Low Noise Amplifier
1.85 - 5.0 GHz

MAAL-011217
Rev. V1

Features

- Broadband 2-Stage LNA
- Gain:
  - 36.8 dB @ 2.5 GHz
  - 35.6 dB @ 3.75 GHz
  - 34.8 dB @ 4.9 GHz
- Noise Figure:
  - 0.58 dB @ 2.5 GHz
  - 0.60 dB @ 3.75 GHz
  - 0.70 dB @ 4.9 GHz
- Single 5 V Supply
- Compatible with 1.8 V and 3.3 V logic
- Low DC Current: 106 mA
- Lead-Free 3 mm 16 Lead QFN Package
- RoHS* Compliant

Applications

- 5G Macro and Massive MIMO
- Wireless Infrastructure
- General purpose wireless
- TDD or FDD systems

Description

The MAAL-011217 is a compact surface mount, highly integrated 2-stage low noise amplifier (LNA). This LNA is housed in a lead-free 3 mm 16-lead QFN plastic package.

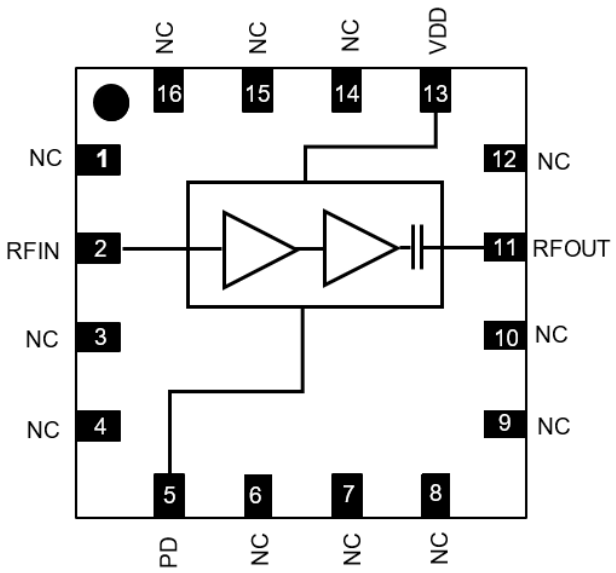
The MAAL-011217 features low noise figure, high gain and low power consumption. The LNA requires a single 5 V supply and the Power Down pin is 1.8 V or 3.3 V CMOS compatible.

Ordering Information[1]

Part Number	Package
MAAL-011217-TR1000	1000 piece reel
MAAL-011217-001SMB	Sample Board

1. Reference Application Note M513 for reel size information.

Functional Schematic



Pin Function[2]

Pin #	Function
1, 3, 4, 6 - 10, 12, 14 - 16	Internally No Connect
2	RF Input
5	Logic Power Down
11	RF Output
13	Supply Voltage
17	Ground Paddle[3]

2. MACOM recommends connecting unused package pins to ground.
3. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

Pin Description

Pin #	Name	Description
1, 3, 4, 6 - 10, 12, 14 - 16	NC	Not connected internally. It is recommended to connect N/C pins to RF grounds of the PCB.
2	RFIN	RF Input. DC blocking capacitor required.
5	PD	Power Down logic control for LNA ON/OFF Modes
11	RFOUT	RF Output. See absolute maximum ratings table for DC voltage limits at this pin.
13	VDD	5 V Supply pin needs external decoupling capacitors.
17	Paddle	Exposed Pad. The exposed pad must be connected to RF, DC and thermal GND.

AC Electrical Specifications: P_{IN} = -30 dBm, V_{DD} = 5 V, Z_0 = 50 Ω, T_C = +25ºC

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	2.5 GHz 3.75 GHz 4.9 GHz	dB	34 33 —	36.8 35.6 34.8	—
Gain Variation	Over Temperature, 3.75 GHz	dB/°C	—	0.01	—
Noise Figure	2.5 GHz 3.75 GHz 4.9 GHz	dB	—	0.58 0.60 0.70	—
Noise Figure Variation	Over Temperature, 2.5 GHz Over Temperature, 3.75 GHz	dB/°C	—	0.003 0.004	—
Input IP3	P_{IN}/tone = -30 dBm, Tone Delta = 2 MHz, 2.5 GHz 3.75 GHz 4.9 GHz	dBm	—	-2.5 -2.5 -3.0	—
Input P1dB	2.5 GHz 3.75 GHz 4.9 GHz	dBm	—	-16 -15 -15	—
Input Return Loss	2.5 GHz 3.75 GHz 4.9 GHz	dB	—	-17 -17 -12	—
Output Return Loss	2.5 GHz 3.75 GHz 4.9 GHz	dB	—	-15 -18 -19	—
Reverse Isolation	RF_{OUT} to RF_{IN} 2.5 GHz 3.75 GHz 4.9 GHz	dB	—	51 49 48	—

DC Electrical Specifications: V_{DD} = 5 V, Z_0 = 50 Ω, T_C = +25ºC

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Supply Voltage	—	V	4.75	5	5.25
Supply Current	LNA ON Mode LNA OFF Mode	mA	—	106 0.6	140 1
Power Down Logic Input Voltage	LNA ON Mode Disable Mode	V	0 1.2	—	0.6 3.45
Power Down Logic Input Current	LNA ON Mode Disable Mode	µA	— 0	-4 40	— 80

