

SKY13698-694LF: 0.4 to 5.9 GHz DPDT Low Insertion Loss High Isolation Switch

Applications

- LTE systems
- Main/diversity antenna swapping

Features

- Very low insertion loss: 0.27 dB @ 1.0 GHz
- High isolation: 30 dB @ 3.8 GHz
- Single control voltage input
- Broadband frequency range: 0.4 to 5.9 GHz
- No dc blocking capacitors required
- Positive control voltage range: 1.35 to 2.8 V
- GSM power handling
- Small 12-pin, 1.83 x 1.83 x 0.5 mm Quad Flat No-Lead (QFN) package, MSL1, 260 °C per JEDEC-J-STD-020
- For RoHS and other product compliance information, see the [Skyworks Certificate of Conformance](#).

Description

The SKY13698-694LF 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.

The SKY13698-694LF 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.

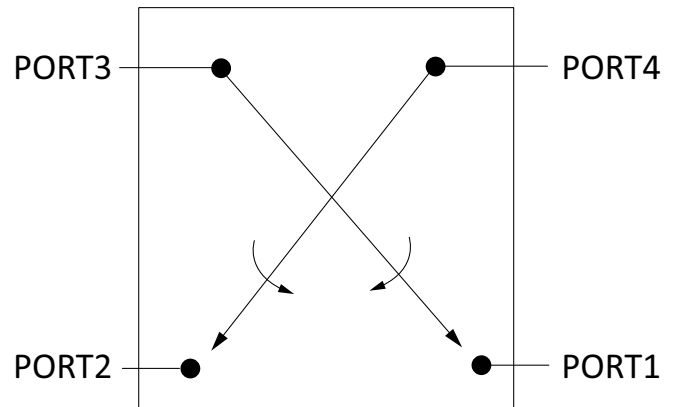


Figure 1. Functional Block Diagram

No external dc blocking capacitors are required on the RF path as long as no dc voltage is applied externally.

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.

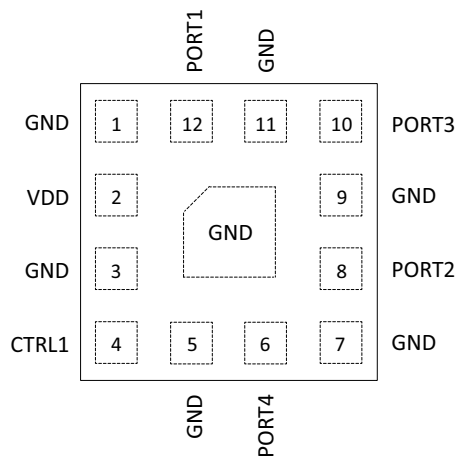


Figure 2. Pinout (Top View)

Table 1. Pin Descriptions¹

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.

Electrical and Mechanical Specifications

Table 2. Absolute Maximum Ratings¹

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{DD}	-0.5	6	V
Control voltage	V_{CTL}	-0.5	3.1	V
Input power: CW, 50% dc, VSWR = 1:1, 0.4 to 0.91 GHz	P_{IN}		+39	dBm
CW, 50% dc, VSWR = 1:1, 1.71 to 2.7 GHz			+38	
CW, 50% dc, VSWR = 1:1, 2.7 to 5.925 GHz			+36	
CW, 50% dc, VSWR = 10:1, 0.4 to 5.925 GHz			+34	
LTE 10M Full RB, VSWR = 10:1, instantaneous			+31	
LTE 10M Full RB, VSWR = 8:1, 30 minutes			+31	
Storage temperature	T_{STG}	-55	+125	°C
Operating temperature	T_{OP}	-40	+90	°C
Electrostatic discharge Human Body Model (HBM), Class 2	ESD		3000	V
Charged Device Model (CDM), Class C3			1000	

1. Exposure to maximum rating conditions for extended periods may reduce device reliability. Exceeding any of the limits listed here may result in permanent damage to the device.

