

DATA SHEET

SKY66110-11: Low-Power Bluetooth® Low Energy Front-End Module for Range Extension Applications

Applications

- Range extender
- Wearable technology
- Beacons
- Sensors
- Home automation
- Internet of Things (IoT) devices

Features

- Low power consumption: 10 mA @ +10 dBm
- Output: +10 dBm
- Supply operation: 1.8 to 5 V
- Low sleep current: < 1 μ A
- RX bypass
- Small MCM (20-pin, 3.3 x 3.0 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.

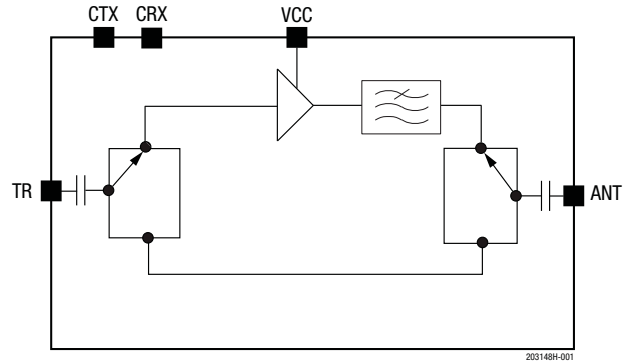


Figure 1. SKY66110-11 Functional Block Diagram

Description

The SKY66110-11 is a highly integrated front-end module (FEM) designed for Bluetooth Low Energy (BLE) range extension applications operating in the 2.4 to 2.485 GHz range.

The device is provided in a 3.3 x 3.0 x 0.8 mm MCM package. A functional block diagram is shown in Figure 1. Pin assignments are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

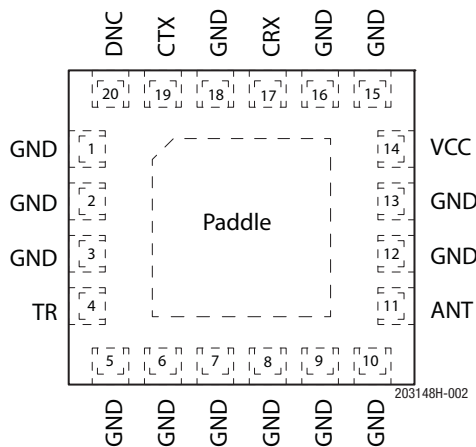


Figure 2. SKY66110-11 Pinout (Top View)

Table 1. SKY66110-11 Signal Descriptions¹

| Pin | Name | Description | Pin | Name | Description |
|-----|------|------------------------------|-----|------|--|
| 1 | GND | Ground | 11 | ANT | Antenna port |
| 2 | GND | Ground | 12 | GND | Ground |
| 3 | GND | Ground | 13 | GND | Ground |
| 4 | TR | Common receive/transmit port | 14 | VCC | Positive power supply |
| 5 | GND | Ground | 15 | GND | Ground |
| 6 | GND | Ground | 16 | GND | Ground |
| 7 | GND | Ground | 17 | CRX | RX control signal |
| 8 | GND | Ground | 18 | GND | Ground |
| 9 | GND | Ground | 19 | CTX | Tx control signal and amplifier bias voltage |
| 10 | GND | Ground | 20 | DNC | Do not connect |

¹ The paddle should be connected to ground. See Figure 6.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY66110-11 are provided in Table 2. The recommended operating conditions are specified in Table 3.

Electrical specifications are provided in Tables 4 through 8.

Table 2. SKY66110-11 Absolute Maximum Ratings¹

| Parameter | Symbol | Minimum | Maximum | Units |
|---|------------|---------|---------|-------|
| Supply voltage | VCC | | 5.5 | V |
| Control voltages | VCTX, VCRX | | 5.0 | V |
| RF Input power | PIN | | +20 | dBm |
| Voltage standing wave ratio | VSWR | | 10:1 | |
| Operating temperature | TA | -40 | +85 | °C |
| Storage temperature | TSTG | -65 | +150 | °C |
| Electrostatic discharge: Human Body Model (HBM), Class 0 | ESD | | 150 | V |

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.

