DATA SHEET

SKY5®-A1007: 0.4 to 5.9 GHz DPDT Low Insertion Loss / High-Isolation Switch

Applications

- Automotive 4G LTE/5G/CV2X/11p telematics systems
- Main/Diversity antenna swapping

Features

- Support for automotive PPAP
- Support for IMDS material declaration
- Independent BOM management to minimize PCN risk
- Extended operating temperature: -40 to 105 °C
- Broadband frequency range: 0.4 to 5.9 GHz
- Low insertion loss: 0.7 dB (typical) @ CV2X/11p frequency (5.75 to 5.925 GHz)
- High isolation: 30 dB @ 3.8 GHz
- GSM power handling
- Small QFN (12-pin, 1.83 × 1.83 × 0.5 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.

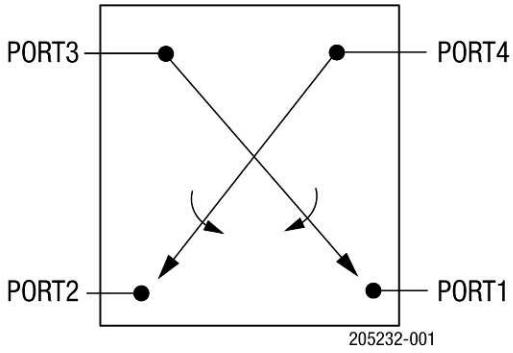


Figure 1. SKY5A1007 Block Diagram

Description

The SKY5A1007 is a state-of-the-art CMOS, silicon-on-insulator (SOI) double-pole, double-throw (DPDT) switch. The switch provides high-linearity performance, low insertion loss, and high isolation.

Switching is controlled by one voltage input, CTRL1. Depending on the logic voltage level applied to this pin, the PORT1 and PORT2 pins connect to one of the two other RF port pins (PORT3 or PORT4) through a low insertion loss path, while maintaining a high isolation path to the alternate port. No external DC blocking capacitors are required on the RF path as long as no DC voltage is applied externally.

The SKY5A1007 DPDT switch is provided in a compact Quad Flat No-Lead (QFN) 1.83 × 1.83 × 0.5 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.

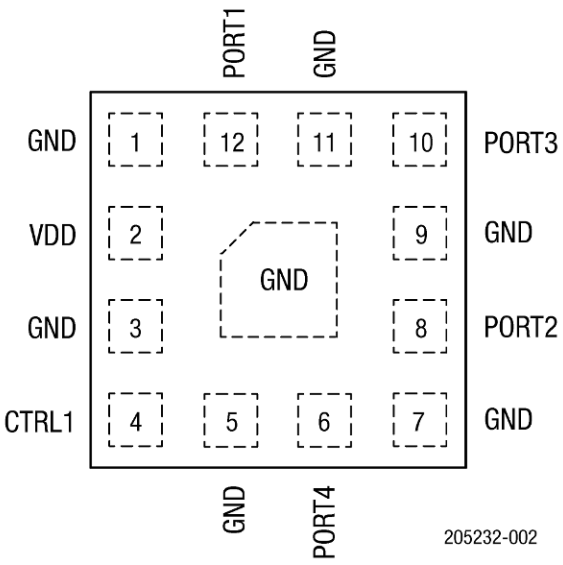


Figure 2. SKY5A1007 Pinout
(Top View)

Table 1. SKY5A1007 Signal Descriptions[1]

Pin	Name	Description	Pin	Name	Description
1	GND	Ground. Internally grounded.	7	GND	Ground. Internally grounded.
2	VDD	DC power supply.	8	PORT2	RF port 2.
3	GND	Ground. Internally grounded.	9	GND	Ground. Internally grounded.
4	CTRL1	DC control voltage 1. See Table 4.	10	PORT3	RF port 3.
5	GND	Ground. Internally grounded.	11	GND	Ground. Internally grounded.
6	PORT4	RF port 4.	12	PORT1	RF port 1.

[1] Exposed pad must be properly grounded using a low impedance path.

Functional Description

The SKY5A1007 DPDT switch can be used to connect either RF port 1 or RF port 2 to either RF port 3 or RF port 4 by applying the proper bias to the control pin (CTRL1). When Port 1 is connected to Port 4 using a low-loss path, Port 2 is connected to Port 3 also with a low-loss path. When Port 1 is connected to Port 3 using a low-loss path, Port 2 is connected to Port 4 also with a low-loss path.

