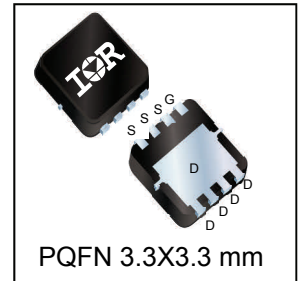
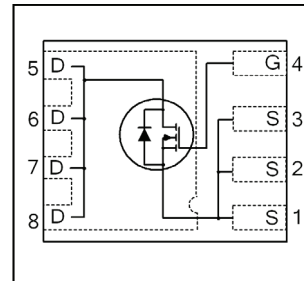


| | | |
|--|-------------|-----------|
| V_{DSS} | 25 | V |
| $V_{GS\ max}$ | ±20 | V |
| $R_{DS(on)\ max}$ (@ $V_{GS} = 10V$) | 5.2 | mΩ |
| (@ $V_{GS} = 4.5V$) | 8.7 | |
| Qg (typical) | 9.0 | nC |
| I_D (@ $T_{C(Bottom)} = 25^\circ C$) | 25 Ⓣ | A |

HEXFET® Power MOSFET


Applications

- Control or synchronous MOSFET for synchronous buck converter

Features

| |
|--|
| Low Thermal Resistance to PCB ($3.7^\circ C/W$) |
| Low Profile ($1.05\ mm$) |
| Industry-Standard Pinout |
| Compatible with Existing Surface Mount Techniques |
| RoHS Compliant, Halogen-Free |
| MSL1, Consumer Qualification |

 results in
 ⇒

Benefits

| |
|-----------------------------------|
| Enable better thermal dissipation |
| Increased Power Density |
| Multi-Vendor Compatibility |
| Easier Manufacturing |
| Environmentally Friendlier |
| Increased Reliability |

| Base part number | Package Type | Standard Pack | | Orderable Part Number |
|------------------|----------------------|---------------|----------|-----------------------|
| | | Form | Quantity | |
| IRFHM8228PbF | PQFN 3.3 mm x 3.3 mm | Tape and Reel | 4000 | IRFHM8228TRPbF |

Absolute Maximum Ratings

| | Parameter | Max. | Units |
|-------------------------------------|---|--------------|-------|
| V_{GS} | Gate-to-Source Voltage | ± 20 | V |
| $I_D @ T_A = 25^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ | 19 | A |
| $I_D @ T_A = 70^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ | 15 | |
| $I_D @ T_{C(Bottom)} = 25^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ | 65ⓉⓈ | |
| $I_D @ T_{C(Bottom)} = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ | 41ⓉⓈ | |
| $I_D @ T_C = 25^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ (Source Bonding Technology Limited) | 25Ⓣ | |
| I_{DM} | Pulsed Drain Current ① | 260 | |
| $P_D @ T_A = 25^\circ C$ | Power Dissipation ⑤ | 2.8 | W |
| $P_D @ T_{C(Bottom)} = 25^\circ C$ | Power Dissipation ⑤ | 34 | |
| | Linear Derating Factor ⑤ | 0.023 | W/°C |
| T_J T_{STG} | Operating Junction and Storage Temperature Range | -55 to + 150 | °C |

Notes ① through ⑧ are on page 10

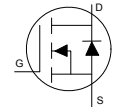
Static @ T_J = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions | |
|-------------------------------------|---|--|------|------|-------|--|---|
| BV _{DSS} | Drain-to-Source Breakdown Voltage | 25 | — | — | V | V _{GS} = 0V, I _D = 250μA | |
| ΔBV _{DSS} /ΔT _J | Breakdown Voltage Temp. Coefficient | — | 18 | — | mV/°C | Reference to 25°C, I _D = 1mA | |
| R _{DS(on)} | Static Drain-to-Source On-Resistance | — | 4.2 | 5.2 | mΩ | V _{GS} = 10V, I _D = 20A ③ | |
| | | — | 6.7 | 8.7 | | V _{GS} = 4.5V, I _D = 16A ③ | |
| V _{GS(th)} | Gate Threshold Voltage | 1.35 | 1.8 | 2.35 | V | V _{DS} = V _{GS} , I _D = 25μA | |
| ΔV _{GS(th)} | Gate Threshold Voltage Coefficient | — | -6.6 | — | mV/°C | | |
| I _{DSS} | Drain-to-Source Leakage Current | — | — | 1.0 | μA | V _{DS} = 20V, V _{GS} = 0V | |
| | | — | — | 150 | | V _{DS} = 20V, V _{GS} = 0V, T _J = 125°C | |
| I _{GSS} | Gate-to-Source Forward Leakage | — | — | 100 | nA | V _{GS} = 20V | |
| | Gate-to-Source Reverse Leakage | — | — | -100 | | V _{GS} = -20V | |
| g _{fs} | Forward Transconductance | 63 | — | — | S | V _{DS} = 10V, I _D = 20A | |
| Q _g | Total Gate Charge | — | 18 | — | nC | V _{GS} = 10V, V _{DS} = 13V, I _D = 20A | |
| Q _g | Total Gate Charge | — | 9.0 | 14 | nC | V _{DS} = 13V V _{GS} = 4.5V I _D = 20A | |
| | Q _{gs1} | Pre-V _{th} Gate-to-Source Charge | — | 2.7 | | | — |
| | Q _{gs2} | Post-V _{th} Gate-to-Source Charge | — | 1.0 | | | — |
| | Q _{gd} | Gate-to-Drain Charge | — | 3.1 | | | — |
| | Q _{godr} | Gate Charge Overdrive | — | 2.2 | | | — |
| Q _{sw} | Switch Charge (Q _{gs2} + Q _{gd}) | — | 4.1 | — | nC | | |
| Q _{oss} | Output Charge | — | 9.7 | — | nC | V _{DS} = 16V, V _{GS} = 0V | |
| R _G | Gate Resistance | — | 1.7 | — | Ω | | |
| t _{d(on)} | Turn-On Delay Time | — | 11 | — | ns | V _{DD} = 13V, V _{GS} = 4.5V I _D = 20A R _G = 1.8Ω | |
| t _r | Rise Time | — | 22 | — | | | |
| t _{d(off)} | Turn-Off Delay Time | — | 13 | — | | | |
| t _f | Fall Time | — | 6.2 | — | | | |
| C _{iss} | Input Capacitance | — | 1667 | — | pF | V _{GS} = 0V V _{DS} = 10V f = 1.0MHz | |
| C _{oss} | Output Capacitance | — | 456 | — | | | |
| C _{rss} | Reverse Transfer Capacitance | — | 195 | — | | | |

