



# TQP5525

## High Power 5 GHz WLAN Power Amplifier

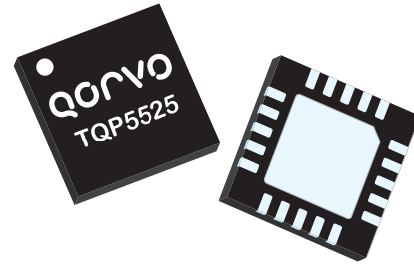
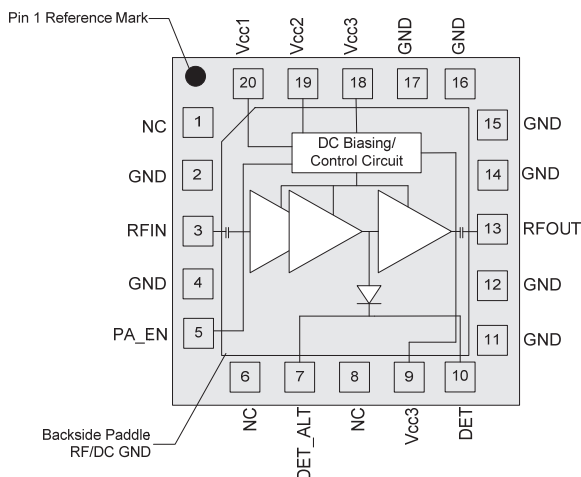
### Product Overview

The TQP5525 is high power WLAN power amplifier module containing an internally matched 3-stage PA, compensated DC biasing circuit and output power detector. This PA module provides high gain (32 dB), high linearity, industry leading EVM floor, and excellent spectral purity for wideband OFDM applications. The architecture and interface are optimized for the most stringent EVM requirements of next generation 802.11ac WLAN devices.

The TQP5525 features chipset logic compatible control voltages and buffered PA enable pin (PAEN) all of which draw very low current to facilitate ease of use and compatibility with current and future transceiver generations. With its optimized power dissipation, this amplifier module is well suited for implementation into next generation MIMO configurations and well designed to work with or without digital pre-distortion (DPD).

The TQP5525 is manufactured using Qorvo's high-reliability HBT technology and is assembled in a small footprint 4.0 mm x 4.0 mm x 0.85 mm 20 pad QFN package.

### Functional Block Diagram



20 Pad 4.0 x 4.0 x 0.85 mm QFN Package

### Key Features

- Fully Integrated 802.11ac Power Amplifier Module With Power Detector
- Internally Matched Input / Output
- Temperature Compensated Bias Network
- High Gain = 32 dB
- Integrated CMOS Compatible Logic and Shutdown
- $P_{OUT} = +25$  dBm (typ.) at  $-35$  dB EVM, (802.11n/HT40/MCS7)
- $P_{OUT} = +18$  dBm (typ.) at  $-40$  dB EVM, (802.11ac/VHT80/MCS9)
- $P_{OUT} = +26$  dBm (typ.) at  $-30$  dB EVM, (802.11ac/VHT80/MCS9)
- Supply Voltage: +3.3 V to +5.0 V
- Leadless 4.0 x 4.0 x 0.85 mm Pb-Free QFN Package

### Applications

- 802.11a/n/ac Wireless LAN Systems
- CPE (Set Top Box, Routers, Gateways)
- WiFi Access Points and Small Cells
- Telematics
- Gaming and Infotainment
- Portable Devices
- Point-to-point and Backhaul
- ISM Band

### Ordering Information

| Part No.    | Description                          |
|-------------|--------------------------------------|
| TQP5525     | 2500 Pieces on a 13" reel (standard) |
| TQP5525-EVB | Assembled Evaluation Board           |

## Absolute Maximum Ratings

| Parameter                           | Rating        |
|-------------------------------------|---------------|
| Storage Temperature                 | -40 to 150 °C |
| Case Temperature, Survival          | -40 to 100 °C |
| RF Input Power, CW, 50 Ω, T = 25 °C | +5 dBm        |
| Device Voltage                      | +6.0 V        |

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

## Recommended Operating Conditions

| Parameter                                              | Min   | Typ | Max   | Units |
|--------------------------------------------------------|-------|-----|-------|-------|
| V <sub>CC1</sub> , V <sub>CC2</sub> , V <sub>CC3</sub> | +3.15 | +5  | +5.25 | V     |
| T <sub>AMB</sub>                                       | -40   | +25 | +85   | °C    |
| T <sub>j</sub> (for >10 <sup>6</sup> hours MTTF)       |       |     | +170  | °C    |

Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions.

