FAIRCHILD SEMICONDUCTOR®

June 2009

# FDI040N06

## N-Channel PowerTrench® MOSFET

**60V, 168A, 4.0mΩ**

### Features

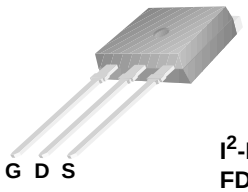
- $R_{DS(on)}$ = 3.2mΩ ( Typ.) @ $V_{GS}$ = 10V, $I_D$ = 75A
- Fast Switching Speed
- Low Gate Charge
- High Performance Trench Technology for Extremely Low $R_{DS(on)}$
- High Power and Current Handling Capability
- RoHS Compliant

### General Description

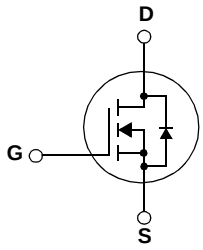
This N-Channel MOSFET is produced using Fairchild Semiconductor's advanced PowerTrench process that has been especially tailored to minimize the on-state resistance and yet maintain superior switching performance.

### Application

- DC to DC convertors / Synchronous Rectification




**$I^2$-PAK**
**FDI Series**




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

| Symbol | Parameter | | Ratings | Units |
|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 60 | V |
| $V_{GSS}$ | Gate to Source Voltage | | ±20 | V |
| $I_D$ | Drain Current | -Continuous ($T_C$ = 25°C, Silicion Limited) | 168* | A |
| | | -Continuous ($T_C$ = 100°C, Silicion Limited) | 118* | |
| | | -Continuous ($T_C$ = 25°C, Package Limited) | 120 | |
| $I_{DM}$ | Drain Current | - Pulsed (Note 1) | 672 | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy | (Note 2) | 872 | mJ |
| dv/dt | Peak Diode Recovery dv/dt | (Note 3) | 7.0 | V/ns |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | 231 | W |
| | | - Derate above 25°C | 1.54 | W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | -55 to +175 | °C |
| $T_L$ | Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds | | 300 | °C |

*Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 120A.

### Thermal Characteristics

| Symbol | Parameter | Ratings | Units |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 0.65 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 62.5 | |

## Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|
| FDI038N06 | FDI038N06 | TO-262 | Tube | - | 50 |

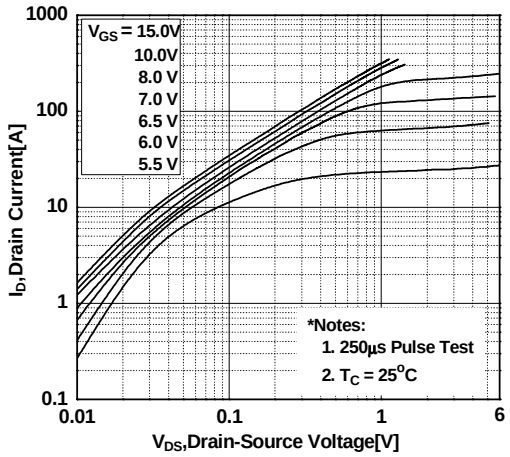
## Electrical Characteristics $T_C = 25^oC$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $I_D$ = 250μA, $V_{GS}$ = 0V, $T_C$= 25°C | 60 | - | - | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250μA, Referenced to 25°C | - | 0.04 | - | V/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 60V, $V_{GS}$ = 0V | - | - | 1 | μA |
| | | $V_{DS}$ = 60V, $V_{GS}$ = 0V, $T_C$ = 150°C | - | - | 500 | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS}$ = ±20V, $V_{DS}$ = 0V | - | - | ±100 | nA |
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 250μA | 2.5 | 3.5 | 4.5 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10V, $I_D$ = 75A | - | 3.2 | 4.0 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 10V, $I_D$ = 75A (Note 4) | - | 169 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25V, $V_{GS}$ = 0V, f = 1MHz | - | 6190 | 8235 | pF |
| $C_{oss}$ | Output Capacitance | | - | 900 | 1195 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 385 | 580 | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS}$ = 48V, $I_D$ = 75A, $V_{GS}$ = 10V (Note 4, 5) | - | 102 | 133 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 32 | - | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 32 | - | nC |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 30V, $I_D$ = 75A, $V_{GS}$ = 10V, $R_{GEN}$ = 4.7Ω (Note 4, 5) | - | 30 | 70 | ns |
| $t_r$ | Turn-On Rise Time | | - | 40 | 90 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 55 | 120 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 24 | 58 | ns |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 168 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 672 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0V, $I_{SD}$ = 75A | - | - | 1.3 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0V, $I_{SD}$ = 75A, $dI_F/dt$ = 100A/μs (Note 4) | - | 41 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 47 | - | nC |

