



SKYWORKS®

## DATA SHEET

# SKY13397-388LF: 0.1 – 3.0 GHz DP5T Switch

### Applications

- WCDMA distribution band switches
- Broadband, high power switches
- Antenna tuning switches

### Features

- Broadband frequency range: 0.1 to 3.0 GHz
- High IPO.1dB: +38 dBm
- Low insertion loss: 0.35 dB @ 1.0 GHz and 0.4 dB @ 2.0 GHz
- High isolation: >30 dB @ 1.0 GHz and 2.0 GHz
- Operating battery voltage range: 2.5 to 5.0 V
- Small, QFN (16-pin, 2.3 x 2.3 mm) package (MSL1, 260 °C per JEDEC J-STD-020)



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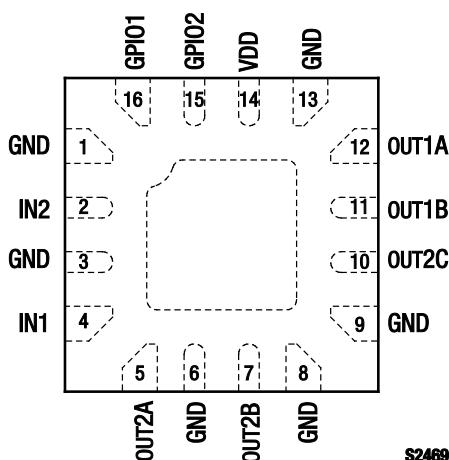


Figure 2. SKY13397-388LF Pinout – 16-Pin QFN  
(Top View)

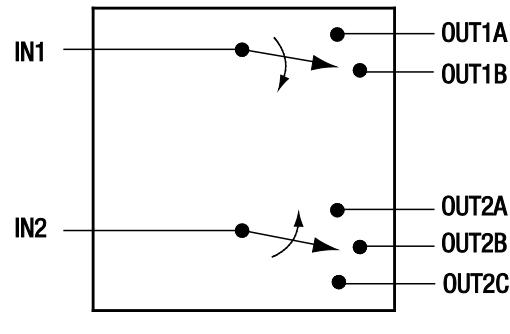


Figure 1. SKY13397-388LF Block Diagram

### Description

The SKY13397-388LF is a double-pole, five-throw (DP5T) switch designed for broadband, high-power switching applications that demand low harmonics and low insertion loss. The switch is optimized for 3G WCDMA applications.

The SKY13397-388LF features integrated logic that uses only two control lines for switch operation. The low current consumption of the device makes it very suitable for battery-operated applications.

The switch is manufactured using a state of the art Silicon on Insulator (SOI) process, and is provided in a compact Quad Flat No-Lead (QFN) 2.3 x 2.3 mm package.

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. SKY13397-388LF Signal Descriptions**

| Pin # | Name  | Description  | Pin # | Name  | Description  |
|-------|-------|--|-------|-------|--|
| 1     | GND   | Ground   | 9     | GND   | Ground   |
| 2     | IN2   | RF input 2. This pin connected to pins 5, 7, or 10 depending on the control voltage applied to pins 15 and 16.   | 10    | OUT2C | RF input 2C, connected to RF input 2   |
| 3     | GND   | Ground   | 11    | OUT1B | RF output 1B, connected to RF input 1  |
| 4     | IN1   | RF input 1. This pin connected to pins pins 11 or 12 depending on the control voltage applied to pins 15 and 16. | 12    | OUT1A | RF output 1A, connected to RF input 1  |
| 5     | OUT2A | RF output 2A, connected to RF input 2  | 13    | GND   | Ground   |
| 6     | GND   | Ground   | 14    | VDD   | Supply voltage input.  |
| 7     | OUT2B | RF output 2B, connected to RF input 2  | 15    | GPIO2 | Control signal 2. Logic level applied to this pin and to pin 16, controls the state of the switch. |
| 8     | GND   | Ground   | 16    | GPIO1 | Control signal 1. Logic level applied to this pin and to pin 15, controls the state of the switch. |

**Table 2. SKY13397-388LF Absolute Maximum Ratings**

| Parameter             | Symbol           | Minimum | Maximum | Units |
|-----------------------|------------------|---------|---------|-------|
| Supply voltage        | V <sub>DD</sub>  | 2.5     | 5.5     | V     |
| Control voltage       | V <sub>CTL</sub> | 1.65    | 3.30    | V     |
| Input power           | P <sub>IN</sub>  |         | +40     | dBm   |
| Storage temperature   | T <sub>STG</sub> | -50     | +100    | °C    |
| Operating temperature | T <sub>OP</sub>  | -30     | +85     | °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.

