SKY59272-707LF: Sky5® 0.6 to 6.0 GHz 4XSPST Shunt MIPI® Antenna Tuning Switch

Applications

- Aperture tuning

Features

- Broadband frequency range: 0.6 to 6.0 GHz

- Vpeak: 84 V

- R_{ON}: 1.65 ohms

- C_{OFF}: 95 fF

- High isolation: +40 dB @ 2.7 GHz

- Supply voltage: 1.8 V

- Control logic: MIPI v2.1

- Small QFN (12-pin, 1.6 x 1.6 x 0.45 mm typical) 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.
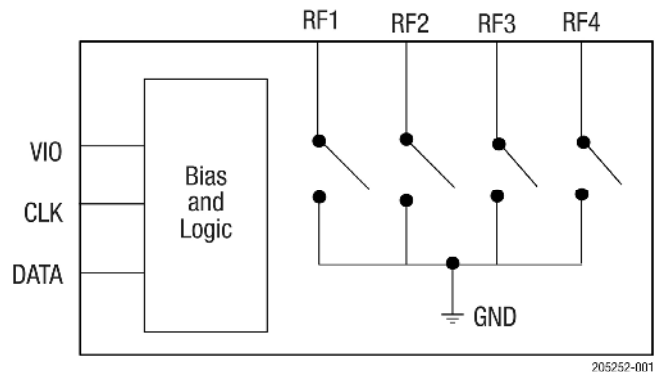

Figure 1. SKY59272-707LF Block Diagram

Description

The SKY59272-707LF is a Quad Flat No-Lead (QFN) 4X single-pole, single-throw (4XSPST) switch designed for antenna tuning applications that require ultra-low ON resistance and low OFF capacitance. Switching is controlled by an integrated Mobile Industry Processor Interface (MIPI) v2.1 controller. The SKY59272-707LF is part of our Sky5® product portfolio.

No external DC blocking capacitors are required as long as no DC voltage is applied on any RF path.

The SKY59272-707LF is provided in a compact 12-pin, 1.6 x 1.6 x 0.45 mm (typical) QFN 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.
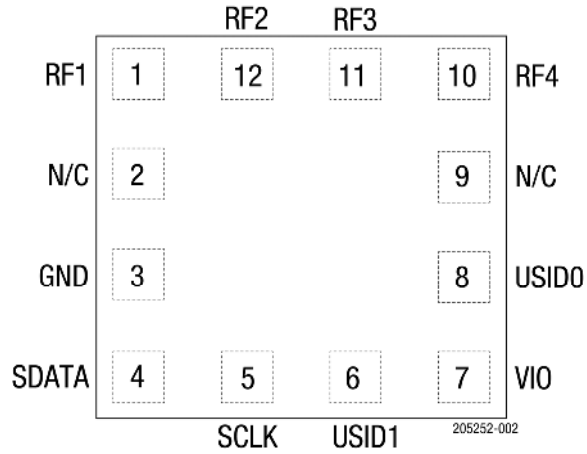
Figure 2. SKY59272-707LF Pinout
(Top View)

Table 1. SKY59272-707LF Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	RF1	Single-ended RF port 1	7	VIO	Voltage supply
2	N/C	Not connected	8	USID0	USID select pin
3	GND	GND	9	N/C	Not connected
4	SDATA	MIPI data	10	RF4	Single-ended RF port 4
5	SCLCK	MIPI clock	11	RF3	Single-ended RF port 3
6	USID1	USID select pin	12	RF2	Single-ended RF port 2

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY59272-707LF are provided in Table 2. The DC electrical specifications are provided in Table 3. RF electrical specifications are shown in Table 4. Harmonic measurement frequencies are provided in Table 5.

The state of the SKY59272-707LF is determined by the logic provided in Table 6. Table 7 shows the MIPI register map. The command sequence bit definitions are listed in Table 8. Timing diagrams are shown in Figures 3 and 4. Figure 5 shows the recommended MIPI time sequence diagram.

Table 2. SKY59272-707LF Absolute Maximum Ratings[1]

Parameter	Symbol	Condition	Minimum	Maximum	Units
Digital control voltage	V_{IO}	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		80	V
Operating case temperature	T_C		-40	+90	°C
Storage temperature	T_{STG}		-55	+150	°C

[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. SKY59272-707LF DC Electrical Specifications[1]
(V_{IO} = 1.8 V, T_{OP} = +25 °C, Characteristic Impedance [Z_0] = 50 ohms, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Digital control voltage	V_{IO}		1.65	1.8	1.95	V

Digital control signal voltage:
    Low
    High
	V_{CTL_LOW}
	V_{CTL_HIGH}
			0
			$0.8 \times V_{IO}$
				
