N-Channel Logic Level Enhancement Mode Field Effect Transistor

BSS138

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
  - \( R_{\text{DS(on)}} = 3.5 \, \Omega \) @ \( V_{\text{GS}} = 10 \, \text{V} \)
  - \( R_{\text{DS(on)}} = 6.0 \, \Omega \) @ \( V_{\text{GS}} = 4.5 \, \text{V} \)
- High Density Cell Design for Extremely Low \( R_{\text{DS(on)}} \)
- Rugged and Reliable
- Compact Industry Standard SOT–23 Surface Mount Package
- This Device is Pb–Free and Halogen Free

MARKING DIAGRAM

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Device</th>
<th>Package</th>
<th>Shipping†</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSS138, BSS138–G</td>
<td>SOT–23–3 (Pb–Free)</td>
<td>3000 / Tape &amp; Reel</td>
</tr>
</tbody>
</table>

†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.
### ABSOLUTE MAXIMUM RATINGST<sub>T<sub>A</sub> = 25°C unless otherwise noted.</p>

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;DSS&lt;/sub&gt;</td>
<td>Drain–Source Voltage</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;GSS&lt;/sub&gt;</td>
<td>Gate–Source Voltage</td>
<td>±20</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
<td>Drain Current – Continuous (Note 1)</td>
<td>0.22</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Drain Current – Pulsed (Note 1)</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>P&lt;sub&gt;D&lt;/sub&gt;</td>
<td>Maximum Power Dissipation (Note 1)</td>
<td>0.36</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>Derate Above 25°C</td>
<td>2.8</td>
<td>mW/°C</td>
</tr>
<tr>
<td>T&lt;sub&gt;J&lt;/sub&gt;, T&lt;sub&gt;STG&lt;/sub&gt;</td>
<td>Operating and Storage Junction Temperature Range</td>
<td>–55 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>T&lt;sub&gt;L&lt;/sub&gt;</td>
<td>Maximum Lead Temperature for Soldering Purposes, 1/16” from Case for 10 s</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

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<sub>A</sub> = 25°C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Ratings</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;JA&lt;/sub&gt;</td>
<td>Thermal Resistance, Junction–to–Ambient (Note 1)</td>
<td>350</td>
<td>°C/W</td>
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### ELECTRICAL CHARACTERISTICS T<sub>A</sub> = 25°C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>B&lt;sub&gt;VDS&lt;/sub&gt;</td>
<td>Drain–Source Breakdown Voltage</td>
<td>V&lt;sub&gt;G&lt;/sub&gt; = 0 V, I&lt;sub&gt;D&lt;/sub&gt; = 250 μA</td>
<td>50</td>
<td>–</td>
<td>–</td>
<td>V</td>
</tr>
<tr>
<td>ΔV&lt;sub&gt;GSS(th)&lt;/sub&gt;</td>
<td>Breakdown Voltage Temperature Coefficient</td>
<td>I&lt;sub&gt;D&lt;/sub&gt; = 250 μA, Referenced to 25°C</td>
<td>–</td>
<td>72</td>
<td>–</td>
<td>mV/°C</td>
</tr>
<tr>
<td>I&lt;sub&gt;DSS&lt;/sub&gt;</td>
<td>Zero Gate Voltage Drain Current</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 50 V, V&lt;sub&gt;GS&lt;/sub&gt; = 0 V</td>
<td>–</td>
<td>–</td>
<td>0.5</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 50 V, V&lt;sub&gt;GS&lt;/sub&gt; = 0 V, T&lt;sub&gt;J&lt;/sub&gt; = 125°C</td>
<td>–</td>
<td>–</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 30 V, V&lt;sub&gt;GS&lt;/sub&gt; = 0 V</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>I&lt;sub&gt;GSS&lt;/sub&gt;</td>
<td>Gate–Body Leakage</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = ±20 V, V&lt;sub&gt;DS&lt;/sub&gt; = 0 V</td>
<td>–</td>
<td>–</td>
<td>±100</td>
<td></td>
</tr>
</tbody>
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### OFF CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
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<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;GS(th)&lt;/sub&gt;</td>
<td>Gate Threshold Voltage</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = V&lt;sub&gt;GS&lt;/sub&gt;, I&lt;sub&gt;D&lt;/sub&gt; = 1 mA</td>
<td>0.8</td>
<td>1.3</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td>ΔV&lt;sub&gt;GS(th)&lt;/sub&gt;</td>
<td>Gate Threshold Voltage Temperature Coefficient</td>
<td>I&lt;sub&gt;D&lt;/sub&gt; = 1 mA, Referenced to 25°C</td>
<td>–</td>
<td>–2</td>
<td>–</td>
<td>mV/°C</td>
</tr>
<tr>
<td>R&lt;sub&gt;DS(on)&lt;/sub&gt;</td>
<td>Static Drain–Source On–Resistance</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 10 V, I&lt;sub&gt;D&lt;/sub&gt; = 0.22 A</td>
<td>–</td>
<td>0.7</td>
<td>3.5</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 4.5 V, I&lt;sub&gt;D&lt;/sub&gt; = 0.22 A</td>
<td>–</td>
<td>1.0</td>
<td>6.0</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 10 V, I&lt;sub&gt;D&lt;/sub&gt; = 0.22 A, T&lt;sub&gt;J&lt;/sub&gt; = 125°C</td>
<td>–</td>
<td>1.1</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;D(on)&lt;/sub&gt;</td>
<td>On–State Drain Current</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 10 V, V&lt;sub&gt;DS&lt;/sub&gt; = 5 V</td>
<td>0.2</td>
<td>–</td>
<td>–</td>
<td>A</td>
</tr>
<tr>
<td>g&lt;sub&gt;F&lt;/sub&gt;</td>
<td>Forward Transconductance</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 10 V, I&lt;sub&gt;D&lt;/sub&gt; = 0.22 A</td>
<td>0.12</td>
<td>0.5</td>
<td>–</td>
<td>S</td>
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### DYNAMIC CHARACTERISTICS

