

FINAL DATA SHEET

SKY19237-001: 0.1 to 6.0 GHz Triple SPST (3xSPST) Shunt MIPI® Antenna Tuning Switch

Applications

- Aperture tuning

Features

- Broadband frequency range: 0.1 to 6.0 GHz
- V_{peak}: 83 V
- R_{ON}: 2.1 Ω
- C_{OFF}: 190 fF
- Three USIDs with single pin
- Supply voltage: 2.5 to 4.8 V
- Control logic: MIPI v1.0
- Ultra-small WLCSP (11-bump, 1.685 × 1.775 × 0.547 mm [maximum], 262 μm diameter, 400 μm pitch) package (MSL1, 260 °C per JEDEC J-STD-020)



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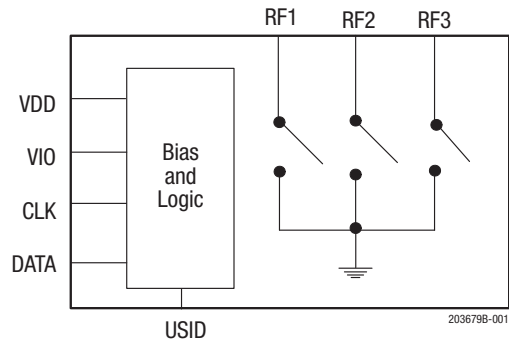


Figure 1. SKY19237-001 Block Diagram

Description

The SKY19237-001 is a wafer level chip scale package (WLCSP) triple-shunt, single-pole, single-throw (3xSPST) switch with integrated logic and bias block. The three paths are connected on one side to a single RF ground bump.

The part is designed to sustain a peak voltage of 83 V typical without going to breakdown.

The switching is controlled by an integrated Mobile Industry Processor Interface (MIPI) decoder.

The SKY19237-001 is provided in a compact 11-bump, 1.66 × 1.75 × 0.5 mm (typical) WLCSP that meets requirements for board-level assembly. Bump diameters are 262 μm, with a minimum bump pitch of 400 μm.

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.

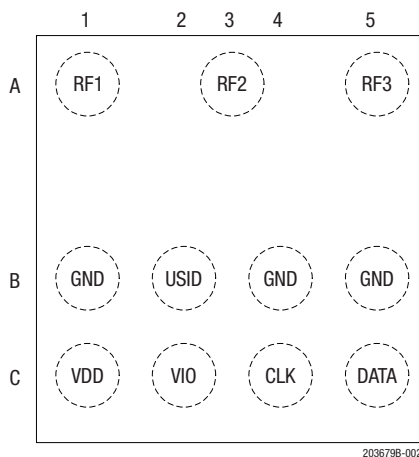


Figure 2. SKY19237-001 Pinout (Top View, Bumps Facing Down)

Table 1. SKY19237-001 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
A1	RF1	Single ended RF port 1	B5	GND	RF ground
B1	GND	Analog ground	A3	RF2	Single-ended RF port 2
C1	VDD	Voltage supply	A5	RF3	Single-ended RF port 3
C2	VIO	MIPI control voltage	B2	USID	USID select pin
C4	CLK	MIPI clock	B4	GND	RF ground
C5	DATA	MIPI data			

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY19237-001 are provided in Table 2. Electrical specifications are provided in Tables 3 and 4.

Harmonic measurement frequencies are listed in Table 5. The state of the SKY19237-001 is determined by the logic provided in Table 6. Table 7 shows the RFFE MIPI reference information. Table 8 shows the command sequence bit definitions. Timing diagrams are shown in Figures 3 and 4. Figure 5 shows the recommended MIPI time sequence diagram.