				1.8
					$0.2 \times V_{IO}$
					V_{IO}
						V
						V

Static VIO leakage current	I_{IO}	V_{IO} = high	45	68	150	uA
Standby supply current	I_{IO}	V_{IO} = high, low-power mode	2	13	15	uA
DC supply turn-on time	t_{ON}	Measured from 50% of final VIO supply voltage to final RF power ± 1 dB		14	20	us
RF path switching time	t_{SW}	Measured from 50% of final control voltage to final RF input power ± 1 dB		6	10	us

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

Table 4. SKY59272-707LF RF Electrical Specifications[1]
(V_{IO} = 1.8 V, T_{OP} = +25 °C, Characteristic Impedance [Z_0] = 50 ohms, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Switch ON resistance	R_{ON}	DC 617 MHz to 0.96 GHz 0.96 to 2.17 GHz 2.17 to 2.7 GHz 3.3 to 3.8 GHz 4.2 to 5.0 GHz 5.15 to 5.925 GHz		1.65 1.7 1.9 2.1 2.2 2.4 2.8	1.95 2.0 2.5 2.5 2.6 2.72 2.94	ohms ohms ohms ohms ohms ohms ohms
Switch OFF capacitance	C_{OFF}	0.96 to 2.17 GHz 2.17 to 2.7 GHz 3.3 to 3.8 GHz 4.2 to 5.0 GHz 5.15 to 5.925 GHz		95 97 97 120 150	116 116 118 141 164	fF fF fF fF fF
Switch OFF resistance	R_{OFF}	DC 617 MHz to 0.96 GHz 0.96 to 2.17 GHz 2.17 to 2.7 GHz 3.3 to 3.8 GHz 4.2 to 5.0 GHz 5.15 to 5.925 GHz	228 15 12.7 11.7 10.9 7.2 6.2	233 17.3 15.2 14.1 12.1 8 7		kohms kohms kohms kohms kohms kohms kohms
Adjacent port isolation, all isolation	ISOL	Isolation mode, all switches OFF: 617 to 960 MHz 960 to 2170 MHz 2170 to 2700 MHz 3300 to 3800 MHz 4200 to 5000 MHz 5150 to 5925 MHz	 39 30 30 25 21.5 20	 41 33.5 32.5 29.5 26 27.5		 dB dB dB dB dB dB
Adjacent port isolation, RF1, RF2, RF3 or RF4 to GND	ISO	Switch ON mode, RF1 to RF4: 617 to 960 MHz 960 to 2170 MHz 2170 to 2700 MHz 3300 to 3800 MHz 4200 to 5000 MHz 5150 to 5925 MHz	 42 32 30 22 18.5 19	 44 34 32 26 20.5 22.5		 dB dB dB dB dB dB
Non- adjacent port isolation, all isolation	ISO	All switches OFF mode, RF1 to RF4: 617 to 960 MHz 960 to 2170 MHz 2170 to 2700 MHz 3300 to 3800 MHz 4200 to 5000 MHz 5150 to 5925 MHz	 60 53 53 50 32 41	 62 55.5 55 52.5 34 43.5		 dB dB dB dB dB dB
Non-adjacent port isolation, RF1, RF2, RF3 or RF4 to GND	ISO	Switch ON mode, RF1 to RF4: 617 to 960 MHz 960 to 2170 MHz 2170 to 2700 MHz 3300 to 3800 MHz 4200 to 5000 MHz 5150 to 5925 MHz	 49 40 37 30 21 31	 51.5 42 39.5 32.5 23 33		 dB dB dB dB dB dB

