DATA SHEET

SKY67175-306LF: 2320-2345 MHz Two-Stage, High Gain Low-Noise Amplifier

Applications

- Digital satellite radio

Features

- Part of complete SDARS LNA reference design
- Ultra-low reference design NF: 0.57 dB @ 2332.5 MHz
- High gain: 32 dB @ 2332.5 MHz
- Low quiescent current: 105 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.

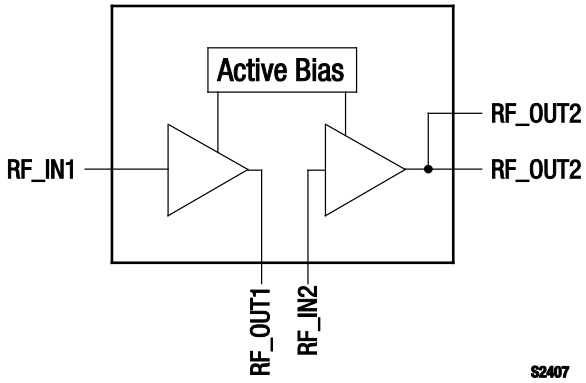


Figure 1. SKY67175-306LF Block Diagram

Description

The SKY67175-306LF is a two-stage, GaAs pHEMT Low-Noise Amplifier (LNA) specifically designed for use as a digital satellite radio LNA over the full 2320 to 2345 MHz band. The Evaluation Board represents a suggested reference design containing the external filters needed to meet the SiriusXM™ Satellite Digital Audio Radio Service (SDARS) performance requirements.

With excellent thermal performance, the SKY67175 is rated for operation up to +105 °C.

The SKY67175-306LF 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.

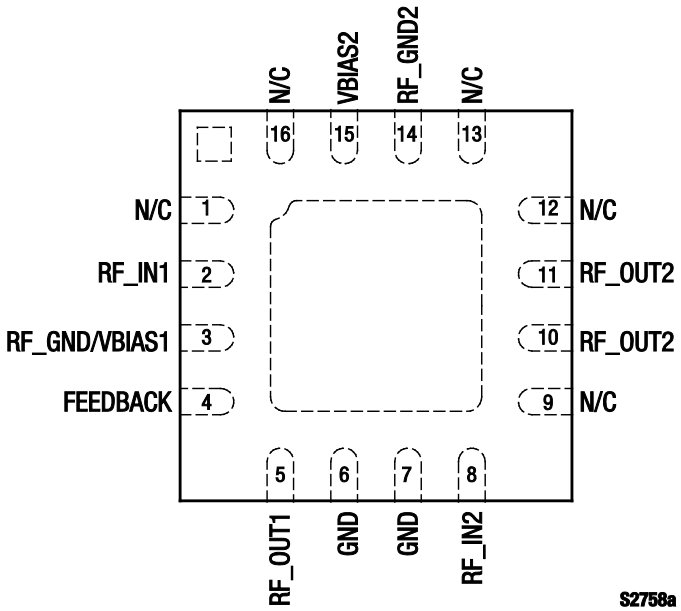


Figure 2. SKY67175-306LF Pinout – 16-Pin QFN (Top View)

Table 1. SKY67175-306LF Signal Descriptions

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

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY67175-306LF are provided in Table 2. Eectrical specifications are provided in Table 3.

Typical performance characteristics of the SKY67175-306LF are illustrated in Figures 3 through 13.

Table 2. SKY67175-306LF Absolute Maximum Ratings

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: Stage 1 Stage 2	Θ_{JC}		 50 65	 °C/W °C/W
Electrostatic Discharge: Charged Device Model (CDM), Class 4 Human Body Model (HBM), Class 1A Machine Model (MM), Class A	ESD		 1000 250 25	 V V V

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 value. 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. SKY67175-306LF Electrical Specifications (Note 1)
(V_{DD} = +5 V, T_{OP} = +25 °C, P_{IN} = –30 dBm, Optimized for 2320 to 2345 MHz Operation, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
RF Specifications						
Noise Figure	NF	@ 2332.5 MHz		0.57	0.70	dB
Small signal gain	|S21|	@ 2332.5 MHz	29	32		dB
Input return loss	|S11|	@ 2332.5 MHz		13		dB
Output return loss	|S22|	@ 2332.5 MHz		13		dB
Reverse isolation	|S12|	@ 2332.5 MHz		65		dB
3rd Order Input Intercept Point	IIP3	@ 2332.5 MHz, Δf = 1 MHz, P_{IN} = –30 dBm/tone	–7	–2		dBm
3rd Order Output Intercept Point	OIP3	@ 2332.5 MHz, Δf = 1 MHz, P_{IN} = –30 dBm/tone	+25	+30		dBm
1 dB Input Compression Point	IP1dB	@ 2332.5 MHz	–16.5	–13.5		dBm
1 dB Output Compression Point	OP1dB	@ 2332.5 MHz	+14.5	+17.5		dBm
DC Specifications						
Supply voltage	V_{DD}			5.0		V
Quiescent current	I_{DD}	Set with external resistor		105	120	mA

Note 1: Performance is guaranteed only under the conditions listed in this Table. Specifications are for the entire reference design including the interstage SAW filter and the output high pass filter.

