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October 2014

# FDPC8013S

## PowerTrench® Power Clip

### 30 V Asymmetric Dual N-Channel MOSFET

#### Features

- Q1: N-Channel
  - Max  $r_{DS(on)}$  = 9.6 mΩ at  $V_{GS} = 4.5$  V,  $I_D = 10$  A
- Q2: N-Channel
  - Max  $r_{DS(on)}$  = 2.7 mΩ at  $V_{GS} = 4.5$  V,  $I_D = 22$  A
  - Low inductance packaging shortens rise/fall times, resulting in lower switching losses
  - MOSFET integration enables optimum layout for lower circuit inductance and reduced switch node ringing
  - RoHS Compliant

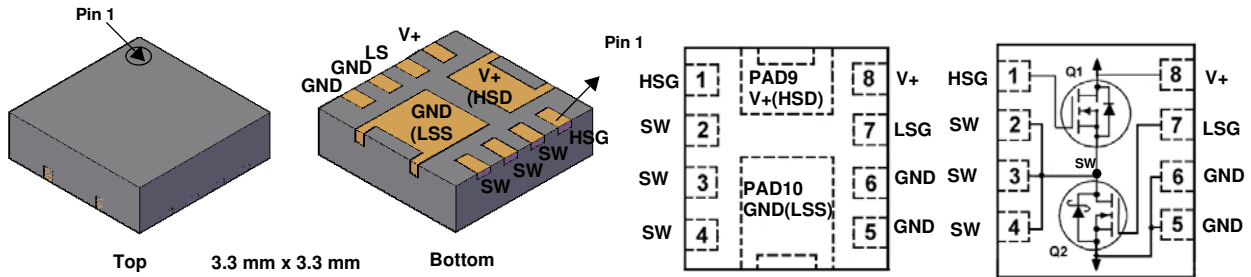


#### General Description

This device includes two specialized N-Channel MOSFETs in a dual package. The switch node has been internally connected to enable easy placement and routing of synchronous buck converters. The control MOSFET (Q1) and synchronous SyncFET™ (Q2) have been designed to provide optimal power efficiency.

#### Applications

- Computing
- Communications
- General Purpose Point of Load



#### MOSFET Maximum Ratings $T_A = 25$ °C unless otherwise noted

Symbol	Parameter	Q1	Q2	Units
$V_{DS}$	Drain to Source Voltage	30	30	V
$V_{GS}$	Gate to Source Voltage (Note 4)	±20	±20	V
$I_D$	Drain Current -Continuous (Package limited) $T_C = 25$ °C	20	55	A
	-Continuous $T_A = 25$ °C	13 <sup>1a</sup>	26 <sup>1b</sup>	
	-Pulsed	40	100	
$E_{AS}$	Single Pulse Avalanche Energy (Note 3)	21	97	mJ
$P_D$	Power Dissipation for Single Operation $T_A = 25$ °C	1.6 <sup>1a</sup>	2.0 <sup>1b</sup>	W
	Power Dissipation for Single Operation $T_A = 25$ °C	0.8 <sup>1c</sup>	0.9 <sup>1d</sup>	
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150		°C

#### Thermal Characteristics

$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	77 <sup>1a</sup>	63 <sup>1b</sup>	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	151 <sup>1c</sup>	135 <sup>1d</sup>	
$R_{\theta JC}$	Thermal Resistance, Junction to Case	5.0	3.5	

#### Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
13CF/15CF	FDPC8013S	Power Clip 33	13 "	12 mm	3000 units

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

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

$BV_{DSS}$	Drain to Source Breakdown Voltage	$I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0\text{ V}$ $I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$	Q1 Q2	30 30			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 250\text{ }\mu\text{A}$ , referenced to $25\text{ }^\circ\text{C}$ $I_D = 10\text{ mA}$ , referenced to $25\text{ }^\circ\text{C}$	Q1 Q2		16 20		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 24\text{ V}$ , $V_{GS} = 0\text{ V}$ $V_{DS} = 24\text{ V}$ , $V_{GS} = 0\text{ V}$	Q1 Q2			1 500	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate to Source Leakage Current, Forward	$V_{GS} = 20\text{ V}$ , $V_{DS} = 0\text{ V}$ $V_{GS} = 20\text{ V}$ , $V_{DS} = 0\text{ V}$	Q1 Q2			100 100	nA nA

