



ON Semiconductor®

# FDS6681Z

## 30 Volt P-Channel PowerTrench® MOSFET

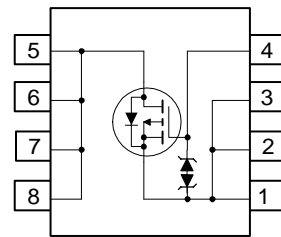
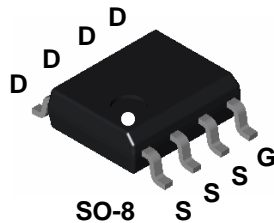
### General Description

This P-Channel MOSFET is produced using ON Semiconductor's advanced PowerTrench® process that has been especially tailored to minimize the on-state resistance.

This device is well suited for Power Management and load switching applications common in Notebook Computers and Portable Battery Packs.

### Features

- -20 A, -30 V.  $R_{DS(ON)} = 4.6 \text{ m}\Omega @ V_{GS} = -10 \text{ V}$   
 $R_{DS(ON)} = 6.5 \text{ m}\Omega @ V_{GS} = -4.5 \text{ V}$
- Extended  $V_{GSS}$  range (-25V) for battery applications
- HBM ESD protection level of 8kV typical (note 3)
- High performance trench technology for extremely low  $R_{DS(ON)}$
- High power and current handling capability
- Termination is Lead-free and RoHS Compliant



### Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted

| Symbol         | Parameter  | Ratings     | Units            |
|----------------|--|-------------|------------------|
| $V_{DSS}$      | Drain-Source Voltage   | -30         | V                |
| $V_{GSS}$      | Gate-Source Voltage  | $\pm 25$    | V                |
| $I_D$          | Drain Current – Continuous (Note 1a)                                       | -20         | A                |
|                | – Pulsed   | -105        |                  |
| $P_D$          | Power Dissipation for Single Operation (Note 1a)<br>(Note 1b)<br>(Note 1c) | 2.5         | W                |
|                |  | 1.2         |                  |
|                |  | 1.0         |                  |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range                           | -55 to +150 | $^\circ\text{C}$ |

### Thermal Characteristics

|                 |   |    |                    |
|-----------------|---|----|--------------------|
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1a) | 50 | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case (Note 1)     | 25 | $^\circ\text{C/W}$ |

### Package Marking and Ordering Information

| Device Marking | Device   | Reel Size | Tape width | Quantity   |
|----------------|----------|-----------|------------|------------|
| FDS6681Z       | FDS6681Z | 13"       | 12mm       | 2500 units |

