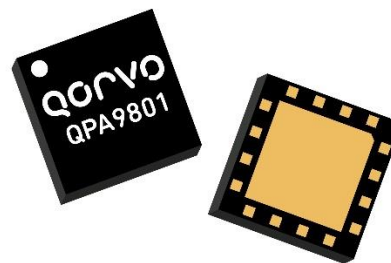


### General Description

The QPA9801 is a balanced amplifier module with embedded hybrid couplers to convert to single ended input and output ports. The module has an enable pin to allow for shutting down of the amplifier. The module requires minimal external components which are VCC choke inductors, decoupling caps and resistors for bias control.

The QPA9801 provides 26 dBm P1dB with 20 dB gain and 42 dBm OIP3 across a wide frequency range of 1805-2400 MHz to cover the 3GPP Bands 1, 2, 3, 4, 10, 23 and 30. The linear driver amplifier is targeted for use in wireless infrastructure where high linearity, medium power and high integration is required. The balanced amplifier configuration provides very good input and output VSWR and is especially ideal as the output stage in a macrocell transceiver board that connects to the high power amplifier (HPA) board through a long cable or microstrip trace. The QPA9801 is packaged in a small 5 x 5 mm leadless package that is internally matched to 50  $\Omega$  on all RF ports.

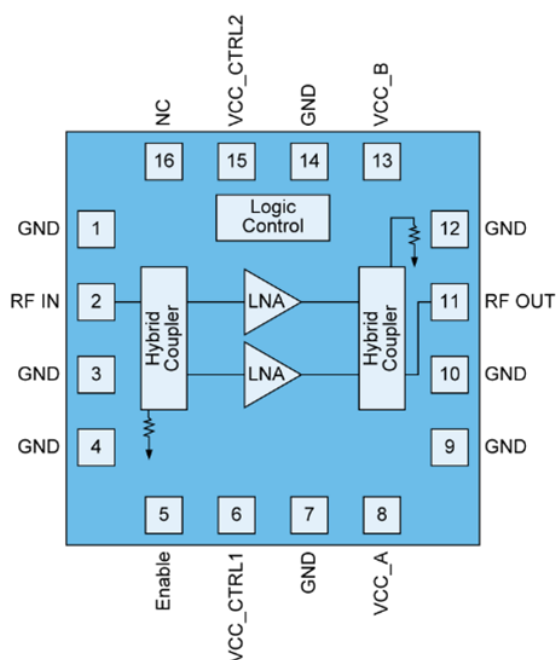


16 Pad 5 x 5 mm leadless SMT Package

### Product Features

- 1805 – 2400 MHz
- Balanced Amplifier with integrated 3 dB hybrids
- Internally Matched 50  $\Omega$  Input / Output
- Shutdown Mode with 1.8V logic control
- 20 dB Gain
- +41.6 dBm OIP3
- +26.4 dBm P1dB
- Good gain flatness across Bands 1, 2, 3, 4, 10, 23, 30

### Functional Block Diagram



Top View

### Applications

- Wireless Infrastructure
- Macro BTS Transceivers
- Booster Amps, Repeaters

### Ordering Information

| Part No.      | Description                           |
|---------------|---------------------------------------|
| QPA9801TR13   | 2,500 pieces on a 13" reel (standard) |
| QPA9801SR     | 100 pieces on a 7" reel               |
| QPA9801PCB401 | 1805 – 2400 MHz Evaluation Board      |

## Absolute Maximum Ratings

| Parameter                         | Rating         |
|-----------------------------------|----------------|
| Storage Temperature               | -40 to +150 °C |
| RF Input Power, CW, 50 Ω, T=25 °C | +22 dBm        |
| Supply Voltage (V <sub>CC</sub> ) | +6 V           |
| Enable Voltage (Enable)           | +5.5 V         |

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

## Recommended Operating Conditions

| Parameter                                      | Min   | Typ  | Max   | Units |
|------------------------------------------------|-------|------|-------|-------|
| Device Voltage (V <sub>CC</sub> )              | +3.30 | +5   | +5.25 | V     |
| Enable (High)                                  | +1.17 | +1.8 | +3.6  | V     |
| Enable (Low)                                   | 0     |      | +0.63 | 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.