Transient Electrical Specifications:
Freq = 2.5 GHz, P_{IN} = -30 dBm, V_{DD} = 5 V, Z_0 = 50 Ω, T_C = +25ºC

Parameter	Test Conditions	Units	Min.	Typ.	Max.
LNA ON Settling Time	Gain shall be within 0.1 dB deviation from final value	µs	—	0.6	—
LNA OFF Settling Time	Power shall be within 10% from final value	µs	—	0.1	—

Power Down Truth Table

PD Control	
LNA ON Mode	Logic Low or Open
Disable Mode	Logic High

Recommended Operating Conditions

Parameter	Operation Conditions
DC Supply V_{DD}	+4.75 to +5.25 V
Logic PD Control Voltage	0 to +3.3 V
Case Temperature (T_C)[4]	-40°C to +115°C

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

Parameter	Rating	Standard
Human Body Model (HBM)	500 V (Class 1B)	ESDA/JEDEC JS-001
Charged Device Model (CDM)	1000 V (Class C3)	ESDA/JEDEC JS-002

Power Supplies

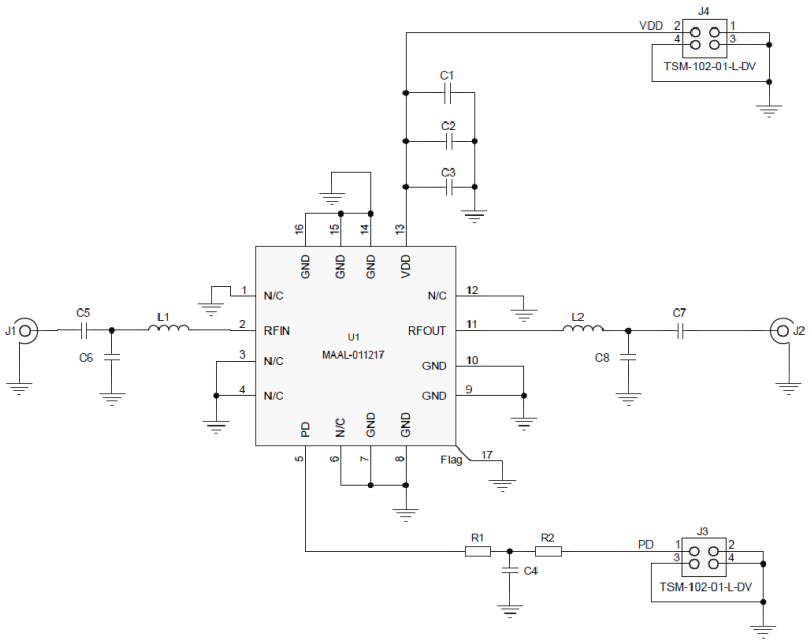
De-coupling capacitors should be placed at the V_{DD} supply pin to minimize noise and fast transients. Supply voltage change or transients should have a slew rate smaller than 1 V / 10 µs. In addition, all control pins should remain at 0 V (+/- 0.3 V) and no RF power should be applied while the supply voltage ramps or while it returns to zero.

Absolute Maximum Ratings[5,6]

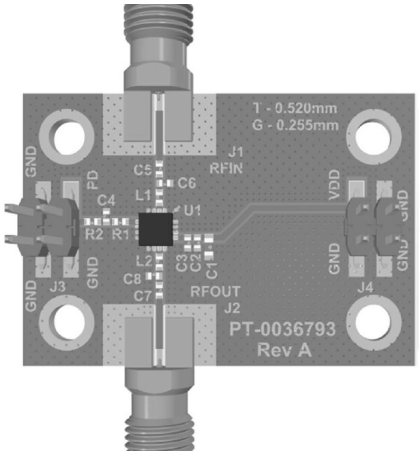
Parameter	Absolute Maximum
RF Input Power: LNA ON Mode	33 dBm CW 30 dBm LTE
DC Supply V_{DD}	-0.5 to +5.5 V
Logic PD Control Voltage	-0.5 to +3.6 V
DC Voltages at RF Output	-0.5 to +2.75 V
Junction Temperature[7,8] LNA ON Mode	+150°C
Storage Temperature	-55°C to +150°C

4. Operating/Case temperature (T_C) is the temperature of the exposed paddle.
5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Operating at nominal conditions with T_J<150ºC (LNA ON Mode) will ensure MTTF >>1x10^6 hours
8. Junction Temperature (T_J) = T_C + Θ_{JC} * P_{DISS} where P_{DISS} is the total DC & RF dissipated power. Typical thermal resistance (Θ_{JC}) = 33.4ºC/W.
   a) For T_C = +25°C,
   T_J = 43°C @ 5 V, 106 mA
   b) For T_C = +115°C,
   T_J = 137°C @ 5 V, 130 mA

