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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

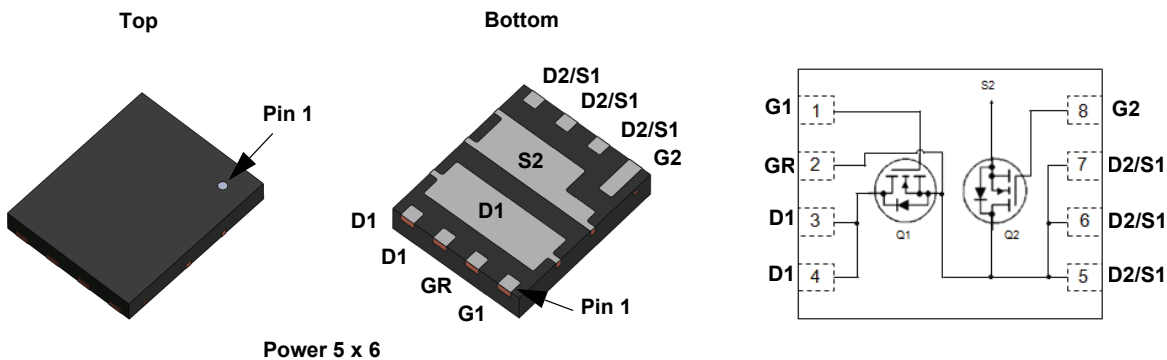
- Q1: N-Channel
- Max  $r_{DS(on)}$  = 3.2 mΩ at  $V_{GS} = 10\text{ V}$ ,  $I_D = 22\text{ A}$
  - Max  $r_{DS(on)}$  = 5.4 mΩ at  $V_{GS} = 4.5\text{ V}$ ,  $I_D = 18\text{ A}$
- Q2: N-Channel
- Max  $r_{DS(on)}$  = 3.2 mΩ at  $V_{GS} = 10\text{ V}$ ,  $I_D = 22\text{ A}$
  - Max  $r_{DS(on)}$  = 5.4 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
	-Continuous	$T_C = 100\text{ °C}$ (Note 5)	59	59
	-Continuous	$T_A = 25\text{ °C}$	22 <sup>1a</sup>	22 <sup>1b</sup>
	-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.

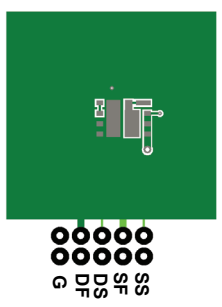
Symbol	Parameter	Test Conditions	Type	Min.	Typ.	Max.	Units
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**Drain-Source Diode Characteristics**

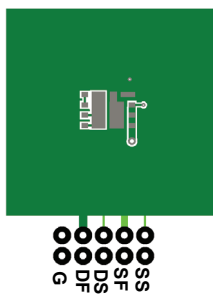
$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 22\text{ A}$ (Note 2)	Q1 Q2		0.8 0.8	1.3 1.3	V
$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 2\text{ A}$ (Note 2)	Q1 Q2		0.7 0.7	1.2 1.2	V
$t_{rr}$	Reverse Recovery Time	$I_F = 22\text{ A}, di/dt =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

NOTES:

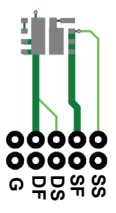
1.  $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 x 1.5 in. board of FR-4 material.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



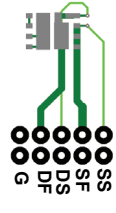
a. 55 °C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



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



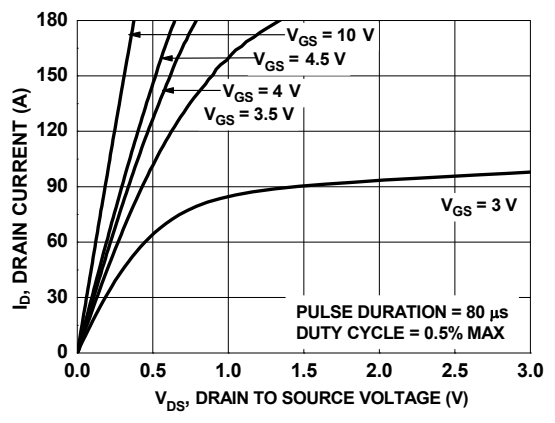
c. 155 °C/W when mounted on a minimum pad of 2 oz copper



