DATA SHEET

SKY13417-485LF: 0.1-3.0 GHz SP7T Antenna Switch

Applications

- Any 2G/3G/4G antenna diversity or LTE (TDD/FDD) transmit/receive system for which GSM transmit is not required

Features

- Broadband frequency range: 0.1 to 3.0 GHz
- Low insertion loss: 0.7 dB typical @ 2.7 GHz
- High isolation: >20 dB @ 2.7 GHz
- Integrated logic
- Internal 50 Ω port to control diversity antenna impedance when device is not in use
- Small QFN (14-pin, 2.0 x 2.0 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

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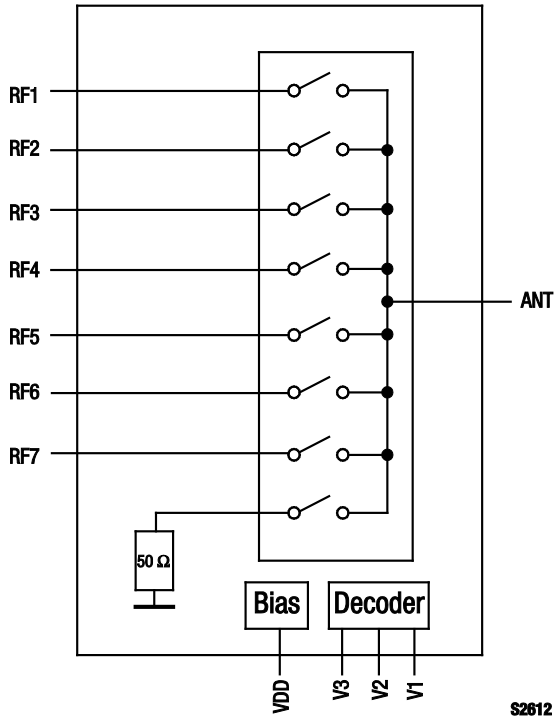


Figure 1. SKY13417-485LF Block Diagram

Description

The SKY13417-485LF is a Single Pole, Seven-Throw (SP7T) switch with an internal 50 Ω termination. The high linearity performance and low insertion loss achieved by the SKY13417-485LF make it an ideal choice for main/diversity switching commonly used in LTE-based handsets, data cards, and tablets that use antenna diversity solutions.

The SKY13417-485LF is part of a scalable family of products that covers SP4T through SP8T switches that allow up to eight bands of WCDMA/LTE.

- SKY13414-485LF SP4T Antenna Switch (Data Sheet #201689)
- SKY13415-485LF SP5T Antenna Switch (Data Sheet #201704)
- SKY13416-485LF SP6T Antenna Switch (Data Sheet #201679)
- SKY13417-485LF SP7T Antenna Switch (this Data Sheet)
- SKY13418-485LF SP8T Antenna Switch (Data Sheet #201712)

The symmetric port designs provide flexibility in signal routing for both receive diversity and higher power TD-SCDMA/TDD-LTE, WCDMA/FDD, and LTE transmit/receive applications.

Switching is controlled by three CMOS/TTL-compatible control voltage inputs (V1, V2, and V3). Depending on the logic voltage level applied to the control pins, the ANT pin is connected to one of seven switched RF input/output (I/O) ports (RF1 to RF7) using a low insertion loss path, while the paths between the ANT pin and the other RF pins are in a high isolation state. The antenna path can also be closed on a 50 Ω load when it needs to be terminated. The 50 Ω load is internally grounded. No external blocking capacitors are required on the RF paths unless V_{DC} is applied externally.

The SKY13417-485LF is manufactured in a compact, 14-pin 2.0 x 2.0 mm, Quad Flat No-Lead (QFN) 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.

