

# BGU7003

## Wideband silicon germanium low-noise amplifier MMIC

Rev. 02 — 22 June 2010

Product data sheet

## 1. Product profile

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### 1.1 General description

The BGU7003 MMIC is a wideband amplifier in SiGe:C technology for high speed, low-noise applications in a plastic, leadless 6 pin, extremely thin small outline SOT891 package.

#### CAUTION



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

### 1.2 Features

- Low noise high gain microwave MMIC
- Applicable between 40 MHz and 6 GHz
- Integrated temperature stabilized bias for easy design
- Bias current configurable with external resistor
- Noise figure NF = 0.80 dB at 1.575 GHz
- Insertion power gain = 18.3 dB at 1.575 GHz
- 110 GHz transit frequency - SiGe:C technology
- Power-down mode current consumption < 1  $\mu$ A
- Optimized performance at low 5 mA supply current
- ESD protection > 1 kV Human Body Model (HBM) on all pins

### 1.3 Applications

- GPS
- Satellite radio
- Low-noise amplifiers for microwave communications systems
- WLAN and CDMA applications
- Analog / digital cordless applications

### 1.4 Quick reference data

**Table 1. Quick reference data**

$T_{amb} = 25\text{ °C}$ ;  $V_{CC} = 2.5\text{ V}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  $V_{ENABLE} \geq 0.7\text{ V}$ ;  $f = 1575\text{ MHz}$ ;  $Z_S = Z_L = 50\ \Omega$  (input and output matched to  $50\ \Omega$ ) unless otherwise specified.

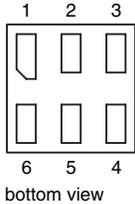
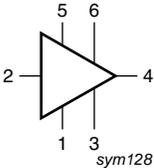
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage	RF input AC coupled	2.2	-	2.85	V
$I_{CC(tot)}$	total supply current	configurable with external resistor	[1] 3	-	15	mA
$T_{amb}$	ambient temperature		-40	+25	+85	°C
$P_{tot}$	total power dissipation	$T_{sp} \leq 103\text{ °C}$	[2] -	-	70	mW
$ S_{21} ^2$	Insertion power gain		-	18.3	-	dB
NF	noise figure		-	0.80	-	dB
$P_{i(1dB)}$	input power at 1 dB gain compression		-	-20.1	-	dBm
$IP3_1$	input third-order intercept point	jammers at $f_1 = f + 138\text{ MHz}$ and $f_2 = f + 276\text{ MHz}$	-	-0.2	-	dBm

[1]  $I_{CC(tot)} = I_{CC} + I_{RF\_OUT} + I_{R\_BIAS}$ .

[2]  $T_{sp}$  is the temperature at the solder point of the ground lead.

## 2. Pinning information

**Table 2. Pinning**

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

## 3. Ordering information

**Table 3. Ordering information**

Type number	Package		
	Name	Description	Version
BGU7003	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body $1 \times 1 \times 0.5\text{ mm}$	SOT891

## 4. Marking

**Table 4. Marking codes**

Type number	Marking code
BGU7003	B3

## 5. Limiting values

**Table 5. Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>CC</sub>	supply voltage	RF input AC coupled	-	3.0	V
I <sub>CC(tot)</sub>	total supply current	configurable with external resistor	-	25	mA
P <sub>tot</sub>	total power dissipation	T <sub>sp</sub> ≤ 103 °C	[1]	70	mW
T <sub>stg</sub>	storage temperature		-65	+150	°C
T <sub>j</sub>	junction temperature		-	150	°C

[1] T<sub>sp</sub> is the temperature at the solder point of the ground lead.

## 6. Thermal characteristics

**Table 6. Thermal characteristics**

Symbol	Parameter	Conditions	Typ	Unit
R <sub>th(j-sp)</sub>	thermal resistance from junction to solder point		235	K/W

## 7. Characteristics

**Table 7. Characteristics**

T<sub>amb</sub> = 25 °C; V<sub>CC</sub> = 2.5 V; I<sub>CC(tot)</sub> = 5.0 mA; V<sub>ENABLE</sub> ≥ 0.7 V unless otherwise specified. All measurements done on characterization board without matching, de-embedded up to the pins.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>CC</sub>	supply voltage	RF input AC coupled	2.2	-	2.85	V
I <sub>CC(tot)</sub>	total supply current	configurable with external resistor	[1]	3	-	15 mA
		V <sub>ENABLE</sub> ≤ 0.4 V	[1]	-	-	0.001 mA
T <sub>amb</sub>	ambient temperature		-40	+25	+85	°C
S <sub>21</sub>   <sup>2</sup>	insertion power gain	T <sub>amb</sub> = 25 °C				
		f = 1.575 GHz	16.0	17.5	-	dB
		f = 2.4 GHz	[2]	14.0	15.2	dB
		f = 5.8 GHz	[2]	10.0	11.4	dB
		-40 °C ≤ T <sub>amb</sub> ≤ 85 °C				
		f = 1.575 GHz	[2]	15.0	17.5	dB
		f = 2.4 GHz	[2]	13.0	15.2	dB
		f = 5.8 GHz	[2]	9.0	11.4	dB
MSG	maximum stable gain	f = 1.575 GHz	-	20.5	-	dB
		f = 2.4 GHz	-	17.8	-	dB
		f = 5.8 GHz	-	15.4	-	dB
NF <sub>min</sub>	minimum noise figure	f = 1.575 GHz	-	0.70	-	dB
		f = 2.4 GHz	-	0.80	-	dB
		f = 5.8 GHz	-	1.5	-	dB