ESD Handling: Industry-standard ESD handling precautions must be adhered to at all times to avoid damage to this device.

Table 3. RF Specifications¹(V_{DD} = 2.8 V, V_{CTL} = 0 V and +1.8 V, T_{Op} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Insertion loss	IL	PORT1 to PORT3:				dB
		0.4 to 1.0 GHz		0.27	0.42	
		1.0 to 2.2 GHz		0.32	0.47	
		2.5 to 2.7 GHz		0.39	0.55	
		3.4 to 3.8 GHz		0.64	0.85	
		5.15 to 5.925 GHz		1.3	1.6	
Insertion loss	IL	PORT2 to PORT4:				dB
		0.4 to 1.0 GHz		0.26	0.41	
		1.0 to 2.2 GHz		0.30	0.45	
		2.5 to 2.7 GHz		0.38	0.53	
		3.4 to 3.8 GHz		0.59	0.8	
		5.15 to 5.925 GHz		1.1	1.45	
Insertion loss	IL	PORT1 to PORT4:				dB
		0.4 to 1.0 GHz		0.27	0.42	
		1.0 to 2.2 GHz		0.32	0.47	
		2.5 to 2.7 GHz		0.42	0.57	
		3.4 to 3.8 GHz		0.58	0.8	
		5.15 to 5.925 GHz		1.1	1.4	
Insertion loss	IL	PORT2 to PORT3:				dB
		0.4 to 1.0 GHz		0.27	0.42	
		1.0 to 2.2 GHz		0.3	0.45	
		2.5 to 2.7 GHz		0.35	0.5	
		3.4 to 3.8 GHz		0.55	0.8	
		5.15 to 5.925 GHz		1.1	1.4	
Isolation (PORT1 to PORT2, PORT3 to PORT4)	Iso	PORT1 to PORT3, PORT2 to PORT4 (on insertion loss mode):				dB
		0.4 to 1.0 GHz	50	53		
		1.0 to 2.2 GHz	43	46		
		2.5 to 2.7 GHz	40	43		
		3.4 to 3.8 GHz	35	38		
		5.15 to 5.925 GHz	25	30		

Table 3. RF Specifications¹ (Continued)(V_{DD} = 2.8 V, V_{CTL} = 0 V and +1.8 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Isolation (PORT1 to PORT2, PORT3 to PORT4)	Iso	PORT1 to PORT4, PORT2 to PORT3 (on insertion loss mode):				dB
		0.4 to 1.0 GHz	54	58		
		1.0 to 2.2 GHz	47	52		
		2.5 to 2.7 GHz	45	51		
		3.4 to 3.8 GHz	40	43		
		5.15 to 5.925 GHz	25	30		
Isolation (PORT1 to PORT4, PORT2 to PORT3)	Iso	PORT1 to PORT3, PORT2 to PORT4 (on insertion loss mode):				dB
		0.4 to 1.0 GHz	43	46		
		1.0 to 2.2 GHz	37	40		
		2.5 to 2.7 GHz	35	38		
		3.4 to 3.8 GHz	33	36		
		5.15 to 5.925 GHz	25	30		
Isolation (PORT1 to PORT3, PORT2 to PORT4)	Iso	PORT1 to PORT4, PORT2 to PORT3 (on insertion loss mode):				dB
		0.4 to 1.0 GHz	40	43		
		1.0 to 2.2 GHz	33	36		
		2.5 to 2.7 GHz	32	35		
		3.4 to 3.8 GHz	30	33		
		5.15 to 5.925 GHz	25	30		
Return loss	S ₁₁	PORT1/PORT2 to PORT3/PORT4:				dB
		0.4 to 3.8 GHz	10	13		
		5.15 to 5.925 GHz	6	9		
Third order input intercept point	IIP3	P _{IN} = +20 dBm, interferer = -15 dBm, 0.4 to 3.8 GHz	65	75		dB
Second harmonic	2fo	P _{IN} = +26 dBm, 0.4 to 3.8 GHz: VSWR = 1.1		-77	-74	dBm
		P _{IN} = +26 dBm, 0.4 to 3.8 GHz: VSWR = 6:1		-73	-68	
Third harmonic	3fo	P _{IN} = +26 dBm, 0.4 to 3.8 GHz: VSWR = 1.1		-75	-72	dBm
		P _{IN} = +26 dBm, 0.4 to 3.8 GHz: VSWR = 6:1		-69	-65	
Second harmonic (5 GHz)	2fo	P _{IN} = +26 dBm, 5.15 to 5.925 GHz: VSWR = 1:1		-76	-62	dBm
		P _{IN} = +26 dBm, 5.15 to 5.925 GHz: VSWR = 4:1		-69	-63	

