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ON Semiconductor®

# FDS6982AS

## Dual Notebook Power Supply N-Channel PowerTrench® SyncFET™

### General Description

The FDS6982AS is designed to replace two single SO-8 MOSFETs and Schottky diode in synchronous DC:DC power supplies that provide various peripheral voltages for notebook computers and other battery powered electronic devices. FDS6982AS contains two unique 30V, N-channel, logic level, PowerTrench MOSFETs designed to maximize power conversion efficiency. The high-side switch (Q1) is designed with specific emphasis on reducing switching losses while the low-side switch (Q2) is optimized to reduce conduction losses. Q2 also includes an integrated Schottky diode using ON Semiconductor's monolithic SyncFET technology.

### Applications

- Notebook

### Features

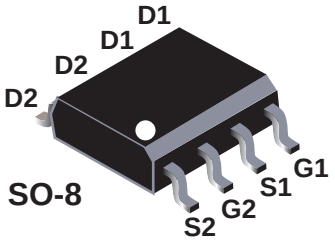
- **Q2**: Optimized to minimize conduction losses
  Includes SyncFET Schottky body diode

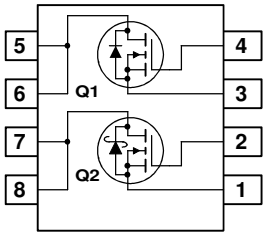
  8.6A, 30V $R_{DS(on)}$ max= 13.5mΩ @ $V_{GS}$ = 10V

  $R_{DS(on)}$ max= 16.5mΩ @ $V_{GS}$ = 4.5V
- Low gate charge (21nC typical)
- **Q1**: Optimized for low switching losses

  6.3A, 30V $R_{DS(on)}$ max= 28.0mΩ @ $V_{GS}$ = 10V

  $R_{DS(on)}$ max= 35.0mΩ @ $V_{GS}$ = 4.5V
- Low gate charge (11nC typical)




## Absolute Maximum Ratings $T_A$ = 25°C unless otherwise noted

| Symbol | Parameter | | Q2 | Q1 | Units |
|---|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | | 30 | 30 | V |
| $V_{GSS}$ | Gate-Source Voltage | | ±20 | ±20 | V |
| $I_D$ | Drain Current - Continuous | (Note 1a) | 8.6 | 6.3 | A |
| | - Pulsed | | 30 | 20 | |
| $P_D$ | Power Dissipation for Dual Operation | | 2 | | W |
| | Power Dissipation for Single Operation | (Note 1a) | 1.6 | | |
| | | (Note 1b) | 1 | | |
| | | (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 |
|---|---|---|---|---|
| FDS6982AS | FDS6982AS | 13" | 12mm | 2500 units |