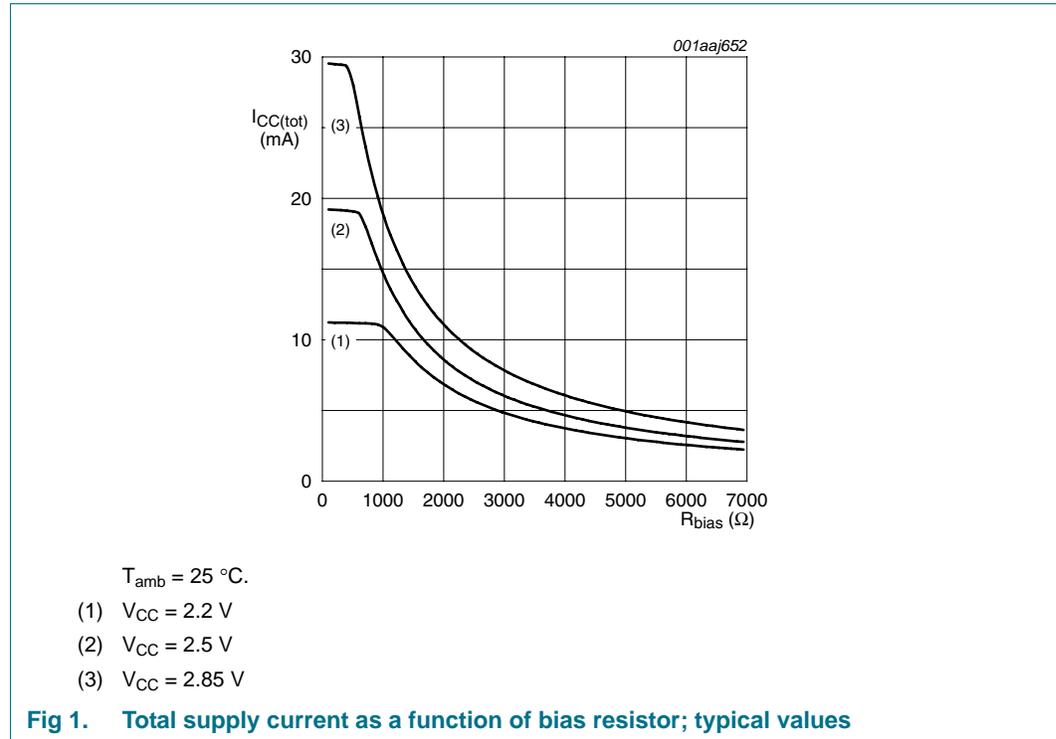
[1] I<sub>CC(tot)</sub> = I<sub>CC</sub> + I<sub>RF\_OUT</sub> + I<sub>R\_BIAS</sub>.

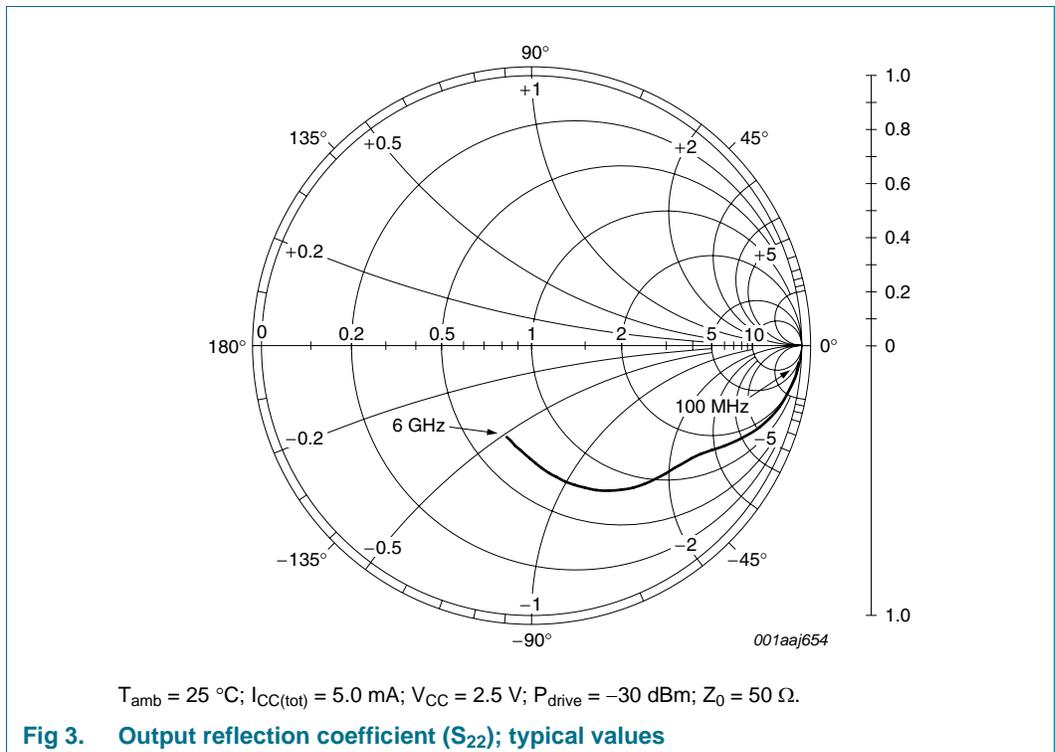
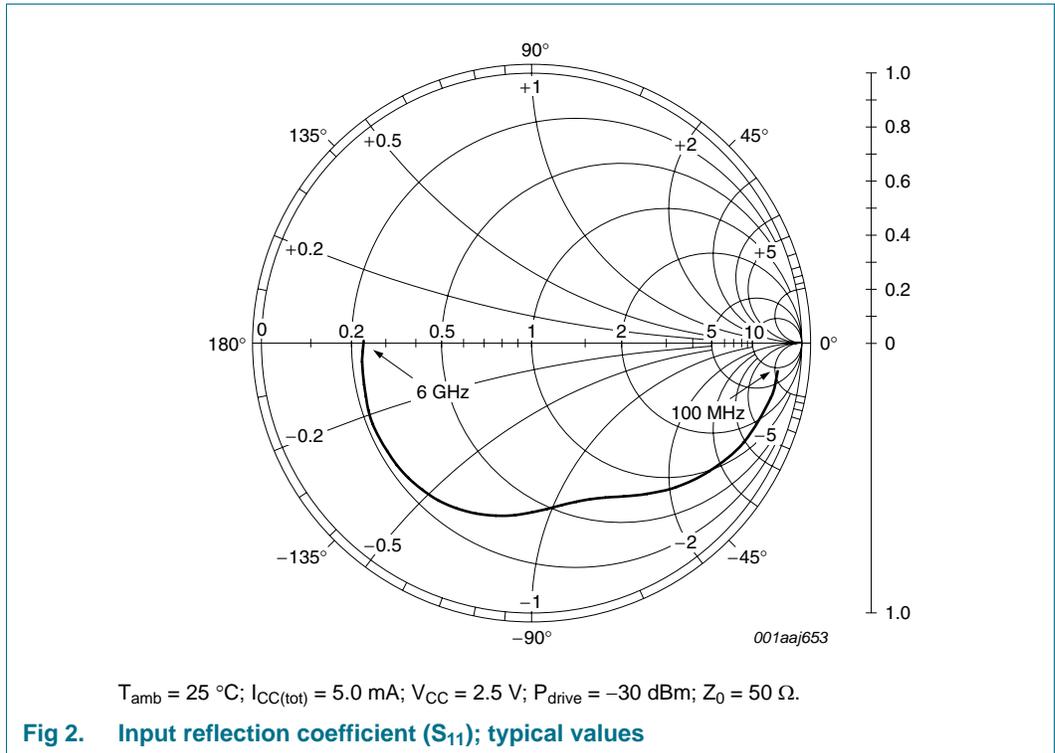
[2] Guaranteed by design and characterization.

