

# SKY13448-001: 0.1 – 3.0 GHz SPDT High Power Switch (Single Bit Control) in a WLCSP Package

## Applications

- LTE TDD/FDD transmit/receive
- GSM transmit
- Embedded modules

## Features

- Broadband frequency range: 0.1 to 3.0 GHz
- Low insertion loss: 0.5 dB @ 2.7 GHz
- High isolation: 25 dB up to 2.7 GHz
- No external DC blocking capacitors required
- Single GPIO control line with V<sub>DD</sub> voltage regulator:
  - V<sub>CTL</sub> = 1.65 to 2.70 V
  - V<sub>DD</sub> = 2.45 to 3.00 V
- Small, 8-bump WLCSP, 200 μm diameter, 400 μm pitch (1.1 x 1.1 x 0.36 mm) package (MSL1, 260 °C per JEDEC J-STD-020)



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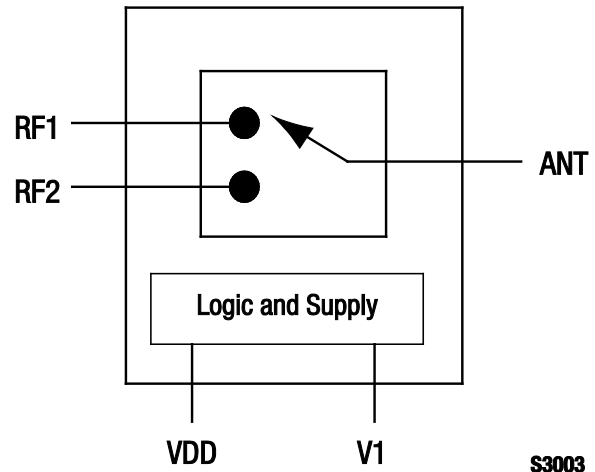


Figure 1. SKY13448-001 Block Diagram

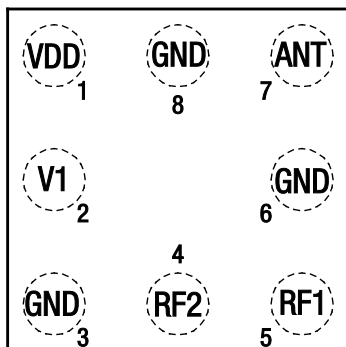
## Description

The SKY13448-001 is a Single-Pole, Double-Throw (SPDT) LTE/WCDMA/GSM transmit switch. Switching is controlled by an integrated GPIO interface with a single control pin. Depending on the logic voltage level applied to the control pin, the antenna port is connected to one of the switched RF outputs (RF1 or RF2) through a low insertion loss path, while the path between the antenna port and the other RF port is in a high isolation state.

No external DC blocking capacitors are required as long as no DC voltage is applied on any RF path.

The SKY13448-001 is provided in a compact 8-bump, 1.1 x 1.1 x 0.36 mm Wafer Level Chip Scale Package (WLCSP) that meets requirements for board-level assembly. Bump diameters are 200 microns with a minimum bump pitch of 400 microns.

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.



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Figure 2. SKY13448-001 Pinout (Top View, Bumps Facing Down)

**Table 1. SKY13448-001 Signal Descriptions**

| Pin # | Name | Description                    | Pin # | Name | Description                    |
|-------|------|--------------------------------|-------|------|--------------------------------|
| 1     | VDD  | Supply voltage                 | 5     | RF1  | RF I/O. Throw 1 of the switch. |
| 2     | V1   | Digital control input          | 6     | GND  | Ground                         |
| 3     | GND  | Ground                         | 7     | ANT  | Antenna                        |
| 4     | RF2  | RF I/O. Throw 2 of the switch. | 8     | GND  | Ground                         |

