PRELIMINARY DATA SHEET

# SKY65902-21: Low-Noise Amplifier Front-End Module with GPS/GNSS Pre- and Post-Filters

## Applications

- GPS/GNSS radio receivers

## Features

- Small signal gain: 12 dB typical @ GNSS band
- IIP3: +2 dBm
- Low Noise Figure: 2 dB
- Low current consumption
- Input/output impedance internally matched to 50 Ω
- Single DC supply: 1.8 to 3.6 V
- Minimal number of external components required
- Small, MCM (12-pin, 3.2 x 2.5 mm) package (MSL3, 250 °C per JEDEC J-STD-020)

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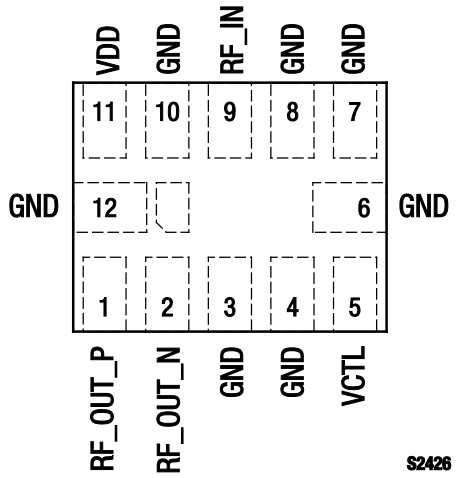


**Figure 2. SKY65902-21 Pinout – 12-Pin MCM (Top View)**

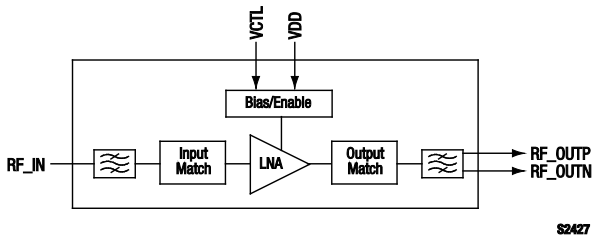


**Figure 1. SKY65902-21 Block Diagram**

## Description

The SKY65902-21 is a Front-End Module (FEM) with an integrated Low Noise Amplifier (LNA), and pre- and post-filters designed for Global Positioning System/Global Navigation Satellite System (GPS/GNSS) receiver applications. The device provides high linearity, excellent gain, and a superior Noise Figure (NF).

The SKY65902-21 is available with both differential and single-ended outputs.

The LNA is fabricated using advanced GaAs pHEMT technology. The GPS pre-filter provides the low in-band insertion loss and excellent rejections for the cellular, PCS, and WLAN frequency bands. The SKY65902-21 uses Surface Mount Technology (SMT) in the form of a 3.2 x 2.5 mm Multi-Chip Module (MCM) package, which allows for a highly manufacturable and low-cost solution.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

**Table 1. SKY65902-21 Signal Descriptions**

| Pin # | Name | Description | Pin # | Name | Description |
|---|---|---|---|---|---|
| 1 | RF_OUT_P | Positive RF output, 100 Ω | 7 | GND | Ground |
| 2 | RF_OUT_N | Negative RF output, 100 Ω | 8 | GND | Ground |
| 3 | GND | Ground | 9 | RF_IN | RF input |
| 4 | GND | Ground | 10 | GND | Ground |
| 5 | VCTL | LNA enable/bias | 11 | VDD | Source voltage |
| 6 | GND | Ground | 12 | GND | Ground |

**Table 2. SKY65902-21 Absolute Maximum Ratings**

| Parameter | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|
| RF input power | $P_{IN}$ | | 15 | dBm |
| Supply voltage | $V_{DD}$ | 1.8 | 3.6 | V |
| Storage temperature | $T_{STG}$ | –65 | +125 | °C |
| Junction temperature | $T_J$ | | +150 | °C |

**Note:** Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

***CAUTION**: Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times. The SKY65902-21 ESD threshold level is 2000 VDC at the RF_IN pin using Human Body Model (HBM) testing.*

**Table 3. SKY65902-21 Recommended Operating Conditions**

| Parameter | Symbol | Minimum | Typical | | Maximum | Units |
|---|---|---|---|---|---|---|
| Frequency range | f | 1565 | 1575 | 1601.8 | 1606 | MHz |
| RF input power | $P_{IN}$ | | –85 | –85 | | dBm |
| Supply voltage (measured at terminals of Evaluation Board) | $V_{DD}$ | 1.80 | 2.85 | 2.85 | 3.60 | V |
| Control voltage:<br>Enable (high)<br>Disable (low) | $V_{CTL}$ | <br>1.3<br>0 | 1.8 | 1.8 | <br>$V_{DD}$<br>0.3 | <br>V<br>V |
| Case operating temperature | $T_C$ | –30 | | | +85 | °C |

## Technical Description

### LNA Enable

The VCTL signal (pin 5) enables or disables the LNA. A logic high signal powers on the LNA and a logic low signal powers off the device. An external series resistor can be used on this pin to adjust the LNA bias current.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65902-21 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4.

