# QPD1014A

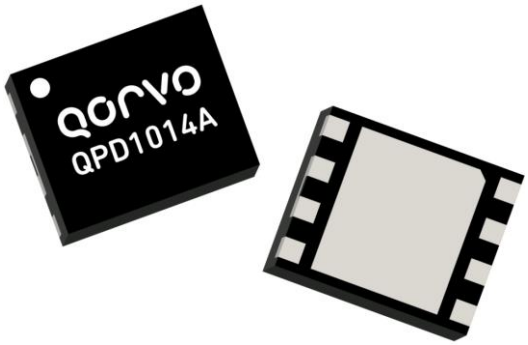
## 15W, 50V, 30 – 1200MHz, GaN Input Matched Transistor

## 1. Product Overview and Benefits

The Qorvo QPD1014A is a 15W ($P_{3dB}$), 50Ω input matched discrete GaN on SiC HEMT which operates from 30MHz to 1.2GHz on a 50V supply rail. The integrated input matching network enables wideband gain and power performance, while the output can be matched on board to optimize for power and efficiency for any region within the band.

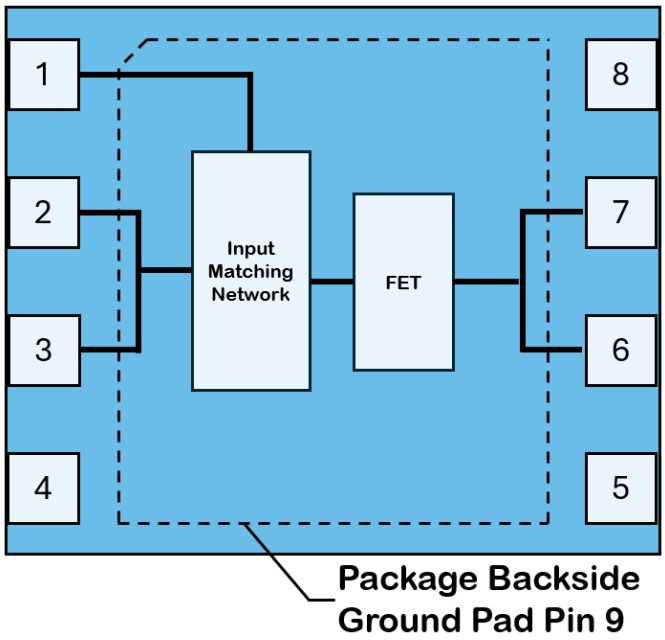
The device is housed in a 6 x 5 mm leadless SMT package that saves real estate of already space-constrained handheld radios.

Evaluation boards are available upon request.




*6 x 5 x 0.85mm DFN Package*

## 2. Functional Block Diagram




*Top View*

## 3. QPD1014AEVB Performance

| Freq.(GHz) | $P_{3dB}$(W) | $G_{3dB}$(dB) | $DE_{3dB}$(%) |
|---|---|---|---|
| 0.1 | 19.4 | 15.3 | 69.9 |
| 0.5 | 15.1 | 15.3 | 60.9 |
| 1.0 | 12.3 | 16.7 | 66.2 |

At Bottom of Baseplate Temperature of 25°C, Signal Type: CW
$V_D$ = 50V, $I_{DQ}$ = 25mA
See Evaluation Board – 100 – 1000MHz for more details.

## 4. Key Features

- Operating Voltage: 50V
- Low Thermal Resistance Package
- CW and Pulse Capable
- 6 x 5mm Package

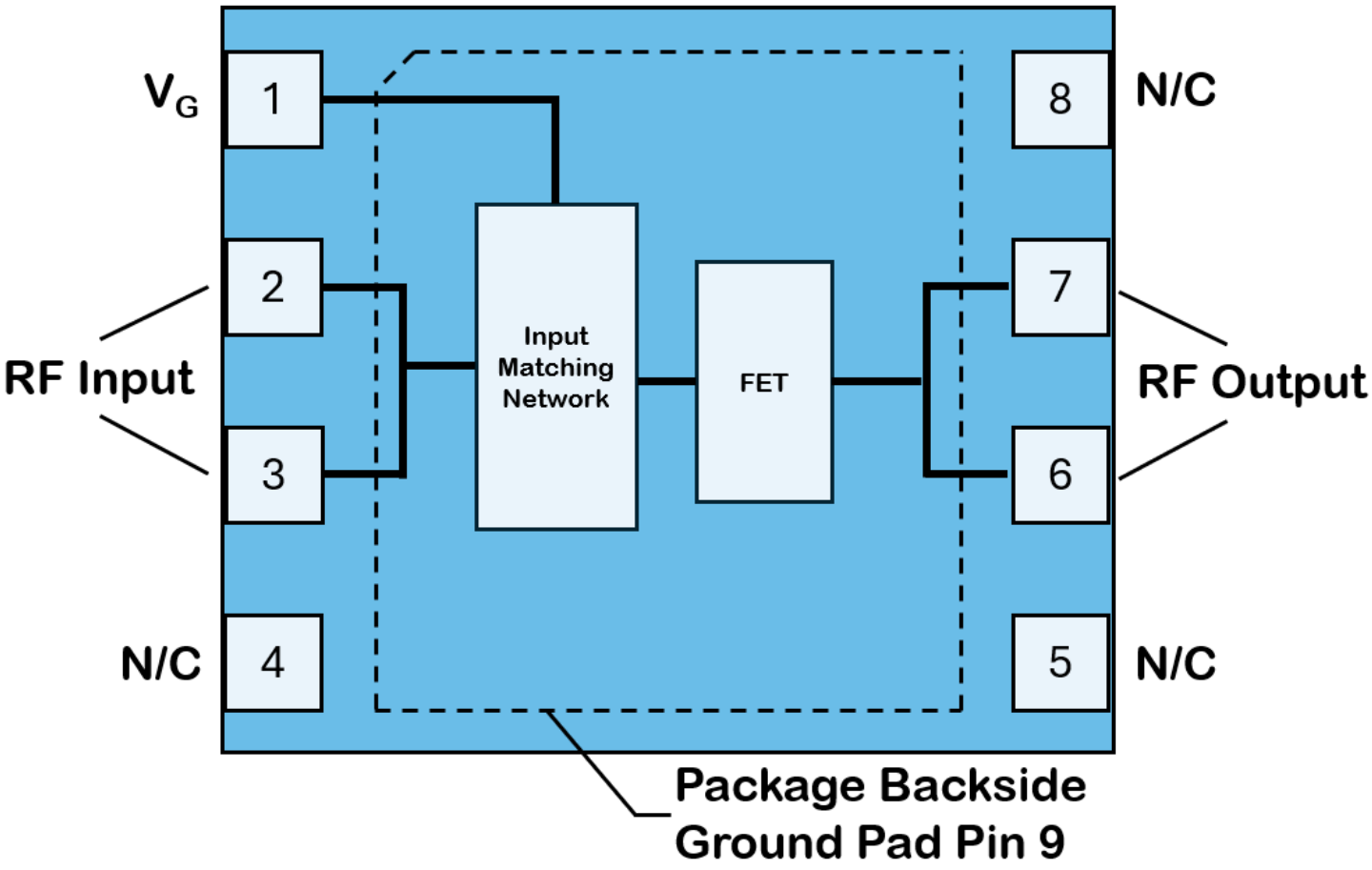
## 5. Applications

- Basesation
- Active Antenna
- Military Radar
- Civilian Radar
- Land Mobile and Radio Communications
- Jammers

## 6. Ordering Information

| Part Number | Description |
|---|---|
| QPD1014AS2 | 2 pcs. WP Sample |
| QPD1014ASR | 100 pcs. 7” Short Reel |
| QPD1014ATR7 | 750 pcs.7” Reel |
| QPD1014AEVB | 100 – 1000MHz Evaluation Board |

