FAIRCHILD SEMICONDUCTOR®

March 2013

# FCP9N60N / FCPF9N60NT

## N-Channel SupreMOS® MOSFET

### 600 V, 9 A, 385 mΩ

## Features

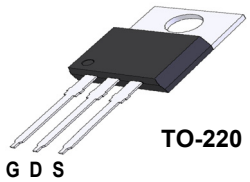
- $R_{DS(on)}$ = 330 mΩ (Typ.)@ $V_{GS}$ = 10 V, $I_D$ = 4.5 A
- Ultra low gate charge (Typ. $Q_g$ = 22 nC)
- Low effective output capacitance (Typ. $C_{oss}$.eff = 106 pF)
- 100% avalanche tested
- RoHS compliant

## Application

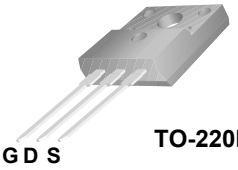
- LCD/LED/PDP TV
- Lighting
- Solar Inverter
- AC-DC Power Supply

## Description

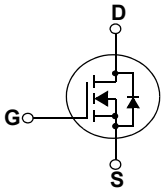
The SupreMOS® MOSFET is Fairchild Semiconductor®'s next-generation of high voltage super-junction (SJ) technology employing a deep trench filling process that differentiate it from the conventional MOSFETs. This advanced technology and precise process control provide lowest Rsp on-resistance, superior switching performance and ruggedness. SupreMOS MOSFET is suitable for high frequency switching power converter applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications.




TO-220




TO-220F




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

| Symbol | Parameter | | FCP9N60N | FCPF9N60NT | Unit |
|---|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 600 | | V |
| $V_{GSS}$ | Gate to Source Voltage | | ±30 | | V |
| $I_D$ | Drain Current | -Continuous ($T_C$ = 25°C) | 9.0 | 9.0* | A |
| | | -Continuous ($T_C$ = 100°C) | 5.7 | 5.7* | |
| $I_{DM}$ | Drain Current | - Pulsed (Note 1) | 27 | 27* | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy | (Note 2) | 135 | | mJ |
| $I_{AR}$ | Avalanche Current | | 3 | | A |
| $E_{AR}$ | Repetitive Avalanche Energy | | 0.83 | | mJ |
| dv/dt | MOSFET dv/dt Ruggedness | | 100 | | V/ns |
| | Peak Diode Recovery dv/dt | (Note 3) | 20 | | V/ns |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | 83.3 | 29.8 | W |
| | | - Derate above 25°C | 0.67 | 0.24 | 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 | FCP9N60N | FCPF9N60NT | Unit |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.5 | 4.2 | °C/W |
| $R_{\theta CS}$ | Thermal Resistance, Case to Heat Sink (Typical) | 0.5 | 0.5 | |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient | 62.5 | 62.5 | |

## Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|
| FCP9N60N | FCP9N60N | TO-220 | - | - | 50 |
| FCPF9N60NT | FCPF9N60NT | 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 | $I_D$ = 1 mA, $V_{GS}$ = 0 V, $T_C = 25^oC$ | 600 | - | - | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 1 mA, Referenced to $25^oC$ | - | 0.72 | - | $V/^oC$ |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V | - | - | 10 | μA |
| | | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V, $T_C = 125^oC$ | - | - | 100 | |
| $I_{GSS}$ | 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 | 2.0 | - | 4.0 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 4.5 A | - | 0.33 | 0.385 | Ω |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 40 V, $I_D$ = 4.5 A | - | 7.5 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 100 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 930 | 1240 | pF |
| $C_{oss}$ | Output Capacitance | | - | 35 | 50 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 2 | 4 | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 380 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 20 | - | pF |
| $C_{oss}$eff. | Effective Output Capacitance | $V_{DS}$ = 0 V to 480 V, $V_{GS}$ = 0 V | - | 106 | - | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS}$ = 380V, $I_D$ = 4.5A, $V_{GS}$ = 10 V (Note 4) | - | 22.0 | 29 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 4.1 | - | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 7.1 | - | nC |
| ESR | Equivalent Series Resistance (G-S) | Drain Open | | 2.9 | | Ω |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 380 V, $I_D$ = 4.5 A, $R_G$ = 4.7 Ω (Note 4) | - | 12.7 | 35.4 | ns |
| $t_r$ | Turn-On Rise Time | | - | 8.7 | 27.4 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 36.9 | 83.8 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 10.2 | 30.4 | ns |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 9.0 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 27 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 4.5 A | - | - | 1.2 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 4.5 A, $dI_F/dt$ = 100 A/μs | - | 213 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 2.2 | - | μC |

