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ON Semiconductor®

# FDMC2514SDC

## N-Channel Dual Cool™ 33 PowerTrench® SyncFET™ 25 V, 40 A, 3.5 mΩ

### Features

- Dual Cool™ Top Side Cooling PQFN package
- Max  $r_{DS(on)}$  = 3.5 mΩ at  $V_{GS} = 10\text{ V}$ ,  $I_D = 22.5\text{ A}$
- Max  $r_{DS(on)}$  = 4.7 mΩ at  $V_{GS} = 4.5\text{ V}$ ,  $I_D = 18\text{ A}$
- High performance technology for extremely low  $r_{DS(on)}$
- SyncFET Schottky Body Diode
- RoHS Compliant

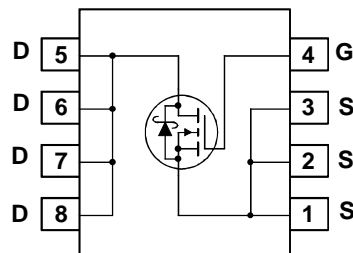
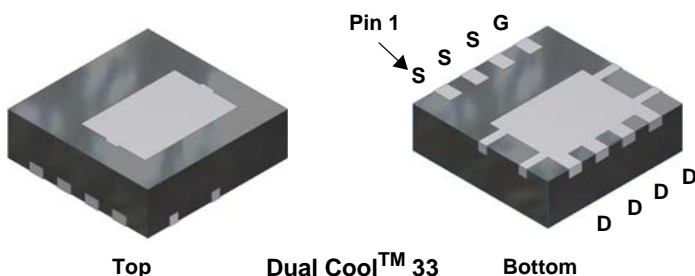


### General Description

This N-Channel MOSFET is produced using ON Semiconductor's advanced PowerTrench® process. Advancements in both silicon and Dual Cool™ package technologies have been combined to offer the lowest  $r_{DS(on)}$  while maintaining excellent switching performance by extremely low Junction-to-Ambient thermal resistance. This device has the added benefit of an efficient monolithic Schottky body diode.

### Applications

- Synchronous Rectifier for DC/DC Converters
- Telecom Secondary Side Rectification
- High End Server/Workstation Vcore Low Side



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

Symbol	Parameter	Rated	Units
$V_{DS}$	Drain to Source Voltage	25	V
$V_{GS}$	Gate to Source Voltage (Note 4)	±20	V
$I_D$	Drain Current -Continuous (Package limited) $T_C = 25^\circ\text{C}$	40	A
	-Continuous (Silicon limited) $T_C = 25^\circ\text{C}$	106	
	-Continuous $T_A = 25^\circ\text{C}$ (Note 1a)	24	
	-Pulsed	200	
$E_{AS}$	Single Pulse Avalanche Energy (Note 3)	84	mJ
$dv/dt$	Peak Diode Recovery $dv/dt$ (Note 5)	2.0	V/ns
$P_D$	Power Dissipation $T_C = 25^\circ\text{C}$	60	W
	Power Dissipation $T_A = 25^\circ\text{C}$ (Note 1a)	3.0	
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150	$^\circ\text{C}$

### Thermal Characteristics

$R_{\theta JC}$	Thermal Resistance, Junction to Case (Top Source)	5.8	$^\circ\text{C/W}$
$R_{\theta JC}$	Thermal Resistance, Junction to Case (Bottom Drain)	2.1	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1a)	42	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1b)	105	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1i)	17	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1j)	26	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1k)	12	

### Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
2514S	FDMC2514SDC	Dual Cool™ 33	13"	12 mm	3000 units

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

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

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

**On Characteristics**

$V_{GS(th)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}, I_D = 1\text{ mA}$	1.2	1.7	3.0	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate to Source Threshold Voltage Temperature Coefficient	$I_D = 10\text{ mA}$ , referenced to $25\text{ }^\circ\text{C}$		-5		mV/ $^\circ\text{C}$
$r_{DS(on)}$	Static Drain to Source On Resistance	$V_{GS} = 10\text{ V}, I_D = 22.5\text{ A}$		2.5	3.5	m $\Omega$
		$V_{GS} = 4.5\text{ V}, I_D = 18\text{ A}$		3.6	4.7	
		$V_{GS} = 10\text{ V}, I_D = 22.5\text{ A}, T_J = 125\text{ }^\circ\text{C}$		3.5	4.5	
$g_{FS}$	Forward Transconductance	$V_{DS} = 5\text{ V}, I_D = 22.5\text{ A}$		122		S

