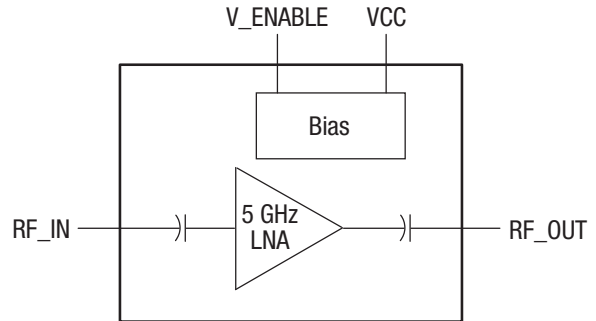# SKY65404-31: 5 GHz Low-Noise Amplifier

Applications

- 802.11a/n/ac radios
- 5 GHz ISM radios
- Smartphones
- Notebooks, netbooks, and tablets
- Access points, routers, and gateways
- Wireless video systems

Features

- Ultra-low Noise Figure: 1.0 dB
- 4.9 GHz to 5.9 GHz operation
- Enable/disable mode
- High IIP3: +7 dBm
- High gain: 13 dB
- 2.8 to 5.0 V single-supply operation
- QFN (6-pin, 1.5 x 1.5 mm) package (MSL1, 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 1. SKY65404-31 LNA Block Diagram

Description

The SKY65404-31 is an ultra Low-Noise Amplifier (LNA) intended for 5 GHz wireless receiver applications. Its industry-leading Noise Figure (NF), together with high linearity, makes it ideal as a first-stage LNA in 802.11a Wireless Local Area Network (WLAN) radios.

Operating with a single supply voltage, the SKY65404-31 consumes only 10 mA of current. The device includes a shutdown mode to save power when the receiver is inactive.

The tiny package footprint of the SKY65404-31, requiring only four external components, enables the industry's smallest PCB area needed to implement a 5 GHz LNA.

A block diagram of the SKY65404-31 is shown in Figure 1. The device package and pinout for the 6-pin Quad Flat No-Lead (QFN) are shown in Figure 2.
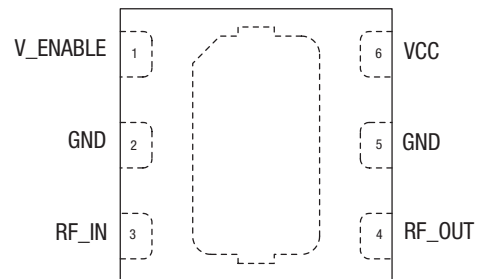
Figure 2. SKY65404-31 Pinout – 6-Pin QFN Package
(Top View)

Technical Description

The SKY65404-31 is matched at the RF output port (pin 4) and requires only a shunt capacitor match at the RF input port (pin 3). The VCC signal (pin 6) requires a simple bypass circuit. An external resistor on the V_ENABLE signal (pin 1) allows a wide range of control voltages to be used. Shutdown mode is achieved by switching the V_ENABLE signal to 0 V.

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 SKY65404-31 is rated to Moisture Sensitivity Level 1 (MSL1) 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.

Electrical and Mechanical Specifications

Signal pin assignments and functional pin descriptions are described in Table 1. The absolute maximum ratings of the SKY65404-31 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4. Table 5 provides the control logic for the SKY65404-31.

Performance characteristics for the SKY65404-31 are illustrated in Figures 3 through 9.

An application schematic diagram for the SKY65404-31 is shown in Figure 10. The PCB footprint drawing for the SKY65404-31 is provided in Figure 11. Typical part markings are shown in Figure 12. The package dimensions for the 6-pin QFN are shown in Figure 13, and the tape and reel dimensions are provided in Figure 14.

