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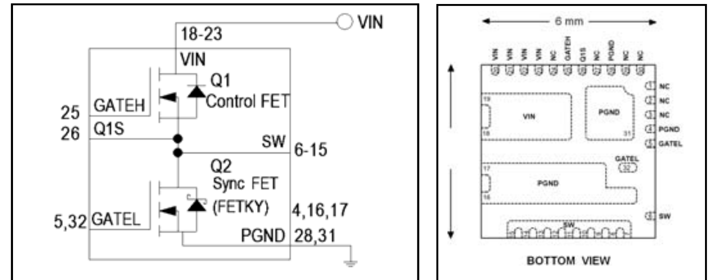
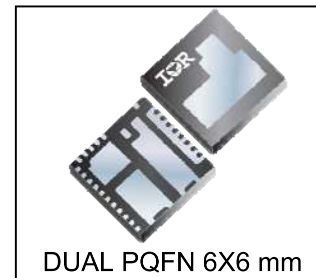
| | Q1 | Q2 | |
|---|---|---|---|
| $V_{DSS}$ | 25 | 25 | V |
| $R_{DS(on)}$ max (@$V_{GS}$ = 4.5V) | 4.10 | 1.35 | mΩ |
| Qg (typical) | 13 | 35 | nC |
| $I_D$ (@$T_C$ = 25°C) | 60⑦ | 60⑦ | A |




## Applications

- Control and Synchronous MOSFETs for synchronous buck converters



DUAL PQFN 6X6 mm

| Features | | Benefits |
|---|---|---|
| Control and synchronous MOSFETs in one package | | Increased power density |
| Low thermal resistance path to the PCB | | Increased power density |
| Low thermal resistance path to the top | | Increased power density |
| Low charge control MOSFET (13nC typical) | results in | Lower switching losses |
| Low $R_{DSON}$ synchronous MOSFET (<1.35mΩ) | ⇒ | Lower conduction losses |
| Intrinsic schottky diode with low forward voltage on Q2 | | Lower switching losses |
| RoHS compliant, halogen-free | | Environmentally friendlier |
| MSL2, industrial qualification | | Increased reliability |

| Base part number | Package Type | Standard Pack | | Orderable Part Number |
|---|---|---|---|---|
| | | Form | Quantity | |
| IRFHE4250DPbF | Dual PQFN 6mm x 6mm | Tape and Reel | 4000 | IRFHE4250DTRPbF |

## Absolute Maximum Ratings

| | Parameter | Q1 Max. | Q2 Max. | Units |
|---|---|---|---|---|
| $V_{GS}$ | Gate-to-Source Voltage | ± 16 | | V |
| $I_D$ @ $T_C$ = 25°C | Continuous Drain Current, $V_{GS}$ @ 10V | 86⑥⑦ | 303⑥⑦ | A |
| $I_D$ @ $T_C$ = 70°C | Continuous Drain Current, $V_{GS}$ @ 10V | 69⑥⑦ | 243⑥⑦ | |
| $I_D$ @ $T_C$ = 25°C | Continuous Drain Current (Source Bonding Technology Limited) | 60⑦ | 60⑦ | |
| $I_{DM}$ | Pulsed Drain Current | 180 | 525⑧ | |
| $P_D$ @$T_C$ = 25°C | Power Dissipation | 156 | 156 | W |
| $P_D$ @$T_C$ = 70°C | Power Dissipation | 100 | 100 | |
| | Linear Derating Factor | 1.3 | 1.3 | W/°C |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to + 150 | | °C |

## Thermal Resistance

| | Parameter | Q1 Max. | Q2 Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ (Bottom) | Junction-to-Case ④ | 3.7 | 0.91 | °C/W |
| $R_{\theta JC}$ (Top) | Junction-to-Case ④ | 0.91 | 2.1 | |
| $R_{\theta JA}$ | Junction-to-Ambient ⑤ | 24 | 24 | |
| $R_{\theta JA}$ (<10s) | Junction-to-Ambient ⑤ | 17 | 17 | |

Notes ① through ⑧ are on page 12

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

| | Parameter | | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain-to-Source Breakdown Voltage | Q1 | 25 | —— | —— | V | $V_{GS}$ = 0V, $I_D$ = 250μA |
| | | Q2 | 25 | —— | —— | | $V_{GS}$ = 0V, $I_D$ = 1.0mA |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | Q1 | —— | 23 | —— | mV/°C | Reference to 25°C, $I_D$ = 1.0mA |
| | | Q2 | —— | 21 | —— | | Reference to 25°C, $I_D$ = 10mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | Q1 | —— | 2.20 | 2.75 | mΩ | $V_{GS}$ = 10V, $I_D$ = 27A ③ |
| | | Q2 | —— | 0.70 | 0.90 | | $V_{GS}$ = 10V, $I_D$ = 27A ③ |
| | | Q1 | —— | 3.20 | 4.10 | | $V_{GS}$ = 4.5V, $I_D$ = 27A ③ |
| | | Q2 | —— | 1.00 | 1.35 | | $V_{GS}$ = 4.5V, $I_D$ = 27A ③ |
| $V_{GS(th)}$ | Gate Threshold Voltage | Q1 | 1.1 | 1.6 | 2.1 | V | Q1: $V_{DS}$ = $V_{GS}$, $I_D$ = 35μA |
| | | Q2 | 1.1 | 1.6 | 2.1 | | Q2: $V_{DS}$ = $V_{GS}$, $I_D$ = 100μA |
| $\Delta V_{GS(th)}/\Delta T_J$ | Gate Threshold Voltage Coefficient | Q1 | —— | -5.8 | —— | mV/°C | Q1: $V_{DS}$ = $V_{GS}$, $I_D$ = 35μA |
| | | Q2 | —— | -7.8 | —— | | Q2: $V_{DS}$ = $V_{GS}$, $I_D$ = 1.0mA |
| $I_{DSS}$ | Drain-to-Source Leakage Current | Q1 | —— | —— | 1.0 | μA | $V_{DS}$ = 20V, $V_{GS}$ = 0V |
| | | Q2 | —— | —— | 500 | | $V_{DS}$ = 20V, $V_{GS}$ = 0V |
| $I_{GSS}$ | Gate-to-Source Forward Leakage | Q1/Q2 | —— | —— | 100 | nA | $V_{GS}$ = 16V |
| | Gate-to-Source Reverse Leakage | Q1/Q2 | —— | —— | -100 | | $V_{GS}$ = -16V |
| gfs | Forward Transconductance | Q1 | 73 | —— | —— | S | $V_{DS}$ = 10V, $I_D$ = 14A |
| | | Q2 | 121 | —— | —— | | $V_{DS}$ = 10V, $I_D$ = 23A |
| $Q_g$ | Total Gate Charge | Q1 | —— | 13 | 20 | nC | |
| | | Q2 | —— | 35 | 53 | | |
| $Q_{gs1}$ | Pre-Vth Gate-to-Source Charge | Q1 | —— | 3.6 | —— | | Q1 |
| | | Q2 | —— | 8.6 | —— | | $V_{DS}$ = 13V |
| $Q_{gs2}$ | Post-Vth Gate-to-Source Charge | Q1 | —— | 1.3 | —— | | $V_{GS}$ = 4.5V, $I_D$ = 13A |
| | | Q2 | —— | 3.8 | —— | | |
| $Q_{gd}$ | Gate-to-Drain Charge | Q1 | —— | 5.2 | —— | | Q2 |
| | | Q2 | —— | 13 | —— | | $V_{DS}$ = 13V |
| $Q_{godr}$ | Gate Charge Overdrive | Q1 | —— | 2.9 | —— | | $V_{GS}$ = 4.5V, $I_D$ = 23A |
| | | Q2 | —— | 9.6 | —— | | |
| $Q_{sw}$ | Switch Charge ($Q_{gs2}$ + $Q_{gd}$) | Q1 | —— | 6.5 | —— | | |
| | | Q2 | —— | 16.8 | —— | | |
| $Q_{oss}$ | Output Charge | Q1 | —— | 14 | —— | nC | $V_{DS}$ = 16V, $V_{GS}$ = 0V |
| | | Q2 | —— | 41 | —— | | |
| $R_G$ | Gate Resistance | Q1 | —— | 0.5 | —— | Ω | |
| | | Q2 | —— | 0.4 | —— | | |
| $t_{d(on)}$ | Turn-On Delay Time | Q1 | —— | 11 | —— | ns | Q1 |
| | | Q2 | —— | 17 | —— | | $V_{DS}$ = 13V $V_{GS}$ = 4.5V |
| $t_r$ | Rise Time | Q1 | —— | 33 | —— | | $I_D$ = 14A, Rg = 1.8Ω |
| | | Q2 | —— | 54 | —— | | |
| $t_{d(off)}$ | Turn-Off Delay Time | Q1 | —— | 14 | —— | | Q2 |
| | | Q2 | —— | 24 | —— | | $V_{DS}$ = 13V $V_{GS}$ = 4.5V |
| $t_f$ | Fall Time | Q1 | —— | 12 | —— | | $I_D$ = 23A, Rg = 1.8Ω |
| | | Q2 | —— | 16 | —— | | |
| $C_{iss}$ | Input Capacitance | Q1 | —— | 1735 | —— | pF | |
| | | Q2 | —— | 4765 | —— | | $V_{GS}$ = 0V |
| $C_{oss}$ | Output Capacitance | Q1 | —— | 493 | —— | | $V_{DS}$ = 13V |
| | | Q2 | —— | 1577 | —— | | $f$ = 1.0MHz |
| $C_{rss}$ | Reverse Transfer Capacitance | Q1 | —— | 137 | —— | | |
| | | Q2 | —— | 370 | —— | | |