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 | Min | Typ | Max | Units |
|-----------------------|------------|-----|-----|-------|-------|
| Frequency | f | 2.4 | | 2.485 | GHz |
| Supply voltage | VCC | 1.8 | 3 | 5.0 | V |
| Control voltages | VCTX, VCRX | 1.7 | 3 | VCC | V |
| Operating temperature | TA | | 25 | | °C |

Table 4. SKY66110-11 Electrical Specifications: DC Characteristics¹
(V_{CC} = 3.3 V, V_{CTX} = 1.8 V, T_A = +25 °C, R_S = 0 kΩ, Characteristic Impedance [Z₀] = 50 Ω, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|-----------------------------------|----------------------|---|-----|-------------------------|-----|----------------------|
| RX current (bypass) | I _{CQ_RX} | RX mode | | 1 | | μA |
| TX quiescent current ² | I _{CQ_TX} | TX mode | | 6 | | mA |
| TX operating current ² | I _{OP_TX} | TX mode (P _{IN} = -1 dBm): V _{CC} = 1.8 V V _{CC} = 3.0 V V _{CC} = 3.3 V V _{CC} = 5.0 V | | 8.5 10 10.5 11 | | mA mA mA mA |
| TX bias current (CTX pin) | I _{BIAS_TX} | | | 550 | | μA |
| Sleep current ³ | I _{CC_OFF} | Sleep mode | | 0.1 | 1 | μA |

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

² For total current, I_{BIAS_TX} should be added to the values.

³ V_{CTX} = 0 V.

Table 5. SKY66110-11 Electrical Specifications Transmit Characteristics¹
(V_{CC} = 3.3 V, V_{CTX} = 1.8 V, T_A = +25 °C, P_{IN} = -1 dBm, R_S = 0 kΩ, Characteristic Impedance [Z₀] = 50 Ω, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|--|-------------------------------------|--|-----|-----------------------------|-----|--------------------------|
| Output power | P _{OUT} | V _{CC} = 1.8 V V _{CC} = 3.0 V V _{CC} = 3.3 V V _{CC} = 5.0 V | | +8 +10 +10.3 +10.8 | | dBm dBm dBm dBm |
| Saturated gain ² | G _{SAT} | P _{IN} = -1 dBm | | 11 | | dB |
| Gain slope | G _{SLOPE} | Over frequency range | | 0.7 | 1 | dB |
| Input return loss | S ₁₁ | | | -14 | | dB |
| Output return loss | S ₂₂ | | | -10 | | dB |
| Insertion loss (sleep mode) ² | S _{21_SLEEP} | | | -15 | -12 | dB |
| Third order input intercept point ² | IIP ₃ | @ 2.44 GHz, Δf = ± 1 MHz, P _{IN} = -14 dBm/tone | | +5 | | dBm |
| Third order output intercept point ² | OIP ₃ | @ 2.44 GHz, Δf = ± 1 MHz, P _{IN} = -14 dBm/tone | | +16 | | dBm |
| 1 dB input compression point | IP1dB | | | -1 | | dBm |
| 1 dB output compression point | OP1dB | | | +10 | | dBm |
| 2 nd to 10 th harmonics ² | 2f _o to 10f _o | | | | -30 | dBm/MHz |
| RX to TX transition time ² | t _{SWITCH} | 10% to 90% RF 50% V _{CTX} to 90% RF | | 500 | | ns |
| TX power on time ² | t _{ON} | 10% to 90% RF 50% V _{CTX} to 90% RF | | 500 | | ns |
| TX power off time ² | t _{OFF} | 90% to 10% RF 50% V _{CTX} to 10% RF | | 150 | | ns |

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

² Guaranteed by characterization.

