DATA SHEET

SKY13380-350LF: 20 MHz-3.0 GHz High Power SP4T Switch With Decoder

Applications

- GSM/WCDMA/EDGE datacards and handsets
- Mobile high power switching systems

Features

- Broadband frequency range: 20 MHz to 3.0 GHz
- Low insertion loss: 0.40 dB @ 1 GHz, 0.45 dB @ 2 GHz with high isolation (28 dB @ 1 GHz)
- V_{DD}: 2.5 to 3.0 V for high power applications; can be used down to 1.6 V for low power applications
- High linearity IMD < –100 dBm over phase
- Good harmonic performance < –80 dBc @ 0.9 GHz
- Low voltage logic compatible (minimum V_{HIGH} = 1.8 V)
- Small, QFN (16-pin, 3 x 3 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

Skyworks Green™ products are RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, are halogen free according to IEC-61249-2-21, and contain <1,000 ppm antimony trioxide in polymeric materials.

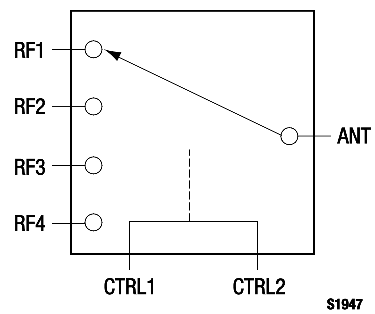

Figure 1. SKY13380-350LF Block Diagram

Description

The SKY13380-350LF is a symmetrical, single-pole, four-throw (SP4T) switch. The device is designed for broadband, high power switching applications that demand high linearity and low insertion loss. This is a general purpose switch optimized for a variety of multimode applications such as GSM/WCDMA/EDGE.

The switch is manufactured using Skyworks state-of-the-art pHEMT process. The SKY13380-350LF features integrated logic that uses only two control lines for switch operation. The low current consumption makes the device suitable for battery-operated applications.

The SKY13380-350LF SP4T switch is provided in a compact Quad Flat No-Lead (QFN) 3 x 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.

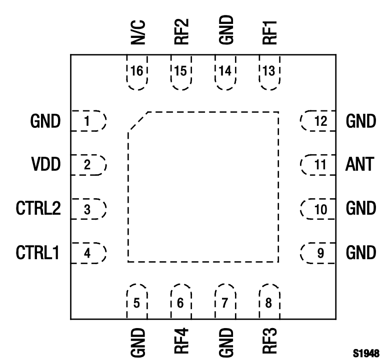

Figure 2. SKY13380-350LF Pinout – 16-Pin QFN (Top View)

Table 1. SKY13380-350LF Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	GND	Ground	9	GND	Ground
2	VDD	Supply voltage input. The voltage may be switched. The switching time must be no longer than the start-up time.	10	GND	Ground
3	CTRL2	Control signal 2. The logic level applied to this pin, along with the logic level applied to pin 4, controls the state of the switch.	11	ANT	Antenna. This pin is connected directly and exclusively to pin 6, 8, 13, or 15 depending on the control voltage applied to pins 3 and 4. A DC blocking capacitor is required.
4	CTRL1	Control signal 1. The logic level applied to this pin, along with the logic level applied to pin 3, controls the state of the switch.	12	GND	Ground
5	GND	Ground	13	RF1	RF output 1. This pin is either connected directly to or is disconnected from pin 11, depending on the control voltage applied to pins 3 and 4. A DC blocking capacitor is required.
6	RF4	RF output 4. This pin is either connected directly to or is disconnected from pin 11, depending on the control voltage applied to pins 3 and 4. A DC blocking capacitor is required.	14	GND	Ground
7	GND	Ground	15	RF2	RF output 2. This pin is either connected directly to or is disconnected from pin 11, depending on the control voltage applied to pins 3 and 4. A DC blocking capacitor is required.
8	RF3	RF output 3. This pin is either connected directly to or is disconnected from pin 11, depending on the control voltage applied to pins 3 and 4. A DC blocking capacitor is required.	16	N/C	No connection.

Table 2. SKY13380-350LF Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{DD}		3	V
Input power (20 MHz to 3.0 GHz, V_{DD} = 2.5 to 3.0 V)	P_{IN}		+40	dBm
Control voltage	CTRL1, CTRL2		3	V
Operating temperature	T_{OP}	–40	+85	°C
Storage temperature	T_{STG}	–50	+100	°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 SKY13380-350LF is comprised of a CMOS decoder that enables two TTL-compatible DC lines to control four RF ports. The decoder is internally connected to a GaAs pHEMT RF switch. Depending on the logic voltage level applied to the control pins, the ANT pin is connected to one of four switched RF outputs (RF1, RF2, RF3, or RF4) by a low insertion loss path, while maintaining a high isolation path to the alternate port.

