

**DATA SHEET**

# SKY66112-11: 2.4 GHz ZigBee®/Thread/Bluetooth® Smart Front-End Module

## Applications

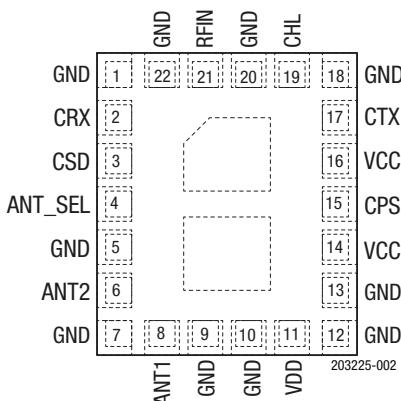
- In-home appliances
- Smart thermostats
- Internet of Things (IoT) devices
- Smart lighting
- Sensors
- Range extender

## Features

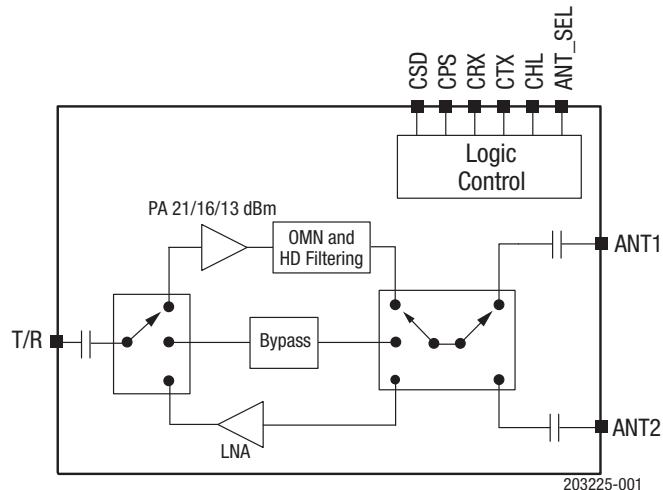
- Integrated PA with up to +21 dBm output power
- Integrated LNA (2 dB noise figure typical) and bypass path
- Integrated antenna diversity switching for all modes
- Single-ended transmit/receive interface
- Fast switch on/off time: < 800 ns
- Supply range: 1.8 V to 3.6 V
- Sleep mode current: < 1  $\mu$ A typical
- No external bias resistor is required
- Small MCM (22-pin, 3.5 mm x 3.0 mm x 1.0 mm) package, NiPdAu-plated (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 2. SKY66112-11 Pinout (Top View)**



**Figure 1. SKY66112-11 Block Diagram**

## Description

The SKY66112-11 is a high-performance, fully integrated RF front-end module (FEM) designed for ZigBee, Thread, and Bluetooth Smart applications.

The SKY66112-11 is designed for ease of use and maximum flexibility. The device provides an integrated inter-stage matching and harmonic filter, and digital controls compatible with 1.6 V to 3.6 V CMOS levels.

The RF blocks operate over a wide supply voltage range from 1.8 V to 3.6 V that allows the SKY66112-11 to be used in battery powered applications over a wide spectrum of the battery discharge curve.

A functional block diagram is shown in Figure 1. The SKY66112-11 is provided in a small, 22-pin, 3.5 mm x 3.0 mm Multi-Chip Module (MCM) package. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

**Table 1. SKY66112-11 Signal Descriptions<sup>1</sup>**

| Pin | Name    | Description  | Pin | Name | Description   |
|-----|---------|--|-----|------|---|
| 1   | GND     | Ground   | 12  | GND  | Ground  |
| 2   | CRX     | Connect to GPIO signal for mode control (see Table 6)          | 13  | GND  | Ground  |
| 3   | CSD     | Connect to GPIO signal for mode control (see Table 6)          | 14  | VCC2 | Connect to positive supply                            |
| 4   | ANT_SEL | Connect to GPIO signal to control antenna switch (see Table 7) | 15  | CPS  | Connect to GPIO signal for mode control (see Table 6) |
| 5   | GND     | Ground   | 16  | VCC1 | Connect to positive supply                            |
| 6   | ANT2    | Connect to 50 Ω antenna  | 17  | CTX  | Connect to GPIO signal for mode control (see Table 6) |
| 7   | GND     | Ground   | 18  | GND  | Ground  |
| 8   | ANT1    | Connect to 50 Ω antenna  | 19  | CHL  | Connect to GPIO signal for mode control (see Table 6) |
| 9   | GND     | Ground   | 20  | GND  | Ground  |
| 10  | GND     | Ground   | 21  | RFIN | RF input power (transmit/receive port)                |
| 11  | VDD     | Connect to positive supply                                     | 22  | GND  | Ground  |

<sup>1</sup> The paddle should be connected to ground.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY66112-11 are provided in Table 2. The recommended operating conditions are specified in Table 3, and electrical specifications are provided in Tables 4 and 5.