## Electrical Specifications – DC Characteristics

| Parameter                           | Conditions                                         | Min  | Typ  | Max              | Units |
|-------------------------------------|----------------------------------------------------|------|------|------------------|-------|
| Quiescent Current                   | No RF                                              |      | 350  | 400              | mA    |
| Operational Current                 | P <sub>out</sub> = +21 dBm, 802.11ac, MCS9, HT80   |      | 475  | 550              | mA    |
|                                     | P <sub>out</sub> = +24 dBm, 802.11ac, MCS9, HT80   |      | 600  | 675              |       |
|                                     | P <sub>out</sub> = +27.5 dBm, 802.11ac, MCS0, HT20 |      | 750  | 850              |       |
| TX Shut Down Current                | PA_EN = Low, No RF                                 |      | 8    |                  | μA    |
| PA Enable Voltage                   | Input Voltage for High State                       | +1.8 | +3.0 | V <sub>CC1</sub> | V     |
|                                     | Input Voltage for Low State                        |      | 0    | +0.45            |       |
| PA Enable Current                   |                                                    |      | 20   | 100              | μA    |
| Rise/Fall Time                      |                                                    |      | 0.4  | 0.8              | μs    |
| Thermal Resistance, θ <sub>JC</sub> | Junction to backside paddle                        |      | 17   |                  | °C/W  |

Notes:

- Test conditions unless otherwise noted: V<sub>CC1</sub> = V<sub>CC2</sub> = V<sub>CC3</sub> = +5.0 V, Temp. = +25 °C.

## Performance Over Voltage

| Parameter                                                         | Conditions                             | Typical Value |      |      | Units |
|-------------------------------------------------------------------|----------------------------------------|---------------|------|------|-------|
| Voltage (V <sub>CC1</sub> , V <sub>CC2</sub> , V <sub>CC3</sub> ) |                                        | +3.3          | +4.2 | +5.0 | Volts |
| Small Signal Gain                                                 | f = 5250 – 5925 MHz                    | 30.5          | 31.5 | 32   | dB    |
| P <sub>out</sub> (11ac / VHT80 / MCS9)                            | DEVM = -35 dB                          | +22           | +24  | +25  | dBm   |
| P <sub>out</sub> (11ac / HT20 / MCS0)                             | DEVM = -30 dB                          | +24           | +26  | +27  | dBm   |
| Operating Current                                                 | 802.11ac / VHT80 / MCS9, DEVM = -35 dB | 470           | 540  | 600  | mA    |

Notes:

- Test conditions unless otherwise noted: Temp. = +25 °C.

## Logic Truth Table

| PA Mode  | PA_EN State |
|----------|-------------|
| Disabled | Low         |
| Enabled  | High        |