Table 1. SKY65404-31 Pin Assignments and Signal Descriptions

Pin	Name	Description
1	V_ENABLE	Enable control input
2	GND	Ground
3	RF_IN	LNA input
4	RF_OUT	LNA output
5	GND	Ground
6	VCC	Supply voltage for LNA

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Table 2. Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	VCC	0	5.5	V
DC voltage at control ports	V$_{ENABLE}$	0	5.0	V
RF input power: LNA enabled LNA disabled	RF$_{IN}$		 +1 +10	 dBm dBm
Operating temperature	T$_A$	−40	+85	°C
Storage temperature	T$_{STG}$	−40	+125	°C
Electrostatic discharge: Charged Device Model (CDM), Class 3 Human Body Model (HBM), Class 0 Machine Model (MM), Class A			 500 150 50	 V V V

Note 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 values. 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 3. Recommended Operating Conditions (@ +25 °C, VCC = 3 V)

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage	VCC	2.8	3.0	5.0	V
RF frequency range	f	4900		5900	MHz
Operating temperature range	T$_A$	−40	+25	+85	°C
DC voltage at control port: High Low	 V$_{ENABLE\_H}$ V$_{ENABLE\_L}$	 2.5 0	 3.0 0	 3.5 0.2	 V V

Table 4. Electrical Characteristics (4900-5900 MHz) (1 of 2) (Note 1)
(VCC = 3 V, T$_A$ = +25 °C, V_ENABLE = 3 V, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Minimum	Typical	Maximum	Units
Enable Mode						
Gain	S21		11	13	16	dB
Noise Figure	NF		0.8	1.0	1.5	dB
3rd Order Input Intercept Point	IIP3		+5	+7	+9	dBm
In-band 1 dB compression point at input	IP1dB		−5	−4	−2	dBm
Out-of-band (2.45 GHz injected signal) 1 dB compression point at input	IP1dB		−7	−3	−2	dBm
Input/output return loss	S11, S22	Z$_{S/L}$ = 50 Ω		−10	−6	dB
Reverse isolation	S12			−26	−20	dB
Drain current		V_ENABLE = 3 V V_ENABLE = 0 V	10 0	11 <1	15 5	mA μA
V_ENABLE current	I$_{EN\_HIGH}$	V_ENABLE = 3 V		2.3	3.0	mA
Rise time	t$_{RISE}$			125	155	ns
Fall time	t$_{FALL}$			60	90	ns

Table 4. Electrical Characteristics (4900-5900 MHz) (2 of 2) (Note 1)
(VCC = 3 V, T_A = +25 °C, V_ENABLE = 3 V, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Minimum	Typical	Maximum	Units
Disable Mode						
Gain	S21		−25		−15	dB
Input return loss	S11		−2	−1	0	dB
Output return loss	S22		−15	−12	−8	dB
V_ENABLE current	I_{EN_LOW}	V_ENABLE = 0 V to 0.2 V		1.7	1.9	µA

Note 1: Performance is guaranteed only under the conditions listed in this table.

Table 5. Mode Control Logic

V_ENABLE Voltage (V)	Description
3	LNA is enabled
0	LNA is disabled
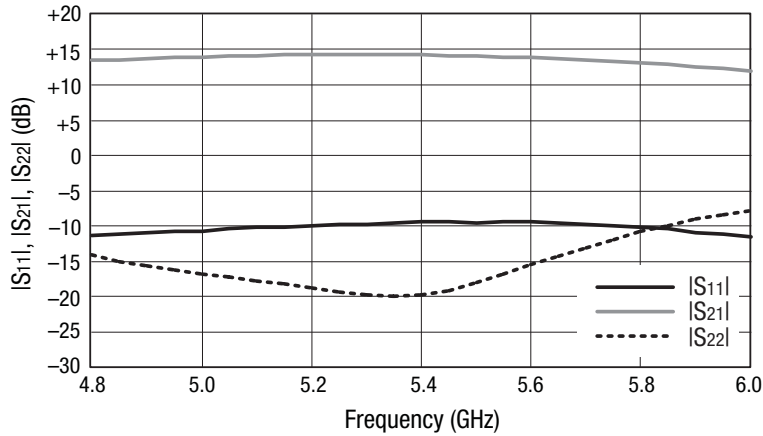
Figure 3. S-Parameter Data
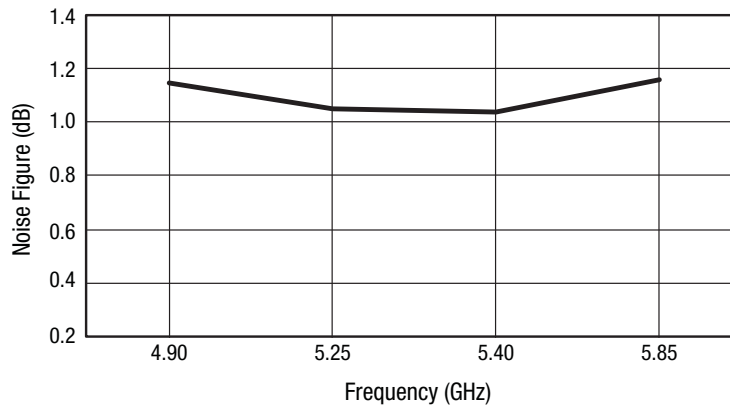
Figure 4. Noise Figure vs Frequency

