

# BGA713N7

Single-Band UMTS LNA (700, 800 MHz)

## Data Sheet

Revision 3.1, 2013-01-31

RF & Protection Devices

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**BGA713N7 Single-Band UMTS LNA (700, 800 MHz)**

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Page	Subjects (major changes since last revision)
25	Footprint recommendation drawing added
26	Marking pattern drawing updated

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## 1 Features

Main features:

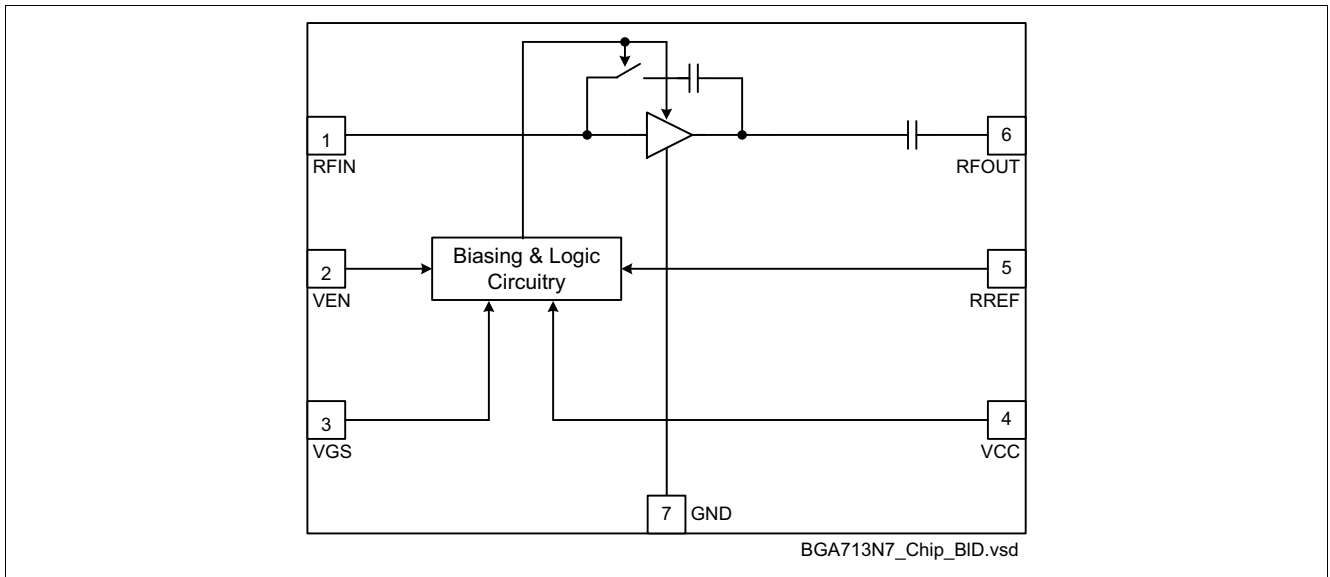
- Gain: 15.5 / -10 dB in high / low gain mode
- Noise figure: 1.1 dB in high gain mode
- Supply current: 4.8 / 0.5 mA in high / low gain mode
- Standby mode (< 2  $\mu$ A typ.)
- Output internally matched to 50  $\Omega$
- Inputs pre-matched to 50  $\Omega$
- 2 kV HBM ESD protection
- Low external component count
- Small leadless TSNP-7-1 package (2.0 x 1.3 x 0.39 mm)
- Pb-free (RoHS compliant) package



### Description

The BGA713N7 is a low current single-band low noise amplifier MMIC for UMTS bands XII, XIII, XIV, XVII and XX. The LNA is based upon Infineon's proprietary and cost-effective SiGe:C technology and comes in a low profile TSNP-7-1 leadless green package. This document specifies electrical parameters, pinout, application circuit and packaging of the chip.

Product Name	Package	Chip	Marking
BGA713N7	TSNP-7-1	T1533	B3



**Figure 1** Block Diagram of Single-Band LNA



## 2 Electrical Characteristics

### 2.1 Absolute Maximum Ratings

**Table 1 Absolute Maximum Ratings**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply voltage	$V_{CC}$	-0.3	–	3.6	V	–
Supply current	$I_{CC}$	–	–	10	mA	–
Pin voltage	$V_{PIN}$	-0.3	–	$V_{CC}+0.3$	V	All pins except RF input pins
Pin voltage RF input pins	$V_{RFIN}$	-0.3	–	0.9	V	–
RF input power	$P_{RFIN}$	–	–	4	dBm	–
Junction temperature	$T_j$	–	–	150	°C	–
Ambient temperature range	$T_A$	-30	–	85	°C	–
Storage temperature range	$T_{stg}$	-65	–	150	°C	–

**Attention: Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.**

### 2.2 Thermal Resistance

**Table 2 Thermal Resistance**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance junction to soldering point	$R_{thJS}$	–	150	–	K/W	–

### 2.3 ESD Integrity

**Table 3 ESD Integrity**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
ESD hardness HBM <sup>1)</sup>	$V_{ESD-HBM}$	–	2000	–	V	All pins

1) According to JESD22-A114

## 2.4 DC Characteristics

**Table 4 DC Characteristics,  $T_A = 25\text{ °C}$**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply voltage	$V_{CC}$	2.6	2.8	3.0	V	–
Supply current high gain mode	$I_{CCHG}$	–	4.8	–	mA	–
Supply current low gain mode	$I_{CCLG}$	–	0.50	–	mA	–
Supply current standby mode	$I_{CCOFF}$	–	0.1	–	$\mu\text{A}$	–
Logic level high	$V_{HI}$	1.5	2.8	–	V	All logic pins
Logic level low	$V_{LO}$	–	0.0	0.5	V	
Logic currents	$I_{HI}$	–	5.0	–	$\mu\text{A}$	All logic pins
	$I_{LO}$	–	0.1	–	$\mu\text{A}$	

## 2.5 Band Select / Gain Control Truth Table

**Table 5 Truth Table**

Control Voltage		State	
		Bands XII, XIII, XIV, XVII and XX	
VEN	VGS	HG	LG
H	L	OFF	ON
H	H	ON	OFF
L	L	STANDBY <sup>1)</sup>	
L	H		

1) In order to achieve minimum standby current it is encouraged to apply logic low-level at the VGS pin in standby mode although this is not mandatory.

## 2.6 Switching Time

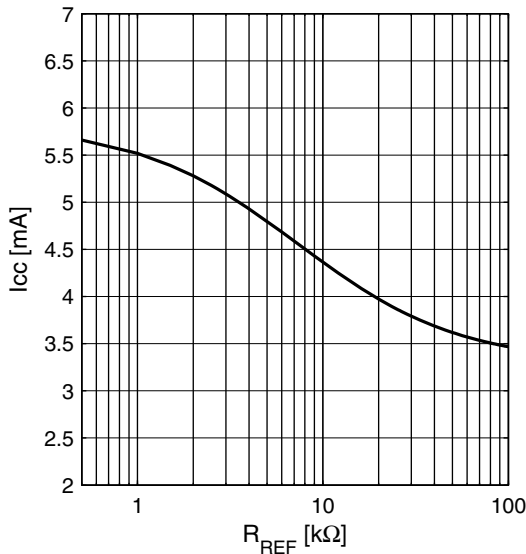
**Table 6 Typical switching times;  $T_A = -30 \dots 85\text{ °C}$**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Settling time gainstep	$t_{GS}$	–	1	–	$\mu\text{s}$	Switching LG $\leftrightarrow$ HG

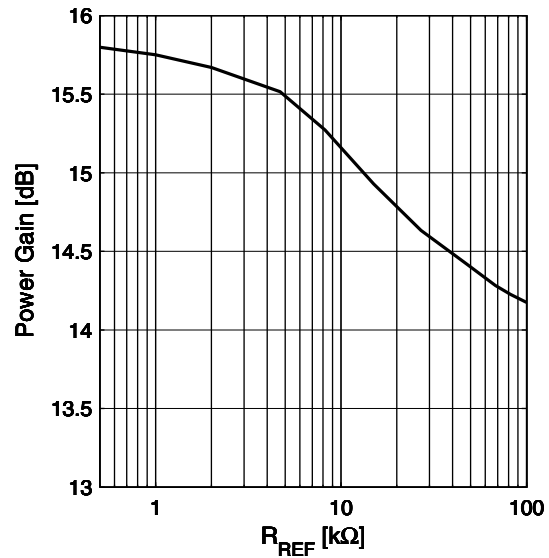
## 2.7 Supply Current and Power Gain Characteristics

Supply current high gain mode versus resistance of reference resistor  $R_{REF}$  see Figure 3 on Page 20; low gain mode supply current is independent of reference resistor).

