DATA SHEET

# SKY13491-21: 0.7 to 2.7 GHz SP14T MIPI® Antenna Switch Module

## Applications

- 2G/3G/4G multimode cellular handsets (LTE, UMTS, CDMA2000, EDGE, GSM, TDD-LTE, TD-SCDMA)
- Embedded data cards

## Features

- Dedicated Band 7 TRX ports: 0.90 dB insertion loss @ 2.7 GHz
- High isolation and linearity
- Broadband frequency range: 0.7 to 2.7 GHz
- Twelve linear TRX ports
- Integrated low and high band GSM harmonic filters
- External MIPI select pin to enable multiple trigger controls
- Small MCM (22-pin, 2.5 x 2.9 x 0.8 mm) package (MSL3, 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.

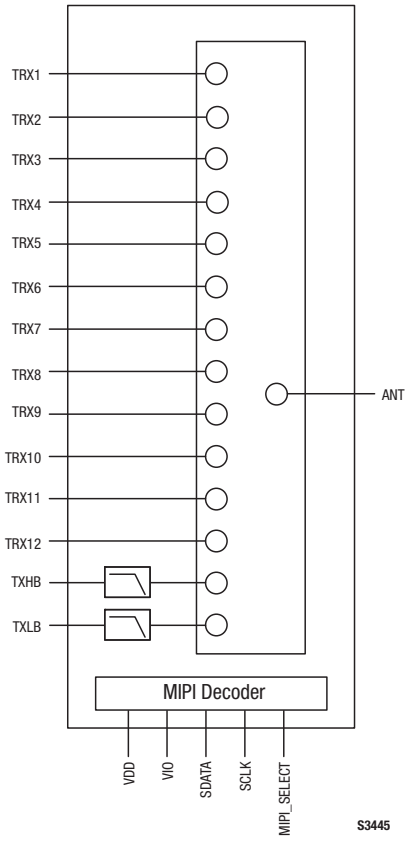



**Figure 1. SKY13491-21 Block Diagram**

## Description

The SKY13491-21 is a Single-Pole, Fourteen-Throw (SP14T) antenna switch with an integrated Mobile Industry Processor Interface (MIPI®) controller. Using an advanced switching technology, the SKY13491-21 maintains low insertion and high isolation, which makes it an ideal choice for UMTS, CDMA2000, EDGE, GSM, and LTE applications.

The design features two dedicated GSM transmit ports and three dedicated ultra low-loss TRX ports. The switch also has an excellent triple beat ratio and 2nd/3rd Order Intermodulation Distortion (IMD2/IMD3) performance.

Switching is controlled by the MIPI decoder. There is an external MIPI select pin that enables how the switch responds to power mode triggers. When this pin is grounded, the switch responds to any of the power mode triggers. When this pin is left open, the switch responds to individual power mode triggers. No external DC blocking capacitors are required on the RF paths as long as no DC voltage is applied.

The SKY13491-21 is manufactured in a compact, 2.5 x 2.9 x 0.8 mm, 22-pin surface mount Multi-Chip Module (MCM) 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.

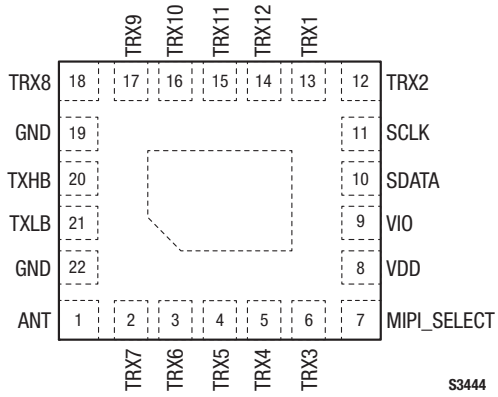



**Figure 2. SKY13491-21 Pinout – 22-Pin MCM (Top View)**

**Table 1. SKY13491-21 Signal Descriptions**

| Pin | Name | Description | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | ANT | Antenna port | 12 | TRX2 | Ultra low-loss 3G WCDMA transmit/receive port 2. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 2 | TRX7 | 3G WCDMA transmit/receive port 7. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. | 13 | TRX1 | Ultra low-loss 3G WCDMA transmit/receive port 1. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 3 | TRX6 | 3G WCDMA transmit/receive port 6. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. | 14 | TRX12 | 3G WCDMA transmit/receive port 12. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 4 | TRX5 | 3G WCDMA transmit/receive port 5. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. | 15 | TRX11 | 3G WCDMA transmit/receive port 11. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 5 | TRX4 | 3G WCDMA transmit/receive port 4. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. | 16 | TRX10 | 3G WCDMA transmit/receive port 10. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 6 | TRX3 | Ultra low-loss 3G WCDMA transmit/receive port 3. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. | 17 | TRX9 | 3G WCDMA transmit/receive port 9. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 7 | MIPI_SELECT | MIPI interface select. When this pin is grounded, the switch responds to any of the power mode triggers. When this pin is left open, the switch is RFFE MIPI compliant and responds to individual power mode triggers. | 18 | TRX8 | 3G WCDMA transmit/receive port 8. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 8 | VDD | DC power supply | 19 | GND | Ground |
| 9 | VIO | MIPI decoder enable/reference voltage | 20 | TXHB | GSM transmit high band. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 10 | SDATA | Data input/output | 21 | TXLB | GSM transmit low band. This pin either connected directly to or is disconnected from pin 1, depending on the applied control data. |
| 11 | SCLK | Clock signal | 22 | GND | Ground |

**Note**: Bottom ground paddles must be connected to ground.

**Table 2. SKY13491-21 Absolute Maximum Ratings**

| Parameter | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | 2.5 | 6.0 | V |
| MIPI decoder enable/reference voltage | VIO | | 2 | V |
| Clock signal voltage | SCLK | | VIO | V |
| Data signal voltage | SDATA | | VIO | V |
| RF input power:<br>LTX pin<br>HTX pin<br>All TRXx pins | $P_{IN}$ | | <br>+36<br>+34<br>+31 | <br>dBm<br>dBm<br>dBm |
| Storage temperature | $T_{STG}$ | –55 | +150 | °C |
| Operating temperature | $T_{OP}$ | –30 | +90 | °C |

**Note:** 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.*

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY13491-21 are provided in Table 2. Electrical specifications are provided in Tables 3 and 4.

IMD2 and IMD3 test conditions for various frequencies are listed in Tables 5 and 6, respectively.

Triple Beat Ratio (TBR) test conditions for bands 2 and 5 are listed in Table 7.

Figure 3 shows a timing diagram. Figure 4 illustrates the test setup used to measure intermodulation products. This industry standardized test is used to simulate the WCDMA Band 1 linearity of the antenna switch. A +20 dBm Continuous Wave (CW) signal, $f_{FUND}$, is sequentially applied to the TRX1 through TRX12 ports, while a –15 dBm CW blocker signal, $f_{BLK}$, is applied to the ANT port.

The resulting 3rd Order Intermodulation Distortion (IMD3), $f_{RX}$, is measured over all phases of $f_{FUND}$. The SKY13491-21 exhibits exceptional performance for all TRXx ports.

Table 8 shows the isolation matrix for "Ant" to "Off" arms. Table 9 shows the isolation matrix for "On" Arms to "Off" arms. Table 10 provides the matrix of insertion loss and return loss information. Table 11 describes the register content and programming read/write sequences. Refer to the *MIPI Alliance Specification for RF Front-End Control Interface (RFFE)*, v1.10 (26 July 2011) for additional information on MIPI programming sequences and MIPI bus specifications.

Figures 5 and 6 provide the timing diagrams for register write commands and read commands, respectively.

Table 12 provides the Register_0 logic. Table 13 describes the register parameters and bit values.

