



April 2000

**QFET™**

# FQPF4N60

## 600V N-Channel MOSFET

### General 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 switch mode power supply.

### Features

- 2.6A, 600V,  $R_{DS(on)} = 2.2\Omega @ V_{GS} = 10V$
- Low gate charge ( typical 15 nC)
- Low Crss ( typical 8.0 pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability



### Absolute Maximum Ratings T<sub>C</sub> = 25°C unless otherwise noted

| Symbol                            | Parameter   | FQPF4N60    | Units |
|-----------------------------------|---|-------------|-------|
| V <sub>DSS</sub>                  | Drain-Source Voltage  | 600         | V     |
| I <sub>D</sub>                    | Drain Current - Continuous (T <sub>C</sub> = 25°C)                            | 2.6         | A     |
|                                   | - Continuous (T <sub>C</sub> = 100°C)   | 1.64        | A     |
| I <sub>DM</sub>                   | Drain Current - Pulsed (Note 1)   | 10.4        | A     |
| V <sub>GSS</sub>                  | Gate-Source Voltage   | ± 30        | V     |
| E <sub>AS</sub>                   | Single Pulsed Avalanche Energy (Note 2)                                       | 260         | mJ    |
| I <sub>AR</sub>                   | Avalanche Current (Note 1)  | 2.6         | A     |
| E <sub>AR</sub>                   | Repetitive Avalanche Energy (Note 1)  | 3.6         | mJ    |
| dv/dt                             | Peak Diode Recovery dv/dt (Note 3)  | 4.5         | V/ns  |
| P <sub>D</sub>                    | Power Dissipation (T <sub>C</sub> = 25°C)                                     | 36          | W     |
|                                   | - Derate above 25°C   | 0.29        | W/°C  |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Temperature Range                                       | -55 to +150 | °C    |
| T <sub>L</sub>                    | Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds | 300         | °C    |

### Thermal Characteristics

| Symbol           | Parameter                               | Typ | Max  | Units |
|------------------|---|-----|------|-------|
| R <sub>θJC</sub> | Thermal Resistance, Junction-to-Case    | --  | 3.47 | °C/W  |
| R <sub>θJA</sub> | Thermal Resistance, Junction-to-Ambient | --  | 62.5 | °C/W  |

## Electrical Characteristics

$T_C = 25^\circ\text{C}$  unless otherwise noted

| Symbol                               | Parameter                                 | Test Conditions   | Min | Typ | Max  | Units                     |
|--------------------------------------|---|---|-----|-----|------|---------------------------|
| <b>Off Characteristics</b>           |   |   |     |     |      |                           |
| $BV_{DSS}$                           | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$               | 600 | --  | --   | V                         |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$ | --  | 0.6 | --   | $\text{V}/^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                | --  | --  | 10   | $\mu\text{A}$             |
|                                      |   | $V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$            | --  | --  | 100  | $\mu\text{A}$             |
| $I_{GSSF}$                           | Gate-Body Leakage Current, Forward        | $V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$                 | --  | --  | 100  | nA                        |
| $I_{GSSR}$                           | Gate-Body Leakage Current, Reverse        | $V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$                | --  | --  | -100 | nA                        |

### On Characteristics

|              |                                   |   |     |      |     |          |
|--------------|-----------------------------------|---|-----|------|-----|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$           | 3.0 | --   | 5.0 | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10\text{ V}, I_D = 1.3\text{ A}$          | --  | 1.77 | 2.2 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = 50\text{ V}, I_D = 1.3\text{ A}$ (Note 4) | --  | 3.1  | --  | S        |

### Dynamic Characteristics

|           |                              |  |    |     |     |    |
|-----------|------------------------------|--|----|-----|-----|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 520 | 670 | pF |
| $C_{oss}$ | Output Capacitance           |  | -- | 70  | 90  | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |  | -- | 8   | 11  | pF |

### Switching Characteristics

|              |                     |  |             |    |     |    |    |
|--------------|---------------------|--|-------------|----|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 300\text{ V}, I_D = 4.4\text{ A},$<br>$R_G = 25\ \Omega$     | --          | 13 | 35  | ns |    |
| $t_r$        | Turn-On Rise Time   |  | --          | 45 | 100 | ns |    |
| $t_{d(off)}$ | Turn-Off Delay Time |  | (Note 4, 5) | -- | 25  | 60 | ns |
| $t_f$        | Turn-Off Fall Time  |  | (Note 4, 5) | -- | 35  | 80 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 480\text{ V}, I_D = 4.4\text{ A},$<br>$V_{GS} = 10\text{ V}$ | --          | 15 | 20  | nC |    |
| $Q_{gs}$     | Gate-Source Charge  |  | (Note 4, 5) | -- | 3.4 | -- | nC |
| $Q_{gd}$     | Gate-Drain Charge   |  | (Note 4, 5) | -- | 7.1 | -- | nC |

