DATA SHEET

# SKY13642-485LF: 5 MHz to 1.5 GHz Ultra-High-Linearity SP6T 75 Ω Switch

## Applications

- Cable modems
- Set-top boxes
- Filter band switching
- Relay/replacement to switch between DOCSIS 3.0 and DOCSIS 3.1 configurations

## Features

- Ultra-high-linearity performance:
  - CTB <-100 dBc
  - CSO <-100 dBc
- Low insertion loss: 0.45 dB typical @ 1.5 GHz
- High isolation: >28 dB @ 1.5 GHz
- No external DC blocking capacitors required
- DC supply voltage: 2.5 V to 4.8 V
- Integrated logic
- Small QFN (14-pin, 2.0 x 2.0 mm) package (MSL1, 260 °C per JEDEC J-STD-020)



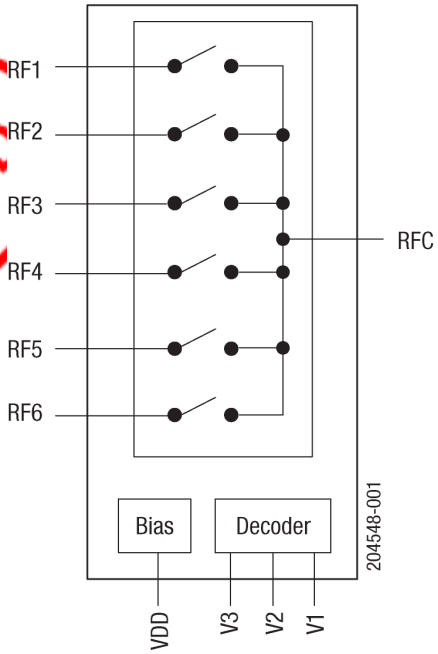



**Figure 1. SKY13642-485LF Block Diagram**

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.

## Description

The SKY13642-485LF is a single pole, six-throw (SP6T) 75 Ω switch. The high-linearity performance and low insertion loss of the SKY13642-485LF meet the most stringent requirements of DOCSIS 3.1 applications.

The SKY13642-485LF is a "reflective short" on the isolated port.

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 RFC pin is connected to one of six switched RF outputs (RF1 to RF6) using a low insertion loss path, while the paths between the RFC pin and the other RF pins are in a high isolation state. No external blocking capacitors are required on the RF paths unless VDC is externally applied.

The SKY13642-485LF 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.

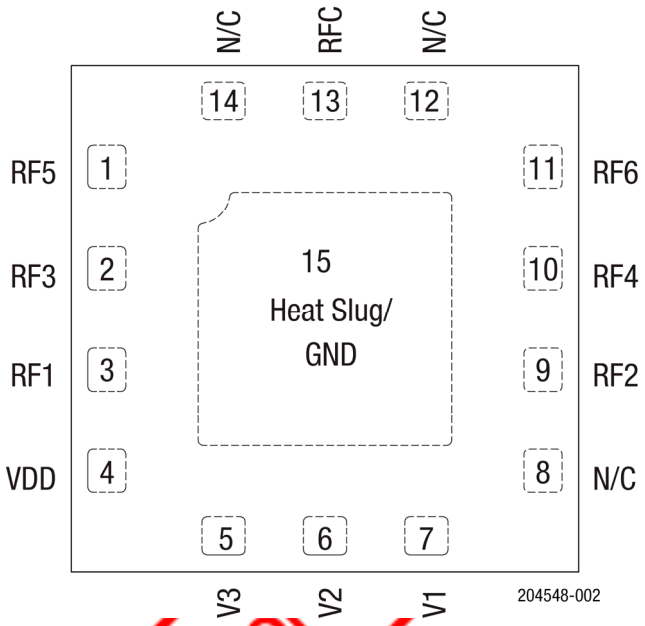



**Figure 2. SKY13642-485LF Pinout (Top View)**



**Table 1. SKY13642-485LF Signal Descriptions**

| Pin | Name | Description | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | RF5 | RF I/O path 5 | 9 | RF2 | RF I/O path 2 |
| 2 | RF3 | RF I/O path 3 | 10 | RF4 | RF I/O path 4 |
| 3 | RF1 | RF I/O path 1 | 11 | RF6 | RF I/O path 6 |
| 4 | VDD | DC power supply | 12 | N/C[1] | Not connected |
| 5 | V3 | DC control voltage 3 | 13 | RFC | Common port |
| 6 | V2 | DC control voltage 2 | 14 | N/C[1] | Not connected |
| 7 | V1 | DC control voltage 1 | 15 | Heat slug/GND[1] | Must be connected to ground |
| 8 | N/C[1] | Not connected | | | |

[1] Note that the Heat Slug/GND (Pin 15) is the only valid connection to ground. The N/C pins (8, 12, 14) are not wire-bonded internally and cannot be used for grounding.