Avalanche Characteristics

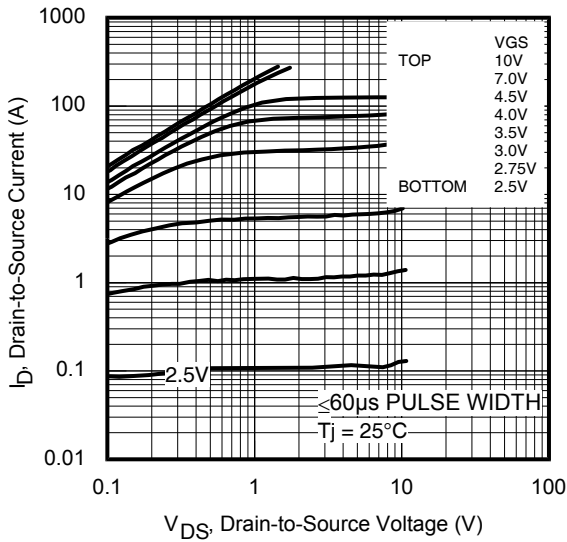
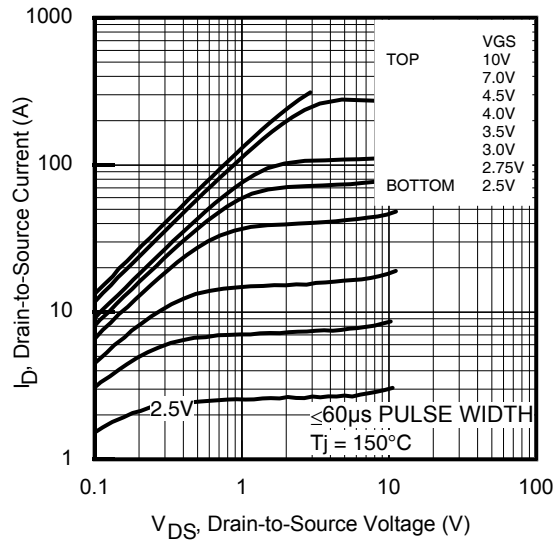
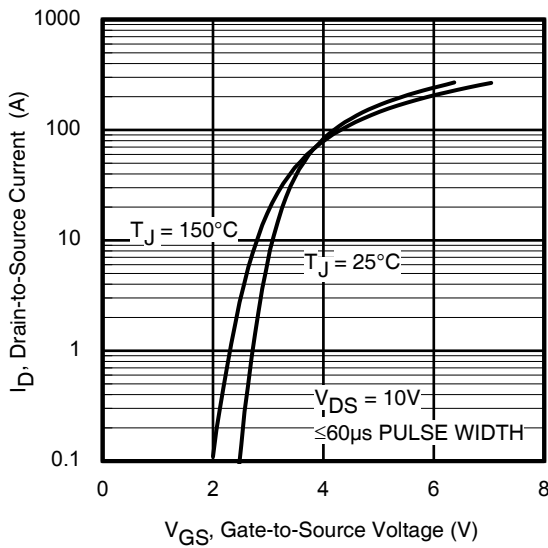
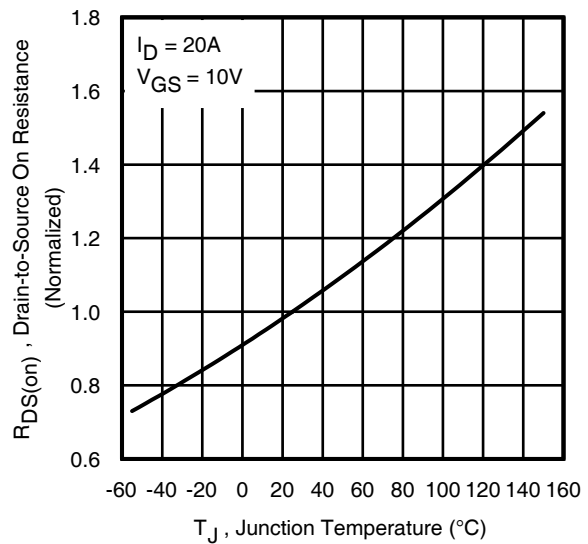
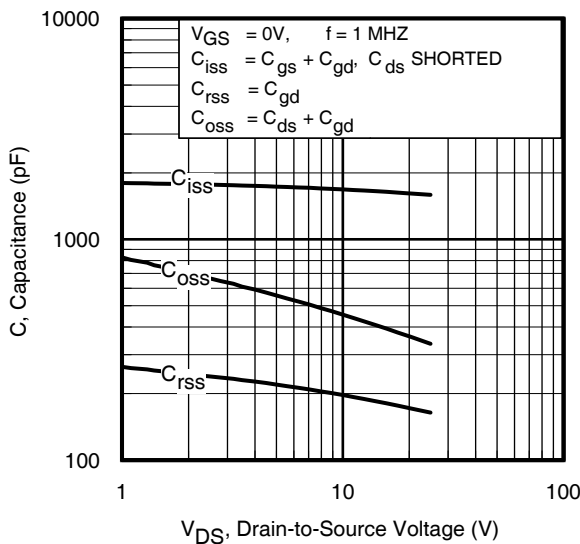
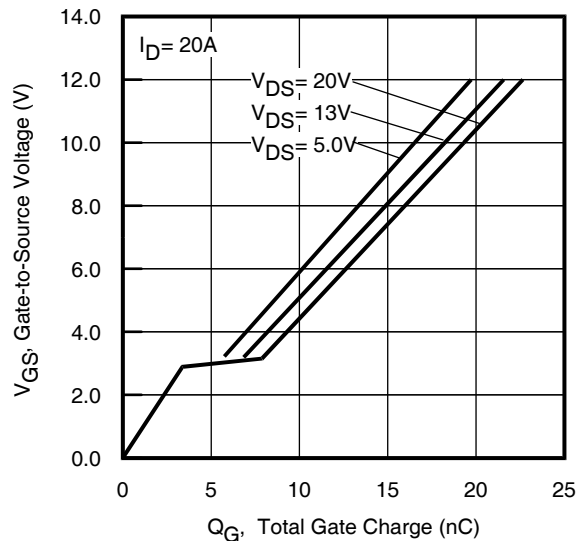
| | Parameter | Typ. | Max. | Units |
|-----------------|---------------------------------|------|------|-------|
| E _{AS} | Single Pulse Avalanche Energy ② | — | 50 | mJ |

