Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor’s system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.
FDP12N50NZ / FDPF12N50NZ
N-Channel UniFET™ II MOSFET
500 V, 11.5 A, 520 mΩ

Features
• $R_{DS(on)} = 460 \text{ mΩ (Typ.)} @ V_{GS} = 10 \text{ V}, I_D = 5.75 \text{ A}$
• Low Gate Charge (Typ. 23 nC)
• Low $C_{rss}$ (Typ. 14 pF)
• 100% Avalanche Tested
• ESD Improved Capability
• RoHS Compliant

Applications
• LCD/LED/PDP TV
• Lighting
• Uninterruptible Power Supply

Description
UniFET™ II MOSFET is Fairchild Semiconductor’s high voltage MOSFET family based on advanced planar stripe and DMOS technology. This advanced MOSFET family has the smallest on-state resistance among the planar MOSFET, and also provides superior switching performance and higher avalanche energy strength. In addition, internal gate-source ESD diode allows UniFET II MOSFET to withstand over 2kV HBM surge stress. This device family is suitable for switching power converter applications such as power factor correction (PFC), flat panel display (FPD) TV power, ATX and electronic lamp ballasts.

MOSFET Maximum Ratings $T_J = 25^\circ \text{C}$ unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>FDP12N50NZ</th>
<th>FDPF12N50NZ</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DSS}$</td>
<td>Drain to Source Voltage</td>
<td>500</td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GSS}$</td>
<td>Gate to Source Voltage</td>
<td>±25</td>
<td>±25</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>Drain Current</td>
<td>11.5</td>
<td>11.5*</td>
<td>A</td>
</tr>
<tr>
<td>$I_{DM}$</td>
<td>Drain Current</td>
<td>46</td>
<td>46*</td>
<td>A</td>
</tr>
<tr>
<td>$E_{AS}$</td>
<td>Single Pulsed Avalanche Energy</td>
<td>560</td>
<td>560</td>
<td>mJ</td>
</tr>
<tr>
<td>$I_{AR}$</td>
<td>Avalanche Current</td>
<td>11.5</td>
<td>11.5</td>
<td>A</td>
</tr>
<tr>
<td>$E_{AR}$</td>
<td>Repetitive Avalanche Energy</td>
<td>17</td>
<td>17</td>
<td>mJ</td>
</tr>
<tr>
<td>$dv/dt$</td>
<td>MOSFET $dv/dt$ Ruggedness</td>
<td>20</td>
<td>20</td>
<td>V/ns</td>
</tr>
<tr>
<td></td>
<td>Peak Diode Recovery $dv/dt$</td>
<td>10</td>
<td>10</td>
<td>V/ns</td>
</tr>
<tr>
<td>$P_D$</td>
<td>Power Dissipation</td>
<td>170</td>
<td>42</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>(Typ. $T_J = 25^\circ \text{C}$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Derate above 25°C</td>
<td>1.37</td>
<td>0.33</td>
<td>W/°C</td>
</tr>
<tr>
<td>$T_J$, $T_{STG}$</td>
<td>Operating and Storage Temperature Range</td>
<td>-55 to +150</td>
<td>-55 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_L$</td>
<td>Maximum Lead Temperature for Soldering, 1/8&quot; from Case for 5 Seconds</td>
<td>300</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>FDPF12N50NZ</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$R_{JUC}$</td>
<td>Thermal Resistance, Junction to Case, Max.</td>
<td>0.73</td>
<td>3.0</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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Package Marking and Ordering Information

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<th>Device Description</th>
<th>Package</th>
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<th>Tape Width</th>
<th>Quantity</th>
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<td>FDP12N50NZ</td>
<td>TO-220</td>
<td>Tube</td>
<td>N/A</td>
<td>50 units</td>
</tr>
<tr>
<td>FDPF12N50NZ</td>
<td>FDPF12N50NZ</td>
<td>TO-220F</td>
<td>Tube</td>
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<td>50 units</td>
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Electrical Characteristics

**TC = 25°C unless otherwise noted.**

### Off 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>BV_DSS</td>
<td>Drain to Source Breakdown Voltage</td>
<td>V_D = 250μA, V_GS = 0V, T_J = 25°C</td>
<td>300</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>ΔBV_DSS / ΔT_J</td>
<td>Breakdown Voltage Temperature Coefficient</td>
<td>V_D = 250μA, Referenced to 25°C</td>
<td>8</td>
<td>-</td>
<td>0.5</td>
<td>V/°C</td>
</tr>
<tr>
<td>I_DSS</td>
<td>Zero Gate Voltage Drain Current</td>
<td>V_D = 500V, V_GS = 0V</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>μA</td>
</tr>
<tr>
<td>I_GSS</td>
<td>Gate to Body Leakage Current</td>
<td>V_GS = ±25V, V_D = 0V</td>
<td>-</td>
<td>-</td>
<td>±10</td>
<td>μA</td>
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### On Characteristics

