

DATA SHEET

SKY66420-11: 860 to 930 MHz RF Front-End Module

Applications

- LP-WAN devices
- Internet of Things
- Smart meters
- Industrial applications
- Range extender

Features

- Integrated PA with +27 dBm output power
- Integrated LNA with noise figure of 1.5 dB, typical
- Alternate TX input pin simplifies connection to any SoC
- Transmit bypass path with low loss: < 1.5 dB
- Single-ended 50 Ω transmit/receive RF interface
- Fast turn-on/turn-off time: <4 μs Rx mode and <2 μs Tx mode
- Low-gain power amplifier
- Supply voltage: 2.0 to 4.8 V
- Sleep mode current: < 1 μA
- MCM (16-pin, 3.0 x 3.0 x 0.75 mm) NiPdAu plated 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.

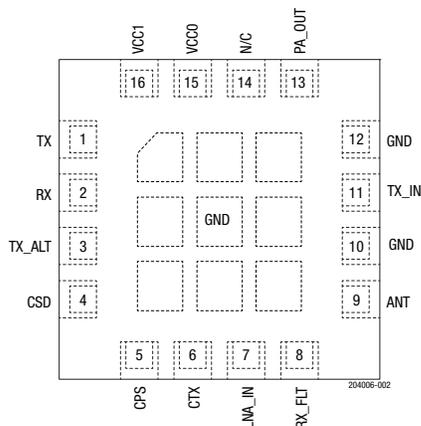


Figure 2. SKY66420-11 Pinout (Top View)

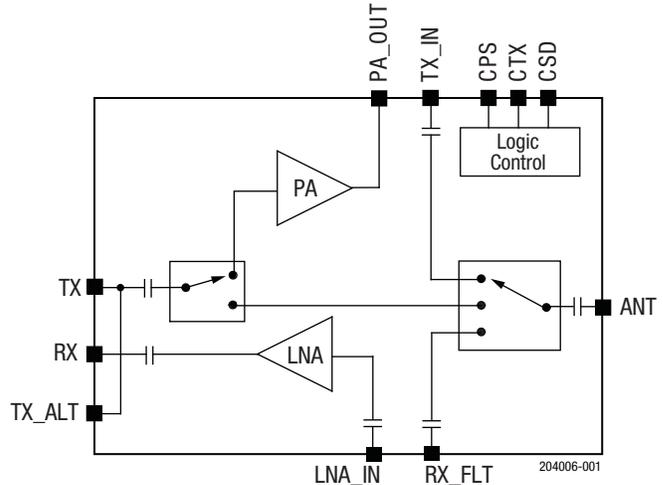


Figure 1. SKY66420-11 Block Diagram

Description

The SKY66420-11 is a high-performance, highly integrated RF front-end module designed for high-power Industrial, Scientific, Medical (ISM) band applications operating in the 860 to 930 MHz frequency range.

The SKY66420-11 is designed for ease of use and maximum flexibility with fully matched 50 Ω TX (or TX_ALT) and RX inputs and antenna outputs, and digital controls compatible with 1.6 to 3.6 V CMOS levels.

The RF blocks operate over a wide supply voltage range from 2.0 to 4.8 V allowing the SKY66420-11 to be used in battery powered applications over a wide spectrum of the battery discharge curve.

The SKY66420-11 is packaged in a 16-pin, 3.0 x 3.0 x 0.75 mm Multi-Chip Module (MCM) package.

A functional block diagram of the SKY66420-11 is provided in Figure 1. Figure 2 shows the pinout for the SKY66420-11. Table 1 lists the pin assignments and signal descriptions.

Table 1. SKY66420-11 Signal Descriptions

| Pin | Name | Description | Pin | Name | Description |
|-----|--------|--|--------|--------|--|
| 1 | TX | Transmit mode RF input | 10 | GND | Connect to PCB ground |
| 2 | RX | Receive mode RF output | 11 | TX_IN | TX input signal to antenna (from OMN) |
| 3 | TX_ALT | Transmit mode RF input (alternate pin) | 12 | GND | Connect to PCB ground |
| 4 | CSD | Shutdown control input | 13 | PA_OUT | PA output and positive power supply |
| 5 | CPS | Bypass mode select input | 14 | N/C | Not connected internally to the device |
| 6 | CTX | Transmit mode select input | 15 | VCC0 | Positive power supply |
| 7 | LNA_IN | LNA input (from RX filter) | 16 | VCC1 | Positive power supply |
| 8 | RX_FLT | RX signal from antenna (to RX filter) | Paddle | GND | Exposed die paddle; electrical and thermal ground. Connect to PCB ground |
| 9 | ANT | Connect to 50 Ω antenna filter | | | |

Electrical and Mechanical Specifications

Table 2 provides the absolute maximum ratings, and Table 3 shows the recommended operating conditions. Electrical specifications are provided in Tables 4 through 6.

The state of the SKY66420-11 is determined by the control logic shown in Tables 7 and 8. Typical performance characteristics are shown in Figures 3 through 10.

Table 2. SKY66420-11 Absolute Maximum Ratings¹

| Parameter | Symbol | Minimum | Maximum | Units |
|--|----------------------------|---------|---------|-------|
| Supply voltage on VCC0 (no RF) | V _{cc0} | -0.3 | +5.5 | V |
| Supply voltage on VCC1 and PA_OUT (no RF) | V _{cc} | -0.3 | +5.5 | V |
| Operating temperature | T _A | -40 | +85 | °C |
| Storage temperature | T _{STG} | -40 | +125 | °C |
| Tx input power at TX port | P _{IN_TX_MAX} | | +17 | dBm |
| TX input power at TX port (bypass mode) | P _{IN_TX_BYP_MAX} | | +20 | dBm |
| Rx input power at ANT port | P _{IN_RX_MAX} | | +10 | dBm |
| Electrostatic discharge: Human Body Model (HBM), Class 1C | ESD | | 1000 | 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. SKY66420-11 Recommended Operating Conditions

| Parameter | Symbol | Min | Typ | Max | Units |
|-----------------------------------|--------|-----|-----|-----|-------|
| Supply voltage on VCC0 | VCC0 | 2.0 | 3.3 | 4.8 | V |
| Supply voltage on VCC1 and PA_OUT | VCC | 2.0 | 3.3 | 4.8 | V |
| Ambient temperature | TA | -40 | +25 | +85 | °C |

