# QPA9154

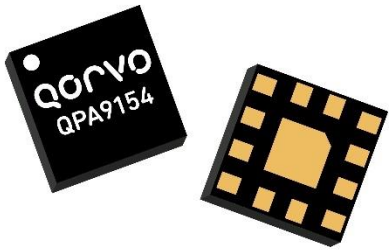
## 2.3 – 3.8 GHz 100Ω Differential Output Gain Block

## Product Overview

The QPA9154 is a 50Ω single-ended input to 100Ω differential output, wideband gain block. It is well suited as the 5G m-MIMO BTS Rx path final gain stage, to directly interface with the ADC of the transceiver, eliminating the need for a discrete balun.

This amplifier delivers exceptional performance with 19 dB of small signal gain and 35 dBm output 3rd order intercept (OIP3). The amplifier has excellent gain flatness of 0.5 dB over any 400 MHz bandwidth and a CMRR of 35 dB. The amplifier features a shut-down function through $V_{PD}$ pin control.

The QPA9154 is optimized over 2.3-3.8 GHz band and is housed in a compact 2 x 2 mm SMT package.

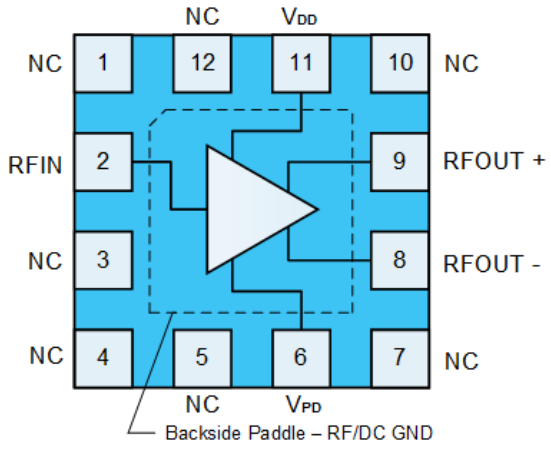



12-pin, 2 x 2 mm SMT Package

## Key Features

- 2.3 – 3.8 GHz Operational Frequency
- 100 Ohm Differential Output
- 50 Ohm Single-Ended Input
- 19 dB Gain at 2.6 GHz
- +34 dBm OIP3
- +18.5 dBm P1dB
- Small 2 x 2 mm SMT Package

## Functional Block Diagram




Top View

## Applications

- 5G m-MIMO
- Mobile Infrastructure
- General Purpose Wireless
- TDD / FDD System

## Ordering Information

| Part No. | Description |
|---|---|
| QPA9154TR7 | 2500 pcs on 7” reel (standard) |
| QPA9154EVB-01 | Differential Output Evaluation Board |

## Absolute Maximum Ratings

| Parameter | Rating |
|---|---|
| Storage Temperature | -65 to +150°C |
| RF Input Power, CW, 50 Ω, T=25 °C | 22 dBm |
| Device Voltage ($V_{DD}$) | 7 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 ($V_{DD}$) | +3.3 | +5 | +5.25 | V |
| $T_{CASE}$ | −40 | | +105 | °C |
| Tj 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

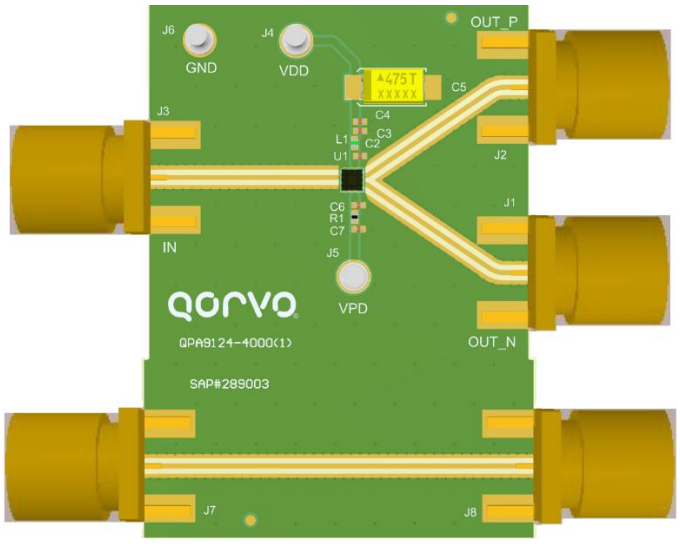
| Parameter | Conditions (1) | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Operational Frequency Range | | 2300 | | 3800 | MHz |
| Test Frequency | | | 2600 | | MHz |
| Small Signal Gain | | 16.5 | 19 | 20.5 | dB |
| Gain Flatness | Any 400 MHz BW | | 0.5 | | dB |
| CMRR | | | 35 | | dB |
| Input Return Loss | | | 13 | | dB |
| Output Return Loss | 100 Ω differential | | 17 | | dB |
| Output P1dB | | +16 | +19 | | dBm |
| Output IP3 | Pout 0 dBm/tone combined, Δf = 1 MHz | +29 | +34 | | dBm |
| Differential Output Impedance | | | 100 | | ohm |
| Noise Figure | | | 1.5 | | dB |
| Device Current, ON | $V_{PD}$ = 0.63 V | | 70 | 110 | mA |
| Device Current, OFF | $V_{PD}$ = 1.17 V | | 4 | | mA |
| $V_{PD}$, Logic Low | | 0 | | 0.63 | V |
| $V_{PD}$, Logic High | | 1.17 | | $V_{DD}$ | V |
| Switching Time | 50% $V_{PD}$ to 10/90% RF | | 100 | | nsec |
| Thermal Resistance, $\theta_{jc}$ | Junction to case | | 50 | | °C/W |

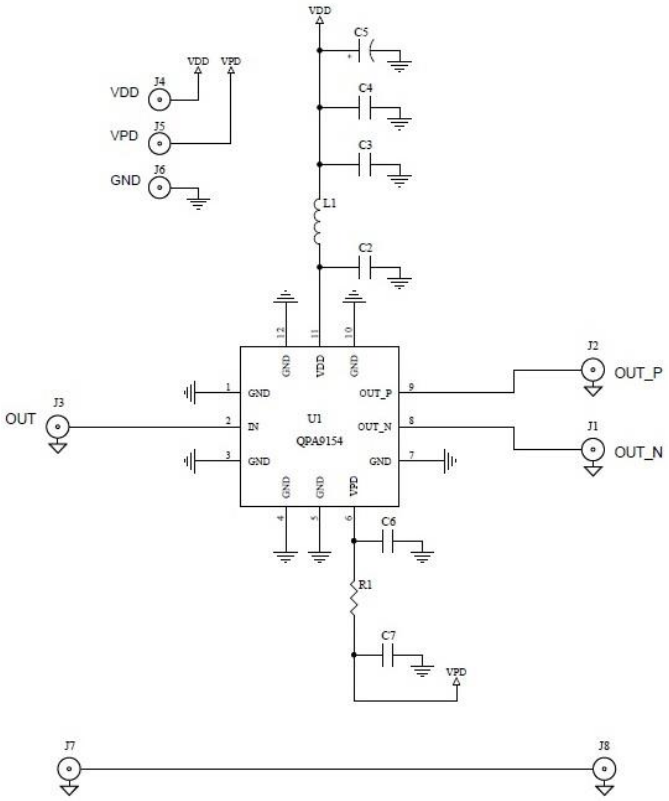
Notes:
1. Test conditions unless otherwise noted: $V_{DD}$ +5.0 V, $V_{PD}$ +0.63 V, Temp +25 °C, 50 Ω system. Differential output conversion with ideal balun

