# T1G4012036-FS

***120W Peak Power, 24W Average Power, 36V DC – 3.5 GHz, GaN RF Power Transistor***

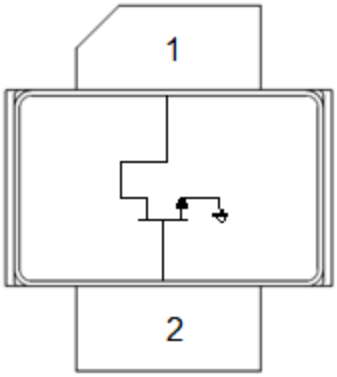
## Applications

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


## Product Features

- Frequency: DC to 3.5 GHz
- Output Power ($P_{3dB}$): 120 W Peak (24 Watts Avg.) at 3.3 GHz
- Linear Gain: >15 dB at 3.3 GHz
- Operating Voltage: 36 V
- Low thermal resistance package

## Functional Block Diagram




## General Description

The TriQuint T1G4012036-FS is a 120 W Peak (24 W Avg.) ($P_{3dB}$) discrete GaN on SiC HEMT which operates from DC to 3.5 GHz. The device is constructed with TriQuint's proven TQGaN25HV process, which features advanced field plate techniques to optimize power and efficiency at high drain bias operating conditions. This optimization can potentially lower system costs in terms of fewer amplifier line-ups and lower thermal management costs.

Lead-free and ROHS compliant

Evaluation boards are available upon request.

## Pin Configuration

| Pin No. | Label |
|---|---|
| 1 | $V_D$ / RF OUT |
| 2 | $V_G$ / RF IN |
| Flange | Source |

## Ordering Information

| Part | ECCN | Description |
|---|---|---|
| T1G4012036-FS | EAR99 | Packaged part Flangeless |
| T1G4012036-FS-EVB1 | EAR99 | 3.1-3.5 GHz Evaluation Board |

## Absolute Maximum Ratings

| Parameter | Value |
|---|---|
| Breakdown Voltage ($BV_{DG}$) | 145 V |
| Gate Voltage Range ($V_G$) | -7 to 0 V |
| Drain Current ($I_D$) | 12 A |
| Gate Current ($I_G$) | -28.8 to 33.6 mA |
| Power Dissipation ($P_D$) | 117 W |
| RF Input Power, CW, T = 25°C ($P_{IN}$) | 44.5 dBm |
| Channel Temperature ($T_{CH}$) | 275 °C |
| 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. These are stress ratings only, and functional operation of the device at these conditions is not implied.

## Recommended Operating Conditions

| Parameter | Value |
|---|---|
| Drain Voltage ($V_D$) | 36 V (Typ.) |
| Drain Quiescent Current ($I_{DQ}$) | 360 mA (Typ.) |
| Peak Drain Current ( $I_D$) | 6 A (Typ.) |
| Gate Voltage ($V_G$) | -2.9 V (Typ.) |
| Channel Temperature ($T_{CH}$) | 250 °C (Max.) |
| Power Dissipation, CW ($P_D$) | 86 W (Max) |
| Power Dissipation, Pulse ($P_D$) | 144 W (Max) |

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

## RF Characterization – Load Pull Performance at 3.1 GHz (1)

Test conditions unless otherwise noted: $T_A$ = 25 °C, $V_D$ = 36 V, $I_{DQ}$ = 360 mA

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain | | 18.4 | | dB |
| $P_{3dB}$ | Output Power at 3 dB Gain Compression | | 130.0 | | W |
| $DE_{3dB}$ | Drain Efficiency at 3 dB Gain Compression | | 64.6 | | % |
| $PAE_{3dB}$ | Power-Added Efficiency at 3 dB Gain | | 62.7 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression | | 15.4 | | dB |

Notes:
1. $V_{DS}$ = 36 V, $I_{DQ}$ = 360 mA; Pulse: 100µs, 20%

## RF Characterization – Load Pull Performance at 3.5 GHz (1)

Test conditions unless otherwise noted: $T_A$ = 25 °C, $V_D$ = 36 V, $I_{DQ}$ = 360 mA

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain | | 18.7 | | dB |
| $P_{3dB}$ | Output Power at 3 dB Gain Compression | | 136.0 | | W |
| $DE_{3dB}$ | Drain Efficiency at 3 dB Gain Compression | | 62.7 | | % |
| $PAE_{3dB}$ | Power-Added Efficiency at 3 dB Gain | | 61.0 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression | | 15.7 | | dB |

Notes:
1. $V_{DS}$ = 36 V, $I_{DQ}$ = 360 mA; Pulse: 100µs, 20%

## RF Characterization – Performance at 3.3 GHz (1, 2)

Test conditions unless otherwise noted: $T_A$ = 25 °C, $V_D$ = 36 V, $I_{DQ}$ = 360 mA

