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FAIRCHILD SEMICONDUCTOR®

December 2013

# FCP36N60N / FCPF36N60NT

## N-Channel SupreMOS® MOSFET

### 600 V, 36 A, 90 mΩ

## Features

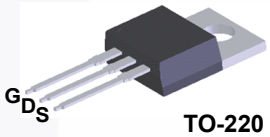
- $R_{DS(on)}$ = 81 mΩ (Typ.) @ $V_{GS}$ = 10 V, $I_D$ = 18 A
- Ultra Low Gate Charge (Typ. $Q_g$ = 86 nC)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 361 pF)
- 100% Avalanche Tested
- RoHS Compliant

## Application

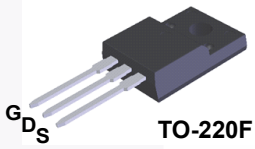
- Solar Inverter
- AC-DC Power Supply

## Description

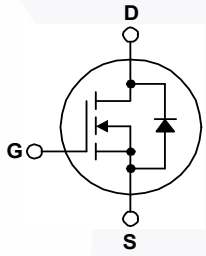
The SupreMOS® MOSFET is Fairchild Semiconductor's next generation of high voltage super-junction (SJ) technology employing a deep trench filling process that differentiates it from the conventional SJ MOSFETs. This advanced technology and precise process control provides lowest Rsp on-resistance, superior 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




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

| Symbol | Parameter | | | FCP36N60N | FCPF36N60NT | 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) | | 36 | 36* | A |
| | | - Continuous ($T_C$ = 100°C) | | 22.7 | 22.7* | |
| $I_{DM}$ | Drain Current | - Pulsed | (Note 1) | 108 | 108* | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy | | (Note 2) | 1800 | | mJ |
| $I_{AR}$ | Avalanche Current | | (Note 1) | 12 | | A |
| $E_{AR}$ | Repetitive Avalanche Energy | | (Note 1) | 3.12 | | mJ |
| dv/dt | MOSFET dv/dt | | | 100 | | V/ns |
| | Peak Diode Recovery dv/dt | | (Note 3) | 20 | | |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | | 312 | | W |
| | | - Derate Above 25°C | | 2.6 | | 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 | FCP36N60N | FCPF36N60NT | Unit |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max. | 0.4 | 3.5 | °C/W |
| $R_{\theta CS}$ | Thermal Resistance, Case to Heat Sink, Typ. | 0.5 | 0.5 | |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5 | 62.5 | |

## Package Marking and Ordering Information

| Part Number | Top Mark | Package | Packing Method | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|---|
| FCP36N60N | FCP36N60N | TO-220 | Tube | N/A | N/A | 50 units |
| FCPF36N60NT | FCPF36N60NT | 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 | $I_D$ = 1 mA, $V_{GS}$ = 0 V, $T_C = 25^oC$ | 600 | - | - | V |
| $\Delta BV_{DSS}$ / $\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 1 mA, Referenced to $25^oC$ | - | 0.7 | - | $V/^oC$ |
| $I_{DSS}$ | 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, $I_D$ = 18 A | - | 81 | 90 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 20 V, $I_D$ = 18 A | - | 41 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 100 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 3595 | 4785 | pF |
| $C_{oss}$ | Output Capacitance | | - | 149 | 200 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 4 | 6 | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 380 V, $V_{GS}$ = 0V, f = 1 MHz | - | 80 | - | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS}$ = 0 V to 380 V, $V_{GS}$ = 0 V | - | 361 | - | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS}$ = 380 V, $I_D$ = 18 A, $V_{GS}$ = 10 V (Note 4) | - | 86 | 112 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 15.4 | - | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 26.4 | - | nC |
| ESR | Equivalent Series Resistance | f = 1 MHz | - | 1 | - | Ω |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 380 V, $I_D$ = 18 A, $V_{GS}$ = 10 V, $R_G$ = 4.7 Ω (Note 4) | - | 23 | 56 | ns |
| $t_r$ | Turn-On Rise Time | | - | 22 | 54 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 94 | 198 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 4 | 18 | ns |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 18 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 108 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 18 A | - | - | 1.2 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 18 A, $dI_F/dt$ = 100 A/µs | - | 574 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 10 | - | µC |

