

BGU7008

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

Rev. 2 — 3 November 2011

Product data sheet

1. Product profile

1.1 General description

The BGU7008 is an AEC-Q100 qualified Low Noise Amplifier (LNA) for GNSS receiver applications in a plastic leadless 6-pin, extremely small SOT886 package. The BGU7008 requires only one external matching inductor and one external decoupling capacitor.

The BGU7008 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

- AEC-Q100 qualified (see [Section 9.1](#))
- Covers full GNSS L1 band, from 1559 MHz to 1610 MHz
- Noise figure (NF) = 0.85 dB
- Gain 18.5 dB
- High input 1 dB compression point $P_{i(1dB)}$ of -12 dBm
- High out of band $IP3_i$ of 4 dBm
- Supply voltage 1.5 V to 2.85 V
- Power-down mode current consumption < 1 μ A
- 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 and Galileo in automotive applications like Toll Collection and Emergency Call.
- LNA for GPS 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

$f = 1559 \text{ MHz to } 1610 \text{ MHz}$; $V_{CC} = 1.8 \text{ V}$; $P_i < -40 \text{ dBm}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; input matched to $50 \text{ }\Omega$ using a 5.6 nH inductor; unless otherwise specified.

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

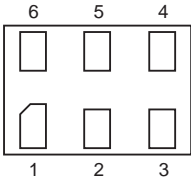
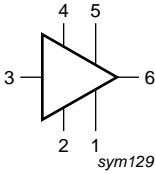
[1] PCB losses are subtracted.

[2] Including PCB losses.

[3] $f_1 = 1713 \text{ MHz}$; $f_2 = 1851 \text{ MHz}$; $P_1 = P_2 = -30 \text{ dBm}$.

2. Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Graphic symbol
1	GND	 <p>Transparent top view</p>	 <p>sym129</p>
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
BGU7008	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
BGU7008	B7

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	3.1	V
V_{ENABLE}	voltage on pin ENABLE	$V_{CC} \geq 2.5$ V	−0.5	3.1	V
		$V_{CC} < 2.5$ V	[2] −0.5	$V_{CC} + 0.6$	V
V_{RF_IN}	voltage on pin RF_IN	DC			
		$V_{CC} \geq 3.0$ V	[3] −0.5	3.6	V
		$V_{CC} < 3.0$ V	[2][3] −0.5	$V_{CC} + 0.6$	V
V_{RF_OUT}	voltage on pin RF_OUT	DC			
		$V_{CC} \geq 1.8$ V	[3] −0.5	3.6	V
		$V_{CC} < 1.8$ V	[2][3] −0.5	$V_{CC} + 1.8$	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

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

[2] Due to internal ESD diode protection, the applied voltage should not exceed the specified maximum 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

$f = 1559\text{ MHz to }1610\text{ MHz}$; $V_{CC} = 1.8\text{ V}$; $V_{ENABLE} \geq 0.8\text{ V}$; $P_i < -40\text{ dBm}$; $T_{amb} = 25\text{ °C}$; input matched to $50\text{ }\Omega$ 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	-	2.85	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		
		V _{ENABLE} ≤ 0.35 V	-	-	1	μA		
T _{amb}	ambient temperature		−40	+25	+125	°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} ≤ +125 °C						
		P _i < −40 dBm, no jammer	15.5	-	21	dB		
		P _i = −20 dBm, no jammer	16.5	-	22	dB		
		P _{jam} = −20 dBm; f _{jam} = 850 MHz	16.5	-	22	dB		
		P _{jam} = −20 dBm; f _{jam} = 1850 MHz	16.5	-	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} ≤ +125 °C						
		P _i < −40 dBm, no jammer	-	-	1.8	dB		
		P _i = −20 dBm, no jammer	-	-	2.0	dB		
		P _{jam} = −20 dBm; f _{jam} = 850 MHz	-	-	1.9	dB		
		P _{jam} = −20 dBm; f _{jam} = 1850 MHz	-	-	2.1	dB		

Table 7. Characteristics ...continued

$f = 1559 \text{ MHz to } 1610 \text{ MHz}$; $V_{CC} = 1.8 \text{ V}$; $V_{ENABLE} \geq 0.8 \text{ V}$; $P_i < -40 \text{ dBm}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; input matched to $50 \text{ }\Omega$ using a 5.6 nH inductor; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{i(1dB)}$	input power at 1 dB gain compression	$f = 1559 \text{ MHz to } 1610 \text{ MHz}$				
		$V_{CC} = 1.5 \text{ V}$	-16	-13	-	dBm
		$V_{CC} = 1.8 \text{ V}$	-15	-12	-	dBm
		$V_{CC} = 2.85 \text{ V}$	-14	-11	-	dBm
		$f = 806 \text{ MHz to } 928 \text{ MHz}$				
		$V_{CC} = 1.5 \text{ V}$	[3] -16	-13	-	dBm
		$V_{CC} = 1.8 \text{ V}$	[3] -15	-12	-	dBm
		$V_{CC} = 2.85 \text{ V}$	[3] -15	-12	-	dBm
		$f = 1612 \text{ MHz to } 1909 \text{ MHz}$				
		$V_{CC} = 1.5 \text{ V}$	[3] -14	-11	-	dBm
		$V_{CC} = 1.8 \text{ V}$	[3] -13	-10	-	dBm
		$V_{CC} = 2.85 \text{ V}$	[3] -11	-8	-	dBm
$IP3_i$	input third-order intercept point	$f = 1.575 \text{ GHz}$				
		$V_{CC} = 1.5 \text{ V}$	[4] 1	4	-	dBm
		$V_{CC} = 1.8 \text{ V}$	[4] 1	4	-	dBm
		$V_{CC} = 2.85 \text{ V}$	[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] $f_1 = 1713 \text{ MHz}$; $f_2 = 1851 \text{ MHz}$; $P_1 = P_2 = -30 \text{ dBm}$.

[5] Within 10 % of the final gain.

