

# FQD3N50C / FQU3N50C

## 500V N-Channel MOSFET

### Features

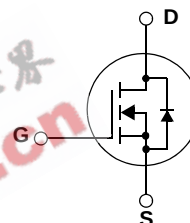
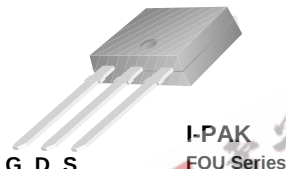
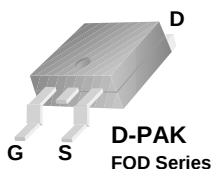
- 2.5A, 500V,  $R_{DS(on)} = 2.5\Omega$  @  $V_{GS} = 10V$
- Low gate charge ( typical 10 nC)
- Low  $C_{rss}$  ( typical 8.5pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability
- RoHS compliant



### Description

These N-Channel enhancement mode power field effect transistors are produced using Fairchild's proprietary, planar stripe, DMOS technology.

This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode. These devices are well suited for high efficient switched mode power supplies, active power factor correction, electronic lamp ballast based on half bridge topology.



### Absolute Maximum Ratings

| Symbol         | Parameter                                                                     | FQD3N50C/FQU3N50C | Units         |
|----------------|-------------------------------------------------------------------------------|-------------------|---------------|
| $V_{DSS}$      | Drain-Source Voltage                                                          | 500               | V             |
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ C$ )                             | 2.5               | A             |
|                | - Continuous ( $T_C = 100^\circ C$ )                                          | 1.5               | A             |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)                                               | 10                | A             |
| $V_{GSS}$      | Gate-Source Voltage                                                           | $\pm 30$          | V             |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                       | 200               | mJ            |
| $I_{AR}$       | Avalanche Current (Note 1)                                                    | 2.5               | A             |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                          | 3.5               | mJ            |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)                                            | 4.5               | V/ns          |
| $P_D$          | Power Dissipation ( $T_C = 25^\circ C$ )                                      | 35                | W             |
|                | - Derate above $25^\circ C$                                                   | 0.28              | W/ $^\circ C$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                       | -55 to +150       | $^\circ C$    |
| $T_L$          | Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds | 300               | $^\circ C$    |

### Thermal Characteristics

| Symbol          | Parameter                                | Typ | Max | Units        |
|-----------------|------------------------------------------|-----|-----|--------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case     | --  | 3.5 | $^\circ C/W$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient* | --  | 50  | $^\circ C/W$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient  | --  | 110 | $^\circ C/W$ |

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

## Package Marking and Ordering Information

| Device Marking | Device     | Package | Reel Size | Tape Width | Quantity |
|----------------|------------|---------|-----------|------------|----------|
| FQD3N50C       | FQD3N50CTM | D-PAK   | 380mm     | 16mm       | 2500     |
| FQD3N50C       | FQD3N50CTF | D-PAK   | 380mm     | 16mm       | 2500     |
| FQU3N50C       | FQU3N50CTU | I-PAK   | -         | -          | 70       |

