

# FDS6680AS

## 30V N-Channel PowerTrench® SyncFET™

### Features

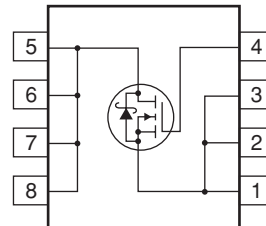
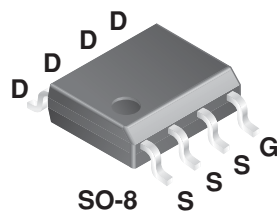
- 11.5 A, 30 V.  $R_{DS(ON)}$  max = 8.0 m $\Omega$  @  $V_{GS} = 10$  V  
 $R_{DS(ON)}$  max = 10.5 m $\Omega$  @  $V_{GS} = 4.5$  V
- Includes SyncFET Schottky body diode
- Low gate charge (22nC typical)
- High performance trench technology for extremely low  $R_{DS(ON)}$  and fast switching
- High power and current handling capability

### Applications

- DC/DC converter
- Low side notebooks

### General Description

The FDS6680AS 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 FDS6680AS includes an integrated Schottky diode using Fairchild's monolithic SyncFET technology. The performance of the FDS6680AS as the low-side switch in a synchronous rectifier is indistinguishable from the performance of the FDS6680 in parallel with a Schottky diode.



### 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) – Pulsed	11.5	A
		50	
$P_D$	Power Dissipation for Single Operation (Note 1a) (Note 1b) (Note 1c)	2.5	W
		1.2	
		1	
$T_J, T_{STG}$	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)	50	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	25	$^\circ\text{C}/\text{W}$

### Package Marking and Ordering Information

Device Marking	Device	Reel Size	Tape width	Quantity
FDS6680AS	FDS6680AS	13"	12mm	2500 units
FDS6680AS	FDS6680AS_NL (Note 4)	13"	12mm	2500 units

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

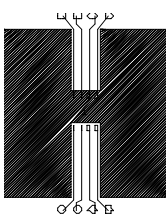
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
<b>Off Characteristics</b>						
$BV_{DSS}$	Drain–Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	30			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 1\text{ mA}$ , Referenced to $25^\circ\text{C}$		29		$\text{mV}/^\circ\text{C}$
$I_{DSS}$	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	1.5	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	$V_{GS} = 10\text{ V}, I_D = 11.5\text{ A}$ $V_{GS} = 4.5\text{ V}, I_D = 9.5\text{ A}$ $V_{GS} = 10\text{ V}, I_D = 11.5\text{ A}, T_J = 125^\circ\text{C}$		6.5 8.3 12.3	8 10.5 15.5	$\text{m}\Omega$
$I_{D(on)}$	On–State Drain Current	$V_{GS} = 10\text{ V}, V_{DS} = 5\text{ V}$	50			A
$g_{FS}$	Forward Transconductance	$V_{DS} = 15\text{ V}, I_D = 11.5\text{ A}$		48		S
<b>Dynamic Characteristics</b>						
$C_{iss}$	Input Capacitance	$V_{DS} = 15\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$		1240		pF
$C_{oss}$	Output Capacitance			350		pF
$C_{rss}$	Reverse Transfer Capacitance			120		pF
$R_G$	Gate Resistance	$V_{GS} = 15\text{ mV}, f = 1.0\text{ MHz}$		1.4		$\Omega$
<b>Switching Characteristics (Note 2)</b>						
$t_{d(on)}$	Turn–On Delay Time	$V_{DS} = 15\text{ V}, I_D = 1\text{ A},$ $V_{GS} = 10\text{ V}, R_{GEN} = 6\ \Omega$		9	18	ns
$t_r$	Turn–On Rise Time			5	10	ns
$t_{d(off)}$	Turn–Off Delay Time			27	42	ns
$t_f$	Turn–Off Fall Time			11	21	ns
$t_{d(on)}$	Turn–On Delay Time	$V_{DS} = 15\text{ V}, I_D = 1\text{ A},$ $V_{GS} = 4.5\text{ V}, R_{GEN} = 6\ \Omega$		11	20	ns
$t_r$	Turn–On Rise Time			12	22	ns
$t_{d(off)}$	Turn–Off Delay Time			18	32	ns
$t_f$	Turn–Off Fall Time			11	20	ns
$Q_{g(TOT)}$	Total Gate Charge at $V_{gs} = 10\text{ V}$	$V_{DD} = 15\text{ V}, I_D = 11.5\text{ A},$		22	30	nC
$Q_g$	Total Gate Charge at $V_{gs} = 5\text{ V}$			12	16	nC
$Q_{gs}$	Gate–Source Charge			3.5		nC
$Q_{gd}$	Gate–Drain Charge			3.4		nC