Startup time is defined as the time from when V_{DD} is applied to when the switch is active. Once the startup time has passed, the control voltages CTRL1 and CTRL2 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_{DD}.

Step 2: Apply CTRL1 and CTRL2

Step 3: Apply RF input.

The device must be turned off in the reverse order.

When V_{DD} is not applied, the device is considered off or inactive. All arms of the switch remain on in this state, creating a poor four-way power splitter. The return loss of all RF ports is very low in this state. RF should not be applied when V_{DD} is not present and should only be used to conserve current.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY13380-350LF are provided in Table 2. Electrical specifications are provided in Table 3.

The state of the SKY13380-350LF is determined by the logic provided in Table 4.

Typical performance characteristics of the SKY13380-350LF are illustrated in Figures 3 through 8.

Figure 9 illustrates the test setup used to measure data for 3rd Order Intermodulation Distortion (IMD3) testing. Figure 10 illustrates the test setup used to measure triple beat ratio data.

Table 3. SKY13380-350LF Electrical Specifications (1 of 2) (Note 1)
(V_{DD} = 2.65 V, CTRL1 = CTRL2 = V_{DD}, T_{OP} = +25 °C, All Unused RF Ports are Terminated in a 50 Ω Load, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
RF Specifications						
Insertion loss	IL	0.02 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.7 GHz		0.40 0.45 0.60	0.50 0.60 0.80	dB dB dB
Isolation	ISO	0.02 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.7 GHz	25 19 19	28 22 21		dB dB dB
Return loss	$\lvert S_{11} \rvert$	0.02 to 2.7 GHz, all RF ports, insertion loss state		20		dB
Second harmonic	2fo	f_{FUND} = 900 MHz, P_{IN} = +35 dBm f_{FUND} = 1800 MHz, P_{IN} = +33 dBm		+80 +75		dBc dBc
Third harmonic	3fo	f_{FUND} = 900 MHz, P_{IN} = +35 dBm f_{FUND} = 1800 MHz, P_{IN} = +33 dBm		+80 +75		dBc dBc
Input 0.1 dB compression point	P0.1dB	@ 900 MHz, 1800 MHz		+39		dBm
3rd Order Intermodulation Distortion	IMD3	f_{FUND} = 1.95 GHz @ +20 dBm, f_{BLK} = 1.76 GHz @ –15 dBm, f_{RX} = 2.14 GHz, worst case over phase. See Figure 9.		100		dBm

Table 3. SKY13380-350LF Electrical Specifications (2 of 2) (Note 1)
(V_{DD} = 2.65 V, CTRL1 = CTRL2 = V_{DD}, T_{OP} = +25 °C, All Unused RF Ports are Terminated in a 50 Ω Load, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
RF Specifications (continued)						
Switching speed		10/90% RF rise/fall time		1		µs
Startup time		Wait time required from when V_{DD} is applied until control voltage can be applied		25		µs
DC/Control Specifications						
Switched supply voltage	V_{DD}		1.60	2.65	3.00	V
Switched supply current	I_{DD}			0.3		mA
Control voltage: High Low	CTRL1, CTRL2		 1.60 	 2.0 0	 V_{DD} 0.3	 V V
Control current: High Low	I_{CTL}			 0.5 0.5		 µA µA

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

Table 4. SKY13380-350LF Truth Table

State	CTRL1 (Pin 4)	CTRL2 (Pin 3)	RF Path
1	V_{LOW}	V_{LOW}	ANT to RF1
2	V_{LOW}	V_{HIGH}	ANT to RF2
3	V_{HIGH}	V_{LOW}	ANT to RF3
4	V_{HIGH}	V_{HIGH}	ANT to RF4

Note: V_{HIGH} = 1.6 V to V_{DD}
V_{LOW} = 0 to 0.3 V
Any state other than described in this Table places the switch into an undefined state.

