

DATA SHEET

# SKY66423-11: 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 ohm transmit/receive RF interface
- Fast turn-on/turn-off time: <4  $\mu$ s Rx mode and <2  $\mu$ s Tx mode
- Supply voltage: 2.0 to 4.8 V
- Sleep mode current: < 1  $\mu$ A
- MCM (16-pin, 3.0 x 3.0 x 0.75 mm) NiPdAu plated package (MSL3, 260 °C per JEDEC J-STD-020)



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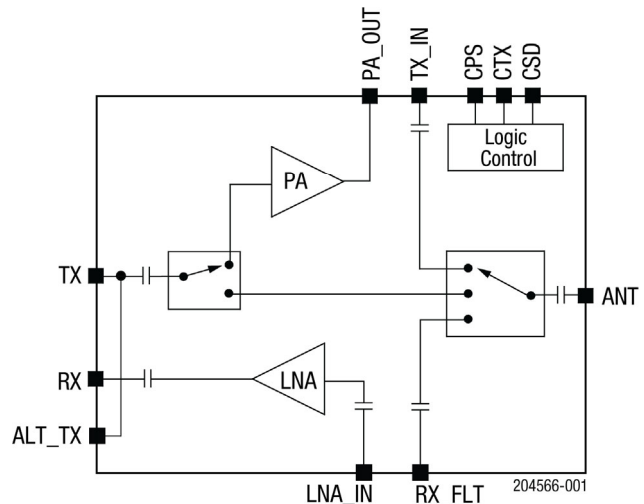


Figure 1. SKY66423-11 Block Diagram

## Description

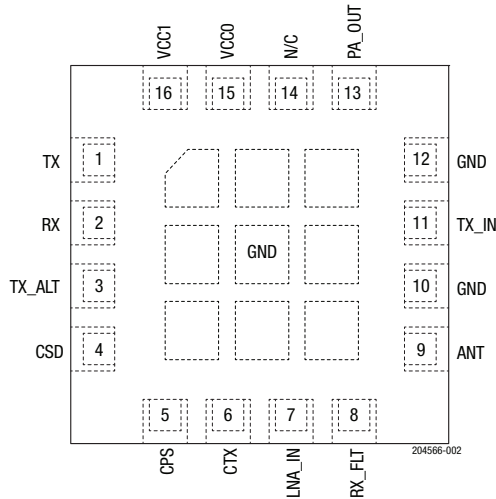
The SKY66423-11 is a high-performance, highly integrated RF front-end module designed for high-power Industrial, Scientific, Medical (ISM) band applications operating in the 860 to 930 MHz frequency range.

The SKY66423-11 is designed for ease of use and maximum flexibility with fully matched 50  $\Omega$  TX 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 SKY66423-11 to be used in battery powered applications over a wide spectrum of the battery discharge curve.

The SKY66423-11 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 SKY66423-11 is provided in Figure 1. Figure 2 shows the pinout for the SKY66423-11. Table 1 lists the pin assignments and signal descriptions.



**Figure 2. SKY66423-11 Pinout (Top View)**

**Table 1. SKY66423-11 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 ohm antenna			

## 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 SKY66423-11 is determined by the control logic shown in Tables 7 and 8. Typical performance characteristics for the EK1 Evaluation Board are shown in Figures 3 through 11. Typical performance characteristics for the EK2 Evaluation Board are shown in Figures 12 through 15.

**Table 2. SKY66423-11 Absolute Maximum Ratings<sup>1</sup>**

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage on VCC0 (no RF)	V <sub>CC0</sub>	-0.3	5.5	V
Supply voltage on VCC1 and PA_OUT (no RF)	V <sub>CC</sub>	-0.3	5.5	V
Operating temperature	T <sub>A</sub>	-40	85	°C
Storage temperature	T <sub>STG</sub>	-40	125	°C
Tx input power at TX port	PIN_TX_MAX		+10	dBm
TX input power at TX port (bypass mode)	PIN_TX_BYP_MAX		+20	dBm
Rx input power at ANT port	PIN_RX_MAX		+10	dBm
Electrostatic discharge: Human Body Model (HBM), Class 1C	ESD		1000	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.

**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. SKY66423-11 Recommended Operating Conditions**

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage on VCC0	V <sub>CC0</sub>	2.0	3.3	4.8	V
Supply voltage on VCC1 and PA_OUT	V <sub>CC</sub>	2.0	3.3	4.8	V
Ambient temperature	T <sub>A</sub>	-40	+25	+85	°C

**Table 4. SKY66423-11 DC Electrical Specifications<sup>1</sup>**  
(V<sub>CC0</sub> = V<sub>CC1</sub> = 3.3 V, f = 915 MHz, T<sub>A</sub> = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Total supply current, transmit mode	I <sub>CC_TX27</sub>	POUT = +27 dBm		280		mA
Total supply current, receive mode	I <sub>CC_RX</sub>	No RF		5		mA
Total supply current, transmit bypass mode	I <sub>CC_TXB</sub>	No RF		200		uA
Quiescent current	I <sub>CQ_TX</sub>	No RF		48		mA
Sleep supply current	I <sub>CC_OFF</sub>	No RF			1.00	uA

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

**Table 5. SKY66423-11 AC Electrical Specifications: Transmit Mode**  
**(Vcc0 = Vcc1 = 3.3 V, Ta = +25 °C, All Unused Ports Terminated at 50 ohms, 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 <sup>1, 2</sup>	POUT_915 POUT_868	f = 915 MHz f = 868 MHz		+27 +27		dBm dBm
Small signal gain <sup>1, 2</sup>	S21_915 S21_868	f = 915 MHz f = 868 MHz		29 29		dB dB
Small signal gain variation <sup>1, 2</sup>	ΔS21	Peak to peak gain variation across frequency band			1	dB
Input return loss <sup>1, 2</sup>	S11	Into 50 ohm (TX port)		-10		dB
Output return loss <sup>1, 2</sup>	S22	Into 50 ohm (ANT port)		-10		dB
Input 1 dB compression point, bypass mode	BYP_IP1dB	Bypass mode	+20			dBm
2 <sup>nd</sup> harmonic <sup>3</sup>	2fo	POUT = +27 dBm			+7	dBm
3 <sup>rd</sup> to 10 <sup>th</sup> harmonic <sup>3</sup>	3fo to 10fo	POUT = +27 dBm			-42	dBm
Insertion loss (bypass mode)	S21_BYP	TX to ANT			1.5	dB
Turn-on time <sup>4</sup>	ton			1	2	μs
Turn-off time <sup>5</sup>	toff				1	μs
Stability	STAB	CW, PIN = +6 dBm 0.1 GHz to 20 GHz load VSWR = 6:1	All non-harmonically related outputs less than -42 dBm			
Ruggedness	RUG	CW, POUT = +27 dBm into 50 ohms , load VSWR = 10:1	No permanent damage			

<sup>1</sup> 900 to 930 MHz with specified matching network on the Evaluation Board.

<sup>2</sup> 860 to 870 MHz with specified matching network on the Evaluation Board.

<sup>3</sup> Measured with continuous wave signal.

<sup>4</sup> From 50% of CTX edge to 90% of final RF output power.

<sup>5</sup> From 50% of CTX edge to 10% of initial RF output power.

