

### Product Overview

The Qorvo T1G4020036-FS is a 2 x 200 W ( $P_{3dB}$ ) discrete GaN on SiC HEMT which operates from DC to 3.5 GHz. The device is in an industry standard air cavity package and is ideally suited for IFF, avionics, military and civilian radar, and test instrumentation. The device can support both pulsed and linear operations.

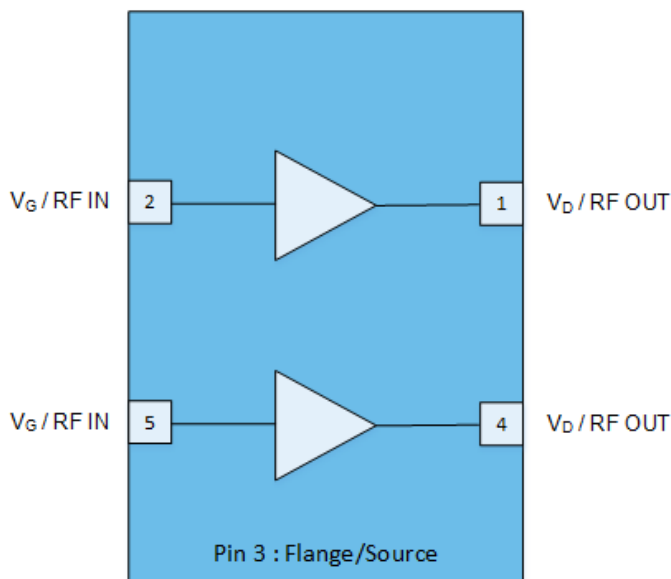
Lead-free and ROHS compliant

Evaluation boards are available upon request.



4-lead NI-650 Package (Earless)

### Functional Block Diagram



### Key Features

- Frequency: DC to 3.5 GHz
  - Output Power ( $P_{3dB}$ )<sup>1</sup>: 200 W
  - Linear Gain<sup>1</sup>: 18.1 dB
  - Typical PAE<sub>3dB</sub><sup>1</sup>: 67.6%
  - Operating Voltage: 50 V
  - CW and Pulse capable
- Note 1: @ 2.8 GHz Load Pull (Half of device)

### Applications

- Military and civilian radar
- Professional and military radio communications
- Test instrumentation
- Wideband or narrowband amplifiers
- Jammers

### Ordering info

| Part No.           | ECCN        | Description                                        |
|--------------------|-------------|----------------------------------------------------|
| T1G4020036-FS      | 3A001.b.3.b | DC–3.5 GHz, 50 V, 200 W GaN RF Transistor, Earless |
| T1G4020036-FS-EVB1 | EAR99       | 2.9 – 3.3 GHz EVB                                  |

### Absolute Maximum Ratings <sup>1</sup>

| Parameter                                  | Rating      | Units            |
|--------------------------------------------|-------------|------------------|
| Breakdown Voltage, $BV_{DG}$               | +145        | V                |
| Gate Voltage Range, $V_G$                  | -7 to +2    | V                |
| Drain Current, $I_{D_{MAX}}$               | 24          | A                |
| Gate Current Range, $I_G$                  | See pg. 14  | mA               |
| Power Dissipation, CW, $P_{DISS}$          | 236         | W                |
| RF Input Power, CW, $T = 25^\circ\text{C}$ | +47.5       | dBm              |
| Channel Temperature, $T_{CH}$              | 275         | $^\circ\text{C}$ |
| Mounting Temperature (30 Seconds)          | 320         | $^\circ\text{C}$ |
| Storage Temperature                        | -65 to +150 | $^\circ\text{C}$ |

Notes:

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

### Recommended Operating Conditions <sup>1</sup>

| Parameter                                    | Min | Typ  | Max | Units            |
|----------------------------------------------|-----|------|-----|------------------|
| Operating Temp. Range                        | -40 | +25  | +85 | $^\circ\text{C}$ |
| Drain Voltage Range, $V_D$                   | +32 | +50  | +55 | V                |
| Drain Bias Current, $I_{DQ}$                 |     | 520  |     | mA               |
| Drain Current, $I_D^4$                       | –   | 12   | –   | A                |
| Gate Voltage, $V_G^3$                        | –   | -2.8 | –   | V                |
| Channel Temperature ( $T_{CH}$ )             | –   | –    | 250 | $^\circ\text{C}$ |
| Power Dissipation ( $P_D$ ) <sup>2,4</sup>   | –   | –    | 374 | W                |
| Power Dissipation ( $P_D$ ), CW <sup>2</sup> | –   | –    | 211 | 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. Package base at  $85^\circ\text{C}$
3. To be adjusted to desired  $I_{DQ}$
4. Pulsed, 100us PW, 20% DC

### Measured Load Pull Performance – Power Tuned <sup>1</sup>

| Parameter                                              | Typical Values |      |      |      | Units |
|--------------------------------------------------------|----------------|------|------|------|-------|
| Frequency, F                                           | 2.4            | 2.8  | 3.2  | 3.6  | GHz   |
| Output Power at 3dB compression, $P_{3dB}$             | 53.1           | 53.0 | 52.8 | 52.9 | dBm   |
| Power Added Efficiency at 3dB compression, $PAE_{3dB}$ | 54.1           | 54.7 | 57.5 | 54.9 | %     |
| Gain at 3dB compression, $G_{3dB}$                     | 15.6           | 15.1 | 15.9 | 16.0 | dB    |

Notes:

1. Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 50\text{ V}$ ,  $I_{DQ} = 260\text{ mA}$  (half device)
2. Pulsed, 100 us Pulse Width, 10% Duty Cycle.

### Measured Load Pull Performance – Efficiency Tuned <sup>1</sup>

| Parameter                                              | Typical Values |      |      |      | Units |
|--------------------------------------------------------|----------------|------|------|------|-------|
| Frequency, F                                           | 2.4            | 2.8  | 3.2  | 3.6  | GHz   |
| Output Power at 3dB compression, $P_{3dB}$             | 50.1           | 50.2 | 50.5 | 50.5 | dBm   |
| Power Added Efficiency at 3dB compression, $PAE_{3dB}$ | 72.9           | 67.6 | 66.5 | 65.8 | %     |
| Gain at 3dB compression, $G_{3dB}$                     | 17.5           | 18.4 | 17.4 | 18.1 | dB    |

Notes:

1. Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 50\text{ V}$ ,  $I_{DQ} = 260\text{ mA}$  (half device)
2. Pulsed, 100 us Pulse Width, 10% Duty Cycle.

## RF Characterization – 2.9 – 3.3 GHz EVB Performance at 2.9 GHz <sup>1</sup>

| Parameter                                          | Min  | Typ  | Max | Units |
|----------------------------------------------------|------|------|-----|-------|
| Linear Gain, $G_{LIN}$                             | –    | 16.1 | –   | dB    |
| Output Power at 3dB compression point, P3dB        | 162  | 244  | –   | W     |
| Drain Efficiency at 3dB compression point, DEFF3dB | –    | 52.0 | –   | %     |
| Gain at 3dB compression point, G3dB                | 12.0 | 13.1 | –   | dB    |

Notes:

1.  $V_D = +36$  V,  $I_{DQ} = 520$  mA (combined), Temp = +25 °C, Pulse Width = 100 us, Duty Cycle = 20%

## RF Characterization – Mismatch Ruggedness at 2.9 GHz <sup>1, 2, 3</sup>

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

Notes:

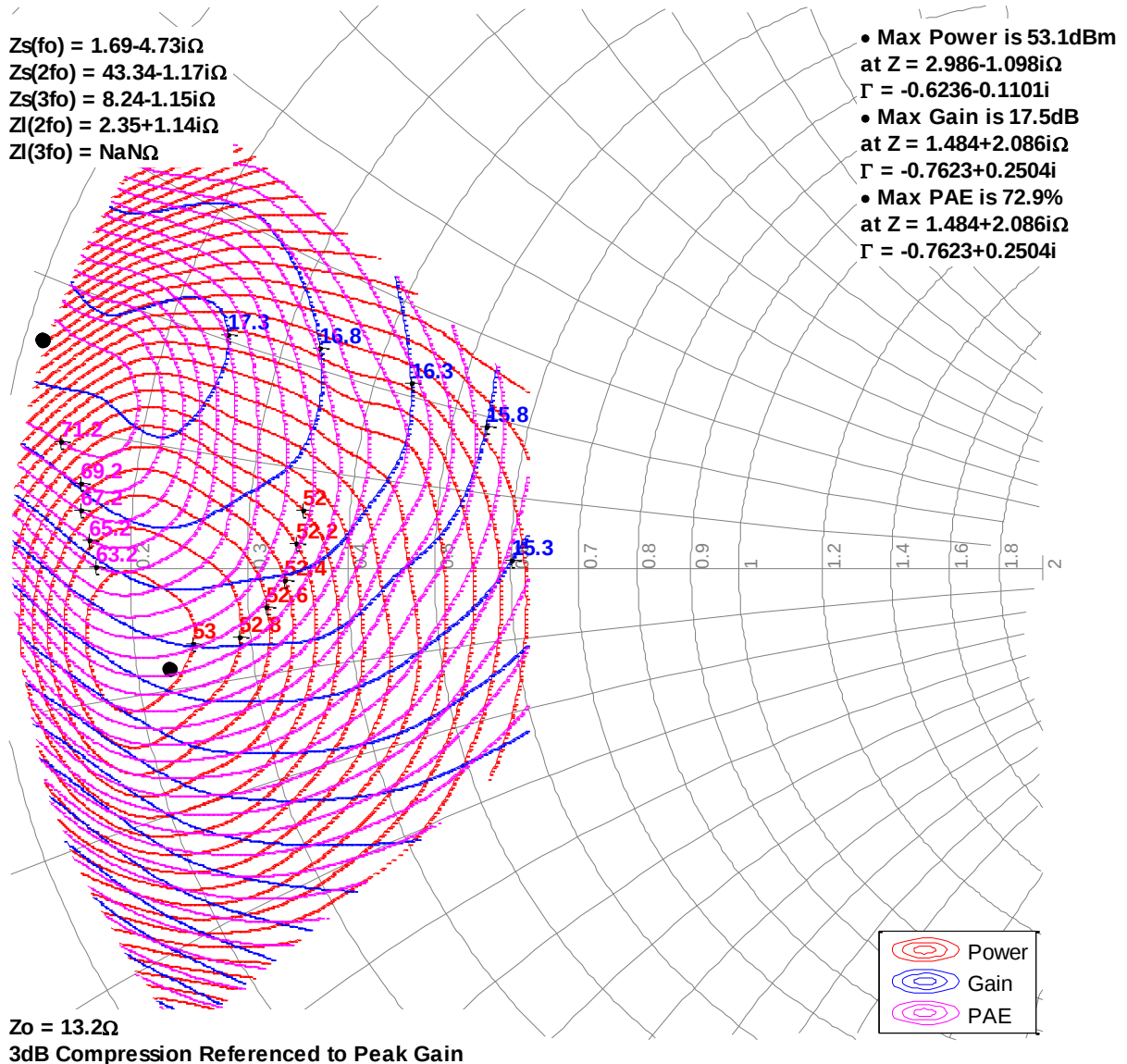
1. Test conditions unless otherwise noted:  $T_A = 25$  °C,  $V_D = 36$  V,  $I_{DQ} = 520$  mA (combined)
2. Input drive power is determined at pulsed 3dB compression under matched condition at EVB output connector.
3. Pulse: 100us, 20% Duty cycle.

## Measured Load-Pull Smith Charts 1, 2, 3

Notes:

1. Test Conditions:  $V_D = 50$  V,  $I_{DQ} = 260$  mA, 100 us Pulse Width, 10% Duty Cycle, Temp = 25°C.
2. The performance shown below is for only half of the device out of the two independent amplification paths.
3. See page 15 for load pull reference planes where the performance was measured.

### 2.4GHz, Load-pull

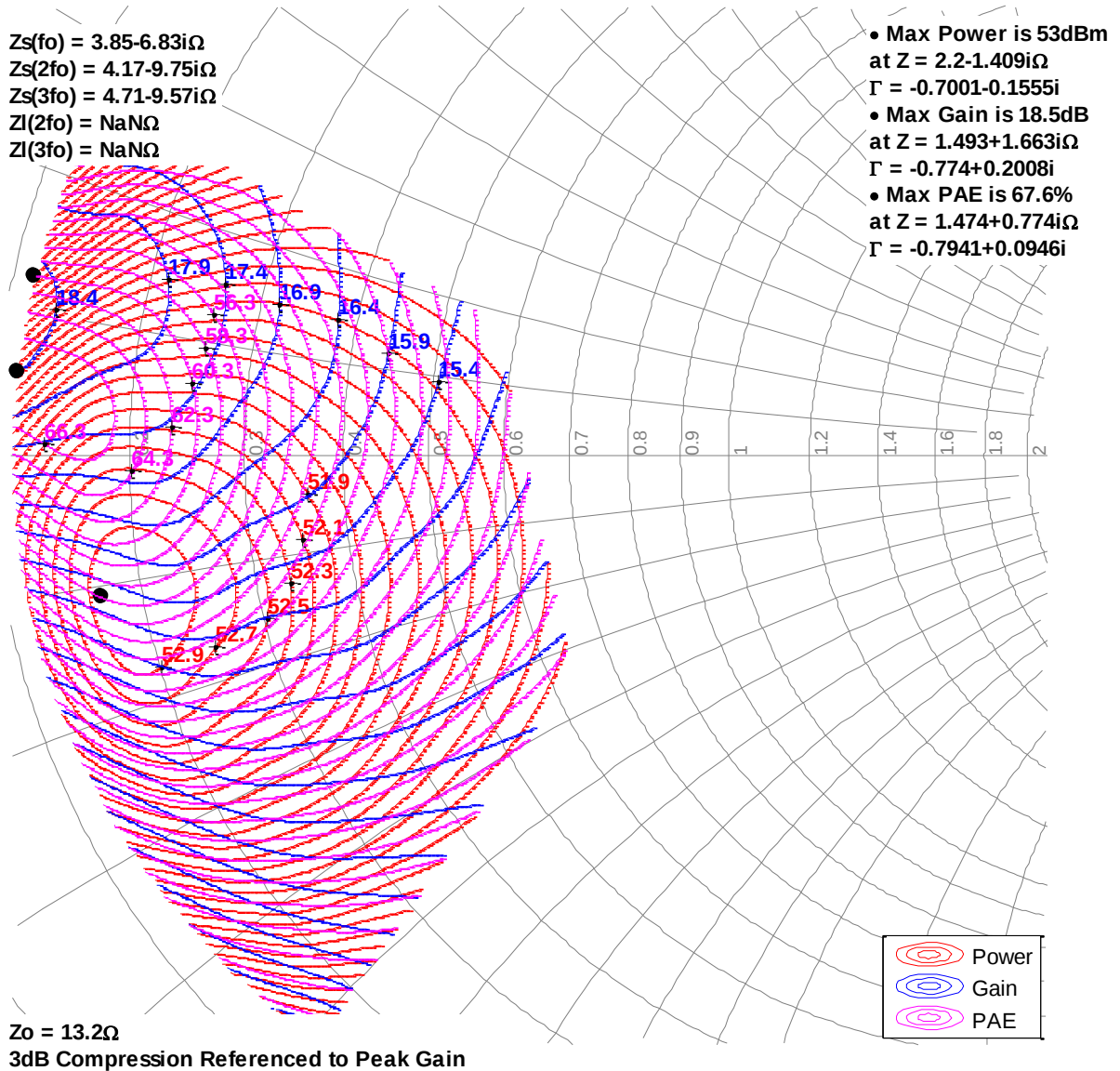


## Measured Load-Pull Smith Charts 1, 2, 3

Notes:

1. Test Conditions:  $V_D = 50$  V,  $I_{DQ} = 260$  mA, 100 us Pulse Width, 10% Duty Cycle, Temp = 25°C.
2. The performance shown below is for only half of the device out of the two independent amplification paths.
3. See page 15 for load pull reference planes where the performance was measured.