## Functional Description

The SKY13397-388LF includes an internal negative voltage generator and decoder that eliminate the need for external DC blocking capacitors on the RF ports. No external components are required for proper operation. DC decoupling capacitors may be added on the VDD and control lines if necessary.

Switching is controlled by two control voltage inputs, GPIO1 and GPIO2. Depending on the logic voltage level applied to the control pins, the OUT1 signal (pin 4) is connected to one of two switched RF inputs (IN1A or IN1B) through a low insertion loss path, while the OUT2 signal (pin 2) is simultaneously switched to one of three RF inputs (IN2A, IN2B, IN2C).

For proper switching operation, the SKY13397-388LF must be set to a state for a minimum of 10 µs before changing to a different state.

Shutdown mode is enabled by connecting both control pins to logic low. This mode reduces the overall current consumption of the device to 5 µA, typical. To prevent the switch from accidentally entering shutdown mode during switching, caution must be taken to avoid having both control signals (GPIO1 and GPIO2) set to logic low for more than 500 ns. When exiting shutdown mode, the switch has a 25 µs startup time before switching occurs.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY13397-388LF are provided in Table 2. Electrical specifications are provided in Table 3.

The SKY13397-388LF may be used in one of two modes: active and standby. These modes are controlled by the General Purpose

I/O (GPIO) pins 15 and 16 with  $V_{DD} = \text{high}$ . When  $V_{DD}$  is high, the switch is active and its state is controlled as described in Table 4. When the switch is in standby mode, all paths are not operating.

**Table 3. SKY13397-388LF Electrical Specifications (Note 1)**

( $V_{DD} = 2.5 \text{ V to } 5.0 \text{ V}$ ,  $T_{OP} = +25^\circ\text{C}$ ,  $V_{HIGH} > 1.8 \text{ V}$ , All Unused RF Ports Terminated in a  $50 \Omega$  Load, Unless Otherwise Noted)

| Parameter                      | Symbol   | Test Condition   | Min            | Typical                 | Max                  | Units  |
|--------------------------------|----------|--|----------------|-------------------------|----------------------|--|
| Insertion loss                 |          | 0.1 to 1.0 GHz<br>1.0 to 2.0 GHz<br>2.0 to 2.5 GHz   |                | 0.35<br>0.40<br>0.45    | 0.45<br>0.50<br>0.60 | dB<br>dB<br>dB   |
| Isolation                      |          | 0.1 to 1.0 GHz<br>1.0 to 2.0 GHz<br>2.0 to 2.5 GHz   | 40<br>28<br>27 | 51<br>31<br>29          |                      | dB<br>dB<br>dB   |
| Return loss                    |          | 0.1 to 2.2 GHz   | 14             | 17                      |                      | dB   |
| 2 <sup>nd</sup> harmonic       | 2fo      | f <sub>FUNDAMENTAL</sub> = 900 MHz,<br>$P_{IN} = +28 \text{ dBm}$<br>f <sub>FUNDAMENTAL</sub> = 1800 MHz,<br>$P_{IN} = +28 \text{ dBm}$  |                | -56<br>-51              |                      | dBm<br>dBm   |
| 3 <sup>rd</sup> harmonic       | 3fo      | f <sub>FUNDAMENTAL</sub> = 900 MHz,<br>$P_{IN} = +28 \text{ dBm}$<br>f <sub>FUNDAMENTAL</sub> = 1800 MHz,<br>$P_{IN} = +28 \text{ dBm}$  |                | -52<br>-45              |                      | dBm<br>dBm   |
| Input 0.1 dB compression point | IP0.1dB  | f = 900 MHz<br>f = 1800 MHz  | +37<br>+37     | +38<br>+38              |                      | dBm<br>dBm   |
| Supply voltage                 | $V_{DD}$ |  | 2.5            |                         | 5.0                  | V  |
| Control voltage (Note 2)       |          | $V_{HIGH}$<br>$V_{LOW}$  | 1.65           | 2.00<br>0               | 3.30<br>0.30         | V  |
| Supply Current                 |          | Control current in active & isolation<br>Control current in standby @ $V_{DD} = 2.5 \text{ V}$<br>Control current in standby @ $V_{DD} = 4.5 \text{ V}$<br>Control current in standby @ $V_{DD} = 5.5 \text{ V}$ |                | 27<br>0.8<br>4.7<br>6.0 |                      | $\mu\text{A}$<br>$\mu\text{A}$<br>$\mu\text{A}$<br>$\mu\text{A}$ |
| Switching rise time            |          | 10/90% RF  |                | 0.40                    | 0.75                 | $\mu\text{s}$  |
| Switching fall time            |          | 90/10% RF  |                | 1.0                     | 1.5                  | $\mu\text{s}$  |
| Switching on time              |          | 50% V <sub>CTL</sub> to 10/90% RF  |                | 2.2                     | 2.5                  | $\mu\text{s}$  |
| Switching off time             |          | 50% V <sub>CTL</sub> to 90/10% RF  |                | 2.2                     | 2.5                  | $\mu\text{s}$  |
| Logic dwell time (Note 3)      |          | $T_{OP} = -40^\circ\text{C to } +85^\circ\text{C}$   | 10             | 12                      |                      | $\mu\text{s}$  |
| Startup time (Note 4)          |          | Shutdown state to any RF switch state  |                | 20                      | 25                   | $\mu\text{s}$  |