**Dynamic Characteristics**

$C_{iss}$	Input Capacitance	$V_{DS} = 13\text{ V}, V_{GS} = 0\text{ V},$ $f = 1\text{ MHz}$		2031	2705	pF
$C_{oss}$	Output Capacitance			596	795	pF
$C_{rss}$	Reverse Transfer Capacitance			134	205	pF
$R_g$	Gate Resistance			1.1	2.4	$\Omega$

**Switching Characteristics**

$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 13\text{ V}, I_D = 22.5\text{ A},$ $V_{GS} = 10\text{ V}, R_{GEN} = 6\text{ }\Omega$		11	22	ns	
$t_r$	Rise Time			3.6	10	ns	
$t_{d(off)}$	Turn-Off Delay Time			26	41	ns	
$t_f$	Fall Time			3	10	ns	
$Q_g$	Total Gate Charge		$V_{GS} = 0\text{ V to }10\text{ V}$		31	44	nC
$Q_g$	Total Gate Charge		$V_{GS} = 0\text{ V to }4.5\text{ V}$	$V_{DD} = 13\text{ V},$ $I_D = 22.5\text{ A}$	14	20	nC
$Q_{gs}$	Gate to Source Gate Charge			6.5		nC	
$Q_{gd}$	Gate to Drain "Miller" Charge			3.9		nC	

**Drain-Source Diode Characteristics**

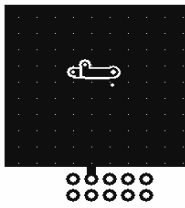
$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 22.5\text{ A}$ (Note 2)		0.79	1.2	V
		$V_{GS} = 0\text{ V}, I_S = 2\text{ A}$ (Note 2)		0.47	0.8	
$t_{rr}$	Reverse Recovery Time	$I_F = 22.5\text{ A}, di/dt = 300\text{ A}/\mu\text{s}$		24	39	ns
$Q_{rr}$	Reverse Recovery Charge			19	34	nC

## Thermal Characteristics

$R_{\theta JC}$	Thermal Resistance, Junction to Case (Top Source)	5.8	$^{\circ}\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance, Junction to Case (Bottom Drain)	2.1	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1a)	42	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1b)	105	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1c)	29	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1d)	40	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1e)	19	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1f)	23	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1g)	30	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1h)	79	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1i)	17	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1j)	26	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1k)	12	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1l)	16	

### NOTES:

- $R_{\theta JA}$  is determined with the device mounted on a FR-4 board using a specified pad of 2 oz copper as shown below.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a. 42  $^{\circ}\text{C}/\text{W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



b. 105  $^{\circ}\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper

- Still air, 20.9x10.4x12.7mm Aluminum Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- Still air, 20.9x10.4x12.7mm Aluminum Heat Sink, minimum pad of 2 oz copper
- Still air, 45.2x41.4x11.7mm Aavid Thermalloy Part # 10-L41B-11 Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- Still air, 45.2x41.4x11.7mm Aavid Thermalloy Part # 10-L41B-11 Heat Sink, minimum pad of 2 oz copper
- 200FPM Airflow, No Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- 200FPM Airflow, No Heat Sink, minimum pad of 2 oz copper
- 200FPM Airflow, 20.9x10.4x12.7mm Aluminum Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- 200FPM Airflow, 20.9x10.4x12.7mm Aluminum Heat Sink, minimum pad of 2 oz copper
- 200FPM Airflow, 45.2x41.4x11.7mm Aavid Thermalloy Part # 10-L41B-11 Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- 200FPM Airflow, 45.2x41.4x11.7mm Aavid Thermalloy Part # 10-L41B-11 Heat Sink, minimum pad of 2 oz copper

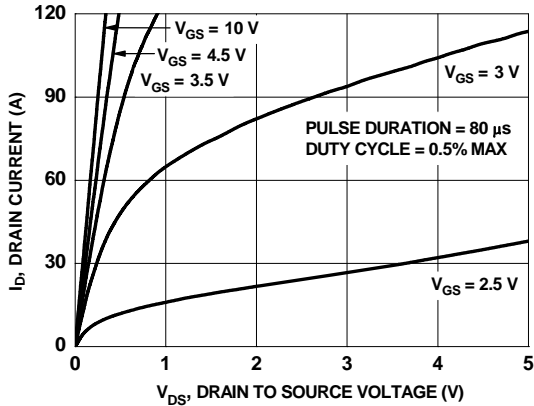
- Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty cycle < 2.0%.