## Electrical Specifications

| Parameter                           | Conditions <sup>(1)</sup>     | Min   | Typ   | Max  | Units |
|-------------------------------------|-------------------------------|-------|-------|------|-------|
| Operational Frequency Range         |                               | 1805  |       | 2400 | MHz   |
| Test Frequency                      |                               |       | 2140  |      | MHz   |
| Gain                                |                               | 18.5  | 20    | 21.5 | dB    |
| Gain Slope (peak to peak)           | F <sub>c</sub> ± 100 MHz      |       | 0.1   |      | dB    |
|                                     | F <sub>c</sub> ± 250 MHz      |       | 0.3   |      | dB    |
|                                     | F <sub>c</sub> ± 350 MHz      |       | 0.6   |      | dB    |
|                                     | F <sub>c</sub> ± 500 MHz      |       | 1.0   |      | dB    |
| Output IP3                          | Pin = -7 dBm/tone, Δf = 1 MHz | +38.5 | +41.6 |      | dBm   |
| Output P1dB                         |                               | +25.0 | +26.4 |      | dBm   |
| Noise Figure                        |                               |       | 1.5   |      | dB    |
| Input Return Loss                   |                               |       | 23    |      | dB    |
| Output Return Loss                  |                               |       | 25    |      | dB    |
| Control Current                     | V <sub>CC_CTRL1</sub> (Pin 6) |       | 2     |      | mA    |
| Total Current                       |                               |       | 296   | 360  | mA    |
| Rise time                           | From Enable to 90% RF         |       | 24    |      | nS    |
| Fall time                           | From Disable to 10% RF        |       | 70    |      | nS    |
| Thermal Resistance, θ <sub>jc</sub> | Module (channel to case)      |       |       | 16.2 | °C/W  |

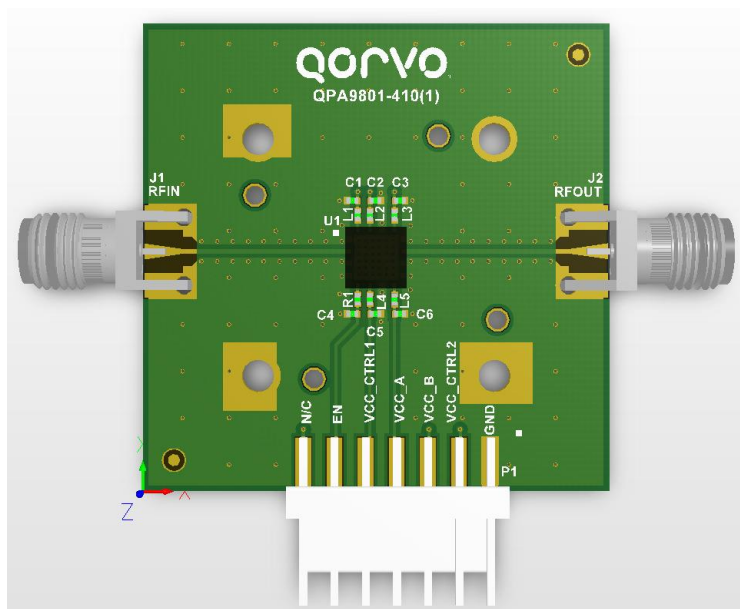
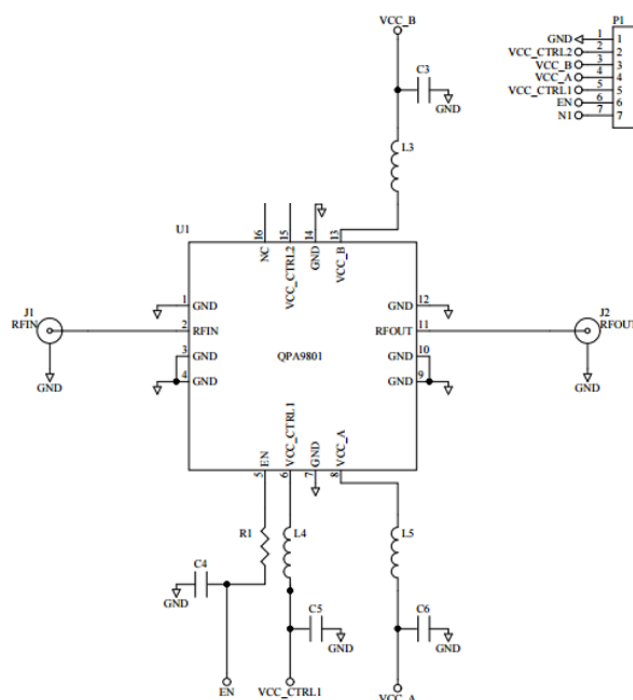
Notes:

1. Test conditions unless otherwise noted: V<sub>CC</sub> = V<sub>CC\_CTRL1</sub> = +5.0 V, Enable = +1.8V, Temp = +25 °C, 50 Ω system.

