# SKY13445-368LF: Dual-Band SP3T and SP2T Switch

## Applications

- WLAN 802.11 a/b/g/n/ac networks
- Embedded modules

## Features

- SP3T (2 GHz) and SP2T (5 GHz) switches with Bluetooth® capability
- Positive voltage control: 2.7 to 3.6 V
- IP0.5dB: +29.5 dBm typical @ 2.5 GHz and 3 V
- Small QFN (12-pin, 2 x 2 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04-0074.
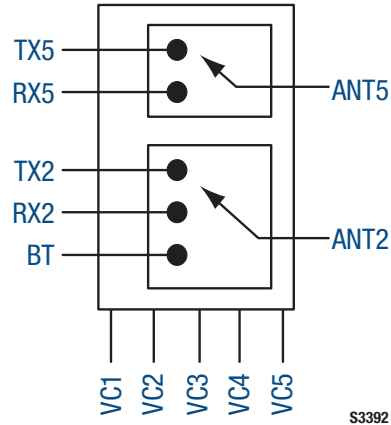


**Figure 2. SKY13445-368LF Pinout – 12-Pin QFN (Top View)**



**Figure 1. SKY13445-368LF Block Diagram**

## Description

The SKY13445-368LF is a pHEMT GaAs switch. The device includes a single-pole, triple-throw (SP3T) switch for 2 GHz WLAN transmit, receive, and Bluetooth functions, and a single-pole, double-throw (SP2T) switch for 5 GHz transmit and receive functions.

Any of the RF ports can be used for any RF function regardless of the port name. The SKY13445-368LF requires external DC blocking capacitors on all RF ports.

Both the SP3T and SP2T switches are fabricated on the same substrate. The active path is selected with five positive voltage control lines (V1, V2, and V3 for low band switching, and V4 and V5 for high band switching). In low band mode, the high band paths are in isolation by applying a low voltage to the two control lines, V4 and V5.

The switch is manufactured in a compact, 2 x 2 mm, 12-pin exposed pad plastic 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.
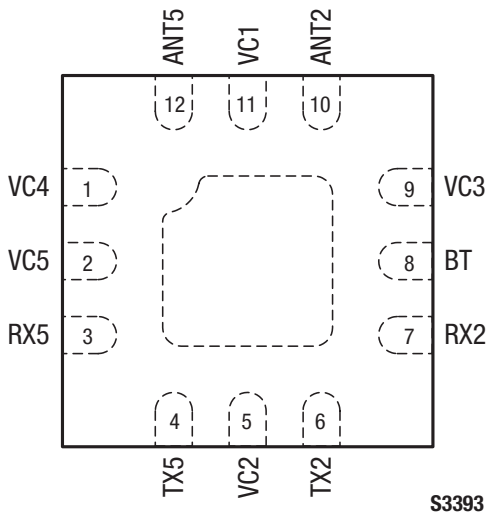
**Table 1. SKY13445-368LF Signal Descriptions (Note 1)**

| Pin | Name | Description | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | VC4 | Control line 4 for ANT5 to RX5 path | 7 | RX2 | 2.4 to 2.5 GHz receive port. Must be DC blocked for proper operation. |
| 2 | VC5 | Control line 5 for ANT5 to TX5 path | 8 | BT | Bluetooth RF port. Must be DC blocked for proper operation. |
| 3 | RX5 | 4.9 to 6.0 GHz receive port. Must be DC blocked for proper operation. | 9 | VC3 | Control line 3 for ANT2 to RX2 path |
| 4 | TX5 | 4.9 to 6.0 GHz transmit port. Must be DC blocked for proper operation. | 10 | ANT2 | 2.4 to 2.5 GHz antenna port. Must be DC blocked for proper operation. |
| 5 | VC2 | Control line 2 for ANT2 to TX2 path | 11 | VC1 | Control line 1 for ANT2 to BT path |
| 6 | TX2 | 2.4 to 2.5 GHz transmit port. Must be DC blocked for proper operation. | 12 | ANT5 | 4.9 to 6.0 GHz antenna port. Must be DC blocked for proper operation. |