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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
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<tr>
<td>V_GS(th)</td>
<td>Gate Threshold Voltage</td>
<td>V_D = V_D, I_D = 250μA</td>
<td>3.0</td>
<td>-</td>
<td>5.0</td>
<td>V</td>
</tr>
<tr>
<td>R_D(on)</td>
<td>Static Drain to Source On Resistance</td>
<td>V_D = 10V, I_D = 5.75A</td>
<td>-</td>
<td>0.46</td>
<td>0.52</td>
<td>Ω</td>
</tr>
<tr>
<td>g_FS</td>
<td>Forward Transconductance</td>
<td>V_D = 20V, I_D = 5.75A</td>
<td>-</td>
<td>12</td>
<td>-</td>
<td>S</td>
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</table>

### Dynamic Characteristics

<table>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_ss</td>
<td>Input Capacitance</td>
<td>V_D = 25V, V_GS = 0V, f = 1MHz</td>
<td>-</td>
<td>945</td>
<td>1235</td>
<td>pF</td>
</tr>
<tr>
<td>C_oss</td>
<td>Output Capacitance</td>
<td>-</td>
<td>155</td>
<td>205</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>Crss</td>
<td>Reverse Transfer Capacitance</td>
<td>-</td>
<td>14</td>
<td>20</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>Q_g</td>
<td>Total Gate Charge at 10V</td>
<td>V_D = 400V, I_D = 11.5A</td>
<td>-</td>
<td>23</td>
<td>30</td>
<td>nC</td>
</tr>
<tr>
<td>Q_gs</td>
<td>Gate to Source Gate Charge</td>
<td>V_GS = 10V</td>
<td>-</td>
<td>5.5</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>Q_gd</td>
<td>Gate to Drain “Miller” Charge</td>
<td>(Note 4)</td>
<td>-</td>
<td>9.6</td>
<td>-</td>
<td>nC</td>
</tr>
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### Switching Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I(on)</td>
<td>Turn-On Delay Time</td>
<td>V_DD = 250V, I_D = 11.5A</td>
<td>-</td>
<td>20</td>
<td>50</td>
<td>ns</td>
</tr>
<tr>
<td>t_r</td>
<td>Turn-On Rise Time</td>
<td>R_G = 25Ω</td>
<td>-</td>
<td>50</td>
<td>110</td>
<td>ns</td>
</tr>
<tr>
<td>I(off)</td>
<td>Turn-Off Delay Time</td>
<td>(Note 4)</td>
<td>-</td>
<td>60</td>
<td>130</td>
<td>ns</td>
</tr>
<tr>
<td>t_f</td>
<td>Turn-Off Fall Time</td>
<td>-</td>
<td>45</td>
<td>100</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

### Drain-Source Diode Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</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>-</td>
<td>11.5</td>
<td>A</td>
</tr>
<tr>
<td>I_SM</td>
<td>Maximum Pulsed Drain to Source Diode Forward Current</td>
<td>-</td>
<td>-</td>
<td>46</td>
<td>A</td>
</tr>
<tr>
<td>V_SD</td>
<td>Drain to Source Diode Forward Voltage</td>
<td>V_GS = 0V, I_SD = 11.5A</td>
<td>-</td>
<td>-</td>
<td>1.4</td>
</tr>
<tr>
<td>t_TR</td>
<td>Reverse Recovery Time</td>
<td>V_GS = 0V, I_SD = 11.5A</td>
<td>-</td>
<td>315</td>
<td>-</td>
</tr>
<tr>
<td>Q_TR</td>
<td>Reverse Recovery Charge</td>
<td>dI/dt = 100A/μs</td>
<td>-</td>
<td>2.0</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes:
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. L = 8.5mH, I_L = 11.5A, V_DD = 50V, R_G = 25Ω, Starting T_J = 25°C
3. I_SD ≤ 11.5A, dI/dt ≤ 200A/μs, V_DD ≤ BV_DSS, Starting T_J = 25°C
4. Essentially Independent of Operating Temperature Typical Characteristics
Typical Characteristics

Figure 1. On-Region Characteristics

- $V_{GS} = 15.0 \text{ V}$
- $10.0 \text{ V}$
- $8.0 \text{ V}$
- $6.5 \text{ V}$
- $6.0 \text{ V}$
- $5.5 \text{ V}$

