

DATA SHEET

# SKY67180-306LF: 1.5 to 3.8 GHz Two-Stage, High-Gain Low-Noise Amplifier

## Applications

- LTE, GSM, WCDMA, HSDPA macro-base and micro-base stations
- S and C band ultra-low-noise receivers
- Cellular repeaters, small-cell, macro-cell, DAS, and RRH/RRUs
- High-temperature applications to +105 °C

## Features

- Ultra-low reference design NF: 0.8 dB @ 3.5 GHz
- High gain: 31 dB (typical) @ 3.5 GHz
- Low quiescent current: 125 mA
- Stage 1 and 2 adjustable current
- Small QFN (16-pin, 4 x 4 mm) Pb-free 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.

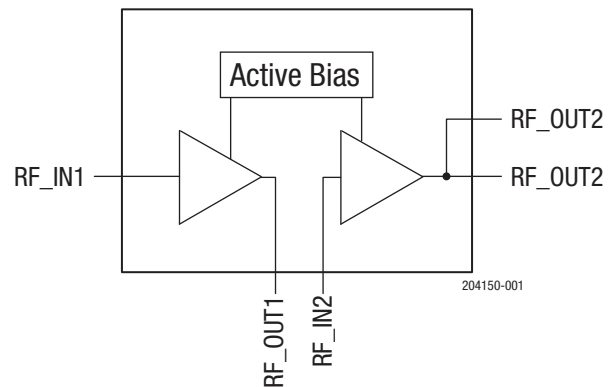


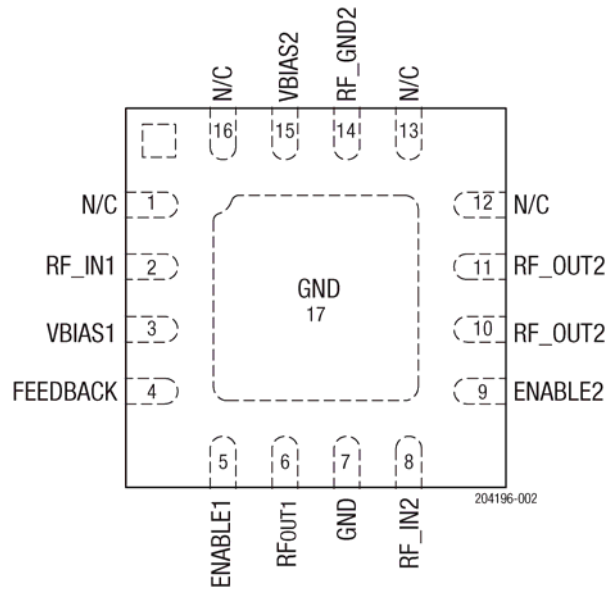
Figure 1. SKY67180-306LF Block Diagram

## Description

The SKY67180-306LF is a two-stage, low-noise amplifier (LNA) with active bias and high-linearity performance. The front end of the device provides an ultra-low noise figure (NF) while the output stage provides high gain, linearity, and efficiency.

With excellent thermal performance, the SKY67180-306LF is rated for operation up to +105 °C.

The SKY67180-306LF is provided in a 4 x 4 mm, 16-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. SKY67180-306LF Pinout (Top View)**

**Table 1. SKY67180-306LF Signal Descriptions**

Pin	Name	Description	Pin	Name	Description
1	N/C	No connection. May be grounded with no change in performance.	10	RF_OUT2	RF output of second stage amplifier
2	RF_IN1	RF input to first stage LNA	11	RF_OUT2	RF output of second stage amplifier
3	RF_GND/VBIAS1	AC ground for first stage bias circuit and bias voltage input that sets the first stage bias current.	12	N/C	No connection. May be grounded with no change in performance.
4	FEEDBACK	Feedback pin. Leave open when not used. This feedback option is typically not used since it reduces gain.	13	N/C	No connection. May be grounded with no change in performance.
5	ENABLE1	First stage LNA Enable pin.	14	RF_GND2	AC ground for second stage bias circuit
6	RF_OUT1	RF output of first stage LNA	15	VBIAS2	Bias voltage input that sets the second stage bias current
7	GND	Ground	16	N/C	No connection. May be grounded with no change in performance.
8	RF_IN2	RF input to second stage amplifier	17	GND	Center ground
9	ENABLE2	Second stage LNA Enable pin.			

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY67180-306LF are provided in Table 2.

Electrical specifications are provided in Tables 3 and 4. Typical performance characteristics are shown in Figures 3 through 10.

**Table 2. SKY67180-306LF Absolute Maximum Ratings<sup>1</sup>**

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V <sub>DD</sub>		6.0	V
RF input power	P <sub>IN</sub>		+20	dBm
Operating temperature	T <sub>OP</sub>	-40	+105	°C
Storage temperature	T <sub>STG</sub>	-65	+125	°C
Junction temperature	T <sub>J</sub>		+150	°C
Thermal resistance:	Θ <sub>JC</sub>			
Stage 1			50	°C/W
Stage 2			65	°C/W
Electrostatic discharge:	ESD			
Charged Device Model (CDM), Class 3			1000	V
Human Body Model (HBM), Class 1A			250	V

<sup>1</sup> 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.

