

# SKY73421-11: 1400 to 2000 MHz Broadband, Application Configurable High Gain and Linearity Diversity Downconversion Mixer

## Applications

- 2G/3G/4G base station transceivers:
  - GSM/EDGE, CDMA, UMTS/WCDMA, LTE
- Land mobile radio
- High performance radio links

## Features

- Operating frequency range: 1400 to 2000 MHz
- IF frequency range: 150 to 320 MHz
- Conversion gain: 9 dB
- Input IP3: up to +29.5 dBm
- Output IP3: up to +38.5 dBm
- Noise Figure: 9 dB
- Power-down mode
- Integrated LO drivers
- Integrated low loss RF baluns
- High linearity IF amplifiers
- Application tuneability
- Small, QFN (36-pin, 6 x 6 mm) package (MSL3, 260 °C per JEDEC J-STD-020)



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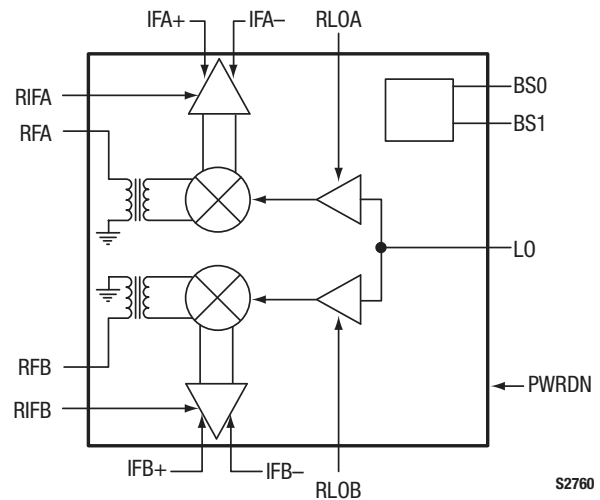


Figure 1. SKY73421-11 Block Diagram

## Description

The SKY73421-11 is a fully integrated diversity mixer that includes Local Oscillator (LO) drivers, high linearity mixers, and large dynamic range Intermediate Frequency (IF) amplifiers. Low loss RF baluns have also been included to reduce design complications and lower system cost.

The SKY73421-11 features an IIP3 of +25 dBm and a Noise Figure (NF) of 9 dB, making the device an ideal solution for high dynamic range systems such as 2G/3G/4G base station receivers.

The SKY73421-11 has been designed for optimum long-term reliability. The SKY73421-11 diversity downconversion mixer is provided in a compact, 36-pin Quad Flat No-Lead (QFN) 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.

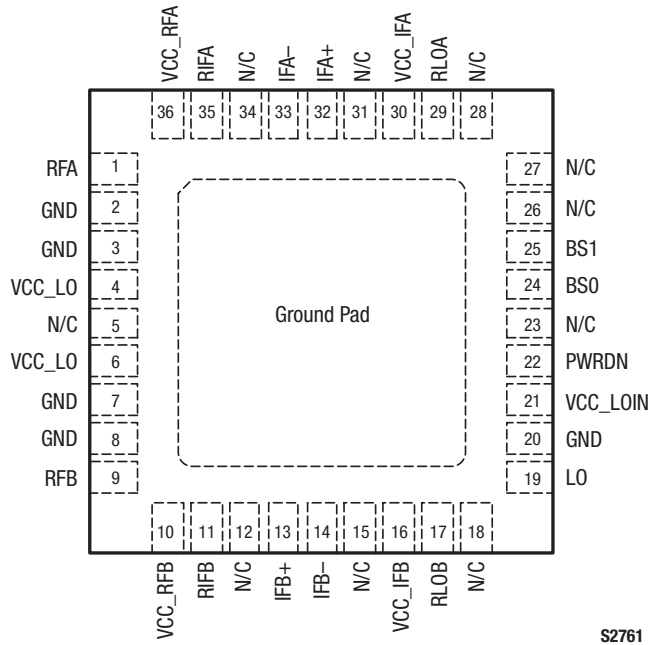


Figure 2. SKY73421-11 Pinout – 36-Pin QFN (Top View)

Table 1. SKY73421-11 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	RFA	RF channel A input	19	LO	Local oscillator input
2	GND	Ground	20	GND	Ground
3	GND	Ground	21	VCC_LOIN	DC supply, +5 V
4	VCC_LO	DC supply, +5 V	22	PWRDN	Power-down mode enable
5	N/C	No internal connection	23	N/C	No internal connection
6	VCC_LO	DC supply, +5 V	24	BS0	Band select 0 control
7	GND	Ground	25	BS1	Band select 1 control
8	GND	Ground	26	N/C	No internal connection
9	RFB	RF channel B input	27	N/C	No internal connection
10	VCC_RFB	DC supply, +5 V	28	N/C	No internal connection
11	RIFB	IF channel B bias control	29	RLOA	LO channel A bias control
12	N/C	No internal connection	30	VCC_IFA	DC supply, +5 V
13	IFB+	IF channel B positive output	31	N/C	No internal connection
14	IFB-	IF channel B negative output	32	IFA+	IF channel A positive output
15	N/C	No internal connection	33	IFA-	IF channel A negative output
16	VCC_IFB	DC supply, +5 V	34	N/C	No internal connection
17	RLOB	LO channel B bias control	35	RIFA	IF channel A bias control
18	N/C	No internal connection	36	VCC_RFA	DC supply, +5 V
			-	Ground pad	Bottom ground pad (Note 1)

Note 1: Bottom ground pad serves as a key electrical and thermal ground.