**Supply Current**  $I_{CC} = f(R_{REF})$   
 $V_{CC} = 2.8\text{ V}$



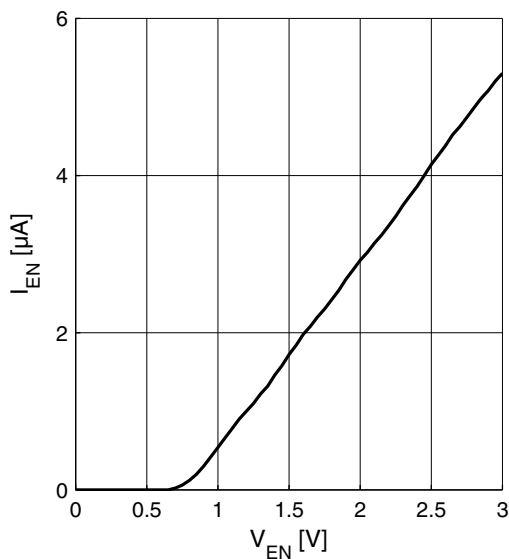
**Power Gain**  $|S_{21}| = f(R_{REF})$   
 $V_{CC} = 2.8\text{ V}$



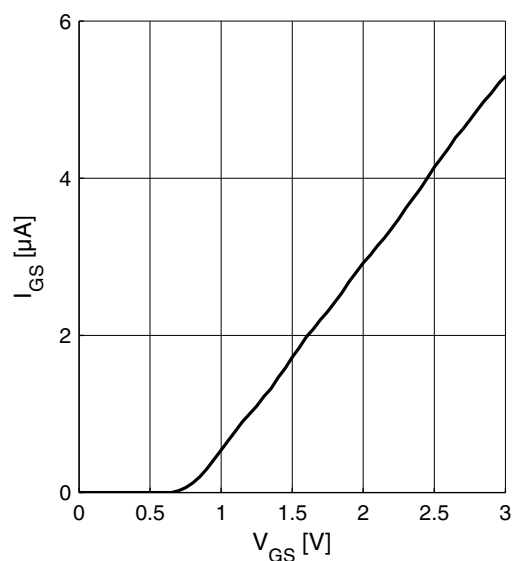
## 2.8 Logic Signal Characteristics

Current consumption of logic inputs VEN, VGS

**Logic currents**  $I_{EN} = f(V_{EN})$   
 $V_{CC} = 2.8\text{ V}$



**Logic currents**  $I_{GS} = f(V_{GS})$   
 $V_{CC} = 2.8\text{ V}$



## 2.9 Measured RF Characteristics UMTS Bands XII / XVII

**Table 7** Typical Characteristics 700 MHz Band,  $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $R_{REF} = 5.6\text{ k}\Omega$ <sup>1)</sup>

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Pass band range band XII		728		746	MHz	
Pass band range band XVII		734		746	MHz	
Current consumption	$I_{CCHG}$	–	4.8	–	mA	High gain mode
	$I_{CCLG}$	–	0.50	–	mA	Low gain mode
Gain	$S_{21HG}$	–	15.3	–	dB	High gain mode
	$S_{21LG}$	–	-9.9	–	dB	Low gain mode
Reverse isolation <sup>2)</sup>	$S_{12HG}$	–	-40	–	dB	High gain mode
	$S_{12LG}$	–	-9.9	–	dB	Low gain mode
Noise figure	$NF_{HG}$	–	1.1	–	dB	High gain mode
	$NF_{LG}$	–	9.9	–	dB	Low gain mode
Input return loss <sup>2)</sup>	$S_{11HG}$	–	-13	–	dB	50 $\Omega$ , high gain mode
	$S_{11LG}$	–	-14	–	dB	50 $\Omega$ , low gain mode
Output return loss <sup>2)</sup>	$S_{22HG}$	–	-27	–	dB	50 $\Omega$ , high gain mode
	$S_{22LG}$	–	-19	–	dB	50 $\Omega$ , low gain mode
Stability factor <sup>3)</sup>	$k$	–	>2.2	–		DC to 8 GHz; all gain modes
Input compression point <sup>2)</sup>	$IP_{1dBHG}$	–	-7	–	dBm	High gain mode
	$IP_{1dB LG}$	–	-12	–	dBm	Low gain mode
Inband IIP3 <sup>2)</sup> $f_1 - f_2 = 1\text{ MHz}$ $P_{f1} = P_{f2} = -37\text{ dBm}$	$IIP3_{HG}$	–	-8	–	dBm	High gain mode
	$IIP3_{LG}$	–	-2	–	dBm	Low gain mode

1) Performance based on application circuit in Figure 2 on Page 19

2) Verification based on AQL; not 100% tested in production

3) Guaranteed by device design; not tested in production

## 2.10 Measured RF Characteristics UMTS Bands XIII / XIV

**Table 8** Typical Characteristics 700 MHz Band,  $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $R_{REF} = 5.6\text{ k}\Omega$ <sup>1)</sup>

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Pass band range band XIII		746		756	MHz	
Pass band range band XIV		758		768	MHz	
Current consumption	$I_{CCHG}$	–	4.8	–	mA	High gain mode
	$I_{CCLG}$	–	0.50	–	mA	Low gain mode
Gain	$S_{21HG}$	–	15.5	–	dB	High gain mode
	$S_{21LG}$	–	-9.8	–	dB	Low gain mode
Reverse isolation <sup>2)</sup>	$S_{12HG}$	–	-39	–	dB	High gain mode
	$S_{12LG}$	–	-9.8	–	dB	Low gain mode
Noise figure	$NF_{HG}$	–	1.1	–	dB	High gain mode
	$NF_{LG}$	–	9.8	–	dB	Low gain mode
Input return loss <sup>2)</sup>	$S_{11HG}$	–	-15	–	dB	50 $\Omega$ , high gain mode
	$S_{11LG}$	–	-12	–	dB	50 $\Omega$ , low gain mode
Output return loss <sup>2)</sup>	$S_{22HG}$	–	-15	–	dB	50 $\Omega$ , high gain mode
	$S_{22LG}$	–	-20	–	dB	50 $\Omega$ , low gain mode
Stability factor <sup>3)</sup>	$k$	–	>2.3	–		DC to 8 GHz; all gain modes
Input compression point <sup>2)</sup>	$IP_{1dBHG}$	–	-7	–	dBm	High gain mode
	$IP_{1dB LG}$	–	-11	–	dBm	Low gain mode
Inband IIP3 <sup>2)</sup> $f_1 - f_2 = 1\text{ MHz}$ $P_{f1} = P_{f2} = -37\text{ dBm}$	$IIP3_{HG}$	–	-7	–	dBm	High gain mode
	$IIP3_{LG}$	–	-2	–	dBm	Low gain mode

1) Performance based on application circuit in Figure 3 on Page 20

2) Verification based on AQL; not 100% tested in production

3) Guaranteed by device design; not tested in production

## 2.11 Measured RF Characteristics UMTS Band XX

**Table 9** Typical Characteristics 800 MHz Band,  $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $R_{REF} = 5.6\text{ k}\Omega$ <sup>1)</sup>