## Logic Table

| Parameter | High   | Low      |
|-----------|--------|----------|
| Enable    | Active | Shutdown |

### Application Circuit Schematic and Layout



### Bill of Material – QPA9801PCB4B01

| Reference Des. | Value  | Description                            | Manuf.    | Part Number    |
|----------------|--------|----------------------------------------|-----------|----------------|
| n/a            | n/a    | Printed Circuit Board                  |           |                |
| U1             | n/a    | ¼ Watt Balanced Amplifier              | Qorvo     | QPA9801        |
| L3, L5         | 68 nH  | Inductor, wire wound                   | Coilcraft | 0402CS-68NXGRW |
| R1, L4         | 0 Ω    | Resistor, Chip, Jumper                 | Various   |                |
| C3, C6         | 1 uF   | Capacitor, Chip, 10%, 10V, X5R         | Various   |                |
| C5             | 100 pF | Capacitor, Chip, NPO, 5%, 50V, NPO/COG | Various   |                |
| C4             |        | DNI                                    |           |                |

## Typical Performance

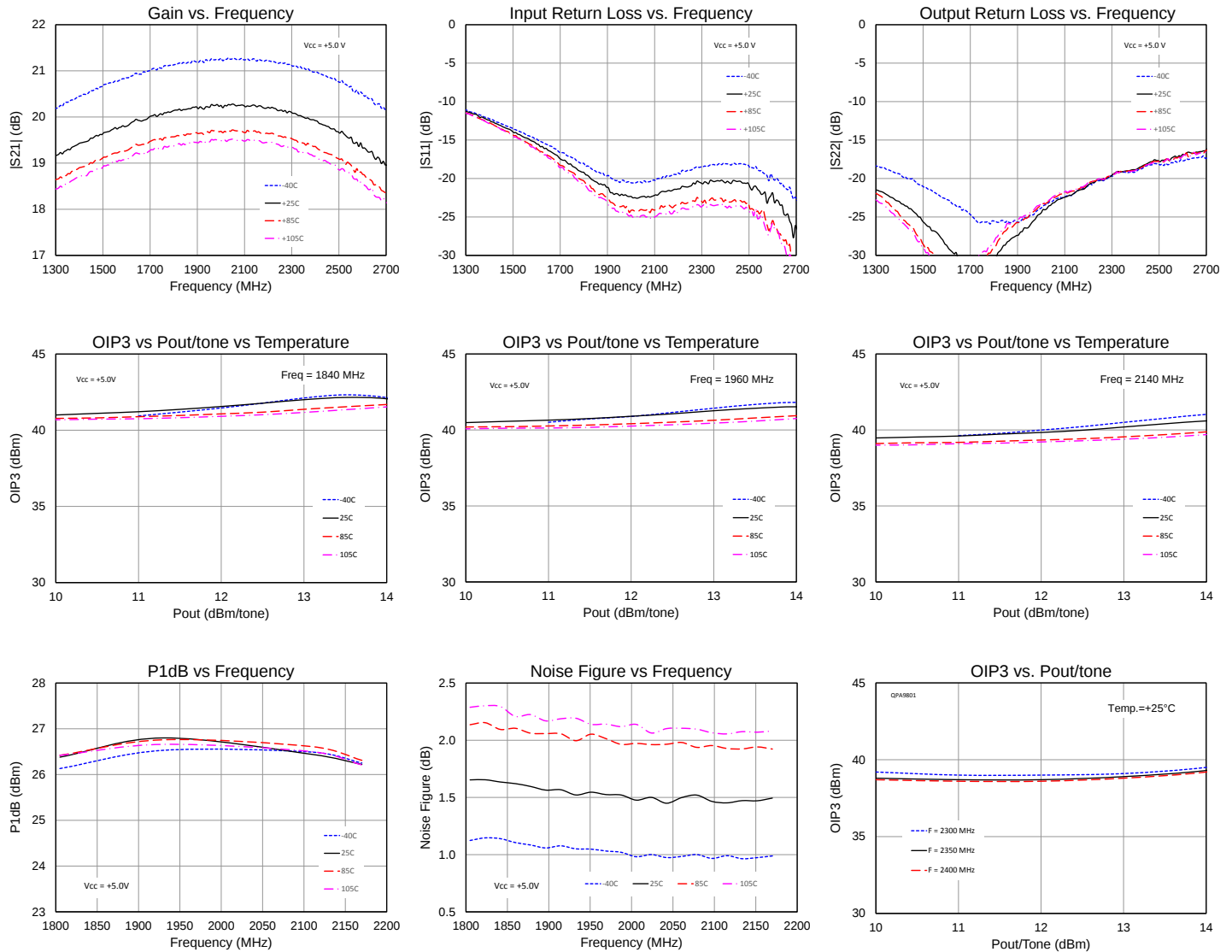
| Parameter                 | Conditions <sup>(1)</sup>       | Typical Value |       |       |       | Units |
|---------------------------|---------------------------------|---------------|-------|-------|-------|-------|
| Frequency                 |                                 | 1840          | 1960  | 2140  | 2350  | MHz   |
| Gain                      |                                 | 20.1          | 20.2  | 20.2  | 19.9  | dB    |
| Gain Slope (peak to peak) | Fc ± 100 MHz                    | 0.2           | 0.1   | 0.1   | 0.4   | dB    |
|                           | Fc ± 250 MHz                    | 0.5           | 0.3   | 0.3   | 0.9   | dB    |
|                           | Fc ± 350 MHz                    | 0.7           | 0.5   | 0.6   | 1.3   | dB    |
|                           | Fc ± 500 MHz                    | 1.1           | 0.8   | 1.0   | 2.2   | dB    |
| Input Return Loss         |                                 | 20            | 23    | 22    | 22    | dB    |
| Output Return Loss        |                                 | 27            | 25    | 21    | 22    | dB    |
| Output IP3                | Pout = +12 dBm/tone, Δf = 1 MHz | +42.0         | +41.1 | +40.0 | +38.7 | dBm   |
| Output P1dB               |                                 | +26.4         | +26.7 | +26.4 | +26.1 | dBm   |
| Noise Figure              |                                 | 1.7           | 1.5   | 1.5   | 1.9   | dB    |

