FAIRCHILD SEMICONDUCTOR®

March 2013

# FCB20N60F

## N-Channel SuperFET® FRFET® MOSFET

### 600 V, 20 A, 190 mΩ

## Features

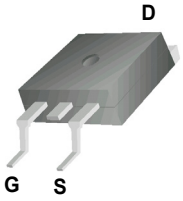
- 650V @$T_J$ = 150°C
- Typ. $R_{DS(on)}$ = 150 mΩ
- Ultra Low Gate Charge (Typ. $Q_g$ = 75 nC)
- Low Effective Output Capacitance (Typ. $C_{oss}$.eff = 165 pF)
- 100% Avalanche Tested
- RoHS Compliant

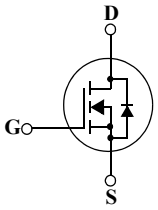
## Application

- Lighting
- Solar Inverter
- AC-DC Power Supply

## Description

SuperFET® MOSFET is Fairchild Semiconductor®'s first generation of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switching performance, dv/dt rate and higher avalanche energy. Consequently, SuperFET MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications. SuperFET FRFET® MOSFET's optimized body diode reverse recovery performance can remove additional component and improve system reliability.




## MOSFET Maximum Ratings $T_C$ = 25°C unless otherwise noted*

| Symbol | Parameter | | | FCB20N60F | Unit |
|---|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | | 600 | V |
| $I_D$ | Drain Current | -Continuous ($T_C$ = 25°C) | | 20 | A |
| | | -Continuous ($T_C$ = 100°C) | | 12.5 | |
| $I_{DM}$ | Drain Current | - Pulsed | (Note 1) | 60 | A |
| $V_{GSS}$ | Gate to Source Voltage | | | ±30 | V |
| $E_{AS}$ | Single Pulsed Avalanche Energy | | (Note 2) | 690 | mJ |
| $I_{AR}$ | Avalanche Current | | (Note 1) | 20 | A |
| $E_{AR}$ | Repetitive Avalanche Energy | | (Note 1) | 20.8 | mJ |
| dv/dt | Peak Diode Recovery dv/dt | | (Note 3) | 50 | V/ns |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | | 208 | W |
| | | - Derate above 25°C | | 1.67 | W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | | -55 to +150 | °C |
| $T_L$ | Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds | | | 300 | °C |

## Thermal Characteristics

| Symbol | Parameter | FCB20N60F | Unit |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max | 0.6 | °C/W |
| $R_{\theta JA}$* | Thermal Resistance, Junction to Ambient, Max* | 40 | |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max | 62.5 | |

* When mounted on the minimum pad size recommended (PCB Mount)

## Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|
| FCB20N60F | FCB20N60FTM | $D^2$-PAK | 330mm | 24m | 800 |

## Electrical Characteristics $T_C = 25^oC$ unless otherwise noted

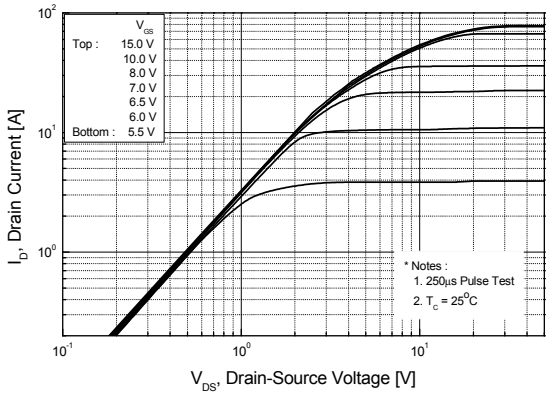
| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 250 μA, $T_C = 25^oC$ | 600 | - | - | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 250 μA, $T_C = 150^oC$ | - | 650 | - | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250 μA, Referenced to $25^oC$ | - | 0.6 | - | $V/^oC$ |
| $BV_{DS}$ | Drain-Source Avalanche Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 20 A | - | 700 | - | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 600 V, $V_{GS}$ = 0 V | - | - | 1 | μA |
| | | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V, $T_C = 125^oC$ | - | - | 10 | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS}$ = ±30 V, $V_{DS}$ = 0 V | - | - | ±100 | nA |
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 250 μA | 3.0 | - | 5.0 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 10 A | - | 0.15 | 0.19 | Ω |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 40 V, $I_D$ = 10 A (Note 4) | - | 17 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1.0 MHz | - | 2370 | 3080 | pF |
| $C_{oss}$ | Output Capacitance | | - | 1280 | 1665 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 95 | - | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V, f = 1.0 MHz | - | 65 | 85 | pF |
| $C_{oss}$eff. | Effective Output Capacitance | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | - | 165 | - | pF |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 300 V, $I_D$ = 20 A, $R_G$ = 25 Ω (Note 4, 5) | - | 62 | 135 | ns |
| $t_r$ | Turn-On Rise Time | | - | 140 | 290 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 230 | 470 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 65 | 140 | ns |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS}$ = 480 V, $I_D$ = 20 A, $V_{GS}$ = 10 V (Note 4, 5) | - | 75 | 98 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 13.5 | 18 | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 36 | - | nC |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 20 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 60 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 20 A | - | - | 1.4 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 20 A, $dI_F/dt$ = 100 A/μs (Note 4) | - | 160 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 1.1 | - | μC |

