FAIRCHILD SEMICONDUCTOR®

March 2013

# FCP600N60Z / FCPF600N60Z

## N-Channel SuperFET® II MOSFET

### 600 V, 7.4 A, 600 mΩ

## Features

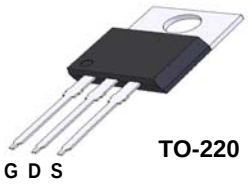
- 650 V @$T_J$ = 150°C
- Max. $R_{DS(on)}$ = 600 mΩ
- Ultra Low Gate Charge (Typ. $Q_g$ = 20 nC)
- Low Effective Output Capacitance (Typ. $C_{oss}$.eff = 74 pF)
- 100% Avalanche Tested
- ESD Improved Capacity

## Description

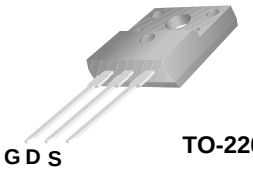
SuperFET®II MOSFET is Fairchild Semiconductor®'s first generation of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance.This advanced technology is tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate and higher avalanche energy. Consequently, SuperFETII MOSFET is suitable for various AC/DC power conversion for system miniaturization and higher efficiency.

## Applications

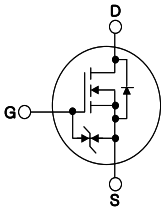
- LCD / LED / PDP TV and Monitor Lighting
- Solar Inverter
- AC-DC Power Supply




TO-220




TO-220F




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

| Symbol | Parameter | | | FCP600N60Z | FCPF600N60Z | Unit |
|---|---|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | | 600 | | V |
| $V_{GSS}$ | Gate to Source Voltage | - DC | | ±20 | | V |
| | | - AC | (f > 1 Hz) | ±30 | | V |
| $I_D$ | Drain Current | -Continuous ($T_C$ = 25°C) | | 7.4 | 7.4* | A |
| | | -Continuous ($T_C$ = 100°C) | | 4.7 | 4.7* | |
| $I_{DM}$ | Drain Current | - Pulsed | (Note 1) | 22.2 | 22.2* | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy | | (Note 2) | 135 | | mJ |
| $I_{AR}$ | Avalanche Current | | (Note 1) | 1.5 | | A |
| $E_{AR}$ | Repetitive Avalanche Energy | | (Note 1) | 0.89 | | mJ |
| dv/dt | Peak Diode Recovery dv/dt | | (Note 3) | 20 | | V/ns |
| | MOSFET dv/dt | | | 100 | | V/ns |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | | 89 | 28 | W |
| | | - Derate above 25°C | | 0.71 | 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 | FCP600N60Z | FCPF600N60Z | Unit |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.4 | 4.5 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 62.5 | 62.5 | |

## Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|
| FCP600N60Z | FCP600N60Z | TO-220 | - | - | 50 |
| FCPF600N60Z | FCPF600N60Z | TO-220F | - | - | 50 |

## 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, $I_D$ = 10 mA, $T_J$ = 25°C | 600 | - | - | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 10 mA, $T_J$ = 150°C | 650 | - | - | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 10 mA, Referenced to 25°C | - | 0.67 | - | V/°C |
| $BV_{DS}$ | Drain-Source Avalanche Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 7.4 A | - | 700 | - | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V | - | - | 1 | µA |
| | | $V_{DS}$ = 480 V, $T_C$ = 125°C | - | - | 10 | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | - | - | ±10 | uA |
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 250 µA | 2.5 | - | 3.5 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 3.7 A | - | 0.51 | 0.6 | Ω |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 20 V, $I_D$ = 3.7 A | - | 6.7 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 840 | 1120 | pF |
| $C_{oss}$ | Output Capacitance | | - | 630 | 840 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 30 | 45 | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 380 V, $V_{GS}$ = 0 V, f = 1.0 MHz | - | 16.5 | - | pF |
| $C_{oss}$ eff. | Effective Output Capacitance | $V_{DS}$ = 0 V to 480 V, $V_{GS}$ = 0 V | - | 74 | - | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS}$ = 380 V, $I_D$ = 3.7 A, $V_{GS}$ = 10 V (Note 4) | - | 20 | 26 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 3.4 | - | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 7.5 | - | nC |
| ESR | Equivalent Series Resistance | Drain open | - | 2.89 | - | Ω |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 380 V, $I_D$ = 3.7 A, $V_{GS}$ = 10 V, $R_G$ = 4.7 Ω (Note 4) | - | 13 | 36 | ns |
| $t_r$ | Turn-On Rise Time | | - | 7 | 24 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 39 | 88 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 9 | 28 | ns |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 7.4 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 22.2 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 3.7 A | - | - | 1.2 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 3.7 A, $dI_F/dt$ = 100 A/µs | - | 200 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 2.3 | - | µC |

