

**DATA SHEET**

# SKY85202-11: 2.4 GHz, 802.11ac Switch/Low-Noise Amplifier Front-End

**Applications**

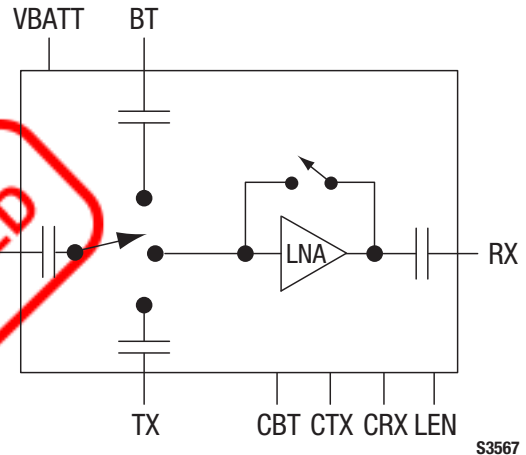
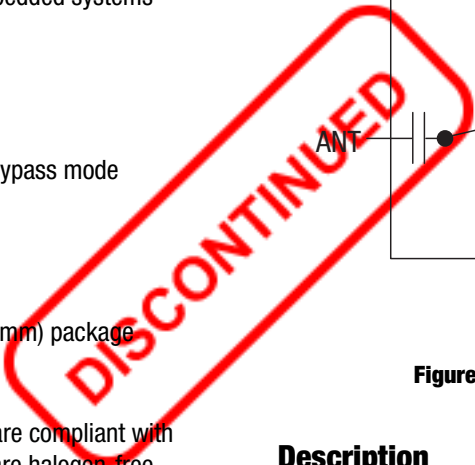
- WiFi-enabled handsets, tablets, and mobile systems
- System-in-Package (SiP) modules for embedded systems
- 802.11n/ac smartphones and tablets

**Features**

- Integrates an SP3T switch and LNA with bypass mode
- Receive gain: 14 dB
- Noise figure: 2 dB
- Transmit/Bluetooth® path loss: 0.6 dB
- Small flip chip die (15-bump, 1.04 x 1.04 mm) package (MSL1, 260 °C per JEDEC-J-STD-020)



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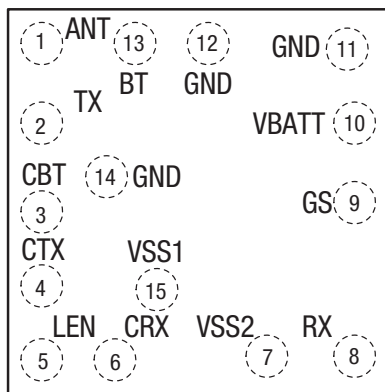


**Figure 1. SKY85202-11 Block Diagram**

**Description**

The SKY85202-11 integrates a single-pole, triple-throw (SP3T) switch and low-noise amplifier (LNA) with a bypass mode in an ultra-compact package. The device is capable of switching between WLAN receive and WLAN transmit.

The SKY85202-11 is provided as a small, 15-bump, 1.04 x 1.04 mm flip chip die 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. SKY85202-11 Pinout – 15-Bump Flip Chip Die (Top View, Bumps Down)**

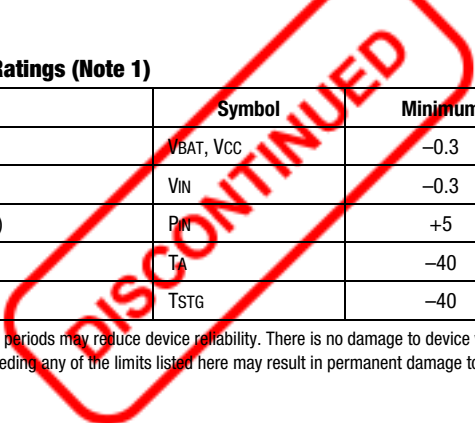
**Table 1. SKY85202-11 Signal Descriptions**

| Pin | Name | Description    | Pin | Name  | Description    |
|-----|------|----------------|-----|-------|----------------|
| 1   | ANT  | Antenna port   | 9   | GS    | Ground         |
| 2   | TX   | Transmit input | 10  | VBATT | Supply voltage |
| 3   | CBT  | Control signal | 11  | GND   | Ground         |
| 4   | CTX  | Control signal | 12  | GND   | Ground         |
| 5   | LEN  | Control signal | 13  | BT    | Bluetooth port |
| 6   | CRX  | Control signal | 14  | GND   | Ground         |
| 7   | VSS2 | Ground         | 15  | VSS1  | Ground         |
| 8   | RX   | LNA output     |     |       |                |

