

# FDMS86500L

## MOSFET, N-Channel, POWERTRENCH®

60 V, 158 A, 2.5 mΩ

### 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 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.

### Features

- Max  $r_{DS(on)}$  = 2.5 mΩ at  $V_{GS} = 10$  V,  $I_D = 25$  A
- Max  $r_{DS(on)}$  = 3.7 mΩ at  $V_{GS} = 4.5$  V,  $I_D = 20$  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

### Applications

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

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

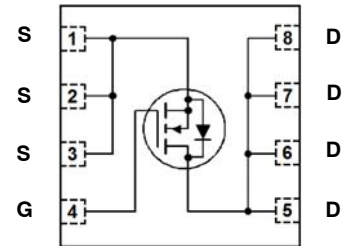
| Symbol         | Parameter                                        | Ratings                                         | Unit             |
|----------------|--------------------------------------------------|-------------------------------------------------|------------------|
| $V_{DS}$       | Drain to Source Voltage                          | 60                                              | V                |
| $V_{GS}$       | Gate to Source Voltage                           | ±20                                             | V                |
| $I_D$          | Drain Current:                                   | - Continuous $T_C = 25^\circ\text{C}$ (Note 5)  | 158              |
|                |                                                  | - Continuous $T_C = 100^\circ\text{C}$ (Note 5) | 100              |
|                |                                                  | - Continuous $T_A = 25^\circ\text{C}$ (Note 1a) | 25               |
|                |                                                  | - Pulsed (Note 4)                               | 799              |
| $E_{AS}$       | Single Pulse Avalanche Energy (Note 3)           | 240                                             | mJ               |
| $P_D$          | Power Dissipation:                               | $T_C = 25^\circ\text{C}$                        | 104              |
|                |                                                  | $T_A = 25^\circ\text{C}$ (Note 1a)              | 2.5              |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range | -55 to +150                                     | $^\circ\text{C}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

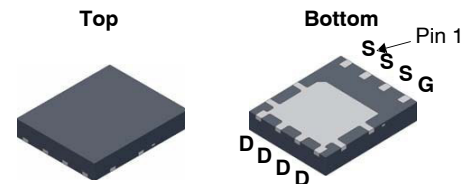


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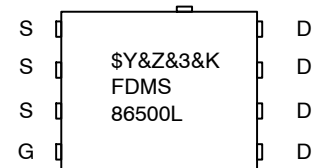


N-Channel MOSFET



Power 56  
(PQFN8)  
CASE 483AE

### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
 &Z = Assembly Plant Code  
 &3 = Data Code (Year & Week)  
 &K = Lot  
 FDMS86500L = Specific Device Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# FDMS86500L

## PACKAGE MARKING AND ORDERING INFORMATION

| Device Marking | Device     | Package                                      | Quantity       |
|----------------|------------|----------------------------------------------|----------------|
| FDMS86500L     | FDMS86500L | Power 56 (PQFN8)<br>(Pb-Free / Halogen Free) | 3000/Tape&Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                         | Value | Unit |
|-----------------|---------------------------------------------------|-------|------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case              | 1.2   | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1a) | 50    |      |

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Symbol | Parameter | Test Condition | Min | Typ | Max | Unit |
|--------|-----------|----------------|-----|-----|-----|------|
|--------|-----------|----------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                |                                           |                                                            |    |    |           |               |
|--------------------------------|-------------------------------------------|------------------------------------------------------------|----|----|-----------|---------------|
| $BV_{DSS}$                     | Drain to Source Breakdown Voltage         | $I_D = 250 \mu\text{A}, V_{GS} = 0 \text{V}$               | 60 |    |           | V             |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250 \mu\text{A}$ , referenced to $25^\circ\text{C}$ |    | 30 |           | mV/°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, Forward   | $V_{GS} = \pm 20 \text{V}, V_{DS} = 0 \text{V}$            |    |    | $\pm 100$ | nA            |

