

# BGA748N16

High Linearity Quad-Band UMTS LNA (2100, 1900, 900, 800 MHz)

## Data Sheet

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**BGA748N16 High Linearity Quad-Band UMTS LNA (2100, 1900, 900, 800 MHz)**

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**Previous Revision:**

| Page | Subjects (major changes since last revision) |
|------|----------------------------------------------|
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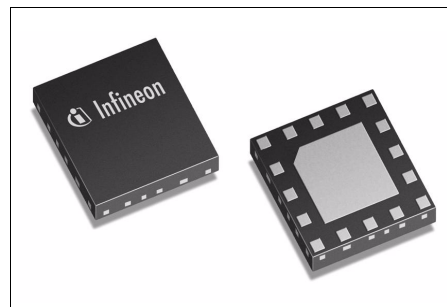
## High Linearity Quad-Band UMTS LNA (2100, 1900, 900, 800 MHz)

**BGA748N16**

### 1 Features

Main features:

- Gain: 16 / -8 dB typ. in high / low gain mode (all bands)
- Noise figure: 1.1 dB typ. in high gain mode
- Supply current: 4.0 / 0.75 mA typ in high / low gain mode (all bands)
- 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-16-1 package (2.3 x 2.3 x 0.39 mm)
- Pb-free (RoHS compliant) package



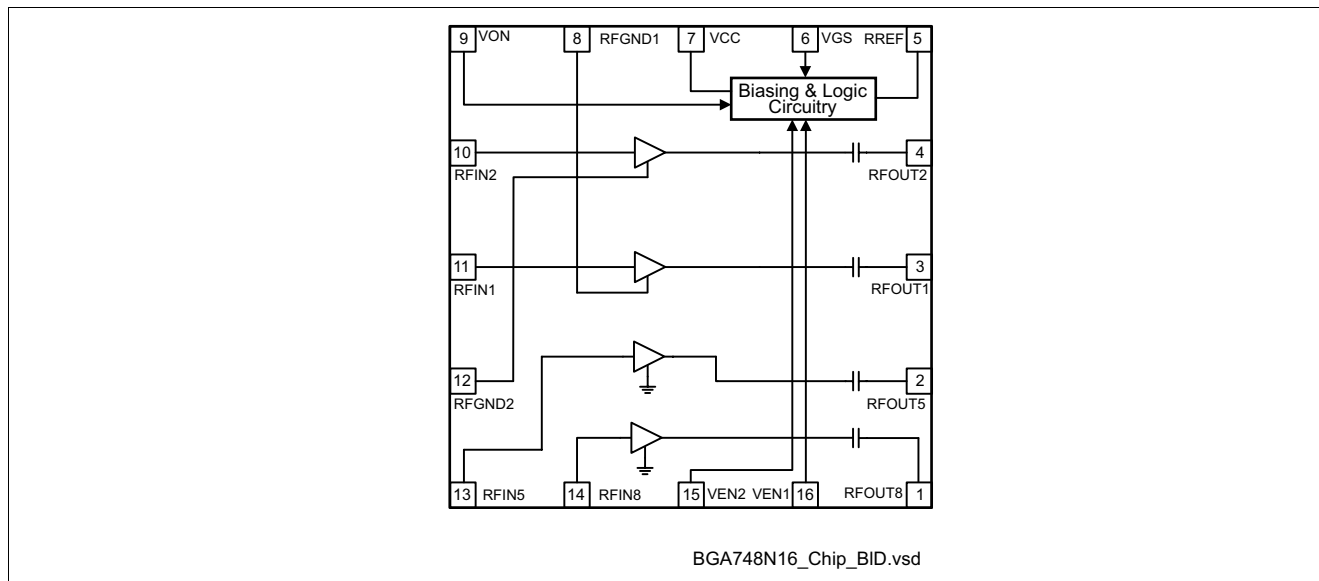
### Description

The BGA748N16 is a highly flexible, high linearity quad-band (2100, 1900, 900, 800 MHz) low noise amplifier MMIC for worldwide use. Based on Infineon's proprietary and cost-effective SiGe:C technology, the BGA748N16 uses an advanced biasing concept in order to achieve high linearity.

The device features dynamic gain control, temperature stabilization, standby mode and 2 kV ESD protection on-chip as well as matching off chip. Because the matching is off chip, different UMTS bands can be easily applied.

*Note: UMTS bands I / II / V / VIII is the standard band combination for this product requiring no external output matching network.*

| Product Name | Package   | Chip  | Marking |
|--------------|-----------|-------|---------|
| BGA748N16    | TSNP-16-1 | T1541 | BGA748  |



**Figure 1**    **Block Diagram of Quad-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 exceeding 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 | $R_{thJS}$ | –      | –    | 67   | 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,  $T_A = -30 \dots 85 \text{ }^\circ\text{C}$

| 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 | $I_{CCHG}$  | –      | 4.4<br>3.8 | –    | mA            | Band 1<br>All other bands |
| Supply current low gain mode  | $I_{CCLG}$  | –      | 0.75       | –    | mA            | All bands                 |
| Supply current standby mode   | $I_{CCOFF}$ | –      | 0.1        | 2.0  | $\mu\text{A}$ | –                         |
| 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                | $I_{LO}$    | –      | 0.1        | –    | $\mu\text{A}$ | All logic pins            |
|                               | $I_{HI}$    | –      | 5.0        | –    | $\mu\text{A}$ |                           |

## 2.5 Band Select / Gain Control Truth Table

**Table 5** Band Select Truth Table,  $V_{CC} = 2.8 \text{ V}$

|      | Band 1 | Band 2 | Band 5 | Band 8 | Stand-by |
|------|--------|--------|--------|--------|----------|
| VEN1 | H      | H      | L      | L      | L        |
| VEN2 | H      | L      | H      | L      | L        |
| VON  | H      | H      | H      | H      | L        |

