PRELIMINARY DATA SHEET

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_{DD} voltage regulator:
  - V_{CTL} = 1.65 to 2.70 V
  - V_{DD} = 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)

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.

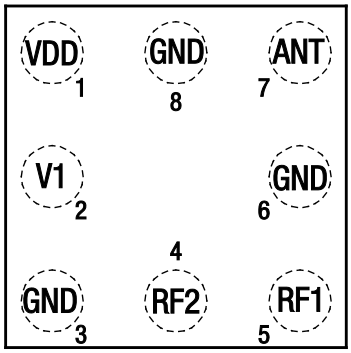


Figure 2. SKY13448-001 Pinout (Top View, Bumps Facing Down)

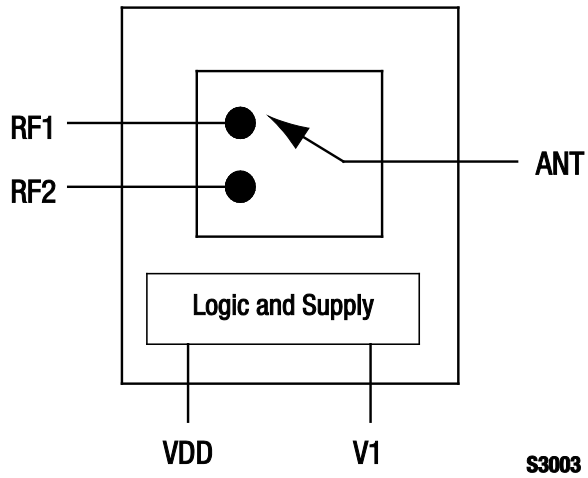


Figure 1. SKY13448-001 Block Diagram

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.

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	V_{DD}	2.4	3.5	V
Digital control voltage	V_{CTL}	–0.5	+3.0	V
RF input power	P_{IN}		+39	dBm
GSM RF input power: Low band High band	P_{IN}		 +36 +34	 dBm dBm
WCDMA/CDMA2000/LTE TDD/FDD RF input power at ANT port	P_{IN}		+26	dBm
Supply ripple	V_{PP}		20	mVpp
Operating temperature	T_{OP}	–35	+90	°C
Storage temperature	T_{STG}	–55	+150	°C
Electrostatic Discharge: Human Body Model (HBM), Class 1C Machine Model (MM), Class A	ESD		 1000 100	 V 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.

***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 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_{DD} = 2.85 V, T_{OP} = +25 °C, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

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

Table 3. SKY13448-001 Electrical Specifications (2 of 2) (Note 1)
(V_{DD} = 2.85 V, T_{OP} = +25 °C, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

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

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

Note 2: ETC = Extreme Test Conditions (V_{DD} = 2.45 V to 3.00 V and T_{OP} = –20 °C to +85 °C)

Table 4. 3rd Order Intermodulation Distortion Frequencies, No WLAN Blocker

IMD3 Band	fTX (MHz)		fBLOCK 1 (MHz)		fBLOCK 2 (MHz)	fBLOCK 3 (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. 3rd Order Intermodulation Distortion Frequencies, WLAN Blocker

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

Table 6. 2nd Order Intermodulation Distortion Frequencies, No WLAN Blocker

IMD2 Band	fTX (MHz)		fBLOCK 1 Minimum (MHz)	fBLOCK 2 (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. 2nd Order Intermodulation Distortion Frequencies, WLAN Blocker

IMD3 WLAN	fTX (MHz)		fBLOCK 1 (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, $P_{BLOCK} = 0$ dBm, and $P_{TX} = +24$ dBm)	880	915	2400	2485
Band 8 (measured at frequencies where 2620 MHz < $f_{BLOCK} - f_{TX}$ < 2690 MHz, $P_{BLOCK} = -30$ dBm, and $P_{TX} = +23$ 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.

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 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, *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 Dimensions