## Electrical Characteristics $T_A = 25^\circ\text{C}$ unless otherwise noted (Continued)

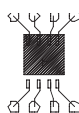
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
<b>Drain–Source Diode Characteristics and Maximum Ratings</b>						
$I_S$	Maximum Continuous Drain–Source Diode Forward Current				3.5	A
$V_{SD}$	Drain–Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 3.5\text{ A}$ (Note 2) $V_{GS} = 0\text{ V}, I_S = 7\text{ A}$ (Note 2)		0.5 0.6	0.7	V
$T_{rr}$	Diode Reverse Recovery Time	$I_F = 11.5\text{ A}$ ,		18		nS
$Q_{rr}$	Diode Reverse Recovery Charge	$d_iF/d_t = 300\text{ A}/\mu\text{s}$ (Note 3)		12		nC

**Notes:**

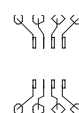
- $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a)  $50^\circ\text{W}$  when mounted on a  $1\text{ in}^2$  pad of 2 oz copper



b)  $105^\circ\text{W}$  when mounted on a  $.04\text{ in}^2$  pad of 2 oz copper



c)  $125^\circ\text{W}$  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.
- FDS6680AS\_NL is a lead free product. The FDS6680AS\_NL marking will appear on the reel label.

## Typical Characteristics

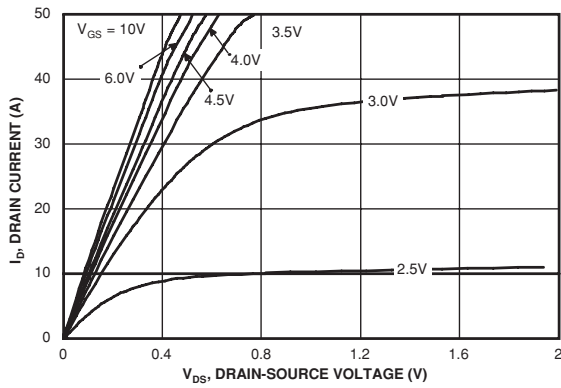


Figure 1. On-Region Characteristics.

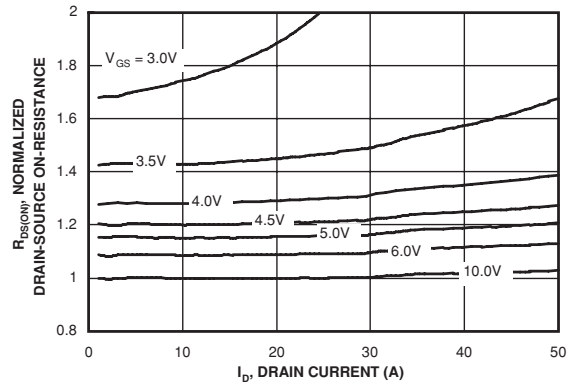


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.

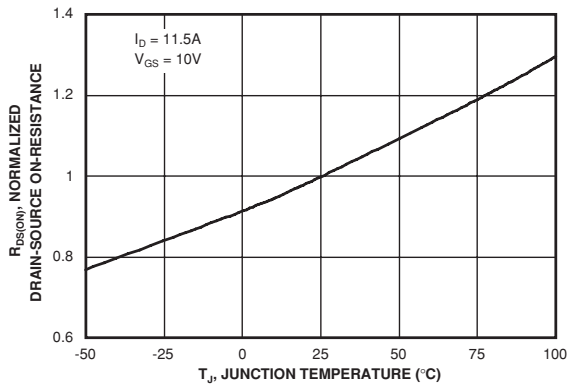


Figure 3. On-Resistance Variation with Temperature.

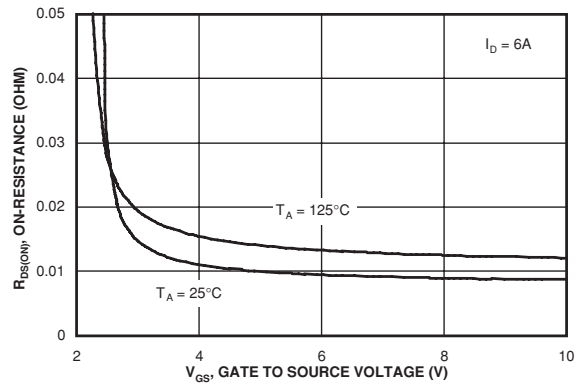


Figure 4. On-Resistance Variation with Gate-to-Source Voltage.