## Electrical Characteristics T<sub>C</sub> = 25°C unless otherwise noted

| Symbol                                                 | Parameter                                             | Test Conditions                                                                          | Min                                                                       | Typ | Max  | Units |
|--------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-----|------|-------|
| Off Characteristics                                    |                                                       |                                                                                          |                                                                           |     |      |       |
| BV <sub>DSS</sub>                                      | Drain-Source Breakdown Voltage                        | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                           | 500                                                                       | --  | --   | V     |
| ΔBV <sub>DSS</sub> /<br>ΔT <sub>J</sub>                | Breakdown Voltage Temperature Coefficient             | I <sub>D</sub> = 250 μA, Referenced to 25°C                                              | --                                                                        | 0.7 | --   | V/°C  |
| I <sub>DSS</sub>                                       | Zero Gate Voltage Drain Current                       | V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V                                           | --                                                                        | --  | 1    | μA    |
|                                                        |                                                       | V <sub>DS</sub> = 400 V, T <sub>C</sub> = 125°C                                          | --                                                                        | --  | 10   | μA    |
| I <sub>GSSF</sub>                                      | Gate-Body Leakage Current, Forward                    | V <sub>GS</sub> = 30 V, V <sub>DS</sub> = 0 V                                            | --                                                                        | --  | 100  | nA    |
| I <sub>GSSR</sub>                                      | Gate-Body Leakage Current, Reverse                    | V <sub>GS</sub> = -30 V, V <sub>DS</sub> = 0 V                                           | --                                                                        | --  | -100 | nA    |
| On Characteristics                                     |                                                       |                                                                                          |                                                                           |     |      |       |
| V <sub>GS(th)</sub>                                    | Gate Threshold Voltage                                | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                              | 2.0                                                                       | --  | 4.0  | V     |
| R <sub>DS(on)</sub>                                    | Static Drain-Source On-Resistance                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 1.25 A                                          | --                                                                        | 2.1 | 2.5  | Ω     |
| g <sub>FS</sub>                                        | Forward Transconductance                              | V <sub>DS</sub> = 40 V, I <sub>D</sub> = 1.25 A (Note 4)                                 | --                                                                        | 1.5 | --   | S     |
| Dynamic Characteristics                                |                                                       |                                                                                          |                                                                           |     |      |       |
| C <sub>iss</sub>                                       | Input Capacitance                                     | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V,<br>f = 1.0 MHz                            | --                                                                        | 280 | 365  | pF    |
| C <sub>oss</sub>                                       | Output Capacitance                                    |                                                                                          | --                                                                        | 50  | 65   | pF    |
| C <sub>rss</sub>                                       | Reverse Transfer Capacitance                          |                                                                                          | --                                                                        | 8.5 | 11   | pF    |
| Switching Characteristics                              |                                                       |                                                                                          |                                                                           |     |      |       |
| t <sub>d(on)</sub>                                     | Turn-On Delay Time                                    | V <sub>DD</sub> = 250 V, I <sub>D</sub> = 2.5A,<br>R <sub>G</sub> = 25 Ω                 | --                                                                        | 10  | 30   | ns    |
| t <sub>r</sub>                                         | Turn-On Rise Time                                     | (Note 4, 5)                                                                              | --                                                                        | 25  | 60   | ns    |
| t <sub>d(off)</sub>                                    | Turn-Off Delay Time                                   |                                                                                          | --                                                                        | 35  | 80   | ns    |
| t <sub>f</sub>                                         | Turn-Off Fall Time                                    |                                                                                          | --                                                                        | 25  | 60   | ns    |
| Q <sub>g</sub>                                         | Total Gate Charge                                     |                                                                                          | V <sub>DS</sub> = 400 V, I <sub>D</sub> = 2.5A,<br>V <sub>GS</sub> = 10 V | --  | 10   | 13    |
| Q <sub>gs</sub>                                        | Gate-Source Charge                                    | (Note 4, 5)                                                                              | --                                                                        | 1.5 | --   | nC    |
| Q <sub>gd</sub>                                        | Gate-Drain Charge                                     |                                                                                          | --                                                                        | 5.5 | --   | nC    |
| Drain-Source Diode Characteristics and Maximum Ratings |                                                       |                                                                                          |                                                                           |     |      |       |
| I <sub>S</sub>                                         | Maximum Continuous Drain-Source Diode Forward Current |                                                                                          | --                                                                        | --  | 2.5  | A     |
| I <sub>SM</sub>                                        | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                          | --                                                                        | --  | 10   | A     |
| V <sub>SD</sub>                                        | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 2.5 A                                            | --                                                                        | --  | 1.4  | V     |
| t <sub>rr</sub>                                        | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 3 A,<br>dI <sub>F</sub> / dt = 100 A/μs (Note 4) | --                                                                        | 170 | --   | ns    |
| Q <sub>rr</sub>                                        | Reverse Recovery Charge                               |                                                                                          | --                                                                        | 0.7 | --   | μC    |