### ON CHARACTERISTICS

|                                  |                                                          |                                                                    |   |     |     |            |
|----------------------------------|----------------------------------------------------------|--------------------------------------------------------------------|---|-----|-----|------------|
| $V_{GS(th)}$                     | Gate to Source Threshold Voltage                         | $V_{GS} = V_{DS}, I_D = 250 \mu\text{A}$                           | 1 | 1.8 | 3   | V          |
| $\Delta V_{GS(th)} / \Delta T_J$ | Gate to Source Threshold Voltage Temperature Coefficient | $I_D = 250 \mu\text{A}$ , referenced to $25^\circ\text{C}$         |   | -7  |     | mV/°C      |
| $r_{DS(on)}$                     | Static Drain to Source On Resistance                     | $V_{GS} = 10 \text{V}, I_D = 25 \text{A}$                          |   | 2.1 | 2.5 | m $\Omega$ |
|                                  |                                                          | $V_{GS} = 4.5 \text{V}, I_D = 20 \text{A}$                         |   | 2.9 | 3.7 |            |
|                                  |                                                          | $V_{GS} = 10 \text{V}, I_D = 25 \text{A}, T_J = 125^\circ\text{C}$ |   | 3.1 | 3.7 |            |
| $g_{FS}$                         | Forward Transconductance                                 | $V_{DS} = 5 \text{V}, I_D = 20 \text{A}$                           |   | 95  |     | S          |

### DYNAMIC CHARACTERISTICS

|           |                              |                                                               |     |      |       |          |
|-----------|------------------------------|---------------------------------------------------------------|-----|------|-------|----------|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 30 \text{V}, V_{GS} = 0 \text{V}, f = 1 \text{MHz}$ |     | 9420 | 12530 | pF       |
| $C_{oss}$ | Output Capacitance           |                                                               |     | 1470 | 1955  |          |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                               |     | 50   | 80    |          |
| $R_g$     | Gate Resistance              | $f = 1 \text{MHz}$                                            | 0.1 | 1.1  | 3.0   | $\Omega$ |

### SWITCHING CHARACTERISTICS

|              |                               |                                                                                     |  |      |     |    |
|--------------|-------------------------------|-------------------------------------------------------------------------------------|--|------|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time            | $V_{DD} = 30 \text{V}, I_D = 25 \text{A}, V_{GS} = 10 \text{V}, R_{GEN} = 6 \Omega$ |  | 27   | 43  | ns |
| $t_r$        | Rise Time                     |                                                                                     |  | 16   | 28  |    |
| $t_{d(off)}$ | Turn-Off Delay Time           |                                                                                     |  | 63   | 100 |    |
| $t_f$        | Fall Time                     |                                                                                     |  | 7.8  | 16  |    |
| $Q_g$        | Total Gate Charge             | $V_{GS} = 0 \text{V to } 10 \text{V}, V_{DD} = 30 \text{V}, I_D = 25 \text{A}$      |  | 117  | 165 | nC |
|              |                               | $V_{GS} = 0 \text{V to } 4.5 \text{V}, V_{DD} = 30 \text{V}, I_D = 25 \text{A}$     |  | 54   | 108 |    |
| $Q_{gs}$     | Gate to Source Charge         | $V_{DD} = 30 \text{V}, I_D = 25 \text{A}$                                           |  | 26.6 |     | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge |                                                                                     |  | 11.5 |     | nC |

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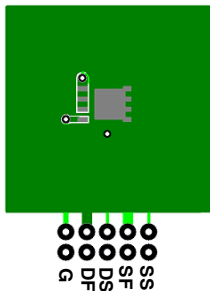
## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted) (continued)

| Symbol                                    | Parameter                                        | Test Condition                                        | Min | Typ  | Max | Unit |
|-------------------------------------------|--------------------------------------------------|-------------------------------------------------------|-----|------|-----|------|
| <b>DRAIN-SOURCE DIODE CHARACTERISTICS</b> |                                                  |                                                       |     |      |     |      |
| $I_S$                                     | Continuous Drain to Source Diode Forward Current | $T_C = 25^\circ\text{C}$                              |     |      | 80  | A    |
| $I_{S,pulse}$                             | Pulse Drain to Source Diode Forward Current      | $T_C = 25^\circ\text{C}$                              |     |      | 799 | A    |
| $V_{SD}$                                  | Source to Drain Diode Forward Voltage            | $V_{GS} = 0\text{ V}, I_S = 2.1\text{ A}$ (Note 2)    |     | 0.68 | 1.2 | V    |
|                                           |                                                  | $V_{GS} = 0\text{ V}, I_S = 25\text{ A}$ (Note 2)     |     | 0.79 | 1.3 |      |
| $t_{rr}$                                  | Reverse Recovery Time                            | $I_F = 25\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ |     | 54   | 87  | ns   |
| $Q_{rr}$                                  | Reverse Recovery Charge                          |                                                       |     | 42   | 67  | nC   |
| $t_{rr}$                                  | Reverse Recovery Time                            | $I_F = 25\text{ A}, di/dt = 300\text{ A}/\mu\text{s}$ |     | 46   | 73  | ns   |
| $Q_{rr}$                                  | Reverse Recovery Charge                          |                                                       |     | 84   | 134 | nC   |

