FAIRCHILD
SEMICONDUCTOR®

May 2004

FDD6688S

30V N-Channel PowerTrench® SyncFET™

General Description

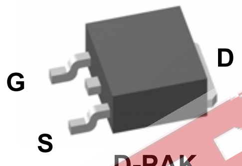
The FDD6688S is designed to replace a single TO-252 MOSFET and Schottky diode in synchronous DC:DC power supplies. This 30V MOSFET is designed to maximize power conversion efficiency, providing a low $R_{DS(ON)}$ and low gate charge. The FDD6688S includes an integrated Schottky diode using Fairchild's monolithic SyncFET technology.

Applications

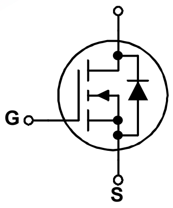
- DC/DC converter
- Motor Drives

Features

- 88 A, 30 V. $R_{DS(ON)} = 5.1\ m\Omega$ @ $V_{GS} = 10\ V$
  $R_{DS(ON)} = 6.3\ m\Omega$ @ $V_{GS} = 4.5\ V$
- Low gate charge (31 nC typical)
- Fast switching
- High performance trench technology for extremely low $R_{DS(ON)}$



D-PAK
(TO-252)



Absolute Maximum Ratings

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

Symbol	Parameter		Ratings	Units
V_{DSS}	Drain-Source Voltage		30	V
V_{GSS}	Gate-Source Voltage		± 20	
I_D	Drain Current – Continuous	(Note 3)	88	A
	– Pulsed	(Note 1a)	100	
P_D	Power Dissipation for Single Operation	(Note 1)	69	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)	40	
		(Note 1b)	96	

Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape width	Quantity
FDD6688S	FDD6688S	D-PAK (TO-252)	13''	12mm	2500 units

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} = 15 V, I_D = 21A		501		mJ
I_{AR}	Drain-Source Avalanche Current				21	A
Off Characteristics						
BV_{DSS}	Drain–Source Breakdown Voltage	V_{GS} = 0 V, I_D = 1mA	30			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	I_D = 15mA, Referenced to 25°C		30		mV/°C
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 24 V, V_{GS} = 0 V			500	µA
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 = 1mA	1	1.4	3	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate Threshold Voltage Temperature Coefficient	I_D = 15mA, Referenced to 25°C		–0.3		mV/°C
$R_{DS(on)}$	Static Drain–Source On–Resistance	V_{GS} = 10 V, I_D = 18.5 A V_{GS} = 4.5 V, I_D = 16.5 A V_{GS} = 10 V, I_D = 18.5 A, T_J=125°C		4.0 4.7 6.0	5.1 6.3 7.5	mΩ
g_{FS}	Forward Transconductance	V_{DS} = 5 V, I_D = 18.5 A		72		S
Dynamic Characteristics						
C_{iss}	Input Capacitance	V_{DS} = 15 V, V_{GS} = 0 V, f = 1.0 MHz		3290		pF
C_{oss}	Output Capacitance			900		pF
C_{rss}	Reverse Transfer Capacitance			300		pF
R_G	Gate Resistance	V_{GS} = 15 mV, f = 1.0 MHz		1.6		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		13	23	ns
t_r	Turn–On Rise Time			13	23	ns
$t_{d(off)}$	Turn–Off Delay Time			31	50	ns
t_f	Turn–Off Fall Time			64	103	ns
$Q_{g(TOT)}$	Total Gate Charge at Vgs=10V	V_{DD} = 15 V, I_D = 18.5 A		58	81	nC
Q_g	Total Gate Charge at Vgs=5V			31	44	nC
Q_{gs}	Gate–Source Charge			8		nC
Q_{gd}	Gate–Drain Charge			10		nC

