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# FCP4N60

## N-Channel SuperFET® MOSFET

600 V, 3.9 A, 1.2 Ω

### Features

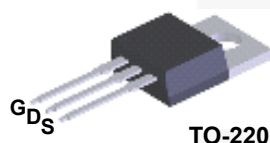
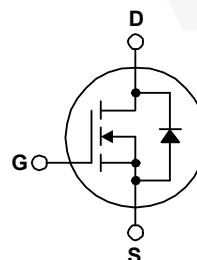
- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 1.0\ \Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 12.8\ \text{nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 32\ \text{pF}$ )
- 100% Avalanche Tested
- RoHS Compliant

### Application

- LCD / LED / PDP TV and Monitor Lighting
- Solar Inverter
- AC-DC Power Supply

### Description

SuperFET® MOSFET is Fairchild Semiconductor's first generation of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switching performance,  $dv/dt$  rate and higher avalanche energy. Consequently, SuperFET MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications.



### MOSFET Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted.

| Symbol         | Parameter                                                                                                | FCP4N60     | Unit                     |
|----------------|----------------------------------------------------------------------------------------------------------|-------------|--------------------------|
| $V_{DSS}$      | Drain-Source Voltage                                                                                     | 600         | V                        |
| $I_D$          | Drain Current<br>- Continuous ( $T_C = 25^\circ\text{C}$ )<br>- Continuous ( $T_C = 100^\circ\text{C}$ ) | 3.9<br>2.5  | A<br>A                   |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)                                                                          | 11.7        | A                        |
| $V_{GSS}$      | Gate-Source voltage                                                                                      | $\pm 30$    | V                        |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                                                  | 128         | mJ                       |
| $I_{AR}$       | Avalanche Current (Note 1)                                                                               | 3.9         | A                        |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                                                     | 5.0         | mJ                       |
| $dv/dt$        | Peak Diode Recovery $dv/dt$ (Note 3)                                                                     | 4.5         | V/ns                     |
| $P_D$          | Power Dissipation<br>( $T_C = 25^\circ\text{C}$ )<br>- Derate Above $25^\circ\text{C}$                   | 50<br>0.4   | W<br>W/ $^\circ\text{C}$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                                                  | -55 to +150 | $^\circ\text{C}$         |
| $T_L$          | Maximum Lead Temperature for Soldering,<br>1/8" from Case for 5 Seconds.                                 | 300         | $^\circ\text{C}$         |

### Thermal Characteristics

| Symbol          | Parameter                                     | FCP4N60 | Unit               |
|-----------------|-----------------------------------------------|---------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 2.5     | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 83      |                    |

## Package Marking and Ordering Information

| Part Number | Top Mark | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-------------|----------|---------|----------------|-----------|------------|----------|
| FCP4N60     | FCP4N60  | TO-220  | Tube           | N/A       | N/A        | 50 units |

