



## DATA SHEET

# SKY13699-21: 0.4 to 6.0 GHz DPDT Low Insertion Loss, High Isolation Switch

## Applications

- LTE systems
- Main/diversity antenna systems

## Features

- Very low insertion loss: 0.3 dB @ 1 GHz, 1 dB @ 5.9 GHz
- High isolation: 32 dB @ 3.8 GHz
- Single-control voltage input
- Broadband frequency range: 0.4 to 6.0 GHz
- No dc blocking capacitors required
- Positive-control voltage range: 1.35 to 2.8 V
- GSM power handling
- Small MCM (10-pin, 1.55 x 1.15 x 0.59 mm [typical]) package (MSL3, 260 °C per JEDEC J-STD-020)
- For RoHS and other product compliance information, see the [Skyworks Certificate of Conformance](#).

## Description

The SKY13699-21 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.

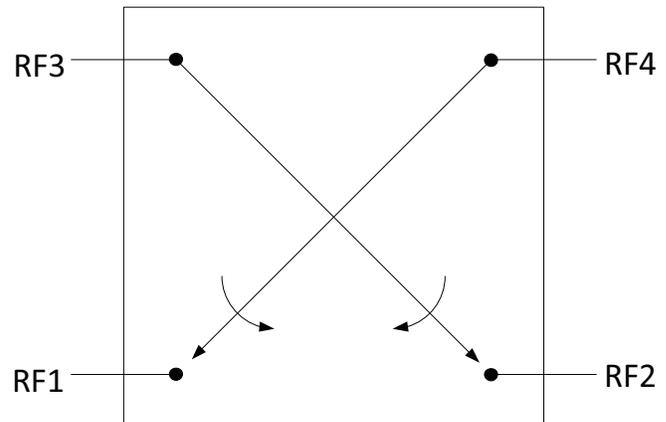


Figure 1. Functional Block Diagram

The DPDT switch is provided in a compact MCM package that meets requirements for board-level assembly. 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.

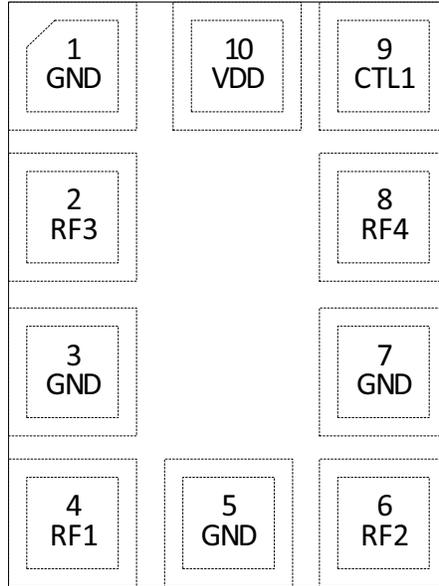


Figure 2. Pinout (Top View)

Table 1. Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	6	RF2	RF port 2
2	RF3	RF port 3	7	GND	Ground
3	GND	Ground	8	RF4	RF port 4
4	RF1	RF port 1	9	CTL1	DC control voltage 1
5	GND	Ground	10	VDD	DC power supply

## Technical Description

The SKY13699-21 DPDT switch is designed to maximize the isolation between ports to minimize coupling between RF paths. It 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 (CTL1).

When port 1 is connected to port 3, port 2 is connected to port 4. When port 1 is connected to port 4, port 2 is connected to port 3.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY13699-21 are provided in Table 2. Other parameters are shown in the tables that follow. The state of the SKY13699-21 is determined by the logic provided in Table 5.

**Table 2. Absolute Maximum Ratings<sup>1</sup>**

Parameter	Symbol	Min	Max	Units
Supply voltage	$V_{DD}$	-0.5	5.5	V
Control voltage	$V_{CTL}$	-0.5	3.1	V
Input power, 50 $\Omega$	$P_{IN\_MAX}$		+39	dBm
Storage temperature	$T_{STG}$	-55	+125	$^{\circ}C$
Operating temperature	$T_{OP}$	-40	+90	$^{\circ}C$
Electrostatic discharge: Human Body Model (HBM)	ESD_HBM		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.