The state of the SKY66112-11 is determined by the logic provided in Table 6. Table 7 shows the antenna select logic.

**Table 2. SKY66112-11 Absolute Maximum Ratings<sup>1</sup>**

| Parameter   | Symbol  | Minimum              | Maximum              | Units |
|---|---|----------------------|----------------------|-------|
| Supply voltage  | V <sub>CC1</sub><br>V <sub>CC2</sub><br>V <sub>DD</sub> | -0.3<br>-0.3<br>-0.3 | +3.6<br>+3.6<br>+3.6 | V     |
| Control pin voltages                                      | V <sub>CTL</sub>  | -0.3                 | +3.6                 | V     |
| Transmit output power at ANT1 or ANT2 port into 50 Ω load | P <sub>OUT_TX_MAX</sub>                                 |                      | +22.5                | dBm   |
| Transmit input power at RFIN port                         | P <sub>IN_TX_MAX</sub>                                  |                      | +5.0                 | dBm   |
| Receive input power at ANT1 or ANT2 ports <sup>2</sup>    | P <sub>IN_RX_MAX</sub>                                  |                      | +15                  | dBm   |
| Bypass input power at ANT1 or ANT2 ports <sup>2</sup>     | P <sub>IN_BYP_MAX</sub>                                 |                      | +20                  | dBm   |
| Operating temperature                                     | T <sub>A</sub>  | -40                  | +85                  | °C    |
| Storage temperature                                       | T <sub>STG</sub>  | -40                  | +125                 | °C    |
| Electrostatic discharge:<br>Human Body Model (HBM)        | ESD   |                      | 3000                 | V     |

<sup>1</sup> 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.

<sup>2</sup> CW test signal.

**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. Recommended Operating Conditions**

| Parameter                  | Symbol | Minimum          | Typical | Maximum | Units |
|----------------------------|--------|------------------|---------|---------|-------|
| Supply voltage on VCC1 pin | Vcc1   | 1.7              | 1.8     | 3.3     | V     |
| Supply voltage on VCC2 pin | Vcc2   | 0.6              | 3.0     | 3.3     | V     |
| Supply voltage on VDD pin  | VDD    | 1.8 <sup>1</sup> | 3.0     | 3.3     | V     |
| Operating temperature      | TA     | -40              | +25     | +85     | °C    |

<sup>1</sup> Performance at VDD = 1.8 V will be slightly degraded compared to VDD = 2.5 V and above.

**Table 4. SKY66112-11 Electrical Specifications<sup>1</sup>**

(Vcc1 = 1.8 V, Vcc2 = 3.0 V, VDD = 3.0 V, TA = +25 °C, Unless Otherwise Noted)

| Parameter                                  | Symbol                             | Test Condition   | Min      | Typical               | Max                    | Units                |
|--|------------------------------------|--|----------|-----------------------|------------------------|----------------------|
| <b>DC Characteristics</b>                  |                                    |  |          |                       |                        |                      |
| Total supply current                       | Icc_TX                             | Pout = +21 dBm <sup>2</sup><br>Pout = +20 dBm <sup>2</sup><br>Pout = +16 dBm <sup>3</sup><br>Pout = +13 dBm <sup>4</sup> |          | 115<br>90<br>60<br>45 |                        | mA<br>mA<br>mA<br>mA |
| Total supply current                       | Icc_RX                             |  |          | 3.5                   | 6                      | mA                   |
| Total supply current                       | Icc_BYP                            |  |          | 5                     |                        | μA                   |
| Sleep supply current                       | Icc_OFF                            | No RF  |          |                       | 1                      | μA                   |
| Quiescent current                          | Icc0_TX                            | High-power mode <sup>2</sup><br>Low-power mode <sup>3</sup><br>Low-power mode <sup>4</sup>                               |          | 12<br>8<br>8          |                        | mA<br>mA<br>mA       |
| <b>Logic Characteristics</b>               |                                    |  |          |                       |                        |                      |
| Control voltage:<br>High<br>Low            | V <sub>IH</sub><br>V <sub>IL</sub> |  | 1.6<br>0 |                       | V <sub>DD</sub><br>0.3 | V<br>V               |
| Control current:<br>High<br>Low            | I <sub>IH</sub><br>I <sub>IL</sub> |  |          |                       | 1.0<br>1.0             | μA<br>μA             |
| <b>Dual Antenna Switch Characteristics</b> |                                    |  |          |                       |                        |                      |
| Isolation between ANT1 and ANT2 ports      | ISOANTSW                           |  |          | -20                   |                        | dB                   |
| ANT1 to ANT2 switching time                | t <sub>ANT1_ANT2</sub>             |  |          | 400                   |                        | ns                   |