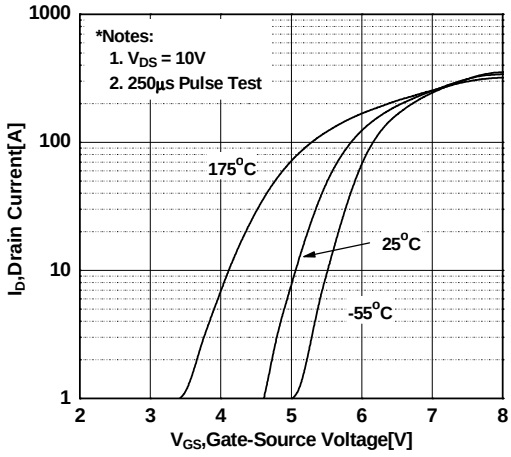
**Notes:**
1: Repetitive Rating: Pulse width limited by maximum junction temperature
2: L = 0.31mH, $I_{AS}$ = 75A, $V_{DD}$ = 50V, $R_G$ = 25Ω, Starting $T_J$ = 25℃
3: $I_{SD}$ ≤ 75A, di/dt ≤ 200A/μs, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25℃
4: Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%
5: Essentially Independent of Operating Temperature Typical Characteristics

## Typical Performance Characteristics

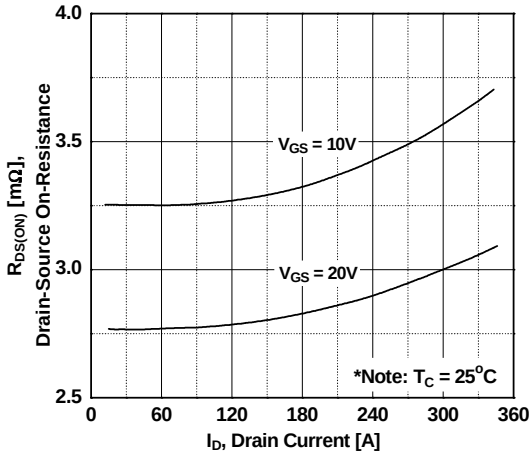
