

# BGA777L7

Single-Band UMTS LNA  
(2300 - 2700 MHz)

RF & Protection Devices



Never stop thinking

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**BGA777L7****Revision History: 2009-07-02, V3.0****Previous Version: 2009-02-18, V1.0 preliminary**

<b>Page</b>	<b>Subjects (major changes since last revision)</b>
7	Updated DC characteristics (added limits)
8	Added supply current and power gain characteristics
9	Updated RF characteristics for application board BGA7xxL7 and added limits
10, 11	Added RF characteristics for UMTS bands 38 and 40
9-11	Updated footnotes
12-16	Updated measured performance for application board BGA7xxL7
17	Updated application circuit schematic for application board BGA7xxL7
18, 19	Added application circuit schematic for UMTS bands 38 and 40
20, 21	Updated application board

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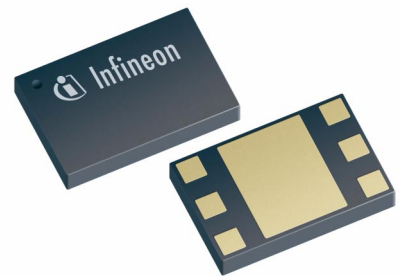
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## 1 Description

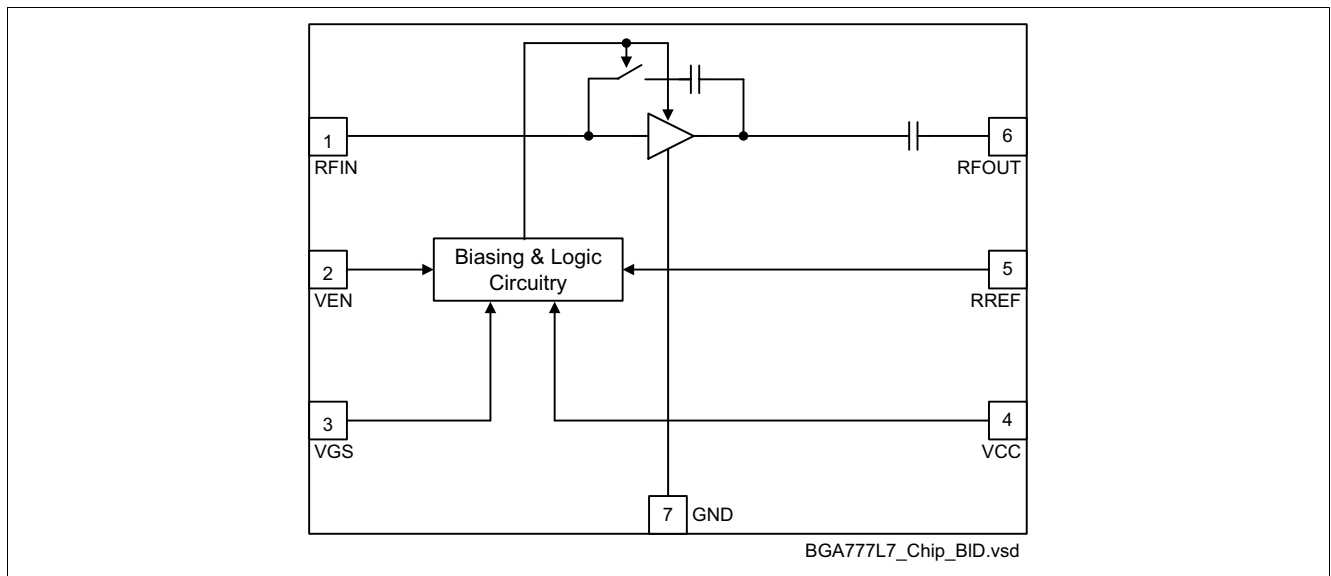
The BGA777L7 is a low current single-band low noise amplifier MMIC for UMTS bands 7, 38 and 40. The LNA is based upon Infineon's proprietary and cost-effective SiGe:C technology and comes in a low profile TSLP-7-1 leadless green package. This document specifies electrical parameters, pinout, application circuit and packaging of the chip. The device features dynamic gain control, temperature stabilization, standby mode and 2 kV ESD protection on-chip as well as matching off chip.

### Features

- Gain: 16 / -7 dB in high / low gain mode
- Noise figure: 1.2 dB in high gain mode
- Supply current: 4.2 / 0.5 mA in high / low gain mode
- Standby mode (< 2  $\mu$ A typ.)
- Inputs pre-matched to 50  $\Omega$
- 2 kV HBM ESD protection
- Low external component count
- Small leadless TSLP-7-1 package (2.0 x 1.3 x 0.39 mm)
- Pb-free (RoHS compliant) package



**TSLP-7-1 package**



**Figure 1 Block diagram of single-band LNA**

Type	Package	Marking	Chip
BGA777L7	TSLP-7-1	B7	T1531

## 2 Electrical Characteristics

### 2.1 Absolute Maximum Ratings

Table 1 Absolute Maximum Ratings

Parameter	Symbol	Values		Unit	Note / Test Condition
		Min.	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 pin
Pin voltage RF Input Pin	$V_{RFIN}$	-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	

### 2.2 Thermal Resistance

Table 2 Thermal Resistance

Parameter	Symbol	Value	Unit	Note / Test Conditions
Thermal resistance junction to soldering point	$R_{thJS}$	240	K/W	

### 2.3 ESD Integrity

Table 3 ESD Integrity

Parameter	Symbol	Value (typ.)	Unit	Note / Test Conditions
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	$I_{CCHG}$		4.2		mA	
Supply current low gain mode	$I_{CCLG}$		530		$\mu\text{A}$	
Supply current standby mode	$I_{CCOFF}$		0.1	2.0	$\mu\text{A}$	
Logic level high	$V_{HI}$	1.5	2.8		V	VEN and VGS
Logic level low	$V_{LO}$	-0.2	0.0	0.5	V	
Logic currents VEN	$I_{ENL}$			0.1	$\mu\text{A}$	VEN
	$I_{ENH}$		5.0	6.0	$\mu\text{A}$	
Logic currents VGS	$I_{GSL}$			0.1	$\mu\text{A}$	VGS
	$I_{GSH}$		5.0	6.0	$\mu\text{A}$	

## 2.5 Gain Mode Select Truth Table

**Table 5 Truth Table**

Control Voltage		State	
		Bands 7, 38, 40	
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. Details see section 2.4.