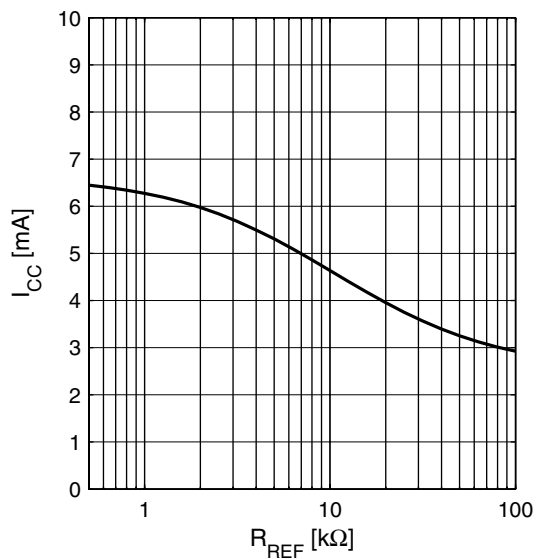
**Table 6** Gain Control Truth Table,  $V_{CC} = 2.8 \text{ V}$

|     | High Gain | Low Gain |
|-----|-----------|----------|
| VGS | H         | L        |

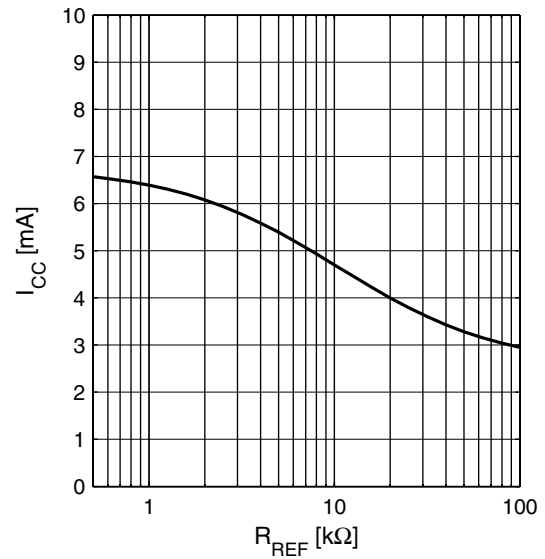
## 2.6 Supply Current Characteristics

Supply current high gain mode versus resistance of reference resistor  $R_{REF}$  (see Figure 2 on Page 25; low gain mode supply current is independent of reference resistor).

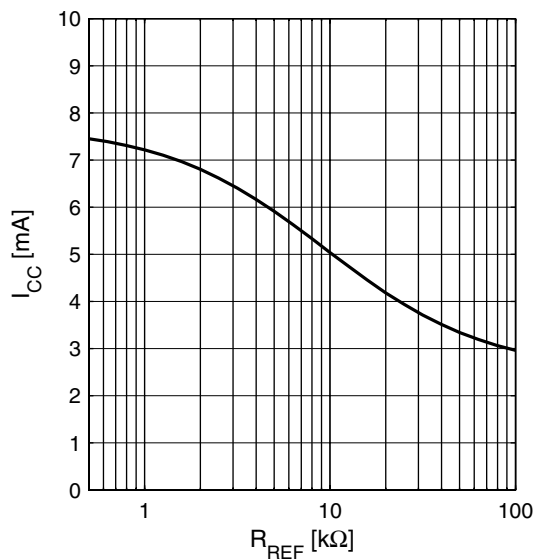
**Supply Current Band 5**  $I_{CC} = f(R_{REF})$   
 $V_{CC} = 2.8 \text{ V}$ ,  $T_A = 25^\circ\text{C}$



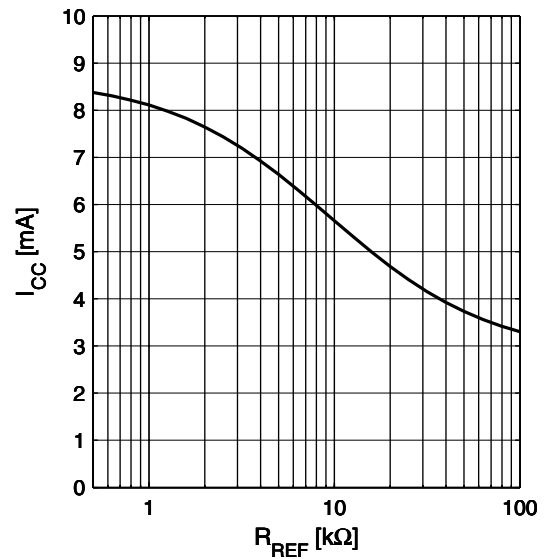
**Supply Current Band 8**  $I_{CC} = f(R_{REF})$   
 $V_{CC} = 2.8 \text{ V}$ ,  $T_A = 25^\circ\text{C}$



**Supply Current Band 2**  $I_{CC} = f(R_{REF})$   
 $V_{CC} = 2.8 \text{ V}$ ,  $T_A = 25^\circ\text{C}$



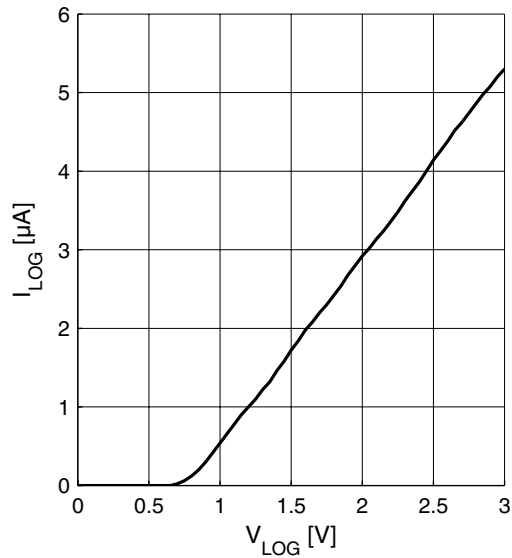
**Supply Current Band 1**  $I_{CC} = f(R_{REF})$   
 $V_{CC} = 2.8 \text{ V}$ ,  $T_A = 25^\circ\text{C}$



