

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.

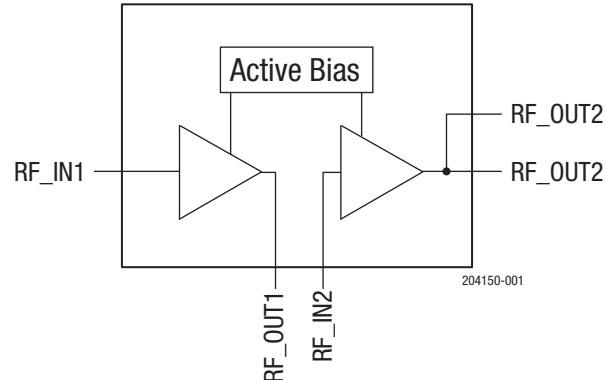


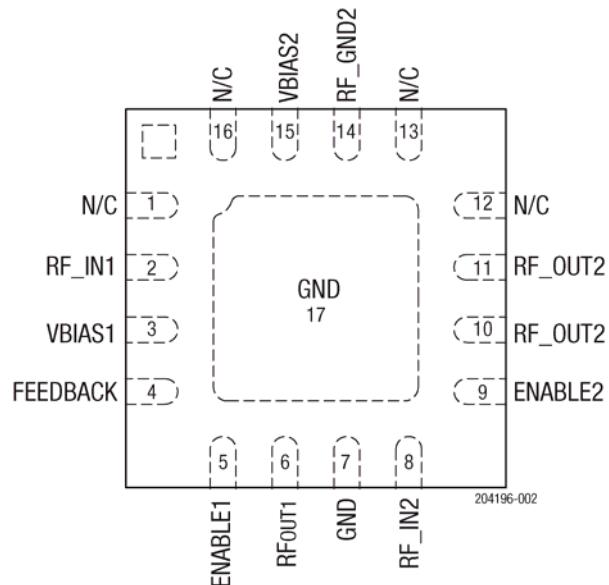
Figure 1. SKY67180-306LF Block Diagram

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 | RFOUT1 | 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 Ratings¹

| Parameter | Symbol | Minimum | Maximum | Units |
|-------------------------------------|------------------|---------|---------|-------|
| Supply voltage | V _{DD} | | 6.0 | V |
| RF input power | P _{IN} | | +20 | dBm |
| Operating temperature | T _{OP} | -40 | +105 | °C |
| Storage temperature | T _{STG} | -65 | +125 | °C |
| Junction temperature | T _J | | +150 | °C |
| Thermal resistance: | Θ _{JC} | | | |
| 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 |

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. SKY67180-306LF Electrical Specifications¹($V_{DD} = +5$ V, $T_{OP} = +25$ °C, $P_{IN} = -30$ dBm, Optimized for 3.4 to 3.6 GHz Operation, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|------------------------------------|--------------|---|-----|-----|-----|-------|
| Noise figure ² | 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, $\Delta f = 1$ MHz, $P_{IN} = -30$ dBm/tone | -1 | +3 | | dBm |
| Output third order intercept point | OIP3 | @ 3500 MHz, $\Delta f = 1$ MHz, $P_{IN} = -30$ dBm/tone | +30 | +34 | | dBm |
| Output 1 dB compression point | OP1dB | @ 3500 MHz | 13 | 17 | | dBm |
| Supply voltage | V_{DD} | | | 5 | | V |
| Enable voltage: | V_{ENABLE} | | | | | |
| Gain mode | | | 0 | | 0.2 | V |
| Power-down mode | | | 1.5 | | 5.5 | V |
| Quiescent supply current | I_{DD} | Set with external resistor Stage 1 Rbias = 18 kΩ Stage 2 Rbias = 7.5 kΩ | 100 | 125 | | mA |