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

Table 5. SKY59272-707LF Harmonic Measurement Specifications[1] (1 of 2)
(V_{IO} = 1.8 V, T_{OP} = +25 °C, Characteristic Impedance [Z_O] = 50 ohms, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Vpeak RF withstanding voltage[2]	VPK	25% duty cycle, switch OFF state, shunt configuration @ 50 ohms: 617 to 3800 MHz 4200 to 5000 MHz	80 75	84 77		V V
GSM LB harmonics: 50 ohms VSWR = 6.1		fo = 0.824 to 0.915GHz, P_{IN} = +35 dBm: 2nd harmonics 3rd harmonics 2nd harmonics 3rd harmonics		-83 -80 -79 -71	-75 -70 -63 -60	dBm dBm dBm dBm
GSM HB harmonics: 50 ohms VSWR = 6:1		fo = 1.710 to 1.910 GHz, P_{IN} = +33 dBm: 2nd harmonics 3rd harmonics 2nd harmonics 3rd harmonics		-81 -82 -76 -72	-70 -73 -65 -63	dBm dBm dBm dBm
LB harmonics: 50 ohms VSWR = 6:1		fo = 0.617 to 0.960 GHz, P_{IN} = +26 dBm: 2nd harmonics 3rd harmonics 2nd harmonics 3rd harmonics		-105 -112 -97 -100	-90 -80 -80 -80	dBm dBm dBm dBm
MB harmonics: 50 ohms VSWR = 6:1		fo = 1.427 to 2.17 GHz, P_{IN} = +26 dBm: 2nd harmonics 3rd harmonics 2nd harmonics 3rd harmonics		-96 -103 -89 -92	-90 -80 -75 -80	dBm dBm dBm dBm
HB harmonics: 50 ohms VSWR = 6:1		fo = 2.3 to 2.69 GHz, P_{IN} = +29 dBm: 2nd harmonics 3rd harmonics 2nd harmonics 3rd harmonics		-88 -101 -80 -93	-80 -80 -66 -68	dBm dBm dBm dBm
UHB harmonics: 50 ohms VSWR = 6:1		fo = 3.3 to 3.8 GHz, P_{IN} = +29 dBm: 2nd harmonics 3rd harmonics 2nd harmonics 3rd harmonics		-85 -87 -78 -75	-75 -80 -65 -68	dBm dBm dBm dBm
Sub6G 2nd harmonic	2fo	Isolation mode, 50 ohms, P_{IN} = +26 dBm, 4200 to 5000 MHz, RF1 to RF4, CW, VIO = 1.65 to 1.95 V		-88	-72	dB
Sub6G 3rd harmonic	3fo			-101	-80	dB
Wi-Fi 2nd harmonic	2fo	Isolation mode, 50 ohms, P_{IN} = +26 dBm, 5150 to 5925 MHz, RF1 to RF4, CW, VIO = 1.65 to 1.95 V		-86	-75	dB
Wi-Fi 3rd harmonic	3fo			-107	-80	dB
Sub6G 2nd harmonic	2fo	Isolation mode, VSWR = 6:1, P_{IN} = +26 dBm, 4200 to 5000 MHz, RF1 to RF4, CW, VIO = 1.65 to 1.95 V		-81	-64	dB
Sub6G 3rd harmonic	3fo			-88	-57	dB
Wi-Fi 2nd harmonic	2fo	Isolation mode, VSWR = 6:1, P_{IN} = +26 dBm, 5150 to 5925 MHz, RF1 to RF4, CW, VIO = 1.65 to 1.95 V		-81	-58	dB
Wi-Fi 3rd harmonic	3fo			-95	-60	dB

Table 5. SKY59272-707LF Harmonic Measurement Specifications[1] (2 of 2)
(V_{IO} = 1.8 V, T_{OP} = +25 °C, Characteristic Impedance [Z_0] = 50 ohms, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
2nd order input interception point	IIP2	Isolation mode, B3+n78, RF1, RF2, RF3, RF4, TX bands = B3, blocker = N78, B3 = 1745 MHz, P_{IN} = +23.5 dBm, n78 = 3585 MHz, P_{IN} = +13 dBm at RFx port, CW signals. Measure reverse IMD2 @ 1840 MHz for B3 desense	+147	+153		dBm
3rd order input interception point	IIP3	Isolation mode, B2+n66 TX, +25 dBm/tone, B2 TX1 = 1852.5 MHz, n66 TX2 = 1772.5 MHz. Measure forward IMD3 @ 1932.5 MHz at RFx port	+85	+90		dBm
0.1 dB compression point	P0.1 dB	fo = 0.7 to 1 GHz, switch series ON state, CW	+43	+45		dBm
0.1 dB compression point	P0.1 dB	fo = 1 to 2.7 GHz, switch series ON state, CW	+43	+45		dBm
0.1 dB compression point	P0.1 dB	fo = 3.3 to 4.2 GHz, switch series ON state, CW	+43	+45		dBm
0.1 dB compression point	P0.1 dB	fo = 4.4 to 5 GHz, switch series ON state, CW	+42	+44		dBm
0.1 dB compression point	P0.1 dB	fo = 5 to 5.925 GHz, switch series ON state, CW	+42	+44		dBm

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

[2] The values are measured in a shunt configuration with the switch in an all ISOLATION state.

Table 6. SKY59272-707LF Truth Table

Register 0									
State	Mode	D7	D6	D5	D4	D3	D2	D1	D0
1	Isolation	x	x	x	x	0	0	0	0
2	RF1 to GND	x	x	x	x	0	0	0	1
3	RF2 to GND	x	x	x	x	0	0	1	0
4	RF3 to GND	x	x	x	x	0	1	0	0
5	RF4 to GND	x	x	x	x	1	0	0	0
6	RF1 and RF2 to GND	x	x	x	x	0	0	1	1
7	RF1 and RF3 to GND	x	x	x	x	0	1	0	1
8	RF1 and RF4 to GND	x	x	x	x	1	0	0	1
9	RF2 and RF3 to GND	x	x	x	x	0	1	1	0
10	RF2 and RF4 to GND	x	x	x	x	1	0	1	0
11	RF3 and RF4 to GND	x	x	x	x	1	1	0	0
12	RF1, RF2, and RF3 to GND	x	x	x	x	0	1	1	1
13	RF1, RF2, and RF4 to GND	x	x	x	x	1	0	1	1
14	RF1, RF3, and RF4 to GND	x	x	x	x	1	1	0	1
15	RF2, RF3, and RF4 to GND	x	x	x	x	1	1	1	0
16	RF1, RF2, RF3, and RF4 to GND	x	x	x	x	1	1	1	1