## 2.7 Logic Signal Characteristics

Current consumption of logic inputs VEN1, VEN2, VGS, VON

**Logic currents**  $I_{\text{LOG}} = f(V_{\text{LOG}})$   
 $V_{\text{CC}} = 2.8 \text{ V}$ ,  $T_{\text{A}} = 25 \text{ }^{\circ}\text{C}$



## 2.8 Switching Times

**Table 7** Typical Switching Times;  $T_{\text{A}} = -30 \dots 85 \text{ }^{\circ}\text{C}$

| Parameter                | Symbol          | Values |      |      | Unit          | Note / Test Condition                                     |
|--------------------------|-----------------|--------|------|------|---------------|-----------------------------------------------------------|
|                          |                 | Min.   | Typ. | Max. |               |                                                           |
| Gainstep settling time   | $t_{\text{GS}}$ | –      | 1    | –    | $\mu\text{s}$ | Switching LG $\leftrightarrow$ HG all bands               |
| Bandselect settling time | $t_{\text{BS}}$ | –      | 1    | –    | $\mu\text{s}$ | Switching from any band to a different band (pins VEN1,2) |
| Power on settling time   | $t_{\text{ON}}$ | –      | 1    | –    | $\mu\text{s}$ | Switching from standby mode to ON mode (pin VON)          |

## 2.9 Measured RF Characteristics UMTS Band V

**Table 8** Typical Characteristics 880 MHz Band,  $T_A = -30\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{1)}$

| Parameter                                               | Symbol        | Values |      |      | Unit | Note / Test Condition        |
|---------------------------------------------------------|---------------|--------|------|------|------|------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                              |
| Pass band range                                         |               | 869    | –    | 894  | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 3.1  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.70 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 16.5 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -7.8 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -38  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -7.8 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 0.9  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 7.8  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -15  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -17  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -15  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -11  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Stability factor <sup>3)</sup>                          | $k$           | –      | >2.5 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -7   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | 1    | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -7   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 14   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.

## 2.10 Measured RF Characteristics UMTS Band V

**Table 9** Typical Characteristics 880 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                                         |               | 869    | –    | 894  | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 3.8  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.75 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 16.2 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -8.0 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -38  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -8.0 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 1.2  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 8.0  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -14  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -15  | –    | 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>                          | $k$           | –      | >2.7 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -7   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | -1   | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -6   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 12   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.

## 2.11 Measured RF Characteristics UMTS Band V

**Table 10** Typical Characteristics 880 MHz Band,  $T_A = 85\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{1)}$

| Parameter                                               | Symbol        | Values |      |      | Unit | Note / Test Condition        |
|---------------------------------------------------------|---------------|--------|------|------|------|------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                              |
| Pass band range                                         |               | 869    | –    | 894  | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 4.6  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.80 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 15.6 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -8.5 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -38  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -8.5 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 1.7  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 8.5  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -17  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -14  | –    | 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>                          | $k$           | –      | >3.2 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -8   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | -4   | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -6   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 6    | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.

## 2.12 Measured RF Characteristics UMTS Band VIII

**Table 11** Typical Characteristics 940 MHz Band,  $T_A = -30\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{1)}$

| Parameter                                               | Symbol        | Values |      |      | Unit | Note / Test Condition        |
|---------------------------------------------------------|---------------|--------|------|------|------|------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                              |
| Pass band range                                         |               | 925    | –    | 960  | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 3.1  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.70 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 16.5 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -7.8 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -35  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -7.8 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 0.9  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 7.8  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -15  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -13  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -19  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -13  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Stability factor <sup>3)</sup>                          | $k$           | –      | >2.5 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -7   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | 3    | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -7   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 14   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.



## 2.13 Measured RF Characteristics UMTS Band VIII

**Table 12** Typical Characteristics 940 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                                         |               | 925    | –    | 960  | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 3.8  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.75 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 16.2 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -8.0 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -36  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -8.0 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 1.2  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 8.0  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -16  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -13  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -28  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -12  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Stability factor <sup>3)</sup>                          | $k$           | –      | >2.8 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -6   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | 1    | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -6   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 12   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.

## 2.14 Measured RF Characteristics UMTS Band VIII

**Table 13** Typical Characteristics 940 MHz Band,  $T_A = 85\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{1)}$

| Parameter                                               | Symbol        | Values |      |      | Unit | Note / Test Condition        |
|---------------------------------------------------------|---------------|--------|------|------|------|------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                              |
| Pass band range                                         |               | 925    | –    | 960  | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 4.6  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.80 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 15.6 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -8.5 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -36  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -8.5 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 1.7  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 8.5  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -17  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -12  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -26  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -12  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Stability factor <sup>3)</sup>                          | $k$           | –      | >3.2 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -9   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | -3   | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -5   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 5    | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.

## 2.15 Measured RF Characteristics UMTS Band II

**Table 14** Typical Characteristics 1960 MHz Band,  $T_A = -30\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{(1)}$

| Parameter                                               | Symbol        | Values |      |      | Unit | Note / Test Condition        |
|---------------------------------------------------------|---------------|--------|------|------|------|------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                              |
| Pass band range                                         |               | 1930   | –    | 1990 | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 3.1  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.70 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 17.1 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -7.8 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -35  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -7.8 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 0.8  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 7.8  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -21  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -24  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -29  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -15  | –    | 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>                   | $IP_{1dBHG}$  | –      | -8   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | 2    | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -8   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 17   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.

