# QPD0060

## 90 W, 48 V, DC to 3.6 GHz, GaN RF Power Transistor

## Product Overview

The QPD0060 is a wide band plastic overmolded DFN discrete power amplifier. The device is a single stage unmatched power amplifier transistor.

The QPD0060 can be used in Doherty architecture for the final stage of a base station amplifier for small cell, microcell, and active antenna systems. The QPD0060 can also be used as a driver in a macrocell base station power amplifier.

The wide bandwidth of the QPD0060 makes it suitable for many different applications from DC to 2.7 GHz. QPD0060 can deliver $P_{SAT}$ of 89.1 W at +48 V operation at 2.1 GHz.

Lead-free and RoHS compliant.


6 Pin 7.2 x 6.6 mm DFN Package

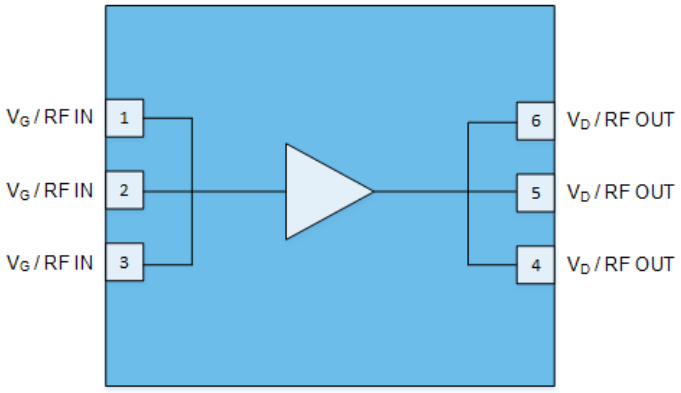
## Key Features

- Operating Frequency Range: DC to 2.7 GHz
- Operating Drain Voltage: +48 V
- Maximum Output Power ($P_{SAT}$): 89.1 W (1)
- Maximum Drain Efficiency: 74.7% (1)
- Efficiency-Tuned P3dB Gain: 21.5 dB (1)
- Surface Mount Plastic Package

Notes:

1. Load pull performance at 2.1 GHz.

## Functional Block Diagram




## Applications

- W-CDMA / LTE
- Macrocell Base Station Driver
- Microcell Base Station
- Small Cell Final Stage
- Active Antenna
- General Purpose Applications

## Ordering Information

| Part Number | Description |
|---|---|
| QPD0060SR | Short Reel – 100 Pieces |
| QPD0060TR7 | 7” Reel – 500 pieces |
| QPD0060PCB4B01 | 1.8 – 2.2 GHz Evaluation Board |
| QPD0060EVB01 | 762 – 944 MHz Evaluation Board |

## Absolute Maximum Ratings

| Parameter | Rating |
|---|---|
| Breakdown Voltage ($BV_{DG}$) | +165 V |
| Gate Voltage Range ($V_G$) | −7 to +2 V |
| Drain Voltage ($V_D$) | +55 V |
| Peak RF Input Power | 38 dBm |
| VSWR Mismatch, P1dB Pulse (20% Duty Cycle, 100 µs Width), T = +25°C | 10:1 |

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

## Recommended Operating Conditions

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Gate Voltage ($V_G$) | | −2.7 | | V |
| Drain Voltage ($V_D$) | | +48 | | V |
| Quiescent Drain Current ($I_{DQ}$) | | 130 | | mA |

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

## Electrical Specifications

| Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Operational Frequency Range | | 1800 | | 2200 | MHz |
| Quiescent Drain Current ($I_{DQ}$) | | | 130 | | mA |
| Gain | 3 dB Compression | 14.7 | 16.4 | | dB |
| Power ($P_{SAT}$) | 3 dB Compression | 48.1 | 49.8 | | dBm |
| Drain Efficiency | 3 dB Compression | 60.0 | 69.2 | | % |

Test conditions unless otherwise noted: $V_D$ = +48 V, $I_{DQ}$ = 130 mA, T = +25°C, Pulse signal (10% Duty Cycle, 100 µs Width) at 2010-2200 MHz on a Class AB single-ended reference design fixture tuned for 1.8-2.2 GHz.

