

**DATA SHEET**

# SKY13364-389LF: 0.4-2.2 GHz GaAs SP10T Switch

## Applications

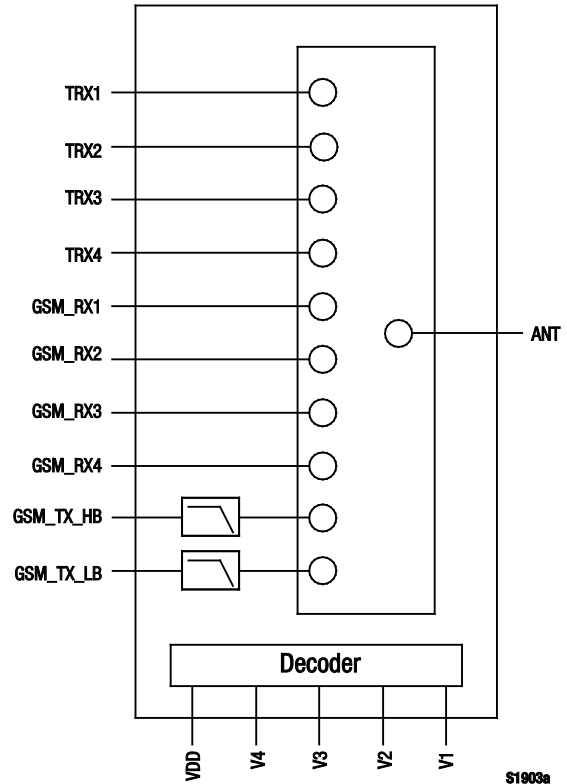
- 2G/3G multimode cellular handsets (UMTS, CDMA2000, EDGE, GSM)
- Embedded data cards

## Features

- Broadband frequency range: 0.4 to 2.2 GHz
- Four CMOS/TTL control voltages (0/1.35 to 3.1 V)
- Single, positive DC power supply (2.5 to 3.3 V)
- Integrated, low-pass harmonic filter for GSM transmit paths
- Integrated CMOS decoder
- Small QFN (26-pin, 3.0 x 3.8 mm) package (MSL1, 260 °C per JEDEC J-STD-020)



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**Figure 1. SKY13364-389LF Block Diagram**

## Description

The SKY13364-389LF is a GaAs pHEMT Single Pole, Ten-Throw (SP10T) antenna switch with an integrated CMOS decoder and dual low-pass harmonic filters. The switch has four WCDMA transmit/receive ports, four GSM receive ports, and two GSM transmit ports that make the device ideal for cellular handset and data card applications.

Using advance switching technologies, the SKY13364-389LF maintains low insertion loss and high isolation for both transmit and receive switching paths. The switch exhibits an excellent 2<sup>nd</sup>/3<sup>rd</sup> order modulation distortion performance.

Switching is controlled by four CMOS/TTL-compatible control voltage inputs (V1, V2, V3, and V4). Depending on the logic voltage level applied to the control pins, the antenna pin is connected to one of ten switched RF ports using a low insertion loss path, while the paths between the antenna pin and the other RF pins are in a high isolation state. No external DC blocking capacitors are required on the RF paths

The SKY13364-389LF is manufactured in a compact, 3.0 x 3.8 mm, 26-pin Quad Flat No-Lead (QFN) 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.

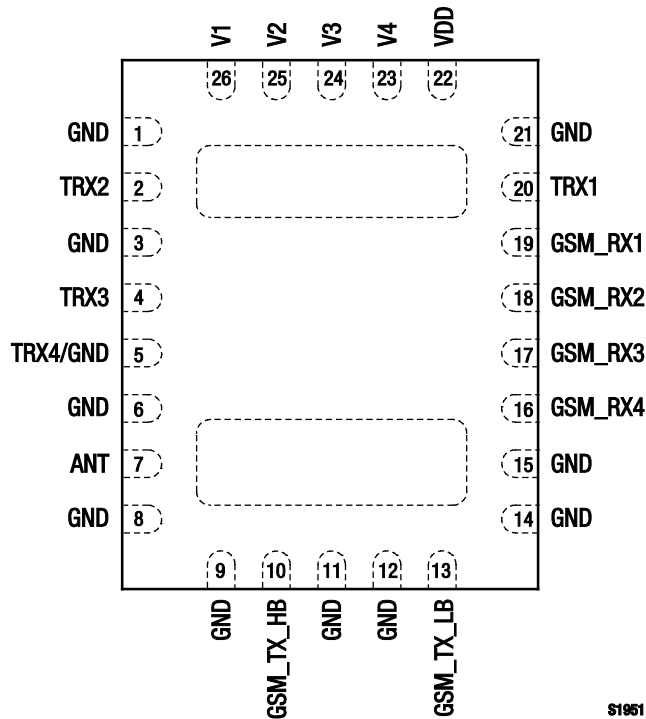


Figure 2. SKY13364-389LF Pinout – 26-Pin QFN (Top View)

Table 1. SKY13364-389LF Signal Descriptions

| Pin # | Name      | Description   | Pin # | Name    | Description                |
|-------|-----------|---|-------|---------|----------------------------|
| 1     | GND       | Ground  | 14    | GND     | Ground                     |
| 2     | TRX2      | RF input/output port 2  | 15    | GND     | Ground                     |
| 3     | GND       | Ground  | 16    | GSM_RX4 | GSM RF output port 4       |
| 4     | TRX3      | RF input/output port 3  | 17    | GSM_RX3 | GSM RF output port 3       |
| 5     | TRX4/GND  | RF input/output port 4 for 10-throw switch; connect to ground for 9-throw switch. | 18    | GSM_RX2 | GSM RF output port 2       |
| 6     | GND       | Ground  | 19    | GSM_RX1 | GSM RF output port 1       |
| 7     | ANT       | Antenna RF port   | 20    | TRX1    | RF input/output port 1     |
| 8     | GND       | Ground  | 21    | GND     | Ground                     |
| 9     | GND       | Ground  | 22    | VDD     | DC power supply            |
| 10    | GSM_TX_HB | GSM high band transmit RF input port with integrated harmonic filter              | 23    | V4      | DC input control voltage 4 |
| 11    | GND       | Ground  | 24    | V3      | DC input control voltage 3 |
| 12    | GND       | Ground  | 25    | V2      | DC input control voltage 2 |
| 13    | GSM_TX_LB | GSM low band transmit RF input port with integrated harmonic filter               | 26    | V1      | DC input control voltage 1 |

Note: Bottom ground paddles must be connected to ground.

