

# BGA728L7

Broadband Low Noise Amplifier for Portable and Mobile TV Applications

Small Signal Discretes



Never stop thinking

**Edition 2009-01-20**

**Published by  
Infineon Technologies AG  
81726 München, Germany  
© Infineon Technologies AG 2009.  
All Rights Reserved.**

#### **Legal Disclaimer**

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie"). With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

#### **Information**

For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office ([www.infineon.com](http://www.infineon.com)).

#### **Warnings**

Due to technical requirements components may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies Office.

Infineon Technologies Components may only be used in life-support devices or systems with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body, or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

---

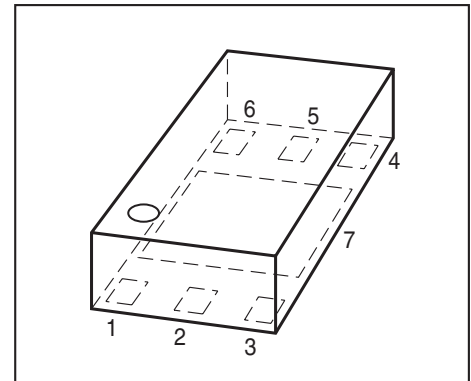
**BGA728L7****Revision History: 2009-01-20, Rev. 2.0****Previous Version: 2008-09-25, Rev. 1.2**

| Page | Subjects (major changes since last revision)        |
|------|-----------------------------------------------------|
| All  | Status changed from preliminary to final data sheet |
|      |                                                     |
|      |                                                     |
|      |                                                     |
|      |                                                     |
|      |                                                     |
|      |                                                     |
|      |                                                     |
|      |                                                     |
|      |                                                     |

# 1 Broadband Low Noise Amplifier for Portable and Mobile TV Applications

## Features

- High gain mode: 15.75 dB gain
- Low gain mode: -5.2 dB gain
- Noise figure: 1.3 / 5.5 dB in high / low gain mode
- Power off function
- Operating frequency: 100 ~ 1700 MHz
- Supply voltage: 1.5 V to 3.6 V
- Small leadless TSLP-7-1 package (2.0 x 1.3 x 0.4 mm<sup>3</sup>)
- Output internally matched to 50  $\Omega$
- Input pre-matched to 50  $\Omega$
- Low external component count
- Integrated ESD protection (1 kV HBM)
- Moisture sensitivity level: MSL 1
- Pb-free (RoHS compliant) package



TSLP-7-1



## Applications

- Portable and mobile TV in VHFIII-, UHF- and L-bands
- ISM applications in 100... 1700 MHz
- RKE applications