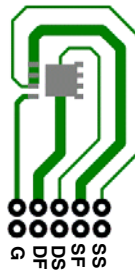
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

### NOTES:

- $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 × 1.5 in. board of FR-4 material.  $R_{\theta CA}$  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.

- Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty cycle < 2.0%.
- $E_{AS}$  of 220 mJ is based on starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.3\text{ mH}$ ,  $I_{AS} = 40\text{ A}$ ,  $V_{DD} = 54\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% test at  $L = 0.1\text{ mH}$ ,  $I_{AS} = 66\text{ A}$ .
- Pulsed  $I_D$  please refer to Figure 11 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

( $T_J = 25^\circ\text{C}$  unless otherwise noted)

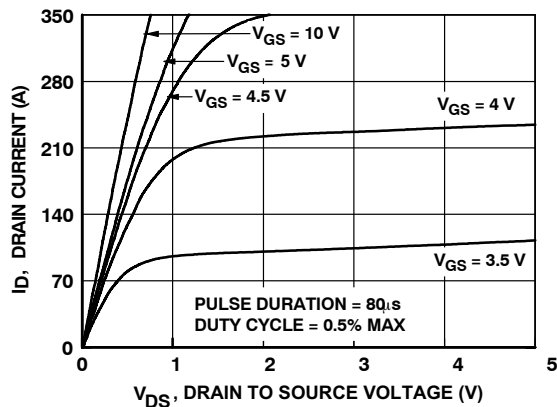


Figure 1. On Region Characteristics

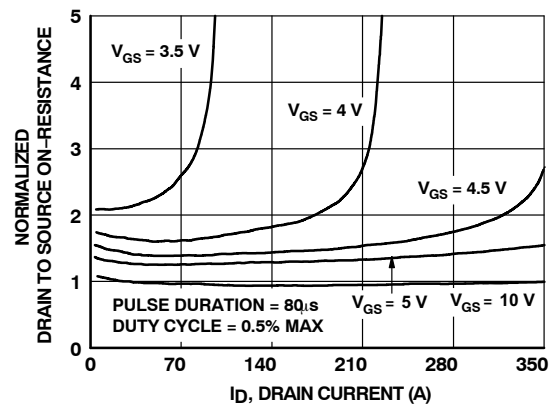


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

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## TYPICAL CHARACTERISTICS (continued)

( $T_J = 25^\circ\text{C}$  unless otherwise noted)