**Notes:**
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_{AS}$ = 3 A, $R_G$ = 25 Ω, Starting $T_J$ = 25°C
3. $I_{SD} \le$ 9 A, di/dt ≤ 200 A/μs, $V_{DD}$ = 380 V, Starting $T_J$ = 25°C
4. Essentially Independent of Operating Temperature Typical Characteristics

## Typical Performance Characteristics

**Figure 1. On-Region Characteristics**

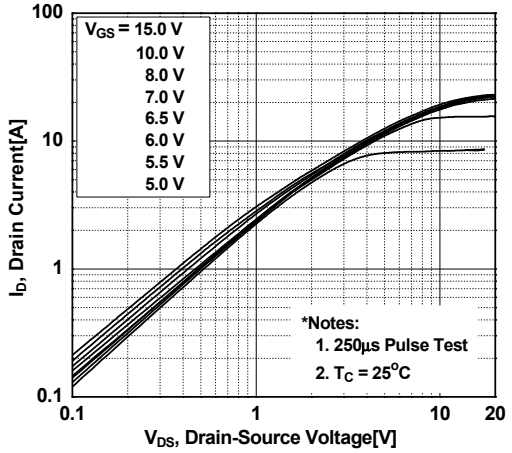



**Figure 2. Transfer Characteristics**

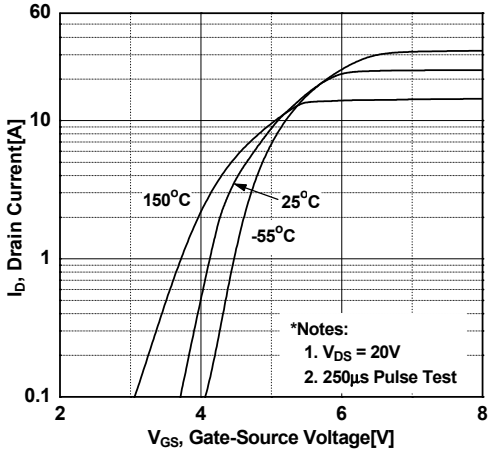



**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**

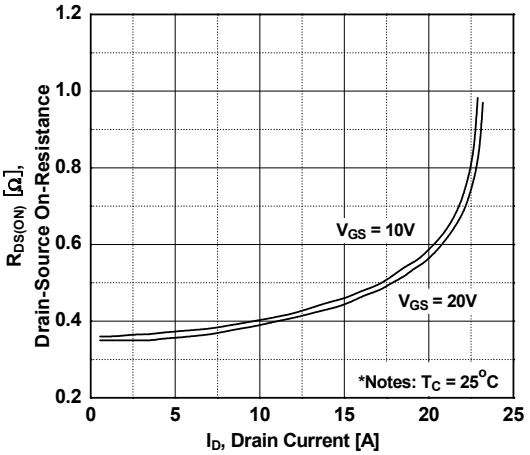



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**

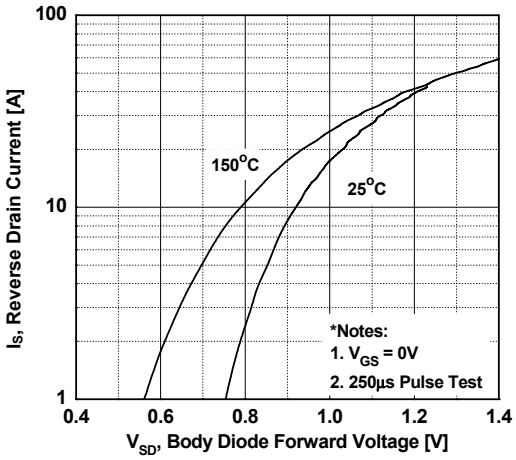



**Figure 5. Capacitance Characteristics**

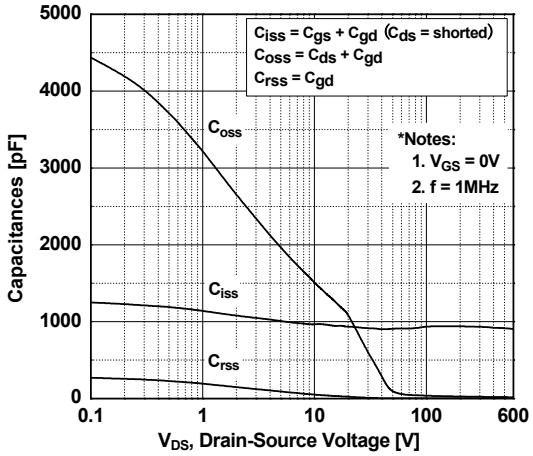
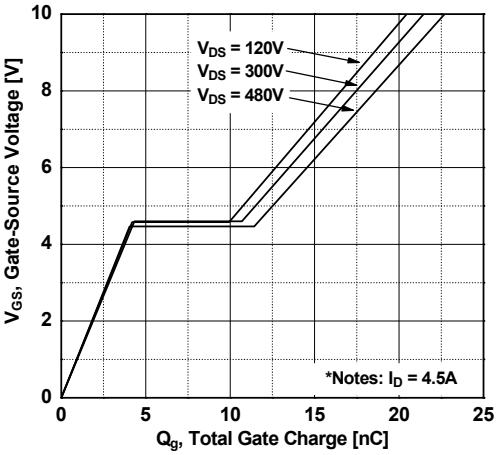