3.  $E_{AS}$  of 84 mJ is based on starting  $T_J = 25^{\circ}\text{C}$ ,  $L = 1\text{ mH}$ ,  $I_{AS} = 13\text{ A}$ ,  $V_{DD} = 23\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% test at  $L = 0.3\text{ mH}$ ,  $I_{AS} = 20\text{ A}$ .

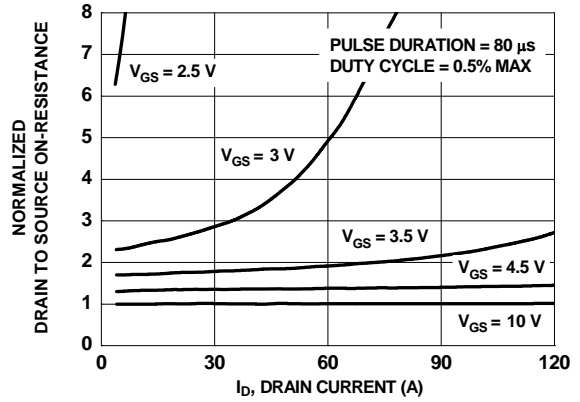
4. As an N-ch device, the negative  $V_{GS}$  rating is for low duty cycle pulse occurrence only. No continuous rating is implied.

5.  $I_{SD} \leq 22.5\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^{\circ}\text{C}$ .

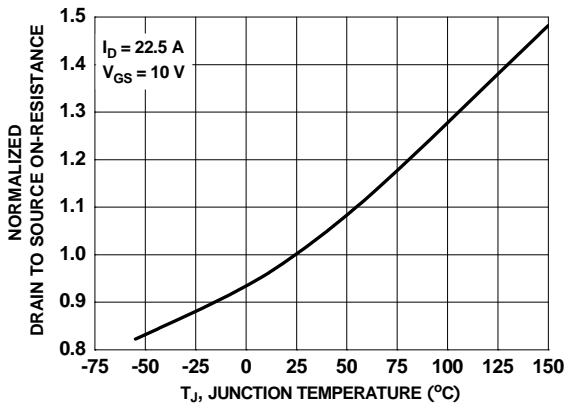
**Typical Characteristics**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



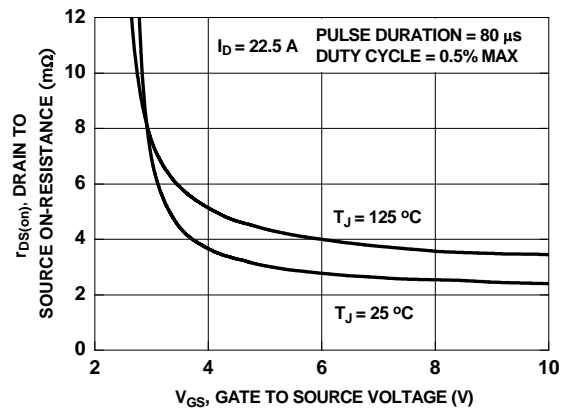
**Figure 1. On-Region Characteristics**



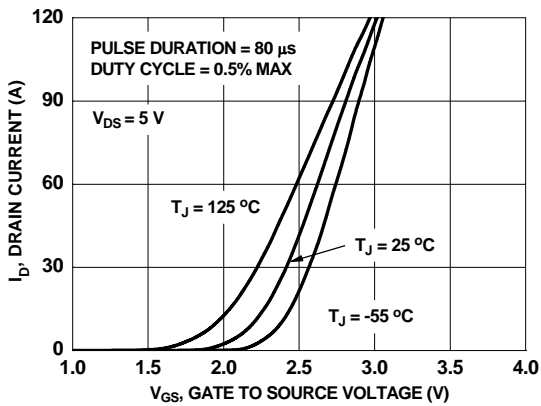
**Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage**



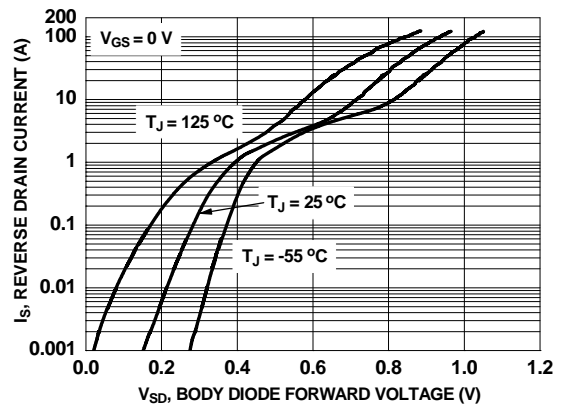
**Figure 3. Normalized On-Resistance vs Junction Temperature**