**Table 2. SKY85202-11 Absolute Maximum Ratings (Note 1)**

| Parameter  | Symbol    | Minimum | Maximum | Units |
|--|-----------|---------|---------|-------|
| Supply voltage                                   | VBAT, VCC | -0.3    | +5.5    | V     |
| DC input on control pins                         | VIN       | -0.3    | +3.6    | V     |
| LNA input power (RXOUT terminated in 50 Ω match) | Pin       | +5      |         | dBm   |
| Operating temperature                            | TA        | -40     | +85     | °C    |
| Storage temperature                              | TSTG      | -40     | +140    | °C    |

**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. Recommended Operating Conditions**

| Parameter                                 | Symbol | Minimum | Typical | Maximum | Units |
|---|--------|---------|---------|---------|-------|
| Supply voltage relative to ground (= 0 V) | VDD    | 2.7     | 3.6     | 5.0     | V     |
| Control voltage:                          |        |         |         |         |       |
| High                                      | VIH    | 1.6     |         | 3.6     | V     |
| Low                                       | VIL    | 0       |         | 0.4     | V     |
| Control current:                          |        |         |         |         |       |
| High                                      | IiH    |         |         | 5       | μA    |
| Low                                       | IiL    |         |         | 1       | μA    |
| Operating temperature                     | TA     | -40     | +25     | +85     | °C    |

**Electrical and Mechanical Specifications**

The absolute maximum ratings of the SKY85202-11 are provided in Table 2. The recommended operating conditions are specified in Table 3, and electrical specifications are provided in Tables 4 through 7.

The state of the SKY85202-11 is determined by the logic provided in Table 8.

**Table 4. SKY85202-11 Electrical Specifications: DC Characteristics (Note 1)**  
**(V<sub>DD</sub> = 3.6 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 |
|----------------|-----------------|----------------|-----|---------|-----|-------|
| Supply current | I <sub>CC</sub> | LNA enabled    |     | 10      | 13  | mA    |
|                |                 | Transmit mode  |     | 8       | 12  | μA    |
|                |                 | Bypass mode    |     | 8       | 12  | μA    |
|                |                 | All off        |     | 8       | 12  | μA    |

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

**Table 5. SKY85202-11 Electrical Specifications: Transmit (ANT to TX) Characteristics (Note 1)**  
**(V<sub>DD</sub> = 3.6 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 |
|---|------------------|--|------|---------|------|-------|
| Frequency                                   | f                |  | 2400 |         | 2500 | MHz   |
| Insertion loss                              | TX <sub>IL</sub> | Insertion loss from TX input to ANT port |      | 0.6     | 0.9  | dB    |
| 1 dB Input Compression Point (TX port)      | IP1dB            |  | 29   | 31      |      | dBm   |
| Transmit input return loss (TX port)        | S11              |  | 18   | 20      |      | dB    |
| Output return loss (ANT port)               | S22              |  | 15   | 20      |      | dB    |
| ANT to RX isolation, bypass (loopback) mode |                  |  | 40   | 43      | 46   | dB    |

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

**Table 6. SKY85202-11 Electrical Specifications: Transmit (ANT to BT) Characteristics (Note 1)**  
**(V<sub>DD</sub> = 3.6 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 |
|--|------------------|--|------|---------|------|-------|
| Frequency                              | f                |  | 2400 |         | 2500 | MHz   |
| Insertion loss                         | BT <sub>IL</sub> | Insertion loss from BT input to ANT port |      | 0.6     | 0.9  | dB    |
| 1 dB Input Compression Point (BT port) | IP1dB            |  | 29   | 31      |      | dBm   |
| Transmit input return loss (BT port)   | S11              |  | 18   | 20      |      | dB    |
| Output return loss (ANT port)          | S22              |  | 15   | 20      |      | dB    |