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Pass band range		791		821	MHz	
Current consumption	$I_{CCHG}$	–	4.8	–	mA	High gain mode
	$I_{CCLG}$	–	0.50	–	mA	Low gain mode
Gain	$S_{21HG}$	–	15.9	–	dB	High gain mode
	$S_{21LG}$	–	-8.4	–	dB	Low gain mode
Reverse isolation <sup>2)</sup>	$S_{12HG}$	–	-38	–	dB	High gain mode
	$S_{12LG}$	–	-8.4	–	dB	Low gain mode
Noise figure	$NF_{HG}$	–	1.0	–	dB	High gain mode
	$NF_{LG}$	–	8.4	–	dB	Low gain mode
Input return loss <sup>2)</sup>	$S_{11HG}$	–	-16	–	dB	50 $\Omega$ , high gain mode
	$S_{11LG}$	–	-11	–	dB	50 $\Omega$ , low gain mode
Output return loss <sup>2)</sup>	$S_{22HG}$	–	-13	–	dB	50 $\Omega$ , high gain mode
	$S_{22LG}$	–	-27	–	dB	50 $\Omega$ , low gain mode
Stability factor <sup>3)</sup>	$k$	–	>2.3	–		DC to 8 GHz; all gain modes
Input compression point <sup>2)</sup>	$IP_{1dBHG}$	–	-6	–	dBm	High gain mode
	$IP_{1dB LG}$	–	-10	–	dBm	Low gain mode
Inband IIP3 <sup>2)</sup> $f_1 - f_2 = 1\text{ MHz}$ $P_{f1} = P_{f2} = -37\text{ dBm}$	$IIP3_{HG}$	–	-8	–	dBm	High gain mode
	$IIP3_{LG}$	–	-1	–	dBm	Low gain mode

1) Performance based on application circuit in Figure 4 on Page 21

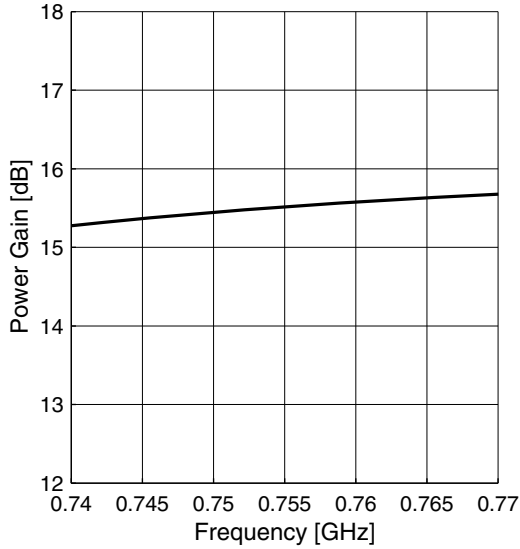
2) Verification based on AQL; not 100% tested in production

3) Guaranteed by device design; not tested in production

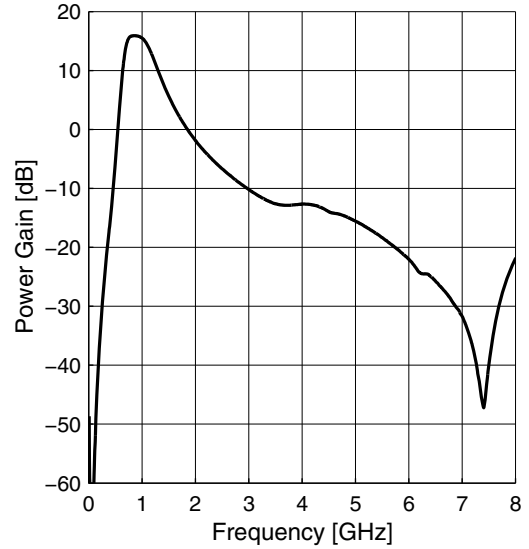
### 2.12 Measured Performance Band XIII High Gain Mode vs. Frequency

$T_A = 25\text{ }^\circ\text{C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $V_{GS} = 2.8\text{ V}$ ,  $V_{EN} = 2.8\text{ V}$ ,  $R_{REF} = 5.6\text{ k}\Omega$

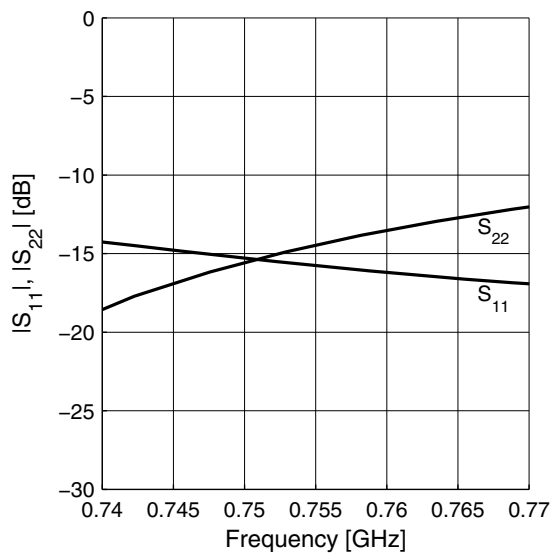
Power Gain  $|S_{21}| = f(f)$



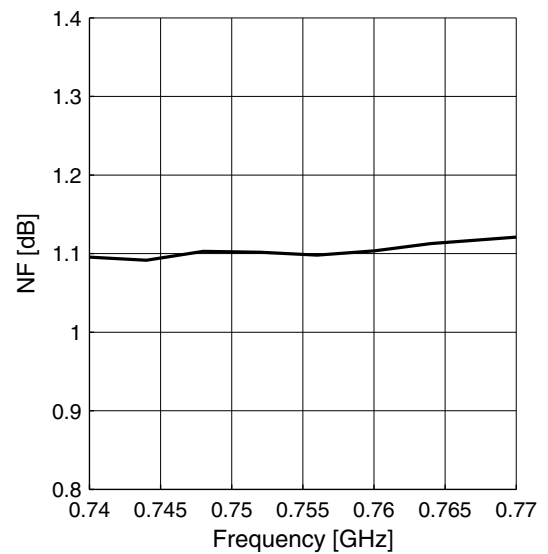
Power Gain wideband  $|S_{21}| = f(f)$



Matching  $|S_{11}| = f(f)$ ,  $|S_{22}| = f(f)$



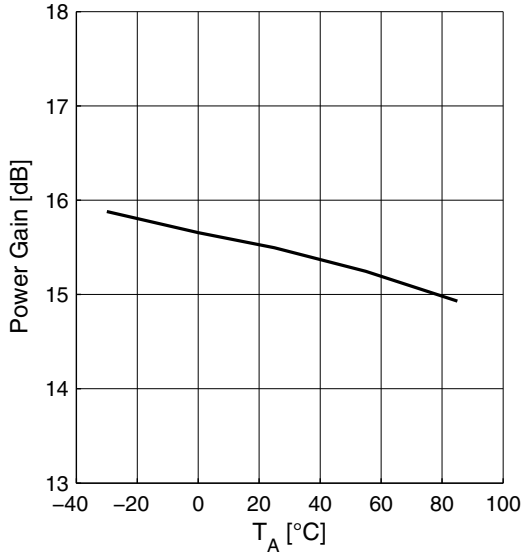
Noise Figure  $NF = f(f)$



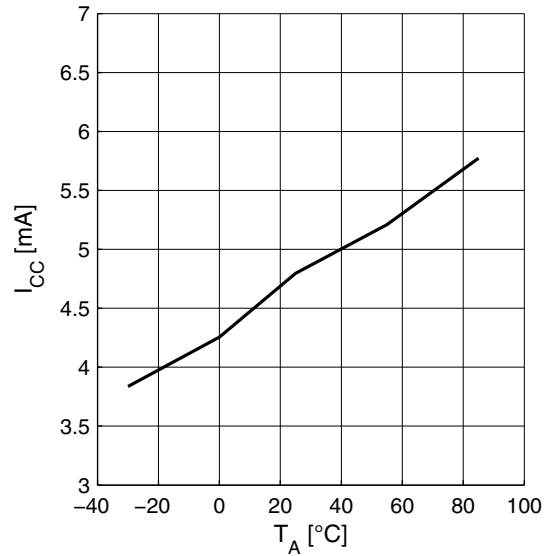
**2.13 Measured Performance Band XIII High Gain Mode vs. Temperature**