**Table 2. SKY13364-389LF Absolute Maximum Ratings**

| Parameter             | Symbol           | Minimum | Typical | Maximum | Units |
|-----------------------|------------------|---------|---------|---------|-------|
| RF input power        | P <sub>IN</sub>  |         |         | +36     | dBm   |
| Power supply          |                  |         |         | 5       | V     |
| Control voltage       | V <sub>CTL</sub> |         |         | 3.3     | V     |
| Storage temperature   | T <sub>STG</sub> | -40     |         | +125    | °C    |
| Operating temperature | T <sub>OP</sub>  | -30     |         | +90     | °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.

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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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**Functional Description**

The time from when V<sub>DD</sub> is applied to when the switch is active is the startup time. Once the startup time has passed, the control voltages can be applied. RF power should not be applied during the startup time or damage to the device could result.

The recommended startup sequence is:

- Step 1: Apply V<sub>DD</sub>.
- Step 2: Apply V1 to V4 voltages.
- Step 3: Apply the RF input.

Recommended startup time is 25 μs.

The device must be turned off in the reverse order.

Typical performance characteristics are illustrated in Figures 3 to 14.

The state of the SKY13364-389LF is determined by the logic provided in Table 4.

Figure 15 illustrates the test setup used to measure data for Figure 12. This industry standardized test is used to simulate the WCDMA Band 1 linearity of the antenna switch. A +20 dBm Continuous Wave (CW) signal, P<sub>FUND</sub>, is sequentially applied to the TRX1 through TRX4 ports, while a -15 dBm CW blocker signal, P<sub>BLK</sub>, is applied to the ANT port.

The resulting 3<sup>rd</sup> Order Intermodulation Distortion (IMD3), f<sub>rx</sub>, is measured over all phases of P<sub>FUND</sub>. The SKY13364-389LF exhibits exceptional performance for all TRX ports.

**Electrical and Mechanical Specifications**

The absolute maximum ratings of the SKY13364-389LF are provided in Table 2. Electrical specifications are provided in Table 3.

**Table 3. SKY13364-389LF Electrical Specifications (Note 1) (1 of 2)**  
**(V<sub>DD</sub> = 2.65 V, V<sub>1</sub> = V<sub>2</sub> = V<sub>3</sub> = V<sub>4</sub> = 0/1.8 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>0</sub>] = 50 Ω, Unless Otherwise Noted)**

| Parameter  | Symbol | Test Condition   | Min   | Typical        | Max          | Units    |    |
|--|--------|--|-------|----------------|--------------|----------|----|
| <b>RF Specifications</b>                               |        |  |       |                |              |          |    |
| Insertion loss (TRX1)                                  | IL     | ANT to TRX1  |       |                |              |          |    |
|  |        | 824 to 960 MHz<br>1710 to 2170 MHz                         |       | 0.50<br>0.70   | 0.60<br>0.80 | dB<br>dB |    |
| Insertion loss (TRX2, TRX3, TRX4)                      | IL     | ANT to TRX2, TRX3, TRX4                                    |       |                |              |          |    |
|  |        | 824 to 960 MHz<br>1710 to 2170 MHz                         |       | 0.60<br>0.75   | 0.70<br>0.85 | dB<br>dB |    |
| Insertion loss (GSM transmit low band)                 |        | ANT to GSM_TX_LB,<br>824 to 915 MHz                        |       | 1.0            | 1.2          | dB       |    |
| Insertion loss (GSM transmit high band)                |        | ANT to GSM_TX_HB,<br>1710 to 1910 MHz                      |       | 1.1            | 1.3          | dB       |    |
| Insertion loss (GSM_RX1, GSM_RX2,<br>GSM_RX3, GSM_RX4) |        | ANT to RX ports  |       |                |              |          |    |
|  |        | 869 to 960 MHz<br>1805 to 1990 MHz                         |       | 0.8<br>1.0     | 1.0<br>1.2   | dB<br>dB |    |
| Isolation  | ISO    | 0.4 to 2.2 GHz, TRX1 to<br>TRX2, TRX3, and TRX4<br>ports   | 30    |                |              | dB       |    |
|  |        | 824 to 915 MHz,<br>GSM_TX_LB to TRX/GSM<br>receive ports   | 35    |                |              | dB       |    |
|  |        | 1710 to 1910 MHz,<br>GSM_TX_HB to TRX/GSM<br>receive ports | 32    |                |              | dB       |    |
|  |        | 824 to 1910 MHz,<br>TRX2/TRX3 to TRX3/TRX4<br>ports        | 20    |                |              | dB       |    |
| Harmonics  |        | UMTS, P <sub>IN</sub> = +27 dBm                            |       |                | -36          | dBm      |    |
|  |        | GSM_TX_LB port,<br>P <sub>IN</sub> = +35 dBm               |       | -45            | -36          | dBm      |    |
|  |        | GSM_TX_HB port,<br>P <sub>IN</sub> = +32 dBm               |       | -45            | -36          | dBm      |    |
| GSM transmit attenuation (low band)<br>GSM850          | Attn   | 2f   | 22    | 25             |              | dB       |    |
|  |        | 3f   | 25    | 28             |              | dB       |    |
|  |        | 4f   | 17    | 20             |              | dB       |    |
|  |        | EGSM900  | 2f    | 25             | 28           |          | dB |
|  |        |  | 3f    | 25             | 28           |          | dB |
|  |        |  | 4f    | 17             | 20           |          | dB |
| GSM transmit attenuation (high band):<br>DCS1800       | Attn   | 2f   | 22    | 25             |              | dB       |    |
|  |        | 3f   | 25    | 28             |              | dB       |    |
|  |        | PCS1900  | 2f    | 25             | 28           |          | dB |
|  |        |  | 3f    | 25             | 28           |          | dB |
|  |        |  |       |                |              |          |    |
|  |        | Return loss  | IS111 | 0.4 to 2.2 GHz | 14           | 18       |    |
| 2 <sup>nd</sup> Order Input Intercept Point            | IIP2   | AWS, PCS, IMT to<br>CDMA2000 modes                         | +95.5 |                |              | dBm      |    |
| 3 <sup>rd</sup> Order Intermodulation Distortion       | IMD3   | UMTS mode  |       | -105           | -97          | dBm      |    |