## 2.6 Switching Times

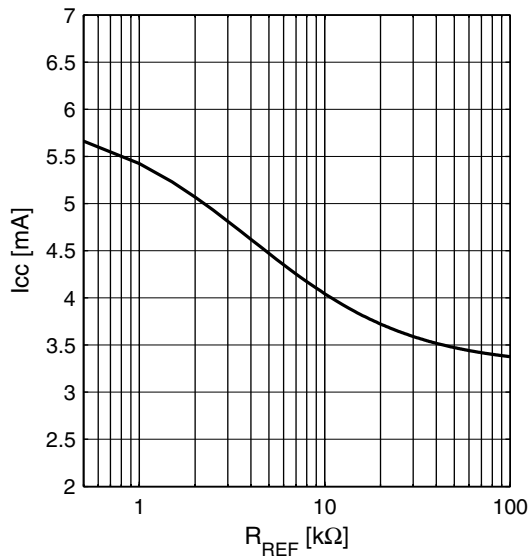
**Table 6 Typical switching times;  $T_A = -30 \dots 85\text{ °C}$**

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

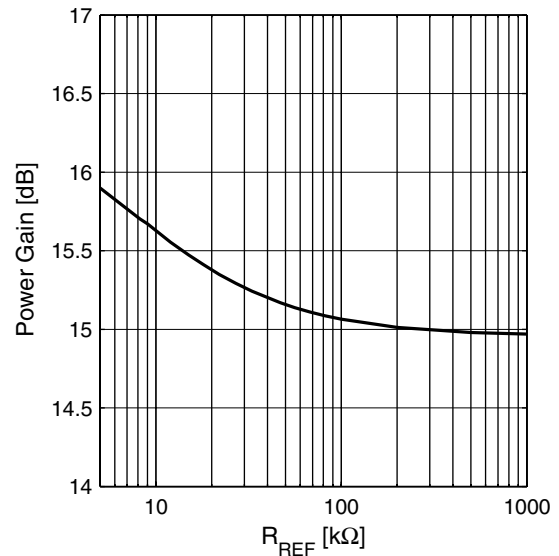
## 2.7 Supply Current and Power Gain Characteristics; $T_A = 25\text{ }^\circ\text{C}$

Supply current and power gain high gain mode versus reference resistor  $R_{REF}$  (see Figure 2 on page 17 for reference resistor; low gain mode supply current is independent of reference resistor).

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



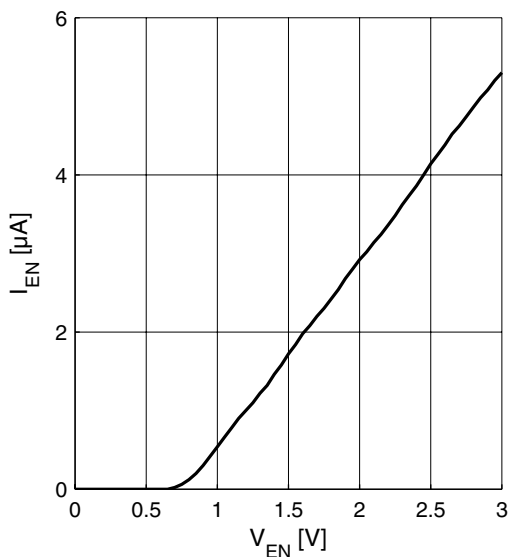
**Power Gain**  $|S_{21}| = f(R_{REF})$   
 $V_{CC} = 2.8\text{ V}$



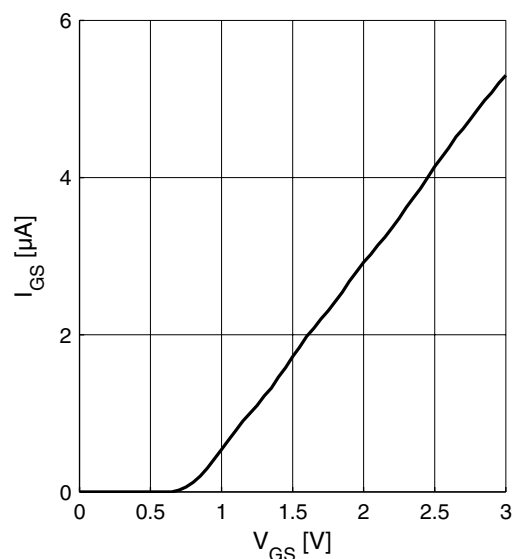
## 2.8 Logic Signal Characteristics; $T_A = 25\text{ }^\circ\text{C}$

Current consumption of logic inputs  $V_{EN}$ ,  $V_{GS}$

**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 Band 7

**Table 7 Typical Characteristics 2650 MHz Band  $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^1$**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Pass band range band I		2620		2690	MHz	
Current consumption	$I_{CCHG}$		4.2	4.9	mA	High gain mode
	$I_{CCLG}$		0.5	0.8	mA	Low gain mode
Gain	$S_{21HG}$	14.4	15.7	17.0	dB	High gain mode
	$S_{21LG}$	-9.6	-7.1	-4.1	dB	Low gain mode
Reverse Isolation <sup>2)</sup>	$S_{12HG}$		-34		dB	High gain mode
	$S_{12LG}$		-7		dB	Low gain mode
Noise figure	$NF_{HG}$		1.2	1.7	dB	High gain mode
	$NF_{LG}$		6.8		dB	Low gain mode
Input return loss <sup>2)</sup>	$S_{11HG}$		-20		dB	50 $\Omega$ , high gain mode
	$S_{11LG}$		-10		dB	50 $\Omega$ , low gain mode
Output return loss <sup>2)</sup>	$S_{22HG}$		-20		dB	50 $\Omega$ , high gain mode
	$S_{22LG}$		-11		dB	50 $\Omega$ , low gain mode
Stability factor <sup>3)</sup>	$k$		>2.3			DC to 10 GHz; all gain modes
Input compression point <sup>2)</sup>	$IP_{1dBHG}$		-10		dBm	High gain mode
	$IP_{1dB LG}$		-2		dBm	Low gain mode
Inband IIP3 <sup>2)</sup> $f_1 - f_2 = 1\text{ MHz}$ $P_{f1} = P_{f2} = -37\text{ dBm}$	$IIP3_{HG}$		-2		dBm	High gain mode
	$IIP3_{LG}$		7			Low gain mode

1) Performance based on application circuit in Figure 2 on page 17

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

3) Guaranteed by device design; not tested in production

## 2.10 Measured RF Characteristics UMTS Band 38

**Table 8** Typical Characteristics 2600 MHz Band  $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^1$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Pass band range band I		2570		2620	MHz	
Current consumption	$I_{CCHG}$		4.2		mA	High gain mode
	$I_{CCLG}$		0.5		mA	Low gain mode
Gain	$S_{21HG}$		15.5		dB	High gain mode
	$S_{21LG}$		-6.9		dB	Low gain mode
Reverse Isolation <sup>2)</sup>	$S_{12HG}$		-34		dB	High gain mode
	$S_{12LG}$		-7		dB	Low gain mode
Noise figure	$NF_{HG}$		1.2		dB	High gain mode
	$NF_{LG}$		6.8		dB	Low gain mode
Input return loss <sup>2)</sup>	$S_{11HG}$		-15		dB	50 $\Omega$ , high gain mode
	$S_{11LG}$		-11		dB	50 $\Omega$ , low gain mode
Output return loss <sup>2)</sup>	$S_{22HG}$		-15		dB	50 $\Omega$ , high gain mode
	$S_{22LG}$		-13		dB	50 $\Omega$ , low gain mode
Stability factor <sup>3)</sup>	$k$		>2.3			DC to 10 GHz; all gain modes
Input compression point <sup>2)</sup>	$IP_{1dBHG}$		-10		dBm	High gain mode
	$IP_{1dB LG}$		-2		dBm	Low gain mode
Inband IIP3 <sup>2)</sup> $f_1 - f_2 = 1\text{ MHz}$ $P_{f1} = P_{f2} = -37\text{ dBm}$	$IIP3_{HG}$		-2		dBm	High gain mode
	$IIP3_{LG}$		7			Low gain mode