Applications Schematic



Sample Board Layout

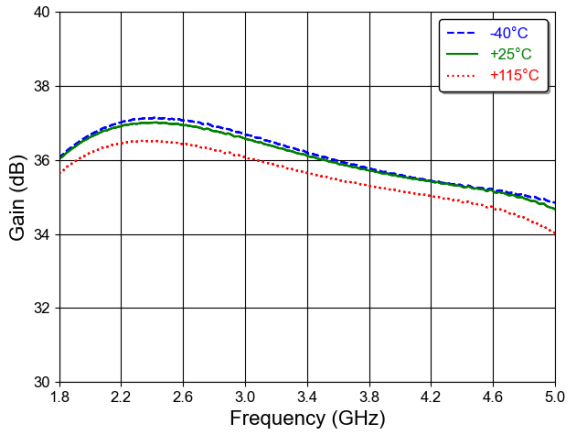


Parts list

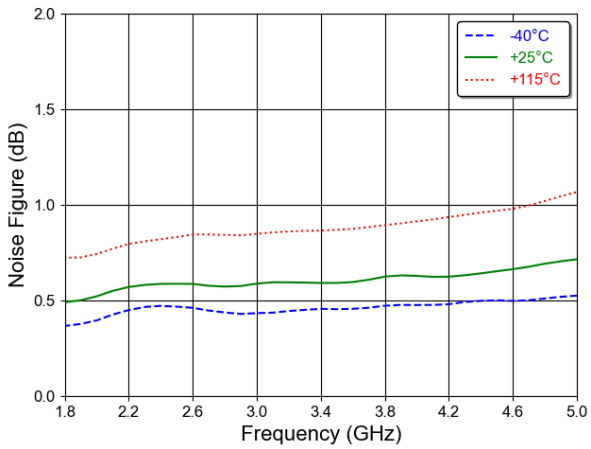
Schematic Component	Component Value	Size	Manufacturer
C1	10 µF	0603	Murata ZRB18AD71A106KE01
C2	10 nF	0402	Murata GRM155R71C103KA01D
C3	470 pF	0402	Murata GRM155R71H471KA01D
C4	5 pF	0402	Kyocera CM05CG5R0B50AH
C5	27 pF	0402	Murata GJM1555C1H270FB01
C6	DNP	DNP	DNP
C7	Cu Shim	0402	-
C8	DNP	DNP	DNP
L1	Cu Shim	0402	-
L2	Cu Shim	0402	-
R1	100 Ω	0402	Yageo RC0402JR-07100R
R2	1 kΩ	0402	Yageo RC0402JR-071K

Typical Performance Curves: P_{IN} = -30 dBm, V_{DD} = 5 V, Z_0 = 50 Ω

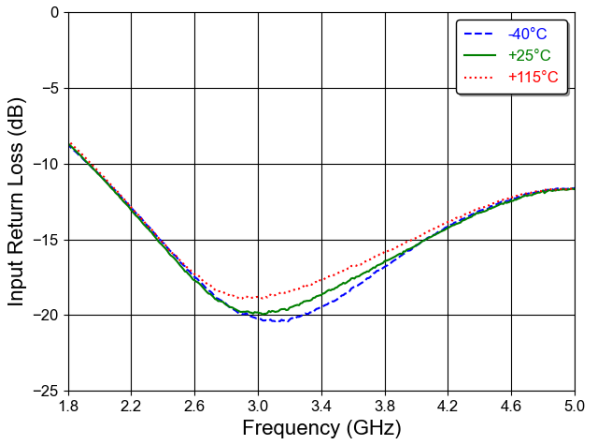
Gain[9]



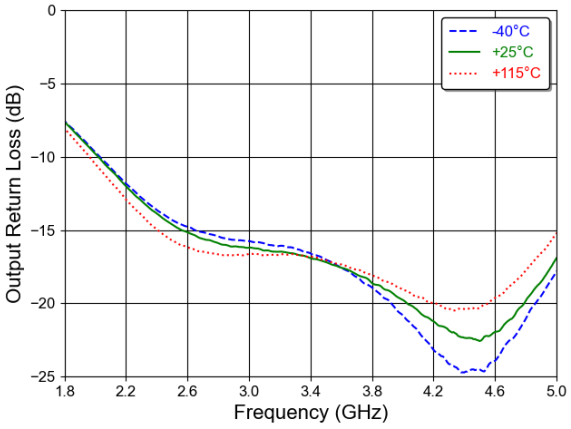
Noise Figure[9]