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

**Table 7. SKY85202-11 Electrical Specifications: Receive (ANT to RX Port) Characteristics (Note 1)**  
**(VDD = 3.6 V, TA = +25 °C, All Unused Ports Terminated With 50 Ω, Unless Otherwise Noted)**

| Parameter   | Symbol     | Test Condition   | Min  | Typical | Max   | Units |
|---|------------|--|------|---------|-------|-------|
| Frequency   | f          |  | 2400 |         | 2500  | MHz   |
| Small signal gain                                 | S21        | LNA enabled  | +13  | +14     | +16   | dB    |
|   |            | Bypass mode  | -8   | -7      | -5.5  | dB    |
| LNA gain step                                     | Gain_STEP  | Gain step change between LNA normal and LNA bypass modes | 19   | 21      | 23    | dB    |
| Gain flatness                                     |            | Over 20 MHz  |      |         | ±0.25 | dB    |
|   |            | Full band  |      |         | ±1.00 | dB    |
| Noise Figure                                      | NF         | LNA enabled  |      | 2       | 2.5   | dB    |
|   |            | Bypass mode  |      | 7       | 8     | dB    |
| Third Order Input Intercept Point                 | IIP3       | LNA enabled  | +3   | +5      |       | dBm   |
|   |            | Bypass mode  | +24  | +27     |       | dBm   |
| Receive input return loss                         | S11        |  |      | -12     | -10   | dB    |
| Receive output return loss                        | S22        |  |      | -18     | -12   | dB    |
| Receive LNA ON to transmit (or BT) switching time | trX-TX(BT) | 10% to 90%   |      |         | 500   | ns    |
| Transmit (or BT) to Receive LNA ON switching time | trX(BT)-RX | 10% to 90%   |      |         | 700   | ns    |
| Receive Bypass to LNA ON switching time           | toFF – toN | 10% to 90%   |      |         | 700   | ns    |
| Receive LNA ON to Bypass switching time           | toN – toFF | 90% to 10%   |      |         | 200   | ns    |

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

**Table 8. SKY85202-11 Control Logic (Note 1)**

| Mode                | CBT<br>(Bump 3) | CTX<br>(Bump 4) | LEN<br>(Bump 5) | CRX<br>(Bump 6) |
|---------------------|-----------------|-----------------|-----------------|-----------------|
| All off             | 0               | 0               | 0               | 0               |
| WLAN receive LNA    | 0               | 0               | 1               | 1               |
| WLAN receive bypass | 0               | 0               | 0               | 1               |
| Bluetooth           | 1               | 0               | 0               | 0               |
| WLAN transmit       | 0               | 1               | 0               | 0               |

**Note 1:** “0” = 0 V to +0.4 V. “1” = +1.6 V to +3.6 V. Any state other than described in this table places the switch into an undefined state. An undefined state will not damage the device.

## Evaluation Board Description

The SKY85202-11 Evaluation Board is used to test the performance of the SKY85202-11 LNA FEM. An Evaluation Board schematic diagram is provided in Figure 3. A photograph of the Evaluation Board is shown in Figure 4.

## Evaluation Board Procedure

1. Connect the system ground to pin 1 of connector J5.
2. Apply 3.3 V to VBAT pin 20 of connector J5.
3. Refer to the Control Logic Table in Table 9 to set the device in the desired mode of operation.
4. Transmit performance is monitored by applying an RF signal to connector J3 (TX) and measuring the output power at the antenna port connector J2 (ANT).

Receive performance in either high gain or bypass mode is monitored by applying an RF signal to the antenna port connector J2 (ANT) and measuring the output power at the receive port connector J1 (RX).

Bluetooth performance is monitored by applying an RF signal to the J4 connector (BT) and measuring the output power at the antenna port connector J2 (ANT).

## Evaluation Board Losses

The total track losses from the RF connectors of the Evaluation Board to the flip chip die bumps of the SKY85202-11 are:

|      |         |
|------|---------|
| ANT: | 0.12 dB |
| TX:  | 0.11 dB |
| BT:  | 0.08 dB |
| RX:  | 0.08 dB |

## Package Dimensions

The PCB layout footprint for the SKY85202-11 is provided in Figure 5. The typical part marking is shown in Figure 6. Package dimensions for the 15-bump flip chip die are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

## 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 SKY85202-11 is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering.

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.

## Pad Coordinates

The SKY85202-11 pad coordinates are provided in Table 9 (also refer to the pinout diagram in Figure 2). The origin of the coordinates (i.e., X = 0, Y = 0) is located at the center of the SKY85202-11 package. Sense is top view through package (PCB footprint).