## Logic Table

| Parameter, $V_{PD}$ | High | Low |
|---|---|---|
| Device State | OFF | ON |

## 2300 to 3800MHz Differential Evaluation Board - QPA9154EVB-01



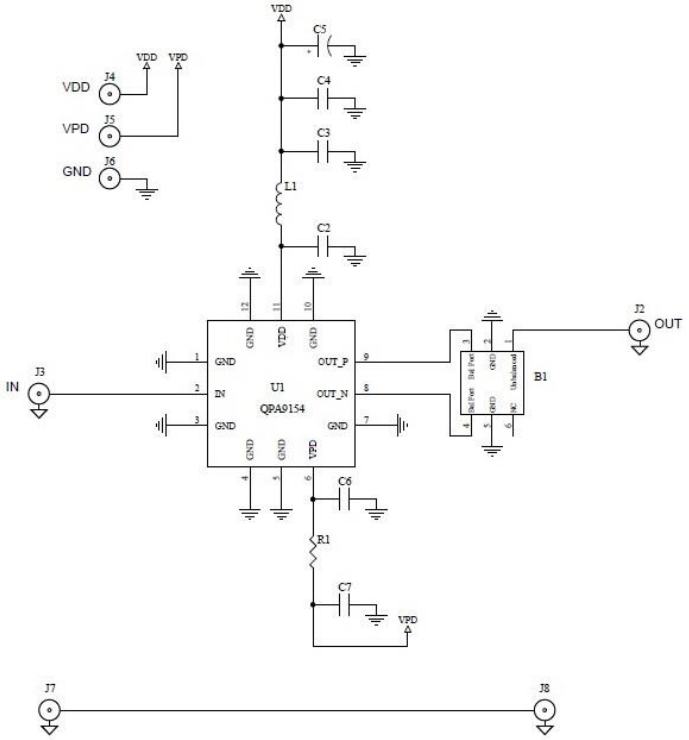




## Bill of Materials

| Reference Des. | Value | Description | Manuf. | Part Number |
|---|---|---|---|---|
| - | - | Printed Circuit Board | Qorvo | |
| U1 | - | Differential Output Rx Gain Block | Qorvo | QPA9154 |
| C5 | 10 µF | CAP, 10 µF, 20%, 25V, Tantalum, 6032 | Cal-Chip | TCMIE106CT |
| C3 | 1000 pF | CAP, 1000 pF, 10%, 50V, X7R, 0402 | Various | |
| C4 | 0.1 µF | CAP, 0.1 µF, 10%, 50V, X5R, 0402 | Various | |
| R1 | 0 Ω | RES, 0 Ω, 1/10W, 0402 | Various | |
| L1 (1) | 3.9 nH | IND, 3.9 nH, Thin Film, 0402 | Various | |
| J1, J2, J3 | - | Conn, SMA F STRT .062” | Cinch Connectivity | 142-0701-851 |

Notes:
1. For optimum performance replace L1 with 6.8 nH inductor for 2.3GHz to 2.7GHz band, or 2.0 nH for 3.3GHz to 3.8GHz band.

## 2300 to 3800MHz Evaluation Board with Output Balun


## Bill of Materials

| Reference Des. | Value | Description | Manuf. | Part Number |
|---|---|---|---|---|
| - | - | Printed Circuit Board | Qorvo | |
| U1 | - | Differential Output Rx Gain Block | Qorvo | QPA9154 |
| B1 | - | BALUN, 3.1GHZ-5GHZ, 50/100, 0404 | Anaren | BD3150N50100AHF |
| C5 | 10 µF | CAP, 10 µF, 20%, 25V, Tantalum, 6032 | Cal-Chip | TCMIE106CT |
| C3 | 1000 pF | CAP, 1000 pF, 10%, 50V, X7R, 0402 | Various | |
| C4 | 0.1 µF | CAP, 0.1 µF, 10%, 50V, X5R, 0402 | Various | |
| R1 | 0 Ω | RES, 0 Ω, 1/10W, 0402 | Various | |
| L1 (1) | 3.9 nH | IND, 3.9 nH, Thin Film, 0402 | Various | |
| J1, J2, J3 | - | Conn, SMA F STRT .062” | Cinch Connectivity | 142-0701-851 |

Notes:
1. For optimum performance replace L1 with 6.8 nH inductor for 2.3GHz to 2.7GHz band, or 2.0 nH for 3.3GHz to 3.8GHz band.

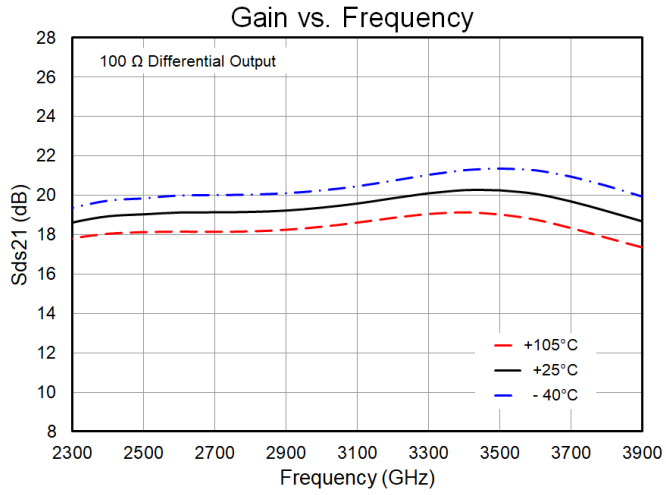
## Typical Performance – QPA9154EVB-01

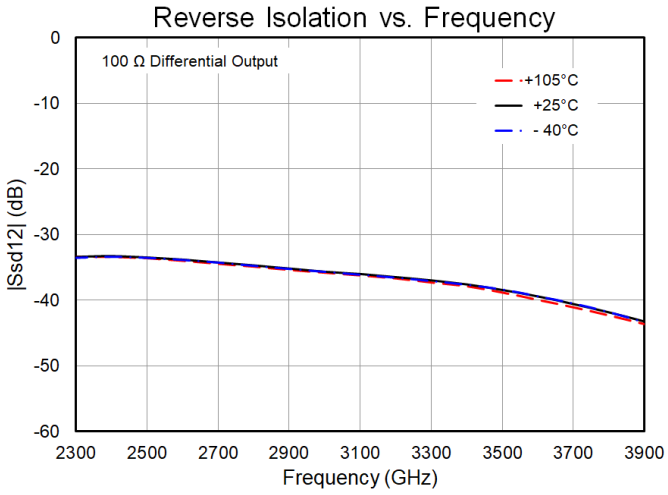
| Parameter | Conditions (1) | Typical Value | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| Frequency | | 2300 | 2600 | 2700 | 3200 | 3600 | 3800 | MHz |
| Gain | | 18.6 | 19.1 | 19.1 | 19.8 | 20.0 | 19.1 | dB |
| Input Return Loss | | 12.5 | 14.1 | 13.8 | 12.7 | 16.7 | 20.2 | dB |
| Output Return Loss | 100 Ω differential | 7.5 | 12.9 | 16.2 | 13.1 | 8.1 | 7.2 | dB |
| Output P1dB | | 18.7 | 18.4 | 18.2 | 18.1 | 17.3 | 16.9 | dBm |
| Output IP3 | Pout 0 dBm/tone combined, Δf 1 MHz | 36.1 | 35.0 | 36.3 | 34.7 | 32.7 | 31.3 | dBm |
| Device Current | $V_{DD}$ | 70 | | | | | | mA |