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October-2017, Rev. 2

Publication Order Number:
FDS6982AS/D

## Electrical Characteristics

$T_A$ = 25°C unless otherwise noted

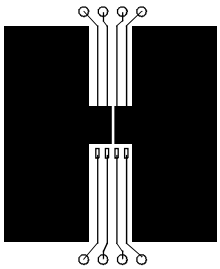
| Symbol | Parameter | Test Conditions | Type | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 1 mA<br>$V_{GS}$ = 0 V, $I_D$ = 250 uA | Q2<br>Q1 | 30<br>30 | | | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 1 mA, Referenced to 25°C<br>$I_D$ = 250 μA, Referenced to 25°C | Q2<br>Q1 | | 28<br>24 | | mV/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 24 V, $V_{GS}$ = 0 V | Q2<br>Q1 | | | 500<br>1 | μA |
| $I_{GSS}$ | Gate-Body Leakage | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | Q2<br>Q1 | | | ±100 | nA |
| **On Characteristics** (Note 2) | | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 1 mA<br>$V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | Q2<br>Q1 | 1<br>1 | 1.4<br>1.9 | 3<br>3 | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D$ = 1 mA, Referenced to 25°C<br>$I_D$ = 250 uA, Referenced to 25°C | Q2<br>Q1 | | –3.1<br>–4.3 | | mV/°C |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS}$ = 10 V, $I_D$ = 8.6 A<br>$V_{GS}$ = 10 V, $I_D$ = 8.6 A, $T_J$ = 125°C<br>$V_{GS}$ = 4.5 V, $I_D$ = 7.5 A | Q2 | | 11<br>16<br>13 | 13.5<br>20.0<br>16.5 | mΩ |
| | | $V_{GS}$ = 10 V, $I_D$ = 6.3 A<br>$V_{GS}$ = 10 V, $I_D$ = 6.3 A, $T_J$ = 125°C<br>$V_{GS}$ = 4.5 V, $I_D$ = 5.6 A | Q1 | | 20<br>26<br>25 | 28<br>33<br>35 | |
| $I_{D(on)}$ | On-State Drain Current | $V_{GS}$ = 10 V, $V_{DS}$ = 5 V | Q2<br>Q1 | 30<br>20 | | | A |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 5 V, $I_D$ = 8.6 A<br>$V_{DS}$ = 5 V, $I_D$ = 6.3 A | Q2<br>Q1 | | 32<br>19 | | S |
| **Dynamic Characteristics** | | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 10 V, $V_{GS}$ = 0 V,<br>f = 1.0 MHz | Q2<br>Q1 | | 1250<br>610 | | pF |
| $C_{oss}$ | Output Capacitance | | Q2<br>Q1 | | 410<br>180 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | Q2<br>Q1 | | 130<br>85 | | pF |
| $R_G$ | Gate Resistance | $V_{GS}$ = 15mV, f = 1.0 MHz | Q2<br>Q1 | | 1.4<br>2.2 | | Ω |
| **Switching Characteristics** (Note 2) | | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 15 V, $I_D$ = 1 A,<br>$V_{GS}$ = 10V, $R_{GEN}$ = 6 Ω | Q2<br>Q1 | | 9<br>10 | 18<br>20 | ns |
| $t_r$ | Turn-On Rise Time | | Q2<br>Q1 | | 6<br>7 | 12<br>14 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | Q2<br>Q1 | | 27<br>24 | 44<br>39 | ns |
| $t_f$ | Turn-Off Fall Time | | Q2<br>Q1 | | 11<br>3 | 20<br>6 | ns |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DD}$ = 15 V, $I_D$ = 1 A,<br>$V_{GS}$ = 4.5V, $R_{GEN}$ = 6 Ω | Q2<br>Q1 | | 12<br>12 | 22<br>22 | ns |
| $t_r$ | Turn-On Rise Time | | Q2<br>Q1 | | 13<br>14 | 23<br>25 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | Q2<br>Q1 | | 19<br>15 | 34<br>27 | ns |
| $t_f$ | Turn-Off Fall Time | | Q2<br>Q1 | | 10<br>5 | 20<br>10 | ns |

## Electrical Characteristics (continued) $T_A$ = 25°C unless otherwise noted

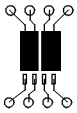
| Symbol | Parameter | Test Conditions | Type | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| **Switching Characteristics** (Note 2) | | | | | | | |
| $Q_{g(TOT)}$ | Total Gate Charge at Vgs=10V | Q2: $V_{DS}$ = 15 V, $I_D$ = 11.5A<br>Q1: $V_{DS}$ = 15 V, $I_D$ = 6.3A | Q2<br>Q1 | | 21<br>11 | 30<br>15 | nC |
| $Q_g$ | Total Gate Charge at Vgs=5V | | Q2<br>Q1 | | 12<br>6 | 16<br>9 | nC |
| $Q_{gs}$ | Gate–Source Charge | | Q2<br>Q1 | | 3.1<br>1.8 | | nC |
| $Q_{gd}$ | Gate–Drain Charge | | Q2<br>Q1 | | 3.6<br>2.4 | | nC |
| **Drain–Source Diode Characteristics and Maximum Ratings** | | | | | | | |
| $I_S$ | Maximum Continuous Drain-Source Diode Forward Current | | Q2<br>Q1 | | | 3.0<br>1.3 | A |
| $T_{rr}$ | Reverse Recovery Time | $I_F$ = 11.5 A, $d_{iF}/d_t$ = 300 A/μs (Note 3) | Q2 | | 19 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | | | 12 | | nC |
| $T_{rr}$ | Reverse Recovery Time | $I_F$ = 6.3 A, $d_{iF}/d_t$ = 100 A/μs (Note 3) | Q1 | | 20 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | | | 9 | | nC |
| $V_{SD}$ | Drain-Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 3 A (Note 2)<br>$V_{GS}$ = 0 V, $I_S$ = 6 A (Note 2)<br>$V_{GS}$ = 0 V, $I_S$ = 1.3 A (Note 2) | Q2<br>Q2<br>Q1 | | 0.5<br>0.6<br>0.8 | 0.7<br>1.0<br>1.2 | V |