### NOTES:

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. L = 58mH, I<sub>AS</sub> = 2.5A, V<sub>DD</sub> = 50V, R<sub>G</sub> = 25 Ω, Starting T<sub>J</sub> = 25°C
3. I<sub>SD</sub> ≤ 2.5A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, Starting T<sub>J</sub> = 25°C
4. Pulse Test : Pulse width ≤ 300μs, Duty cycle ≤ 2%
5. Essentially independent of operating temperature

## Typical Performance Characteristics

Figure 1. On-Region Characteristics

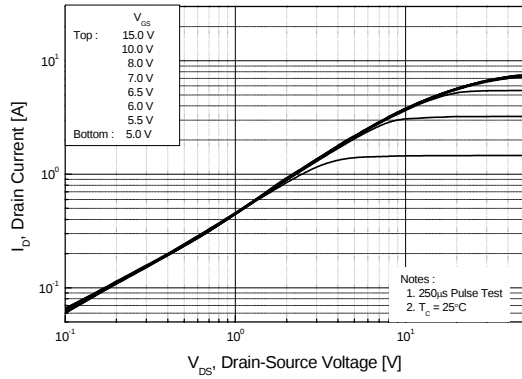


Figure 2. Transfer Characteristics

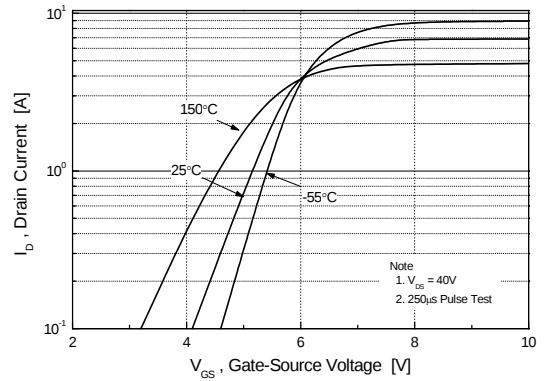


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