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain | 15.0 | 16.0 | | dB |
| $P_{3dB}$ | Output Power at 3 dB Gain Compression | 100.0 | 120.0 | | W |
| $DE_{3dB}$ | Drain Efficiency at 3 dB Gain Compression | 50.0 | 52.0 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression | 12.0 | 13.0 | | dB |

Notes:
1. Performance at 3.3 GHz in the 3.1 to 3.5 GHz Evaluation Board
2. $V_{DS}$ = 36 V, $I_{DQ}$ = 360 mA; Pulse: 100µs, 20%

## RF Characterization – Narrow Band Performance at 3.50 GHz (1)

Test conditions unless otherwise noted: $T_A$ = 25 °C, $V_D$ = 36 V, $I_{DQ}$ = 360 mA

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

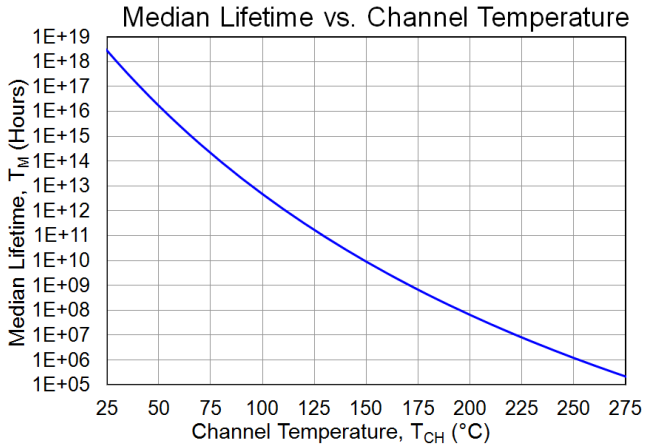
Notes:
1. $V_{DS}$ = 36 V, $I_{DQ}$ = 360 mA, CW at $P_{3dB}$

## Thermal and Reliability Information

| Parameter | Test Conditions | Value | Units |
|---|---|---|---|
| Thermal Resistance ($\theta_{JC}$) | Vd = 36V, DC at 85°C Case CW | 1.62 | °C/W |
| Channel Temperature ($T_{CH}$) | | 225 | °C |
| Thermal Resistance ($\theta_{JC}$) | Vd = 32 V, DC at 85°C Case 100 usec, 20% duty cycle | 0.90 | °C/W |
| Channel Temperature ($T_{CH}$) | | 175.5 | °C |
| Thermal Resistance ($\theta_{JC}$) | Vd = 32 V, DC at 85°C Case 100 usec, 10% duty cycle | 0.81 | °C/W |
| Channel Temperature ($T_{CH}$) | | 167 | °C |
| Thermal Resistance ($\theta_{JC}$) | Vd = 32 V, DC at 85°C Case 300 usec, 20% duty cycle | 1.03 | °C/W |
| Channel Temperature ($T_{CH}$) | | 189 | °C |
| Thermal Resistance ($\theta_{JC}$) | Vd = 32 V, DC at 85°C Case 300 usec, 10% duty cycle | 0.97 | °C/W |
| Channel Temperature ($T_{CH}$) | | 183 | °C |