**Notes:**

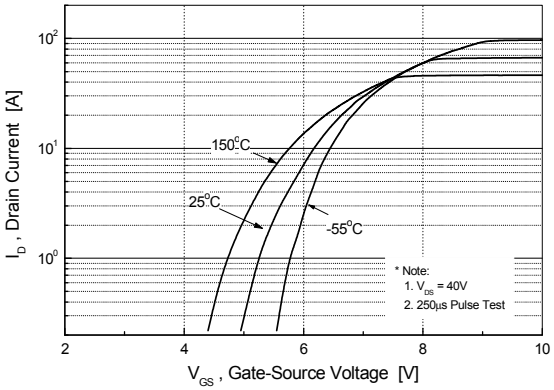
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_{AS}$ = 10 A, $V_{DD}$ = 50 V, $R_G$ = 25 Ω, Starting $T_J$ = 25°C
3. $I_{SD} \le$ 20 A, di/dt ≤ 1200 A/μs, $V_{DD} \le BV_{DSS}$, Starting $T_J$ = 25°C
4. Pulse Test: Pulse width ≤ 300 μs, Duty Cycle ≤ 2%
5. Essentially Independent of Operating Temperature Typical Characteristics

## Typical Performance Characteristics

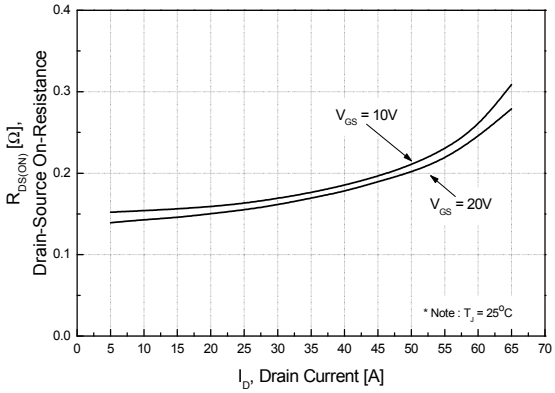