**Table 2. SKY13448-001 Absolute Maximum Ratings**

| Parameter   | Symbol | Minimum | Maximum     | Units      |
|---|--------|---------|-------------|------------|
| Supply voltage  | VDD    | 2.4     | 3.5         | V          |
| Digital control voltage   | VCTL   | -0.5    | +3.0        | V          |
| RF input power  | PIN    |         | +39         | dBm        |
| GSM RF input power:<br>Low band<br>High band  | PIN    |         | +36<br>+34  | dBm<br>dBm |
| WCDMA/CDMA2000/LTE TDD/FDD RF input power at ANT port                                       | PIN    |         | +26         | dBm        |
| Supply ripple   | VPP    |         | 20          | mVpp       |
| Operating temperature   | TOP    | -35     | +90         | °C         |
| Storage temperature   | TSTG   | -55     | +150        | °C         |
| Electrostatic Discharge:<br>Human Body Model (HBM), Class 1C<br>Machine Model (MM), Class A | ESD    |         | 1000<br>100 | V<br>V     |

**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.

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**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.

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**Electrical and Mechanical Specifications**

The absolute maximum ratings of the SKY13448-001 are provided in Table 2. Electrical specifications are provided in Tables 3 through 7.

The state of the SKY13448-001 is determined by the logic provided in Table 8.

**Table 3. SKY13448-001 Electrical Specifications (1 of 2) (Note 1)**  
**(V<sub>DD</sub> = 2.85 V, T<sub>OP</sub> = +25 °C, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)**

| Parameter                                      | Symbol                                   | Test Condition<br>(Note 2)   | Min        | Typical    | Max            | Units  |
|--|--|--|------------|------------|----------------|--------|
| <b>DC Specifications</b>                       |  |  |            |            |                |        |
| Supply voltage                                 | V <sub>DD</sub>                          |  | 2.45       | 2.65       | 3.00           | V      |
| Control voltage:<br>Low<br>High                | V <sub>CTL_L</sub><br>V <sub>CTL_H</sub> | P <sub>IN</sub> = +35 dBm  | 0<br>+1.65 | 0<br>+1.80 | +0.45<br>+2.70 | V<br>V |
| Current on V1 pin                              | I <sub>CTL</sub>                         |  |            |            | 10             | μA     |
| Supply current                                 | I <sub>DD</sub>                          | V <sub>DD</sub> = 2.65 V, V1 =<br>V <sub>CTL_H</sub>   |            | 35         |                | μA     |
| DC supply turn-on/turn-off time                | t <sub>ON</sub>                          | Measured from 50% of<br>final V <sub>DD</sub> supply voltage to<br>final RF power ± 1 dB   |            |            | 20             | μs     |
| RF path switching time                         | t <sub>SW</sub>                          | From one active state to<br>another active state<br>transition, measured from<br>50% of final control<br>voltage to final RF input<br>power ± 1 dB |            |            | 2              | μs     |
| <b>RF Specifications</b>                       |  |  |            |            |                |        |
| Insertion loss (RF1 or RF2 to ANT pin)         | IL                                       | 0.8 to 1.0 GHz   |            | 0.35       |                | dB     |
|  |  | 0.8 to 1.0 GHz (ETC)   |            |            | 0.55           | dB     |
|  |  | 1.0 to 2.2 GHz   |            | 0.40       |                | dB     |
|  |  | 1.0 to 2.2 GHz (ETC)   |            |            | 0.60           | dB     |
|  |  | 2.2 to 2.7 GHz   |            | 0.50       |                | dB     |
| 2.2 to 2.7 GHz (ETC)                           |  |  |            | 0.70       | dB             |        |
| Noise Figure (RF1 or RF2 to ANT pin)           | NF                                       | 0.8 to 1.0 GHz (ETC)   |            |            | 0.55           | dB     |
|  |  | 1.0 to 2.2 GHz (ETC)   |            |            | 0.60           | dB     |
|  |  | 2.2 to 2.7 GHz (ETC)   |            |            | 0.70           | dB     |
| Isolation                                      | ISO                                      | 0.8 to 1.0 GHz (ETC)   | 32         | 37         |                | dB     |
|  |  | 1.0 to 2.2 GHz (ETC)   | 27         | 30         |                | dB     |
|  |  | 2.2 to 2.7 GHz (ETC)   | 25         | 27         |                | db     |
| Voltage Standing Wave Ratio, all ports         | VSWR                                     | Referenced to 50 Ω,<br>0.8 to 6.0 GHz  |            | 1.15:1     | 1.3:1          | –      |
| <b>Large Signal Specifications</b>             |  |  |            |            |                |        |
| LTE/WCDMA harmonics<br>(RF1 or RF2 to ANT pin) |  | fo = 815 to 915 MHz,<br>P <sub>IN</sub> = +24 dBm,<br>VSWR = 2.5:1:<br><br>3 <sup>rd</sup> harmonics   |            |            | –80            | dBm    |
|  |  | All other harmonics up to<br>12.75 GHz   |            |            | –65            | dBm    |

