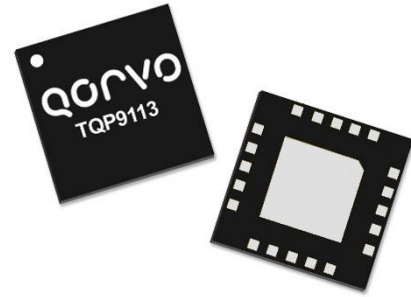


General Description

The TQP9113 is a 1 W, linear, two-stage driver amplifier in a low-cost surface-mount package. The amplifier is able to achieve high performance with +42 dBm OIP3 and +30.4 dBm P1dB while only consuming 216 mA current. The input is internally matched and the amplifier only requires only a few external components for operation. The integrated interstage match minimizes performance variation that would otherwise be attributed to external matching component value and placement tolerances.

The TQP9113 is bias adjustable allowing the amplifier's power consumption to be reduced for occasions when linear performance is not required. The amplifier can also be switched on and off for TDD applications. The output match is tunable externally to allow the amplifier to be optimized for high power or high linearity applications.

The TQP9113 is available in a RoHS-compliant 20-pin 4 x 4 mm surface mount package.



20-Pin 4 x 4 mm Leadless QFN Package

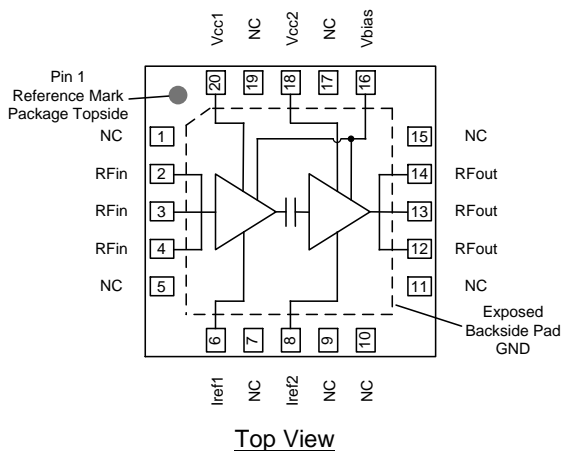
Product Features

- 1800 – 2700 MHz Frequency Range
- 27.2 dB Gain
- +42 dBm Output IP3
- +30.4 dBm P1dB
- +5 V supply, 216 mA Current
- Internal Input and Interstage Matching
- Bias Adjustable
- Power down functionality for TDD systems

Applications

- Wireless Infrastructure
- FDD / TDD Base Stations
- Repeaters, Boosters, DAS
- High Power Amplifiers

Functional Block Diagram



Ordering Information

| Part No. | Description |
|-----------------|----------------------------------|
| TQP9113* | 1800 – 2700 MHz Linear Amplifier |
| TQP9113-PCB2140 | 1800 – 2200 MHz Evaluation Board |
| TQP9113-PCB2600 | 2300 – 2700 MHz Evaluation Board |

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

Absolute Maximum Ratings

| Parameter | Rating |
|-----------------------------------|---------------|
| Storage Temperature | -55 to 150 °C |
| Supply Voltage (V _{CC}) | +6 V |
| RF Input Power, CW, 50 Ω, T=25 °C | +15 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 _{CC}) | +4.75 | +5.0 | +5.25 | V |
| T _{CASE} | -40 | | +105 | °C |
| T _j for >10 ⁶ hours MTTF | | | +170 | °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_{CC} = +5.0 V, Temp = +25 °C, in a matched 2140 MHz reference circuit.

| Parameter | Conditions | Min | Typ | Max | Units |
|-------------------------------------|--|------|-------|------|-------|
| Operational Frequency Range | | 1800 | | 2700 | MHz |
| Test Frequency | | | 2140 | | MHz |
| Gain | | 25 | 27.2 | 30 | dB |
| Input Return Loss | | | 14 | | dB |
| Output Return Loss | | | 14 | | dB |
| Noise Figure | | | 4.7 | | dB |
| Output P1dB | | 28.9 | +30.4 | | dBm |
| Output IP3 | P _{out} = +16 dBm/ tone, Δf = 1 MHz | 38 | +42 | | dBm |
| WCDMA Channel Power ⁽¹⁾ | -50 dBc ACLR | | +18.4 | | dBm |
| Current, I _{CC} | Pin 16, 18 and 20 | | 212 | | mA |
| Current, I _{REF1} | | | 1.2 | | mA |
| Current, I _{REF2} | | | 2.2 | | mA |
| Total Current | on V _{CC} of EVB circuit | | 216 | 245 | mA |
| Thermal Resistance, θ _{JC} | Junction to case | | | 41.7 | °C/W |

Notes:

1. ACLR test set-up: 3GPP WCDMA, TM1+64 DPCH, +5 MHz offset, PAR = 10.2 dB at 0.01% Probability

Switching Time

Test Conditions: V_{PD} High = +5V, V_{PD} Low = 0V, V_{CC} = +5V, C10 = 1000pF on 2600MHz EVB, Temp = +25°C

| Parameter | Conditions | Typical Value | Units |
|-----------------|---|---------------|-------|
| Switch-ON Time | 50% of V _{PD} to 90% of RF output, Effective V _{PD} rise time 167ns | 106 | ns |
| Switch-OFF Time | 50% of V _{PD} to 10% of RF output, Effective V _{PD} fall time 171ns | 13 | ns |

