

General Description

The QPL9057 is a flat-gain, high-linearity, ultra-low noise amplifier in a small 2 x 2 mm surface-mount package. The LNA provides a gain flatness of 2.4 dB (peak-to-peak) over a wide bandwidth from 1.5 to 3.8GHz. At 3.5 GHz, the amplifier typically provides 22.8 dB gain, +32 dBm OIP3 at a 50 mA bias setting, and 0.54 dB noise figure. The LNA can be biased from a single positive supply ranging from 3.3 to 5 volts. The device is housed in a green/RoHS-compliant industry-standard 2x2 mm package.

The QPL9057 is internally matched using a high-performance E-pHEMT process and only requires five external components for operation from a single positive supply: an external RF choke and blocking/bypass capacitors and a bias resistor going to pin 1. This LNA integrates a shut-down biasing capability to allow for operation in TDD applications.

The QPL9057 is optimized for linear performance across the 1.5 to 4.2 GHz frequency band but can operate down to 600 MHz.

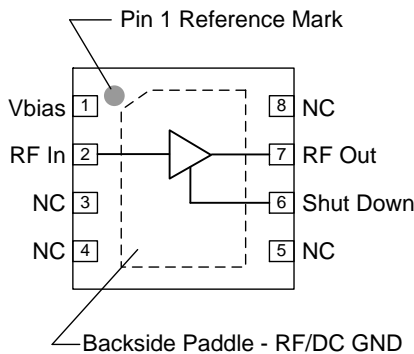


8 Pin 2X2 mm DFN Package

Product Features

- 0.6-4.2 GHz Operational Bandwidth
- Ultra-low noise figure, 0.54 dB NF @ 3.5 GHz
- >20 dB gain across 1.5 to 3.8 GHz
- Flat 2.4 dB gain variation across 1.7 to 3.8GHz
- Bias adjustable for linearity optimization
- 32 dBm OIP3 at 50mA I_{DD}
- Shut-down mode pin with 1.8V logic
- Unconditionally stable
- Integrated shutdown control pin
- Maintains OFF state with high Pin over drive
- +3V to +5V single supply; does not require -V_{GG}

Functional Block Diagram



Top View

Applications

- Repeaters / DAS
- Mobile Infrastructure
- LTE / WCDMA / CDMA / GSM
- General Purpose Wireless
- TDD or FDD systems

Ordering Information

| Part No. | Description |
|---------------|------------------------------|
| QPL9057TR7 | 2500 pieces on a 7" Reel |
| QPL9057EVB-01 | 0.6-4.2 GHz Evaluation Board |

Absolute Maximum Ratings

| Parameter | Rating |
|-----------------------------------|--------------|
| Storage Temperature | -65 to 150°C |
| Supply Voltage (V _{DD}) | +7 V |
| RF Input Power, CW, 50Ω, T=25°C | +27 dBm |
| RF Input Power, CW, OFF State | +27 dBm |

Operation of this device outside the parameter ranges given above may cause permanent damage.

Recommended Operating Conditions

| Parameter | Min | Typ | Max | Units |
|--|-----|-----|------|-------|
| Supply Voltage (V _{DD}) | 3.3 | 5.0 | 5.25 | V |
| T _{CASE} | -40 | | +105 | °C |
| T _j for >10 ⁶ hours MTTF | | | +190 | °C |

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

Electrical Specifications

Test conditions unless otherwise noted: V_{DD} =+5V, Temp=+25°C, 50 Ω system.

| Parameter | Conditions | Min | Typ | Max | Units |
|---|--|------|------|-----------------|-------|
| Operational Frequency Range | | 600 | | 4200 | MHz |
| Test Frequency | | | 3500 | | MHz |
| Gain | | 21.5 | 22.8 | 25.0 | dB |
| Gain Flatness | 1700-3800MHz | | 2.4 | | dB |
| Input Return Loss | | | 13 | | dB |
| Output Return Loss | | | 12 | | dB |
| Noise Figure ⁽¹⁾ | | | 0.54 | 0.90 | dB |
| Output P1dB | | 14.5 | 17 | | dBm |
| Output IP3 | P _{out} =+5 dBm/tone, Δf=1 MHz | 29 | 32 | | dBm |
| Shutdown Control Levels, V _{SD} | On state | 0 | | 0.63 | V |
| | Off state (Power down) | 1.17 | | V _{DD} | V |
| LNA Current, I _{DD} | On state | | 50 | 70 | mA |
| | Off state (Power down) | | 3 | 6 | mA |
| Shutdown Control Current, I _{SD} | V _{SD} ≥ 1.17 V, Off state (Power down) | | 1 | | μA |
| LNA Switch OFF Time | 50% V _{PD} to 10% RF output | | 48 | | ns |
| LNA Switch ON Time | 50% V _{PD} to 90% RF output | | 91 | | ns |
| Thermal Resistance, θ _{jc} | channel to case | | | 40.6 | °C/W |

Note:

1) Noise figure data has input trace loss de-embedded.

