DATA SHEET

SKY67189-396LF: 400 to 6000 MHz Broadband Low-Noise Amplifier

Applications

- 2G/3G/4G/5G TDD and FDD systems
- Active antenna array and massive MIMO systems
- Receive LNA for micro-cell, macro-cell, and small-cell base stations
- Land mobile radios and military communications
- Low-noise broadband gain blocks and driver amplifiers

Features

- Excellent broadband flat gain performance
- Low noise figure
- High IP3 performance over voltage
- Minimal external components
- Low current IDD: 50 mA @ 5.0 V
- Fast rise/fall time enable function suitable for 5G TDD applications
- Temperature and process-stable active bias up to +115 °C
- Miniature 8-pin, 2 x 2 mm dual flat no lead (DFN) package, MSL1 @ 260 °C per JEDEC J-STD-020
- For RoHS and other product compliance information, see the Skyworks Certificate of Conformance.

Description

The SKY67189-396LF is a broadband low-noise amplifier with excellent gain flatness and linearity.

The compact DFN-packaged LNA is designed for 2G/3G/4G/5G TDD and FDD infrastructure systems operating from 400 MHz to 6 GHz.

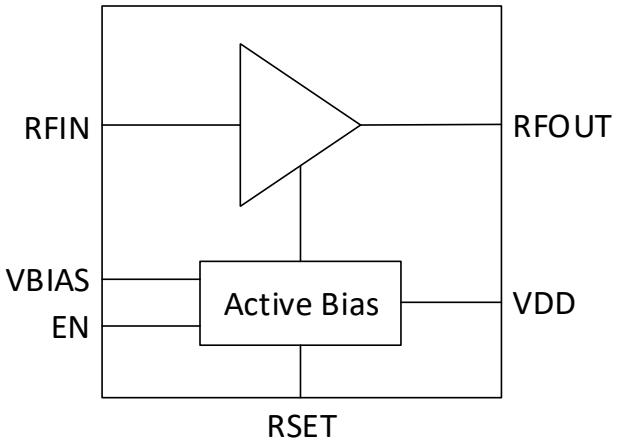


Figure 1. Functional Block Diagram

The internal active bias circuitry provides stable performance over temperature and process variation.

A functional block diagram is shown in Figure 1. The pin configuration is shown in Figure 2, pin assignments and descriptions are provided in Table 1.

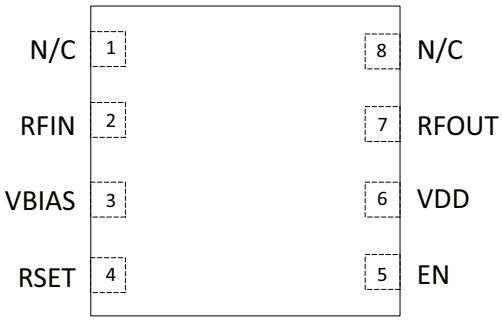


Figure 2. Pinout (Top View)

Table 1. Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	N/C	No connection (may be connected to ground with no change in performance)	5	EN	Enable voltage to LNA
2	RFIN	RF input. DC blocking capacitor required.	6	VDD	VDD voltage to LNA
3	VBIAS	Bias voltage for input gate	7	RFOUT	RF output. DC blocking capacitor is required.
4	RSET	External resistor to set the bias current	8	N/C	No connection (may be connected to ground with no change in performance)

Electrical Specifications

For all tables, performance is assured only under the conditions listed and is not invariant over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.

Table 2. Absolute Maximum Ratings[1]

Parameter	Symbol	Min	Max	Units
Supply voltage	V_{DD}	0	5.5	V
Quiescent supply current	I_{DQ}		100	mA
RF input power (C/W)	P_{IN}		+22	dBm
Storage temperature	T_{STG}	–40	+150	°C
Operating temperature	T_A	–40	+115	°C
Junction temperature	T_J		+150	°C
Electrostatic discharge: Charged Device Model (CDM) Class C3 Human Body Model (HBM), Class 1A	ESD		 1000 250	V

1. Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to the 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: Industry-standard ESD handling precautions must be adhered to at all times to avoid damage to this device.

Table 3. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage	V_{DD}	3.3	5.0	5.25	V
LNA enable ON OFF	EN	1.17	 0 1.8	 0.63 2.4	V

Table 4. Thermal Data

(V_{DD} = 5.0 V, enable = GND, T_A = +25 °C, P_{IN} = no RF, characteristic impedance [Z_O] = 50 Ω, unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Thermal resistance	Θ_{JC}			57.6		°C/W
Channel temperature @ +115 °C reference (package heat slug)	T_J	V_{DD} = 5.0 V, I_{DQ} = 55.6 mA, no RF applied, dissipated power = 0.28 W		131		°C

Table 5. 2500 to 6000 MHz Optimized Tuning

(V_{DD} = 5.0 V, enable = GND, T_A = +25 °C, P_{IN} = –20 dBm, characteristic impedance [Z_O] = 50 Ω, unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Noise figure	NF	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz		0.69 0.69 0.75 0.81	0.98 0.97 1.08 1.17	dB
Gain	|S21|	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	16.4 16.1 15.5 14.8	18.3 18.0 17.4 16.7		dB
Input return loss	|S11|	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	17.0 19.4 15.6 10.8	22.7 29.2 23.7 14.9		dB
Output return loss	|S22|	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	8.6 9.2 9.2 8.2	12.1 13.2 12.3 11.5		dB
Reverse isolation	|S21|	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	25.8 25.9 26.5 27.2	28.8 28.9 29.5 30.5		dB

Table 5. 2500 to 6000 MHz Optimized Tuning (Continued)