Note: V_{PD} requires 100% of +5V to ensure the ON state performances

S-Parameters

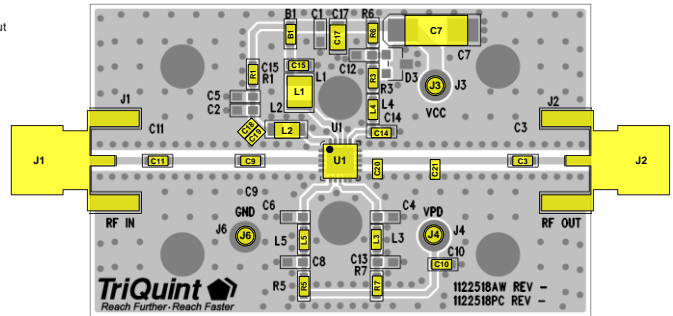
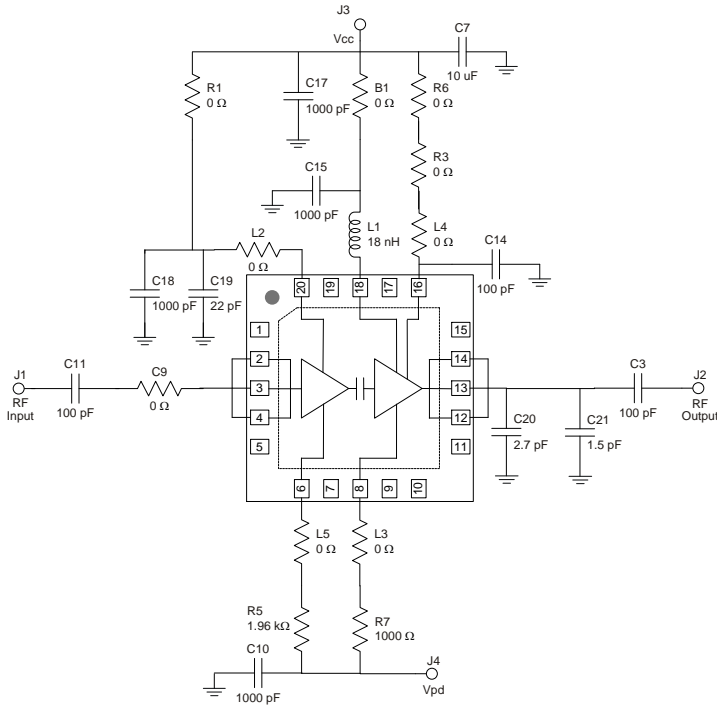
Test Conditions: $V_{CC} = V_{PD} = +5\text{ V}$, $I_{CQ} = 215\text{ mA}$, Temp. = $+25\text{ }^{\circ}\text{C}$, unmatched $50\text{ }\Omega$ system, calibrated to device leads

| Freq (GHz) | S11 (dB) | S11 (ang) | S21 (dB) | S21 (ang) | S12 (dB) | S12 (ang) | S22 (dB) | S22 (ang) |
|------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| 0.1 | -0.7 | 175 | -59.9 | -133 | -64.4 | -170 | -2.6 | -173 |
| 0.2 | -0.7 | 171 | -34.4 | -150 | -68.6 | 78 | -2.1 | -177 |
| 0.3 | -0.8 | 166 | -24.8 | -147 | -57.9 | 122 | -1.9 | -180 |
| 0.4 | -0.8 | 160 | -17.9 | -151 | -73.6 | -80 | -2.0 | 179 |
| 0.5 | -1.0 | 156 | -12.1 | -159 | -56.4 | -49 | -2.2 | 178 |
| 0.6 | -1.0 | 149 | -7.1 | -164 | -63.4 | -43 | -2.3 | 177 |
| 0.7 | -1.1 | 143 | -2.3 | -173 | -52.0 | 167 | -2.5 | 175 |
| 0.8 | -1.2 | 135 | 2.1 | 177 | -50.7 | 62 | -2.7 | 175 |
| 0.9 | -1.3 | 126 | 6.3 | 165 | -52.4 | 54 | -3.2 | 173 |
| 1 | -1.6 | 117 | 10.4 | 149 | -61.0 | 53 | -3.7 | 172 |
| 1.1 | -2.0 | 104 | 14.3 | 127 | -63.1 | 160 | -4.3 | 172 |
| 1.2 | -2.8 | 94 | 15.8 | 99 | -60.3 | 97 | -4.7 | 171 |
| 1.3 | -3.2 | 79 | 18.6 | 95 | -60.8 | -144 | -5.7 | 171 |
| 1.4 | -4.9 | 60 | 22.4 | 69 | -65.7 | 108 | -6.3 | 178 |
| 1.5 | -7.9 | 49 | 24.4 | 39 | -55.5 | 137 | -6.2 | -177 |
| 1.6 | -10.7 | 50 | 25.3 | 10 | -50.3 | 124 | -5.8 | -175 |
| 1.7 | -11.6 | 55 | 25.6 | -15 | -48.6 | 94 | -5.3 | -175 |
| 1.8 | -11.7 | 50 | 25.8 | -37 | -51.8 | 86 | -5.1 | -175 |
| 1.9 | -11.7 | 39 | 25.9 | -57 | -48.6 | 59 | -5.2 | -174 |
| 2 | -12.1 | 22 | 26.0 | -77 | -48.6 | 54 | -4.9 | -174 |
| 2.1 | -12.6 | 0 | 26.0 | -97 | -50.7 | 64 | -4.8 | -173 |
| 2.2 | -13.1 | -27 | 25.9 | -118 | -52.6 | 29 | -4.5 | -171 |
| 2.3 | -13.0 | -54 | 25.6 | -138 | -51.6 | 29 | -3.8 | -170 |
| 2.4 | -12.4 | -79 | 25.1 | -158 | -51.3 | -12 | -3.3 | -170 |
| 2.5 | -11.7 | -95 | 24.3 | -178 | -56.0 | -31 | -2.7 | -171 |
| 2.6 | -11.2 | -106 | 23.3 | 163 | -60.6 | 7 | -2.2 | -171 |
| 2.7 | -10.5 | -113 | 22.1 | 144 | -58.0 | -113 | -1.7 | -174 |
| 2.8 | -9.9 | -115 | 20.7 | 126 | -63.8 | 89 | -1.5 | -175 |
| 2.9 | -9.1 | -116 | 19.0 | 110 | -53.0 | 138 | -1.3 | -176 |
| 3 | -8.2 | -117 | 17.2 | 94 | -55.3 | 112 | -1.3 | -177 |
| 3.2 | -6.8 | -120 | 12.8 | 65 | -50.9 | 88 | -1.1 | -178 |
| 3.4 | -5.9 | -116 | 3.6 | 54 | -58.9 | -133 | -1.0 | -179 |
| 3.6 | -3.5 | -117 | 7.8 | 82 | -57.0 | 178 | -1.6 | 179 |
| 3.8 | -3.2 | -123 | 6.7 | 51 | -46.7 | 134 | -2.3 | -177 |
| 4 | -3.3 | -125 | 4.4 | 32 | -49.3 | 154 | -2.7 | -176 |

Notes:

1. Pins 6, 8, 16, 18, 20 are loaded as shown in the PCB2140 design.

1.8 – 2.2 GHz Evaluation Board (TQP9113-PCB2140)



Notes:

1. See Evaluation Board PCB Information section for PCB material and stack-up
2. Components (C11 and C3) are blocking capacitors and their locations are not critical to the matching network.
3. All components are of 0603 size unless otherwise specified.
4. Critical component placement locations:
 Distance from U1 Package (right edge) to C20 (left edge): 25 mils
 Distance from U1 Package (right edge) to C21 (left edge): 310 mils