**Notes:**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_{AS}$ = 1.5 A, $V_{DD}$ = 50 V, $R_G$ = 25 Ω, Starting $T_J$ = 25°C
3. $I_{SD}$ ≤ 3.7 A, di/dt ≤ 200 A/µs, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25°C
4. Essentially Independent of Operating Temperature Typical Characteristics

## Typical Performance Characteristics

**Figure 1. On-Region Characteristics**

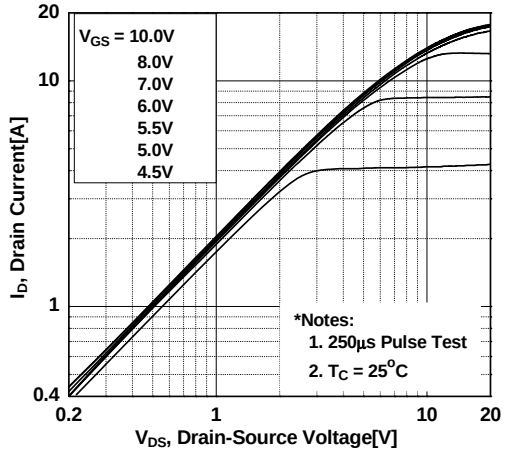



**Figure 2. Transfer Characteristics**

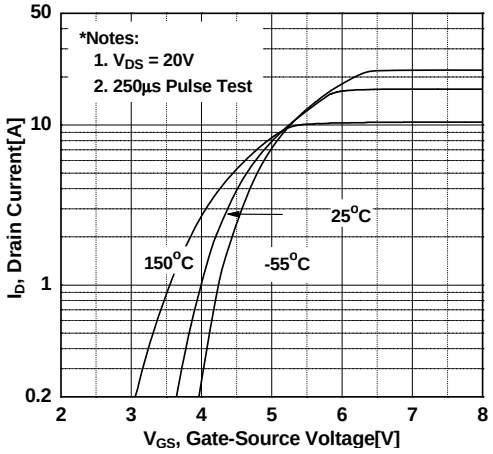



**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**

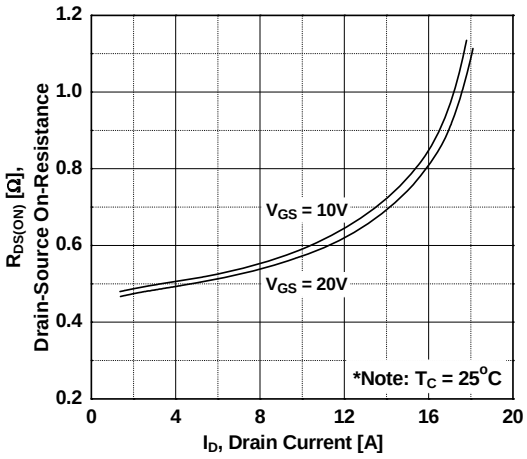



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**

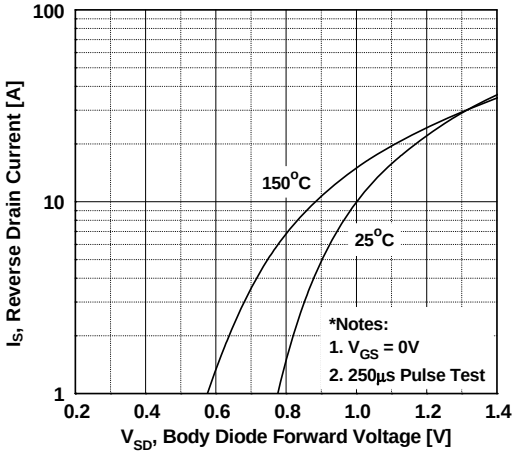



**Figure 5. Capacitance Characteristics**

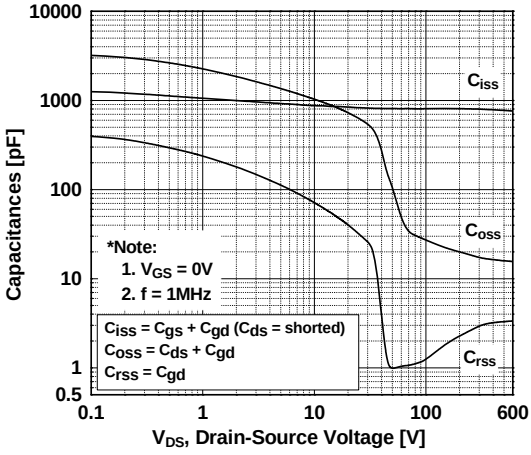
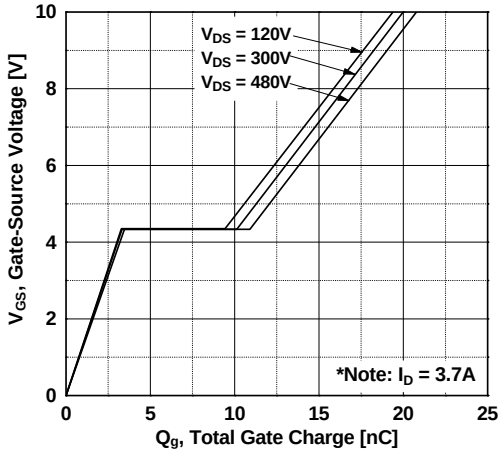



