

# FDS6990AS

## Dual 30V N-Channel PowerTrench® SyncFET™

### Features

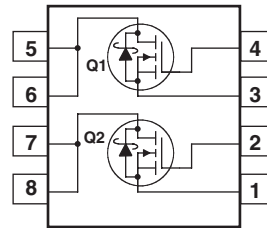
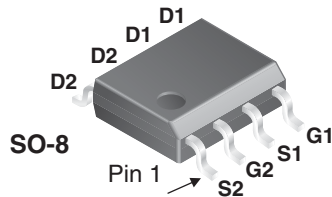
- 7.5 A, 30 V.  $R_{DS(ON)} = 22\text{ m}\Omega @ V_{GS} = 10\text{ V}$   
 $R_{DS(ON)} = 28\text{ m}\Omega @ V_{GS} = 4.5\text{ V}$
- Includes SyncFET Schottky diode
- Low gate charge (10nC typical)
- High performance trench technology for extremely low  $R_{DS(ON)}$
- High power and current handling capability

### General Description

The FDS6990AS is designed to replace a dual SO-8 MOSFET and two Schottky diodes 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. Each MOSFET includes integrated Schottky diodes using Fairchild's monolithic SyncFET technology. The performance of the FDS6990AS as the low-side switch in a synchronous rectifier is similar to the performance of the FDS6990A in parallel with a Schottky diode.

### Applications

- DC/DC converter
- Motor drives



### 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)	7.5	A	
		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 $+150$	$^\circ\text{C}$	
<b>Thermal Characteristics</b>				
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (Note 1a)	78	$^\circ\text{C/W}$	
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	40	$^\circ\text{C/W}$	

### Package Marking and Ordering Information

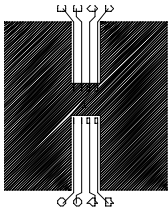
Device Marking	Device	Reel Size	Tape width	Quantity
FDS6990AS	FDS6990AS	13"	12mm	2500 units

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

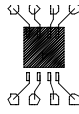
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
<b>Off Characteristics</b>						
$BV_{DSS}$	Drain–Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	30			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 1\text{ mA}$ , Referenced to $25^\circ\text{C}$		31		$\text{mV}/^\circ\text{C}$
$I_{DSS}$	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
<b>On Characteristics (Note 2)</b>						
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 1\text{ mA}$	1	1.7	3	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate Threshold Voltage Temperature Coefficient	$I_D = 1\text{ mA}$ , Referenced to $25^\circ\text{C}$		–3		$\text{mV}/^\circ\text{C}$
$R_{DS(on)}$	Static Drain–Source On–Resistance	$V_{GS} = 10\text{ V}, I_D = 7.5\text{ A}$ $V_{GS} = 10\text{ V}, I_D = 7.5\text{ A}, T_J = 125^\circ\text{C}$ $V_{GS} = 4.5\text{ V}, I_D = 6.5\text{ A}$		17 26 21	22 35 28	$\text{m}\Omega$
$I_{D(on)}$	On–State Drain Current	$V_{GS} = 10\text{ V}, V_{DS} = 5\text{ V}$	20			A
$g_{FS}$	Forward Transconductance	$V_{DS} = 15\text{ V}, I_D = 10\text{ A}$		29		S
<b>Dynamic Characteristics</b>						
$C_{iss}$	Input Capacitance	$V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$		550		pF
$C_{oss}$	Output Capacitance			330		pF
$C_{rss}$	Reverse Transfer Capacitance			60		pF
$R_G$	Gate Resistance	$V_{GS} = 15\text{ mV}, f = 1.0\text{ MHz}$		3.1		$\Omega$
<b>Switching Characteristics (Note 2)</b>						
$t_{d(on)}$	Turn–On Delay Time	$V_{DS} = 15\text{ V}, I_D = 1\text{ A},$ $V_{GS} = 10\text{ V}, R_{GEN} = 6\ \Omega$		8	16	ns
$t_r$	Turn–On Rise Time			5	10	ns
$t_{d(off)}$	Turn–Off Delay Time			24	38	ns
$t_f$	Turn–Off Fall Time			4	88	ns
$t_{d(on)}$	Turn–On Delay Time	$V_{DS} = 15\text{ V}, I_D = 1\text{ A},$ $V_{GS} = 4.5\text{ V}, R_{GEN} = 6\ \Omega$		9	18	ns
$t_r$	Turn–On Rise Time			8	16	ns
$t_{d(off)}$	Turn–Off Delay Time			14	24	ns
$t_f$	Turn–Off Fall Time			5	10	ns
$Q_{g(TOT)}$	Total Gate Charge at $V_{GS} = 10\text{ V}$	$V_{DD} = 15\text{ V}, I_D = 10\text{ A}, V_{GS} = 5\text{ V}$		10	14	nC
$Q_g$	Total Gate Charge at $V_{GS} = 5\text{ V}$			6	8	nC
$Q_{gs}$	Gate–Source Charge			1.5		nC
$Q_{gd}$	Gate–Drain Charge			2.0		nC
<b>Drain–Source Diode Characteristics and Maximum Ratings</b>						
$I_S$	Maximum Continuous Drain–Source Diode Forward Current				2.9	A
$V_{SD}$	Drain–Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 2.3\text{ A}$ (Note 2)		0.6	0.7	V
$t_{rr}$	Diode Reverse Recovery Time	$I_F = 10\text{ A},$		18		nS
$Q_{rr}$	Diode Reverse Recovery Charge	$dI_F/dt = 300\text{ A}/\mu\text{s}$ (Note 3)		11		nC

