# QPD1022

## 10W, 32V, DC – 12 GHz, GaN RF Transistor

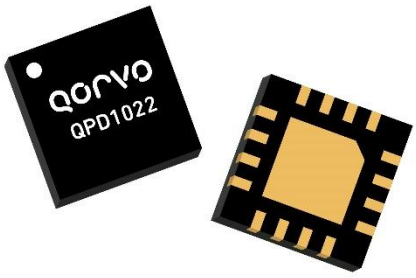
## General Description

The Qorvo QPD1022 is a 10 W ($P_{3dB}$) discrete GaN on SiC HEMT which operates from DC to 12 GHz. This wideband device is a single stage unmatched power amplifier transistor in an over-molded plastic package. The wide bandwidth of the QPD1022 makes it suitable for many different applications from DC to 12 GHz.

The device is housed in an industry-standard 3 x 3 mm surface mount QFN package.

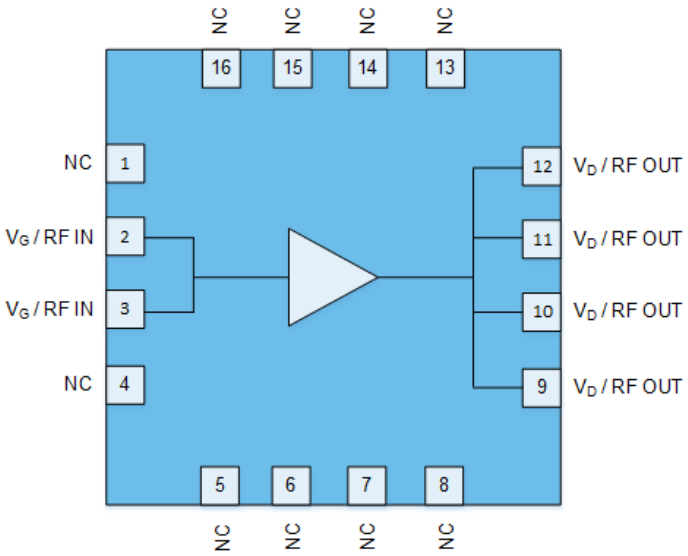
Lead-free and ROHS compliant

Evaluation boards are available upon request.




16 Pin QFN (3 x 3 x 0.85 mm)

## Functional Block Diagram




## Product Features[1]

- Frequency: DC to 12 GHz
- Output Power ($P_{3dB}$): 11 W[1]
- Linear Gain: 24.0 dB[1]
- Typical $PAE_{3dB}$: 68.8 %[1]
- Operating Voltage: 32 V
- Low thermal resistance package
- CW and Pulse capable
- 3 x 3 mm package

Note 1: @ 2 GHz (Loadpull)

## Applications

- Military radar
- Civilian radar
- Land mobile and military radio communications
- Test instrumentation
- Wideband or narrowband amplifiers
- Jammers

## Ordering Information

| Part No. | Description |
|---|---|
| QPD1022S2 | 2 Piece Sample Bag |
| QPD1022SQ | 25 Piece Sample Bag |
| QPD1022SR | 100 Piece 7” Reel |
| QPD1022EVB01 | 3.1 – 3.5 GHz EVB |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## Absolute Maximum Ratings[1, 2]

| Parameter | Rating | Units |
|---|---|---|
| Breakdown Voltage, $BV_{DG}$ | 100 | V |
| Gate Voltage Range, $V_G$ | -7 – +2 | V |
| Drain Current, $I_D$ | 2.4 | A |
| Gate Current Range, $I_G$[1] | 0.9 | mA |
| Power Dissipation, CW, $P_{DISS}$ | 17.5 | W |
| RF Input Power at 3.3 GHz, CW, 50 Ω, T = 25 °C | +29 | dBm |
| Mounting Temperature (30 Seconds) | 320 | °C |
| Storage Temperature | −65 to +150 | °C |

Notes:
1. At Channel temperature of 160°C.
2. Operation of this device outside the parameter ranges given above may cause permanent damage.

## Recommended Operating Conditions[1, 2, 3, 4]

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Operating Temp. Range | −40 | +25 | +85 | °C |
| Drain Voltage Range, $V_D$ | +12 | +32 | +40 | V |
| Drain Bias Current, $I_{DQ}$ | – | 50 | – | mA |
| Drain Current, $I_D$ | – | 610 | – | mA |
| Gate Voltage, $V_G$[4] | – | −2.8 | – | V |
| Power Dissipation, CW ($P_D$)[2] | – | – | 13.8 | W |
| Power Dissipation, Pulsed ($P_D$)[2, 3] | – | – | 18.0 | W |

Notes:
1. Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions.
2. Back plane of package at 85 °C
3. Pulse Width = 100 us, Duty Cycle = 20%
4. To be adjusted to desired $I_{DQ}$


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## Pulsed Characterization – Load Pull Performance – Power Tuned[1]

| Parameters | Typical Values | | | | | | Unit |
|---|---|---|---|---|---|---|---|
| Frequency, F | 2 | 3 | 4 | 6 | 9 | 10 | GHz |
| Linear Gain, $G_{LIN}$ | 24.0 | 21.9 | 19.7 | 16.1 | 12.2 | 10.7 | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | 40.4 | 40.0 | 40.3 | 40.4 | 40.0 | 39.9 | dBm |
| Power-Added-Efficiency at 3dB compression point, $PAE_{3dB}$ | 58.0 | 52.8 | 57.0 | 54.5 | 45.0 | 40.0 | % |
| Gain at 3dB compression point | 21.0 | 18.9 | 16.7 | 13.1 | 9.2 | 7.7 | dB |

Notes:
1. Test conditions unless otherwise noted: $V_D$ = 32 V, $I_{DQ}$ = 50 mA, Temp = +25 °C

## Pulsed Characterization – Load Pull Performance – Efficiency Tuned[1]

| Parameters | Typical Values | | | | | | Unit |
|---|---|---|---|---|---|---|---|
| Frequency | 2 | 3 | 4 | 6 | 9 | 10 | GHz |
| Linear Gain, $G_{LIN}$ | 25.6 | 23.4 | 21.3 | 16.9 | 12.9 | 11.9 | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | 36.8 | 39.0 | 38.3 | 39.4 | 39.4 | 38.7 | dBm |
| Power-Added-Efficiency at 3dB compression point, $PAE_{3dB}$ | 68.8 | 66. | 69.4 | 61.2 | 50.3 | 46.3 | % |
| Gain at 3dB compression point, $G_{3dB}$ | 22.6 | 20.4 | 18.3 | 13.9 | 9.9 | 8.9 | dB |

Notes:
1- Test conditions unless otherwise noted: $V_D$ = 32 V, $I_{DQ}$ = 50 mA, Temp = +25 °C

## RF Characterization – 3.1 – 3.5 GHz EVB Performance At 3.3 GHz[1]

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Linear Gain, $G_{LIN}$ | – | 16.3 | – | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | – | 39.9 | – | dBm |
| Drain Efficiency at 3dB compression point, $DEFF_{3dB}$ | – | 58.7 | – | % |
| Gain at 3dB compression point, $G_{3dB}$ | – | 13.3 | – | dB |

Notes:
1. $V_D$ = 32 V, $I_{DQ}$ = 50 mA, Temp = +25 °C, Pulse Width = 100 us, Duty Cycle = 20%

## RF Characterization – Mismatch Ruggedness at 3.3 GHz[1,2]

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

Notes:
1. Test conditions unless otherwise noted: $T_A$ = 25 °C, $V_D$ = 32 V, $I_{DQ}$ = 50 mA
2. Driving input power is determined at pulsed compression under matched condition at EVB output connector.


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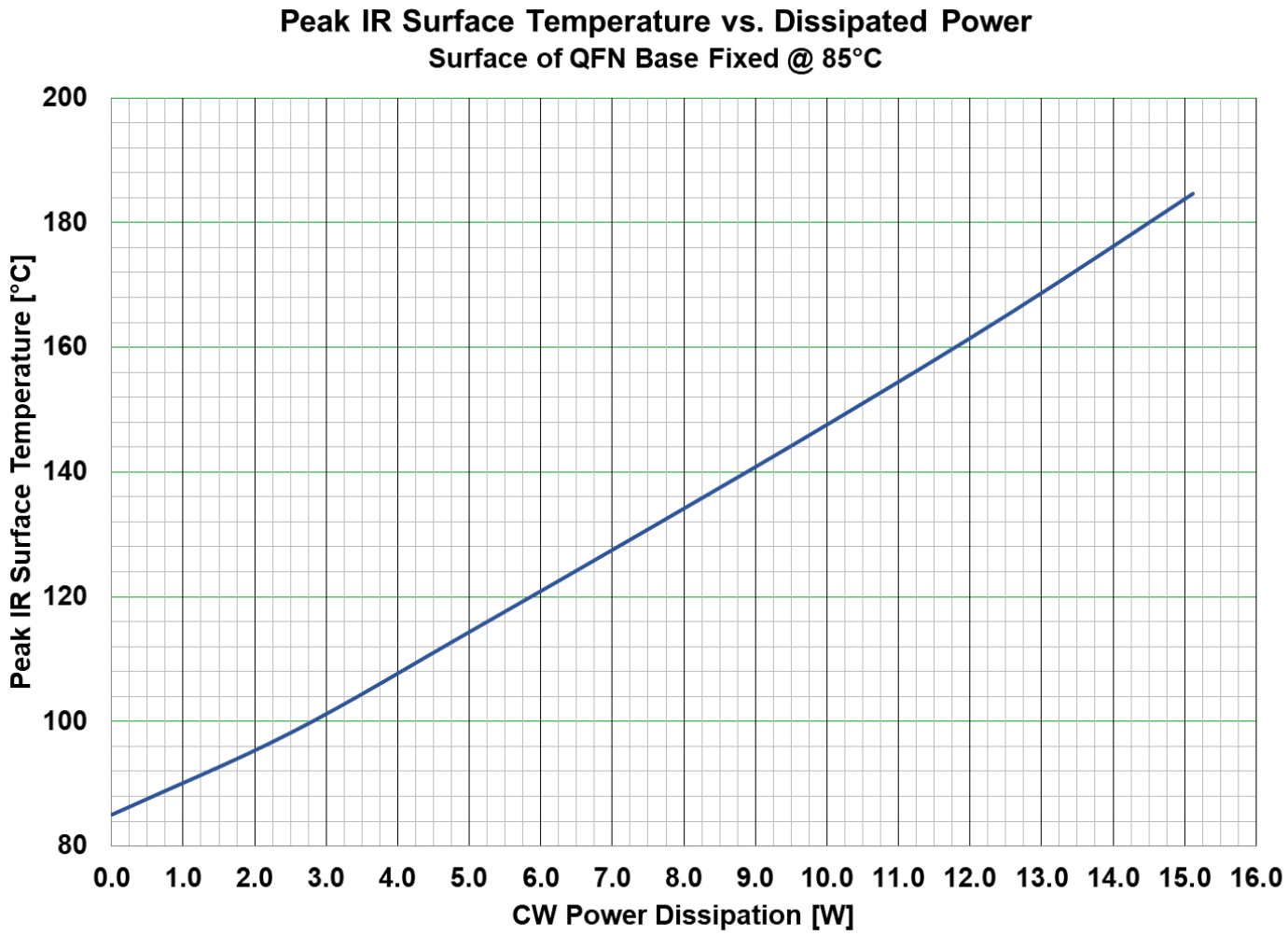
## Thermal and Reliability Information – CW[1]