**Notes:**

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2. $I_{AS}$ = 12 A, $R_G$ = 25 Ω, starting $T_J$ = 25°C.
3. $I_{SD} \le$ 36 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**

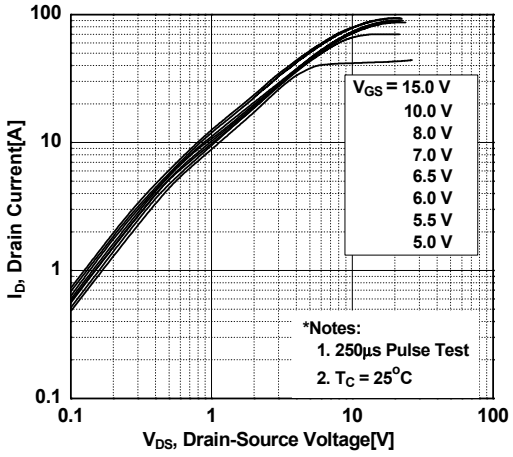



**Figure 2. Transfer Characteristics**

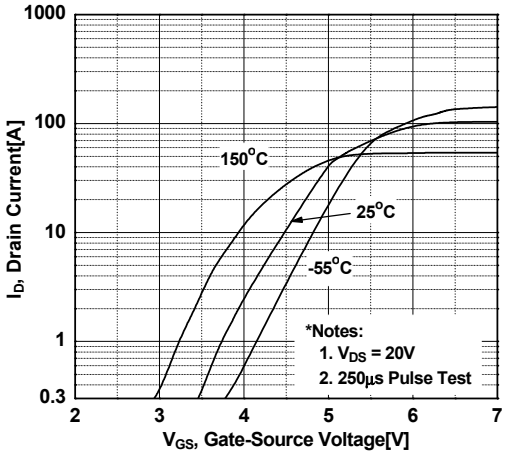



**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**

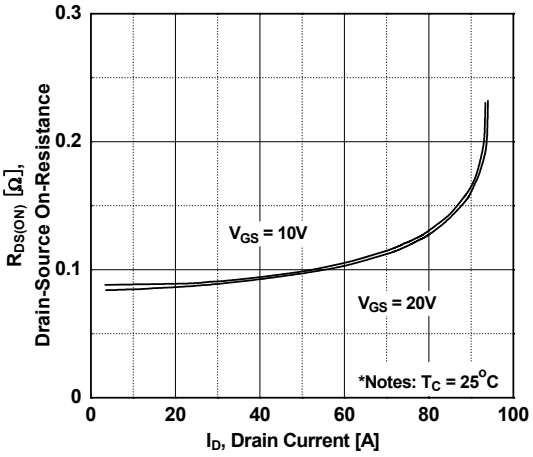



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**

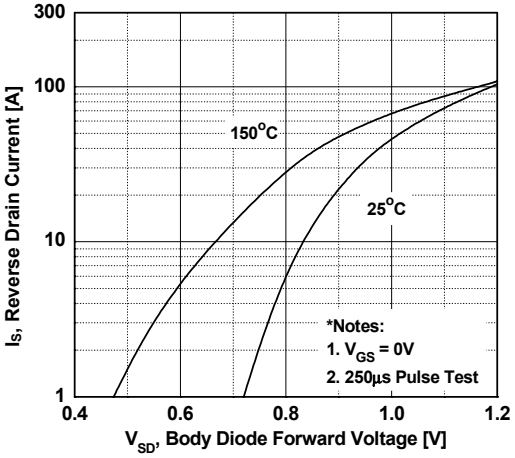



**Figure 5. Capacitance Characteristics**

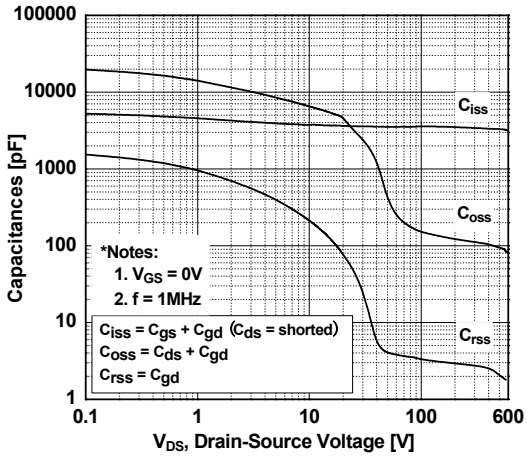
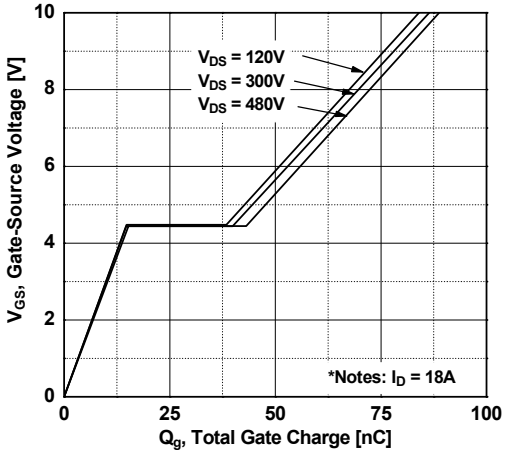