Table 2. SKY19237-001 Absolute Maximum Ratings¹

Parameter	Symbol	Condition	Minimum	Maximum	Units
Supply voltage	V _{DD}	25 °C		5.5	V
Digital control voltages	V _{IO}	25 °C	-0.5	+2.4	V
Digital control signal voltages	V _{DATA} , V _{CLK}	25 °C	-0.5	+2.4	V
RF maximum voltage	V _{RF_MAX}	Measured between RF ports to ground with shunt circuit configuration in 25% duty cycle RF power		85	V
RF maximum power	P _{IN}	Measured between RF ports to ground with shunt circuit configuration in 25% duty cycle RF power		+48.6	dBm
Operating case temperature	T _C		-40	+90	°C
Storage temperature	T _{STG}		-55	+150	°C
Electrostatic discharge:	ESD				
Human Body Model (HBM)				2000	V
Charged Device Model (CDM)				1000	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.

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. SKY19237-001 DC Electrical Specifications¹
(V_{DD} = 2.85 V, T_{OP} = +25 °C, Characteristic Impedance [Z₀] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Supply voltage	V _{DD}		2.5	2.85	4.8	V
Digital control voltage	V _{IO}		1.65	1.80	1.95	V
Digital control signal voltage: Low High	V _{CTL_LOW} V _{CTL_HIGH}		0 0.8 × V _{IO}	1.85	0.2 × V _{IO} V _{IO}	V V
V _{IO} leakage current	I _{IO}	V _{DD} = 2.85 V, V _{IO} = high		50	130	μA
Supply current	I _{DD}	V _{DD} = 2.85 V, V _{IO} = high		70	100	μA
DC supply turn-on/turn-off time	t _{ON}	Measured from point of V _{DD} > 2.5 V		30	50	μs
RF path switching time	t _{SW}	Rising edge of last clock signal that sets the switch into the desired state to final RF power ±1 dB		15	20	μs

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

Table 4. SKY19237-001 RF Electrical Specifications: Small Signal¹
(V_{DD} = 2.85 V, T_{OP} = +25 °C, Characteristic Impedance [Z₀] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Switch ON resistance, RFx to GND	R _{ON}	Switch path ON, 0.1 to 1.0 GHz		2.1	2.3	Ω
		Switch path ON, 1.0 to 2.2 GHz		2.2	2.4	Ω
		Switch path ON, 2.2 to 2.7 GHz		2.2	2.5	Ω
		Switch path ON, 3.3 GHz		1.9		Ω
		Switch path ON, 4.2 GHz		2.2		Ω
		Switch path ON, 4.4 GHz		2.6		Ω
		Switch path ON, 5.0 GHz		3.1		Ω
Switch OFF capacitance, RFx to GND	C _{OFF}	Switch path OFF, 0.1 to 2.7 GHz	170	190	220	fF
		Switch path OFF, 3.3 GHz		195		fF
		Switch path OFF, 4.2 GHz		203		fF
		Switch path OFF, 4.4 GHz		206		fF
		Switch path OFF, 5.0 GHz		213		fF
Isolation, RFx to RFx	ISO	0.7 to 1.0 GHz	40	43		dB
		1.0 to 2.2 GHz	32	35		dB
		2.2 to 2.7 GHz	30	33		dB
		3.3 GHz		32		dB
		4.2 GHz		28		dB
		4.4 GHz		26		dB
5.0 GHz		24		dB		

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

² The value is measured with shunt configuration.