| Parameter | Conditions | Values | Units |
|---|---|---|---|
| Thermal Resistance, IR[1] ($\theta_{JC}$) | 85 °C back side temperature<br>7.6 W Pdiss, CW | 6.2 | °C/W |
| Peak IR Surface Temperature[1] ($T_{CH}$) | | 132 | °C |

Notes:
1- Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates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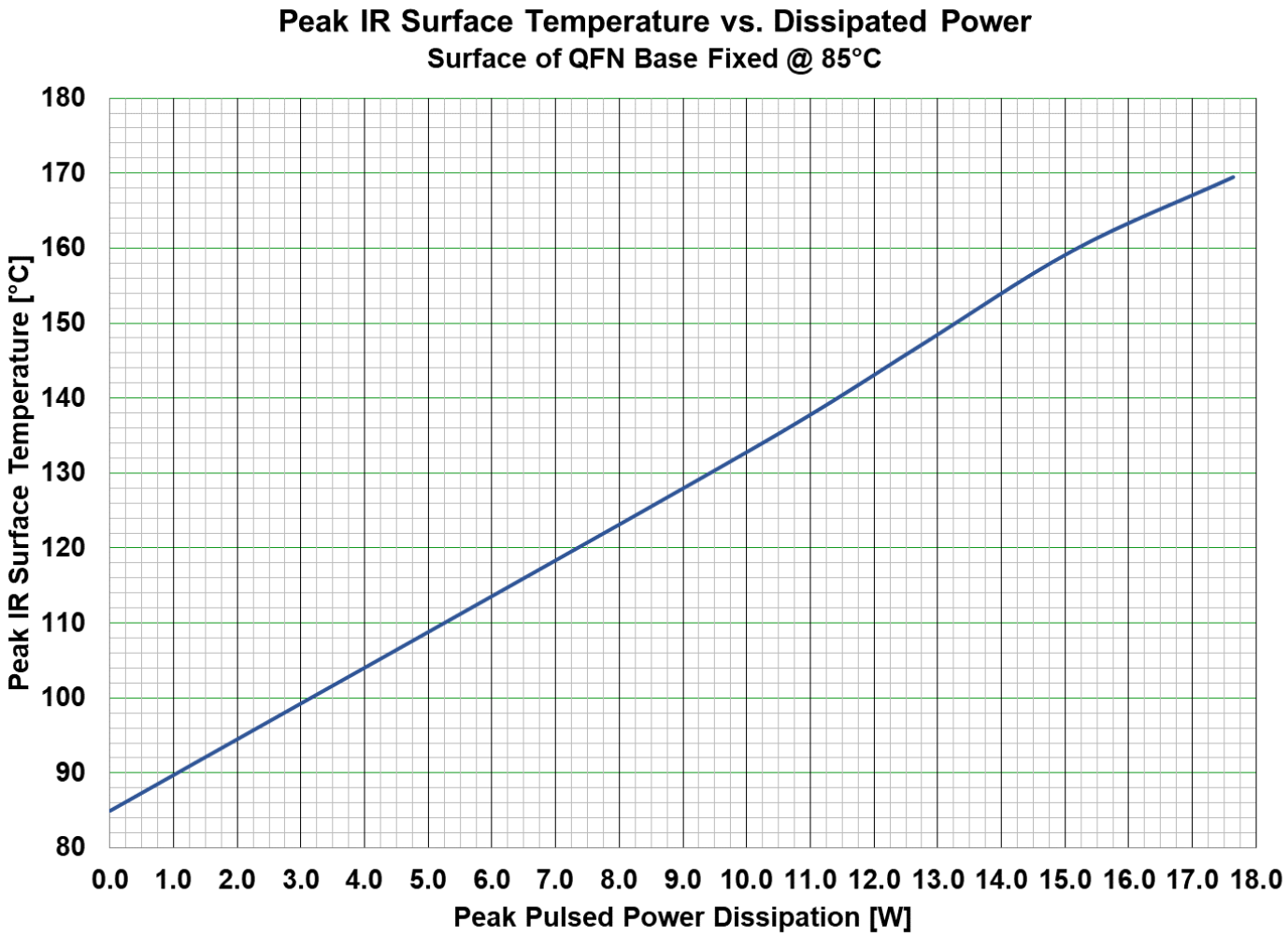
## Thermal and Reliability Information – Pulsed[1]




| Parameter | Conditions | Values | Units |
|---|---|---|---|
| Thermal Resistance, IR[1] ($\theta_{JC}$) | 85 °C back side temperature | 4.7 | °C/W |
| Peak IR Surface Temperature[1] ($T_{CH}$) | 7.6 W Pdiss, 100us PW, 20% Duty cycle | 121 | °C |

Notes:

1- Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates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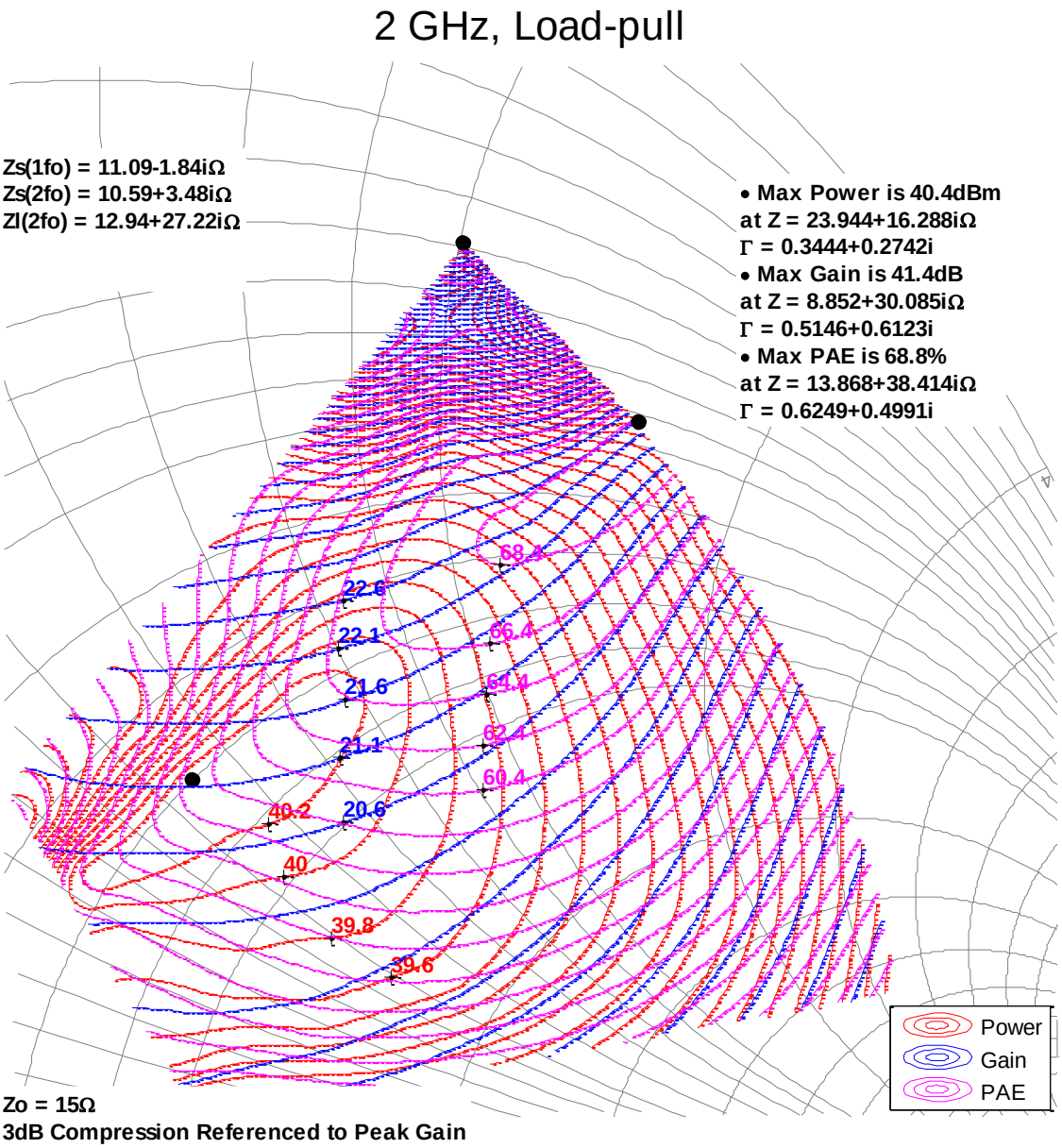
## Load Pull Smith Charts[1, 2]

Notes:
1. Vd = 32 V, $I_{DQ}$ = 50 mA, Pulsed signal with 100 us pulse width and 20 % duty cycle.
2. See page 17 for load pull and source pull reference planes.





