

SKY73090-21: 1700 – 2200 MHz High Gain and Linearity Diversity Downconversion Mixer With Power-Down Mode

Applications

- 2G/3G base station transceivers:
 - GSM/EDGE, CDMA, UMTS/WCDMA
- Land mobile radio
- ISM band transceivers
- High performance radio links
- RF identification

Features

- Operating frequency range: 1700 to 2200 MHz
- IF frequency range: 50 to 500 MHz
- Conversion gain: 8.7 dB
- Input IP3: +24.2 dBm
- Output IP3: +32.8 dBm
- Noise figure: 9.4 dB
- Power-down mode
- Integrated LO drivers
- Integrated low loss RF baluns
- High linearity IF amplifiers
- On-chip SPDT LO switch (greater than 40 dB LO-to-LO isolation)
- Small, MCM (36-pin, 6 x 6 mm) package (MSL3, 260 °C per JEDEC J-STD-020)



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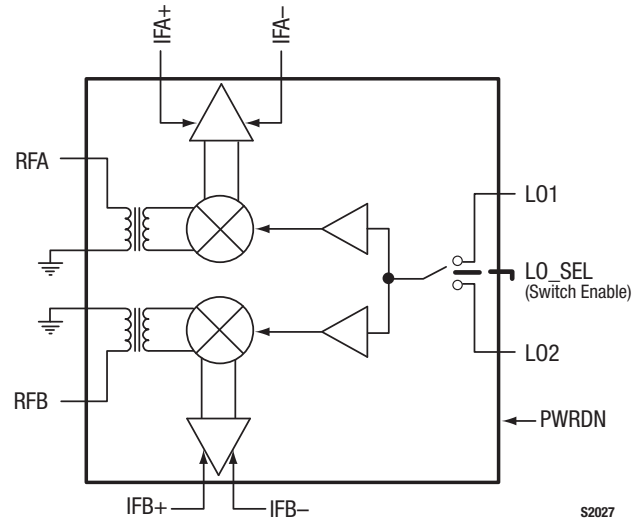


Figure 1. SKY73090-21 Block Diagram

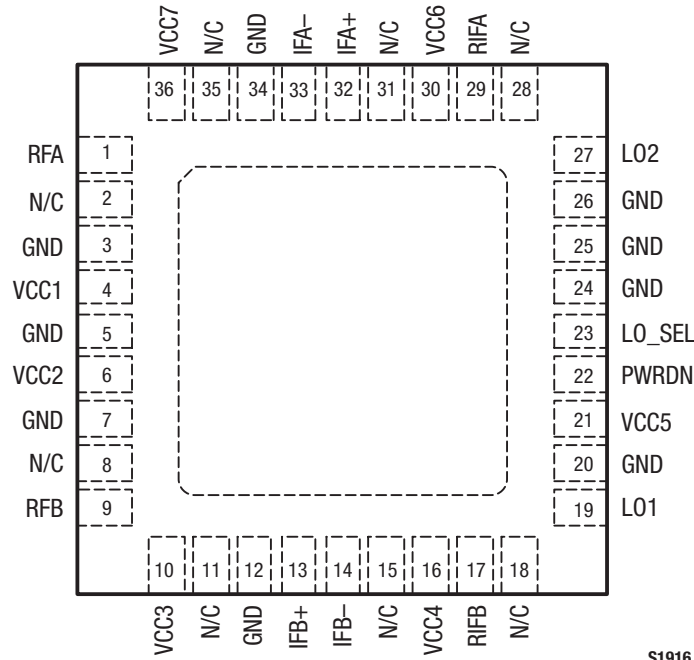
Description

The SKY73090-21 is a fully integrated diversity mixer that includes Local Oscillator (LO) drivers, an LO switch, 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 SKY73090-21 features an input IP3 of +24.2 dBm and a Noise Figure (NF) of 9.4 dB, making the device an ideal solution for high dynamic range systems such as 2G/3G base station receivers. The LO switch provides more than 40 dB of isolation between LO inputs and supports the switching time required for GSM/EDGE base stations.