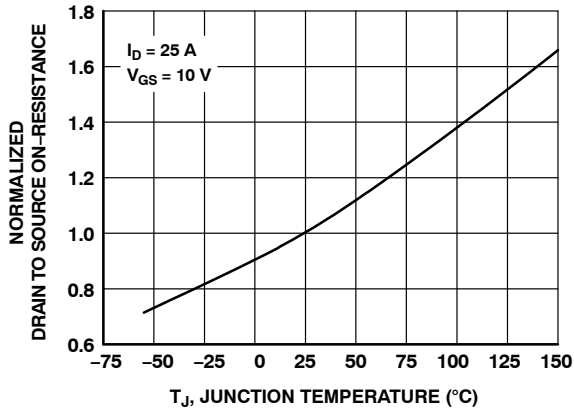


Figure 3. Normalized On Resistance vs. Junction Temperature

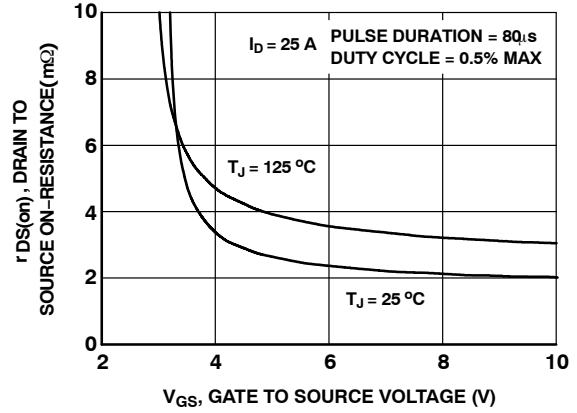


Figure 4. On-Resistance vs. Gate to Source Voltage

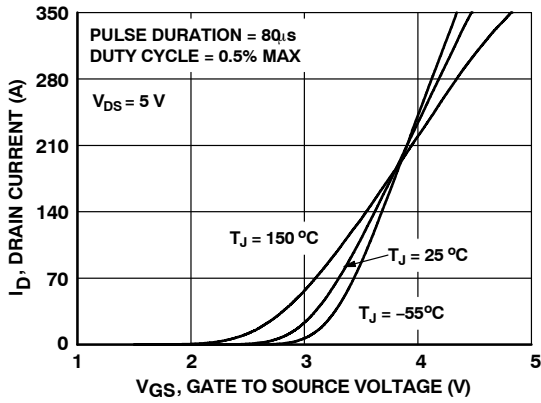


Figure 5. Transfer Characteristics

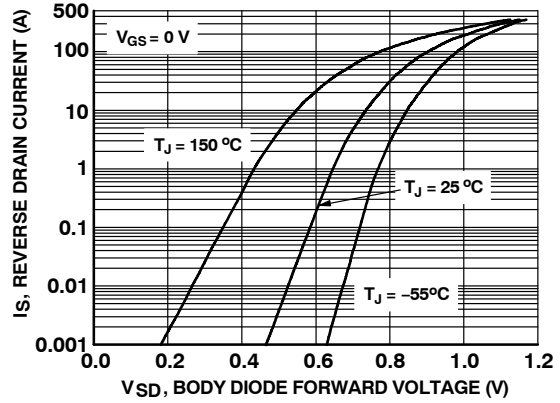


Figure 6. Source to Drain Diode Forward Voltage vs. Source Current

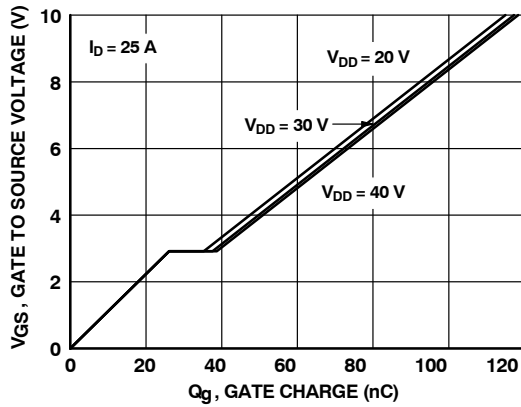


Figure 7. Gate Charge Characteristics

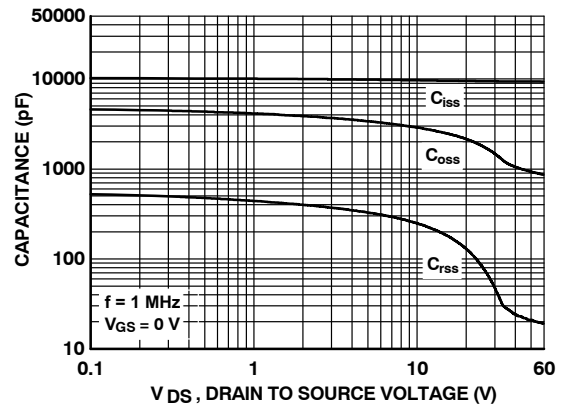


Figure 8. Capacitance vs. Drain to Source Voltage

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## TYPICAL CHARACTERISTICS (continued)

( $T_J = 25^\circ\text{C}$  unless otherwise noted)