$V_{CC} = 2.8\text{ V}$ ,  $V_{GS} = 2.8\text{ V}$ ,  $V_{EN} = 2.8\text{ V}$ ,  $f = 750\text{ MHz}$ ,  $R_{REF} = 5.6\text{ k}\Omega$

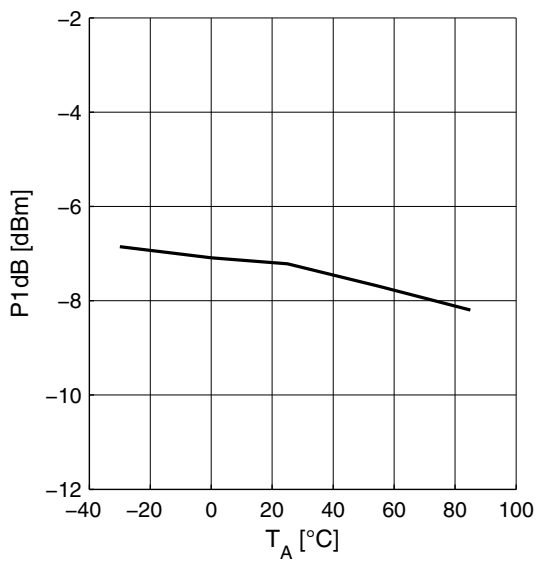
**Power Gain  $|S_{21}| = f(T_A)$**



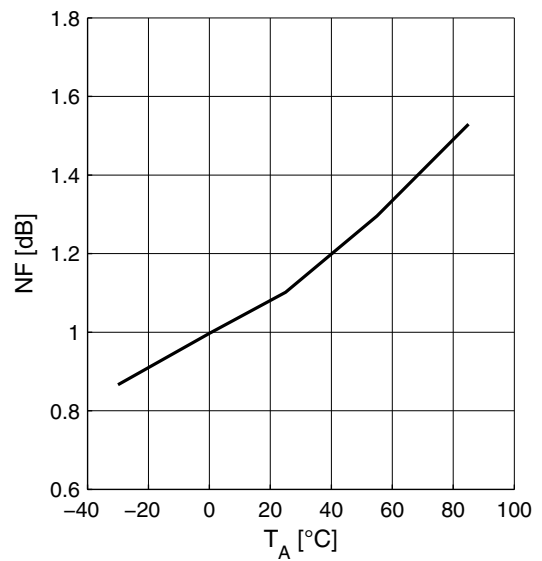
**Supply Current  $I_{CC} = f(T_A)$**



**Input Compression  $P1dB = f(T_A)$**



**Noise Figure  $NF = f(T_A)$**

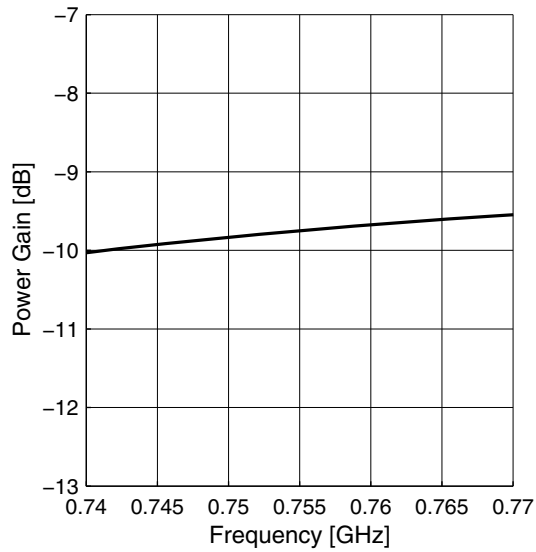




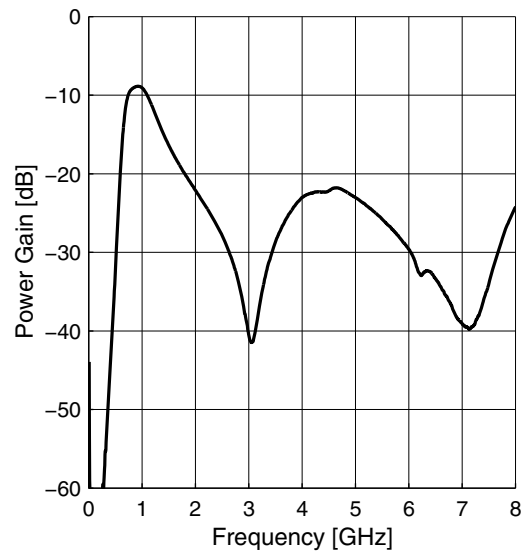
### 2.14 Measured Performance Band XIII Low Gain Mode vs. Frequency

$T_A = 25\text{ }^\circ\text{C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $V_{GS} = 0\text{ V}$ ,  $V_{EN} = 2.8\text{ V}$ ,  $R_{REF} = 5.6\text{ k}\Omega$