**Note 1**: Bottom ground paddle must be connected to ground.

**Table 2. SKY13445-368LF Absolute Maximum Ratings (Note 1)**

| Parameter | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|
| Control voltage (room temperature, normal operating power) | $V_{CTL}$ | −0.5 | +5.0 | V |
| RF input power (OFDM modulated):<br>    2.5 GHz, SP3T switch<br>    5.0 GHz, SP2T switch | <br>$P_{IN2G}$<br>$P_{IN5G}$ | | <br>+31<br>+29 | <br>dBm<br>dBm |
| Storage temperature | $T_{STG}$ | −55 | +150 | °C |
| Operating temperature | $T_{OP}$ | −30 | +90 | °C |

**Note 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.

***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.*

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY13445-368LF are provided in Table 2. Electrical specifications are provided in Tables 3 and 4.

The state of the SKY13445-368LF is determined by the logic provided in Table 5.

Typical performance characteristics of the SKY13445-368LF are illustrated in Figures 3 to 10.

**Table 3. SKY13445-368LF Electrical Specifications (Note 1)**
**(V$_{CTL}$ = 0 V [Low] and 3 V [High], T$_{OP}$ = +25 °C, Characteristic Impedance [Z$_0$] = 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| *2 GHz SP3T* | | | | | | |
| Insertion loss, 2 GHz | IL | ANT2 to RX2, TX2, and BT; f = 2.4 to 2.5 GHz | | 0.7 | 0.9 | dB |
| Return loss (insertion loss state), 2 GHz | RL | ANT2 to RX2, TX2, and BT; f = 2.4 to 2.5 GHz | 14 | 18 | | dB |
| Isolation, 2 GHz | Iso | ANT2 to RX2, TX2, and BT; one path on; f = 2.4 to 2.5 GHz | 18 | 24 | | dB |
| Antenna isolation, 2 GHz | Iso | ANT2 to ANT5: | | | | |
| | | One 2 GHz path on, f = 2.4 to 2.5 GHz | 20 | 22 | | dB |
| | | One 2 GHz path on, f = 4.8 to 5.0 GHz | 20 | 22 | | dB |
| Switching speed | | 50% control to 90/10% RF steady state power | | 50 | | ns |
| Error vector magnitude | EVM | Input power for 2.5% error, WLAN 2.45 GHz, 802.11g, OFDM, 54 Mbps, 64 QAM | +20 | +22 | | dBm |
| 0.5 dB input compression point | IP0.5dB | f = 2.5 GHz | +27.0 | +29.5 | | dBm |
| *5 GHz SP2T* | | | | | | |
| Insertion loss, 5 GHz | IL | ANT5 to RX5 and TX5, f = 4.9 to 5.9 GHz | | 1.20 | 1.35 | dB |
| Return loss (insertion loss state), 5 GHz | RL | ANT5 to RX2 and TX2, f = 4.9 to 5.9 GHz | | 13 | | dB |
| Isolation, 5 GHz | Iso | ANT5 to RX5, or ANT5 to TX5; one path on; f = 4.9 to 5.9 GHz | 15.0 | 20.5 | | dB |
| Antenna isolation, 5 GHz | Iso | ANT2 to ANT5, one 5 GHz path on, f = 4.8 to 5.9 GHz | 15 | 20 | | dB |
| Switching speed | | 50% control to 90/10% RF steady state power | | 50 | | ns |
| Error vector magnitude | EVM | Input power for 2.5% error, WLAN 4.9 to 6.0 GHz, 802.11g, OFDM, 54 Mbps, 64 QAM | +17.5 | +19.0 | | dBm |
| 0.5 dB input compression point | IP0.5dB | f = 5.0 GHz | +26 | +28 | | dBm |