**Figure 6. Gate Charge Characteristics**



## Typical Performance Characteristics (Continued)

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

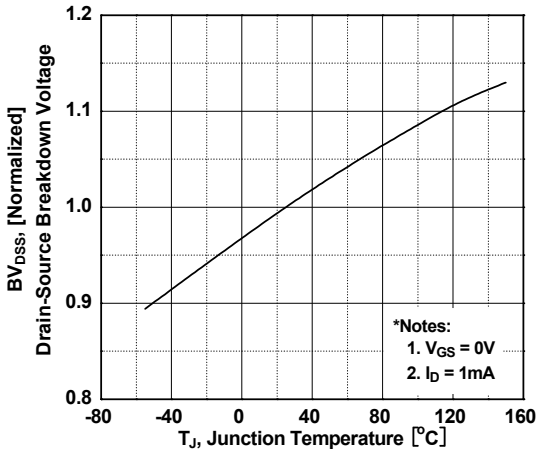



**Figure 8. On-Resistance Variation vs. Temperature**

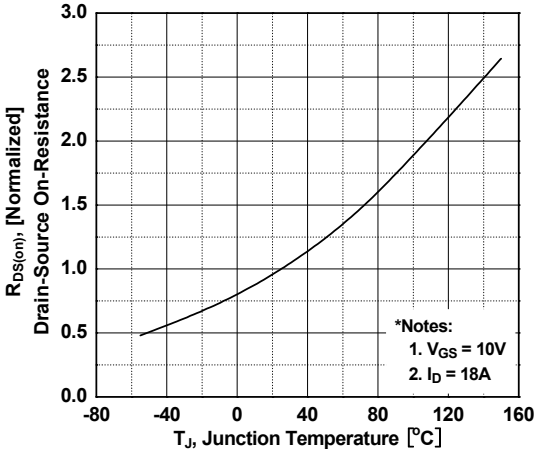



**Figure 9. Maximum Safe Operating Area for FCP36N60N**

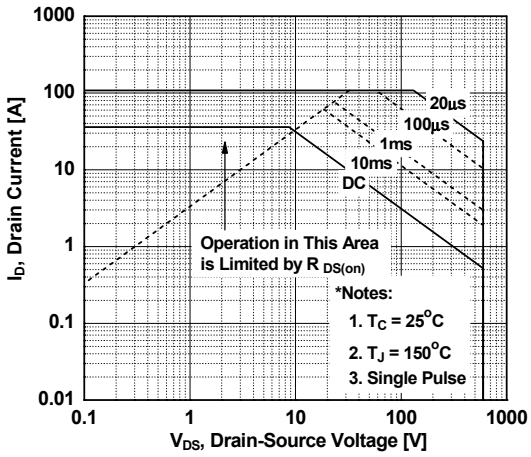