(V_{DD} = 5.0 V, enable = GND, T_A = +25 °C, P_{IN} = –20 dBm, characteristic impedance [Z_O] = 50 Ω, unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Third order output intercept point	OIP3	P_{IN} = –20 dBm, Δ Tone = 1 MHz @ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	 25.8 25.4 25.3 24.8	 29.2 29.0 28.5 28.3		dBm
1 dB output compression point	OP1dB	@ 3300 MHz @ 3800 MHz @ 4400 MHz @ 5000 MHz	16.8 16.6 16.0 15.6	19.2 19.0 18.4 17.9		dBm
Supply voltage	V_{DD}			5.0		V
Quiescent current	I_{DD}			52	60	mA
Settling time 0.3 dB[1] Settling time 0.1 dB[2]	t_{ON}	@ 4400 MHz		0.2 0.2	1 1	µs

1. Settling time 0.3 dB is measured from the time the LNA enable reaches 50% of LNA enable “on” level to the time at which the RF output power achieves within 0.3 dB of the average steady-state “on” level.
2. Settling time 0.1 dB is measured from the time the LNA enable reaches 50% of LNA enable “on” level to the time at which the RF output power achieves within 0.1 dB of the average steady-state “on” level.

Typical Performance Characteristics

2500 to 6000 MHz, V_{DD} = 5 V, P_{IN} = –20 dBm, characteristic impedance = 50 Ω, unless otherwise noted.

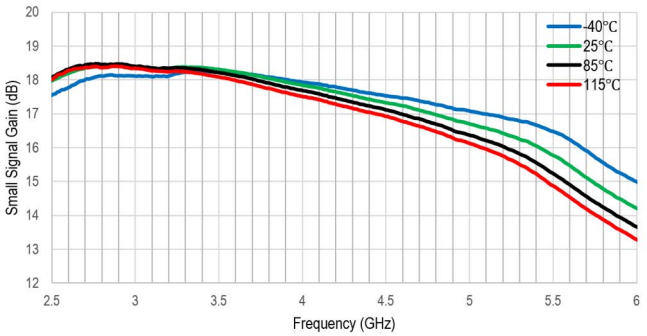


Figure 3. Small Signal Gain (dB) vs. Frequency

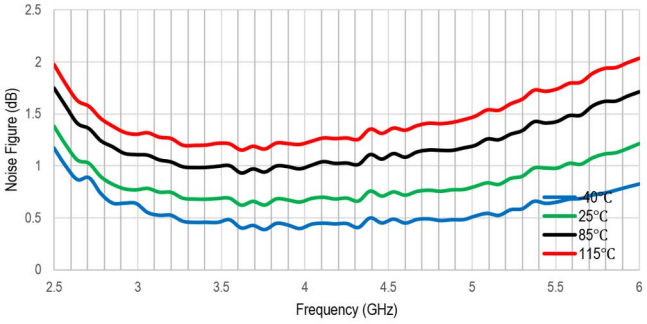


Figure 4. Noise Figure (dB) vs. Frequency (GHz)

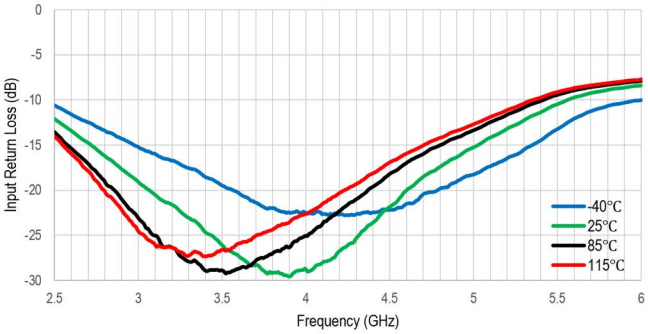


Figure 5. Input Return loss (dB) vs. Frequency

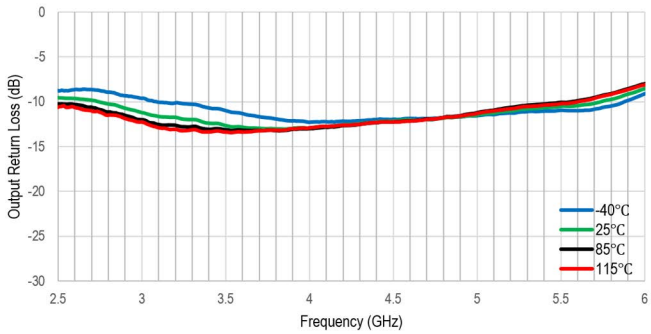


Figure 6. Output Return Loss (dB) vs. Frequency (GHz)

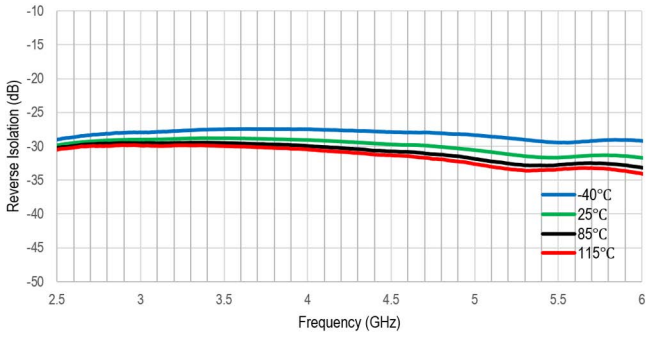


Figure 7. Reverse Isolation (dB) vs. Frequency (GHz)

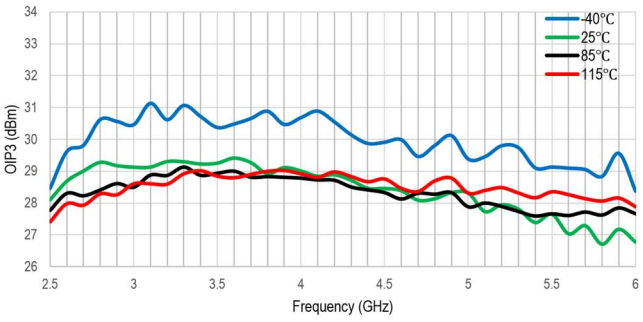


Figure 8. OIP3 (dBm) vs. Frequency (GHz)

