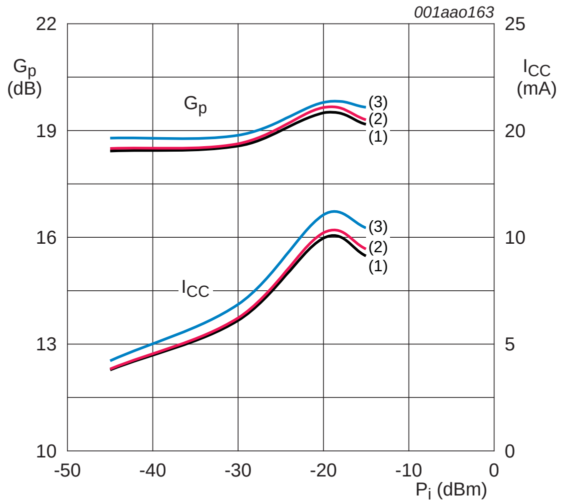
P_i = –45 dBm; T_{amb} = 25 °C.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

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



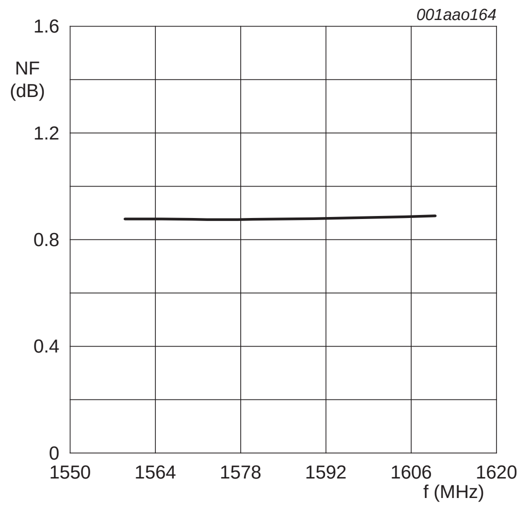
T_{amb} = 25 °C; f = 1575 MHz.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

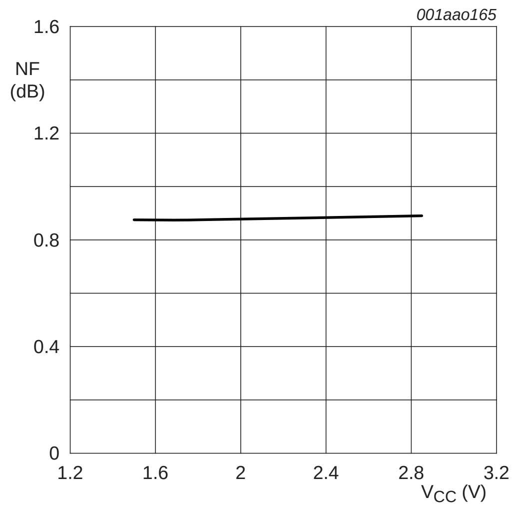
(3) V_{CC} = 2.85 V

Fig 7. Power gain as a function of input power; typical values



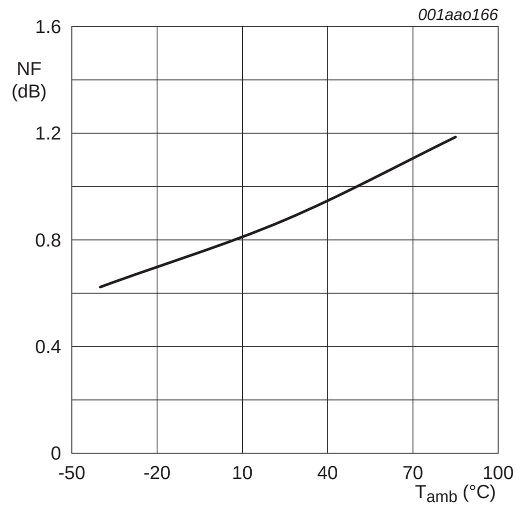
V_{CC} = 1.8 V; T_{amb} = 25 °C; no jammer.