**Figure 10. Maximum Safe Operating Area for FCPF36N60NT**

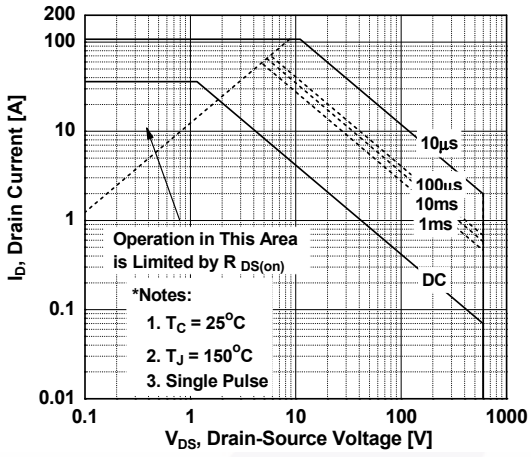
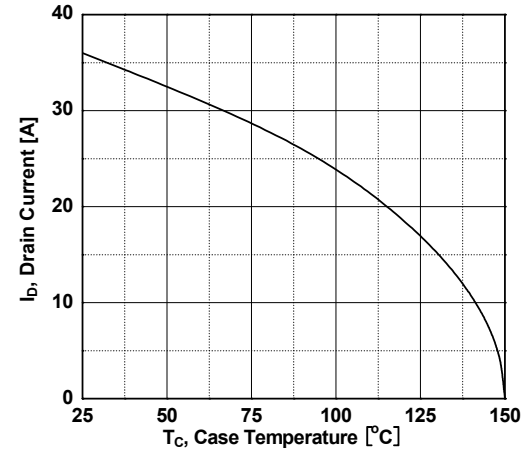



**Figure 11. Maximum Drain Current vs. Case Temperature**



## Typical Performance Characteristics (Continued)

**Figure 12. Transient Thermal Response Curve for FCP36N60N**

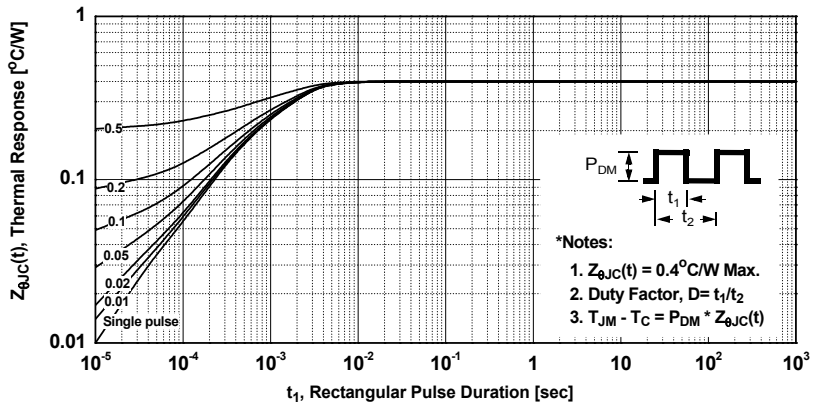
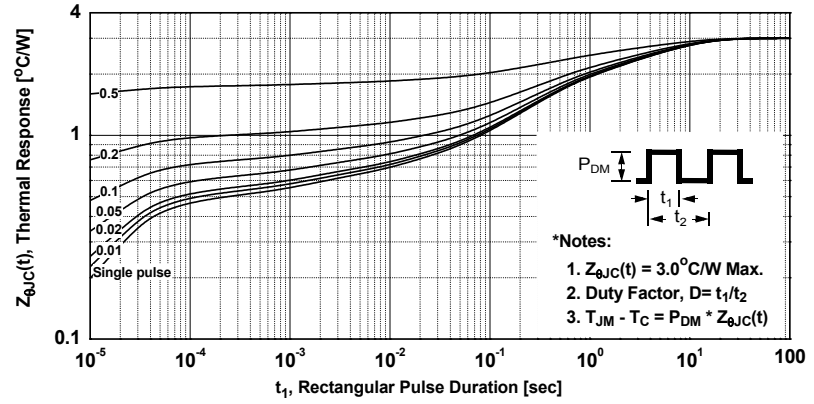