Bill of Material TQP9113-PCB2140

| Ref Des | Value | Description | Manuf. | Part Number |
|--------------------------------|---------|-----------------------------------|---------|-------------|
| U1 | | TQP9113 | Qorvo | TQP9113 |
| C10, C15, C18 | 1000 pF | CAP, 0603, 5%, 50V, NPO | various | |
| C3, C11, C14 | 100 pF | CAP, 0603, 5%, 50V, NPO | various | |
| C19 | 22 pF | CAP, 0603, 5PCT, 50V, NPO/COG | various | |
| C20 | 2.7 pF | CAP, 0603, +/-0.1PF, 50V, NPO/COG | various | |
| C21 | 1.5 pF | CAP, 0603, 5PCT, 50V, NPO/COG | various | |
| C7 | 10 uF | CAP, 6032, 20%, 50V, Tantalum | various | |
| R5 | 1.96 kΩ | RES, 0603, 1PCT, 1/16W | various | |
| R7 | 1000 Ω | RES, 0603, 1PCT, 1/16W | various | |
| B1, R1, R3, R6, L3, L4, L5, C9 | 0 Ω | RES, 0603, 1/16W, Chip | various | |
| L2 | 0 Ω | RES, 0805, 1/10W, Chip | various | |
| L1 | 18 nH | IND, 1008, 5%, Ceramic | various | |
| C17 | 1000pF | CAP, 0805, 5PCT, 50V, NPO | various | |

Typical Performance TQP9113- PCB2140

Test conditions unless otherwise noted: $V_{CC} = +5\text{ V}$, $V_{pd} = +5\text{ V}$, $I_{CQ} = 215\text{ mA}$ (typ.), Temp. = $+25\text{ }^{\circ}\text{C}$

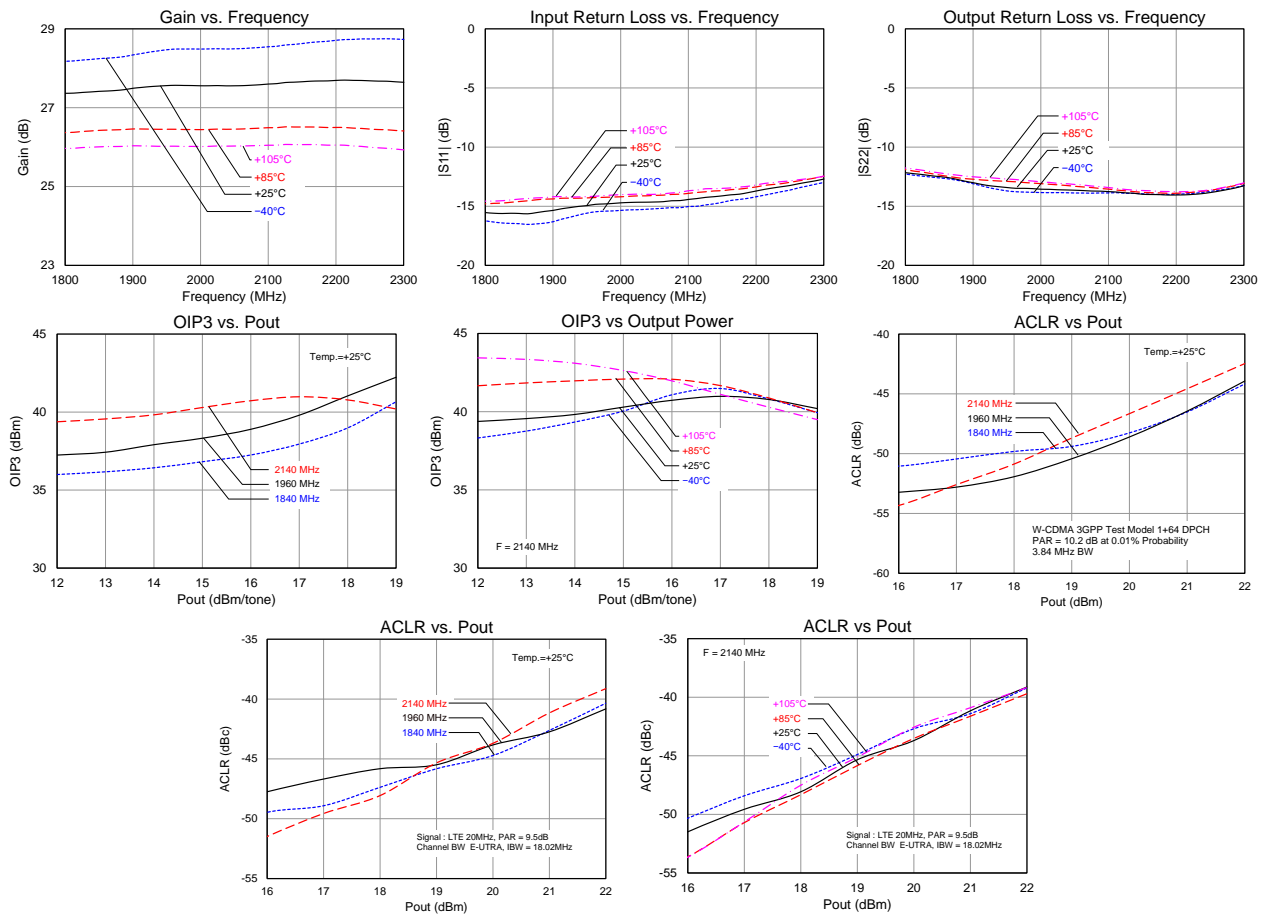
| Parameter | Conditions | Typical Value | | | Units |
|------------------------------------|---|---------------|-------|-------|-------|
| Frequency | | 1840 | 1960 | 2140 | MHz |
| Gain | | 27.4 | 27.6 | 27.6 | dB |
| Input Return Loss | | 16 | 15 | 14 | dB |
| Output Return Loss | | 12 | 13 | 14 | dB |
| Output P1dB | | +30.5 | +30.6 | +30.6 | dBm |
| OIP3 | Pout= +16 dBm/tone, $\Delta f=1\text{ MHz}$ | +37 | +39 | +41 | dBm |
| Noise Figure | | 5.2 | 4.9 | 4.7 | dB |
| WCDMA Channel Power ⁽¹⁾ | -50 dBc ACLR | +17.9 | +19.3 | +18.4 | dBm |

Notes:

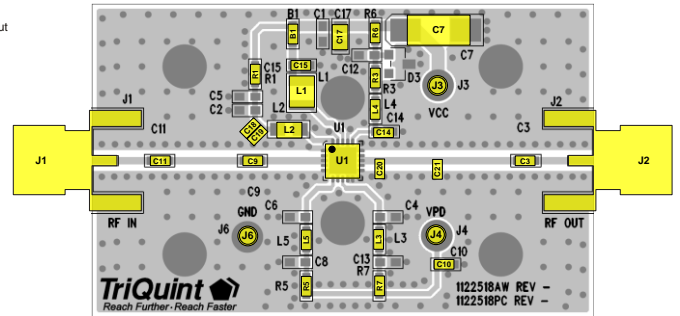
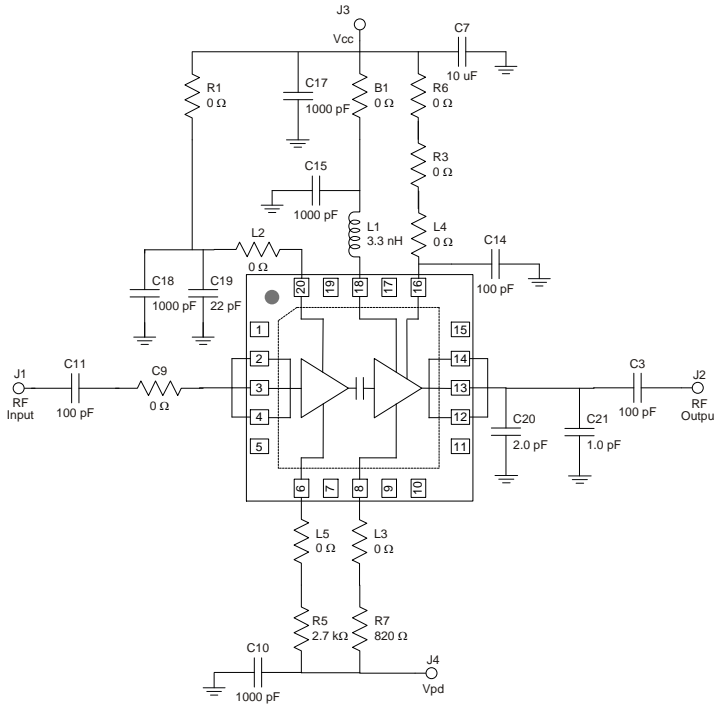
1. ACLR Test set-up: 3GPP WCDMA, TM1+64 DPCH, +5 MHz offset, PAR = 10.2 dB at 0.01% Probability

Typical Performance TQP9113-PCB2140

Test conditions unless otherwise noted: $V_{CC} = +5\text{ V}$, $I_{CQ} = 215\text{ mA}$ (typ.), Temp. = $+25\text{ }^{\circ}\text{C}$



2.3 – 2.7 GHz Evaluation Board (TQP9113-PCB2600)



Notes:

1. See Evaluation Board PCB Information section for PCB material and stack-up
2. Components (C11 and C3) are blocking capacitors and their locations are not critical to the matching network.
3. All components are of 0603 size unless otherwise specified.
4. Critical component placement locations:
 Distance from U1 Package (right edge) to C20 (left edge): 25 mils
 Distance from U1 Package (right edge) to C21 (left edge): 285 mils

Bill of Material TQP9113-PCB2600

| Ref Des | Value | Description | Manuf. | Part Number |
|--------------------------------|---------|-----------------------------------|---------|-------------|
| U1 | | TQP9113 | Qorvo | TQP9113 |
| C10, C15, C18 | 1000 pF | CAP, 0603, 5%, 50V, NPO | various | |
| C3, C11, C14 | 100 pF | CAP, 0603, 5%, 50V, NPO | various | |
| C19 | 22 pF | CAP, 0603, 5PCT, 50V, NPO/COG | various | |
| C20 | 2.0 pF | CAP, 0603, +/-0.1PF, 50V, NPO/COG | various | |
| C21 | 1.0 pF | CAP, 0603, 5PCT, 50V, NPO/COG | various | |
| C7 | 10 uF | CAP, 6032, 20%, 50V, Tantalum | various | |
| R5 | 2.7 kΩ | RES, 0603, 1PCT, 1/16W | various | |
| R7 | 820 Ω | RES, 0603, 1PCT, 1/16W | various | |
| B1, R1, R3, R6, L3, L4, L5, C9 | 0 Ω | RES, 0603, 1/16W, Chip | various | |
| L2 | 0 Ω | RES, 0805, 1/10W, Chip | various | |
| L1 | 3.3 nH | IND, 1008, 5%, Ceramic | various | |
| C17 | 1000pF | CAP, 0805, 5PCT, 50V, NPO | various | |

Typical Performance TQP9113-PCB2600

Test conditions unless otherwise noted: $V_{CC} = +5\text{ V}$, $V_{pd} = +5\text{ V}$, $I_{CQ} = 250\text{ mA}$ (typ.), Temp. = $+25\text{ }^{\circ}\text{C}$

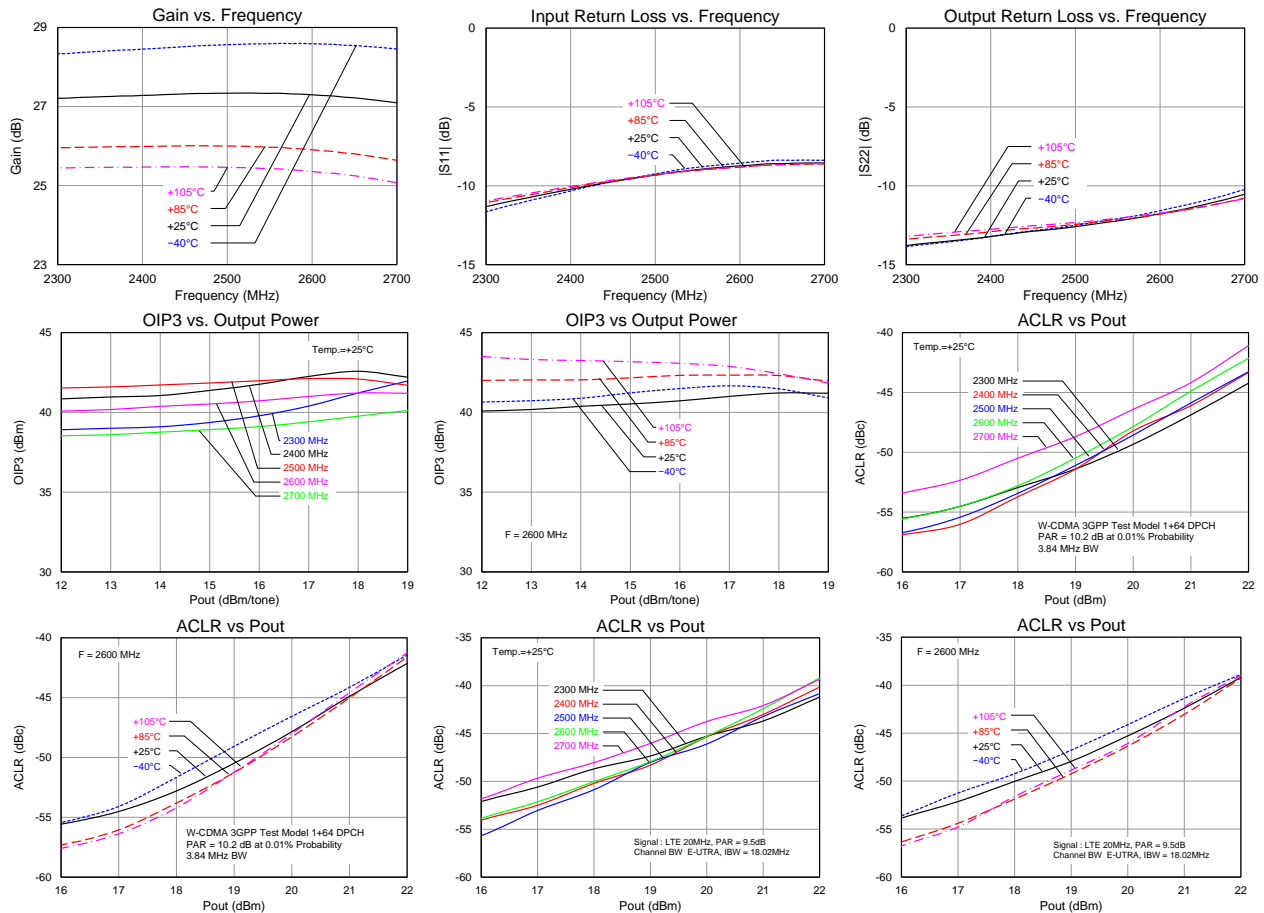
| Parameter | Conditions | Typical Value | | | Units |
|------------------------------------|---|---------------|-------|-------|-------|
| | | 2300 | 2500 | 2700 | |
| Frequency | | 2300 | 2500 | 2700 | MHz |
| Gain | | 27.2 | 27.3 | 27.1 | dB |
| Input Return Loss | | 11 | 9.3 | 8.6 | dB |
| Output Return Loss | | 14 | 12 | 11 | dB |
| Output P1dB | | +30.8 | +30.3 | +29.8 | dBm |
| OIP3 | $P_{out} = +16\text{ dBm/tone}$, $\Delta f = 1\text{ MHz}$ | +39.8 | +42.0 | +39.1 | dBm |
| Noise Figure | | 4.7 | 4.9 | 5.0 | |
| WCDMA Channel Power ⁽¹⁾ | -50 dBc ACLR | +19.7 | +19.4 | +18.3 | dBm |