## 7. Pin Configuration and Description

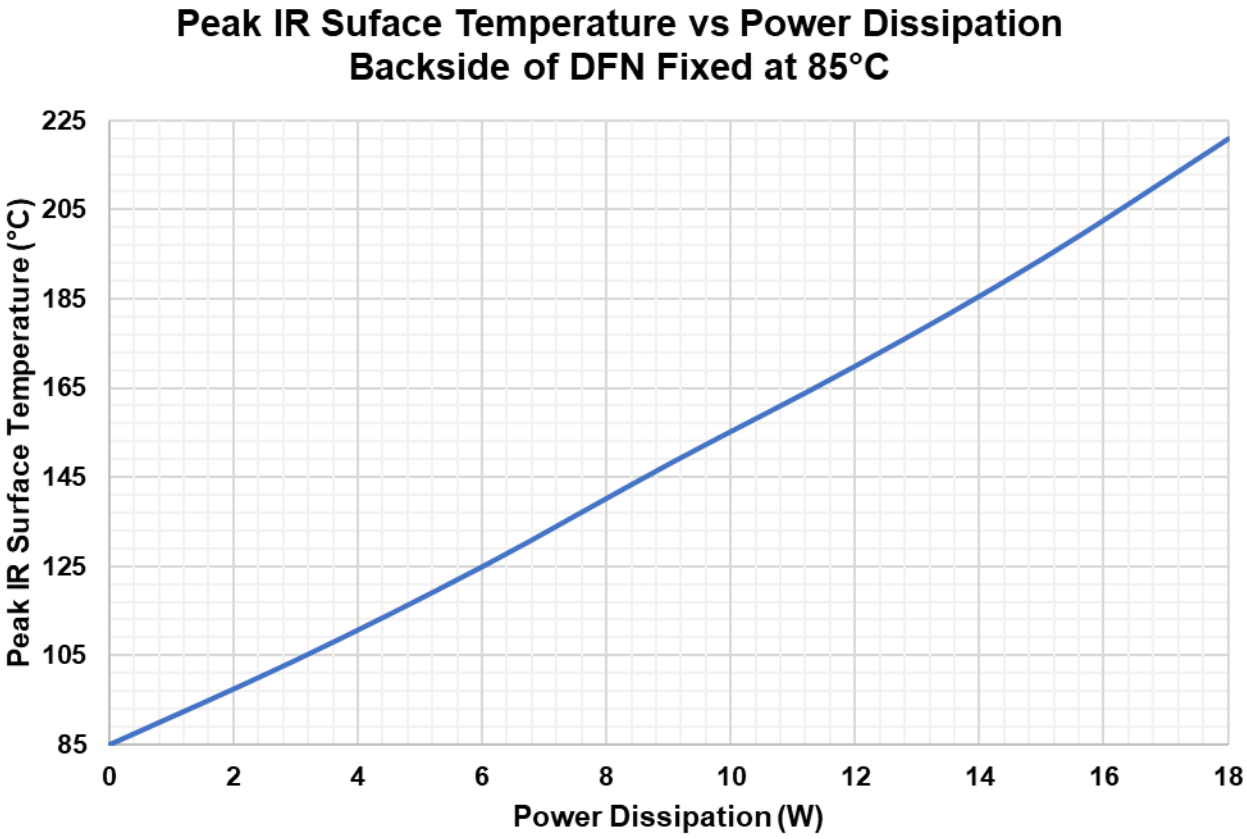



*Top View*

| Pin Number | Label | Description |
|---|---|---|
| 1 | $V_G$ | Gate Supply |
| 2, 3 | $RF_{IN}$ | RF Input Port 50 OHM |
| 6, 7 | $RF_{OUT}$ | Drain Supply, RF Output Port |
| 9 | GND | Ground Pad |
| 4, 5, 8 | N/C | No connections required. Can be used for reflow alignment. |

# 8. Thermal and Reliability Information

## 8.1. Continuous Wave




| Parameter | Conditions | Values | Unit |
|---|---|---|---|
| IR Thermal Resistance, $\theta_{JC}$ | 85°C backside temperature | 6.48 | °C/W |
| Peak IR Surface Temperature, $T_{CH}$ | 2.5 W Pdiss, CW | 101.2 | °C |
| IR Thermal Resistance, $\theta_{JC}$ | 85°C backside temperature | 6.64 | °C/W |
| Peak IR Surface Temperature, $T_{CH}$ | 5.0 W Pdiss, CW | 118.2 | °C |
| IR Thermal Resistance, $\theta_{JC}$ | 85°C backside temperature | 6.8 | °C/W |
| Peak IR Surface Temperature, $T_{CH}$ | 7.5 W Pdiss, CW | 136.0 | °C |
| IR Thermal Resistance, $\theta_{JC}$ | 85°C backside temperature | 6.96 | °C/W |
| Peak IR Surface Temperature, $T_{CH}$ | 10.0 W Pdiss, CW | 154.6 | °C |
| IR Thermal Resistance, $\theta_{JC}$ | 85°C backside temperature | 7.12 | °C/W |
| Peak IR Surface Temperature, $T_{CH}$ | 12.5 W Pdiss, CW | 174.0 | °C |
| IR Thermal Resistance, $\theta_{JC}$ | 85°C backside temperature | 7.3 | °C/W |
| Peak IR Surface Temperature, $T_{CH}$ | 15.0 W Pdiss, CW | 194.5 | °C |

Please refer to the following document GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

# 9. Electrical Characteristics

## 9.1. Absolute Maximum Ratings

| Parameter | Rating | Unit |
|---|---|---|
| Breakdown Voltage, $BV_{DG}$ | +145 | V |
| Gate Voltage Range, $V_G$ | -8 to +2 | V |
| Drain Current | 1 | A |
| Gate Current Range, $I_G$[2] | 3.6 | mA |
| Power Dissipation, CW, $P_{DISS}$ | 15.8 | W |
| RF Input Power, $P_{IN}$[1] | +31 | dBm |
| Mounting Temperature (30 Seconds) | 320 | °C |
| Storage Temperature | -40 to +150 | °C |

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

Note:

1. Continuous Wave(CW), T = 25°C, 1GHz
2. At FEA Channel Temperature of 200°C

## 9.2. Recommended Operating Conditions

| Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|
| Operating Temperature Range | -40 | +25 | +85 | °C |
| Drain Voltage Range, $V_D$ | +12 | +50 | +55 | V |
| Drain Bias Current, $I_{DQ}$ | - | 25 | - | mA |
| Gate Voltage, $V_G$[1] | - | -2.8 | - | V |
| Channel Temperature ($T_{CH}$) | - | - | +250 | °C |
| Power Dissipation, CW ($P_{DISS}$)[3] | - | - | 14.4 | W |

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

Note:

1. To be adjusted to desired $I_{DQ}$
2. Back side of package at 85°C

## 9.3. Load Pull Performance – Power Tuned

| Parameters | Typical Values | | | | Unit |
|---|---|---|---|---|---|
| Frequency, Freq. | 0.6 | 0.8 | 1.0 | 1.2 | GHz |
| Linear Gain, $G_{LIN}$ | 20.1 | 21.0 | 21.5 | 20.8 | dB |
| Output Power at 3dB Compression, $P_{3dB}$ | 41.9 | 42.4 | 42.7 | 42.3 | dBm |
| Power Added Efficiency at 3dB Compression, $PAE_{3dB}$ | 65.0 | 62.0 | 63.0 | 60.0 | % |
| Gain at 3dB Compression | 17.1 | 18.0 | 18.5 | 17.8 | dB |

Note:

1. Test conditions: Pulsed Continuous Wave(Pulsed CW), Pulse Width = 100us, Duty Cycle = 10%, $V_D$ = +50V, $I_{DQ}$ = 25mA, Temperature = +25°C.

## 9.4. Load Pull Performance – Efficiency Tuned

| Parameters | Typical Values | | | | Unit |
|---|---|---|---|---|---|
| Frequency, Freq. | 0.6 | 0.8 | 1.0 | 1.2 | GHz |
| Linear Gain, $G_{LIN}$ | 21.8 | 22.6 | 23.0 | 21.2 | dB |
| Output Power at 3dB Compression, $P_{3dB}$ | 39.0 | 39.7 | 41.2 | 40.7 | dBm |
| Power Added Efficiency at 3dB Compression, $PAE_{3dB}$ | 79.2 | 70.7 | 72.6 | 70.4 | % |
| Gain at 3dB Compression | 18.8 | 19.6 | 20.0 | 18.2 | dB |

Note:

1. Test conditions: Pulsed Continuous Wave(Pulsed CW), Pulse Width = 100us, Duty Cycle = 10%, $V_D$ = +50V, $I_{DQ}$ = 25mA, Temperature = +25°C.