**Table 3. SKY13491-21 DC Electrical Specifications (Note 1)**
**($V_{DD}$ = 2.85 V, $T_{OP}$ = +25 °C, Characteristic Impedance [$Z_0$] = 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | | 2.50 | 2.85 | 6.00 | V |
| Supply current, active mode | $I_{DD}$ | | | 50 | 100 | µA |
| Interface supply voltage | VIO | | 1.65 | 1.80 | 1.95 | V |
| Interface signal:<br>High<br>Low | SDATA | | <br>0.8 × VIO | | <br><br>0.2 × VIO | <br>V<br>V |
| Control current:<br>High<br>Low | | | | | <br>5<br>5 | <br>µA<br>µA |

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

**Table 4. SKY13491-21 RF Electrical Specifications (Note 1) (1 of 2)**
**($V_{DD}$ = 2.85 V, $T_{OP}$ = +25 °C, Characteristic Impedance [$Z_0$] = 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| Operating frequency | f | | 0.7 | | 2.7 | GHz |
| Insertion loss | IL | TXLB, 824 to 915 MHz | | 1.25 | 1.45 | dB |
| | | TXHB, 1710 to 1910 MHz | | 1.25 | 1.45 | dB |
| | | TRX1 to TRX12 ports: | | | | |
| | | 700 to 824 MHz | | 0.70 | 0.80 | dB |
| | | 824 to 960 MHz | | 0.70 | 0.80 | dB |
| | | 1710 to 1990 MHz | | 0.75 | 1.00 | dB |
| | | TRX4 to TRX12 ports (except TRX7): | | | | |
| | | 2110 to 2170 MHz | | 0.80 | 1.05 | dB |
| | | 2300 to 2690 MHz | | 1.05 | 1.25 | dB |
| | | TRX1/2/3 ports: | | | | |
| | | 2110 to 2170 MHz | | 0.70 | 1.00 | dB |
| | | 2300 to 2690 MHz | | 0.90 | 1.05 | dB |
| | | TRX7 port: | | | | |
| | | 824 to 960 MHz | | 0.80 | 0.90 | dB |
| | | 1710 to 1990 MHz | | 0.85 | 1.15 | dB |
| | | 2110 to 2170 MHz | | 0.90 | 1.30 | dB |
| | | 2300 to 2690 MHz | | 1.15 | 1.30 | dB |
| GSM LB TX: | | | | | | |
| 2f0 attenuation | H2LB | 2f0 attenuation 1830 MHz | 23 | 28 | | dB |
| 3f0 attenuation | H3LB | 3f0 attenuation 2745 MHz | 23 | 28 | | dB |
| 4f0 attenuation | H4LB | 4f0 attenuation 3660 MHz | | 25 | | dB |
| GSM HB TX: | | | | | | |
| 2f0 attenuation | H2HB | 2f0 attenuation 3820 MHz | 21 | 28 | | dB |
| 3f0 attenuation | H3HB | 3f0 attenuation 5730 MHz | 15 | 28 | | dB |
| Isolation (TRXx to any off TRXx port [non-adjacent ports]) (See Table 8 for full matrix) | Iso | 824 to 1910 MHz | 23 | 28 | | dB |
| | | 1910 to 2690 MHz | 20 | 23 | | dB |
| Isolation (TRXx to any off TRXx port [adjacent ports]) (See Table 8 for full matrix) | Iso | 824 to 1910 MHz | 19 | 23 | | dB |
| | | 1910 to 2690 MHz | 16 | 20 | | dB |
| On state match | Return Loss | 0.7 to 2.7 GHz | | 14 | | dB |

**Table 4. SKY13491-21 RF Electrical Specifications (Note 1) (2 of 2)**
**($V_{DD}$ = 2.85 V, $T_{OP}$ = +25 °C, Characteristic Impedance [$Z_O$] = 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| GSM harmonics:<br>High band<br><br>Low band | 2fo, 3fo | <br>$P_{IN}$ = +33 dBm, 50 Ω<br>$P_{IN}$ = +33 dBm, 3:1 VSWR<br>$P_{IN}$ = +35 dBm, 50 Ω<br>$P_{IN}$ = +35 dBm, 3:1 VSWR | | <br>–45<br>–36<br>–45<br>–36 | <br>–38<br><br>–40<br> | <br>dBm<br>dBm<br>dBm<br>dBm |
| TRXx harmonics | 2fo, 3fo | $P_{IN}$ = +25 dBm, 50 Ω, f = 704 to 2700 MHz<br>$P_{IN}$ = +25 dBm, 5:1 VSWR, f = 704 to 2700 MHz | | –63 | –59<br>–40 | dBm<br>dBm |
| TRX1 through TRX10, band 13 2nd harmonics | 2fo | $P_{IN}$ = +25 dBm, f = 787 MHz | | –81 | –78 | dBm |
| 2nd Order Intermodulation Distortion | IMD2 | See test conditions in Table 5 | | –110 | –105 | dBm |
| 3rd Order Intermodulation Distortion | IMD3 | See test conditions in Table 6 | | –110 | –105 | dBm |
| Triple Beat Ratio:<br>650 to 900 MHz<br>1710 to 2155 MHz | TBR | See test conditions in Table 7 | <br>+81<br>+81 | | | <br>dBc<br>dBc |
| Turn-on time (See Figure 3) | $t_{ON}$ | From application of $V_{DD}$ and VIO | | | 20 | µs |
| Switching speed (See Figure 3) | $t_S$ | Port to port | | 2 | 5 | µs |

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

**Table 5. IMD2 Test Conditions**

| Band | Transmit Frequency (MHz) | Transmit Power (dBm) | Frequency Blocker, Low (MHz) | Frequency Blocker, High (MHz) | Power Blocker (dBm) | Receive Frequency (MHz) |
|---|---|---|---|---|---|---|
| 1 | 1950.0 | +20 | 190 | 4090 | –15 | 2140.0 |
| 2 | 1880.0 | | 80 | 3840 | | 1960.0 |
| 4 | 1732.0 | | 400 | 3864 | | 2132.0 |
| 5 | 836.5 | | 45 | 1718 | | 881.5 |
| 7 | 2535.0 | | 120 | 5187 | | 2655.0 |
| 8 | 897.0 | | 45 | 1839 | | 942.0 |

**Table 6. IMD3 Test Conditions**

| Band | Transmit Frequency (MHz) | Transmit Power (dBm) | Frequency Blocker (MHz) | Power Blocker (dBm) | Receive Frequency (MHz) |
|---|---|---|---|---|---|
| 1 | 1950.0 | +20 | 1760.0 | –15 | 2140.0 |
| 2 | 1880.0 | | 1800.0 | | 1960.0 |
| 4 | 1732.0 | | 1332.0 | | 2132.0 |
| 5 | 836.5 | | 791.5 | | 881.5 |
| 7 | 2535.0 | | 2415.0 | | 2655.0 |
| 8 | 897.0 | | 852.0 | | 942.0 |

**Table 7. Triple Beat Ratio Test Conditions**

| Band | Transmit Frequency 1 (MHz) | Transmit Power 1 (dBm) | Transmit Frequency 2 (MHz) | Transmit Power 2 (dBm) | Frequency Blocker @ ANT (MHz) | Power Blocker (dBm) | TBR Product Frequency (MHz) |
|---|---|---|---|---|---|---|---|
| 2 | 1880.0 | +21.5 | 1881.0 | +21.5 | 1960.0 | –30 | 1960.0 ± 1 |
| 5 | 836.5 | | 837.5 | | 881.5 | | 881.5 ± 1 |