## Functional Description

The SKY13642-485LF 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 RFC pin is connected to one of six switched RF outputs.

A seventh state enables RF3 and RF5 at the same time. The output power measured at RF3 and RF5 in this state is 3 dB less than the typical insertion loss.

Shutdown mode is enabled by connecting all three control pins (V1, V2, and V3) to logic high. This mode reduces the overall current consumption of the device to 5 μA typical.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY13642-485LF are provided in Table 2. Electrical specifications are provided in Table 3.

The state of the SKY13642-485LF is determined by the logic shown in Table 4.

Table 5 and Table 6 list the typical RFC-to-PORT and PORT-to-PORT isolation at various frequency points as measured on the Evaluation Board.



**Table 2. SKY13642-485LF Absolute Maximum Ratings[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 RF6), 0.1 to 1.5 GHz | $P_{IN}$ | | +84.5 | dBmV |
| Operating temperature | $T_{OP}$ | -40 | +85 | °C |
| Storage temperature | $T_{STG}$ | -55 | +150 | °C |
| Electrostatic discharge: | ESD | | | |
| Charged-Device Model (CDM), Class C3 | | | 500 | V |
| Human Body Model (HBM), Class 1B | | | 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. SKY13642-485LF General Electrical Specifications**
**($V_{DD}$ = 2.6 V, V1 = V2 = V3 = 0/1.8 V, $P_{IN}$ = 47 dBmV, $T_{OP}$ = +25 °C, Characteristic Impedance [$Z_0$] = 75 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| ***DC Specifications*[1]** | | | | | | |
| Supply voltage | $V_{DD}$ | | 2.5 | 3.0 | 4.8 | V |
| Supply current | $I_{DD}$ | | | 40 | 50 | µA |
| Control voltage:<br>High<br>Low | <br>$V_{CTL\_H}$<br>$V_{CTL\_L}$ | | 1.35 | 1.80 | 2.70<br>0.4 | <br>V<br>V |
| Control current | $I_{CTL}$ | $V_{CTL}$ = 1.8 V | | 0.5 | 1.0 | µA |
| Shutdown mode supply current | $I_{OFF}$ | V1/2/3 = 1.8 V, $V_{DD}$ = 3 V | | 5 | 10 | µA |
| Turn-on switching time[2] | $t_{ON}$ | 50% of final control voltage to 90% of final RF power, switching between RF1/2/3/4/5/6 | | 1.75 | | µs |
| ***RF Specifications (Pins De-Embedded)*[2]** | | | | | | |
| Insertion loss (RFC pin to RF1/2/3/4/5/6 pins) | IL | 5 to 200 MHz<br>0.2 to 1.5 GHz | | 0.4<br>0.45 | | dB<br>dB |
| Isolation (RFC pin to RF1/2/3/4/5/6 pins) | Iso | 5 to 200 MHz<br>0.2 to 1.5 GHz | | 39<br>28 | | dB<br>dB |
| Return loss (RFC pin to RF1/2/3/4/5/6 pins) | RL | 5 to 200 MHz<br>0.2 to 1.5 GHz | | 27<br>25 | | dB<br>dB |
| 2nd harmonics (RFC pin to RF1/2/3/4/5/6 pins) | 2fo | $P_{IN}$ = +73 dBmV, 5 MHz to 1.5 GHz | | 96 | | dBc |
| 3rd harmonics (RFC pin to RF1/2/3/4/5/6 pins) | 3fo | $P_{IN}$ = +73 dBmV, 5 MHz to 1.5 GHz | | 99 | | dBc |
| 0.1 dB compression point (RFC pin to RF1/2/3/4/5/6 pins) | P0.1dB | 0.1 @ 1.0 GHz | | +84.5 | | dBmV |
| CTB | | 79 channels, +45 dBmV per channel output power | | -100 | | dBc |
| CSO | | 79 channels, +45 dBmV per channel output power | | -100 | | dBc |
| ***Typical RF Performance (Measured in EVB*[2]** | | | | | | |
| Insertion loss (RFC port to RF1/2/3/4/5/6 ports) | IL-EVB | 5 to 200 MHz<br>0.2 to 1.5 GHz | | 0.7<br>1.1 | | dB<br>dB |
| Return loss (RFC port to RF1/2/3/4/5/6 ports) | RL-EVB | 5 to 200 MHz<br>0.2 to 1.5 GHz | | -20<br>-15 | | dB<br>dB |