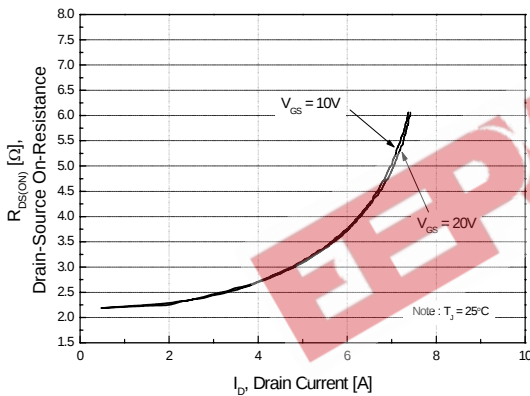


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

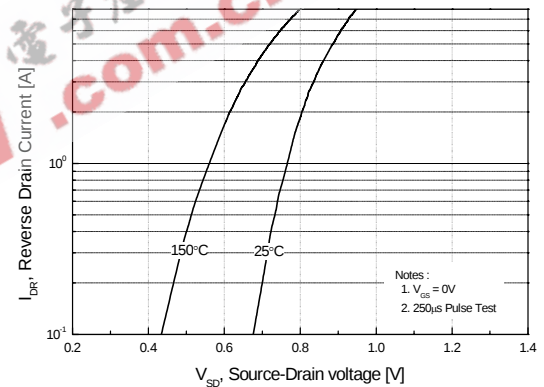


Figure 5. Capacitance Characteristics

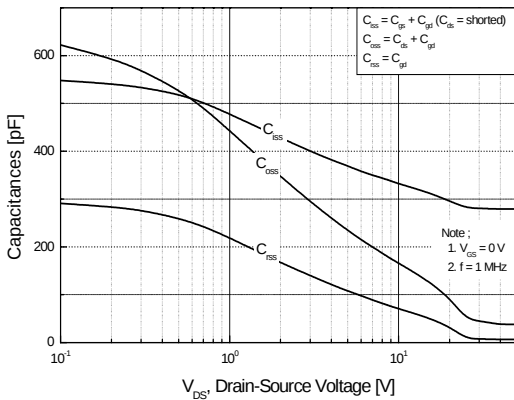
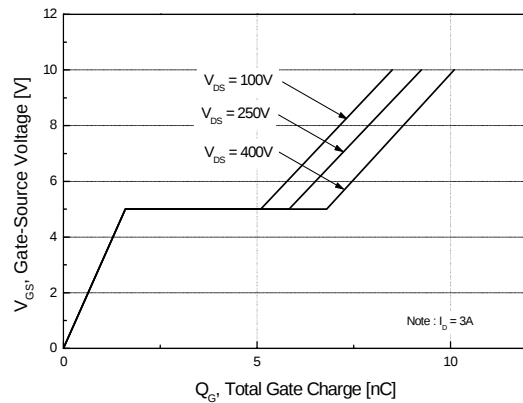
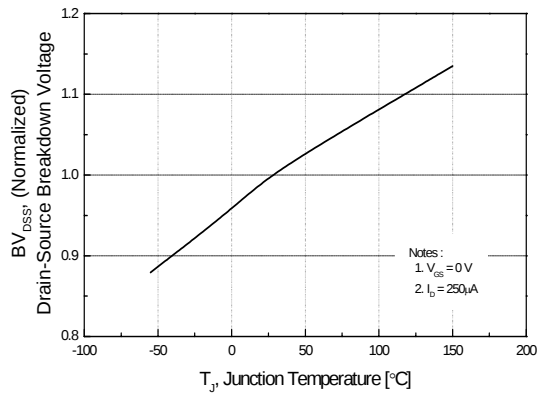


Figure 6. Gate Charge Characteristics

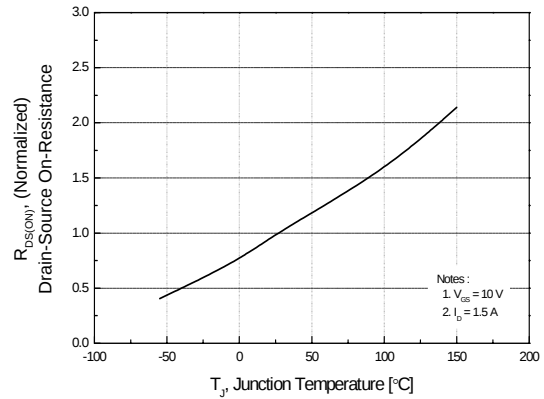


## Typical Performance Characteristics (Continued)

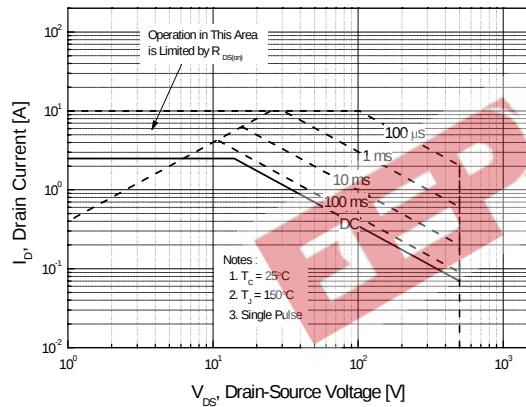
**Figure 7. Breakdown Voltage Variation vs. Temperature**



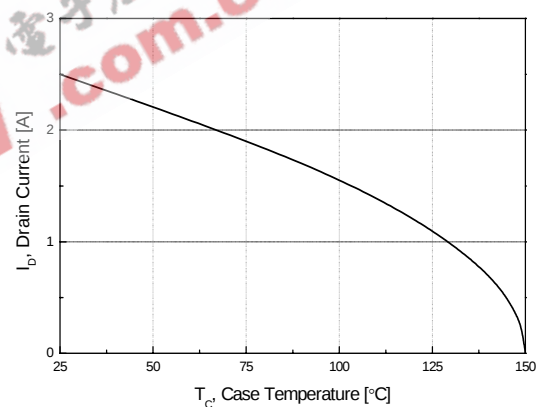
**Figure 8. On-Resistance Variation vs. Temperature**



