

### Applications

- IF Amplifier
- VHF / UHF Transmission
- Wireless Infrastructure
- CATV / SATV / MoCA
- General Purpose Wireless

### Product Features

- 50 Ohm Cascadable Gain Block
- 50 – 1000 MHz
- 19.5 dB Gain at 200 MHz
- +20.5 dBm P1dB at 200 MHz
- +43.5 dBm Output IP3 at 200 MHz
- +60 dBm Output IP2 at 200 MHz
- Single +5 V Supply, 95 mA Current
- Robust 1000 V ESD, Class 1C
- SOT-89 Package

### General Description

The WJA1500 is a cascadable gain block that offers high linearity in a low-cost surface-mount package. At 200 MHz, the WJA1500 typically provides 19.5 dB gain, +43.5 dBm OIP3, and +20.5 dBm P1dB. The device is housed in a RoHS-compliant SOT-89 industry-standard SMT package using Annealed Matte Tin or NiPdAu plating to reduce or eliminate the possibility of tin whiskers.

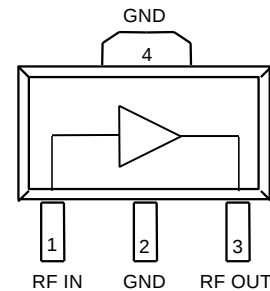
The WJA1500 consists of Darlington pair amplifiers using a high reliability InGaP / GaAs HBT process technology. The MMIC amplifier is internally matched to 50  $\Omega$  and only requires DC-blocking capacitors and a bias inductor for operation. An internal active bias is designed to enable stable performance over temperature. A dropping bias resistor is not required allowing the device to be biased directly from +5 V supply voltage.

The amplifier is targeted for high performance IF applications in existing and next generation wireless technologies. The WJA1500 is ideal for general purpose applications such as LO buffering, IF amplification and pre-driver stages within the 50 to 1000 MHz frequency range.



SOT-89 Package

### Functional Block Diagram



### Pin Configuration

| Pin No. | Label  |
|---------|--------|
| 1       | RF IN  |
| 3       | RF OUT |
| 2, 4    | GND    |

### Ordering Information

| Part No.    | Description                          |
|-------------|--------------------------------------|
| WJA1500     | 1,000 pieces on a 7" reel (standard) |
| WJA1500-PCB | 50 – 1000 MHz Evaluation Board       |

### Absolute Maximum Ratings

| Parameter                         | Rating        |
|-----------------------------------|---------------|
| Storage Temperature               | -55 to 150 °C |
| RF Input Power, CW, 50 Ω, T=25 °C | +24 dBm       |
| Supply Voltage                    | +6.5 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>CC</sub>                                | +4.75 | +5  | +5.25 | V     |
| T <sub>CASE</sub>                              | -40   |     | +85   | °C    |
| T <sub>j</sub> for >10 <sup>6</sup> hours MTTF |       |     | +150  | °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<sub>SUPPLY</sub> = +5 V, T<sub>CASE</sub> = +25 °C, 50 Ω system

| Parameter                              | Conditions                               | Min  | Typ   | Max  | Units |
|----------------------------------------|------------------------------------------|------|-------|------|-------|
| Operational Frequency Range            |                                          | 50   |       | 1000 | MHz   |
| Test Frequency                         |                                          |      | 200   |      | MHz   |
| Gain                                   |                                          | 17.8 | 19.4  | 20.8 | dB    |
| Input Return Loss                      |                                          |      | 17    |      | dB    |
| Output Return Loss                     |                                          |      | 21    |      | dB    |
| Output P1dB                            |                                          |      | +20.5 |      | dBm   |
| Output IP3                             | P <sub>out</sub> =+8 dBm/tone, Δf= 1 MHz | +39  | +43.7 |      | dBm   |
| Output IP2                             |                                          |      | +59.8 |      | dBm   |
| Noise Figure                           |                                          |      | 5.0   |      | dB    |
| Device Current, (I <sub>CC</sub> )     |                                          | 79   | 95    | 99   | mA    |
| Thermal Resistance, (θ <sub>JC</sub> ) | Junction to case <sup>(1)</sup>          |      |       | 78   | °C/W  |