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

<sup>2</sup> Vcc1 = 1.8 V, Vcc2 = 3.0 V

<sup>3</sup> Vcc1 = 1.8 V, Vcc2 = 1.8 V

<sup>4</sup> Vcc1 = 1.8 V, Vcc2 = 1.2 V

**Table 5. SKY66112-11 Electrical Specifications<sup>1</sup>**(V<sub>CC1</sub> = 1.8 V, V<sub>CC2</sub> = 3.0 V, V<sub>DD</sub> = 3.0 V, T<sub>A</sub> = +25 °C, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

| Parameter  | Symbol                            | Test Condition   | Min  | Typical                  | Max  | Units                    |
|--|-----------------------------------|--|--|--------------------------|------|--------------------------|
| <b>Transmit Characteristics</b>                            |                                   |  |  |                          |      |                          |
| Frequency range  | f                                 |  | 2400   |                          | 2483 | MHz                      |
| Output power at ANT1 or ANT2 port                          | P <sub>OUT</sub>                  | V <sub>CC1</sub> = 1.8 V, V <sub>CC2</sub> = 3.0 V, P <sub>IN</sub> = -1 dBm<br>V <sub>CC1</sub> = 1.8 V, V <sub>CC2</sub> = 3.0 V, P <sub>IN</sub> = -2 dBm<br>V <sub>CC1</sub> = 1.8 V, V <sub>CC2</sub> = 1.8 V, P <sub>IN</sub> = -3 dBm<br>V <sub>CC1</sub> = 1.8 V, V <sub>CC2</sub> = 1.2 V, P <sub>IN</sub> = -3 dBm |  | +21<br>+20<br>+16<br>+13 |      | dBm<br>dBm<br>dBm<br>dBm |
| Saturated gain, high power mode                            | G <sub>SAT</sub>                  |  |  | 22                       |      | dB                       |
| Saturated output power variation                           | ΔP <sub>OUT</sub>                 | Across all ZigBee channels   |  |                          | 1    | dBp-p                    |
| 2 <sup>nd</sup> and 3 <sup>rd</sup> harmonics <sup>2</sup> | 2f <sub>o</sub> , 3f <sub>o</sub> | P <sub>OUT</sub> = +20.0 dBm,<br>IEEE 802.15.4 source  |  |                          | -42  | dBm/MHz                  |
| Input return loss  | S <sub>11</sub>                   |  |  | -12                      |      | dB                       |
| Turn-on time <sup>2</sup>                                  | t <sub>RISE</sub>                 | From 50% of CTX edge to 90% of final RF output power   |  | 800                      |      | ns                       |
| Turn-off time <sup>2</sup>                                 | t <sub>FALL</sub>                 | From 50% of CTX edge to 10% of final RF output power   |  | 800                      |      | ns                       |
| Stability <sup>2</sup>                                     | STAB                              | CW, P <sub>IN</sub> = 0 dBm, 0.1 GHz to 20 GHz, load VSWR = 6:1  | All non-harmonically related outputs < -42 dBm/MHz |                          |      |                          |
| Ruggedness <sup>2</sup>                                    | RUG                               | CW, P <sub>IN</sub> = 0 dBm,<br>load VSWR = 10:1   | No permanent damage                                |                          |      |                          |
| <b>Receive Characteristics</b>                             |                                   |  |  |                          |      |                          |
| Frequency range  | f                                 |  | 2400   |                          | 2483 | MHz                      |
| Receive gain   | RX_GAIN                           |  |  | 11                       |      | dB                       |
| Receive noise figure                                       | NF                                |  |  | 2                        |      | dB                       |
| Third order input intercept point                          | IIP3                              |  |  | 0                        |      | dBm                      |
| 1 dB input compression point                               | IP1dB                             |  | -14  | -8                       |      | dBm                      |
| Input return loss  | S <sub>11</sub>                   | ANT1 or ANT2 ports   |  | -10                      |      | dB                       |
| Output return loss   | S <sub>22</sub>                   |  |  | -12                      |      | dB                       |
| Turn-on time <sup>2</sup>                                  | t <sub>RISE</sub>                 | From 50% of CRX edge to 90% of final RF output power   |  | 800                      |      | ns                       |
| Turn-off time <sup>2</sup>                                 | t <sub>FALL</sub>                 | From 50% of CRX edge to 10% of final RF output power   |  | 800                      |      | ns                       |
| <b>Bypass Characteristics</b>                              |                                   |  |  |                          |      |                          |
| Frequency range  | f                                 |  | 2400   |                          | 2483 | MHz                      |
| Bypass gain  | BYP_GAIN                          |  |  | -2                       |      | dB                       |
| Input return loss  | S <sub>11</sub>                   |  |  | -15                      |      | dB                       |
| Output return loss   | S <sub>22</sub>                   |  |  | -20                      |      | dB                       |

