**FAIRCHILD**

**SEMICONDUCTOR®**

**May 2012**

**UniFET™**

# FDP5N50 / FDPF5N50T

## N-Channel MOSFET

### 500V, 5A, 1.4Ω

### Features

- $R_{DS(on)}$ = 1.15Ω ( Typ.)@ $V_{GS}$ = 10V, $I_D$ = 2.5A

- Low gate charge ( Typ. 11nC)

- Low $C_{rss}$ ( Typ. 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 pluse in the avalanche and commutation mode. These devices are well suited for high efficient switched mode power suppliesand active power factor correction.

**TO-220**
**FDP Series**

**G D S**

**TO-220F**
**FDPF Series**

**G D S**

**D**

**G**

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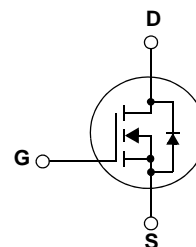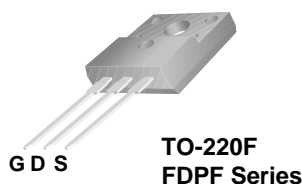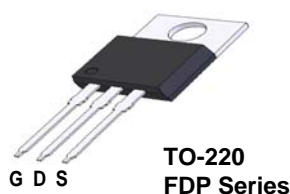
## MOSFET Maximum Ratings $T_C$ = 25°C unless otherwise noted*

| Symbol | Parameter | | FDP5N50 | FDPF5N50 | Units |
|---|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 500 | | V |
| $V_{GSS}$ | Gate to Source Voltage | | ±30 | | V |
| $I_D$ | Drain Current | -Continuous ($T_C$ = 25°C) | 5 | 5* | A |
| | | -Continuous ($T_C$ = 100°C) | 3 | 3* | |
| $I_{DM}$ | Drain Current | - Pulsed           (Note 1) | 20 | 20* | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy           (Note 2) | | 225 | | mJ |
| $I_{AR}$ | Avalanche Current           (Note 1) | | 5 | | A |
| $E_{AR}$ | Repetitive Avalanche Energy           (Note 1) | | 8.5 | | mJ |
| dv/dt | Peak Diode Recovery dv/dt           (Note 3) | | 4.5 | | V/ns |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | 85 | 28 | W |
| | | - Derate above 25°C | 0.67 | 0.22 | 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 |

*Drain current limited by maximum junction temperature

## Thermal Characteristics

| Symbol | Parameter | FDP5N50 | FDPF5N50 | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.4 | 4.5 | |
| $R_{\theta CS}$ | Thermal Resistance, Case to Sink Typ. | 0.5 | - | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 62.5 | 62.5 | |

www.fairchildsemi.com

## Package Marking and Ordering Information $T_C = 25^oC$ unless otherwise noted

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|
| FDP5N50 | FDP5N50 | TO-220 | - | - | 50 |
| FDPF5N50T | FDPF5N50T | TO-220F | - | - | 50 |

## Electrical Characteristics

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $I_D = 250\mu A$, $V_{GS} = 0V$, $T_J = 25^oC$ | 500 | - | - | V |
| $\dfrac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\mu A$, Referenced to $25^oC$ | - | 0.6 | - | $V/^oC$ |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS} = 500V$, $V_{GS} = 0V$ | - | - | 1 | $\mu A$ |
| | | $V_{DS} = 400V$, $T_C = 125^oC$ | - | - | 10 | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS} = \pm 30V$, $V_{DS} = 0V$ | - | - | $\pm 100$ | nA |
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS} = V_{DS}$, $I_D = 250\mu A$ | 3.0 | - | 5.0 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10V$, $I_D = 2.5A$ | - | 1.15 | 1.4 | $\Omega$ |
| $g_{FS}$ | Forward Transconductance | $V_{DS} = 20V$, $I_D = 2.5A$     (Note 4) | - | 4.3 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS} = 25V$, $V_{GS} = 0V$ f = 1MHz | - | 480 | 640 | pF |
| $C_{oss}$ | Output Capacitance | | - | 66 | 88 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 5 | 8 | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS} = 400V$, $I_D = 5A$ $V_{GS} = 10V$                      (Note 4, 5) | - | 11 | 15 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 3 | - | nC |
| $Q_{gd}$ | Gate to Drain "Miller" Charge | | - | 5 | - | nC |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD} = 250V$, $I_D = 5A$ $R_G = 25\Omega$                      (Note 4, 5) | - | 13 | 36 | ns |
| $t_r$ | Turn-On Rise Time | | - | 22 | 54 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 28 | 66 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 20 | 50 | ns |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 5 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 20 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS} = 0V$, $I_{SD} = 5A$ | - | - | 1.4 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS} = 0V$, $I_{SD} = 5A$ $dI_F/dt = 100A/\mu s$     (Note 4) | - | 300 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 1.8 | - | $\mu C$ |