## Functional Description

The SKY73421-11 is a high gain diversity mixer, optimized for base station receiver applications. The device consists of two diversity channels, each consisting of a low loss RF balun, high linearity passive mixer, and a low noise IF amplifier.

The SKY73421-11 also includes a power-down feature used to lower the supply current for standby operation (refer to Tables 4 and 5):

PWRDN Logic:	Mixer State:
High	Standby (low power mode)
Low	Full operation

LO amplifiers are also included that allow the SKY73421-11 to connect directly to the output of a Voltage Controlled Oscillator (VCO). This eliminates the extra gain stages needed by most discrete passive mixers.

### RF Baluns and Passive Mixer

The RF baluns provide a single ended input, which can easily be matched to 50 Ω using a simple matching circuit. The RF baluns offer very low loss and excellent amplitude and phase balance over a wide frequency range of 1200 to 2000 MHz.

The high linearity mixer is a passive, double balanced mixer that provides a very low insertion loss, and excellent 3<sup>rd</sup> Order Input Insertion Point (IIP3) and linearity performance.

Additionally, the balanced nature of the mixer provides for excellent port-to-port isolation.

### Bandselect Logic

The SKY73421-11 is designed to optimize performance in four sub-bands. The particular sub-band of interest is selected by setting pin 24 (BS0) and pin 25 (BS1). The bandselect logic is provided in Table 2.

Depending on the LO injection side, and the RF and IF frequencies involved, there could be multiple bandselect solutions. Table 5 identifies recommended bandselects for a number of frequency ranges.

**Table 2. SKY73421-11 Bandselect Logic**

BS1 (Pin 25)	BS0 (Pin 24)	LO Center Frequency (MHz)
0	0	1250
0	1	1500
1	0	1700
1	1	1750

### LO Buffers

The LO buffers allow the input power of the SKY73421-11 to be driven in the range of -6 to +6 dBm. The LO section has been optimized for 1250 to 1900 MHz. However, the LO can be driven over a wide frequency range with only slight degradation in performance.

Pins 17 (RLOB) and 29 (RLOA) allow for external biasing of the LO driver bias currents to trade off linearity for the core passive mixer current.

### Power-Down Mode

The SKY73421-11 also includes a low current power-down mode controlled by pin 22 (PWRDN). When this pin is at a logic high level, the power-down function is enabled with the total mixer current under 45 mA. PWRDN does not have an internal pull up or pull down.

### IF Amplifier

The SKY73421-11 includes high dynamic range IF amplifiers that follow the passive mixers in the signal path. The outputs require a supply voltage connection using inductive chokes. These choke inductors should be high-Q and have the ability to handle 200 mA or greater.

A simple matching network allows the output ports to be matched to a balanced 200 Ω impedance. The IF amplifiers are optimized for IF frequencies between 100 and 350 MHz. The IF amplifiers can be operated outside of this range, but with a slight degradation in performance.

Pins 11 (RIFB) and 35 (RIFA) allow for external biasing of the IF amplifier bias currents to trade off linearity for the IF amplifier current.

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY73421-11 are provided in Table 3. The recommended operating conditions are specified in Table 4 and electrical specifications are provided in Tables 5 and 6.

**Table 3. SKY73421-11 Absolute Maximum Ratings**

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage, +5 V (VCC_LO, VCC_RFA, VCC_RFB, VCC_IFA, VCC_IFB, VCC_LOIN)	Vcc	4.5	5.5	V
Total supply current:	Icc		360	mA
IFA+ (pin 32)			32	mA
IFA- (pin 33)			32	mA
IFB+ (pin 13)			32	mA
IFB- (pin 14)			32	mA
VCC_LO (pin 4)			82	mA
VCC_LO (pin 6)			82	mA
VCC_LOIN (pin 21)			28	mA
VCC_IFA (pin 30)			20	mA
VCC_IFB (pin 16)			20	mA
RF input power	PRF		+20	dBm
LO input power	PLo		+20	dBm
Operating case temperature	Tc	-40	+100	°C
Junction temperature	Tj		+125	°C
Storage case temperature	TSTG	-40	+150	°C
Thermal resistance	ΘJC		10.4	°C/W
Electrostatic discharge:	ESD			
Charged Device Model (CDM), Class 4			1000	V
Human Body Model (HBM), Class 1C			1000	V
Machine Model (MM), Class A			50	V

**Notes:** 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 4. SKY73421-11 Recommended Operating Conditions**

Parameter	Symbol	Minimum	Typical	Maximum	Units
RF frequency range	f <sub>RF</sub>	1425		1980	MHz
LO frequency range	f <sub>LO</sub>	1100		1900	MHz
IF frequency range	f <sub>IF</sub>	100		350	MHz
Supply voltage, +5 V	Vcc	4.75	5.00	5.25	V
Supply current (Note 1), PWRDN = 0 V	Icc		310		mA
LO input power	PLo	-6	0	+6	dBm
Logic levels (Note 2):					
high	V <sub>IN_H</sub>	1.09		Vcc	V
low	V <sub>IN_L</sub>	0		0.74	V
Logic input current	I <sub>L</sub>		0		mA
Operating case temperature (Note 3)	Tc	-40		+100	°C

**Note 1:** With RIFA/B and RLOA/B bias resistors to ground = 8.2 kΩ.

**Note 2:** Logic signals are: PWRDN, BS0, and BS1. Valid logic levels must be applied. There are no internal pull-ups or pull-downs.

