FCP22N60N / FCPF22N60NT
N-Channel SupreMOS® MOSFET
600 V, 22 A, 165 mΩ

Features
- BV_DSS > 650 V @ TJ = 150°C
- RDSON(Typ.) = 140 mΩ @ VGS = 10 V, ID = 11 A
- Ultra Low Gate Charge (Typ. Qg = 45 nC)
- Low Effective Output Capacitance (Typ. Coss(eff.) = 196.4 pF)
- 100% Avalanche Tested
- RoHS Compliant

Application
- LCD/LED/PDP TV
- Lighting
- 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.

Absolute Maximum Ratings  TC = 25°C unless otherwise noted.

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<tr>
<th>Symbol</th>
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<th>FCPF22N60NT</th>
<th>Unit</th>
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<tbody>
<tr>
<td>V_DSS</td>
<td>Drain to Source Voltage</td>
<td>600</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>V_GSS</td>
<td>Gate to Source Voltage</td>
<td>±45</td>
<td>±45</td>
<td>V</td>
</tr>
<tr>
<td>I_D</td>
<td>Drain Current</td>
<td>- Continuous (TC = 25°C)</td>
<td>22</td>
<td>22*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Continuous (TC = 100°C)</td>
<td>13.8</td>
<td>13.8*</td>
</tr>
<tr>
<td>I_DM</td>
<td>Drain Current</td>
<td>- Pulsed</td>
<td>66</td>
<td>66*</td>
</tr>
<tr>
<td>E_AS</td>
<td>Single Pulsed Avalanche Energy</td>
<td>(Note 2)</td>
<td>672</td>
<td>mJ</td>
</tr>
<tr>
<td>I_AR</td>
<td>Avalanche Current</td>
<td>(Note 1)</td>
<td>7.3</td>
<td>A</td>
</tr>
<tr>
<td>E_AR</td>
<td>Repetitive Avalanche Energy</td>
<td>(Note 1)</td>
<td>2.75</td>
<td>mJ</td>
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<tr>
<td>dv/dt</td>
<td>MOSFET dv/dt</td>
<td>(Note 3)</td>
<td>100</td>
<td>V/ns</td>
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<tr>
<td>P_D</td>
<td>Power Dissipation</td>
<td>(TC = 25°C)</td>
<td>205</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Derate Above 25°C</td>
<td>1.64</td>
<td>0.31</td>
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<tr>
<td>T_J, T_STG</td>
<td>Operating and Storage Temperature Range</td>
<td>-55 to +150</td>
<td>°C</td>
<td></td>
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<tr>
<td>T_L</td>
<td>Maximum Lead Temperature for Soldering, 1/8” from Case for 5 Seconds</td>
<td>300</td>
<td>°C</td>
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*Drain current limited by maximum junction temperature.

Thermal Characteristics

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<th>Unit</th>
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<td>R_JUC</td>
<td>Thermal Resistance, Junction to Case, Max.</td>
<td>0.61</td>
<td>3.2</td>
<td>°C/W</td>
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<tr>
<td>R_JUA</td>
<td>Thermal Resistance, Junction to Ambient, Max.</td>
<td>62.5</td>
<td>62.5</td>
<td>°C/W</td>
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<th>Packing Method</th>
<th>Reel Size</th>
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<td>FCP22N60N</td>
<td>TO-220</td>
<td>Tube</td>
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<td>N/A</td>
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<td>FCPF22N60NT</td>
<td>FCPF22N60NT</td>
<td>TO-220F</td>
<td>Tube</td>
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<td>N/A</td>
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## Electrical Characteristics  \( T_C = 25^\circ C \) unless otherwise noted.

### Off Characteristics

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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>( BVDSS )</td>
<td>Drain to Source Breakdown Voltage</td>
<td>( I_D = 1 ) mA, ( V_GS = 0 ) V, ( T_J = 25^\circ C )</td>
<td>600</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>( \Delta BVDSS / \Delta T_J )</td>
<td>Breakdown Voltage Temperature Coefficient</td>
<td>( I_D = 1 ) mA, Referenced to 25°C</td>
<td>650</td>
<td>-</td>
<td>-</td>
<td>V/°C</td>
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<tr>
<td>( I_DSS )</td>
<td>Zero Gate Voltage Drain Current</td>
<td>( V_D = 480 ) V, ( V_GS = 0 ) V</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>μA</td>
</tr>
<tr>
<td>( I_GSS )</td>
<td>Gate to Body Leakage Current</td>
<td>( V_GS = \pm 45 ) V, ( V_D = 0 ) V</td>
<td>-</td>
<td>-</td>
<td>±100</td>
<td>nA</td>
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### On Characteristics

