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December 2014

# FCPF190N65FL1

## N-Channel SuperFET® II FRFET® MOSFET

### 650 V, 20.6 A, 190 mΩ

## Features

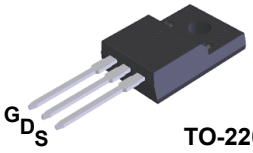
- 700 V @$T_J$ = 150°C
- $R_{DS(on)}$ = 168 mΩ (Typ.)
- Ultra Low Gate Charge (Typ. $Q_g$ = 60 nC)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)}$ = 304 pF)
- 100% Avalanche Tested
- RoHS Compliant

## Applications

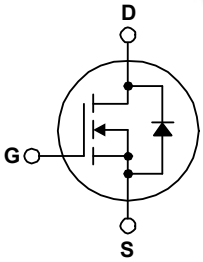
- LCD / LED / PDP TV
- Telecom / Server Power Supplies
- Solar Inverter
- AC - DC Power Supply

## Description

SuperFET® II MOSFET is Fairchild Semiconductor's brand-new 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 II MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications. SuperFET II FRFET® MOSFET's optimized body diode reverse recovery performance can remove additional component and improve system reliability.




TO-220F




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

| Symbol | Parameter | | FCPF190N65FL1 | Unit |
|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 650 | V |
| $V_{GSS}$ | Gate to Source Voltage | - DC | ±20 | V |
| | | - AC (f > 1 Hz) | ±30 | |
| $I_D$ | Drain Current | - Continuous ($T_C$ = 25°C) | 20.6 | A |
| | | - Continuous ($T_C$ = 100°C) | 13.1 | |
| $I_{DM}$ | Drain Current | - Pulsed (Note 1) | 61.8 | A |
| $E_{AS}$ | Single Pulsed Avalanche Energy | (Note 2) | 400 | mJ |
| $I_{AR}$ | Avalanche Current | (Note 1) | 4 | A |
| $E_{AR}$ | Repetitive Avalanche Energy | (Note 1) | 0.39 | mJ |
| dv/dt | MOSFET dv/dt | | 100 | V/ns |
| | Peak Diode Recovery dv/dt | (Note 3) | 50 | |
| $P_D$ | Power Dissipation | ($T_C$ = 25°C) | 39 | W |
| | | - Derate Above 25°C | 0.31 | 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 |

## Thermal Characteristics

| Symbol | Parameter | FCPF190N65FL1 | Unit |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max. | 3.2 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5 | |

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## Package Marking and Ordering Information

| Part Number | Top Mark | Package | Packing Method | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|---|
| FCPF190N65FL1 | FCPF190N65F | 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. | Unit |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 10 mA, $T_J$ = 25°C | 650 | - | - | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 10 mA, $T_J$ = 150°C | 700 | - | - | V |
| $\Delta BV_{DSS}$ / $\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 10 mA, Referenced to 25°C | - | 0.72 | - | V/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V | - | - | 10 | μA |
| | | $V_{DS}$ = 520 V, $V_{GS}$ = 0 V, $T_C$ = 125°C | - | 60 | - | |
| $I_{GSS}$ | Gate to Body Leakage Current | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | - | - | ±100 | μA |
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 2 mA | 3 | - | 5 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 10 V, $I_D$ = 10 A | - | 168 | 190 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 20 V, $I_D$ = 10 A | - | 18 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 100 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 2350 | 3055 | pF |
| $C_{oss}$ | Output Capacitance | | - | 77 | 100 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | - | 0.68 | - | pF |
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 380 V, $V_{GS}$ = 0 V, f = 1 MHz | - | 44 | - | pF |
| $C_{oss(eff.)}$ | Effective Output Capacitance | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | - | 304 | - | pF |
| $Q_{g(tot)}$ | Total Gate Charge at 10V | $V_{DS}$ = 380 V, $I_D$ = 10 A, $V_{GS}$ = 10 V (Note 4) | - | 60 | 78 | nC |
| $Q_{gs}$ | Gate to Source Gate Charge | | - | 12 | - | nC |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 25 | - | nC |
| ESR | Equivalent Series Resistance | f = 1 MHz | - | 0.6 | - | Ω |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 380 V, $I_D$ = 10 A, $V_{GS}$ = 10 V, $R_g$ = 4.7 Ω (Note 4) | - | 25 | 60 | ns |
| $t_r$ | Turn-On Rise Time | | - | 11 | 32 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 62 | 134 | ns |
| $t_f$ | Turn-Off Fall Time | | - | 4.2 | 18 | ns |
| **Drain-Source Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Drain to Source Diode Forward Current | | - | - | 20.6 | A |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current | | - | - | 61.8 | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 10 A | - | - | 1.2 | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$ = 0 V, $I_{SD}$ = 10 A, $dI_F/dt$ = 100 A/μs | - | 105 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 515 | - | nC |