| <b>Electrical Characteristics</b>               |  |   |     |                   |                   |                      |
|---|--|---|-----|-------------------|-------------------|----------------------|
| $T_A = 25^\circ\text{C}$ unless otherwise noted |  |   |     |                   |                   |                      |
| Symbol  | Parameter                                      | Test Conditions   | Min | Typ               | Max               | Units                |
| <b>Off Characteristics</b>                      |  |   |     |                   |                   |                      |
| $BV_{DSS}$                                      | Drain–Source Breakdown Voltage                 | $V_{GS} = 0\text{ V}, I_D = -250\ \mu\text{A}$  | -30 |                   |                   | V                    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$            | Breakdown Voltage Temperature Coefficient      | $I_D = -250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$  |     | -26               |                   | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                                       | Zero Gate Voltage Drain Current                | $V_{DS} = -24\text{ V}, V_{GS} = 0\text{ V}$  |     |                   | -1                | $\mu\text{A}$        |
| $I_{GSS}$                                       | Gate–Body Leakage                              | $V_{GS} = \pm 25\text{ V}, V_{DS} = 0\text{ V}$   |     |                   | $\pm 10$          | $\mu\text{A}$        |
| <b>On Characteristics (Note 2)</b>              |  |   |     |                   |                   |                      |
| $V_{GS(th)}$                                    | Gate Threshold Voltage                         | $V_{DS} = V_{GS}, I_D = -250\ \mu\text{A}$  | -1  | -1.8              | -3                | V                    |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$          | Gate Threshold Voltage Temperature Coefficient | $I_D = -250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$  |     | 6                 |                   | mV/ $^\circ\text{C}$ |
| $R_{DS(on)}$                                    | Static Drain–Source On–Resistance              | $V_{GS} = -10\text{ V}, I_D = -20\text{ A}$<br>$V_{GS} = -4.5\text{ V}, I_D = -17\text{ A}$<br>$V_{GS} = -10\text{ V}, I_D = -20\text{ A}, T_J = 125^\circ\text{C}$ |     | 3.8<br>5.2<br>5.0 | 4.6<br>6.5<br>6.3 | m $\Omega$           |
| $g_{FS}$  | Forward Transconductance                       | $V_{DS} = -5\text{ V}, I_D = -20\text{ A}$  |     | 79                |                   | S                    |
| <b>Dynamic Characteristics</b>                  |  |   |     |                   |                   |                      |
| $C_{iss}$                                       | Input Capacitance                              | $V_{DS} = -15\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$   |     | 7540              |                   | pF                   |
| $C_{oss}$                                       | Output Capacitance                             |   |     | 1400              |                   | pF                   |
| $C_{rss}$                                       | Reverse Transfer Capacitance                   |   |     | 1120              |                   | pF                   |
| <b>Switching Characteristics (Note 2)</b>       |  |   |     |                   |                   |                      |
| $t_{d(on)}$                                     | Turn–On Delay Time                             | $V_{DD} = -15\text{ V}, I_D = -1\text{ A},$<br>$V_{GS} = -10\text{ V}, R_{GEN} = 6\ \Omega$   |     | 20                | 35                | ns                   |
| $t_r$   | Turn–On Rise Time                              |   |     | 9                 | 18                | ns                   |
| $t_{d(off)}$                                    | Turn–Off Delay Time                            |   |     | 660               | 1060              | ns                   |
| $t_f$   | Turn–Off Fall Time                             |   |     | 380               | 610               | ns                   |
| $Q_{g(TOT)}$                                    | Total Gate Charge at $V_{GS} = -10\text{V}$    | $V_{DS} = -15\text{ V}, I_D = -20\text{ A}$   |     | 185               | 260               | nC                   |
| $Q_{g(TOT)}$                                    | Total Gate Charge at $V_{GS} = -5\text{V}$     |   |     | 105               | 150               | nC                   |
| $Q_{gs}$  | Gate–Source Charge                             |   |     | 26                |                   | nC                   |
| $Q_{gd}$  | Gate–Drain Charge                              |   |     | 47                |                   | nC                   |
|   |  |   |     |                   |                   |                      |

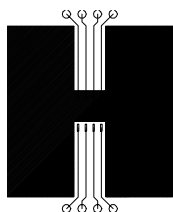
## Electrical Characteristics

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

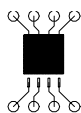
| Symbol  | Parameter   | Test Conditions                                     | Min | Typ  | Max  | Units |
|---|---|---|-----|------|------|-------|
| <b>Drain–Source Diode Characteristics and Maximum Ratings</b> |   |   |     |      |      |       |
| $I_S$   | Maximum Continuous Drain–Source Diode Forward Current |   |     |      | -2.1 | A     |
| $V_{SD}$  | Drain–Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_S = -2.1\text{ A}$ (Note 2) |     | -0.7 | -1.2 | V     |
| $t_{RR}$  | Reverse Recovery Time                                 | $I_F = -20\text{ A},$                               |     | 125  |      | ns    |
| $Q_{RR}$  | Reverse Recovery Charge                               | $dI_F/dt = 100\text{ A}/\mu\text{s}$ (Note 2)       |     | 94   |      | nC    |

### Notes:

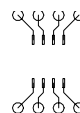
- $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



- a)  $50^\circ\text{C/W}$  (10 sec)  
 $62.5^\circ\text{C/W}$  steady state  
 when mounted on a  
 $1\text{ in}^2$  pad of 2 oz  
 copper



- b)  $105^\circ\text{C/W}$  when  
 mounted on a  $.04\text{ in}^2$   
 pad of 2 oz copper



- c)  $125^\circ\text{C/W}$  when mounted  
 on a minimum pad.

Scale 1 : 1 on letter size paper

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

- The diode connected between the gate and source serves only as protection against ESD. No gate overvoltage rating is implied.

