

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

**20 V, 6.1 A, 28 mΩ**

## FDN028N20

### General Description

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

### Features

- Max  $r_{DS(on)}$  = 28 mΩ at  $V_{GS} = 4.5$  V,  $I_D = 5.2$  A
- Max  $r_{DS(on)}$  = 45 mΩ at  $V_{GS} = 2.5$  V,  $I_D = 4.4$  A
- High Performance Trench Technology for Extremely Low  $r_{DS(on)}$
- High Power and Current Handling Capability in a Widely Used Surface Mount Package
- Fast Switching Speed
- 100% UIL Tested
- This Device is Pb-Free, Halide Free and is RoHS Compliant

### Applications

- Primary DC-DC Switch
- Load Switch

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

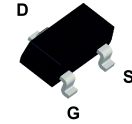
| Symbol         | Parameter  |                                    | Ratings    | Unit             |
|----------------|--|------------------------------------|------------|------------------|
| $V_{DS}$       | Drain to Source Voltage                          |                                    | 20         | V                |
| $V_{GS}$       | Gate to Source Voltage (Note 3)                  |                                    | $\pm 12$   | V                |
| $I_D$          | Continuous                                       | $T_A = 25^\circ\text{C}$ (Note 1a) | 6.1        | A                |
|                | Pulsed   | (Note 5)                           | 52         |                  |
| $E_{AS}$       | Single Pulse Avalanche Energy (Note 4)           |                                    | 6          | mJ               |
| $P_D$          | Power Dissipation                                | (Note 1a)                          | 1.5        | W                |
|                |  | (Note 1b)                          | 0.6        |                  |
| $T_J, T_{STG}$ | 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 ( $T_C = 25^\circ\text{C}$ , unless otherwise noted)

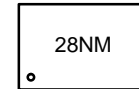
| Symbol          | Parameter   | Ratings | Unit               |
|-----------------|---|---------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case (Note 1)     | 75      | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1a) | 80      | $^\circ\text{C/W}$ |

| $V_{DS}$ | $r_{DS(on)}$ MAX | $I_D$ MAX |
|----------|------------------|-----------|
| 20 V     | 28 mΩ @ 4.5 V    | 6.1 A     |
|          | 45 mΩ @ 2.5 V    |           |



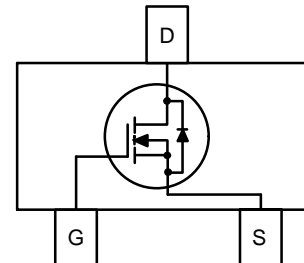
SOT-23/SUPERSOT<sup>™</sup>-23, 3 LEAD, 1.4x2.9  
CASE 527AG

### MARKING DIAGRAM



28N = Specific Device Code  
M = Date Code

### PIN ASSIGNMENT



### ORDERING INFORMATION

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

# FDN028N20

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

| Symbol                               | Parameter                                 | Conditions                                     | Min | Typ | Max | Unit  |
|--------------------------------------|---|--|-----|-----|-----|-------|
| <b>OFF CHARACTERISTICS</b>           |   |  |     |     |     |       |
| BV <sub>DSS</sub>                    | Drain to Source Breakdown Voltage         | I <sub>D</sub> = 250 μA, V <sub>GS</sub> = 0 V | 20  | –   | –   | V     |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 250 μA, referenced to 25°C    | –   | 15  | –   | mV/°C |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 16 V, V <sub>GS</sub> = 0 V  | –   | –   | 1   | μA    |
| I <sub>GSS</sub>                     | Gate to Source Leakage Current            | V <sub>GS</sub> = 12 V, V <sub>DS</sub> = 0 V  | –   | –   | 100 | nA    |

