March 2014

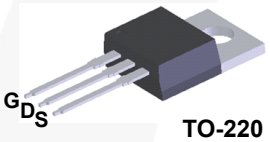
# FCP11N60/FCPF11N60

## General Description

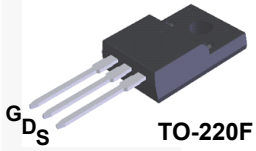
SuperFET® MOSFET is Fairchild Semiconductor's first genera-tion of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switch-ing performance, dv/dt rate and higher avalanche energy. Con-sequently, 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.

## Features

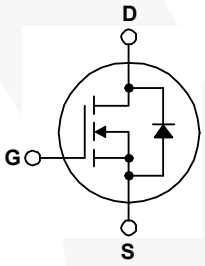
- 650V @$T_j$ = 150°C
- Typ. Rds(on)=0.32Ω
- Ultra low gate charge (typ. Qg=40nC)
- Low effective output capacitance (typ. Coss.eff=95pF)
- 100% avalanche tested
- RoHS Compliant




TO-220




TO-220F




## Absolute Maximum Ratings

$T_C$ = 25°C unless otherwise noted

| Symbol | Parameter | | FCP11N60 | FCPF11N60 | Units |
|---|---|---|---|---|---|
| $I_D$ | Drain Current - Continuous ($T_C$ = 25°C) | | 11 | 11* | A |
| | - Continuous ($T_C$ = 100°C) | | 7 | 7* | A |
| $I_{DM}$ | Drain Current - Pulsed | (Note 1) | 33 | 33* | A |
| $V_{GSS}$ | Gate-Source Voltage | | ± 30 | | V |
| $E_{AS}$ | Single Pulsed Avalanche Energy | (Note 2) | 340 | | mJ |
| $I_{AR}$ | Avalanche Current | (Note 1) | 11 | | A |
| $E_{AR}$ | Repetitive Avalanche Energy | (Note 1) | 12.5 | | mJ |
| dv/dt | Peak Diode Recovery dv/dt | (Note 3) | 4.5 | | V/ns |
| $P_D$ | Power Dissipation ($T_C$ = 25°C) | | 125 | 36 | W |
| | - Derate above 25°C | | 1.0 | 0.29 | W/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | -55 to +150 | | °C |
| $T_L$ | Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds | | 300 | | °C |

* Drain current limited by maximum junction termperature

## Thermal Characteristics

| Symbol | Parameter | FCP11N60 | FCPF11N60 | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | 1.0 | 3.5 | °C/W |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink | 0.5 | -- | °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 |
|---|---|---|---|---|---|---|
| FCP11N60 | FCP11N60 | TO-220 | Tube | N/A | N/A | 50 units |
| FCPF11N60 | FCPF11N60 | TO-220F | Tube | N/A | N/A | 50 units |
| FCPF11N60T | FCPF11N60T | TO-220F | Tube | N/A | N/A | 50 units |

