

DATA SHEET

# SKY65362-11: 900 to 930 MHz High-Power RF Front-End Module

## Applications

- Smart meters
- In-home appliances
- Smart thermostats

## Features

- Integrated PA with +30.5 dBm output power
- Integrated LNA with programmable bypass
- Low FEM NF of 2.5 dB, typical
- Single-ended 50 Ω transmit/receive RF interface
- Supply voltage: 3.00 V to 5.25 V
- Sleep mode current: <1 μA
- Small MCM (36-pin, 6 x 6 mm) package (MSL3, 260 °C per JEDEC J-STD-020)

## Description


The SKY65362-11 is a high-performance, highly integrated RF front-end module (FEM) designed for high-power Industrial, Scientific, Medical (ISM) band applications operating in the 900 to 930 MHz frequency range.

The FEM is designed for ease of use and maximum flexibility with fully matched, 50 Ω power amplifier (PA) input and output, and digital controls compatible with 1.6 to 3.3 V CMOS levels.

The RF blocks operate over a wide supply voltage range from 3.00 to 5.25 V that allows the SKY65362-11 to be used in battery powered applications over a wide spectrum of the battery discharge curve.

The SKY65362-11 is packaged in a 36-pin, 6 x 6 mm Multi-Chip Module (MCM), which allows for a highly manufacturable low-cost solution.

A functional block diagram of the SKY65362-11 is shown in Figure 1. The 36-pin MCM package and pinout are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.



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.

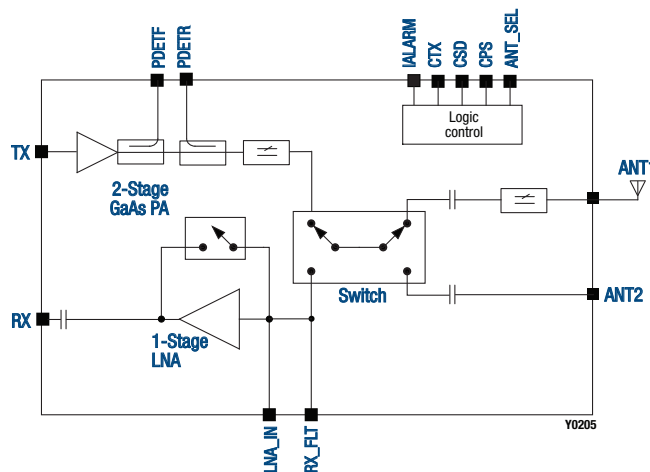


Figure 1. SKY65362-11 FEM Block Diagram

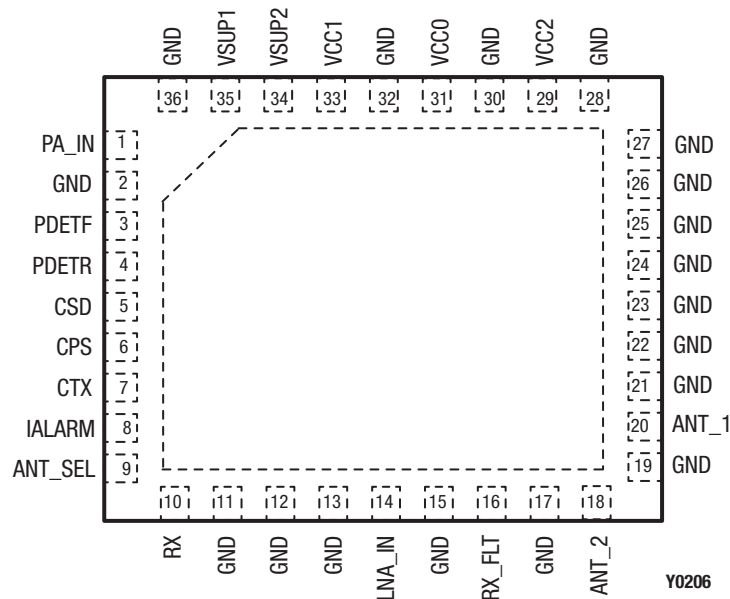


Figure 2. SKY65362-11 Pinout – 36-Pin MCM (Top View)