## ON CHARACTERISTICS

|  |  |   |     |     |     |       |
|--|--|---|-----|-----|-----|-------|
| V <sub>GS(th)</sub>                    | Gate to Source Threshold Voltage                         | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 μA             | 0.5 | 0.9 | 1.5 | V     |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate to Source Threshold Voltage Temperature Coefficient | I <sub>D</sub> = 250 μA, referenced to 25°C                             | –   | –3  | –   | mV/°C |
| r <sub>DS(on)</sub>                    | Static Drain to Source On Resistance                     | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 5.2 A                         | –   | 23  | 28  | mΩ    |
|  |  | V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 4.4 A                         | –   | 32  | 45  |       |
|  |  | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 5.2 A, T <sub>J</sub> = 125°C | –   | 30  | 41  |       |
| g <sub>FS</sub>                        | Forward Transconductance                                 | V <sub>DS</sub> = 5 V, I <sub>D</sub> = 5.2 A                           | –   | 28  | –   | S     |

## DYNAMIC CHARACTERISTICS

|                  |                              |  |   |     |     |    |
|------------------|------------------------------|--|---|-----|-----|----|
| C <sub>iss</sub> | Input Capacitance            | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 0 V, f = 1 MHz | – | 399 | 600 | pF |
| C <sub>oss</sub> | Output Capacitance           |  | – | 91  | 140 | pF |
| C <sub>rss</sub> | Reverse Transfer Capacitance |  | – | 87  | 130 | pF |

## SWITCHING CHARACTERISTICS

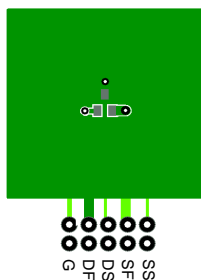
|                     |                               |  |   |     |     |    |
|---------------------|-------------------------------|--|---|-----|-----|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time            | V <sub>DD</sub> = 10 V, I <sub>D</sub> = 5.2 A, V <sub>GS</sub> = 10 V, R <sub>GEN</sub> = 6 Ω | – | 5   | 10  | ns |
| t <sub>r</sub>      | Rise Time                     |  | – | 2   | 10  | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time           |  | – | 15  | 29  | ns |
| t <sub>f</sub>      | Fall Time                     |  | – | 2   | 10  | ns |
| Q <sub>g(TOT)</sub> | Total Gate Charge             | V <sub>GS</sub> = 0 V to 4.5 V<br>V <sub>DD</sub> = 10 V, I <sub>D</sub> = 5.2 A               | – | 4.3 | 6.0 | nC |
| Q <sub>g(TOT)</sub> | Total Gate Charge             | V <sub>GS</sub> = 0 V to 2.5 V<br>V <sub>DD</sub> = 10 V, I <sub>D</sub> = 5.2 A               | – | 2.8 | 3.9 | nC |
| Q <sub>gs</sub>     | Gate to Source Charge         | V <sub>DD</sub> = 10 V, I <sub>D</sub> = 5.2 A   | – | 0.7 | –   | nC |
| Q <sub>gd</sub>     | Gate to Drain “Miller” Charge |  | – | 1.6 | –   | nC |

## DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

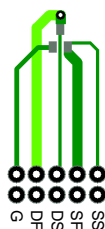
|                 |                                       |  |   |      |     |    |
|-----------------|---------------------------------------|--|---|------|-----|----|
| V <sub>SD</sub> | Source to Drain Diode Forward Voltage | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 5.2 A (Note 2) | – | 0.85 | 1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                 | I <sub>F</sub> = 5.2 A, di/dt = 100 A/μs               | – | 13   | 27  | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge               |  | – | 3    | 10  | 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.

- R<sub>θJA</sub> 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<sub>θJC</sub> is guaranteed by design while R<sub>θCA</sub> is determined by the user's board design.



a. 80°C/W when mounted on a 1 in² pad of 2 oz copper.



b. 180°C/W when mounted on a minimum pad.

- Pulse Test: Pulse Width < 300 μs, Duty Cycle < 2.0%.
- As an N-ch device, the negative V<sub>GS</sub> rating is for low duty cycle pulse occurrence only. No continuous rating is implied.
- E<sub>AS</sub> of 6 mJ is based on starting T<sub>J</sub> = 25°C, L = 3 mH, I<sub>AS</sub> = 2 A, V<sub>DD</sub> = 20 V, V<sub>GS</sub> = 10 V. 100% test at L = 0.1 mH, I<sub>AS</sub> = 7 A.
- Pulsed I<sub>D</sub> please refer to Figure 10 SOA graph for more details.