## Electrical Characteristics

$T_C$ = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 250 μA, $T_J$ = 25°C | 600 | -- | -- | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 250 μA, $T_J$ = 150°C | -- | 650 | -- | V |
| $\Delta BV_{DSS}$ / $\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250 μA, Referenced to 25°C | -- | 0.6 | -- | V/°C |
| $BV_{DS}$ | Drain-Source Avalanche Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 11 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°C | -- | -- | 10 | μA |
| $I_{GSSF}$ | Gate-Body Leakage Current, Forward | $V_{GS}$ = 30 V, $V_{DS}$ = 0 V | -- | -- | 100 | nA |
| $I_{GSSR}$ | Gate-Body Leakage Current, Reverse | $V_{GS}$ = -30 V, $V_{DS}$ = 0 V | -- | -- | -100 | nA |
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | 3.0 | -- | 5.0 | V |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS}$ = 10 V, $I_D$ = 5.5 A | -- | 0.32 | 0.38 | Ω |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 40 V, $I_D$ = 5.5 A (Note 4) | -- | 9.7 | -- | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1.0 MHz | -- | 1148 | 1490 | pF |
| $C_{oss}$ | Output Capacitance | | -- | 671 | 870 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | -- | 63 | 82 | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 480 V, $V_{GS}$ = 0 V, f = 1.0 MHz | -- | 35 | -- | pF |
| $C_{oss}$ eff. | Effective Output Capacitance | $V_{DS}$ = 0V to 480 V, $V_{GS}$ = 0 V | -- | 95 | -- | pF |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 300 V, $I_D$ = 11 A, $R_G$ = 25 Ω (Note 4, 5) | -- | 34 | 80 | ns |
| $t_r$ | Turn-On Rise Time | | -- | 98 | 205 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | -- | 119 | 250 | ns |
| $t_f$ | Turn-Off Fall Time | | -- | 56 | 120 | ns |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = 480 V, $I_D$ = 11 A, $V_{GS}$ = 10 V (Note 4, 5) | -- | 40 | 52 | nC |
| $Q_{gs}$ | Gate-Source Charge | | -- | 7.2 | -- | nC |
| $Q_{gd}$ | Gate-Drain Charge | | -- | 21 | -- | nC |
| **Drain-Source Diode Characteristics and Maximum Ratings** | | | | | | |
| $I_S$ | Maximum Continuous Drain-Source Diode Forward Current | | -- | -- | 11 | A |
| $I_{SM}$ | Maximum Pulsed Drain-Source Diode Forward Current | | -- | -- | 33 | A |
| $V_{SD}$ | Drain-Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 11 A | -- | -- | 1.4 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_S$ = 11 A, $dI_F$ / dt = 100 A/μs (Note 4) | -- | 390 | -- | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | -- | 5.7 | -- | μC |

**Notes:**
1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. $I_{AS}$ = 5.5A, $V_{DD}$ = 50V, $R_G$ = 25 Ω, Starting $T_J$ = 25°C
3. $I_{SD}$ ≤ 11A, di/dt ≤ 200A/μs, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25°C
4. Pulse Test : Pulse width ≤ 300μs, Duty cycle ≤ 2%
5. Essentially independent of operating temperature