**Notes:**
1: Repetitive Rating: Pulse width limited by maximum junction temperature
2: L = 18mH, $I_{AS} = 5A$, $V_{DD} = 50V$, $R_G = 25\Omega$, Starting $T_J = 25°C$
3: $I_{SD} \leq 5A$, di/dt $\leq 200A/\mu s$, $V_{DD} \leq BV_{DSS}$, Starting $T_J = 25°C$
4: Pulse Test: Pulse width $\leq 300\mu s$, Duty Cycle $\leq 2\%$
5: Essentially Independent of Operating Temperature Typical Characteristics

## Typical Performance Characteristics
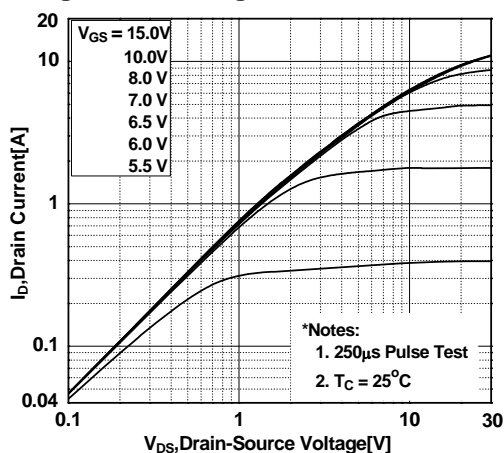
### Figure 1. On-Region Characteristics



$V_{GS}$ = 15.0V
10.0V
8.0 V
7.0 V
6.5 V
6.0 V
5.5 V

*Notes:
1. 250μs Pulse Test
2. $T_C$ = 25°C

$I_D$,Drain Current[A]

$V_{DS}$,Drain-Source Voltage[V]

### Figure 2. Transfer Characteristics



150°C
25°C
-55°C

*Notes:
1. $V_{DS}$ = 20V
2. 250μs Pulse Test

$I_D$,Drain Current[A]

$V_{GS}$,Gate-Source Voltage[V]
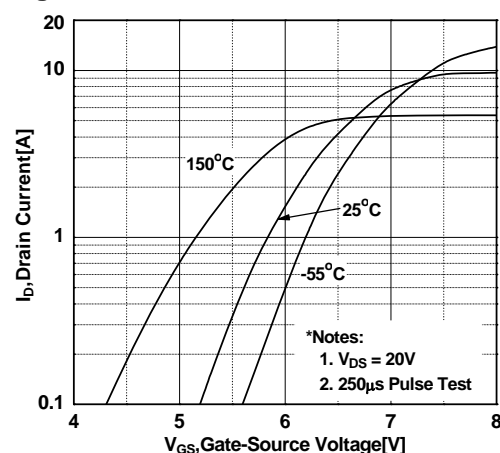
### Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage



$V_{GS}$ = 10V

$V_{GS}$ = 20V

*Note: $T_J$ = 25°C

$R_{DS(ON)}$ [Ω], Drain-Source On-Resistance

$I_D$, Drain Current [A]
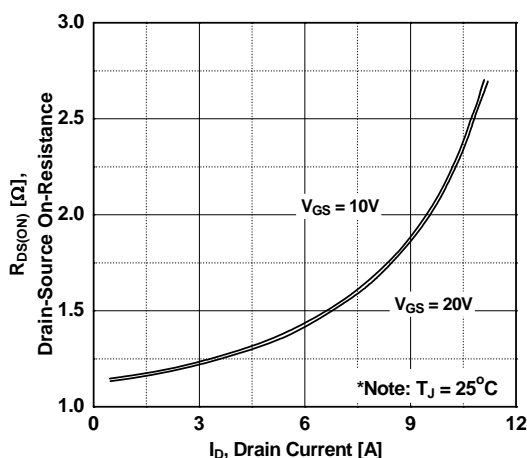
### Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature



150°C
25°C

*Notes:
1. $V_{GS}$ = 0V
2. 250μs Pulse Test

$I_S$, Reverse Drain Current [A]

