DATA SHEET

SKY65372-11: 699 to 798 MHz High Linearity, Active Bias Low-Noise Variable Gain Amplifier

Applications

- LTE, WCDMA, GSM wireless infrastructure
- Low-noise, high-linearity systems
- Macro-base stations
- Small cells

Features

- Fully integrated low-noise front end
- High gain: 42 dB
- Excellent return loss: >20 dB
- High linearity gain control > 35 dB
- Low NF: 0.8 dB
- Switchable high/low gain state modes
- Temperature and process stable active bias
- Small MCM (16-pin, 8 x 8 mm) package (MSL3 @ 260 °C per JEDEC J-STD-020)

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.

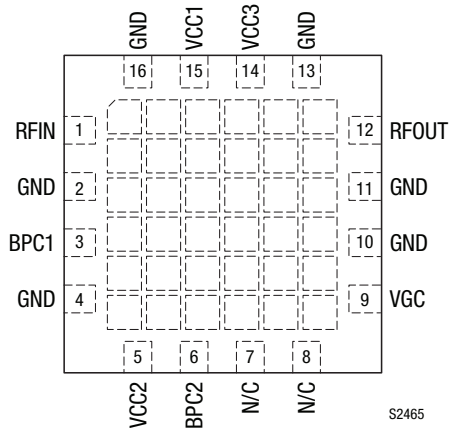

Figure 2. SKY65372-11 Pinout (Top View)

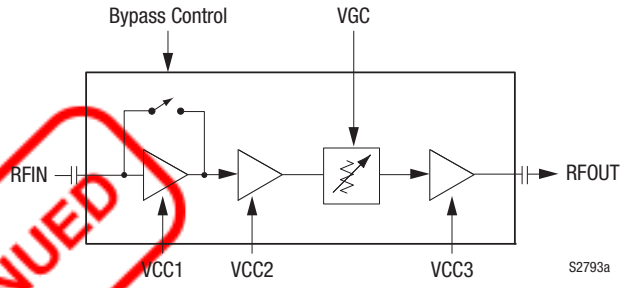

Figure 1. SKY65372-11 Block Diagram

Description

The SKY65372-11 is a variable gain low-noise amplifier (LNA) with an active bias and high-linearity performance. The first stage of the device is comprised of an LNA with a bypass switch that is followed by a high-linearity driver amplifier, a variable voltage attenuator, and a high-linearity power amplifier. This module architecture provides excellent return loss, low noise, and high-linearity performance.

The internal active bias circuitry ensures repeatable performance over temperature. The device is fully integrated and requires minimal external components.

The SKY65372-11 is manufactured in a compact, 8 x 8 mm, 16-pin Multi-Chip Module (MCM) 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.

The SKY65372-11 is part of a family of LNAs that cover the frequency range of 699 MHz to 2570 MHz:

Part Number	Frequency
SKY65369-11	832 to 862 MHz
SKY65370-11	814 to 849 MHz
SKY65371-11	880 to 915 MHz
SKY65372-11	699 to 798 MHz
SKY65373-11	1710 to 1785 MHz
SKY65374-11	1850 to 1915 MHz
SKY65375-11	1920 to 1980 MHz
SKY65376-11	2500 to 2570 MHz

Table 1. SKY65372-11 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	RFIN	RF input	9	VGC	Gain control, 0 V (maximum gain) to +3.3 V (minimum gain)
2	GND	Ground	10	GND	Ground
3	BPC1	Bypass switch for high/low gain state, terminal 1. See Table 7.	11	GND	Ground
4	GND	Ground	12	RFOUT	RF output
5	VCC2	Second state amplifier bias. Connect to +5 V, 200 mA minimum DC supply.	13	GND	Ground
6	BPC2	Bypass switch for high/low gain state, terminal 2. See Table 7.	14	VCC3	Third stage amplifier bias. Connect to +5 V, 300 mA minimum DC supply.
7	N/C	No connection. Can be left open or grounded.	15	VCC1	First stage amplifier bias. Connect to +5 V, 80 mA minimum DC supply.
8	N/C	No connection. Can be left open or grounded.	16	GND	Ground

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65372-11 are provided in Table 2. The recommended operating conditions are specified in Table 3. Electrical specifications are provided in Tables 4 through 7. The gain control logic is shown in Table 8.

Typical performance characteristics of the SKY65372-11 are shown in Figures 3 through 12.

Table 2. SKY65372-11 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{CC}		5.5	V
RF input power	P_{IN}		+5	dBm
Storage temperature	T_{STG}	-55	+150	°C
Operating temperature	T_C	-40	+100	°C
Junction temperature	T_J		+150	°C
Thermal resistance	R_{TH}		20	C/W

[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**: 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. SKY65372-11 Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
RF input power	P_{IN}		-25	-12	dBm
Frequency range	f	699		798	MHz
Supply voltage	V_{CC}	4.75	5.00	5.25	V
Gain control voltage	V_{GC}	0		+3.3	V
Bypass control voltage: Logic high Logic low	V_{BPC1}, V_{BPC2}	 2.7 0	3.0	 3.3 0.6	 V V
Operating case temperature	T_C	-40		+85	°C