Typical Performance Characteristics

(V_{DD} = +5 V, T_{OP} = +25 °C, P_{IN} = –30 dBm, Reference Design Optimized for 2320 to 2345 MHz Operation, Unless Otherwise Noted)

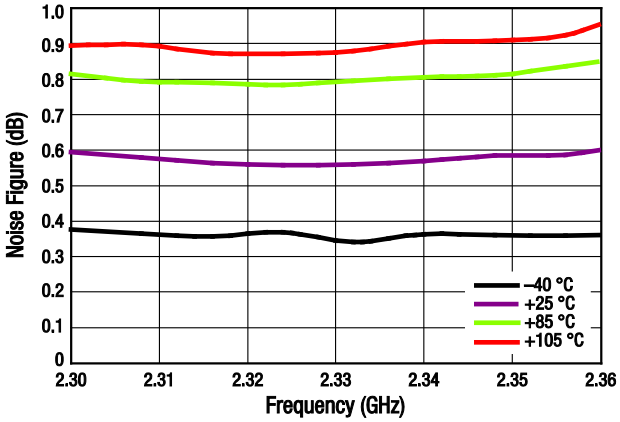


Figure 3. Noise Figure vs Frequency Over Temperature

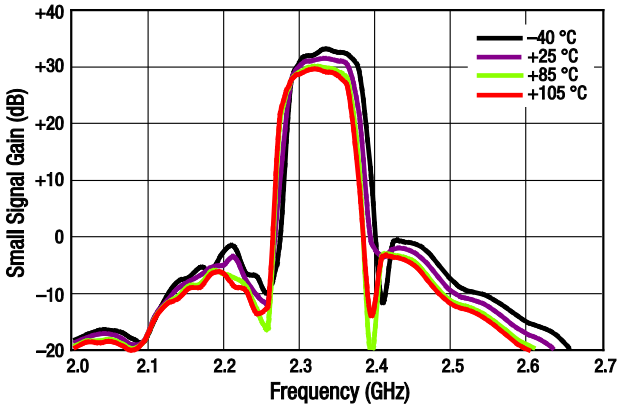


Figure 4. Small Signal Gain vs Frequency Over Temperature Narrow Band

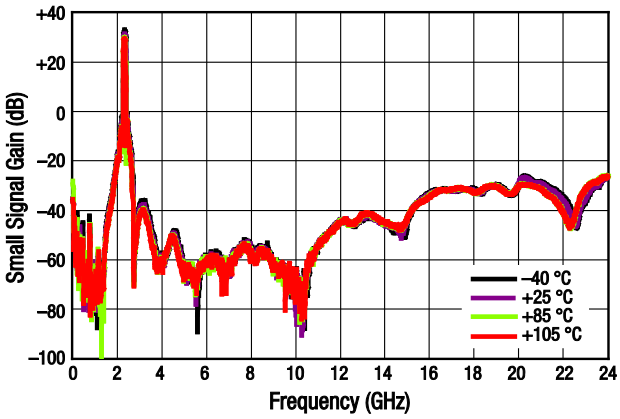


Figure 5. Small Signal Gain vs Frequency Over Temperature, Wide Band

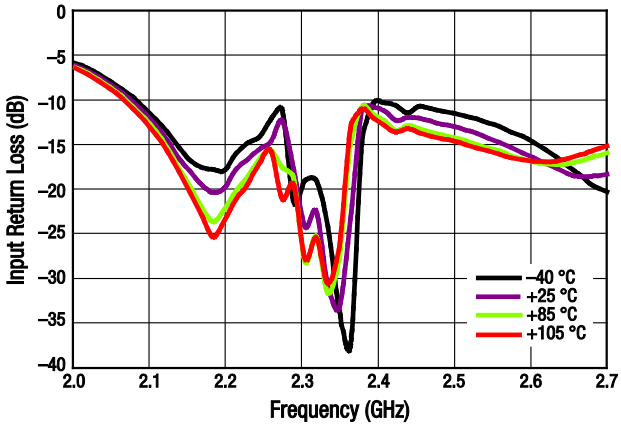


Figure 6. Input Return Loss vs Frequency Over Temperature, Narrow Band

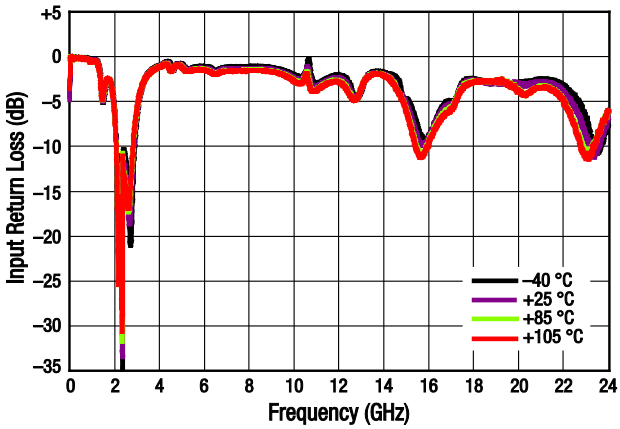


Figure 7. Input Return Loss vs Frequency Over Temperature, Wide Band

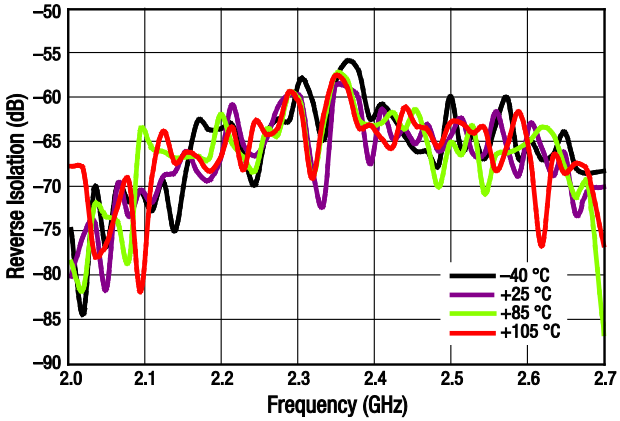


Figure 8. Reverse Isolation vs Frequency Over Temperature, Narrow Band

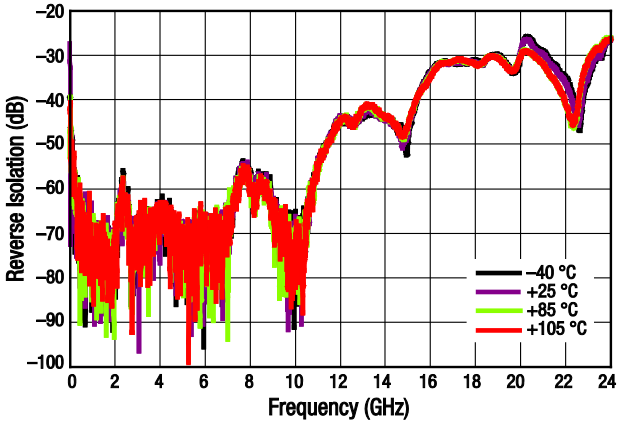


Figure 9. Reverse Isolation vs Frequency Over Temperature, Wide Band

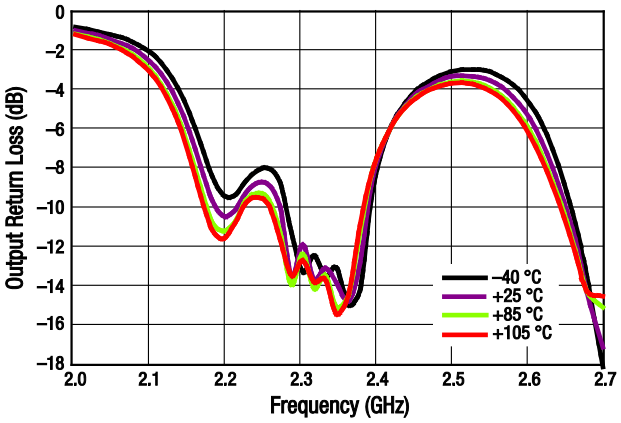


Figure 10. Output Return Loss vs Frequency Over Temperature, Narrow Band

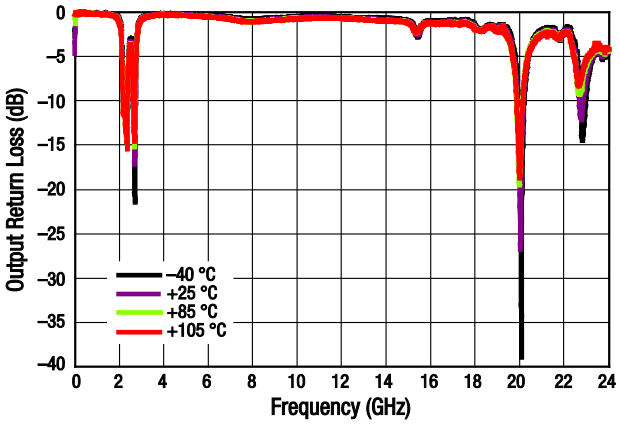


Figure 11. Output Return Loss vs Frequency Over Temperature Wide Band

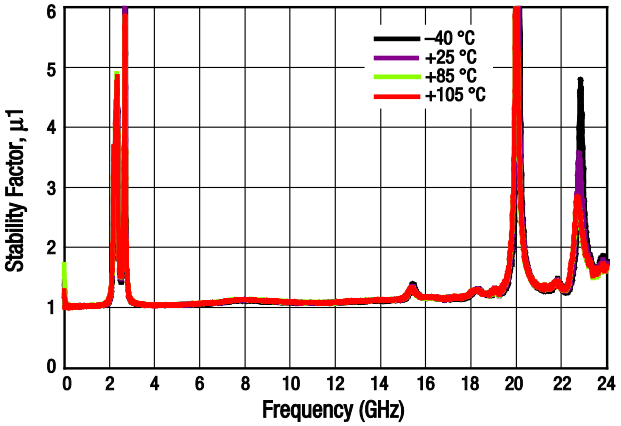


Figure 12. Stability Factor (µ1) vs Frequency Over Temperature

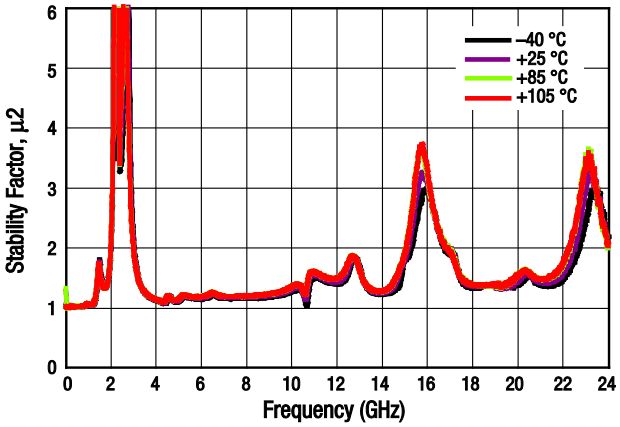


Figure 13. Stability Factor (µ2) vs Frequency Over Temperature

Evaluation Board Description

The SKY67175-306LF Evaluation Board is used to test the performance of the SKY67175-306LF two-stage LNA. An Evaluation Board schematic diagram is provided in Figure 14 and Table 5 provides the Evaluation Board Bill of Materials.

The Evaluation Board assembly drawing is shown in Figure 15.

Theory of Operation

The SKY67175-306LF Evaluation Board contains a complete 2320 MHz to 2345 MHz satellite radio reference design with an interstage SAW filter and a high pass filter on the output. The design is compliant with the SiriusXM Standard LNA Performance Requirements (SX-9845-0105-01 section 8.1.3) even with a V_{DD} variation from 4.0 to 5.5 V.