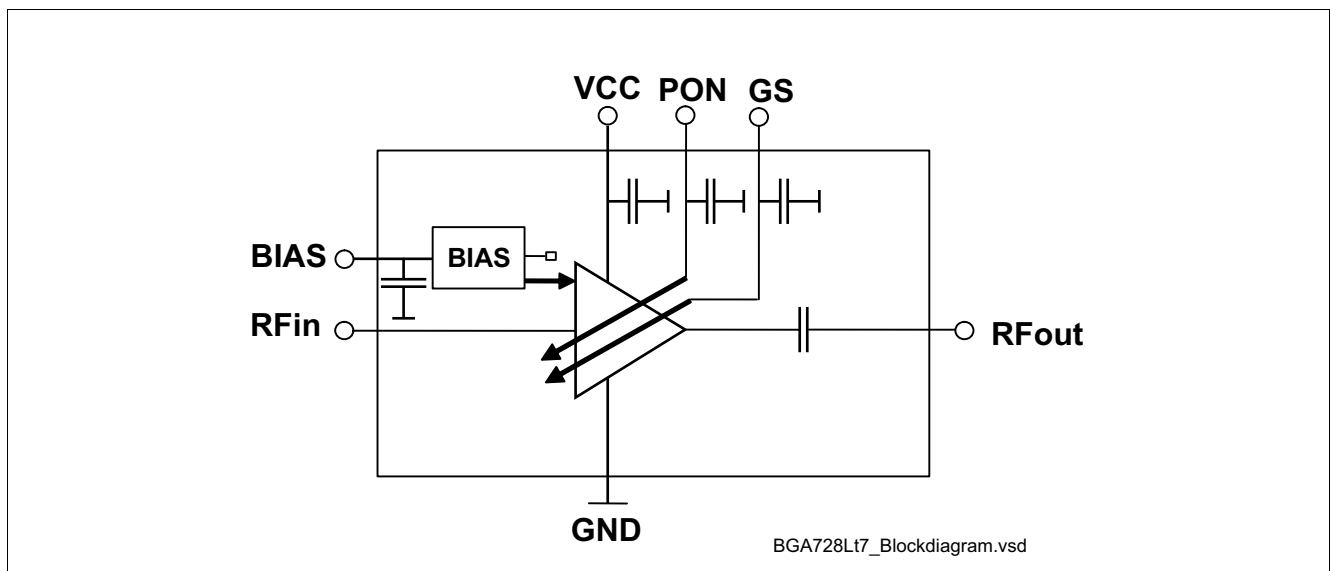


Figure 1 Block diagram

## 2 Description

The BGA728L7 is a low power low noise amplifier (LNA) MMIC for portable and mobile TV applications in the VHFIII-, UHF- and L-Bands. The low gain mode with much higher linearity enables this LNA to work with much lower current consumption than commonly used TV LNAs. The LNA is based upon Infineon Technologies cost effective B7HFM Silicon Germanium technology and comes into a low profile TSLP-7-1 leadless green package. This document specifies the electrical parameters, pin-out, application circuit and packaging of the chip.

| Type     | Package  | Marking |
|----------|----------|---------|
| BGA728L7 | TSLP-7-1 | AP      |

### Pin Definition and Function

**Table 1 Pin Definition and Function**

| Pin No. | Symbol | Function                     |
|---------|--------|------------------------------|
| 1       | GS     | High-gain / Low-gain control |
| 2       | RFin   | RF input                     |
| 3       | BIAS   | Bias voltage                 |
| 4       | PON    | Power on / off control       |
| 5       | RFout  | RF output                    |
| 6       | VCC    | Supply voltage               |
| 7       | GND    | DC/RF ground                 |

### Maximum Ratings

**Table 2 Maximum Ratings**

| Parameter <sup>1)</sup>         | Symbol      | Value                  | Unit |
|---------------------------------|-------------|------------------------|------|
| Voltage at pin VCC              | $V_{CC}$    | -0.3... 3.6            | V    |
| Voltage at pin RF_IN            | $V_{RFIN}$  | -0.3... 0.9            | V    |
| Voltage at pin RF_OUT           | $V_{RFOUT}$ | -0.3... $V_{CC} + 0.3$ | V    |
| Voltage at pin PON              | $V_{PON}$   | -0.3... $V_{CC} + 0.3$ | V    |
| Current into pin VCC            | $I_{CC}$    | 20                     | mA   |
| RF input power                  | $P_{IN}$    | 10                     | dBm  |
| Total power dissipation         | $P_{tot}$   | 72                     | mW   |
| Junction temperature            | $T_J$       | 150                    | °C   |
| Ambient temperature range       | $T_A$       | -40... 85              | °C   |
| Storage temperature range       | $T_{STG}$   | -65... 150             | °C   |
| ESD integrity HBM <sup>2)</sup> | $V_{ESD}$   | 1                      | kV   |

1) All voltages refer to GND-Node.

2) According to JESD22-A114

## Thermal resistance

**Table 3 Thermal resistance**

| Parameter                                | Symbol     | Value | Unit |
|------------------------------------------|------------|-------|------|
| Junction - soldering point <sup>1)</sup> | $R_{thJS}$ | 240   | K/W  |

1) For calculation of  $R_{thJA}$  please refer to Application Note Thermal Resistance

## 3 Electrical Characteristics

**Table 4 DC Characteristics:  $T_A = 25\text{ °C}$  ;  $V_{CC} = 2.8\text{ V}$ , unless otherwise stated; no RF input signal**

| Parameter                     | Symbol     | Values |      |      | Unit | Note / Test Condition                         |
|-------------------------------|------------|--------|------|------|------|-----------------------------------------------|
|                               |            | Min.   | Typ. | Max. |      |                                               |
| Supply voltage                | $V_{CC}$   | 1.5    |      | 3.6  | V    |                                               |
| Supply current high gain mode | $I_{CCHG}$ |        | 5.85 |      | mA   |                                               |
| Supply current low gain mode  | $I_{CCLG}$ |        | 0.55 |      | mA   |                                               |
| Supply current at shutdown    | $I_{OFF}$  |        |      | 5    | μA   |                                               |
| Logic levels PON pin          | $V_{PON}$  | 1.5    |      | 3.3  | V    | High                                          |
|                               |            | 0      |      | 0.4  | V    | Low                                           |
| Current into PON pin          | $I_{PON}$  |        | 25   |      | μA   | $V_{PON} = \text{High}, V_{GS} = \text{Low}$  |
|                               |            |        | 35   |      | μA   | $V_{PON} = \text{High}, V_{GS} = \text{High}$ |
|                               |            |        | 5    |      | μA   | $V_{PON} = \text{Low}, V_{GS} = \text{High}$  |
|                               |            |        |      | 2    | μA   | $V_{PON} = \text{Low}, V_{GS} = \text{Low}$   |
| Logic levels GS pin           | $V_{GS}$   | 1.5    |      | 3.3  | V    | High                                          |
|                               |            | 0      |      | 0.4  | V    | Low                                           |
| Current into GS pin           | $I_{GS}$   |        | 35   |      | μA   | $V_{GS} = \text{High}$                        |
|                               |            |        |      | 2    | μA   | $V_{GS} = \text{Low}$                         |