Table 4. SKY66420-11 DC Electrical Specifications¹
(VCC0 = VCC1 = 3.3 V, f = 915 MHz, TA = +25 °C, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|--|----------|----------------|-----|-----|------|-------|
| Total supply current, transmit mode | ICC_TX27 | POUT = +27 dBm | | 280 | | mA |
| Total supply current, receive mode | ICC_RX | No RF | | 5 | | mA |
| Total supply current, transmit bypass mode | ICC_TXB | No RF | | 200 | | μA |
| Quiescent current | ICQ_TX | No RF | | 50 | | mA |
| Sleep supply current | ICC_OFF | No RF | | | 1.00 | μA |

¹ Performance is guaranteed only under the conditions listed in this table.**Table 5. SKY66420-11 AC Electrical Specifications: Transmit Mode**
(VCC0 = VCC1 = 3.3 V, TA = +25 °C, All Unused Ports Terminated at 50 Ω, Unless Otherwise Noted. Input Port TX, Output Port ANT, Matching Network Connected between the PA_OUT and TX_IN)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|---|----------------------|---|--|------------|-----|------------|
| Frequency range | f | | 860 | | 930 | MHz |
| Output power at ANT ^{1,2} | POUT_915 POUT_868 | f = 915 MHz f = 868 MHz | | +27 +27 | | dBm dBm |
| Small signal gain ^{1,2} | S21_915 S21_868 | f = 915 MHz f = 868 MHz | | 16 16 | | dB dB |
| Small signal gain variation ^{1,2} | ΔS21 | Peak to peak gain variation across frequency band | | | 1 | dB |
| Input return loss ^{1,2} | S11 | Into 50 Ω (TX port) | | -10 | | dB |
| Output return loss ^{1,2} | S22 | Into 50 Ω (ANT port) | | -10 | | dB |
| Input 1 dB compression point, bypass mode | BYP_IP1dB | Bypass mode | +20 | | | dBm |
| 2 nd harmonic ³ | 2fo | POUT = +27 dBm | | | +7 | dBm |
| 3 rd to 10 th harmonic ³ | 3fo to 10fo | POUT = +27 dBm | | | -42 | dBm |
| Insertion loss (bypass mode) | S21_BYP | TX to ANT | | | 1.5 | dB |
| Turn-on time ⁴ | ton | | | 1 | 2 | μs |
| Turn-off time ⁵ | toff | | | | 1 | μs |
| Stability | STAB | CW, PIN = +16 dBm 0.1 GHz to 20 GHz load VSWR = 6:1 | All non-harmonically related outputs less than -42 dBm | | | |
| Ruggedness | RU | CW, POUT = +27 dBm into 50 Ω, load VSWR = 10:1 | No permanent damage | | | |

¹ 900 to 930 MHz with specified matching network on the Evaluation Board.² 860 to 870 MHz with specified matching network on the Evaluation Board.³ Measured with continuous wave signal.⁴ From 50% of CTX edge to 90% of final RF output power.⁵ From 50% of CTX edge to 10% of initial RF output power.

Table 6. SKY66420-11 AC Electrical Specifications: Receive Mode

(Vcc0 = Vcc1 = 3.3 V, TA = +25 °C, All Unused Ports Terminated at 50 Ω, Unless Otherwise Noted. Input Port ANT, Output Port RX, 0 Ω Connected between RX_FLT and LNA_IN)

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|------------------------------|------------------|----------------------|-------|---------|-----|-------|
| Frequency range | f _{IN} | | 860 | | 930 | MHz |
| Receive gain | RX_GAIN | | | 18 | | dB |
| Receive noise figure | NF | | | 1.5 | 2.5 | dB |
| Input third order intercept | IIP3 | | -6.5 | -2 | | dBm |
| Input 1-dB compression point | IP1dB | | -16.5 | -12 | | dBm |
| Antenna port return loss | S11ANT | Into 50 Ω (ANT port) | | -12 | | dB |
| RX port return loss | S22RX | Into 50 Ω (RX port) | | -12 | | dB |
| Turn-on time ¹ | t _{ON} | | | 2.5 | | μs |
| Turn-off time ² | t _{OFF} | | | | 1 | μs |

¹ From 50% of CTX edge to 90% of final RF output power.

² From 50% of CTX edge to 10% of initial RF output power.

Table 7. SKY66420-11 Electrical Specifications: Control Logic Characteristics¹

(TA = +25 °C, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|------------------|-----------------|----------------|------------------|---------|------------------|-------|
| Control voltage: | | | | | | |
| High | V _{IH} | | 1.6 ² | | VCC0 | V |
| Low | V _{IL} | | 0 | | 0.3 ² | V |
| Input current: | | | | | | |
| High | I _{IH} | | | | 1 | μA |
| Low | I _{IL} | | | | 1 | μA |

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

² Logic inputs must be VCC0 or GND to achieve specified sleep currents.

Table 8. SKY66420-11 Electrical Specifications: Mode Control Logic (TA = +25)

| Mode | CSD | CTX | GPS |
|------------------|-----|----------------|----------------|
| Shutdown | 0 | x ¹ | x ¹ |
| Receive LNA mode | 1 | 0 | x ¹ |
| Transmit bypass | 1 | 1 | 0 |
| Transmit | 1 | 1 | 1 |

¹ X (don't care) inputs must be held at VCC0 or GND to achieve specified sleep current.