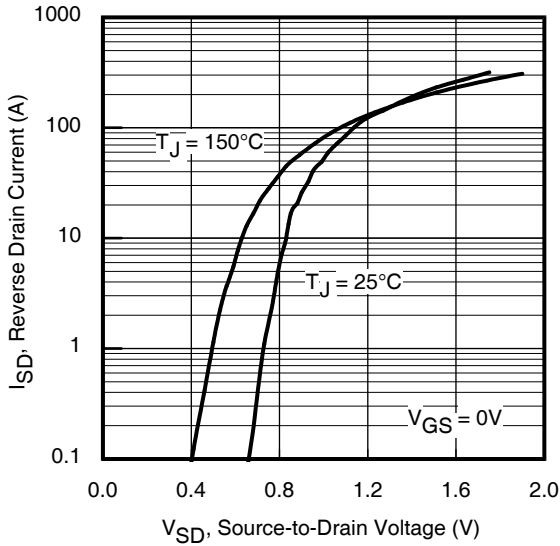
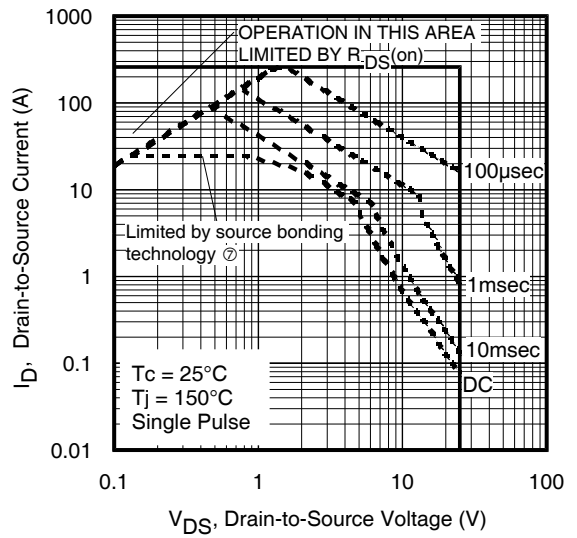
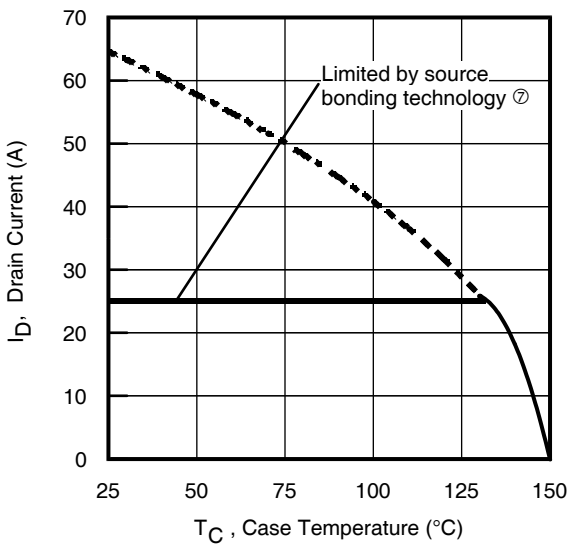
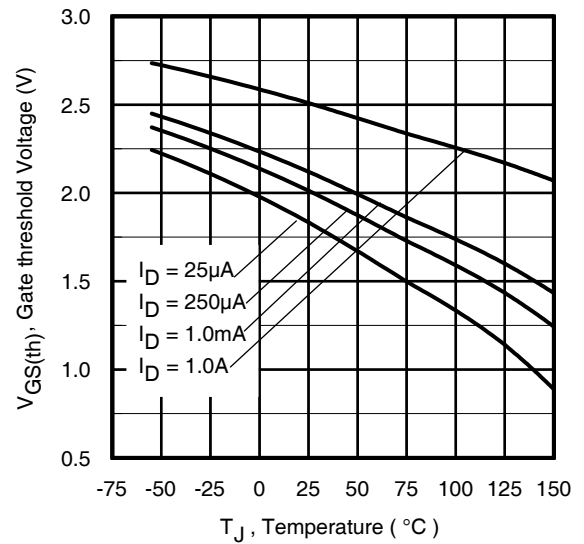
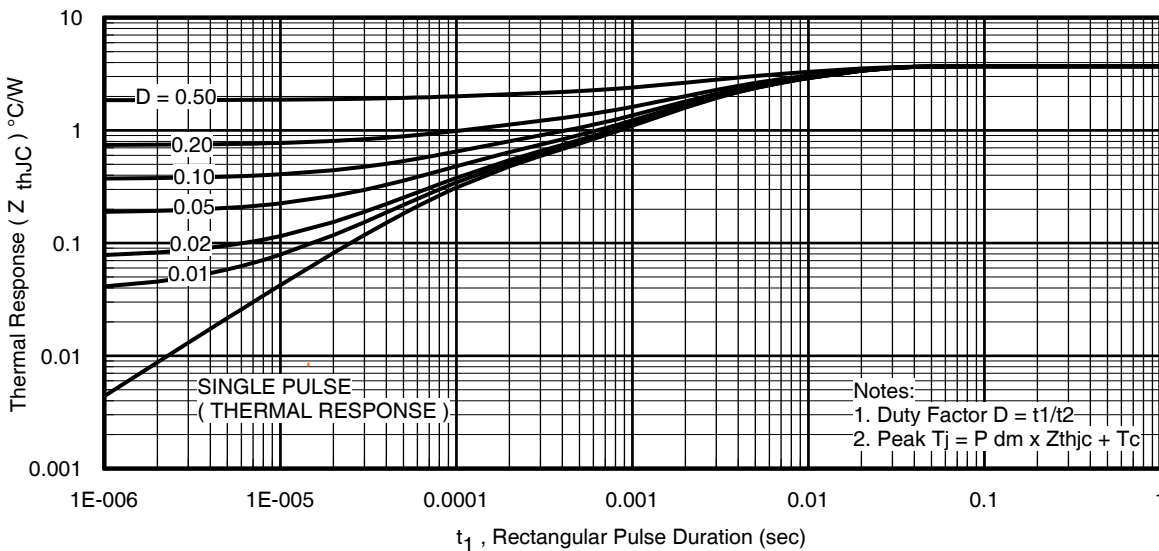
Diode Characteristics

