



October 2014

# FDMS86540

## N-Channel PowerTrench<sup>®</sup> MOSFET 60 V, 50 A, 3.4 mΩ

### Features

- Max  $r_{DS(on)}$  = 3.4 mΩ at  $V_{GS} = 10\text{ V}$ ,  $I_D = 20\text{ A}$
- Max  $r_{DS(on)}$  = 4.1 mΩ at  $V_{GS} = 8\text{ V}$ ,  $I_D = 18.5\text{ A}$
- Advanced Package and Silicon combination for low  $r_{DS(on)}$  and high efficiency
- Next generation enhanced body diode technology, engineered for soft recovery
- MSL1 robust package design
- 100% UIL tested
- RoHS Compliant



### General Description

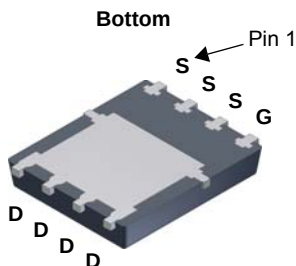
This N-Channel MOSFET has been designed specifically to improve the overall efficiency and to minimize switch node ringing of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low  $r_{DS(on)}$ , fast switching speed and body diode reverse recovery performance.

### Applications

- Primary Switch in isolated DC-DC
- Synchronous Rectifier
- Load Switch



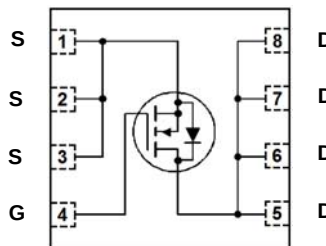
Top



Bottom

Pin 1

Power 56



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

| Symbol         | Parameter                                                      | Ratings     | Units              |
|----------------|----------------------------------------------------------------|-------------|--------------------|
| $V_{DS}$       | Drain to Source Voltage                                        | 60          | V                  |
| $V_{GS}$       | Gate to Source Voltage                                         | $\pm 20$    | V                  |
| $I_D$          | Drain Current -Continuous $T_C = 25\text{ }^{\circ}\text{C}$   | 50          | A                  |
|                | -Continuous $T_A = 25\text{ }^{\circ}\text{C}$ (Note 1a)       | 20          |                    |
|                | -Pulsed (Note 4)                                               | 350         |                    |
| $E_{AS}$       | Single Pulse Avalanche Energy (Note 3)                         | 228         | mJ                 |
| $P_D$          | Power Dissipation $T_C = 25\text{ }^{\circ}\text{C}$           | 96          | W                  |
|                | Power Dissipation $T_A = 25\text{ }^{\circ}\text{C}$ (Note 1a) | 2.5         |                    |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range               | -55 to +150 | $^{\circ}\text{C}$ |

### Thermal Characteristics

|                 |                                                   |     |                      |
|-----------------|---------------------------------------------------|-----|----------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case              | 1.3 | $^{\circ}\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1a) | 50  |                      |

### Package Marking and Ordering Information

| Device Marking | Device    | Package  | Reel Size | Tape Width | Quantity   |
|----------------|-----------|----------|-----------|------------|------------|
| FDMS86540      | FDMS86540 | Power 56 | 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 |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

**Off Characteristics**

|                                      |                                           |                                                                             |    |    |           |                        |
|--------------------------------------|-------------------------------------------|-----------------------------------------------------------------------------|----|----|-----------|------------------------|
| $BV_{DSS}$                           | Drain to Source Breakdown Voltage         | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0\text{ V}$                      | 60 |    |           | V                      |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , referenced to $25\text{ }^{\circ}\text{C}$ |    | 28 |           | mV/ $^{\circ}\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 48\text{ V}$ , $V_{GS} = 0\text{ V}$                              |    |    | 1         | $\mu\text{A}$          |
| $I_{GSS}$                            | Gate to Source Leakage Current            | $V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$                          |    |    | $\pm 100$ | nA                     |