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

## Table 4. SKY13445-368LF Electrical Specifications (Note 1)
($V_{CTL}$ = 3 V, $T_{OP}$ = +25 °C, Characteristic Impedance [$Z_0$] = 50 Ω, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Control voltage:<br>    Low<br>    High | $V_{CTL\_L}$<br>$V_{CTL\_H}$ | | 0<br>2.7 | <br>3.0 | 0.2<br>5.0 | V<br>V |
| Leakage current | $I_{LEAK}$ | VC1/2/3/4/5 = 3 V | | 15 | 30 | µA |

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

## Table 5. SKY13445-368LF Truth Table (Note 1)

| Function | Control Signal Logic | | | | | Insertion Loss/Isolation State | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VC1<br>(Pin 11) | VC2<br>(Pin 5) | VC3<br>(Pin 9) | VC4<br>(Pin 1) | VC5<br>(Pin 2) | ANT2 to<br>BT | ANT2 to<br>TX2 | ANT2 to<br>RX2 | ANT5 to<br>Rx5 | ANT5 to<br>TX5 |
| ANT2 to BT | 1 | 0 | 0 | 0 | 0 | Insertion Loss | Isolation | Isolation | Isolation | Isolation |
| ANT2 to TX2 | 0 | 1 | 0 | 0 | 0 | Isolation | Insertion Loss | Isolation | Isolation | Isolation |
| ANT2 to RX2 | 0 | 0 | 1 | 0 | 0 | Isolation | Isolation | Insertion Loss | Isolation | Isolation |
| ANT5 to RX5 | 0 | 0 | 0 | 1 | 0 | Isolation | Isolation | Isolation | Insertion Loss | Isolation |
| ANT5 to TX5 | 0 | 0 | 0 | 0 | 1 | Isolation | Isolation | Isolation | Isolation | Insertion Loss |
| ANT2 to BT, ANT5 to RX5 | 1 | 0 | 0 | 1 | 0 | Insertion Loss | Isolation | Isolation | Insertion Loss | Isolation |
| ANT2 to BT, ANT5 to TX5 | 1 | 0 | 0 | 0 | 1 | Insertion Loss | Isolation | Isolation | Isolation | Insertion Loss |
| ANT2 to TX2, ANT5 to RX5 | 0 | 1 | 0 | 1 | 0 | Isolation | Insertion Loss | Isolation | Insertion Loss | Isolation |
| ANT2 to TX2, ANT5 to TX5 | 0 | 1 | 0 | 0 | 1 | Isolation | Insertion Loss | Isolation | Isolation | Insertion Loss |
| ANT2 to RX2, ANT5 to RX5 | 0 | 0 | 1 | 1 | 0 | Isolation | Isolation | Insertion Loss | Insertion Loss | Isolation |
| ANT2 to RX2, ANT5 to TX5 | 0 | 0 | 1 | 0 | 1 | Isolation | Isolation | Insertion Loss | Isolation | Insertion Loss |

**Note 1**: Any state other than described in this Table places the switch into an undefined state. An undefined state will not damage the device.

