



ON Semiconductor®

# FDC6333C

## 30V N & P-Channel PowerTrench® MOSFETs

### General Description

These N & P-Channel MOSFETs are produced using ON Semiconductor's advanced PowerTrench process that has been especially tailored to minimize on-state resistance and yet maintain superior switching performance.

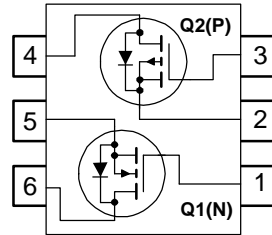
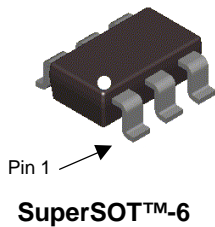
These devices have been designed to offer exceptional power dissipation in a very small footprint for applications where the bigger more expensive SO-8 and TSSOP-8 packages are impractical.

### Applications

- DC/DC converter
- Load switch
- LCD display inverter

### Features

- **Q1** 2.5 A, 30V.  $R_{DS(ON)} = 95 \text{ m}\Omega @ V_{GS} = 10 \text{ V}$   
 $R_{DS(ON)} = 150 \text{ m}\Omega @ V_{GS} = 4.5 \text{ V}$
- **Q2** -2.0 A, 30V.  $R_{DS(ON)} = 150 \text{ m}\Omega @ V_{GS} = -10 \text{ V}$   
 $R_{DS(ON)} = 220 \text{ m}\Omega @ V_{GS} = -4.5 \text{ V}$
- Low gate charge
- High performance trench technology for extremely low  $R_{DS(ON)}$ .
- SuperSOT -6 package: small footprint (72% smaller than SO-8); low profile (1mm thick).



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

| Symbol                            | Parameter  | Q1          | Q2   | Units |
|-----------------------------------|--|-------------|------|-------|
| V <sub>DSS</sub>                  | Drain-Source Voltage                             | 30          | -30  | V     |
| V <sub>GSS</sub>                  | Gate-Source Voltage                              | ±16         | ±25  | V     |
| I <sub>D</sub>                    | Drain Current – Continuous (Note 1a)             | 2.5         | -2.0 | A     |
|                                   | – Pulsed   | 8           | -8   |       |
| P <sub>D</sub>                    | Power Dissipation for Single Operation (Note 1a) | 0.96        |      | W     |
|                                   | (Note 1b)  | 0.9         |      |       |
|                                   | (Note 1c)  | 0.7         |      |       |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Junction Temperature Range | -55 to +150 |      | °C    |

### Thermal Characteristics

|                  |   |     |      |
|------------------|---|-----|------|
| R <sub>θJA</sub> | Thermal Resistance, Junction-to-Ambient (Note 1a) | 130 | °C/W |
| R <sub>θJC</sub> | Thermal Resistance, Junction-to-Case (Note 1)     | 60  | °C/W |

### Package Marking and Ordering Information

| Device Marking | Device   | Reel Size | Tape width | Quantity   |
|----------------|----------|-----------|------------|------------|
| .333           | FDC6333C | 7"        | 8mm        | 3000 units |

## Electrical Characteristics

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

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

### Off Characteristics

|                                      |   |   |                        |           |              |                      |
|--------------------------------------|---|---|------------------------|-----------|--------------|----------------------|
| $BV_{DSS}$                           | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$<br>$V_{GS} = 0\text{ V}, I_D = -250\ \mu\text{A}$                           | <b>Q1</b><br><b>Q2</b> | 30<br>-30 |              | V                    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\ \mu\text{A}, \text{Ref. to } 25^\circ\text{C}$<br>$I_D = -250\ \mu\text{A}, \text{Ref. to } 25^\circ\text{C}$ | <b>Q1</b><br><b>Q2</b> |           | 27<br>-22    | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 24\text{ V}, V_{GS} = 0\text{ V}$<br>$V_{DS} = -24\text{ V}, V_{GS} = 0\text{ V}$                               | <b>Q1</b><br><b>Q2</b> |           | 1<br>-1      | $\mu\text{A}$        |
| $I_{GSSF}$                           | Gate-Body Leakage, Forward                | $V_{GS} = 16\text{ V}, V_{DS} = 0\text{ V}$<br>$V_{GS} = 25\text{ V}, V_{DS} = 0\text{ V}$                                | <b>Q1</b><br><b>Q2</b> |           | 100<br>100   | nA                   |
| $I_{GSSR}$                           | Gate-Body Leakage, Reverse                | $V_{GS} = -16\text{ V}, V_{DS} = 0\text{ V}$<br>$V_{GS} = -25\text{ V}, V_{DS} = 0\text{ V}$                              | <b>Q1</b><br><b>Q2</b> |           | -100<br>-100 | nA                   |

