BGU7003

Wideband silicon germanium low-noise amplifier MMIC

Rev. 02 — 22 June 2010 Product data sheet

1. Product profile

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

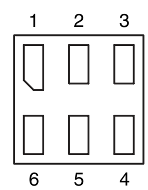
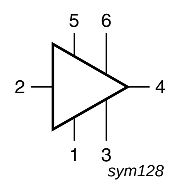
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CC}	supply voltage	RF input AC coupled		2.2	-	2.85	V
$I_{CC(tot)}$	total supply current	configurable with external resistor	[1]	3	-	15	mA
T_{amb}	ambient temperature			−40	+25	+85	°C
P_{tot}	total power dissipation	$T_{sp} \leq$ 103 °C	[2]	-	-	70	mW
$\lvert s_{21}\rvert^2$	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
$IP3_I$	input third-order intercept point	jammers at f_1 = f + 138 MHz and f_2 = f + 276 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	 bottom view	
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 × 1 × 0.5 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_{CC}	supply voltage	RF input AC coupled		-	3.0	V
$I_{CC(tot)}$	total supply current	configurable with external resistor		-	25	mA
P_{tot}	total power dissipation	$T_{sp} \leq 103$ °C	[1]	-	70	mW
T_{stg}	storage temperature			–65	+150	°C
T_j	junction temperature			-	150	°C

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

6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point		235	K/W

7. Characteristics

Table 7. Characteristics

T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; $V_{ENABLE} \geq 0.7$ V unless otherwise specified. All measurements done on characterization board without matching, de-embedded up to the pins.

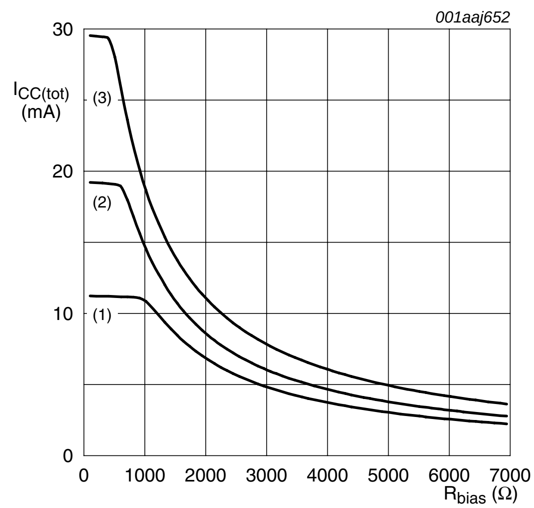
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CC}	supply voltage	RF input AC coupled		2.2	-	2.85	V
$I_{CC(tot)}$	total supply current	configurable with external resistor	[1]	3	-	15	mA
		$V_{ENABLE} \leq 0.4$ V	[1]	-	-	0.001	mA
T_{amb}	ambient temperature			–40	+25	+85	°C
$\lvert s_{21}\rvert^2$	insertion power gain	T_{amb} = 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_{amb} ≤ 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_{min}	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] $I_{CC(tot)} = I_{CC} + I_{RF\_OUT} + I_{R\_BIAS}$.

[2] Guaranteed by design and characterization.

Table 8. ENABLE (pin 5)
−40 °C ≤ T_{amb} ≤ +85 °C

V_{ENABLE} (V)	State
≤ 0.4	OFF
≥ 0.7	ON



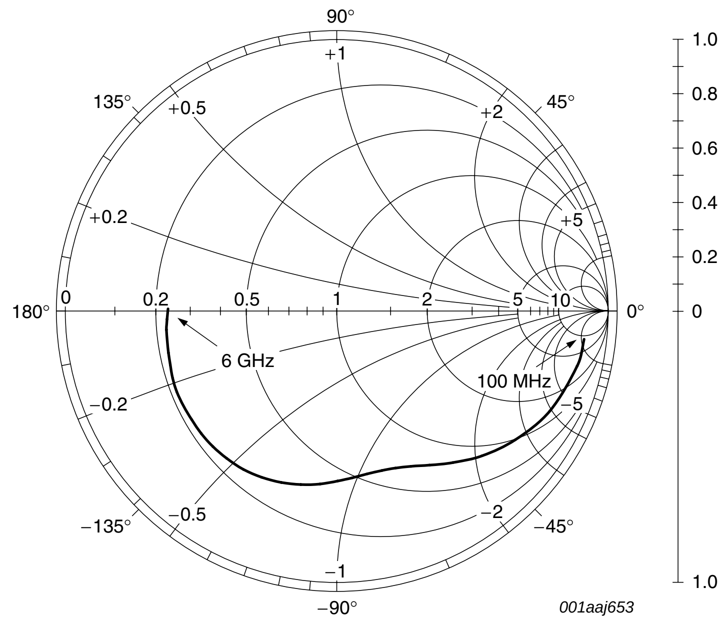
T_{amb} = 25 °C.