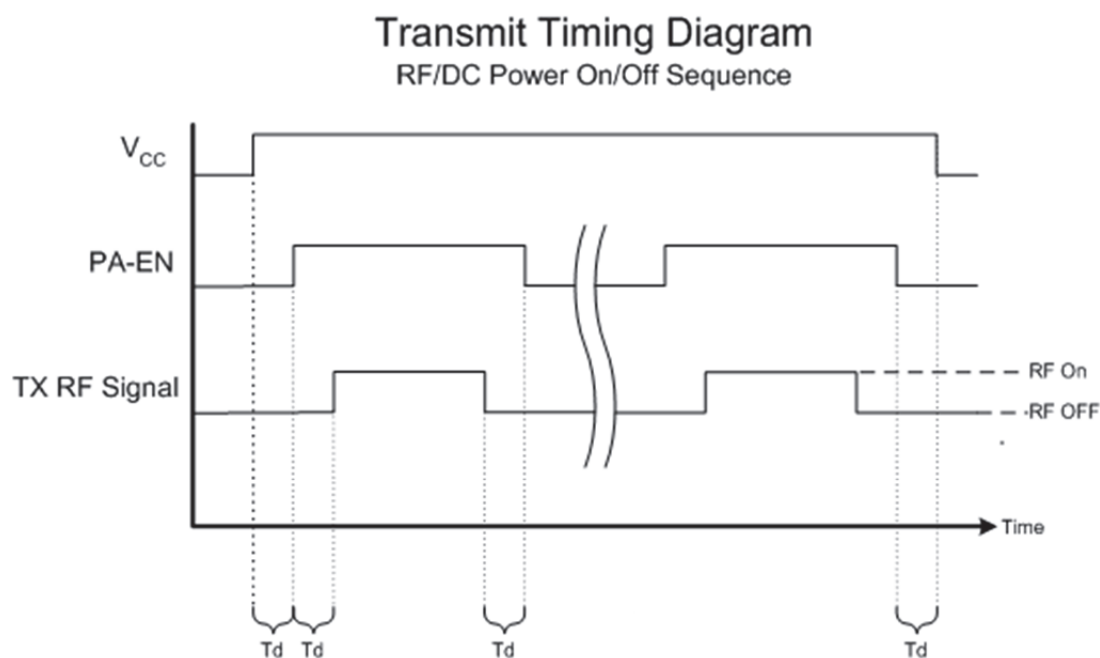
## Electrical Specifications

| Parameter                                                                          | Conditions <sup>(1)</sup>                             | Min                                                       | Typ    | Max   | Units       |
|------------------------------------------------------------------------------------|-------------------------------------------------------|-----------------------------------------------------------|--------|-------|-------------|
| Operational Freq. Range                                                            |                                                       | 4900                                                      |        | 5925  | MHz         |
| 3dB Bandwidth                                                                      | At each 802.11ac VHT80 channel                        | 4740                                                      |        | 6100  | MHz         |
| Saturation Power (P <sub>sat</sub> )                                               | f = 4900 – 5150 MHz                                   |                                                           | +31.5  |       | dBm         |
|                                                                                    | f = 5150 – 5925 MHz                                   |                                                           | +34    |       |             |
| P <sub>1dB</sub>                                                                   | f = 4900 MHz – 5150 MHz                               | +29.5                                                     | +30.5  |       | dBm         |
|                                                                                    | f = 5150 MHz – 5925 MHz                               | +30                                                       | +32    |       |             |
| Small Signal Gain                                                                  | f = 4900 – 5250 MHz                                   | 28                                                        | 31     | 35    | dB          |
|                                                                                    | f = 5250 – 5925 MHz                                   | 29                                                        | 32     | 37    |             |
| Gain OOB                                                                           | Absolute gain, f = 3433 – 3917 MHz                    |                                                           | 0      |       | dB          |
|                                                                                    | Absolute gain, f = 1716 – 1959 MHz                    |                                                           | -50    |       |             |
| Gain Flatness Across Band                                                          | For any 80 MHz BW, 802.11ac/VHT80                     |                                                           | ± 0.25 |       | dB          |
| Spectral Emission Mask Margin<br>Relative to 11ac standard<br>(802.11ac/HT20/MCS0) | P <sub>out</sub> = +24 dBm, f = 5150 – 5250 MHz       |                                                           | 5      |       | dB          |
|                                                                                    | P <sub>out</sub> = +26.5 dBm, f = 5250 – 5725 MHz     |                                                           | 5      |       |             |
|                                                                                    | P <sub>out</sub> = +27.5 dBm, f = 5725 – 5925 MHz     |                                                           | 5      |       |             |
| PA Noise Figure                                                                    |                                                       |                                                           | 7      |       | dB          |
| Input Return Loss                                                                  |                                                       |                                                           | 10     |       | dB          |
| Output Return Loss                                                                 |                                                       |                                                           | 10     |       | dB          |
| CW Signal Phase Variation Harmonics (2f <sub>0</sub> )                             | P <sub>out</sub> = +18 dBm to +24 dBm                 |                                                           | 1.0    |       | Deg.        |
| TX Harmonics (2f <sub>0</sub> )<br>(802.11ac/VHT20/MCS0)                           | P <sub>out</sub> = +22 dBm, f = 5150 – 5250 MHz       |                                                           | -45    |       | dBm/<br>MHz |
|                                                                                    | P <sub>out</sub> = +26.5 dBm, f = 5250 – 5725 MHz     |                                                           | -45    |       |             |
|                                                                                    | P <sub>out</sub> = +27.5 dBm, f = 5725 – 5925 MHz     |                                                           | -45    |       |             |
| TX Harmonics (3f <sub>0</sub> )<br>(802.11ac/VHT20/MCS0)                           | P <sub>out</sub> = +22 dBm, f = 5150 – 5250 MHz       |                                                           | -45    |       | dBm/<br>MHz |
|                                                                                    | P <sub>out</sub> = +26.5 dBm, f = 5250 – 5725 MHz     |                                                           | -45    |       |             |
|                                                                                    | P <sub>out</sub> = +27.5 dBm, f = 5725 – 5925 MHz     |                                                           | -45    |       |             |
| DEVM (802.11n/HT40/MCS7)                                                           | P <sub>out</sub> = +25 dBm                            |                                                           | -33    |       | dB          |
| DEVM (802.11ac/VHT80/MCS9)                                                         | P <sub>out</sub> = +18 dBm                            |                                                           | -40    | -36   | dB          |
|                                                                                    | P <sub>out</sub> = +24 dBm                            |                                                           | -36    | -31   |             |
| DEVM (802.11ac/VHT20/MCS0)                                                         | P <sub>out</sub> = +27 dBm                            |                                                           | -26    |       | dB          |
| Detector Voltage                                                                   | No RF                                                 | +0.25                                                     | +0.35  | +0.38 | V           |
|                                                                                    | P <sub>out</sub> = +27.5 dBm                          | +0.8                                                      | +0.9   | +1.2  |             |
| Stability                                                                          | P <sub>out</sub> = +28 dBm,<br>VSWR = 6:1, all phases | All non-harmonically related<br>outputs < -50 dBc/100 kHz |        |       | -           |

**Notes:**

- Test conditions unless otherwise noted: V<sub>CC1</sub> = V<sub>CC2</sub> = V<sub>CC3</sub> = +5.0 V Temp. = +25 °C, Measured on TQP5525-EVB, PA\_EN High = +3.0 V, -45 dBm EVM source