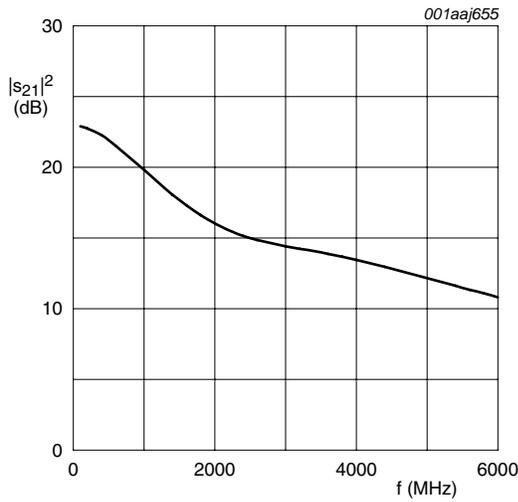
**Table 8. ENABLE (pin 5)**

$-40\text{ }^{\circ}\text{C} \leq T_{\text{amb}} \leq +85\text{ }^{\circ}\text{C}$

$V_{\text{ENABLE}}$ (V)	State
$\leq 0.4$	OFF
$\geq 0.7$	ON

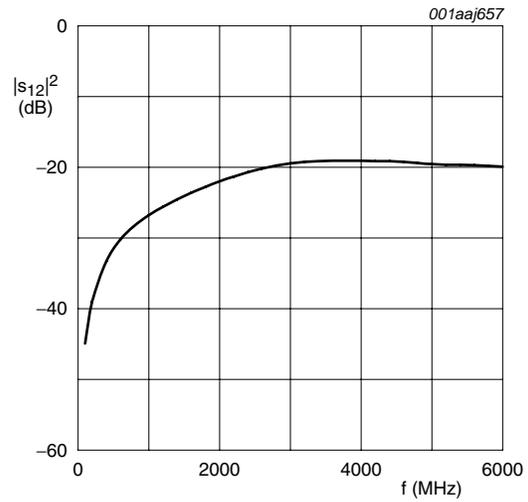






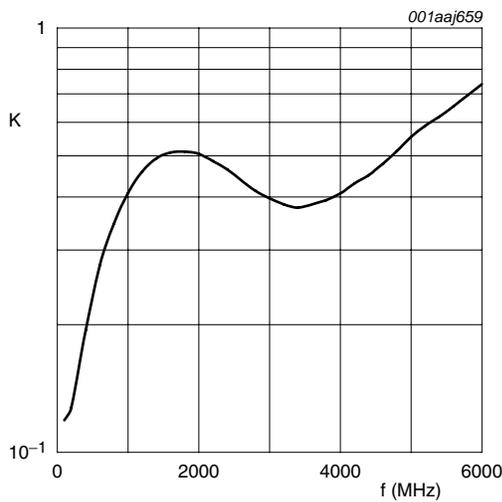
$T_{amb} = 25\text{ }^\circ\text{C}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  $V_{CC} = 2.5\text{ V}$ ;  
 $P_{drive} = -30\text{ dBm}$ ;  $Z_0 = 50\text{ }\Omega$ .

**Fig 4.** Insertion power gain ( $|s_{21}|^2$ ) as a function of frequency; typical values



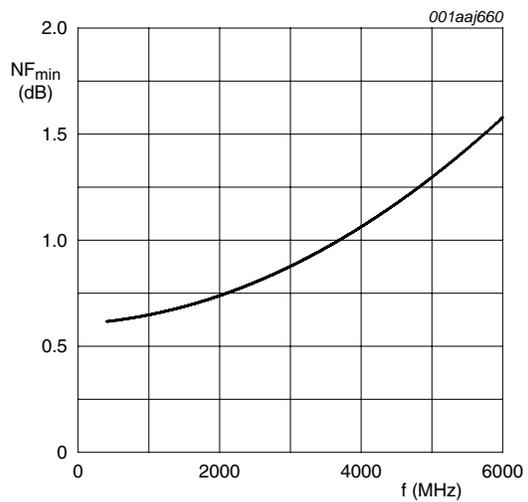
$T_{amb} = 25\text{ }^\circ\text{C}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  $V_{CC} = 2.5\text{ V}$ ;  
 $P_{drive} = -30\text{ dBm}$ ;  $Z_0 = 50\text{ }\Omega$ .

**Fig 5.** Isolation ( $|s_{12}|^2$ ) as a function of frequency; typical values



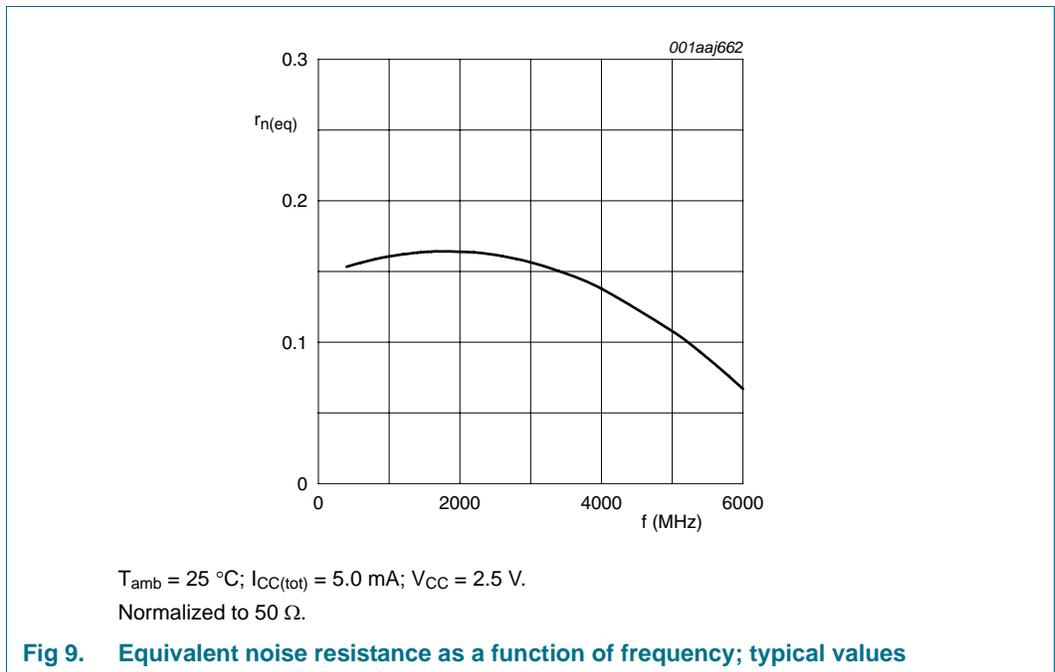
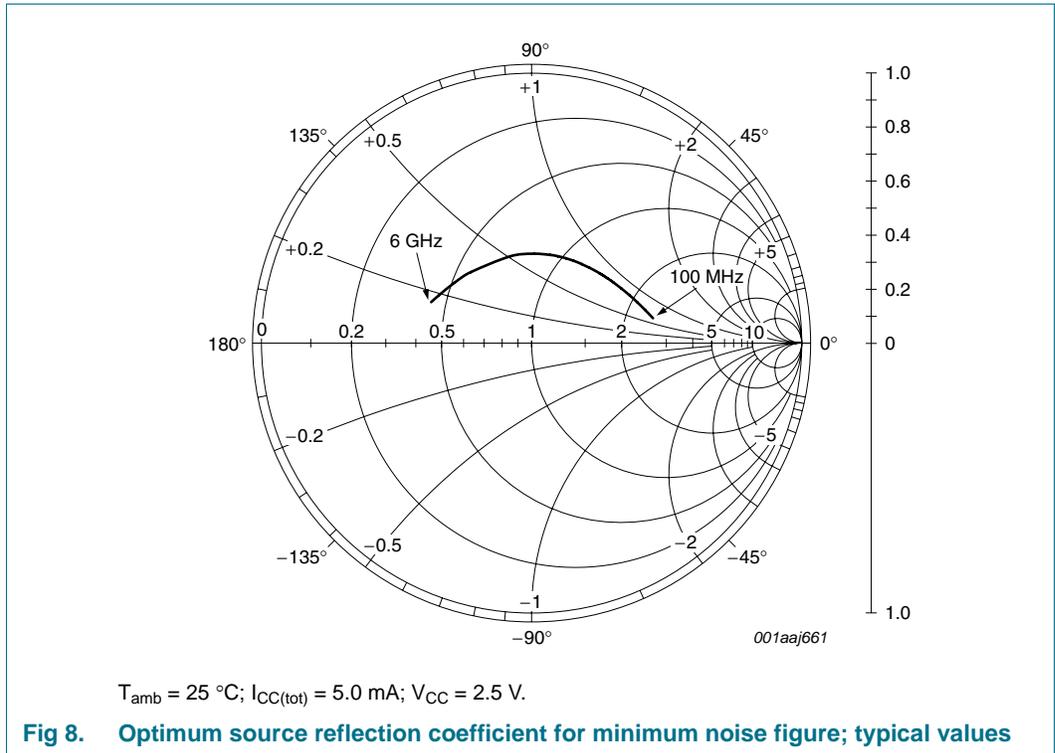
$T_{amb} = 25\text{ }^\circ\text{C}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  $V_{CC} = 2.5\text{ V}$ ;  
 $P_{drive} = -30\text{ dBm}$ ;  $Z_0 = 50\text{ }\Omega$ .