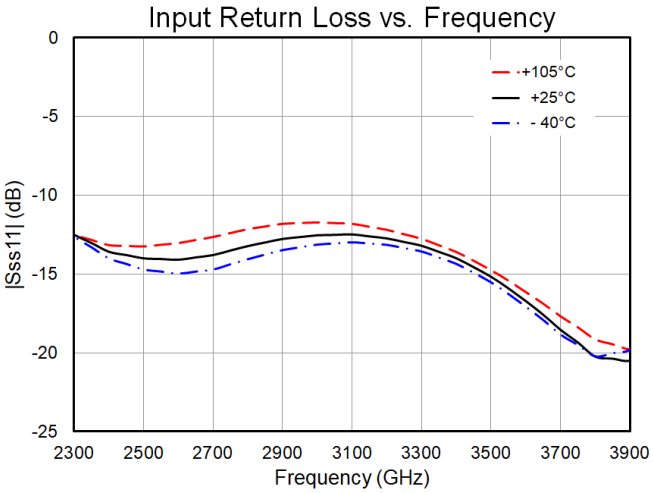
Notes:
1. Test Conditions unless otherwise noted: $V_{DD}$ +5.0 V, $V_{PD}$ +0.63 V, Temp.+25 °C. L1 3.9 nH. Differential output conversion with ideal balun

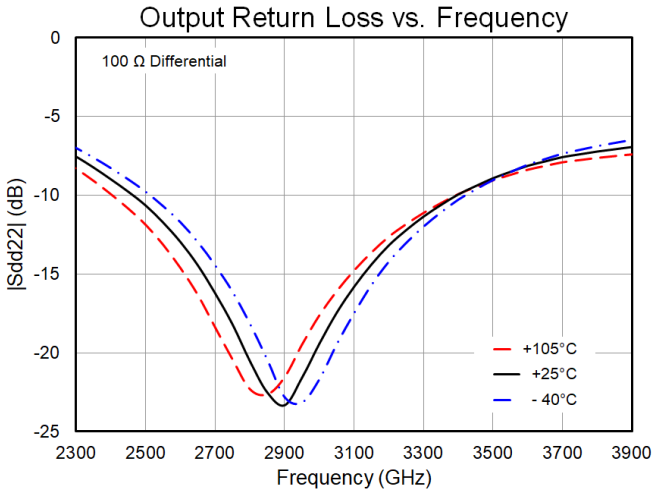
## Performance Plots – QPA9154EVB-01

Test conditions unless otherwise noted: $V_{DD}$ = +5.0 V, $I_{DD}$ = 70 mA, $V_{PD}$ = +0.63 V, 50 Ω system



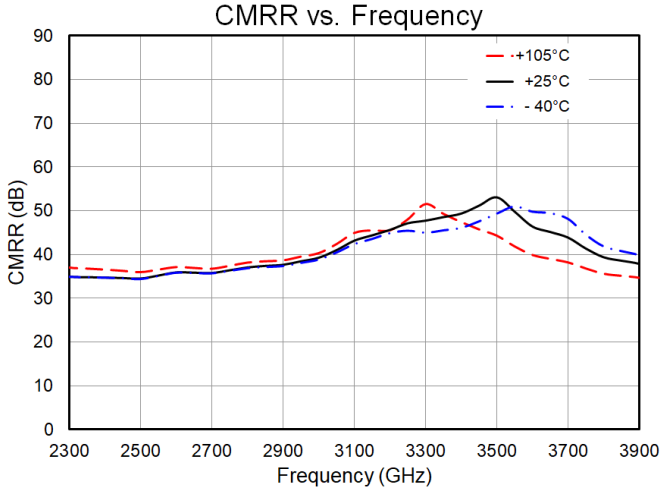



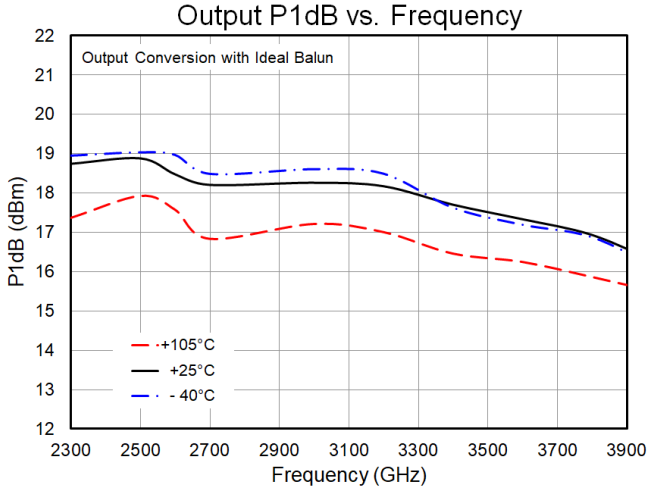
## Performance Plots – QPA9154EVB-01 (Continue)

Test conditions unless otherwise noted: $V_{DD}$ = +5.0 V, $I_{DD}$ = 70 mA, $V_{PD}$ = +0.63 V, 50 Ω system

