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.
# FQD11P06 / FQU11P06

## P-Channel QFET® MOSFET

-60 V, -9.4 A, 185 mΩ

### Description

This P-Channel enhancement mode power MOSFET is produced using Fairchild Semiconductor’s proprietary planar stripe and DMOS technology. This advanced MOSFET technology has been especially tailored to reduce on-state resistance, and to provide superior switching performance and high avalanche energy strength. These devices are suitable for switched mode power supplies, audio amplifier, DC motor control, and variable switching power applications.

### Features

- -9.4 A, -60 V, \( R_{\text{DS(on)}} \) = 185 mΩ (Max.) @ \( V_{\text{GS}} = -10 \) V, \( I_D = -4.7 \) A
- Low Gate Charge (Typ. 13 nC)
- Low \( Crss \) (Typ. 45 pF)
- 100% Avalanche Tested

### Absolute Maximum Ratings

\( T_C = 25^\circ \text{C} \) unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>FQD11P06TM / FQU11P06TU</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{DS}} )</td>
<td>Drain-Source Voltage</td>
<td>-60</td>
<td>V</td>
</tr>
<tr>
<td>( I_D )</td>
<td>Drain Current</td>
<td>- Continuous (( T_C = 25^\circ \text{C} ))</td>
<td>-9.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Continuous (( T_C = 100^\circ \text{C} ))</td>
<td>-5.95</td>
</tr>
<tr>
<td>( I_{\text{DM}} )</td>
<td>Drain Current - Pulsed (Note 1)</td>
<td>-37.6</td>
<td>A</td>
</tr>
<tr>
<td>( V_{\text{GS}} )</td>
<td>Gate-Source Voltage</td>
<td>± 30</td>
<td>V</td>
</tr>
<tr>
<td>( E_{\text{AS}} )</td>
<td>Single Pulsed Avalanche Energy (Note 2)</td>
<td>160</td>
<td>mJ</td>
</tr>
<tr>
<td>( I_{\text{AR}} )</td>
<td>Avalanche Current (Note 1)</td>
<td>-9.4</td>
<td>A</td>
</tr>
<tr>
<td>( E_{\text{AR}} )</td>
<td>Repetitive Avalanche Energy (Note 1)</td>
<td>3.8</td>
<td>mJ</td>
</tr>
<tr>
<td>( \frac{dv}{dt} )</td>
<td>Peak Diode Recovery ( dv/dt ) (Note 3)</td>
<td>-7.0</td>
<td>V/ns</td>
</tr>
<tr>
<td>( P_D )</td>
<td>Power Dissipation (( T_A = 25^\circ \text{C} )) *</td>
<td>2.5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>Power Dissipation (( T_C = 25^\circ \text{C} ))</td>
<td>38</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>- Derate above 25°C</td>
<td>0.3</td>
<td>W/°C</td>
</tr>
<tr>
<td>( T_J, T_{\text{STG}} )</td>
<td>Operating and Storage Temperature Range</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>°C</td>
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### Thermal Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>FQD11P06TM / FQU11P06TU</th>
<th>Unit</th>
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<tbody>
<tr>
<td>( R_{\text{JUC}} )</td>
<td>Thermal Resistance, Junction to Case, Max.</td>
<td>3.28</td>
<td>°C/W</td>
</tr>
<tr>
<td>( R_{\text{JJA}} )</td>
<td>Thermal Resistance, Junction to Ambient (Minimum Pad of 2-oz Copper), Max.</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thermal Resistance, Junction to Ambient (*1 in² Pad of 2-oz Copper), Max.</td>
<td>50</td>
<td></td>
</tr>
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## Package Marking and Ordering Information

<table>
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<tr>
<th>Part Number</th>
<th>Top Mark</th>
<th>Package</th>
<th>Packing Method</th>
<th>Reel Size</th>
<th>Tape Width</th>
<th>Quantity</th>
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</thead>
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<tr>
<td>FQD11P06TM</td>
<td>FQD11P06</td>
<td>D-PAK</td>
<td>Tape and Reel</td>
<td>330 mm</td>
<td>16 mm</td>
<td>2500 units</td>
</tr>
<tr>
<td>FQU11P06TU</td>
<td>FQU11P06</td>
<td>I-PAK</td>
<td>Tube</td>
<td>N/A</td>
<td>N/A</td>
<td>70 units</td>
</tr>
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</table>