$V_{SD}$, Body Diode Forward Voltage [V]
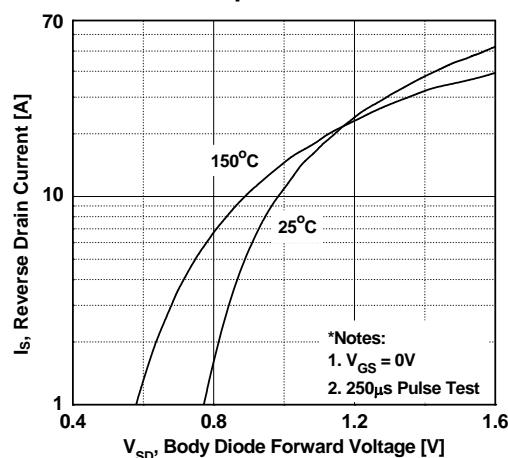
### Figure 5. Capacitance Characteristics



$C_{iss}$ = $C_{gs}$ + $C_{gd}$ ($C_{ds}$ = shorted)
$C_{oss}$ = $C_{ds}$ + $C_{gd}$
$C_{rss}$ = $C_{gd}$

*Note:
1. $V_{GS}$ = 0V
2. f = 1MHz

$C_{iss}$
$C_{oss}$
$C_{rss}$

Capacitances [pF]

$V_{DS}$, Drain-Source Voltage [V]
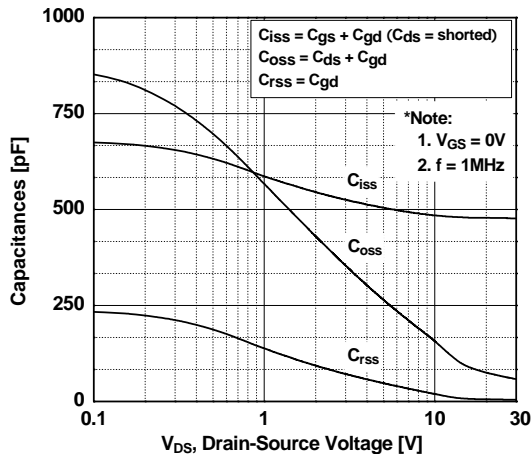
### Figure 6. Gate Charge Characteristics



$V_{DS}$ = 100V
$V_{DS}$ = 250V
$V_{DS}$ = 400V

*Note: $I_D$ = 5A

$V_{GS}$, Gate-Source Voltage [V]

$Q_g$, Total Gate Charge [nC]
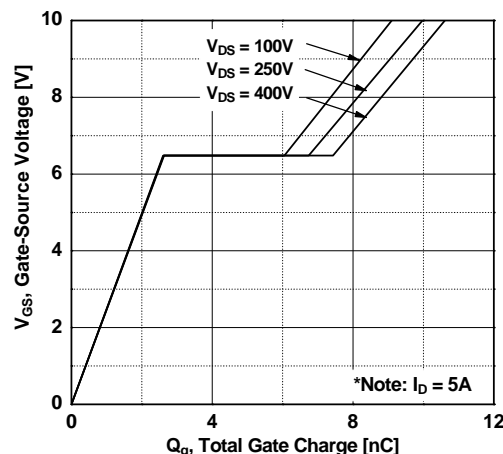
## Typical Performance Characteristics (Continued)

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

*Notes:
1. $V_{GS} = 0V$
2. $I_D = 250\mu A$

$BV_{DSS}$, [Normalized] Drain-Source Breakdown Voltage

$T_J$, Junction Temperature [$^o$C]
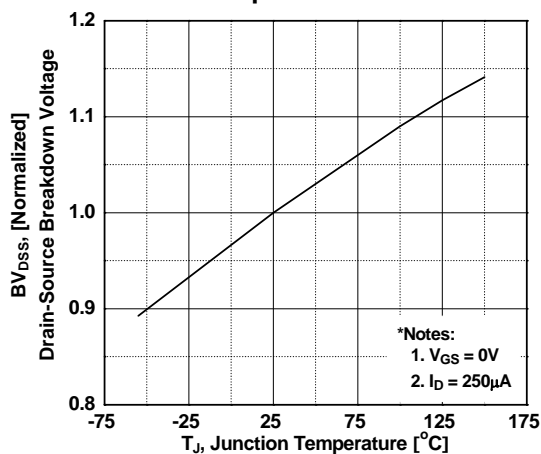
### Figure 8. On-Resistance Variation vs. Temperature