To limit I_{DDQ} variation, the reference design contains a Low Drop Out (LDO) regulator that regulates the varying V_{DD} to a fixed 3.3 V called V_{BIAS}. External resistors for stages 1 and 2 in series with V_{BIAS} determine the I_{DDQ} for stages 1 and 2. Only this V_{BIAS} voltage is regulated, and the V_{DD} inputs to stages 1 and 2 are tied directly to the varying V_{DD}.

The new out-of-band compression point specifications require the design to have a discrete high pass filter structure on the input. The Noise Filter (NF) impact of this series C, shunt L filter is approximately 0.05 dB but it is necessary to pass the –4 dBm input compression requirement for the 824 to 894 MHz band. If the –4 dBm requirement is relaxed in the future, this input filter may likely be modified or omitted, which would result in a reference design NF improvement to approximately 0.50 dB.

The reference design uses an EPCOS SAW filter on the interstage network. This can be changed as appropriate provided that the filter used achieves the required gain flatness and out-of-band rejection requirements. Likewise, the high pass filter on the output serves to reduce the low frequency gain of the design so that the out-of-band rejection requirements are met.

Note that the performance data shown in this Data Sheet is for the entire reference design including the insertion loss and selectivity provided by both external filters.

Package Dimensions

The PCB layout footprint for the SKY67175-306LF is shown in Figure 16. Typical case markings are noted in Figure 17. Package dimensions for the 16-pin QFN are shown in Figure 18, and tape and reel dimensions are provided in Figure 19.

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 SKY67175-306LF 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.