## 2.16 Measured RF Characteristics UMTS Band II

**Table 15** Typical Characteristics 1960 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                                         |               | 1930   | –    | 1990 | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 4.0  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.75 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 16.5 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -8.0 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -36  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -8.0 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 1.1  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 8.0  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -20  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -17  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -32  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -15  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Stability factor <sup>3)</sup>                          | $k$           | –      | >2.6 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -8   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | 2    | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -7   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 17   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.

## 2.17 Measured RF Characteristics UMTS Band II

**Table 16** Typical Characteristics 1960 MHz Band,  $T_A = 85\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{1)}$

| Parameter                                               | Symbol        | Values |      |      | Unit | Note / Test Condition        |
|---------------------------------------------------------|---------------|--------|------|------|------|------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                              |
| Pass band range                                         |               | 1930   | –    | 1990 | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 4.9  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.80 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 15.9 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -8.5 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -36  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -8.5 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 1.5  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 8.5  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -17  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -14  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -23  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -16  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Stability factor <sup>3)</sup>                          | $k$           | –      | >3.1 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -9   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | 0    | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -6   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 10   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test.

3) Guaranteed by device design; not tested in production.

## 2.18 Measured RF Characteristics UMTS Band I

**Table 17** Typical Characteristics 2140 MHz Band,  $T_A = -30\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{1)}$

| Parameter                                               | Symbol        | Values |      |      | Unit | Note / Test Condition        |
|---------------------------------------------------------|---------------|--------|------|------|------|------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                              |
| Pass band range                                         |               | 2110   | –    | 2170 | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 3.6  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.70 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 18.0 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -7.8 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -36  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -7.8 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 0.8  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 7.8  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -18  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -18  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -18  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -10  | –    | 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>                   | $IP_{1dBHG}$  | –      | -9   | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | 1    | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -8   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 16   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test..

3) Guaranteed by device design; not tested in production.

## 2.19 Measured RF Characteristics UMTS Band I

**Table 18 Typical Characteristics 2140 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                                         |               | 2110   | –    | 2170 | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 4.4  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.75 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 17.4 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -8.0 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -36  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -8.0 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 1.1  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 8.0  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -20  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -17  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -19  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -11  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Stability factor <sup>3)</sup>                          | $k$           | –      | >2.4 | –    |      | DC to 8 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><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -6   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 16   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

2) Verification based on AQL; random production test..

3) Guaranteed by device design; not tested in production.

## 2.20 Measured RF Characteristics UMTS Band I

**Table 19** Typical Characteristics 2140 MHz Band,  $T_A = 85\text{ °C}$ ,  $V_{CC} = 2.8\text{ V}^{1)}$

| Parameter                                               | Symbol        | Values |      |      | Unit | Note / Test Condition        |
|---------------------------------------------------------|---------------|--------|------|------|------|------------------------------|
|                                                         |               | Min.   | Typ. | Max. |      |                              |
| Pass band range                                         |               | 2110   | –    | 2170 | MHz  | –                            |
| Current consumption                                     | $I_{CCHG}$    | –      | 5.3  | –    | mA   | High gain mode               |
|                                                         | $I_{CCLG}$    | –      | 0.80 | –    | mA   | Low gain mode                |
| Gain                                                    | $S_{21HG}$    | –      | 16.8 | –    | dB   | High gain mode               |
|                                                         | $S_{21LG}$    | –      | -8.5 | –    | dB   | Low gain mode                |
| Reverse Isolation <sup>2)</sup>                         | $S_{12HG}$    | –      | -36  | –    | dB   | High gain mode               |
|                                                         | $S_{12LG}$    | –      | -8.5 | –    | dB   | Low gain mode                |
| Noise figure                                            | $NF_{HG}$     | –      | 1.4  | –    | dB   | High gain mode               |
|                                                         | $NF_{LG}$     | –      | 8.5  | –    | dB   | Low gain mode                |
| Input return loss <sup>2)</sup>                         | $S_{11HG}$    | –      | -23  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{11LG}$    | –      | -16  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Output return loss <sup>2)</sup>                        | $S_{22HG}$    | –      | -17  | –    | dB   | 50 $\Omega$ , high gain mode |
|                                                         | $S_{22LG}$    | –      | -11  | –    | dB   | 50 $\Omega$ , low gain mode  |
| Stability factor <sup>3)</sup>                          | $k$           | –      | >2.7 | –    |      | DC to 8 GHz; all gain modes  |
| Input compression point <sup>2)</sup>                   | $IP_{1dBHG}$  | –      | -11  | –    | dBm  | High gain mode               |
|                                                         | $IP_{1dB LG}$ | –      | 1    | –    | dBm  | Low gain mode                |
| Inband IIP3 <sup>2)</sup><br>$f_1 - f_2 = 1\text{ MHz}$ | $IIP3_{HG}$   | –      | -5   | –    | dBm  | High gain mode               |
|                                                         | $IIP3_{LG}$   | –      | 11   | –    |      | Low gain mode                |

