August 2014

# FCP16N60 / FCPF16N60

## N-Channel SuperFET® MOSFET

### 600 V, 16 A, 260 mΩ

## Features

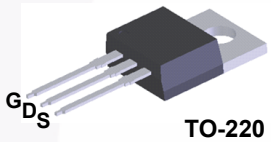
- 650V @ $T_J$ = 150°C
- Typ. $R_{DS(on)}$ = 220 mΩ
- Ultra Low Gate Charge (Typ. $Q_g$ = 55 nC )
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 110 pF )
- 100% Avalanche Tested

## Applications

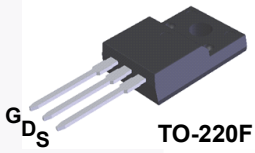
- Solar Inverter
- AC-DC Power Supply

## Description

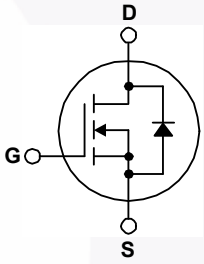
SuperFET® MOSFET is Fairchild Semiconductor's first generation of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switching performance, dv/dt rate and higher avalanche energy. Consequently, SuperFET MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications.




TO-220




TO-220F




## Absolute Maximum Ratings

| Symbol | Parameter | | FCP16N60 | FCPF16N60 | Unit |
|---|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | | 600 | | V |
| $I_D$ | Drain Current | - Continuous ($T_C$ = 25°C)<br>- Continuous ($T_C$ = 100°C) | 16<br>10.1 | 16*<br>10.1* | A<br>A |
| $I_{DM}$ | Drain Current | - Pulsed (Note 1) | 48 | 48* | A |
| $V_{GSS}$ | Gate-Source Voltage | | ± 30 | | V |
| $E_{AS}$ | Single Pulsed Avalanche Energy | (Note 2) | 450 | | mJ |
| $I_{AR}$ | Avalanche Current | (Note 1) | 16 | | A |
| $E_{AR}$ | Repetitive Avalanche Energy | (Note 1) | 20.8 | | mJ |
| dv/dt | Peak Diode Recovery dv/dt | (Note 3) | 4.5 | | V/ns |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C)<br>- Derate Above 25°C | 167<br>1.33 | 37.9<br>0.3 | W<br>W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | -55 to +150 | | °C |
| $T_L$ | Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds | | 300 | | °C |

*Drain current limited by maximum junction temperature.

## Thermal Characteristics

| Symbol | Parameter | FCP16N60 | FCPF16N60 | Unit |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | 0.75 | 3.3 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 62.5 | 62.5 | °C/W |

## Package Marking and Ordering Information

| Part Number | Top Mark | Package | Packing Method | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|---|
| FCP16N60 | FCP16N60 | TO-220 | Tube | N/A | N/A | 50 units |
| FCPF16N60 | FCPF16N60 | TO-220F | Tube | N/A | N/A | 50 units |

## 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 | $I_D$ = 250 μA, $V_{GS}$ = 0 V, $T_J = 25^oC$ | 600 | - | - | V |
| | | $I_D$ = 250 μA, $V_{GS}$ = 0 V, $T_J = 150^oC$ | - | 650 | - | V |
| $\Delta BV_{DSS}$ / $\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250 μA, Referenced to $25^oC$ | - | 0.6 | - | $V/^oC$ |
| $BV_{DS}$ | Drain-Source Avalanche Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 16 A | - | 700 | - | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 600 V, $V_{GS}$ = 0 V | - | - | 1 | μA |
| | | $V_{DS}$ = 480 V, $T_C = 125^oC$ | - | - | 10 | |
| $I_{GSS}$ | 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 | 3.0 | - | 5.0 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 8 A | - | 0.55 | 0.26 | Ω |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 40 V, $I_D$ = 8 A | - | 11.5 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 1730 | 2250 | pF |
| $C_{oss}$ | Output Capacitance | | - | 960 | 1150 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 85 | - | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 45 | 60 | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | - | 110 | - | pF |
| $Q_g$ | Total Gate Charge at 10V | $V_{DS}$ = 480 V, $I_D$ = 16 A, $V_{GS}$ = 10 V (Note 4) | - | 55 | 70 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 10.5 | 13 | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 28 | - | nC |
| ESR | Equivalent Series Resistance | f = 1 MHz | - | 1.7 | - | Ω |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 300 V, $I_D$ = 16 A, $V_{GS}$ = 10 V, $R_G$ = 25 Ω (Note 4) | - | 42 | 85 | ns |
| $t_r$ | Turn-On Rise Time | | - | 130 | 270 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 165 | 340 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 90 | 190 | ns |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 16 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 48 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 16 A | - | - | 1.4 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 16 A, $dI_F/dt$ = 100 A/μs | - | 435 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 7.0 | - | μC |

