

# N-Channel Logic Level Enhancement Mode Field Effect Transistor

## BSS138W

### Description

These N-Channel Enhancement Mode Field Effect Transistor. 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

- $R_{DS(on)} = 3.5 \Omega @ V_{GS} = 10 V, I_D = 0.22 A$   
 $R_{DS(on)} = 6.0 \Omega @ V_{GS} = 4.5 V, I_D = 0.22 A$
- High Density Cell Design For Extremely Low  $R_{DS(on)}$
- Rugged and Reliable
- Compact Industry Standard SOT-323 Surface Mount Package
- These Devices are Pb-Free and Halide Free

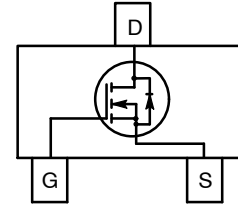
### ABSOLUTE MAXIMUM RATINGS $T_A = 25^\circ C$ unless otherwise noted

| Symbol         | Parameter                                                                       | Value           | Unit       |
|----------------|---------------------------------------------------------------------------------|-----------------|------------|
| $V_{DSS}$      | Drain to Source Voltage                                                         | 50              | V          |
| $V_{GSS}$      | Gate to Source Voltage                                                          | $\pm 20$        | V          |
| $I_D$          | Drain Current<br>– Continuous (Note 1)<br>– Pulsed                              | 0.21<br>0.84    | A          |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range                                | $-55$ to $+150$ | $^\circ C$ |
| $T_L$          | Maximum Lead Temperature for Soldering Purposes, 1/16" from Case for 10 Seconds | 300             | $^\circ C$ |

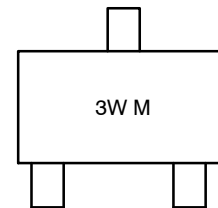
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.



SOT-323, 3 Lead, 1.25X2  
CASE 419AB



### MARKING DIAGRAM



3W = Device Code  
M = Date Code

### ORDERING INFORMATION

| Device  | Package              | Shipping <sup>†</sup> |
|---------|----------------------|-----------------------|
| BSS138W | SOT-323<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 Specifications Brochure, [BRD8011/D](#).

# BSS138W

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                            | Value       | Unit        |
|-----------------|------------------------------------------------------|-------------|-------------|
| $P_D$           | Maximum Power Dissipation Derate Above 25°C (Note 1) | 340<br>2.72 | mW<br>mW/°C |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1)     | 367         | °C/W        |

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

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

### Off Characteristics

|                                          |                                           |                                                                                                                                                                    |    |    |                 |                                      |
|------------------------------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|-----------------|--------------------------------------|
| $BV_{DSS}$                               | Drain to Source Breakdown Voltage         | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$                                                                                                                | 50 | –  | –               | V                                    |
| $\frac{\Delta BV_{DSS(th)}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to 25°C                                                                                                                | –  | 71 | –               | mV/°C                                |
| $I_{DSS}$                                | Zero Gate Voltage Drain Current           | $V_{DS} = 50\text{ V}, V_{GS} = 0\text{ V}$<br>$V_{DS} = 50\text{ V}, V_{GS} = 0\text{ V}, T_J = 125^\circ\text{C}$<br>$V_{DS} = 30\text{ V}, V_{GS} = 0\text{ V}$ | –  | –  | 0.5<br>5<br>100 | $\mu\text{A}$<br>$\mu\text{A}$<br>nA |
| $I_{GSS}$                                | Gate–Body Leakage                         | $V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$                                                                                                                    | –  | –  | $\pm 100$       | nA                                   |

### On Characteristics (Note2)

|                                        |                                                   |                                                                                                                                                                     |      |                      |                   |                                  |
|----------------------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------------------|-------------------|----------------------------------|
| $V_{GS(th)}$                           | Gate to Threshold Voltage                         | $V_{DS} = V_{GS}, I_D = 1\text{ mA}$                                                                                                                                | 0.8  | 1.3                  | 1.5               | V                                |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate to Threshold Voltage Temperature Coefficient | $I_D = 1\text{ mA}$ , Referenced to 25°C                                                                                                                            | –    | –3.9                 | –                 | mV/°C                            |
| $R_{DS(on)}$                           | Static Drain–Source On–Resistance                 | $V_{GS} = 10\text{ V}, I_D = 0.22\text{ A}$<br>$V_{GS} = 4.5\text{ V}, I_D = 0.22\text{ A}$<br>$V_{GS} = 10\text{ V}, I_D = 0.22\text{ A}, T_J = 125^\circ\text{C}$ | –    | 1.17<br>1.36<br>2.16 | 3.5<br>6.0<br>5.8 | $\Omega$<br>$\Omega$<br>$\Omega$ |
| $I_{D(on)}$                            | On–State Drain Current                            | $V_{GS} = 10\text{ V}, V_{DS} = 5\text{ V}$                                                                                                                         | 0.2  | –                    | –                 | A                                |
| $g_{FS}$                               | Forward Transconductance                          | $V_{DS} = 10\text{ V}, I_D = 0.22\text{ A}$                                                                                                                         | 0.12 | –                    | –                 | S                                |