### 2.8GHz, Load-pull

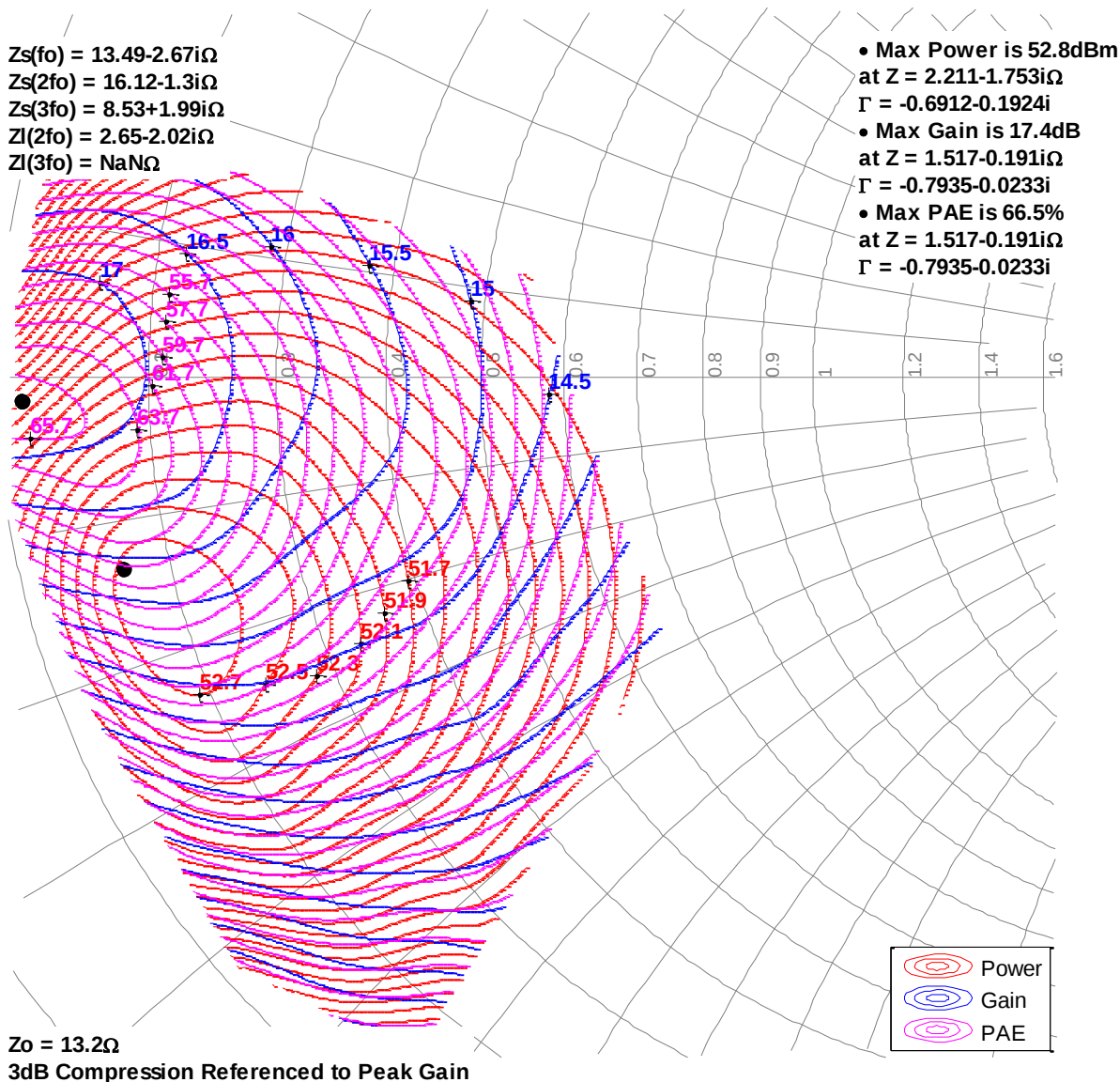


## Measured Load-Pull Smith Charts 1, 2, 3

Notes:

1. Test Conditions:  $V_D = 50$  V,  $I_{DQ} = 260$  mA, 100 us Pulse Width, 10% Duty Cycle, Temp = 25°C.
2. The performance shown below is for only half of the device out of the two independent amplification paths.
3. See page 15 for load pull reference planes where the performance was measured.

### 3.2GHz, Load-pull

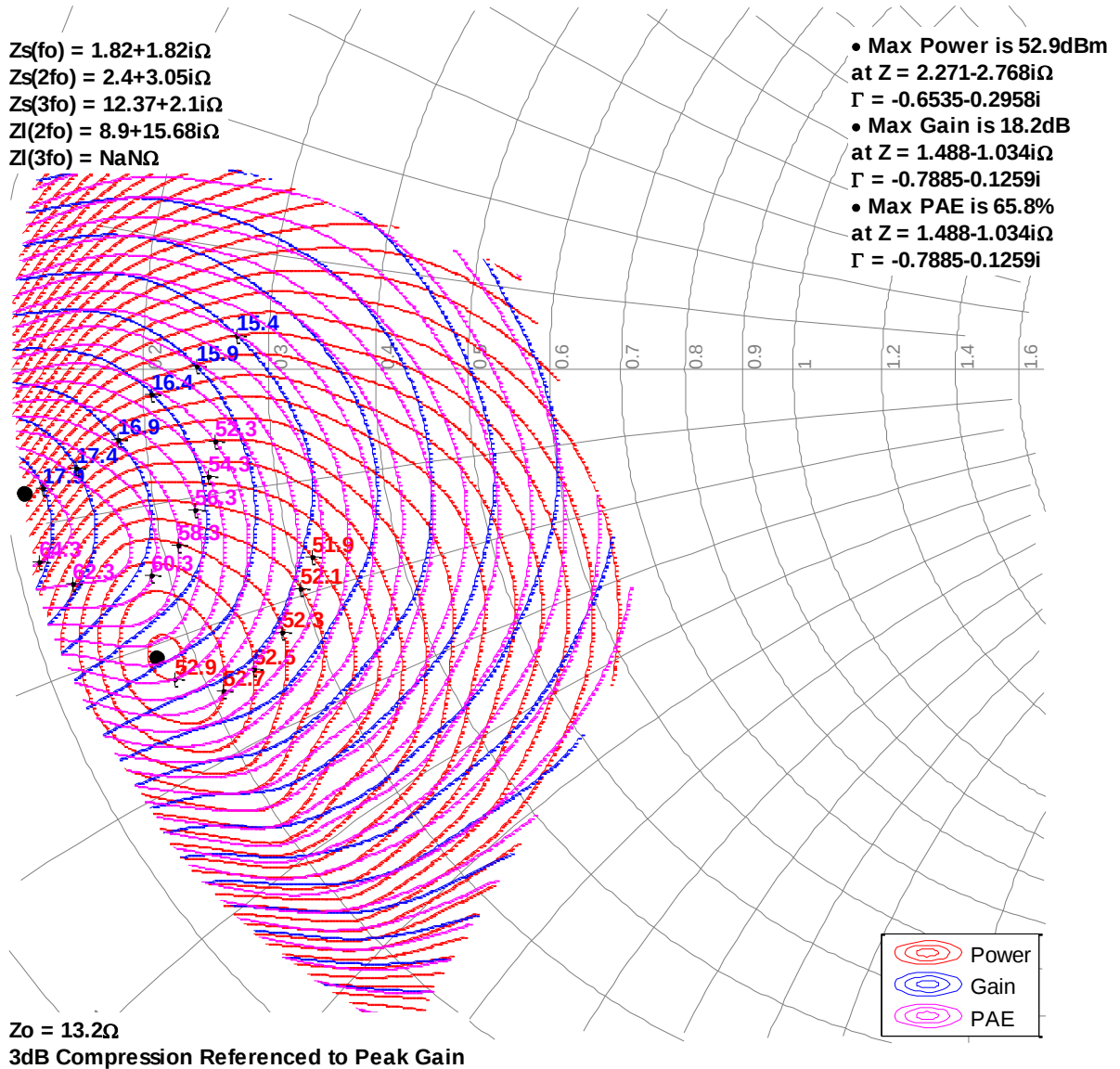


## Measured Load-Pull Smith Charts 1, 2, 3

Notes:

1. Test Conditions:  $V_D = 50$  V,  $I_{DQ} = 260$  mA, 100 us Pulse Width, 10% Duty Cycle, Temp = 25°C.
2. The performance shown below is for only half of the device out of the two independent amplification paths.
3. See page 15 for load pull reference planes where the performance was measured.

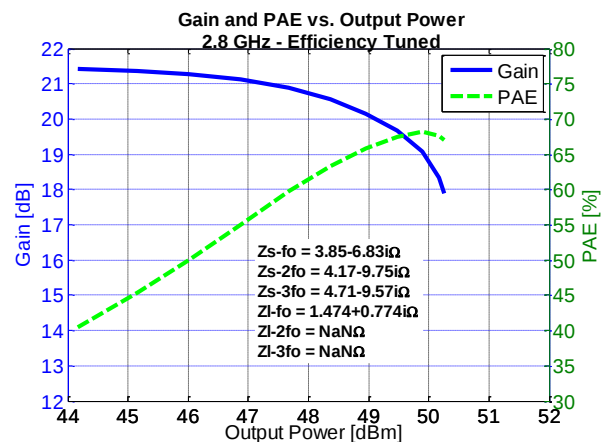
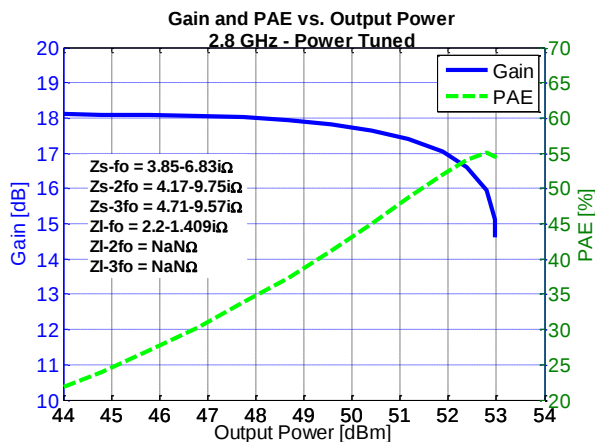
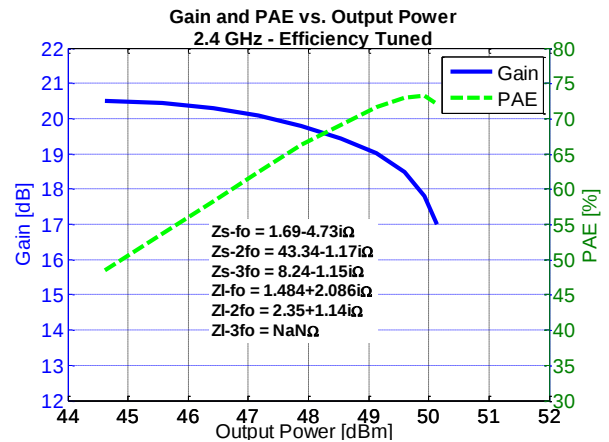
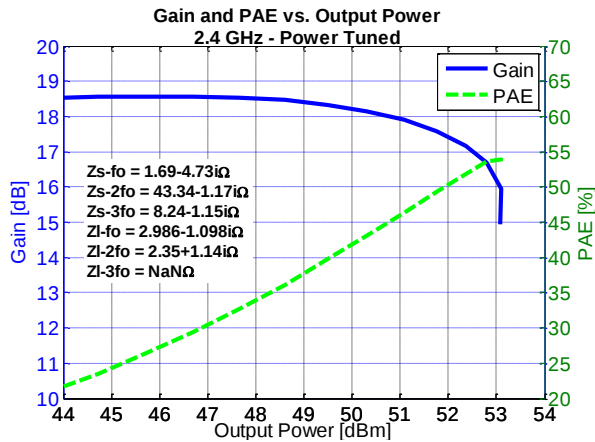
### 3.6GHz, Load-pull