**Table 3. SKY13448-001 Electrical Specifications (2 of 2) (Note 1)**  
**(V<sub>DD</sub> = 2.85 V, T<sub>OP</sub> = +25 °C, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)**

| Parameter  | Symbol | Test Condition<br>(Note 2)   | Min | Typical | Max | Units |
|--|--------|--|-----|---------|-----|-------|
| <b>Large Signal Specifications (continued)</b>     |        |  |     |         |     |       |
| GSM harmonics (RF1 or RF2 to ANT pin):<br>Low band |        | fo = 824 to 915 MHz,<br>P <sub>IN</sub> = +34 dBm, load<br>VSWR = 2.5:1, all other<br>harmonics up to<br>12.75 GHz   |     | -50     | -45 | dBm   |
| High band  |        | fo = 1710 to 1910 MHz,<br>P <sub>IN</sub> = +31 dBm, load<br>VSWR = 2.5:1, all other<br>harmonics up to<br>12.75 GHz   |     | -50     | -45 | dBm   |
| 3 <sup>rd</sup> Order Intermodulation Distortion   | IMD3   | CW carrier = +20 dBm;<br>Bands 1, 2, 3, 5, 8, CW<br>blocker on ANT port with<br>P <sub>IN</sub> = -15 dBm (see<br>Table 4 for carrier and<br>interferer frequencies)         |     | -110    |     | dBm   |
|  |        | CW carrier = +24 dBm;<br>Bands 1 & 2, WLAN CW<br>blocker = -20 dBm (see<br>Table 5 for carrier and<br>interferer frequencies)  |     | -100    |     | dBm   |
|  |        | CW carrier = +23 dBm;<br>Band 7, WLAN CW blocker<br>= -5 dBm (see Table 5 for<br>carrier and interferer<br>frequencies)  |     | -110    |     | dBm   |
| 2 <sup>nd</sup> Order Intermodulation Distortion   | IMD2   | frx: CW carrier =<br>+20 dBm, Bands 1, 2, 3,<br>5, 8, CW blocker on ANT<br>port with<br>P <sub>IN</sub> = -15 dBm (see<br>Table 6 for carrier and<br>interferer frequencies) |     | -100    |     | dBm   |
|  |        | frx: CW carrier =<br>+24 dBm; bands 5 & 8,<br>WLAN CW blocker on ANT<br>port with<br>P <sub>IN</sub> = 0 dBm (see Table 7<br>for carrier and interferer<br>frequencies)      |     | -100    |     | dBm   |
|  |        | frx: CW carrier =<br>+23 dBm; band 7, WLAN<br>CW blocker on ANT port =<br>-30 dBm (see Table 7 for<br>carrier and interferer<br>frequencies)                                 |     | -110    |     | dBm   |

