



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 μs Rx mode and <2 μs Tx mode
- 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)

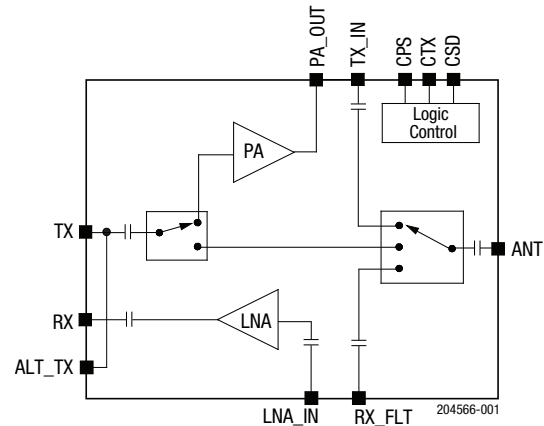


Figure 1. SKY66423-11 Block Diagram

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 Ω 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 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.



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.

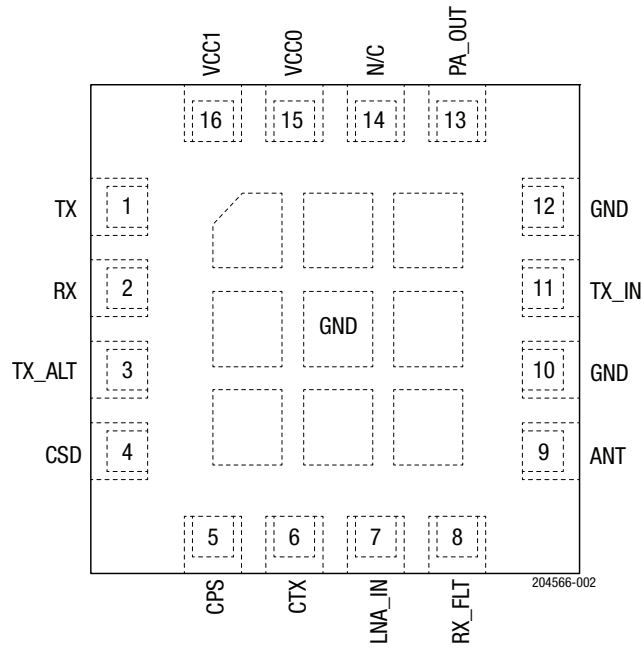


Figure 2. SKY66423-11 Pinout (Top View)

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

The absolute maximum ratings of the SKY66423-11 are provided in Table 2. The recommended operating conditions are specified in Table 3, followed by electrical specifications, control logic tables, and typical performance characteristics for the Evaluation Boards.

Table 2. SKY66423-11 Absolute Maximum Ratings¹

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage on VCC0 (no RF)	VCC0	-0.3	5.5	V
Supply voltage on VCC1 and PA_OUT (no RF)	VCC	-0.3	5.5	V
Operating temperature	TA	-40	85	°C
Storage temperature	TSTG	-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

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: Industry-standard ESD handling precautions must be adhered to at all times to avoid damage to this device.

Table 3. SKY66423-11 Recommended Operating Conditions¹

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

1. During production test, devices will be tested at 5 V.

Table 4. SKY66423-11 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		uA
Quiescent current	ICQ_TX	No RF		48		mA
Sleep supply current	ICC_OFF	No RF			1.00	uA

1. Performance is guaranteed only under the conditions listed in this Table and is not guaranteed over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.

Table 5. SKY66423-11 AC Electrical Specifications: Transmit Mode¹

(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 ^{2, 3}	POUT_915 POUT_868	f = 915 MHz f = 868 MHz		+27 +27		dBm dBm
Small signal gain ^{2, 3}	S21_915 S21_868	f = 915 MHz f = 868 MHz		29 29		dB dB
Small signal gain variation ^{2, 3}	ΔS21	Peak to peak gain variation across frequency band			1	dB
Input return loss ^{2, 3}	S11	Into 50 ohm (TX port)		-10		dB
Output return loss ^{2, 3}	S22	Into 50 ohm (ANT port)		-10		dB
Input 1 dB compression point, bypass mode	BYP_IP1dB	Bypass mode	+20			dBm
2nd harmonic ⁴	2fo	POUT = +27 dBm			+7	dBm
3rd to 10th harmonic ⁴	3fo to 10fo	POUT = +27 dBm			-42	dBm
Insertion loss (bypass mode)	S21_BYP	TX to ANT			1.5	dB
Turn-on time ⁵	tON			1	2	μs
Turn-off time ⁶	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			

1. Performance is guaranteed only under the conditions listed in this Table and is not guaranteed over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.
2. 900 to 930 MHz with specified matching network on the Evaluation Board.
3. 860 to 870 MHz with specified matching network on the Evaluation Board.
4. Measured with continuous wave signal.
5. From 50% of CTX edge to 90% of final RF output power.
6. From 50% of CTX edge to 10% of initial RF output power.

Table 6. SKY66423-11 AC Electrical Specifications: Receive Mode¹

(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 _{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	S11 _{ANT}	Into 50 ohms (ANT port)		-12		dB
RX port return loss	S22 _{RX}	Into 50 ohms (RX port)		-12		dB
Turn-on time ²	tON			2.5		us
Turn-off time ³	tOFF				1	us

1. Performance is guaranteed only under the conditions listed in this Table and is not guaranteed over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.
2. From 50% of CTX edge to 90% of final RF output power.
3. From 50% of CTX edge to 10% of initial RF output power.

Table 7. SKY66423-11 Electrical Specifications: Control Logic Characteristics¹
(TA = +25 °C, Unless Otherwise Noted)

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

1. Performance is guaranteed only under the conditions listed in this Table and is not guaranteed over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.
2. Logic inputs must be VCC0 or GND to achieve specified sleep currents.

Table 8. SKY66423-11 Electrical Specifications: Mode Control Logic¹
(TA = +25 °C)

Mode	CSD	CTX	CPS
Shutdown	0	X ²	X ²
Receive LNA mode	1	0	X ²
Transmit bypass	1	1	0
Transmit	1	1	1

1. Make sure each control logic has the proper pull-up and pull-down in the application circuit.
2. X = (Don't care) inputs must be held at VCC0 or GND to achieve specified sleep current.