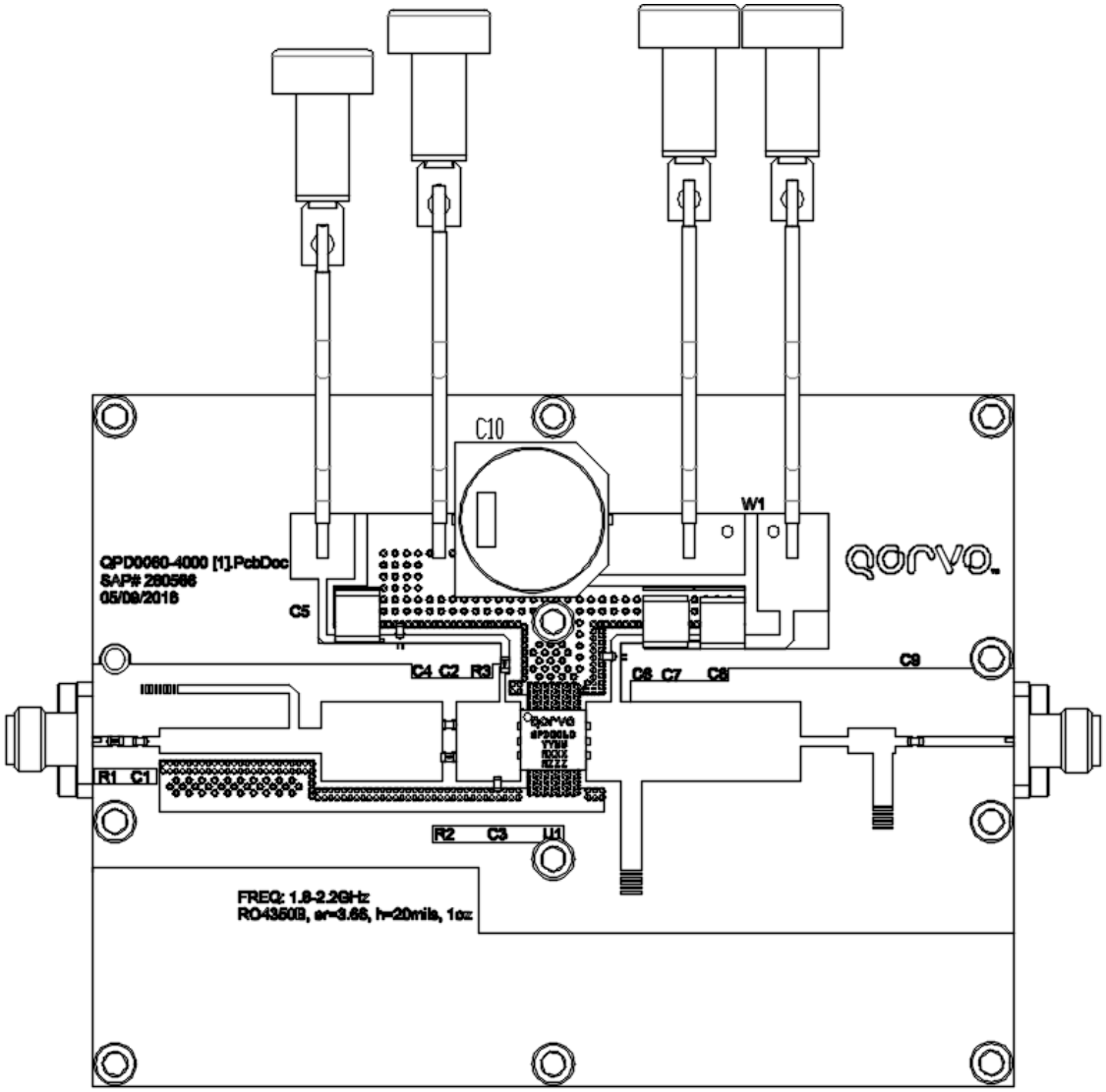
## Thermal Information

| Parameter | Conditions | Values | Units |
|---|---|---|---|
| Doherty Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) (1) (2) | $T_{CASE}$ = +105°C, $T_{CH}$ = 121°C<br>CW: $P_{DISS}$ = 11.9 W, $P_{OUT}$ = 17.9 W | 1.3 | °C/W |
| Device Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $T_{CASE}$ = +105°C, $T_{CH}$ = 142°C<br>CW: $P_{DISS}$ = 21.4 W, $P_{OUT}$ = 5 W | 1.7 | °C/W |

Notes:

1. Based on expected carrier amplifier efficiency of Doherty.
2. $P_{OUT}$ assumes 20% peaking amplifier contribution of total average Doherty rated power.
3. Thermal resistance is measured to package backside.
4. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

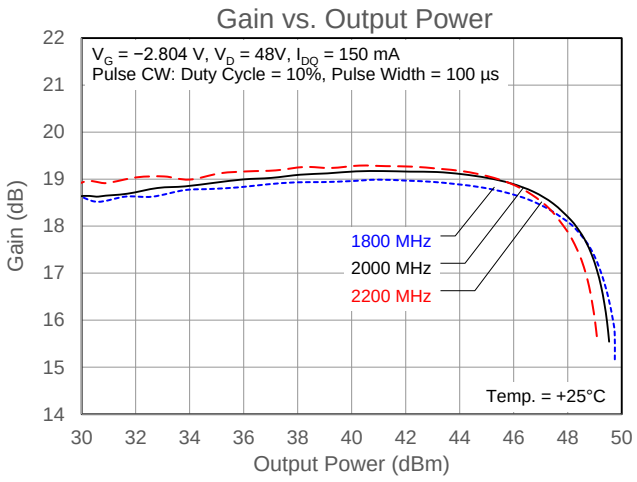
## QPD0060PCB4B01 Layout – 1800 – 2200 MHz Reference Design