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

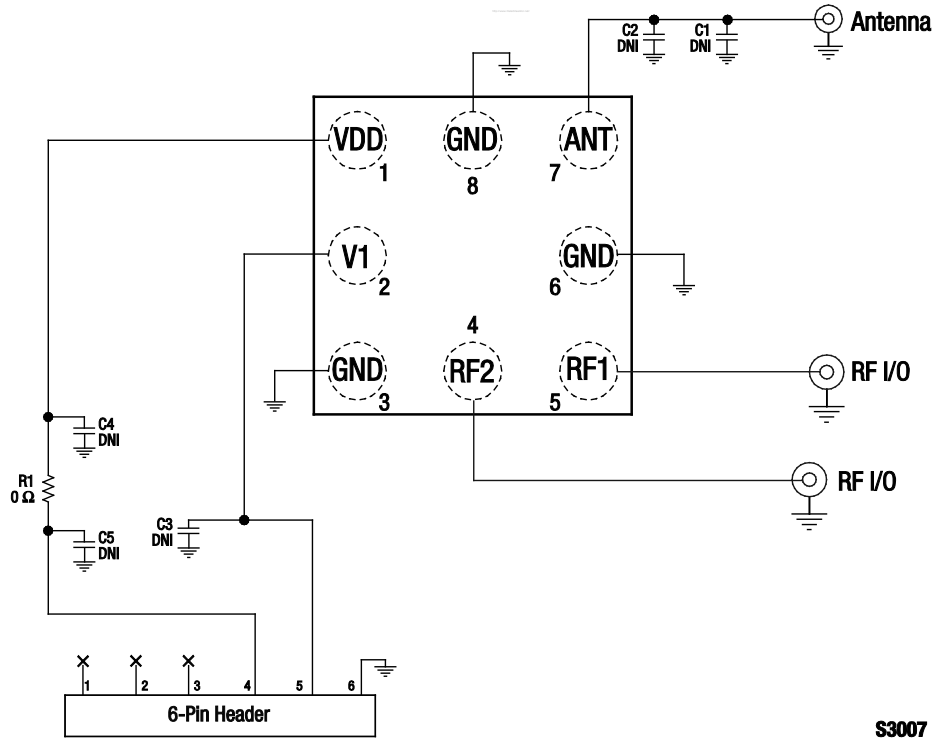


Figure 3. SKY13448-001 Evaluation Board Schematic

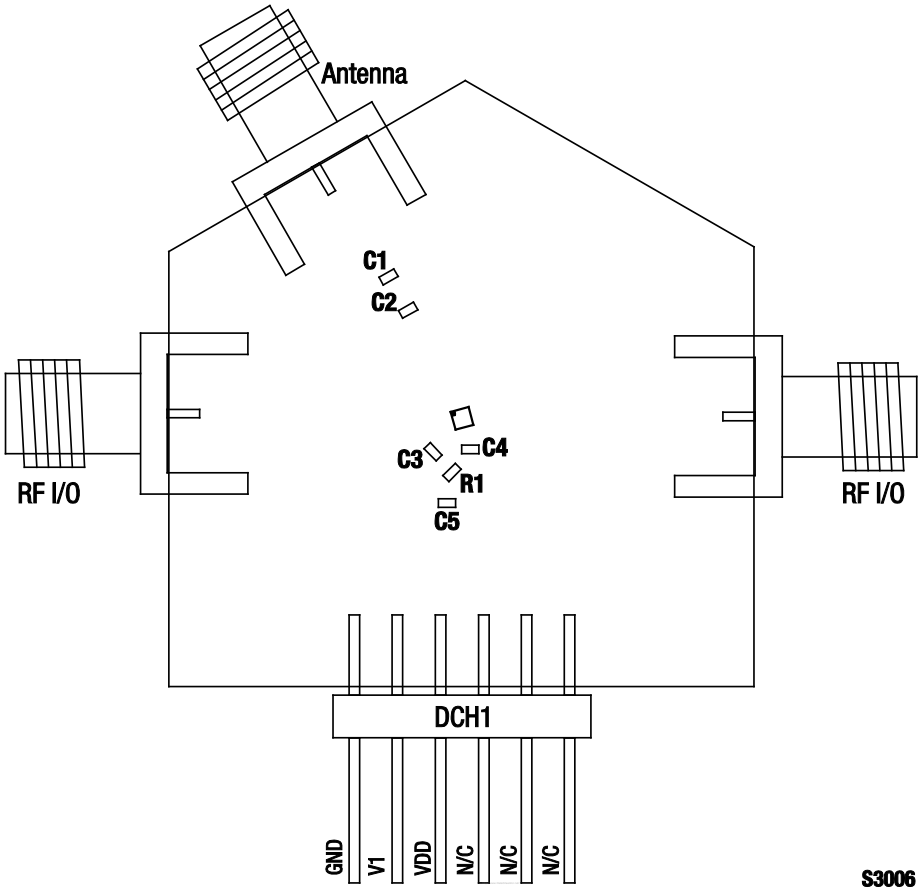
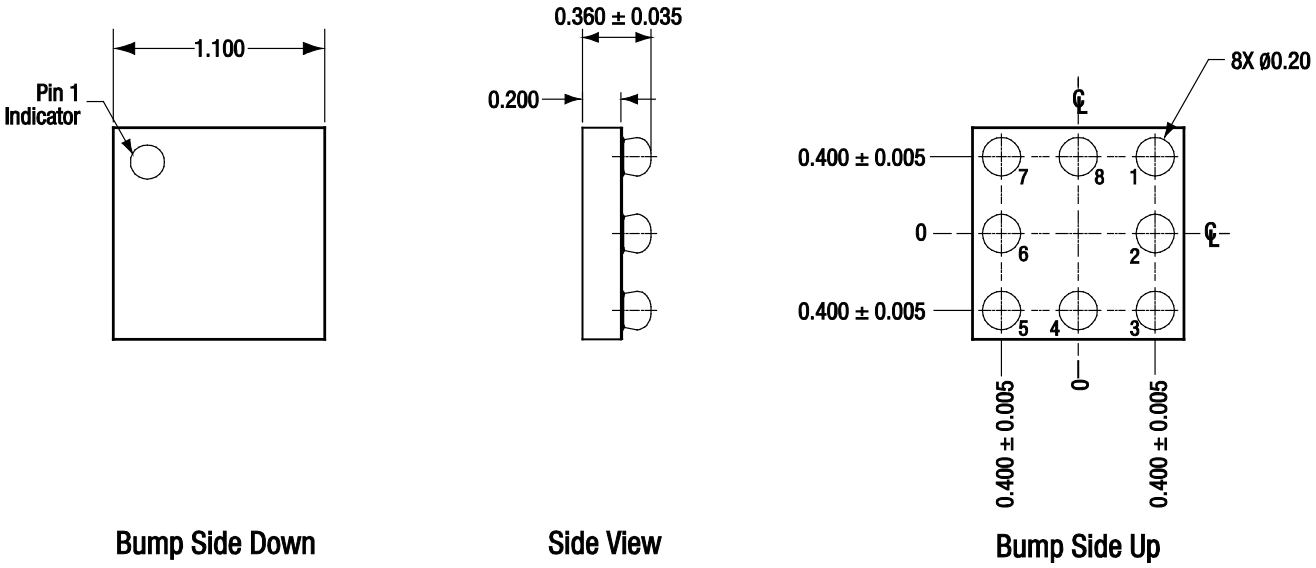
