



August 2009  
SupreMOS™

## FCP9N60N / FCPF9N60NT

### N-Channel MOSFET

600V, 9A, 0.385Ω

#### Features

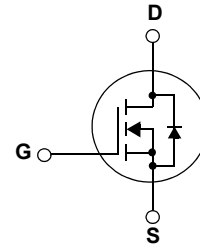
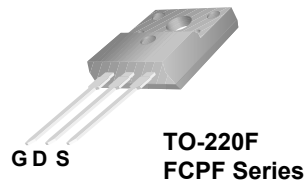
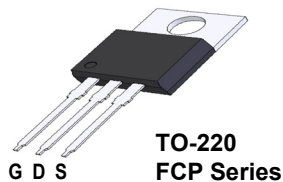
- $R_{DS(on)} = 0.33\Omega$  (Typ.) @  $V_{GS} = 10V$ ,  $I_D = 4.5A$
- Ultra low gate charge (Typ.  $Q_g = 22nC$ )
- Low effective output capacitance
- 100% avalanche tested
- RoHS compliant



#### Description

The SupreMOS MOSFET, Fairchild's next generation of high voltage super-junction MOSFETs, employs a deep trench filling process that differentiates it from preceding multi-epi based technologies. By utilizing this advanced technology and precise process control, SupreMOS provides world class  $R_{sp}$ , superior switching performance and ruggedness.

This SupreMOS MOSFET fits the industry's AC-DC SMPS requirements for PFC, server/telecom power, FPD TV power, ATX power, and industrial power applications.



#### MOSFET Maximum Ratings $T_C = 25^\circ C$ unless otherwise noted\*

| Symbol         | Parameter                                                                    | FCP9N60N                            | FCPF9N60NT | Units      |
|----------------|------------------------------------------------------------------------------|-------------------------------------|------------|------------|
| $V_{DSS}$      | Drain to Source Voltage                                                      | 600                                 |            | V          |
| $V_{GSS}$      | Gate to Source Voltage                                                       | ±30                                 |            | V          |
| $I_D$          | Drain Current                                                                | -Continuous ( $T_C = 25^\circ C$ )  | 9.0        | 9.0*       |
|                |                                                                              | -Continuous ( $T_C = 100^\circ C$ ) | 5.7        | 5.7*       |
| $I_{DM}$       | Drain Current                                                                | - Pulsed (Note 1)                   | 27         | 27*        |
| $E_{AS}$       | 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                                                            | ( $T_C = 25^\circ C$ )              | 83.3       | 29.8       |
|                |                                                                              | - Derate above $25^\circ C$         | 0.67       | 0.24       |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                      | -55 to +150                         |            | $^\circ C$ |
| $T_L$          | Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds | 300                                 |            | $^\circ C$ |

\*Drain current limited by maximum junction temperature

#### Thermal Characteristics

| Symbol          | Parameter                                       | FCP9N60N | FCPF9N60NT | Units        |
|-----------------|-------------------------------------------------|----------|------------|--------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case            | 1.5      | 4.2        | $^\circ C/W$ |
| $R_{\theta CS}$ | 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 $T_C = 25^\circ\text{C}$ unless otherwise noted

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|--------|-----------|-----------------|------|------|------|-------|
|--------|-----------|-----------------|------|------|------|-------|

### Off Characteristics

|                                      |                                           |                                                                           |     |      |           |                    |
|--------------------------------------|-------------------------------------------|---------------------------------------------------------------------------|-----|------|-----------|--------------------|
| $BV_{DSS}$                           | Drain to Source Breakdown Voltage         | $I_D = 1\text{mA}$ , $V_{GS} = 0\text{V}$ , $T_C = 25^\circ\text{C}$      | 600 | -    | -         | V                  |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 1\text{mA}$ , Referenced to $25^\circ\text{C}$                     | -   | 0.72 | -         | $V/^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 480\text{V}$ , $V_{GS} = 0\text{V}$                             | -   | -    | 10        | $\mu\text{A}$      |
|                                      |                                           | $V_{DS} = 480\text{V}$ , $V_{GS} = 0\text{V}$ , $T_C = 125^\circ\text{C}$ | -   | -    | 100       |                    |
| $I_{GSS}$                            | Gate to Body Leakage Current              | $V_{GS} = \pm 30\text{V}$ , $V_{DS} = 0\text{V}$                          | -   | -    | $\pm 100$ | nA                 |