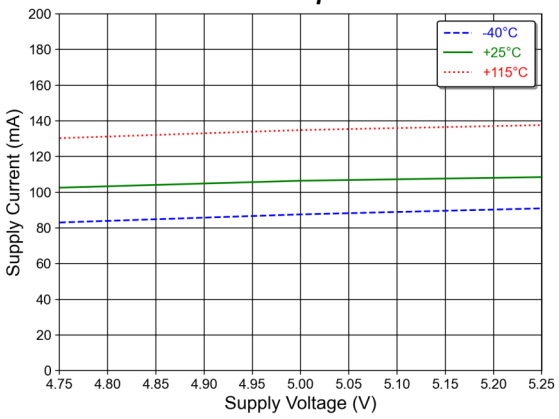
Input Return Loss



Output Return Loss



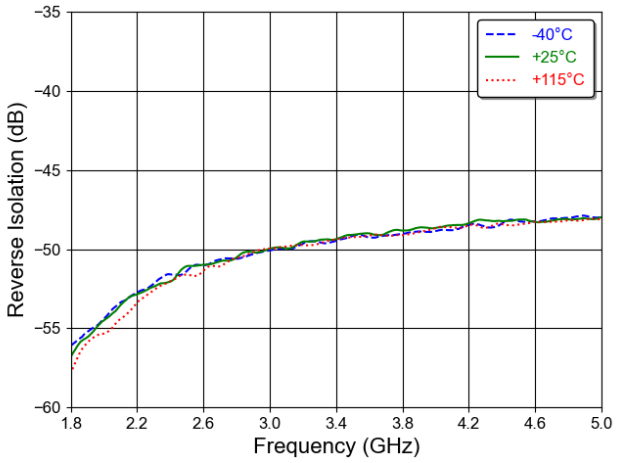
DC Current Over VDD and Temp



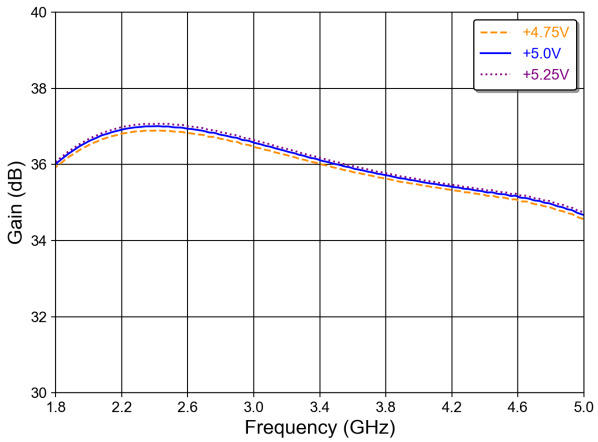
9. For gain, noise figure, reverse isolation, P1dB and IP3 plots, RF trace and connector losses are de-embedded.

