FAIRCHILD SEMICONDUCTOR®

September 2005

# FDU6676AS

## N-Channel PowerTrench® SyncFET™
## 30V, 90A, 5.8mΩ

### General Description

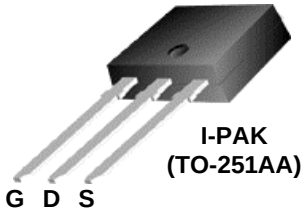
The FDU6676AS is designed to replace a single MOSFET and Schottky diode in synchronous DC/DC power supplies. This 30V MOSFET is designed to maximize power conversion efficiency, providing a low $R_{DS(ON)}$ and low gate charge. The FDU6676AS includes a patented combination of a MOSFET monolithically integrated with a Schottky diode using Fairchild's monolithic SyncFET technology.

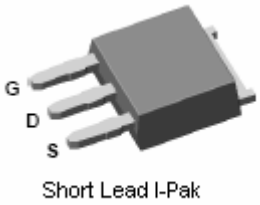
### Applications

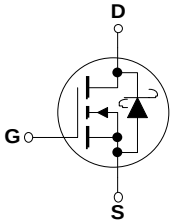
- DC/DC converter

### Features

- $R_{DS(ON)}$ = 5.8mΩ Max, VGS = 10V
- $R_{DS(ON)}$ = 7.3mΩ Max, VGS = 4.5V
- High performance trench technology for extremely low $R_{DS(ON)}$
- Low Gate Charge
- High power and current handling capability
- Includes SyncFET Schottky diode




## 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 | | ±20 | V |
| $I_D$ | Drain Current –Continuous | (Note 1a) | 90 | A |
| | –Pulsed | | 100 | |
| $P_D$ | Power Dissipation for Single Operation | (Note 1) | 70 | W |
| | | (Note 1a) | 3.1 | |
| | | (Note 1b) | 1.3 | |
| $T_J$, $T_{STG}$ | Operating and Storage Junction Temperature Range | | –55 to +150 | °C |

## Thermal Characteristics

| | | | | |
|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance junction to Case | (Note 1) | 1.8 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance junction to Ambient | (Note 1a) | 45 | |
| $R_{\theta JA}$ | Thermal Resistance junction to Ambient | (Note 1b) | 96 | |

## Package Marking and Ordering Information

| Device Marking | Device | Package | Reel Size | Tape width | Quantity |
|---|---|---|---|---|---|
| FDU6676AS | FDU6676AS | I-PAK (TO-251) | Tube | N/A | 75 |
| FDU6676AS | FDU6676AS_NL (Note 4) | I-PAK (TO-251) | Tube | N/A | 75 |
| FDU6676AS | FDU6676AS_F071 (Note 5) | I-PAK (TO-251) | Tube | N/A | 75 |

## Electrical Characteristics

$T_A$ = 25°C unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Drain-Source Avalanche Ratings (Note 2)** | | | | | | |
| $W_{DSS}$ | Drain-Source Avalanche Energy | Single Pulse, $V_{DD}$ = 15V, $I_D$ = 16A | | 108 | 250 | mJ |
| $I_{AR}$ | Drain-Source Avalanche Current | | | | 16 | A |
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain–Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 250 μA | 30 | | | V |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250 μA, Referenced to 25°C | | 29 | | mV/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 24 V, $V_{GS}$ = 0 V | | | 500 | μA |
| | | $V_{DS}$ = 24 V, $V_{GS}$ = 0 V, $T_J$=125°C | | 13 | | mA |
| $I_{GSS}$ | Gate–Body Leakage | $V_{GS}$ = ±20 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 | 1 | 1.5 | 3 | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D$ = 250 μA, Referenced to 25°C | | –4 | | mV/°C |
| $R_{DS(on)}$ | Static Drain–Source On–Resistance | $V_{GS}$ = 10 V, $I_D$ = 16 A | | 4.8 | 5.8 | mΩ |
| | | $V_{GS}$ = 4.5 V, $I_D$ = 10 A | | 5.8 | 7.3 | |
| | | $V_{GS}$ = 10 V, $I_D$ = 16 A, $T_J$=125°C | | 7.7 | 9.6 | |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 10 V, $I_D$ = 16 A | | 67 | | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 15 V, $V_{GS}$ = 0 V, f = 1.0 MHz | | 2470 | | pF |
| $C_{oss}$ | Output Capacitance | | | 710 | | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | | 260 | | pF |
| $R_G$ | Gate Resistance | $V_{GS}$ = 100 mV, f = 1.0 MHz | | 1.8 | | 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 | | 12 | 22 | ns |
| $t_r$ | Turn–On Rise Time | | | 12 | 22 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time | | | 50 | 80 | ns |
| $t_f$ | Turn–Off Fall Time | | | 25 | 40 | ns |
| $t_{d(on)}$ | Turn–On Delay Time | $V_{DD}$ = 15 V, $I_D$ = 1 A, $V_{GS}$ = 4.5 V, $R_{GEN}$ = 6 Ω | | 20 | 32 | ns |
| $t_r$ | Turn–On Rise Time | | | 24 | 38 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time | | | 34 | 54 | ns |
| $t_f$ | Turn–Off Fall Time | | | 26 | 42 | ns |
| $Q_g$ | Total Gate Charge, $V_{GS}$ = 10V | $V_{DS}$ = 15V, $I_D$ = 16 A | | 46 | 64 | nC |
| $Q_g$ | Total Gate Charge, $V_{GS}$ = 5V | | | 25 | 35 | nC |
| $Q_{gs}$ | Gate–Source Charge | | | 6 | | nC |
| $Q_{gd}$ | Gate–Drain Charge | | | 7 | | nC |