### Figure 1. On-Region Characteristics



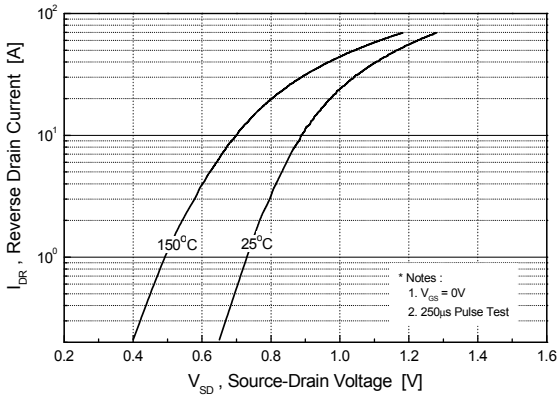

### Figure 2. Transfer Characteristics



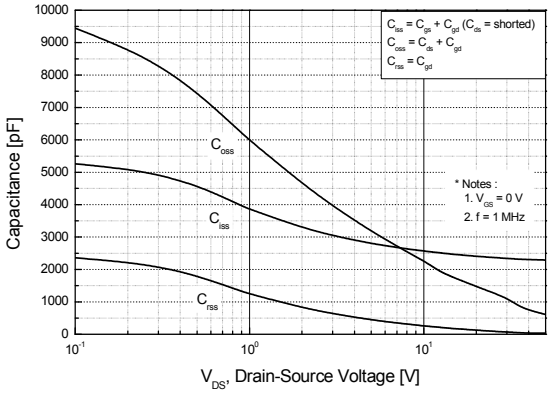

### Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage



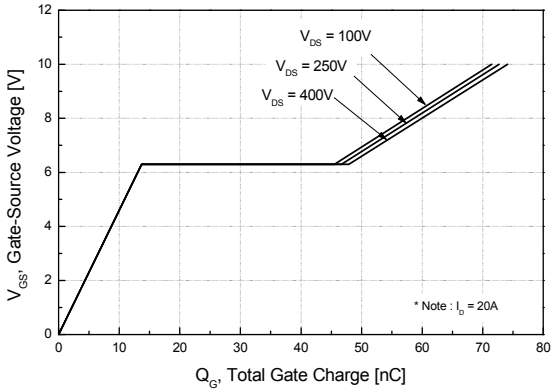

### Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperatue




### Figure 5. Capacitance Characteristics




### Figure 6. Gate Charge Characteristics



## Typical Performance Characteristics (Continued)