### On Characteristics

|              |                                      |                                             |     |      |       |          |
|--------------|--------------------------------------|---------------------------------------------|-----|------|-------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage               | $V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$  | 2.0 | -    | 4.0   | V        |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10\text{V}$ , $I_D = 4.5\text{A}$ | -   | 0.33 | 0.385 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance             | $V_{DS} = 40\text{V}$ , $I_D = 4.5\text{A}$ | -   | 7.5  | -     | S        |

### Dynamic Characteristics

|                      |                                    |                                                                                     |   |      |      |          |
|----------------------|------------------------------------|-------------------------------------------------------------------------------------|---|------|------|----------|
| $C_{iss}$            | Input Capacitance                  | $V_{DS} = 100\text{V}$ , $V_{GS} = 0\text{V}$<br>$f = 1\text{MHz}$                  | - | 930  | 1240 | pF       |
| $C_{oss}$            | Output Capacitance                 |                                                                                     | - | 35   | 50   | pF       |
| $C_{rss}$            | Reverse Transfer Capacitance       |                                                                                     | - | 2    | 4    | pF       |
| $C_{oss}$            | Output Capacitance                 | $V_{DS} = 380\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1\text{MHz}$                   | - | 20   | -    | pF       |
| $C_{oss\text{eff.}}$ | Effective Output Capacitance       | $V_{DS} = 0\text{V to } 480\text{V}$ , $V_{GS} = 0\text{V}$                         | - | 106  | -    | pF       |
| $Q_{g(tot)}$         | Total Gate Charge at 10V           | $V_{DS} = 380\text{V}$ , $I_D = 4.5\text{A}$ ,<br>$V_{GS} = 10\text{V}$<br>(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  | -    | $\Omega$ |

### Switching Characteristics

|              |                     |                                                                               |   |      |      |    |
|--------------|---------------------|-------------------------------------------------------------------------------|---|------|------|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 380\text{V}$ , $I_D = 4.5\text{A}$<br>$R_G = 4.7\Omega$<br>(Note 4) | - | 12.7 | 35.4 | ns |
| $t_{r(on)}$  | 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 <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current |                                              | - | -   | 9.0 | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     |                                              | - | -   | 27  | A  |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0V, I <sub>SD</sub> = 4.5A | - | -   | 1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0V, I <sub>SD</sub> = 4.5A | - | 213 | -   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  | dI <sub>F</sub> /dt = 100A/μs                | - | 2.2 | -   | μC |

#### Notes:

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS} = 3\text{A}$ ,  $R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 9\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} = 380\text{V}$ , Starting  $T_J = 25^\circ\text{C}$
4. Essentially Independent of Operating Temperature Typical Characteristics