**Table 3. SKY13364-389LF Electrical Specifications (Note 1) (2 of 2)**

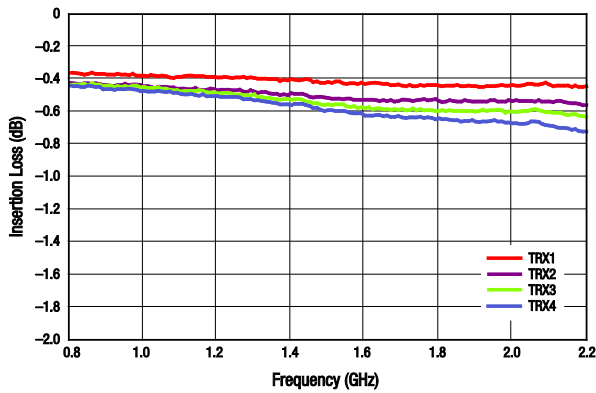
( $V_{DD} = 2.65\text{ V}$ ,  $V_1 = V_2 = V_3 = V_4 = 0/1.8\text{ V}$ ,  $T_{OP} = +25\text{ }^\circ\text{C}$ ,  $P_{IN} = 0\text{ dBm}$ , Characteristic Impedance [ $Z_0$ ] =  $50\ \Omega$ , Unless Otherwise Noted)

| Parameter   | Symbol               | Test Condition   | Min       | Typical | Max         | Units                          |
|---|----------------------|------------------|-----------|---------|-------------|--------------------------------|
| <b>RF Specifications (continued)</b>                |                      |                  |           |         |             |                                |
| GSM transmit low band 1 dB Input Compression Point  | IP1dB                | 824 to 915 MHz   | +40       |         |             | dBm                            |
| GSM transmit high band 1 dB Input Compression Point | IP1dB                | 1710 to 1910 MHz | +39       |         |             | dBm                            |
| Switching speed                                     |                      | 10/90% RF        |           | 3       | 5           | $\mu\text{s}$                  |
| <b>DC Specifications</b>                            |                      |                  |           |         |             |                                |
| Supply voltage                                      | $V_{DD}$             |                  | 2.50      | 2.65    | 3.30        | V                              |
| Supply current                                      | $I_{DD}$             |                  |           | 0.3     | 0.6         | mA                             |
| Control voltage:<br>High<br>Low                     | $V_1, V_2, V_3, V_4$ |                  | 1.35<br>0 | 1.80    | 3.10<br>0.3 | V<br>V                         |
| Control current:<br>High<br>Low                     |                      |                  |           | 1<br>1  | 10<br>10    | $\mu\text{A}$<br>$\mu\text{A}$ |

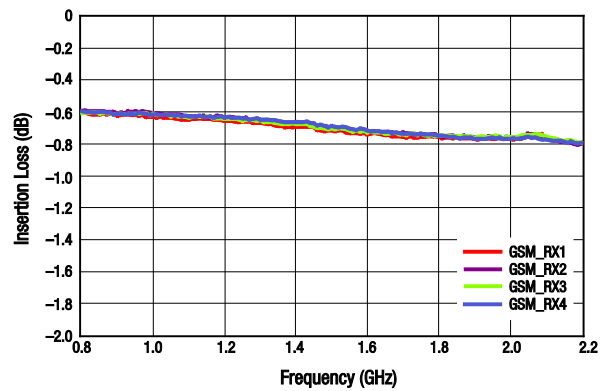
Note 1: Performance is guaranteed only under the conditions listed in this Table.

**Typical Performance Characteristics**

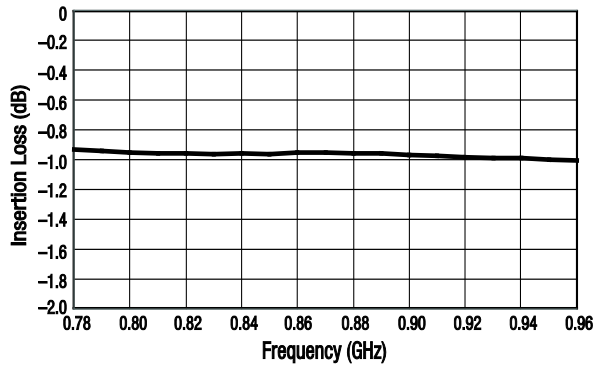
( $V_{DD} = 2.65\text{ V}$ ,  $V_1 = V_2 = V_3 = V_4 = 0/1.8\text{ V}$ ,  $T_{OP} = +25\text{ }^\circ\text{C}$ ,  $P_{IN} = 0\text{ dBm}$ , Characteristic Impedance [ $Z_0$ ] =  $50\ \Omega$ , Unless Otherwise Noted)



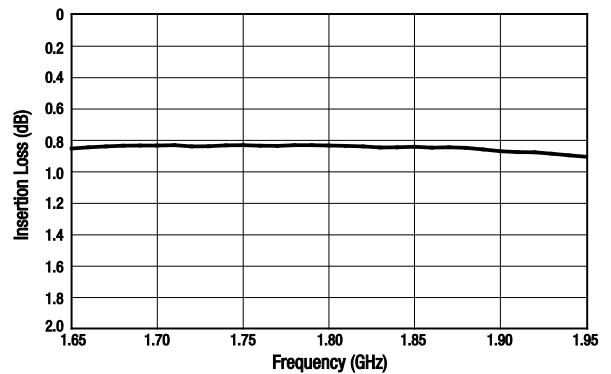
**Figure 3. Insertion Loss vs Frequency (ANT to TRX Ports)**



