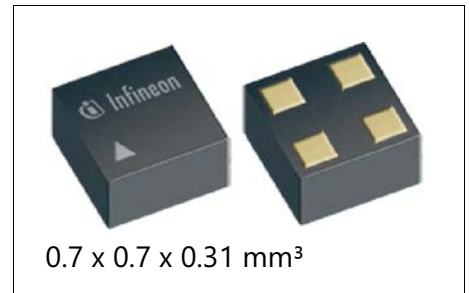


# BGA123L4

## Small Footprint Ultra Low Current Low Noise Amplifier for Global Navigation Satellite Systems (GNSS)

### Features

- Operating frequencies: 1550 - 1615 MHz
- Ultra low current consumption: 1.1 mA
- Wide supply voltage range: 1.1 V to 3.6 V
- High insertion power gain: 18.2 dB
- Low noise figure: 0.75 dB
- 2 kV HBM ESD protection (including AI pin)
- Ultra small TSLP-4-11 leadless package (footprint: 0.7 x 0.7 x 0.31 mm<sup>3</sup>)
- RF output internally matched to 50 Ohm
- Only one external SMD component necessary
- Pb-free (RoHS complaint) package



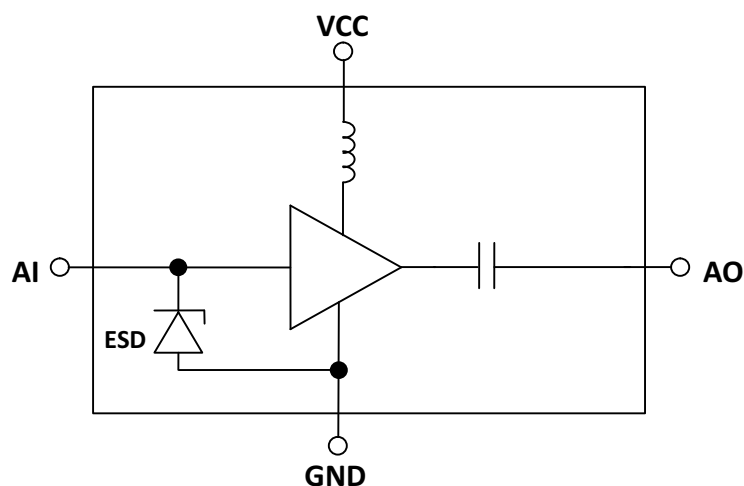
### Application

BGA123L4 is designed to enhance GNSS signal sensitivity especially in wearables and mobile cellular IoT devices. With 18.2 dB gain and only 0.75 dB noise figure it ensures high system sensitivity. The current needed is only 1.1 mA which means just 1.3 mW power consumption, which is critical to help to conserve batteries. The wide supply voltage range of 1.1 V to 3.6 V ensures flexible design and high compatibility. It supports all GNSS systems including GPS, GLONASS, Beidou and Galileo.