The DPDT switch is designed to maximize the isolation between ports to minimize coupling between RF paths.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY5A1007 are provided in Table 2. Electrical specifications are provided in Table 3.

The state of the SKY5A1007 is determined by the logic provided in Table 4.

Table 2. SKY5A1007 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{DD}	-0.5	6	V
Control voltage	V_{CTL}	-0.5	3.1	V
Input power:	P_{IN}			
CW, 50% DC, VSWR = 1:1, 0.4 to 0.91 GHz			+39	dBm
CW, 50% DC, VSWR = 1:1, 1.71 to 2.7 GHz			+38	dBm
CW, 50% DC, VSWR = 1:1, 2.7 to 5.925 GHz			+36	dBm
CW, 50% DC, VSWR = 10:1, 0.4 to 5.925 GHz			+34	dBm
LTE 10M Full RB, VSWR = 10:1, instantaneous			+31	dBm
LTE 10M Full RB, VSWR = 8:1, 30 minutes			+31	dBm
Storage temperature	T_{STG}	-55	+150	°C
Ambient operating temperature[2]	T_{OP}	-40	+105	°C
Electrostatic discharge:	ESD			
Charged-Device Model (CDM), Class C3			1000	V
Human Body Model (HBM), Class 2			3000	V

[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.

[2] In all cases, ambient operating temperature (T_{OP}) is specified relative to case temperature (T_C) and assumes $T_{OP} = (T_C - 10\ °C)$

***ESD HANDLING**: 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 when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.*

Table 3. SKY5A1007 Electrical Specifications (1 of 3)[1]
(V_{DD} = 2.8 V, V_{CTL} = 0 V and +1.8 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
RF Specifications						
Insertion loss	IL	PORT1 to PORT3:				
		0.4 to 1.0 GHz		0.27	0.42	dB
		1.0 to 2.2 GHz		0.32	0.47	dB
		2.5 to 2.7 GHz		0.39	0.55	dB
		3.4 to 3.8 GHz		0.64	0.85	dB
		5.15 to 5.925 GHz[2]		0.7		dB
		PORT2 to PORT4:				
		0.4 to 1.0 GHz		0.26	0.41	dB
		1.0 to 2.2 GHz		0.30	0.45	dB
		2.5 to 2.7 GHz		0.38	0.53	dB
		3.4 to 3.8 GHz		0.59	0.8	dB
		5.15 to 5.925 GHz[2]		0.7		dB
		PORT1 to PORT4:				
		0.4 to 1.0 GHz		0.27	0.42	dB
		1.0 to 2.2 GHz		0.32	0.47	dB
		2.5 to 2.7 GHz		0.42	0.57	dB
		3.4 to 3.8 GHz		0.58	0.8	dB
		5.15 to 5.925 GHz[2]		0.7		dB
		PORT2 to PORT3:				
		0.4 to 1.0 GHz		0.27	0.42	dB
		1.0 to 2.2 GHz		0.3	0.45	dB
		2.5 to 2.7 GHz		0.35	0.5	dB
		3.4 to 3.8 GHz		0.55	0.8	dB
		5.15 to 5.925 GHz[2]		0.7		dB
Isolation (PORT1 to PORT2, PORT3 to PORT4)	Iso	PORT1 to PORT3 PORT2 to PORT4 (on insertion loss mode):				
		0.4 to 1.0 GHz	50	53		dB
		1.0 to 2.2 GHz	43	46		dB
		2.5 to 2.7 GHz	40	43		dB
		3.4 to 3.8 GHz	35	38		dB
		5.15 to 5.925 GHz	25	30		dB
Isolation (PORT1 to PORT2, PORT3 to PORT4)	Iso	PORT1 to PORT4 PORT2 to PORT3 (on insertion loss mode):				
		0.4 to 1.0 GHz	54	58		dB
		1.0 to 2.2 GHz	47	52		dB
		2.5 to 2.7 GHz	45	51		dB
		3.4 to 3.8 GHz	40	43		dB
		5.15 to 5.925 GHz	25	30		dB
Isolation (PORT1 to PORT4, PORT2 to PORT3)	Iso	PORT1 to PORT3 PORT2 to PORT4 (on insertion loss mode):				
		0.4 to 1.0 GHz	43	46		dB
		1.0 to 2.2 GHz	37	40		dB
		2.5 to 2.7 GHz	35	38		dB
		3.4 to 3.8 GHz	33	36		dB
		5.15 to 5.925 GHz	25	30		dB
Isolation (PORT1 to PORT3, PORT2 to PORT4)	Iso	PORT1 to PORT4 PORT2 to PORT3 (on insertion loss mode):				
		0.4 to 1.0 GHz	40	43		dB
		1.0 to 2.2 GHz	33	36		dB
		2.5 to 2.7 GHz	32	35		dB
		3.4 to 3.8 GHz	30	33		dB
		5.15 to 5.925 GHz	25	30		dB