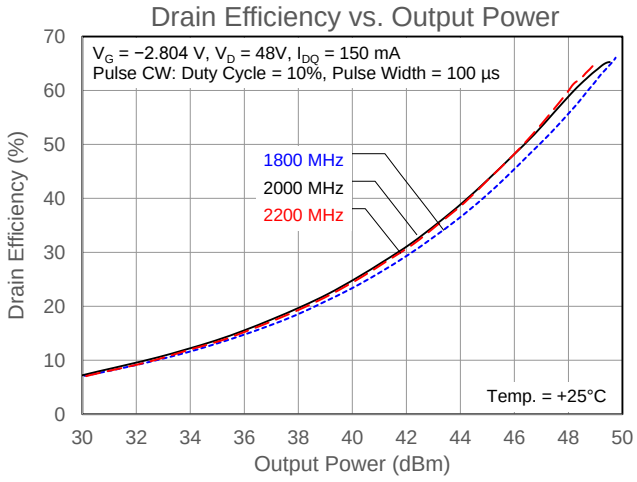


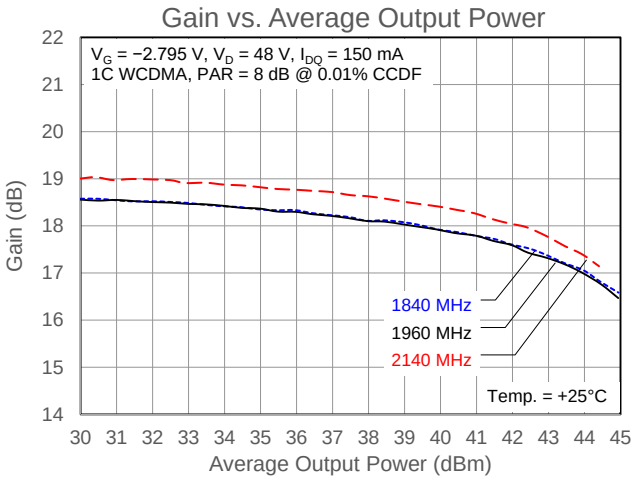

## QPD0060PCB4B01 Bill of Materials

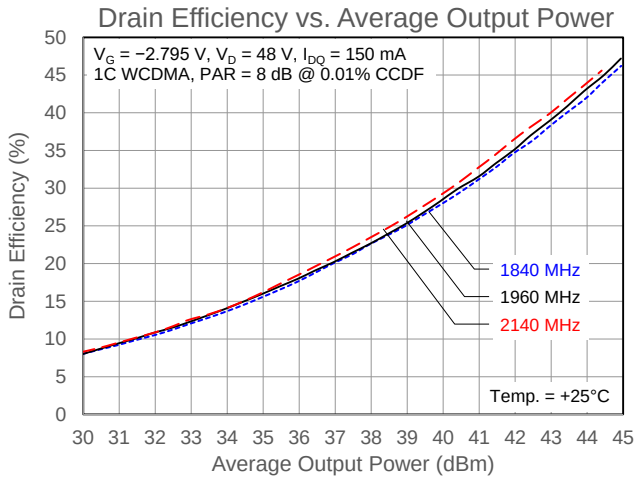
| Reference Des. | Value | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| C1 | 1.6 pF | Capacitor, 1.6 pF, ±0.05 pF, 250 V, HI-Q, 0603 | ATC | 600S1R6AT250XT |
| C2, C3 | 3 pF | Capacitor, 3 pF, ±0.1 pF, 250 V, HI-Q, 0603 | ATC | 600S3R0BT250XT |
| C4, C6, C9 | 20 pF | Capacitor, 20 pF, ±1%, 250 V, HI-Q, 0603 | ATC | 600S200FT250XT |
| C5, C7, C8 | 10 µF | Capacitor, 10 µF, ±20%, 100 V, X7S, 2220 | TDK | C5750X7S2A106M230KB |
| C10 | 100 µF | Capacitor, 100 µF, ±20%, 100 V, Electrolytic | Panasonic | EEV-TG2A101M |
| R1 | 3 Ω | Resistor, 3 Ω, ±5%, 0.1 W, 0603 | Vishay | CRCW06033R00FKEAC |
| R2 | 220 Ω | Resistor, 220 Ω, ±5%, 0.1 W, 0603, Lead Free | KOA Speer | RK73B1JTTD221J |
| R3 | 10 Ω | Resistor, 10 Ω, 0603, RoHS | Kamaya | RMC1/16K10R0FTP |