**Figure 13. Transient Thermal Response Curve for FCPF36N60NT**



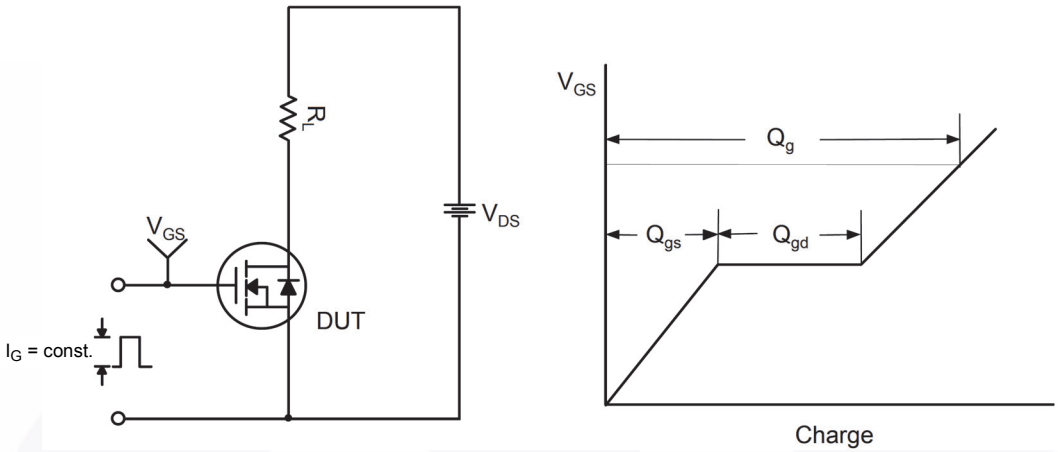



**Figure 14. Gate Charge Test Circuit & Waveform**

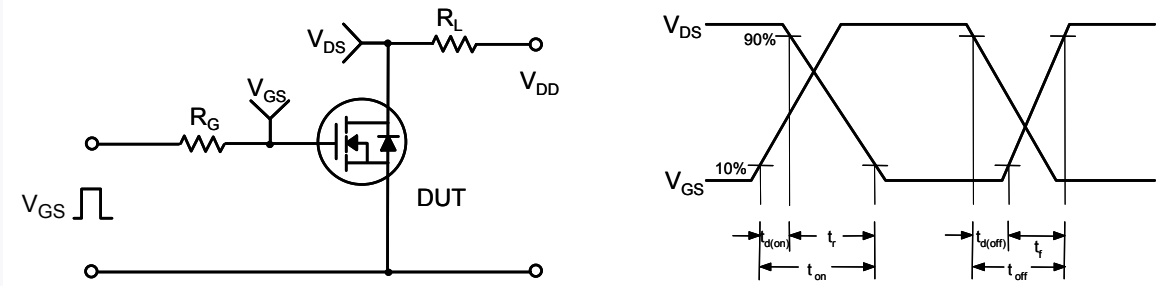