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<tr>
<th>Symbol</th>
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<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&lt;sub&gt;iss&lt;/sub&gt;</td>
<td>Input Capacitance</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 25 V, V&lt;sub&gt;GS&lt;/sub&gt; = 0 V, f = 1.0 MHz</td>
<td>–</td>
<td>27</td>
<td>–</td>
<td>pF</td>
</tr>
<tr>
<td>C&lt;sub&gt;oss&lt;/sub&gt;</td>
<td>Output Capacitance</td>
<td>–</td>
<td>13</td>
<td>–</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;riss&lt;/sub&gt;</td>
<td>Reverse Transfer Capacitance</td>
<td>–</td>
<td>6</td>
<td>–</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>R&lt;sub&gt;G&lt;/sub&gt;</td>
<td>Gate Resistance</td>
<td>V&lt;sub&gt;GS&lt;/sub&gt; = 15 mV, f = 1.0 MHz</td>
<td>–</td>
<td>9</td>
<td>–</td>
<td>Ω</td>
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</table>
ELECTRICAL CHARACTERISTICS  $T_a = 25^\circ C$ unless otherwise noted. (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{d(on)}$</td>
<td>Turn–On Delay Time</td>
<td>$V_{DD} = 30 , V$, $I_D = 0.29 , A$, $V_{GS} = 10 , V$, $R_{GEN} = 6 , \Omega$</td>
<td>–</td>
<td>2.5</td>
<td>5</td>
<td>ns</td>
</tr>
<tr>
<td>$t_r$</td>
<td>Turn–On Rise Time</td>
<td>–</td>
<td>9</td>
<td>18</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{d(off)}$</td>
<td>Turn–Off Delay Time</td>
<td>–</td>
<td>20</td>
<td>36</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_f$</td>
<td>Turn–Off Fall Time</td>
<td>–</td>
<td>7</td>
<td>14</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$Q_g$</td>
<td>Total Gate Charge</td>
<td>$V_{DS} = 25 , V$, $I_D = 0.22 , A$, $V_{GS} = 10 , V$</td>
<td>–</td>
<td>1.7</td>
<td>2.4</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{gs}$</td>
<td>Gate–Source Charge</td>
<td>–</td>
<td>0.1</td>
<td>–</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>$Q_{gd}$</td>
<td>Gate–Drain Charge</td>
<td>–</td>
<td>0.4</td>
<td>–</td>
<td>nC</td>
<td></td>
</tr>
</tbody>
</table>

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. $R_{JA}$ 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. $R_{JA}$ is guaranteed by design while $R_{JA}$ is determined by the user’s board design.

