

# MOSFET – Dual, N-Channel, POWERTRENCH<sup>®</sup>, Specified

2.5 V

## FDC6401N

### General Description

This Dual N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low  $R_{DS(ON)}$  and fast switching speed.

### Features

- 3.0 A, 20 V.  $R_{DS(ON)} = 70 \text{ m}\Omega @ V_{GS} = 4.5 \text{ V}$   
 $R_{DS(ON)} = 95 \text{ m}\Omega @ V_{GS} = 2.5 \text{ V}$
- Low Gate Charge (3.3 nC)
- High Performance Trench Technology for Extremely Low  $R_{DS(ON)}$
- High Power and Current Handling Capability
- This is a Pb-Free and Halide Free Device

### Applications

- DC/DC Converter
- Battery Protection
- Power Management

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

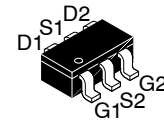
| Symbol         | Parameter                                        | Value       | Unit             |
|----------------|--------------------------------------------------|-------------|------------------|
| $V_{DSS}$      | Drain–Source Voltage                             | 20          | V                |
| $V_{GSS}$      | Gate–Source Voltage                              | $\pm 12$    | V                |
| $I_D$          | Drain Current<br>–Continuous (Note 1a.)          | 3.0         | A                |
|                | –Pulsed                                          | 12          |                  |
| $P_D$          | Power Dissipation for Single Operation           |             | W                |
|                | (Note 1a.)                                       | 0.96        |                  |
|                | (Note 1b.)                                       | 0.9         |                  |
|                | (Note 1c.)                                       | 0.7         |                  |
| $T_J, T_{STG}$ | 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

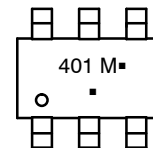
| Symbol          | Parameter                                          | Value | Unit                      |
|-----------------|----------------------------------------------------|-------|---------------------------|
| $R_{\theta JA}$ | Thermal Resistance, Junction–to–Ambient (Note 1a.) | 130   | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction–to–Case (Note 1)      | 60    | $^\circ\text{C}/\text{W}$ |

| $V_{DSS}$ | $R_{DS(ON)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|-----------|--------------------------|-------------------|
| 20 V      | 70 m $\Omega$ @ 4.5 V    | 3.0 A             |
|           | 95 m $\Omega$ @ 2.5 V    |                   |



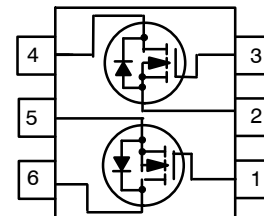
TSOT23 6-Lead  
(SUPERSOT™ –6)  
CASE 419BL

### MARKING DIAGRAM



401 = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

### PIN ASSIGNMENT



### ORDERING INFORMATION

| Device   | Package                                  | Shipping <sup>†</sup> |
|----------|------------------------------------------|-----------------------|
| FDC6401N | TSOT–23–6<br>(SUPERSOT™ –6)<br>(Pb–Free) | 3000 /<br>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 Specification Brochure, BRD8011/D.

# FDC6401N

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

| Symbol | Parameter | Test Conditions | 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 $25^\circ\text{C}$ | –  | 13 | –    | 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–Body Leakage, Forward                | $V_{GS} = 12\text{ V}, V_{DS} = 0\text{ V}$                       | –  | –  | –100 | nA                   |
| $I_{GSSR}$                           | Gate–Body Leakage, Reverse                | $V_{GS} = -12\text{ V}, V_{DS} = 0\text{ V}$                      | –  | –  | 100  | nA                   |