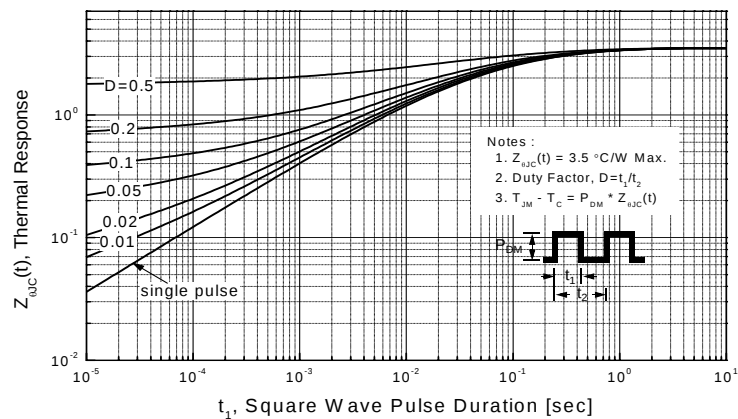
**Figure 9. Maximum Safe Operating Area**



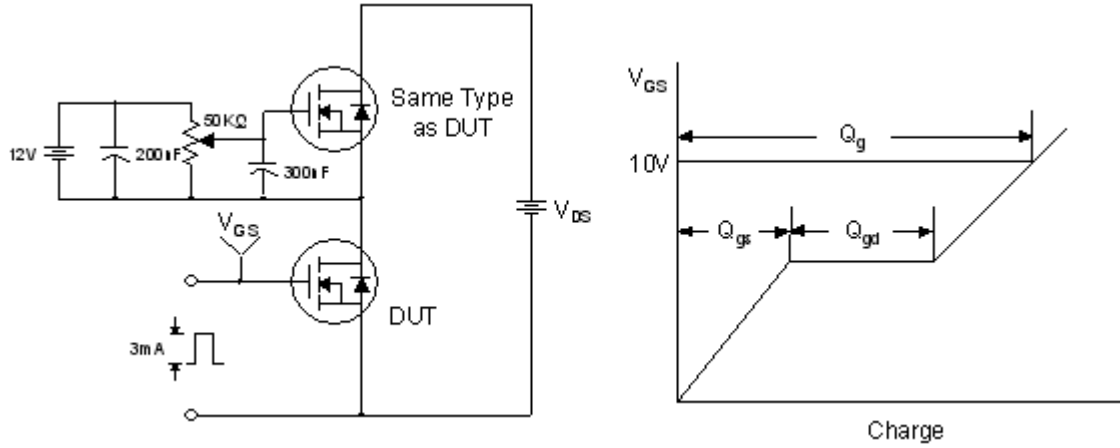
**Figure 10. Maximum Drain Current vs. Case Temperature**



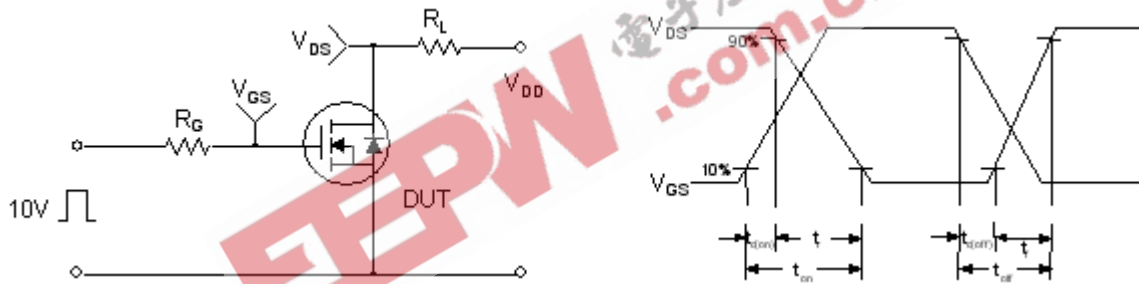
**Figure 11. Transient Thermal Response Curve**