Fig 8. Noise figure as a function of frequency; typical values



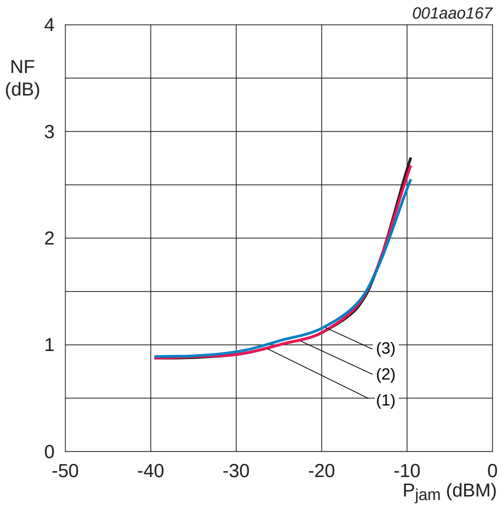
f = 1575 MHz; T_{amb} = 25 °C; no jammer.

Fig 9. Noise figure as a function of supply voltage; typical values



f = 1575 MHz; V_{CC} = 1.8 V; no jammer.

Fig 10. Noise figure as a function of ambient temperature; typical values



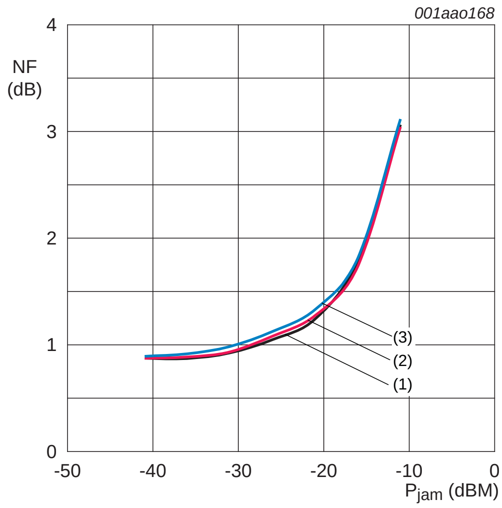
f_{jam}= 850 MHz; T_{amb} = 25 °C; f = 1575 MHz.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

Fig 11. Noise figure as a function of jamming power; typical values



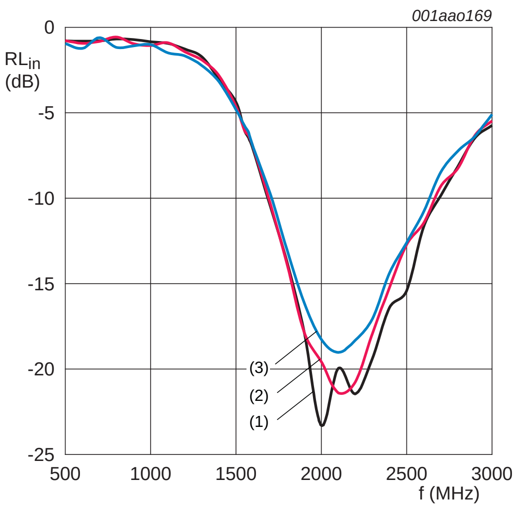
f_{jam}= 1850 MHz; T_{amb} = 25 °C; f = 1575 MHz.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

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



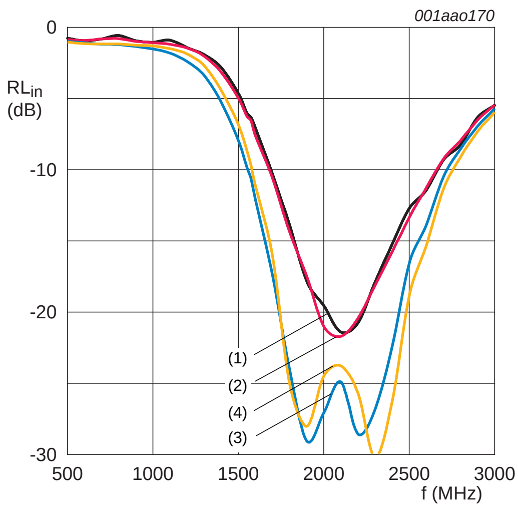
V_{CC} = 1.8 V; P_i = −45 dBm.