**Figure 6. Gate Charge Characteristics**



## Typical Performance Characteristics (Continued)

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

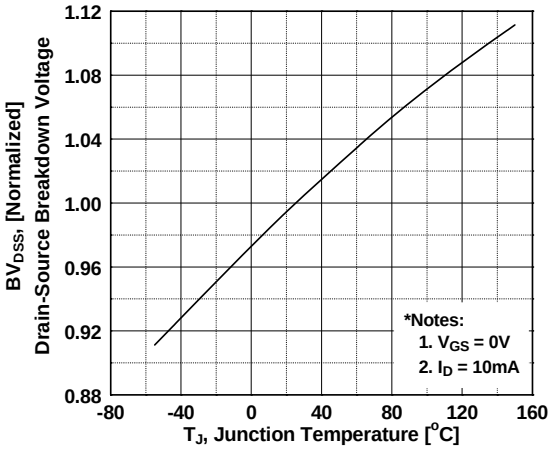



**Figure 8. On-Resistance Variation vs. Temperature**

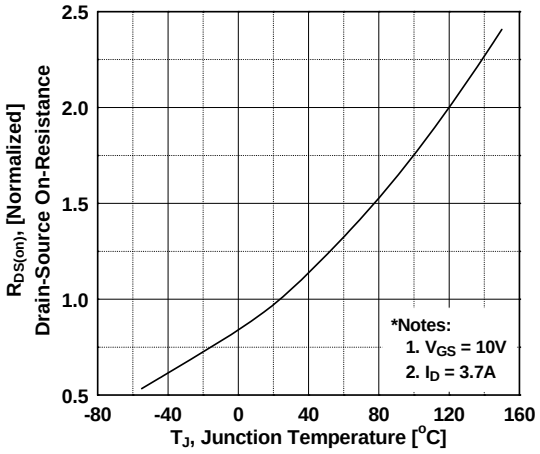



**Figure 9. Maximum Safe Operating Area vs. Case Temperature - FCP600N60Z**

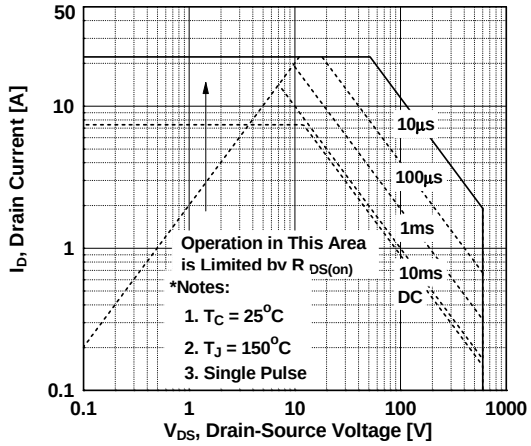



**Figure 10. Maximum Safe Operating Area vs. Case Temperature - FCPF600N60Z**

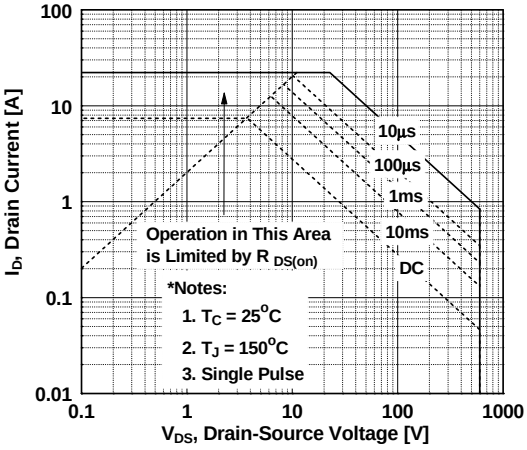



**Figure 11. Maximum Drain Current**

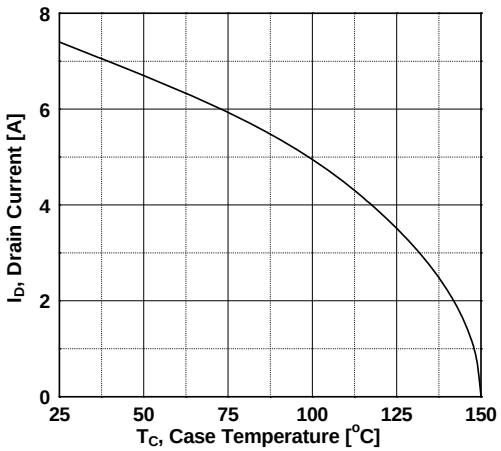
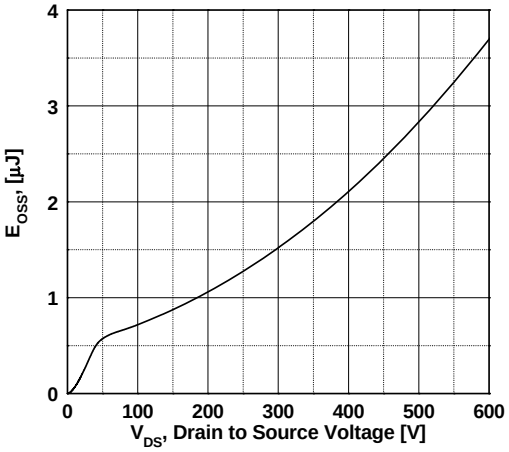