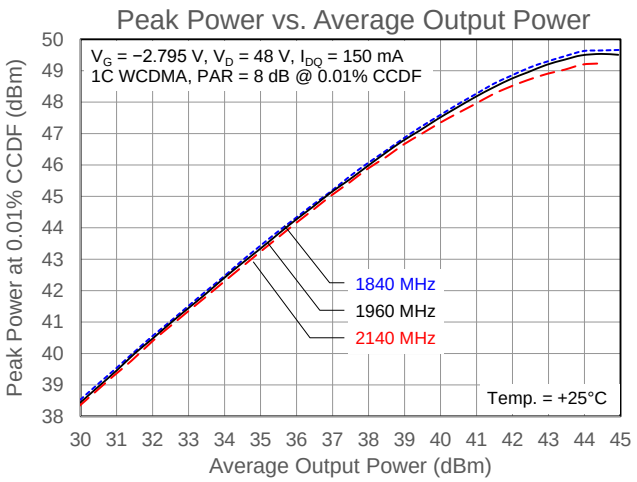
## QPD0060PCB4B01 Performance Plots

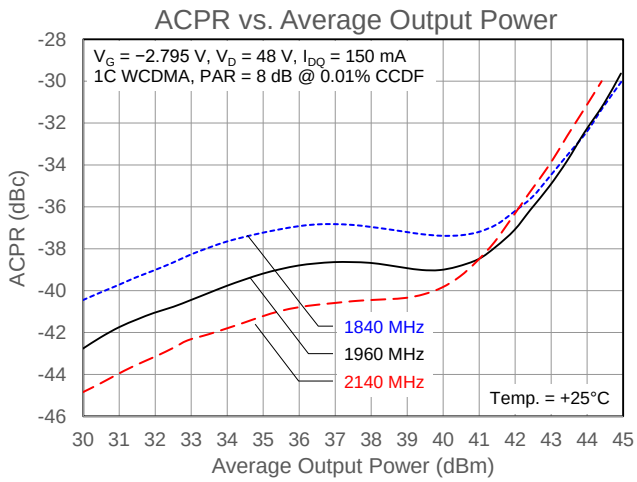


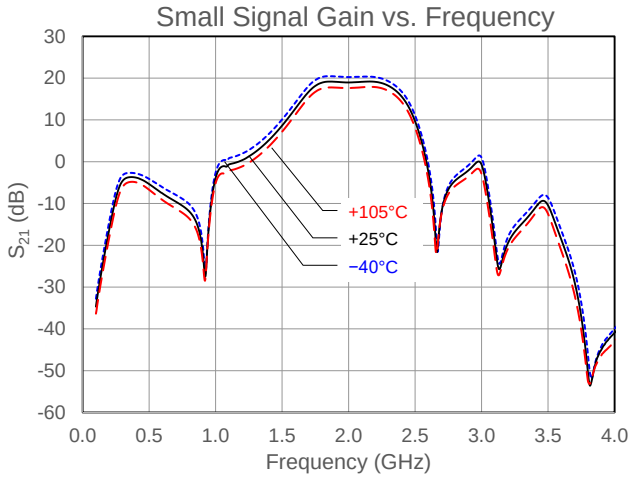



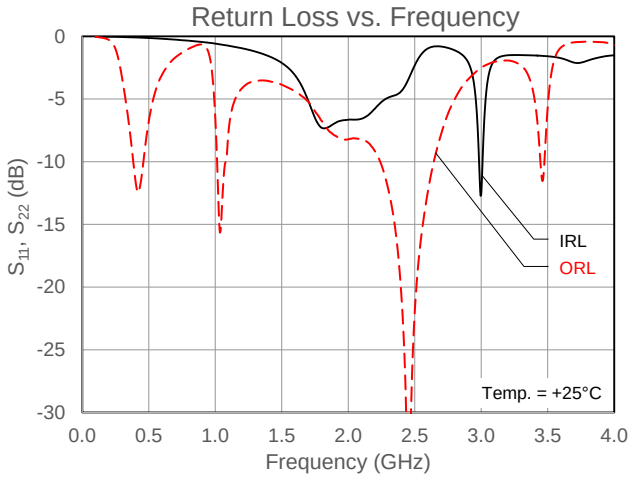



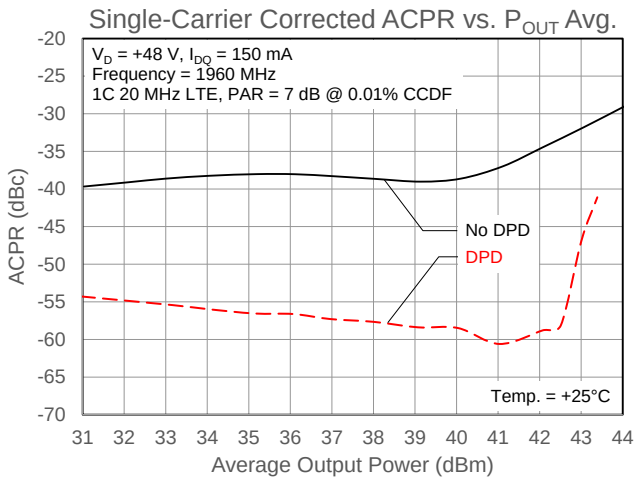



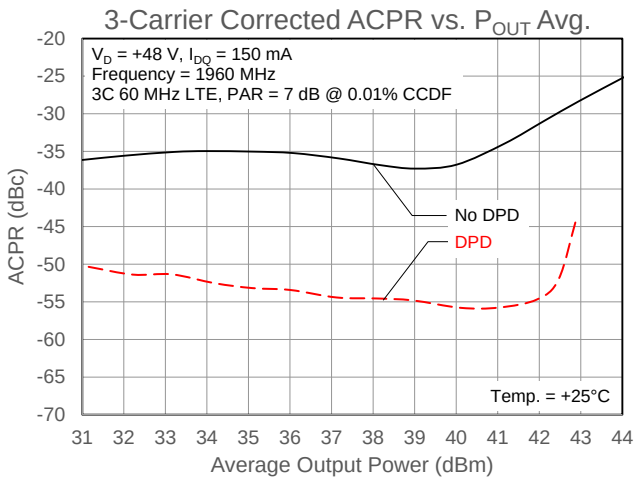

Test conditions unless otherwise noted: $V_D$ = +48 V, $I_{DQ}$ = 150 mA, T = +25°C, on a 1.8 – 2.2 GHz reference design fixture.

## QPD0060PCB4B01 Performance Plots



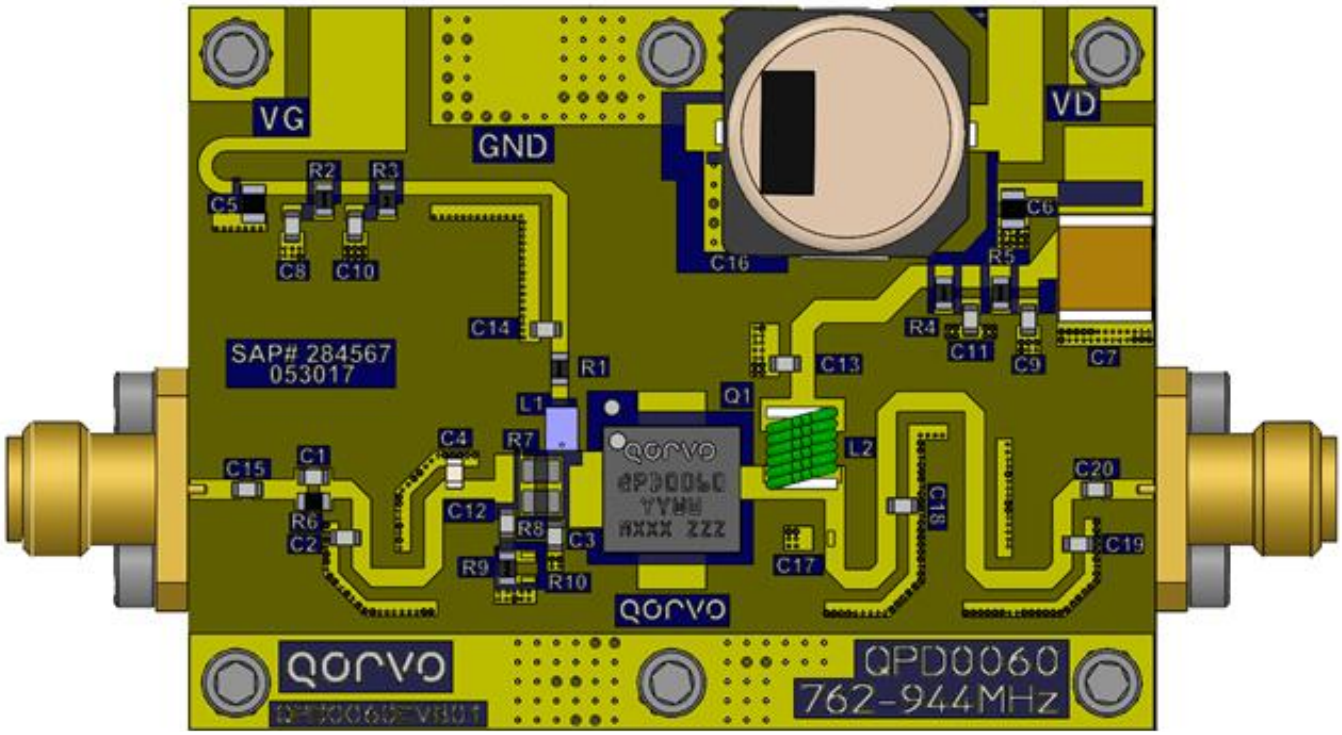




Test conditions unless otherwise noted: $V_D$ = +48 V, $I_{DQ}$ = 150 mA, T = +25°C, on a 1.8 – 2.2 GHz reference design fixture.