S-Parameters

Test Conditions: $V_{DD}=+5\text{ V}$, $I_{DD}=50\text{ mA (typ.)}$, $T=+25^{\circ}\text{C}$, Reference planes at device pins

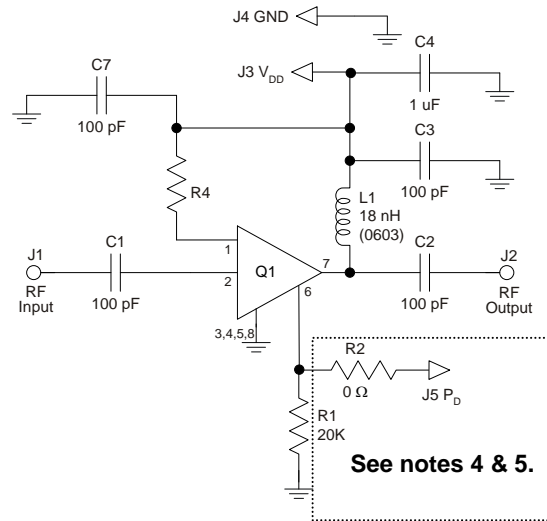
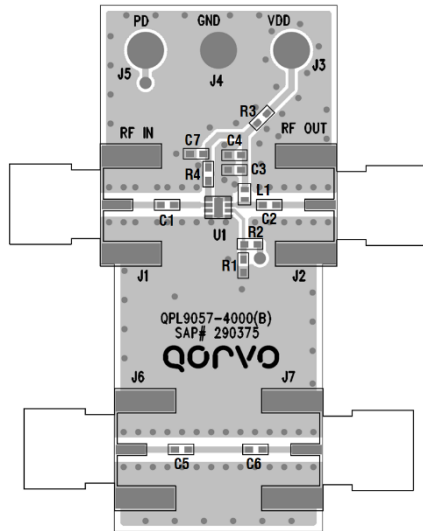
| Freq (GHz) | S11 (mag) | S11 (ang) | S21 (mag) | S21 (ang) | S12 (mag) | S12 (ang) | S22 (mag) | S22 (ang) |
|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1.0 | 0.363 | -62.40 | 12.256 | 40.27 | 0.021 | -7.21 | 0.079 | -111.83 |
| 1.1 | 0.349 | -64.72 | 11.937 | 31.80 | 0.021 | -11.15 | 0.057 | -122.11 |
| 1.2 | 0.338 | -66.97 | 11.726 | 23.70 | 0.021 | -15.27 | 0.037 | -134.96 |
| 1.3 | 0.333 | -69.47 | 11.590 | 15.99 | 0.021 | -19.39 | 0.022 | -155.81 |
| 1.4 | 0.331 | -72.56 | 11.536 | 8.54 | 0.021 | -23.49 | 0.011 | 153.14 |
| 1.5 | 0.330 | -75.77 | 11.540 | 1.25 | 0.021 | -27.66 | 0.016 | 86.83 |
| 1.6 | 0.332 | -79.54 | 11.620 | -5.84 | 0.020 | -31.88 | 0.025 | 61.12 |
| 1.7 | 0.337 | -83.50 | 11.751 | -12.88 | 0.020 | -36.27 | 0.034 | 47.76 |
| 1.8 | 0.345 | -88.04 | 11.924 | -19.83 | 0.020 | -40.95 | 0.042 | 34.14 |
| 1.9 | 0.354 | -92.89 | 12.173 | -26.82 | 0.019 | -45.86 | 0.050 | 24.15 |
| 2.0 | 0.365 | -98.45 | 12.460 | -33.85 | 0.019 | -51.11 | 0.054 | 12.78 |
| 2.1 | 0.376 | -104.44 | 12.798 | -41.05 | 0.019 | -56.72 | 0.058 | -1.99 |
| 2.2 | 0.390 | -110.49 | 13.197 | -48.32 | 0.018 | -62.58 | 0.065 | -16.74 |
| 2.3 | 0.403 | -117.36 | 13.609 | -55.92 | 0.018 | -68.97 | 0.070 | -31.21 |
| 2.4 | 0.420 | -124.54 | 14.058 | -63.77 | 0.017 | -76.11 | 0.077 | -47.98 |
| 2.5 | 0.434 | -132.38 | 14.508 | -71.91 | 0.017 | -83.90 | 0.090 | -65.73 |
| 2.6 | 0.449 | -140.69 | 14.994 | -80.39 | 0.016 | -92.51 | 0.107 | -82.09 |
| 2.7 | 0.463 | -149.41 | 15.403 | -89.27 | 0.016 | -101.95 | 0.126 | -97.44 |
| 2.8 | 0.473 | -158.73 | 15.747 | -98.57 | 0.015 | -112.06 | 0.150 | -112.41 |
| 2.9 | 0.480 | -168.68 | 15.976 | -108.18 | 0.014 | -123.37 | 0.177 | -126.71 |
| 3.0 | 0.481 | -179.03 | 16.074 | -118.07 | 0.014 | -135.08 | 0.210 | -139.42 |
| 3.1 | 0.478 | 170.34 | 15.996 | -128.17 | 0.014 | -147.69 | 0.242 | -151.03 |
| 3.2 | 0.467 | 159.39 | 15.696 | -138.34 | 0.013 | -160.17 | 0.270 | -162.97 |
| 3.3 | 0.450 | 148.27 | 15.228 | -148.37 | 0.013 | -172.30 | 0.300 | -174.34 |
| 3.4 | 0.428 | 137.38 | 14.633 | -158.07 | 0.013 | 175.93 | 0.327 | 176.01 |
| 3.5 | 0.404 | 127.03 | 13.903 | -167.45 | 0.013 | 165.17 | 0.347 | 166.69 |
| 3.6 | 0.381 | 116.60 | 13.101 | -176.23 | 0.013 | 155.28 | 0.364 | 157.49 |
| 3.7 | 0.357 | 106.24 | 12.271 | 175.47 | 0.013 | 146.87 | 0.378 | 149.10 |
| 3.8 | 0.332 | 96.18 | 11.474 | 167.75 | 0.013 | 139.24 | 0.386 | 141.83 |
| 3.9 | 0.314 | 83.15 | 10.730 | 160.14 | 0.013 | 132.16 | 0.386 | 134.10 |
| 4.0 | 0.296 | 74.96 | 9.999 | 153.51 | 0.014 | 127.06 | 0.392 | 128.18 |
| 4.1 | 0.282 | 66.96 | 9.308 | 147.28 | 0.014 | 122.02 | 0.396 | 122.56 |
| 4.2 | 0.267 | 58.82 | 8.687 | 141.49 | 0.014 | 118.13 | 0.400 | 117.01 |
| 4.3 | 0.252 | 51.86 | 8.143 | 136.02 | 0.015 | 114.50 | 0.403 | 112.77 |
| 4.4 | 0.238 | 45.26 | 7.647 | 130.75 | 0.015 | 110.83 | 0.401 | 108.89 |
| 4.5 | 0.227 | 39.31 | 7.182 | 125.74 | 0.016 | 107.90 | 0.401 | 104.56 |
| 4.6 | 0.216 | 32.68 | 6.770 | 120.86 | 0.016 | 105.34 | 0.402 | 100.53 |
| 4.7 | 0.203 | 26.93 | 6.392 | 116.21 | 0.017 | 102.88 | 0.400 | 96.95 |
| 4.8 | 0.190 | 20.82 | 6.056 | 111.63 | 0.018 | 100.30 | 0.398 | 93.19 |
| 4.9 | 0.178 | 15.55 | 5.740 | 107.27 | 0.018 | 97.92 | 0.397 | 89.45 |
| 5.0 | 0.169 | 10.06 | 5.448 | 103.06 | 0.019 | 95.81 | 0.396 | 86.01 |
| 5.1 | 0.156 | 4.12 | 5.181 | 98.77 | 0.020 | 93.45 | 0.394 | 82.07 |
| 5.2 | 0.141 | -1.67 | 4.943 | 94.71 | 0.020 | 91.54 | 0.394 | 78.96 |
| 5.3 | 0.132 | -7.43 | 4.722 | 90.73 | 0.021 | 89.25 | 0.391 | 75.43 |
| 5.4 | 0.122 | -14.31 | 4.515 | 86.71 | 0.022 | 87.22 | 0.388 | 71.86 |
| 5.5 | 0.112 | -22.69 | 4.315 | 82.73 | 0.023 | 84.51 | 0.388 | 68.09 |
| 5.6 | 0.102 | -32.31 | 4.133 | 78.92 | 0.024 | 82.03 | 0.388 | 65.06 |
| 5.7 | 0.093 | -41.13 | 3.971 | 75.14 | 0.025 | 79.79 | 0.385 | 61.53 |
| 5.8 | 0.090 | -51.19 | 3.818 | 71.35 | 0.025 | 77.65 | 0.389 | 57.47 |
| 5.9 | 0.089 | -63.48 | 3.666 | 67.57 | 0.026 | 75.64 | 0.389 | 54.11 |
| 6.0 | 0.091 | -76.48 | 3.537 | 63.84 | 0.027 | 73.59 | 0.387 | 50.63 |