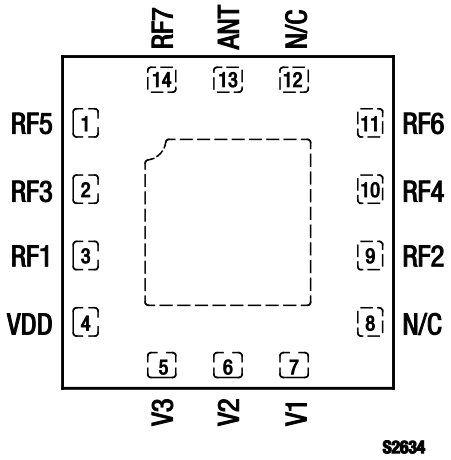


Figure 2. SKY13417-485LF Pinout – 14-Pin QFN
(Top View)

Table 1. SKY13417-485LF Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	RF5	RF I/O path 5	8	N/C	Not connected
2	RF3	RF I/O path 3	9	RF2	RF I/O path 2
3	RF1	RF I/O path 1	10	RF4	RF I/O path 4
4	VDD	DC power supply	11	RF6	RF I/O path 6
5	V3	DC control voltage 3	12	N/C	Not connected
6	V2	DC control voltage 2	13	ANT	Antenna port
7	V1	DC control voltage 1	14	RF7	RF I/O path 7

Note: Bottom ground paddles must be connected to ground.

Table 2. SKY13417-485LF Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{DD}	2.5	5.0	V
Control voltage (V1, V2, and V3)	V_{CTL}	–0.5	+3.0	V
RF input power (RF1 to RF7)	P_{IN}		+37.5	dBm
RF input power (50_OHM)	P_{IN}		+27	dBm
Operating temperature	T_{OP}	–40	+90	°C
Storage temperature	T_{STG}	–55	+150	°C
Electrostatic Discharge, Human Body Model (HBM), Class 1C	ESD		1000	V

Note 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.

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

Functional Description

The SKY13417-485LF includes an internal negative voltage generator and decoder that eliminate the need for external DC blocking capacitors on the RF ports. No external components are required for proper operation. DC decoupling capacitors may be added on the VDD and control lines if necessary.

Switching is controlled by three control voltage inputs, V1, V2, and V3. Depending on the logic voltage level applied to the control pins, the antenna pin is connected to one of seven switched RF outputs or a 50 Ω termination.

The recommended startup sequence is:

1. Apply VDD
2. Apply V1, V2, and V3 voltages
3. Apply RF input

The device must be turned off in reverse order.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY13417-485LF are provided in Table 2. Electrical specifications are provided in Table 3.

The state of the SKY13417-485LF is determined by the logic shown in Table 4.

The isolation matrix shown in Table 5 provides the port-to-port isolation for all available RF states at three different frequencies: 1.0 GHz, 2.0 GHz, and 2.7 GHz.

Table 3. SKY13417-485LF General Electrical Specifications (Note 1)
(V_{DD} = 2.6 V, V1 = V2 = V3 = 0/1.8 V, P_{IN} = 0 dBm, T_{OP} = +25 °C, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition (Note 2)	Min	Typical	Max	Units
DC Specifications						
Supply voltage	V_{DD}		2.5	3.0	4.8	V
Supply current	I_{DD}			40	50	µA
Control voltage: High Low	 V_{CTL_H} V_{CTL_L}		 1.35	 1.80	 2.70 0.3	 V V
Control current	I_{CTL}	V_{CTL} = 1.8 V		0.5	1.0	µA
Turn-on switching time	t_{ON}	50% of final control voltage to 90% of final RF power, switching between RF1/2/3/4/5/6/7/50_OHM		1.5	2.2	µs
RF Specifications						
Insertion loss (ANT pin to RF1/2/3/4/5/6 pins)	IL	0.1 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.7 GHz		0.45 0.55 0.70	0.50 0.60 0.90	dB dB dB
Insertion loss (ANT pin to RF7 pin)	IL	0.1 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.7 GHz		0.45 0.60 0.80	0.55 0.75 1.05	dB dB dB
Isolation (ANT pin to RF1/2/3/4/5/6 pins)	Iso	0.1 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.7 GHz	30 28 18	37 31 27		dB dB dB
Isolation (ANT pin to RF7 pin)	Iso	0.1 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.7 GHz	29 23 19	31 24 21		dB dB dB
Input return loss (ANT pin to RF1/2/3/4/5/6 pins)	RL	0.1 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.7 GHz	24 23 15	27 25 18		dB dB dB
Input return loss (ANT pin to RF7 pin)	RL	0.1 to 1.0 GHz 1.0 to 2.0 GHz 2.0 to 2.7 GHz	21 15 11	24 18 13		dB dB dB
Second harmonics (ANT pin to RF1/2/3/4/5/6/7 pins)	2fo	P_{IN} = +26 dBm, 0.1 to 3.0 GHz		+92		dBc
Third harmonics (ANT pin to RF1/2/3/4/5/6/7 pins)	3fo	P_{IN} = +26 dBm, 0.1 to 3.0 GHz		+93		dBc
0.1 dB Compression Point (ANT pin to RF1/2/3/4/5/6/7 pins)	P0.1dB	0.8 GHz to 3.0 GHz		+37.5		dBm
3rd Order Input Intercept Point	IIP3	@ 2.0 GHz, P_{IN} = +26 dBm, Δf = 1 MHz		+66		dBm