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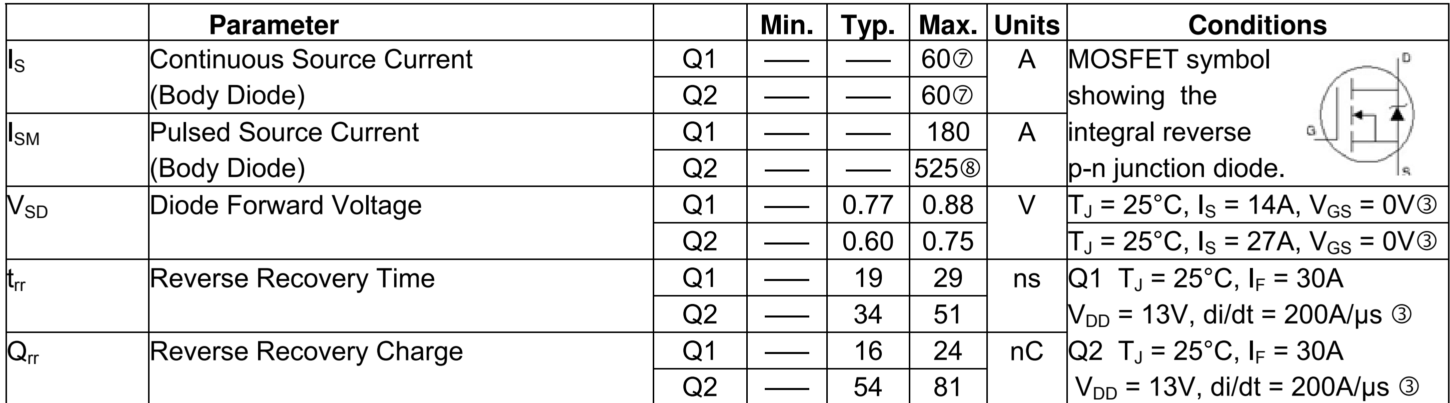
### Avalanche Characteristics

| | Parameter | Typ. | Q1 Max. | Q2 Max. | Units |
|---|---|---|---|---|---|
| $E_{AS}$ | Single Pulse Avalanche Energy ② | —— | 71② | 481② | mJ |
| $I_{AR}$ | Avalanche Current ① | —— | 32 | 63 | A |

### Diode Characteristics



| | Parameter | | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) | Q1 | —— | —— | 60⑦ | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| | | Q2 | —— | —— | 60⑦ | | |
| $I_{SM}$ | Pulsed Source Current (Body Diode) | Q1 | —— | —— | 180 | A | |
| | | Q2 | —— | —— | 525⑧ | | |
| $V_{SD}$ | Diode Forward Voltage | Q1 | —— | 0.77 | 0.88 | V | $T_J$ = 25°C, $I_S$ = 14A, $V_{GS}$ = 0V③ |
| | | Q2 | —— | 0.60 | 0.75 | | $T_J$ = 25°C, $I_S$ = 27A, $V_{GS}$ = 0V③ |
| $t_{rr}$ | Reverse Recovery Time | Q1 | —— | 19 | 29 | ns | Q1 $T_J$ = 25°C, $I_F$ = 30A<br>$V_{DD}$ = 13V, di/dt = 200A/μs ③ |
| | | Q2 | —— | 34 | 51 | | |
| $Q_{rr}$ | Reverse Recovery Charge | Q1 | —— | 16 | 24 | nC | Q2 $T_J$ = 25°C, $I_F$ = 30A<br>$V_{DD}$ = 13V, di/dt = 200A/μs ③ |
| | | Q2 | —— | 54 | 81 | | |