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

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**Table 3. RF Specifications<sup>1</sup>**

(V<sub>DD</sub> = 2.8 V, V<sub>CTL</sub> = 0 V and +1.8 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>O</sub>] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Insertion loss	IL	RF1 to RF3, parallel state: 0.4 to 1.0 GHz		0.3	0.4	dB
		1.0 to 2.2 GHz		0.45	0.6	
		2.5 to 2.7 GHz		0.5	0.7	
		3.4 to 3.8 GHz		0.6	0.8	
		5.1 to 5.9 GHz		1.1		
		RF2 to RF4, parallel state: 0.4 to 1.0 GHz		0.3	0.4	dB
		1.0 to 2.2 GHz		0.45	0.65	
		2.5 to 2.7 GHz		0.5	0.7	
		3.4 to 3.8 GHz		0.6	0.85	
		5.1 to 5.9 GHz		1.2		
		RF1 to RF4, crossing state: 0.4 to 1.0 GHz		0.3	0.4	dB
		1.0 to 2.2 GHz		0.45	0.6	
		2.5 to 2.7 GHz		0.5	0.7	
		3.4 to 3.8 GHz		0.6	0.8	
		5.1 to 5.9 GHz		1.1		
		RF2 to RF3, crossing state: 0.4 to 1.0 GHz		0.3	0.4	dB
		1.0 to 2.2 GHz		0.45	0.6	
		2.5 to 2.7 GHz		0.5	0.7	
		3.4 to 3.8 GHz		0.6	0.8	
		5.1 to 5.9 GHz		0.9		
Port-to-port isolation (RF1 to RF3, RF2 to RF4)	Iso	RF1 to RF4, RF2 to RF3, IL state: 0.4 to 1.0 GHz	37	40		dB
		1.0 to 2.2 GHz	32	35		
		2.5 to 2.7 GHz	31	34		
		3.4 to 3.8 GHz	30	33		
		5.1 to 5.9 GHz	25	30		
Port-to-port isolation (RF1 to RF4, RF2 to RF3)	Iso	RF1 to RF3, RF2 to RF4, IL state: 0.4 to 1.0 GHz	53	61		dB
		1.0 to 2.2 GHz	47	52		
		2.5 to 2.7 GHz	43	46		
		3.4 to 3.8 GHz	38	42		
		5.1 to 5.9 GHz	26	31		
Port-to-port isolation (RF1 to RF2, RF3 to RF4)	Iso	RF1 to RF4, RF2 to RF3, IL state: 0.4 to 1.0 GHz	40	46		dB
		1.0 to 2.2 GHz	35	39		
		2.5 to 2.7 GHz	34	38		
		3.4 to 3.8 GHz	32	35		
		5.1 to 5.9 GHz	23	28		
Port-to-port isolation (RF1 to RF2, RF3 to RF4)	Iso	RF1 to RF3, RF2 to RF4, IL state: 0.4 to 1.0 GHz	41	45		dB
		1.0 to 2.2 GHz	37	42		
		2.5 to 2.7 GHz	34	38		
		3.4 to 3.8 GHz	31	35		
		5.1 to 5.9 GHz	23	28		

