



# QPL9058

## 0.5 – 6.0 GHz Ultra Low-Noise LNA

### Product Overview

The QPL9058 is a high-linearity, ultra-low noise amplifier in a small 2 x 2 mm surface-mount package. At 3.6 GHz, the amplifier typically provides 18 dB gain, +36 dBm OIP3 at a 54 mA bias setting, and 0.6 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 QPL9058 is bias adjustable and requires minimal external components to operate. It also has a power down control capability integrated into the die for TDD applications.

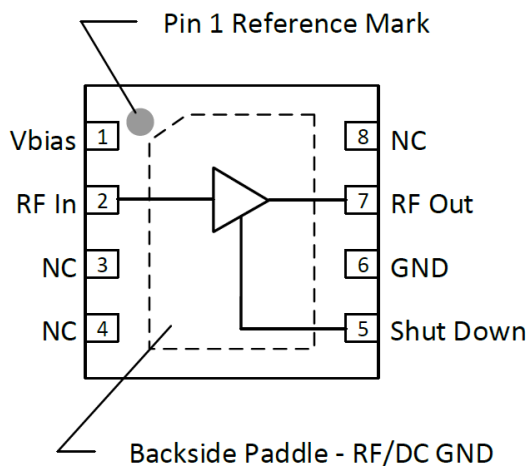


8 Pin 2X2 mm DFN Package

### Key Features

- 0.5-6.0 GHz Operational Bandwidth
- Low noise figure, 0.6 dB NF @ 3.6 GHz
- 36 dBm OIP3
- 18 dB small signal gain
- Bias adjustable for linearity optimization
- Unconditionally stable
- Shut-down mode pin with 1.8V logic
- Maintains OFF state with high Pin drive

### Functional Block Diagram



Top View

### Applications

- 5G m-MIMO
- Repeaters / DAS
- Mobile Infrastructure
- LTE / WCDMA / CDMA / GSM
- General Purpose Wireless
- TDD or FDD systems

### Ordering Information

| Part No.      | Description                  |
|---------------|------------------------------|
| QPL9058TR7    | 2500 pieces on a 7" reel     |
| QPL9058EVB-01 | 0.5-6.0 GHz Evaluation Board |

## Absolute Maximum Ratings

| Parameter                           | Rating        |
|-------------------------------------|---------------|
| Storage Temperature                 | -65 to +150°C |
| Supply Voltage (V <sub>DD</sub> )   | +7 V          |
| RF Input Power, CW, 50 Ω, T=25°C    | +27 dBm       |
| RF Input Power, LTE 9dB PAR, T=25°C | +22 dBm       |

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device.

## Recommended Operating Conditions

| Parameter                                      | Min   | Typ | Max   | Units |
|------------------------------------------------|-------|-----|-------|-------|
| Supply Voltage (V <sub>DD</sub> )              | +3.15 | +5  | +5.25 | V     |
| T <sub>CASE</sub>                              | -40   |     | +105  | °C    |
| T <sub>j</sub> for >10 <sup>6</sup> hours MTTF |       |     | +190  | °C    |

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions. Application of conditions to the device outside the Recommended Operating Conditions may reduce device reliability and performance.

## Electrical Specifications

Test conditions unless otherwise noted: V<sub>DD</sub>=+5 V, Temp.=+25 °C, 50 Ω system.

| Parameter                             | Conditions                              | Min   | Typ   | Max             | Units |
|---------------------------------------|-----------------------------------------|-------|-------|-----------------|-------|
| Operational Frequency Range           |                                         | 500   |       | 6000            | MHz   |
| Test Frequency                        |                                         |       | 3600  |                 | MHz   |
| Gain                                  |                                         | 16.5  | 18.0  | 19.9            | dB    |
| Input Return Loss                     |                                         |       | 15.0  |                 | dB    |
| Output Return Loss                    |                                         |       | 19.5  |                 | dB    |
| Noise Figure <sup>(1)</sup>           |                                         |       | 0.59  | 0.95            | dB    |
| Output P1dB                           |                                         | +17.7 | +20.6 |                 | dBm   |
| Output IP3                            | P <sub>out</sub> =+2 dBm/tone, Δf=1 MHz | +32.0 | +36.4 |                 | dBm   |
| Power Shutdown Control (pin 5)        | On state                                | 0     |       | 0.63            | V     |
|                                       | Off state (Power down)                  | 1.17  |       | V <sub>DD</sub> | V     |
| Current, I <sub>DD</sub>              | On state                                |       | 54    | 74              | mA    |
|                                       | Off state (Power down)                  |       | 4     | 7               | mA    |
| Shutdown pin current, I <sub>SD</sub> | V <sub>PD</sub> = 1.8 V                 |       | 18    |                 | μA    |
| Switching Time (LNA On)               | 50% DC to 0.5dB of settled power/gain   |       | 60    |                 | ns    |
| Switching Time (LNA Off)              | 50% DC to -20dB from LNA ON power/gain  |       | 41    |                 | ns    |
| Thermal Resistance                    | Channel to case                         |       | 63.7  |                 | °C/W  |

Notes:

1. Input trace loss de-embedded from NF data.

## S-Parameters

Test Conditions:  $V_{DD}=+5$  V,  $I_{DD}=54$  mA (typ.),  $T=+25^{\circ}\text{C}$ , unmatched 50  $\Omega$  system, calibrated to device leads