Typical Performance Curves: P_{IN} = -30 dBm, V_{DD} = 5 V, Z_0 = 50 Ω

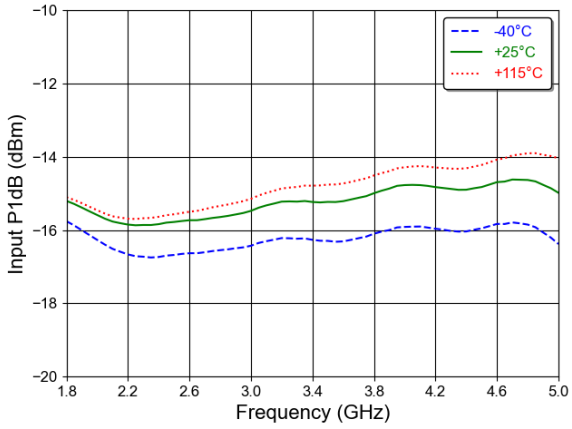
***Reverse Isolation*[9]**



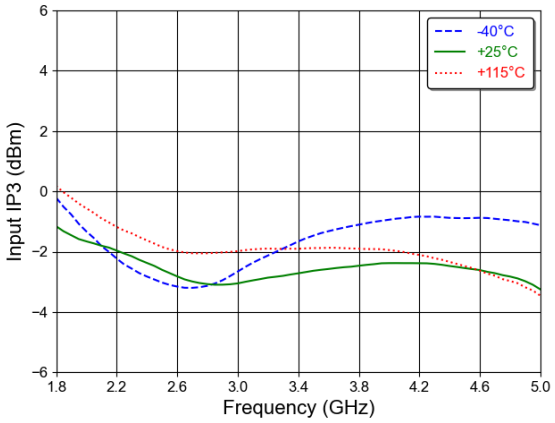
Gain*[9] *over Supply



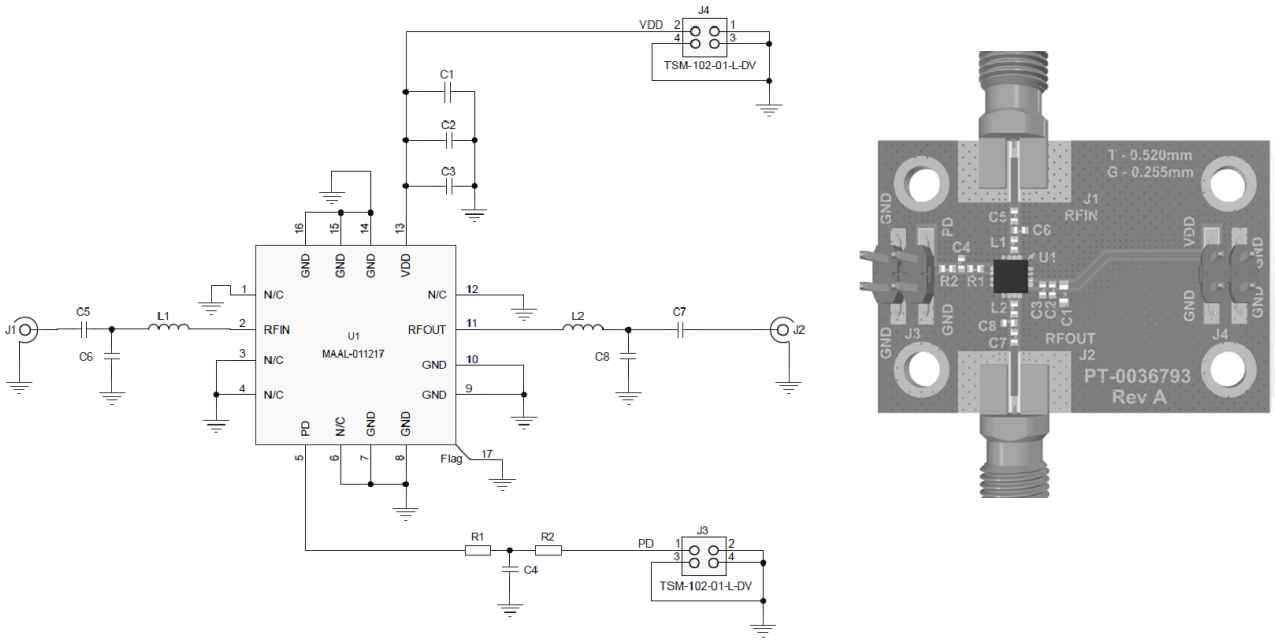
***Input P1dB*[9]**



***Input IP3*[9]**



Applications Section A: 2.3 - 2.7 GHz



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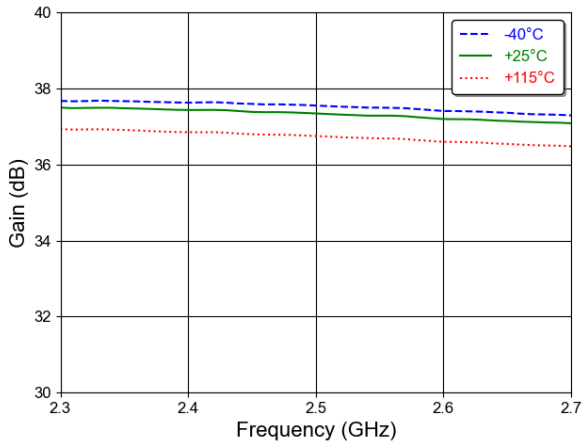
C4	5 pF	0402	Kyocera CM05CG5R0B50AH
C5	27 pF	0402	Murata GJM1555C1H270FB01
C6	0.7 pF	0402	Murata GJM1555C1HR70WB01D
C7	3.9 pF	0402	Murata GJM1555C1H3R9CB01D
C8	DNP	DNP	DNP
L1	1 nH	0402	Coilcraft 0402CS-1N0XJLW
L2	Cu Shim	0402	—
R1	100 Ω	0402	Yageo RC0402JR-07100R
R2	1 kΩ	0402	Yageo RC0402JR-071K

AC Electrical Specifications:
Freq = 2.3 - 2.7 GHz, P_{IN} = -30 dBm, V_{DD} = 5 V, Z_0 = 50 Ω, T_C = +25ºC

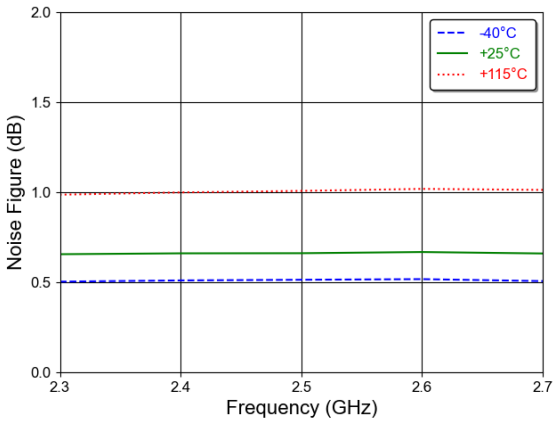
Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	—	dB	—	37.3	—
Gain Variation	Over Temperature	dB/°C	—	0.015	—
Noise Figure	—	dB	—	0.65	—
Noise Figure Variation	Over Temperature	dB/°C	—	0.006	—
Input IP3	P_{IN}/tone = -30 dBm, Tone Delta = 2 MHz,	dBm	—	-2.5	—
Input P1dB	—	dBm	—	-16	—
Input Return Loss	—	dB	—	-23	—
Output Return Loss	—	dB	—	-23	—
Reverse Isolation	RFOUT to RFIN	dB	—	52	—

Typical Performance Curves: P_{IN} = -30 dBm, V_{DD} = 5 V, Z_0 = 50 Ω

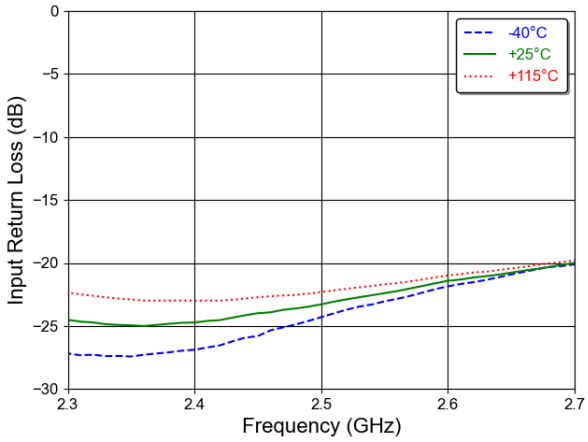
Gain[10]