1) Performance based on application circuit in Figure 3 on page 18

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

3) Guaranteed by device design; not tested in production

## 2.11 Measured RF Characteristics UMTS Band 40

**Table 9** Typical Characteristics 2300 MHz Band  $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{1)}$

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Pass band range band I		2300		2400	MHz	
Current consumption	$I_{CCHG}$		4.2		mA	High gain mode
	$I_{CCLG}$		0.5		mA	Low gain mode
Gain	$S_{21HG}$		16.8		dB	High gain mode
	$S_{21LG}$		-7.2		dB	Low gain mode
Reverse Isolation <sup>2)</sup>	$S_{12HG}$		-35		dB	High gain mode
	$S_{12LG}$		-7		dB	Low gain mode
Noise figure	$NF_{HG}$		1.2		dB	High gain mode
	$NF_{LG}$		7.0		dB	Low gain mode
Input return loss <sup>2)</sup>	$S_{11HG}$		-23		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
	$S_{22LG}$		-12		dB	50 $\Omega$ , low gain mode
Stability factor <sup>3)</sup>	$k$		>2.3			DC to 10 GHz; all gain modes
Input compression point <sup>2)</sup>	$IP_{1dBHG}$		-11		dBm	High gain mode
	$IP_{1dB LG}$		-2		dBm	Low gain mode
Inband IIP3 <sup>2)</sup> $f_1 - f_2 = 1\text{ MHz}$ $P_{f1} = P_{f2} = -37\text{ dBm}$	$IIP3_{HG}$		-2		dBm	High gain mode
	$IIP3_{LG}$		8			Low gain mode

1) Performance based on application circuit in Figure 4 on page 19

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

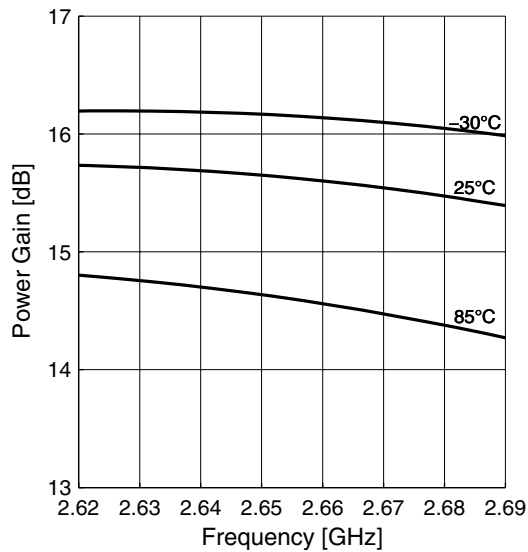
3) Guaranteed by device design; not tested in production

Measured Performance Band 7 Application High Gain Mode vs. Frequency

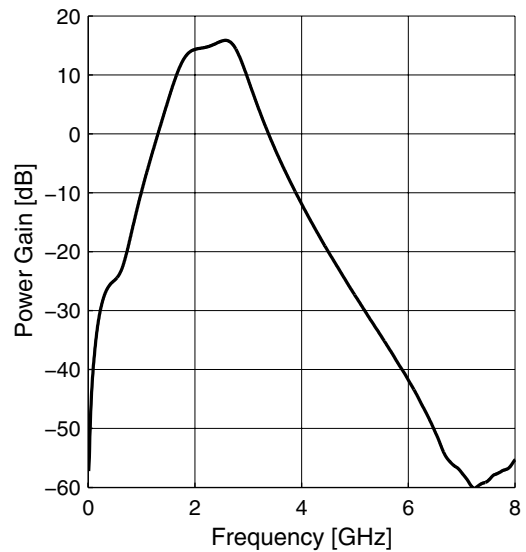
2.12 Measured Performance Band 7 Application High Gain Mode vs. Frequency

$T_A = 25\text{ }^\circ\text{C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $V_{GS} = 2.8\text{ V}$ ,  $V_{EN} = 2.8\text{ V}$

