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# FDFMA2P859T

## Integrated P-Channel PowerTrench® MOSFET and Schottky Diode

–20 V, –3.0 A, 120 mΩ

### Features

#### MOSFET:

- Max  $r_{DS(on)}$  = 120 mΩ at  $V_{GS} = -4.5$  V,  $I_D = -3.0$  A
- Max  $r_{DS(on)}$  = 160 mΩ at  $V_{GS} = -2.5$  V,  $I_D = -2.5$  A
- Max  $r_{DS(on)}$  = 240 mΩ at  $V_{GS} = -1.8$  V,  $I_D = -1.0$  A

#### Schottky:

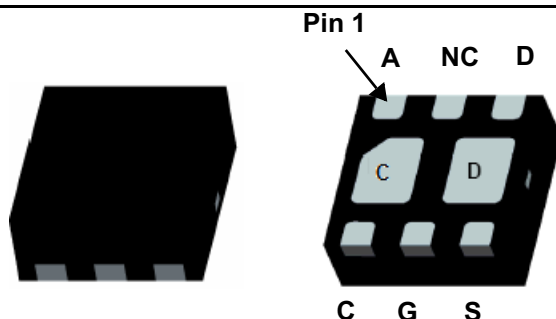
- $V_F < 0.54$  V @ 1 A
- Low profile - 0.55 mm maximum - in the new package MicroFET 2x2 Thin
- Free from halogenated compounds and antimony oxides
- RoHS compliant



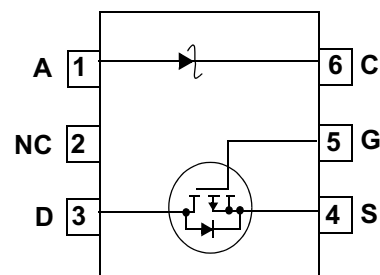
### General Description

This device is designed specifically as a single package solution for the battery charge switch in cellular handset and other ultra-portable applications. It features a MOSFET with low on-state resistance and an independently connected low forward voltage schottky diode for minimum conduction losses.

The MicroFET 2x2 Thin package offers exceptional thermal performance for its physical size and is well suited to linear mode applications.



MicroFET 2x2 Thin



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

| Symbol         | Parameter                                        | Ratings     | Units |
|----------------|--------------------------------------------------|-------------|-------|
| $V_{DSS}$      | Drain to Source Voltage                          | 20          | V     |
| $V_{GSS}$      | Gate to Source Voltage                           | ±8          | V     |
| $I_D$          | Drain Current -Continuous (Note 1a)              | –3          | A     |
|                | -Pulsed                                          | –6          |       |
| $P_D$          | Power Dissipation (Note 1a)                      | 1.4         | W     |
|                | Power Dissipation (Note 1b)                      | 0.7         |       |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range | –55 to +150 | °C    |
| $V_{RRM}$      | Schottky Repetitive Peak Reverse Voltage         | 30          | V     |
| $I_O$          | Schottky Average Forward Current                 | 1           | A     |

### Thermal Characteristics

|                 |                                                   |     |      |
|-----------------|---------------------------------------------------|-----|------|
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1a) | 86  | °C/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1b) | 173 |      |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1c) | 86  |      |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1d) | 140 |      |

### Package Marking and Ordering Information

| Device Marking | Device      | Package           | Reel Size | Tape Width | Quantity   |
|----------------|-------------|-------------------|-----------|------------|------------|
| 59             | FDFMA2P859T | MicroFET 2x2 Thin | 7"        | 8 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         | $I_D = -250\text{ }\mu\text{A}$ , $V_{GS} = 0\text{ V}$                      | -20 |     |           | V                      |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = -250\text{ }\mu\text{A}$ , referenced to $25\text{ }^{\circ}\text{C}$ |     | -12 |           | mV/ $^{\circ}\text{C}$ |
| $I_{DSS}$                    | Zero Gate Voltage Drain Current           | $V_{DS} = -16\text{ V}$ , $V_{GS} = 0\text{ V}$                              |     |     | -1        | $\mu\text{A}$          |
| $I_{GSS}$                    | Gate to Source Leakage Current            | $V_{GS} = \pm 8\text{ V}$ , $V_{DS} = 0\text{ V}$                            |     |     | $\pm 100$ | nA                     |