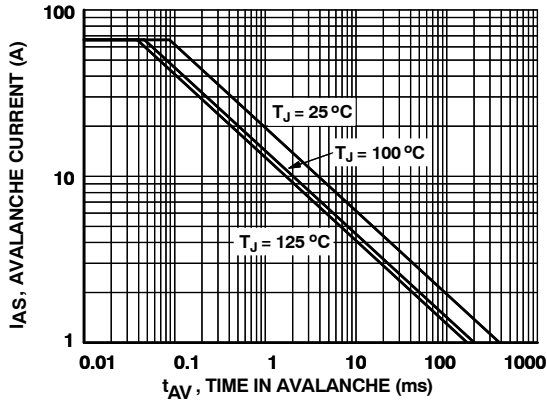


Figure 9. Unclamped Inductive Switching Capability

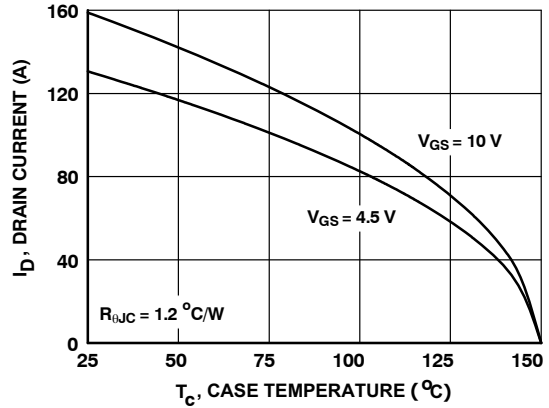


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

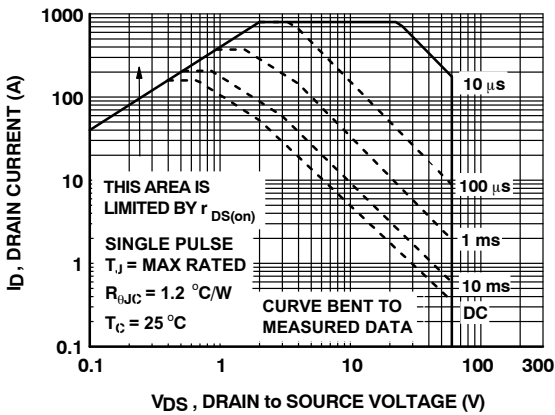


Figure 11. Forward Bias Safe Operating Area

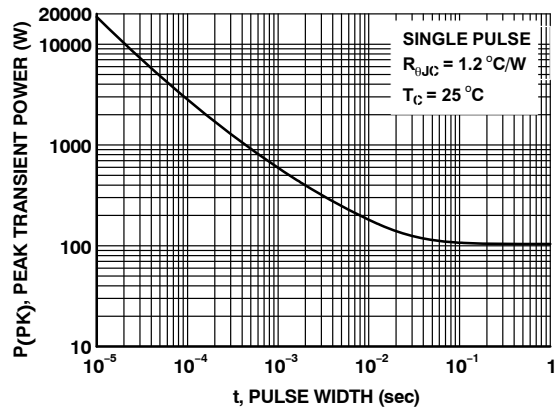


Figure 12. Single Pulse Maximum Power Dissipation

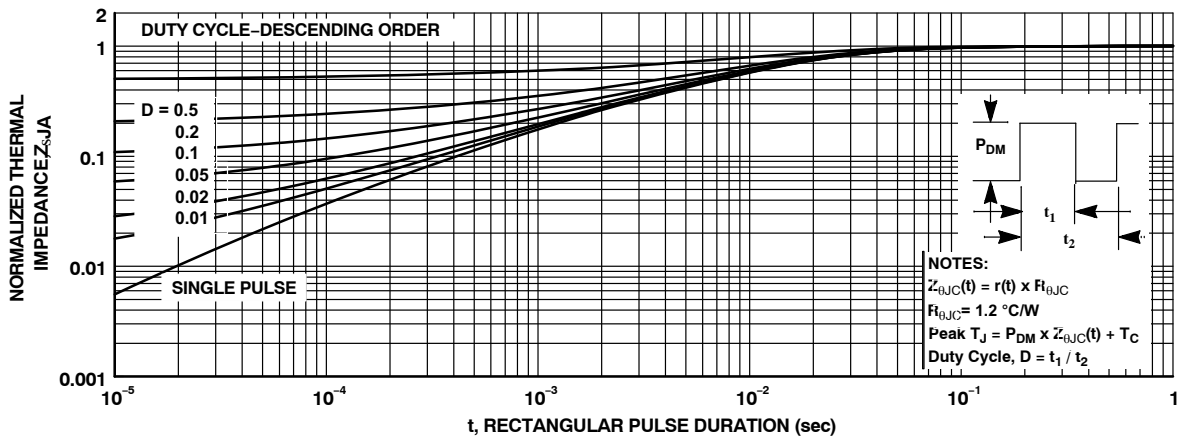
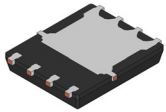