Table 8. ENABLE (pin 5)

$-40 \text{ }^\circ\text{C} \leq T_{amb} \leq +125 \text{ }^\circ\text{C}$; $1.5 \text{ V} \leq V_{CC} \leq 2.85 \text{ V}$

$V_{ENABLE} \text{ (V)}$	State
≤ 0.3	OFF
≥ 0.8	ON

8. Application information

8.1 GNSS LNA

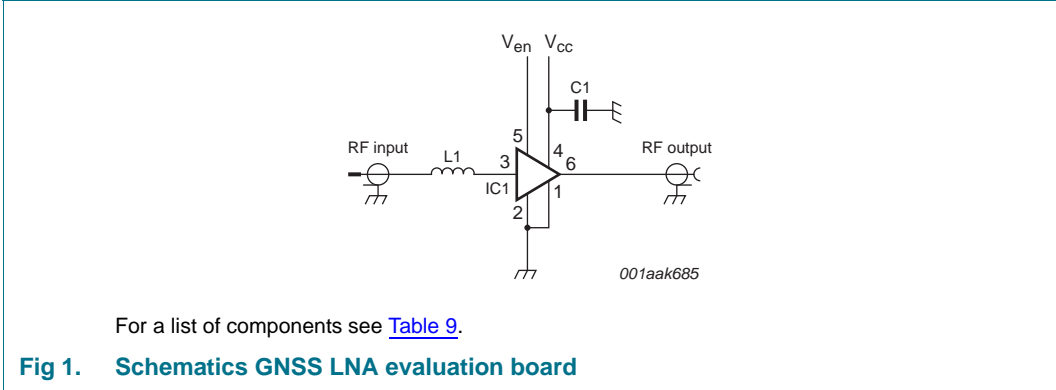
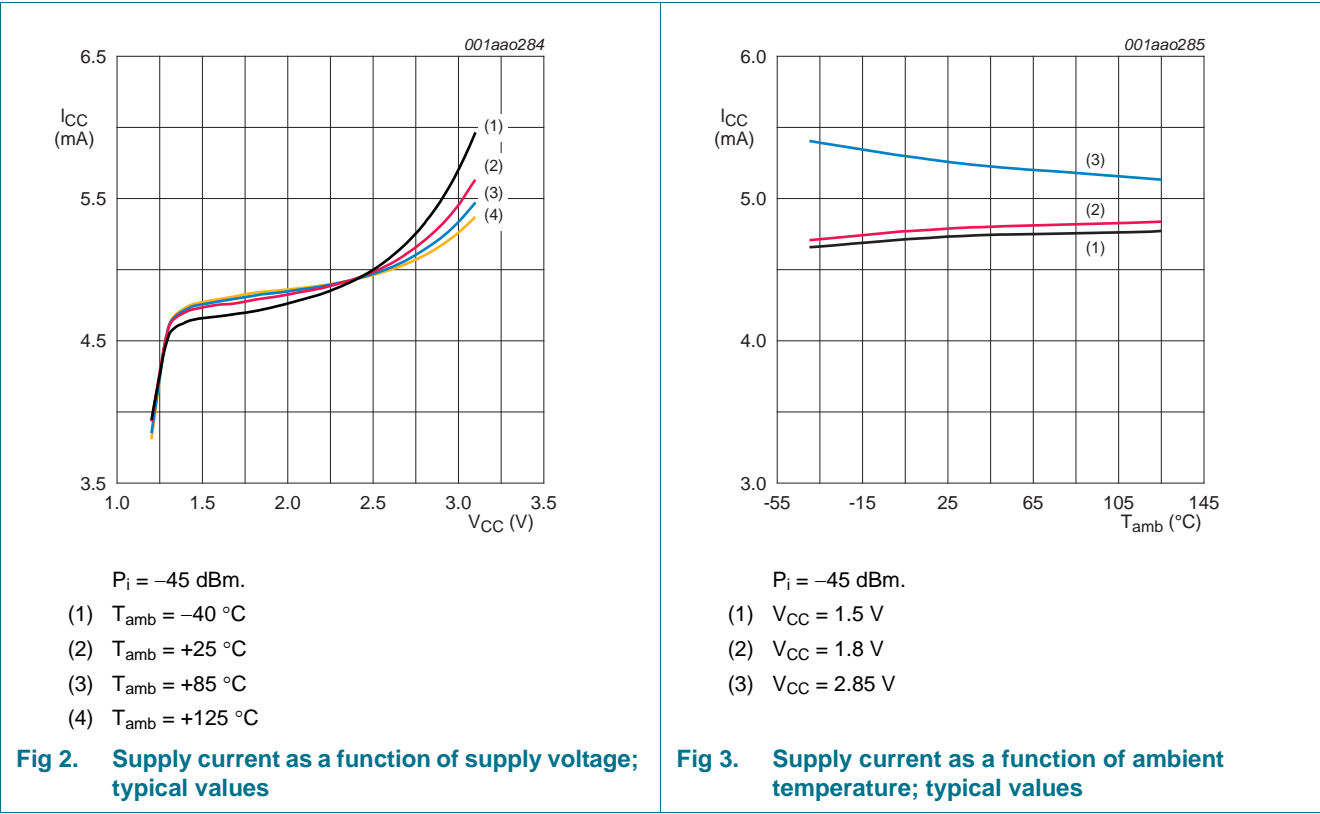
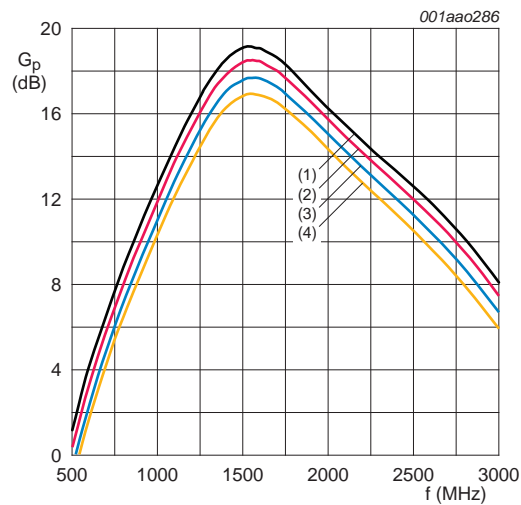


Table 9. List of components
For schematics see [Figure 1](#).

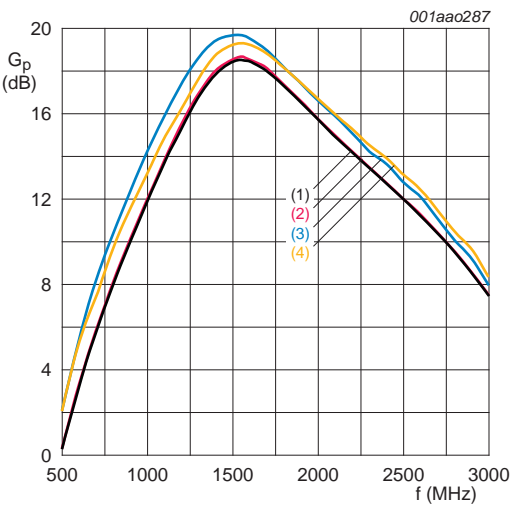
Component	Description	Value	Supplier	Remarks
C1	decoupling capacitor	1 nF	various	
IC1	BGU7008	-	NXP	
L1	high quality matching inductor	5.6 nH	Murata LQW15A	