### On Characteristics

$V_{GS(th)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}$ , $I_D = 250\text{ }\mu\text{A}$ $V_{GS} = V_{DS}$ , $I_D = 1\text{ mA}$	Q1 Q2	1.2 1.2	1.5 1.7	3.0 3.0	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate to Source Threshold Voltage Temperature Coefficient	$I_D = 250\text{ }\mu\text{A}$ , referenced to $25\text{ }^\circ\text{C}$ $I_D = 10\text{ mA}$ , referenced to $25\text{ }^\circ\text{C}$	Q1 Q2		-5 -6		mV/ $^\circ\text{C}$
$r_{DS(on)}$	Drain to Source On Resistance	$V_{GS} = 10\text{ V}$ , $I_D = 13\text{ A}$ $V_{GS} = 4.5\text{ V}$ , $I_D = 10\text{ A}$ $V_{GS} = 10\text{ V}$ , $I_D = 13\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	Q1		4.6 6.7 6.6	6.4 9.6 9.2	m $\Omega$
		$V_{GS} = 10\text{ V}$ , $I_D = 26\text{ A}$ $V_{GS} = 4.5\text{ V}$ , $I_D = 22\text{ A}$ $V_{GS} = 10\text{ V}$ , $I_D = 26\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	Q2		1.4 2.0 1.9	1.9 2.7 2.6	
$g_{FS}$	Forward Transconductance	$V_{DS} = 5\text{ V}$ , $I_D = 13\text{ A}$ $V_{DS} = 5\text{ V}$ , $I_D = 26\text{ A}$	Q1 Q2		53 168		S

### Dynamic Characteristics

$C_{iss}$	Input Capacitance	Q1: $V_{DS} = 15\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	Q1 Q2		827 2785		pF
$C_{oss}$	Output Capacitance	Q2: $V_{DS} = 15\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	Q1 Q2		333 997		pF
$C_{riss}$	Reverse Transfer Capacitance	$V_{DS} = 15\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	Q1 Q2		44 128		pF
$R_g$	Gate Resistance		Q1 Q2		0.5 0.5		$\Omega$

### Switching Characteristics

$t_{d(on)}$	Turn-On Delay Time	Q1: $V_{DD} = 15\text{ V}$ , $I_D = 13\text{ A}$ , $R_{GEN} = 6\text{ }\Omega$	Q1 Q2		6 11		ns
$t_r$	Rise Time		Q1 Q2		2 5		ns
$t_{d(off)}$	Turn-Off Delay Time	Q2: $V_{DD} = 15\text{ V}$ , $I_D = 26\text{ A}$ , $R_{GEN} = 6\text{ }\Omega$	Q1 Q2		16 30		ns
$t_f$	Fall Time		Q1 Q2		2 4		ns
$Q_g$	Total Gate Charge	$V_{GS} = 0\text{ V}$ to $10\text{ V}$	Q1 Q2		13 44		nC
$Q_g$	Total Gate Charge	$V_{GS} = 0\text{ V}$ to $4.5\text{ V}$	Q1 Q2		6 21		nC
$Q_{gs}$	Gate to Source Gate Charge	Q2 $V_{DD} = 15\text{ V}$ , $I_D = 26\text{ A}$	Q1 Q2		2.2 7.2		nC
$Q_{gd}$	Gate to Drain "Miller" Charge		Q1 Q2		1.9 6.6		nC

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

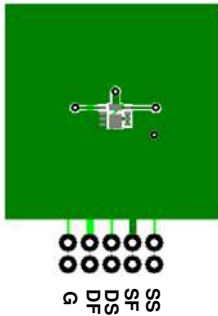
Symbol	Parameter	Test Conditions	Type	Min	Typ	Max	Units
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### Drain-Source Diode Characteristics

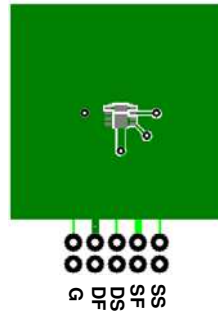
$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 13\text{ A}$ (Note 2)	Q1		0.80	1.2	V
		$V_{GS} = 0\text{ V}, I_S = 26\text{ A}$ (Note 2)	Q2		0.77	1.2	
$t_{rr}$	Reverse Recovery Time	Q1 $I_F = 13\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$	Q1		22		ns
			Q2		29		
$Q_{rr}$	Reverse Recovery Charge	Q2 $I_F = 26\text{ A}, di/dt = 300\text{ A}/\mu\text{s}$	Q1		7		nC
			Q2		30		

Notes:

1.  $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 x 1.5 in. board of FR-4 material.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a. 77 °C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



b. 63 °C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



c. 151 °C/W when mounted on a minimum pad of 2 oz copper



d. 135 °C/W when mounted on a minimum pad of 2 oz copper

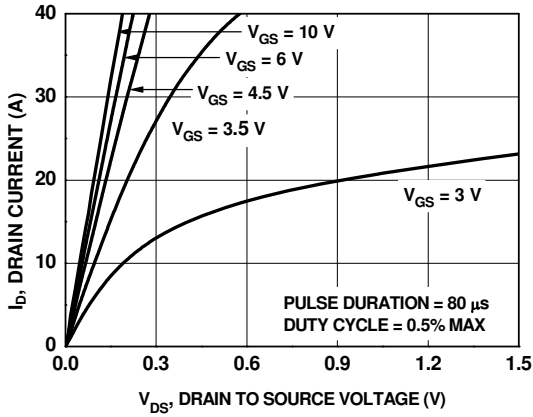
2 Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty cycle < 2.0%.