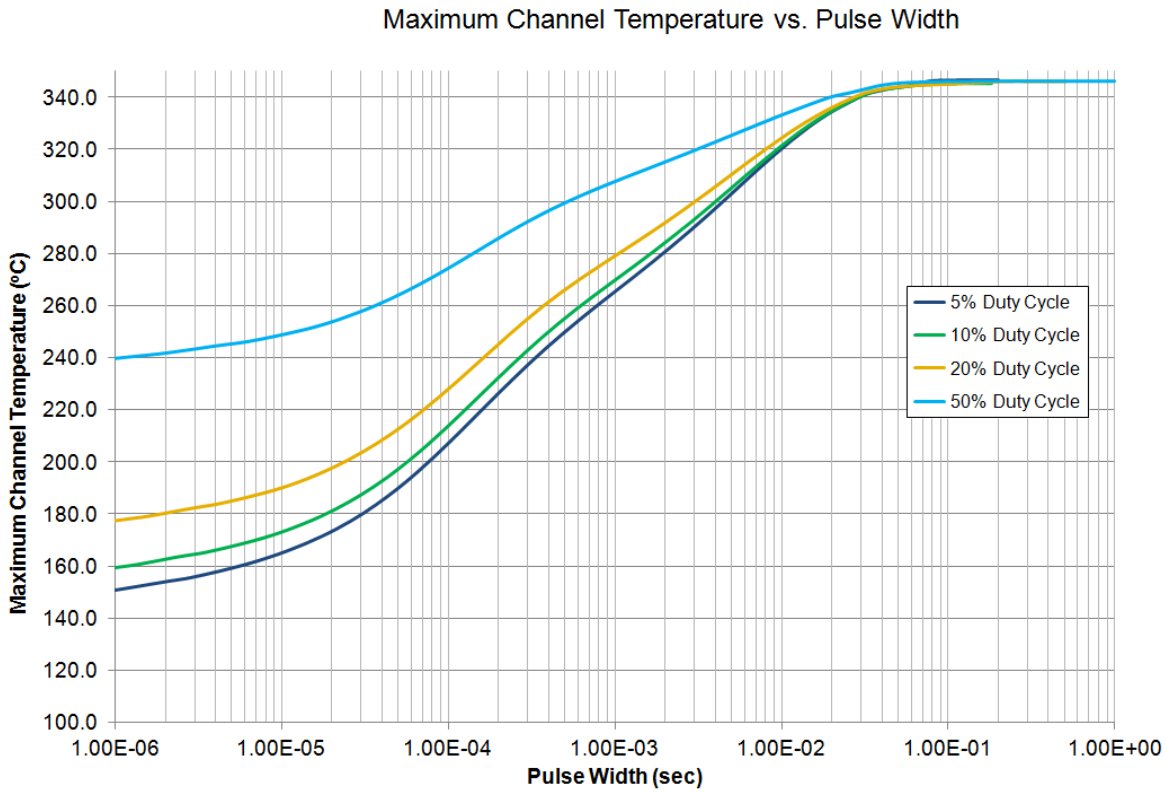
Notes:
Thermal resistance measured to bottom of package, CW.