Typical Performance Characteristics for the SKY66423-11EK1 Evaluation Board (915 MHz)

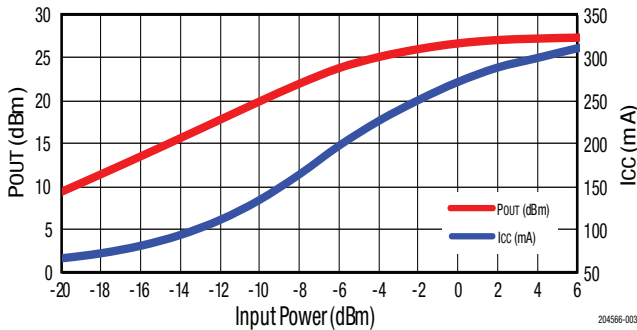


Figure 3. POUT and ICC vs PIN, CW

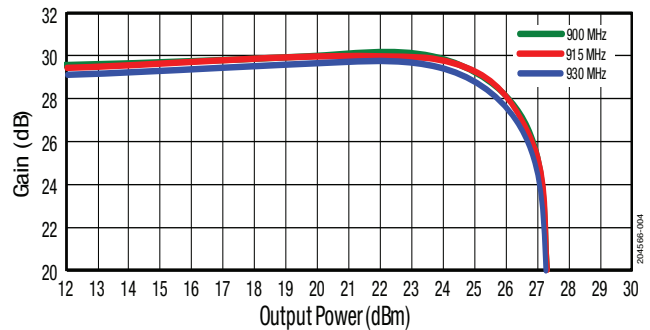


Figure 4. Gain vs POUT, CW

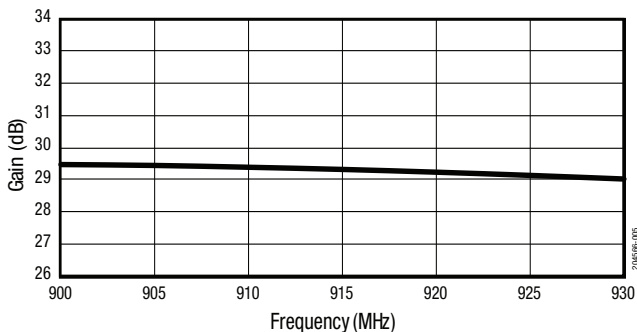


Figure 5. Small Signal Gain vs Frequency, CW

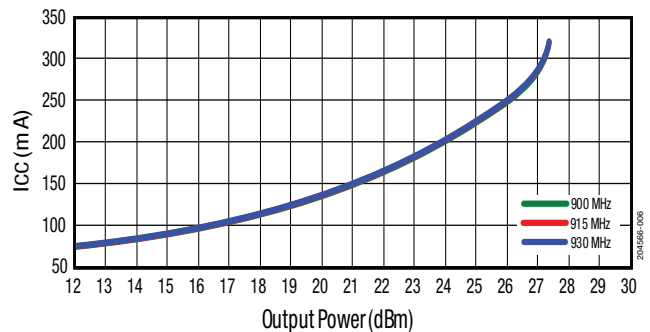


Figure 6. ICC vs POUT

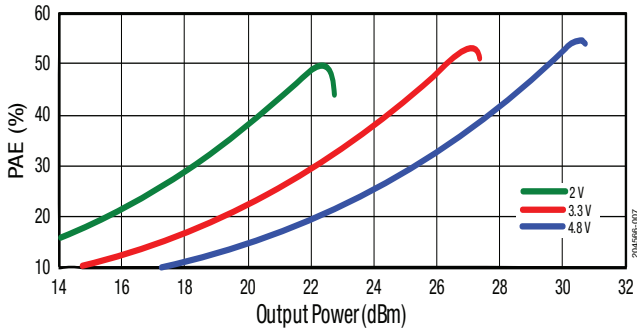


Figure 7. PAE vs POUT and VCC, CW

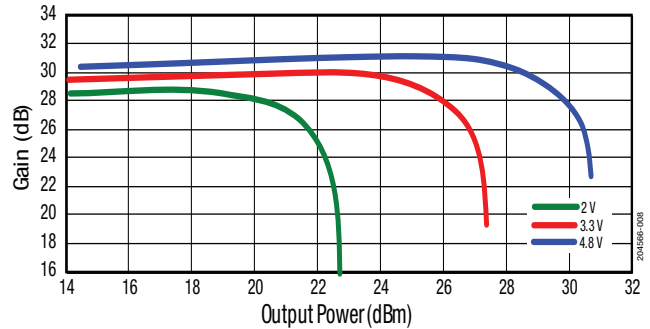


Figure 8. Gain vs POUT and VCC, CW

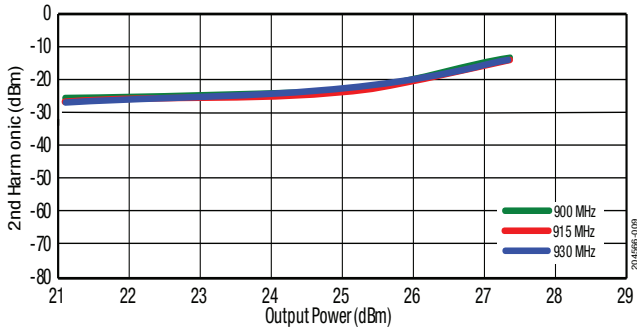


Figure 9. Second Harmonic vs POUT, CW

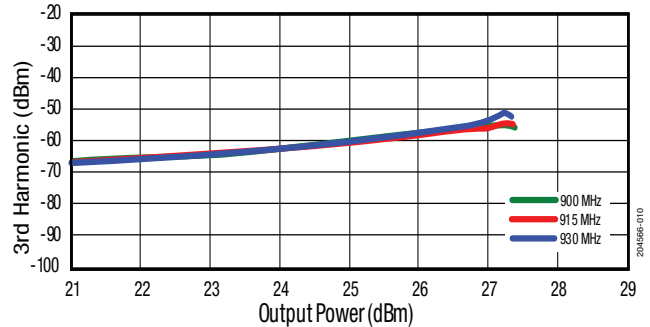


Figure 10. Third Harmonic vs POUT, CW

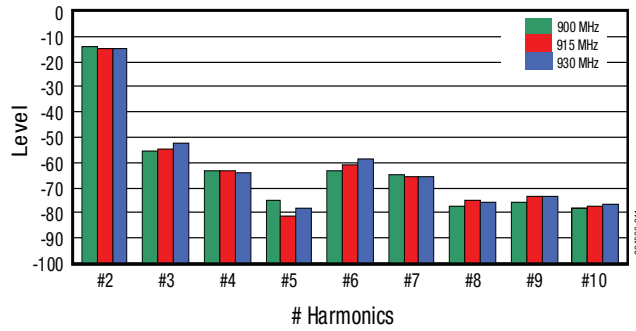


Figure 11. Harmonics at POUT = +27 dBm

Typical Performance Characteristics for the SKY66423-11EK2 Evaluation Board with Ceramic Filter for ETSI and FCC Compliance (868 to 915 MHz)