1) Performance based on application circuit in Figure 2 on Page 25

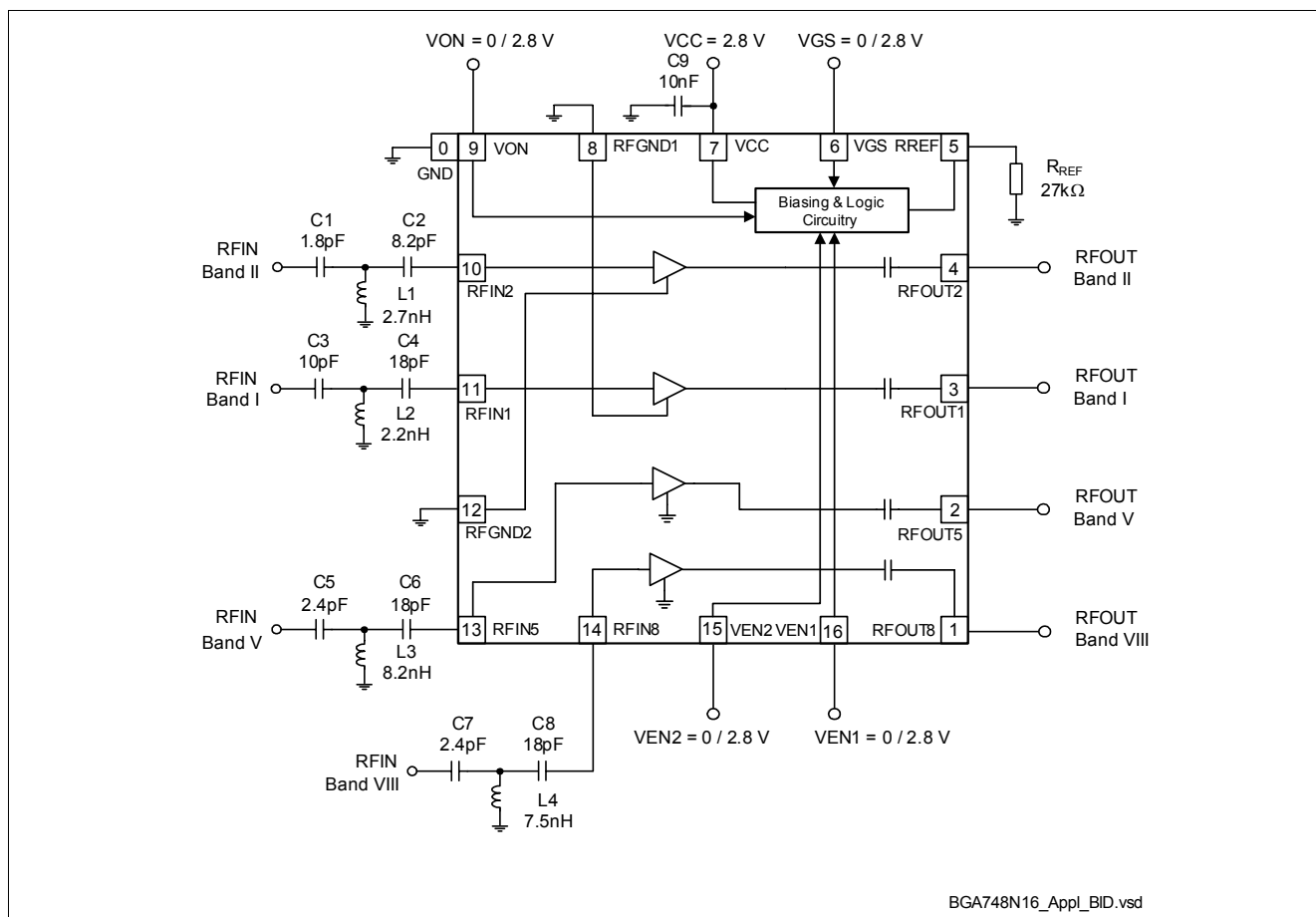
2) Verification based on AQL; random production test..

3) Guaranteed by device design; not tested in production.



### 3 Application Circuit and Block Diagram

#### 3.1 UMTS Bands I, II, V and VIII Application Circuit Schematic



**Figure 2 Application Circuit with Chip Outline (Top View)**

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

**Table 20 Bill of Materials**

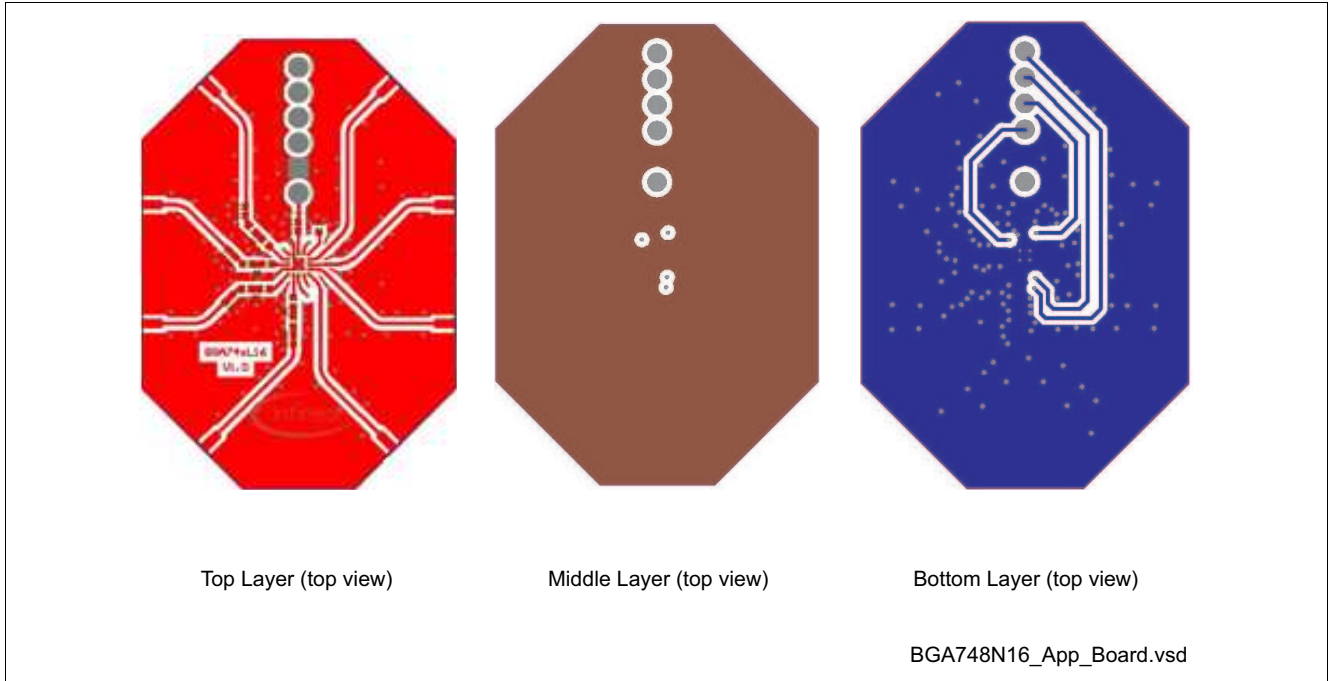
| Part Number | Part Type      | Manufacturer | Size | Comment                   |
|-------------|----------------|--------------|------|---------------------------|
| L1 ... L4   | Chip inductor  | Various      | 0402 | Wirewound, $Q \approx 50$ |
| C1 ... C9   | Chip capacitor | Various      | 0402 |                           |
| $R_{REF}$   | Chip resistor  | Various      | 0402 |                           |