### Figure 1. On-Region Characteristics



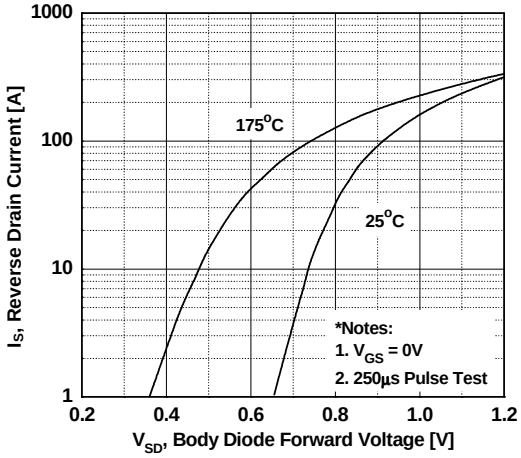

### Figure 2. Transfer Characteristics



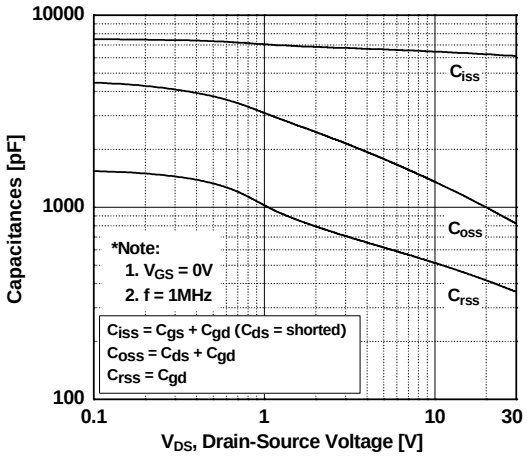

### Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage



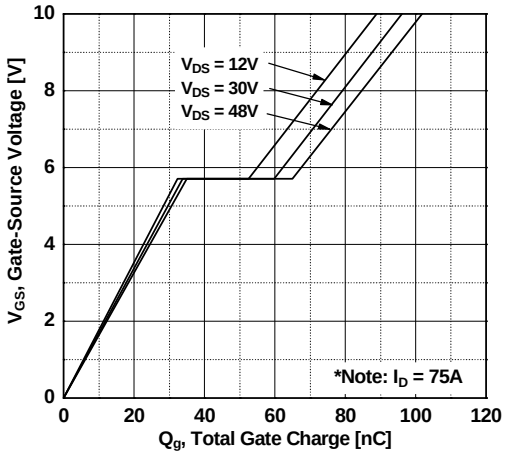

### Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature




### Figure 5. Capacitance Characteristics




### Figure 6. Gate Charge Characteristics



## Typical Performance Characteristics (Continued)

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

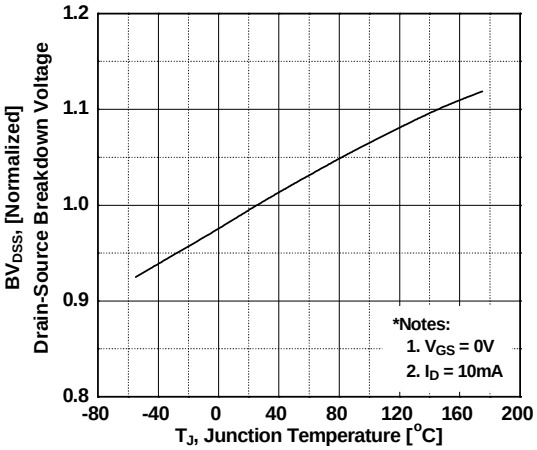



**Figure 8. On-Resistance Variation vs. Temperature**

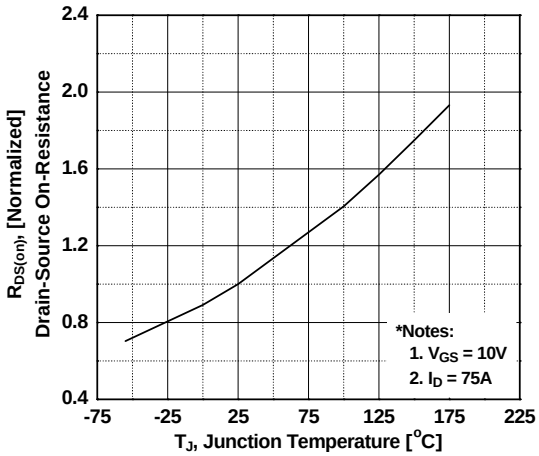



**Figure 9. Maximum Safe Operating Area**

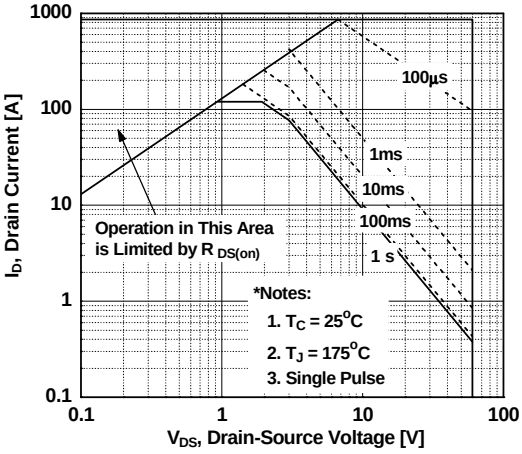



**Figure 10. Maximum Drain Current vs. Case Temperature**

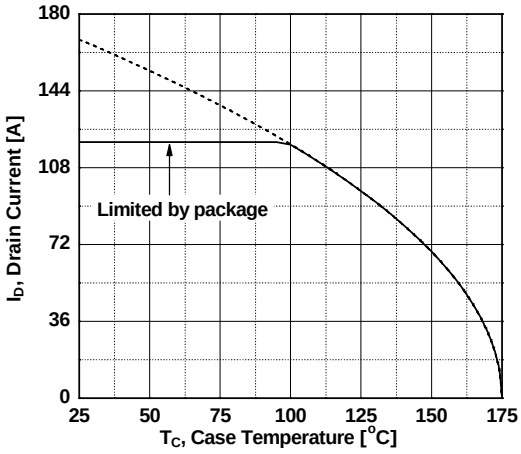
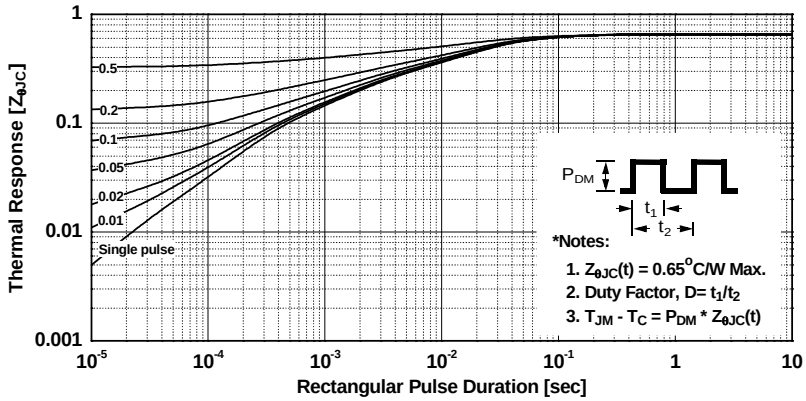
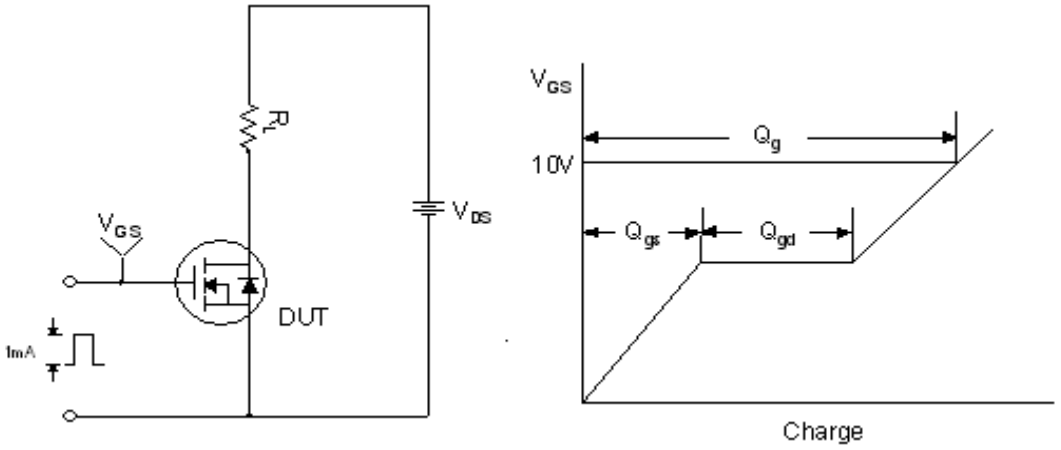