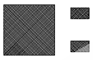
Electrical Characteristics (continued) T_A = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
Drain–Source Diode Characteristics and Maximum Ratings						
V_{SD}	Drain–Source Diode Forward Voltage	V_{GS} = 0 V, I_S = 4.4 A (Note 2)		400	700	mV
t_{rr}	Diode Reverse Recovery Time	I_F = 18.5 A, d_{iF}/d_t = 300 A/µs		28		ns
Q_{rr}	Diode Reverse Recovery Charge			30		nC
I_{rr}	Diode Reverse Recovery Current			2.1		A

Notes:8

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) $R_{\theta JA}$ = 40°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

Typical Characteristics

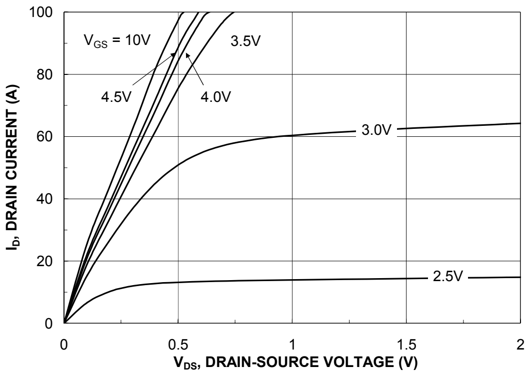


Figure 1. On-Region Characteristics.

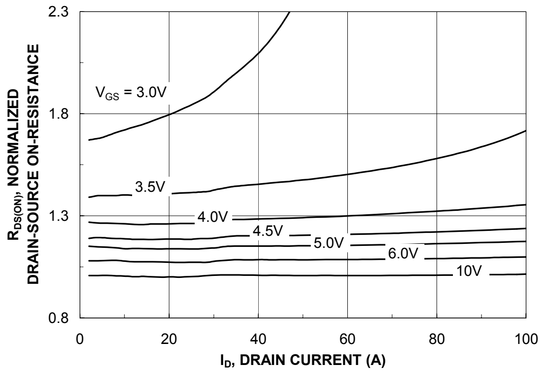


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.

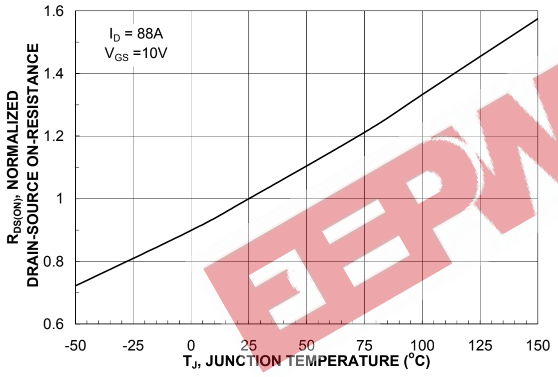


Figure 3. On-Resistance Variation with Temperature.

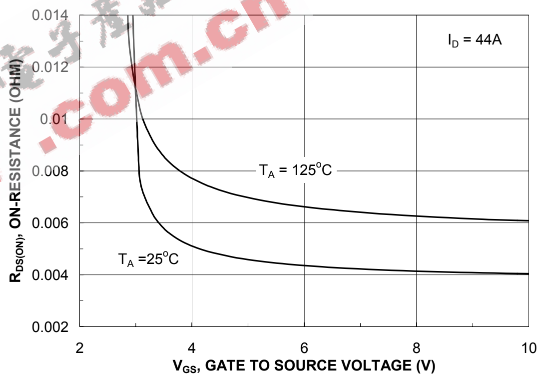


Figure 4. On-Resistance Variation with Gate-to-Source Voltage.