Table 4. SKY65372-11 Electrical Specifications[1]
(V_{DD} = 5.0 V @ Maximum Gain [V_{GC} = V_{BPC1} = 0 V, V_{BPC2} = 3.3 V], T_C = +25 °C, P_{IN} = -25 dBm, f = 723.5 MHz, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
RF Specifications						
Frequency range	f		698		749	MHz
Quiescent current	I_{CQ}			380	445	mA
Noise figure[2]	NF	Gain = +21 dB (high-gain mode) Gain = +35 dB (high-gain mode)[5]		2.0 0.8	2.3	dB
Small signal gain	|S21|	P_{IN} = -25 dBm	37.5	39.0		dB
Gain variation over frequency (over 35 MHz bandwidth)		P_{IN} = -25 dBm: Gain = 2 and 17 dB (low gain) Gain = 18 and 35 dB (high gain)			 1.0 1.0	 dB dB
Part-to-part gain variation		Gain = 32, 29, 26, 22, 13, 10, and 6 dB	-1		+1	
Gain control range (absolute gain)		P_{IN} = -25 dBm: High-gain mode, BPC1 = 0, BPC2 = 1, V_{GC} = 0 V BPC1 = 0, BPC2 = 1, V_{GC} = 3.3 V Low-gain mode, BPC1 = 1, BPC2 = 0, V_{GC} = 0 V BPC1 = 1, BPC2 = 0, V_{GC} = 3.3 V	 37.5 18.5	 42 12 21 -8	 16.5 0	 dB dB dB dB
Input return loss	|S11|	P_{IN} = -25 dBm: Gain = 2 dB (low-gain mode) Gain = 35 dB @ 798 MHz (high-gain mode) [5] Gain = 35 dB (high-gain mode)	 18.5 21.5	 25		 dB dB dB
Output return loss	|S22|	P_{IN} = -25 dBm: Gain = 17 dB (low-gain mode) Gain = 35 dB @ 798 MHz (high-gain mode) [5] Gain = 35 dB (high-gain mode)	 15.5 15.5	 17		 dB dB dB

Table 4. SKY65372-11 Electrical Specifications[1]
(V_{DD} = 5.0 V @ Maximum Gain [V_{GC} = V_{BPC1} = 0 V, V_{BPC2} = 3.3 V], T_C = +25 °C, P_{IN} = -25 dBm, f = 723.5 MHz, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
RF Specifications (continued)						
Reverse isolation	|S12|	P_{IN} = -25 dBm, gain = 35 dB (high gain)	60.5			dB
Third order input intercept point[3]	IIP3	Δf = 1 MHz, P_{IN} = -25 dBm/tone: Gain = 17 dB (low-gain mode) Gain = 35 dB (high-gain mode)	 +14 +2			 dBm dBm
1 dB input compression point[4]	IP1dB	Gain = 17 dB (low-gain mode) Gain = 35 dB (high-gain mode)	+9.5 -10.0			dBm dBm

1 Performance is guaranteed only under the conditions listed in this table, unless otherwise noted.
2 Loss from the input SMA connector and Evaluation Board up to pin 1 has been de-embedded from the NF measurement. See Table 5 for full specification.
3 See Table 6 for full specification.
4 See Table 7 for full specification.
5 Verified by characterization.

Table 5. SKY65372-11 Electrical Specifications: Noise Figure[1]
(V_{DD} = 4.75 to 5.25 V, f = 699 to 798 MHz, T_C = -40 °C to +85 °C, P_{IN} = -25 dBm, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Test Condition	Min	Typ	Max	Test Condition	Min	Typ	Max
Noise figure (NF)	Gain = 2 dB			24.7 dB	Gain = 20 dB			7.7 dB
	Gain = 3 dB			23.7 dB	Gain = 21 dB			6.7 dB
	Gain = 4 dB			22.7 dB	Gain = 22 dB			5.7 dB
	Gain = 5 dB			21.7 dB	Gain = 23 dB			4.8 dB
	Gain = 6 dB			20.7 dB	Gain = 24 dB			4.7 dB
	Gain = 7 dB			19.7 dB	Gain = 25 dB			3.8 dB
	Gain = 8 dB			18.7 dB	Gain = 26 dB			3.3 dB
	Gain = 9 dB			17.7 dB	Gain = 27 dB			2.9 dB
	Gain = 10, 11 dB			16.7 dB	Gain = 28 dB			2.5 dB
	Gain = 12 dB			15.7 dB	Gain = 29 dB			2.4 dB
	Gain = 13 dB			14.7 dB	Gain = 30 dB			2.2 dB
	Gain = 14 dB			13.7 dB	Gain = 31 dB			1.95 dB
	Gain = 15 dB			12.7 dB	Gain = 32 dB			1.8 dB
	Gain = 16 dB			11.7 dB	Gain = 33 dB			1.35 dB
	Gain = 17 dB			10.7 dB	Gain = 34 dB			1.25 dB
	Gain = 18 dB			9.7 dB	Gain = 35 dB			1.15 dB
	Gain = 19 dB			8.7 dB				

Table 6. SKY65372-11 Electrical Specifications: IIP3[1]
(V_{DD} = 4.75 to 5.25 V, T_C = -40 °C to +85 °C, P_{IN} = -25 dBm, f = 699 to 798 MHz, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Third order input intercept point	IIP3	Gain = 2,3 dB	12			dBm
		Gain = 4 dB	11			dBm
		Gain = 5 dB	10			dBm
		Gain = 6 dB	9			dBm
		Gain = 7 dB	8			dBm
		Gain = 8 dB	7			dBm
		Gain = 9 dB	6			dBm
		Gain = 10 dB	5			dBm
		Gain = 11 dB	4			dBm
		Gain = 12 dB	3			dBm
		Gain = 13 dB	2			dBm
		Gain = 14 dB	1			dBm
		Gain = 15 dB	0			dBm
		Gain = 16 to 35 dB	-1			dBm