**Notes:**

1. Test conditions unless otherwise noted:  $V_{CC} = V_{CC\_CTRL1} = +5.0V$ , Enable = +1.8V, Temp.=+25 °C

### Performance Plots

Test conditions unless otherwise noted:  $V_{CC} = V_{CC\_CTRL1} = +5V$ , Enable = +1.8 V, Temp.=+25 °C



## Typical Performance – $V_{CC} = +3.6\text{ V}$

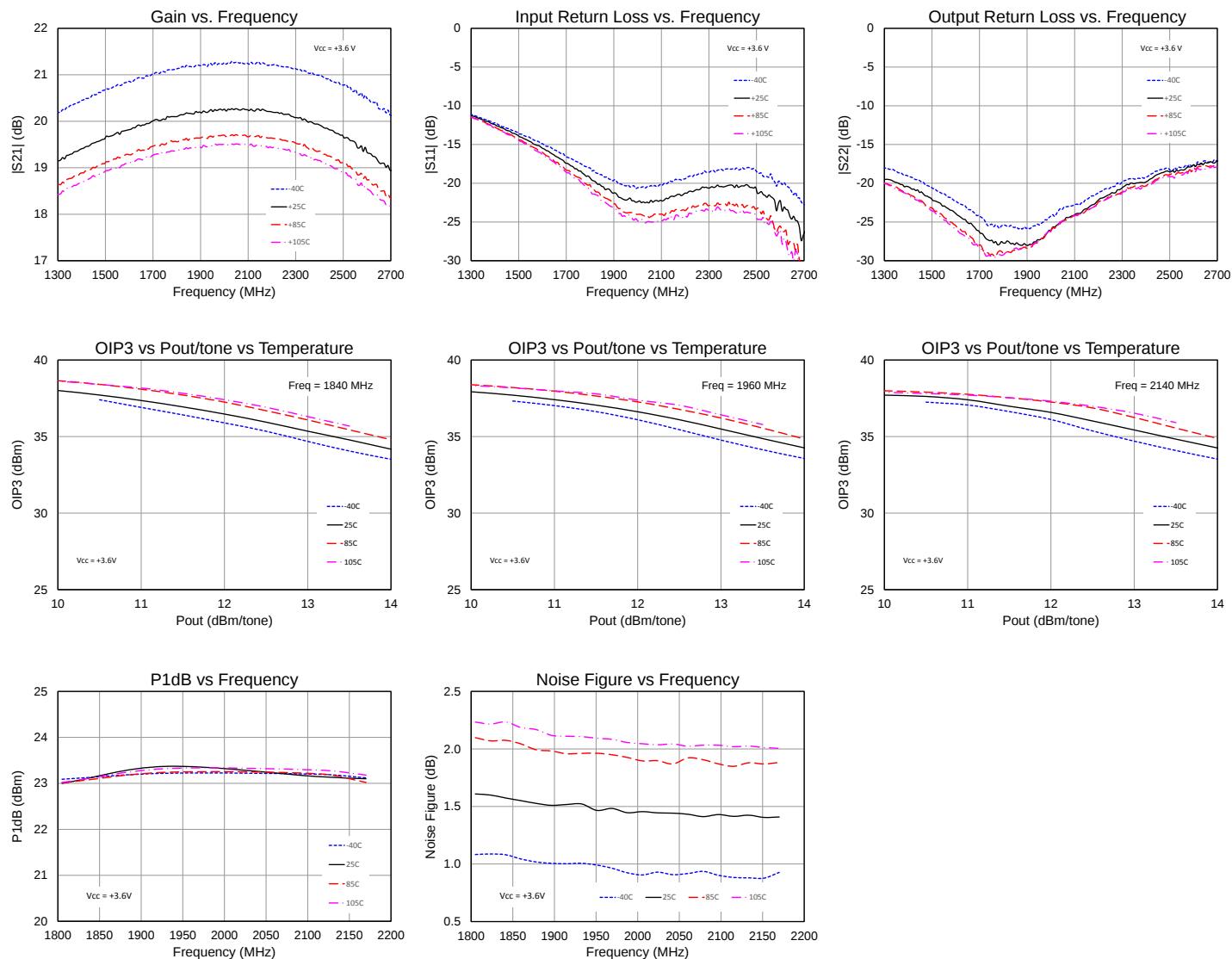
| Parameter                 | Conditions <sup>(1)</sup>                      | Typical Value |       |       | Units |
|---------------------------|------------------------------------------------|---------------|-------|-------|-------|
| Frequency                 |                                                | 1840          | 1960  | 2140  | MHz   |
| Gain                      |                                                | 20.1          | 20.2  | 20.2  | dB    |
| Gain Slope (peak to peak) | Fc $\pm$ 100 MHz                               | 0.2           | 0.1   | 0.1   |       |
|                           | Fc $\pm$ 250 MHz                               | 0.5           | 0.3   | 0.3   | dB    |
|                           | Fc $\pm$ 350 MHz                               | 0.7           | 0.5   | 0.5   | dB    |
|                           | Fc $\pm$ 500 MHz                               | 1.1           | 0.8   | 1.0   | dB    |