### On Characteristics (Note 2)

|  |  |           |   |    |                  |                   |                      |
|--|--|-----------|---|----|------------------|-------------------|----------------------|
| $V_{GS(th)}$                           | Gate Threshold Voltage                         | <b>Q1</b> | $V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$   | 1  | 1.8              | 3                 | V                    |
|  |  | <b>Q2</b> | $V_{DS} = V_{GS}, I_D = -250\ \mu\text{A}$  | -1 | -1.8             | -3                |                      |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | <b>Q1</b> | $I_D = 250\ \mu\text{A}, \text{Ref. To } 25^\circ\text{C}$  |    | 4                |                   | mV/ $^\circ\text{C}$ |
|  |  | <b>Q2</b> | $I_D = -250\ \mu\text{A}, \text{Ref. to } 25^\circ\text{C}$   |    | -4               |                   |                      |
| $R_{DS(on)}$                           | Static Drain-Source On-Resistance              | <b>Q1</b> | $V_{GS} = 10\text{ V}, I_D = 2.5\text{ A}$<br>$V_{GS} = 4.5\text{ V}, I_D = 2.0\text{ A}$<br>$V_{GS} = 10\text{ V}, I_D = 2.5\text{ A}, T_J = 125^\circ\text{C}$      |    | 73<br>90<br>106  | 95<br>150<br>148  | m $\Omega$           |
|  |  | <b>Q2</b> | $V_{GS} = -10\text{ V}, I_D = -2.0\text{ A}$<br>$V_{GS} = -4.5\text{ V}, I_D = -1.7\text{ A}$<br>$V_{GS} = 10\text{ V}, I_D = -2.0\text{ A}, T_J = 125^\circ\text{C}$ |    | 95<br>142<br>149 | 130<br>220<br>216 |                      |
| $I_{D(on)}$                            | On-State Drain Current                         | <b>Q1</b> | $V_{GS} = 10\text{ V}, V_{DS} = 5\text{ V}$   | 8  |                  |                   | A                    |
|  |  | <b>Q2</b> | $V_{GS} = -10\text{ V}, V_{DS} = -5\text{ V}$   | -8 |                  |                   |                      |
| $g_{FS}$                               | Forward Transconductance                       | <b>Q1</b> | $V_{DS} = 5\text{ V}, I_D = 2.5\text{ A}$   |    | 7                |                   | S                    |
|  |  | <b>Q2</b> | $V_{DS} = -5\text{ V}, I_D = -2.0\text{ A}$   |    | 3                |                   |                      |

### Dynamic Characteristics

|            |                              |           |   |  |     |  |    |
|------------|------------------------------|-----------|---|--|-----|--|----|
| $C_{iss}$  | Input Capacitance            | <b>Q1</b> | $V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{MHz}$  |  | 282 |  | pF |
|            |                              | <b>Q2</b> | $V_{DS} = -15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{MHz}$ |  | 185 |  |    |
| $C_{oss}$  | Output Capacitance           | <b>Q1</b> | $V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{MHz}$  |  | 49  |  | pF |
|            |                              | <b>Q2</b> | $V_{DS} = -15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{MHz}$ |  | 56  |  |    |
| $C_{riss}$ | Reverse Transfer Capacitance | <b>Q1</b> | $V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{MHz}$  |  | 20  |  | pF |
|            |                              | <b>Q2</b> | $V_{DS} = -15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{MHz}$ |  | 26  |  |    |