Noise Parameters

Test conditions: $V_{DD}=+5\text{ V}$, $I_{DD}=50\text{ mA}$ (typ.), $T=+25^{\circ}\text{C}$, Reference planes at device pins

| Freq (GHz) | NF _{min} (dB) | Gamma Opt (mag) | Gamma Opt (deg) | Rn (Ω) |
|------------|------------------------|-----------------|-----------------|--------|
| 2.0 | 0.246 | 0.283 | 47.66 | 0.076 |
| 2.2 | 0.261 | 0.231 | 68.48 | 0.061 |
| 2.4 | 0.279 | 0.213 | 81.15 | 0.054 |
| 2.6 | 0.315 | 0.198 | 92.03 | 0.050 |
| 2.8 | 0.334 | 0.191 | 103.07 | 0.046 |
| 3.0 | 0.408 | 0.146 | 110.96 | 0.053 |
| 3.2 | 0.413 | 0.189 | 117.92 | 0.044 |
| 3.4 | 0.450 | 0.162 | 131.84 | 0.045 |
| 3.5 | 0.491 | 0.131 | 143.21 | 0.048 |
| 3.6 | 0.531 | 0.157 | 152.91 | 0.043 |
| 4.0 | 0.599 | 0.099 | 172.03 | 0.050 |
| 4.2 | 0.634 | 0.142 | -176.97 | 0.051 |
| 4.4 | 0.686 | 0.142 | -160.26 | 0.051 |
| 4.6 | 0.681 | 0.149 | -153.24 | 0.057 |
| 4.8 | 0.775 | 0.102 | -141.49 | 0.069 |
| 5.0 | 0.817 | 0.138 | -132.51 | 0.076 |
| 5.2 | 0.863 | 0.149 | -131.67 | 0.079 |
| 5.4 | 0.957 | 0.134 | -130.72 | 0.092 |
| 5.6 | 1.051 | 0.185 | -114.16 | 0.107 |
| 5.8 | 1.184 | 0.178 | -113.36 | 0.109 |

QPL9057EVB-01 Evaluation Board



Notes:

1. See Evaluation Board PCB Information section for material and stack-up.
2. R3 (0 Ω jumper) is not shown on the schematic and may be replaced with copper trace in the target application layout.
3. All components are of 0402 size unless stated on the schematic.
4. For TDD Applications: R1 = 20K & R2 = 0 Ω
5. For FDD Applications: R1 = 20K 'OR' Pin 6 tied to ground. R2 = DNP/Omitted
6. A through line is included on the evaluation board to de-embed the board losses.
7. R4 sets the current draw. Can be changed for the desired bias point.