## Typical Performance Characteristics

Figure 1. On-Region Characteristics

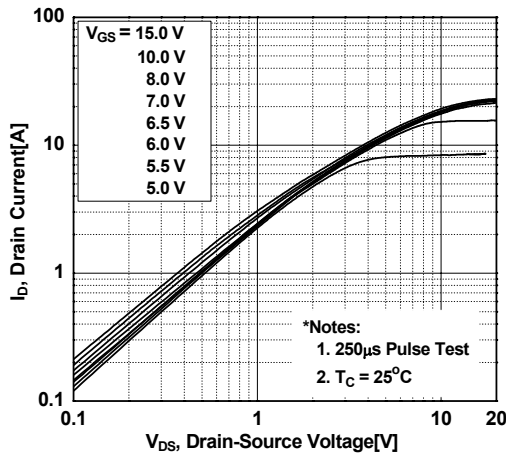


Figure 2. Transfer Characteristics

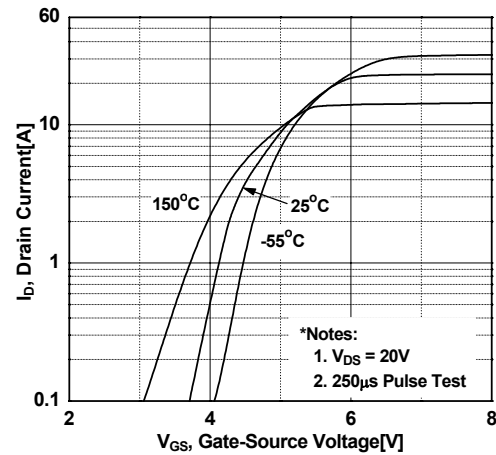


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

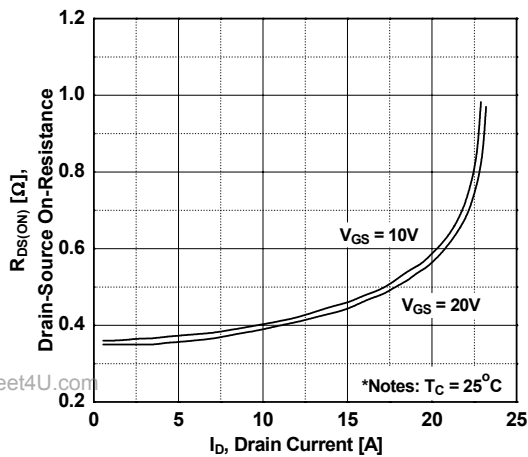


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

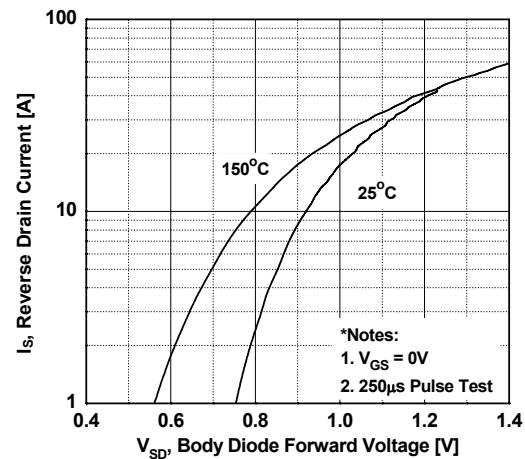


Figure 5. Capacitance Characteristics

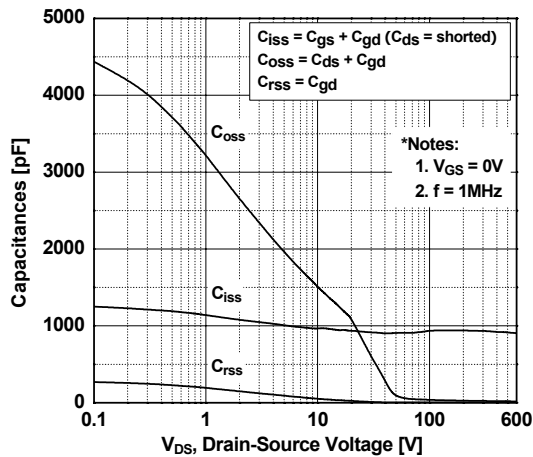
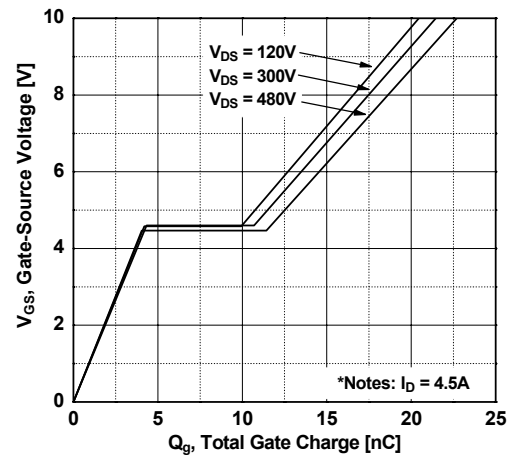
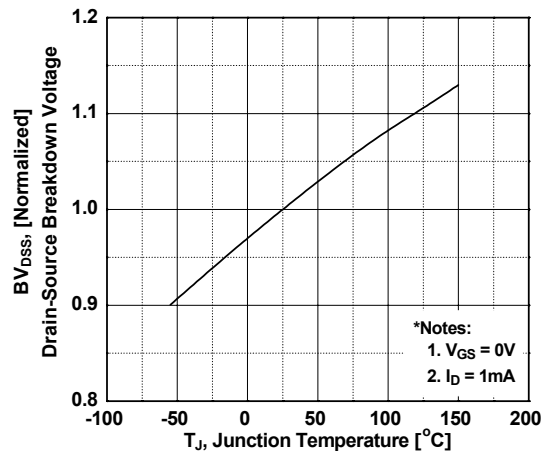