**Notes:**

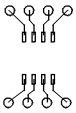
**1.** $R_{\theta JA}$ is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. $R_{\theta JC}$ is guaranteed by design while $R_{\theta CA}$ is determined by the user's board design.



a) 78°C/W when mounted on a 0.5in$^2$ pad of 2 oz copper



b) 125°C/W when mounted on a 0.02 in$^2$ pad of 2 oz copper



c) 135°C/W when mounted on a minimum pad.

Scale 1 : 1 on letter size paper

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

**3.** See “SyncFET Schottky body diode characteristics” below.

## Typical Characteristics: Q2

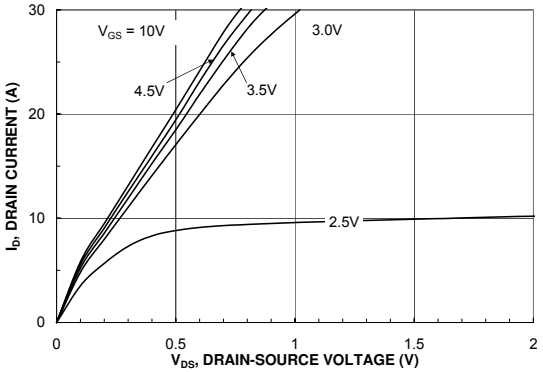



**Figure 1. On-Region Characteristics.**

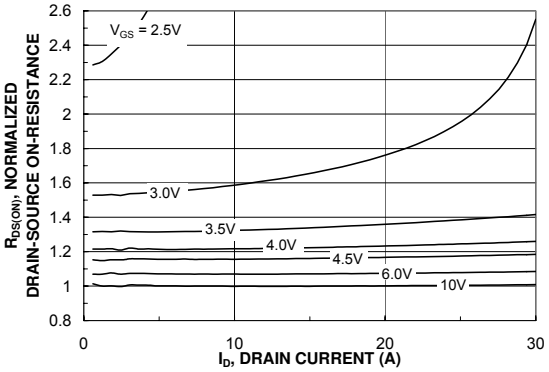



**Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.**

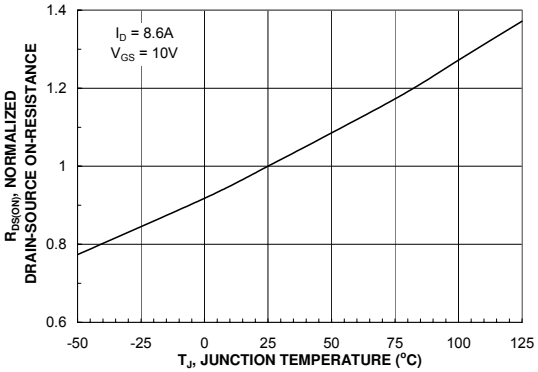