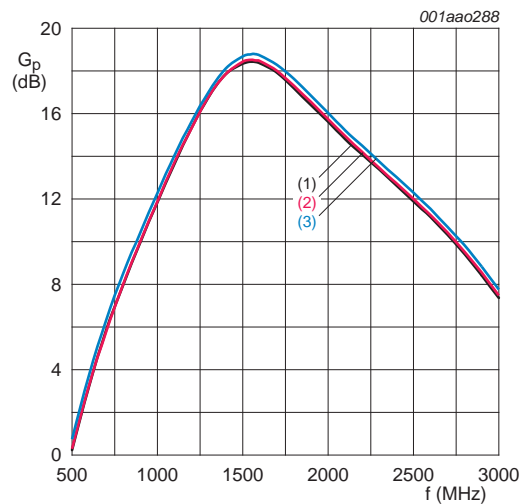
- $V_{CC} = 1.8\text{ V}$; $P_i = -45\text{ dBm}$.
- (1) $T_{amb} = -40\text{ }^{\circ}\text{C}$
 - (2) $T_{amb} = +25\text{ }^{\circ}\text{C}$
 - (3) $T_{amb} = +85\text{ }^{\circ}\text{C}$
 - (4) $T_{amb} = +125\text{ }^{\circ}\text{C}$

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



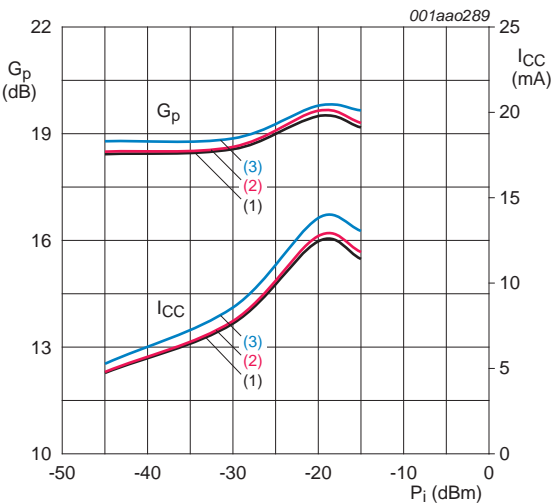
- $V_{CC} = 1.8\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$.
- (1) $P_i = -45\text{ dBm}$
 - (2) $P_i = -30\text{ dBm}$
 - (3) $P_i = -20\text{ dBm}$
 - (4) $P_i = -15\text{ dBm}$

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



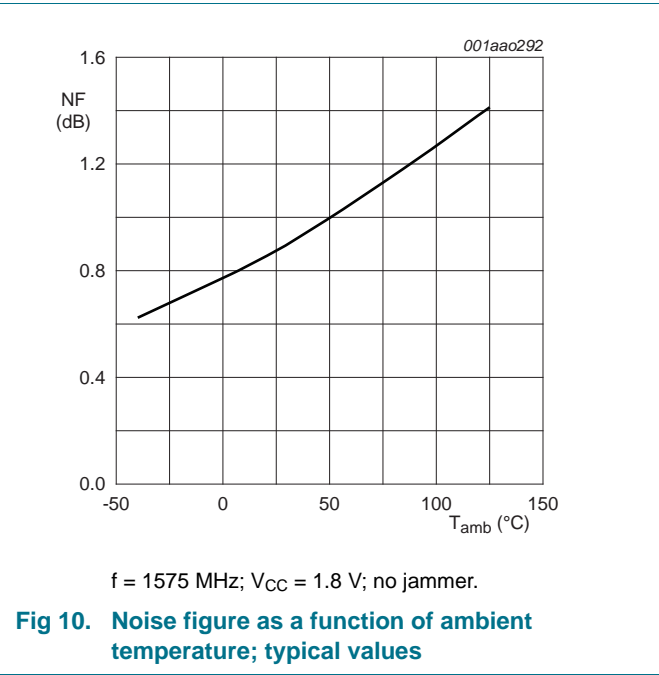
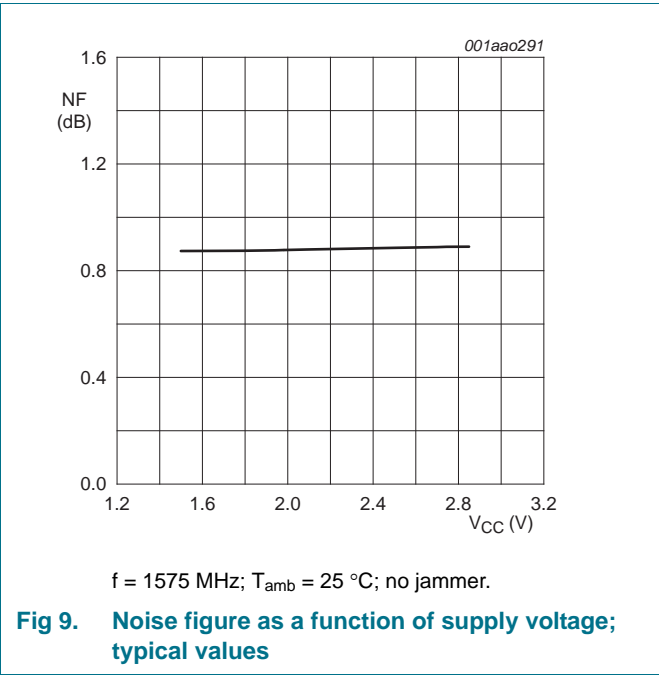
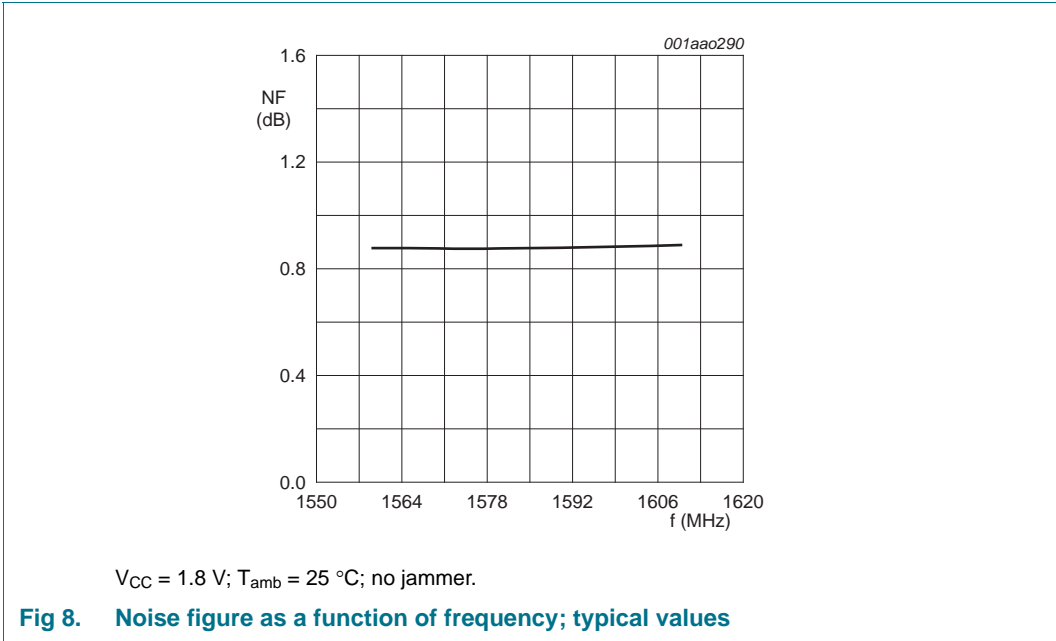
- $P_i = -45\text{ dBm}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$.
- (1) $V_{CC} = 1.5\text{ V}$
 - (2) $V_{CC} = 1.8\text{ V}$
 - (3) $V_{CC} = 2.85\text{ V}$