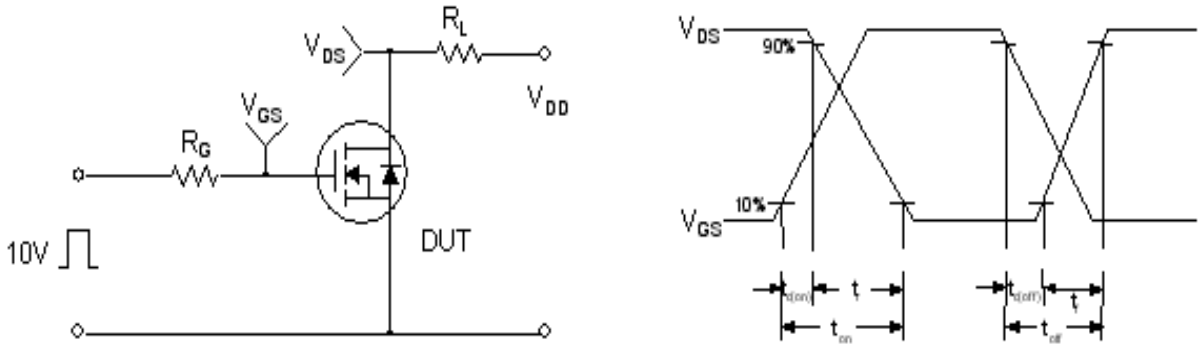

**Figure 11. Transient Thermal Response Curve**



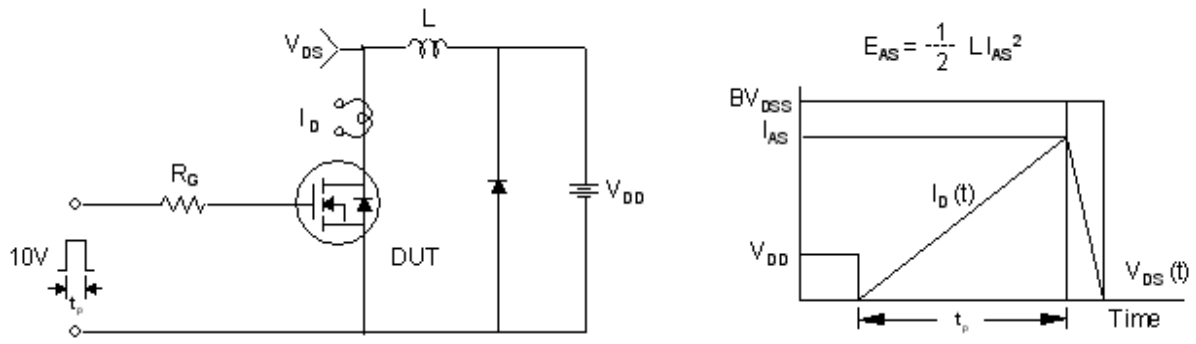
**Gate Charge Test Circuit & Waveform**



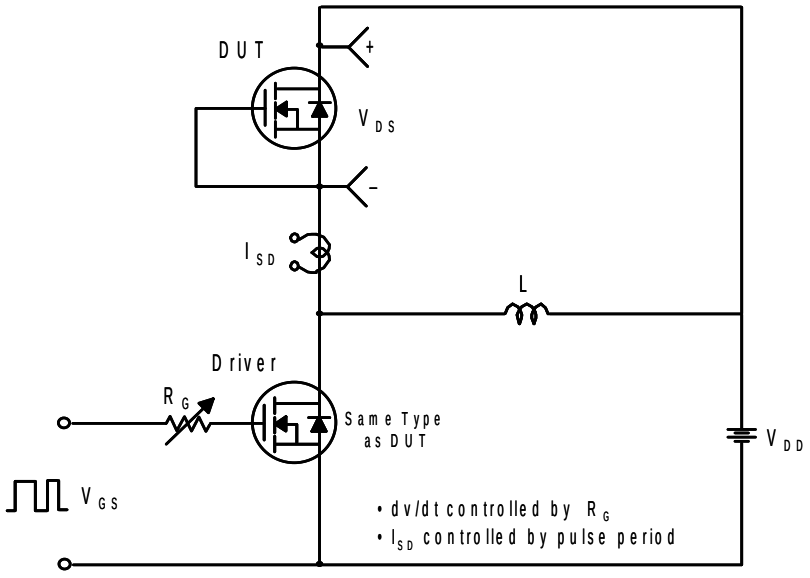

**Resistive Switching Test Circuit & Waveforms**

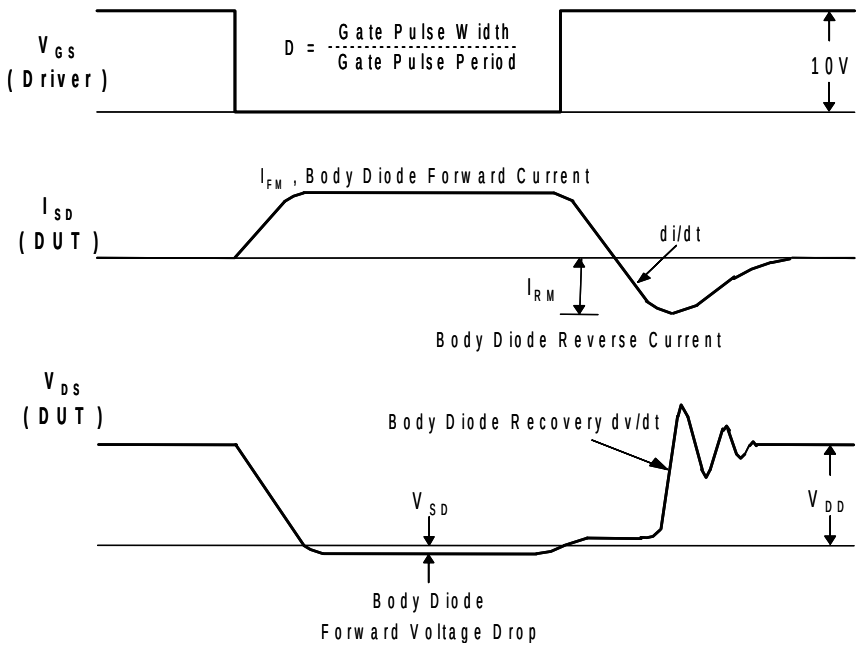