### Typical Measured Performance – Load-Pull Drive-up <sup>1, 2</sup>

Notes:

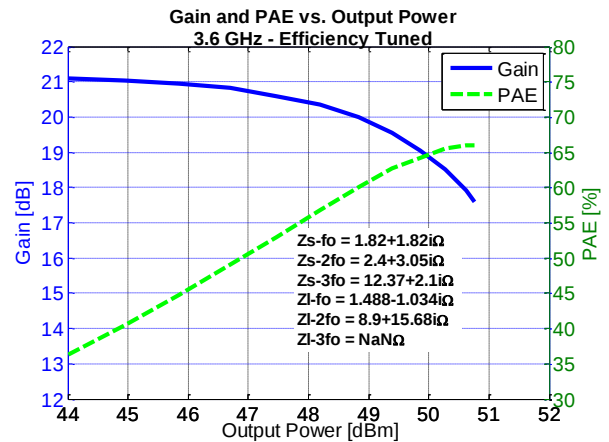
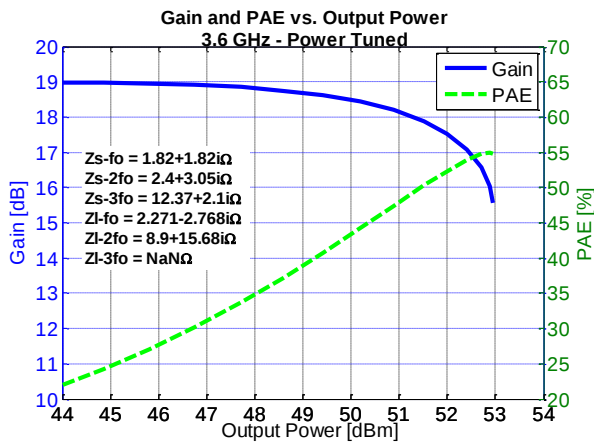
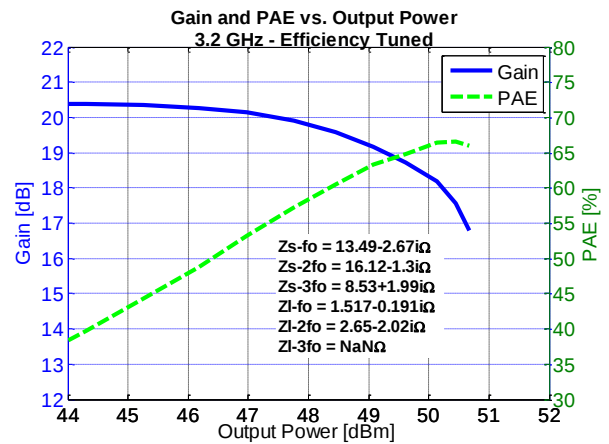
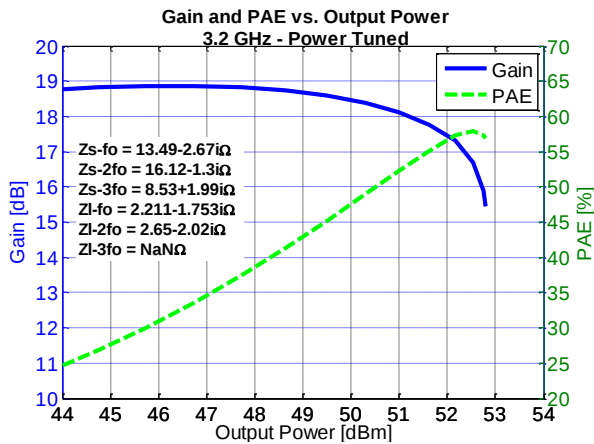
1. Test Conditions:  $V_D = 50$  V,  $I_{DQ} = 260$  mA, 100  $\mu$ s Pulse Width, 10% Duty Cycle, Temp = 25°C.
2. The performance shown below is for only half of the device out of the two independent amplification paths.
3. See page 15 for load pull reference planes where the performance was measured.



### Typical Measured Performance – Load-Pull Drive-up <sup>1, 2</sup>

Notes:

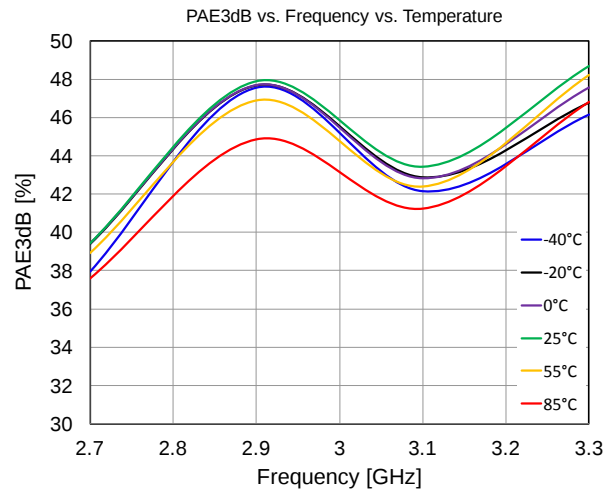
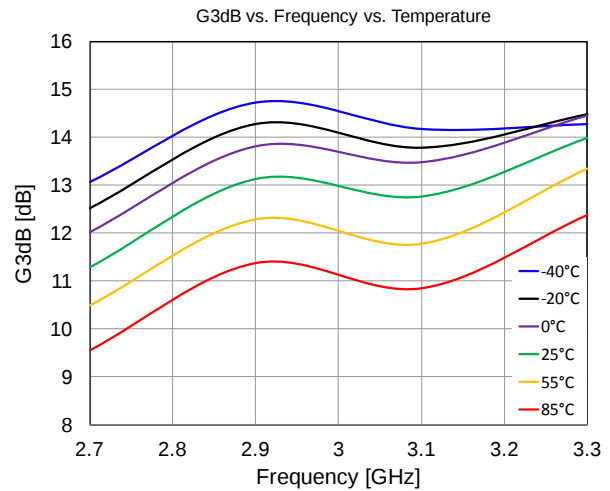
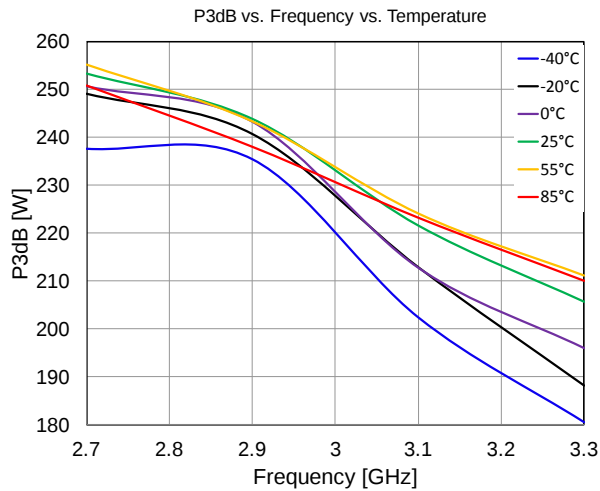
1. Test Conditions:  $V_D = 50$  V,  $I_{DQ} = 260$  mA, 100  $\mu$ s Pulse Width, 10% Duty Cycle, Temp = 25°C.
2. The performance shown below is for only half of the device out of the two independent amplification paths.
3. See page 15 for load pull reference planes where the performance was measured.