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**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.*

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**Table 3. SKY67180-306LF Electrical Specifications<sup>1</sup>**  
**(V<sub>DD</sub> = +5 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = -30 dBm, Optimized for 3.4 to 3.6 GHz Operation, Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Noise figure <sup>2</sup>	NF	@ 3500 MHz		0.8	1.1	dB
Small signal gain	IS21I	@ 3500 MHz	28	31		dB
Input return loss	IS11I	@ 3500 MHz		9.5		dB
Output return loss	IS22I	@ 3500 MHz		15		dB
Reverse isolation	IS12I	@ 3500 MHz		49		dB
Input third order intercept point	IIP3	@ 3500 MHz, Δf = 1 MHz, P <sub>IN</sub> = -30 dBm/tone	-1	+3		dBm
Output third order intercept point	OIP3	@ 3500 MHz, Δf = 1 MHz, P <sub>IN</sub> = -30 dBm/tone	+30	+34		dBm
Output 1 dB compression point	OP1dB	@ 3500 MHz	13	17		dBm
Supply voltage	V <sub>DD</sub>			5		V
Enable voltage:	V <sub>ENABLE</sub>					
Gain mode			0		0.2	V
Power-down mode			1.5		5.5	V
Quiescent supply current	I <sub>DD</sub>	Set with external resistor Stage 1 R <sub>bias</sub> = 18 kΩ Stage 2 R <sub>bias</sub> = 7.5 kΩ	100	125		mA

<sup>1</sup> Performance is guaranteed only under the conditions listed in this table.

<sup>2</sup> Noise figure has been de-embedded as 0.1 dB @ 3.5 GHz for connector and board loss.

**Table 4. SKY67180-306LF Electrical Specifications<sup>1,2</sup>**  
**(V<sub>DD</sub> = +5 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = -30 dBm, Optimized for 2.6 GHz Operation, Unless Otherwise Noted)**

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Noise figure <sup>3</sup>	NF	@ 2.6 GHz		0.7		dB
Small signal gain	IS21I	@ 2.6 GHz		34.17		dB
Input return loss	IS11I	@ 2.6 GHz		17.3		dB
Output return loss	IS22I	@ 2.6 GHz		14.6		dB
Reverse isolation	IS12I	@ 2.6 GHz		50.04		dB
Input third order intercept point	IIP3	@ 2.6 GHz, Δf = 1 MHz, P <sub>IN</sub> = -30 dBm/tone		+4.22		dBm
Output third order intercept point	OIP3	@ 2.6 GHz, Δf = 1 MHz, P <sub>IN</sub> = -30 dBm/tone		+38.76		dBm

<sup>1</sup> Performance is guaranteed by characterization.

<sup>2</sup> Tested using the Evaluation Board BOM listed in Table 6.

<sup>3</sup> Noise figure has been de-embedded as 0.1 dB @ 2.6 GHz for connector and board loss.

### Typical Performance Characteristics

(V<sub>DD</sub> = +5 V, T<sub>OP</sub> = +25 °C, P<sub>IN</sub> = -30 dBm, Optimized for 3.4 to 3.6 GHz Operation, Unless Otherwise Noted)

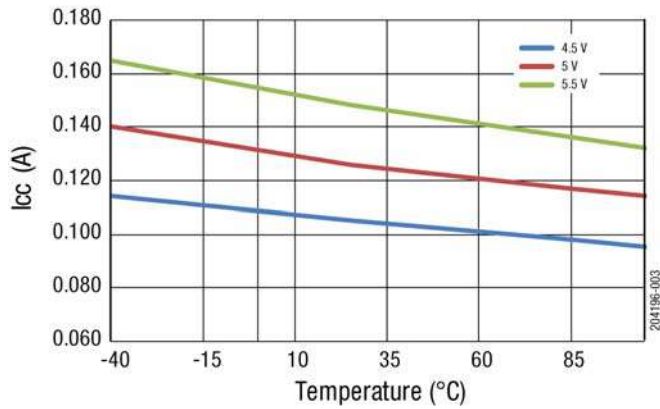


Figure 3. ICC vs Temperature and Bias

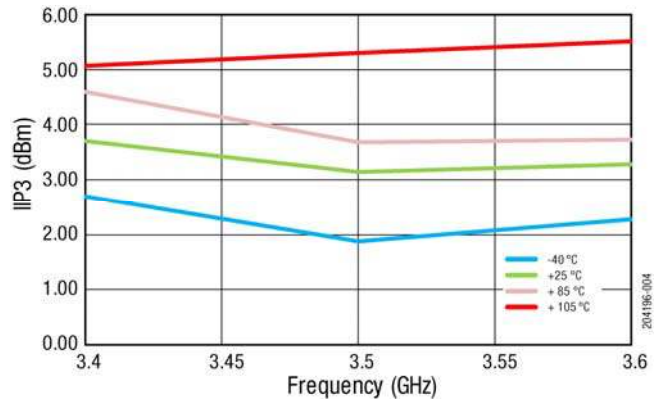


Figure 4. IIP3 vs Frequency and Bias (25 °C)

