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May 2016

# FDMD8560L

## Dual N-Channel PowerTrench<sup>®</sup> MOSFET

Q1: 60 V, 22 A, 3.2 mΩ Q2: 60 V, 22 A, 3.2 mΩ

### Features

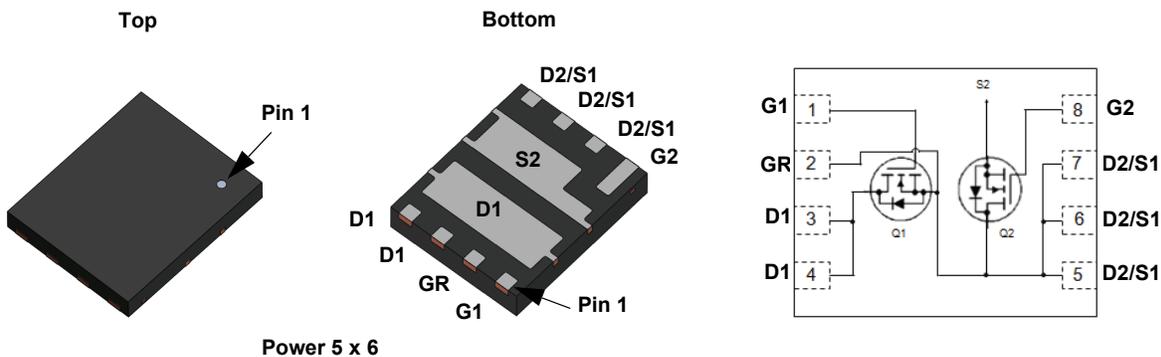
- Q1: N-Channel
- Max  $r_{DS(on)}$  = 3.2 mΩ at  $V_{GS} = 10\text{ V}$ ,  $I_D = 22\text{ A}$
  - Max  $r_{DS(on)}$  = 5.4 mΩ at  $V_{GS} = 4.5\text{ V}$ ,  $I_D = 18\text{ A}$
- Q2: N-Channel
- Max  $r_{DS(on)}$  = 3.2 mΩ at  $V_{GS} = 10\text{ V}$ ,  $I_D = 22\text{ A}$
  - Max  $r_{DS(on)}$  = 5.4 mΩ at  $V_{GS} = 4.5\text{ V}$ ,  $I_D = 18\text{ A}$
- Ideal for Flexible Layout in Primary Side of Bridge Topology
  - 100% UIL Tested
  - Kelvin High Side MOSFET Drive Pin-out Capability
  - RoHS Compliant

### General Description

This device includes two 60V N-Channel MOSFETs in a dual power (5 mm X 6 mm) package. HS source and LS drain internally connected for half/full bridge, low source inductance package, low  $r_{DS(on)}$ /Qg FOM silicon.

### Applications

- Synchronous Buck: Primary Switch of Half / Full Bridge Converter for Telecom
- Motor Bridge: Primary Switch of Half / Full Bridge Converter for BLDC Motor
- MV POL: 48V Synchronous Buck Switch
- Half/Full Bridge Secondary Synchronous Rectification



Power 5 x 6

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

Symbol	Parameter	Q1	Q2	Units
$V_{DS}$	Drain to Source Voltage	60	60	V
$V_{GS}$	Gate to Source Voltage	±20	±20	V
$I_D$	Drain Current -Continuous	$T_C = 25\text{ °C}$ (Note 5)	93	93
	Drain Current -Continuous	$T_C = 100\text{ °C}$ (Note 5)	59	59
	Drain Current -Continuous	$T_A = 25\text{ °C}$	22 <sup>1a</sup>	22 <sup>1b</sup>
	Drain Current -Pulsed	(Note 4)	550	550
$E_{AS}$	Single Pulse Avalanche Energy	(Note 3)	384	384
$P_D$	Power Dissipation	$T_C = 25\text{ °C}$	48	48
	Power Dissipation	$T_A = 25\text{ °C}$	2.2 <sup>1a</sup>	2.2 <sup>1b</sup>
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150		°C

### Thermal Characteristics

$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	2.6	2.6	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	55 <sup>1a</sup>	55 <sup>1b</sup>	

### Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FDMD8560L	FDMD8560L	Power 5 x 6	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	$I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0\text{ V}$	Q1 Q2	60 60			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 250\text{ }\mu\text{A}$ , referenced to $25\text{ }^\circ\text{C}$	Q1 Q2		32 32		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 48\text{ V}$ , $V_{GS} = 0\text{ V}$	Q1 Q2			1 1	$\mu\text{A}$
$I_{GSS}$	Gate to Source Leakage Current	$V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$	Q1 Q2			$\pm 100$ $\pm 100$	nA