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

**Note 2:** Control voltage must be less than or equal to  $V_{DD}$  at all times.

**Note 3:** Dwell time refers to the amount of time the switch is required to stay in any one state before switching to another state. Refer to the Functional Description section for more information.

**Note 4:** Startup time refers to the amount of time it takes for the switch to be fully operational when coming out of shutdown mode.

**Table 4. SKY13397-388LF Truth Table**

| State | GPIO1 | GPIO2 | RF Path      |
|-------|-------|-------|--------------|
| 1     | 0     | 0     | Standby      |
| 2     | 0     | 1     | OUT1B, OUT2B |
| 3     | 1     | 0     | OUT1A, OUT2A |
| 4     | 1     | 1     | OUT2C        |

**Note:** “1” = +1.65 to +3.30 V (for GPIO1 and GPIO2 pins). “0” = 0 V to +0.2 V. Any state other than described in this Table places the switch into an undefined state. An undefined state will not damage the device.

## Evaluation Board

The SKY13397-388LF Evaluation Board is used to test the performance of the SKY13397-388LF DP6T Switch. An Evaluation Board schematic diagram is provided in Figure 3. An assembly drawing for the Evaluation Board is shown in Figure 4.

## Package Dimensions

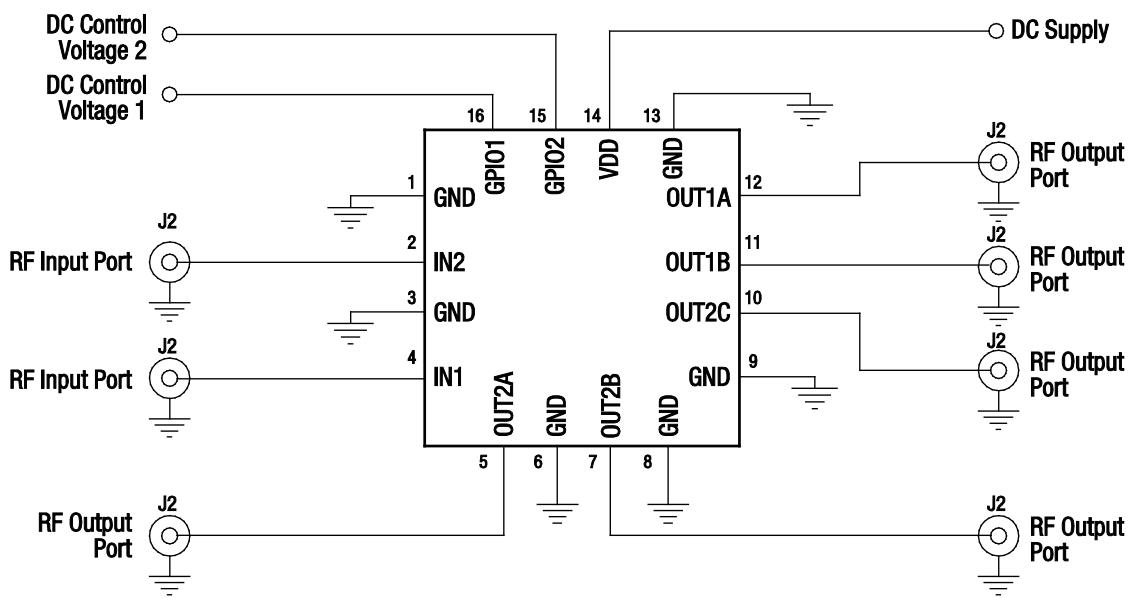
The PCB layout footprint for the SKY13397-388LF is provided in Figure 5. Typical case markings are shown in Figure 6. Package dimensions for the 16-pin QFN are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