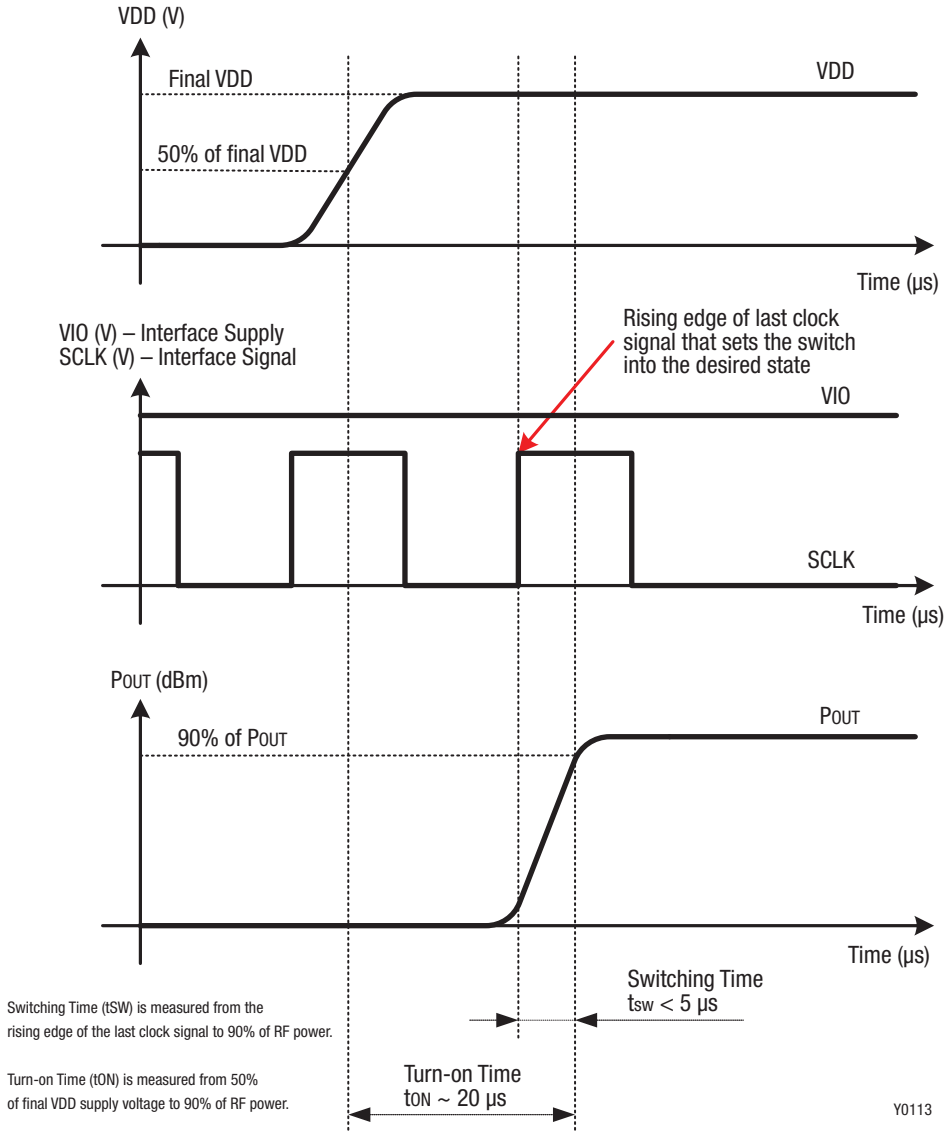



**Figure 3. SKY13491-21. Timing Diagram**

**Table 8. SKY13491-21: Isolation Matrix: Isolation "On" Arms to "Off" Arms (1 of 2)**

| | | Isolation (dB) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ON_Throw | freq_GHz | TXLB | TXHB | TRX1 | TRX2 | TRX3 | TRX4 | TRX5 | TRX6 | TRX7 | TRX8 | TRX9 | TRX10 | TRX11 | TRX12 |
| TXLB | 0.915 | | –32 | –52 | –49 | –48 | –44 | –42 | –43 | –42 | –45 | –47 | –50 | –50 | –51 |
| TXLB | 1.91 | | –26 | –49 | –49 | –43 | –42 | –46 | –41 | –39 | –36 | –38 | –42 | –44 | –47 |
| TXLB | 2.69 | | –17 | –45 | –44 | –42 | –40 | –41 | –37 | –35 | –32 | –34 | –38 | –40 | –43 |
| TXHB | 0.915 | –37 | | –47 | –45 | –52 | –53 | –53 | –49 | –46 | –37 | –41 | –43 | –53 | –49 |
| TXHB | 1.91 | –23 | | –40 | –37 | –44 | –44 | –44 | –41 | –38 | –32 | –35 | –37 | –55 | –46 |
| TXHB | 2.69 | –17 | | –49 | –43 | –53 | –53 | –52 | –46 | –52 | –33 | –35 | –40 | –34 | –42 |
| TRX1 | 0.915 | –35 | –50 | | –27 | –50 | –52 | –54 | –53 | –48 | –52 | –49 | –45 | –43 | –34 |
| TRX1 | 1.91 | –34 | –33 | | –20 | –41 | –42 | –42 | –43 | –38 | –41 | –40 | –38 | –35 | –27 |
| TRX1 | 2.69 | –28 | –29 | | –17 | –37 | –38 | –38 | –38 | –34 | –36 | –36 | –34 | –31 | –24 |
| TRX2 | 0.915 | –36 | –55 | –35 | | –48 | –51 | –53 | –53 | –48 | –53 | –51 | –47 | –45 | –38 |
| TRX2 | 1.91 | –34 | –35 | –27 | | –39 | –41 | –41 | –42 | –37 | –41 | –42 | –39 | –37 | –31 |
| TRX2 | 2.69 | –28 | –30 | –24 | | –36 | –37 | –37 | –37 | –34 | –36 | –37 | –35 | –33 | –27 |
| TRX3 | 0.915 | –33 | –56 | –51 | –48 | | –28 | –36 | –43 | –43 | –55 | –59 | –58 | –56 | –54 |
| TRX3 | 1.91 | –31 | –35 | –45 | –43 | | –23 | –30 | –35 | –34 | –43 | –47 | –47 | –45 | –46 |
| TRX3 | 2.69 | –27 | –31 | –39 | –35 | | –20 | –27 | –32 | –31 | –37 | –41 | –41 | –40 | –40 |
| TRX4 | 0.915 | –32 | –52 | –52 | –49 | –35 | | –29 | –38 | –41 | –55 | –59 | –58 | –55 | –54 |
| TRX4 | 1.91 | –31 | –36 | –44 | –41 | –28 | | –23 | –31 | –32 | –43 | –47 | –47 | –45 | –45 |
| TRX4 | 2.69 | –27 | –31 | –39 | –34 | –25 | | –20 | –28 | –29 | –37 | –41 | –41 | –39 | –40 |
| TRX5 | 0.915 | –33 | –48 | –52 | –49 | –42 | –35 | | –29 | –35 | –55 | –58 | –57 | –54 | –54 |
| TRX5 | 1.91 | –32 | –35 | –44 | –40 | –35 | –28 | | –22 | –28 | –43 | –46 | –46 | –44 | –44 |
| TRX5 | 2.69 | –28 | –32 | –39 | –35 | –32 | –25 | | –19 | –24 | –37 | –41 | –41 | –39 | –40 |
| TRX6 | 0.915 | –34 | –46 | –52 | –49 | –45 | –41 | –34 | | –30 | –54 | –56 | –55 | –53 | –53 |
| TRX6 | 1.91 | –34 | –35 | –43 | –40 | –38 | –34 | –27 | | –23 | –42 | –45 | –45 | –43 | –44 |
| TRX6 | 2.69 | –29 | –34 | –39 | –34 | –34 | –31 | –24 | | –19 | –36 | –40 | –40 | –38 | –39 |
| TRX7 | 0.915 | –35 | –44 | –51 | –49 | –47 | –45 | –39 | –36 | | –52 | –54 | –53 | –52 | –52 |
| TRX7 | 1.91 | –39 | –36 | –42 | –39 | –39 | –37 | –31 | –28 | | –41 | –43 | –43 | –42 | –42 |
| TRX7 | 2.69 | –30 | –36 | –38 | –34 | –35 | –33 | –28 | –25 | | –35 | –38 | –39 | –37 | –38 |
| TRX8 | 0.915 | –35 | –42 | –46 | –46 | –53 | –54 | –56 | –52 | –48 | | –30 | –35 | –38 | –43 |
| TRX8 | 1.91 | –46 | –36 | –38 | –36 | –43 | –44 | –44 | –43 | –38 | | –24 | –28 | –31 | –37 |
| TRX8 | 2.69 | –32 | –34 | –35 | –32 | –39 | –39 | –40 | –38 | –34 | | –20 | –25 | –27 | –33 |
| TRX9 | 0.915 | –35 | –44 | –44 | –44 | –53 | –55 | –56 | –52 | –49 | –37 | | –28 | –35 | –41 |
| TRX9 | 1.91 | –41 | –37 | –37 | –35 | –43 | –44 | –44 | –43 | –38 | –29 | | –22 | –28 | –35 |
| TRX9 | 2.69 | –31 | –45 | –33 | –31 | –39 | –39 | –40 | –38 | –34 | –25 | | –19 | –25 | –31 |

**Table 8. SKY13491-21: Isolation Matrix: Isolation "On" Arms to "Off" Arms (2 of 2)**

| | | Isolation (dB) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ON_Throw | freq_GHz | TXLB | TXHB | TRX1 | TRX2 | TRX3 | TRX4 | TRX5 | TRX6 | TRX7 | TRX8 | TRX9 | TRX10 | TRX11 | TRX12 |
| TRX10 | 0.915 | –35 | –45 | –41 | –43 | –53 | –55 | –56 | –52 | –49 | –40 | –33 | | –29 | –37 |
| TRX10 | 1.91 | –37 | –34 | –35 | –34 | –43 | –44 | –44 | –43 | –38 | –32 | –27 | | –23 | –31 |
| TRX10 | 2.69 | –31 | –33 | –32 | –31 | –39 | –39 | –39 | –38 | –34 | –28 | –24 | | –20 | –28 |
| TRX11 | 0.915 | –35 | –46 | –37 | –40 | –53 | –55 | –55 | –52 | –49 | –42 | –39 | –34 | | –30 |
| TRX11 | 1.91 | –35 | –32 | –31 | –32 | –43 | –44 | –44 | –43 | –38 | –33 | –31 | –28 | | –24 |
| TRX11 | 2.69 | –29 | –30 | –28 | –29 | –39 | –39 | –39 | –38 | –34 | –29 | –28 | –25 | | –21 |
| TRX12 | 0.915 | –35 | –47 | –28 | –33 | –51 | –53 | –55 | –52 | –49 | –51 | –46 | –42 | –37 | |
| TRX12 | 1.91 | –35 | –33 | –22 | –25 | –42 | –43 | –43 | –43 | –38 | –40 | –38 | –35 | –30 | |
| TRX12 | 2.69 | –29 | –29 | –19 | –21 | –38 | –39 | –39 | –38 | –34 | –35 | –34 | –32 | –26 | |