## Electrical Characteristics

**Table 5** Typical RF Characteristics<sup>1)</sup> High-Gain Mode:  $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $V_{PON} = 2.8\text{ V}$ ,  $V_{GS} = 0\text{ V}$ 

| Parameter                                     | Symbol           | Values            |       |      | Unit          | Note / Test Condition                |
|-----------------------------------------------|------------------|-------------------|-------|------|---------------|--------------------------------------|
|                                               |                  | Min.              | Typ.  | Max. |               |                                      |
| Frequency Range                               | $F_{BW}$         | 170 <sup>2)</sup> |       | 1675 | MHz           | VHFIII/UHF/L-Band<br>US/L-Band EU    |
| Power Gain                                    | $ S_{21} $       |                   | 15.75 |      | dB            | $f = 470\text{ MHz}$                 |
| Power Gain Variation over Frequency           | $\Delta S_{21} $ |                   | 1     |      | dB            | $f = 170\text{ MHz}-1675\text{ MHz}$ |
| Reverse Isolation                             | $1/ S_{12} $     |                   | >25   |      | dB            |                                      |
| Noise figure <sup>3)</sup>                    | $NF$             |                   | 1.3   |      | dB            | $f = 470\text{ MHz}$                 |
| Input return loss                             | $1/ S_{11} $     |                   | >8    |      | dB            | 50 $\Omega$                          |
| Output return loss                            | $1/ S_{22} $     |                   | >8    |      | dB            | 50 $\Omega$                          |
| Stability factor <sup>3)</sup>                | $k$              |                   | >1.5  |      |               | From 30 kHz to 6 GHz                 |
| Input 1 dB compression point <sup>3)</sup>    | $IP_{1dB}$       |                   | -10   |      | dBm           | $f = 170\text{ MHz}$                 |
|                                               |                  |                   | -10   |      | dBm           | $f = 470\text{ MHz}$                 |
|                                               |                  |                   | -9    |      | dBm           | $f = 1500\text{ MHz}$                |
| 3rd order input intercept point <sup>3)</sup> | $IIP_3$          |                   | -7    |      | dBm           | $f = 170\text{ MHz}$ ; 1 MHz offset  |
|                                               |                  |                   | -7    |      | dBm           | $f = 470\text{ MHz}$ ; 1 MHz offset  |
|                                               |                  |                   | -3    |      | dBm           | $f = 1500\text{ MHz}$ ; 1 MHz offset |
| Settling time for Power On <sup>3)</sup>      | $t_{PON}$        |                   | 3.5   |      | $\mu\text{s}$ |                                      |
| Settling time Power Off <sup>3)</sup>         | $t_{POFF}$       |                   | 2     |      | $\mu\text{s}$ |                                      |

1) Measured on BGA728L7 application board without subtracting PCB losses (unless noted otherwise) at 470 - 1675 MHz

2) 170 MHz to 240 MHz (VHF III) can be covered by adding external capacitor on input circuit (see [Application Information](#))

3) Verify by random sampling

## Electrical Characteristics

**Table 6** Typical RF Characteristics<sup>1)</sup> Low-Gain Mode:  $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $V_{PON} = 2.8\text{ V}$ ,  $V_{GS} = 2.8\text{ V}$ 

| Parameter                                     | Symbol           | Values            |      |      | Unit          | Note / Test Condition                |
|-----------------------------------------------|------------------|-------------------|------|------|---------------|--------------------------------------|
|                                               |                  | Min.              | Typ. | Max. |               |                                      |
| Frequency Range                               | $F_{PW}$         | 170 <sup>2)</sup> |      | 1675 | MHz           | VHFIII/UHF/L-Band<br>US/L-Band EU    |
| Power Gain                                    | $ S_{21} $       |                   | -5.2 |      | dB            |                                      |
| Power Gain Variation over Frequency           | $\Delta S_{21} $ |                   | 2.1  |      | dB            | $f = 170\text{ MHz}-1675\text{ MHz}$ |
| Noise figure <sup>3)</sup>                    | $NF$             |                   | 5.5  |      | dB            | $f = 470\text{ MHz}$                 |
| Input return loss                             | $1/ S_{11} $     |                   | >8   |      | dB            | 50 $\Omega$                          |
| Output return loss                            | $1/ S_{22} $     |                   | >8   |      | dB            | 50 $\Omega$                          |
| Input compression point <sup>3)</sup>         | $IP_{1dB}$       |                   | 3    |      | dBm           | $f = 170\text{ MHz}$                 |
|                                               |                  |                   | 3.5  |      | dBm           | $f = 470\text{ MHz}$                 |
|                                               |                  |                   | 5    |      | dBm           | $f = 1500\text{ MHz}$                |
| 3rd order input intercept point <sup>3)</sup> | $IIP_3$          |                   | 16   |      | dBm           | $f = 170\text{ MHz}$ ; 1 MHz offset  |
|                                               |                  |                   | 16   |      | dBm           | $f = 470\text{ MHz}$ ; 1 MHz offset  |
|                                               |                  |                   | 20   |      | dBm           | $f = 1500\text{ MHz}$ ; 1 MHz offset |
| Settling time GS ON <sup>3)</sup>             | $t_{GSON}$       |                   | 2    |      | $\mu\text{s}$ |                                      |
| Settling time GS OFF <sup>3)</sup>            | $t_{GSOFF}$      |                   | 3.5  |      | $\mu\text{s}$ |                                      |