Table 3. SKY5A1007 Electrical Specifications (2 of 3)[1]
(V_{DD} = 2.8 V, V_{CTL} = 0 V and +1.8 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
RF Specifications						
Return loss	|S11|	PORT1/PORT2 to PORT3/PORT4 : 0.4 to 3.8 GHz 5.15 to 5.925 GHz	 10 6	 13 9		 dB dB
Third order input intercept point	IIP3	P_{IN} = +20 dBm, Interferer = -15 dBm, 0.4 to 3.8 GHz	65	75		dB
2nd harmonic	2fo	P_{IN} = +26 dBm, 0.4 to 3.8 GHz: VSWR = 1.1 VSWR = 6:1		 -77 -73	 -74 -68	 dBm dBm
3rd harmonic	3fo	P_{IN} = +26 dBm, 0.4 to 3.8 GHz: VSWR = 1.1 VSWR = 6:1		 -75 -69	 -72 -65	 dBm dBm
2nd harmonic (5 GHz)	2fo	P_{IN} = +26 dBm, 5.15 to 5.925 GHz: VSWR = 1:1 VSWR = 4:1		 -76 -69	 -62 -60	 dBm dBm
3rd harmonic (5 GHz)	3fo	P_{IN} = +26 dBm, 5.15 to 5.925 GHz: VSWR = 1:1 VSWR = 4:1		 -72 -59	 -60 -50	 dBm dBm
Band 13 2nd harmonic	$2fo_{B13}$	f = 786.5 MHz, P_{IN} = +25 dBm		-88	-83	dBm
Band 17 3rd harmonic	$3fo_{B17}$	f = 710 MHz, P_{IN} = +25 dBm		-91	-86	dBm
GSM harmonics: Low-band High-band 	 2fo 3fo 2fo 3fo 2fo 3fo 2fo 3fo	 fo = 824 to 915 MHz, P_{IN} = +35 dBm, 50 Ω fo = 824 to 915 MHz, P_{IN} = +35 dBm, 50 Ω fo = 824 to 915 MHz, P_{IN} = +35 dBm, 6:1 VSWR, all phases fo = 824 to 915 MHz, P_{IN} = +35 dBm, 6:1 VSWR, all phases fo = 1710 to 1910 MHz, P_{IN} = +33 dBm, 50 Ω fo = 1710 to 1910 MHz, P_{IN} = +33 dBm, 50 Ω fo = 1710 to 1910 MHz, P_{IN} = +33 dBm, 6:1 VSWR, all phases fo = 1710 to 1910 MHz, P_{IN} = +33 dBm, 6:1 VSWR, all phases		 -59 -54 -56 -45 -70 -62 -62 -51	 -54 -49 -51 -40 -65 -57 -57 -46	 dBm dBm dBm dBm dBm dBm dBm dBm
0.1 dB input compression point	IP0.1dB	0.4 to 2.7 GHz 3.4 to 3.8 GHz 5.15 to 5.925 GHz		+39.7 +38 +36		dBm dBm dBm
Second order intermodulation distortion	IMD2	f1 > 800 MHz @ +20 dBm, f2 > 2.5 GHz @ -15 dBm		-115	-110	dBm
Third order intermodulation distortion	IMD3	f1 > 800 MHz @ +20 dBm, f2 > 2.5 GHz @ -15 dBm		-110	-105	dBm
DC supply turn-on/turn-off time	tON	Measured from 50% of final V_{DD} supply voltage to 90% of final RF power		2.5		µs
Switching speed	tSW	Measured from 50% of final Vctrl voltage to 90% of final RF power		2.5		µs

Table 3. SKY5A1007 Electrical Specifications (3 of 3)[1]
(V_{DD} = 2.8 V, V_{CTL} = 0 V and +1.8 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
DC Specifications						
Control voltage: High Low	VCTRL1		 1.35 -0.20	 1.8 0	 2.8 +0.4	 V V
Supply voltage	V_{DD}		2.3	2.8	5.8	V
Supply current	I_{DD}			45	100	µA
Control current	I_{CC}			1	10	µA

1 Performance is guaranteed only under the conditions listed in this table.
2 External matching required.

Table 4. SKY5A1007 Truth Table[1]

CTRL1	State
1	PORT3 to PORT1, PORT4 to PORT2
0	PORT3 to PORT2, PORT4 to PORT1

1 1 = 1.35 to 2.8 V, 0 = -0.2 to +0.4 V
Any state other than described in this table places the switch into an undefined state.