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 4. SKY13417-485LF Control Logic

Control Pins			Switched RF I/O							
V1 (Pin 7)	V2 (Pin 6)	V3 (Pin 5)	RF1 (Pin 3)	RF2 (Pin 9)	RF3 (Pin 2)	RF4 (Pin 10)	RF5 (Pin 1)	RF6 (Pin 11)	RF7 (Pin 14)	50 Ω
0	0	0	**Insertion Loss**	Isolation	Isolation	Isolation	Isolation	Isolation	Isolation	Isolation
0	0	1	Isolation	**Insertion Loss**	Isolation	Isolation	Isolation	Isolation	Isolation	Isolation
0	1	0	Isolation	Isolation	**Insertion Loss**	Isolation	Isolation	Isolation	Isolation	Isolation
0	1	1	Isolation	Isolation	Isolation	**Insertion Loss**	Isolation	Isolation	Isolation	Isolation
1	0	0	Isolation	Isolation	Isolation	Isolation	**Insertion Loss**	Isolation	Isolation	Isolation
1	0	1	Isolation	Isolation	Isolation	Isolation	Isolation	**Insertion Loss**	Isolation	Isolation
1	1	0	Isolation	Isolation	Isolation	Isolation	Isolation	Isolation	**Insertion Loss**	Isolation
1	1	1	Isolation	Isolation	Isolation	Isolation	Isolation	Isolation	Isolation	**50 Ω**

Note 1: "High" = 1.8 V; "Low" = 0 V. Any state other than that described in this Table places the switch into an undefined state. An undefined state will not damage the device.

Table 5. Isolation Matrix (1 of 2)

"On" Port	Frequency (GHz)	Isolation (dB)						
		RF1	RF2	RF3	RF4	RF5	RF6	RF7
Antenna-to-Port								
RF1	1.0	–	–50	–39	–44	–40	–38	–31
RF1	2.0	–	–41	–32	–36	–31	–32	–24
RF1	2.7	–	–37	–29	–33	–27	–29	–21
RF2	1.0	–47	–	–41	–39	–37	–40	–31
RF2	2.0	–40	–	–35	–32	–31	–31	–25
RF2	2.7	–36	–	–32	–28	–28	–27	–22
RF3	1.0	–39	–48	–	–43	–42	–39	–32
RF3	2.0	–32	–40	–	–36	–31	–32	–25
RF3	2.7	–29	–36	–	–33	–27	–29	–21
RF4	1.0	–46	–39	–41	–	–37	–42	–31
RF4	2.0	–39	–32	–35	–	–31	–31	–25
RF4	2.7	–35	–29	–32	–	–28	–27	–22
RF5	1.0	–48	–48	–39	–44	–	–40	–35
RF5	2.0	–36	–40	–31	–37	–	–32	–26
RF5	2.7	–31	–36	–28	–33	–	–29	–22
RF6	1.0	–46	–48	–42	–39	–38	–	–32
RF6	2.0	–39	–36	–35	–32	–32	–	–25
RF6	2.7	–35	–31	–32	–28	–28	–	–22

Table 5. Isolation Matrix (2 of 2)

