DATA SHEET

# SKY65933-11: GNSS Low-Noise Amplifier Front-End Module with Integrated Pre-Filter and Post-Filter

## Applications

- Wearables
- Actions cameras
- Drones
- Personal navigation devices
- GNSS radio receivers

## Features

- Small signal gain: 14.5 dB
- In-band IIP3: -8 dBm
- Low noise figure: 1.9 dB
- Low current consumption: 2.9 mA @ 1.8 V
- Shut-down current: 0.1 uA
- Input/output impedance internally matched to 50 Ω
- Single DC supply: 1.5 to 2.85 V
- No external matching components required
- Pin-to-pin compatible with SKY65903-11
- Small MCM (16-pin, 2.5 x 2.5 mm) package (MSL3, 260 °C per JEDEC J-STD-020)
- For RoHS and other product compliance information, see the Skyworks Certificate of Conformance

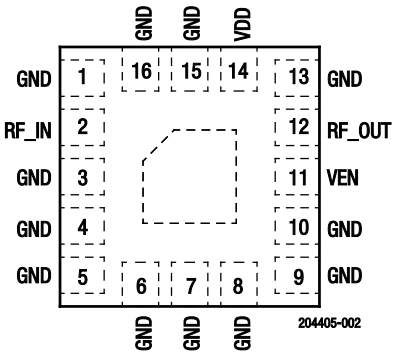


**Figure 2. SKY65933-11 Pinout (Top View)**

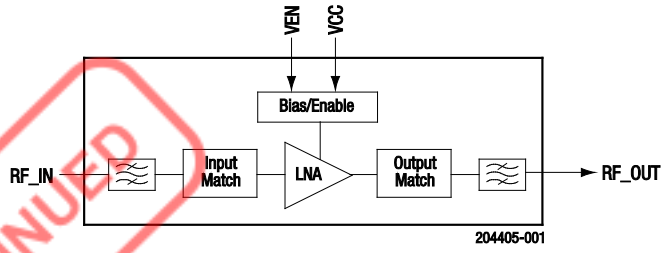


**Figure 1. SKY65933-11 Block Diagram**

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## Description

The SKY65933-11 is a front-end module (FEM) with an integrated low-noise amplifier (LNA), pre-filter, and post-filter designed for Global Navigation Satellite System receiver applications. The device fully integrates all input and output matching components to simplify PCB designs. The pre-filter and post-filter provide low in-band insertion loss and excellent rejection for the cellular, PCS, and WLAN frequency bands. The device also features a single-pin enable and an extremely low shut-down current when disabled.

The SKY65933-11 is optimized to operate at 1559 to 1606 MHz, which makes it ideal for GPS/GLONASS/Galileo/Compass/QZSS radio receiver applications.

The SKY65933-11 uses surface-mount technology (SMT) in the form of a 2.5 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. SKY65933-11 Signal Descriptions**

| Pin | Name | Description | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | GND | Ground | 9 | GND | Ground |
| 2 | RF_IN | RF input | 10 | GND | Ground |
| 3 | GND | Ground | 11 | VEN | LNA enable |
| 4 | GND | Ground | 12 | RF_OUT | RF output |
| 5 | GND | Ground | 13 | GND | Ground |
| 6 | GND | Ground | 14 | VCC | LNA power supply |
| 7 | GND | Ground | 15 | GND | Ground |
| 8 | GND | Ground | 16 | GND | Ground |

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## Technical Description

### LNA Enable

The VEN signal (pin 11) enables or disables the LNA. A logic high signal powers on the LNA, and a logic low signal powers off the device.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65933-11 are provided in Table 2. The recommended operating conditions are specified in Table 3. Electrical specifications for 1.8 V and 2.8 V operation are shown in Table 4 and Table 5, respectively.