Figure 6. Gate Charge Characteristics

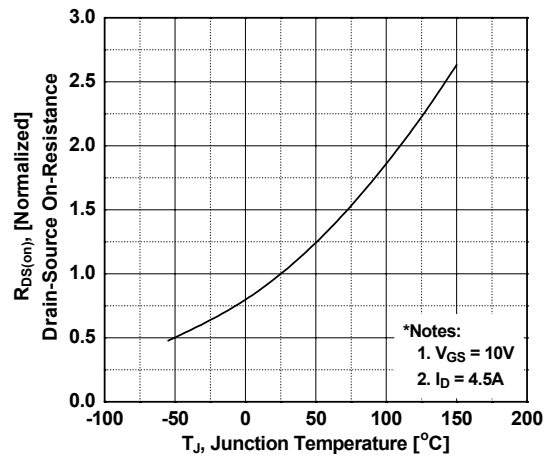


## Typical Performance Characteristics (Continued)

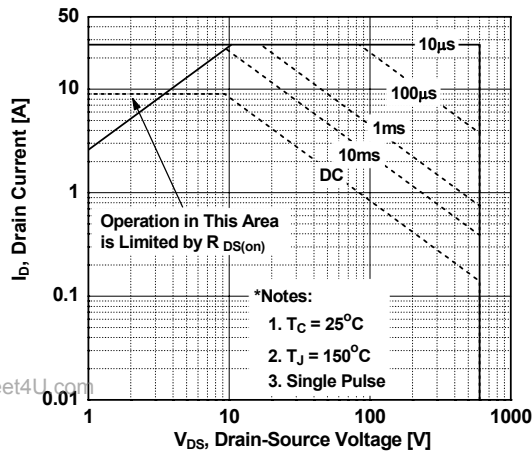
**Figure 7. Breakdown Voltage Variation vs. Temperature**



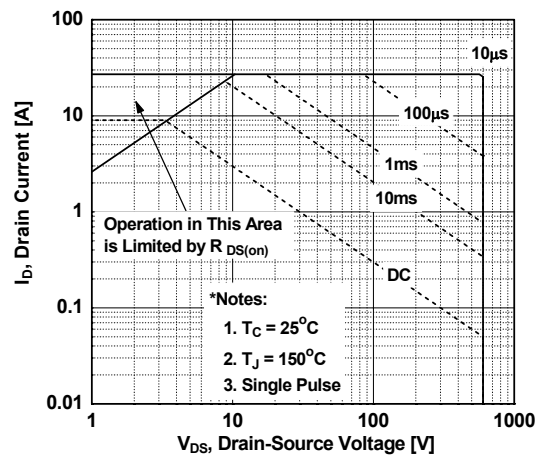
**Figure 8. On-Resistance Variation vs. Temperature**



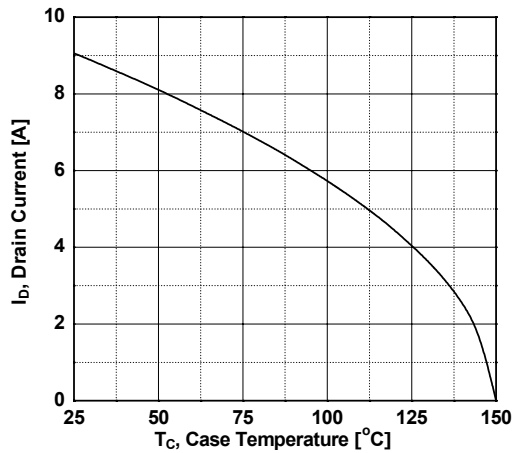
**Figure 9. Maximum Safe Operating Area \_FCP9N60N**