**Table 3. RF Specifications<sup>1</sup> (Continued)**

(V<sub>DD</sub> = 2.8 V, V<sub>CTL</sub> = 0 V and +1.8 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>O</sub>] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Return loss	S <sub>11</sub>	RF1/RF4 to RF2/RF3: 0.4 to 1.0 GHz	16	22		dB
		1.0 to 2.2 GHz	12	14		
		2.2 to 3.8 GHz	10	12		
		5.1 to 5.9 GHz		7		
Input 0.1 dB compression point	P0.1dB	0.4 to 3.8 GHz, CW	38.5	39		dB
Band 13 second harmonic	2fo_B13	f = 786.5 MHz, P <sub>IN</sub> = +25 dBm		-86	-82	dBm
Band 17 third harmonic	3fo_B17	f = 710 MHz, P <sub>IN</sub> = +25 dBm		-87	-83	dBm
GSM harmonics: Low band	2fo	fo = 824 to 915 MHz, P <sub>IN</sub> = +35 dBm, 50 Ω		-68	-58	dBm
	3fo	fo = 824 to 915 MHz, P <sub>IN</sub> = +35 dBm, 50 Ω		-56	-48	
	2fo	fo = 824 to 915 MHz, P <sub>IN</sub> = +35 dBm, VSWR = 5:1		-61	-56	
	3fo	fo = 824 to 915 MHz, P <sub>IN</sub> = +35 dBm, VSWR = 5:1		-45	-40	
GSM harmonics: High band	2fo	fo = 1710 to 1910 MHz, P <sub>IN</sub> = +33 dBm, 50 Ω		-70	-65	dBm
	3fo	fo = 1710 to 1910 MHz, P <sub>IN</sub> = +33 dBm, 50 Ω		-59	-55	
	2fo	fo = 1710 to 1910 MHz, P <sub>IN</sub> = +33 dBm, VSWR = 5:1		-61	-57	
	3fo	fo = 1710 to 1910 MHz, P <sub>IN</sub> = +33 dBm, VSWR = 5:1		-50	-46	
LTE harmonics: Low band	2fo	fo = 400 MHz to 960 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-79	-75	dBm
	3fo	fo = 400 MHz to 960 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-78	-73	
	2fo	fo = 400 MHz to 960 MHz, P <sub>IN</sub> = +26 dBm, VSWR = 6:1		-73	-67	
	3fo	fo = 400 MHz to 960 MHz, P <sub>IN</sub> = +26 dBm, VSWR = 6:1		-67	-60	
LTE harmonics: Mid band	2fo	fo = 1710 MHz to 2170 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-81	-75	dBm
	3fo	fo = 1710 MHz to 2170 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-78	-72	
	2fo	fo = 1710 MHz to 2170 MHz, P <sub>IN</sub> = +26 dBm, VSWR = 6:1		-73	-67	
	3fo	fo = 1710 MHz to 2170 MHz, P <sub>IN</sub> = +26 dBm, VSWR = 6:1		-67	-61	
LTE harmonics: High band	2fo	fo = 2300 MHz to 2700 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-81	-75	dBm
	3fo	fo = 2300 MHz to 2700 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-81	-75	
	2fo	fo = 2300 MHz to 2700 MHz, P <sub>IN</sub> = +26 dBm, VSWR = 6:1		-72	-65	
	3fo	fo = 2300 MHz to 2700 MHz, P <sub>IN</sub> = +26 dBm, VSWR = 6:1		-69	-63	
LTE harmonics: Ultra-high band	2fo	fo = 3400 MHz to 3800 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-83	-83	dBm
	3fo	fo = 3400 MHz to 3800 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-77	-77	
	2fo	fo = 3400 MHz to 3800 MHz, P <sub>IN</sub> = +26 dBm, VSWR = 6:1		-74	-74	
	3fo	fo = 3400 MHz to 3800 MHz, P <sub>IN</sub> = +26 dBm, VSWR = 6:1		-67	-67	

**Table 3. RF Specifications<sup>1</sup> (Continued)**

(V<sub>DD</sub> = 2.8 V, V<sub>CTL</sub> = 0 V and +1.8 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>O</sub>] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
LTE harmonics: Sub_6 GHz	2fo	5150 MHz to 5925 MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-75		dBm
	3fo	5150 MHz to 5925MHz, P <sub>IN</sub> = +26 dBm, 50 Ω		-70		
Second order intermodulation distortion	IMD2	f1 > 800 MHz @ +20 dBm, f2 > 2.5 GHz @ -15 dBm		-114	-107	dBm
Third order intermodulation distortion	IMD3	f1 > 800 MHz @ +20 dBm, f2 > 2.5 GHz @ -15 dBm		-110	-105	dBm