3. Q1 :  $E_{AS}$  of 21 mJ is based on starting  $T_J = 25\text{ }^\circ\text{C}$ ; N-ch:  $L = 1.2\text{ mH}, I_{AS} = 6\text{ A}, V_{DD} = 23\text{ V}, V_{GS} = 10\text{ V}$ . 100% test at  $L = 0.1\text{ mH}, I_{AS} = 14.5\text{ A}$ .

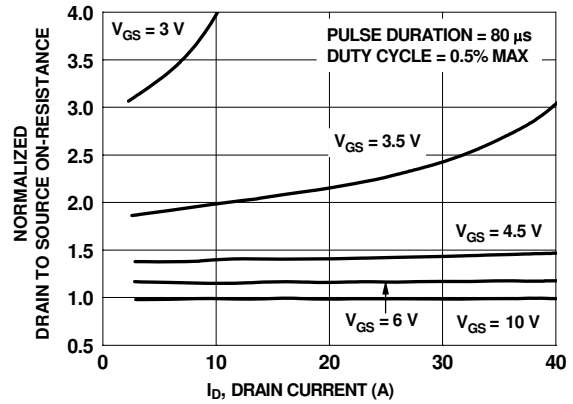
Q2:  $E_{AS}$  of 97 mJ is based on starting  $T_J = 25\text{ }^\circ\text{C}$ ; N-ch:  $L = 0.6\text{ mH}, I_{AS} = 18\text{ A}, V_{DD} = 23\text{ V}, V_{GS} = 10\text{ V}$ . 100% test at  $L = 0.1\text{ mH}, I_{AS} = 32.9\text{ A}$ .

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

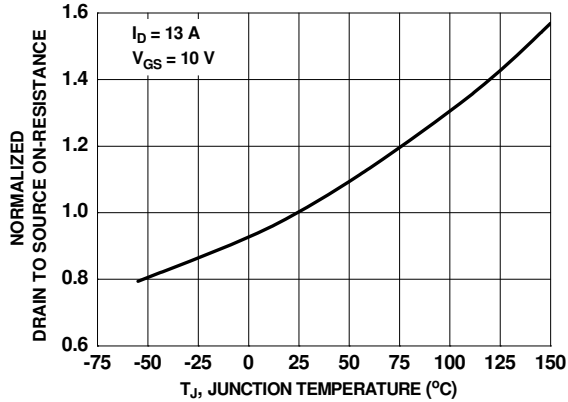
**Typical Characteristics (Q1 N-Channel)**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



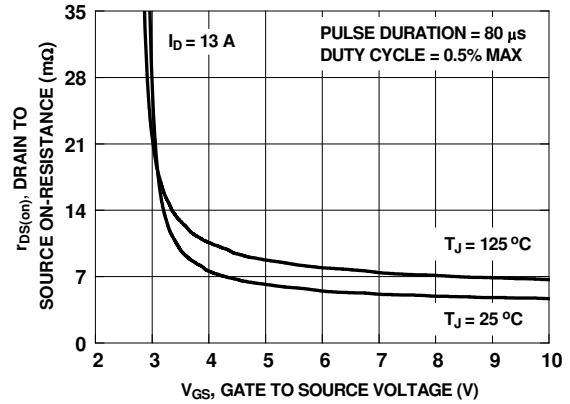
**Figure 1. On Region Characteristics**



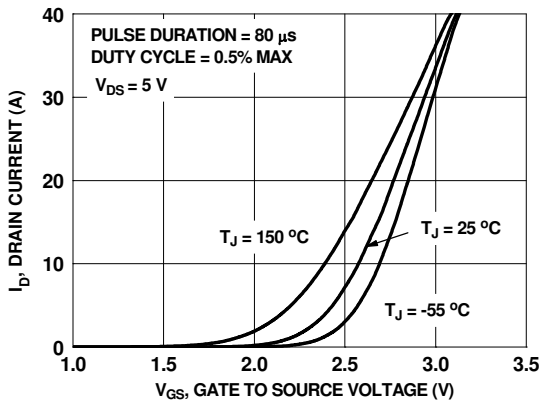
**Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage**



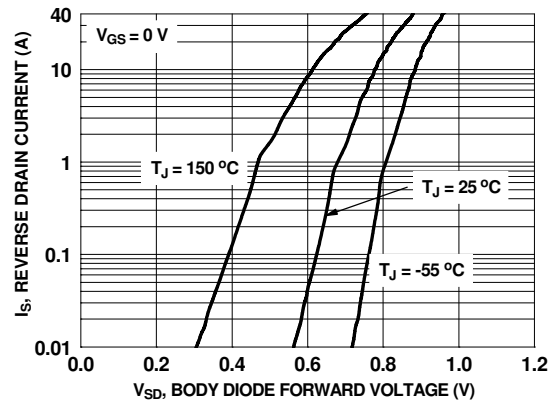
**Figure 3. Normalized On Resistance vs Junction Temperature**