**Table 2. SKY65933-11 Absolute Maximum Ratings[1]**

| Parameter | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|
| RF input power | $P_{IN}$ | | +10 | dBm |
| Supply voltage | $V_{CC}$ | 0 | 3.1 | V |
| Storage temperature | $T_{STG}$ | -55 | +150 | °C |
| Junction temperature | $T_J$ | | +150 | °C |
| Electrostatic discharge: | ESD | | | |
| Human Body Model (HBM), Class 1A | | | 250 | V |

1 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.

***ESD HANDLING**: 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 when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.*

**Table 3. SKY65933-11 Recommended Operating Conditions**

| Parameter | Symbol | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Frequency | f | 1559 | 1575 | 1606 | MHz |
| Supply voltage | $V_{CC}$ | 1.5 | 1.8 | 2.85 | V |
| LNA enable: | | | | | |
| Enable (high) | $LNA_{ENABLE}$ | $V_{CC}$ - 0.3 | | $V_{CC}$ | V |
| Disable (low) | $LNA_{DISABLE}$ | | 0 | 0.3 | V |
| Case temperature | $T_C$ | -40 | +25 | +85 | °C |

**Table 4. SKY65933-11 Electrical Specifications[1]**
**(Vcc = 1.8 V, VEN = 1.8 V, f = 1575 MHz, Tc = +25°C, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Small signal gain | \|S21\| | $P_{IN}$ = -30 dBm:<br>@ 1559 MHz<br>@ 1575 MHz<br>@ 1606 MHz | <br>11.0<br>12.0<br>10.5 | <br>13.0<br>14.0<br>13.0 | | <br>dB<br>dB<br>dB |
| Noise figure | NF | @ 1559 MHz<br>@ 1575 MHz<br>@ 1606 MHz | | 2.3<br>1.9<br>2.3 | 2.6<br>2.5<br>3.0 | dB<br>dB<br>dB |
| In-band third order input intercept point | IIP3 | f1 = 1575 MHz @ $P_{IN}$ = -30 dBm<br>f2 = 1576 MHz @ $P_{IN}$ = -30 dBm | | -8 | | dBm |
| 1 dB input compression point (in-band) | IP1dB | | | -13 | | dBm |
| Reverse isolation | \|S12\| | $P_{IN}$ = -30 dBm | | 42 | | dB |
| Input return loss | \|S11\| | $P_{IN}$ = -30 dBm | | 8 | | dB |
| Output return loss | \|S22\| | $P_{IN}$ = -30 dBm | | 20 | | dB |
| Supply current | $I_{CC}$ | No RF | | 2.9 | 4.0 | mA |
| Shut-down current | $I_{LEAK}$ | No RF, VEN = 0 V | | 0.1 | 1.0 | µA |
| Out-of-band rejection | OOB | $P_{IN}$ = 0 dBm (in-band referred):<br>@ 806 to 928 MHz<br>@1710 to 1980 MHz<br>@2400 to 2500 MHz | | <br>95<br>80<br>75 | | <br>dBc<br>dBc<br>dBc |

1 Performance is guaranteed only under the conditions listed in this table.

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**Table 5. SKY65933-11 Electrical Specifications[1]**
**(Vcc = 2.8 V, VEN = 2.8 V, f = 1575 MHz, Tc = +25°C, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Small signal gain | \|S21\| | $P_{IN}$ = -30 dBm:<br>@ 1559 MHz<br>@ 1575 MHz<br>@ 1606 MHz | <br>12.0<br>12.5<br>11.5 | <br>14<br>14.5<br>13.5 | | <br>dB<br>dB<br>dB |
| Noise figure | NF | @ 1559 MHz<br>@ 1575 MHz<br>@ 1606 MHz | | 2.3<br>1.9<br>2.3 | | dB<br>dB<br>dB |
| In-band third order input intercept point | IIP3 | f1 = 1575 MHz @ $P_{IN}$ = -30 dBm<br>f2 = 1576 MHz @ $P_{IN}$ = -30 dBm | | -8 | | dBm |
| 1 dB input compression point (in-band) | IP1dB | | | -10 | | dBm |
| Reverse isolation | \|S12\| | $P_{IN}$ = -30 dBm | | 42 | | dB |
| Input return loss | \|S11\| | $P_{IN}$ = -30 dBm | | 8 | | dB |
| Output return loss | \|S22\| | $P_{IN}$ = -30 dBm | | 20 | | dB |
| Supply current | $I_{CC}$ | No RF | | 3 | 4 | mA |
| Shut-down current | $I_{LEAK}$ | No RF, VEN = 0 V | | 0.1 | 1.0 | µA |
| Out-of-band rejection | OOB | $P_{IN}$ = 0 dBm (in-band referred):<br>@ 806 to 928 MHz<br>@1710 to 1980 MHz<br>@2400 to 2500 MHz | | <br>95<br>80<br>75 | | <br>dBc<br>dBc<br>dBc |