## Typical Characteristics

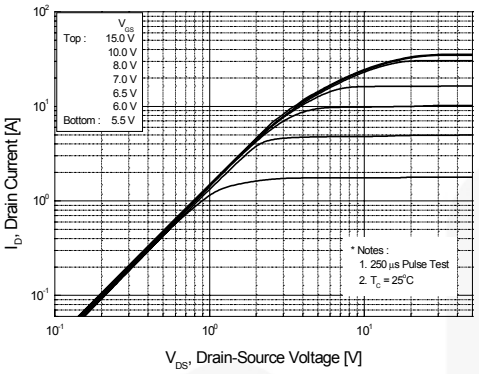



**Figure 1. On-Region Characteristics**

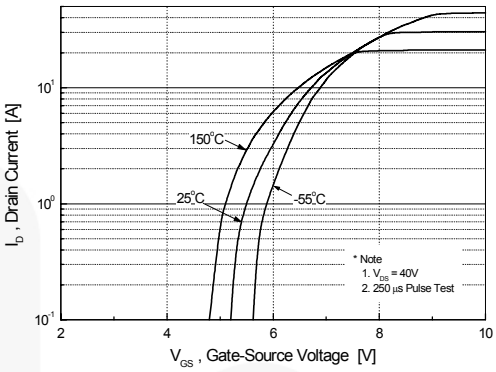



**Figure 2. Transfer Characteristics**

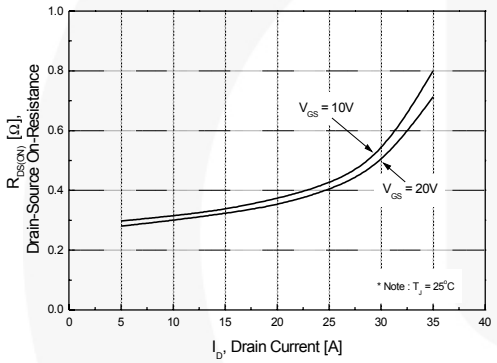



**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**

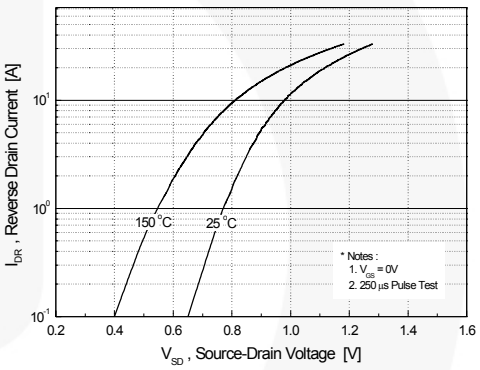