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

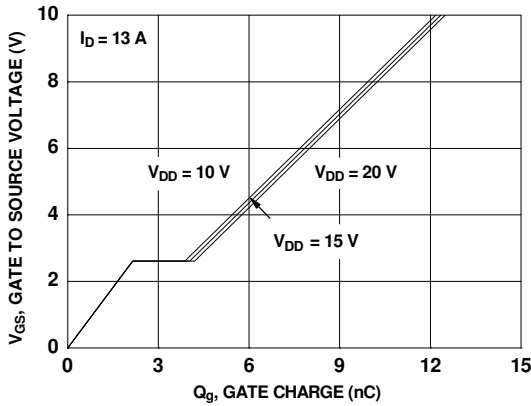


**Figure 5. Transfer Characteristics**

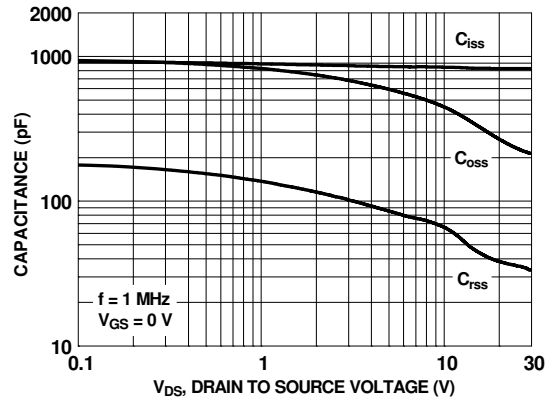


**Figure 6. Source to Drain Diode Forward Voltage vs Source Current**

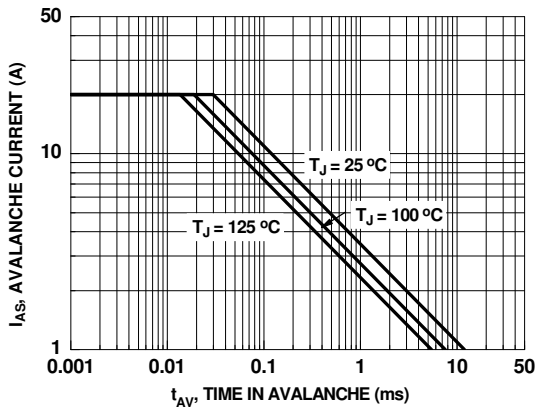
**Typical Characteristics (Q1 N-Channel)**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



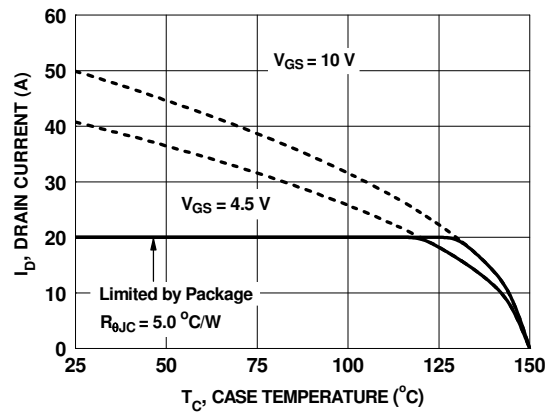
**Figure 7. Gate Charge Characteristics**



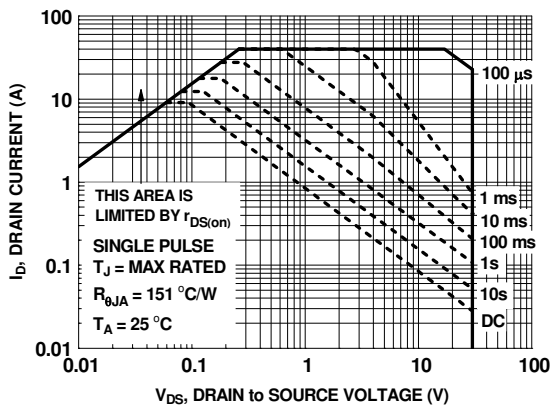
**Figure 8. Capacitance vs Drain to Source Voltage**