1 Verified by characterization.

Table 7. SKY65372-11 Electrical Specifications: IP1dB[1]
(V_{DD} = 4.75 to 5.25 V, T_C = -40 °C to +85 °C, P_{IN} = -25 dBm, f = 699 to 798 MHz, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
1 dB input compression point	IP1dB	Gain = 2 to 3 dB	+6.5			dBm
		Gain = 4 dB	+5.5			dBm
		Gain = 5 dB	+4.5			dBm
		Gain = 6 dB	+3.5			dBm
		Gain = 7 dB	+2.5			dBm
		Gain = 8 dB	+1.5			dBm
		Gain = 9 dB	+0.5			dBm
		Gain = 10	-0.5			dBm
		Gain = 11	-1.5			dBm
		Gain = 12	-2.5			dBm
		Gain = 13	-3.5			dBm
		Gain = 14	-4.5			dBm
		Gain = 15	-5.5			dBm
		Gain = 16	-6.5			dBm
		Gain = 17	-7.5			dBm
		Gain = 18	-8.5			dBm
		Gain = 19	-9.5			dBm
		Gain = 20	-10.5			dBm
		Gain = 21	-11.5			dBm
		Gain = 22	-12.5			dBm
		Gain = 23-35	-13.0			dBm

1 Verified by characterization.

Table 8. Gain Control Logic[1]

	BPC1 (Pin 3)	BPC2 (Pin 6)
High gain	0	1
Low gain	1	0

1 "1" = 3.0 V, "0" = 0 V.

Typical Performance Characteristics

(V_{DD} = 5.0 V @ Maximum Gain [V_{GC} = V_{BPC1} = 0 V, V_{BPC2} = 3.3 V], T_C = +25 °C, P_{IN} = -25 dBm, Characteristic Impedance [Z_O] = 50 Ω, Unless Otherwise Noted)