| Input Return Loss         |                                                | 20            | 23    | 22    | dB    |
| Output Return Loss        |                                                | 27            | 26    | 24    | dB    |
| Output IP3                | Pout = +12 dBm/tone, $\Delta f = 1\text{ MHz}$ | +37.0         | +37.0 | +37.0 | dBm   |
| Output P1dB               |                                                | +23.0         | +23.3 | +23.1 | dBm   |
| Noise Figure              |                                                | 1.6           | 1.5   | 1.4   | dB    |

**Notes:**

1. Test conditions unless otherwise noted:  $V_{CC} = V_{CC\_CTRL1} = +3.6\text{ V}$ , Enable = +1.8V, Temp.=+25 °C

### Performance Plots – $V_{CC} = +3.6\text{ V}$

Test conditions unless otherwise noted:  $V_{CC} = V_{CC\_CTRL1} = +3.6\text{ V}$ , Enable = +1.8 V, Temp. = +25 °C



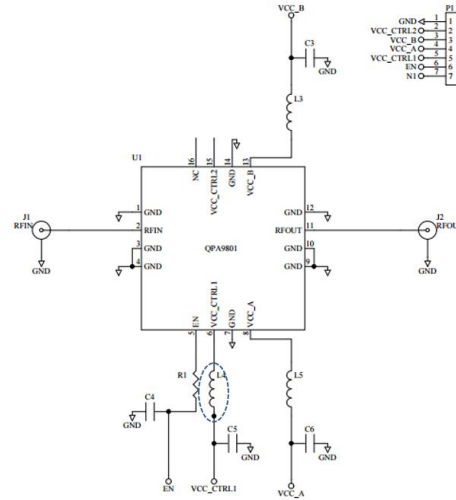
## Application Note – Reduced Bias Performance

The QPA9801 can be configured to be operated with lower bias current either by lowering  $V_{CC\_CTRL1}$  or by replacing L4 with a resistor and leaving  $V_{CC\_CTRL1} = V_{CC}$ . Typical performance is displayed below for various quiescent current settings.