**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

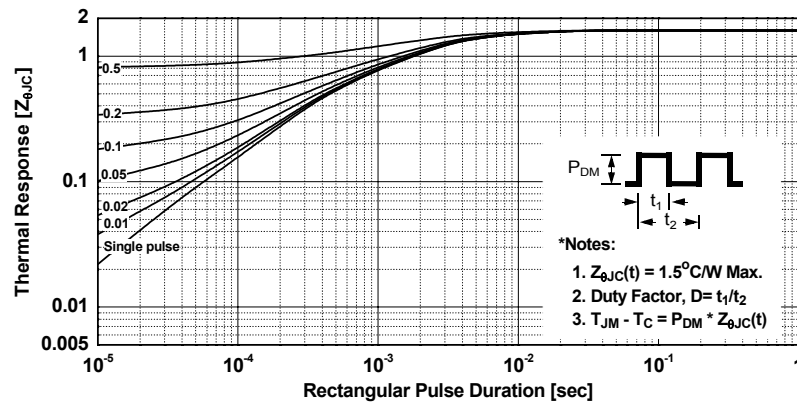
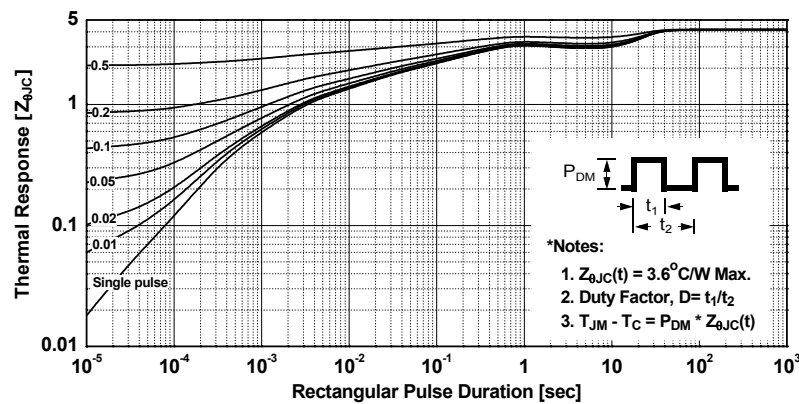
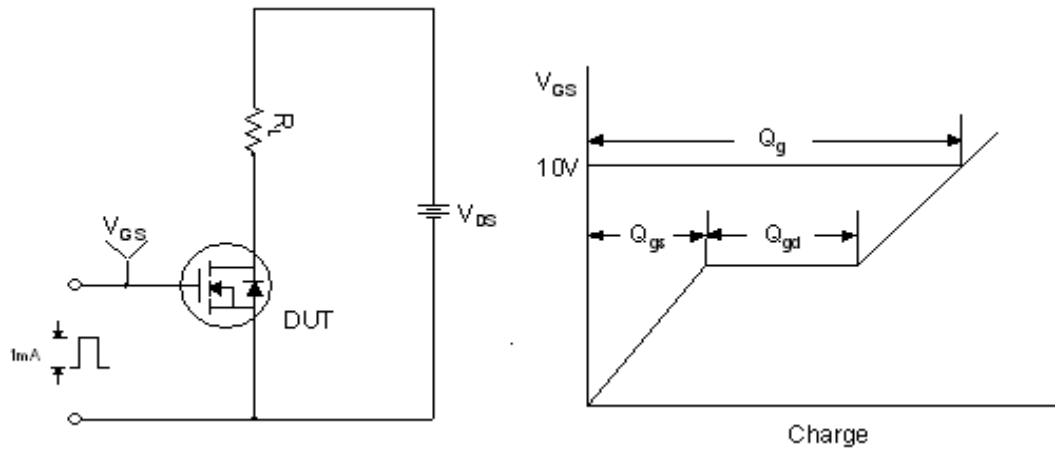