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.<sup>2</sup> Not tested in production. Fully characterized and guaranteed by design.

**Table 6. SKY66112-11 Mode Control Logic<sup>1</sup>**(V<sub>CC1</sub> = 1.8 V, V<sub>CC2</sub> = 3.0 V, V<sub>DD</sub> = 3.0 V, T<sub>A</sub> = +25 °C)

| Mode | Description                       | CSD (Pin 3) | CPS (Pin 15) | CRX (Pin 2) | CTX (Pin 17) | CHL (Pin 19) |
|------|-----------------------------------|-------------|--------------|-------------|--------------|--------------|
| 0    | All off (sleep mode) <sup>1</sup> | 0           | X            | X           | X            | X            |
| 1    | Receive LNA mode                  | 1           | 0            | 1           | 0            | X            |
| 2    | Transmit high-power mode          | 1           | 0            | X           | 1            | 1            |
| 3    | Transmit low-power mode           | 1           | 0            | X           | 1            | 0            |
| 4    | Receive bypass mode               | 1           | 1            | 1           | 0            | X            |
| 5    | Transmit bypass mode              | 1           | 1            | X           | 1            | X            |
| 6    | All off (sleep mode)              | 1           | X            | 0           | 0            | X            |

<sup>1</sup> All controls must be at logic “0” to achieve the specified sleep current.**Table 7. SKY66112-11 Antenna Select Logic**(V<sub>CC1</sub> = 1.8 V, V<sub>CC2</sub> = 3.0 V, V<sub>DD</sub> = 3.0 V, T<sub>A</sub> = +25 °C)

| Description       | ANT_SEL (Pin 4) |
|-------------------|-----------------|
| ANT1 port enabled | 0               |
| ANT2 port enabled | 1               |

## Application Schematic Description

A reference design schematic is provided in Figure 3. An evaluation board schematic diagram is shown in Figure 4.

## Package Dimensions

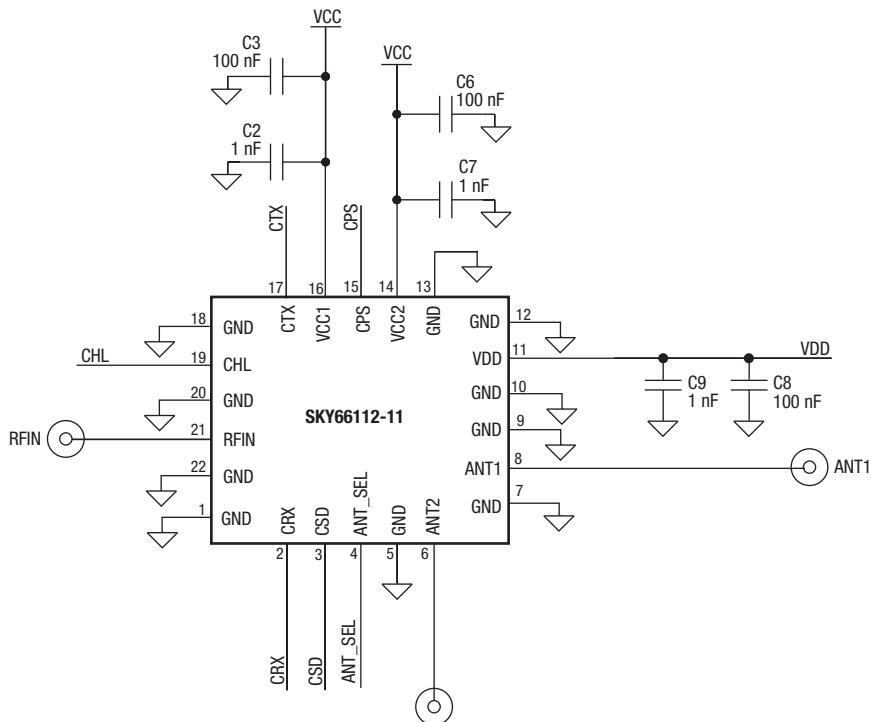
The PCB layout footprint for the SKY66112-11 is provided in Figure 5. The typical part marking is shown in Figure 6. Package dimensions are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