Notes:

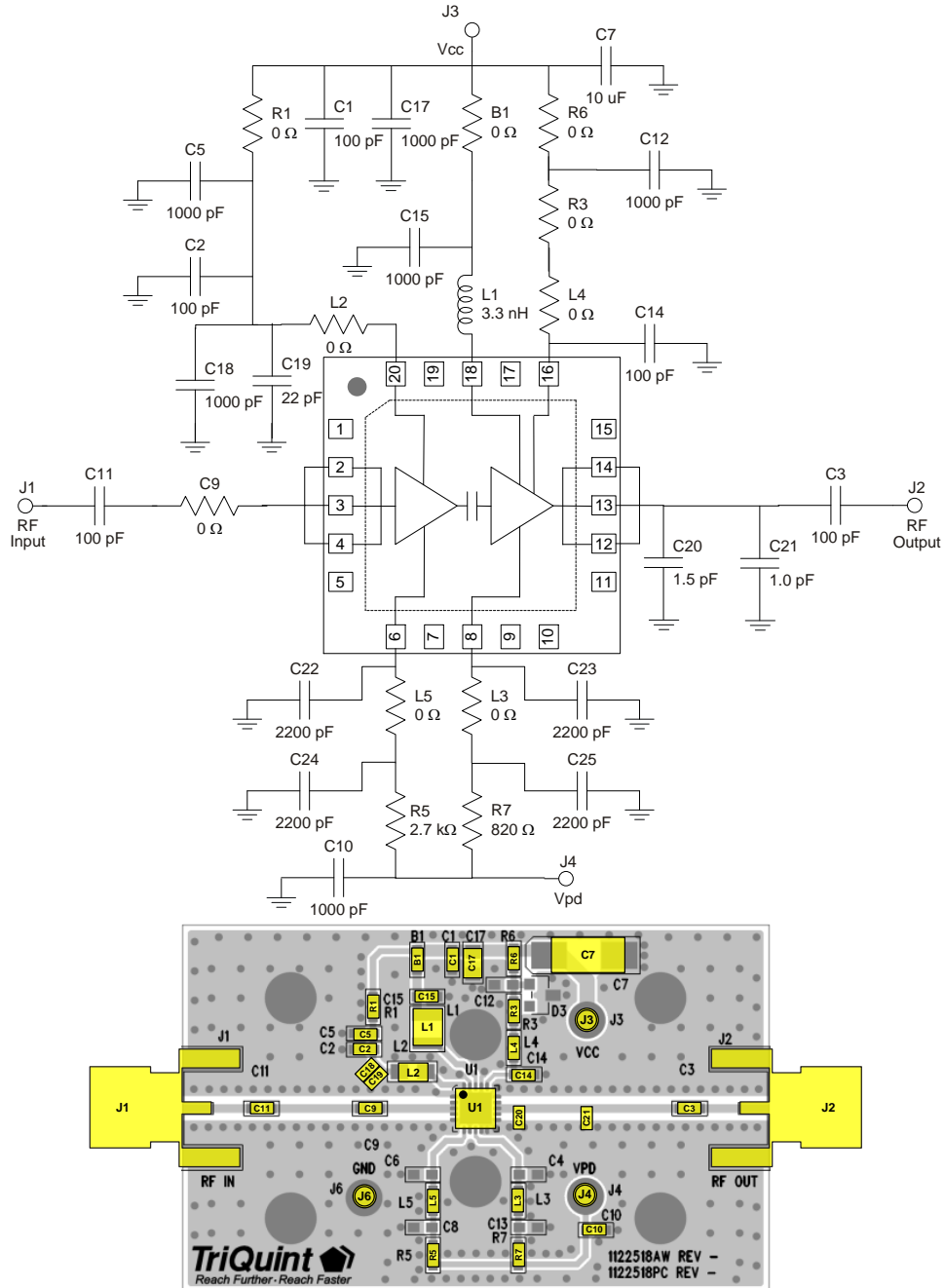
1. ACLR Test set-up: 3GPP WCDMA, TM1+64 DPCH, +5 MHz offset, PAR = 10.2 dB at 0.01% Probability

Typical Performance TQP9113-PCB2600

Test conditions unless otherwise noted: $V_{CC} = +5\text{ V}$, $I_{CQ} = 250\text{ mA}$ (typ.), Temp. = $+25\text{ }^{\circ}\text{C}$



Application Circuit for Improved Intermodulation Distortion Balance



Notes:

1. See Evaluation Board PCB Information section for PCB material and stack-up
2. Components (C11 and C3) are blocking capacitors and their locations are not critical to the matching network.
3. All components are of 0603 size unless otherwise specified.
4. Critical component placement locations:
 Distance from U1 Package (right edge) to C20 (left edge): 25 mils
 Distance from U1 Package (right edge) to C21 (left edge): 285 mils