**On Characteristics**

|                                |                                                          |                                                                                         |      |      |      |                        |
|--------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------------------|------|------|------|------------------------|
| $V_{GS(th)}$                   | Gate to Source Threshold Voltage                         | $V_{GS} = V_{DS}$ , $I_D = -250\text{ }\mu\text{A}$                                     | -0.4 | -0.7 | -1.3 | V                      |
| $\Delta V_{GS(th)}/\Delta T_J$ | Gate to Source Threshold Voltage Temperature Coefficient | $I_D = -250\text{ }\mu\text{A}$ , referenced to $25\text{ }^{\circ}\text{C}$            |      | 2    |      | mV/ $^{\circ}\text{C}$ |
| $r_{DS(on)}$                   | Static Drain to Source On Resistance                     | $V_{GS} = -4.5\text{ V}$ , $I_D = -3.0\text{ A}$                                        |      | 90   | 120  | m $\Omega$             |
|                                |                                                          | $V_{GS} = -2.5\text{ V}$ , $I_D = -2.5\text{ A}$                                        |      | 120  | 160  |                        |
|                                |                                                          | $V_{GS} = -1.8\text{ V}$ , $I_D = -1.0\text{ A}$                                        |      | 172  | 240  |                        |
|                                |                                                          | $V_{GS} = -4.5\text{ V}$ , $I_D = -3.0\text{ A}$<br>$T_J = 125\text{ }^{\circ}\text{C}$ |      | 118  | 160  |                        |
| $g_{FS}$                       | Forward Transconductance                                 | $V_{DS} = -5\text{ V}$ , $I_D = -3.0\text{ A}$                                          |      | 7    |      | S                      |

**Dynamic Characteristics**

|           |                              |                                                                           |  |     |  |    |
|-----------|------------------------------|---------------------------------------------------------------------------|--|-----|--|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = -10\text{ V}$ , $V_{GS} = 0\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ |  | 435 |  | pF |
| $C_{oss}$ | Output Capacitance           |                                                                           |  | 80  |  | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                           |  | 45  |  | pF |

**Switching Characteristics**

|              |                               |                                                                                                           |  |     |    |    |
|--------------|-------------------------------|-----------------------------------------------------------------------------------------------------------|--|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time            | $V_{DD} = -10\text{ V}$ , $I_D = -1.0\text{ A}$<br>$V_{GS} = -4.5\text{ V}$ , $R_{GEN} = 6\text{ }\Omega$ |  | 9   | 18 | ns |
| $t_r$        | Rise Time                     |                                                                                                           |  | 11  | 19 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time           |                                                                                                           |  | 15  | 27 | ns |
| $t_f$        | Fall Time                     |                                                                                                           |  | 6   | 12 | ns |
| $Q_{g(TOT)}$ | Total Gate Charge             | $V_{DD} = -10\text{ V}$ , $I_D = -3.0\text{ A}$<br>$V_{GS} = -4.5\text{ V}$                               |  | 4   | 6  | nC |
| $Q_{gs}$     | Gate to Source Gate Charge    |                                                                                                           |  | 0.8 |    | nC |
| $Q_{gd}$     | Gate to Drain "Miller" Charge |                                                                                                           |  | 0.9 |    | nC |

**Drain-Source Diode Characteristics**

|          |                                                       |                                                            |  |      |      |    |
|----------|-------------------------------------------------------|------------------------------------------------------------|--|------|------|----|
| $I_S$    | Maximum Continuous Drain-Source Diode Forward Current |                                                            |  |      | -1.1 | A  |
| $V_{SD}$ | Source to Drain Diode Forward Voltage                 | $V_{GS} = 0\text{ V}$ , $I_S = -1.1\text{ A}$ (Note 2)     |  | -0.8 | -1.2 | V  |
| $t_{rr}$ | Reverse Recovery Time                                 | $I_F = -3.0\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ |  | 17   |      | ns |
| $Q_{rr}$ | Reverse Recovery Charge                               |                                                            |  | 6    |      | nC |