### Product Validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22.

### Block diagram



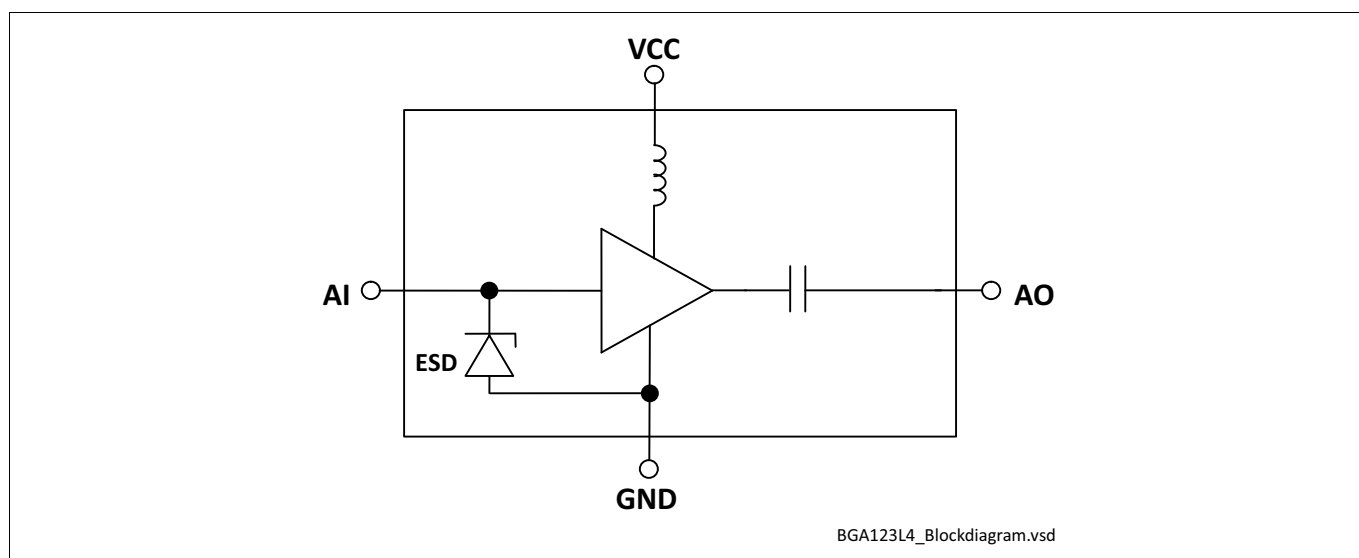
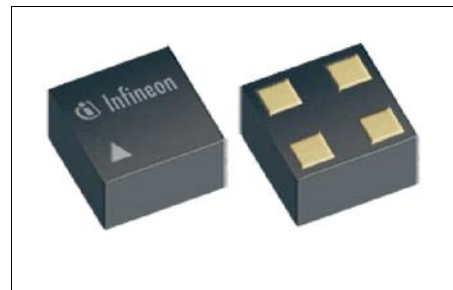
BGA123L4\_Blockdiagram.vsd

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**Features****1 Features**

- Operating frequencies: 1550 - 1615 MHz
- Ultra low current consumption: 1.1 mA
- Wide supply voltage range: 1.1 V to 3.6 V
- High insertion power gain: 18.2 dB
- Low noise figure: 0.75 dB
- 2 kV HBM ESD protection (including AI pin)
- Ultra small TSLP-4-11 leadless package (footprint: 0.7 x 0.7 x 0.31 mm<sup>3</sup>)
- RF output internally matched to 50 Ohm
- Only one external SMD component necessary
- Pb-free (RoHS complaint) package
- B7HF Silicon Germanium technology

**Figure 1 Block Diagram**

| Product Name | Marking | Package   |
|--------------|---------|-----------|
| BGA123L4     | B       | TSLP-4-11 |

**Features****Description**

The BGA123L4 is a ultra low current low noise amplifier for Global Navigation Satellite Systems (GNSS) which covers all GNSS frequency bands from 1550 MHz to 1615 MHz like GPS, GLONASS, Beidou, Galileo and others. The LNA provides 18.2 dB gain and 0.75 dB noise figure at a current consumption of only 1.1 mA in the application configuration described in [Chapter 4](#). The BGA123L4 is based upon Infineon Technologies' B7HF Silicon Germanium technology. It operates from 1.1 V to 3.6 V supply voltage.