Notes:

1. Thermal path is from the device junction through the package ground tab (pins 2, 4) to the backside mounting surface.

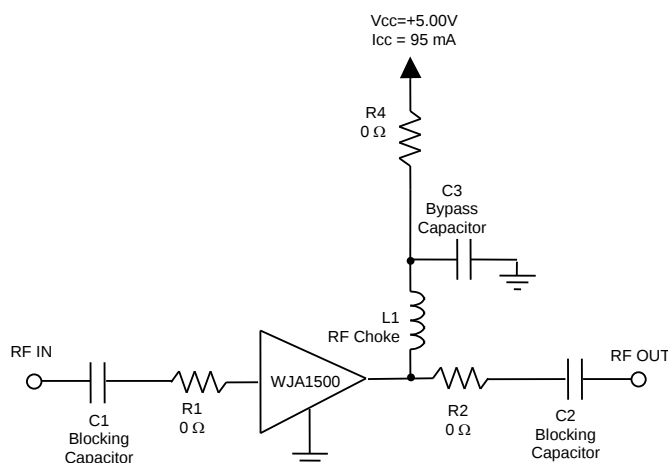
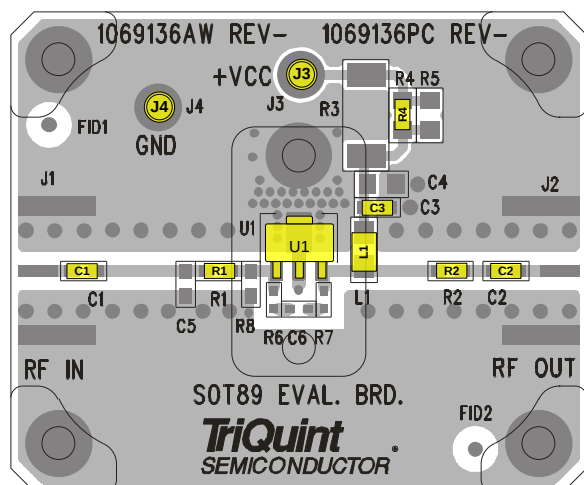
## S-Parameters

Test Conditions:  $V_{SUPPLY}=+5\text{ V}$ ,  $I_{CC}=94\text{ mA}$  (typ.),  $T_{CASE}=+25\text{ }^{\circ}\text{C}$ , fixture measurement, calibrated to device leads

