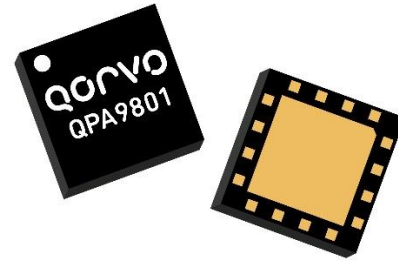


General Description

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 Ω on all RF ports.

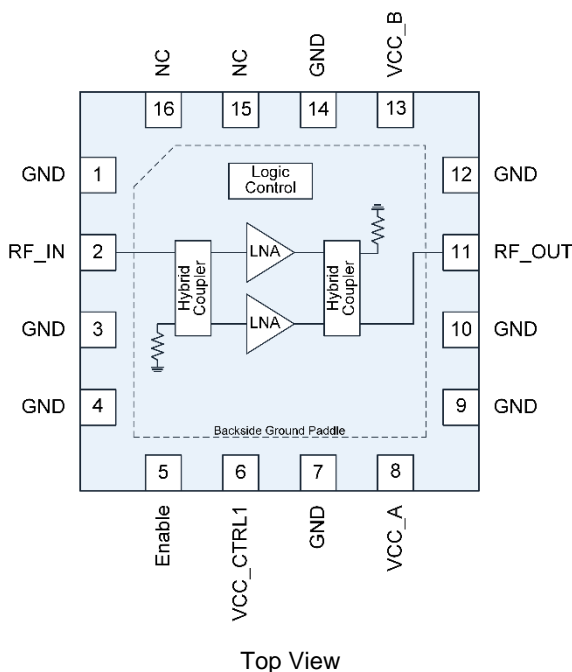


16 Pad 5 x 5 mm leadless SMT Package

Product Features

- 1805 – 2400 MHz
- Balanced Amplifier with integrated 3 dB hybrids
- Internally Matched 50 Ω 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



Applications

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

Ordering Information

| Part No. | Description |
|---------------|---------------------------------------|
| QPA9801TR13 | 2,500 pieces on a 13" reel (standard) |
| 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 (VCC) | +6.0 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 (VCC_A&B) | +3.30 | +5 | +5.25 | V |
| Enable (High) | +1.17 | +1.8 | +3.6 | V |
| Enable (Low) | 0 | | +0.63 | 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

| Parameter | Conditions ⁽¹⁾ | 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 _c ± 100 MHz | | 0.1 | | dB |
| | F _c ± 250 MHz | | 0.3 | | dB |
| | F _c ± 350 MHz | | 0.6 | | dB |
| | F _c ± 500 MHz | | 1.0 | | dB |
| Output IP3 | P _{out} = +10dBm/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 | VCC_CTRL1 (Pin 6) | | 2 | | mA |
| Total Current | I _{VCC_A} and I _{VCC_B} | | 296 | 360 | mA |
| Rise Time | From Enable to 90% RF | | 24 | | ns |
| Fall Time | From Disable to 10% RF | | 70 | | ns |
| Thermal Resistance, θ _{jc} | Module, Channel to case backside paddle | | 24.2 | | °C/W |

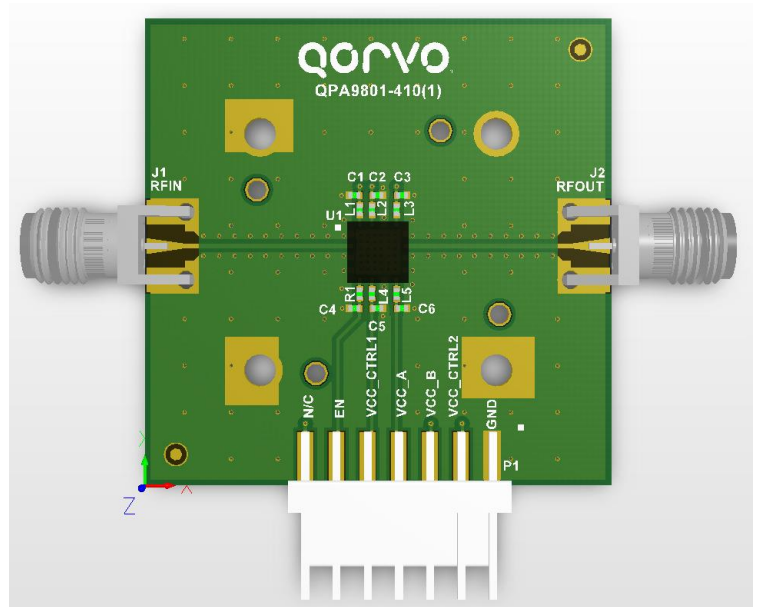
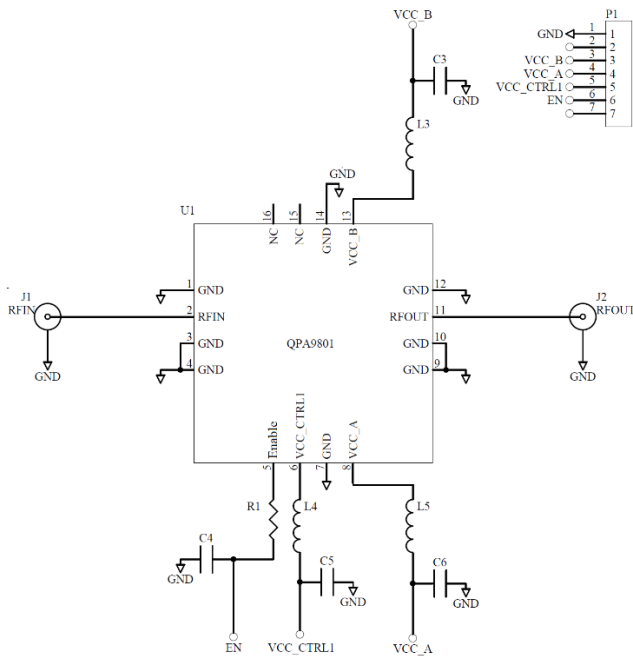
Notes:

1. Test conditions unless otherwise noted: VCC_A&B = VCC_CTRL1 = +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 |
|----------------|--------|--|-----------|----------------|
| - | - | Printed Circuit Board | - | - |
| U1 | - | ¼ Watt Balanced amplifier | Qorvo | QPA9801 |
| L3, L5 | 18 nH | Inductor, wire wound | Coilcraft | 0402CS-18NXGEW |
| R1, L4 | 0 Ω | Resistor, Chip, Jumper | Various | |
| C3, C6 | 1 μF | Capacitor, Chip, 10%, 10V, X5R | Various | |
| C5 | 100 pF | Capacitor, Chip, NPO, 5%, 50V, NPO/C0G | Various | |
| C4 | - | DNI | - | |



Typical Performance – VCC +5.0 V

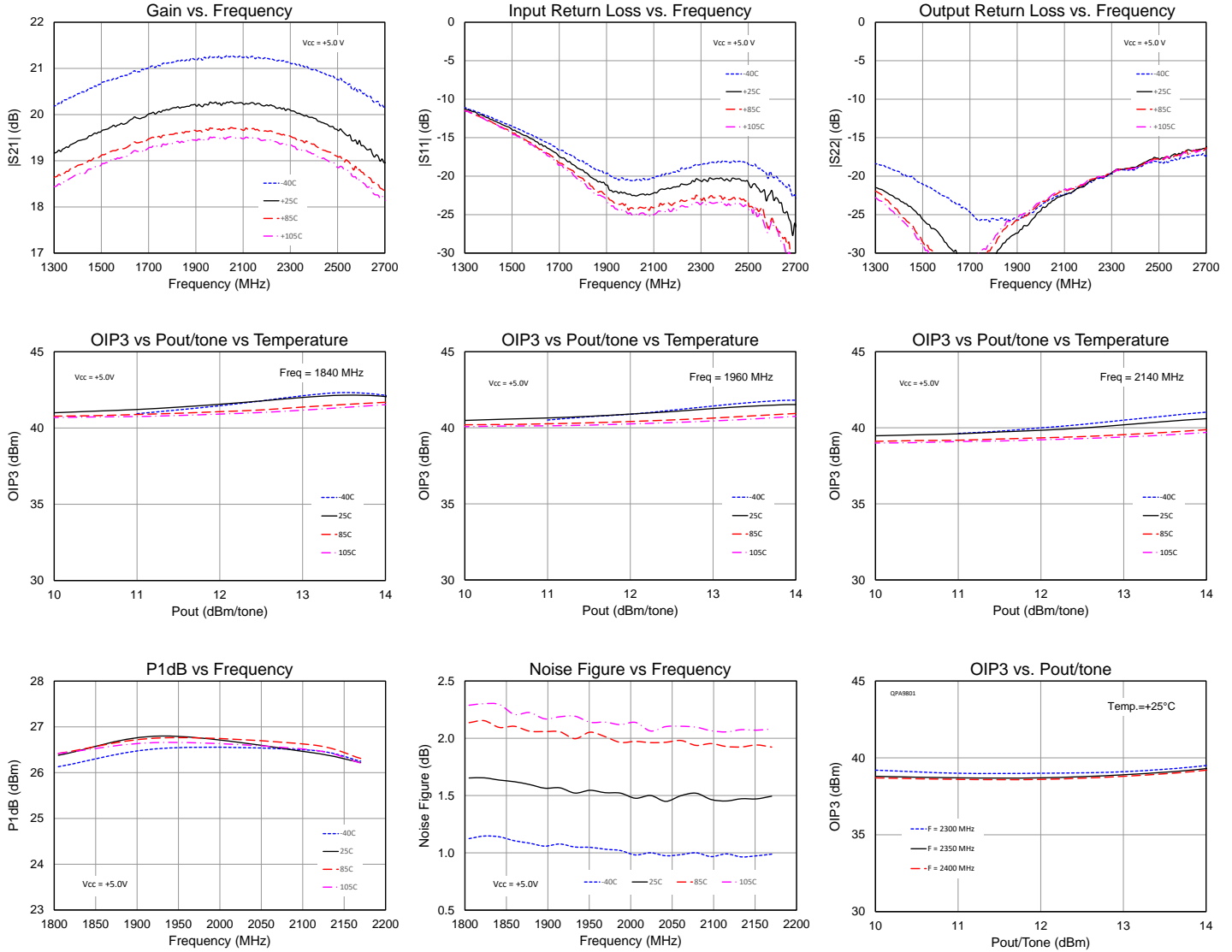
| Parameter | Conditions ⁽¹⁾ | Typical Value | | | | Units |
|---------------------------|---------------------------------|---------------|-------|-------|-------|-------|
| Frequency | | 1840 | 1960 | 2140 | 2350 | MHz |
| Gain | | 20.1 | 20.2 | 20.2 | 19.9 | dB |
| Gain Slope (peak to peak) | Fc ± 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: VCC_A&B = VCC_CTRL1 = +5.0V, Enable = +1.8V, Temp.=+25 °C