Table 5. SKY19237-001 RF Electrical Specifications: Large Signal¹
(V_{DD} = 2.85 V, T_{OP} = +25 °C, Characteristic Impedance [Z₀] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
VPEAK withstanding voltage ²	V _{RF}	f = 0.7 to 2.7 GHz f = 3.3 to 4.2 GHz f = 4.4 to 5.0 GHz	80	83 79 71		V V V
Harmonic Specifications²						
LTE LB harmonic, 0.698 to 0.915 GHz	2fo _{LB}	PIN = +26 dBm, 1:1 VSWR		-102	-92	dBm
	3fo _{LB}			-100	-90	dBm
LTE MHB harmonic, 1.710 to 2.690 GHz	2fo _{MHB}	PIN = +26 dBm, 1:1 VSWR		-100	-85	dBm
	3fo _{MHB}			-95	-85	dBm
LTE LB harmonic, 0.698 to 0.915 GHz	2fo _{LB}	PIN = +26 dBm, 6:1 VSWR		-95	-80	dBm
	3fo _{LB}			-97	-87	dBm
LTE MHB harmonic, 1.710 to 2.690 GHz	2fo _{MHB}	PIN = +26 dBm, 6:1 VSWR		-95	-85	dBm
	3fo _{MHB}			-95	-80	dBm
GSM LB harmonic, 0.824 to 0.915 GHz	2fo _{LB}	PIN = +35 dBm, 1:1 VSWR		-85	-75	dBm
	3fo _{LB}			-85	-70	dBm
GSM HB harmonic, 1.710 to 1.910 GHz	2fo _{MB}	PIN = +33 dBm, 1:1 VSWR		-95	-80	dBm
	3fo _{MB}			-84	-70	dBm
GSM LB harmonic, 0.824 to 0.915 GHz	2fo _{LB}	PIN = +35 dBm, 6:1 VSWR		-80	-65	dBm
	3fo _{LB}			-75	-60	dBm
GSM HB harmonic, 1.710 to 1.910 GHz	2fo _{MB}	PIN = +33 dBm, 6:1 VSWR		-85	-70	dBm
	3fo _{MB}			-75	-65	dBm
2nd harmonic UHB	2fo _{UHB}	PIN = 26 dBm, CW, 50 ohm, 3300 to 4200 MHz		-92		dBm
3rd harmonic UHB	3fo _{UHB}	PIN = +26 dBm, CW, 50 ohm, 3300 to 4200 MHz		-96		dBm
2nd harmonic UHB	2fo _{UHB}	PIN = +26 dBm, CW, 50 ohm, 4400 to 5000 MHz		-90		dBm
3rd harmonic UHB	3fo _{UHB}	PIN = +26 dBm, CW, 50 ohm, 4400 to 5000 MHz		-86		dBm
0.1dB input compression point	P0.1dB	F ₀ = 0.7 to 2.69 GHz	+48	+48.5		dBm
Stability	S _{TB}	VSWR ≤ 10:1, PIN = +35 dBm, 0.824 to 0.915 GHz, PIN = +33 dBm, 1.71 to 1.91 GHz, Over temperature			-36	dBm

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

² The values are measured at switch OFF state with the shunt circuit configuration.

Table 6. SKY19237-001 Truth Table

State	Bit[2]	Bit[1]	Bit[0]
All On	1	1	1
RF1	1	0	0
RF2	0	1	0
RF3	0	0	1
RF1 + RF2	1	1	0
RF1 + RF3	1	0	1
RF2 + RF3	0	1	1
All OFF	0	0	0

Table 7. SKY19237-001 RFFE MIPI Reference Table

Register Address	Register Name	Data Bit	Bit Name	Default	R/W	Description
0x00	STATE CONTROL	7:3	RESERVED	0x0	R	Reserved for future use
		2:0	STATE CONTROL	0x0	R/W	0x00: All OFF to GND
						0x01: RF3 to GND
						0x02: RF2 to GND
						0x03: RF2 + RF3 to GND
						0x04: RF1 to GND
						0x05: RF1 + RF3 to GND
						0x06: RF1 + RF2 to GND
0x07: All ON to GND						
0x1C	PM_TRIGER	7:6	PWR_MODE	0x0	R/W	Power Mode Control
		5	Trigger_Mask_2	0x0		If this bit is set to 1, trigger_2 is disabled
		4	Trigger_Mask_1	0x0		If this bit is set to 1, trigger_1 is disabled
		3	Trigger_Mask_0	0x0		If this bit is set to 1, trigger_0 is disabled
		2	Trigger_2	0x0		A write of 1 to this bit loads trigger_2's registers
		1	Trigger_1	0x0		A write of 1 to this bit loads trigger_1's registers
		0	Trigger_0	0x0		A write of 1 to this bit loads trigger_0's registers
0x1D	PRODUCT_ID	7:0	PRODUCT_ID[7:0]	0xFC	R	Product Identification
0x1E	MANUFACTURER_ID	7:0	MANUFACTURER_ID[7:0]	0xA5	R	LSB Manufacturing Identification
0x1F	MAN_USID	7:6	RESERVED	0x0	R	Reserved for future use
		5:4	MANUFACTURER_ID[9:8]	0x1	R	MSB Manufacturing Identification
		3:0	USID[3:0]	0x6	R/W	User Identification, with pin "B2" = grounded
				0x7	R/W	User Identification, with pin "B2" = floating
0x9	R/W			User Identification, with pin "B2" = tied to VIO		