### Switching Characteristics (Note 2)

|              |                     |           |  |  |     |     |    |
|--------------|---------------------|-----------|--|--|-----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | <b>Q1</b> | For <b>Q1</b> :<br>$V_{DS} = 15\text{ V}, I_{DS} = 1\text{ A}$<br>$V_{GS} = 10\text{ V}, R_{GEN} = 6\ \Omega$    |  | 4.5 | 9   | ns |
|              |                     | <b>Q2</b> |  |  | 4.5 | 9   |    |
| $t_r$        | Turn-On Rise Time   | <b>Q1</b> | For <b>Q2</b> :<br>$V_{DS} = -15\text{ V}, I_{DS} = -1\text{ A}$<br>$V_{GS} = -10\text{ V}, R_{GEN} = 6\ \Omega$ |  | 6   | 12  | ns |
|              |                     | <b>Q2</b> |  |  | 13  | 23  |    |
| $t_{d(off)}$ | Turn-Off Delay Time | <b>Q1</b> |  |  | 19  | 34  | ns |
|              |                     | <b>Q2</b> |  |  | 11  | 20  |    |
| $t_f$        | Turn-Off Fall Time  | <b>Q1</b> |  |  | 1.5 | 3   | ns |
|              |                     | <b>Q2</b> |  |  | 2   | 4   |    |
| $Q_g$        | Total Gate Charge   | <b>Q1</b> | For <b>Q1</b> :<br>$V_{DS} = 15\text{ V}, I_{DS} = 2.5\text{ A}$<br>$V_{GS} = 10\text{ V}, R_{GEN} = 6\ \Omega$  |  | 4.7 | 6.6 | nC |
|              |                     | <b>Q2</b> |  |  | 4.1 | 5.7 |    |
| $Q_{gs}$     | Gate-Source Charge  | <b>Q1</b> | For <b>Q2</b> :<br>$V_{DS} = -15\text{ V}, I_{DS} = -2.0\text{ A}$<br>$V_{GS} = -10\text{ V}$                    |  | 0.9 |     | nC |
|              |                     | <b>Q2</b> |  |  | 0.8 |     |    |
| $Q_{gd}$     | Gate-Drain Charge   | <b>Q1</b> |  |  | 0.6 |     | nC |
|              |                     | <b>Q2</b> |  |  | 0.4 |     |    |

### Electrical Characteristics

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

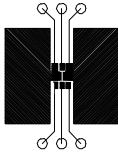
| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

#### Drain–Source Diode Characteristics and Maximum Ratings

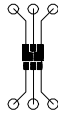
|          |   |    |   |          |      |      |   |
|----------|---|----|---|----------|------|------|---|
| $I_S$    | Maximum Continuous Drain–Source Diode Forward Current | Q1 |   |          | 0.8  | A    |   |
|          |   | Q2 |   |          | -0.8 |      |   |
| $V_{SD}$ | Drain–Source Diode Forward Voltage                    | Q1 | $V_{GS} = 0\text{ V}, I_S = 0.8\text{ A}$ | (Note 2) | 0.8  | 1.2  | V |
|          |   | Q2 | $V_{GS} = 0\text{ V}, I_S = 0.8\text{ A}$ | (Note 2) | 0.8  | -1.2 |   |

**Notes:**

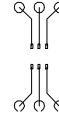
1.  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a)  $130^\circ\text{C/W}$  when mounted on a  $0.125\text{ in}^2$  pad of 2 oz. copper.



b)  $140^\circ\text{C/W}$  when mounted on a  $.004\text{ in}^2$  pad of 2 oz copper



c)  $180^\circ\text{C/W}$  when mounted on a minimum pad.