*Notes:
1. $V_{GS} = 10V$
2. $I_D = 2.5A$

$R_{DS(on)}$, [Normalized] Drain-Source On-Resistance

$T_J$, Junction Temperature [$^o$C]
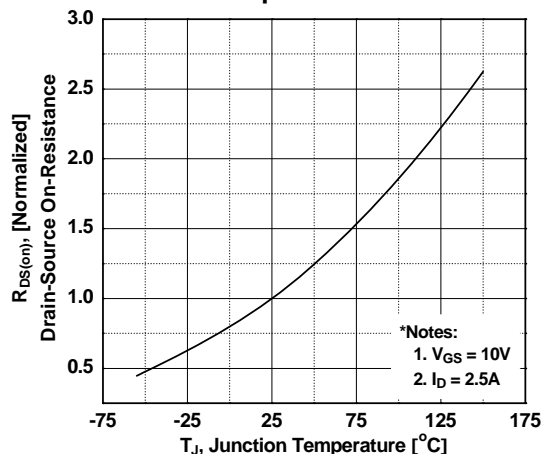
### Figure 9. Maximum Safe Operating Area - FDP5N50

30µs
100µs
1ms
10ms
DC

Operation in This Area is Limited by $R_{DS(on)}$

*Notes:
1. $T_C = 25^oC$
2. $T_J = 150^oC$
3. Single Pulse

$I_D$, Drain Current [A]

$V_{DS}$, Drain-Source Voltage [V]
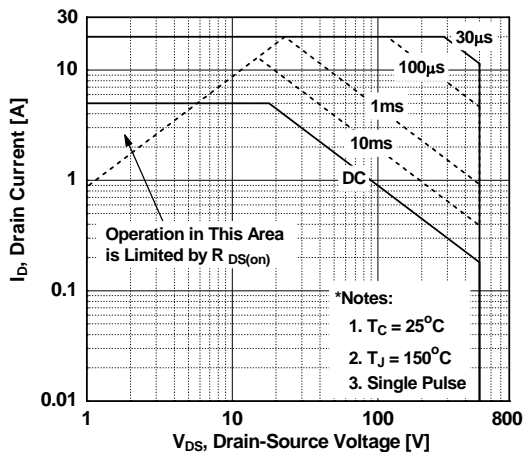
### Figure 10. Maximum Safe Operating Area - FDPF5N50T

30µs
100µs
1ms
10ms
DC

Operation in This Area is Limited by $R_{DS(on)}$

*Notes:
1. $T_C = 25^oC$
2. $T_J = 150^oC$
3. Single Pulse

$I_D$, Drain Current [A]

$V_{DS}$, Drain-Source Voltage [V]
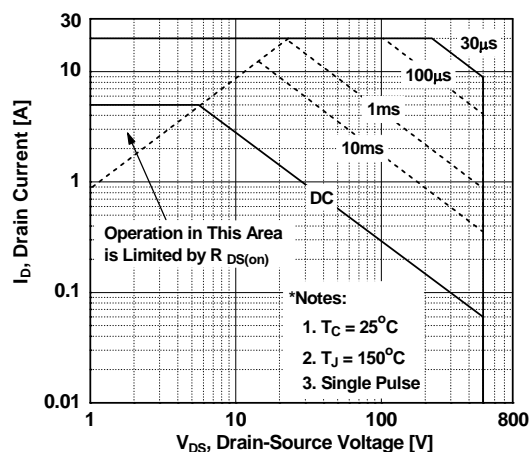
### Figure 11. Maximum Drain Current vs. Case Temperature

$I_D$, Drain Current [A]

$T_C$, Case Temperature [$^o$C]
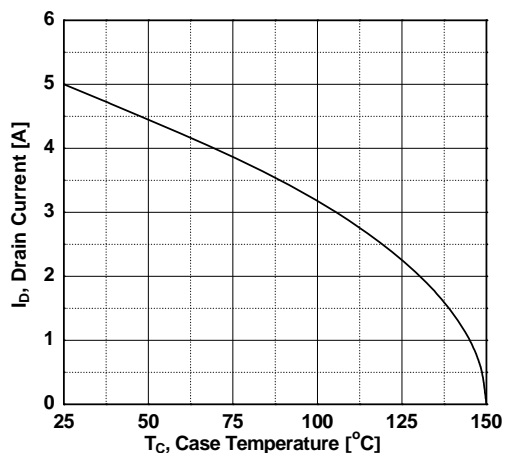
## Typical Performance Characteristics (Continued)