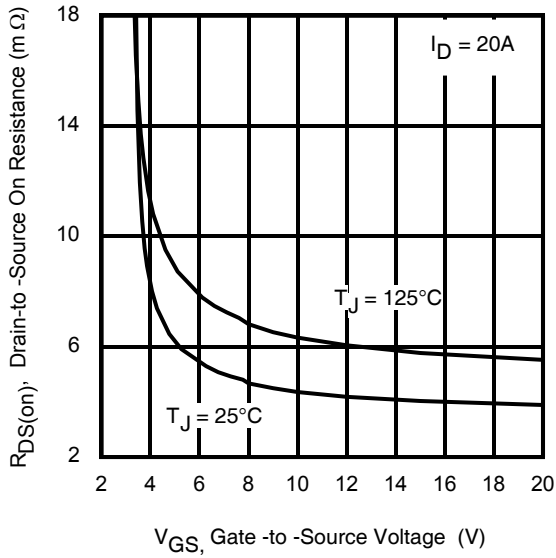
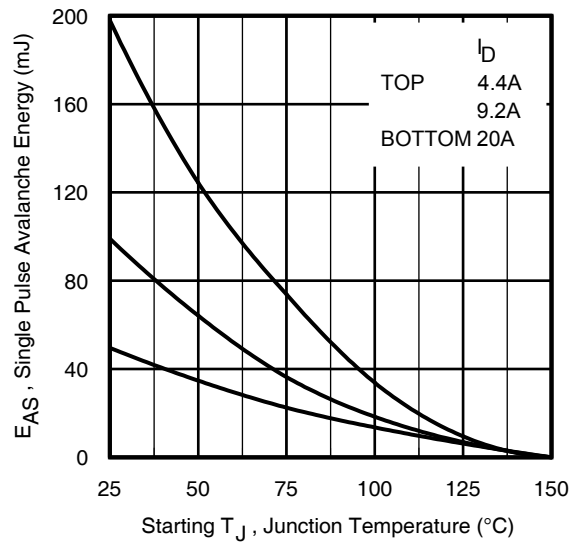
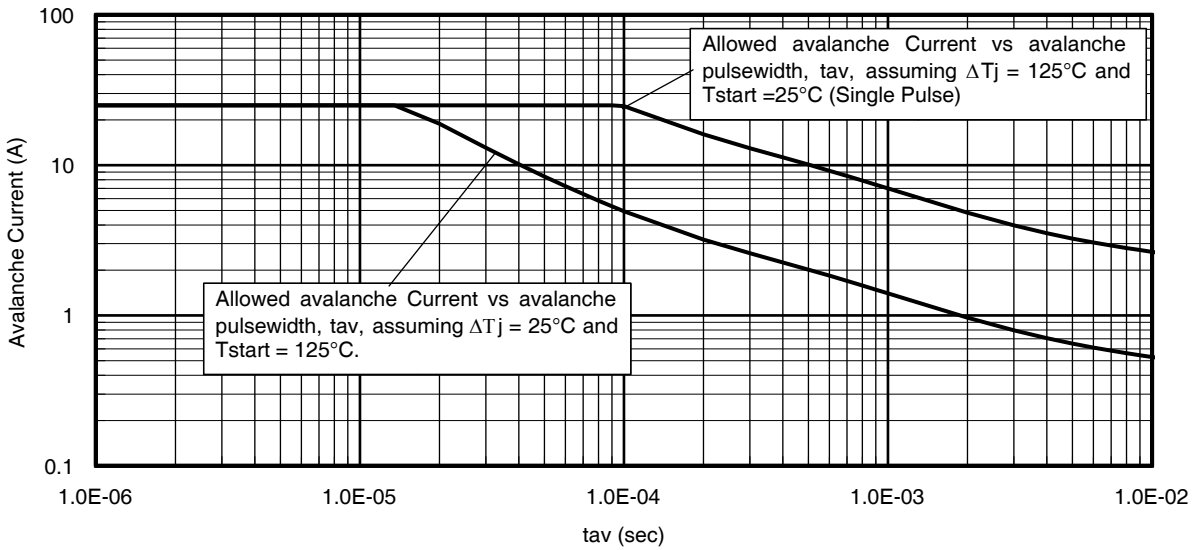
| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|-----------------|--|------|------|-----------------|-------|--|
| I _S | Continuous Source Current (Body Diode) | — | — | 25 ^⑦ | A | MOSFET symbol showing the integral reverse p-n junction diode.  |
| I _{SM} | Pulsed Source Current (Body Diode) ① | — | — | 260 | | |
| V _{SD} | Diode Forward Voltage | — | — | 1.0 | V | T _J = 25°C, I _S = 20A, V _{GS} = 0V ③ |
| t _{rr} | Reverse Recovery Time | — | 14 | 21 | ns | T _J = 25°C, I _F = 20A, V _{DD} = 13V |
| Q _{rr} | Reverse Recovery Charge | — | 10 | 15 | nC | di/dt = 260A/μs ③ |