### Dynamic Characteristics

|           |                              |                                                                 |   |     |   |          |
|-----------|------------------------------|-----------------------------------------------------------------|---|-----|---|----------|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$ | – | 38  | – | pF       |
| $C_{oss}$ | Output Capacitance           |                                                                 | – | 5.9 | – | pF       |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                 | – | 3.5 | – | pF       |
| $R_g$     | Gate Resistance              | $V_{GS} = 15\text{ mV}, f = 1.0\text{ MHz}$                     | – | 11  | – | $\Omega$ |

### Switching Characteristics

|              |                     |                                                                                                   |   |      |    |    |
|--------------|---------------------|---------------------------------------------------------------------------------------------------|---|------|----|----|
| $t_{d(on)}$  | Turn–On Delay Time  | $V_{DD} = 30\text{ V}, I_D = 0.29\text{ A},$<br>$V_{GS} = 10\text{ V}, R_{GEN} = 6\text{ }\Omega$ | – | 2.3  | 5  | ns |
| $t_r$        | Turn–On Rise Time   |                                                                                                   | – | 1.9  | 18 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time |                                                                                                   | – | 6.7  | 36 | ns |
| $t_f$        | Turn–Off Fall Time  |                                                                                                   | – | 6.5  | 14 | ns |
| $Q_g$        | Total Gate Change   | $V_{DS} = 25\text{ V}, I_D = 0.22\text{ A},$<br>$V_{GS} = 10\text{ V}$                            | – | 1.1  | –  | nC |
| $Q_{gs}$     | Gate–Source Change  |                                                                                                   | – | 0.12 | –  | nC |
| $Q_{gd}$     | Gate–Drain Change   |                                                                                                   | – | 0.22 | –  | nC |

### Drain–Source Diode Characteristics

|                 |                                                       |                                                         |   |   |      |   |
|-----------------|-------------------------------------------------------|---------------------------------------------------------|---|---|------|---|
| I <sub>S</sub>  | Maximum Continuous Drain–Source Diode Forward Current |                                                         | – | – | 0.22 | A |
| V <sub>SD</sub> | Drain–Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 0.44 A (Note 2) | – | – | 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.

- 367°C/W When Mounted on a minimum pad.
- Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$