## 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.

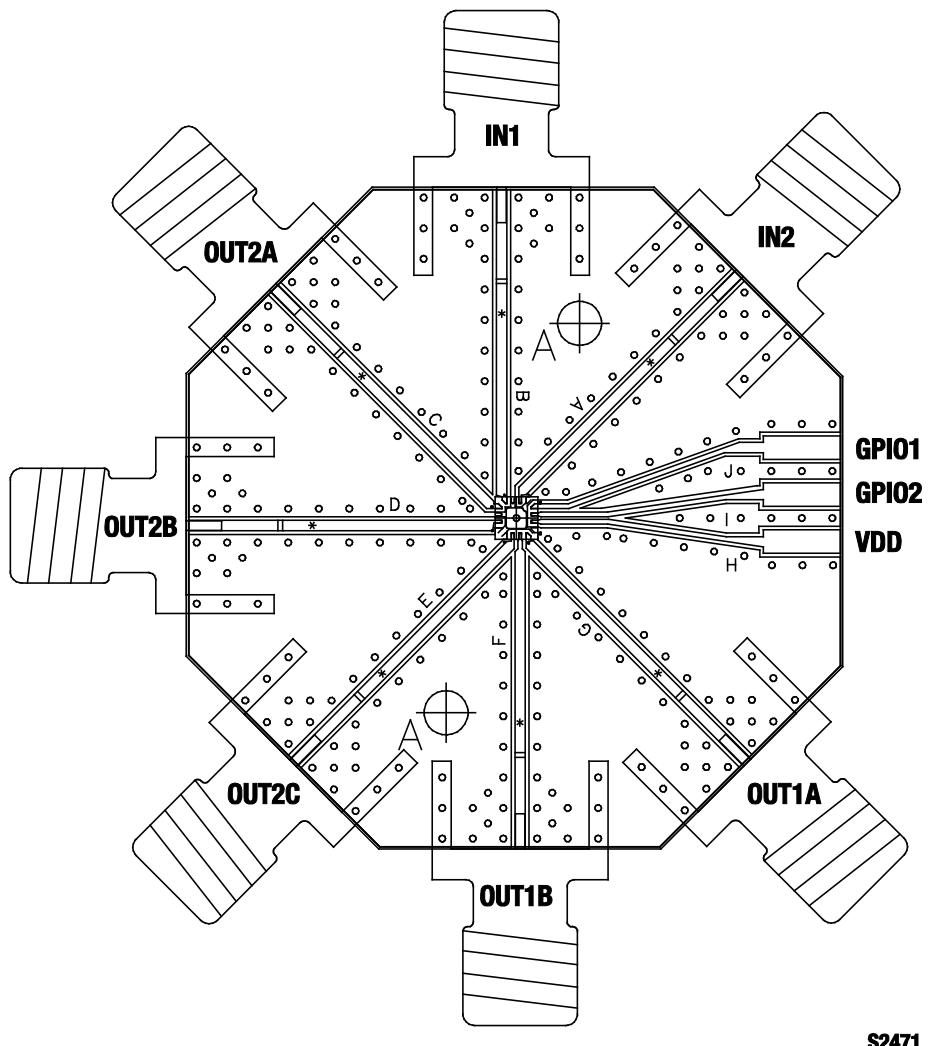
THE SKY13397-388LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

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.