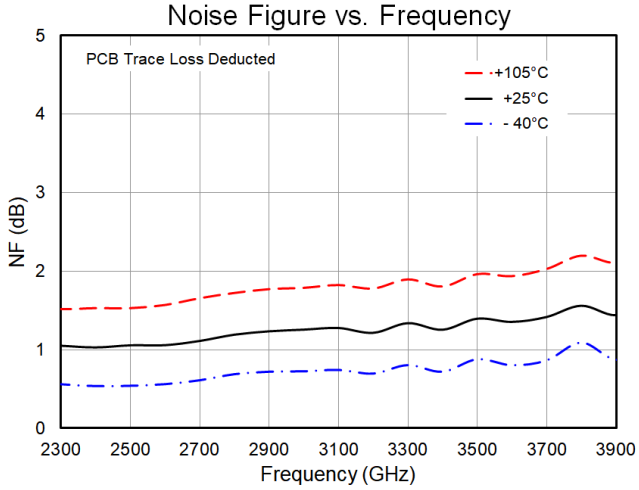
CMRR vs. Frequency



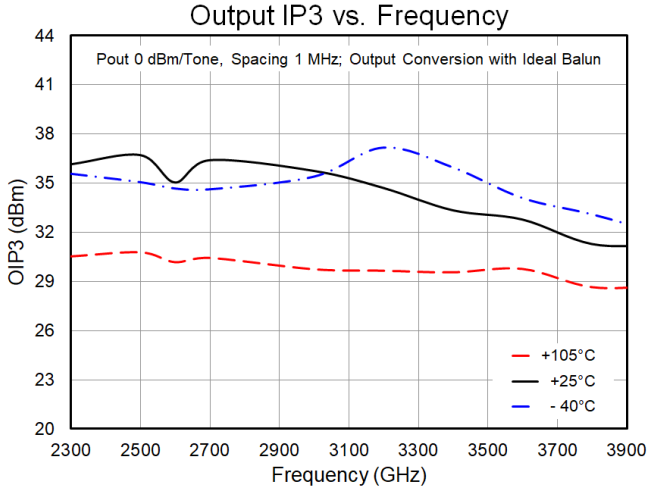

Output P1dB vs. Frequency



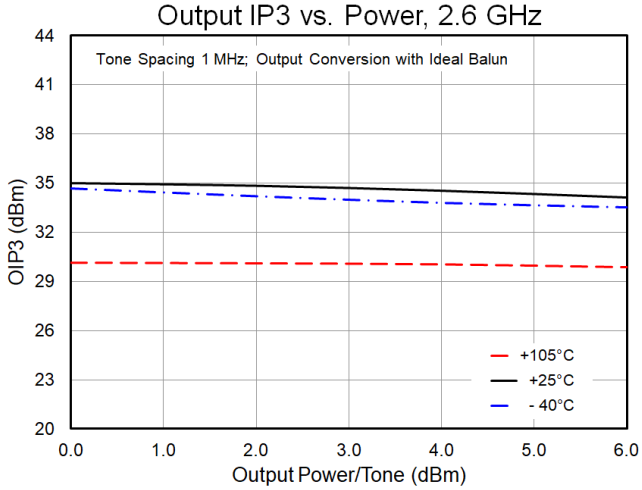

Noise Figure vs. Frequency



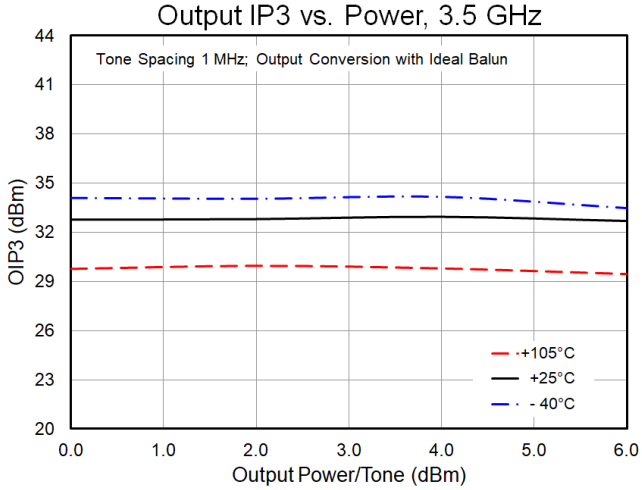

Output IP3 vs. Frequency




Output IP3 vs. Power, 2.6 GHz




Output IP3 vs. Power, 3.5 GHz



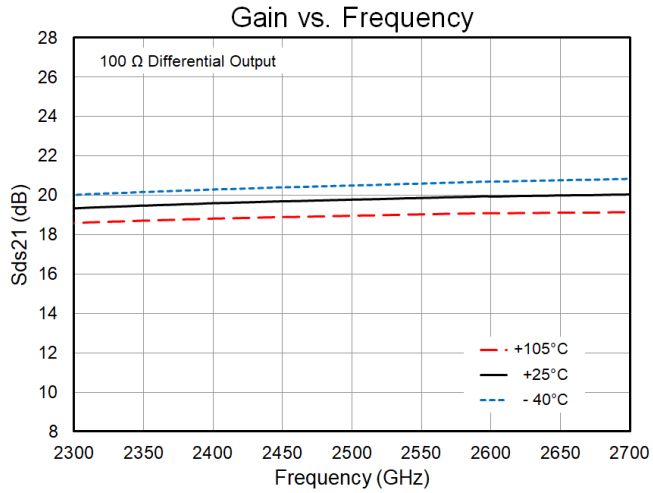
## Typical Performance – EVB with L1 6.8 nH for 2.3-2.7 GHz

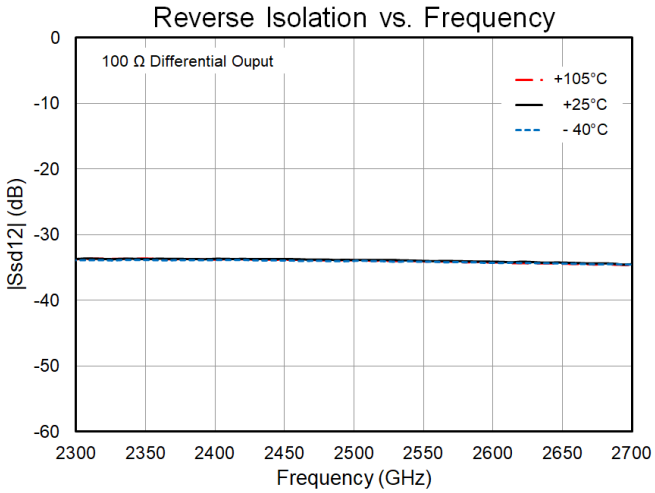
| Parameter | Conditions (1) | Typical Value | | | Units |
|---|---|---|---|---|---|
| Frequency | | 2300 | 2600 | 2700 | MHz |
| Gain | | 19.3 | 19.9 | 20.0 | dB |
| Input Return Loss | | 14.1 | 13.0 | 12.3 | dB |
| Output Return Loss | 100 Ω differential | 9.6 | 17.6 | 18.3 | dB |
| Output P1dB | | 18.9 | 18.9 | 18.9 | dBm |
| Output IP3 | Pout 0 dBm/tone combined, Δf 1 MHz | 35.5 | 34.9 | 35.8 | dBm |
| Device Current | $V_{DD}$ | 70 | | | mA |

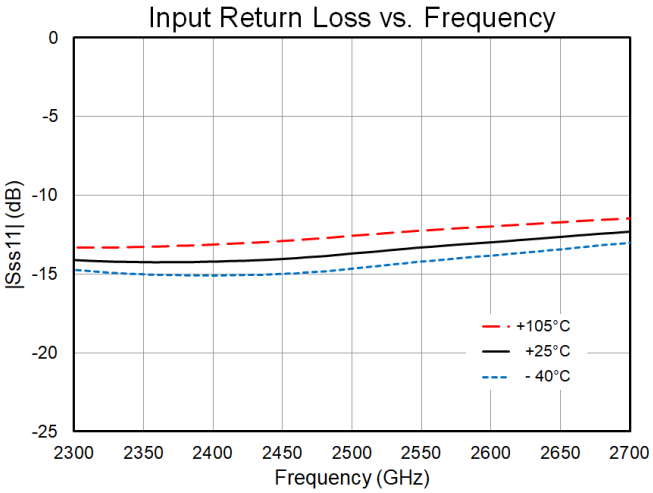
Notes:
1. Test Conditions unless otherwise noted: $V_{DD}$ +5.0 V, $V_{PD}$ +0.63 V, Temp. +25 °C. L1 = 6.8nH. Differential output conversion with ideal balun

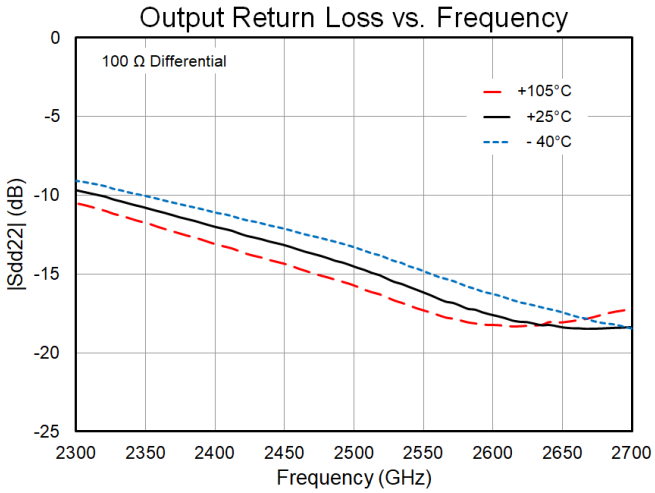
## Performance Plots – EVB with L1 6.8 nH for 2.3-2.7 GHz

Test conditions unless otherwise noted: $V_{DD}$ = +5.0 V, $I_{DD}$ = 70 mA, $V_{PD}$ = +0.63 V, 50 Ω system