**Fig 6.** Rollet's stability factor as a function of frequency; typical values



$T_{amb} = 25\text{ }^\circ\text{C}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  $V_{CC} = 2.5\text{ V}$ ;  
 $P_{drive} = -30\text{ dBm}$ ;  $Z_0 = 50\text{ }\Omega$ .

**Fig 7.** Minimum noise figure as a function of frequency; typical values

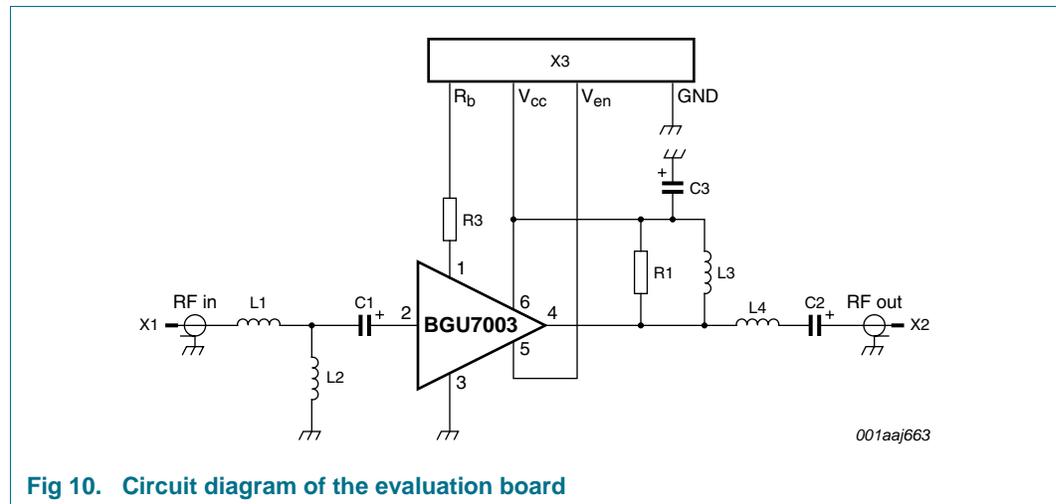


## 8. Application information GPS LNA

Other applications available. Please contact your local sales representative for more information. Application note(s) available on the NXP website.

### 8.1 Application circuit

In [Figure 10](#) the application diagram as supplied on the evaluation board is given.



**Fig 10. Circuit diagram of the evaluation board**

**Table 9. List of components**

For circuit, see [Figure 10](#).

Component	Description	Value	Supplier name/type	Remarks
C1, C2	capacitor	100 pF	[1] MurataGRM1555	DC blocking
C3	capacitor	180 pF	[1] MurataGRM1555	decoupling
L1	inductor	2.7 nH	[1] Murata/LQW15A high quality factor, low series resistance	input matching
L2	inductor	33 nH	[1] Murata/LQW15A high quality factor, low series resistance	input matching
L3	inductor	3.9 nH	[1] Murata/LQG15HS	output matching / DC shunt
L4	inductor	4.7 nH	[1] Murata/LQG15HS	output matching
R1	resistor	180 Ω	[1]	
R2	resistor	0 Ω	[1]	bridge
R3	resistor	3300 Ω	[1]	bias setting
X1, X2	SMA RF connector	-	Johnson, end launch SMA 142-0701-841	RF input / RF output
X3	DC header	-	Molex, PCB header, right angle, 1 row, 4 way 90121-0764	bias connector

[1] all capacitors, inductors and resistors have 0402 footprint.

### 8.2 Application board layout

Figure 11 shows the board layout with component identifications.