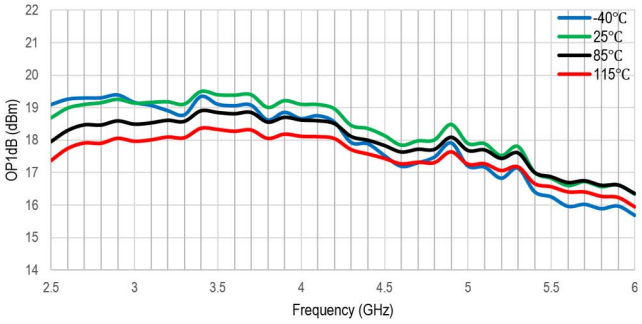


Figure 9. OIP1dB (dBm) vs. Frequency

Typical Performance Characteristics

0 to 20 GHz, V_{DD} = 5 V, P_{IN} = –20 dBm, characteristic impedance = 50 Ω, unless otherwise noted.

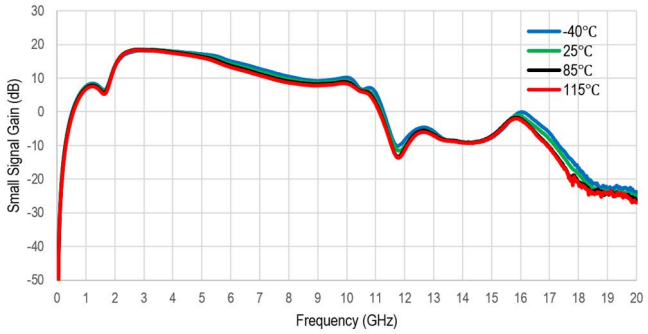


Figure 10. Small Signal Gain (dB) vs. Frequency (GHz)

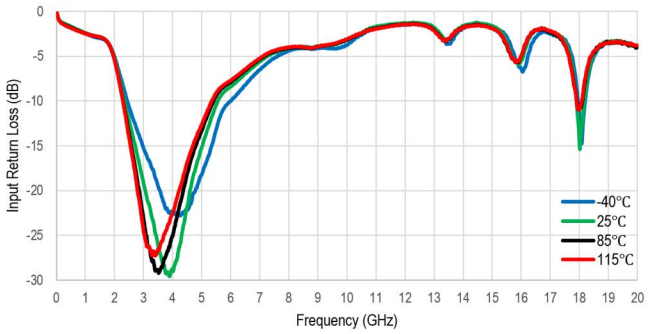


Figure 11. Noise Figure (dB) vs. Frequency (GHz)

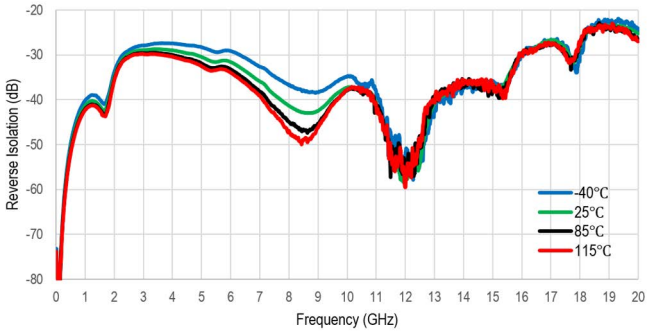


Figure 12. Reverse Isolation (dB) vs. Frequency (GHz)

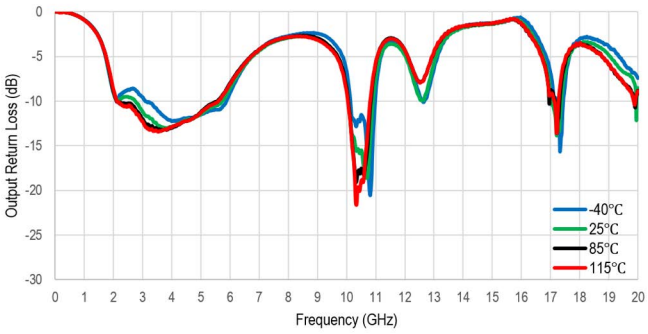


Figure 13. Output Return Loss (dB) vs. Frequency (GHz)

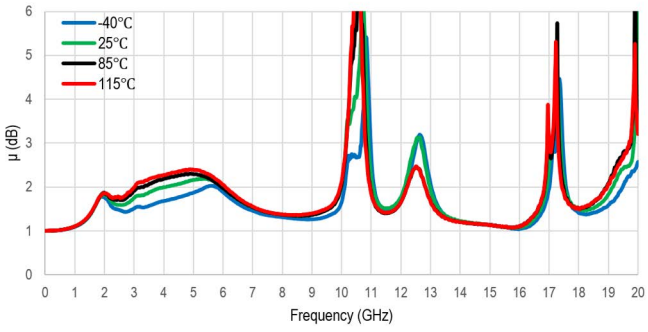


Figure 14. Stability Factor, μ1 (dB) vs. Frequency (GHz)

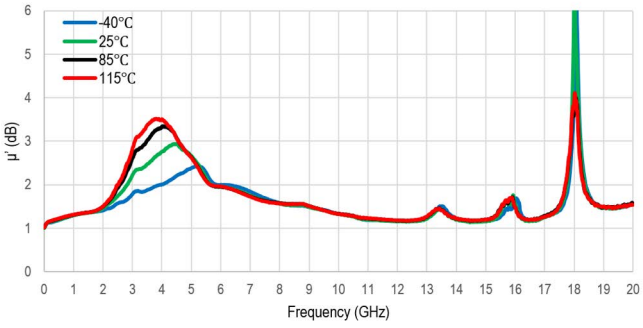


Figure 15. Stability Factor, μ2 (dB) vs. Frequency (GHz)