1) Measured on BGA728L7 application board including PCB losses (unless noted otherwise) at 470 - 1675 MHz

2) 170 MHz to 240 MHz (VHF III) can be covered by adding external capacitor on input circuit (see [Application Information](#))

3) Verify by random sampling

### Gain Mode Selection Truth Table

| Control Voltage $V_{PON}$ <sup>1)</sup> | Control Voltage $V_{GS}$ <sup>1)</sup> | Gain Mode |
|-----------------------------------------|----------------------------------------|-----------|
| High                                    | Low                                    | High Gain |
| High                                    | High                                   | Low Gain  |
| Low                                     | High                                   | Low Gain  |
| Low                                     | Low                                    | OFF       |

1) See [Table 4](#) for the High/Low voltage range



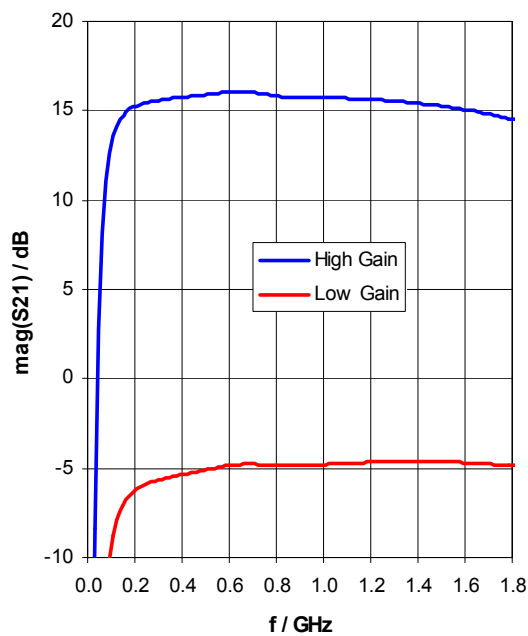
## 4 Typical Measured Results

$T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $V_{PON} = 2.8\text{ V}$ ,  $V_{GS} = 0\text{ V}$  for High Gain Mode,  $V_{GS} = 2.8\text{ V}$  for Low Gain Mode

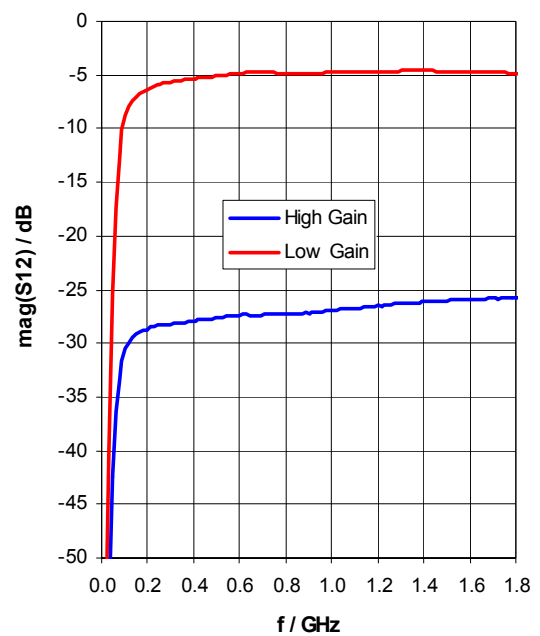
Note: Measurements based on VHF-board application. For UHF application NF can be further optimized by omitting the optional capacitor C5.

