# QPD1013

## 150W, 65V, DC – 2.7 GHz, GaN RF Transistor

## General Description

The Qorvo QPD1013 is a 150 W ($P_{3dB}$) discrete GaN on SiC HEMT which operates from DC to 2.7 GHz. This is a single stage unmatched power amplifier transistor in an over-molded plastic package. The high power and wide bandwidth of the QPD1013 makes it suitable for many different applications from DC to 2.7 GHz.

The device is housed in an industry-standard 7.2 x 6.6 mm surface mount DFN package.

Lead-free and ROHS compliant

Evaluation boards are available upon request.

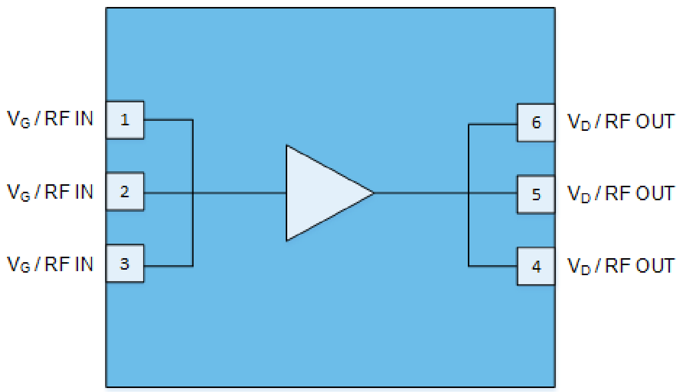

6 Pin DFN (7.2 x 6.6 x 0.9 mm)

## Product Features

- Frequency: DC to 2.7 GHz
- Output Power ($P_{3dB}$): 178 W[1]
- Linear Gain: 21.8 dB[1]
- Typical $PAE_{3dB}$: 64.8 %[1]
- Operating Voltage: 65 V
- Low thermal resistance package
- CW and Pulse capable
- 7.2 x 6.6 mm package

Note 1: @ 1.8 GHz (Loadpull)

## Functional Block Diagram




## Applications

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

## Ordering info

| Part No. | ECCN | Description |
|---|---|---|
| QPD1013S2 | EAR99 | 2 Piece Sample Bag |
| QPD1013SQ | EAR99 | 25 Piece Sample Bag |
| QPD1013SR | EAR99 | 100 Piece 7" Reel |
| QPD1013EVB01 | EAR99 | 1.2 – 1.9 GHz EVB |

## Absolute Maximum Ratings[2]

| Parameter | Rating | Units |
|---|---|---|
| Breakdown Voltage, $BV_{DG}$ | 225 | V |
| Gate Voltage Range, $V_G$ | -8 to +2 | V |
| Drain Current, $I_D$ | 9 | A |
| Gate Current Range, $I_G$[1] | 19.2 | mA |
| Power Dissipation, CW, $P_{DISS}$ | 74 | W |
| RF Input Power at 1.6 GHz, CW, 50 Ω, T = 25 °C | +39 | dBm |
| Channel Temperature, $T_{CH}$ | 275 | °C |
| Mounting Temperature (30 Seconds) | 320 | °C |
| Storage Temperature | −65 to +150 | °C |

Notes:
1. At Channel temperature of 200°C.
2. Operation of this device outside the parameter ranges given above may cause permanent damage.

## Recommended Operating Conditions[1]

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Operating Temp. Range | −40 | +25 | +85 | °C |
| Drain Voltage Range, $V_D$ | – | +65 | +70 | V |
| Drain Bias Current, $I_{DQ}$ | – | 240 | – | mA |
| Drain Current, $I_D$ | – | 1.7 | – | A |
| Gate Voltage, $V_G$[4] | – | −2.8 | – | V |
| Channel Temperature ($T_{CH}$) | – | – | 250 | °C |
| Power Dissipation, CW ($P_D$)[2] | – | – | 67.0 | W |
| Power Dissipation, Pulsed ($P_D$)[2, 3] | – | – | 120.0 | 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 = 10%
4. To be adjusted to desired $I_{DQ}$

## Pulsed Characterization – Load Pull Performance – Power Tuned – 65 V[1]

| Parameters | Typical Values | | | | | Unit |
|---|---|---|---|---|---|---|
| Frequency, F | 1.2 | 1.5 | 1.8 | 2.3 | 2.7 | GHz |
| Linear Gain, $G_{LIN}$ | 23.7 | 22.3 | 20.3 | 18.1 | 15.2 | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | 52.7 | 52.5 | 52.5 | 52.3 | 52.1 | dBm |
| Power-Added-Efficiency at 3dB compression point, $PAE_{3dB}$ | 61.5 | 58.1 | 53.7 | 51.1 | 43.2 | % |
| Gain at 3dB compression point | 20.7 | 19.3 | 17.3 | 15.1 | 12.2 | dB |

Notes:
1. Test conditions unless otherwise noted: $V_D$ = +65 V, $I_{DQ}$ = 240 mA, Temp = +25 °C

## Pulsed Characterization – Load Pull Performance – Efficiency Tuned – 65 V[1]

| Parameters | Typical Values | | | | | Unit |
|---|---|---|---|---|---|---|
| Frequency | 1.2 | 1.5 | 1.8 | 2.3 | 2.7 | GHz |
| Linear Gain, $G_{LIN}$ | 25.3 | 23.7 | 21.8 | 19.3 | 16.8 | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | 50.6 | 50.2 | 51.1 | 51.1 | 50.9 | dBm |
| Power-Added-Efficiency at 3dB compression point, $PAE_{3dB}$ | 70.9 | 69.4 | 64.8 | 57.5 | 52.3 | % |
| Gain at 3dB compression point | 22.3 | 20.7 | 18.8 | 16.3 | 13.8 | dB |

Notes:
1- Test conditions unless otherwise noted: $V_D$ = +65 V, $I_{DQ}$ = 240 mA, Temp = +25 °C

## Pulsed Characterization – Load Pull Performance – Power Tuned – 50 V[1]

| Parameters | Typical Values | | | | Unit |
|---|---|---|---|---|---|
| Frequency, F | 1.2 | 1.5 | 1.8 | 2.7 | GHz |
| Linear Gain, $G_{LIN}$ | 22.5 | 21.9 | 19.7 | 15.2 | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | 51.5 | 51.5 | 51.6 | 51.4 | dBm |
| Power-Added-Efficiency at 3dB compression point, $PAE_{3dB}$ | 62.8 | 56.8 | 50.5 | 50.9 | % |
| Gain at 3dB compression point | 19.5 | 18.9 | 16.7 | 12.2 | dB |

Notes:
1. Test conditions unless otherwise noted: $V_D$ = +50 V, $I_{DQ}$ = 240 mA, Temp = +25 °C

## Pulsed Characterization – Load Pull Performance – Efficiency Tuned – 50 V[1]

| Parameters | Typical Values | | | | Unit |
|---|---|---|---|---|---|
| Frequency, F | 1.2 | 1.5 | 1.8 | 2.7 | GHz |
| Linear Gain, $G_{LIN}$ | 23.7 | 23.3 | 21.0 | 16.2 | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | 49.9 | 50.4 | 49.6 | 50.8 | dBm |
| Power-Added-Efficiency at 3dB compression point, $PAE_{3dB}$ | 73.1 | 67.7 | 64.6 | 58.1 | % |
| Gain at 3dB compression point | 20.7 | 20.3 | 18.0 | 13.2 | dB |

Notes:
1. Test conditions unless otherwise noted: $V_D$ = +50 V, $I_{DQ}$ = 240 mA, Temp = +25 °C

## RF Characterization – 1.2 – 1.9 GHz EVB Performance At 1.6 GHz[1]

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Linear Gain, $G_{LIN}$ | – | 16.6 | – | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | – | 51.9 | – | dBm |
| Drain Efficiency at 3dB compression point, $DEFF_{3dB}$ | – | 55.3 | – | % |
| Gain at 3dB compression point, $G_{3dB}$ | – | 13.6 | – | dB |

Notes:

1. $V_D$ = +65 V, $I_{DQ}$ = 240 mA, Temp = +25 °C, Pulse Width = 100 us, Duty Cycle = 10%

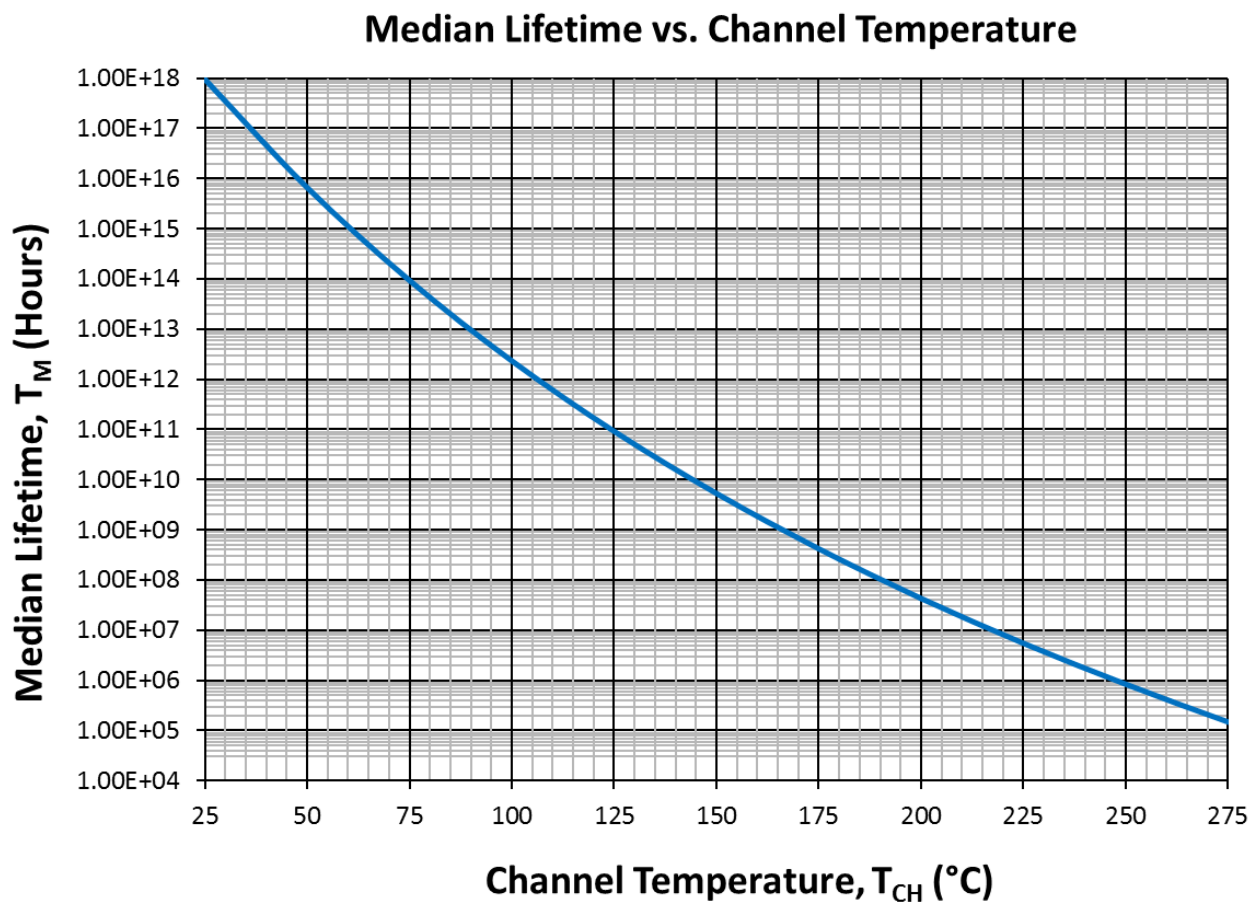
## RF Characterization – Mismatch Ruggedness at 1.6 GHz[1,2]

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

Notes:

1- Test conditions unless otherwise noted: $T_A$ = 25 °C, $V_D$ = 65 V, $I_{DQ}$ = 240 mA
2- Driving input power is determined at pulsed compression under matched condition at EVB output connector.