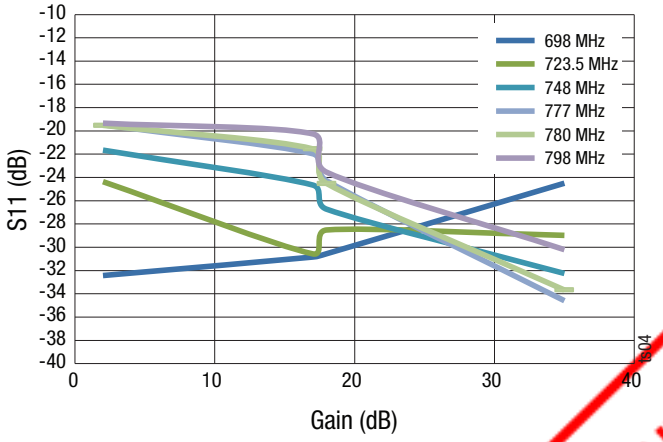

Figure 3. S11 vs Gain over Different Frequency

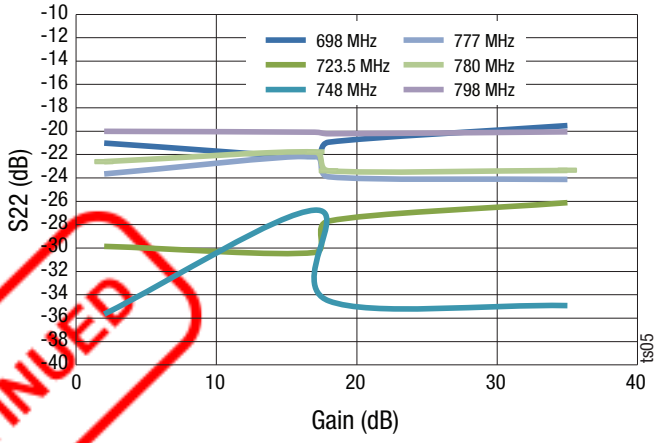

Figure 4. S22 vs Gain over Different Frequency

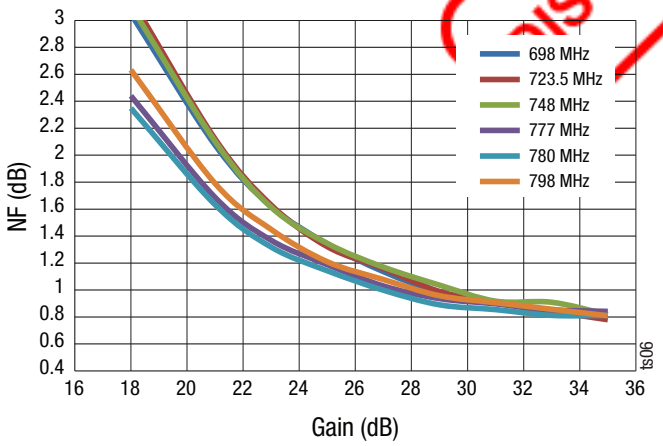

Figure 5. NF vs High Gain over Different Frequency

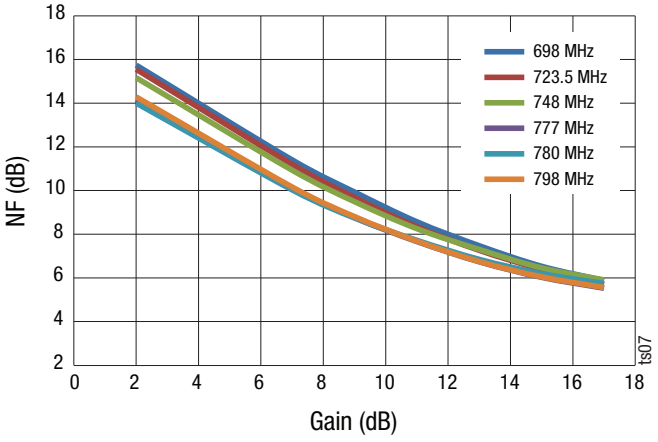

Figure 6. NF vs Low Gain over Different Frequency

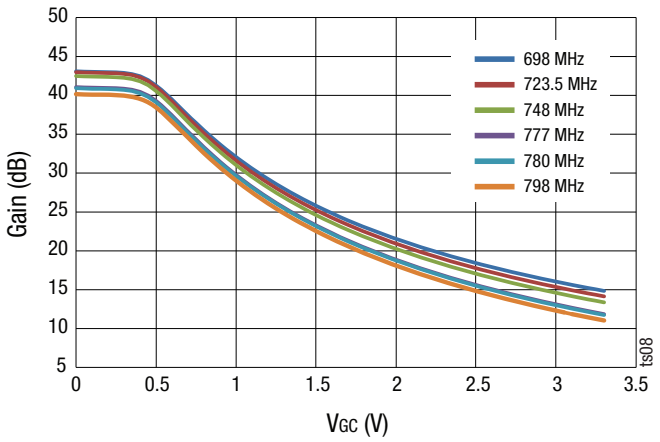

Figure 7. High Gain vs V_{GC} over Different Frequency

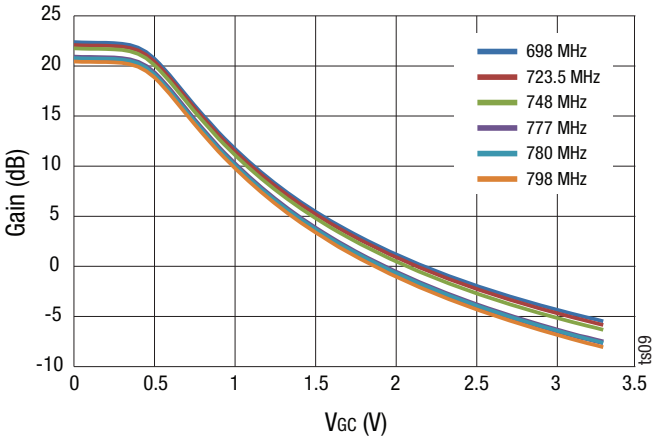

Figure 8. Low Gain vs V_{GC} over Different Frequency

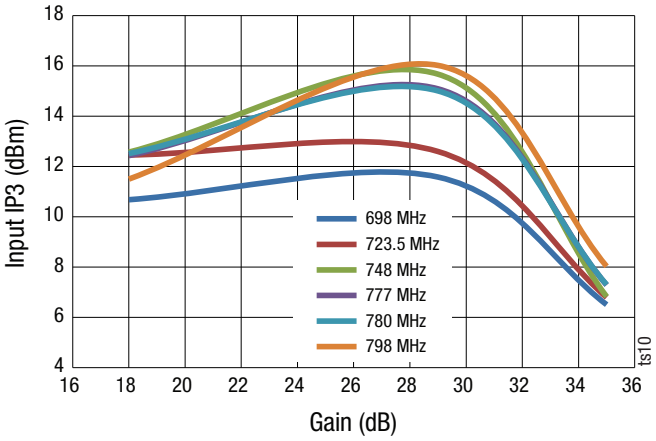

Figure 9. IIP3 vs High Gain Setting over Different Frequency

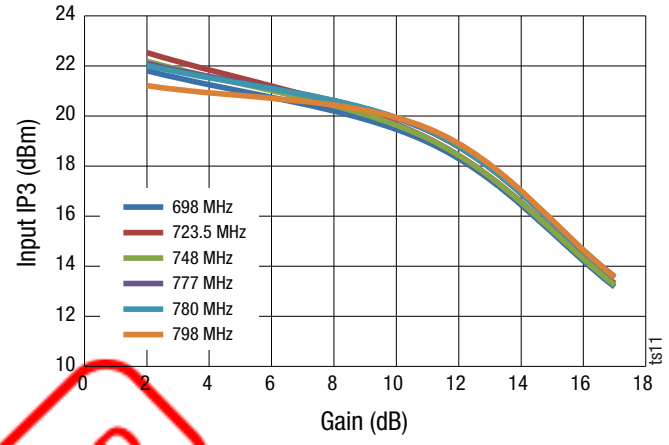

Figure 10. IIP3 vs Low Gain Setting over Different Frequency

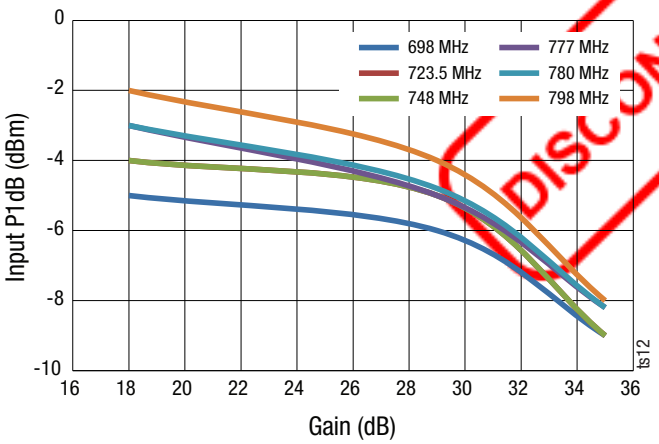

Figure 11. P1dB vs High Gain Setting over Different Frequency

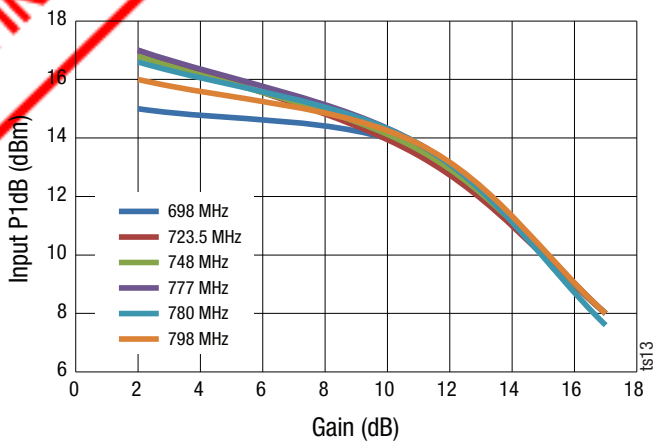

Figure 12. P1dB vs Low Gain Setting over Different Frequency