## 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 SKY66112-11 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.

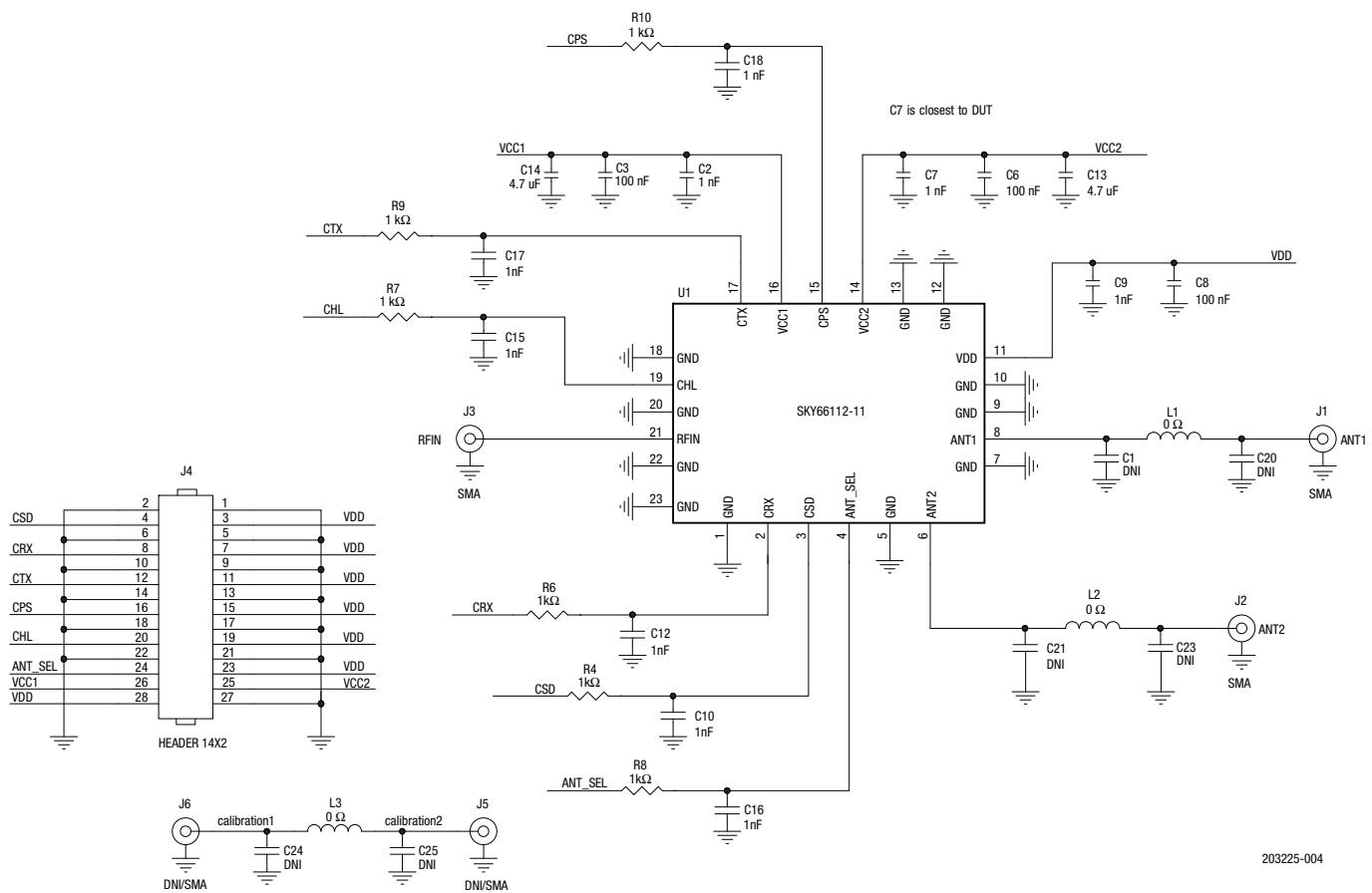
Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.