Typical Performance Characteristics

(Vcc0 = Vcc1 = 3.3 V, f = 915 MHz, Ta = +25 °C, Unless Otherwise Noted)

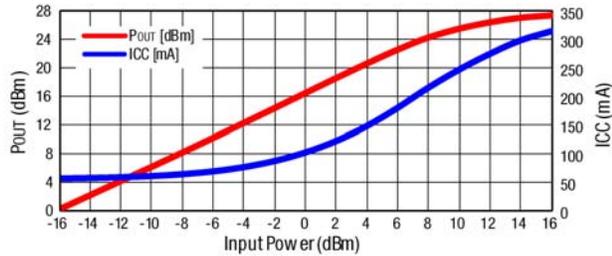


Figure 3. Pout and Icc vs Pin, CW

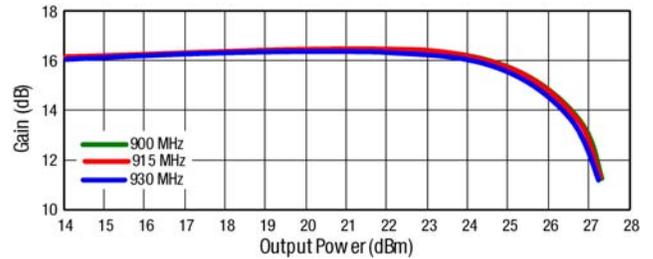


Figure 4. Gain vs Pout, CW

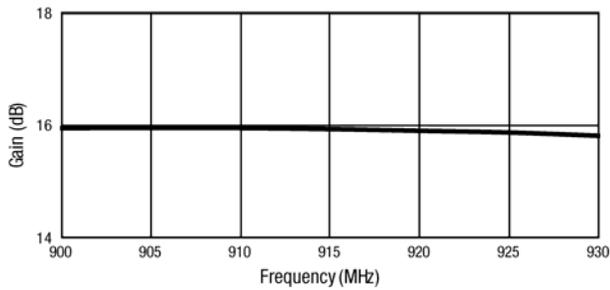


Figure 5. Small Signal Gain vs Frequency, CW

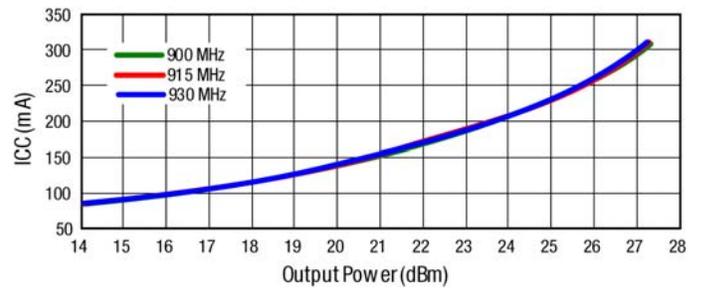


Figure 6. Icc vs Pout, CW

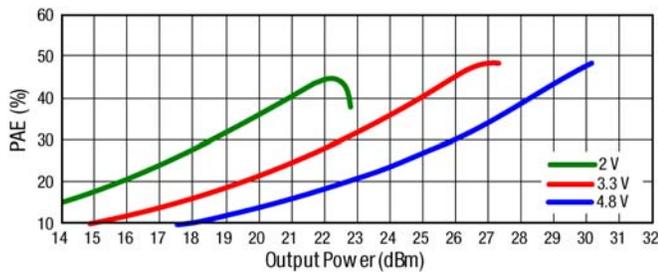


Figure 7. PAE vs Pout and VCC, CW

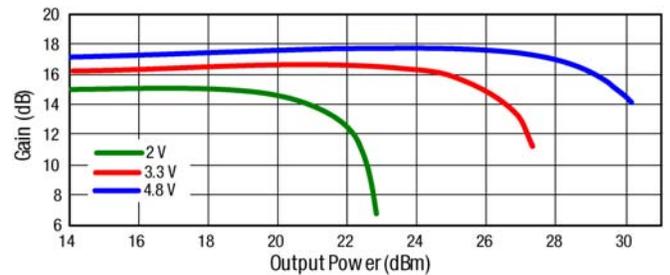


Figure 8. Gain vs Pout and VCC, CW

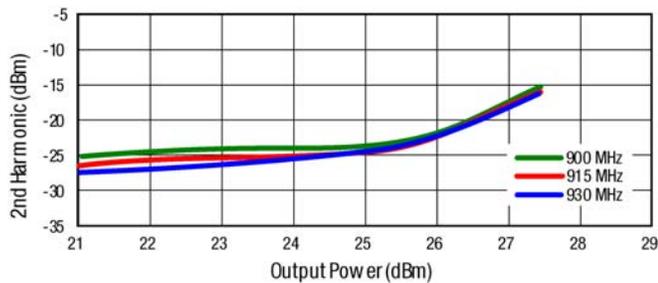


Figure 9. 2nd Harmonic vs Pout, CW

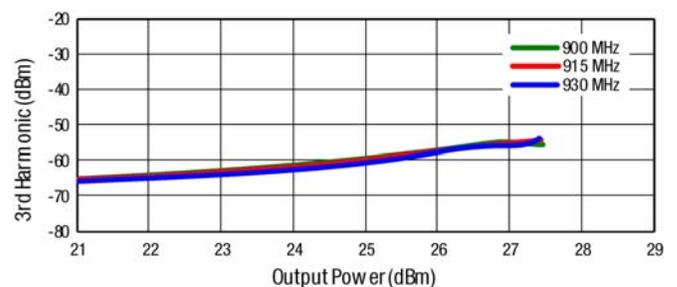


Figure 10. 3rd Harmonic vs Pout, CW

Evaluation Board Description

The SKY66420-11-EK1 Evaluation Board is designed to demonstrate the performance of the SKY66420-11 RF Front-End Module. It is optimized for evaluation, experimentation, and investigation, using CW (continuous wave) signals.

Figure 11 shows the Evaluation Board. The Evaluation Board schematic diagram for 915 MHz application (EK1) is provided in Figure 12. The Bill of Materials (BOM) for the SKY66420-11 Evaluation Board for 915 MHz application (EK1) is listed in Table 9

The Evaluation Board schematic diagram for 868 MHz (EK3) is provided in Figure 13. The Bill of Materials (BOM) for the SKY66420-11 Evaluation Board for 868 MHz (EK3) is listed in Table 10.

