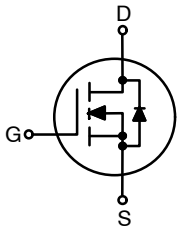
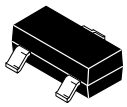
# N-Channel Logic Level Enhancement Mode Field Effect Transistor

# BSS138



**SOT−23−3**
**CASE 318−08**

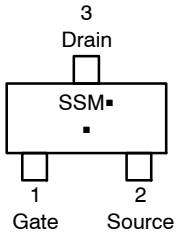
### General Description

These N−Channel enhancement mode field effect transistors are produced using **onsemi's** proprietary, high cell density, DMOS technology. These products have been designed to minimize on−state resistance while provide rugged, reliable, and fast switching performance. These products are particularly suited for low voltage, low current applications such as small servo motor control, power MOSFET gate drivers, and other switching applications.

### Features

- 0.22 A, 50 V
  - $R_{DS(on)}$ = 3.5 Ω @ $V_{GS}$ = 10 V
  - $R_{DS(on)}$ = 6.0 Ω @ $V_{GS}$ = 4.5 V
- High Density Cell Design for Extremely Low $R_{DS(on)}$
- Rugged and Reliable
- Compact Industry Standard SOT−23 Surface Mount Package
- HBM Class 0A, MM Class M2 (Note 3)
- This Device is Pb−Free and Halogen Free

### MARKING DIAGRAM




SS = Specific Device Code
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*Date Code orientation and/or position may vary depending upon manufacturing location.

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| BSS138,<br>BSS138−G | SOT−23−3<br>(Pb−Free) | 3000 /<br>Tape & Reel |

†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.

© Semiconductor Components Industries, LLC, 2005

**ABSOLUTE MAXIMUM RATINGS** $T_A$ = 25°C unless otherwise noted.

| Symbol | Parameter | Ratings | Unit |
|---|---|---|---|
| $V_{DSS}$ | Drain–Source Voltage | 50 | V |
| $V_{GSS}$ | Gate–Source Voltage | ±20 | |
| $I_D$ | Drain Current – Continuous (Note 1) | 0.22 | A |
| | Drain Current – Pulsed (Note 1) | 0.88 | |
| $P_D$ | Maximum Power Dissipation (Note 1) | 0.36 | W |
| | Derate Above 25°C | 2.8 | mW/°C |
| $T_J$, $T_{STG}$ | Operating and Storage Junction Temperature Range | –55 to +150 | °C |
| $T_L$ | Maximum Lead Temperature for Soldering Purposes, 1/16" from Case for 10 s | 300 | |

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°C unless otherwise noted.

| Symbol | Parameter | Ratings | Unit |
|---|---|---|---|
| $R_{\theta JA}$ | Thermal Resistance, Junction–to–Ambient (Note 1) | 350 | °C/W |

**ELECTRICAL CHARACTERISTICS** $T_A$ = 25°C unless otherwise noted.

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| $BV_{DSS}$ | Drain–Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 250 μA | 50 | – | – | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D$ = 250 μA, Referenced to 25°C | – | 72 | – | mV/°C |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 50 V, $V_{GS}$ = 0 V | – | – | 0.5 | μA |
| | | $V_{DS}$ = 50 V, $V_{GS}$ = 0 V, $T_J$ = 125°C | – | – | 5 | |
| | | $V_{DS}$ = 30 V, $V_{GS}$ = 0 V | – | – | 100 | nA |
| $I_{GSS}$ | Gate–Body Leakage | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | – | – | ±100 | |
| **ON CHARACTERISTICS** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 1 mA | 0.8 | 1.3 | 1.5 | V |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D$ = 1 mA, Referenced to 25°C | – | –2 | – | mV/°C |
| $R_{DS(on)}$ | Static Drain–Source On–Resistance | $V_{GS}$ = 10 V, $I_D$ = 0.22 A | – | 0.7 | 3.5 | Ω |
| | | $V_{GS}$ = 4.5 V, $I_D$ = 0.22 A | – | 1.0 | 6.0 | Ω |
| | | $V_{GS}$ = 10 V, $I_D$ = 0.22 A, $T_J$ = 125°C | – | 1.1 | 5.8 | |
| $I_{D(on)}$ | On–State Drain Current | $V_{GS}$ = 10 V, $V_{DS}$ = 5 V | 0.2 | – | – | A |
| $g_{FS}$ | Forward Transconductance | $V_{DS}$ = 10 V, $I_D$ = 0.22 A | 0.12 | 0.5 | – | S |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1.0 MHz | – | 27 | – | pF |
| $C_{oss}$ | Output Capacitance | | – | 13 | – | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | – | 6 | – | pF |
| $R_G$ | Gate Resistance | $V_{GS}$ = 15 mV, f = 1.0 MHz | – | 9 | – | Ω |