Typical Performance Characteristics

(V_{DD} = 2.5 to 3.0 V, CTRL1 = CTRL2 = V_{DD}, T_{OP} = +25 °C, All Unused RF Ports are Terminated in a 50 Ω Load, Unless Otherwise Noted)

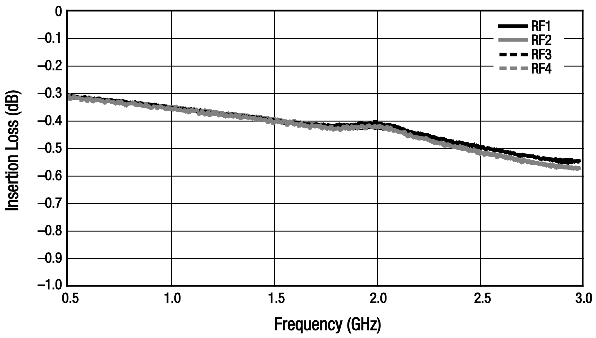

Figure 3. Insertion Loss vs Frequency

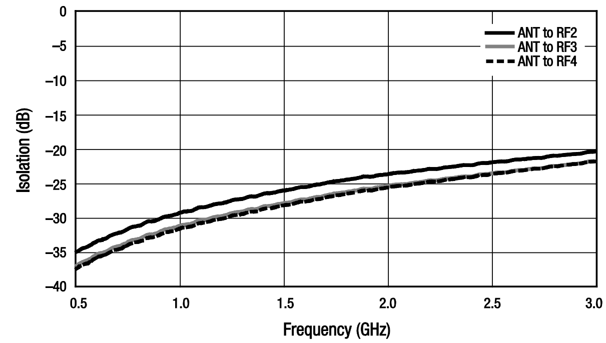

Figure 4. Isolation vs Frequency (ANT to RF1 Insertion Loss State)

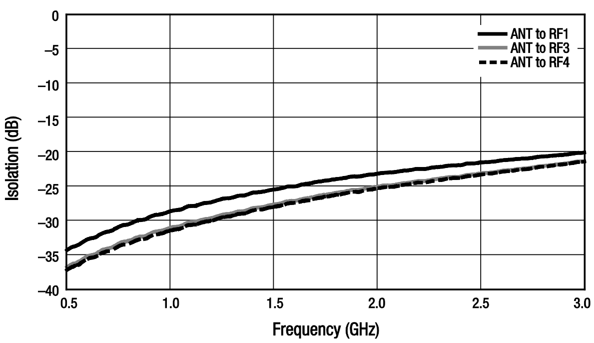

Figure 5. Isolation vs Frequency (ANT to RF2 Insertion Loss State)

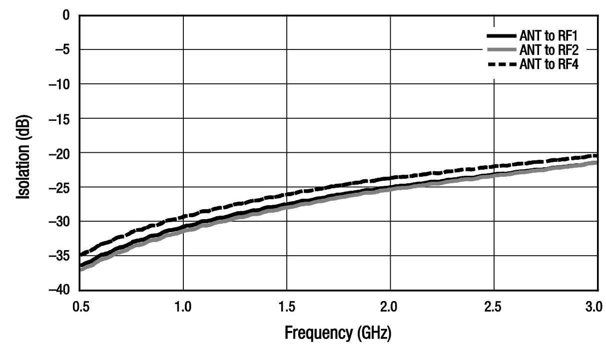

Figure 6. Isolation vs Frequency (ANT to RF3 Insertion Loss State)

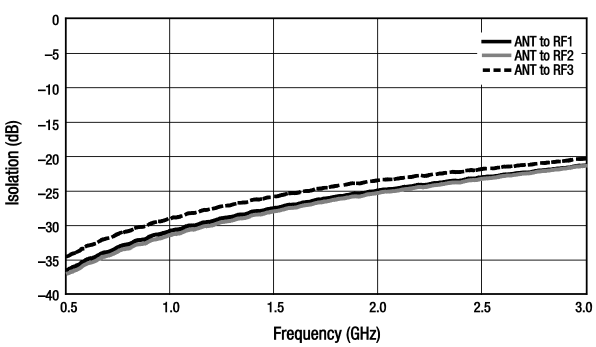

Figure 7. Isolation vs Frequency (ANT to RF4 Insertion Loss State)

