PRELIMINARY DATA SHEET

# SKY13402-466LF: 0.4-2.2 GHz GaAs SP10T Switch with MIPI Decoder

## Applications

- 2G/3G multimode cellular handsets (UMTS, CDMA2000, EDGE, GSM)
- Embedded data cards

## Features

- Broadband frequency range: 0.4 to 2.2 GHz
- Single, positive DC power supply (2.5 to 3.3 V)
- Excellent triple beat ratio performance
- Integrated, low-pass harmonic filter for GSM transmit paths
- Integrated MIPI decoder
- Small QFN (26-pin, 2.6 x 3.4 x 0.55 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

**NEW** **Skyworks Green™ products are RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, are halogen free according to IEC-61249-2-21, and contain <1,000 ppm antimony trioxide in polymeric materials.**

## Description

The SKY13402-466LF is a GaAs pHEMT Single Pole, Ten-Throw (SP10T) antenna switch with an integrated Mobile Industry Processor Interface (MIPI) decoder and dual low-pass harmonic filters. The switch has six transmit/receive ports that make it ideal for any combination of 2G/3G multimode cellular applications.

Using advance switching technologies, the SKY13402-466LF maintains low insertion loss and high isolation for both transmit and receive switching paths. The switch also exhibits an excellent triple beat ratio and 2nd/3rd order modulation distortion performance.

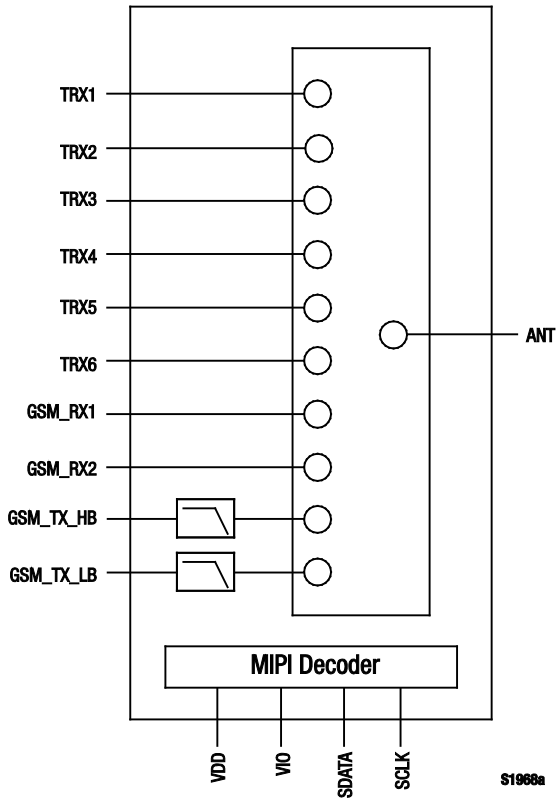


**Figure 1. SKY13402-466LF Block Diagram**

Switching is controlled by an integrated MIPI decoder. The VIO signal (pin 23) enables and disables the decoder. The SDATA and SCLK signals (pins 24 and 25, respectively) clock in the data to the decoder. Depending on the logic applied to the decoder, the antenna pin is connected to one of ten switched RF ports using a low insertion loss path, while the paths between the antenna pin and the other RF pins are in a high isolation state. No external DC blocking capacitors are required on the RF paths.

The SKY13402-466LF is manufactured in a compact, 2.6 x 3.4 x 0.55 mm, 26-pin 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.