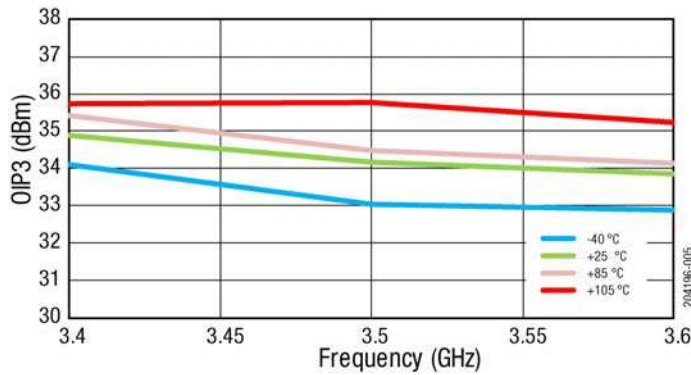


Figure 5. OIP3 vs Frequency and Bias (25 °C)

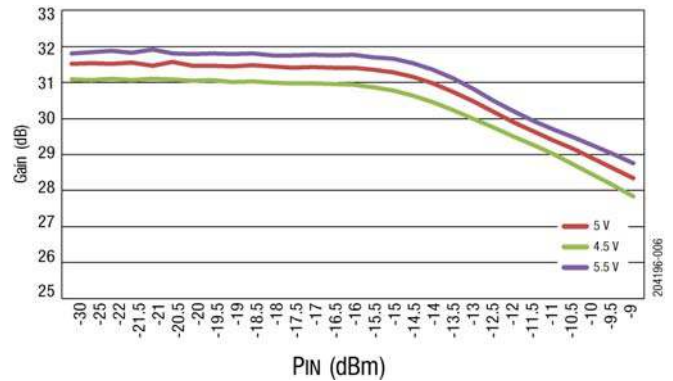


Figure 6. 3.4 GHz, IP1dB over Bias

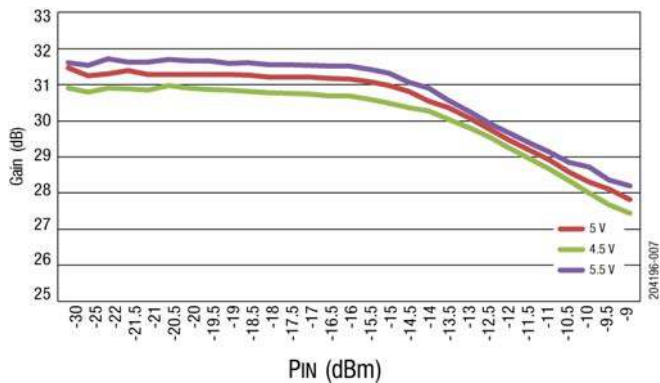


Figure 7. 3.5 GHz, IP1dB over Bias

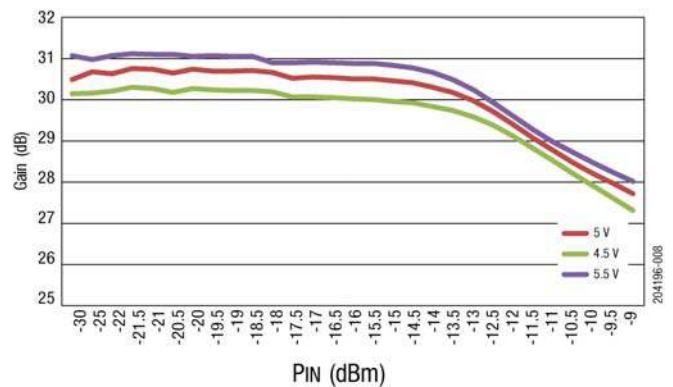


Figure 8. 3.6 GHz, IP1dB over Bias

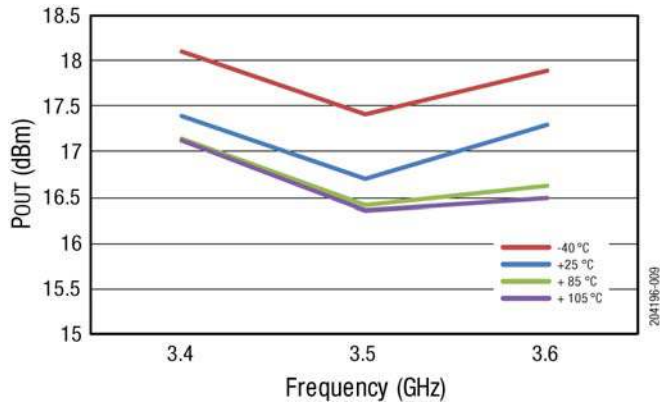


Figure 9. OP1dB over Temperature (5 V)