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Q1 - Control FET

Q2 - Synchronous FET

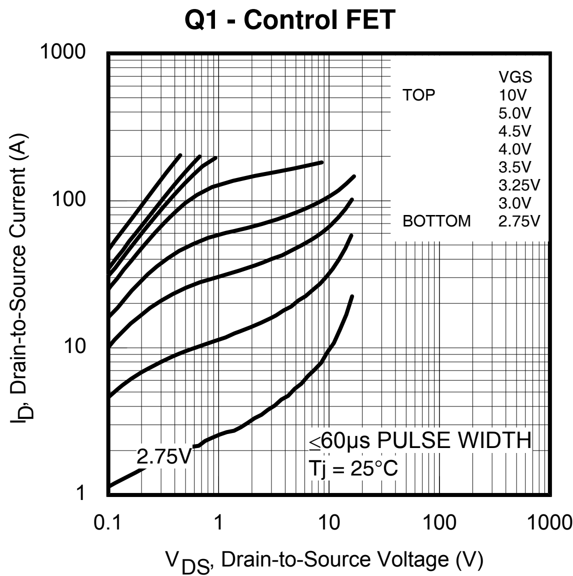


**Fig 1.** Typical Output Characteristics

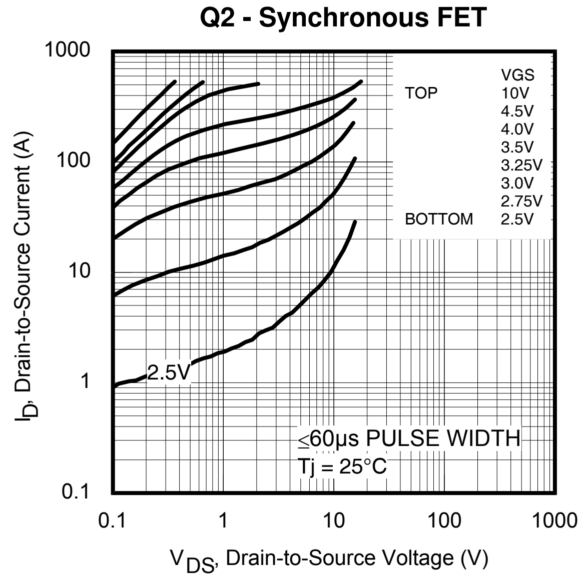


**Fig 2.** Typical Output Characteristics

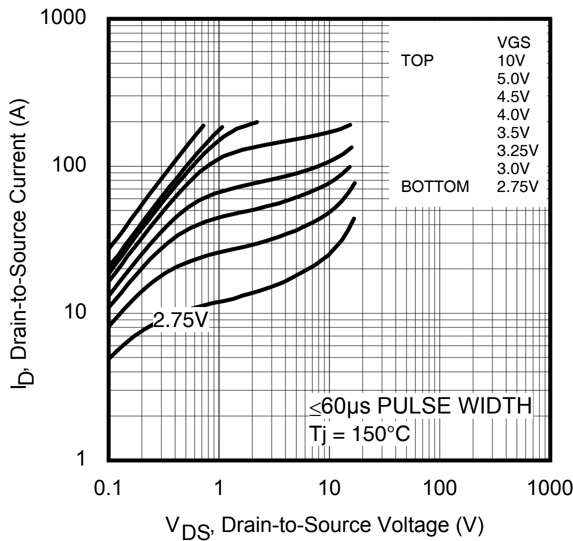


**Fig 3.** Typical Output Characteristics

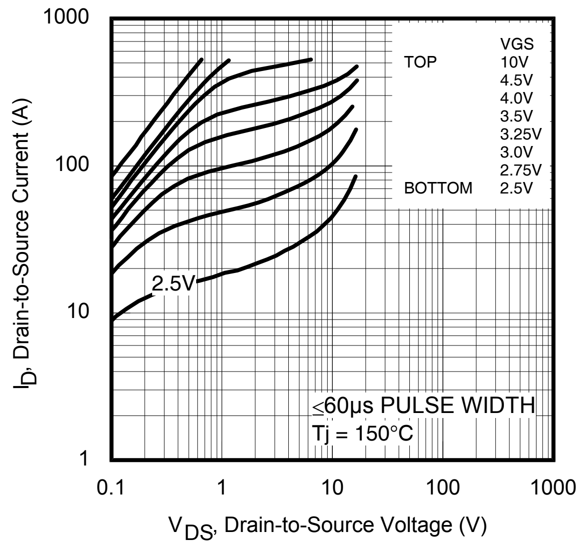


**Fig 4.** Typical Output Characteristics

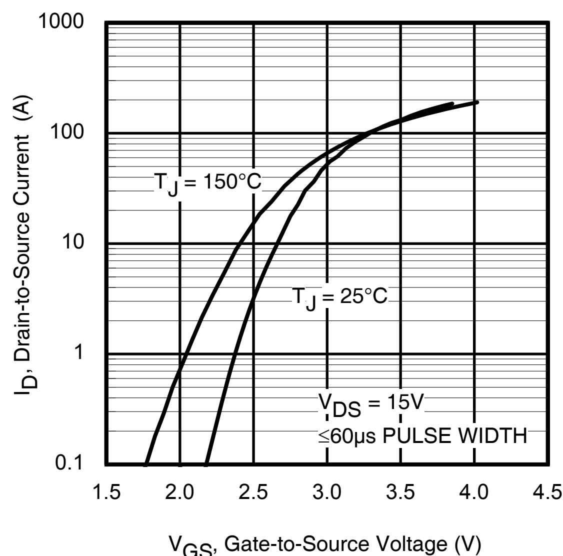


**Fig 5.** Typical Transfer Characteristics

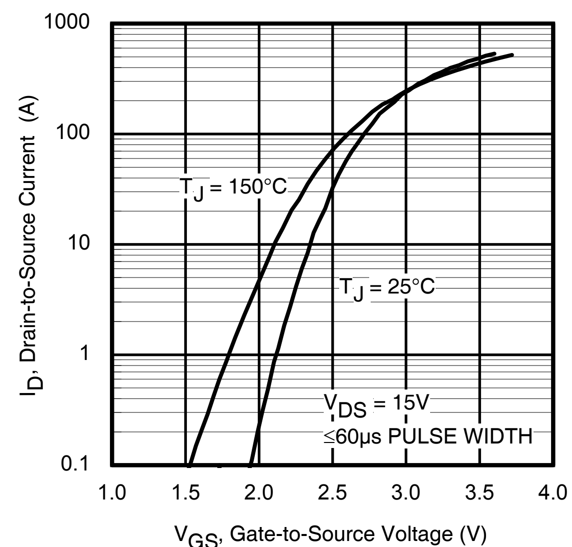


**Fig 6.** Typical Transfer Characteristics

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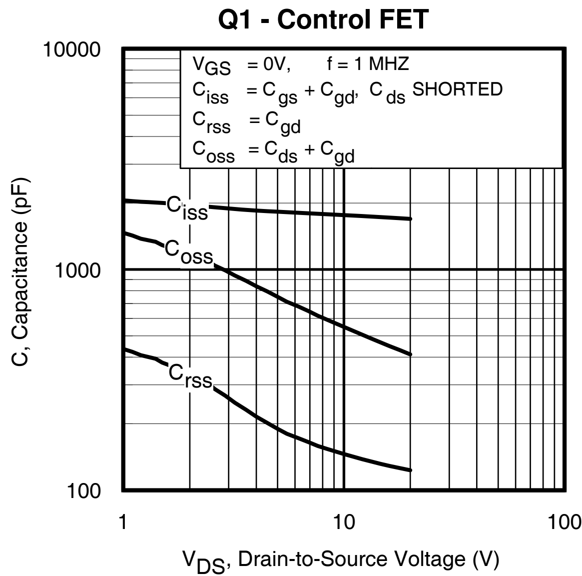