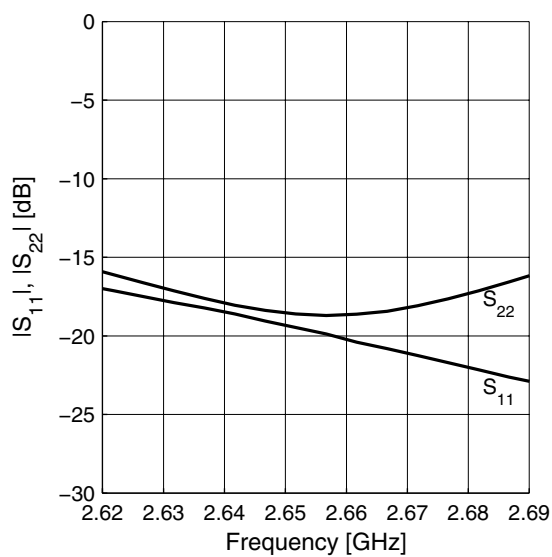
Power Gain  $|S_{21}| = f(f)$



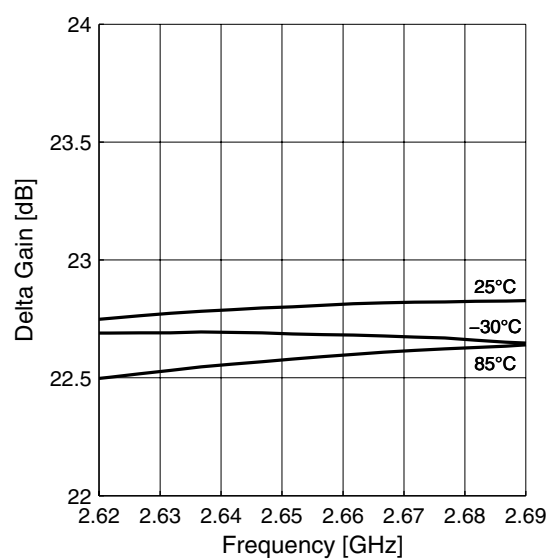
Power Gain Wideband  $|S_{21}| = f(f)$



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

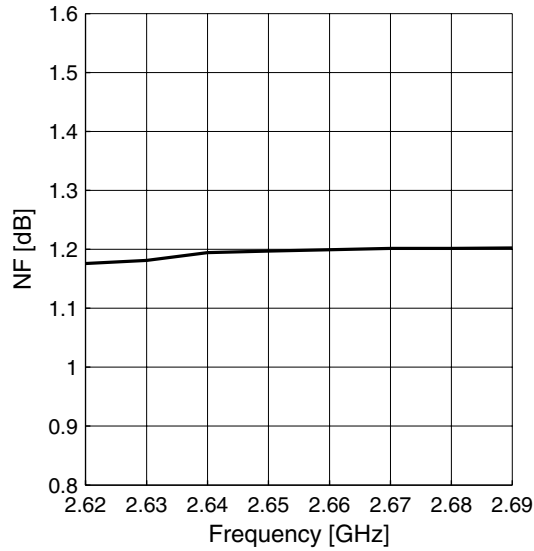


Gainstep HG-LG  $|\Delta S_{21}| = f(f)$

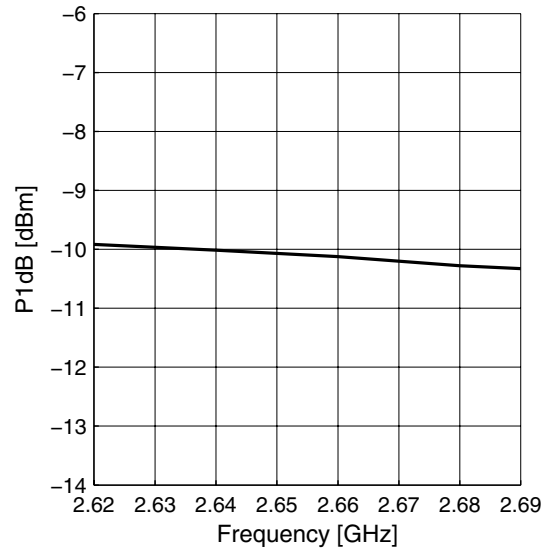


**Measured Performance Band 7 Application High Gain Mode vs. Temperature**

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



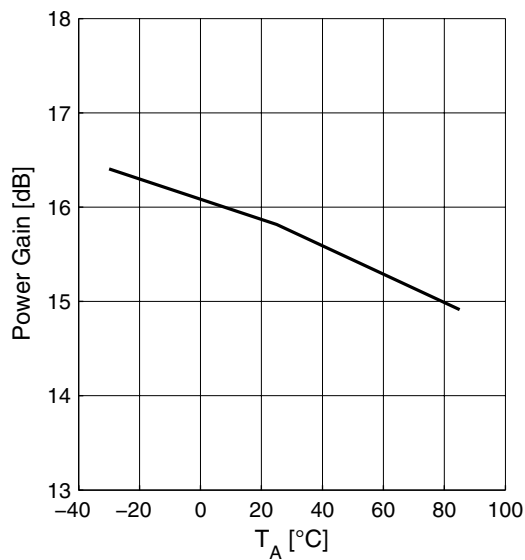
**Input Compression  $P1dB = f(f)$**



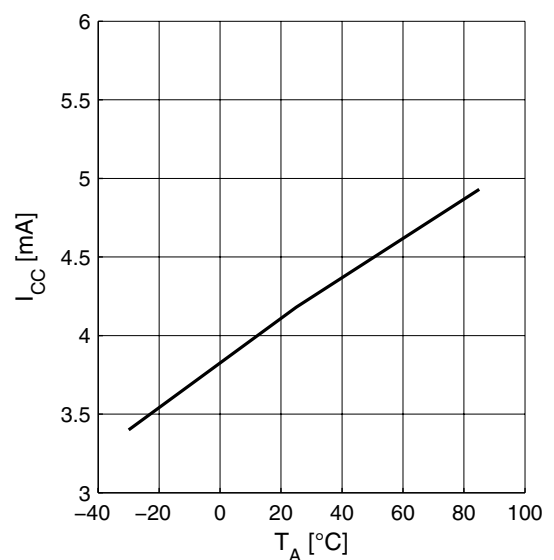
**2.13 Measured Performance Band 7 Application High Gain Mode vs. Temperature**

$V_{CC} = 2.8 \text{ V}$ ,  $V_{GS} = 2.8 \text{ V}$ ,  $V_{EN} = 2.8 \text{ V}$ ,  $f = 2650 \text{ MHz}$