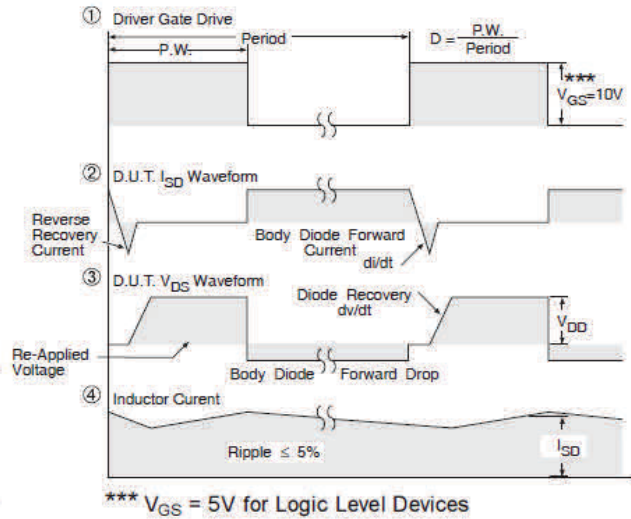
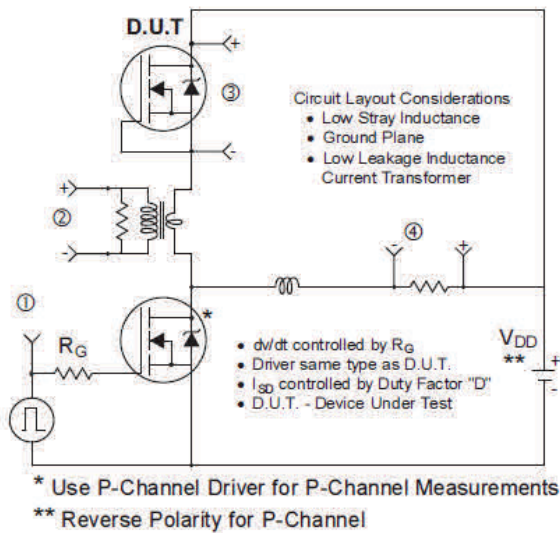
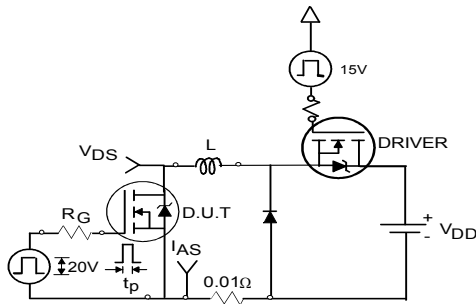
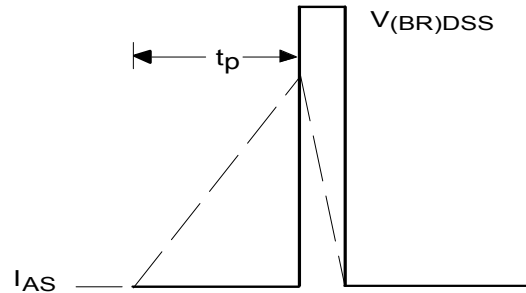
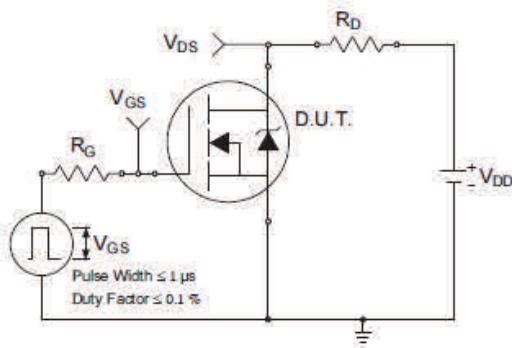
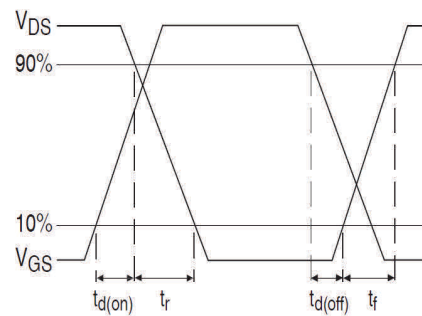
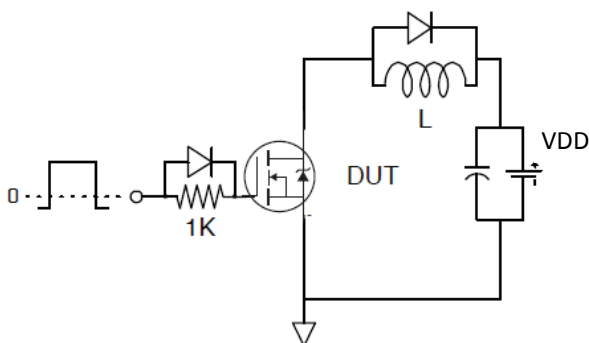
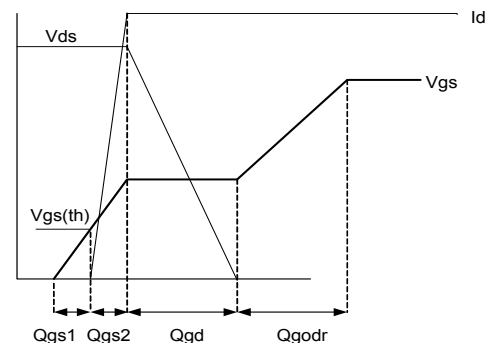
Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---------------------------|-----------------------|------|------|-------|
| R _{θJC} (Bottom) | Junction-to-Case ④ | — | 3.7 | °C/W |
| R _{θJC} (Top) | Junction-to-Case ④ | — | 41 | |
| R _{θJA} | Junction-to-Ambient ⑤ | — | 44 | |
| R _{θJA} (<10s) | Junction-to-Ambient ⑤ | — | 29 | |