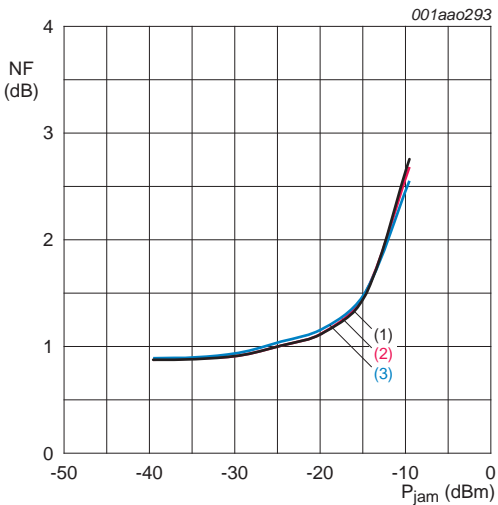
Fig 6. Power gain as a function of frequency; typical values



- $T_{amb} = 25\text{ }^{\circ}\text{C}$; $f = 1575\text{ MHz}$.
- (1) $V_{CC} = 1.5\text{ V}$
 - (2) $V_{CC} = 1.8\text{ V}$
 - (3) $V_{CC} = 2.85\text{ V}$

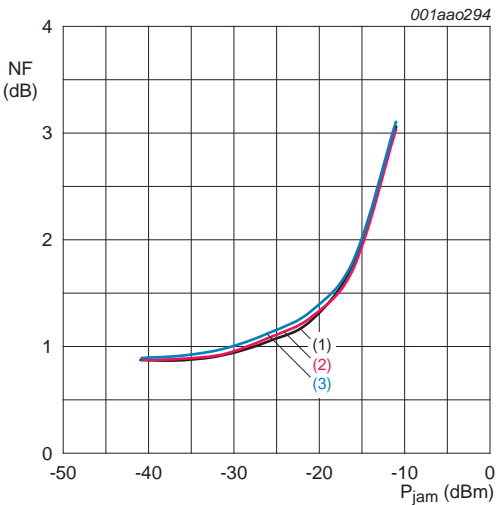
Fig 7. Power gain as a function of input power; typical values





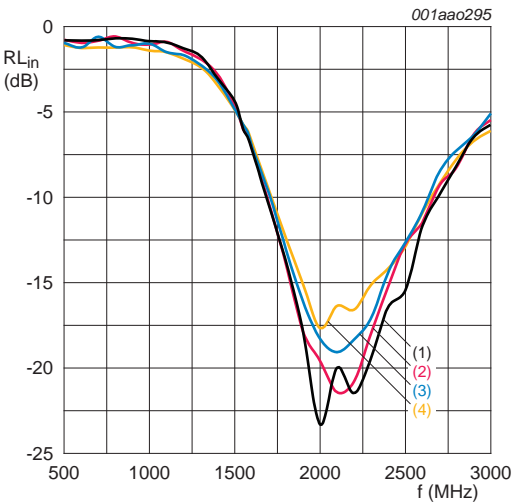
$f_{jam} = 850\text{ MHz}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; $f = 1575\text{ MHz}$.
(1) $V_{CC} = 1.5\text{ V}$
(2) $V_{CC} = 1.8\text{ V}$
(3) $V_{CC} = 2.85\text{ V}$

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



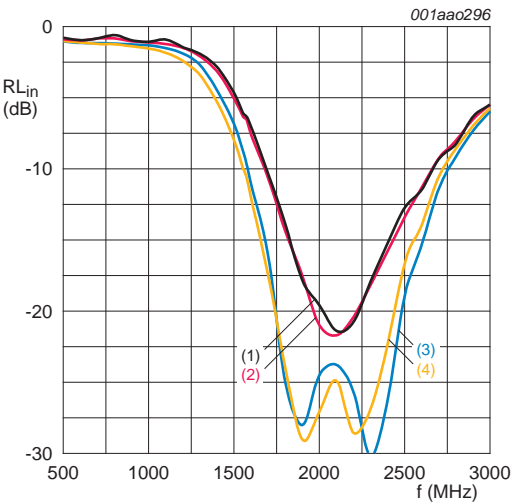
$f_{jam} = 1850\text{ MHz}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; $f = 1575\text{ MHz}$.
(1) $V_{CC} = 1.5\text{ V}$
(2) $V_{CC} = 1.8\text{ V}$
(3) $V_{CC} = 2.85\text{ V}$

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



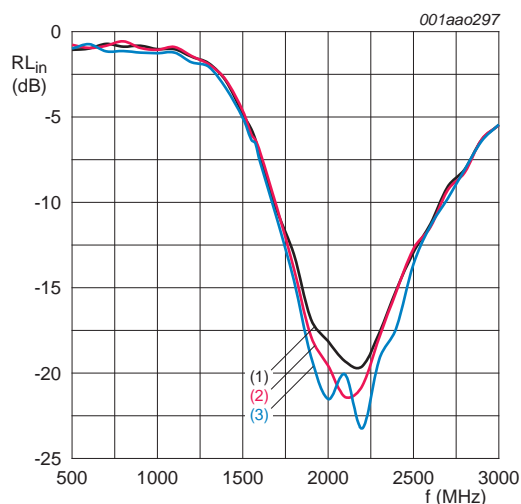
$V_{CC} = 1.8\text{ V}$; $P_i = -45\text{ dBm}$.
(1) $T_{amb} = -40\text{ }^{\circ}\text{C}$
(2) $T_{amb} = +25\text{ }^{\circ}\text{C}$
(3) $T_{amb} = +85\text{ }^{\circ}\text{C}$
(4) $T_{amb} = +125\text{ }^{\circ}\text{C}$