**Notes:**

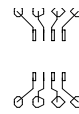
1.  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a) 78°C/W when mounted on a 0.5 in<sup>2</sup> pad of 2 oz copper



b) 125°C/W when mounted on a 0.02 in<sup>2</sup> 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

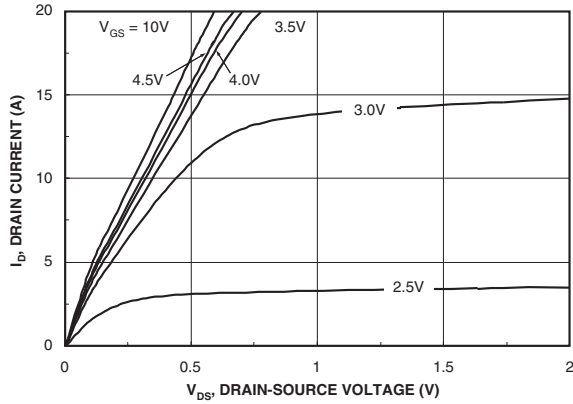


Figure 1. On-Region Characteristics.

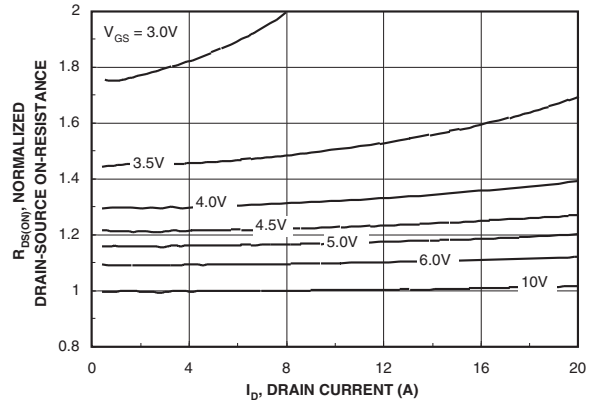


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.

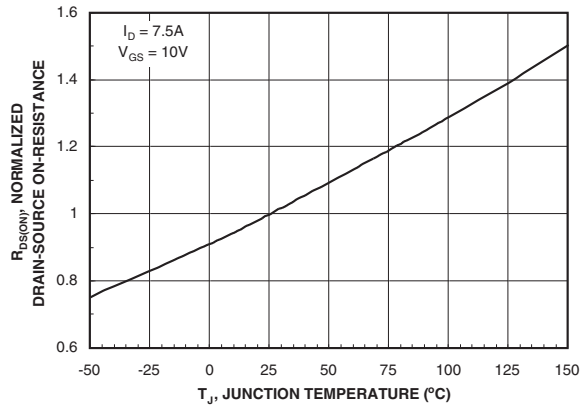


Figure 3. On-Resistance Variation with Temperature.

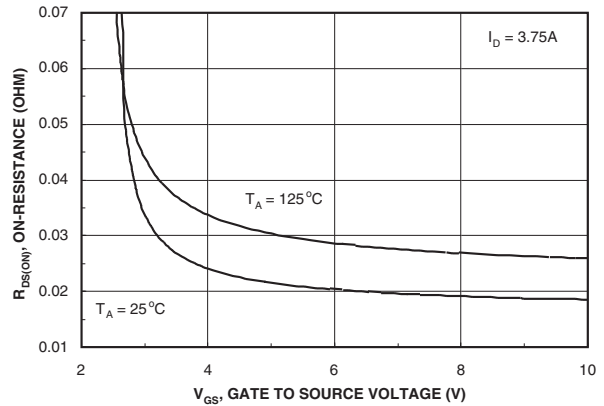


Figure 4. On-Resistance Variation with Gate-to-Source Voltage.