(1) V_{CC} = 2.2 V

(2) V_{CC} = 2.5 V

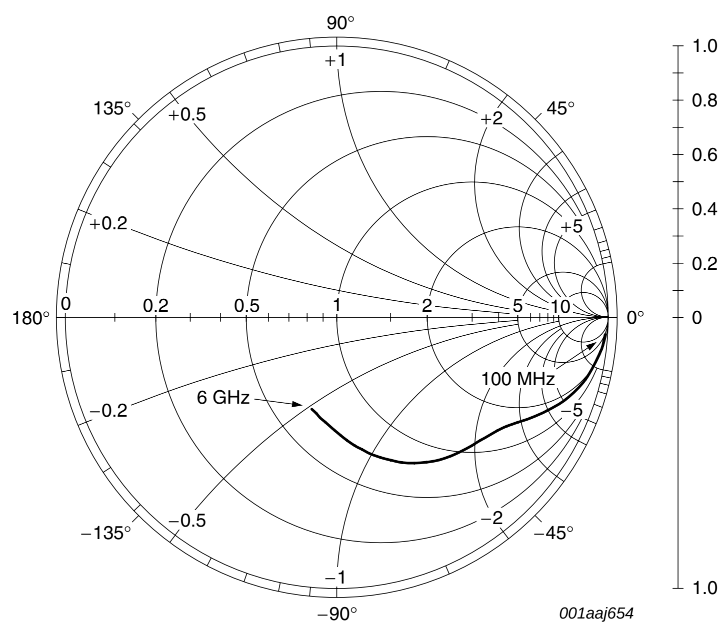
(3) V_{CC} = 2.85 V

Fig 1. Total supply current as a function of bias resistor; typical values



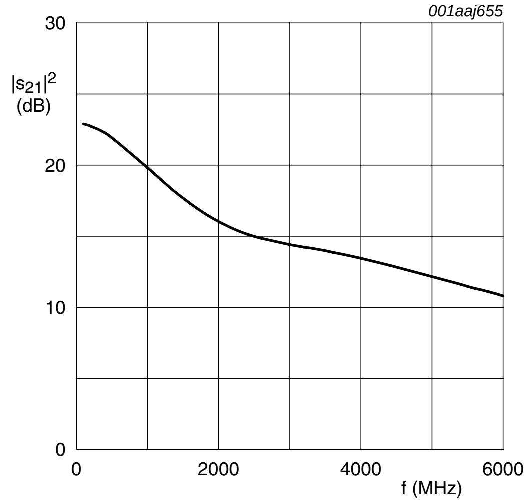
T_{amb} = 25 °C; $I_{CC(tot)}$ = 5.0 mA; V_{CC} = 2.5 V; P_{drive} = −30 dBm; Z_0 = 50 Ω.

Fig 2. Input reflection coefficient (S_{11}); typical values



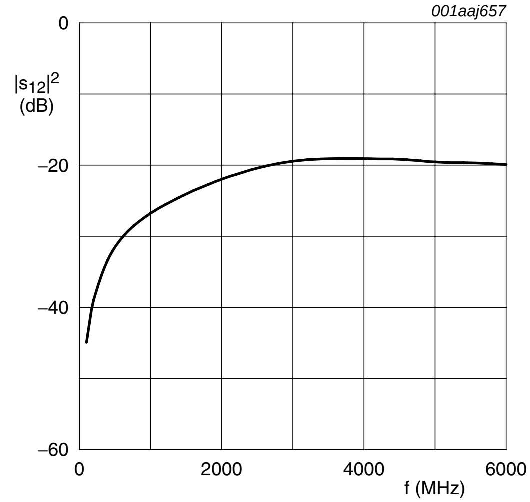
T_{amb} = 25 °C; $I_{CC(tot)}$ = 5.0 mA; V_{CC} = 2.5 V; P_{drive} = −30 dBm; Z_0 = 50 Ω.

