

# MOSFET – P-Channel, 2.5 V Specified, POWERTRENCH®

**-20 V, -4.5 A, 48 mΩ**

## FDC638P

### General Description

This P-Channel 2.5 V specified MOSFET is produced using onsemi's advanced POWERTRENCH process that has been especially tailored to minimize the on-state resistance and yet maintain low gate charge for superior switching performance.

These devices are well suited for battery power applications: load switching and power management, battery charging circuits, and DC/DC conversion.

### Features

- -4.5 A, -20 V
  - ♦  $R_{DS(on)} = 48\text{ m}\Omega$  @  $V_{GS} = -4.5\text{ V}$
  - ♦  $R_{DS(on)} = 65\text{ m}\Omega$  @  $V_{GS} = -2.5\text{ V}$
- Low Gate Charge (10 nC Typical)
- High Performance Trench Technology for Extremely Low  $R_{DS(on)}$
- SUPERSOT™-6 Package: Small Footprint (72% Smaller than Standard SO-8); Low Profile (1 mm Thick)
- This Device is Pb-Free, Halide Free and is RoHS Compliant

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

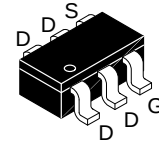
| Symbol         | Parameter                                                        | Ratings     | Unit             |
|----------------|------------------------------------------------------------------|-------------|------------------|
| $V_{DSS}$      | Drain-Source Voltage                                             | -20         | V                |
| $V_{GSS}$      | Gate-Source Voltage                                              | $\pm 8$     | V                |
| $I_D$          | Drain Current<br>– Continuous (Note 1a)<br>– Pulsed              | -4.5<br>-20 | A                |
| $P_D$          | Power Dissipation for Single Operation<br>(Note 1a)<br>(Note 1b) | 1.6<br>0.8  | W                |
| $T_J, T_{STG}$ | 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.

### THERMAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)

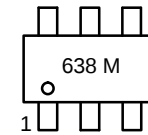
| Symbol          | Parameter                                            | Ratings | Unit               |
|-----------------|------------------------------------------------------|---------|--------------------|
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient<br>(Note 1a) | 78      | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case<br>(Note 1)     | 30      | $^\circ\text{C/W}$ |

| $V_{DSS}$ | $R_{DS(on)}\text{ MAX}$ | $I_D\text{ MAX}$ |
|-----------|-------------------------|------------------|
| -20 V     | 48 mΩ @ -4.5 V          | -4.5 A           |
|           | 65 mΩ @ -2.5 V          |                  |



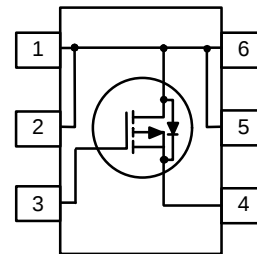
TSOT23 6-Lead  
SUPERSOT-6  
CASE 419BL

### MARKING DIAGRAM



638 = Specific Device Code  
M = Date Code

### PIN CONNECTIONS



### ORDERING INFORMATION

See detailed ordering and shipping information on page 5 of this data sheet.

# FDC638P

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

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

### OFF CHARACTERISTICS

|                                      |                                           |                                                                    |     |     |      |                      |
|--------------------------------------|-------------------------------------------|--------------------------------------------------------------------|-----|-----|------|----------------------|
| $BV_{DSS}$                           | Drain–Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$               | -20 | –   | –    | V                    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = -250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ | –   | -14 | –    | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = -16\text{ V}, V_{GS} = 0\text{ V}$                       | –   | –   | -1   | $\mu\text{A}$        |
| $I_{GSSF}$                           | Gate to Source Leakage Current, Forward   | $V_{GS} = 8\text{ V}, V_{DS} = 0\text{ V}$                         | –   | –   | 100  | nA                   |
| $I_{GSSR}$                           | Gate to Source Leakage Current, Reverse   | $V_{GS} = -8\text{ V}, V_{DS} = 0\text{ V}$                        | –   | –   | -100 | nA                   |