Evaluation Board Description

The SKY65372-11 Evaluation Board is used to test the performance of the SKY65372-11 LNA. An assembly drawing for the Evaluation Board is shown in Figure 13 and the layer detail is provided in Figure 14. The layer detail physical characteristics are noted in Figure 15.

An Evaluation Board schematic diagram is provided in Figure 16. Table 9 provides the Bill of Materials (BOM) list for Evaluation Board components.

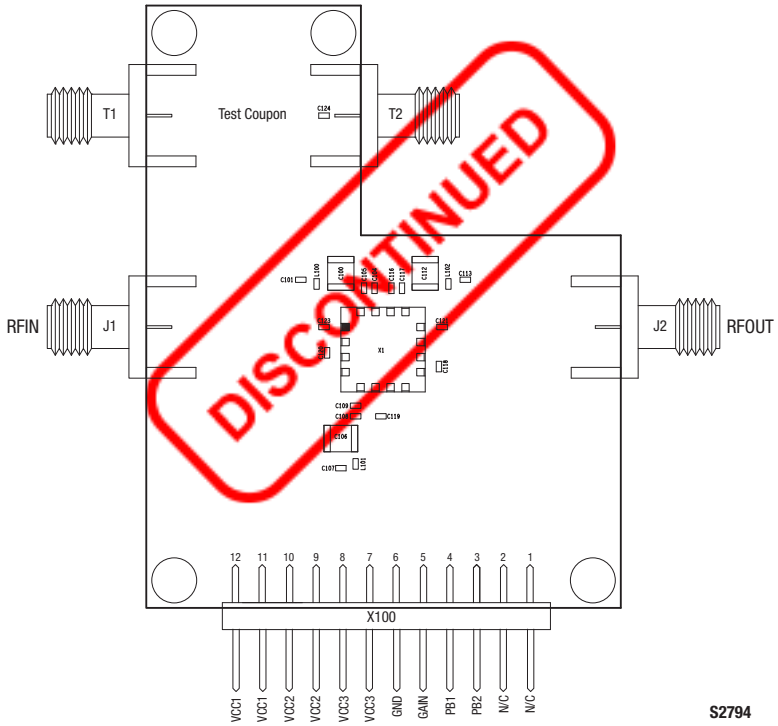

Figure 13. SKY65372-11 Evaluation Board Assembly Diagram

Figure 14. SKY65372-11 Evaluation Board Layer Detail

Cross Section	Name	Thickness (mm)	Material
	Tmask	0.010	Solder Resist
	L1	0.035	–
	Dielectric	0.305	R04003C
	L2	0.018	–
	Dielectric	4 x 0.101	R04350B RF
	L3	0.018	–
	Dielectric	0.305	R04003C
	L4	0.035	–
	Bmask	0.010	Solder Resist

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Figure 15. Layer Detail Physical Characteristics