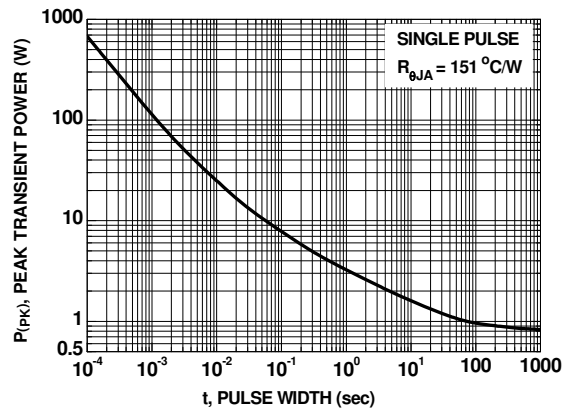
**Figure 9. Unclamped Inductive Switching Capability**



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

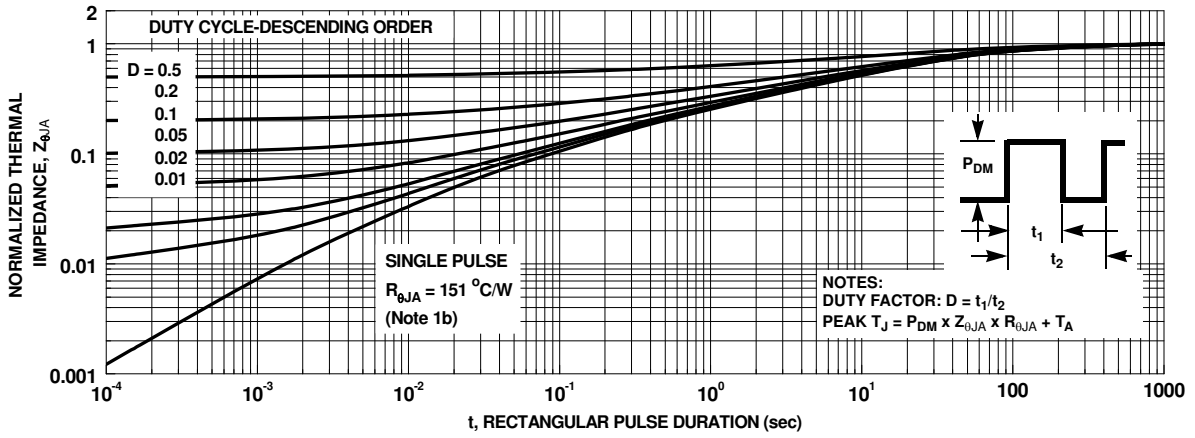


**Figure 11. Forward Bias Safe Operating Area**



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

**Typical Characteristics (Q1 N-Channel)**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



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



**Typical Characteristics (Q2 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted

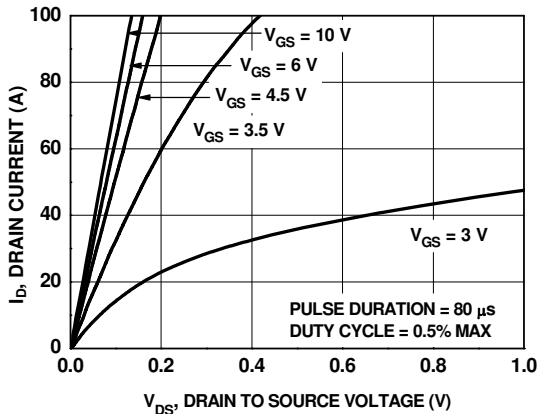


Figure 14. On-Region Characteristics

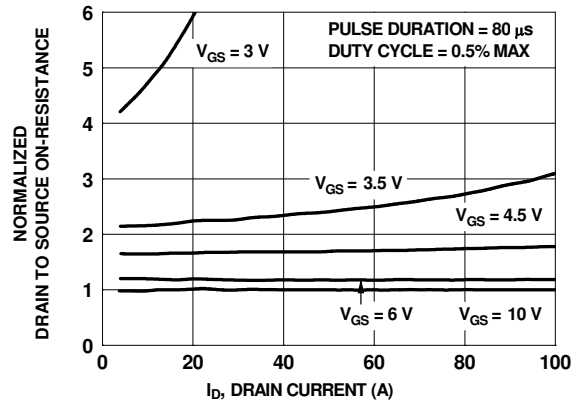