(1) T_{amb} = −40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 13. Input return loss as a function of frequency; typical values



V_{CC} = 1.8 V; T_{amb} = 25 °C.

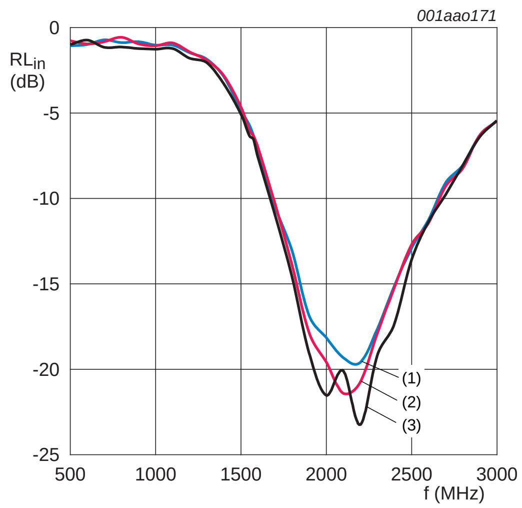
(1) P_i = −45 dBm

(2) P_i = −30 dBm

(3) P_i = −20 dBm

(4) P_i = −15 dBm

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



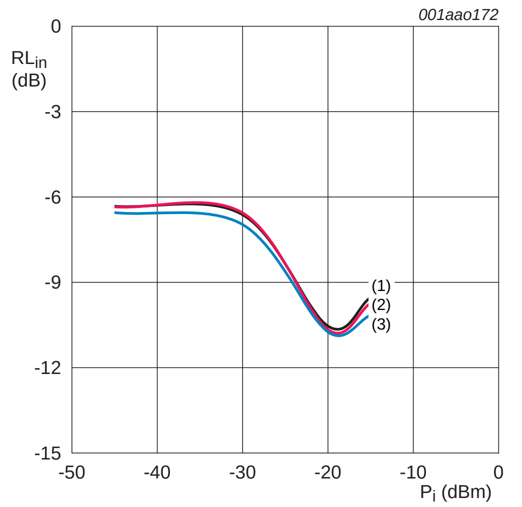
P_i = –45 dBm; T_{amb} = 25 °C.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

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



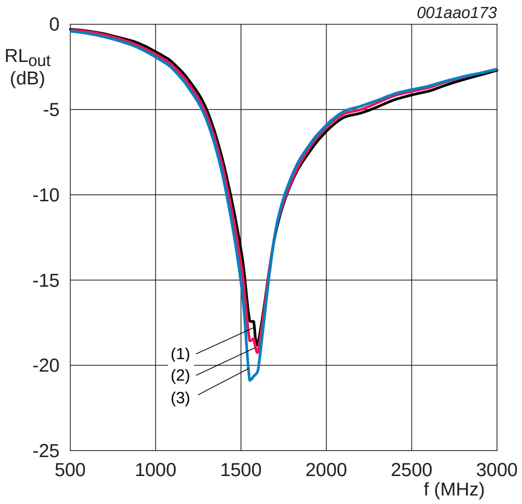
T_{amb} = 25 °C; f = 1575 MHz.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

Fig 16. Input return loss as a function of input power; typical values



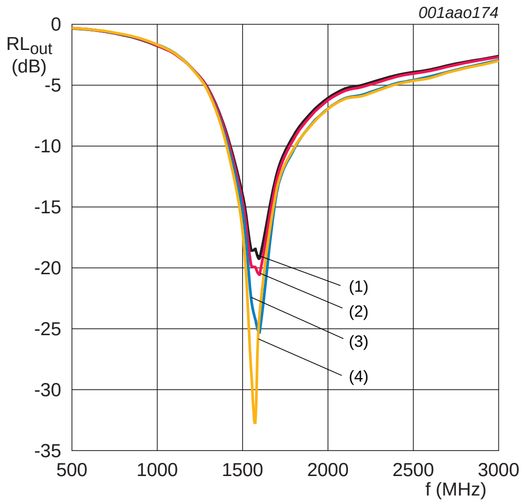
V_{CC} = 1.8 V; P_i = –45 dBm.