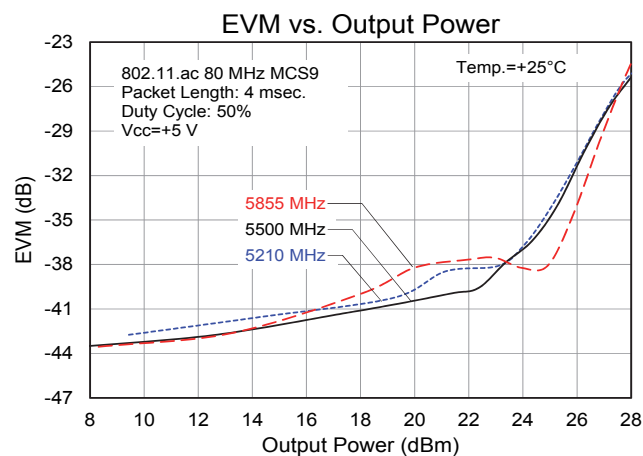
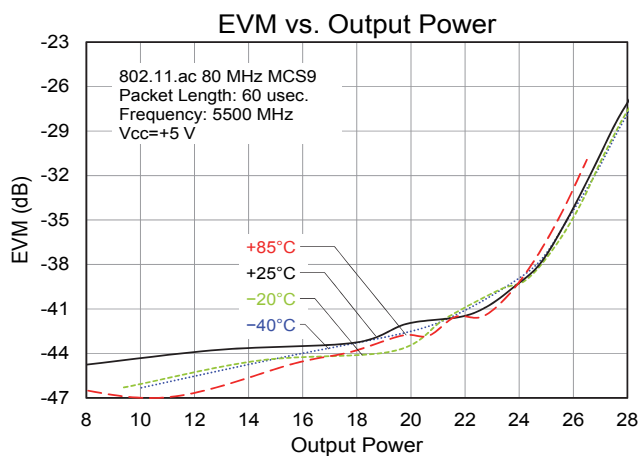
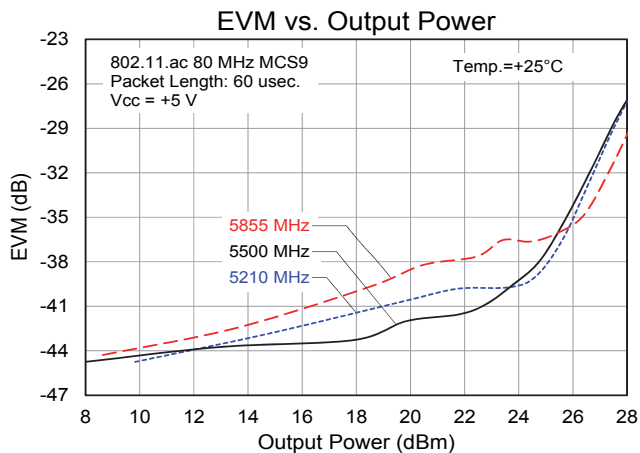
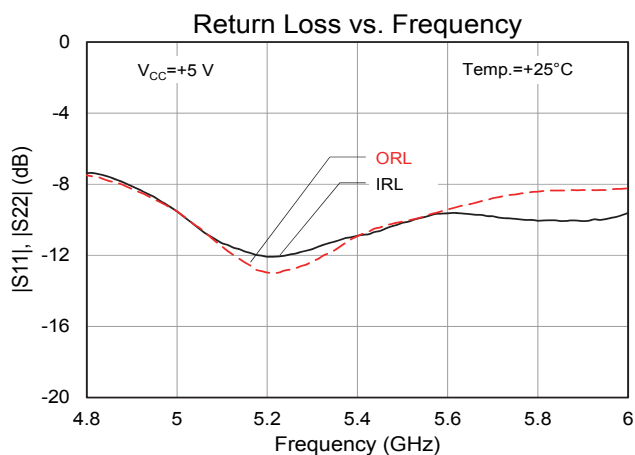
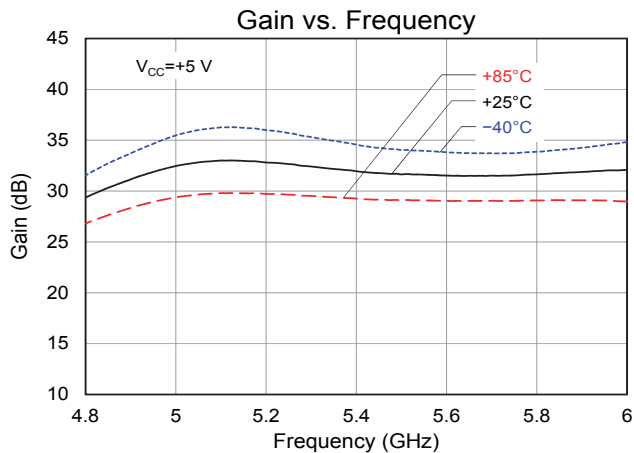
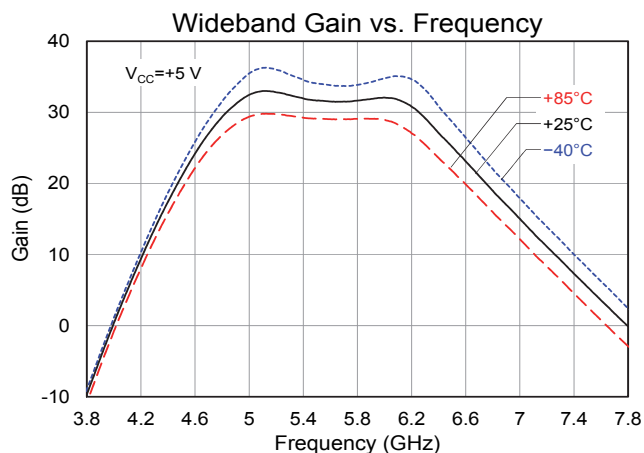
## Timing Diagram