**Figure 4. On-Resistance vs Gate to Source Voltage**

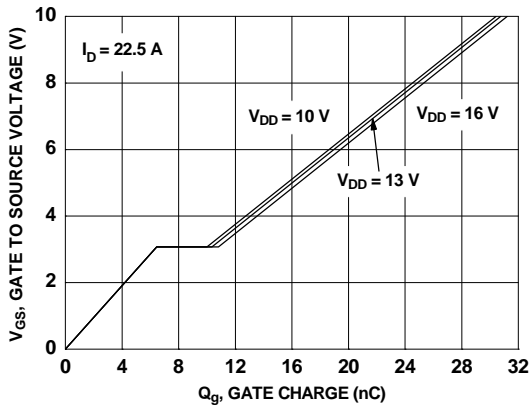


**Figure 5. Transfer Characteristics**

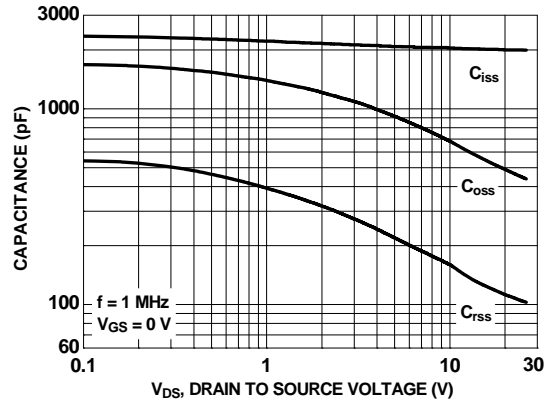


**Figure 6. Source to Drain Diode Forward Voltage vs Source Current**

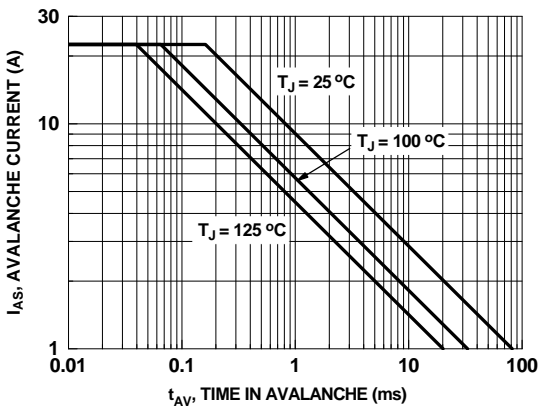
**Typical Characteristics**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



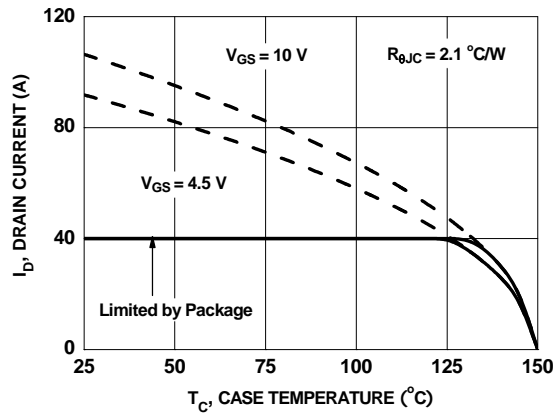
**Figure 7. Gate Charge Characteristics**



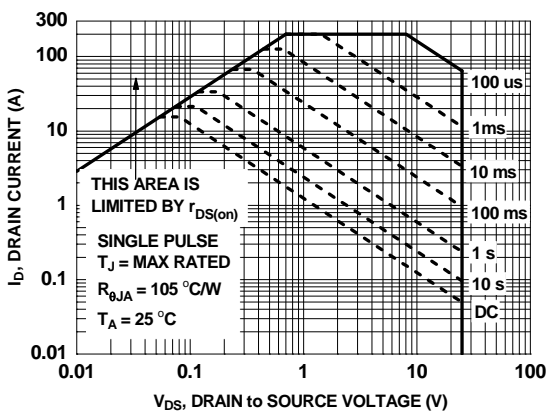
**Figure 8. Capacitance vs Drain to Source Voltage**