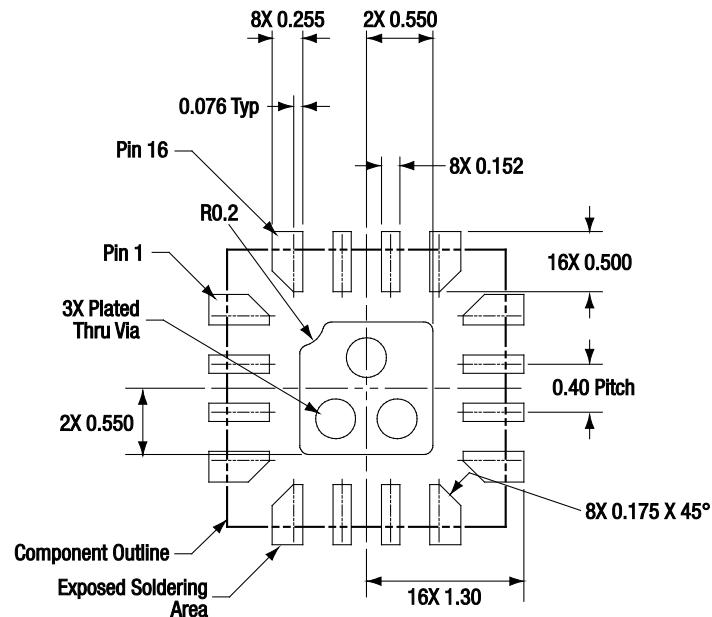


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**Figure 3. SKY13397-388LF Evaluation Board Schematic**



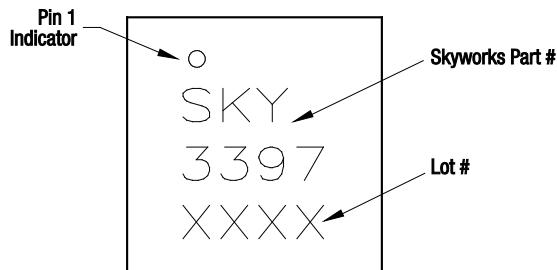
**Figure 4. SKY13397-388LF Evaluation Board Assembly Diagram**



*All measurements in millimeters*

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**Figure 5. SKY13397-388LF PCB Layout Footprint  
(Top View)**