**Note 3:** Case temperature measured at bottom of package where device is soldered to board.

**Table 5. SKY73421-11 Electrical Specifications (Note 1)**

(V<sub>CC</sub> = 4.75 to 5.25 V, T<sub>C</sub> = -40 to +100 °C, P<sub>LO</sub> = -3 to +3 dBm, PWRDN = Logic “0,” BS0/BS1 = Logic “1,” P<sub>RF</sub> = -10 dBm, f<sub>IF</sub> = 200 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Condition				Min	Typical	Max	Units
		RF Frequency Range (MHz)	LO Injection	BS1	BS0				
Conversion gain	G	1427 to 1463	high side	1	1	7.5	9.8		dB
		1710 to 1785	low side	1	0	7.5	9.2		dB
		1850 to 1915	low side	1	1	7.5	8.9		dB
		1920 to 1980	low side	1	1	7.5	8.8		dB
Noise Figure	NF	1427 to 1463	high side	1	1		8.4	11.0	dB
		1710 to 1785	low side	1	0		8.7	11.0	dB
		1850 to 1915	low side	1	1		9.1	11.0	
		1920 to 1980	low side	1	1		9.3	11.0	
3 <sup>rd</sup> Order Input Intercept Point (two tones, 800 kHz separation)	IIP3	1427 to 1463	high side	1	1	+23.5	+25.0		dBm
		1710 to 1785	low side	1	0	+23.5	+25.9		dBm
		1850 to 1915	low side	1	1	+23.5	+26.1		dBm
		1850 to 1980 (Note 2)	low side	1	1		+29.5		dBm
		1920 to 1980	low side	1	1	+23.5	+25.7		dBm
2RF – 2LO	2x2	1427 to 1463	high side	1	1		-69	-63	dBc
		1710 to 1785	low side	1	0		-70	-63	dBc
		1850 to 1915	low side	1	1		-74	-63	dBc
		1920 to 1980	low side	1	1		-74	-63	dBc
3RF – 3LO	3x3	1427 to 1463	high side	1	1		-99	-70	dBc
		1710 to 1785	low side	1	0		-99	-70	dBc
		1850 to 1915	low side	1	1		-88	-70	dBc
		1920 to 1980	low side	1	1		-88	-70	dBc
Operating current	I <sub>CC_ON</sub>	1427 to 1463	high side	1	1		310	325	mA
		1710 to 1785	low side	1	0		294	310	mA
		1850 to 1915	low side	1	1		302	315	mA
		1920 to 1980	low side	1	1		308	325	mA

**Note 1:** Performance is guaranteed only under the conditions listed in this Table. Production tested: RF frequency = 1880 MHz, LO frequency= 1680 MHz. All others guaranteed by design and characterization. Testing conducted with balun on IF output (see Figure 5). Table 1 performance is of the DUT, with balun loss de-embedded. Input matching can be unique for each bandselect setting.

Conditions for typical values: V<sub>CC</sub> = 5 V, T<sub>C</sub> = +35 C, P<sub>LO</sub> = 0 dBm, middle of RF range.

The following bias resistors are used for the corresponding frequencies. Each of the f<sub>RF</sub> ranges have their own RF/LO/IF matching:

f<sub>RF</sub> = 1427 to 1463 MHz, high side LO injection: R<sub>IF</sub> = 8.2 kΩ, R<sub>LO</sub> = 8.2 kΩ

f<sub>RF</sub> = 1710 to 1785 MHz, low side LO injection: R<sub>IF</sub> = 2 kΩ, R<sub>LO</sub> = 8.2 kΩ

f<sub>RF</sub> = 1850 to 1920 MHz, low side LO injection: R<sub>IF</sub> = 2 kΩ, R<sub>LO</sub> = 18 kΩ

f<sub>RF</sub> = 1920 to 1980 MHz, low side LO injection: R<sub>IF</sub> = 1 kΩ, R<sub>LO</sub> = DNI

R<sub>IF</sub> bias resistors (R<sub>IFA</sub> and R<sub>IFB</sub>) are noted R31 and R35 on schematic and Evaluation Board.

R<sub>LO</sub> bias resistors (R<sub>LOA</sub> and R<sub>LOB</sub>) are noted R29 and R37 on schematic and Evaluation Board.