1 Performance is guaranteed only under the conditions listed in this table.

## Evaluation Board Description

The SKY65933-11 Evaluation Board is used to test the performance of the SKY65933-11 LNA. The Evaluation Board schematic diagram is shown in Figure 3.

The Evaluation Board physical layer details are shown in Figure 4. Table 5 provides the Bill of Materials (BOM) list for the Evaluation Board components.

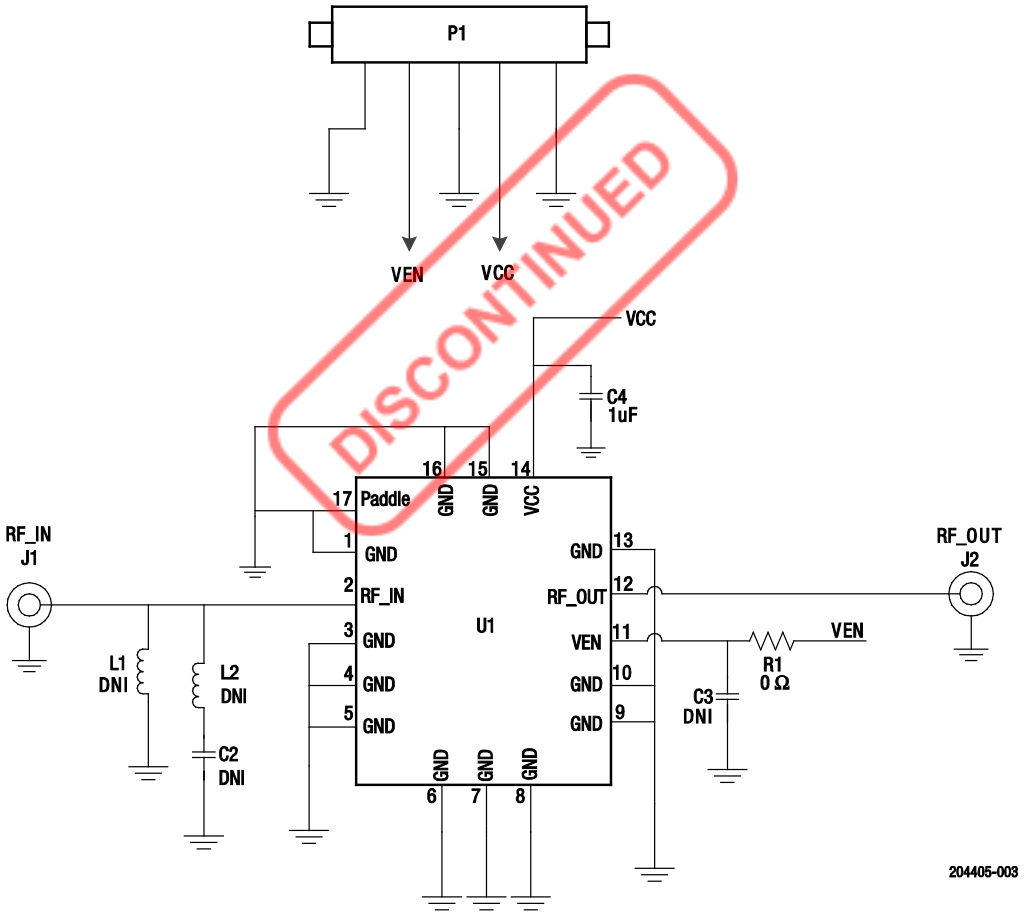


**Figure 3. SKY65933-11 Evaluation Board Schematic**

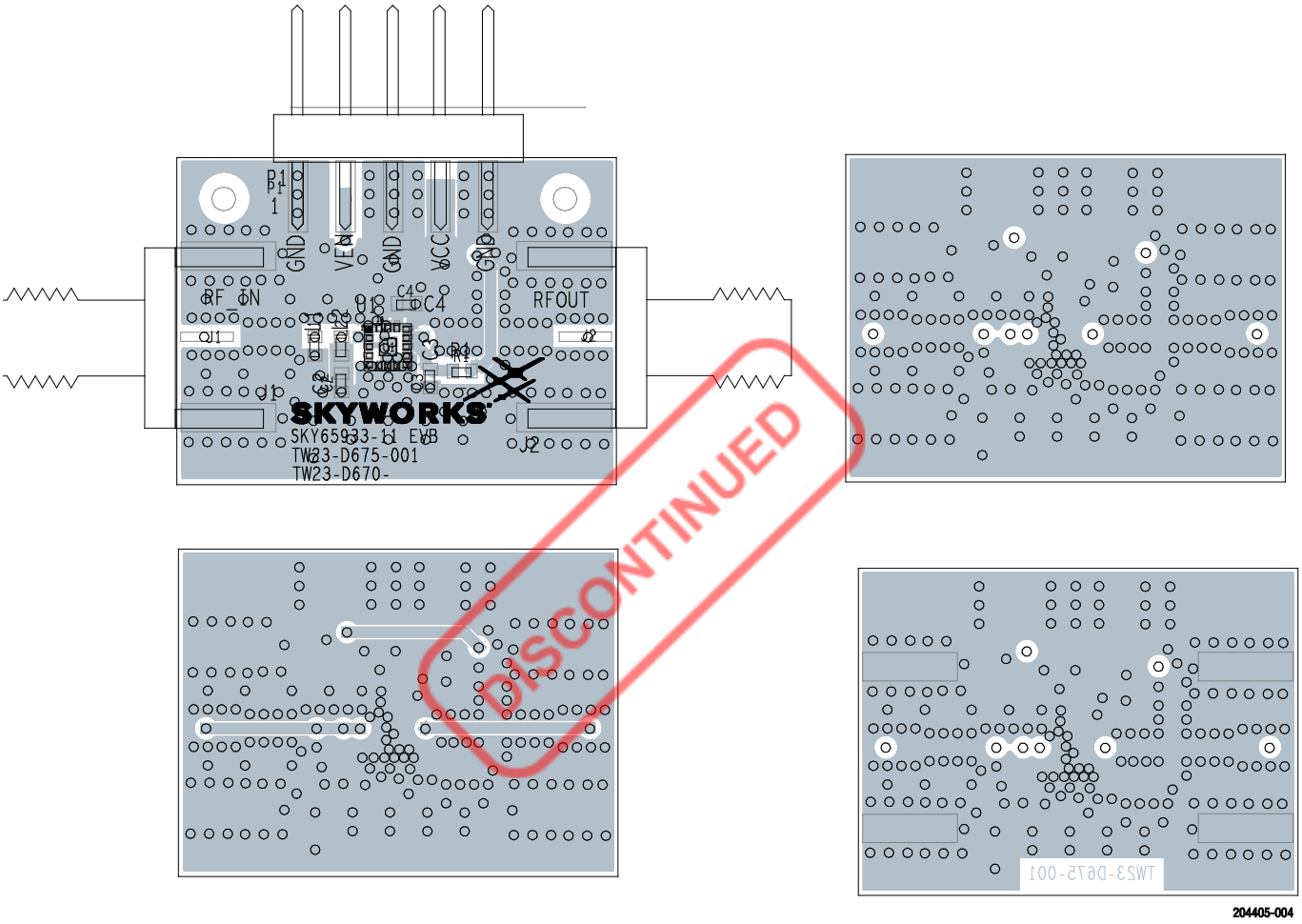


**Figure 4. SKY65933-11 Evaluation Board Assembly Diagram**

**Table 5. SKY65933-11 Evaluation Board Bill of Materials**

| Component | Size | Value |
|---|---|---|
| L1, L2, C2, and C3 | 0402 | DNI |
| C4 | 0402 | 1 µF |
| R1 | 0402 | 0 Ω |