(1) T_{amb} = –40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 17. Output return loss as a function of frequency; typical values



V_{CC} = 1.8 V; T_{amb} = 25 °C.

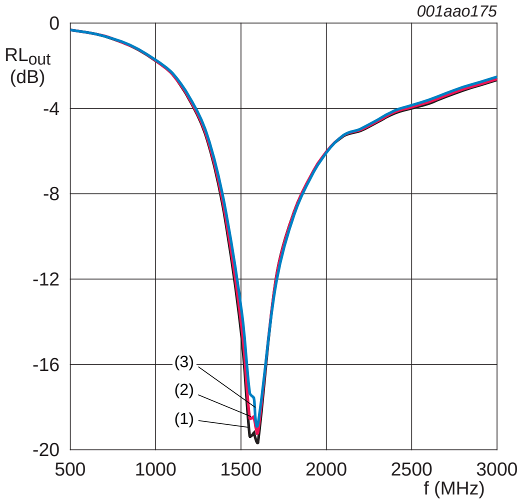
(1) P_i = –45 dBm

(2) P_i = –30 dBm

(3) P_i = –20 dBm

(4) P_i = –15 dBm

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



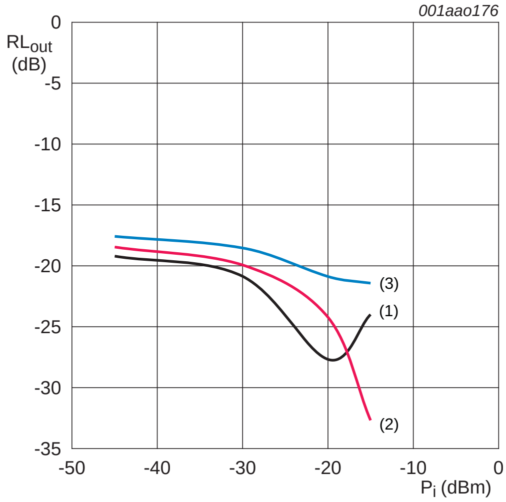
P_i = –45 dBm; T_{amb} = 25 °C.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

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



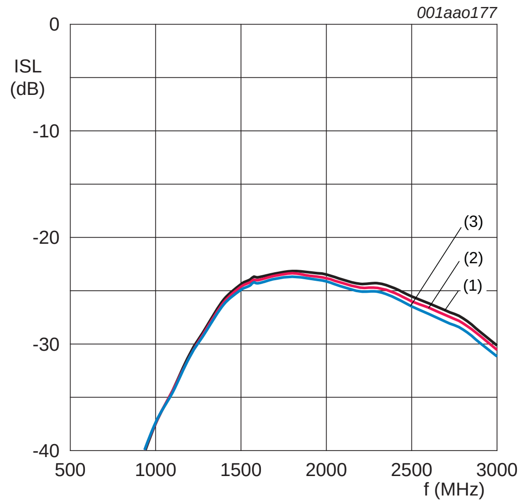
T_{amb} = 25 °C; f = 1575 MHz.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