**Pin Definition and Function****Table 1 Pin Definition and Function**

| Pin No. | Name | Function   |
|---------|------|------------|
| 1       | VCC  | DC supply  |
| 2       | AO   | LNA output |
| 3       | GND  | Ground     |
| 4       | AI   | LNA input  |

## Maximum Ratings

## 2 Maximum Ratings

Table 2 Maximum Ratings

| Parameter                                              | Symbol         | Values |      |                | Unit | Note or Test Condition |
|--------------------------------------------------------|----------------|--------|------|----------------|------|------------------------|
|                                                        |                | Min.   | Typ. | Max.           |      |                        |
| Voltage at pin VCC                                     | $V_{CC}$       | -0.3   | –    | 3.6            | V    | 1)                     |
| Voltage at pin AI                                      | $V_{AI}$       | -0.3   | –    | 0.9            | V    | –                      |
| Voltage at pin AO                                      | $V_{AO}$       | -0.3   | –    | $V_{CC} + 0.3$ | V    | –                      |
| Voltage at pin GND                                     | $V_{GND}$      | -0.3   | –    | 0.3            | V    | –                      |
| Current into pin VCC                                   | $I_{CC}$       | –      | –    | 10             | mA   | –                      |
| RF input power                                         | $P_{IN}$       | –      | –    | 0              | dBm  | –                      |
| Total power dissipation,<br>$T_S < 148\text{ °C}^{2)}$ | $P_{tot}$      | –      | –    | 40             | mW   | –                      |
| Junction temperature                                   | $T_J$          | –      | –    | 150            | °C   | –                      |
| Ambient temperature range                              | $T_A$          | -40    | –    | 85             | °C   | –                      |
| Storage temperature range                              | $T_{STG}$      | -65    | –    | 150            | °C   | –                      |
| ESD capability all pins                                | $V_{ESD\_HBM}$ | -2000  | –    | 2000           | V    | according to JS-001    |

1) All voltages refer to GND-Node unless otherwise noted

2)  $T_S$  is measured on the ground lead at the soldering point

**Attention:** Stresses above the max. values listed here may cause permanent damage to the device. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit. Exposure to conditions at or below absolute maximum rating but above the specified maximum operation conditions may affect device reliability and life time. Functionality of the device might not be given under these conditions.

## Electrical Characteristics

## 3 Electrical Characteristics

Table 3 Electrical Characteristics<sup>1)</sup> $T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{CC} = 1.2\text{ V}$ ,  $f = 1550 - 1615\text{ MHz}$ 

| Parameter                                                                                                                     | Symbol         | Values |      |      | Unit          | Note or Test Condition                  |
|-------------------------------------------------------------------------------------------------------------------------------|----------------|--------|------|------|---------------|-----------------------------------------|
|                                                                                                                               |                | Min.   | Typ. | Max. |               |                                         |
| Supply voltage                                                                                                                | $V_{CC}$       | 1.1    | 1.8  | 3.6  | V             | ON-Mode                                 |
|                                                                                                                               |                | 0.0    | –    | 0.4  | V             | OFF-Mode                                |
| Supply current                                                                                                                | $I_{CC}$       | –      | 1.05 | 1.55 | mA            | ON-Mode, $V_{CC}=1.2\text{ V}$          |
|                                                                                                                               |                | –      | 0.1  | 2    | $\mu\text{A}$ | OFF-Mode                                |
| Insertion power gain<br>$f = 1575\text{ MHz}$                                                                                 | $ S_{21} ^2$   | 16.4   | 17.9 | 19.4 | dB            | ON-Mode                                 |
| Noise figure <sup>2)</sup><br>$f = 1575\text{ MHz}$ , $Z_S = 50\text{ }\Omega$                                                | $NF$           | –      | 0.75 | 1.25 | dB            | ON-Mode, $Z_S = 50\text{ }\Omega$       |
| Input return loss <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                      | $RL_{IN}$      | 7      | 9    | –    | dB            | ON-Mode                                 |
| Output return loss <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                     | $RL_{OUT}$     | 10     | 16   | –    | dB            | ON-Mode                                 |
| Reverse isolation <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                      | $1/ S_{12} ^2$ | 25     | 36   | –    | dB            | ON-Mode                                 |
| Transient time <sup>4)7)</sup>                                                                                                | $t_S$          | –      | 0.5  | 2    | $\mu\text{s}$ | ON- to OFF-Mode                         |
|                                                                                                                               |                | –      | 9    | 12   | $\mu\text{s}$ | OFF- to ON-Mode                         |
| Inband input 1dB-compression point, $f = 1575\text{ MHz}$ <sup>3)</sup>                                                       | $IP_{1dB}$     | -21    | -17  | –    | dBm           | ON-Mode                                 |
| Inband input 3 <sup>rd</sup> -order intercept point <sup>3)5)</sup><br>$f_1 = 1575\text{ MHz}$ , $f_2 = f_1 \pm 1\text{ MHz}$ | $IIP_3$        | -19    | -14  | –    | dBm           | ON-Mode                                 |
| Out of band input 3 <sup>rd</sup> -order intercept point <sup>3)6)</sup><br>$f_1 = 1713\text{ MHz}$ , $f_2 = 1851\text{ MHz}$ | $OOB-IIP_3$    | -14    | -9   | –    | dBm           | ON-Mode                                 |
| Stability <sup>7)</sup>                                                                                                       | $k$            | > 1    | –    | –    |               | $f = 20\text{ MHz} \dots 10\text{ GHz}$ |