**Table 9. SKY13491-21 Isolation Matrix: Isolation "Ant" to "Off" Arms (1 of 2)**
**($V_{DD}$ = 2.85 V, $T_{OP}$=+25 °C, Characteristic Impedance [Z0] = 50 Ω, Unless Otherwise Noted)**

| | | Isolation (dB) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ON_Throw | freq_GHz | TXLB | TXHB | TRX1 | TRX2 | TRX3 | TRX4 | TRX5 | TRX6 | TRX7 | TRX8 | TRX9 | TRX10 | TRX11 | TRX12 |
| ANT | 0.915 | | –33 | –47 | –46 | –40 | –39 | –40 | –38 | –35 | –41 | –43 | –45 | –46 | –47 |
| ANT | 1.91 | | –43 | –51 | –50 | –45 | –41 | –34 | –32 | –33 | –42 | –44 | –47 | –49 | –50 |
| ANT | 2.69 | | –35 | –46 | –41 | –43 | –39 | –33 | –31 | –33 | –41 | –43 | –45 | –45 | –46 |
| ANT | 0.915 | –44 | | –49 | –46 | –46 | –45 | –43 | –41 | –39 | –42 | –45 | –47 | –44 | –47 |
| ANT | 1.91 | –24 | | –40 | –37 | –39 | –38 | –36 | –34 | –32 | –31 | –34 | –37 | –36 | –39 |
| ANT | 2.69 | –21 | | –38 | –34 | –37 | –35 | –33 | –31 | –33 | –28 | –32 | –34 | –38 | –40 |
| ANT | 0.915 | –38 | –35 | | –33 | –49 | –46 | –45 | –42 | –40 | –46 | –50 | –53 | –49 | –43 |
| ANT | 1.91 | –33 | –31 | | –26 | –40 | –39 | –38 | –36 | –33 | –38 | –41 | –42 | –38 | –31 |
| ANT | 2.69 | –28 | –31 | | –21 | –37 | –36 | –36 | –33 | –30 | –34 | –37 | –37 | –34 | –27 |
| ANT | 0.915 | –37 | –34 | –43 | | –50 | –47 | –46 | –43 | –40 | –46 | –49 | –52 | –50 | –45 |
| ANT | 1.91 | –33 | –30 | –32 | | –41 | –39 | –39 | –36 | –33 | –38 | –41 | –42 | –39 | –34 |
| ANT | 2.69 | –28 | –34 | –27 | | –37 | –36 | –36 | –33 | –29 | –34 | –37 | –38 | –34 | –29 |
| ANT | 0.915 | –37 | –36 | –50 | –48 | | –34 | –41 | –47 | –41 | –45 | –46 | –47 | –47 | –48 |
| ANT | 1.91 | –31 | –32 | –39 | –35 | | –29 | –35 | –37 | –32 | –38 | –39 | –40 | –39 | –40 |
| ANT | 2.69 | –27 | –37 | –36 | –32 | | –24 | –30 | –32 | –28 | –34 | –36 | –37 | –36 | –36 |
| ANT | 0.915 | –36 | –36 | –49 | –48 | –44 | | –33 | –43 | –42 | –45 | –46 | –47 | –47 | –48 |
| ANT | 1.91 | –31 | –33 | –40 | –36 | –32 | | –28 | –35 | –32 | –38 | –39 | –40 | –39 | –40 |
| ANT | 2.69 | –27 | –38 | –36 | –32 | –28 | | –23 | –30 | –27 | –34 | –36 | –37 | –36 | –37 |

**Table 9. SKY13491-21 Isolation Matrix: Isolation "Ant" to "Off" Arms (2 of 2)**
**($V_{DD}$ = 2.85 V, $T_{OP}$=+25 °C, Characteristic Impedance [Z0] = 50 Ω, Unless Otherwise Noted)**

| | | Isolation (dB) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ON_Throw | freq_GHz | TXLB | TXHB | TRX1 | TRX2 | TRX3 | TRX4 | TRX5 | TRX6 | TRX7 | TRX8 | TRX9 | TRX10 | TRX11 | TRX12 |
| ANT | 0.915 | –38 | –37 | –49 | –48 | –50 | –43 | | –35 | –40 | –45 | –46 | –47 | –47 | –49 |
| ANT | 1.91 | –32 | –33 | –41 | –37 | –39 | –34 | | –29 | –30 | –38 | –40 | –40 | –40 | –41 |
| ANT | 2.69 | –27 | –41 | –37 | –33 | –35 | –29 | | –24 | –25 | –34 | –36 | –37 | –36 | –37 |
| ANT | 0.915 | –39 | –38 | –50 | –48 | –52 | –50 | –44 | | –37 | –46 | –47 | –48 | –48 | –49 |
| ANT | 1.91 | –33 | –34 | –41 | –38 | –40 | –39 | –32 | | –28 | –38 | –40 | –41 | –40 | –41 |
| ANT | 2.69 | –27 | –45 | –37 | –33 | –36 | –34 | –28 | | –23 | –34 | –36 | –37 | –36 | –37 |
| ANT | 0.915 | –42 | –39 | –50 | –48 | –50 | –50 | –45 | –42 | | –47 | –48 | –49 | –49 | –50 |
| ANT | 1.91 | –36 | –34 | –41 | –38 | –40 | –39 | –34 | –31 | | –38 | –40 | –41 | –40 | –41 |
| ANT | 2.69 | –28 | –45 | –37 | –33 | –36 | –35 | –30 | –27 | | –33 | –36 | –37 | –36 | –37 |
| ANT | 0.915 | –41 | –34 | –55 | –50 | –47 | –45 | –44 | –42 | –40 | | –37 | –46 | –48 | –54 |
| ANT | 1.91 | –36 | –29 | –43 | –39 | –40 | –38 | –37 | –35 | –33 | | –31 | –36 | –36 | –43 |
| ANT | 2.69 | –28 | –27 | –38 | –33 | –36 | –35 | –34 | –32 | –30 | | –26 | –31 | –31 | –38 |
| ANT | 0.915 | –40 | –36 | –53 | –50 | –47 | –45 | –43 | –41 | –40 | –41 | | –34 | –45 | –49 |
| ANT | 1.91 | –36 | –32 | –43 | –40 | –40 | –38 | –37 | –35 | –33 | –30 | | –29 | –36 | –42 |
| ANT | 2.69 | –28 | –37 | –38 | –34 | –36 | –35 | –34 | –32 | –30 | –26 | | –25 | –30 | –37 |
| ANT | 0.915 | –39 | –36 | –49 | –49 | –47 | –45 | –43 | –41 | –40 | –43 | –44 | | –36 | –43 |
| ANT | 1.91 | –35 | –33 | –42 | –39 | –40 | –38 | –37 | –35 | –33 | –33 | –33 | | –30 | –38 |
| ANT | 2.69 | –28 | –40 | –37 | –33 | –36 | –35 | –34 | –32 | –30 | –28 | –28 | | –26 | –34 |
| ANT | 0.915 | –39 | –35 | –42 | –46 | –47 | –45 | –44 | –42 | –40 | –42 | –46 | –46 | | –34 |
| ANT | 1.91 | –34 | –32 | –37 | –38 | –40 | –38 | –37 | –35 | –33 | –33 | –35 | –33 | | –29 |
| ANT | 2.69 | –28 | –35 | –32 | –32 | –36 | –35 | –35 | –33 | –30 | –28 | –31 | –29 | | –25 |
| ANT | 0.915 | –38 | –35 | –34 | –40 | –48 | –46 | –44 | –42 | –40 | –46 | –52 | –50 | –45 | |
| ANT | 1.91 | –33 | –32 | –29 | –30 | –40 | –39 | –38 | –36 | –33 | –38 | –41 | –40 | –34 | |
| ANT | 2.69 | –28 | –31 | –24 | –24 | –37 | –36 | –35 | –33 | –30 | –34 | –36 | –36 | –30 | |

**Table 10. SKY13491-21: Insertion loss and Return loss Matrix (1 of 2)**
**($V_{DD}$ = 2.85 V, $T_{OP}$=+25 °C, Characteristic Impedance [Z0]=50 Ω, Unless Otherwise Noted)**

| ON_Throw | freq_GHz | IL (dB) | RL_pole (dB) | RL_throw (dB) |
|---|---|---|---|---|
| TXLB | 0.915 | –1.3 | –15.6 | –18.5 |
| TXLB | 1.91 | –25.4 | –1.5 | -0.2 |
| TXLB | 2.69 | –28.9 | –2.2 | -0.5 |
| TXHB | 0.915 | -0.8 | –25.2 | –18.4 |
| TXHB | 1.91 | –1.3 | –15.6 | –16.1 |
| TXHB | 2.69 | -8.1 | –3.6 | –2.0 |
| TRX1 | 0.915 | -0.6 | –25.5 | –22.7 |
| TRX1 | 1.91 | -0.8 | –20.1 | –23.6 |
| TRX1 | 2.69 | -0.9 | –28.0 | –19.6 |
| TRX2 | 0.915 | -0.6 | –23.2 | –21.4 |