Performance characteristics for the SKY65902-21 are illustrated in Figures 3 through 6.

**Table 4. SKY65902-21 Electrical Specifications (Note 1)**
**($V_{DD}$ = 2.85 V, VCTL = 1.8 V, $T_C$= +25 °C, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical (1575 MHz) | Typical (1601.8 MHz) | Max | Units |
|---|---|---|---|---|---|---|---|
| Small signal gain | G | | | 12.9 | 12.0 | | dB |
| Noise Figure | NF | | | 2.0 | 2.5 | | dB |
| Third Order Input Intercept Point (in band) | IIP3 | f1 = 1575 MHz and f2 = 1576 MHz @ $P_{IN}$ = –30 dBm | | +2 | +2 | | dBm |
| 700 MHz harmonic | | Input jammer @ 787.76 MHz @ +15 dBm, measured at 1575.52 MHz | | –60 | –60 | | dBm |
| Cellular band rejection @ 824.6 MHz | | | | +70 | +70 | | dBc |
| DCS band rejection @ 1712.7 MHz | | | | +70 | +70 | | dBc |
| PCS band rejection @ 1800 MHz | | | | +60 | +60 | | dBc |
| WLAN rejection @ 2400 MHz | | | | +65 | +65 | | dBc |
| Reverse isolation | $\|S12\|$ | | | 20 | 20 | | dB |
| Input return loss | $\|S11\|$ | | | 10 | 10 | | dB |
| Output return loss | $\|S22\|$ | | | 10 | 10 | | dB |
| Current consumption | $I_{DD}$ | | | 5 | 5 | | mA |
| Shut down current | $I_{SHUTDOWN}$ | | | 0.5 | 0.5 | | µA |
| Power gain settling time | | | | 5 | 5 | | µs |

**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

## Typical Performance Characteristics

**($V_{DD}$ = 2.85 V, $T_C$= +25 °C, VCTL = 1.8 V, Unless Otherwise Noted)**

*** TBD ***

**Figure 3. Input Return Loss vs Frequency**

*** TBD ***

**Figure 4. Output Return Loss vs Frequency**

*** TBD ***

**Figure 5. Reverse Isolation vs Frequency**

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**Figure 6. Small Signal Gain vs Frequency**

## Evaluation Board Description

The SKY65902-21 Evaluation Board is used to test the performance of the SKY65902-21 LNA. An assembly drawing for the Evaluation Board is shown in Figure 7. The Evaluation Board schematic diagram is shown in Figure 8. Table 5 provides the Bill of Materials (BOM) list for Evaluation Board components.

## Package Dimensions

The PCB layout footprint for the SKY65902-21 is provided in Figure 9. Package dimensions for the 12-pin MCM are shown in Figure 10, and tape and reel dimensions are provided in Figure 11.

## Package and Handling Information

Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

THE SKY65902-21 is rated to Moisture Sensitivity Level 3 (MSL3) at 250 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design & SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