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

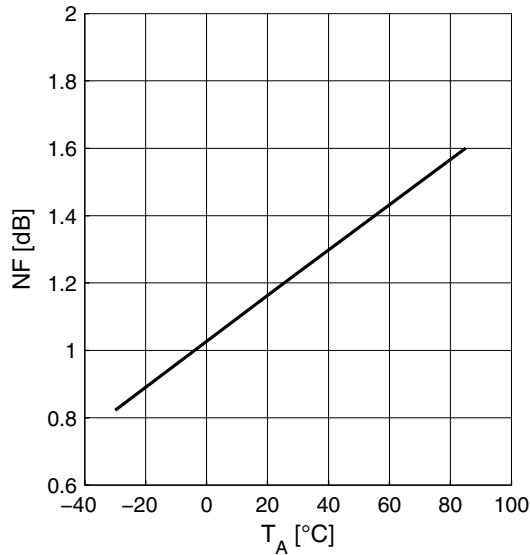


**Supply Current  $I_{CC} = f(T_A)$**

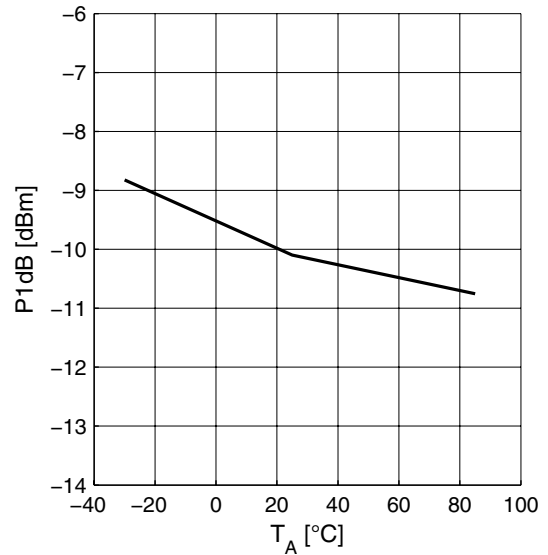


**Measured Performance Band 7 Application Low Gain Mode vs. Frequency**

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



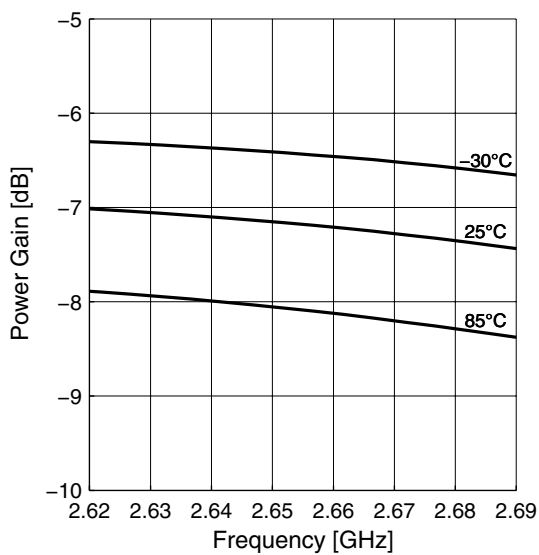
**Input Compression  $P1dB = f(T_A)$**



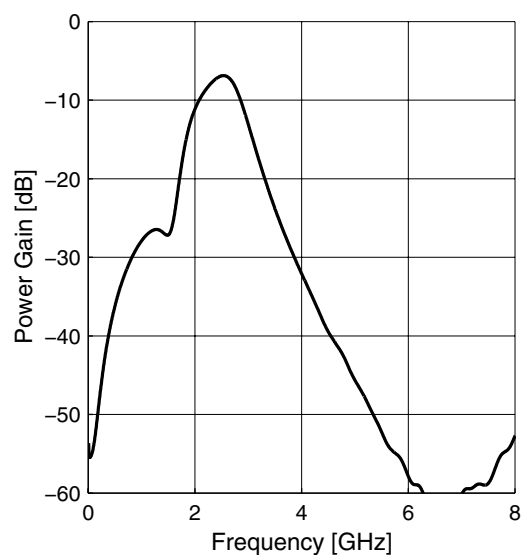
**2.14 Measured Performance Band 7 Application Low Gain Mode vs. Frequency**

$T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $V_{GS} = 0\text{ V}$ ,  $V_{EN} = 2.8\text{ V}$

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

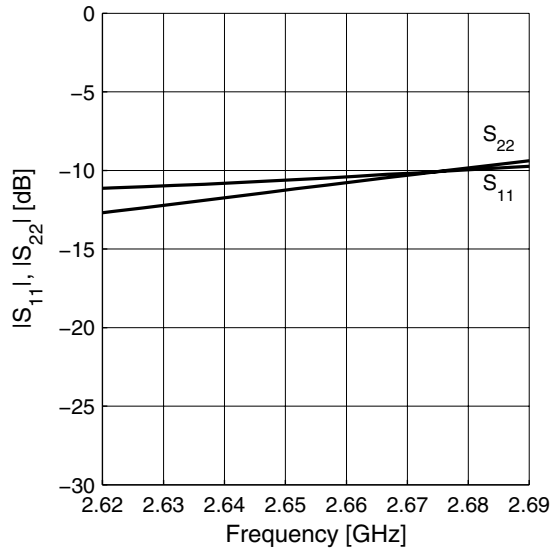


**Power Gain Wideband  $|S_{21}| = f(f)$**

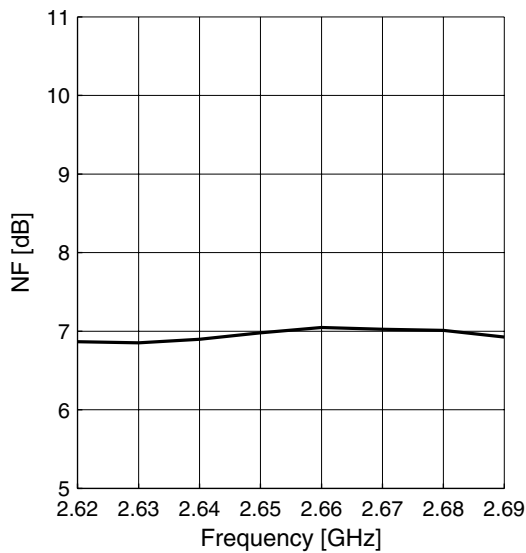


**Measured Performance Band 7 Application Low Gain Mode vs. Frequency**

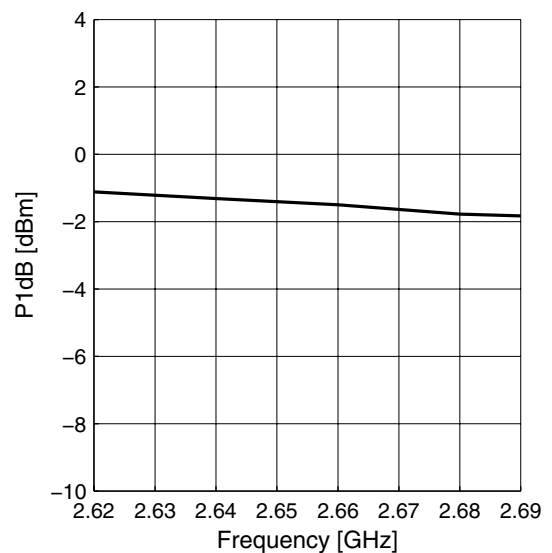
**Matching**  $|S_{11}| = f(f)$ ,  $|S_{22}| = f(f)$



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



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

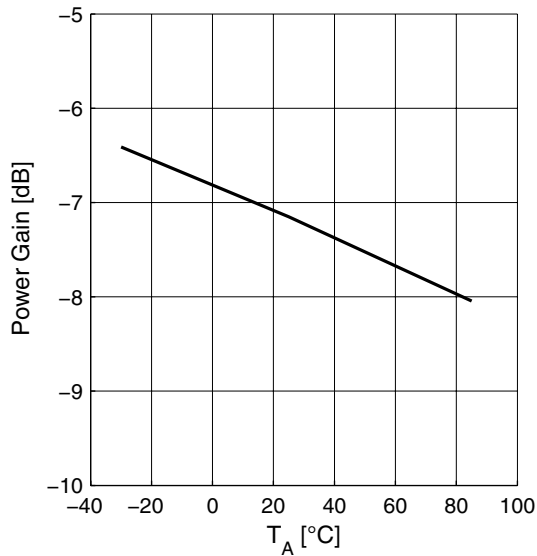


Measured Performance Band 7 Application Low Gain Mode vs. Temperature

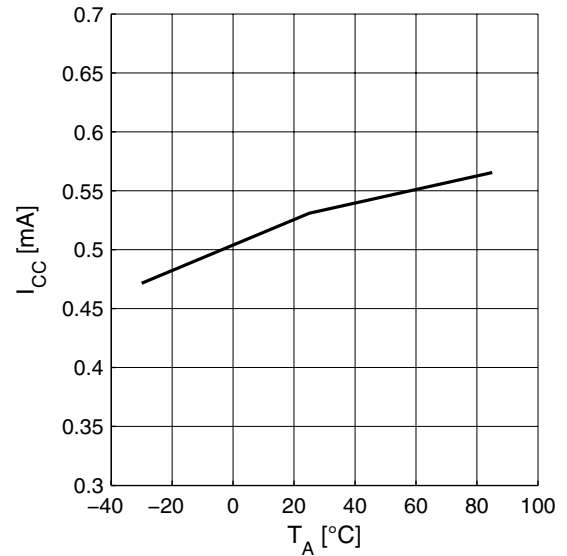
2.15 Measured Performance Band 7 Application Low Gain Mode vs. Temperature