Table 7. SKY59272-707LF MIPI Register Map

Register Address	Register Name	Data Bit	Bit Name	Default	R/W	Description
0x00	STATE CONTROL	7:6	RESERVED	0x0	R/W	Reserved for future use
		5:4	RESERVED	0x0	R/W	Reserved for future use
		3:0	STATE CONTROL	0x0	R/W	Described in Table 8
0x1C	PM_TRIGGER	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]	0x9	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]	0x8	R/W	Programmable USID. A write to these bits programs the USID, selectable via pins 6 and 8: USID1 (Pin 6) USID0 (Pin 8) USID VIO or N/C 0 1000 VIO or N/C VIO or N/C 1001 0 0 0110 0 VIO or N/C 0111

Table 8. SKY59272-707LF Command Sequence Bit Definitions

Type	SSC	C11-C8	C7	C6-C5	C4	C3-C0	Parity Bits	BPC	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
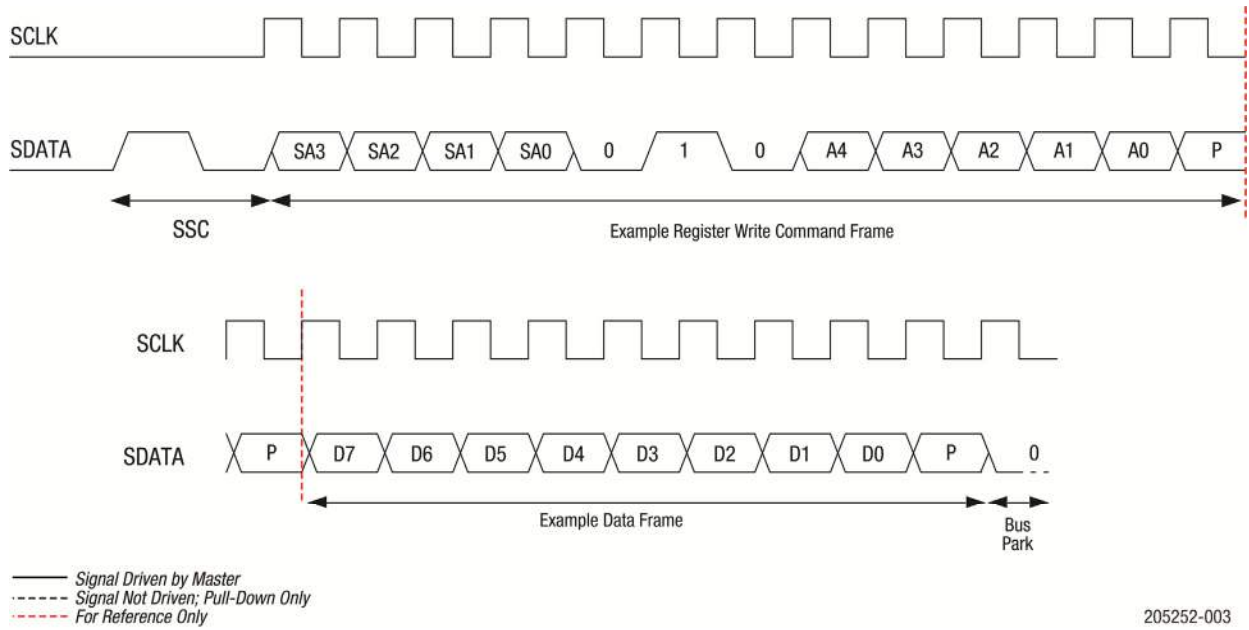
Figure 3. Register Write Command Timing Diagram
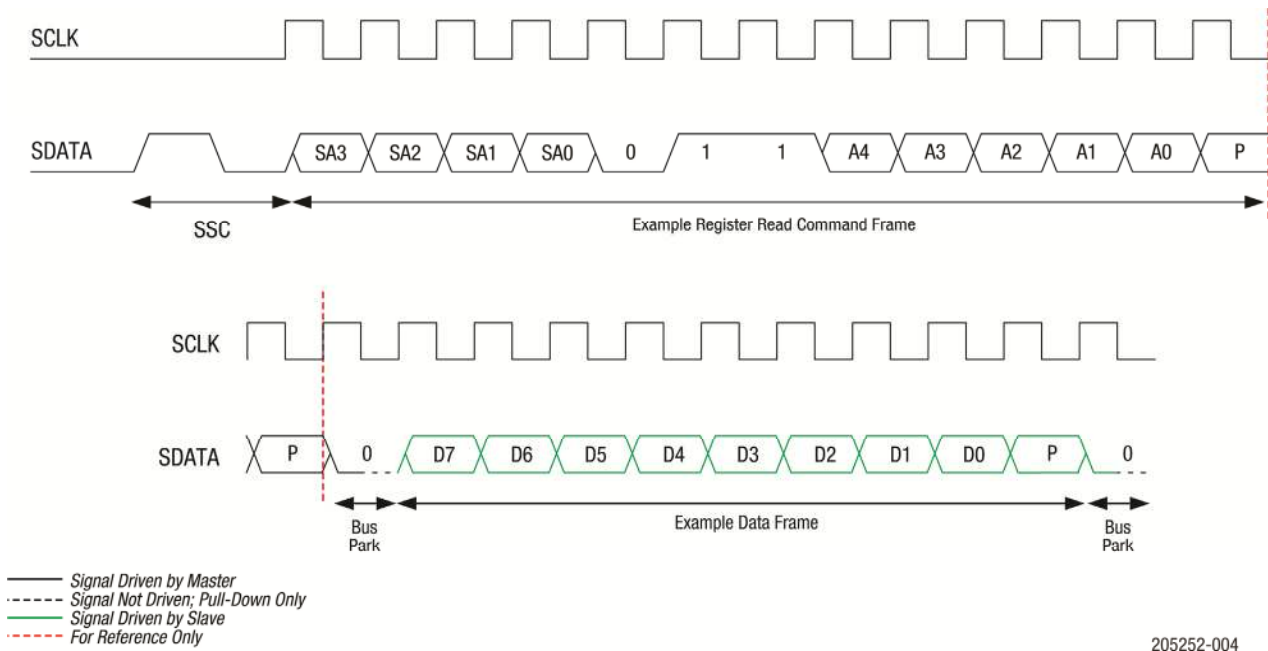
Figure 4. Register Read Command Timing Diagram
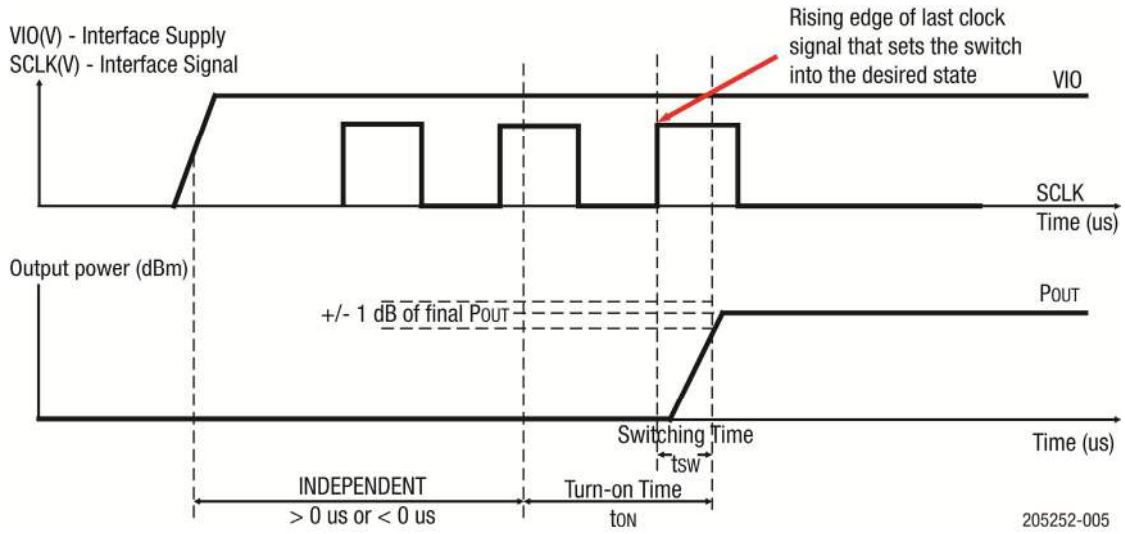
Figure 5. Recommended MIPI Time Sequence Diagram

Evaluation Board Description

The SKY59272-707LF Evaluation Board is used to test the performance of the SKY59272-707LF 4xSPST Switch.