*Note: The paddle should be connected to ground.*

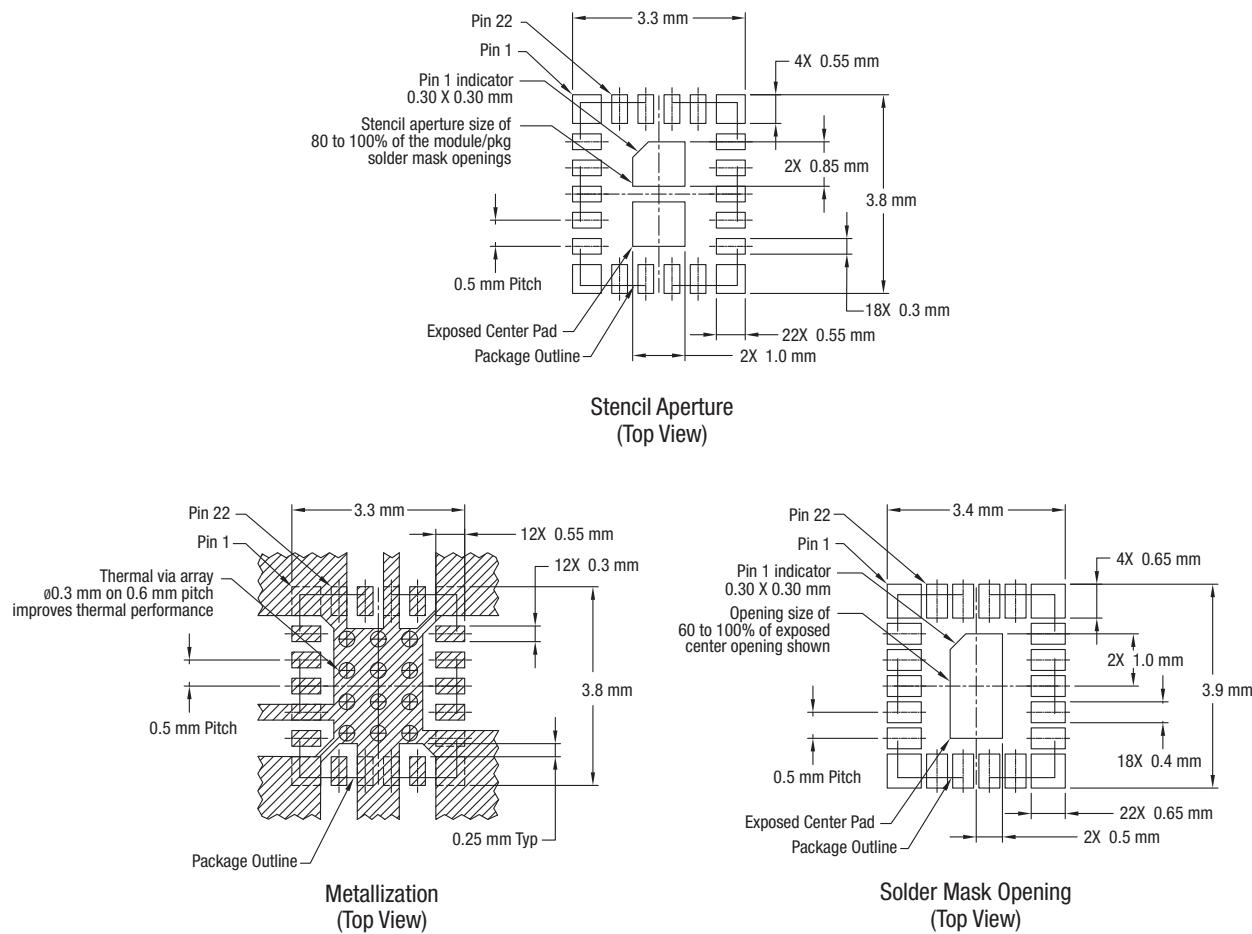
203225-003

**Figure 3. SKY66112-11 Reference Design Schematic**



203225-004

Figure 4. SKY66112-11 Evaluation Board Schematic Diagram



*Note:*