### ON CHARACTERISTICS (Note 2)

|                                        |                                                |                                                                                                                                                                          |             |                |                |                      |
|----------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------------|----------------|----------------------|
| $V_{GS(th)}$                           | Gate Threshold Voltage                         | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$                                                                                                                         | -0.4        | -0.8           | -1.5           | V                    |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D = -250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$                                                                                                       | –           | 3              | –              | mV/ $^\circ\text{C}$ |
| $R_{DS(on)}$                           | Static Drain–Source On–Resistance              | $V_{GS} = -4.5\text{ V}, I_D = -4.5\text{ A}$<br>$V_{GS} = -2.5\text{ V}, I_D = -3.8\text{ A}$<br>$V_{GS} = -4.5\text{ V}, I_D = -4.5\text{ A}, T_J = 125^\circ\text{C}$ | –<br>–<br>– | 39<br>52<br>54 | 48<br>65<br>72 | m $\Omega$           |
| $I_{D(on)}$                            | On–State Drain Current                         | $V_{GS} = -4.5\text{ V}, V_{DS} = -5\text{ V}$                                                                                                                           | -20         | –              | –              | A                    |
| $g_{FS}$                               | Forward Transconductance                       | $V_{DS} = -10\text{ V}, I_D = -4.5\text{ A}$                                                                                                                             | –           | 15             | –              | S                    |

### DYNAMIC CHARACTERISTICS

|           |                              |                                                                  |   |      |   |    |
|-----------|------------------------------|------------------------------------------------------------------|---|------|---|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$ | – | 1160 | – | pF |
| $C_{oss}$ | Output Capacitance           |                                                                  | – | 195  | – | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                  | – | 105  | – | pF |

### SWITCHING CHARACTERISTICS (Note 2)

|              |                     |                                                                                              |   |     |    |    |
|--------------|---------------------|----------------------------------------------------------------------------------------------|---|-----|----|----|
| $t_{d(on)}$  | Turn–On Delay Time  | $V_{DD} = -5\text{ V}, I_D = -1\text{ A}, V_{GS} = -4.5\text{ V}, R_{GEN} = 6\text{ }\Omega$ | – | 12  | 22 | ns |
| $t_r$        | Turn–On Rise Time   |                                                                                              | – | 9   | 18 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time |                                                                                              | – | 33  | 53 | ns |
| $t_f$        | Turn–Off Fall Time  |                                                                                              | – | 12  | 22 | ns |
| $Q_{g(Tot)}$ | Total Gate Charge   | $V_{DS} = -10\text{ V}, I_D = -4.5\text{ A}, V_{GS} = -4.5\text{ V}$                         | – | 10  | 14 | nC |
| $Q_{gs}$     | Gate–Source Charge  |                                                                                              | – | 2.2 | –  | nC |
| $Q_{gd}$     | Gate–Drain Charge   |                                                                                              | – | 1.5 | –  | nC |

### DRAIN–SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

|                 |                                                       |                                                         |   |       |      |   |
|-----------------|-------------------------------------------------------|---------------------------------------------------------|---|-------|------|---|
| I <sub>S</sub>  | Maximum Continuous Drain–Source Diode Forward Current |                                                         | – | –     | –1.3 | A |
| V <sub>SD</sub> | Drain–Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = –1.3 A (Note 2) | – | –0.73 | –1.2 | V |

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 the sum of the junction–to–case and case–to–ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