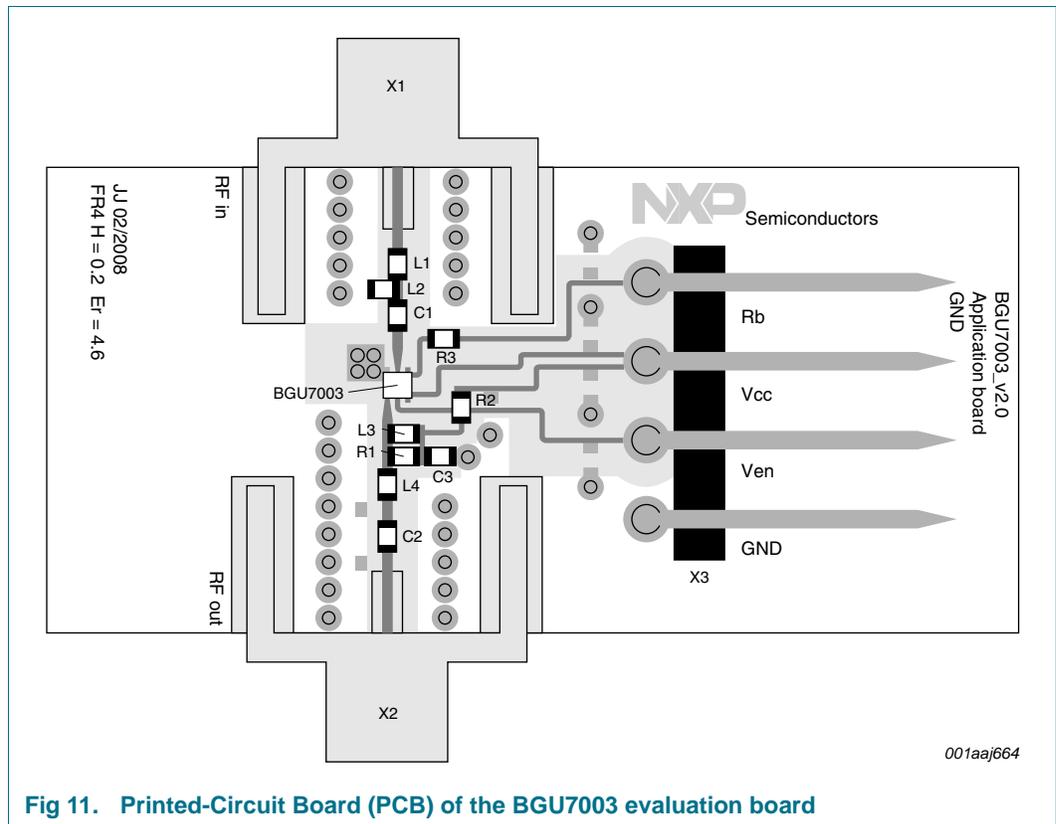


Fig 11. Printed-Circuit Board (PCB) of the BGU7003 evaluation board

### 8.3 Printed-Circuit Board

The material that has been used for the evaluation board is FR4 using the stack shown in Figure 12.