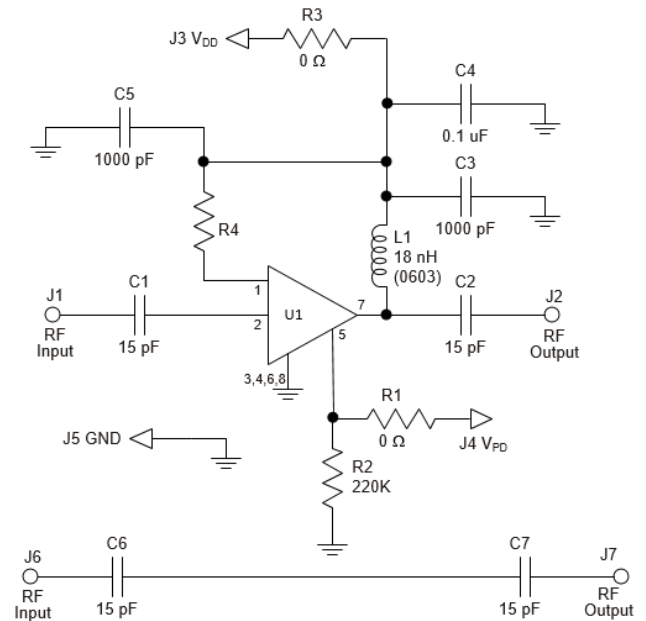
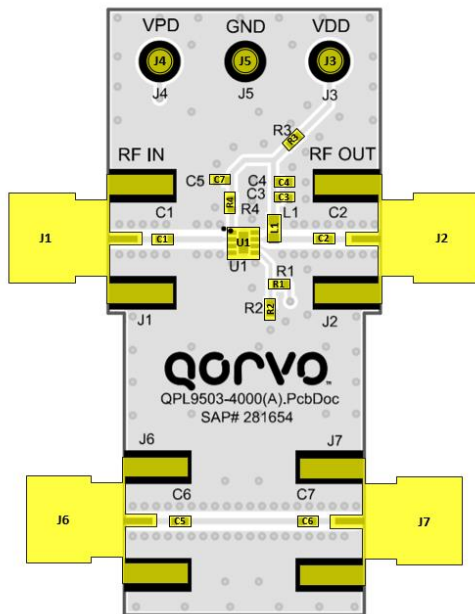
| Freq (GHz) | S11 (dB) | S11 (ang) | S21 (dB) | S21 (ang) | S12 (dB) | S12 (ang) | S22 (dB) | S22 (ang) |
|------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| 2          | -13.3    | -142      | 19.4     | 13        | -29.8    | -17       | -22.9    | -21       |
| 2.1        | -13.8    | -145      | 19.2     | 8         | -29.7    | -20       | -23.3    | -17       |
| 2.2        | -14.2    | -148      | 19.0     | 2         | -29.6    | -23       | -23.4    | -12       |
| 2.3        | -14.7    | -150      | 18.9     | -4        | -29.5    | -26       | -23.5    | -8        |
| 2.4        | -15.1    | -152      | 18.7     | -9        | -29.5    | -29       | -23.5    | -4        |
| 2.5        | -15.4    | -153      | 18.6     | -15       | -29.5    | -33       | -23.4    | -2        |
| 2.6        | -15.7    | -154      | 18.5     | -20       | -29.5    | -36       | -23.4    | 1         |
| 2.7        | -15.9    | -155      | 18.5     | -26       | -29.5    | -40       | -23.3    | 1         |
| 2.8        | -16.1    | -155      | 18.4     | -32       | -29.5    | -43       | -23.4    | 2         |
| 2.9        | -16.1    | -155      | 18.4     | -37       | -29.5    | -47       | -23.6    | 1         |
| 3          | -16.0    | -155      | 18.4     | -43       | -29.5    | -51       | -24.1    | 1         |
| 3.1        | -15.7    | -155      | 18.4     | -49       | -29.6    | -55       | -24.6    | -1        |
| 3.2        | -15.4    | -155      | 18.5     | -55       | -29.6    | -59       | -25.6    | -4        |
| 3.3        | -15.0    | -156      | 18.5     | -61       | -29.7    | -63       | -26.9    | -9        |
| 3.4        | -14.4    | -157      | 18.6     | -67       | -29.8    | -67       | -29.2    | -17       |
| 3.5        | -13.8    | -158      | 18.7     | -73       | -29.8    | -72       | -32.2    | -34       |
| 3.6        | -13.3    | -159      | 18.8     | -79       | -29.9    | -77       | -36.5    | -61       |
| 3.7        | -12.9    | -160      | 18.9     | -86       | -30.0    | -82       | -45.1    | -87       |
| 3.8        | -12.2    | -163      | 19.0     | -92       | -30.1    | -87       | -33.3    | -168      |
| 3.9        | -11.3    | -167      | 19.1     | -99       | -30.3    | -93       | -26.4    | 175       |
| 4          | -10.6    | -172      | 19.2     | -106      | -30.4    | -99       | -22.4    | 168       |
| 4.1        | -9.8     | -177      | 19.3     | -114      | -30.6    | -105      | -19.2    | 162       |
| 4.2        | -9.1     | 177       | 19.3     | -122      | -30.8    | -112      | -16.7    | 155       |
| 4.3        | -8.5     | 171       | 19.3     | -130      | -31.1    | -119      | -14.5    | 150       |
| 4.4        | -7.9     | 165       | 19.3     | -138      | -31.4    | -126      | -12.8    | 143       |
| 4.5        | -7.4     | 159       | 19.2     | -146      | -31.8    | -134      | -11.2    | 137       |
| 4.6        | -6.9     | 152       | 19.1     | -154      | -32.2    | -142      | -9.9     | 130       |
| 4.7        | -6.6     | 146       | 18.9     | -162      | -32.6    | -149      | -8.8     | 125       |
| 4.8        | -6.3     | 140       | 18.7     | -170      | -33.1    | -157      | -7.8     | 118       |
| 4.9        | -6.1     | 133       | 18.4     | -178      | -33.6    | -165      | -7.0     | 113       |
| 5.0        | -6.0     | 127       | 18.1     | 174       | -34.1    | -173      | -6.3     | 107       |

