SKY73001: 2 – 3500 MHz Direct Conversion Mixer

Applications

- PCS, DCS, and GSM/GPRS, and EDGE base station receivers

- CDMA and W-CDMA receivers

- Third Generation (3G) wireless communications

- Mobile base stations

- Wireless Local Loops

- Wireless Local Area Networks

- Direct conversion receivers

Features

- High IIP2 and IIP3

- Wideband RF and LO input frequency range (2 to 3500 MHz)

- Single +3.0 V supply

- Operating temperature range –40 °C to +85 °C

- Zero IF architecture eliminates need for image rejection filter

- Differential IF output supports direct interface to A/D circuitry

- AM demodulation immunity

- Low power consumption

- RFLGA™ (32 pin, 5 x 5 mm) Pb-free package (MSL3, 260 °C per JEDEC J-STD-020)
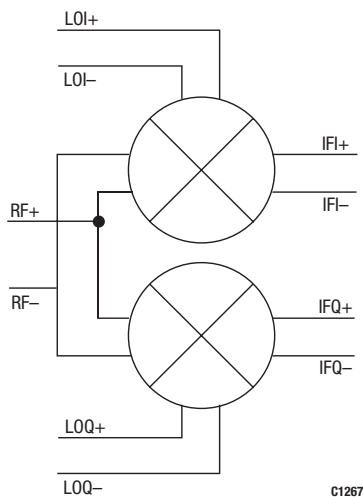
Description

Skyworks SKY73001 direct conversion mixer is an integrated, high-dynamic range, zero Intermediate Frequency (IF) architecture down-converter for use in wireless communication applications. High second and third order input intercept points (IIP2 and IIP3, respectively) allow seamless integration into high performance systems. The SKY73001 has a wide RF and Local Oscillator (LO) frequency range of 2 to 3500 MHz.
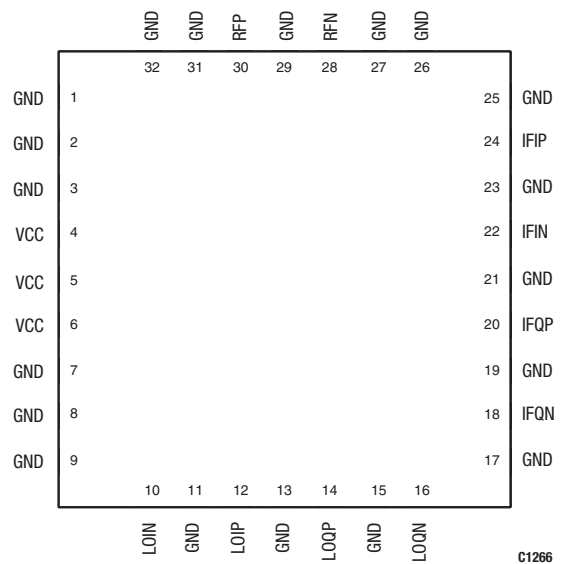
Figure 1 shows a functional block diagram for the SKY73001. The device package and pinout for the 32-pin RF Land Grid Array (RFLGA) are shown in Figure 2.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances) compliant packaging.

Figure 1. SKY73001 Functional Block Diagram

Figure 2. SKY73001 Pinout– 32-Pin RFLGA Package (Top View)

Electrical and Mechanical Specifications

Signal pin assignments and functional pin descriptions are provided in Table 1. The absolute maximum ratings of the SKY73001 are provided in Table 2 and the recommended operating conditions provided in Table 3. Electrical characteristics of the SKY73001 are provided in Table 4.

The typical performance of the SKY73001 with respect to varying conditions are illustrated in Figures 3 through 7. Figure 12 provides the package dimensions for the 32-pin RFLGA, and Figure 13 provides the tape and reel dimensions.