$V_{CC} = 2.8\text{ V}$ ,  $V_{GS} = 0\text{ V}$ ,  $V_{EN} = 2.8\text{ V}$ ,  $f = 2650\text{ MHz}$

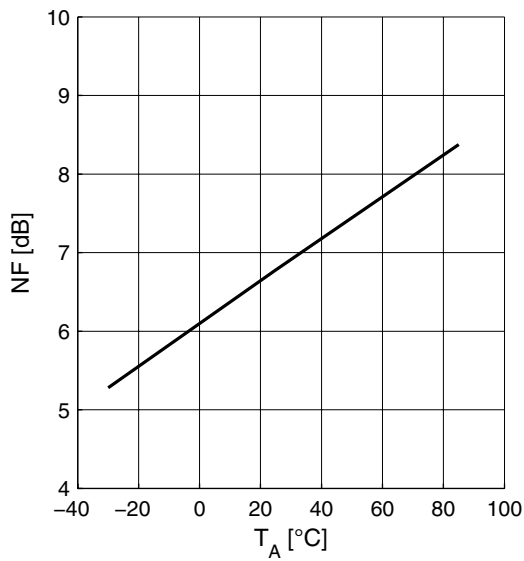
Power Gain  $|S_{21}| = f(T_A)$



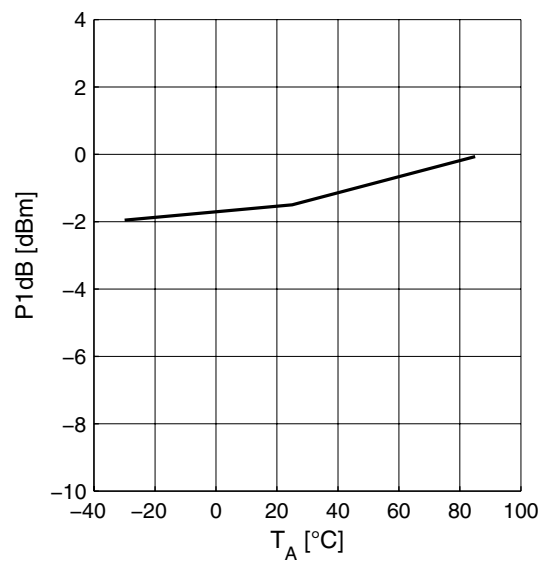
Supply Current  $I_{CC} = f(T_A)$



Noise Figure  $NF = f(T_A)$



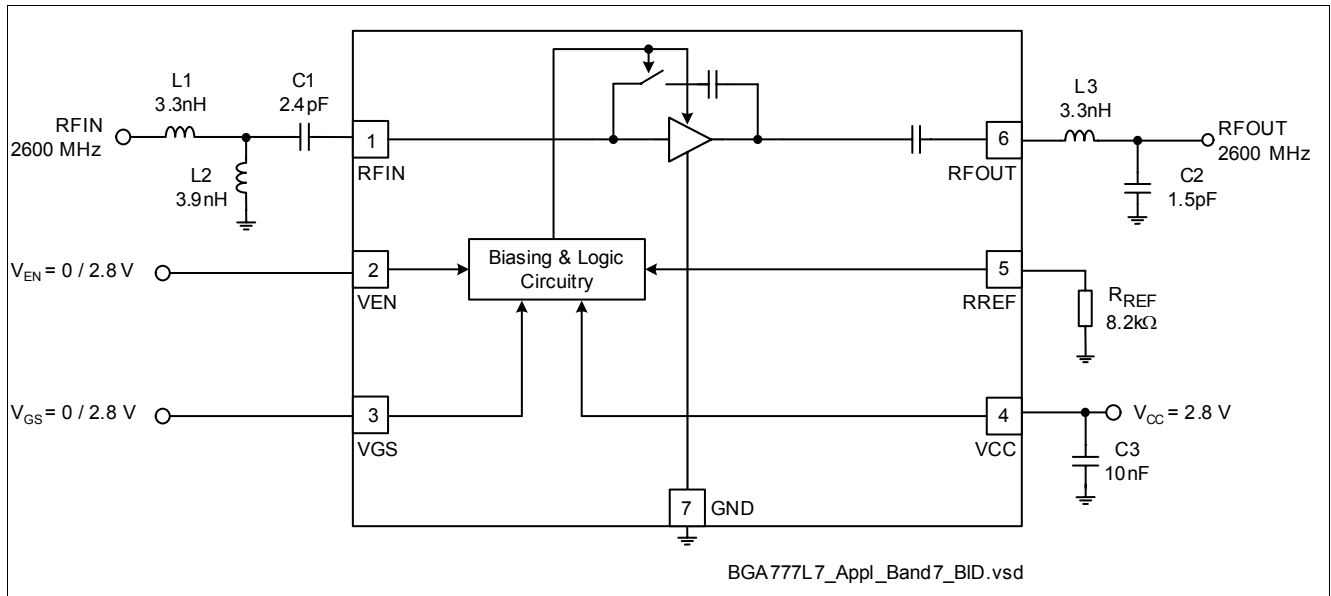
Input Compression  $P1dB = f(T_A)$





### 3 Application Circuit and Block Diagram

#### 3.1 UMTS Band 7 Application Circuit Schematic



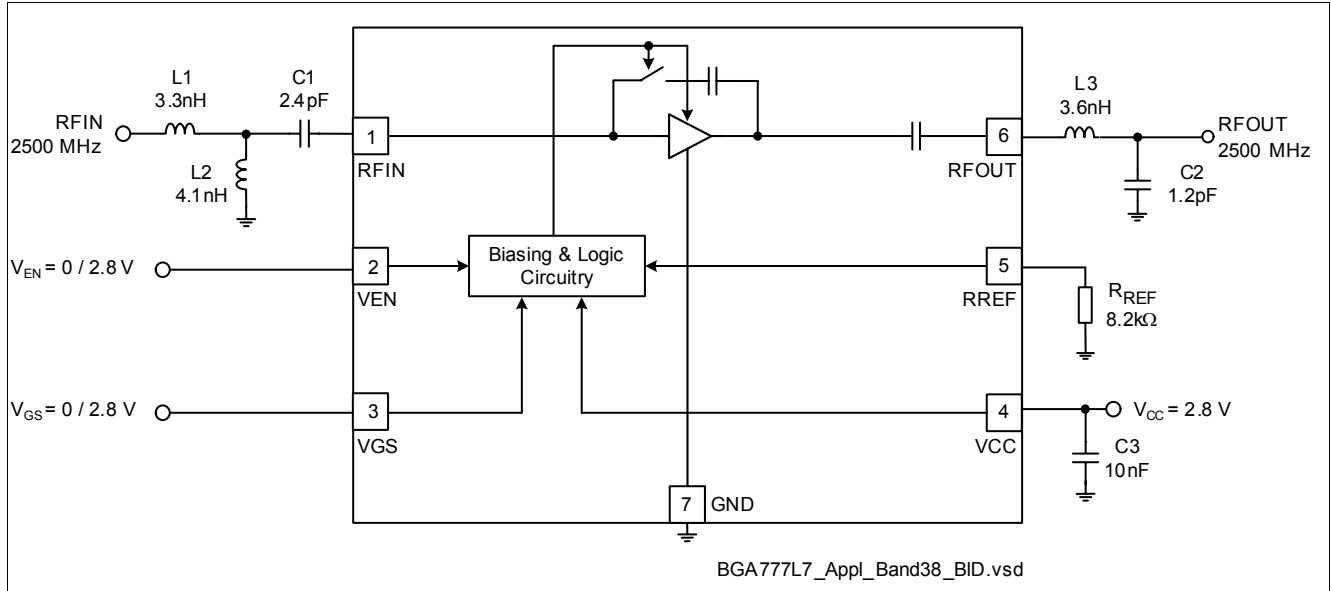
**Figure 2 Application circuit with chip outline (top view)**