### Drain-Source Diode Characteristics and Maximum Ratings

|          |   |   |    |      |     |               |
|----------|---|---|----|------|-----|---------------|
| $I_S$    | Maximum Continuous Drain-Source Diode Forward Current | --  | -- | 2.6  | A   |               |
| $I_{SM}$ | Maximum Pulsed Drain-Source Diode Forward Current     | --  | -- | 10.4 | A   |               |
| $V_{SD}$ | Drain-Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_S = 2.6\text{ A}$   | -- | --   | 1.4 | V             |
| $t_{rr}$ | Reverse Recovery Time                                 | $V_{GS} = 0\text{ V}, I_S = 4.4\text{ A},$<br>$di_F / dt = 100\text{ A}/\mu\text{s}$ (Note 4) | -- | 250  | --  | ns            |
| $Q_{rr}$ | Reverse Recovery Charge                               |   | -- | 1.5  | --  | $\mu\text{C}$ |

#### Notes:

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L = 71\text{ mH}, I_{AS} = 2.6\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 4.4\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$
4. Pulse Test : Pulse width  $\leq 300\ \mu\text{s}$ , Duty cycle  $\leq 2\%$
5. Essentially independent of operating temperature

Typical Characteristics

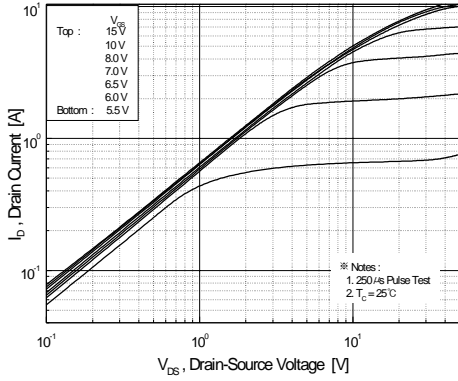


Figure 1. On-Region Characteristics

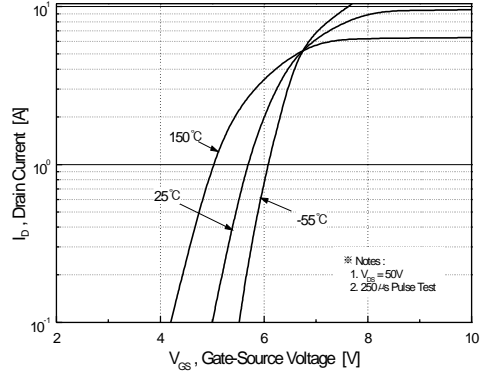


Figure 2. Transfer Characteristics

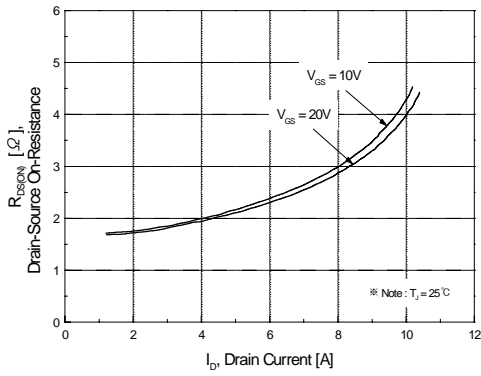


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

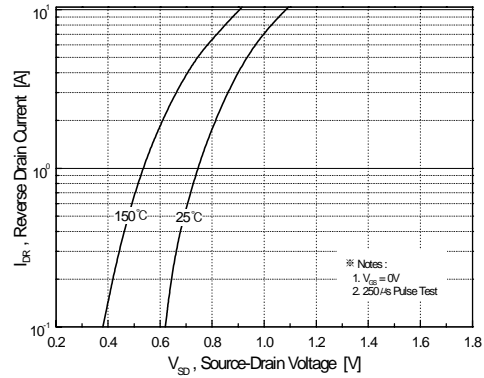


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

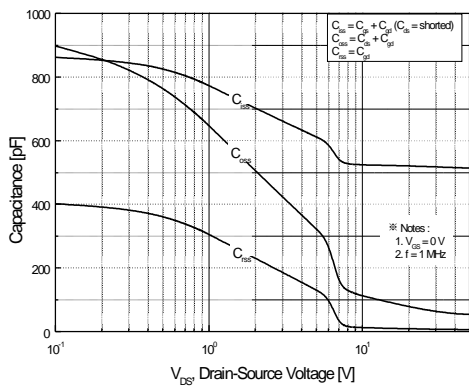


Figure 5. Capacitance Characteristics

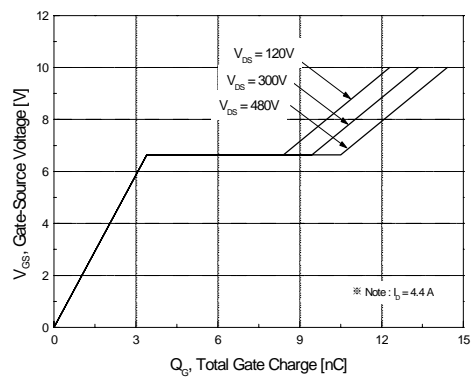
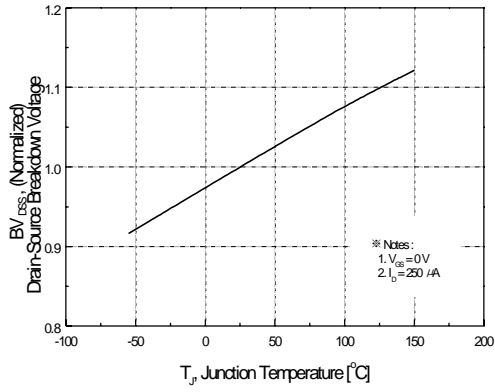
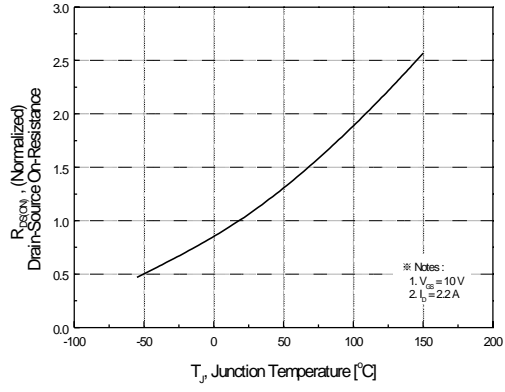


Figure 6. Gate Charge Characteristics

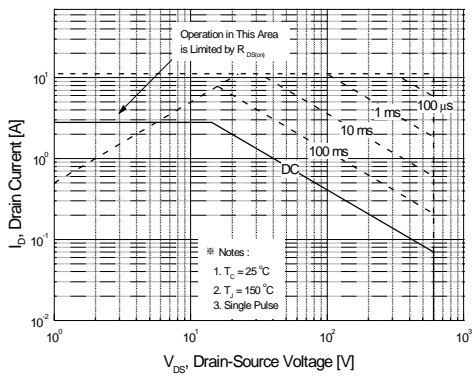
**Typical Characteristics** (Continued)



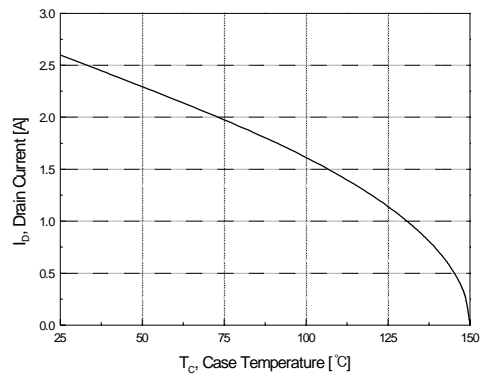
**Figure 7. Breakdown Voltage Variation vs. Temperature**



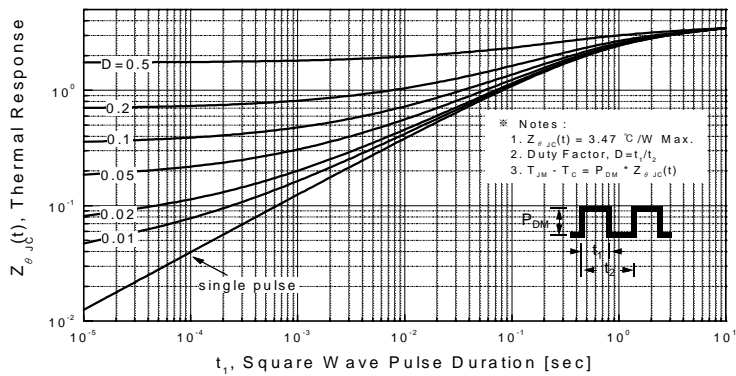
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