**Schottky Diode Characteristics**

|       |                 |                       |                                     |  |      |      |               |
|-------|-----------------|-----------------------|-------------------------------------|--|------|------|---------------|
| $I_R$ | Reverse Leakage | $V_R = 10\text{ V}$   | $T_J = 25\text{ }^{\circ}\text{C}$  |  | 0.3  | 1.0  | $\mu\text{A}$ |
|       |                 |                       | $T_J = 85\text{ }^{\circ}\text{C}$  |  | 25   | 40   | $\mu\text{A}$ |
|       |                 |                       | $T_J = 125\text{ }^{\circ}\text{C}$ |  | 0.28 | 0.37 | mA            |
| $I_R$ | Reverse Leakage | $V_R = 20\text{ V}$   | $T_J = 25\text{ }^{\circ}\text{C}$  |  | 1.0  | 2.5  | $\mu\text{A}$ |
|       |                 |                       | $T_J = 85\text{ }^{\circ}\text{C}$  |  | 74   | 110  | $\mu\text{A}$ |
|       |                 |                       | $T_J = 125\text{ }^{\circ}\text{C}$ |  | 0.73 | 1.00 | mA            |
| $V_F$ | Forward Voltage | $I_F = 100\text{ mA}$ | $T_J = 25\text{ }^{\circ}\text{C}$  |  | 0.40 | 0.41 | V             |
|       |                 |                       | $T_J = 85\text{ }^{\circ}\text{C}$  |  | 0.31 | 0.33 | V             |
|       |                 |                       | $T_J = 125\text{ }^{\circ}\text{C}$ |  | 0.26 | 0.27 | V             |
| $V_F$ | Forward Voltage | $I_F = 1\text{ A}$    | $T_J = 25\text{ }^{\circ}\text{C}$  |  | 0.52 | 0.54 | V             |
|       |                 |                       | $T_J = 85\text{ }^{\circ}\text{C}$  |  | 0.45 | 0.47 | V             |
|       |                 |                       | $T_J = 125\text{ }^{\circ}\text{C}$ |  | 0.41 | 0.43 | V             |

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

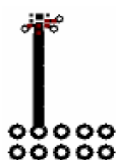
### Notes:

1:  $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> 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) MOSFET  $R_{\theta JA} = 86^\circ\text{C/W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper, 1.5 " x 1.5 " x 0.062 " thick PCB.
- (b) MOSFET  $R_{\theta JA} = 173^\circ\text{C/W}$  when mounted on a minimum pad of 2 oz copper.
- (c) Schottky  $R_{\theta JA} = 86^\circ\text{C/W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper, 1.5 " x 1.5 " x 0.062 " thick PCB.
- (d) Schottky  $R_{\theta JA} = 140^\circ\text{C/W}$  when mounted on a minimum pad of 2 oz copper.



a)  $86^\circ\text{C/W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper.



b)  $173^\circ\text{C/W}$  when mounted on a minimum pad of 2 oz copper.



c)  $86^\circ\text{C/W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper.



d)  $140^\circ\text{C/W}$  when mounted on a minimum pad of 2 oz copper.

