FAIRCHILD SEMICONDUCTOR®

September 2002

# FDS7764S

## 30V N-Channel PowerTrench® SyncFET™

### General Description

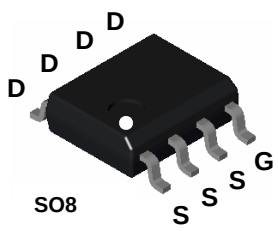
The FDS7764S is designed to replace a single SO-8 MOSFET and Schottky diode in synchronous DC:DC power supplies. This 30V MOSFET is designed to maximize power conversion efficiency, providing a low $R_{DS(ON)}$ and low gate charge. The FDS7764S includes an integrated Schottky diode using Fairchild's monolithic SyncFET technology.

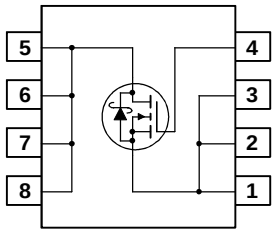
### Applications

- DC/DC converter
- Motor drives

### Features

- 13.5 A, 30 V. $R_{DS(ON)}$ = 7.5 mΩ @ $V_{GS}$ = 10 V
  $R_{DS(ON)}$ = 9.0 mΩ @ $V_{GS}$ = 4.5 V
- Includes SyncFET Schottky body diode
- Low gate charge (25 nC typical)
- High performance trench technology for extremely low $R_{DS(ON)}$ and fast switching
- High power and current handling capability




## Absolute Maximum Ratings

$T_A$=25°C unless otherwise noted

| Symbol | Parameter | | Ratings | Units |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | | 30 | V |
| $V_{GSS}$ | Gate-Source Voltage | | ±16 | V |
| $I_D$ | Drain Current – Continuous | (Note 1a) | 13.5 | A |
| | – Pulsed | | 50 | |
| $P_D$ | Power Dissipation for Single Operation | (Note 1a) | 2.5 | W |
| | | (Note 1b) | 1.2 | |
| | | (Note 1c) | 1.0 | |
| $T_J$, $T_{STG}$ | Operating and Storage Junction Temperature Range | | –55 to +150 | °C |

## Thermal Characteristics

| | | | | |
|---|---|---|---|---|
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | (Note 1a) | 50 | °C/W |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | (Note 1) | 30 | |

## Package Marking and Ordering Information

| Device Marking | Device | Reel Size | Tape width | Quantity |
|---|---|---|---|---|
| FDS7764S | FDS7764S | 13'' | 12mm | 2500 units |

## 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, $I_D$ = 1 mA | 30 | | | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 10 mA, Referenced to 25°C | | 23 | | mV/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 24 V, $V_{GS}$ = 0 V | | | 500 | µA |
| $I_{GSSF}$ | Gate–Body Leakage, Forward | $V_{GS}$ = 16 V, $V_{DS}$ = 0 V | | | 100 | nA |
| $I_{GSSR}$ | Gate–Body Leakage, Reverse | $V_{GS}$ = –16 V , $V_{DS}$ = 0 V | | | –100 | nA |
| **On Characteristics** (Note 2) | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 1 mA | 0.8 | 1.4 | 2 | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D$ = 10 mA, Referenced to 25°C | | –2 | | mV/°C |
| $R_{DS(on)}$ | Static Drain–Source On–Resistance | $V_{GS}$ = 10 V, $I_D$ = 13.5 A<br>$V_{GS}$ = 4.5 V, $I_D$ = 12 A<br>$V_{GS}$ = 10 V, $I_D$=13.5A, $T_J$ = 125°C | | 6<br>7<br>8 | 7.5<br>9<br>10 | mΩ |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 10 V, $I_D$ = 13.5 A | | 72 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 15 V, $V_{GS}$ = 0 V, f = 1.0 MHz | | 2800 | | pF |
| $C_{oss}$ | Output Capacitance | | | 530 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 195 | | pF |
| $R_G$ | Gate Resistance | $V_{GS}$ = 15 mV, f = 1.0 MHz | | 1.4 | | Ω |
| **Switching Characteristics** (Note 2) | | | | | | |
| $t_{d(on)}$ | Turn–On Delay Time | $V_{DD}$ = 15 V, $I_D$ = 1 A, $V_{GS}$ = 10 V, $R_{GEN}$ = 6 Ω | | 9 | 18 | ns |
| $t_r$ | Turn–On Rise Time | | | 7 | 14 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time | | | 46 | 74 | ns |
| $t_f$ | Turn–Off Fall Time | | | 16 | 29 | ns |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = 15 V, $I_D$ = 13.5 A, $V_{GS}$ = 5 V | | 25 | 35 | nC |
| $Q_{gs}$ | Gate–Source Charge | | | 6 | | nC |
| $Q_{gd}$ | Gate–Drain Charge | | | 6 | | nC |