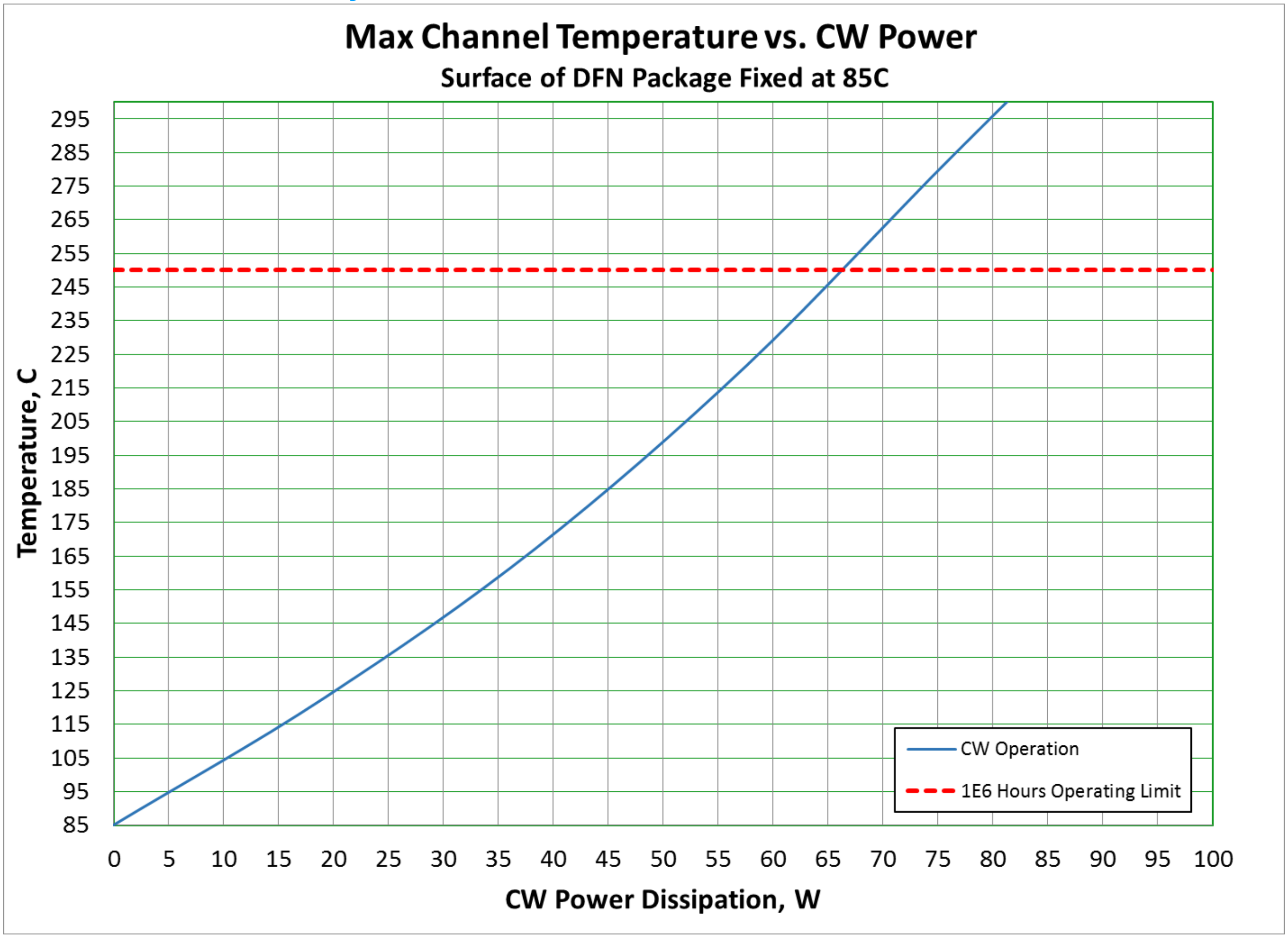
## Median Lifetime[1]




Notes:

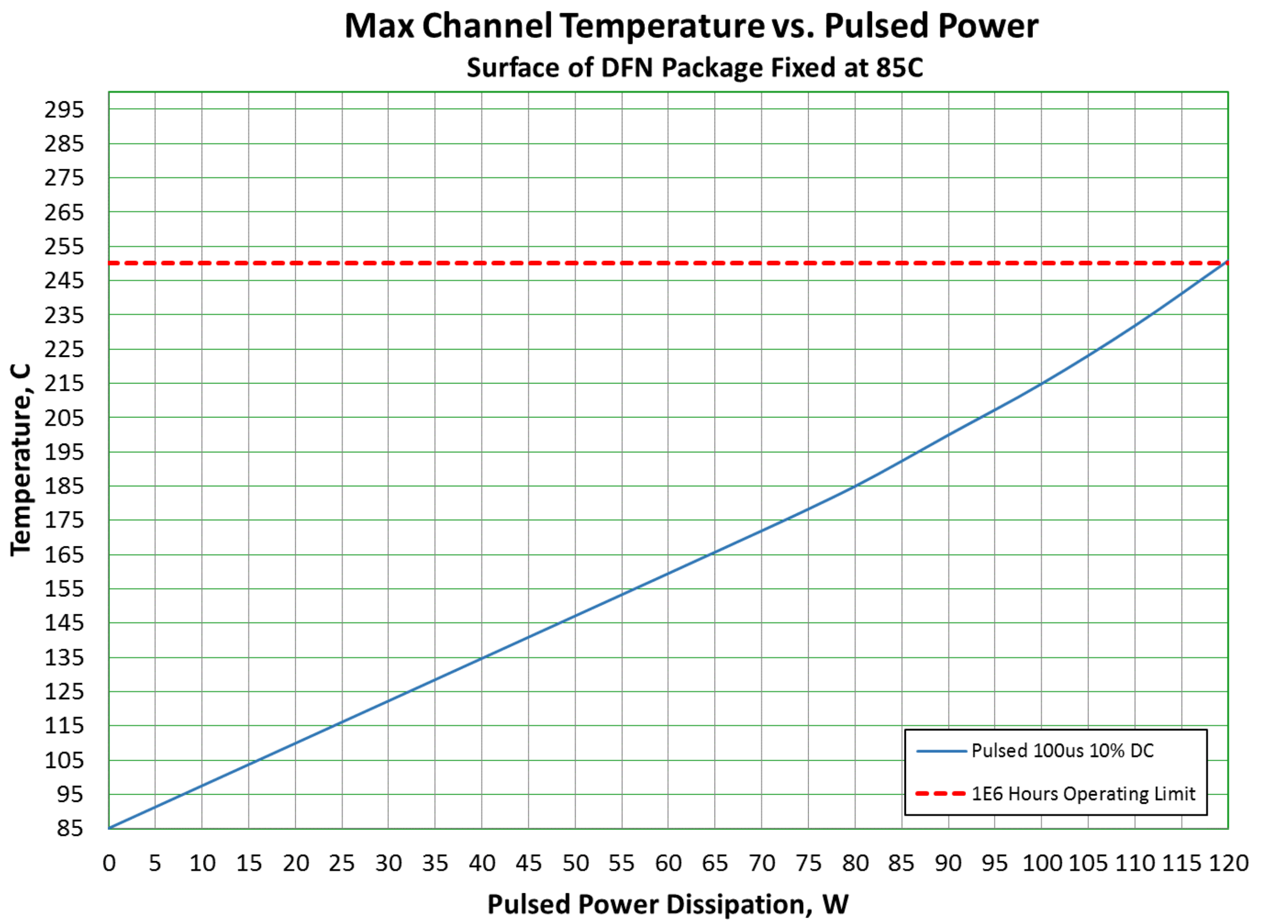
1- For pulsed signals, average lifetime is average lifetime at maximum channel temperature divided by duty cycle.

## Thermal and Reliability Information - CW




| Parameter | Conditions | Values | Units |
|---|---|---|---|
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>19.2 W Pdiss, CW | 2.0 | °C/W |
| Maximum Channel Temperature ($T_{CH}$) | | 124 | °C |
| Median Lifetime ($T_M$) | | 9.0E10 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>38.4 W Pdiss, CW | 2.2 | °C/W |
| Maximum Channel Temperature ($T_{CH}$) | | 168 | °C |
| Median Lifetime ($T_M$) | | 7.0E8 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>57.6 W Pdiss, CW | 2.4 | °C/W |
| Maximum Channel Temperature ($T_{CH}$) | | 222 | °C |
| Median Lifetime ($T_M$) | | 7.0E6 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>76.8 W Pdiss, CW | 2.6 | °C/W |
| Maximum Channel Temperature ($T_{CH}$) | | 285 | °C |
| Median Lifetime ($T_M$) | | 7.0E4 | Hrs |