**Note 2:** External bias resistors for IF and LO (R<sub>IF</sub> and R<sub>LO</sub> of Note 1) are not installed.

**Table 6. SKY73421-11 Electrical Specifications (Note 1)**

(V<sub>CC</sub> = 4.75 to 5.25 V, T<sub>C</sub> = -40 to +100 °C, P<sub>LO</sub> = -3 to +3 dBm, P<sub>WRDN</sub> = Logic “0,” BS0/BS1 = Logic “1,” P<sub>RF</sub> = -10 dBm, f<sub>IF</sub> = 200 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Noise Figure with a blocker signal (Note 2)	NFBLK	Blocking signal input power = +8 dBm, 5 MHz offset		21	25	dB
Input 1 dB compression point	IP1dB		+10.0	+12.6		dBm
Channel-to-channel isolation			40	57		dB
RF to IF isolation			30	66		dB
LO leakage:						
1xLO to RF port				-44	-25	dBm
2xLO to RF port				-38	-25	dBm
3xLO to RF port				-56	-28	dBm
4xLO to RF port				-56	-25	dBm
1xLO to IF port				-60	-23	dBm
Power-down current	I <sub>OFF</sub>	P <sub>WRDN</sub> = 1		37	45	mA
Power-up time (Note 2) (Note 3)	t <sub>ON</sub>			0.42	1	μs
Power-down time (Note 2) (Note 4)	t <sub>OFF</sub>			0.10	1	μs
RF port input return loss (Note 2)	Z <sub>IN_RF</sub>	With external matching components	14			dB
LO port input return loss (Note 2)	Z <sub>IN_LO</sub>	With external matching components	14			dB
IF port input return loss (Note 2)	Z <sub>OUT_IF</sub>	With external matching components	14			dB

**Note 1:** Performance is guaranteed only under the conditions listed in this Table. Production tested: RF frequency = 1880 MHz, LO frequency = 1680 MHz. All others guaranteed by design and characterization. Testing conducted with balun on IF output (see Figure 5). Table 1 performance is of the DUT, with balun loss de-embedded. Input matching can be unique for each bandselect setting.

Conditions for typical values: V<sub>CC</sub> = 5 V, T<sub>C</sub> = +35 °C, P<sub>LO</sub> = 0 dBm, middle of RF range.

The following bias resistors are used for the corresponding frequencies and each of the f<sub>RF</sub> ranges have their own RF/LO/IF matching:

f<sub>RF</sub> = 1427 to 1463 MHz, high side LO injection: R<sub>IF</sub> = 8.2 kΩ, R<sub>LO</sub> = 8.2 kΩ

f<sub>RF</sub> = 1710 to 1785 MHz, low side LO injection: R<sub>IF</sub> = 2 kΩ, R<sub>LO</sub> = 8.2 kΩ

f<sub>RF</sub> = 1850 to 1920 MHz, low side LO injection: R<sub>IF</sub> = 2 kΩ, R<sub>LO</sub> = 18 kΩ

f<sub>RF</sub> = 1920 to 1980 MHz, low side LO injection: R<sub>IF</sub> = 1 kΩ, R<sub>LO</sub> = DNI

R<sub>IF</sub> bias resistors are noted R31 and R35 on schematic and Evaluation Board.

R<sub>LO</sub> bias resistors are noted R29 and R37 on schematic and Evaluation Board.

**Note 2:** Not production tested. Guaranteed by design and characterization.

**Note 3:** Time required for IF envelope to reach 90% of final value following a P<sub>WRDN</sub> transition to logic “0” with t<sub>FALL</sub> < 1 ns.

**Note 4:** Time required for IF envelope to reach 10% of final value following a P<sub>WRDN</sub> transition to logic “1” with t<sub>RISE</sub> < 1 ns.

## Evaluation Board Description

The SKY73421-11 Evaluation Board is used to test the performance of the SKY73421-11 downconversion mixer. An assembly drawing for the Evaluation Board is shown in Figure 3 and the layer detail is provided in Figure 4. A schematic diagram of the SKY73421-11 Evaluation Board is shown in Figure 5.

## Circuit Design Considerations

The following design considerations are general in nature and must be followed regardless of final use or configuration:

1. Paths to ground should be made as short as possible.
2. The ground pad of the SKY73421-11 has special electrical and thermal grounding requirements. This pad is the main thermal conduit for heat dissipation. Since the circuit board acts as the heat sink, it must shunt as much heat as possible from the device. Therefore, design the connection to the ground pad to dissipate the maximum wattage produced by the circuit board.
3. Skyworks recommends including external bypass capacitors on the VCC voltage inputs of the device.
4. Components L12, L13, L14, and L15 (see Figure 5) are high-Q low loss inductors. These inductors must be able to pass currents in excess of 200 mA DC.
5. Components R8, R9, R31, and R35 (see Figure 5) allow for external adjustment of the IF amplifier bias currents. Skyworks recommends that these resistors have a tolerance of  $\pm 1\%$  to optimize performance consistency of the SKY73421-11. These resistors are optional for device operation, but the performance in Tables 5 and 6 is specified for the values of the R<sub>IF</sub> resistors (R31 and R35) as indicated in the Tables.

6. Components R29, R33, R34, and R37 (see Figure 5) allow for external adjustment of the LO driver bias currents. Skyworks recommends that these resistors have a tolerance of  $\pm 1$  percent to optimize performance consistency of the SKY73421-11. These resistors are optional for device operation, but the performance in Tables 5 and 6 is specified for the values of the R<sub>LO</sub> resistors (R29 and R37) as indicated in the Tables.
7. It is recommended to apply solder paste with stencil, as noted in Figure 6.