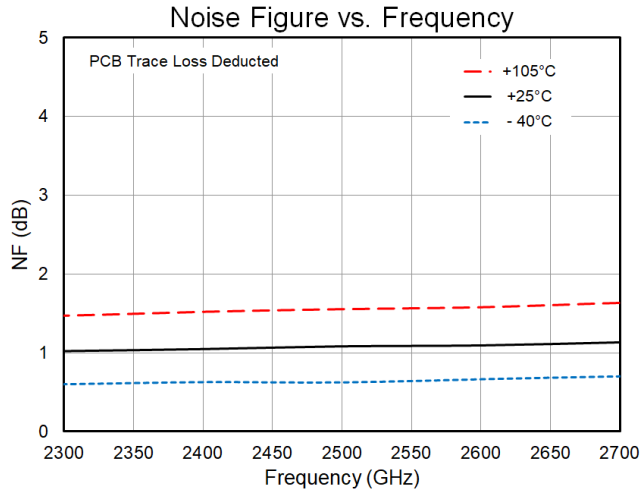



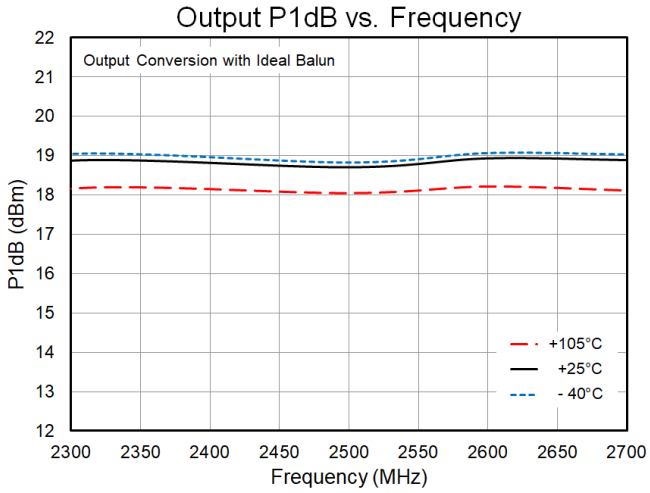



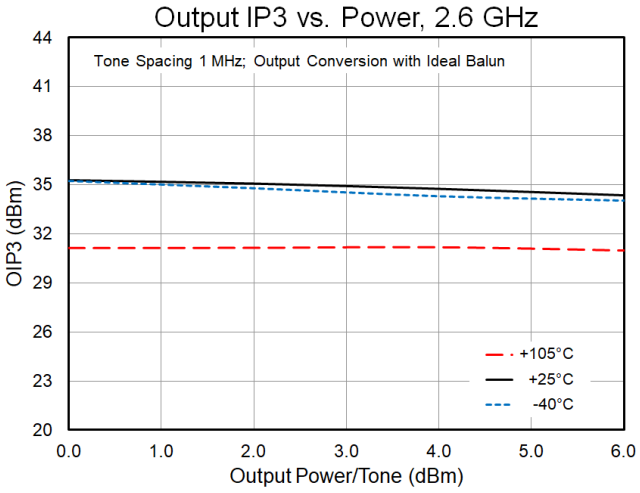



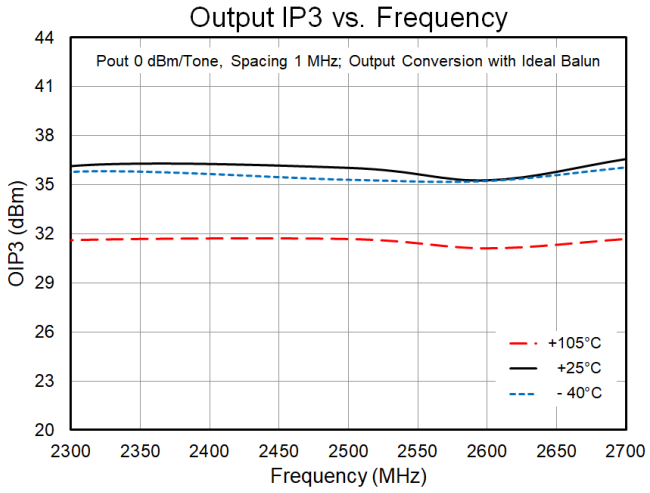
## Performance Plots – EVB with L1 6.8 nH for 2.3-2.7 GHz (Continue)

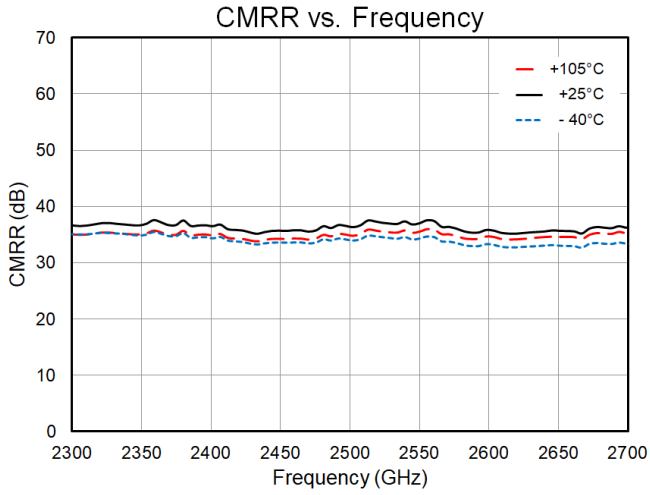
Test conditions unless otherwise noted: $V_{DD}$ = +5.0 V, $I_{DD}$ = 70 mA, $V_{PD}$ = +0.63 V, 50 Ω system



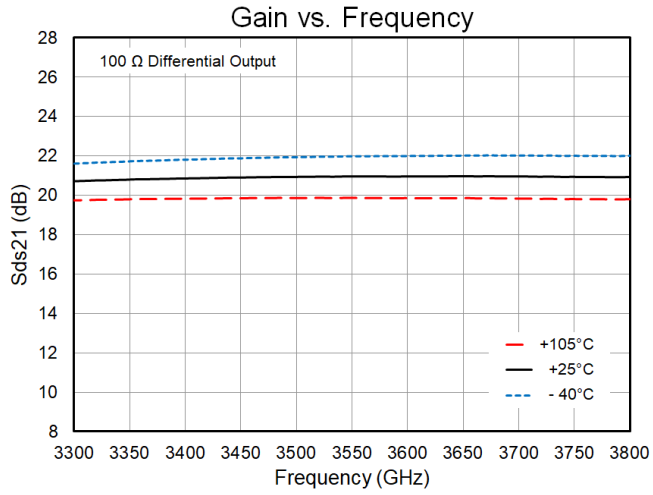
## Typical Performance – EVB with L1 2.0 nH for 3.3-3.8 GHz