**Table 6. SKY66423-11 AC Electrical Specifications: Receive Mode**

(Vcc0 = Vcc1 = 3.3 V, Ta = +25 °C, All Unused Ports Terminated at 50 ohms, Unless Otherwise Noted. Input Port ANT, Output Port RX, 0 ohms Connected between RX\_FLT and LNA\_IN)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Frequency range	f <sub>IN</sub>		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 ohms (ANT port)		-12		dB
RX port return loss	S22RX	Into 50 ohms (RX port)		-12		dB
Turn-on time <sup>1</sup>	t <sub>ON</sub>			2.5		us
Turn-off time <sup>2</sup>	t <sub>OFF</sub>				1	us

<sup>1</sup> From 50% of CTX edge to 90% of final RF output power.

<sup>2</sup> From 50% of CTX edge to 10% of initial RF output power.

**Table 7. SKY66423-11 Electrical Specifications: Control Logic Characteristics<sup>1</sup>**

(Ta = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Control voltage:						
High	V <sub>IH</sub>		1.6 <sup>2</sup>		VCC0	V
Low	V <sub>IL</sub>		0		0.3 <sup>2</sup>	V
Input current:						
High	I <sub>IH</sub>				1	uA
Low	I <sub>IL</sub>				1	uA

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

<sup>2</sup> Logic inputs must be VCC0 or GND to achieve specified sleep currents.

**Table 8. SKY66423-11 Electrical Specifications: Mode Control Logic (Ta = +25)<sup>1</sup>**

Mode	CSD	CTX	GPS
Shutdown	0	X <sup>2</sup>	X <sup>2</sup>
Receive LNA mode	1	0	X <sup>2</sup>
Transmit bypass	1	1	0
Transmit	1	1	1

<sup>1</sup> Make sure each control logic has the proper pull-up and pull-down in the application circuit.

<sup>2</sup> X (don't care) inputs must be held at VCC0 or GND to achieve specified sleep current.