### ON CHARACTERISTICS (Note 2)

|                                        |                                                |                                                                                                                                                                    |             |                |                 |                      |
|----------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------------|-----------------|----------------------|
| $V_{GS(th)}$                           | Gate Threshold Voltage                         | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                                                                                                                    | 0.5         | 0.9            | 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              | $V_{GS} = 4.5\text{ V}, I_D = 3.0\text{ A}$<br>$V_{GS} = 2.5\text{ V}, I_D = 2.5\text{ A}$<br>$V_{GS} = 4.5\text{ V}, I_D = 3.0\text{ A}, T_J = 125^\circ\text{C}$ | –<br>–<br>– | 50<br>66<br>71 | 70<br>95<br>106 | m $\Omega$           |
| $I_{D(on)}$                            | On–State Drain Current                         | $V_{GS} = 4.5\text{ V}, V_{DS} = 5\text{ V}$                                                                                                                       | 12          | –              | –               | A                    |
| $g_{FS}$                               | Forward Transconductance                       | $V_{DS} = 5\text{ V}, I_D = 3.0\text{ A}$                                                                                                                          | –           | 10             | –               | S                    |

### DYNAMIC CHARACTERISTICS

|           |                              |                                                                 |   |     |   |    |
|-----------|------------------------------|-----------------------------------------------------------------|---|-----|---|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$ | – | 324 | – | pF |
| $C_{oss}$ | Output Capacitance           |                                                                 | – | 82  | – | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                 | – | 42  | – | pF |

### SWITCHING CHARACTERISTICS (Note 2)

|              |                     |                                                                                                 |   |      |     |    |
|--------------|---------------------|-------------------------------------------------------------------------------------------------|---|------|-----|----|
| $t_{d(on)}$  | Turn–On Delay Time  | $V_{DD} = 10\text{ V}, I_D = 1\text{ A},$<br>$V_{GS} = 4.5\text{ V}, R_{GEN} = 6\text{ }\Omega$ | – | 5    | 10  | ns |
| $t_r$        | Turn–On Rise Time   |                                                                                                 | – | 7    | 14  | ns |
| $t_{d(off)}$ | Turn–Off Delay Time |                                                                                                 | – | 13   | 23  | ns |
| $t_f$        | Turn–Off Fall Time  |                                                                                                 | – | 1.6  | 3   | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 10\text{ V}, I_D = 3.0\text{ A},$<br>$V_{GS} = 4.5\text{ V}$                          | – | 3.3  | 4.6 | nC |
| $Q_{gs}$     | Gate–Source Charge  |                                                                                                 | – | 0.95 | –   | nC |
| $Q_{gd}$     | Gate–Drain Charge   |                                                                                                 | – | 0.7  | –   | nC |

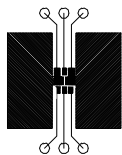
### DRAIN–SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

|                 |                                                       |                                                        |   |     |     |   |
|-----------------|-------------------------------------------------------|--------------------------------------------------------|---|-----|-----|---|
| I <sub>S</sub>  | Maximum Continuous Drain–Source Diode Forward Current |                                                        | – | –   | 0.8 | A |
| V <sub>SD</sub> | Drain–Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 0.8 A (Note 2) | – | 0.7 | 1.2 | V |

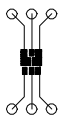
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

#### NOTES:

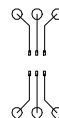
- $R_{\theta JA}$  is the sum of the junction–to–case and case–to–ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a.  $130^\circ\text{C/W}$  when mounted on a  $0.125\text{ in}^2$  pad of 2 oz. copper.



b.  $140^\circ\text{C/W}$  when mounted on a  $.004\text{ in}^2$  pad of 2 oz. copper.



c.  $180^\circ\text{C/W}$  when mounted on a minimum pad.