Table 1. SKY65362-11 Signal Descriptions

| Pin | Name    | Description   | Pin | Name  | Description          |
|-----|---------|---|-----|-------|----------------------|
| 1   | PA_IN   | PA input  | 19  | GND   | Ground               |
| 2   | GND     | Ground  | 20  | ANT1  | Antenna 1            |
| 3   | PDETF   | Forward power detector output                                   | 21  | GND   | Ground               |
| 4   | PDETR   | Reverse power detector output                                   | 22  | GND   | Ground               |
| 5   | CSD     | Standby control (see Table 9)                                   | 23  | GND   | Ground               |
| 6   | CPS     | Receive mode gain control (see Table 9)                         | 24  | GND   | Ground               |
| 7   | CTX     | Transmit/receive control (see Table 9)                          | 25  | GND   | Ground               |
| 8   | IALARM  | PA current alarm output (see Table 9)                           | 26  | GND   | Ground               |
| 9   | ANT_SEL | Antenna select control input (see Table 9)                      | 27  | GND   | Ground               |
| 10  | RX      | Receive output  | 28  | GND   | Ground               |
| 11  | GND     | Ground  | 29  | VCC2  | PA voltage supply    |
| 12  | GND     | Ground  | 30  | GND   | Ground               |
| 13  | GND     | Ground  | 31  | VCC0  | Decoupling capacitor |
| 14  | LNA_IN  | LNA input   | 32  | GND   | Ground               |
| 15  | GND     | Ground  | 33  | VCC1  | PA voltage supply    |
| 16  | RX_FLT  | Receive path after internal switches that connect ANT1 and ANT2 | 34  | VSUP2 | FEM voltage supply   |
| 17  | GND     | Ground  | 35  | VSUP1 | FEM voltage supply   |
| 18  | ANT2    | Antenna 2. No integrated filtering.                             | 36  | GND   | Ground               |

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65362-11 are provided in Table 2. The recommended operating conditions are specified in Table 3.

Electrical specifications are provided in Tables 4 through 8. The state of the SKY65362-11 is determined by the logic provided in Table 9.

**Table 2. SKY65362-11 Absolute Maximum Ratings (Note 1)**

| Parameter  | Symbol                 | Minimum | Maximum                                 | Units |
|--|------------------------|---------|---|-------|
| Supply voltage (no RF)                                       | V <sub>CC</sub>        | -0.3    | +6.0                                    | V     |
| Control pin (CSD, CPS, CTX, IALARM, and ANT_SEL) voltage     |                        | -0.3    | V <sub>CC</sub> (V <sub>CC</sub> < 5 V) | V     |
| Operating temperature  | T <sub>A</sub>         | -40     | +85                                     | °C    |
| Storage temperature  | T <sub>STG</sub>       | -40     | +125                                    | °C    |
| Transmit input power   | P <sub>IN_TX_MAX</sub> |         | +10                                     | dBm   |
| Receive RF input power @ ANT1 or ANT2 ports                  | P <sub>IN_RX_MAX</sub> |         | +10                                     | dBm   |
| Voltage Standing Wave Ratio @ ANT1 or ANT2 ports             | VSWR                   |         | 10:1                                    | –     |
| Electrostatic discharge:<br>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.

**Table 3. SKY65362-11 Recommended Operating Conditions**

| Parameter             | Symbol          | Minimum | Typical | Maximum | Units |
|-----------------------|-----------------|---------|---------|---------|-------|
| Supply voltage        | V <sub>CC</sub> | 4.75    | 5.00    | 5.25    | V     |
| Operating temperature | T <sub>A</sub>  | -40     | +25     | +85     | °C    |

**Table 4. SKY65362-11 DC Electrical Specifications (Note 1)**  
**(V<sub>CC</sub> = +5.0 V, T<sub>A</sub> = +25 °C, as Measured on the SKY65362-11 Evaluation Board [De-Embedded to Device], Unless Otherwise Noted)**

| Parameter                                 | Symbol                | Test Condition                           | Min | Typical | Max  | Units |
|---|-----------------------|--|-----|---------|------|-------|
| Total supply current, transmit mode       | I <sub>CC_TX30</sub>  | P <sub>OUT</sub> = +30.5 dBm<br>(Note 2) |     | 515     |      | mA    |
|   | I <sub>CC_TX27</sub>  | P <sub>OUT</sub> = +27 dBm               |     | 300     |      | mA    |
|   | I <sub>CC_TX24</sub>  | P <sub>OUT</sub> = +24 dBm               |     | 230     |      | mA    |
| Quiescent current, transmit mode          | I <sub>CO_TX</sub>    | No RF                                    |     | 85      |      | mA    |
| Total supply current, receive mode        | I <sub>CC_RX</sub>    |  |     | 6       |      | mA    |
| Total supply current, receive bypass mode | I <sub>CC_RXBYP</sub> |  |     | 820     |      | μA    |
| Sleep supply current                      | I <sub>CC_OFF</sub>   | No RF                                    |     | 0.05    | 1.00 | μA    |

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

**Note 2:** Typical current listed into VSWR = 1:1. I<sub>CC</sub> = 700 mA into VSWR = 2.5:1 guaranteed by characterization.