## Thermal and Reliability Information - Pulsed

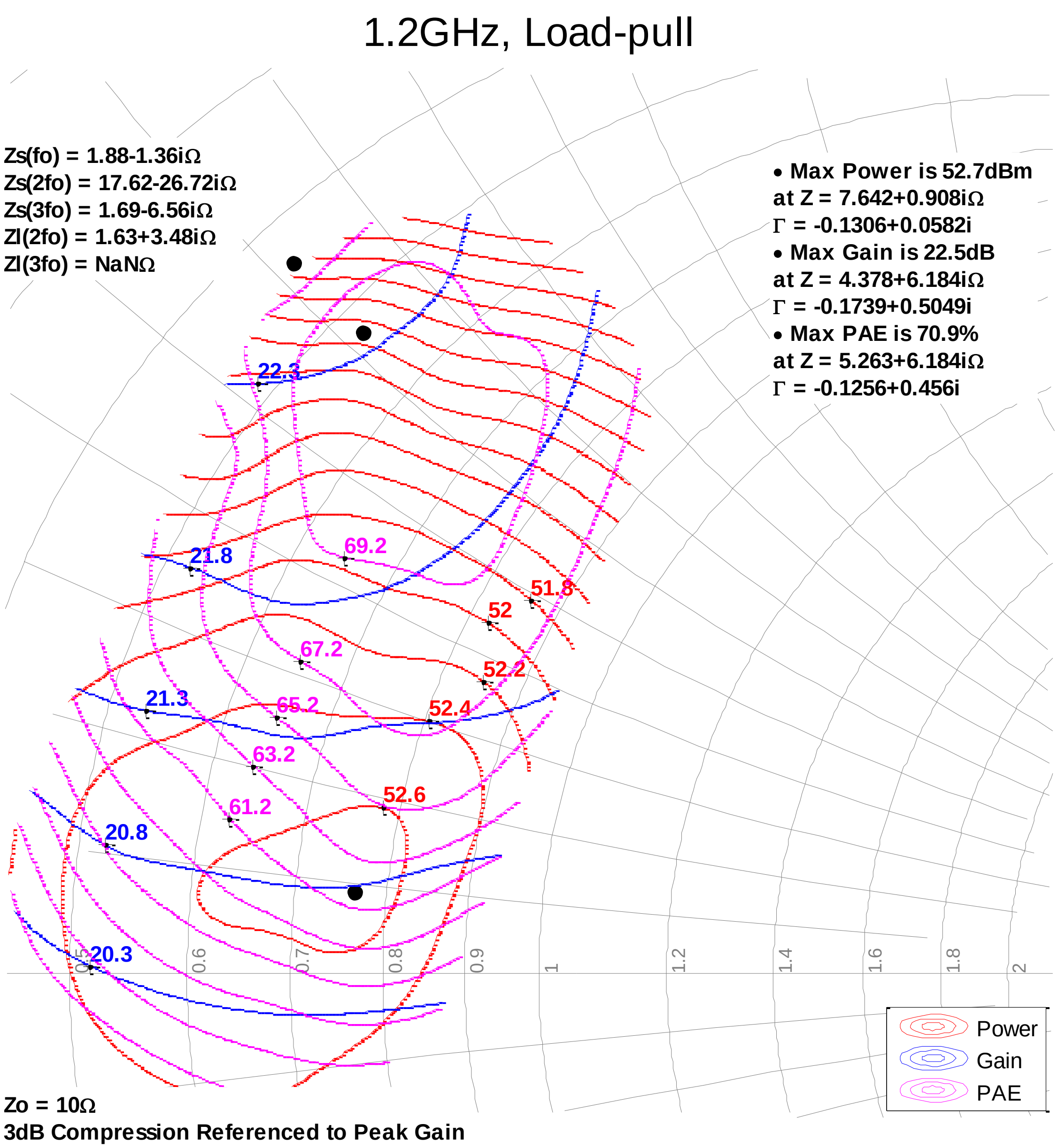



| Parameter | Conditions | Values | Units |
|---|---|---|---|
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>90 W Pdiss, Pulsed 100us 10% DC | 2.0 | °C/W |
| Maximum Channel Temperature ($T_{CH}$) | | 200 | °C |
| Median Lifetime ($T_M$) | | 4.0E8 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>100 W Pdiss, Pulsed 100us 10% DC | 1.7 | °C/W |
| Maximum Channel Temperature ($T_{CH}$) | | 215 | °C |
| Median Lifetime ($T_M$) | | 1.0E8 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>110 W Pdiss, Pulsed 100us 10% DC | 1.5 | °C/W |
| Maximum Channel Temperature ($T_{CH}$) | | 232 | °C |
| Median Lifetime ($T_M$) | | 3.0E7 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>120 W Pdiss, Pulsed 100us 10% DC | 1.4 | °C/W |
| Maximum Channel Temperature ($T_{CH}$) | | 251 | °C |
| Median Lifetime ($T_M$) | | 8.0E6 | Hrs |

## Load Pull Smith Charts[1, 2]

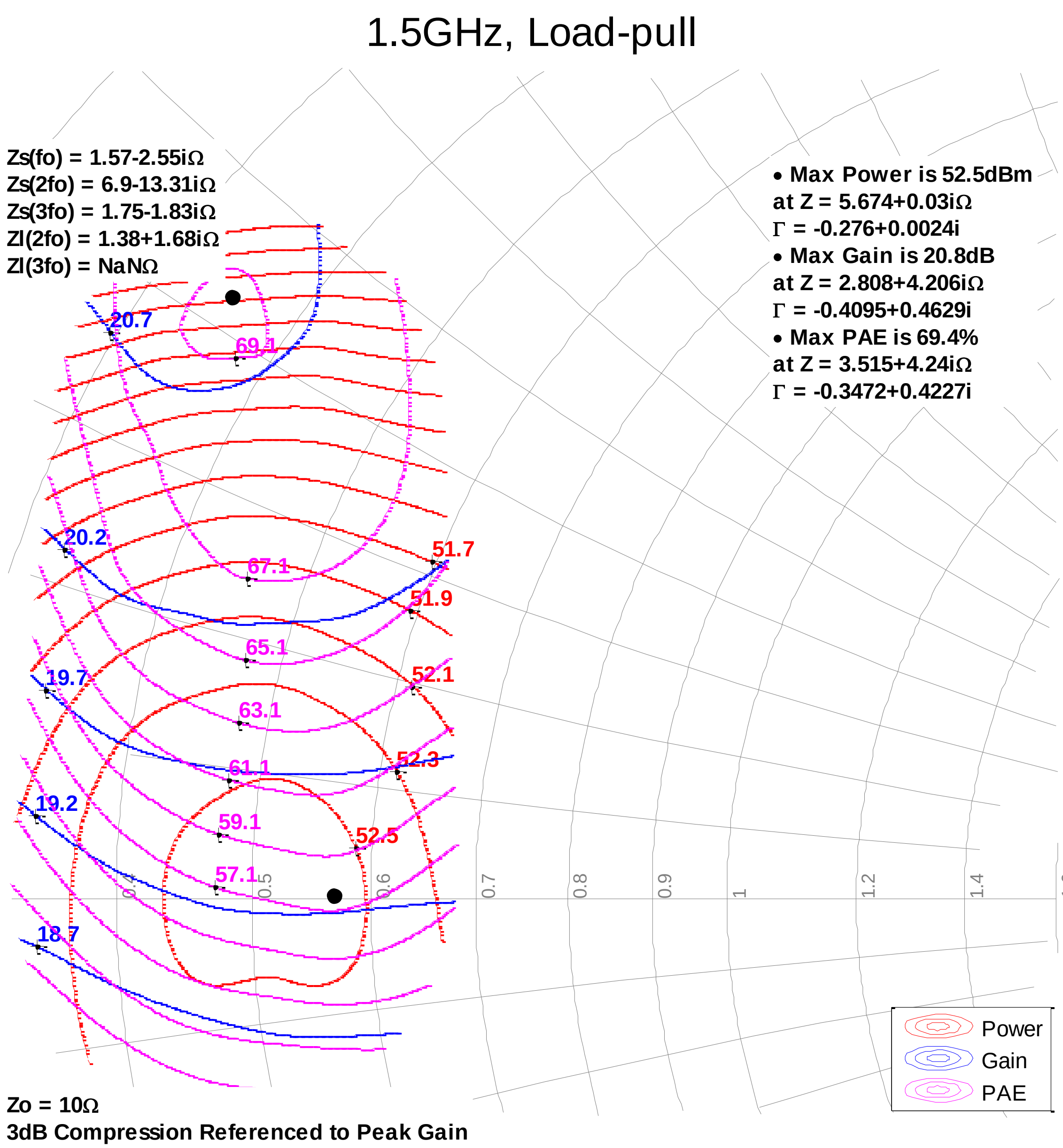
Notes:

1. Vd = 65 V, $I_{DQ}$ = 240 mA, Pulsed signal with 100 us pulse width and 10 % duty cycle.
2. See page 20 for load pull and source pull reference planes.



## Load Pull Smith Charts[1, 2]

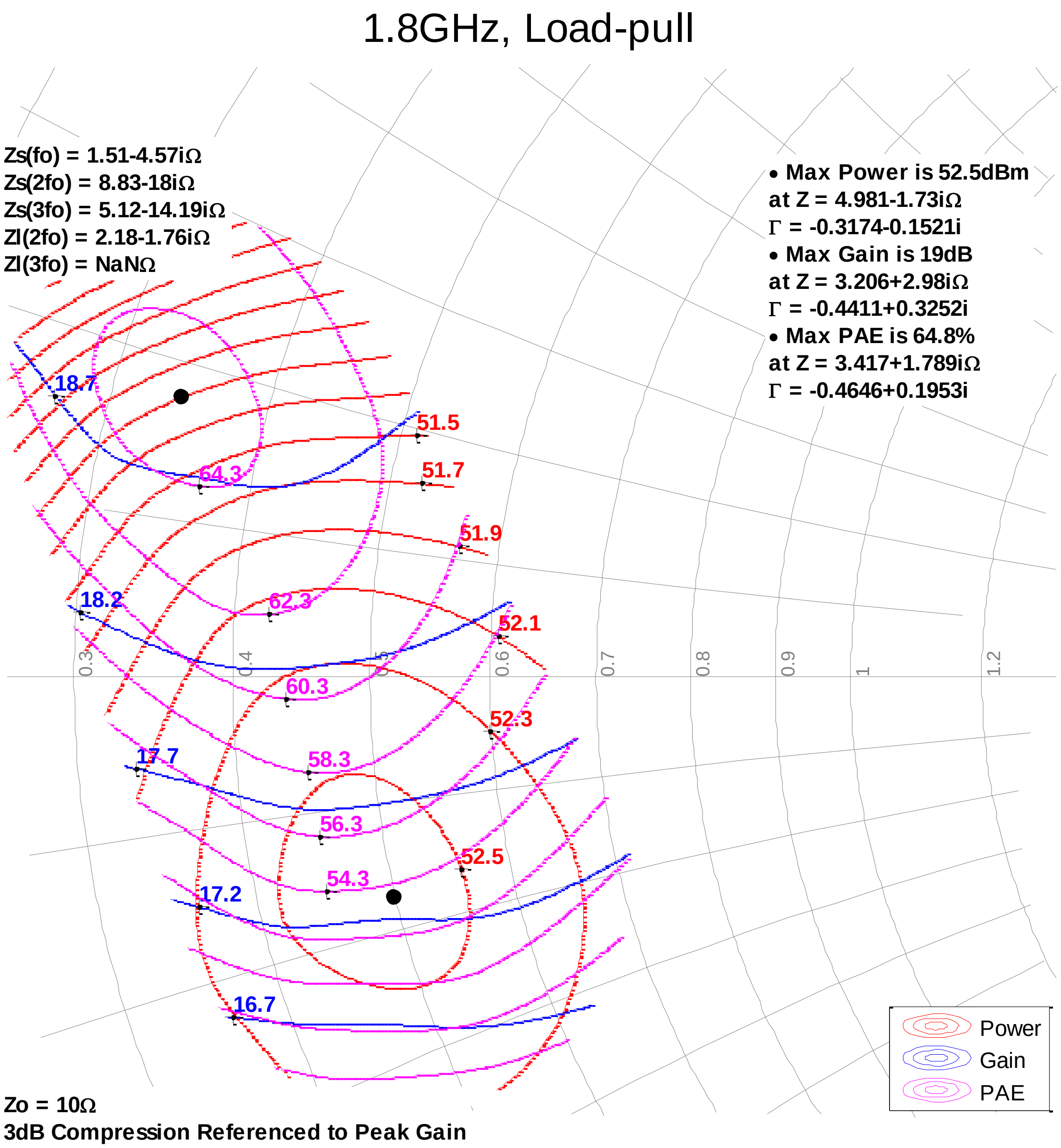
Notes:
1. Vd = 65 V, $I_{DQ}$ = 240 mA, Pulsed signal with 100 us pulse width and 10 % duty cycle.
2. See page 20 for load pull and source pull reference planes.



## Load Pull Smith Charts[1, 2]

Notes:

1. Vd = 65 V, $I_{DQ}$ = 240 mA, Pulsed signal with 100 us pulse width and 10 % duty cycle.
2. See page 20 for load pull and source pull reference planes.