Evaluation Board Description

The SKY5A1007 Evaluation Board is used to test the performance of the SKY5A1007 DPDT Switch. An Evaluation Board schematic diagram is provided in Figure 3.

Figure 4 shows a recommended ESD protection circuit. An assembly drawing for the Evaluation Board is shown in Figure 5.

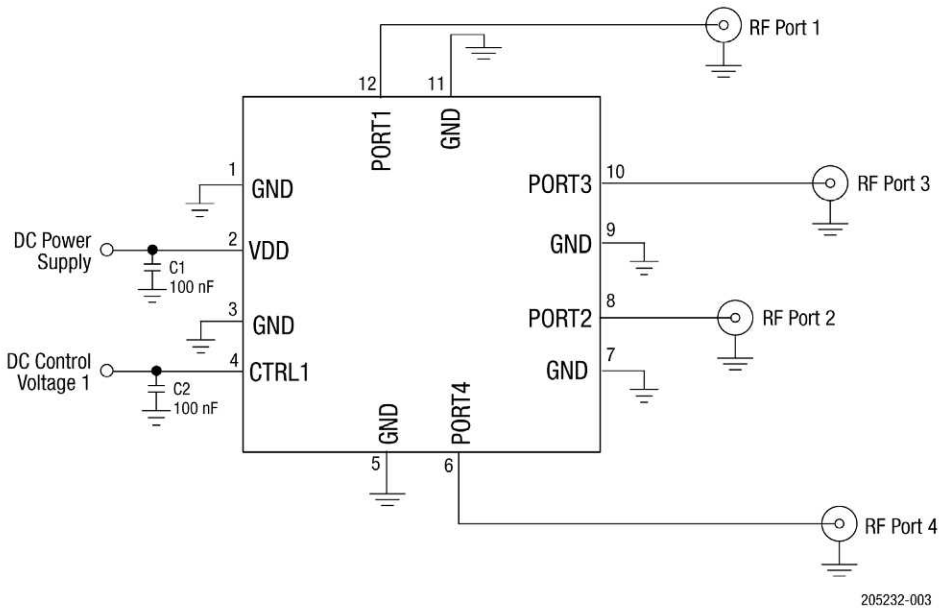


Figure 3. SKY5A1007 Evaluation Board Schematic

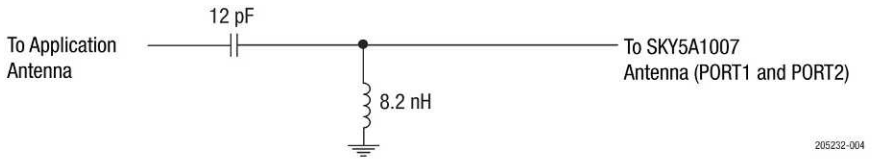


Figure 4. Recommended ESD Protection Circuit

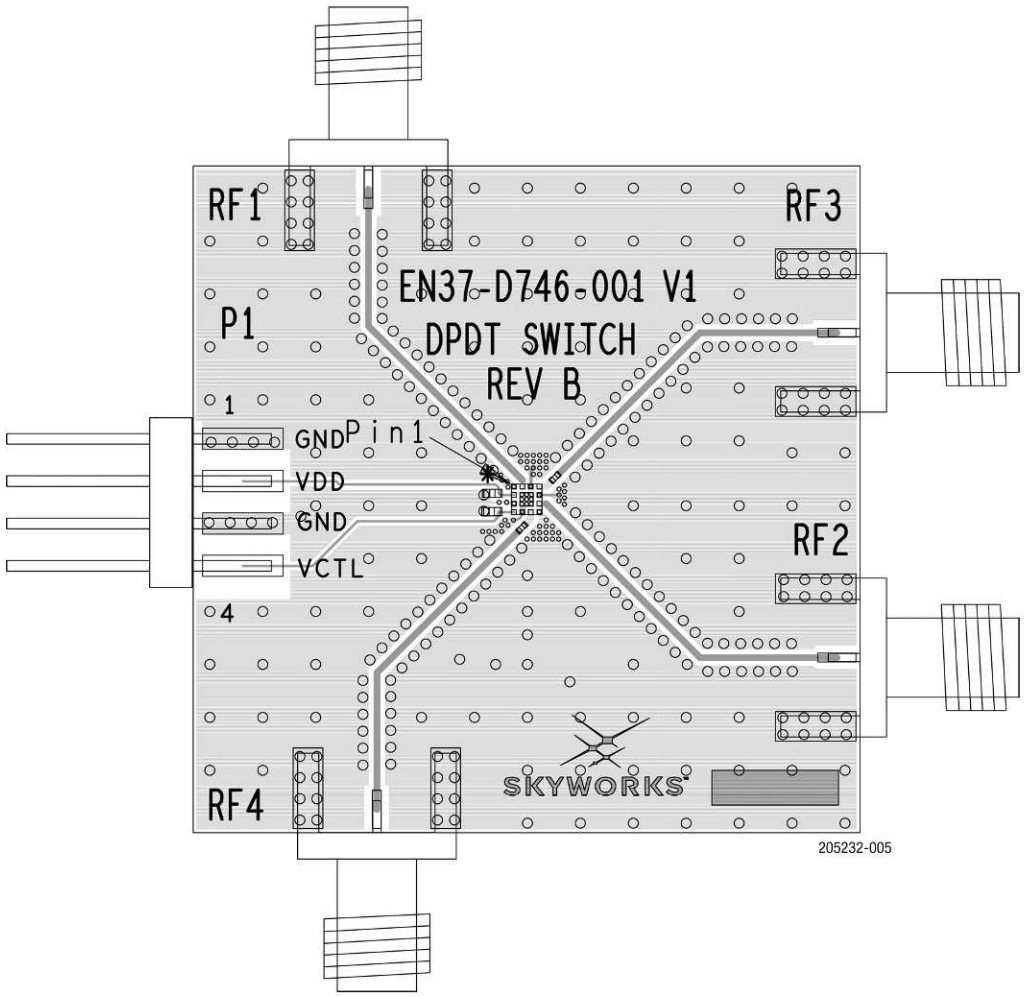