Table 1. SKY73001 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	GND	Ground	17	GND	Ground
2	GND	Ground	18	IFQN	Negative quadrature IF output
3	GND	Ground	19	GND	Ground
4	VCC	+3 VDC supply	20	IFQP	Positive quadrature IF output
5	VCC	+3 VDC supply	21	GND	Ground
6	VCC	+3 VDC supply	22	IFIN	Negative in-phase IF output
7	GND	Ground	23	GND	Ground
8	GND	Ground	24	IFIP	Positive in-phase IF output
9	GND	Ground	25	GND	Ground
10	LOIN	Negative LO input	26	GND	Ground
11	GND	Ground	27	GND	Ground
12	LOIP	Positive LO input	28	RFN	Negative RF input
13	GND	Ground	29	GND	Ground
14	LOQP	Positive quadrature LO input	30	RFP	Positive RF input
15	GND	Ground	31	GND	Ground
16	LOQN	Negative quadrature LO input	32	GND	Ground

Table 2. SKY73001 Absolute Maximum Ratings
(T_A = +25 °C, unless otherwise noted)

Parameter	Symbol	Min	Typical	Max	Units
+3 V supply voltage	VCC	2.7		3.6	V
Power dissipation	P_D		140	230	mW
RF input power	P_{RFIN}			20	dBm
LO input power	P_{LOIN}			6	dBm
Thermal resistance	θjc		36		°C/W
Operating case temperature	T_{OPR}	−40		+85	°C
Storage case temperature	T_{STG}	−40	0	+125	°C

Note: 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 values.

Table 3. SKY73001 Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Units
+3 V supply voltage	VCC	2.7	3.0	3.3	V
Operating case temperature	T_{OPR}	−40		+85	°C

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Table 4. SKY73001 Electrical Characteristics
(IF = 10 MHz, LO Input Power = 0 dBm, Tᴄ = 25 °C, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
RF input frequency range			2		3500	MHz
LO input frequency range			2		3500	MHz
IF frequency range			DC		100	MHz
I/Q amplitude imbalance			−0.3		+0.3	dB
I/Q phase error				1		deg
Image rejection (Note 1)						dB
IF output impedance				500		Ω
RF Input (900 MHz)						
Voltage conversion gain			−4.8	−3.5		dB
SSB Noise Figure				14.7	16.2	dB
IIP2				67		dBm
IIP3			25	27		dBm
−1 dB compression point			13	15		dBm
RF input impedance				1.5:1	2.0:1	VSWR
LO input impedance				1.5:1	2.0:1	VSWR
RF Input (1900 MHz)						
Voltage conversion gain			−5.7	−4.4		dB
SSB Noise Figure				17	18.5	dB
IIP2				70		dBm
IIP3			23	25		dBm
−1 dB compression point			12.5	14.5		dBm
RF input impedance				1.5:1	2.0:1	VSWR
LO input impedance				1.5:1	2.0:1	VSWR

Note 1: Image rejection is determined using the following equation:

$$IR = 10 \, log \left(\frac{1 + A^2 + 2A[cos\,\theta]}{1 + A^2 - 2A[cos\,\theta]} \right) \; where \; A = 10^{-\left(\frac{amplitude\;error}{20} \right)} \; in \; dB.$$
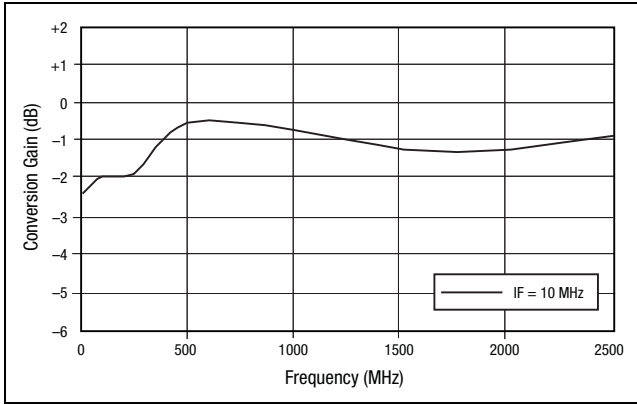
Figure 3. Voltage Conversion Gain vs Frequency
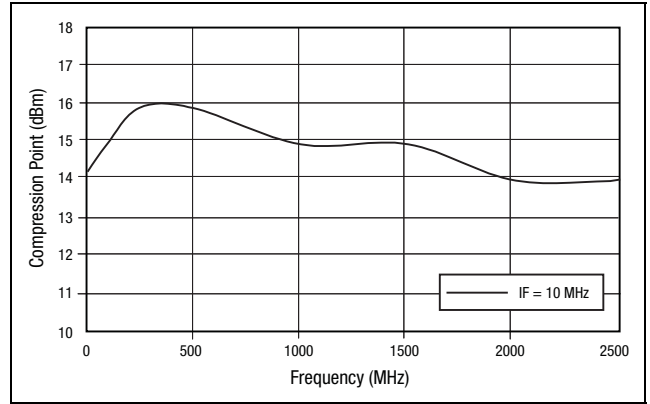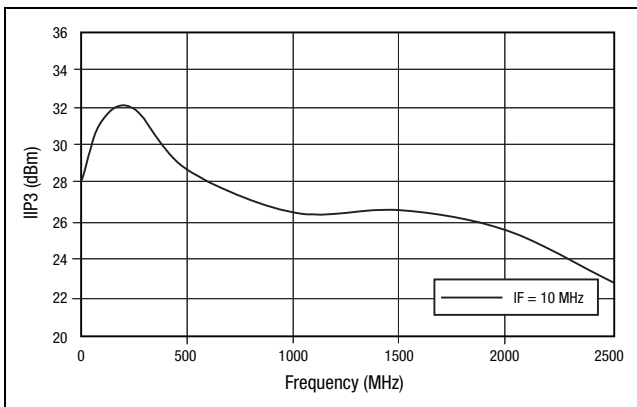

