## 1. Description

- The D2209 is a 350W ($P_{SAT}$) wideband pre-matched gallium nitride (GaN) high electron mobility transistor (HEMT) with first generation RF GaN technology from Raytron.
- The D2209 operates from DC to 3GHz with a 48V supply rail. The device is offered in an industry standard air cavity package.

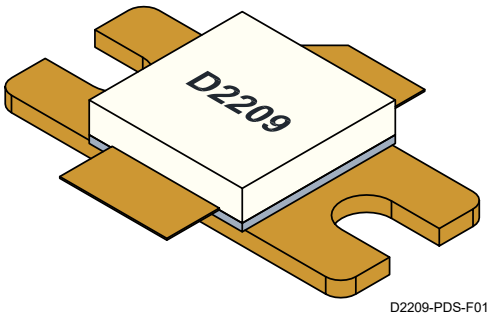



**Figure 1. D2209 Package Outline**

## 2. Applications

- Military and Civilian Radar
- Land Mobile and Military Radio Communications
- Avionics and Test Instrumentation

## 3. Features[1]

- Operating Frequency: DC–3GHz
- Output Power ($P_{SAT}$): 55.8dBm (380W)
- Linear Gain: 19.5dB
- Typical DE @$P_{SAT}$: 72.3%
- Operating Voltage: 48V
- CW and Pulse Capable
- Package Type: 400F-A

[1] Measured in Raytron DEMO @2.1GHz

## 4. Brief Typical Performance

**Table 1. Brief Typical Performance**

| Parameter | 1.2GHz | 2.1GHz | Units |
|---|---|---|---|
| Linear Gain | 22.1 | 19.5 | dB |
| Drain Efficiency | 76.1 | 72.3 | % |
| Output Power | 55.5 | 55.8 | dBm |

- Typical Class AB performance in Raytron DEMO with the device soldered onto the heatsink, test condition: $V_{DS}$ = 48V, $I_{DS}$ = 350mA, $V_{GS}$ = -3.15V
- Test Condition: Pulse, Pulse width = 100μs, Duty cycle = 10%

## 5. Block Diagram

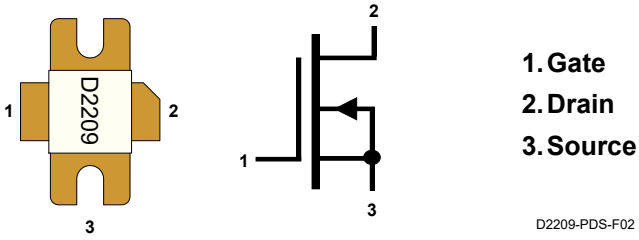



**Figure 2. D2209 Block Diagram**

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## 6. Absolute Maximum Ratings

### Table 2. Absolute Maximum Ratings

| Parameter | Symbol | Rating | Units |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | 150 | V |
| Gate-Source Voltage | $V_{GS}$ | -10 ~ +1 | V |
| Operating Voltage | $V_{DS}$ | 10 ~ +55 | V |
| Maximum Forward Gate Current | $I_{GMax}$ | 44 | mA |
| Storage Temperature Range | $T_{STG}$ | -65 ~ +150 | °C |
| Operating Junction Temperature | $T_J$ | 250 | °C |

## 7. Recommended Operating Conditions

### Table 3. Recommended Operating Conditions

| Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|
| Operating Temperature Range | -40 | 25 | 85 | °C |
| Drain-Source Voltage Range, $V_{DS}$ | - | 48 | 55 | V |
| Drain Bias Current, $I_{DS}$ | - | 350 | - | mA |
| Gate-Source Voltage, $V_{GS}$ | - | -3.15 | - | V |
| Channel Temperature, $T_{CH}$ | - | - | 225 | °C |

### Table 4. Thermal Resistance

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance (Active Die Surface-to-Case)[1] | $R_{thsc}$ (IR) | - | °C/W |
| Thermal Resistance (Junction-to-Case)[2] | $R_{thjc}$ (FEA) | 1.1 | °C/W |

1. Thermal Resistance at average power by infrared measurement, Active Die Surface-to-Case, $T_{base\text{-}plate}$ = 85℃, $P_D$ = 70.0W
2. Thermal Resistance at average power by Finite Element Analysis, Junction-to-Case, $T_{base\text{-}plate}$ = 85℃, $P_D$ = 70.0W