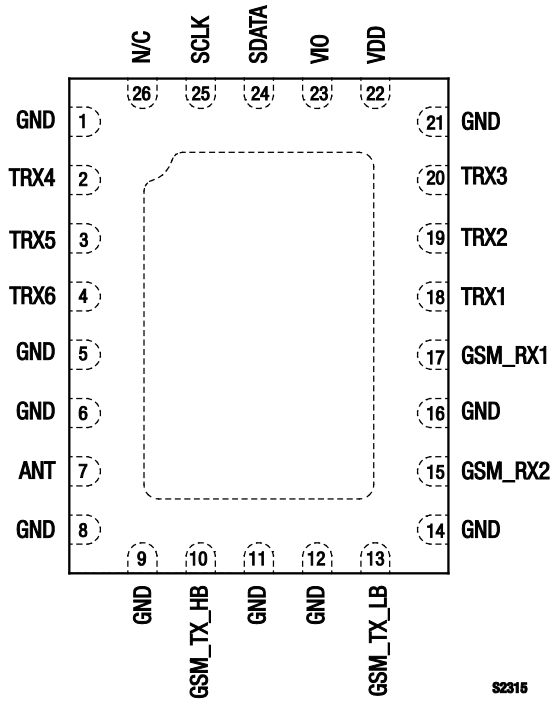


**Figure 2. SKY13402-466LF Pinout – 26-Pin QFN**
**(Top View)**

**Table 1. SKY13402-466LF Signal Descriptions**

| Pin # | Name | Description | Pin # | Name | Description |
|---|---|---|---|---|---|
| 1 | GND | Ground | 14 | GND | Ground |
| 2 | TRX4 | RF input/output port 4 | 15 | GSM_RX2 | GSM RF output port 2 |
| 3 | TRX5 | RF input/output port 5 | 16 | GND | Ground |
| 4 | TRX6 | RF input/output port 6 | 17 | GSM_RX1 | GSM RF output port 1 |
| 5 | GND | Ground | 18 | TRX1 | RF input/output port 1 |
| 6 | GND | Ground | 19 | TRX2 | RF input/output port 2 |
| 7 | ANT | Antenna RF port | 20 | TRX3 | RF input/output port 3 |
| 8 | GND | Ground | 21 | GND | Ground |
| 9 | GND | Ground | 22 | VDD | DC power supply |
| 10 | GSM_TX_HB | GSM high band transmit RF input port with integrated harmonic filter | 23 | VIO | MIPI decoder enable |
| 11 | GND | Ground | 24 | SDATA | Serial data input |
| 12 | GND | Ground | 25 | SCLK | Clock input |
| 13 | GSM_TX_LB | GSM low band transmit RF input port with integrated harmonic filter | 26 | N/C | No connection. Pin may be connected to ground with no change in performance. |

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

**Table 2. SKY13402-466LF Absolute Maximum Ratings**

| Parameter | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|
| RF input power | $P_{IN}$ | | +36 | dBm |
| Power supply | | | 5 | V |
| Interface supply | VIO | | 1.9 | V |
| Storage temperature | $T_{STG}$ | –40 | +125 | °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 SKY13402-466LF are provided in Table 2. Electrical specifications are provided in Table 3.

Typical performance characteristics of the SKY13402-466LF are illustrated in Figures 3 to 19.

The MIPI interface is programmed serially according to the logic shown in Tables 4, 5, and 6.

Figure 20 illustrates the test setup used to measure data for Figure 17. 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 TRX6 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 SKY13402-466LF exhibits exceptional performance for all TRX ports.

**Table 3. SKY13402-466LF Electrical Specifications (Note 1) (1 of 2)**
**($V_{DD}$ = 2.65 V, V1 = V2 = V3 = V4 = 0/1.8 V, $T_{OP}$ = +25 °C, $P_{IN}$ = 0 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| ***RF Specifications*** | | | | | | |
| Insertion loss: ANT to TRX1/2/3 ports | IL | 824 to 960 MHz | | 0.5 | 0.7 | dB |
| | | 1710 to 2170 MHz | | 0.6 | 0.8 | dB |
| | | 2300 to 2690 MHz | | 0.9 | 1.1 | dB |
| Insertion loss: ANT to TRX4/5/6 ports | IL | 824 to 960 MHz | | 0.50 | 0.70 | dB |
| | | 1710 to 2170 MHz | | 0.65 | 0.85 | dB |
| | | 2300 to 2690 MHz | | 0.90 | 1.10 | dB |
| Insertion loss: ANT to GSM_TX_LB port | IL | 824 to 915 MHz | | 1.35 | 1.55 | dB |
| Insertion loss: ANT to GSM_TX_HB port | IL | 1710 to 1910 MHz | | 1.2 | 1.4 | dB |
| Insertion loss: ANT to GSM_RX1/2/3 ports | IL | 869 to 960 MHz | | 0.8 | 1.0 | dB |
| | | 1805 to 1990 MHz | | 1.0 | 1.2 | dB |
| Isolation (TRX1/2/3 to TRX4/5/6 ports) | ISO | 824 to 1910 MHz | 32 | 35 | | dB |
| Isolation (GSM_TX_LB to TRX1/2/3/4/5/6 and GSM_RX1/2 ports) | ISO | 824 to 915 MHz | 30 | 33 | | dB |
| Isolation (GSM_TX_HB to TRX1/2/3/4/5/6 and GSM_RX1/2 ports) | ISO | 1710 to 1910 MHz | 32 | 35 | | dB |
| Isolation (TRX4 to TRX6 port) | ISO | 824 to 1910 MHz | 25 | 28 | | dB |
| Isolation (TRX1 to TRX2, TRX2 to TRX3, TRX4 to TRX5, TRX5 to TRX6 ports) | ISO | 824 to 1910 MHz | 18 | 21 | | dB |
| Isolation (ANT to GSM_RX2 ports) | ISO | 1805 to 1990 MHz | 30 | 33 | | dB |
| Harmonics | | UMTS, $P_{IN}$ = +27 dBm | | –48 | –36 | dBm |
| | | GSM_TX_LB port, $P_{IN}$ = +35 dBm | | –45 | –36 | dBm |
| | | GSM_TX_HB port, $P_{IN}$ = +33 dBm | | –44 | –36 | dBm |
| Attenuation (GSM_TX_LB port) | | GSM850 | | | | |
| | | 2f | 18 | 22 | | dB |
| | | 3f | 25 | 28 | | dB |
| | | >4f | 17 | 20 | | dB |
| | | EGSM900 | | | | |
| | | 2f | 22 | 25 | | dB |
| | | 3f | 22 | 25 | | dB |
| | | >4f | 17 | 20 | | dB |
| Attenuation (GSM_TX_HB port) | | DCS1800 | | | | |
| | | 2f | 20 | 25 | | dB |
| | | 3f | 25 | 28 | | dB |
| | | >4f | 17 | 20 | | dB |
| | | PCS1900 | | | | |
| | | 2f | 22 | 25 | | dB |
| | | 3f | 25 | 28 | | dB |
| | | >4f | 17 | 20 | | dB |
| Return loss | \|S11\| | 0.4 to 2.2 GHz | 14 | 18 | | dB |