Note: Board losses are not subtracted

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

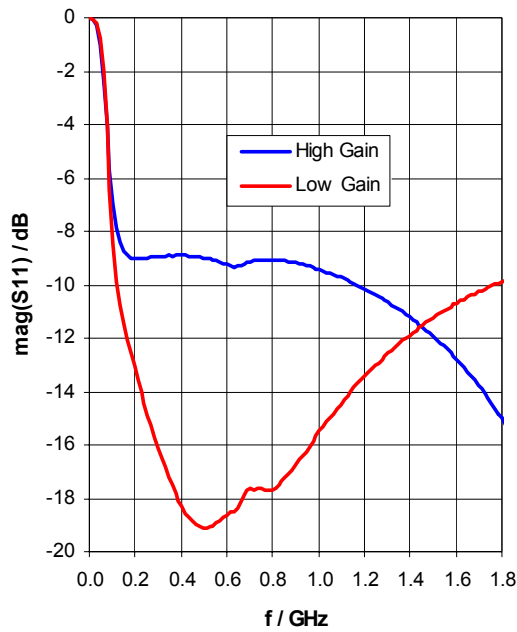


Isolation  $|S_{12}| = f(f)$



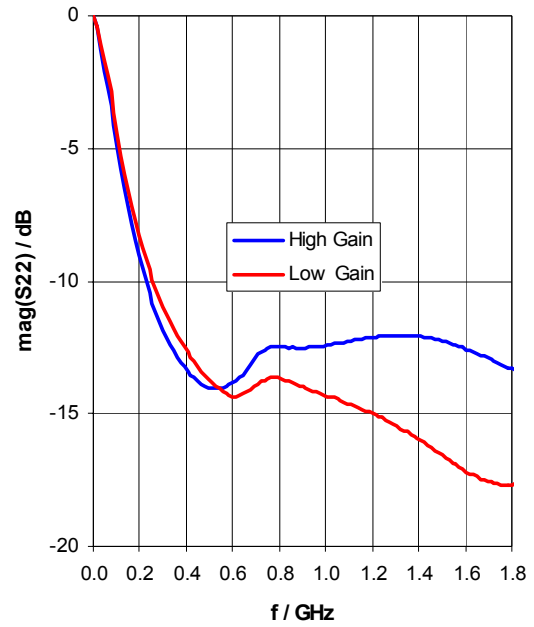
Typical Measured Results

Input Return Loss  $|S_{11}| = f(f)$



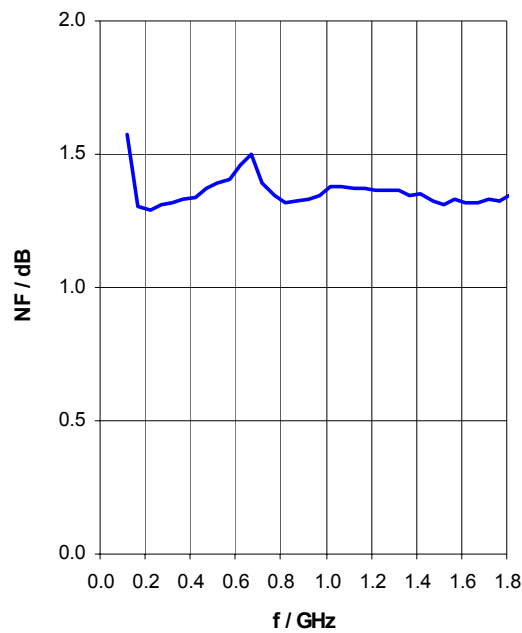
IRL.vsd

Output Return Loss  $|S_{22}| = f(f)$