Bill of Material – QPL9057EVB-01

| Reference Des. | Value | Description | Manuf. | Part Number |
|--------------------|-------------|---------------------------------------|-----------|--------------|
| PCB | -- | Printed Circuit Board | Qorvo | 290375 |
| U1 | -- | Amplifier, Ultra-Low Noise, Flat Gain | Qorvo | QPL9057 |
| R4 | 5.1 K | Resistor, 0402, 5%, 1/16W | various | |
| R1 | 20 K | Resistor, 0402, 5%, 1/16W | various | |
| R2, R3 | 0 Ω | Resistor, 0402, 5%, 1/16W | various | |
| L1 | 18 nH | Inductor, 0402, 2%, | Coilcraft | 0402CS-18NXG |
| C4 | 1.0 μ F | Capacitor, 0402, 10%, 10V, X5R | various | |
| C1, C2, C3, C5, C6 | 100 pF | Capacitor, 0402, 5%, 50V, NPO/COG | various | |

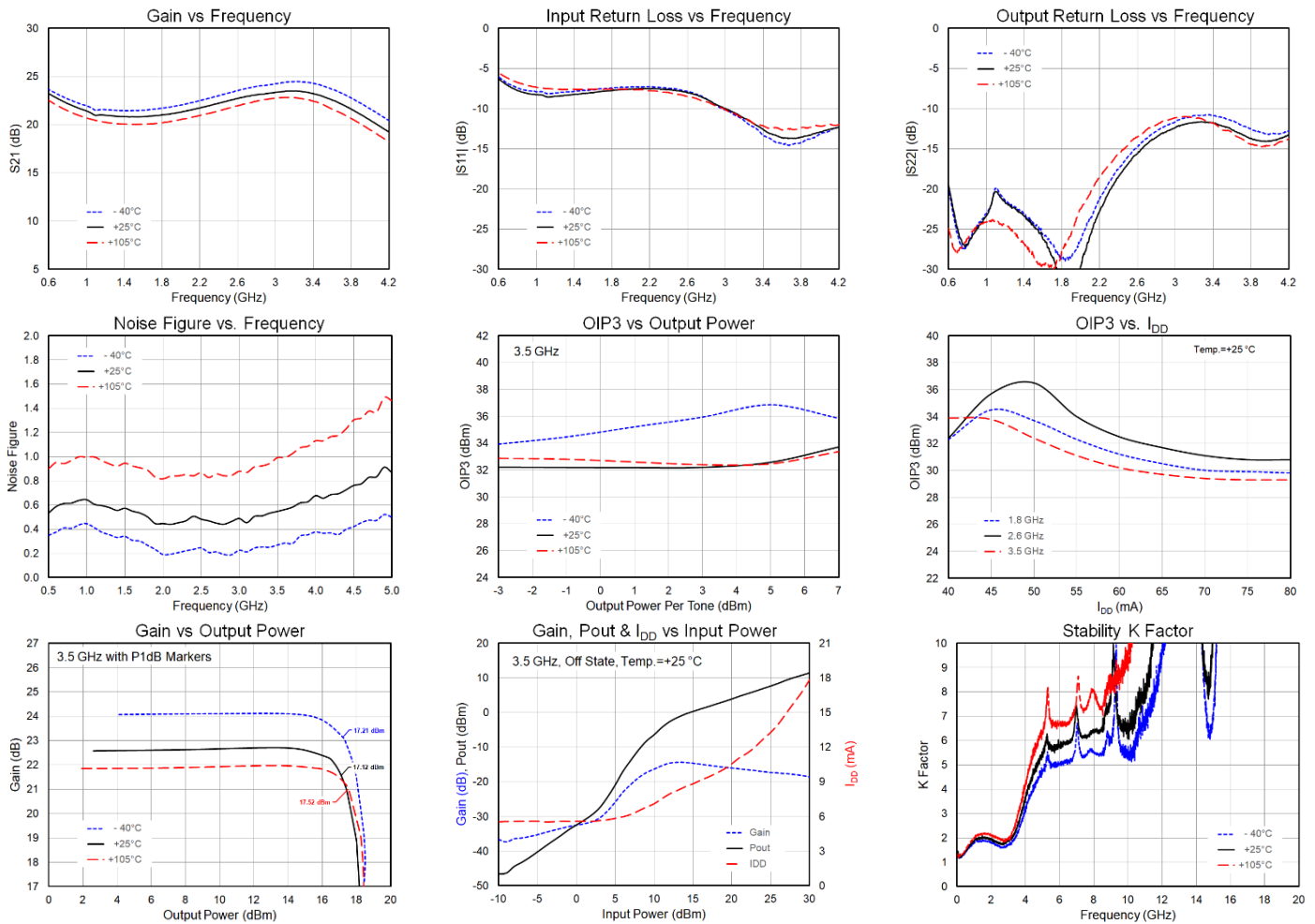
Typical Performance – QPL9057EVB-01

Test conditions unless otherwise noted: $V_{DD}=+5\text{ V}$, $I_{DD}=50\text{ mA}$ (typ.), $\text{Temp}=+25^\circ\text{C}$