PCB Recommendations

Top layer: Plan to add the footprint for a shield case over the RF section.

Bottom layer: Lay out as much as possible for minimum traces on the bottom. Having a solid ground plane under the shield case will complete the shielding.

Avoid using thermal relief pads for ground connections of components and the shield case. Always place vias close to each shunt connection.

Spread ground vias equally in a manner that stitches the grounds together.

Metal Layer 1 = RF traces (microstripes or coplanar) + control lines. Core thickness between top RF layer and ground plane is critical.

Metal Layer 2 = Solid ground plane. No trace routings.

Metal Layer 3 = Control lines + VCC traces (no VCC plane)

Metal Layer 4 = Solid ground plane under the shield case area.

Pour copper on each layer connected to the ground plane. Use VCC traces in a star distribution pattern.

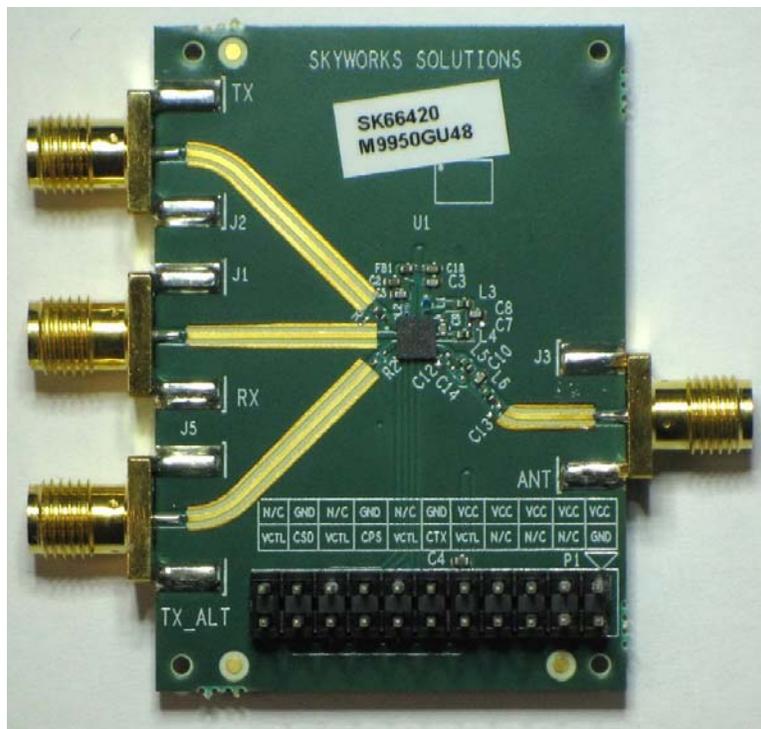


Figure 11. SKY66420-11 Evaluation Board

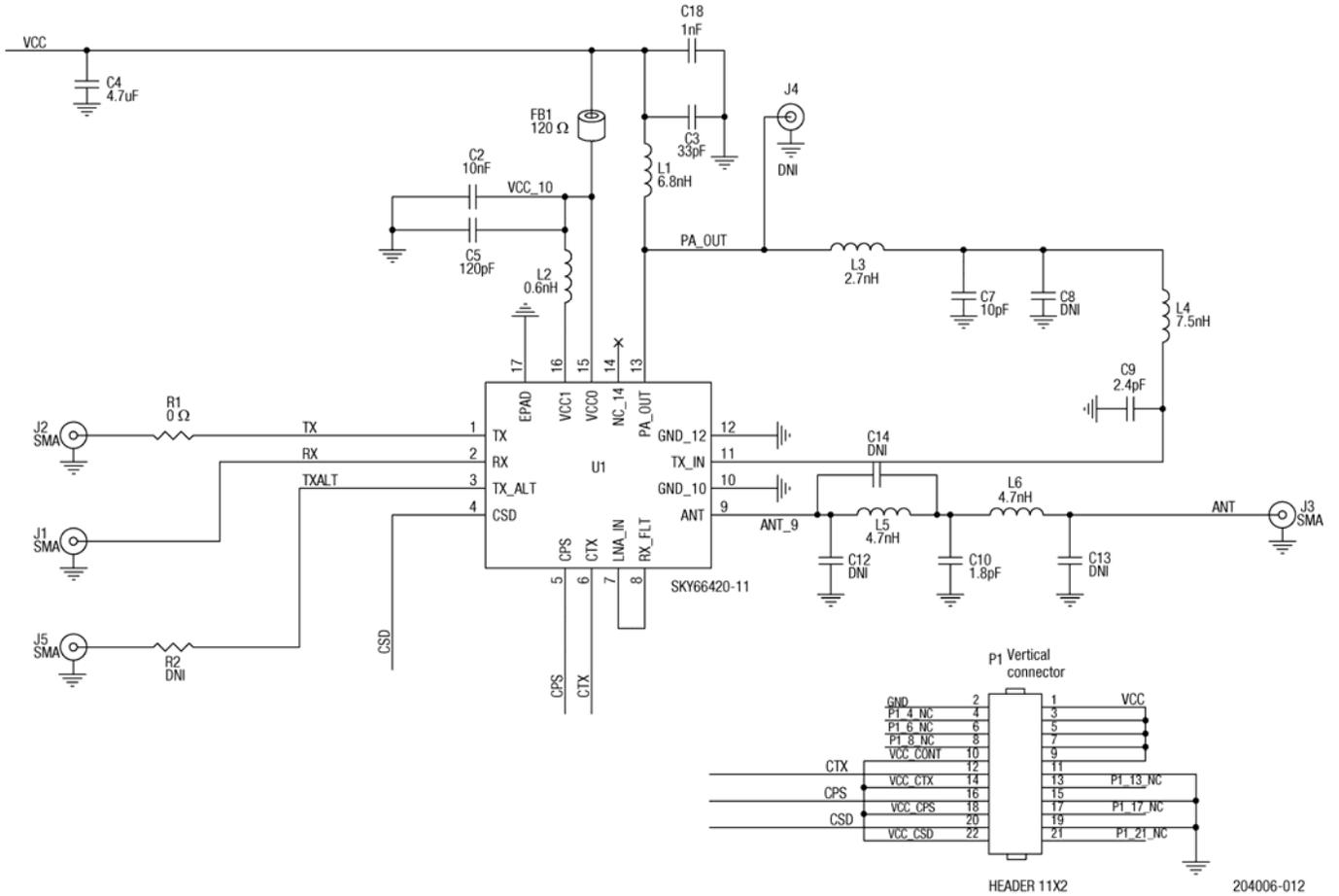


Figure 12. SKY66420-11 Evaluation Board Schematic for 915 MHz Application (EK1)

Table 9. SKY66420-11 Evaluation Board Bill of Materials for 915 MHz Application¹ (EK1)

| Component | Value | Manufacturer | Mfr Part Number | Size | Description |
|-------------|-------------|--------------------|--------------------|-----------------|---|
| C2 | 10 nF | Murata | GRM155R71H103KA88 | 0402 | Ceramic capacitor 10000 pF 50 V X7R |
| C3 | 33 pF | Murata | GRM1555C1H330JA01 | 0402 | Ceramic capacitor 33 pF 50 V COG/NP0 |
| C4 | 4.7 uF | Murata | GRM155R61A475MEAA | 0402 | Ceramic capacitor 4.7 uF 10 V X5R |