**Table 3. SKY13402-466LF Electrical Specifications (Note 1) (2 of 2)**
**($V_{DD}$ = 2.65 V, V1 = V2 = V3 = V4 = 0/1.8 V, $T_{OP}$ = +25 °C, $P_{IN}$ = 0 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| ***RF Specifications (continued)*** | | | | | | |
| 2nd Order Input Intercept Point | IIP2 | AWS, PCS, IMT to CDMA2000 modes | +95.5 | | | dBm |
| 2nd Order Intermodulation Distortion | IMD2 | UMTS mode | | –105 | –97 | dBm |
| 3rd Order Intermodulation Distortion | IMD3 | UMTS mode | | –105 | –97 | dBm |
| Triple Beat Ratio | TBR | 650 to 900 MHz<br>1710 to 2155 MHz | | 81<br>81 | | dBc<br>dBc |
| 1 dB Input Compression Point | IP1dB | GSM_TX_LB port, 824 to 915 MHz<br>GSM_TX_HB port, 1710 to 1910 MHz | +40<br>+39 | | | dBm<br>dBm |
| Switching speed | | 10/90% RF | | 3 | 5 | µs |
| ***DC Specifications*** | | | | | | |
| Supply voltage | $V_{DD}$ | | 2.50 | 2.65 | 3.30 | V |
| Supply current | $I_{DD}$ | | | 0.4 | 0.5 | mA |
| Control voltage:<br>High<br>Low | V1, V2, V3, V4 | | <br>1.35<br>0 | <br>1.80 | <br>3.10<br>0.3 | <br>V<br>V |
| Control current:<br>High<br>Low | | | | <br><br>5 | <br>10 | <br>µA<br>µA |

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

## Typical Performance Characteristics

**($V_{DD}$ = 2.65 V, V1 = V2 = V3 = V4 = 0/1.8 V, $T_{OP}$ = +25 °C, $P_{IN}$ = 0 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Unless Otherwise Noted)**