## 3.2 Pin Description

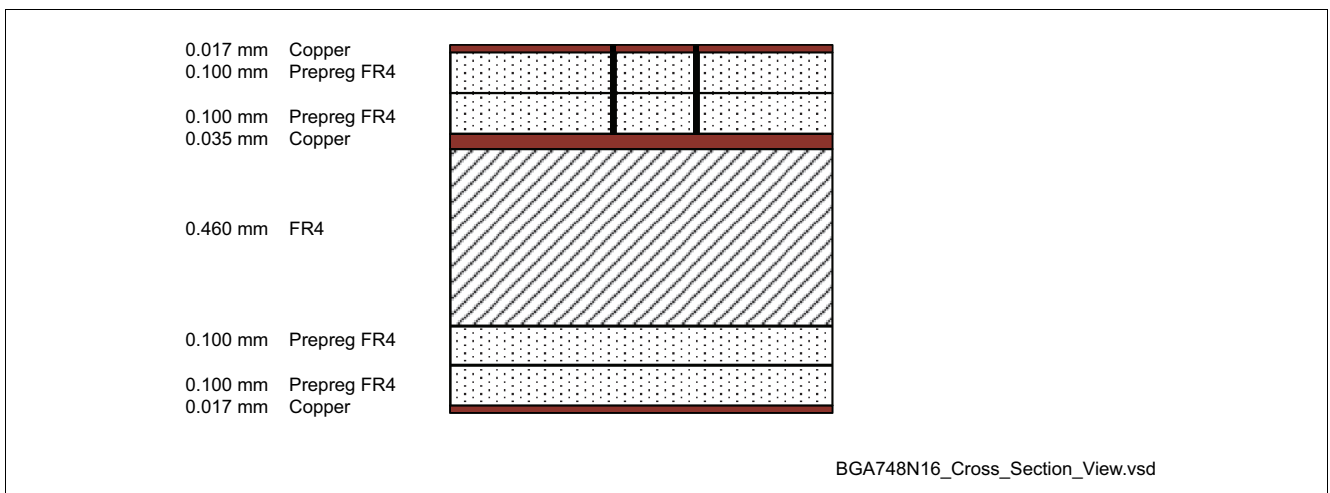
**Table 21 Pin Definition and Function**

| Pin No. | Name   | Function                                                         |
|---------|--------|------------------------------------------------------------------|
| 0       | GND    | Ground connection for LNA and control circuitry (package paddle) |
| 1       | RFOUT8 | LNA output UMTS band VIII                                        |
| 2       | RFOUT5 | LNA output UMTS band V                                           |
| 3       | RFOUT1 | LNA output UMTS band I                                           |
| 4       | RFOUT2 | LNA output UMTS band II                                          |
| 5       | RREF   | Bias current reference resistor (high gain mode)                 |
| 6       | VGS    | Gain step control voltage                                        |
| 7       | VCC    | Supply voltage                                                   |
| 8       | RFGND1 | LNA emitter ground UMTS band I                                   |
| 9       | VON    | Power on control voltage                                         |
| 10      | RFIN2  | LNA input UMTS band II                                           |
| 11      | RFIN1  | LNA input UMTS band I                                            |
| 12      | RFGND2 | LNA emitter ground UMTS band II                                  |
| 13      | RFIN5  | LNA input UMTS band V                                            |
| 14      | RFIN8  | LNA input UMTS band VIII                                         |
| 15      | VEN2   | Band select control voltage                                      |
| 16      | VEN1   | Band select control voltage                                      |