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## Typical Performance Characteristics
($V_{CTL}$ = 0 V [Low] and 3 V [High], $T_{OP}$ = +25 °C, Characteristic Impedance [$Z_O$] = 50 Ω, Unless Otherwise Noted)
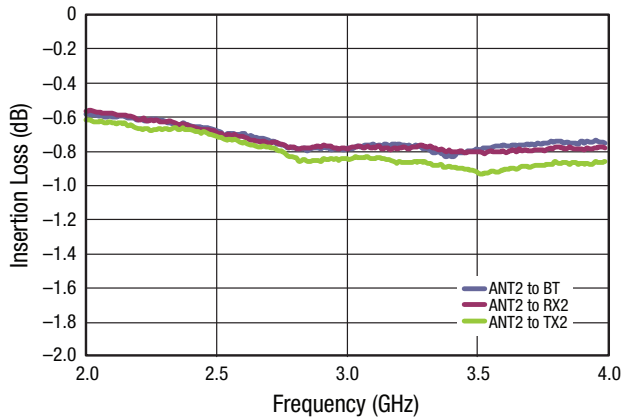
**Figure 3. Typical Insertion Loss vs Frequency
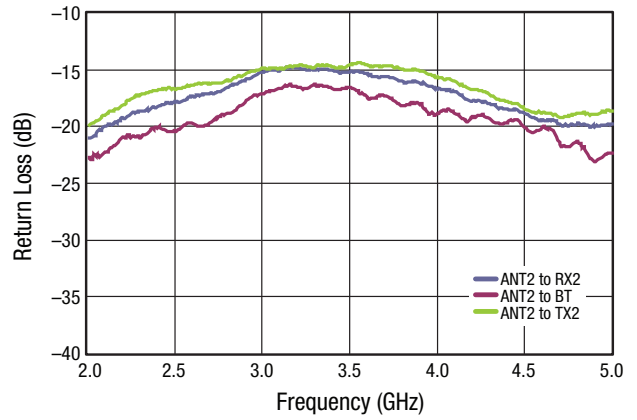(2 GHz, SP3T)**

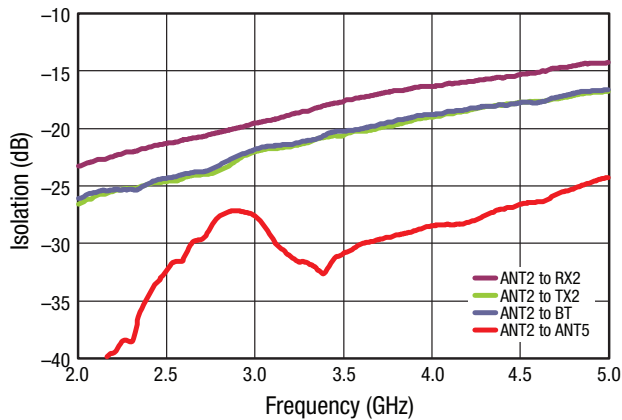**Figure 4. Typical Input Return Loss vs Frequency
(2 GHz, SP3T)**
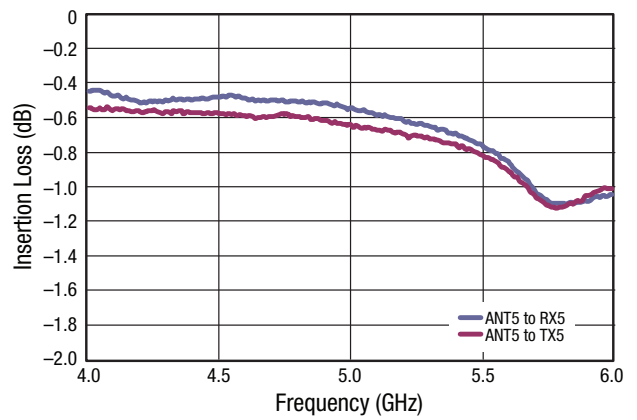
**Figure 5. Typical Isolation vs Frequency
(2 GHz, SP3T)**
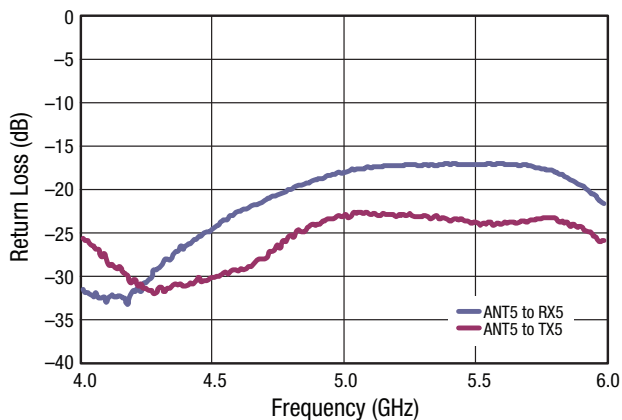
**Figure 6. Typical Insertion Loss vs Frequency
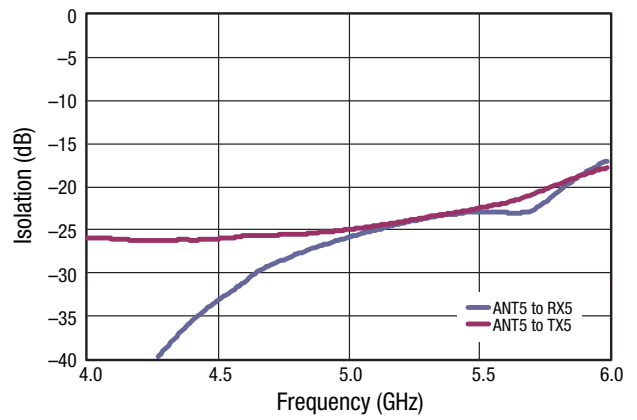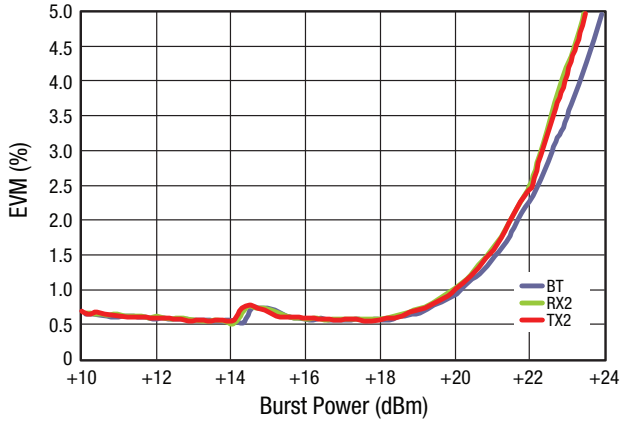(5 GHz, SP2T)**