## 9.5. RF Characterization – 100 – 1000 MHz EVB Performance at 900MHz

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Linear Gain, $G_{LIN}$ | - | 19.9 | - | dB |
| Output Power at 3dB Compression, $P_{3dB}$ | - | 41.9 | - | dBm |
| Drain Efficiency at 3dB Compression, $DE_{3dB}$ | - | 68.4 | - | % |
| Gain at 3dB Compression, $G_{3dB}$ | - | 16.9 | - | dB |

Notes:
1. Test conditions unless otherwise noted: $V_D$ = +50V, $I_{DQ}$ = 25mA, Continuous Wave(CW), Bottom of Baseplate Temp = 25°C.

## 9.6. RF Characterization – Mismatch Ruggedness at 1000 MHz

| Symbol | Parameter | dB Compression | Typical |
|---|---|---|---|
| VSWR | Impedance Mismatch Ruggedness | 3 | 10:1 |

Notes:

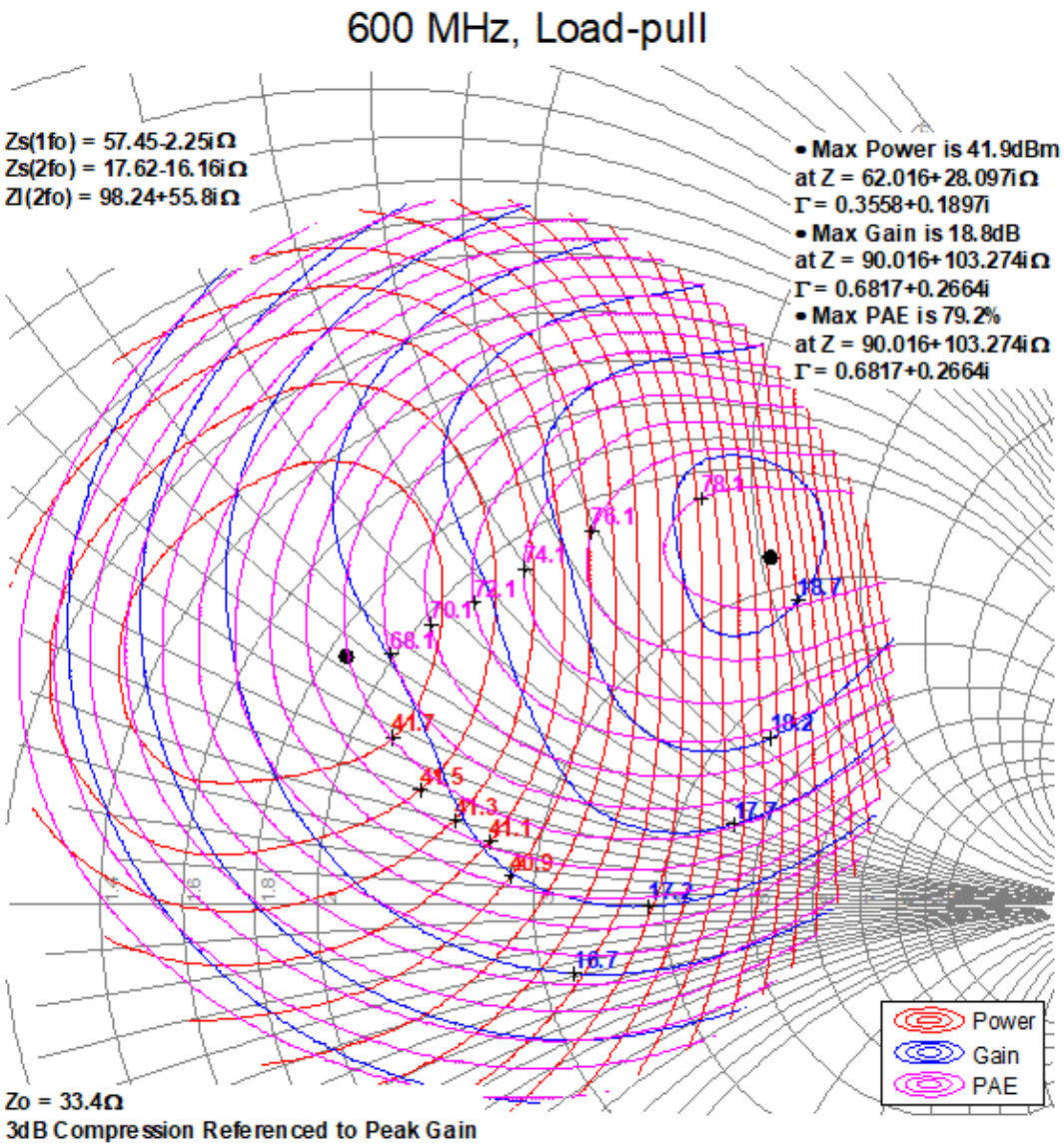
1. Test conditions unless otherwise noted: Bottom of Baseplate Temp = 25°C, $V_D$ = 50V, $I_{DQ}$ = 25mA, Continuous Wave(CW). Driving input power is determined at CW compression under matched condition at EVB output connector.

## 9.7. Load Pull Contours

### 9.7.1. 600MHz

Notes:

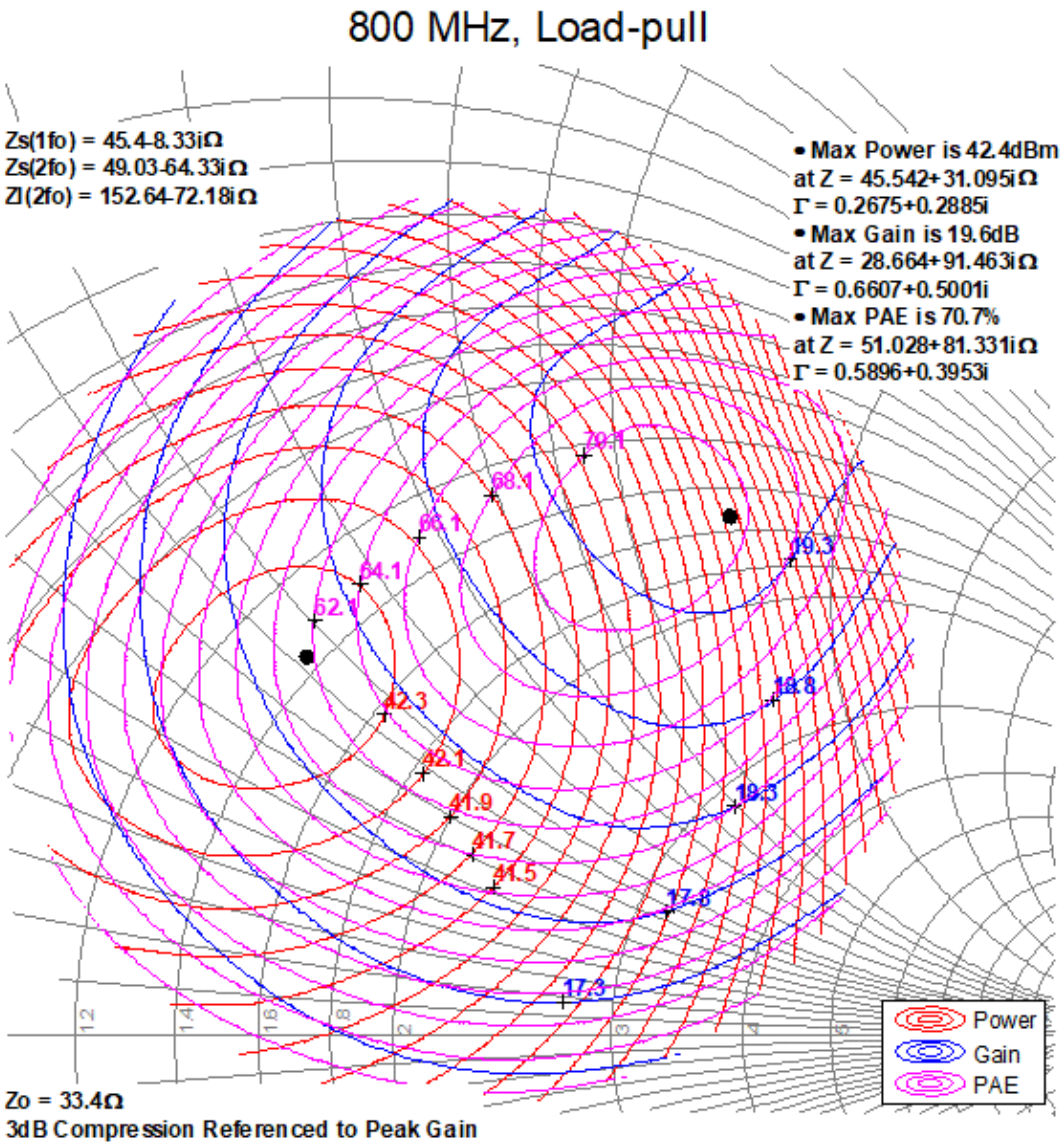
1. $V_D$ = 50V, $I_{DQ}$ = 25mA, Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%. Performance is at 3dB compression referenced to peak gain.
2. See Recommended Package Footprint for load pull and source pull reference planes. 50OHM load pull fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load pull system.