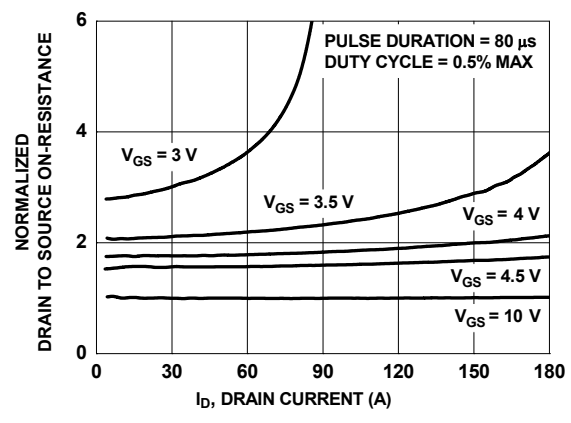
d. 155 °C/W when mounted on a minimum pad of 2 oz copper

- Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty cycle < 2.0 %.
- 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  $L = 0.1\text{ mH}$ ,  $I_{AS} = 51\text{ A}$ .
- Pulsed  $I_d$  please refer to Fig 11 and Fig 24 SOA graph for more details.
- Computed continuous current limited to Max Junction Temperature only, actual continuous current will be limited by thermal & electro-mechanical application board design.

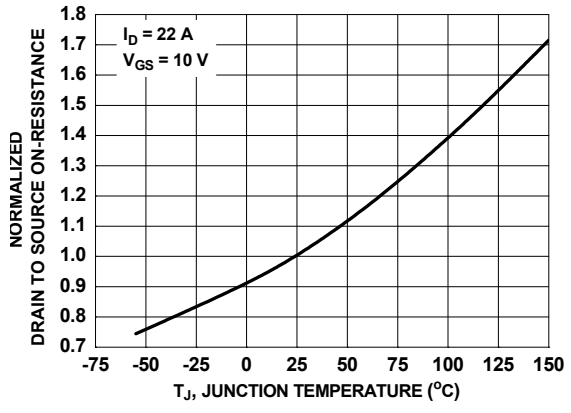
**Typical Characteristics (Q1 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted.



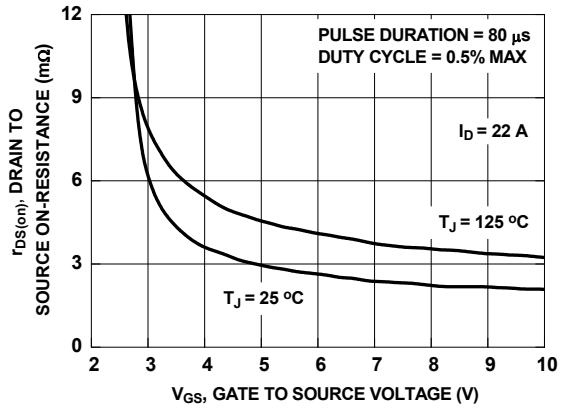
**Figure 1. On Region Characteristics**



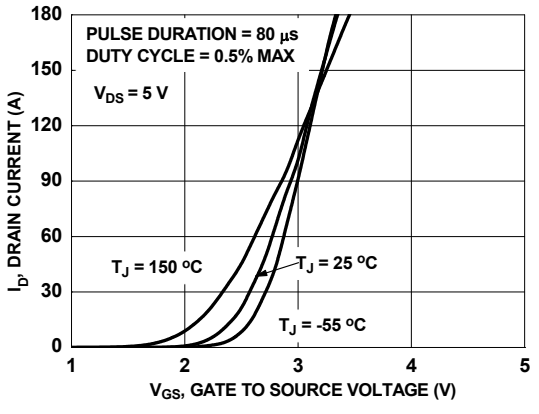
**Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage**