**Figure 7. Typical Input Return Loss vs Frequency
(5 GHz, SP2T)**

**Figure 8. Typical Isolation vs Frequency
(5 GHz, SP5T)**

Figure 9. Typical EVM vs Burst Power @ 2500 MHz
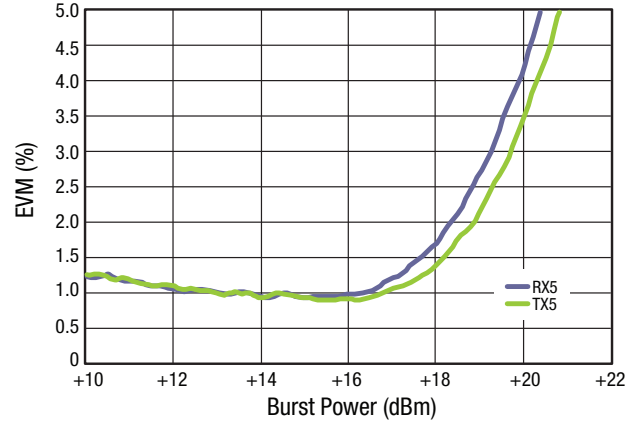


Figure 10. Typical EVM vs Burst Power @ 5500 MHz

## Evaluation Board Description

The SKY13445-368LF Evaluation Board is used to test the performance of the SKY13445-368LF dual-band switch. An Evaluation Board schematic diagram is provided in Figure 11. An assembly drawing for the Evaluation Board is shown in Figure 12.

## Package Dimensions

The PCB layout footprint for the SKY13445-368LF is provided in Figure 13. Typical part markings are shown in Figure 14. Package dimensions are shown in Figure 15, and tape and reel dimensions are provided in Figure 16.