## 8. Electrical Characteristics ($T_C$ = 25˚C)

### Table 5. DC Characteristics

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Drain-Source Breakdown Voltage[1] ($V_{GS}$ = -10V, $I_{DS}$ = 44mA) | $V_{DS(BR)}$ | 150 | - | - | V |
| Saturated Drain Current[2] ($V_{DS}$ = 10V, $V_{GS}$ = 1V) | $I_{Max}$ | - | 45.75 | - | A |
| Gate Threshold Voltage[3] ($V_{DS}$ = 48V, $I_{DS}$ = 44mA) | $V_{GS(TH)}$ | -3.95 | -3.32 | -2.60 | V |
| Gate Quiescent Voltage[3] ($V_{DS}$ = 48V, $I_{DS}$ = 350mA) | $V_{GS(Q)}$ | - | -3.15 | - | V |

1. Measured on wafer prior to packaging
2. Measured with packaged device
3. Measured in Raytron DEMO

### Table 6. RF Characteristics[1]

| Test Method | Parameter | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| DEMO[2] @1.2GHz | Linear Gain | $G_{LIN}$ | - | 22.1 | - | dB |
| | Drain Efficiency | $\eta_D$ | - | 76.1 | - | % |
| | Output Power | $P_{SAT}$ | - | 55.5 | - | dBm |
| DEMO[2] @2.1GHz | Linear Gain | $G_{LIN}$ | - | 19.5 | - | dB |
| | Drain Efficiency | $\eta_D$ | - | 72.3 | - | % |
| | Output Power | $P_{SAT}$ | - | 55.8 | - | dBm |

1. Test Condition: Pulse, Pulse width = 100μs, Duty cycle = 10%
2. Typical Class AB performance in Raytron DEMO with the device soldered onto the heatsink, test condition: $V_{DS}$ = 48V, $I_{DS}$ = 350mA, $V_{GS}$ = -3.15V

### Table 7. Dynamic Characteristics

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Input Capacitance | $C_{GS}$ | - | 73.2 | | pF |
| Output Capacitance | $C_{DS}$ | - | 17.3 | | pF |
| Feedback Capacitance | $C_{GD}$ | - | 2.1 | | pF |