**On Characteristics**

|                                        |                                                          |                                                                                    |   |     |     |                        |
|----------------------------------------|----------------------------------------------------------|------------------------------------------------------------------------------------|---|-----|-----|------------------------|
| $V_{GS(th)}$                           | Gate to Source Threshold Voltage                         | $V_{GS} = V_{DS}$ , $I_D = 250\text{ }\mu\text{A}$                                 | 2 | 3.2 | 4   | 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 $25\text{ }^{\circ}\text{C}$        |   | -11 |     | mV/ $^{\circ}\text{C}$ |
| $r_{DS(on)}$                           | Static Drain to Source On Resistance                     | $V_{GS} = 10\text{ V}$ , $I_D = 20\text{ A}$                                       |   | 2.7 | 3.4 | m $\Omega$             |
|                                        |                                                          | $V_{GS} = 8\text{ V}$ , $I_D = 18.5\text{ A}$                                      |   | 3.1 | 4.1 |                        |
|                                        |                                                          | $V_{GS} = 10\text{ V}$ , $I_D = 20\text{ A}$ , $T_J = 125\text{ }^{\circ}\text{C}$ |   | 3.8 | 4.8 |                        |
| $g_{FS}$                               | Forward Transconductance                                 | $V_{DS} = 10\text{ V}$ , $I_D = 20\text{ A}$                                       |   | 73  |     | S                      |

**Dynamic Characteristics**

|           |                              |                                                                        |  |      |      |          |
|-----------|------------------------------|------------------------------------------------------------------------|--|------|------|----------|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$ ,<br>$f = 1\text{ MHz}$ |  | 4837 | 6435 | pF       |
| $C_{oss}$ | Output Capacitance           |                                                                        |  | 1413 | 1880 | pF       |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                        |  | 50   | 90   | pF       |
| $R_g$     | Gate Resistance              |                                                                        |  | 1.0  |      | $\Omega$ |

**Switching Characteristics**

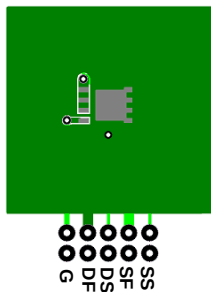
|              |                               |                                                                                                        |                                                 |     |    |    |
|--------------|-------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time            | $V_{DD} = 30\text{ V}$ , $I_D = 20\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_{GEN} = 6\text{ }\Omega$ |                                                 | 28  | 45 | ns |
| $t_r$        | Rise Time                     |                                                                                                        |                                                 | 16  | 29 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time           |                                                                                                        |                                                 | 32  | 52 | ns |
| $t_f$        | Fall Time                     |                                                                                                        |                                                 | 7.2 | 15 | ns |
| $Q_g$        | Total Gate Charge             | $V_{GS} = 0\text{ V}$ to $10\text{ V}$                                                                 | $V_{DD} = 30\text{ V}$ ,<br>$I_D = 20\text{ A}$ | 65  | 90 | nC |
| $Q_g$        | Total Gate Charge             | $V_{GS} = 0\text{ V}$ to $8\text{ V}$                                                                  |                                                 | 53  | 75 | nC |
| $Q_{gs}$     | Gate to Source Charge         |                                                                                                        |                                                 | 23  |    | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge |                                                                                                        |                                                 | 12  |    | nC |

**Drain-Source Diode Characteristics**

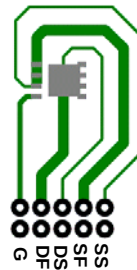
|          |                                       |                                                          |  |      |     |    |
|----------|---------------------------------------|----------------------------------------------------------|--|------|-----|----|
| $V_{SD}$ | Source to Drain Diode Forward Voltage | $V_{GS} = 0\text{ V}$ , $I_S = 2.1\text{ A}$ (Note 2)    |  | 0.70 | 1.2 | V  |
|          |                                       | $V_{GS} = 0\text{ V}$ , $I_S = 20\text{ A}$ (Note 2)     |  | 0.79 | 1.3 |    |
| $t_{rr}$ | Reverse Recovery Time                 | $I_F = 20\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ |  | 55   | 88  | ns |
| $Q_{rr}$ | Reverse Recovery Charge               |                                                          |  | 41   | 66  | nC |
| $t_{rr}$ | Reverse Recovery Time                 | $I_F = 20\text{ A}$ , $di/dt = 300\text{ A}/\mu\text{s}$ |  | 44   | 70  | ns |
| $Q_{rr}$ | Reverse Recovery Charge               |                                                          |  | 76   | 122 | 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) 50  $^{\circ}\text{C}/\text{W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



b) 125  $^{\circ}\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper.

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

3. Starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $L = 0.3\text{ mH}$ ,  $I_{AS} = 39\text{ A}$ ,  $V_{DD} = 54\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% test at  $L = 0.1\text{ mH}$ ,  $I_{AS} = 57\text{ A}$ .