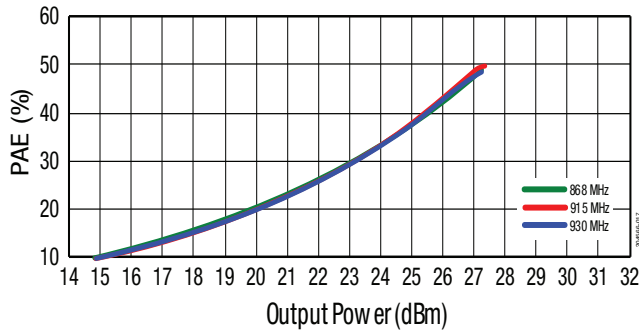


Figure 12. Gain vs POUT, CW @ 3.3 V

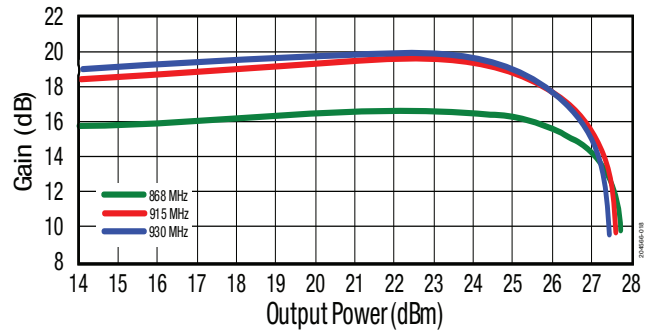


Figure 13. PAE vs POUT and VCC, CW @ 3.3 V

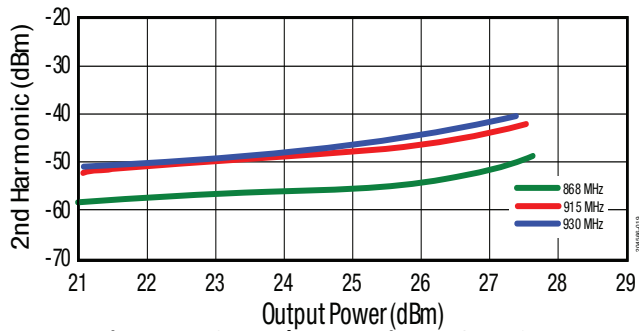


Figure 14. Second Harmonic vs POUT, CW

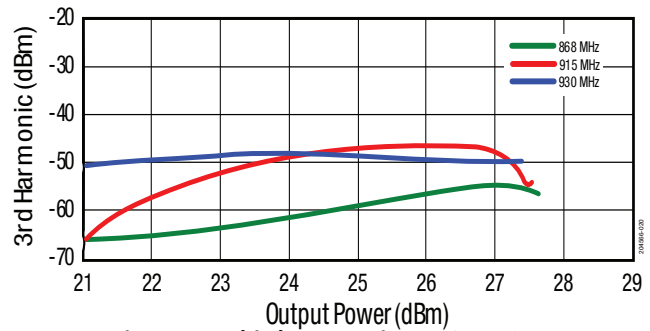


Figure 15. Third Harmonic vs POUT, CW

Evaluation Board Description

An Evaluation Board is used to test the performance of the SKY66423-11 FEM. It is optimized for evaluation, experimentation, and investigation, using CW (continuous wave) signals.

SKY66423-11EK1 Evaluation Board, 915 MHz

See Figure 16. The Evaluation Board schematic diagram for 915 MHz applications is provided in Figure 17. The Bill of Materials (BOM) is listed in Table 9.

SKY66423-11EK2 Evaluation Board, 868 to 915 MHz with Ceramic Filter

See Figure 18. Figure 19 shows the Evaluation Board schematic, and the BOM appears in Table 10.

SKY66423-11EK3 Evaluation Board, 868 MHz

See Figure 20. Ground via stitching is shown in Figure 21. Figure 22 shows that the SKY66423-11EK3 has no thermal relief pad. The schematic diagram is shown in Figure 23. The BOM is listed in Table 11.

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 (microstrips 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.