Figure 4. 1 dB Compression Point vs Frequency
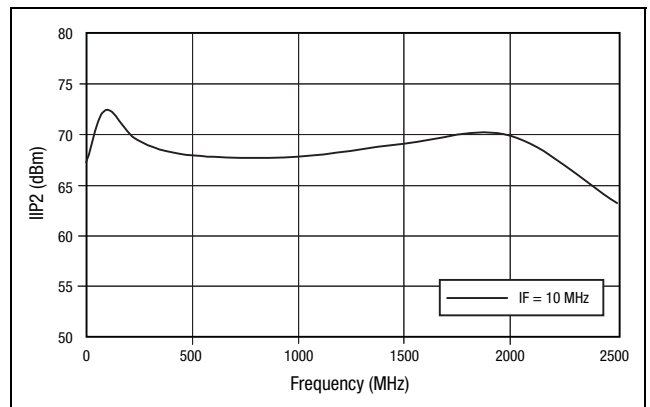

Figure 5. IIP3 vs Frequency (100 kHz Tone Spacing)

Figure 6. IIP2 vs Frequency

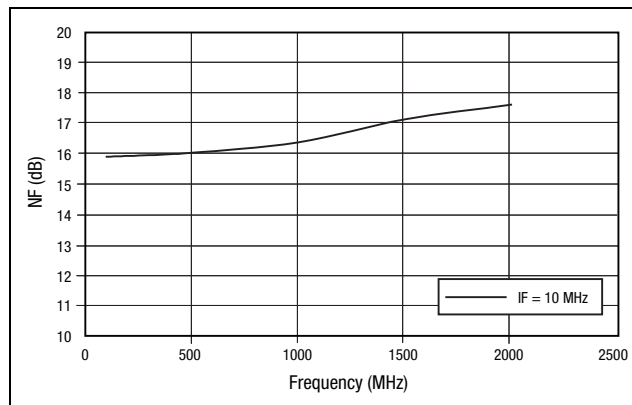Figure 7. Noise Figure vs Frequency

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Evaluation Board Description

The SKY73001 Evaluation Board is used to test the performance of the SKY73001 direct conversion mixer. An Evaluation Board schematic diagram (500-2500 MHz) is shown in Figure 8. Evaluation Board assembly diagrams are shown in Figure 9 (2-2500 MHz) and Figure 10 (3200-3500 MHz). Bills of Material (BOMs) are provided in Table 5 (2-500 MHz and 500-2500 MHz) and Table 6 (3200-3500 MHz).

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 SKY73001 direct conversion mixer 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 mixer. As such, design the connection to the ground pad to dissipate the maximum wattage produced to the circuit board. Multiple vias to the grounding layer are required.

3. Two external output bypass capacitors are required on the VCC pins. The values of these capacitors will change with respect to the desired RF frequency. One capacitor should be used for low frequency bypassing and the other capacitor for high frequency bypassing. Special attention should be given so that the smaller value capacitor does not go into self-resonance at the desired RF frequency.