"On" Port	Frequency (GHz)	Isolation (dB)						
		RF1	RF2	RF3	RF4	RF5	RF6	RF7
Antenna-to-Port (continued)								
RF7	1.0	–46	–48	–47	–45	–42	–41	–
RF7	2.0	–36	–40	–35	–37	–32	–33	–
RF7	2.7	–31	–36	–30	–33	–27	–29	–
Port-to-Port								
RF1	1.0	–	–52	–31	–52	–42	–43	–38
RF1	2.0	–	–42	–24	–43	–33	–37	–31
RF1	2.7	–	–38	–21	–39	–28	–34	–28
RF2	1.0	–52	–	–48	–31	–41	–42	–34
RF2	2.0	–41	–	–40	–24	–35	–33	–28
RF2	2.7	–37	–	–37	–21	–33	–29	–26
RF3	1.0	–31	–55	–	–52	–32	–44	–42
RF3	2.0	–24	–43	–	–43	–25	–37	–32
RF3	2.7	–21	–39	–	–39	–21	–35	–28
RF4	1.0	–53	–31	–48	–	–41	–33	–34
RF4	2.0	–42	–25	–40	–	–35	–26	–29
RF4	2.7	–38	–21	–37	–	–33	–22	–26
RF5	1.0	–37	–55	–31	–53	–	–46	–39
RF5	2.0	–30	–44	–24	–43	–	–38	–28
RF5	2.7	–27	–39	–21	–39	–	–35	–23
RF6	1.0	–54	–37	–49	–31	–43	–	–36
RF6	2.0	–42	–30	–40	–24	–36	–	–29
RF6	2.7	–38	–27	–37	–21	–33	–	–27
RF7	1.0	–40	–54	–38	–54	–33	–48	–
RF7	2.0	–33	–43	–30	–42	–25	–39	–
RF7	2.7	–30	–39	–27	–38	–22	–34	–

Evaluation Board Description

The SKY13417-485LF Evaluation Board is used to test the performance of the SKY13417-485LF SP7T Switch. An Evaluation Board schematic diagram is provided in Figure 3. An assembly drawing for the Evaluation Board is shown in Figure 4.

Package Dimensions

The PCB layout footprint for the SKY13417-485LF is provided in Figure 5. Typical case markings are shown in Figure 6. Package dimensions for the 14-pin QFN are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

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 SKY13417-485LF 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, *PCB Design & SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

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.