**Notes:**

1: Repetitive rating: pulse-width limited by maximum junction temperature.

2: $I_{AS}$ = 8 A, $V_{DD}$ = 50 V, $R_G$ = 25 Ω, starting $T_J$ = 25°C.

3: $I_{SD} \le 16$ A, di/dt ≤ 200 A/μs, $V_{DD} \le BV_{DSS}$, starting $T_J$ = 25°C.

4: Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

**Figure 1. On-Region Characteristics**

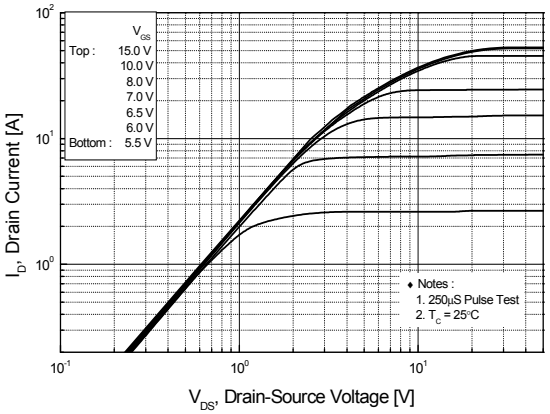



**Figure 2. Transfer Characteristics**

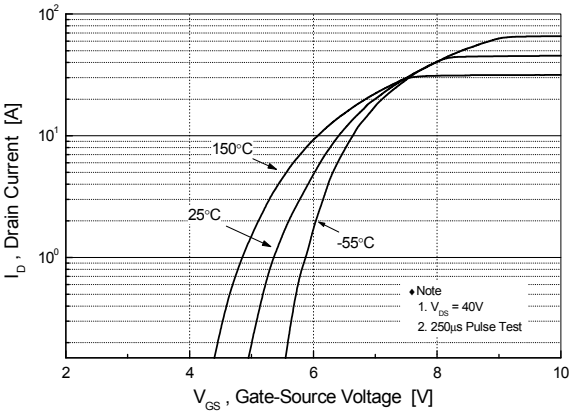



**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**

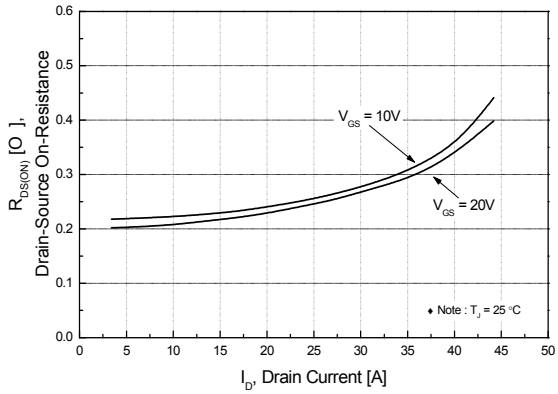



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperatue**

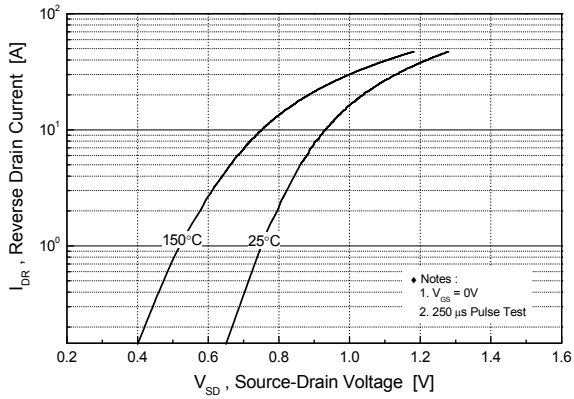



**Figure 5. Capacitance Characteristics**

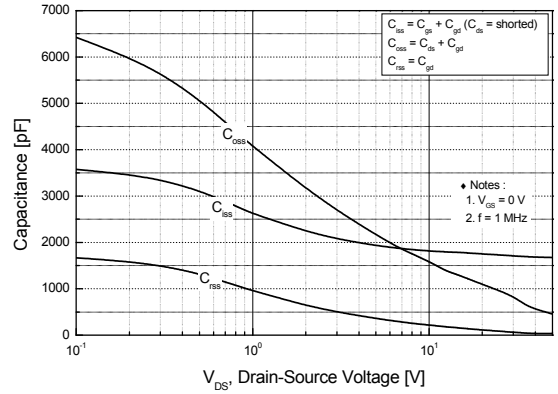
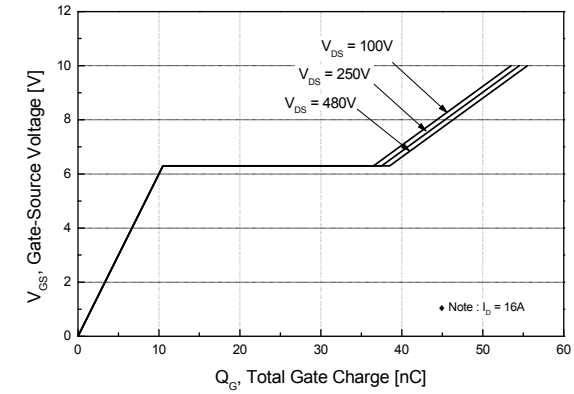