4. Wire wound balanced transformers (baluns) were used during the test and characterization of the SKY73001. Ceramic baluns can be used to create the differential input signals (i.e., RF and LO). However, their performance will limit the overall system performance of the SKY73001.

Testing Procedure

Use the following procedure to set up the SKY73001 Evaluation Board for testing. Refer to Figure 11 for guidance:

1. Connect a +3.0 VDC power supply using an insulated supply cable. If available, enable the current limiting function of the power supply to 100 mA.

2. Connect a signal generator to the RF signal input port. Set it to the desired RF frequency at a power level of 0 dBm to the Evaluation Board but do NOT enable the RF signal.

3. Connect a signal generator to the LOQ signal input port. Set to the desired LO frequency at a power level of 0 dBm, but do not enable.

4. Connect a spectrum analyzer to the IFQ signal output port and terminate the IFI signal input port in 50 Ω.

5. Enable the power supply.

6. Enable the LO input signal.

7. Enable the RF signal.

8. Take measurements and repeat these steps for channel I.

CAUTION: *If any of the input signals exceed the rated maximum values, the SKY73001 Evaluation Board can be permanently damaged.*
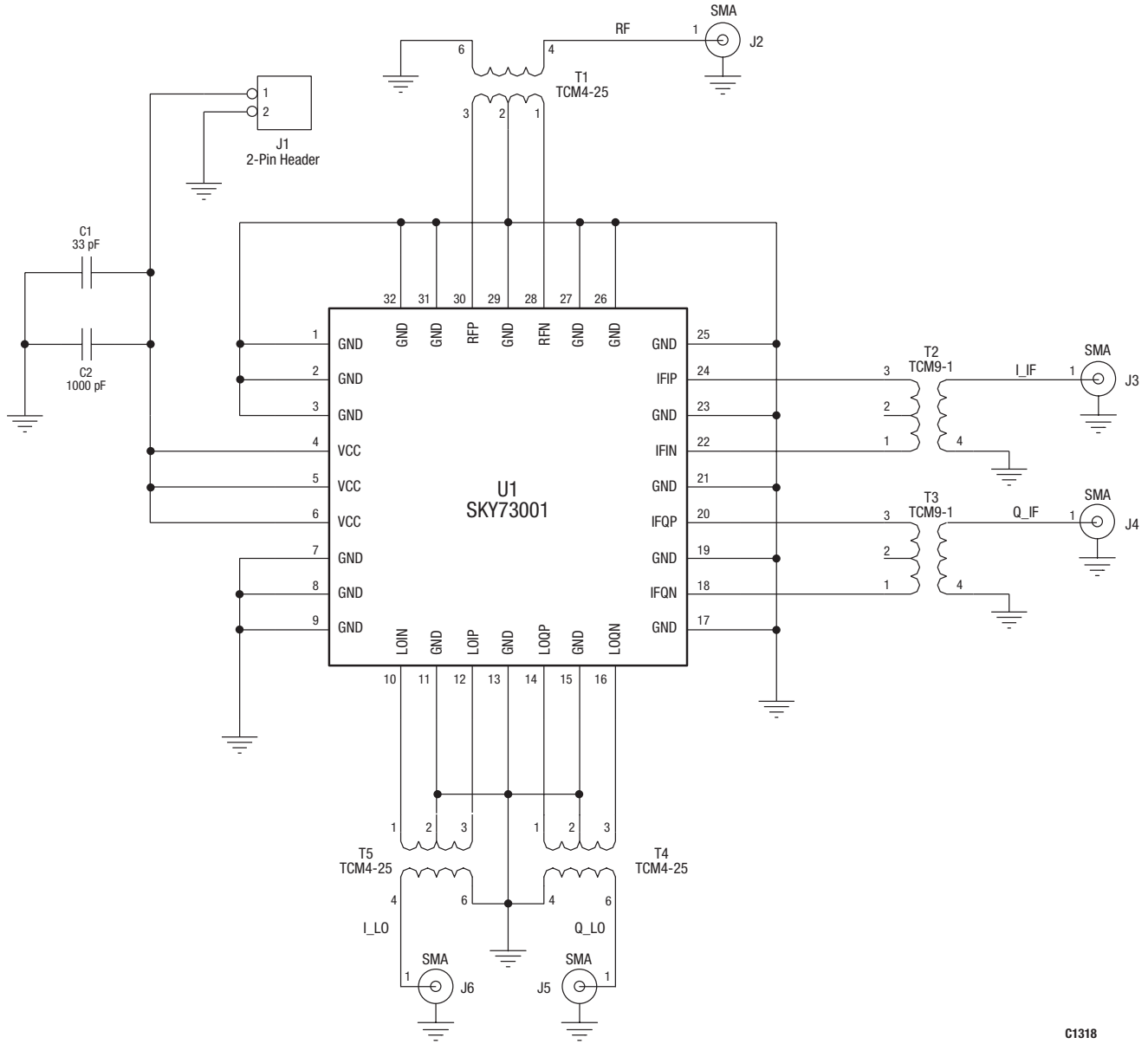