### Typical Characteristics

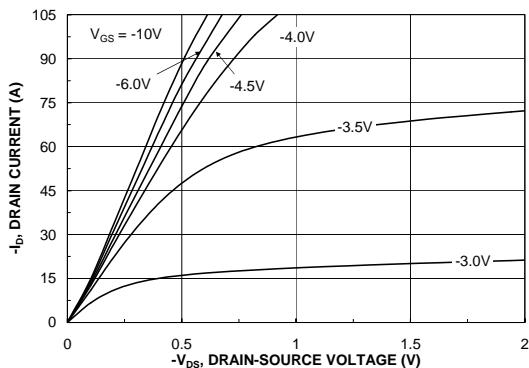


Figure 1. On-Region Characteristics.

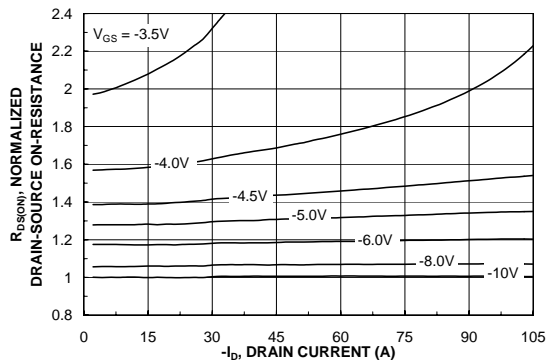


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.

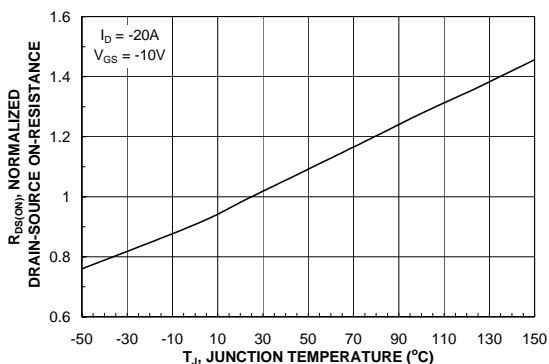


Figure 3. On-Resistance Variation with Temperature.

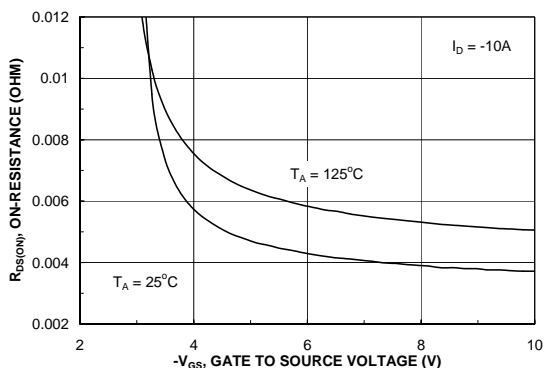


Figure 4. On-Resistance Variation with Gate-to-Source Voltage.

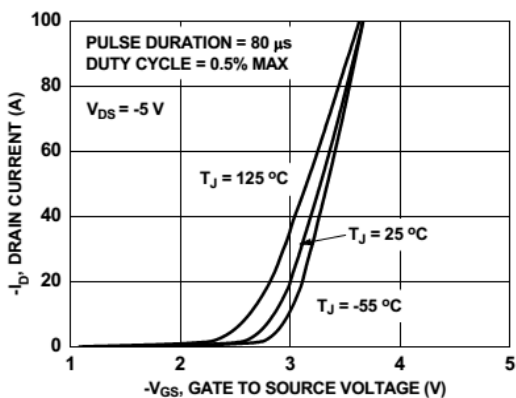


Figure 5. Transfer Characteristics.

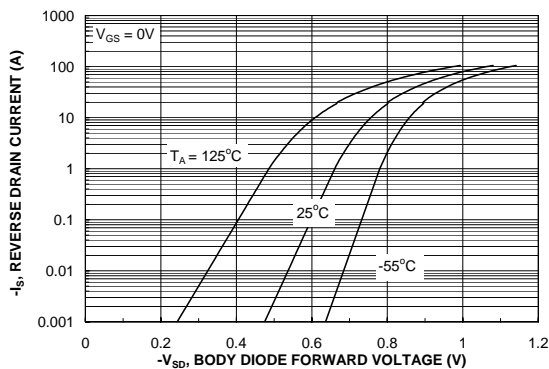


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.