## QPD0060EVB01 Layout – 762 – 944 MHz Reference Design

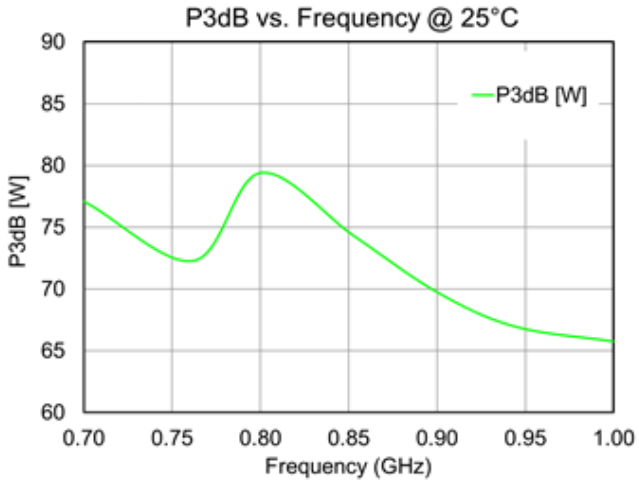


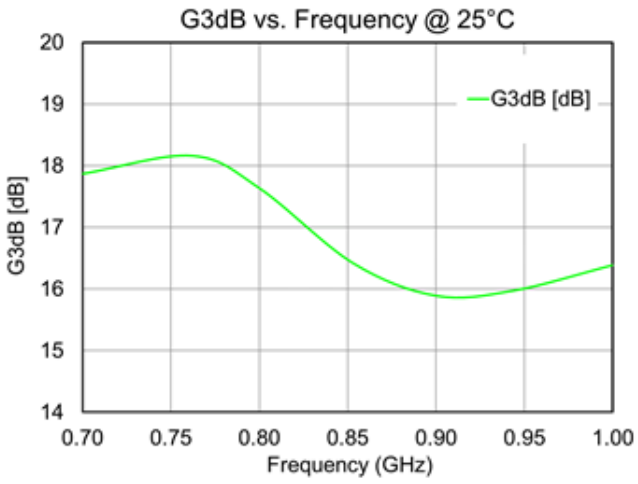

Note: PCB material is RO4350B, 20 mil thick substrate, 1 oz. copper each side.

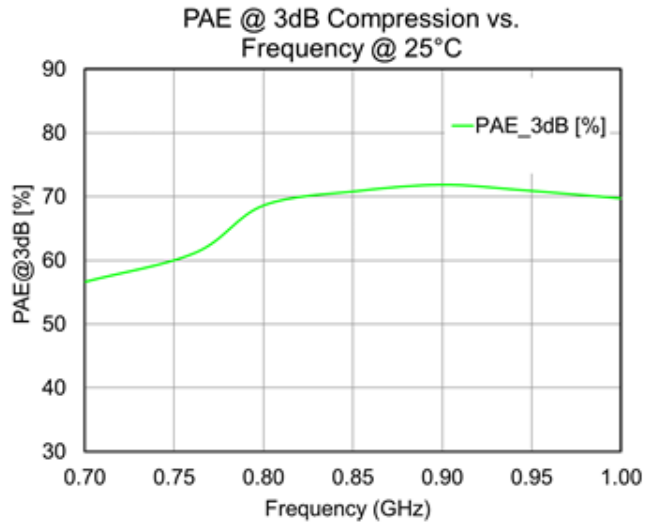
## QPD0060EVB01 Bill of Materials

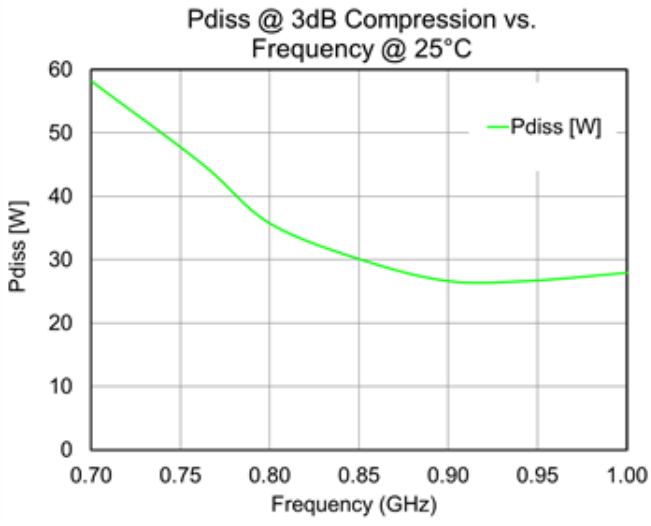
| Reference Des. | Value | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| C1, C2, C15, C18 | 8.2 pF | Capacitor, 8.2 pF, ±0.1 pF, 250 V, RF NPO | ATC | 600S8R2BT250XT |
| C3, C19 | 3.3 pF | Capacitor, 3.3 pF, ±0.1 pF, 250 V, RF NPO | ATC | 600S3R3BT250XT |
| C4 | 22 pF | Capacitor, 22 pF, ±5%, 250 V, RF NPO | ATC | 600S220JT250XT |
| C5, C6 | 1 µF | Capacitor, 1 µF, ±10%, 100 V, X7S, 0805 | TDK | CGA4J3X7S2A105K |
| C7 | 10 µF | Capacitor, 10 µF, ±10%, 100 V, X7S, 2220 | TDK | C5750X7S2A106K230KB |
| C8, C9 | 0.1 µF | Capacitor, 0.1 µF, ±10%, 100 V, X7R, 0603 | Murata | GRM188R72A104KA35D |
| C10, C11, C12 | 100 pF | Capacitor, 100 pF, ±5%, 250 V, RF C0G | TDK | C1608C0G2E101JT080AA |
| C13, C14 | 15 pF | Capacitor, 15 pF, ±5%, 250 V, RF NPO | ATC | 600S150JT250XT |
| C16 | 100 µF | Capacitor, 100 µF, ±20%, 100 V, ALUM, 12.5x12.5 mm | BC Components | MAL215099907E3 |
| C20 | 47 pF | Capacitor, 47 pF, ±5%, 250 V, RF NPO | ATC | 600S470JT250XT |
| L1 | 68 nH | Inductor, 68 nH, ±10%, 0805 W/W | Coilcraft | 0805CS-680XK |
| L2 | 47 nH | Inductor, 47 nH, ±5%, 1515 | Coilcraft | 1515SQ-47NJ |
| R1, R2, R3, R4, R5 | 10 Ω | Resistor, 10 Ω, ±5%, 0603, Thick Film | KOA Speer | RK73B1JTTD100J |
| R6 | 1 kΩ | Resistor, 1000 Ω, ±1%, 0603, Thick Film | Cal-Chip | RM06F1001CT |
| R7, R8 | 5.1 Ω | Resistor, 5.1 Ω, ±1%, 0805, Thick Film | Vishay | CRCW08055R10FKEA |
| R9 | 120 Ω | 0603 1% Thick Film Resistor | KOA Speer | RK73B1JTTD121J |

## QPD0060EVB01 Performance Plots




Test conditions unless otherwise noted: $V_D$ = +50 V, $I_{DQ}$ = 150 mA, T = +25°C, Pulsed (10% Duty Cycle, 100 µs Width) on a 762 – 944 MHz reference design fixture.