## Noise Parameters

Test Conditions:  $V_{DD}=+5$  V,  $I_{DD}=54$  mA (typ.),  $T=+25^{\circ}\text{C}$ , unmatched 50 ohm system, calibrated to device leads

| Freq (GHz) | NF <sub>min</sub> (dB) | GammaOpt (mag) | GammaOpt (deg) | r <sub>n</sub> (Ω) |
|------------|------------------------|----------------|----------------|--------------------|
| 2.0        | 0.22                   | 0.14           | 66             | 0.048              |
| 2.1        | 0.26                   | 0.08           | 81             | 0.048              |
| 2.2        | 0.29                   | 0.12           | 72             | 0.047              |
| 2.3        | 0.28                   | 0.10           | 90             | 0.048              |
| 2.4        | 0.34                   | 0.08           | 83             | 0.052              |
| 2.5        | 0.36                   | 0.06           | 111            | 0.053              |
| 2.6        | 0.37                   | 0.12           | 104            | 0.046              |
| 2.7        | 0.39                   | 0.11           | 110            | 0.049              |
| 2.8        | 0.43                   | 0.10           | 116            | 0.052              |
| 2.9        | 0.39                   | 0.14           | 121            | 0.046              |
| 3.0        | 0.49                   | 0.06           | 150            | 0.062              |
| 3.1        | 0.42                   | 0.14           | 127            | 0.049              |
| 3.2        | 0.49                   | 0.14           | 125            | 0.052              |
| 3.3        | 0.47                   | 0.19           | 127            | 0.046              |
| 3.4        | 0.46                   | 0.22           | 139            | 0.040              |
| 3.5        | 0.60                   | 0.08           | 148            | 0.065              |
| 3.6        | 0.54                   | 0.19           | 131            | 0.050              |
| 3.7        | 0.52                   | 0.20           | 133            | 0.050              |
| 3.8        | 0.55                   | 0.11           | -123           | 0.051              |
| 3.9        | 0.52                   | 0.17           | 135            | 0.055              |
| 4.0        | 0.55                   | 0.18           | 147            | 0.052              |
| 4.1        | 0.54                   | 0.16           | 154            | 0.055              |
| 4.2        | 0.57                   | 0.16           | 165            | 0.055              |
| 4.3        | 0.58                   | 0.16           | 161            | 0.050              |
| 4.4        | 0.59                   | 0.17           | 156            | 0.051              |
| 4.5        | 0.59                   | 0.20           | -168           | 0.052              |
| 4.6        | 0.56                   | 0.17           | 180            | 0.046              |
| 4.7        | 0.58                   | 0.16           | -179           | 0.045              |
| 4.8        | 0.55                   | 0.18           | 178            | 0.047              |
| 4.9        | 0.56                   | 0.16           | -171           | 0.048              |
| 5.0        | 0.58                   | 0.16           | -168           | 0.050              |

## Evaluation Board – QPL9058EVB-01



### Notes:

1. See Evaluation Board PCB Information section for material and stack-up.
2. All components are of 0402 size unless otherwise mentioned.
3. For TDD Applications: R1 = 0Ω and R2 = 220K.
4. For FDD Applications: R2 = 220K 'OR' Pin 5 tied to ground. R1 = DNP/Omitted
5. A through line is included on the evaluation board to de-embed the board losses.
6. R4 sets the current draw. Can be changed for the desired bias point.

## Bill of Material – QPL9058EVB-01

| Reference Des. | Value   | Description                     | Manuf.    | Part Number        |
|----------------|---------|---------------------------------|-----------|--------------------|
| N/A            | N/A     | Printed Circuit Board           | Qorvo     |                    |
| U1             | n/a     | Ultra Low Noise QPL9058 LNA     | Qorvo     | QPL9058            |
| R1, R3         | 0 Ω     | Resistor, chip, 0402, 1%, 1/10W | various   |                    |
| R2             | 220 KΩ  | Resistor, chip, 0402, 5%, 1/16W | various   |                    |
| R4             | 3.83 KΩ | Resistor, Chip, 0402, 1%, 1/16W | various   |                    |
| C1, C2, C6, C7 | 15 pF   | Cap., Chip, 0402, 2%, 50V, HI-Q | Murata    | GJM1555C1H150JB01D |
| C3, C5         | 1000 pF | Cap., Chip, 0402, 10%, 50V, X7R | Murata    | GRM155R71H102KA01D |
| C4             | 0.1 uF  | Cap., Chip, 0402, 10%, 50V, X5R | various   |                    |
| L1             | 18 nH   | Inductor, coil, 0603, 5%        | Coilcraft | 0603CS-18NXJL      |

## R4 Resistor values for various I<sub>DD</sub> settings

| I <sub>DD</sub> (mA) |             | 40    | 45   | 50    | 55    | 60    | 65    | 70   | 75    |
|----------------------|-------------|-------|------|-------|-------|-------|-------|------|-------|
| R4                   | VDD = 5 V   | 5.75K | 4.8K | 4.1K  | 3.7K  | 3.12K | 2.8K  | 2.5K | 2.27K |
| R4                   | VDD = 3.3 V | 2.9K  | 2.4K | 2.05K | 1.75K | 1.53K | 1.33K | 1.2K | 1.05K |