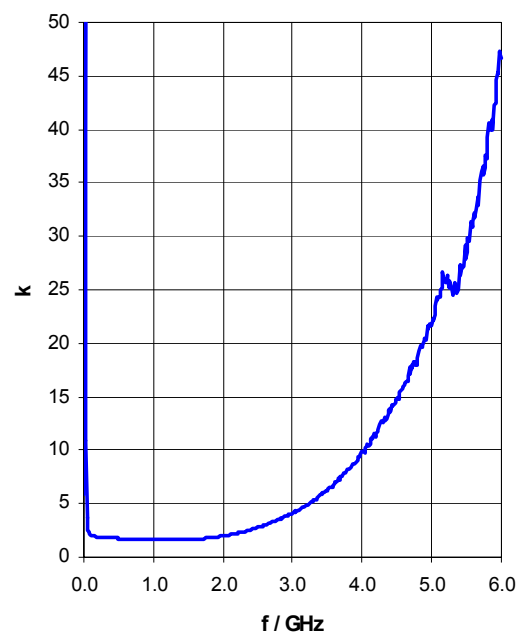
ORL.vsd

High Gain Noise Figure  $NF = f(f)$



NF.vsd

High Gain Stability Factor  $k = f(f)$



K\_factor.vsd

## 5 Application Information

### Application Circuit

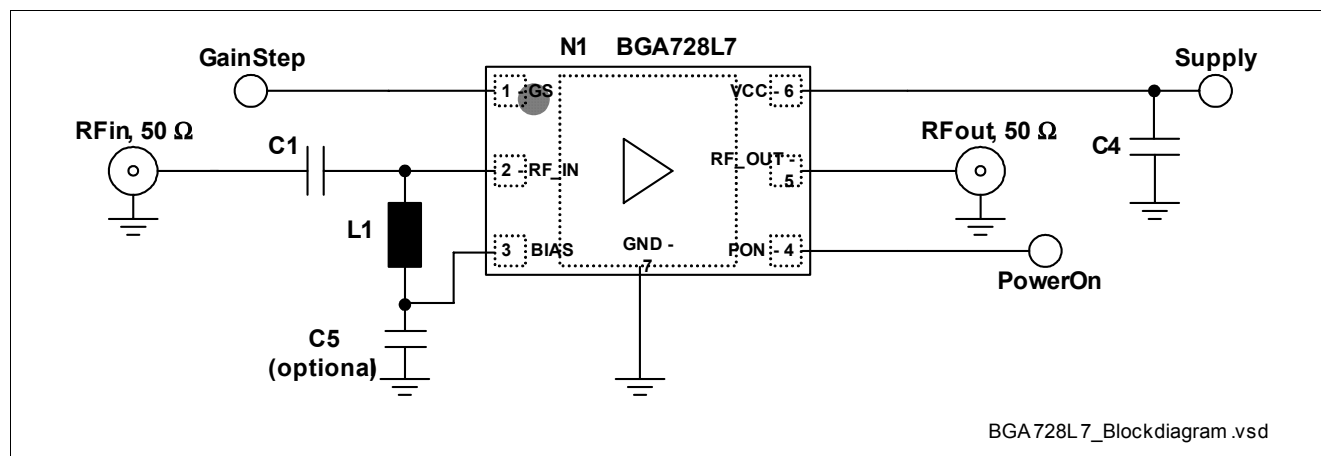


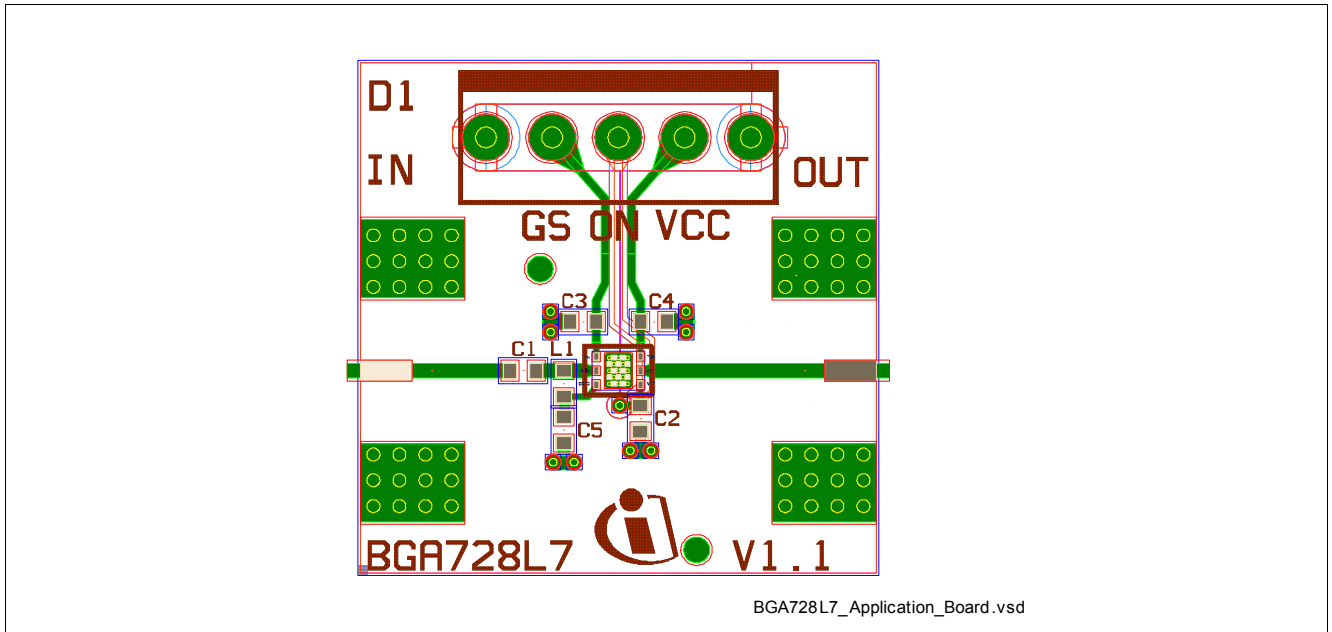
Figure 2 Application circuit of BGA728L7