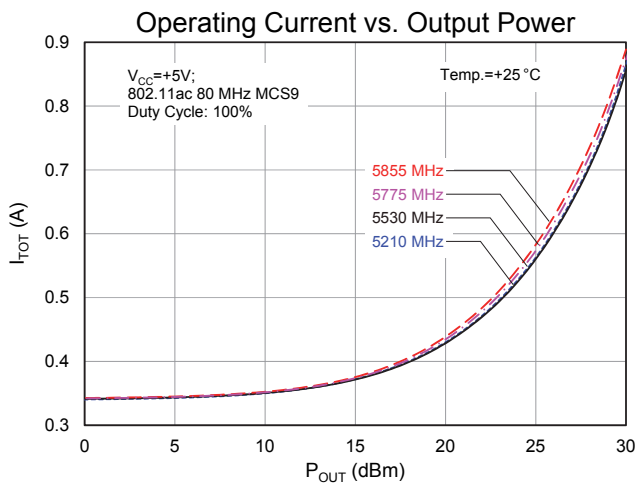
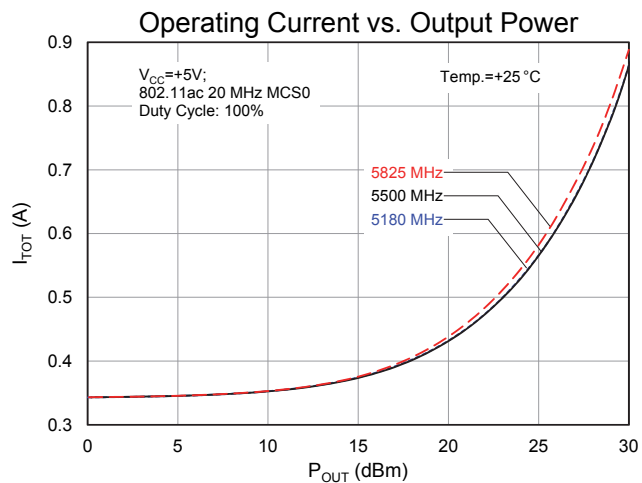
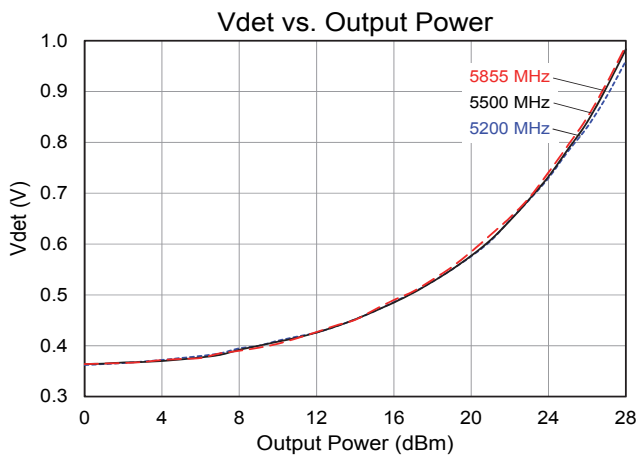
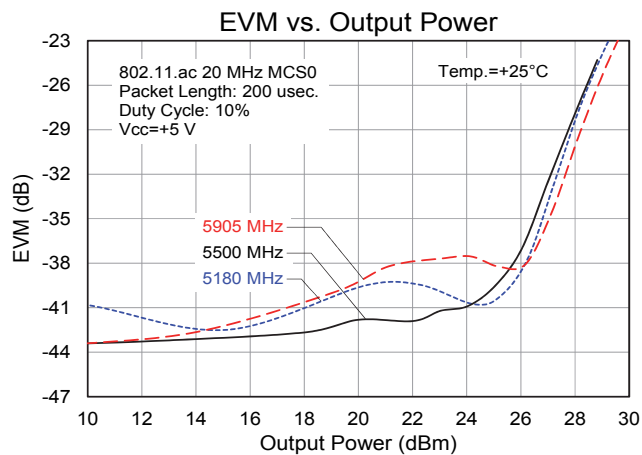
Notes: DC and RF signal levels per data sheet specification.  
Observe the timing sequence shown in the diagram above and described below.

- Apply  $V_{CC}$  prior to turning on or pulsing PA enable.
- Turn off PA enable prior to turning off  $V_{CC}$ .
- Turn on PA enable prior to applying RF signal.
- Turn off RF signal prior to turning off PA enable.