**Figure 12. Eoss vs. Drain to Source Voltage Switching Capability**



## Typical Performance Characteristics (Continued)

**Figure 13. Transient Thermal Response Curve - FCP600N60Z**

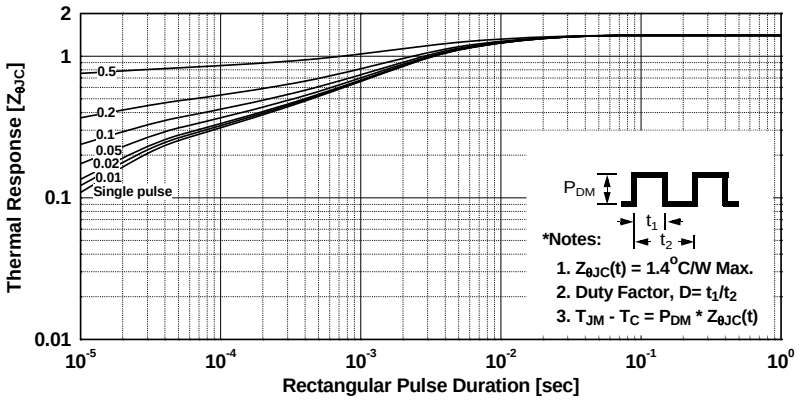
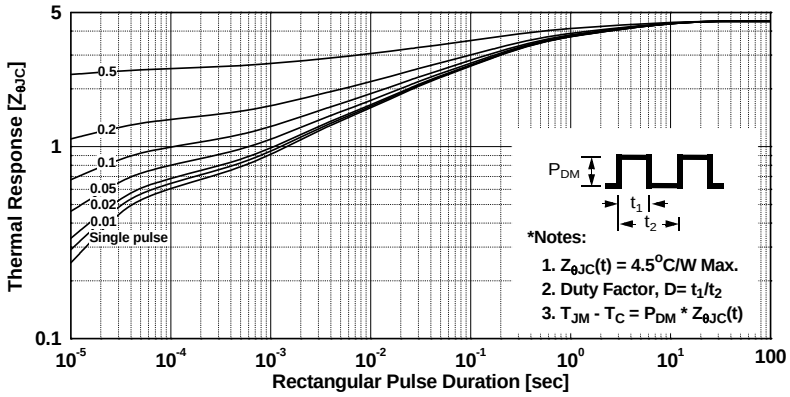
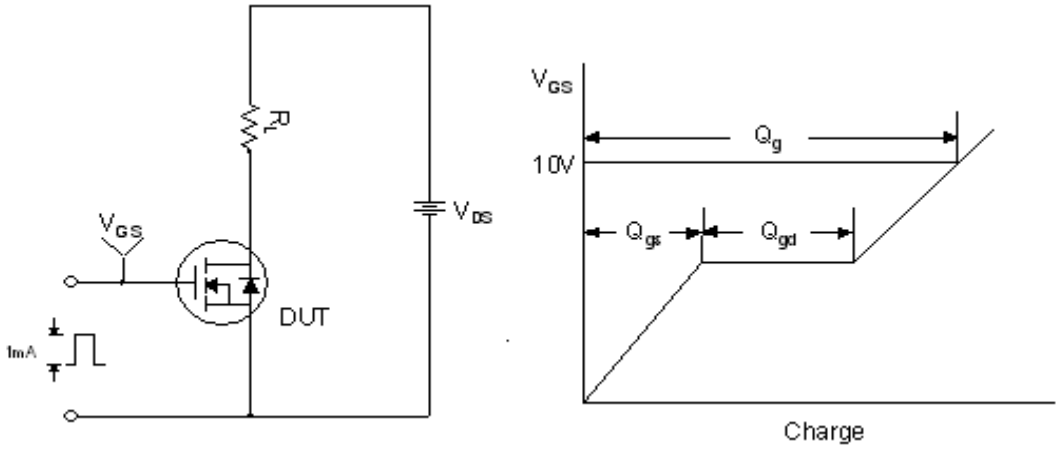