4. Pulse  $I_d$  limited by junction temperature,  $t_d \leq 100\text{ }\mu\text{s}$ , please refer to SOA curve for more details.

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

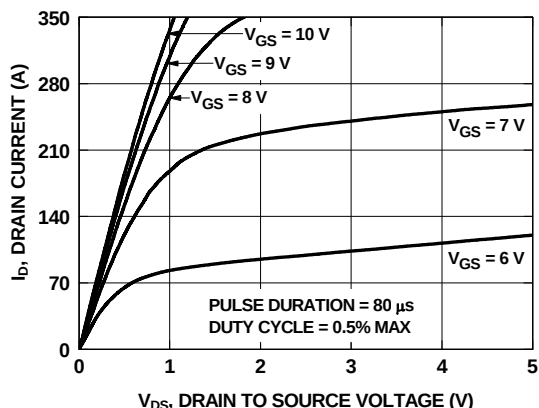


Figure 1. On-Region Characteristics

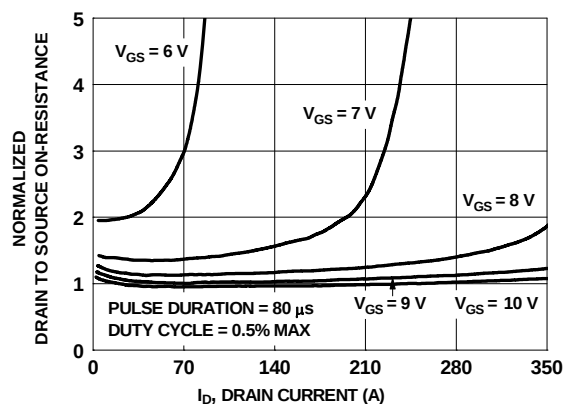


Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage

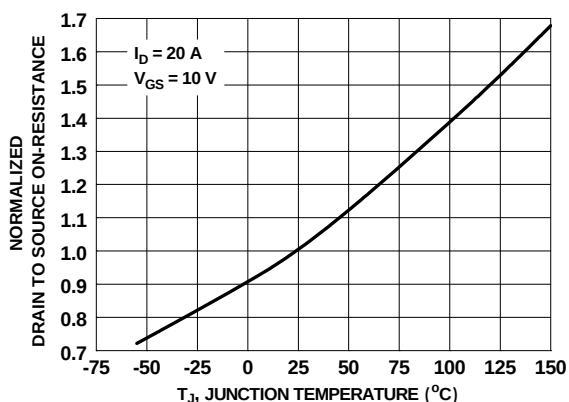


Figure 3. Normalized On-Resistance vs Junction Temperature