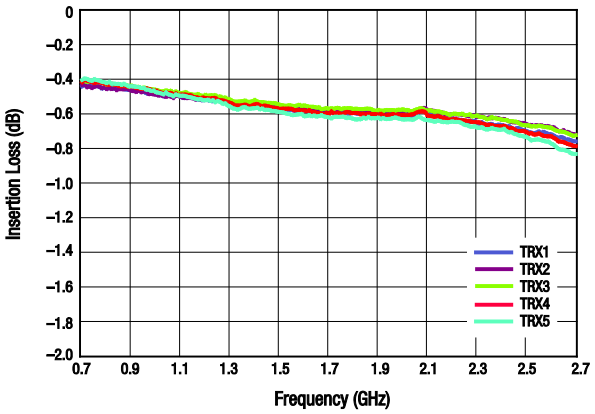


**Figure 3. Insertion Loss vs Frequency (ANT to TRX Ports)**

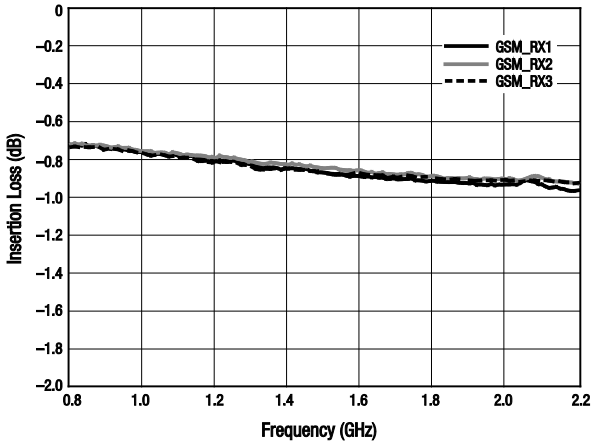


**Figure 4. Insertion Loss vs Frequency (ANT to GSM_RX Ports)**

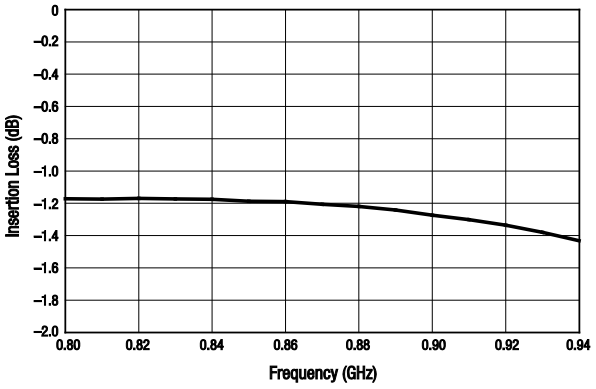


**Figure 5. Insertion Loss vs Frequency (ANT to GSM_TX_LB Port)**

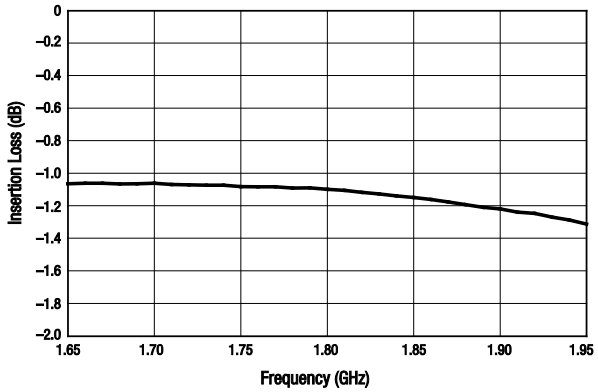


**Figure 6. Insertion Loss vs Frequency (ANT to GSM_TX_HB Port)**

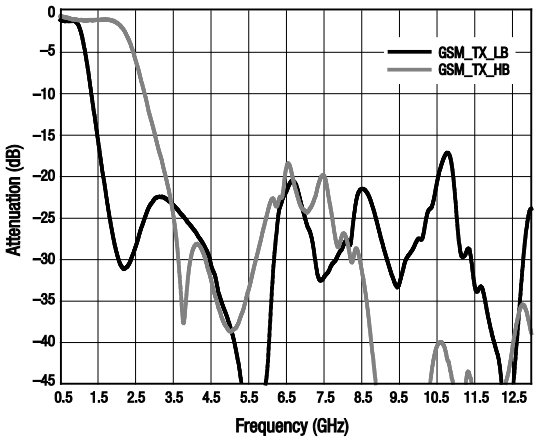


**Figure 7. Attenuation vs Frequency (ANT to GSM_TX_HB/LB Ports)**

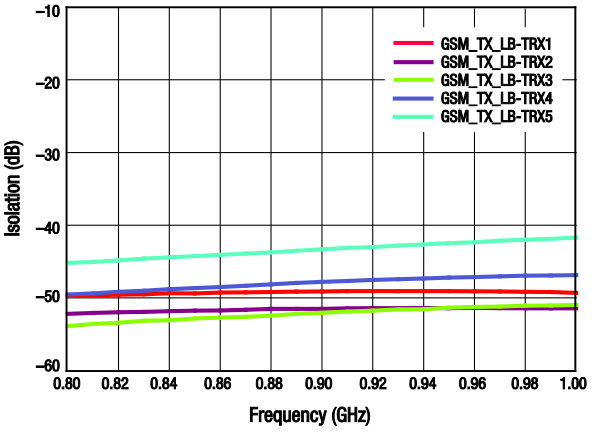


**Figure 8. Isolation vs Frequency (GSM_TX_LB to TRX Ports)**

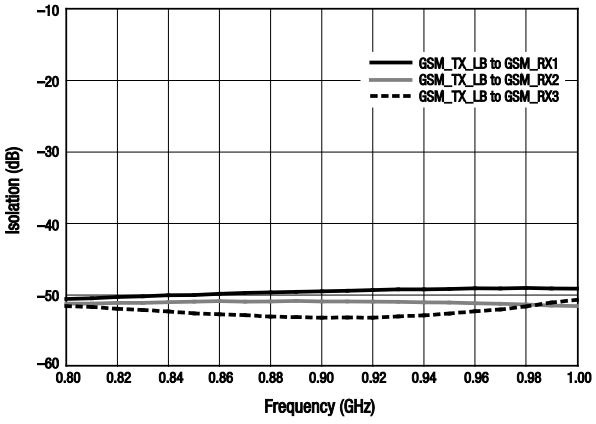


**Figure 9. Isolation vs Frequency (GSM_TX_LB to GSM_RX1/2 Ports)**

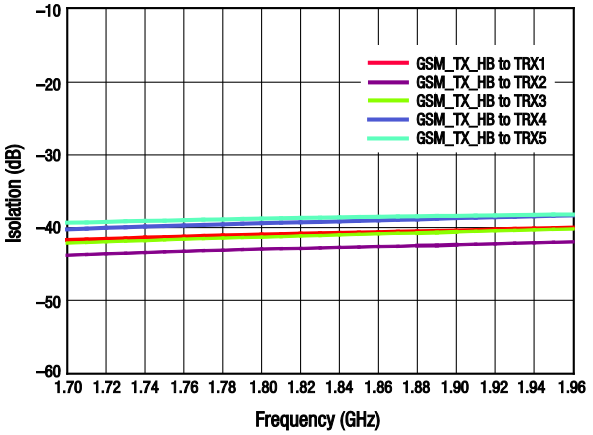


**Figure 10. Isolation vs Frequency (GSM_TX_HB to TRX Ports)**

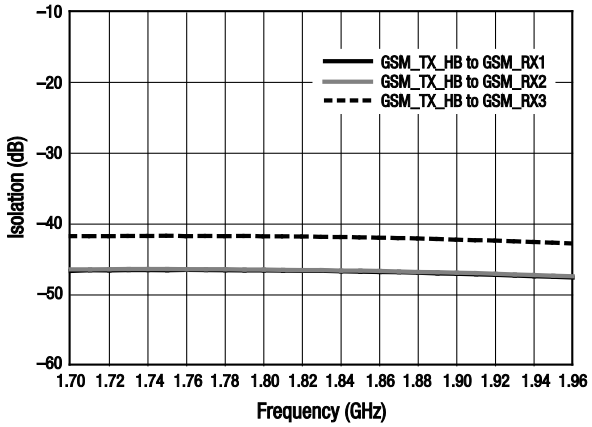


**Figure 11. Isolation vs Frequency (GSM_TX_HB to GSM_RX1/2 Ports)**

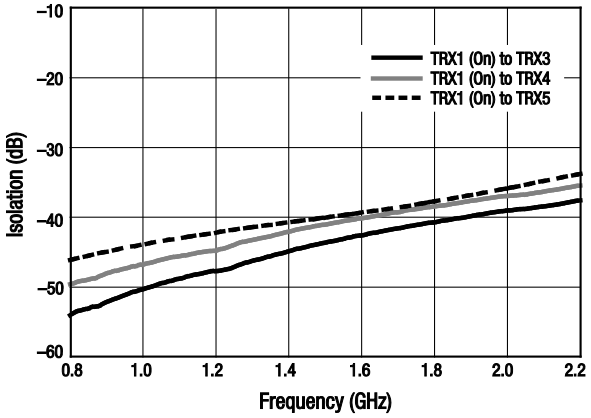