Figure 5. SKY5A1007 Evaluation Board Assembly Diagram

Package Dimensions

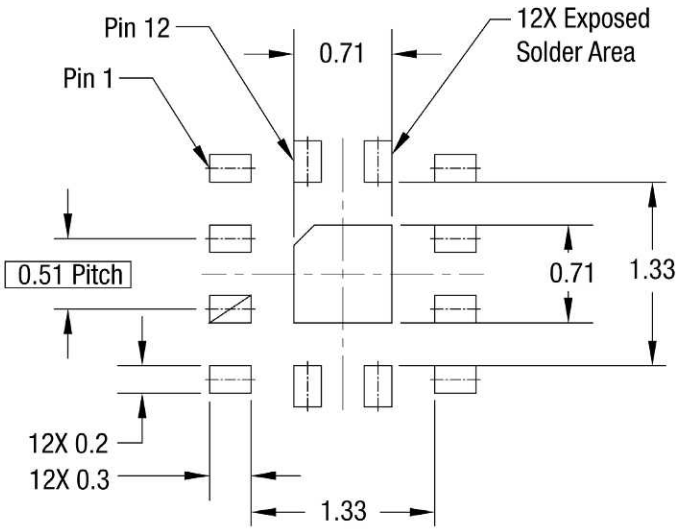
The PCB layout footprint for the SKY5A1007 is provided in Figure 6. Typical part markings are shown in Figure 7. Package dimensions are shown in Figure 8, and tape and reel dimensions are provided in Figure 9.

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 SKY5A1007 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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Note: All dimensions are in millimeters.