**Figure 7. Breakdown Voltage Variation vs. Temperature**

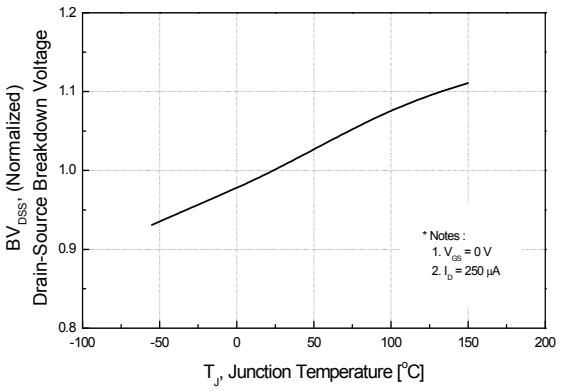



**Figure 8. On-Resistance Variation vs. Temperature**

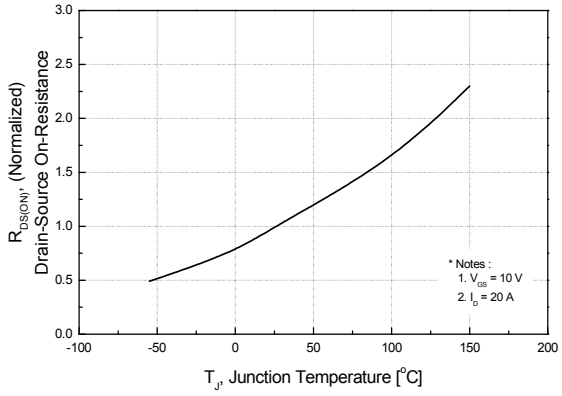



**Figure 9. Maximum Safe Operating Area**

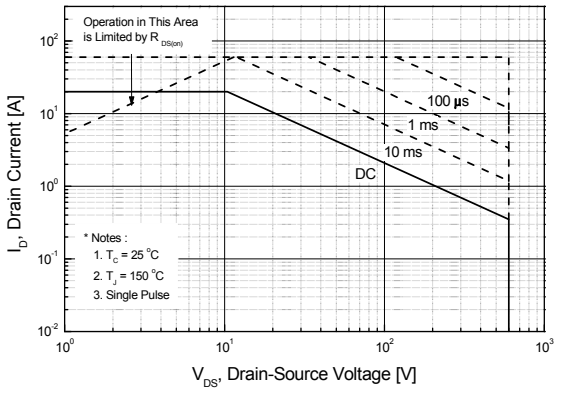



**Figure 10. Maximum Drain Current vs. Case Temperature**

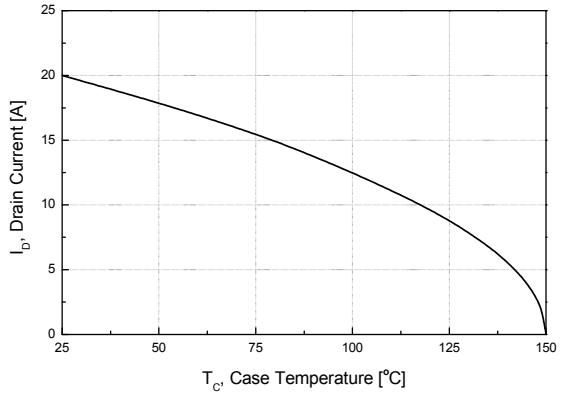
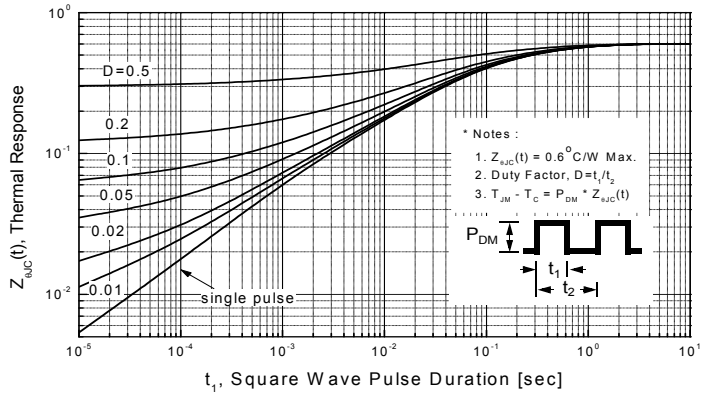
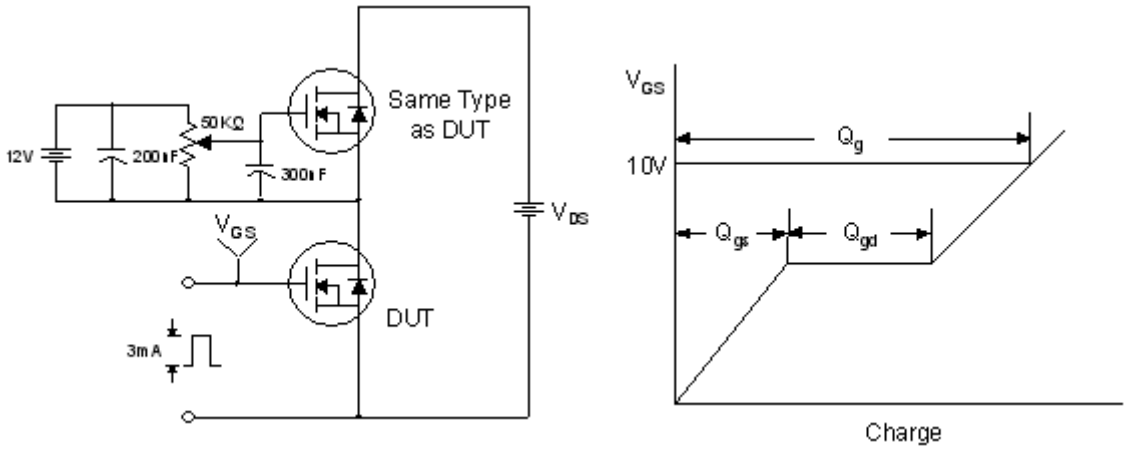