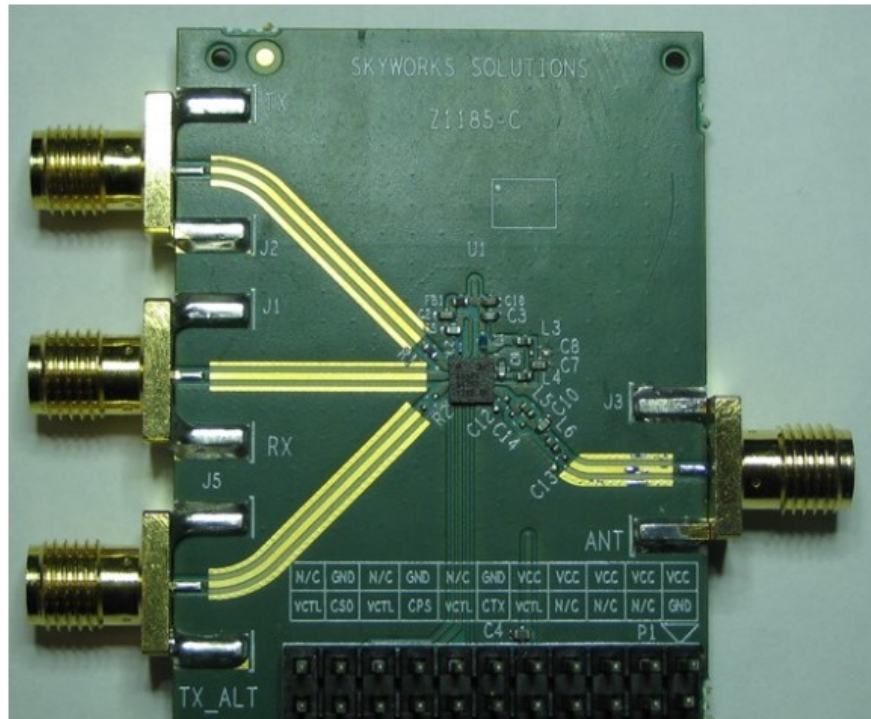


Figure 16. SKY66423-11-EK1 Evaluation Board, 915 MHz

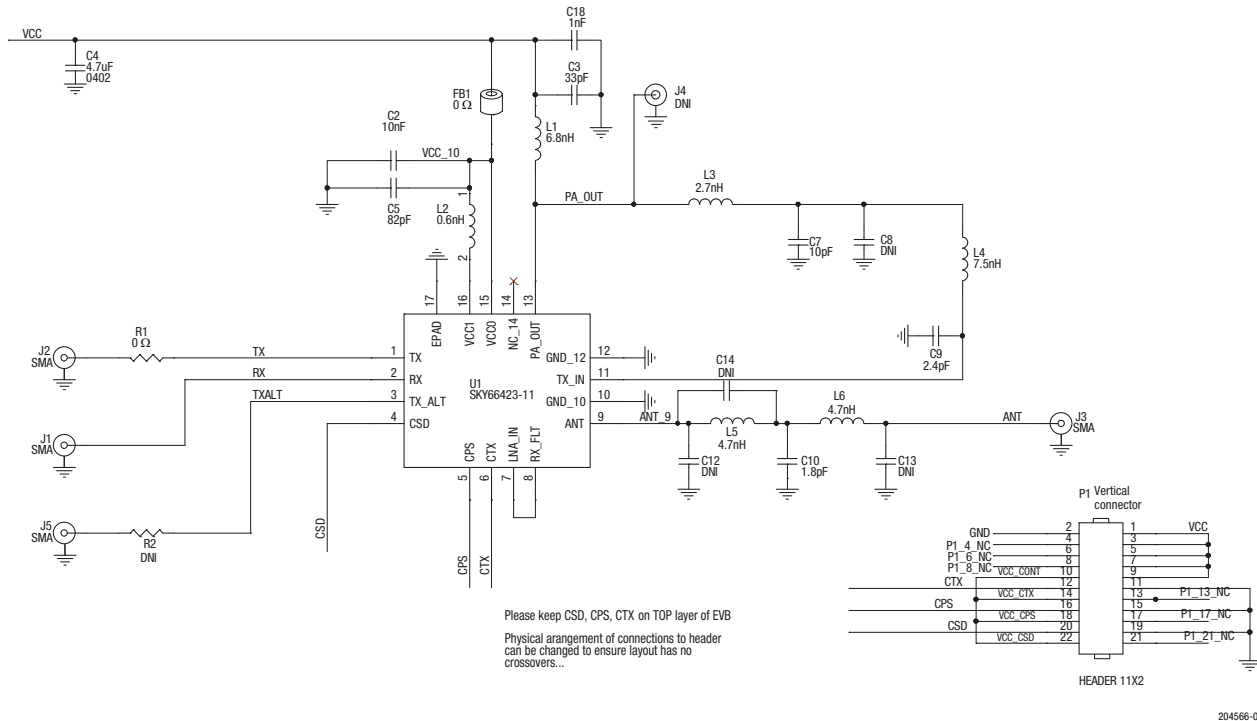


Figure 17. SKY66423-11EK1 Evaluation Board Schematic for 915 MHz

Table 9. SKY66423-11EK1 Evaluation Board Bill of Materials (915 MHz)

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 Ω		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 Ω PCB
L1	6.8 nH	Murata	LQW15AN6N8J00D	0402	Fixed inductor, 6.8 nH, 600 mA, 290 M Ω
L2	0.6 nH	Murata	LQP03TN0N6B02D	0201	Fixed inductor, 0.6 nH, 850 mA, 70 M Ω
L3	2.7 nH	Murata	LQG15WZ2N7S02D	0402	Fixed inductor, 2.7 nH, 900 mA, 70 M Ω
L4	7.5 nH	Murata	LQG15HN7N5J02	0402	Fixed inductor, 7.5 nH, 500 mA, 310 M Ω
L5,L6	4.7 nH	Murata	LQG15HN4N7S02	0402	Fixed inductor, 4.7 nH, 600 mA, 260 M Ω
PCB1	Z1185-C	Skyworks Solutions	Z1185-C		EVB
P1	HEADER 11X2	Molex	10-89-1221	11X2	Header 11X2
R1	0 Ω	Panasonic	ERJ2GE0R00	0402	Resistor, SMD, 0 Ω , jumper, 1/10 W
U1	SKY66423-11	Skyworks Solutions	SKY66423-11	MCM 16-Pin 3X3	860 to 930 MHz RF front-end module

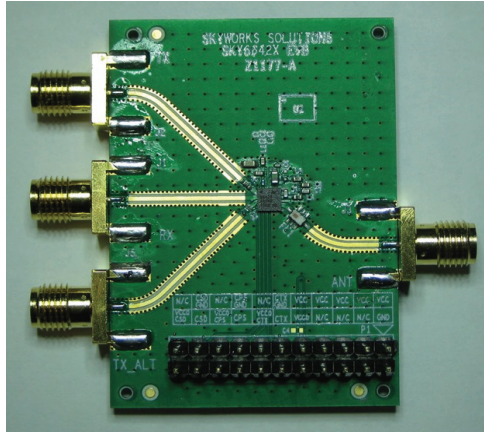
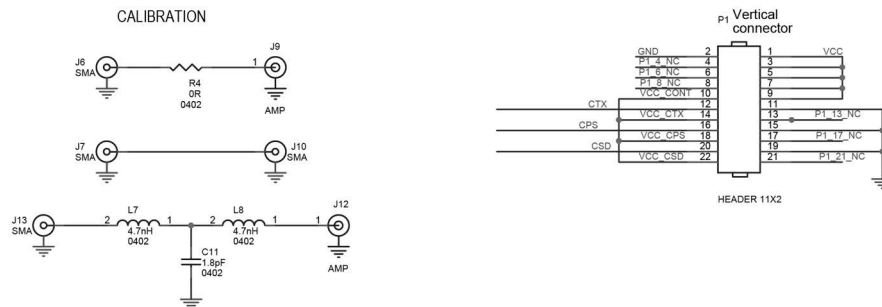
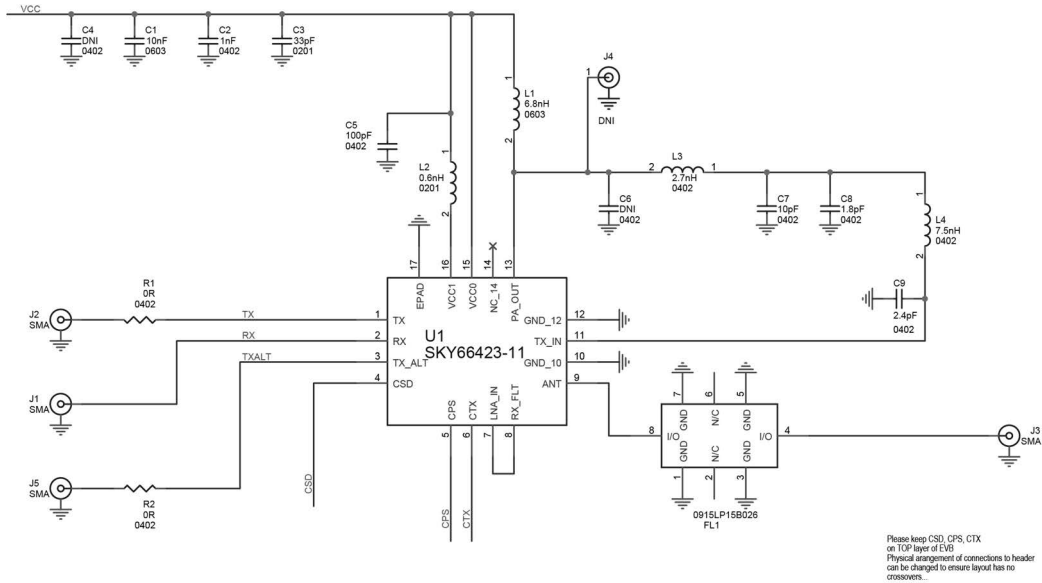