The SKY73090-21 is manufactured using a robust silicon BiCMOS process and has been designed for optimum long-term reliability. The SKY73090-21 diversity downconversion mixer is provided in a compact, 36-pin Multi-Chip Module (MCM). 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.

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Figure 2. SKY73090-21 Pinout – 36-Pin MCM (Top View)

Table 1. SKY73090-21 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	RFA	RF channel A input	19	LO1	Local oscillator #1 input
2	N/C	No connect	20	GND	Ground
3	GND	Ground	21	VCC5	DC supply, +5 V
4	VCC1	DC supply, +5 V	22	PWRDN	Power-down mode enable
5	GND	Ground	23	LO_SEL	Local oscillator switch select
6	VCC2	DC supply, +5 V	24	GND	Ground
7	GND	Ground	25	GND	Ground
8	N/C	No connect	26	GND	Ground
9	RFB	RF channel B input	27	LO2	Local oscillator #2 input
10	VCC3	DC supply, +5 V	28	N/C	No connect
11	N/C	No connect	29	RIFA	IF channel A bias control
12	GND	Ground	30	VCC6	DC supply, +5 V
13	IFB+	IF channel B positive output	31	N/C	No connect
14	IFB-	IF channel B negative output	32	IFA+	IF channel A positive output
15	N/C	No connect	33	IFA-	IF channel A negative output
16	VCC4	DC supply, +5 V	34	GND	Ground
17	RIFB	IF channel B bias control	35	N/C	No connect
18	N/C	No connect	36	VCC7	DC supply, +5 V

Functional Description

The SKY73090-21 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 SKY73090-21 also includes a power-down feature used to lower the supply current for standby operation.

LO amplifiers are also included that allow the SKY73090-21 to connect directly to the output of a Voltage Controlled Oscillator (VCO). This eliminates the extra gain stages needed by most discrete passive mixers. A Single Pole, Double Throw (SPDT) switch has been included to select between two different LO inputs for frequency hopping applications (i.e., GSM).

RF Baluns and Passive Mixer

The RF baluns provide a single ended input, which can easily be matched to $50\ \Omega$ using a simple matching circuit. The RF baluns offer very low loss and excellent amplitude and phase balance.

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

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

LO Buffers and SPDT LO Switch

The LO buffers allow the input power of the SKY73090-21 to be programmed in the range of -6 to $+6$ dBm. The LO section has been optimized for low-side LO injection. However, the LO can be driven over a wide frequency range with only slight degradation in performance.

A high isolation SPDT switch allows the SKY73090-21 to be used for frequency hopping applications. This switch provides greater than 55 dB of LO1 to LO2 isolation:

LO_SEL Logic:	State:
High	LO1 enabled
Low	LO2 enabled

For applications that do not require frequency hopping, LO_SEL is fixed to one state and the appropriate LO input is used.

IF Amplifier

The SKY73090-21 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 $200\ \Omega$ impedance. The IF amplifiers are optimized for IF frequencies between 40 and 250 MHz. The IF amplifiers can be operated outside of this range, but with a slight degradation in performance.

Power-Down Mode

The SKY73090-21 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 $1\ \mu\text{A}$.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY73090-21 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4.

Table 2. SKY73090-21 Absolute Maximum Ratings

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage, +5 V (VCC1 – VCC7)	VCC	4.5	5.0	5.5	V
Supply current	I _{CC}		370	420	mA
RF input power	P _{RF}			+20	dBm
LO input power	P _{LO}		0	+20	dBm
Operating case temperature	T _C	–40		+85	°C
Junction temperature	T _J			+150	°C
Storage case temperature	T _{STG}	–40		+125	°C

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.

Nominal thermal resistance (junction to center ground pad) is 5.1 °C/W.

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 3. SKY73090-21 Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units
RF frequency range	F _{RF}	1700		2200	MHz
LO frequency range (Note 1)	F _{LO}	1750		2700	MHz
IF frequency range	F _{IF}	50	350	500	MHz
Supply voltage, +5 V (VCC1 – VCC7)	VCC	4.75	5.00	5.25	V
Supply current	I _{CC}		364		mA
LO input power	P _{LO}	–6	0	+6	dBm
Logic levels (LO_SEL, PWRDN): high		2.2			V
low				0.8	V
Operating case temperature	T _C	–40		+85	°C

Note 1: The SKY73090-21 has been optimized for high side LO injection. However, the LO can be used outside of the specified frequency range with degraded performance.