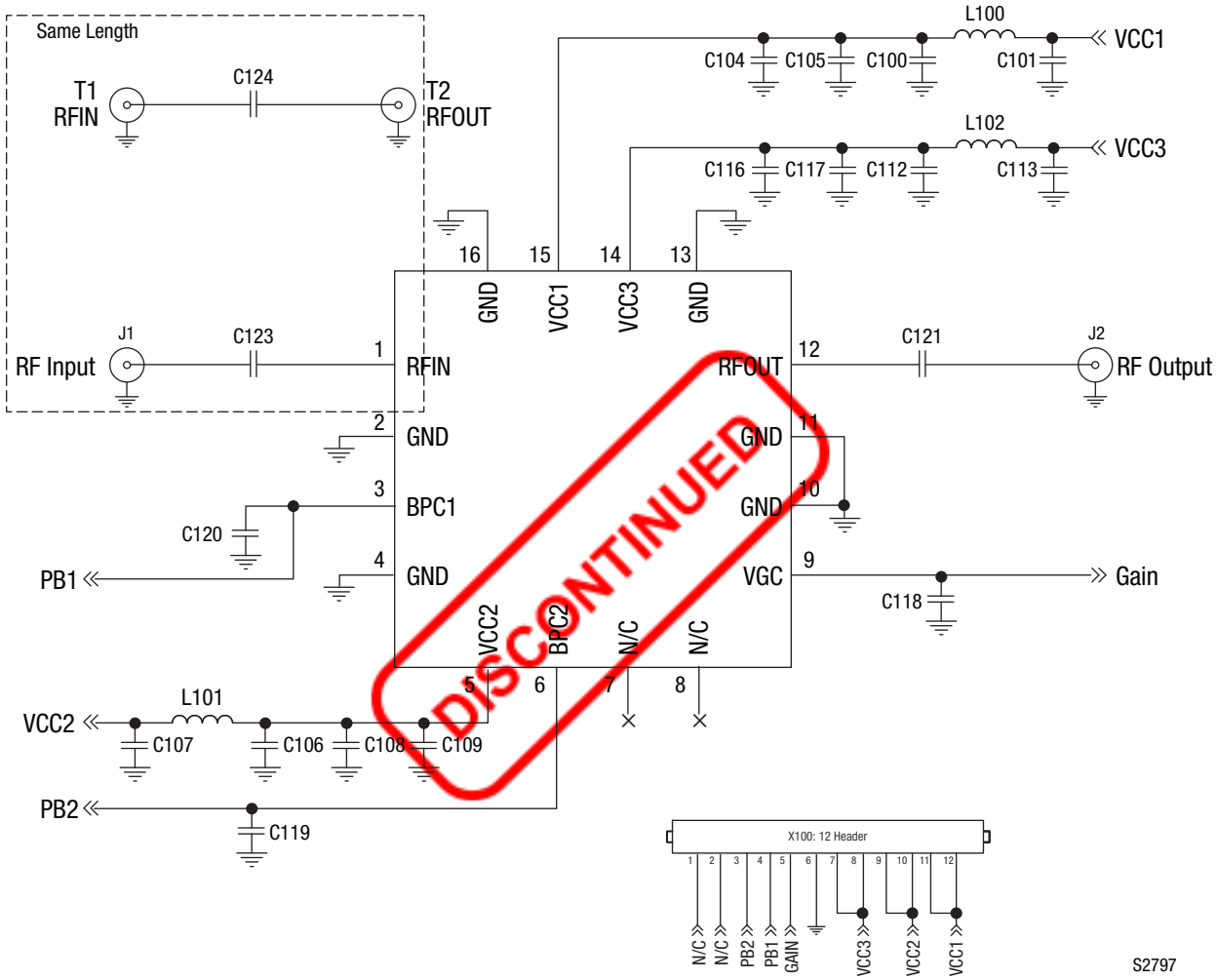


Figure 16. SKY65372-11 Evaluation Board Schematic

Table 9. SKY65372-11 Evaluation Board Bill of Materials

Component	Size	Value	Tolerance (%)
C100, C106, C112	1210	10 µF	10
C101, C107, C113	0402	10 pF	5
C104, C109, C116, C124	0402	1000 pF	5
C105, C108, C117	0402	100 nF	10
C118	0402	DNI	-
C119, C120	0402	1000 pF	5
C121, C123	0402	150 pF	5
L100, L101, L102	0603	68 nH	2