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

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

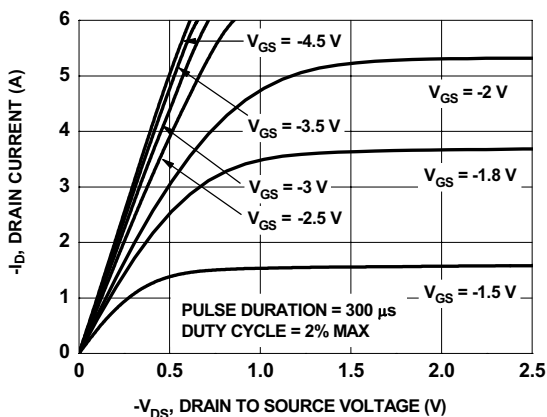


Figure 1. On-Region Characteristics

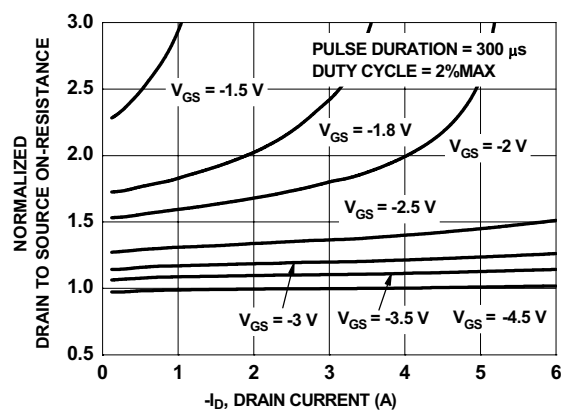


Figure 2. Normalized On-Resistance vs Drain Current and Gate Voltage

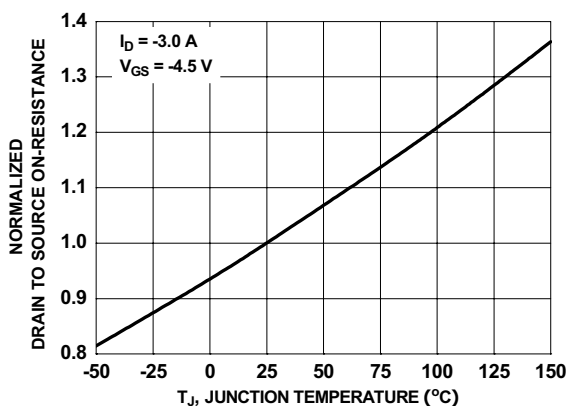


Figure 3. Normalized On-Resistance vs Junction Temperature

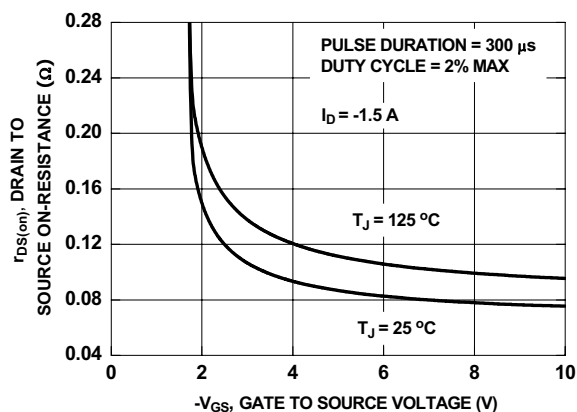


Figure 4. On-Resistance vs Gate to Source Voltage