Table 6. SKY66110-11 Electrical Specifications: Receive Characteristics¹

(V_{CC} = 3.3 V, V_{CRX} = 1.8 V, V_{CTX} = 0 V, T_A = +25 °C, P_{IN} = -20 dBm, Characteristic Impedance [Z₀] = 50 Ω, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|---------------------------------------|---------------------|---|-----|-----|-----|-------|
| Insertion loss | S21 | | | 0.9 | | dB |
| Isolation | S12 | TX Mode (P _{IN} = -20 dBm) | | 25 | | dB |
| Input return loss | S11 | | | -15 | | dB |
| Output return loss | S22 | | | -15 | | dB |
| TX to RX transition time ² | t _{SWITCH} | 10% to 90% RF 50% V _{CRX} to 90% RF | | 500 | | ns |
| RX power on time ² | t _{ON} | 10% to 90% RF 50% V _{CRX} to 90% RF | | 150 | | ns |
| RX power off time ² | t _{OFF} | 90% to 10% RF 50% V _{CRX} to 10% RF | | 150 | | ns |

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

² Guaranteed by characterization.

Table 7. SKY66110-11 Electrical Characteristics: Logic Characteristics (T_A = +25 °C)

| Parameter | Symbol | Minimum | Maximum | Units |
|---------------------------------|-------------------|---------|---------|-------|
| Voltage logic high ¹ | V _{HIGH} | 1.8 | 5 | V |
| Voltage logic low | V _{LOW} | 0 | 0.2 | V |

¹ Difference between logic high voltages for V_{CRX} and V_{CTX} should not exceed 0.2 V.

Table 8. SKY66110-11 Mode Logic Truth Table

| Mode | CTX | CRX |
|------------------------------------|-----|-----|
| Sleep mode | 0 | 0 |
| Receive (RX) mode | 0 | 1 |
| Transmit (TX) mode | 1 | 0 |
| Non-permissible state ¹ | 1 | 1 |

¹ This state will enable both the TX and RX paths. It is not permitted to operate in this state.

Evaluation Board Description

The SKY66110-11 Evaluation Board is used to test the performance of the SKY66110-11 front-end module. The board is optimized for evaluation, experimentation, and investigation with an 802.15.4 signal source. The design and layout can be quickly and easily transferred into a production design.

An Evaluation Board schematic diagram is provided in Figure 3. A reference design schematic is provided in Figure 4. Table 9 provides the Bill of Materials (BOM) list for Evaluation Board components. A photograph of the Evaluation Board is shown in Figure 5.

Evaluation Board Setup Procedure

Connect Supply

1. Connect J1 and J4 to 50 Ω instruments. Terminate all unused ports (if applicable) with 50 Ω .
2. Connect the supply ground to Pins 1, 4, and 6 of J2.
3. Connect 3.3 V to pin 7 of J2.
4. Connect 1.8 V to one of the logic pins (pin 3 or pin 5) on J2 to select RX or TX mode. Connect the other logic pin to ground. Refer to Table 8 for mode control settings.

Measure Performance

TX

Monitor the 2.4 GHz amplifier performance by applying an RF signal to connector J4 (TR) and verify the output power on connector J1 (ANT).

RX

Monitor the 2.4 GHz switch performance by applying an RF signal to connector J1 (ANT) and verify the output signal on connector J4 (TR).

CAUTION: *Be careful not to overdrive the switch by applying too much RF on the input to the device. A starting input power of -20 dBm is suitable.*