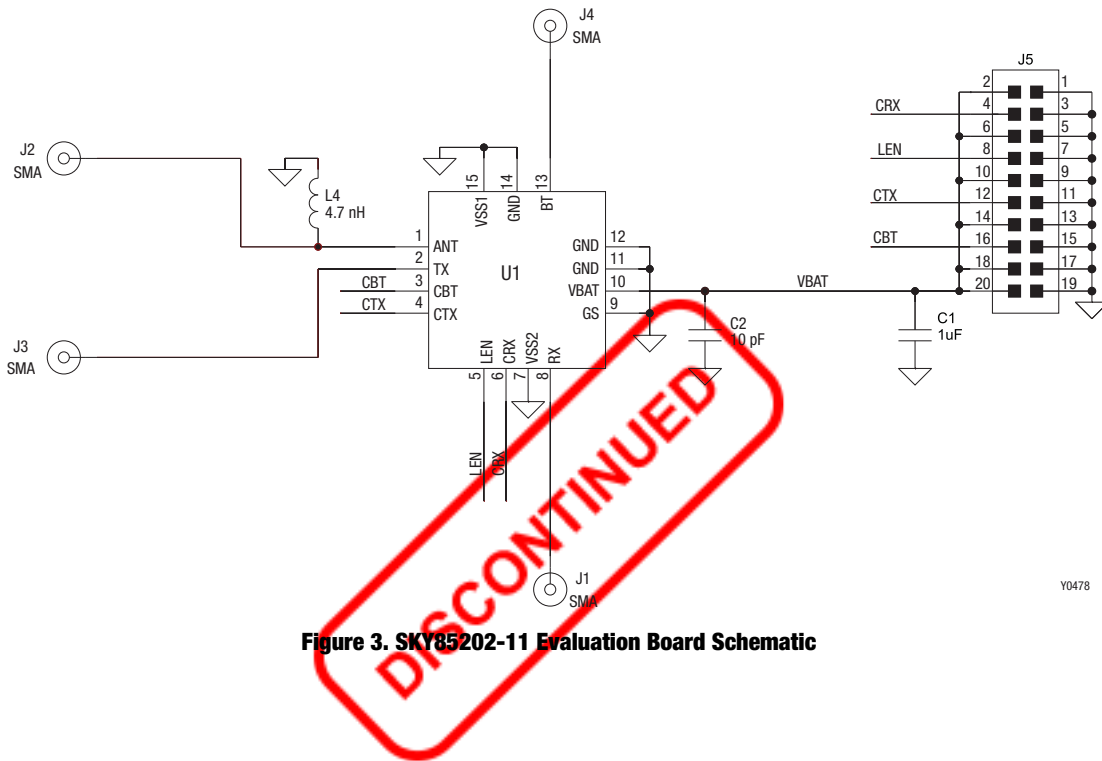
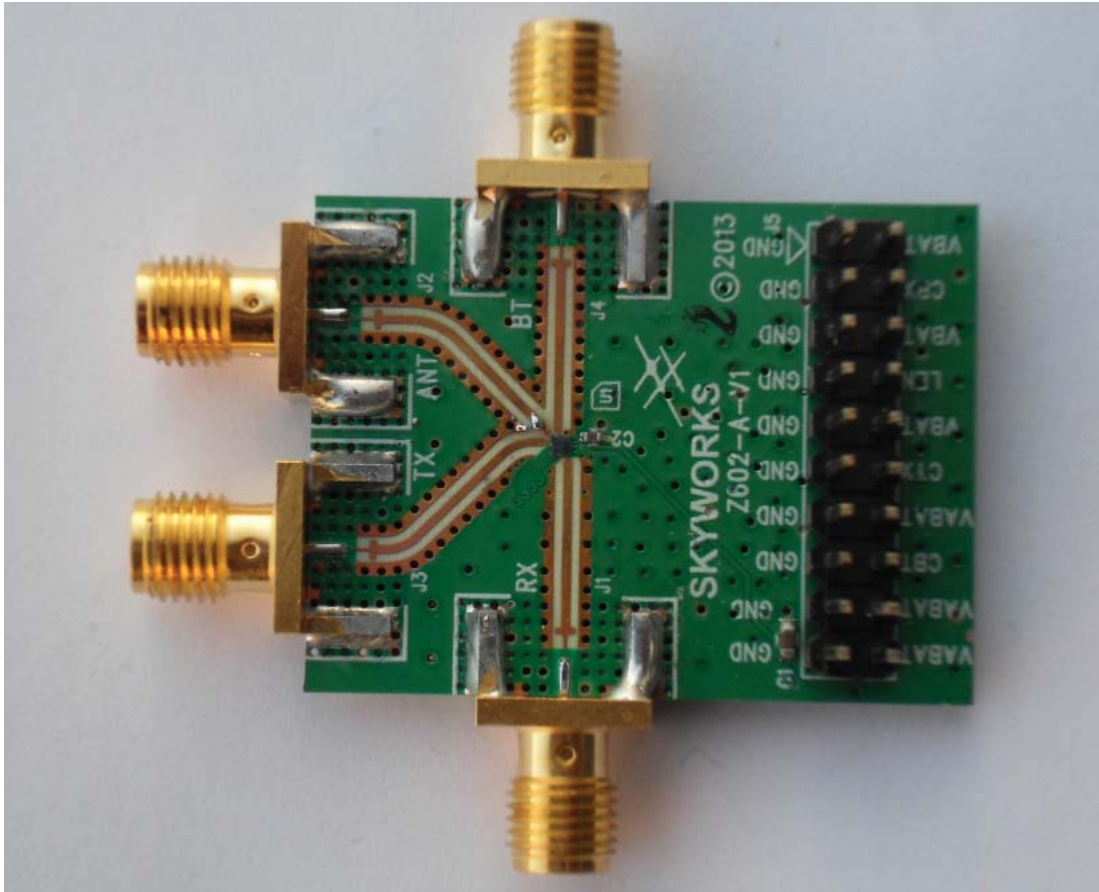