## Power-Matched Load Pull Performance

| Frequency (MHz) | Source Impedance (Ω) | Load Impedance (Ω) | P3dB (dBm) | Drain Efficiency (%) | G3dB (dB) |
|---|---|---|---|---|---|
| 1800 | 2.0 – j6.0 | 5.7 + j1.4 | 49.2 | 61.2 | 19.9 |
| 1900 | 2.1 – j6.9 | 5.5 + j0.7 | 49.2 | 62.0 | 19.7 |
| 2100 | 2.9 – j10.3 | 6.4 + j1.0 | 49.5 | 65.7 | 19.6 |
| 2200 | 4.2 – j13.5 | 5.0 + j.01 | 49.5 | 65.9 | 18.7 |
| 2600 | 8.9 + j13.3 | 4.8 + j0.0 | 49.0 | 63.0 | 18.2 |
| 3500 | 2.1 – j9.1 | 3.4 – j5.8 | 49.7 | 57.7 | 13.4 |

Test conditions unless otherwise noted: $V_D$ = +48 V, $I_{DQ}$ = 150 mA, T = +25°C, Pulse (10% Duty Cycle, 100 µs Width).

## Efficiency-Matched Load Pull Performance

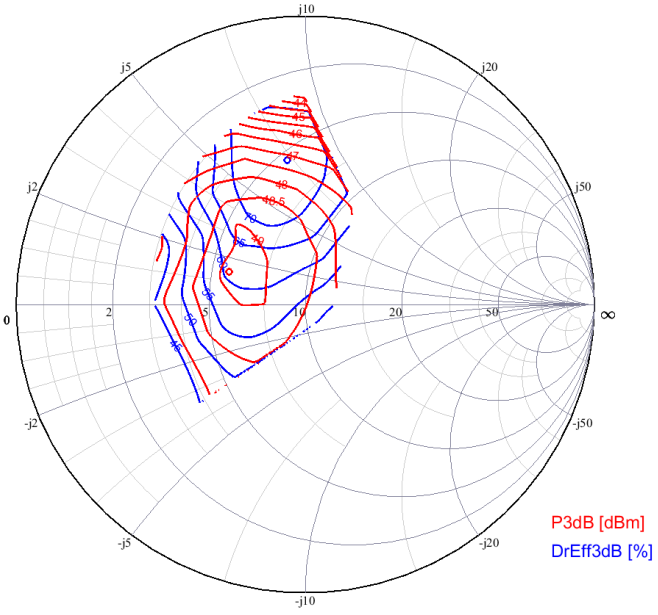
| Frequency (MHz) | Source Impedance (Ω) | Load Impedance (Ω) | P3dB (dBm) | Drain Efficiency (%) | G3dB (dB) |
|---|---|---|---|---|---|
| 1800 | 2.0 – j6.0 | 5.4 + j7.3 | 47.2 | 74.9 | 21.9 |
| 1900 | 2.1 – j6.9 | 5.1 + j5.7 | 47.7 | 75.8 | 22.0 |
| 2100 | 2.9 – j10.3 | 4.7 + j3.5 | 48.5 | 74.7 | 21.5 |
| 2200 | 4.2 – j13.5 | 4.7 + j3.5 | 48.4 | 73.9 | 20.9 |
| 2600 | 8.9 + j13.3 | 3.1 + 2.6 | 46.6 | 68.3 | 20.0 |
| 3500 | 2.1 – j9.1 | 2.0 – j3.6 | 48.0 | 68.2 | 15.0 |

Test conditions unless otherwise noted: $V_D$ = +48 V, $I_{DQ}$ = 150 mA, T = +25°C, Pulse (10% Duty Cycle, 100 µs Width).

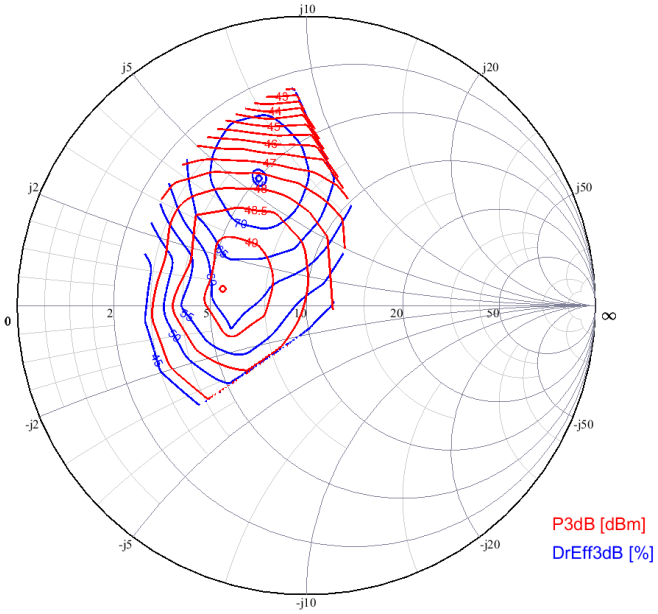
## Load Pull Contours

Test Conditions unless otherwise noted: $V_D$ = +48 V, $I_{DQ}$ = 150 mA, T = +25°C, Pulse (10% Duty Cycle, 100 µs Width).