## Typical Performance – Reduced Bias

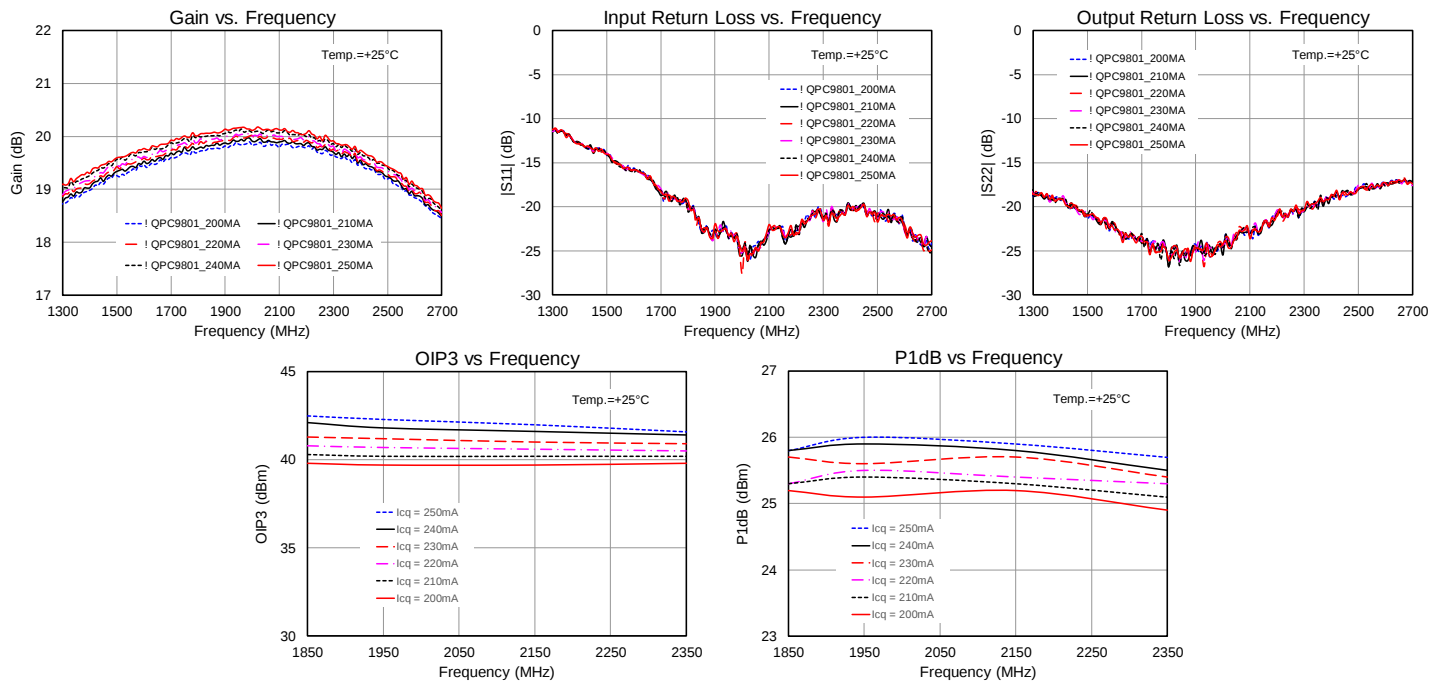
| $V_{CC\_CTRL1}$<br>(V) | $I_{CQ}$<br>(mA) | NF<br>(dB) | P1dB<br>(dBm) | OIP3<br>(dBm) |
|------------------------|------------------|------------|---------------|---------------|
| 4.8                    | 250              | 1.5        | +25.9         | +42.0         |
| 4.6                    | 240              | 1.5        | +25.8         | +41.6         |
| 4.3                    | 230              | 1.5        | +25.7         | +41.0         |
| 4.1                    | 220              | 1.5        | +25.4         | +40.6         |
| 3.9                    | 210              | 1.5        | +25.3         | +40.2         |
| 3.7                    | 200              | 1.5        | +25.2         | +39.7         |