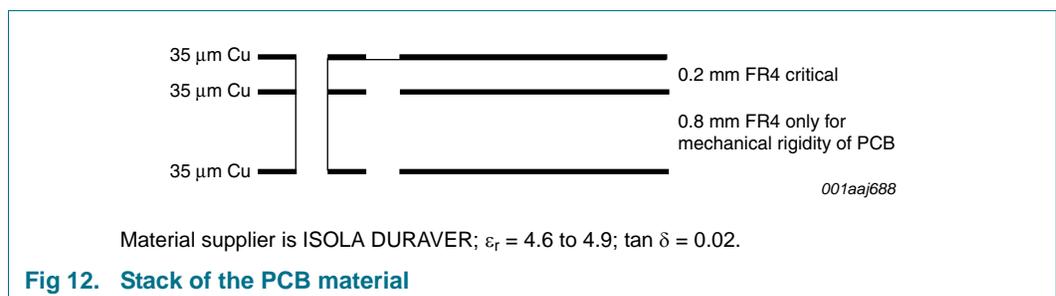


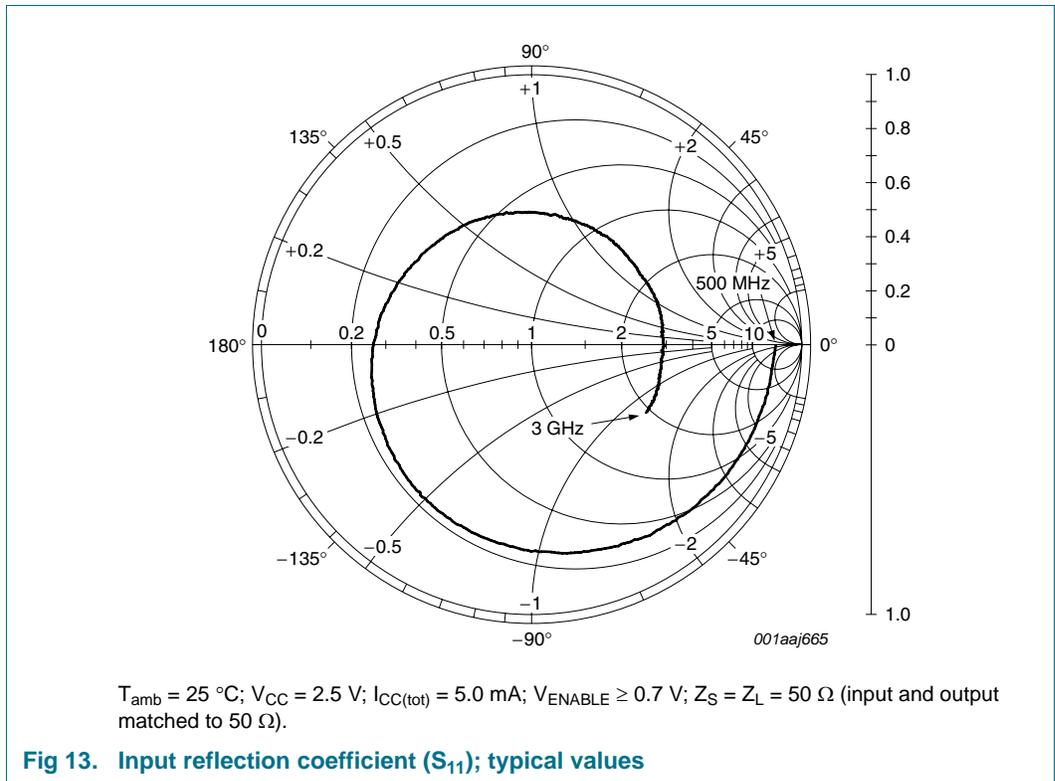
Fig 12. Stack of the PCB material

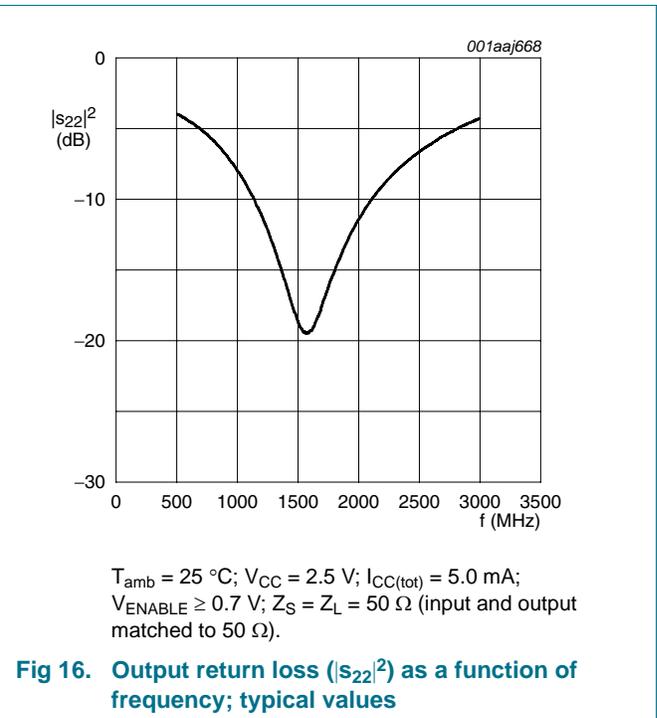
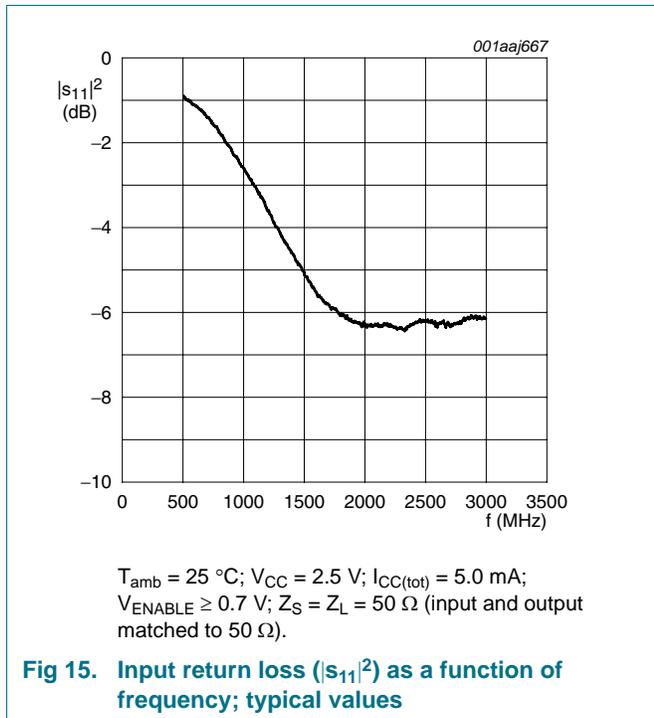
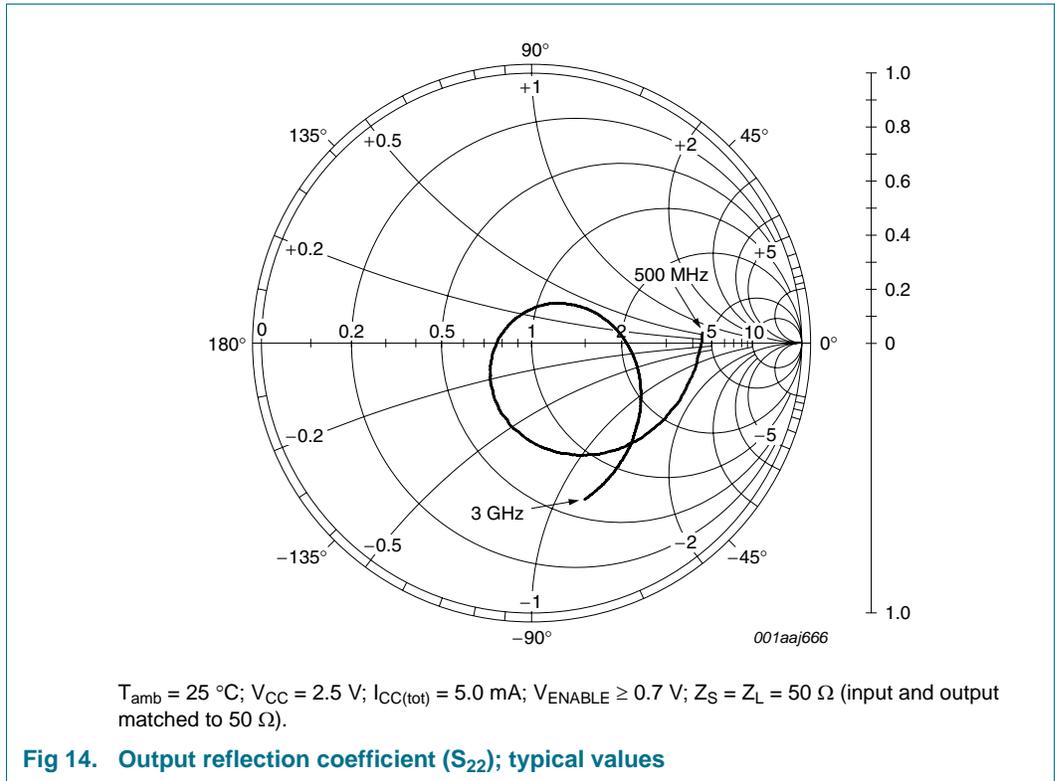
8.4 GPS evaluation board

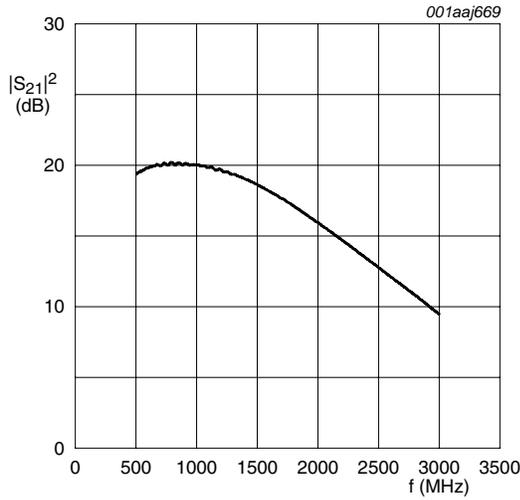
Table 10. GPS application characteristics

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 2.5\text{ V}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  $f = 1.575\text{ GHz}$ ;  $V_{ENABLE} \geq 0.7\text{ V}$ ;  $Z_S = Z_L = 50\text{ }\Omega$  (input and output matched to  $50\text{ }\Omega$ ) unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$ S_{21} ^2$	Insertion power gain		-	18.3	-	dB
$ S_{11} ^2$	input return loss		-	-5.4	-	dB
$ S_{22} ^2$	output return loss		-	-19.5	-	dB
$ S_{12} ^2$	isolation		-	-24.6	-	dB
NF	noise figure		-	0.80	-	dB
$P_{i(1dB)}$	input power at 1 dB gain compression		-	-20.1	-	dBm
$P_{L(1dB)}$	output power at 1 dB gain compression		-	-2.8	-	dBm
$IP3_1$	input third-order intercept point	jammers at $f_1 = f + 138\text{ MHz}$ and $f_2 = f + 276\text{ MHz}$	-	-0.2	-	dBm
		$f_1 = f + 5\text{ MHz}$ ; $f_2 = f + 10\text{ MHz}$	-	-5.2	-	dBm