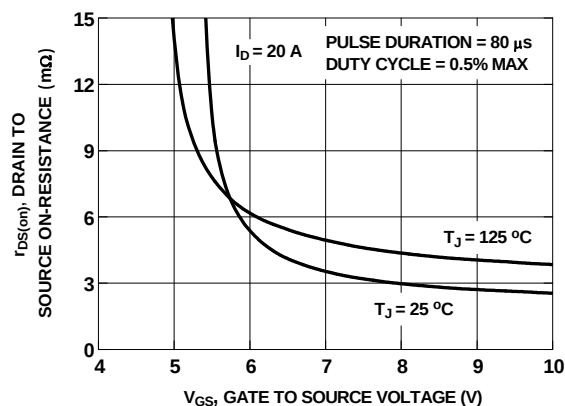


Figure 4. On-Resistance vs Gate to Source Voltage

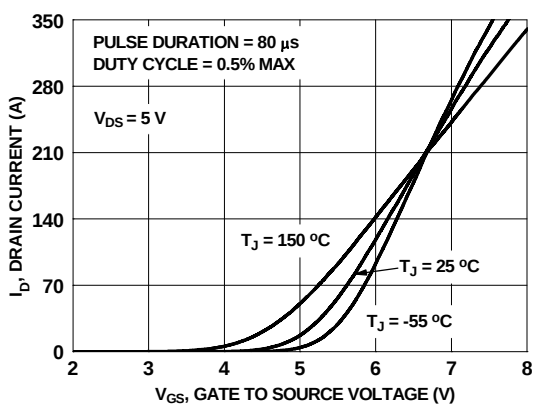


Figure 5. Transfer Characteristics

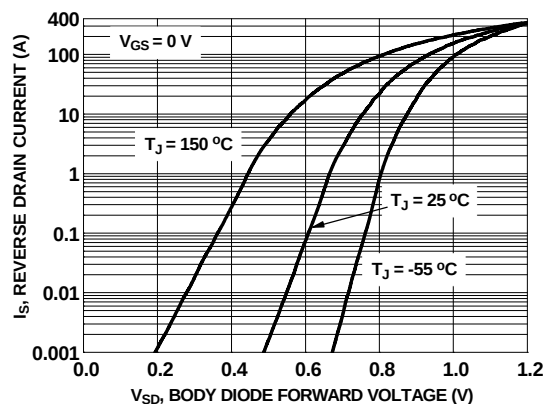


Figure 6. Source to Drain Diode Forward Voltage vs Source Current

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

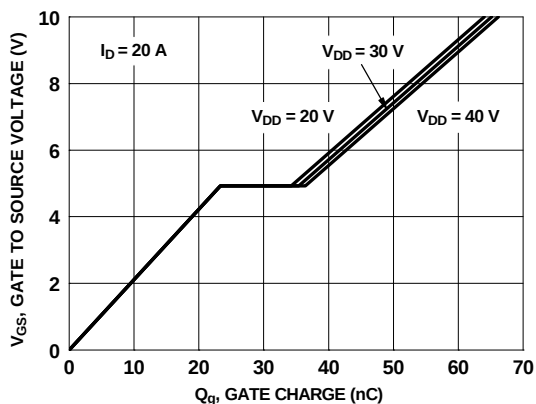


Figure 7. Gate Charge Characteristics

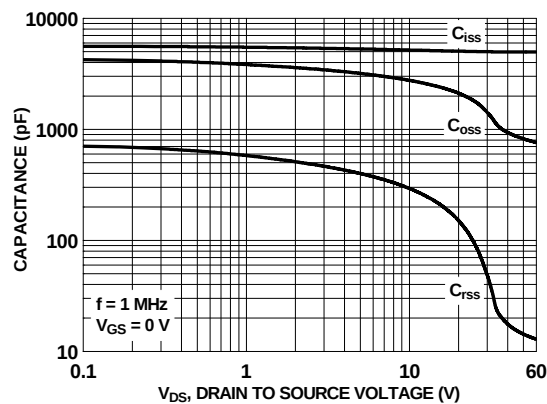