Table 4. SKY73090-21 Electrical Specifications (Note 1)**(Voltage Supply = +5 V, T_c = +25 °C, LO = 0 dBm, RF Frequency = 2020 MHz, IF Frequency = 350 MHz, LO Frequency = 2370 MHz, PWRDN = 0, Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Conversion gain	G			8.7		dB
Noise Figure	NF			9.4		dB
Noise Figure with a blocker signal	NF _{BLK}	Blocking signal input power = +8 dBm			25	dB
Third order input intercept point	IIP3	Tone space = 800 kHz, input tone power = -10 dBm		+24.2		dBm
Third order output intercept point	OIP3	Tone space = 800 kHz, input tone power = -10 dBm		+32.8		dBm
2RF – 2LO	2x2	P _{RF} = -10 dBm		-62		dBc
3RF – 3LO	3x3	P _{RF} = -10 dBm	-70	-80		dBc
Input 1 dB compression point	IP1dB		+9.5	+13.3		dBm
Output 1 dB compression point	OP1dB			+20.8		dBm
LO1 to LO2 isolation			30	39		dB
Channel-to-channel isolation			40	52		dB
RF to IF isolation			30	62		dB
LO leakage @ IF port			-23	-44		dBm
LO leakage: 1xLO @ RF 2xLO @ RF 3xLO @ RF 4xLO @ RF			-25 -25 -28 -28	-28 -30 -78 -84		dBm dBm dBm dBm
Spurious measurements: 6RF-5LO 8RF-7LO	6x5 8x7	P _{IN} = 0 dBm	-85 -85	-107 -108		dBc dBc
LO switching time (Note 2)					1	μs
Power-down current (Note 2) (Note 3)	I _{OFF}	PWRDN = 1		0.1	1.0	μA
Power-down/up time (Note 2)					1	μs
Logic input current (Note 2)			-20	+150	+250	μA

Note 1: Performance is guaranteed only under the conditions listed in this Table.**Note 2:** Characterized and guaranteed by design; not tested in production.**Note 3:** Power-down functionality tested in production. Power-down current (I_{OFF}) production-tested to be < 1 mA.

Evaluation Board Description

The SKY73090-21 Evaluation Board is used to test the performance of the SKY73090-21 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 SKY73090-21 Evaluation Board is shown in Figure 5.

Circuit Design Configurations

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 SKY73090-21 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 L5, L6, 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 R1 and R2 (see Figure 5) set the bias current for the IF amplifiers. Skyworks recommends that these resistors have a tolerance of $\pm 1\%$ to optimize performance consistency of the SKY73090-21. These resistors are not required for the Evaluation Board to operate as specified in Tables 3 and 4.