Performance Plots – VCC +5.0 V

Test conditions unless otherwise noted: VCC_A&B = VCC_CTRL1 = +5V, Enable = +1.8 V, Temp.=+25 °C



Typical Performance – VCC +3.6 V

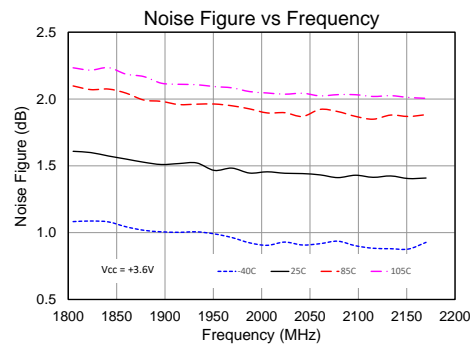
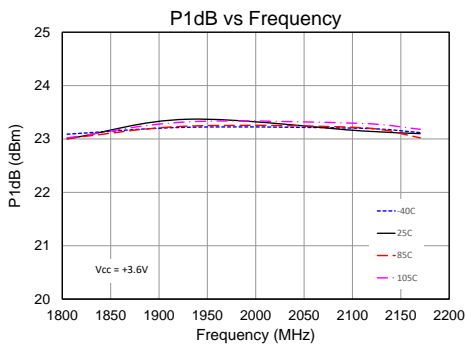
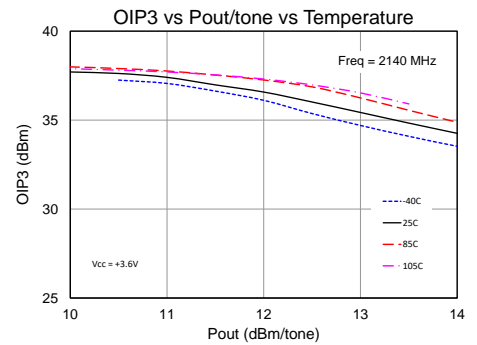
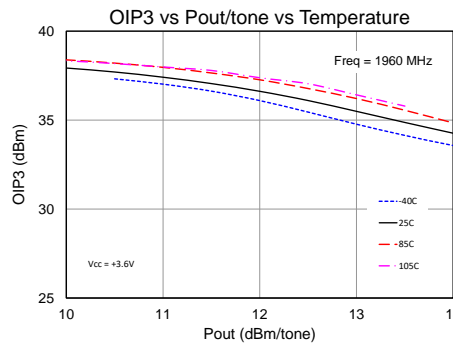
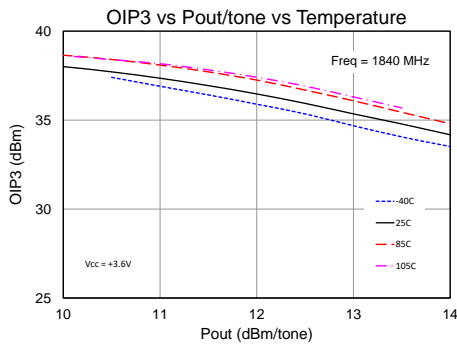
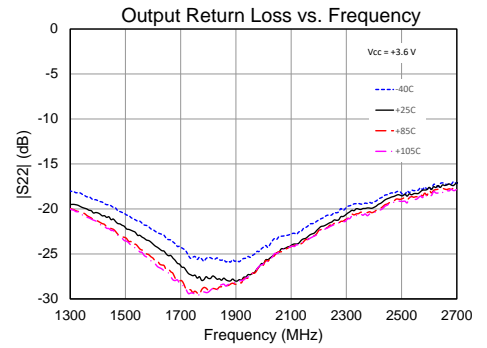
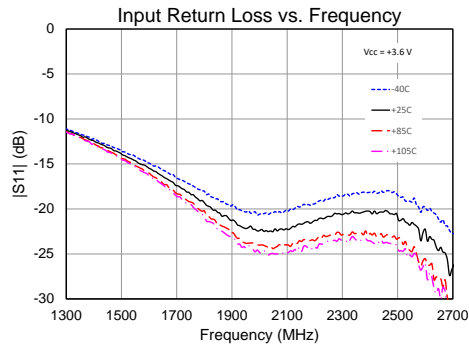
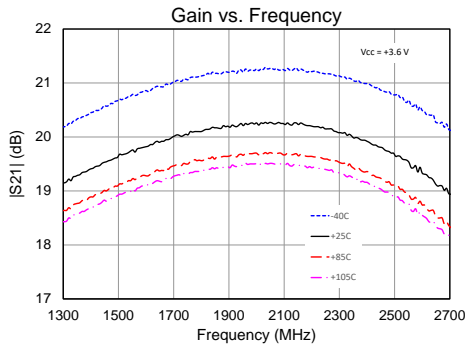
| Parameter | Conditions ⁽¹⁾ | Typical Value | | | Units |
|---------------------------|---------------------------------|---------------|-------|-------|-------|
| Frequency | | 1840 | 1960 | 2140 | MHz |
| Gain | | 20.1 | 20.2 | 20.2 | dB |
| Gain Slope (peak to peak) | Fc ± 100 MHz | 0.2 | 0.1 | 0.1 | dB |
| | Fc ± 250 MHz | 0.5 | 0.3 | 0.3 | dB |
| | Fc ± 350 MHz | 0.7 | 0.5 | 0.5 | dB |
| | Fc ± 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, Δf = 1 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: VCC_A&B = VCC_CTRL1 = +3.6V, Enable = +1.8V, Temp.=+25 °C