**Figure 3. On-Resistance Variation with Temperature.**

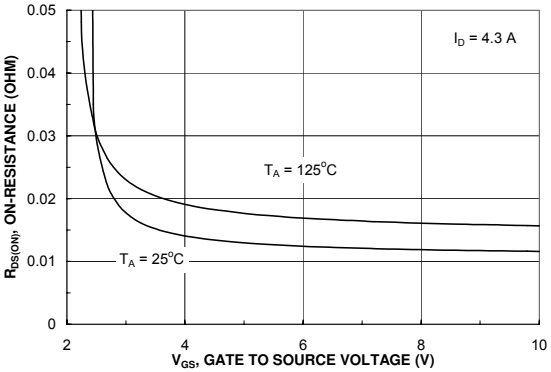



**Figure 4. On-Resistance Variation with Gate-to-Source Voltage.**

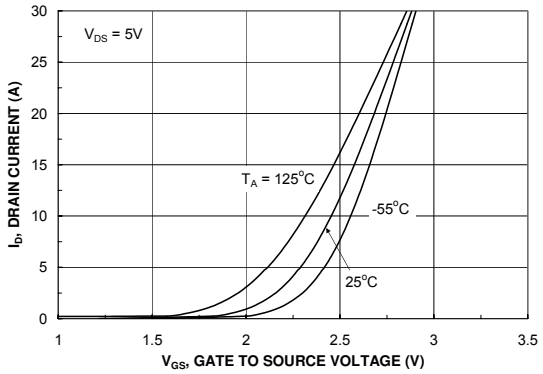



**Figure 5. Transfer Characteristics.**

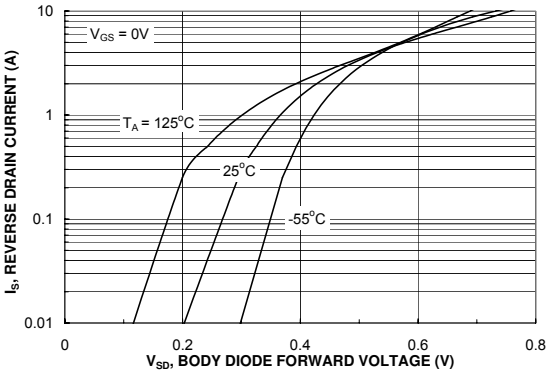



**Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.**

## Typical Characteristics: Q2

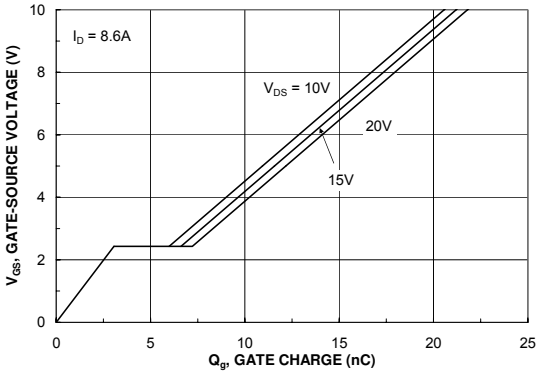



**Figure 7. Gate Charge Characteristics.**

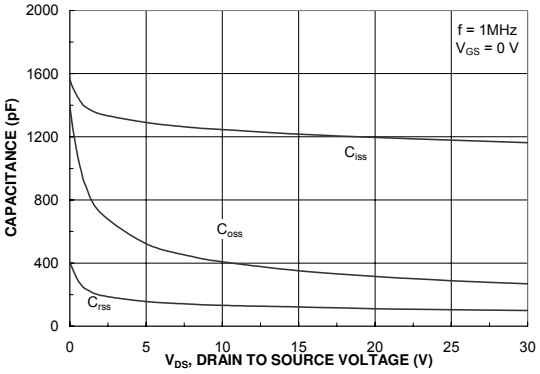



**Figure 8. Capacitance Characteristics.**

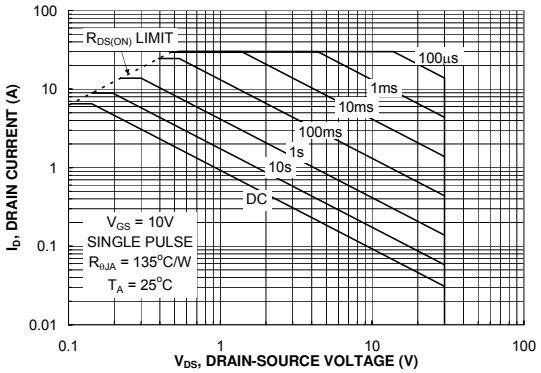



**Figure 9. Maximum Safe Operating Area.**

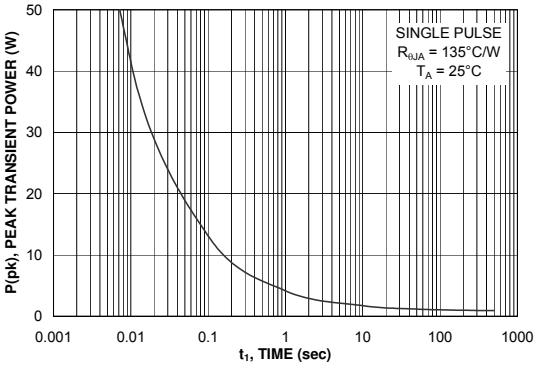