Table 3. RF Specifications¹ (Continued)(V_{DD} = 2.8 V, V_{CTL} = 0 V and +1.8 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Third harmonic (5 GHz)	3fo	P _{IN} = +26 dBm, 5.15 to 5.925 GHz, VSWR = 1:1		–72	–60	dBm
		P _{IN} = +26 dBm, 5.15 to 5.925 GHz, VSWR = 4:1		–59	–50	
Band 13 second harmonic	2fo_B13	f = 786.5 MHz, P _{IN} = +25 dBm		–88	–83	dBm
Band 17 third harmonic	3fo_B17	f = 710 MHz, P _{IN} = +25 dBm		–91	–86	dBm
GSM harmonics: low-band	2fo	fo = 824 to 915 MHz, P _{IN} = +35 dBm, 50 Ω		–59	–54	dBm
	3fo	fo = 824 to 915 MHz, P _{IN} = +35 dBm, 50 Ω		–54	–49	
	2fo	fo = 824 to 915 MHz, P _{IN} = +35 dBm, 6:1 VSWR, all phases		–56	–51	
	3fo	fo = 824 to 915 MHz, P _{IN} = +35 dBm, 6:1 VSWR, all phases		–45	–40	
GSM harmonics: high-band	2fo	fo = 1710 to 1910 MHz, P _{IN} = +33 dBm, 50 Ω		–70	–65	dBm
	3fo	fo = 1710 to 1910 MHz, P _{IN} = +33 dBm, 50 Ω		–62	–57	
	2fo	fo = 1710 to 1910 MHz, P _{IN} = +33 dBm, 6:1 VSWR, all phases		–62	–57	
	3fo	fo = 1710 to 1910 MHz, P _{IN} = +33 dBm, 6:1 VSWR, all phases		–51	–46	
0.1 dB input compression point	IP0.1dB	0.4 to 2.7 GHz		+39.7		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	5	μs
Switching speed		50% V _{CTRL1} to 90/10% RF		2.5	5	μs
		90/10% RF or 10/90% RF		3.5	5	

1. Performance is assured only under the conditions listed in this table.

Table 4. DC Specifications¹

(V_{DD} = 2.8 V, V_{CTL} = 0 V and +1.8 V, T_{OP} = +25 °C, P_{IN} = 0 dBm, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Control voltage: high	V _{CTRL1}		1.35	1.8	2.8	V
Control voltage: low			−0.20	0	+0.4	
Supply voltage	V _{DD}		2.3	2.8	5.8	V
Supply current	I _{DD}			45	100	μA
Control current	I _{CC}			0.2	10	μA

1. Performance is assured only under the conditions listed in this table.

Table 5. Truth Table¹

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

An evaluation board (EVB) is used to test the performance of the SKY13698-694LF. An EVB schematic 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.