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

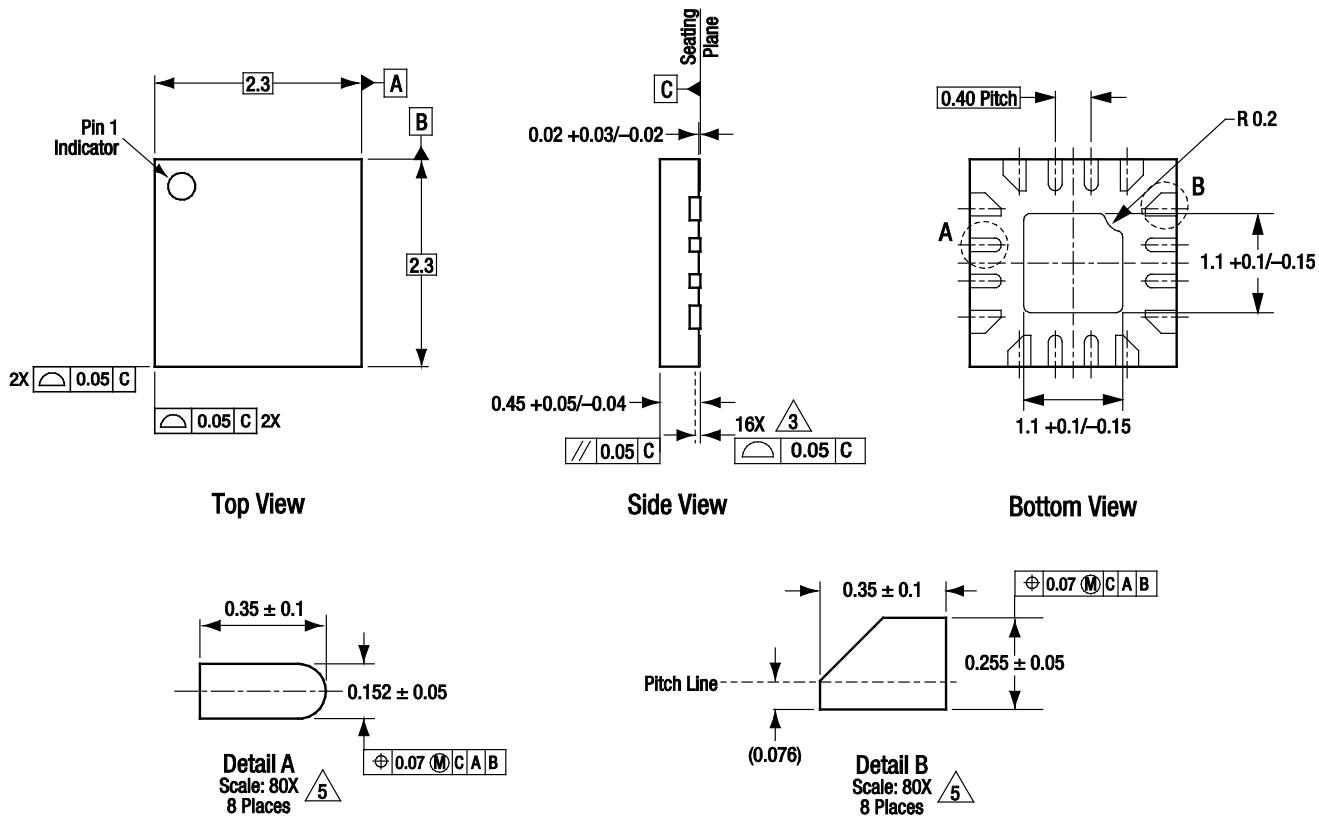


Figure 7. SKY13397-388LF 16-Pin QFN Package Dimensions

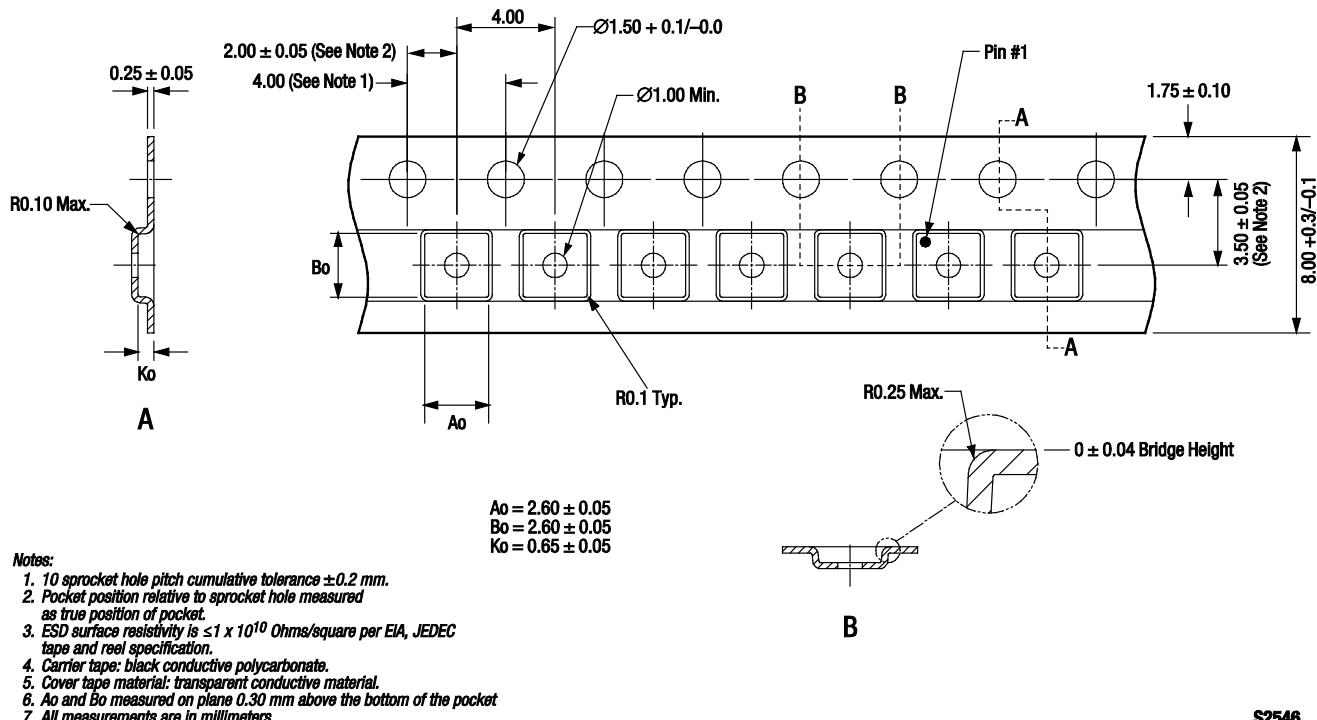


Figure 8. SKY13397-388LF Tape and Reel Dimensions

## Ordering Information

| Model Name                 | Manufacturing Part Number | Evaluation Board Part Number |
|----------------------------|---------------------------|------------------------------|
| SKY13397-388LF DP5T Switch | SKY13397-388LF            | SK41602-1                    |

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