Package Dimensions

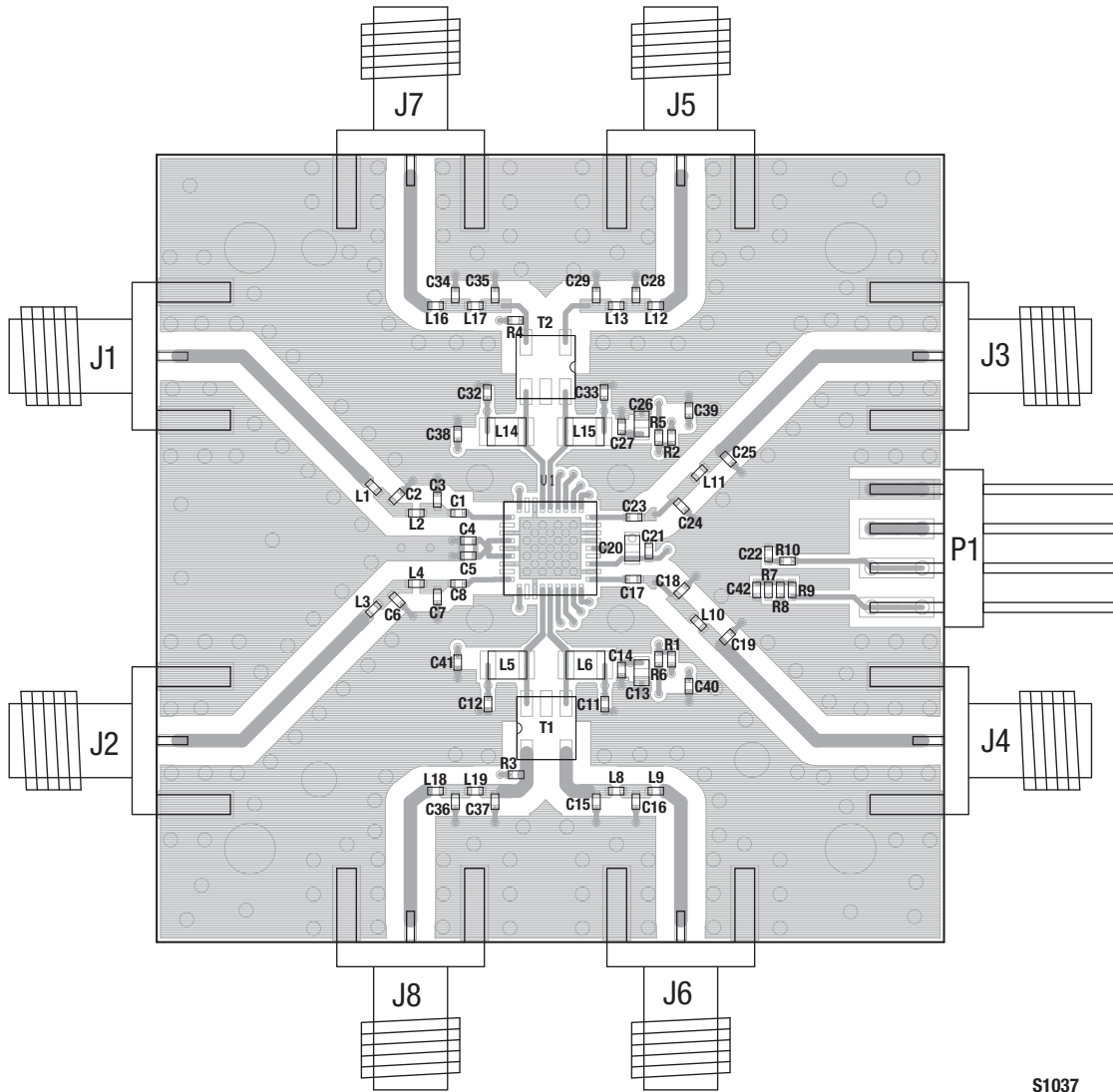
The PCB layout footprint for the SKY73090-21 is provided in Figure 6. Figure 7 shows the package dimensions for the 36-pin MCM and Figure 8 provides the tape and reel dimensions.

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.

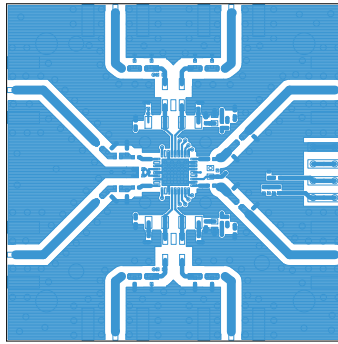
THE SKY73090-21 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design & SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

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.