Package and Handling Information

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 SKY73001 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 RFLGA Packages*, document number 103147.

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. For packaging details, refer to the Skyworks Application Note, *Tape and Reel*, document number 101568.
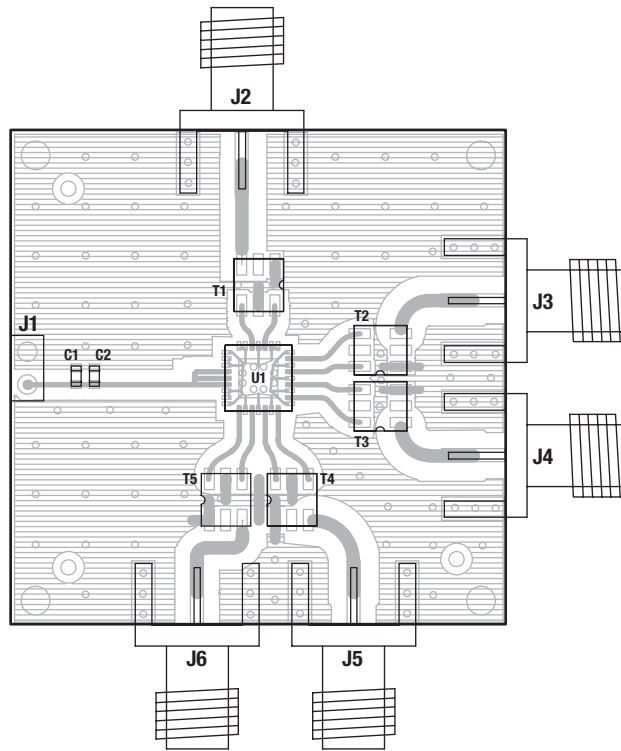
Electrostatic Discharge (ESD) Sensitivity

The SKY73001 is a static-sensitive electronic device. Do not operate or store near strong electrostatic fields. Take proper ESD precautions.
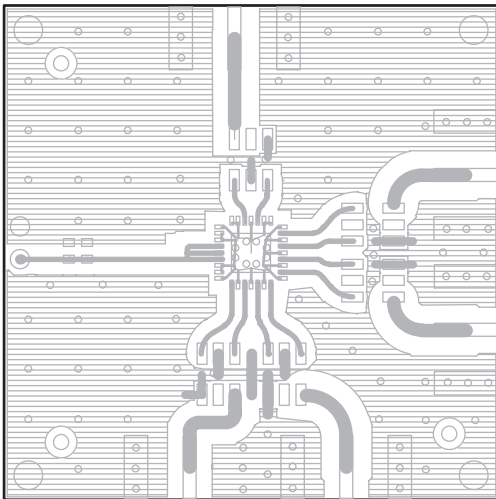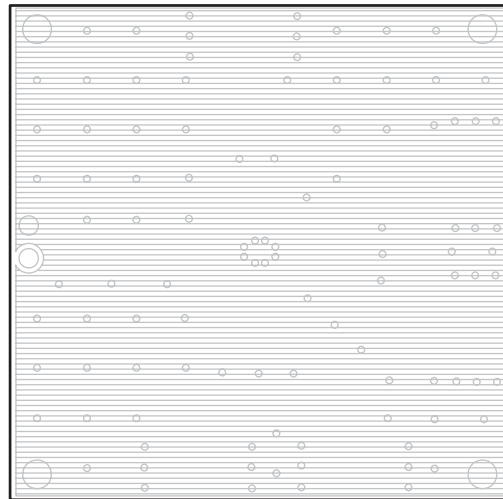
**Figure 8. SKY73001 Evaluation Board Schematic
(500-2500 MHz)**