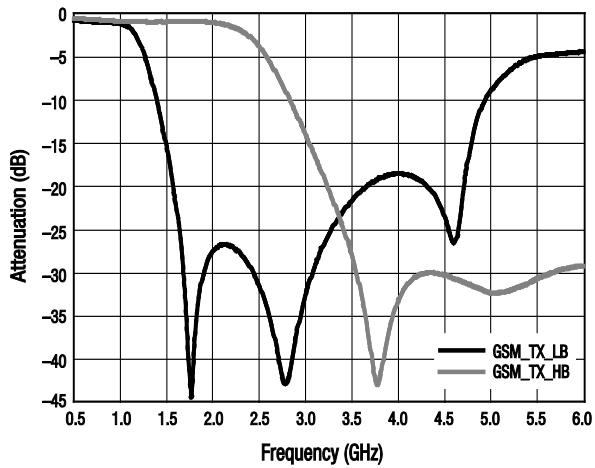
**Figure 4. Insertion Loss vs Frequency (ANT to GSM\_RX Ports)**



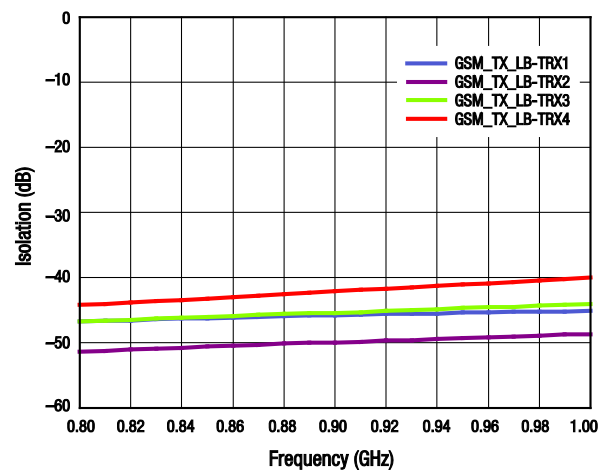
**Figure 5. Insertion Loss vs Frequency (ANT to GSM\_TX\_LB Port)**



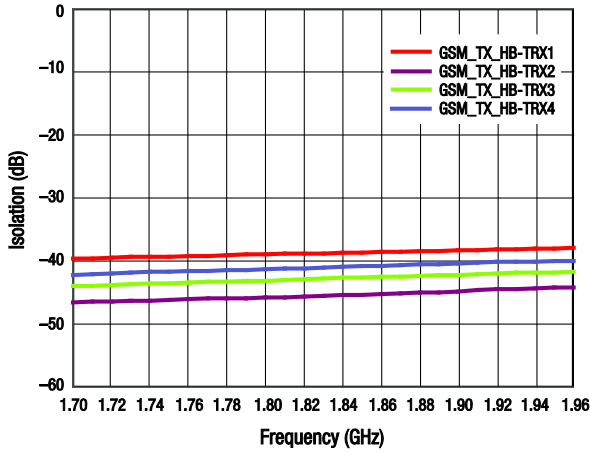
**Figure 6. Insertion Loss vs Frequency (ANT to GSM\_TX\_HB Port)**



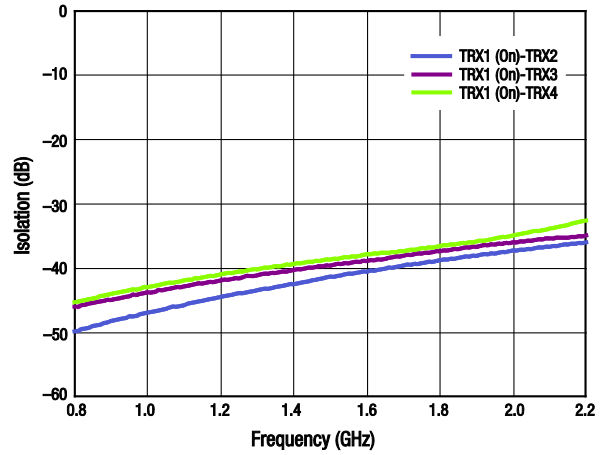
**Figure 7. Attenuation vs Frequency (ANT to GSM\_TX\_HB/LB Ports)**



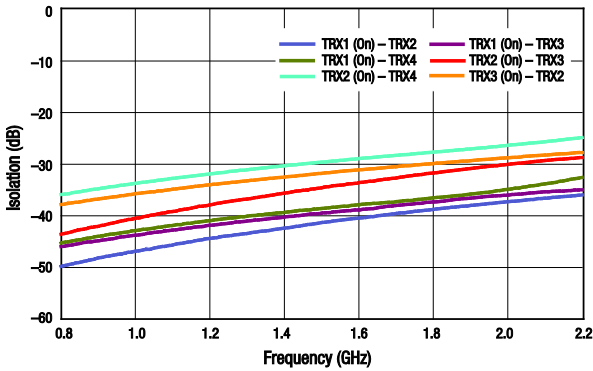
**Figure 8. Isolation vs Frequency (GSM\_TX\_LB to TRX Ports)**



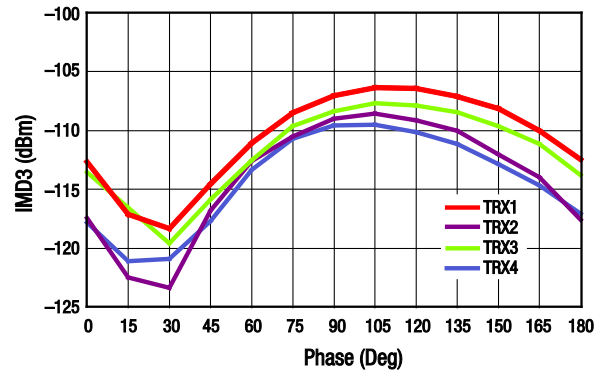
**Figure 9. Isolation vs Frequency (GSM\_TX\_HB to TRX Ports)**



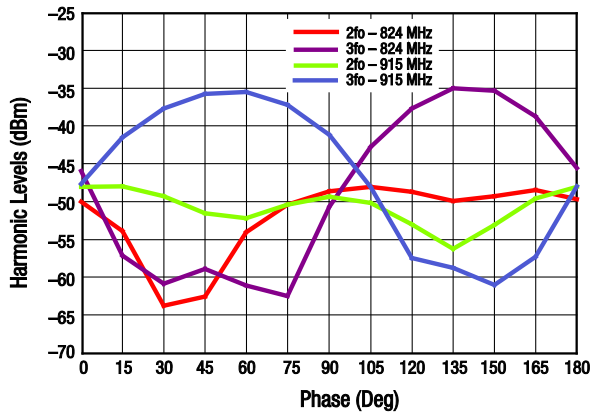
**Figure 10. Isolation vs Frequency (TRX to TRX Ports)**