## Electrical Characteristics $T_C = 25^\circ\text{C}$ unless otherwise noted.

| Symbol                                                 | Parameter                                             | Conditions                                                                                | Min. | Typ. | Max. | Unit |
|--------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------|------|------|------|------|
| Off Characteristics                                    |                                                       |                                                                                           |      |      |      |      |
| BV <sub>DSS</sub>                                      | Drain-Source Breakdown Voltage                        | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA, T <sub>J</sub> = 25°C                     | 600  | --   | --   | V    |
|                                                        |                                                       | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA, T <sub>J</sub> = 150°C                    | --   | 650  | --   | V    |
| ΔBV <sub>DSS</sub> / ΔT <sub>J</sub>                   | Breakdown Voltage Temperature Coefficient             | I <sub>D</sub> = 250 μA, Referenced to 25°C                                               | --   | 0.6  | --   | V/°C |
| BV <sub>DS</sub>                                       | Drain-Source Avalanche Breakdown Voltage              | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 3.9 A                                             | --   | 700  | --   | V    |
| I <sub>DSS</sub>                                       | Zero Gate Voltage Drain Current                       | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V                                            | --   | --   | 1    | μA   |
|                                                        |                                                       | V <sub>DS</sub> = 480 V, T <sub>C</sub> = 125°C                                           | --   | --   | 10   | μA   |
| I <sub>GSSF</sub>                                      | Gate-Body Leakage Current, Forward                    | V <sub>GS</sub> = 30 V, V <sub>DS</sub> = 0 V                                             | --   | --   | 100  | nA   |
| I <sub>GSSR</sub>                                      | Gate-Body Leakage Current, Reverse                    | V <sub>GS</sub> = -30 V, V <sub>DS</sub> = 0 V                                            | --   | --   | -100 | nA   |
| On Characteristics                                     |                                                       |                                                                                           |      |      |      |      |
| V <sub>GS(th)</sub>                                    | Gate Threshold Voltage                                | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                               | 3.0  | --   | 5.0  | V    |
| R <sub>DS(on)</sub>                                    | Static Drain-Source On-Resistance                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 2.0 A                                            | --   | 1.0  | 1.2  | Ω    |
| g <sub>FS</sub>                                        | Forward Transconductance                              | V <sub>DS</sub> = 40 V, I <sub>D</sub> = 2.0 A                                            | --   | 3.2  | --   | S    |
| Dynamic Characteristics                                |                                                       |                                                                                           |      |      |      |      |
| C <sub>iSS</sub>                                       | Input Capacitance                                     | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1.0 MHz                                | --   | 415  | 540  | pF   |
| C <sub>oSS</sub>                                       | Output Capacitance                                    |                                                                                           | --   | 210  | 275  | pF   |
| C <sub>rSS</sub>                                       | Reverse Transfer Capacitance                          |                                                                                           | --   | 19.5 | --   | pF   |
| C <sub>oSS</sub>                                       | Output Capacitance                                    | V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, f = 1.0 MHz                               | --   | 12   | 16   | pF   |
| C <sub>oSS</sub> eff.                                  | Effective Output Capacitance                          | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                                     | --   | 32   | --   | pF   |
| Switching Characteristics                              |                                                       |                                                                                           |      |      |      |      |
| t <sub>d(on)</sub>                                     | Turn-On Delay Time                                    | V <sub>DD</sub> = 300 V, I <sub>D</sub> = 3.9 A<br>R <sub>G</sub> = 25 Ω<br><br>(Note 4)  | --   | 16   | 45   | ns   |
| t <sub>r</sub>                                         | Turn-On Rise Time                                     |                                                                                           | --   | 45   | 100  | ns   |
| t <sub>d(off)</sub>                                    | Turn-Off Delay Time                                   |                                                                                           | --   | 36   | 85   | ns   |
| t <sub>f</sub>                                         | Turn-Off Fall Time                                    |                                                                                           | --   | 30   | 70   | ns   |
| Q <sub>g</sub>                                         | Total Gate Charge                                     | V <sub>DS</sub> = 480 V, I <sub>D</sub> = 3.9 A<br>V <sub>GS</sub> = 10 V<br><br>(Note 4) | --   | 12.8 | 16.6 | nC   |
| Q <sub>gs</sub>                                        | Gate-Source Charge                                    |                                                                                           | --   | 2.4  | --   | nC   |
| Q <sub>gd</sub>                                        | Gate-Drain Charge                                     |                                                                                           | --   | 7.1  | --   | nC   |
| Drain-Source Diode Characteristics and Maximum Ratings |                                                       |                                                                                           |      |      |      |      |
| I <sub>S</sub>                                         | Maximum Continuous Drain-Source Diode Forward Current |                                                                                           | --   | --   | 3.9  | A    |
| I <sub>SM</sub>                                        | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                           | --   | --   | 11.7 | A    |
| V <sub>SD</sub>                                        | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 3.9 A                                             | --   | --   | 1.4  | V    |
| t <sub>rr</sub>                                        | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 3.9 A                                             | --   | 277  | --   | ns   |
| Q <sub>rr</sub>                                        | Reverse Recovery Charge                               | dI <sub>F</sub> /dt =100 A/μs                                                             | --   | 2.07 | --   | μC   |

### Notes:

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 1.9\text{ A}$ ,  $V_{DD} = 50\text{ V}$ ,  $R_G = 25\text{ }\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 3.9\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