**Figure 15. Resistive Switching Test Circuit & Waveforms**

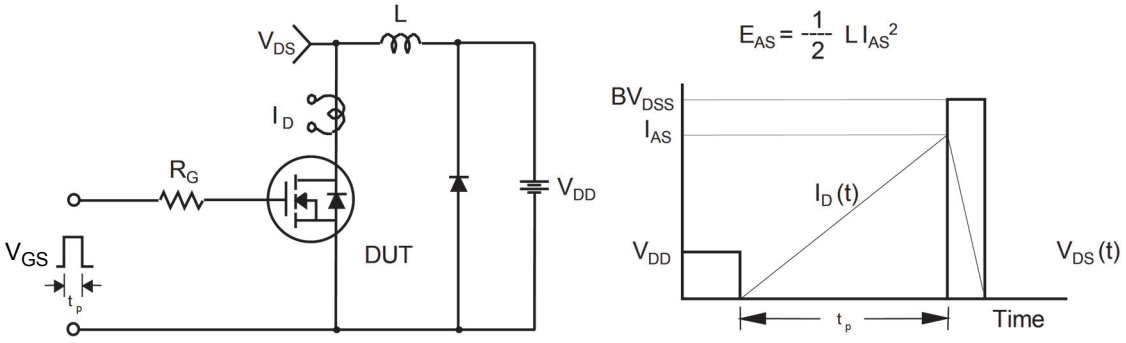



**Figure 16. Unclamped Inductive Switching Test Circuit & Waveforms**

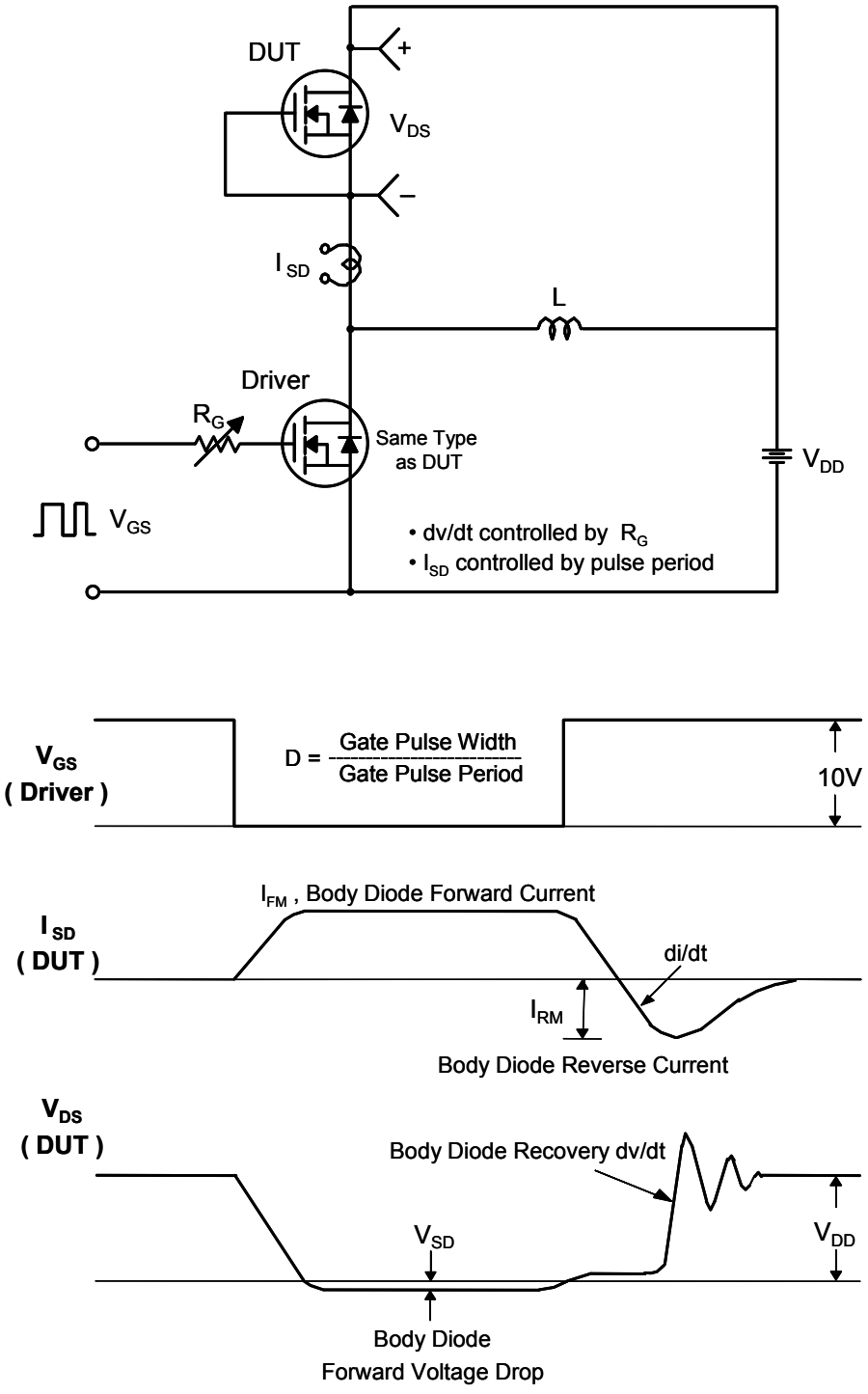



**Figure 17. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