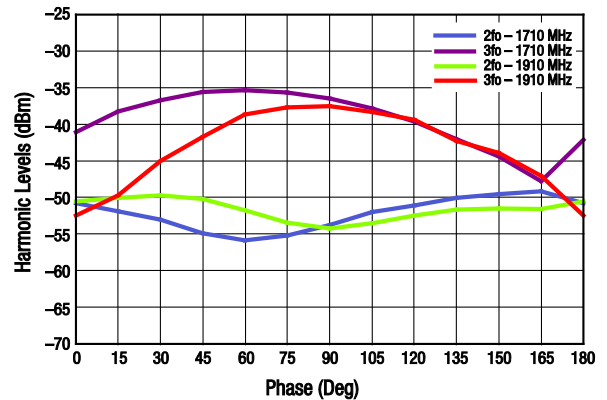
**Figure 11. Isolation vs Frequency (TRX to TRX Ports)**



**Figure 12. 3<sup>rd</sup> Order Intermodulation Distortion vs Phase, TRX Ports ( $P_{FUND} = 1.95$  GHz,  $f_{BLK} = 1.76$  GHz,  $f_{RX} = 2.14$  GHz)**



**Figure 13. Harmonics vs Phase (ANT to GSM\_TX\_LB,  $P_{IN} = +35$  dBm, 5:1 VSWR Mismatch)**

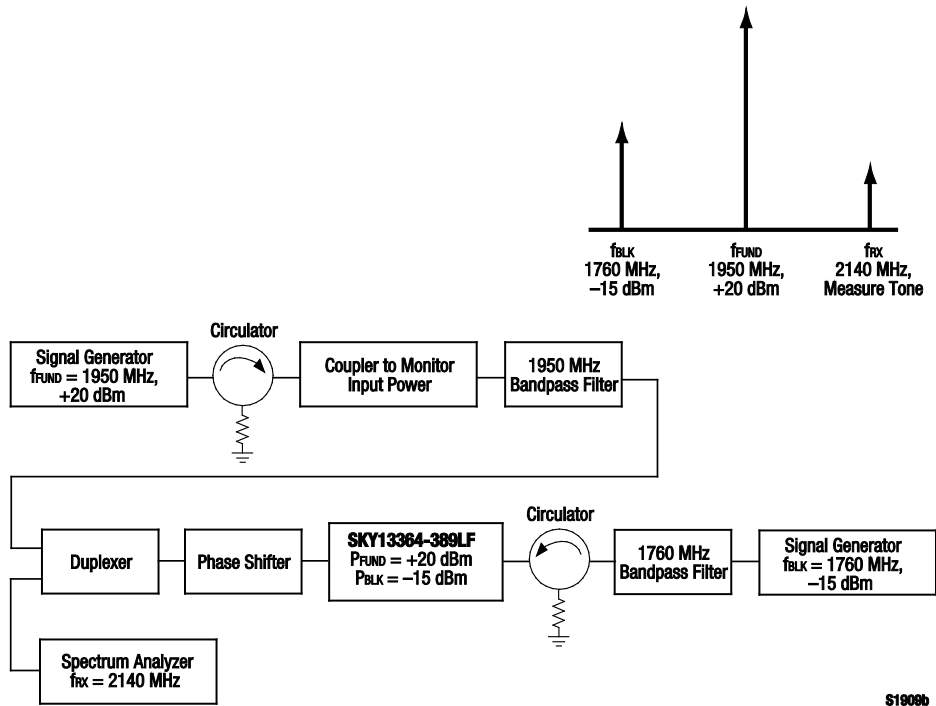


**Figure 14. Harmonics vs Phase ( $P_{IN} = +33$  dBm, 5:1 VSWR Mismatch)**

**Table 4. SKY13364-389LF Truth Table**

| Insertion Loss State | V1 (Pin 26) | V2 (Pin 25) | V3 (Pin 24) | V4 (Pin 23) |
|----------------------|-------------|-------------|-------------|-------------|
| ANT to GSM_TX_LB     | 1           | 1           | 0           | 0           |
| ANT to GSM_TX_HB     | 1           | 0           | 0           | 0           |
| ANT to GSM_RX1       | 0           | 0           | 0           | 0           |
| ANT to GSM_RX2       | 0           | 0           | 1           | 0           |
| ANT to GSM_RX3       | 0           | 1           | 1           | 0           |
| ANT to GSM_RX4       | 0           | 1           | 0           | 0           |
| ANT to TRX1          | 1           | 0           | 1           | 0           |
| ANT to TRX2          | 1           | 1           | 1           | 0           |
| ANT to TRX3          | 1           | 0           | 1           | 1           |
| ANT to TRX4          | 1           | 1           | 1           | 1           |

**Note:** "1" = +1.35 V to +3.10 V (1.8 V typical). "0" = 0 V to +0.3 V. Any state other than described in this Table places the switch into an undefined state. An undefined state will not damage the device.



**Figure 15. 3<sup>rd</sup> Order Intermodulation Test Setup**



### Evaluation Board Description

The SKY13364-389LF Evaluation Board is used to test the performance of the SKY13364-389LF SP10T Switch. An Evaluation Board schematic diagram is provided in Figure 16. An assembly drawing for the Evaluation Board is shown in Figure 17.