Share Feedback
Your Opinion Matters

**ELECTRICAL CHARACTERISTICS** $T_A$ = 25°C unless otherwise noted. (continued)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS** | | | | | | |
| $t_{d(on)}$ | Turn–On Delay Time | $V_{DD}$ = 30 V, $I_D$ = 0.29 A, $V_{GS}$ = 10 V, $R_{GEN}$ = 6 Ω | – | 2.5 | 5 | ns |
| $t_r$ | Turn–On Rise Time | | – | 9 | 18 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time | | – | 20 | 36 | ns |
| $t_f$ | Turn–Off Fall Time | | – | 7 | 14 | ns |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = 25 V, $I_D$ = 0.22 A, $V_{GS}$ = 10 V | – | 1.7 | 2.4 | nC |
| $Q_{gs}$ | Gate–Source Charge | | – | 0.1 | – | nC |
| $Q_{gd}$ | Gate–Drain Charge | | – | 0.4 | – | nC |
| **DRAIN–SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS** | | | | | | |
| $I_S$ | Maximum Continuous Drain–Source Diode Forward Current | | – | – | 0.22 | A |
| $V_{SD}$ | Drain–Source Diode Forward Voltage | $V_{GS}$ = 0 V, $I_S$ = 0.44 A (Note 2) | – | 0.8 | 1.4 | 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.

1. $R_{\theta JA}$ 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. $R_{\theta JA}$ is guaranteed by design while $R_{\theta JA}$ is determined by the user's board design.



a) 350°C/W when mounted on a minimum pad.

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%
3. ESD between the gate and source serves only, no gate overvoltage rating is implied.