Performance Plots – VCC +3.6 V

Test conditions unless otherwise noted: VCC_A&B = VCC_CTRL1 = +3.6V, Enable = +1.8 V, Temp.=+25 °C



Applications with Reduced Bias Performance

The QPA9801 can be configured to be operated with lower bias current either by lowering VCC_CTRL1 or by replacing L4 with a resistor and leaving VCC_CTRL1 = VCC_A & B. Typical performance is displayed below for various quiescent current settings.

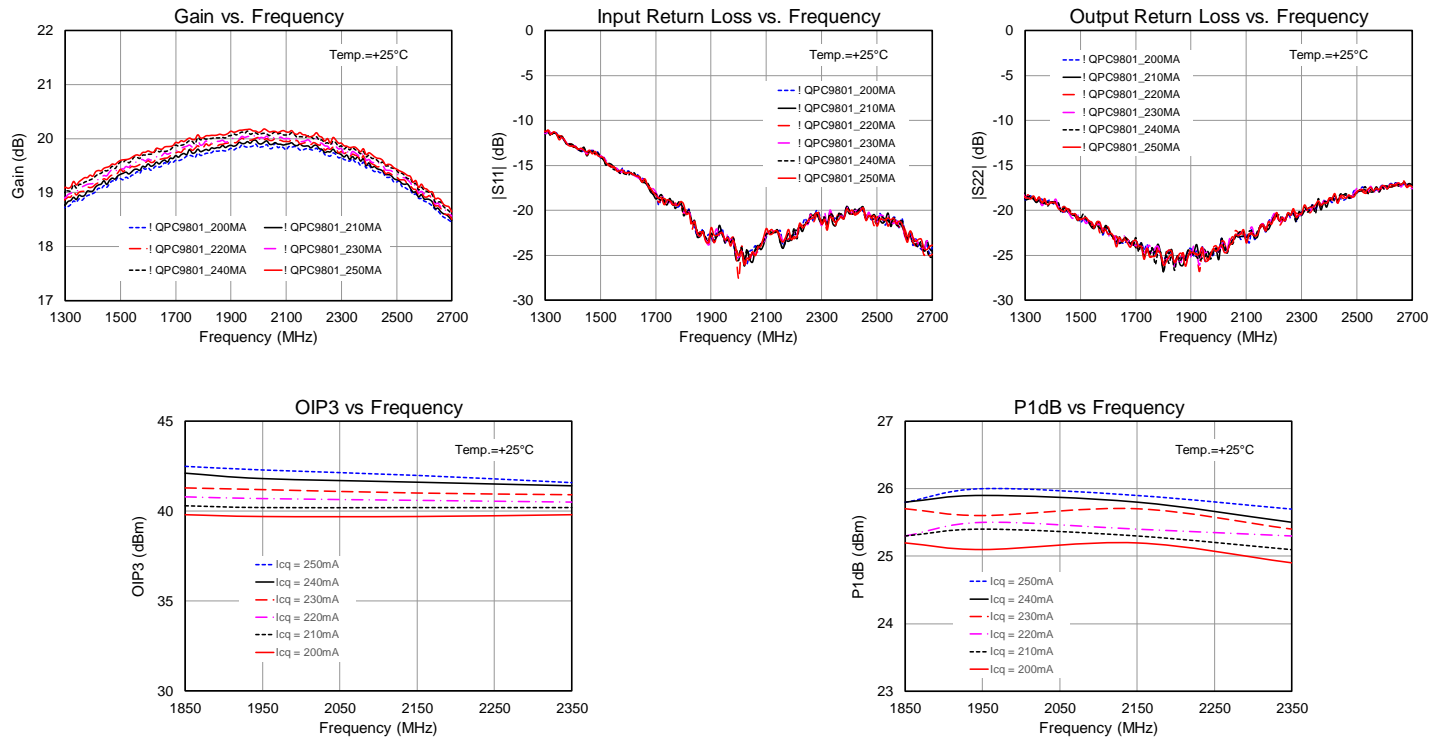
Performance – Reduced Bias

| VCC_CTRL1 (V) | I _{VCC_A&B_Q} (mA) | NF (dB) | P1dB (dBm) | OIP3 (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 |

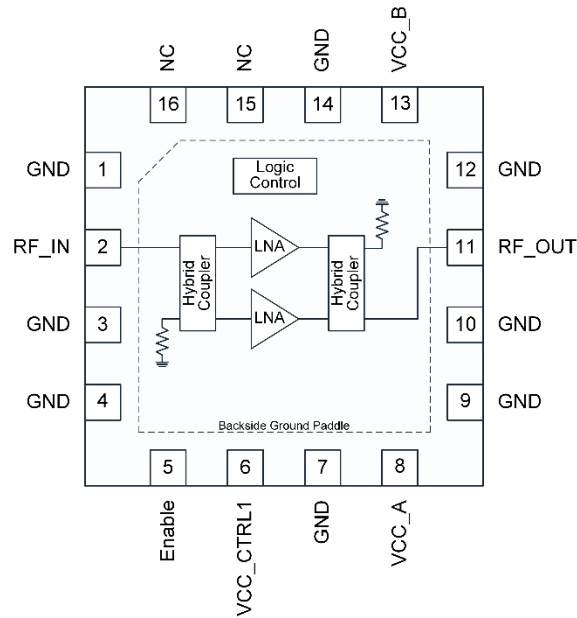
Frequency = 2140 MHz

Performance Plot – Reduced Bias

Test conditions unless otherwise noted: VCC_A&B = +5.0 V, I_{VCC_A&B} = Vary, Enable = +1.8 V, Temp. = +25 °C



Pin Configuration and Description



Top View

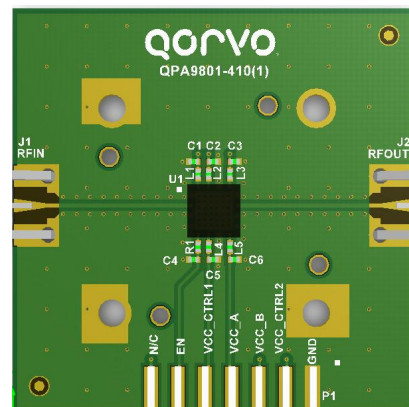
| Pad No. | Label | Description |
|---------------------------|-----------|---|
| 1, 3, 4, 7, 9, 10, 12, 14 | GND | RF and DC Ground |
| 2 | RF_IN | RF Input, 50 Ω resistance presents, DC blocking capacitor required when cascading with none zero DC voltage external circuitry |
| 5 | Enable | Enable Input, Logic "1"- Amplifiers ON, Logic "0" – Amplifiers OFF |
| 6 | VCC_CTRL1 | DC Supply Voltage Input, BIAS control |
| 8 | VCC_A | DC Supply Voltage Input, Amplifier A |
| 11 | RF_OUT | RF Output: 50 Ω resistance presents, DC blocking capacitor required when cascading with none zero DC voltage external circuitry |
| 13 | VCC_B | Supply Voltage Input, Amplifier B |
| 15 | NC | Not connected |
| 16 | NC | Not connected |
| Backside Paddle | - | RF/DC ground. See PCB Mounting Pattern for suggested footprint. |