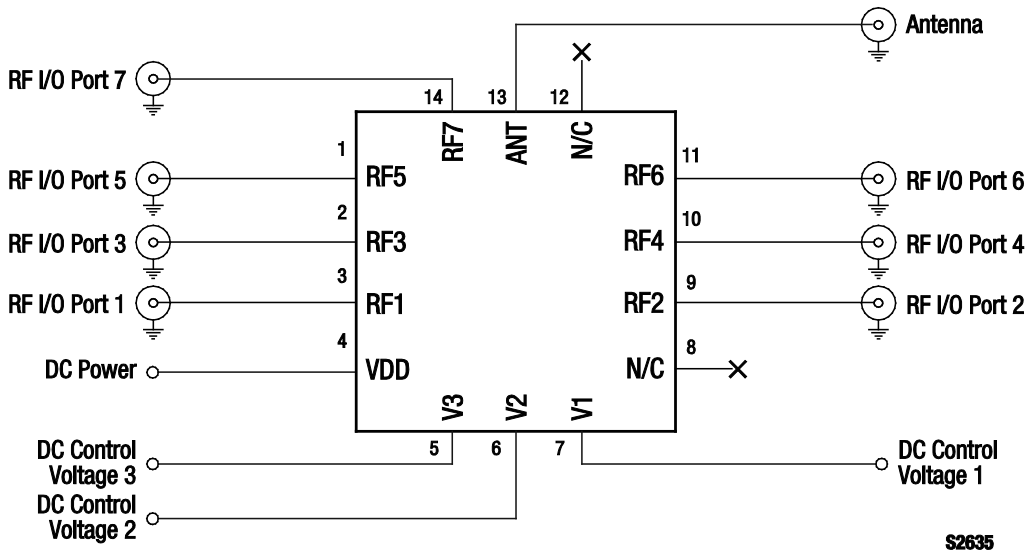


Figure 3. SKY13417-485LF Evaluation Board Schematic

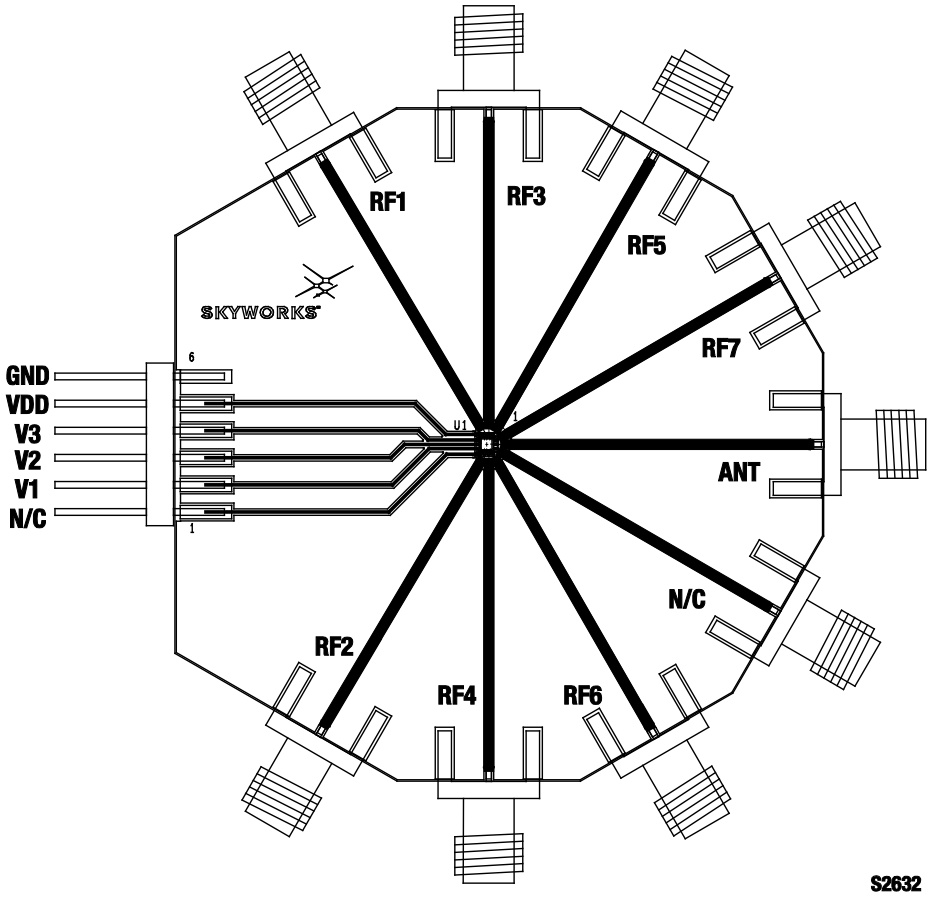


Figure 4. SKY13417-485LF Evaluation Board Assembly Diagram

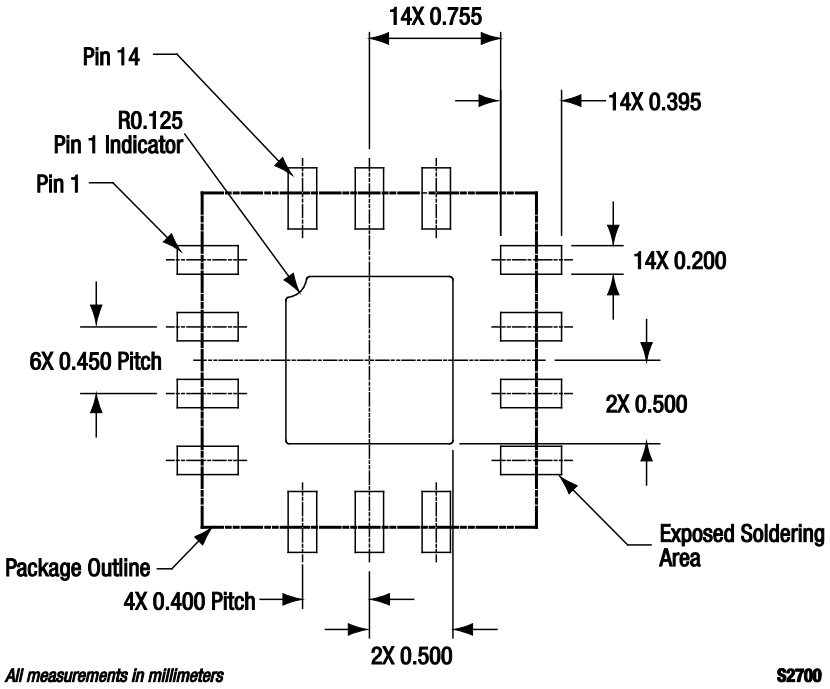


Figure 5. SKY13417-485LF PCB Layout Footprint
(Top View)