**Table 10. SKY13491-21: Insertion loss and Return loss Matrix (2 of 2)**
**($V_{DD}$ = 2.85 V, $T_{OP}$=+25 °C, Characteristic Impedance [Z0]=50 Ω, Unless Otherwise Noted)**

| ON_Throw | freq_GHz | IL (dB) | RL_pole (dB) | RL_throw (dB) |
|---|---|---|---|---|
| TRX2 | 1.91 | –0.7 | –22.7 | –28.7 |
| TRX2 | 2.69 | –0.9 | –25.4 | –19.8 |
| TRX3 | 0.915 | –0.6 | –23.1 | –21.7 |
| TRX3 | 1.91 | –0.7 | –21.5 | –24.9 |
| TRX3 | 2.69 | –0.9 | –26.0 | –18.8 |
| TRX4 | 0.915 | –0.6 | –24.2 | –23.5 |
| TRX4 | 1.91 | –0.7 | –19.7 | –22.5 |
| TRX4 | 2.69 | –0.9 | –33.2 | –21.2 |
| TRX5 | 0.915 | –0.5 | –27.3 | –27.7 |
| TRX5 | 1.91 | –0.8 | –17.4 | –20.1 |
| TRX5 | 2.69 | –0.9 | –25.2 | –27.8 |
| TRX6 | 0.915 | –0.5 | –27.7 | –29.3 |
| TRX6 | 1.91 | –0.8 | –15.4 | –17.2 |
| TRX6 | 2.69 | –0.9 | –19.3 | –22.3 |
| TRX7 | 0.915 | –0.6 | –27.5 | –27.3 |
| TRX7 | 1.91 | –0.9 | –13.4 | –14.9 |
| TRX7 | 2.69 | –1.1 | –14.1 | –15.7 |
| TRX8 | 0.915 | –0.6 | –30.5 | –25.5 |
| TRX8 | 1.91 | –0.8 | –16.4 | –18.8 |
| TRX8 | 2.69 | –0.9 | –22.8 | –22.9 |
| TRX9 | 0.915 | –0.6 | –29.8 | –25.7 |
| TRX9 | 1.91 | –0.8 | –16.6 | –18.9 |
| TRX9 | 2.69 | –0.9 | –24.6 | –23.0 |
| TRX10 | 0.915 | –0.6 | –28.7 | –26.1 |
| TRX10 | 1.91 | –0.8 | –16.8 | –18.9 |
| TRX10 | 2.69 | –0.9 | –24.3 | –22.1 |
| TRX11 | 0.915 | –0.6 | –28.1 | –25.9 |
| TRX11 | 1.91 | –0.8 | –17.9 | –20.8 |
| TRX11 | 2.69 | –0.9 | –28.5 | –23.7 |
| TRX12 | 0.915 | –0.6 | –25.5 | –23.5 |
| TRX12 | 1.91 | –0.8 | –19.0 | –22.2 |
| TRX12 | 2.69 | –0.9 | –31.1 | –22.2 |

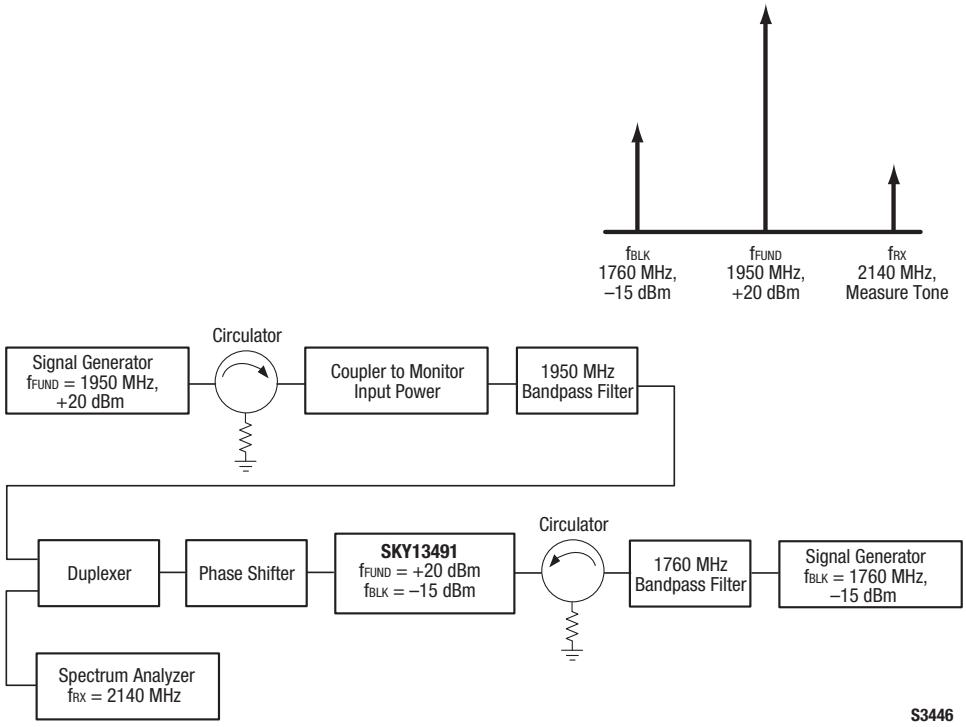



**Figure 4. 3rd Order Intermodulation Test Setup**

**Table 11. 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 | – | – | – | – | – | – |
| Reg 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
C = Command frame bits
DA = Data/address frame bits
BPC = Bus park cycle
BC = Byte count (# of consecutive addresses)