Figure 1. On-Region Characteristics

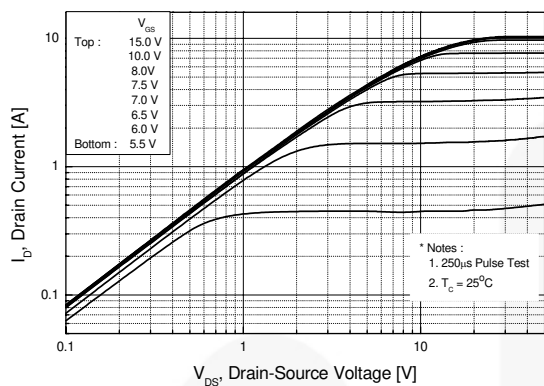


Figure 2. Transfer Characteristics

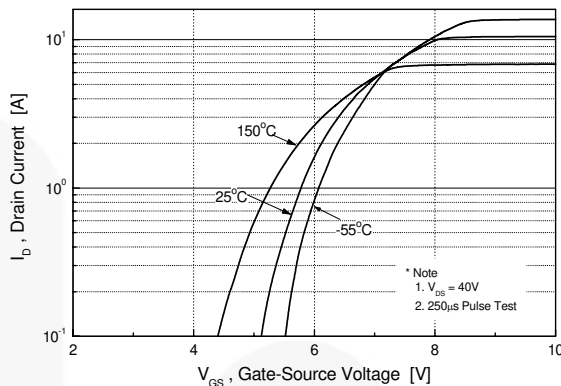


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

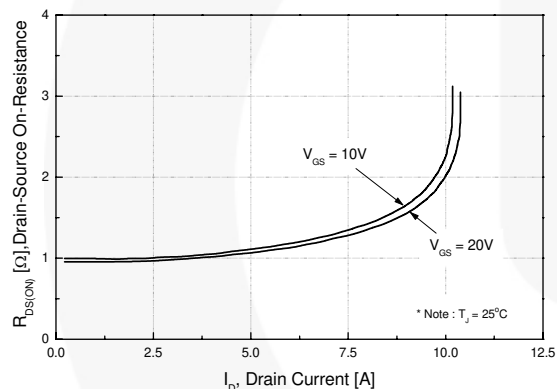


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

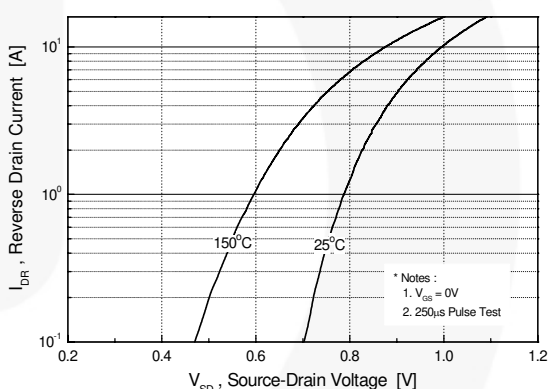


Figure 5. Capacitance Characteristics

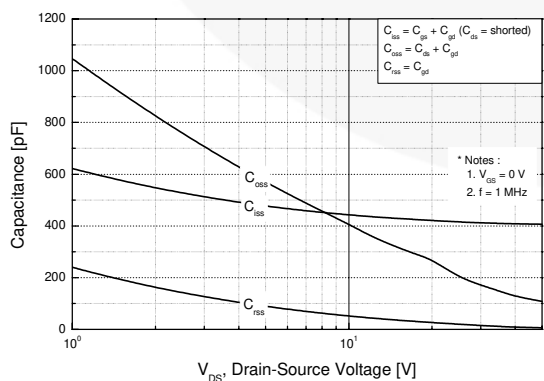
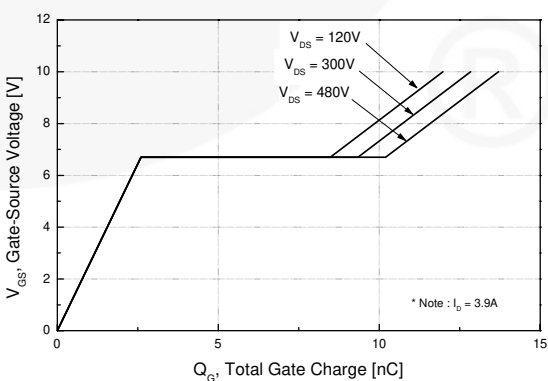