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



$V_{CC} = 1.8\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$.
(1) $P_i = -45\text{ dBm}$
(2) $P_i = -30\text{ dBm}$
(3) $P_i = -20\text{ dBm}$
(4) $P_i = -15\text{ dBm}$

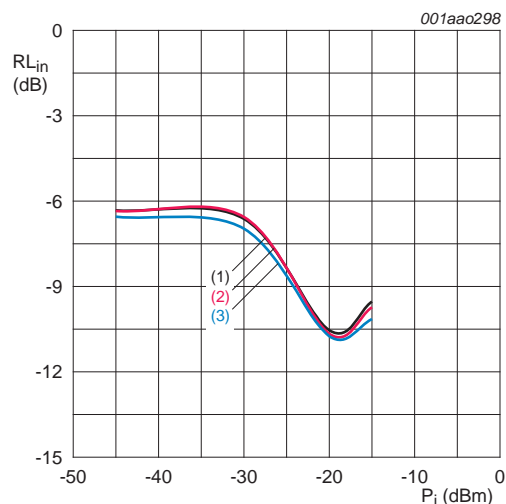
Fig 14. Input return loss as a function of frequency; typical values



$P_i = -45$ dBm; $T_{amb} = 25$ °C.

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

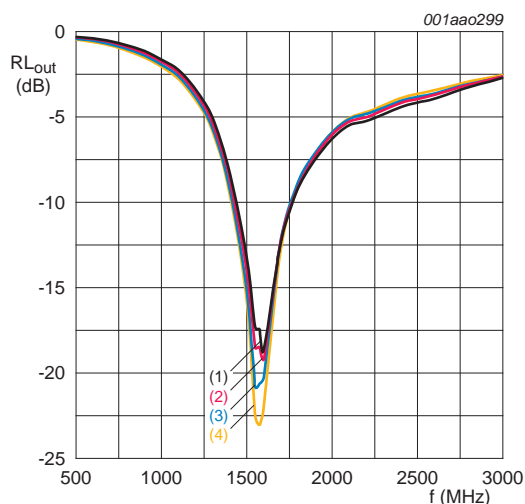
Fig 15. Input return loss as a function of frequency; typical values



$T_{amb} = 25$ °C; $f = 1575$ MHz.

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

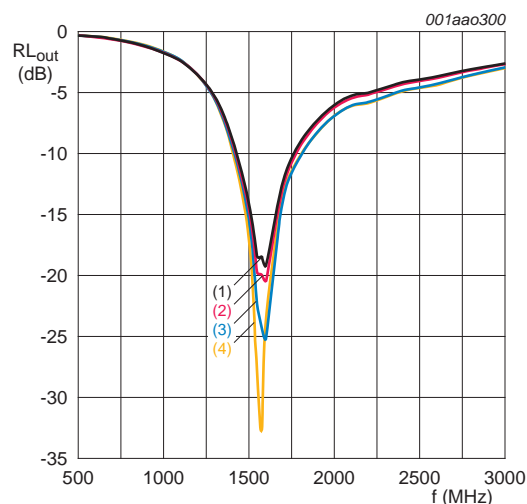
Fig 16. Input return loss as a function of input power; typical values



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

- (1) $T_{amb} = -40$ °C
- (2) $T_{amb} = +25$ °C
- (3) $T_{amb} = +85$ °C
- (4) $T_{amb} = +125$ °C

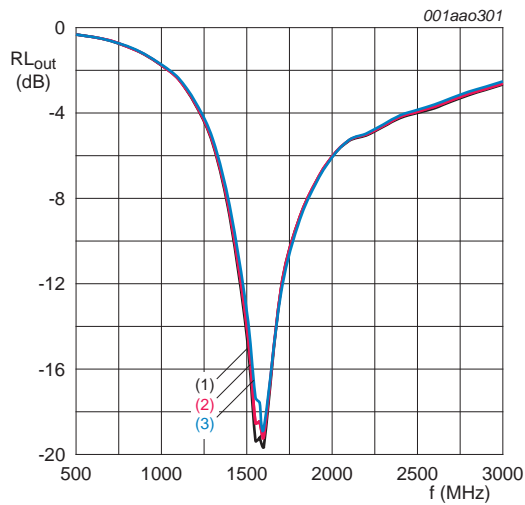
Fig 17. Output return loss as a function of frequency; typical values



$V_{CC} = 1.8$ 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

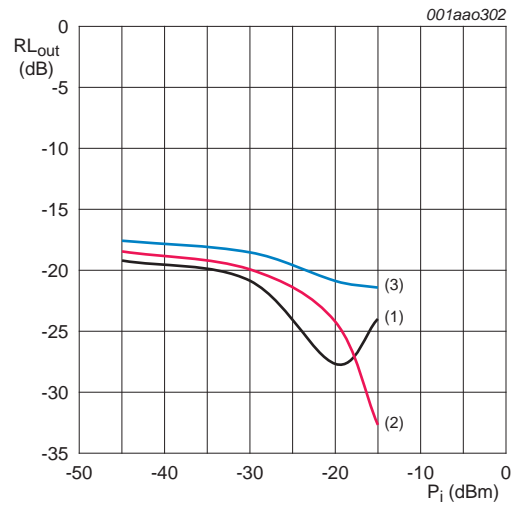
Fig 18. Output return loss as a function of frequency; typical values



$P_i = -45$ dBm; $T_{amb} = 25$ °C.

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

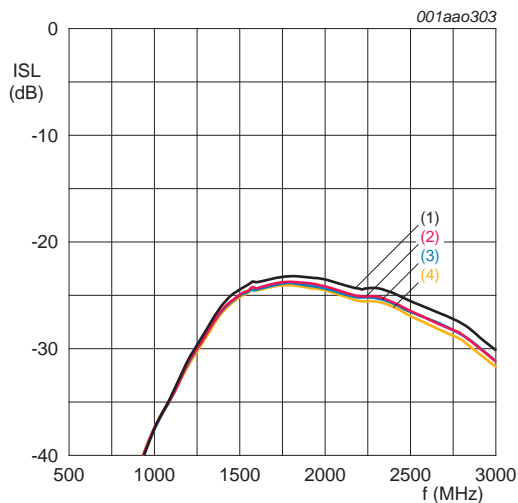
Fig 19. Output return loss as a function of frequency; typical values



$T_{amb} = 25$ °C; $f = 1575$ MHz.