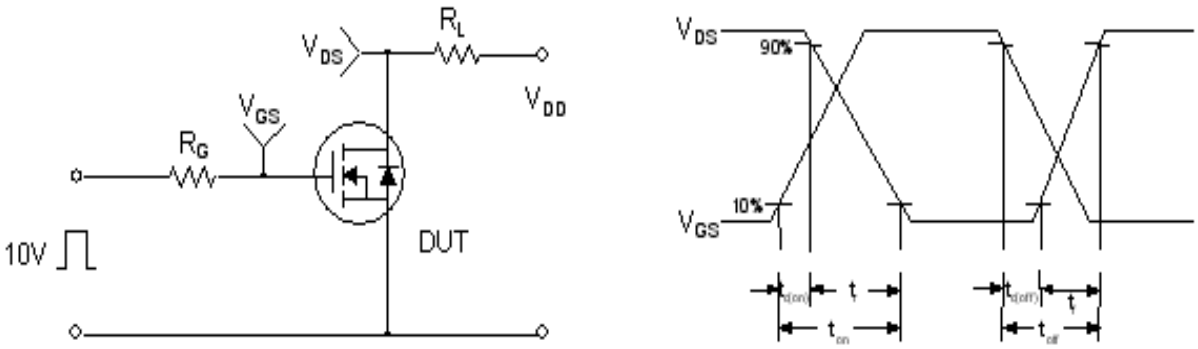

**Figure 14. Transient Thermal Response Curve - FCPF600N60Z**



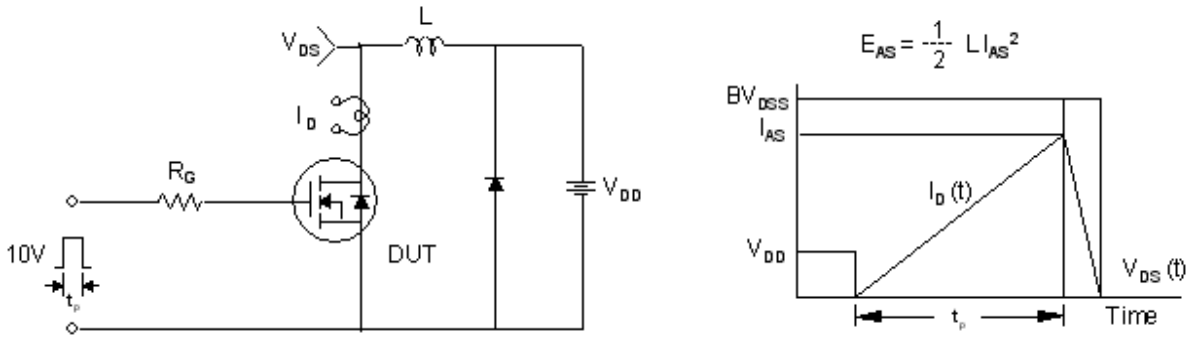