An Evaluation Board schematic diagram is provided in Figure 6. An assembly drawing for the Evaluation Board is shown in Figure 7.
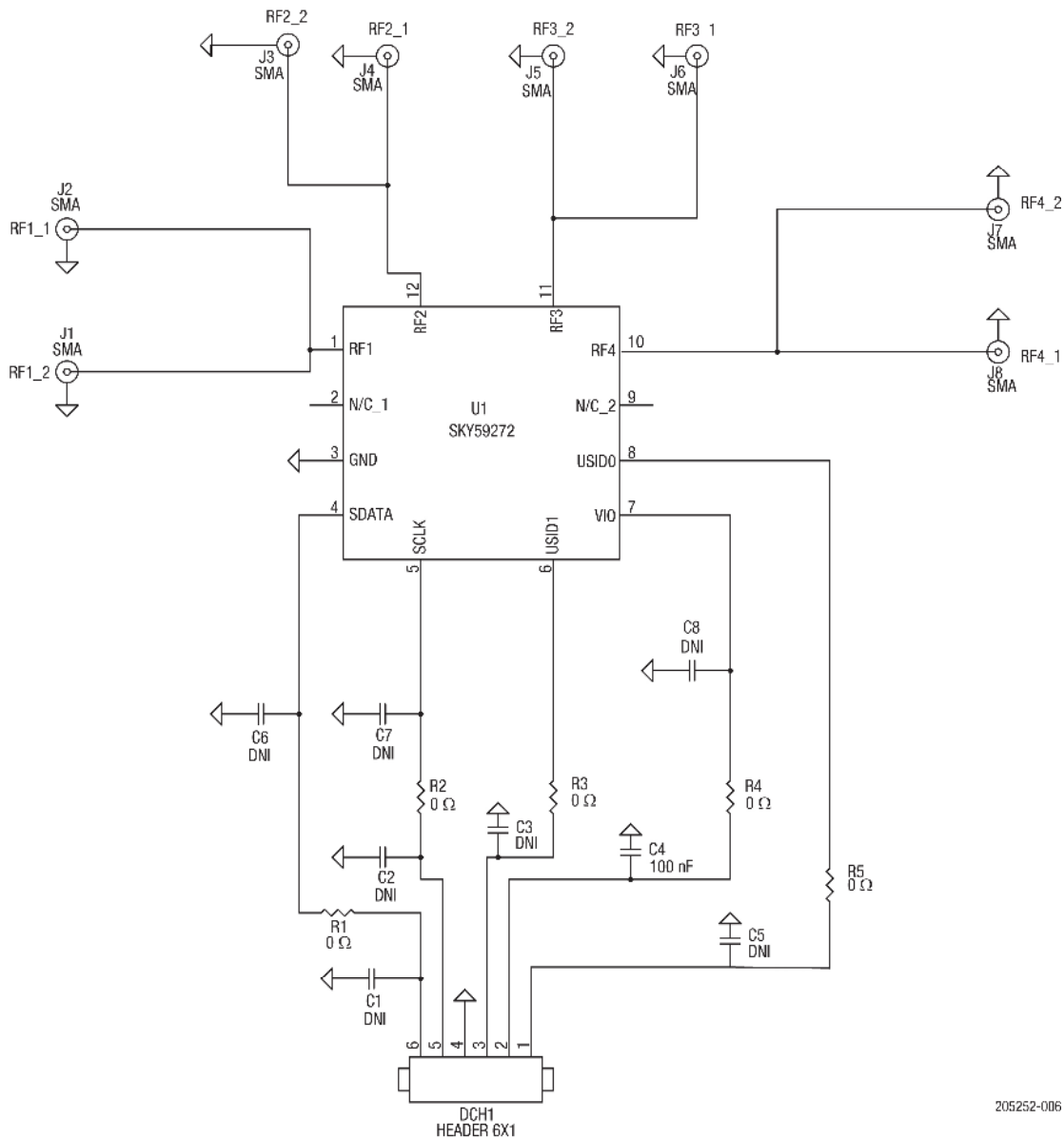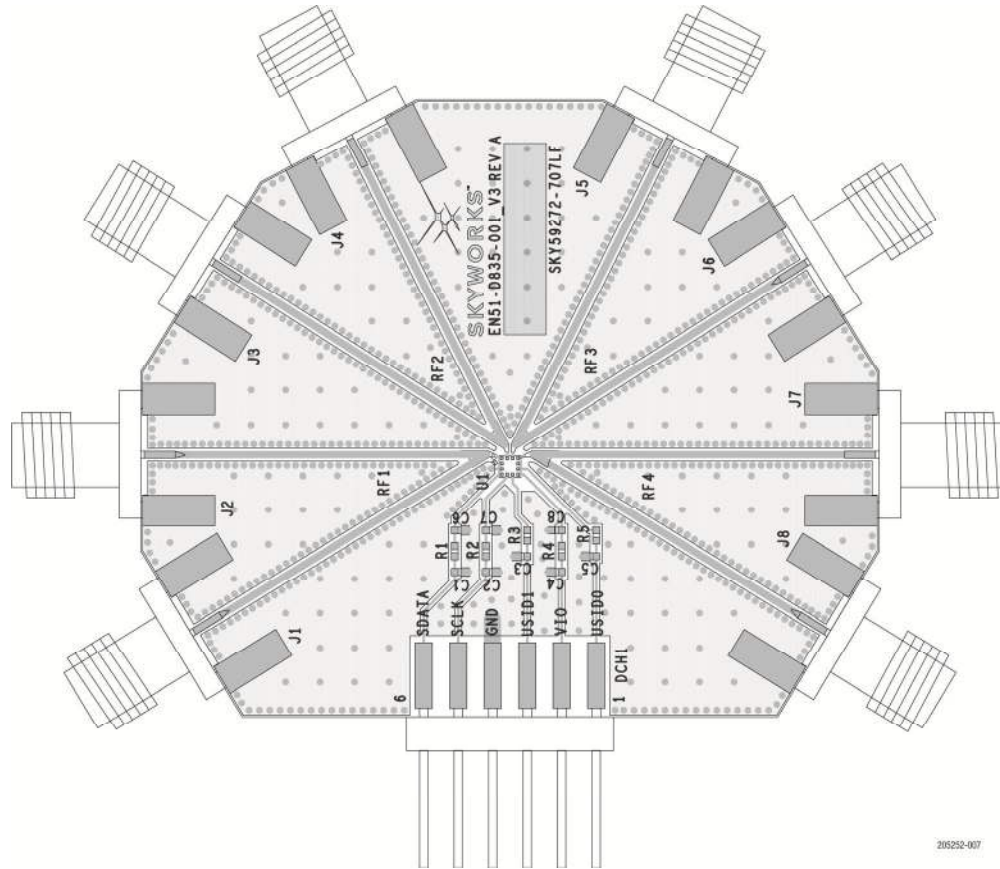
Figure 6. SKY59272-707LF Evaluation Board Schematic