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

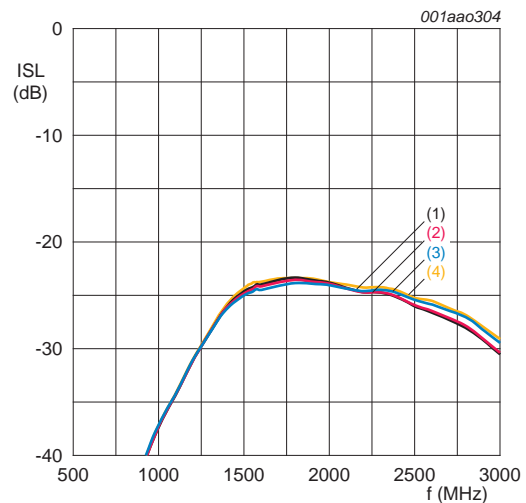
Fig 20. Output return loss as a function of input power; typical values



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

- (1) $T_{amb} = -40$ °C
- (2) $T_{amb} = +25$ °C
- (3) $T_{amb} = +85$ °C
- (4) $T_{amb} = +125$ °C

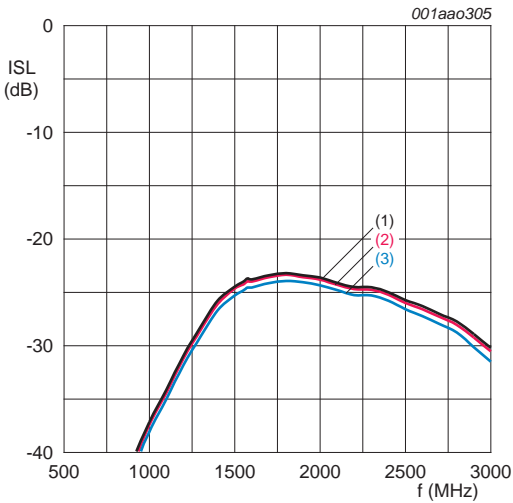
Fig 21. Isolation as a function of frequency; typical values



$V_{CC} = 1.8$ 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

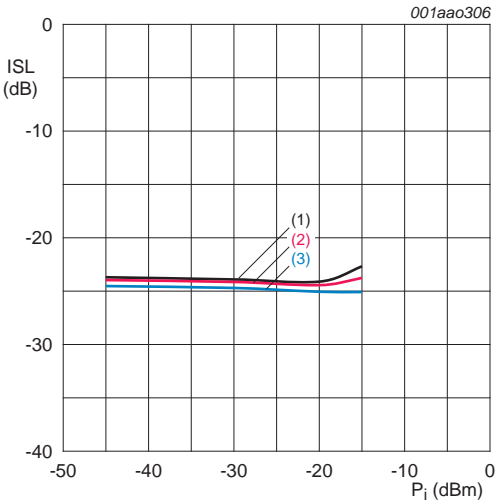
Fig 22. Isolation as a function of frequency; typical values



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

- (1) $V_{\text{CC}} = 1.5 \text{ V}$
- (2) $V_{\text{CC}} = 1.8 \text{ V}$
- (3) $V_{\text{CC}} = 2.85 \text{ V}$

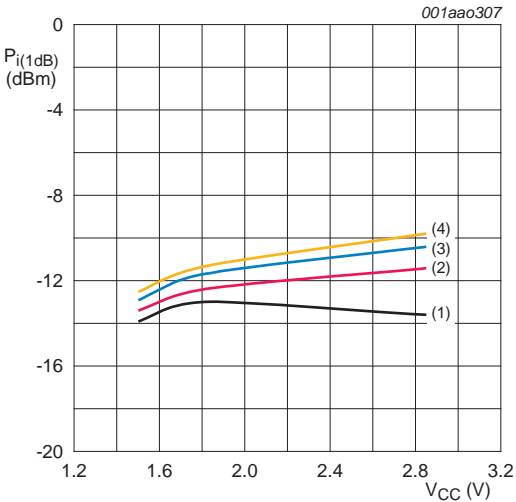
Fig 23. Isolation as a function of frequency; typical values



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

- (1) $V_{\text{CC}} = 1.5 \text{ V}$
- (2) $V_{\text{CC}} = 1.8 \text{ V}$
- (3) $V_{\text{CC}} = 2.85 \text{ V}$

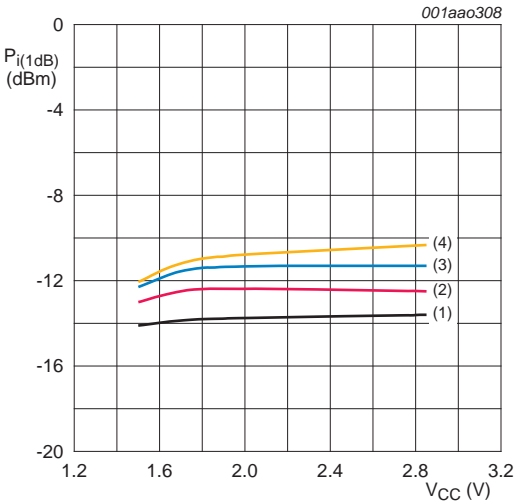
Fig 24. Isolation as a function of input power; typical values



$f = 1575 \text{ MHz}$.

- (1) $T_{\text{amb}} = -40 \text{ }^{\circ}\text{C}$
- (2) $T_{\text{amb}} = +25 \text{ }^{\circ}\text{C}$
- (3) $T_{\text{amb}} = +85 \text{ }^{\circ}\text{C}$
- (4) $T_{\text{amb}} = +125 \text{ }^{\circ}\text{C}$