**Fig 7.** Typical Capacitance vs. Drain-to-Source Voltage

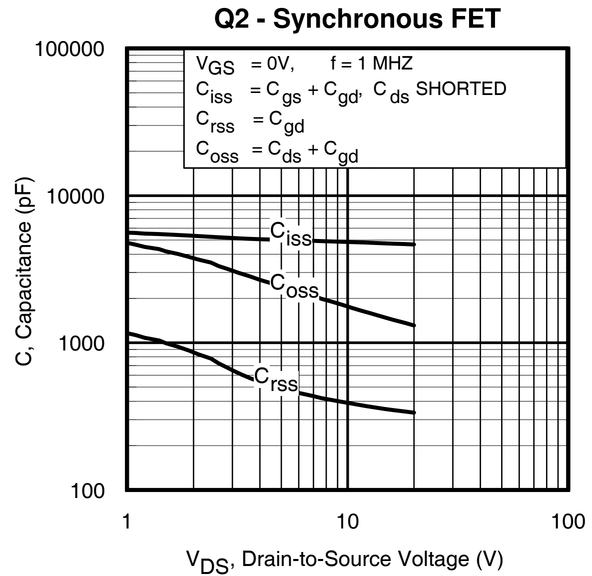


**Fig 8.** Typical Capacitance vs. Drain-to-Source Voltage

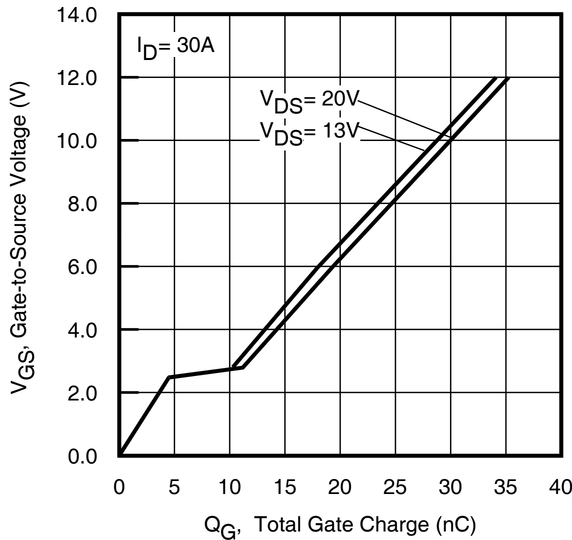


**Fig 9.** Typical Gate Charge vs. Gate-to-Source Voltage

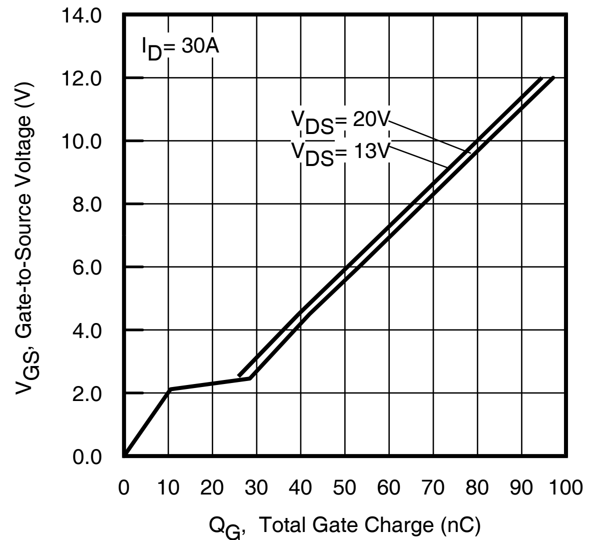


**Fig 10.** Typical Gate Charge vs. Gate-to-Source Voltage

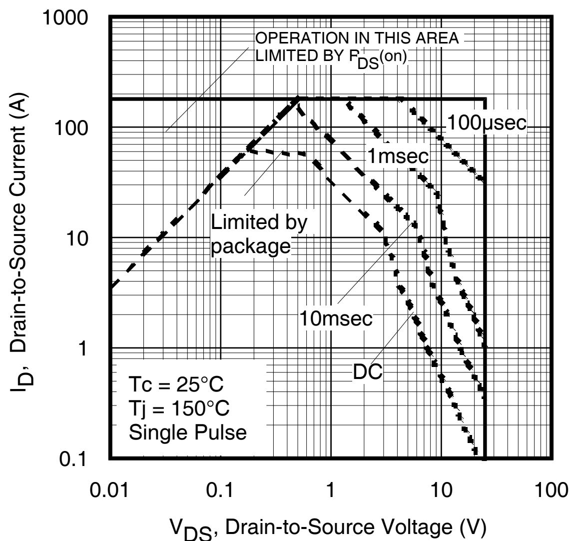


**Fig 11.** Maximum Safe Operating Area

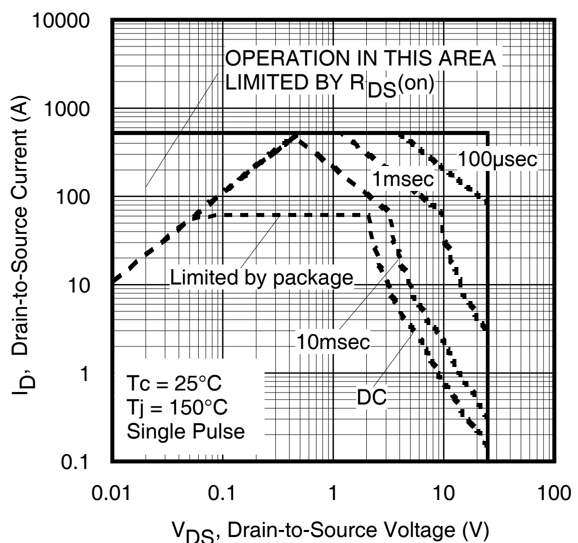


**Fig 12.** Maximum Safe Operating Area

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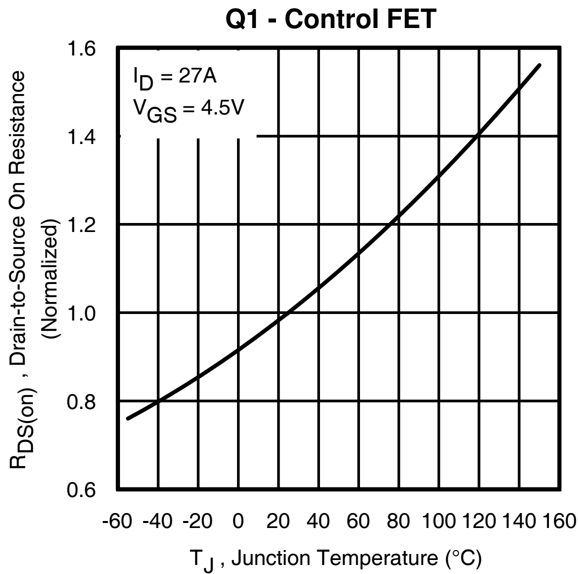