**Table 5. SKY65362-11 Receive Mode Electrical Specifications (Note 1)**  
**(V<sub>CC</sub> = +5.0 V, T<sub>A</sub> = +25 °C, as Measured on the SKY65362-11 Evaluation Board [De-Embedded to Device], All Unused Ports Terminated with 50 Ω, Input Port = ANT1, Output Port = RX, Unless Otherwise Noted)**

| Parameter  | Symbol                                      | Test Condition  | Min | Typical | Max | Units |
|--|---|---|-----|---------|-----|-------|
| Frequency range  | f   |   | 900 |         | 930 | MHz   |
| Gain   | S <sub>21_RX</sub>                          | 900 to 930 MHz  |     | 16      |     | dB    |
| Noise figure   | NF  | 900 to 930 MHz  |     | 2.5     |     | dB    |
| Third order input intercept point                          | IIP3  | 900 to 930 MHz,<br>-20 dBm/tone, 200 kHz tone separation  | -5  | -2      |     | dBm   |
| 1 dB Input compression point                               | IP1dB                                       | 900 to 930 MHz  | -15 | -12     |     | dBm   |
| Antenna port return loss                                   | S <sub>11_RX</sub>                          | 900 to 930 MHz, into 50 Ω, ANT1 or ANT2 port  |     | -12     | -6  | dB    |
| Receive port return loss in receive or receive bypass mode | S <sub>22_RX</sub>                          | ANT1 terminated in 50 Ω   |     | -12     | -6  | dB    |
| Turn-on/off time   | t <sub>ON_RX</sub> ,<br>t <sub>OFF_RX</sub> | Receive or receive bypass to "off," "off" to receive or receive bypass, from 50% of CTX edge to 10% of final RF output power (Note 2) |     |         | 11  | μs    |
| Gain in receive bypass mode                                | S <sub>21_RXBYP</sub>                       |   | -4  | -3      |     | dB    |
| 1 dB Input compression point in receive bypass mode        | IP1dB_RXBYP                                 |   | +10 |         |     | dBm   |

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

**Note 2:** Not production tested. Guaranteed by characterization.

**Table 6. SKY65362-11 Transmit Mode Electrical Specifications (1 of 2) (Note 1)****(V<sub>CC</sub> = +5.0 V, T<sub>A</sub> = +25 °C, as Measured on the SKY65362-11 Evaluation Board [De-Embedded to Device], All Unused Ports Terminated with 50 Ω, Input Port = PA\_IN, Output Port = ANT1, Unless Otherwise Noted)**

| Parameter   | Symbol                                      | Test Condition   | Min | Typical             | Max  | Units             |
|---|---|--|-----|---------------------|------|-------------------|
| Frequency range   | f   |  | 900 |                     | 930  | MHz               |
| Output power @ ANT1 port  | P <sub>OUT</sub>                            | 900 to 930 MHz with specified matching network on EVB, CW, P <sub>IN</sub> = 0 dBm:<br>V <sub>CC</sub> = 5.0 V<br>V <sub>CC</sub> = 4.0 V<br>V <sub>CC</sub> = 3.6 V |     | +30.5<br>+28<br>+26 |      | dBm<br>dBm<br>dBm |
| PA power added efficiency   | PAE   | P <sub>OUT</sub> = +30.5 dBm @ ANT1 port, 915 MHz  |     | 43                  |      | %                 |
| Input return loss   | S <sub>11_TX</sub>                          | 902 to 928 MHz   |     | -10                 |      | dB                |
| Small signal gain   | S <sub>21_900</sub>                         | 902 to 928 MHz   |     | 33                  |      | dB                |
| Output return loss  | S <sub>22_TX</sub>                          | 900 to 930 MHz, into 50 Ω, ANT1 and ANT2 ports   |     | -10                 |      | dB                |
| 2 <sup>nd</sup> , 6 <sup>th</sup> , 7 <sup>th</sup> , and 10 <sup>th</sup> harmonics (HD 2, 6, 7, and 10)                   | 2fo, 6fo, 7fo, 10fo                         | 900 to 930 MHz with specified matching network on EVB, CW, P <sub>OUT</sub> = +30.5 dBm @ ANT1 port (Note 2)   |     | -35                 | -30  | dBc               |
| 3 <sup>rd</sup> , 4 <sup>th</sup> , 5 <sup>th</sup> , 8 <sup>th</sup> , and 9 <sup>th</sup> harmonic (HD 3, 4, 5, 8, and 9) | 3fo, 4fo, 5fo, 8fo, 9fo                     | 900 to 930 MHz with specified matching network on EVB, CW, P <sub>OUT</sub> = +30.5 dBm @ ANT1 port (Note 2)   |     | -50                 | -45  | dBc               |
| Non-harmonic spurious   | Spurious                                    | P <sub>OUT</sub> = +30.5 dBm @ ANT1 port, resolution bandwidth = 100 kHz, CW (Note 3)  |     | -55                 | -50  | dBm               |
| Change in output power under VSWR   | P <sub>OUT_VSWR</sub>                       | VSWR = 2.5:1, CW, reference P <sub>OUT</sub> = +30.5 dBm into 50 Ω (Note 3)  | -3  |                     | +1.5 | dB                |
| Turn-on/off time  | t <sub>ON_TX</sub> ,<br>t <sub>OFF_TX</sub> | "Off" to transmit or transmit to "off," from 50% of CTX edge to 90% of final RF output power (Note 3)  |     |                     | 11   | μs                |
| Mode change time  | t <sub>MODE_CHANGE</sub>                    | Transmit to receive or receive bypass, receive or receive bypass to transmit, from 50% of CTX edge to 10% of final RF output power (Note 3)                          |     |                     | 11   | μs                |