**Notes:**

1. Repetitive rating: pulse width limited by maximum junction temperature.
2. $I_{AS}$ = 4 A, $R_G$ = 25 Ω, Starting $T_J$ = 25°C
3. $I_{SD}$ ≤ 10 A, di/dt ≤ 200 A/μs, $V_{DD}$ ≤ 380 V, Starting $T_J$ = 25°C
4. Essentially independent of operating temperature.

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## Typical Performance Characteristics

**Figure 1. On-Region Characteristics**

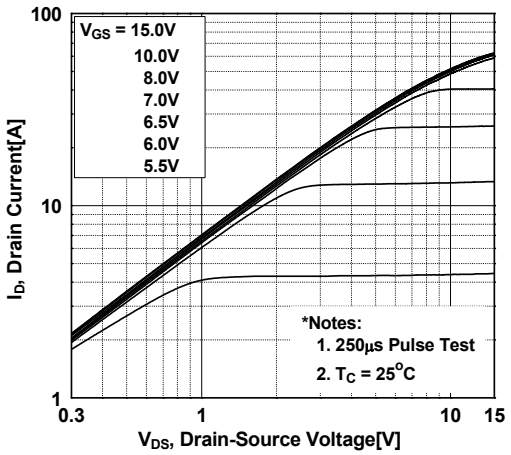



**Figure 2. Transfer Characteristics**

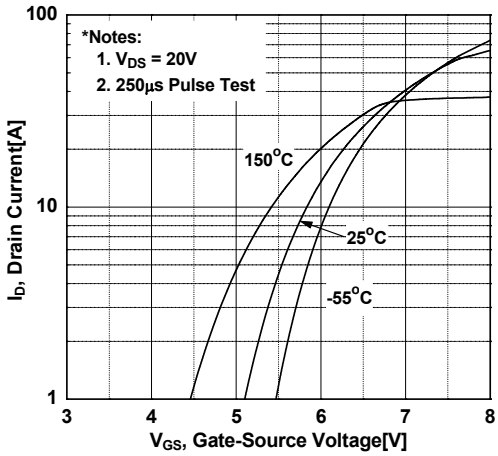



**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**

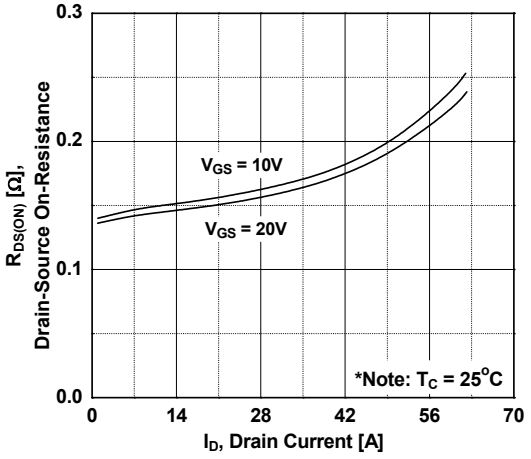



**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**

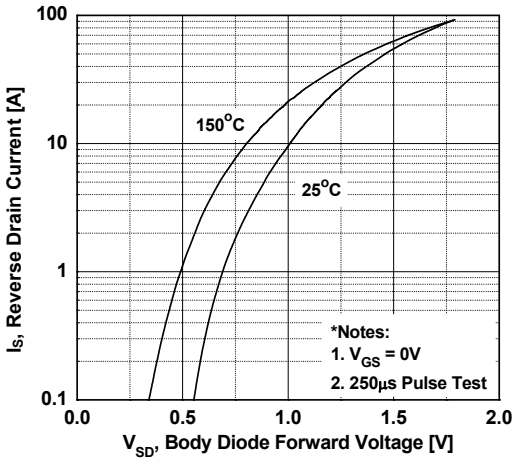



**Figure 5. Capacitance Characteristics**

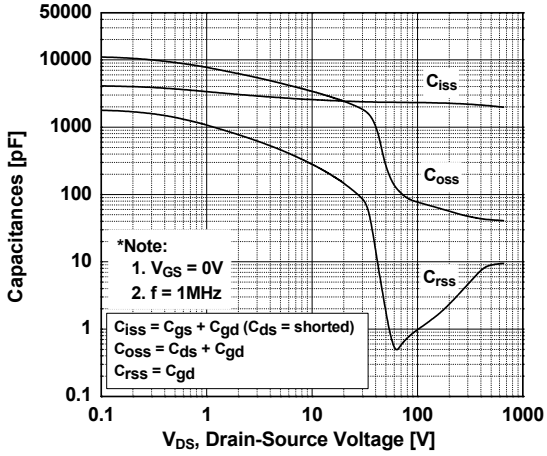
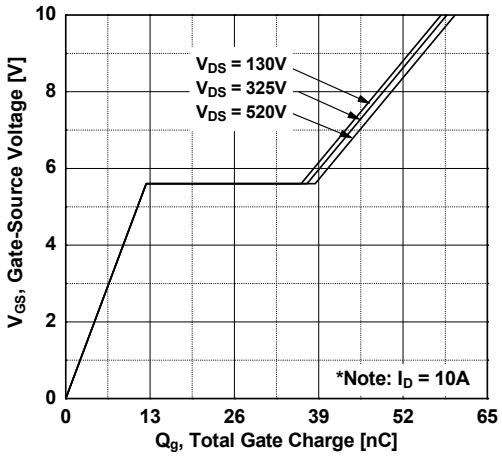