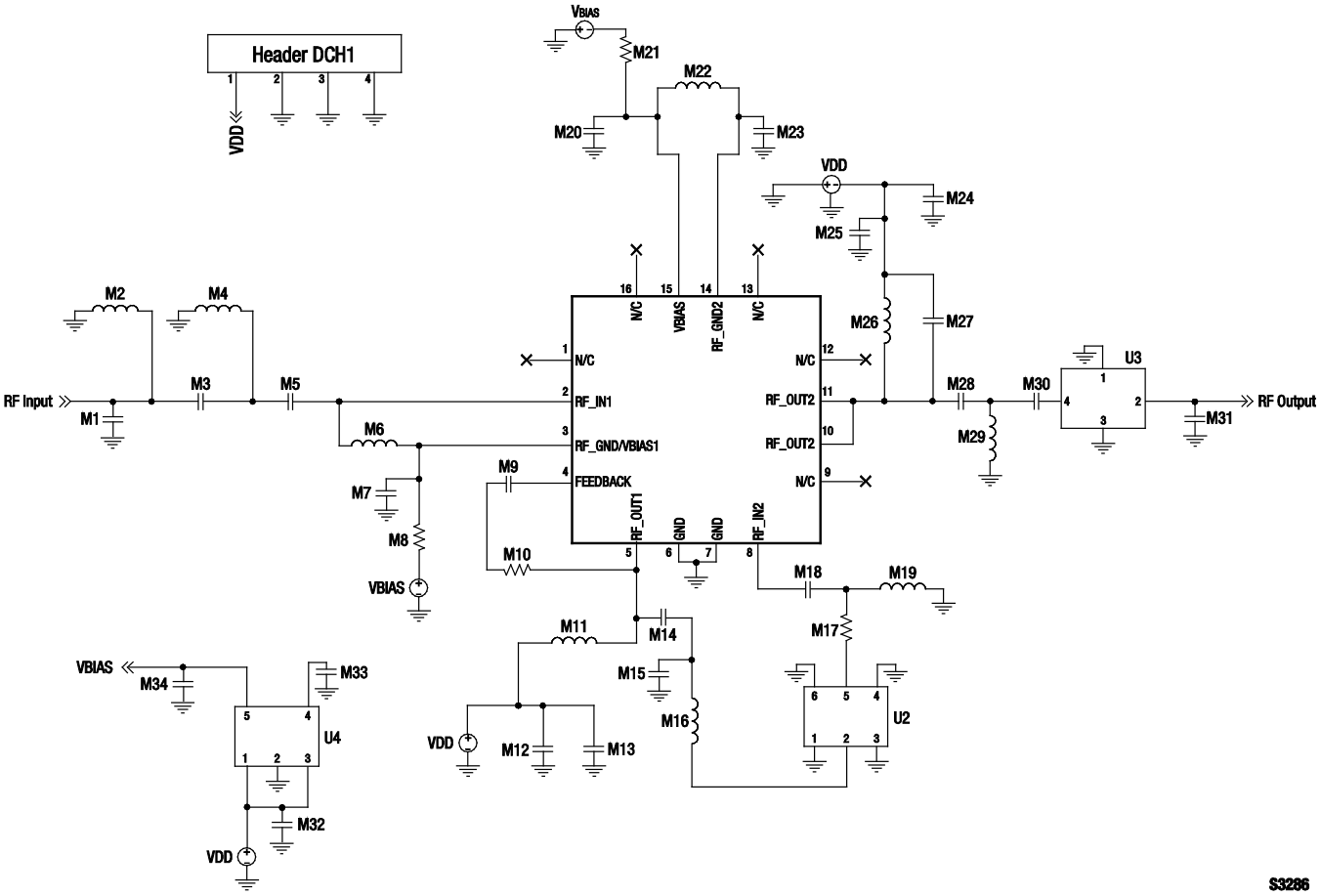


Figure 14. SKY67175-306LF Evaluation Board Schematic

Table 5. SKY67175-306LF Evaluation Board Bill of Materials (Complete Reference Design)