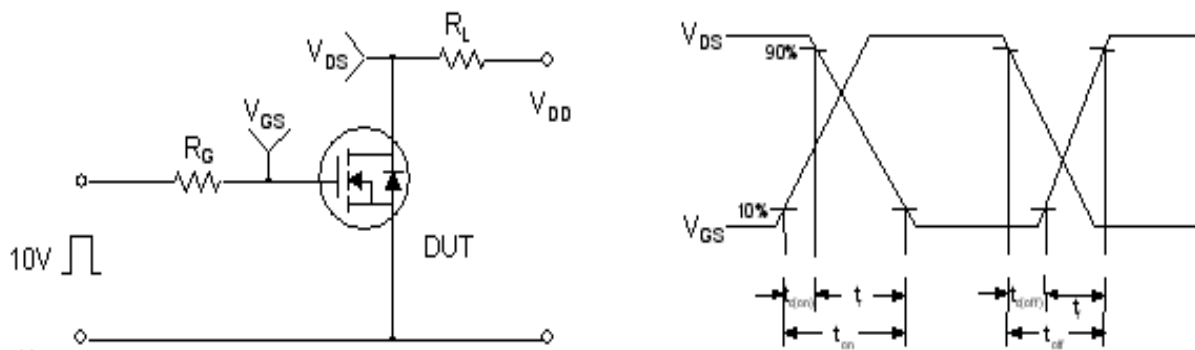
Figure 13. Transient Thermal Response Curve \_ FCPF9N60NT