**Unclamped Inductive Switching Test Circuit & Waveforms**



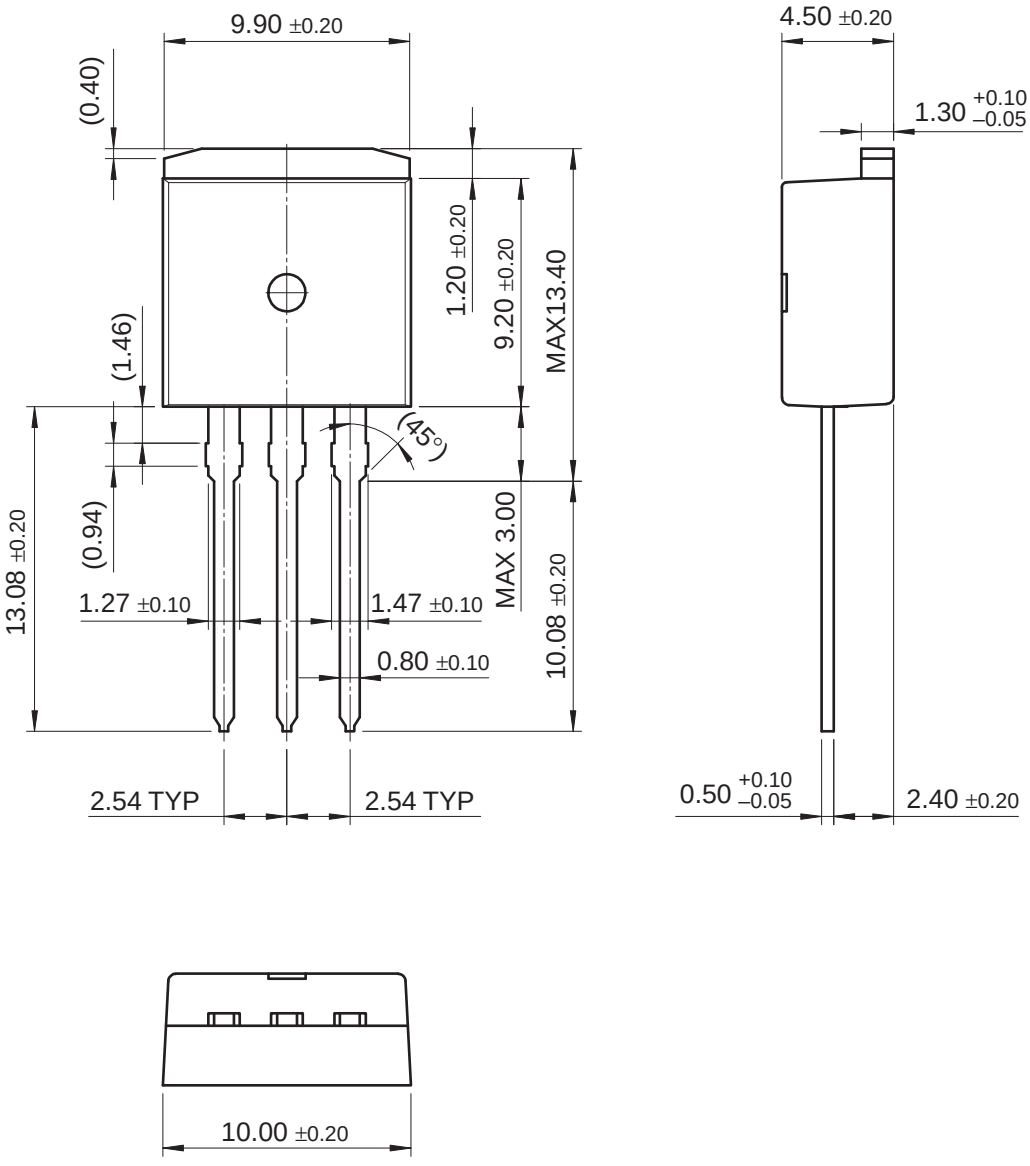
**Peak Diode Recovery dv/dt Test Circuit & Waveforms**



## Mechanical Dimensions

# $I^2$-PAK



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