## TYPICAL CHARACTERISTICS

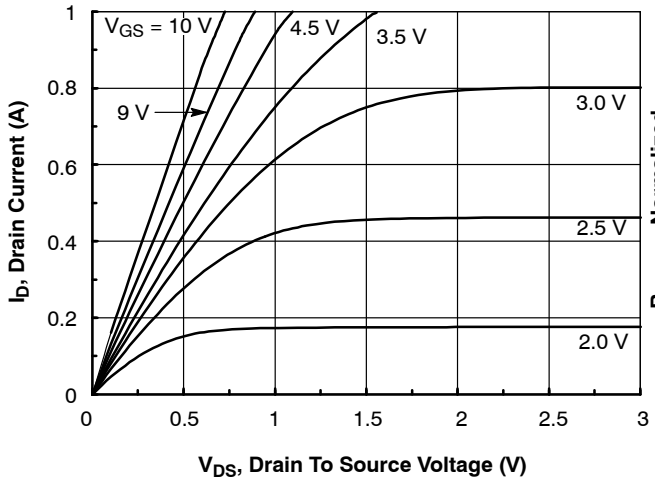



**Figure 1. On–Region Characteristics**

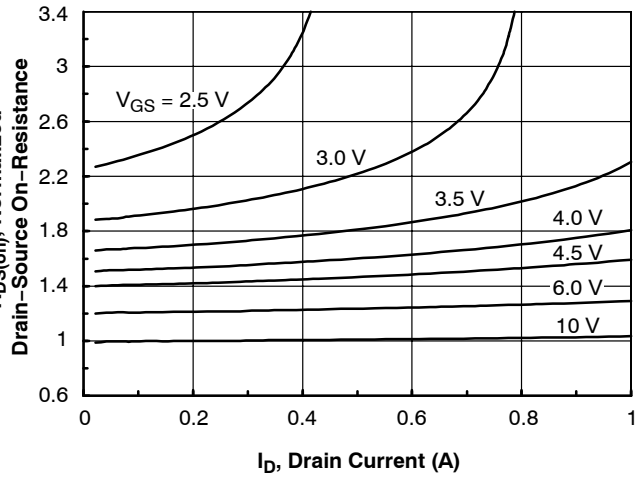



**Figure 2. On–Resistance Variation with Drain Current and Gate Voltage**



Share Feedback
Your Opinion Matters

## TYPICAL CHARACTERISTICS (continued)

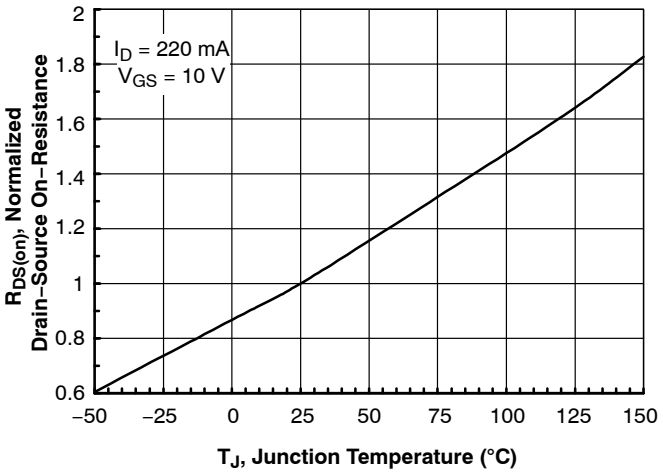



Figure 3. On−Resistance Variation with Temperature

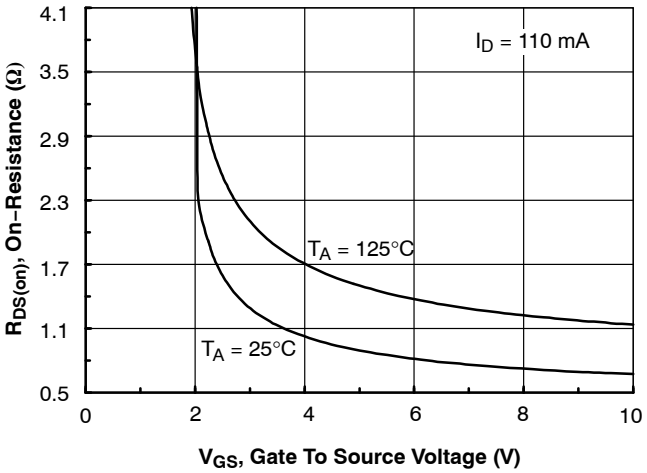



Figure 4. On−Resistance Variation with Gate−to−Source Voltage

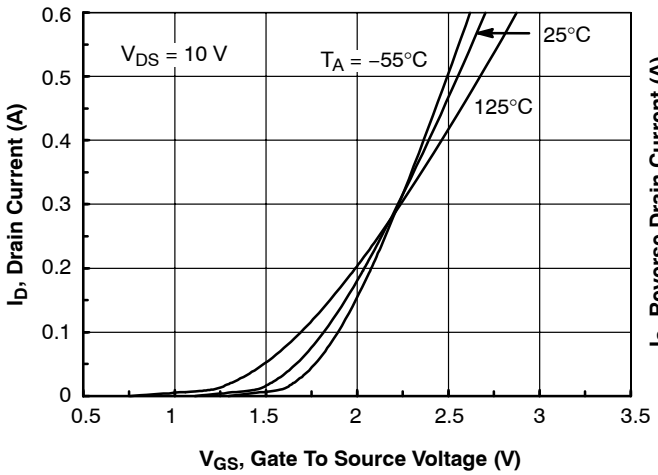



Figure 5. Transfer Characteristics

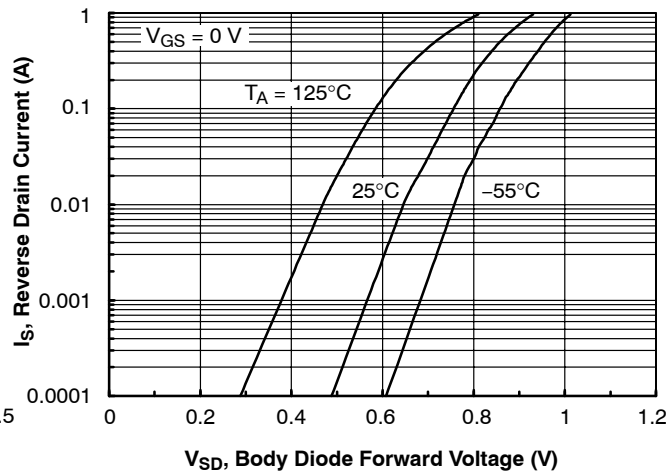



Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