Load Pull at 1.8 GHz



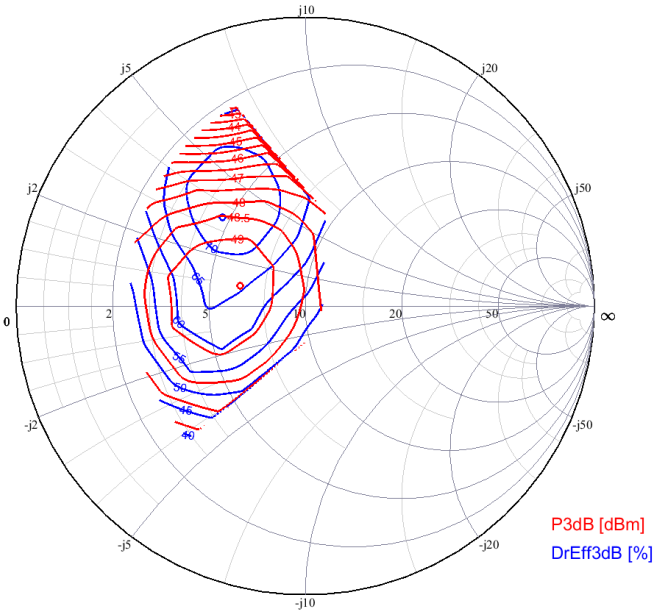

Load Pull at 1.9 GHz



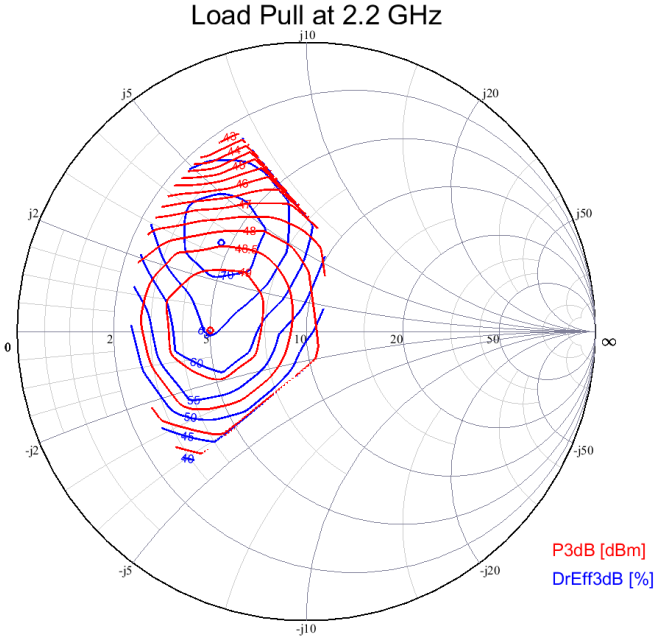
## Load Pull Contours

Test Conditions unless otherwise noted: $V_D$ = +48 V, $I_{DQ}$ = 150 mA, T = +25°C, Pulse (10% Duty Cycle, 100 µs Width).