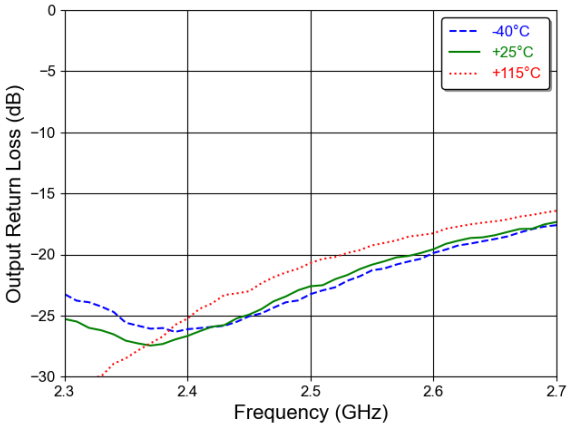
Noise Figure[10]



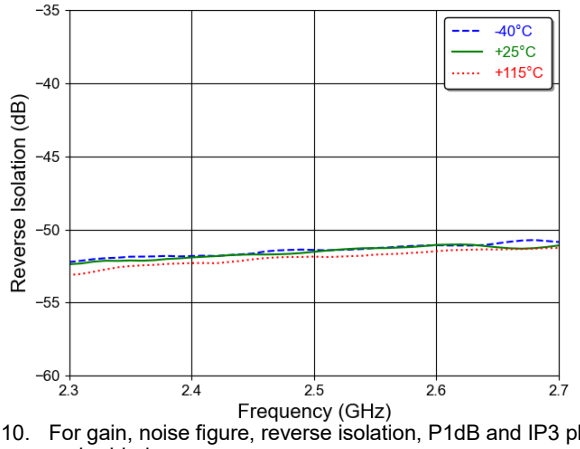
Input Return Loss



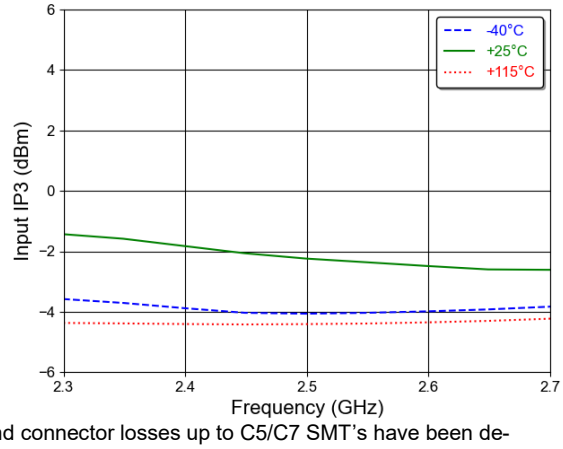
Output Return Loss



Reverse Isolation[10]

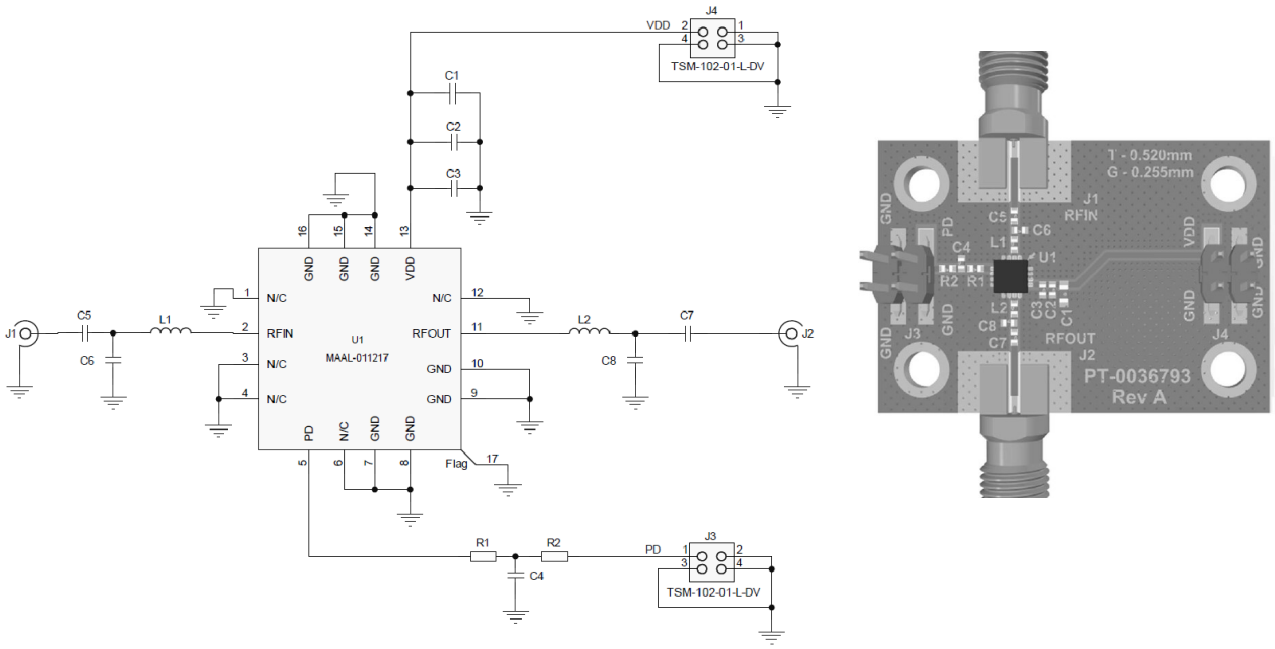


Input IP3[10]