Figure 15. Normalized on-Resistance vs Drain Current and Gate Voltage

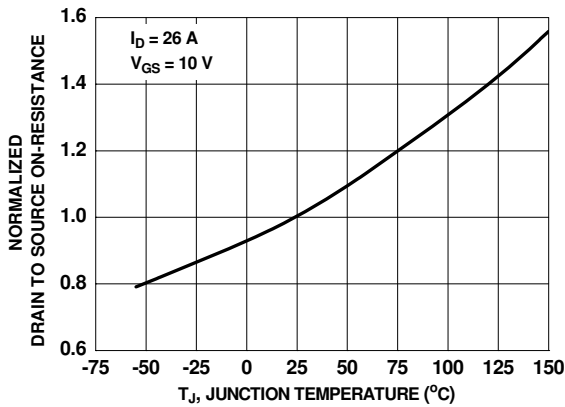


Figure 16. Normalized On-Resistance vs Junction Temperature

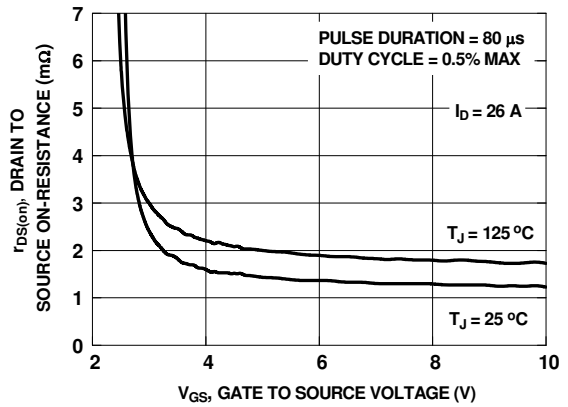


Figure 17. On-Resistance vs Gate to Source Voltage

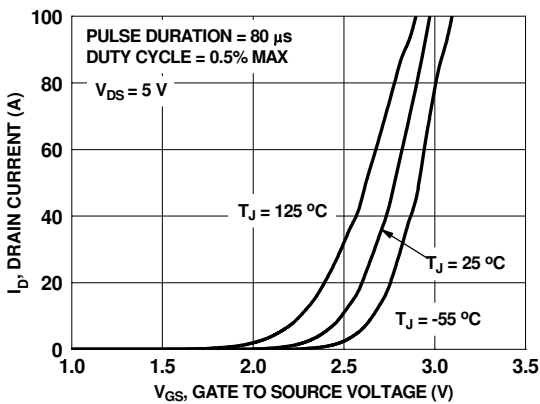


Figure 18. Transfer Characteristics

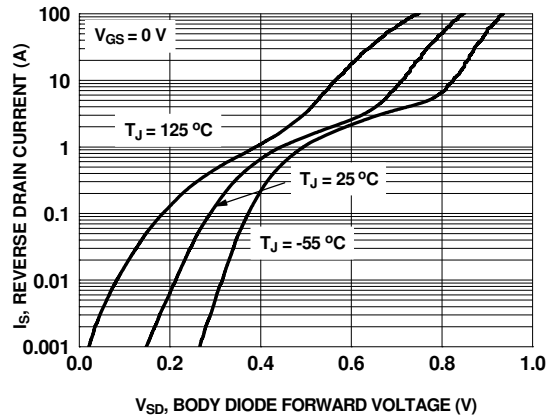
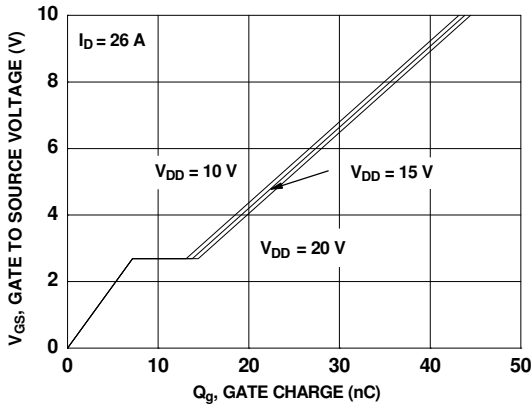
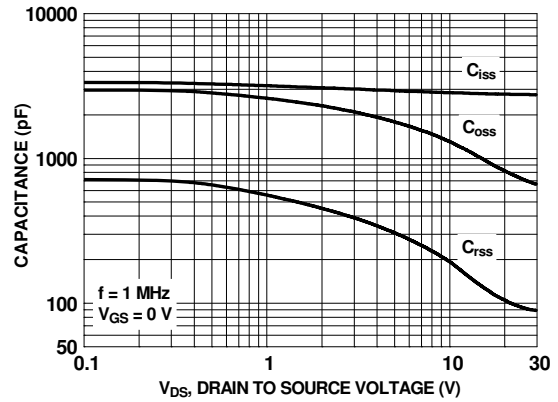


Figure 19. Source to Drain Diode Forward Voltage vs Source Current

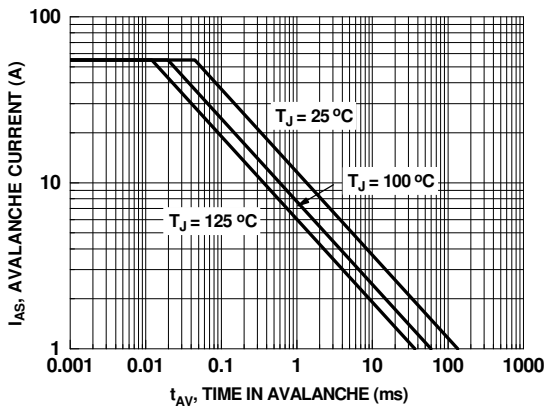
**Typical Characteristics (Q2 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted



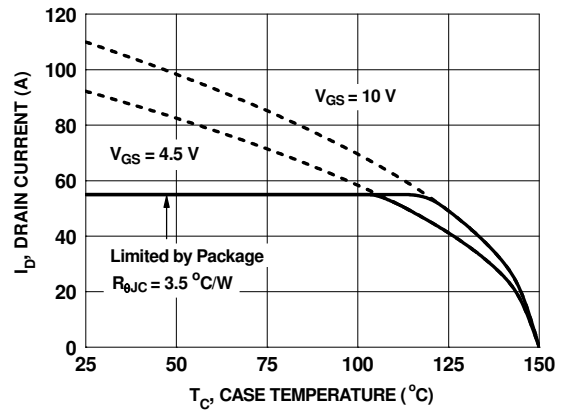
**Figure 20. Gate Charge Characteristics**



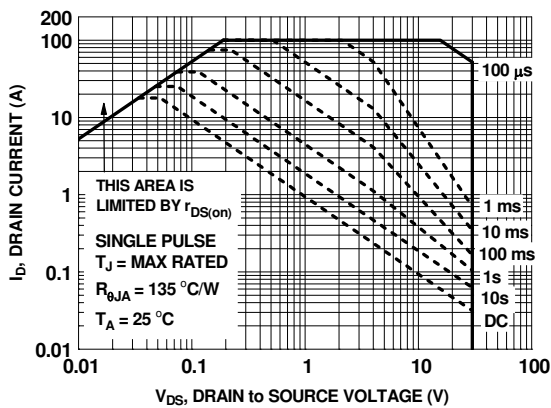
**Figure 21. Capacitance vs Drain to Source Voltage**



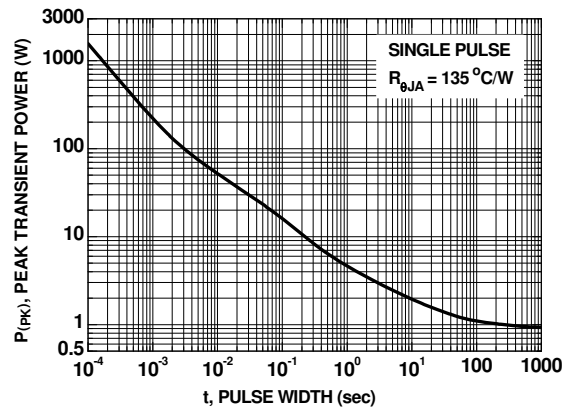
**Figure 22. Unclamped Inductive Switching Capability**