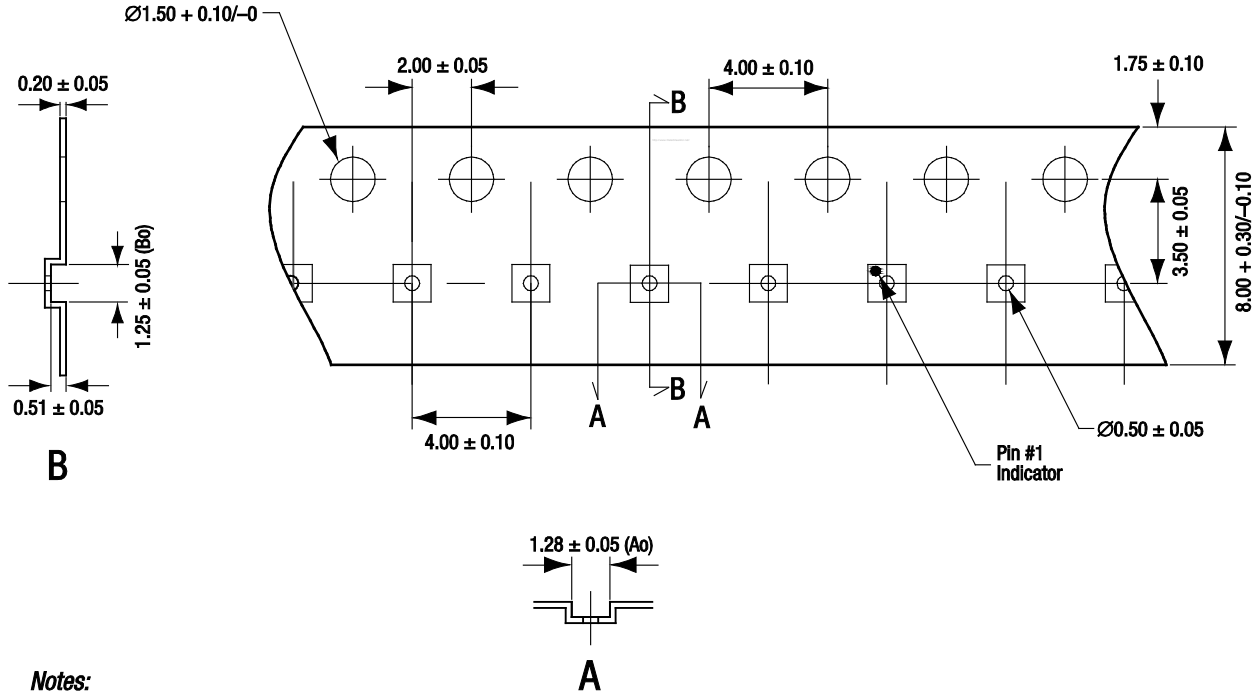


Figure 4. SKY13448-001 Evaluation Board Assembly Diagram



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. S3283

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