¹ Performance is guaranteed only under the conditions listed in this table.² Noise figure has been de-embedded as 0.1 dB @ 3.5 GHz for connector and board loss.**Table 4. SKY67180-306LF Electrical Specifications^{1,2}**($V_{DD} = +5$ V, $T_{OP} = +25$ °C, $P_{IN} = -30$ dBm, Optimized for 2.6 GHz Operation, Unless Otherwise Noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Units |
|------------------------------------|--------|--|-----|--------|-----|-------|
| Noise figure ³ | 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, $\Delta f = 1$ MHz, $P_{IN} = -30$ dBm/tone | | +4.22 | | dBm |
| Output third order intercept point | OIP3 | @ 2.6 GHz, $\Delta f = 1$ MHz, $P_{IN} = -30$ dBm/tone | | +38.76 | | dBm |

¹ Performance is guaranteed by characterization.² Tested using the Evaluation Board BOM listed in Table 6.³ Noise figure has been de-embedded as 0.1 dB @ 2.6 GHz for connector and board loss.

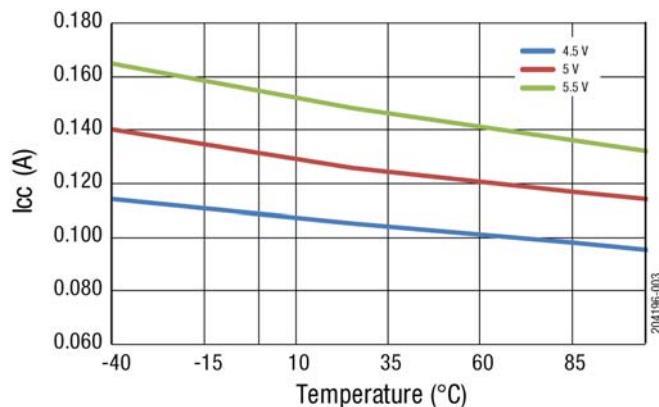
Typical Performance Characteristics(V_{DD} = +5 V, TOP = +25 °C, PIN = -30 dBm, Optimized for 3.4 to 3.6 GHz Operation, Unless Otherwise Noted)

Figure 3. ICC vs Temperature and Bias

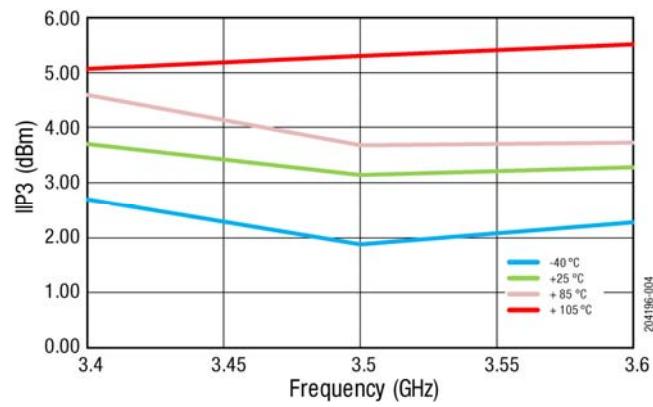


Figure 4. IIP3 vs Frequency and Bias (25 °C)

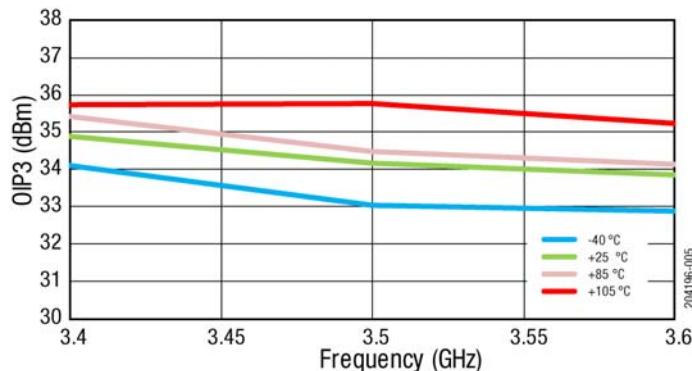


Figure 5. OIP3 vs Frequency and Bias (25 °C)