Fig 3. Output reflection coefficient (S_{22}); typical values



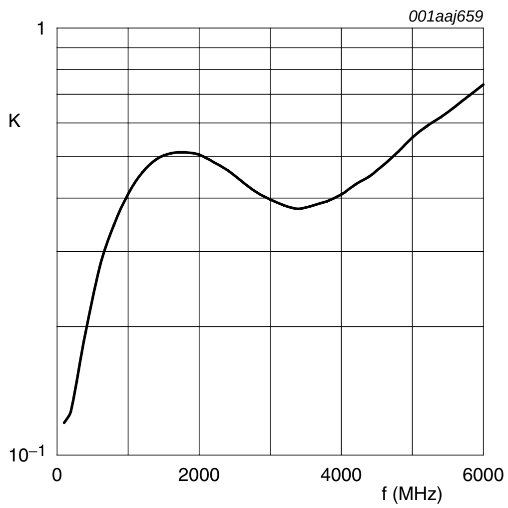
T_{amb} = 25 °C; $I_{CC(tot)}$ = 5.0 mA; V_{CC} = 2.5 V;
P_{drive} = −30 dBm; Z_0 = 50 Ω.

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



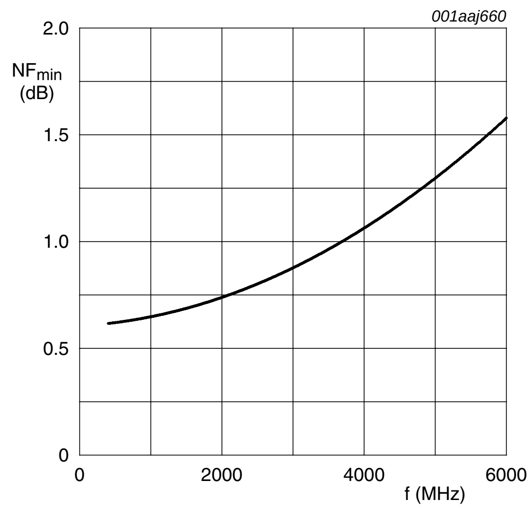
T_{amb} = 25 °C; $I_{CC(tot)}$ = 5.0 mA; V_{CC} = 2.5 V;
P_{drive} = −30 dBm; Z_0 = 50 Ω.

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



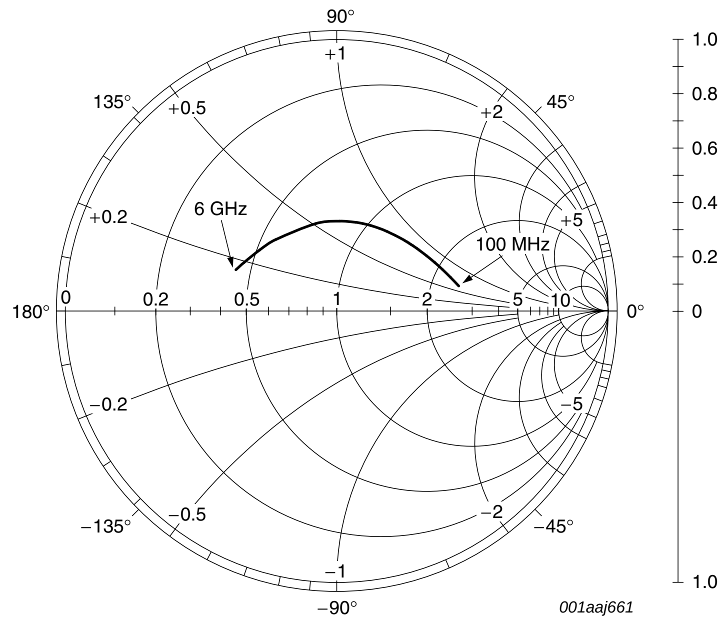
T_{amb} = 25 °C; $I_{CC(tot)}$ = 5.0 mA; V_{CC} = 2.5 V;
P_{drive} = −30 dBm; Z_0 = 50 Ω.

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



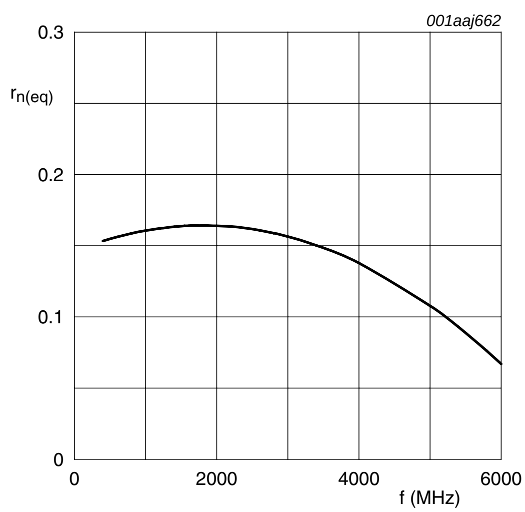
T_{amb} = 25 °C; $I_{CC(tot)}$ = 5.0 mA; V_{CC} = 2.5 V;
P_{drive} = −30 dBm; Z_0 = 50 Ω.