## Package Dimensions

The PCB layout footprint for the SKY65933-11 is provided in Figure 5. Typical part markings are shown in Figure 6. Package dimensions are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

## 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 SKY65933-11 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °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.

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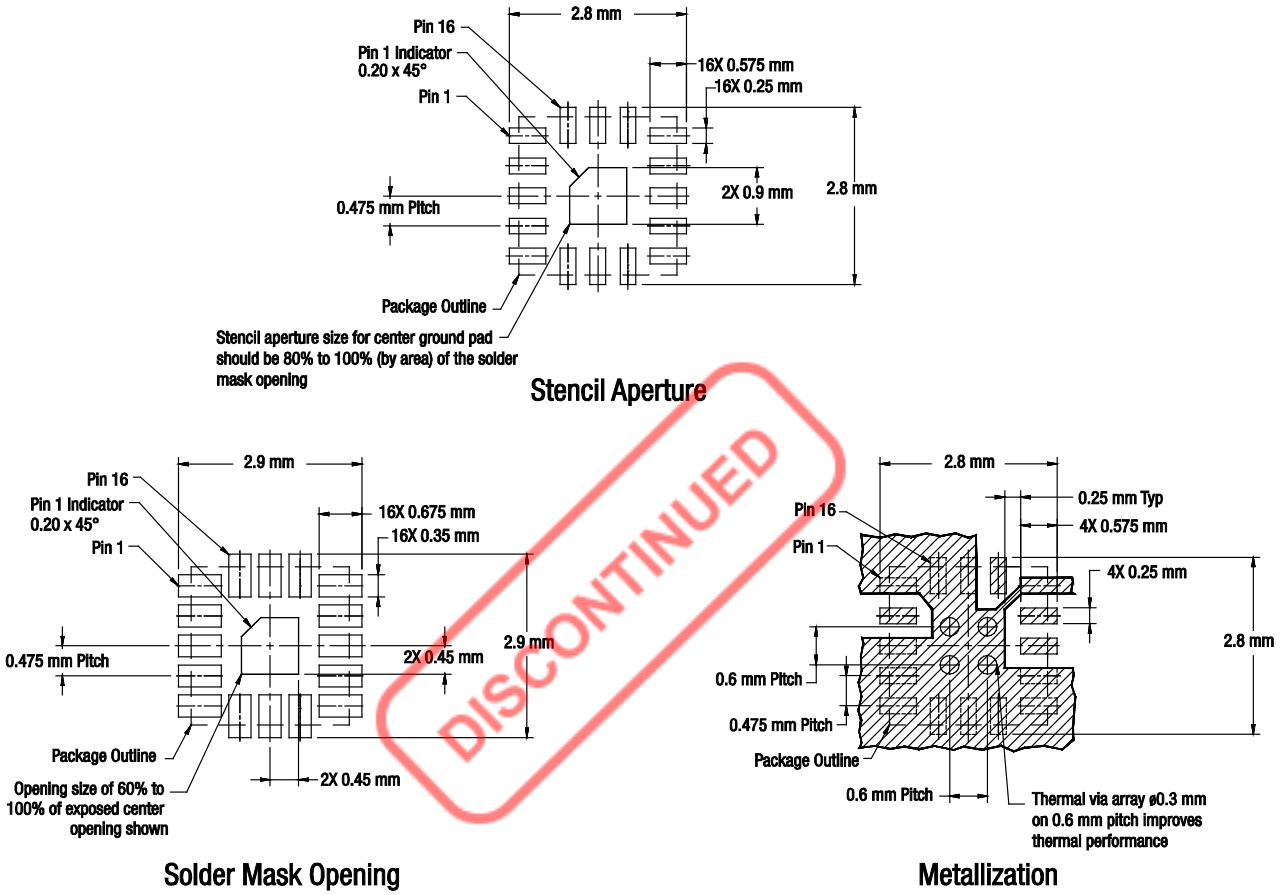


