

# Field Effect Transistor – N-Channel, Logic Level, Enhancement Mode

## BSS138L

### Description

This N-channel enhancement mode field effect transistor is produced using high cell density, trench MOSFET technology. This product minimizes on-state resistance while providing rugged, reliable, and fast switching performance. This product is particularly suited for low-voltage, low-current applications such as small servo motor control, power MOSFET gate drivers, logic level translator, high speed line drivers, power management/power supply and switching applications.

### Features

- High Density Cell Design for Low  $R_{DS(ON)}$
- Rugged and Reliable
- Compact Industry Standard SOT-23 Surface Mount Package
- Very Low Capacitance
- Fast Switching Speed
- This Device is Pb-Free, Halide Free and is RoHS Compliant

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

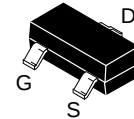
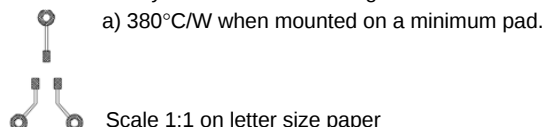
| Symbol         | Parameter                                                                           | Value           | Unit             |
|----------------|-------------------------------------------------------------------------------------|-----------------|------------------|
| $V_{DSS}$      | Drain-Source Voltage                                                                | 50              | V                |
| $V_{GSS}$      | Gate-Source Voltage                                                                 | $\pm 20$        | V                |
| $I_D$          | Maximum Drain Current                                                               | Continuous      | 0.20 A           |
|                |                                                                                     | Pulsed          | 0.80 A           |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range                                    | $-55$ to $+150$ | $^\circ\text{C}$ |
| $T_L$          | Maximum Lead Temperature for Soldering Purposes, 1/16 inch from Case for 10 Seconds | 300             | $^\circ\text{C}$ |

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)

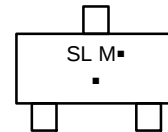
| Symbol          | Parameter                                        | Value | Unit                 |
|-----------------|--------------------------------------------------|-------|----------------------|
| $P_D$           | Maximum Power Dissipation (Note 1)               | 0.35  | W                    |
|                 | Derate Above $25^\circ\text{C}$                  | 2.8   | mW/ $^\circ\text{C}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1) | 380   | $^\circ\text{C/W}$   |

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



SOT-23 (TO-236)  
CASE 318

### MARKING DIAGRAM



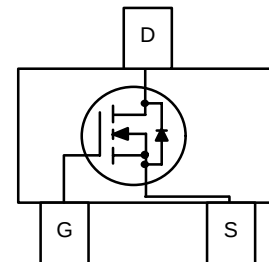
SL = Specific Device Code

M = Date Code\*

■ = Pb-Free Package

(Note: Microdot may be in either location)

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



### ORDERING INFORMATION

| Device  | Package                      | Shipping†             |
|---------|------------------------------|-----------------------|
| BSS138L | SOT-23 (TO-236)<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 Specifications Brochure, BRD8011/D.

# BSS138L

## ESD RATING (Note 2)

| Symbol | Parameter                                        | Value | Unit |
|--------|--------------------------------------------------|-------|------|
| HBM    | Human Body Model per ANSI/ESDA/JEDEC JS-001-2012 | 50    | V    |
| CDM    | Charged Device Model per JEDEC C101C             | >2000 |      |