**Figure 6. Gate Charge Characteristics**



## Typical Performance Characteristics (Continued)

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

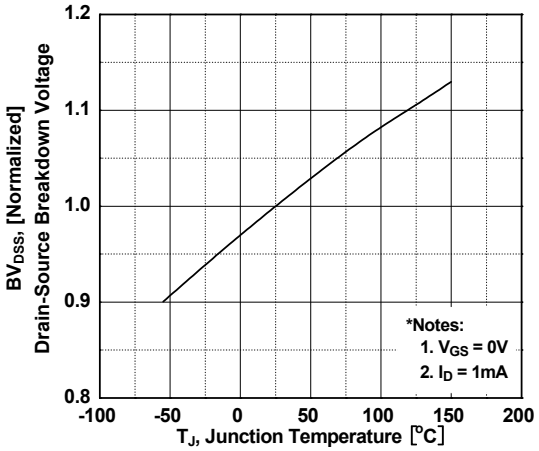



**Figure 8. On-Resistance Variation vs. Temperature**

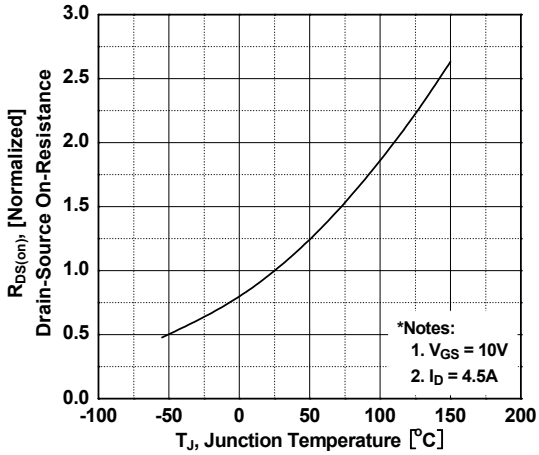



**Figure 9. Maximum Safe Operating Area _ FCP9N60N**

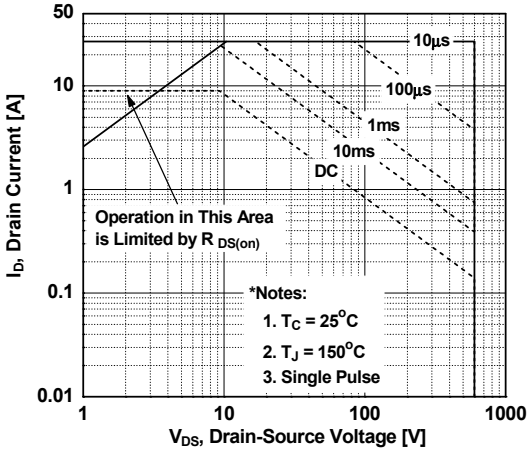



