November 1998

# FDS9933A

## Dual P-Channel 2.5V Specified PowerTrench™ MOSFET

### General Description

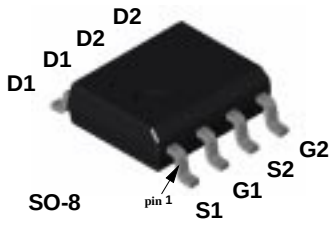
These P-Channel 2.5V specified MOSFETs are produced using Fairchild Semiconductor's advanced PowerTrench process that has been especially tailored to minimize the on-state resistance and yet maintain low gate charge for superior switching performance.

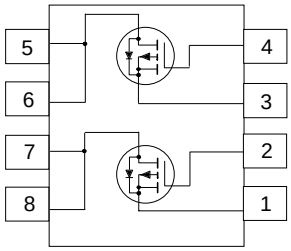
### Applications

- Load switch
- DC/DC converter
- Motor drives

### Features

- -3.8 A, -20 V. $R_{DS(on)}$ = 0.075 Ω @ $V_{GS}$ = -4.5 V
  $R_{DS(on)}$ = 0.105 Ω @ $V_{GS}$ = -2.5 V.
- Low gate charge ( 7nC typical ).
- Fast switching speed.
- High performance trench technology for extremely low $R_{DS(on)}$.
- High power and current handling capability.




## Absolute Maximum Ratings

$T_A$=25°C unless otherwise noted

| Symbol | Parameter | | FDS9933A | Units |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | | -20 | V |
| $V_{GSS}$ | Gate-Source Voltage | | ± 8 | V |
| $I_D$ | Drain Current - Continuous | (Note 1a) | -3.8 | A |
| | - Pulsed | | -20 | |
| $P_D$ | Power Dissipation for Dual Operation | | 2.0 | W |
| | Power Dissipation for Single Operation | (Note 1a) | 1.6 | |
| | | (Note 1b) | 1.0 | |
| | | (Note 1c) | 0.9 | |
| $T_J$, $T_{stg}$ | Operating and Storage Junction Temperature Range | | -55 to +150 | °C |

## Thermal Characteristics

| | | | | |
|---|---|---|---|---|
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | (Note 1a) | 78 | °C/W |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | (Note 1) | 40 | °C/W |

## Package Marking and Ordering Information

| Device Marking | Device | Reel Size | Tape width | Quantity |
|---|---|---|---|---|
| FDS9933A | FDS9933A | 13'' | 12mm | 2500 units |

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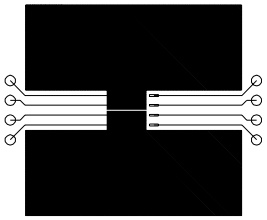
## DMOS Electrical Characteristics

$T_A$ = 25°C unless otherwise noted

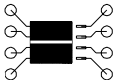
| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = -250 μA | -20 | | | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = -250 μA, Referenced to 25°C | | -16 | | mV/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = -16 V, $V_{GS}$ = 0 V | | | -1 | μA |
| $I_{GSSF}$ | Gate-Body Leakage, Forward | $V_{GS}$ = 8 V, $V_{DS}$ = 0 V | | | 100 | nA |
| $I_{GSSR}$ | Gate-Body Leakage, Reverse | $V_{GS}$ = -8 V, $V_{DS}$ = 0 V | | | -100 | nA |
| **On Characteristics** (Note 2) | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = -250 μA | -0.4 | -0.8 | -1.5 | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D$ = -250 μA, Referenced to 25°C | | 2.5 | | mV/°C |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS}$ = -4.5 V, $I_D$ = -3.8 A<br>$V_{GS}$ = -4.5 V, $I_D$ = -3.8 A, $T_J$ = 125°C<br>$V_{GS}$ = -2.5 V, $I_D$ = -3.3 A | | 0.058<br>0.086<br>0.084 | 0.075<br>0.12<br>0.105 | Ω<br>Ω<br>Ω |
| $I_{D(on)}$ | On-State Drain Current | $V_{GS}$ = -4.5 V, $V_{DS}$ = -5.0 V | -10 | | | A |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = -4.5 V, $I_D$ = -3.8 A | | 10 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = -10 V, $V_{GS}$ = 0 V, f = 1.0 MHz | | 600 | | pF |
| $C_{oss}$ | Output Capacitance | | | 175 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 80 | | pF |
| **Switching Characteristics** (Note 2) | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = -5 V, $I_D$ = -0.5 A, | | 6 | 12 | ns |
| $t_r$ | Turn-On Rise Time | $V_{GS}$ = -4.5 V, $R_{GEN}$ = 6.0 Ω | | 9 | 18 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | | 31 | 50 | ns |
| $t_f$ | Turn-Off Fall Time | | | 28 | 42 | ns |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = -10 V, $I_D$ = -3.8 A, | | 7 | 10 | nC |
| $Q_{gs}$ | Gate-Source Charge | $V_{GS}$ = -4.5 V | | 1.3 | | nC |
| $Q_{gd}$ | Gate-Drain Charge | | | 2 | | nC |
| **Drain-Source Diode Characteristics and Maximum Ratings** | | | | | | |
| $I_S$ | Maximum Continuous Drain-Source Diode Forward Current | | | | -1.3 | A |
| $V_{SD}$ | Drain-Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = -1.3 A (Note 2) | | -0.75 | -1.2 | V |