Table 7 Bill of Materials

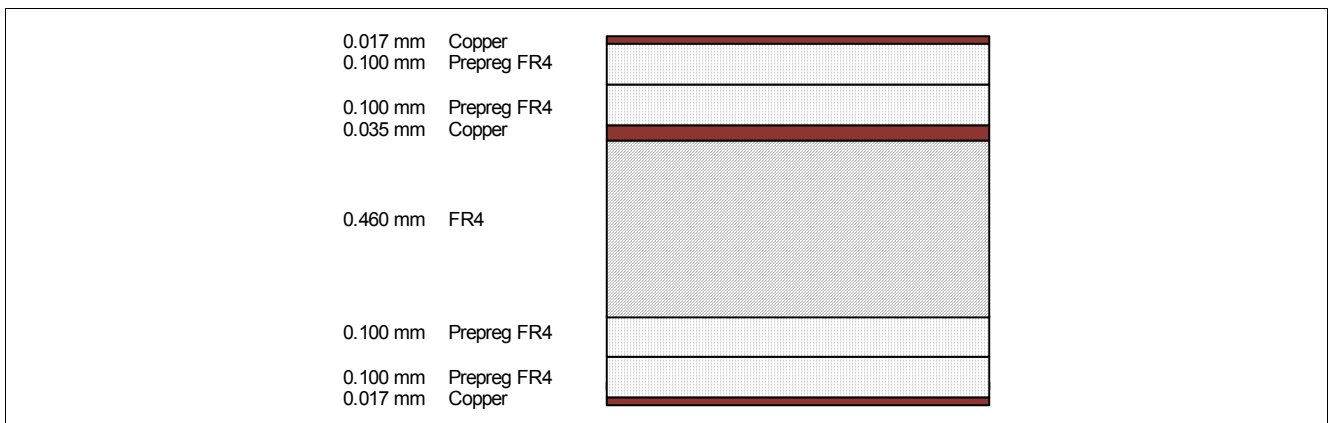
| Name   | Value    | Package  | Manufacturer            | Function                 |
|--------|----------|----------|-------------------------|--------------------------|
| C1     | 56 pF    | 0402     | Various                 | DC block                 |
| C4     | 1 nF     | 0402     | Various                 | Supply voltage filtering |
| C5     | 1 nF     | 0402     | Various                 | Optional for VHF-band    |
| L1     | 75 nH    | 0402     | Murata<br>LQW15AN75NG00 | Bias Feed                |
| N1     | BGA728L7 | TSLP-7-1 | Infineon                | SiGe LNA                 |
| C2, C3 | not used |          |                         |                          |

A list of all application notes including AN163 in particular for BGA728L7 is available at <http://www.infineon.com/MobileTVLNA>