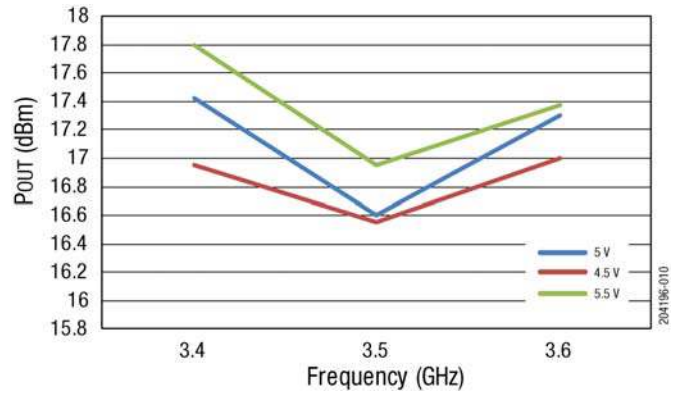


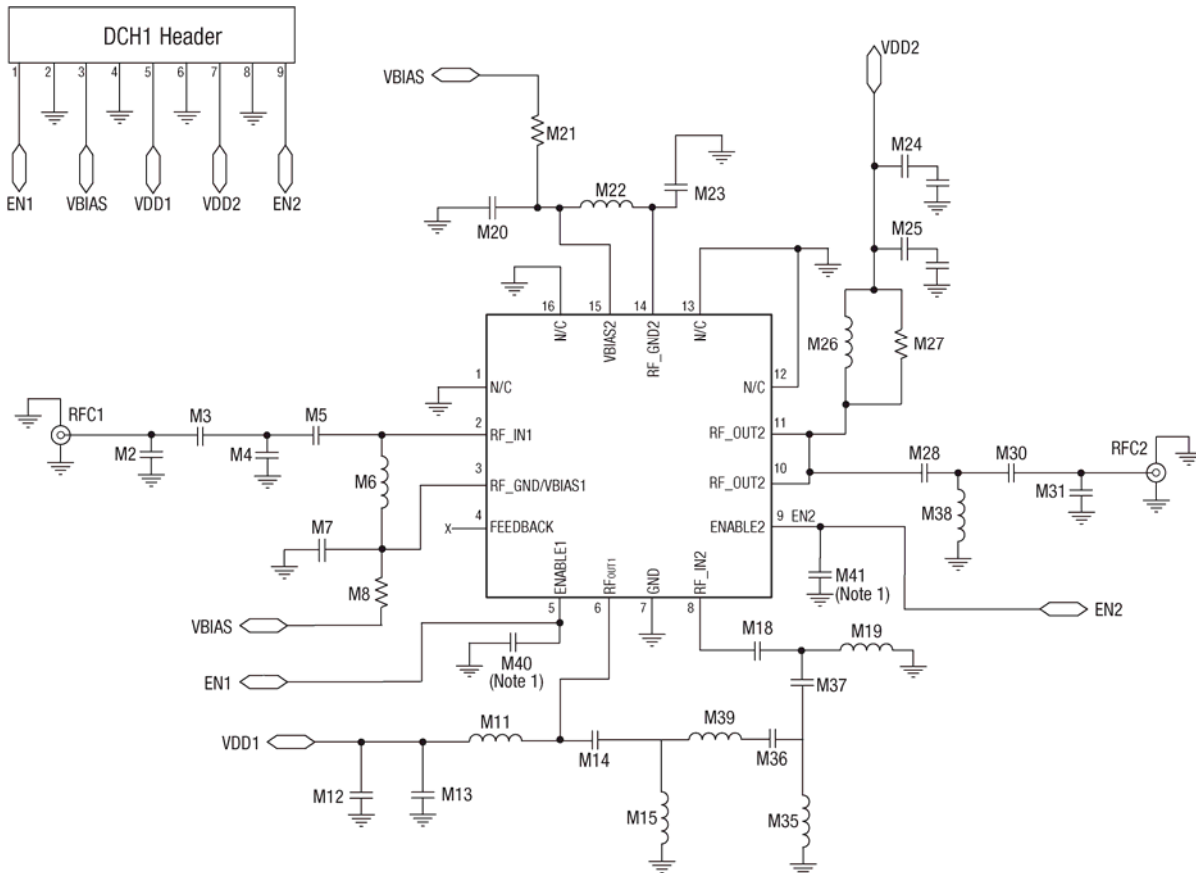
Figure 10. OP1dB over Bias (25 °C)

### Evaluation Board Description

The SKY67180-306LF Evaluation Board is used to test the performance of the SKY67180-306LF two-stage LNA. An Evaluation Board schematic diagram is provided in Figure 11 and represents device performance in a matched environment.