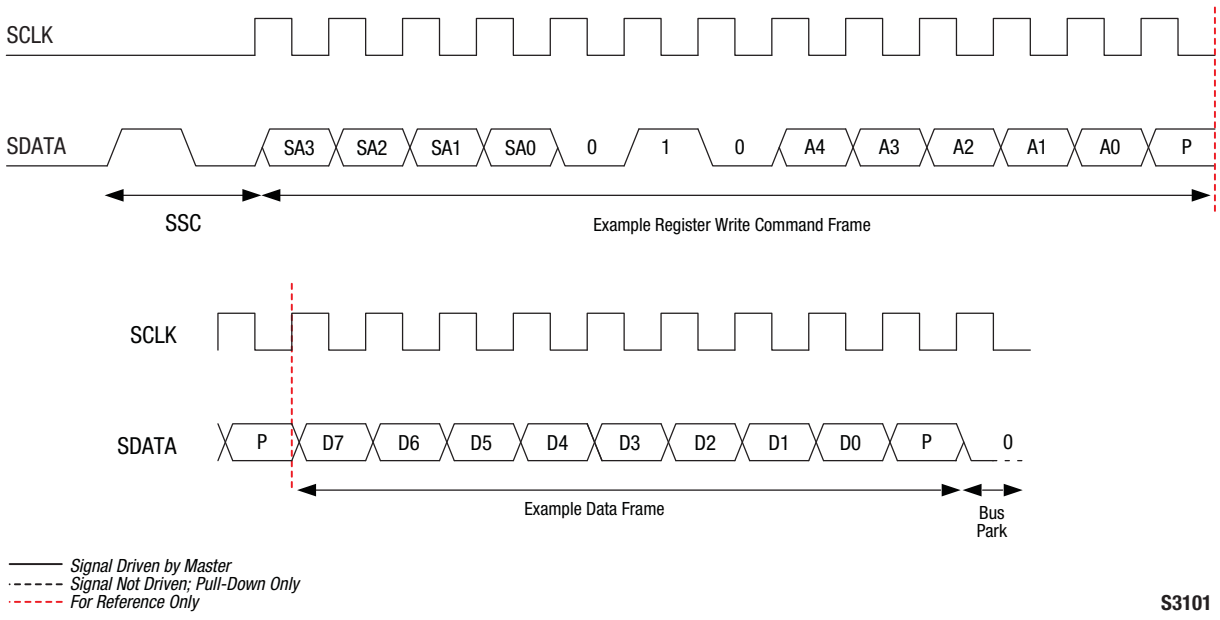



**Figure 5. Register Write Command Timing Diagram**

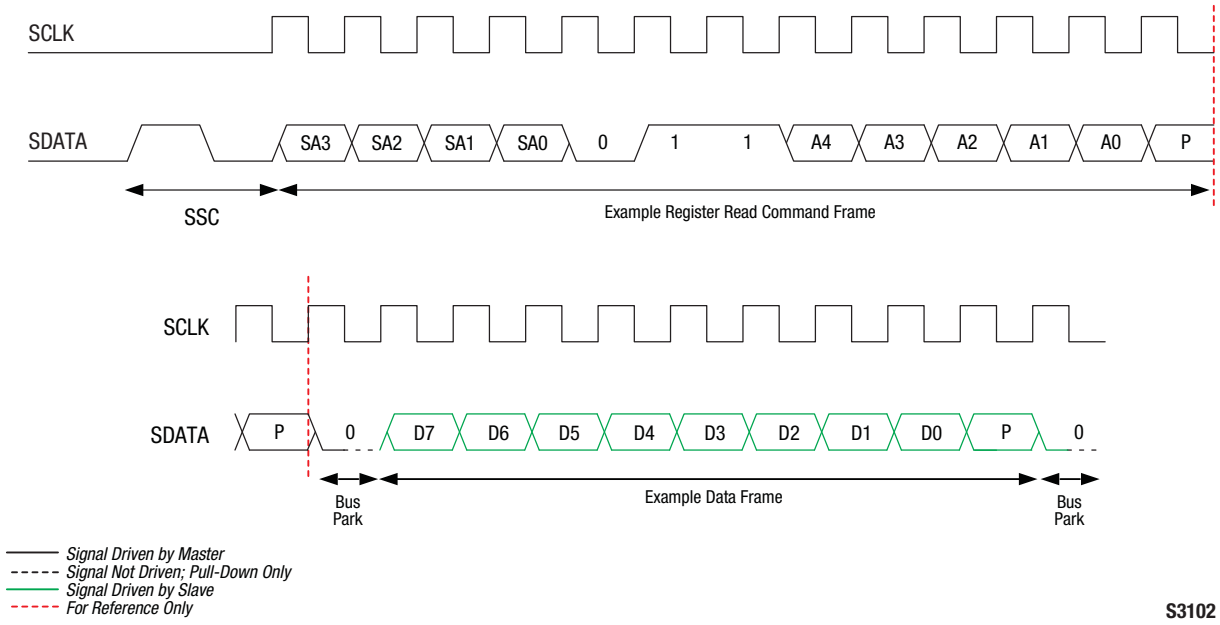



**Figure 6. Register Read Command Timing Diagram**

**Table 12. Register_0 Truth Table**

| Antenna Path | Register_0 Bits | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Bit[7] | Bit[6] | Bit[5] | Bit[4] | Bit[3] | Bit[2] | Bit[1] | Bit[0] |
| Sleep mode (standby) | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2G transmit low band | X | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2G transmit high band | X | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| TRX1 | X | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| TRX2 | X | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| TRX3 | X | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| TRX4 | X | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| TRX5 | X | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| TRX6 | X | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| TRX7 | X | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| TRX8 | X | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| TRX9 | X | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| TRX10 | X | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| TRX11 | X | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| TRX12 | X | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| Isolation mode (warm-up) | X | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Table 13. Register Description and Programming (1 of 2)**

| Register | | Parameter | Description | Default (Binary) |
|---|---|---|---|---|
| Name | Address (Hex) | | | |
| Register_0 | 0000 | MODE_CTRL | Bits[7:0]:<br>Switch control. See Table 8 for logic | – |
| RFFE_STATUS | 001A | SOFTWARE RESET | Bit[7]:<br>Resets all data to default values except for USID, GSID, or the contents of the PM_TRIG Register.<br>0 = Normal operation<br>1 = Software reset | 0 |
| | | COMMAND_FRAME_PARITY_ERR | Bit[6]:<br>Command sequence received with parity error – discard command. | 0 |
| | | COMMAND_LENGTH_ERR | Bit[5]:<br>Command length error. | 0 |
| | | ADDRESS_FRAME_PARITY_ERR | Bit[4]:<br>Address frame parity error = 1. | 0 |
| | | DATA_FRAME_PARITY_ERR | Bit[3]:<br>Data frame with parity error. | 0 |
| | | READ_UNUSED_REG | Bit[2]:<br>Read command to an invalid address. | 0 |
| | | WRITE_UNUSED_REG | Bit[1]:<br>Write command to an invalid address. | 0 |
| | | BID_GID_ERR | Bit[0]:<br>Read command with a BROADCAST_ID (refer to the *MIPI Alliance Specification*) or GSID. | 0 |
| GROUP_SID | 001B | Reserved | Bits[7:4]: Reserved | 0000 |
| | | GSID | Bits[3:0]:<br>Group slave ID | 0000 |

**Table 13. Register Description and Programming (2 of 2)**

| Register | | Parameter | Description | Default (Binary) |
|---|---|---|---|---|
| Name | Address (Hex) | | | |
| PM_TRIG (Note 1) | 001C | PWR_MODE | Bits[7:6]:<br>00 = Normal operation (active)<br>01 = Default settings (startup)<br>10 = Low power (low power)<br>11 = Reserved | 01 |
| | | Trigger_Mask_2 | Bit[5]:<br>If this bit is set, trigger 2 is disabled. When all triggers are disabled, if writing to a register that is associated with trigger 2, the data goes directly to the destination register. | 0 |
| | | Trigger_Mask_1 | Bit[4]:<br>If this bit is set, trigger 1 is disabled. When all triggers are disabled, if writing to a register that is associated with trigger 1, the data goes directly to the destination register. | 0 |
| | | Trigger_Mask_0 | Bit[3]:<br>If this bit is set, trigger 0 is disabled. When all triggers are disabled, if writing to a register that is associated with trigger 0, the data goes directly to the destination register. | 0 |
| | | Trigger_2 | Bit[2]:<br>If this bit is set, data is loaded into the trigger 2 registers. | 0 |
| | | Trigger_1 | Bit[1]:<br>If this bit is set, data is loaded into the trigger 1 registers (unsupported). | 0 |
| | | Trigger_0 | Bit[0]:<br>If this bit is set, data is loaded into the trigger 0 registers (unsupported). | 0 |
| PRODUCT_ID | 001D | PRODUCT_ID | Bits[7:0]:<br>This is a read-only register. However, during the programming of the Unique Slave Identifier (USID), a write command sequence is performed on this register but the value is not changed. | 01011101 |
| MANUFACTURER_ID | 001E | MANUFACTURER_ID | Bits[7:0]:<br>Read-only register | 10100101 |
| MAN_USID | 001F | Reserved | Bits[7:6]:<br>Reserved | 00 |
| | | MANUFACTURER_ID | Bits[5:4]:<br>Read-only register | 01 |
| | | USID | Bits[3:0]:<br>Programmable USID. A write to these bits programs the USID. | 1011 |

**Note 1**: Unlike the complete independence between triggers 0, 1, and 2, and also between the associated trigger masks 0, 1, and 2, respectively (as described in the MIPI RFFE Specification), when pin 7 is grounded, this device uses additional interactions between the provided trigger functions.

The delayed application of updated data to all triggerable registers in this device may be accomplished using any of the three triggers (0, 1, or 2), provided that the particular trigger used is not currently masked off. If multiple triggers are enabled, any or all of those are sufficient to cause the data to be transferred from shadow registers to destination registers for all triggerable registers in the device.

It is also necessary to disable all three triggers (i.e., set all three trigger masks) to ensure that data written to any triggerable register will immediately be written to the destination register at the conclusion of the RFFE command sequence where the data is written.

## Evaluation Board Description

The SKY13491-21 Evaluation Board is used to test the performance of the SKY13491-21 SP14T Switch. An Evaluation Board schematic diagram is provided in Figure 7. A recommended ESD protection circuit diagram is provided in Figure 8. An assembly drawing for the Evaluation Board is shown in Figure 9.

## Package Dimensions

The PCB layout footprint for the SKY13491-21 is provided in Figure 10. Typical case markings are shown in Figure 11. Package dimensions for the 22-pin MCM are shown in Figure 12, and tape and reel dimensions are provided in Figure 13.

## Package and Handling Information

Since the device package 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 SKY13491-21 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, *PCB Design and 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.