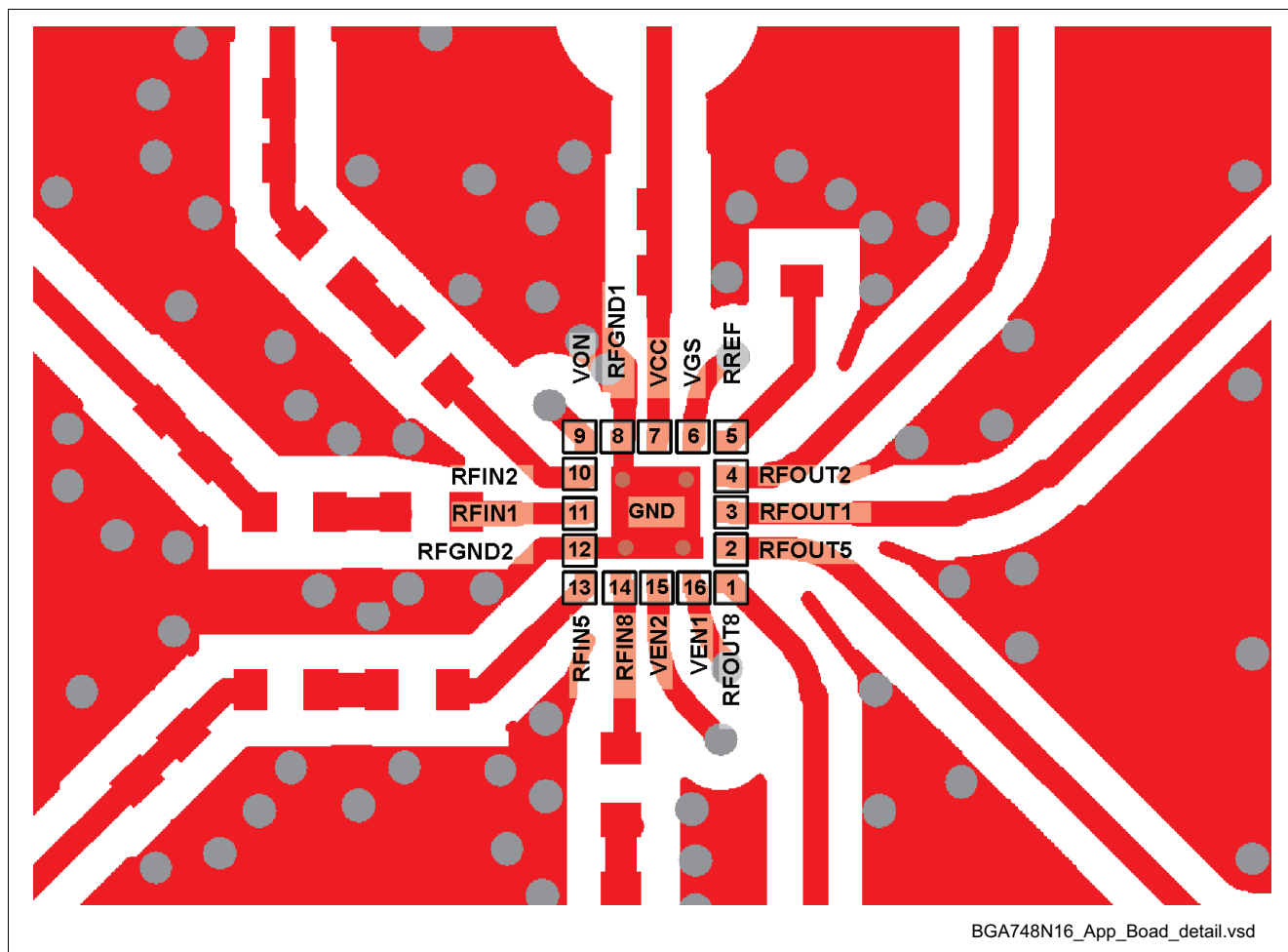
### 3.3 Application Board



*Note: Top layer thickness: 0.2 mm, bottom layer thickness: 0.8 mm, 17 mm Cu metallization, gold plated. Board size: 32 x 45mm.*