Evaluation Board PCB Information

PC Board Layout

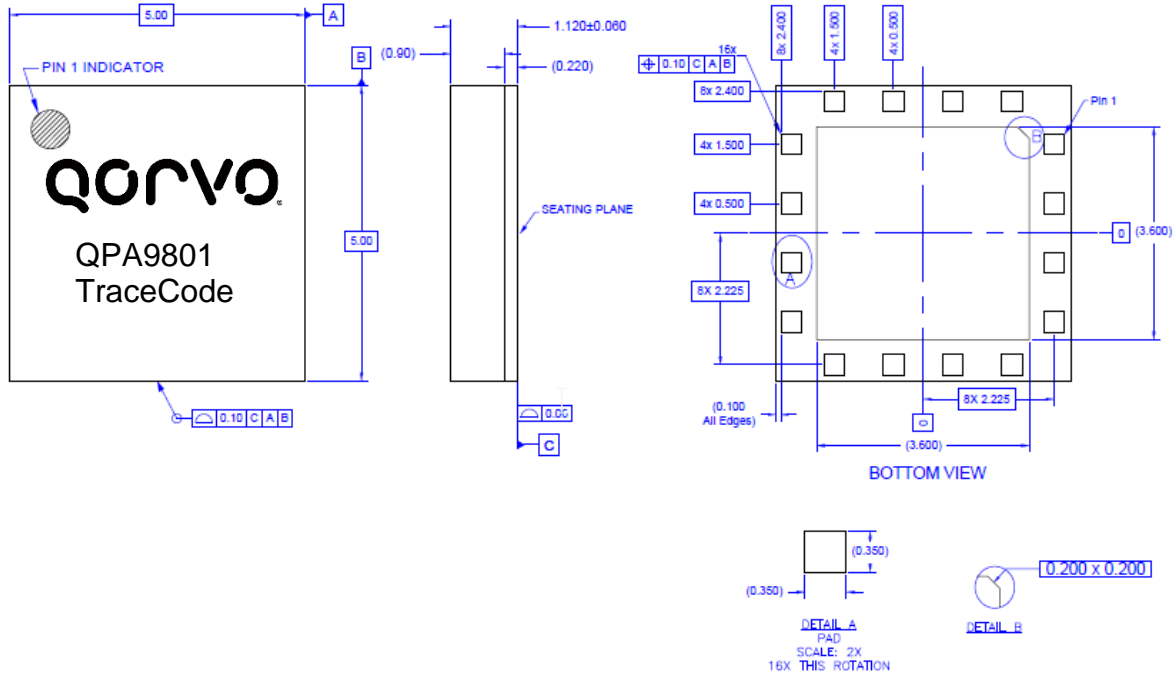
PCB Material (stack up):

- 1/2 oz. Cu top layer
- 0.008 Inch FR-4
- 1 oz. Cu middle layer 1
- 0.012 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±.003