**Figure 6. Gate Charge Characteristics**



## Typical Performance Characteristics (Continued)

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

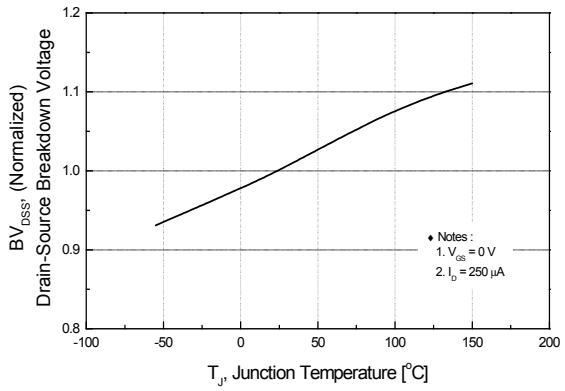



**Figure 8. On-Resistance Variation vs. Temperature**

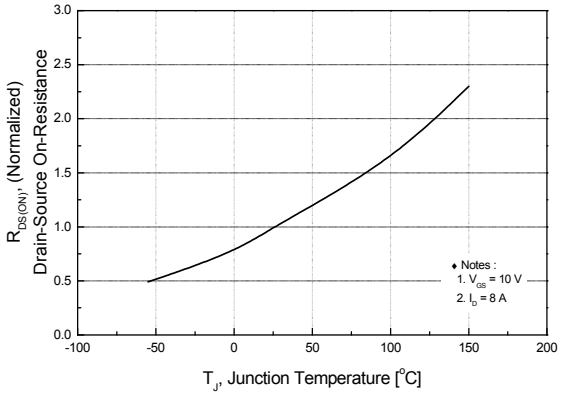



**Figure 9-1. Maximum Safe Operating Area for FCP16N60**

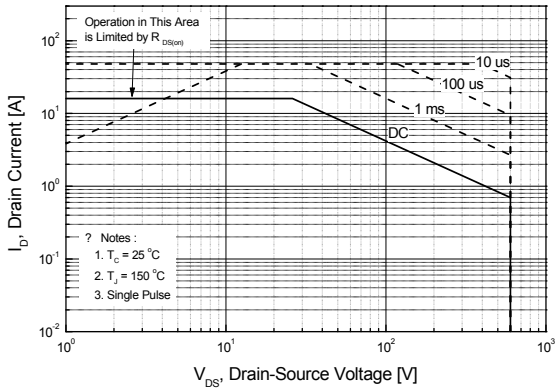