Typical Performance TQP9113 Improved IMD Balance

Test conditions unless otherwise noted: $V_{CC} = +5\text{ V}$, $V_{pd} = +5\text{ V}$, $I_{CQ} = 250\text{ mA}$ (typ.), $Temp. = +25\text{ }^{\circ}\text{C}$

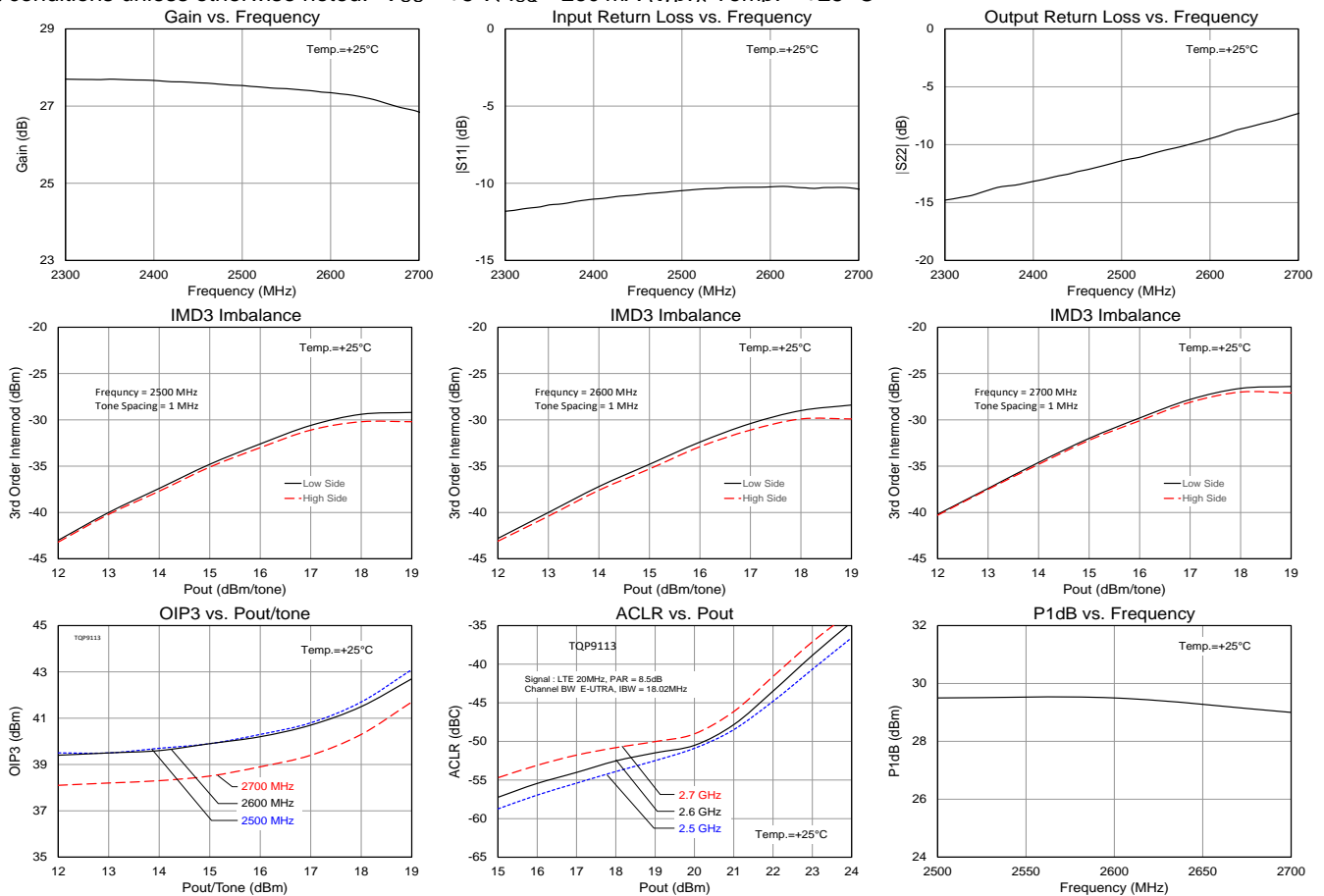
| Parameter | Conditions | Typical Value | | | Units |
|------------------------------------|---|---------------|-------|-------|-------|
| Frequency | | 2500 | 2600 | 2700 | MHz |
| Gain | | 27.7 | 27.4 | 26.9 | dB |
| Input Return Loss | | 11 | 11 | 10 | dB |
| Output Return Loss | | 15 | 12 | 7 | dB |
| Output P1dB | | +29.5 | +29.5 | +29.0 | dBm |
| OIP3 | $P_{out} = +19\text{ dBm/tone}$, $\Delta f = 1\text{ MHz}$ | +43.0 | +42.7 | +41.7 | dBm |
| Noise Figure | | 4.7 | 4.8 | 4.8 | dB |
| WCDMA Channel Power ⁽¹⁾ | -50 dBc ACLR | +20.5 | +20.4 | +19.0 | dBm |

Notes:

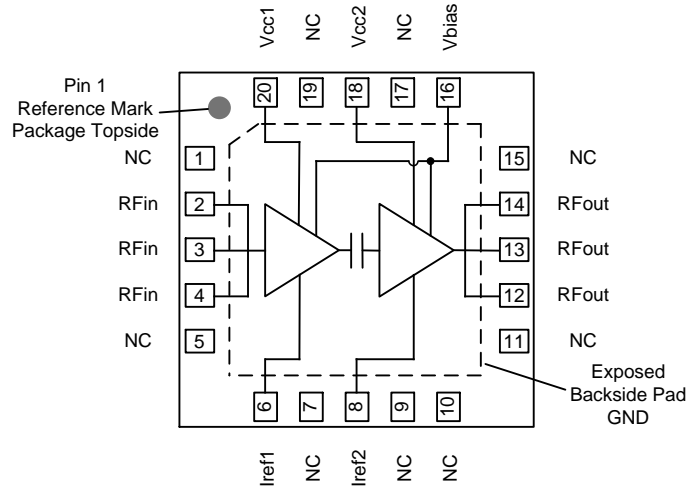
1. ACLR Test set-up: 20 MHz LTE, 1-CH, +20 MHz offset, PAR = 8.5 dB at 0.01% Probability

Typical Performance TQP9113 Improved IMD Balance

Test conditions unless otherwise noted: $V_{CC} = +5\text{ V}$, $I_{CQ} = 250\text{ mA}$ (typ.), $Temp. = +25\text{ }^{\circ}\text{C}$