Figure 6. SKY5A1007 PCB Layout Footprint (Top View)

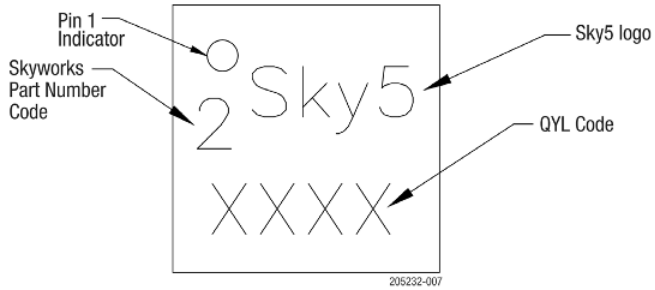
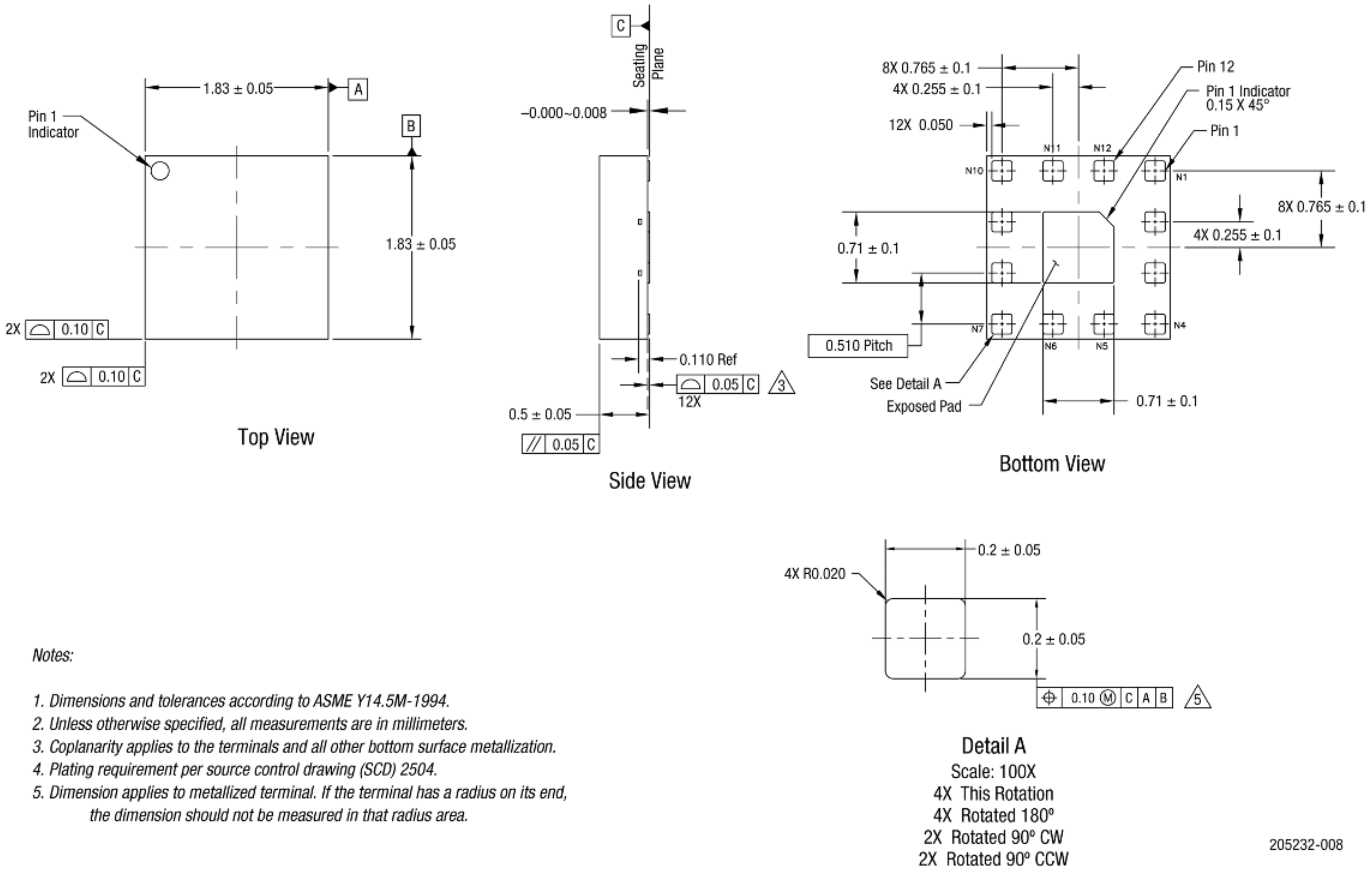