Figure 3. SKY85202-11 Evaluation Board Schematic

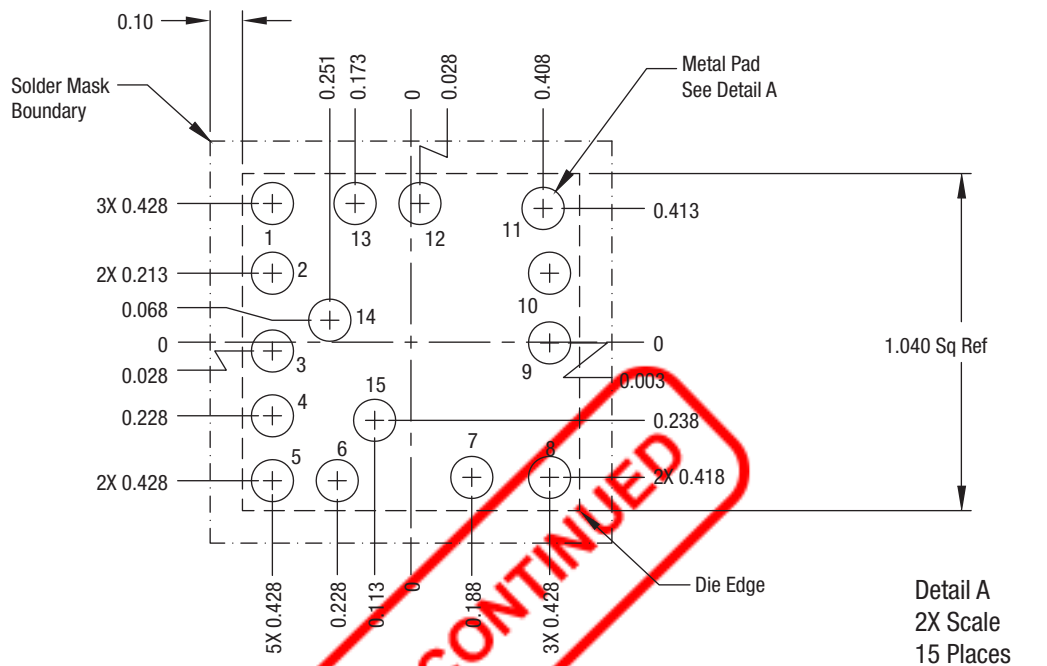
Table 8. SKY85202-11 Bump Pad Coordinates

| Bump Number | Signal | Bump Coordinates<br>(Top View) |                        |
|-------------|--------|--------------------------------|------------------------|
|             |        | X<br>( $\mu\text{m}$ )         | Y<br>( $\mu\text{m}$ ) |
| 1           | ANT    | -428                           | +428                   |
| 2           | TX     | -428                           | +213                   |
| 3           | CBT    | -428                           | -28                    |
| 4           | CTX    | -428                           | -228                   |
| 5           | LEN    | -428                           | -428                   |
| 6           | CRX    | -228                           | -428                   |
| 7           | VSS2   | +188                           | -418                   |
| 8           | RX     | +428                           | -418                   |
| 9           | GS     | +428                           | -3                     |
| 10          | VBATT  | +428                           | +213                   |
| 11          | GND    | +408                           | +413                   |
| 12          | GND    | +28                            | +428                   |
| 13          | BT     | -173                           | +428                   |
| 14          | GND    | -251                           | +68                    |
| 15          | VSS1   | -113                           | -238                   |