Typical Performance Characteristics for the EK1 Evaluation Board

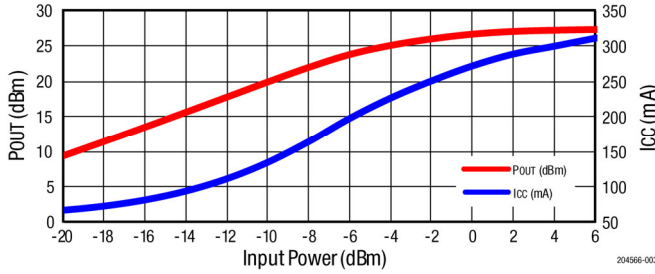


Figure 3. Pout and Icc vs Pin, CW

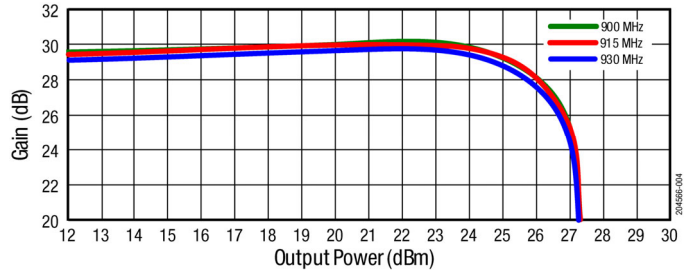


Figure 4. Gain vs Pout, CW

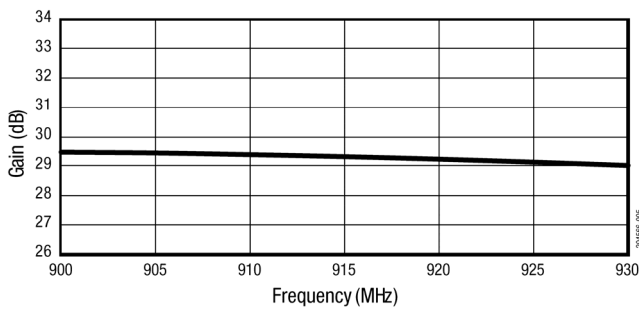


Figure 5. Small Signal Gain vs Frequency, CW

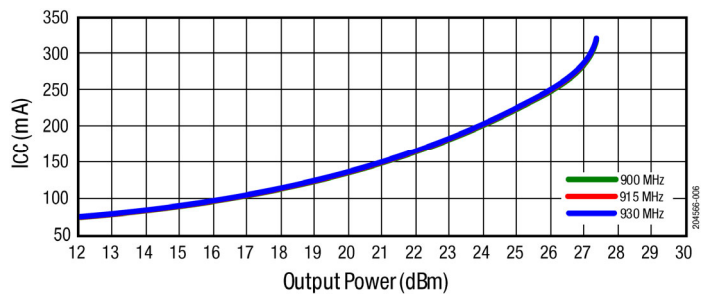


Figure 6. Icc vs Pout

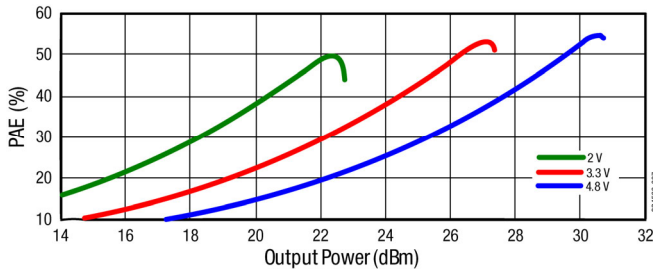


Figure 7. PAE vs Pout and Vcc, CW

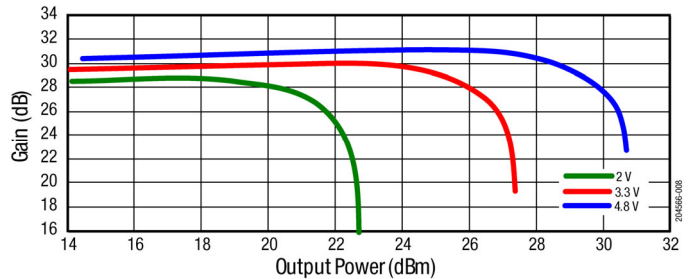


Figure 8. Gain vs Pout and Vcc, CW

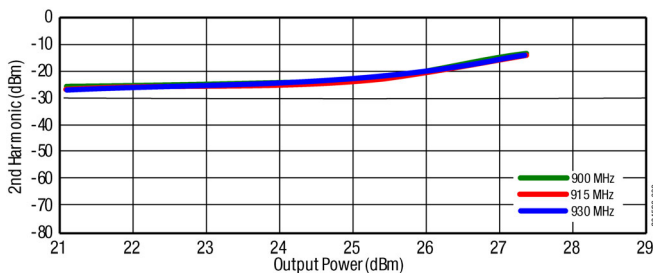


Figure 9. Second Harmonic vs Pout, CW

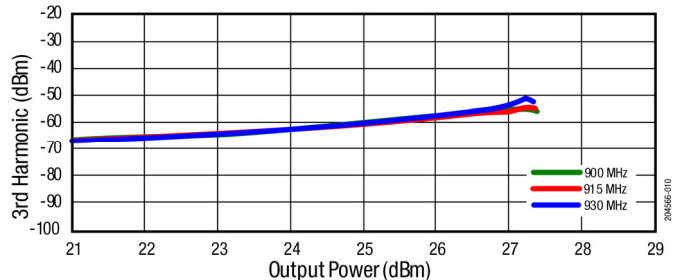


Figure 10. Third Harmonic vs Pout, CW

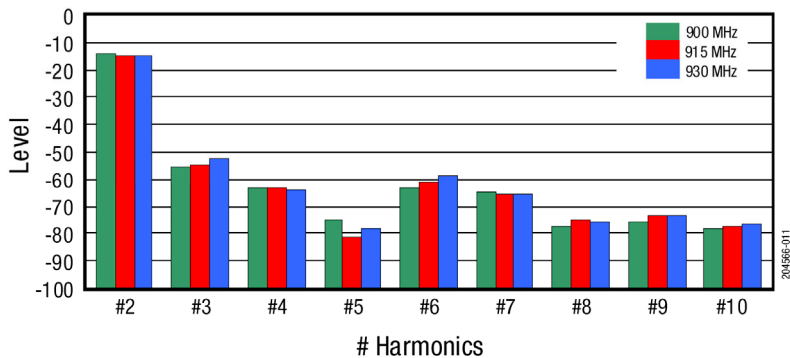


Figure 11. Harmonics at Pout = +27 dBm

**Typical Performance Characteristics for the EK2 Evaluation Board with Ceramic Antenna Filter for ETSI and FCC Compliance and Single BoM**

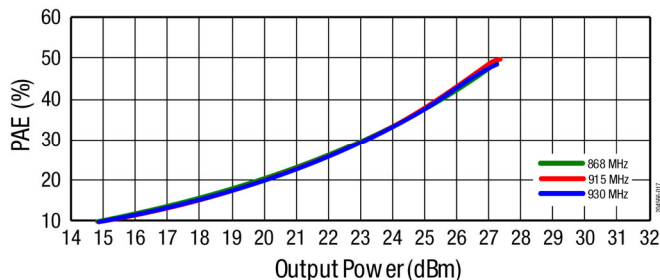


Figure 12. Gain vs POUT, CW @ 3.3 V

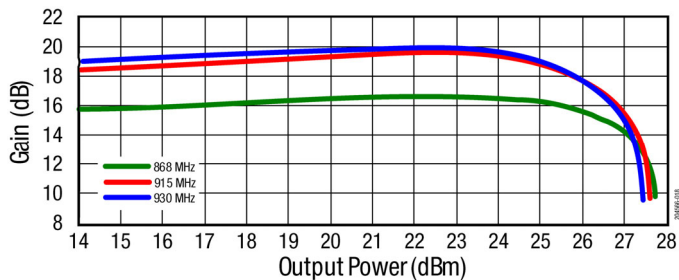


Figure 13. PAE vs POUT and VCC, CW @ 3.3 V

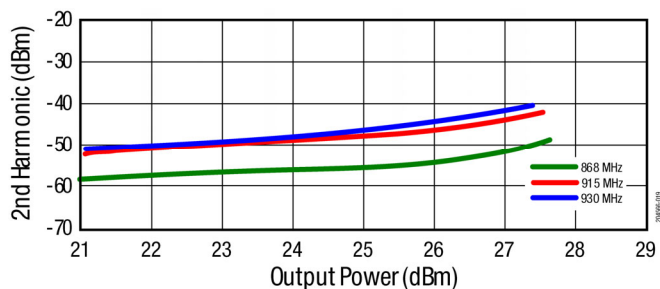


Figure 14. Second Harmonic vs POUT, CW

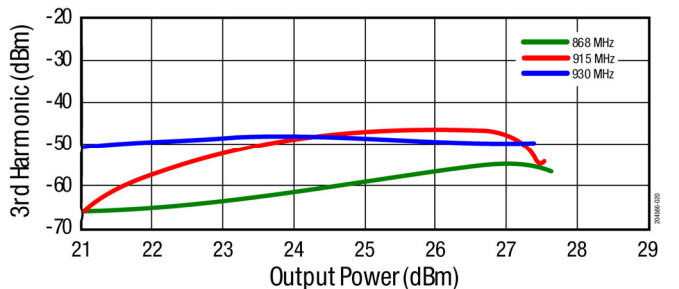


Figure 15. Third Harmonic vs POUT, CW

## Evaluation Board Description

The SKY66423-11-EK1 Evaluation Board is designed to demonstrate the performance of the SKY66423-11 RF Front-End Module. It is optimized for evaluation, experimentation, and investigation, using CW (continuous wave) signals.

### EK1 Evaluation Board

Figure 16 shows the EK1 Evaluation Board. The Evaluation Board schematic diagram for 915 MHz application is provided in Figure 17. The Bill of Materials (BOM) for the SKY66423-11 Evaluation Board for 915 MHz application is listed in Table 9.

### EK2 Evaluation Board

Figure 18 shows the EK2 Evaluation Board assembly diagram, with the recommended locations for the components. Figure 19 shows the EK2 Evaluation Board assembly diagram, with information on how to stitch the board with vias. In Figure 20, the EK2 Evaluation Board assembly diagram shows that no thermal relief pad is used.

### EK3 Evaluation Board

The Evaluation Board schematic diagram for 868 MHz application is provided in Figure 21. Figure 22 shows the EK3 Evaluation Board. The Bill of Materials (BOM) for the SKY66423-11 Evaluation Board for 868 MHz application 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.