Figure 8. Capacitance vs Drain to Source Voltage

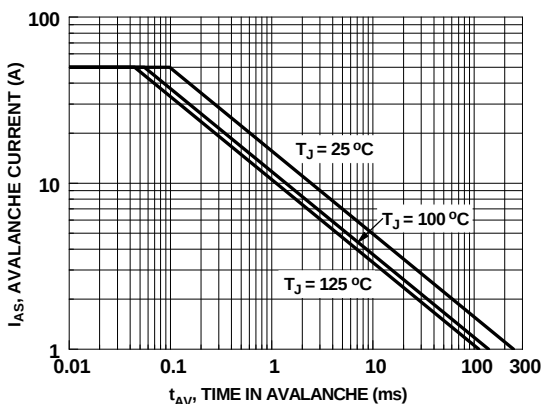


Figure 9. Unclamped Inductive Switching Capability

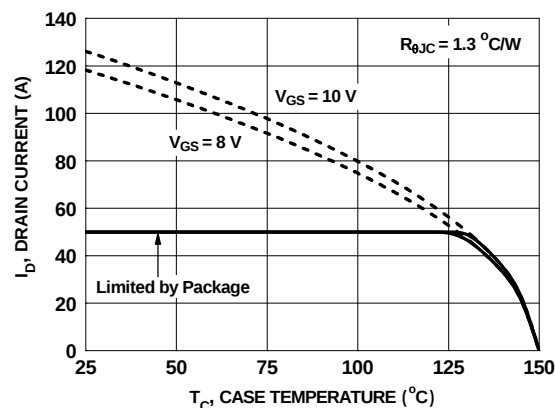


Figure 10. Maximum Continuous Drain Current vs Case Temperature

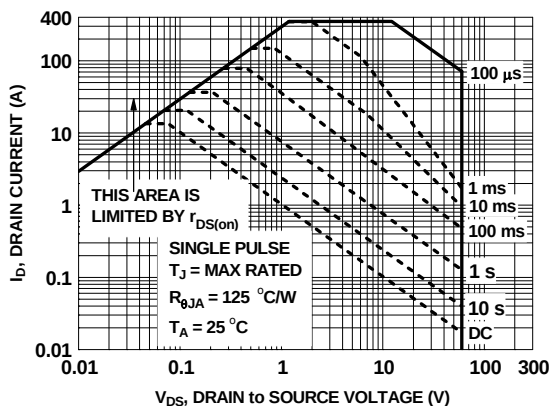


Figure 11. Forward Bias Safe Operating Area

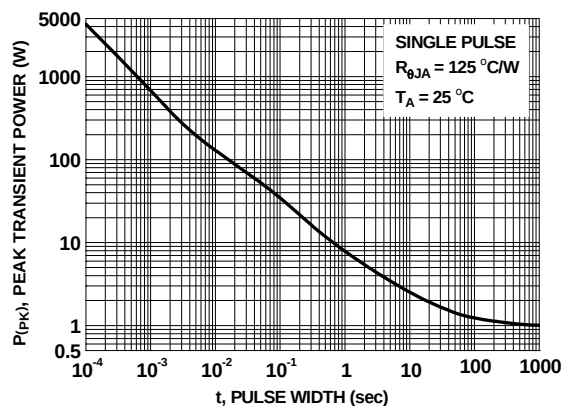
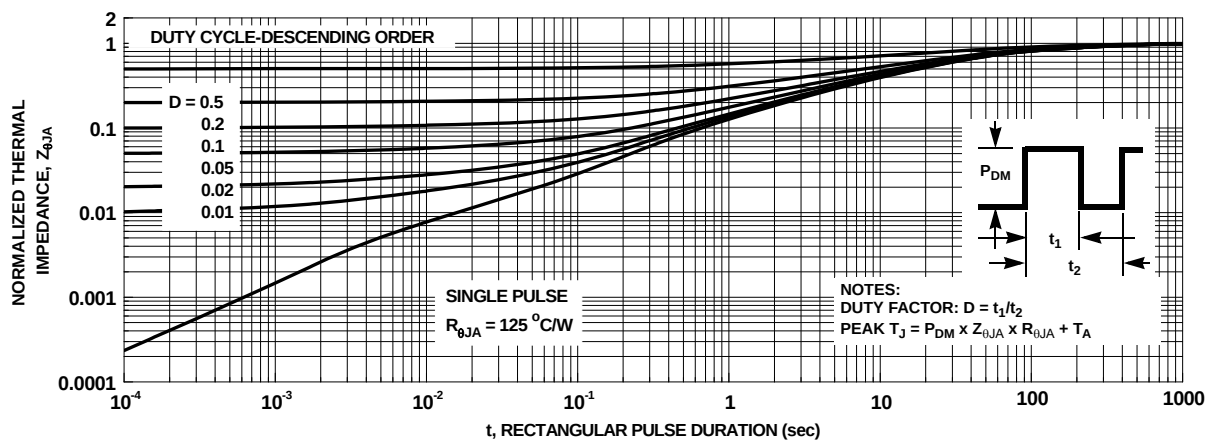
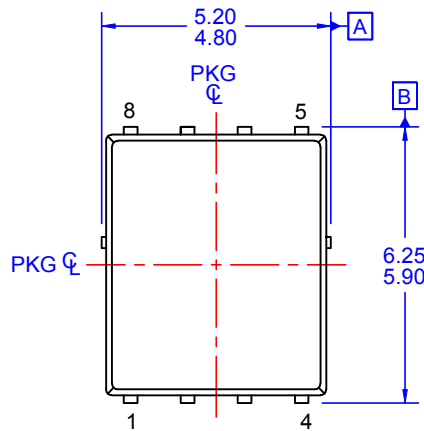