Figure 13. Transient Thermal Response Curve

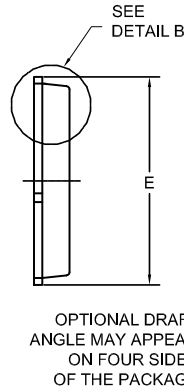
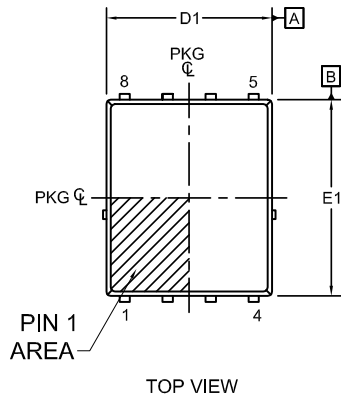
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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



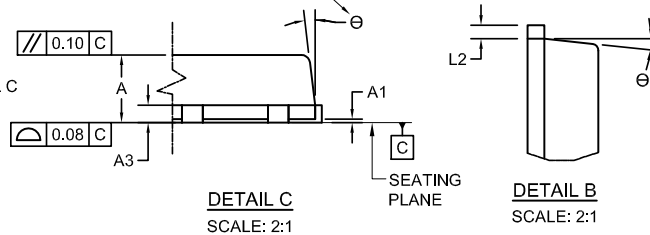
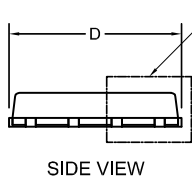
**PQFN8 5X6, 1.27P**  
CASE 483AE  
ISSUE C

DATE 21 JAN 2022

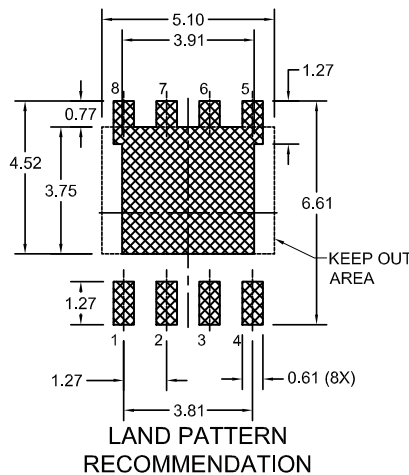
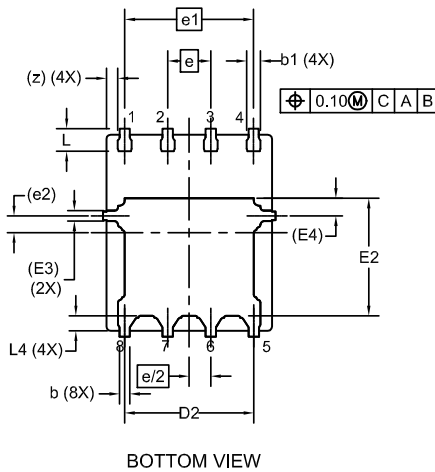


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE EXPOSED PADS AS WELL AS THE TERMINALS.
4. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. SEATING PLANE IS DEFINED BY THE TERMINALS. "A1" IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.
6. IT IS RECOMMENDED TO HAVE NO TRACES OR VIAS WITHIN THE KEEP OUT AREA.



| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | 0.90        | 1.00 | 1.10 |
| A1  | 0.00        | -    | 0.05 |
| b   | 0.21        | 0.31 | 0.41 |
| b1  | 0.31        | 0.41 | 0.51 |
| A3  | 0.15        | 0.25 | 0.35 |
| D   | 4.90        | 5.00 | 5.20 |
| D1  | 4.80        | 4.90 | 5.00 |
| D2  | 3.61        | 3.82 | 3.96 |
| E   | 5.90        | 6.15 | 6.25 |
| E1  | 5.70        | 5.80 | 5.90 |
| E2  | 3.38        | 3.48 | 3.78 |
| E3  | 0.30 REF    |      |      |
| E4  | 0.52 REF    |      |      |
| e   | 1.27 BSC    |      |      |
| e/2 | 0.635 BSC   |      |      |
| e1  | 3.81 BSC    |      |      |
| e2  | 0.50 REF    |      |      |
| L   | 0.51        | 0.66 | 0.76 |
| L2  | 0.05        | 0.18 | 0.30 |
| L4  | 0.34        | 0.44 | 0.54 |
| z   | 0.34 REF    |      |      |
| θ   | 0°          | -    | 12°  |



\*FOR ADDITIONAL INFORMATION ON OUR PB-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

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