Figure 18. SKY66423-11E2K Evaluation Board, 868 to 915 MHz, with Ceramic Filter



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Figure 19. SKY66423-11E2K Evaluation Board, 868 to 915 MHz with Ceramic Filter

Table 10. SKY66423-11EK2 Evaluation Board BOM, 868 to 915 MHz with Ceramic Filter

Item	Qty	Ref	Value	Manufacturer	Part Number	Package	Description
1	1	C1	10nF	Murata	GRM188R71H103KA01	603	Cap ceramic 10000 pF 50 V X7R 0603
2	1	C2	1nF	Murata	GRM155R71H102KA01	402	Cap ceramic 1000 pF 50 V X7R 0402
3	1	C3	33 pF	Murata	GRM0335C1E330JD01	201	Cap ceramic 33 pF 25 V COG/NP0 0201
4	2	C4,C6	DNI			402	DNI
5	1	C5	100 pF	Murata	GRM1555C1H101GA01	402	Cap ceramic 100 pF 50 V COG/NP0 0402
6	1	C7	10 pF	Murata	GRM1555C1H100GA01D	402	Cap ceramic 10 pF 50 V COG/NP0 0402
7	2	C8	1.8 pF	Murata	GRM1555C1H1R8BA01D	402	Cap ceramic 1.8 pF 50 V COG/NP0 0402
8	1	C9	2.4 pF	Murata	GRM1555C1H2R4BA01D	402	Cap ceramic 2.4 pF 50 V COG/NP0 0402
9	1	J4	DNI	Amphenol	132134		Conn SMA jack STR 50 Ω PCB
10	4	J2,J3,J1,J5	SMA	Johnson Components	142-0701-851	SMA_EDGE	Conn SMA jack str 50 Ω edge mnt
11	1	L1	6.8 nH	Murata	LQG18HN6N8J00	603	Fixed ind 6.8 nH 430 mA 250 MΩ
12	1	L2	0.6 nH	Murata	LQP03TN0N6C00	201	Fixed ind 0.6 nH 840 mA 80 MΩ
13	1	L3	2.7 nH	Murata	LQG15HN2N7S02	402	Fixed ind 2.7 nH 800 mA 160 MΩ
14	1	L4	7.5 nH	Murata	LQG15HN7N5J02	402	Fixed ind 7.5 nH 500 mA 310 MΩ
15	1	PCB1	Z1177-A	Skyworks Solutions	Z1177-A		EVb
16	1	P1	Header 11X2	Molex	10-89-1221	11X2	Header 11X2
17	2	R1,R2	0R	Panasonic	ERJ2GE0R00	402	Thick film chip resistor
18	1	FL1	0915LP15B026	Johanson		0915LP15B026	915 MHz low pass ceramic filter
19	1	U1	SKY66423-11	Skyworks Solutions	SKY66423-11	MCM 16-PIN 3X3	860 to 930 MHz RF front-end module