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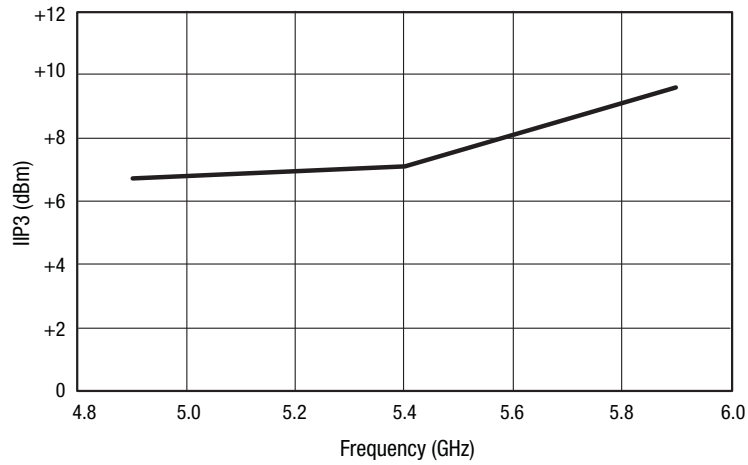
Figure 5. IIP3 vs Frequency
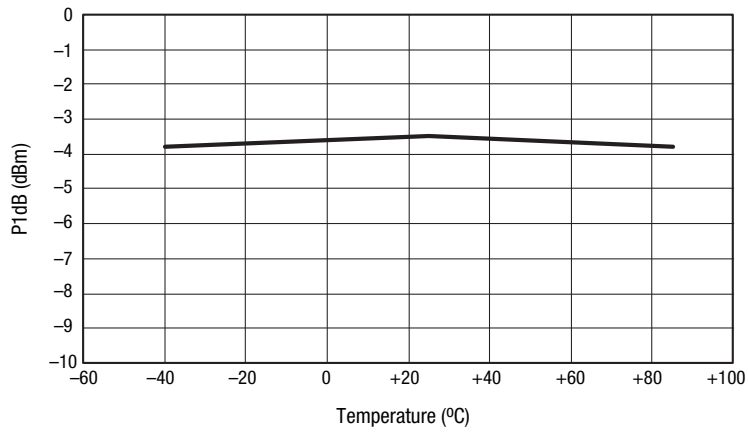
Figure 6. P1dB vs Temperature
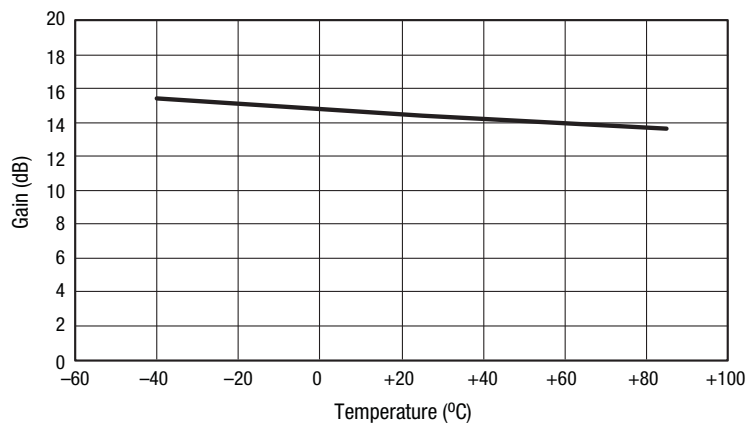