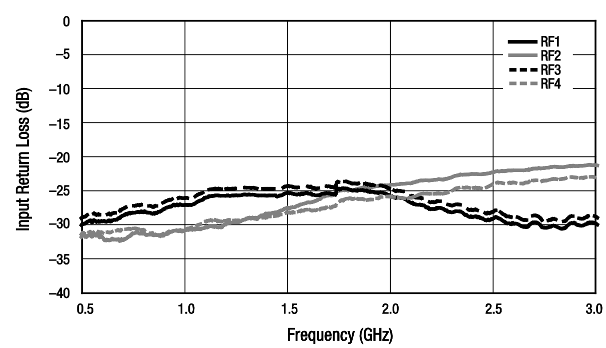

Figure 8. Input Return Loss vs Frequency

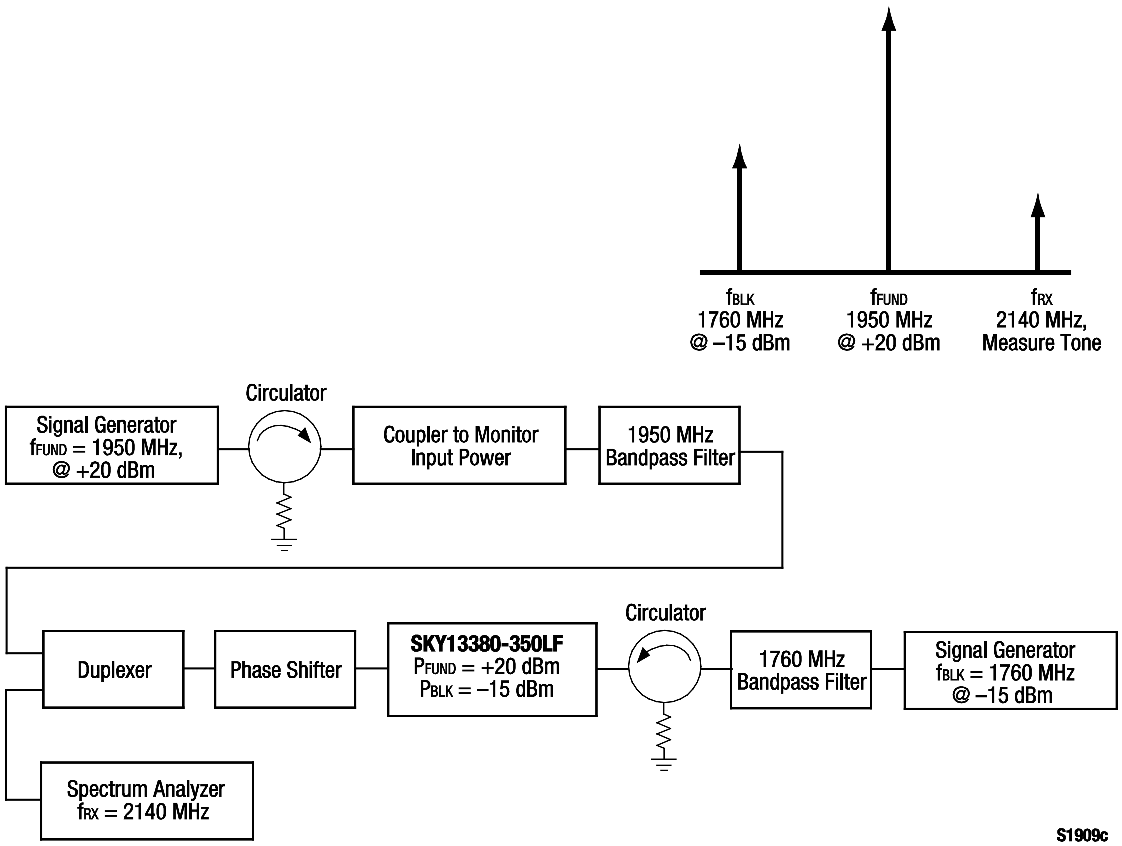

Figure 9. 3rd Order Intermodulation Test Setup

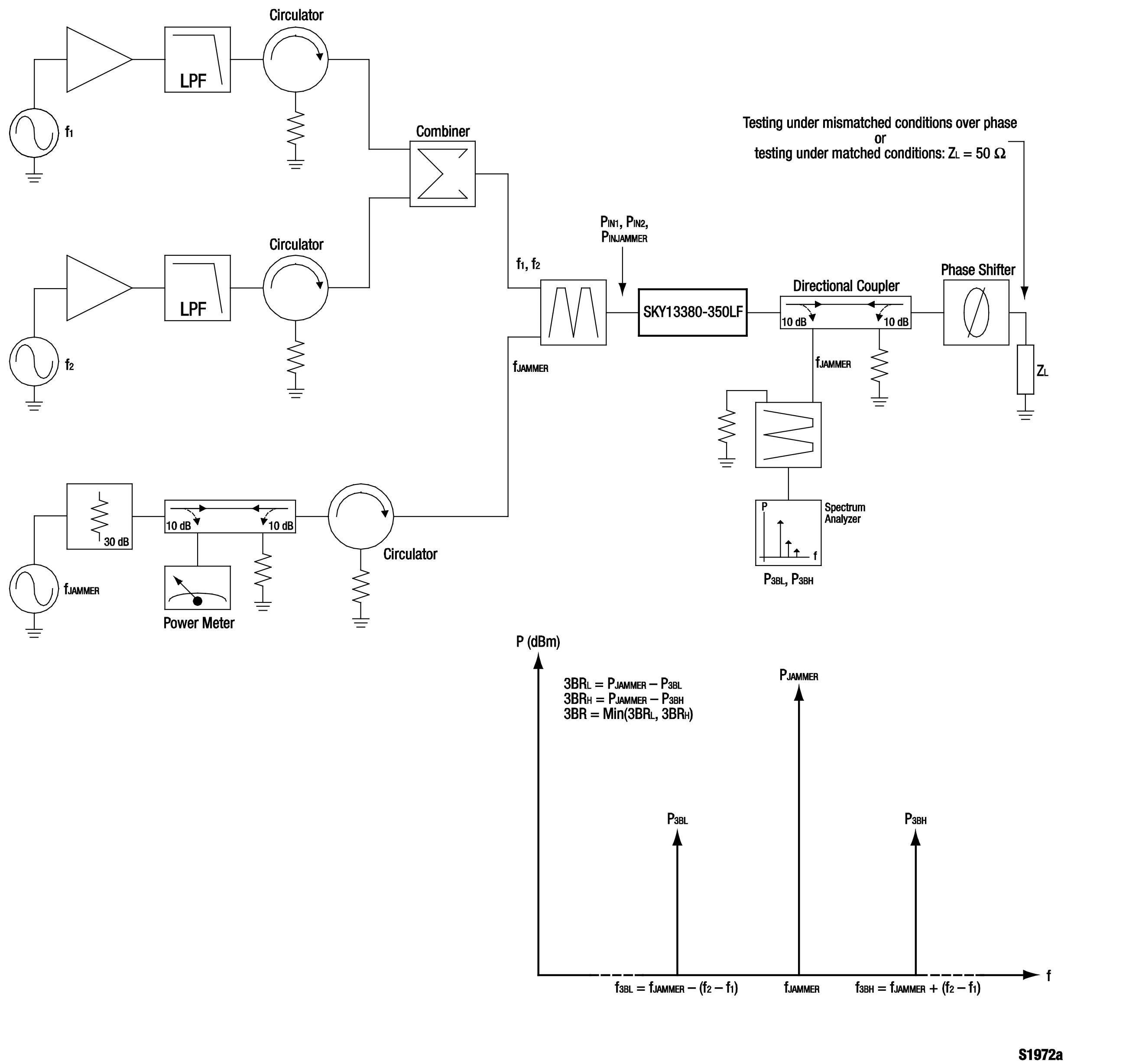

Figure 10. Triple Beat Ratio (3BR) Test Setup

Evaluation Board Description

The SKY13380-350LF Evaluation Board is used to test the performance of the SKY13380-350LF SP4T Switch. An Evaluation Board schematic diagram is provided in Figure 11. An assembly drawing for the Evaluation Board is shown in Figure 12.

Components C3 and L1 constitute an ESD filter. This topology and the component values noted in Figure 11 may vary according to the ESD requirement and acceptable insertion loss for a specific application.

Decoupling capacitors (C3 through C6) are recommended to suppress noise and to prevent RF leakage into the DC control circuits.

DC blocking capacitors C1, C2, C7, C8, and C9 determine the low frequency operation of the switch. Increase the capacitor values to lower operation frequency.