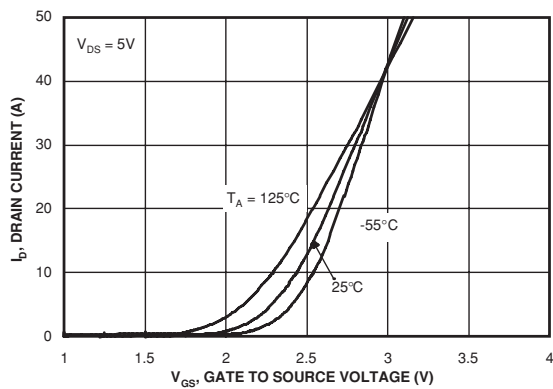


Figure 5. Transfer Characteristics.

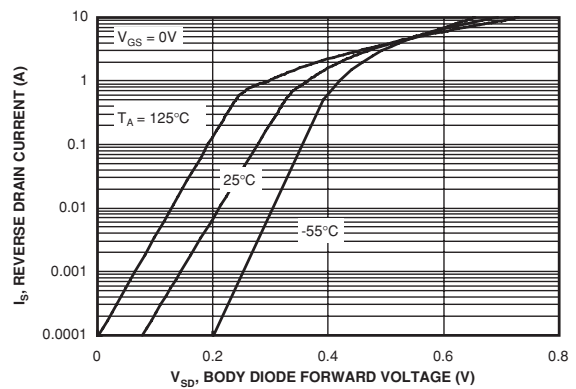
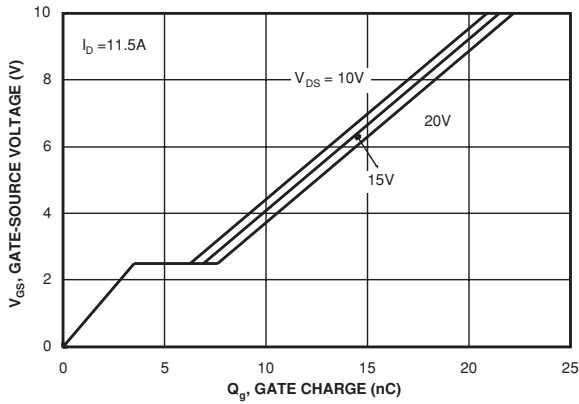
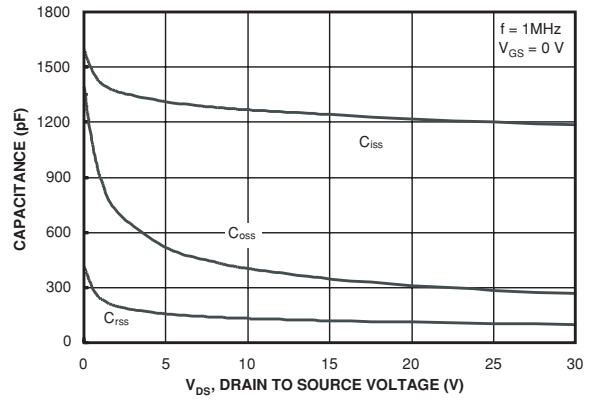


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature.

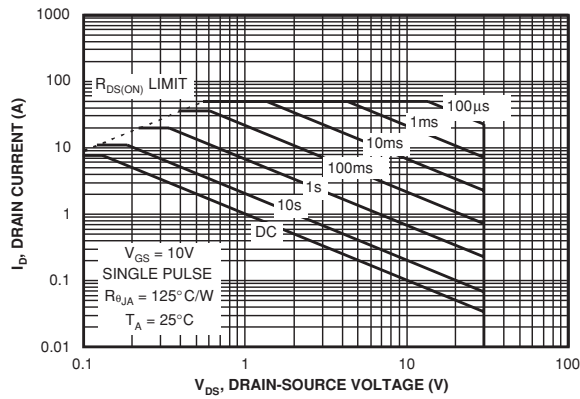
**Typical Characteristics** (continued)