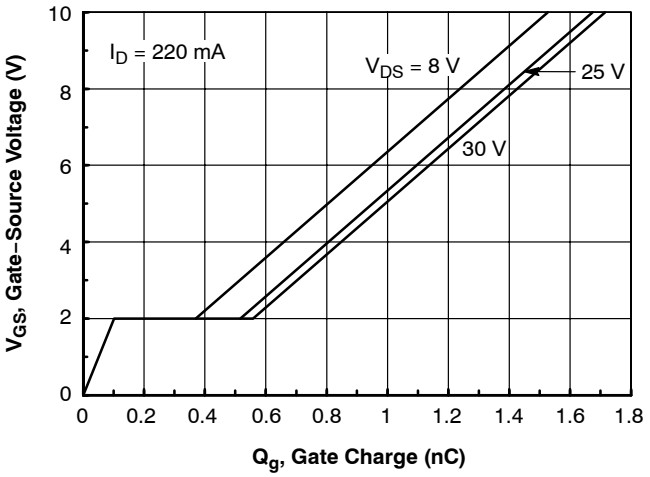



Figure 7. Gate Charge Characteristics

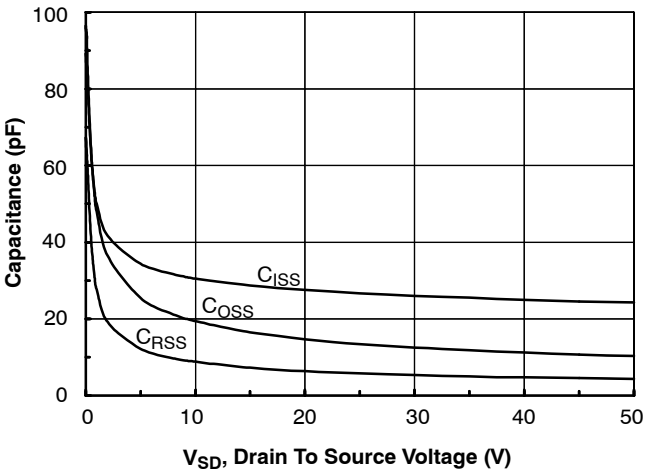



Figure 8. Capacitance Characteristics



Share Feedback
Your Opinion Matters

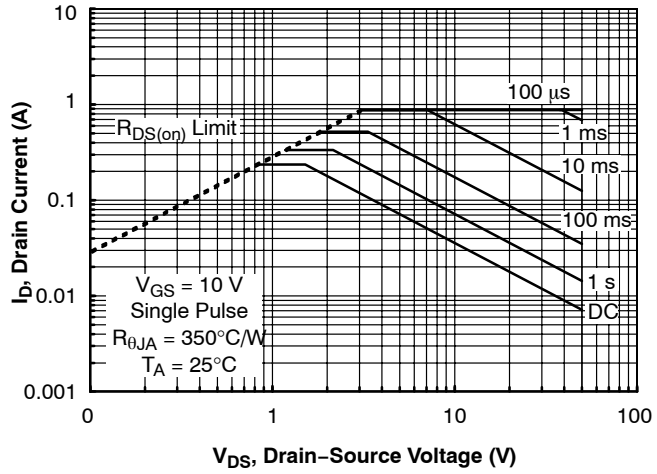



**Figure 9. Maximum Safe Operating Area**

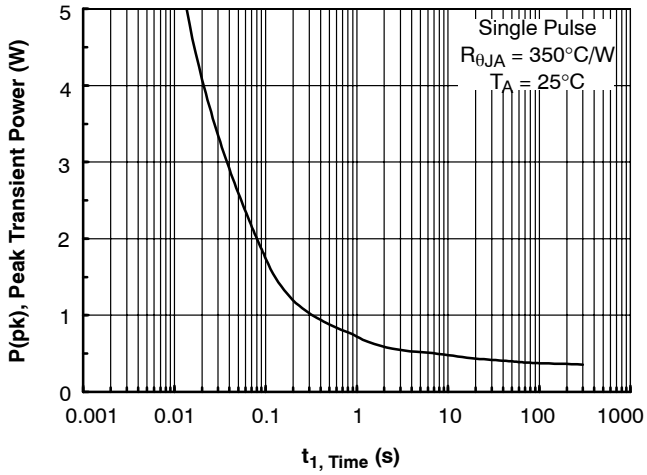



**Figure 10. Single Pulse Maximum Power Dissipation**

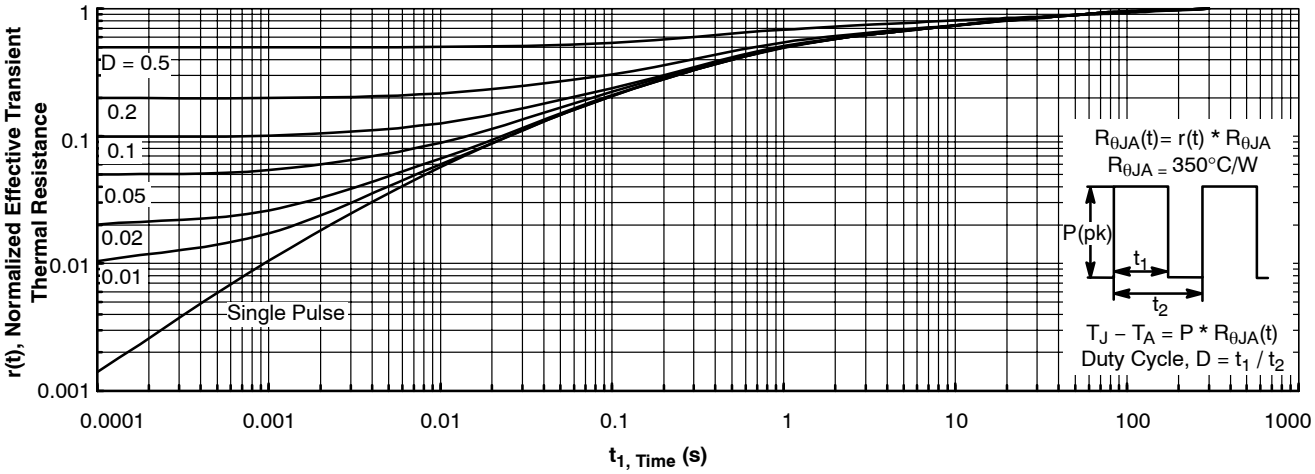
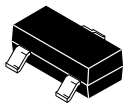



**Figure 11. Transient Thermal Response Curve**

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



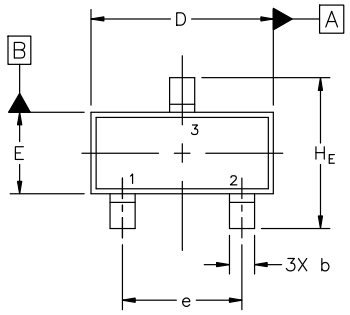
Share Feedback
Your Opinion Matters