Fig 20. Output return loss as a function of input power; typical values



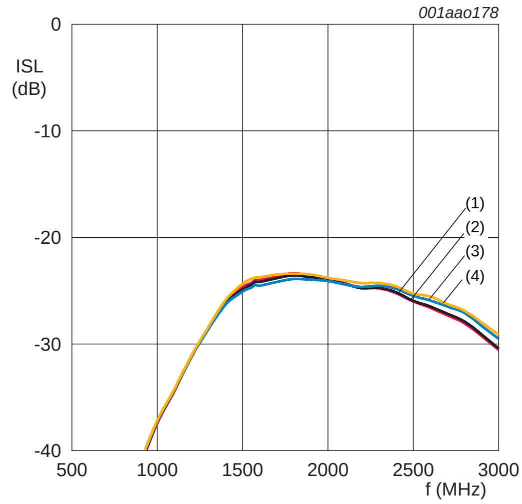
V_{CC} = 1.8 V; P_i = –45 dBm.

(1) T_{amb} = –40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 21. Isolation as a function of frequency; typical values



V_{CC} = 1.8 V; T_{amb} = 25 °C.

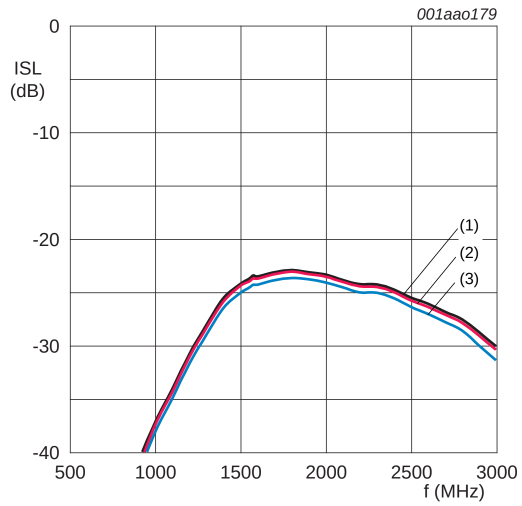
(1) P_i = –45 dBm

(2) P_i = –30 dBm

(3) P_i = –20 dBm

(4) P_i = –15 dBm

Fig 22. Isolation as a function of frequency; typical values



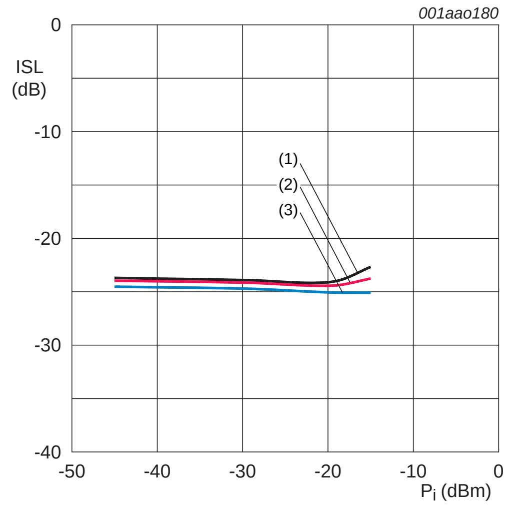
P_i = –45 dBm; T_{amb} = 25 °C.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

Fig 23. Isolation as a function of frequency; typical values



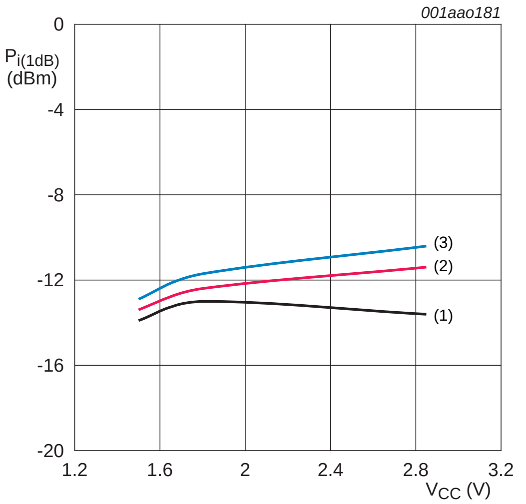
T_{amb} = 25 °C; f = 1575 MHz.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