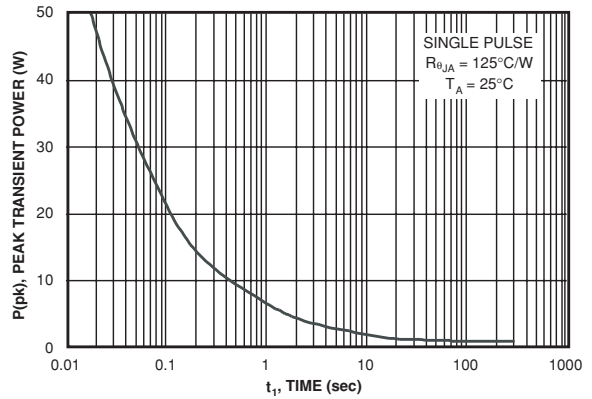
**Figure 7. Gate Charge Characteristics.**



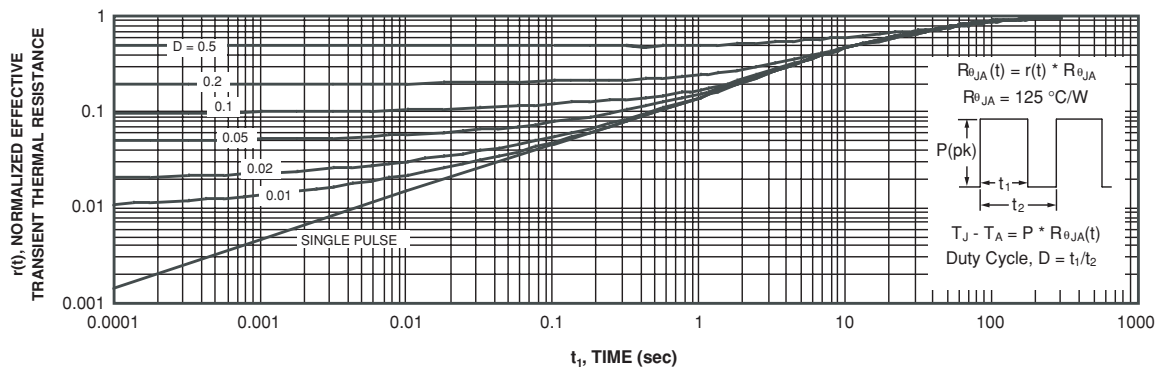
**Figure 8. Capacitance Characteristics.**



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



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



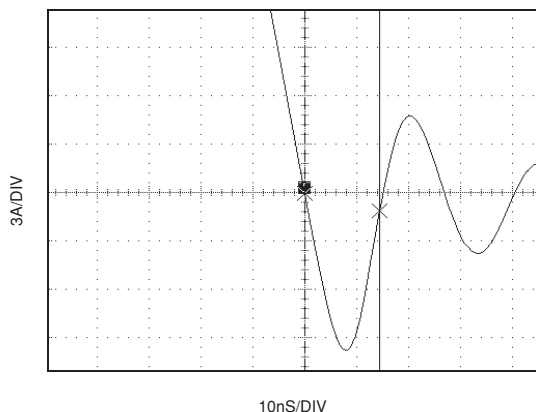
**Figure 11. Transient Thermal Response Curve.**

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

## Typical Characteristics (continued)

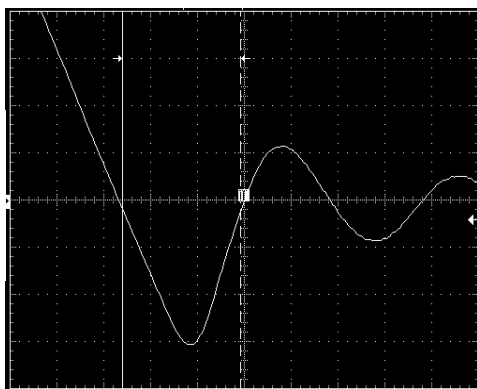
### SyncFET Schottky Body Diode Characteristics

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 FDS6680AS.



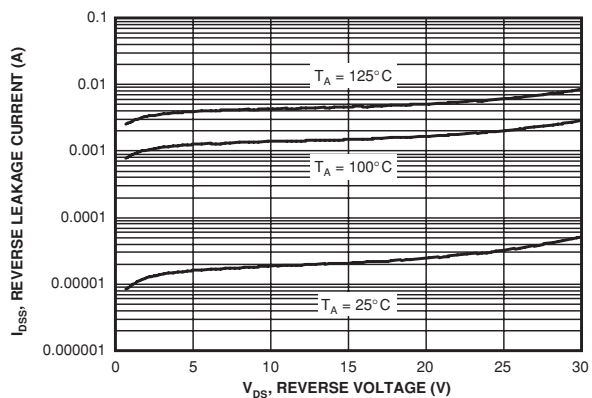
**Figure 12. FDS6680AS SyncFET body diode reverse recovery characteristic.**

For comparison purposes, Figure 13 shows the reverse recovery characteristics of the body diode of an equivalent size MOSFET produced without SyncFET (FDS6680).