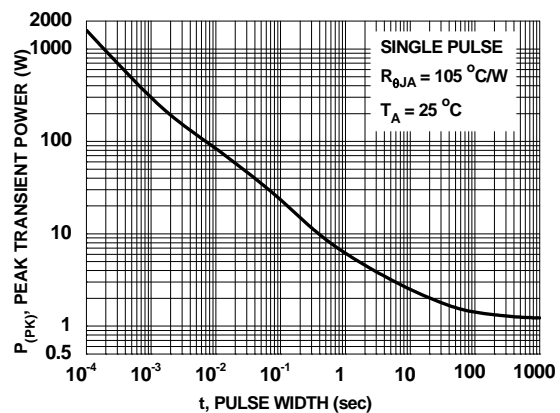
**Figure 9. Unclamped Inductive Switching Capability**



**Figure 10. Maximum Continuous Drain Current vs Case Temperature**



**Figure 11. Forward Bias Safe Operating Area**



**Figure 12. Single Pulse Maximum Power Dissipation**

**Typical Characteristics**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted

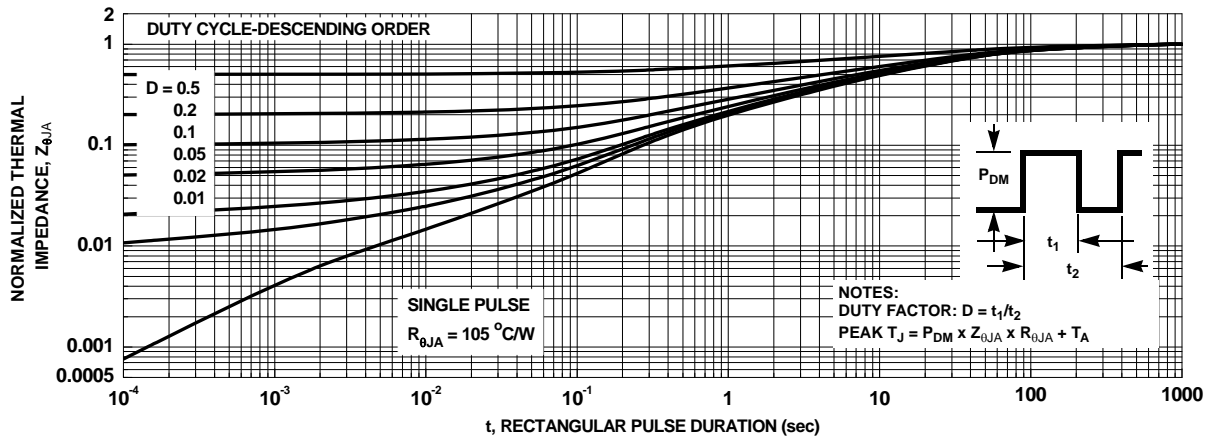


Figure 13. Junction-to-Ambient Transient Thermal Response Curve

## Typical Characteristics (continued)

### SyncFET Schottky body diode Characteristics

ON Semiconductor'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 13 shows the reverse recovery characteristic of the FDMC2514SDC.

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

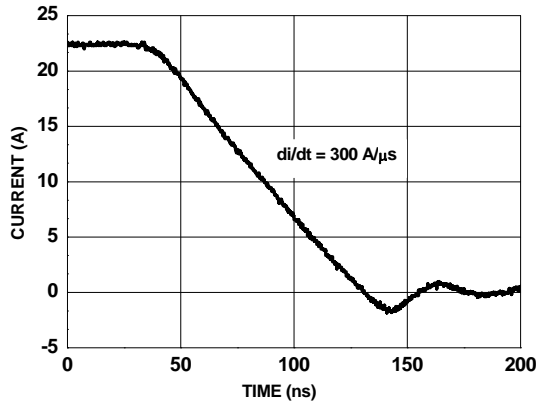


Figure 13. FDMC2514SDC SyncFET body diode reverse recovery characteristic

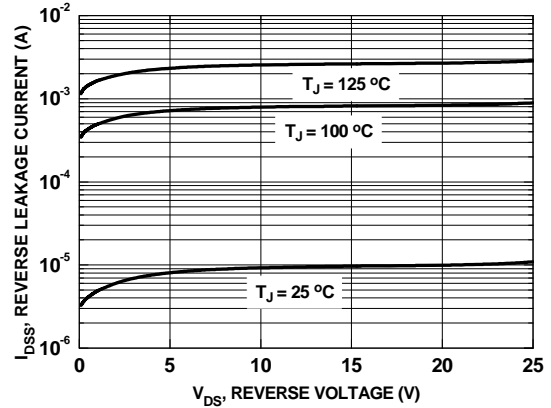


Figure 14. SyncFET body diode reverse leakage versus drain-source voltage



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