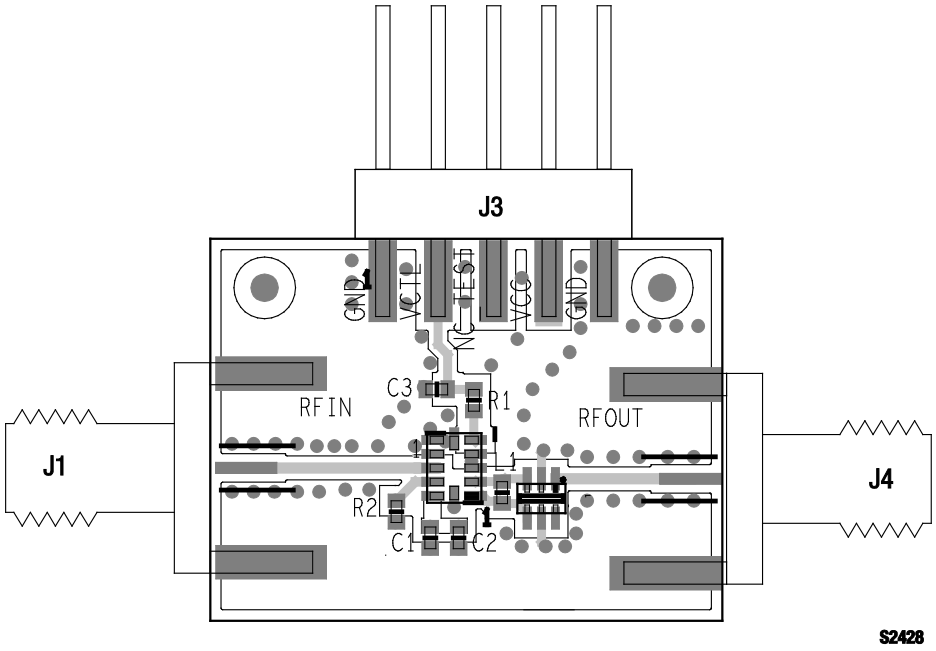



**Figure 7. SKY65902-21 Evaluation Board Assembly Diagram**

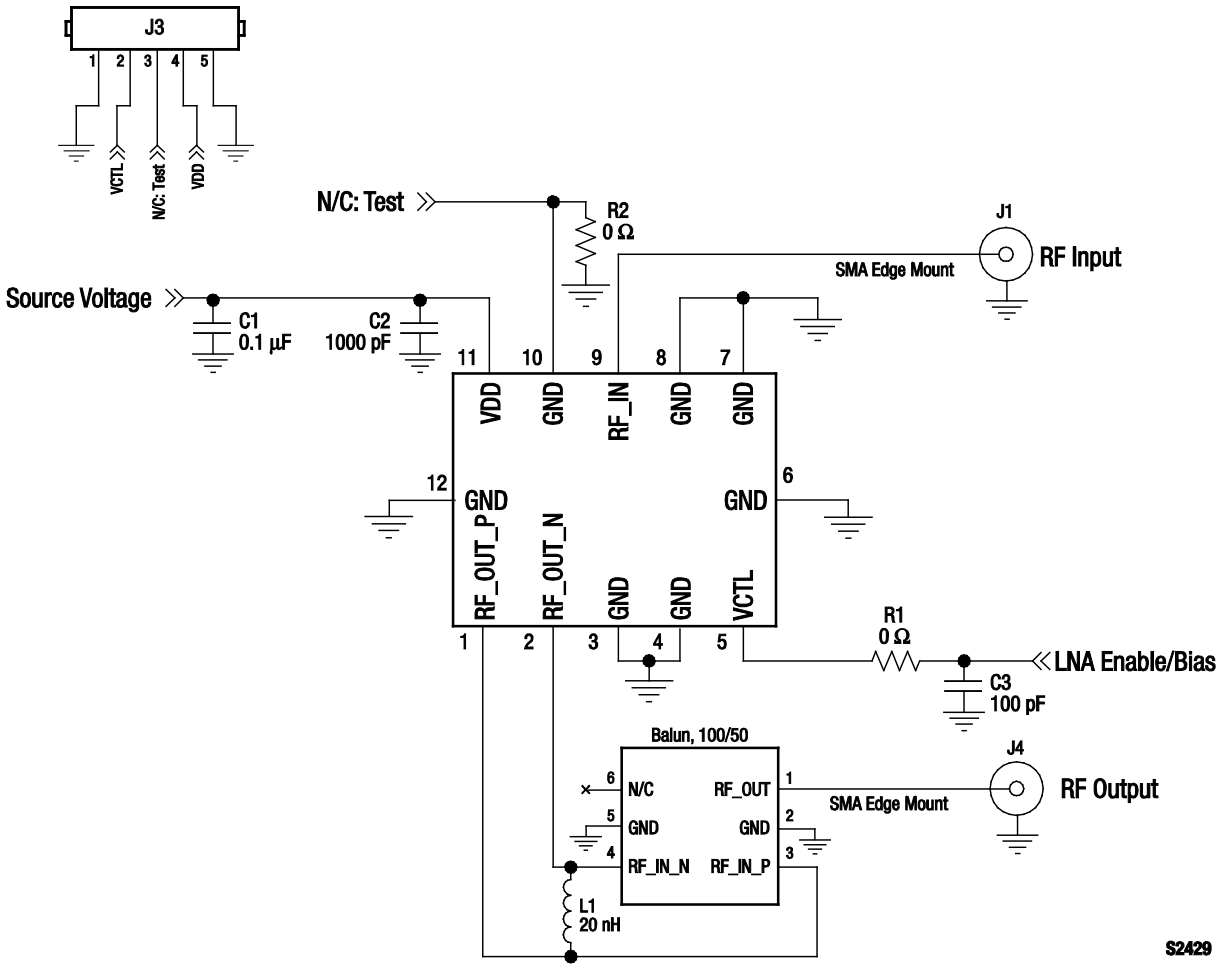
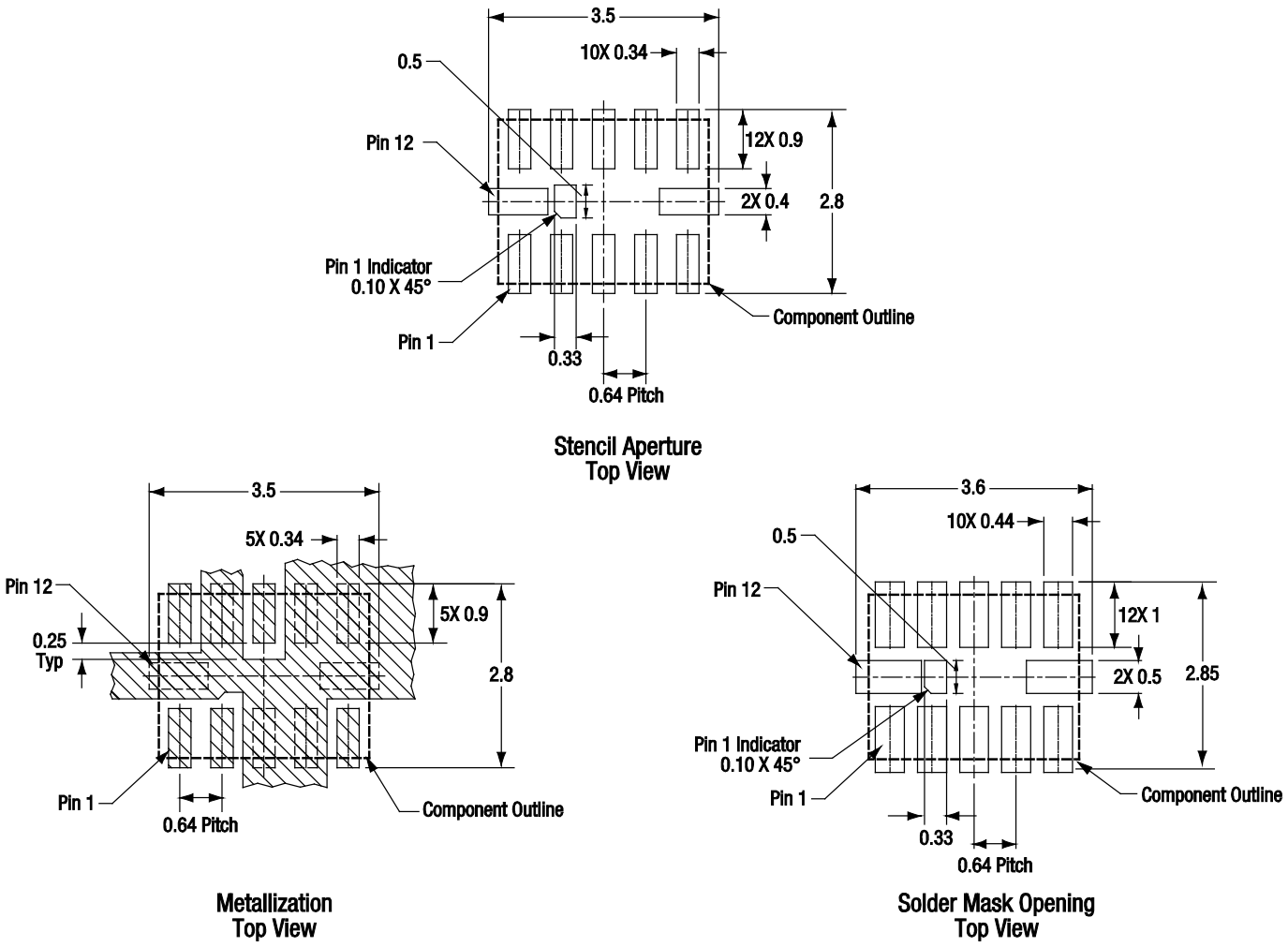



**Figure 8. SKY65902-21 Evaluation Board Schematic**

**Table 5. SKY65902-21 Evaluation Board Bill of Materials**

| Component | Size | Value | Vendor | Part Number |
|---|---|---|---|---|
| C1 | 0402 | 0.1 µF | | |
| C2 | 0402 | 1000 pF | | |
| C3 | 0402 | 100 pF | | |
| L1 | 0402 | 20 nH | | |
| R1 | 0402 | 0 Ω | | |
| R2 | 0402 | 0 Ω | | |