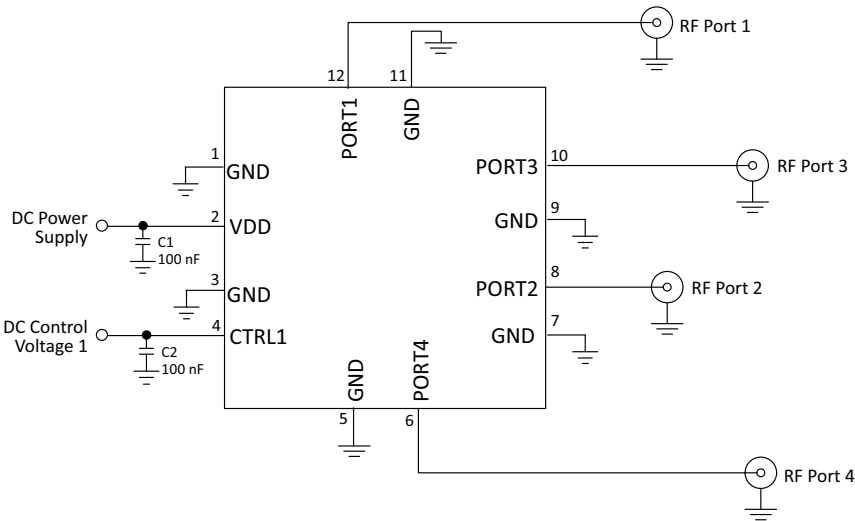


Figure 3. Evaluation Board Schematic

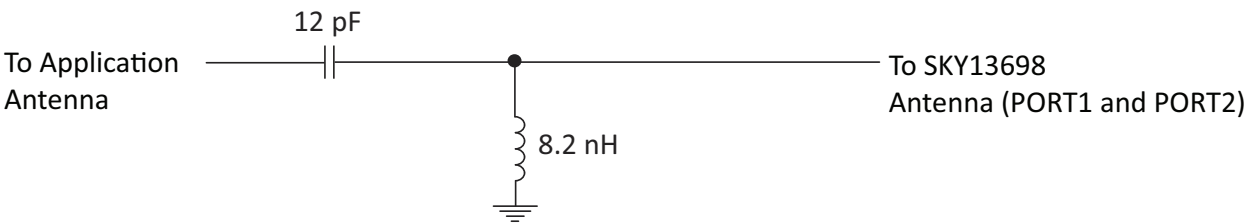


Figure 4. Recommended ESD Protection Circuit