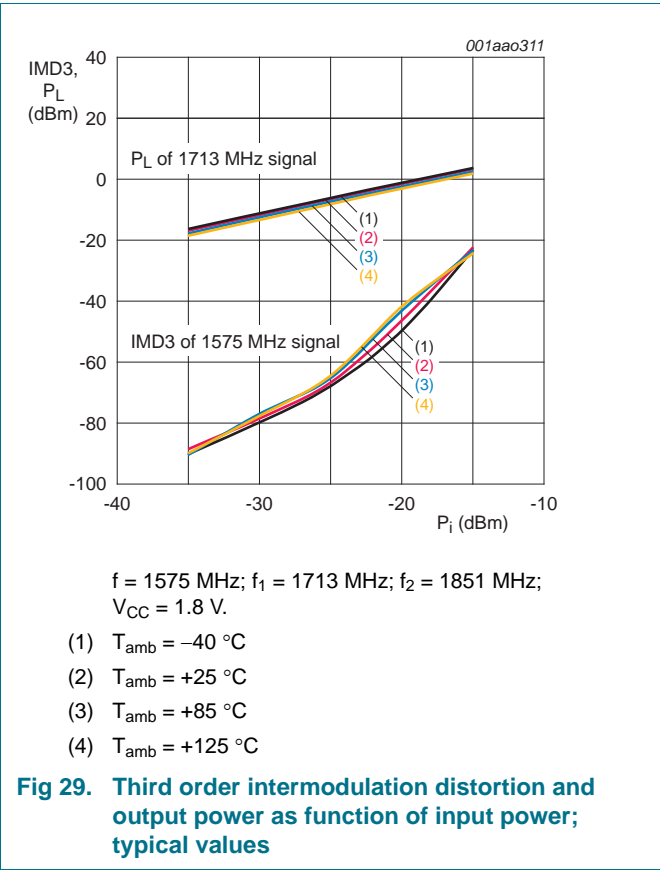
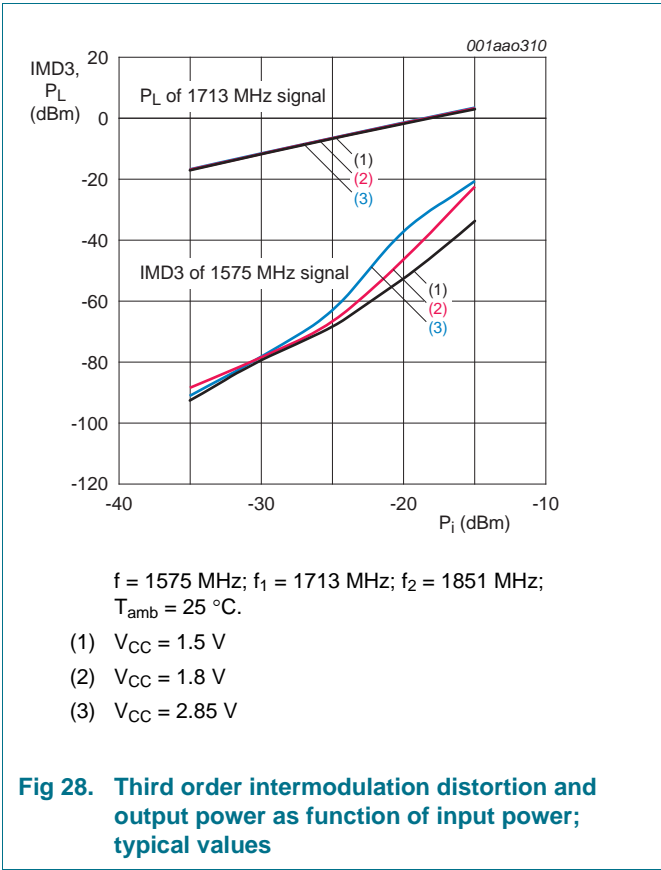
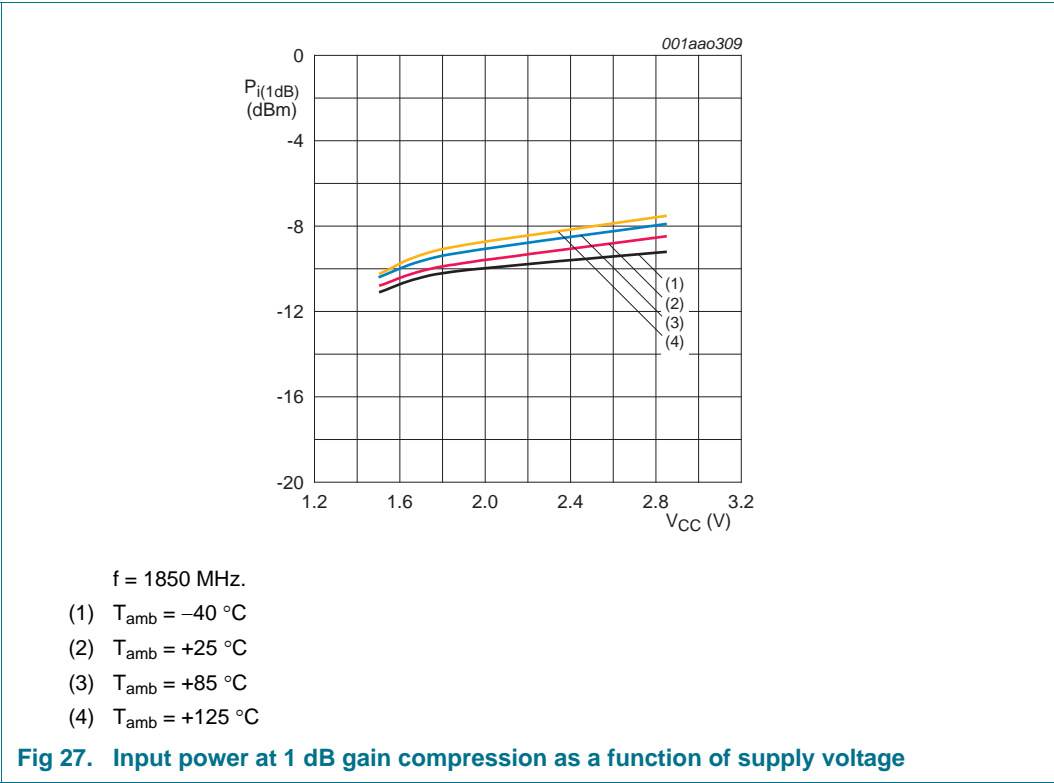
Fig 25. Input power at 1 dB gain compression as a function of supply voltage; typical values

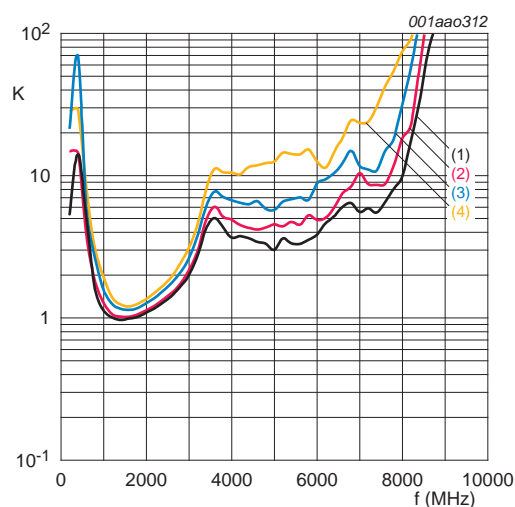


$f = 850 \text{ MHz}$.