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

**Note 2:** ETC = Extreme Test Conditions (V<sub>DD</sub> = 2.45 V to 3.00 V and T<sub>OP</sub> = -20 °C to +85 °C)

**Table 4. 3<sup>rd</sup> Order Intermodulation Distortion Frequencies, No WLAN Blocker**

| IMD3 Band | f <sub>TX</sub> (MHz) |         | f <sub>BLOCK 1</sub> (MHz) |         | f <sub>BLOCK 2</sub> (MHz) | f <sub>BLOCK 3</sub> (MHz) |         |
|-----------|-----------------------|---------|----------------------------|---------|----------------------------|----------------------------|---------|
|           | Minimum               | Maximum | Minimum                    | Maximum |                            | Minimum                    | Maximum |
| Band 1    | 1920                  | 1980    | 1730                       | 1790    | 95.0                       | 5950                       | 6130    |
| Band 2    | 1850                  | 1910    | 1770                       | 1830    | 40.0                       | 5630                       | 5810    |
| Band 3    | 1710                  | 1785    | 1615                       | 1690    | 47.5                       | 5225                       | 5450    |
| Band 5    | 824                   | 849     | 779                        | 804     | 22.5                       | 2517                       | 2592    |
| Band 8    | 880                   | 915     | 835                        | 870     | 22.5                       | 2685                       | 2790    |

**Table 5. 3<sup>rd</sup> Order Intermodulation Distortion Frequencies, WLAN Blocker**

| IMD3 WLAN  | f <sub>TX</sub> (MHz) |         | f <sub>BLOCK 1</sub> (MHz) |         |
|--|-----------------------|---------|----------------------------|---------|
|  | Minimum               | Maximum | Minimum                    | Maximum |
| Band 1 (measured at frequencies where $2f_{TX} - f_{BLOCK} = 1575$ MHz, P <sub>BLOCK</sub> = -20 dBm, and P <sub>TX</sub> = +24 dBm)               | 1920                  | 1980    | 5150                       | 5850    |
| Band 2 (measured at frequencies where $2f_{TX} - f_{BLOCK} = 1575$ MHz, P <sub>BLOCK</sub> = -20 dBm, and P <sub>TX</sub> = +24 dBm)               | 1850                  | 1910    | 5150                       | 5850    |
| Band 7 (measured at frequencies where $2620$ MHz < $2f_{TX} - f_{BLOCK}$ < $2690$ MHz, P <sub>BLOCK</sub> = -5 dBm, and P <sub>TX</sub> = +23 dBm) | 2500                  | 2570    | 2400                       | 2485    |

**Table 6. 2<sup>nd</sup> Order Intermodulation Distortion Frequencies, No WLAN Blocker**

| IMD2 Band | f <sub>TX</sub> (MHz) |         | f <sub>BLOCK 1</sub> Minimum (MHz) | f <sub>BLOCK 2</sub> (MHz) |         |
|-----------|-----------------------|---------|------------------------------------|----------------------------|---------|
|           | Minimum               | Maximum |                                    | Minimum                    | Maximum |
| Band 1    | 1920                  | 1980    | 190                                | 3650                       | 3770    |
| Band 2    | 1850                  | 1910    | 80                                 | 3620                       | 3740    |
| Band 3    | 1710                  | 1785    | 95                                 | 3325                       | 3475    |
| Band 5    | 824                   | 849     | 45                                 | 1603                       | 1653    |
| Band 7    | 2500                  | 2570    | 120                                | 4880                       | 5020    |
| Band 8    | 880                   | 915     | 45                                 | 1715                       | 1785    |
| Band 10   | 1710                  | 1770    | 400                                | 3020                       | 3140    |

**Table 7. 2<sup>nd</sup> Order Intermodulation Distortion Frequencies, WLAN Blocker**

| IMD3 WLAN  | f <sub>TX</sub> (MHz) |         | f <sub>BLOCK 1</sub> (MHz) |         |
|--|-----------------------|---------|----------------------------|---------|
|  | Minimum               | Maximum | Minimum                    | Maximum |
| Band 5 (WLAN: measured IMD2 at $f_{BLOCK} - f_{TX} = 1575$ MHz)  | 824                   | 849     | 2400                       | 2485    |
| Band 7 (WLAN: measured IMD2 at $f_{BLOCK} - f_{TX} = 1575$ MHz, P <sub>BLOCK</sub> = 0 dBm, and P <sub>TX</sub> = +24 dBm )                        | 880                   | 915     | 2400                       | 2485    |
| Band 8 (measured at frequencies where $2620$ MHz < $f_{BLOCK} - f_{TX}$ < $2690$ MHz, P <sub>BLOCK</sub> = -30 dBm, and P <sub>TX</sub> = +23 dBm) | 2500                  | 2570    | 5150                       | 5850    |

**Table 8. SKY13448-001 Truth Table**

| State | Active Path | V1 (Bump 2) |
|-------|-------------|-------------|
| 0     | ANT to RF1  | 0           |
| 1     | ANT to RF2  | 1           |

Note: "1" = 1.65 V to 2.70 V. "0" = -0 V to +0.45 V.