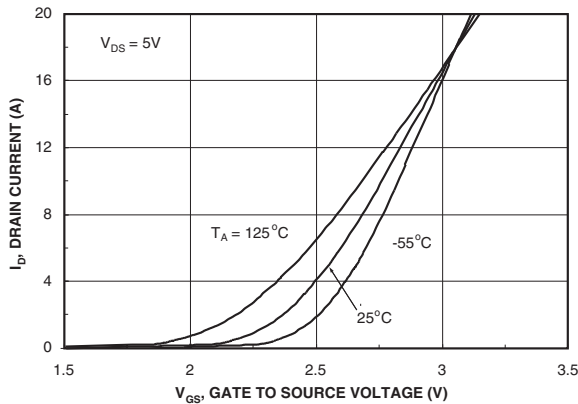


Figure 5. Transfer Characteristics.

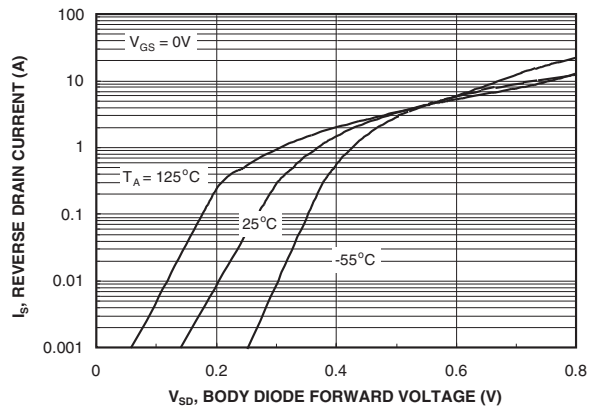
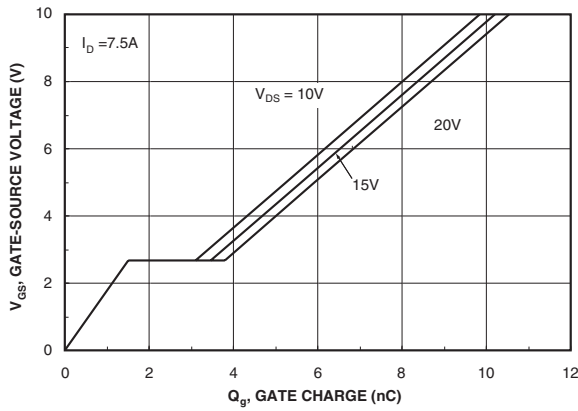
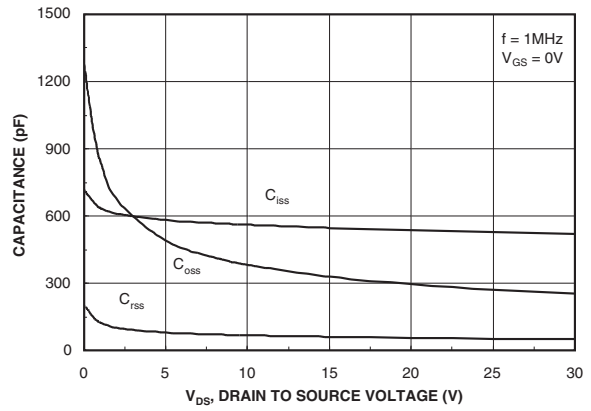


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.