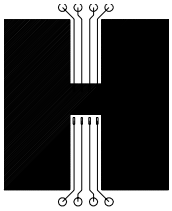
## Electrical Characteristics

$T_A$ = 25°C unless otherwise noted

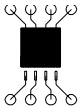
| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Drain–Source Diode Characteristics and Maximum Ratings** | | | | | | |
| $I_S$ | Maximum Continuous Drain–Source Diode Forward Current | | | | 3.5 | A |
| $V_{SD}$ | Drain–Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 3.5 A (Note 2) | | 450 | 700 | mV |
| $t_{rr}$ | Diode Reverse Recovery Time | $I_F$ = 3.5 A, $d_{iF}/d_t$ = 300 A/µs (Note 2) | | 25 | | ns |
| $Q_{rr}$ | Diode Reverse Recovery Charge | | | 40 | | nC |

**Notes:**

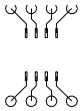
**1.** $R_{\theta JA}$ is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. $R_{\theta JC}$ is guaranteed by design while $R_{\theta CA}$ is determined by the user's board design.



a) 50°/W when mounted on a 1in$^2$ pad of 2 oz copper



b) 105°/W when mounted on a .04 in$^2$ pad of 2 oz copper



c) 125°/W when mounted on a minimum pad.

Scale 1 : 1 on letter size paper

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

## Typical Characteristics

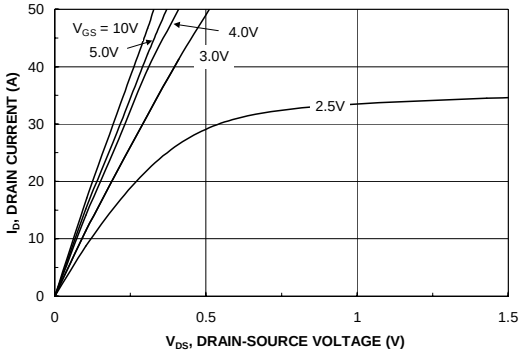



**Figure 1. On-Region Characteristics.**

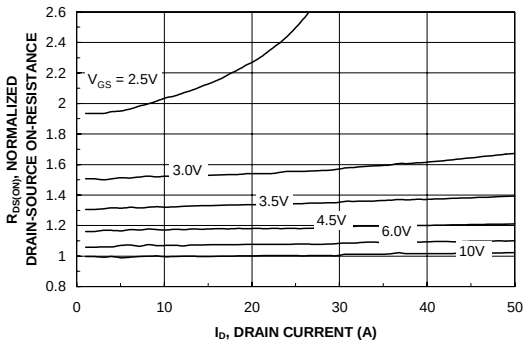



**Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.**

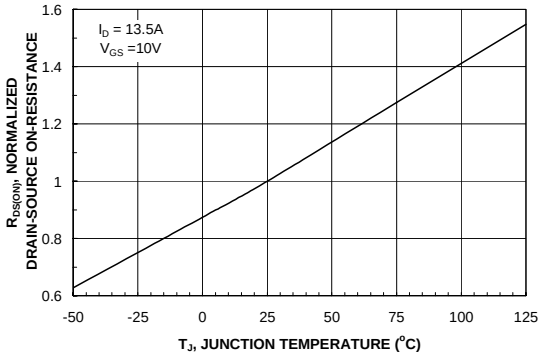



**Figure 3. On-Resistance Variation withTemperature.**

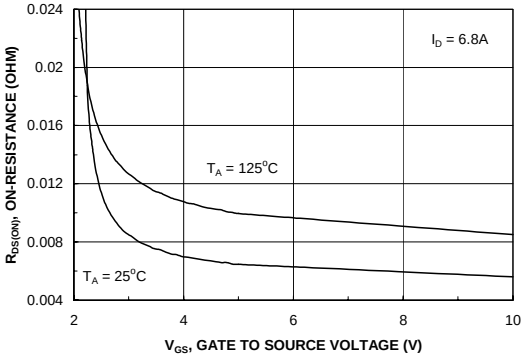



**Figure 4. On-Resistance Variation with Gate-to-Source Voltage.**

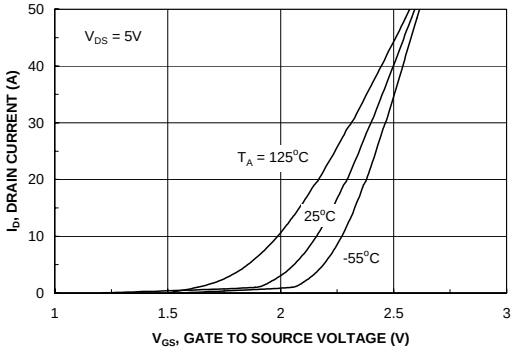



**Figure 5. Transfer Characteristics.**

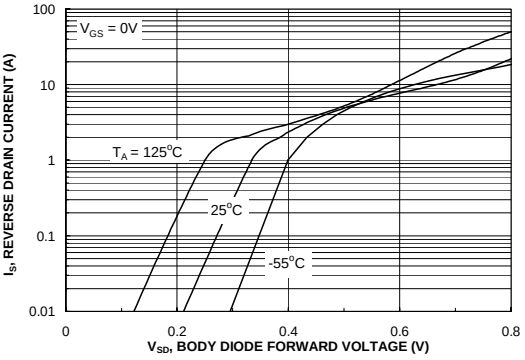



**Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.**

## Typical Characteristics

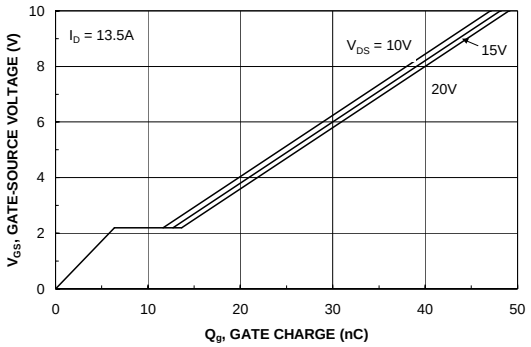



**Figure 7. Gate Charge Characteristics.**

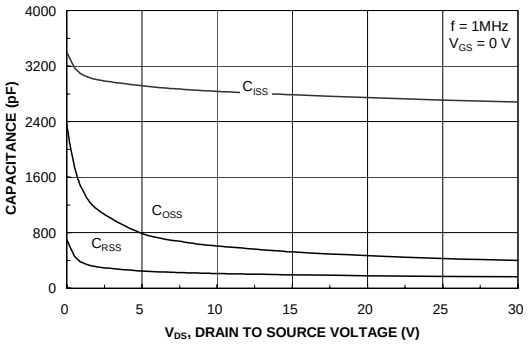



**Figure 8. Capacitance Characteristics.**

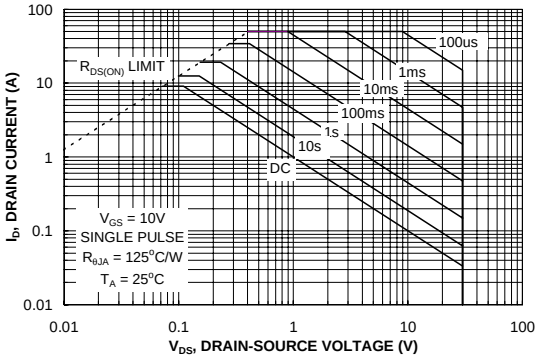



**Figure 9. Maximum Safe Operating Area.**

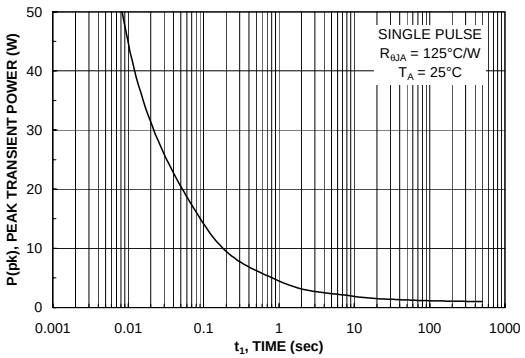