- (1) $T_{\text{amb}} = -40 \text{ }^{\circ}\text{C}$
- (2) $T_{\text{amb}} = +25 \text{ }^{\circ}\text{C}$
- (3) $T_{\text{amb}} = +85 \text{ }^{\circ}\text{C}$
- (4) $T_{\text{amb}} = +125 \text{ }^{\circ}\text{C}$

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

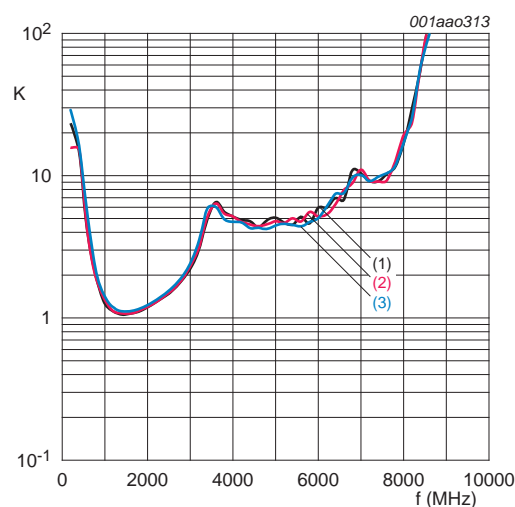




$V_{CC} = 1.8 \text{ V}$; $P_i = -45 \text{ dBm}$.

- (1) $T_{amb} = -40 \text{ }^{\circ}\text{C}$
- (2) $T_{amb} = +25 \text{ }^{\circ}\text{C}$
- (3) $T_{amb} = +85 \text{ }^{\circ}\text{C}$
- (4) $T_{amb} = +125 \text{ }^{\circ}\text{C}$

Fig 30. 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) $V_{CC} = 2.85 \text{ V}$

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

9. Test information

9.1 Quality information

All qualification tests are performed according AEC-Q100 except for read point testing (final test of qualification sample). Which is done only at room temperature.

As part of the zero defect program, the following is part of the industrial test flow:

- Part Average Testing
- Maverick Lot Handling at assembly factory

10. Package outline

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

SOT886

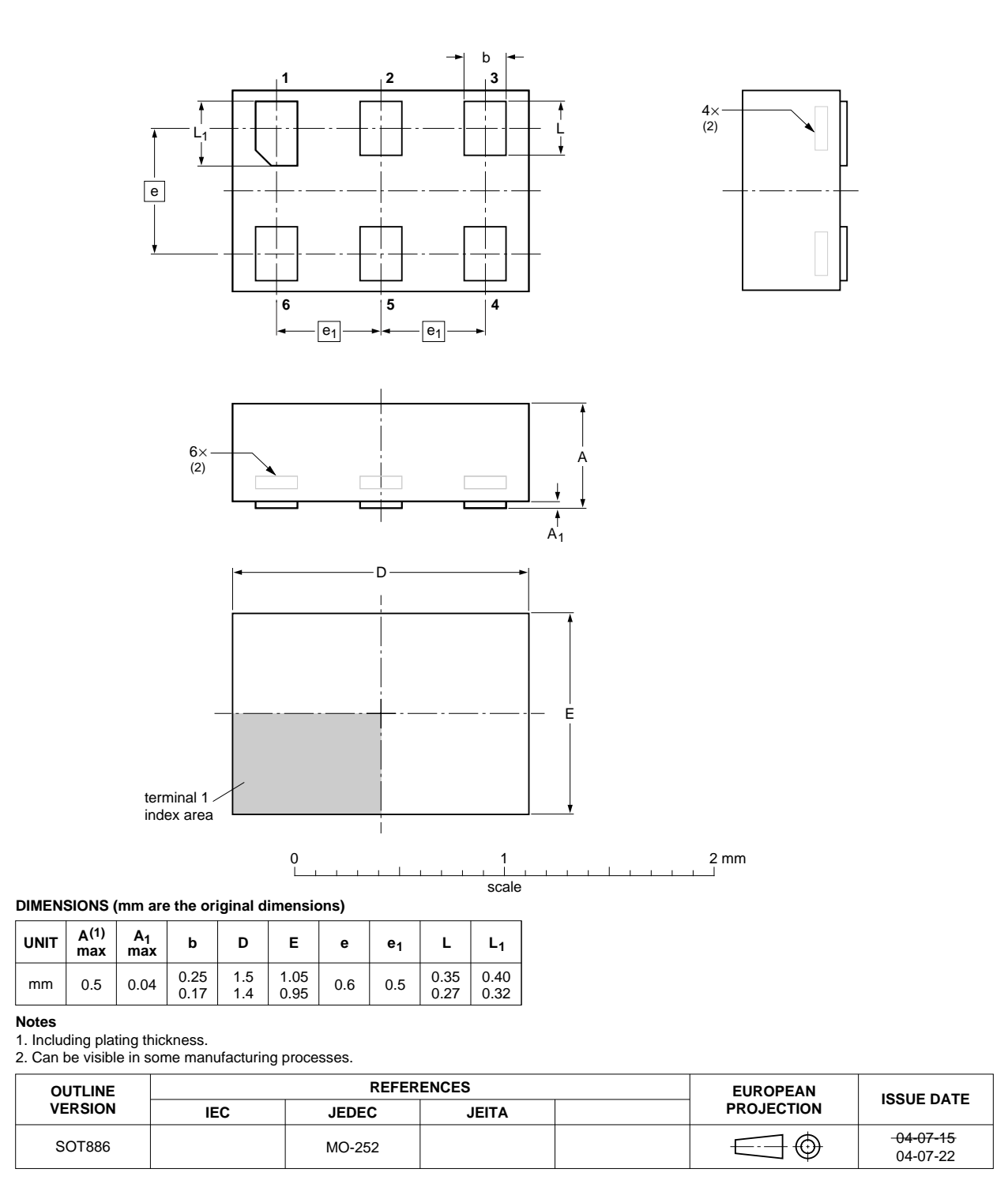


Fig 32. Package outline SOT886 (XSON6)

11. Abbreviations

Table 10. Abbreviations

Acronym	Description
AC	Alternating Current
AEC	Automotive Electronics Council
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

12. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGU7008 v.2	20111103	Product data sheet	-	BGU7008 v.1
Modifications:	<ul style="list-style-type: none">• Figure 25: f = 850 MHz changed to f = 1575 MHz• Figure 26: f = 1850 MHz changed to f = 850 MHz• Figure 27: f = 1575 MHz changed to f = 1850 MHz			
BGU7008 v.1	20110822	Product data sheet	-	-

13. Legal information

13.1 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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