| Freq (MHz) | S11 (dB) | S11 (ang) | S21 (dB) | S21 (ang) | S12 (dB) | S12 (ang) | S22 (dB) | S22 (ang) |
|------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| 10         | -15.69   | -55.09    | 21.82    | 171.35    | -25.19   | 11.61     | -10.46   | -28.13    |
| 50         | -17.40   | -135.23   | 19.98    | 168.76    | -23.20   | 4.28      | -18.29   | -60.10    |
| 100        | -17.59   | -153.75   | 19.68    | 167.63    | -23.05   | 0.79      | -21.02   | -64.45    |
| 150        | -17.77   | -158.44   | 19.59    | 164.26    | -22.99   | -1.17     | -21.22   | -67.20    |
| 200        | -17.56   | -160.17   | 19.47    | 160.44    | -22.96   | -2.89     | -21.01   | -73.21    |
| 250        | -17.54   | -160.17   | 19.42    | 157.05    | -22.91   | -4.24     | -20.25   | -76.35    |
| 300        | -17.25   | -159.36   | 19.36    | 153.10    | -23.00   | -5.88     | -19.36   | -80.46    |
| 350        | -17.04   | -156.92   | 19.33    | 148.71    | -22.99   | -6.83     | -18.55   | -83.44    |
| 400        | -16.88   | -156.28   | 19.26    | 144.56    | -22.97   | -8.61     | -17.94   | -86.00    |
| 450        | -16.50   | -152.39   | 19.19    | 140.90    | -23.01   | -9.69     | -16.95   | -90.06    |
| 500        | -16.25   | -152.53   | 19.10    | 136.81    | -22.93   | -10.49    | -16.62   | -92.43    |
| 550        | -16.04   | -151.61   | 19.01    | 132.74    | -23.00   | -12.61    | -15.94   | -96.08    |
| 600        | -15.71   | -149.87   | 18.90    | 128.80    | -23.02   | -13.57    | -15.45   | -98.43    |
| 650        | -15.45   | -147.51   | 18.80    | 124.94    | -23.01   | -14.81    | -14.87   | -101.00   |
| 700        | -15.11   | -146.25   | 18.69    | 120.76    | -23.04   | -15.97    | -14.15   | -104.13   |
| 750        | -14.84   | -144.74   | 18.58    | 117.69    | -23.01   | -17.76    | -13.71   | -106.18   |
| 800        | -14.67   | -144.80   | 18.45    | 113.29    | -23.00   | -19.31    | -13.28   | -108.81   |
| 850        | -14.45   | -143.29   | 18.38    | 109.27    | -23.05   | -19.69    | -12.67   | -111.55   |
| 900        | -14.25   | -141.96   | 18.20    | 105.66    | -23.02   | -21.32    | -12.12   | -114.03   |
| 950        | -14.05   | -141.12   | 18.16    | 101.96    | -23.09   | -22.91    | -11.61   | -116.73   |
| 1000       | -13.98   | -140.85   | 18.02    | 97.92     | -23.14   | -23.65    | -11.22   | -119.37   |
| 1050       | -13.75   | -140.40   | 17.84    | 94.26     | -23.06   | -24.91    | -10.74   | -121.30   |
| 1100       | -13.40   | -139.62   | 17.69    | 90.54     | -23.10   | -26.92    | -10.34   | -123.81   |
| 1150       | -13.24   | -138.81   | 17.60    | 86.83     | -23.10   | -28.23    | -9.89    | -125.85   |
| 1200       | -13.05   | -138.36   | 17.43    | 82.58     | -23.24   | -29.00    | -9.59    | -128.24   |

Device S-parameters are available for download on the WJA1500 product page at [www.qorvo.com](http://www.qorvo.com)

# WJA1500-PCB Evaluation Board



Notes:

1. See Evaluation Board PCB Information section for material and stack-up.
2. All components are of 0603 size unless otherwise stated.

## Bill of Material – WJA1500-PCB

| Reference Des. | Value         | Description                                           | Manuf.    | Part Number |
|----------------|---------------|-------------------------------------------------------|-----------|-------------|
| U1             | n/a           | InGaP HBT Gain Block                                  | Qorvo     | WJA1500     |
| L1             | 470 nH        | Ferrite core wire wound inductor, 0805 <sup>(1)</sup> | various   |             |
| C1, C2         | 1000 pF       | Cap, Chip, 0603, 50V, NPO, 5%                         | various   |             |
| C3             | 0.018 $\mu$ F | Cap, Chip, 0603, 16V, X7R, 10%                        | Coilcraft |             |
| R1, R2, R4     | 0 $\Omega$    | Res, Chip, 0603, 1/10W, 5%                            | various   |             |

Notes:

1. For lower cost and performance (100 – 1000 MHz) option use 470 nH air core wire wound inductor.
2. R1, R2, and R4 may be replaced by copper trace in end user applications.

## Typical Performance - WJA1500-PCB

Test conditions unless otherwise stated:  $V_{\text{SUPPLY}}=+5\text{ V}$ ,  $I_{\text{CC}}=94\text{ mA}$  (typ.),  $T_{\text{CASE}}=+25\text{ }^{\circ}\text{C}$

