FQP11N40C/FQPF11N40C
400V N-Channel MOSFET

Features
- 10.5 A, 400V, $R_{DS(on)} = 0.5 \Omega @ V_{GS} = 10$ V
- Low gate charge (typical 28 nC)
- Low Crss (typical 85pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability

Description
These N-Channel enhancement mode power field effect transitors 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>FQP11N40C</th>
<th>FQPF11N40C</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DSS}$</td>
<td>Drain-Source Voltage</td>
<td>400</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>Drain Current</td>
<td>- Continuous ($T_C = 25°C$)</td>
<td>10.5</td>
<td>10.5 *</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Continuous ($T_C = 100°C$)</td>
<td>6.6</td>
<td>6.6 *</td>
</tr>
<tr>
<td>$I_{DM}$</td>
<td>Drain Current</td>
<td>- Pulsed (Note 1)</td>
<td>42</td>
<td>42 *</td>
</tr>
<tr>
<td>$V_{GSS}$</td>
<td>Gate-Source Voltage</td>
<td></td>
<td>±30</td>
<td>V</td>
</tr>
<tr>
<td>$E_{AS}$</td>
<td>Single Pulsed Avalanche Energy (Note 2)</td>
<td></td>
<td>360</td>
<td>mJ</td>
</tr>
<tr>
<td>$I_{AR}$</td>
<td>Avalanche Current (Note 1)</td>
<td></td>
<td>11</td>
<td>A</td>
</tr>
<tr>
<td>$E_{AR}$</td>
<td>Repetitive Avalanche Energy (Note 1)</td>
<td></td>
<td>13.5</td>
<td>mJ</td>
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<tr>
<td>$dv/dt$</td>
<td>Peak Diode Recovery $dv/dt$ (Note 3)</td>
<td></td>
<td>4.5</td>
<td>V/ns</td>
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<tr>
<td>$P_D$</td>
<td>Power Dissipation ($T_C = 25°C$)</td>
<td></td>
<td>135</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Derate above 25°C</td>
<td></td>
<td>1.07</td>
</tr>
<tr>
<td>$T_J, T_{STG}$</td>
<td>Operating and Storage Temperature Range</td>
<td></td>
<td>-55 to +150</td>
<td>°C</td>
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<tr>
<td>$T_L$</td>
<td>Maximum lead temperature for soldering purposes, 1/8&quot; from case for 5 seconds</td>
<td></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>Symbol</th>
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<th>FQP11N40C</th>
<th>FQPF11N40C</th>
<th>Units</th>
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<tr>
<td>$R_{JIC}$</td>
<td>Thermal Resistance, Junction-to-Case</td>
<td>0.93</td>
<td>2.86</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{ICS}$</td>
<td>Thermal Resistance, Case-to-Sink Typ.</td>
<td>0.5</td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{JJA}$</td>
<td>Thermal Resistance, Junction-to-Ambient</td>
<td></td>
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<td>62.5</td>
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## Package Marking and Ordering Information

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<th>Reel Size</th>
<th>Tape Width</th>
<th>Quantity</th>
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<td>FQP11N40C</td>
<td>FQP11N40C</td>
<td>TO-220</td>
<td>--</td>
<td>--</td>
<td>50</td>
</tr>
<tr>
<td>FQPF11N40C</td>
<td>FQPF11N40C</td>
<td>TO-220F</td>
<td>--</td>
<td>--</td>
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## Electrical Characteristics