Package Dimensions

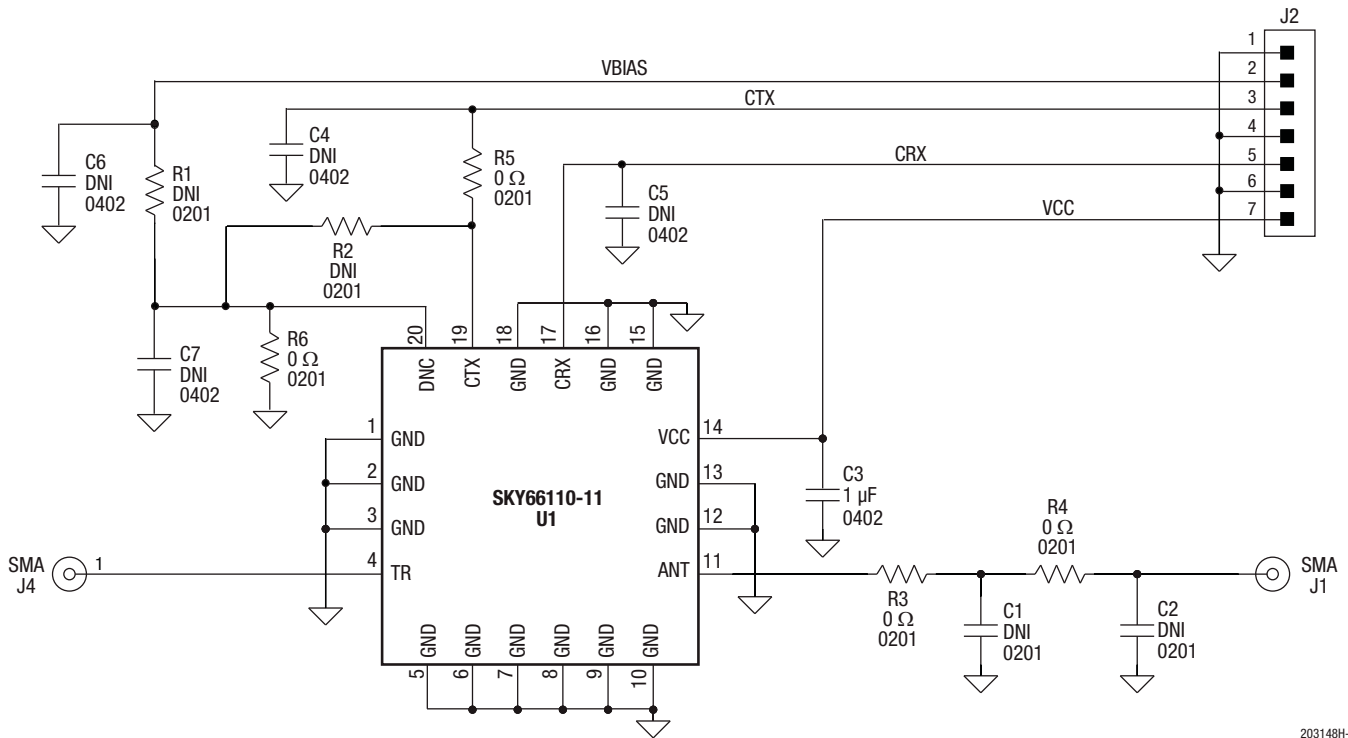
The PCB layout footprint for the SKY66110-11 is provided in Figure 6. Typical part markings are shown in Figure 7. Package dimensions are shown in Figure 8, and tape and reel dimensions are provided in Figure 9.

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 SKY66110-11 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.