1 Performance is guaranteed.
2 Typical performance only; not guaranteed.

**Table 4. SKY13642-485LF Control Logic[1]**

| Control Pins | | | RFC to Switched RF Outputs | | | | | |
|---|---|---|---|---|---|---|---|---|
| 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) |
| 0 | 0 | 0 | **Insertion Loss** | Isolation | Isolation | Isolation | Isolation | Isolation |
| 0 | 0 | 1 | Isolation | **Insertion Loss** | Isolation | Isolation | Isolation | Isolation |
| 0 | 1 | 0 | Isolation | Isolation | **Insertion Loss** | Isolation | Isolation | Isolation |
| 0 | 1 | 1 | Isolation | Isolation | Isolation | **Insertion Loss** | Isolation | Isolation |
| 1 | 0 | 0 | Isolation | Isolation | Isolation | Isolation | **Insertion Loss** | Isolation |
| 1 | 0 | 1 | Isolation | Isolation | Isolation | Isolation | Isolation | **Insertion Loss** |
| 1 | 1 | 0 | Isolation | Isolation | **Insertion Loss** | Isolation | **Insertion Loss** | Isolation |
| 1 | 1 | 1 | Shutdown Mode | | | | | |

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. Insertion loss in V1/V2/V3 = 110b state is 3 dB lower than typical insertion loss.



**Table 5. Isolation Matrix (Common Port RFC ↔ Output Port N) (1 of 2)**

| Selected Output Port | Frequency (MHz) | *Isolation (Common Port RFC ↔ Output Port N) (typical) (dB)* | | | | | |
|---|---|---|---|---|---|---|---|
| | | RF1 | RF2 | RF3 | RF4 | RF5 | RF6 |
| RF1 | 50 | Insertion Loss | -75 | -72 | -70 | -66 | -65 |
| RF1 | 250 | Insertion Loss | -61 | -62 | -57 | -53 | -52 |
| RF1 | 500 | Insertion Loss | -54 | -53 | -50 | -47 | -45 |
| RF1 | 750 | Insertion Loss | -52 | -48 | -48 | -44 | -44 |
| RF1 | 1000 | Insertion Loss | -49 | -44 | -46 | -41 | -42 |
| RF1 | 1250 | Insertion Loss | -45 | -41 | -42 | -37 | -39 |
| RF1 | 1500 | Insertion Loss | -46 | -45 | -42 | -37 | -39 |
| RF2 | 50 | -75 | Insertion Loss | -69 | -71 | -65 | -68 |
| RF2 | 250 | -60 | Insertion Loss | -55 | -59 | -51 | -55 |
| RF2 | 500 | -54 | Insertion Loss | -48 | -50 | -44 | -48 |
| RF2 | 750 | -51 | Insertion Loss | -47 | -47 | -43 | -45 |
| RF2 | 1000 | -49 | Insertion Loss | -45 | -44 | -41 | -42 |
| RF2 | 1250 | -45 | Insertion Loss | -41 | -42 | -38 | -37 |
| RF2 | 1500 | -45 | Insertion Loss | -42 | -46 | -38 | -38 |
| RF3 | 50 | -69 | -75 | Insertion Loss | -71 | -76 | -66 |
| RF3 | 250 | -57 | -60 | Insertion Loss | -57 | -73 | -52 |
| RF3 | 500 | -48 | -54 | Insertion Loss | -50 | -56 | -46 |
| RF3 | 750 | -45 | -51 | Insertion Loss | -48 | -48 | -44 |
| RF3 | 1000 | -43 | -49 | Insertion Loss | -46 | -43 | -43 |
| RF3 | 1250 | -42 | -45 | Insertion Loss | -42 | -38 | -39 |
| RF3 | 1500 | -47 | -45 | Insertion Loss | -43 | -38 | -39 |