TYPICAL CHARACTERISTICS

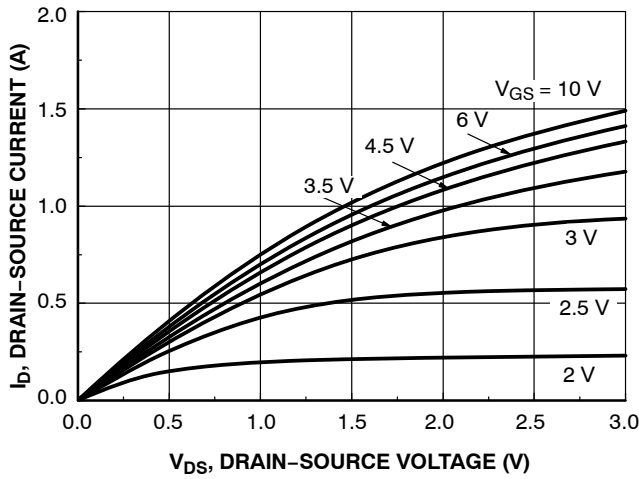


Figure 1. On-Region Characteristics

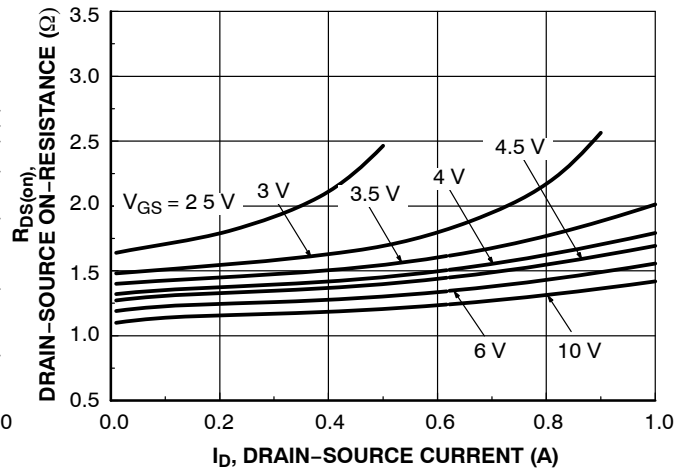


Figure 2. On-Resistance Variation With Drain Current and Gate Voltage

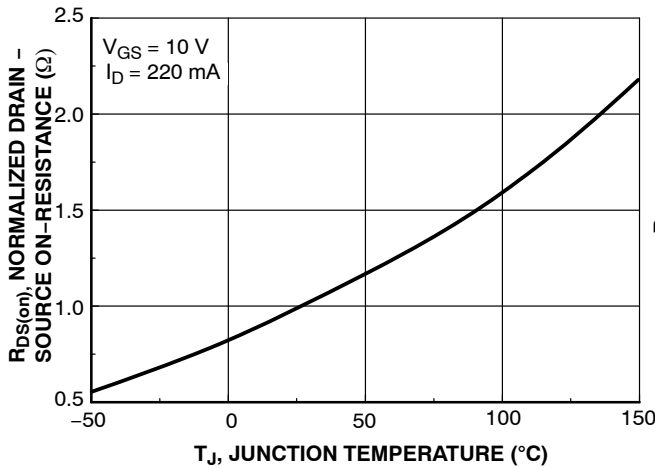


Figure 3. On-Resistance Variation with Temperature.

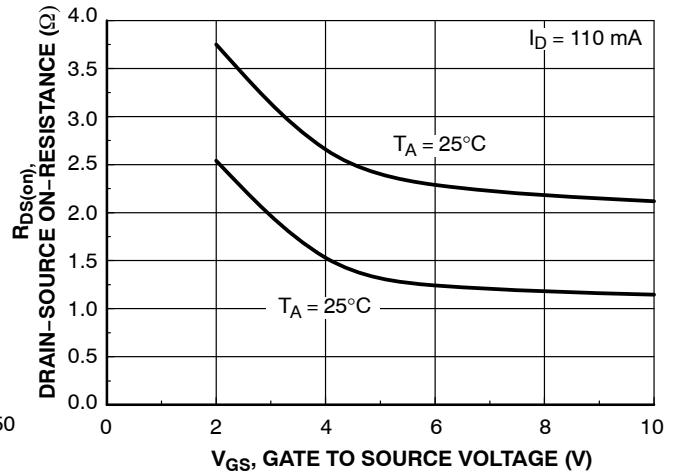


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

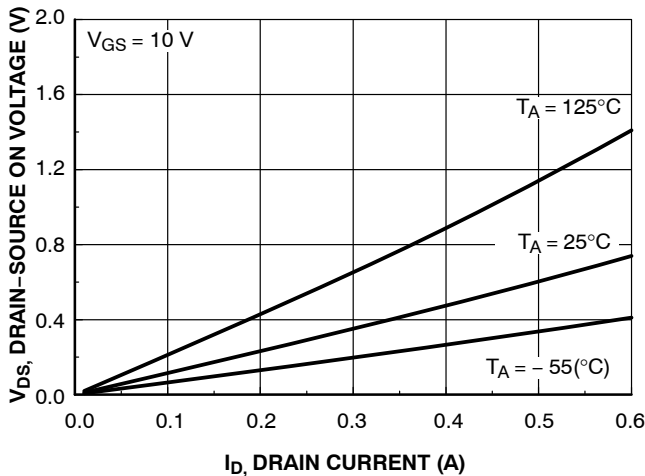


Figure 5. Drain-Source On Voltage with Temperature.