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

TYPICAL CHARACTERISTICS

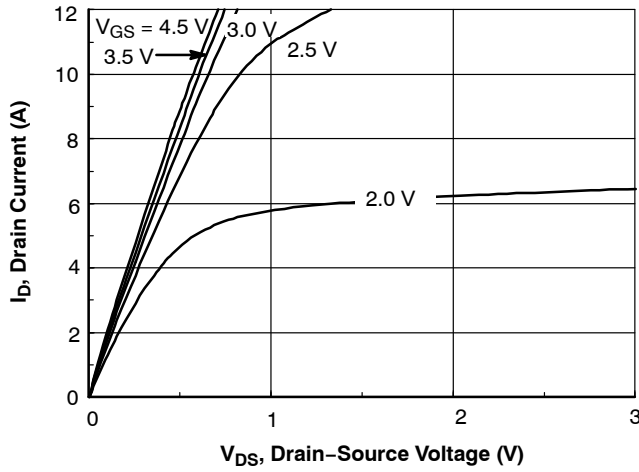


Figure 1. On-Region Characteristics

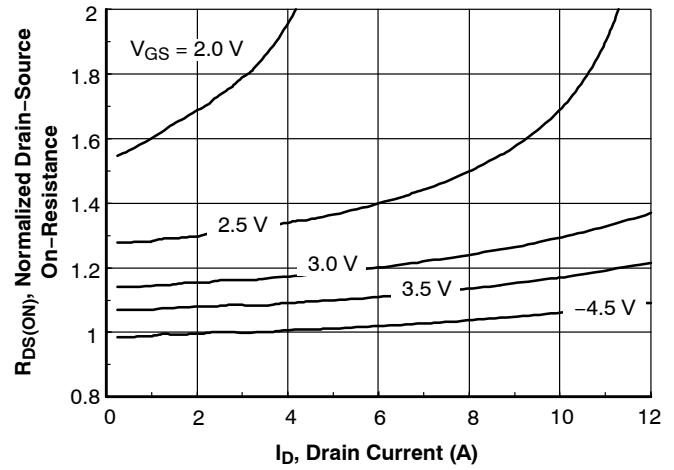


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

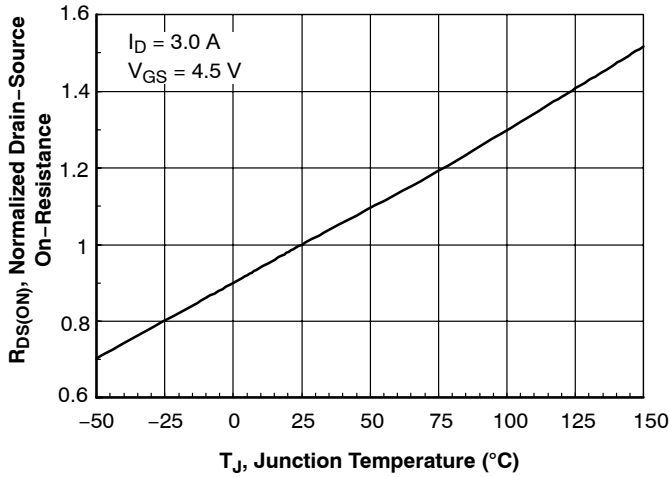


Figure 3. On-Resistance Variation with Temperature