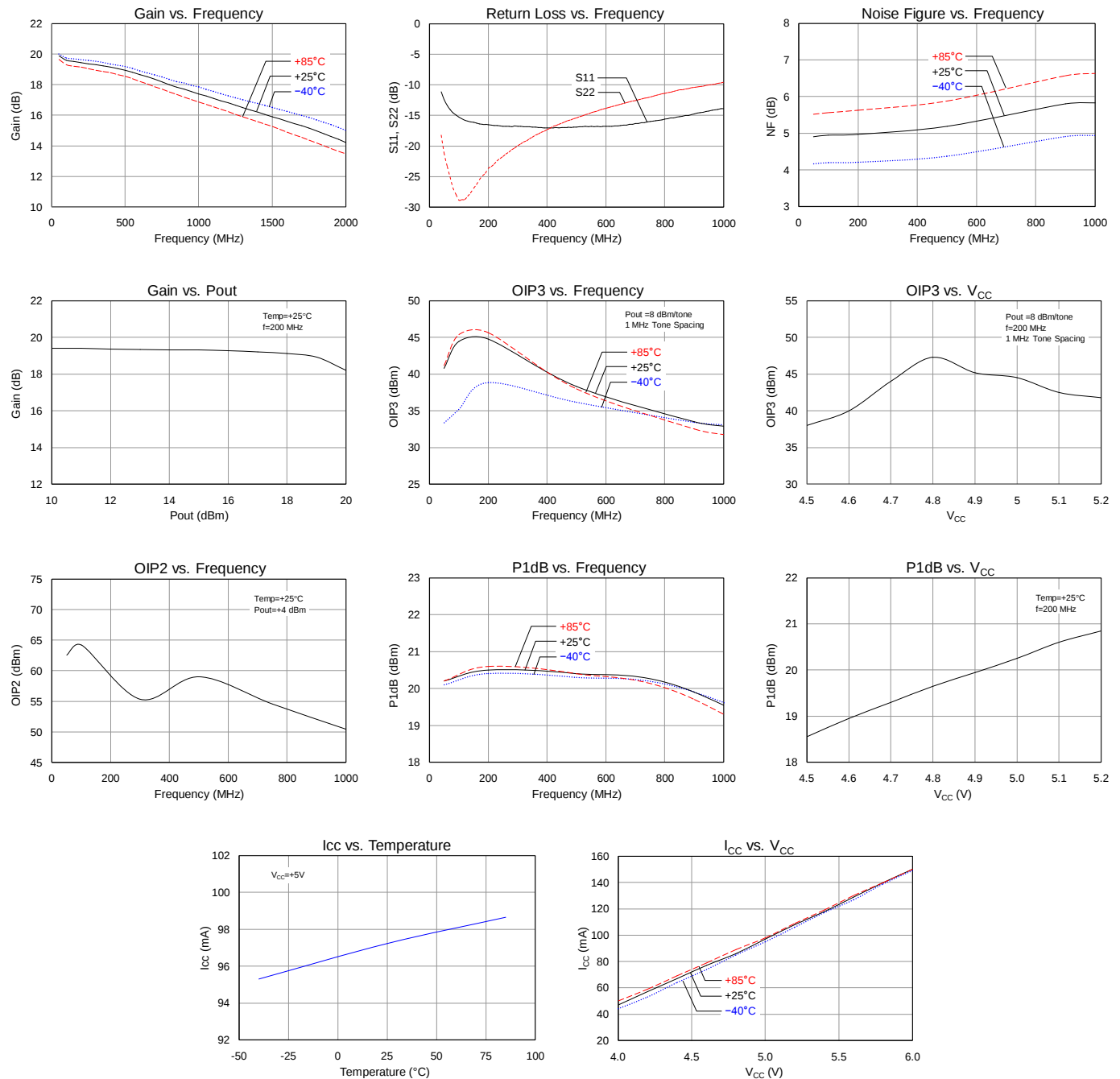
| Parameter                 | Typical Value |       |       |       |       | Units |
|---------------------------|---------------|-------|-------|-------|-------|-------|
| Frequency                 | 70            | 170   | 240   | 500   | 900   | MHz   |
| Gain                      | 19.6          | 19.3  | 19.2  | 18.8  | 17.6  | dB    |
| Input Return Loss         | 14            | 16    | 17    | 17    | 14    | dB    |
| Output Return Loss        | 25            | 27    | 22    | 15    | 10    | dB    |
| Output P1dB               | +20.2         | +20.3 | +20.4 | +20.4 | +19.9 | dBm   |
| Output IP3 <sup>(1)</sup> | +42.1         | +44.6 | +43.8 | +38.3 | +33.4 | dBm   |
| Output IP2                | +63.2         | +61.1 | +58.0 | +59.0 | +52.0 | dBm   |
| Noise Figure              | 4.9           | 4.9   | 5.0   | 5.2   | 5.8   | dB    |

Notes:

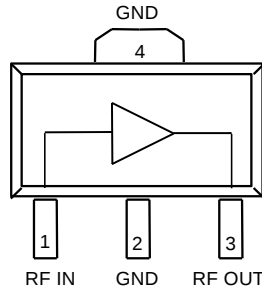
1. OIP3 measured with two tones at an output power of +8 dBm / tone separated by 1 MHz.

