FQP10N60C / FQPF10N60C  
600V N-Channel MOSFET

Features
- 9.5A, 600V, \( R_{\text{DS(on)}} = 0.73\Omega @ V_{GS} = 10 \text{ V} \)
- Low gate charge (typical 44 nC)
- Low Crss (typical 18 pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability

Description
These N-Channel enhancement mode power field effect transistors are produced using Fairchild's proprietary, planar stripe, DMOS technology.

This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode. These devices are well suited for high efficiency switched mode power supplies, active power factor correction, electronic lamp ballasts based on half bridge topology.

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Parameter</th>
<th>FQP10N60C</th>
<th>FQPF10N60C</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{\text{DSS}})</td>
<td>Drain-Source Voltage</td>
<td>600</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_D)</td>
<td>Drain Current</td>
<td>- Continuous ((T_C = 25\text{°C}))</td>
<td>9.5</td>
<td>9.5 *</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Continuous ((T_C = 100\text{°C}))</td>
<td>5.7</td>
<td>5.7 *</td>
<td>A</td>
</tr>
<tr>
<td>(I_{\text{DM}})</td>
<td>Drain Current</td>
<td>- Pulsed ((\text{Note 1}))</td>
<td>38</td>
<td>38 *</td>
<td>A</td>
</tr>
<tr>
<td>(V_{\text{GSS}})</td>
<td>Gate-Source Voltage</td>
<td>± 30</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(E_{\text{AS}})</td>
<td>Single Pulsed Avalanche Energy</td>
<td>(\text{Note 2})</td>
<td>700</td>
<td>mJ</td>
<td></td>
</tr>
<tr>
<td>(I_{\text{AR}})</td>
<td>Avalanche Current</td>
<td>(\text{Note 1})</td>
<td>9.5</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>(E_{\text{AR}})</td>
<td>Repetitive Avalanche Energy</td>
<td>(\text{Note 1})</td>
<td>15.6</td>
<td>mJ</td>
<td></td>
</tr>
<tr>
<td>(dv/dt)</td>
<td>Peak Diode Recovery (dv/dt)</td>
<td>(\text{Note 3})</td>
<td>4.5</td>
<td>V/ns</td>
<td></td>
</tr>
<tr>
<td>(P_D)</td>
<td>Power Dissipation ((T_C = 25\text{°C}))</td>
<td>156</td>
<td>W</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Derate above 25°C</td>
<td>1.25</td>
<td>0.4</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>
<td></td>
<td></td>
</tr>
<tr>
<td>(T_L)</td>
<td>Maximum lead temperature for soldering purposes, (1/8)&quot; from case for 5 seconds</td>
<td>300</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Drain current limited by maximum junction temperature.

Thermal Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>FQP10N60C</th>
<th>FQPF10N60C</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R_{\text{JJC}})</td>
<td>Thermal Resistance, Junction-to-Case</td>
<td>0.8</td>
<td>2.5</td>
<td>°C/W</td>
</tr>
<tr>
<td>(R_{\text{JCS}})</td>
<td>Thermal Resistance, Case-to-Sink Typ.</td>
<td>0.5</td>
<td>--</td>
<td>°C/W</td>
</tr>
<tr>
<td>(R_{\text{JUA}})</td>
<td>Thermal Resistance, Junction-to-Ambient</td>
<td>62.5</td>
<td>62.5</td>
<td>°C/W</td>
</tr>
</tbody>
</table>
### Package Marking and Ordering Information

<table>
<thead>
<tr>
<th>Device Marking</th>
<th>Device</th>
<th>Package</th>
<th>Reel Size</th>
<th>Tape Width</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>FQP10N60C</td>
<td>FQP10N60C</td>
<td>TO-220</td>
<td>--</td>
<td>--</td>
<td>50</td>
</tr>
<tr>
<td>FQPF10N60C</td>
<td>FQPF10N60C</td>
<td>TO-220F</td>
<td>--</td>
<td>--</td>
<td>50</td>
</tr>
</tbody>
</table>

### Electrical Characteristics

**TC = 25°C unless otherwise noted**

**Off Characteristics**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$BV_{DSS}$</td>
<td>Drain-Source Breakdown Voltage</td>
<td>$V_{DS} = 0 \text{ V}, I_D = 250 \mu\text{A}$</td>
<td>600</td>
<td>--</td>
<td>--</td>
<td>V</td>
</tr>
<tr>
<td>$\Delta BV_{DSS}/\Delta T_J$</td>
<td>Breakdown Voltage Temperature Coefficient</td>
<td>$I_D = 250 \mu\text{A},$ Referenced to 25°C</td>
<td>--</td>
<td>0.7</td>
<td>--</td>
<td>V/°C</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>Zero Gate Voltage Drain Current</td>
<td>$V_{DS} = 600 \text{ V}, V_{GS} = 0 \text{ V}$</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>μA</td>
</tr>
<tr>
<td>$IG_{SSF}$</td>
<td>Gate-Body Leakage Current, Forward</td>
<td>$V_{GS} = 30 \text{ V}, V_{DS} = 0 \text{ V}$</td>
<td>--</td>
<td>--</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$IG_{SSR}$</td>
<td>Gate-Body Leakage Current, Reverse</td>
<td>$V_{GS} = -30 \text{ V}, V_{DS} = 0 \text{ V}$</td>
<td>--</td>
<td>--</td>
<td>-100</td>
<td>nA</td>
</tr>
</tbody>
</table>