**Figure 10. Maximum Safe Operating Area _ FCPF9N60NT**

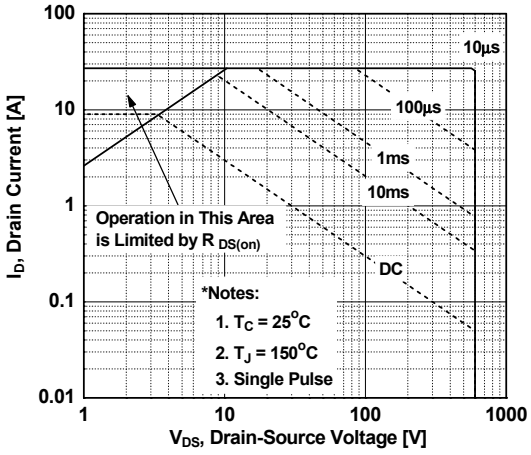
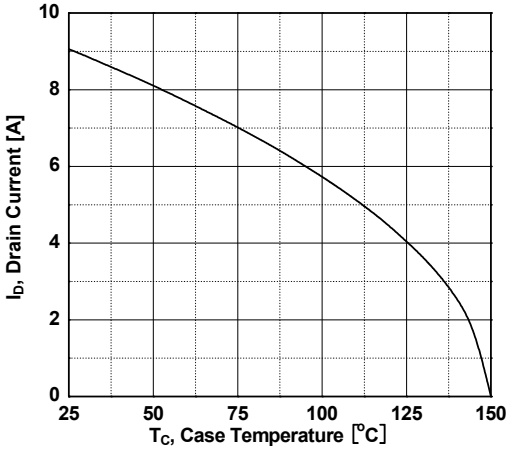



**Figure 11. Maximum Drain Current vs. Case Temperature**



## Typical Performance Characteristics (Continued)

**Figure 12. Transient Thermal Response Curve _ FCP9N60N**

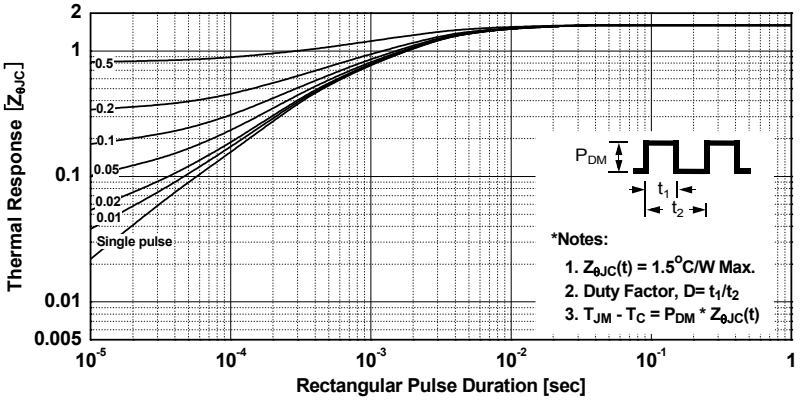
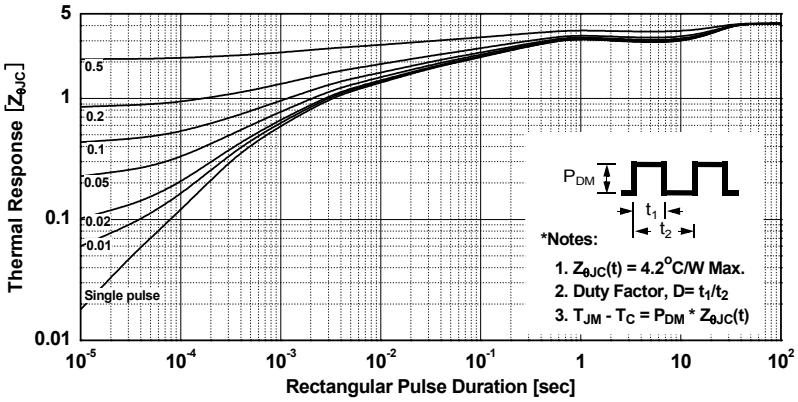
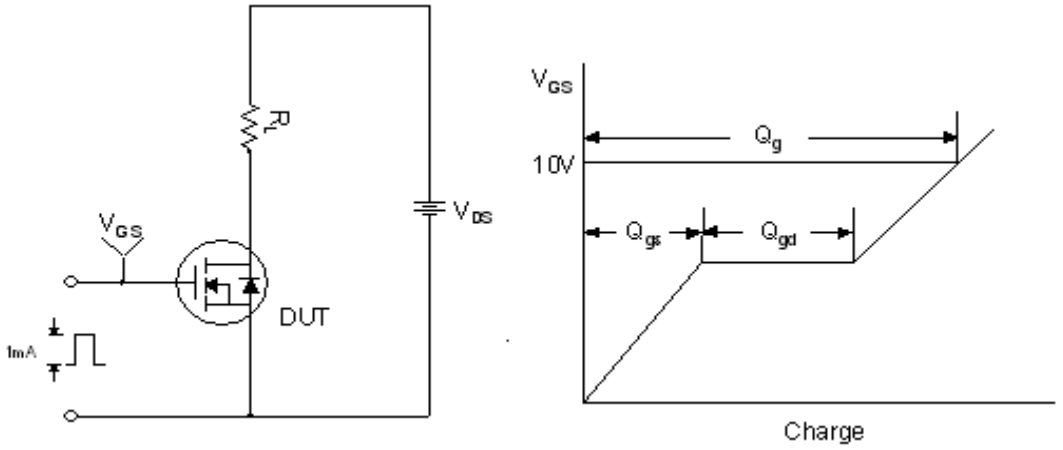