Table 6. 700 to 2500 MHz Optimized Tuning

(V_{DD} = 3.3 V, enable = GND, T_A = +25 °C, P_{IN} = –20 dBm, characteristic impedance [Z_O] = 50 Ω, unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Noise figure	NF	@ 700 MHz @ 1300 MHz @ 1900 MHz @ 2500 MHz		0.68 0.62 0.63 0.8	0.91 0.84 0.85 1.1	dB
Gain	|S21|	@ 700 MHz @ 1300 MHz @ 1900 MHz @ 2500 MHz	19.5 18.9 18.1 16.7	21.7 21.1 20.3 18.8		dB
Input return loss	|S11|	@ 700 MHz @ 1300 MHz @ 1900 MHz @ 2500 MHz	7.9 7.8 11.6 11	10 10.5 16.6 15		dB
Output return loss	|S22|	@ 700 MHz @ 1300 MHz @ 1900 MHz @ 2500 MHz	8.5 10.1 9.9 6.3	11 13.4 13.4 8.3		dB
Reverse isolation	|S12|	@ 700 MHz @ 1300 MHz @ 1900 MHz @ 2500 MHz	21.8 21.7 21.8 22.6	27.3 27.2 27.3 28.3		dB
Third order output intercept point	OIP3	P_{IN} = -20 dBm, Δ Tone = 1 MHz @ 700 MHz @ 1300 MHz @ 1900 MHz @ 2500 MHz	 25.1 24 23.7 24.8	 28.5 27.5 27.3 28.4		dBm
1 dB output compression point	OP1dB	@ 700 MHz @ 1300 MHz @ 1900 MHz @ 2500 MHz	14.6 13.9 13.7 14	16.7 16 15.8 16		dBm
Supply voltage	V_{DD}			3.3		V
Quiescent current	I_{DD}			42	50	mA
Settling time 0.3 dB[1] Settling time 0.1 dB[2]	t_{ON}	@ 1900 MHz		0.2 0.2	1 1	µs

1. Settling time 0.3 dB is measured from the time the LNA enable reaches 50% of LNA enable “on” level to the time at which the RF output power achieves within 0.3 dB of the average steady-state “on” level.
2. Settling time 0.1 dB is measured from the time the LNA enable reaches 50% of LNA enable “on” level to the time at which the RF output power achieves within 0.1 dB of the average steady-state “on” level.

Typical Performance Characteristics

700 to 2500 MHz, V_{DD} = 3.3 V, P_{IN} = –20 dBm, characteristic impedance = 50 Ω, unless otherwise noted.

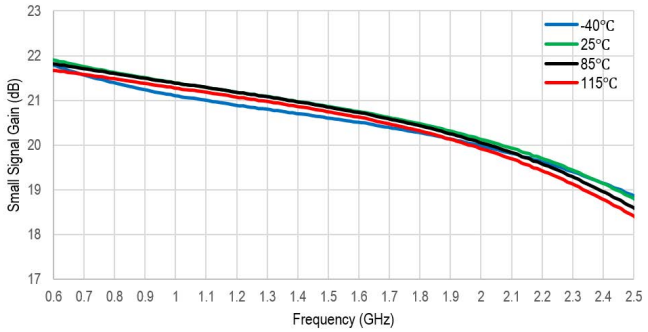


Figure 16. Small Signal Gain (dB) vs. Frequency (GHz)

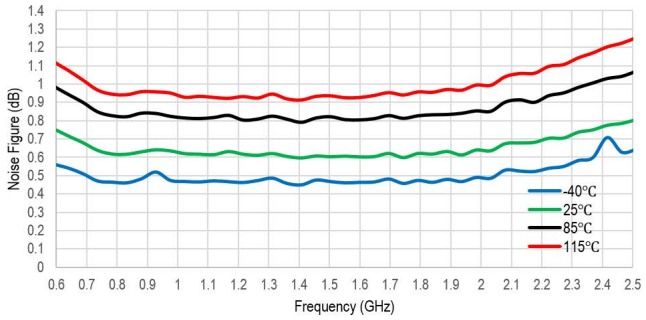


Figure 17. Noise Figure (dB) vs. Frequency (GHz)

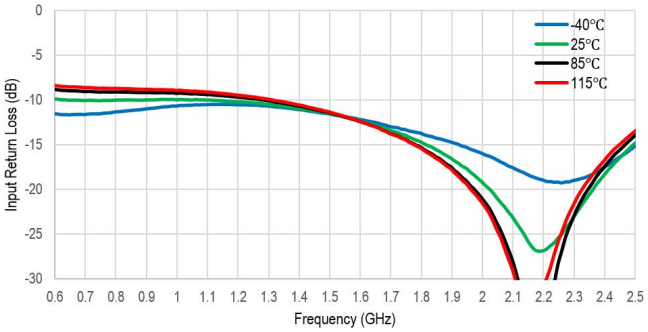


Figure 18. Input Return Loss (dB) vs. Frequency (GHz)

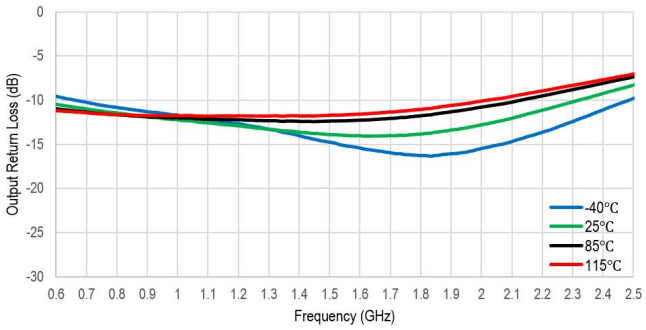


Figure 19. Output Return Loss (dB) vs. Frequency (GHz)