### Typical Performance – QPL9058EVB-01

Test conditions unless otherwise noted:  $V_{DD} = +5\text{ V}$ ,  $I_{DD} = 54\text{ mA}$  (typ.), Temp = +25°C

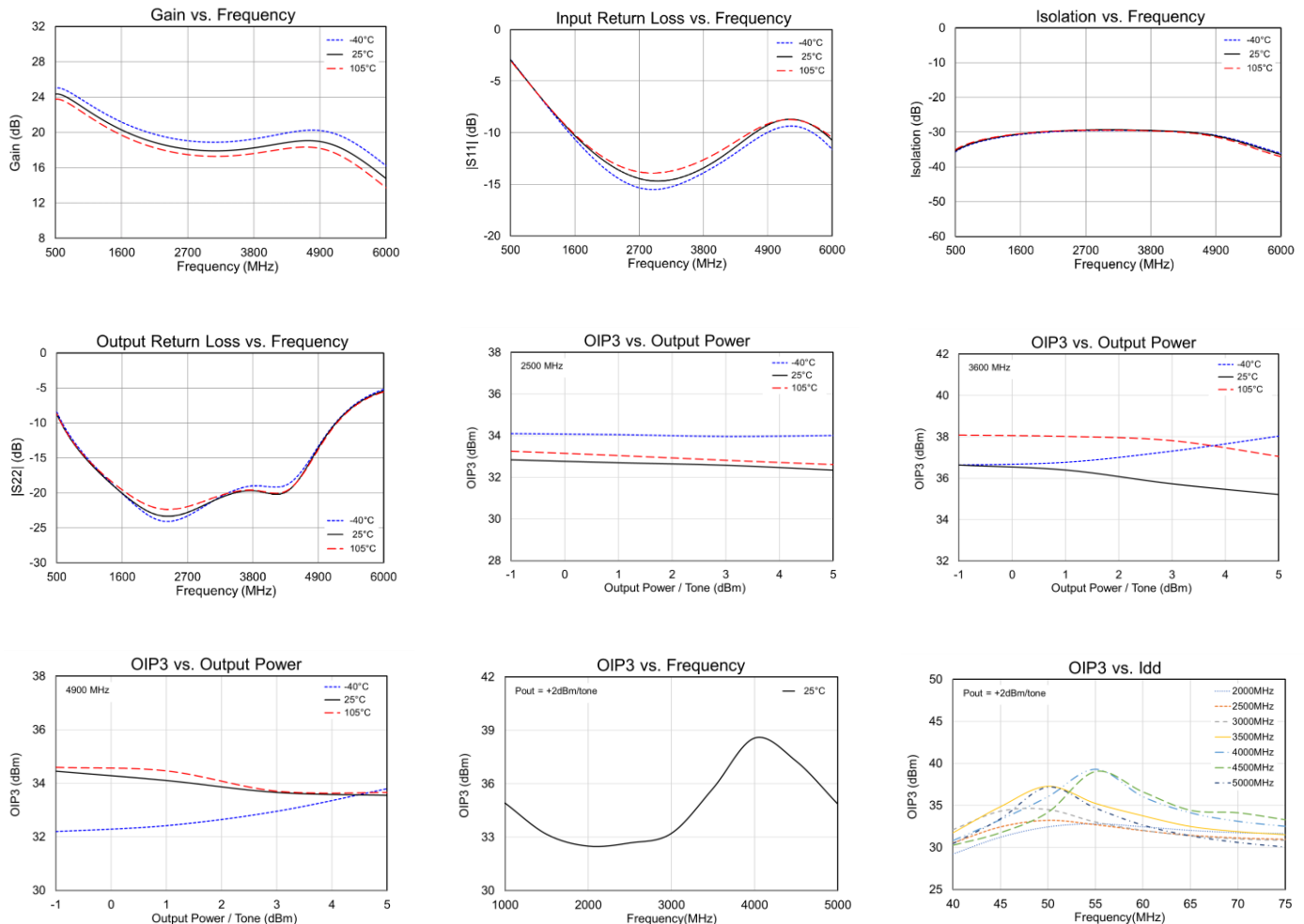
| Parameter                   | Conditions                                              | Typical Values |      |      | Units |
|-----------------------------|---------------------------------------------------------|----------------|------|------|-------|
| Frequency                   |                                                         | 2500           | 3600 | 4900 | MHz   |
| Gain                        |                                                         | 18.2           | 18.0 | 18.9 | dB    |
| Input Return Loss           |                                                         | 14.3           | 14.7 | 9.8  | dB    |
| Output Return Loss          |                                                         | 23.1           | 20.0 | 13.5 | dB    |
| Output P1dB                 |                                                         | 20.6           | 20.5 | 16.6 | dBm   |
| OIP3                        | $P_{out}=+2\text{ dBm/ tone}$ , $\Delta f=1\text{ MHz}$ | 32.6           | 36.0 | 33.9 | dBm   |
| Noise figure <sup>(1)</sup> |                                                         | 0.47           | 0.62 | 0.56 | dB    |

Note:

1. Input trace loss de-embedded from NF data

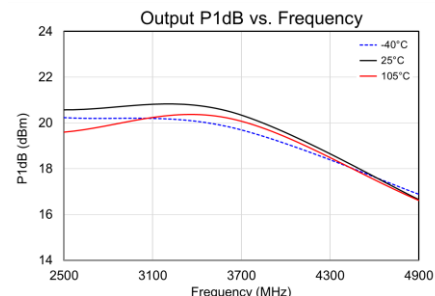
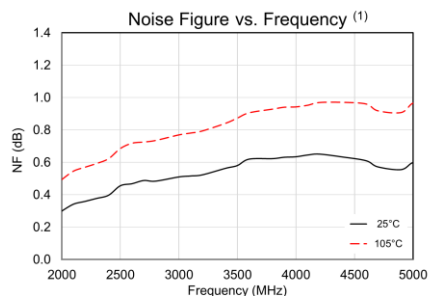
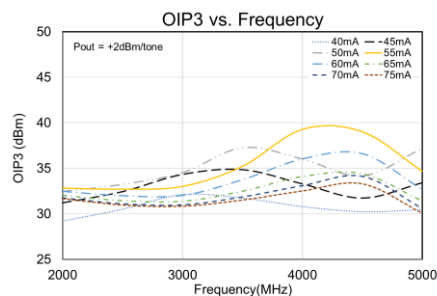
### Performance Plots – QPL9058EVB-01

Test conditions unless otherwise noted:  $V_{DD} = +5\text{ V}$ ,  $I_{DD} = 54\text{ mA}$ , 50  $\Omega$  system



## Performance Plots – QPL9058EVB-01 Continued

Test conditions unless otherwise noted:  $V_{DD} = +5\text{ V}$ ,  $I_{DD} = 54\text{ mA}$ ,  $50\ \Omega$  system



### Notes:

1. Input trace loss de-embedded from NF. NF at cold temp is better than 0.3dB causing measurement uncertainties. Therefore, not shown on the plot

## Typical Performance – QPL9058EVB-01

Test conditions unless otherwise noted:  $V_{DD} = +3.3$  V,  $I_{DD} = 50$  mA, Temp = +25°C

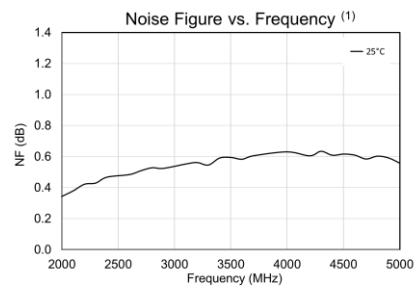
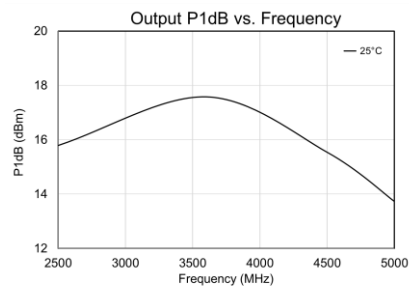
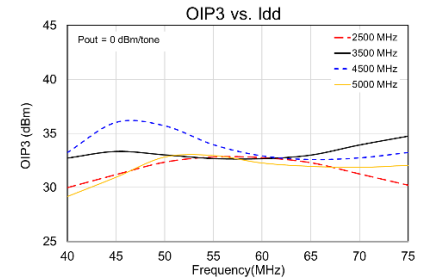
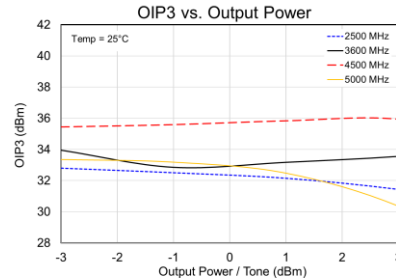
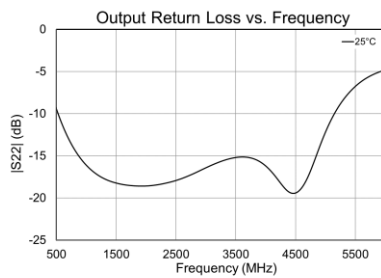
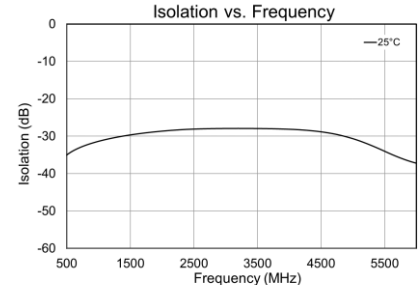
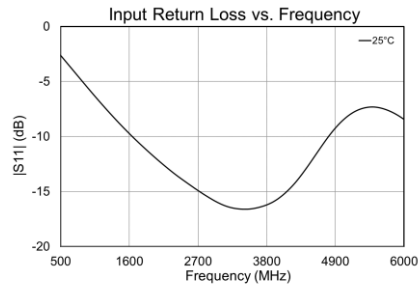
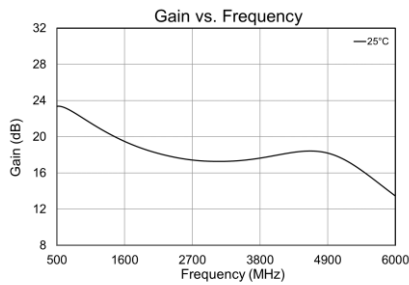
| Parameter                   | Conditions                         | Typical Values |      |      | Units |
|-----------------------------|------------------------------------|----------------|------|------|-------|
| Frequency                   |                                    | 2500           | 3500 | 5000 | MHz   |
| Gain                        |                                    | 17.6           | 17.4 | 18.0 | dB    |
| Input Return Loss           |                                    | 14.1           | 16.6 | 8.6  | dB    |
| Output Return Loss          |                                    | 18.0           | 15.2 | 12.2 | dB    |
| Output P1dB                 |                                    | 15.8           | 17.6 | 13.8 | dBm   |
| OIP3                        | Pout=+0 dBm/tone, $\Delta f=1$ MHz | 32.3           | 33.0 | 32.8 | dBm   |
| Noise figure <sup>(1)</sup> |                                    | 0.48           | 0.59 | 0.56 | dB    |