**Table 6. SKY65362-11 Transmit Mode Electrical Specifications (2 of 2) (Note 1)**

(V<sub>CC</sub> = +5.0 V, T<sub>A</sub> = +25 °C, as Measured on the SKY65362-11 Evaluation Board [De-Embedded to Device], All Unused Ports Terminated with 50 Ω, Input Port = PA\_IN, Output Port = ANT1, Unless Otherwise Noted)

| Parameter                    | Symbol   | Test Condition  | Min  | Typical | Max | Units |
|------------------------------|----------|---|--|---------|-----|-------|
| Forward power detect         | PFWD     | Up to VSWR = 2.5:1  | 0.35   |         | 1.2 | V     |
| Reverse power detect         | PREV     | Up to VSWR = 2.5:1  | 0.35   |         | 1.2 | V     |
| Power detector accuracy      | PDET_ACC | VSWR = 2.5:1 (Note 3)   |  | ±1      |     | dB    |
| Current alarm trigger output | IALARM   | Low if I <sub>CC</sub> < 800 mA,<br>High if I <sub>CC</sub> > 800 mA (Note 4)             |  | 800     |     | mA    |
| Stability                    | STAB     | CW, P <sub>OUT</sub> = +30.5 dBm into<br>50 Ω, 0.1 to 20 GHz,<br>load VSWR = 6:1 (Note 3) | All non-harmonically related outputs < -43 dBm |         |     |       |
| Ruggedness                   | RUG      | CW, P <sub>OUT</sub> = +30.5 dBm into<br>50 Ω load, VSWR = 10:1 (Note 3)                  | No permanent damage                            |         |     |       |

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

**Note 2:** Harmonics above 5th are not production tested. Guaranteed by characterization.

**Note 3:** Not production tested. Guaranteed by characterization.

**Note 4:** Current Alarm trigger point is adjustable by external components R2, R3, R4, R5 in Figure 3. Contact Sales support for further information.

**Table 7. SKY65362-11 Diversity Antenna Electrical Specifications (Note 1)**

(V<sub>CC</sub> = +5.0 V, T<sub>A</sub> = +25 °C, f = 900 MHz to 930 MHz, as Measured on the SKY65362-11 Evaluation Board [De-Embedded to Device], All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

| Parameter                                  | Symbol                    | Test Condition | Min | Typical | Max | Units |
|--|---------------------------|----------------|-----|---------|-----|-------|
| Isolation between ANT1 and ANT2 ports      | ISOL_ANT1/2               |                |     | -20     |     | dB    |
| ANT1 to ANT2 switching time, transmit mode | t <sub>ANT1-ANT2_TX</sub> | (Note 2)       |     | 1       |     | μs    |
| ANT1 to ANT2 switching time, receive mode  | t <sub>ANT1-ANT2_RX</sub> | (Note 2)       |     | 1       |     | μs    |

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

**Note 2:** Not production tested. Guaranteed by characterization.

**Table 8. SKY65362-11 Electrical Specifications: Control Logic Characteristics (Note 1)**

(T<sub>A</sub> = +25 °C, as Measured on the SKY65362-11 Evaluation Board [De-Embedded to Device], Unless Otherwise Noted)

| Parameter                    | Symbol          | Test Condition        | Min | Typical | Max | Units |
|------------------------------|-----------------|-----------------------|-----|---------|-----|-------|
| Control voltage:<br>High     | V <sub>IH</sub> | (Note 2)              | 1.6 |         | 3.6 | V     |
| Low                          | V <sub>IL</sub> |                       | 0   |         | 0.3 | V     |
| Input current:<br>High       | I <sub>IH</sub> | (Note 2)              |     |         | 1   | μA    |
| Low                          | I <sub>IL</sub> |                       |     |         | 1   | μA    |
| Current alarm output voltage | V <sub>OH</sub> | V <sub>CC</sub> = 5 V |     | 3.3     |     | V     |