*Note: Package paddle (Pin 0) has to be RF grounded.*

**Table 10 Parts List**

Part Number	Part Type	Manufacturer	Size	Comment
L1 ... L3	Chip inductor	Various	0402	Wirewound, $Q \approx 50$
C1 ... C3	Chip capacitor	Various	0402	
RREF	Chip resistor	Various	0402	

### 3.2 UMTS Band 38 Application Circuit Schematic



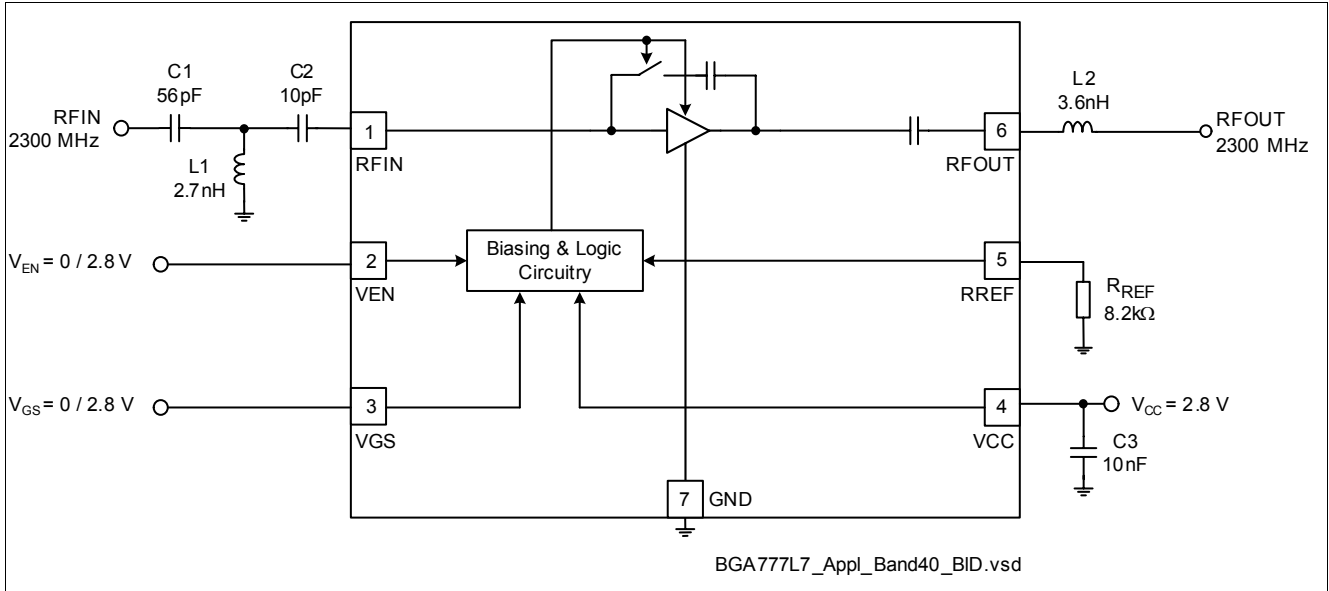
**Figure 3 Application circuit with chip outline (top view)**

*Note: Package paddle (Pin 0) has to be RF grounded.*

**Table 11 Parts List**

Part Number	Part Type	Manufacturer	Size	Comment
L1 ... L3	Chip inductor	Various	0402	Wirewound, Q ≈ 50
C1 ... C3	Chip capacitor	Various	0402	
RREF	Chip resistor	Various	0402	

### 3.3 UMTS Band 40 Application Circuit Schematic



**Figure 4 Application circuit with chip outline (top view)**

*Note: Package paddle (Pin 0) has to be RF grounded.*

**Table 12 Parts List**

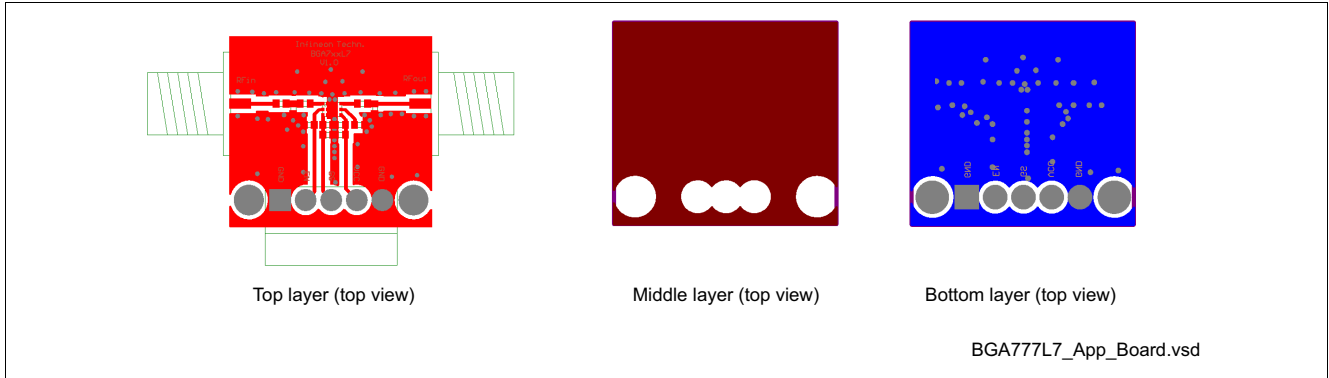
Part Number	Part Type	Manufacturer	Size	Comment
L1 ... L2	Chip inductor	Various	0402	Wirewound, $Q \approx 50$
C1 ... C3	Chip capacitor	Various	0402	
RREF	Chip resistor	Various	0402	