### 9.7.2. 800MHz

Notes:

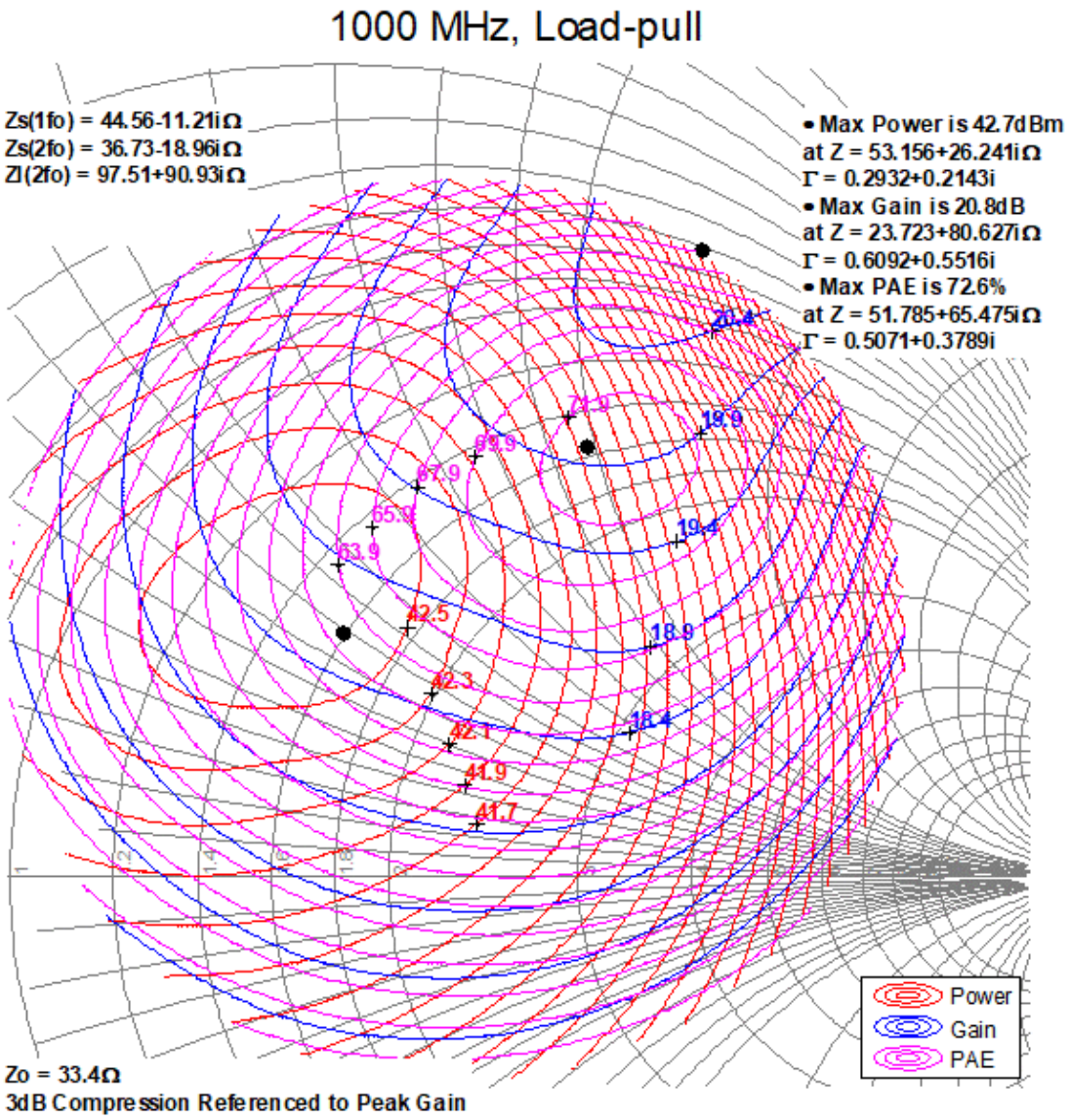
1. $V_D$ = 50V, $I_{DQ}$ = 25mA, Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%. Performance is at 3dB compression referenced to peak gain.
2. See Recommended Package Footprint for load pull and source pull reference planes. 50OHM load pull fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load pull system.



### 9.7.3. 1000MHz

Notes:

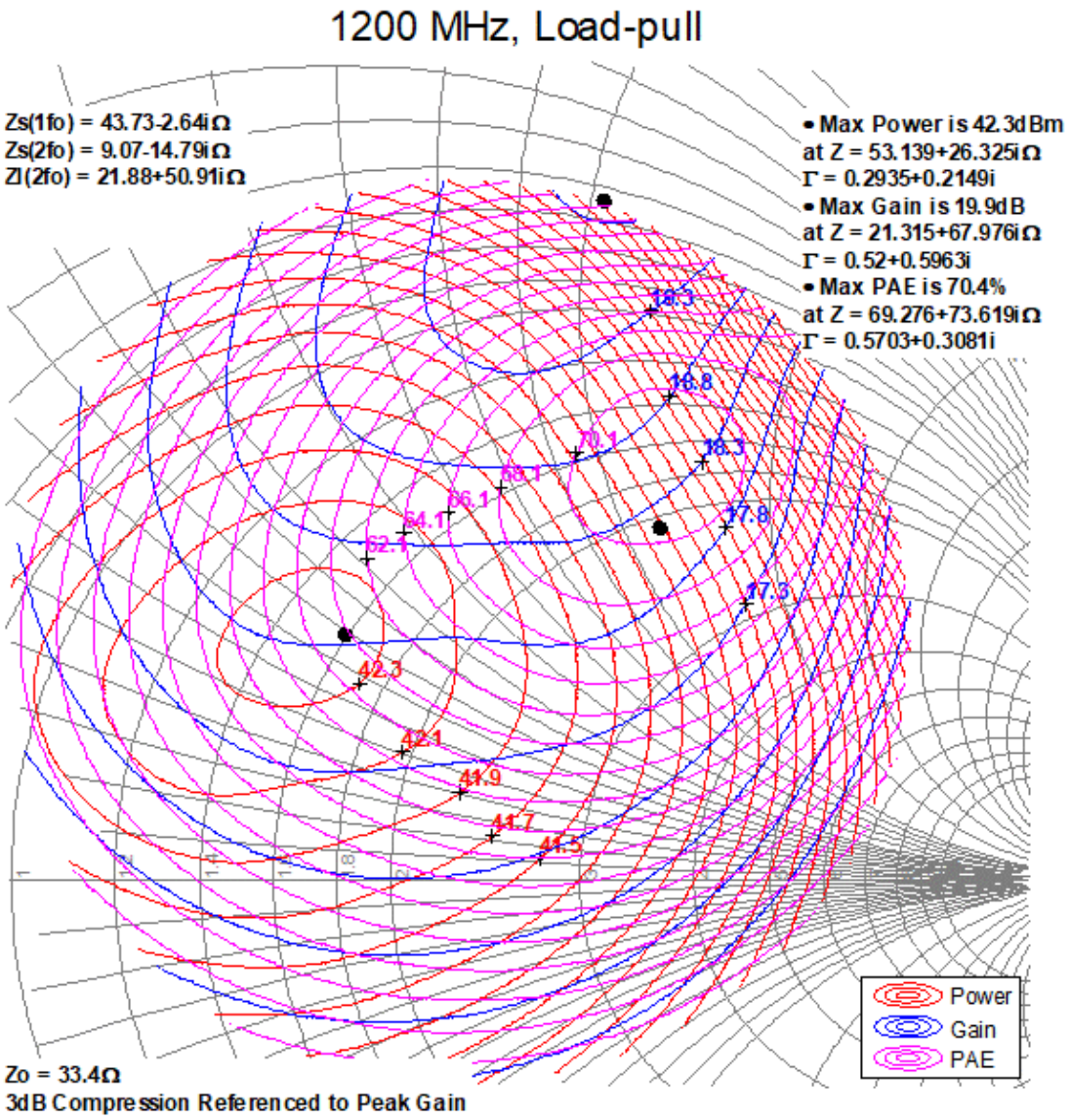
1. $V_D$ = 50V, $I_{DQ}$ = 25mA, Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%. Performance is at 3dB compression referenced to peak gain.
2. See Recommended Package Footprint for load pull and source pull reference planes. 50OHM load pull fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load pull system.