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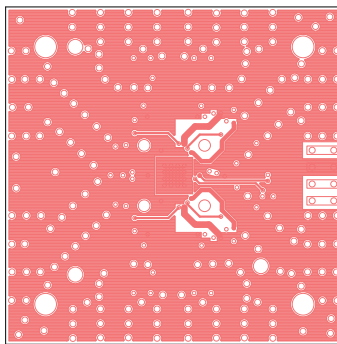
Figure 3. SKY73090-21 Evaluation Board Assembly Diagram



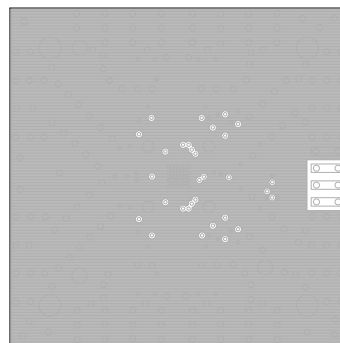
Layer 1: Top – Metal



Layer 2: Ground



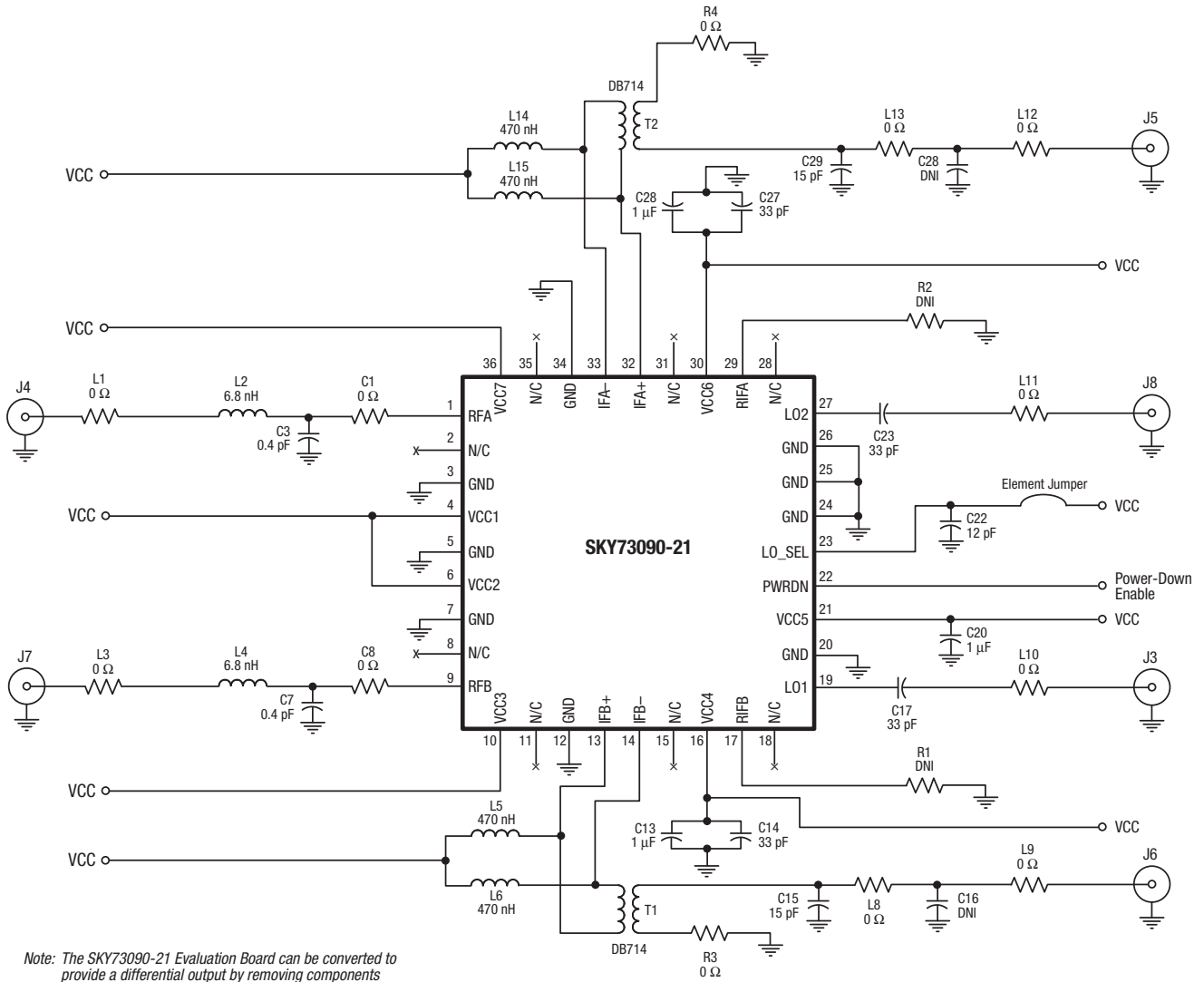
Layer 3: Power Plane



Layer 4: Solid Ground Plane

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Figure 4. SKY73090-21 Evaluation Board Layer Detail