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

**Table 4. DC Specifications<sup>1</sup>**

(V<sub>DD</sub> = 2.8 V, V<sub>CTL</sub> = 0 V and +1.8 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = 0 dBm, Characteristic Impedance [Z<sub>O</sub>] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Control voltage: high	V <sub>CC</sub>		1.35	1.8	2.8	V
Control voltage: low			-0.2	0	+0.4	
Supply voltage	V <sub>DD</sub>		2.3	2.8	4.8	V
Supply current	I <sub>DD</sub>			30	60	μA
Control current	I <sub>CC</sub>			5	10	μA
DC supply turn-on time	t <sub>ON</sub>	Measured from 2.3 V to ±1 dB of final RF power		5	10	μs
Switching speed		50% VCTRL to 90% RF or 50% VCTRL to 10% RF		2.7	3	μs

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

**Table 5. Truth Table<sup>1</sup>**

CTRL1	State
1	RF1 to RF4, RF2 to RF3
0	RF1 to RF3, RF2 to RF4

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 is used to test the performance of the SKY13699-21 DPDT switch. An evaluation board schematic diagram is provided in Figure 3. An assembly drawing is shown in Figure 4.

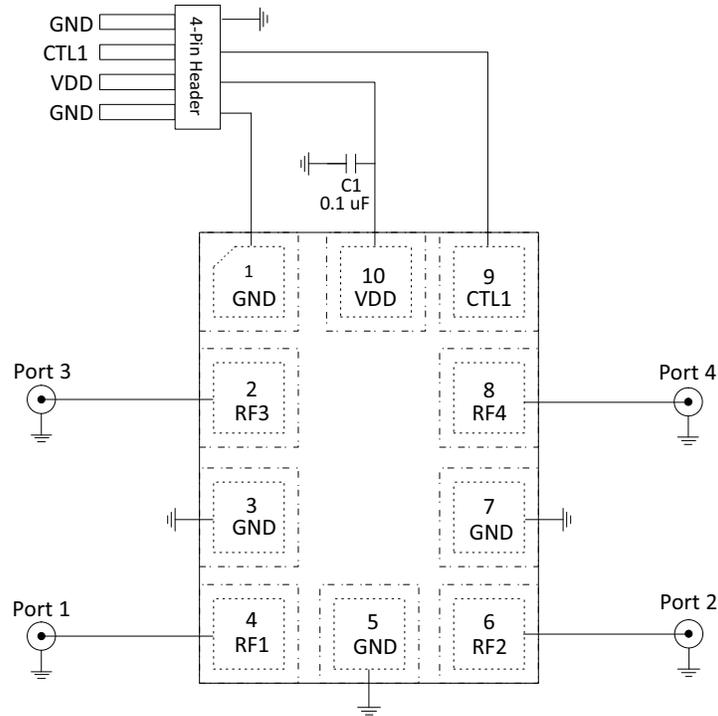


Figure 3. Evaluation Board Schematic

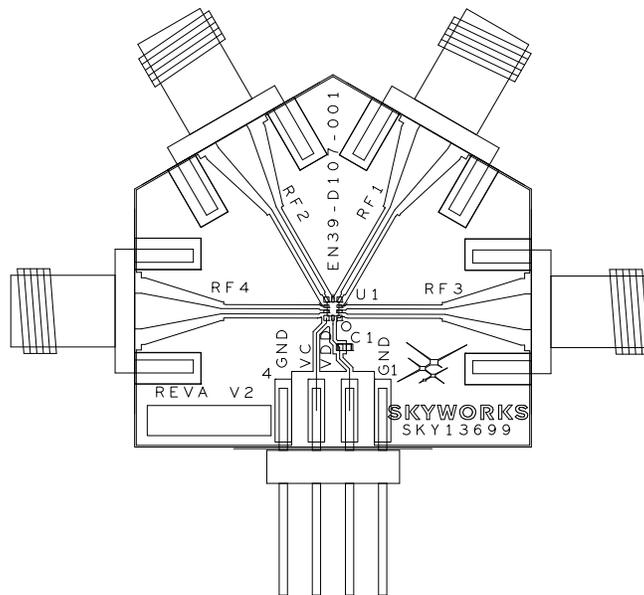


Figure 4. Evaluation Board Assembly Diagram

## Package and Handling Information

Since the device is sensitive to moisture absorption, it is baked and vacuum packed before shipping. 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 SKY13699-21 is rated to Moisture Sensitivity Level 3 (MSL3) 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.