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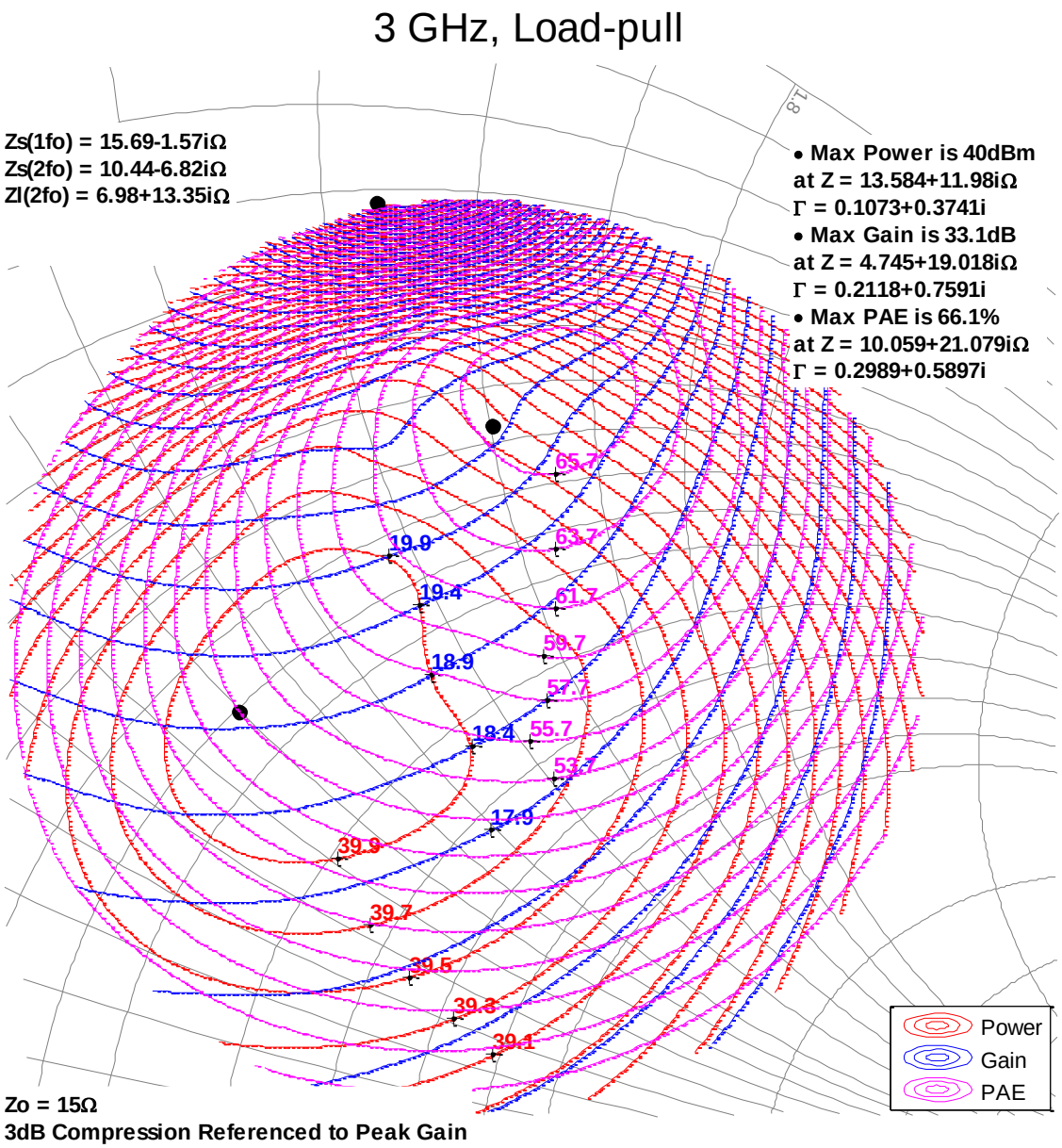



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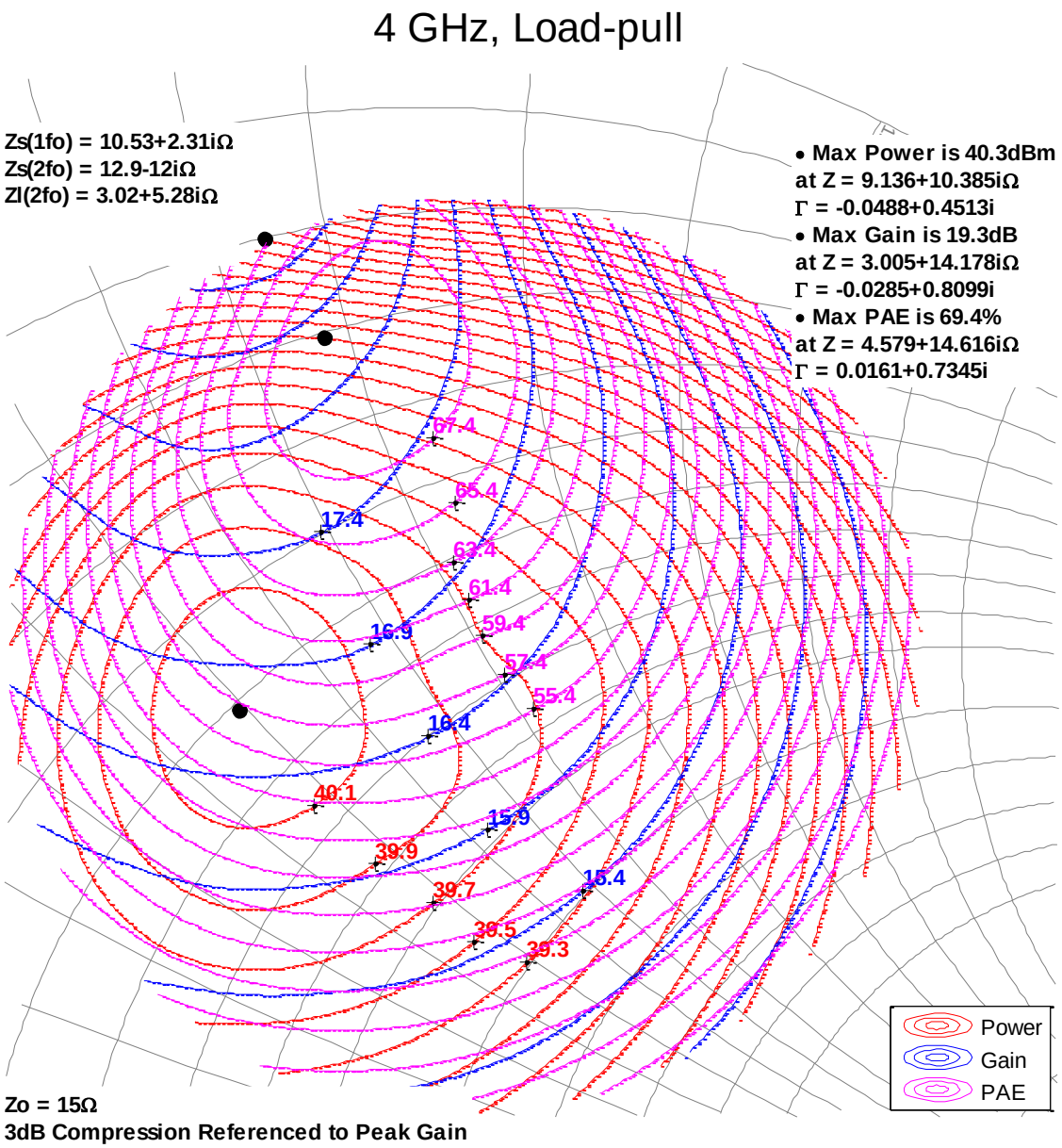



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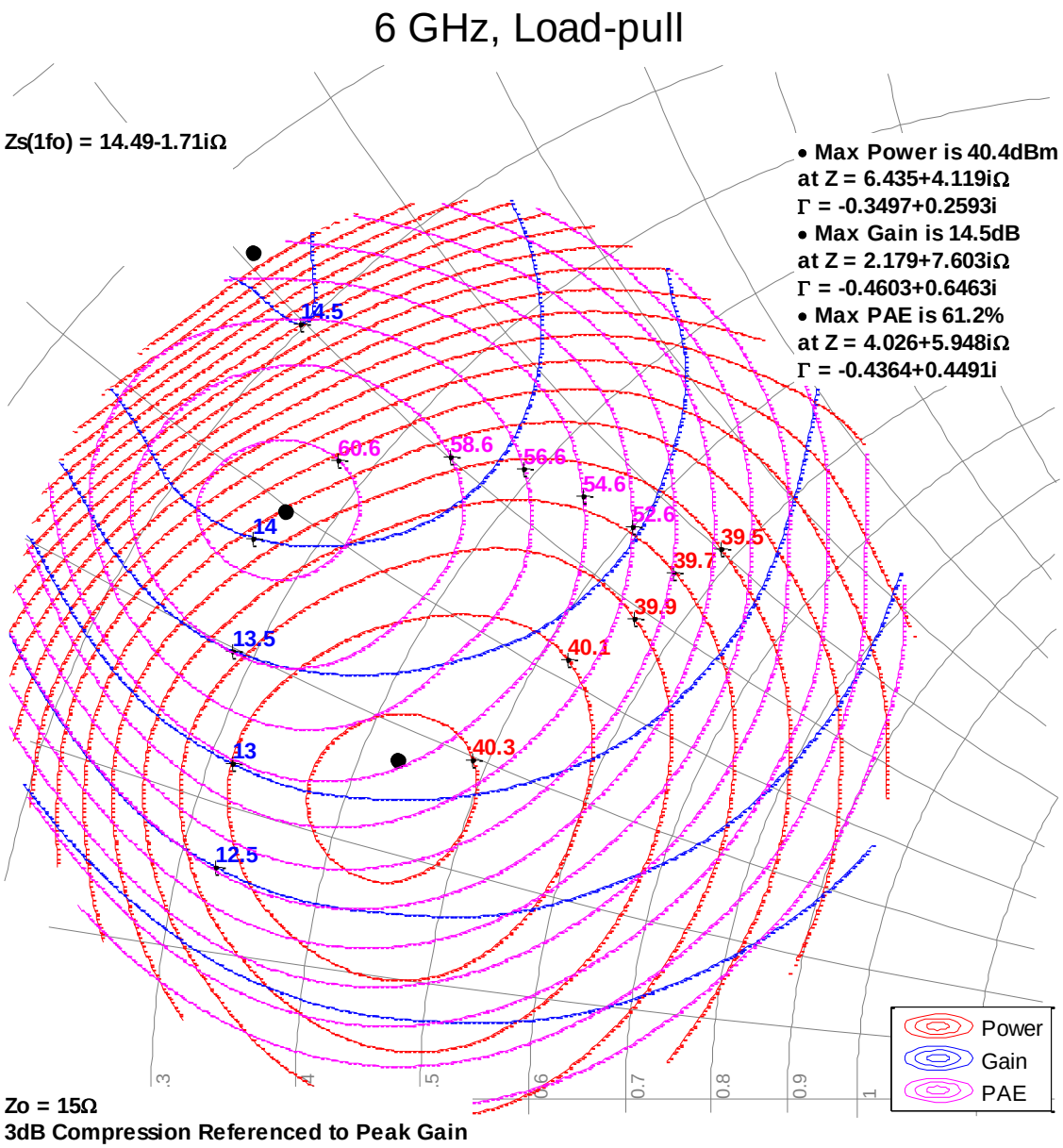