Component	Type	Value	Size	Manufacturer	Manufacturer Part Number
M1, M9, M10, M27, M29		DNI	–	–	–
M2	Inductor	3.3 nH	0402	Coilcraft	0402HP3N3XJL
M3, M28	Capacitor	1.5 pF	0402	Murata	GJM1555C1H1R5CB01
M4	Inductor	2.7 nH	0402	Coilcraft	0402HP2N7XJL
M5	Capacitor	7.5 pF	0402	Murata	GJM1555C1H7R5DB01
M6	Inductor	8.2 nH	0402	Coilcraft	0402HP-8N2X_L
M7	Capacitor	2 pF	0402	Murata	GJM1555C1H2R0CB01
M8	Resistor	6.8 kΩ	0402	Kamaya	RMC1/16S-682JTH
M11	Inductor	3.9 nH	0402	Murata	LQG15HS3N9S02
M12	Capacitor	10000 pF	0402	Murata	GRM155R71H102KA01
M13	Capacitor	10000 pF	0402	Murata	GRM155R71H103KA88
M14	Capacitor	8.2 pF	0403	Murata	GJM1555C1H8R2DB01
M15	Capacitor	0.8 pF	0402	Murata	GJM1555C1HR80BB01
M16	Inductor	3 nH	0402	Murata	LQG15HS3N0S02
M17	Resistor	0 Ω	0402	Kamaya	RMC1/16SJPTH
M18	Capacitor	2.4 pF	0402	Murata	GJM1555C1H2R4CB01
M19	Inductor	8.2 nH	0402	Murata	LQG15HS8N2J02
M20	Capacitor	5.6 pF	0402	Murata	GRM1555C1H5R6DZ01
M21	Resistor	9.1 kΩ	0402	Kamaya	RMC1/16S-912JTH
M22	Inductor	15 nH	0402	Coilcraft	0402HP-15NX_L
M23, M33	Capacitor	1000 pF	0402	Murata	GRM155R71H102KA01
M24, M32	Capacitor	1 μF	0402	Murata	GRM155R61A105KE15
M25	Capacitor	10 pF	0402	Murata	GRM1555C1H100JZ01
M26	Inductor	8.2 nH	0402	Murata	LQG15HS8N2J02
M30	Inductor	1 nH	0402	Murata	LQG15HS1N0S02
M31	Capacitor	0.5 pF	0402	Murata	GJM1555C1HR50BB01
M34	Capacitor	2.2 μF	0402	Murata	GRM155R60G225ME15
U2	SAW filter	2332.5 MHz (25 MHz bandwidth)	SMD 3 x 3	Epcos	B39232-B1669-U410
U3	High pass filter	2.35 GHz	SMD 1.8 x 2	Murata	LFB2H2G35SG7V330
U4	LDO regulator	3.3 V	SOT23-5	Skyworks	AAT3236IGV-3.3-T1