**Figure 3 Cross-Section View of Application Board**

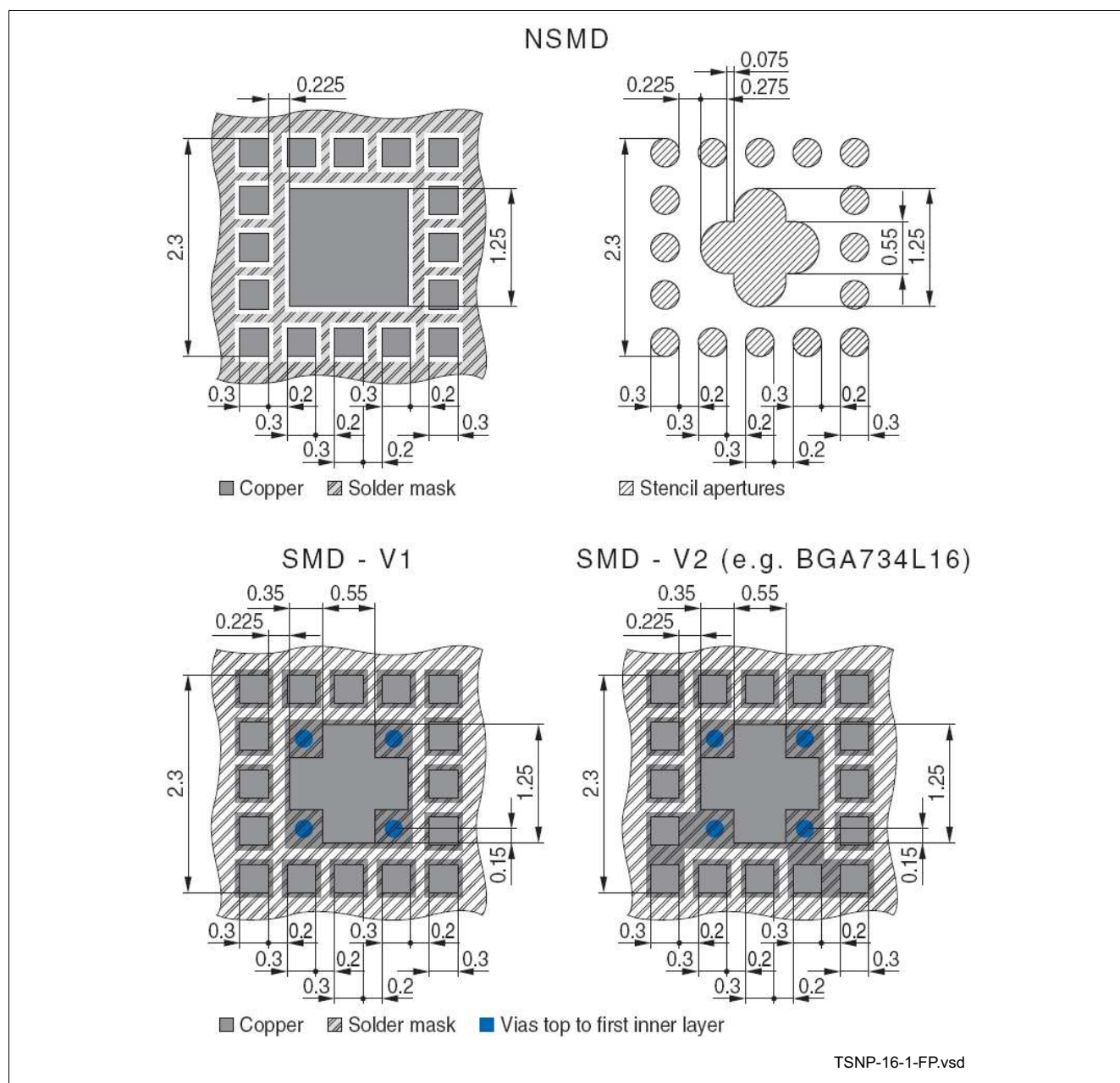


**Figure 4** Detail of Application Board Layout

*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.*

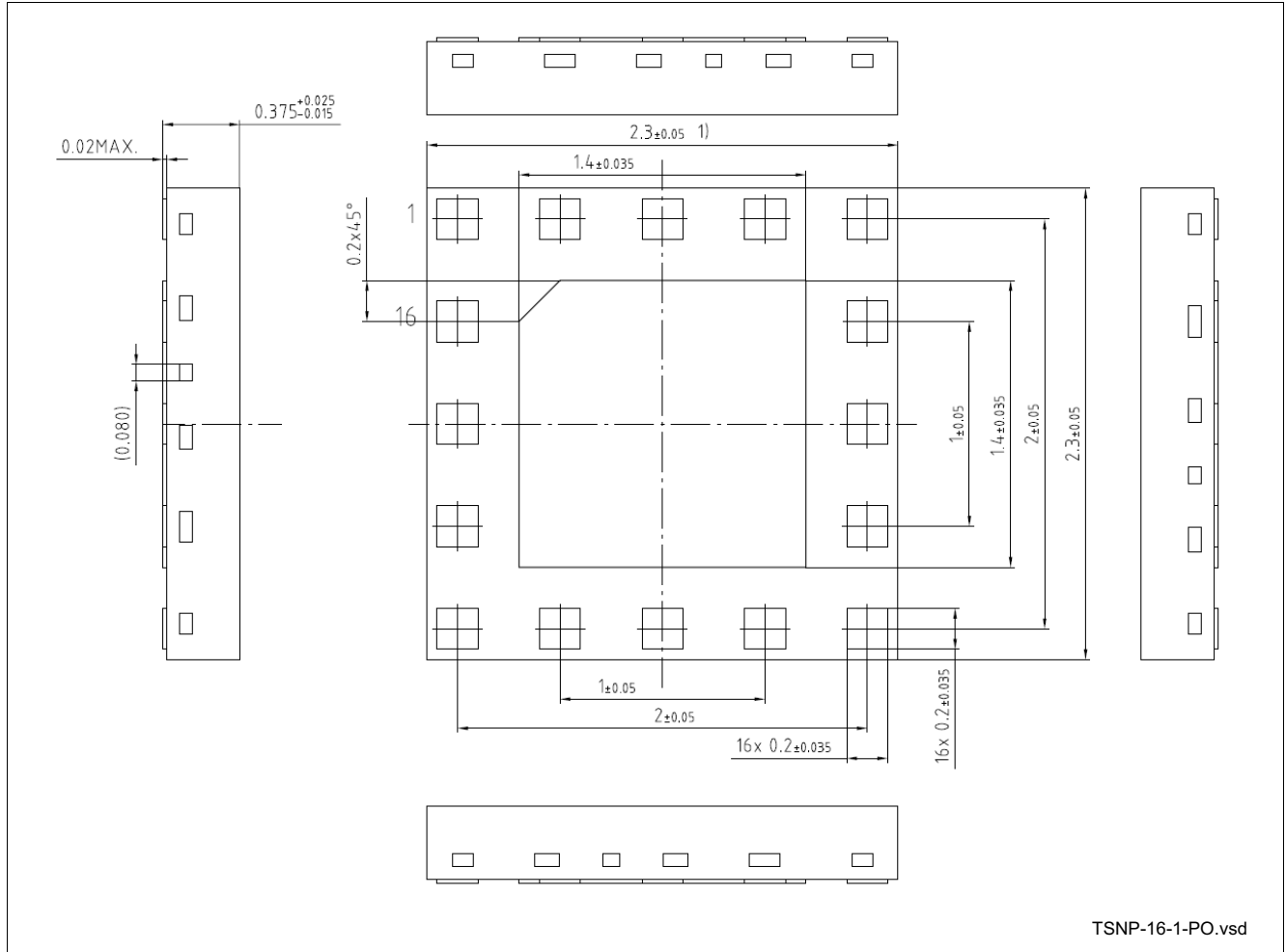
## 4 Physical Characteristics

### 4.1 Package Footprint



**Figure 5 Recommended Footprint and Stencil Layout for the TSNP-16-1 Package**

## 4.2 Package Dimensions



**Figure 6 Package Outline (Top, Side and Bottom View)**

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