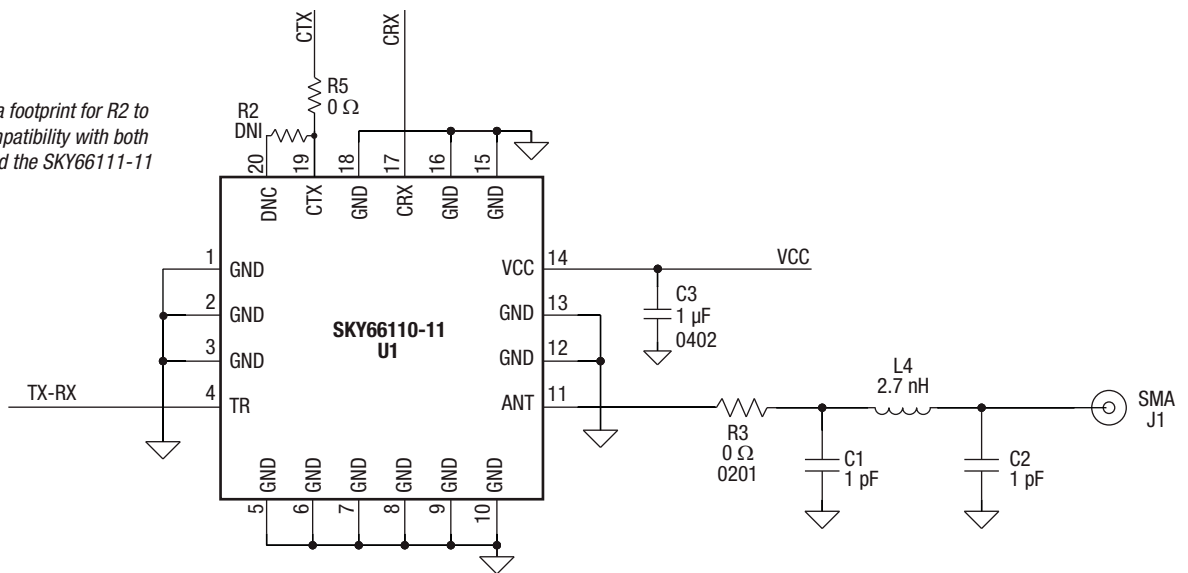
Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.



203148H-003

Figure 3. SKY66110-11 Evaluation Board Schematic

Note: Include a footprint for R2 to enable compatibility with both the SKY66110-11 and the SKY66111-11



203184H-004

Figure 4. SKY66110-11 Reference Design Schematic

Table 9. SKY66110-11 Evaluation Board Bill of Materials (BOM)

| Component | Value | Size | Manufacturer | Mfr Part Number | Characteristics |
|----------------|-------------|------------------|-------------------------|-----------------|---|
| C1, C2 | DNI | 0201 | | | |
| C3 | 1 uF | 0402 | | | Capacitor |
| C4, C5, C6 | DNI | 0402 | | | |
| J1, J4 | SMA | end launch | Johnson Components | 142-0701-851 | SMA end launch straight jack receptacle - tab contact |
| J2 | 7X1 | 100 mil | Samtec | TSW-107-07-G-S | 100mil header |
| PCB1 | Z720-B | | Skyworks Solutions Inc. | Z720-B | PCB |
| R1, R2 | DNI | 0201 | | | Do not install |
| R3, R4, R5, R6 | 0 Ω | 0201 | Panasonic | ERJ1GE0R00 | Thick film chip resistor |
| U1 | SKY66110-11 | MCM50P300X330-20 | Skyworks Solutions Inc. | SKY66110-11 | Low-power Bluetooth low energy FEM |