- Test Condition: $V_{DS}$ = 48V, $V_{GS}$ = -8V, f = 1MHz

## 9. Typical Performance

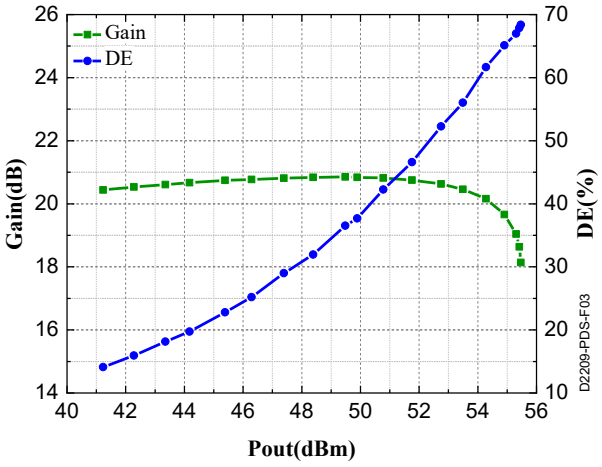



**Figure 3. 1.2GHz Gain and DE @ MXP vs. Output Power**

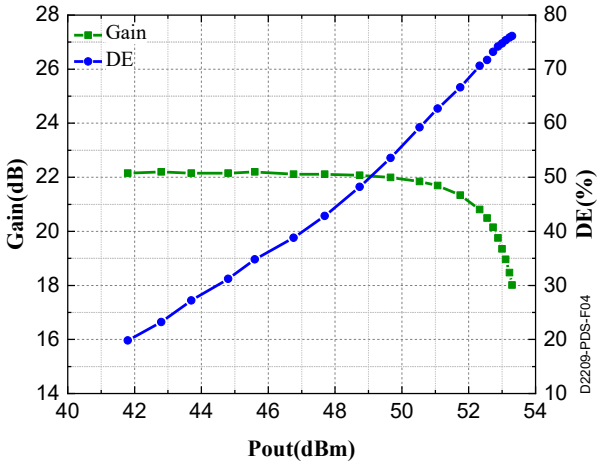



**Figure 4. 1.2GHz Gain and DE @ MXE vs. Output Power**

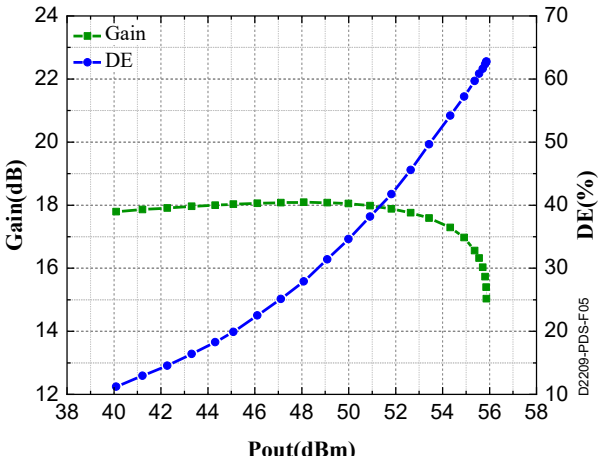



Figure 5. 2.1GHz Gain and DE @ MXP vs. Output Power

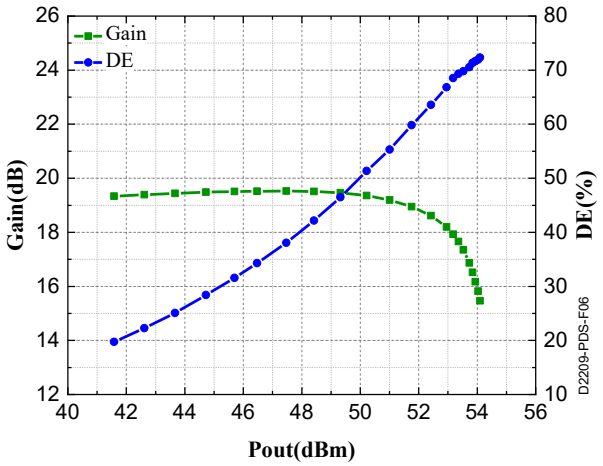



Figure 6. 2.1GHz Gain and DE @ MXE vs. Output Power

- Typical Class AB performance in Raytron DEMO with the device soldered onto the heatsink, test condition: $V_{DS}$ = 48V, $I_{DS}$ = 350mA, $V_{GS}$ = -3.15V
- Test Condition: Pulse, Pulse width = 100μs, Duty cycle = 10%

## 10. Package Outline

### ■ Pin Layout

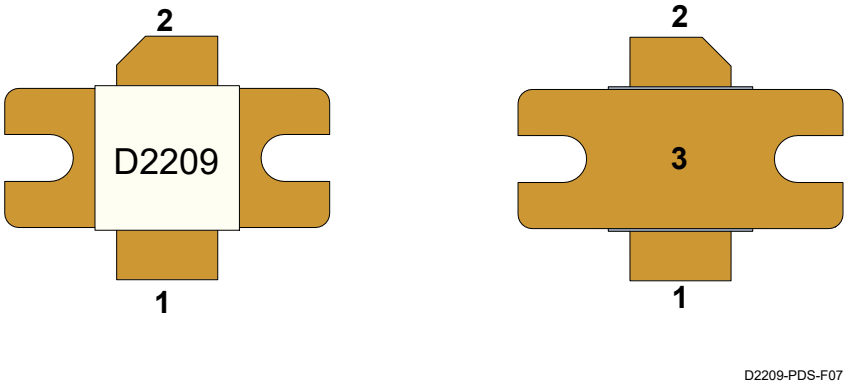



Figure 7. D2209 Pin Layout

### Table 8. Pin Description

| Pin | Symbol | Description |
|---|---|---|
| 1 | $V_G$ / RF IN | Gate Voltage / RF Input |
| 2 | $V_D$ / RF OUT | Drain Voltage / RF Output |
| 3 | Flange | Source to be Connected to Ground |