Figure 6. Gate Charge Characteristics



# Typical Performance Characteristics (Continued)

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

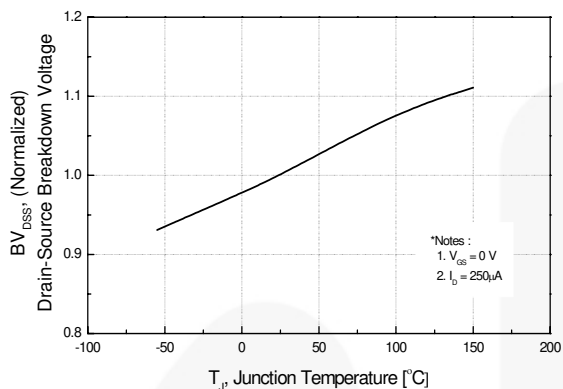


**Figure 8. On-Resistance Variation vs. Temperature**

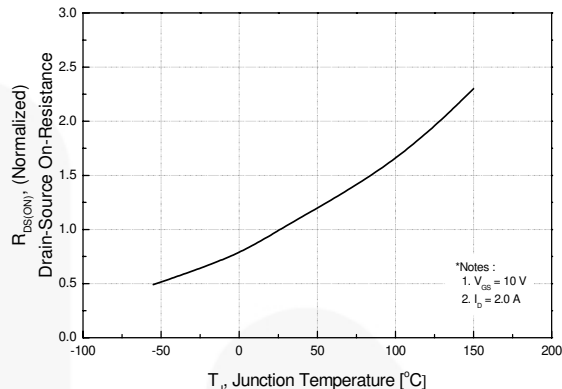


**Figure 9. Maximum Safe Operating Area**

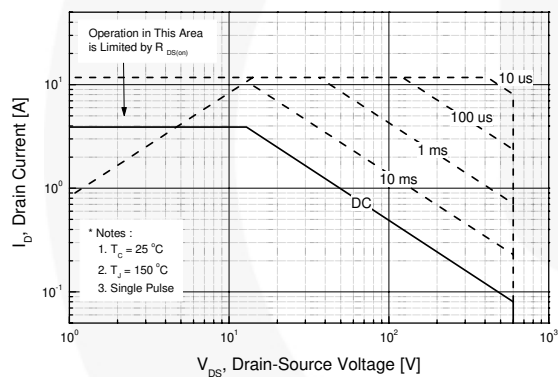


**Figure 10. Maximum Drain Current vs. Case Temperature**

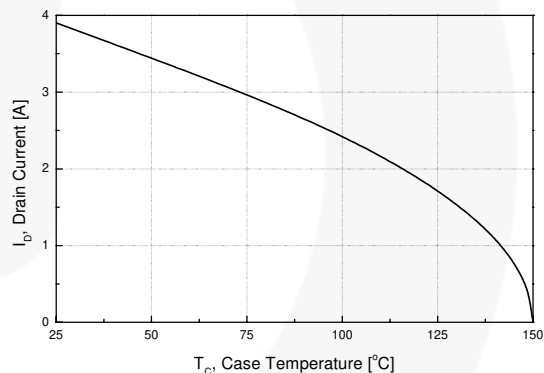
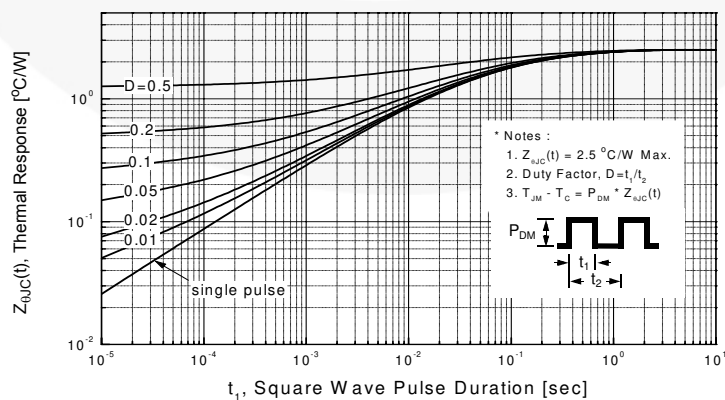