| Parameter | Conditions | Typical Values | | | Units |
|--------------------|---|----------------|------|------|-------|
| Frequency | | 1800 | 2600 | 3500 | MHz |
| Gain | | 21.0 | 22.7 | 22.8 | dB |
| Input Return Loss | | 7.8 | 8.0 | 13.0 | dB |
| Output Return Loss | | 31.9 | 15.6 | 12.0 | dB |
| Output P1dB | | 17.1 | 17.1 | 17.0 | dBm |
| OIP3 | $P_{out}=+5\text{ dBm/ tone}$, $\Delta f=1\text{ MHz}$ | 33.8 | 37.8 | 32.0 | dBm |
| Noise figure | EVB input trace loss de-embedded | 0.50 | 0.47 | 0.54 | dB |

Performance Plots – QPL9057EVB-01

Test conditions unless otherwise noted: $V_{DD}=+5\text{ V}$, $I_{DD}=50\text{ mA}$, $\text{Temp}=+25^\circ\text{C}$. Noise figure data has input trace loss de-embedded.



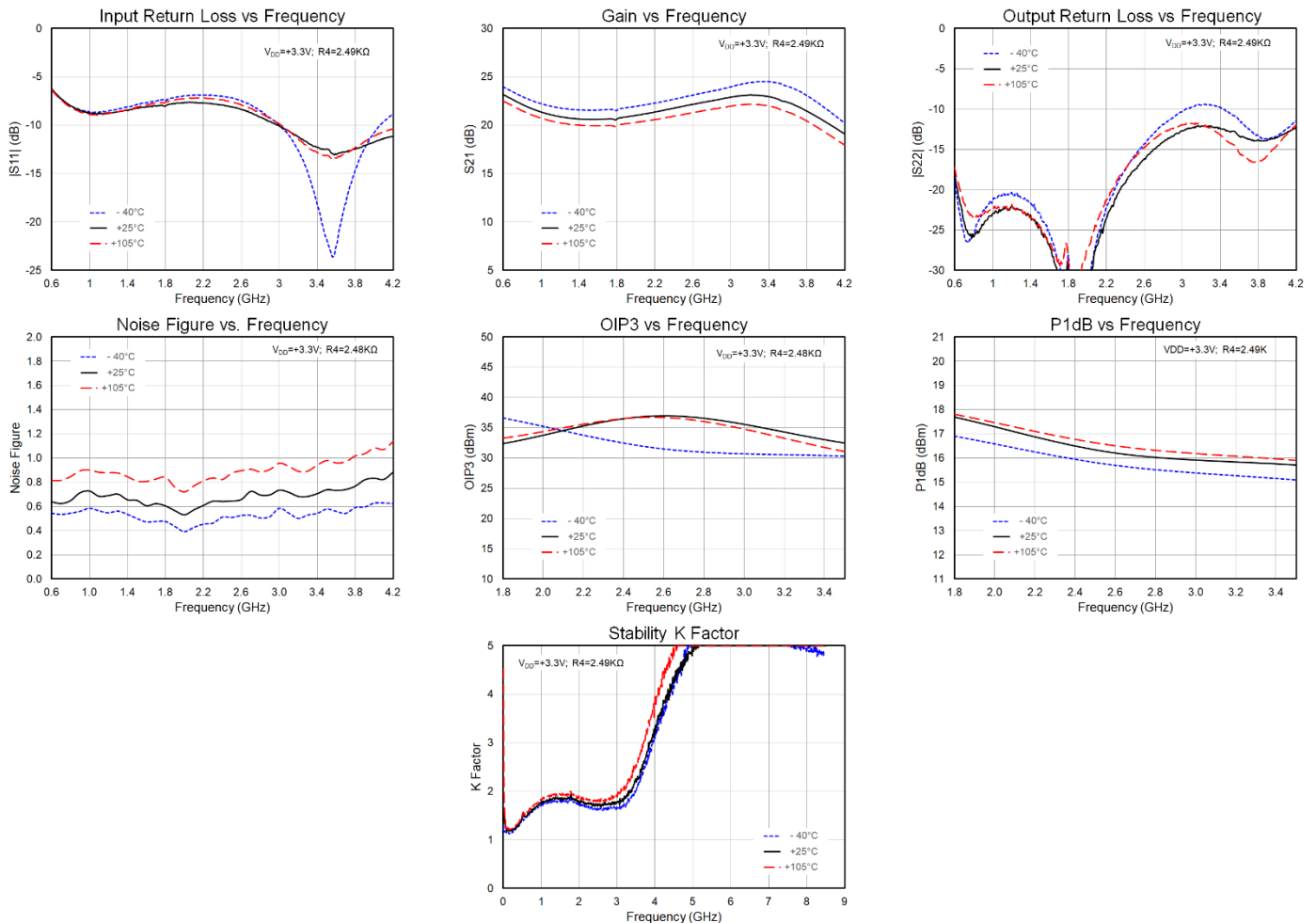
Typical Performance – $V_{DD} +3.3\text{ V}$, $R_4\ 2.49\text{ K}\Omega$

Test conditions unless otherwise noted: $V_{DD}=+3.3\text{ V}$, $I_{DD}=50\text{ mA}$ (typ.), $\text{Temp}=+25^\circ\text{C}$