Scale 1 : 1 on letter size paper

2. Pulse Test: Pulse Width <  $300\mu\text{s}$ , Duty Cycle < 2.0%

## Typical Characteristics: N-Channel

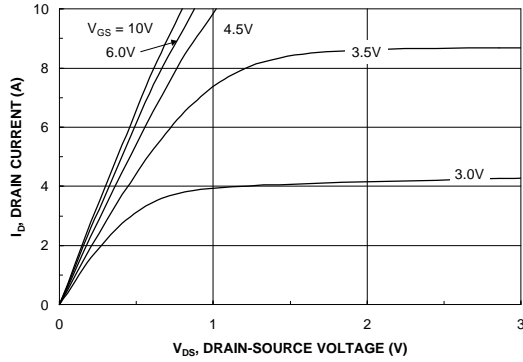


Figure 1. On-Region Characteristics.

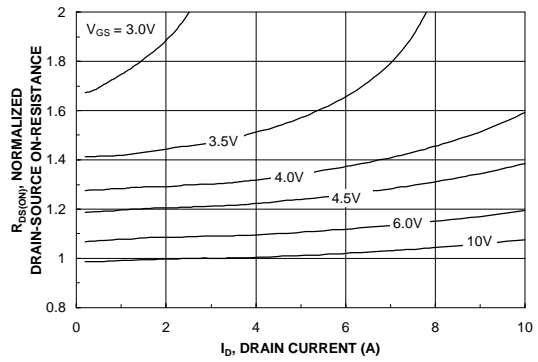


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.

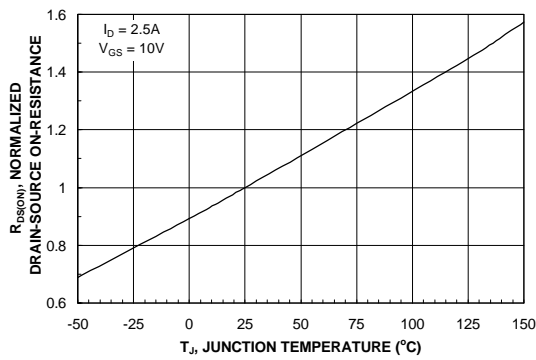


Figure 3. On-Resistance Variation with Temperature.

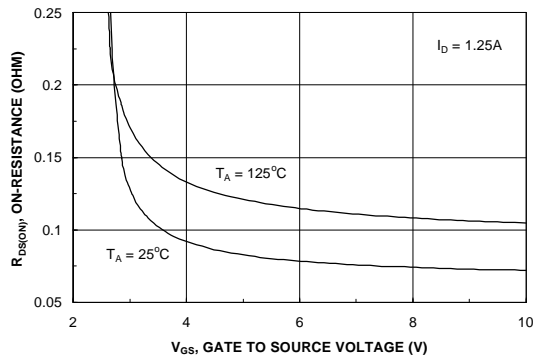


Figure 4. On-Resistance Variation with Gate-to-Source Voltage.

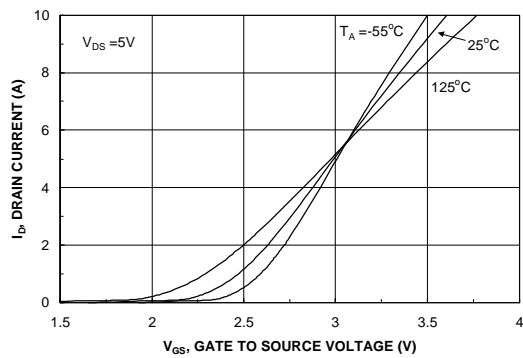


Figure 5. Transfer Characteristics.