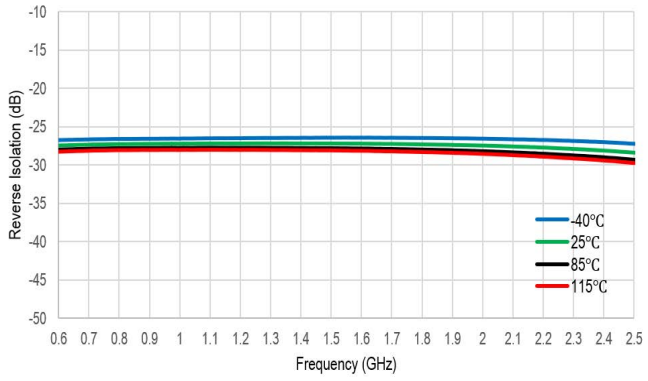


Figure 20. Reverse Isolation (dB) vs. Frequency (GHz)

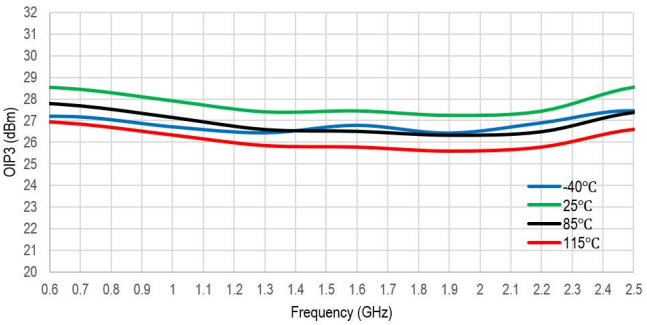


Figure 21. OIP3 (dBm) vs. Frequency (GHz)

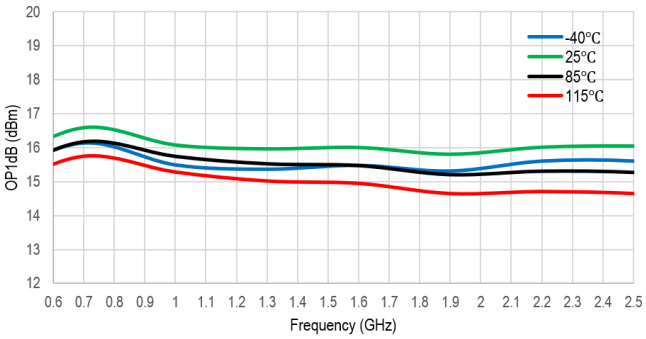


Figure 22. OP1dB (dBm) vs. Frequency (GHz)

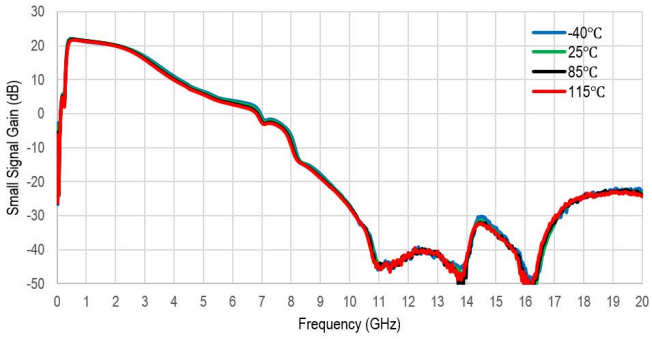


Figure 23. Small Signal Gain (dB) vs. Frequency (GHz)

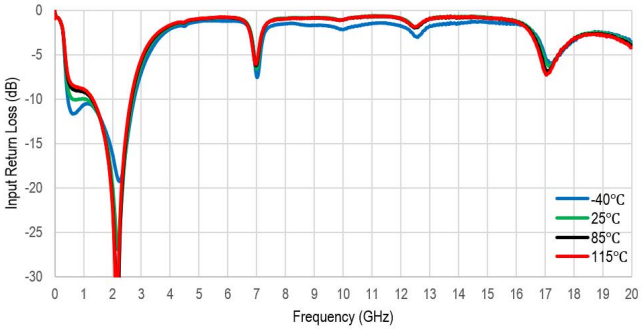


Figure 24. Input Return Loss (dB) vs. Frequency (GHz)

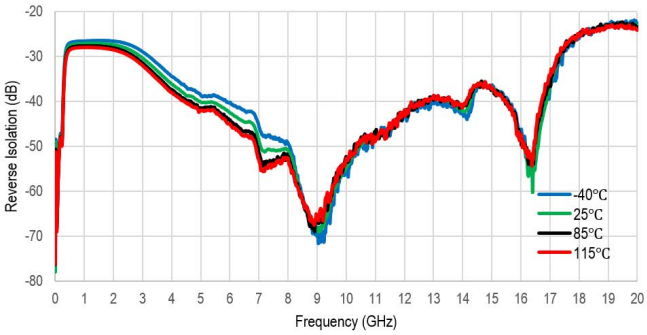


Figure 25. Reverse Isolation (dB) vs. Frequency (GHz)

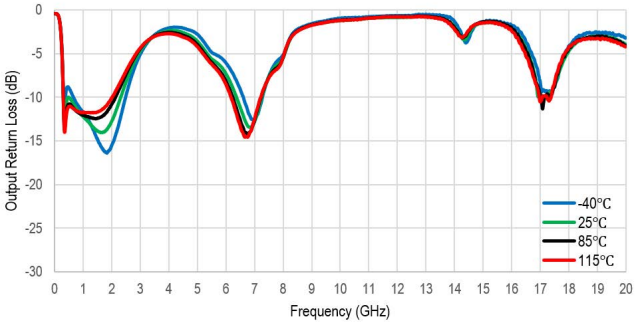


Figure 26. Output Loss (dB) vs. Frequency (GHz)