## Electrical Characteristics

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

<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>$BVDSS$</td>
<td>Drain-Source Breakdown Voltage $V_{GS} = 0, V, I_D = -250, \mu A$</td>
<td>$-60$</td>
<td>--</td>
<td>--</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$\Delta BVDSS$ / $\Delta T_J$</td>
<td>Breakdown Voltage Temperature Coefficient $I_D = -250, \mu A$, Referenced to $25^\circ C$</td>
<td>--</td>
<td>-0.07</td>
<td>--</td>
<td>V/$^\circ C$</td>
<td></td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>Zero Gate Voltage Drain Current $V_{DS} = -60, V, V_{GS} = 0, V$</td>
<td>--</td>
<td>--</td>
<td>-1</td>
<td>$\mu A$</td>
<td></td>
</tr>
<tr>
<td>$I_{GSFF}$</td>
<td>Gate-Body Leakage Current, Forward $V_{GS} = -25, V, V_{DS} = 0, V$</td>
<td>--</td>
<td>--</td>
<td>-100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$I_{GSSR}$</td>
<td>Gate-Body Leakage Current, Reverse $V_{GS} = 25, V, V_{DS} = 0, V$</td>
<td>--</td>
<td>--</td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>Gate Threshold Voltage $V_{DS} = V_{GS}, I_D = -250, \mu A$</td>
<td>--</td>
<td>-2.0</td>
<td>--</td>
<td>-4.0</td>
<td>V</td>
</tr>
<tr>
<td>$R_{DS(on)}$</td>
<td>Static Drain-Source On-Resistance $V_{GS} = -10, V, I_D = -4.7, A$</td>
<td>--</td>
<td>0.15</td>
<td>0.185</td>
<td>$\Omega$</td>
<td></td>
</tr>
<tr>
<td>$g_{FS}$</td>
<td>Forward Transconductance $V_{DS} = -30, V, I_D = -4.7, A$</td>
<td>--</td>
<td>4.9</td>
<td>--</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>$C_{iss}$</td>
<td>Input Capacitance $V_{DS} = -25, V, V_{GS} = 0, V$, $f = 1.0, MHz$</td>
<td>--</td>
<td>420</td>
<td>550</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{oss}$</td>
<td>Output Capacitance</td>
<td>--</td>
<td>195</td>
<td>250</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{rss}$</td>
<td>Reverse Transfer Capacitance</td>
<td>--</td>
<td>45</td>
<td>60</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$t_{(on)}$</td>
<td>Turn-On Delay Time $V_{DD} = -30, V, I_D = -5.7, A$, $R_G = 25, \Omega$</td>
<td>--</td>
<td>6.5</td>
<td>25</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_r$</td>
<td>Turn-On Rise Time</td>
<td>--</td>
<td>40</td>
<td>90</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{(off)}$</td>
<td>Turn-Off Delay Time</td>
<td>--</td>
<td>15</td>
<td>40</td>
<td>ns</td>
<td></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>
<tr>
<td>$Q_g$</td>
<td>Total Gate Charge $V_{DS} = -48, V, I_D = -11.4, A$, $V_{GS} = -10, V$</td>
<td>--</td>
<td>13</td>
<td>17</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>$Q_{gs}$</td>
<td>Gate-Source Charge</td>
<td>--</td>
<td>2.0</td>
<td>--</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>$Q_{gd}$</td>
<td>Gate-Drain Charge</td>
<td>--</td>
<td>6.3</td>
<td>--</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>$I_{SD}$</td>
<td>Maximum Continuous Drain-Source Diode Forward Current</td>
<td>--</td>
<td>--</td>
<td>-9.4</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$I_{GMS}$</td>
<td>Maximum Pulsed Drain-Source Diode Forward Current</td>
<td>--</td>
<td>--</td>
<td>-37.6</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$V_{SD}$</td>
<td>Drain-Source Diode Forward Voltage $V_{GS} = 0, V, I_S = -9.4, A$</td>
<td>--</td>
<td>--</td>
<td>-4.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Reverse Recovery Time $V_{GS} = 0, V, I_S = -11.4, A$, $dV_{DS}/dt &lt; 300, A/\mu s$</td>
<td>--</td>
<td>83</td>
<td>--</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Reverse Recovery Charge $dI_{DS}/dt = 100, A/\mu s$</td>
<td>--</td>
<td>0.26</td>
<td>--</td>
<td>$\mu C$</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2. $L = 2.1\, mH, I_{DS} = -9.4\, A, V_{DD} = -25\, V, R_G = 25\, \Omega$, starting $T_J = 25^\circ C$.
3. $I_{DS} \leq -11.4\, A, d\left| V_{DS}\right|/dt \leq 300\, A/\mu s, V_{DD} < BVDSS$, starting $T_J = 25^\circ C$.
4. Essentially independent of operating temperature.
Typical 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. Transient Thermal Response Curve
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

- DUT
- V_DS
- ISD
- Driver
- Compliment of DUT (N-Channel)
- RG
- V_GS
- V_DD
- L
- Body Diode Reverse Current
- Body Diode Forward Current
- V_DS
- V_SD
- Body Diode Forward Voltage Drop
- Body Diode Recovery dv/dt
- dv/dt controlled by RG
- I_SD controlled by pulse period

The diagram illustrates the test circuit for measuring peak diode recovery dv/dt in a P-channel MOSFET (QFET). The circuit includes a DUT (Device Under Test) which is a P-channel MOSFET, a driver, and a complement of DUT (N-channel). The test involves applying a gate pulse to the driver to control the dv/dt, while the body diode currents (forward and reverse) are monitored. The waveforms show the voltage and current changes during the test period.
Mechanical Dimensions

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

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Figure 17. TO251 (I-PAK), Molded, 3-Lead

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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>
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