## Median Lifetime



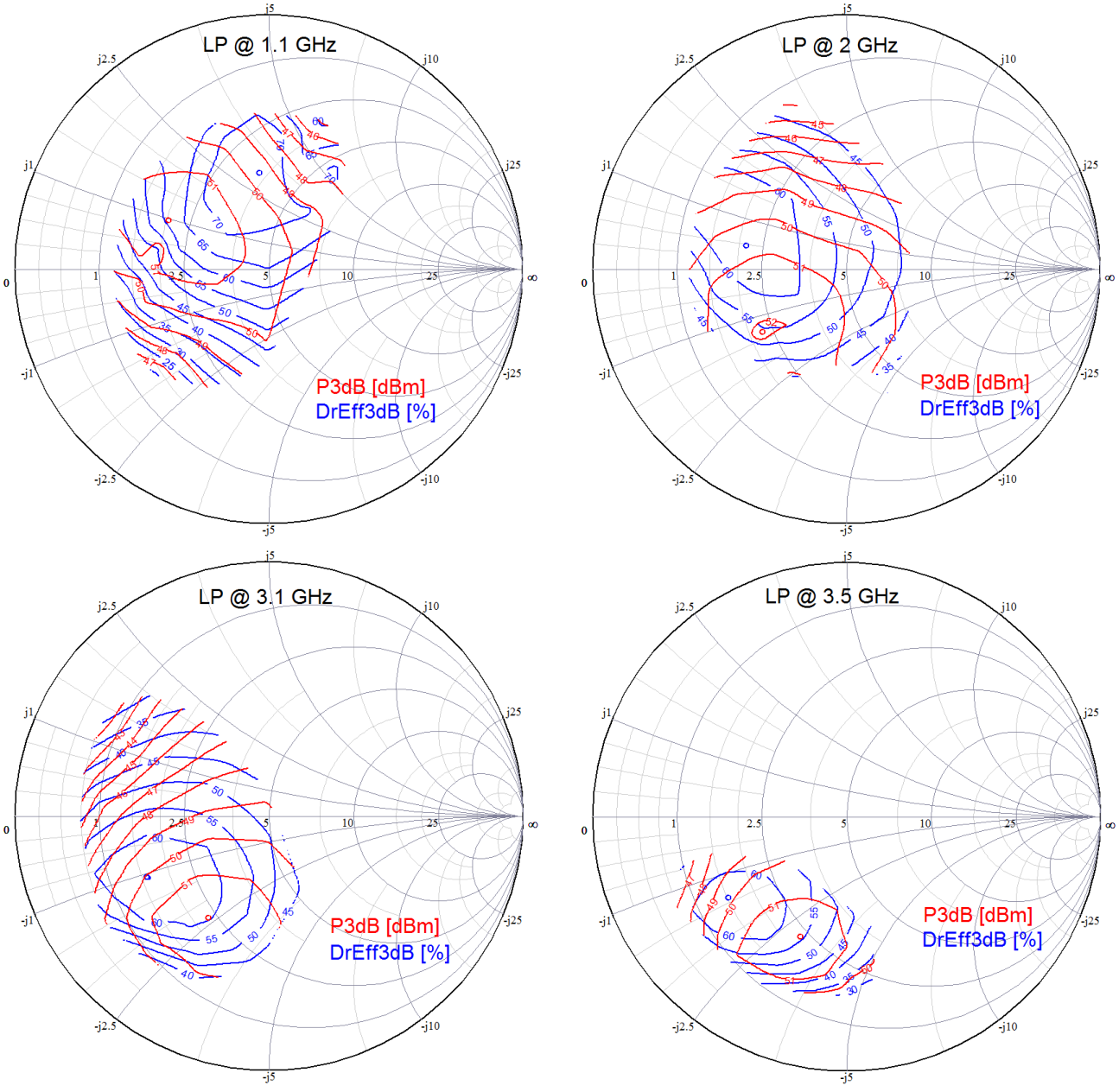

## Maximum Channel Temperature

$T_{BASE}$ = 85°C, $P_D$ = 144 W



## Load Pull Smith Charts (1, 2)

RF performance that the device typically exhibits when placed in the specified impedance environment. The impedances are not the impedances of the device, they are the impedances presented to the device via an RF circuit or load-pull system. The impedances listed follow an optimized trajectory to maintain high power and high efficiency.



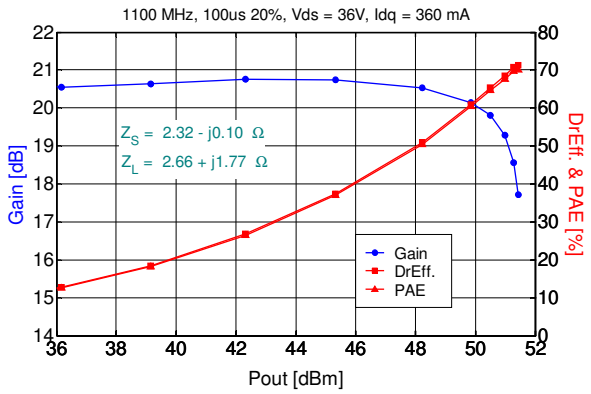

Notes:

1. Test Conditions: $V_{DS}$ = 36 V, $I_{DQ}$ = 360 mA
2. Test Signal: Pulse Width = 100 µsec, Duty Cycle = 20%

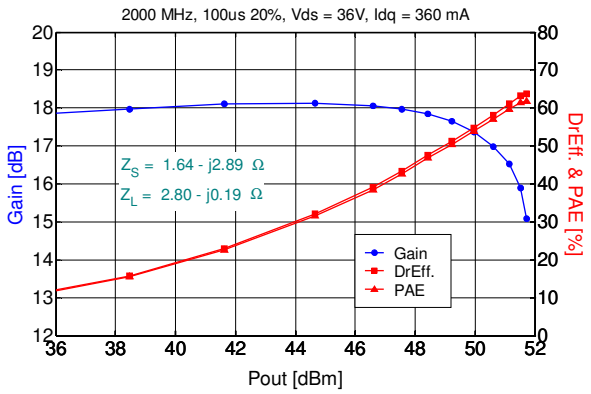
## Typical Performance

Performance is based on compromised impedance point and measured at DUT reference plane.

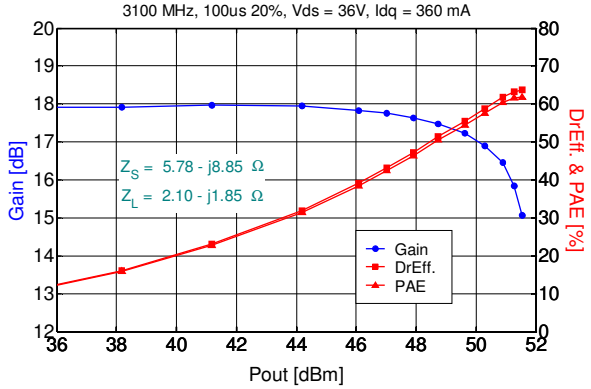
T1G4012036-FS Gain DrEff. and PAE vs. Pout