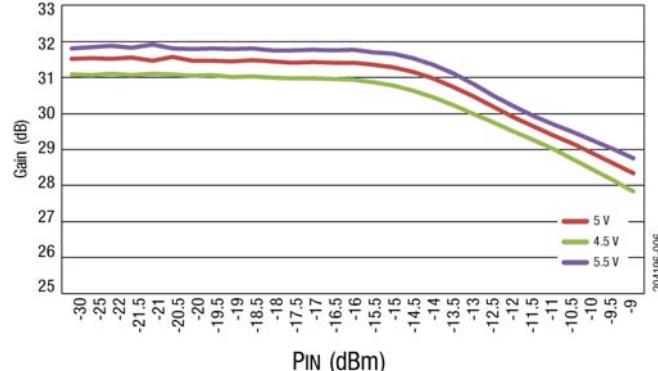


Figure 6. 3.4 GHz, IP1dB over Bias

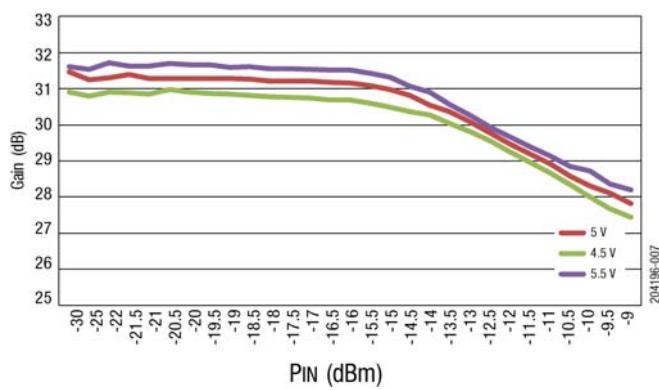


Figure 7. 3.5 GHz, IP1dB over Bias

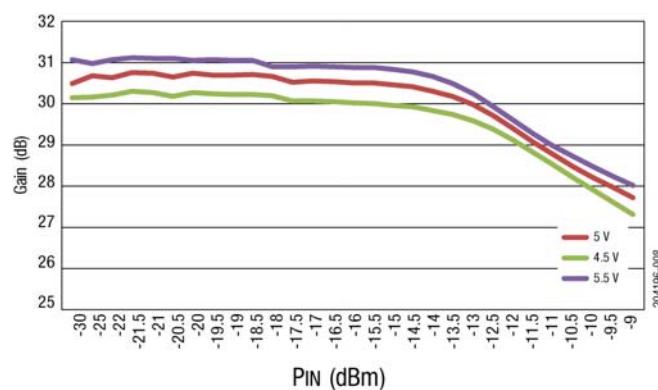


Figure 8. 3.6 GHz, IP1dB over Bias

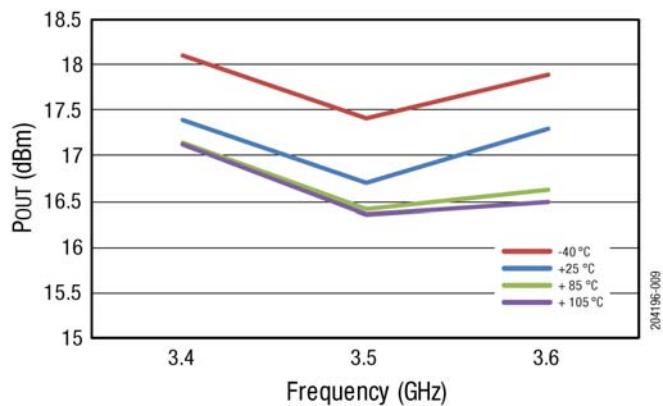


Figure 9. OP1dB over Temperature (5 V)

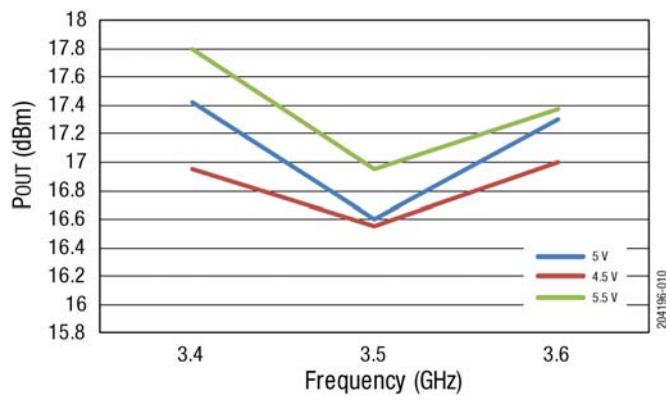


Figure 10. OP1dB over Bias (25 °C)

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.