**On Characteristics**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{GS(th)}$</td>
<td>Gate Threshold Voltage</td>
<td>$V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$</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</td>
<td>$V_{GS} = 10 \text{ V}, I_D = 4.75 \text{ A}$</td>
<td>--</td>
<td>0.6</td>
<td>0.73</td>
<td>W</td>
</tr>
<tr>
<td>$g_{FS}$</td>
<td>Forward Transconductance</td>
<td>$V_{DS} = 40 \text{ V}, I_D = 4.75 \text{ A}$</td>
<td>(Note 4)</td>
<td>--</td>
<td>8.0</td>
<td>S</td>
</tr>
</tbody>
</table>

**Dynamic Characteristics**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{iss}$</td>
<td>Input Capacitance</td>
<td>$V_{DS} = 25 \text{ V}, V_{GS} = 0 \text{ V}$, $f = 1.0 \text{ MHz}$</td>
<td>--</td>
<td>1570</td>
<td>2040</td>
<td>pF</td>
</tr>
<tr>
<td>$C_{oss}$</td>
<td>Output Capacitance</td>
<td></td>
<td>--</td>
<td>166</td>
<td>215</td>
<td>pF</td>
</tr>
<tr>
<td>$C_{rss}$</td>
<td>Reverse Transfer Capacitance</td>
<td></td>
<td>--</td>
<td>18</td>
<td>24</td>
<td>pF</td>
</tr>
</tbody>
</table>

**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>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{d(on)}$</td>
<td>Turn-On Delay Time</td>
<td>$V_{DD} = 300 \text{ V}, I_D = 9.5\text{A},$ $R_G = 25 \Omega$</td>
<td>--</td>
<td>23</td>
<td>55</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{r}$</td>
<td>Turn-On Rise Time</td>
<td></td>
<td>--</td>
<td>69</td>
<td>150</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{d(0ff)}$</td>
<td>Turn-Off Delay Time</td>
<td></td>
<td>--</td>
<td>144</td>
<td>300</td>
<td>ns</td>
</tr>
<tr>
<td>$t_f$</td>
<td>Turn-Off Fall Time</td>
<td></td>
<td>--</td>
<td>77</td>
<td>165</td>
<td>ns</td>
</tr>
<tr>
<td>$Q_g$</td>
<td>Total Gate Charge</td>
<td>$V_{DS} = 480 \text{ V}, I_D = 9.5\text{A},$ $V_{GS} = 10 \text{ V}$</td>
<td>--</td>
<td>44</td>
<td>57</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{gs}$</td>
<td>Gate-Source Charge</td>
<td></td>
<td>--</td>
<td>6.7</td>
<td>--</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{gd}$</td>
<td>Gate-Drain Charge</td>
<td></td>
<td>--</td>
<td>18.5</td>
<td>--</td>
<td>nC</td>
</tr>
</tbody>
</table>

**Drain-Source Diode Characteristics and Maximum Ratings**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_S$</td>
<td>Maximum Continuous Drain-Source Diode Forward Current</td>
<td>--</td>
<td>--</td>
<td>9.5</td>
<td>A</td>
</tr>
<tr>
<td>$I_{SM}$</td>
<td>Maximum Pulsed Drain-Source Diode Forward Current</td>
<td>--</td>
<td>--</td>
<td>38</td>
<td>A</td>
</tr>
<tr>
<td>$V_{SD}$</td>
<td>Drain-Source Diode Forward Voltage</td>
<td>$V_{GS} = 0 \text{ V}, I_S = 9.5 \text{ A}$</td>
<td>--</td>
<td>--</td>
<td>1.4</td>
</tr>
<tr>
<td>$I_{TR}$</td>
<td>Reverse Recovery Time</td>
<td>$V_{DS} = 0 \text{ V}, I_S = 9.5 \text{ A},$ $dI_F/dt = 100 \text{ A/μs}$</td>
<td>(Note 4)</td>
<td>--</td>
<td>420</td>
</tr>
<tr>
<td>$Q_r$</td>
<td>Reverse Recovery Charge</td>
<td></td>
<td>--</td>
<td>4.2</td>
<td>--</td>
</tr>
</tbody>
</table>

**Notes:**

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. $L = 14.2\text{mH}$, $I_{DS(on)} = 9.5\text{ A}, V_{DD} = 50\text{V}, R_G = 25 \Omega,$ Starting $T_J = 25^\circ\text{C}$
3. $I_D \leq 9.5\text{A}, \frac{dI}{dt} \leq 200\text{A/μs}, V_{DD} \leq BV_{DSS},$ Starting $T_J = 25^\circ\text{C}$
4. Pulse Test : Pulse width $\leq 300\text{μs}$, Duty cycle $\leq 2\%$
5. Essentially independent of operating temperature
Typical Performance Characteristics

Figure 1. On-Region Characteristics

![Graph showing on-region characteristics with various VDS values.