## TYPICAL CHARACTERISTICS

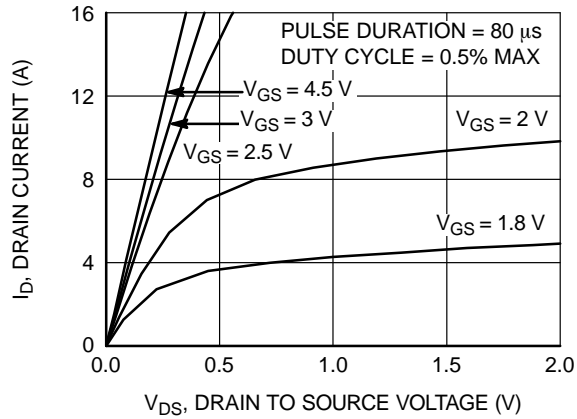
 $(T_J = 25^\circ\text{C}$  unless otherwise noted)

Figure 1. On Region Characteristics

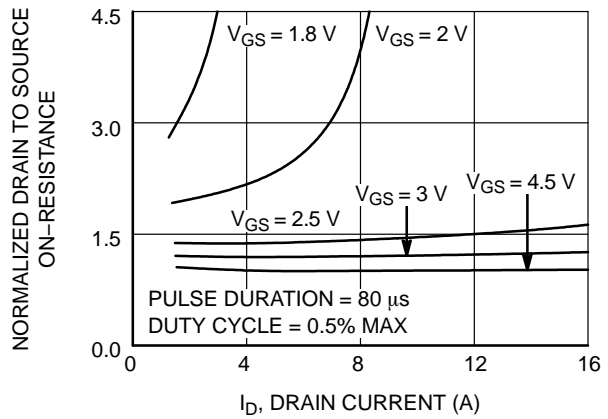


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

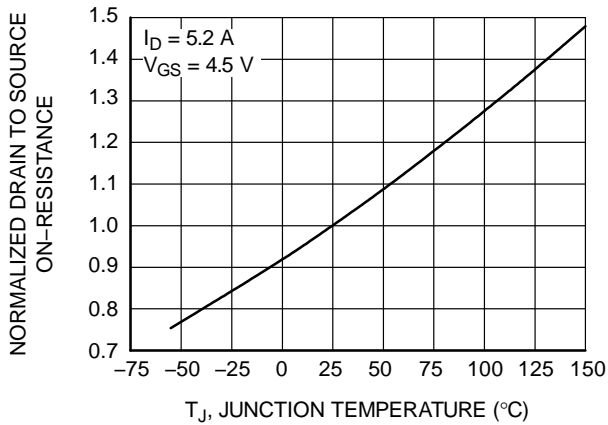


Figure 3. Normalized On-Resistance vs. Junction Temperature

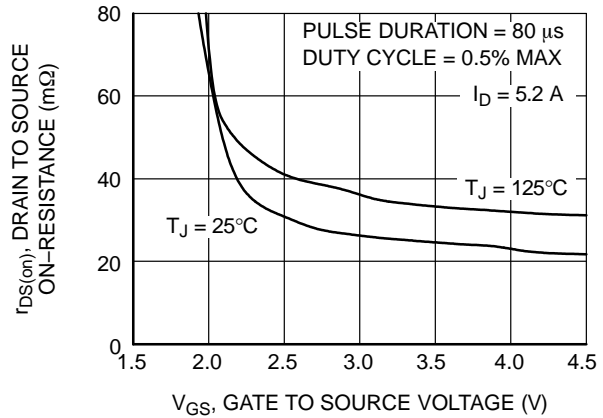