**Gate Charge Test Circuit & Waveform**



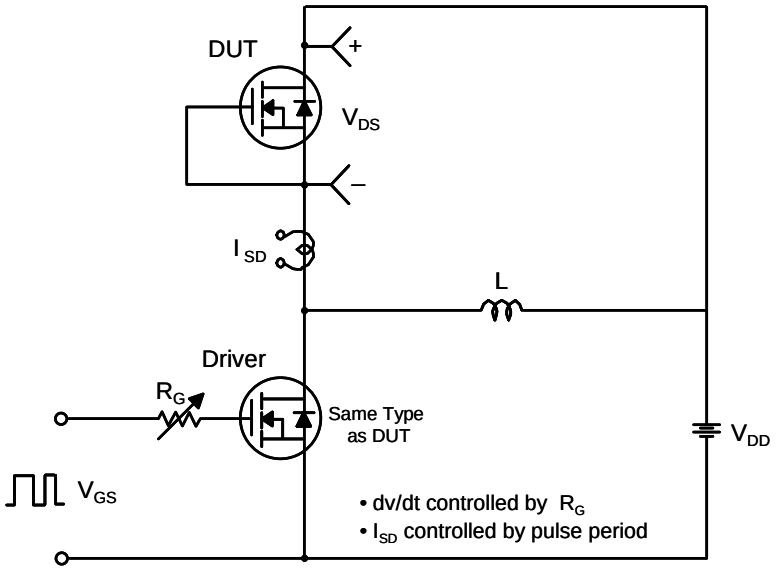

**Resistive Switching Test Circuit & Waveforms**

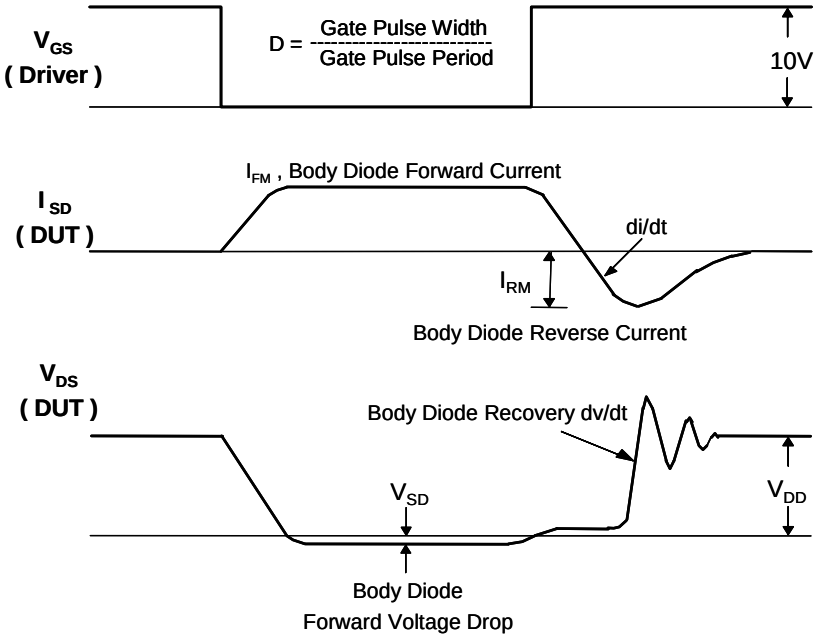