**On Characteristics**

$V_{GS(th)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}$ , $I_D = 250\text{ }\mu\text{A}$	Q1 Q2	1.0 1.0	1.6 1.6	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 $25\text{ }^\circ\text{C}$	Q1 Q2		-7 -7		mV/ $^\circ\text{C}$
$r_{DS(on)}$	Static Drain to Source On Resistance	$V_{GS} = 10\text{ V}$ , $I_D = 22\text{ A}$	Q1		2.5	3.2	m $\Omega$
		$V_{GS} = 4.5\text{ V}$ , $I_D = 18\text{ A}$		4.1	5.4		
		$V_{GS} = 10\text{ V}$ , $I_D = 22\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$		3.9	5.0		
		$V_{GS} = 10\text{ V}$ , $I_D = 22\text{ A}$	Q2		2.5	3.2	
		$V_{GS} = 4.5\text{ V}$ , $I_D = 18\text{ A}$		4.1	5.4		
		$V_{GS} = 10\text{ V}$ , $I_D = 22\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$		3.9	5.0		
$g_{FS}$	Forward Transconductance	$V_{DD} = 5\text{ V}$ , $I_D = 22\text{ A}$	Q1 Q2		98 98		S

**Dynamic Characteristics**

$C_{iss}$	Input Capacitance	$V_{DS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$ $f = 1\text{ MHz}$	Q1 Q2		7420 7420	11130 11130	pF
$C_{oss}$	Output Capacitance		Q1 Q2		1110 1110	1665 1665	pF
$C_{rss}$	Reverse Transfer Capacitance		Q1 Q2		38 38	60 60	pF
$R_g$	Gate Resistance		Q1 Q2	0.1 0.1	1.5 1.5	3.0 3.0	$\Omega$

**Switching Characteristics**

$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 30\text{ V}$ , $I_D = 22\text{ A}$ $V_{GS} = 10\text{ V}$ , $R_{GEN} = 6\text{ }\Omega$	Q1 Q2		20 20	35 35	ns
$t_r$	Rise Time		Q1 Q2		15 15	26 26	ns
$t_{d(off)}$	Turn-Off Delay Time		Q1 Q2		57 57	90 90	ns
$t_f$	Fall Time		Q1 Q2		11 11	20 20	ns
$Q_{g(TOT)}$	Total Gate Charge		$V_{GS} = 0\text{ V to }10\text{ V}$	Q1 Q2		92 92	128 128
$Q_{g(TOT)}$	Total Gate Charge	$V_{GS} = 0\text{ V to }4.5\text{ V}$	Q1 Q2		42 42	59 59	nC
$Q_{gs}$	Gate to Source Charge	$V_{DD} = 30\text{ V}$ , $I_D = 22\text{ A}$	Q1 Q2		19 19		nC
$Q_{gd}$	Gate to Drain "Miller" Charge		Q1 Q2		7 7		nC

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

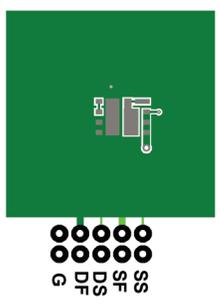
Symbol	Parameter	Test Conditions	Type	Min.	Typ.	Max.	Units
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**Drain-Source Diode Characteristics**

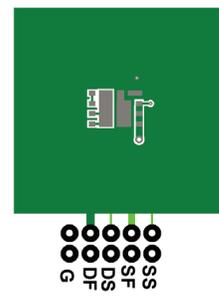
$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 22\text{ A}$ (Note 2)	Q1 Q2		0.8 0.8	1.3 1.3	V
$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 2\text{ A}$ (Note 2)	Q1 Q2		0.7 0.7	1.2 1.2	V
$t_{rr}$	Reverse Recovery Time	$I_F = 22\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$	Q1 Q2		53 53	84 84	ns
$Q_{rr}$	Reverse Recovery Charge		Q1 Q2		44 44	70 70	nC

NOTES:

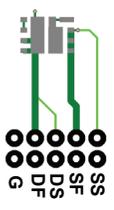
1.  $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 x 1.5 in. board of FR-4 material.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



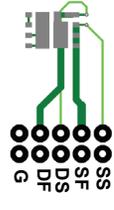
a. 55 °C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



b. 55 °C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



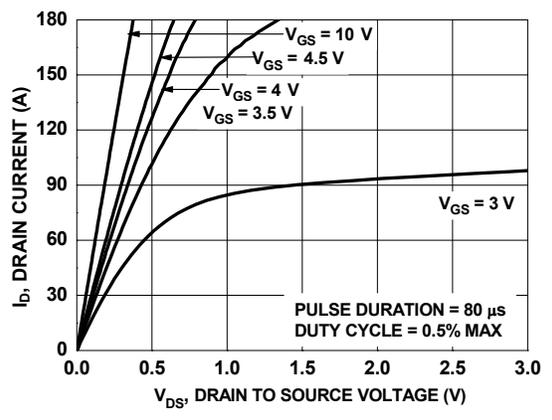
c. 155 °C/W when mounted on a minimum pad of 2 oz copper