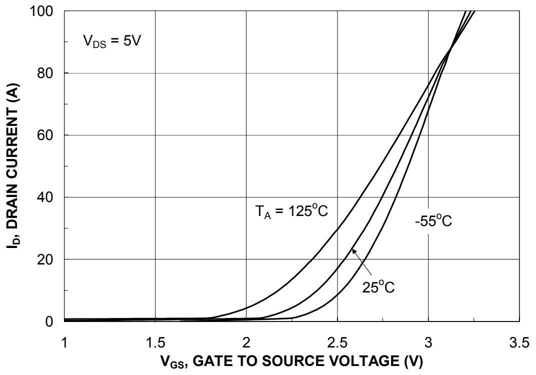


Figure 5. Transfer Characteristics

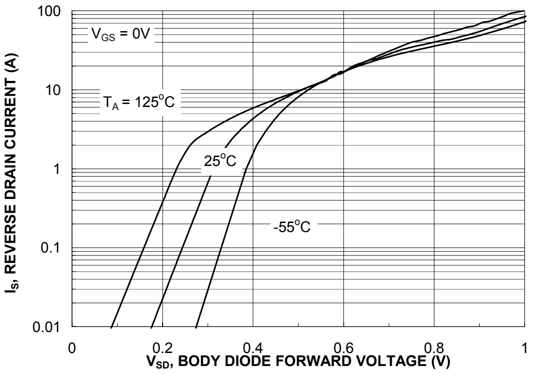


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

Typical Characteristics

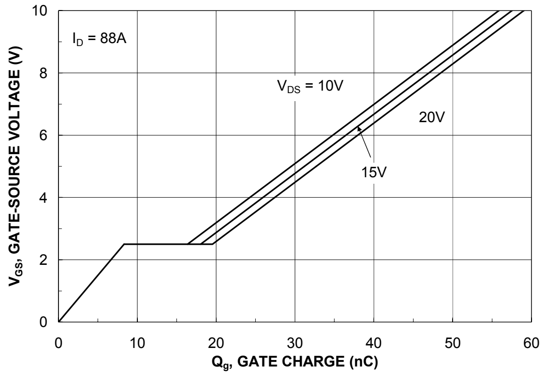


Figure 7. Gate Charge Characteristics

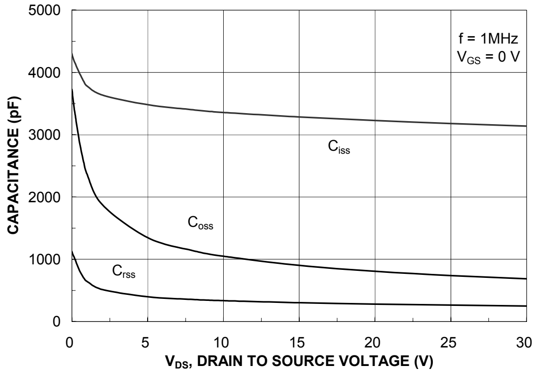


Figure 8. Capacitance Characteristics

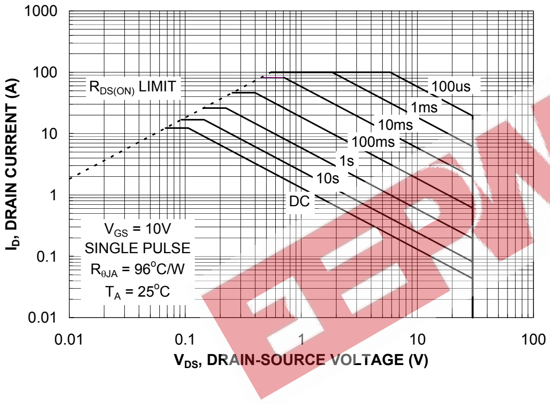


Figure 9. Maximum Safe Operating Area

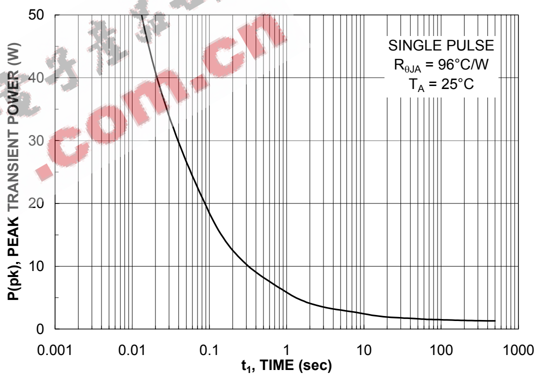


Figure 10. Single Pulse Maximum Power Dissipation

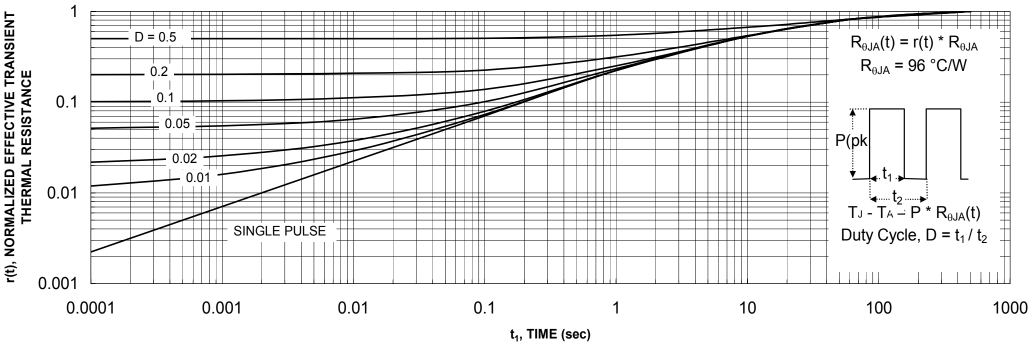


Figure 11. Transient Thermal Response Curve