**Figure 10. Maximum Drain Current vs. Case Temperature**



**Figure 11. Transient Thermal Response Curve**

Gate Charge Test Circuit & Waveform



Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching Test Circuit & Waveforms

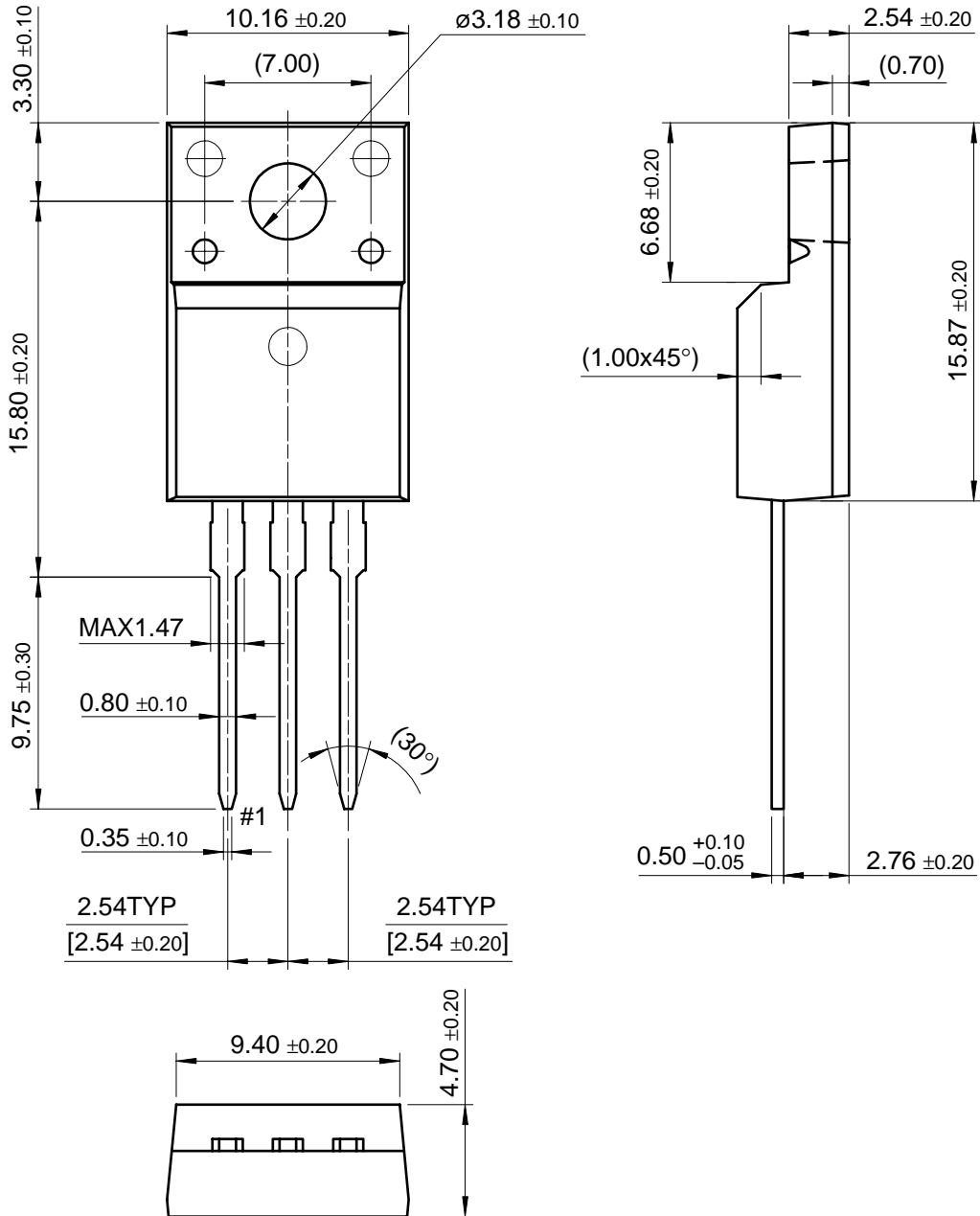


Peak Diode Recovery dv/dt Test Circuit & Waveforms



Package Dimensions

TO-220F



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| E <sup>2</sup> CMOS™ | PowerTrench®  | VCX™        |
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| FACT Quiet Series™   | QS™           |             |
| FAST®                | Quiet Series™ |             |
| FASTr™               | SuperSOT™-3   |             |
| GTO™                 | SuperSOT™-6   |             |

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