Package Marking and Dimensions

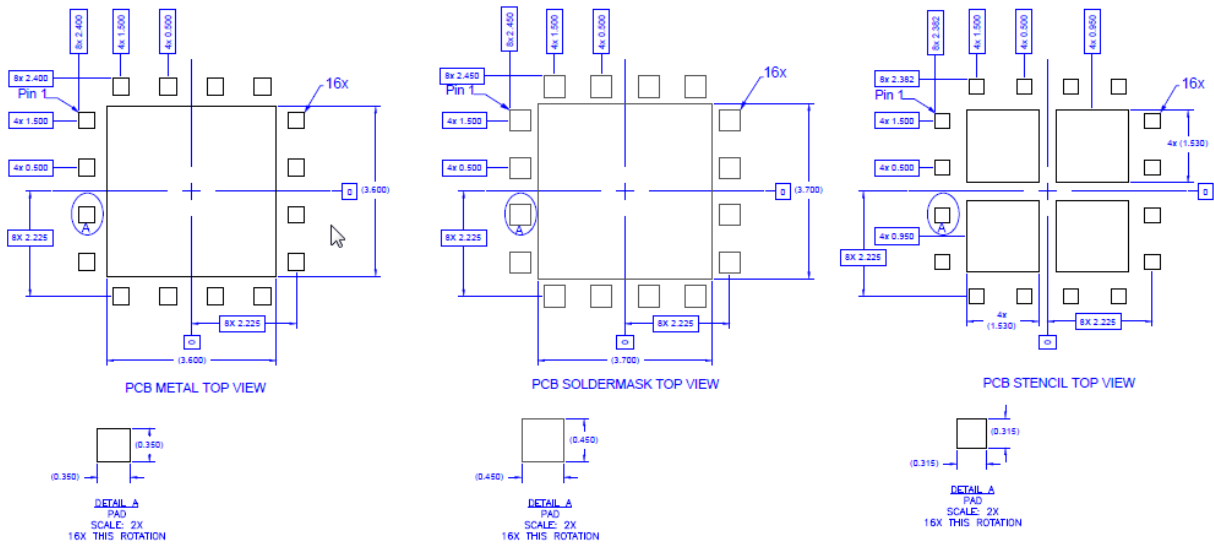
Marking: Part Number – QPA9801



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: ENEPIG

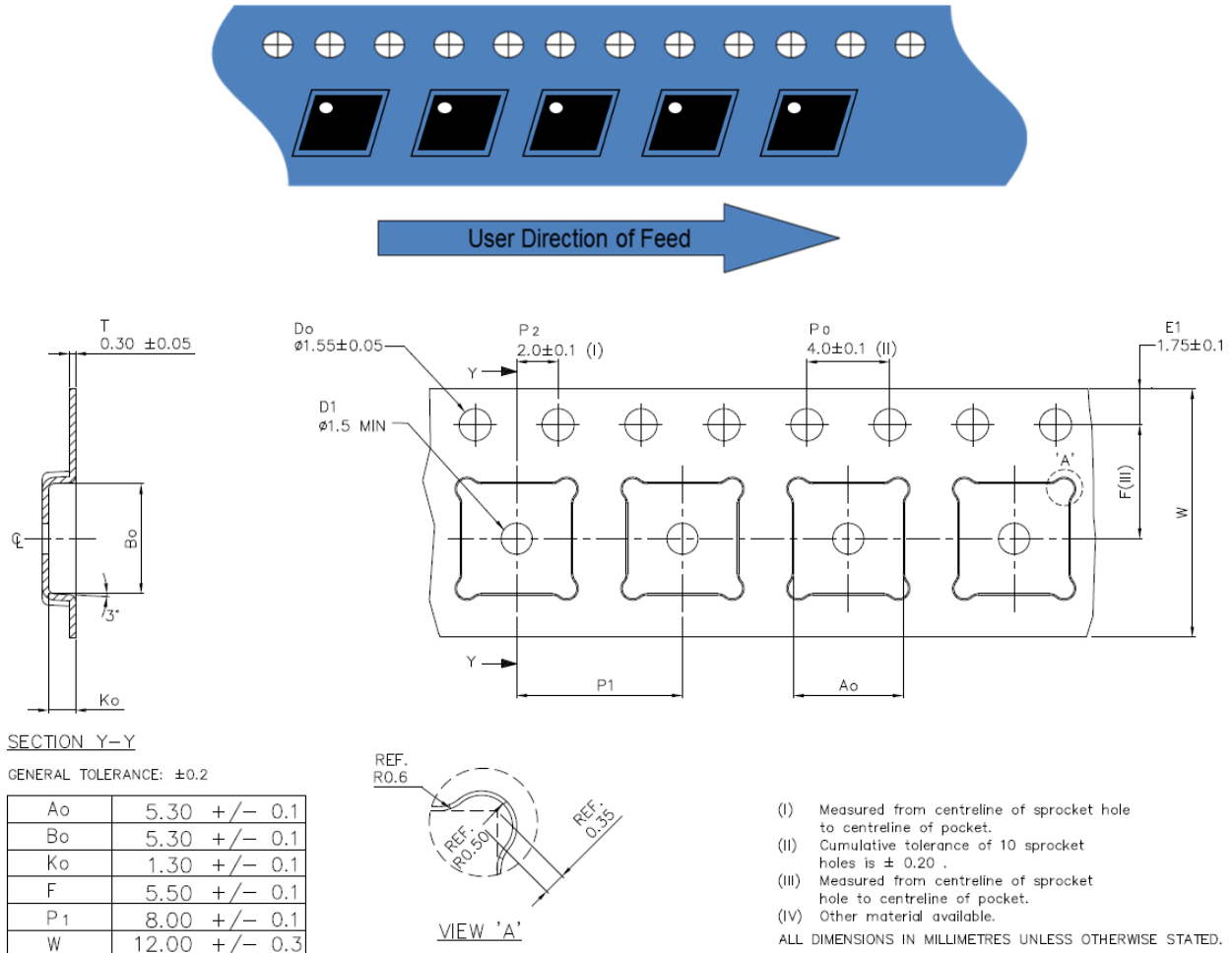
PCB Mounting Pattern