1. All measurements are in millimeters.
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.

203225-005

Figure 5. SKY66112-11 PCB Layout Footprint

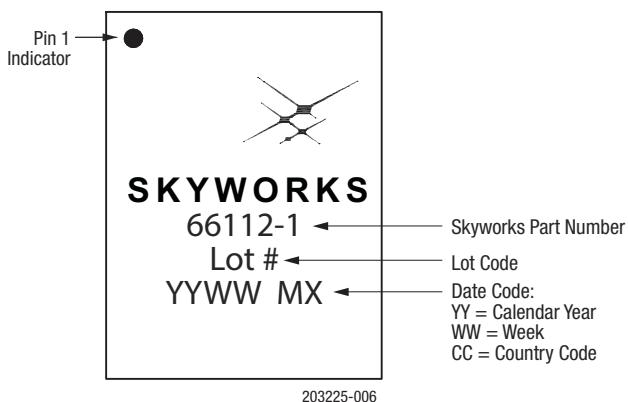
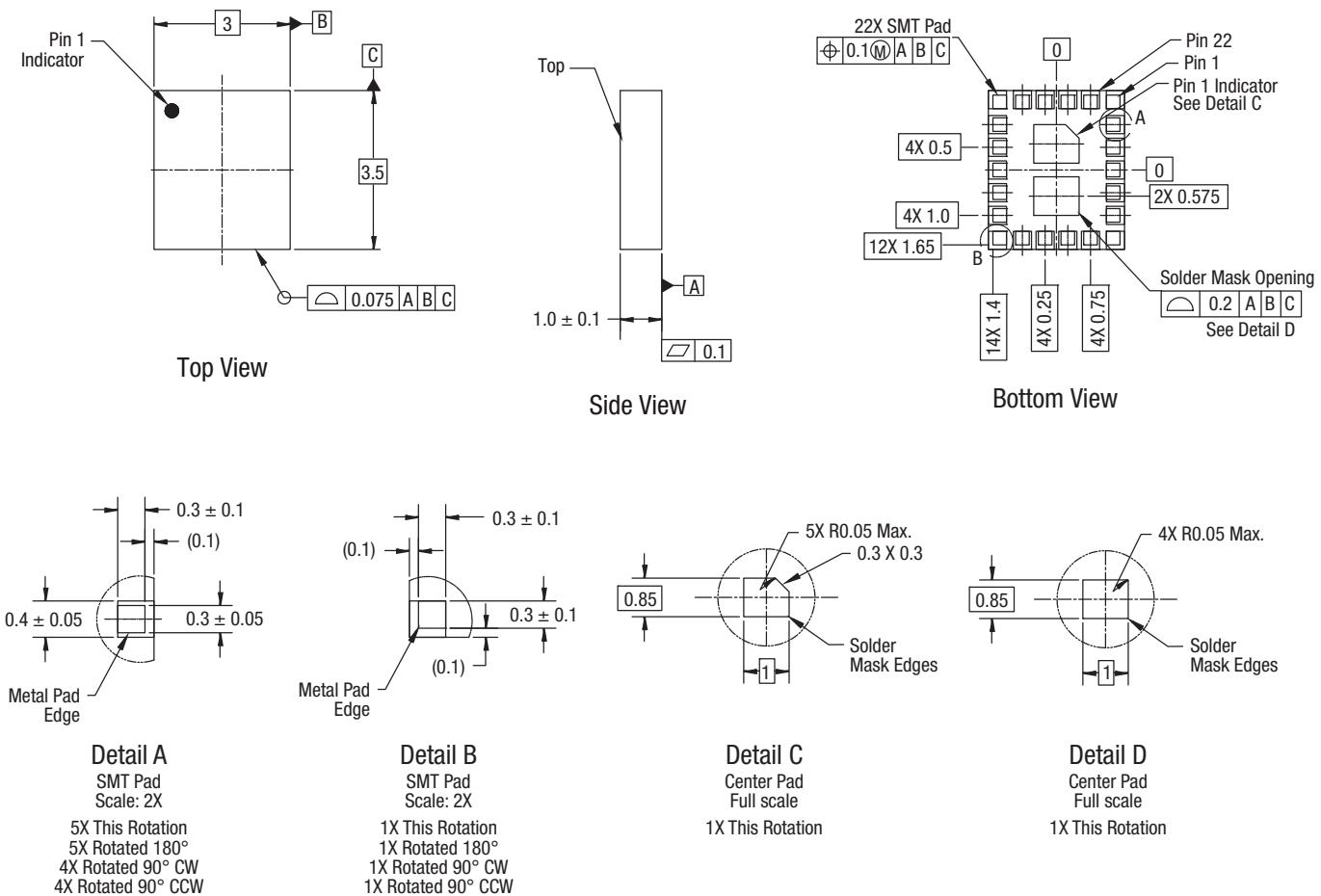