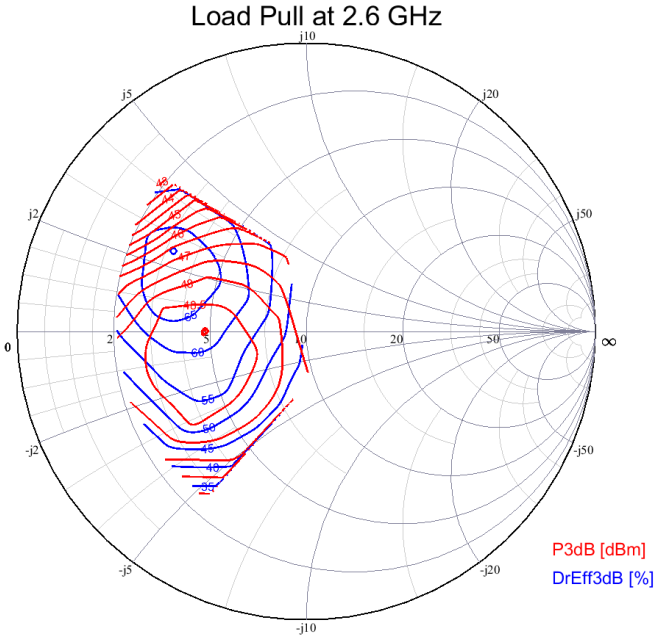
Load Pull at 2.1 GHz



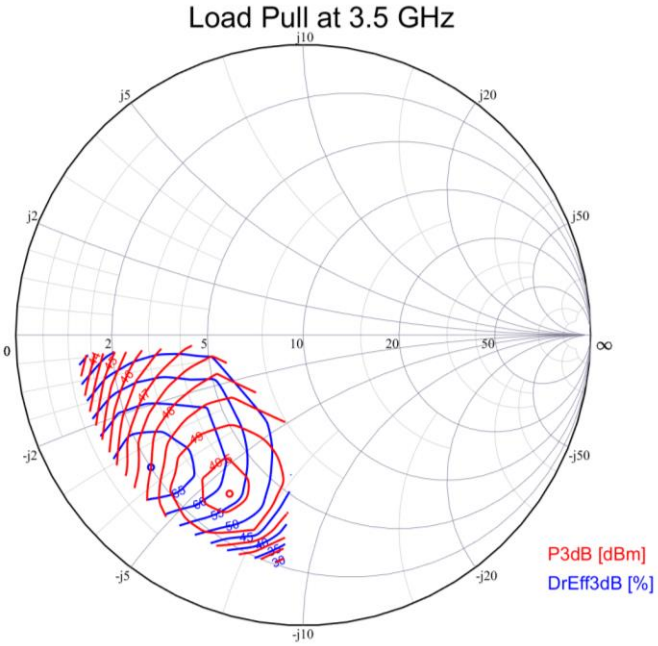

Load Pull at 2.2 GHz




Load Pull at 2.6 GHz

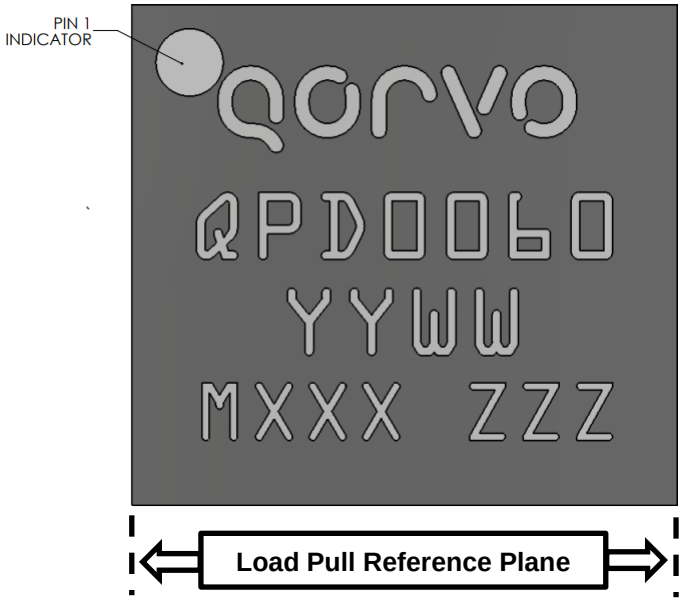



Load Pull at 3.5 GHz

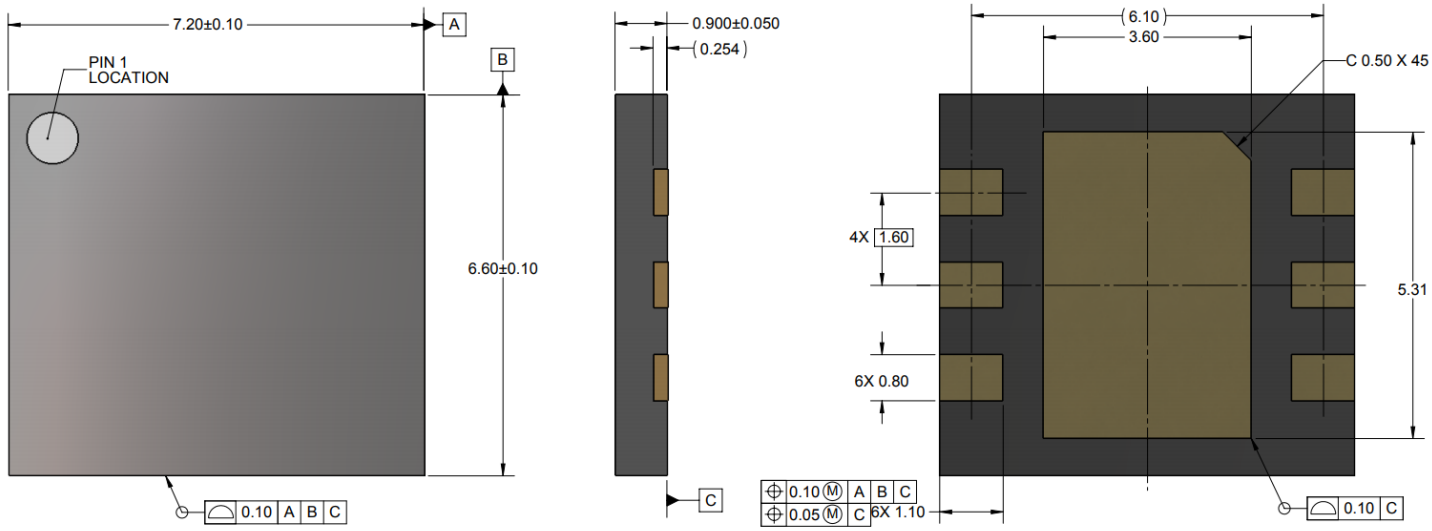


## Package Markings

Marking: Qorvo Logo
Part Number – QPD0060
Date Code – YYWW
Lot Code – MXXX
Serial Number – ZZZ

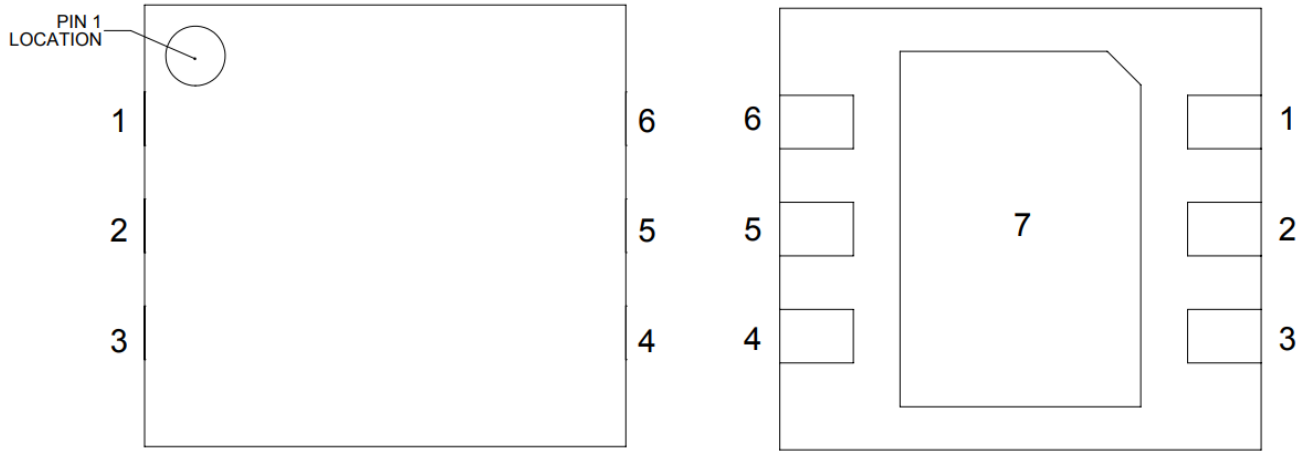



## Package Dimensions




Notes:
1. Dimensions are in millimeters [inches]. Angles are in degrees.
2. Part is overmold encapsulated.
3. Contact plating is NiPdAu. Au thickness is 0.00254 to 0.01501 µm.
4. General tolerance is ±0.25.

## Pin Configuration and Description




| Pin Number | Label | Description |
|---|---|---|
| 1, 2, 3 | RF IN, $V_G$ | RF Input, Gate Bias |
| 4, 5, 6 | RF OUT, $V_D$ | RF Output, Drain Bias |
| 7 (Backside Paddle) | RF/DC GND | RF/DC Ground |

## Bias Procedure

| Bias On | Bias Off |
|---|---|
| 1. Turn ON $V_G$ to –4 V. | 1. Turn OFF RF. |
| 2. Turn ON $V_D$ to +48 V. | 2. Set $V_G$ to −5 V. |
| 3. Slowly adjust $V_G$ until $I_D$ is set to 130 mA. (Typically, $V_G$ = −2.7 V.) | 3. Turn OFF $V_D$. |
| 5. Turn ON RF. | 4. Wait two (2) seconds to allow drain capacitor to discharge. |
| | 5. Turn OFF $V_G$. |

## Recommended Solder Temperature Profile