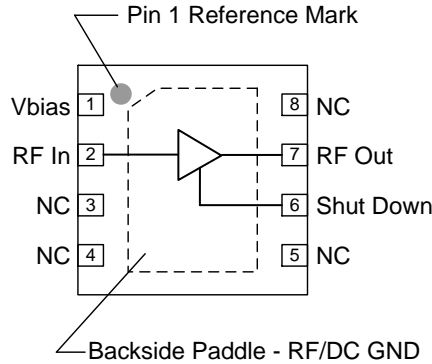
| Parameter | Conditions | Typical Values | | | Units |
|--------------------|--|----------------|------|------|-------|
| Frequency | | 1800 | 2600 | 3500 | MHz |
| Gain | | 20.6 | 22.1 | 22.7 | dB |
| Input Return Loss | | 8.0 | 8.4 | 12.5 | dB |
| Output Return Loss | | 29.4 | 16.1 | 12.8 | dB |
| Output P1dB | | 17.7 | 16.2 | 157 | dBm |
| OIP3 | $P_{out}=+5\text{ dBm/tone}$, $\Delta f=1\text{ MHz}$ | 32.4 | 37.0 | 32.5 | dBm |
| Noise figure | EVB input trace loss de-embedded | 0.61 | 0.66 | 0.74 | dB |

Performance Plots – $V_{DD} +3.3\text{ V}$, $R_4\ 2.49\text{ K}\Omega$

Test conditions unless otherwise noted: $V_{DD}=+3.3\text{ V}$, $I_{DD} = 50\text{mA}$, $\text{Temp}=+25^\circ\text{C}$. Noise figure data has input trace loss de-embedded.



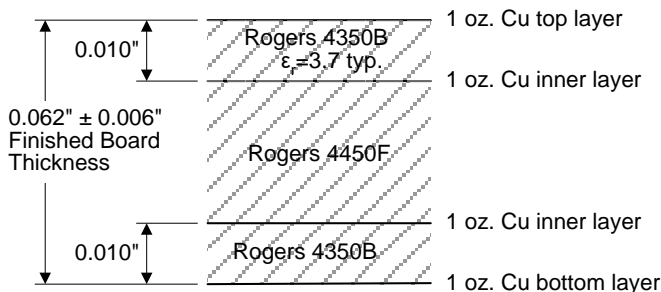
Pin Configuration and Description



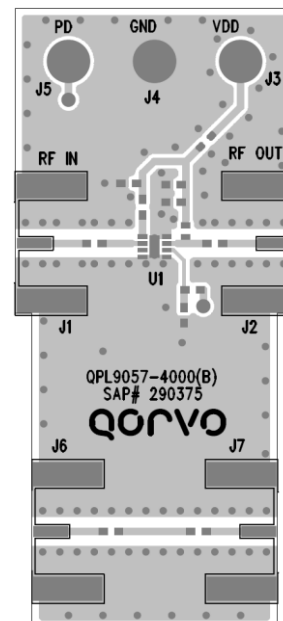
| Pin No. | Label | Description |
|-----------------|------------------|---|
| 1 | Vbias | Sets the I_{DQ} bias point for the device. |
| 2 | RF In | RF Input pin. A DC Block is required. |
| 6 | Shut Down | $V_{SD} \geq 1.17V$ turns off the device. If the pin is pulled to ground or driven with a voltage $\leq 0.63V$, then the device will operate under LNA ON state. |
| 7 | RF Out / DC Bias | RF Output pin. DC bias will also need to be injected through a RF bias choke/inductor for operation. |
| 3, 4, 5, 8 | NC | No electrical connection. Provide grounded land pads for PCB mounting integrity. |
| Backside Paddle | RF/DC GND | RF/DC ground. Use recommended via hole pattern to minimize inductance and thermal resistance; see PCB Mounting Pattern for suggested footprint. |

Evaluation Board PCB Information

Qorvo PCB 290375 Material and Stack-up



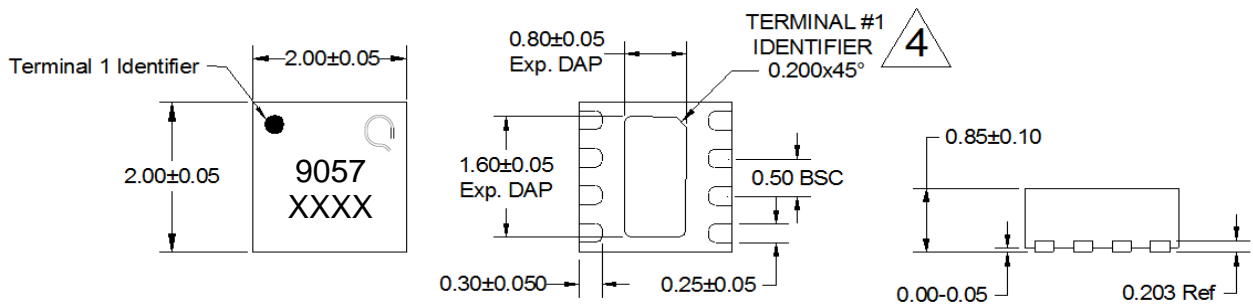
50 ohm line dimensions: width = 0.020", spacing = 0.032"