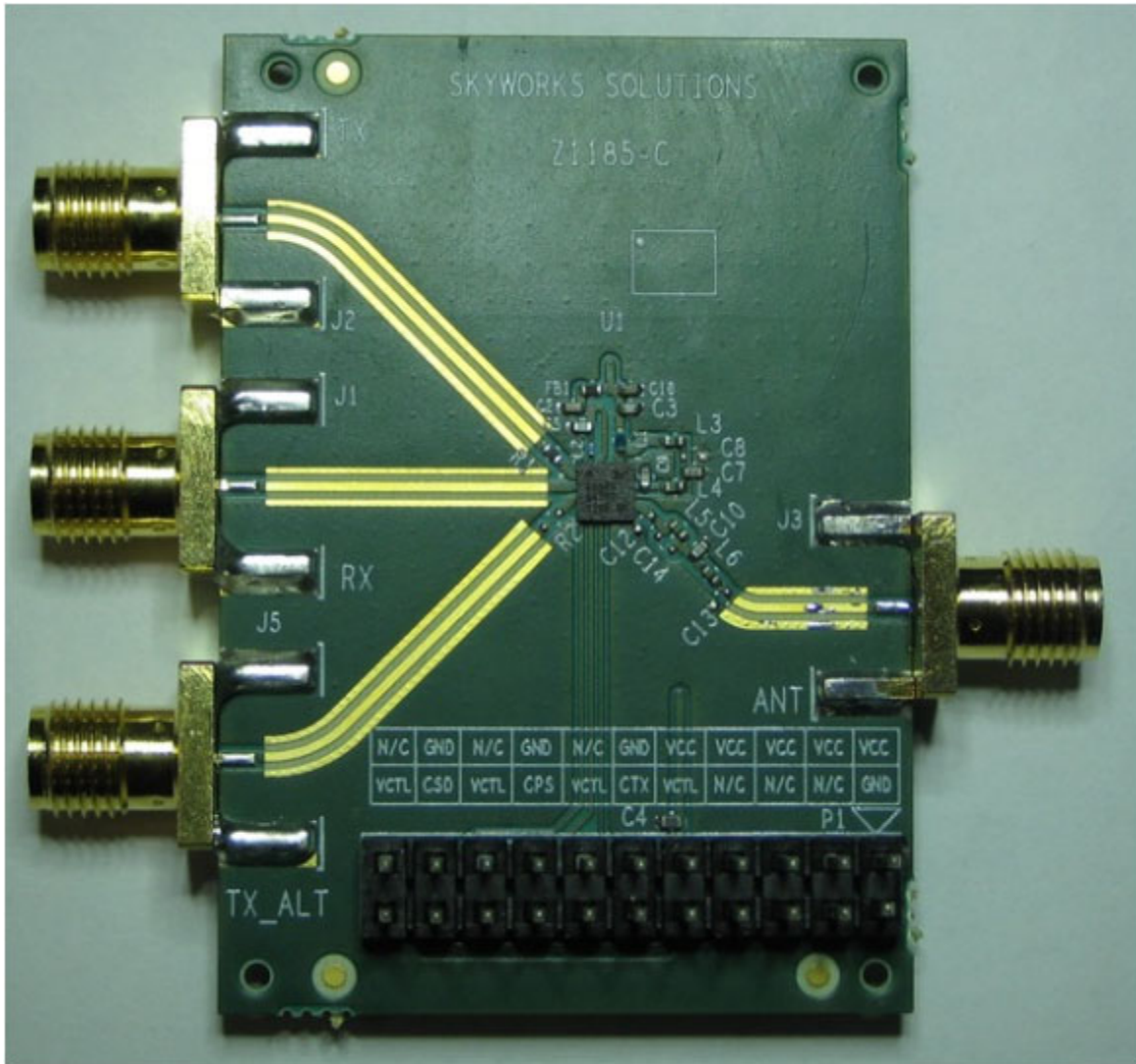
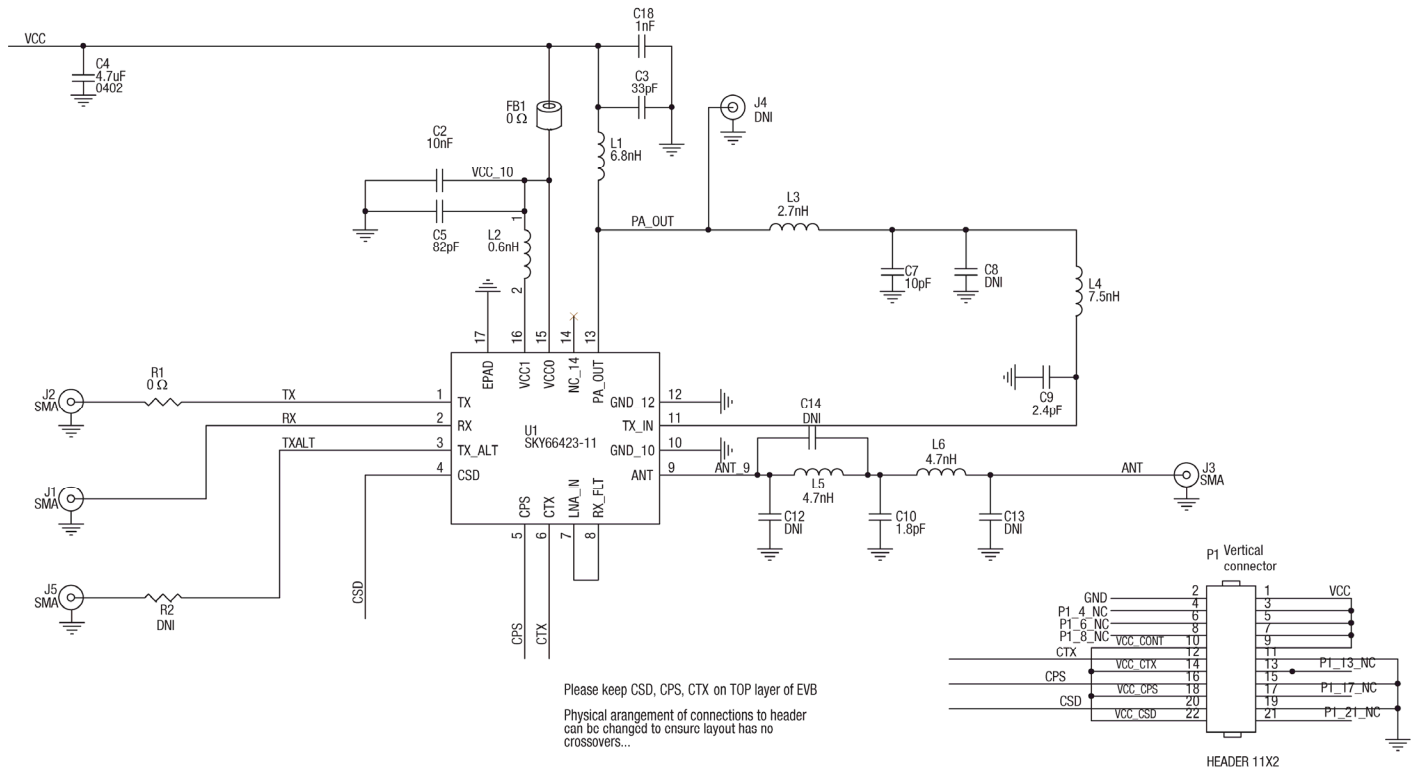


Figure 16. SKY66423-11EK1 Evaluation Board

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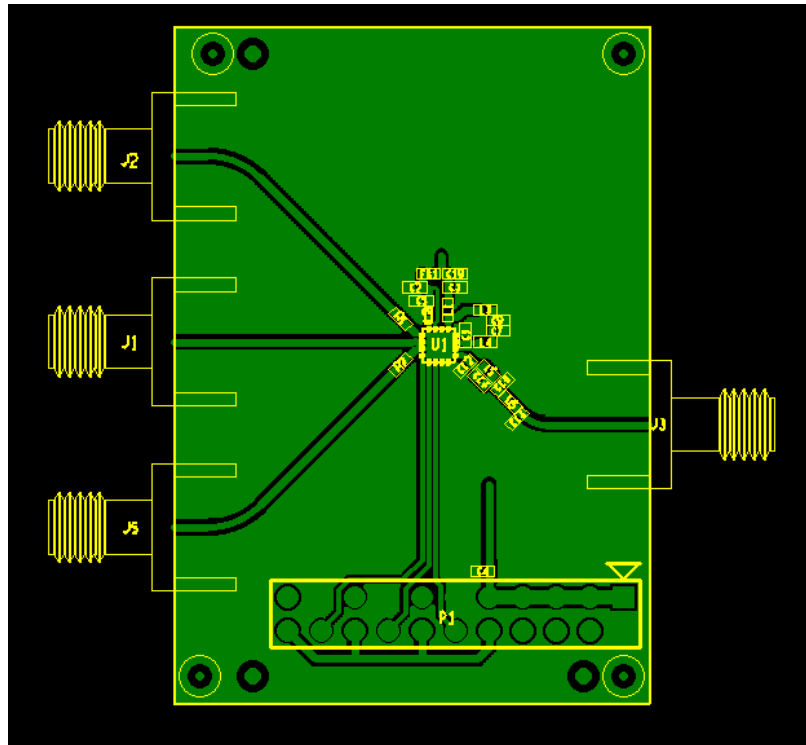