**Figure 11. Transient Thermal Response Curve**



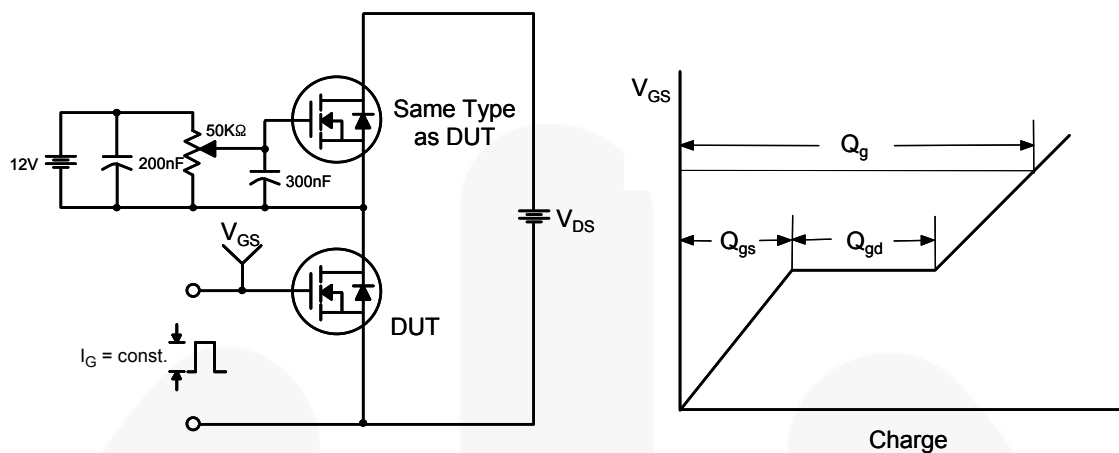


Figure 12. Gate Charge Test Circuit & Waveform

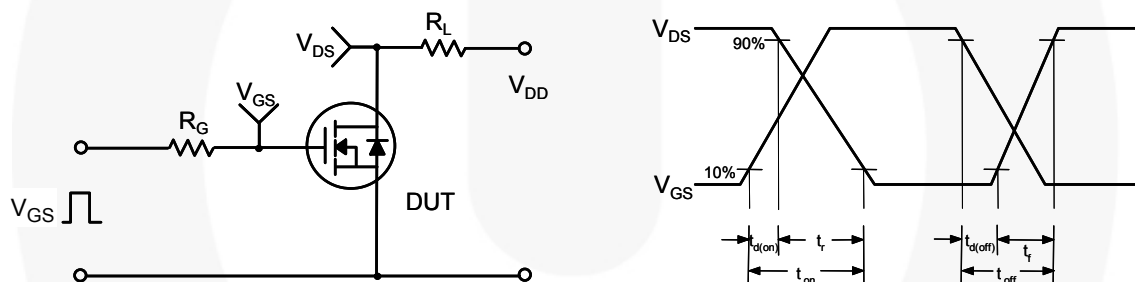


Figure 13. Resistive Switching Test Circuit & Waveforms

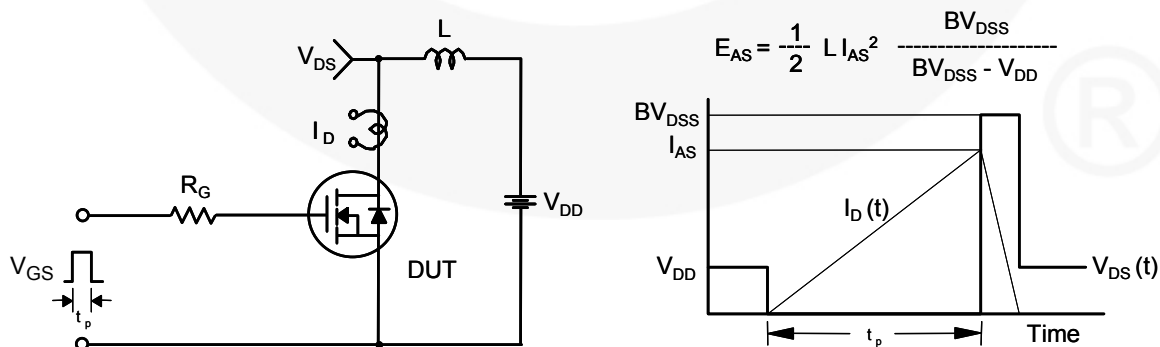


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms





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