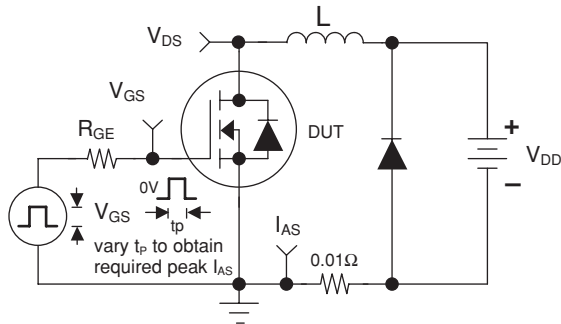
**Figure 13. Non-SyncFET (FDS6680) body diode reverse recovery characteristic.**

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

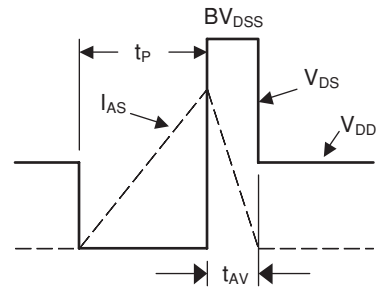


**Figure 14. SyncFET body diode reverse leakage versus drain-source voltage and temperature.**

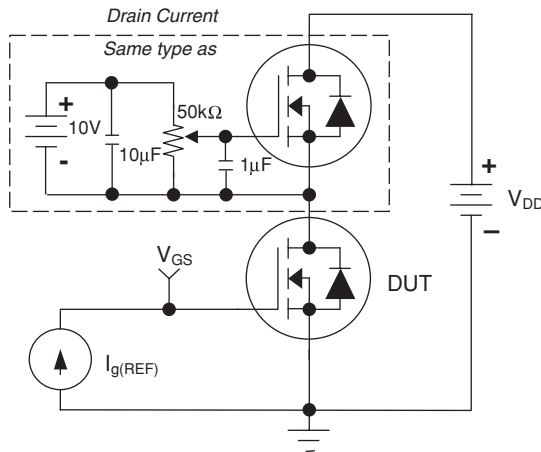
## Typical Characteristics



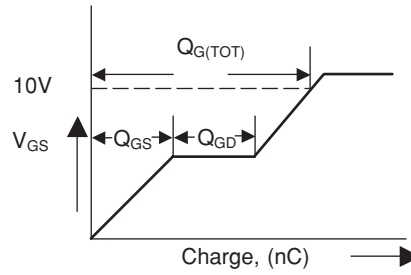
**Figure 15. Unclamped Inductive Load Test Circuit**



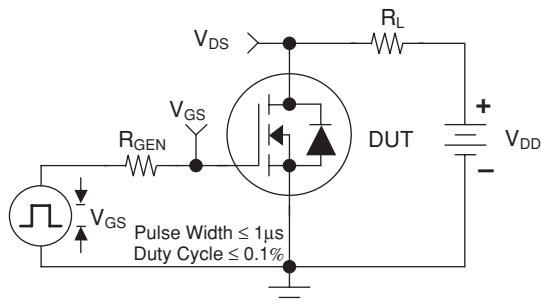
**Figure 16. Unclamped Inductive Waveforms**



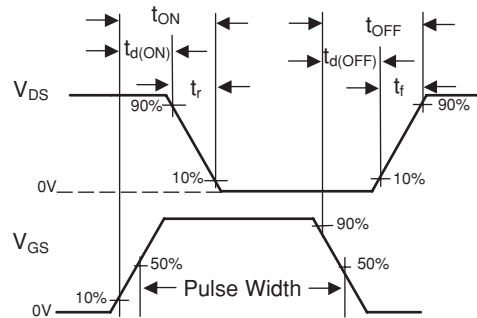
**Figure 17. Gate Charge Test Circuit**



**Figure 18. Gate Charge Waveform**



**Figure 19. Switching Time Test Circuit**



**Figure 19. Switching Time Waveforms**

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CROSSVOLT™	GlobalOptoisolator™	MicroFET™	PowerTrench®	SuperSOT™-6
DOME™	GTO™	MicroPak™	QFET®	SuperSOT™-8
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FACT Quiet Series™		OCXPro™	RapidConnect™	UHC™
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