**Figure 17. SKY66423-11E K1 Evaluation Board Schematic for 915 MHz Application**

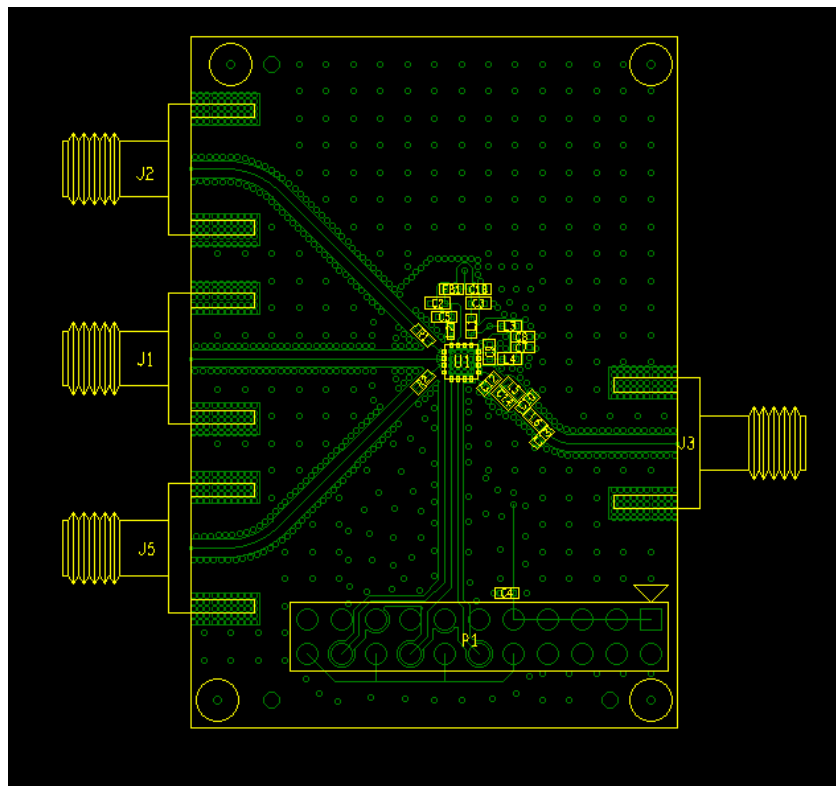
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**Table 9. SKY66423-11 EK1 Evaluation Board Bill of Materials for 915 MHz Application**

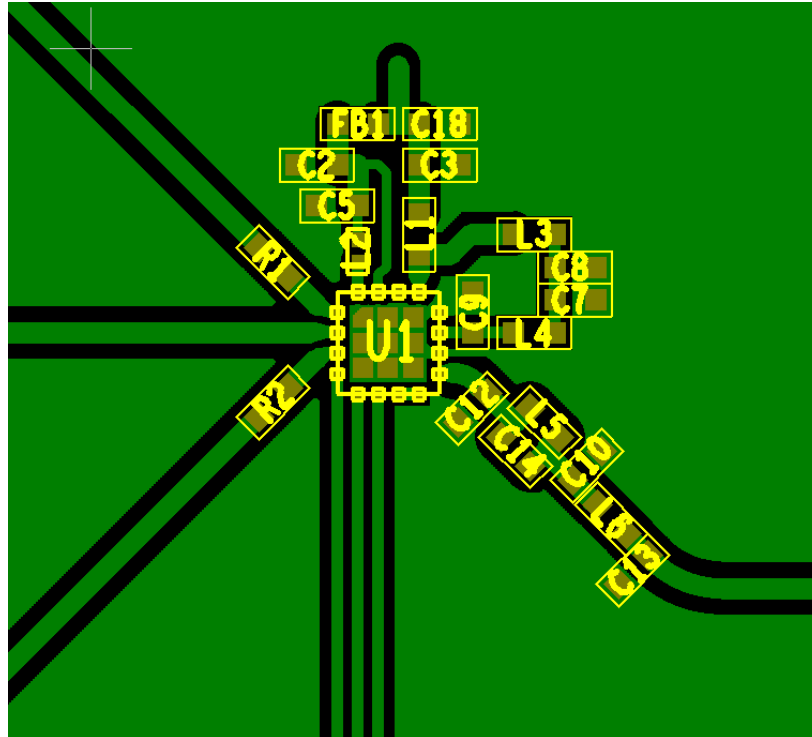
Component	Value	Manufacturer	Mfr Part Number	Size	Description
C2	10 nF	muRata	GRM155R71H103KA88	0402	Ceramic capacitor, 10000 pF, 50 V, X7R
C3	33 pF	muRata	GRM1555C1H330JA01	0402	Ceramic capacitor, 33 pF, 50 V, COG/NP0
C4	4.7 uF	muRata	GRM155R61A475MEAA	0402	Ceramic capacitor, 4.7 uF, 10 V, X5R 0402
C5	82 pF	muRata	GRM1555C1H820JA01	0402	Ceramic capacitor, 82 pF, 50 V, COG/NP0
C7	10 pF	muRata	GRM1555C1E100JA01D	0402	Ceramic capacitor, 10 pF, 25 V, COG/NP0
R2,C8,C14	DNI			0402	
C9	2.4 pF	muRata	GRM1555C1H2R4CA01	0402	Ceramic capacitor, 2.4 pF, 50 V, COG/NP0
C10	1.8 pF	muRata	GRM1555C1H1R8CA01	0402	Ceramic capacitor, 1.8 pF, 50 V, COG/NP0
C12,C13	DNI	muRata		0402	
C18	1 nF	muRata	GRM155R71H102KA01	0402	Ceramic capacitor, 1000 pF, 50 V X7R
FB1	0 ohm		ERJ2GE0R00	0402	
J1,J2,J3,J5	SMA	Johnson Components	142-0701-851	end launch	SMA end launch straight jack receptacle
J4	DNI	Amphenol		AMPHENOL_132134	Conn SMA jack str 50 ohm PCB
L1	6.8 nH	muRata	LQW15AN6N8J00D	0402	Fixed inductor, 6.8 nH, 600 mA, 290 Mohm
L2	0.6 nH	muRata	LQP03TN0N6B02D	0201	Fixed inductor, 0.6 nH, 850 mA, 70 Mohm
L3	2.7 nH	muRata	LQG15WZ2N7S02D	0402	Fixed inductor, 2.7 nH, 900 mA, 70 Mohm
L4	7.5 nH	muRata	LQG15HN7N5J02	0402	Fixed inductor, 7.5 nH, 500 mA, 310 Mohm
L5,L6	4.7 nH	muRata	LQG15HN4N7S02	0402	Fixed inductor, 4.7 nH, 600 mA, 260 Mohm
PCB1	Z1185-C	Skyworks Solutions	Z1185-C		EVB
P1	HEADER 11X2	Molex	10-89-1221	11X2	Header 11X2
R1	0 ohm	Panasonic	ERJ2GE0R00	0402	Resistor, SMD, 0 ohm, jumper, 1/10 W
U1	SKY66423-11	Skyworks Solutions	SKY66423-11	MCM 16-Pin 3X3	860 to 930 MHz RF front-end module



**Figure 18. SKY66423-11 Recommended Locations for Components on the EK2 Evaluation Board (Gerber Files are Available on Request)**



**Figure 19. SKY66423-11 EK2 Evaluation Board Stitching Diagram Showing Vias**



**Figure 20. SKY66423-11 EK2 Evaluation Board Diagram Showing That No Thermal Relief Pad Is Used (Use R1 or R2, But Not Both at the Same Time)**