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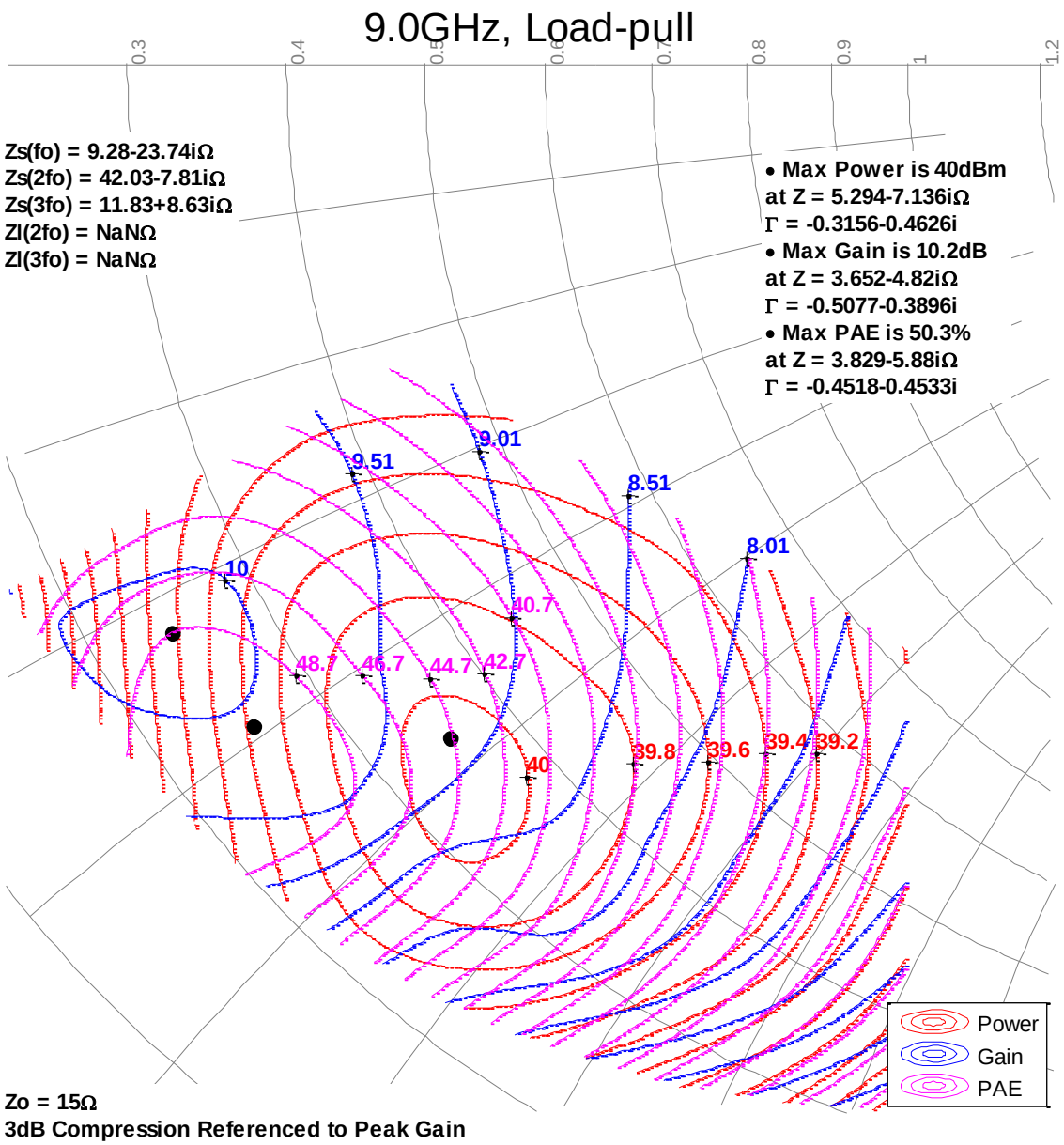



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## Load Pull Smith Charts[1, 2]

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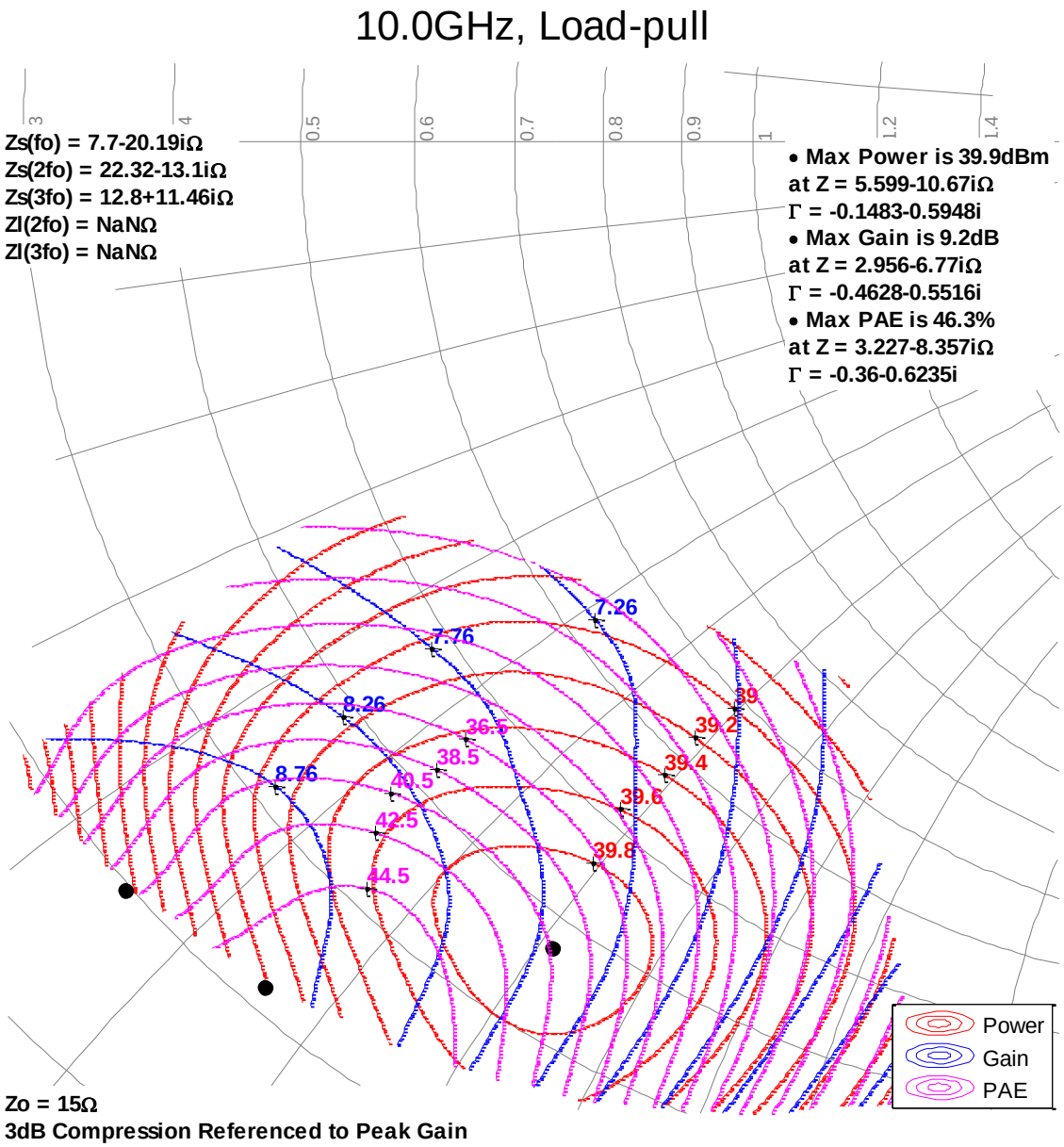