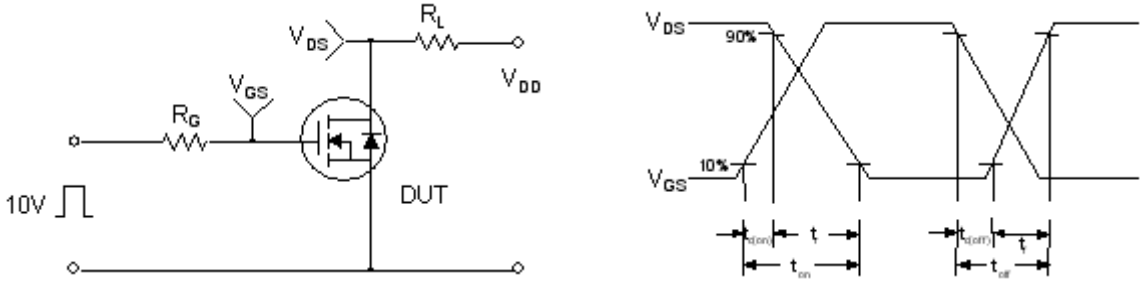

**Figure 11. Transient Thermal Response Curve**



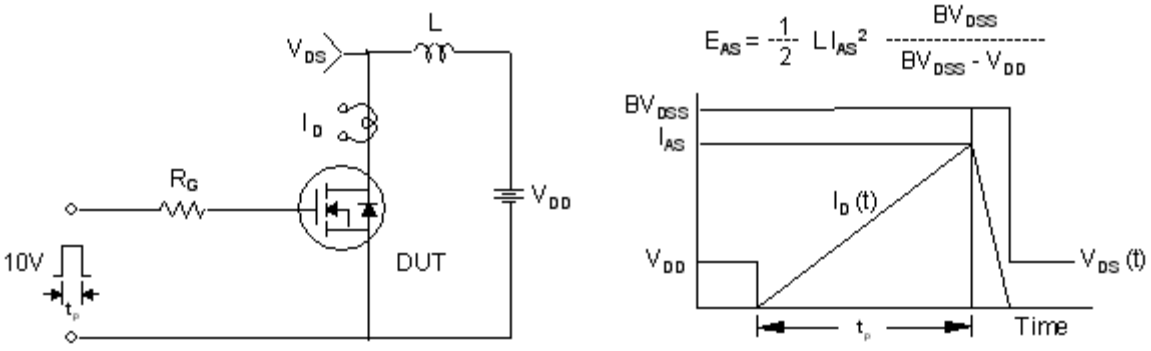
**Gate Charge Test Circuit & Waveform**



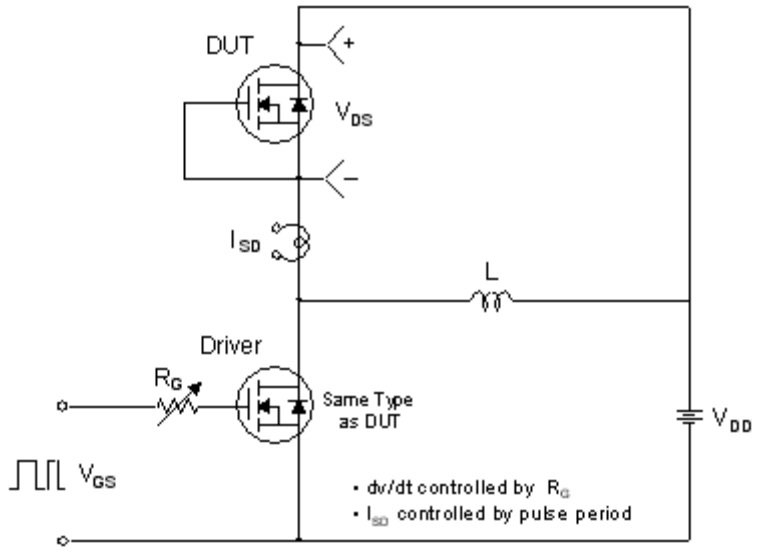

**Resistive Switching Test Circuit & Waveforms**

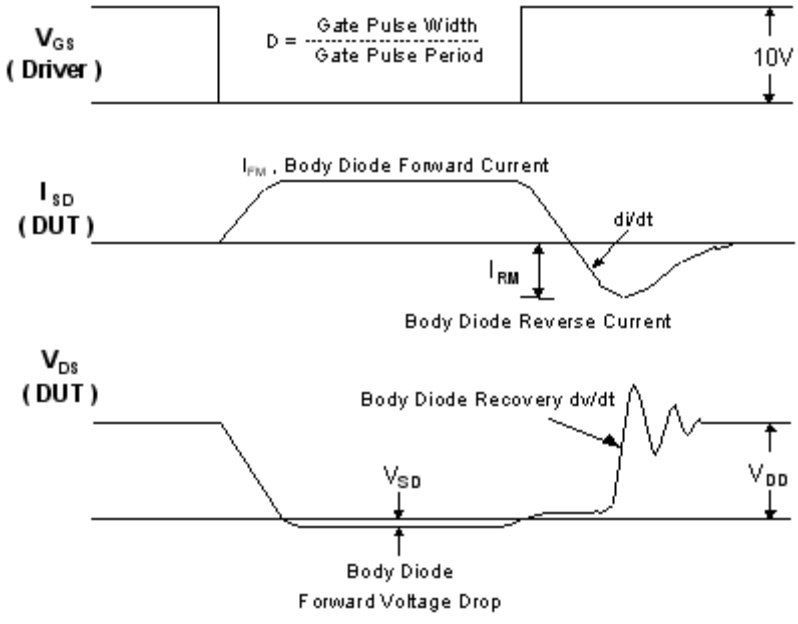