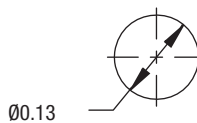
Y0479

Figure 4. SKY85202-11 Evaluation Board



Notes:

1. All measurements are in millimeters.
2. Dimensions and tolerances according to ASME Y14.5M-1994.
3. Unless specified, dimensions are symmetrical about center lines.
4. Unless otherwise specified, the following values apply:  
 Decimal Tolerance:            Angular Tolerance:  
 X.X (1 place) ± 0.1 mm            ±1/2°  
 X.XX (2 places) ± 0.05 mm  
 X.XXX (3 places) ± 0.025 mm



Y0480

Figure 5. SKY85202-11 PCB Footprint

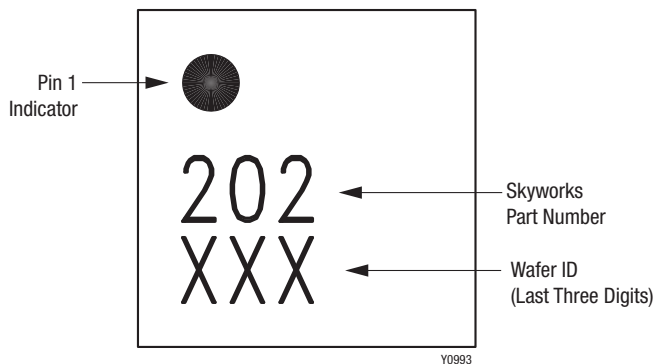
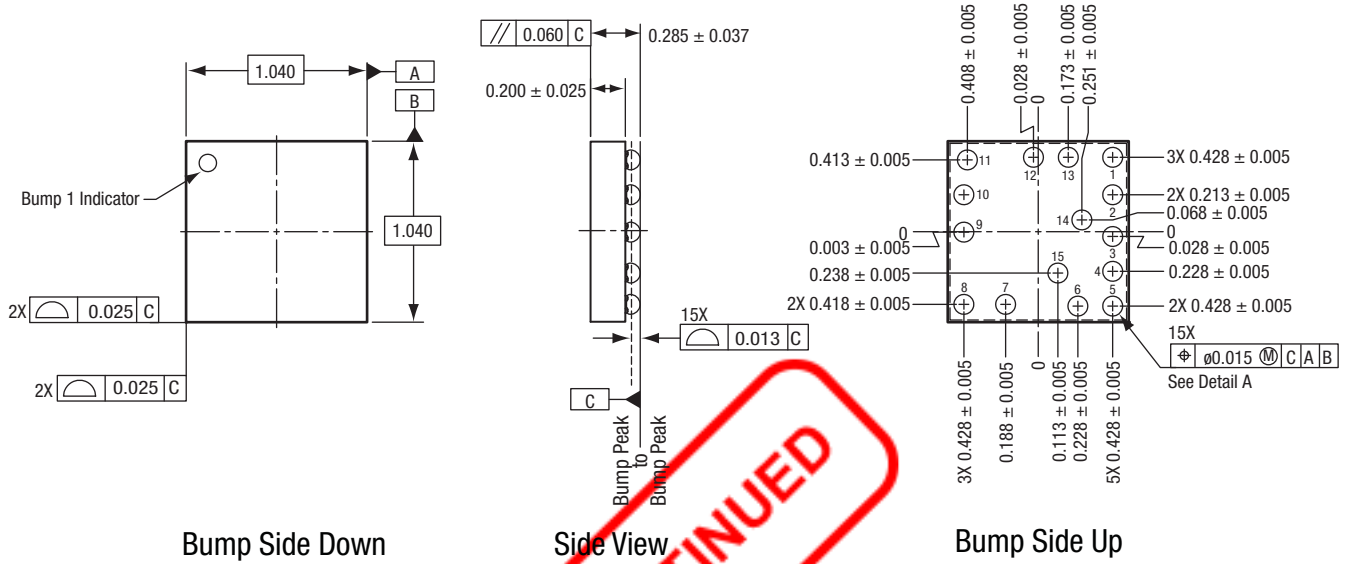