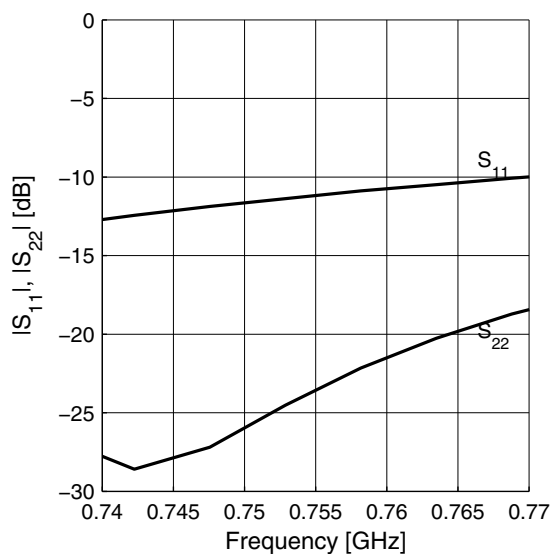
Power Gain  $|S_{21}| = f(f)$



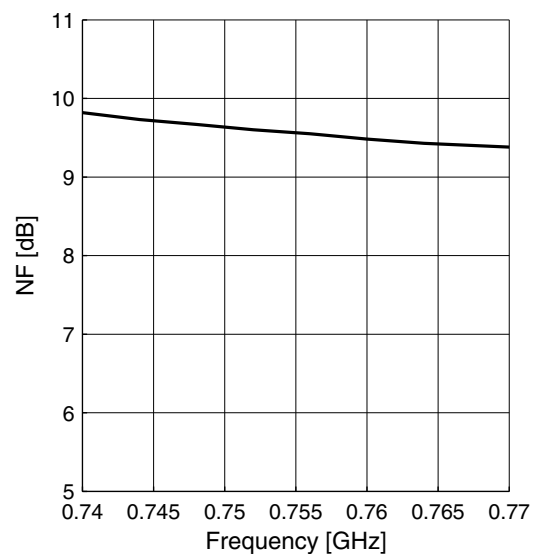
Power Gain wideband  $|S_{21}| = f(f)$



Matching  $|S_{11}| = f(f)$ ,  $|S_{22}| = f(f)$



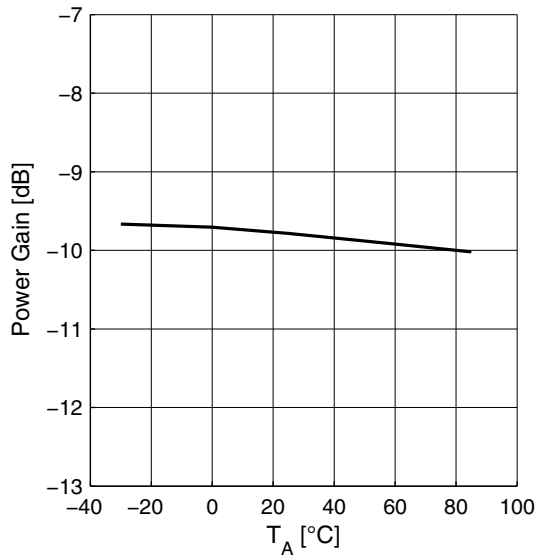
Noise Figure  $NF = f(f)$



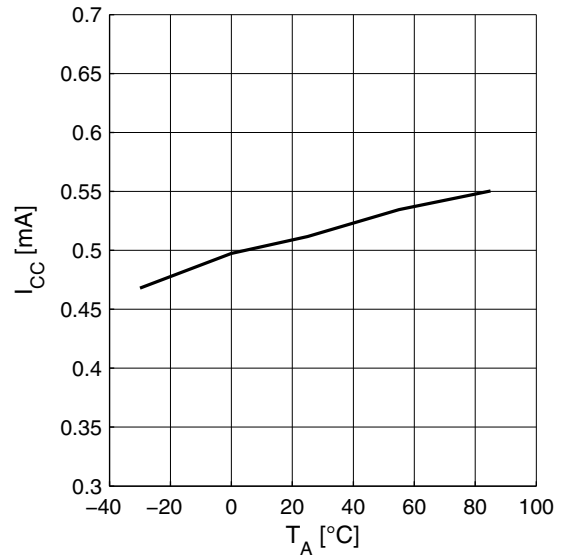
### 2.15 Measured Performance Band XIII Low Gain Mode vs. Temperature

$V_{CC} = 2.8\text{ V}$ ,  $V_{GS} = 0\text{ V}$ ,  $V_{EN} = 2.8\text{ V}$ ,  $f = 750\text{ MHz}$ ,  $R_{REF} = 5.6\text{ k}\Omega$

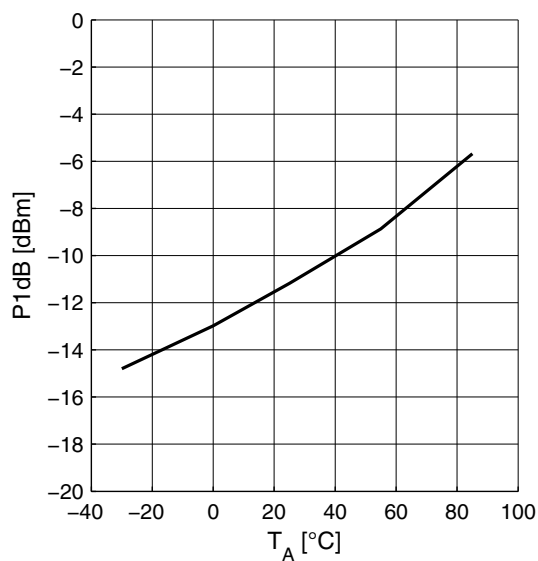
Power Gain  $|S_{21}| = f(T_A)$



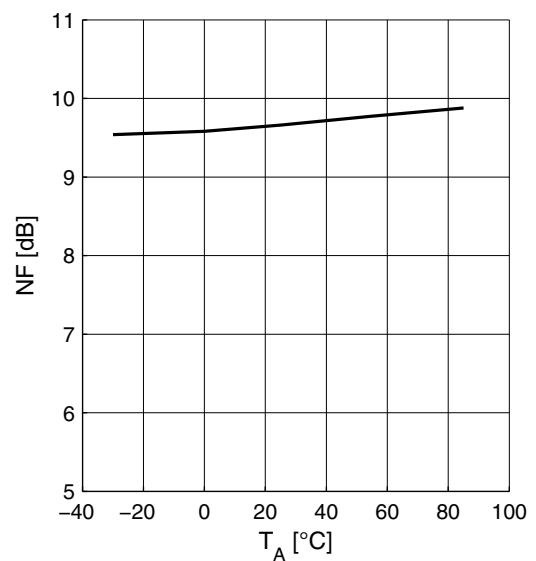
Supply Current  $I_{CC} = f(T_A)$



Input Compression  $P1dB = f(T_A)$

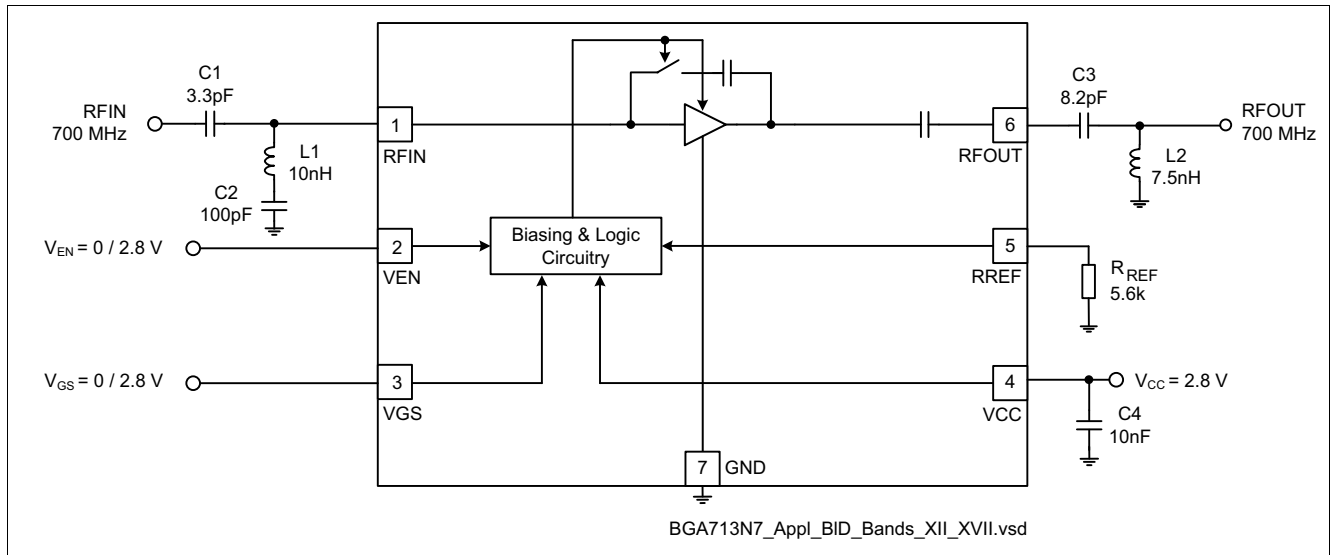


Noise Figure  $NF = f(T_A)$



### 3 Application Circuit and Block Diagram

#### 3.1 UMTS Bands XII and XVII Application Circuit Schematic



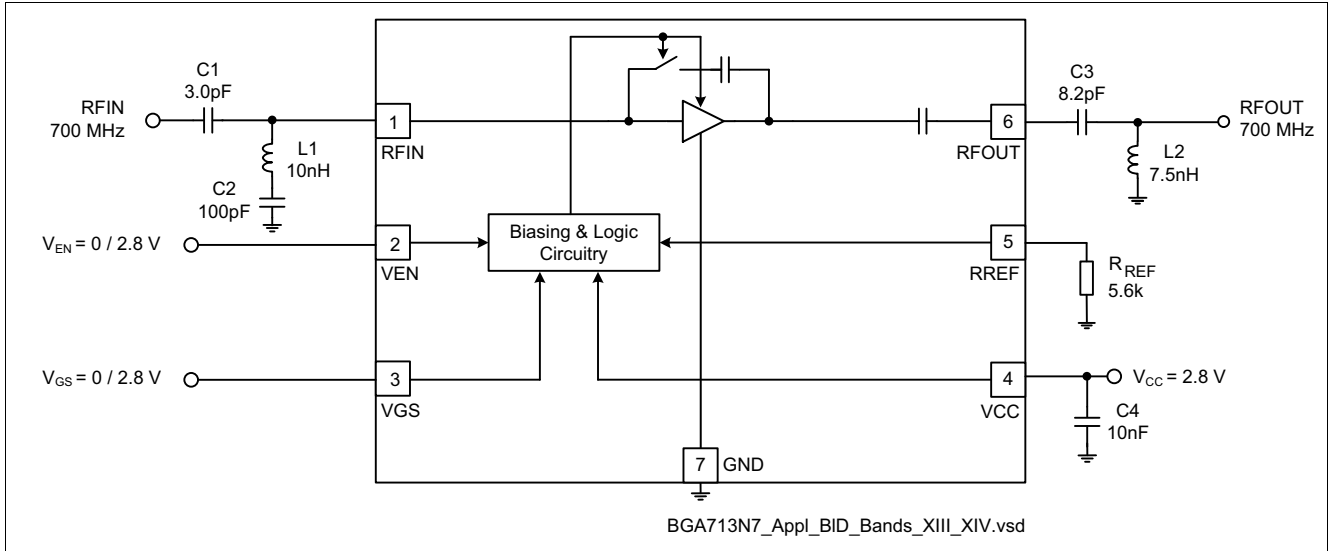
**Figure 2 Application Circuit with Chip Outline (top view)**