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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<td>( V_{GS(th)} )</td>
<td>Gate Threshold Voltage</td>
<td>( V_GS = V_D, I_D = 250 ) μA</td>
<td>2.0</td>
<td>3.0</td>
<td>4.0</td>
<td>V</td>
</tr>
<tr>
<td>( R_{DS(on)} )</td>
<td>Static Drain to Source On Resistance</td>
<td>( V_GS = 10 ) V, ( I_D = 11 ) A</td>
<td>-</td>
<td>0.140</td>
<td>0.165</td>
<td>Ω</td>
</tr>
<tr>
<td>( g_{FS} )</td>
<td>Forward Transconductance</td>
<td>( V_D = 20 ) V, ( I_D = 11 ) A</td>
<td>-</td>
<td>22</td>
<td>-</td>
<td>S</td>
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### Dynamic Characteristics

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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
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<tr>
<td>( C_{iss} )</td>
<td>Input Capacitance</td>
<td>( V_D = 100 ) V, ( V_GS = 0 ) V, ( f = 1 ) MHz</td>
<td>-</td>
<td>1950</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>( C_{oss} )</td>
<td>Output Capacitance</td>
<td>( V_D = 380 ) V, ( V_GS = 0 ) V, ( f = 1 ) MHz</td>
<td>-</td>
<td>43.2</td>
<td>-</td>
<td>pF</td>
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<tr>
<td>( C_{rss} )</td>
<td>Reverse Transfer Capacitance</td>
<td>( V_D = 0 ) V to 480 ( V_GS = 0 ) V</td>
<td>-</td>
<td>196.4</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>( C_{oss(eff)} )</td>
<td>Effective Output Capacitance</td>
<td>( V_D = 380 ) V, ( I_D = 11 ) A, ( V_GS = 10 ) V</td>
<td>-</td>
<td>45</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>( Q_{gs} )</td>
<td>Total Gate Charge at 10V</td>
<td>( V_D = 380 ) V, ( I_D = 11 ) A, ( V_GS = 10 ) V</td>
<td>-</td>
<td>8.7</td>
<td>-</td>
<td>nC</td>
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<tr>
<td>( Q_{gd} )</td>
<td>Gate to Drain “Miller” Charge</td>
<td>-</td>
<td>14.5</td>
<td>-</td>
<td>nC</td>
<td></td>
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<tr>
<td>ESR</td>
<td>Equivalent Series Resistance (G-S)</td>
<td>( f = 1 ) MHz</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>Ω</td>
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### Switching Characteristics

<table>
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<tr>
<th>Symbol</th>
<th>Parameter</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>( t_{on} )</td>
<td>Turn-On Delay Time</td>
<td>( V_D = 380 ) V, ( I_D = 11 ) A</td>
<td>-</td>
<td>16.9</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{r} )</td>
<td>Turn-On Rise Time</td>
<td>( V_GS = 10 ) V, ( R_G = 4.7 ) Ω</td>
<td>-</td>
<td>16.7</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{off} )</td>
<td>Turn-Off Delay Time</td>
<td>-</td>
<td>49</td>
<td>-</td>
<td>ns</td>
<td></td>
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<tr>
<td>( t_{f} )</td>
<td>Turn-Off Fall Time</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>ns</td>
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### Drain-Source Diode Characteristics

<table>
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<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_S )</td>
<td>Maximum Continuous Drain to Source Diode Forward Current</td>
<td>-</td>
<td>22</td>
<td>-</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>( I_{SM} )</td>
<td>Maximum Pulsed Drain to Source Diode Forward Current</td>
<td>-</td>
<td>66</td>
<td>-</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>( V_{SD} )</td>
<td>Drain to Source Diode Forward Voltage</td>
<td>( V_GS = 0 ) V, ( I_{SD} = 11 ) A</td>
<td>-</td>
<td>1.2</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>( t_{rr} )</td>
<td>Reverse Recovery Time</td>
<td>( dV_GS/dt = 100 ) A/μs</td>
<td>-</td>
<td>350</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( Q_{rr} )</td>
<td>Reverse Recovery Charge</td>
<td>-</td>
<td>6</td>
<td>-</td>
<td>μC</td>
<td></td>
</tr>
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</table>

### Notes:
1. Repetitive rating: pulse width-limited by maximum junction temperature.
2. \( I_{GD} = 7.3 \) A, \( R_G = 25 \) Ω, starting \( T_J = 25^\circ C \).
3. \( I_{SD} = 22 \) A, \( dV_D/dt = 200 \) A/μs, \( V_D = 380 \) V, starting \( T_J = 25^\circ C \).
4. Essentially independent of operating temperature typical characteristics.
Typical Performance Characteristics