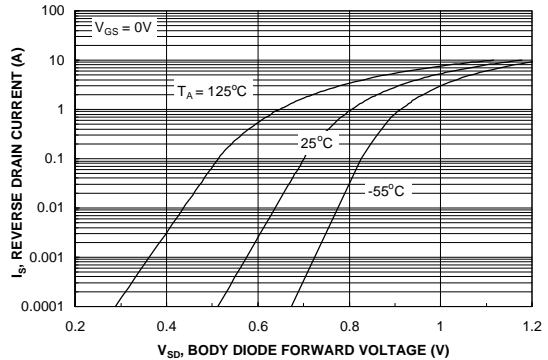
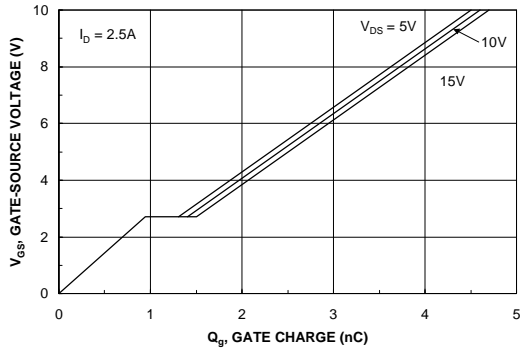
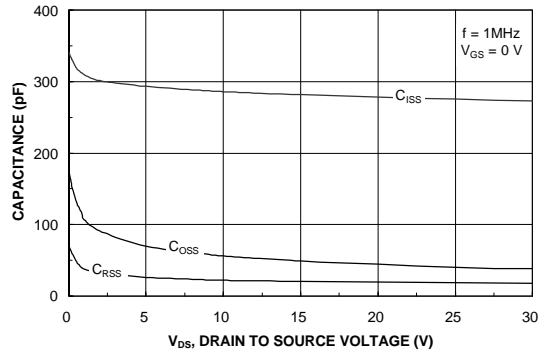


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.

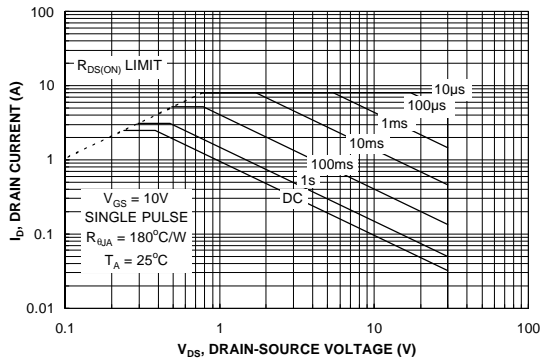
**Typical Characteristics: N-Channel** (continued)



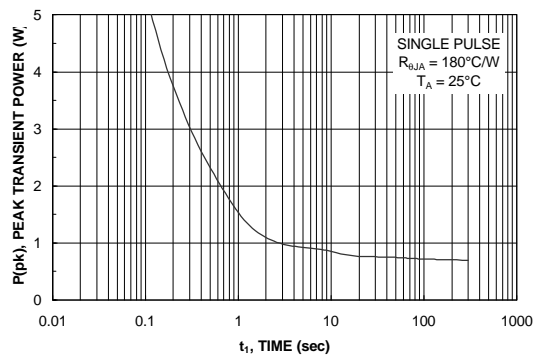
**Figure 7. Gate Charge Characteristics.**



**Figure 8. Capacitance Characteristics.**



**Figure 9. Maximum Safe Operating Area.**



**Figure 10. Single Pulse Maximum Power Dissipation.**

Typical Characteristics: P-Channel

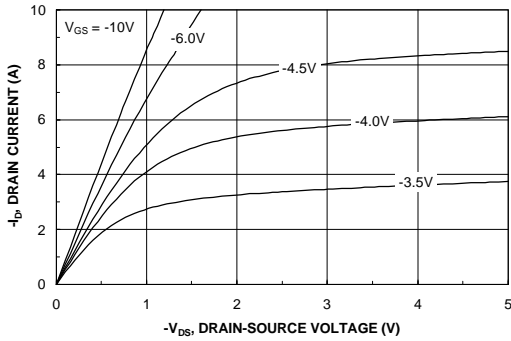


Figure 11. On-Region Characteristics.