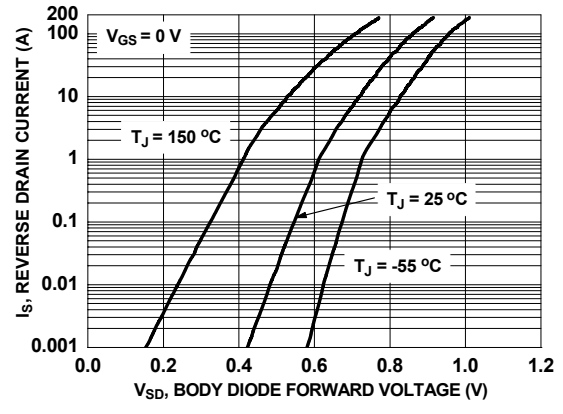
**Figure 3. Normalized On Resistance vs. Junction Temperature**



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

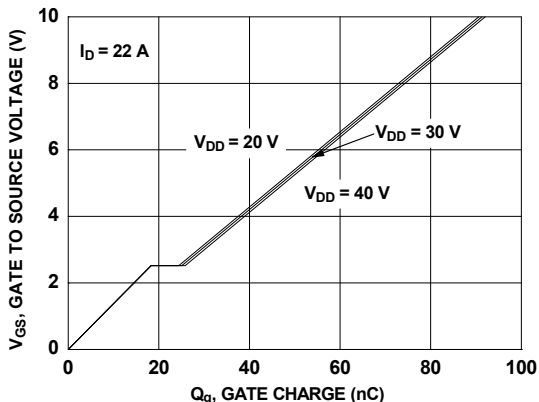


**Figure 5. Transfer Characteristics**

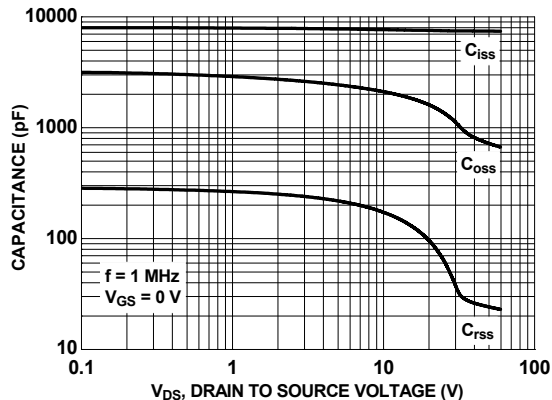


**Figure 6. Source to Drain Diode Forward Voltage vs. Source Current**

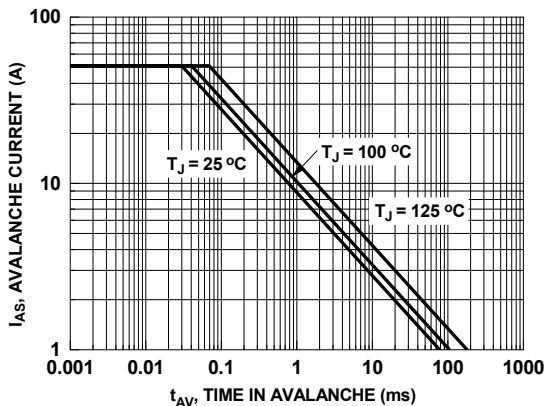
**Typical Characteristics (Q1 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted.



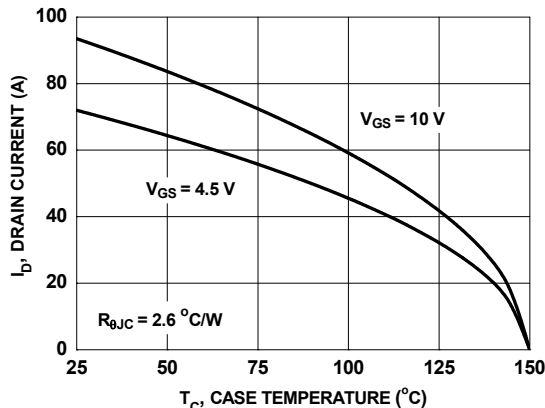
**Figure 7. Gate Charge Characteristics**