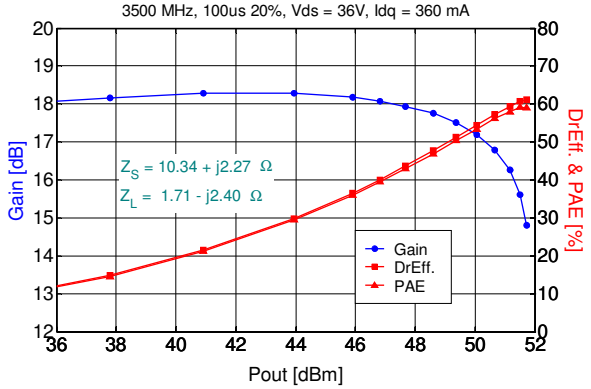

T1G4012036-FS Gain DrEff. and PAE vs. Pout




T1G4012036-FS Gain DrEff. and PAE vs. Pout

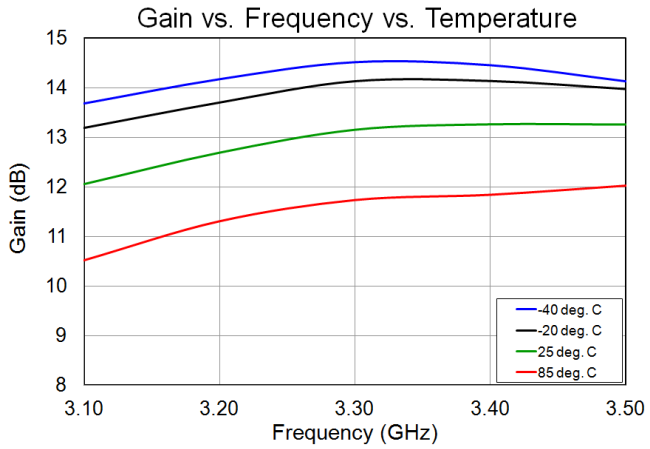


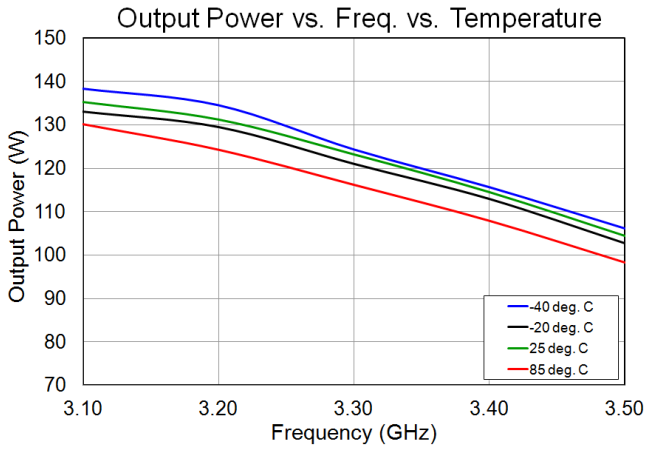

T1G4012036-FS Gain DrEff. and PAE vs. Pout

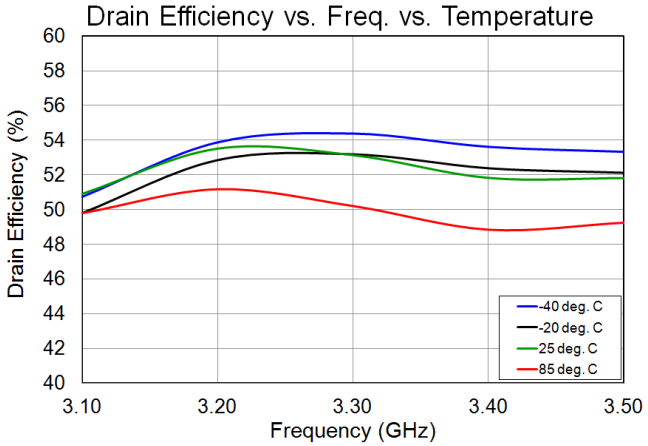


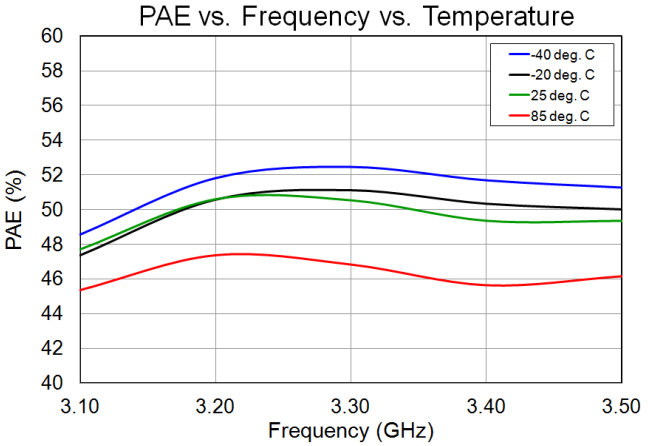
## Performance Over Temperature (1, 2)

Performance measured in TriQuint's 3.1 GHz to 3.5 GHz Evaluation Board at 3 dB compression.