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



T_{amb} = 25 °C; $I_{CC(tot)}$ = 5.0 mA; V_{CC} = 2.5 V.

Fig 8. Optimum source reflection coefficient for minimum noise figure; typical values



T_{amb} = 25 °C; $I_{CC(tot)}$ = 5.0 mA; V_{CC} = 2.5 V.

Normalized to 50 Ω.

Fig 9. Equivalent noise resistance 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.

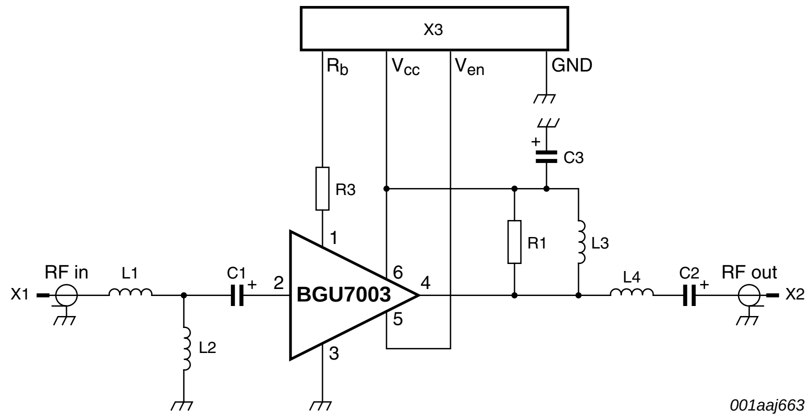


Fig 10. Circuit diagram of the evaluation board

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.

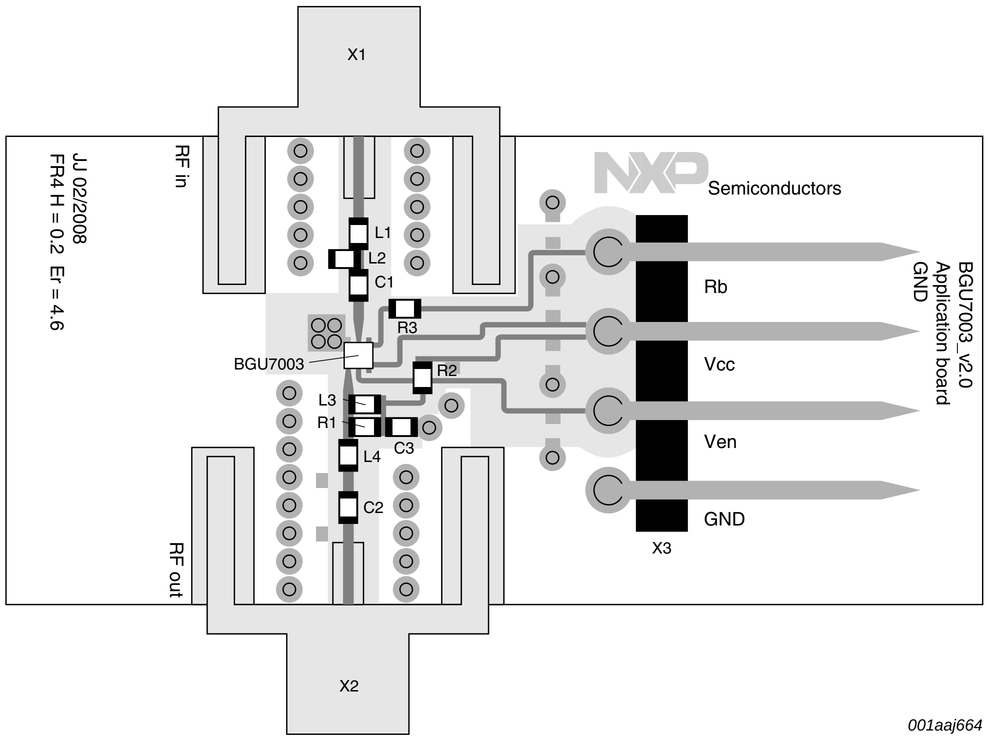
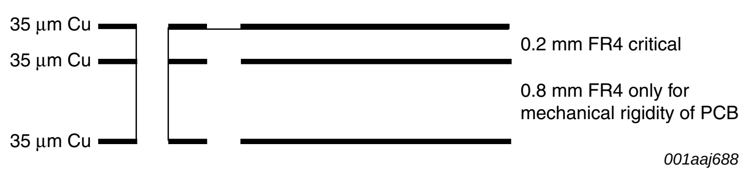


Fig 11. Printed-Circuit Board (PCB) of the BGU7003 evaluation board

8.3 Printed-Circuit Board

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



Material supplier is ISOLA DURAVER; ε_r = 4.6 to 4.9; tan δ = 0.02.