**Fig 13.** Normalized On-Resistance vs. Temperature

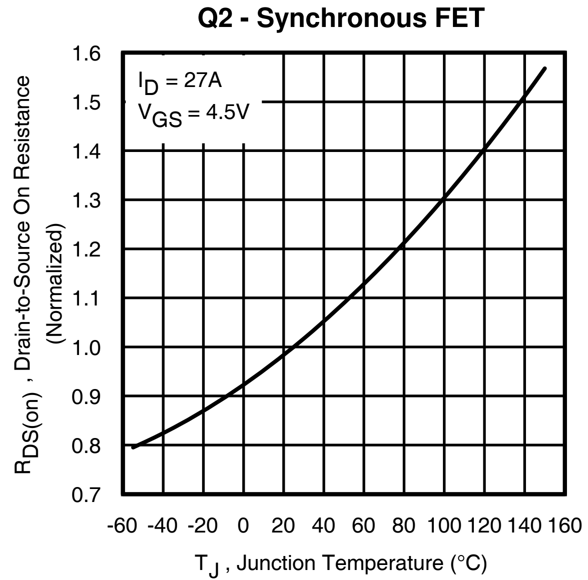


**Fig 14.** Normalized On-Resistance vs. Temperature

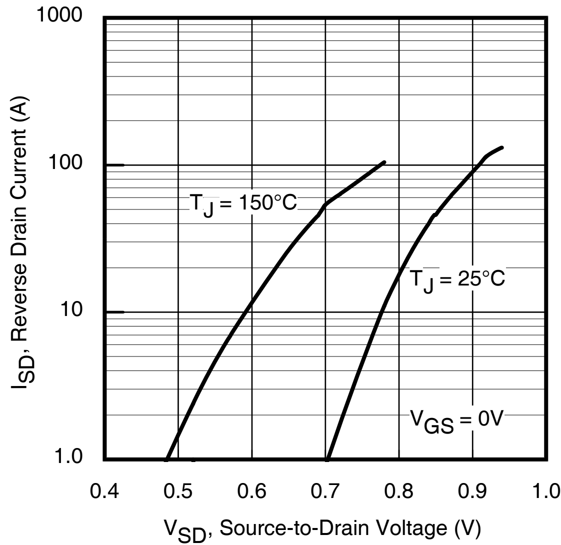


**Fig 15.** Typical Source-Drain Diode Forward Voltage

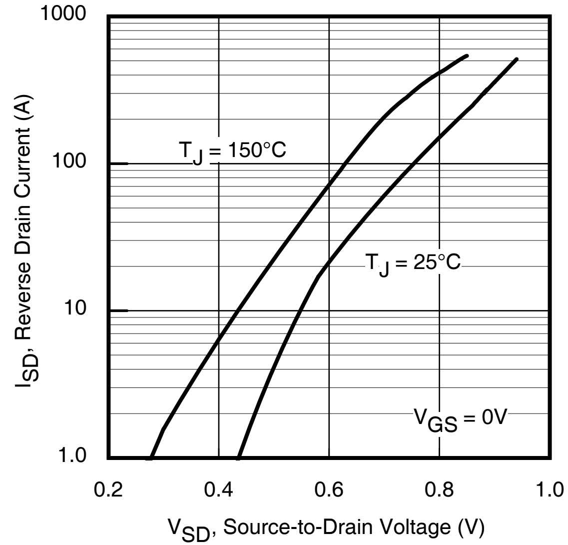


**Fig 16.** Typical Source-Drain Diode Forward Voltage

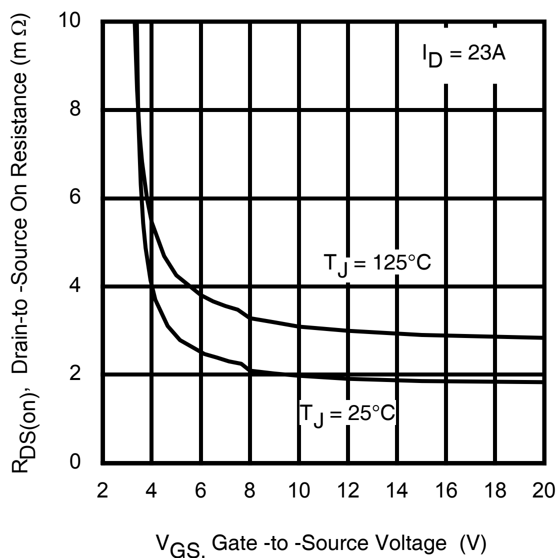


**Fig 17.** Typical On-Resistance vs. Gate Voltage

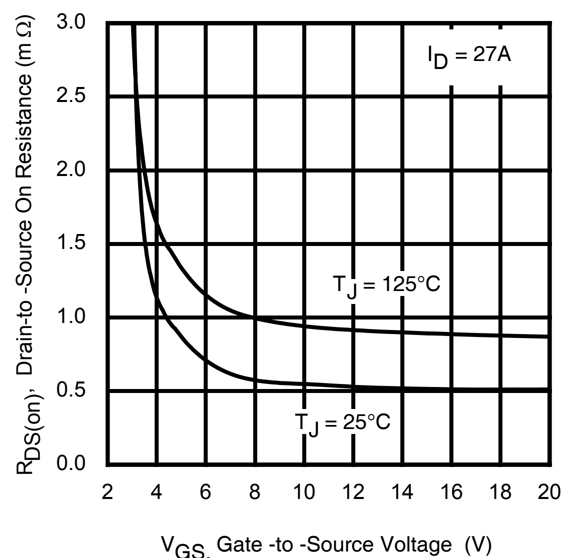


**Fig 18.** Typical On-Resistance vs. Gate Voltage

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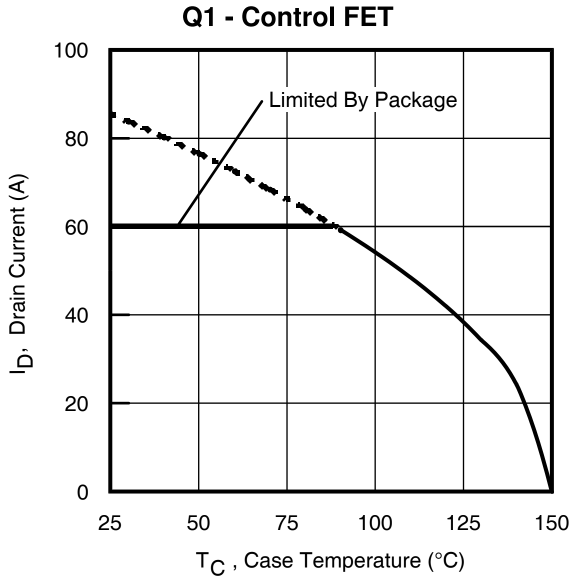