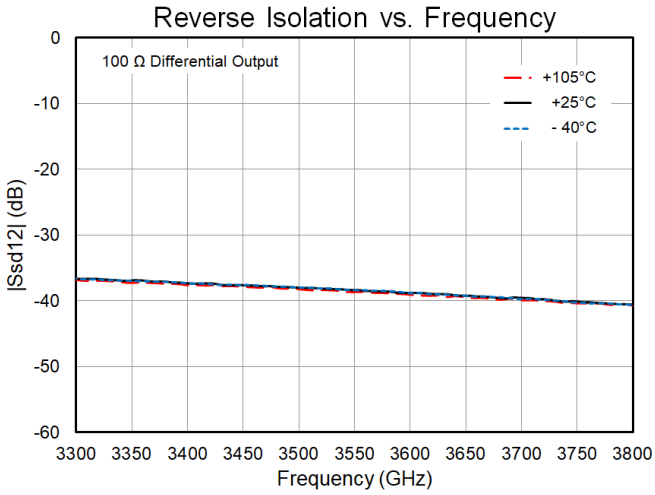
| Parameter | Conditions (1) | Typical Value | | | Units |
|---|---|---|---|---|---|
| Frequency | | 3200 | 3500 | 3800 | MHz |
| Gain | | 20.5 | 20.9 | 20.9 | dB |
| Input Return Loss | | 15.7 | 16.6 | 19.7 | dB |
| Output Return Loss | 100 Ω differential | 27.2 | 12.9 | 7.8 | dB |
| Output P1dB | | 18.5 | 19.1 | 18.6 | dBm |
| Output IP3 | Pout 0 dBm/tone combined, Δf 1 MHz | 34.9 | 36.1 | 35.4 | dBm |
| Device Current | $V_{DD}$ | | 70 | | mA |

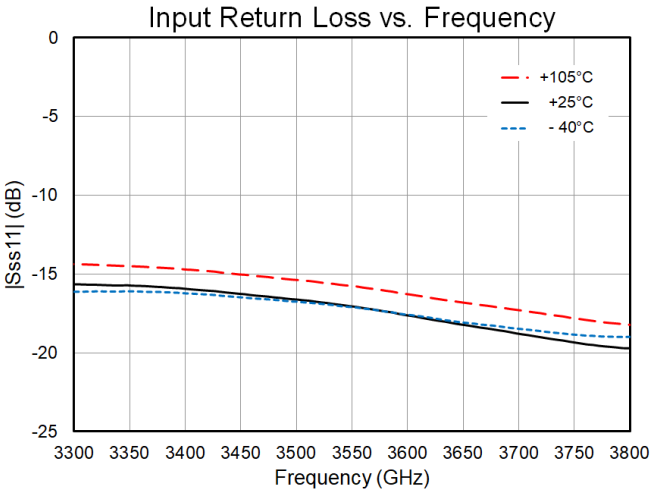
Notes:
1. Test Conditions unless otherwise noted: $V_{DD}$ +5.0 V, $V_{PD}$ +0.63 V, Temp. +25 °C, L1 2.0 nH. Differential output conversion with ideal balun

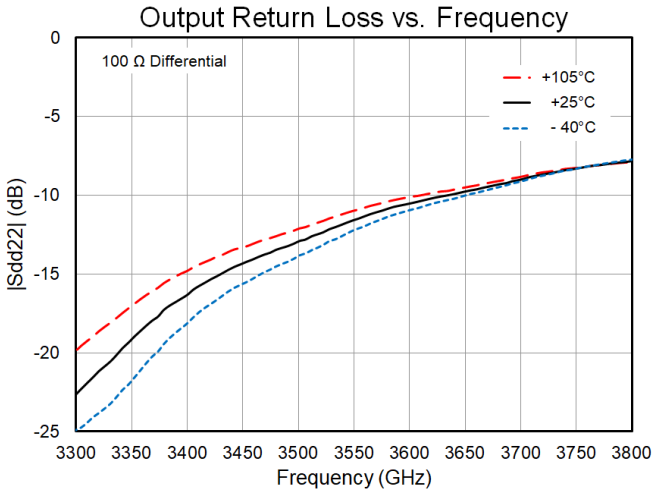
## Performance Plots – EVB with L1 2.0 nH for 3.3-3.8 GHz

Test conditions unless otherwise noted: $V_{DD}$ = +5.0 V, $I_{DD}$ = 70 mA, $V_{PD}$ = +0.63 V, 50 Ω system



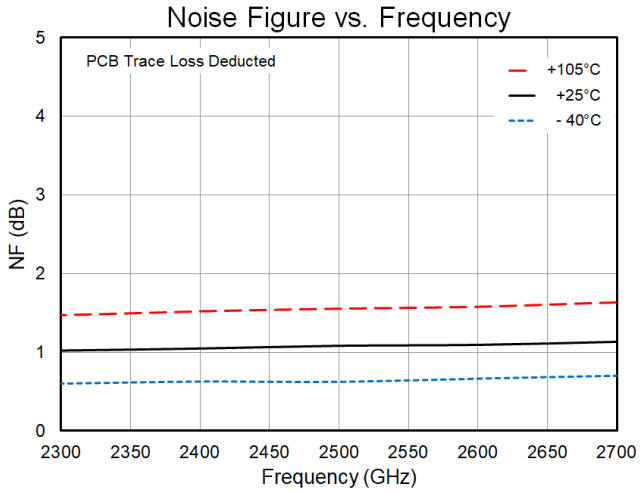



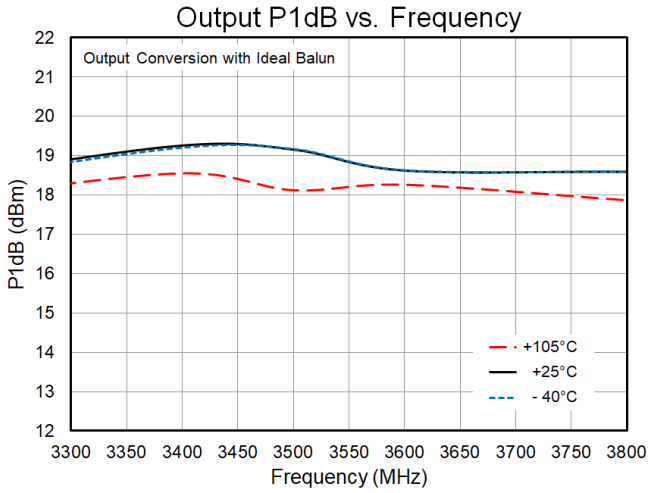



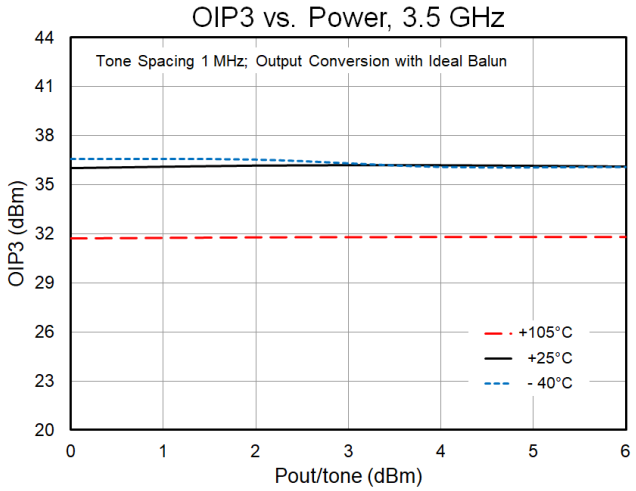



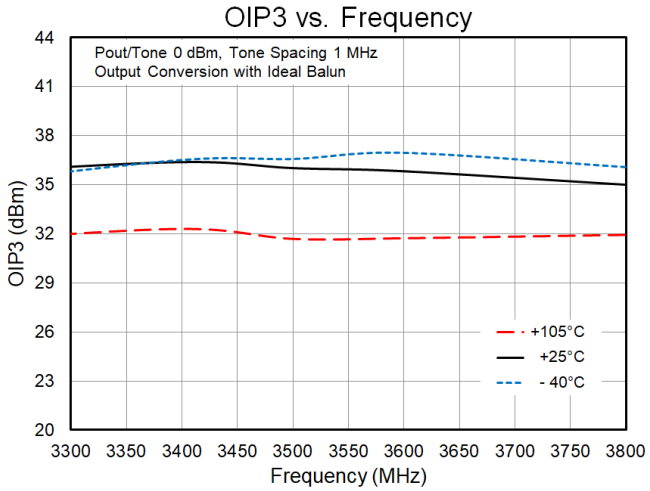
## Performance Plots – EVB with L1 2.0 nH for 3.3-3.8 GHz (Continue)