### Package Dimensions

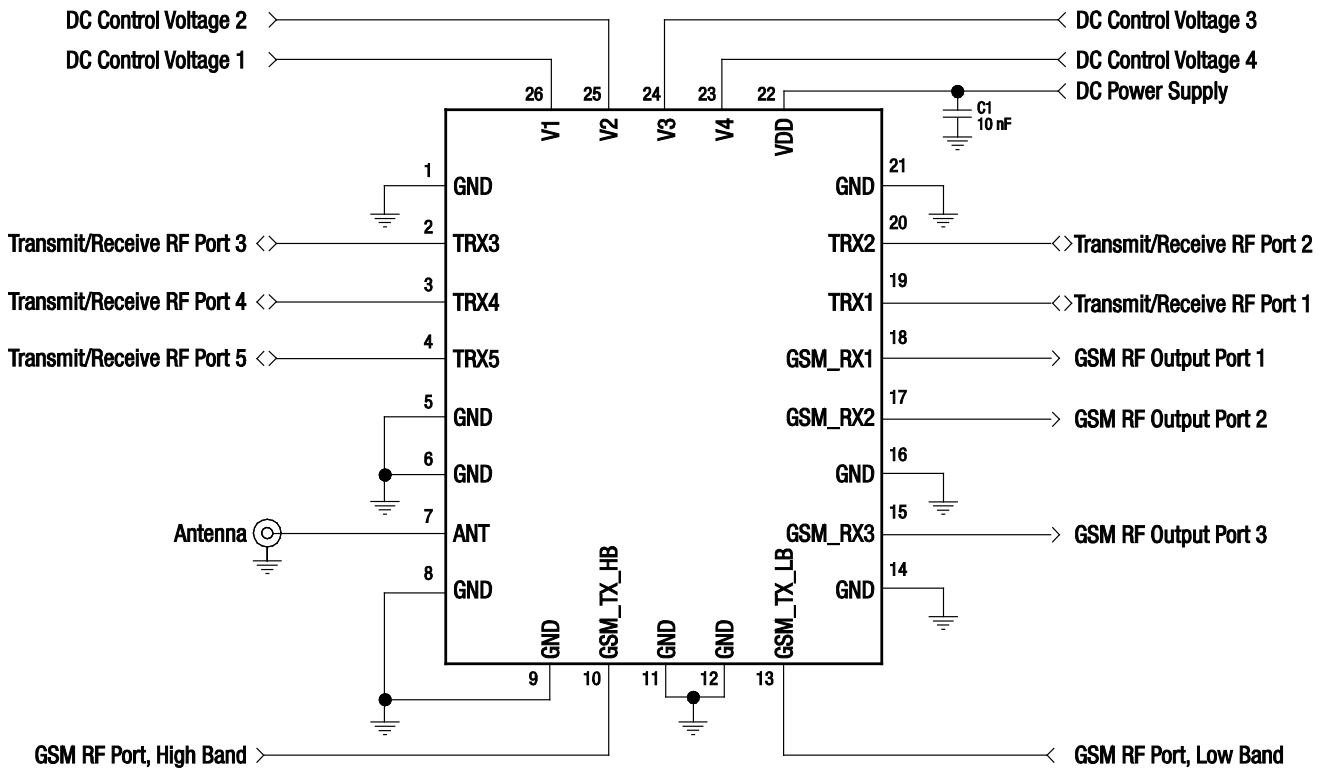
The PCB layout footprint for the SKY13364-389LF is provided in Figure 18. Typical case markings are shown in Figure 19. Package dimensions for the 26-pin QFN are shown in Figure 20, and tape and reel dimensions are provided in Figure 21.

### 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 SKY13364-389LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering.

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.



S1906

Figure 16. SKY13364-389LF Evaluation Board Schematic

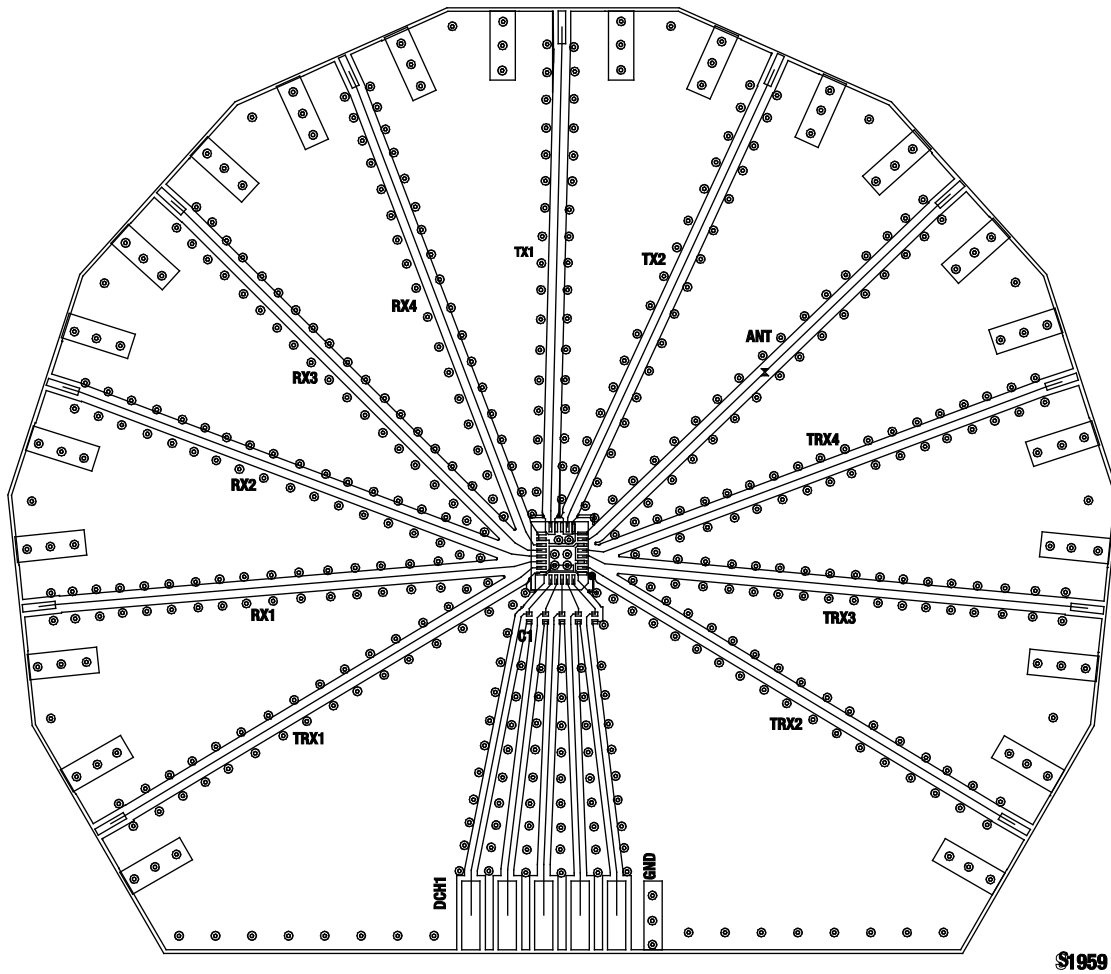
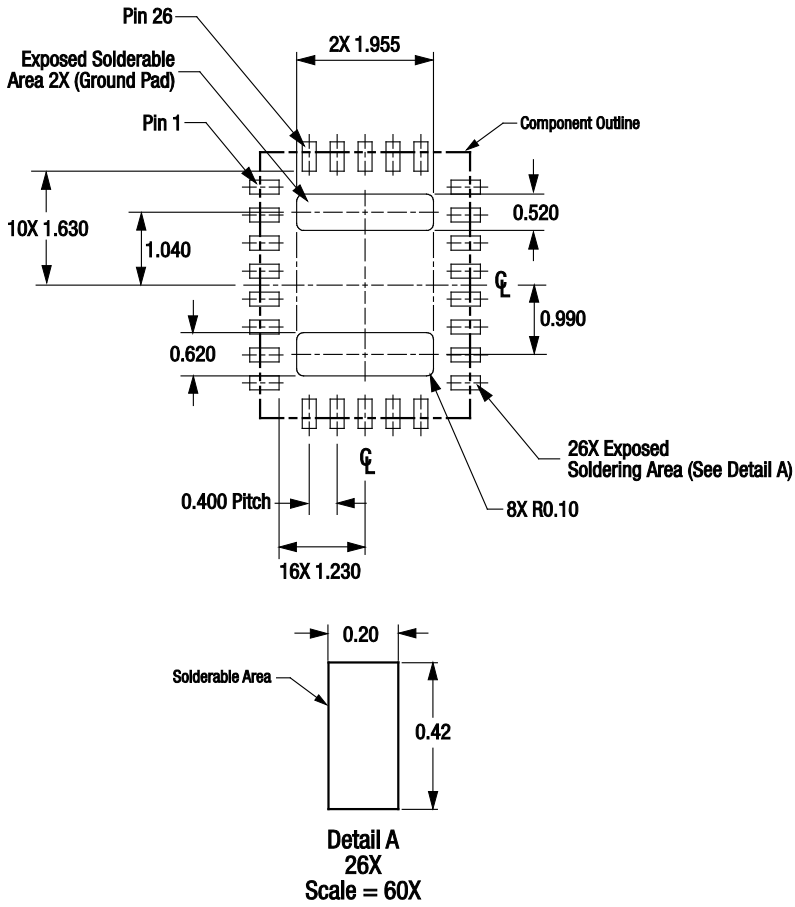


