



**THE DATASHEET OF  
FDS6689S**



# FDS6689S

## 30V N-Channel PowerTrench® SyncFET™

### General Description

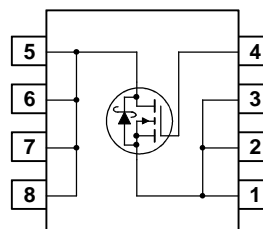
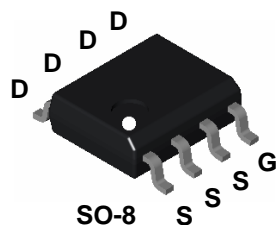
The FDS6689S is designed to replace a single SO-8 MOSFET and Schottky diode in synchronous DC:DC power supplies. This 30V MOSFET is designed to maximize power conversion efficiency, providing a low  $R_{DS(ON)}$  and low gate charge. The FDS6689S includes an integrated Schottky diode using Fairchild's monolithic SyncFET technology.

### Applications

- Synchronous Rectifier for DC/DC converter –
  - Notebook Vcore low side switch
  - Point of Load low side switch

### Features

- 16 A, 30 V.  $R_{DS(ON)} = 5.4\text{ m}\Omega @ V_{GS} = 10\text{ V}$   
 $R_{DS(ON)} = 6.5\text{ m}\Omega @ V_{GS} = 4.5\text{ V}$
- Includes SyncFET Schottky body diode
- High performance trench technology for extremely low  $R_{DS(ON)}$  and fast switching
- High power and current handling capability
- 100%  $R_G$  (Gate Resistance) tested



### Absolute Maximum Ratings $T_A=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Ratings	Units
$V_{DSS}$	Drain-Source Voltage	30	V
$V_{GSS}$	Gate-Source Voltage	$\pm 20$	V
$I_D$	Drain Current – Continuous (Note 1a)	16	A
	– Pulsed	50	
$P_D$	Power Dissipation for Single Operation (Note 1a)	2.5	W
	(Note 1b)	1.2	
	(Note 1c)	1	
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150	$^\circ\text{C}$

### Thermal Characteristics

$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (Note 1a)	50	$^\circ\text{C/W}$
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	25	

### Package Marking and Ordering Information

Device Marking	Device	Reel Size	Tape width	Quantity
FDS6689S	FDS6689S	13"	12mm	2500 units

### Electrical Characteristics

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
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#### Off Characteristics

$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	30			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$		21		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 24\text{ V}, V_{GS} = 0\text{ V}$			500	$\mu\text{A}$
$I_{GSS}$	Gate-Body Leakage	$V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$			$\pm 100$	nA

#### On Characteristics

$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 1\text{ mA}$	1	1.6	3	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate Threshold Voltage Temperature Coefficient	$I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$		-5		mV/ $^\circ\text{C}$
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = 10\text{ V}, I_D = 16\text{ A}$ $V_{GS} = 4.5\text{ V}, I_D = 14.5\text{ A}$ $V_{GS} = 10\text{ V}, I_D = 16\text{ A}, T_J = 150^\circ\text{C}$		4.5 5.2 6.1	5.4 6.5	m $\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 10\text{ V}, I_D = 16\text{ A}$		74		S

#### Dynamic Characteristics

$C_{iss}$	Input Capacitance	$V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$		3290		pF
$C_{oss}$	Output Capacitance			890		pF
$C_{riss}$	Reverse Transfer Capacitance			290		pF
$R_G$	Gate Resistance	$V_{GS} = 15\text{ mV}, f = 1.0\text{ MHz}$		1.5	2.6	$\Omega$

#### Switching Characteristics (Note 2)

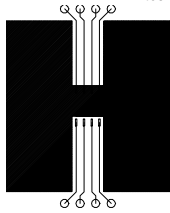
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 15\text{ V}, I_D = 1\text{ A}, V_{GS} = 10\text{ V}, R_{GEN} = 6\text{ }\Omega$		12	22	ns
$t_r$	Turn-On Rise Time			12	22	ns
$t_{d(off)}$	Turn-Off Delay Time			30	46	ns
$t_f$	Turn-Off Fall Time			60	96	ns
$Q_{g(TOT)}$	Total Gate Charge at $V_{GS}=10\text{V}$	$V_{DS} = 15\text{ V}, I_D = 16\text{ A}$		56	78	nC
$Q_g$	Total Gate Charge at $V_{GS}=5\text{V}$			31	44	nC
$Q_{gs}$	Gate-Source Charge			8.2		nC
$Q_{gd}$	Gate-Drain Charge			9.0		nC