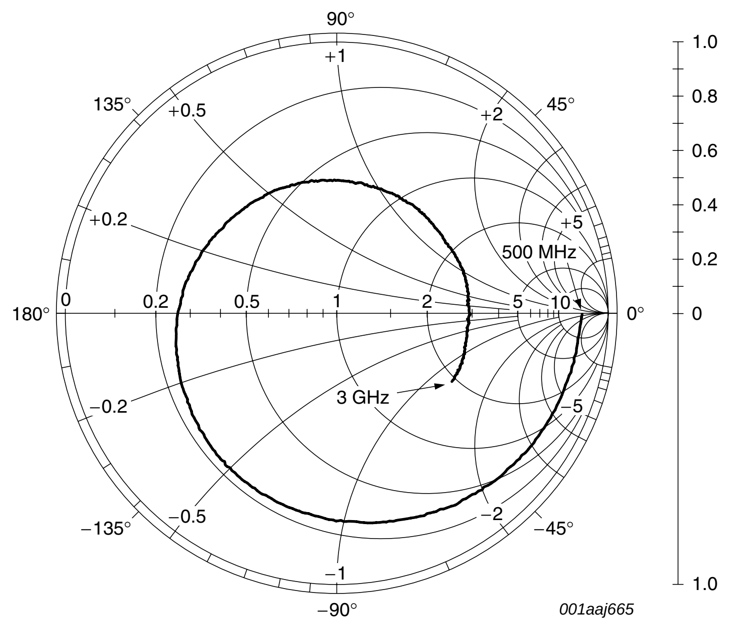
Fig 12. Stack of the PCB material

8.4 GPS evaluation board

Table 10. GPS application characteristics

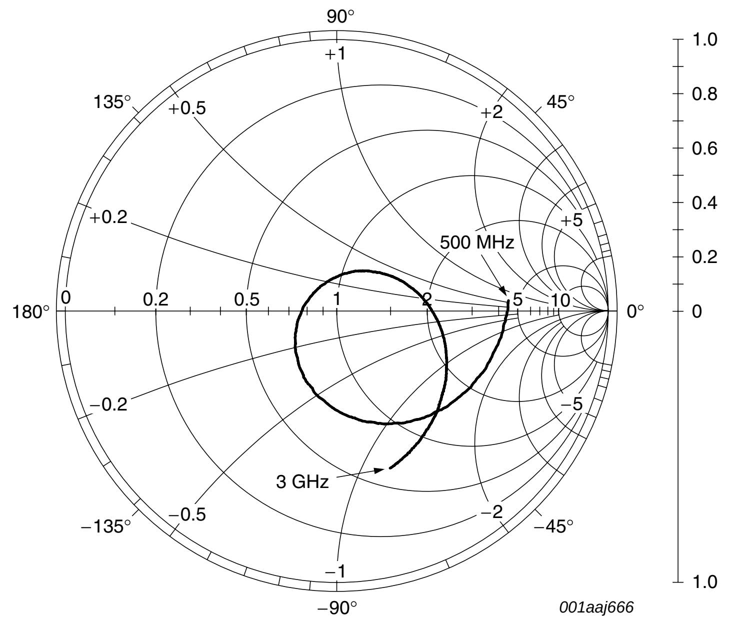
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; f = 1.575 GHz; V_{ENABLE} ≥ 0.7 V; Z_S = Z_L = 50 Ω (input and output matched to 50 Ω) unless otherwise specified.

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
$IP3_I$	input third-order intercept point	jammers at f_1 = f + 138 MHz and f_2 = f + 276 MHz	-	–0.2	-	dBm
		f_1 = f + 5 MHz; f_2 = f + 10 MHz	-	–5.2	-	dBm



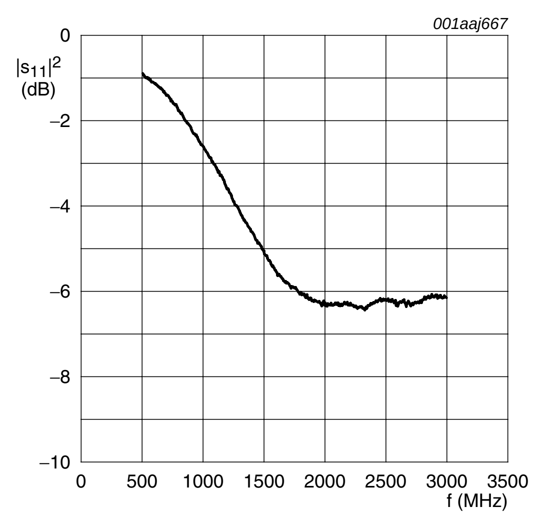
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; V_{ENABLE} ≥ 0.7 V; Z_S = Z_L = 50 Ω (input and output matched to 50 Ω).