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

**Note 2:** Not production tested. Guaranteed by characterization.

**Table 9. SKY65362-11 Mode Control Logic (Note 1)**

| Mode              | CPS<br>(Pin 6) | CSD<br>(Pin 5) | CTX<br>(Pin 7) | ANT_SEL<br>(Pin 9) |
|-------------------|----------------|----------------|----------------|--------------------|
| Sleep (all off)   | 0              | 0              | 0              | X                  |
| Receive bypass    | 0              | 1              | 0              | X                  |
| Receive LNA mode  | 1              | 1              | 0              | X                  |
| Transmit          | X              | 1              | 1              | X                  |
| ANT1 port enabled | X              | X              | X              | 0                  |
| ANT2 port enabled | X              | X              | X              | 1                  |

**Note 1:** "1" = 1.6 to 3.6 V, "0" = 0 to 0.3 V, "X" = don't care.

## Evaluation Board Description

The SKY65362-11 Evaluation Board is used to test the performance of the SKY65362-11 FEM. 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 SKY65362-11 is provided in Figure 5. Figure 6 shows the package dimensions for the 36-pin MCM, and Figure 7 provides the tape and reel dimensions.

## 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 SKY65362-11 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.

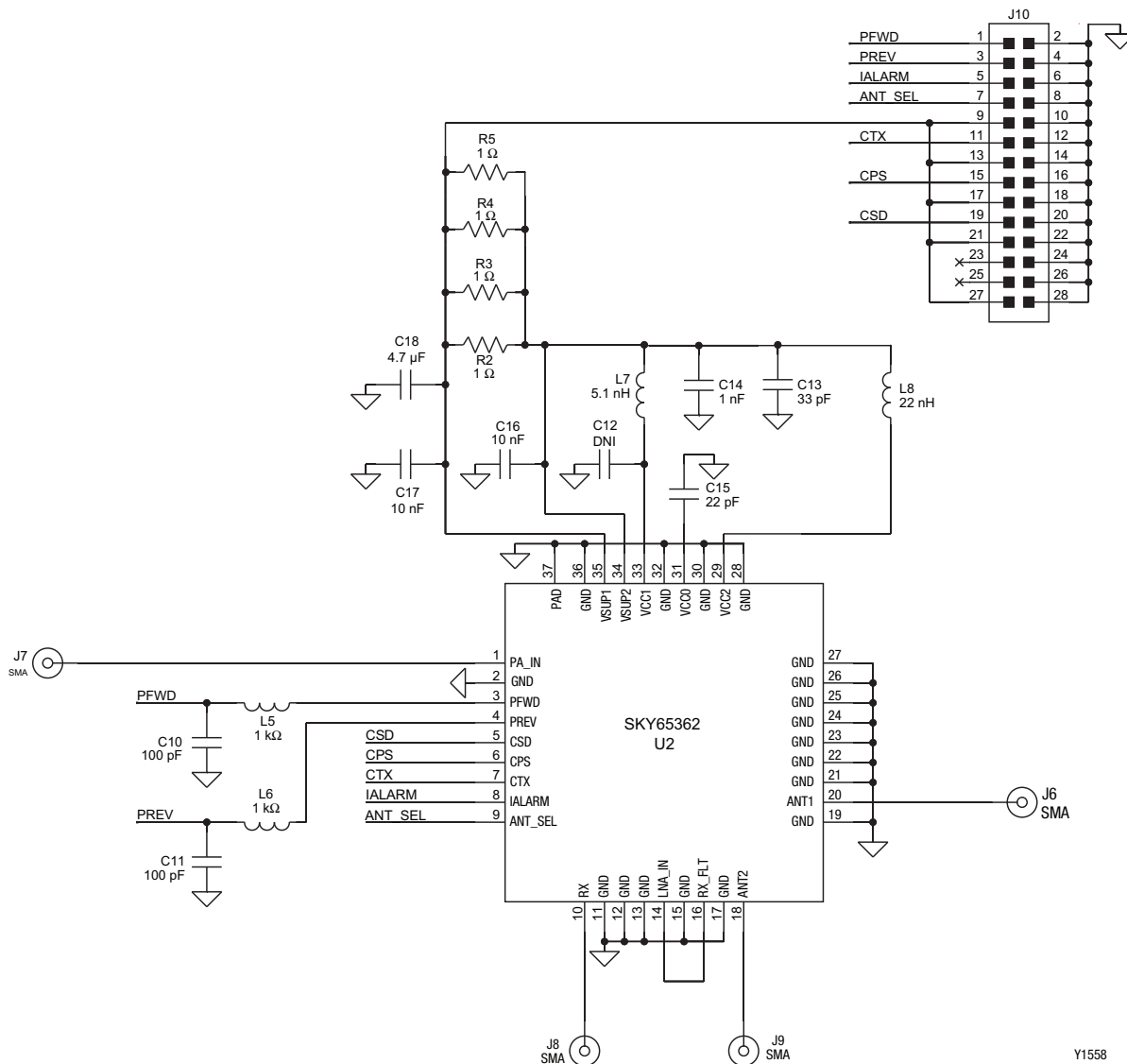


Figure 3. SKY65362-11 Evaluation Board Schematic

Y1558



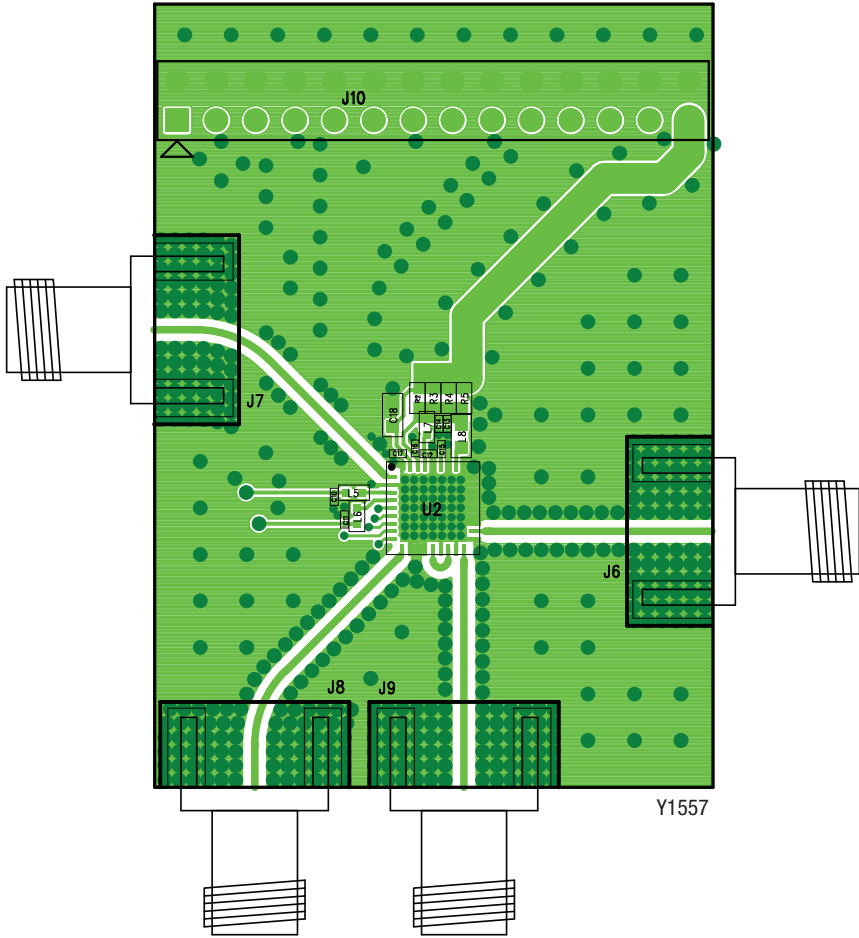
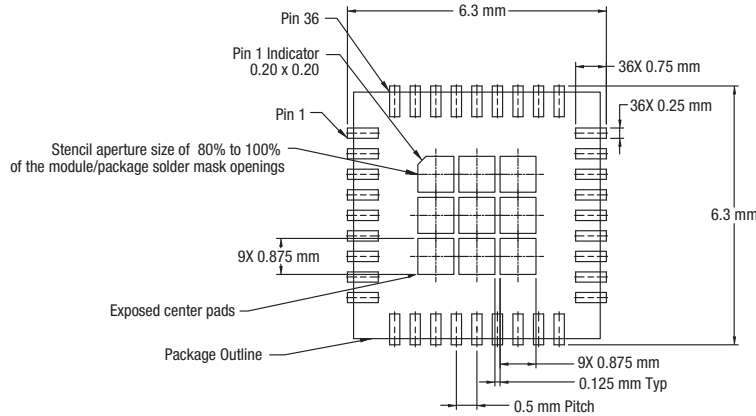
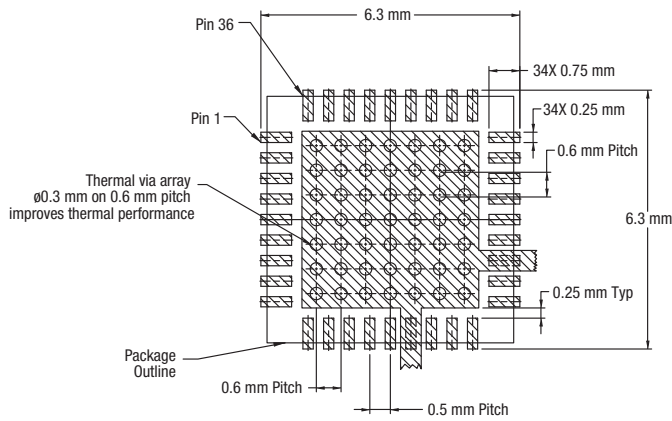