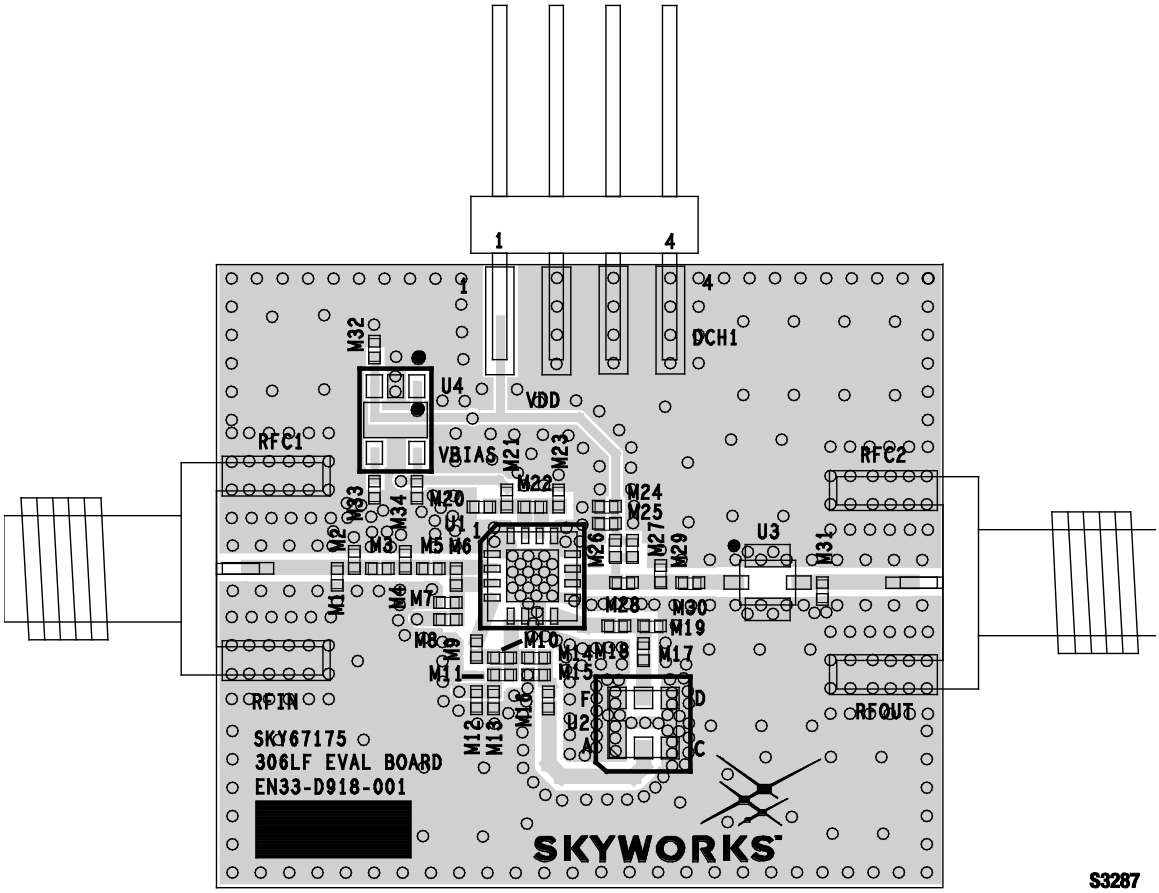


Figure 15. SKY67175-306LF Evaluation Board Assembly Diagram

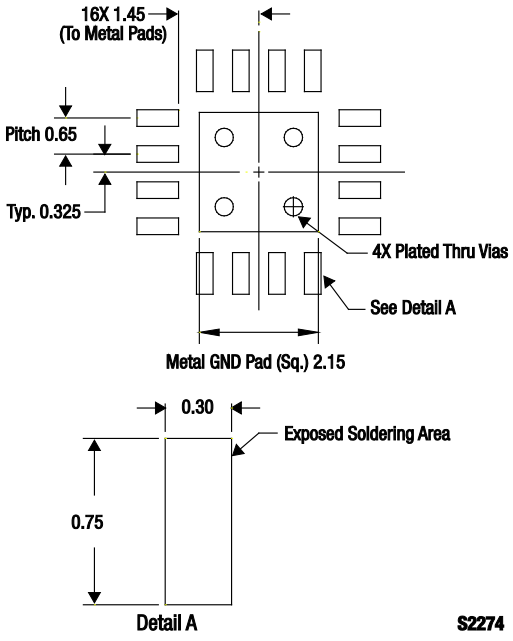