#### Drain-Source Diode Characteristics and Maximum Ratings

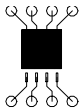
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 3.5\text{ A}$ (Note 2)		380	700	mV
$t_{rr}$	Diode Reverse Recovery Time	$I_F = 16\text{ A}, d_I/d_t = 300\text{ A}/\mu\text{s}$ (Note 3)		30		ns
$I_{RM}$	Diode Reverse Recovery Current			2		A
$Q_{rr}$	Diode Reverse Recovery Charge			31		nC

#### Notes:

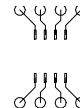
- $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a) 50°W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



b) 105°W when mounted on a .04 in<sup>2</sup> pad of 2 oz copper



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

Scale 1 : 1 on letter size paper

- Pulse Test: Pulse Width < 300 $\mu\text{s}$ , Duty Cycle < 2.0%.
- See "SyncFET Schottky body diode characteristics" below.

## Typical Characteristics

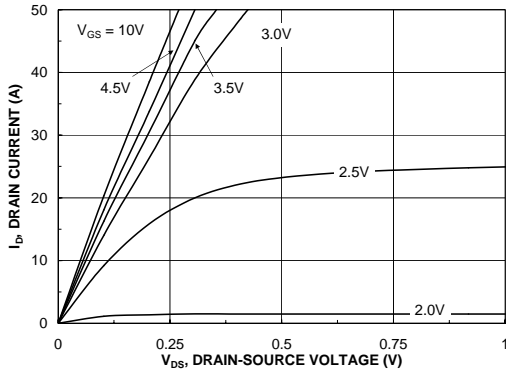


Figure 1. On-Region Characteristics.

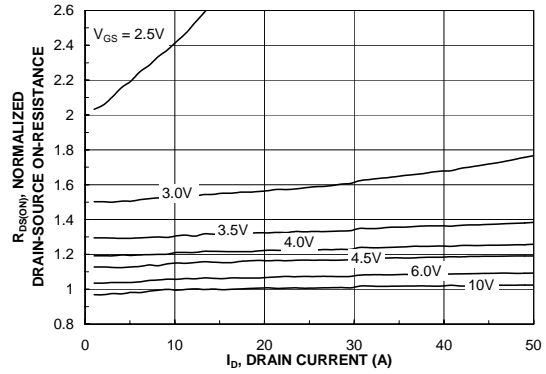


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.

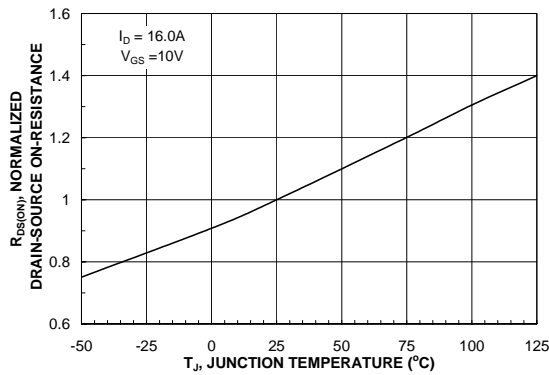


Figure 3. On-Resistance Variation with Temperature.

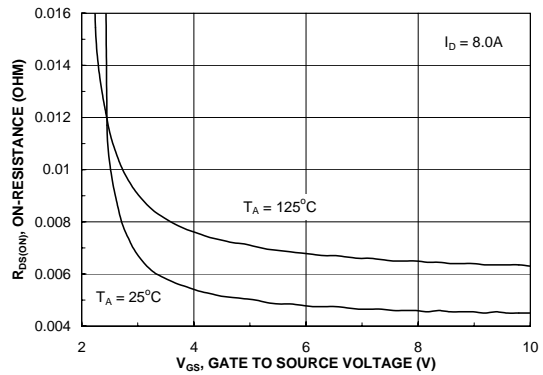


Figure 4. On-Resistance Variation with Gate-to-Source Voltage.