**Unclamped Inductive Switching Test Circuit & Waveforms**



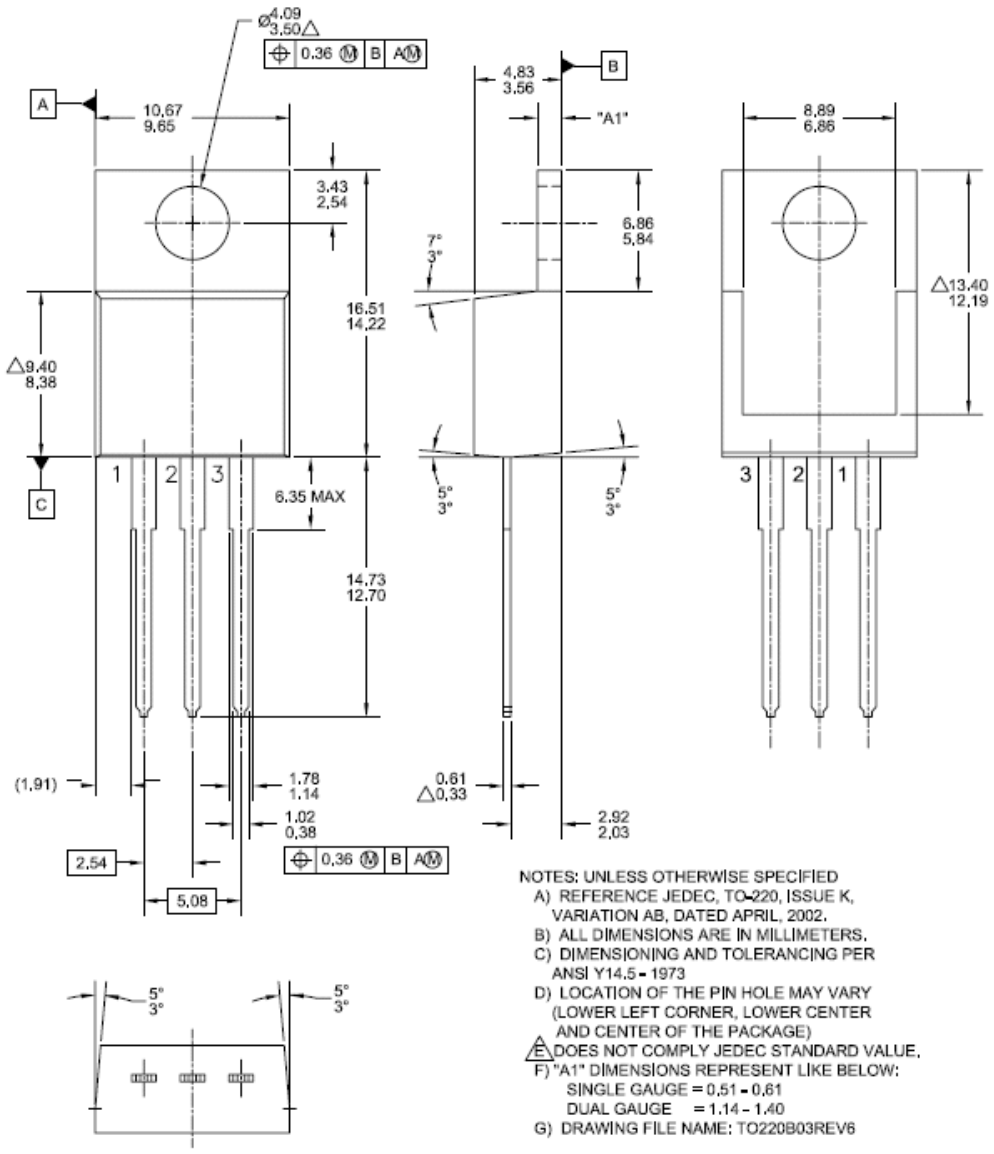
**Peak Diode Recovery dv/dt Test Circuit & Waveforms**