## Mechanical Dimensions

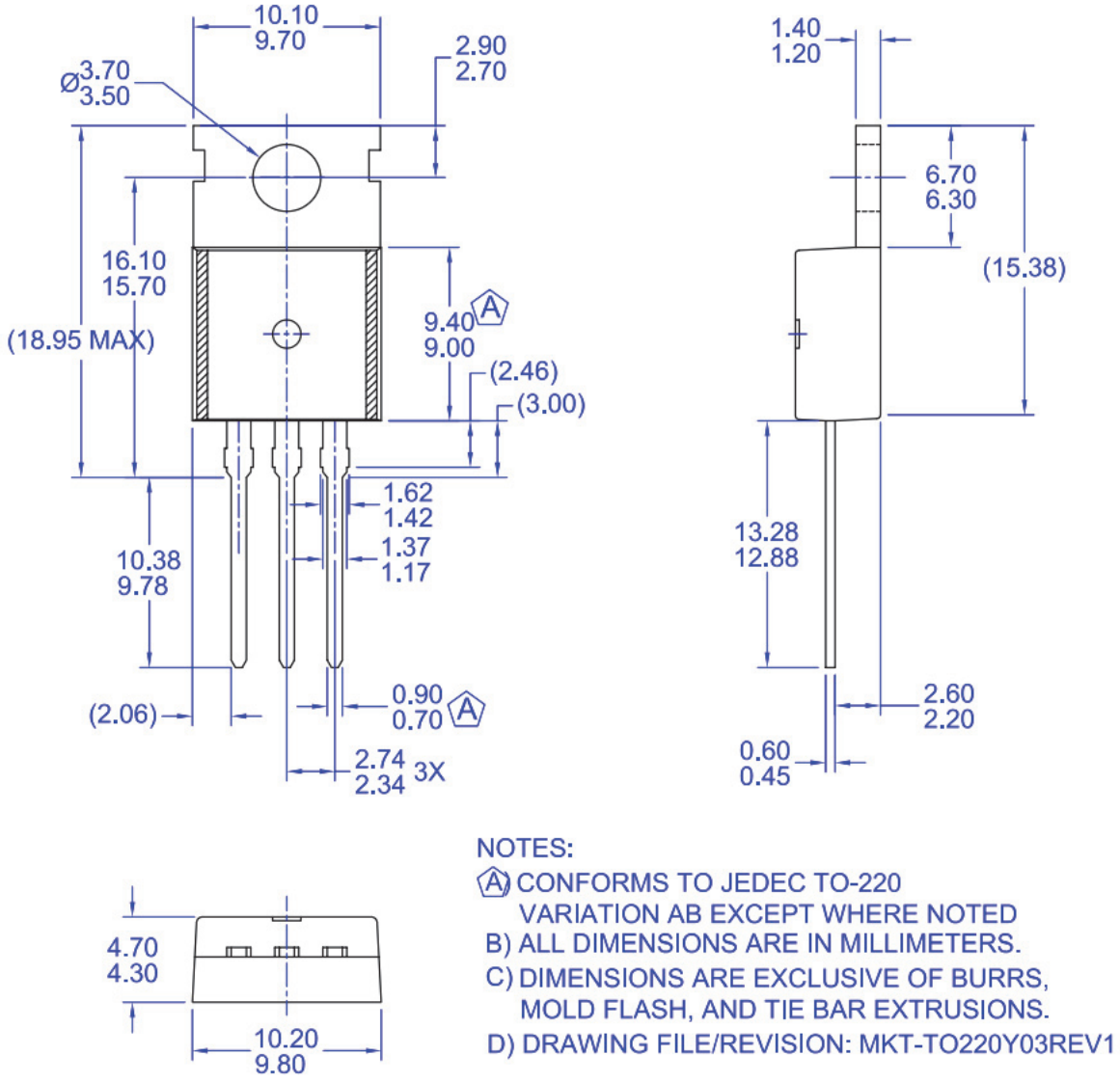



**Figure 18. TO220, Molded, 3-Lead, Non Jedec Variation AB**

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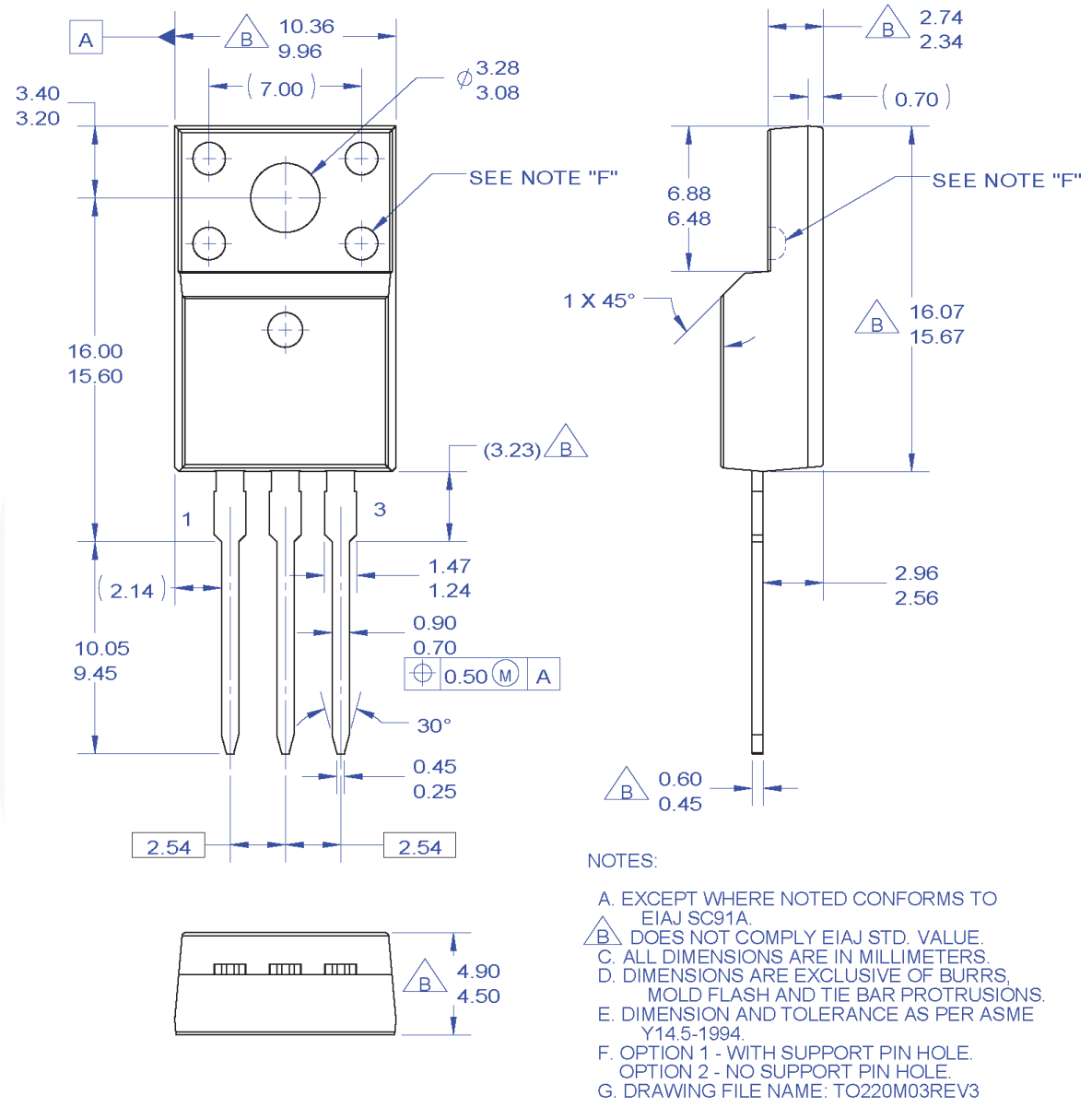


**Figure 19. TO220, Molded, 3-Lead, Full Pack, EIAJ SC91, Straight Lead**

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| 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. I66

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