Figure 4. On-Resistance vs. Gate to Source Voltage

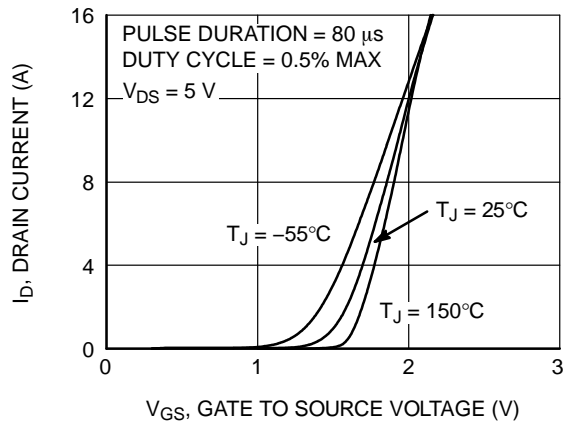


Figure 5. Transfer Characteristics

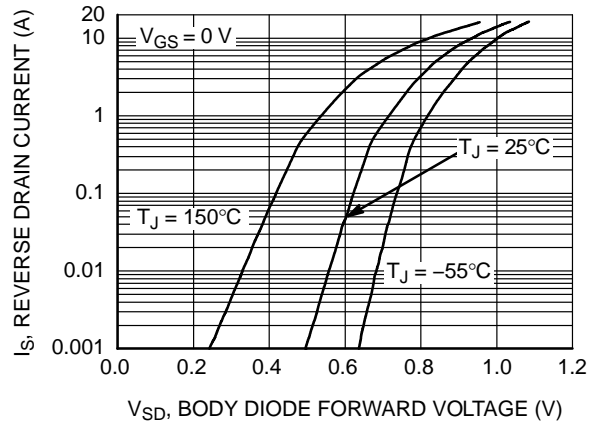


Figure 6. Source to Drain Diode Forward Voltage vs. Source Current

## TYPICAL CHARACTERISTICS

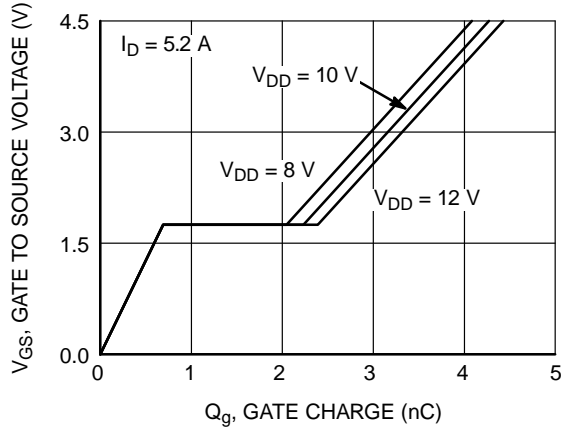
(T<sub>J</sub> = 25°C unless otherwise noted) (continued)