**Table 5. Isolation Matrix (Common Port RFC ↔ Output Port N) (2 of 2)**

| Selected Output Port | Frequency (MHz) | *Isolation (Common Port RFC ↔ Output Port N) (typical) (dB)* | | | | | |
|---|---|---|---|---|---|---|---|
| | | RF1 | RF2 | RF3 | RF4 | RF5 | RF6 |
| RF4 | 50 | -73 | -68 | -70 | Insertion Loss | -66 | -74 |
| RF4 | 250 | -59 | -55 | -56 | Insertion Loss | -52 | -73 |
| RF4 | 500 | -53 | -47 | -48 | Insertion Loss | -45 | -57 |
| RF4 | 750 | -51 | -44 | -47 | Insertion Loss | -43 | -49 |
| RF4 | 1000 | -48 | -43 | -45 | Insertion Loss | -41 | -43 |
| RF4 | 1250 | -44 | -42 | -42 | Insertion Loss | -38 | -38 |
| RF4 | 1500 | -45 | -49 | -42 | Insertion Loss | -38 | -39 |
| RF5 | 50 | -77 | -75 | -69 | -72 | Insertion Loss | -68 |
| RF5 | 250 | -72 | -61 | -57 | -58 | Insertion Loss | -54 |
| RF5 | 500 | -61 | -54 | -49 | -51 | Insertion Loss | -47 |
| RF5 | 750 | -54 | -52 | -45 | -49 | Insertion Loss | -45 |
| RF5 | 1000 | -48 | -49 | -43 | -47 | Insertion Loss | -43 |
| RF5 | 1250 | -43 | -45 | -41 | -43 | Insertion Loss | -40 |
| RF5 | 1500 | -44 | -46 | -45 | -43 | Insertion Loss | -40 |
| RF6 | 50 | -72 | -77 | -70 | -70 | -67 | Insertion Loss |
| RF6 | 250 | -60 | -72 | -56 | -56 | -53 | Insertion Loss |
| RF6 | 500 | -53 | -62 | -49 | -48 | -46 | Insertion Loss |
| RF6 | 750 | -51 | -53 | -48 | -45 | -44 | Insertion Loss |
| RF6 | 1000 | -49 | -48 | -46 | -44 | -42 | Insertion Loss |
| RF6 | 1250 | -45 | -44 | -42 | -42 | -39 | Insertion Loss |
| RF6 | 1500 | -45 | -45 | -42 | -48 | -39 | Insertion Loss |

**Table 6. Isolation Matrix (Selected Output Port ↔ Output Port N) (1 of 2)**

| Selected Output Port | Frequency (MHz) | *Isolation (Selected Output Port ↔ Output Port N) (typical) (dB)* | | | | | |
|---|---|---|---|---|---|---|---|
| | | RF1 | RF2 | RF3 | RF4 | RF5 | RF6 |
| RF1 | 50 | Common Port terminated | -83 | -59 | -83 | -72 | -71 |
| RF1 | 250 | Common Port terminated | -69 | -45 | -73 | -58 | -60 |
| RF1 | 500 | Common Port terminated | -62 | -39 | -63 | -51 | -52 |
| RF1 | 750 | Common Port terminated | -57 | -37 | -59 | -48 | -50 |
| RF1 | 1000 | Common Port terminated | -53 | -35 | -55 | -44 | -49 |
| RF1 | 1250 | Common Port terminated | -49 | -31 | -52 | -39 | -48 |
| RF1 | 1500 | Common Port terminated | -50 | -32 | -54 | -40 | -54 |
| RF2 | 50 | -85 | Common Port terminated | -79 | -59 | -68 | -69 |
| RF2 | 250 | -71 | Common Port terminated | -67 | -45 | -57 | -57 |
| RF2 | 500 | -63 | Common Port terminated | -58 | -38 | -50 | -49 |
| RF2 | 750 | -58 | Common Port terminated | -55 | -36 | -48 | -46 |
| RF2 | 1000 | -54 | Common Port terminated | -53 | -34 | -47 | -43 |
| RF2 | 1250 | -49 | Common Port terminated | -52 | -31 | -47 | -39 |
| RF2 | 1500 | -50 | Common Port terminated | -56 | -32 | -52 | -39 |
| RF3 | 50 | -58 | -85 | Common Port terminated | -83 | -62 | -73 |
| RF3 | 250 | -45 | -70 | Common Port terminated | -74 | -47 | -61 |
| RF3 | 500 | -38 | -63 | Common Port terminated | -64 | -40 | -53 |
| RF3 | 750 | -36 | -59 | Common Port terminated | -58 | -38 | -51 |
| RF3 | 1000 | -34 | -54 | Common Port terminated | -55 | -36 | -49 |
| RF3 | 1250 | -31 | -50 | Common Port terminated | -51 | -32 | -49 |
| RF3 | 1500 | -31 | -51 | Common Port terminated | -53 | -33 | -54 |