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**

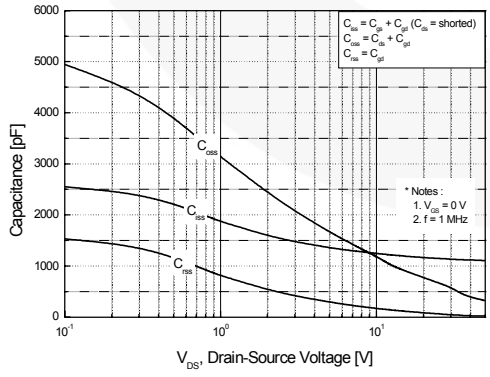



**Figure 5. Capacitance Characteristics**

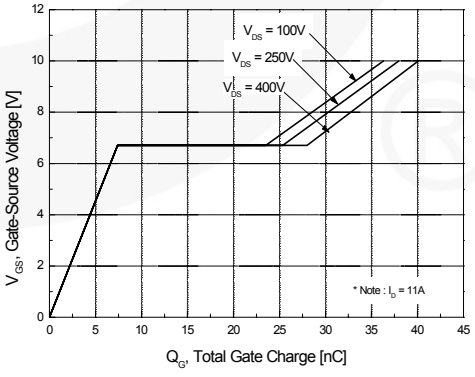



**Figure 6. Gate Charge Characteristics**

## Typical Characteristics (Continued)

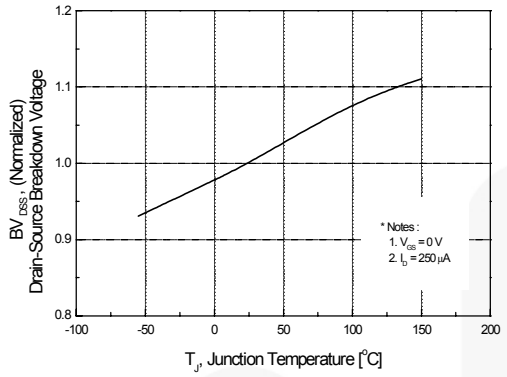