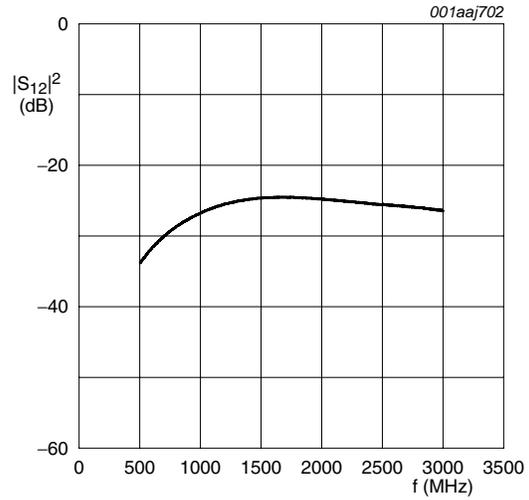






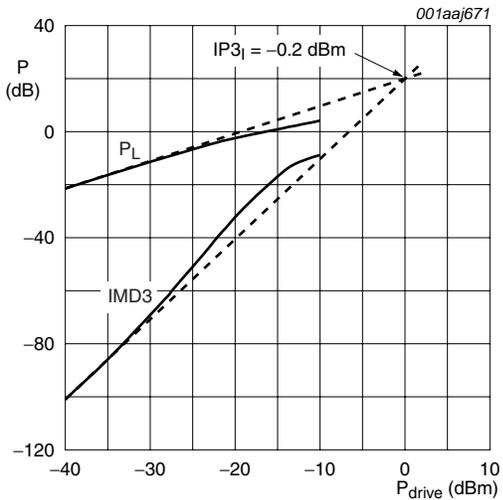
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 2.5\text{ V}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  
 $V_{ENABLE} \geq 0.7\text{ V}$ ;  $Z_S = Z_L = 50\text{ }\Omega$  (input and output  
 matched to  $50\text{ }\Omega$ ).

**Fig 17. Insertion power gain ( $|S_{21}|^2$ ) as a function of frequency; typical values**



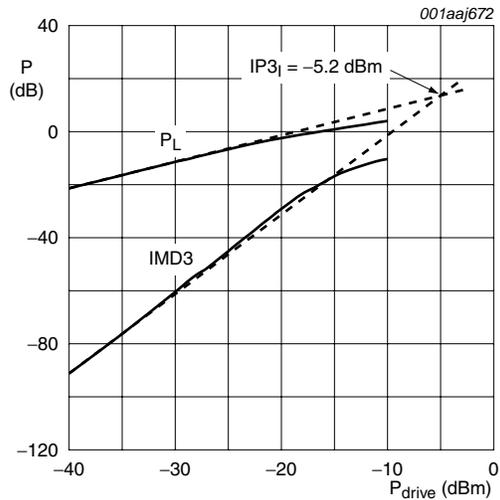
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 2.5\text{ V}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  
 $V_{ENABLE} \geq 0.7\text{ V}$ ;  $Z_S = Z_L = 50\text{ }\Omega$  (input and output  
 matched to  $50\text{ }\Omega$ ).

**Fig 18. Reverse Isolation ( $|S_{12}|^2$ ) as a function of frequency; typical values**



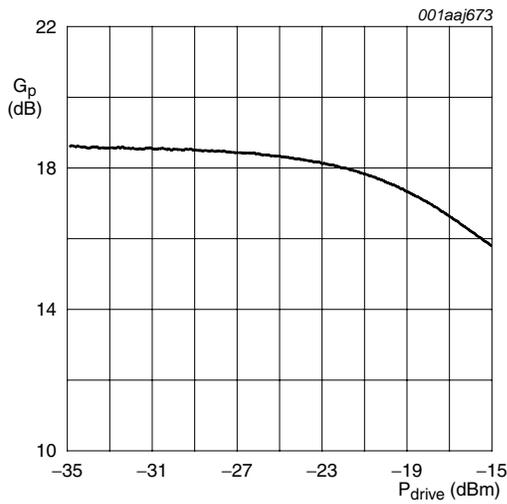
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 2.5\text{ V}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  
 $f = 1.575\text{ GHz}$ ;  $f_1 = f + 138\text{ MHz}$ ;  $f_2 = f + 276\text{ MHz}$ ;  
 $V_{ENABLE} \geq 0.7\text{ V}$ ;  $Z_S = Z_L = 50\text{ }\Omega$  (input and output  
 matched to  $50\text{ }\Omega$ )

**Fig 19. Load power and third order intermodulation distortion as function of drive power; typical values**



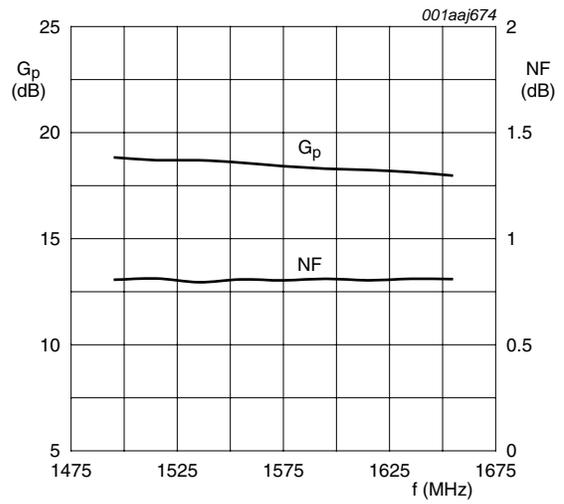
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 2.5\text{ V}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  
 $f = 1.575\text{ GHz}$ ;  $f_1 = f + 5\text{ MHz}$ ;  $f_2 = f + 10\text{ MHz}$ ;  
 $V_{ENABLE} \geq 0.7\text{ V}$ ;  $Z_S = Z_L = 50\text{ }\Omega$  (input and output  
 matched to  $50\text{ }\Omega$ )

**Fig 20. Load power and third order intermodulation distortion as function of drive power; typical values**



$T_{amb} = 25\text{ }^\circ\text{C}$ ;  $V_{CC} = 2.5\text{ V}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  
 $f = 1.575\text{ GHz}$ ;  $V_{ENABLE} \geq 0.7\text{ V}$ ;  $Z_S = Z_L = 50\ \Omega$  (input and output matched to  $50\ \Omega$ ).

**Fig 21. Power gain as a function of drive power; typical values**



$T_{amb} = 25\text{ }^\circ\text{C}$ ;  $V_{CC} = 2.5\text{ V}$ ;  $I_{CC(tot)} = 5.0\text{ mA}$ ;  
 $V_{ENABLE} \geq 0.7\text{ V}$ ;  $Z_S = Z_L = 50\ \Omega$  (input and output matched to  $50\ \Omega$ ).