*Note: Package paddle (Pin 7) has to be RF grounded.*

**Table 10 Parts List**

Part Number	Part Type	Manufacturer	Size	Comment
L1 ... L2	Chip inductor	Various	0402	Wirewound, Q ≈ 50
C1 ... C4	Chip capacitor	Various	0402	
RREF	Chip resistor	Various	0402	

### 3.2 UMTS Bands XIII and XIV Application Circuit Schematic



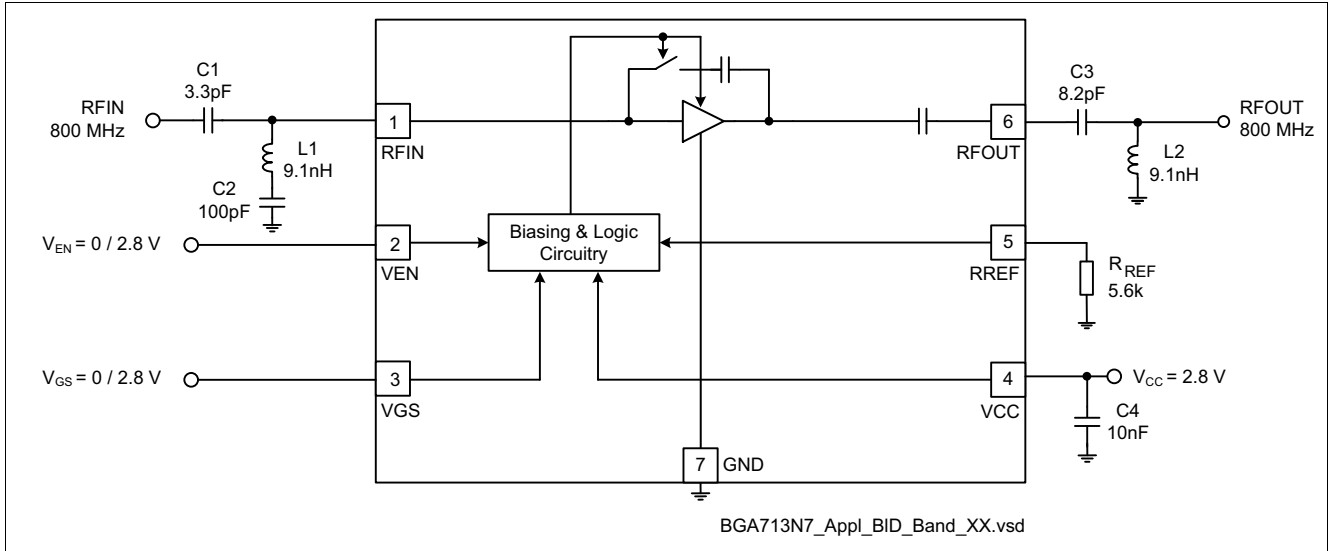
**Figure 3 Application Circuit with Chip Outline (top view)**

*Note: Package paddle (Pin 7) has to be RF grounded.*

**Table 11 Parts List**

Part Number	Part Type	Manufacturer	Size	Comment
L1 ... L2	Chip inductor	Various	0402	Wirewound, $Q \approx 50$
C1 ... C4	Chip capacitor	Various	0402	
RREF	Chip resistor	Various	0402	

### 3.3 UMTS Bands XX Application Circuit Schematic



**Figure 4 Application Circuit with Chip Outline (top view)**

*Note: Package paddle (Pin 7) has to be RF grounded.*

**Table 12 Parts List**

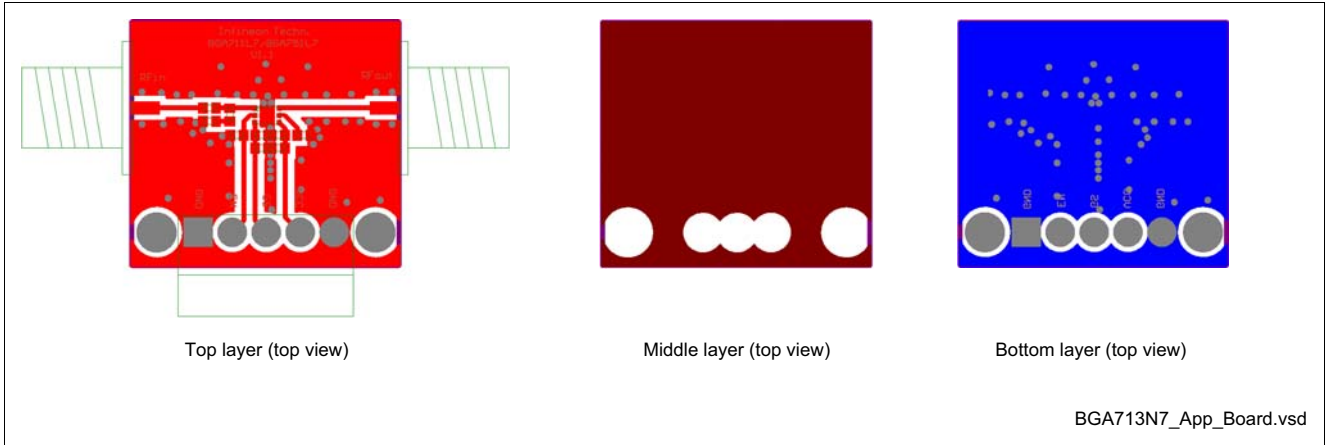
Part Number	Part Type	Manufacturer	Size	Comment
L1 ... L2	Chip inductor	Various	0402	Wirewound, $Q \approx 50$
C1 ... C4	Chip capacitor	Various	0402	
RREF	Chip resistor	Various	0402	

### 3.4 Pin Description

**Table 13 Pin Definition and Function**

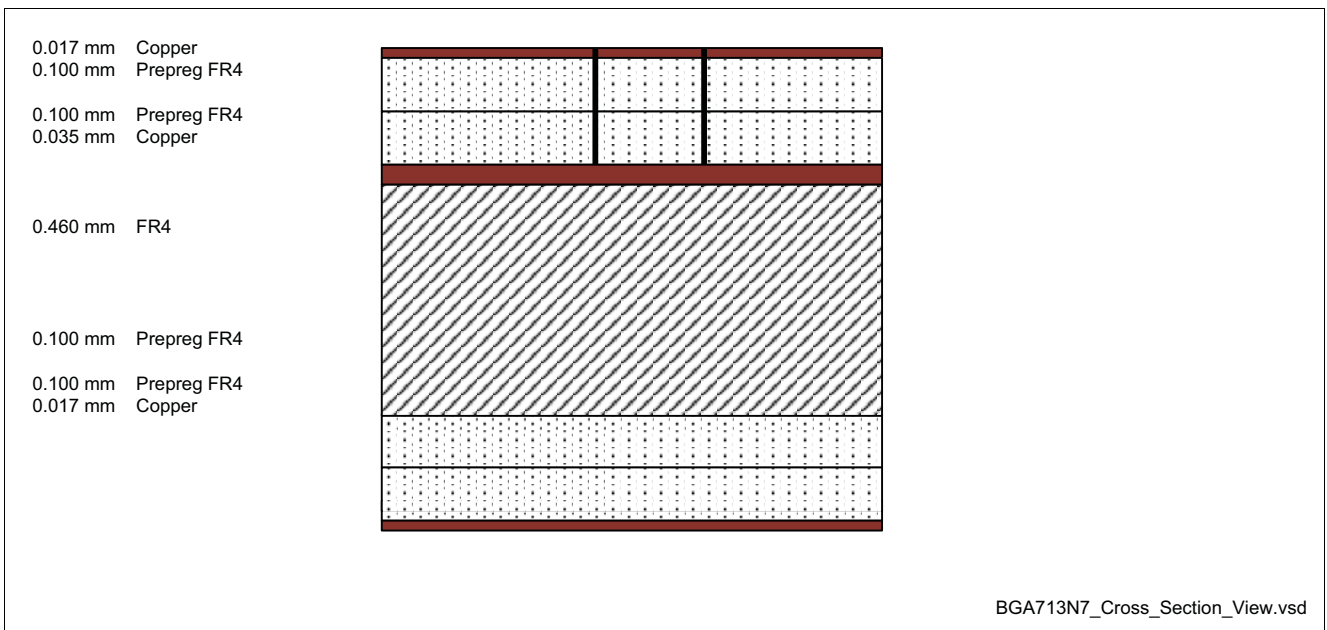
Pin No.	Name	Pin Type	Buffer Type	Function
1	RFIN			LNA input
2	VEN			Band select control
3	VGS			Gain step control
4	VCC			Supply voltage
5	RREF			Bias current reference resistor (high gain mode)
6	RFOUT			LNA output
7	GND			Ground Package paddle; ground connection and control circuitry