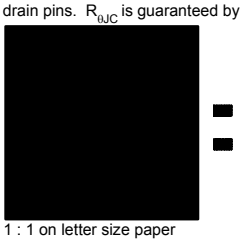
## Electrical Characteristics

$T_A$ = 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 | | | | 2.3 | A |
| $V_{SD}$ | Drain–Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 2.3 A (Note 2) | | 0.4 | 1.2 | V |
| $t_{rr}$ | Diode Reverse Recovery Time | $I_F$ = 16 A, $dI_F/dt$ = 100 A/µs | | 28 | | ns |
| $Q_{rr}$ | Diode Reverse Recovery Charge | | | 19 | | 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) $R_{\theta JA}$ = 45°C/W when mounted on a 1in$^2$ pad of 2 oz copper

b) $R_{\theta JA}$ = 96°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.** Maximum current is calculated as: $\sqrt{\frac{P_D}{R_{DS(ON)}}}$

where $P_D$ is maximum power dissipation at $T_C$ = 25°C and $R_{DS(on)}$ is at $T_{J(max)}$ and $V_{GS}$ = 10V. Package current limitation is 21A

**4.** FDU6676AS_NL is a lead free product. The FDU6676AS_NL marking will appear on the reel label.

**5.** FDU6676AS_F071 is a lead free product. The FDU6676AS_F071 marking will appear on the reel label.

## Typical Characteristics

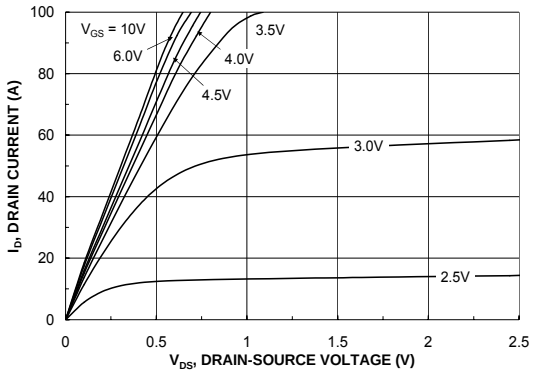