Figure 17. SKY13364-389LF Evaluation Board Assembly Diagram



All dimensions are in millimeters

S2140

Figure 18. SKY13364-389LF PCB Layout Footprint (Top View)

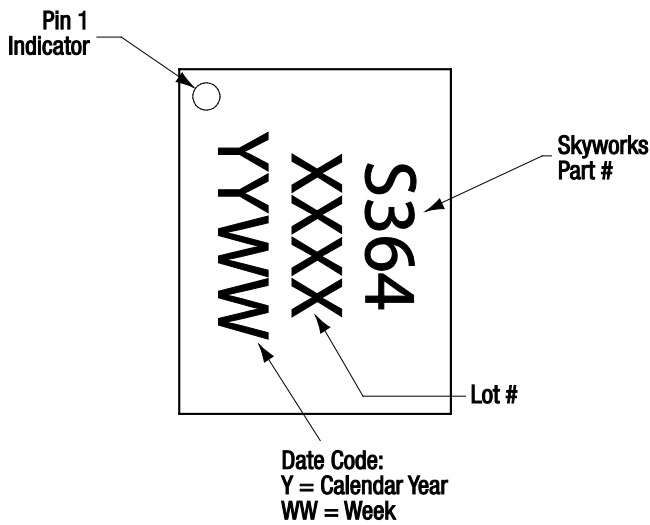
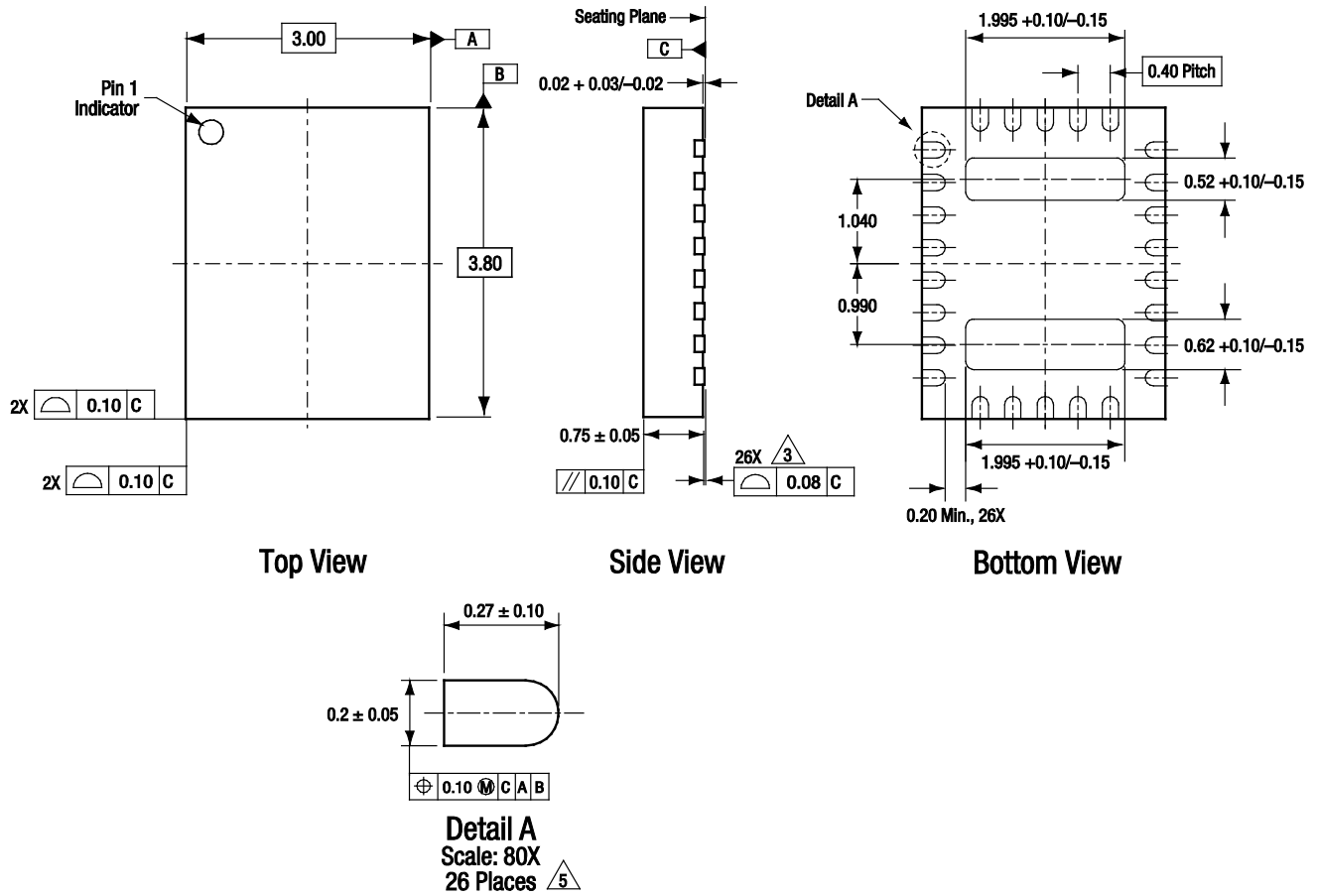