### Power Driveup Performance Over Temperatures Of 2.9 – 3.3 GHz EVB <sup>1</sup>

Notes:

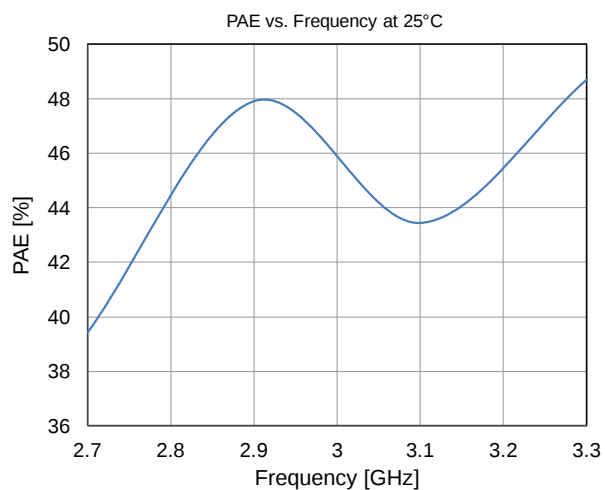
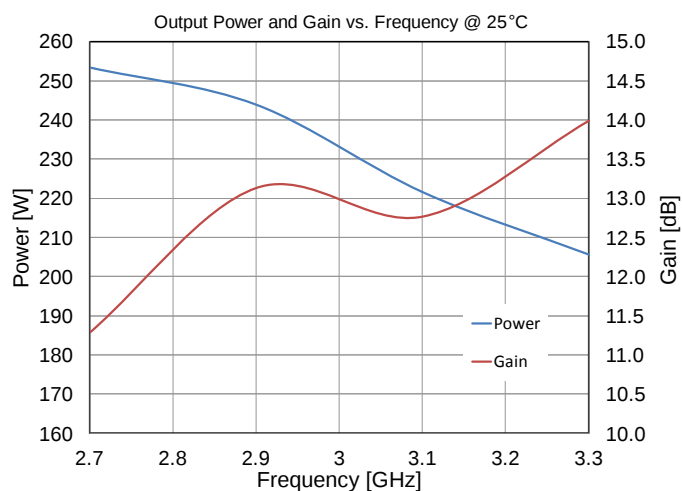
1. Test Conditions:  $V_D = 36$  V,  $I_{DQ} = 520$  mA, 100  $\mu$ s Pulse Width, 20% Duty Cycle.



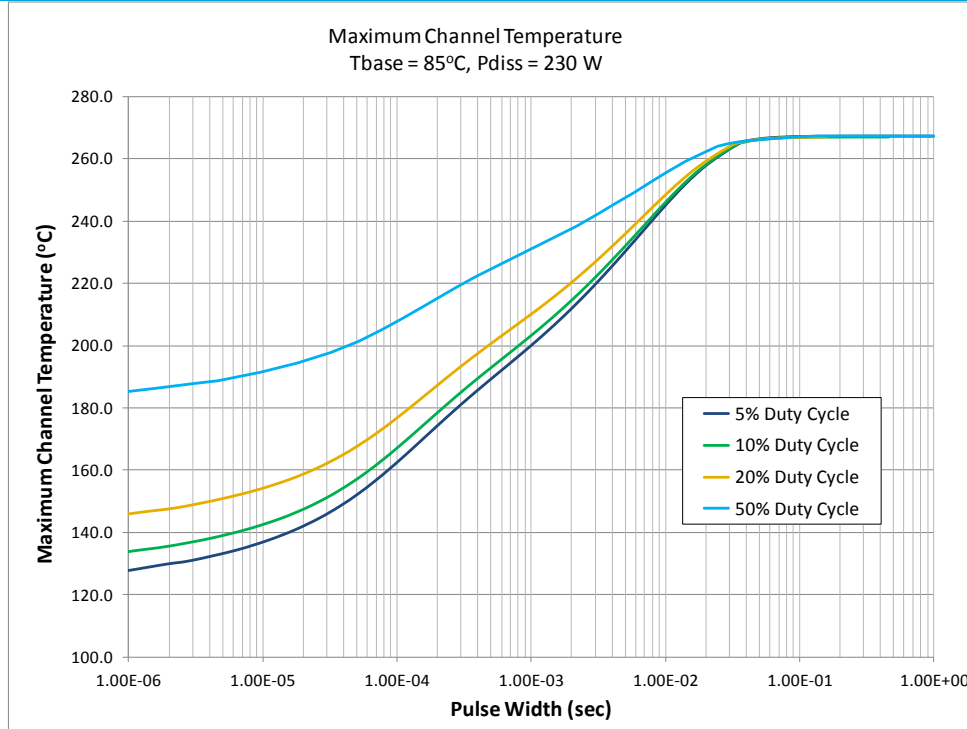
## Power Driveup Performance At 25°C Of 2.9 – 3.3 GHz EVB <sup>1</sup>

Notes:

1. Test Conditions:  $V_D = 36$  V,  $I_{DQ} = 520$  mA, 20  $\mu$ s Pulse Width, 20% Duty Cycle.



### Thermal and Reliability Information

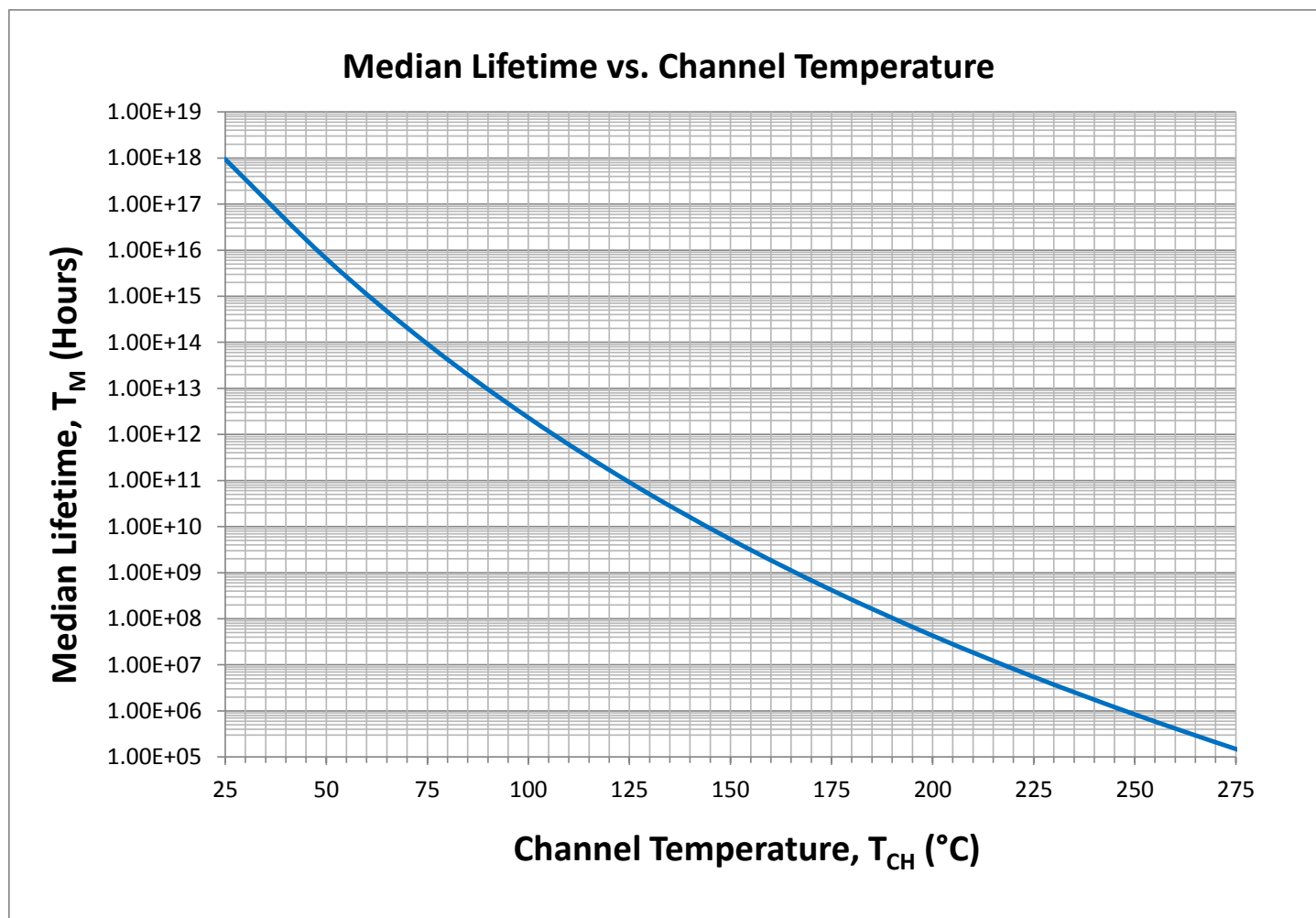


| Parameter                                                       | Conditions                                                            | Values             | Units |
|-----------------------------------------------------------------|-----------------------------------------------------------------------|--------------------|-------|
| Thermal Resistance, FEA ( $\theta_{JC}$ ) <sup>(1)(3)</sup>     | 85 °C Case<br>P <sub>diss</sub> = 211 W<br>CW                         | 0.78               | °C/W  |
| Peak Channel Temperature, FEA (T <sub>CH</sub> ) <sup>(1)</sup> |                                                                       | 250                | °C    |
| Median Lifetime, FEA (T <sub>M</sub> ) <sup>(1)</sup>           |                                                                       | 1.0E6              | Hrs   |
| Peak Channel Temperature, IR <sup>(2)</sup>                     |                                                                       | 189 <sup>(2)</sup> | °C    |
| Thermal Resistance, FEA ( $\theta_{JC}$ ) <sup>(1)(3)</sup>     | 85 °C Case<br>P <sub>diss</sub> = 230.4 W<br>Pulse: 100 us PW, 20% DC | 0.40               | °C/W  |
| Peak Channel Temperature, FEA (T <sub>CH</sub> ) <sup>(1)</sup> |                                                                       | 177                | °C    |
| Median Lifetime, FEA (T <sub>M</sub> ) <sup>(1)</sup>           |                                                                       | 1.5E9              | Hrs   |
| Peak Channel Temperature, IR <sup>(2)</sup>                     |                                                                       | 147 <sup>(2)</sup> | °C    |
| Thermal Resistance, FEA ( $\theta_{JC}$ ) <sup>(1)(3)</sup>     | 85 °C Case<br>P <sub>diss</sub> = 230.4 W<br>Pulse: 100 us PW, 10% DC | 0.36               | °C/W  |
| Peak Channel Temperature, FEA (T <sub>CH</sub> ) <sup>(1)</sup> |                                                                       | 168                | °C    |
| Median Lifetime, FEA (T <sub>M</sub> ) <sup>(1)</sup>           |                                                                       | 7.0E9              | Hrs   |
| Peak Channel Temperature, IR <sup>(2)</sup>                     |                                                                       | 141 <sup>(2)</sup> | °C    |
| Thermal Resistance, FEA ( $\theta_{JC}$ ) <sup>(1)(3)</sup>     | 85 °C Case<br>P <sub>diss</sub> = 230.4 W<br>Pulse: 300 us PW, 20% DC | 0.47               | °C/W  |
| Peak Channel Temperature, FEA (T <sub>CH</sub> ) <sup>(1)</sup> |                                                                       | 194                | °C    |
| Median Lifetime, FEA (T <sub>M</sub> ) <sup>(1)</sup>           |                                                                       | 3.5E8              | Hrs   |
| Peak Channel Temperature, IR <sup>(2)</sup>                     |                                                                       | 157 <sup>(2)</sup> | °C    |
| Thermal Resistance, FEA ( $\theta_{JC}$ ) <sup>(1)(3)</sup>     | 85 °C Case<br>P <sub>diss</sub> = 230.4 W<br>Pulse: 300 us PW, 10% DC | 0.43               | °C/W  |
| Peak Channel Temperature, FEA (T <sub>CH</sub> ) <sup>(1)</sup> |                                                                       | 185                | °C    |
| Median Lifetime, FEA (T <sub>M</sub> ) <sup>(1)</sup>           |                                                                       | 1.7E9              | Hrs   |
| Peak Channel Temperature, IR <sup>(2)</sup>                     |                                                                       | 152 <sup>(2)</sup> | °C    |

#### Notes:

1. Finite Element Analysis (FEA) thermal values shall be used to determine performance and reliability. Unless otherwise noted, all thermal references are FEA.
2. Infrared (IR) thermal values are for reference only and can not be used to determine performance or reliability.
3. Thermal resistance measured to backside of package.

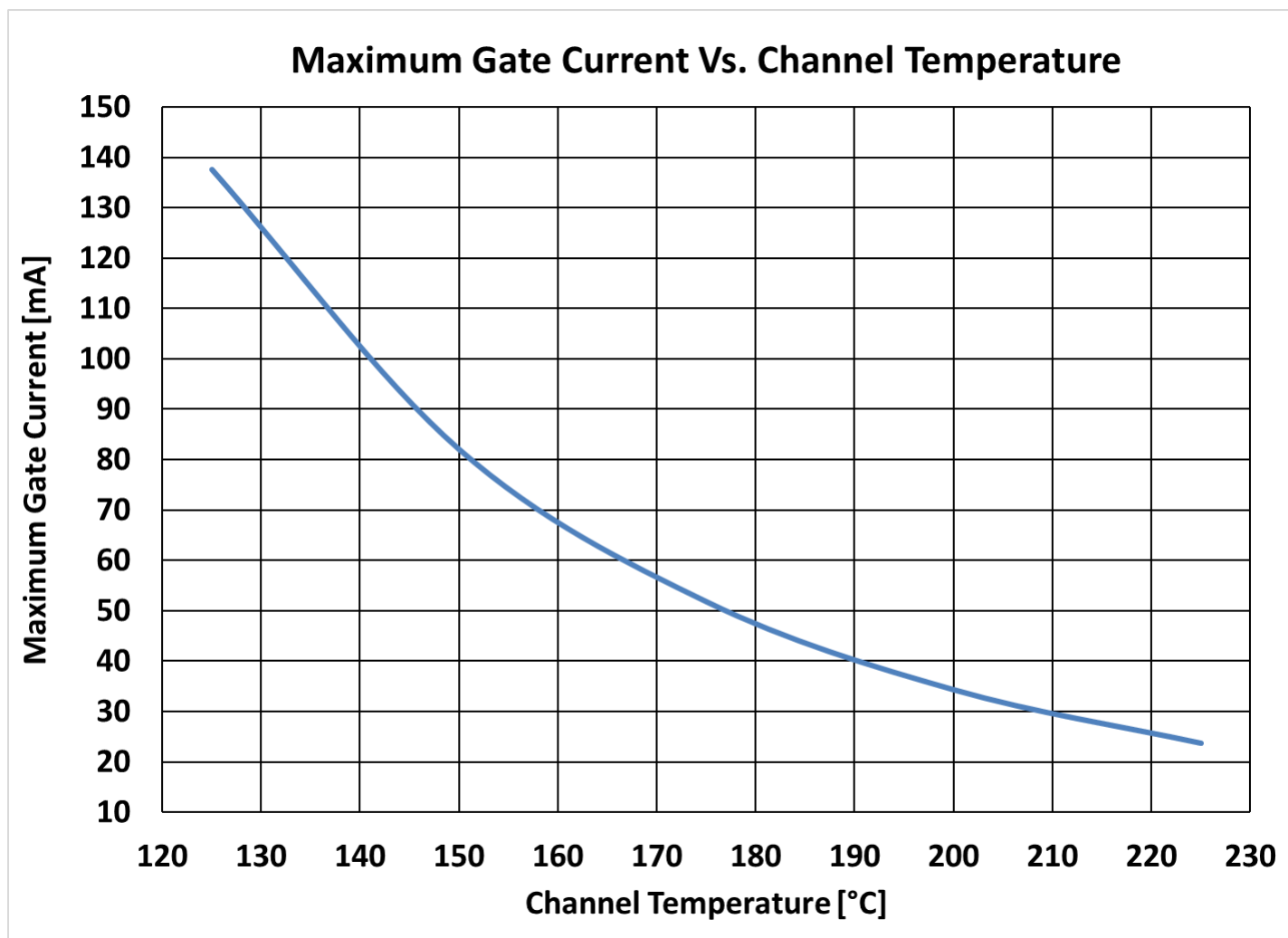
Median Lifetime <sup>1, 2</sup>



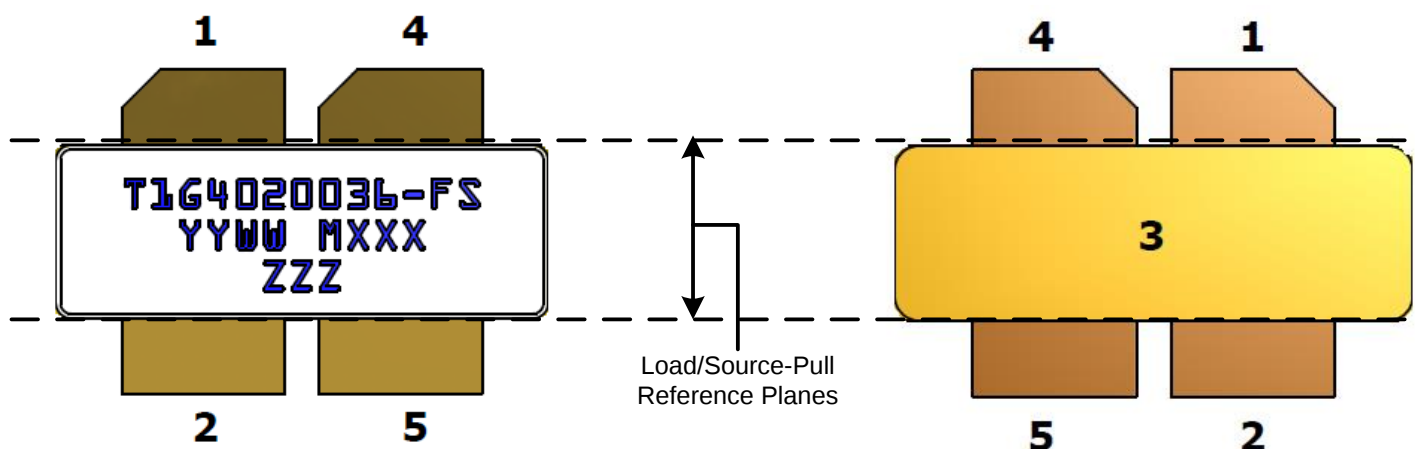
Notes:

1. Test Conditions:  $V_D = +50$  V; Failure Criteria = 10 % reduction in  $I_{D\_MAX}$  during DC Life Testing.
2. For pulsed signals, average lifetime is average lifetime at maximum channel temperature divided by duty cycle.

## Maximum Gate Current



## Pin Configuration and Description <sup>1</sup>

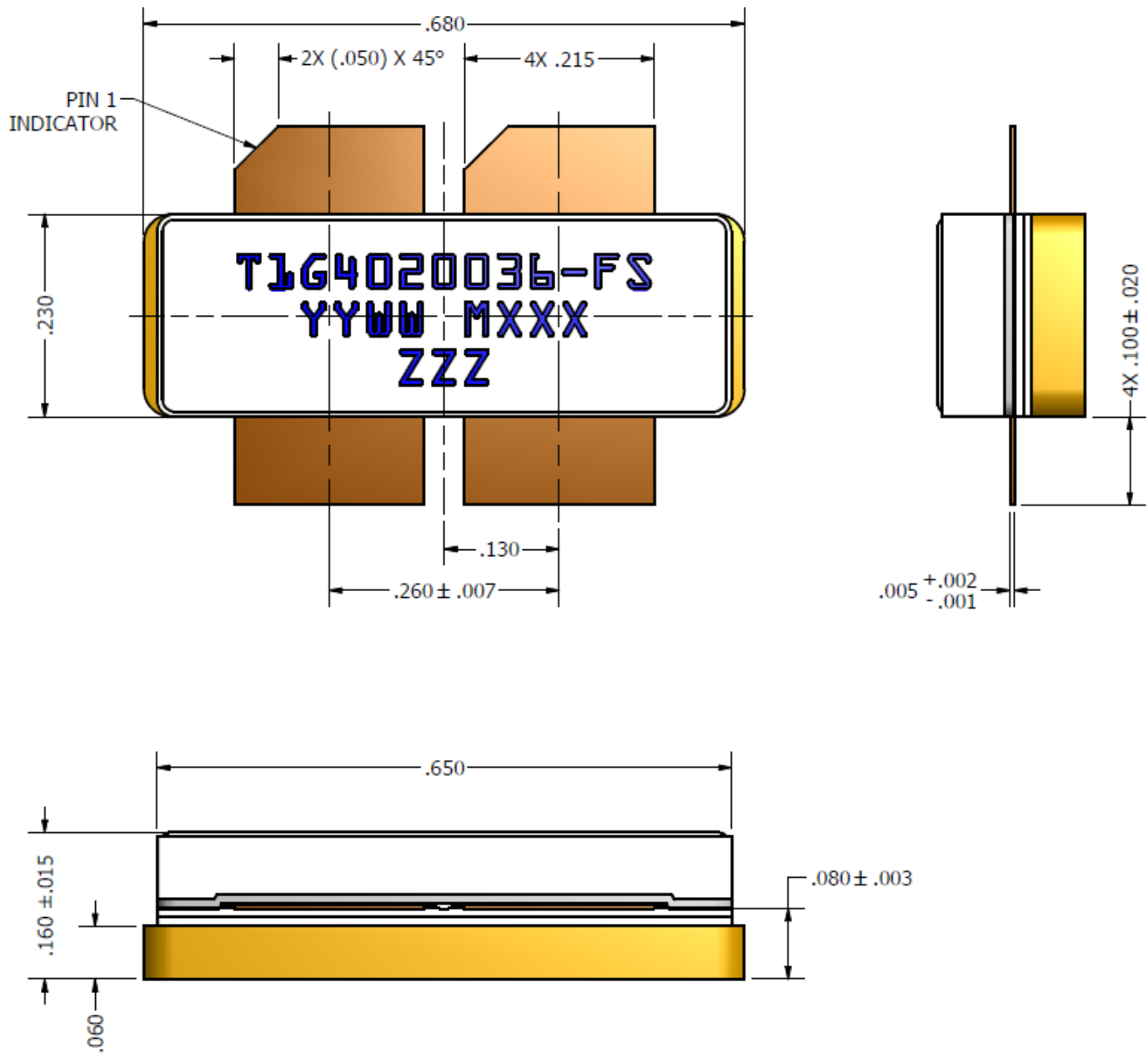


**Note:**

- 1- The T1G4020036-FS will be marked with the “20036” 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 “MXXX” is the production lot number, and the “ZZZ” is an auto-generated serial number.

| Pin  | Symbol         | Description                        |
|------|----------------|------------------------------------|
| 2, 5 | RF IN / $V_G$  | Gate                               |
| 1, 4 | RF OUT / $V_D$ | Drain                              |
| 3    | Source         | Source / Ground / Backside of part |

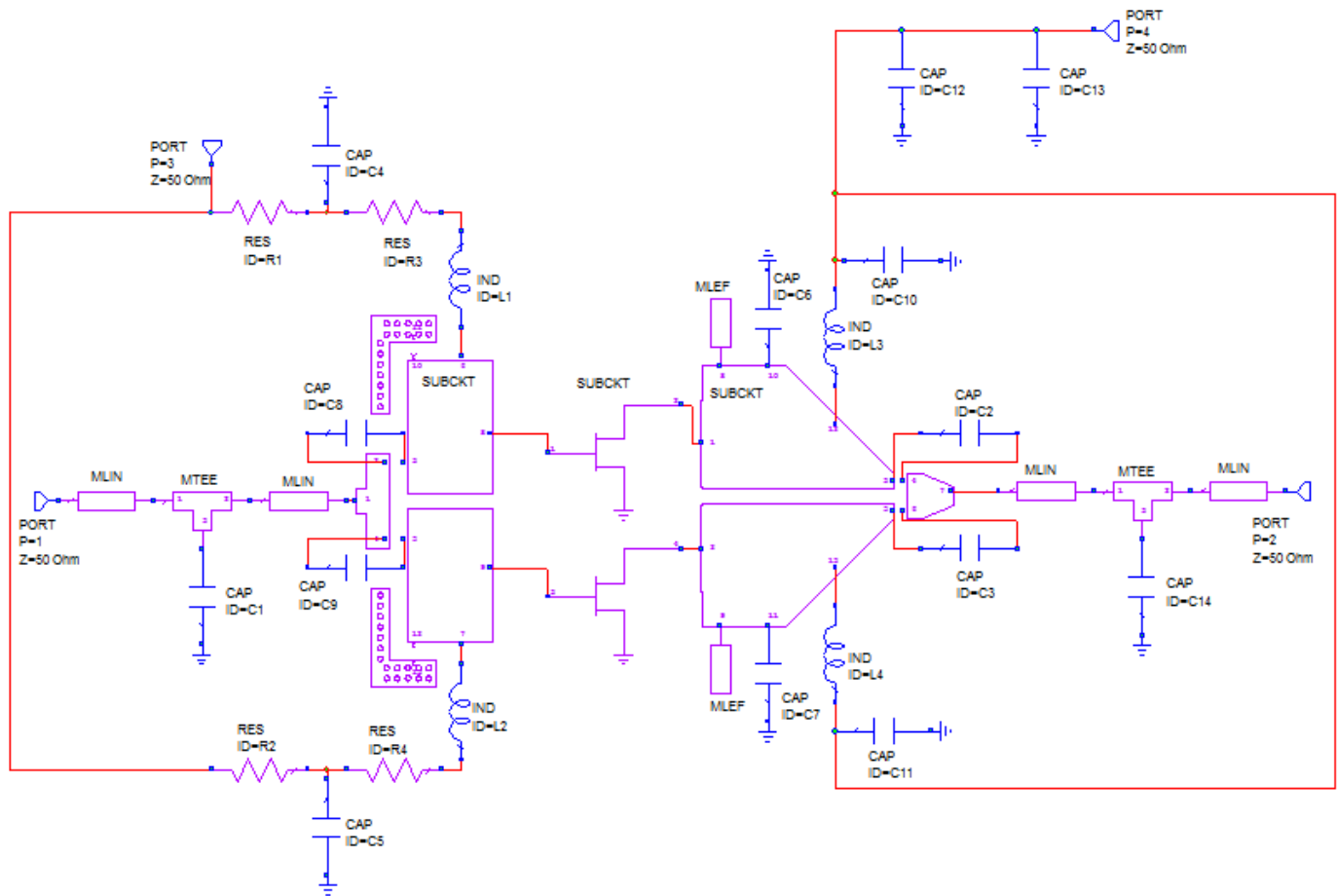
## Mechanical Drawing <sup>1</sup>



**Note:**

- 1- All dimensions are in inches. Dimension tolerance is ± 0.005 mil, unless noted otherwise.