Fig 19. Maximum Drain Current vs. Case Temperature

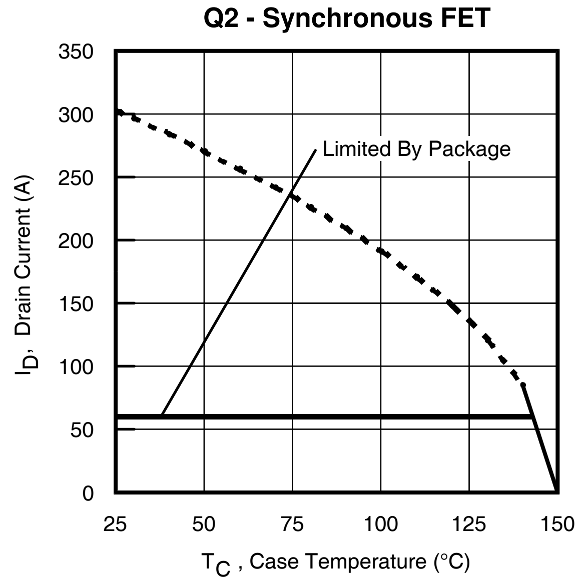


Fig 20. Maximum Drain Current vs. Case Temperature

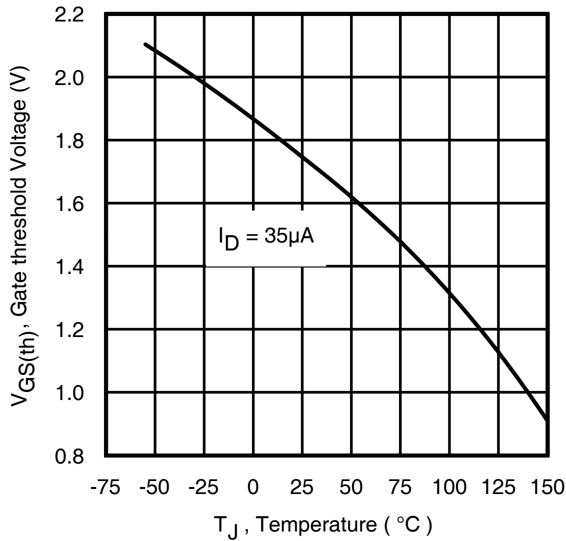


Fig 21. Threshold Voltage vs. Temperature

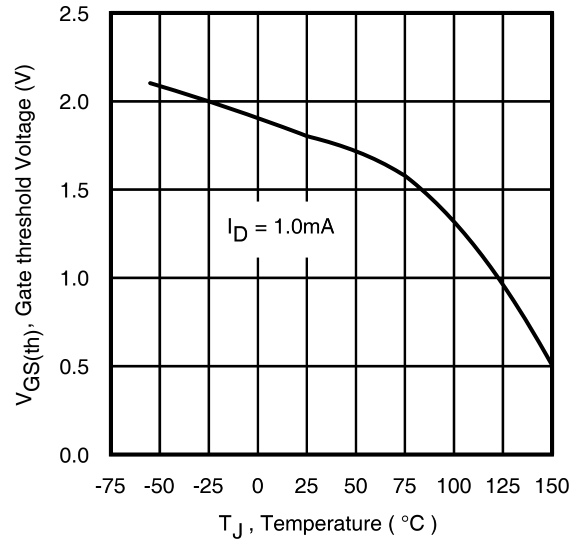


Fig 22. Threshold Voltage vs. Temperature

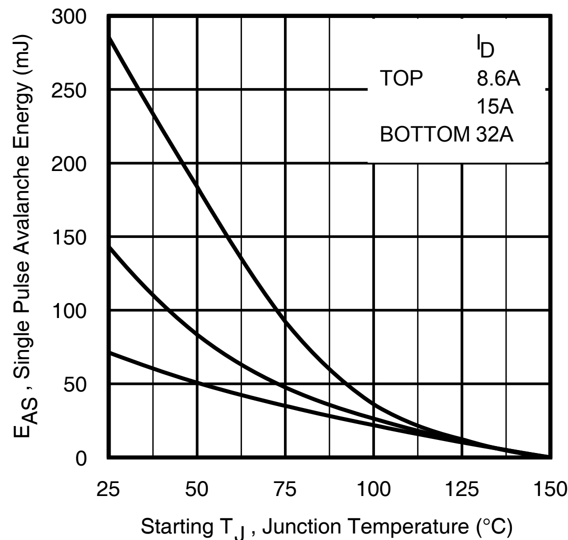


Fig 23. Maximum Avalanche Energy vs. Drain Current

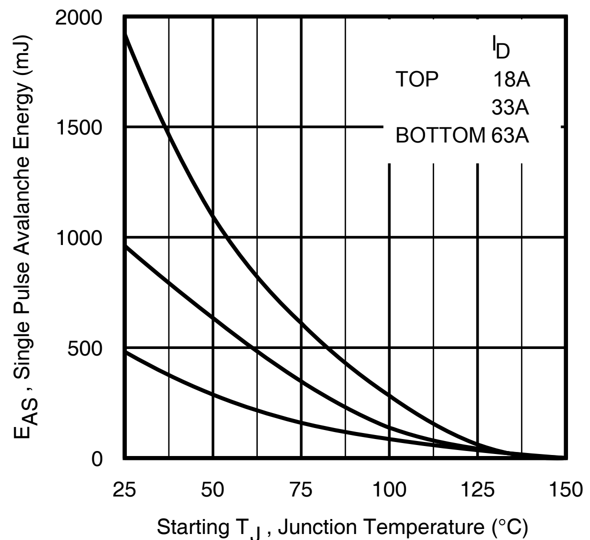


Fig 24. Maximum Avalanche Energy vs. Drain Current

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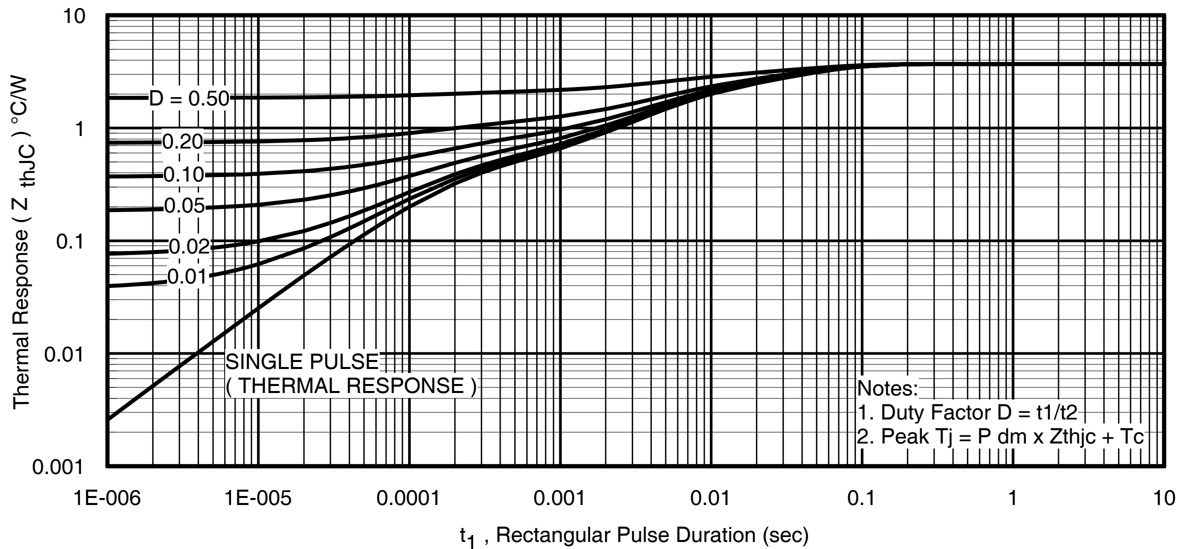