**Figure 12. Isolation vs Frequency (TRX1 to TRX4/5/6 Ports)**

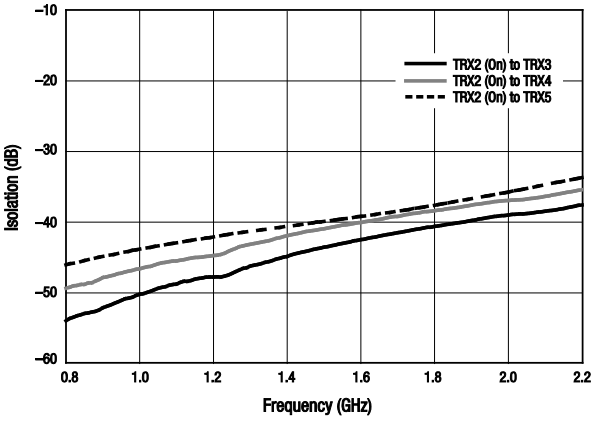


**Figure 13. Isolation vs Frequency (TRX2 to TRX4/5/6 Ports)**

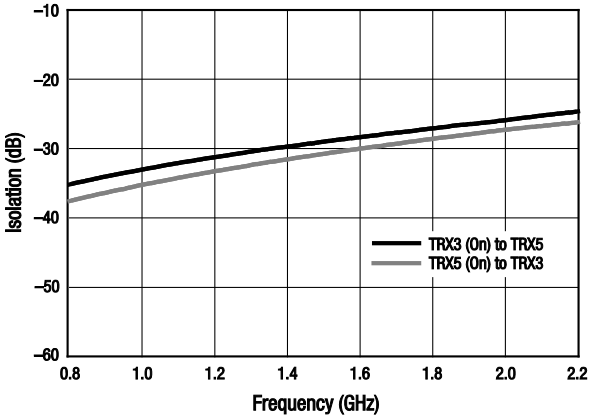


**Figure 14. Isolation vs Frequency (TRX3 to TRX5 Port**

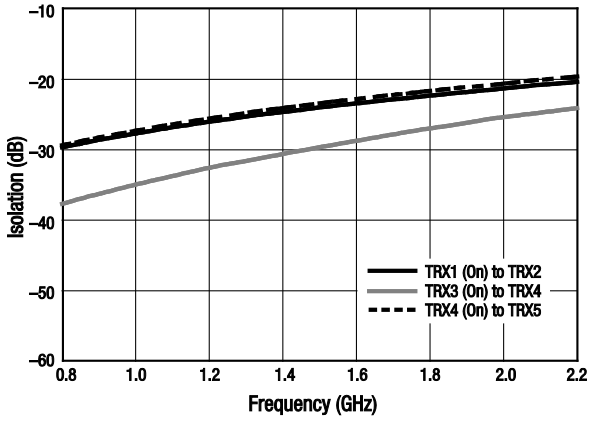


**Figure 15. Isolation vs Frequency (TRX Adjacent Ports)**

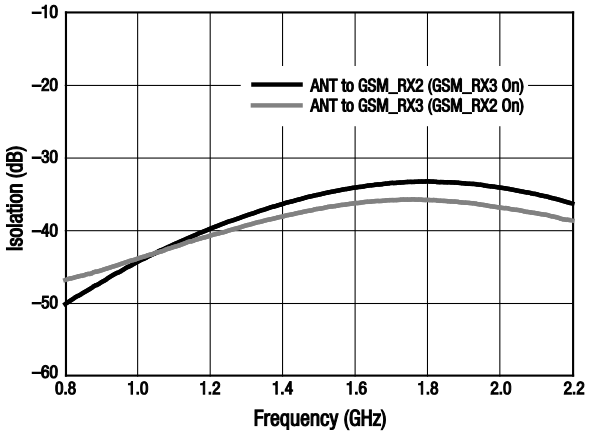


**Figure 16. Isolation vs Frequency (ANT to GSM_RX1/2 Ports)**

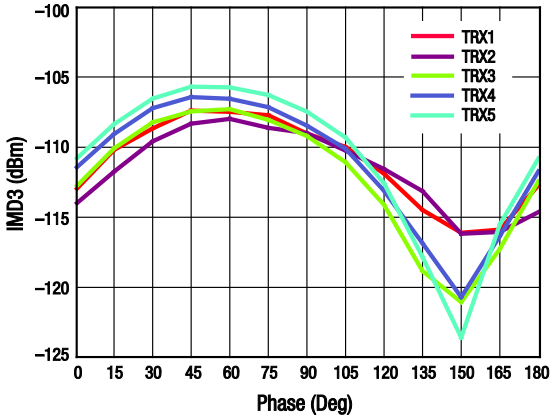


**Figure 17. 3rd Order Intermodulation Distortion vs Phase, TRX Ports ($f_{FUND}$ = 1.95 GHz, $f_{BLK}$ = 1.76 GHz, $f_{RX}$ = 2.14 GHz)**

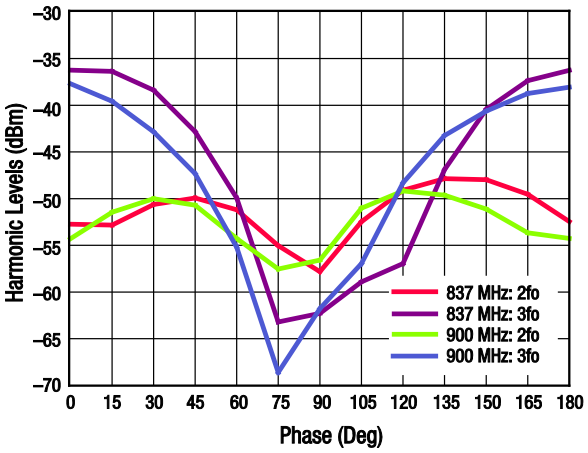


**Figure 18. Harmonics vs Phase (ANT to GSM_TX_LB, $P_{IN}$ = +35 dBm, 5:1 VSWR Mismatch)**

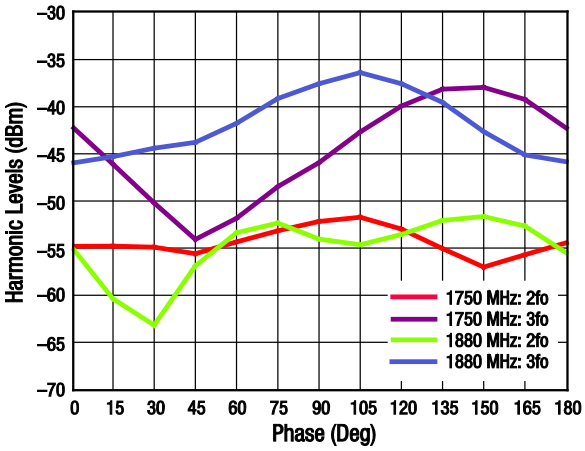


**Figure 19. Harmonics vs Phase (ANT to GSM_TX_HB, $P_{IN}$ = +33 dBm, 5:1 VSWR Mismatch)**

**Table 4. MIPI Interface Insertion Loss Logic, Register 0x01 (Note 1)**

| Insertion Loss State | SDATA Signal (Pin 24) | | | |