*Notes:
1. 250 $\mu$s Pulse Test
2. $T_C = 25^\circ\text{C}$

Figure 2. Transfer Characteristics

- $V_{GS} = 15.0 \text{ V}$
- $10.0 \text{ V}$
- $8.0 \text{ V}$
- $7.0 \text{ V}$
- $6.5 \text{ V}$

*Notes:
1. $V_{GS} = 20 \text{ V}$
2. 250 $\mu$s Pulse Test

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

- $R_{DS(ON)}$ [\Omega]
- $V_{GS} = 10 \text{ V}$
- $V_{GS} = 20 \text{ V}$

*Note: $T_C = 25^\circ\text{C}$

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

- $I_D$, Reverse Drain Current [A]
- $V_{DS}$, Body Diode Forward Voltage [V]

*Notes:
1. $V_{GS} = 0 \text{ V}$
2. 250 $\mu$s Pulse Test

Figure 5. Capacitance Characteristics

- $C_{oss} = C_{gs} + C_{gd}$ ($C_{ds}$ is shorted)
- $C_{oss} = C_{ds} + C_{gd}$
- $C_{oss} = C_{gd}$

*Note:
1. $V_{GS} = 0 \text{ V}$
2. $f = 1 \text{ MHz}$

Figure 6. Gate Charge Characteristics

- $Q_{g}$, Total Gate Charge [nC]
- $V_{DS}$, Drain-Source Voltage [V]

*Note: $I_D = 11.5 \text{ A}$
Typical Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

![Breakdown Voltage Variation Graph](image)

*Notes:
1. VGS = 0V
2. IO = 250µA

Figure 8. On-Resistance Variation vs. Temperature

![On-Resistance Variation Graph](image)

*Notes:
1. VGS = 10V
2. IO = 5.75A

Figure 9. Maximum Safe Operating Area - FDPF12N50NZ

![Maximum Safe Operating Area Graph](image)

*Notes:
1. TC = 25°C
2. TJ = 150°C
3. Single Pulse

Figure 10. Maximum Safe Operating Area - FDP12N50NZ

![Maximum Safe Operating Area Graph](image)

*Notes:
1. TC = 25°C
2. TJ = 150°C
3. Single Pulse

Figure 11. Maximum Drain Current vs. Case Temperature

![Maximum Drain Current Graph](image)

ID, Drain Current [A] vs. TC, Case Temperature [°C]
Typical Characteristics (Continued)

Figure 12. Transient Thermal Response Curve - FDP12N50NZ

![Graph showing transient thermal response curve for FDP12N50NZ](image)

Figure 13. Transient Thermal Response Curve - FDPF12N50NZ

![Graph showing transient thermal response curve for FDPF12N50NZ](image)

Notes:
1. $Z_{jc}(t) = 0.73^\circ C/W$ Max.
2. Duty Factor, $D = \frac{t_1}{t_2}$
3. $T_{JM} - T_C = P_{DM} \cdot Z_{jc}(t)$

$Z_{jc}(t)$, Thermal Response [$^\circ C/W$]

$t_1$, Square Wave Pulse Duration [sec]
Figure 17. Peak Diode Recovery dv/dt Test Circuit & Waveforms

- DUT
- V_{DS}
- I_{SD}
- Driver
- R_G
- Same Type as DUT
- V_{DD}
- Body Diode
- Forward Voltage Drop
- V_{SD}
- Body Diode Forward Current
- I_{FM}
- DI/dt
- Body Diode Reverse Current
- I_{RM}
- Body Diode Recovery dv/dt
- V_{DD}
- Body Diode Forward Voltage Drop

\[ V_{GS} \quad \text{(Driver)} \]

\[ D = \frac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}} \]

\[ 10V \]

\[ V_{DS} \quad \text{(DUT)} \]

\[ I_{SD} \quad \text{(DUT)} \]

\[ I_{FM}, \text{Body Diode Forward Current} \]

\[ I_{RM} \]

\[ \text{Body Diode Reverse Current} \]

\[ \text{Body Diode Recovery dv/dt} \]

\[ V_{DD} \]

\[ V_{SD} \]

\[ \text{Body Diode Forward Voltage Drop} \]
Mechanical Dimensions

TO-220F 3L

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.
F. OPTION 1 - WITH SUPPORT PIN HOLE.
   OPTION 2 - NO SUPPORT PIN HOLE.
G. DRAWING FILE NAME: TO220M03REV4
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<th>Datasheet Identification</th>
<th>Product Status</th>
<th>Definition</th>
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<td>Advance Information</td>
<td>Formative / In Design</td>
<td>Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.</td>
</tr>
<tr>
<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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<tr>
<td>No Identification Needed</td>
<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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<tr>
<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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Rev. 177

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