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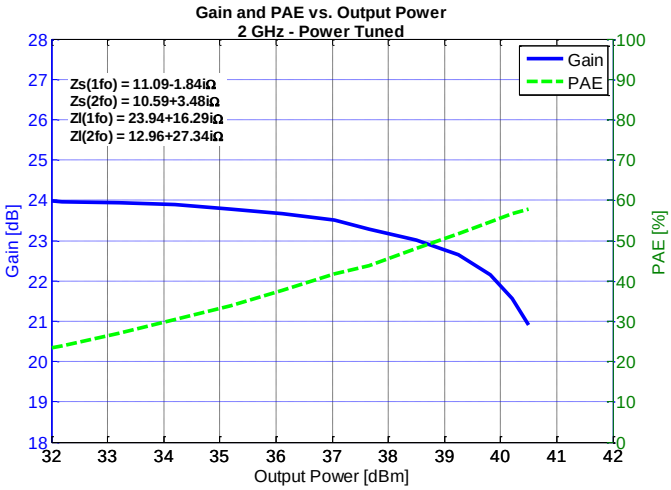
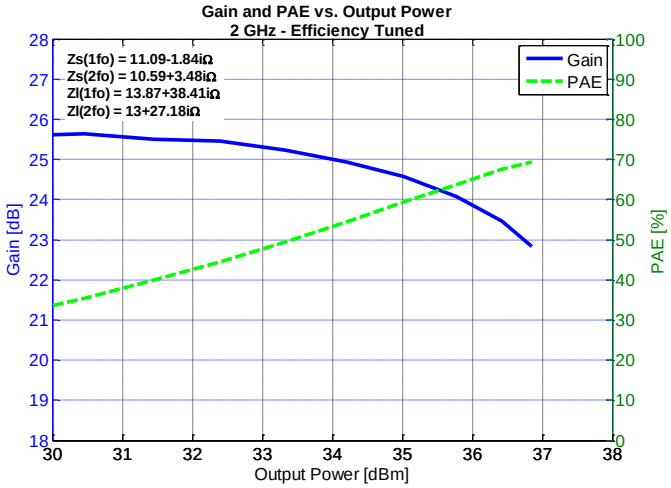
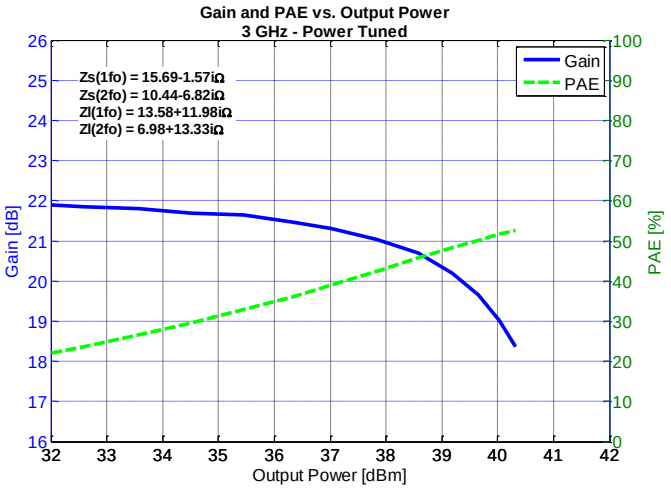
## Typical Performance – Load Pull Drive-up[1, 2]

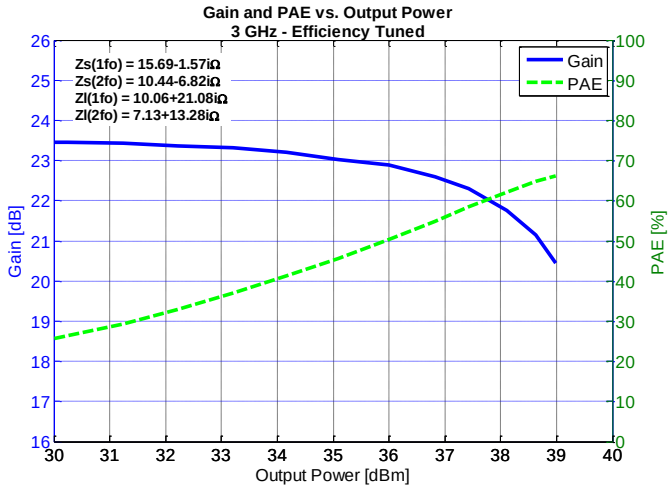
Notes:

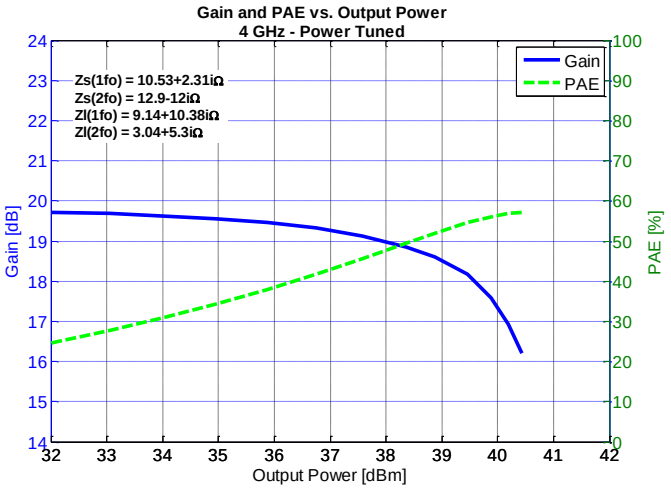
1. Pulsed signal with 100 us pulse width and 20 % duty cycle, Vd = 32 V, $I_{DQ}$ = 50 mA
2. See page 17 for load pull and source pull reference planes where the performance was measured.

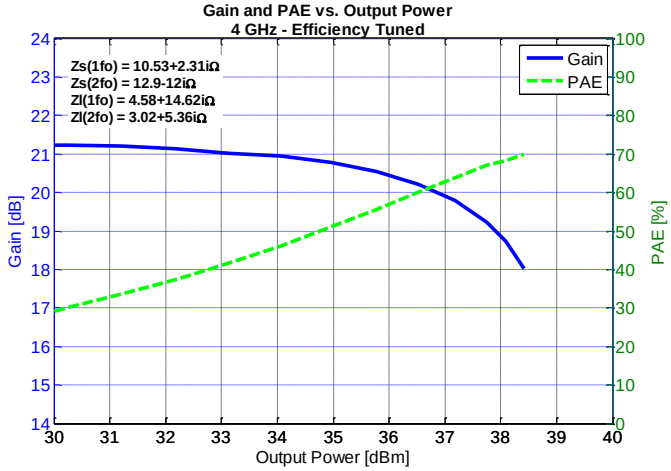




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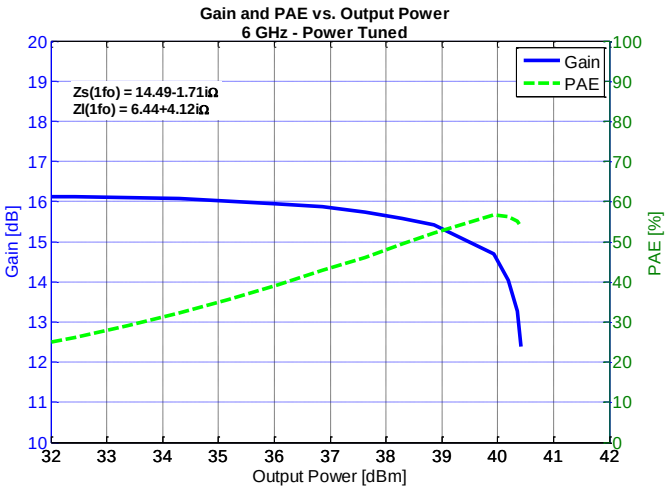
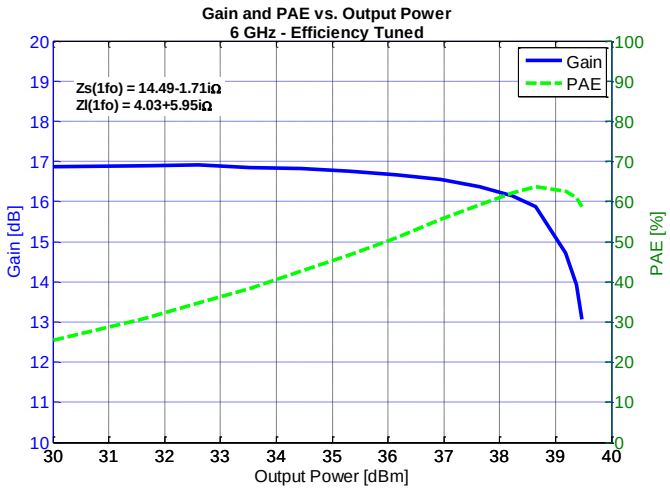
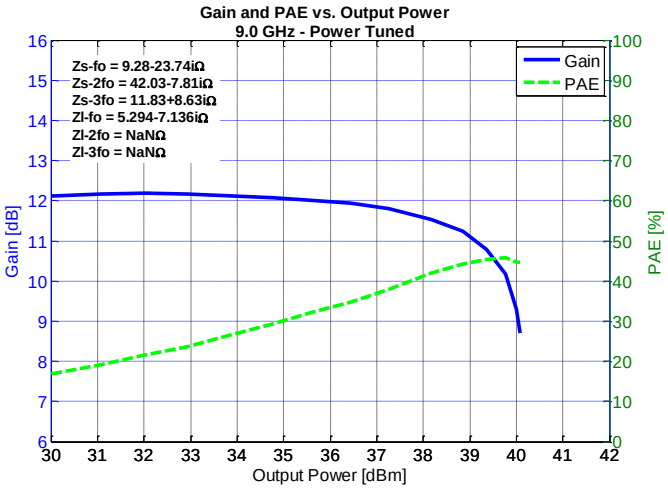
## Typical Performance – Load Pull Drive-up[1, 2]

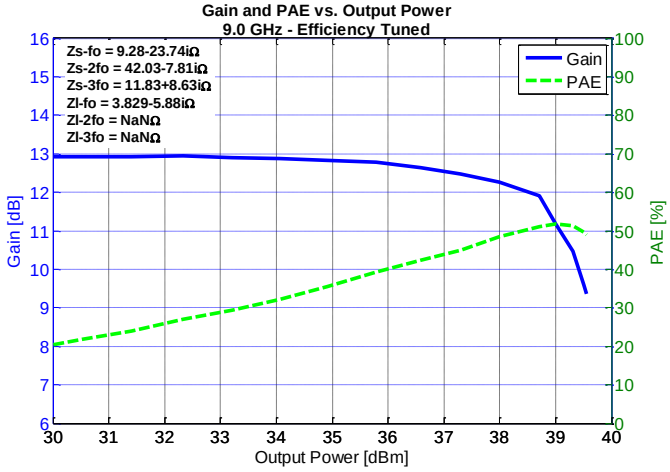
Notes:

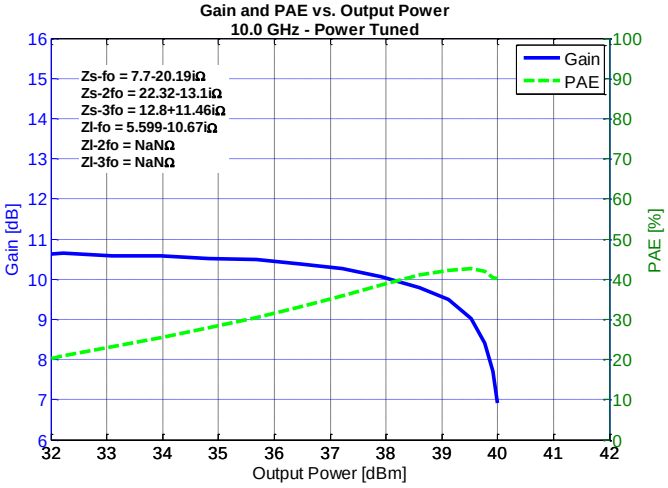
1. Pulsed signal with 100 us pulse width and 20 % duty cycle, Vd = 32 V, $I_{DQ}$ = 50 mA
2. See page 17 for load pull and source pull reference planes where the performance was measured.