1) Based on the application described in chapter 4

2) PCB losses are subtracted

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

4) To be within 1 dB of the final gain

5) Input power = -30 dBm for each tone

6) Input power = -20 dBm at  $f_1$  and -65 dBm at  $f_2$ 

7) Guaranteed by device design; not tested in production

## Electrical Characteristics

**Table 4 Electrical Characteristics<sup>1)</sup>** $T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{CC} = 1.8\text{ V}$ ,  $f = 1550 - 1615\text{ MHz}$ 

| Parameter                                                                                                                     | Symbol         | Values |      |      | Unit          | Note or Test Condition                  |
|-------------------------------------------------------------------------------------------------------------------------------|----------------|--------|------|------|---------------|-----------------------------------------|
|                                                                                                                               |                | Min.   | Typ. | Max. |               |                                         |
| Supply voltage                                                                                                                | $V_{CC}$       | 1.1    | 1.8  | 3.6  | V             | ON-Mode                                 |
|                                                                                                                               |                | 0.0    | –    | 0.4  | V             | OFF-Mode                                |
| Supply current                                                                                                                | $I_{CC}$       | –      | 1.1  | 1.6  | mA            | ON-Mode, $V_{CC}=1.8\text{ V}$          |
|                                                                                                                               |                | –      | 0.1  | 2    | $\mu\text{A}$ | OFF-Mode                                |
| Insertion power gain<br>$f = 1575\text{ MHz}$                                                                                 | $ S_{21} ^2$   | 16.7   | 18.2 | 19.7 | dB            | ON-Mode                                 |
| Noise figure <sup>2)</sup><br>$f = 1575\text{ MHz}$ , $Z_S = 50\text{ }\Omega$                                                | $NF$           | –      | 0.75 | 1.25 | dB            | ON-Mode, $Z_S = 50\text{ }\Omega$       |
| Input return loss <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                      | $RL_{IN}$      | 7      | 9    | –    | dB            | ON-Mode                                 |
| Output return loss <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                     | $RL_{OUT}$     | 10     | 16   | –    | dB            | ON-Mode                                 |
| Reverse isolation <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                      | $1/ S_{12} ^2$ | 25     | 36   | –    | dB            | ON-Mode                                 |
| Transient time <sup>4)7)</sup>                                                                                                | $t_S$          | –      | 0.5  | 2    | $\mu\text{s}$ | ON- to OFF-Mode                         |
|                                                                                                                               |                | –      | 6    | 9    | $\mu\text{s}$ | OFF- to ON-Mode                         |
| Inband input 1dB-compression point, $f = 1575\text{ MHz}$ <sup>3)</sup>                                                       | $IP_{1dB}$     | -19    | -15  | –    | dBm           | ON-Mode                                 |
| Inband input 3 <sup>rd</sup> -order intercept point <sup>3)5)</sup><br>$f_1 = 1575\text{ MHz}$ , $f_2 = f_1 \pm 1\text{ MHz}$ | $IIP_3$        | -19    | -14  | –    | dBm           | ON-Mode                                 |
| Out of band input 3 <sup>rd</sup> -order intercept point <sup>3)6)</sup><br>$f_1 = 1713\text{ MHz}$ , $f_2 = 1851\text{ MHz}$ | $OOB-IIP_3$    | -14    | -9   | –    | dBm           | ON-Mode                                 |
| Stability <sup>7)</sup>                                                                                                       | $k$            | > 1    | –    | –    |               | $f = 20\text{ MHz} \dots 10\text{ GHz}$ |