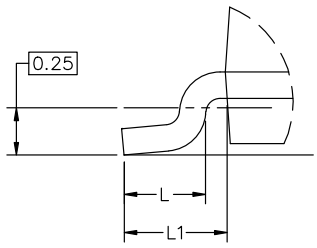
**SCALE 4:1**

**SOT−23 (TO−236) 2.90x1.30x1.00 1.90P**
CASE 318
ISSUE AU

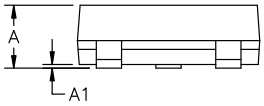
DATE 14 AUG 2024



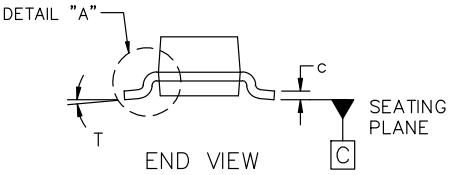

TOP VIEW




DETAIL "A"
Scale 3:1




SIDE VIEW

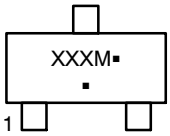



END VIEW

| MILLIMETERS | | | |
|---|---|---|---|
| DIM | MIN | NOM | MAX |
| A | 0.89 | 1.00 | 1.11 |
| A1 | 0.01 | 0.06 | 0.10 |
| b | 0.37 | 0.44 | 0.50 |
| c | 0.08 | 0.14 | 0.20 |
| D | 2.80 | 2.90 | 3.04 |
| E | 1.20 | 1.30 | 1.40 |
| e | 1.78 | 1.90 | 2.04 |
| L | 0.30 | 0.43 | 0.55 |
| L1 | 0.35 | 0.54 | 0.69 |
| $H_E$ | 2.10 | 2.40 | 2.64 |
| T | 0° | −−− | 10° |