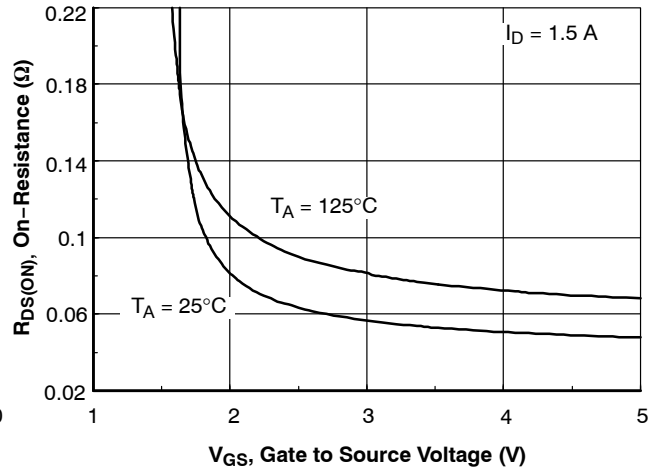


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

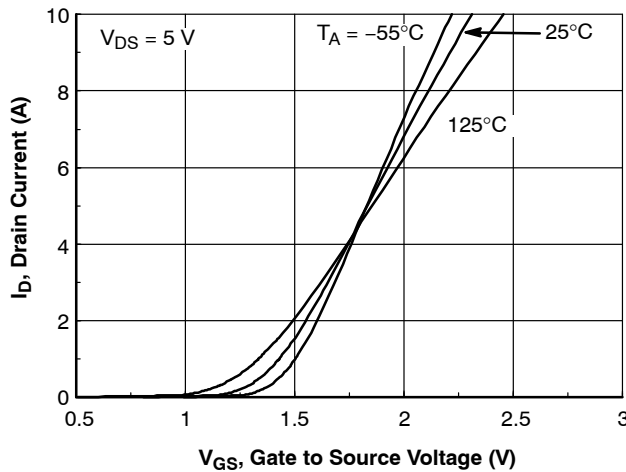


Figure 5. Transfer Characteristics

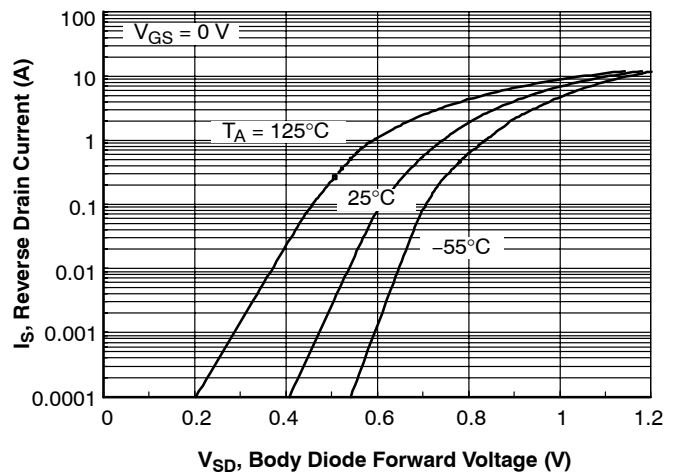


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

TYPICAL CHARACTERISTICS (continued)