2. Pulse Test: Pulse Width $\leq 300 \mu s$, Duty Cycle $\leq 2.0\%$

TYPICAL CHARACTERISTICS

Figure 1. On–Region Characteristics

Figure 2. On–Resistance Variation with Drain Current and Gate Voltage
TYPICAL CHARACTERISTICS (continued)

**Figure 3. On-Resistance Variation with Temperature**

![Graph showing On-Resistance Variation with Temperature](image1)

**Figure 4. On-Resistance Variation with Gate-To-Source Voltage**

![Graph showing On-Resistance Variation with Gate-To-Source Voltage](image2)

**Figure 5. Transfer Characteristics**

![Graph showing Transfer Characteristics](image3)

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

![Graph showing Body Diode Forward Voltage Variation](image4)

**Figure 7. Gate Charge Characteristics**

![Graph showing Gate Charge Characteristics](image5)

**Figure 8. Capacitance Characteristics**

![Graph showing Capacitance Characteristics](image6)
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.
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

SOT-23 (TO-236)
CASE 318-08
ISSUE AS

DATE 30 JAN 2018

NOTES:
2. CONTROLLING DIMENSION: 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.

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R E C O M M E N D E D
S O L D E R I N G  F O O T P R I N T

G E N E R I C
M A R K I N G  D I A G R A M*

*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.

M I L L I M E T E R S

<table>
<thead>
<tr>
<th>DIM</th>
<th>MIN</th>
<th>NOM</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.89</td>
<td>1.00</td>
<td>1.11</td>
</tr>
<tr>
<td>A1</td>
<td>0.01</td>
<td>0.06</td>
<td>0.10</td>
</tr>
<tr>
<td>B</td>
<td>0.37</td>
<td>0.44</td>
<td>0.50</td>
</tr>
<tr>
<td>B1</td>
<td>0.08</td>
<td>0.14</td>
<td>0.20</td>
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<tr>
<td>C</td>
<td>2.80</td>
<td>2.90</td>
<td>3.04</td>
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<tr>
<td>C1</td>
<td>1.20</td>
<td>1.30</td>
<td>1.40</td>
</tr>
<tr>
<td>D</td>
<td>1.20</td>
<td>1.30</td>
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<tr>
<td>E</td>
<td>1.20</td>
<td>1.30</td>
<td>1.40</td>
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<tr>
<td>L</td>
<td>0.30</td>
<td>0.43</td>
<td>0.55</td>
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<tr>
<td>L1</td>
<td>0.35</td>
<td>0.54</td>
<td>0.69</td>
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<tr>
<td>T</td>
<td>0.00</td>
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I N C H E S

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<td>0.035</td>
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<td>0.002</td>
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<tr>
<td>A1</td>
<td>0.01</td>
<td>0.06</td>
<td>0.10</td>
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<tr>
<td>B</td>
<td>0.003</td>
<td>0.006</td>
<td>0.008</td>
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<tr>
<td>B1</td>
<td>0.017</td>
<td>0.020</td>
<td>0.022</td>
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<tr>
<td>C</td>
<td>0.039</td>
<td>0.044</td>
<td>0.002</td>
</tr>
<tr>
<td>C1</td>
<td>0.017</td>
<td>0.020</td>
<td>0.022</td>
</tr>
<tr>
<td>D</td>
<td>0.114</td>
<td>0.120</td>
<td>0.120</td>
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<tr>
<td>E</td>
<td>0.051</td>
<td>0.055</td>
<td>0.008</td>
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<td>L</td>
<td>0.075</td>
<td>0.114</td>
<td>0.114</td>
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<tr>
<td>L1</td>
<td>0.017</td>
<td>0.020</td>
<td>0.022</td>
</tr>
</tbody>
</table>

D I M E N S I O N S: MILLIMETERS

3X 0.80
2.90
0.95 PITCH

3X 0.90

SIDE VIEW

TOP VIEW

VIEW C

SEE VIEW C

END VIEW

NOTE: 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.

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. BASE
3. EMITTER

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

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

STYLE 12:
PIN 1. SOURCE
2. DRAIN
3. GATE

STYLE 13:
PIN 1. ANODE
2. NO CONNECTION
3. ANODE

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

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

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

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

STYLE 18:
PIN 1. CATHODE
2. ANODE
3. GATE

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

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

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

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

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

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

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

STYLE 26:
PIN 1. ANODE
2. ANODE
3. CATHODE−ANODE

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

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

STYLE 29:
PIN 1. GATE
2. SOURCE
3. DRATE

STYLE 30:
PIN 1. DRAIN
2. CATHODE
3. ANODE

STYLE 31:
PIN 1. CATHODE
2. ANODE
3. CATHODE

STYLE 32:
PIN 1. GATE
2. DRAIN
3. CATHODE

S O T− 23 (T O− 236)

G U I D E  N O.:
98ASB42226B

D E S C R I P T I O N: S O T − 23 (T O− 236)

P A G E 1 O F 1

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