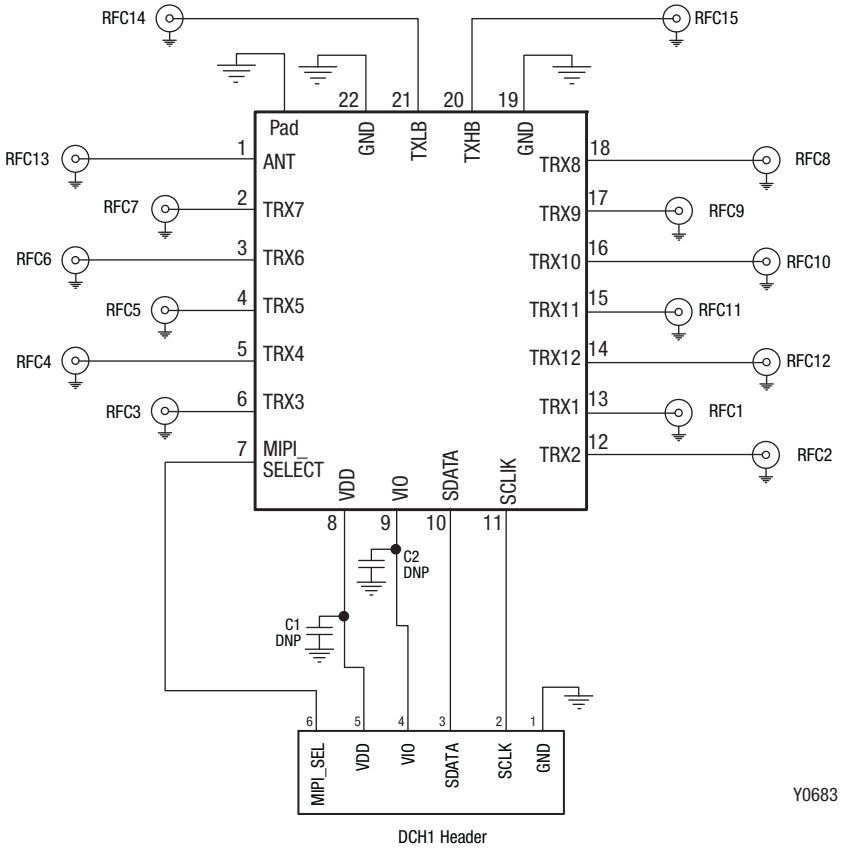
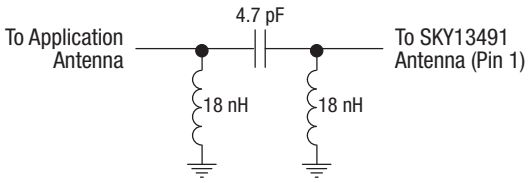
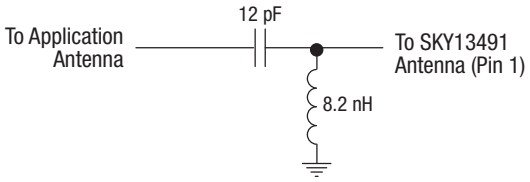



**Figure 7. SKY13491-21 Evaluation Board Schematic**




ESD Circuit 1




ESD Circuit 2

S3447

**Figure 8. SKY13491-21 Recommended ESD Protection Circuits**

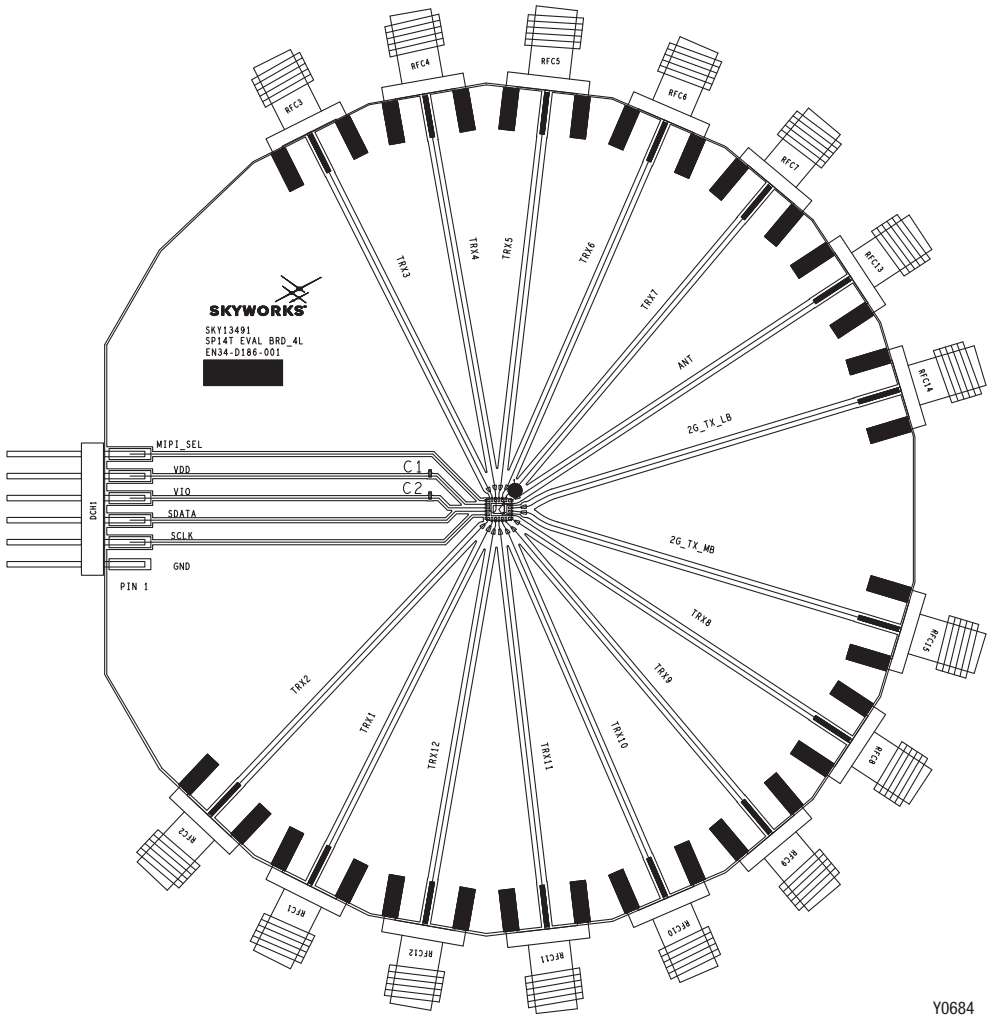
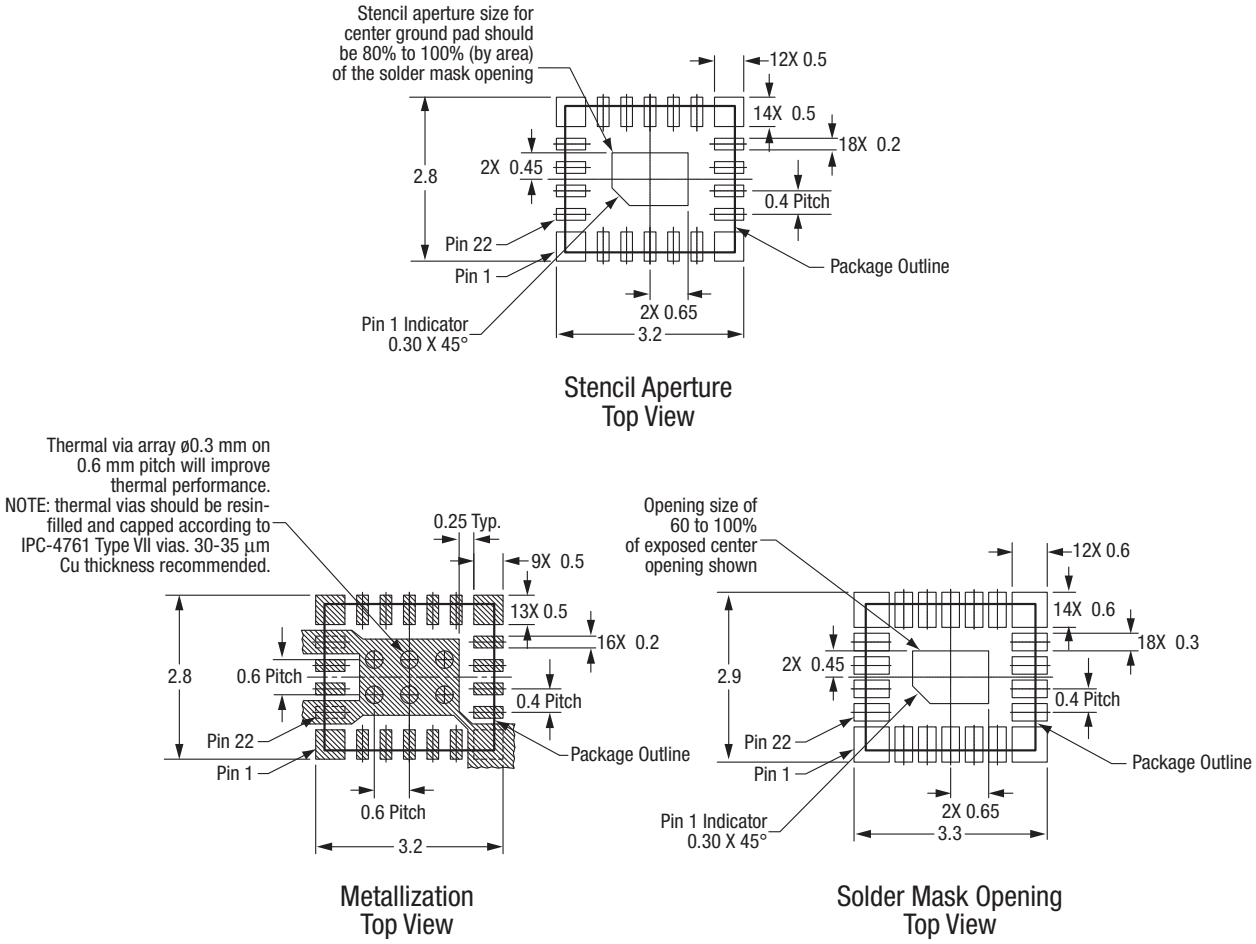