## Package Dimensions

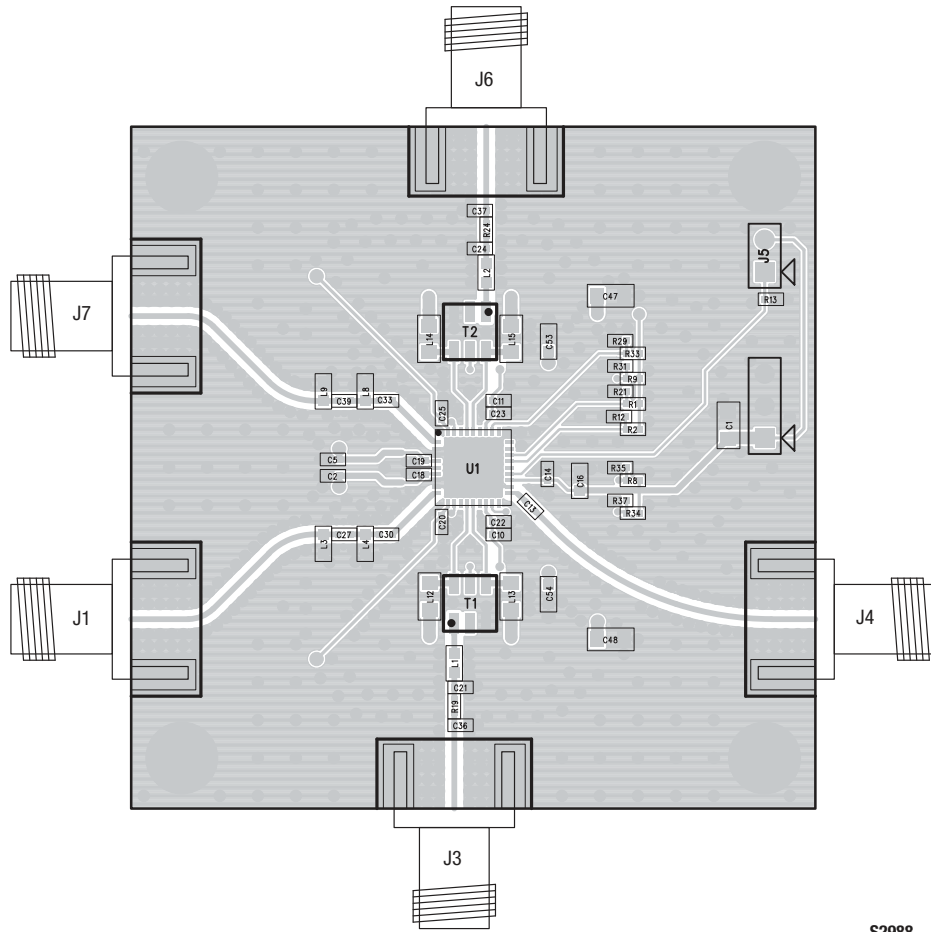
The PCB layout footprint for the SKY73421-11 is provided in Figure 6. Figure 7 shows the package dimensions for the 36-pin QFN and Figure 8 provides the tape and reel dimensions.

## 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 SKY73421-11 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 & SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

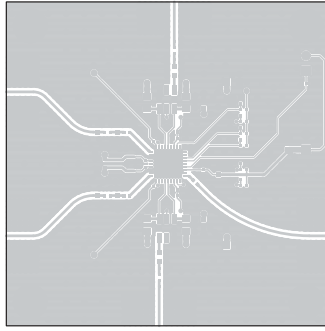
Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.