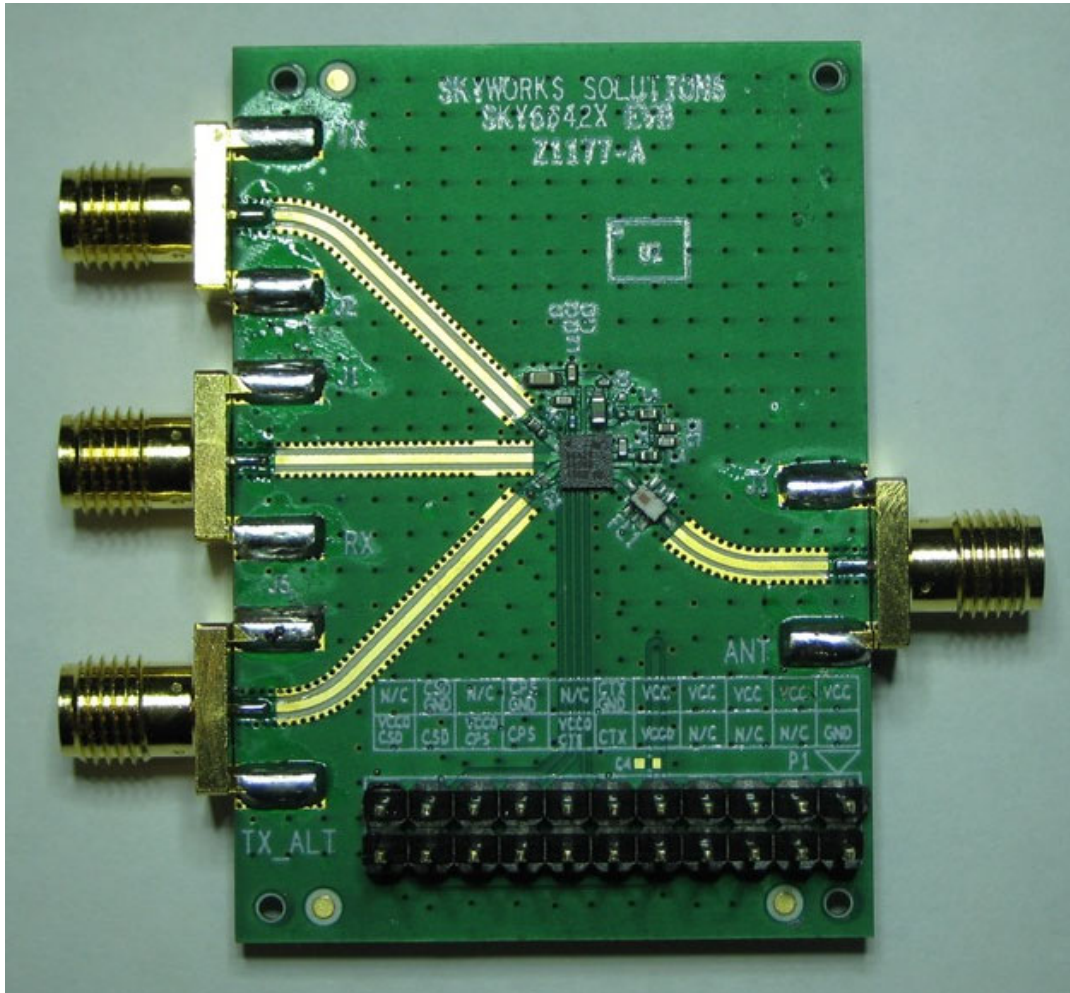
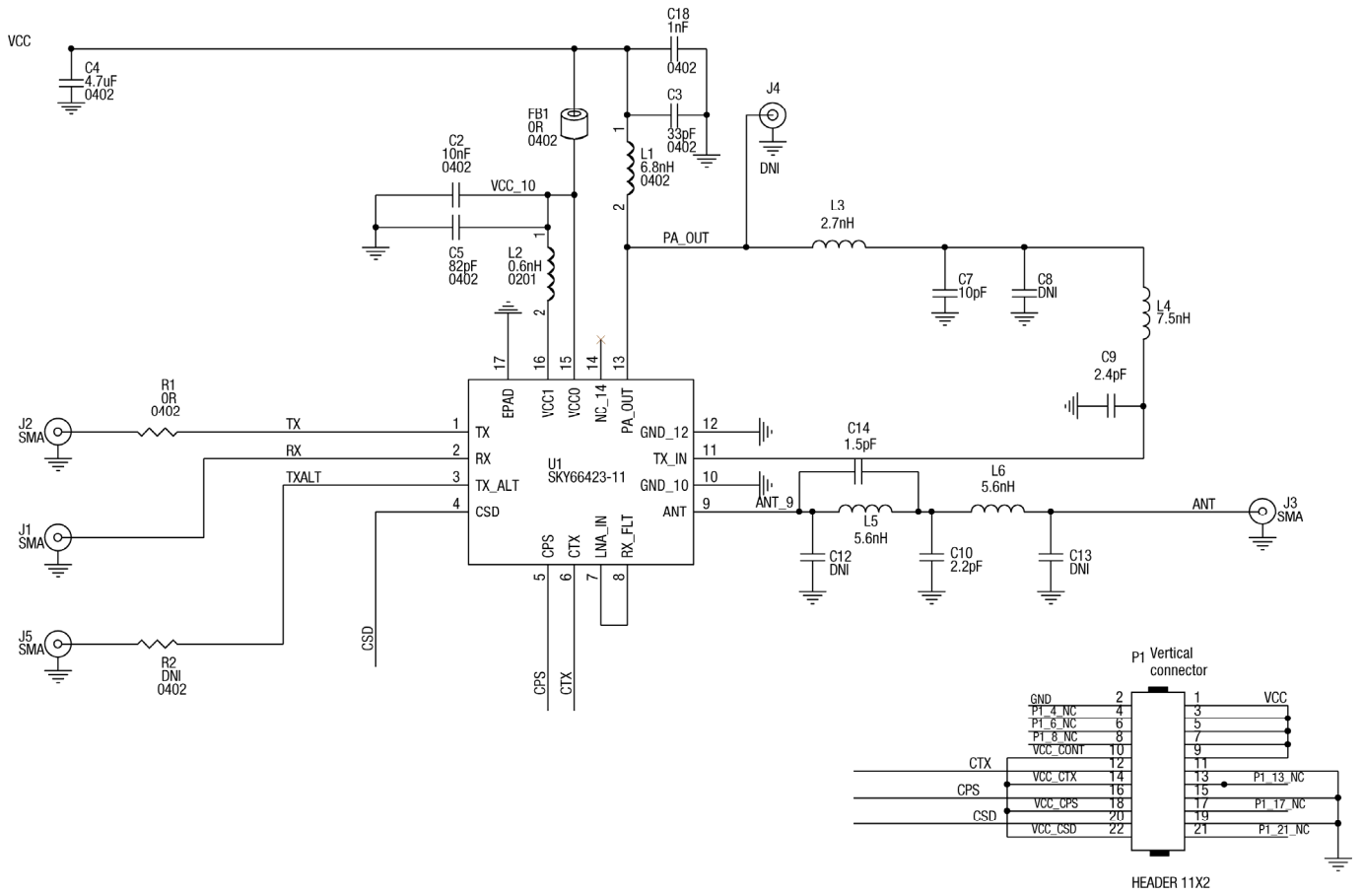