*Notes:*

1. *Thermal vias should be resin filled and capped in accordance with IPC–4761 type VII vias.*
2. *Recommended Cu thickness is 30 to 35 µm.*

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**Figure 5. SKY65933-11 PCB Layout Footprint**

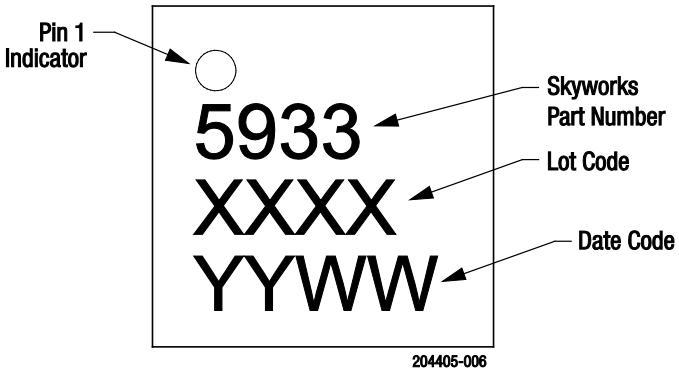
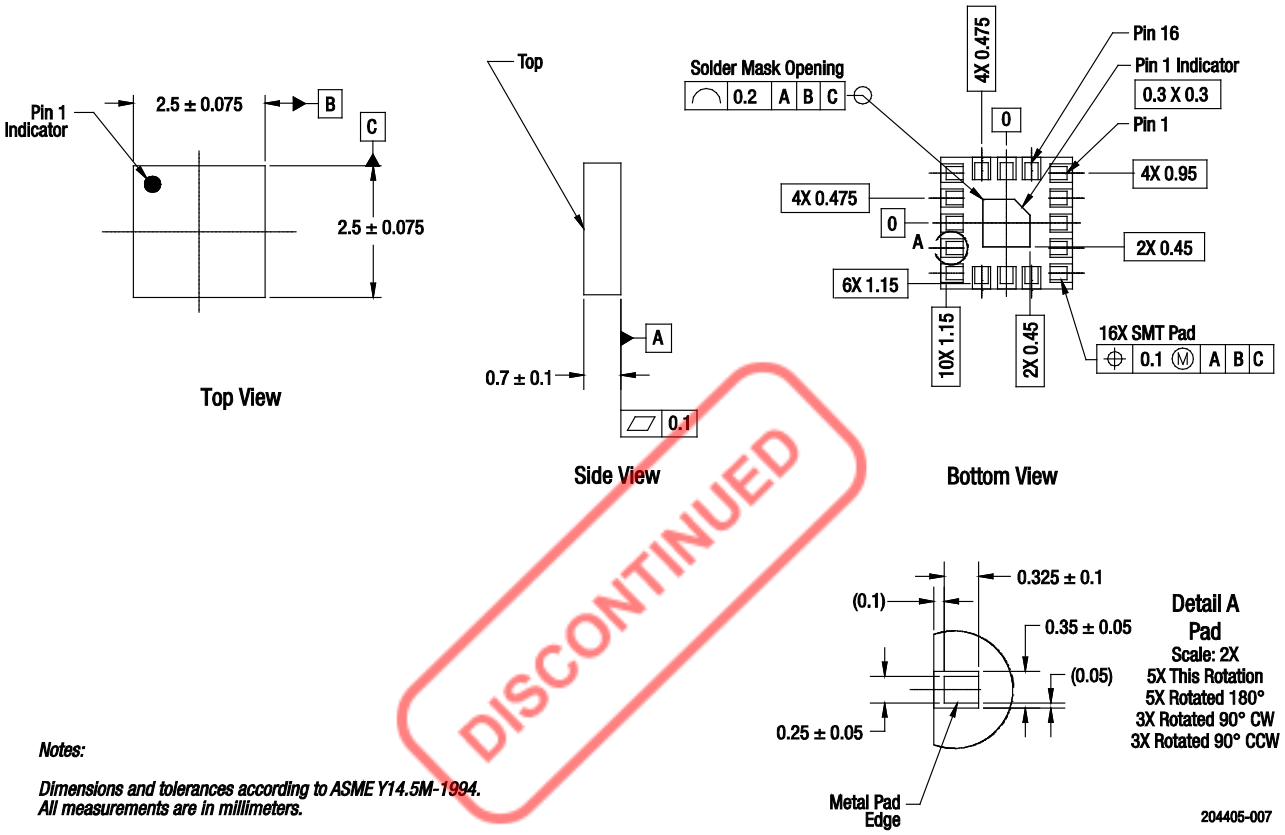