**Figure 10. Single Pulse Maximum Power Dissipation.**

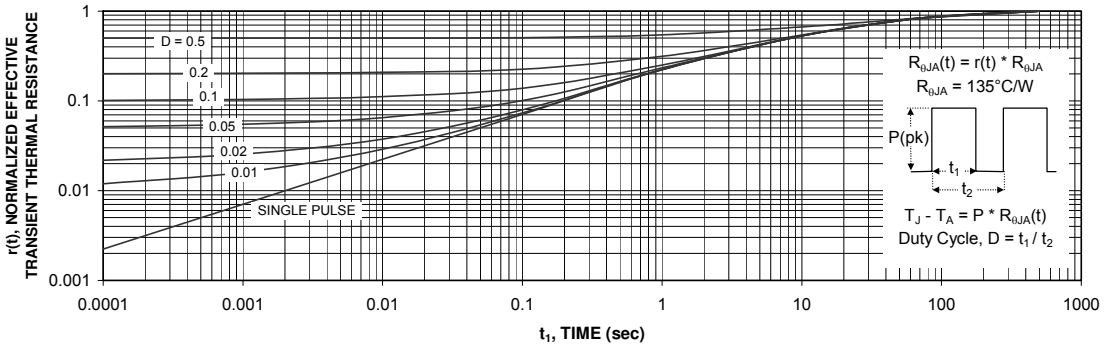



**Figure 11. Transient Thermal Response Curve.**

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

## Typical Characteristics Q1

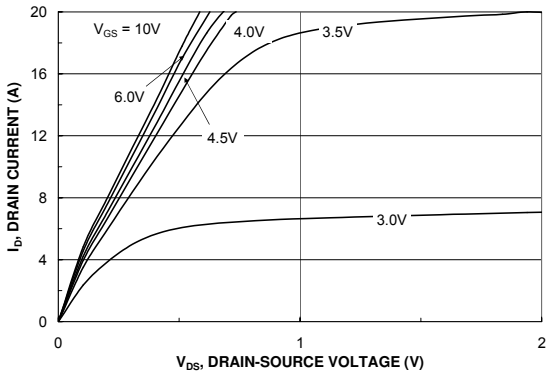



**Figure 12. On-Region Characteristics.**

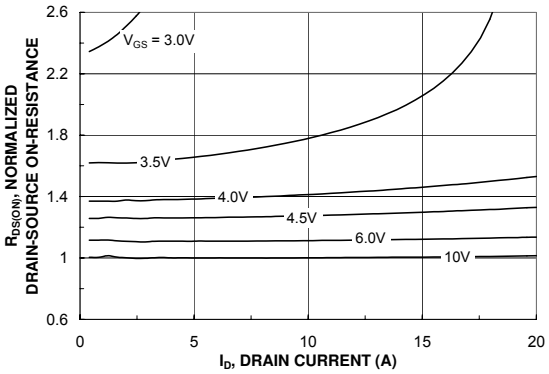



**Figure 13. On-Resistance Variation with Drain Current and Gate Voltage.**

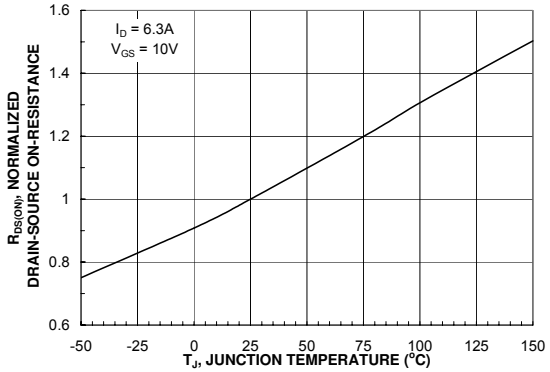



**Figure 14. On-Resistance Variation with Temperature.**

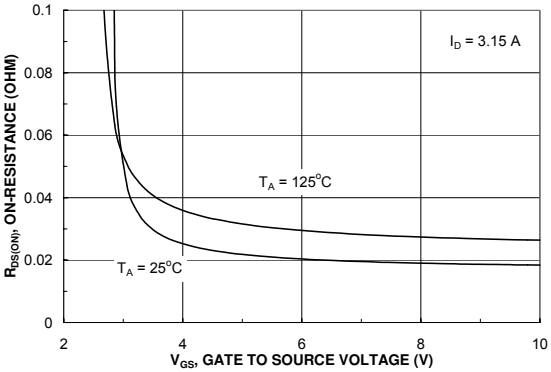



**Figure 15. On-Resistance Variation with Gate-to-Source Voltage.**

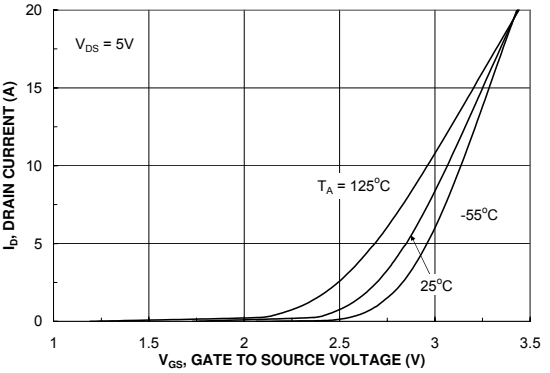



**Figure 16. Transfer Characteristics.**

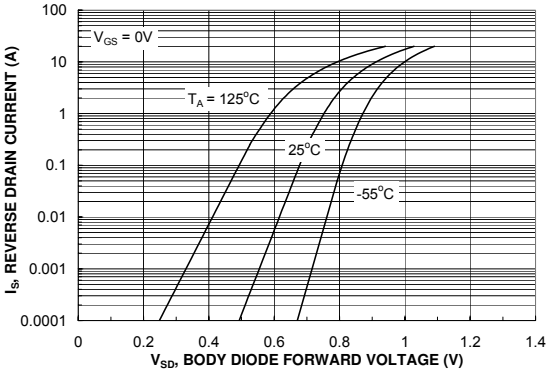