Figure 21. SKY66423-11 EK3 with Ceramic Filter at the Antenna

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**Figure 22. SKY66423-11 EK3 Evaluation Board Schematic for 868 MHz Application**

**Table 10. SKY66423-11 EK3 Evaluation Board Bill of Materials for 868 MHz Operation**

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, 4.7 uF, 10 V X5R
C5	82 pF	muRata	GRM1555C1H820JA01	0402	Ceramic capacitor, 82 pF, 50 V COG/NPO
C7	10 pF	muRata	GRM1555C1E100JA01D	0402	Ceramic capacitor, 10 pF, 25 V COG/NPO
R2,C8	DNI			0402	
C9	2.4 pF	muRata	GRM1555C1H2R4CA01	0402	Ceramic capacitor, 2.4pf, 50 V COG/NPO
C10	2.2 pF	muRata	GRM1555C1H2R2CA01	0402	Ceramic capacitor, 2.2pf, 50 V COG/NPO
C12,C13	DNI	muRata		0402	
C14	1.5 pF	muRata	GRM1555C1H1R5CA01	0402	Ceramic capacitor, 1.5 pF, 50 V COG/NPO 0
C18	1nF	muRata	GRM155R71H102KA01	0402	Ceramic capacitor, 1000 pF, 50 V X7R
FB1	0 ohm		ERJ2GE0R00	0402	
J1,J2,J3,J5	SMA	Johnson Components	142-0701-851	end launch	SMA end launch straight jack receptacle
J4	DNI	Amphenol		AMPHENOL_132134	Conn SMA jack str 50 ohm PCB
L1	6.8 nH	muRata	LQW15AN6N8J00D	0402	Fixed inductor, 6.8 nH, 600 mA 290 Mohm
L2	0.6 nH	muRata	LQP03TN0N6B02D	0201	Fixed inductor, 0.6 nH, 850 mA 70 Mohm
L3	2.7 nH	muRata	LQG15WZ2N7S02D	0402	Fixed inductor, 2.7 nH, 900 mA 70 Mohm
L4	7.5 nH	muRata	LQG15HN7N5J02	0402	Fixed inductor, 7.5 nH, 500 mA 310 Mohm
L5,L6	5.6 nH	muRata	LQG15HN5N6S02D	0402	Fixed inductor, 5.6 nH, 600 mA 260 Mohm
PCB1	Z1185-C	Skyworks	Z1185-C		EVB
P1	Header 11X2	Molex	10-89-1221	11X2	Header 11x2
R1	0 ohm	Panasonic	ERJ2GE0R00	0402	Resistor, SMD, 0 ohm jumper, 1/10 W
U1	SKY66423-11	Skyworks Solutions	SKY66423-11	MCM 16-Pin 3X3	860 to 930 MHz RF front-end module



## Package Dimensions

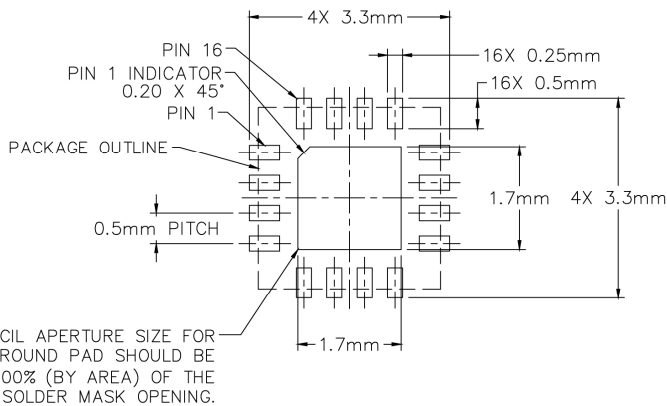
The layout footprint for the SKY66423-11 is provided in Figure 23. Typical part markings are shown in Figure 24. Package dimensions for the SKY66423-11 are shown in Figure 25, and tape and reel dimensions are provided in Figure 26.

## Package and Handling Information

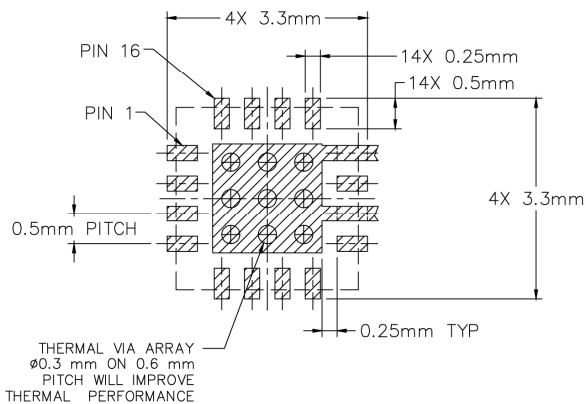
Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY66423-11 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, *Solder Reflow Information*, document number 200164.

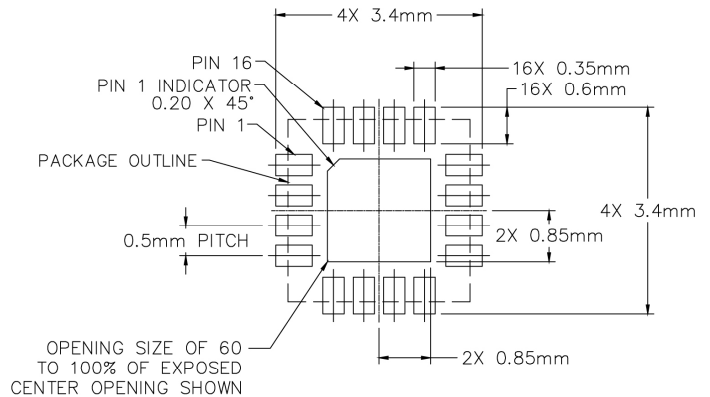
Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.