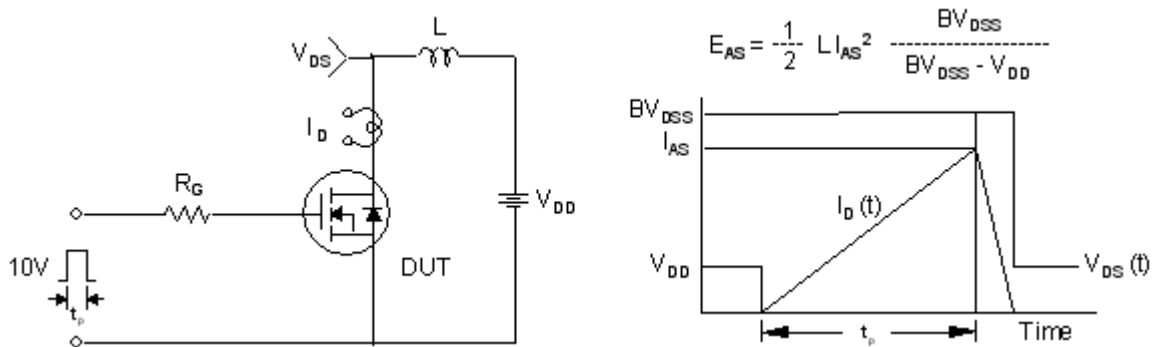
Gate Charge Test Circuit & Waveform



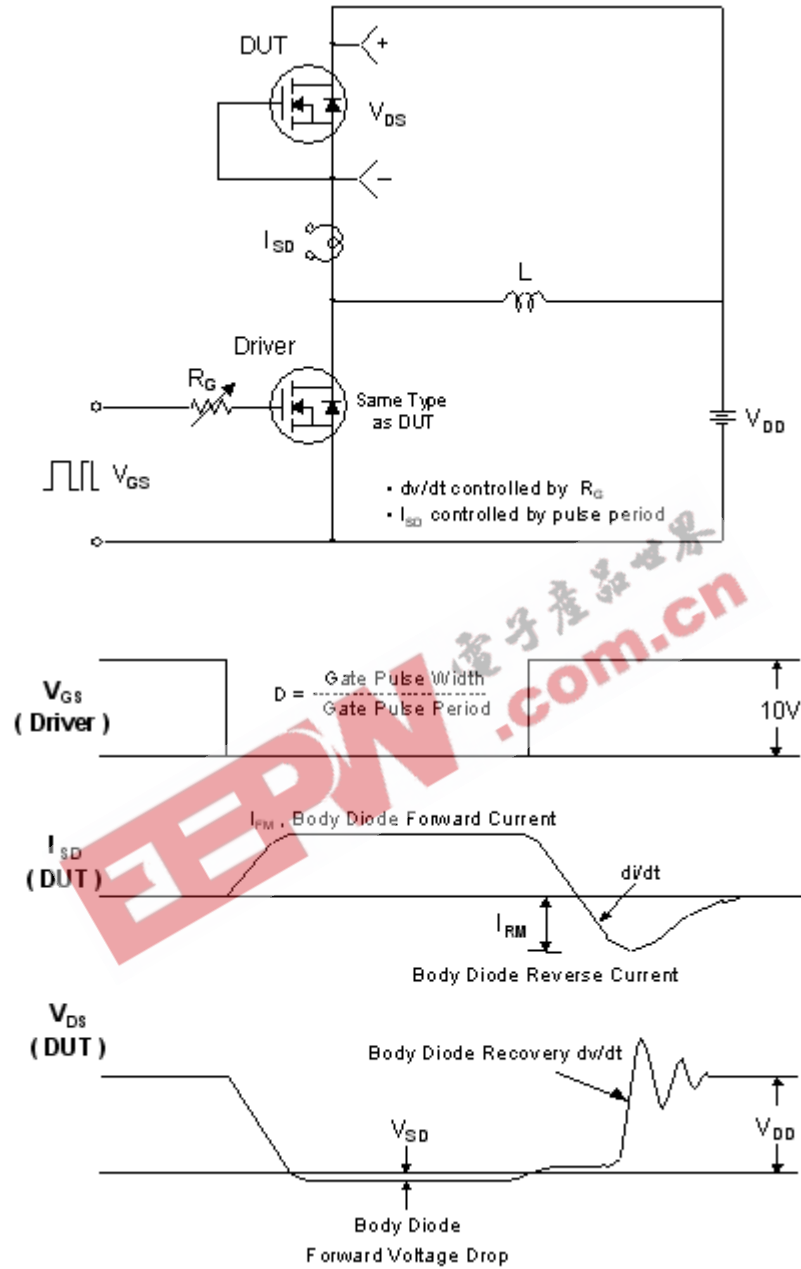
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching Test Circuit & Waveforms