**Figure 1. On-Region Characteristics**

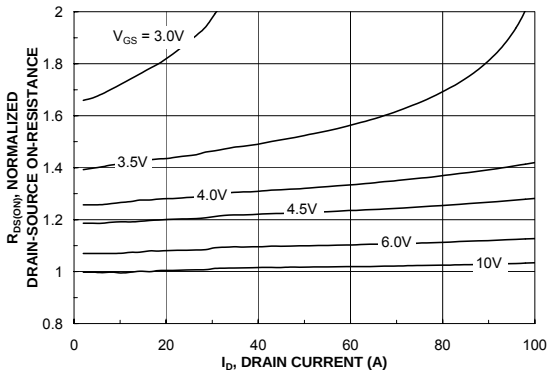



**Figure 2. On-Resistance Variation with Drain Current and Gate Voltage**

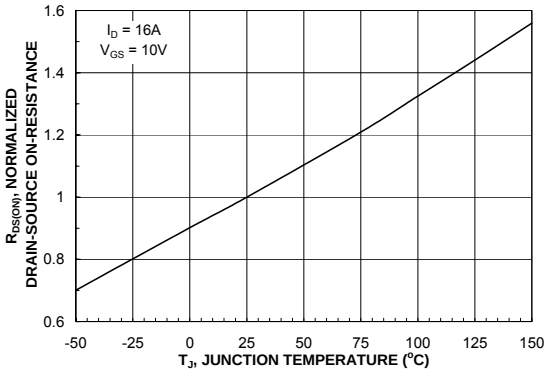



**Figure 3. On-Resistance Variation with Temperature**

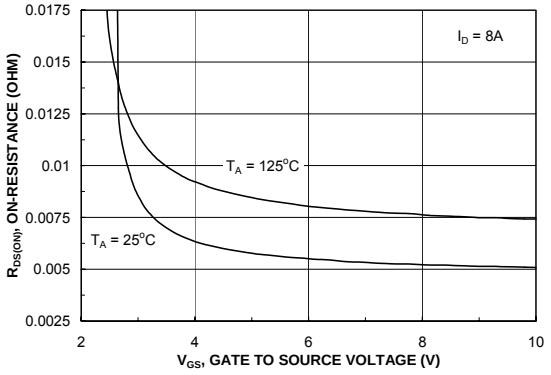



**Figure 4. On-Resistance Variation with Gate-to-Source Voltage**

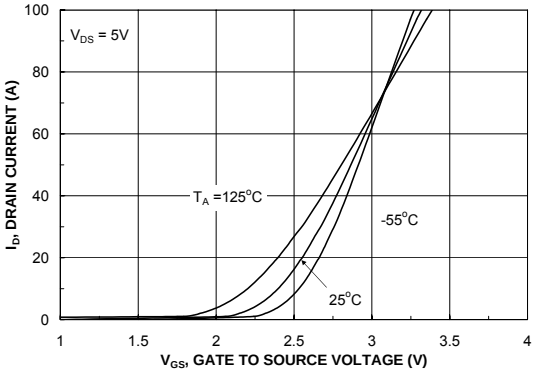



**Figure 5. Transfer Characteristics**

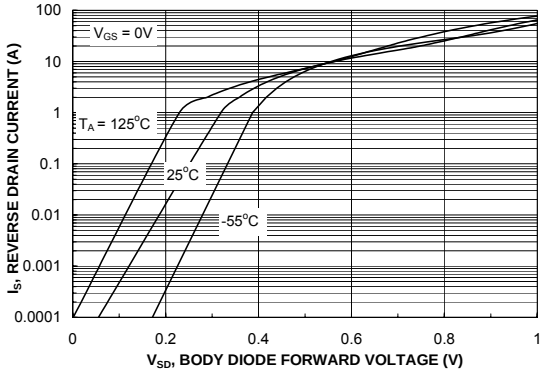



**Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature**

## Typical Characteristics

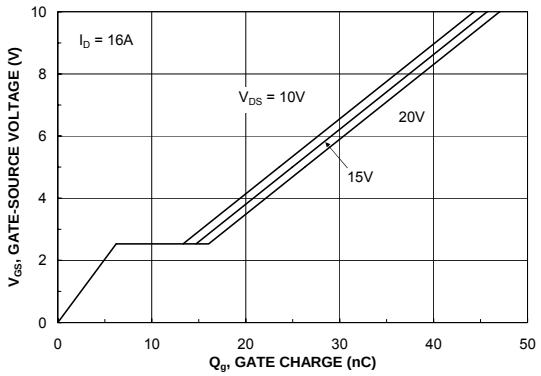



**Figure 7. Gate Charge Characteristics**

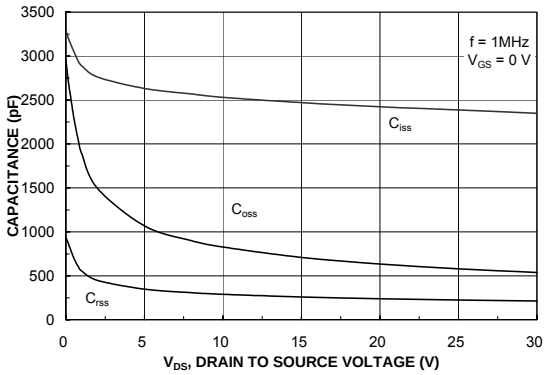



**Figure 8. Capacitance Characteristics**

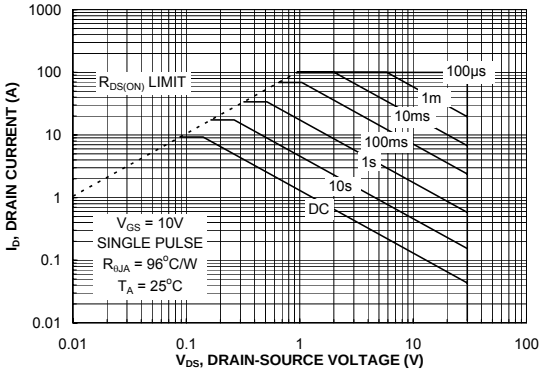



**Figure 9. Maximum Safe Operating Area**

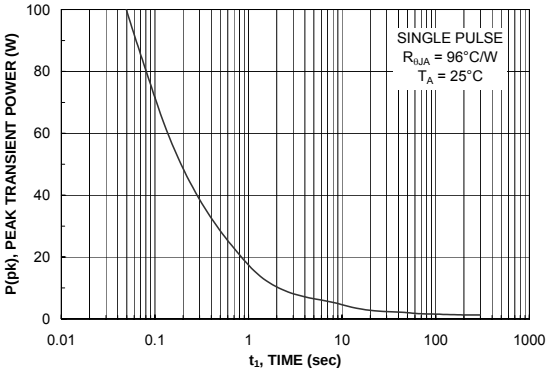