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 FDD6688S.

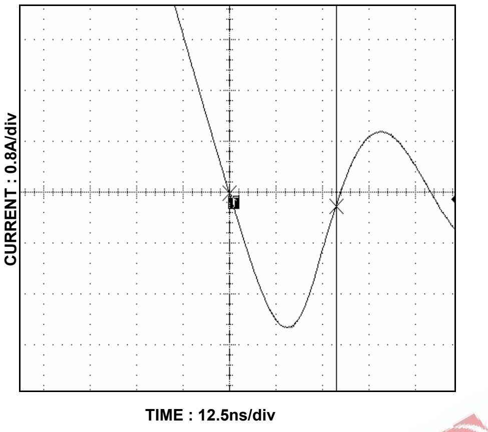


Figure 12. FDD6688S SyncFET body diode reverse recovery characteristic.

For comparison purposes, Figure 13 shows the reverse recovery characteristics of the body diode of an equivalent size MOSFET produced without SyncFET (FDD6688).

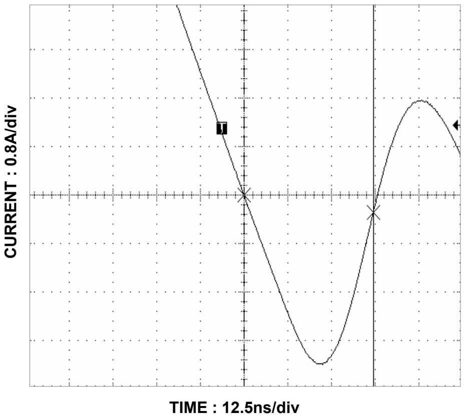


Figure 13. Non-SyncFET (FDD6688) body diode reverse recovery characteristic.

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

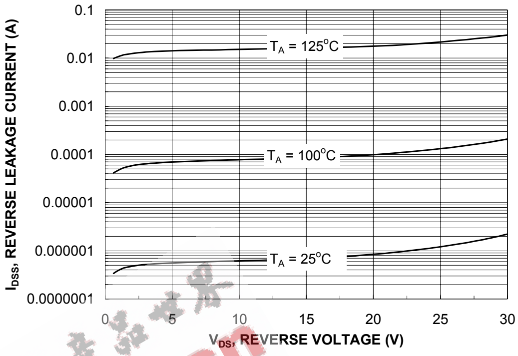


Figure 14. SyncFET body diode reverse leakage versus drain-source voltage and temperature.