Pin Configuration and Description

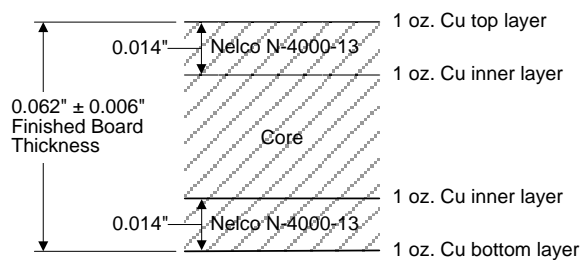


Top View

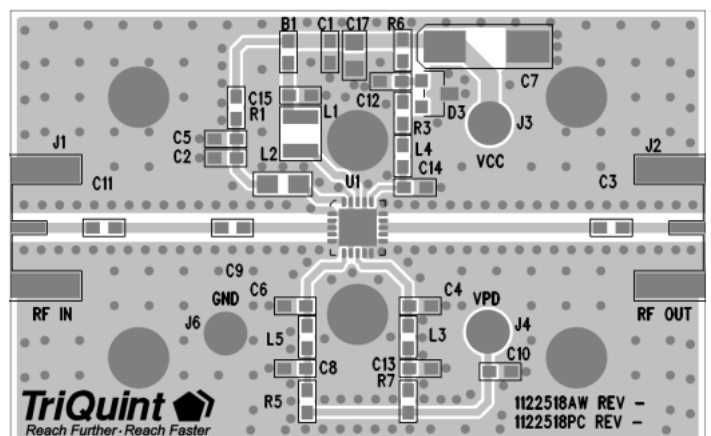
| Pin No. | Label | Description |
|--------------------------------|--------|--|
| 1, 5, 7, 9, 10, 11, 15, 17, 19 | NC | No internal connection. Provide grounded land pads for PCB mounting integrity. |
| 2, 3, 4 | RF in | RF input pins. Requires only DC blocking cap for operation. |
| 6 | IREF1 | Sets the bias current for Amp1. Also can be used to power down Amp 1. |
| 8 | IREF2 | Sets the bias current for Amp2. Also can be used to power down Amp 2. |
| 12, 13, 14 | RF out | RF output pins. Require DC blocking and RF match for optimal performance. |
| 16 | VBIAS | Bias circuit supply voltage. |
| 18 | VCC2 | 2 nd Stage DC voltage supply connection. |
| 20 | VCC1 | 1 st Stage DC voltage supply connection. |
| Backside Pad | GND | RF/DC ground. Use recommended via pattern to minimize inductance and thermal resistance; see PCB Mounting Pattern for suggested footprint. |

Evaluation Board PCB Information

PCB 1100415 Material and Stack-up

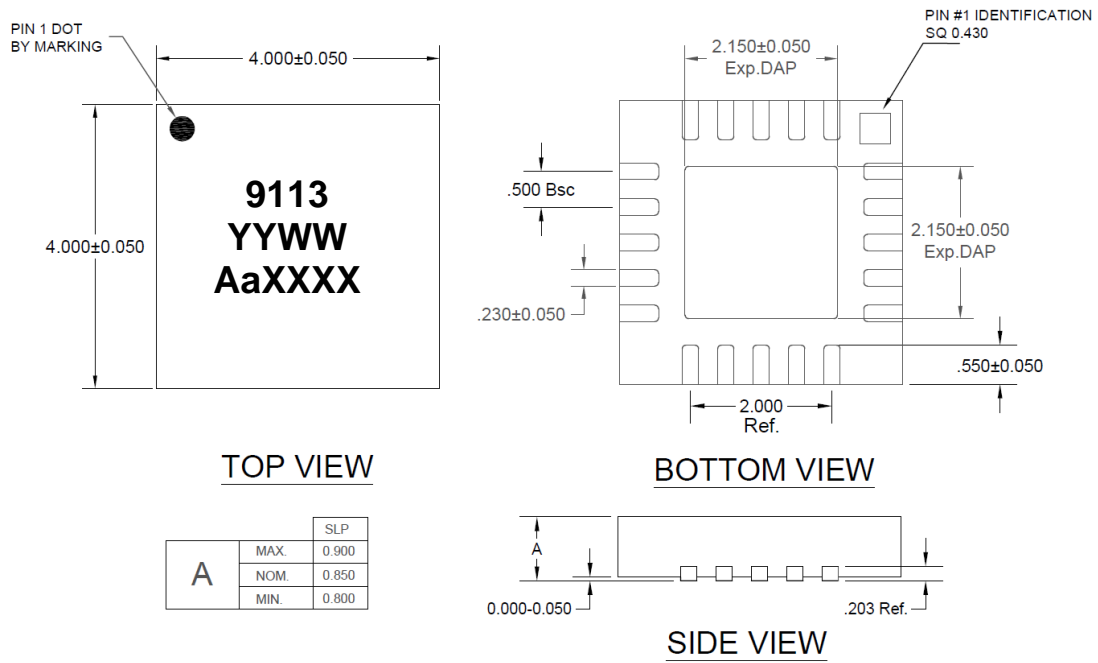


50 ohm line dimensions: width = .028"
spacing = .028".