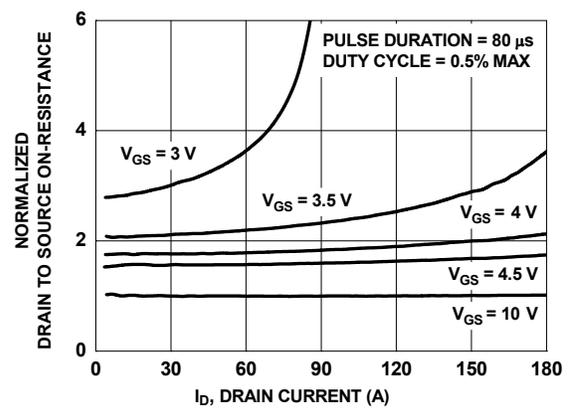
d. 155 °C/W when mounted on a minimum pad of 2 oz copper

2. Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty cycle < 2.0 %.
3. Q1:  $E_{AS}$  of 384 mJ is based on starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 3\text{ mH}$ ,  $I_{AS} = 16\text{ A}$ ,  $V_{DD} = 60\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% tested at  $L = 0.1\text{ mH}$ ,  $I_{AS} = 51\text{ A}$ .  
Q2:  $E_{AS}$  of 384 mJ is based on starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 3\text{ mH}$ ,  $I_{AS} = 16\text{ A}$ ,  $V_{DD} = 60\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% tested at  $L = 0.1\text{ mH}$ ,  $I_{AS} = 51\text{ A}$ .
4. Pulsed  $I_d$  please refer to Fig 11 and Fig 24 SOA graph for more details.
5. Computed continuous current limited to Max Junction Temperature only, actual continuous current will be limited by thermal & electro-mechanical application board design.

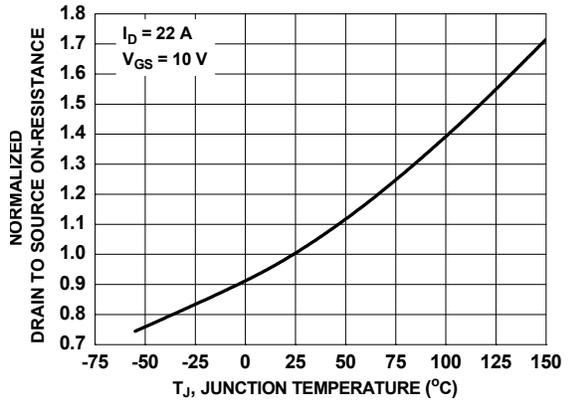
**Typical Characteristics (Q1 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted.



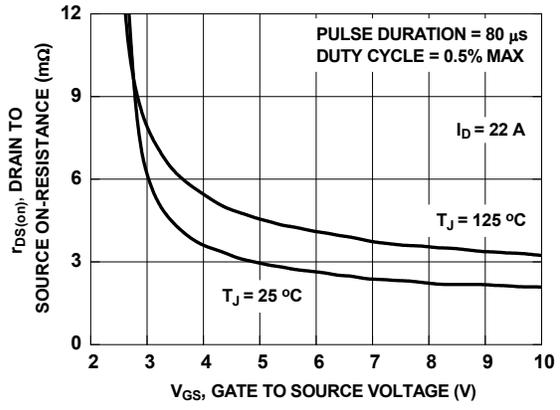
**Figure 1. On Region Characteristics**



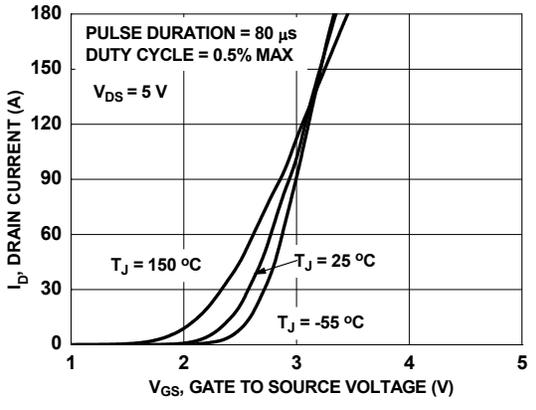
**Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage**



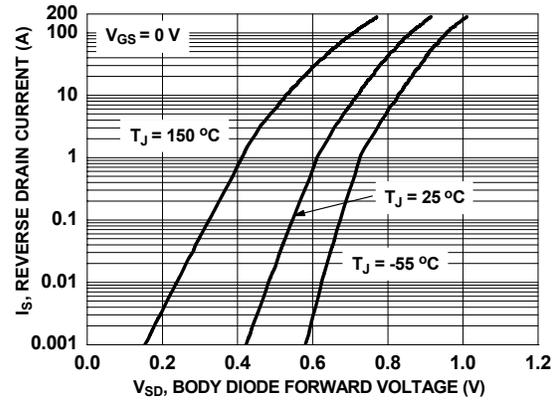
**Figure 3. Normalized On Resistance vs. Junction Temperature**