Figure 7. Gate Charge Characteristics

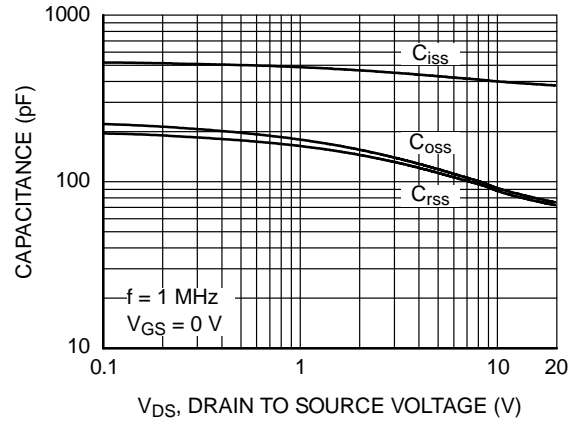


Figure 8. Capacitance vs. Drain to Source Voltage

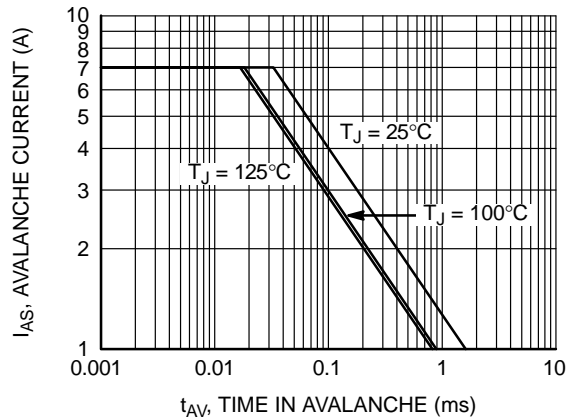


Figure 9. Unclamped Inductive Switching Capability

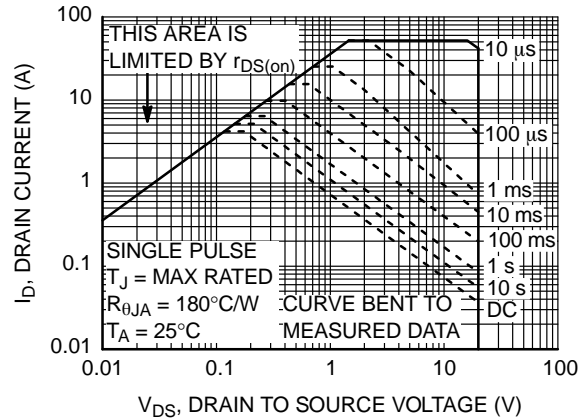


Figure 10. Forward Bias Safe Operating Area

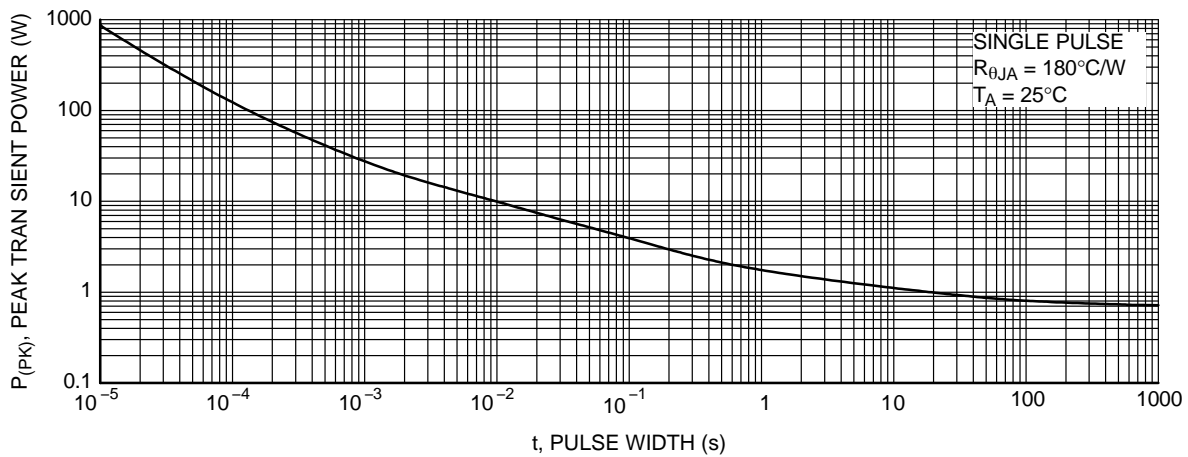


Figure 11. Single Pulse Maximum Power Dissipation

# FDN028N20

## TYPICAL CHARACTERISTICS

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

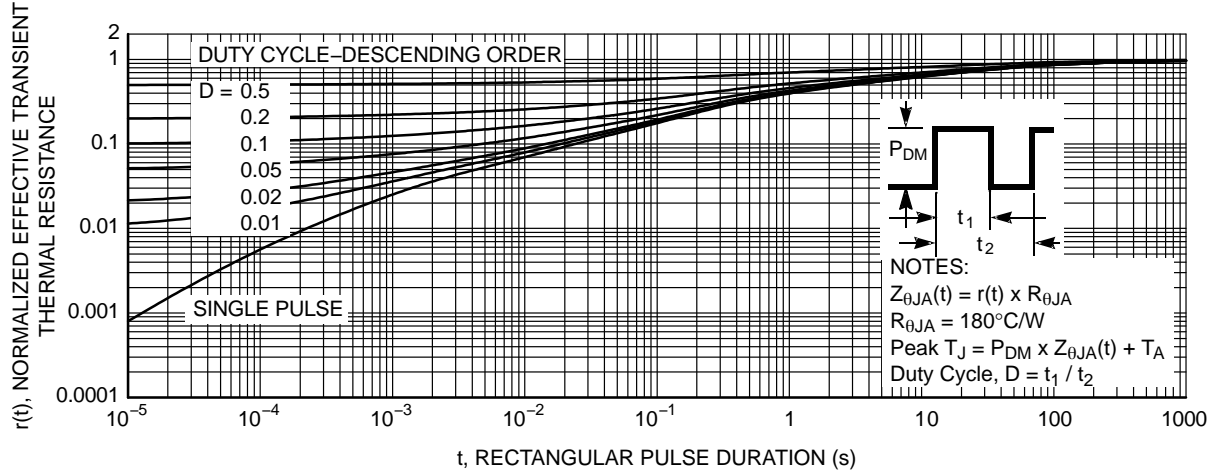


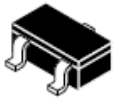
Figure 12. Junction-to-Ambient Transient Thermal Response Curve

## PACKAGE MARKING AND ORDERING INFORMATION

| Device    | Device Marking | Package   | Reel Size | Tape Width | Shipping <sup>†</sup> |
|-----------|----------------|---|-----------|------------|-----------------------|
| FDN028N20 | 28N            | SOT-23/SUPERSOT-23, 3 LEAD, 1.4x2.9<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.

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### SOT-23/SUPERSOT™ –23, 3 LEAD, 1.4x2.9