Notes:

1. Input trace loss de-embedded from NF data

## Performance Plots – QPL9058EVB-01

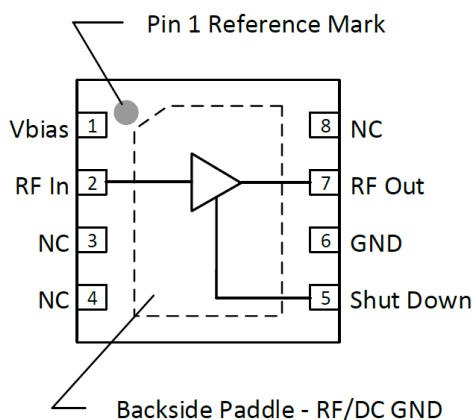
Test conditions unless otherwise noted:  $V_{DD} = +3.3$  V,  $I_{DD} = 50$  mA, Temp = +25°C, 50  $\Omega$  system



Note:

1. Input trace loss de-embedded from NF data.

## Pad Configuration and Description

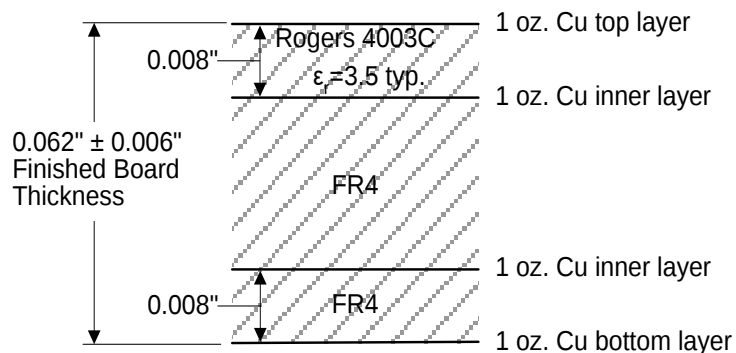


Top View

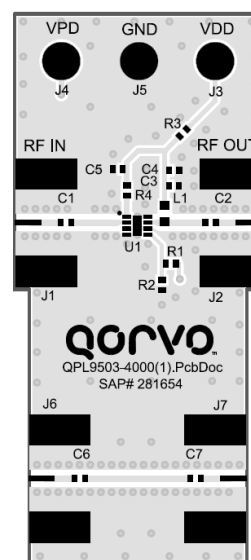
| Pad No.         | Label             | Description                                                                                                                                                                    |
|-----------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1               | V <sub>bias</sub> | Sets the LNA bias current for the device.                                                                                                                                      |
| 2               | RF In             | RF Input pin, internally matched to 50 ohms. A DC block is required.                                                                                                           |
| 5               | Shut Down         | A high voltage (>1.17V) turns off the device. If the pin is pulled to ground or driven with a voltage less than 0.63V, then the device will operate under LNA ON state.        |
| 7               | RF Out            | RF Output pin, internally matched to 50 ohms. A DC block is required. V <sub>DD</sub> supply pin.                                                                              |
| 3, 4, 6, 8      | NC                | Not connected internally. This pin may be left floating or connected to ground.                                                                                                |
| Backside Paddle | RF/DC GND         | Ground connection. The back side of the package should be connected to the ground plan though as short of a connection as possible. PCB vias under the device are recommended. |

## Evaluation Board PCB Information

### Qorvo PCB Material and Stack-up



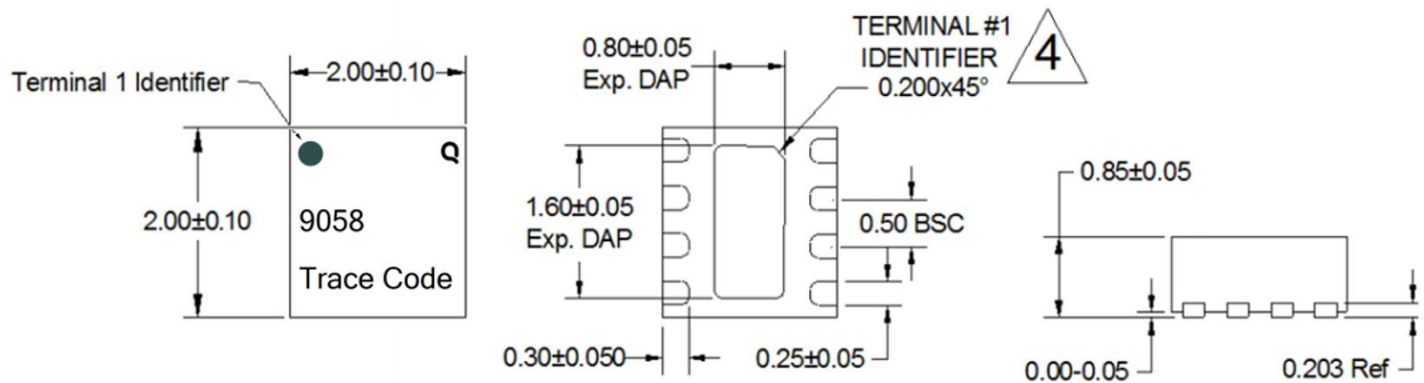
50 ohm line dimensions: width = 0.0182", spacing = 0.020"