Fig 1. Typical Output Characteristics

Fig 2. Typical Output Characteristics

Fig 3. Typical Transfer Characteristics

Fig 4. Normalized On-Resistance vs. Temperature

Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage


Fig 7. Typical Source-Drain Diode Forward Voltage

Fig 8. Maximum Safe Operating Area

Fig 9. Maximum Drain Current vs. Case Temperature

Fig 10. Drain-to-Source Breakdown Voltage

Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case


Fig 12. On-Resistance vs. Gate Voltage

Fig 13. Maximum Avalanche Energy vs. Drain Current

Fig 14. Single Avalanche Event: Pulse Current vs. Pulse Width


Fig 15. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

Fig 16a. Unclamped Inductive Test Circuit

Fig 16b. Unclamped Inductive Waveforms

Fig 17a. Switching Time Test Circuit

Fig 17b. Switching Time Waveforms

Fig 18a. Gate Charge Test Circuit

Fig 18b. Gate Charge Waveform

Placement and Layout Guidelines

The typical application topology for this product is the synchronous buck converter. These converters operate at high frequencies (typically around 400 kHz). During turn-on and turn-off switching cycles, the high di/dt currents circulating in the parasitic elements of the circuit induce high voltage ringing which may exceed the device rating and lead to undesirable effects. One of the major contributors to the increase in parasitics is the PCB power circuit inductance.

This section introduces a simple guideline that mitigates the effect of these parasitics on the performance of the circuit and provides reliable operation of the devices.

To reduce high frequency switching noise and the effects of Electromagnetic Interference (EMI) when the control MOSFET (Q1) is turned on, the layout shown in Figure 19 is recommended. The input bypass capacitors, control MOSFET and output capacitors are placed in a tight loop to minimize parasitic inductance which in turn lowers the amplitude of the switch node ringing, and minimizes exposure of the MOSFETs to repetitive avalanche conditions.

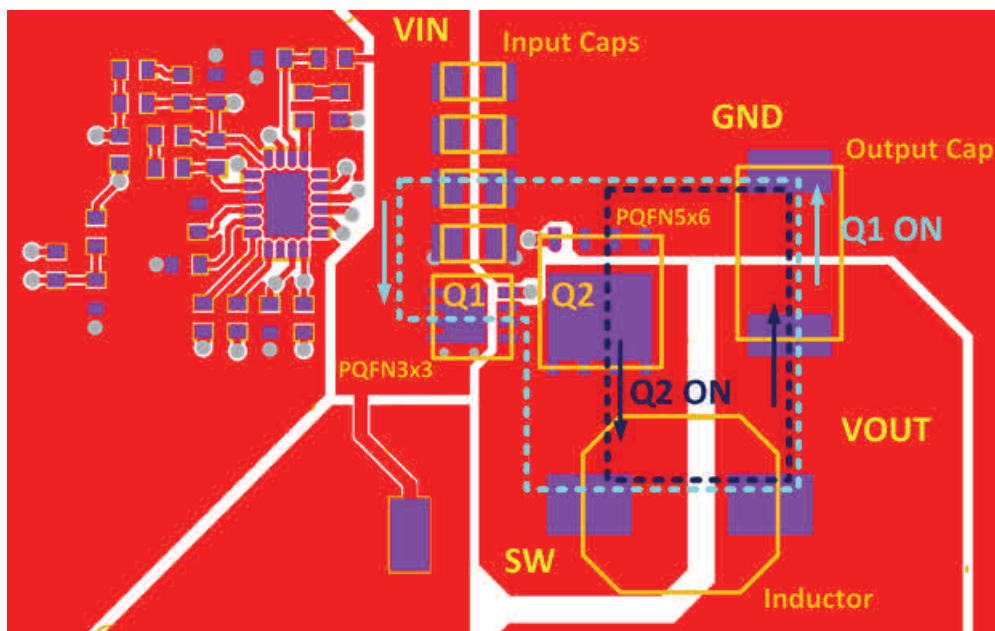
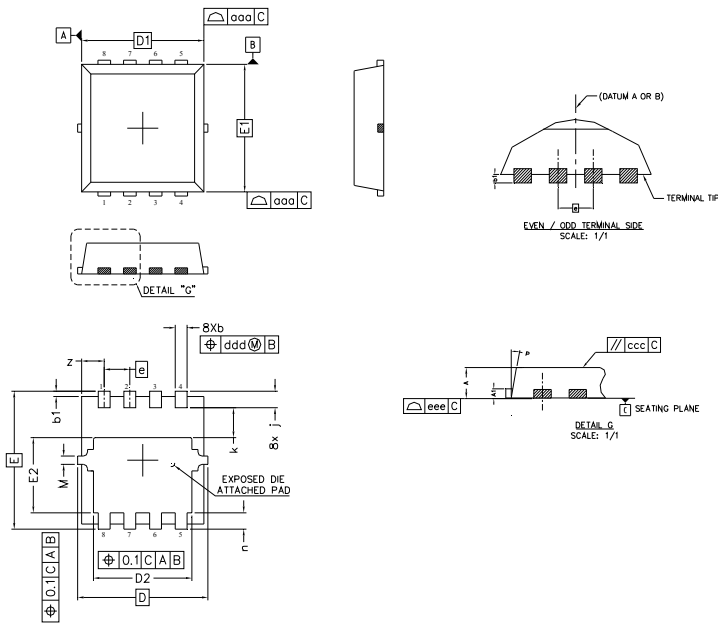