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

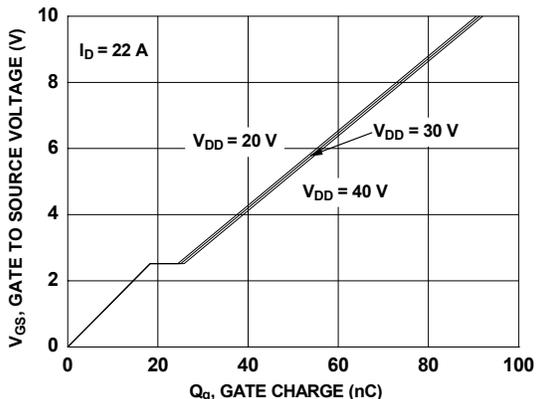


**Figure 5. Transfer Characteristics**

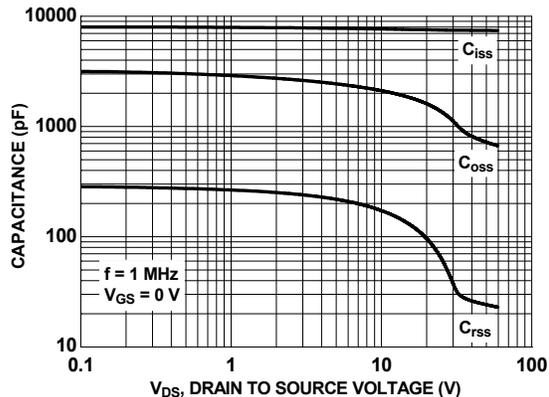


**Figure 6. Source to Drain Diode Forward Voltage vs. Source Current**

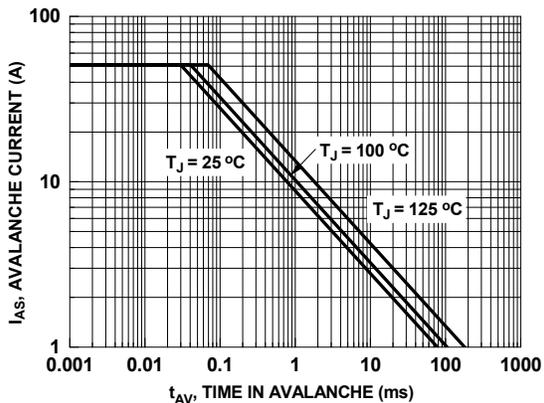
**Typical Characteristics (Q1 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted.



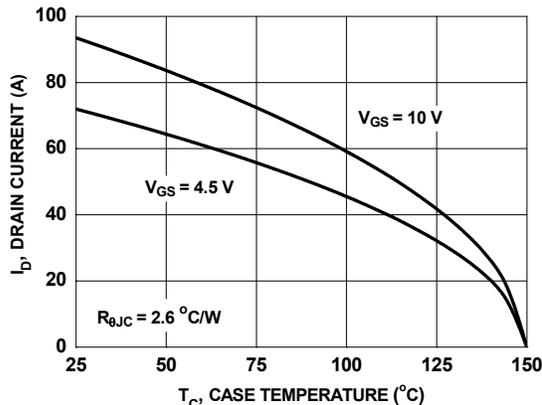
**Figure 7. Gate Charge Characteristics**



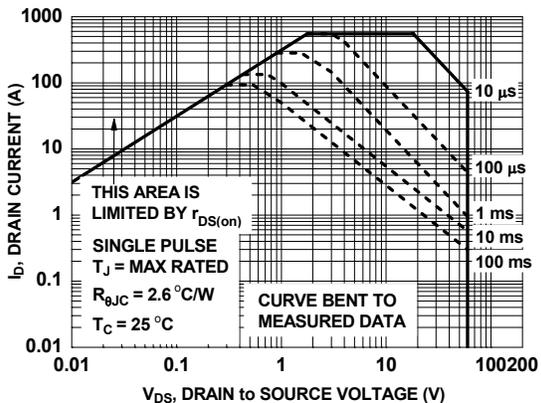
**Figure 8. Capacitance vs. Drain to Source Voltage**



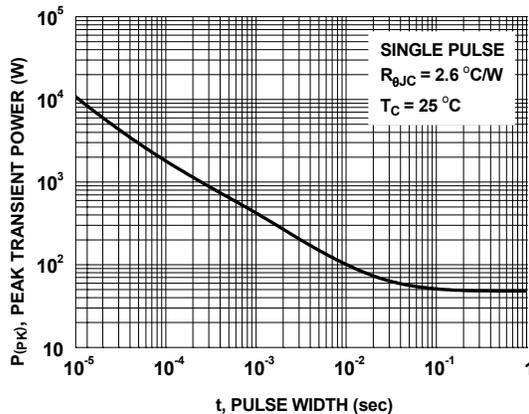
**Figure 9. Unclamped Inductive Switching Capability**