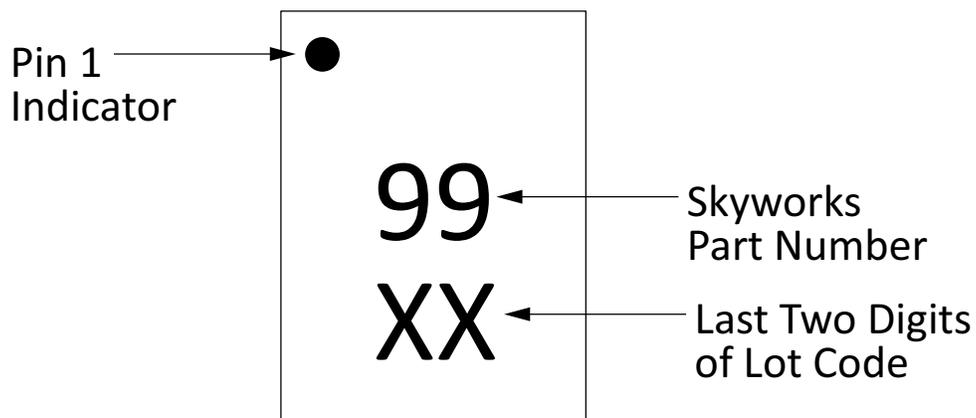
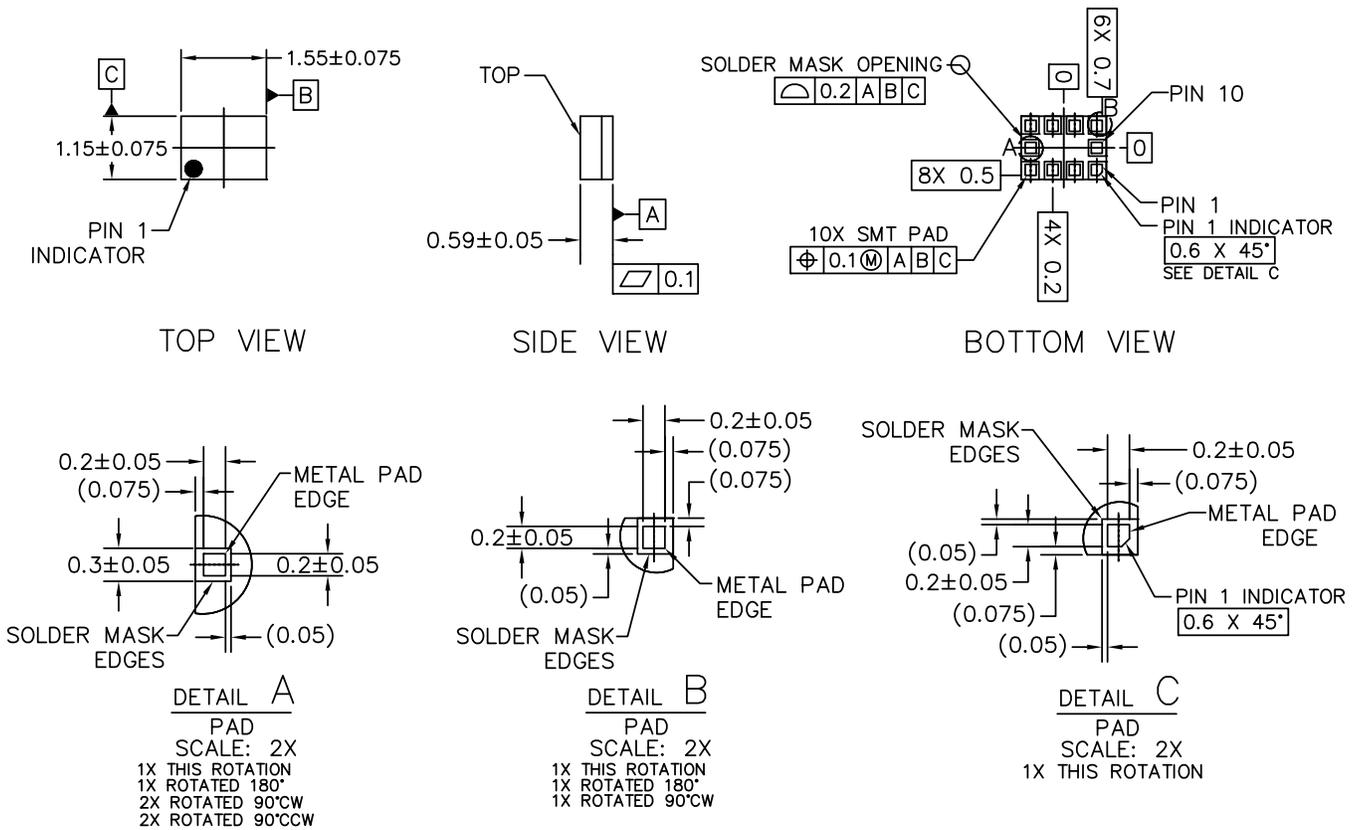