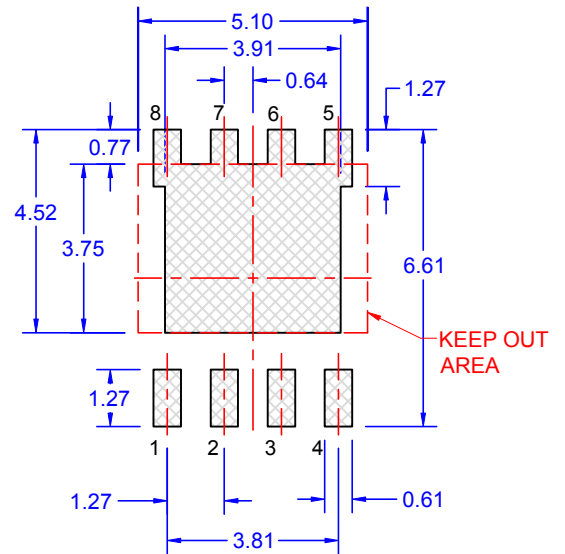
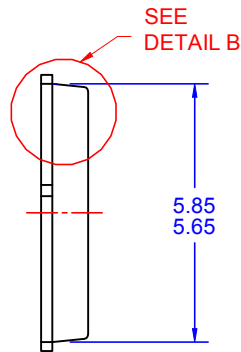
Figure 12. Single Pulse Maximum Power Dissipation

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

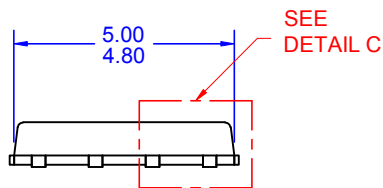




TOP VIEW

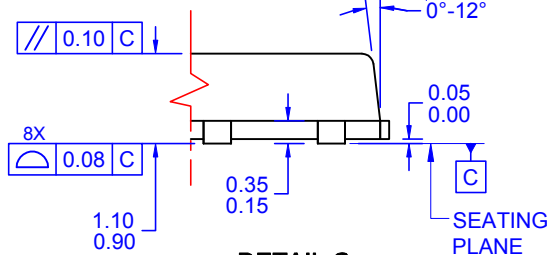


LAND PATTERN  
RECOMMENDATION



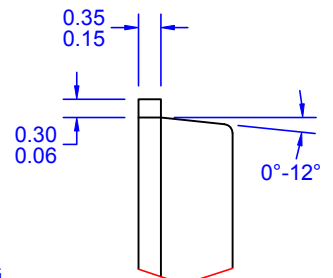
SIDE VIEW

OPTIONAL DRAFT  
ANGLE MAY APPEAR  
ON FOUR SIDES  
OF THE PACKAGE



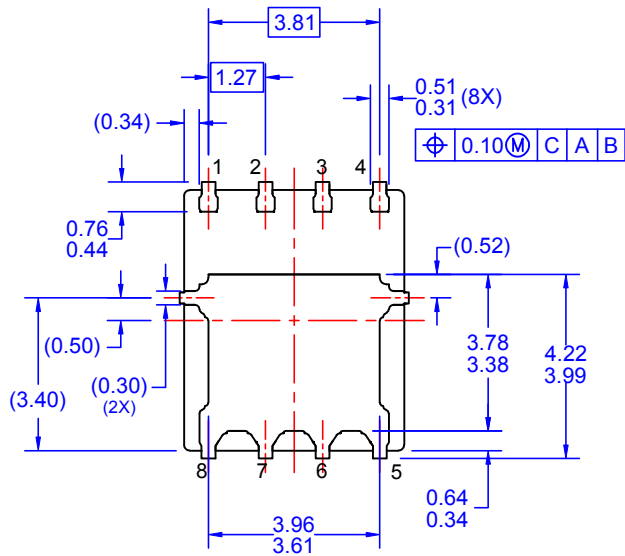
**DETAIL C**

SCALE: 2:1



**DETAIL B**

SCALE: 2:1



BOTTOM VIEW

NOTES: UNLESS OTHERWISE SPECIFIED

- PACKAGE STANDARD REFERENCE: JEDEC MO-240, ISSUE A, VAR. AA, DATED OCTOBER 2002.
- DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.
- ALL DIMENSIONS ARE IN MILLIMETERS.
- DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
- IT IS RECOMMENDED TO HAVE NO TRACES OR VIAS WITHIN THE KEEP OUT AREA.
- DRAWING FILE NAME: PQFN08AREV8





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| ESBC™                    | MicroPak2™                                     | SuperFET®                             | UniFET™          |
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| FACT®                    | MTx®                                           | SyncFET™                              | Xsens™           |
| FAST®                    | MVN®                                           | Sync-Lock™                            | 仙童™              |
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| FETBench™                | OptoHit™                                       |                                       |                  |
| FPS™                     | OPTOLOGIC®                                     |                                       |                  |

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