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Component Placement

Top Layer

Bottom Layer

S758

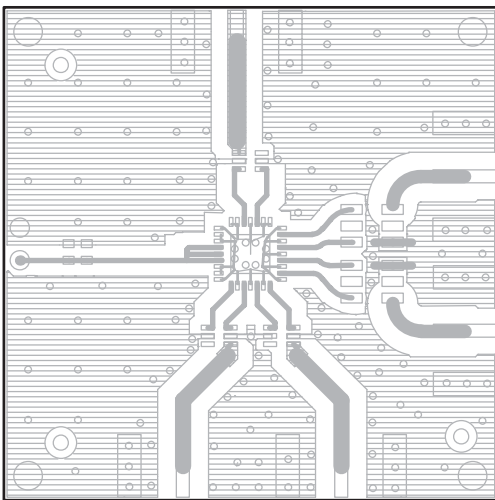**Figure 9. SKY73001 Evaluation Board Assembly Diagram
(2-2500 MHz)**

Table 5. SKY73001 Evaluation Board Component Values (2-2500 MHz)

Reference Designator	Quantity	Value	Manufacturer	Part Number
2-500 MHz				
C1	1	33 pF (0603)		
C2	1	1000 pF (0603)		
J1	1	2-pin header connector		
J2, J3, J4, J5, J6	5	SMA connector		
T1, T4, T5	3	4:1 (3-800 MHz)	Mini-Circuits	TC4-1W
T2, T3	2	9:1 (2-280 MHz)	Mini-Circuits	TCM9-1
U1	1	Direct Conversion Mixer	Skyworks	SKY73001-11
500-2500 MHz				
C1	1	33 pF (0603)		
C2	1	1000 pF (0603)		
J1	1	2-pin header connector		
J2, J3, J4, J5, J6	5	SMA connector		
T1, T4, T5	3	4:1 (500-2500 MHz)	Mini-Circuits	TCM4-25
T2, T3	2	9:1 (2-280 MHz)	Mini-Circuits	TCM9-1
U1	1	Direct Conversion Mixer	Skyworks	SKY73001-11

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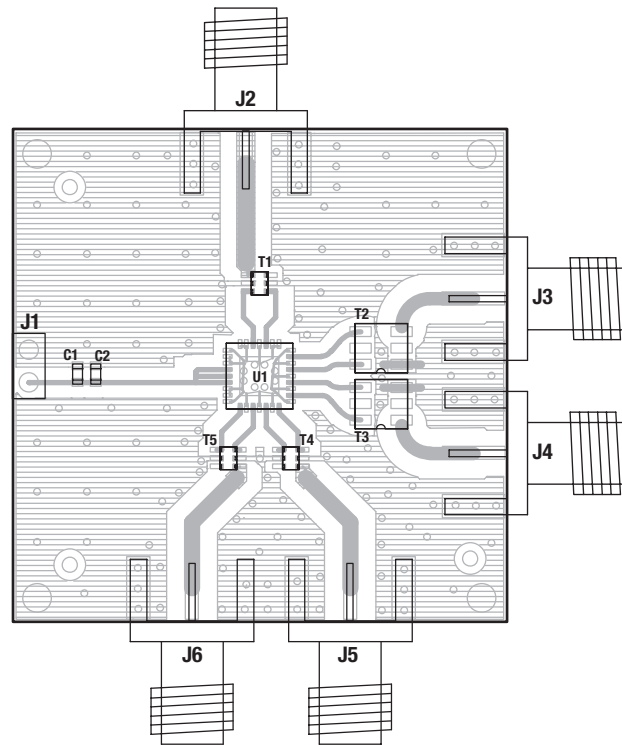
Component Placement