**Figure 17. Body Diode Forward Voltage Variation with Source Current and Temperature.**

## Typical Characteristics Q1

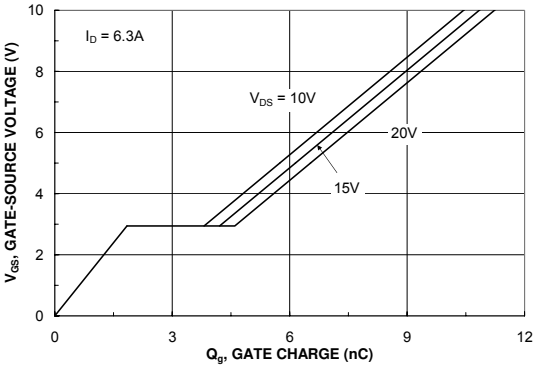



**Figure 18. Gate Charge Characteristics.**

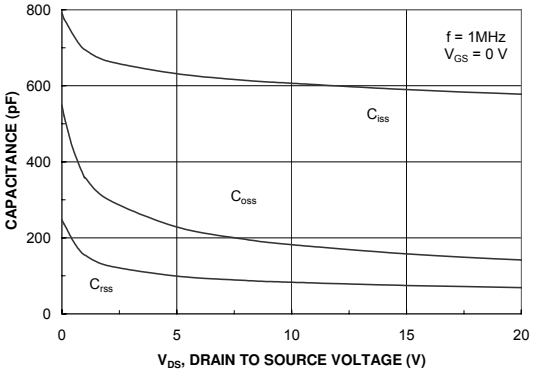



**Figure 19. Capacitance Characteristics.**

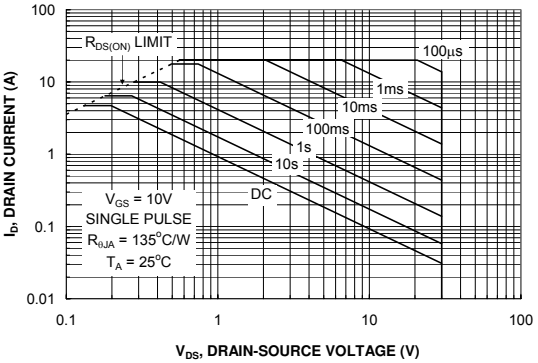



**Figure 20. Maximum Safe Operating Area.**

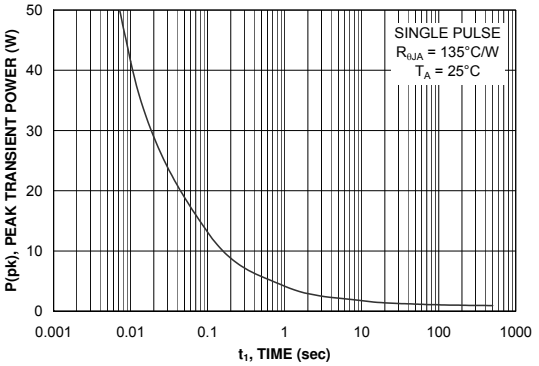



**Figure 21. Single Pulse Maximum Power Dissipation.**

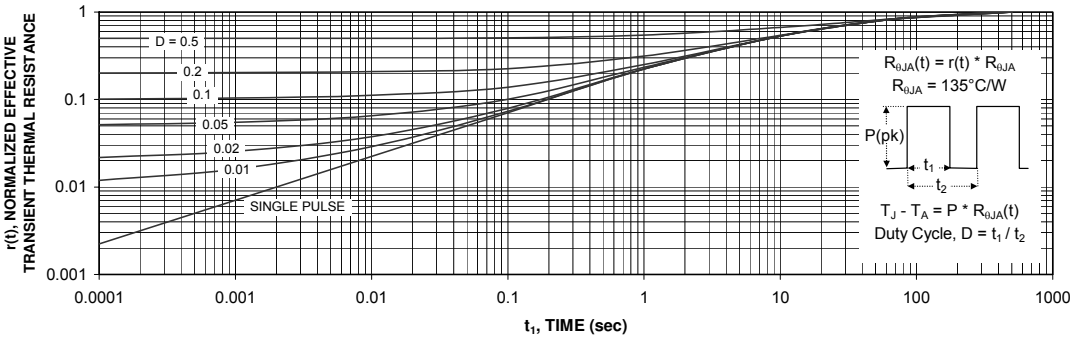



**Figure 22. Transient Thermal Response Curve.**

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

## Typical Characteristics (continued)

### SyncFET Schottky Body Diode Characteristics

ON Semiconductor's SyncFET process embeds a Schottky diode in