Package Dimensions

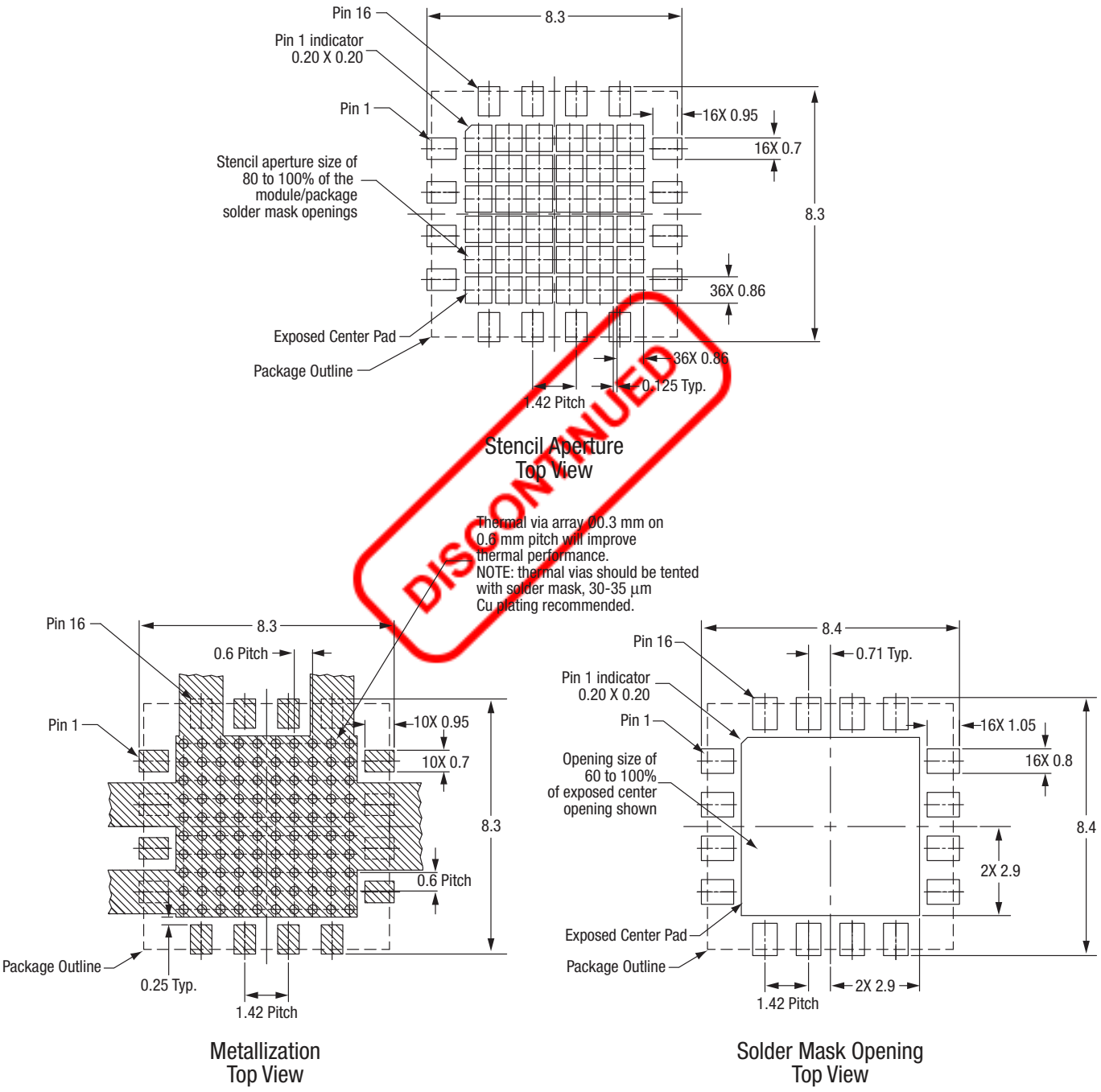
The PCB layout footprint for the SKY65372-11 is provided in Figure 17. Package dimensions are shown in Figure 18, and tape and reel dimensions are provided in Figure 19.

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 SKY65372-11 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 Skyworks Application Note, *PCB Design and 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.



All dimensions are in millimeters

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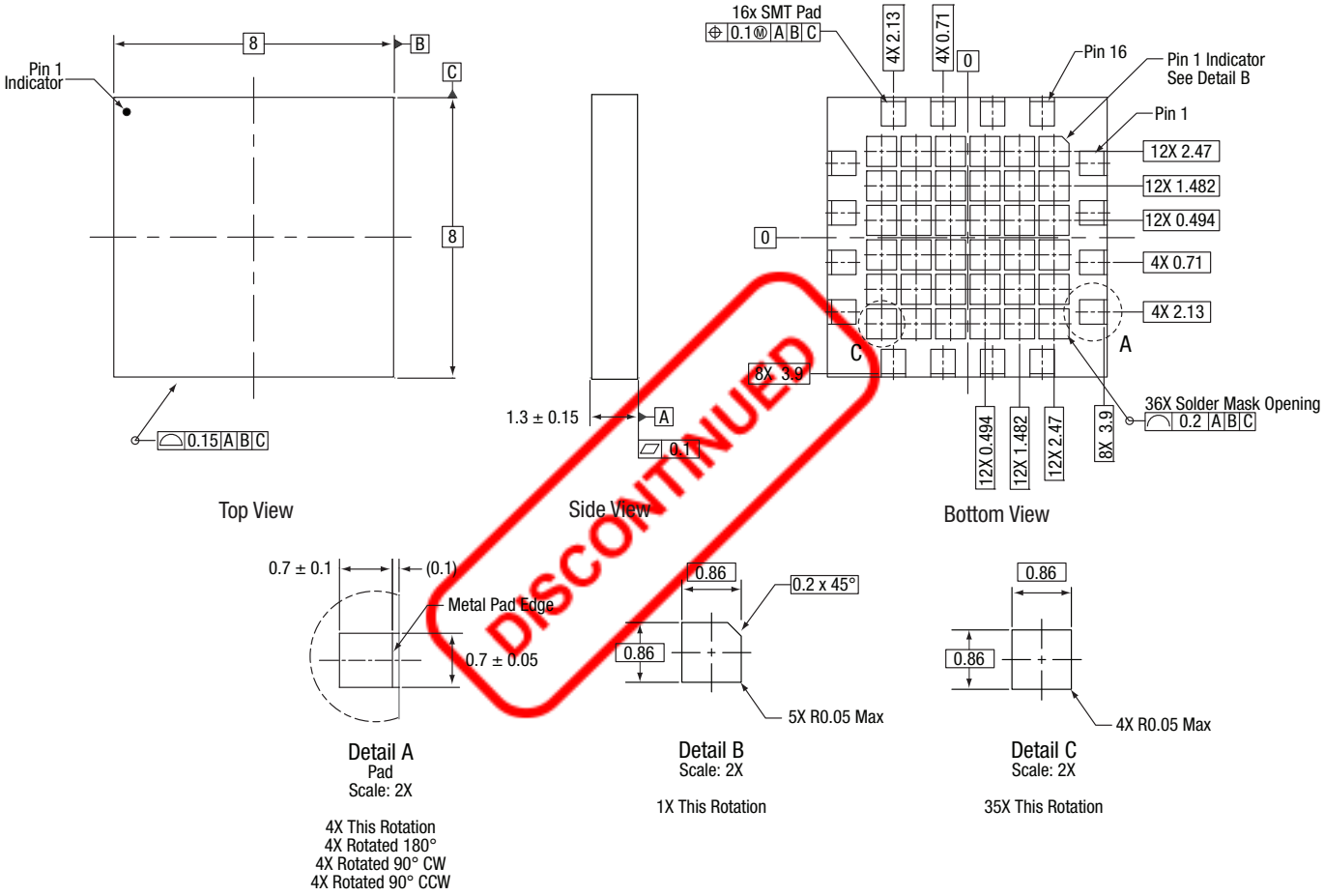
Figure 17. SKY65372-11 PCB Layout Footprint (Top View)