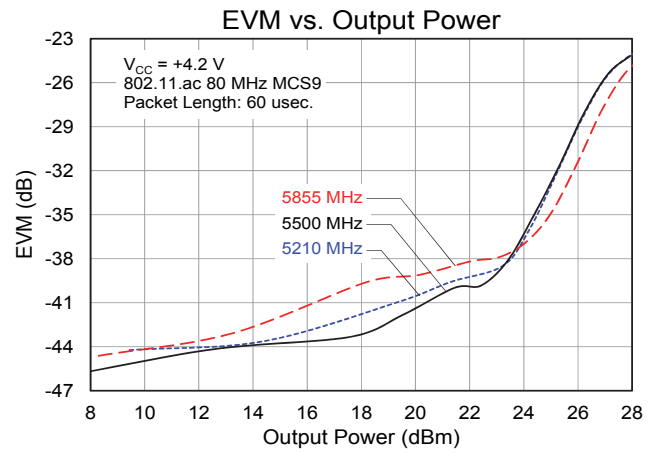
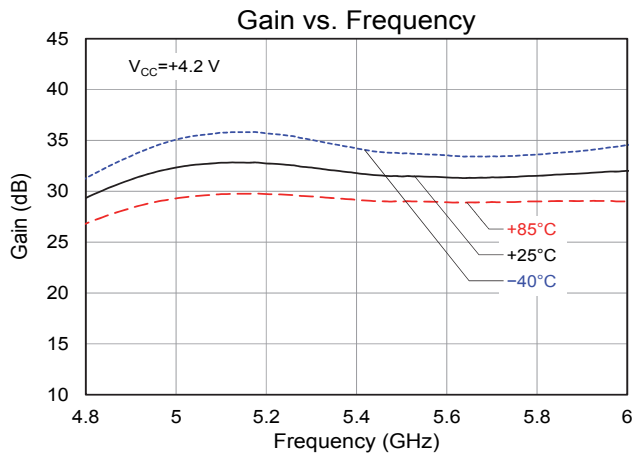
Performance Plots  $V_{CC} = +5\text{ V}$



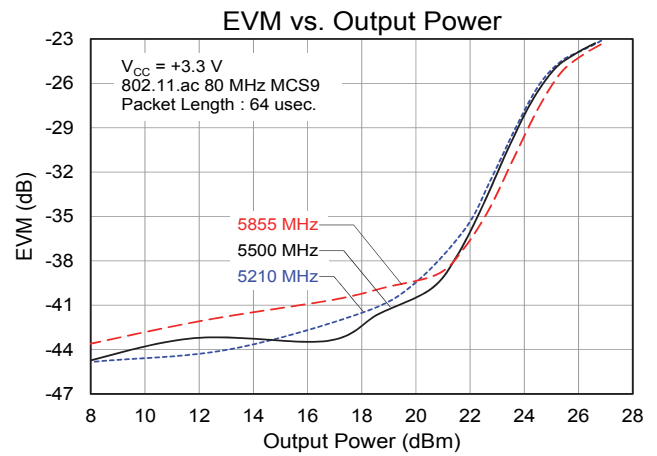
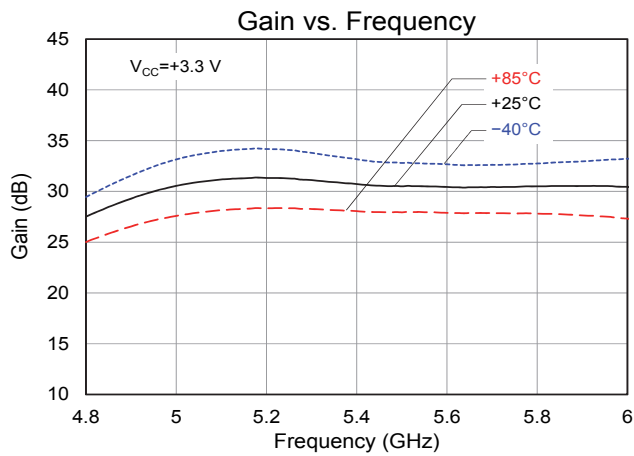
Performance Plots  $V_{CC} = +5\text{ V}$  (cont.)



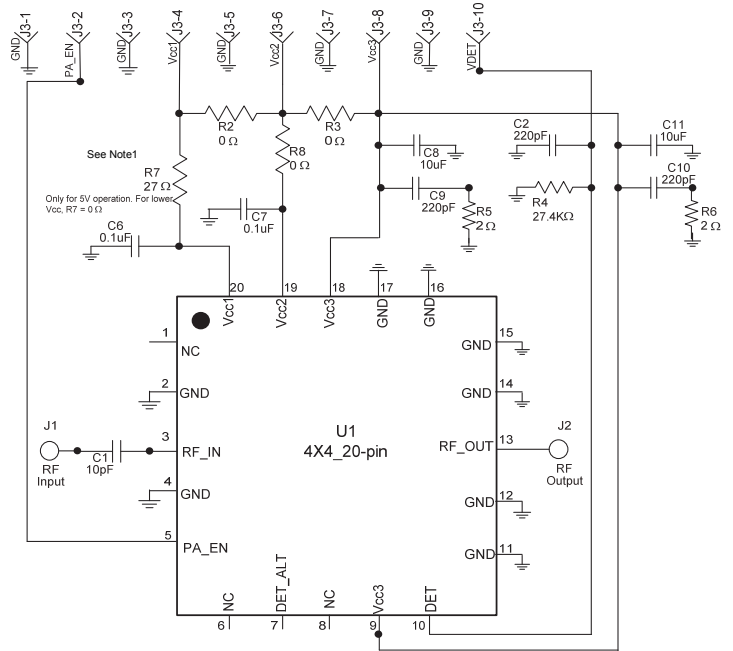
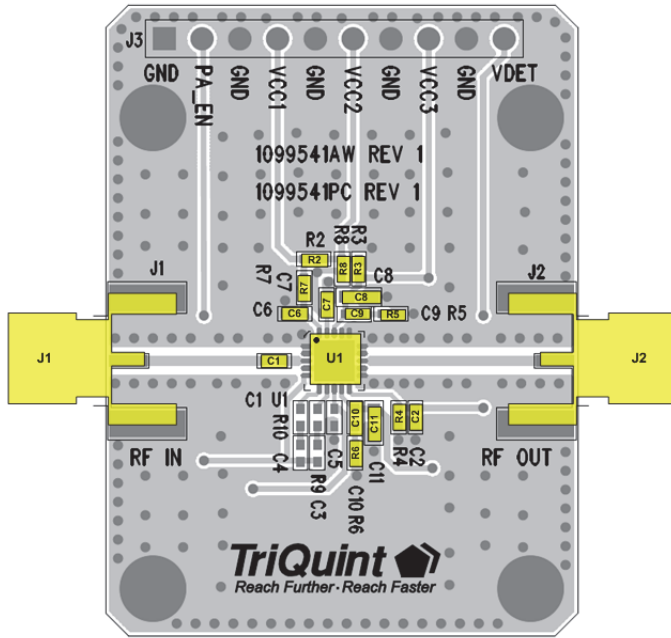
## Performance Plots $V_{CC} = +4.2\text{ V}$