**Figure 7. Breakdown Voltage Variation vs. Temperature**

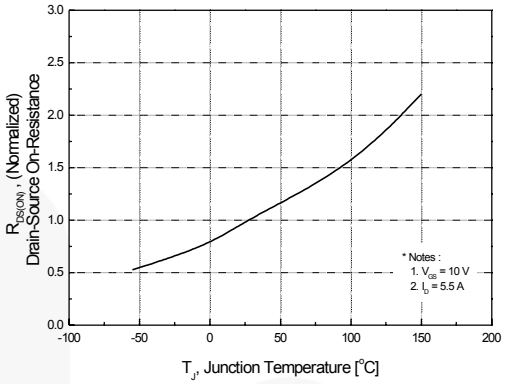



**Figure 8. On-Resistance Variation vs. Temperature**

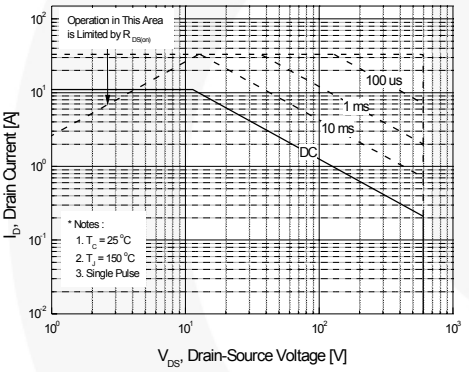



**Figure 9-1. Maximum Safe Operating Area for FCP11N60**

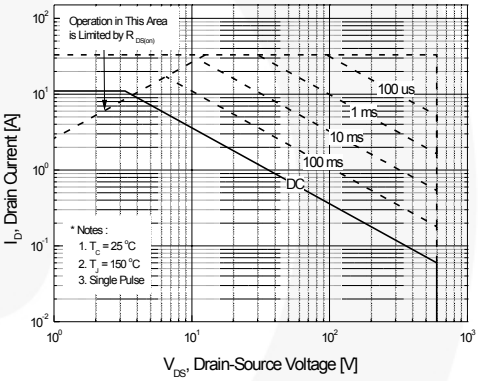



**Figure 9-2. Maximum Safe Operating Area for FCPF11N60**

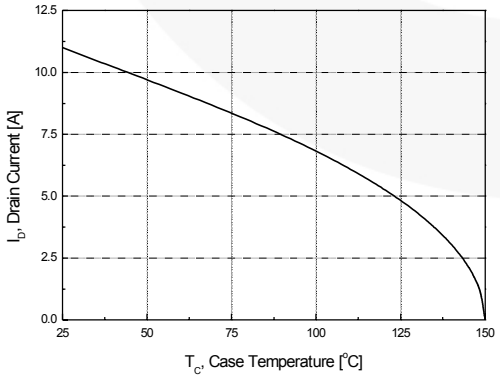