### Figure 12. Transient Thermal Response Curve - FDP5N50



*Notes:
1. $Z_{\theta JC}(t) = 1.4^{\circ}C/W$ Max.
2. Duty Factor, $D = t_1/t_2$
3. $T_{JM} - T_C = P_{DM} * Z_{\theta JC}(t)$
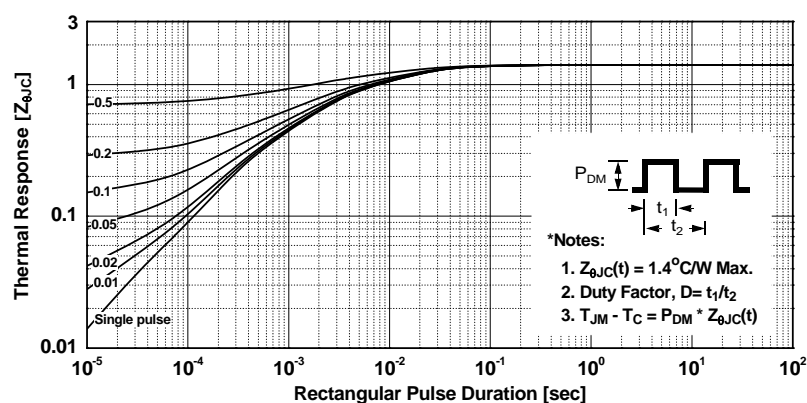
### Figure 13. Transient Thermal Response Curve - FDPF5N50T



*Notes:
1. $Z_{\theta JC}(t) = 4.5^{\circ}C/W$ Max.
2. Duty Factor, $D = t_1/t_2$
3. $T_{JM} - T_C = P_{DM} * Z_{\theta JC}(t)$
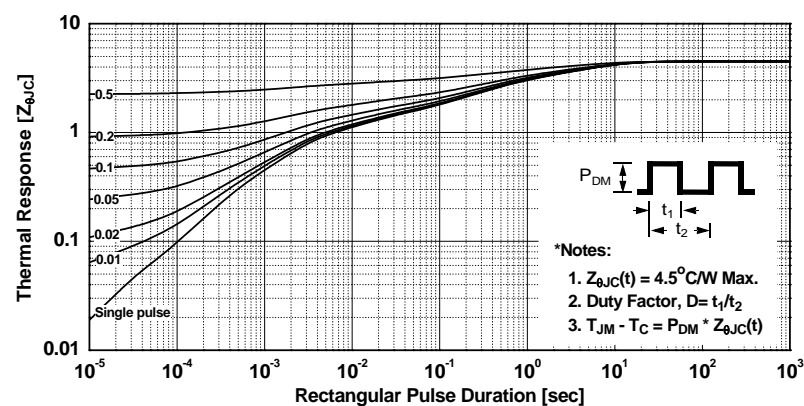
**Gate Charge Test Circuit & Waveform**

$$V_{GS}$$

10V

$$Q_g$$

$$Q_{gs}$$   $$Q_{gd}$$

Charge

DUT

$$V_{GS}$$

$$V_{DS}$$

1mA

**Resistive Switching Test Circuit & Waveforms**

$$R_L$$

$$V_{DS}$$   $$V_{DD}$$

$$R_G$$   $$V_{GS}$$

10V

DUT

$$V_{DS}$$

90%

10%

$$V_{GS}$$

$$t_{d(on)}$$   $$t_r$$   $$t_{d(off)}$$   $$t_f$$

$$t_{on}$$   $$t_{off}$$

**Unclamped Inductive Switching Test Circuit & Waveforms**

$$V_{DS}$$   L

$$I_D$$

$$R_G$$

10V

$$t_p$$

DUT

$$V_{DD}$$

$$E_{AS} = \frac{1}{2} L I_{AS}^2$$

$$BV_{DSS}$$

$$I_{AS}$$

$$I_D (t)$$

$$V_{DD}$$

$$V_{DS} (t)$$

$$t_p$$   Time

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

DUT

$V_{DS}$

+

−

$I_{SD}$

L

Driver

$R_G$

Same Type
as DUT

$V_{DD}$

$V_{GS}$

• dv/dt controlled by $R_G$
• $I_{SD}$ controlled by pulse period

$V_{GS}$
( Driver )

$$D = \frac{Gate\ Pulse\ Width}{Gate\ Pulse\ Period}$$

10V

$I_{SD}$
( DUT )

$I_{FM}$ , Body Diode Forward Current

di/dt

$I_{RM}$

Body Diode Reverse Current

$V_{DS}$
( DUT )