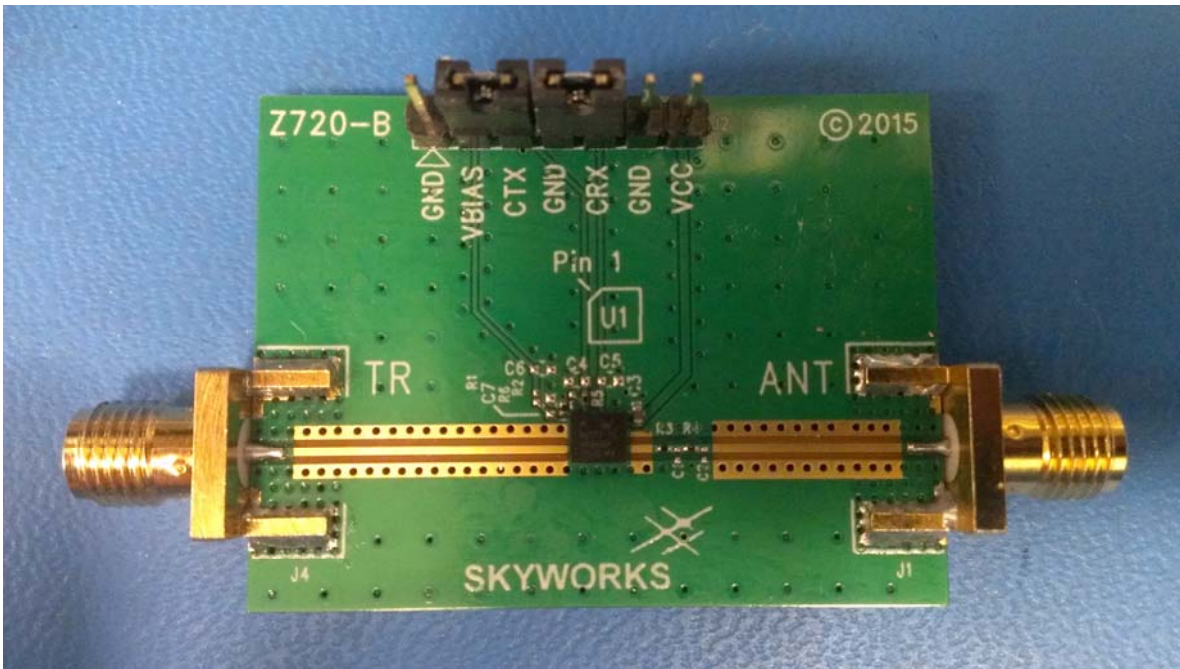
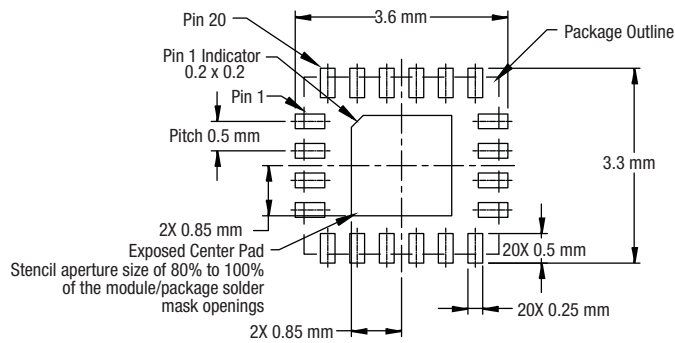
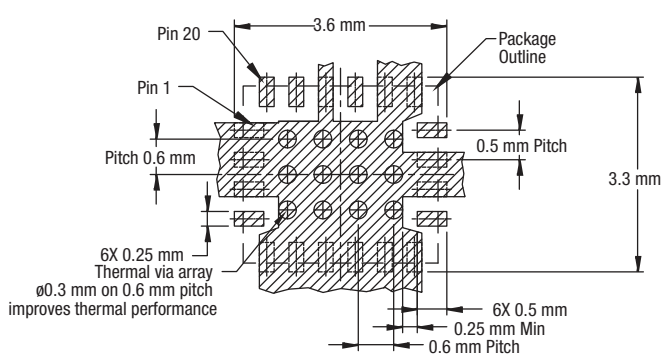


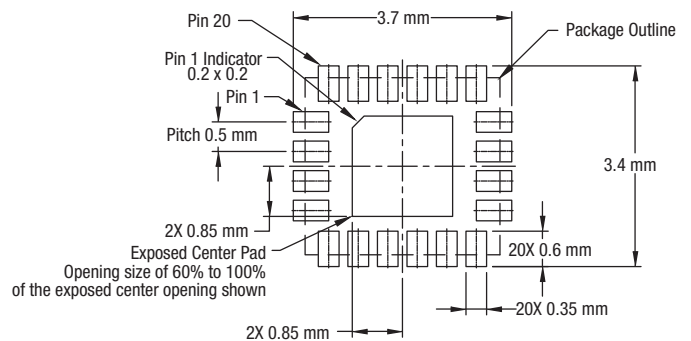
Figure 5. SKY66110-11 Evaluation Board



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 μ m.