**Evaluation Board Description**

The SKY13448-001 Evaluation Board is used to test the performance of the SKY13448-001 SPDT Switch. An Evaluation Board schematic diagram is provided in Figure 3. An assembly drawing for the Evaluation Board is shown in Figure 4.

*Wafer Level Chip Scale Packages: SMT Process Guidelines and Handling Considerations*, document number 201676.

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.

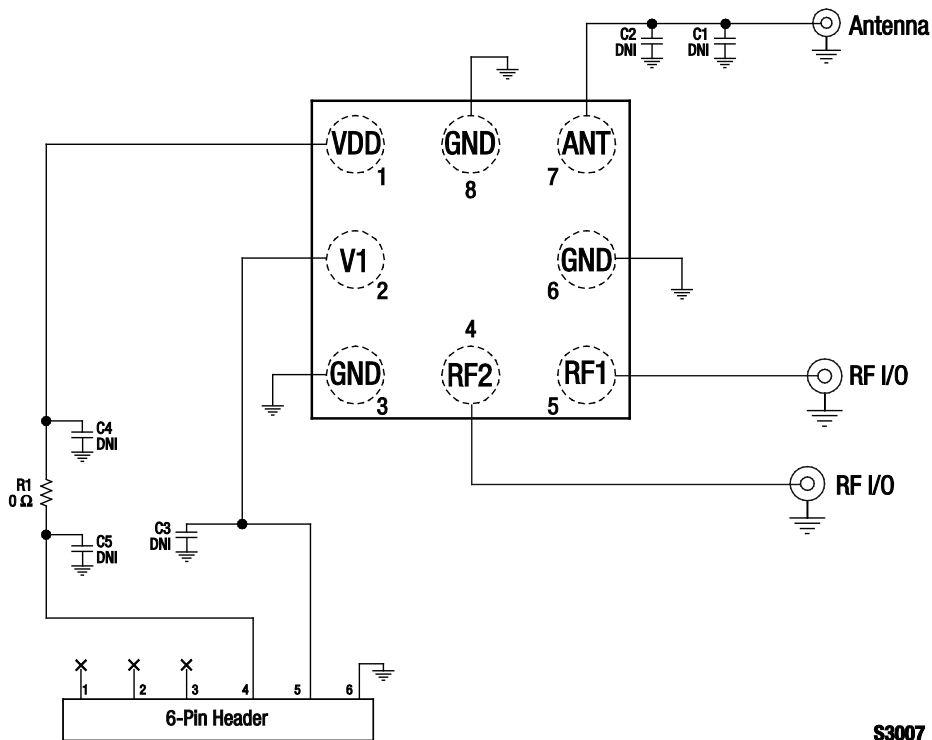
**Package and Handling Information**

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.

**Package Dimensions**

Package dimensions for the SKY13448-001 die are shown in Figure 5, and tape and reel dimensions are provided in Figure 6.

The SKY13448-001 is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note,



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**Figure 3. SKY13448-001 Evaluation Board Schematic**