**Figure 9-2. Maximum Safe Operating Area for FCPF16N60**

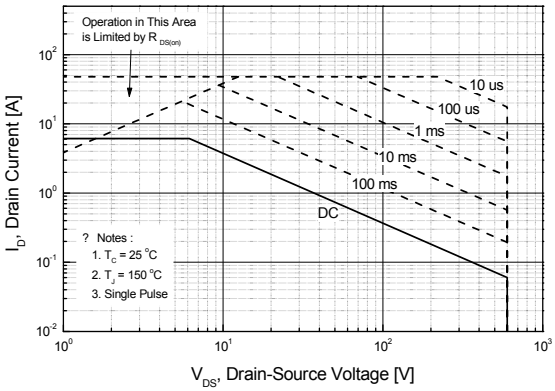
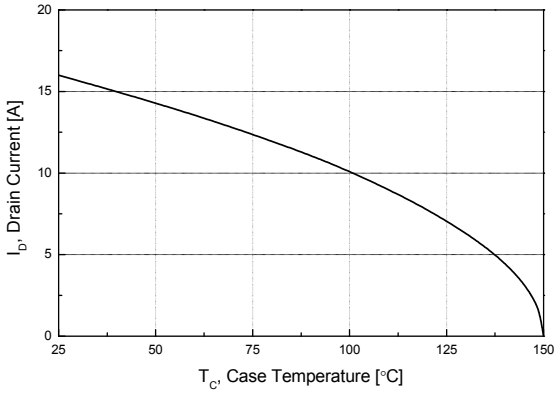



**Figure 10. Maximum Drain Current vs. Case Temperature**



## Typical Performance Characteristics (Continued)

**Figure 11-1. Transient Thermal Response Curve for FCP16N60**

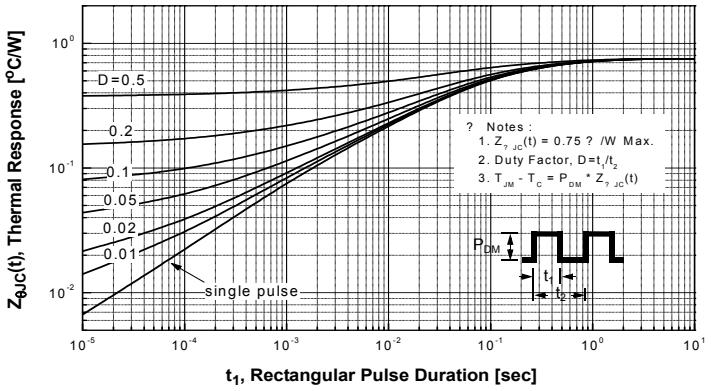
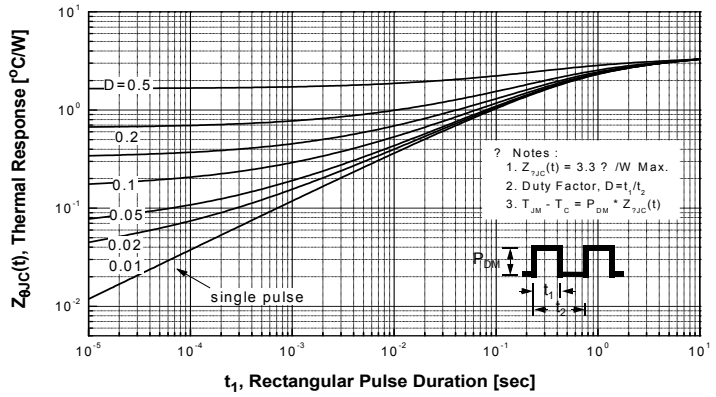