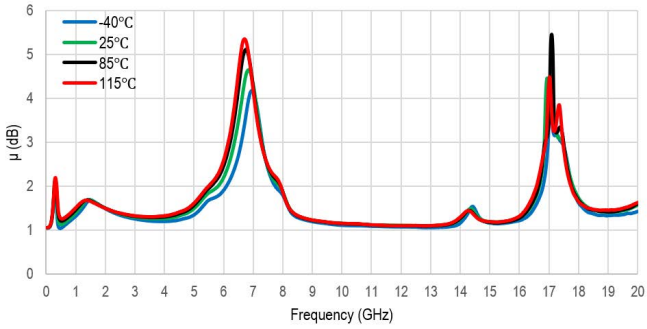


Figure 27. Stability Factor, μ (dB) vs. Frequency (GHz)

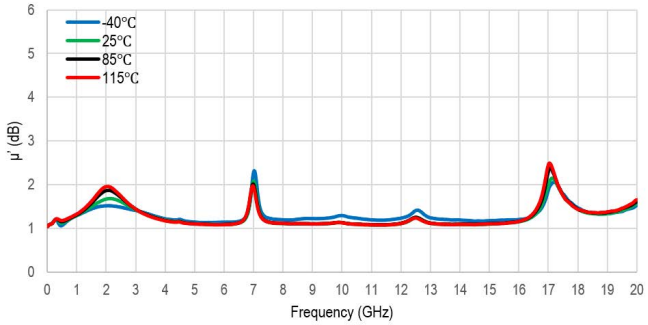


Figure 28. Stability Factor, μ' (dB) vs. Frequency (GHz)

Evaluation Board Description

An evaluation board (EVB) is used to test the performance of the SKY67189-396LF LNA. An EVB schematic and assembly diagram are shown below, followed by bill of materials lists optimized for 2500 to 6000 MHz and 700 to 2500 MHz.