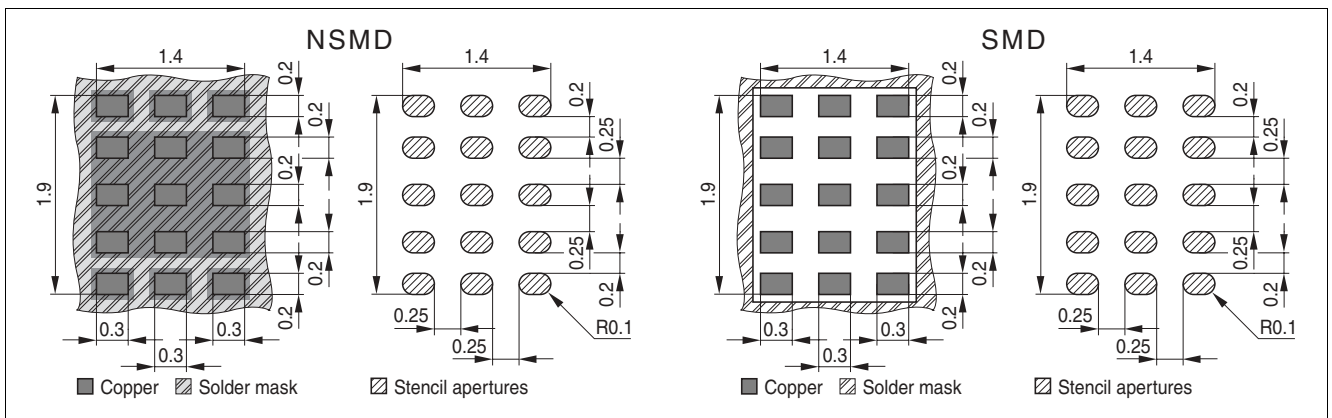
## Application Board



**Figure 3 Application Board**

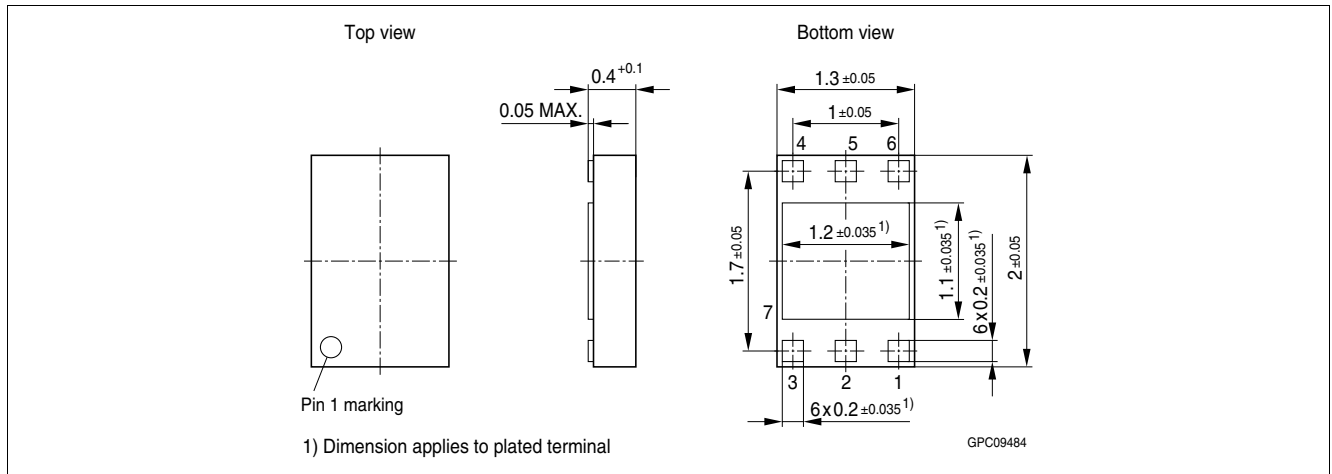


**Figure 4 Cross section View of Application board**

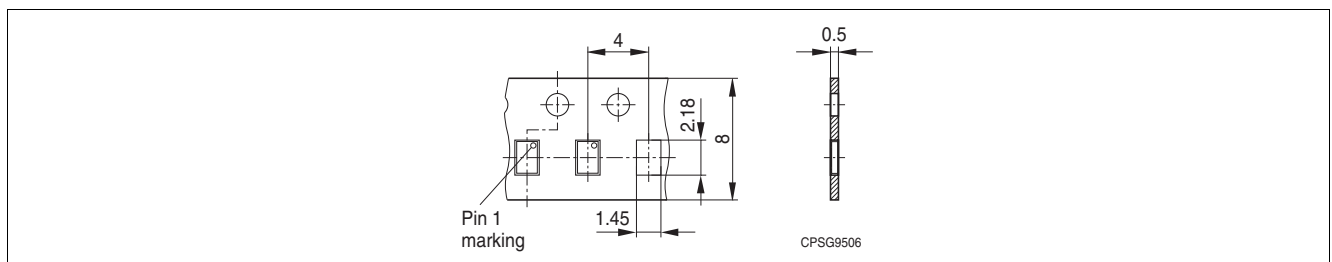


**Figure 5 Recommended Land Pattern**

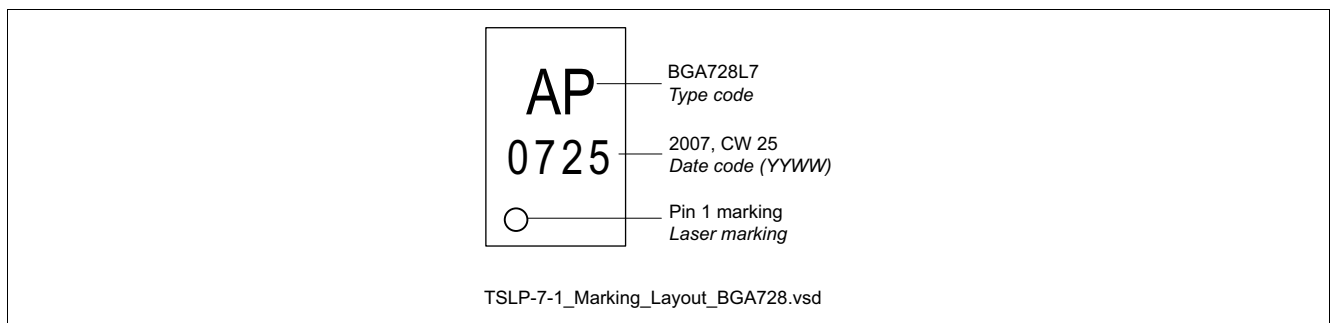
## 6 Package Information



**Figure 6** Package Dimensions for TSLP-7-1



**Figure 7** Tape & Reel Dimensions (Ø reel 180, pieces/reel 7500)



**Figure 8** Marking Layout