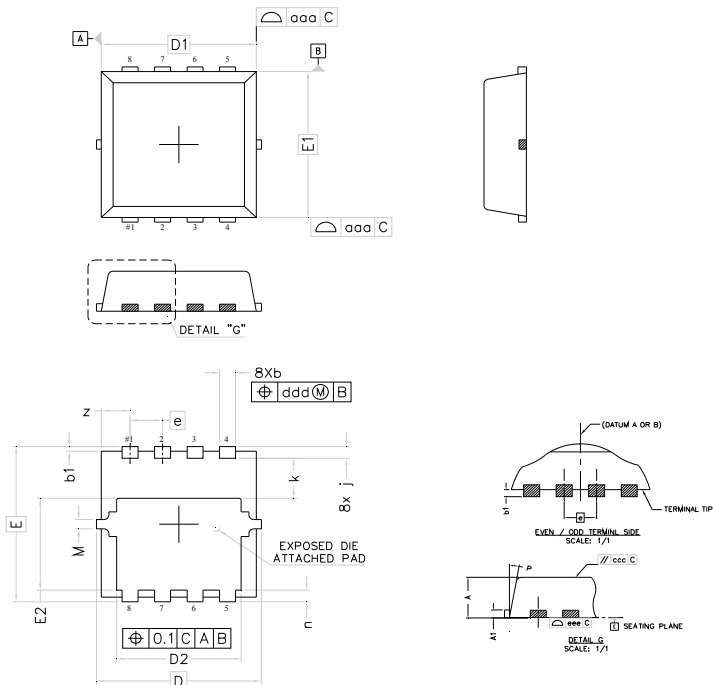
Fig 19. Placement and Layout Guidelines

PQFN 3.3 x 3.3 Outline "C" Package Details



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.70 | 0.80 | .0276 | .0315 |
| A1 | 0.10 | 0.25 | .0039 | .0098 |
| b | 0.25 | 0.35 | .0098 | .0138 |
| b1 | 0.05 | 0.15 | .0020 | .0059 |
| D | 3.20 | 3.40 | .1260 | .1339 |
| D1 | 3.00 | 3.20 | .1181 | .1260 |
| D2 | 2.39 | 2.59 | .0941 | .1020 |
| E | 3.25 | 3.45 | .1280 | .1358 |
| E1 | 3.00 | 3.20 | .1181 | .1260 |
| E2 | 1.78 | 1.98 | .0701 | .0780 |
| e | 0.65 BSC | | .0255 BSC | |
| j | 0.30 | 0.50 | .0118 | .0197 |
| k | 0.59 | 0.79 | .0232 | .0311 |
| n | 0.30 | 0.50 | .0118 | .0197 |
| M | 0.03 | 0.23 | .0012 | .0091 |
| P | 10° | 12° | 10° | 12° |
| z | 0.50 | 0.70 | .0197 | .0276 |

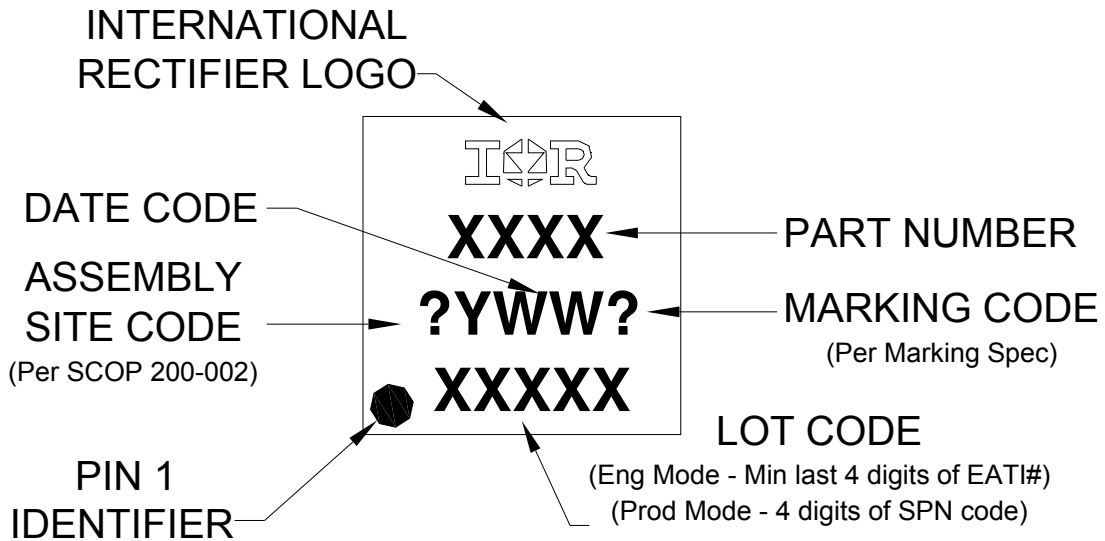
PQFN 3.3 x 3.3 Outline "G" Package Details