Gate Charge Test Circuit &amp; Waveform

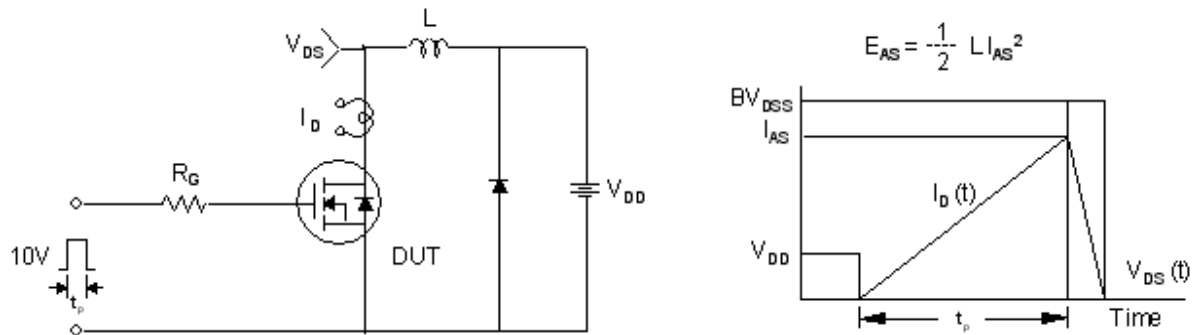


Resistive Switching Test Circuit &amp; Waveforms



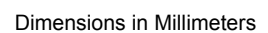
www.DataSheet4U.com

Unclamped Inductive Switching Test Circuit &amp; Waveforms



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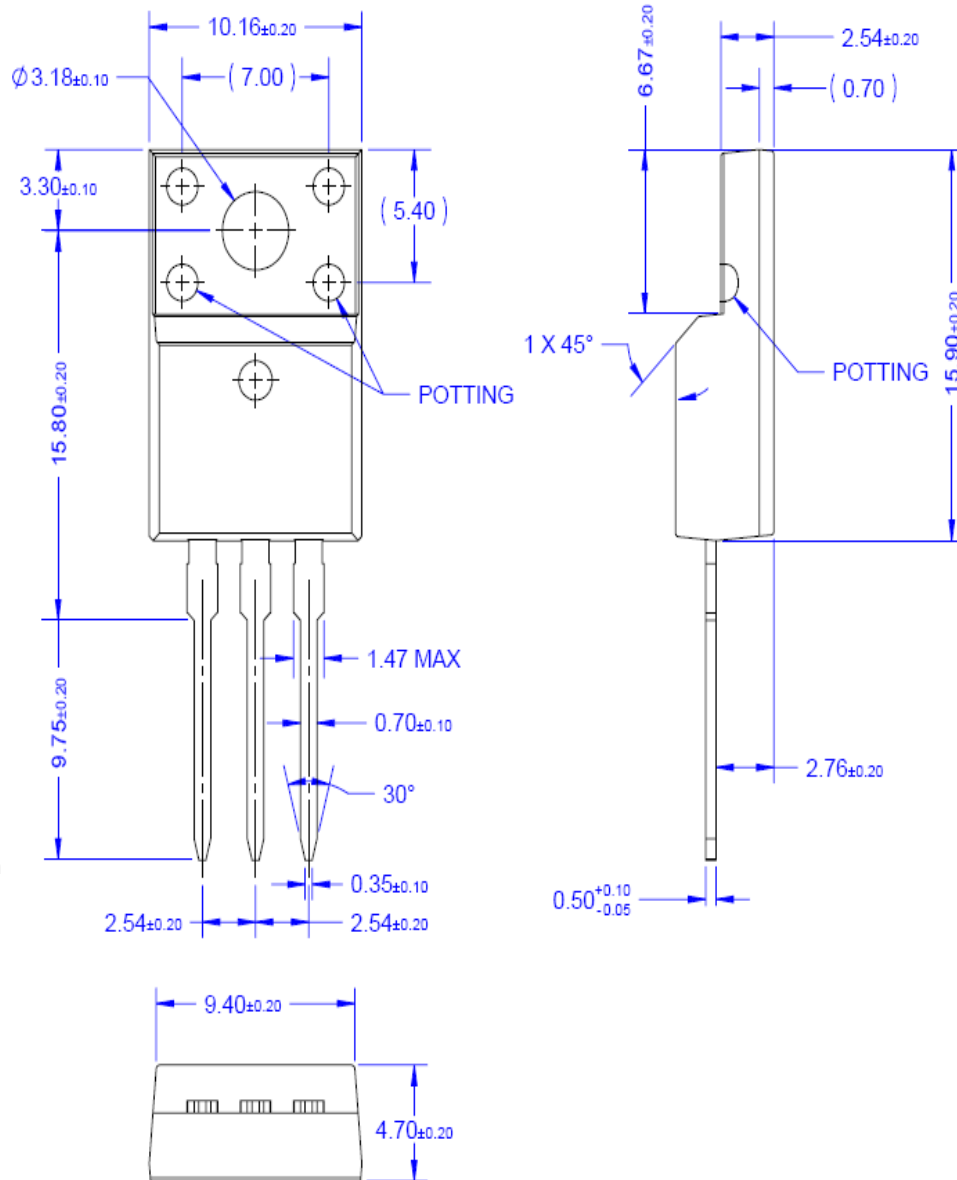
# TO-220



## Mechanical Dimensions

## TO-220F

FCP9N60N / FCPF9N60NT N-Channel MOSFET



Dimensions in Millimeters



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| CorePOWER™                                                                        | Green FPS™                                                                        | QS™                                                                               | TinyBuck™                                                                           |
| CROSSVOLT™                                                                        | Green FPS™ e-Series™                                                              | Quiet Series™                                                                     | TinyCalc™                                                                           |
| CTL™                                                                              | Gmax™                                                                             | RapidConfigure™                                                                   | TinyLogic®                                                                          |
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| Fairchild Semiconductor®                                                          | MillerDrive™                                                                      | SuperSOT™-3                                                                       | UHC®                                                                                |
| FACT Quiet Series™                                                                | MotionMax™                                                                        | SuperSOT™-6                                                                       | Ultra FRFET™                                                                        |
| FACT®                                                                             | Motion-SPM™                                                                       | SuperSOT™-8                                                                       | UniFET™                                                                             |
| FAST®                                                                             | OPTOLOGIC®                                                                        | SupreMOS™                                                                         | VCX™                                                                                |
| FastvCore™                                                                        | OPTOPLANAR®                                                                       | SyncFET™                                                                          | VisualMax™                                                                          |
| FETBench™                                                                         |  | Sync-Lock™                                                                        | XS™                                                                                 |
| FlashWriter®*                                                                     | PDP SPM™                                                                          |  |                                                                                     |
|                                                                                   | Power-SPM™                                                                        |                                                                                   |                                                                                     |

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| 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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