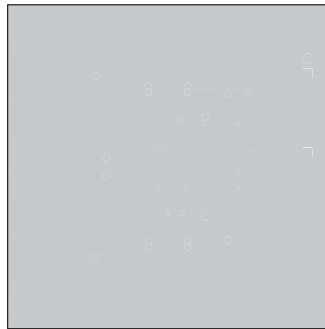
S2988

Figure 3. SKY73421-11 Evaluation Board Assembly Diagram

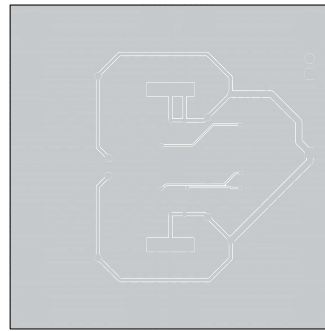




Top Layer



Ground Plane



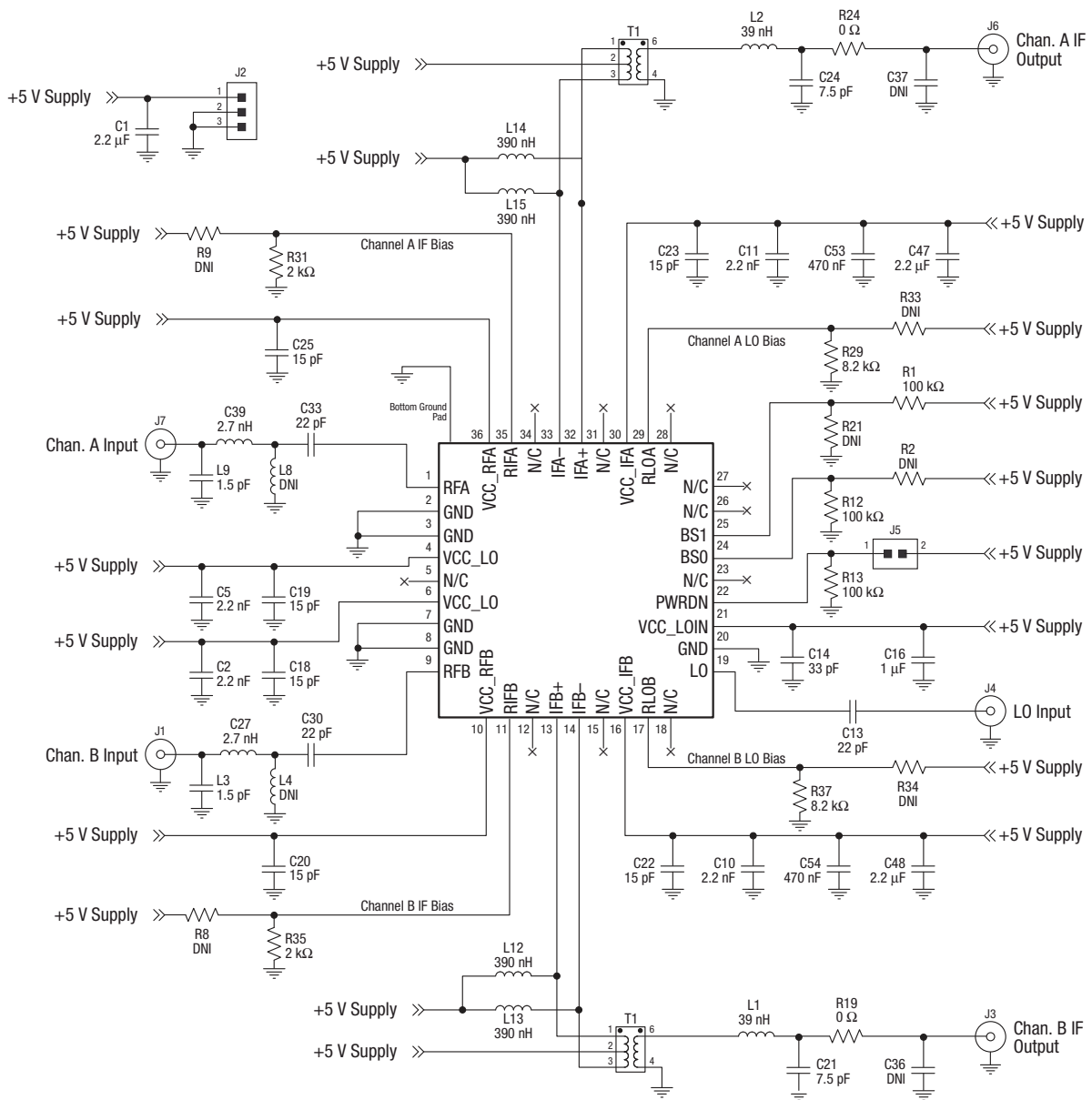
Power Plane



Bottom Layer

S2989

Figure 4. SKY73421-11 Evaluation Board Layer Detail



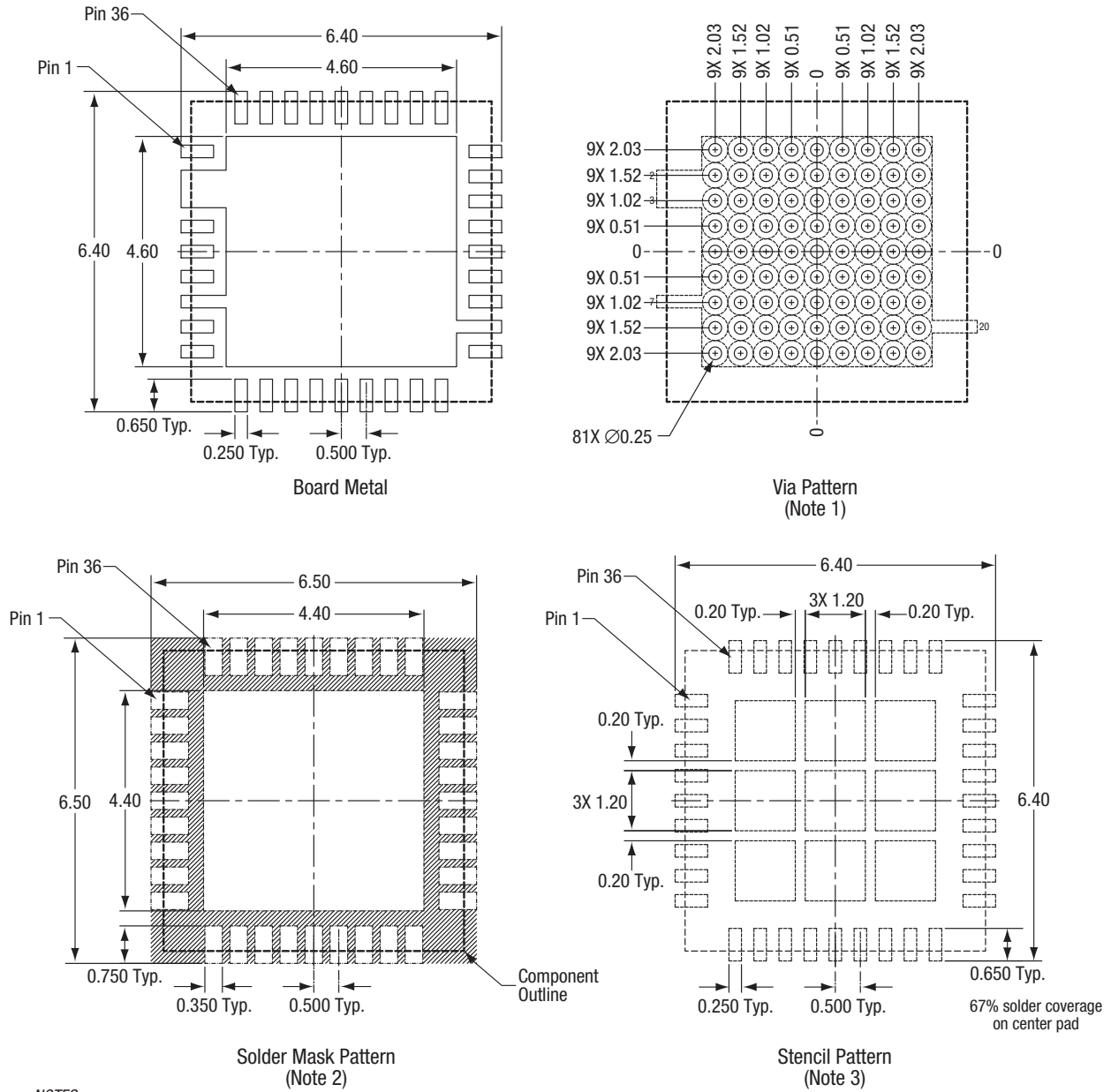
Notes: Some component labels may be different than the corresponding component symbol shown here. Component values, however, are accurate as of the date of this Data Sheet.