**Figure 6. Gate Charge Characteristics**



## Typical Performance Characteristics (Continued)

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

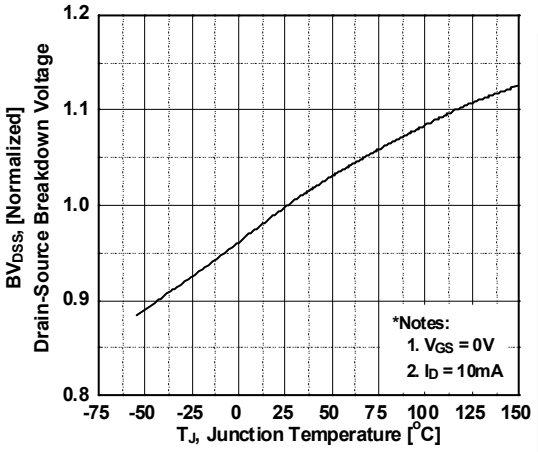



**Figure 8. On-Resistance Variation vs. Temperature**

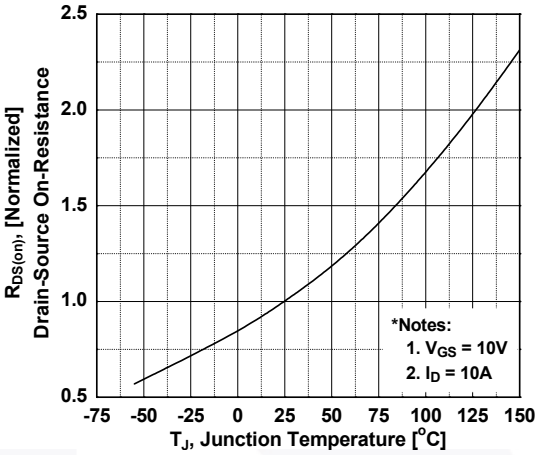