Actual values used in application may vary particular to layout parasitics. Table 5 provides the Evaluation Board Bill of Materials for 3.4 to 3.6 GHz operation. Table 6 provides the Evaluation Board Bill of Materials for 2.6 GHz operation.

The Evaluation Board assembly drawing is shown in Figure 12.



Note 1:  
M40 and M41 are general noise immunity bypass capacitors and are optional.  
These capacitors are not recommended for applications with series resistance on control lines.

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Figure 11. SKY67180-306LF Evaluation Board Schematic

**Table 5. SKY67180-306LF Evaluation Board Bill of Materials (BOM) for 3.4 to 3.6 GHz Operation**

Component	Description	Value	Size	Manufacturer	Mfr Part Number
M2	Capacitor	0.3 pF	0402	Murata	GJM155C1HR30WB01
M3	Capacitor	2.7 pF	0402	Murata	GJM155C1H2R7BB01
M4	Capacitor	0.5 pF	0402	Murata	GJM155C1HR50WB01
M5	Capacitor	8.2 pF	0402	Murata	GJM155C1H8R2CB01
M6	Inductor	18 nH	0402	Murata	LQW15AN18NH00
M7	DNP				
M8	Resistor	18 kΩ	0402	Panasonic	ERJ-2RFK180NH
M11	Inductor	3.3 nH	0402	Murata	LQG15HS3N3S02
M12	Capacitor	1000 pF	0402	Murata	GRM155R71H102KA01
M13	Capacitor	10000 pF	0402	Murata	GRM155R71H103KA88
M14	Capacitor	1.5 pF	0402	Murata	GJM1555C1H1R5BB01
M15	Inductor	1.3 nH	0402	TDK	MLG1005S1N3BT00
M18	Capacitor	0.6 pF	0402	Murata	GJM1555C1HR60WB01
M19	Inductor	1.8 nH	0402	TDK	MLK1005S1N8ST000
M20	Capacitor	5.6 pF	0402	Murata	GRM36C0G5R6C50
M21	Resistor	7.5 kΩ	0402	Panasonic	ERJ-2RFK750NH
M22	Inductor	15 nH	0402	Murata	LQW15AN15NH00
M23	Capacitor	1000 pF	0402	Murata	GRM155R71H102KA01
M24	Capacitor	1 μF	0402	Murata	GRM155R61A105KE15
M25	Capacitor	10 pF	0402	Murata	GRM36C0G1R5C50
M26	Inductor	9.1 nH	0402	Murata	LQG15HN9N1J02D
M27	Resistor	560 Ω	0402	Panasonic	
M28	Capacitor	22 pF	0402	Murata	GJM1555C1H220GB01
M30	Inductor	1.0 nH	0402	TDK	MLK1005S1N0ST000
M31	Capacitor	1 pF	0402	Murata	GJM1555C1H1R0BB01
M35	DNP				
M36	Resistor	0 Ω	0402	Panasonic	ERJ-2GE0R00X
M37	Capacitor	3.9 pF	0402	Murata	GJM1555C1H3R9BB01
M38	DNP	0.2 pF	0402	Murata	GJM155C1H0R2BB01
M39	Capacitor	22 pF	0402	Murata	GJM1555C1H220GB01
M40	DNP				
M41	Capacitor	1000 pF	0402	Murata	GRM155R71H102KA01



**Table 6. SKY67180-306LF Evaluation Board Bill of Materials (BOM) for 2.6 GHz Operation**

Component	Description	Value	Size	Manufacturer	Mfr Part Number
M2	Capacitor	1 pF	0402	Murata	GJM1555C1H1R0BB01
M3	Resistor	0 $\Omega$	0402	Panasonic	ERJ-2GE0R00X
M4	DNP				
M5	Capacitor	8.2 pF	0402	Murata	GJM155C1H8R2CB01
M6	Inductor	18 nH	0402	Murata	LQW15AN18NH00
M7	DNP				
M8	Resistor	11 k $\Omega$	0402	Panasonic	ERJ-2RFK180NH
M11	Inductor	3.3 nH	0402	Murata	LQG15HS3N3S02
M12	Capacitor	1000 pF	0402	Murata	GRM155R71H102KA01
M13	Capacitor	10000 pF	0402	Murata	GRM155R71H103KA88
M14	Capacitor	1.5 pF	0402	Murata	GJM1555C1H1R5BB01
M15	DNP				
M18	Capacitor	0.6 pF	0402	Murata	GJM1555C1HR60WB01
M19	Inductor	2.4 nH	0402	Murata	LQP
M20	Capacitor	5.6 pF	0402	Murata	GRM36C0G5R6C50
M21	Resistor	11 k $\Omega$	0402	Panasonic	
M22	Inductor	15 nH	0402	Murata	LQW15AN15NH00
M23	Capacitor	1000 pF	0402	Murata	GRM155R71H102KA01
M24	Capacitor	1 $\mu$ F	0402	Murata	GRM155R61A105KE15
M25	Capacitor	10 pF	0402	Murata	GRM36C0G1R5C50
M26	Inductor	9.1 nH	0402	Murata	LQG15HN9N1J02D
M27	DNP				
M28	Capacitor	5.1 pF	0402	Murata	GJM
M30	Resistor	0 $\Omega$	0402	Panasonic	ERJ-2GE0R00X
M31	DNP				
M35	DNP				
M36	Resistor	0 $\Omega$	0402	Panasonic	ERJ-2GE0R00X
M37	Capacitor	3.9 pF	0402	Murata	GJM1555C1H3R9BB01
M38	Inductor	3 nH	0402	Murata	LQP
M39	Capacitor	22 pF	0402	Murata	GJM1555C1H220GB01
M40	DNP				
M41	Capacitor	1000 pF	0402	Murata	GRM155R71H102KA01