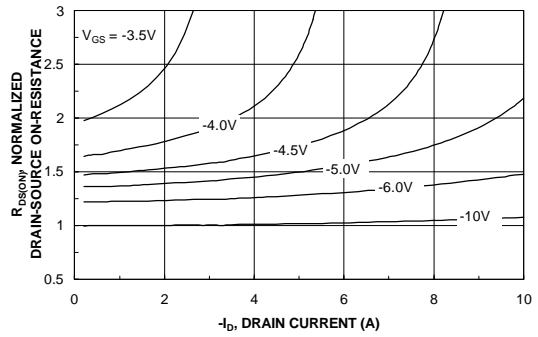


Figure 12. On-Resistance Variation with Drain Current and Gate Voltage.

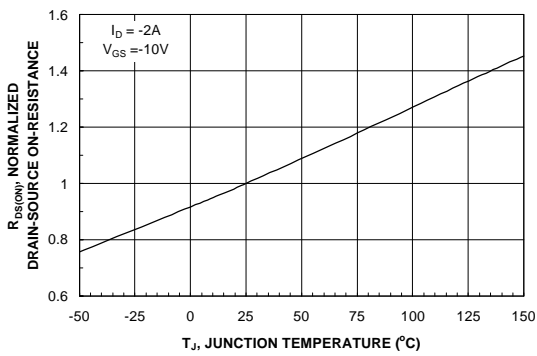


Figure 13. On-Resistance Variation with Temperature.

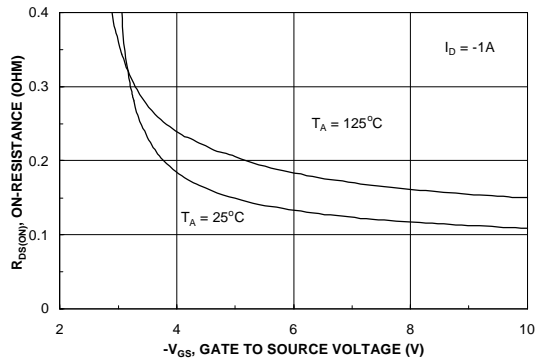


Figure 14. On-Resistance Variation with Gate-to-Source Voltage.

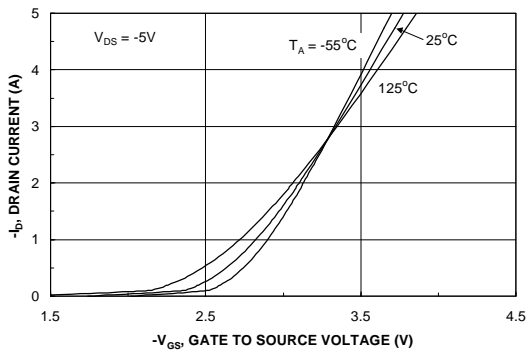


Figure 15. Transfer Characteristics.

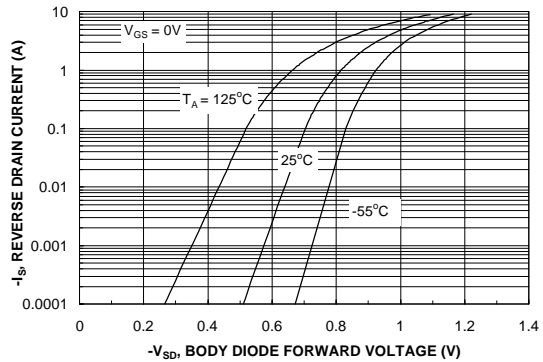
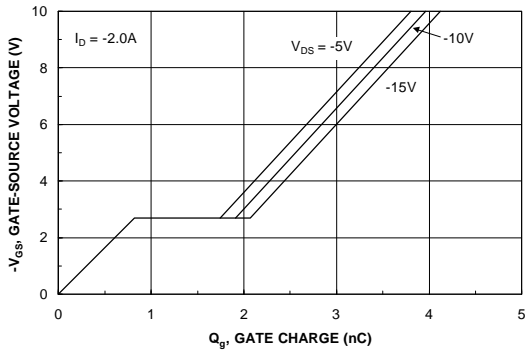
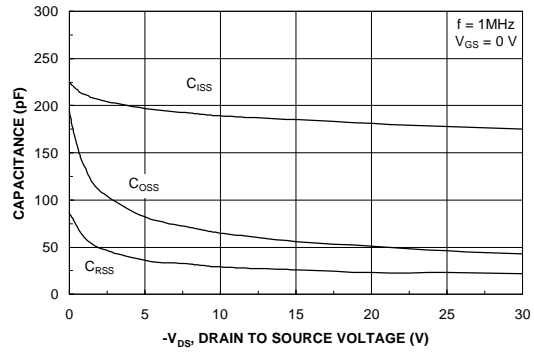