203184H-006

Figure 6. PCB Layout Footprint

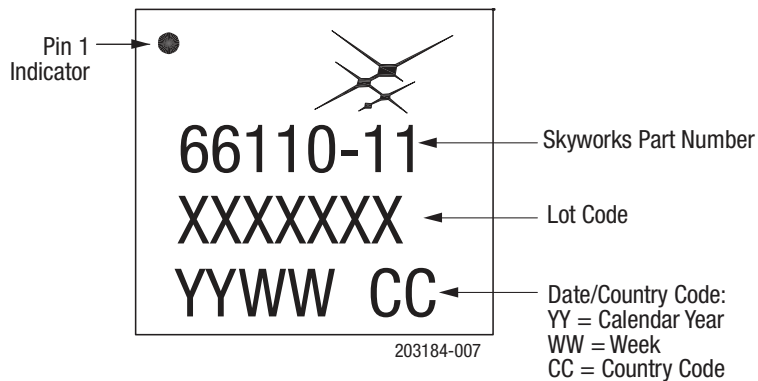


Figure 7. Typical Part Marking

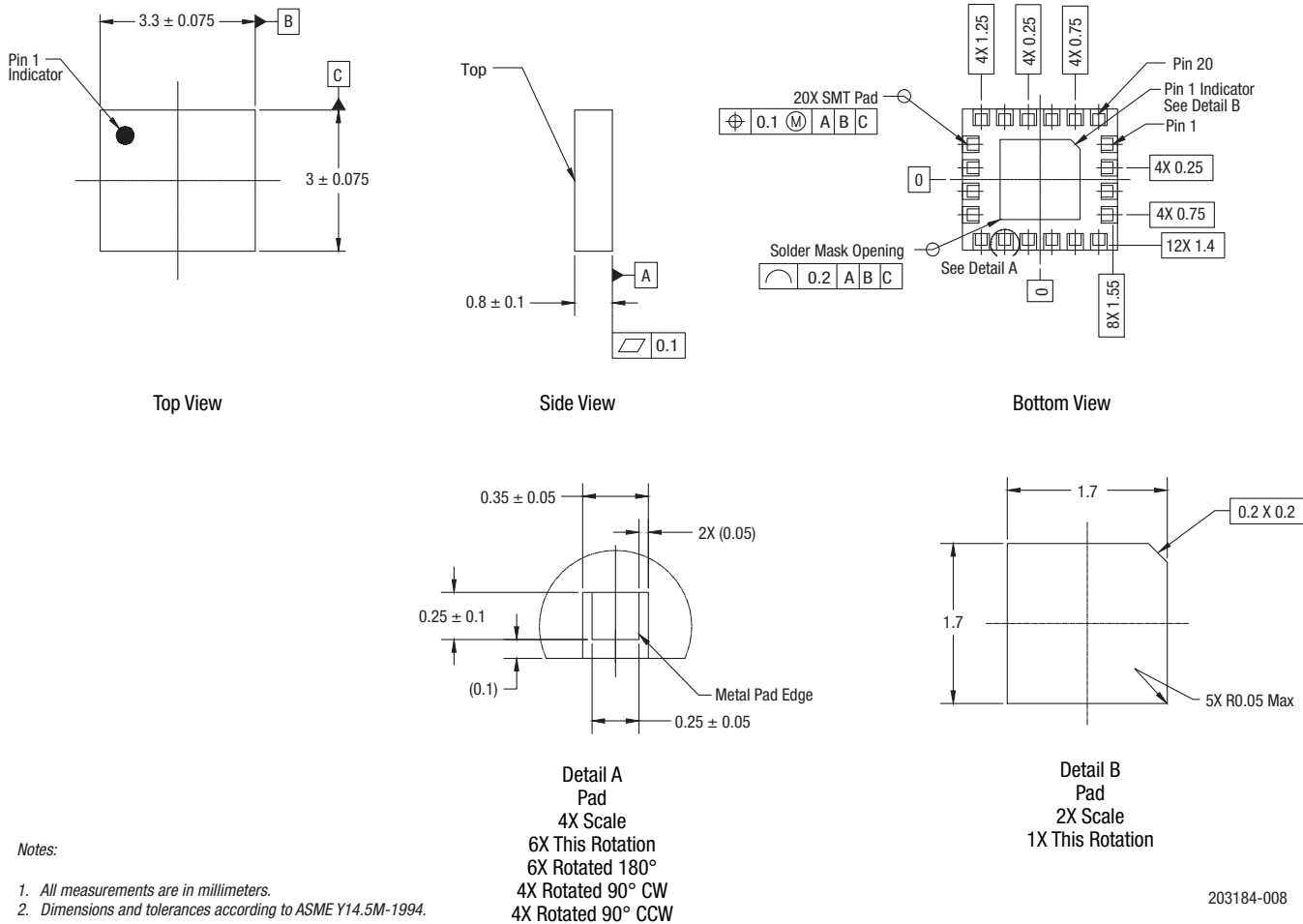