### Performance Plots – WJA1500-PCB

Test conditions unless otherwise stated:  $V_{\text{SUPPLY}} = +5 \text{ V}$ ,  $I_{\text{CC}} = 94 \text{ mA}$  (typ.),  $T_{\text{CASE}} = +25^\circ \text{C}$



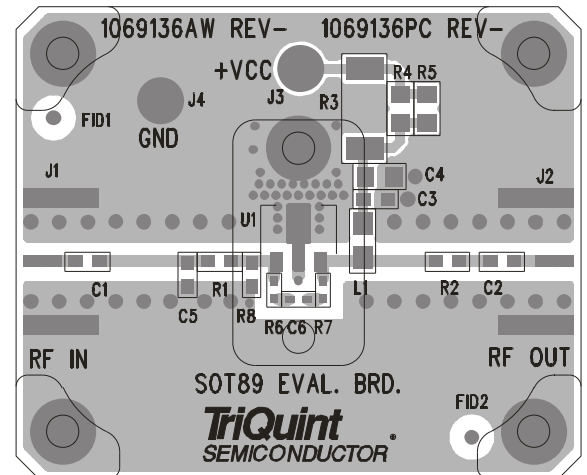
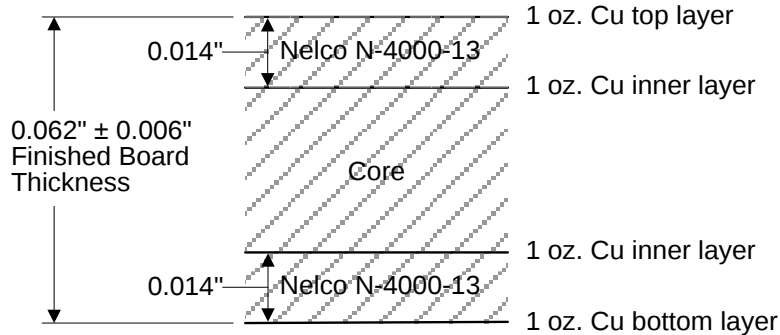
## Pin Configuration and Description



| Pin No. | Label  | Description                                                                                                                                                                  |
|---------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | RF IN  | RF input, matched to 50 ohms. External DC Block is required.                                                                                                                 |
| 3       | RF OUT | RF output / DC supply, matched to 50 ohms. External DC Block, RF choke required.                                                                                             |
| 2, 4    | GND    | Ground and Backside Paddle. Multiple via holes should be employed to minimize inductance and thermal resistance; see PCB mounting pattern in Mechanical Information section. |