Fig 24. Isolation as a function of input power; typical values



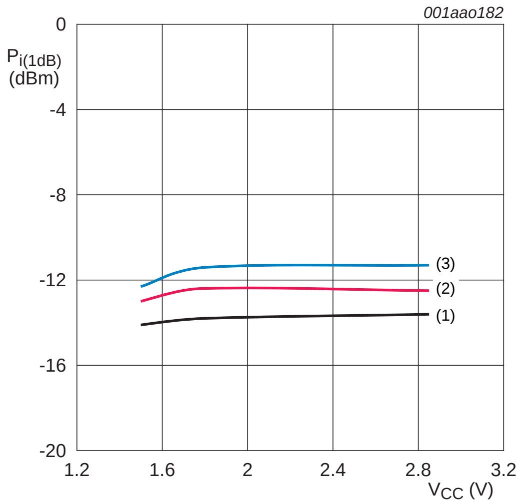
f = 1575 MHz.

(1) T_{amb} = –40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 25. Input power at 1 dB gain compression as a function of supply voltage; typical values



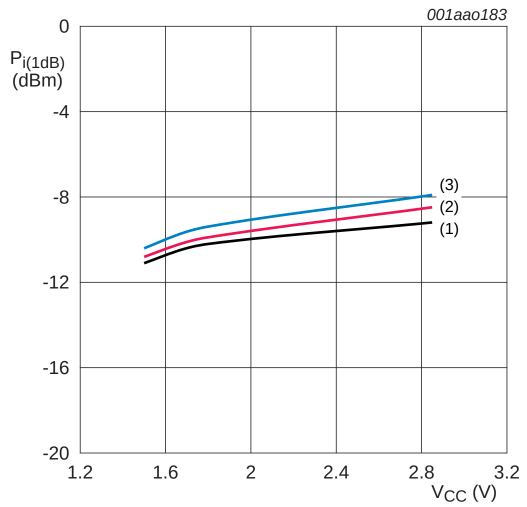
f = 850 MHz.

(1) T_{amb} = –40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 26. Input power at 1 dB gain compression as a function of supply voltage; typical values



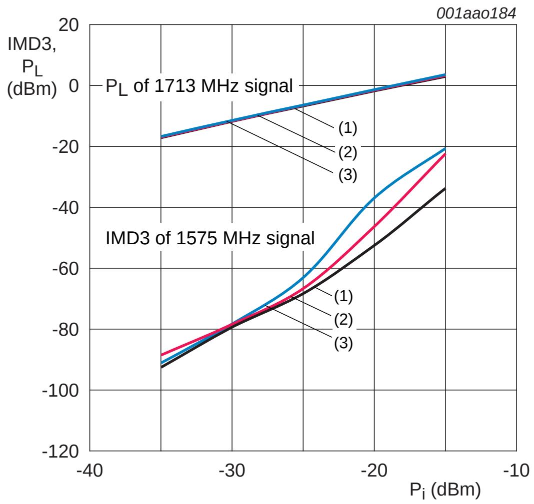
f = 1850 MHz.

(1) T_{amb} = −40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 27. Input power at 1 dB gain compression as a function of supply voltage; typical values



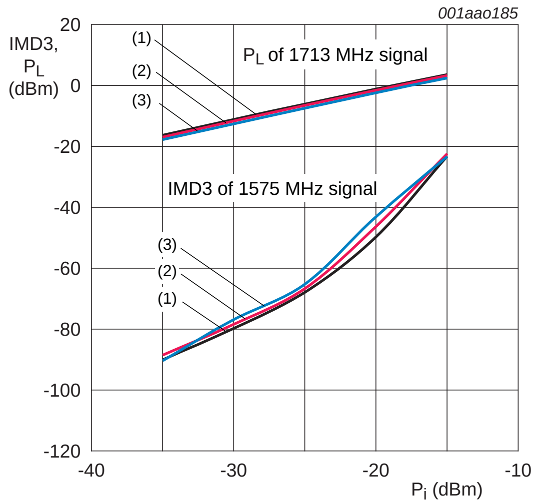
f = 1575 MHz; f_1 = 1713 MHz; f_2 = 1851 MHz; T_{amb} = 25 °C.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