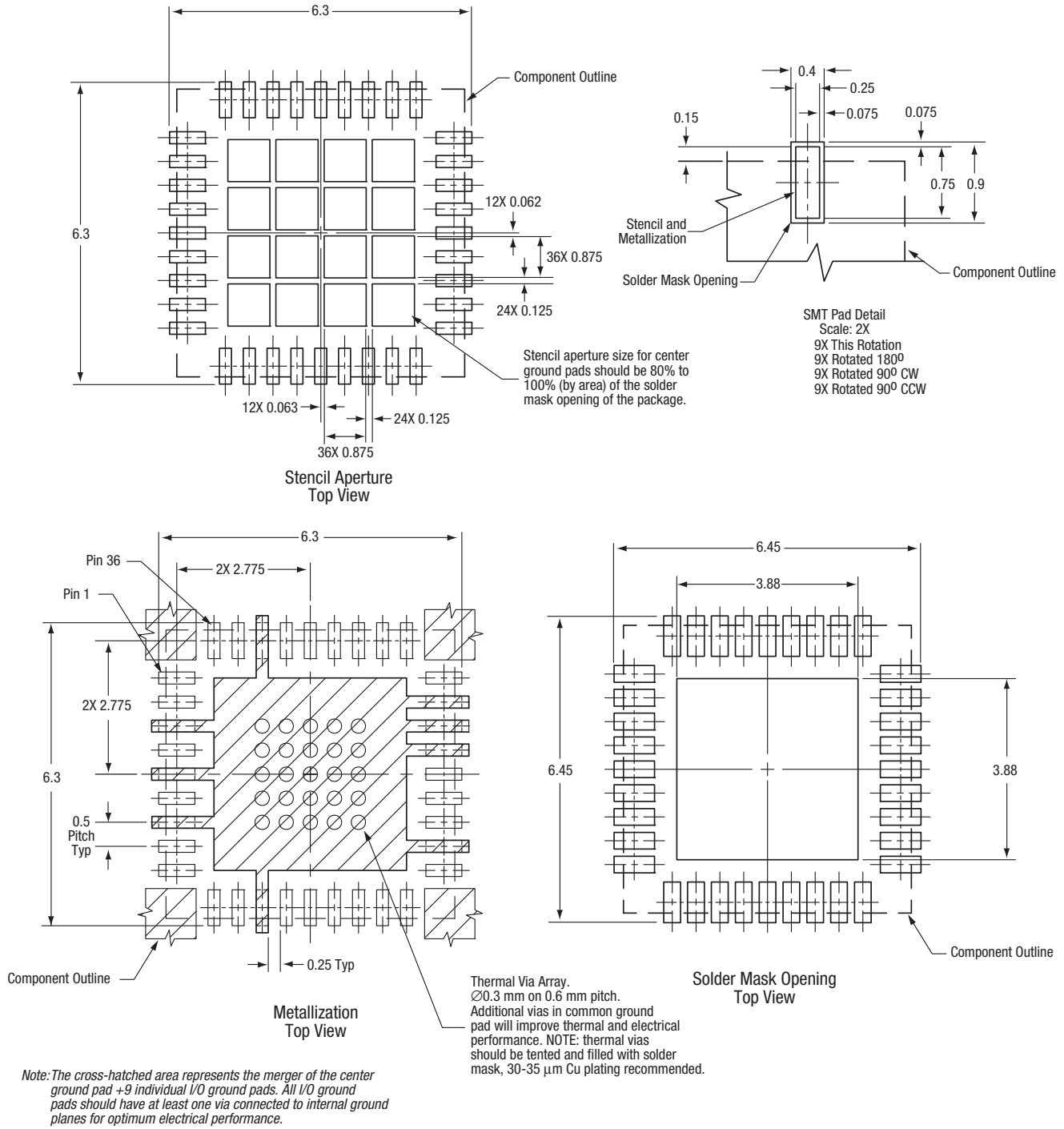
Note: The SKY73090-21 Evaluation Board can be converted to provide a differential output by removing components T1, T2, R3, and R4.