**Notes:**

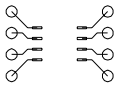
**1:** $R_{\theta JA}$ is the sum of the junction-to-case and case-to-ambient resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. $R_{\theta JC}$ is guaranteed by design while $R_{\theta JA}$ is determined by the user's board design.



a) 78° C/W when mounted on a 0.5 in² pad of 2 oz. copper.



b) 125° C/W when mounted on a 0.02 in² pad of 2 oz. copper.



c) 135° C/W when mounted on a 0.003 in² pad of 2 oz. copper.

Scale 1 : 1 on letter size paper

**2:** Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

## Typical Characteristics (continued)

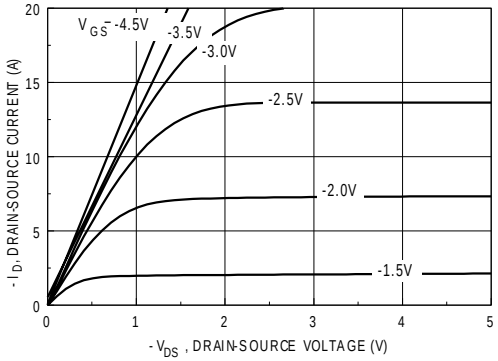



**Figure 1. On-Region Characteristics.**

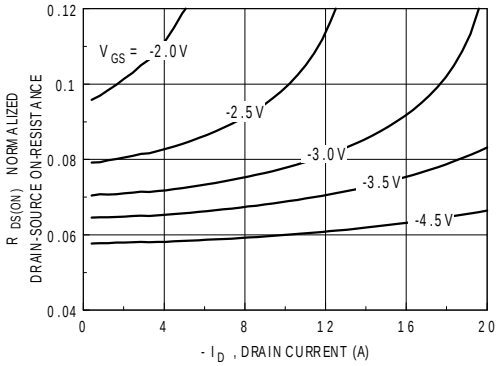



**Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.**

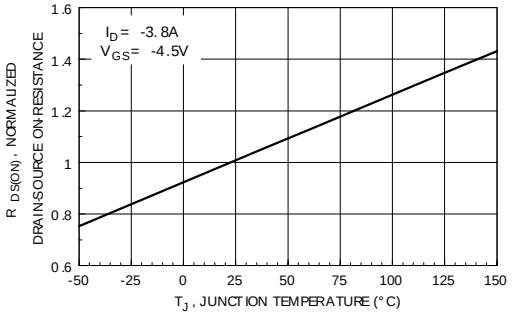



**Figure 3. On-Resistance Variation withTemperature.**

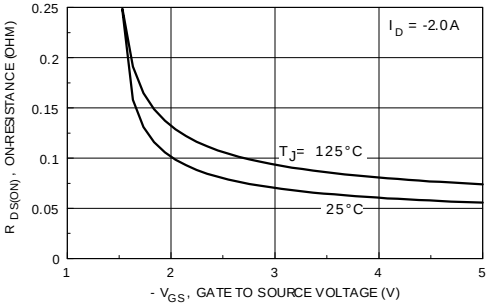