(3) V_{CC} = 2.85 V

Fig 28. Third order intermodulation distortion and output power as function of input power; typical values



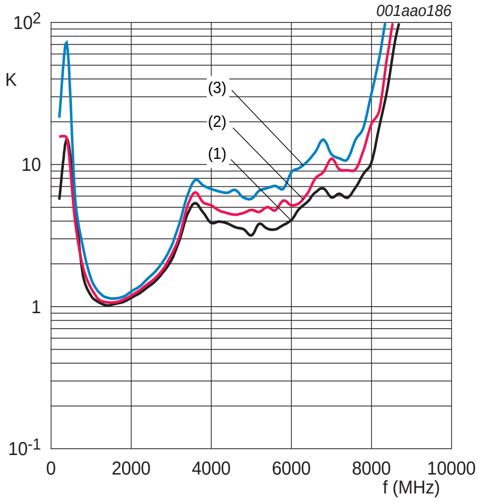
f = 1575 MHz; f_1 = 1713 MHz; f_2 = 1851 MHz; V_{CC} = 1.8 V.

(1) T_{amb} = −40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 29. Third order intermodulation distortion and output power as function of input power; typical values



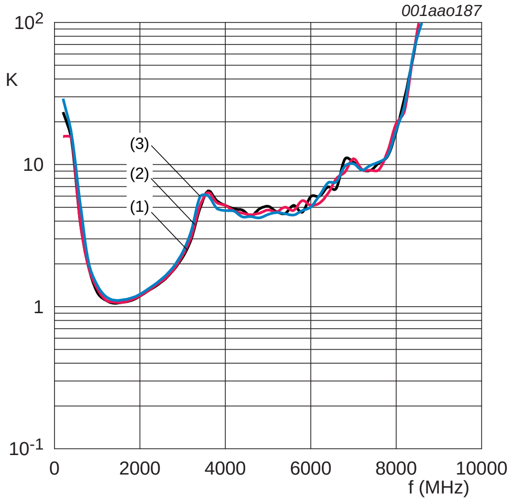
V_{CC} = 1.8 V; P_i = –45 dBm.

(1) T_{amb} = –40 °C

(2) T_{amb} = +25 °C

(3) T_{amb} = +85 °C

Fig 30. Rollett stability factor as a function of frequency; typical values



T_{amb} = 25 °C; P_i = –45 dBm.