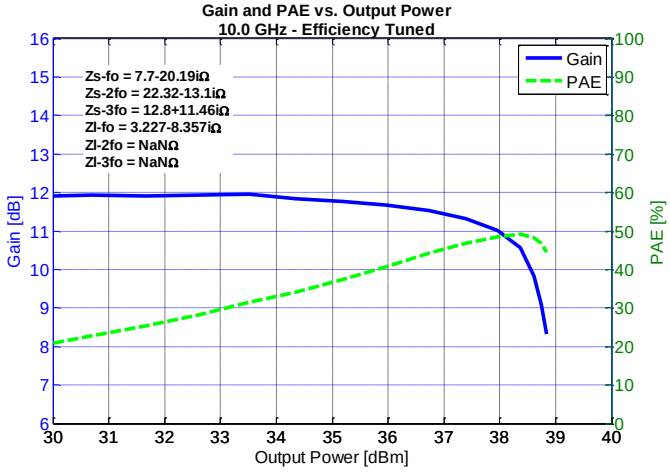




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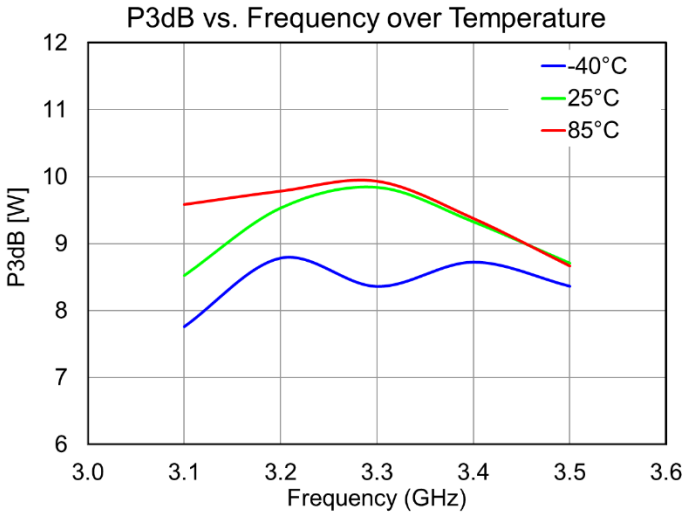
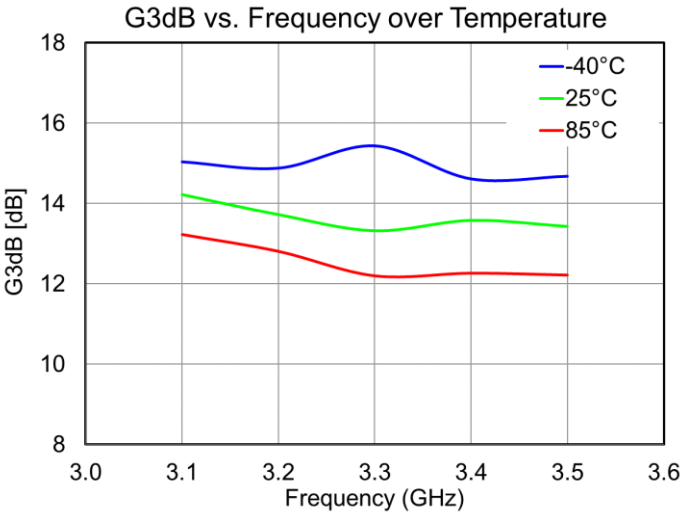
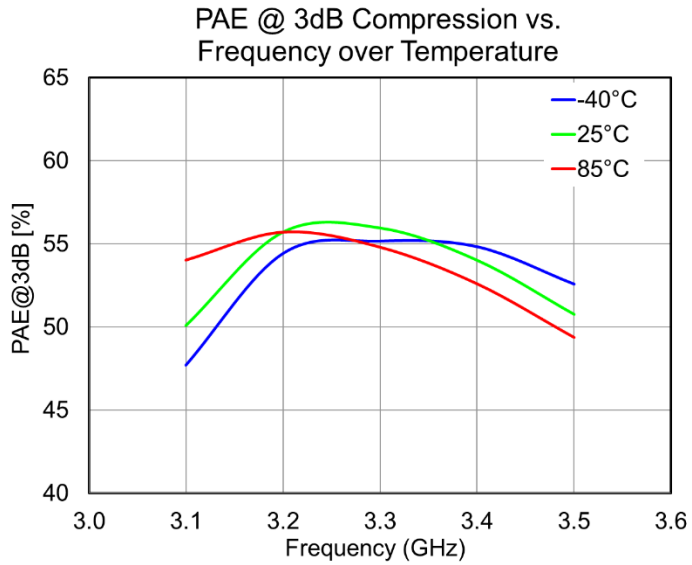
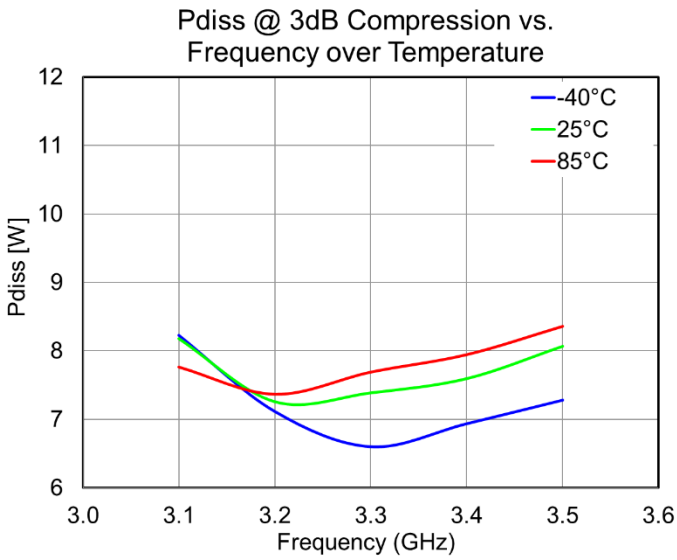
## Power Driveup Performance Over Temperatures of 3.1 – 3.5 GHz EVB[1]

Notes:
1- Vd = 32 V, $I_{DQ}$ = 50 mA, Pulse Width = 100 us, Duty Cycle = 20 %





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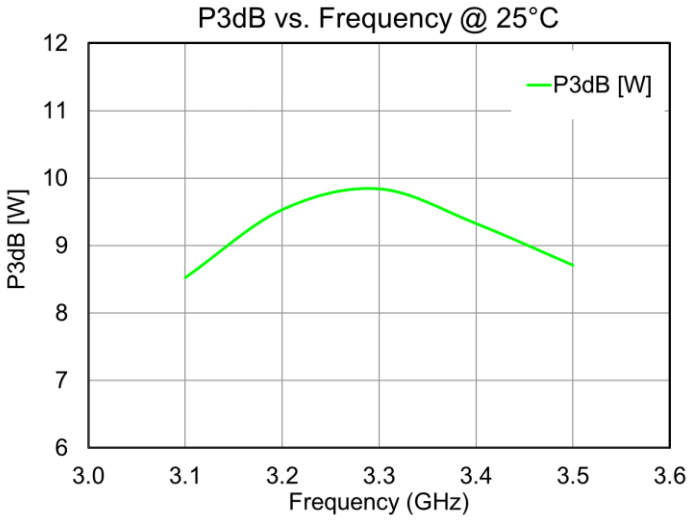
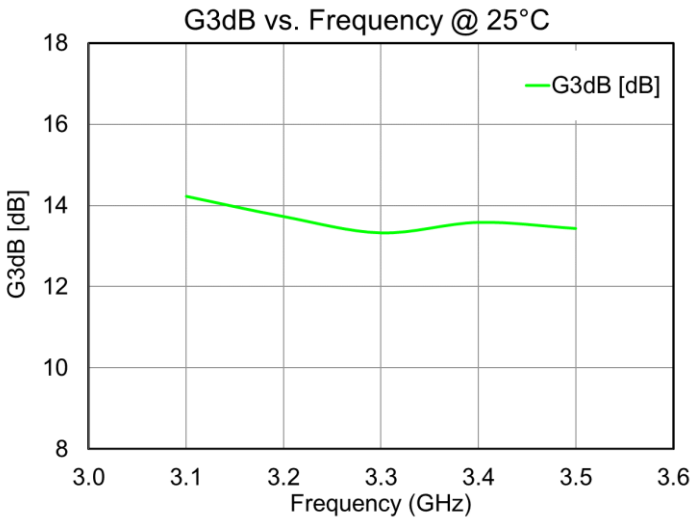
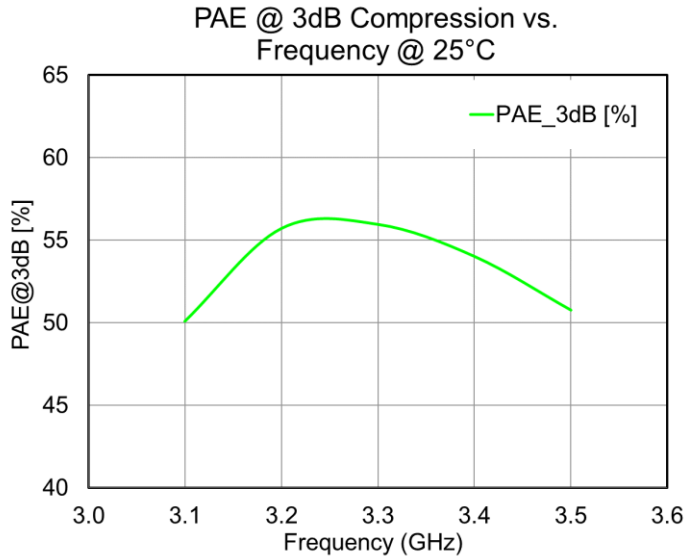
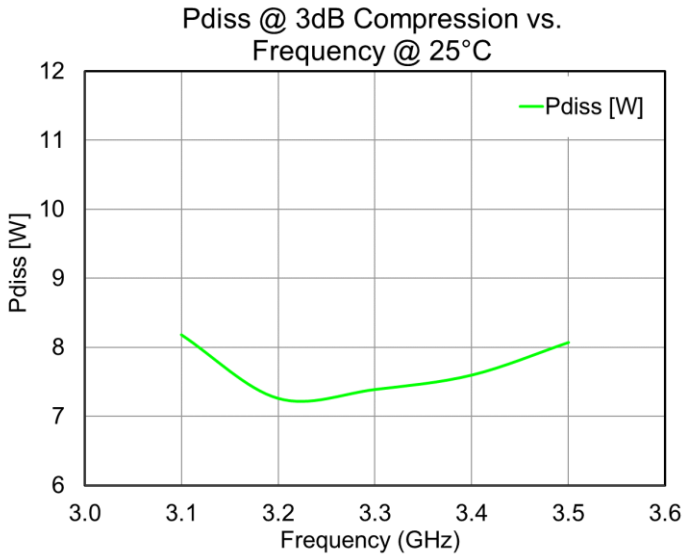
## Power Driveup Performance at 25 °C of 3.1 – 3.5 GHz EVB[1]