Mechanical Information

Package Marking and Dimensions

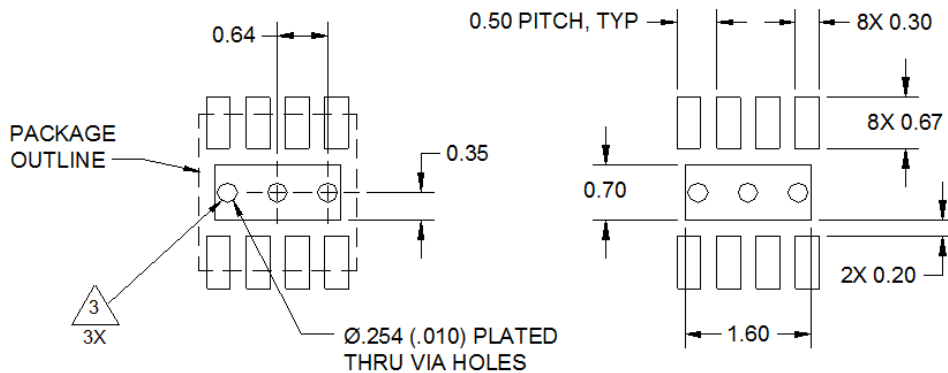
Marking: Part number – 9057
Trace code – XXXX



Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Except where noted, this part outline conforms to JEDEC standard MO-220, Issue E (Variation VGGC) for thermally enhanced plastic very thin fine pitch dual flat no lead package (DFN).
3. Dimension and tolerance formats conform to ASME Y14.4M-1994.
4. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

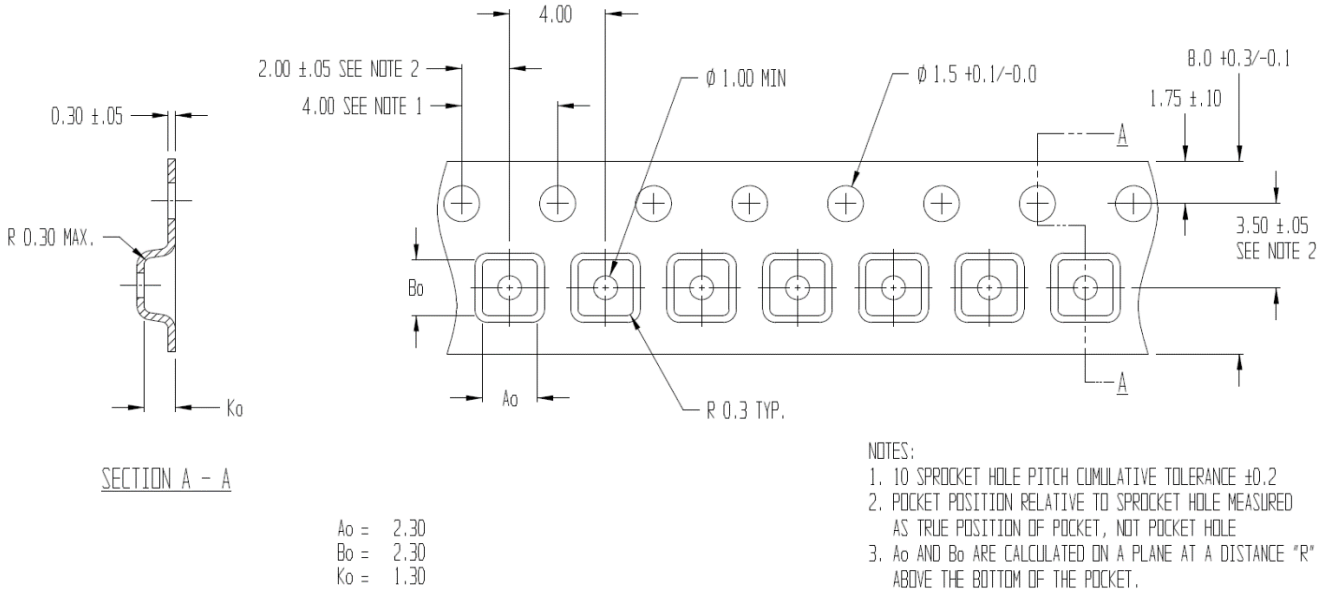
PCB Mounting Pattern



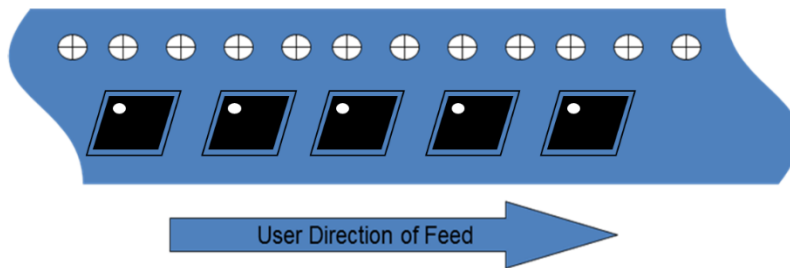
Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layer metal.
3. Via holes are required under the backside paddle of this device for proper RF/DC grounding and thermal dissipation. We recommend a 0.35 mm (#80/.0135") diameter bit for drilling via holes and a final plated thru diameter of 0.25 mm (0.01 ").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