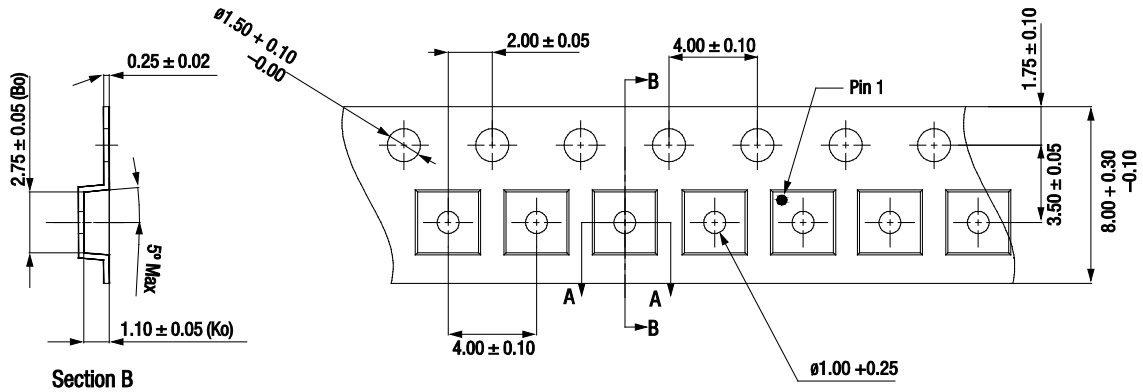

**Figure 6. Typical Part Markings (Top View)**




*Notes:*

*Dimensions and tolerances according to ASME Y14.5M-1994.*
*All measurements are in millimeters.*

**Figure 7. SKY65933-11 Package Dimensions**




*Notes:*

*1. Carrier tapes must meet all requirements of Skyworks GP01-D232 procurement spec for tape and reel shipping.*
*2. Carrier tape shall be black conductive polycarbonate or polystyrene.*
*3. Cover tape shall be transparent conductive material.*
*4. ESD-surface resistivity shall be ≤ 1 × $10^{10}$Ω/square per EIA, JEDEC TNR specification.*
*5. 10-sprocket hole pitch cumulative tolerance: ±0.20 mm.*
*6. Ao and Bo measured on plane 0.30 mm above the bottom of the pocket.*
*7. All measurements are in millimeters.*

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**Figure 8. SKY65933-11 Tape and Reel Dimensions**

## Ordering Information

| Part Number | Product Description | Evaluation Board Part Number |
|---|---|---|
| SKY65933-11 | GNSS Low-Noise Amplifier FEM with Integrated Pre-Filter and Post-Filter | SKY65933-11EK1 |


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