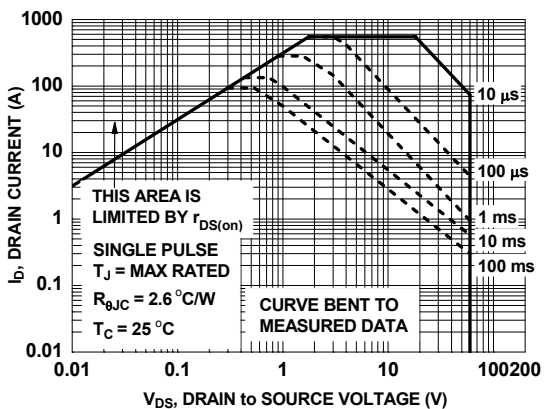
**Figure 8. Capacitance vs. Drain to Source Voltage**



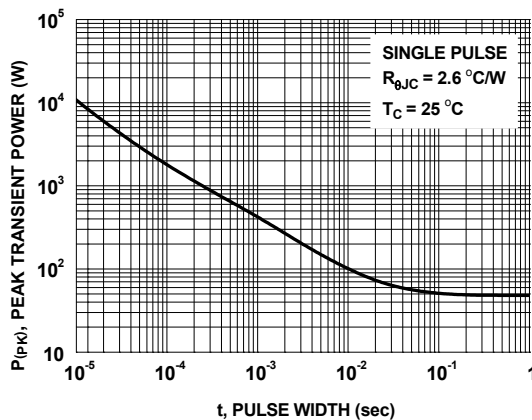
**Figure 9. Unclamped Inductive Switching Capability**