**Figure 10. Maximum Drain Current vs. Case Temperature**

## Typical Characteristics (Continued)

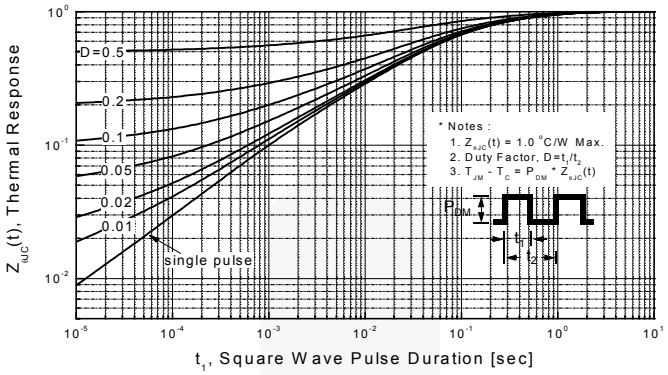



**Figure 11-1. Transient Thermal Response Curve for FCP11N60**

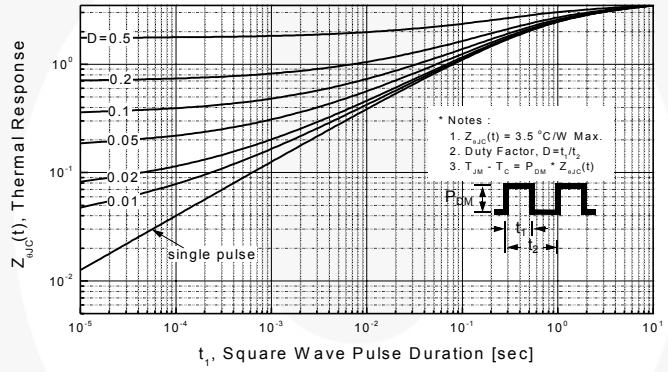



**Figure 11-2. Transient Thermal Response Curve for FCPF11N60**

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