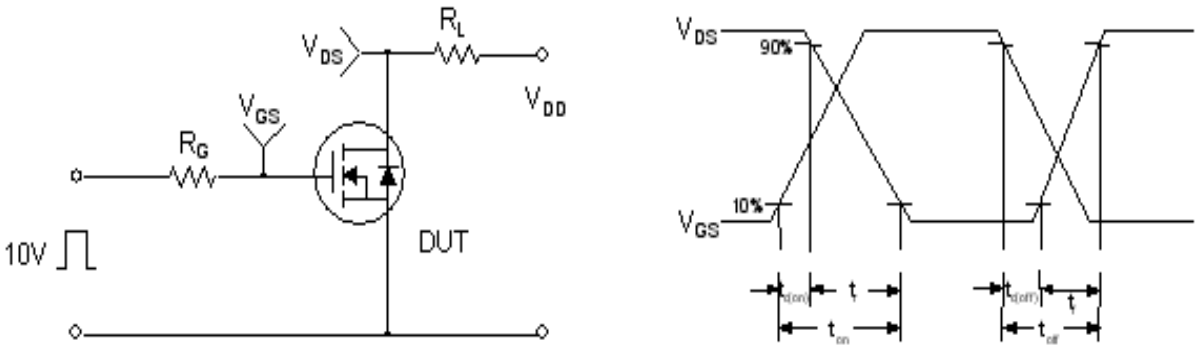

**Figure 13. Transient Thermal Response Curve _ FCPF9N60NT**



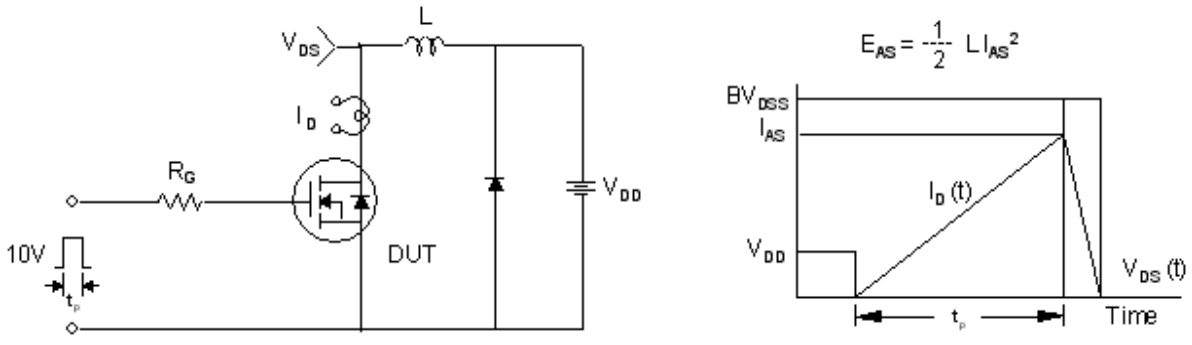