Frequency = 2140 MHz

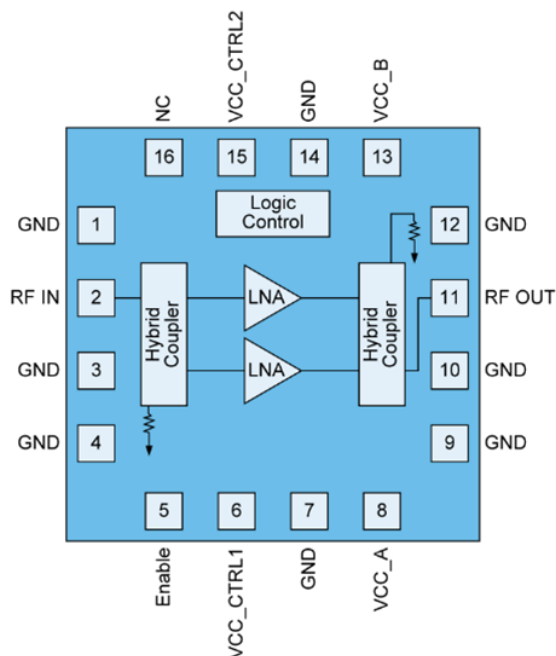


## Performance Plot

Test conditions unless otherwise noted:  $V_{CC} = +5.0V$ , Enable = +1.8 V, Temp. = +25 °C



### Pin Configuration and Description



Top View

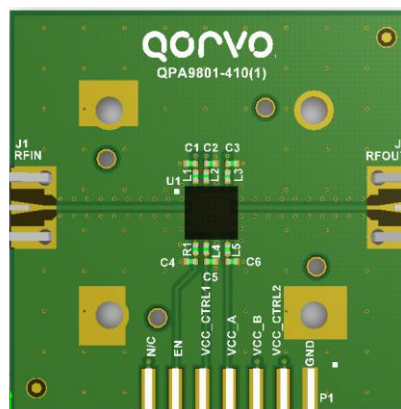
| Pad No.                   | Label     | Description                                                     |
|---------------------------|-----------|-----------------------------------------------------------------|
| 1, 3, 4, 7, 9, 10, 12, 14 | GND       | RF and DC Ground                                                |
| 2                         | RFin      | RF Input; Internally 50 $\Omega$ matched                        |
| 5                         | Enable    | Enable pin to turn off amplifiers, 1- ON, 0 – OFF               |
| 6                         | VCC_CTRL1 | Supply Voltage for control circuitry                            |
| 8                         | VCC_A     | Supply Voltage to Amplifier A                                   |
| 11                        | RFout     | RF Output; Internally 50 $\Omega$ matched                       |
| 13                        | VCC_B     | Supply Voltage to Amplifier B                                   |
| 15                        | NC        | Not connected                                                   |
| 16                        | VCC_CTRL2 | Not connected                                                   |
| Backside Paddle           |           | RF/DC ground. See PCB Mounting Pattern for suggested footprint. |

### Evaluation Board PCB Information

#### PC Board Layout

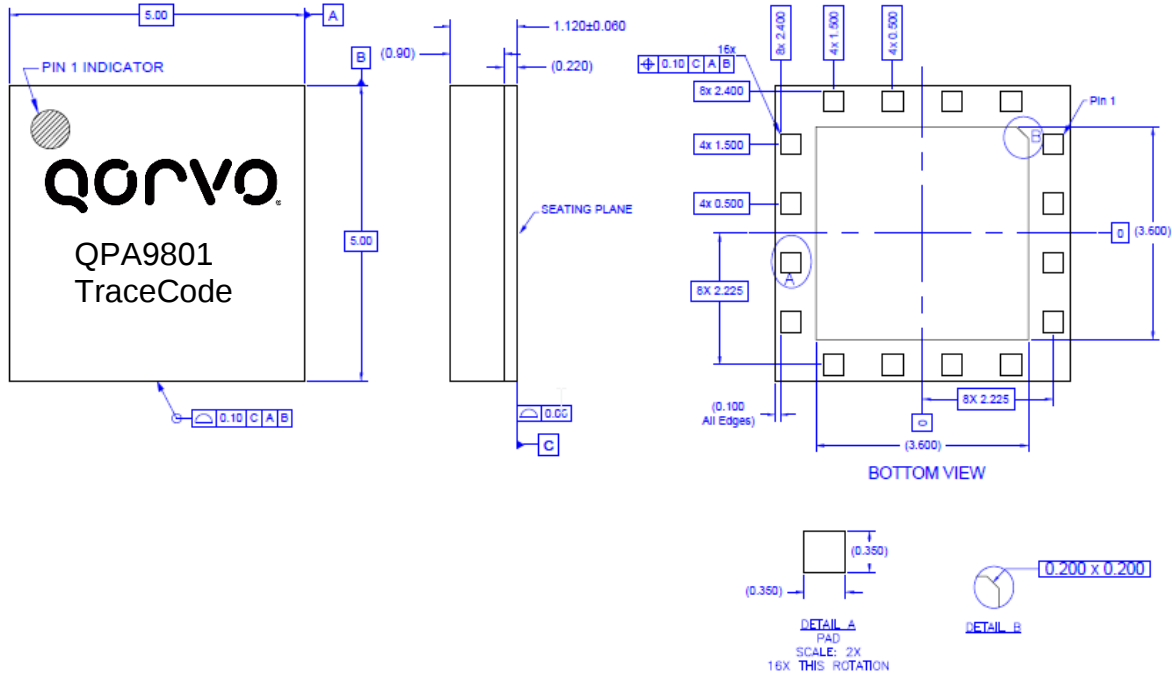
PCB Material (stackup):