## Performance Plots $V_{CC} = +3.3\text{ V}$



## Application Circuit



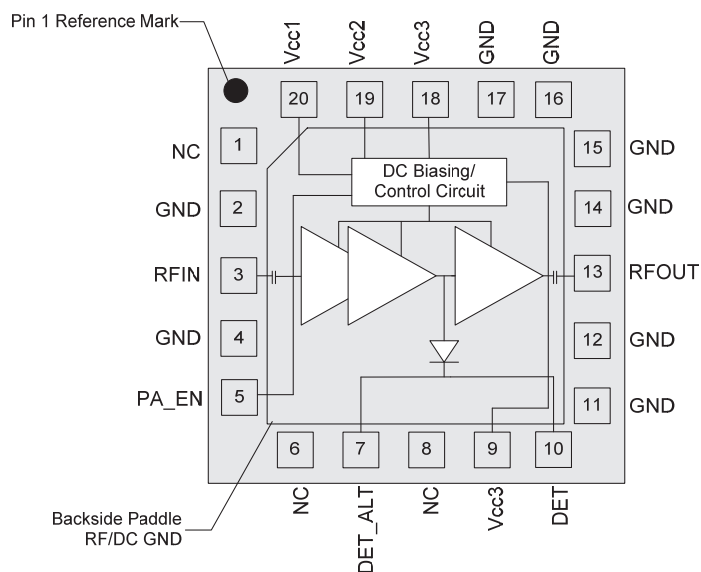
## Bill of Material

| Ref Des               | Value     | Description                     | Manuf.   | Part Number |
|-----------------------|-----------|---------------------------------|----------|-------------|
| n/a                   | n/a       | Printed Circuit Board           |          | 1099541     |
| U1                    | n/a       | High Power WLAN 5GHz PA         | TriQuint | TQP5525     |
| R2, R8, R3            | 0 Ω       | Resistor, Chip, 04023, 5%       | various  |             |
| C1                    | 10 pF     | Capacitor, Chip, 0402, 5%       | various  |             |
| C6, C7                | 0.1 uF    | Capacitor, Chip, 0402, 10%      | various  |             |
| C8, C11               | 10 uF     | Capacitor, Chip, 0402, 10%      | various  |             |
| C9, C10, C2           | 220 pF    | Capacitor, Chip, 0402, 10%      | various  |             |
| R7 <sup>(1)</sup>     | 0 to 27 Ω | Resistor, Chip, 0402, 5%, 1/10W | various  |             |
| R5, R6 <sup>(2)</sup> | 2 Ω       | Resistor, Chip, 0402, 5%, 1/16W | various  |             |
| R4                    | 27.4 KΩ   | Resistor, Chip, 0402, 5%, 1/16W | various  |             |

### Notes:

1. For Vcc1>+4.5V, value of R7 may be varied between 0 and 27 Ohms for EVM floor optimization.
2. R5 and R6 are de-Q resistors.