Body Diode Recovery dv/dt

$V_{SD}$

$V_{DD}$

Body Diode
Forward Voltage Drop
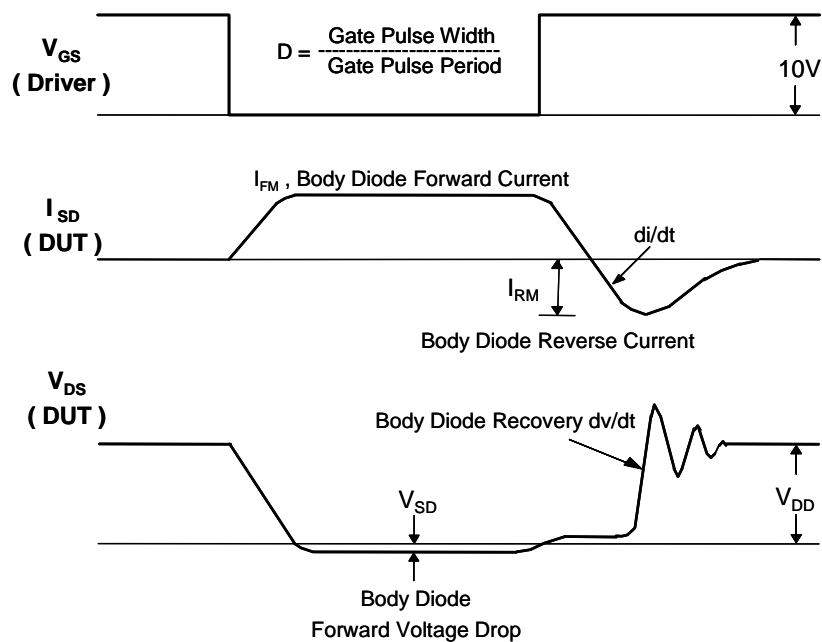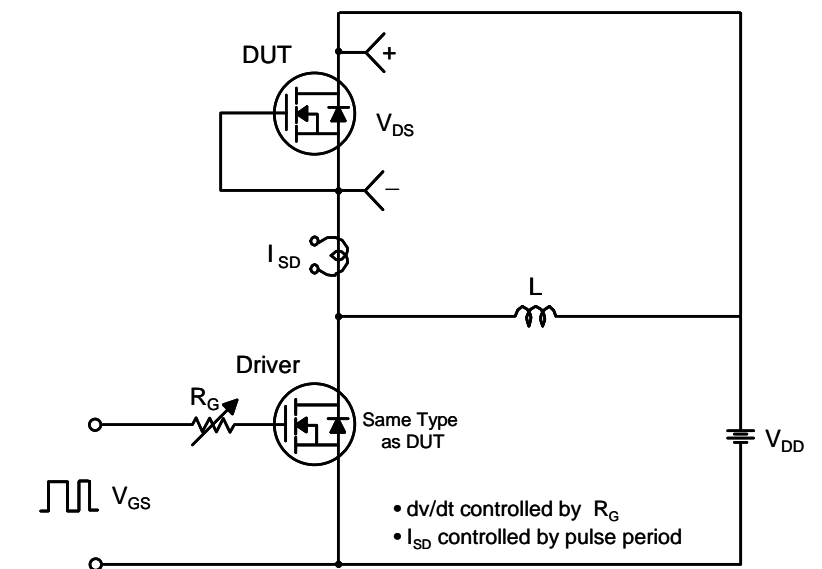
**Mechanical Dimensions**