### 3.4 Pin Definition

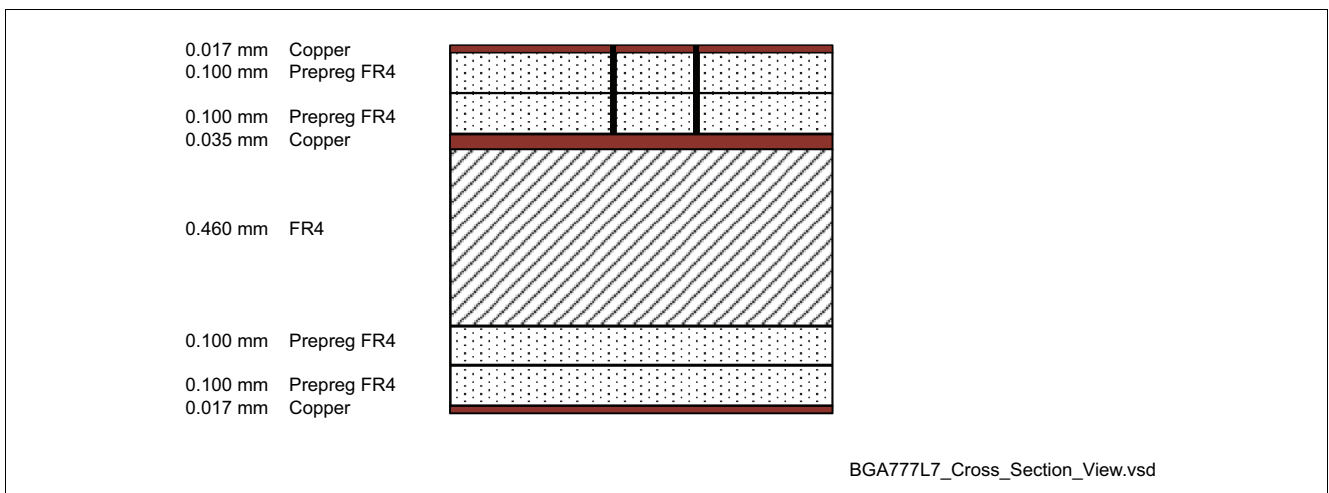
**Table 13 Pin Definition and Function**

Pin Number	Symbol	Function
1	RFIN	LNA input (2600 MHz)
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 (2600 MHz)
7	GND	Package paddle; ground connection for LNA and control circuitry

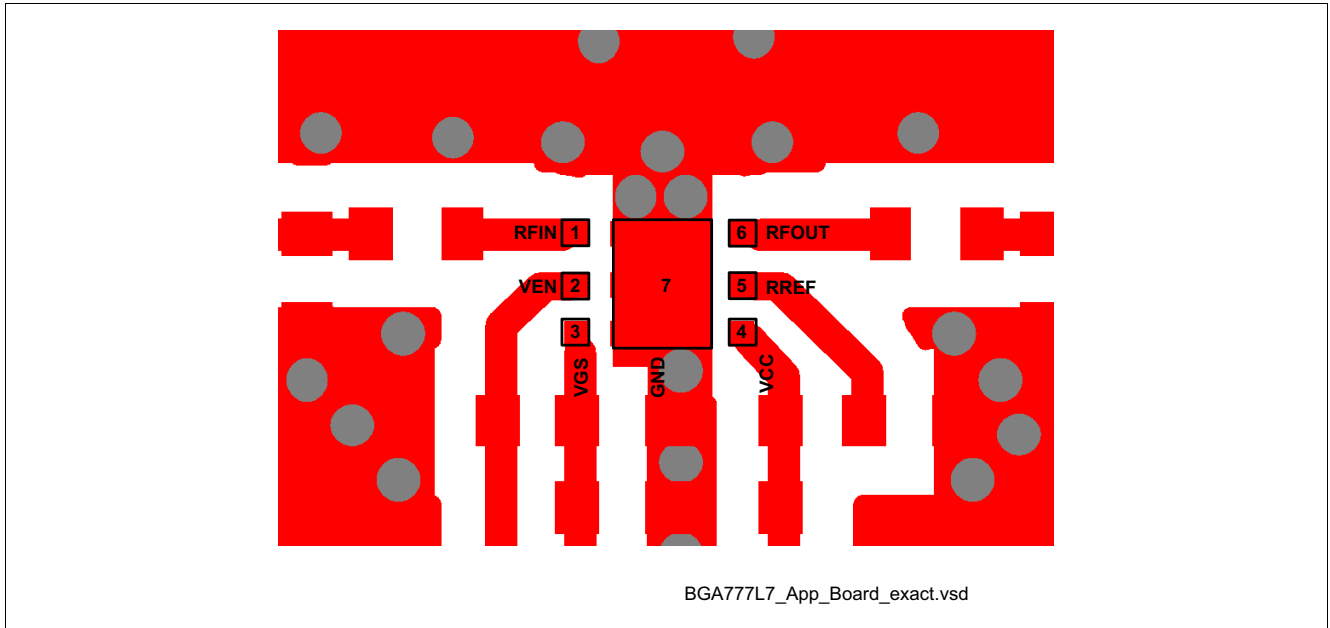
**3.5 Application Board**



**Figure 5** Application board layout on 3-layer FR4. Top layer thickness: 0.2 mm, bottom layer thickness: 0.8 mm, 35  $\mu\text{m}$  Cu metallization, gold plated. Board size: 21 x 19 mm



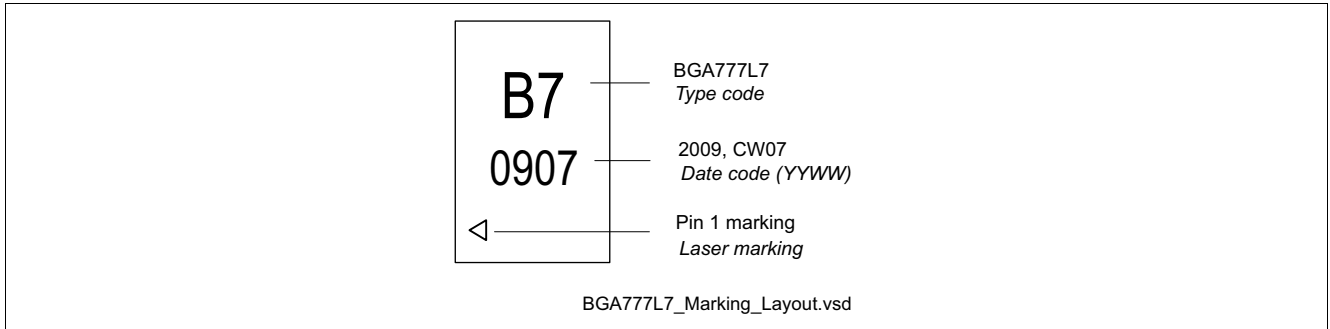
**Figure 6** Cross-section view of application board



**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.*





**Figure 11** Marking layout

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