1/2 oz. Cu top layer  
 0.008 inch FR-4  
 1 oz. Cu middle layer 1  
 .012 inch FR-4  
 1 oz. Cu middle layer 2  
 0.008 inch FR-4  
 1/2 oz. Cu bottom layer  
 Finished board thickness is 0.034 $\pm$ .003



### Package Marking and Dimensions

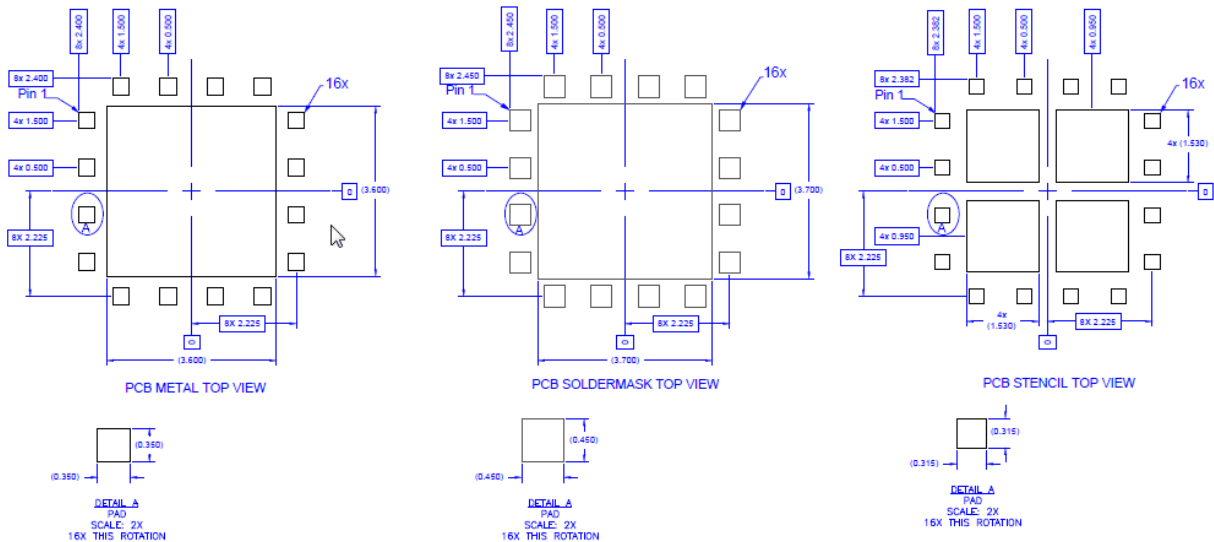
Marking: Part Number – QPA9801



#### Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.
3. Contact plating: Au over Ni

### 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. Vias 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 (0.10").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

### Handling Precautions

| Parameter                        | Rating   | Standard                 |
|----------------------------------|----------|--------------------------|
| ESD – Human Body Model (HBM)     | Class 1A | ESDA / JEDEC JS-001-2012 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC JESD22-C101F       |
| MSL – Moisture Sensitivity Level | Level 3  | IPC/JEDEC J-STD-020      |



Caution!  
ESD-Sensitive Device

### Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes.

Solder profiles available upon request.

Contact plating: Electrolytic plated Au over Ni

### RoHS Compliance

This part is compliant with EU 2002/95/EC RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment). This product also has the following attributes:

- Product uses RoHS Exemption 7c-I to meet RoHS Compliance requirements
- 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
- Qorvo Green



### Contact Information

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

Tel: 1-844-890-8163

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

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

For technical questions and application information: Email: [appsupport@qorvo.com](mailto:appsupport@qorvo.com)

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