Notes:
1- Vd = 32 V, $I_{DQ}$ = 50 mA, Pulse Width = 100 us, Duty Cycle = 20 %





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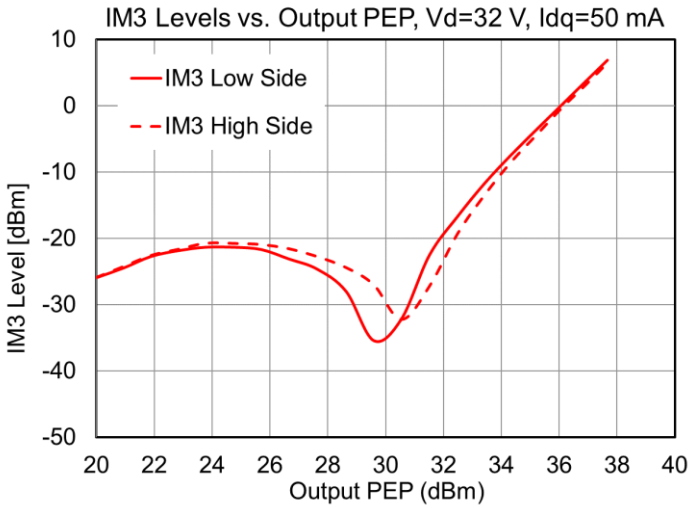
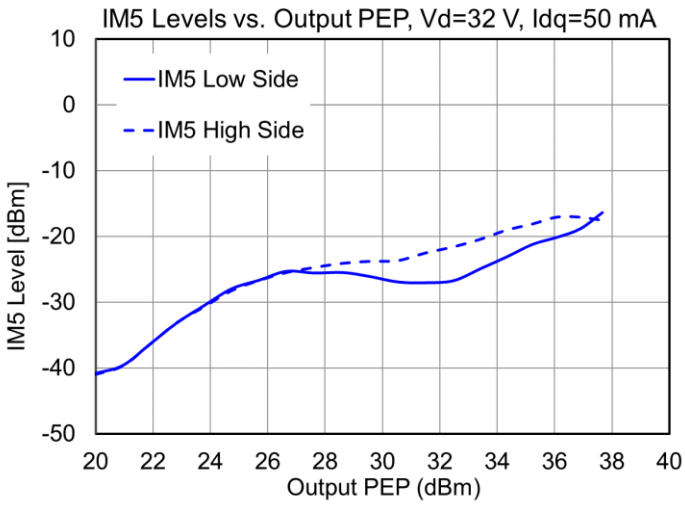
## Two-Tone Performance at 25 °C of 3.1 – 3.5 GHz EVB[1]

Notes:
1- Center Frequency = 3.3 GHz. Tone Seperation = 10 MHz.





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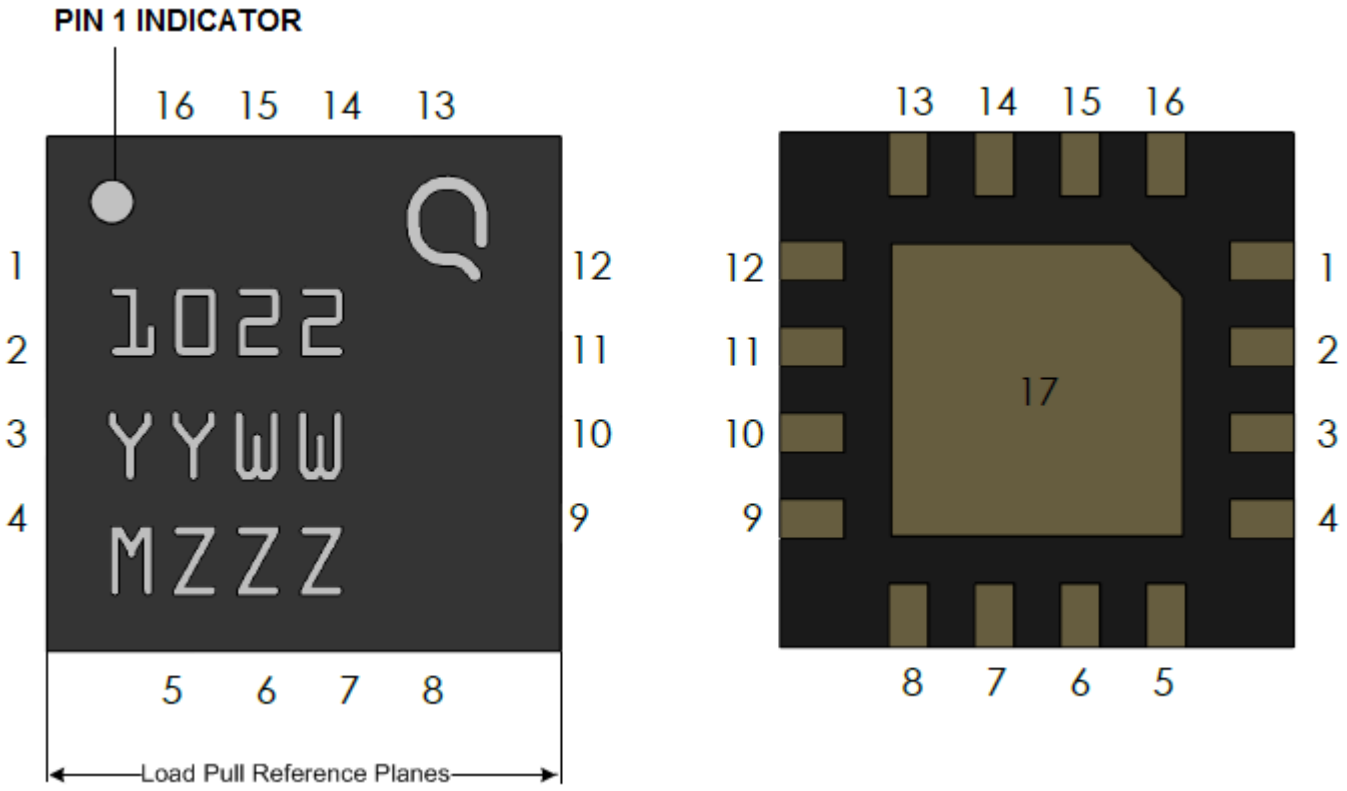
## Pin Layout[1]




Notes:
1. The QPD1022 will be marked with the “1022” designator and a lot code marked below the part designator. The “YY” represents the last two digits of the calendar year the part was manufactured, the “WW” is the work week of the assembly lot start, the “MZZZ” is the batch ID.