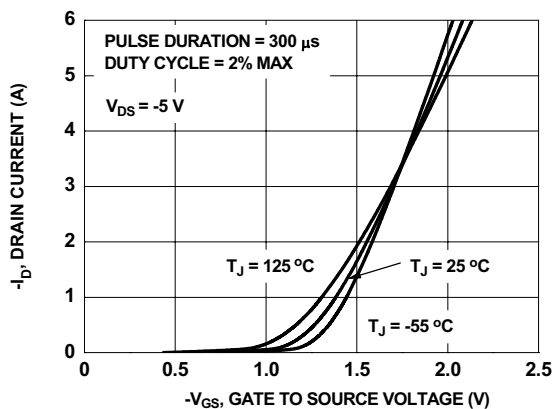


Figure 5. Transfer Characteristics

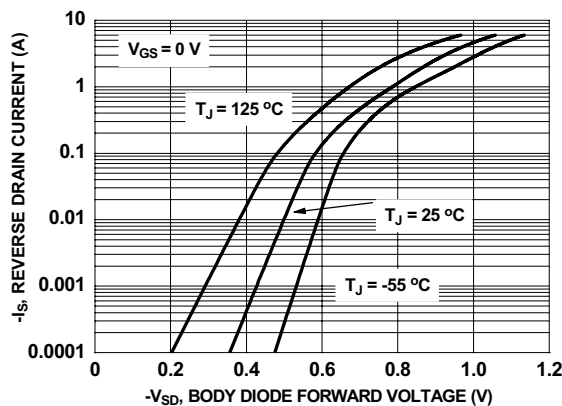


Figure 6. Source to Drain Diode Forward Voltage vs Source Current

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

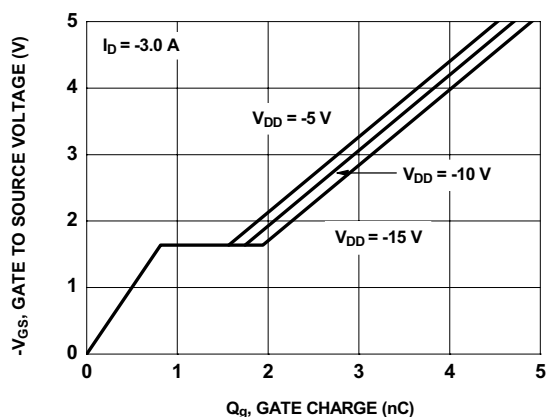


Figure 7. Gate Charge Characteristics

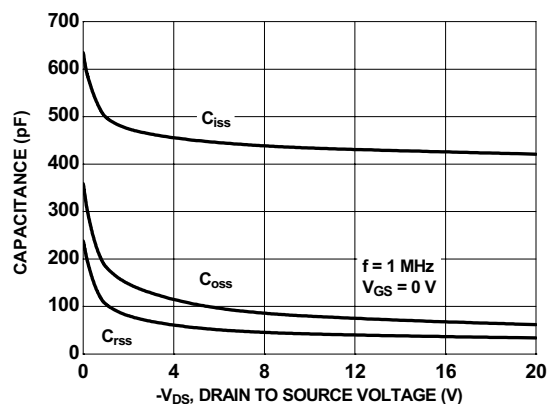


Figure 8. Capacitance vs Drain to Source Voltage

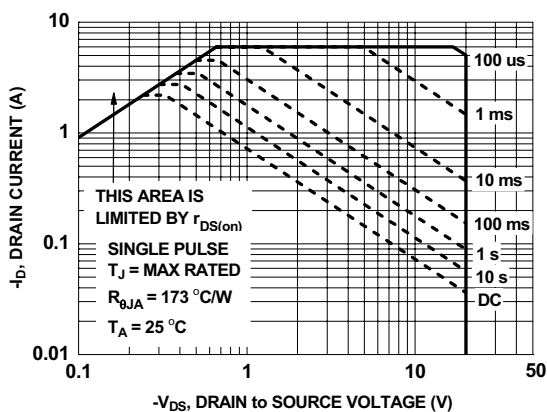