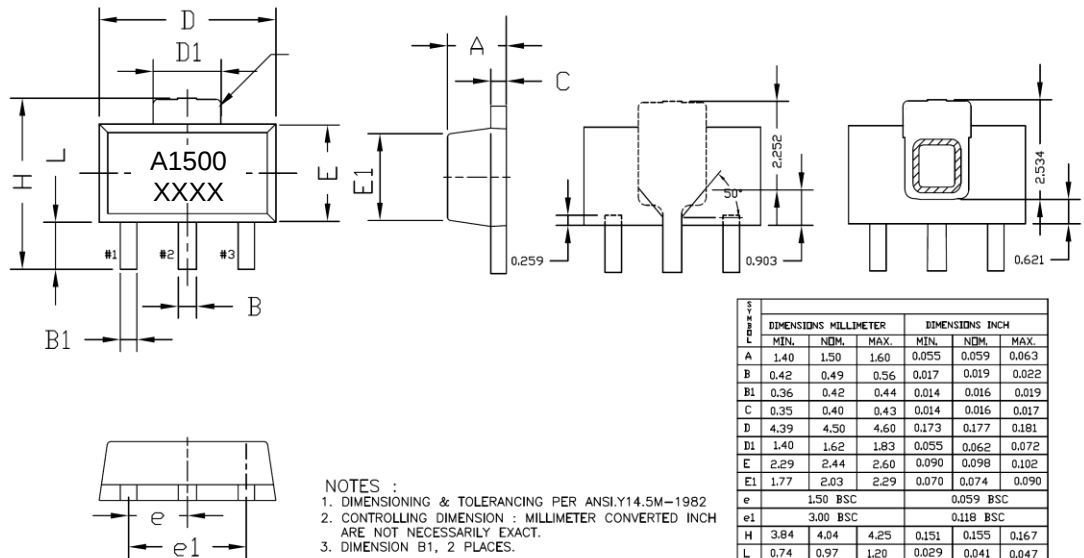
## Evaluation Board PCB Information

PCB 1069136 Material and Stack-up



### Package Marking and Dimensions

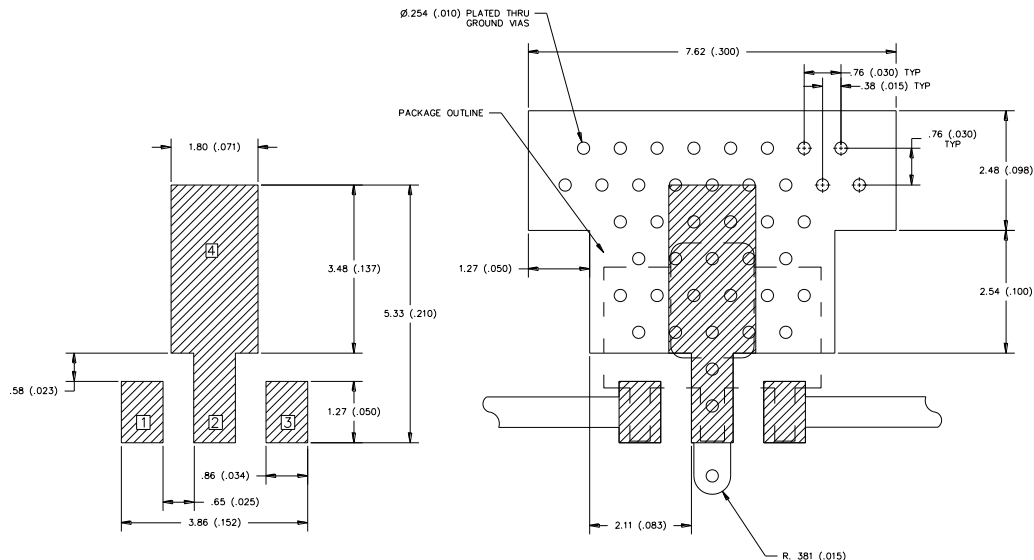
Marking:  
Part Number – A1500  
Trace Code – XXXX



#### 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. Trace Code up to 4 digits assigned by sub-contractor

### 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 conductivity.
4. Do not remove or minimize via hole structure in the PCB. Thermal and RF grounding is critical.
5. 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").
6. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

### Product Compliance Information

#### ESD Sensitivity Ratings



Caution! ESD-Sensitive Device

ESD Rating: Class 1C  
Value:  $\geq 1000$  V and  $< 2000$  V  
Test: Human Body Model (HBM)  
Standard: JEDEC Standard JS-001-2012

ESD Rating: Class C3  
Value:  $\geq 1000$  V  
Test: Charged Device Model (CDM)  
Standard: JEDEC Standard JESD22-C101F

#### MSL Rating

MSL Rating: Level 3 or better  
Test:  $260^{\circ}\text{C}$  convection reflow  
Standard: JEDEC Standard IPC/JEDEC J-STD-020

#### Solderability

Compatible with both lead-free ( $260^{\circ}\text{C}$  maximum reflow temperature) and tin/lead ( $245^{\circ}\text{C}$  maximum reflow temperature) soldering processes.

Contact plating: Annealed Matte Tin or NiPdAu

#### 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:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ( $\text{C}_{15}\text{H}_{12}\text{Br}_4\text{O}_2$ ) 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)

For technical questions and application information:

Email: [appsupport@qorvo.com](mailto:appsupport@qorvo.com)

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