Tape and Reel Information – Carrier and Cover Tape Dimensions

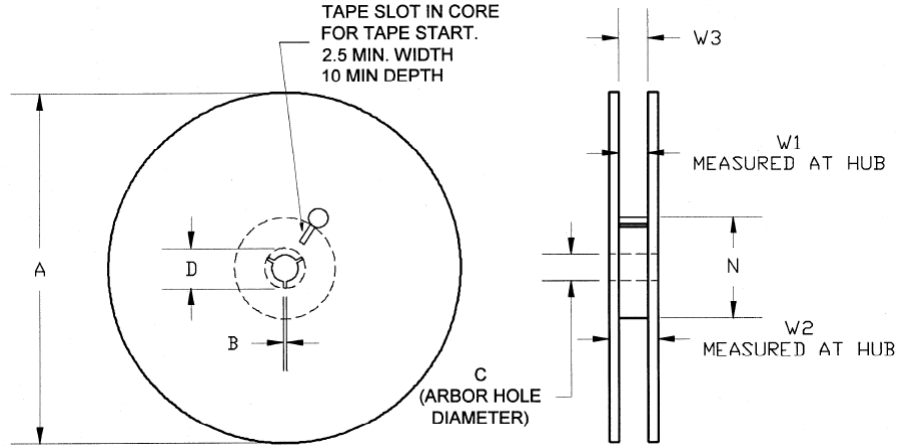


| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---------------------|--|--------|-----------|-----------|
| Cavity | Length | A0 | 0.091 | 2.30 |
| | Width | B0 | 0.091 | 2.30 |
| | Depth | K0 | 0.039 | 1.30 |
| | Pitch | P1 | 0.157 | 4.00 |
| Centerline Distance | Cavity to Perforation - Length Direction | P2 | 0.079 | 2.00 |
| | Cavity to Perforation - Width Direction | F | 0.138 | 3.50 |
| Cover Tape | Width | C | 0.213 | 5.40 |
| Carrier Tape | Width | W | 0.315 | 8.00 |



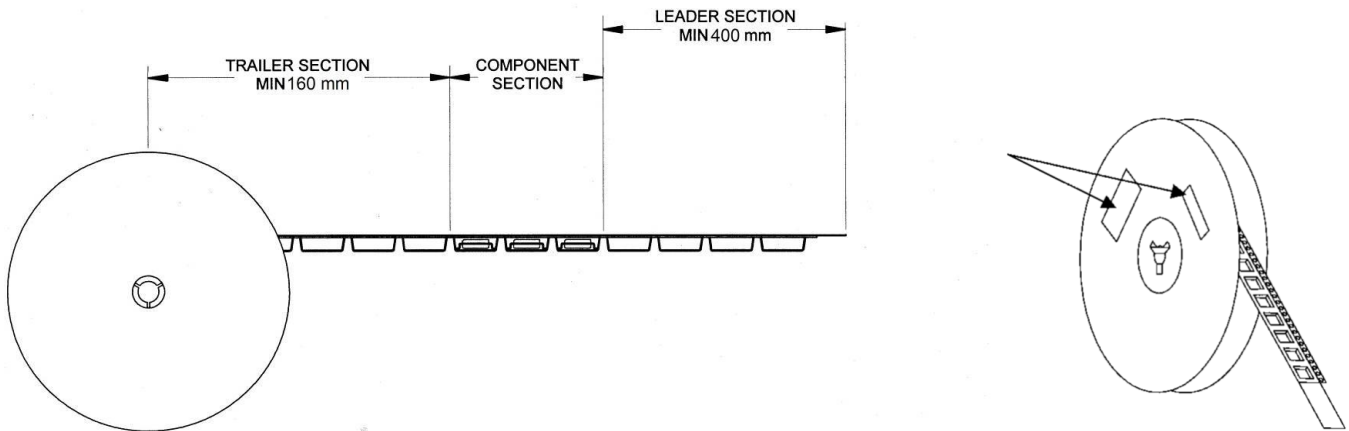
Tape and Reel Information – Reel Dimensions

Standard T/R size = 2,500 pieces on a 7" reel.



| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange | Diameter | A | 6.969 | 177.00 |
| | Thickness | W2 | 0.559 | 14.20 |
| | Space Between Flange | W1 | 0.346 | 8.80 |
| Hub | Outer Diameter | N | 2.283 | 58.00 |
| | Arbor Hole Diameter | C | 0.512 | 13.00 |
| | Key Slit Width | B | 0.079 | 2.00 |
| | Key Slit Diameter | D | 0.787 | 20.00 |

Tape and Reel Information – Tape Length and Label Placement



- Notes:
1. Empty part cavities at the trailing and leading ends are sealed with cover tape. See EIA 481-1-A.
 2. Labels are placed on the flange opposite the sprockets in the carrier tape.

Handling Precautions

| Parameter | Rating | Standard |
|----------------------------------|----------|--------------------------|
| ESD – Human Body Model (HBM) | Class 1B | ESDA / JEDEC JS-001-2014 |
| ESD – Charged Device Model (CDM) | Class C3 | ESDA / JEDEC JS-002-2014 |
| MSL – Moisture Sensitivity Level | Level 1 | IPC/JEDEC J-STD-020 |



Caution!
ESD-Sensitive Device

Solderability

Compatible with lead-free (260°C max. reflow temp.) soldering process.
Solder profiles available upon request.

Contact plating - NiPdAu (*Thickness: Ni 0.508 ~ 1.524 μm; Pd 0.023 ~ 0.1016 μm; Au 0.00254 ~ 0.01016 μm*)

RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C₁₅H₁₂Br₄O₂) Free
- PFOS Free
- SVHC Free



Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

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Email: customer.support@qorvo.com

For technical questions and application information:

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