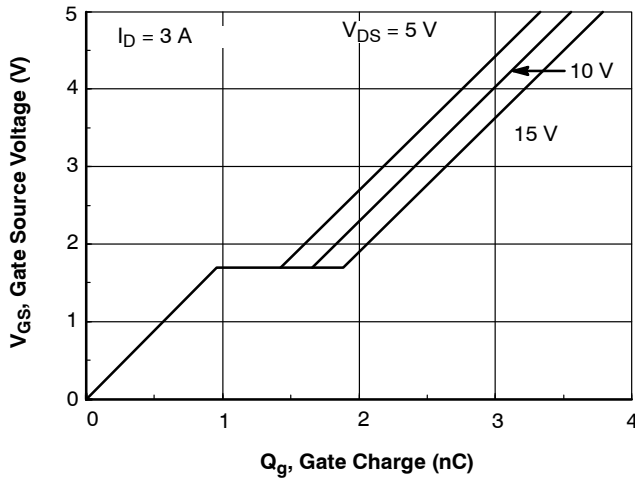


Figure 7. Gate Charge Characteristics

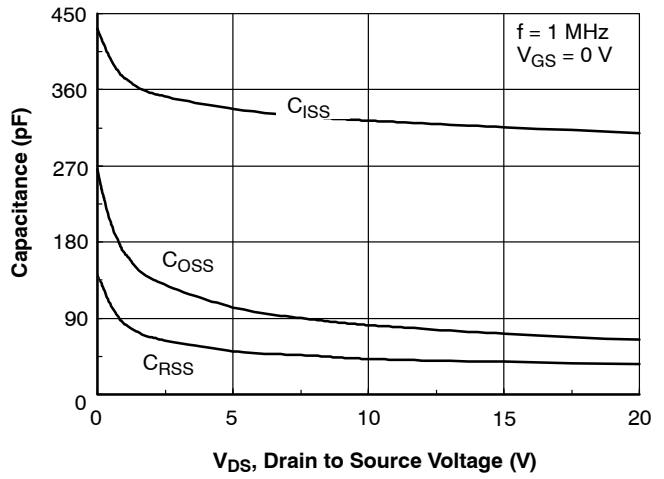


Figure 8. Capacitance Characteristics

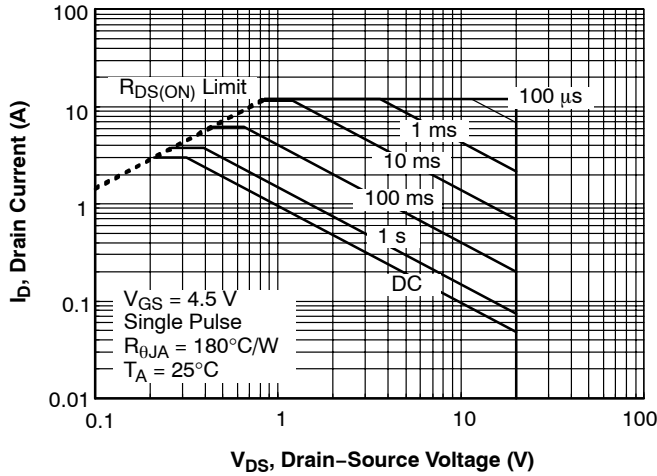


Figure 9. Maximum Safe Operating Area

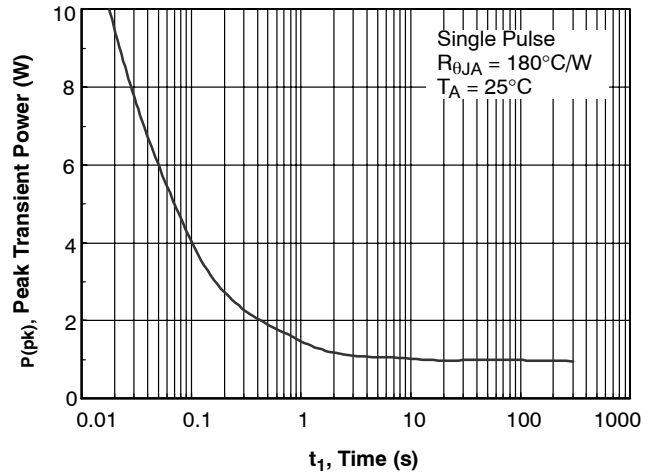


Figure 10. Single Pulse Maximum Power Dissipation

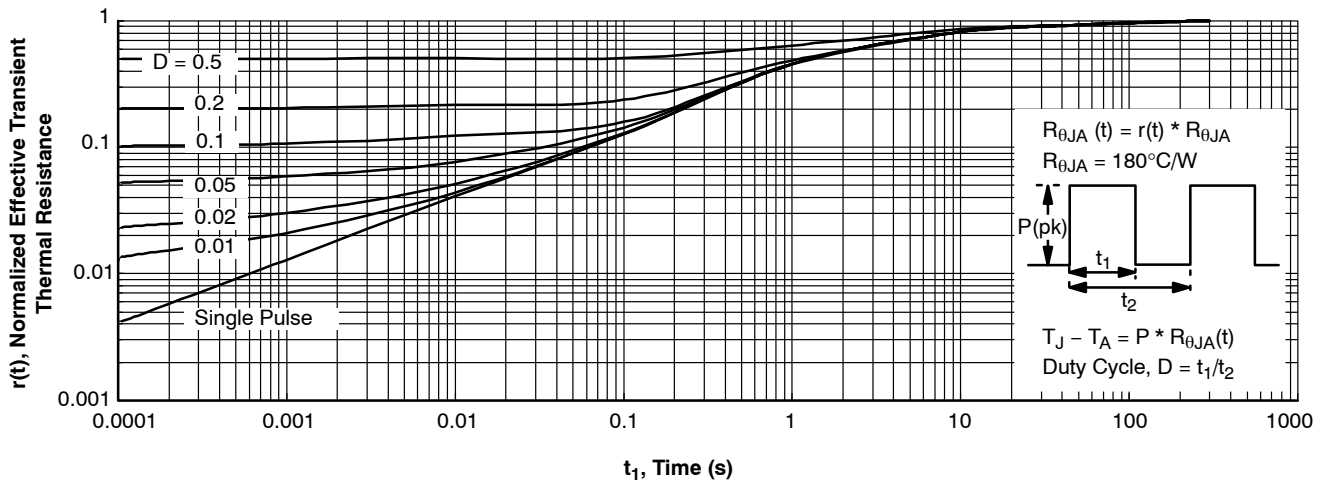


Figure 11. Transient Thermal Response Curve

NOTE: Thermal characterization performed using the conditions described in Note 1c. Transient thermal response will change depending on the circuit board design.

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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

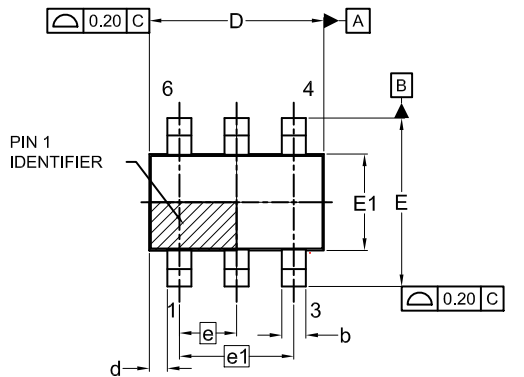
ON Semiconductor®



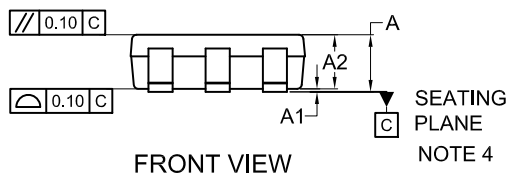
SCALE 2:1

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

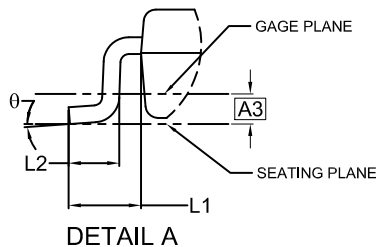
DATE 31 AUG 2020



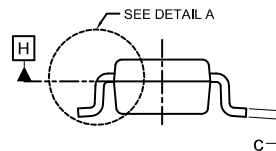
TOP VIEW



FRONT VIEW

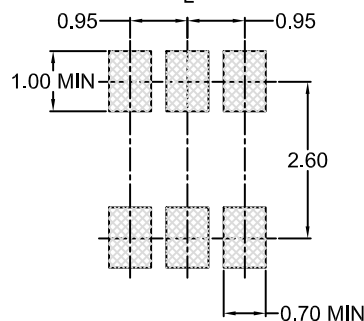


DETAIL A



SIDE VIEW

SYMM



### LAND PATTERN RECOMMENDATION

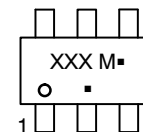
\*FOR ADDITIONAL INFORMATION ON OUR  
Pb-FREE STRATEGY AND SOLDERING DETAILS,  
PLEASE DOWNLOAD THE ON SEMICONDUCTOR  
SOLDERING AND MOUNTING TECHNIQUES  
REFERENCE MANUAL, SOLDERRM/D.

### 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.

|                  |               |                                                                                                                                                                                  |
|------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| DESCRIPTION:     | TSOT23 6-Lead | PAGE 1 OF 1                                                                                                                                                                      |

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