**Figure 10. Single Pulse Maximum Power Dissipation**

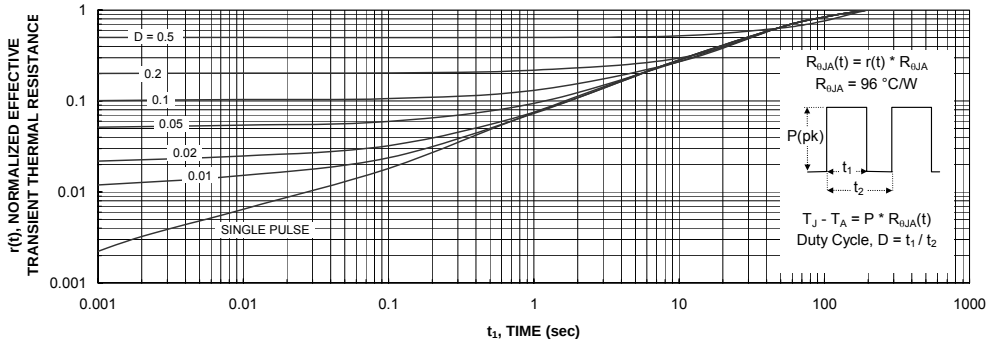



**Figure 11. Transient Thermal Response Curve**

**Thermal characterization performed using the conditions described in Note 1b. 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 shows the reverse recovery characteristic of the FDU6676AS.

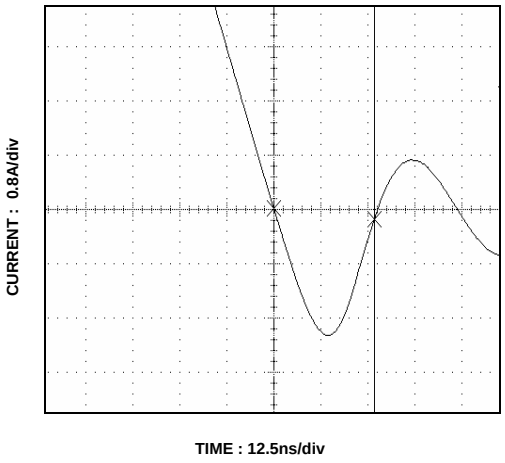



**Figure 12. FDU6676AS SyncFET Body Diode Reverse Recovery Characteristic.**

For comparison purposes, Figure 13 shows the reverse recovery characteristics of the body diode of an equivalent size MOSFET produced without SyncFET (FDU6676A).

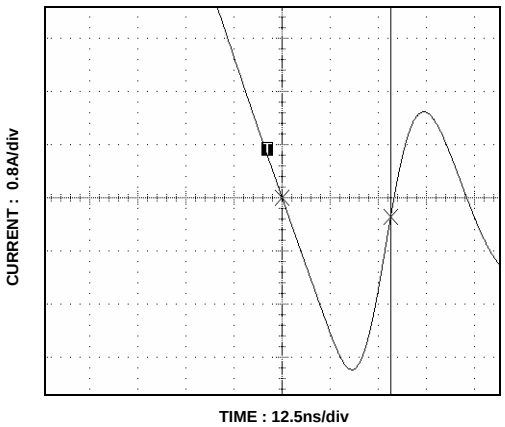



**Figure 13. Non-SyncFET (FDU6676A) Body Biode Reverse Recovery Characteristic.**

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

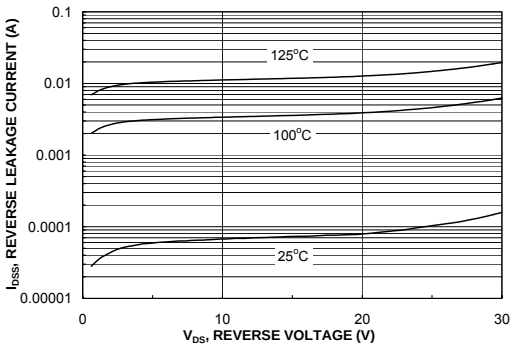



**Figure 14. SyncFET Body Diode Reverse Leakage Versus Drain-Source Voltage and Temperature.**

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