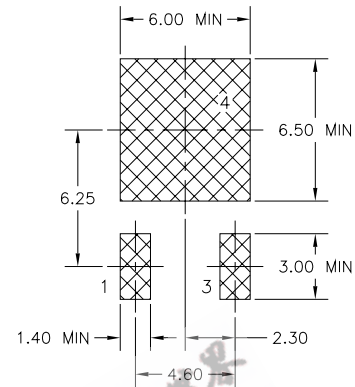
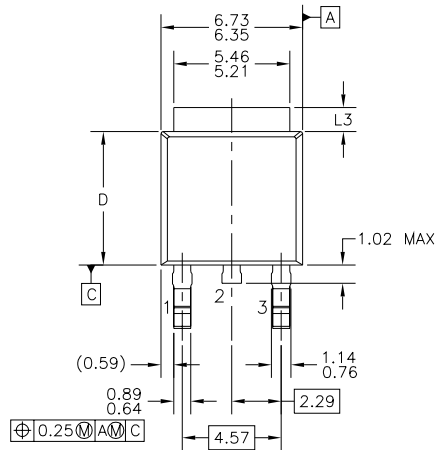


# Peak Diode Recovery dv/dt Test Circuit & Waveforms

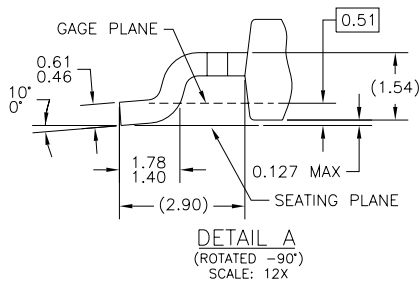
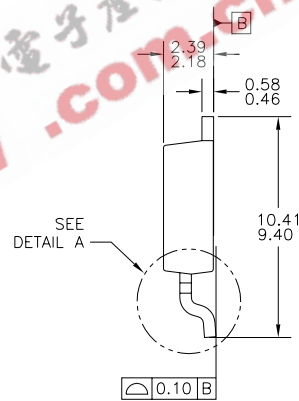
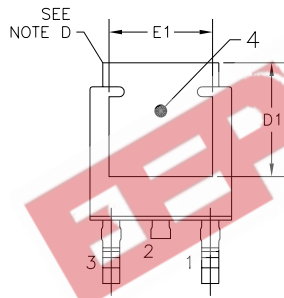


## Mechanical Dimensions

### D-PAK



LAND PATTERN RECOMMENDATION



NOTES: UNLESS OTHERWISE SPECIFIED

A) ALL DIMENSIONS ARE IN MILLIMETERS.  
B) THIS PACKAGE CONFORMS TO JEDEC, TO-252, ISSUE C, VARIATION AA & AB, DATED NOV. 1999.

C) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.