**Fig 25.** Maximum Effective Transient Thermal Impedance, Junction-to-Case (Q1)

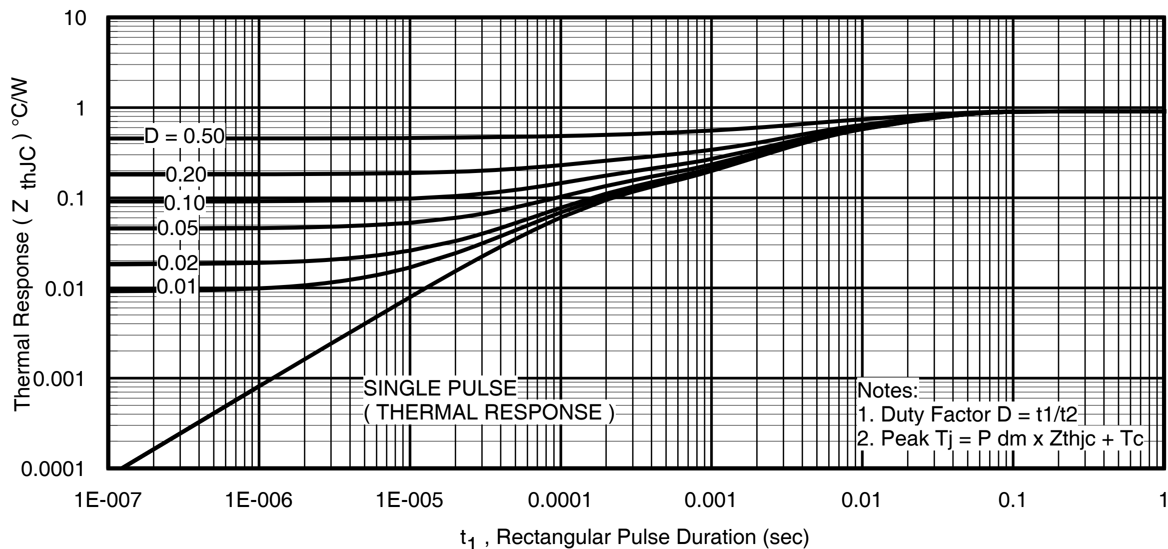


**Fig 26.** Maximum Effective Transient Thermal Impedance, Junction-to-Case (Q2)

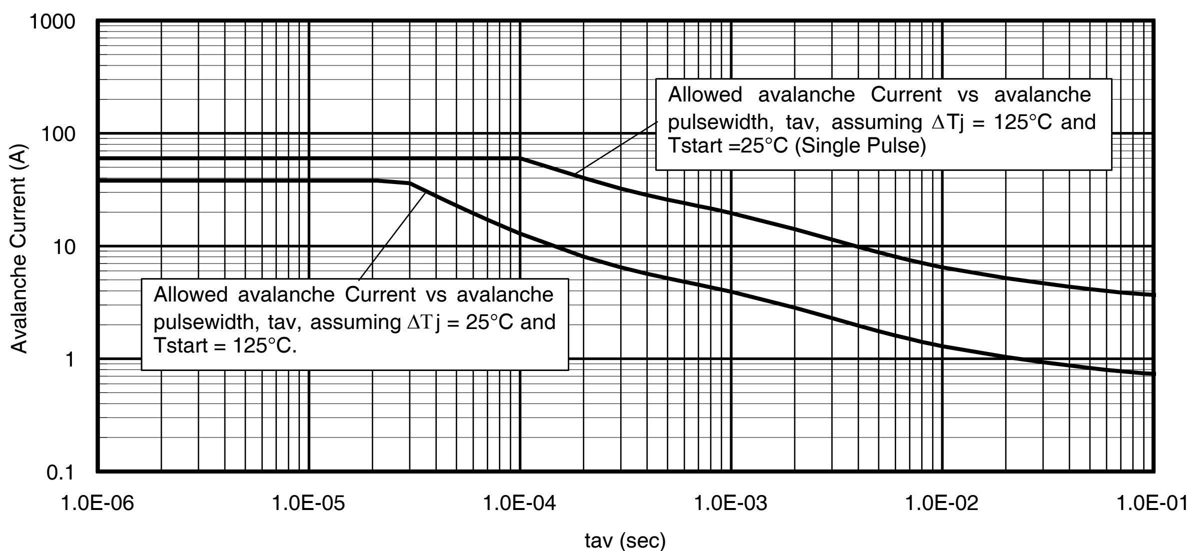


**Fig 27.** Single Avalanche Event: Pulse Current vs. Pulse Width (Q1)


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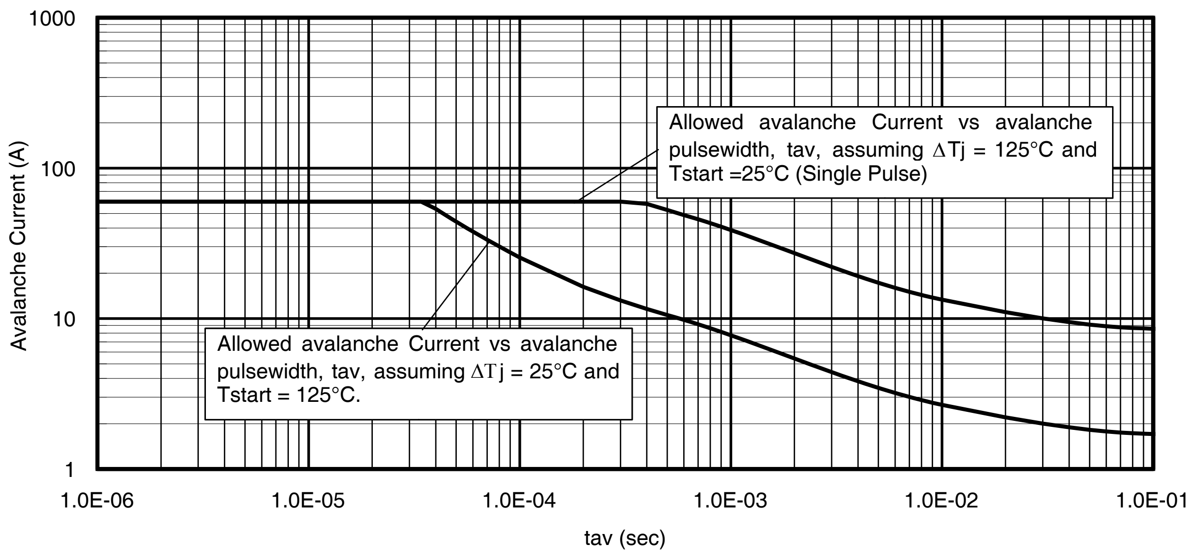


**Fig 28.** Single Avalanche Event: Pulse Current vs. Pulse Width (Q2)

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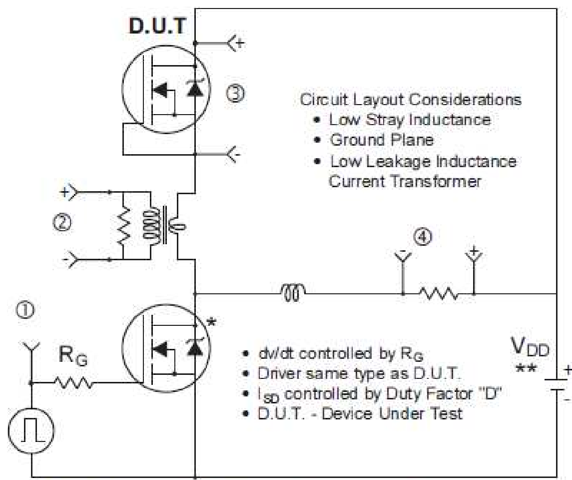