Table 8. SKY19237-001 Command Sequence Bit Definitions

Type	SSC	C11-C8	C7	C6-C5	C4	C3-C0	Parity Bits	BPC	Extended Operation					
									DA7(1)-DA0(1)	Parity Bits	BPC	DA7(n)-DA0(n)	Parity Bits	BPC
Reg0 Write	Y	SA[3:0]	1	Data[6:5]	Data[4]	Data[3:0]	Y	Y	-	-	-	-	-	-
Reg1 Write	Y	SA[3:0]	0	10	Addr[4]	Addr[3:0]	Y	-	Data[7:0]	-	-	-	Y	Y
Reg Read	Y	SA[3:0]	0	11	Addr[4]	Addr[3:0]	Y	Y	Data[7:0]	-	-	-	Y	Y

Legend:

SSC = Sequence start command DA = Data/address frame bits BC = Byte count (# of consecutive addresses)
 C = Command frame bits BPC = Bus park cycle

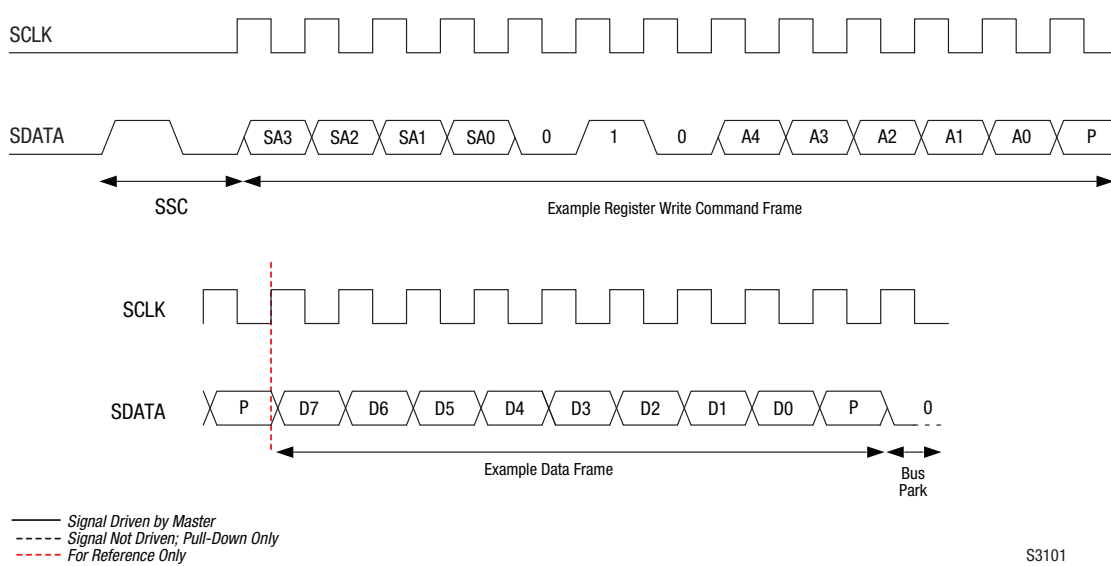


Figure 3. Register Write Command Timing Diagram

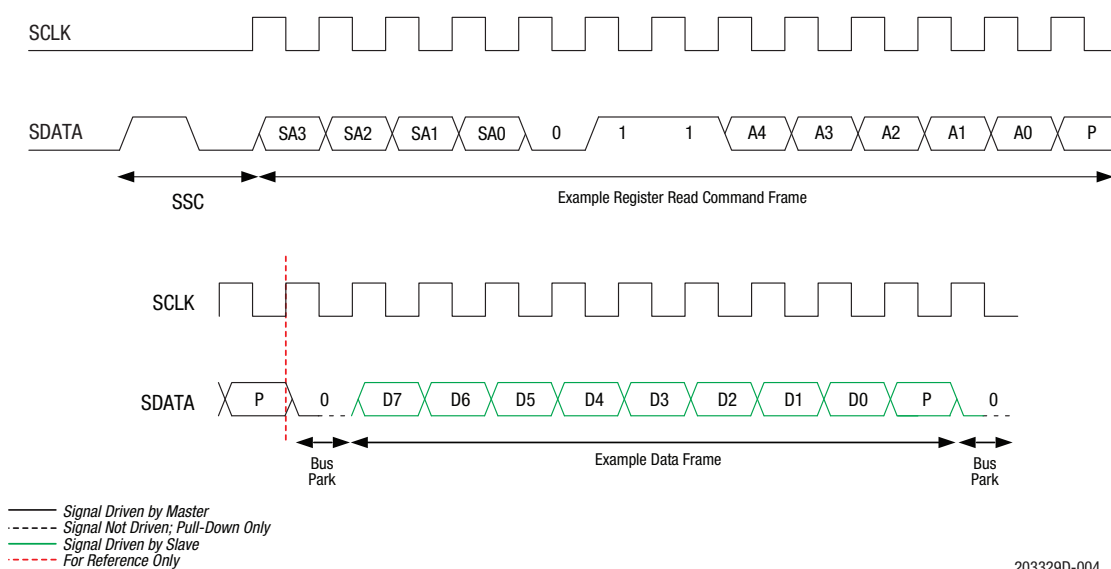
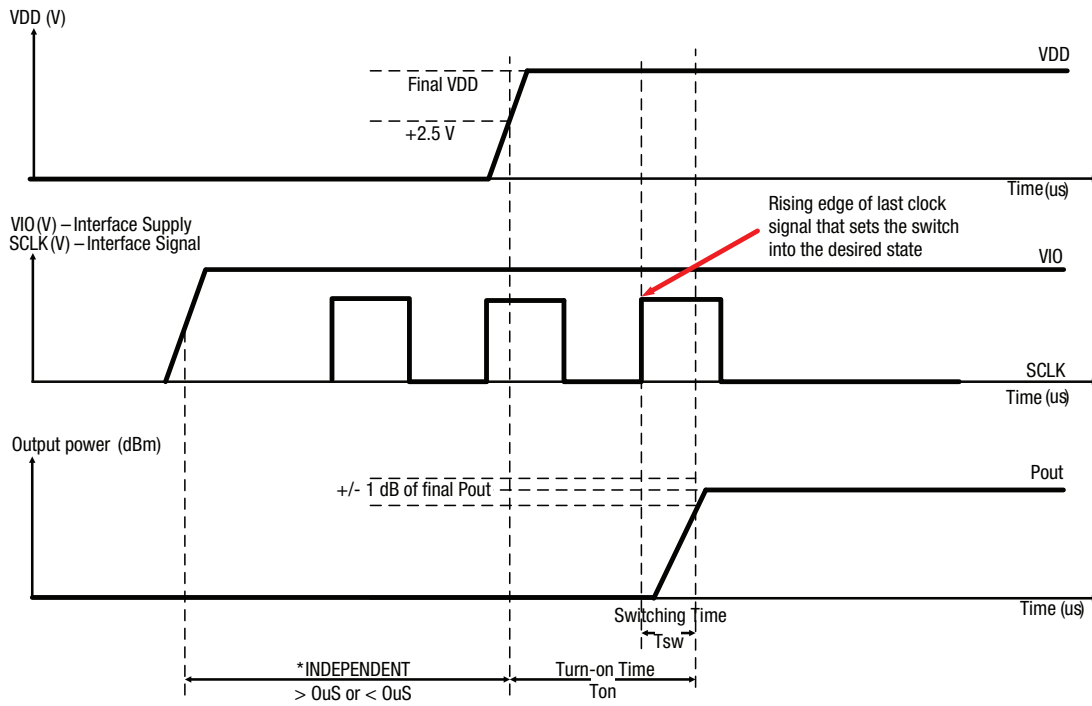