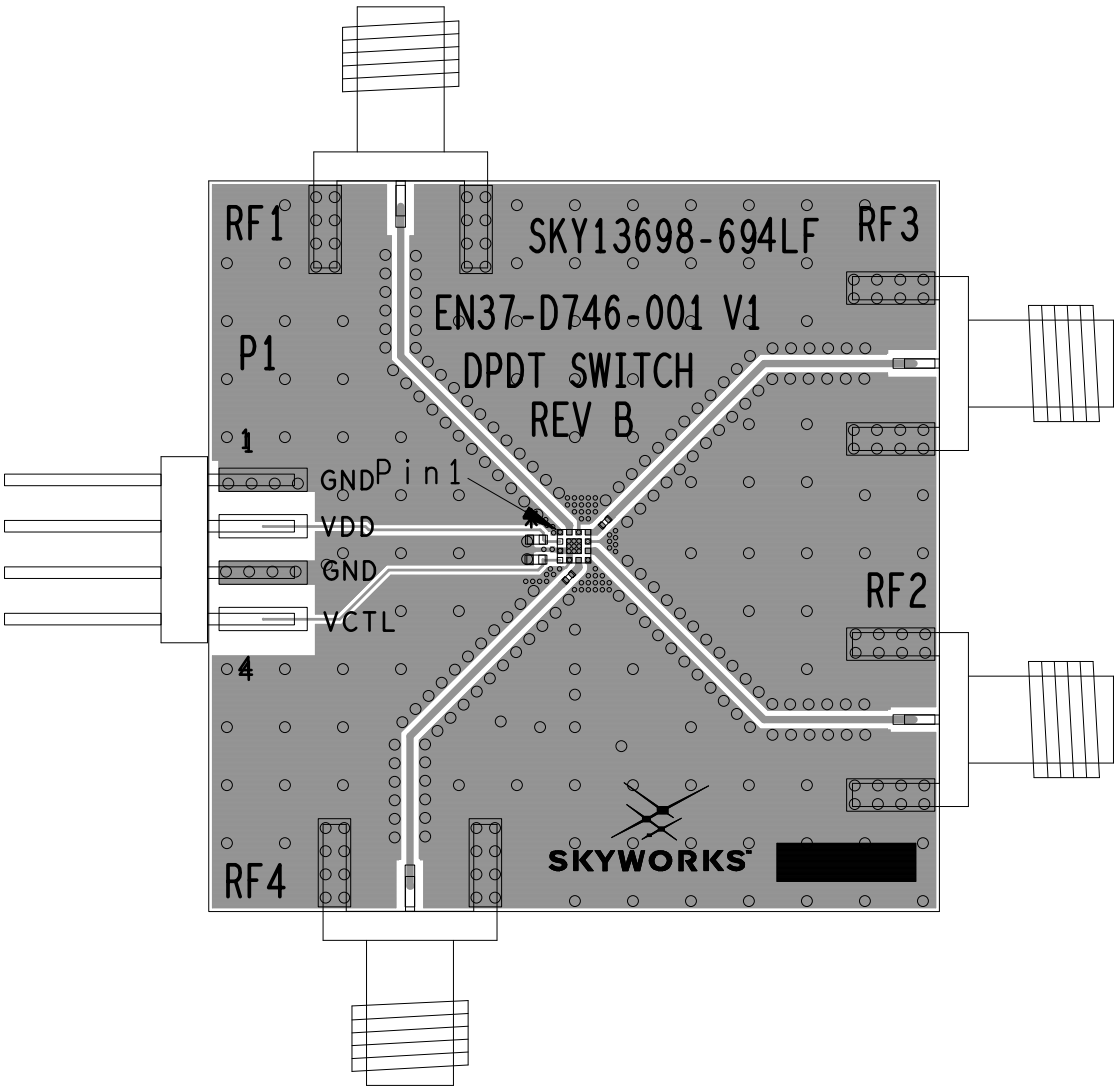


Figure 5. Evaluation Board Assembly Diagram

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 SKY13698-694LF 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