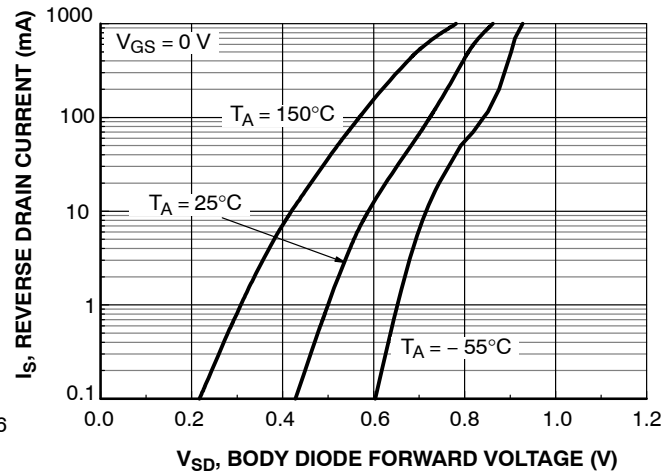


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

TYPICAL CHARACTERISTICS (continued)

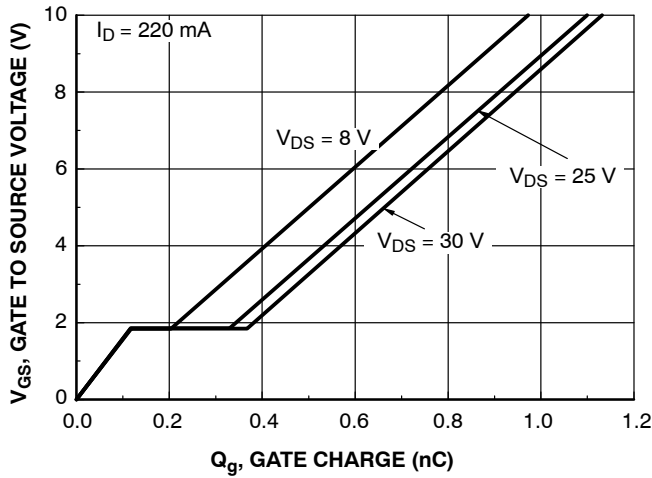


Figure 7. Gate Charge Characteristics

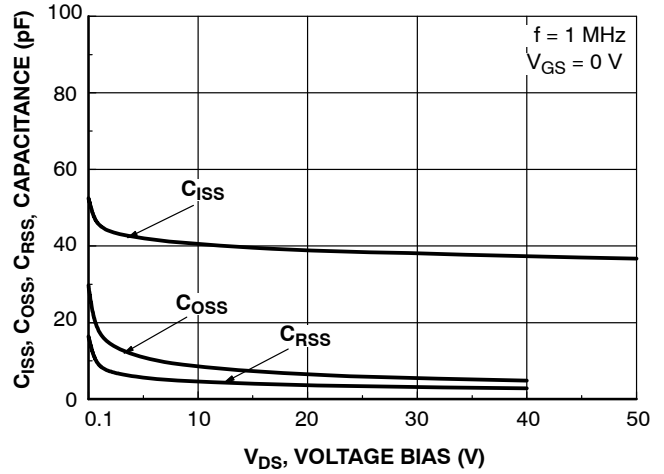


Figure 8. Capacitance Characteristics

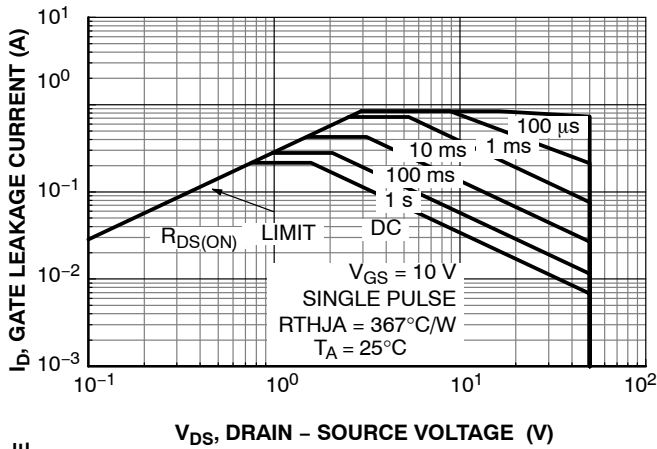


Figure 9. Maximum Safe Operating Area

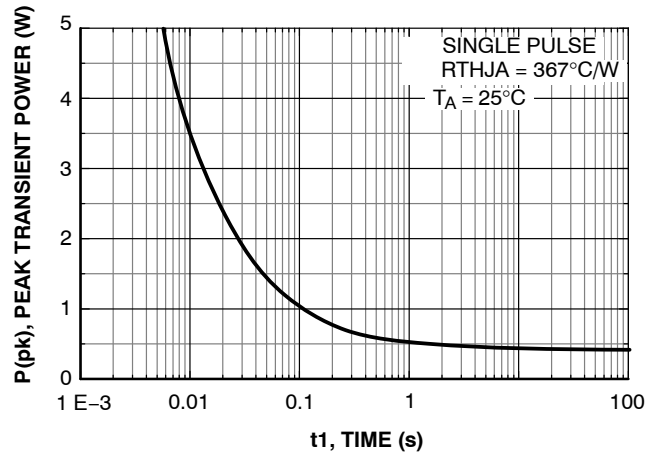


Figure 10. Single Pulse Maximum Power Dissipation

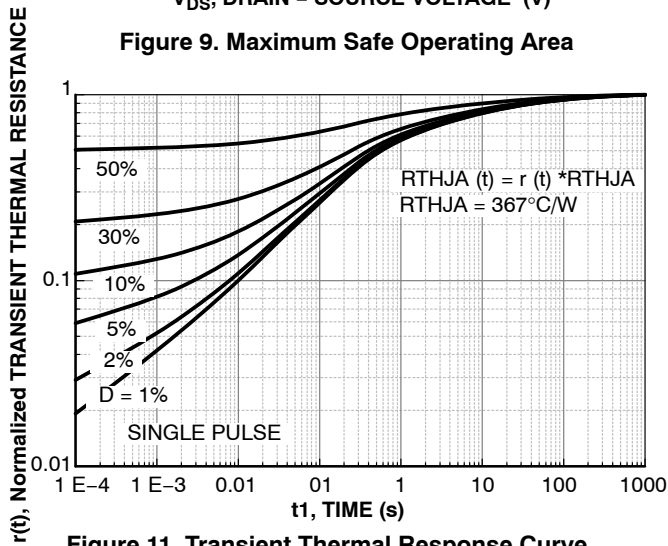
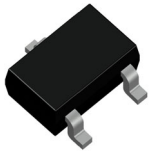
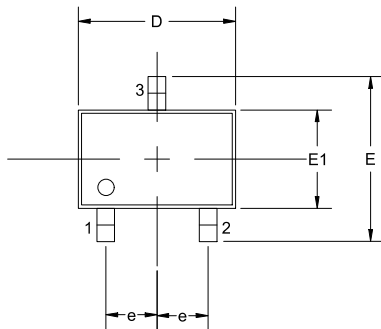


Figure 11. Transient Thermal Response Curve

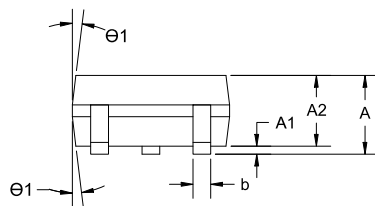


SC-70, 3 Lead, 1.25x2  
CASE 419AB  
ISSUE A

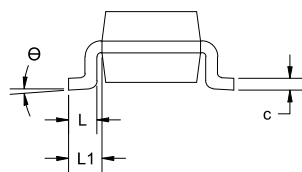
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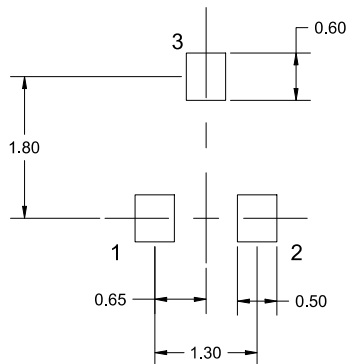
TOP VIEW



SIDE VIEW



END VIEW



SOLDERING FOOTPRINT

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES IN DEGREES.
2. COMPLIES WITH JEDEC MO-203

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | 0.80        |      | 1.10 |
| A1  | 0.00        |      | 0.10 |
| A2  | 0.80        | 0.90 | 1.00 |
| b   | 0.15        |      | 0.30 |
| c   | 0.08        |      | 0.22 |
| D   | 1.80        | 2.00 | 2.20 |
| E   | 1.80        | 2.10 | 2.40 |
| E1  | 1.15        | 1.25 | 1.35 |
| e   | 0.65 BSC    |      |      |
| L   | 0.26        | 0.36 | 0.46 |
| L1  | 0.42 REF    |      |      |
| Θ   | 0°          |      | 8°   |
| Θ1  | 4°          |      | 10°  |

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

|                  |                       |                                                                                                                                                                                     |
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| DESCRIPTION:     | SC-70, 3 LEAD, 1.25X2 | PAGE 1 OF 1                                                                                                                                                                         |

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