- 78 $^\circ\text{C/W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



- 156 $^\circ\text{C/W}$  when mounted on a minimum pad of 2 oz copper

Scale 1 : 1 on letter size paper

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

## TYPICAL CHARACTERISTICS

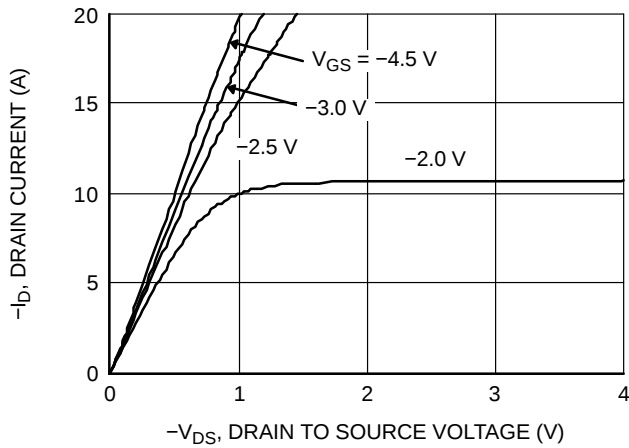


Figure 1. On-Region Characteristics

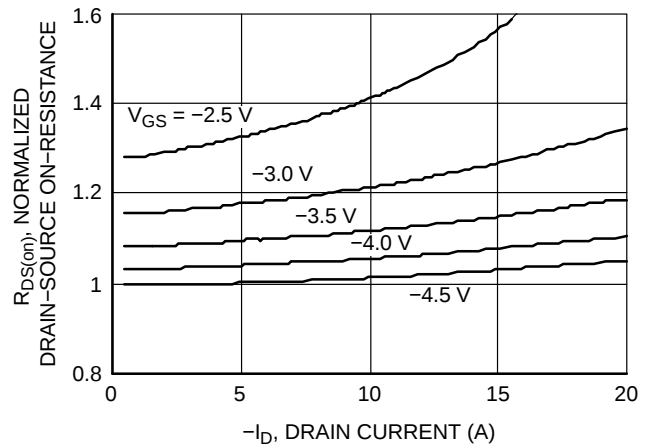


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

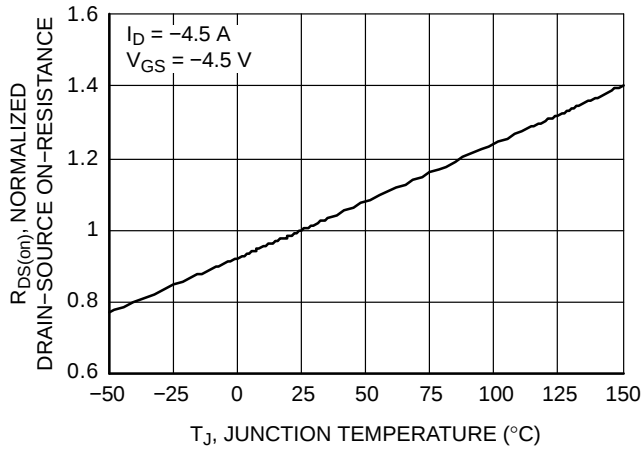


Figure 3. On-Resistance Variation with Temperature

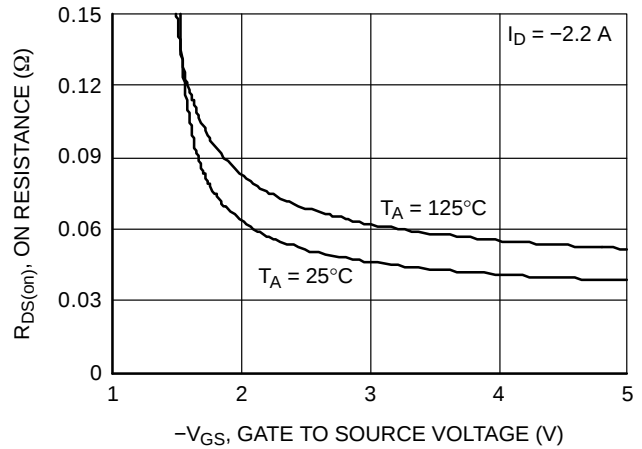


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

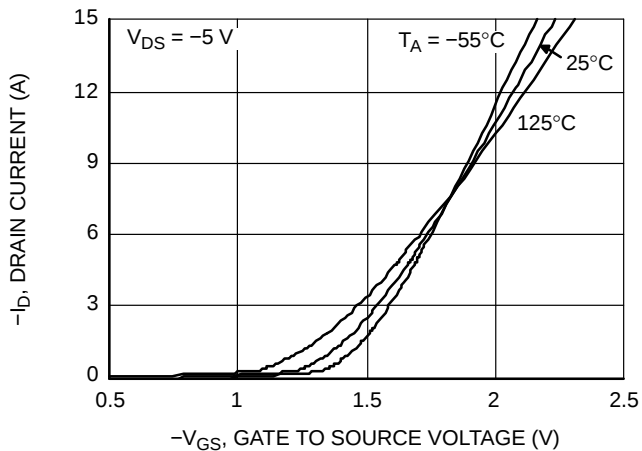


Figure 5. Transfer Characteristics

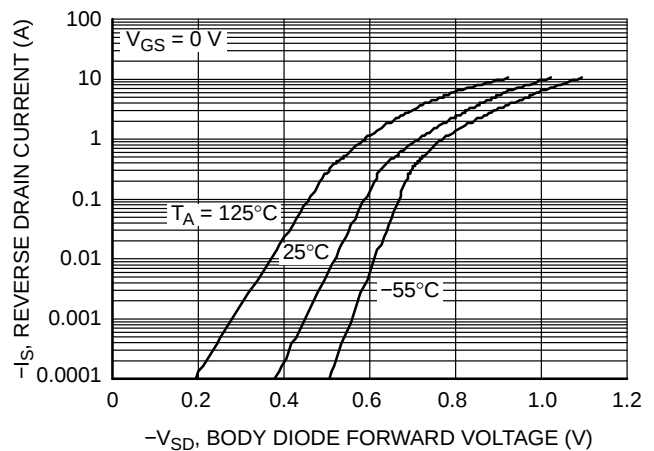


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

TYPICAL CHARACTERISTICS (continued)