## 2.9 – 3.3 GHz Application Circuit - Schematic



### Bias-up Procedure

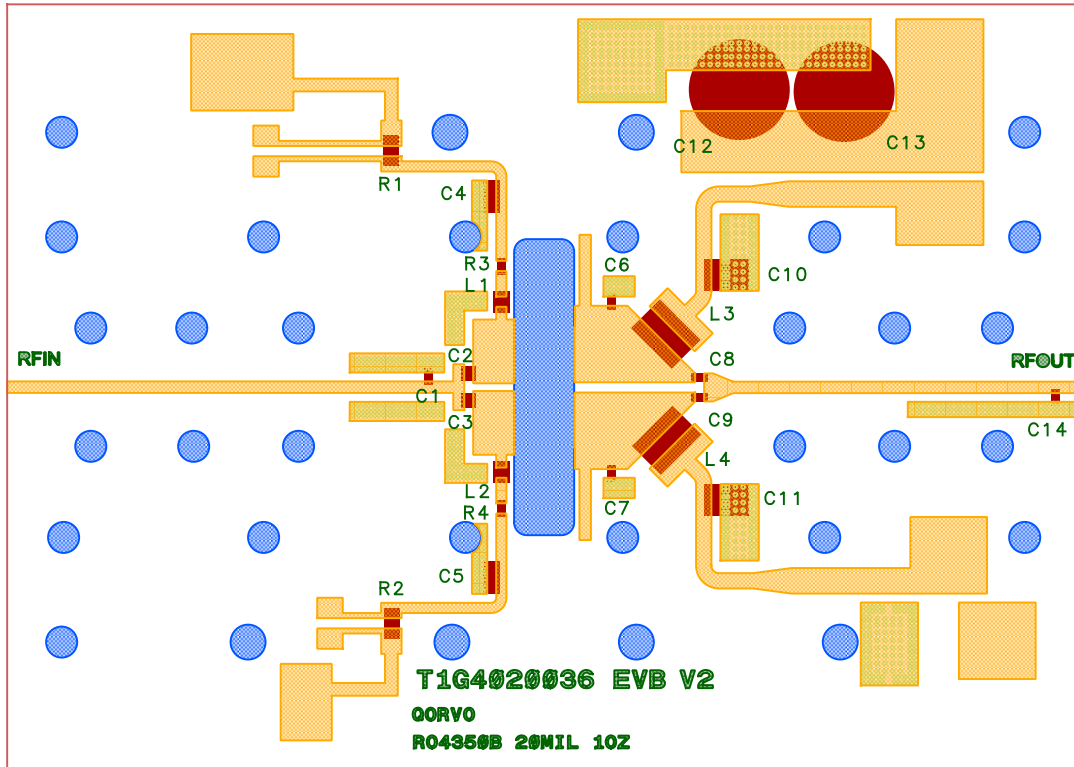
1. Set  $V_G$  to -5 V.
2. Set  $I_D$  current limit to 4 A.
3. Apply 36 V  $V_D$ .
4. Slowly adjust  $V_G$  until  $I_D$  is set to 520 mA.
5. Apply RF.

### Bias-down Procedure

1. Turn off RF signal.
2. Turn off  $V_D$
3. Wait 2 seconds to allow drain capacitor to discharge.
4. Turn off  $V_G$

## 2.9 – 3.3 GHz Application Circuit - Layout

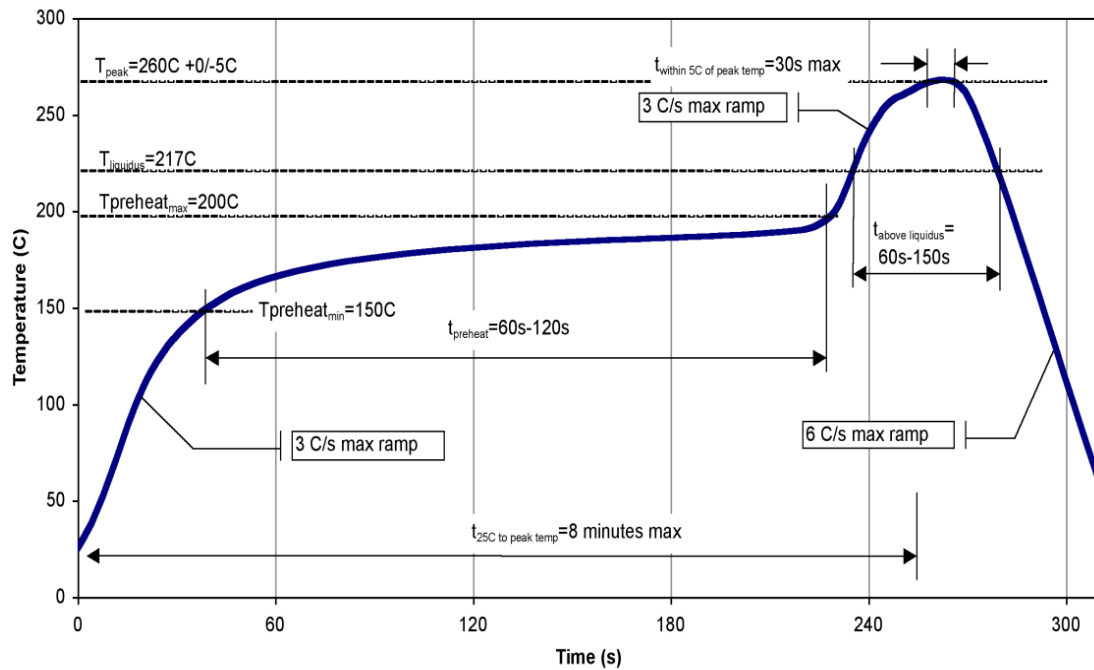
PCB material is RO4350B 0.020" thick.



## 2.9 – 3.3 GHz Application Circuit – Bill of Material

| Reference Design | Value      | Qty | Manufacturer          | Part Number         |
|------------------|------------|-----|-----------------------|---------------------|
| C4, C5           | 10uF, 6.3V | 2   | TDK                   | C1632X5R0J106M130AC |
| C10, C11         | 1uF, 100V  | 2   | AVX                   | 18121C105KAT2A      |
| C12, C13         | 220uF, 50V | 2   | United Chemi-Con      | EMVY500ADA221MJA0G  |
| C2, C3           | 2.7pF      | 2   | ATC                   | 600F2R7AT250X       |
| C8, C9           | 5.6pF      | 2   | ATC                   | 600S5R6AT250X       |
| C1               | 1.6pF      | 1   | ATC                   | 600S1R6AT250X       |
| C6, C7           | 0.5pF      | 2   | ATC                   | 600S0R5AT250X       |
| C14              | 0.8pF      | 1   | ATC                   | 600S0R8AT250X       |
| R3, R4           | 10Ohms     | 2   | Vishay                | CRCW060310R0FKEA    |
| R1, R2           | 0.0010hms  | 2   | Stackpole Electronics | CSNL1206FT1L00      |
| L1, L2           | 22nH       | 2   | Coilcraft             | 0805CS-220X_E_      |
| L3, L4           | 6.6nH      | 2   | Coilcraft             | GA3093-AL_          |
| Connectors       | SMA        | 2   | Gigalane              | 1101055             |

## Recommended Solder Temperature Profile



### Handling Precautions

| Parameter                        | Rating   | Standard                                         |
|----------------------------------|----------|--------------------------------------------------|
| ESD – Human Body Model (HBM)     | Class 1B | JESD22-A114                                      |
| ESD – Charged Device Model (CDM) | Class C3 | JESD22-C101                                      |
| MSL – Moisture Sensitivity Level | MSL3     | IPC/JEDEC J-STD-020<br>(260°C Convection reflow) |



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: NiAu

### 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<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) 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](http://www.Qorvo.com)  
**Email:** [info-sales@qorvo.com](mailto:info-sales@qorvo.com)

**Tel:** +1.972.994.8465  
**Fax:** +1.972.994.8504

For technical questions and application information: **Email:** [info-products@qorvo.com](mailto:info-products@qorvo.com)

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