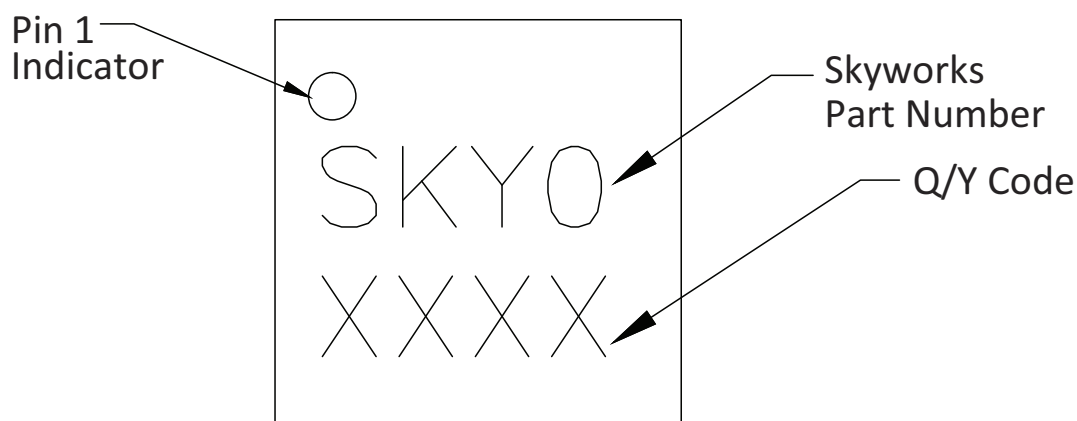
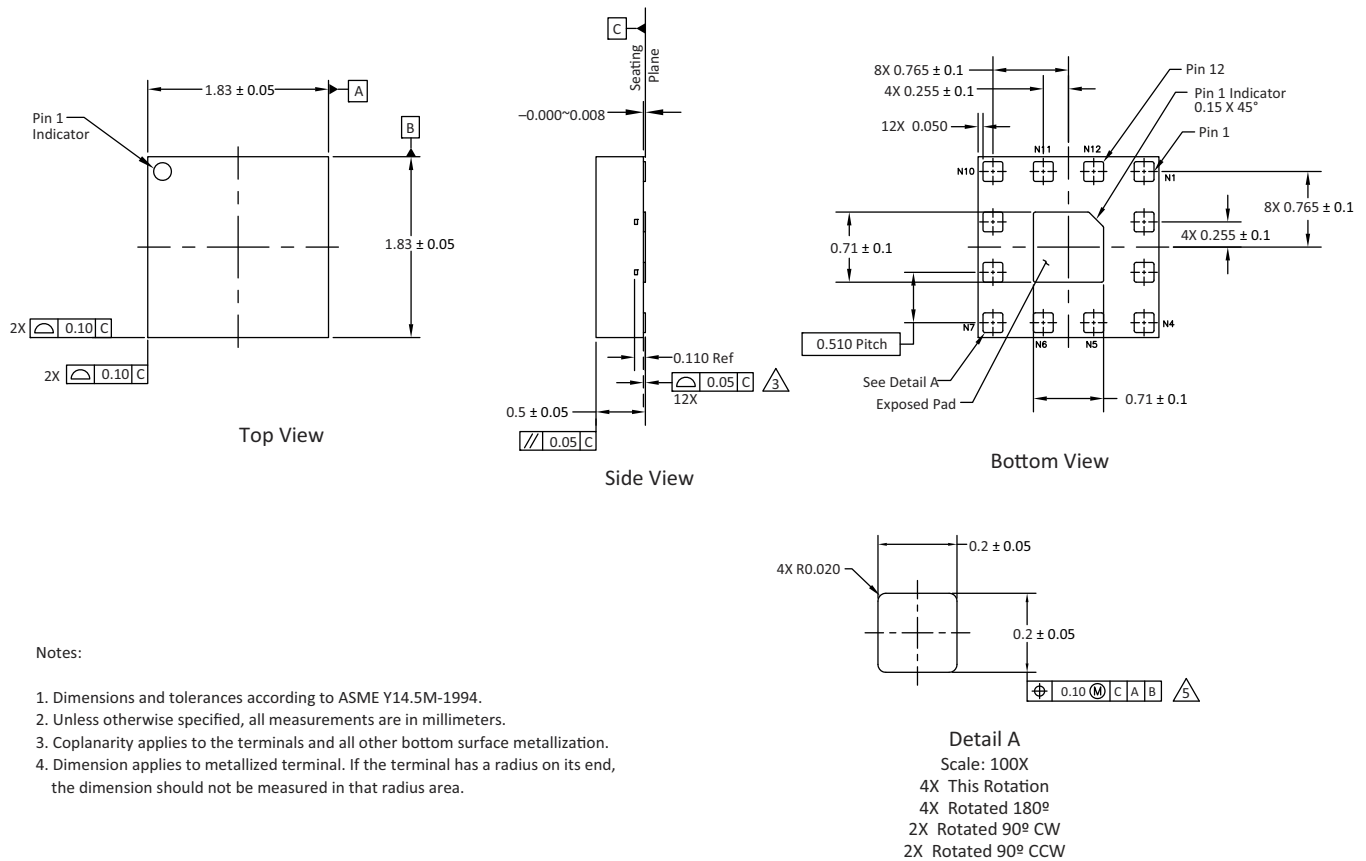