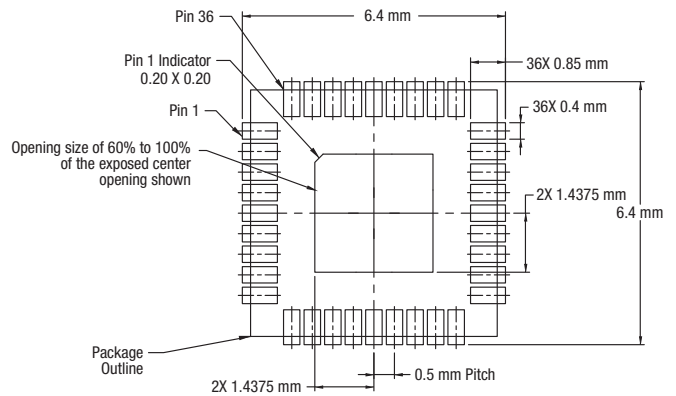
Figure 4. SKY65362-11 Evaluation Board Assembly Drawing



Stencil Aperture



Metallization



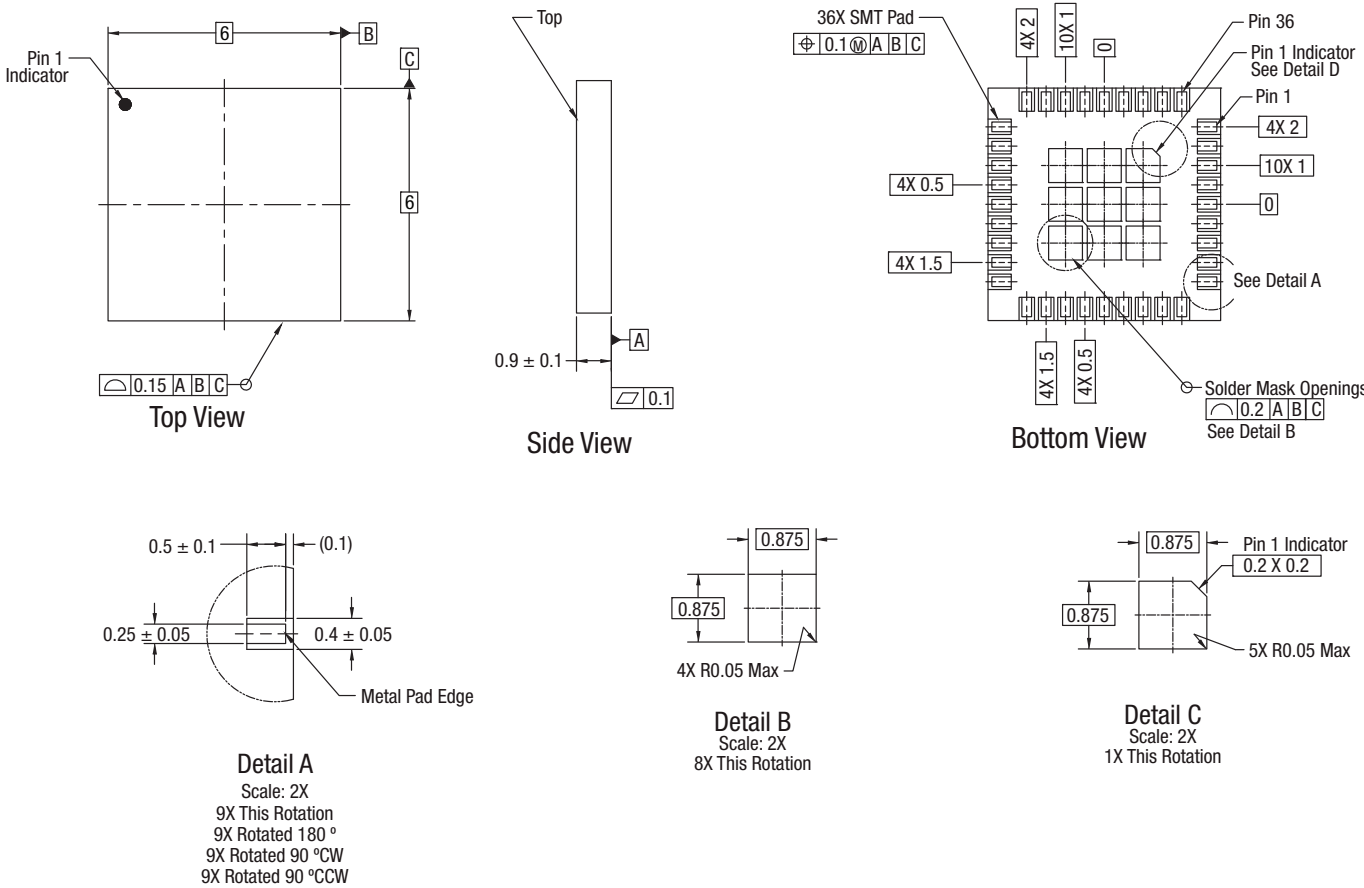
Solder Mask Opening

Notes:

1. All dimensions are in millimeters, unless otherwise specified.
2. Thermal vias should be resin filled and capped in accordance with IPC-4761 Type VII vias. Recommended Cu thickness is 30 to 35  $\mu$ m.

Y1554

Figure 5. SKY65362-11 PCB Layout Footprint



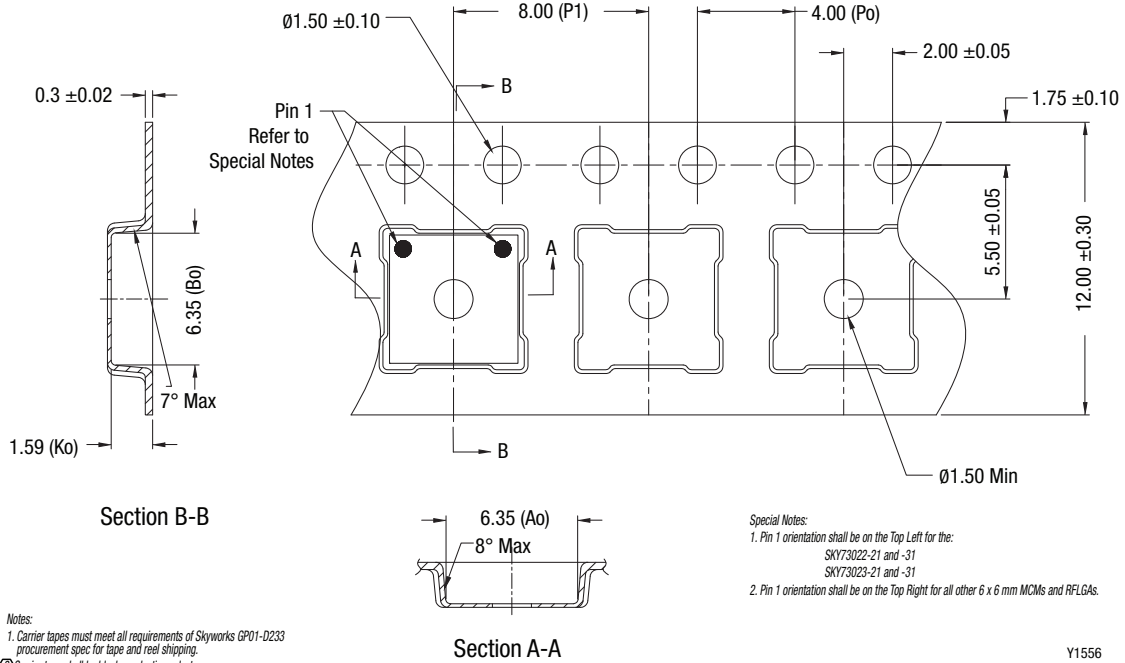
Notes:

1. Dimensions and tolerances per ASME Y14.5-1994.
2. All dimensions are in millimeters unless otherwise specified.
3. Pad definitions per details on drawing.

Y1555

Figure 6. SKY65362-11 36-Pin MCM Package Dimensions

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- Notes:**
- Carrier tapes must meet all requirements of Skyworks GP01-D233 procurement spec for tape and reel shipping.
  - Carrier tape shall be black conductive polystyrene.
  - Cover tape shall be transparent conductive pressure sensitive adhesive (PSA) material with 9.30 mm width.
  - ESD-surface resistivity shall be  $<1 \times 10^{10}$  ohms/square per EIA JEDEC TR9 specification.
  - Po/P1 10 pitches cumulative tolerance on tape:  $\pm 0.20$  mm.
  - Ao & Bo measurement point to be 0.30 mm from bottom pocket.
  - All dimensions are in millimeters.
  - Part Number: eC3-MCMM0606-12-8-F3-L  
 (Please indicate on Purchase Order)

Y1556

**Figure 7. SKY65362-11 Tape and Reel Dimensions**

## Ordering Information

| Model Name                     | Manufacturing Part Number | Evaluation Board Part Number |
|--------------------------------|---------------------------|------------------------------|
| SKY65362-11: High-Power RF FEM | SKY65362-11               | SKY65362-11-EK1              |

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