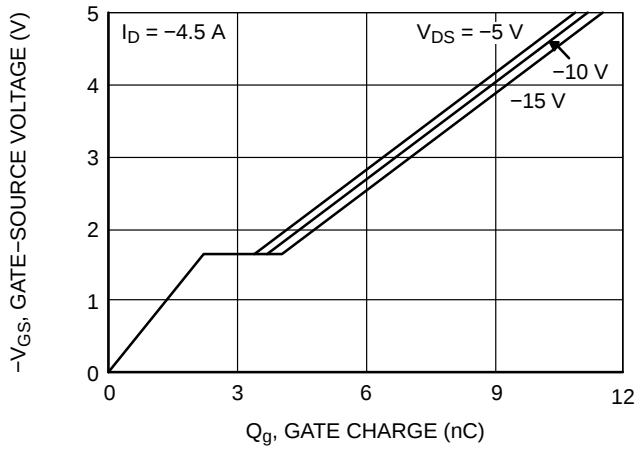


Figure 7. Gate Charge Characteristics

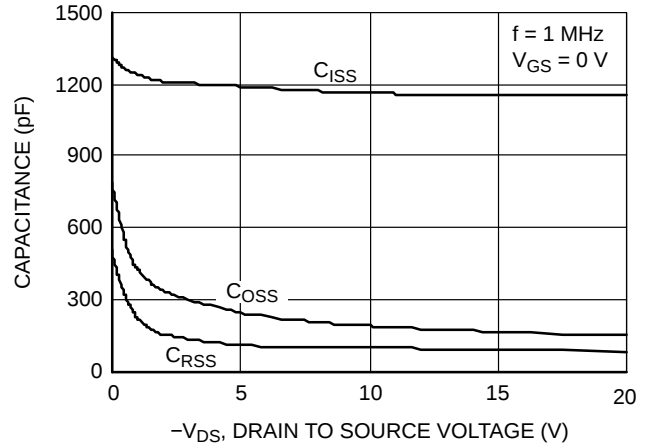


Figure 8. Capacitance Characteristics

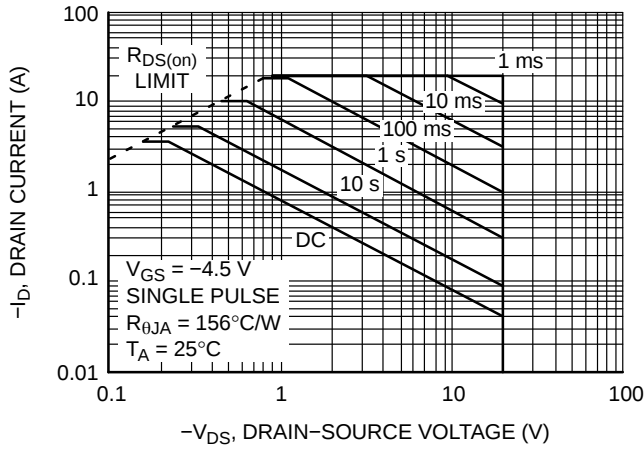


Figure 9. Maximum Safe Operating Area

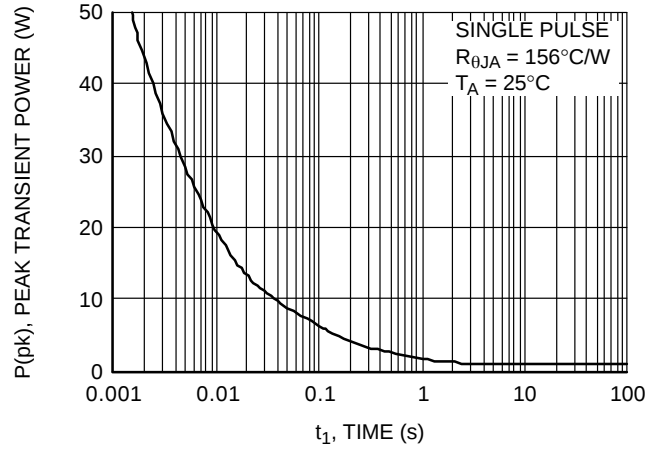


Figure 10. Single Pulse Maximum Power Dissipation

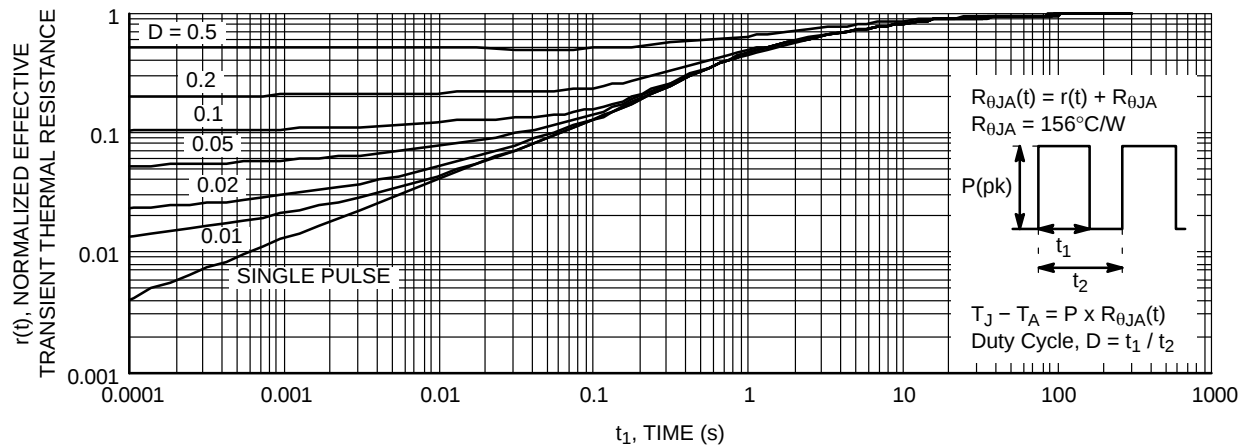


Figure 11. Transient Thermal Response Curve

(Thermal characterization performed using the conditions described in Note 1b.  
Transient thermal response will change depending on the circuit board design.)

## FDC638P

### PACKAGE OUTLINES AND ORDERING INFORMATION

| Device  | Device Marking | Package                                               | Reel Size | Tape Width | Shipping <sup>†</sup> |
|---------|----------------|-------------------------------------------------------|-----------|------------|-----------------------|
| FDC638P | 638            | TSOT23 6-Lead<br>SUPERSOT-6<br>(Pb-Free, Halide Free) | 7"        | 8 mm       | 3000 / Tape & Reel    |

<sup>†</sup>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.