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 (0.010").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

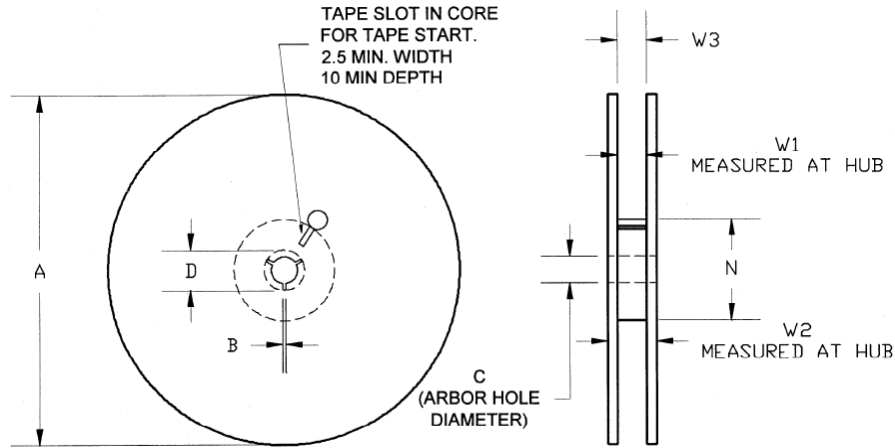
Tape and Reel Information – Carrier and Cover Tape Dimensions



| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---------------------|--|--------|-----------|-----------|
| Cavity | Length | A0 | 0.209 | 5.30 |
| | Width | B0 | 0.209 | 5.30 |
| | Depth | K0 | 0.051 | 1.30 |
| | Pitch | P1 | 0.315 | 8.00 |
| Centerline Distance | Cavity to Perforation - Length Direction | P2 | 0.079 | 2.00 |
| | Cavity to Perforation - Width Direction | F | 0.217 | 5.50 |
| Cover Tape | Width | C | 0.362 | 9.20 |
| Carrier Tape | Width | W | 0.472 | 12.00 |

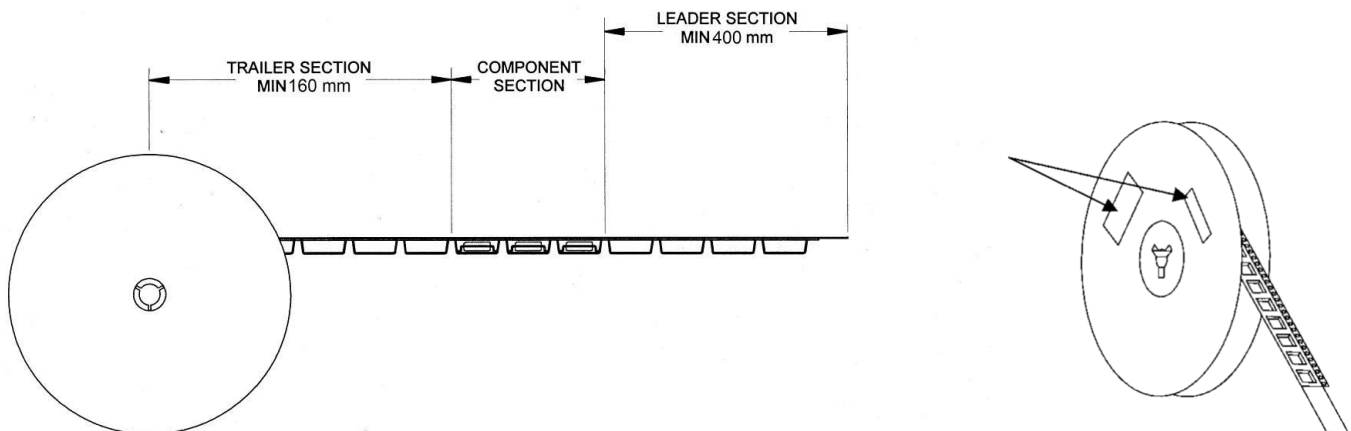
Tape and Reel Information – Reel Dimensions

Standard T/R size = 2,500 pieces on a 13" reel.



| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange | Diameter | A | 12.992 | 330.0 |
| | Thickness | W2 | 0.717 | 18.2 |
| | Space Between Flange | W1 | 0.504 | 12.8 |
| Hub | Outer Diameter | N | 4.016 | 102.0 |
| | 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 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: ENEPIG (*Plating thickness: Ni 0.40±0.10 μm; Pd 0.145±0.035 μm; Au 0.095±0.025 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:

- 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:

Web: www.qorvo.com

Tel: 1-844-890-8163

Email: customer.support@qorvo.com

Important Notice

The information contained herein is believed to be reliable; however, Qorvo makes no warranties regarding the information contained herein and assumes no responsibility or liability whatsoever for the use of the information contained herein. All information contained herein is subject to change without notice. Customers should obtain and verify the latest relevant information before placing orders for Qorvo products. The information contained herein or any use of such information does not grant, explicitly or implicitly, to any party any patent rights, licenses, or any other intellectual property rights, whether with regard to such information itself or anything described by such information. **THIS INFORMATION DOES NOT CONSTITUTE A WARRANTY WITH RESPECT TO THE PRODUCTS DESCRIBED HEREIN, AND QORVO HEREBY DISCLAIMS ANY AND ALL WARRANTIES WITH RESPECT TO SUCH PRODUCTS WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

Without limiting the generality of the foregoing, Qorvo products are not warranted or authorized for use as critical components in medical, life-saving, or life-sustaining applications, or other applications where a failure would reasonably be expected to cause severe personal injury or death.

Copyright 2020 © Qorvo, Inc. | Qorvo is a registered trademark of Qorvo, Inc.