**Gate Charge Test Circuit & Waveform**



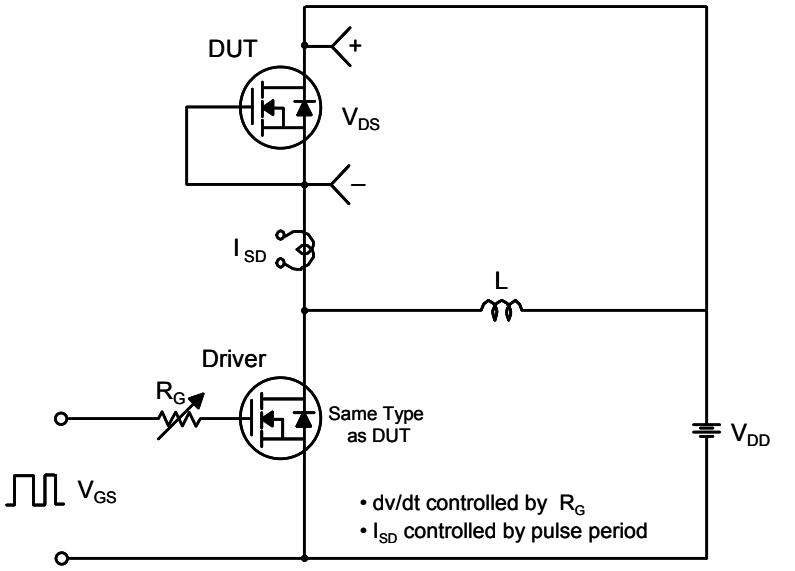

**Resistive Switching Test Circuit & Waveforms**

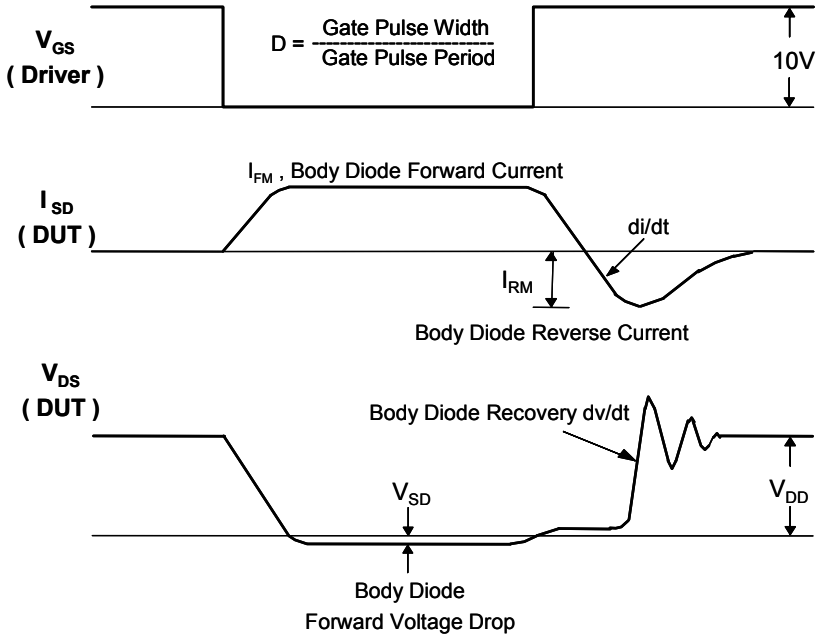