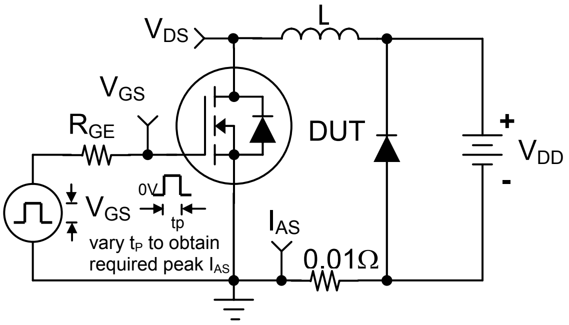


Figure 15. Unclamped Inductive Load Test Circuit

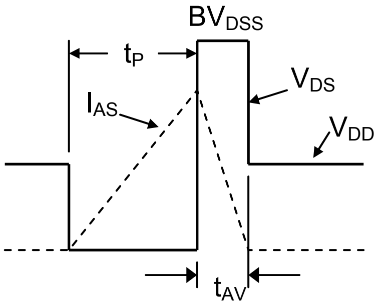


Figure 16. Unclamped Inductive Waveforms

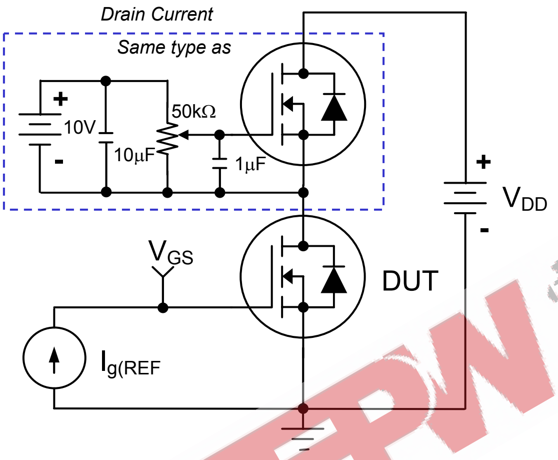


Figure 17. Gate Charge Test Circuit

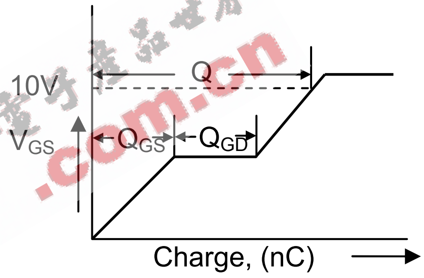


Figure 18. Gate Charge Waveform

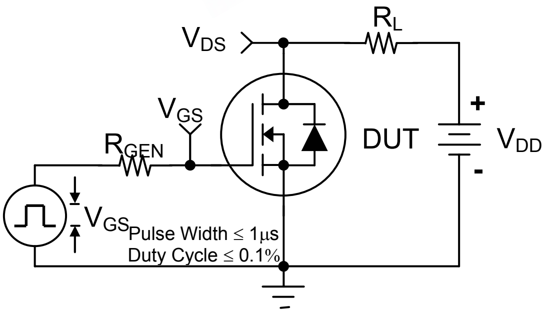


Figure 19. Switching Time Test Circuit

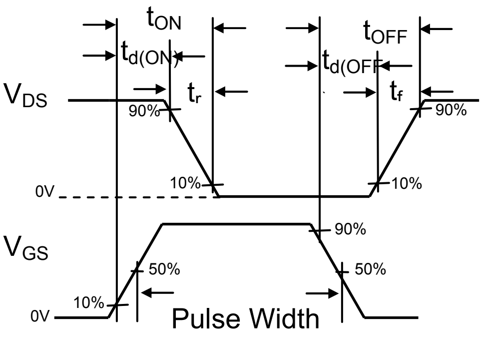


Figure 20. Switching Time Waveforms

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