**Fig 22. Power gain and noise figure as function of frequency; typical values**

### 9. Package outline

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

SOT891

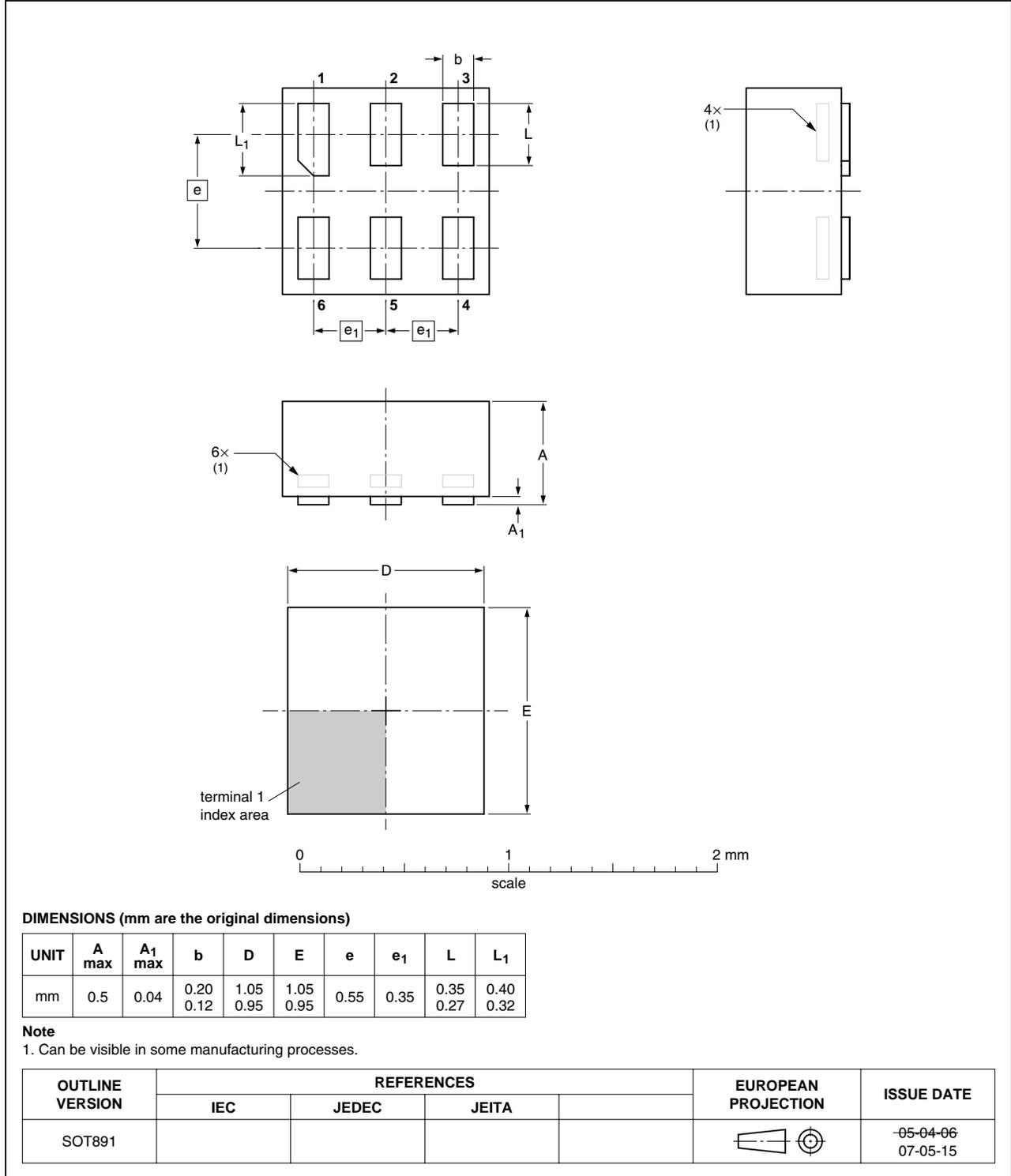
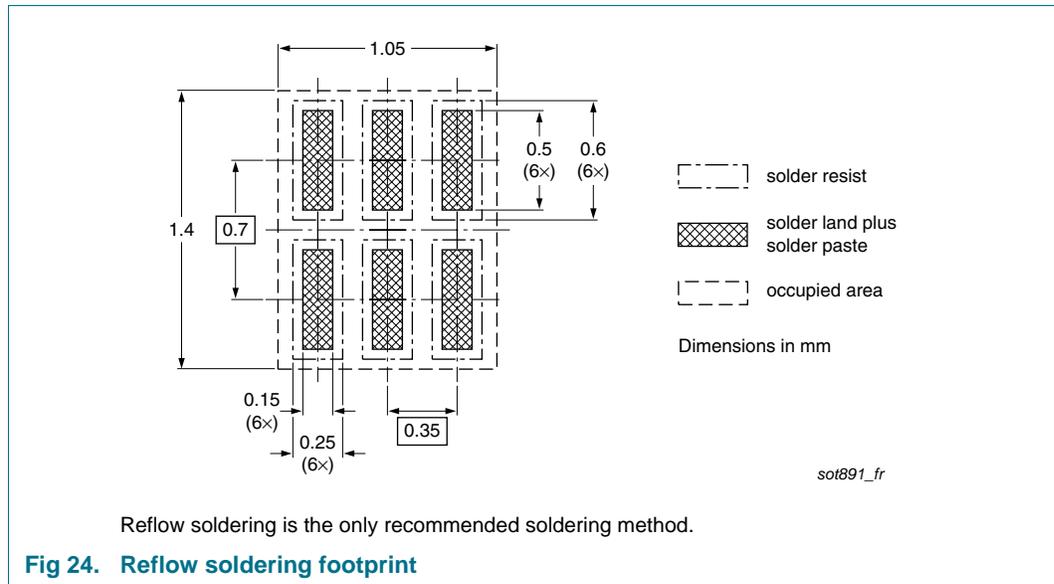


Fig 23. Package outline SOT891 (XSON6)

## 10. Soldering



## 11. Abbreviations

**Table 11. Abbreviations**

Acronym	Description
AC	Alternating Current
CDMA	Code Division Multiple Access
DC	Direct Current
FR4	Flame Retardant 4
GPS	Global Positioning System
LNA	Low-Noise Amplifier
MMIC	Monolithic Microwave Integrated Circuit
RF	Radio Frequency
SiGe:C	Silicon Germanium Carbon
SMA	SubMiniature version A
WLAN	Wireless Local Area Network

## 12. Revision history

**Table 12. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
BGU7003 v.2	20100622	Product data sheet	-	BGU7003 v.1
Modifications:	<ul style="list-style-type: none"> <li>Legal information updated.</li> </ul>			
BGU7003 v.1	20090302	Product data sheet	-	-

## 13. Legal information

### 13.1 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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