1) Based on the application described in chapter 4

2) PCB losses are subtracted

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

4) To be within 1 dB of the final gain

5) Input power = -30 dBm for each tone

6) Input power = -20 dBm at  $f_1$  and -65 dBm at  $f_2$ 

7) Guaranteed by device design; not tested in production

## Electrical Characteristics

Table 5 Electrical Characteristics<sup>1)</sup> $T_A = 25\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}$ ,  $f = 1550 - 1615\text{ MHz}$ 

| Parameter                                                                                                                     | Symbol         | Values |      |      | Unit | Note or Test Condition                  |
|-------------------------------------------------------------------------------------------------------------------------------|----------------|--------|------|------|------|-----------------------------------------|
|                                                                                                                               |                | Min.   | Typ. | Max. |      |                                         |
| Supply voltage                                                                                                                | $V_{CC}$       | 1.1    | 1.8  | 3.6  | V    | ON-Mode                                 |
|                                                                                                                               |                | 0.0    | –    | 0.4  | V    | OFF-Mode                                |
| Supply current                                                                                                                | $I_{CC}$       | –      | 1.2  | 1.7  | mA   | ON-Mode, $V_{CC}=2.8\text{ V}$          |
|                                                                                                                               |                | –      | 0.1  | 2    | μA   | OFF-Mode                                |
| Insertion power gain<br>$f = 1575\text{ MHz}$                                                                                 | $ S_{21} ^2$   | 16.9   | 18.4 | 19.9 | dB   | ON-Mode                                 |
| Noise figure <sup>2)</sup><br>$f = 1575\text{ MHz}$ , $Z_S = 50\text{ Ω}$                                                     | $NF$           | –      | 0.75 | 1.25 | dB   | ON-Mode, $Z_S = 50\text{ Ω}$            |
| Input return loss <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                      | $RL_{IN}$      | 7      | 9    | –    | dB   | ON-Mode                                 |
| Output return loss <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                     | $RL_{OUT}$     | 10     | 15   | –    | dB   | ON-Mode                                 |
| Reverse isolation <sup>3)</sup><br>$f = 1575\text{ MHz}$                                                                      | $1/ S_{12} ^2$ | 25     | 36   | –    | dB   | ON-Mode                                 |
| Transient time <sup>4)7)</sup>                                                                                                | $t_S$          | –      | 0.5  | 2    | μs   | ON- to OFF-Mode                         |
|                                                                                                                               |                | –      | 5    | 8    | μs   | OFF- to ON-Mode                         |
| Inband input 1dB-compression point, $f = 1575\text{ MHz}$ <sup>3)</sup>                                                       | $IP_{1dB}$     | -17    | -13  | –    | dBm  | ON-Mode                                 |
| Inband input 3 <sup>rd</sup> -order intercept point <sup>3)5)</sup><br>$f_1 = 1575\text{ MHz}$ , $f_2 = f_1 \pm 1\text{ MHz}$ | $IIP_3$        | -19    | -14  | –    | dBm  | ON-Mode                                 |
| Out of band input 3 <sup>rd</sup> -order intercept point <sup>3)6)</sup><br>$f_1 = 1713\text{ MHz}$ , $f_2 = 1851\text{ MHz}$ | $OOB-IIP_3$    | -14    | -9   | –    | dBm  | ON-Mode                                 |
| Stability <sup>7)</sup>                                                                                                       | $k$            | > 1    | –    | –    |      | $f = 20\text{ MHz} \dots 10\text{ GHz}$ |