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.

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Figure 5. SKY73090-21 Evaluation Board Schematic

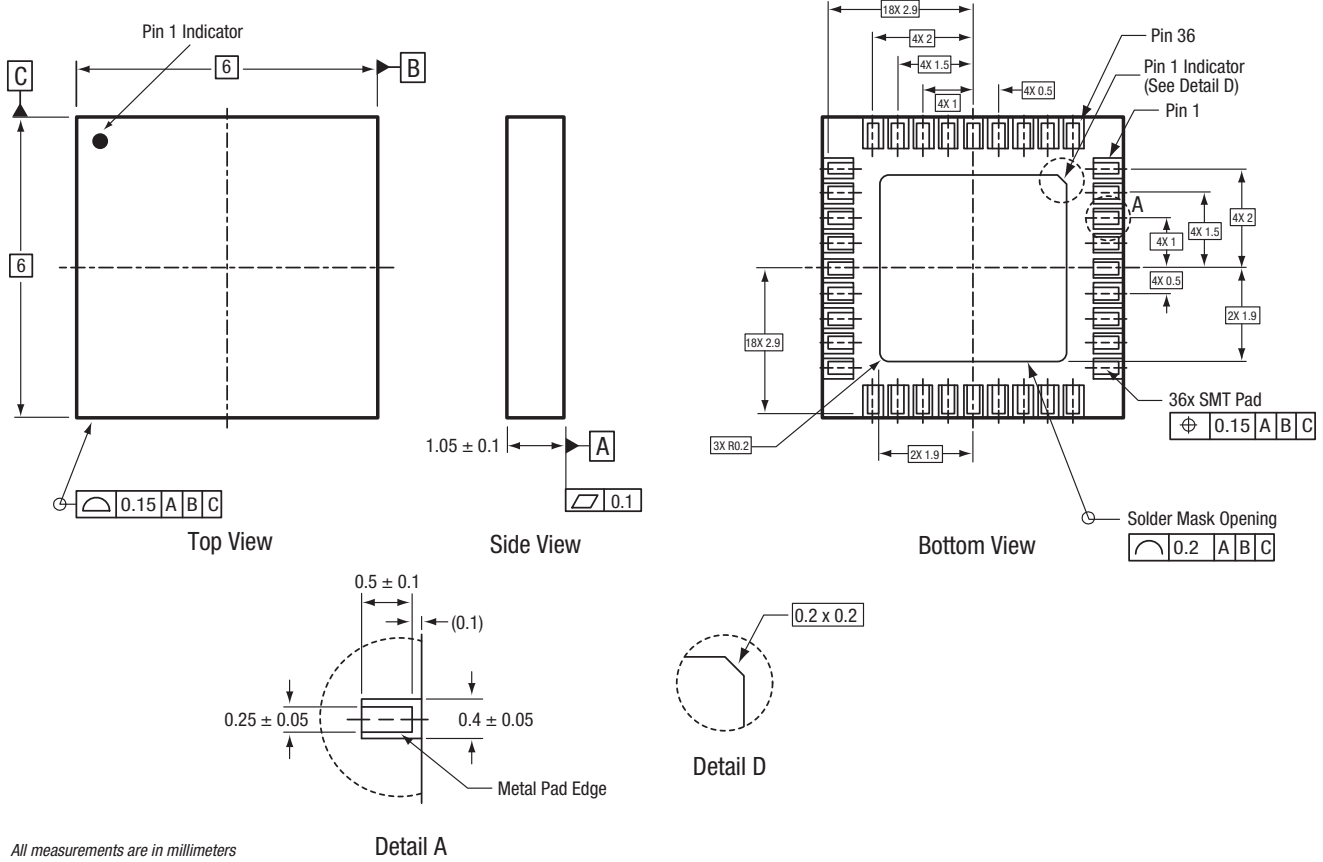
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All measurements are in millimeters