| C5 | 120 pF | Murata | GRM1555C1H121GA01 | 0402 | Ceramic capacitor 120 pF 50 V COG/NP0 |
| C7 | 10 pF | Murata | GRM1555C1E100JA01D | 0402 | Ceramic capacitor 10 pF 25 V COG/NP0 |
| R2,C8 | DNI | | | 0402 | |
| C9 | 2.4 pF | Murata | GRM1555C1H2R4CA01 | 0402 | Ceramic capacitor 2.4 pF 50 V COG/NP0 |
| C10 | 2.2 pF | Murata | GRM1555C1H2R2CA01 | 0402 | Ceramic capacitor 2.2 pF 50 V COG/NP0 |
| C12,C13 | DNI | Murata | | 0402 | |
| C14 | DNI | | | | |
| C18 | 1 nF | Murata | GRM155R71H102KA01 | 0402 | Ceramic capacitor 1000 pF 50 V X7R |
| FB1 | 120 Ω | Taiyo Yuden | BK1005HM121 | 0402 | Ferrite bead 120 Ω 0402 1LN |
| J1,J2,J3,J5 | SMA | Johnson Components | 142-0701-851 | End launch | Small end launch straight jack receptacle |
| J4 | DNI | Amphenol | | Amphenol_132134 | Conn SMA jack straight 50 Ω PCB |
| L1 | 6.8 nH | Murata | LQW15AN6N8J00D | 0402 | Fixed inductor 6.8 nH 600 mA 290 MΩ |
| L2 | 0.6 nH | Murata | LQP03TN0N8B02D | 0201 | Fixed inductor 0.6 nH 850 mA 70 MΩ |
| L3 | 2.7 nH | Murata | LQG15WZ2N7S02D | 0402 | Fixed inductor 2.7 nH 900 mA 70 MΩ |
| L4 | 7.5 nH | Murata | LQG15HN7N5J02 | 0402 | Fixed inductor 7.5 nH 500 mA 310 MΩ |
| L5,L6 | 4.7 nH | Murata | LQG15HN4N7S02 | 0402 | Fixed inductor 4.7 nH 700 mA 230 MΩ |
| PCB1 | Z1185-B2 | Skyworks | Z1185-B2 | | EVB |
| P1 | HEADER 11X2 | Molex | 10-89-1221 | 11X2 | Header 11x2 |
| R1 | 0 Ω | Panasonic | ERJ2GE0R00 | 0402 | Res SMD 0 Ω jumper 1/10w 0402 |
| U1 | SKY66420-11 | | | | |

¹ Schematic and BOM have been designed to optimize performance with CW signals, 100% duty cycle.