parallel with PowerTrench MOSFET. This diode exhibits similar characteristics to a discrete external Schottky diode in parallel with a MOSFET. **Figure 23** shows the reverse recovery characteristic of the FDS6982AS.

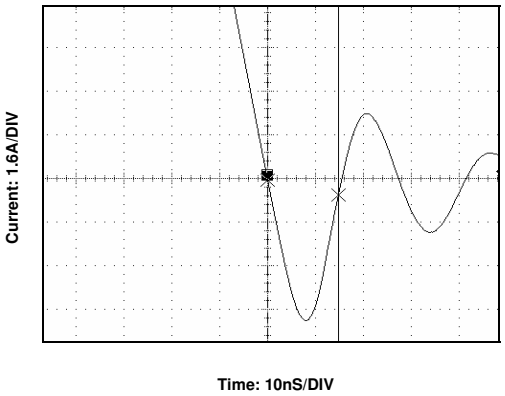



**Figure 23. FDS6982AS SyncFET body diode reverse recovery characteristic.**

For comparison purposes, **Figure 24** shows the reverse recovery characteristics of the body diode of an equivalent size MOSFET produced without SyncFET (FDS6982).

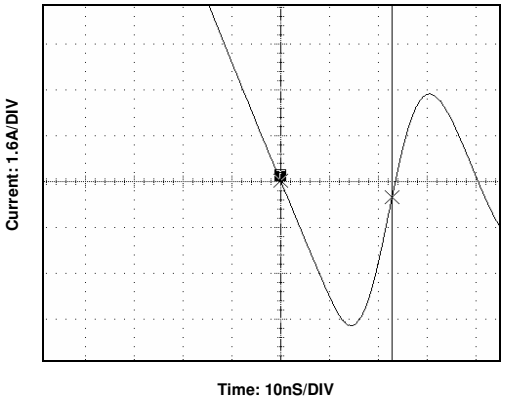



**Figure 24. Non-SyncFET (FDS6982) body diode reverse recovery characteristic.**

Schottky barrier diodes exhibit significant leakage at high temperature and high reverse voltage. This will increase the power in the device.