Figure 1. On-Region Characteristics

*N Notes:
1. 250μs Pulse Test
2. TC = 25°C

Figure 2. Transfer Characteristics

*N Notes:
1. VGS = 20V
2. 250μs Pulse Test

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

*Note: TC = 25°C

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

*N Notes:
1. VDS = 0V
2. 250μs Pulse Test

Figure 5. Capacitance Characteristics

*C Ciss = Cgs + Cgd (Cds = shorted)
Coss = Cds + Cgd
Crss = Cgd

*Note:
1. VGS = 0V
2. f = 1MHz

Figure 6. Gate Charge Characteristics

*Note: ID = 11A
Typical Performance Characteristics (Continued)

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

![Breakdown Voltage Variation vs. Temperature Graph](image)

*Notes:
1. \( V_{GS} = 0V \)
2. \( I_D = 1mA \)

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

![On-Resistance Variation vs. Temperature Graph](image)

*Notes:
1. \( V_{GS} = 10V \)
2. \( I_D = 11A \)

**Figure 9. Maximum Safe Operating Area for FCP22N60N**

![Maximum Safe Operating Area Graph](image)

*Notes:
1. \( T_C = 25^\circ C \)
2. \( T_J = 150^\circ C \)
3. Single Pulse

**Figure 10. Maximum Safe Operating Area for FCPF22N60NT**

![Maximum Safe Operating Area Graph](image)

*Notes:
1. \( T_C = 25^\circ C \)
2. \( T_J = 150^\circ C \)
3. Single Pulse

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

![Maximum Drain Current vs. Case Temperature Graph](image)
Typical Performance Characteristics (Continued)

**Figure 12. Transient Thermal Response Curve for FCP22N60N**

<table>
<thead>
<tr>
<th>Rectangular Pulse Duration [sec]</th>
<th>ZθJC(t), Thermal Response [°C/W]</th>
</tr>
</thead>
<tbody>
<tr>
<td>10^-5</td>
<td>0.01</td>
</tr>
<tr>
<td>10^-4</td>
<td>0.05</td>
</tr>
<tr>
<td>10^-3</td>
<td>0.1</td>
</tr>
<tr>
<td>10^-2</td>
<td>0.3</td>
</tr>
<tr>
<td>10^-1</td>
<td>0.6</td>
</tr>
<tr>
<td>1</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*Notes:*
1. ZθJC(t) = 0.61°C/W Max.
2. Duty Factor, D = t1/t2
3. TJM - TC = PDM * ZθJC(t)

**Figure 13. Transient Thermal Response Curve for FCPF22N60NT**

<table>
<thead>
<tr>
<th>Rectangular Pulse Duration [sec]</th>
<th>ZθJC(t), Thermal Response [°C/W]</th>
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</thead>
<tbody>
<tr>
<td>10^-5</td>
<td>0.001</td>
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<tr>
<td>10^-4</td>
<td>0.01</td>
</tr>
<tr>
<td>10^-3</td>
<td>0.05</td>
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<tr>
<td>10^-2</td>
<td>0.1</td>
</tr>
<tr>
<td>10^-1</td>
<td>0.3</td>
</tr>
<tr>
<td>1</td>
<td>0.6</td>
</tr>
</tbody>
</table>

*Notes:*
1. ZθJC(t) = 3.2°C/W Max.
2. Duty Factor, D = t1/t2
3. TJM - TC = PDM * ZθJC(t)
**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

- DUT
- $V_{DS}$
- $I_{SD}$
- Driver
- $RG$
- Same Type as DUT
- $V_{DD}$
- $V_{GS}$
- $dV/dt$ controlled by $RG$
- $I_{SD}$ controlled by pulse period

- $V_{GS}$ (Driver)
- $D = \frac{Gate Pulse Width}{Gate Pulse Period}$
- $10V$

- $I_{SD}$ (DUT)
- $I_{FM}$, Body Diode Forward Current
- $I_{RM}$, Body Diode Reverse Current
- $V_{DS}$ (DUT)
- Body Diode Recovery $dv/dt$
- $V_{SD}$
- $V_{DD}$
- Body Diode Forward Voltage Drop

Figure 17. Peak Diode Recovery $dv/dt$ Test Circuit & Waveforms
Figure 18. TO-220, Molded, 3-Lead, Jedec Variation AB

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

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Definition of Terms

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<th>Datasheet Identification</th>
<th>Product Status</th>
<th>Definition</th>
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<td>Formative / In Design</td>
<td>Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.</td>
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<td>Preliminary</td>
<td>First Production</td>
<td>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.</td>
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<td>Full Production</td>
<td>Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.</td>
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<td>Obsolete</td>
<td>Not In Production</td>
<td>Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.</td>
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