**Table 6. Isolation Matrix (Selected Output Port ↔ Output Port N) (2 of 2)**

| "ON" Port | Frequency (MHz) | *Isolation (Selected Output Port ↔ Output Port N) (typical) (dB)* | | | | | |
|---|---|---|---|---|---|---|---|
| | | RF1 | RF2 | RF3 | RF4 | RF5 | RF6 |
| RF4 | 50 | -95 | -58 | -81 | Common Port terminated | -71 | -61 |
| RF4 | 250 | -75 | -44 | -68 | Common Port terminated | -58 | -47 |
| RF4 | 500 | -66 | -37 | -60 | Common Port terminated | -50 | -40 |
| RF4 | 750 | -60 | -35 | -57 | Common Port terminated | -49 | -38 |
| RF4 | 1000 | -55 | -33 | -54 | Common Port terminated | -47 | -36 |
| RF4 | 1250 | -50 | -31 | -52 | Common Port terminated | -47 | -32 |
| RF4 | 1500 | -51 | -31 | -55 | Common Port terminated | -51 | -33 |
| RF5 | 50 | -64 | -85 | -58 | -92 | Common Port terminated | -76 |
| RF5 | 250 | -50 | -68 | -45 | -81 | Common Port terminated | -64 |
| RF5 | 500 | -44 | -61 | -38 | -66 | Common Port terminated | -56 |
| RF5 | 750 | -42 | -58 | -36 | -59 | Common Port terminated | -53 |
| RF5 | 1000 | -40 | -53 | -34 | -54 | Common Port terminated | -50 |
| RF5 | 1250 | -36 | -49 | -31 | -50 | Common Port terminated | -48 |
| RF5 | 1500 | -37 | -50 | -31 | -51 | Common Port terminated | -51 |
| RF6 | 50 | -90 | -63 | -82 | -58 | -73 | Common Port terminated |
| RF6 | 250 | -72 | -50 | -72 | -44 | -61 | Common Port terminated |
| RF6 | 500 | -64 | -43 | -63 | -38 | -53 | Common Port terminated |
| RF6 | 750 | -59 | -41 | -58 | -36 | -50 | Common Port terminated |
| RF6 | 1000 | -54 | -39 | -54 | -34 | -49 | Common Port terminated |
| RF6 | 1250 | -50 | -36 | -51 | -31 | -47 | Common Port terminated |
| RF6 | 1500 | -51 | -37 | -53 | -31 | -52 | Common Port terminated |

## Evaluation Board Description

The SKY13642-485LF Evaluation Board is used to test the performance of the SKY13642-485LF SP6T Switch.

An Evaluation Board schematic diagram is provided in Figure 3. An assembly drawing for the Evaluation Board is shown in Figure 4. A photograph of a typical Evaluation Board is shown in Figure 5. Table 7 lists the Bill of Materials (BOM) for the Evaluation Board.