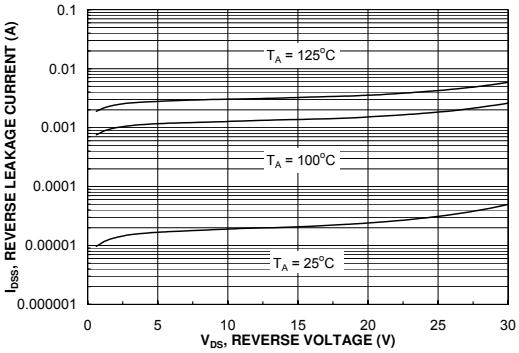



**Figure 25. SyncFET body diode reverse leakage versus drain-source voltage and temperature**

## Typical Characteristics

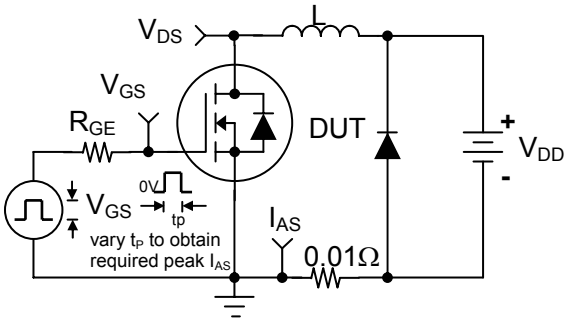



Figure 26. Unclamped Inductive Load Test Circuit

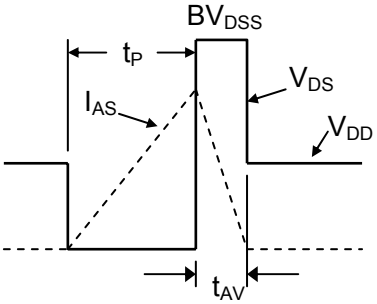



Figure 27. Unclamped Inductive Waveforms

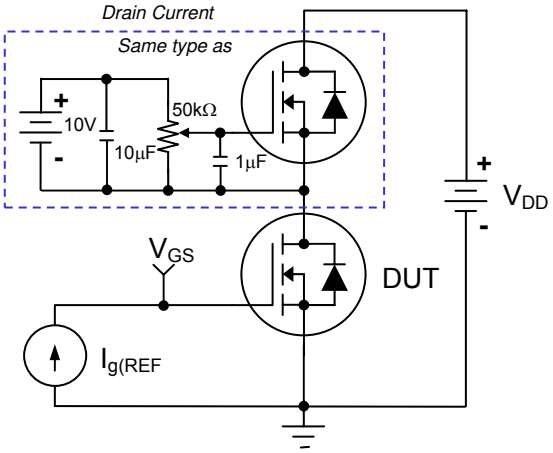



Figure 28. Gate Charge Test Circuit

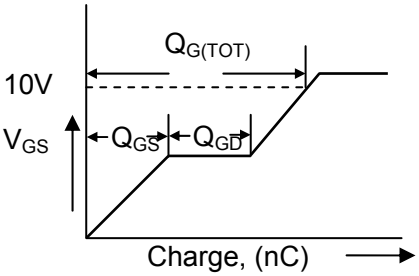



Figure 29. Gate Charge Waveform

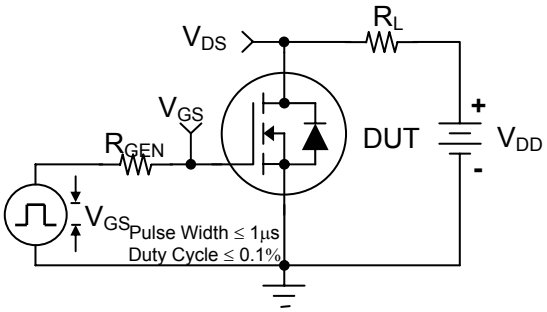



Figure 30. Switching Time Test Circuit

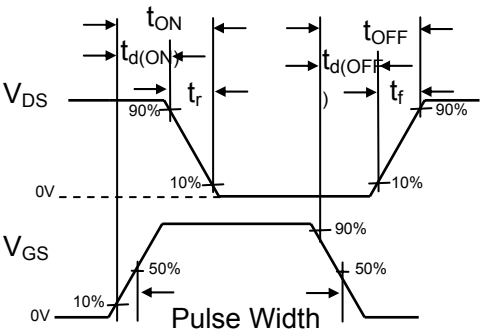



Figure 31. Switching Time Waveforms

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