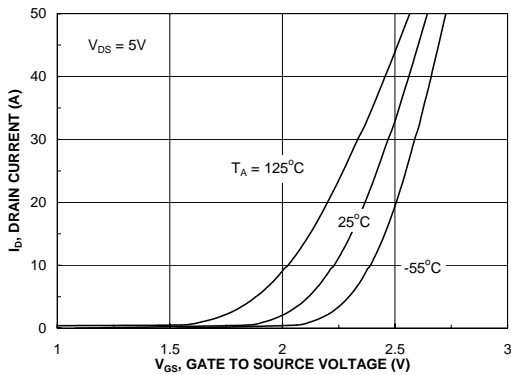


Figure 5. Transfer Characteristics.

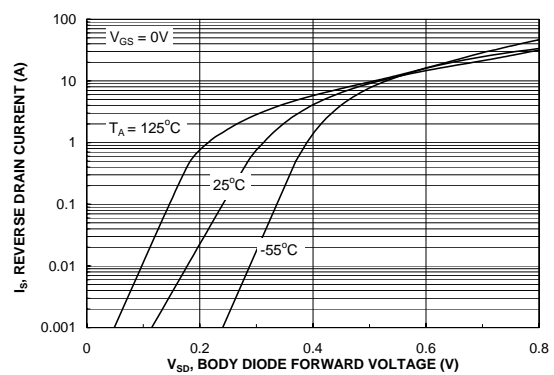
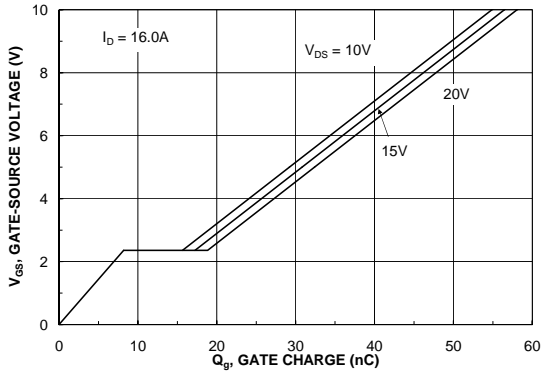
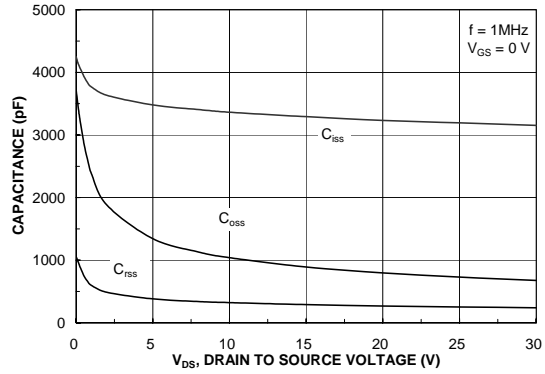


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.

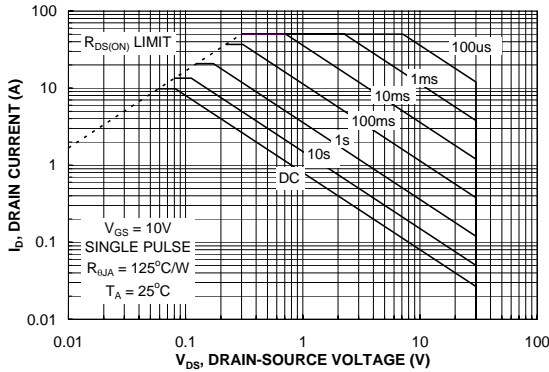
**Typical Characteristics** (continued)