### Off Characteristics

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<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
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<tbody>
<tr>
<td>BVDS</td>
<td>Drain-Source Breakdown Voltage</td>
<td>VGS = 0 V, ID = 250 µA</td>
<td>400</td>
<td>--</td>
<td>--</td>
<td>V</td>
</tr>
<tr>
<td>ABVDS</td>
<td>Breakdown Voltage Temperature Coefficient</td>
<td>ID = 250 µA, Referenced to 25°C</td>
<td>--</td>
<td>0.54</td>
<td>--</td>
<td>V/°C</td>
</tr>
<tr>
<td>IDSS</td>
<td>Zero Gate Voltage Drain Current</td>
<td>VDS = 400 V, VGS = 0 V</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>IDSS</td>
<td>Zero Gate Voltage Drain Current</td>
<td>VDS = 320 V, TC = 125°C</td>
<td>--</td>
<td>--</td>
<td>10</td>
<td>µA</td>
</tr>
<tr>
<td>IGSSF</td>
<td>Gate-Body Leakage Current, Forward</td>
<td>VGS = 30 V, VDS = 0 V</td>
<td>--</td>
<td>--</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>IGSSR</td>
<td>Gate-Body Leakage Current, Reverse</td>
<td>VGS = -30 V, VDS = 0 V</td>
<td>--</td>
<td>--</td>
<td>-100</td>
<td>nA</td>
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### On Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
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<tbody>
<tr>
<td>VGStth</td>
<td>Gate Threshold Voltage</td>
<td>VDS = VGS, ID = 250 µA</td>
<td>400</td>
<td>--</td>
<td>2.0</td>
<td>V</td>
</tr>
<tr>
<td>RDS(on)</td>
<td>Static Drain-Source On-Resistance</td>
<td>VGS = 10 V, ID = 5.25 A</td>
<td>--</td>
<td>0.43</td>
<td>0.53</td>
<td>Ω</td>
</tr>
<tr>
<td>gFSS</td>
<td>Forward Transconductance</td>
<td>VDS = 40 V, ID = 5.25 A</td>
<td>--</td>
<td>7.1</td>
<td>--</td>
<td>S</td>
</tr>
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</table>

### Dynamic Characteristics

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<tr>
<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciss</td>
<td>Input Capacitance</td>
<td>VDS = 25 V, VGS = 0 V, f = 1.0 MHz</td>
<td>840</td>
<td>1090</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>Coss</td>
<td>Output Capacitance</td>
<td>--</td>
<td>250</td>
<td>325</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>Crss</td>
<td>Reverse Transfer Capacitance</td>
<td>--</td>
<td>85</td>
<td>110</td>
<td>pF</td>
<td></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>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tD(on)</td>
<td>Turn-On Delay Time</td>
<td>VDD = 200 V, ID = 10.5 A, RG = 25 Ω</td>
<td>14</td>
<td>40</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>tR</td>
<td>Turn-On Rise Time</td>
<td>--</td>
<td>89</td>
<td>190</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>tD(off)</td>
<td>Turn-Off Delay Time</td>
<td>--</td>
<td>81</td>
<td>170</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>tF</td>
<td>Turn-Off Fall Time</td>
<td>--</td>
<td>81</td>
<td>170</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Qg</td>
<td>Total Gate Charge</td>
<td>VDS = 320 V, ID = 10.5 A, VGS = 10 V</td>
<td>28</td>
<td>35</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>Qgs</td>
<td>Gate-Source Charge</td>
<td>--</td>
<td>4</td>
<td>--</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>Qgd</td>
<td>Gate-Drain Charge</td>
<td>--</td>
<td>15</td>
<td>--</td>
<td>nC</td>
<td></td>
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</table>

### Drain-Source Diode Characteristics and Maximum Ratings

<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>IS</td>
<td>Maximum Continuous Drain-Source Diode Forward Current</td>
<td>--</td>
<td>--</td>
<td>10.5</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>ISM</td>
<td>Maximum Pulsed Drain-Source Diode Forward Current</td>
<td>--</td>
<td>--</td>
<td>42</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>VSD</td>
<td>Drain-Source Diode Forward Voltage</td>
<td>VGS = 0 V, IS = 10.5 A</td>
<td>--</td>
<td>--</td>
<td>1.4</td>
<td>V</td>
</tr>
<tr>
<td>trr</td>
<td>Reverse Recovery Time</td>
<td>VGS = 0 V, IS = 10.5 A, dV / dt = 100 A/µs</td>
<td>290</td>
<td>--</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Qrr</td>
<td>Reverse Recovery Charge</td>
<td>--</td>
<td>2.4</td>
<td>--</td>
<td>µC</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. L = 5.7 mH, ISD = 10.5 A, VDD = 50 V, RG = 25 Ω. Starting TJ = 25°C
3. ISD ≤ 10.5 A, dV / dt ≤ 200 A/µs, VDD ≤ BVDS, Starting TJ = 25°C
4. Pulse Test : Pulse width ≤ 300 µs, Duty cycle ≤ 2%
5. Essentially independent of operating temperature
Typical Performance Characteristics