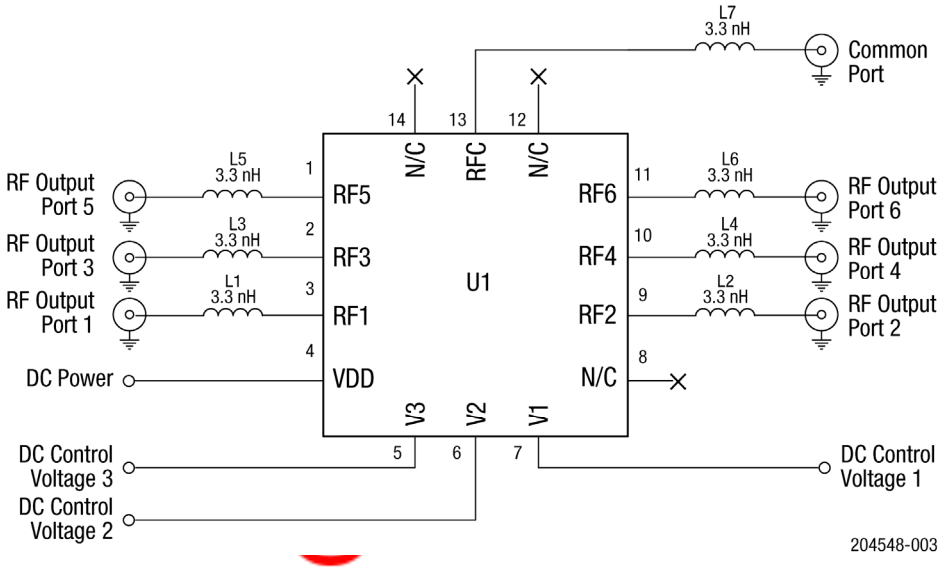



**Figure 3. SKY13642-485LF Evaluation Board Schematic**

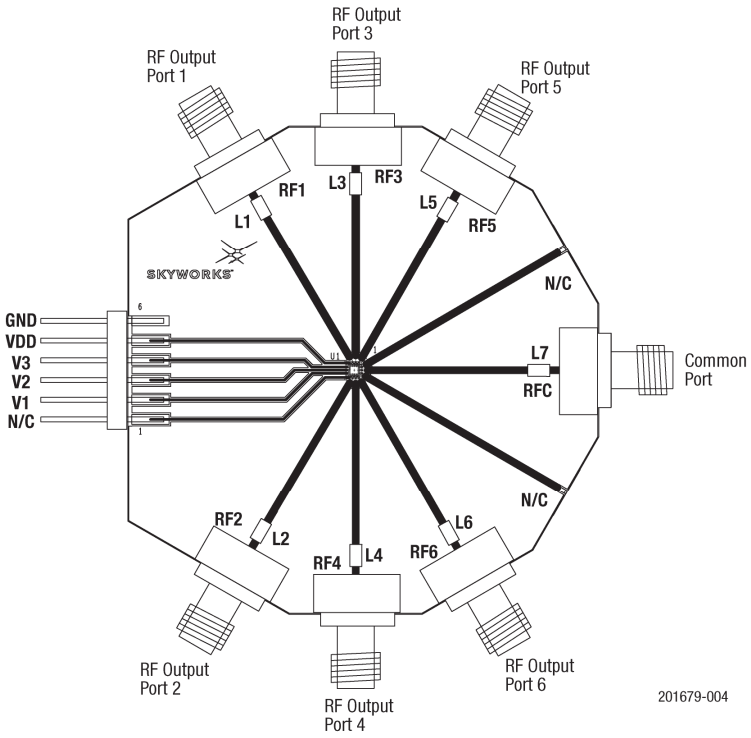



**Figure 4. SKY13642-485LF Evaluation Board Assembly Diagram**

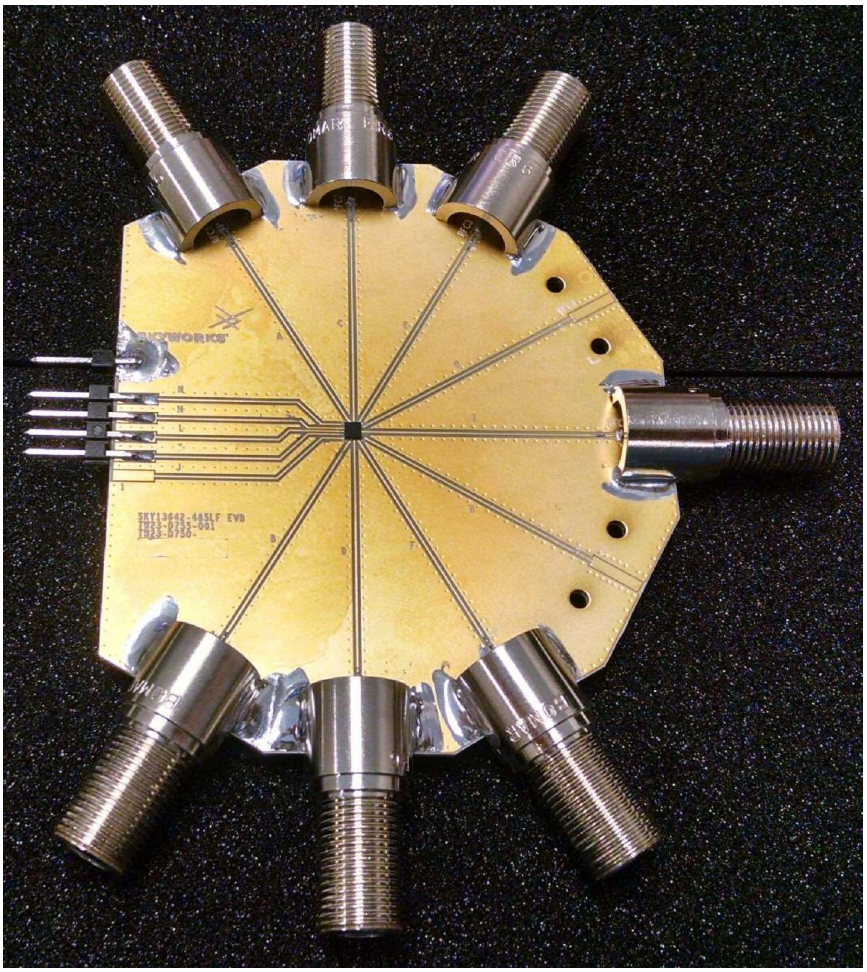


**Figure 5. SKY13642-485LF Evaluation Board Photograph**

**Table 7. SKY13642-485LF Bill of Materials (BOM)**

| Component | Description | Value | Mfr Part Number | Vendor |
|---|---|---|---|---|
| J1 | Header, in-line | 5 pos. | 5-146280-5 | TE Connectivity |
| L1 - L7 | Inductor, 0201 | 3.3 nH | LQP03TN3N3B00D | Murata |
| RFC - RF7 | Connector, F | 75 Ω | 861V509ER6 | Bomar Interconnect |
| PCB | | | PTW23-D755-001 | South Coast Circuits |
| U1 | RF Switch, SP6T | 75 Ω | SKY13642-485LF | Skyworks |

## Package Dimensions

The PCB layout footprint for the SKY13642-485LF is provided in Figure 6. Typical part markings are shown in Figure 7. Package dimensions are shown in Figure 8, and tape and reel dimensions are provided in Figure 9.