Figure 4. Register Read Command Timing Diagram



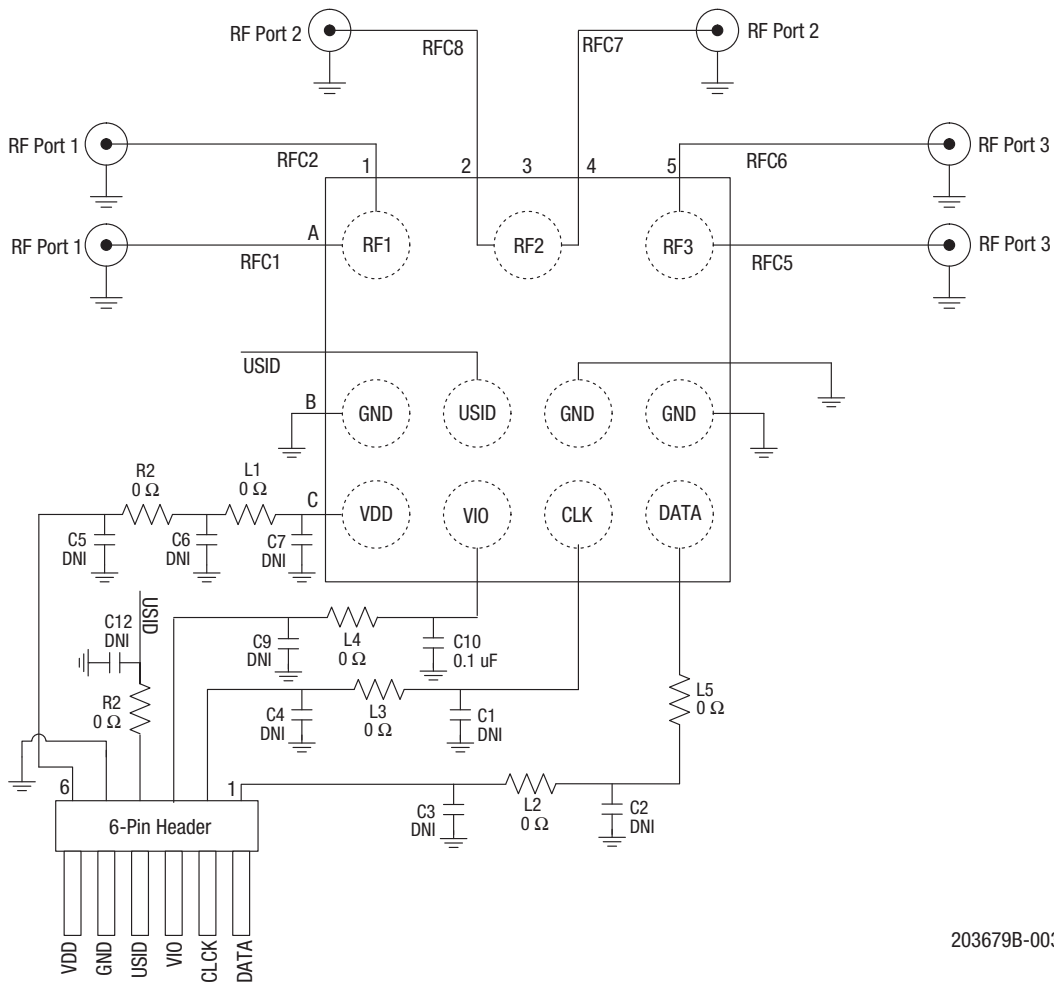
Note: VDD and VIO power time are independent from each other.
Users can power-on either bias in a random sequence, or leave one on and the other off

Figure 5. Recommended MIPI Time Sequence Diagram

Evaluation Board Description

The SKY19237-001 Evaluation Board is used to test the performance of the SKY19237-001 3xSPST Switch.