## TO-220
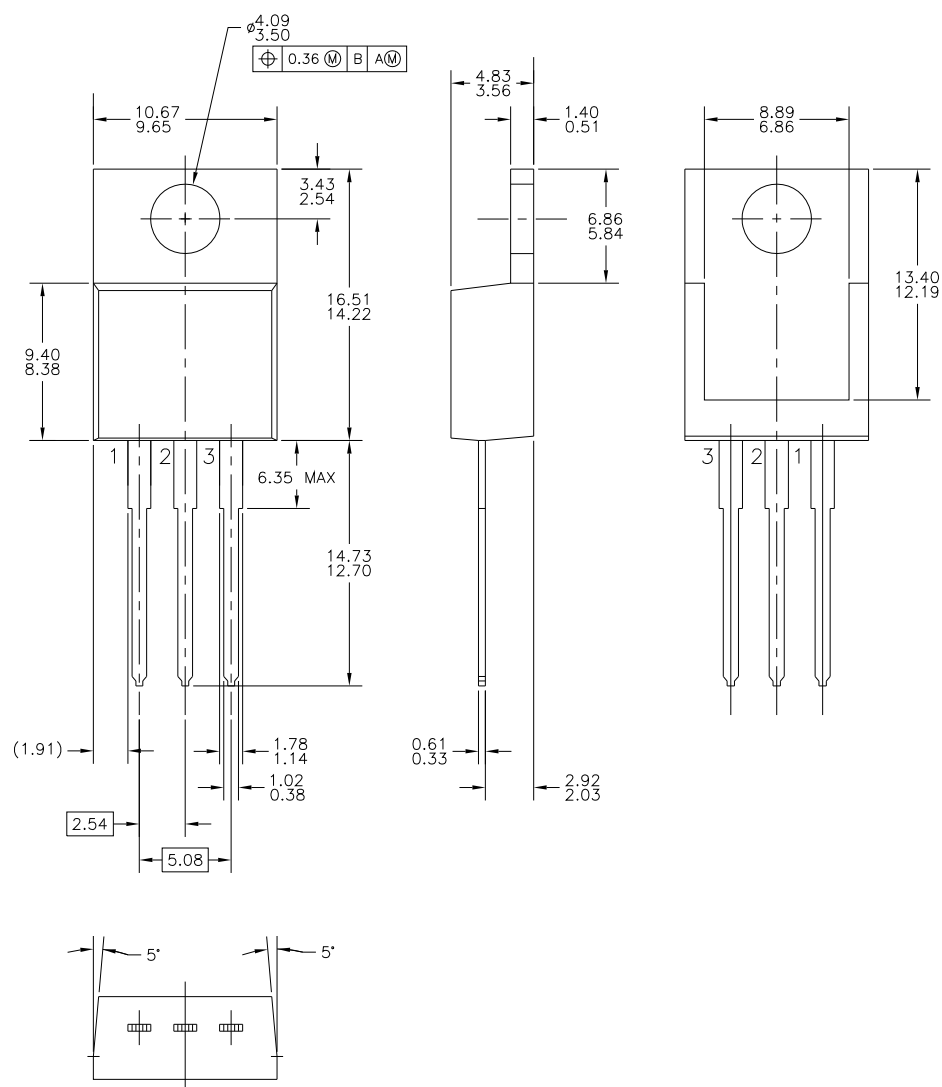
**Package Dimensions**

# TO-220F Potted



Ø3.18±0.10  10.16±0.20  (7.00)  Potting  (5.40)  3.30±0.10  15.80±0.20  MAX1.47  0.70±0.10  #1  0.35±0.10  2.54TYP [2.54±0.20]  30°  2.54TYP [2.54±0.20]  9.75±0.20

2.54±0.20  (0.70)  6.70±0.20  A* (Potting)  (1.00x45°)  15.90±0.20  0.50 +0.10 -0.05  2.76±0.20