Figure 16. SKY67175-306LF PCB Layout Footprint

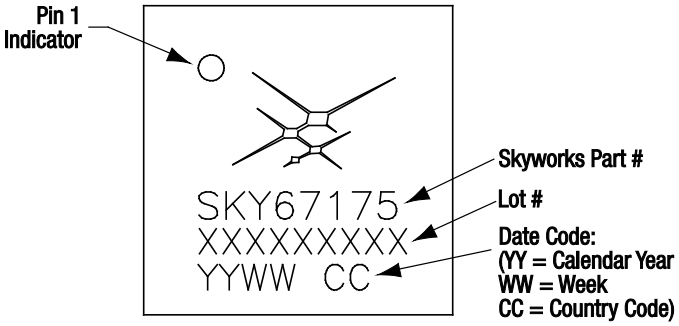
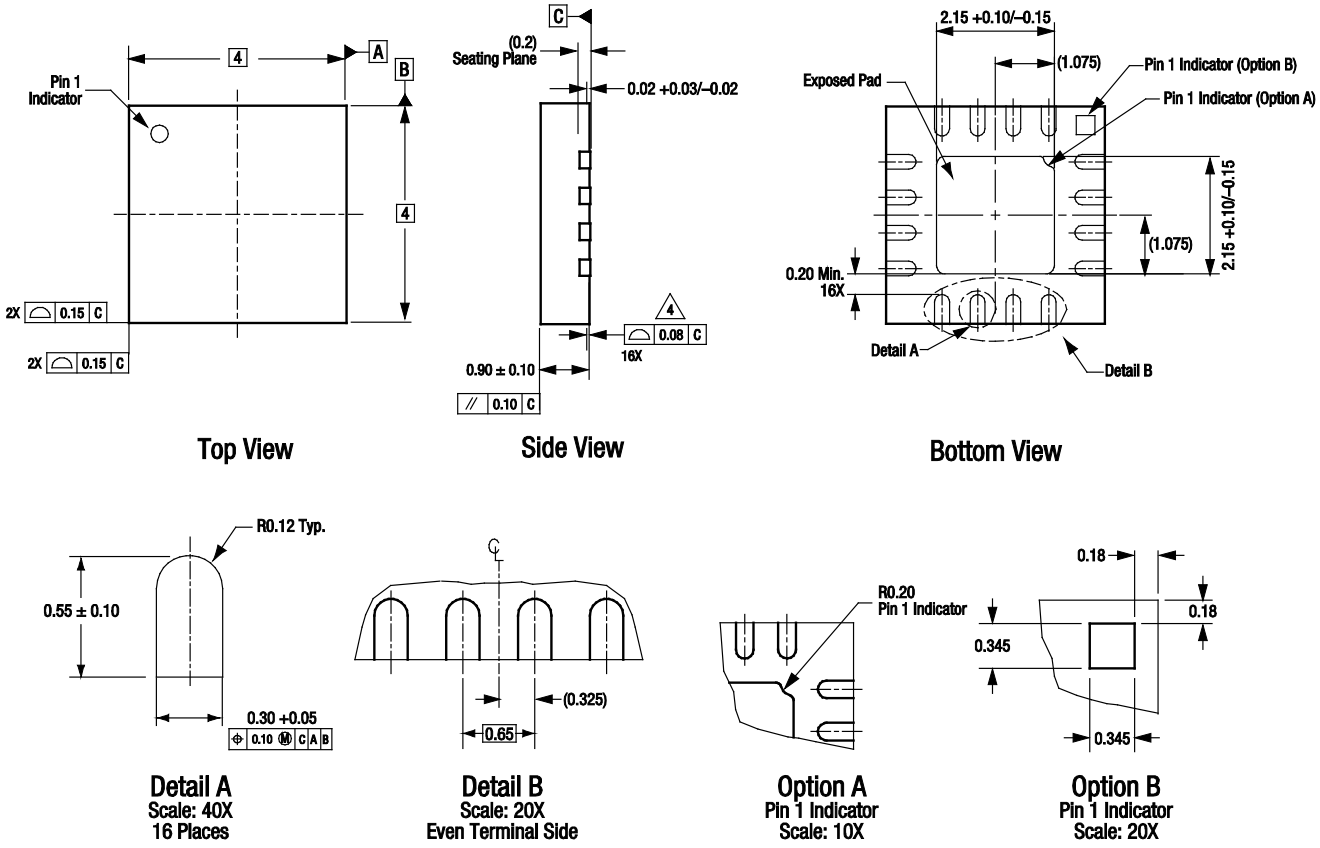