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

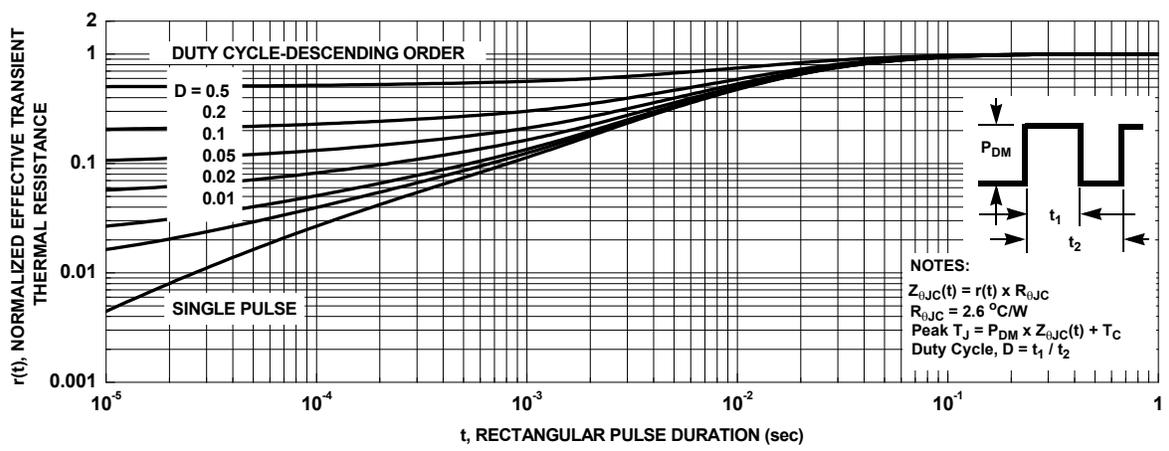


**Figure 11. Forward Bias Safe Operating Area**



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

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



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

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

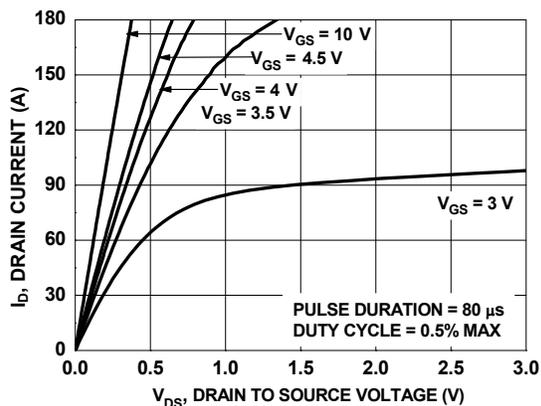


Figure 14. On-Region Characteristics

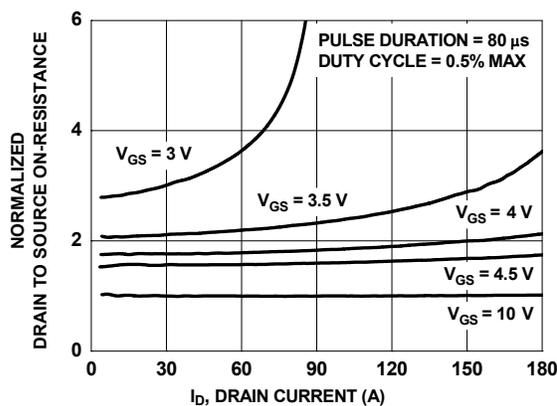


Figure 15. Normalized on-Resistance vs. Drain Current and Gate Voltage