9.40±0.20  4.70±0.20
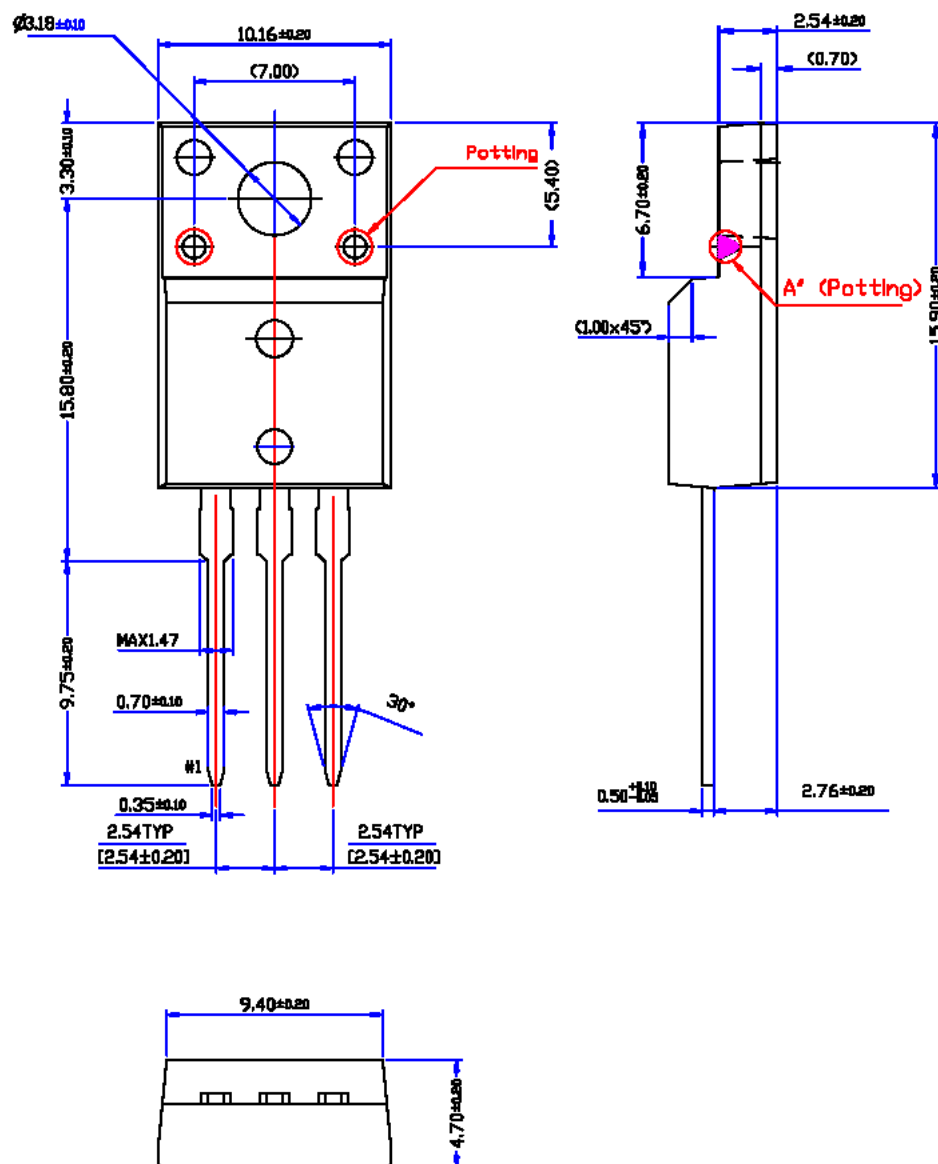
# * Front/Back Side Isolation Voltage : AC 2500V

Dimensions in Millimeters

**FAIRCHILD**

SEMICONDUCTOR®

## TRADEMARKS
The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

2Cool™
AccuPower™
AX-CAP™*
BitSiC®
Build it Now™
CorePLUS™
CorePOWER™
CROSSVOLT™
CTL™
Current Transfer Logic™
DEUXPEED®
Dual Cool™
EcoSPARK®
EfficentMax™
ESBC™

F®

Fairchild®
Fairchild Semiconductor®
FACT Quiet Series™
FACT®
FAST®
FastvCore™
FETBench™
FlashWriter® *
FPS™

F-PFS™
FRFET®
Global Power Resource℠
Green Bridge™
Green FPS™
Green FPS™ e-Series™
Gmax™
GTO™
IntelliMAX™
ISOPLANAR™
Marking Small Speakers Sound Louder and Better™
MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MicroPak2™
MillerDrive™
MotionMax™
Motion-SPM™
mWSaver™
OptoHiT™
OPTOLOGIC®
OPTOPLANAR®

®

PowerTrench®
PowerXS™
Programmable Active Droop™
QFET®
QS™
Quiet Series™
RapidConfigure™

™

Saving our world, 1mW/W/kW at a time™
SignalWise™
SmartMax™
SMART START™
Solutions for Your Success™
SPM®
STEALTH™
SuperFET®
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SupreMOS®
SyncFET™
Sync-Lock™

SYSTEM GENERAL ®*

The Power Franchise®

the power franchise ®

TinyBoost™
TinyBuck™
TinyCalc™
TinyLogic®
TINYOPTO™
TinyPower™
TinyPWM™
TinyWire™
TranSiC®
TriFault Detect™
TRUECURRENT®*
μSerDes™

SerDes

UHC®
Ultra FRFET™
UniFET™
VCX™
VisualMax™
VoltagePlus™
XS™

*Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

## DISCLAIMER
FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

## LIFE SUPPORT POLICY
FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used here in:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.

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.

## ANTI-COUNTERFEITING POLICY
Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.Fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufactures of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed application, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handing and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address and warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

## PRODUCT STATUS DEFINITIONS
### Definition of Terms

| Datasheet Identification | Product Status | Definition |
|---|---|---|
| Advance Information | Formative / In Design | Datasheet contains the design specifications for product development. Specifications may change in any manner without notice. |
| Preliminary | First Production | 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 | 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 | Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only. |

Rev. I61