**Unclamped Inductive Switching Test Circuit & Waveforms**



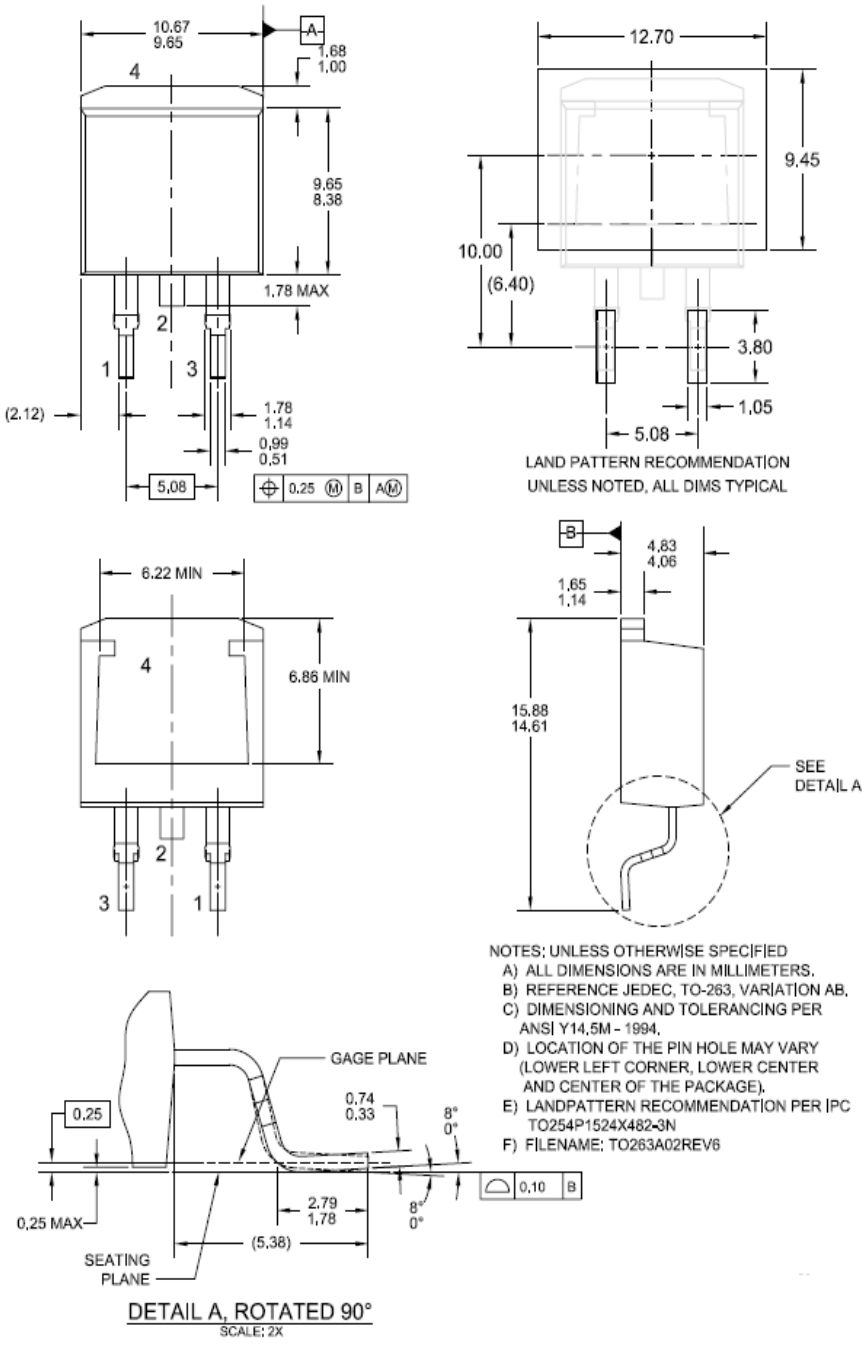
**Peak Diode Recovery dv/dt Test Circuit & Waveforms**



## Mechanical Dimensions

# $D^2PAK$




Dimensions in Millimeters

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