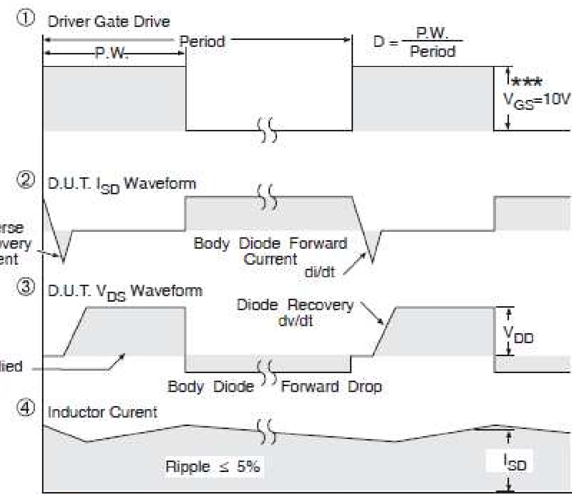


**Fig 29.** Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

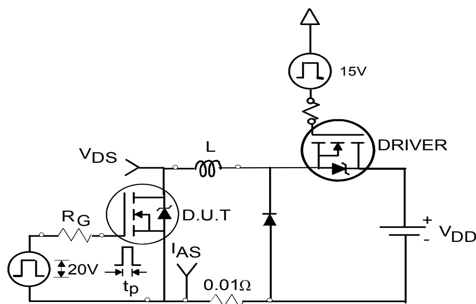


**Fig 30a.** Unclamped Inductive Test Circuit

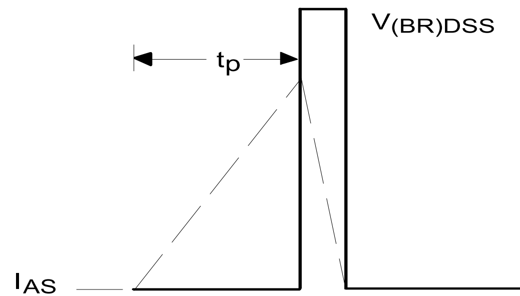


**Fig 30b.** Unclamped Inductive Waveforms

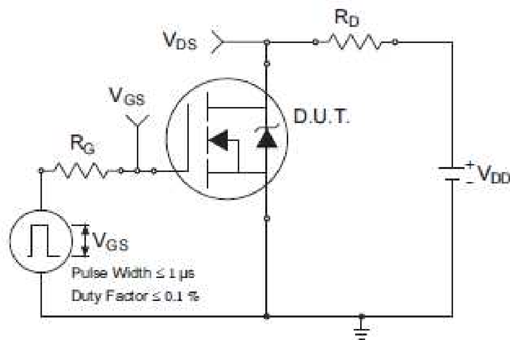


**Fig 31a.** Switching Time Test Circuit

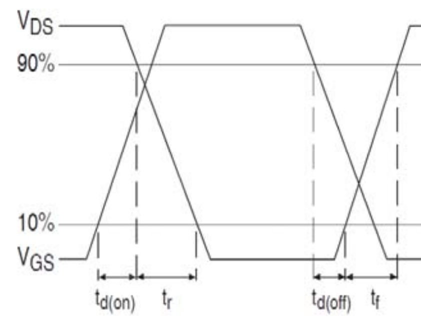


**Fig 31b.** Switching Time Waveforms

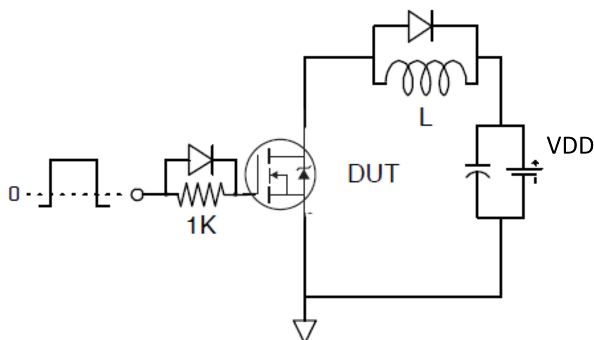


**Fig 32a.** Gate Charge Test Circuit

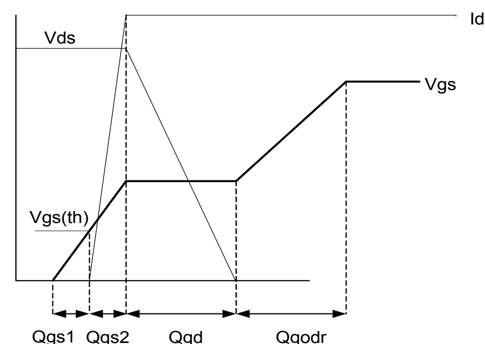


**Fig 32b.** Gate Charge Waveform

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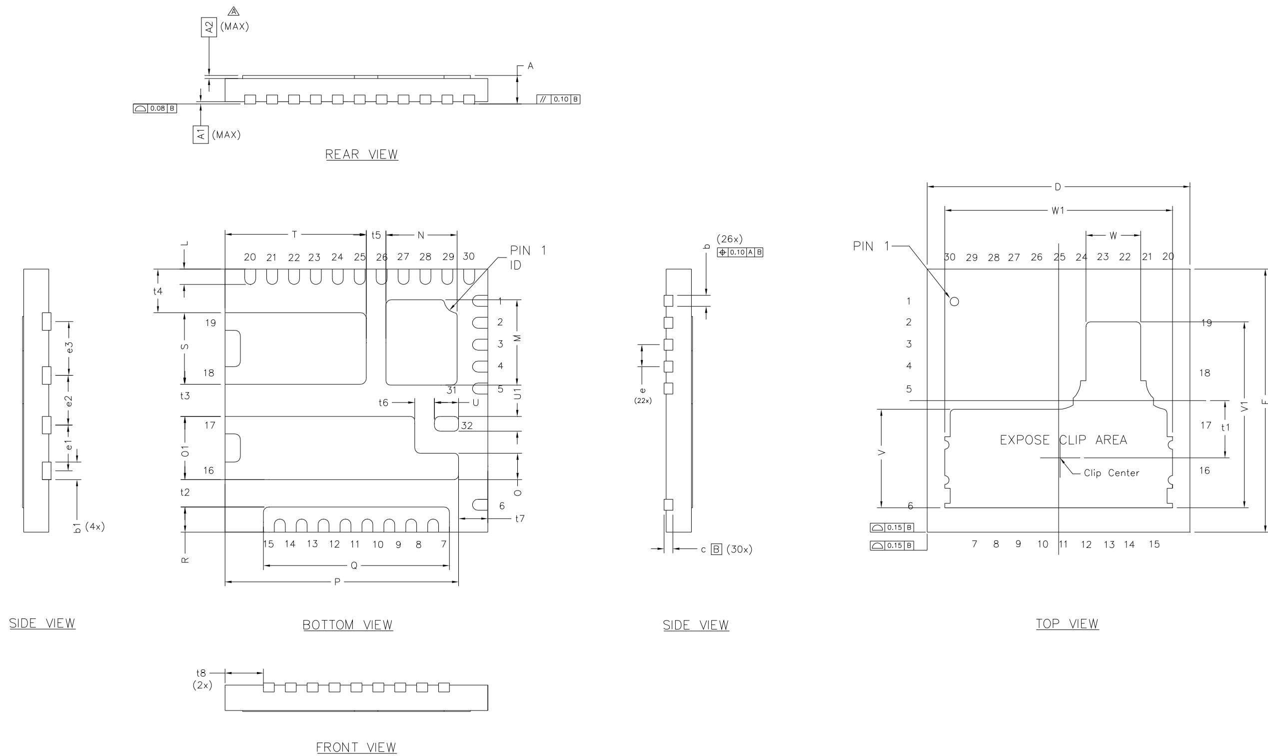
## Dual PQFN 6x6 Outline Package Details




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.55 | 0.75 | .0217 | .0295 |
| A1 | 0.000 | 0.050 | .0000 | .0020 |
| A2 | 0.000 | 0.070 | .0000 | .0028 |
| b | 0.20 | 0.30 | .0079 | .0118 |
| b1 | 0.350 | 0.450 | .0138 | .0177 |
| c | 0.203 REF. | | .0080 REF. | |
| D | 6.000 BASIC | | .2362 BASIC | |
| E | 6.000 BASIC | | .2362 BASIC | |
| e | 0.500 BASIC | | .0197 BASIC | |
| e1 | 1.041 BASIC | | .0410 BASIC | |
| e2 | 1.134 BASIC | | .0446 BASIC | |
| e3 | 1.230 BASIC | | .0484 BASIC | |
| L | 0.300 | 0.400 | .0118 | .0157 |
| M | 1.846 | 2.046 | .0727 | .0806 |
| N | 1.527 | 1.727 | .0601 | .0680 |
| O | 0.500 | 0.700 | .0197 | .0276 |
| O1 | 1.341 | 1.541 | .0528 | .0607 |
| P | 5.231 | 5.431 | .2059 | .2138 |

| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| Q | 4.150 | 4.350 | .1634 | .1713 |
| R | 0.475 | 0.675 | .0187 | .0266 |
| S | 1.530 | 1.730 | .0602 | .0681 |
| T | 3.123 | 3.323 | .1230 | .1308 |
| t1 | 1.207 | 1.407 | .0475 | .0554 |
| t2 | 0.525 | 0.725 | .0207 | .0285 |
| t3 | 0.634 | 0.834 | .0250 | .0328 |
| t4 | 0.896 | 1.096 | .0353 | .0431 |
| t5 | 0.350 | 0.550 | .0138 | .0217 |
| t6 | 0.350 | 0.550 | .0138 | .0217 |
| t7 | 0.569 | 0.769 | .0224 | .0303 |
| t8 | 0.775 | 0.975 | .0305 | .0384 |
| U | 0.450 | 0.650 | .0177 | .0256 |
| U1 | 0.237 | 0.437 | .0093 | .0172 |
| V | 2.147 | 2.347 | .0845 | .0924 |
| V1 | 4.140 | 4.340 | .1630 | .1709 |
| W | 1.148 | 1.348 | .0452 | .0531 |
| W1 | 5.100 | 5.300 | .0200 | .0208 |

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

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

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## Dual PQFN 6x6 Outline Tape and Reel

NOTE

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.
(V) Typical SR of form tape Max 10 OHM/SQ

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

MATERIAL: CONDUCTIVE POLYSTYRENE (IV)

| CODE | DIMENSION (MM) | | DIMENSION (INCH) | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| Ao | 6.20 | 6.40 | 0.244 | 0.252 |
| Bo | 6.20 | 6.40 | 0.244 | 0.252 |
| Ko | 1.00 | 1.20 | 0.039 | 0.047 |
| F | 7.40 | 7.60 | 0.291 | 0.299 |
| P1 | 11.90 | 12.10 | 0.469 | 0.476 |
| W | 15.70 | 16.30 | 0.618 | 0.642 |

NOTES :
1. MATERIAL : POLYSTYRENE (WHITE)
2. ANTISTATIC COATED
3. FLANGE WARPAGE : 3 MM MAXIMUM
4. ALL DIMENSIONS ARE IN MM
5. ESD – SURFACE RESISTIVITY – $10^{8}$ TO $10^{11}$ OHMS/SQ.
6. GENERAL TOLERANCE : ±0.25 UNLESS OTHERWISE SPECIFIED.
7. TOTAL THICKNESS OF REEL: W2=22.4 MAX.

| SYMBOL | DIMENSION (MM) | | DIMENSION (INCH) | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 326.00 | 330.25 | 12.835 | 13.002 |
| B | 12.80 | 13.20 | 0.504 | 0.520 |
| C | 1.95 | 2.45 | 0.077 | 0.096 |
| D | 16.40 | 18.90 | 0.646 | 0.744 |
| E | 98.00 | 102.00 | 3.858 | 4.016 |
| F | 2.00 | 2.00 | 0.079 | 0.110 |

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

### Qualification Information†

| Qualification level | Industrial (per JEDEC JESD47F †† guidelines ) | |
|---|---|---|
| Moisture Sensitivity Level | DUAL PQFN 6mm x 6mm | MSL2 (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
†† 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°C,
Q1: L = 0.14 mH, $R_G$ = 50Ω, $I_{AS}$ = 32A;
Q2: L = 0.24 mH, $R_G$ = 50Ω, $I_{AS}$ = 63A.
③ Pulse width ≤ 400μs; duty cycle ≤ 2%.
④ $R_\theta$ is measured at $T_J$ approximately 90°C.
⑤ When mounted on 1 inch square PCB (FR-4). 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 Q1 = 60A & Q2 = 60A by source bonding technology.
⑧ Pulsed drain current is limited to 240A by source bonding technology.

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To contact International Rectifier, please visit http://www.irf.com/whoto-call/

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