## Pin Description

| Pin | Symbol | Description |
|---|---|---|
| 2, 3 | VG / RF IN | Gate voltage / RF Input |
| 9 – 12 | VD / RF OUT | Drain voltage / RF Output |
| 1, 4, 5 – 8, 13 – 16 | NC | Not Connected |
| 17 | Back Plane | Source to be connected to ground |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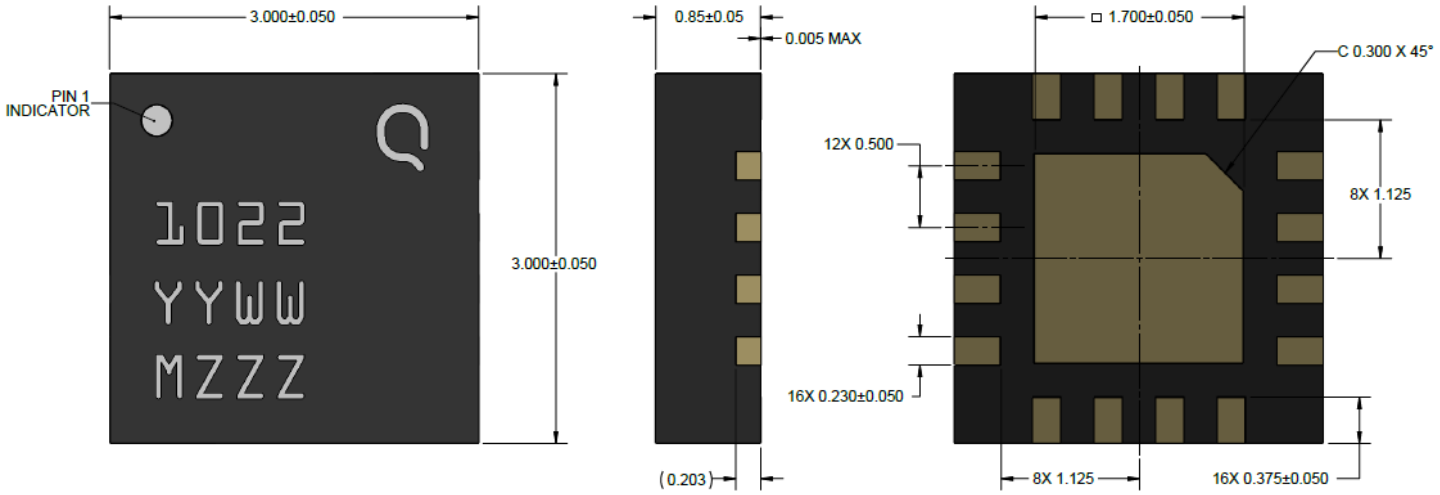
## Mechanical Drawing[1]




Notes:
1- All dimensions are in mm, otherwise noted. Tolerance is ±0.050 mm.

| Bias-up Procedure | Bias-down Procedure |
|---|---|
| 1. Set $V_G$ to -4 V. | 1. Turn off RF signal. |
| 2. Set ID current limit to 100 mA. | 2. Turn off VD |
| 3. Apply 32 V VD. | 3. Wait 2 seconds to allow drain capacitor to discharge |
| 4. Slowly adjust VG until ID is set to 50 mA. | 4. Turn off VG |
| 5. Set ID current limit to 1 A | |
| 6. Apply RF. | |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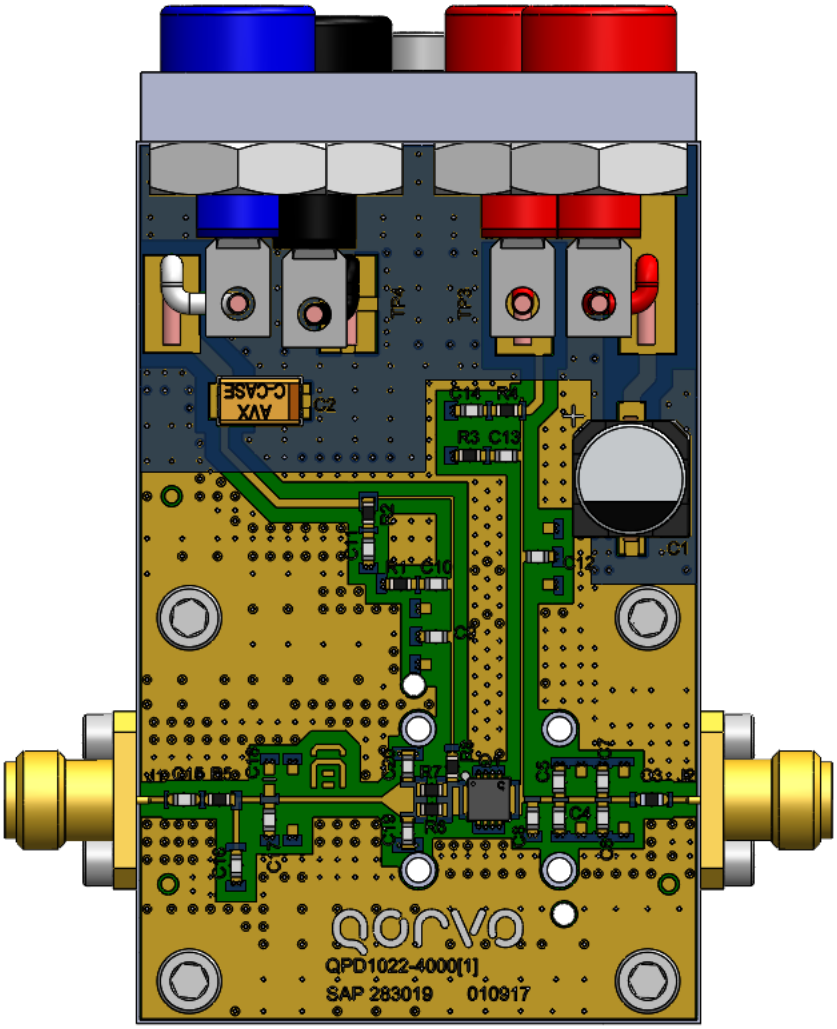
## PCB Layout – 3.1 – 3.5 GHz EVB[1]




Notes:
1- PCB Material is RO4003, 8 mil thick substrate, 1 oz. copper each side.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## Bill Of material – 3.1 – 3.5 GHz EVB

| Ref Des | Value | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| C10, C13 | 100 pF | C0G 100V 5% 0603 Capacitor | TDK | C1608C0G2E101JT080AA |
| C11, C14 | 1 nF | X7R 100V 10% 0603 Capacitor | AVX | 06031C102KAT2A |
| C6 – C8 | 1.0 pF | RF NPO 250VDC ± 0.05 pF Capacitor | ATC | 600S1R0AT250X |
| C9, C12 | 9.1 pF | RF NPO 250VDC ± 0.1 pF Capacitor | ATC | 600S9R1BT250X |
| C16 | 10 pF | RF NPO 250VDC 1% Capacitor | ATC | 600S100FT250X |
| C17 | 0.2 pF | RF NPO 250VDC ± 0.05 pF Capacitor | ATC | 600S0R3AT250X |
| C15 | 0.6 pF | RF NPO 250VDC ± 0.05 pF Capacitor | ATC | 600S0R6AT250X |
| C19 – C20 | 0.8 pF | RF NPO 250VDC ± 0.05 pF Capacitor | ATC | 600S0R8AT250X |
| C4 – C5 | 2.2 pF | RF NPO 250VDC ± 0.05 pF Capacitor | ATC | 600S2R2AT250X |
| C3 | 5.6pF | RF NPO 250VDC ± 0.1 pF Capacitor | ATC | 600S5R6BT250X |
| C1 | 33 uF | 80V 20% SVP Capacitor | Panasonic | EEEFK1K330P |
| C2 | 10 uF | 16V 10% Tantalum Capacitor | AVX | TPSC106KR0500 |
| J1 – J2 | – | SMA Panel Mount 4-hole Jack | Gigalane | PSF-S00-000 |
| R5 | 0 Ohm | 0603 5% Thick Film Resistor | ANY | – |
| R6 – R7 | 5.1 Ohm | 0603 1% Thick Film Resistor | ANY | – |
| R8 | 10 Ohm | 0603 1% Thick Film Resistor | ANY | – |
| R1 | 22 Ohm | 0603 5% Thick Film Resistor | ANY | – |
| R3 | 5.6 Ohm | 0603 5% Thick Film Resistor | ANY | – |
| R2, R4 | 33 Ohm | 0603 1% Thick Film Resistor | ANY | – |


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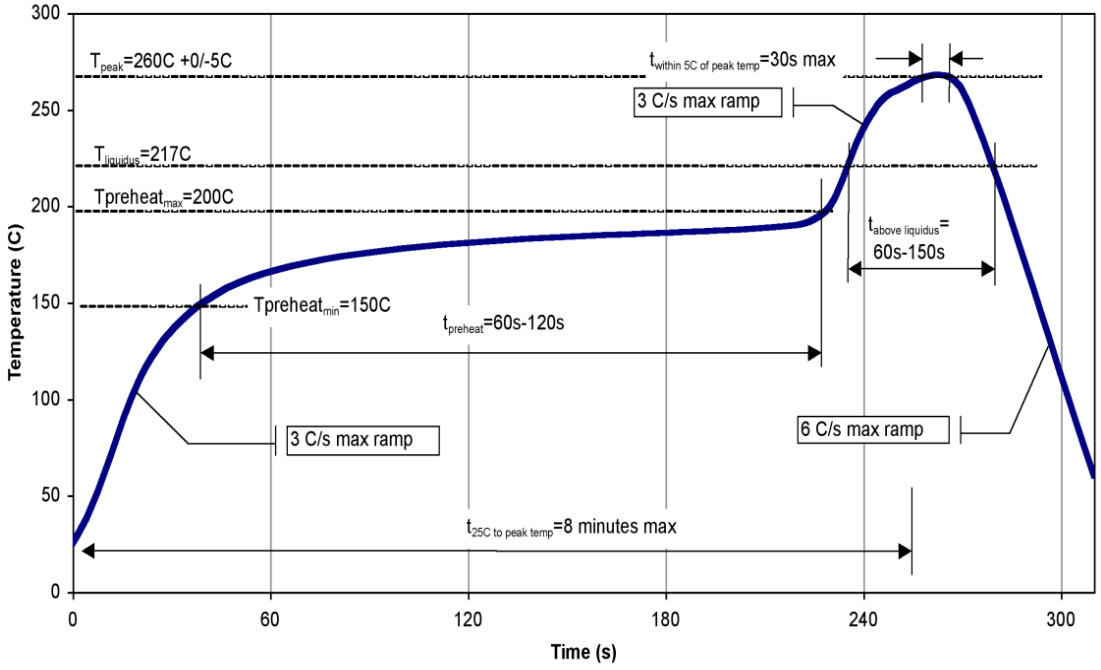
## Recommended Solder Temperature Profile





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## Handling Precautions

| Parameter | Rating | Standard |
|---|---|---|
| ESD – Human Body Model (HBM) | Class 1A | ANSI / ESDA / JEDEC JS-001 |
| ESD – Charged Device Model (CDM) | Class C3 | ANSI / ESDA / JEDEC JS-002 |
| MSL – Moisture Sensitivity Level | MSL3 | 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  Au thickness is 0.00254µm min.

## 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
- 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, and information about Qorvo:

**Web:** www.Qorvo.com  **Tel:** +1.844.890.8163
**Email:** customer.support@qorvo.com

For technical questions and application information: **Email:** info-products@qorvo.com

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