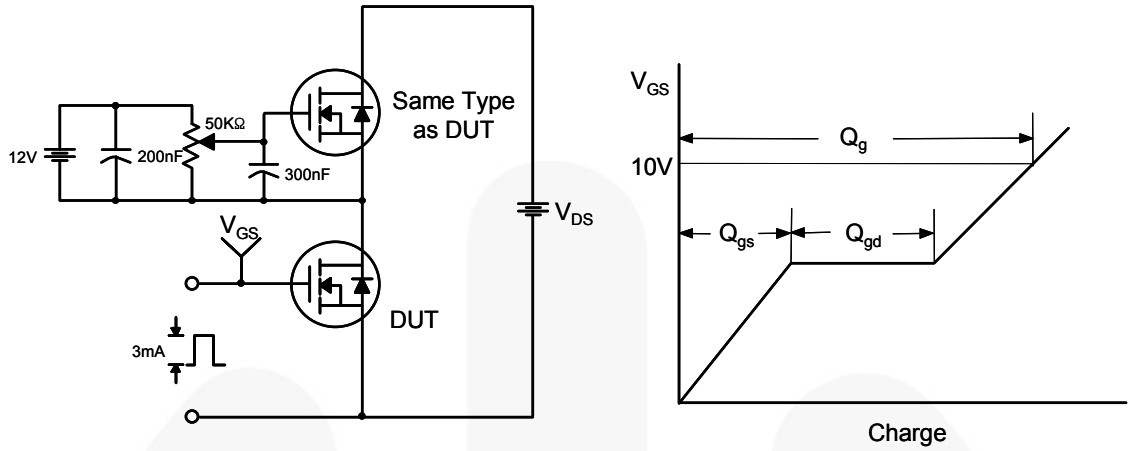



**Figure 13. Resistive Switching Test Circuit & Waveforms**

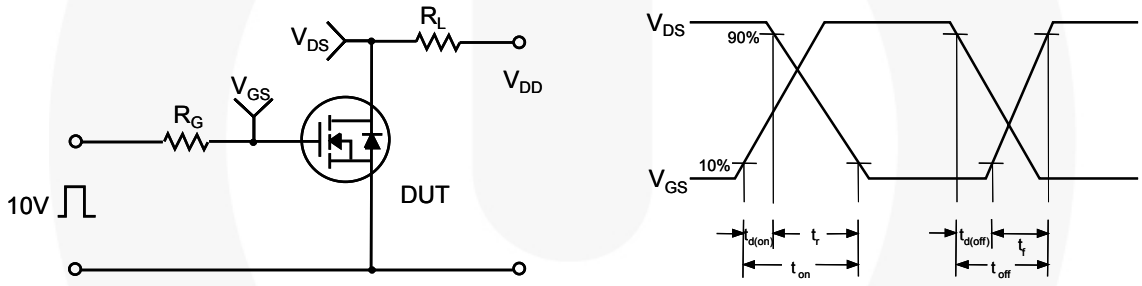



**Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms**

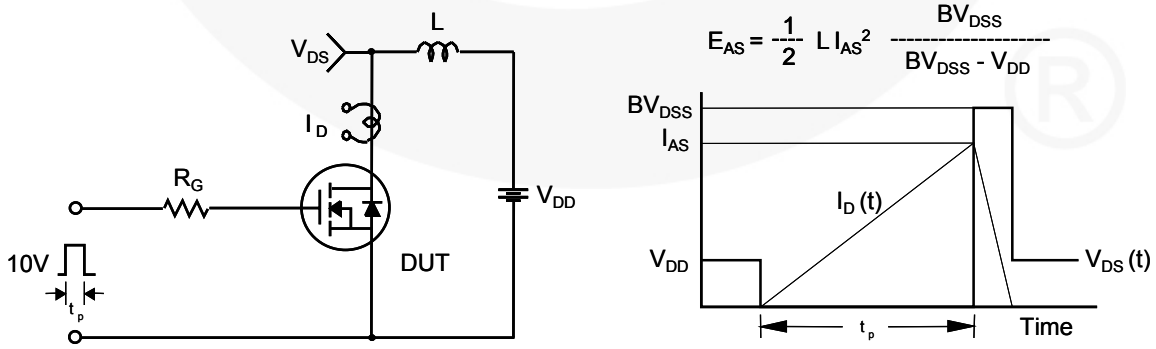
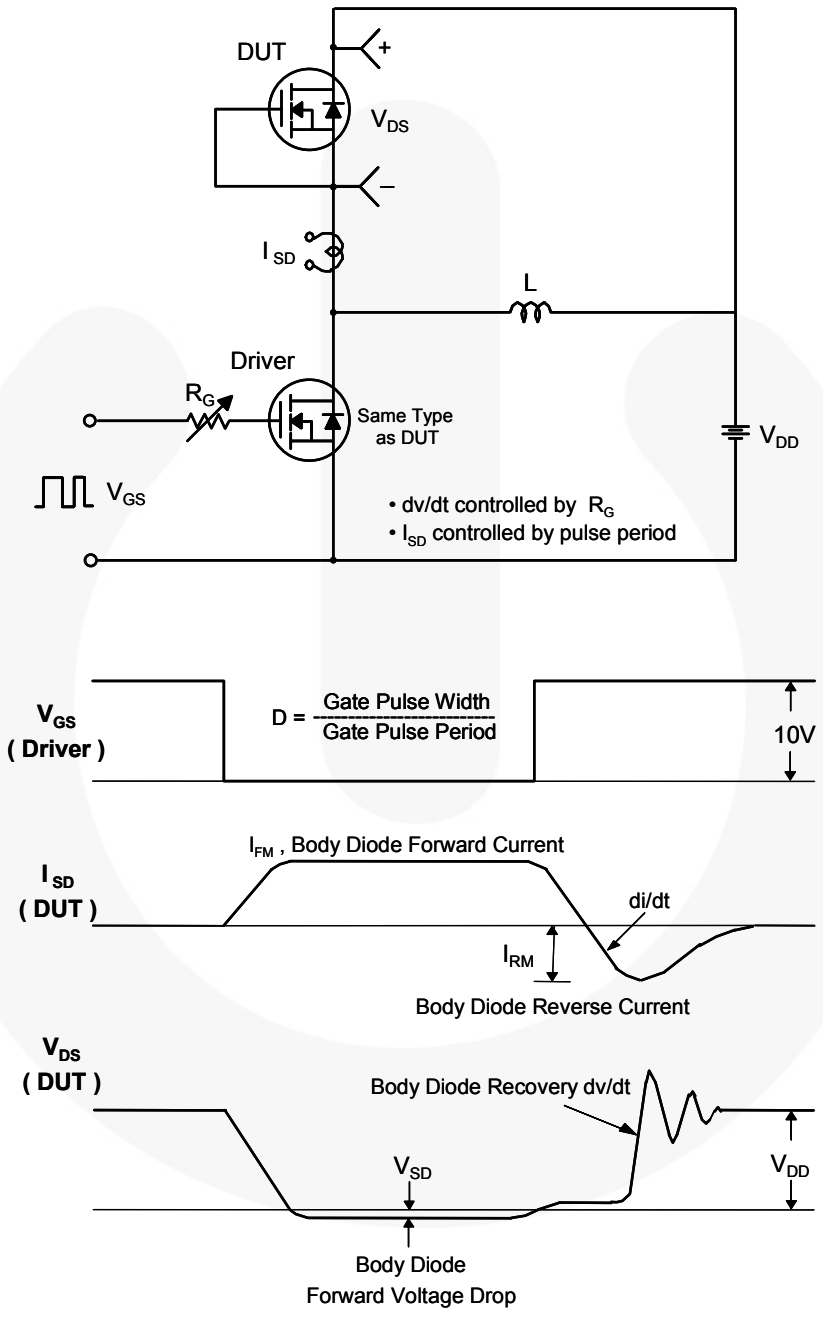
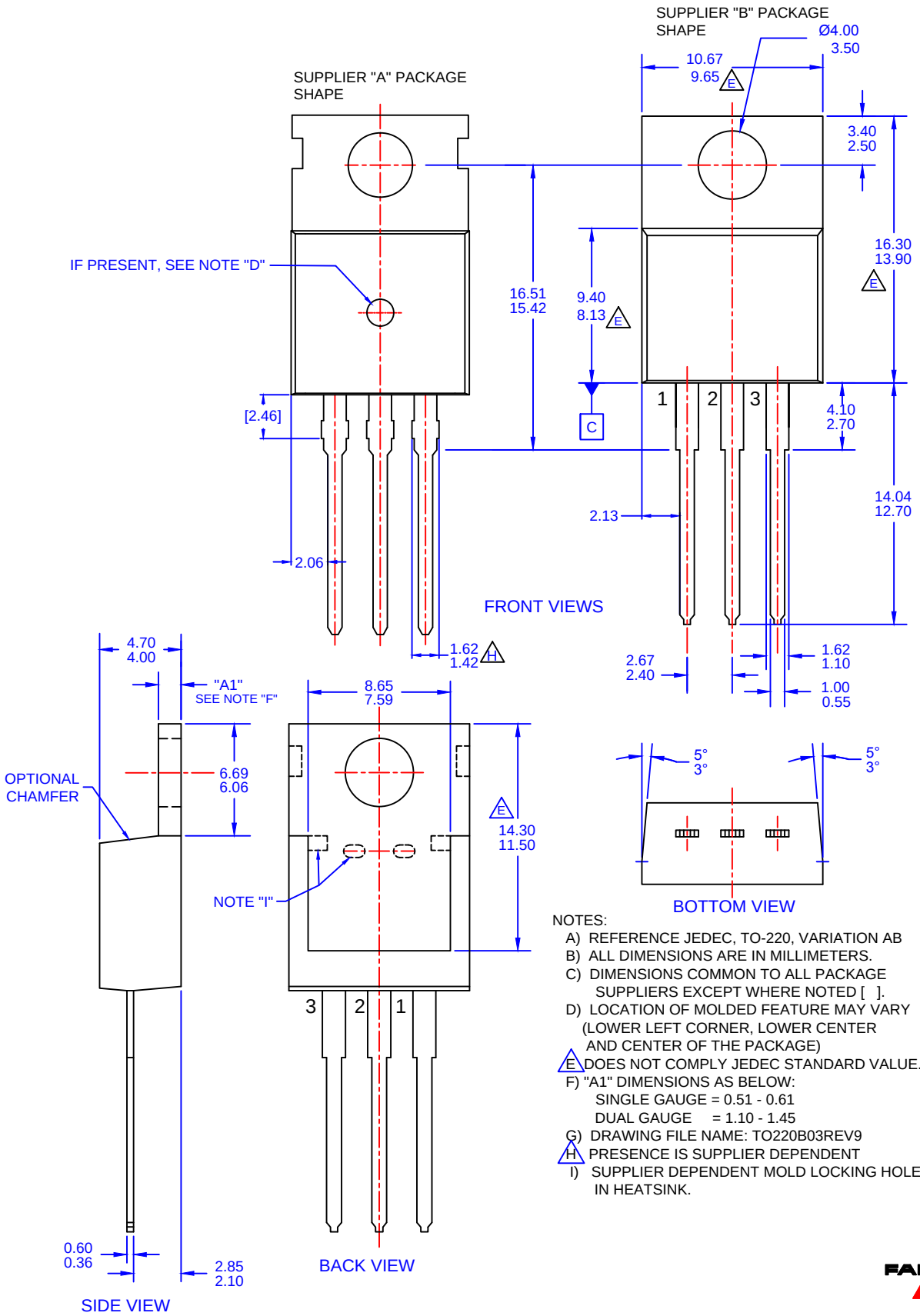


**Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

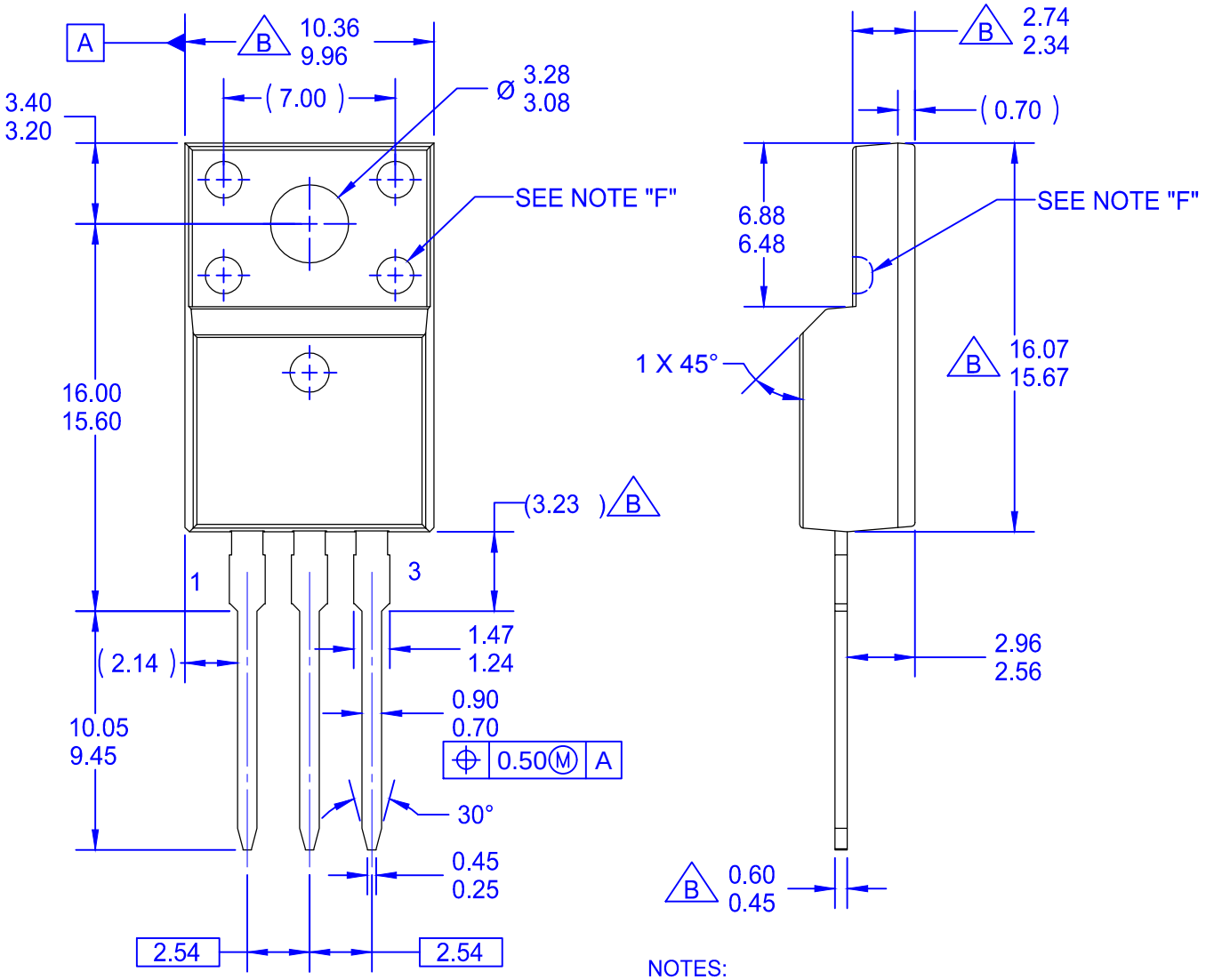





NOTES:

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: TO220B03REV9
H PRESENCE IS SUPPLIER DEPENDENT
I) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.

FAIRCHILD




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: TO220M03REV4

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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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