D) HEAT SINK TOP EDGE COULD BE IN CHAMFERED CORNERS OR EDGE PROTRUSION.

E) DIMENSIONS L3, D, E1 & D1 TABLE:

|    | OPTION AA | OPTION AB |
|----|-----------|-----------|
| L3 | 0.89-1.27 | 1.52-2.03 |
| D  | 5.97-6.22 | 5.33-5.59 |
| E1 | 4.32 MIN  | 3.81 MIN  |
| D1 | 5.21 MIN  | 4.57 MIN  |

F) PRESENCE OF TRIMMED CENTER LEAD IS OPTIONAL.

Dimensions in Millimeters





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| Build it Now <sup>™</sup>                                                         | F-PFS <sup>™</sup>                                                                | Power-SPM <sup>™</sup>                                                            | the power franchise                                                                 |
| CorePLUS <sup>™</sup>                                                             | FRFET <sup>®</sup>                                                                | PowerTrench <sup>®</sup>                                                          | TinyBoost <sup>™</sup>                                                              |
| CorePOWER <sup>™</sup>                                                            | Global Power Resource <sup>SM</sup>                                               | Programmable Active Droop <sup>™</sup>                                            | TinyBuck <sup>™</sup>                                                               |
| CROSSVOLT <sup>™</sup>                                                            | Green FPS <sup>™</sup>                                                            | QFET <sup>®</sup>                                                                 | TinyLogic <sup>®</sup>                                                              |
| CTL <sup>™</sup>                                                                  | Green FPS <sup>™</sup> e-Series <sup>™</sup>                                      | QS <sup>™</sup>                                                                   | TINYOPTO <sup>™</sup>                                                               |
| Current Transfer Logic <sup>™</sup>                                               | GTO <sup>™</sup>                                                                  | Quiet Series <sup>™</sup>                                                         | TinyPower <sup>™</sup>                                                              |
| EcoSPARK <sup>®</sup>                                                             | IntelliMAX <sup>™</sup>                                                           | RapidConfigure <sup>™</sup>                                                       | TinyPWM <sup>™</sup>                                                                |
| EfficientMax <sup>™</sup>                                                         | ISOPLANAR <sup>™</sup>                                                            | Saving our world 1mW at a time <sup>™</sup>                                       | TinyWire <sup>™</sup>                                                               |
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|  | MICROCOUPLER <sup>™</sup>                                                         | SMART START <sup>™</sup>                                                          |  |
|  | MicroFET <sup>™</sup>                                                             | SPM <sup>®</sup>                                                                  | UHC <sup>®</sup>                                                                    |
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| Fairchild Semiconductor <sup>®</sup>                                              | MillerDrive <sup>™</sup>                                                          | SuperFET <sup>™</sup>                                                             | UniFET <sup>™</sup>                                                                 |
| FACT Quiet Series <sup>™</sup>                                                    | MotionMax <sup>™</sup>                                                            | SuperSOT <sup>™</sup> -3                                                          | VCX <sup>™</sup>                                                                    |
| FACT <sup>®</sup>                                                                 | Motion-SPM <sup>™</sup>                                                           | SuperSOT <sup>™</sup> -6                                                          | VisualMax <sup>™</sup>                                                              |
| FAST <sup>®</sup>                                                                 | OPTOLOGIC <sup>®</sup>                                                            | SuperSOT <sup>™</sup> -8                                                          |                                                                                     |
| FastvCore <sup>™</sup>                                                            | OPTOPLANAR <sup>®</sup>                                                           | SuperMOS <sup>™</sup>                                                             |                                                                                     |
| FlashWriter <sup>®</sup> *                                                        |  |  |                                                                                     |

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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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### Definition of Terms

| Datasheet Identification | Product Status         | Definition                                                                                                                                                                                               |
|--------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance Information      | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.                                                                       |
| Preliminary              | First Production       | This datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |
| No Identification Needed | Full Production        | This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.                                               |
| Obsolete                 | Not In Production      | This datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.                                                    |

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