POWERTRENCH is registered trademark of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries.  
SUPERSOT is trademark of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries.

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

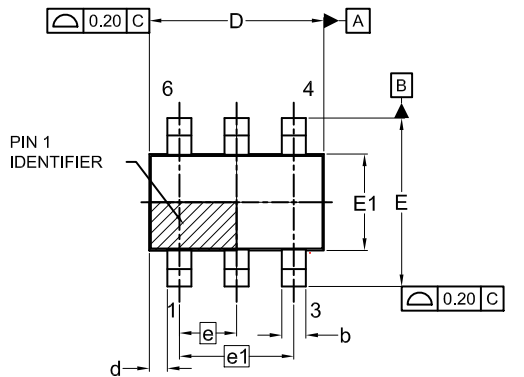
ON Semiconductor®



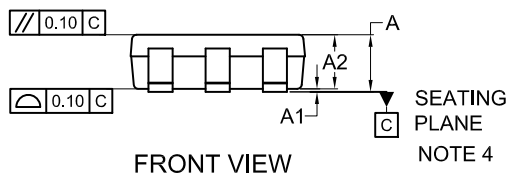
SCALE 2:1

### TSOT23 6-Lead CASE 419BL ISSUE A

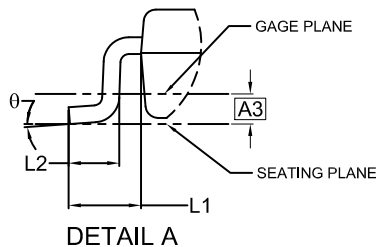
DATE 31 AUG 2020



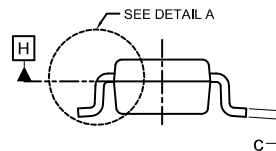
TOP VIEW



FRONT VIEW

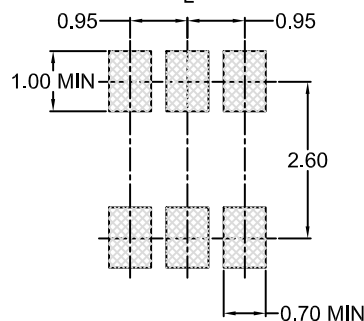


DETAIL A



SIDE VIEW

SYMM



### LAND PATTERN RECOMMENDATION

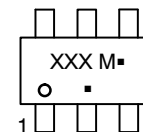
\*FOR ADDITIONAL INFORMATION ON OUR Pb-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.25MM PER END. DIMENSIONS D AND E1 ARE DETERMINED AT DATUM H.
4. 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.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | 0.90        | 1.00 | 1.10 |
| A1  | 0.00        | 0.05 | 0.10 |
| A2  | 0.70        | 0.85 | 1.00 |
| A3  | 0.25 BSC    |      |      |
| b   | 0.25        | 0.38 | 0.50 |
| c   | 0.10        | 0.18 | 0.26 |
| D   | 2.80        | 2.95 | 3.10 |
| d   | 0.30 REF    |      |      |
| E   | 2.50        | 2.75 | 3.00 |
| E1  | 1.30        | 1.50 | 1.70 |
| e   | 0.95 BSC    |      |      |
| e1  | 1.90 BSC    |      |      |
| L1  | 0.60 REF    |      |      |
| L2  | 0.20        | 0.40 | 0.60 |
| Θ   | 0°          | —    | 10°  |

### GENERIC MARKING DIAGRAM\*



XXX = Specific Device Code

M = Date Code

▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

|                  |               |                                                                                                                                                                                  |
|------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOCUMENT NUMBER: | 98AON83292G   | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| DESCRIPTION:     | TSOT23 6-Lead | PAGE 1 OF 1                                                                                                                                                                      |

ON Semiconductor and are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

**onsemi**, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## ADDITIONAL INFORMATION

### TECHNICAL PUBLICATIONS:

Technical Library: [www.onsemi.com/design/resources/technical-documentation](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

### ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at  
[www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)