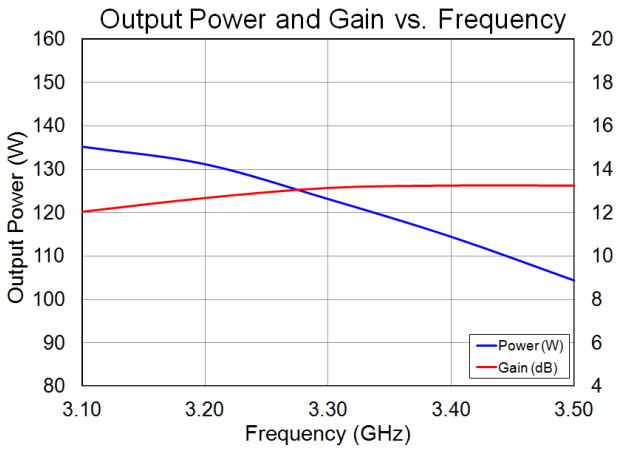



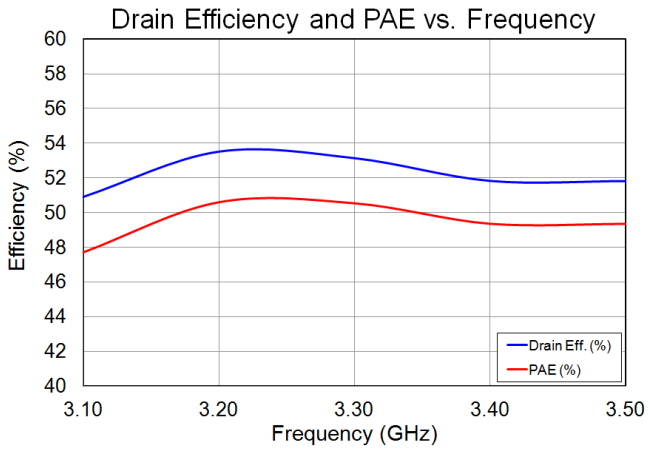

Notes:

1. Test Conditions: $V_{DS}$ = 36 V, $I_{DQ}$ = 360 mA
2. Test Signal: Pulse Width = 100 µs, Duty Cycle = 20%

## Evaluation Board Performance (1, 2)

Performance at 3 dB Compression

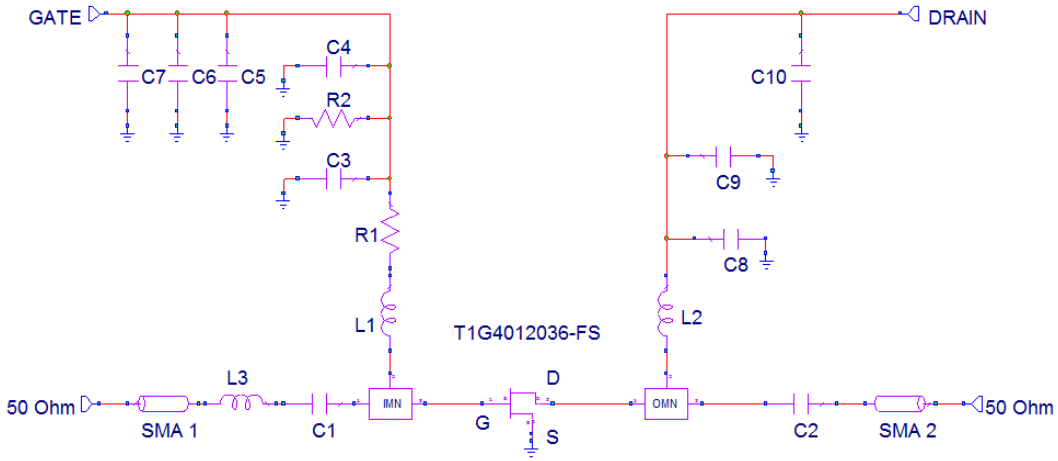



Notes:

1. Test Conditions: $V_{DS}$ = 36 V, $I_{DQ}$ = 360 mA
2. Test Signal: Pulse Width = 100 µs, Duty Cycle = 20 %

## Application Circuit




## Bias-up Procedure

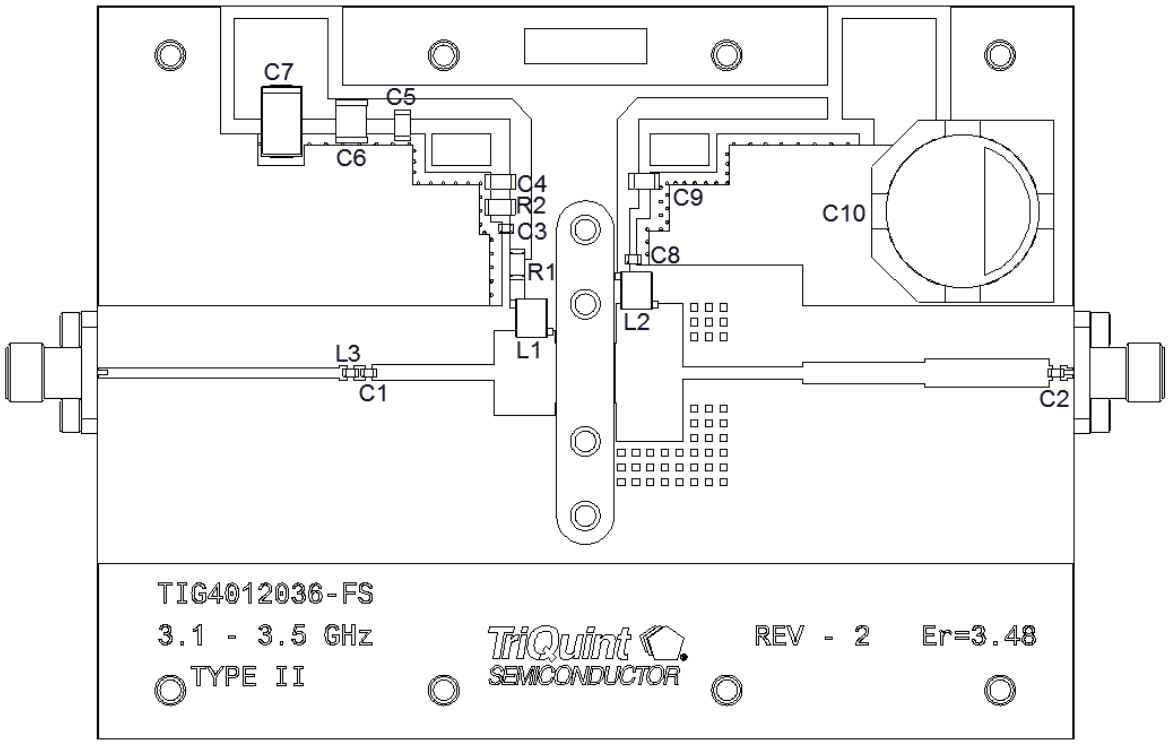
| |
|---|
| Set gate voltage ($V_G$) to -5.0V |
| Set drain voltage ($V_D$) to 36 V |
| Slowly increase $V_G$ until quiescent $I_D$ is 360 mA. |
| Apply RF signal |

## Bias-down Procedure

| |
|---|
| Turn off RF signal |
| Turn off $V_D$ and wait 1 second to allow drain capacitor dissipation |
| Turn off $V_G$ |

## Evaluation Board Layout

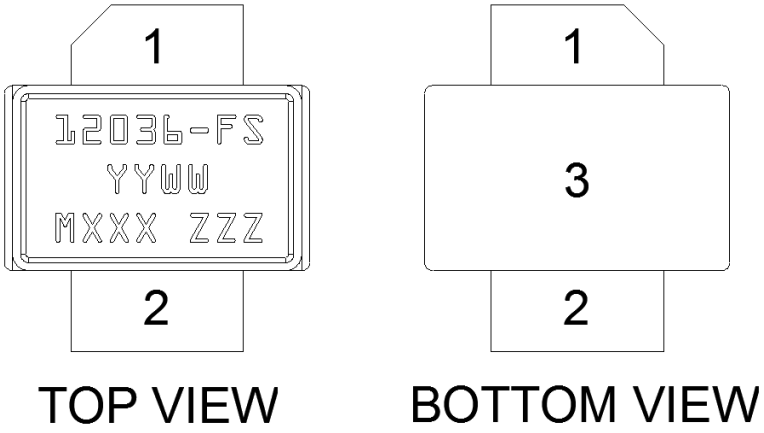
Top RF layer is 0.020" thick Rogers RO4350B, $\varepsilon_r$ = 3.48. The pad pattern shown has been developed and tested for optimized assembly at TriQuint Semiconductor. The PCB land pattern has been developed to accommodate lead and package tolerances.




