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.
FDD5N60NZ
N-Channel UniFET™ II MOSFET
600 V, 4.0 A, 2Ω

Features
- $R_{DS(on)} = 1.65\ \Omega$ (Typ.) @ $V_{GS} = 10\ V$, $I_D = 2.0\ A$
- Low Gate Charge (Typ. 10 nC)
- Low $C_{rss}$ (Typ. 5 pF)
- 100% Avalanche Tested
- Improved $dv/dt$ Capability
- 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 $T_J = 25^\circ C$ unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>FDD5N60NZ</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$V_{DSS}$</td>
<td>Drain to Source Voltage</td>
<td>600</td>
<td>V</td>
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<tr>
<td>$V_{GSS}$</td>
<td>Gate to Source Voltage</td>
<td>±25</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>Drain Current</td>
<td>(Note 1)</td>
<td>4.0</td>
</tr>
<tr>
<td>$I_{DM}$</td>
<td>Drain Current</td>
<td>(Note 1)</td>
<td>16</td>
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<tr>
<td>$E_{AS}$</td>
<td>Single Pulsed Avalanche Energy</td>
<td>(Note 2)</td>
<td>216</td>
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<tr>
<td>$I_{AR}$</td>
<td>Avalanche Current</td>
<td>(Note 1)</td>
<td>4.0</td>
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<tr>
<td>$E_{AR}$</td>
<td>Repetitive Avalanche Energy</td>
<td>(Note 1)</td>
<td>8.3</td>
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<tr>
<td>$dv/dt$</td>
<td>Peak Diode Recovery $dv/dt$</td>
<td>(Note 3)</td>
<td>10</td>
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<tr>
<td>$P_D$</td>
<td>Power Dissipation</td>
<td>(Note 1)</td>
<td>83</td>
</tr>
<tr>
<td>$T_J$, $T_{STG}$</td>
<td>Operating and Storage Temperature Range</td>
<td>-55 to +150</td>
<td>°C</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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Thermal Characteristics

<table>
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<td>$R_{JUC}$</td>
<td>Thermal Resistance, Junction to Case, Max.</td>
<td>1.5</td>
<td>°C/W</td>
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<tr>
<td>$R_{JUA}$</td>
<td>Thermal Resistance, Junction to Ambient, Max.</td>
<td>90</td>
<td>°C/W</td>
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<th>Reel Size</th>
<th>Tape Width</th>
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<td>FDD5N60NZ</td>
<td>DPAK</td>
<td>Tape and Reel</td>
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<td>16 mm</td>
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### Electrical Characteristics

$T_C = 25^\circ C$ unless otherwise noted.

#### Off Characteristics

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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$BV_{DSS}$</td>
<td>Drain to Source Breakdown Voltage $I_D = 250 \mu A, V_{GS} = 0 \text{ V}, T_J = 25^\circ C$</td>
<td>$600$</td>
<td>-</td>
<td>-</td>
<td>V</td>
<td></td>
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<tr>
<td>$\Delta BV_{DSS} / \Delta T_J$</td>
<td>Breakdown Voltage Temperature Coefficient $I_D = 250 \mu A$, Referenced to $25^\circ C$</td>
<td>-</td>
<td>$0.6$</td>
<td>-</td>
<td>V/°C</td>
<td></td>
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<tr>
<td>$I_{DSS}$</td>
<td>Zero Gate Voltage Drain Current $V_{DS} = 600 \text{ V}, V_{GS} = 0 \text{ V}$</td>
<td>-</td>
<td>-</td>
<td>$50$</td>
<td>μA</td>
<td></td>
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<tr>
<td>$I_{GSS}$</td>
<td>Gate to Body Leakage Current $V_{GS} = \pm 25 \text{ V}, V_{DS} = 0 \text{ V}$</td>
<td>-</td>
<td>-</td>
<td>$\pm 10$</td>
<td>μA</td>
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#### On Characteristics