Figure 7. Gain vs Temperature
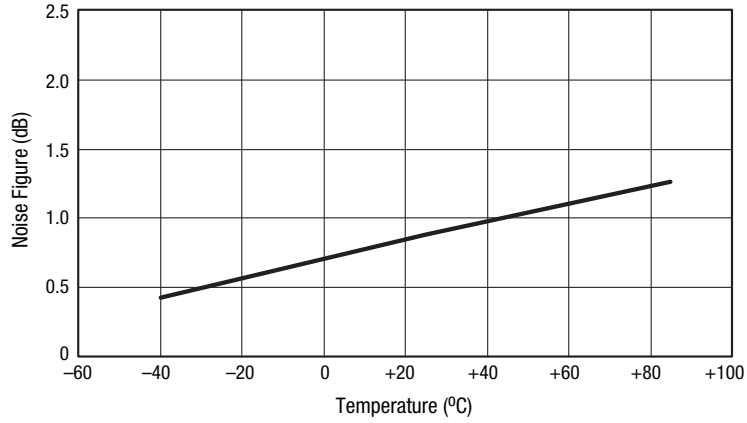
Figure 8. Noise Figure vs Temperature
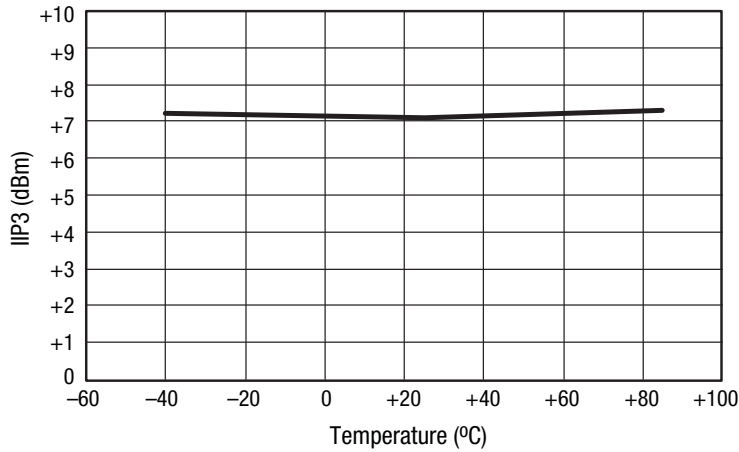
Figure 9. IIP3 vs Temperature
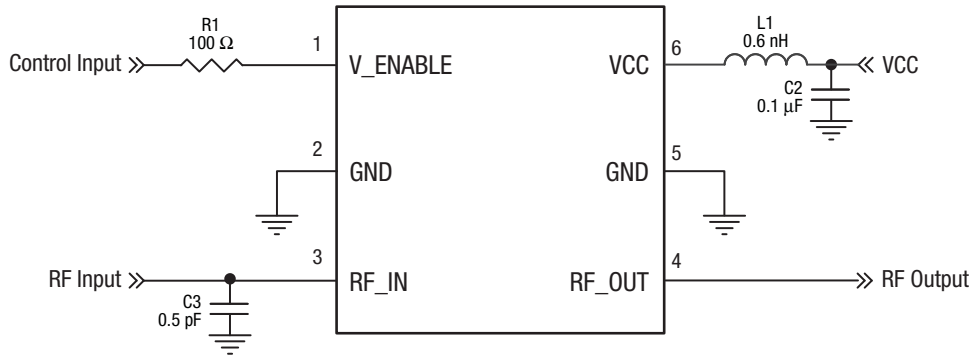
Figure 10. SKY65404-31 Schematic Diagram