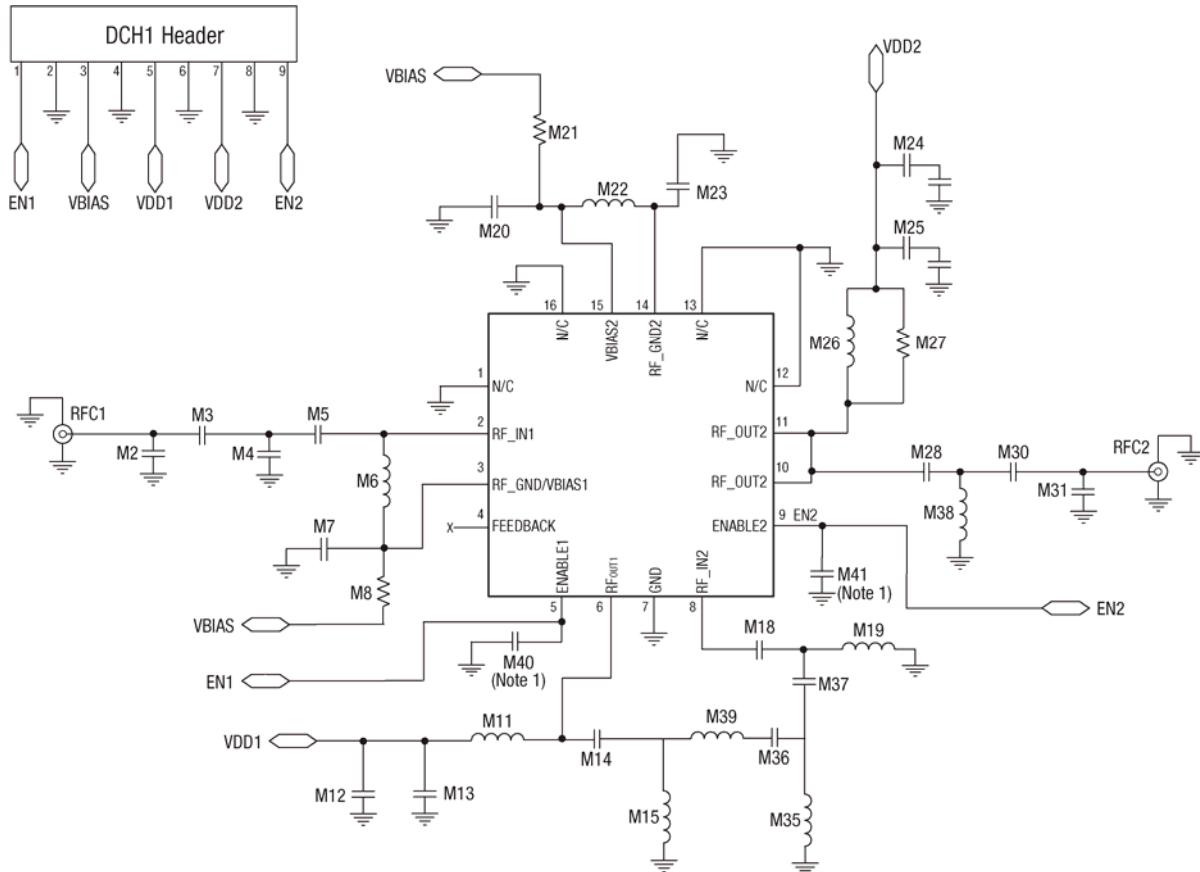


Figure 11. SKY67180-306LF Evaluation Board Schematic

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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 | MLK1005S1NOST000 |
| 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 Ω | 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 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 | 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 kΩ | 0402 | Panasonic | |
| 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 | DNP | | | | |
| M28 | Capacitor | 5.1 pF | 0402 | Murata | GJM |
| M30 | Resistor | 0 Ω | 0402 | Panasonic | ERJ-2GE0R00X |
| M31 | DNP | | | | |
| M35 | DNP | | | | |
| M36 | Resistor | 0 Ω | 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 |