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<th>Unit</th>
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<td>$V_{G(S)abh}$</td>
<td>Gate Threshold Voltage $V_{GS} = V_{DS}, I_D = 250 \mu A$</td>
<td>$3.0$</td>
<td>-</td>
<td>$5.0$</td>
<td>V</td>
<td></td>
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<tr>
<td>$R_{DSS(on)}$</td>
<td>Static Drain to Source On Resistance $V_{GS} = 10 \text{ V}, I_D = 2.0 \text{ A}$</td>
<td>-</td>
<td>$1.65$</td>
<td>$2.00$</td>
<td>Ω</td>
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<tr>
<td>$g_{FS}$</td>
<td>Forward Transconductance $V_{DS} = 20 \text{ V}, I_D = 2.0 \text{ A}$</td>
<td>-</td>
<td>$5$</td>
<td>-</td>
<td>S</td>
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#### Dynamic Characteristics

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<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$C_{iss}$</td>
<td>Input Capacitance $V_{DS} = 25 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$</td>
<td>-</td>
<td>$450$</td>
<td>$600$</td>
<td>pF</td>
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<tr>
<td>$C_{oss}$</td>
<td>Output Capacitance $V_{DS} = 400 \text{ V}, I_D = 4.0 \text{ A}, V_{GS} = 10 \text{ V}$</td>
<td>-</td>
<td>$10$</td>
<td>$13$</td>
<td>nC</td>
<td></td>
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<tr>
<td>$C_{rss}$</td>
<td>Reverse Transfer Capacitance $V_{DS} = 25 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$</td>
<td>-</td>
<td>$5$</td>
<td>$7.5$</td>
<td>pF</td>
<td></td>
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<tr>
<td>$Q_{Gtot}$</td>
<td>Total Gate Charge at 10V $V_{DS} = 400 \text{ V}, I_D = 4.0 \text{ A}, V_{GS} = 10 \text{ V}$</td>
<td>-</td>
<td>$2.5$</td>
<td>-</td>
<td>nC</td>
<td></td>
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<tr>
<td>$Q_{gs}$</td>
<td>Gate to Source Gate Charge $V_{DS} = 25 \text{ V}, I_D = 4.0 \text{ A}, V_{GS} = 0 \text{ V}$</td>
<td>-</td>
<td>$4$</td>
<td>-</td>
<td>nC</td>
<td></td>
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<td>$Q_{gd}$</td>
<td>Gate to Drain “Miller” Charge $V_{DS} = 400 \text{ V}, I_D = 4.0 \text{ A}$</td>
<td>-</td>
<td>$220$</td>
<td>-</td>
<td>-</td>
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#### Switching Characteristics

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<tr>
<th>Symbol</th>
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<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$t_{on}$</td>
<td>Turn-On Delay Time $V_{DD} = 250 \text{ V}, I_D = 4.0 \text{ A}, V_{GS} = 10 \text{ V}$</td>
<td>-</td>
<td>$15$</td>
<td>$40$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_r$</td>
<td>Turn-On Rise Time $V_{DD} = 250 \text{ V}, I_D = 4.0 \text{ A}, V_{GS} = 10 \text{ V}, R_{G} = 25 \Omega$</td>
<td>-</td>
<td>$20$</td>
<td>$50$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>Turn-Off Delay Time $V_{DD} = 250 \text{ V}, I_D = 4.0 \text{ A}, V_{GS} = 10 \text{ V}$</td>
<td>-</td>
<td>$35$</td>
<td>$80$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_f$</td>
<td>Turn-Off Fall Time $V_{DD} = 250 \text{ V}, I_D = 4.0 \text{ A}$</td>
<td>-</td>
<td>$20$</td>
<td>$50$</td>
<td>ns</td>
<td></td>
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#### 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>$I_{DS}$</td>
<td>Maximum Continuous Drain to Source Diode Forward Current</td>
<td>-</td>
<td>$-4.0$</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>$16$</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$V_{DS}$</td>
<td>Drain to Source Diode Forward Voltage $V_{GS} = 0 \text{ V}, I_{DS} = 4.0 \text{ A}$</td>
<td>-</td>
<td>$1.4$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Reverse Recovery Time $V_{GS} = 0 \text{ V}, I_{DS} = 4.0 \text{ A}$</td>
<td>-</td>
<td>$-230$</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Reverse Recovery Charge $di/dt = 100 \text{ A/\mu s}$</td>
<td>-</td>
<td>$0.9$</td>
<td>μC</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Repetitive rating: pulse-width limited by maximum junction temperature.
2. $L = 27 \text{ mH}, I_{AS} = 4.0 \text{ A}, V_{CO} = 50 \text{ V}, R_{G} = 25 \Omega$, starting $T_J = 25^\circ C$.
3. $I_{DS} \leq 4.0 \text{ A}, di/dt \leq 200 \text{ A/\mu s}, V_{DD} \leq BVDSS$, starting $T_J = 25^\circ C$.
4. Essentially independent of operating temperature typical characteristics.
Typical Performance Characteristics