*NOTE: thermal vias should be tented and filled with solder mask, 30-35 µm Cu plating recommended.*

*All measurements are in millimeters*

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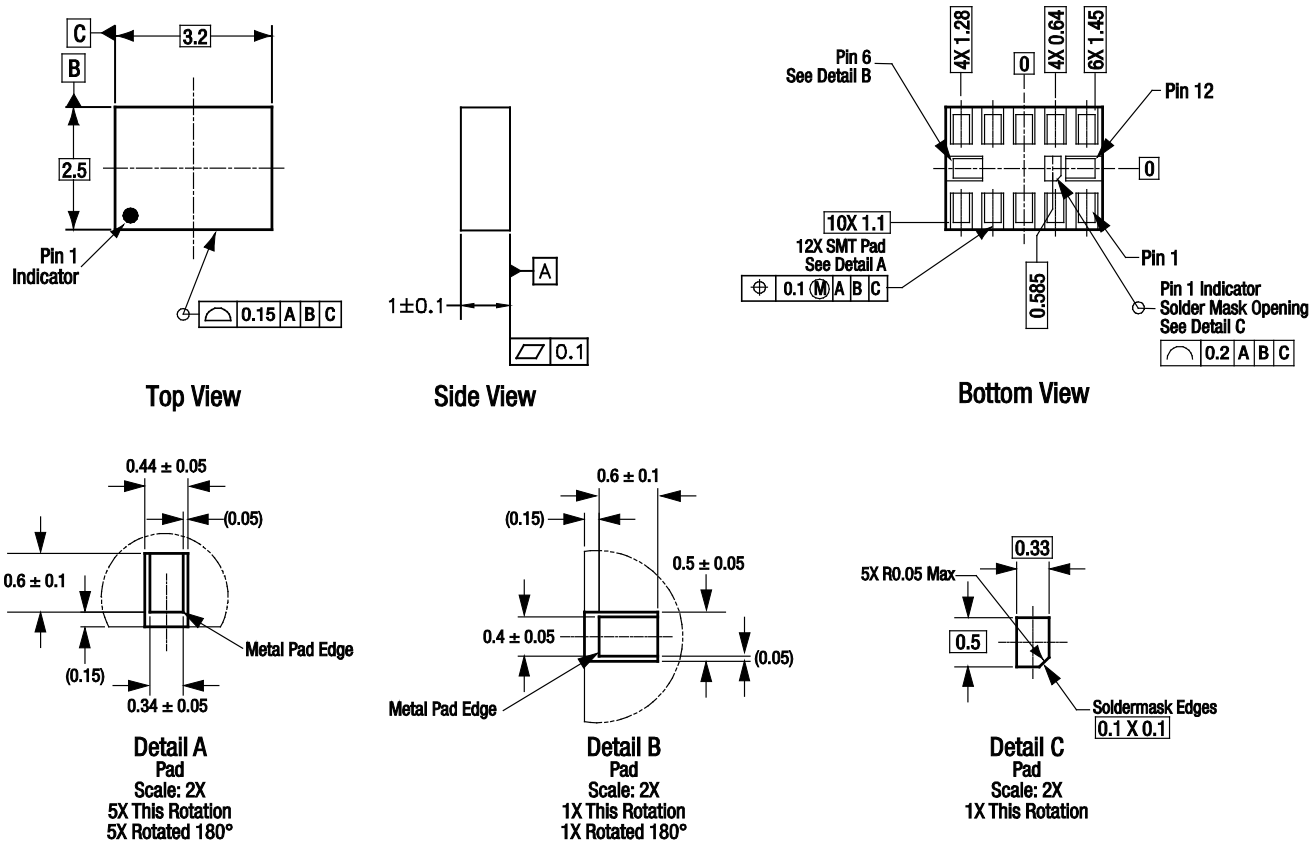
**Figure 9. PCB Layout Footprint for the SKY65902-21 3.2 x 2.5 mm MCM**




*All measurements are in millimeters*

*Dimensioning and tolerancing according to ASME Y14.5M-1994*

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**Figure 10. SKY65902-21 12-Pin MCM Package Dimensions**

*** TBD ***

**Figure 11. SKY65902-21 Tape and Reel Dimensions**

## Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|---|---|---|
| SKY65902-21 Low-Noise Amplifier FEM with GPS/GNSS Pre- and Post-Filters | SKY65902-21 | TW19-D330-V1 |