### 9.7.4. 1200MHz

Notes:

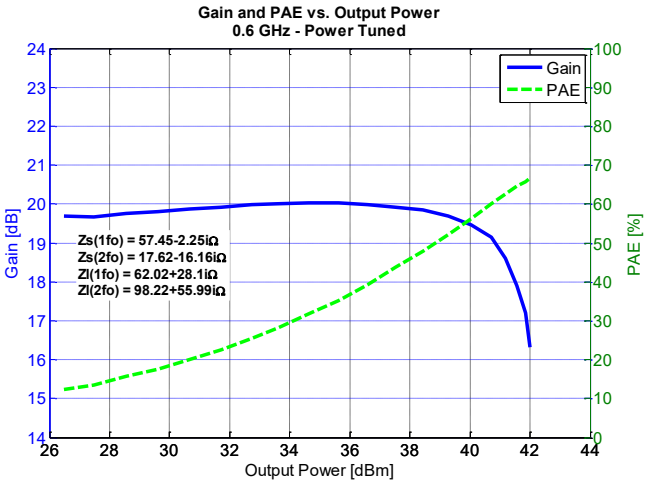
1. $V_D$ = 50V, $I_{DQ}$ = 25mA, Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%. Performance is at 3dB compression referenced to peak gain.
2. See Recommended Package Footprint for load pull and source pull reference planes. 50OHM load pull fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load pull system.

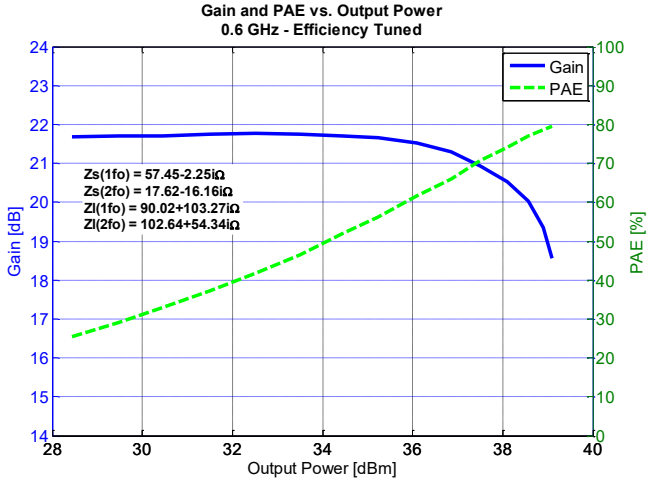


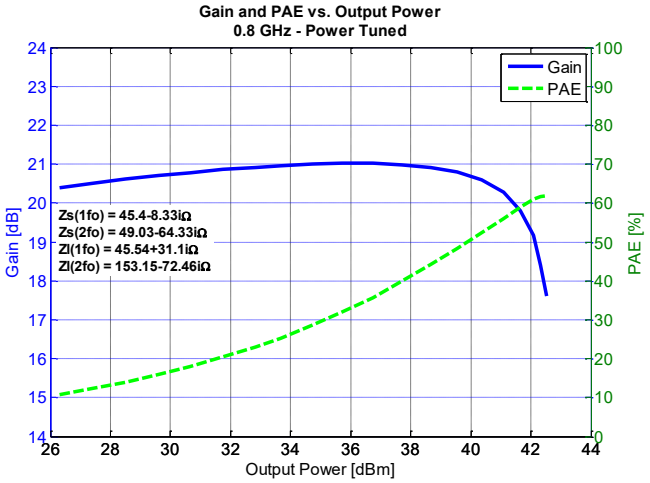
## 9.8. Load Pull Drive-up[1,2]

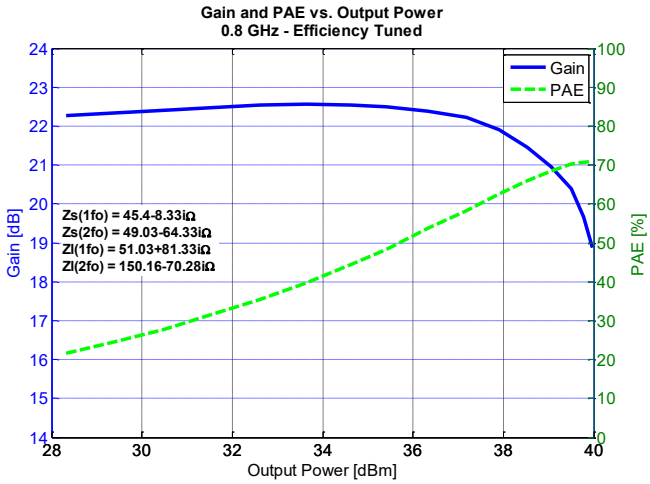
Notes:

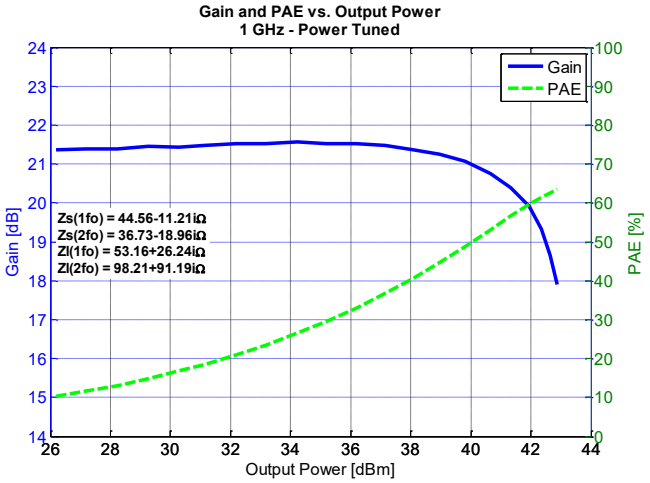
1. Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%, $V_D$ = 50V, $I_{DQ}$ = 25mA
2. See Recommended Package Footprint for load pull and source pull reference planes where the performance was measured.