|---|---|---|---|---|
| | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| ANT to GSM_TX_LB | 0 | 0 | 0 | 1 |
| ANT to GSM_TX_HB | 0 | 0 | 1 | 0 |
| ANT to GSM_RX1 | 1 | 1 | 0 | 0 |
| ANT to GSM_RX2 | 1 | 1 | 0 | 1 |
| ANT to TRX1 | 0 | 1 | 0 | 0 |
| ANT to TRX2 | 0 | 1 | 0 | 1 |
| ANT to TRX3 | 0 | 1 | 1 | 0 |
| ANT to TRX4 | 1 | 0 | 0 | 0 |
| ANT to TRX5 | 1 | 0 | 0 | 1 |
| ANT to TRX6 | 1 | 0 | 1 | 0 |
| Power off (low current) | 0 | 0 | 0 | 0 |
| Isolation | 1 | 1 | 1 | 1 |

**Note 1**: "1" = (0.8 × VIO – VIO); "0" = (0 – 0.2 × VIO). 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. MIPI Interface Unique Slave Identifier (USID) Logic**

| USID | SDATA Signal (Pin 24) | | | |
|---|---|---|---|---|
| | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| | 1 | 0 | 1 | 1 |

**Table 6. MIPI Interface Skyworks Product ID (P_ID) Logic, Register 0x1D**

| P_ID | SDATA Signal (Pin 24) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Skyworks | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