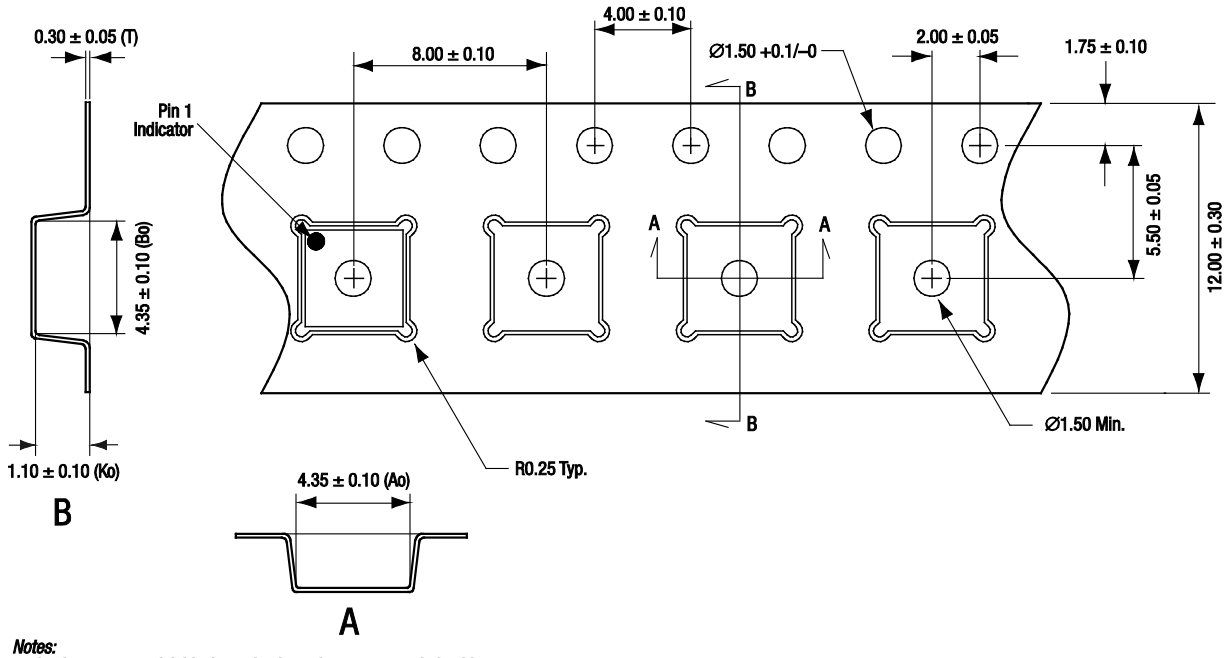
Figure 17. Typical Case Markings (Top View)



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.
Package may have option A or option B pin 1 indicator.

S2400

Figure 18. SKY67175-306LF 16-Pin QFN 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 ≥1 x 10^5 ~ ≤ 1 x 10^{10} Ohms/square per EIA, JEDEC TNR Specification.
5. All measurements are in millimeters

S1846

Figure 19. SKY67175-306LF Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY67175-306LF Two-Stage, High Gain LNA	SKY67175-306LF	SKY67175-306LF-EVB