Top Layer
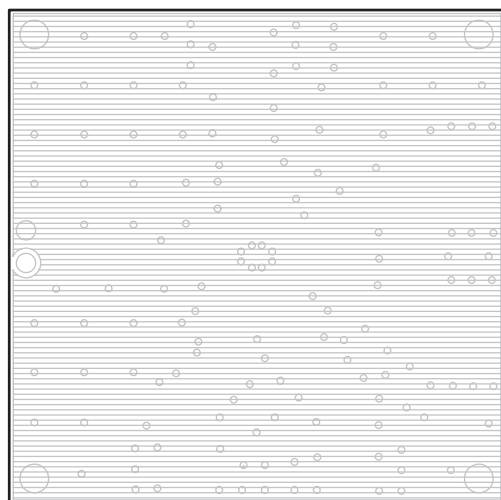
Bottom Layer

S759

Figure 10. SKY73001 Evaluation Board Assembly Diagram
(3200-3500 MHz)

Table 6. SKY73001 Evaluation Board Component Values (3200-3500 MHz)

Reference Designator	Quantity	Value	Manufacturer	Part Number
C1	1	33 pF (0603)		
C2	1	1000 pF (0603)		
J1	1	2-pin header connector		
J2, J3, J4, J5, J6	5	SMA connector		
T1, T4, T5	3	4:1 (3200-3500 MHz)	Johanson	3700BL15B100
T2, T3	2	9:1 (2-280 MHz)	Mini-Circuits	TCM9-1
U1	1	Direct Conversion Mixer	Skyworks	SKY73001-11
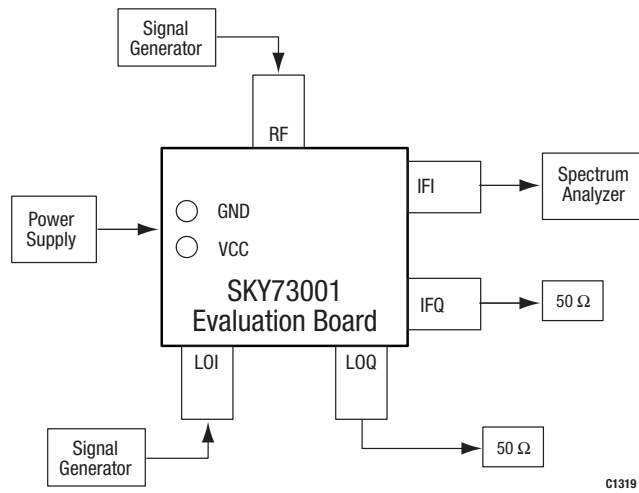
Figure 11. SKY73001 Evaluation Board Testing Configuration