#### CASE 527AG

#### ISSUE A

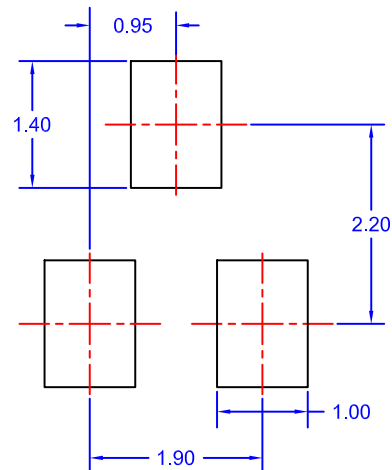
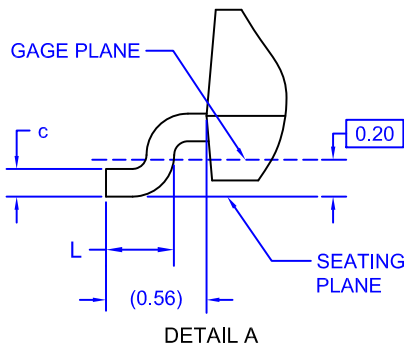
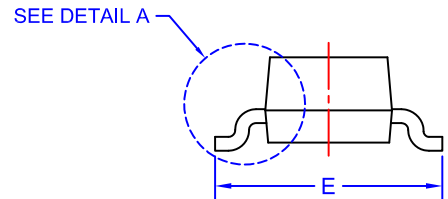
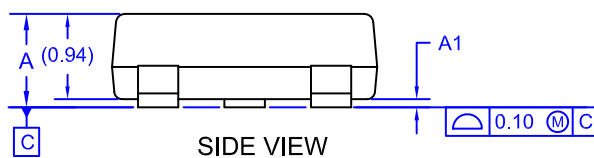
DATE 09 DEC 2019



NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.

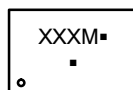
| DIM | MIN.     | NOM.  | MAX.  |
|-----|----------|-------|-------|
| A   | 0.85     | 0.95  | 1.12  |
| A1  | 0.00     | 0.05  | 0.10  |
| b   | 0.370    | 0.435 | 0.508 |
| c   | 0.085    | 0.150 | 0.180 |
| D   | 2.80     | 2.92  | 3.04  |
| E   | 2.31     | 2.51  | 2.71  |
| E1  | 1.20     | 1.40  | 1.52  |
| e   | 0.95 BSC |       |       |
| e1  | 1.90 BSC |       |       |
| L   | 0.33     | 0.38  | 0.43  |



#### 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.

#### GENERIC MARKING DIAGRAM\*



XXX = Specific Device Code  
M = Month 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:     | SOT-23/SUPERSOT-23, 3 LEAD, 1.4X2.9 | PAGE 1 OF 1  |

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