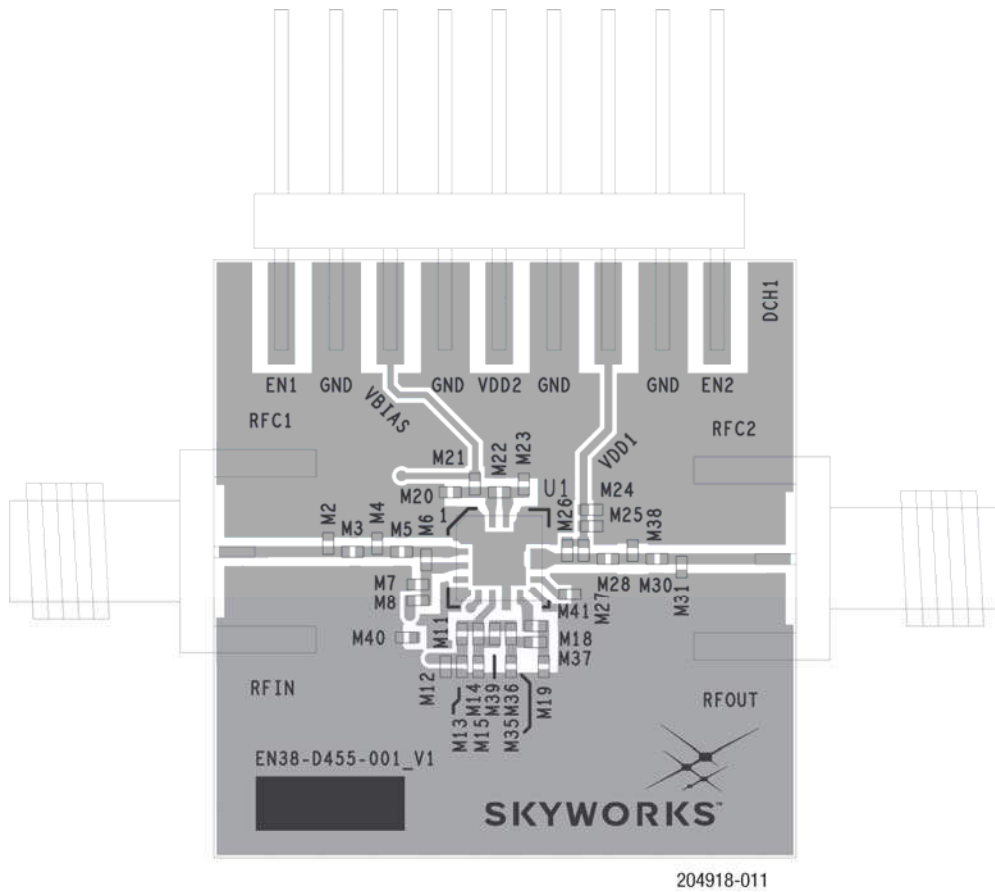


Figure 12. SKY67180-306LF Evaluation Board Assembly Diagram

### Package Dimensions

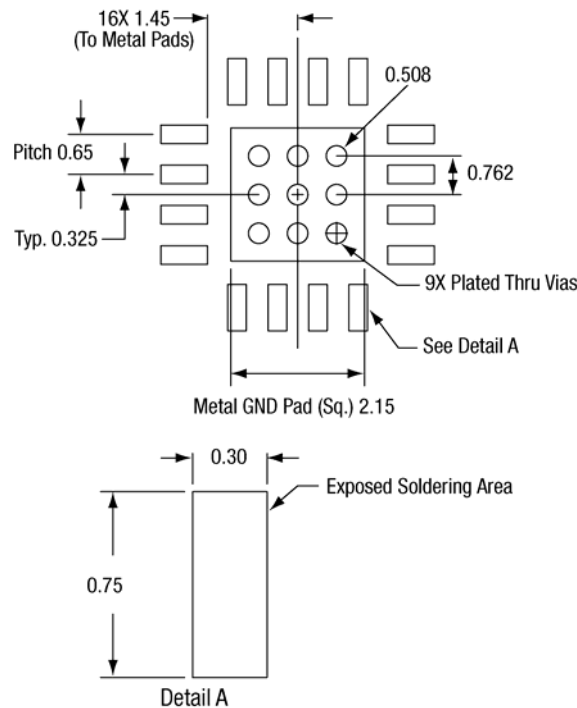
The PCB layout footprint for the SKY67180-306LF is shown in Figure 13. Typical part markings are noted in Figure 14. Package dimensions are shown in Figure 15, and tape and reel dimensions are provided in Figure 16.