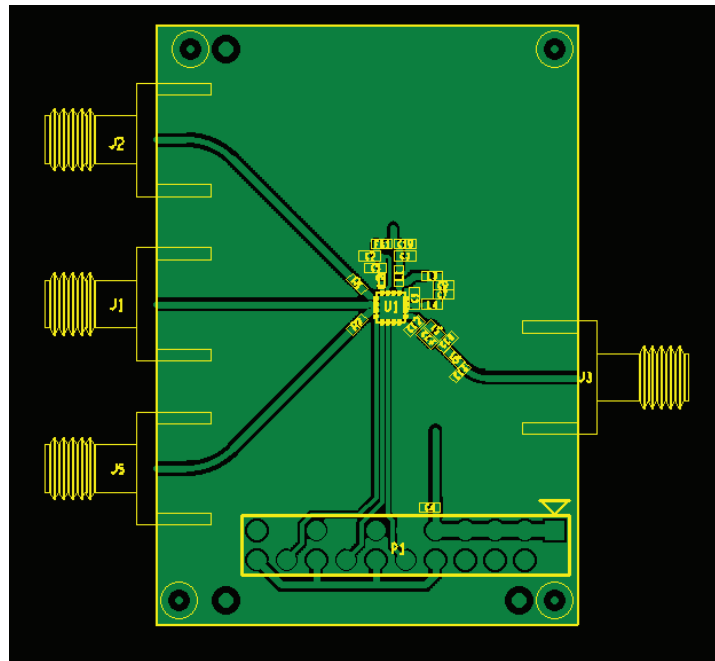


Figure 20. SKY66423-11EK3 Evaluation Board, 868 MHz

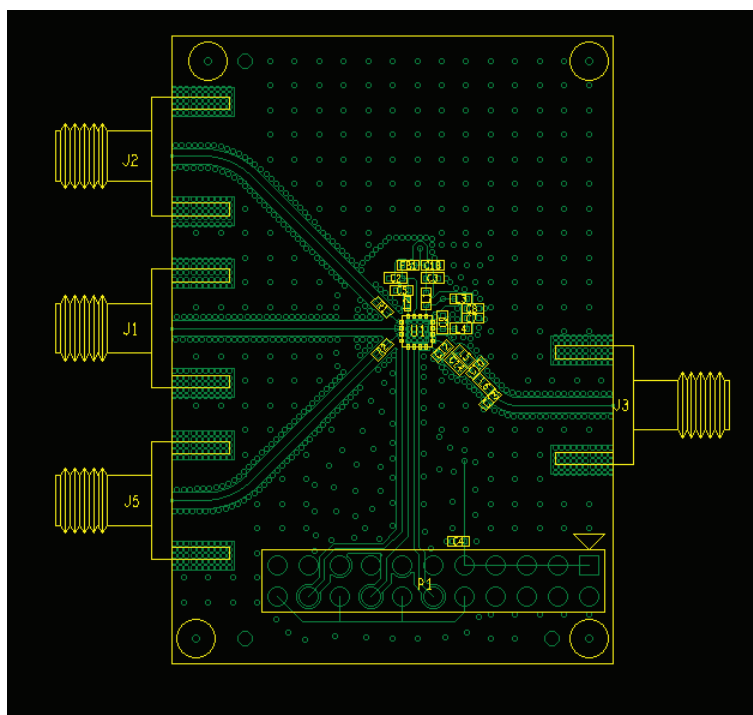
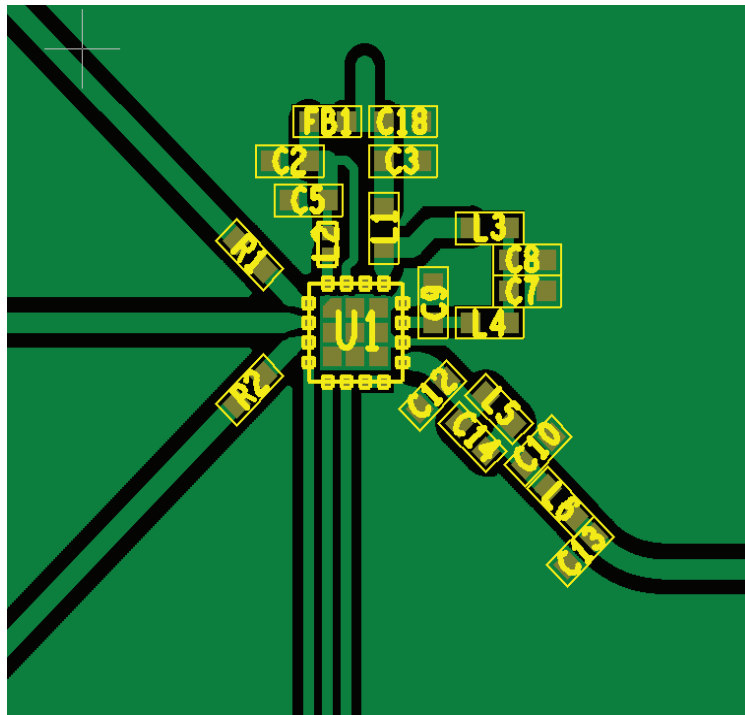
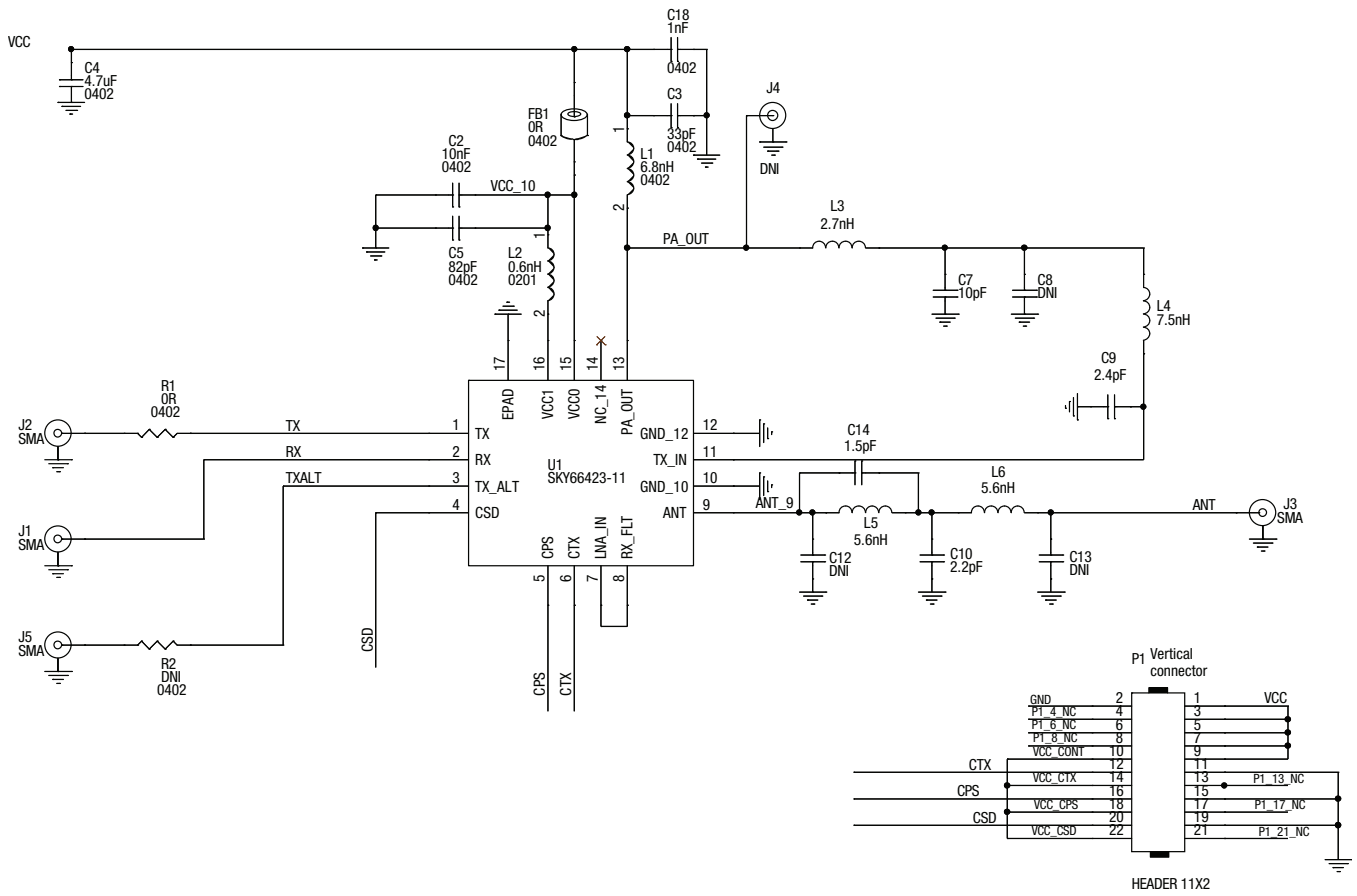


Figure 21. SKY66423-11EK3 Evaluation Board Ground Via Stitching



Use R1 or R2, But Not Both

Figure 22. SKY66423-11EK3 Evaluation Board Showing That No Thermal Relief Pad Is Used



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Figure 23. SKY66423-11 EK3 Evaluation Board, 868 MHz