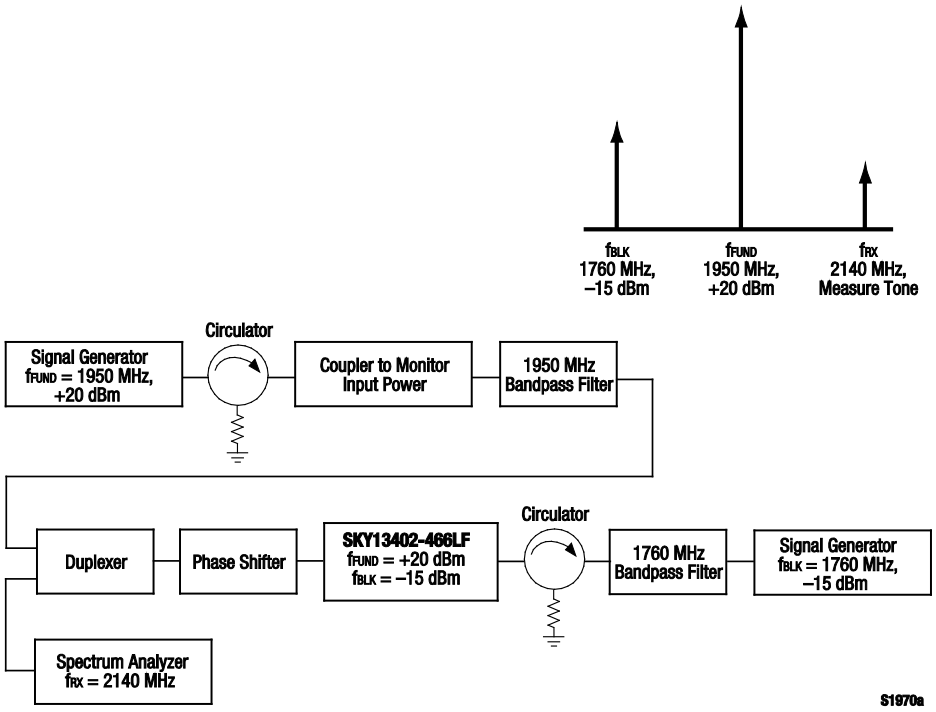


**Figure 20. 3rd Order Intermodulation Test Setup**

## Evaluation Board Description

The SKY13402-466LF Evaluation Board is used to test the performance of the SKY13402-466LF SP10T Switch. An Evaluation Board schematic diagram is provided in Figure 21. An assembly drawing for the Evaluation Board is shown in Figure 22.

## Package Dimensions

The PCB layout footprint for the SKY13402-466LF is provided in Figure 23. Typical case markings are shown in Figure 24. Package dimensions for the 26-pin QFN are shown in Figure 25, and tape and reel dimensions are provided in Figure 26.

## 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 SKY13402-466LF 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, *Solder Reflow Information*, document number 200164.

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.