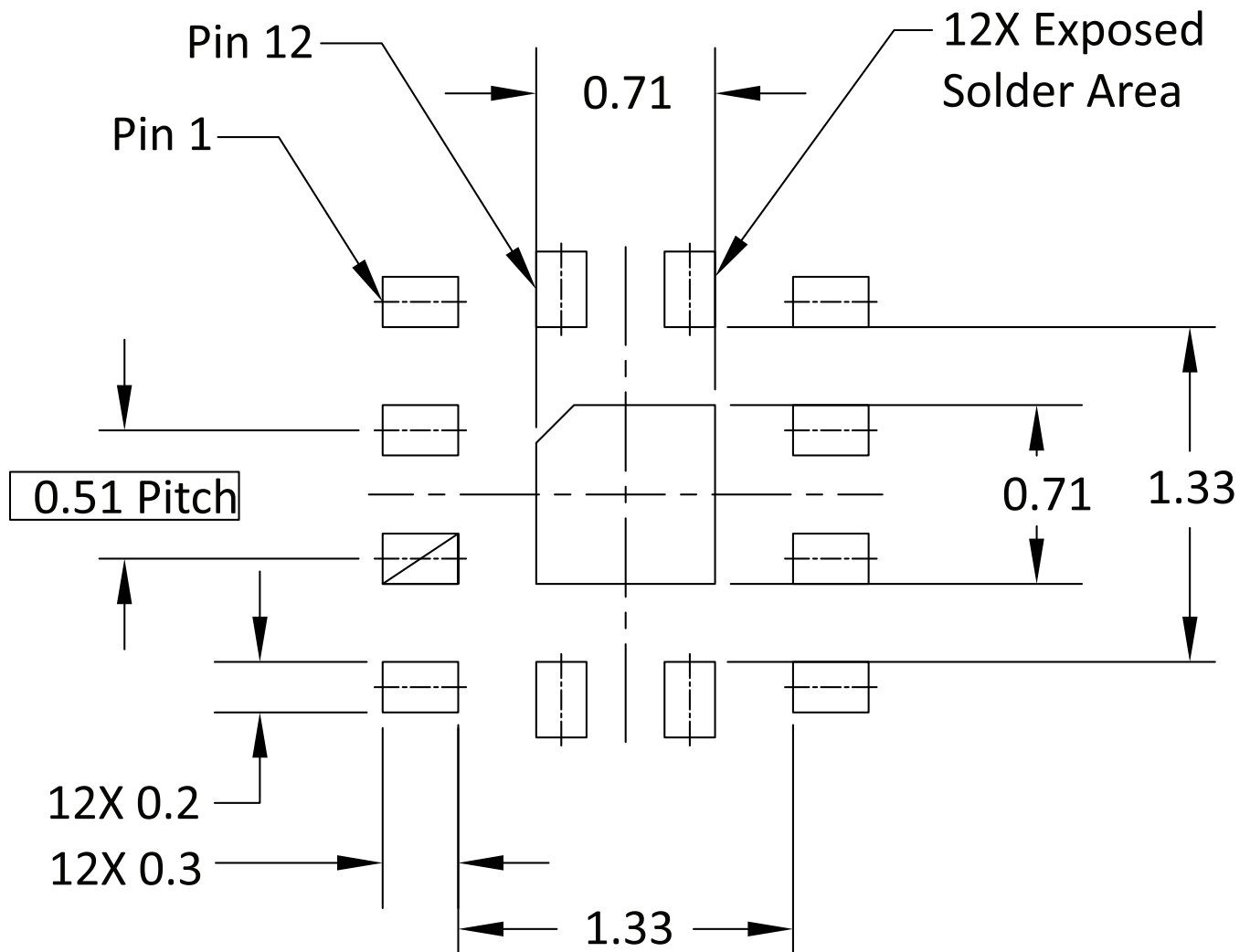
Figure 6. Typical Part Marking



Notes:

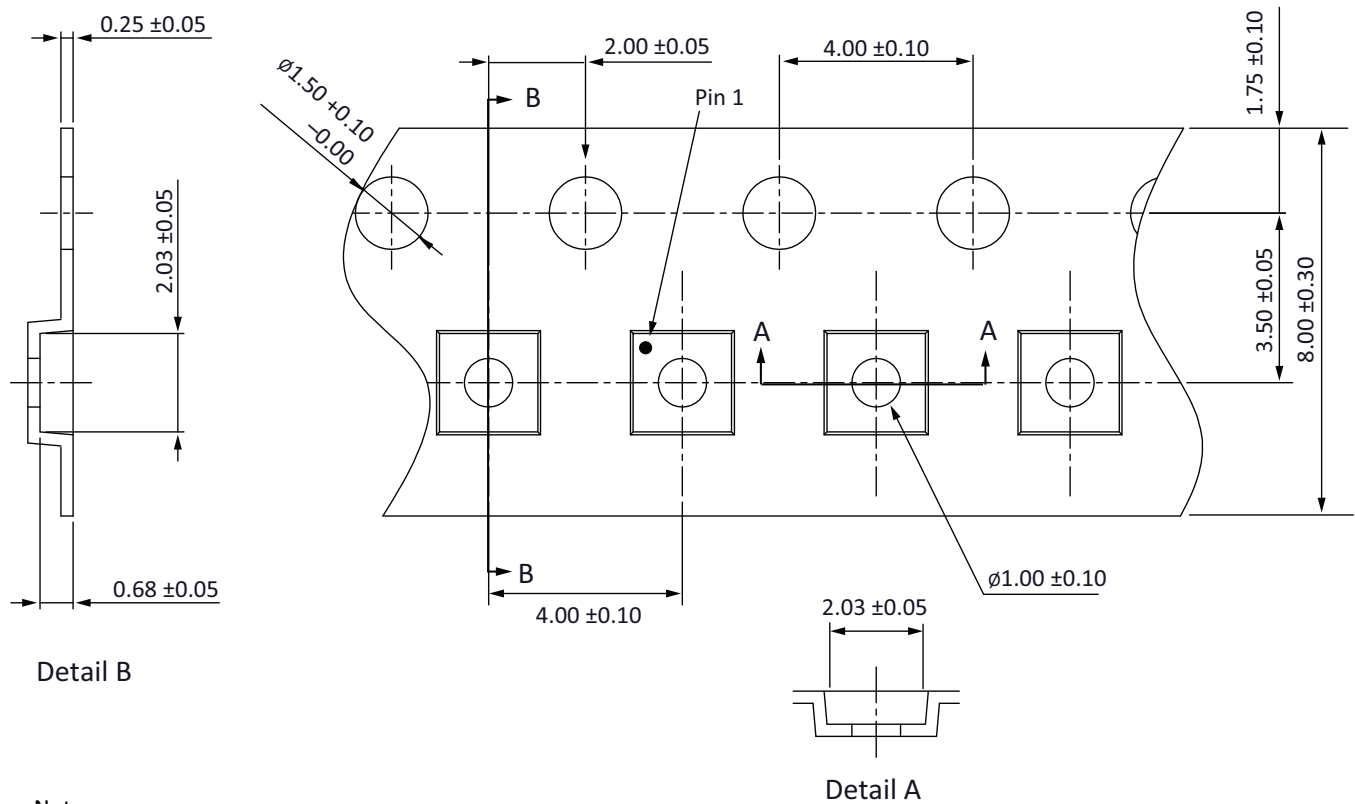
1. Dimensions and tolerances according to ASME Y14.5M-1994.
2. Unless otherwise specified, all measurements are in millimeters.
3. Coplanarity applies to the terminals and all other bottom surface metallization.
4. Dimension applies to metallized terminal. If the terminal has a radius on its end, the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

Figure 7. Package Dimensions



Note: All dimensions are in millimeters.

Figure 8. PCB Layout Footprint



Notes:

1. 10-sprocket hole pitch cumulative tolerance: ± 0.2 mm.
2. Ao and Bo measured on plane 0.30 mm above the bottom of the pocket.
3. Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
4. All dimensions are in millimeters.

Figure 9. Tape and Reel Information

Ordering Information

Part Number	Description	Evaluation Board Part Number
SKY13698-694LF	0.4 to 5.9 GHz DPDT Low Insertion Loss High Isolation Switch	SKY13698-394EK1

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