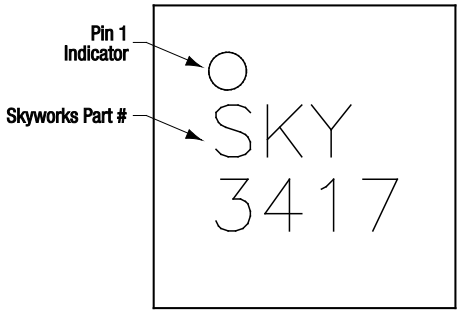


Figure 6. Typical Part Markings
(Top View)

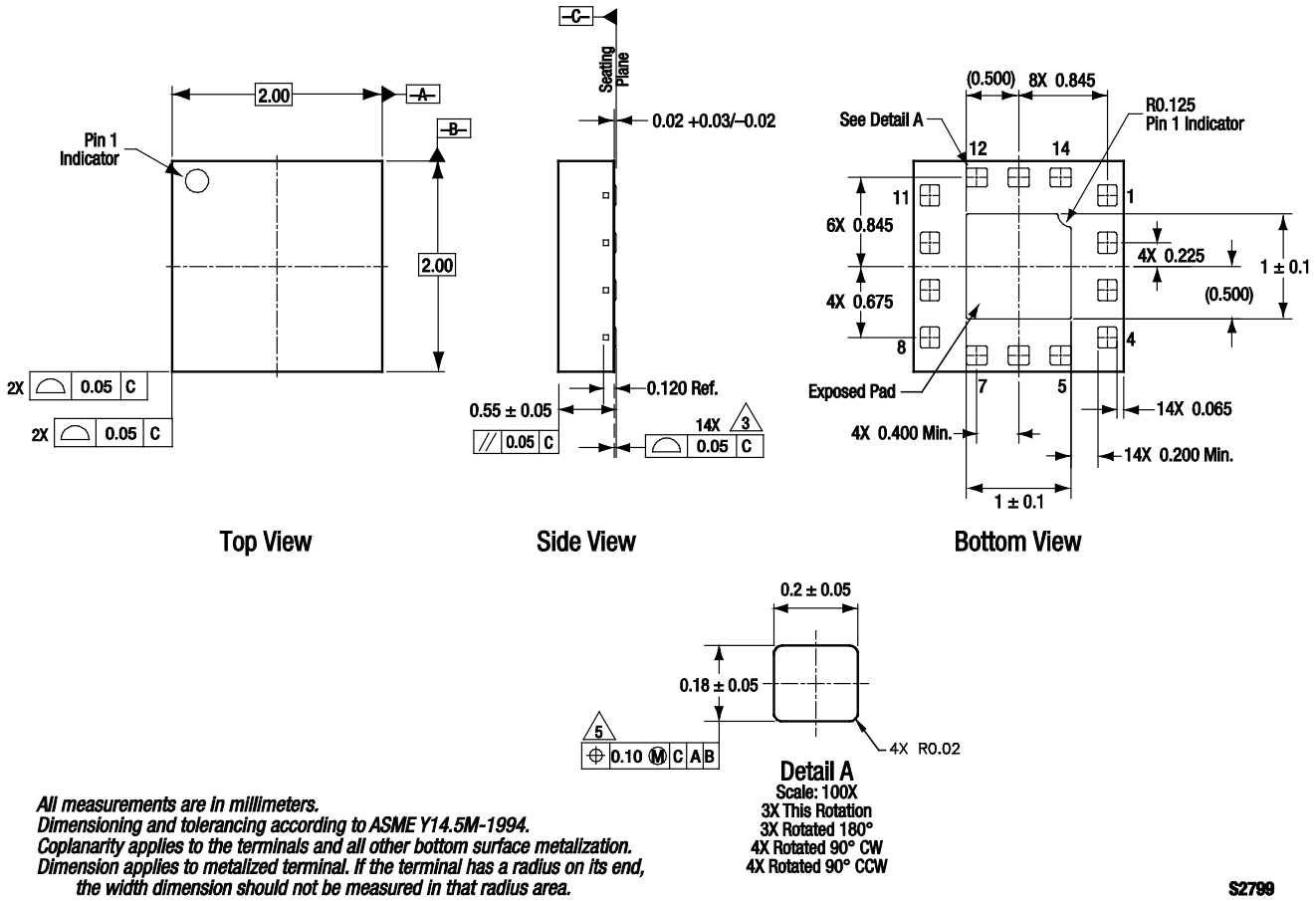
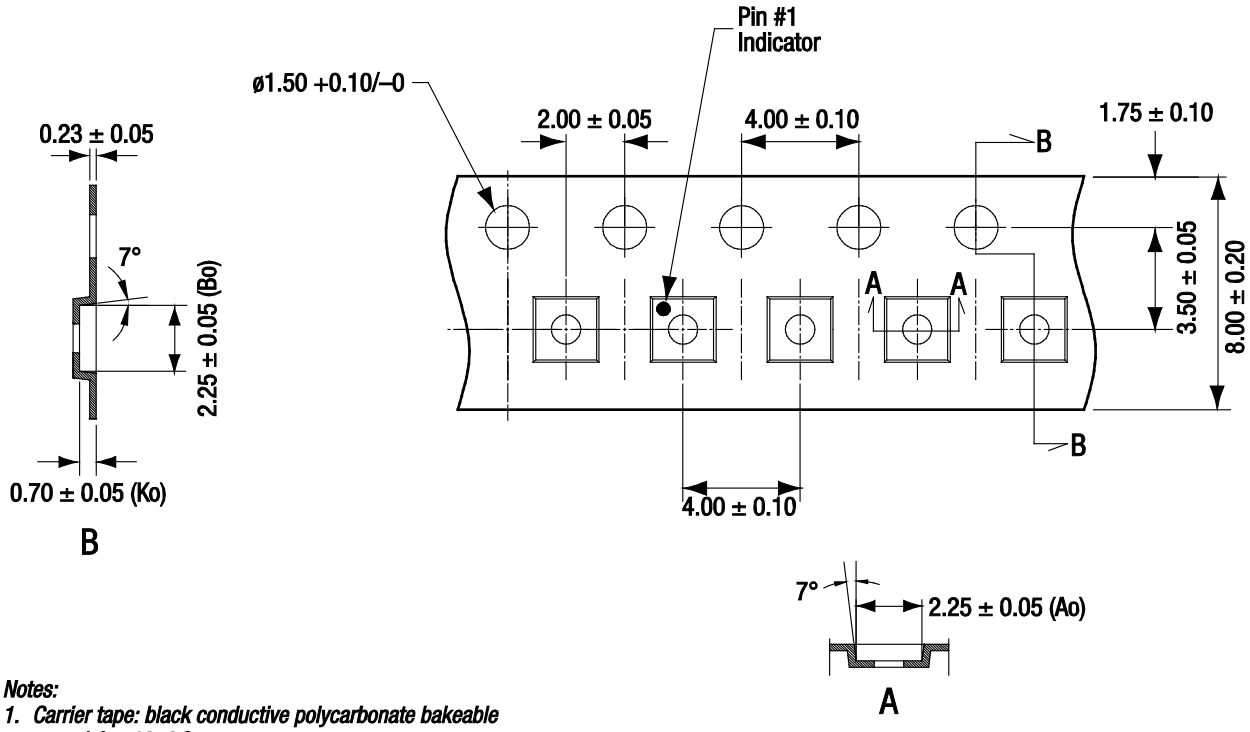


Figure 7. SKY13417-485LF 14-Pin QFN Package Dimensions



Notes:
1. *Carrier tape: black conductive polycarbonate bakeable material at 125 °C.*
2. *Carrier tape material: transparent conductive PSA.*
3. *Cover tape material: transparent conductive with 5.40 mm width.*
4. *All dimensions are in millimeters.*

S2712

Figure 8. SKY13417-485LF Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY13417-485LF 0.7-2.7 GHz SP7T Switch	SKY13417-485LF	SKY13417-485LF-EVB

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