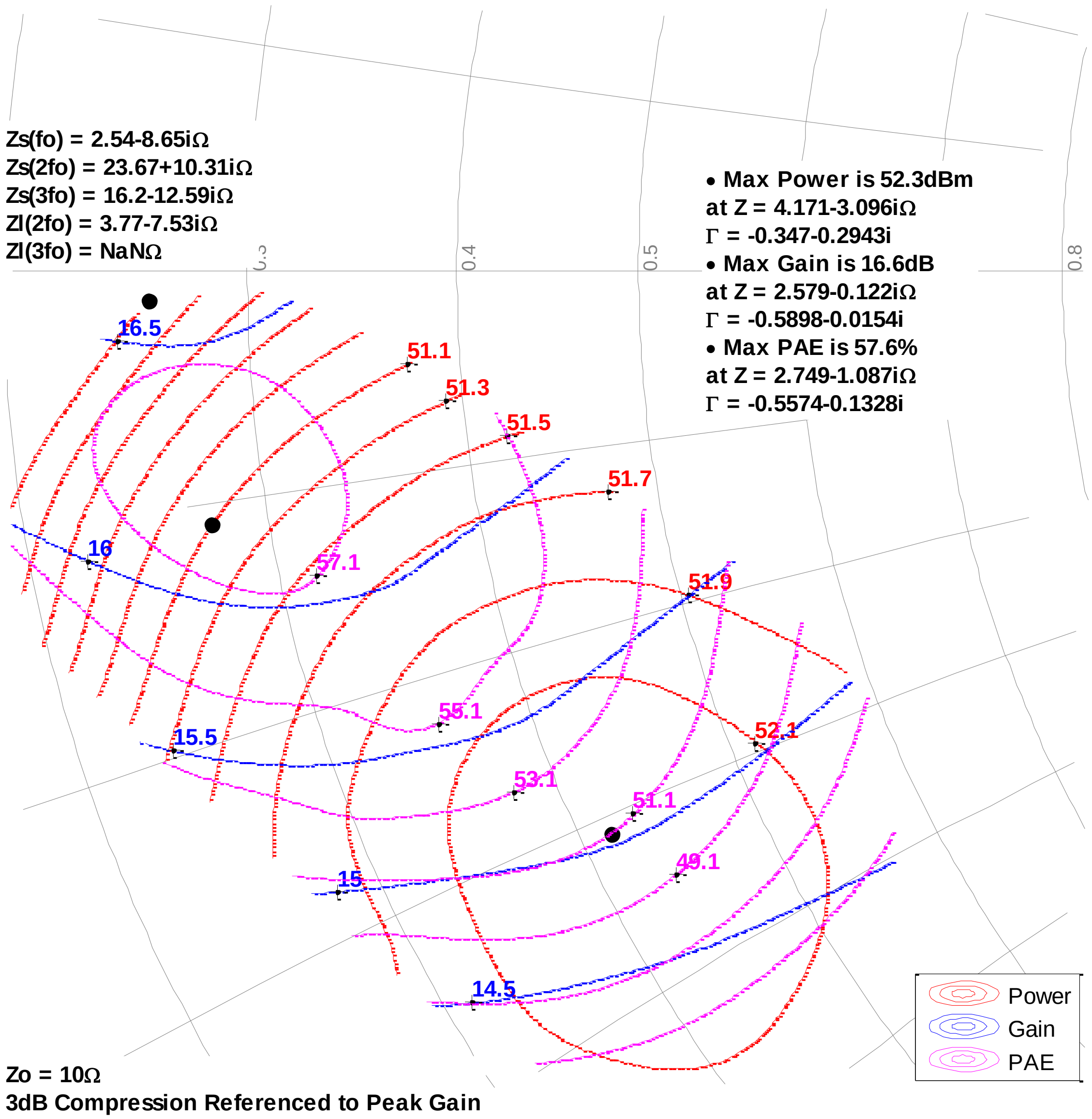


## Load Pull Smith Charts[1, 2]

Notes:

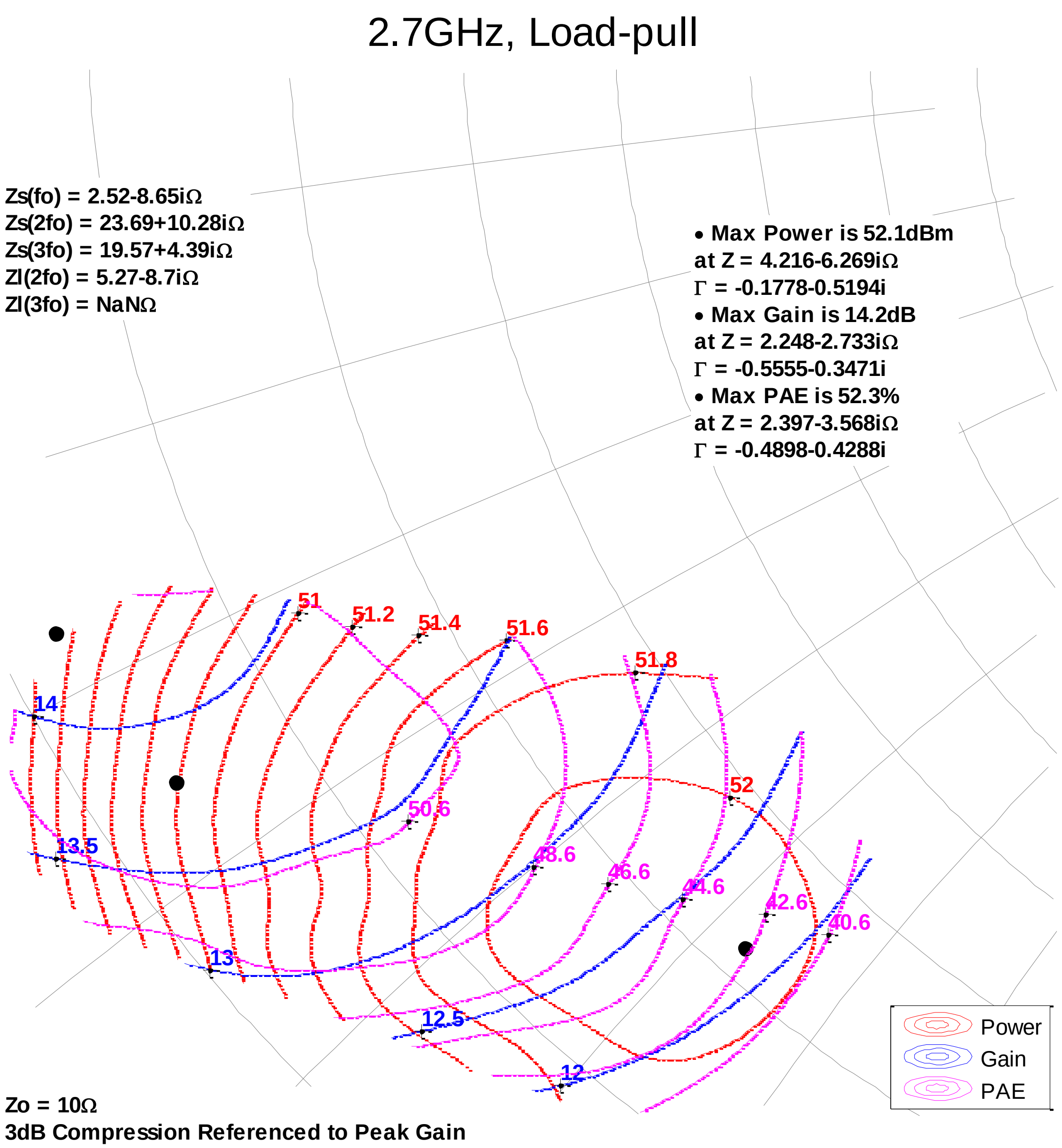
1. Vd = 65 V, $I_{DQ}$ = 240 mA, Pulsed signal with 100 us pulse width and 10 % duty cycle.
2. See page 20 for load pull and source pull reference planes.

2.3GHz, Load-pull



## Load Pull Smith Charts[1, 2]

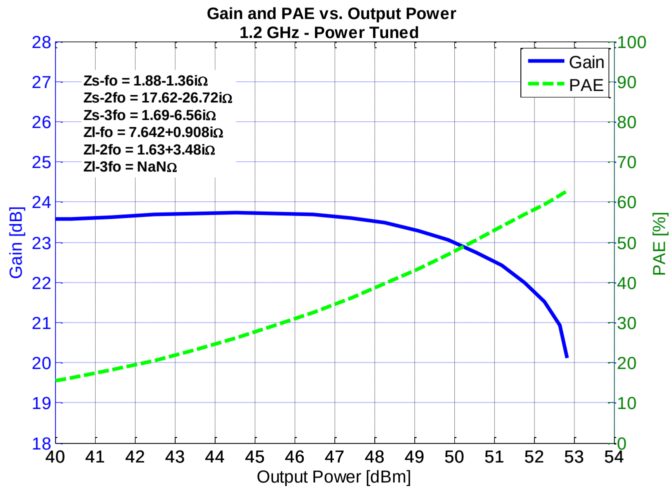
Notes:
1. Vd = 65 V, $I_{DQ}$ = 240 mA, Pulsed signal with 100 us pulse width and 10 % duty cycle.
2. See page 20 for load pull and source pull reference planes.

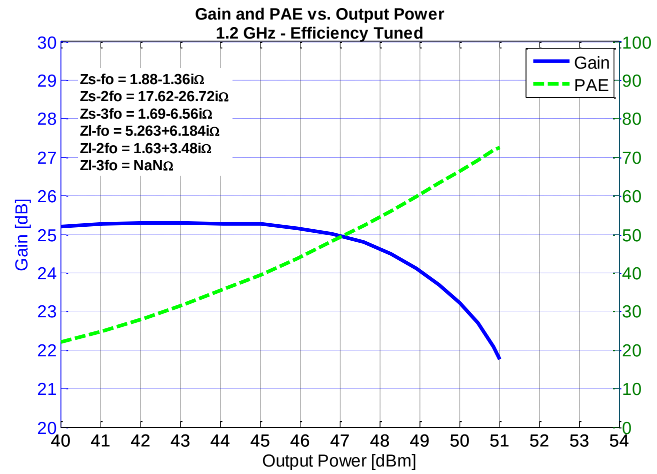


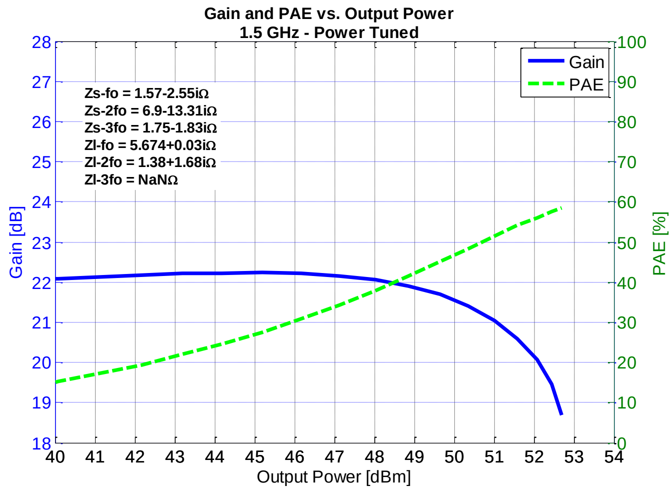
## Typical Performance – Load Pull Drive-up

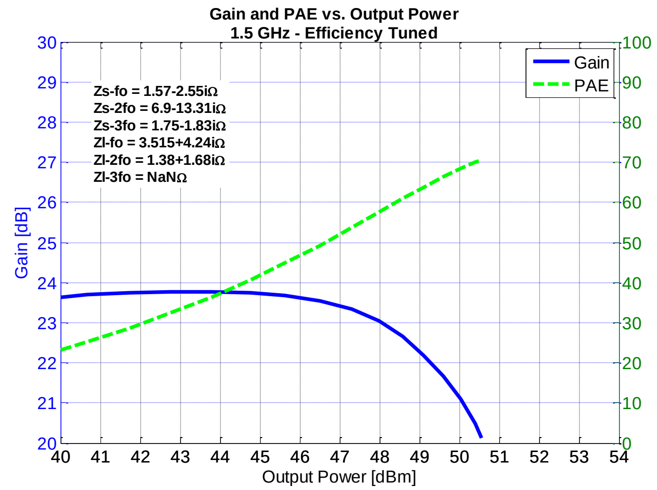
Notes:

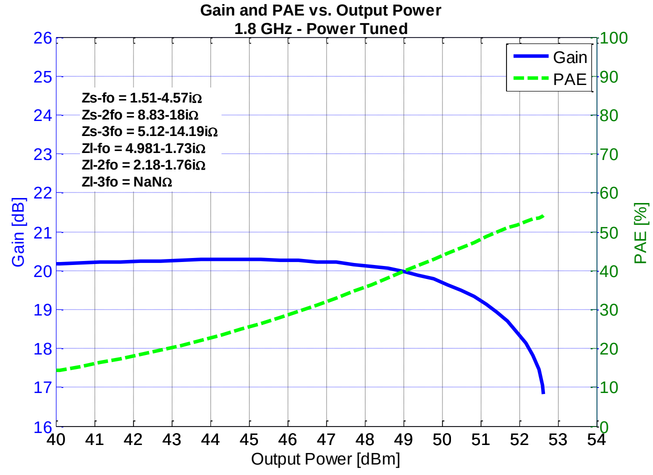
1. Pulsed signal with 100 us pulse width and 10 % duty cycle, Vd = 65 V, $I_{DQ}$ = 240 mA
2. See page 20 for load pull and source pull reference planes where the performance was measured.