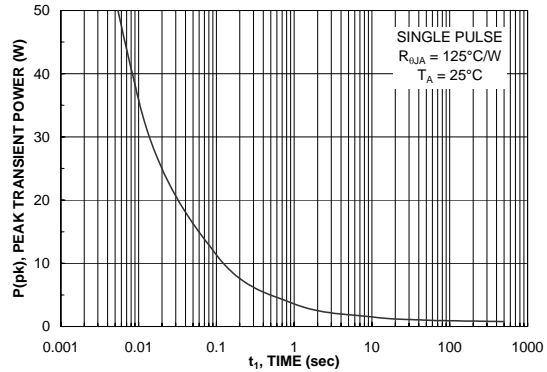
**Figure 7. Gate Charge Characteristics.**



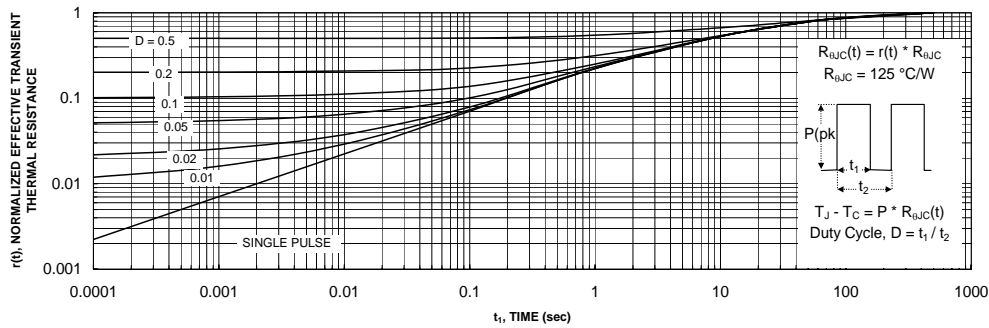
**Figure 8. Capacitance Characteristics.**



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



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



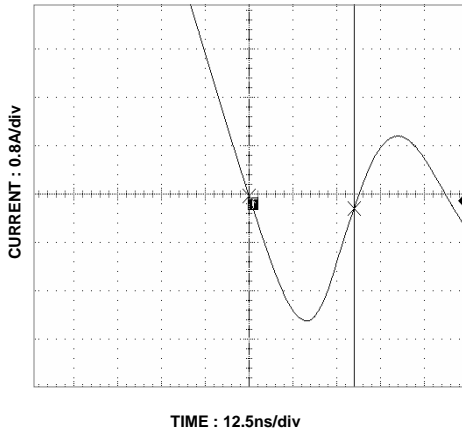
**Figure 11. Transient Thermal Response Curve.**

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

**Typical Characteristics** (continued)

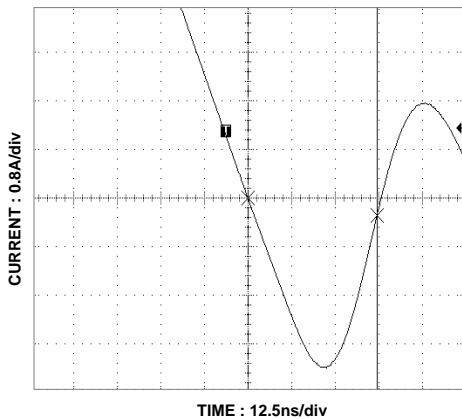
**SyncFET Schottky Body Diode Characteristics**

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 FDS6689S.



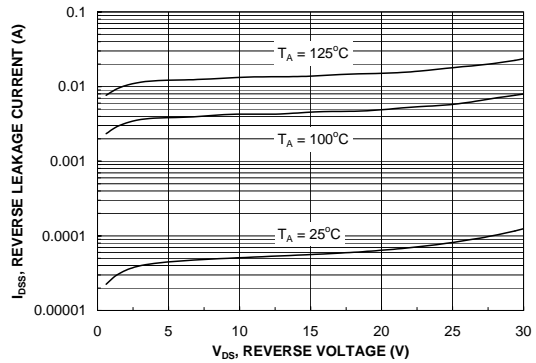
**Figure 12. FDS6689S SyncFET body diode reverse recovery characteristic.**

For comparison purposes, Figure 13 shows the reverse recovery characteristics of the body diode of an equivalent size MOSFET produced without SyncFET (FDS6688).



**Figure 13. Non-SyncFET (FDS6688) 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.**



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