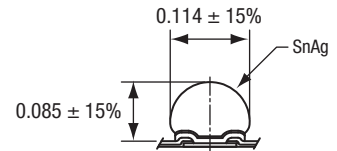
Figure 6. Typical Part Marking





Notes:

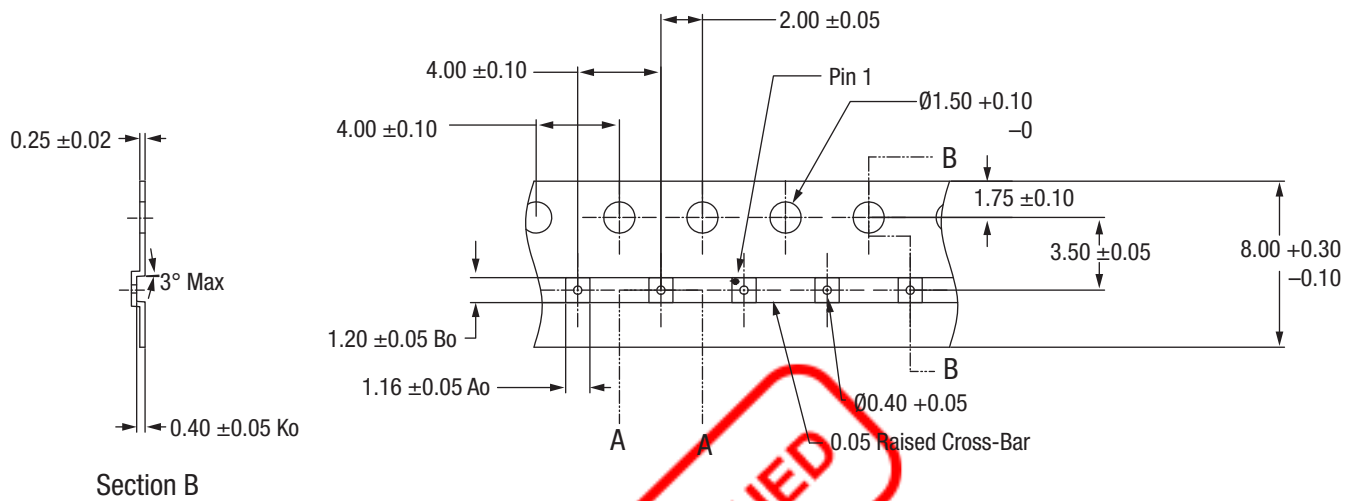
1. All measurements are in millimeters.
2. Dimensions and tolerances according to ASME Y14.5M-1994.
3. Unless otherwise specified, the following values apply:  
 Decimal Tolerance: Angular Tolerance:  
 X.X (1 place) ± 0.1 mm ±1/2°  
 X.XX (2 places) ± 0.05 mm  
 X.XXX (3 places) ± 0.025 mm
4. Unless specified, dimensions are symmetrical about center lines.



Detail A  
Scale: 4X  
15 Places

Y0994

Figure 7. SKY85202-11 15-Bump Flip Chip Die Package Dimensions



Notes:

1. Carrier tape: black conductive polycarbonate.
2. Cover tape material: transparent conductive.
3. All dimensions are in millimeters.
4. 10-sprocket hole pitch cumulative tolerance on tape:  $\pm 0.20$  mm.
5.  $A_o$  and  $B_o$  measurement point to be 0.30 mm from bottom of pocket.
6. Pocket position relative to sprocket hole measured as true position of pocket.

Tolerances:

Decimals:  $.x = \pm 0.15$       Angles:  $\pm 1^\circ$   
 .xx =  $\pm 0.10$



Section A

Figure 8. SKY85202-11 Tape and Reel Dimensions

Y0483

**Ordering Information**

| Model Name  | Manufacturing Part Number | Evaluation Board Part Number |
|---|---------------------------|------------------------------|
| SKY85202-11: 2.4 GHz, 802.11ac Switch/LNA Front-End | SKY85202-11               | SKY85202-11-EVB              |



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