**Figure 23. Maximum Continuous Drain Current vs Ambient Temperature**

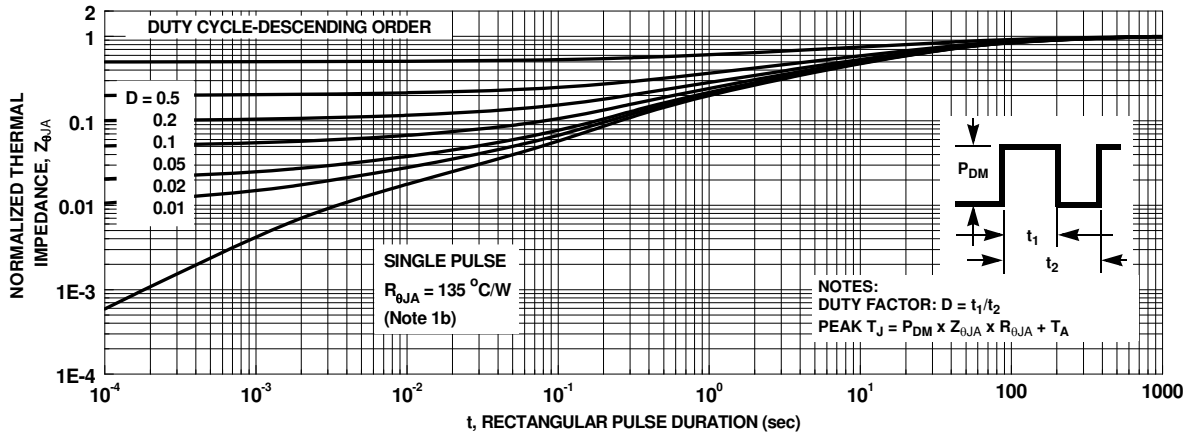


**Figure 24. Forward Bias Safe Operating Area**



**Figure 25. Single Pulse Maximum Power Dissipation**

**Typical Characteristics (Q2 N-Channel)**  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise noted



**Figure 26. Junction-to-Ambient Transient Thermal Response Curve**

## 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 27 shows the reverse recovery characteristic of the FDPC8013S.

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

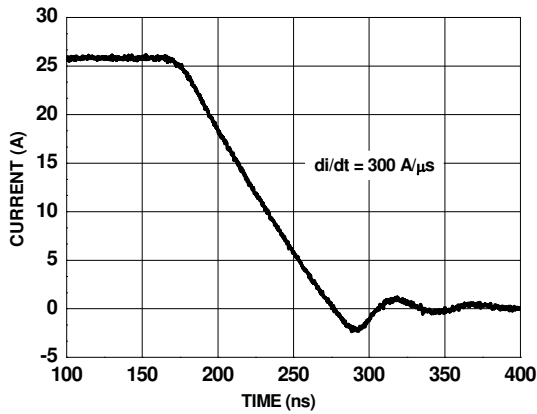


Figure 27. FDPC8013S SyncFET™ body diode reverse recovery characteristic

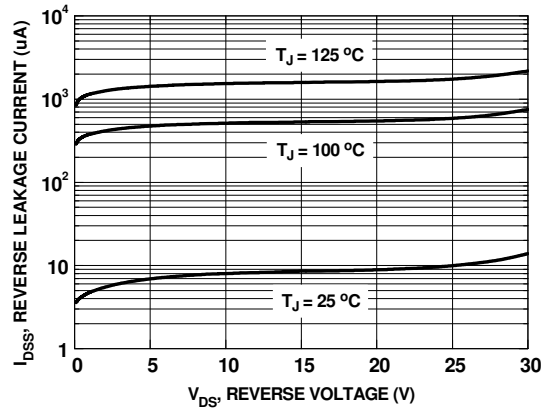
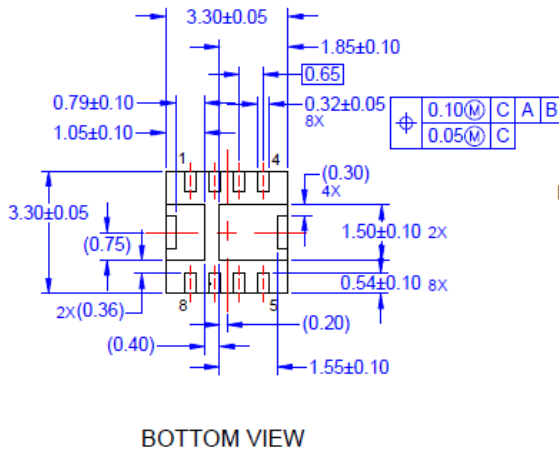
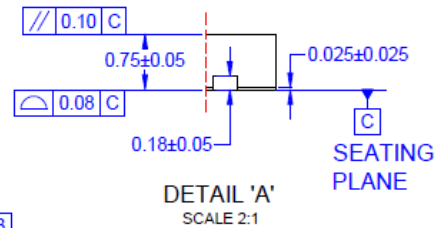
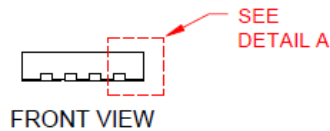
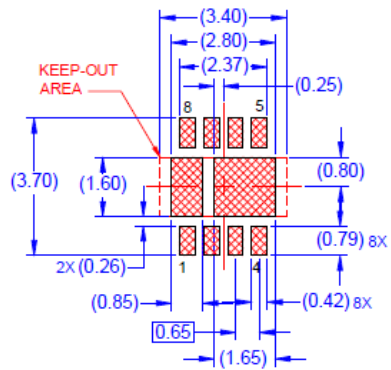
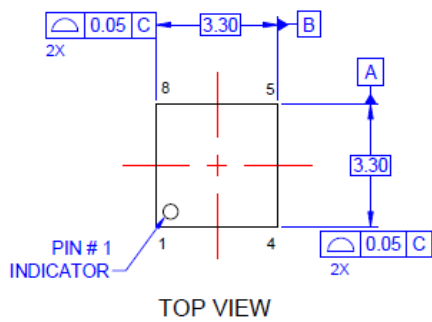


Figure 28. SyncFET™ body diode reverse leakage versus drain-source voltage

## Dimensional Outline and Pad Layout



- NOTES: UNLESS OTHERWISE SPECIFIED
- A) THIS PACKAGE IS REFERENCED FROM JEDEC MO-240, VARIATION BA.
  - B) ALL DIMENSIONS ARE IN MILLIMETERS.
  - C) DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.
  - D) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2009.
  - E) IT IS RECOMMENDED TO HAVE NO TRACES OR VIAS WITHIN THE KEEP OUT AREA.
  - F) DRAWING FILE NAME: MKT-PQFN08GREV4







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[https://www.fairchildsemi.com/evaluate/package-specifications/packageDetails.html?id=PN\\_PQDEU-X08](https://www.fairchildsemi.com/evaluate/package-specifications/packageDetails.html?id=PN_PQDEU-X08).



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