### 3.5 Application Board

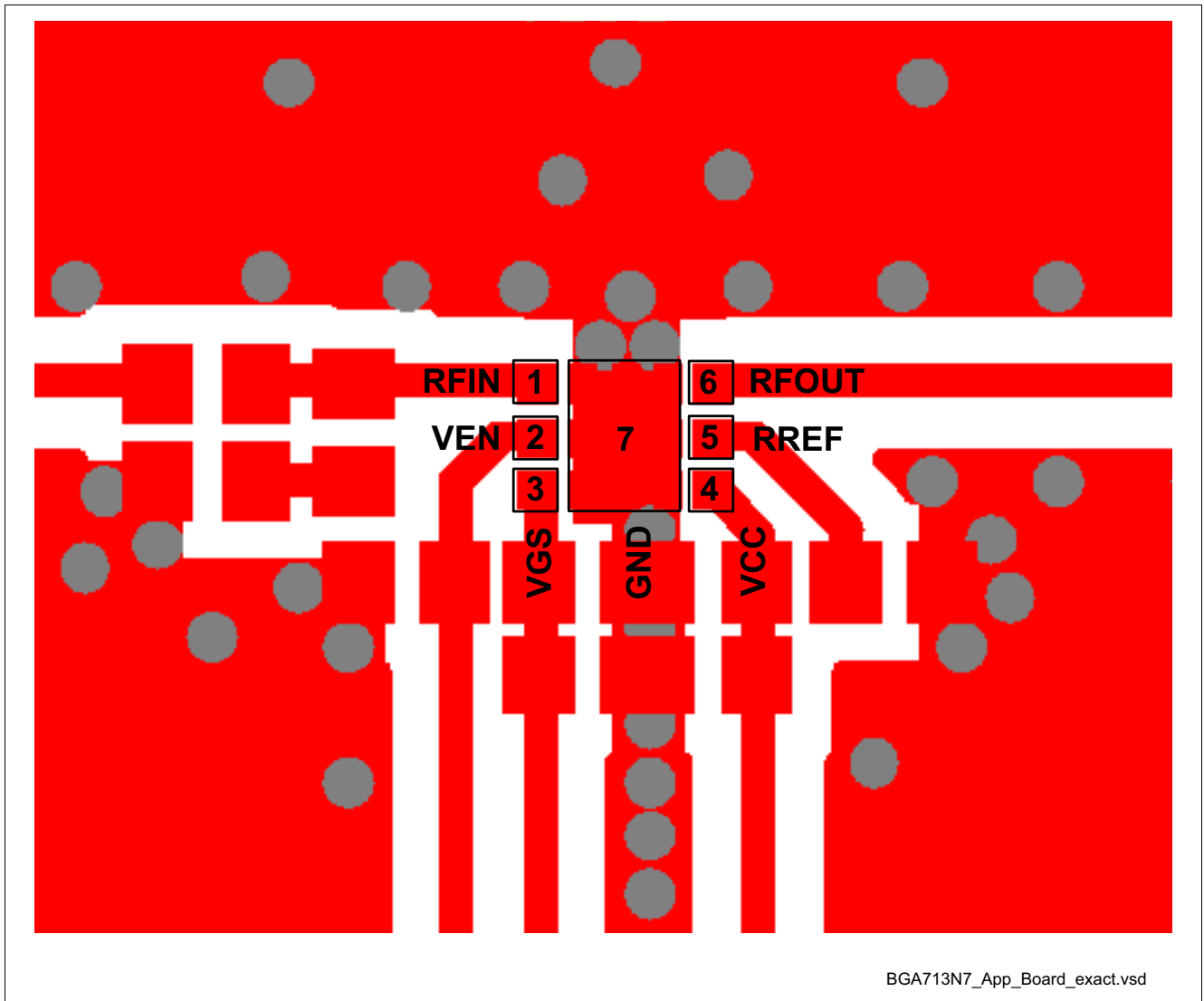


**Figure 5 Application Board Layout on 3-layer FR4**

*Note: Top layer thickness: 0.2 mm, bottom layer thickness: 0.8 mm, 17 mm Cu metallization, gold plated. Board size: 21 x 18 mm.*



**Figure 6 Cross-Section view of Application Board**



**Figure 7** Detail of Application Board Layout

*Note: In order to achieve the same performance as given in this datasheet please follow the suggested PCB-layout as closely as possible. The position of the GND vias is critical for RF performance.*