1) Based on the application described in chapter 4

2) PCB losses are subtracted

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

4) To be within 1 dB of the final gain

5) Input power = -30 dBm for each tone

6) Input power = -20 dBm at  $f_1$  and -65 dBm at  $f_2$ 

7) Guaranteed by device design; not tested in production



## Application Information

## 4 Application Information

## Application Board Configuration

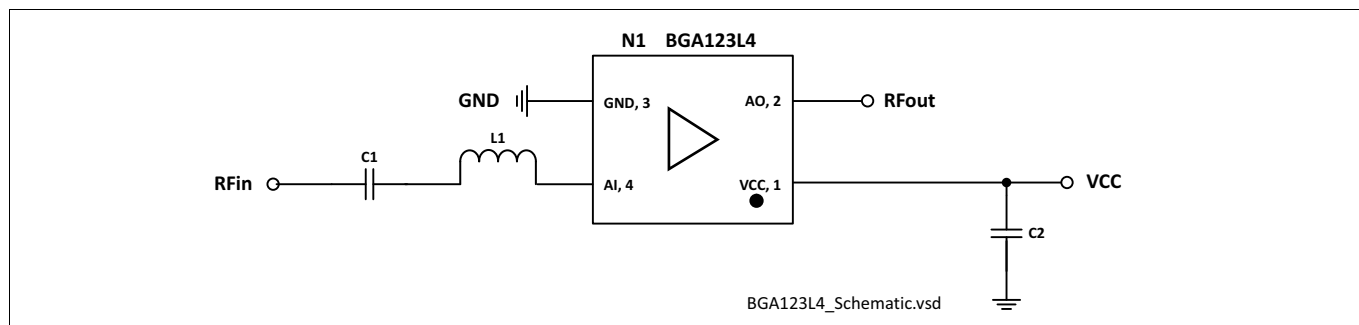


Figure 2 Application Schematic BGA123L4

Table 6 Bill of Materials

| Name          | Value                           | Package   | Manufacturer      | Function                |
|---------------|---------------------------------|-----------|-------------------|-------------------------|
| C1 (optional) | 1nF                             | 0402      | Various           | DC block <sup>1)</sup>  |
| C2            | $\geq 1\text{nF}$ <sup>2)</sup> | 0402      | Various           | RF bypass <sup>3)</sup> |
| L1            | 10nH                            | 0402      | Murata LQW15 type | Input matching          |
| N1            | BGA123L4                        | TSLP-4-11 | Infineon          | SiGe LNA                |

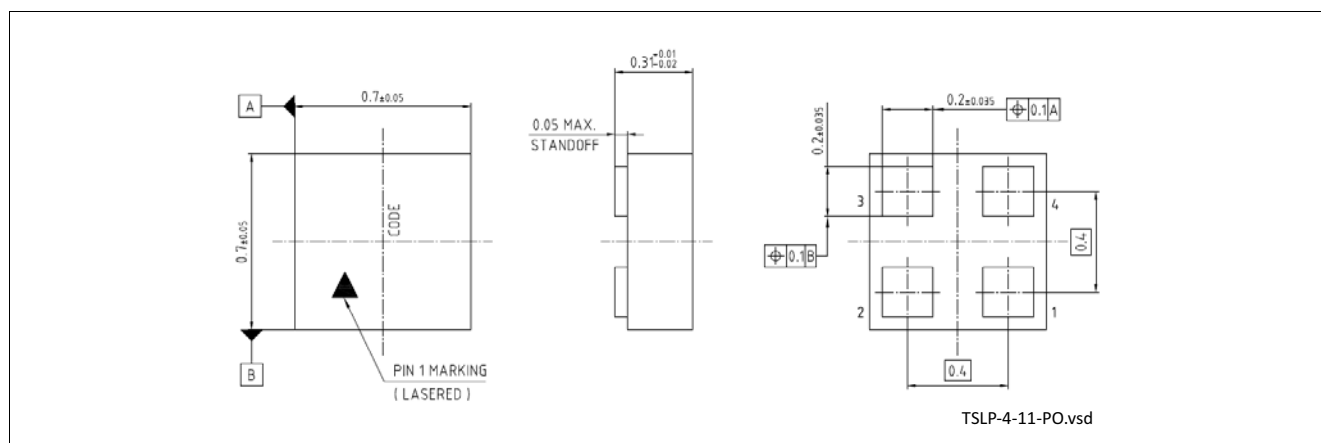
1) DC block might be realized with pre-filter in GNSS applications