Table 11. SKY66423-11EK3 Evaluation Board BOM, 868 MHz

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	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	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	1.5 pF	Murata	GRM1555C1H1R5CA01	0402	Ceramic capacitor, 1.5 pF, 50 V COG/NP0 0
C18	1 nF	Murata	GRM155R71H102KA01	0402	Ceramic capacitor, 1000 pF, 50 V X7R
FB1	0 Ω		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 Ω PCB
L1	6.8 nH	Murata	LQW15AN6N8J00D	0402	Fixed inductor, 6.8 nH, 600 mA 290 M Ω
L2	0.6 nH	Murata	LQP03TN0N6B02D	0201	Fixed inductor, 0.6 nH, 850 mA 70 M Ω
L3	2.7 nH	Murata	LQG15WZ2N7S02D	0402	Fixed inductor, 2.7 nH, 900 mA 70 M Ω
L4	7.5 nH	Murata	LQG15HN7N5J02	0402	Fixed inductor, 7.5 nH, 500 mA 310 M Ω
L5,L6	5.6 nH	Murata	LQG15HN5N6S02D	0402	Fixed inductor, 5.6 nH, 600 mA 260 M Ω
PCB1	Z1185-C	Skyworks	Z1185-C		EVB
P1	Header 11X2	Molex	10-89-1221	11X2	Header 11x2
R1	0 Ω	Panasonic	ERJ2GE0R00	0402	Resistor, SMD, 0 Ω 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

Typical part marking for the SKY66423-11 is shown below, followed by the PCB layout footprint, package dimensions, and tape and reel information.

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.

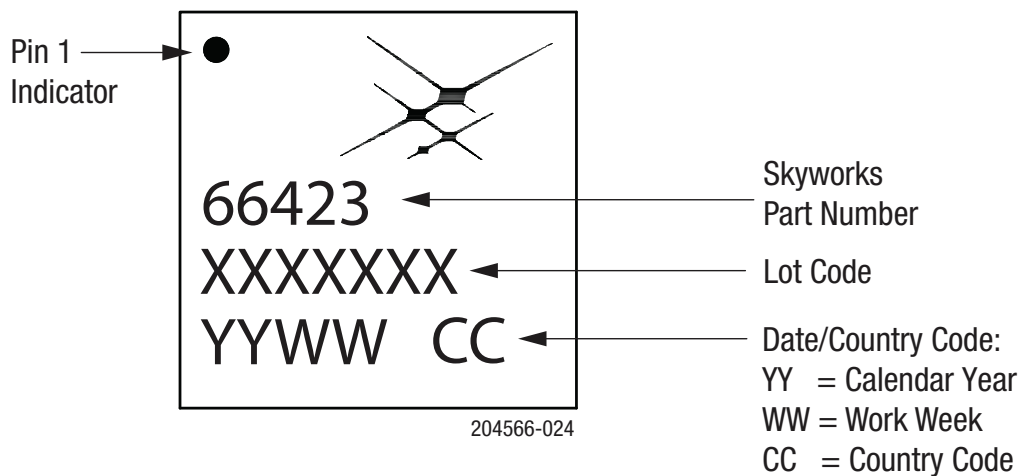
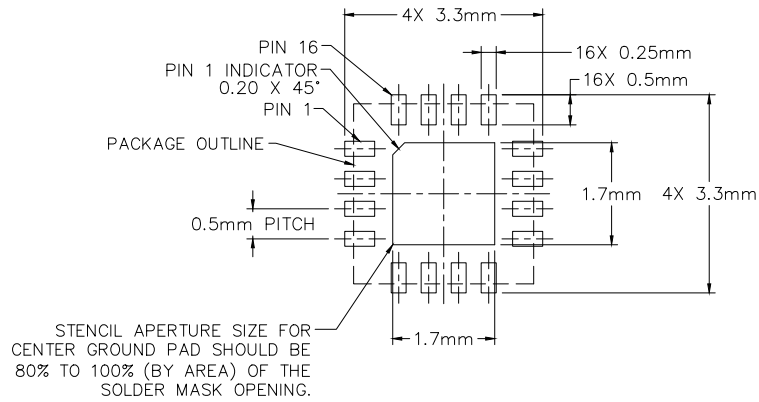
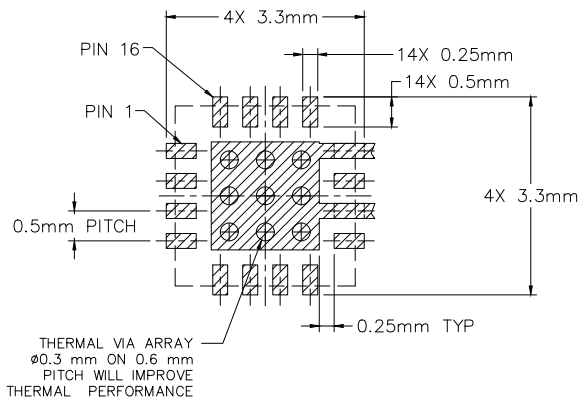


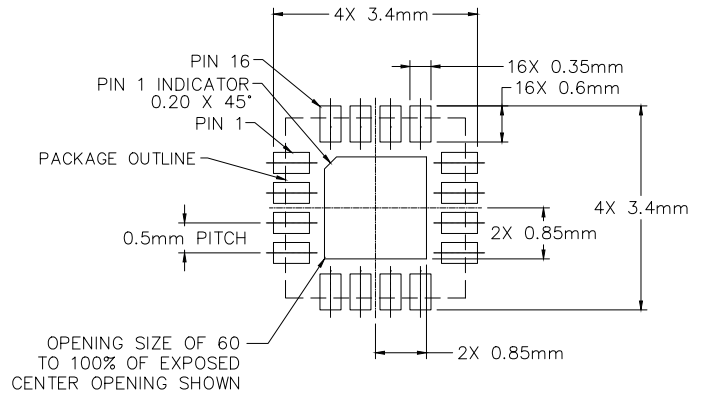
Figure 24. SKY66423-11 Typical Part Markings (Top View)