STENCIL APERTURE  
Top View



METALLIZATION  
Top View

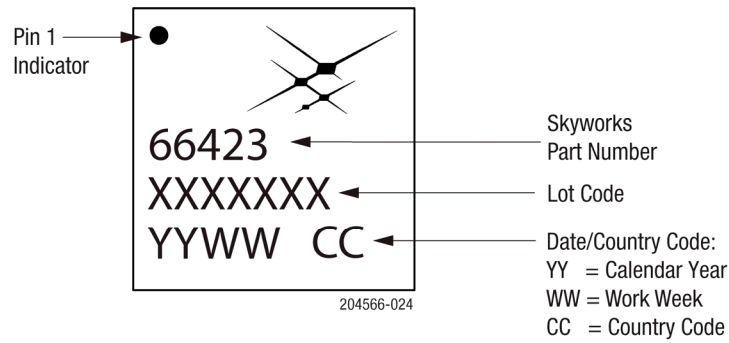


SOLDER MASK OPENING  
Top View

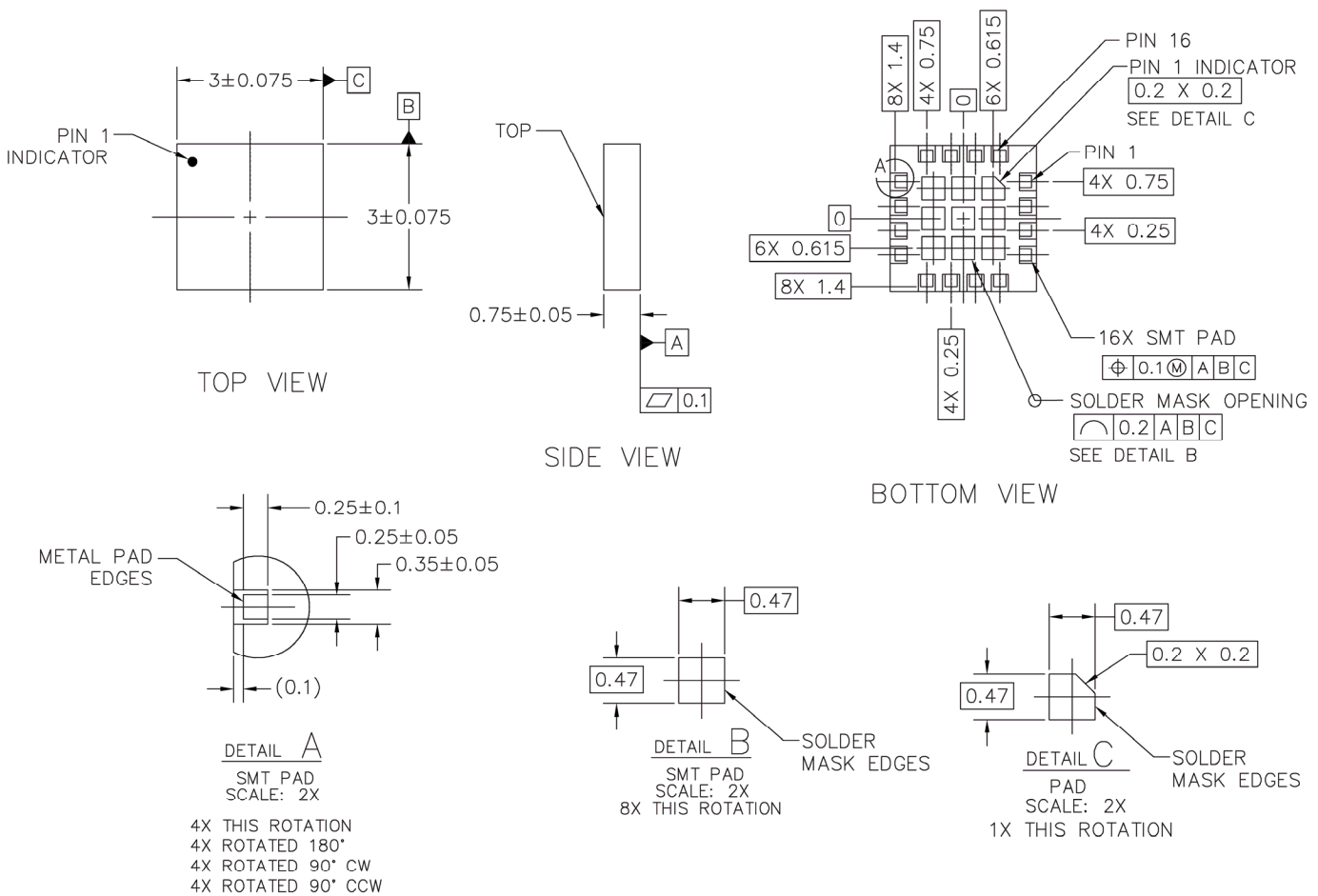
NOTE: THERMAL VIAS SHOULD BE RESIN FILLED AND CAPPED IN ACCORDANCE WITH IPC-4761 TYPE VII VIAS. 30-35UM Cu THICKNESS IS RECOMMENDED.

204566-023

**Figure 23. SKY66423-11 Recommended Footprint (Top View)**



**Figure 24. Typical Part Markings (Top View)**



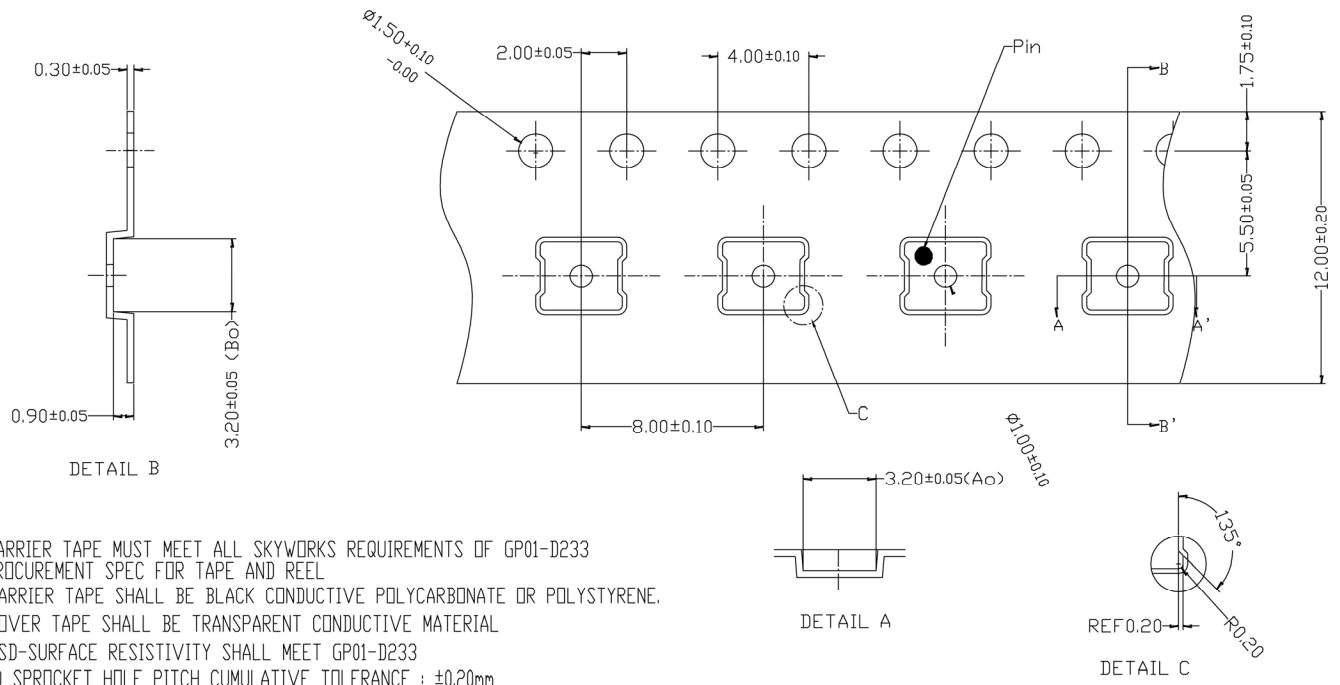
NOTES: UNLESS OTHERWISE SPECIFIED.

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

204566-025

**Figure 25. SKY66423-11 Package Dimensions**

**DATA SHEET • SKY66423-11: 860 to 930 MHz RF Front-End Module**



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 :  $\pm 0.20\text{mm}$
6.  $A_o$  &  $B_o$  MEASURED ON PLANE 0.30mm ABOVE THE BOTTOM OF THE POCKET.
7. ALL DIMENSIONS ARE IN MILLIMETERS.

204566-026

**Figure 26. SKY66423-11 Tape and Reel Dimensions**

## Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY66423-11	RF Front-End Module 915 MHz	SKY66423-11EK1
SKY66423-11	RF Front-End Module 868 to 915 MHz with ceramic filter	SKY66423-11EK2
SKY66423-11	RF Front-End Module 868 MHz	SKY66423-11EK3

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