**Unclamped Inductive Switching Test Circuit & Waveforms**



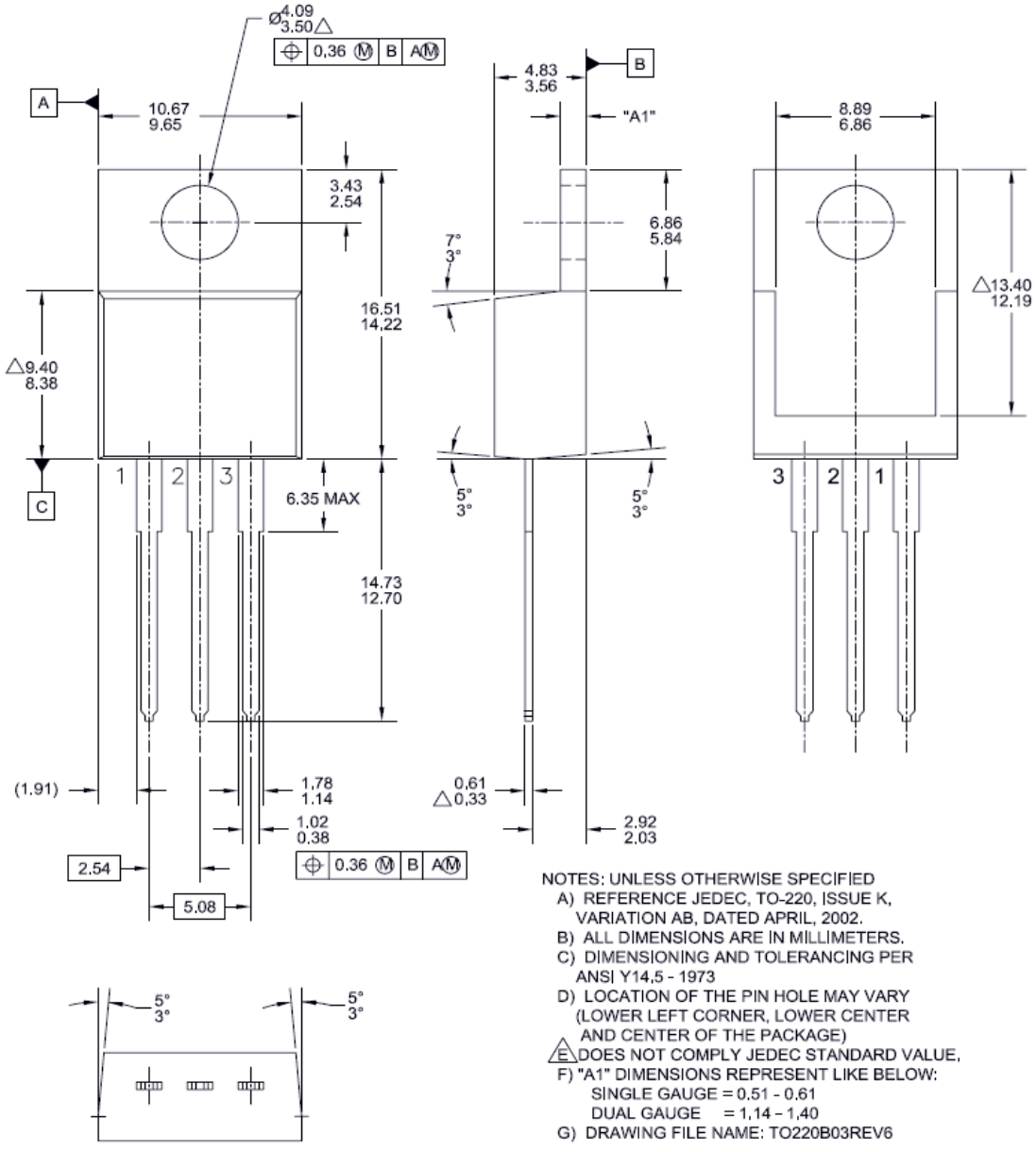
**Peak Diode Recovery dv/dt Test Circuit & Waveforms**