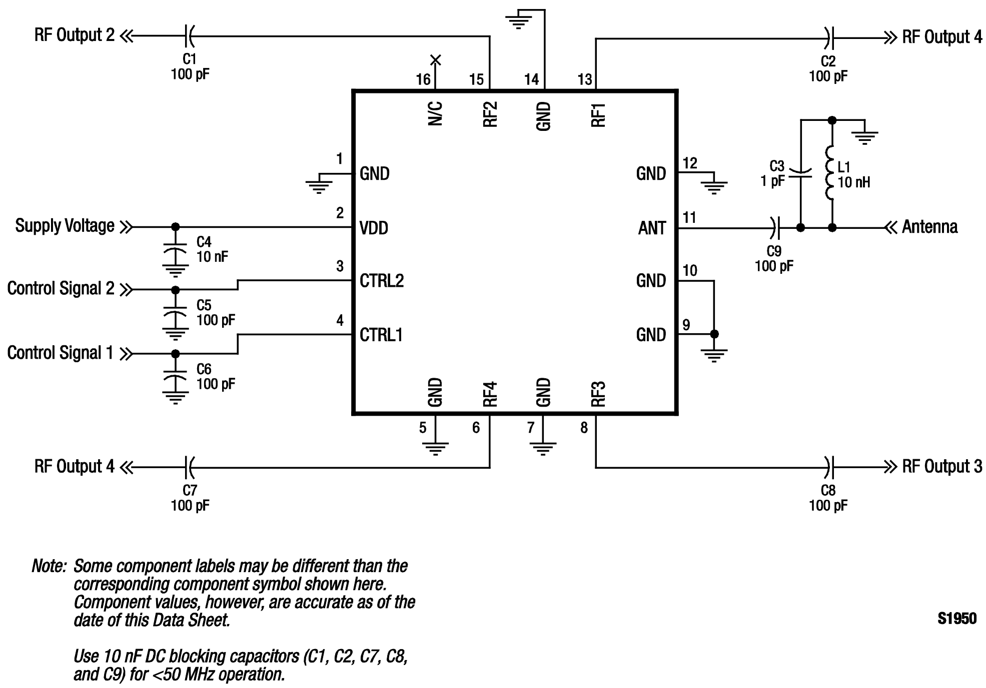

Figure 11. SKY13380-350LF Evaluation Board Schematic

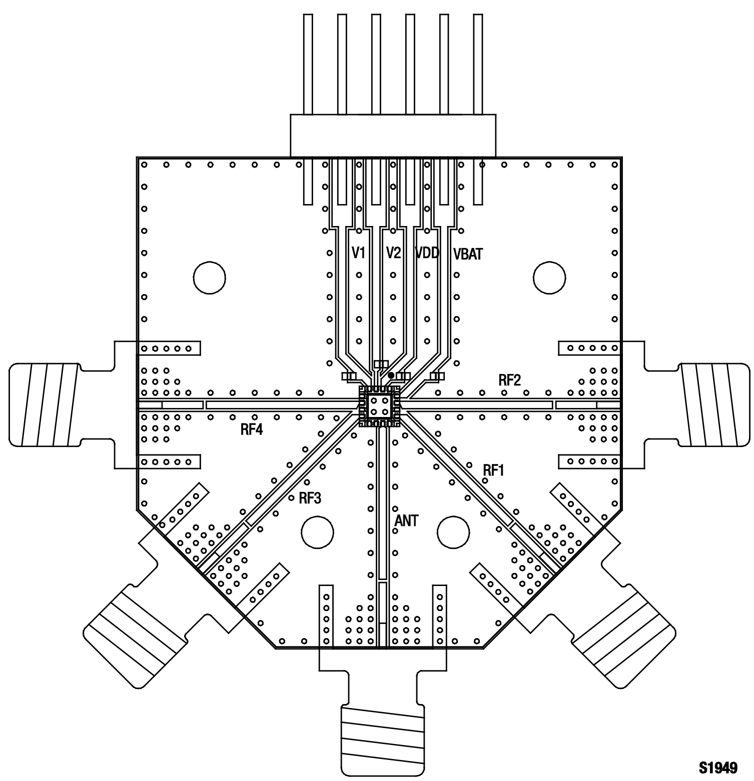

Figure 12. SKY13380-350LF Evaluation Board Assembly Diagram

Package Dimensions

The PCB layout footprint for the SKY13380-350LF is provided in Figure 13. Typical case markings are shown in Figure 14. Package dimensions for the 16-pin QFN 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 SKY13380-350LF 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.