10. For gain, noise figure, reverse isolation, P1dB and IP3 plots, RF trace and connector losses up to C5/C7 SMT's have been de-embedded

Applications Section B: 4.4 - 5.0 GHz



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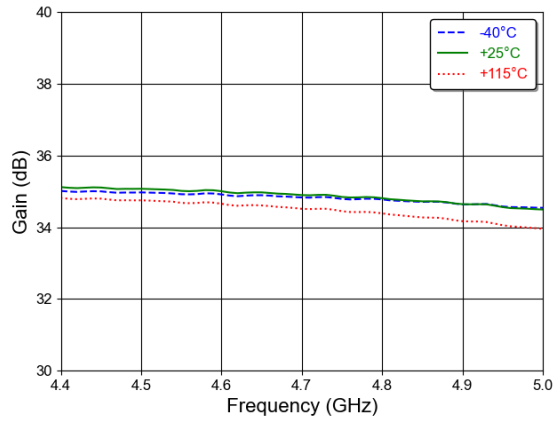
C3	470 pF	0402	Murata GRM155R71H471KA01D
C4	5 pF	0402	Kyocera CM05CG5R0B50AH
C5	27 pF	0402	Murata GJM1555C1H270FB01
C6	0.2 pF	0402	Murata GJM1555C1HR20BB01D
C7	Cu Shim	0402	—
C8	DNP	DNP	DNP
L1	Cu Shim	0402	—
L2	Cu Shim	0402	—
R1	100 Ω	0402	Yageo RC0402JR-07100R
R2	1 kΩ	0402	Yageo RC0402JR-071K

AC Electrical Specifications:
Freq = 4.4 - 5.0 GHz, P_{IN} = -30 dBm, V_{DD} = 5 V, Z_0 = 50 Ω, T_C = +25ºC

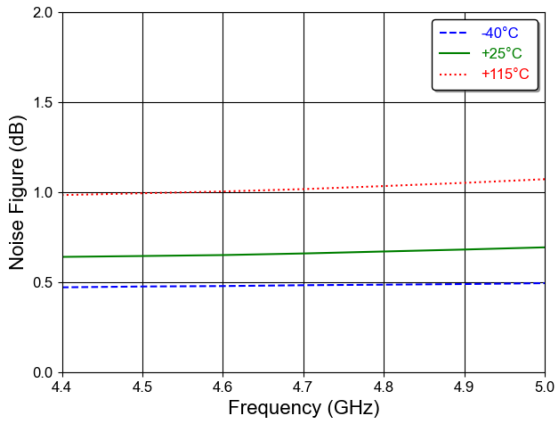
Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	-	dB	—	35.1	—
Gain Variation	Over Temperature	dB/°C	—	0.01	—
Noise Figure	-	dB	—	0.7	—
Noise Figure Variation	Over Temperature	dB/°C	—	0.004	—
Input IP3	P_{IN}/tone = -30 dBm, Tone Delta = 2 MHz	dBm	—	-2	—
Input P1dB	-	dBm	—	-16	—
Input Return Loss	-	dB	—	-17	—
Output Return Loss	-	dB	—	-19	—
Reverse Isolation	RFOUT to RFIN	dB	—	48	—