An Evaluation Board schematic diagram is provided in Figure 6. An assembly drawing for the Evaluation Board is shown in Figure 7.



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Figure 6. SKY19237-001 Evaluation Board Schematic (2-Port Shunt Configuration)

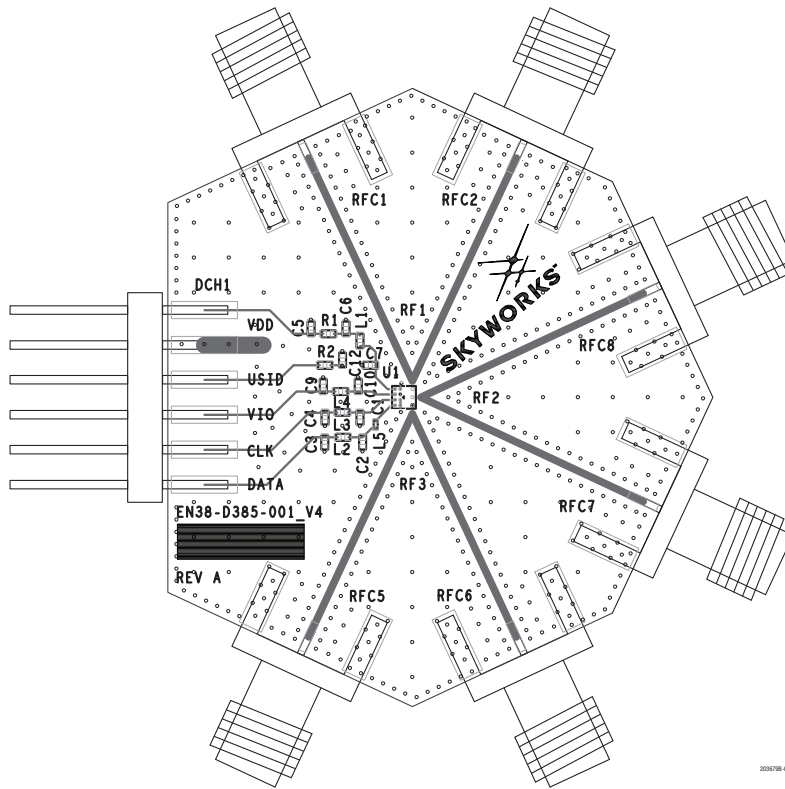
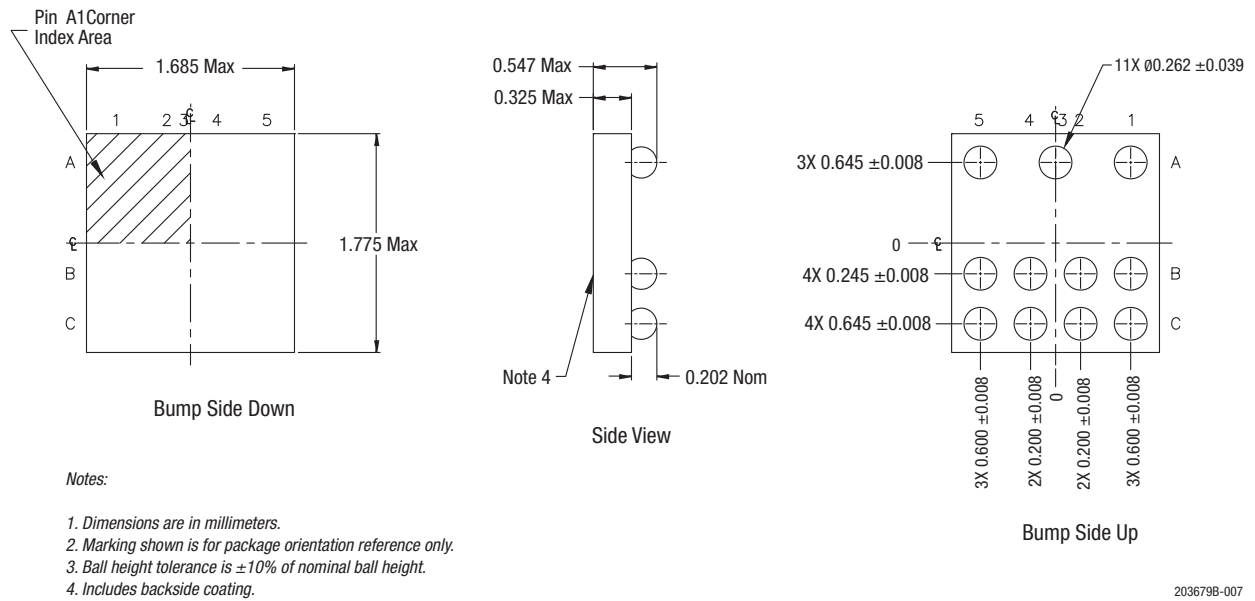
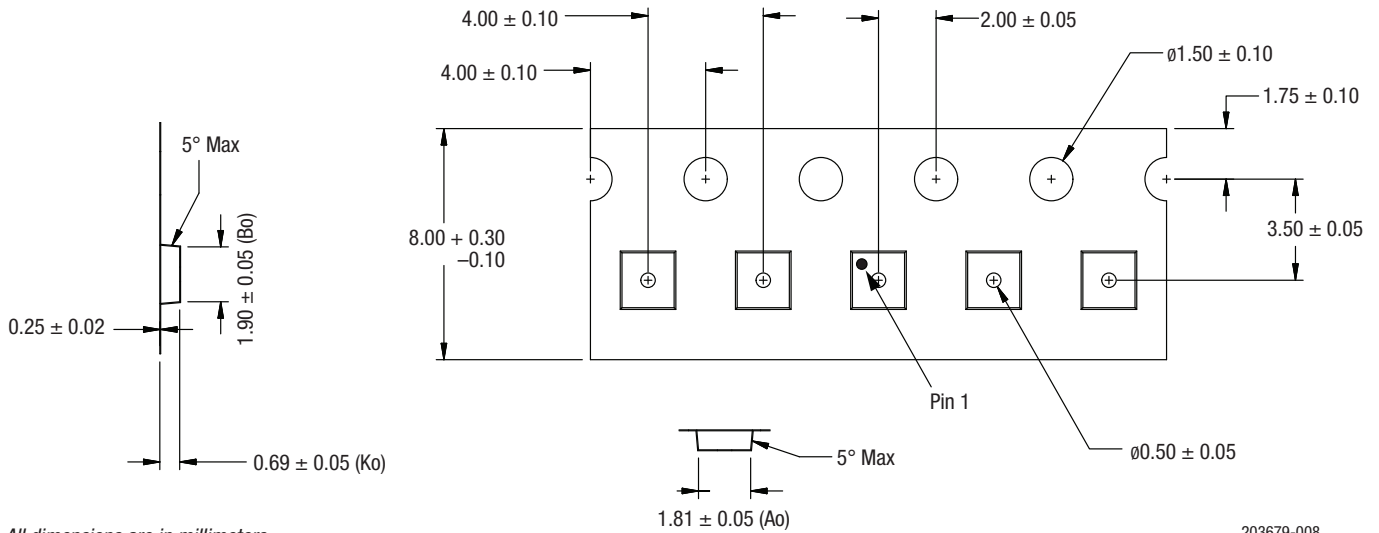


Figure 7. SKY19237-001 Evaluation Board Assembly



203679B-007

Figure 10. SKY19237-001 Package Dimensions



203679-008

Figure 11. SKY19237-001 Tape and Reel Dimensions

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY19237-001	0.1 to 6.0 GHz Triple SPST (3xSPST) Shunt MIPI Antenna Tuning Switch	SKY19237-001-EVB

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