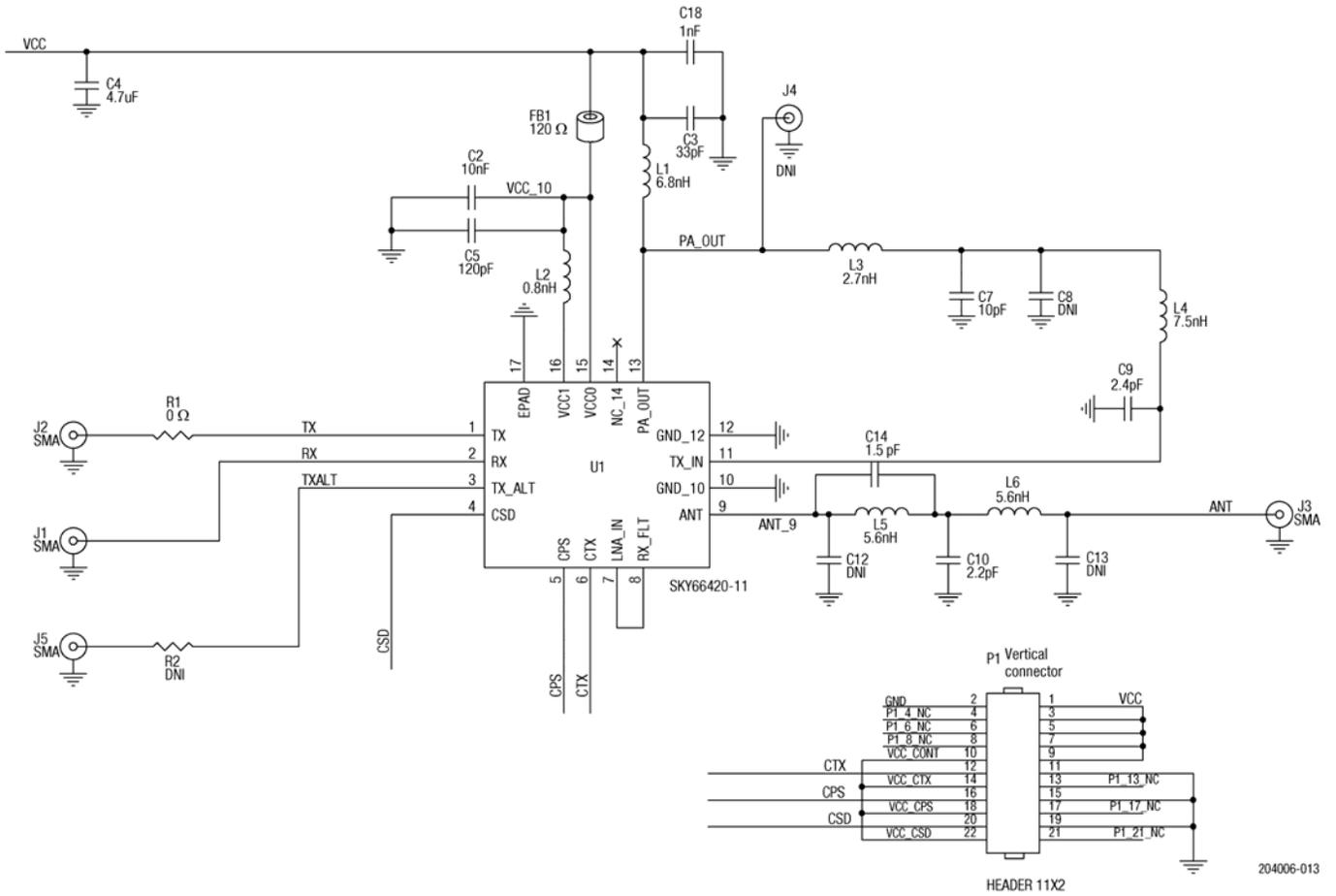


Figure 13. SKY66420-11 Evaluation Board Schematic for 868 MHz Application (EK3)

Table 10. SKY66420-11 Evaluation Board Bill of Materials for 868 MHz Operation¹ (EK3)

| Component | Value | Manufacturer | Mfr Part Number | Size | Description |
|-------------|-------------|--------------------|--------------------|-----------------|---|
| C2 | 10 nF | Murata | GRM155R71H103KA88 | 0402 | Ceramic capacitor 10000 pF 50 V X7R |
| C3 | 33 pF | Murata | GRM1555C1H330JA01 | 0402 | Ceramic capacitor 33 pF 50 V COG/NPO |
| C4 | 4.7 uF | Murata | GRM155R61A475MEAA | 0402 | Ceramic capacitor 4.7uF 10 V X5R |
| C5 | 120 pF | Murata | GRM1555C1H121GA01 | 0402 | Ceramic capacitor 120 pF 50 V COG/NPO |
| R2, C7 | DNI | | GRM1555C1E100JA01D | | |
| C8 | 10 pF | Murata | | 0402 | Ceramic capacitor 10 pF 50 V X7R |
| C9 | 2.4 pF | Murata | GRM1555C1H2R4CA01 | 0402 | Ceramic capacitor 2.4 pF 50 V COG/NPO |
| C10 | 2.2 pF | Murata | GRM1555C1H2R2CA01 | 0402 | Ceramic capacitor 2.2 pF 50 V COG/NPO |
| C12,C13 | DNI | Murata | | 0402 | |
| C14 | 1.5 pF | Murata | GRM1555C1H1R5CA01 | | Ceramic capacitor 1.5 pF 50 V COG/NPO |
| C18 | 1 nF | Murata | GRM155R71H102KA01 | 0402 | Ceramic capacitor 1000 pF 50 V X7R |
| FB1 | 120 Ω | Taiyo Yuden | BK1005HM121 | 0402 | Ferrite bead 120 Ω 0402 1LN |
| J1,J2,J3,J5 | SMA | Johnson Components | 142-0701-851 | End launch | Small end launch straight jack receptacle |
| J4 | DNI | Amphenol | | Amphenol_132134 | Conn SMA jack straight 50 Ω PCB |
| L1 | 6.8 nH | Murata | LQW15AN6N8J00D | 0402 | Fixed inductor 6.8 nH 600 mA 290 MΩ |
| L2 | 0.8 nH | Murata | LQP03TN0N8B02D | 0201 | Fixed inductor 0.8 nH 850 mA 70 MΩ |
| L3 | 2.7 nH | Murata | LQG15WZ2N7S02D | 0402 | Fixed inductor 2.7 nH 800 mA 70 MΩ |
| L4 | 7.5 nH | Murata | LQG15HN7N5J02 | 0402 | Fixed inductor 7.5 nH 500 mA 310 MΩ |
| L5,L6 | 5.6 nH | Murata | LQG15HN5N6S02D | 0402 | Fixed inductor 5.6 nH 600 mA 260 MΩ |
| PCB1 | Z1185-B2 | Skyworks | Z1185-B2 | | EVB |
| P1 | HEADER 11X2 | Molex | 10-89-1221 | 11X2 | Header 11x2 |
| R1 | 0 Ω | Panasonic | ERJ2GE0R00 | 0402 | Res SMD 0 Ω jumper 1/10w |
| U1 | SKY66420-11 | | | | |

¹ Schematic and BOM have been designed to optimize performance with CW signals, 100% duty cycle.