Typical Performance Curves: P_{IN} = -30 dBm, V_{DD} = 5 V, Z_0 = 50 Ω

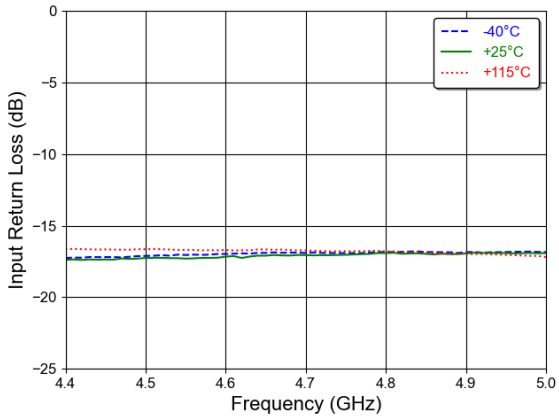
***Gain*[10]**



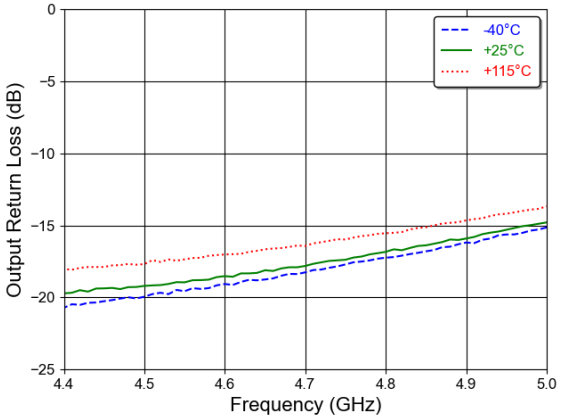
***Noise Figure*[10]**



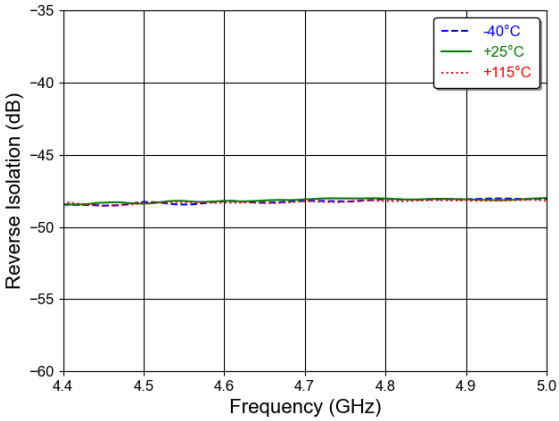
Input Return Loss



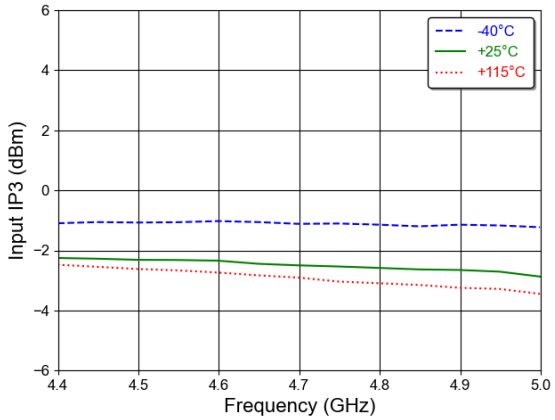
Output Return Loss



***Reverse Isolation*[10]**

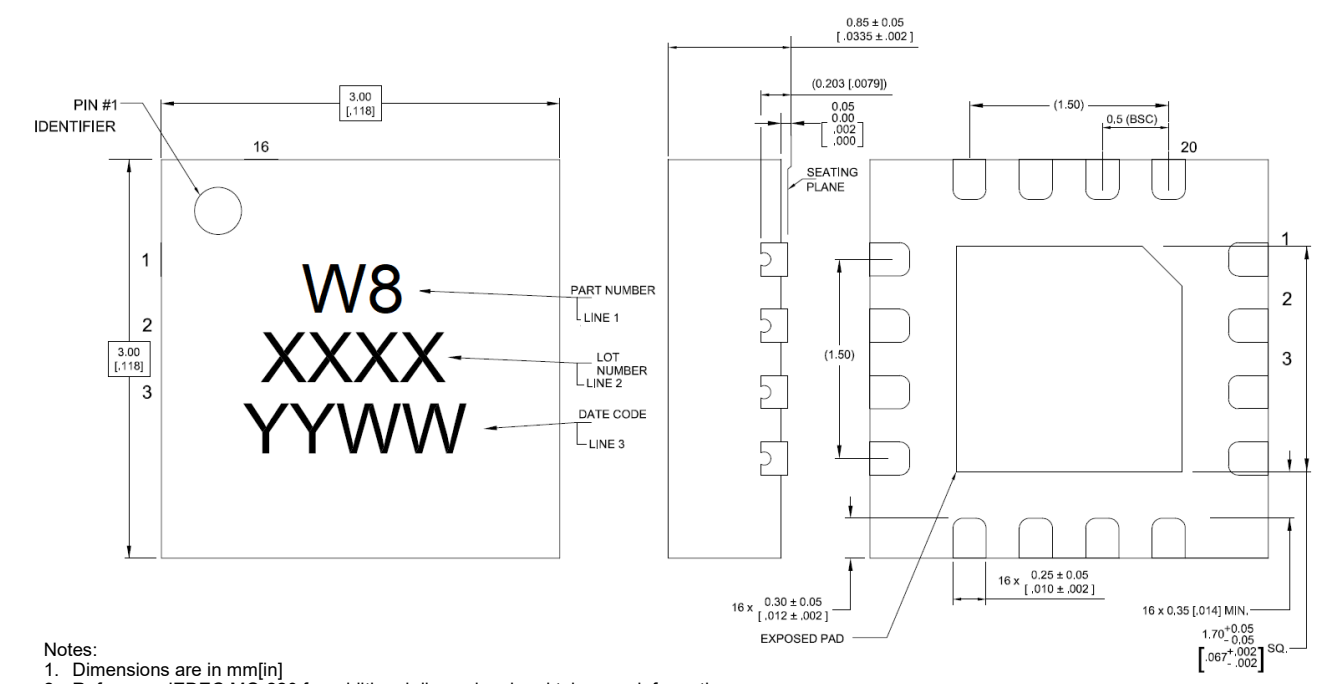


***Input IP3*[10]**



10. For gain, noise figure, reverse isolation, P1dB and IP3 plots, RF trace and connector losses up to C5/C7 SMT's have been de-embedded.

Lead-Free 3 mm 16-Lead QFN†



Notes:
1. Dimensions are in mm[in]
2. Reference JEDEC MO-220 for additional dimensional and tolerance information

† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements in accordance to JEDEC J-STD-020D.
Plating is NiPdAu over Copper

Revision History

Rev	Date	Change Description
V1	04/09/24	Initial Release