Fig 13. Input reflection coefficient (S_{11}); typical values



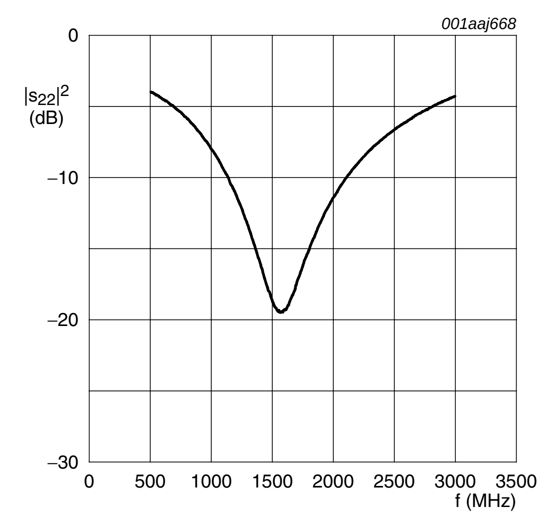
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; V_{ENABLE} ≥ 0.7 V; Z_S = Z_L = 50 Ω (input and output matched to 50 Ω).

Fig 14. Output reflection coefficient (S_{22}); typical values



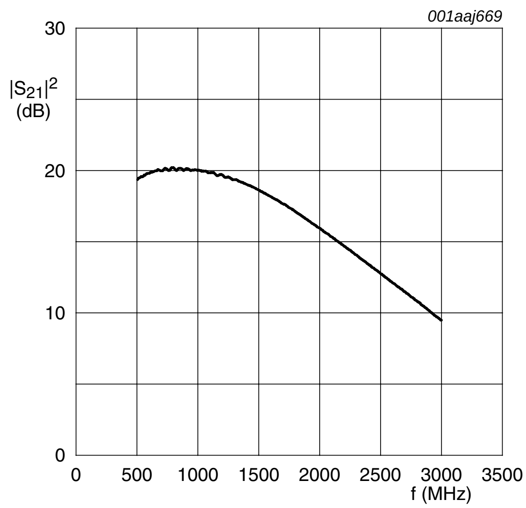
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; V_{ENABLE} ≥ 0.7 V; Z_S = Z_L = 50 Ω (input and output matched to 50 Ω).

Fig 15. Input return loss ($|s_{11}|^2$) as a function of frequency; typical values



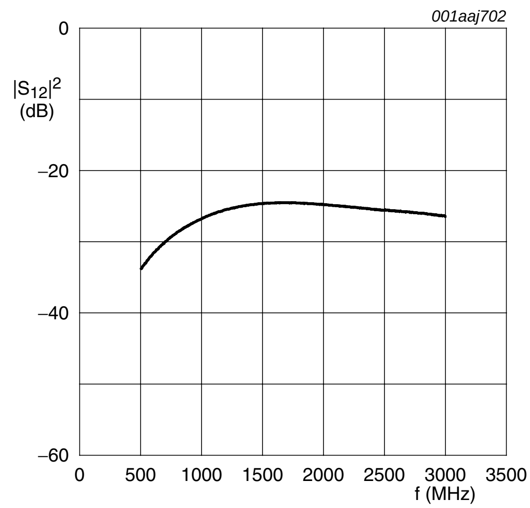
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; V_{ENABLE} ≥ 0.7 V; Z_S = Z_L = 50 Ω (input and output matched to 50 Ω).

Fig 16. Output return loss ($|s_{22}|^2$) as a function of frequency; typical values



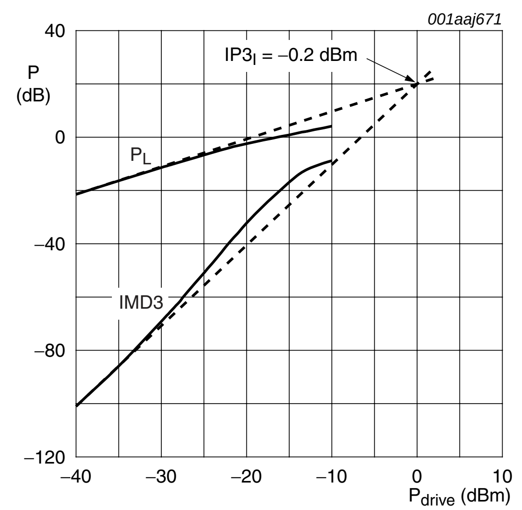
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; $V_{ENABLE} \geq$ 0.7 V; $Z_S = Z_L$ = 50 Ω (input and output matched to 50 Ω).