Figure 7. SKY59272-707LF Evaluation Board Assembly Diagram

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Package Dimensions

The PCB layout footprint is shown in Figure 8. Typical part markings are shown in Figure 9. Package dimensions for the SKY59272-707LF are shown in Figure 10, and tape and reel dimensions are provided in Figure 11.

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 SKY59272-707LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering.

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.
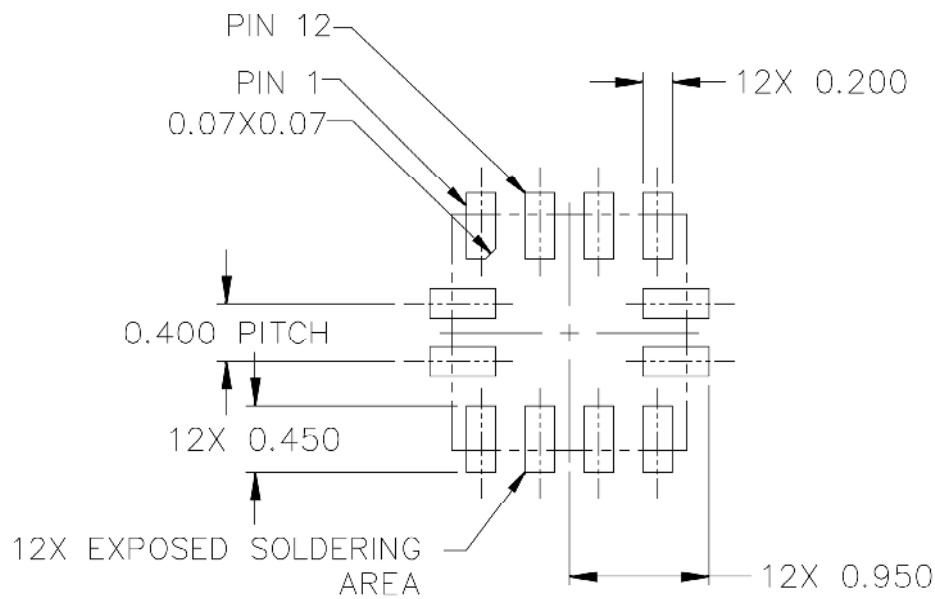
205252-008

Figure 8. SKY59272-707LF PCB Layout Footprint
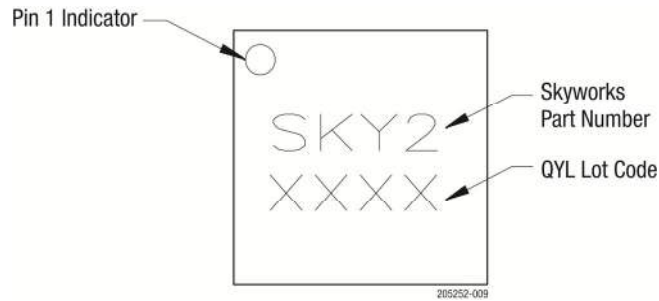
**Figure 9. SKY59272-707LF Typical Part Markings
(Top View)**

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M – 1994.
2. DIMENSIONS 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 WIDTH DIMENSION SHOULD NOT BE MEASURED IN THAT RADIUS AREA.