## ■ Mechanical Drawing (Package Type:400F-A)

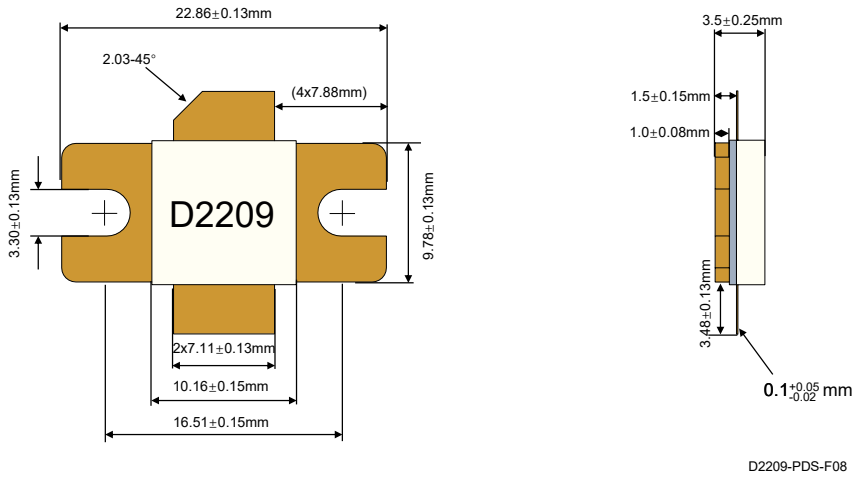



**Figure 8. D2209 Mechanical Drawing**

# 11. DEMO Summary

### Table 9. DEMO Summary

| NO. | D2209 DEMO Name | $V_{DS}$ (V) | Freq (GHz) | Linear Gain(dB) | $P_{SAT}$ (dBm) | $P_{SAT}$ (W) | Drain Efficiency | Pulse or CW |
|---|---|---|---|---|---|---|---|---|
| 1 | DEMO_A, 230W | 48 | 0.1 | 33.8 | 53.7 | 234 | 83% | CW |
| 2 | DEMO_B, 130W | 28 | 0.117-0.137 | 25.0 | 51.2 | 132 | 74% | CW |
| 3 | DEMO_C, 260W | 48 | 1.09 | 22.5 | 54.2 | 260 | 73% | Pulse |

### Table 10. Bias Procedure

| Bias-up Procedure | Bias-down Procedure |
|---|---|
| 1) Set $V_{GS}$ to the pinch-off voltage, typically -6V | 1) Turn off RF signal |
| 2) Turn on $V_{DS}$ to nominal supply voltage | 2) Turn off $V_{DS}$ |
| 3) Slowly adjust $V_{GS}$ until $I_{DS}$ current is attained | 3) Wait two seconds to allow drain capacitor to discharge |
| 4) Apply RF input power to desired level | 4) Turn off $V_{GS}$ |

## 12. Recommended Solder Temperature Profile

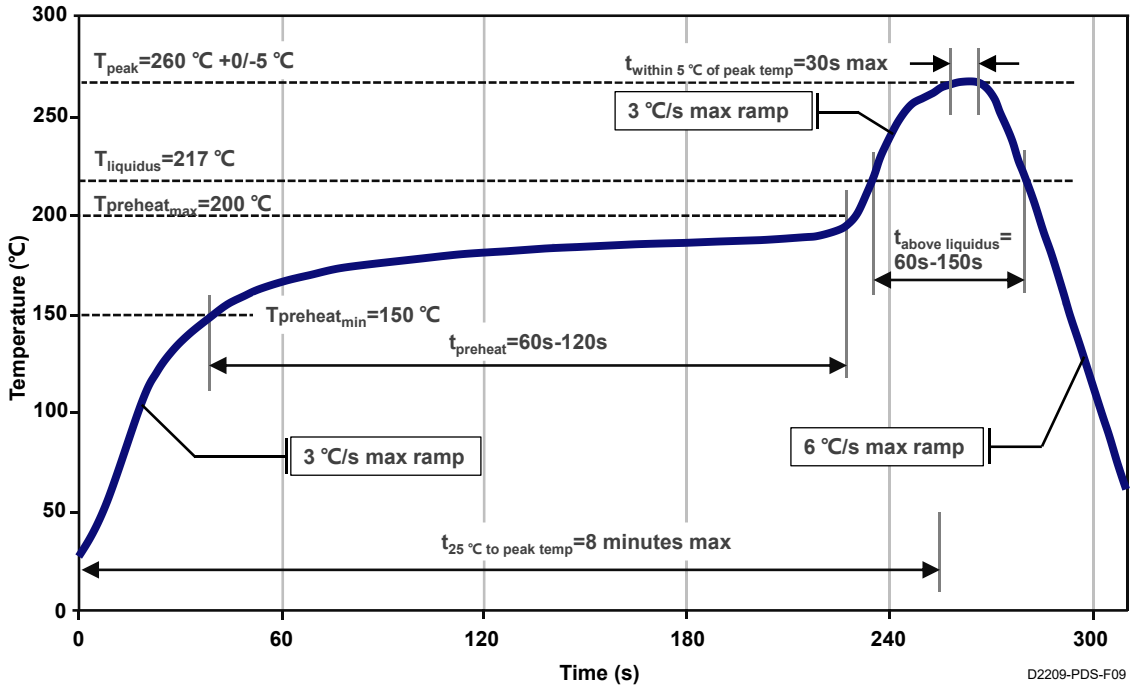



**Figure 9. Recommended Solder Temperature Profile**

## 13. Handling Precautions

- **ESD Caution**

  ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore proper ESD precautions should be taken to avoid performance degradation or loss of functionality.




## 14. Contact Information

For the latest specifications, additional product information, technical support and sales support, please contact:

- **Email:** RF.support@raytrontek.com
- **Web:** www.raytrontek.com

## 15. Disclaimer

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