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



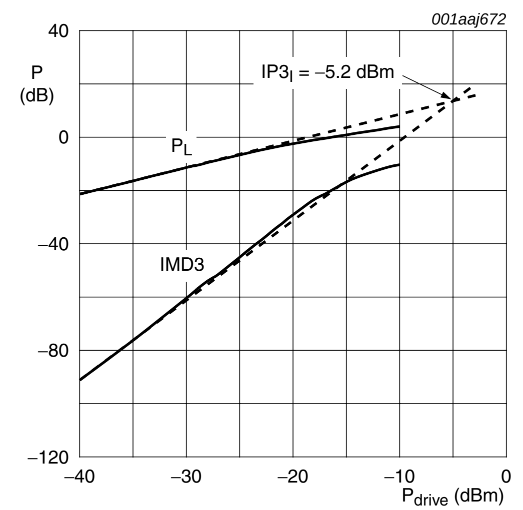
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; $V_{ENABLE} \geq$ 0.7 V; $Z_S = Z_L$ = 50 Ω (input and output matched to 50 Ω).

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



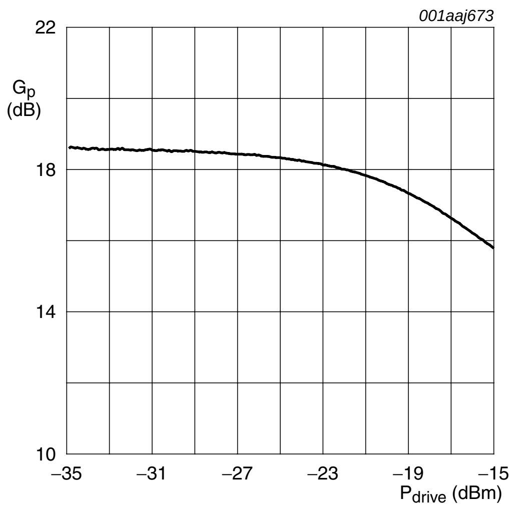
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; f = 1.575 GHz; f_1 = f + 138 MHz; f_2 = f + 276 MHz; $V_{ENABLE} \geq$ 0.7 V; $Z_S = Z_L$ = 50 Ω (input and output matched to 50 Ω)

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



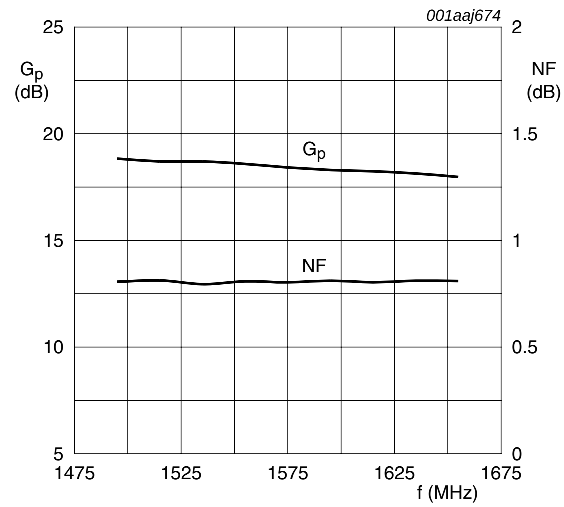
T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; f = 1.575 GHz; f_1 = f + 5 MHz; f_2 = f + 10 MHz; $V_{ENABLE} \geq$ 0.7 V; $Z_S = Z_L$ = 50 Ω (input and output matched to 50 Ω)

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



T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; f = 1.575 GHz; V_{ENABLE} ≥ 0.7 V; $Z_S = Z_L$ = 50 Ω (input and output matched to 50 Ω).