**Figure 9. Maximum Safe Operating Area**

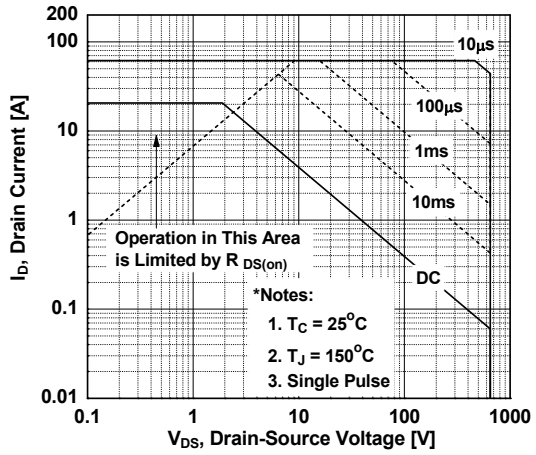



**Figure 10. Maximum Drain Current vs. Case Temperature**

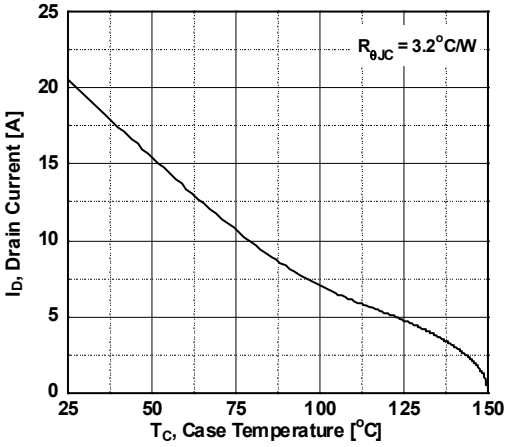
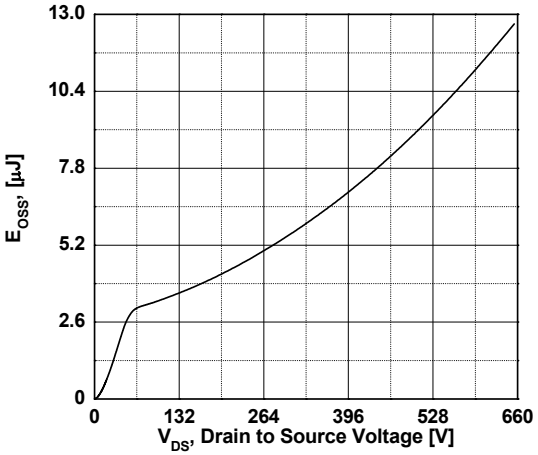
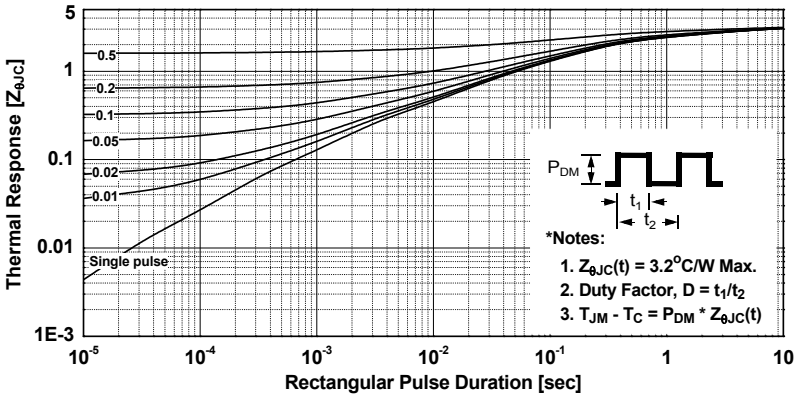