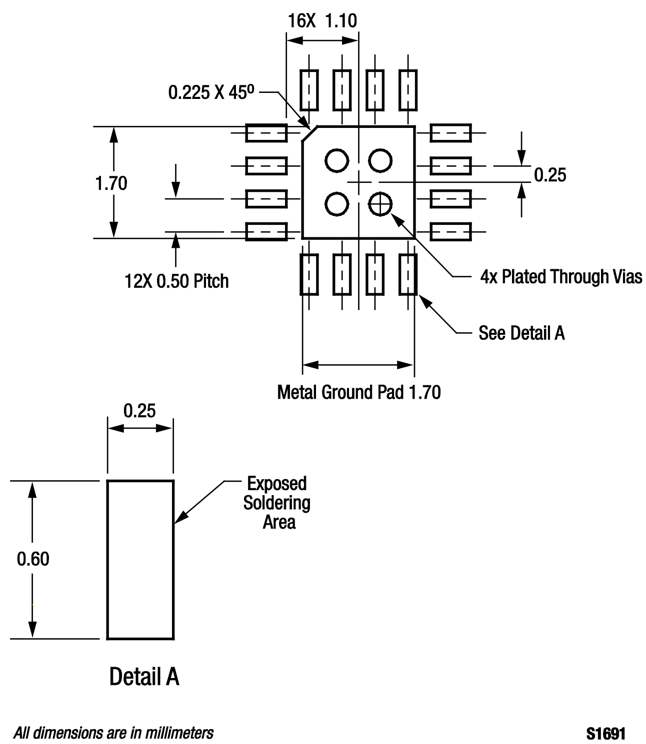

Figure 13. SKY13380-350LF PCB Layout Footprint (Top View)

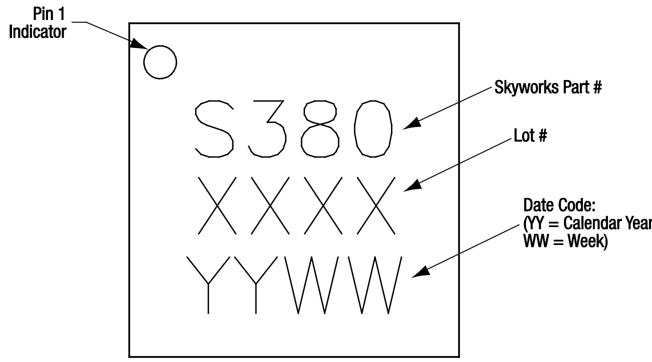

Figure 14. Typical Case Markings
(Top View)