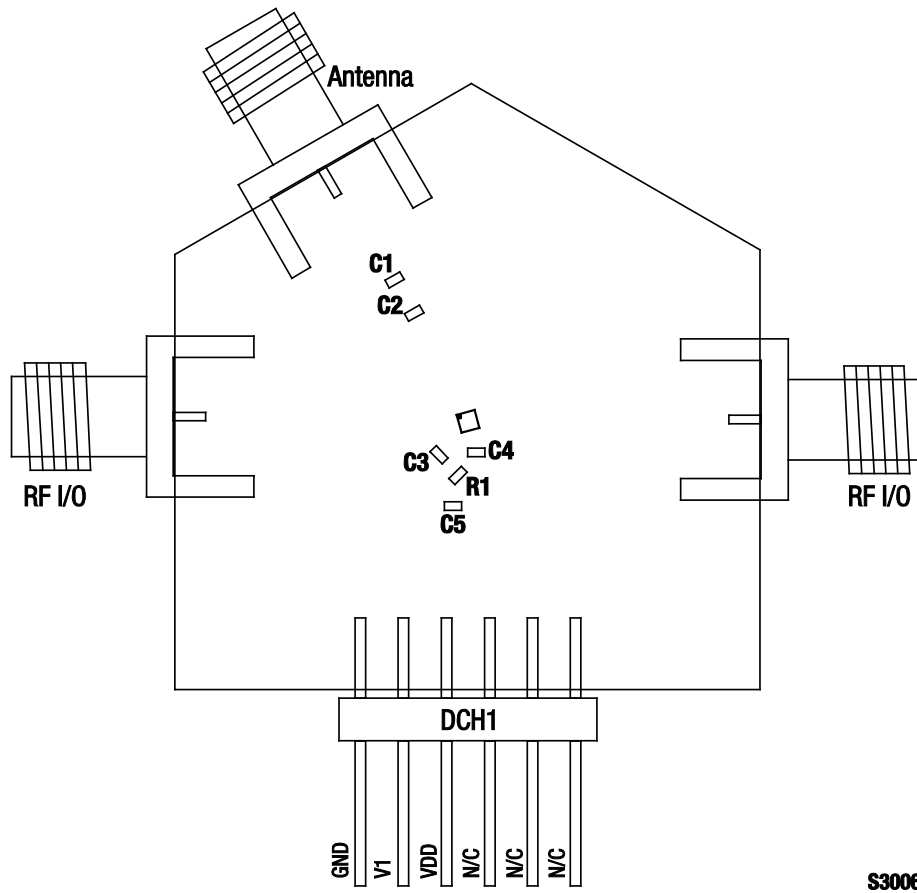
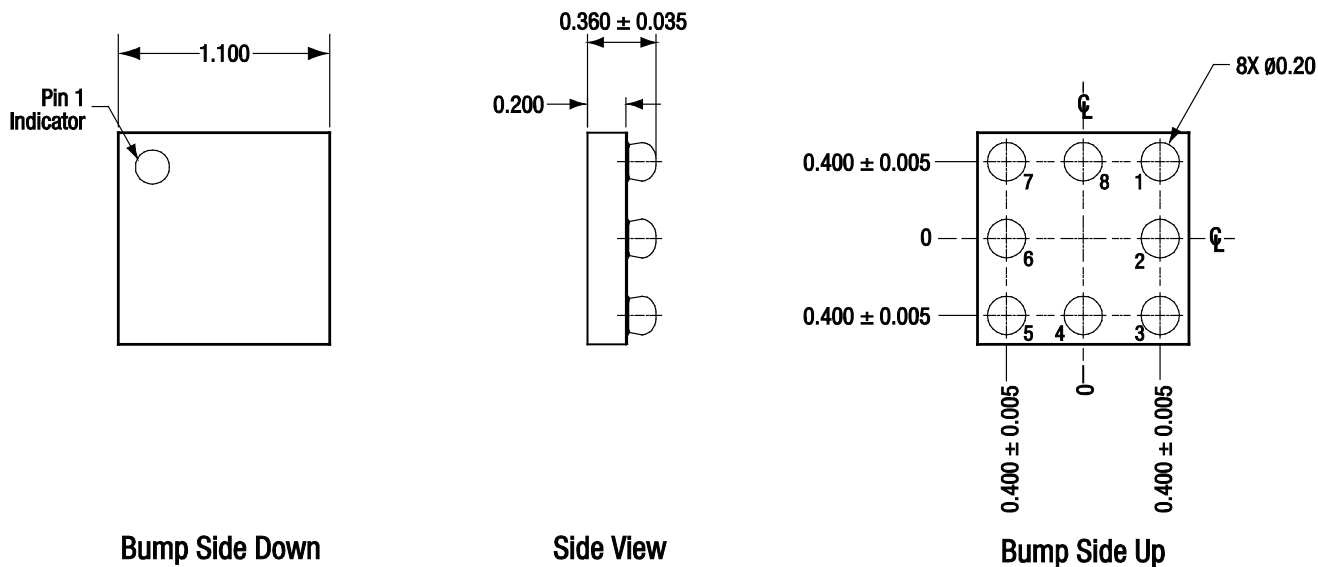