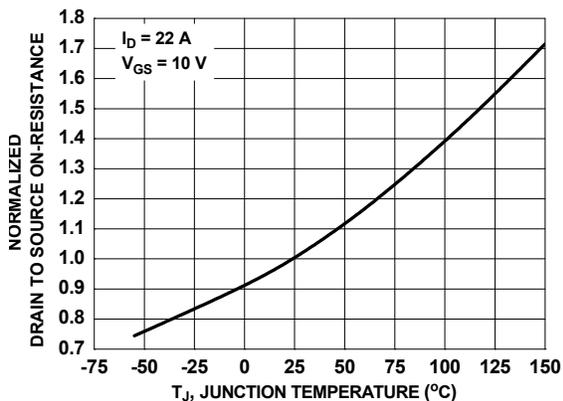


Figure 16. Normalized On-Resistance vs. Junction Temperature

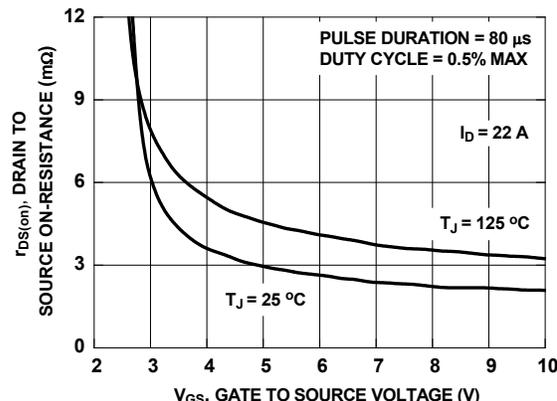


Figure 17. On-Resistance vs. Gate to Source Voltage

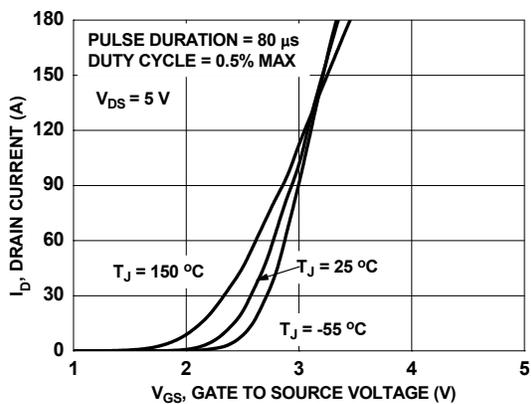


Figure 18. Transfer Characteristics

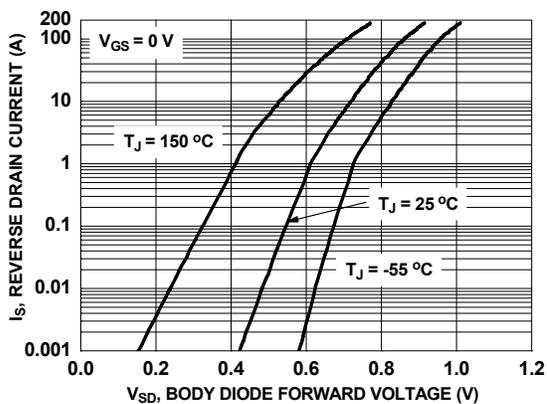
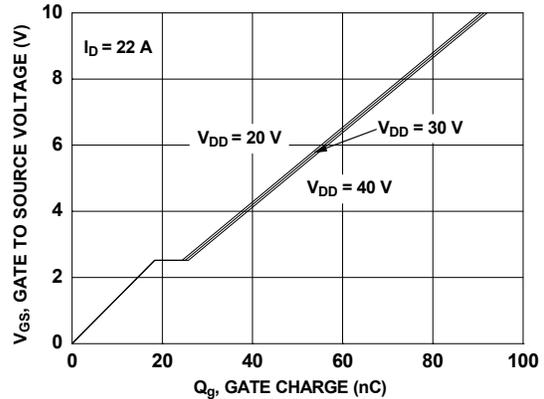
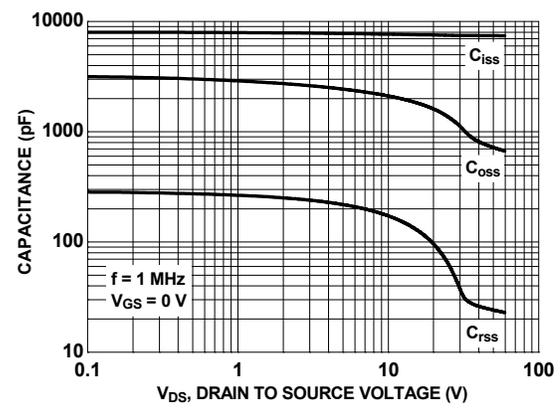


Figure 19. Source to Drain Diode Forward Voltage vs. Source Current

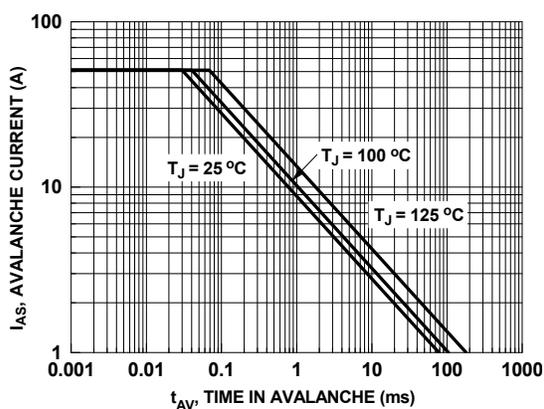
**Typical Characteristics (Q2 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted.