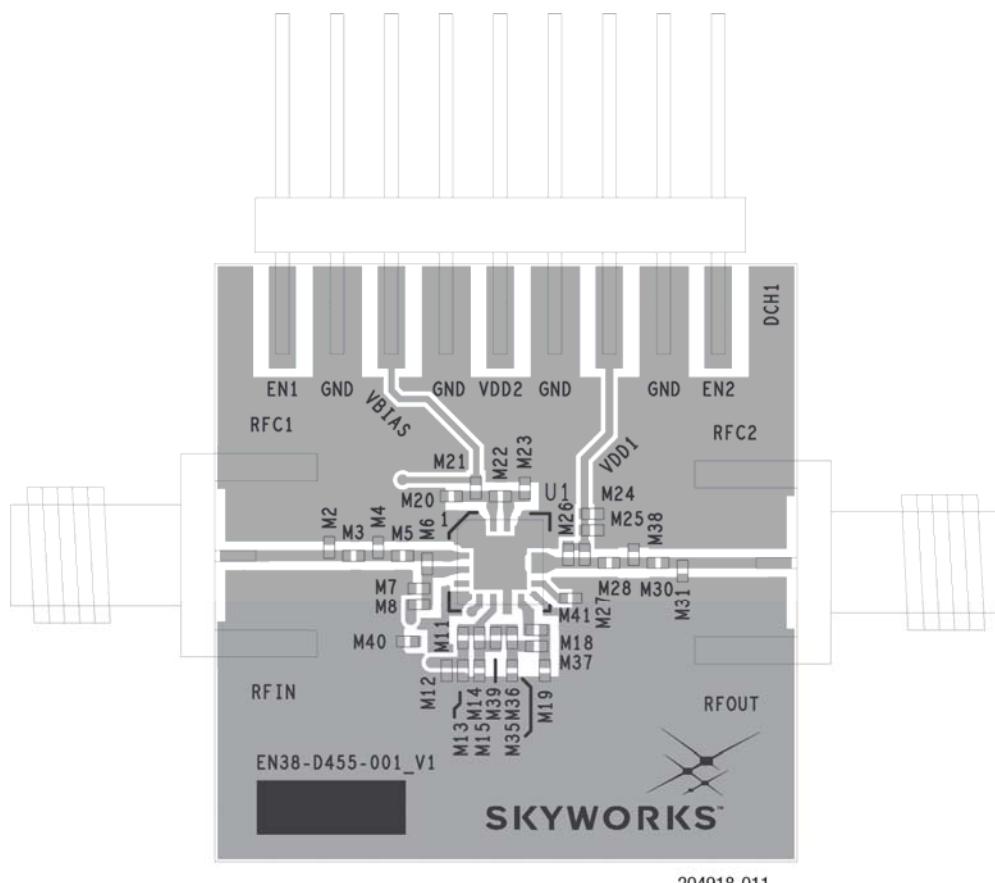


Figure 12. SKY67180-306LF Evaluation Board Assembly Diagram

Package Dimensions

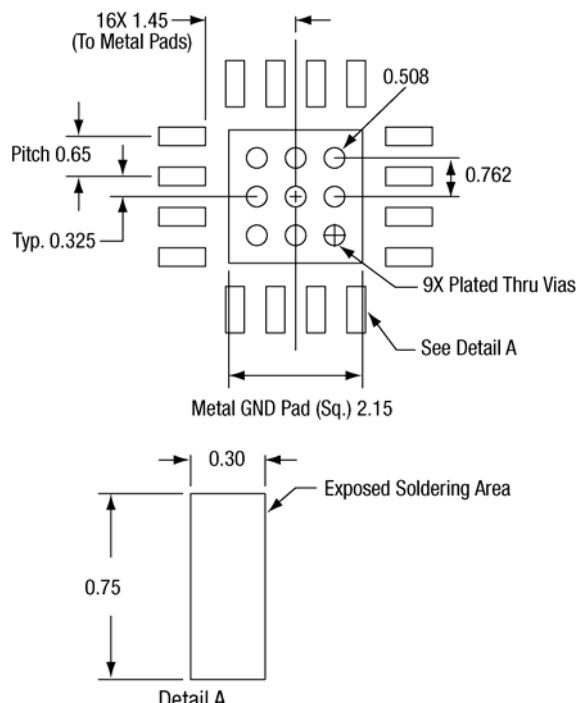
The PCB layout footprint for the SKY67180-306LF is shown in Figure 13. Typical part markings are noted in Figure 14. Package dimensions are shown in Figure 15, and tape and reel dimensions are provided in Figure 16.