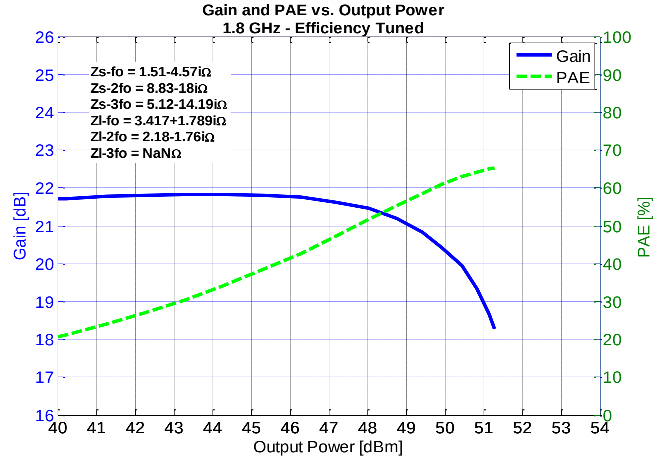


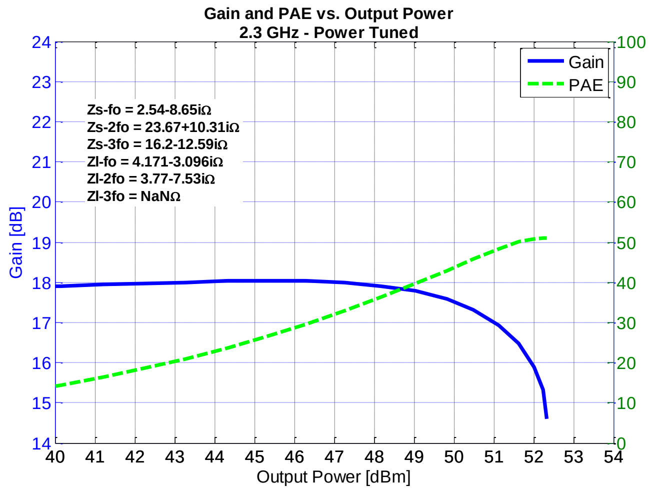



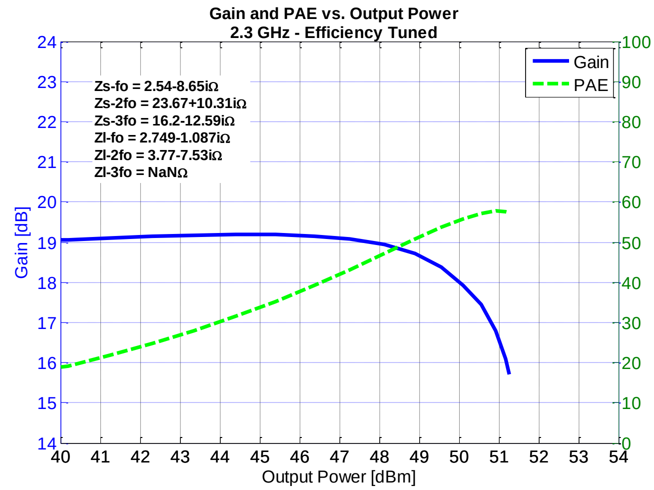



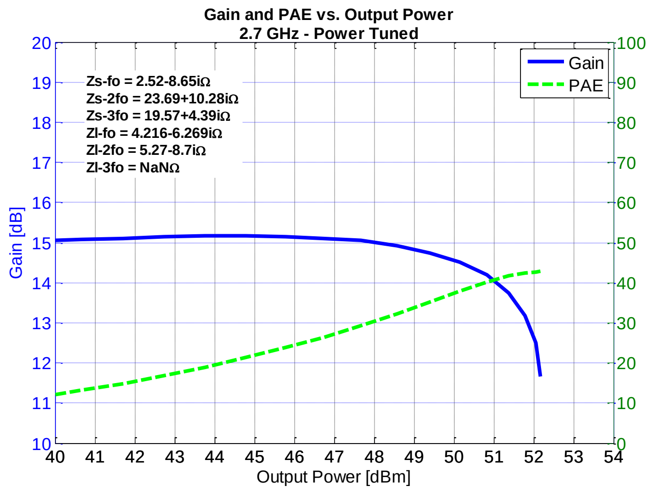



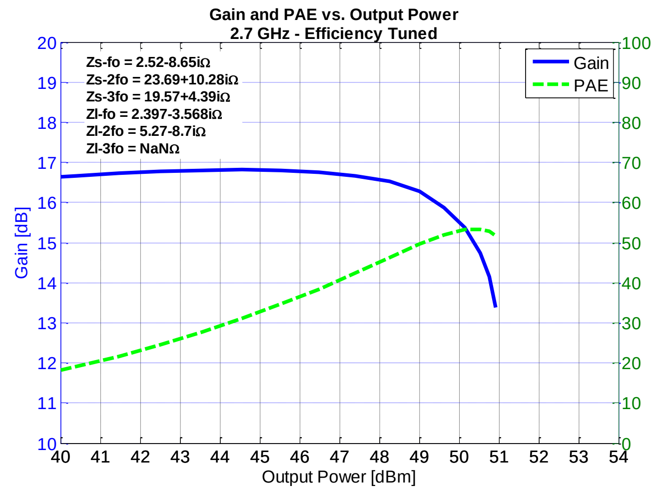
## Typical Performance – Load Pull Drive-up

Notes:
1. Pulsed signal with 100 us pulse width and 10 % duty cycle, Vd = 65 V, $I_{DQ}$ = 240 mA
2. See page 20 for load pull and source pull reference planes where the performance was measured.



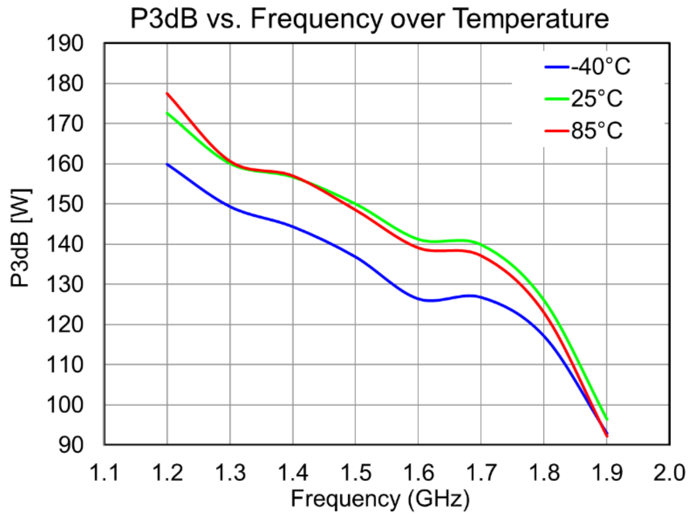



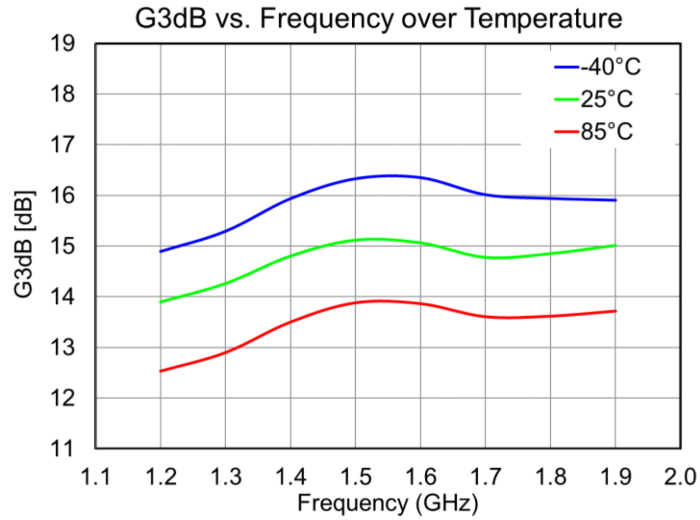



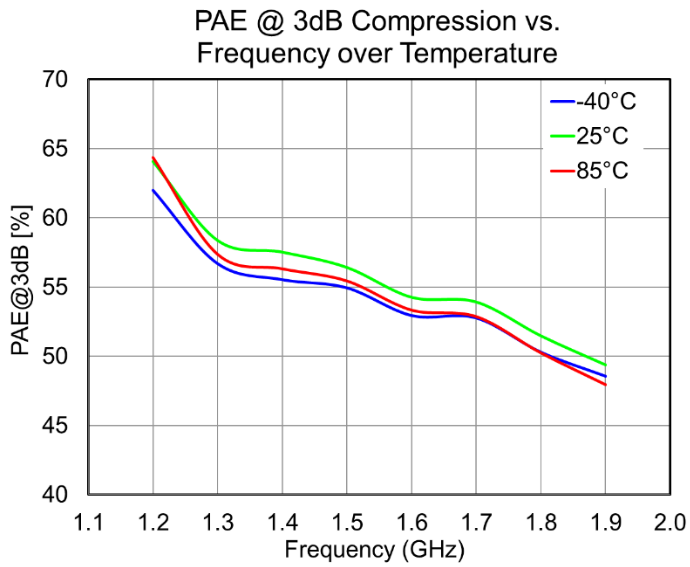



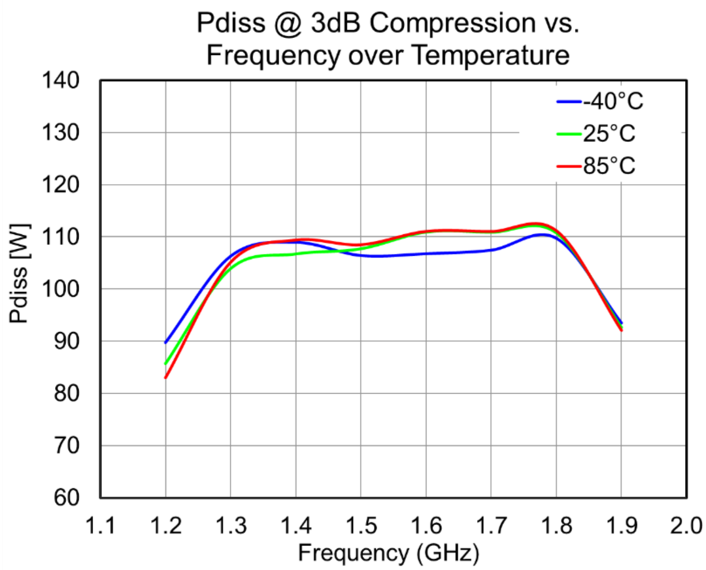
## Power Driveup Performance Over Temperatures of 1.2 – 1.9 GHz EVB – 65 V[1]