### Package and Handling Information

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 SKY67180-306LF 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.



All measurements in millimeters

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**Figure 13. SKY67180-306LF PCB Layout Footprint**

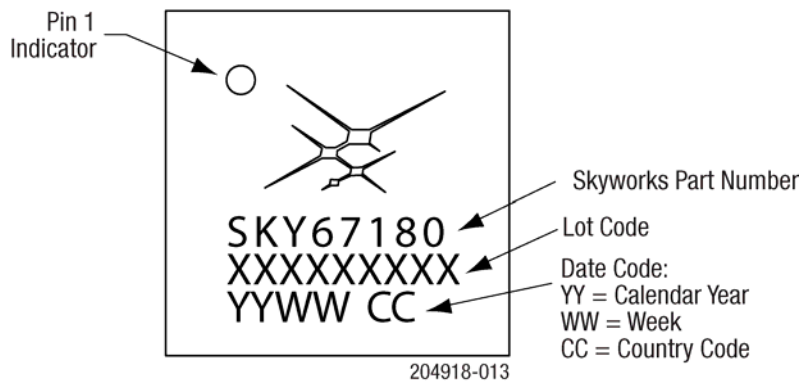
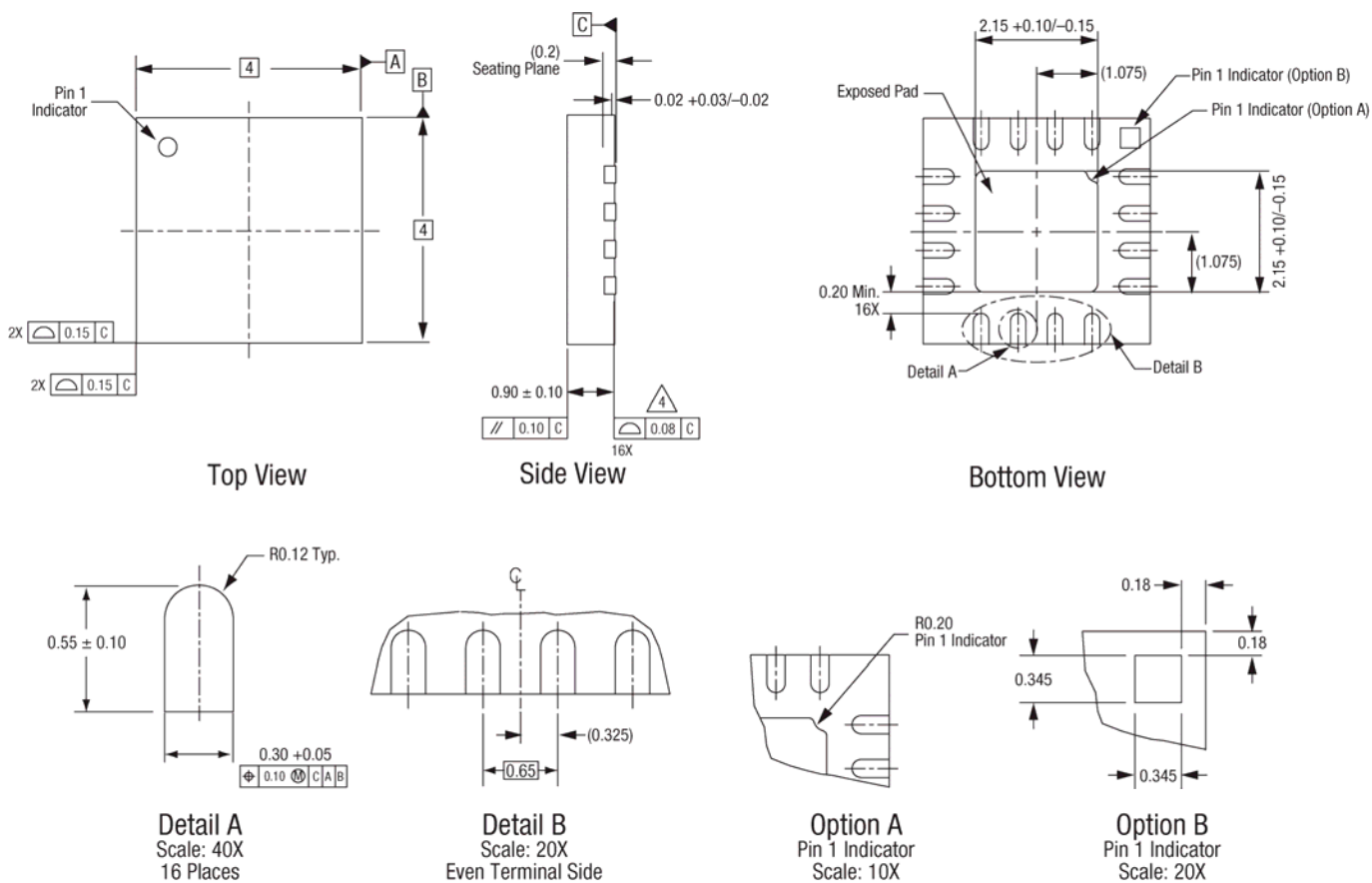