2) For data sheet characteristics 1nF used

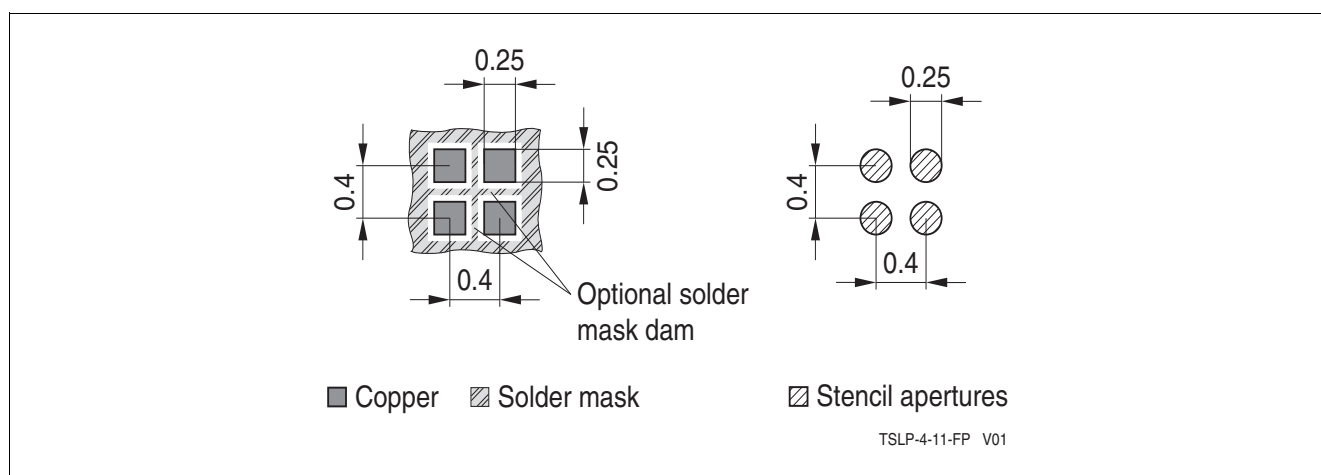
3) RF bypass recommended to mitigate power supply noise

A list of all application notes is available at <http://www.infineon.com/gpslna.appnotes>