## 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 SKY13642-485LF 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.



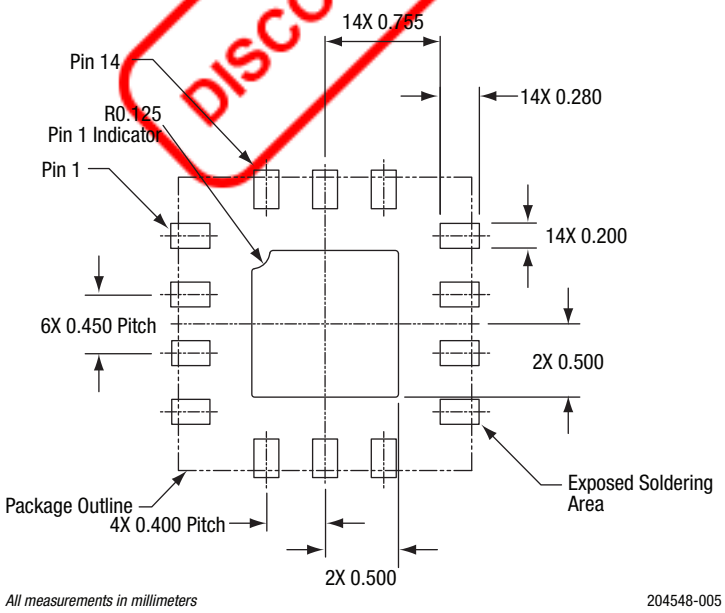



**Figure 6. SKY13642-485LF PCB Layout Footprint (Top View)**

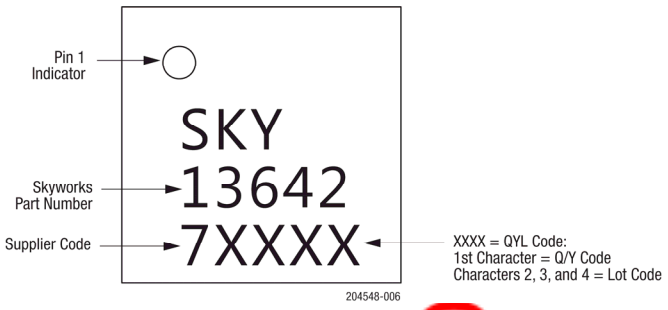
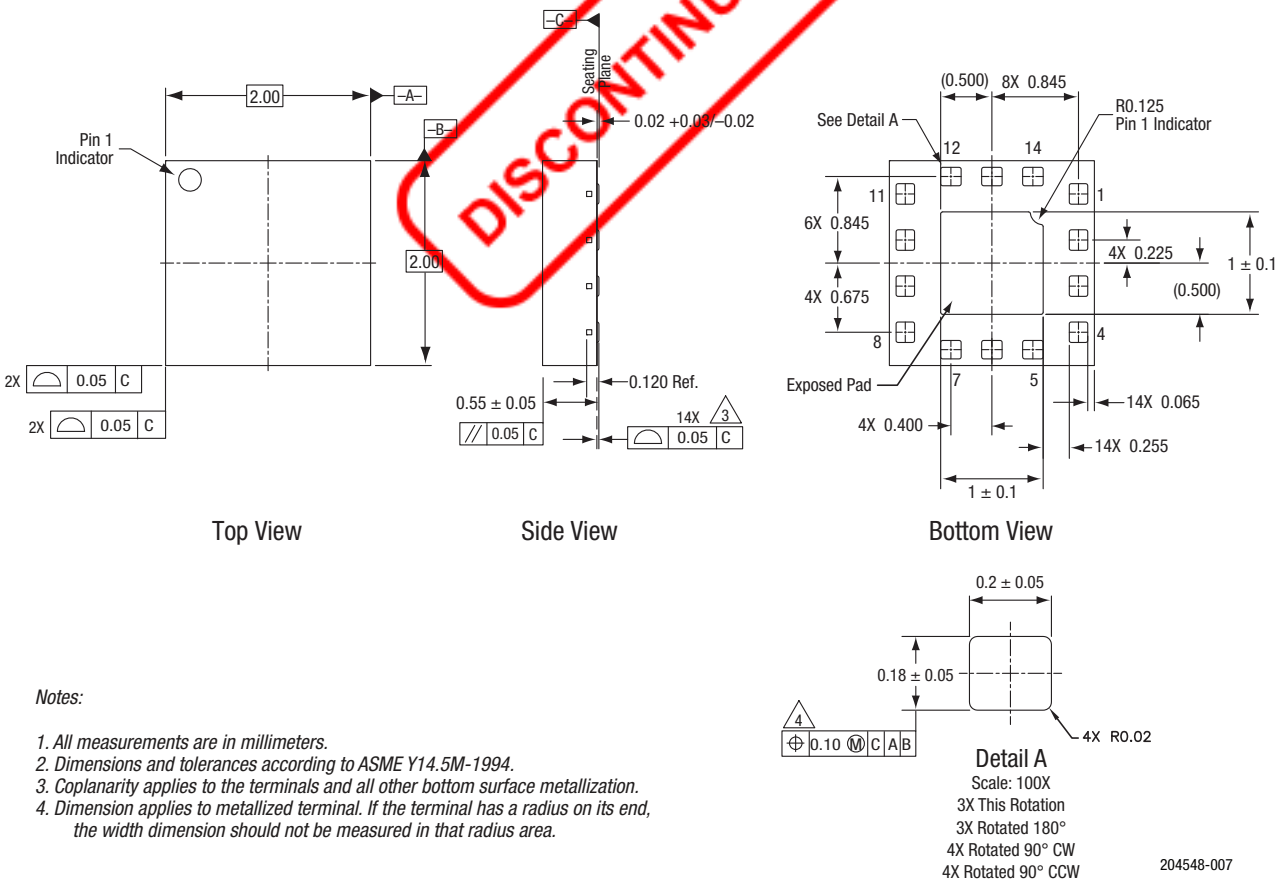