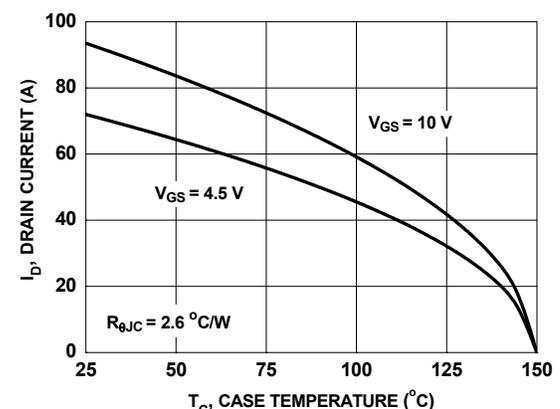
**Figure 20. Gate Charge Characteristics**



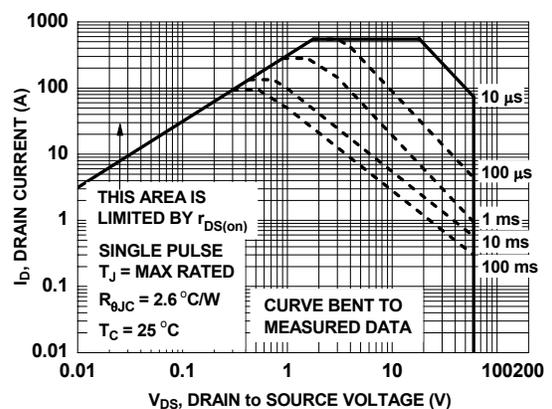
**Figure 21. Capacitance vs. Drain to Source Voltage**



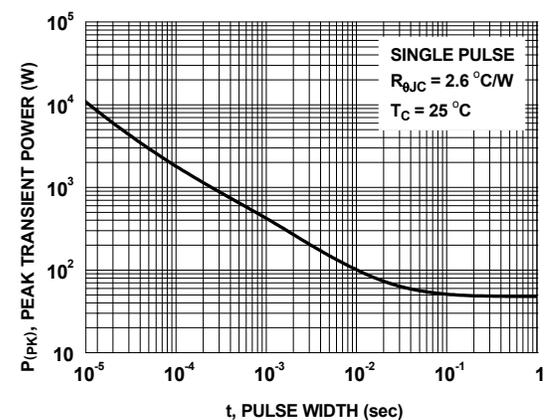
**Figure 22. Unclamped Inductive Switching Capability**