**Figure 11. Eoss vs. Drain to Source Voltage**



## Typical Performance Characteristics (Continued)

**Figure 12. Transient Thermal Response Curve**



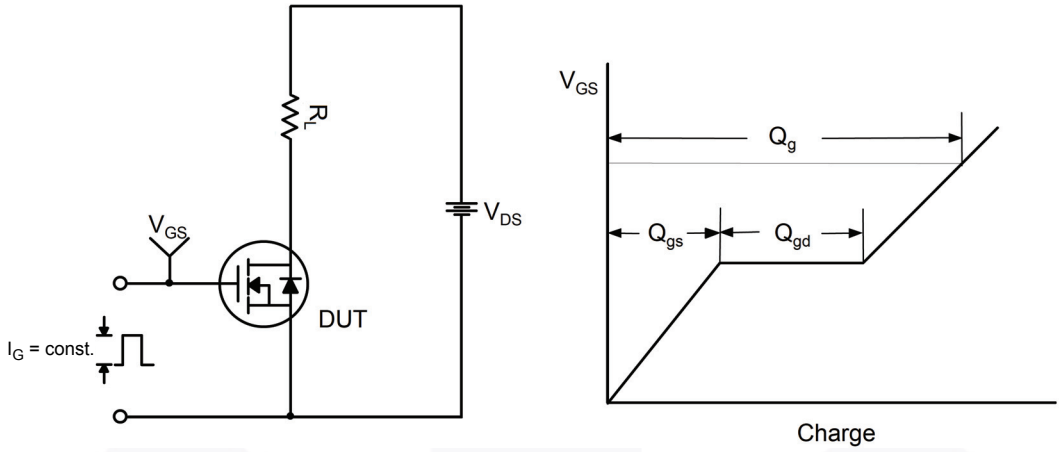



**Figure 13. Gate Charge Test Circuit & Waveform**

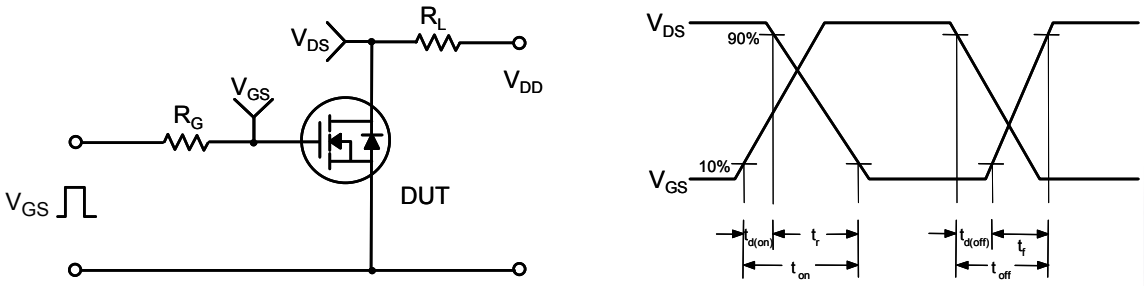