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Top View

Bottom View

Side View

All measurements are in millimeters

Detail A

C1285a
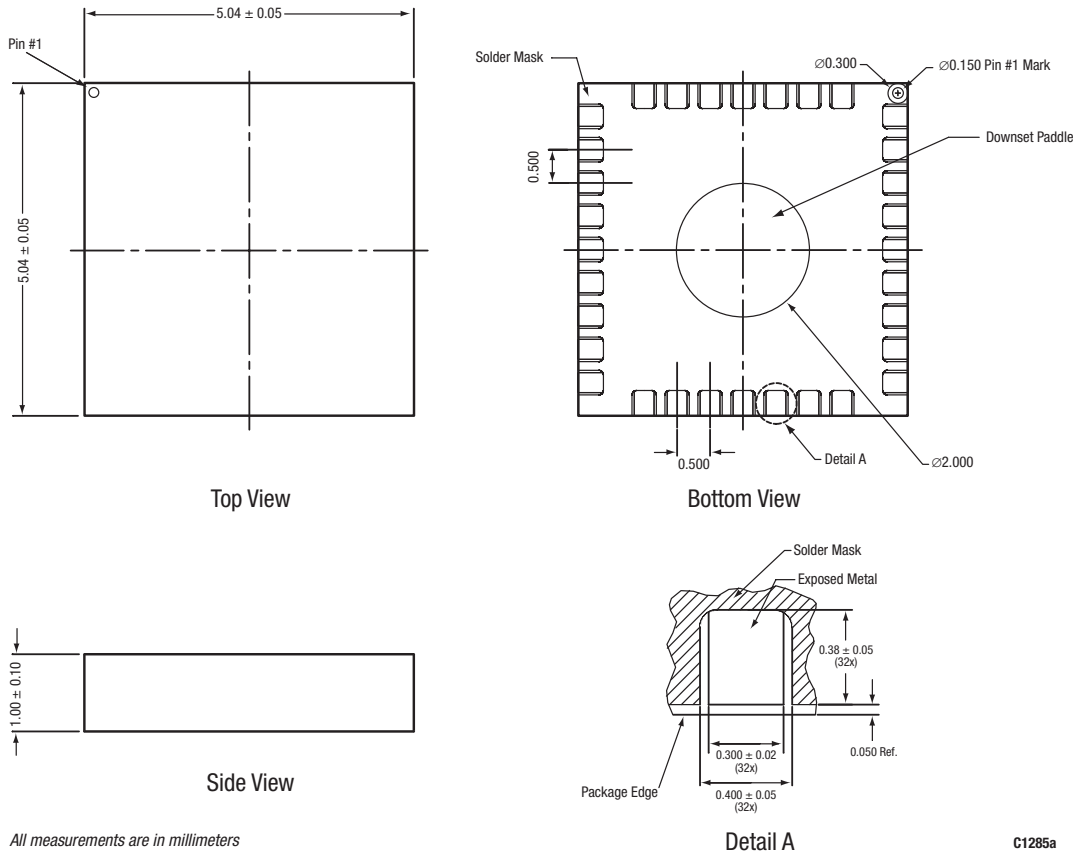
Figure 12. SKY73001 32-Pin RFLGA Package Dimensions

Notes:
1. Carrier tape: black conductive polystyrene
2. Cover tape material: transparent conductive PSA
3. Cover tape size: 9.3 mm width
4. All dimensions are in millimeters

S461
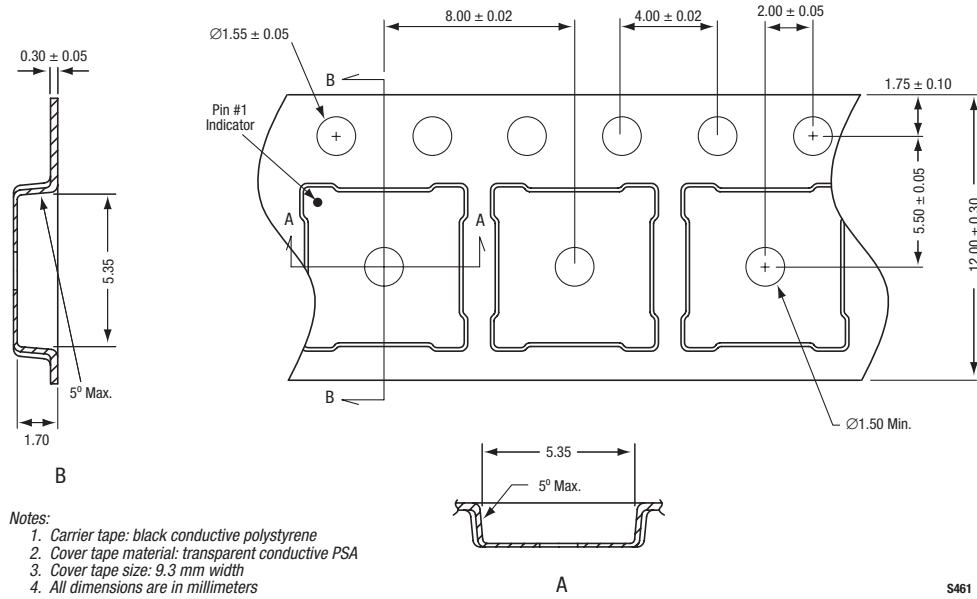
Figure 13. SKY73001 32-Pin RFLGA Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Kit Part Number
SKY73001 2-3500 MHz Direct Conversion Mixer	SKY73001-11 (Pb-free package)	TW10-D913 (tuned for 2-500 MHz) TW10-D912 (tuned for 500-2500 MHz) TW12-D342 (tuned for 3200-3500 MHz)

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