## Mechanical Dimensions

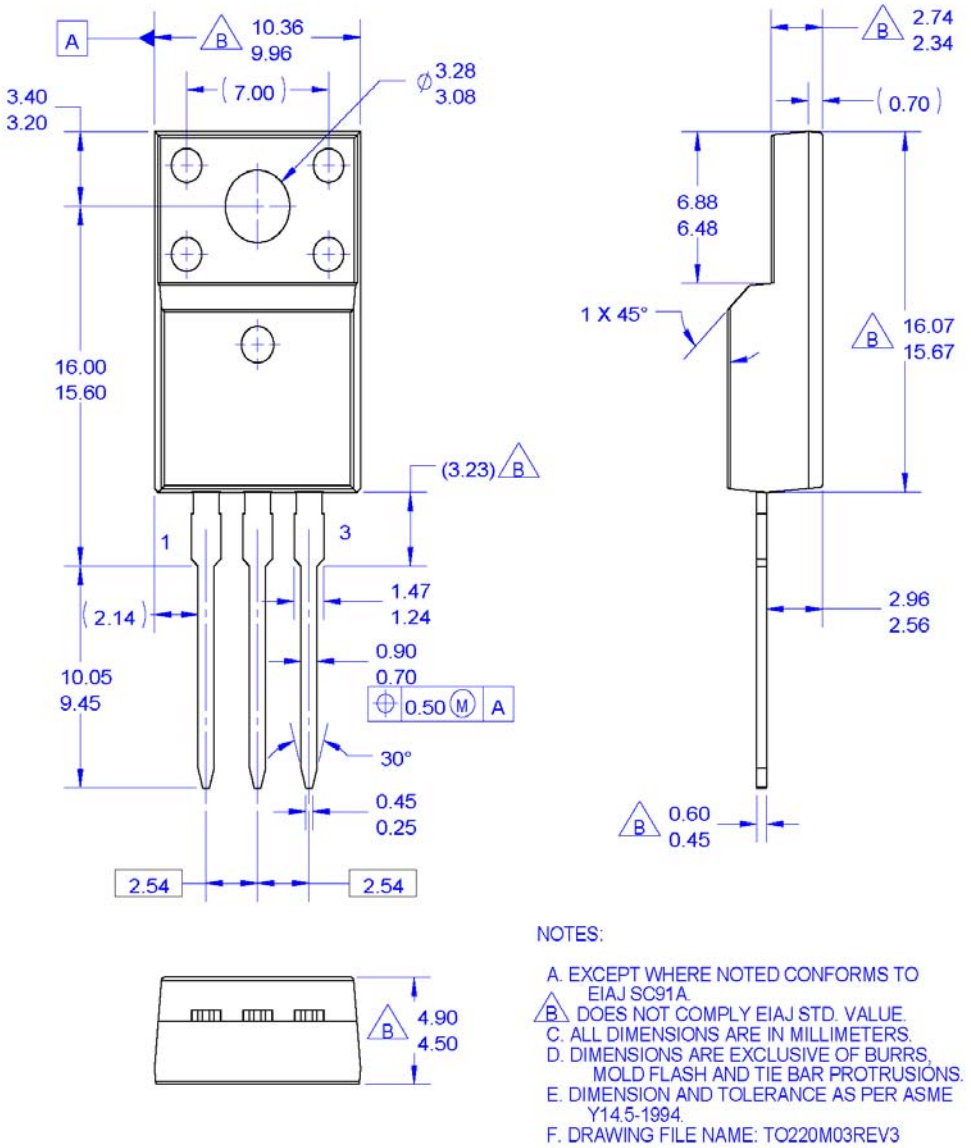
# TO-220AB




NOTES: UNLESS OTHERWISE SPECIFIED
A) REFERENCE JEDEC, TO-220, ISSUE K, VARIATION AB, DATED APRIL, 2002.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONING AND TOLERANCING PER ANSI Y14.5 - 1973
D) LOCATION OF THE PIN HOLE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
△E DOES NOT COMPLY JEDEC STANDARD VALUE.
F) "A1" DIMENSIONS REPRESENT LIKE BELOW:
SINGLE GAUGE = 0,51 - 0,61
DUAL GAUGE = 1.14 - 1.40
G) DRAWING FILE NAME: TO220B03REV6

## Package Dimensions

# TO-220F (Retractable)




NOTES:

A. EXCEPT WHERE NOTED CONFORMS TO EIAJ SC91A.
B. DOES NOT COMPLY EIAJ STD. VALUE.
C. ALL DIMENSIONS ARE IN MILLIMETERS.
D. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
E. DIMENSION AND TOLERANCE AS PER ASME Y14.5-1994.
F. DRAWING FILE NAME: TO220M03REV3

## * Front/Back Side Isolation Voltage : AC 2500V

Dimensions in Millimeters

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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 / 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. |

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