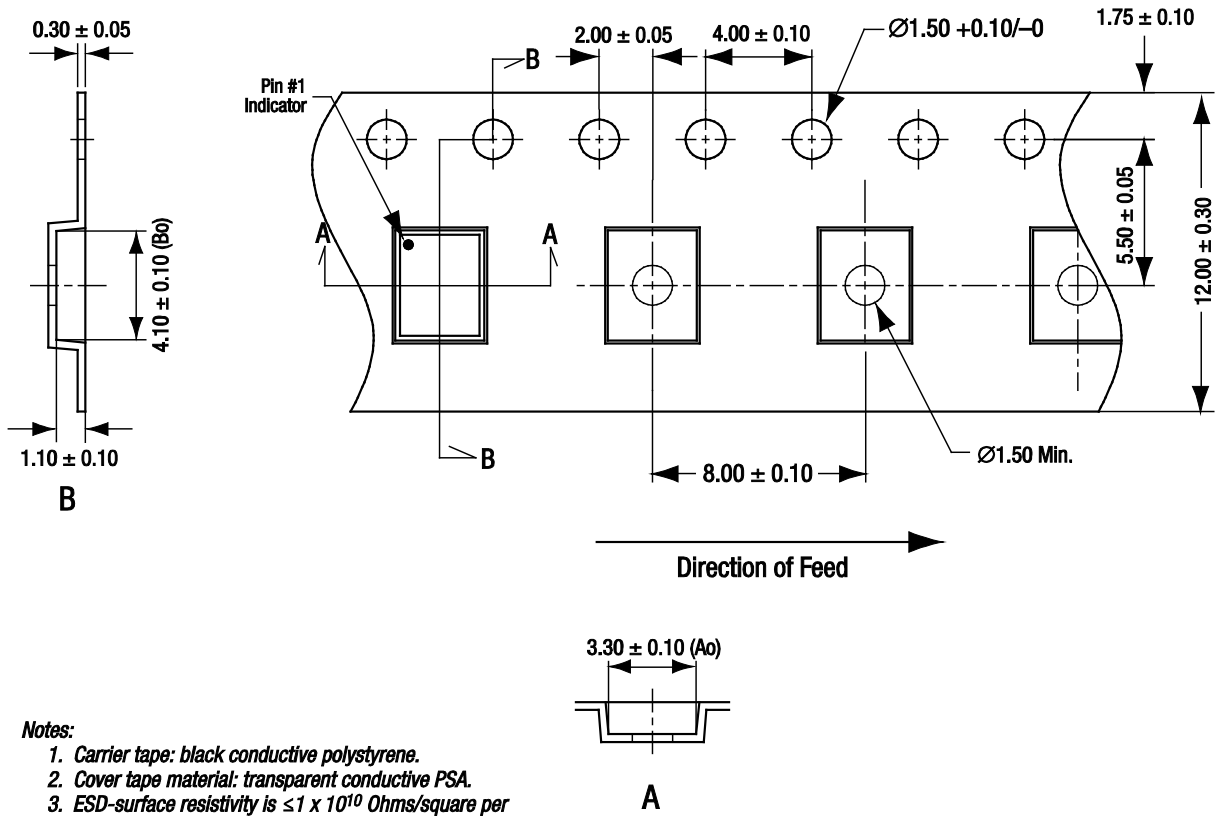
Figure 19. Typical Part Markings (Top View)



All measurements are in millimeters.  
Dimensioning and tolerancing according to ASME Y14.5M-1994.  
Coplanarity applies to the exposed bottom surface metalization, as well as the terminals.  
Plating requirement per source control drawing (SCD) 2504.

S1904

Figure 20. SKY13364-389LF 26-Pin QFN Package Dimensions



**Notes:**

1. Carrier tape: black conductive polystyrene.
2. Cover tape material: transparent conductive PSA.
3. ESD-surface resistivity is  $\leq 1 \times 10^{10}$  Ohms/square per EIA, JEDEC TNR Specification.
4. Ten sprocket hole pitch cumulative tolerance:  $\pm 0.20$  mm.
5. Ao and Bo measured on plane 0.30 mm above the bottom of the pocket.
6. All measurements are in millimeters.

S2141

**Figure 21. SKY13364-389LF Tape and Reel Dimensions**

**Ordering Information**

| Model Name                              | Manufacturing Part Number | Evaluation Board Part Number |
|---|---------------------------|------------------------------|
| SKY13364-389LF 0.4-2.2 GHz SP10T Switch | SKY13364-389LF            | SKY13364-389LF-EVB           |

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