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

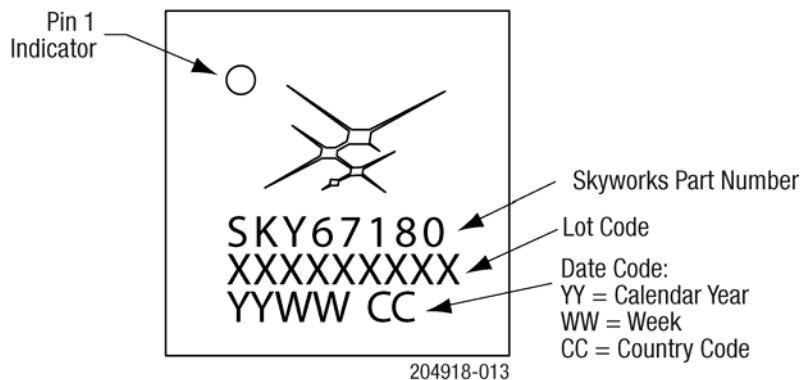
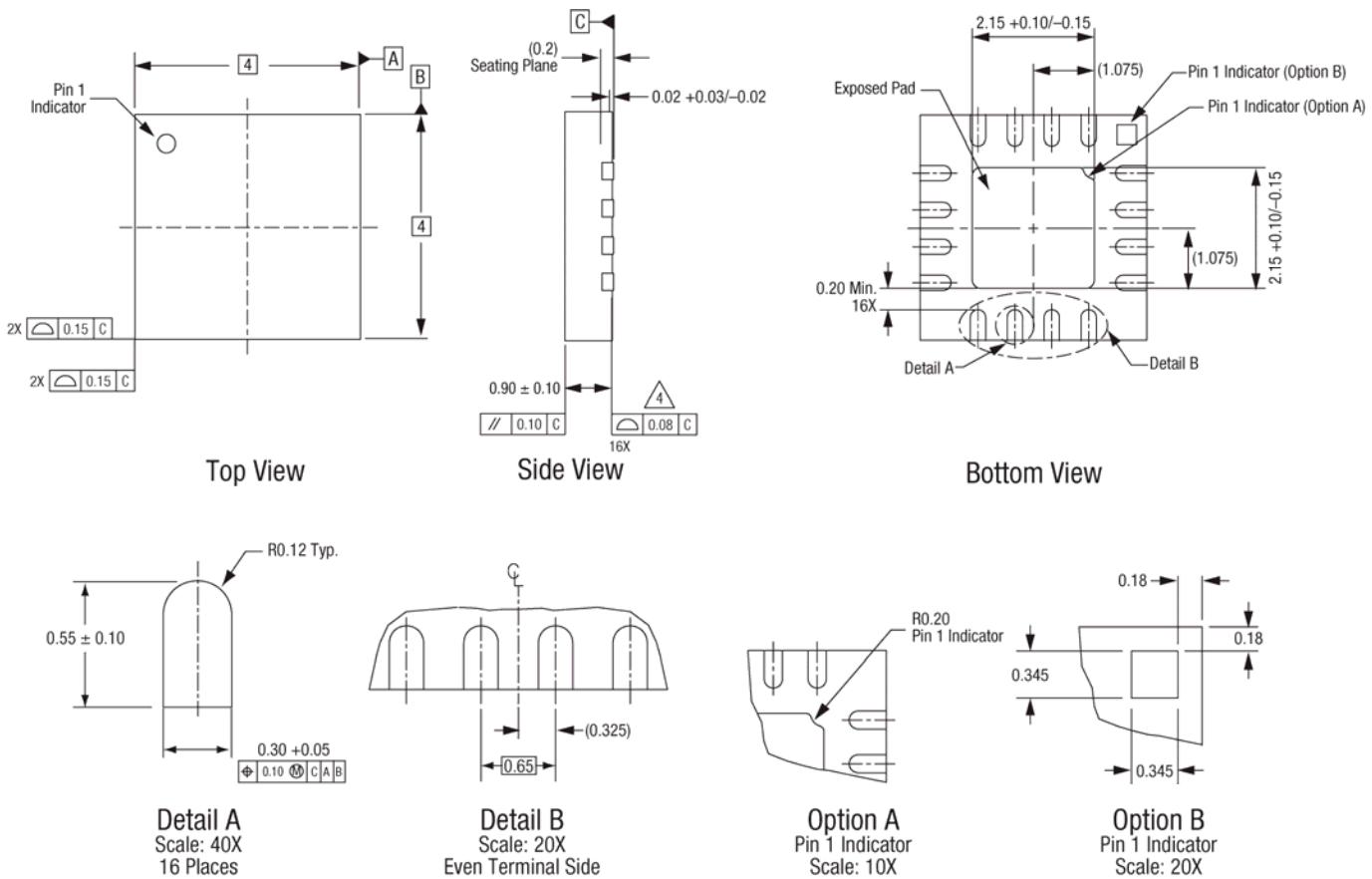