## 4 Physical Characteristics

### 4.1 Package Footprint

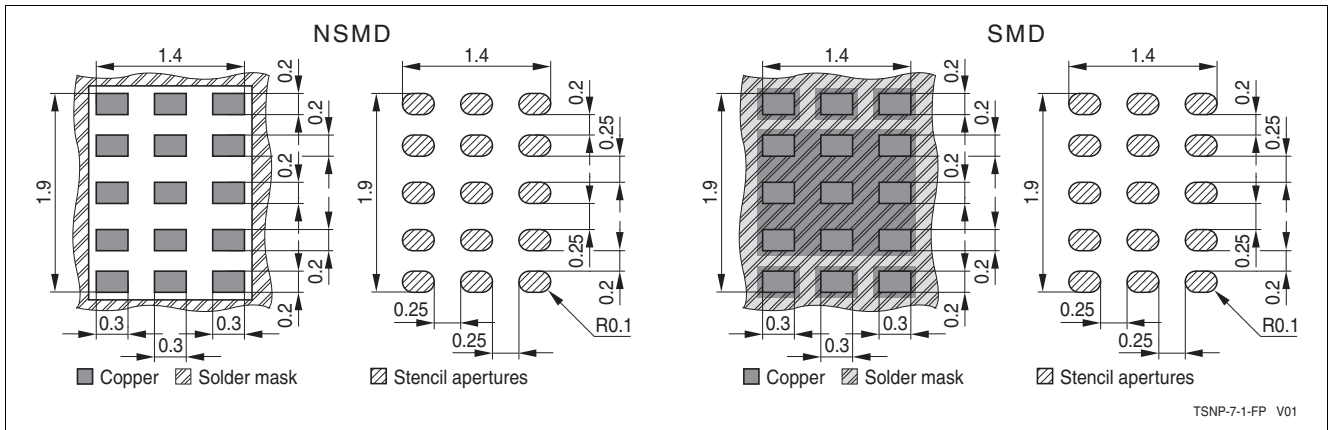


Figure 8 Footprint Recommendation 1 for the TSNP-7-1 Package

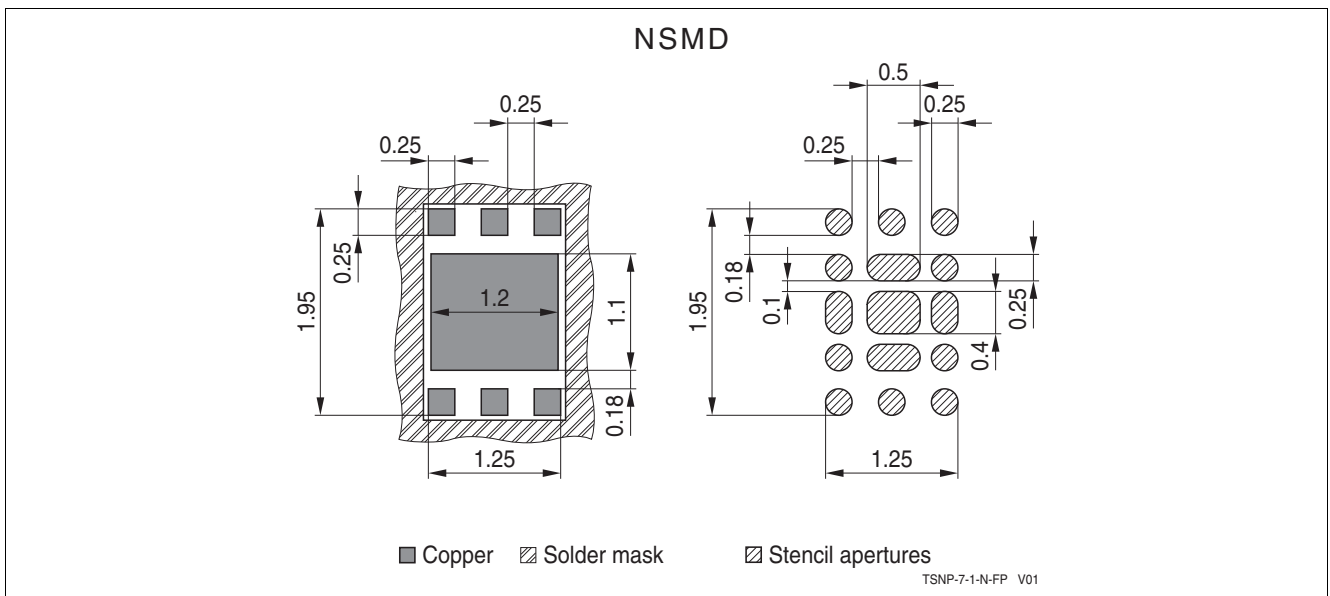
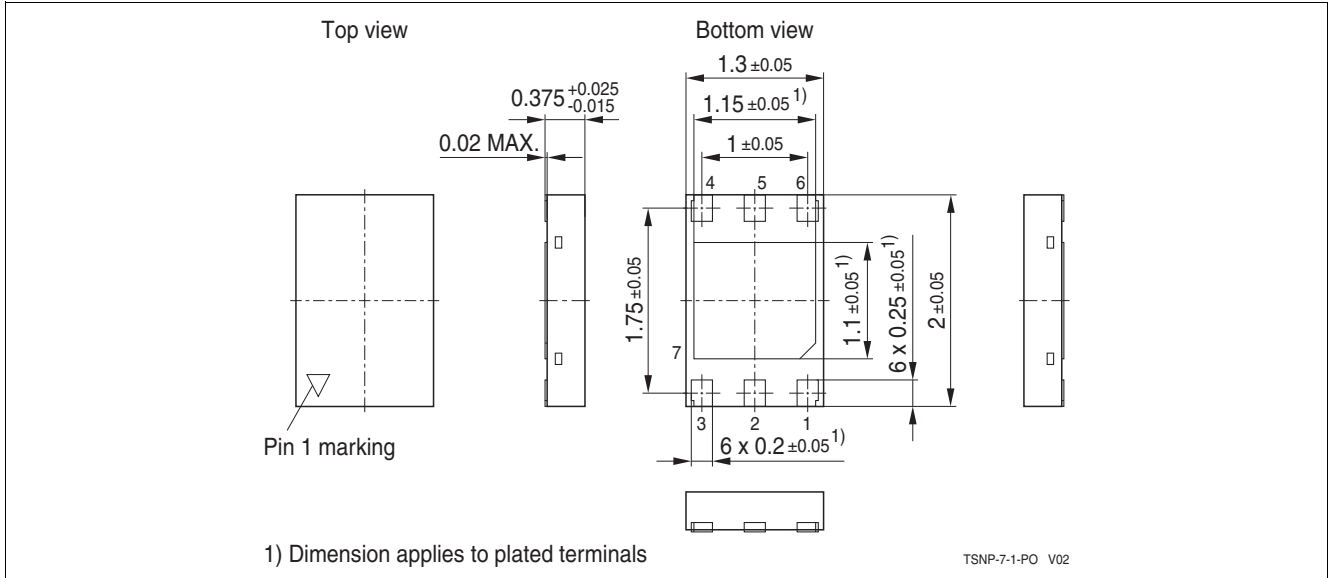
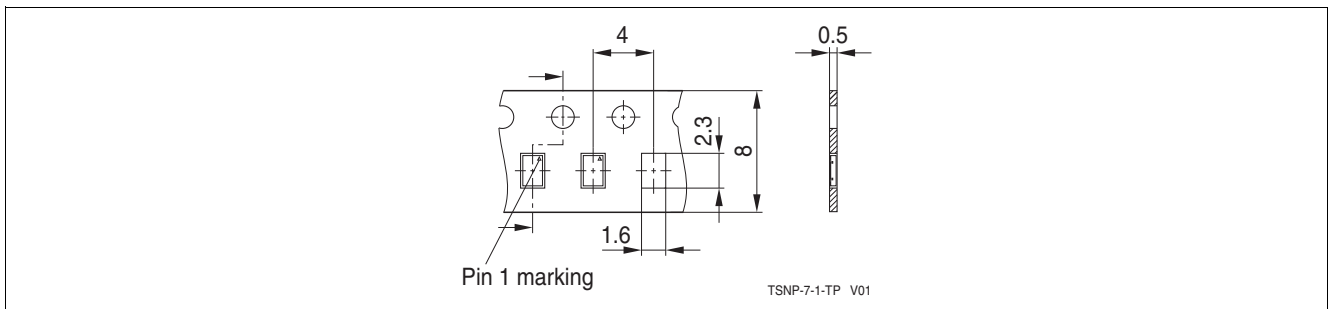


Figure 9 Footprint Recommendation 2 for the TSNP-7-1 Package

## 4.2 Package Dimensions

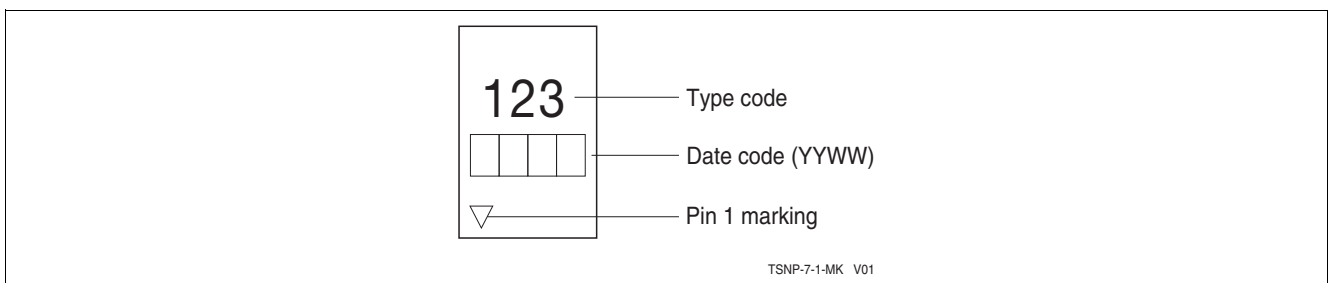


**Figure 10 Package Outline (top, side and bottom view)**



**Figure 11 Tape & Reel Dimensions**

## 4.3 Product Marking Pattern



**Figure 12 Marking Pattern (top view)**

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