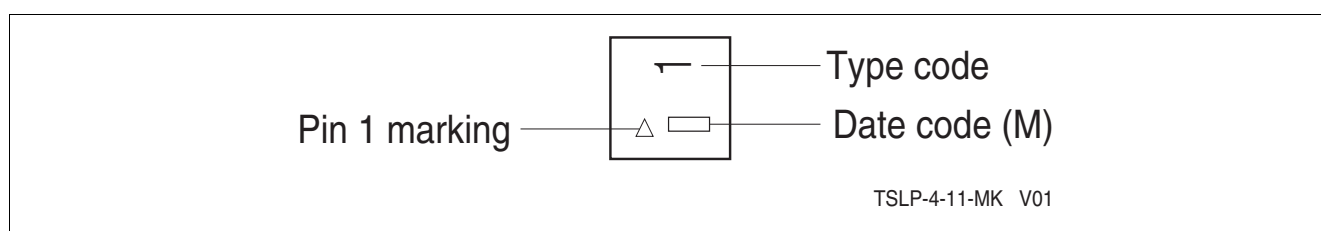
## 5 Package Information



**Figure 3** TSLP-4-11 Package Outline (top, side and bottom views)

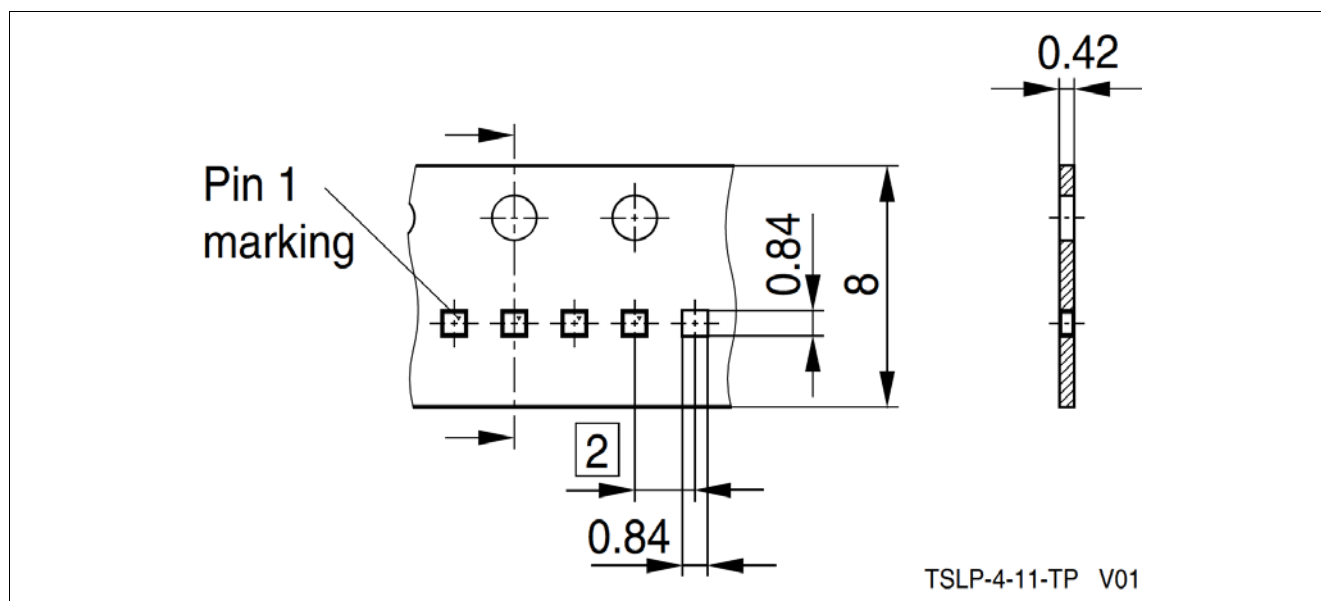


**Figure 4** Footprint Recommendation TSLP-4-11



**Figure 5** Marking Layout (top view)

## Package Information



**Figure 6** Tape & Reel Dimensions (reel diameter 180 mm, pieces/reel 15000)

**Revision History**

| Page or Item                              | Subjects (major changes since previous revision) |
|-------------------------------------------|--------------------------------------------------|
| <b>Revision 2.0 (min/max), 2017-09-14</b> |                                                  |
| 1, 3, 4, 6, 7 , 8                         | Update Electrical Characteristics                |
| 13                                        | Update Trademark Information                     |
|                                           |                                                  |

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**Edition 2017-09-14**

**Published by**

**Infineon Technologies AG**

**81726 Munich, Germany**

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**Email: [erratum@infineon.com](mailto:erratum@infineon.com)**

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