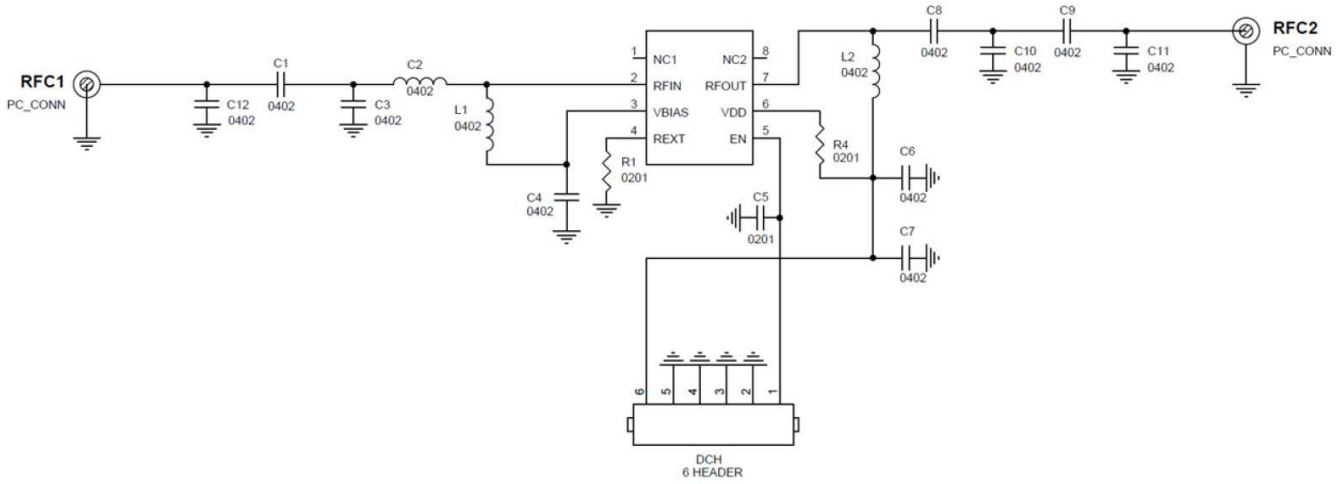


Figure 29. Evaluation Board Schematic

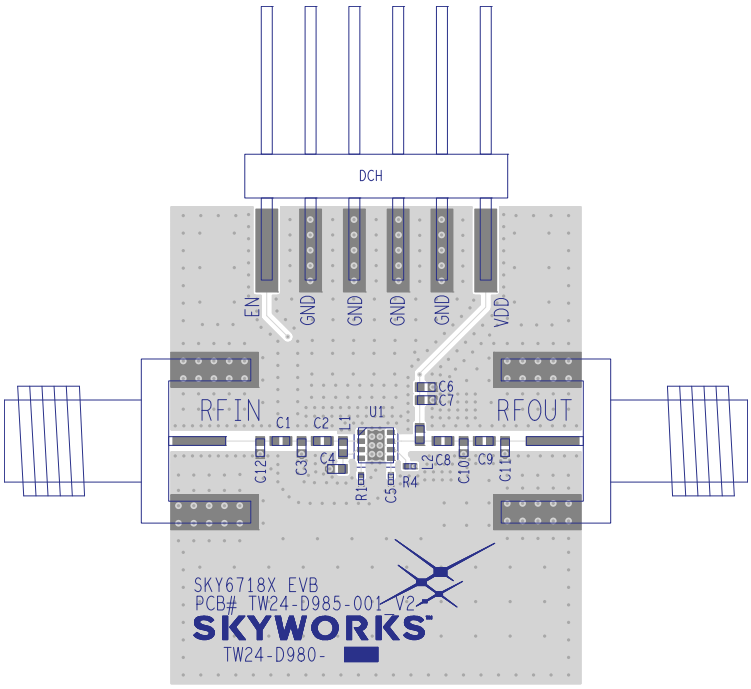


Figure 30. EVB Assembly Diagram

Table 7. Evaluation Board Bill of Materials (BOM) for 2500 to 6000 MHz Tuning

Component	Description	Value	Size	Manufacturer	Part Number
C1	Capacitor	6.8 pF	0402	muRata®	GJM1555C1H6R8CB01
C2	Inductor	0.4 nH	0402	TDK	MLG1005S0N4BT
C3	Capacitor	0.2 pF	0402	muRata	GJM1555C1HR20WB01
C4	Capacitor	2.0 pF	0402	muRata	GJM1555C1H2R0BB01
C6	Capacitor	5.6 pF	0402	muRata	GRM1555C1H5R6DA01
C7	Capacitor	4.7 uF	0402	muRata	GRM155C80J475MEAA
C8	Capacitor	3.3 pF	0402	muRata	GRM1555C1H3R3CA01
C9	Resistor	0 Ω	0402		
L1	Inductor	3.6 nH	0402	muRata	LQW15AN3N6C10
L2	Inductor	1.8 nH	0402	muRata	LQG15HS1N8S02
R1	Resistor	5.1 kΩ (1%)	0201		
R4	Resistor	20 Ω	0201		
C5, C10, C11, C12	DNI				

Table 8. Evaluation Board Bill of Materials (BOM) for 700 to 2500 MHz Tuning

Component	Description	Value	Size	Manufacturer	Part Number
C1	Capacitor	20 pF	0402	muRata	GJM1555C1H200GB01
C2	Inductor	4.3 nH	0402	muRata	LQW15AN4N3B00
C3	Capacitor	0.4 pF	0402	muRata	GJM1555C1HR40WB01
C4	Capacitor	22 pF	0402	muRata	GRM1555C1H220JA01
C7	Capacitor	330 pF	0402	muRata	GRM155C1H331JA01
C8	Capacitor	10 pF	0402	muRata	GRM1555C1H100JA01
C9	Resistor	0 Ω	0402		
C10	Capacitor	0.5 pF	0402	muRata	GRM1555C1HR50WA01
C11	Resistor	2 kΩ	0402		
L1	Inductor	19 nH	0402	muRata	LQW15AN19NG00
L2	Inductor	27 nH	0402	muRata	LQG15HS27NJ02
R1	Resistor	5.6 kΩ (1%)	0201		
R4	Resistor	20 Ω	0201		
C5, C6, C12	DNI				

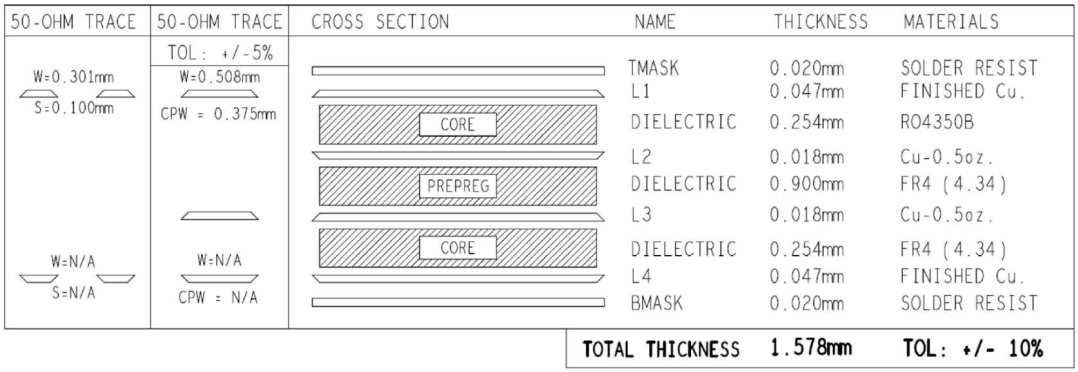


Figure 31. EVB Layer Details

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 SKY67189-396LF 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.

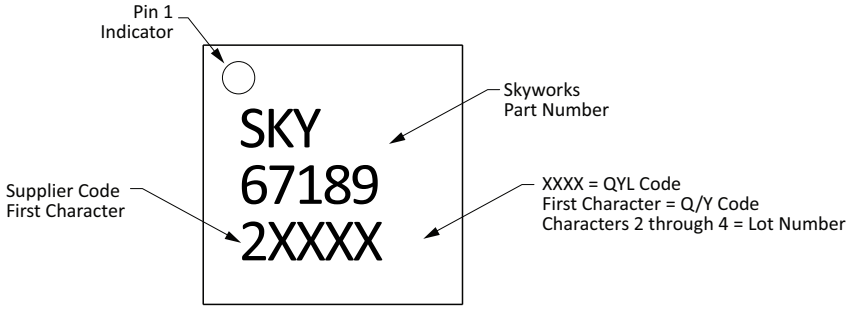
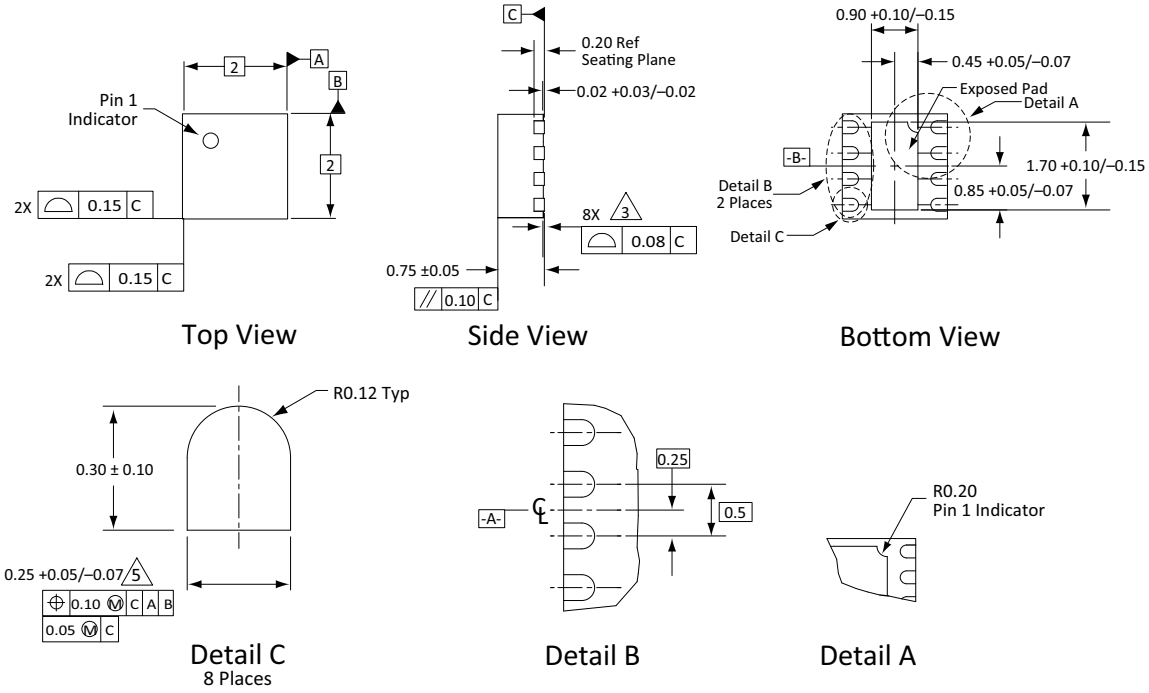