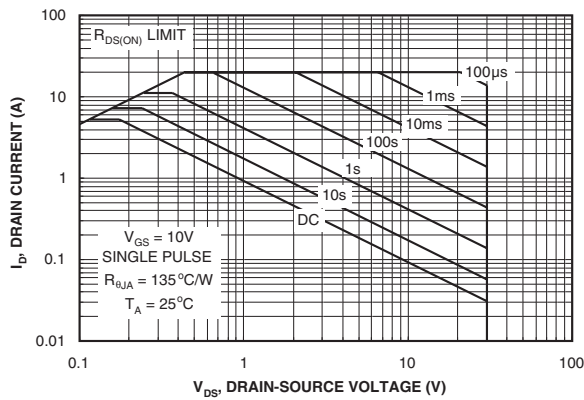
### Typical Characteristics



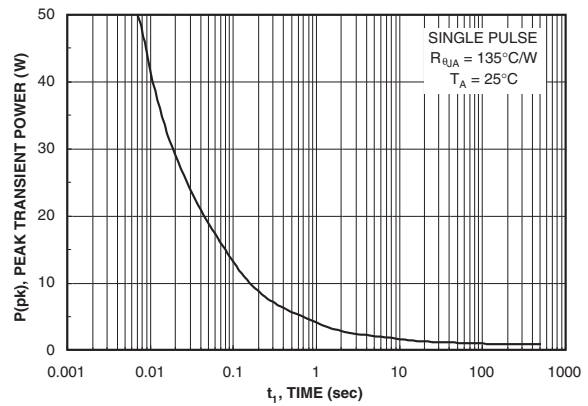
**Figure 7. Gate Charge Characteristics.**



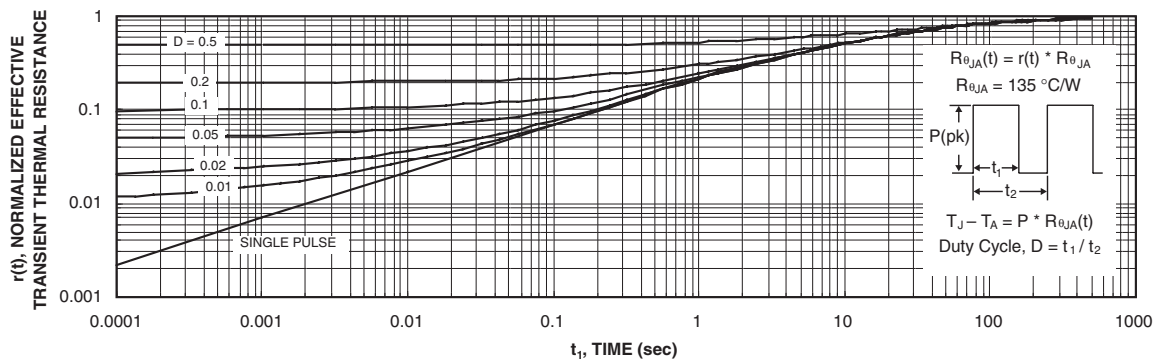
**Figure 8. Capacitance Characteristics.**



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



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



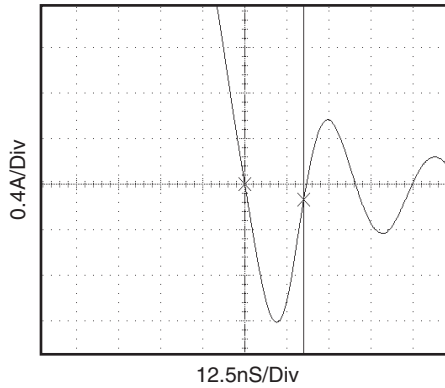
**Figure 11. Transient Thermal Response Curve.**

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

## Typical Characteristics (continued)

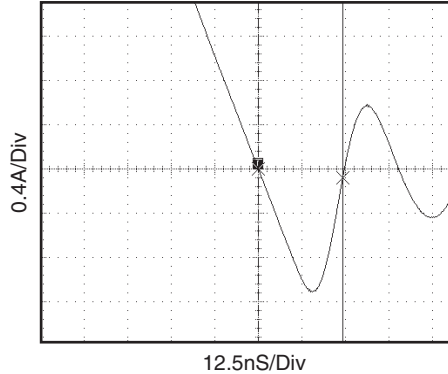
### SyncFET Schottky Body Diode Characteristics

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 FDS6990AS.



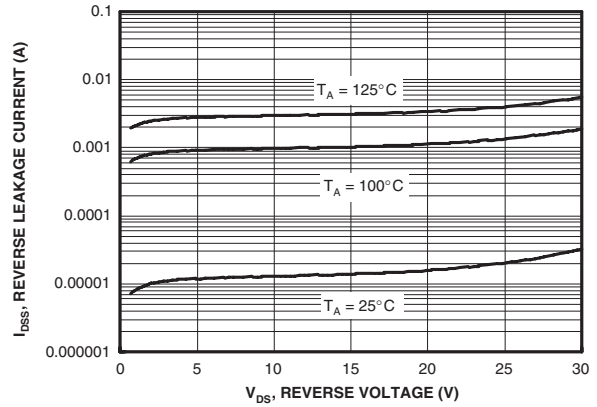
**Figure 12. FDS6990AS SyncFET body diode reverse recovery characteristic.**

For comparison purposes, Figure 13 shows the reverse recovery characteristics of the body diode of an equivalent size MOSFET produced without SyncFET (FDS6990A).