Figure 16. Body Diode Forward Voltage Variation with Source Current and Temperature.

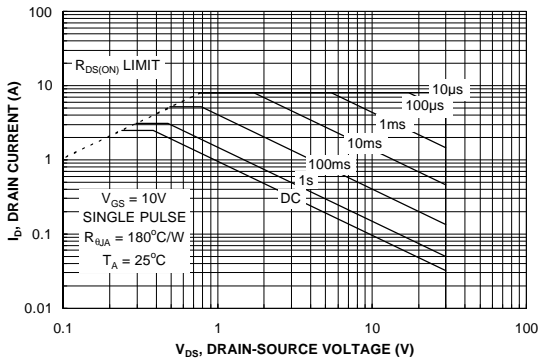
**Typical Characteristics: P-Channel** (continued)



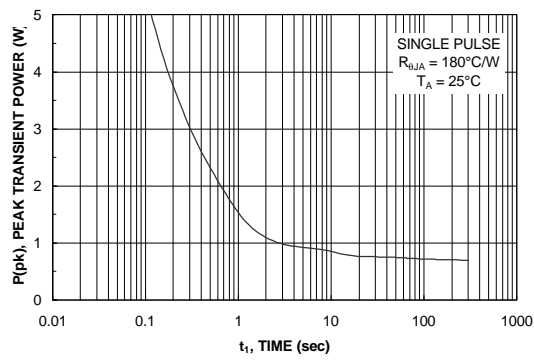
**Figure 17. Gate Charge Characteristics.**



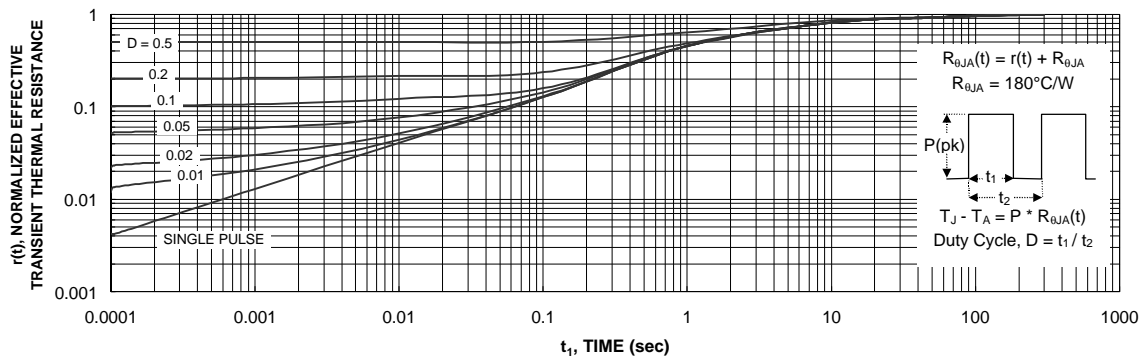
**Figure 18. Capacitance Characteristics.**



**Figure 19. Maximum Safe Operating Area.**



**Figure 20. Single Pulse Maximum Power Dissipation.**



**Figure 21. Transient Thermal Response Curve.**

Thermal characterization performed using the conditions described in Note 1c.  
Transient thermal response will change depending on the circuit board design.

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