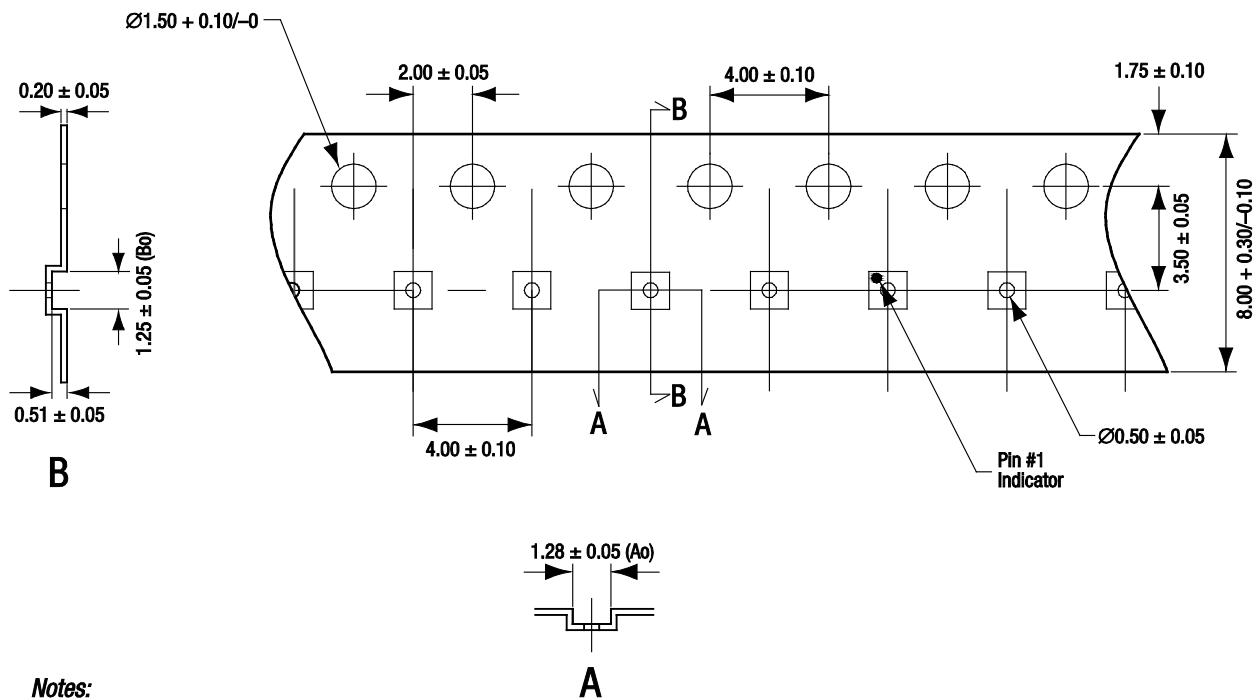
Figure 4. SKY13448-001 Evaluation Board Assembly Diagram



All measurements are in millimeters.

S3004

Figure 5. SKY13448-001 Package Dimensions



Notes:

1. Carrier tape: black conductive polycarbonate.
2. Cover tape material: transparent conductive material.
3. 10 sprocket hole pitch cumulative tolerance: ±0.20 mm.
4. Ao and Bo measured on plane 0.30 mm from bottom pocket.
5. All measurements are in millimeters.

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Figure 6. SKY13448-001 Tape and Reel Dimensions



**Ordering Information**

| Model Name   | Manufacturing Part Number | Evaluation Board Part Number |
|--|---------------------------|------------------------------|
| SKY13448-001 0.1-2.7 GHz GPIO SPDT Switch in a WLCSP Package | SKY13448-001              | SKY13448-001-EVB             |

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