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

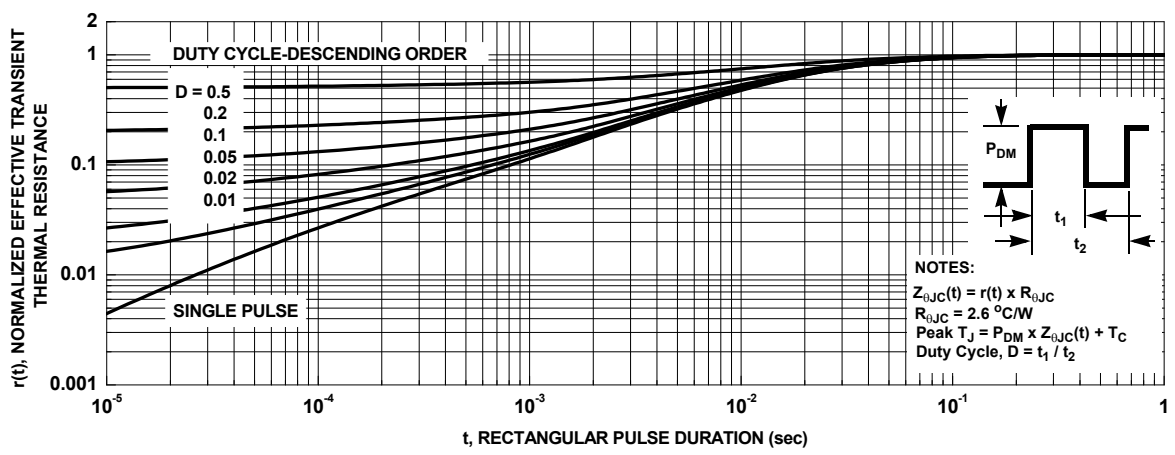


**Figure 11. Forward Bias Safe Operating Area**



**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.

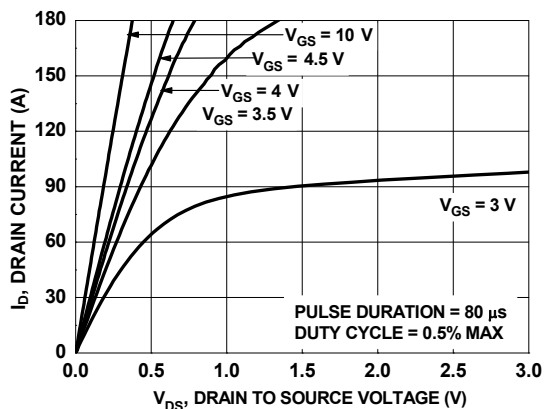


Figure 14. On-Region Characteristics

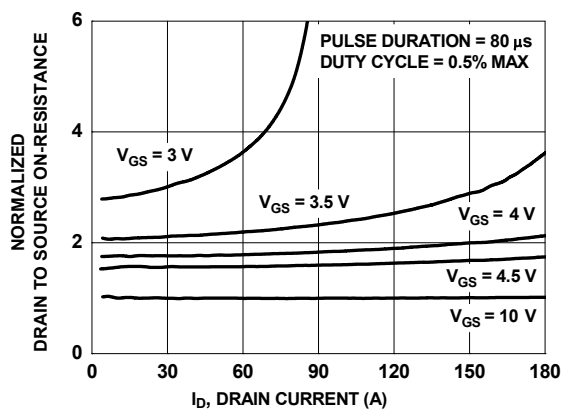


Figure 15. Normalized on-Resistance vs. Drain Current and Gate Voltage

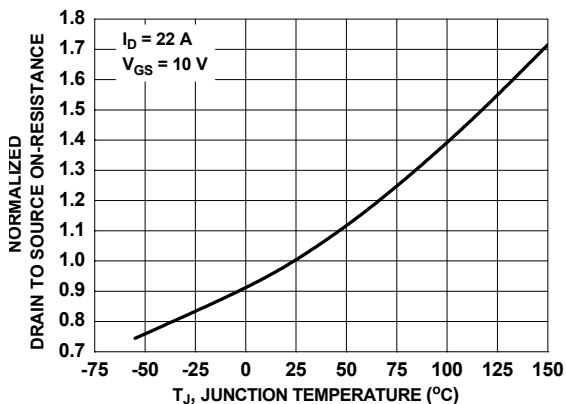


Figure 16. Normalized On-Resistance vs. Junction Temperature

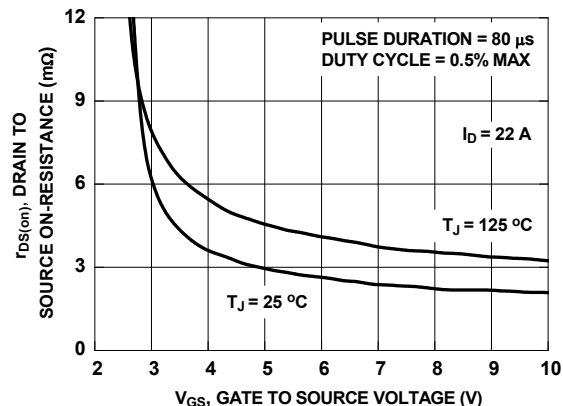


Figure 17. On-Resistance vs. Gate to Source Voltage

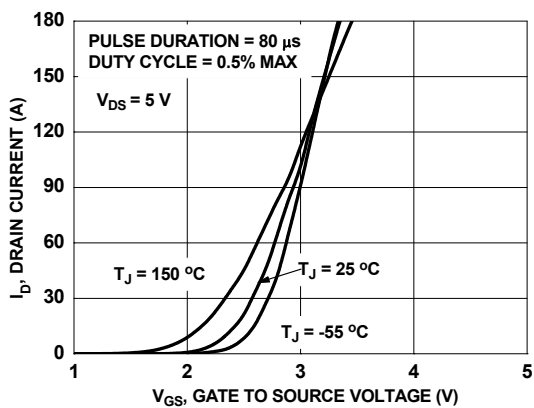


Figure 18. Transfer Characteristics

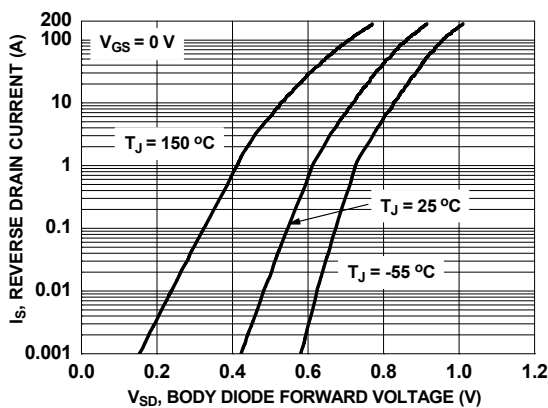
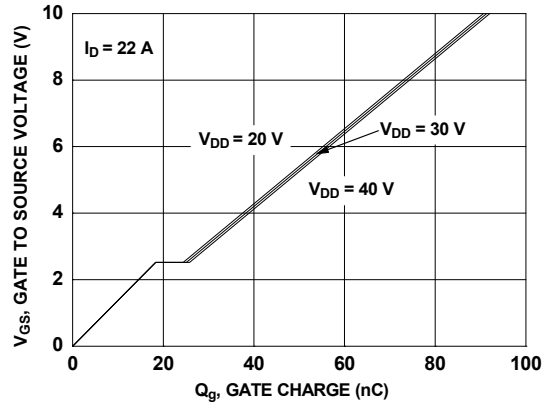