Figure 1. On-Region Characteristics

- $V_{DS} = 12.0V$
- $10.0V$
- $9.0V$
- $8.0V$
- $7.0V$
- $6.5V$
- $6.0V$
- $5.5V$

$\text{IO, Drain Current [A]}$

$\text{VDS, Drain-Source Voltage [V]}$

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

Figure 2. Transfer Characteristics

- $V_{DS} = 20V$
- 150°C
- 25°C
- -55°C

$\text{IO, Drain Current [A]}$

$\text{VGS, Gate-Source Voltage [V]}$

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

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

- $V_{GS} = 10V$
- $V_{GS} = 20V$

$R_{DS(ON)} [Ω]$

$\text{IO, Drain Current [A]}$

*Note: TC = 25°C

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

- $V_{DS} = 120V$
- $V_{DS} = 300V$
- $V_{DS} = 480V$

$\text{IS, Reverse Drain Current [A]}$

$\text{VSD, Body Diode Forward Voltage [V]}$

*Note: ID = 4A

Figure 5. Capacitance Characteristics

- $C_{oss} = Cgs + Cgd$
- $C_{iss} = Cgs$
- $C_{iss} = Cgd$

$\text{Capacitance [pF]}$

$\text{VDS, Drain-Source Voltage [V]}$

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

Figure 6. Gate Charge Characteristics

- $V_{DS} = 120V$
- $V_{DS} = 300V$
- $V_{DS} = 480V$

$\text{VGS, Gate-Source Voltage [V]}$

$\text{Qg, Total Gate Charge [nC]}$

*Note: ID = 4A

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Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

- Breakdown Voltage Variation vs. Temperature
  - Notes:
    1. VGS = 0V
    2. ID = 250 μA

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

Figure 8. On-Resistance Variation vs. Temperature

- On-Resistance Variation vs. Temperature
  - Notes:
    1. VGS = 10V
    2. ID = 2.0A

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

Figure 9. Maximum Safe Operating Area

- Maximum Safe Operating Area
  - Notes:
    1. TC = 25°C
    2. TJ = 150°C
    3. Single Pulse

![Graph showing Maximum Safe Operating Area](image)

Figure 10. Maximum Drain Current vs. Case Temperature

- Maximum Drain Current vs. Case Temperature
  - Notes:
    1. ZθJC(t) = 1.5°C/W Max.
    2. Duty Factor, D = t1/t2
    3. TJM - TC = PDM * ZθJC(t)

![Graph showing Maximum Drain Current vs. Case Temperature](image)

Figure 11. Transient Thermal Response Curve

- Transient Thermal Response Curve
  - Notes:
    1. ZθJC(t) = 1.5°C/W Max.
    2. Duty Factor, D = t1/t2
    3. TJM - TC = PDM * ZθJC(t)

![Graph showing Transient Thermal Response Curve](image)
Figure 12. Gate Charge Test Circuit & Waveform

Figure 13. Resistive Switching Test Circuit & Waveforms

Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms
Figure 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms

- Driver: Same Type as DUT
- $\frac{d}{dt}$ controlled by $R_G$
- $I_{SD}$ controlled by pulse period
- $V_{GS}$
- $V_{DD}$
- $V_{DS}$
- $L$
- $I_{FM}$, body diode forward current
- $I_{RM}$, body diode reverse current
- Body diode recovery $\frac{d}{dt}$
- Body diode forward voltage drop
Mechanical Dimensions

Figure 16. TO252 (D-PAK), Molded, 3-Lead, Option AA&AB

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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>
</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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