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

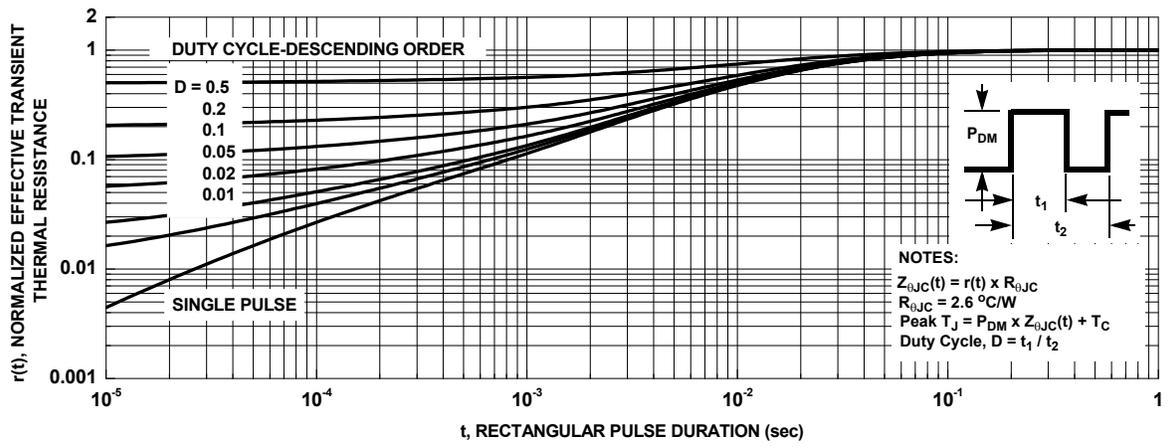


**Figure 24. Forward Bias Safe Operating Area**

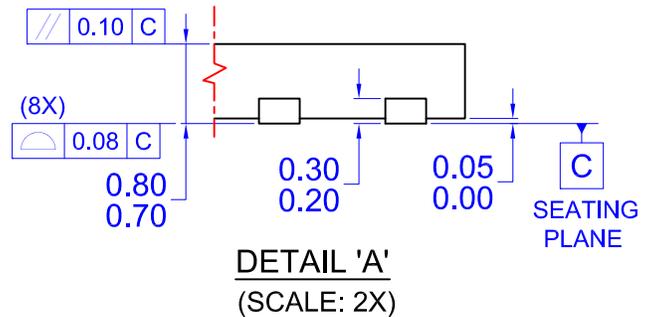
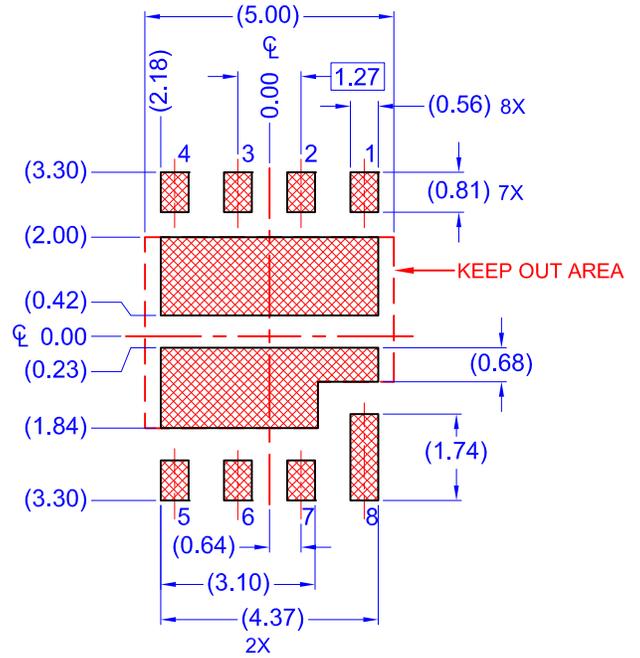
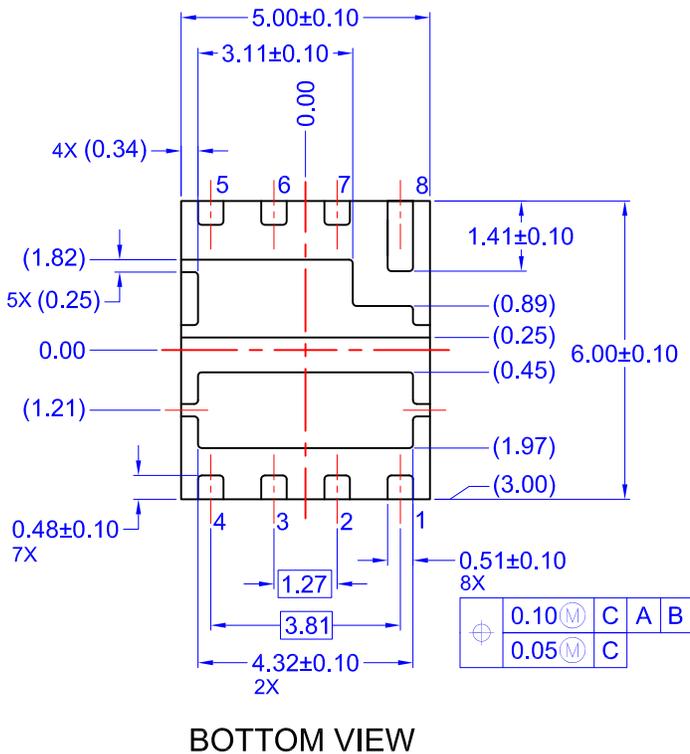
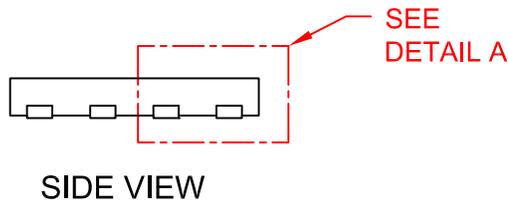
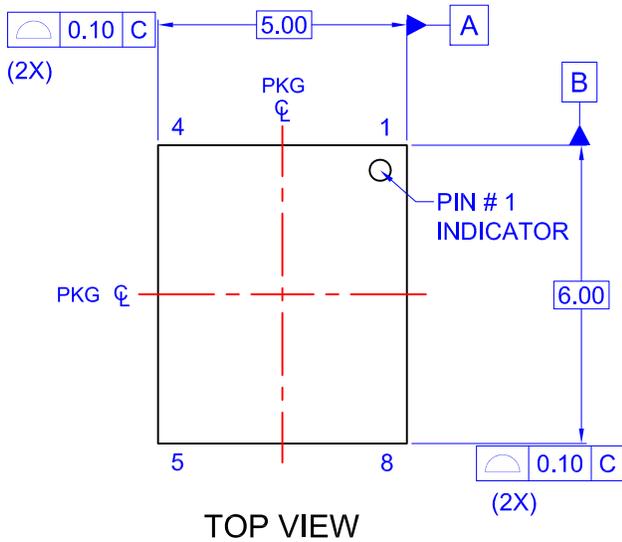


**Figure 25. Single Pulse Maximum Power Dissipation**

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



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



- NOTES: UNLESS OTHERWISE SPECIFIED
- PACKAGE STANDARD REFERENCE: JEDEC REGISTRATION, MO-240, VARIATION AA.
  - ALL DIMENSIONS ARE IN MILLIMETERS.
  - DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.
  - DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2009.
  - IT IS RECOMMENDED TO HAVE NO TRACES OR VIAS WITHIN THE KEEP OUT AREA.
  - DRAWING FILE NAME: MKT-PQFN08QREV2



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