Notes:
1- Vd = 65 V, $I_{DQ}$ = 240 mA, Pulse Width = 100 us, Duty Cycle = 10 %



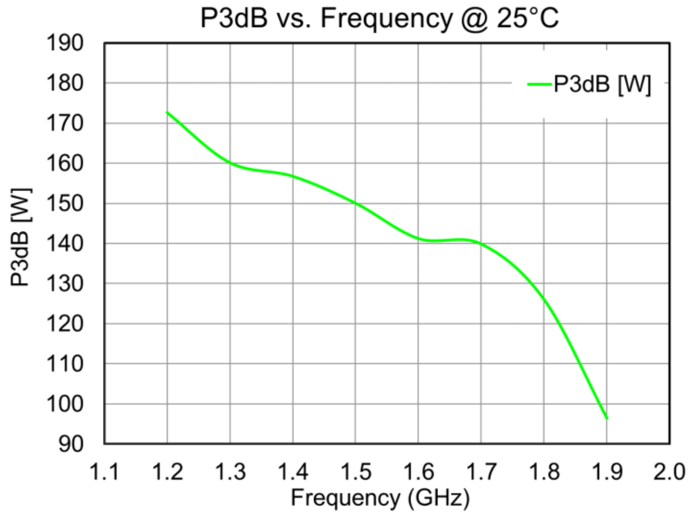



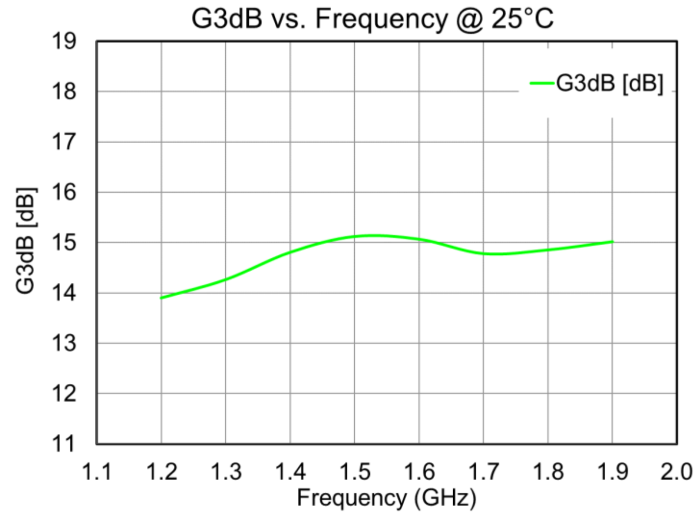



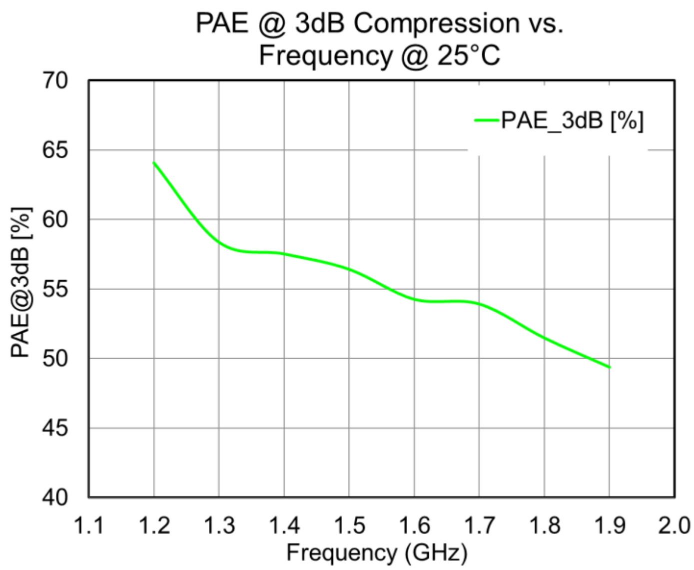



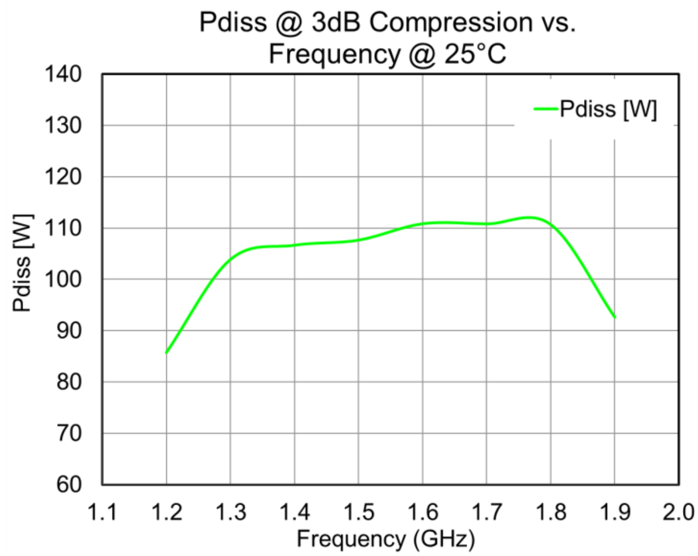
## Power Driveup Performance at 25 °C of 1.2 – 1.9 GHz EVB – 65 V[1]

Notes:
1- Vd = 65 V, $I_{DQ}$ = 240 mA, Pulse Width = 100 us, Duty Cycle = 10 %



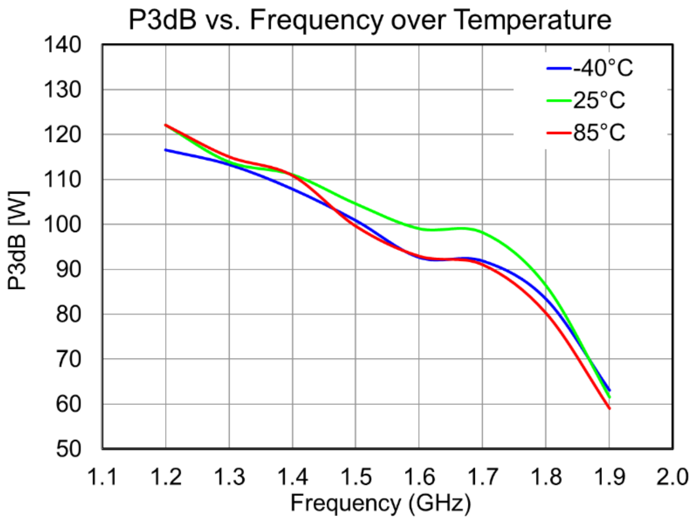



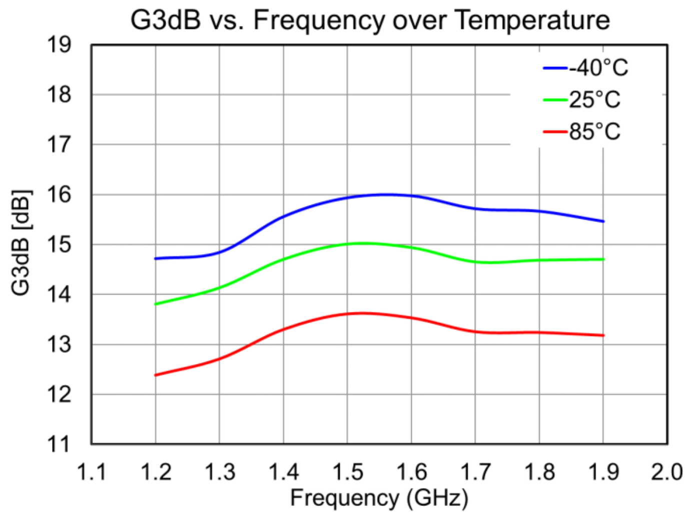



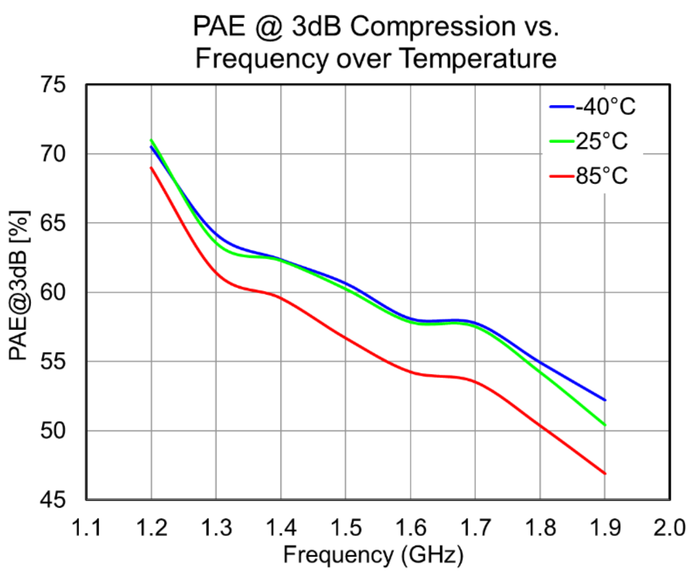
## Power Driveup Performance Over Temperatures of 1.2 – 1.9 GHz EVB – 50 V[1]

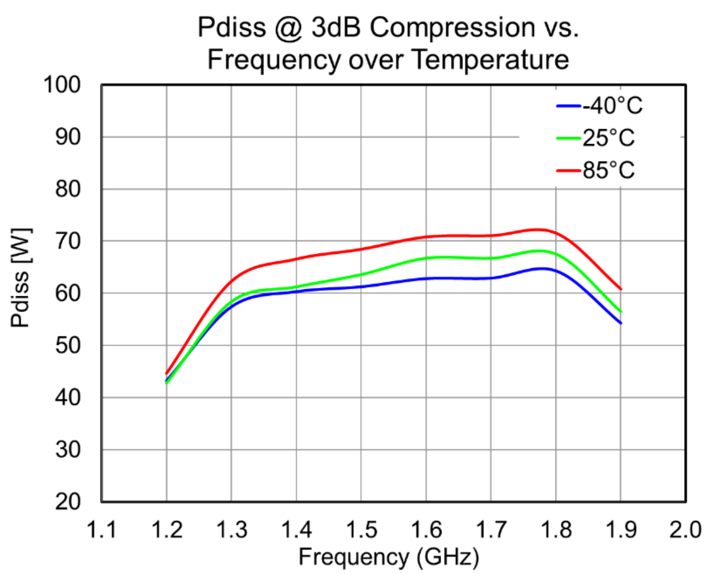
Notes:

1- Vd = 50 V, $I_{DQ}$ = 240 mA, Pulse Width = 100 us, Duty Cycle = 10 %



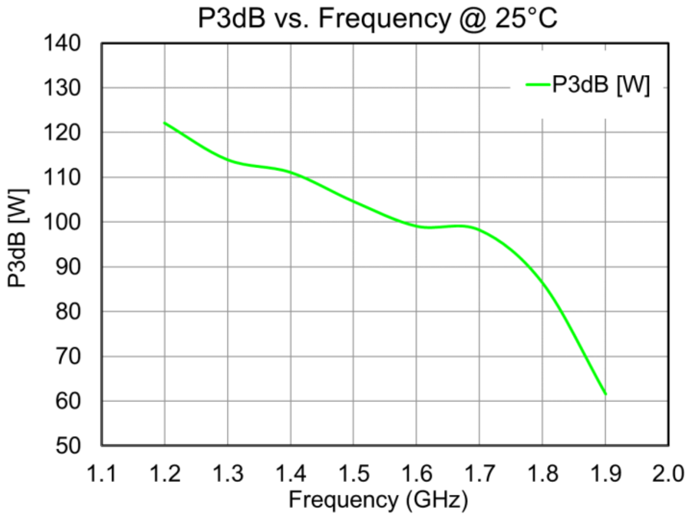



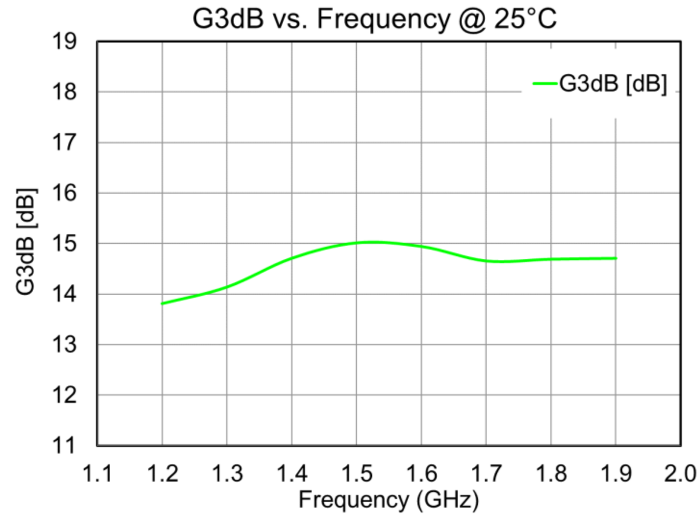



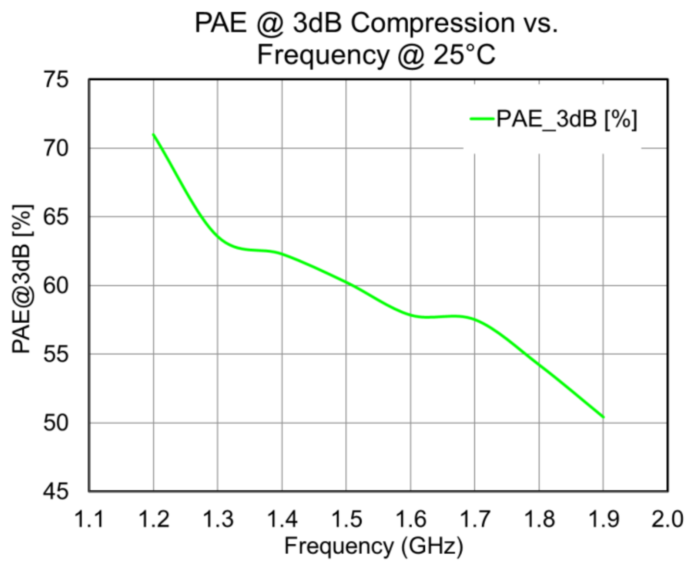
## Power Driveup Performance at 25 °C of 1.2 – 1.9 GHz EVB – 50 V[1]

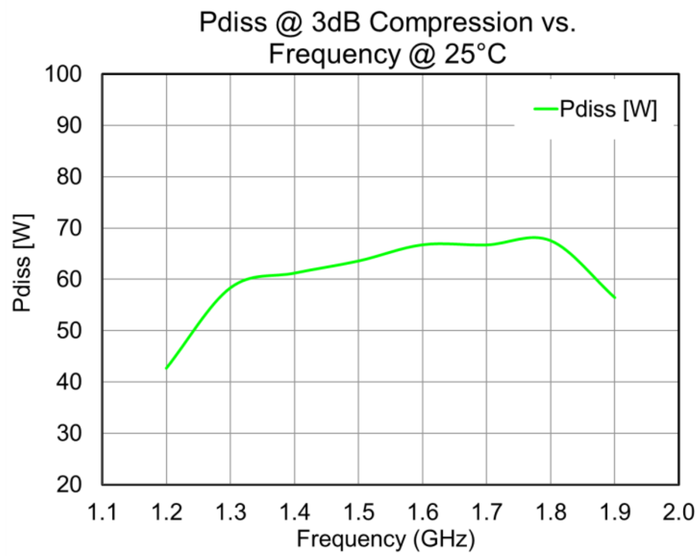
Notes:

1- Vd = 50 V, $I_{DQ}$ = 240 mA, Pulse Width = 100 us, Duty Cycle = 10 %



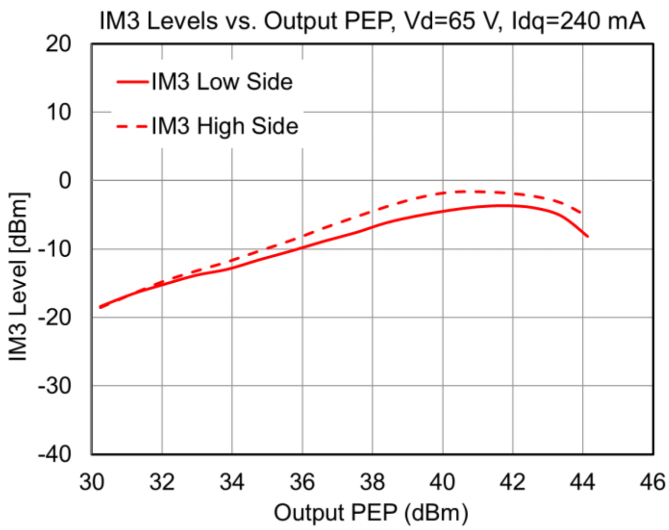



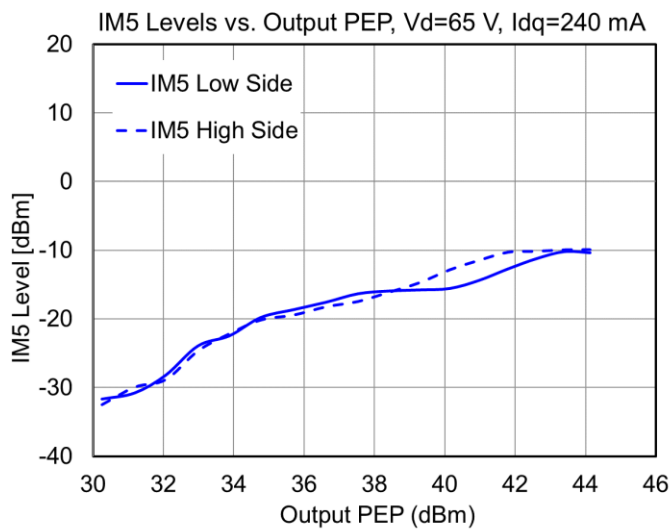



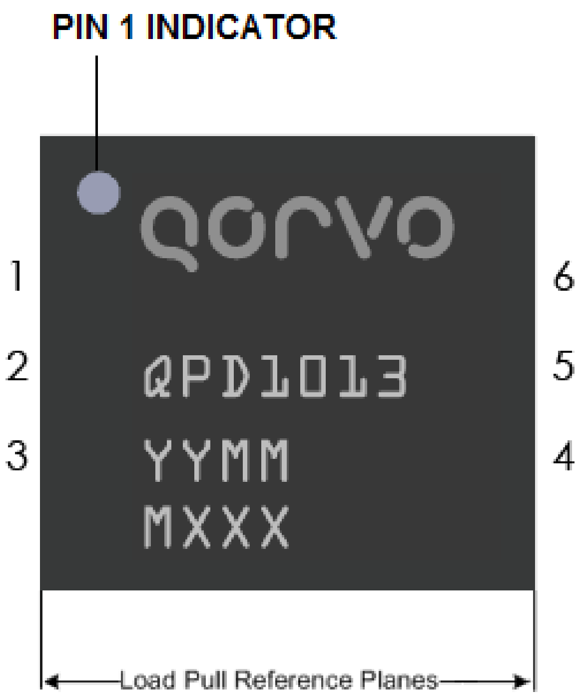
## Two-Tone Performance at 25 °C of 1.2 – 1.9 GHz EVB[1]

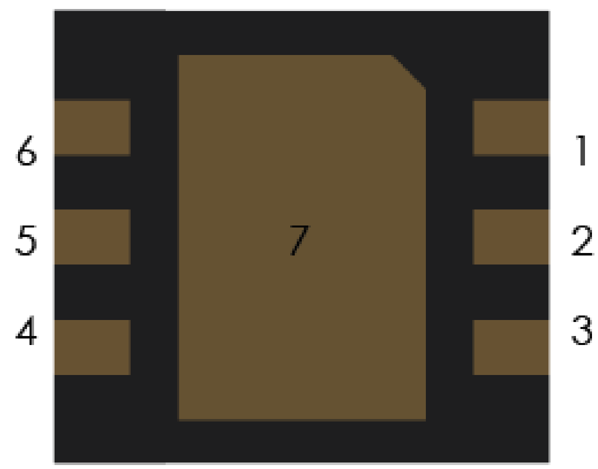
Notes:
1- Center Frequency = 1.5 GHz. Tone Seperation = 1 MHz.



## Pin Layout [1]



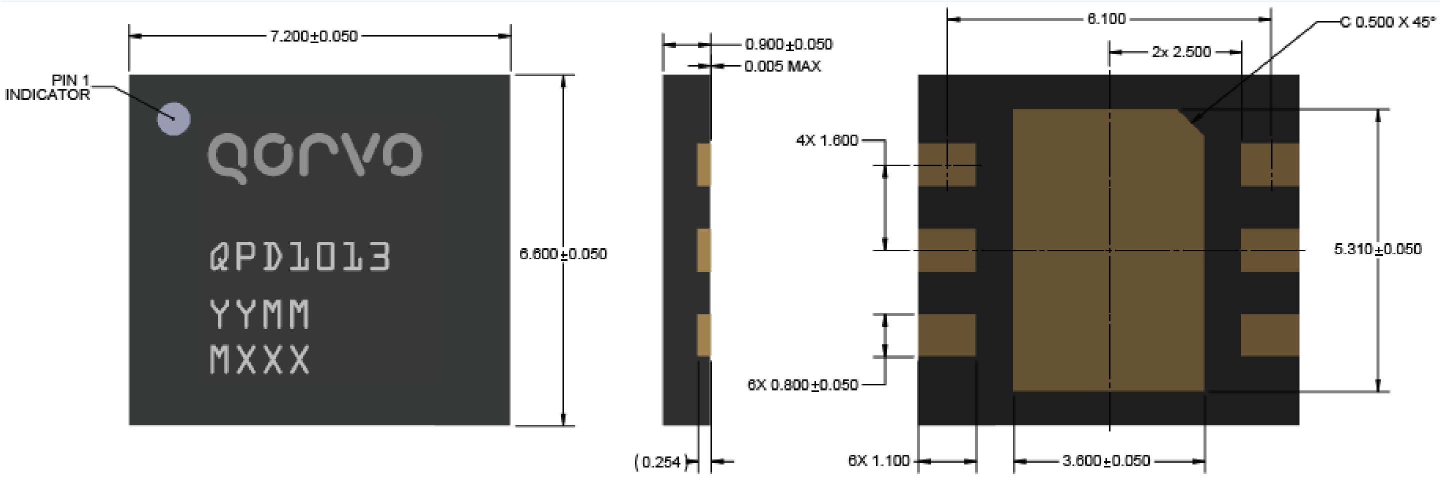




Notes:
1. The QPD1013 will be marked with the "QPD1013" designator and a lot code marked below the part designator. The "YY" represents the last two digits of the calendar year the part was manufactured, the "MM" is the work week of the assembly lot start, the "MXXX" is the batch ID.