Y0067

Figure 5. SKY73421-11 Evaluation Board Schematic

Table 7. RF and IF Matching Components

RF Range (MHz)	Band Selects				RF Matching Components				IF Matching Components (IF = 200 MHz)				IF Bias	LO Bias
	BS1	BS0	R2	R12	L9, L3	C39, C27	L8, L4	C33, C30	L2, L1	C24, C21	R24, R19	C37, C36		
1427 to 1463	1	1	100 kΩ	DNI	DNI	22 pF	8.2 nH	22 pF	27 nH	6.8 pF	0 Ω	DNI	8.2 kΩ	8.2 kΩ
1710 to 1785	1	0	DNI	100 kΩ	1.5 pF	2.7 nH	DNI	22 pF	39 nH	7.5 pF	0 Ω	DNI	2 kΩ	8.2 kΩ
1850 to 1915	1	1	100 kΩ	DNI	1.5 pF	2.2 nH	DNI	11 pF	39 nH	7.5 pF	0 Ω	DNI	2 kΩ	18 kΩ
1920 to 1980	1	1	100 kΩ	DNI	1.2 pF	2.2 nH	DNI	5.1 pF	39 nH	7.5 pF	0 Ω	DNI	1 kΩ	DNI



**NOTES:**

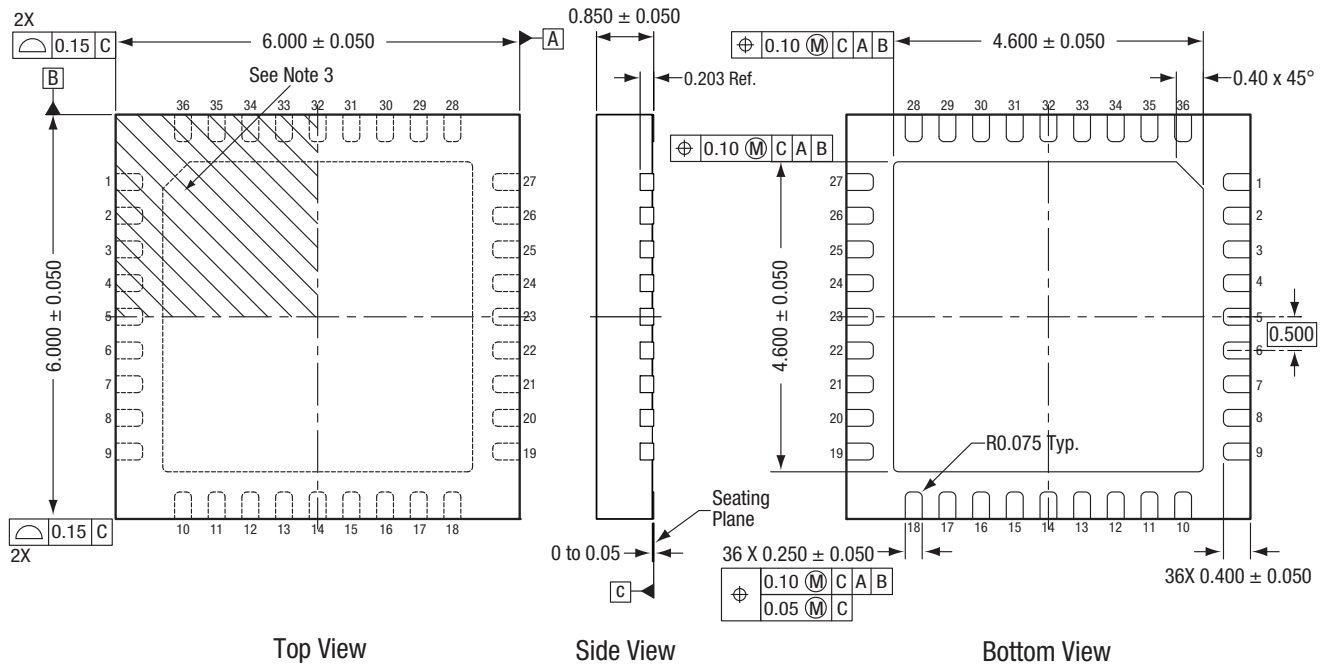
1. Via hole recommendations:  
0.025 mm Cu via wall plating (minimum),  
soldermask on the far side should tent  
or plug via holes.
2. Soldermask recommendations:  
Contact board fabricator for recommended  
soldermask offset and tolerance.
3. Stencil recommendations:  
0.125 mm stencil thickness, laser cut apertures,  
trapezoidal walls and rounded corners offer  
better paste release.