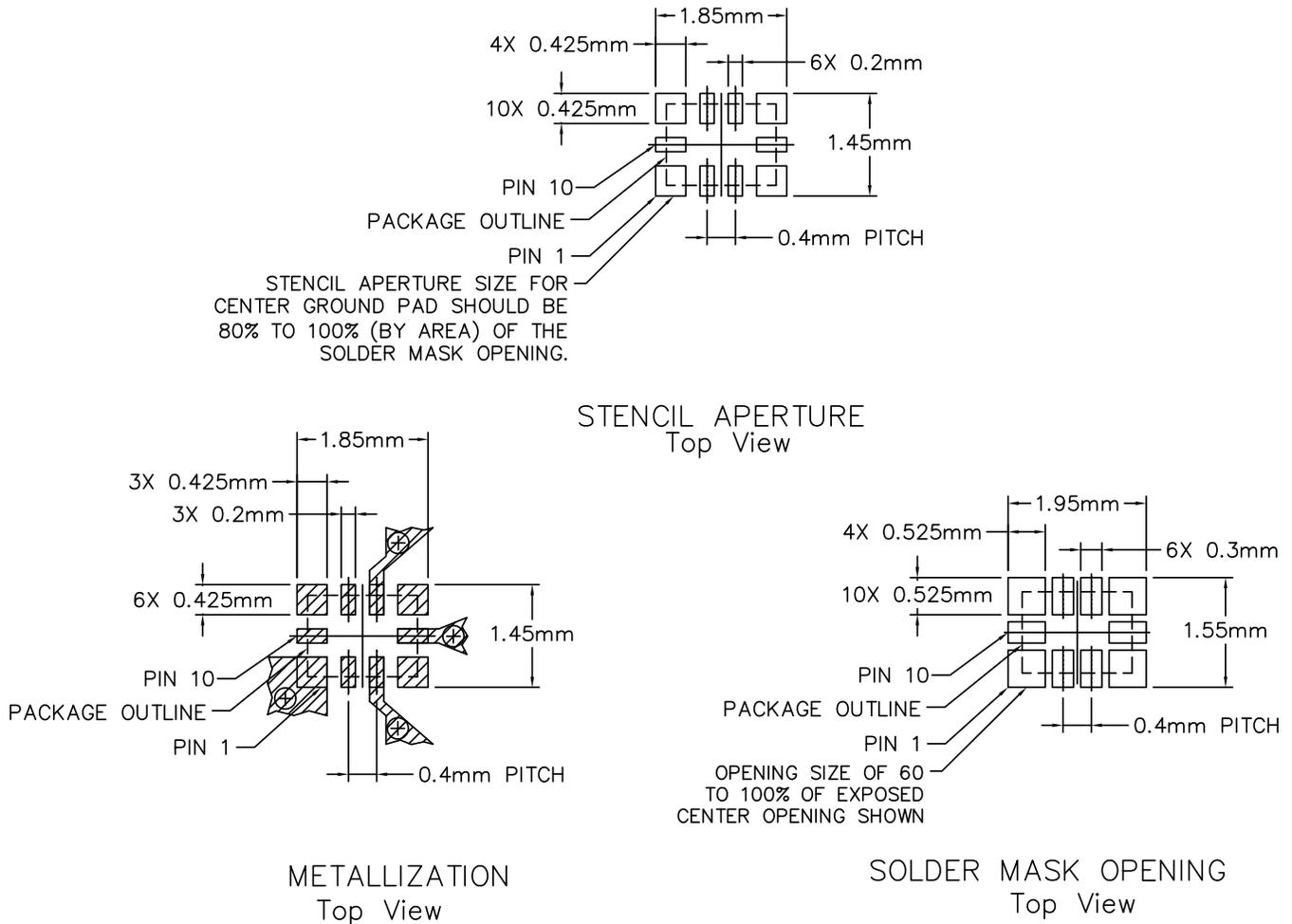
Figure 5. Typical Part Marking



NOTES: UNLESS OTHERWISE SPECIFIED.

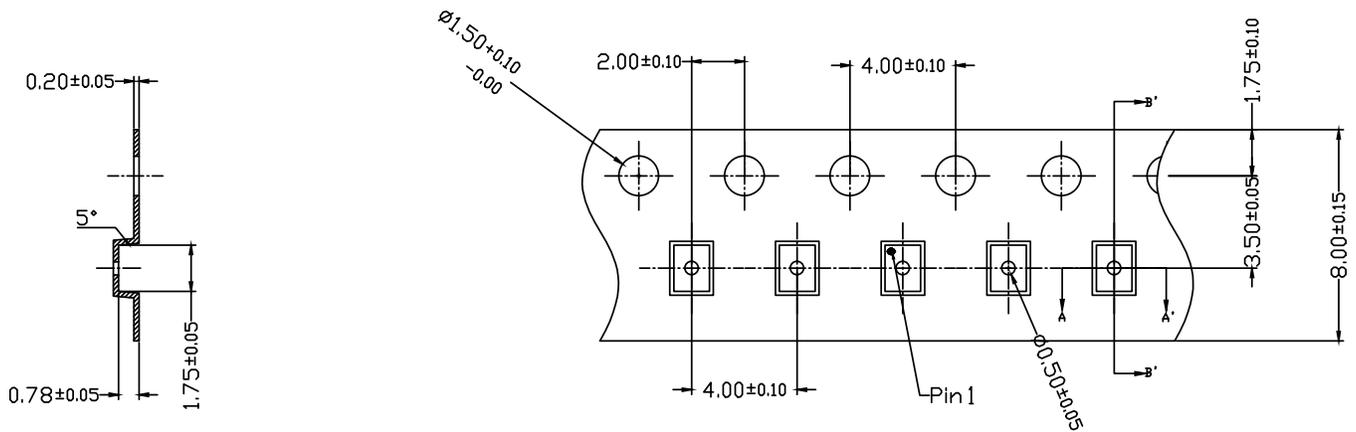
1. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.
2. DIMENSIONS ARE IN MILLIMETERS.

Figure 6. Package Dimensions



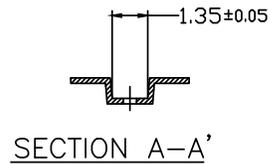
NOTE: THERMAL VIAS SHOULD BE RESIN FILLED AND CAPPED IN ACCORDANCE WITH IPC-4761 TYPE VII VIAS. 30-35UM Cu THICKNESS IS RECOMMENDED.

Figure 7. PCB Layout Footprint



SECTION B-B'

1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE :  $\pm 0.20\text{mm}$
2. A<sub>0</sub> & B<sub>0</sub> MEASURED ON PLANE 0.30mm ABOVE THE BOTTOM OF THE POCKET.
3. ALL DIMENSIONS ARE IN MILLIMETERS.



**Figure 8. Tape and Reel Information**

## Ordering Information

Part Number	Description	Evaluation Board Part Number
SKY13699-21	0.4 to 6.0 GHz DPDT Low Insertion Loss, High Isolation Switch	SKY13699-21EK1

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