2. ESD values are in typical, no over-voltage rating is implied, ESD CDM zap voltage is 2000 V maximum.

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

| Symbol                               | Parameter                                 | Conditions                                                           | Min  | Typ   | Max  | Unit                 |
|--------------------------------------|-------------------------------------------|----------------------------------------------------------------------|------|-------|------|----------------------|
| <b>OFF CHARACTERISTICS</b>           |                                           |                                                                      |      |       |      |                      |
| $BV_{DSS}$                           | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$                  | 50.0 | 65.4  | –    | V                    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$    | –    | 58    | –    | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 50\text{ V}, V_{GS} = 0\text{ V}$                          | –    | 0.263 | 500  | nA                   |
|                                      |                                           | $V_{DS} = 50\text{ V}, V_{GS} = 0\text{ V}, T_J = 125^\circ\text{C}$ | –    | 0.109 | 5    | $\mu\text{A}$        |
|                                      |                                           | $V_{DS} = 30\text{ V}, V_{GS} = 0\text{ V}$                          | –    | 0.062 | 100  | nA                   |
| $I_{GSSF}$                           | Gate-Body Leakage, Forward                | $V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$                          | –    | 0.058 | 100  | nA                   |
| $I_{GSSR}$                           | Gate-Body Leakage, Reverse                | $V_{GS} = -20\text{ V}, V_{DS} = 0\text{ V}$                         | –    | -0.06 | -100 | nA                   |

## ON CHARACTERISTICS (Note 3)

|                                        |                                                |                                                        |      |       |      |                      |
|----------------------------------------|------------------------------------------------|--------------------------------------------------------|------|-------|------|----------------------|
| $V_{GS(th)}$                           | Gate Threshold Voltage                         | $V_{DS} = V_{GS}, I_D = 1\text{ mA}$                   | 0.80 | 1.25  | 1.50 | V                    |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate Threshold Voltage Temperature Coefficient | $I_D = 1\text{ mA}$ , Referenced to $25^\circ\text{C}$ | –    | -2.42 | –    | mV/ $^\circ\text{C}$ |
| $R_{DS(on)}$                           | Static Drain-Source On-Resistance              | $V_{GS} = 5\text{ V}, I_D = 0.20\text{ A}$             | –    | 2.78  | 3.50 | $\Omega$             |
|                                        |                                                | $V_{GS} = 2.75\text{ V}, I_D = 0.20\text{ A}$          | –    | 3.78  | 10   |                      |
| $I_{D(on)}$                            | On-State Drain Current                         | $V_{GS} = 10\text{ V}, V_{DS} = 5\text{ V}$            | 0.20 | 0.67  | –    | A                    |
| $g_{FS}$                               | Forward Transconductance                       | $V_{DS} = 10\text{ V}, I_D = 0.22\text{ A}$            | 0.12 | 0.35  | –    | S                    |

## DYNAMIC CHARACTERISTICS

|           |                              |                                                                 |   |      |    |          |
|-----------|------------------------------|-----------------------------------------------------------------|---|------|----|----------|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$ | – | 12.2 | 50 | pF       |
| $C_{oss}$ | Output Capacitance           |                                                                 | – | 3.04 | 25 | pF       |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                 | – | 1.43 | 5  | pF       |
| $R_G$     | Gate Resistance              | $V_{GS} = 15\text{ V}, V_{GS} = 1.0\text{ MHz}$                 | – | 26.6 | –  | $\Omega$ |

## SWITCHING CHARACTERISTICS (Note 3)

|              |                    |                                                                                        |   |       |     |    |
|--------------|--------------------|----------------------------------------------------------------------------------------|---|-------|-----|----|
| $t_{d(on)}$  | Turn-On Delay      | $V_{DD} = 30\text{ V}, I_D = 0.29\text{ A}, V_{GS} = 10\text{ V}$                      | – | 2.2   | 5   | ns |
| $t_r$        | Turn-On Rise Time  |                                                                                        | – | 1.8   | 18  | ns |
| $t_{d(off)}$ | Turn-Off Delay     |                                                                                        | – | 5.3   | 36  | ns |
| $t_f$        | Turn-Off Fall Time |                                                                                        | – | 5.1   | 14  | ns |
| $Q_g$        | Total Gate Charge  | $V_{DS} = 25\text{ V}, I_D = 0.22\text{ A}, V_{GS} = 10\text{ V}, I_G = 0.1\text{ mA}$ | – | 0.549 | 2.4 | nC |
| $Q_{gs}$     | Gate-Source Charge |                                                                                        | – | 0.075 | –   | nC |
| $Q_{gd}$     | Gate-Drain Charge  |                                                                                        | – | 0.117 | –   | nC |

## DRAIN-SOURCE CHARACTERISTICS AND MAXIMUM RATINGS

|                 |                                                       |                                                |   |      |      |   |
|-----------------|-------------------------------------------------------|------------------------------------------------|---|------|------|---|
| 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> = 115 mA | – | 0.93 | 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.