**Figure 4. On-Resistance Variation with Gate-to-Source Voltage.**

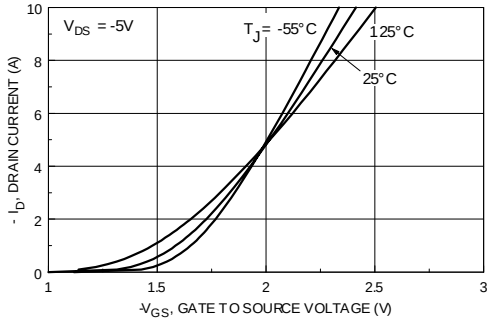



**Figure 5. Transfer Characteristics.**

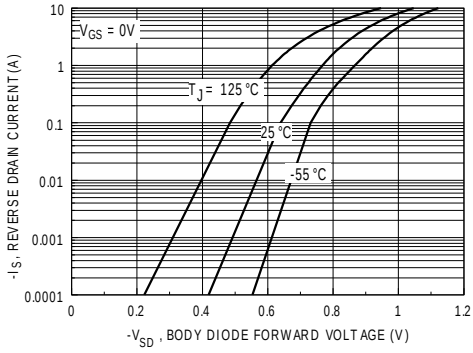



**Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.**

## Typical Characteristics (continued)

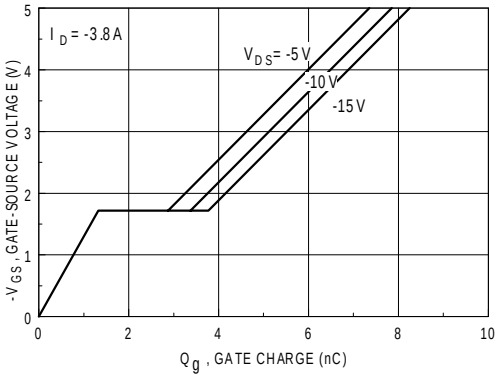



**Figure 7. Gate Charge Characteristics.**

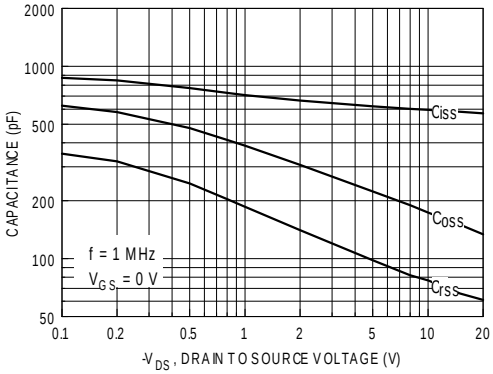



**Figure 8. Capacitance Characteristics.**

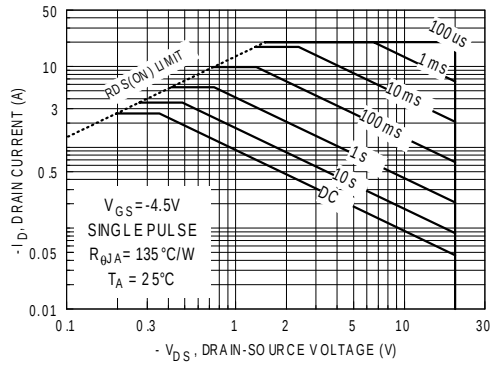



**Figure 9. Maximum Safe Operating Area.**

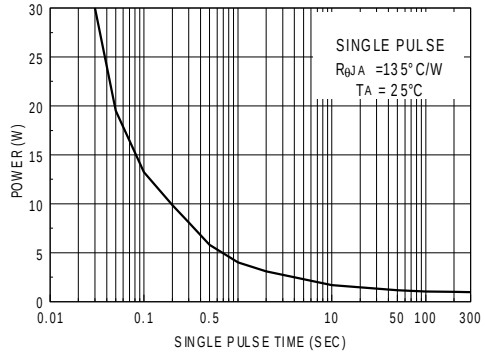



**Figure 10. Single Pulse Maximum Power Dissipation.**

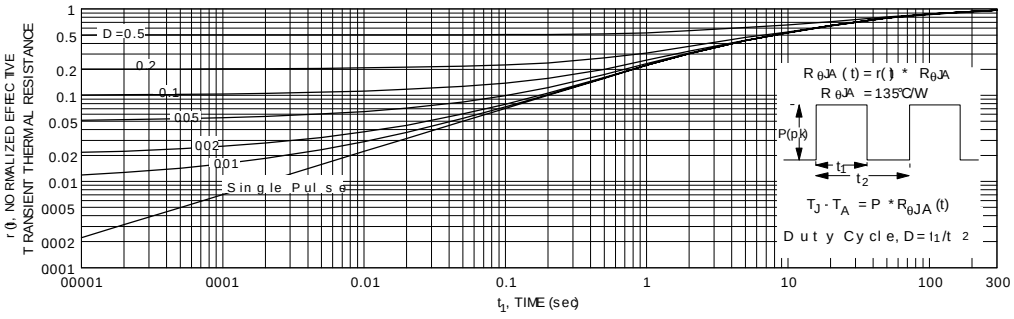



**Figure 11. Transient Thermal Response Curve.**

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

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