Figure 8. SKY66110 Package Dimensions

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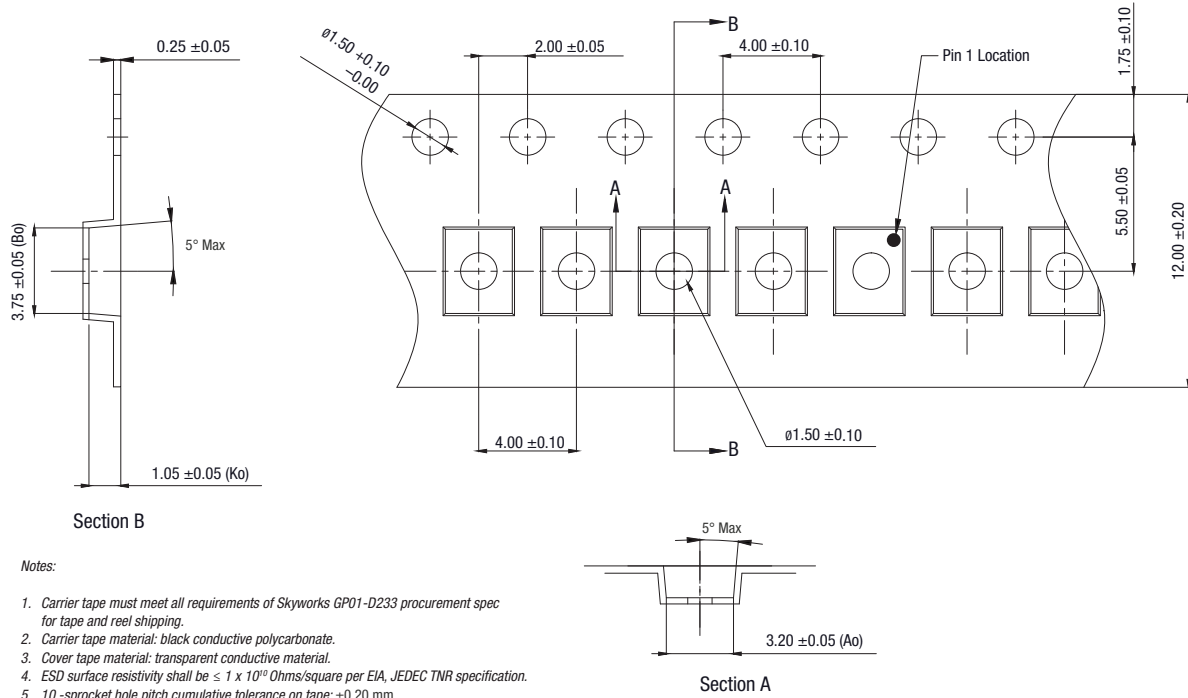


Figure 9. SKY66110-11 Tape and Reel Dimensions