Package Dimensions

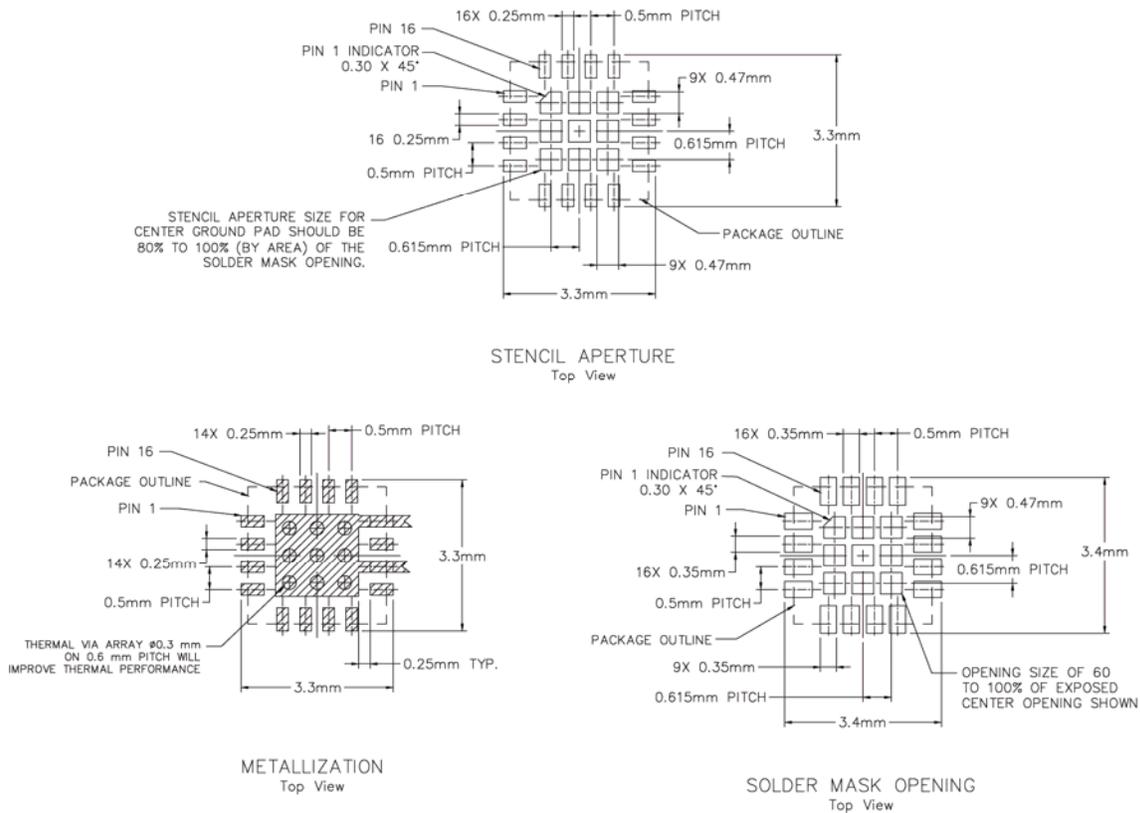
The layout footprint for the SKY66420-11 is provided in Figure 14. Typical part markings are shown in Figure 15. Package dimensions for the SKY66420-11 are shown in Figure 16, and tape and reel dimensions are provided in Figure 17.

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 SKY66420-11 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.



NOTE: THERMAL VIAS SHOULD BE RESIN FILLED AND CAPPED IN ACCORDANCE WITH IPC-4761 TYPE VII VIAS. 30-35UM Cu THICKNESS IS RECOMMENDED.

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Figure 14. SKY66420-11 Recommended Footprint (Top View)

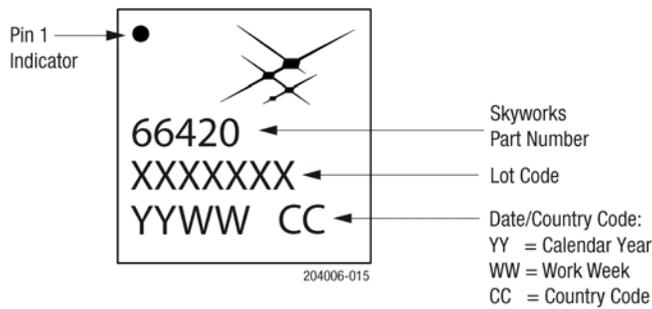
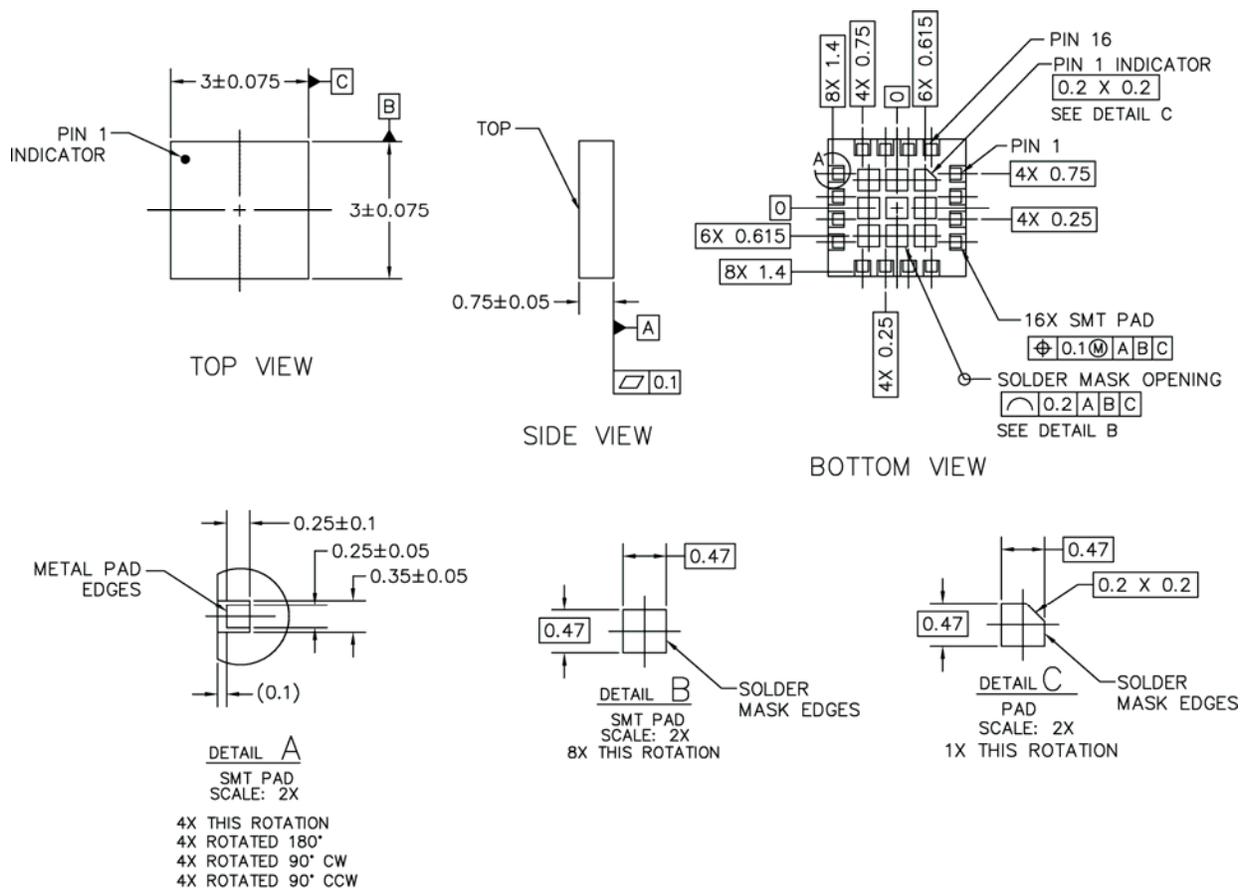