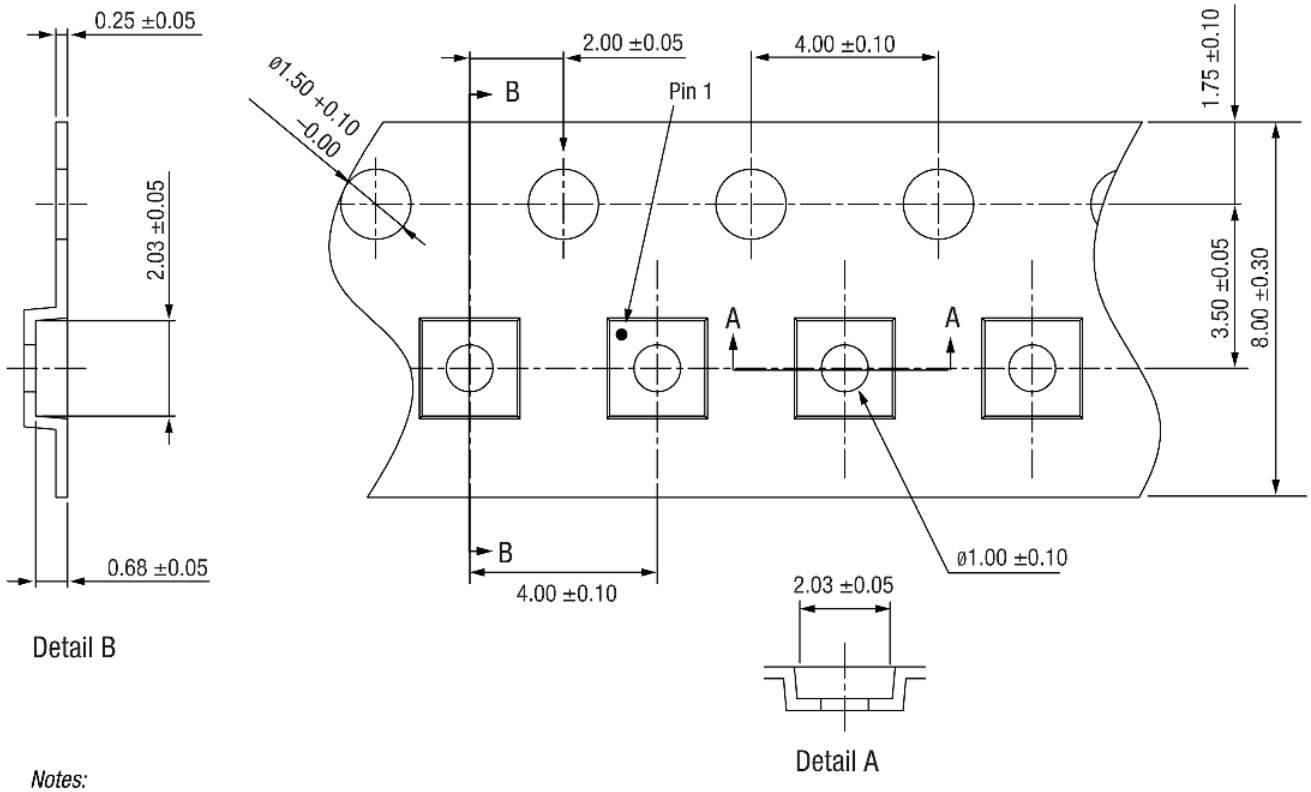
Figure 7. Typical Part Markings (Top View)



Notes:

1. Dimensions and tolerances according to ASME Y14.5M-1994.
2. Unless otherwise specified, all measurements are in millimeters.
3. Coplanarity applies to the terminals and all other bottom surface metallization.
4. Plating requirement per source control drawing (SCD) 2504.
5. Dimension applies to metallized terminal. If the terminal has a radius on its end, the dimension should not be measured in that radius area.

Figure 8. SKY5A1007 Package Dimensions



Notes:

1. *10-sprocket hole pitch cumulative tolerance: ±0.2 mm.*
2. *Camber not to exceed 1 mm in 250 mm.*
3. *Carrier tape shall be black conductive polystyrene.*
4. *Ao and Bo measured on plane 0.30 mm above the bottom of the pocket.*
5. *Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.*
6. *Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.*
7. *Pocket center and pocket hole center must be the same position.*
8. *All dimensions are in millimeters.*

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Figure 9. SKY5A1007 Tape and Reel Dimensions

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY5A1007	0.4 to 5.9 GHz DPDT Low Insertion Loss / High Isolation Switch	SKY5A1007EK1