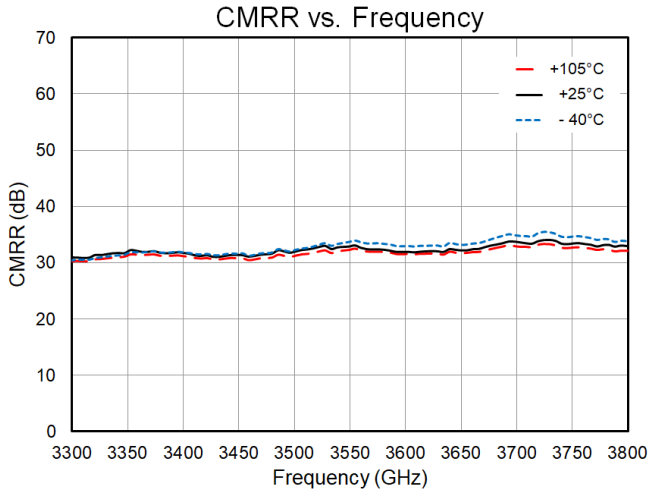
Test conditions unless otherwise noted: $V_{DD}$ = +5.0 V, $I_{DD}$ = 70 mA, $V_{PD}$ = +0.63 V, 50 Ω system



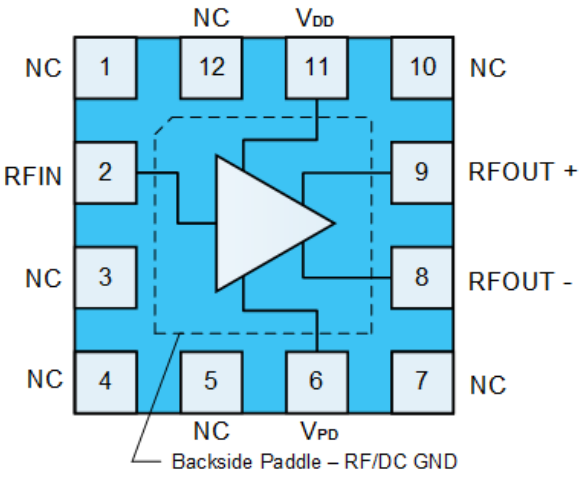



## Pad Configuration and Description

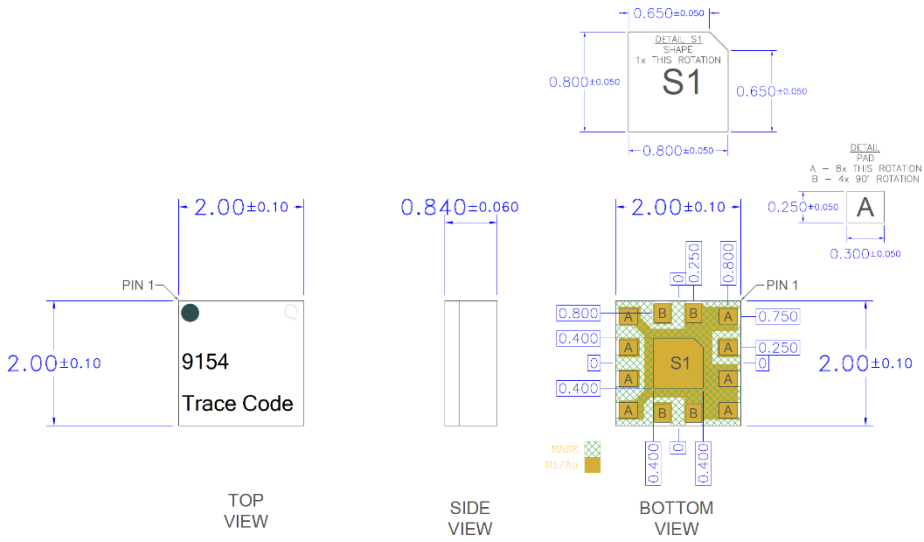



Top View

| Pad No. | Label | Description |
|---|---|---|
| 1, 3, 4, 5, 7, 10, 12 | NC | No electrical connection internally. It may be left floating or connected to ground. Land pads should be provided for PCB mounting integrity. |
| 2 | RFIN | RF input. Internally matched to 50Ohm. |
| 6 | $V_{PD}$ | Power down control input, Turn down amplifier bias. |
| 8 | RFOUT- | Differential output –. Requires external DC blocking capacitor if DC is present on this pin. |
| 9 | RFOUT+ | Differential output +. Requires external DC blocking capacitor if DC is present on this pin. |
| 11 | $V_{DD}$ | DC Power input, supply voltage for amplifier. |
| Backside Paddle | GND | RF/DC ground. Use recommended via hole pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint. |