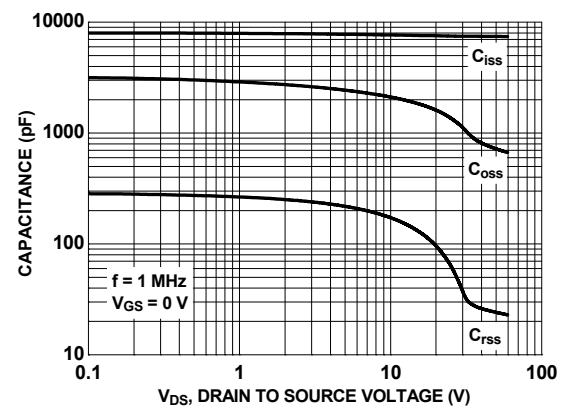
Figure 19. Source to Drain Diode Forward Voltage vs. Source Current



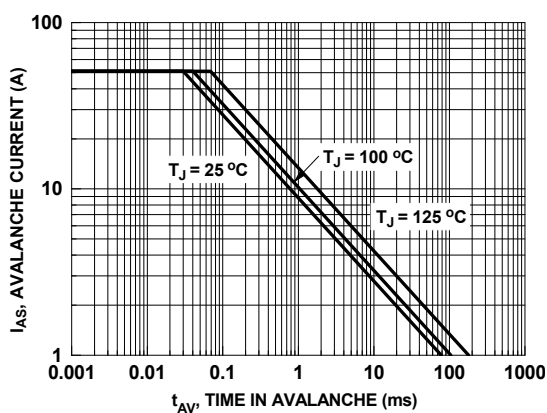
**Typical Characteristics (Q2 N-Channel)**  $T_J = 25^\circ\text{C}$  unless otherwise noted.



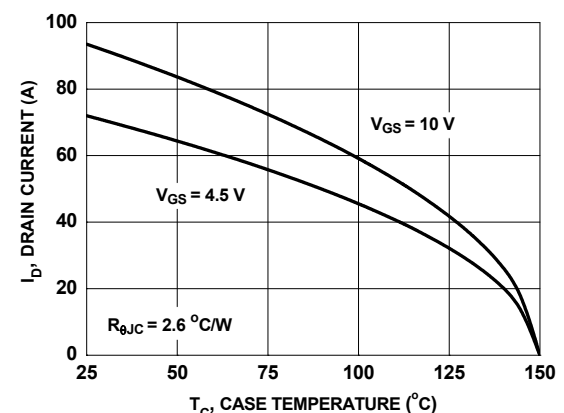
**Figure 20. Gate Charge Characteristics**



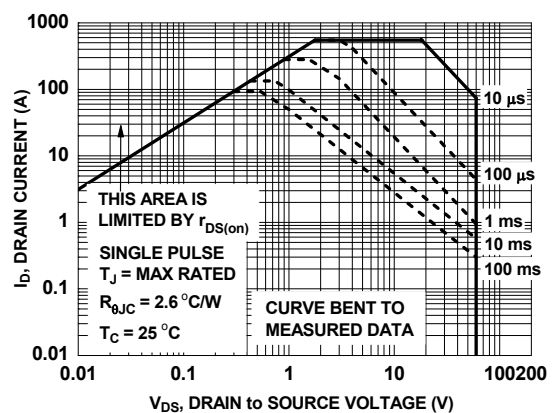
**Figure 21. Capacitance vs. Drain to Source Voltage**