Figure 10. SKY59272-707LF Package Dimensions

Figure 11. SKY59272-707LF Tape and Reel Dimensions
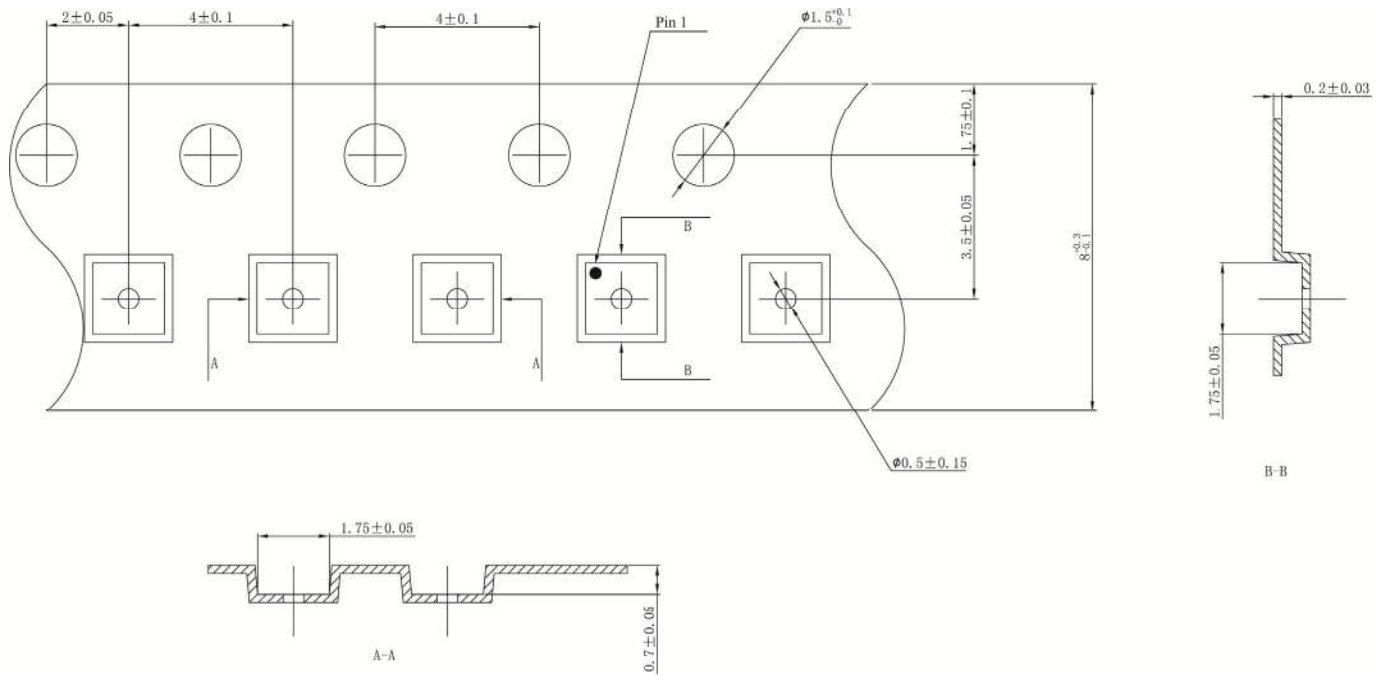
NOTES:[技术要求]:
1. CARRIER TAPE COLOR:BLACK.[载带颜色为黑色]
2. COVER TAPE WIDTH:5.50±0.10.[配套5.50±0.10宽盖带]
3. COVER TAPE COLOR:TRANSPARENT.[盖带颜色无色透明]
4. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.20MAX.
[10个传送定位孔间距累积公差0.20MAX.]
5. CAMBER NOT TO EXCEED 1 MM IN 100 MM[载带直线弯曲度：≤1mm/100mm.]
6. MOLD# DFN/QFN/MIS/FBP(1.6×1.6×0.55).[载带规格DFN/QFN/MIS/FBP(1.6×1.6×0.55)]
7. ALL DIMS IN mm.[所有单位为mm]
8. BAN TO USE THE LEVEL 1 ENVIRONMENT-RELATED SUBSTANCES OF JCET PRESCRIBING.
[禁止使用长电科技规定的一级环境管理物质]
9. THE DIRECTION OF VIEW: ⊲⊕ 。[视图方向: ⊲⊕]

205252-011

Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY59272-707LF	0.6 to 6.0 GHz 4XSPST Shunt MIPI Antenna Tuning Switch	SKY59272-707EK1