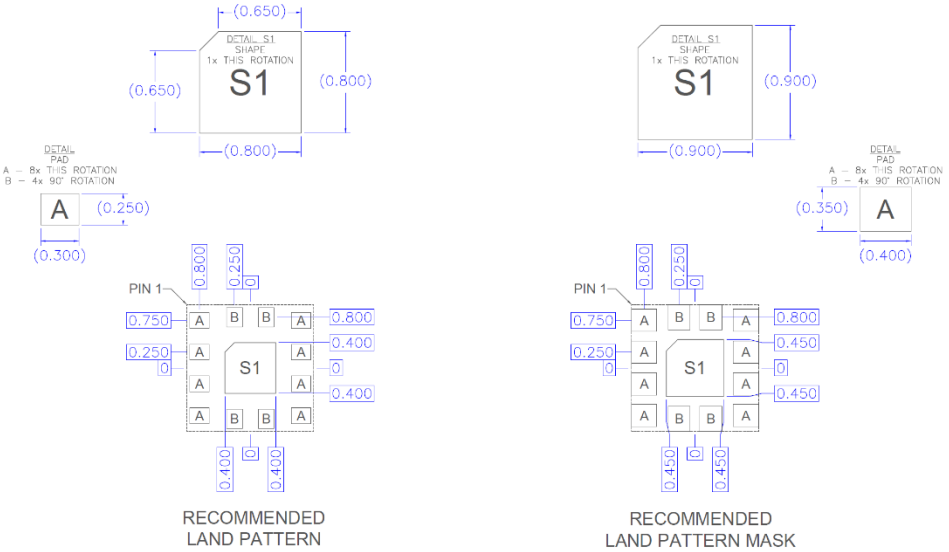
## Package Marking and Dimensions

Marking: Part Number – 9154
Trace Code – to be assigned by sub-contractor



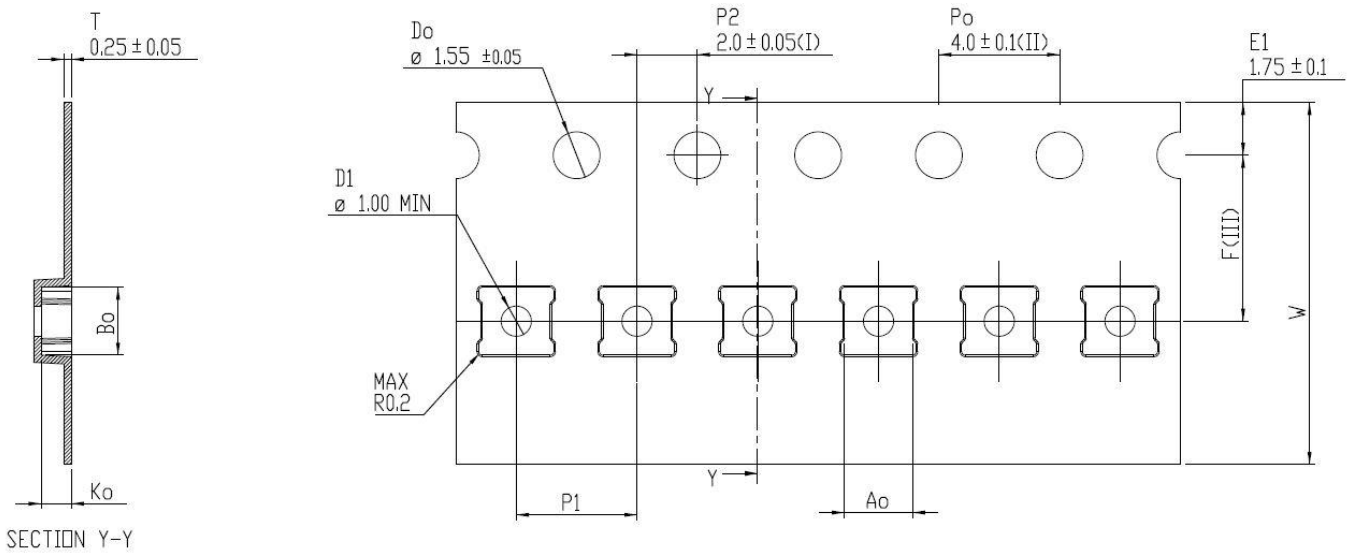

Notes:
1. All dimensions are in millimeters. Angles are in degrees.
2. The terminal #1 identifier and terminal numbering conform to SPE-000677.
3. Contact plating: ENEPIG

## Recommended PCB Layout Pattern

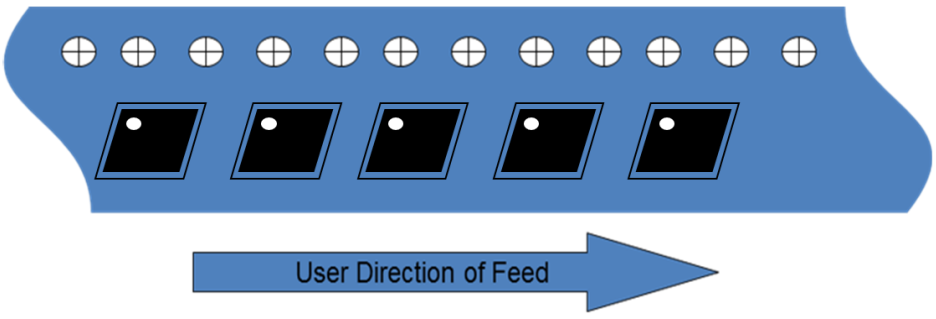



Notes:
1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layer metal.
3. Via holes are required under the backside paddle of this device for proper RF/DC grounding and thermal dissipation. We recommend a 0.35mm (#80/.0135") diameter bit for drilling 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

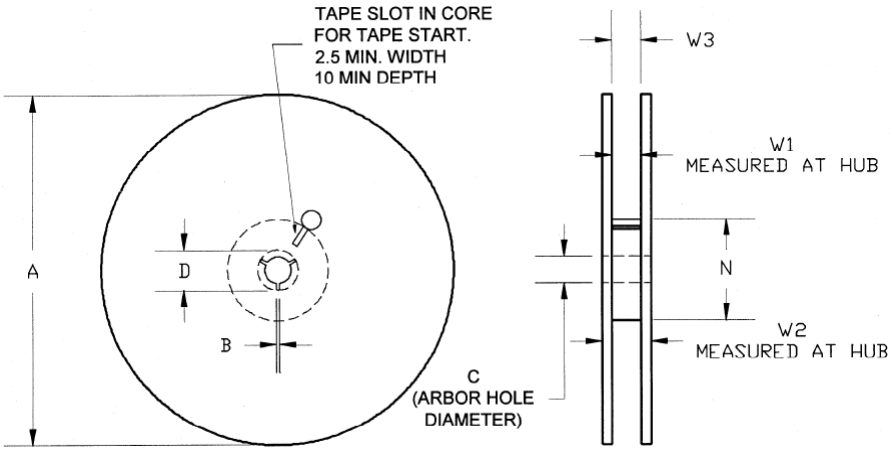



| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---|---|---|---|---|
| Cavity | Length | A0 | 0.087 | 2.20 |
| | Width | B0 | 0.087 | 2.20 |
| | Depth | K0 | 0.037 | 0.95 |
| | Pitch | P1 | 0.157 | 4.00 |
| Centerline Distance | Cavity to Perforation - Length Direction | P2 | 0.079 | 2.00 |
| | Cavity to Perforation - Width Direction | F | 0.217 | 5.50 |
| Cover Tape | Width | C | 0.362 | 9.20 |
| Carrier Tape | Width | W | 0.472 | 12.00 |



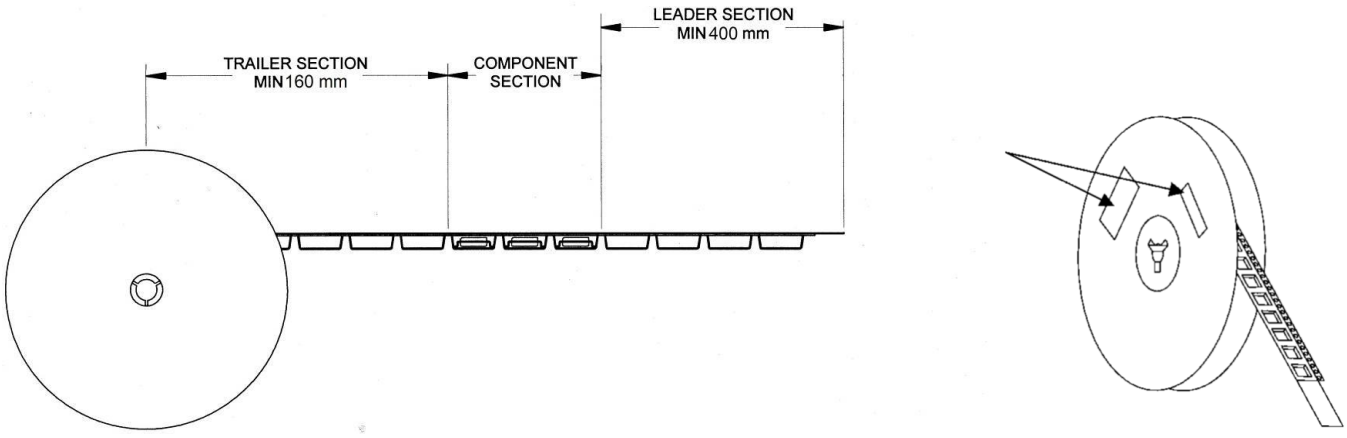
## Tape and Reel Information – Reel Dimensions

Standard T/R size = 2,500 pieces on a 7” reel.




| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---|---|---|---|---|
| Flange | Diameter | A | 6.969 | 177.0 |
| | Thickness | W2 | 0.717 | 18.2 |
| | Space Between Flange | W1 | 0.504 | 12.8 |
| 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 1C | ESDA / JEDEC JS-001-2017 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC JESD22-C101F |
| MSL – Moisture Sensitivity Level | Level 3 | 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: ENEPIG *(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:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) 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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