**Figure 10. Single Pulse Maximum Power Dissipation.**

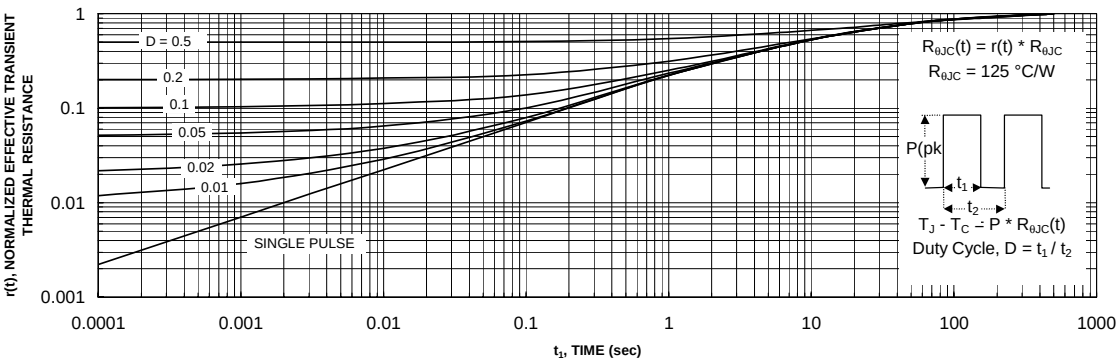



**Figure 11. Transient Thermal Response Curve.**

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

## Typical Characteristics (continued)

### SyncFET Schottky Body Diode Characteristics

Fairchild'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 12 FDS7764S.

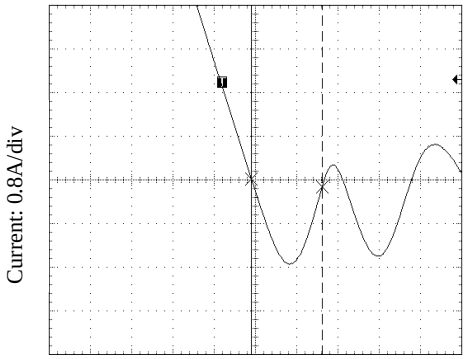



**Figure 12. FDS7764S SyncFET body diode reverse recovery characteristic.**

For comparison purposes, Figure 13 shows the reverse recovery characteristics of the body diode of an equivalent size MOSFET produced without SyncFET (FDS6644).

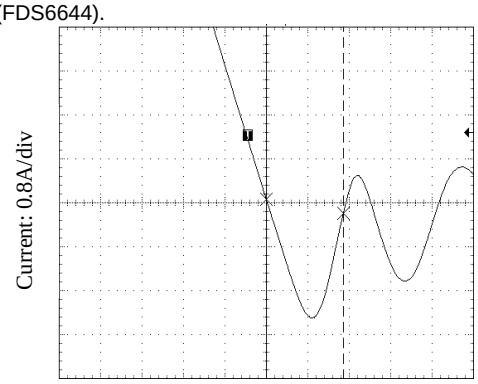



**Figure 13. Non-SyncFET (FDS6644) body diode reverse recovery characteristic.**

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

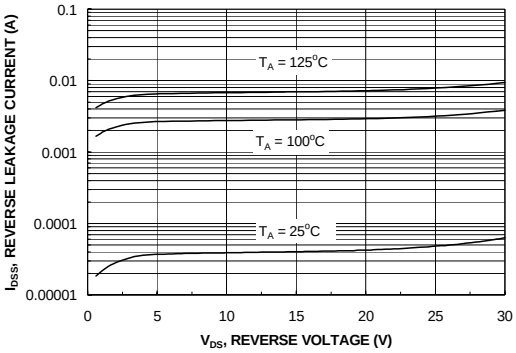



**Figure 14. SyncFET diode reverse leakage versus drain-source voltage and temperature.**

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