**Figure 1. On-Region Characteristics**

- $I_D$ vs. $V_{DS}$
- $V_{GS}$ vs. $I_D$

**Figure 2. Transfer Characteristics**

- $I_D$ vs. $V_{GS}$
- $V_{DS}$ vs. $V_{GS}$

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

- $R_{DS(ON)}$ vs. $I_D$
- $V_{GS}$ vs. $R_{DS(ON)}$

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

- $V_{F(BD)}$ vs. $I_S$
- $T_J$ vs. $V_{F(BD)}$

**Figure 5. Capacitance Characteristics**

- $C_{iss} = C_{ss} + C_{gd}$ (Cds = shorted)
- $C_{oss} = C_{ds} + C_{gd}$
- $C_{rss} = C_{gd}$

**Figure 6. Gate Charge Characteristics**

- $Q_G$ vs. $V_{DS}$
- $V_{GD}$ vs. $Q_G$
Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

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

Notes:
1. $V_{GS} = 0\, \text{V}$
2. $I_D = 250\, \mu\text{A}$

Figure 8. On-Resistance Variation vs. Temperature

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

Notes:
1. $V_{GS} = 10\, \text{V}$
2. $I_D = 5.25\, \text{A}$

Figure 9-1. Maximum Safe Operating Area of FQP3N50C

![Maximum Safe Operating Area of FQP3N50C](image)

Notes:
1. $V_{GS} = 0\, \text{V}$
2. $I_D = 250\, \mu\text{A}$

Figure 9-2. Maximum Safe Operating Area of FQPF3N50C

![Maximum Safe Operating Area of FQPF3N50C](image)

Notes:
1. $V_{GS} = 10\, \text{V}$
2. $I_D = 5.25\, \text{A}$

Figure 10. Maximum Drain Current

![Maximum Drain Current](image)

Notes:
1. $V_{GS} = 0\, \text{V}$
2. $I_D = 250\, \mu\text{A}$

Operation in this area is limited by $R_{DS(on)}$.

Notes:
1. $T_C = 25\, ^\circ\text{C}$
2. $T_J = 150\, ^\circ\text{C}$
3. Single Pulse

ID, Drain Current [A]
VDS, Drain-Source Voltage [V]
Figure 11-1. Transient Thermal Response Curve of FQP3N50C

Figure 11-2. Transient Thermal Response Curve of FQPF3N50C

Notes:
1. \( Z_{\theta JC}(t) = 0.93 \, ^\circ C/W \) Max.
2. Duty Factor, \( D = t_1/t_2 \)
3. \( T_{JM} - T_C = P_{DM} \cdot Z_{\theta JC}(t) \) single pulse

Notes:
1. \( Z_{\theta JC}(t) = 2.86 \, ^\circ C/W \) Max.
2. Duty Factor, \( D = t_1/t_2 \)
3. \( T_{JM} - T_C = P_{DM} \cdot Z_{\theta JC}(t) \) 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
- ISD
- Driver
- Same Type as DUT
- RG
- VDD
- L
- VGS
- ISD (DUT)
- VDS (DUT)

- dV/dt controlled by RG
- ISD controlled by pulse period

D = Gate Pulse Width
Gate Pulse Period

10V

IFM, Body Diode Forward Current
IRM, Body Diode Reverse Current

Body Diode Recovery dv/dt

Body Diode Forward Voltage Drop
Mechanical Dimensions (Continued)

Dimensions in Millimeters
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MicroPak™
MICROWIRE™
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QFET®
QT Optoelectronics™
Quiet Series™
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SuperFET™
SuperSOT™.3
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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>
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<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>
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<td>Full Production</td>
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<tr>
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<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>
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Rev. 115

FQP11N40C/FQPF11N40C 400V N-Channel MOSFET

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