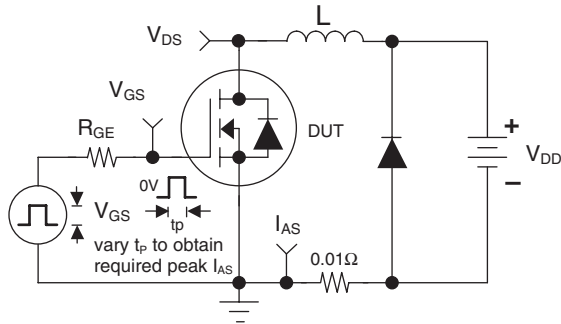
**Figure 13. Non-SyncFET (FDS6990A) body diode reverse recovery characteristic.**

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

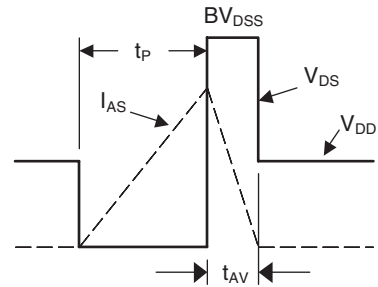


**Figure 14. SyncFET body diode reverse leakage versus drain-source voltage and temperature.**

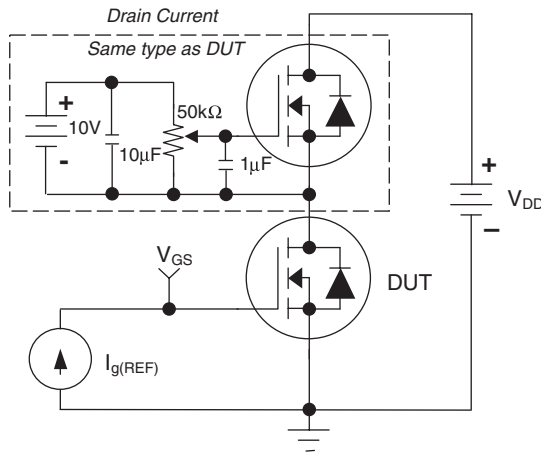
**Typical Characteristics** (continued)



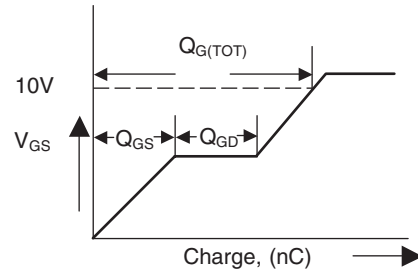
**Figure 15. Unclamped Inductive Load Test Circuit**



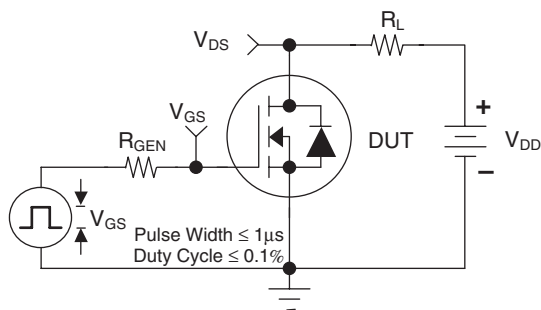
**Figure 16. Unclamped Inductive Waveforms**



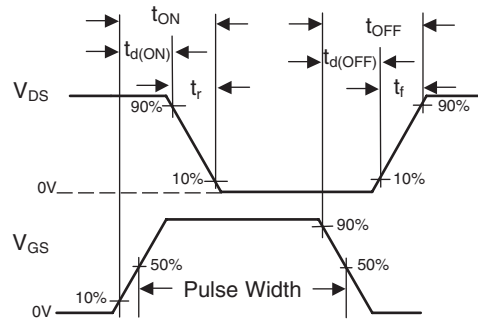
**Figure 17. Gate Charge Test Circuit**



**Figure 18. Gate Charge Waveform**



**Figure 19. Switching Time Test Circuit**







**Figure 20. Switching Time Waveforms**



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