Package Marking and Dimensions

Marking: Part number – 9113
 Date - YYWW
 Country Code - CCCC
 Lot code – AaXXXX

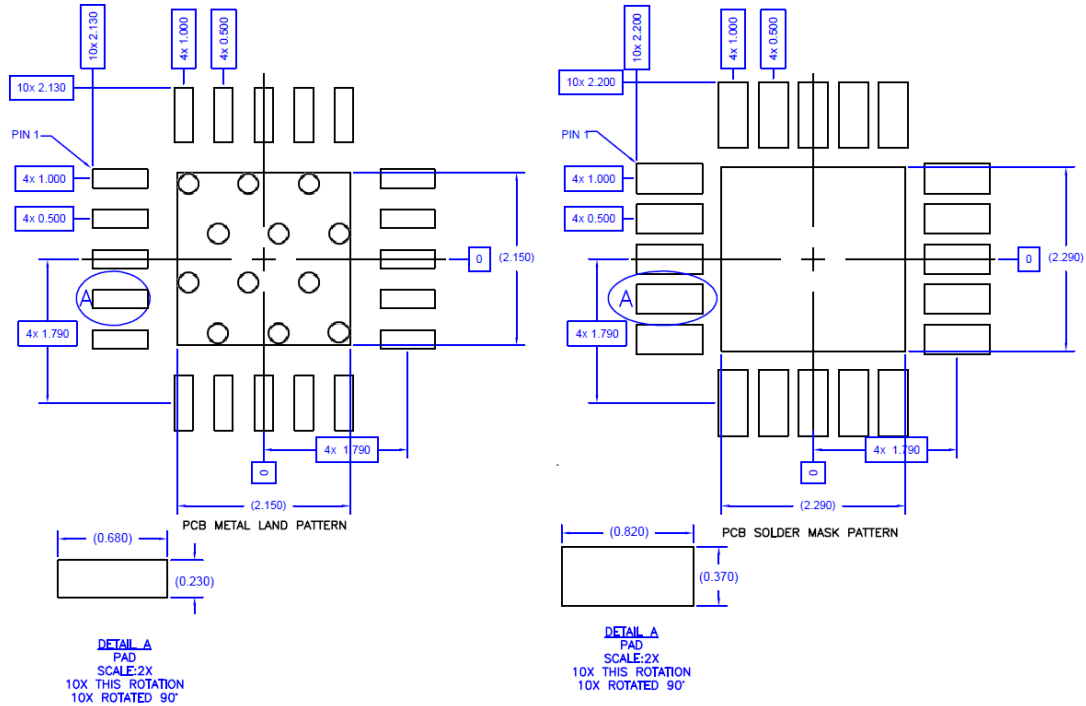


| | | |
|---|------|--------------|
| A | MAX. | SLP 0.900 |
| | NOM. | 0.850 |
| | MIN. | 0.800 |

Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Dimension and tolerance formats conform to ASME Y14.4M-1994.
3. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

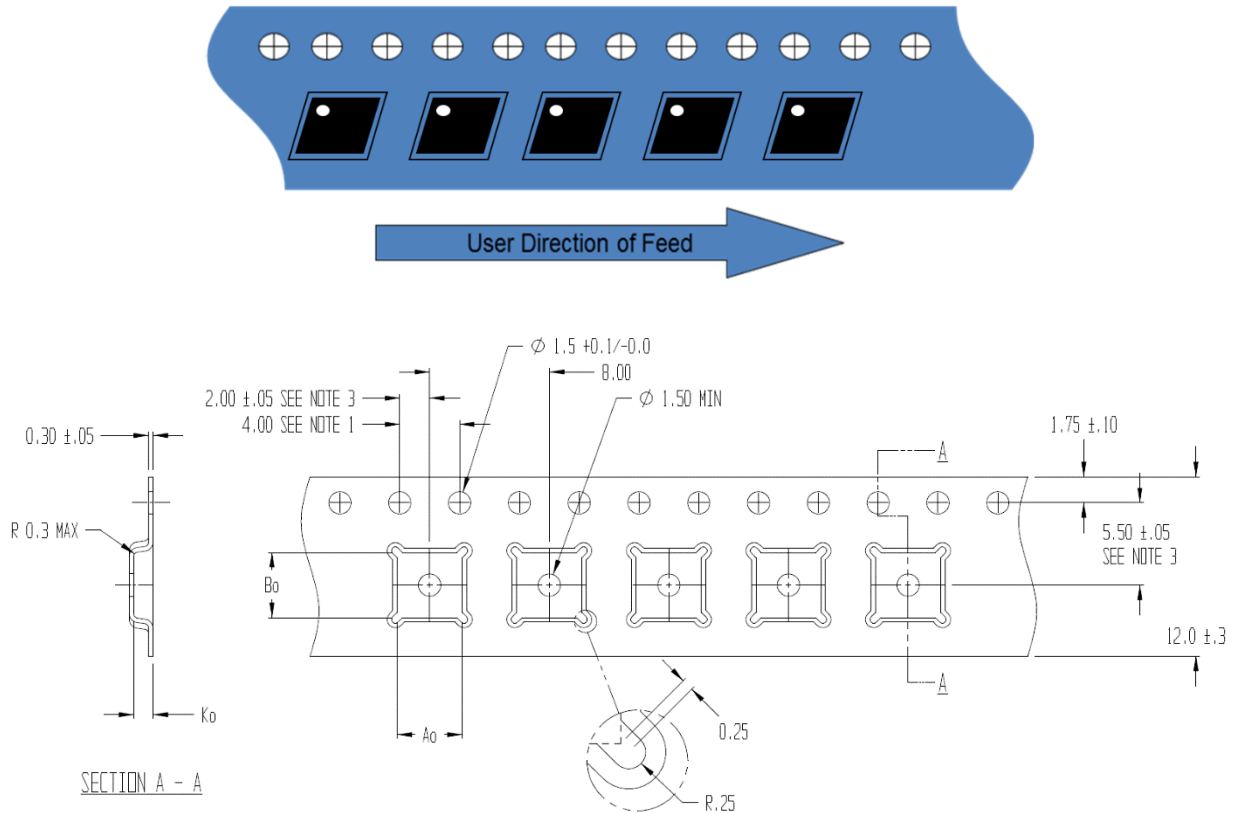
PCB Mounting Pattern



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 12 holes in the pattern of vertical 0.64 mm (0.025") and horizontal 0.76 mm (0.030") spacings. And 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.

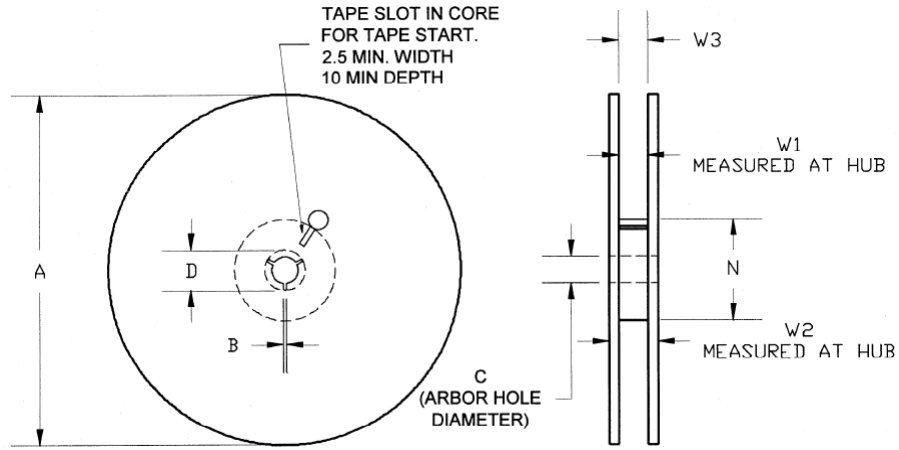
Tape and Reel Information – Carrier and Cover Tape Dimensions



| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---------------------|--|--------|-----------|-----------|
| Cavity | Length | A0 | 0.171 | 4.35 |
| | Width | B0 | 0.171 | 4.35 |
| | 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 | 12.0 |

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 | 330.00 |
| | Thickness | W2 | 0.717 | 18.20 |
| | Space Between Flange | W1 | 0.504 | 12.80 |
| Hub | Outer Diameter | N | 4.016 | 102.00 |
| | Arbor Hole Diameter | C | 0.512 | 13.00 |
| | Key Slit Width | B | 0.079 | 2.00 |
| | Key Slit Diameter | D | 0.787 | 20.00 |

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 2 | 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: Matte Sn

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

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