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Figure 6. PCB Layout Footprint for the SKY73090-21 6 x 6 mm MCM



All measurements are in millimeters

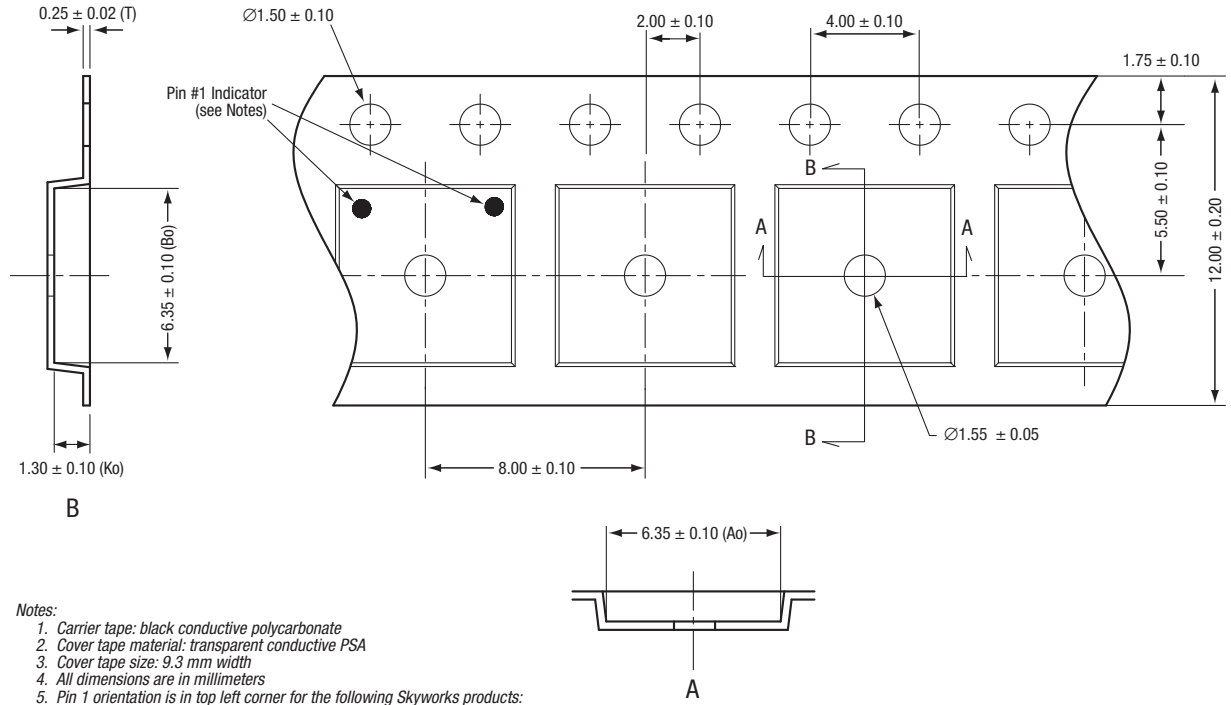
Pads are solder mask defined on one edge and metal defined on three edges.

Dimensioning and tolerancing according to ASME Y14.5M-1994

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Figure 7. SKY73090-21 36-Pin MCM Package Dimensions

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- Notes:
1. Carrier tape: black conductive polycarbonate
 2. Cover tape material: transparent conductive PSA
 3. Cover tape size: 9.3 mm width
 4. All dimensions are in millimeters
 5. Pin 1 orientation is in top left corner for the following Skyworks products:

SKY73022-21, -31
 SKY73023-21, -31

For all other 6 x 6 mm MCM/RFLGA products, pin 1 orientation is in top right corner.

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Figure 8. SKY73090-21 Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY73090-21 1700 – 2200 MHz Downconversion Mixer with Power-Down Mode	SKY73090-21	*** TBD ***

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