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

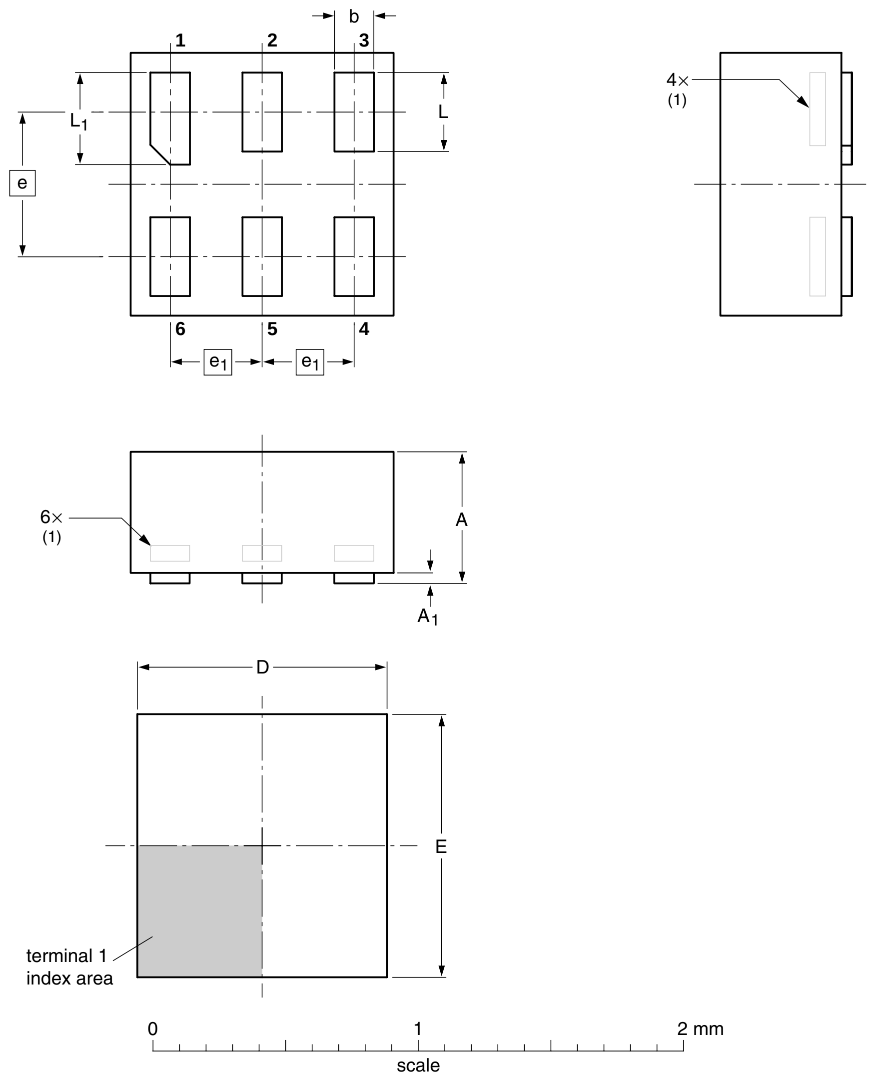


T_{amb} = 25 °C; V_{CC} = 2.5 V; $I_{CC(tot)}$ = 5.0 mA; V_{ENABLE} ≥ 0.7 V; $Z_S = Z_L$ = 50 Ω (input and output matched to 50 Ω).

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**



DIMENSIONS (mm are the original dimensions)

UNIT	A max	A_1 max	b	D	E	e	e_1	L	L_1
mm	0.5	0.04	0.20 0.12	1.05 0.95	1.05 0.95	0.55	0.35	0.35 0.27	0.40 0.32

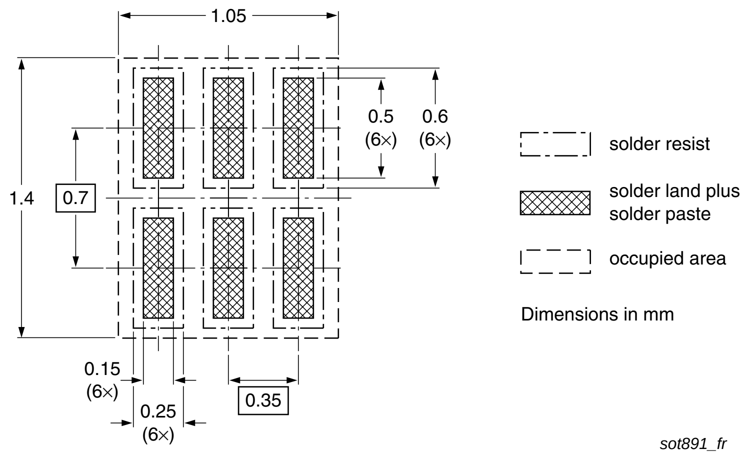
Note

1. Can be visible in some manufacturing processes.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT891						~~05-04-06~~ 07-05-15

Fig 23. Package outline SOT891 (XSON6)

10. Soldering



Reflow soldering is the only recommended soldering method.

Fig 24. Reflow soldering footprint

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:	• Legal information updated.			
BGU7003 v.1	20090302	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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14. Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

15. Contents

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