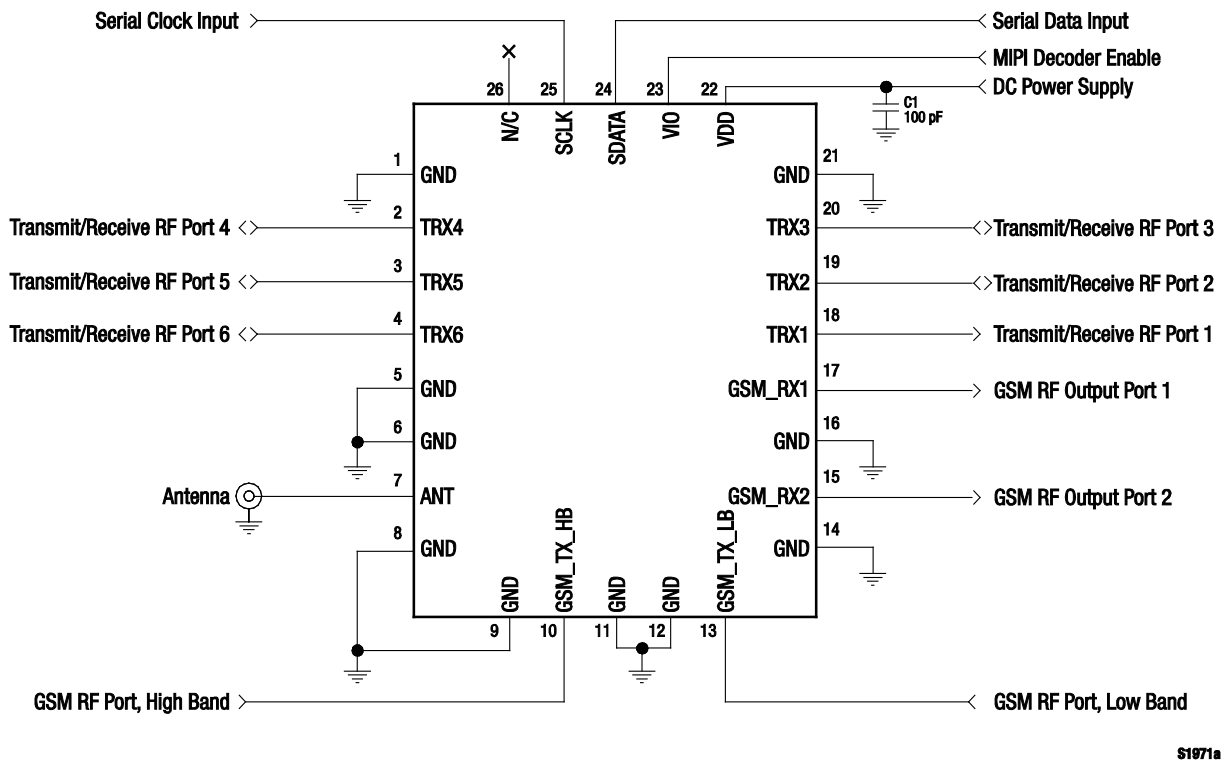


**Figure 21. SKY13402-466LF Evaluation Board Schematic**

*** TBD ***

**Figure 22. SKY13402-466LF Evaluation Board Assembly Diagram**

*** TBD ***

**Figure 23. SKY13402-466LF PCB Layout Footprint**
**(Top View)**

*** TBD ***

**Figure 24. Typical Part Markings**
**(Top View)**

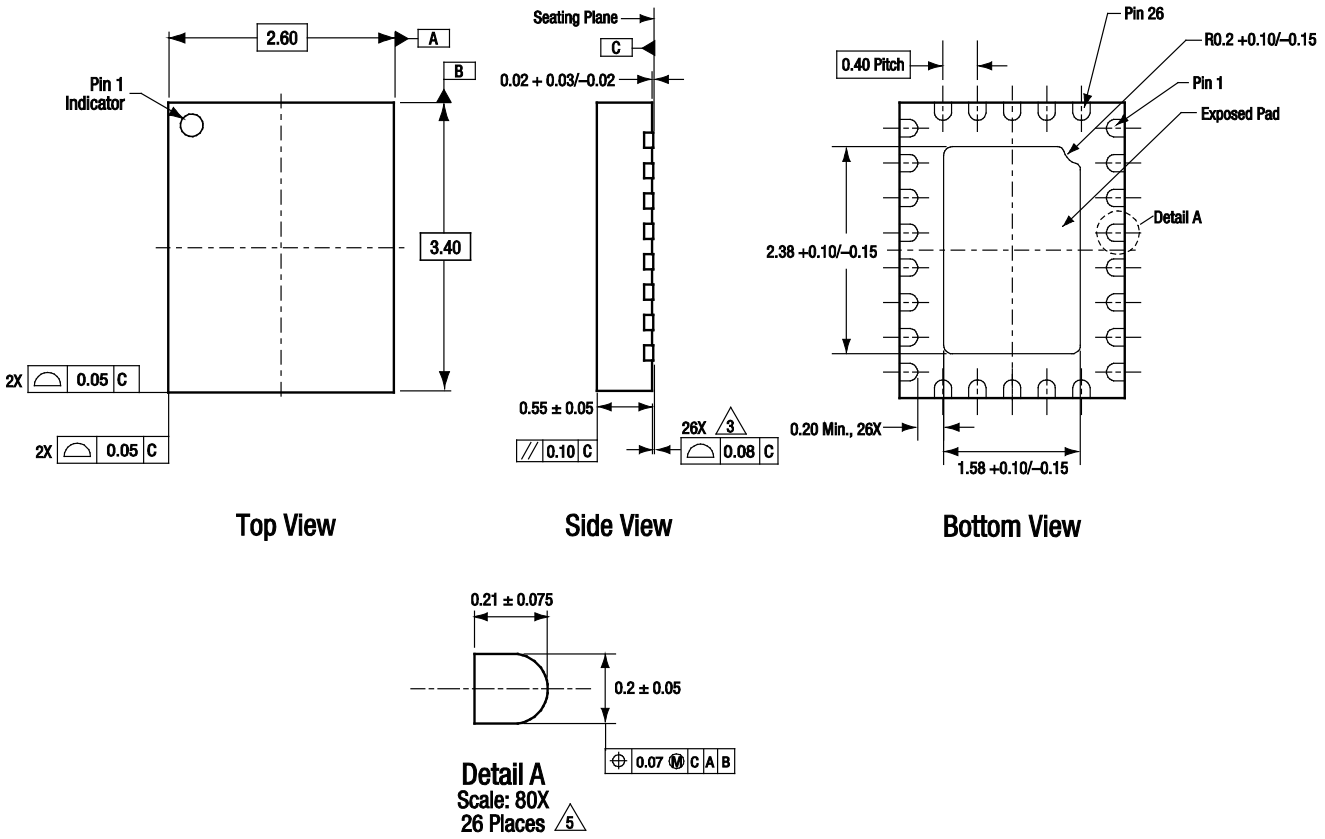


**Figure 25. SKY13402-466LF 26-Pin QFN Package Dimensions**

*** TBD ***

**Figure 26. SKY13402-466LF Tape and Reel Dimensions**

## Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|---|---|---|
| SKY13402-466LF 0.4-2.2 GHz SP10T Switch | SKY13402-466LF | SKY13402-466LF-EVB |