## 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 SKY13445-368LF 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.
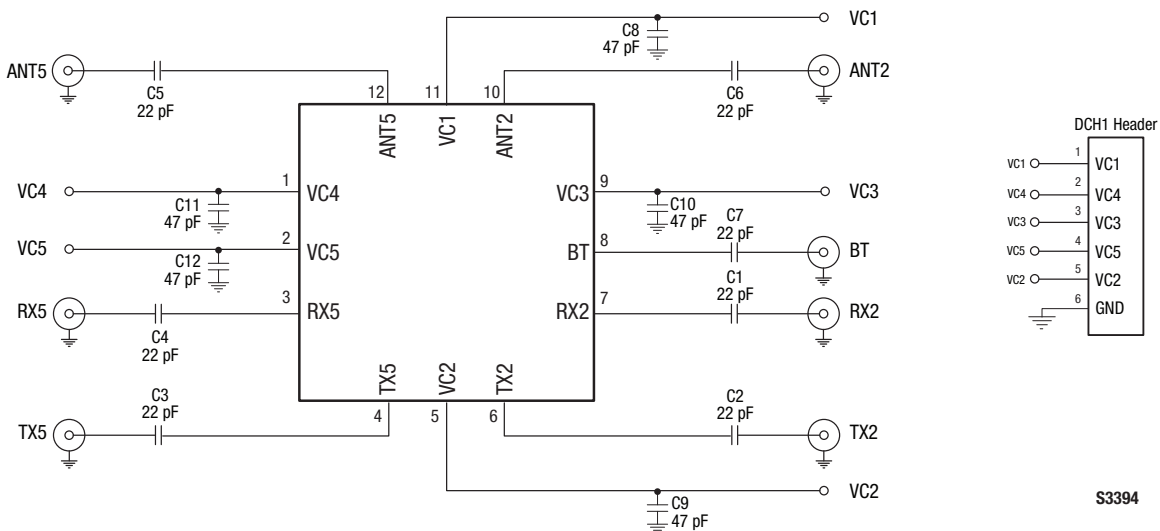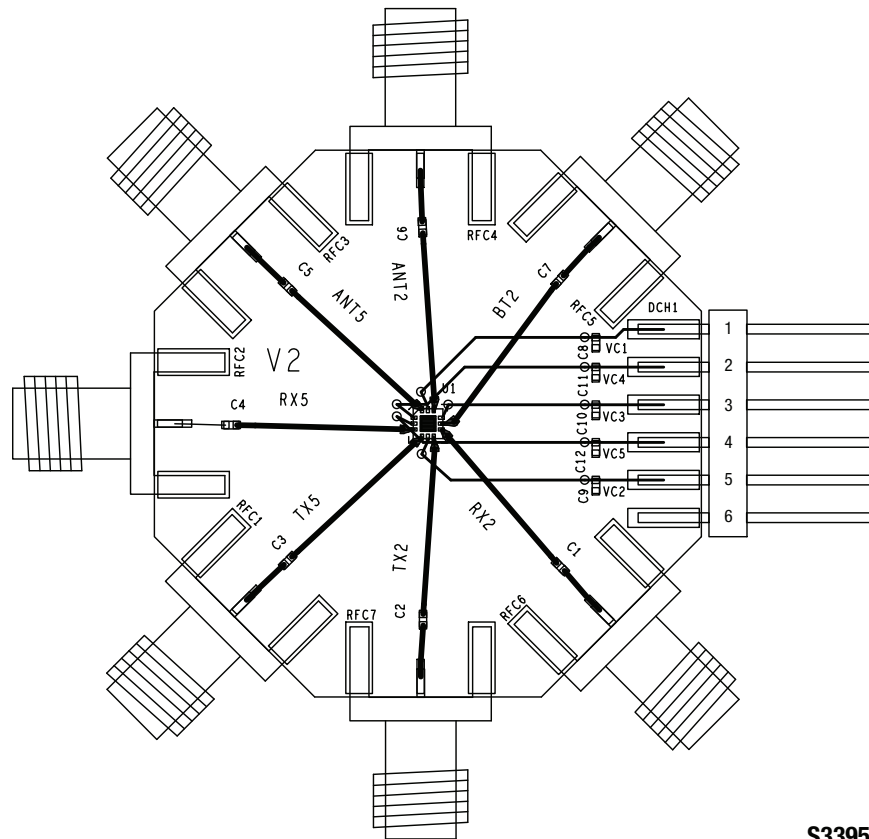