Dimension and tolerancing according to ASME Y14.5M-1994.  
Unless specified, dimensions are symmetrical about center lines.  
All dimensions are in millimeters.

S3158

**Figure 6. PCB Layout Footprint for the SKY73421-11 6 x 6 mm QFN**

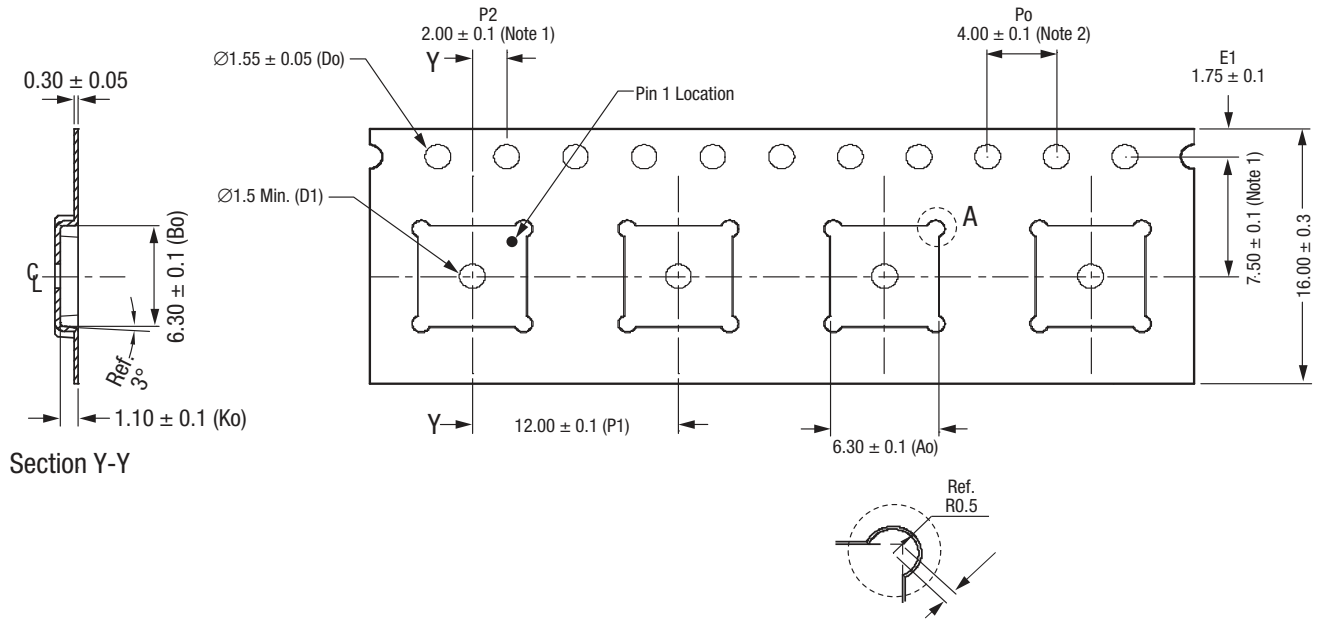
**DATA SHEET • SKY73421-11 DOWNCONVERSION MIXER**



- NOTES:**
- All measurements are in millimeters.
  - Dimensioning and tolerancing according to ASME Y14.5M-1994. Unless otherwise specified the following values apply:  
 Decimal Tolerance:      Angular Tolerance:  
 X.X (1 place)  $\pm 0.1$  mm       $\pm 1^\circ$   
 X.XX (2 places)  $\pm 0.05$  mm  
 X.XXX (3 places)  $\pm 0.025$  mm
  - Terminal #1 identification mark located within marked area.
  - Unless specified, dimensions are symmetrical about center lines.

S2944

**Figure 7. SKY73421-11 36-Pin QFN Package Dimensions**



Section Y-Y

Detail A

- Notes:
1. Measured from center line of sprocket hole to center line of pocket.
  2. Cumulative tolerance of 10 sprocket holes is  $\pm 0.20$  mm.
  3. Other material available.

All measurements are in millimeters.

S2943

Figure 8. SKY73421-11 Tape and Reel Dimensions

## Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY73421-11 1400-2000 MHz Downconversion Mixer	SKY73421-11	SKY73421-11-EK1 (1427.9 to 1462.9 MHz) SKY73421-11-EK3 (1710 to 1785 MHz) SKY73421-11-EK2 (1850 to 1915 MHz) SKY73421-11-EK4 (1920 to 1980 MHz)

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