STENCIL APERTURE
Top View



METALLIZATION
Top View

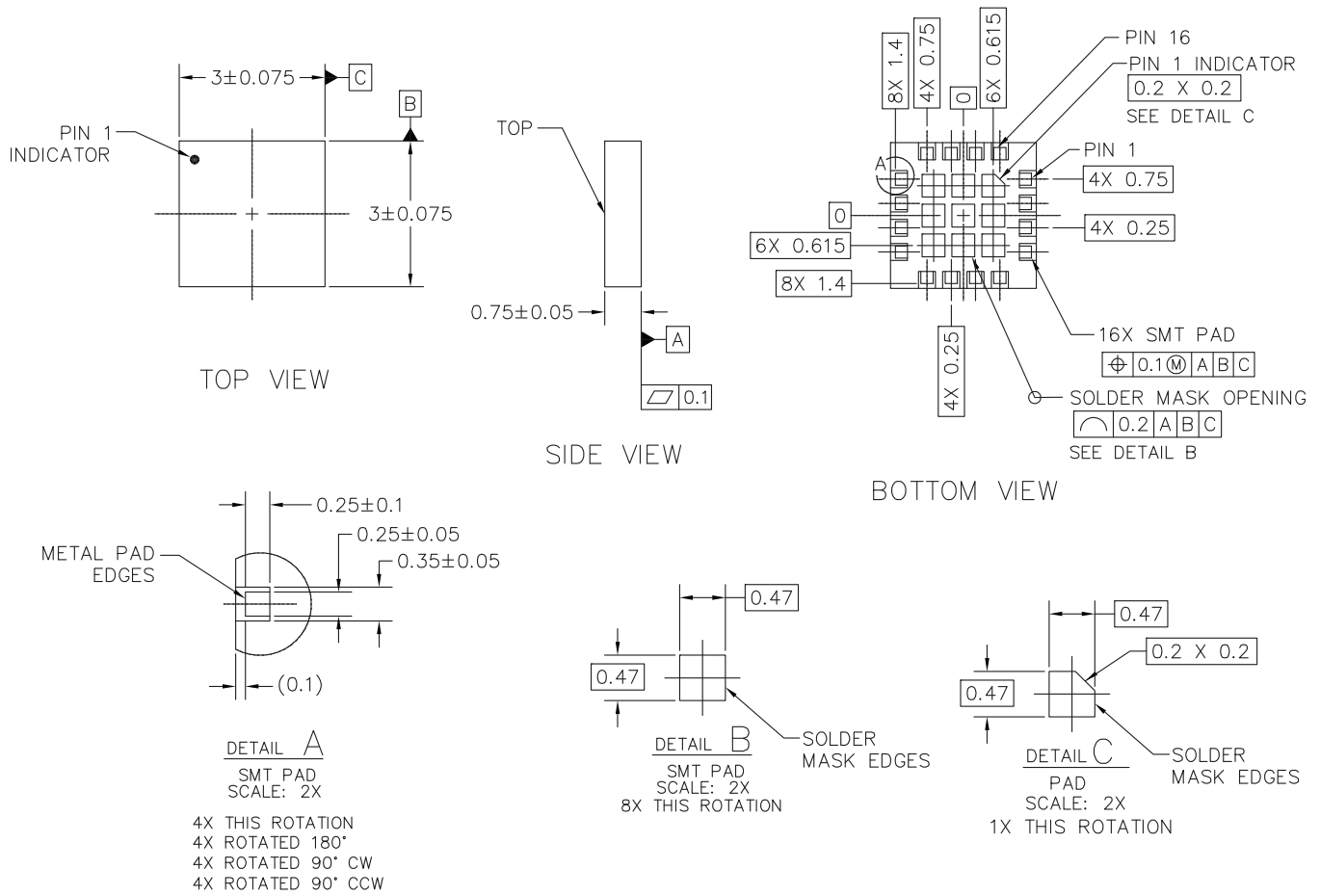


SOLDER MASK OPENING
Top View

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 25. SKY66423-11 PCB Layout Footprint (Top View)

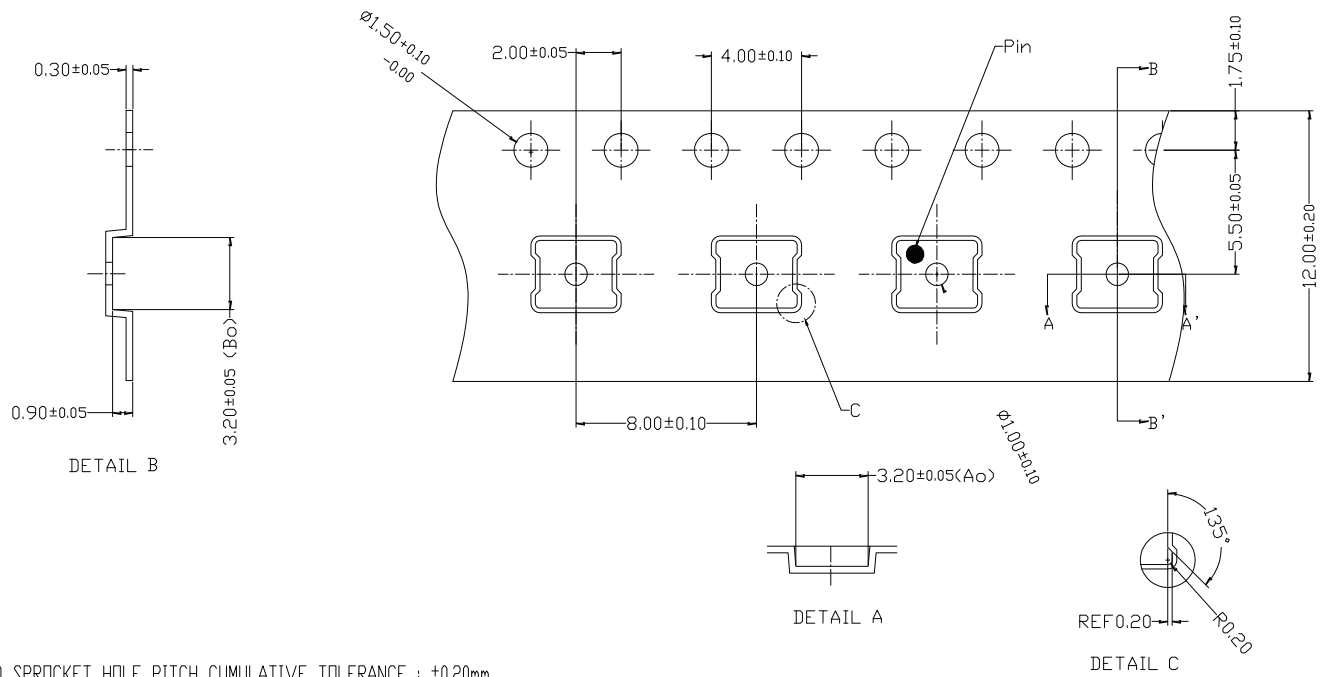


NOTES: UNLESS OTHERWISE SPECIFIED.

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

204566-025

Figure 26. SKY66423-11 Package Dimensions



10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE : $\pm 0.20\text{mm}$
 Ao & Bo MEASURED ON PLANE 0.30mm ABOVE THE BOTTOM OF THE POCKET.
 ALL DIMENSIONS ARE IN MILLIMETERS.

204566-026

Figure 27. SKY66423-11 Tape and Reel Dimensions

Ordering Information

Part Number	Description
SKY66423-11	860 to 930 MHz RF Front-End Module
SKY66423-11EK1	Evaluation Board, 915 MHz
SKY66423-11EK2	Evaluation Board, 868 to 915 MHz with Ceramic Filter
SKY66423-11EK3	Evaluation Board, 868 MHz

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