Figure 15. Typical Part Markings (Top View)

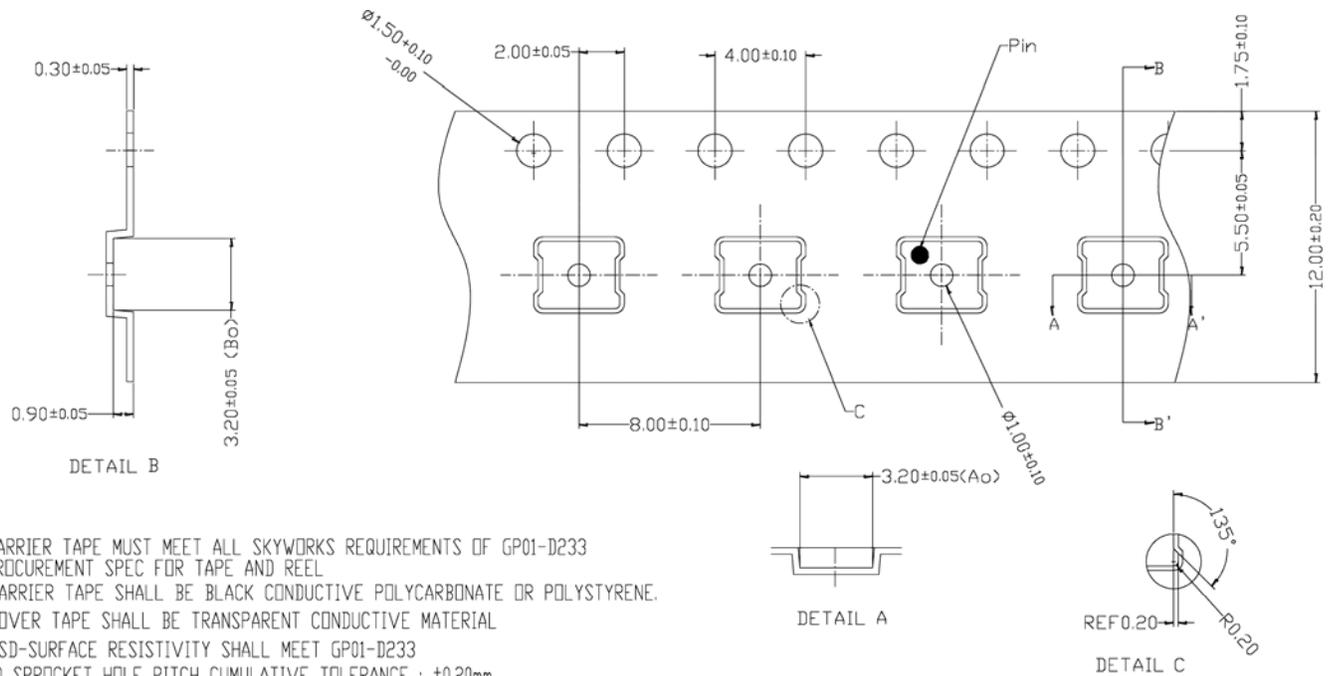


NOTES: UNLESS OTHERWISE SPECIFIED.

1. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M-1994.
2. DIMENSIONS ARE IN MILLIMETERS

204006-016

Figure 16. SKY66420-11 Package Dimensions



1. CARRIER TAPE MUST MEET ALL SKYWORKS REQUIREMENTS OF GP01-D233 PROCUREMENT SPEC FOR TAPE AND REEL
2. CARRIER TAPE SHALL BE BLACK CONDUCTIVE POLYCARBONATE OR POLYSTYRENE.
3. COVER TAPE SHALL BE TRANSPARENT CONDUCTIVE MATERIAL
4. ESD-SURFACE RESISTIVITY SHALL MEET GP01-D233
5. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE : ±0.20mm
6. Ao & Bo MEASURED ON PLANE 0.30mm ABOVE THE BOTTOM OF THE POCKET.
7. ALL DIMENSIONS ARE IN MILLIMETERS.

Figure 17. SKY66420-11 Tape and Reel Dimensions

204566-017

Ordering Information

| Part Number | Product Description | Evaluation Board Part Number |
|-------------|-----------------------------|------------------------------|
| SKY66420-11 | RF Front-End Module 915 MHz | SKY66420-11EK1 |
| SKY66420-11 | RF Front-End Module 868 MHz | SKY66420-11EK3 |

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