Notes:

1. *Dimensions and tolerances according to ASME Y14.5M-1994.*
2. *All measurements are in millimeters.*

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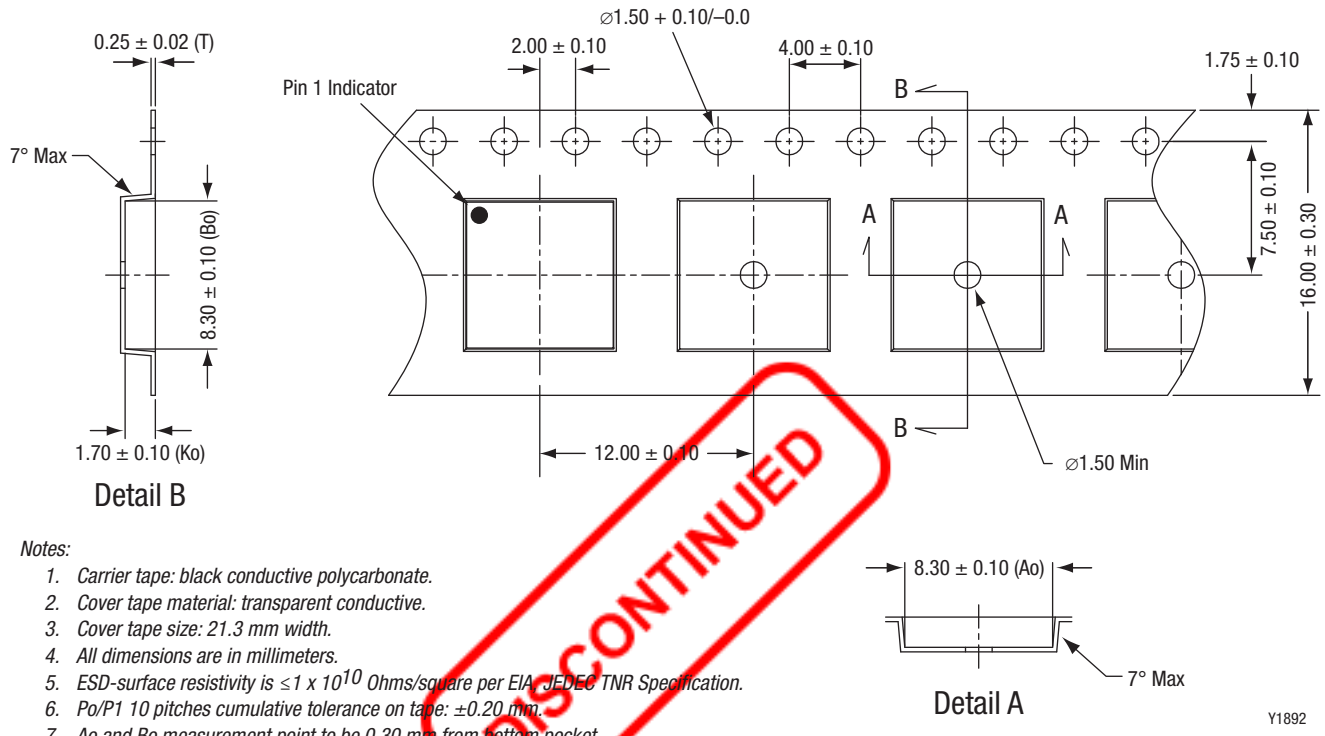
Figure18. SKY65372-11 Package Dimensions



Notes:

1. *Carrier tape: black conductive polycarbonate.*
2. *Cover tape material: transparent conductive.*
3. *Cover tape size: 21.3 mm width.*
4. *All dimensions are in millimeters.*
5. *ESD-surface resistivity is ≤1 x 10^{10} Ohms/square per EIA/JEDEC TNR Specification.*
6. *Po/P1 10 pitches cumulative tolerance on tape: ±0.20 mm.*
7. *Ao and Bo measurement point to be 0.30 mm from bottom pocket.*

Figure 19. SKY65372-11 Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY65372-11: LNA	SKY65372-11	SKY65372-11-EVB