### Typical Characteristics

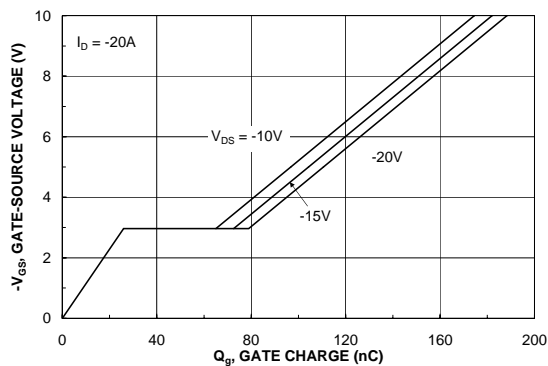


Figure 7. Gate Charge Characteristics.

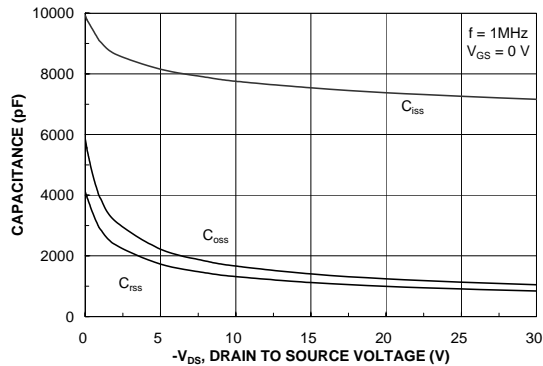


Figure 8. Capacitance Characteristics.

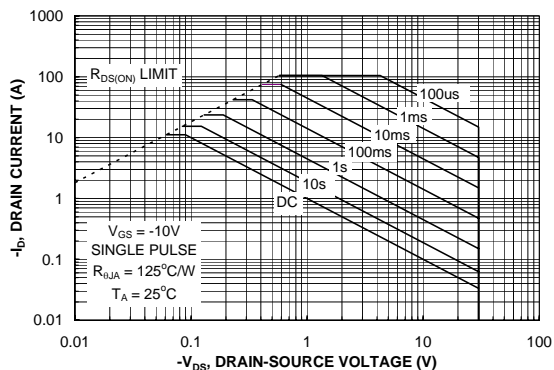


Figure 9. Maximum Safe Operating Area.

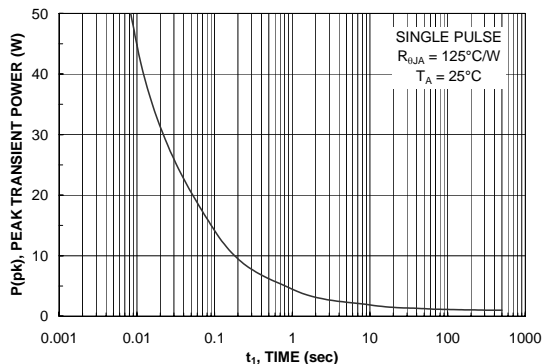


Figure 10. Single Pulse Maximum Power Dissipation.

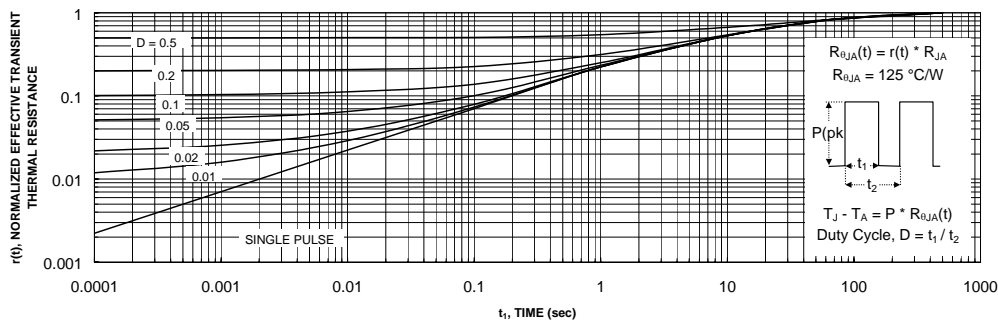


Figure 11. Transient Thermal Response Curve.

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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