## Pin Description

| Pin | Symbol | Description |
|---|---|---|
| 1 – 3 | VG / RF IN | Gate voltage / RF Input |
| 4 – 6 | VD / RF OUT | Drain voltage / RF Output |
| 7 | Back Plane | Source to be connected to ground |

## Mechanical Drawing



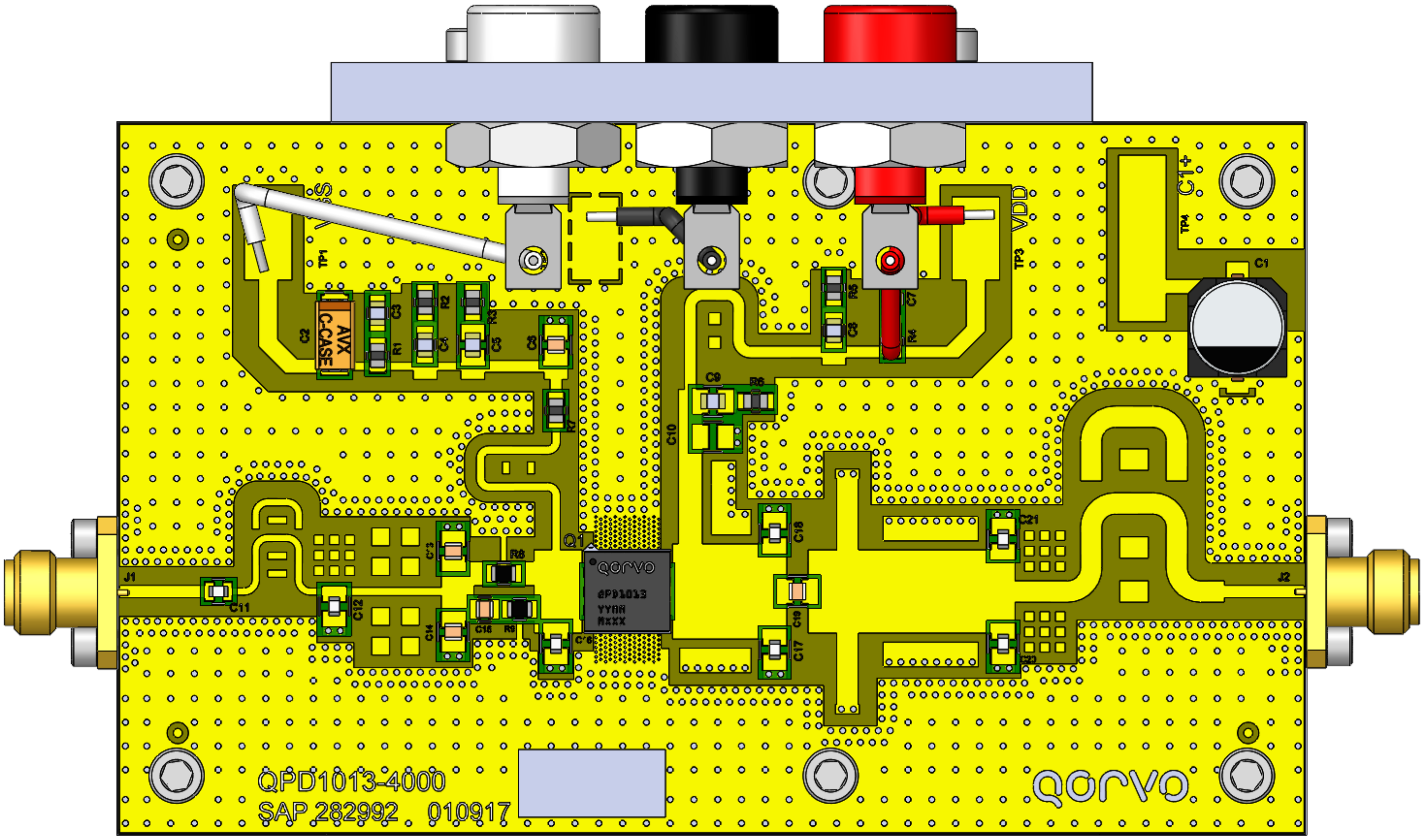

Notes:

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 500 mA. | 2. Turn off VD |
| 3. Apply 65 V VD. | 3. Wait 2 seconds to allow drain capacitor to discharge |
| 4. Slowly adjust VG until ID is set to 240 mA. | 4. Turn off VG |
| 5. Set ID current limit to 3 A | |
| 6. Apply RF. | |

## PCB Layout – 1.2 – 1.9 GHz EVB[1]

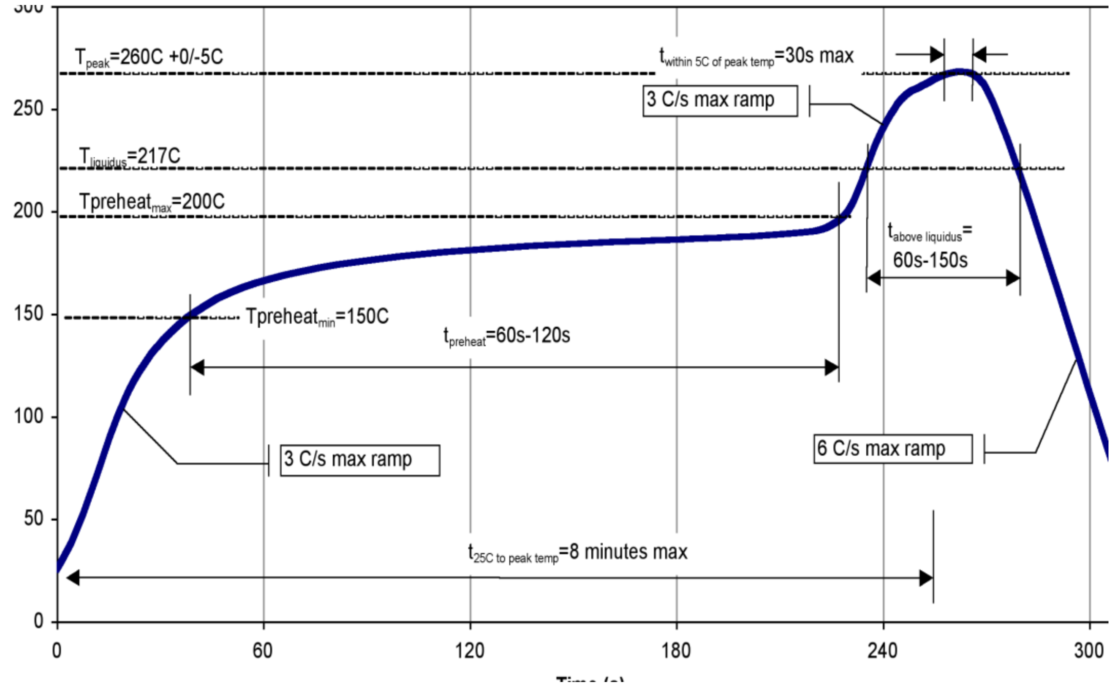
Notes:
1- PCB Material is RO4350B, 20 mil thick substrate, 1 oz. copper each side.



## Bill Of material – 1.2 – 1.9 GHz EVB

| Ref Des | Value | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| C4, C8 | 1.0 nF | X7R 100V 5% 0805 Capacitor | AVX | 08051C102JAT2A |
| C3, C7 | 10.0 nF | X7R 100V 5% 0805 Capacitor | AVX | 08051C103JAT2A |
| C20 – C21 | 1.5 pF | RF NPO 250VDC ± 0.1 pF Capacitor | ATC | ATC600S1R5BT250XT |
| C13 – C14 | 1.2 pF | RF NPO 250VDC ± 0.1 pF Capacitor | ATC | ATC800A1R2BT250XT |
| C12 | 2.0 pF | RF NPO 250VDC ± 0.1 pF Capacitor | ATC | ATC600S2R0BT250XT |
| C16 | 3.6 pF | RF NPO 250VDC ± 0.1 pF Capacitor | ATC | ATC600S3R6BT250XT |
| C17 – C18 | 3.9 pF | RF NPO 250VDC ± 0.1 pF Capacitor | ATC | ATC600S3R9BT250XT |
| C11 | 4.7 pF | RF NPO 250VDC ± 0.1 pF Capacitor | ATC | ATC600S4R7BT250XT |
| C15, C19 | 12.0 pF | RF C0G 250VDC 5% Capacitor | ATC | ATC800A120JT250XT |
| C6 | 22.0 pF | RF C0G 250VDC 5% Capacitor | ATC | ATC800A220JT250XT |
| C5, C9 | 100 pF | RF C0G 250VDC 5% Capacitor | ATC | ATC600F101JT250XT |
| C1 | 33 uF | 80V 20% SVP Capacitor | Panasonic | EEEFK1K330P |
| C2 | 10 uF | 16V 10% Tantalum Capacitor | AVX | TPSC106KR0500 |
| J1 - 2 | – | SMA Panel Mount 4-hole Jack | Gigalane | PSF-S00-000 |
| R7 | 3.0 Ohm | 0805 1% Thick Film Resistor | ANY | – |
| R1 – R6 | 5.1 Ohm | 0805 1% Thick Film Resistor | ANY | – |
| R8 | 3.0 Ohm | 0805 16W 5% Thick Film Resistor | IMS | NGC-0805CS3R00J |
| R9 | 5.0 Ohm | 0805 16W 5% Thick Film Resistor | IMS | NGC-0805CS5R00J |

## Recommended Solder Temperature Profile



## Product Compliance Information

### ESD Sensitivity Ratings

Caution! ESD Sensitive Device

### ESD Rating

| | |
|---|---|
| ESD Rating: | Class 1A |
| Value: | 450 V |
| Test: | Human Body Model (HBM) |
| Standard: | JEDEC Standard JESD22-A114 |

### MSL Rating

| | |
|---|---|
| MSL Rating: | TBD |
| Test: | 260 °C convection reflow |
| Standard: | JEDEC Standard IPC/JEDEC J-STD-020 |

### Solderability

Compatible with lead free soldering processes, 260 °C maximum reflow temperature.

Package lead plating: NiAu

The use of no-clean solder to avoid washing after soldering is recommended.

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 ($C_{15}H_{12}Br_4O_2$) 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:** | **+1.972.994.8465** |
| **Email:** | info-sales@qorvo.com | **Fax:** | **+1.972.994.8504** |

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

## Important Notice

The information contained herein is believed to be reliable. Qorvo makes no warranties regarding the information contained herein. Qorvo assumes no responsibility or liability whatsoever for any of the information contained herein. Qorvo assumes no responsibility or liability whatsoever for the use of the information contained herein. The information contained herein is provided "AS IS, WHERE IS" and with all faults, and the entire risk associated with such information is entirely with the user. All information contained herein is subject to change without notice. Customers should obtain and verify the latest relevant information before placing orders for Qorvo products. The information contained herein or any use of such information does not grant, explicitly or implicitly, to any party any patent rights, licenses, or any other intellectual property rights, whether with regard to such information itself or anything described by such information.

Qorvo products are not warranted or authorized for use as critical components in medical, life-saving, or life-sustaining applications, or other applications where a failure would reasonably be expected to cause severe personal injury or death.

# OCEAN CHIPS
## Океан Электроники
## Поставка электронных компонентов

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения **«JONHON»**, а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов **«FORSTAR»**.

**«JONHON»** (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

**«FORSTAR»** (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).

Телефон: 8 (812) 309-75-97 (многоканальный)
Факс: 8 (812) 320-03-32
Электронная почта: ocean@oceanchips.ru
Web: http://oceanchips.ru/
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А