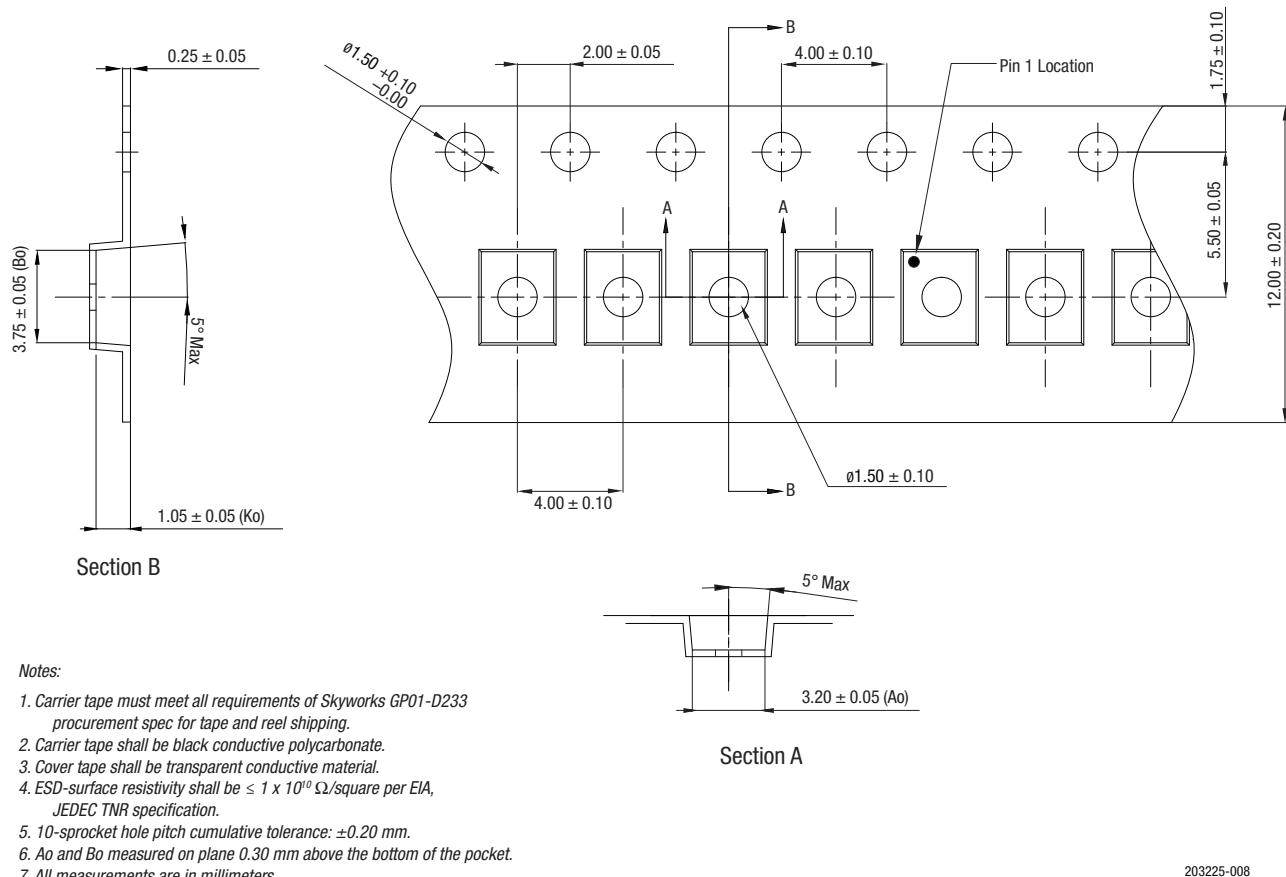
Figure 6. SKY66112-11 Typical Part Marking (Top View)

**Notes:**

Dimensions and tolerances according to ASME Y14.5M-1994.  
All measurements are in millimeters.

203225-007

**Figure 7. SKY66112-11 Package Dimensions**



**Figure 8. SKY66112-11 Tape and Reel Dimensions**

## Ordering Information

| Model Name   | Manufacturing Part Number | Evaluation Board Part Number |
|--|---------------------------|------------------------------|
| SKY66112-11: 2.4 GHz Zigbee/Thread/Bluetooth Smart FEM | SKY66112-11               | SKY66112-11EK1               |

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