Figure 9. Forward Bias Safe Operating Area

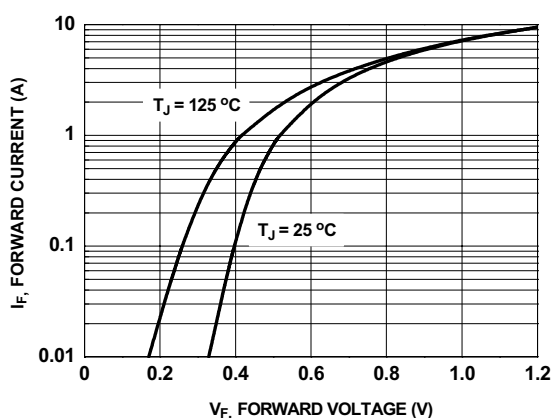


Figure 10. Schottky Diode Forward Voltage

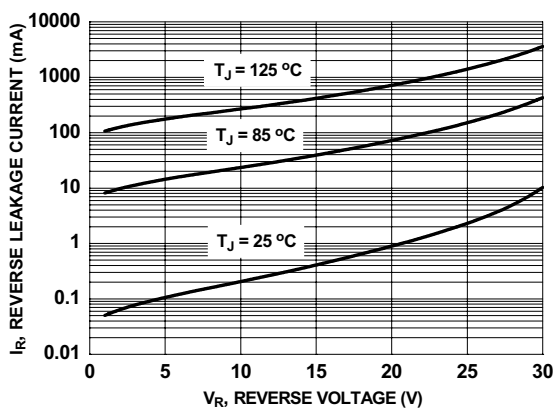


Figure 11. Schottky Diode Reverse Current

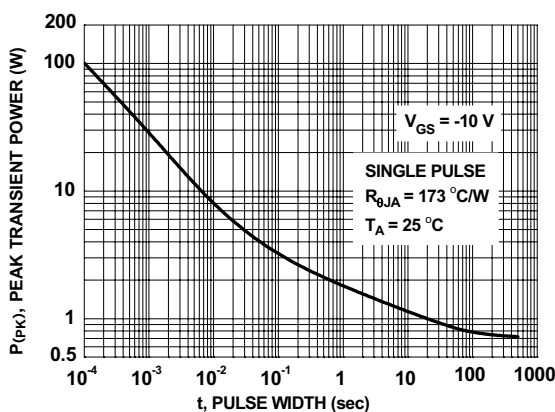
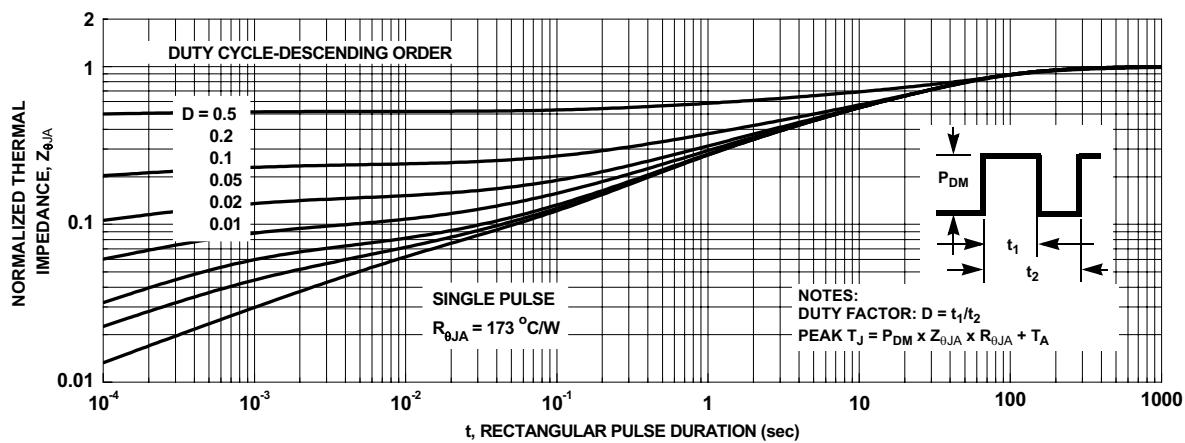
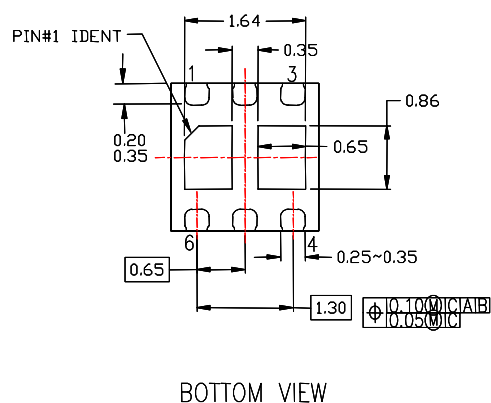
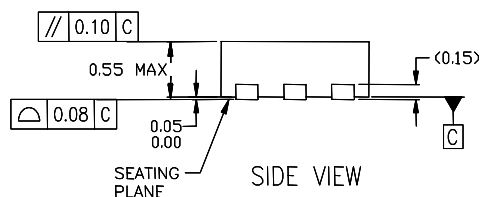
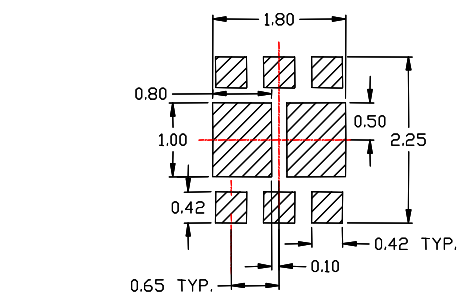
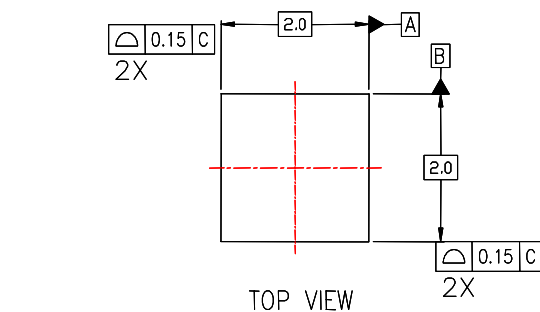