## Mechanical Dimensions

# TO-220

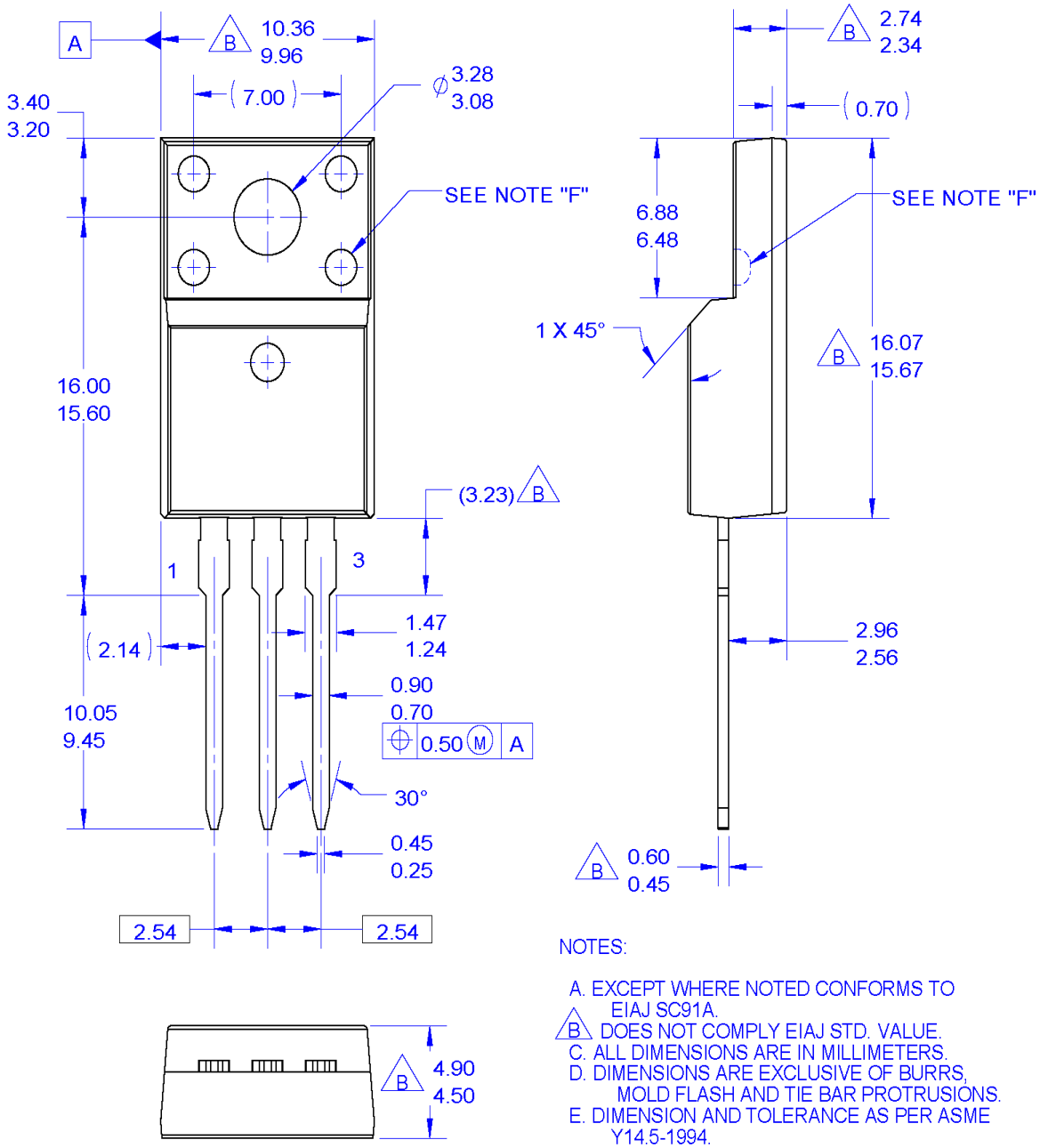



NOTES: UNLESS OTHERWISE SPECIFIED
A) REFERENCE JEDEC, TO-220, ISSUE K, VARIATION AB, DATED APRIL, 2002.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONING AND TOLERANCING PER ANSI Y14.5 - 1973
D) LOCATION OF THE PIN HOLE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
△E DOES 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

Dimensions in Millimeters

## Mechanical Dimensions

# TO-220F




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. OPTION 1 - WITH SUPPORT PIN HOLE.
OPTION 2 - NO SUPPORT PIN HOLE.
G. DRAWING FILE NAME: TO220M03REV3

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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