**Figure 9. SKY13491-21 Evaluation Board Assembly Diagram**




*All dimensions are in millimeters*

S3448

**Figure 10. SKY13491-21 PCB Layout Footprint (Top View)**

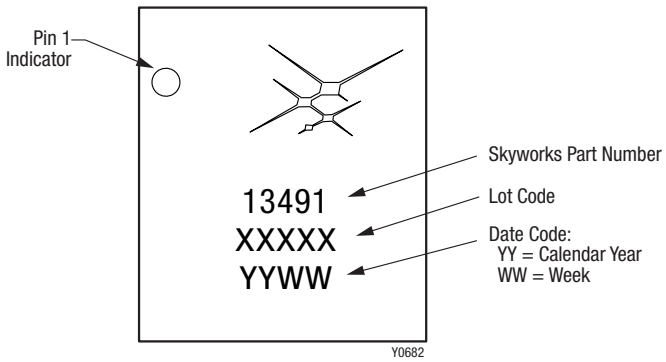
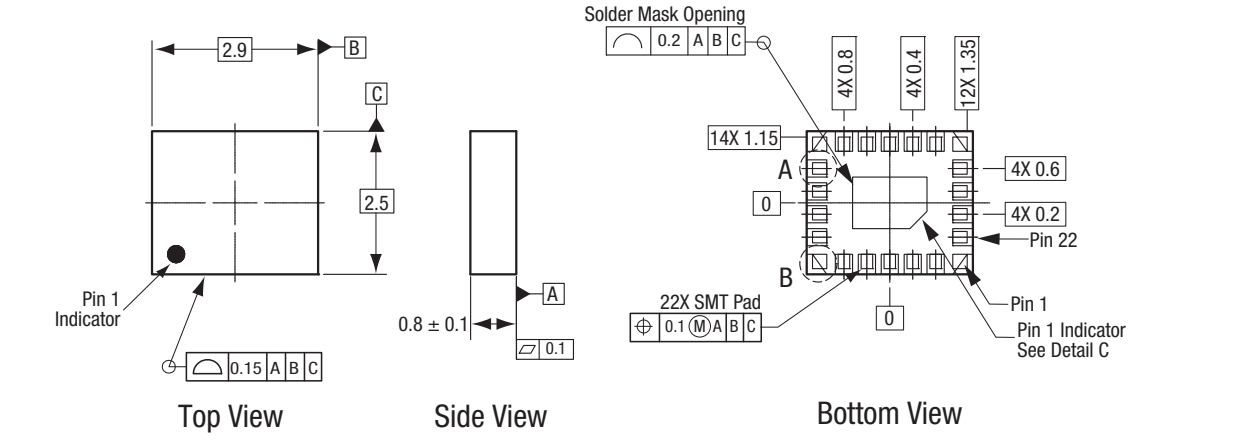
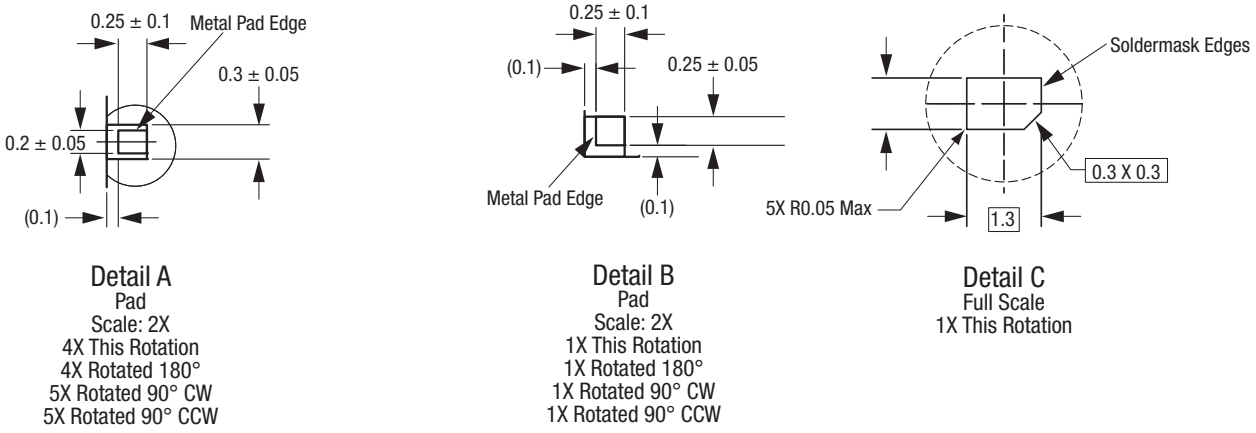



**Figure 11. Typical Part Markings (Top View)**



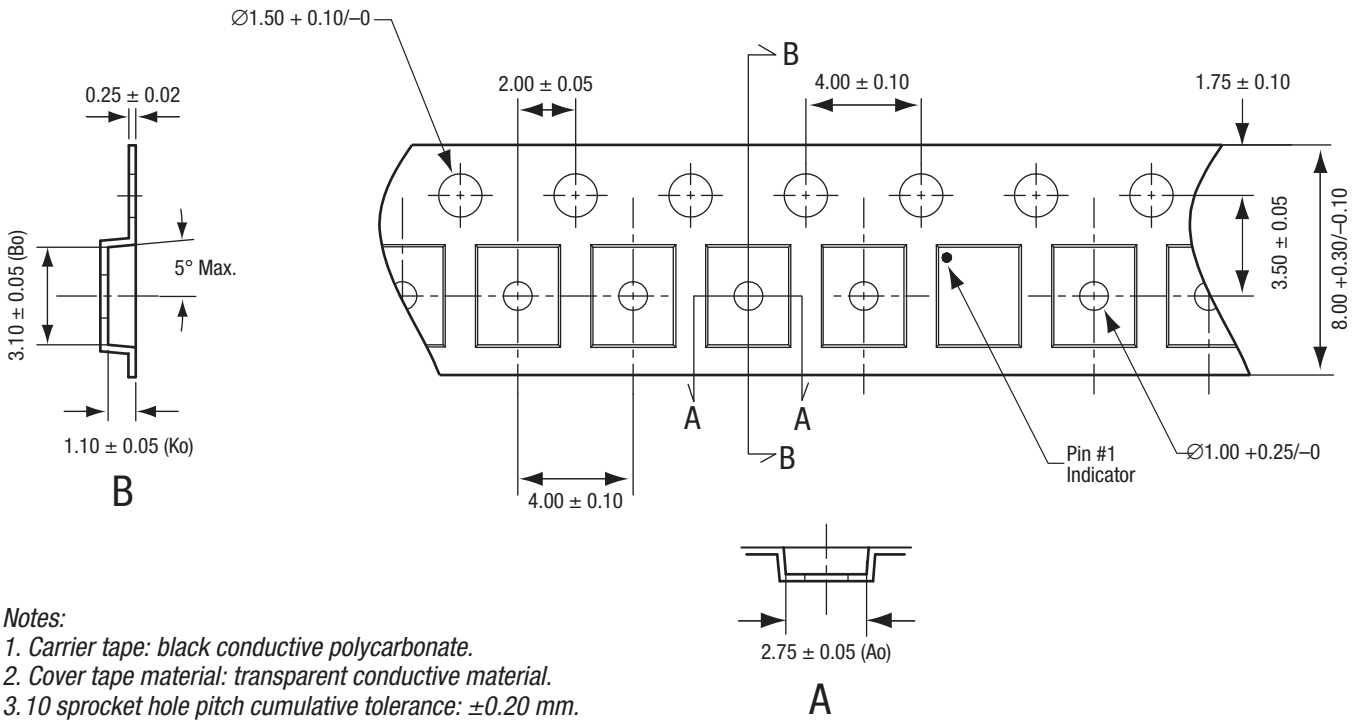




*All measurements are in millimeters*

*Dimensioning and tolerancing according to ASME Y14.5M-1994*

S3324

**Figure 12. SKY13491-21 22-Pin MCM Package Dimensions**




*Notes:*
*1. Carrier tape: black conductive polycarbonate.*
*2. Cover tape material: transparent conductive material.*
*3. 10 sprocket hole pitch cumulative tolerance: ±0.20 mm.*
*4. ESD surface resistivity meets GP01-D232.*
*5. Ao and Bo measured on plane 0.30 mm from bottom pocket.*
*6. All measurements are in millimeters.*

Y0021

**Figure 13. SKY13491-21 Tape and Reel Dimensions**

## Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|---|---|---|
| SKY13491-21 0.7 to 2.7 GHz SP14T Antenna Switch with MIPI Interface | SKY13491-21 | SKY13491-21-EVB |

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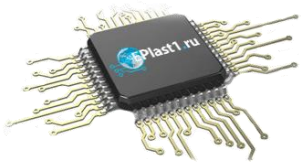
Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.




**Как с нами связаться**

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