Figure 14. Typical Part Markings (Top View)

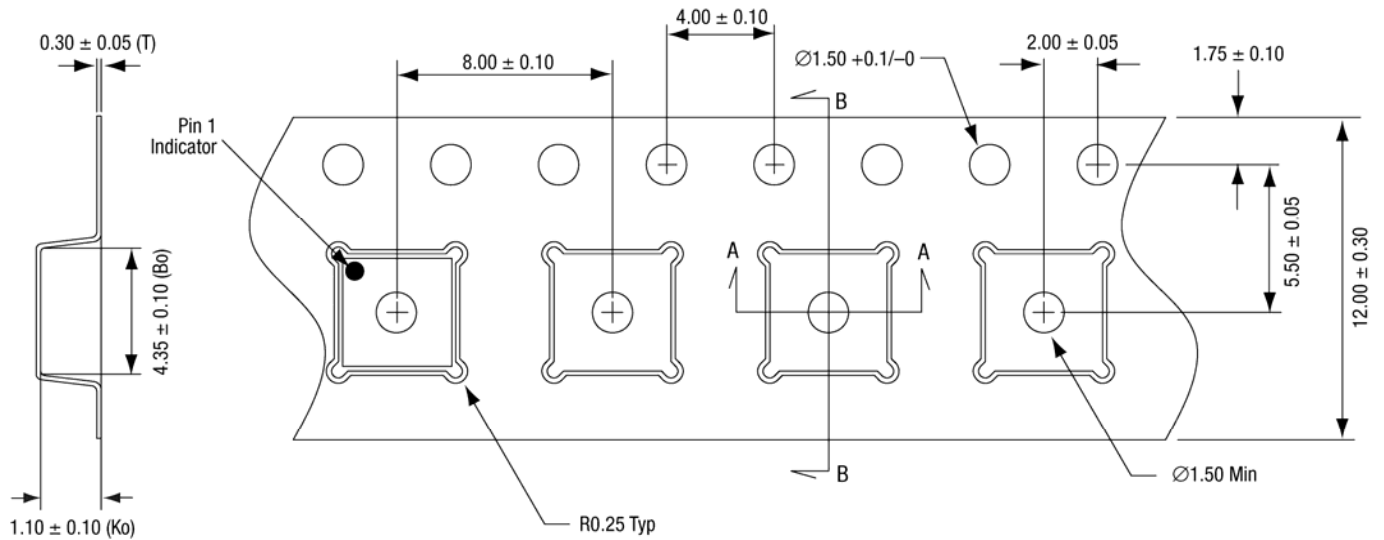


Notes:

1. All measurements are in millimeters.
2. Dimensions and tolerances according to ASME Y14.5M-1994.
3. Coplanarity applies to the exposed heat sink slug as well as the terminals.
4. Package may have option A or option B pin 1 indicator.

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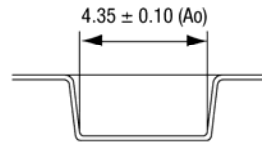
Figure 15. SKY67180-306LF Package Dimensions



Detail B

Notes:

1. Carrier tape material: black conductive polystyrene, non-bakeable
2. Cover tape material: transparent conductive HSA
3. Cover tape size: 9.2 mm width
4. ESD surface resistivity is  $\geq 1 \times 10^5 \sim \leq 1 \times 10^{10}$  Ohms/square per EIA, JEDEC TNR Specification.
5. All measurements are in millimeters



Detail A

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Figure 16. SKY67180-306LF Tape and Reel Dimensions

## Ordering Information

Part Number	Product Description	Evaluation Board Part Number
SKY67180-306LF	1.5 to 3.8 GHz Two-Stage, High-Gain Low-Noise Amplifier	SKY67180-306EK1 (3.4 to 3.6 GHz operation) SKY67180-306EK2 (2.6 GHz operation)

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