**Figure 14. Resistive Switching Test Circuit & Waveforms**

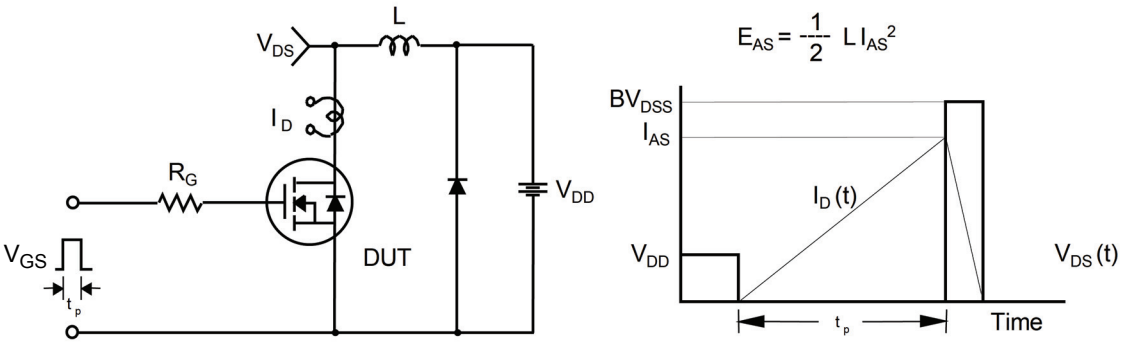



**Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms**

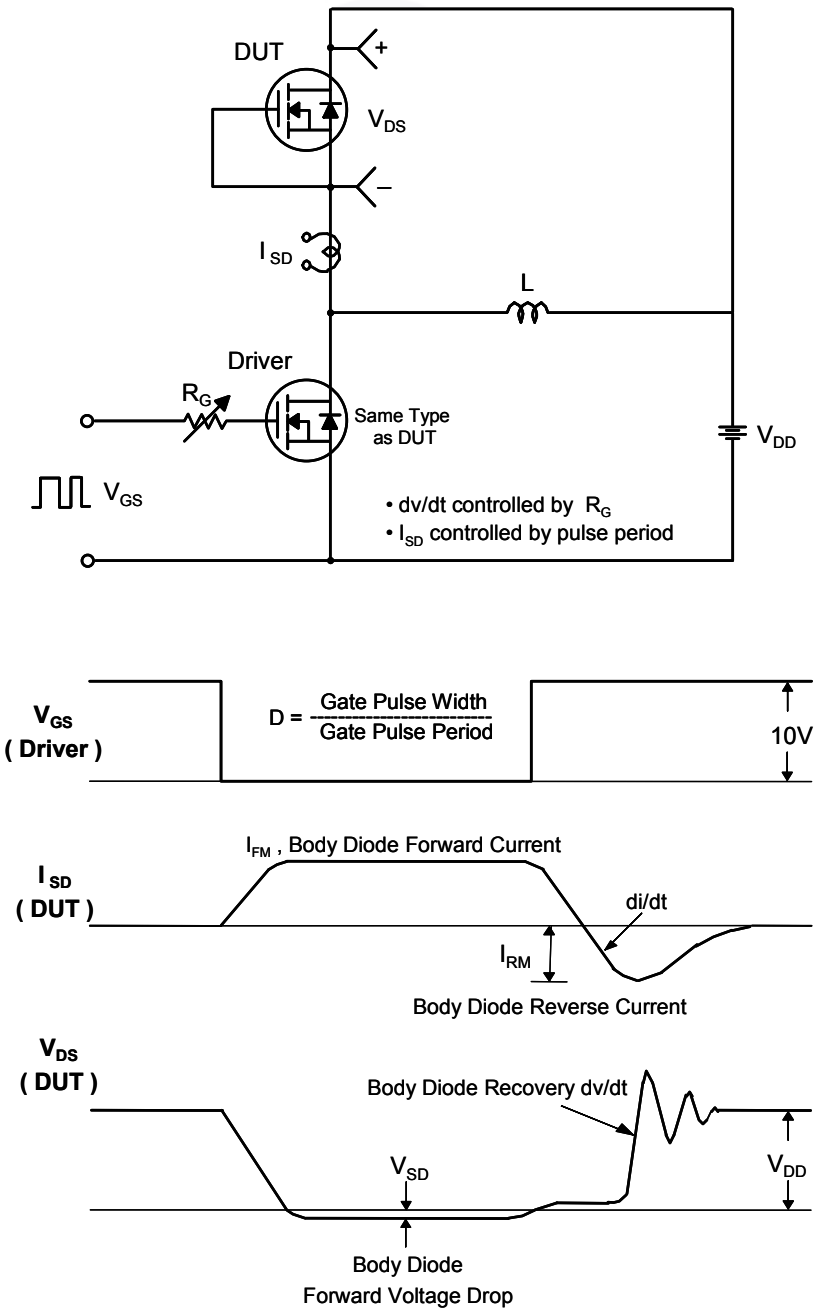



**Figure 16. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