Figure 11. SKY13445-368LF Evaluation Board Schematic

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S3395

**Figure 12. SKY13445-368LF Evaluation Board Assembly Diagram**



*All measurements in millimeters*

S1802
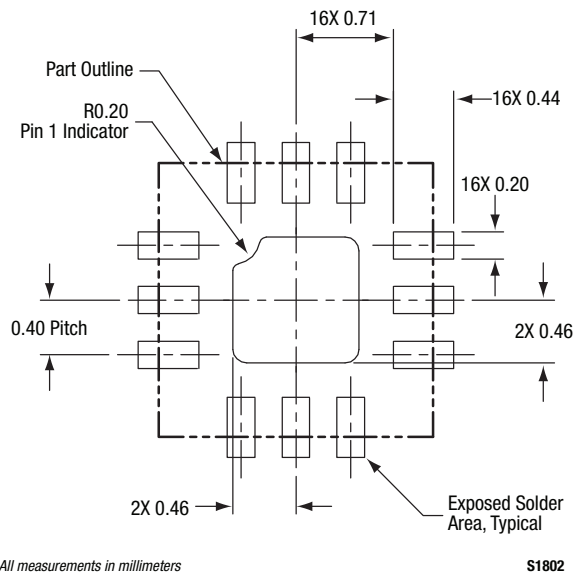
**Figure 13. SKY13445-368LF PCB Layout Footprint
(Top View)**

Pin 1
Indicator

Skyworks P/N

SKY
3445

**Figure 14. Typical Part Markings**
**(Top View)**

–C–

Seating
Plane

2.00

–A–

–B–

Pin 1
Indicator

2.00

2X 0.10 C

2X 0.10 C

Top View

0.02 +0.03/–0.02

0.55 + 0.05/–0.04

// 0.10 C

12X 3

0.08 C

Side View

0.92 +0.10/–0.15

(0.460)

R0.20
Pin 1 Indicator

Detail A

Pin 1

0.40

0.92 +0.10/–0.15

(0.460)

Exposed Pad

12X 0.20 Min.

Bottom View

0.29 ± 0.10

0.2 ± 0.05

Detail B

⊕ 0.10 M C A B
0.10 M C
5

*All measurements are in millimeters.*
*Dimensioning and tolerancing according to ASME Y14.5M-1994.*
*Coplanarity applies to the terminals and all other bottom surface metalization.*
*Plating requirement per source control drawing (SCD) 2504.*
*Dimension applies to metalized terminal and is measured between 0.15 and 0.30 mm*
 *from terminal tip.*

S1731

**Figure 15. SKY13445-368LF 12-Pin QFN Package Dimensions**

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**Figure 16. SKY13445-368LF Tape and Reel Dimensions**

Notes:

1. Carrier tape must meet all requirements of Skyworks GP01-D232 procurement spec for tape and reel shipping.
2. Carrier tape shall be black conductive polycarbonate bakeable material at 125 ℃ temperature.
3. Cover tape shall be transparent conductive with 5.40 mm width.
4. ESD-surface resistivity must meet all ESD requirements of Skyworks specified on GP01-D232.
5. All measurements are in millimeters.

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## Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|---|---|---|
| SKY13445-368LF Dual-Band SP2T and SP3T Switch | SKY13445-368LF | SKY13445-368LF-EVB |

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