## Bill of Materials

| Reference Design | Value | Qty | Manufacturer | Part Number |
|---|---|---|---|---|
| L1 | 12.55 nH | 1 | Coilcraft | 1606-10_L |
| L2 | 12.5 nH | 1 | Coilcraft | A04T_L |
| L3 | 1.6 nH | 1 | Coilcraft | 0603HC-1N6X_L |
| R1 | 51 ohms | 1 | Vishay/Dale | CRCW120651R0FKEA |
| R2 | 1000 ohms | 1 | Vishay/Dale | CRCW12061K00FKTA |
| C1 | 1.8 pF | 1 | ATC | 600S1R8BT |
| C2, C3 | 15 PF | 2 | ATC | 600S150JT250XT |
| C4, C9 | 1000 pF | 2 | ATC | 800B102JT50XT |
| C5 | 0.01 uF | 1 | Kemet | C1206C103KRAC7800 |
| C6 | 1 uF | 1 | Allied | 18121C105KAT2A |
| C7 | 22 uF | 1 | Sprague | T4910D |
| C8 | 2400 pF | 1 | Murata | C08BL242X-5UN-X0T |
| C10 | 220 uF | 1 | United Chemi-Con | EMVY500ADA221MJA0G |

## Pin Layout




Note:
The T1G4012036-FS will be marked with the "12036" 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.

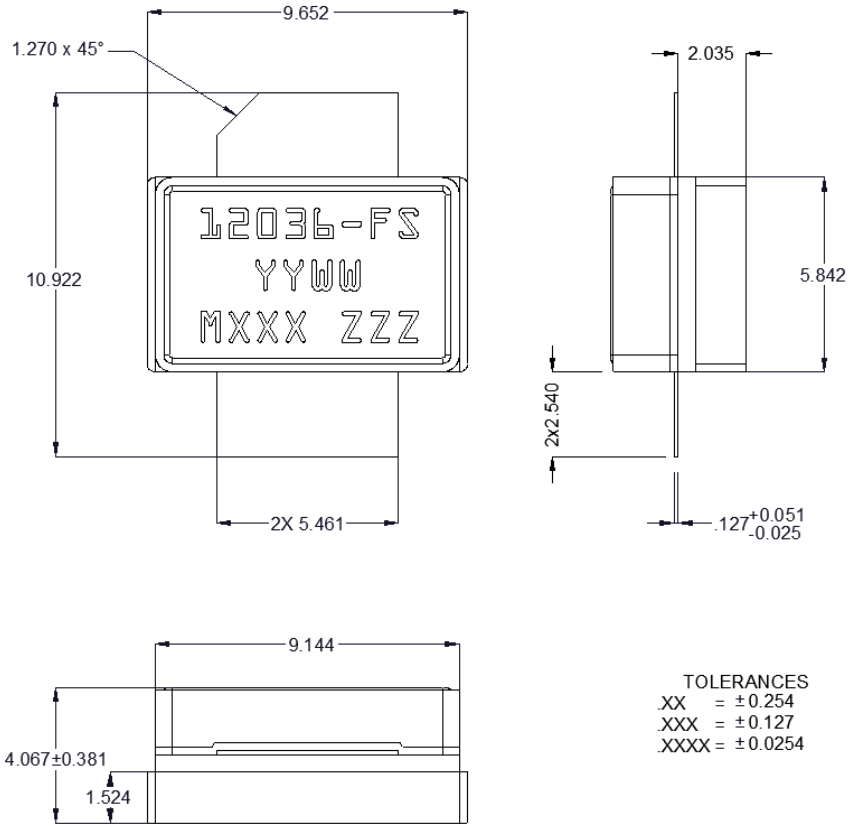
## Pin Description

| Pin | Symbol | Description |
|---|---|---|
| 1 | $V_D$ / RF OUT | Drain voltage / RF Output matched to 50 ohms; see EVB Layout on page 9 as an example. |
| 2 | $V_G$ / RF IN | Gate voltage / RF Input matched to 50 ohms; see EVB Layout on page 9 as an example. |
| 3 | Flange | Source connected to ground; see EVB Layout on page 9 as an example. |

Notes:
Thermal resistance measured to bottom of package

## Mechanical Information

All dimensions are in millimeters.




Note:

This package is lead-free/RoHS-compliant. The plating material on the leads is NiAu. It is compatible with both lead-free (maximum 260 ℃ reflow temperature) and tin-lead (maximum 245℃ reflow temperature) soldering processes.

## Product Compliance Information

### ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

| | |
|---|---|
| ESD Rating: | Class 1B |
| Value: | Passes ≥ 500 V to < 1,000 V max. |
| Test: | Human Body Model (HBM) |
| Standard: | JEDEC Standard JESD22-A114 |

### MSL Rating

Level 3 at +260 °C convection reflow
The part is rated Moisture Sensitivity Level 3 at 260°C per JEDEC standard IPC/JEDEC J-STD-020.

### ECCN

US Department of Commerce EAR99

### Solderability

Compatible with the latest version of J-STD-020, Lead free solder, 260° C

### 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 ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free

## Recommended Soldering Temperature Profile