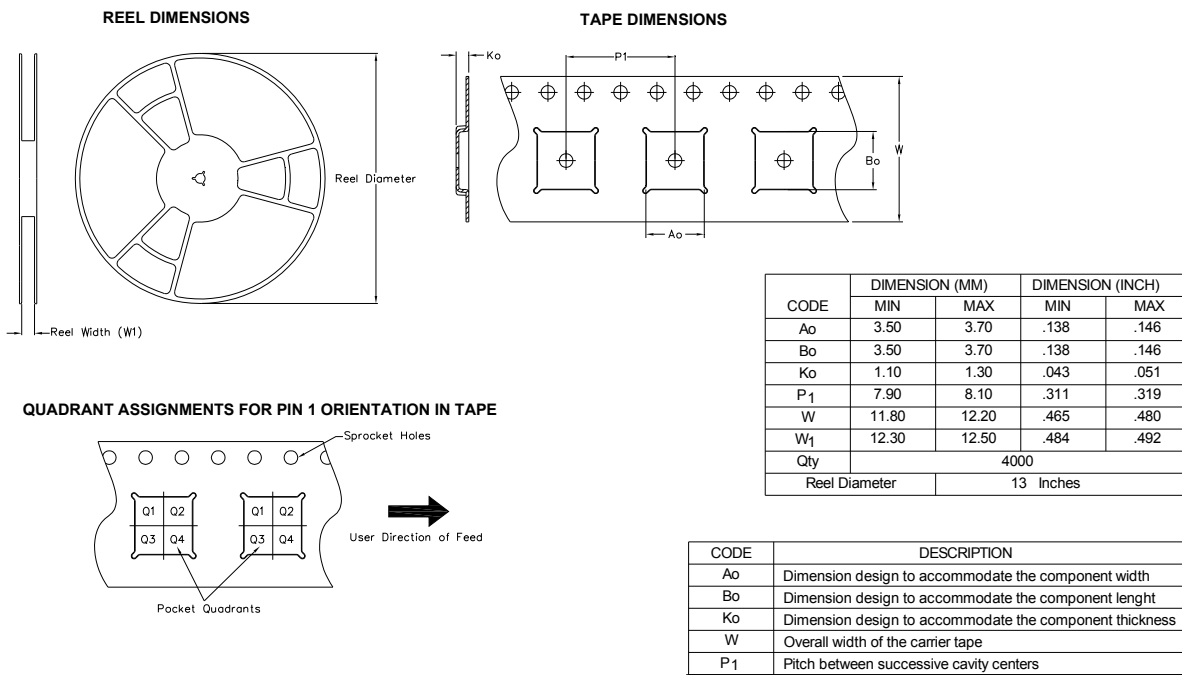
| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.80 | 0.90 | .0315 | .0354 |
| A1 | 0.12 | 0.22 | .0047 | .0086 |
| b | 0.22 | 0.42 | .0087 | .0165 |
| b1 | 0.05 | 0.15 | .0020 | .0059 |
| D | 3.30 BSC | | .1299 BSC | |
| D1 | 3.10 BSC | | .1220 BSC | |
| D2 | 2.29 | 2.69 | .0902 | .1059 |
| E | 3.30 BSC | | .1299 BSC | |
| E1 | 3.10 BSC | | .1220 BSC | |
| E2 | 1.85 | 2.05 | .0728 | .0807 |
| e | 0.65 BSC | | .0255 BSC | |
| j | 0.15 | 0.35 | .0059 | .0137 |
| k | 0.75 | 0.95 | .0295 | .0374 |
| n | 0.15 | 0.35 | .0059 | .0137 |
| M | NOM. | 0.20 | NOM. | .0078 |
| P | 9° | 11° | 9° | 11° |

For more information on board mounting, including footprint and stencil recommendation, please refer to application note AN-1136: <http://www.irf.com/technical-info/appnotes/an-1136.pdf>

For more information on package inspection techniques, please refer to application note AN-1154: <http://www.irf.com/technical-info/appnotes/an-1154.pdf>

PQFN 3.3mm x 3.3mm Outline Part Marking


Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

PQFN 3.3mm x 3.3mm Outline Tape and Reel


Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

Qualification Information[†]

| | | |
|-----------------------------------|---|---|
| Qualification Level | Consumer ^{††} (per JEDEC JESD47F ^{†††} guidelines) | |
| Moisture Sensitivity Level | PQFN 3.3mm x 3.3mm | MSL1 (per JEDEC J-STD-020D ^{††}) |
| RoHS Compliant | Yes | |

† Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/product-info/reliability>

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier representative for further information: <http://www.irf.com/whoto-call/salesrep/>

††† Applicable version of JEDEC standard at the time of product release.

Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting $T_J = 25^\circ\text{C}$, $L = 0.25\text{mH}$, $R_G = 50\Omega$, $I_{AS} = 20\text{A}$.
- ③ Pulse width $\leq 400\mu\text{s}$; duty cycle $\leq 2\%$.
- ④ R_θ is measured at T_J of approximately 90°C .
- ⑤ When mounted on 1 inch square 2 oz copper pad on 1.5x1.5 in. board of FR-4 material. Please refer to AN-994 for more details: <http://www.irf.com/technical-info/appnotes/an-994.pdf>
- ⑥ Calculated continuous current based on maximum allowable junction temperature.
- ⑦ Current is limited to 25A by source bonding technology.

Revision History

| Date | Comments |
|-----------|---|
| 6/5/2014 | <ul style="list-style-type: none"> • Updated schematic on page 1. • Updated part marking on page 8. • Updated tape and reel on page 9. |
| 6/30/2014 | <ul style="list-style-type: none"> • Remove "SAWN" package outline on page 8. |
| 2/23/2016 | <ul style="list-style-type: none"> • Updated datasheet with corporate template • Updated package outline to reflect the PCN # (241-PCN30-Public) for "Option C" and "Option G" on page 8. |

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