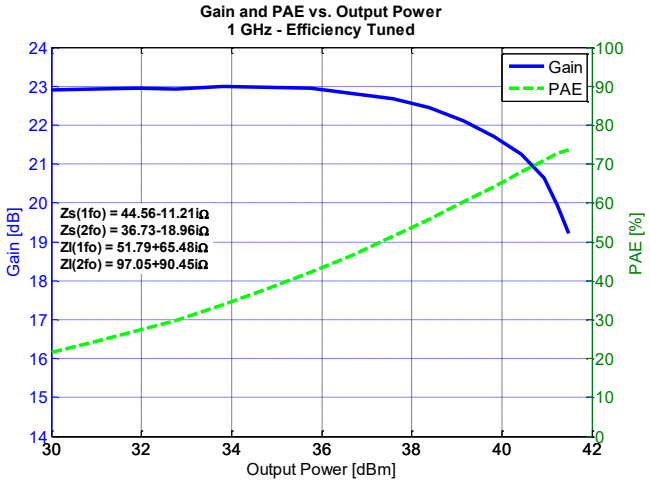


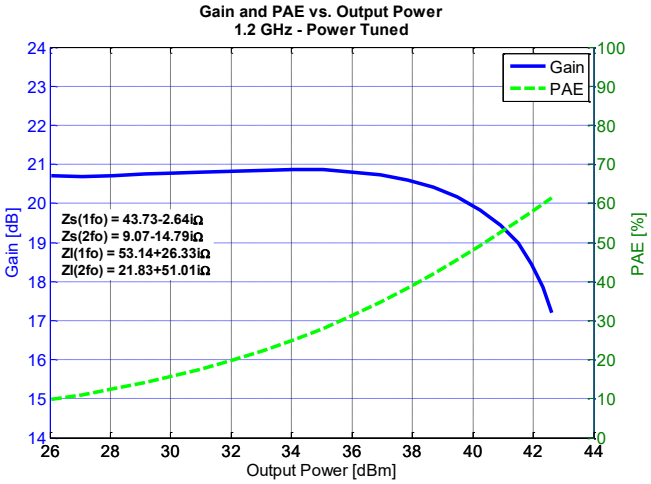



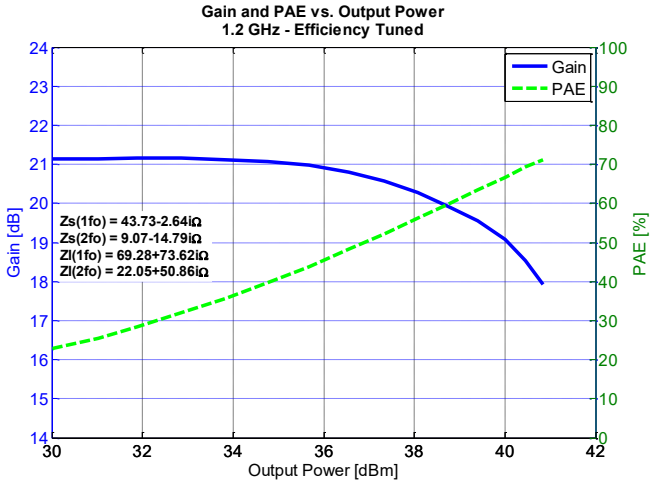





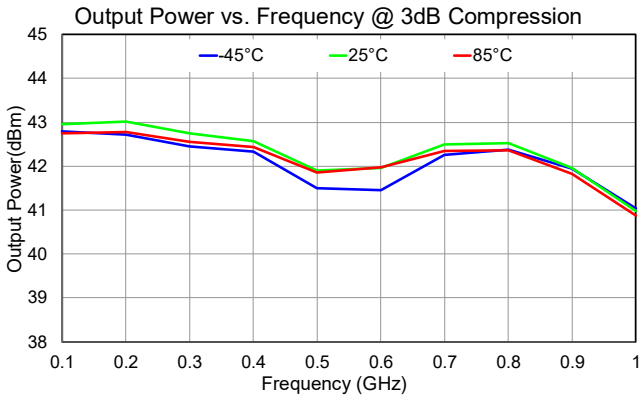



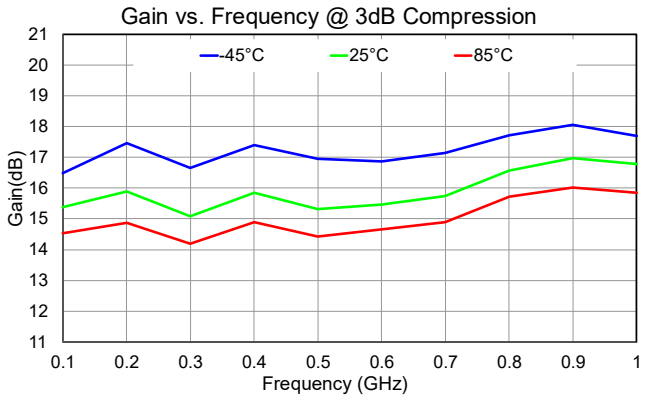
# 10. Evaluation Board – 100 – 1000MHz

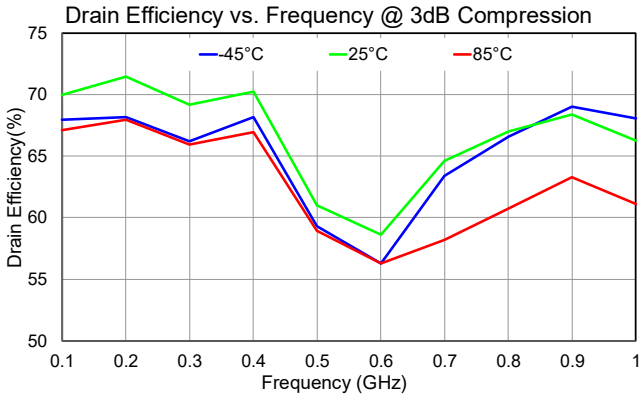
### 10.1.1. Power Drive-up Performance Over Temperature

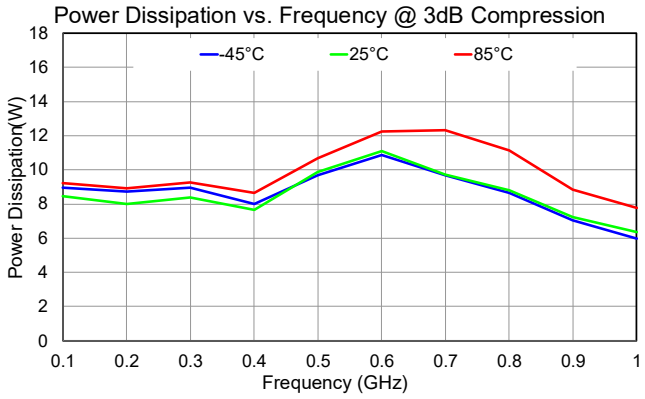
Notes:

1. $V_D$ = 50V, $I_{DQ}$ = 25mA, Continuous Wave(CW)



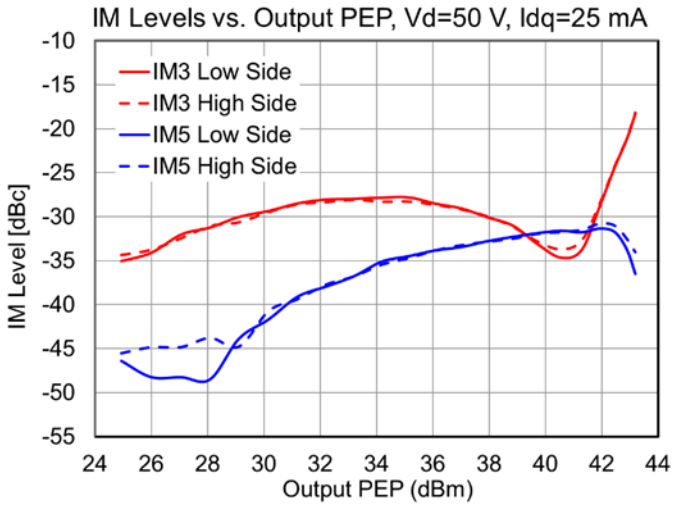



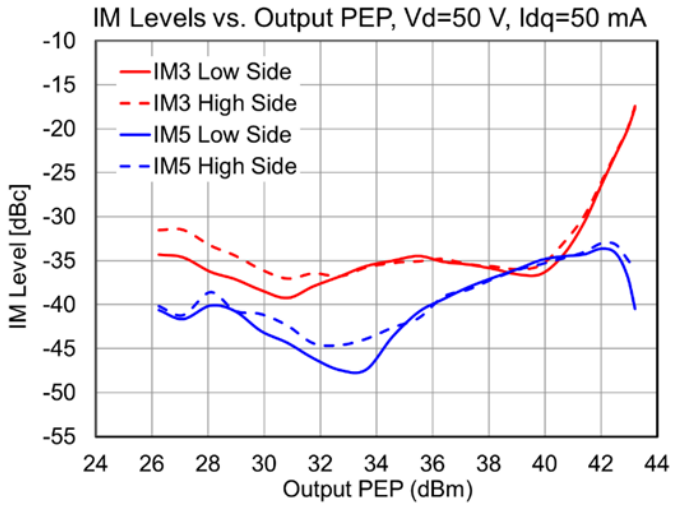



### 10.1.2. Two-Tone Performance at 25°C

Notes:

1. Data based on QPD1014A's predecessor: QPD1014 50 – 1000MHz Evaluation Board.

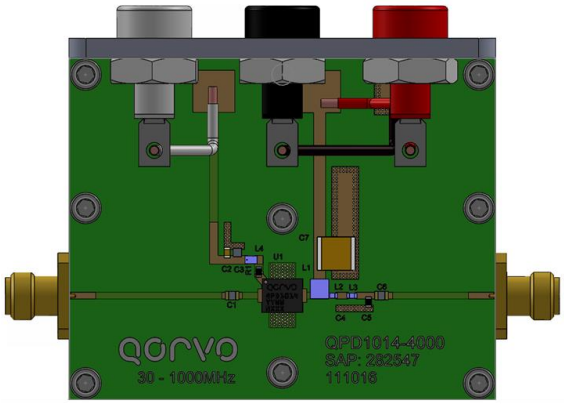


### 10.1.3. PCB Layout – 100 – 1000MHz

Notes:

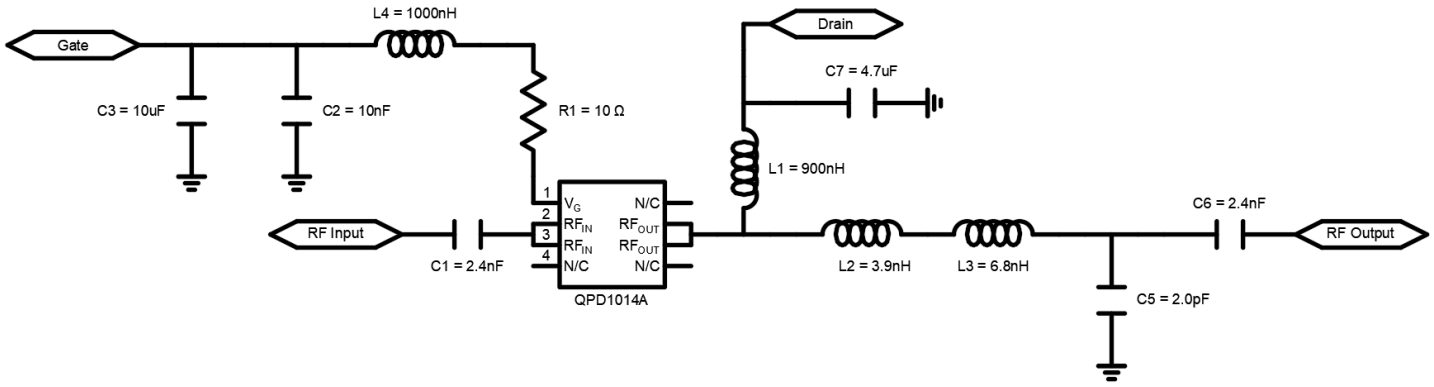
1. PCB Material: RO4350B, 20mil thickness, 0.5oz copper cladding.




### 10.1.4. Bill of Material

| Reference Designator | Value | Quantity | Manufacturer | Part Number |
|---|---|---|---|---|
| R1 | 10 OHM | 1 | Vishay | CRCW060310R0JNEA |
| C2 | 10 nF | 1 | AVW | 0603YC103KAT2A |
| C3 | 10 uF | 1 | Murata | GRM21BR71A106KE51L |
| C1, C6 | 2400 pF | 2 | Dielectric Labs | C08BL242X-5UN-X0T |
| C5 | 2.0 pF | 1 | ATC | 600S2R0BT250XT |
| C7 | 4.7 uF | 1 | Murata | GRM55ER72A475KA01L |
| L1 | 900 nH | 1 | Coilcraft | 1008AF-901XJLC |
| L2 | 3.9 nH | 1 | Coilcraft | 0603HC-3N9XGLW |
| L3 | 6.8 nH | 1 | Coilcraft | 0603HC-6N8XGJE |
| L4 | 1000 nH | 1 | Coilcraft | 0603LS-102XGLC |

### 10.1.5. Circuit Schematic



# 11. Application Information

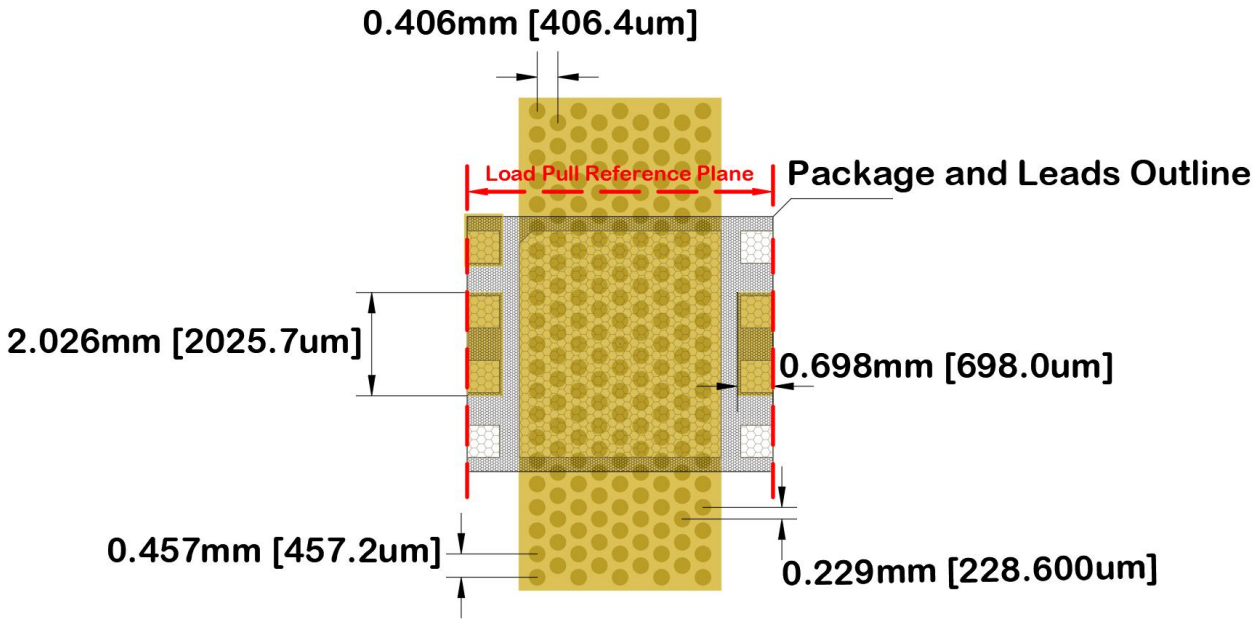
## 11.1. Biasing Sequence

| Bias Up Sequence | Bias Down Sequence |
|---|---|
| 1. Set $V_G$ to -4V | 1. Turn off RF |
| 2. Set $I_D$ current limit to 40mA | 2. Set $V_G$ to -5V |
| 3. Set $V_D$ to 50V | 3. Set $V_D$ to 0V |
| 4. Slowly adjust $V_G$ until $I_{DQ}$ is set to 25mA | 4. Wait until drain voltage supplying the device is discharged to 0V |
| 5. Set $I_D$ current limit to 1A | 5. Turn off Drain Supply |
| 6. Apply RF | 6. Turn off Gate Supply |

Note:

1. The above biasing sequence is based on typical biasing condition of VD = 50V, IDQ = 25mA

## 11.2. Recommended Package Footprint




**LAYER STACK LEGEND**

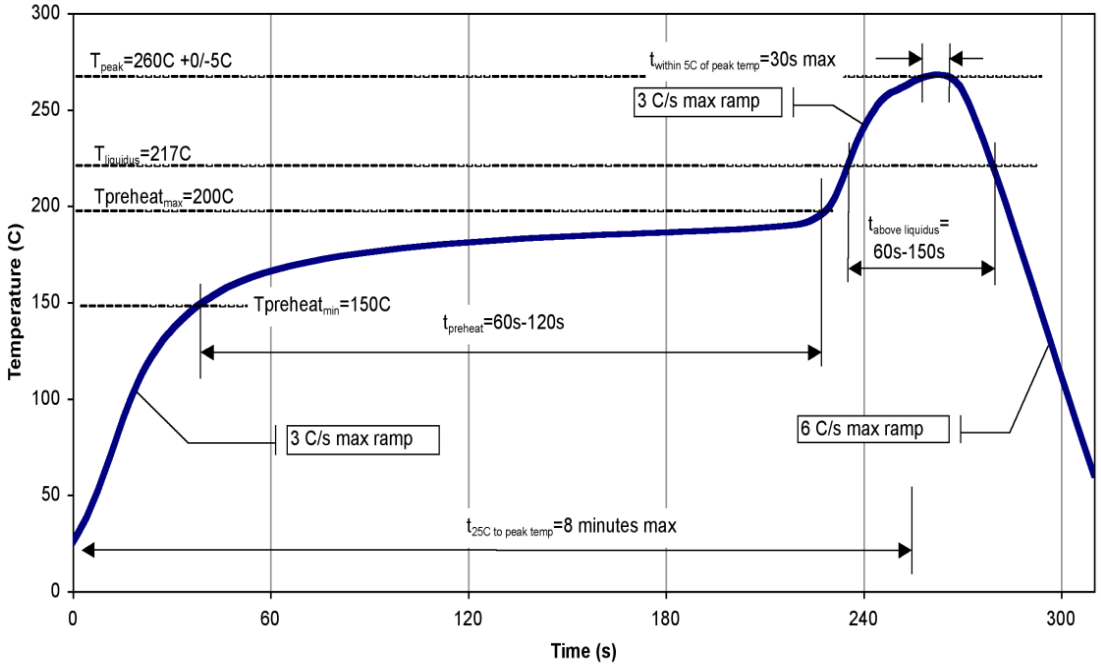
| Material | Layer | Thickness | Dielectric Material | Type |
|---|---|---|---|---|
| | SILKSCREEN_TOP | | | Legend |
| Surface Material | SOLDERMASK_TOP | 0.0010in | Solder Resist | Solder Mask |
| Copper | METAL1_TOP | 0.0007in | | Signal |
| *Core* | | *0.0200in* | *RO4350B* | *Dielectric* |
| Copper | METAL2_BOT | 0.0007in | | Signal |

Total thickness: 0.0224in

Note:

1. All vias shown in the package footprint are copper filled.

### 11.3. Recommended Solder Temperature Profile

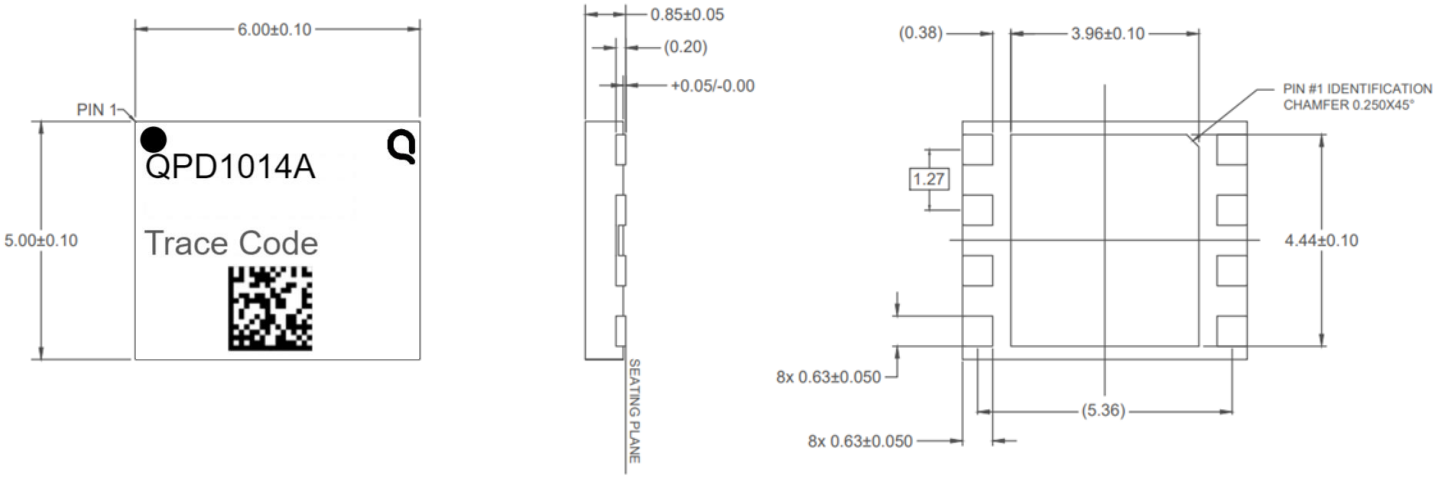


# 12. Packaging and Ordering Information

## 12.1. Device Marking and Package Dimensions

Marking: Part number – QPD1014A

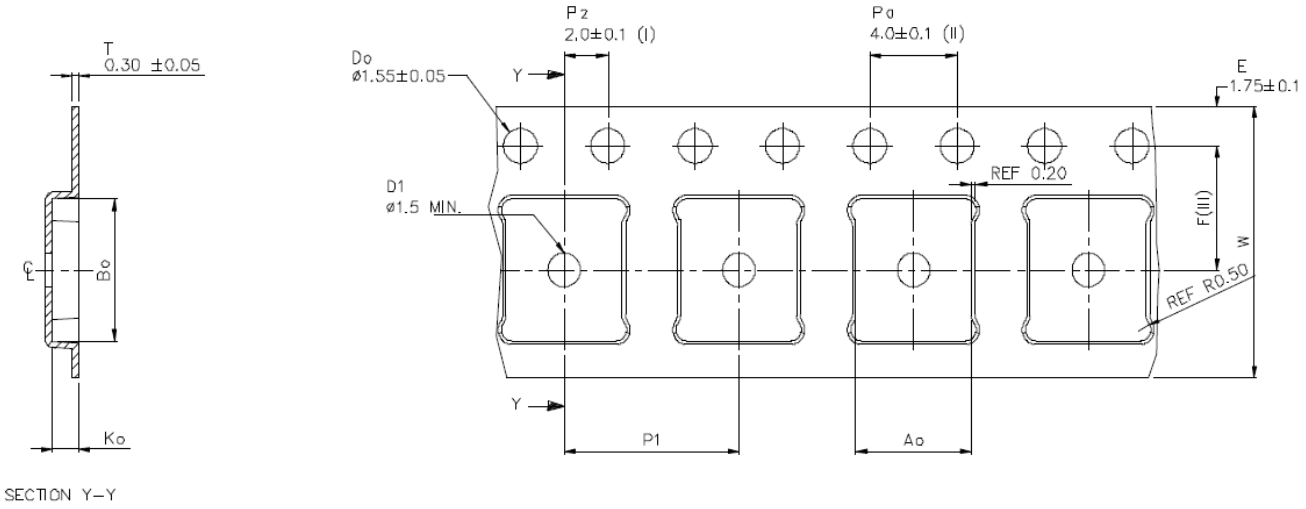
Trace code – QR Code Format




Notes:

1. Package leads are gold plated.
2. Part is mold encapsulated.
3. All units are in millimeter.

## 12.2. Tape and Reel Information




| | |
|---|---|
| Ao | 5.30 +/– 0.1 |
| Bo | 6.30 +/– 0.1 |
| Ko | 1.20 +/– 0.1 |
| F | 5.50 +/– 0.1 |
| P1 | 8.00 +/– 0.1 |
| W | 12.00 +/– 0.3 |

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

## 13. Handling Precautions

| Parameter | Rating | Standard |
|---|---|---|
| ESD – Human Body Model (HBM) | 250V | ANSI/ESD/JEDEC JS-001 |
| ESD – Charged Device Model (CDM) | 1000V | ANSI/ESD/JEDEC JS-001 |
| MSL – Moisture Sensitivity Level | Level 3 | JESD J-STD-020 |

**Caution!**

ESD sensitive device

## 14. Solderability

Compatible with both lead-free (260 °C max. reflow temperature) and tin/lead (245 °C max. reflow temperature) soldering processes.

Contact Plating: NiPdAu

## 15. Environmental Compliance

This part is compliant with the 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
- SVHC Free
- PFOS Free

## 16. Revision History

| Revision | Description |
|---|---|
| A | Datasheet Release |

## 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 Notices

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