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6X 0.55

0.15 X 45°

6X 0.35

6X 0.25

0.50 Pitch

0.60

1.20

0.05

7X Exposed Solder Area

0.20

0.35

0.70

S1535
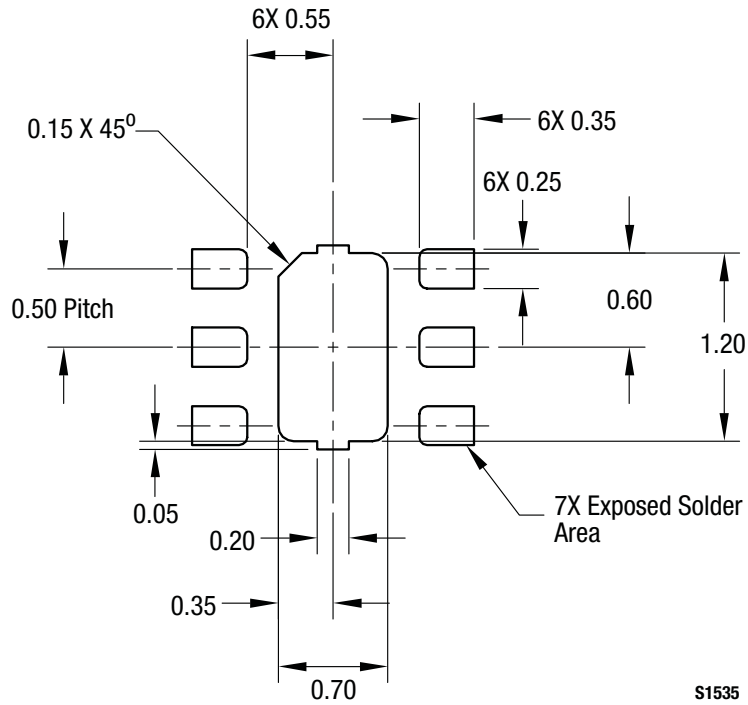
Figure 11. SKY65404-31 PCB Layout Footprint
(Top View)

Pin 1 Indicator

Skyworks Part #

SKY3
5404
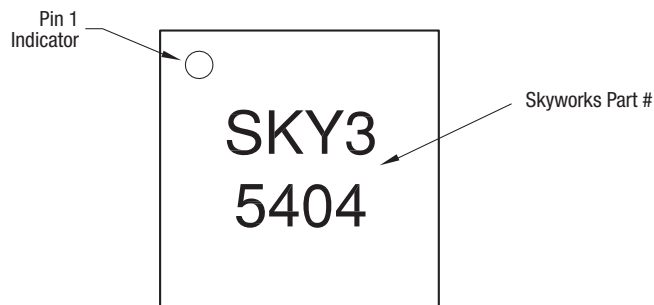
Figure 12. Typical Part Markings
(Top View)

Top View

Side View

Bottom View

Detail C
6 Places

Detail B
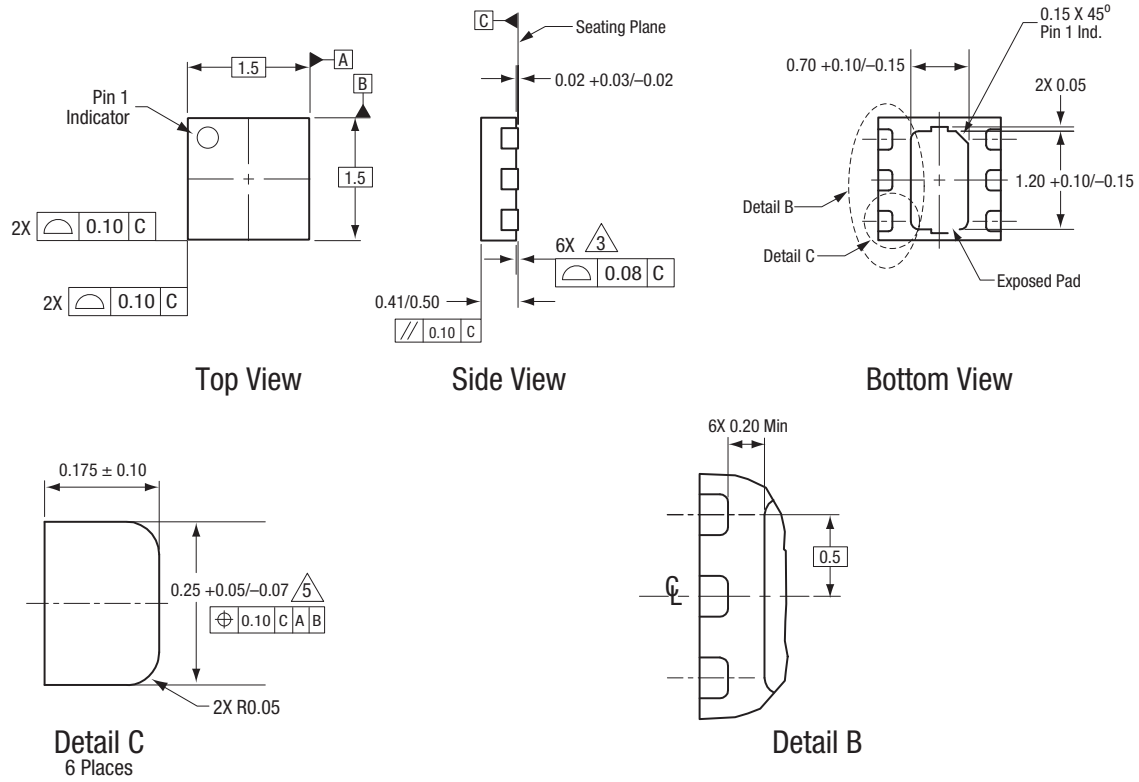
All measurements are in millimeters.
Dimensioning and tolerancing according to ASME Y14.5M-1994.
Coplanarity applies to the exposed heat sink slug as well as the terminals..
Plating requirement per source control drawing (SCD) 2504.
Dimension applies to metalized terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.