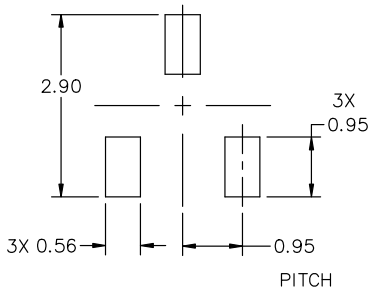
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSIONS: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

**GENERIC**
**MARKING DIAGRAM***




XXX = Specific Device Code
M = Date Code
▪ = Pb−Free Package

*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.




RECOMMENDED
MOUNTING FOOTPRINT

* For additional information on our Pb−Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

**STYLES ON PAGE 2**

| | | | |
|---|---|---|---|
| **DOCUMENT NUMBER:** | **98ASB42226B** | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. | |
| **DESCRIPTION:** | **SOT−23 (TO−236) 2.90x1.30x1.00 1.90P** | | **PAGE 1 OF 2** |

**onsemi** and onsemi are trademarks of Semiconductor Components Industries, LLC dba **onsemi** or its subsidiaries in the United States and/or other countries. **onsemi** reserves the right to make changes without further notice to any products herein. **onsemi** makes no warranty, representation or guarantee regarding the 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. **onsemi** does not convey any license under its patent rights nor the rights of others.

© Semiconductor Components Industries, LLC, 2019

**SOT−23 (TO−236) 2.90x1.30x1.00 1.90P**
CASE 318
ISSUE AU

DATE 14 AUG 2024

STYLE 1 THRU 5:
CANCELLED

STYLE 6:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

STYLE 7:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

STYLE 8:
PIN 1. ANODE
2. NO CONNECTION
3. CATHODE

STYLE 9:
PIN 1. ANODE
2. ANODE
3. CATHODE

STYLE 10:
PIN 1. DRAIN
2. SOURCE
3. GATE

STYLE 11:
PIN 1. ANODE
2. CATHODE
3. CATHODE−ANODE

STYLE 12:
PIN 1. CATHODE
2. CATHODE
3. ANODE

STYLE 13:
PIN 1. SOURCE
2. DRAIN
3. GATE

STYLE 14:
PIN 1. CATHODE
2. GATE
3. ANODE

STYLE 15:
PIN 1. GATE
2. CATHODE
3. ANODE

STYLE 16:
PIN 1. ANODE
2. CATHODE
3. CATHODE

STYLE 17:
PIN 1. NO CONNECTION
2. ANODE
3. CATHODE

STYLE 18:
PIN 1. NO CONNECTION
2. CATHODE
3. ANODE

STYLE 19:
PIN 1. CATHODE
2. ANODE
3. CATHODE−ANODE

STYLE 20:
PIN 1. CATHODE
2. ANODE
3. GATE

STYLE 21:
PIN 1. GATE
2. SOURCE
3. DRAIN

STYLE 22:
PIN 1. RETURN
2. OUTPUT
3. INPUT

STYLE 23:
PIN 1. ANODE
2. ANODE
3. CATHODE

STYLE 24:
PIN 1. GATE
2. DRAIN
3. SOURCE

STYLE 25:
PIN 1. ANODE
2. CATHODE
3. GATE

STYLE 26:
PIN 1. CATHODE
2. ANODE
3. NO CONNECTION

STYLE 27:
PIN 1. CATHODE
2. CATHODE
3. CATHODE

STYLE 28:
PIN 1. ANODE
2. ANODE
3. ANODE




**onsemi** and ONSEMI are trademarks of Semiconductor Components Industries, LLC dba **onsemi** or its subsidiaries in the United States and/or other countries. **onsemi** reserves the right to make changes without further notice to any products herein. **onsemi** makes no warranty, representation or guarantee regarding the 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. **onsemi** does not convey any license under its patent rights nor the rights of others.

© Semiconductor Components Industries, LLC, 2019

**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. **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
**onsemi Website:** www.onsemi.com

**ONLINE SUPPORT**: www.onsemi.com/support
**For additional information, please contact your local Sales Representative at** www.onsemi.com/support/sales