Figure 2. Transfer Characteristics

![Graph showing transfer characteristics with various VGS values.

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

![Graph showing on-resistance variation with drain current and gate voltage.

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

![Graph showing body diode forward voltage variation with source current and temperature.

Figure 5. Capacitance Characteristics

![Graph showing capacitance with drain-source voltage.

Figure 6. Gate Charge Characteristics

![Graph showing gate charge with gate-source voltage and drain-source voltage.

Notes:
1. 250 µs Pulse Test
2. TC = 25°C
3. VDS = 40V
4. 250 µs Pulse Test
5. VGS = 0V
6. 250 µs Pulse Test
7. TJ = 25°C
Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

Figure 8. On-Resistance Variation vs. Temperature

Figure 9-1. Maximum Safe Operating Area for FQP10N60C

Figure 9-2. Maximum Safe Operating Area for FQPF10N60C

Figure 10. Maximum Drain Current vs. Case Temperature

* Notes:
  1. VGS = 0 V
  2. ID = 250 µA

BVDSS, (Normalized)
Drain-Source Breakdown Voltage

* Notes:
  1. VGS = 10 V
  2. ID = 4.75 A

RDS(ON), (Normalized)
Drain-Source On-Resistance

Operation in This Area is Limited by RDS(on)

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

ID, Drain Current [A]
VDS, Drain-Source Voltage [V]
Figure 11-1. Transient Thermal Response Curve for FQP10N60C

Figure 11-2. Transient Thermal Response Curve for FQPF10N60C

Notes:
1. $Z_{\theta JC}(t) = 0.8$ °C/W Max.
2. Duty Factor, $D = t_1/t_2$
3. $T_J - T_C = P_{DM} \cdot Z_{\theta JC}(t)$ for single pulse
Gate Charge Test Circuit & Waveform

 Resistive Switching Test Circuit & Waveforms

 Unclamped Inductive Switching Test Circuit & Waveforms
Peak Diode Recovery dv/dt Test Circuit & Waveforms

- DUT
- VDS
- L
- VDD
- I_{SD}
- I_{RM}, Body Diode Forward Current
- di/dt
- Body Diode Reverse Current
- V_{DS}, Body Diode Recovery dv/dt
- Body Diode Forward Voltage Drop

- D = \frac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}

- \text{\textbullet\ dv/dt controlled by } R_G

- \text{\textbullet\ } I_{SD} \text{ controlled by pulse period}
Mechanical Dimensions (Continued)

TO-220F

Dimensions in Millimeters
TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACEx™ FAST®
ActiveArray™ FAST™
Bottomless™ FPS™
Build it Now™ FRFET™
CoolFET™ GlobalOptoisolator™
CROSSVOLT™ GTO™
DOME™ HiSeC™
EcoSPARK™ i²C™
E²CMOS™ i-Lo™
EnSigna™ ImpliedDisconnect™
FACT™ IntelliMAX™
FACT Quiet Series™
Across the board. Around the world.™
The Power Franchise®
Programmable Active Droop™

ISPLANAR™
LittleFET™
MICROCOUPLER™
MicroFET™
MicroPak™
MICROWIRE™
MSX™
MSXPro™
OCX™
OCXPro™
OPTOLOGIC®
OPTOPLANAR™
OPTOPLANAR™
PACMAN™
POP™
Power247™
PowerEdge™
PowerSaver™
PowerTrench®
QFET®
QS™
QT Optoelectronics™
Quiet Series™
RapidConfigure™
RapidConnect™
μSerDes™
SILENT SWITCHER®
SMART START™
SPM™
Stealth™
SuperFET™
SuperSOT™-3
SuperSOT™-6

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD’S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

<table>
<thead>
<tr>
<th>Datasheet Identification</th>
<th>Product Status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advance Information</td>
<td>Formative or In Design</td>
<td>This 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>This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.</td>
</tr>
<tr>
<td>No Identification Needed</td>
<td>Full Production</td>
<td>This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.</td>
</tr>
<tr>
<td>Obsolete</td>
<td>Not In Production</td>
<td>This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.</td>
</tr>
</tbody>
</table>