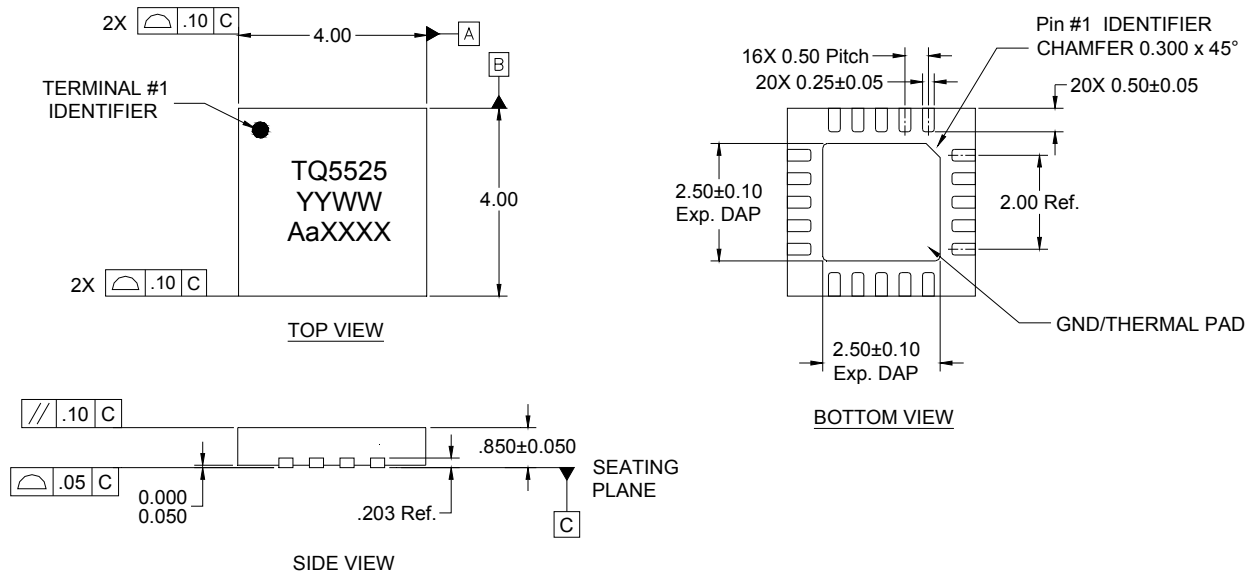
## Pin Configuration and Description



| Pin No.      | Label     | Description                                                                                                                                |
|--------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 1            | NC        | No internal connection. This pin can be grounded or N/C on PCB.                                                                            |
| 2            | GND       | Ground                                                                                                                                     |
| 3            | RF_IN     | RF Input                                                                                                                                   |
| 4            | GND       | Ground                                                                                                                                     |
| 5            | PA_EN     | PA Enable                                                                                                                                  |
| 6            | NC        | No internal connection. This pin can be grounded or N/C on PCB.                                                                            |
| 7            | DET_ALT   | Alternate Detector Output                                                                                                                  |
| 8            | NC        | No internal connection. This pin can be grounded or N/C on PCB.                                                                            |
| 9            | VCC3      | Supply voltage for third stage PA                                                                                                          |
| 10           | DET       | Detector Output                                                                                                                            |
| 11           | GND       | Ground                                                                                                                                     |
| 12           | GND       | Ground                                                                                                                                     |
| 13           | RF_OUT    | RF Output                                                                                                                                  |
| 14           | GND       | Ground                                                                                                                                     |
| 15           | GND       | Ground                                                                                                                                     |
| 16           | GND       | Ground                                                                                                                                     |
| 17           | GND       | Ground                                                                                                                                     |
| 18           | VCC3      | Supply voltage for third stage PA                                                                                                          |
| 19           | VCC2      | Supply voltage for second stage PA                                                                                                         |
| 20           | VCC1      | Supply voltage for first stage PA                                                                                                          |
| Backside Pad | RF/DC GND | RF/DC ground. Use recommended via pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint. |

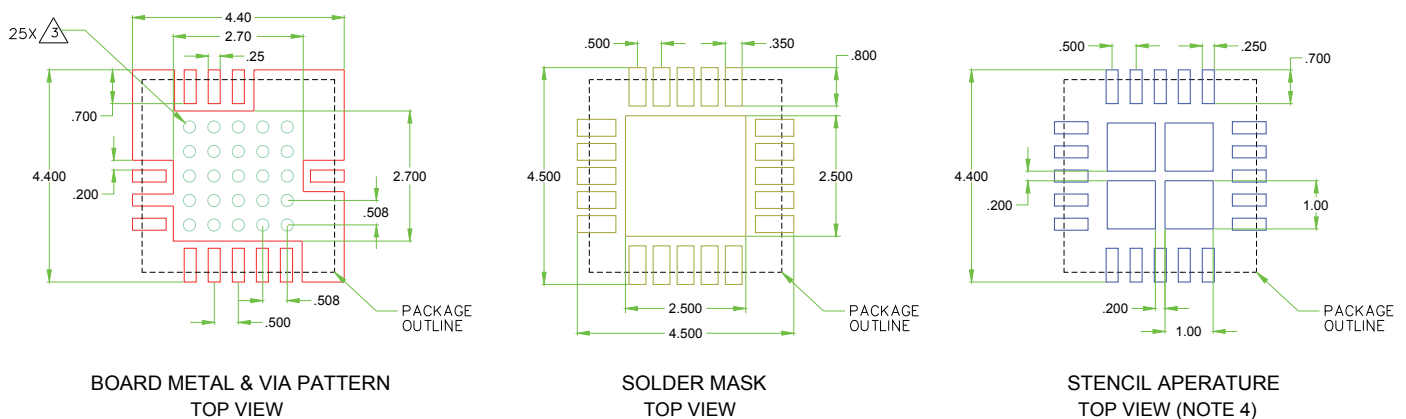
## Package Marking and Dimensions

Marking: Product Identifier - TQ5525  
Date Code - YYWW (Year, workweek)  
Lot Code - AaXXXX



- Notes:
1. All dimensions are in millimeters.
  2. Contact plating: NiPdAu.

## 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 1C | ESDA / JEDEC JS-001-2012 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC JESD22-C101F       |
| MSL – Moisture Sensitivity Level | Level 1  | 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: NiPdAu

## 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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