**Figure 11-2. Transient Thermal Response Curve for FCPF16N60**



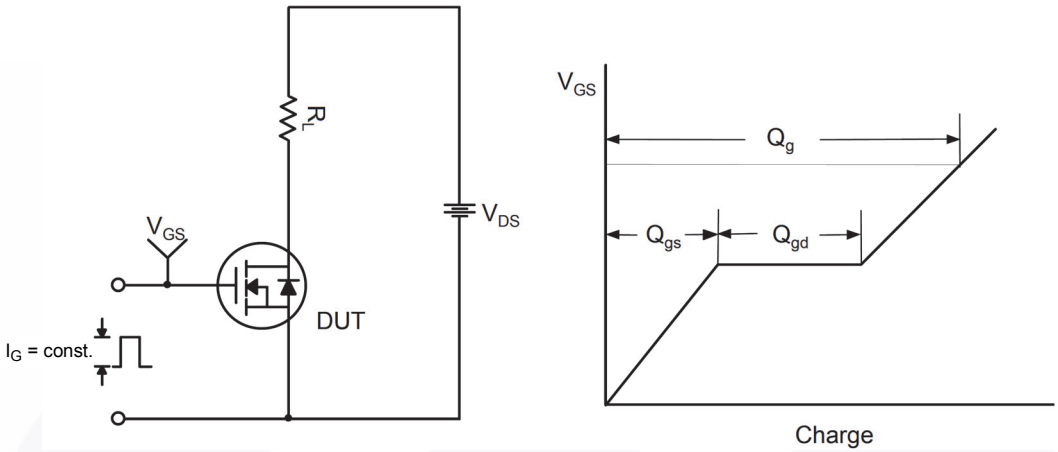



**Figure 12. Gate Charge Test Circuit & Waveform**

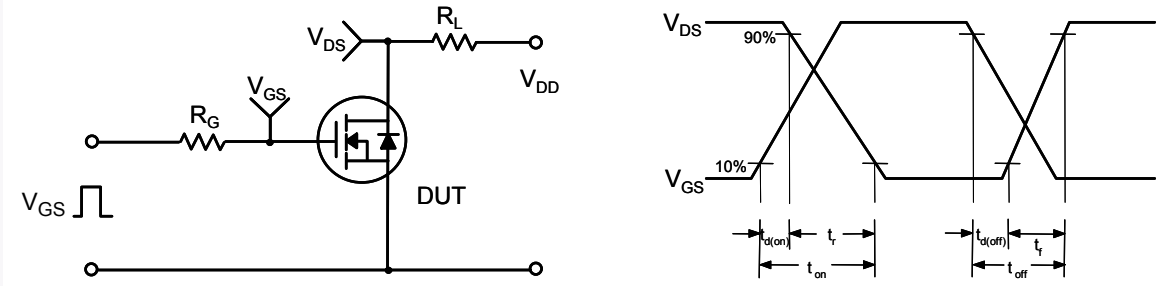



**Figure 13. Resistive Switching Test Circuit & Waveforms**

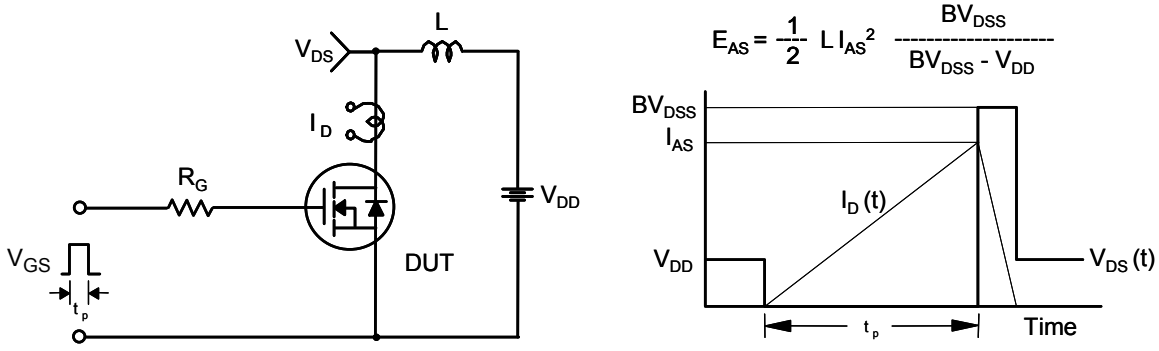



**Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms**

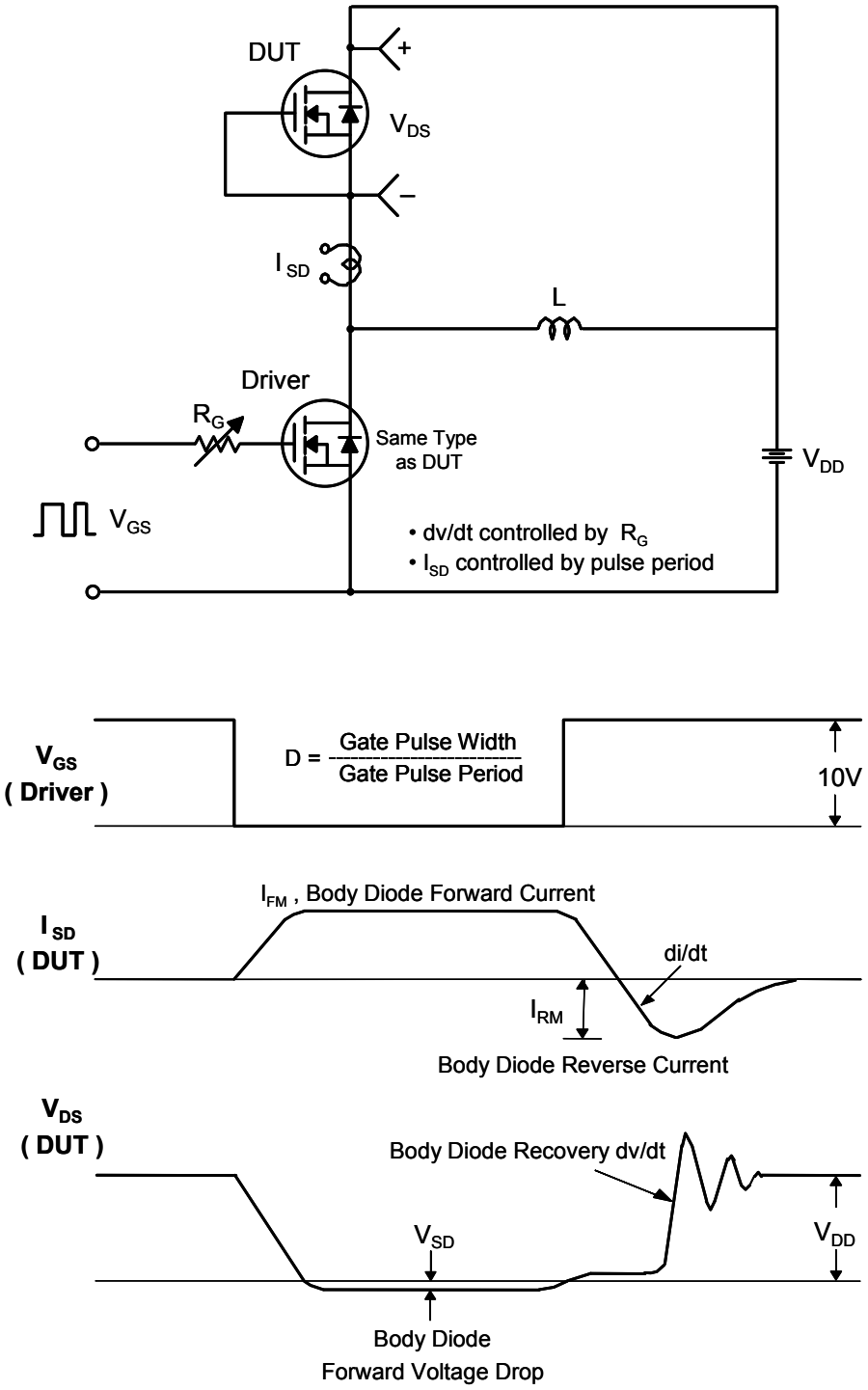
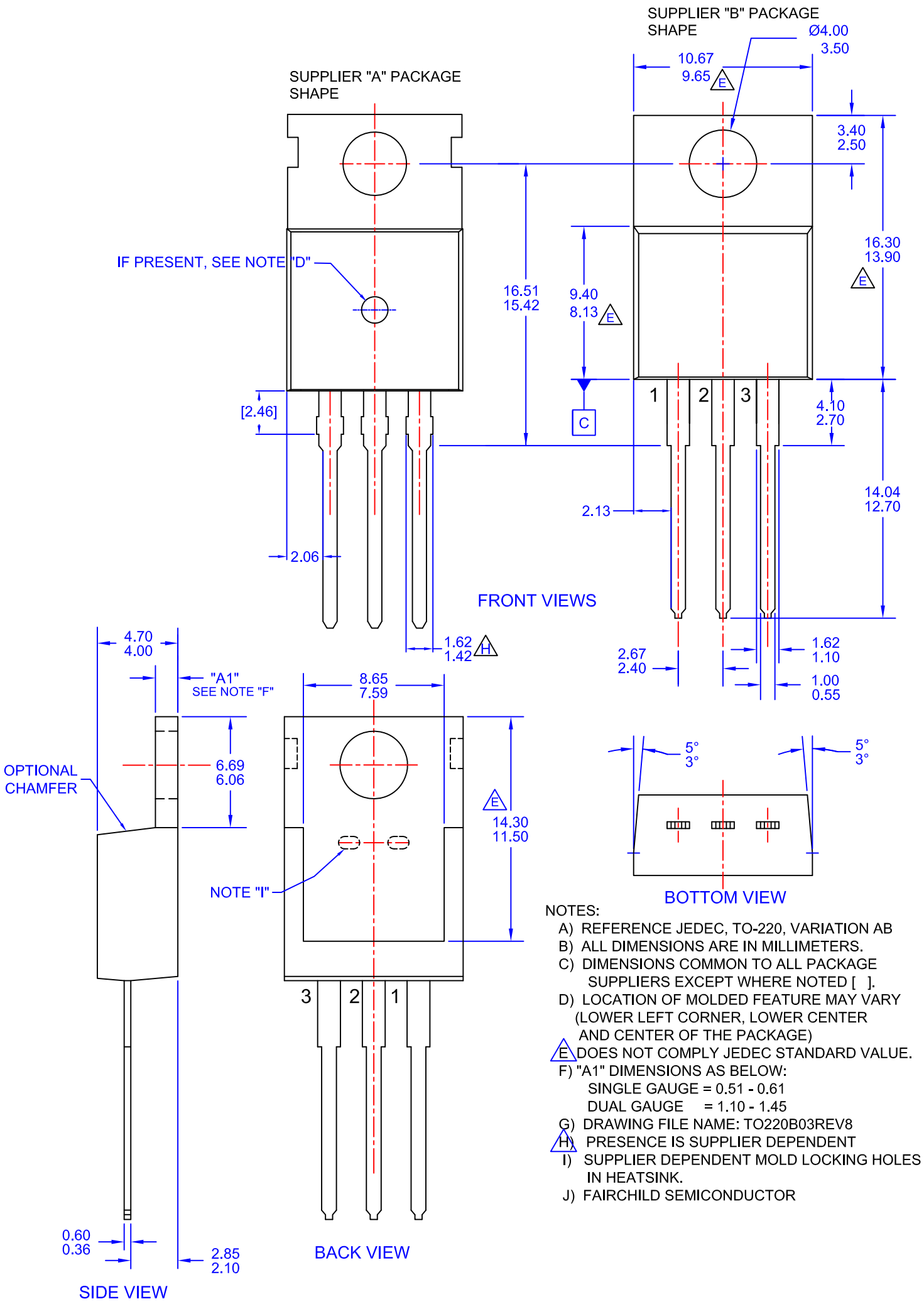
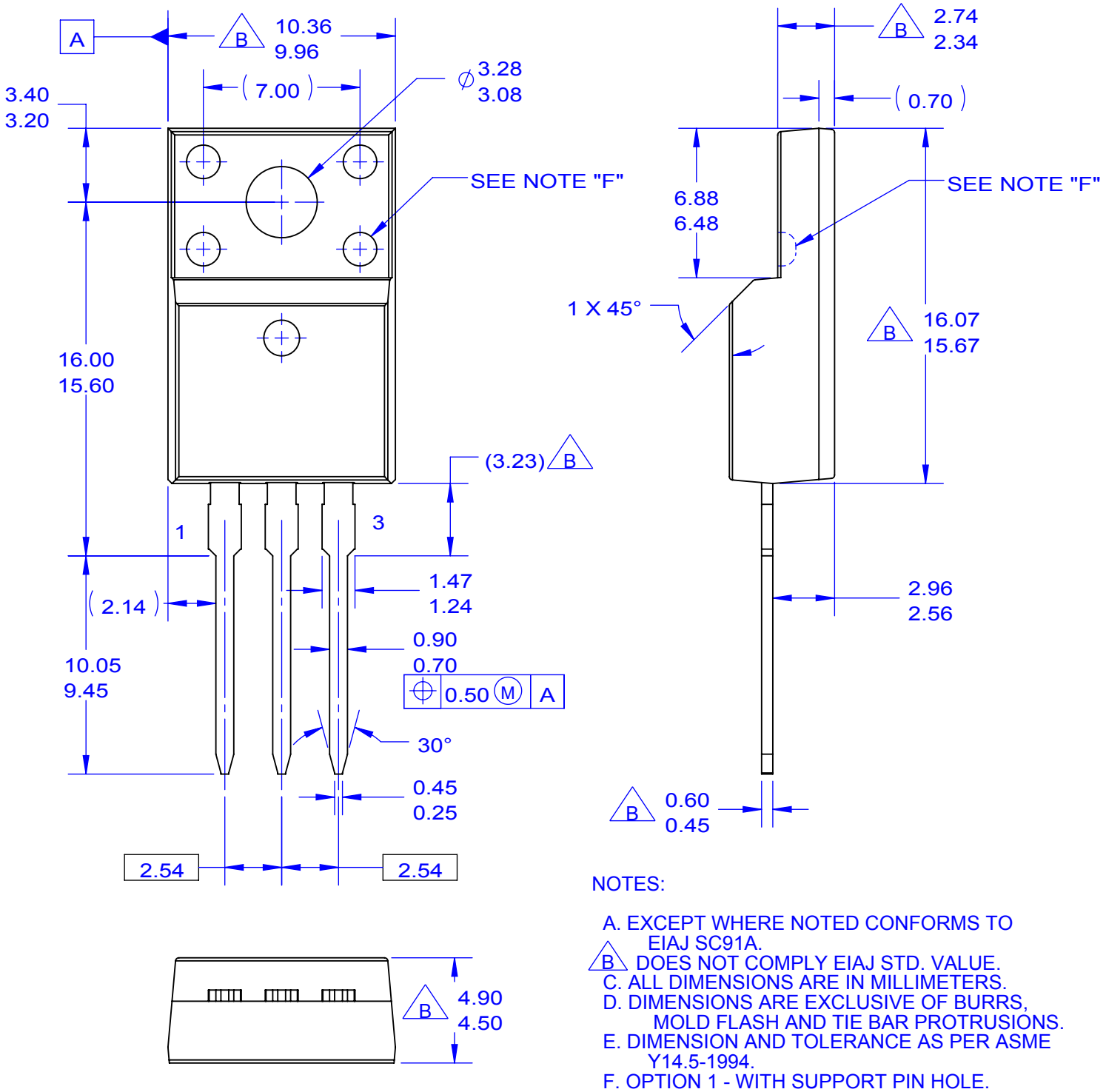



**Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms**




NOTES:

A) REFERENCE JEDEC, TO-220, VARIATION AB
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONS COMMON TO ALL PACKAGE SUPPLIERS EXCEPT WHERE NOTED [ ].
D) LOCATION OF MOLDED FEATURE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
E) DOES NOT COMPLY JEDEC STANDARD VALUE.
F) "A1" DIMENSIONS AS BELOW:
SINGLE GAUGE = 0.51 - 0.61
DUAL GAUGE = 1.10 - 1.45
G) DRAWING FILE NAME: TO220B03REV8
H) PRESENCE IS SUPPLIER DEPENDENT
I) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.
J) FAIRCHILD SEMICONDUCTOR




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

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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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## 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. |
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Rev. I73