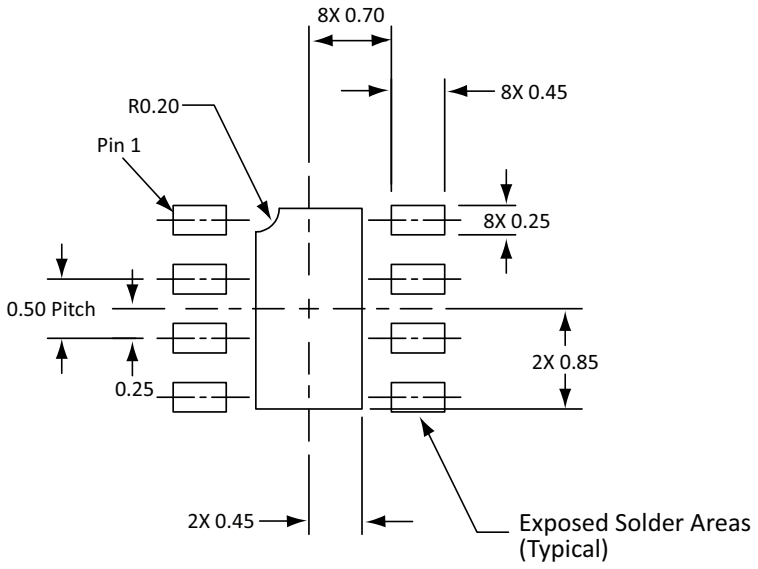
Figure 32. Typical Part Marking



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 ground pad as well as the terminals.
4. Dimension applies to metallized terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.

Figure 33. Package Dimensions



All dimensions are in millimeters

Figure 34. PCB Layout Footprint

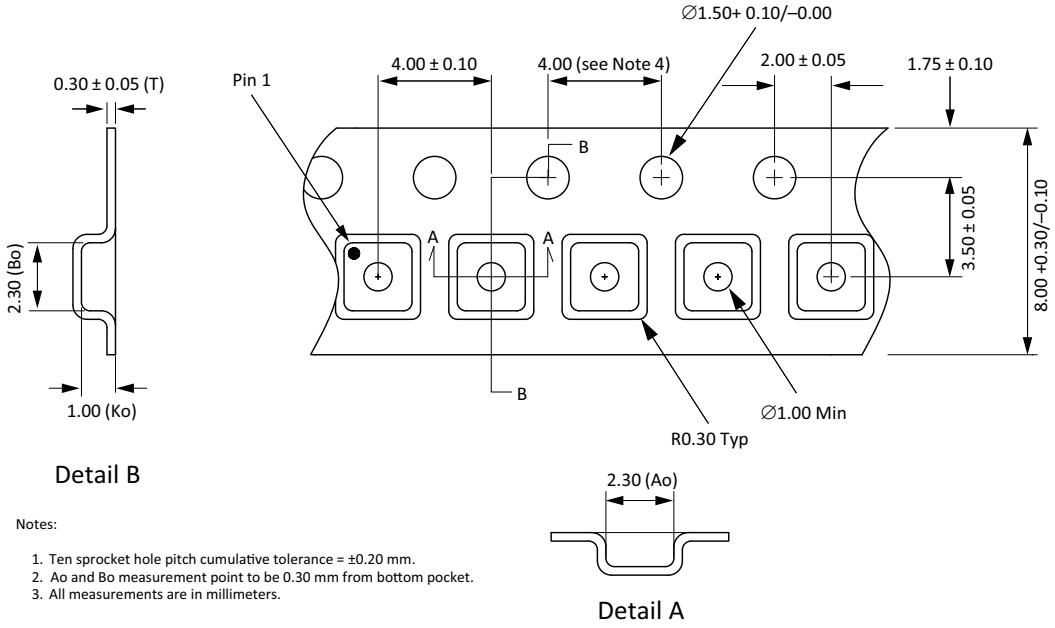


Figure 35. Tape and Reel Information

Ordering Information

Part Number	Description	Evaluation Board Part Number
SKY67189-396LF	400 to 6000 MHz Broadband Low-Noise Amplifier	SKY67189-396EK1 (2.5 to 6.0 GHz Tuning) SKY67189-396EK2(0.7 to 2.5 GHz Tunning)

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