**Figure 7. Typical Part Markings (Top View)**

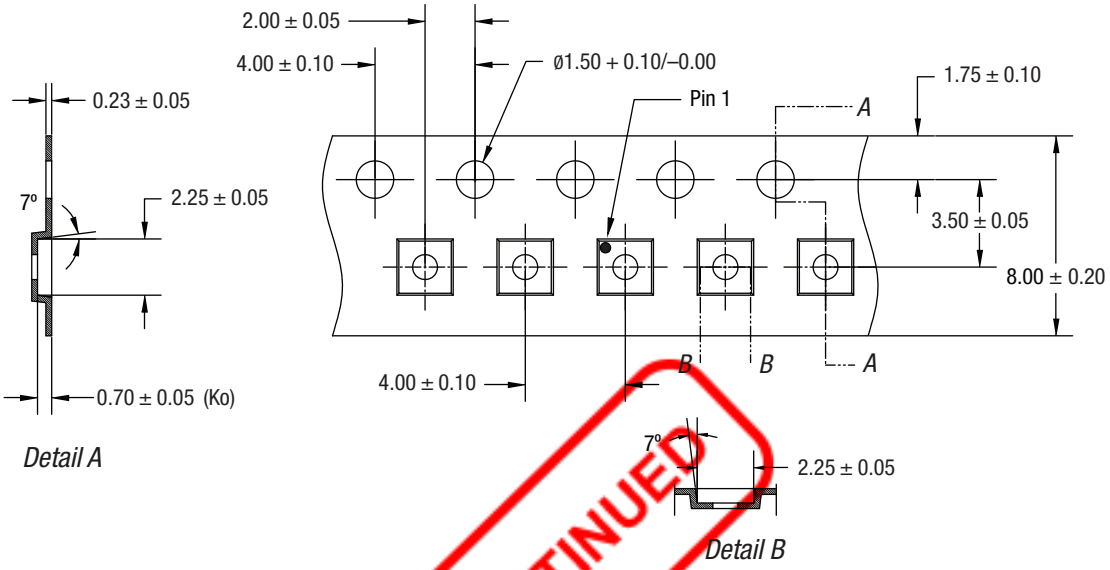





*Notes:*

*1. All measurements are in millimeters.*
*2. Dimensions and tolerances according to ASME Y14.5M-1994.*
*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 width dimension should not be measured in that radius area.*

**Figure 8. SKY13642-485LF Package Dimensions**






*Notes:*

1. *Carrier tape must meet all requirements of Skyworks GP01-D232 procurement spec for tape and reel shipping.*
2. *Carrier tape shall be black conductive polycarbonate bakeable material at 125 ˚C temperature.*
3. *Cover tape shall be transparent conductive with 5.40 mm width.*
4. *ESD-surface resistivity must meet all ESD requirements of Skyworks specified on GP01-D232.*
5. *All measurements are in millimeters.*

204548-008

**Figure 9. SKY13642-485LF Tape and Reel Dimensions**

## Ordering Information

| Part Number | Product Description | Evaluation Board Part Number |
|---|---|---|
| SKY13642-485LF | 5 MHz to 1.5 GHz Ultra-High-Linearity SP6T 75 Ω Switch | SKY13642-485LF-EVB |