Figure 12. Single Pulse Maximum Power Dissipation

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



## Dimensional Outline and Pad Layout



### NOTES:

- A. NON CONFORMS TO JEDEC REGISTRATION MO-288,
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

MLP06XrevA



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| Auto-SPM™                                                                         | F-PFS™                                                                            | PowerXS™                                                                          | the power®                                                                          |
| Build it Now™                                                                     | FRFET®                                                                            | Programmable Active Droop™                                                        | franchise                                                                           |
| CorePLUS™                                                                         | Global Power Resource <sup>SM</sup>                                               | QFET®                                                                             | TinyBoost™                                                                          |
| CorePOWER™                                                                        | Green FPS™                                                                        | QS™                                                                               | TinyBuck™                                                                           |
| CROSSVOLT™                                                                        | Green FPS™ e-Series™                                                              | Quiet Series™                                                                     | TinyCalc™                                                                           |
| CTL™                                                                              | Gmax™                                                                             | RapidConfigure™                                                                   | TinyLogic®                                                                          |
| Current Transfer Logic™                                                           | GTO™                                                                              |  | TINYOPTO™                                                                           |
| EcoSPARK®                                                                         | IntelliMAX™                                                                       | Saving our world, 1mW /W /kW at a time™                                           | TinyPower™                                                                          |
| EfficientMax™                                                                     | ISOPLANAR™                                                                        | SmartMax™                                                                         | TinyPWM™                                                                            |
| EZSWITCH™*                                                                        | MegaBuck™                                                                         | SMART START™                                                                      | TinyWire™                                                                           |
|  | MICROCOUPLER™                                                                     | SPM®                                                                              | TriFault Detect™                                                                    |
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| Fairchild Semiconductor®                                                          | MicroPak™                                                                         | SuperFET™                                                                         |  |
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| FACT®                                                                             | MotionMax™                                                                        | SuperSOT™-6                                                                       | Ultra FRFET™                                                                        |
| FAST®                                                                             | Motion-SPM™                                                                       | SuperSOT™-8                                                                       | UniFET™                                                                             |
| FastvCore™                                                                        | OPTOLOGIC®                                                                        | SupreMOS™                                                                         | VCX™                                                                                |
| FETBench™                                                                         | OPTOPLANAR®                                                                       | SyncFET™                                                                          | VisualMax™                                                                          |
| FlashWriter®*                                                                     |  | Sync-Lock™                                                                        | XS™                                                                                 |
|                                                                                   | PDP SPM™                                                                          |  |                                                                                     |
|                                                                                   | Power-SPM™                                                                        |                                                                                   |                                                                                     |

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### Definition of Terms

| Datasheet Identification | Product Status        | Definition                                                                                                                                                                                          |
|--------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance Information      | Formative / In Design | Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.                                                                       |
| Preliminary              | First Production      | Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |
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