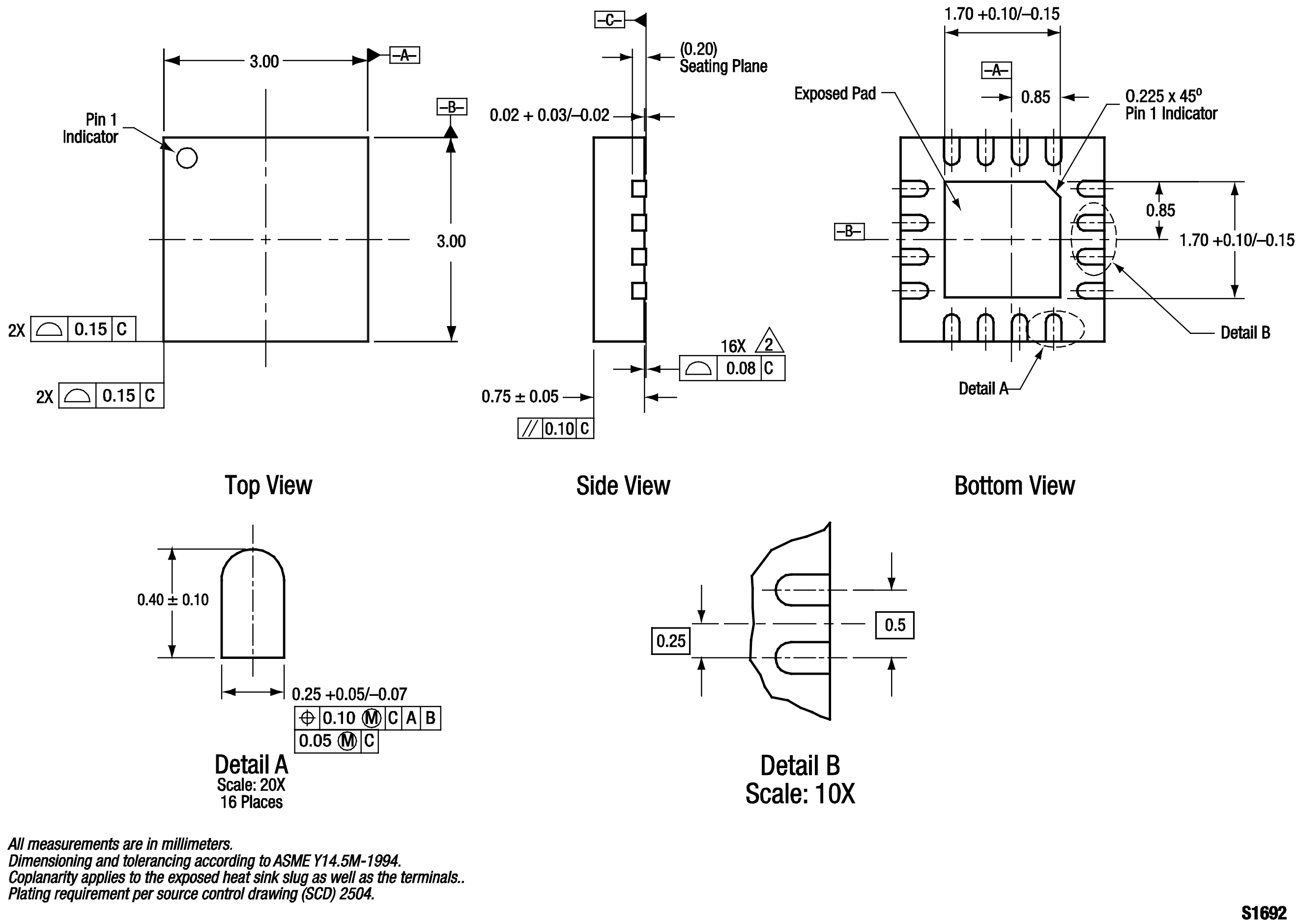

Figure 15. SKY13380-350LF 16-Pin QFN Package Dimensions

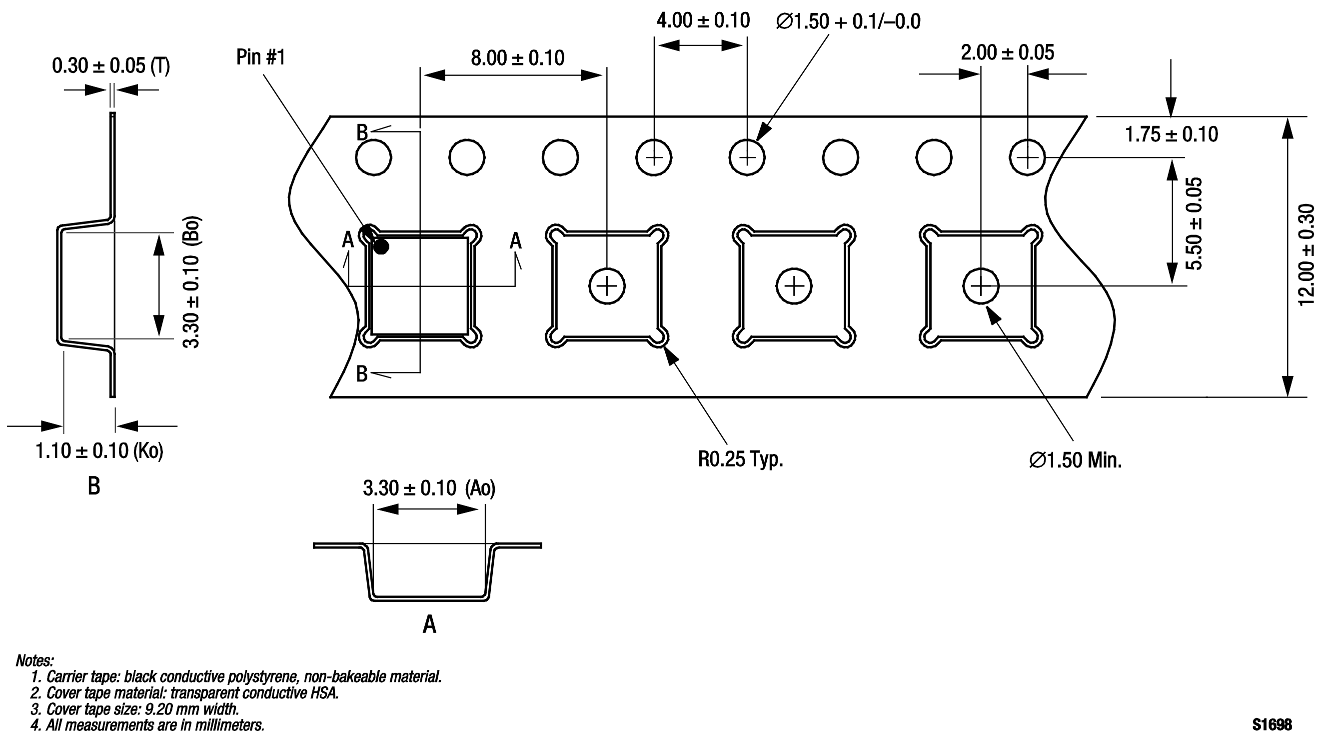

Figure 16. SKY13380-350LF Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY13380-350LF SP4T Switch	SKY13380-350LF	SKY13380-350LF-EVB