## Mechanical Dimensions

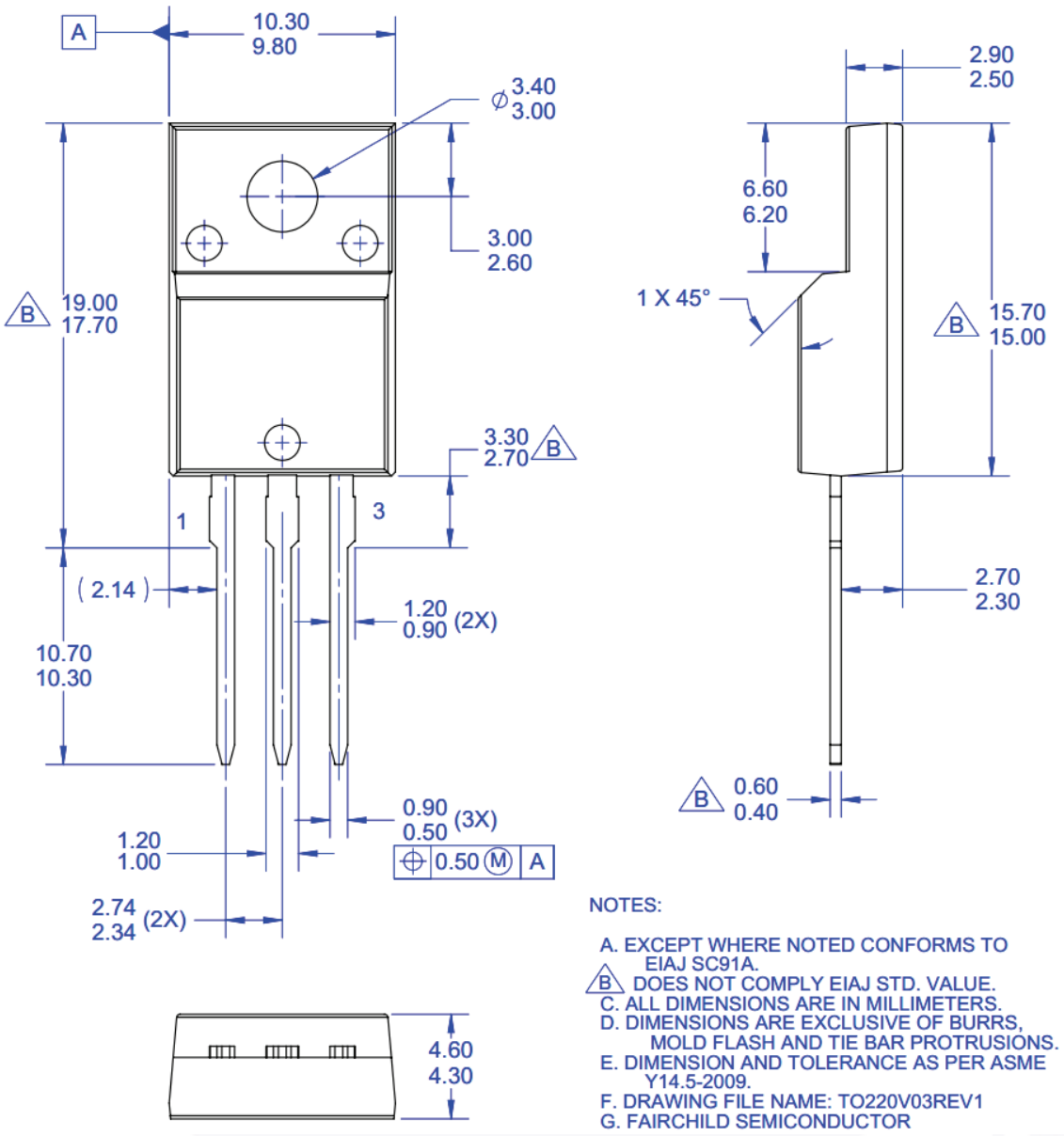



**Figure 17. TO220, Molded, 3LD, Full Pack, EIAJ SC91, Takcheong**

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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. |