## Package Marking and Dimensions

Marking: Part Number – 9058

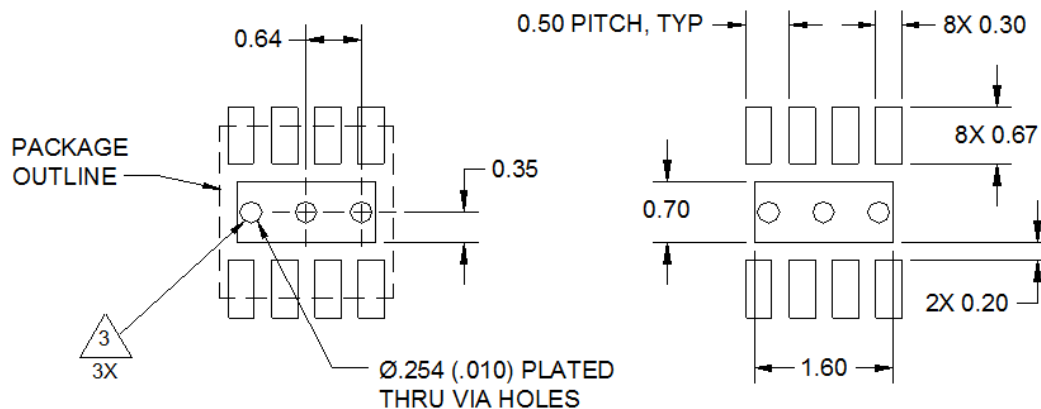
Trace Code – XXXX up to 4 Characters assigned by sub-contractor



### Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. The terminal #1 identifier and terminal numbering conform to SPE-000677.
3. Contact plating: NiPdAu

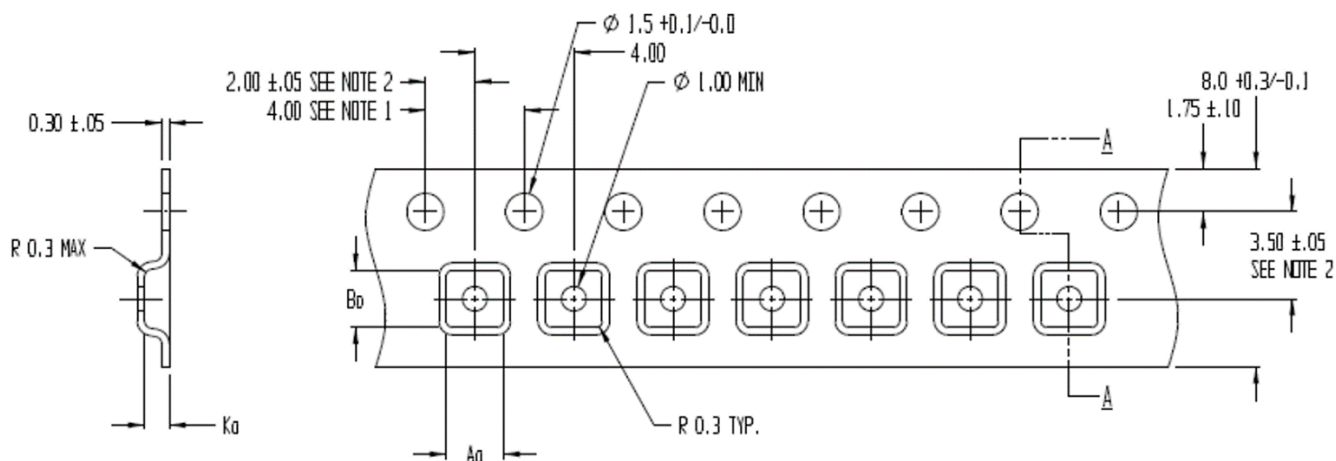
## Recommended PCB Layout Pattern



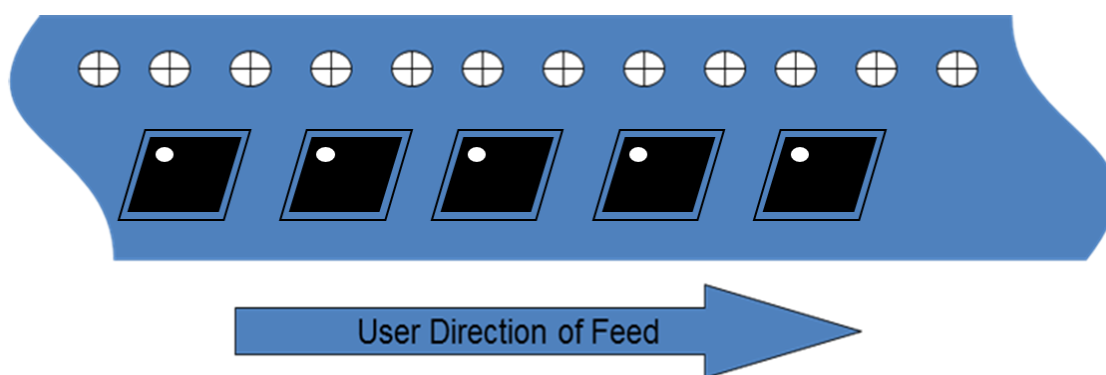
### Notes:

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 0.35mm (#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

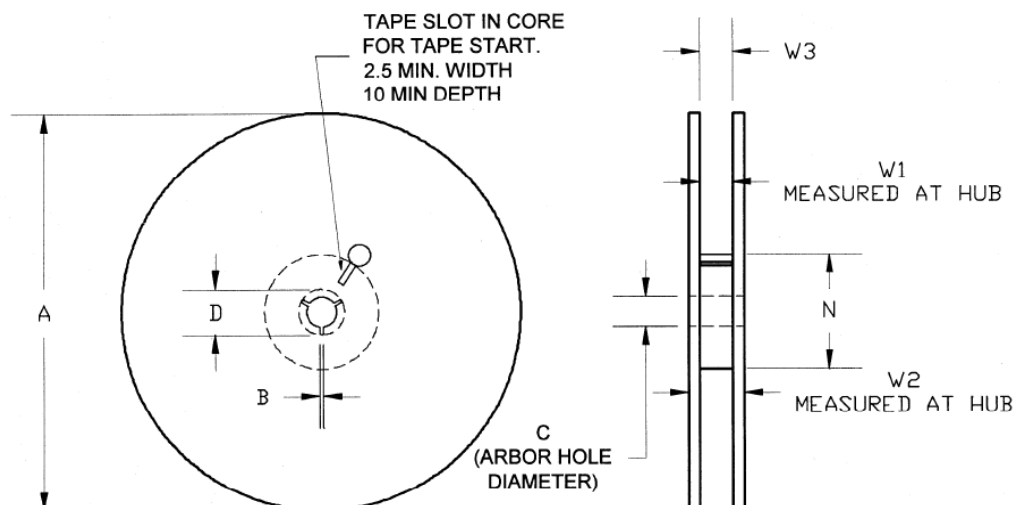


| Feature             | Measure                                  | Symbol | Size (in) | Size (mm) |
|---------------------|------------------------------------------|--------|-----------|-----------|
| Cavity              | Length                                   | A0     | 0.091     | 2.30      |
|                     | Width                                    | B0     | 0.091     | 2.30      |
|                     | Depth                                    | K0     | 0.039     | 1.00      |
|                     | 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      |



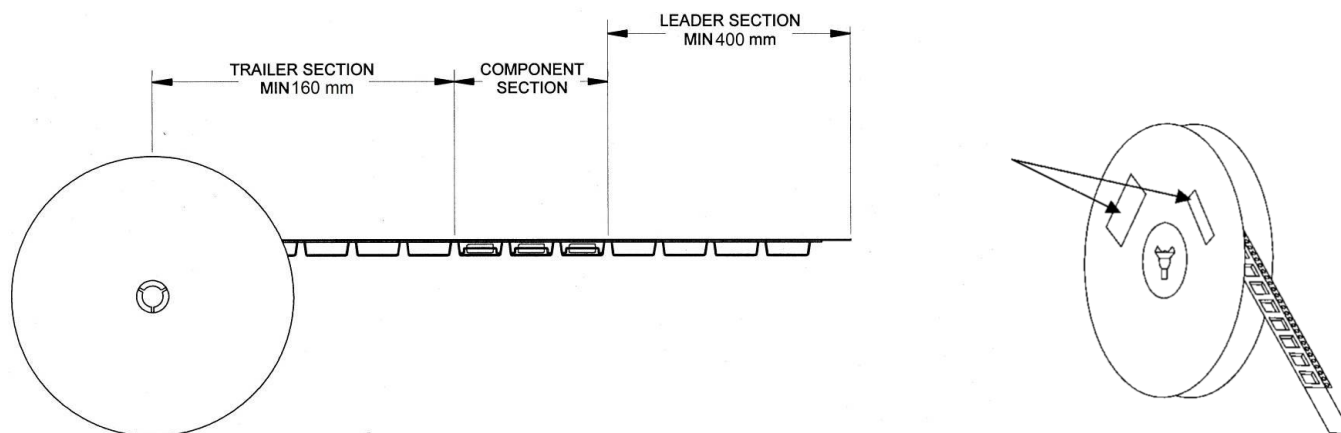
## Tape and Reel Information – Reel Dimensions

Standard T/R size = 2500 pieces on a 7" reel.



| Feature | Measure              | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange  | Diameter             | A      | 6.969     | 177.0     |
|         | Thickness            | W2     | 0.559     | 14.2      |
|         | Space Between Flange | W1     | 0.346     | 8.8       |
| Hub     | Outer Diameter       | N      | 2.283     | 58.0      |
|         | Arbor Hole Diameter  | C      | 0.512     | 13.0      |
|         | Key Slit Width       | B      | 0.079     | 2.0       |
|         | Key Slit Diameter    | D      | 0.787     | 20.0      |

## 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-001-2017 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC JESD22-C101F       |
| MSL – Moisture Sensitivity Level | Level 1  | IPC/JEDEC J-STD-020E     |



Caution!  
ESD-Sensitive Device

## Solderability

Compatible with both lead-free (260°C max. reflow temperature) and tin/lead (245°C max. reflow temperature) soldering processes. Solder profiles available upon request.

Contact plating: NiPdAu (*Thickness: Ni 0.508 ~ 1.524  $\mu$ m; Pd 0.023 ~ 0.1016  $\mu$ m; Au 0.00254 ~ 0.01016  $\mu$ m*)

## 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 (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free



## Contact Information

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

Web: [www.qorvo.com](http://www.qorvo.com)

Tel: 1-844-890-8163

Email: [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

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