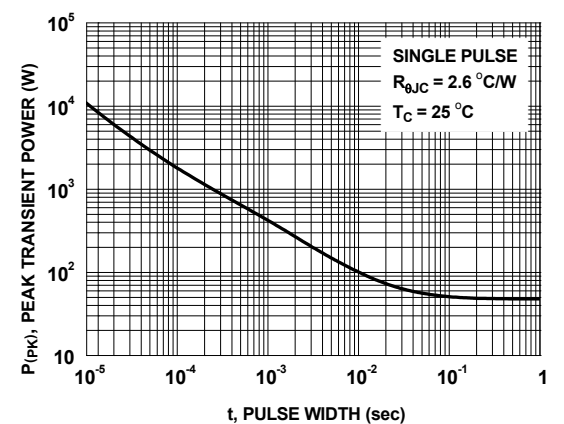
**Figure 22. Unclamped Inductive Switching Capability**



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

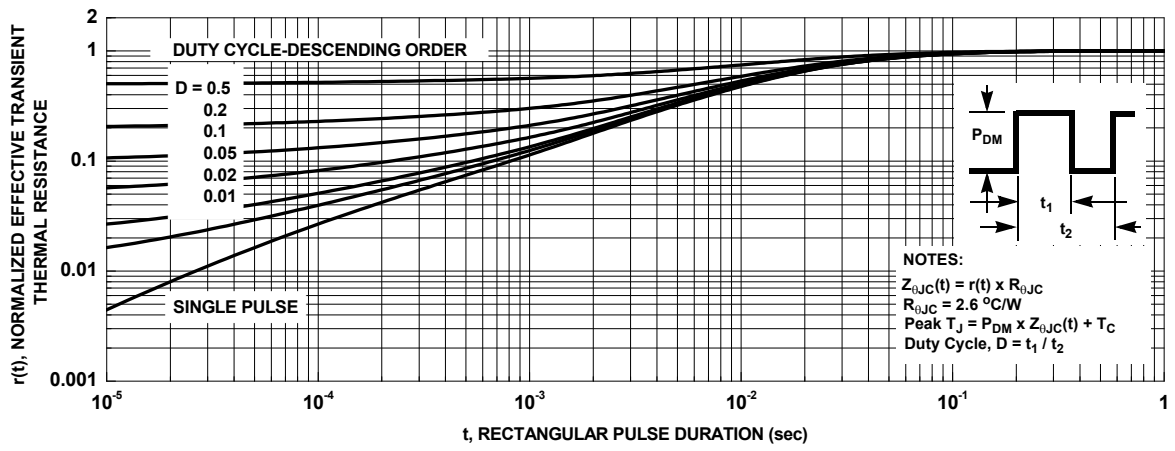


**Figure 24. Forward Bias Safe Operating Area**

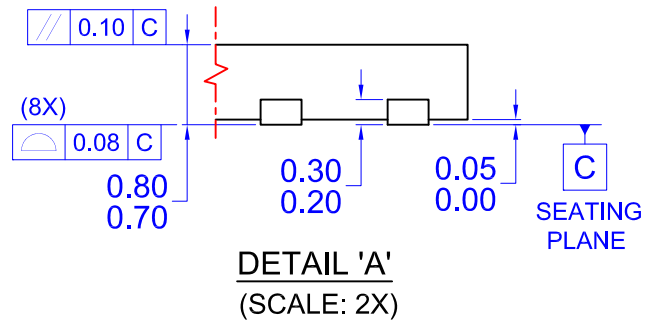
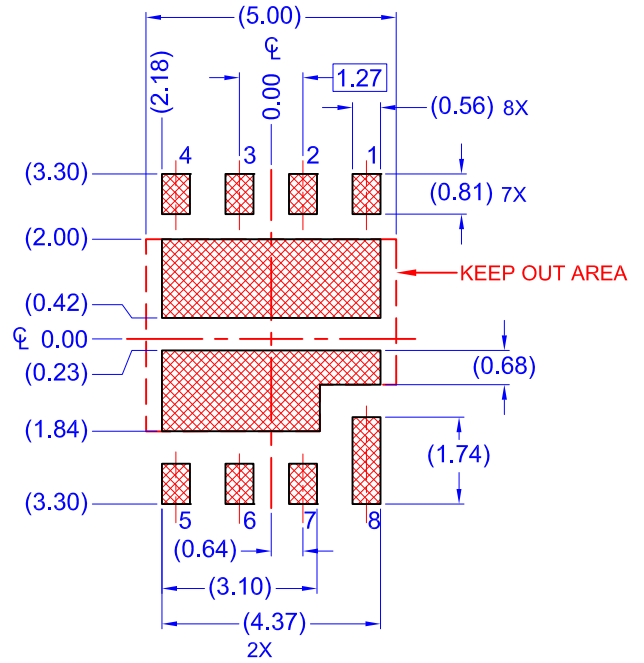
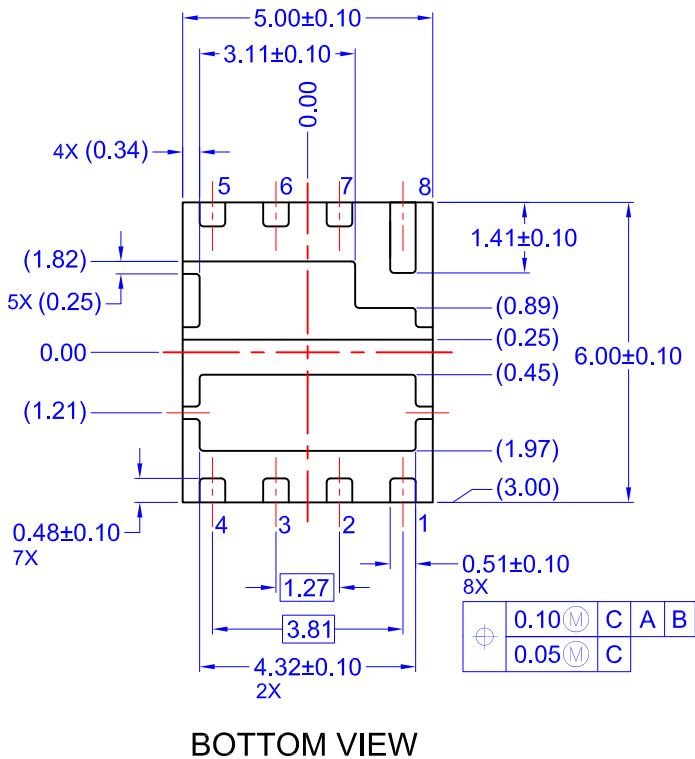