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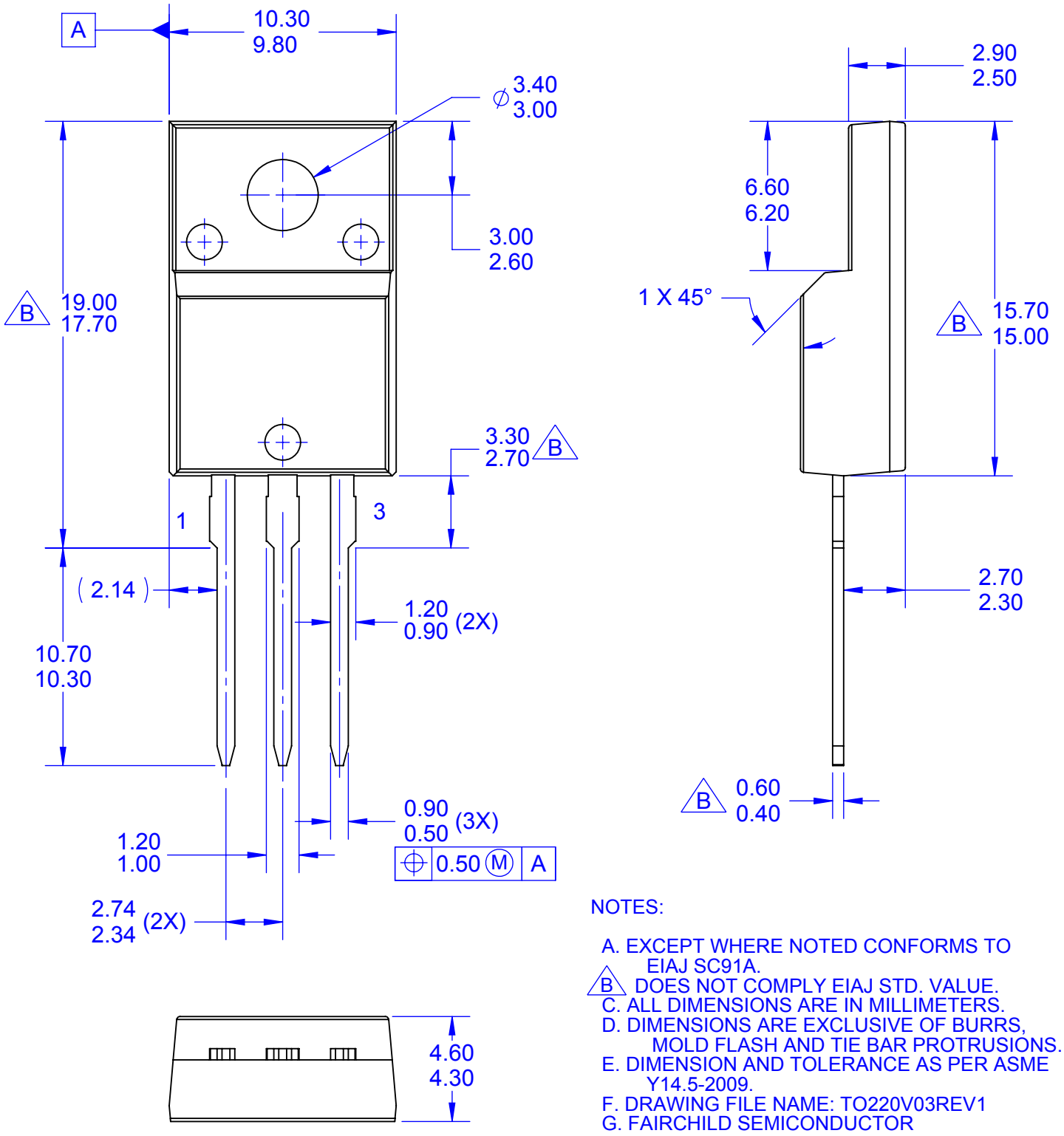
| Obsolete | Not In Production | Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only. |

Rev. I73




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 Y14.5-2009.
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