(1) V_{CC} = 1.5 V

(2) V_{CC} = 1.8 V

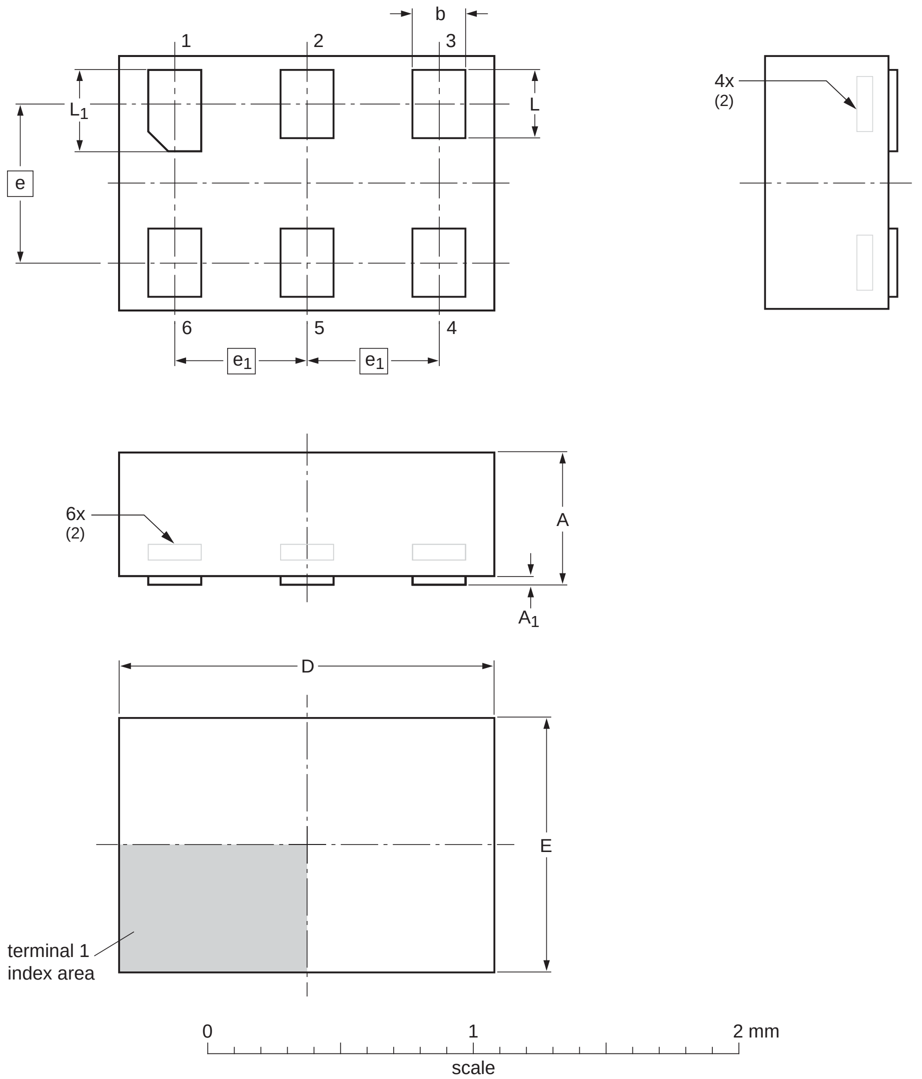
(3) V_{CC} = 2.85 V

Fig 31. Rollett stability factor as a function of frequency; typical values

9. Package outline

XSON6: plastic extremely thin small outline package; no leads; 6 terminals; body 1 x 1.45 x 0.5 mm

SOT886



Dimensions (mm are the original dimensions)

Unit		A(1)	A_1	b	D	E	e	e_1	L	L_1
mm	max	0.5	0.04	0.25	1.50	1.05			0.35	0.40
	nom			0.20	1.45	1.00	0.6	0.5	0.30	0.35
	min			0.17	1.40	0.95			0.27	0.32

Notes
1. Including plating thickness.
2. Can be visible in some manufacturing processes.

sot886_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT886		MO-252				~~04-07-22~~ 12-01-05

Fig 32. Package outline SOT886 (XSON6)

10. Abbreviations

Table 10. Abbreviations

Acronym	Description
AC	Alternating Current
ATM	Automated Teller Machine (cash dispenser)
DC	Direct Current
GLONASS	GLObal NAvigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HBM	Human Body Model
MMIC	Monolithic Microwave Integrated Circuit
PC	Personal Computer
PCB	Printed Circuit Board
RF	Radio Frequency
SiGe:C	Silicon Germanium Carbon

11. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGU7007 v.3	20120329	Product data sheet	-	BGU7007 v.2
Modifications:	• Added ‘Compass’ to descriptive title • Section 1.3 on page 2: added ‘Compass’ to text • Section 1.2 on page 1: row 6, changed 2.85 V to 3.1 V • Table 1 on page 2: changed max. value V_{CC} from 2.85 V to 3.1 V • Table 7 on page 4: changed max. value V_{CC} from 2.85 V to 3.1 V • Table 8 on page 5: changed max. value V_{CC} from 2.85 V to 3.1 V • Table 5 on page 3: Several additions and changes			
BGU7007 v.2	20111103	Product data sheet	-	BGU7007 v.1
BGU7007 v.1	20110520	Product data sheet	-	-

12. Legal information

12.1 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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