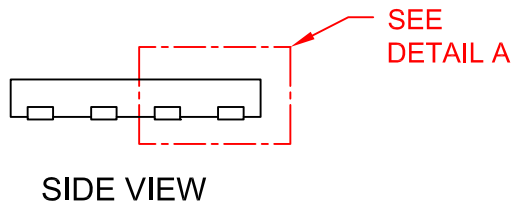
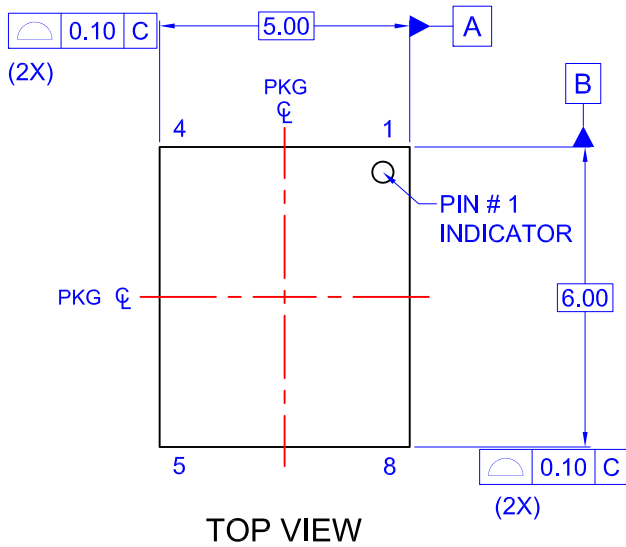


**Figure 25. Single Pulse Maximum Power Dissipation**

**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
- A) PACKAGE STANDARD REFERENCE: JEDEC REGISTRATION, MO-240, VARIATION AA.
  - 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-PQFN08QREV2



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