Figure 14. Typical Part Markings
(Top View)

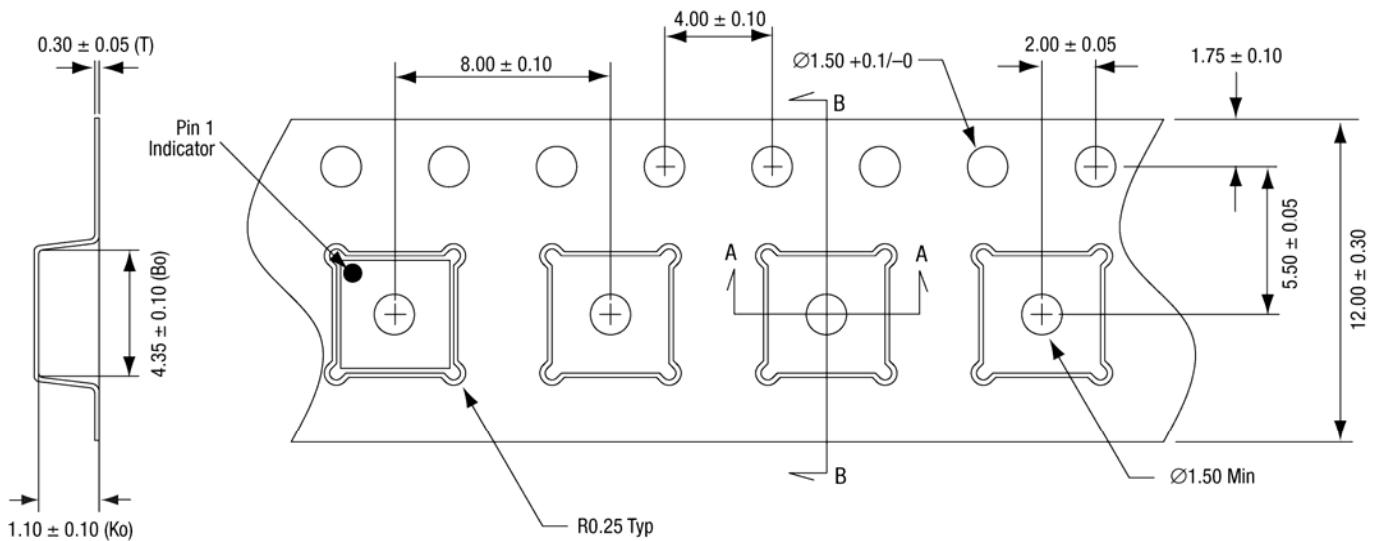


Notes:

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.

204196-014

Figure 15. SKY67180-306LF Package Dimensions



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 TMR Specification.
5. All measurements are in millimeters

204196-015

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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