S1350

Figure 13. SKY65404-31 6-Pin LGA Package Dimensions

0.20 ± 0.02 (T)

5⁰ Max

1.78 ± 0.05 (B0)

0.69 ± 0.05 (Ko)

B

Pin 1

4.00 ± 0.10   φ1.50± 0.10   2.00 ± 0.05

1.75 ± 0.10

3.50 ± 0.05

8.00 +0.30/–0.10

φ0.50± 0.05

5⁰ Max

1.78 ± 0.05 (Ao)

A
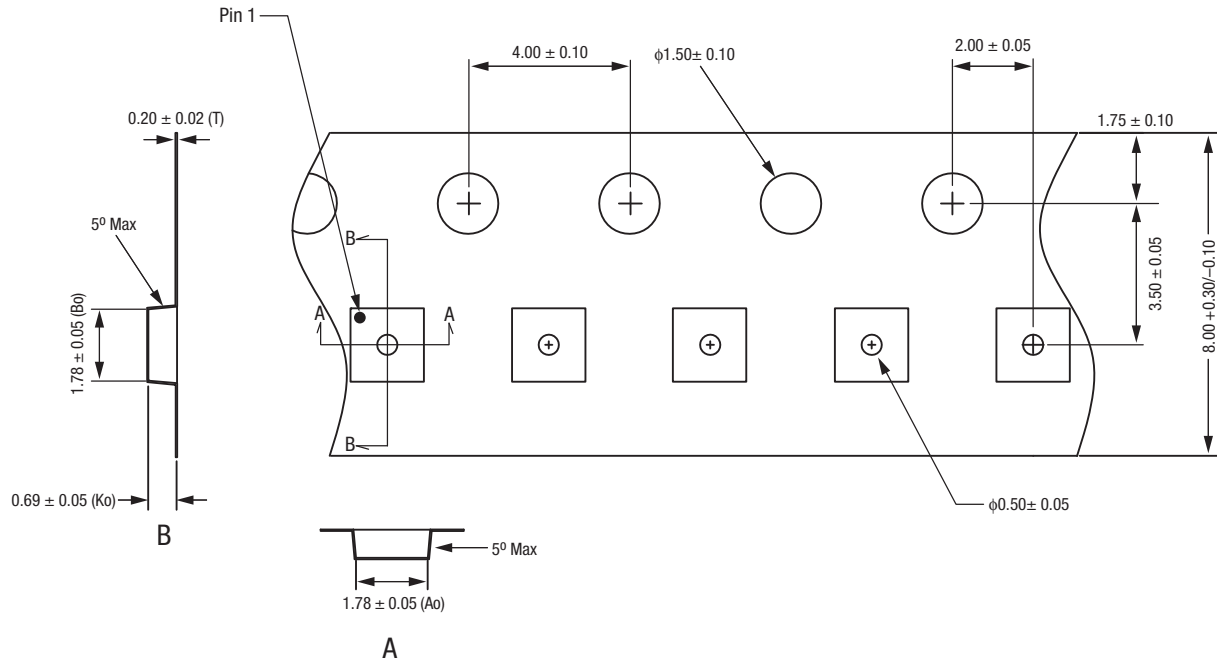
Notes:
1. *Carrier tape: black conductive polycarbonate or polystyrene.*
2. *Cover tape material: transparent conductive PSA.*
3. *Cover tape size: 5.4 mm width.*
4. *All measurements are in millimeters.*

S1382a

Figure 14. SKY65404-31 Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY65404-31 LNA	SKY65404-31	EN31-D985-001

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