3. Pulse test: pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2.0\%$ .

TYPICAL PERFORMANCE CHARACTERISTICS

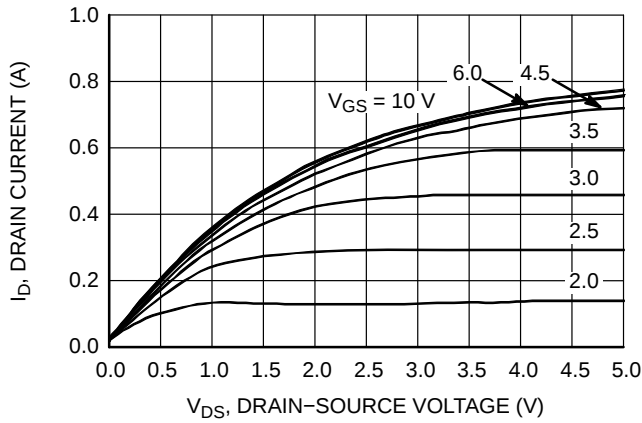


Figure 1. On-Region Characteristics

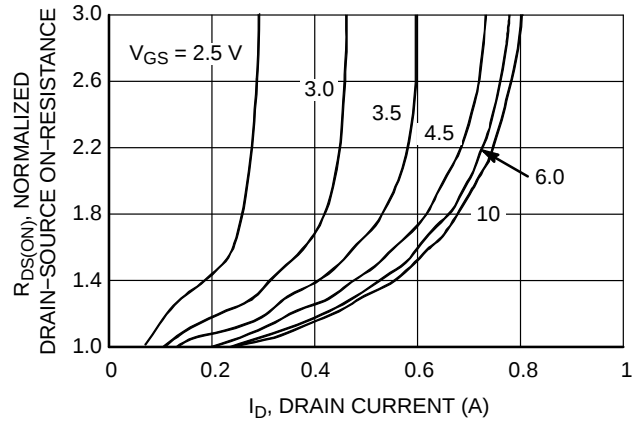


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

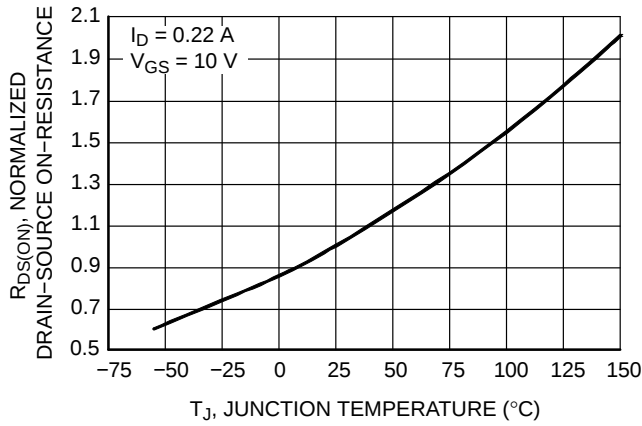


Figure 3. On-Resistance Variation with Temperature

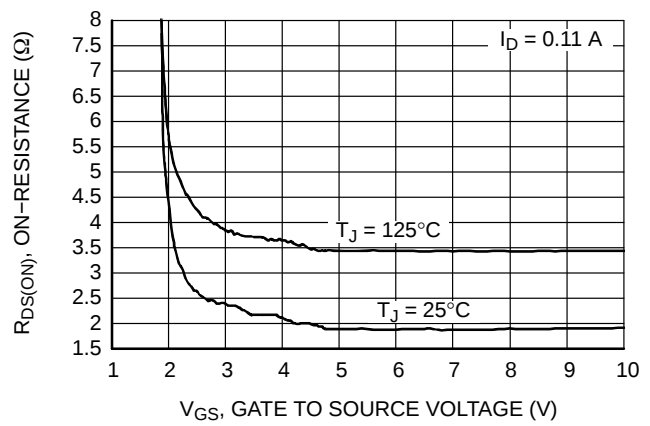


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

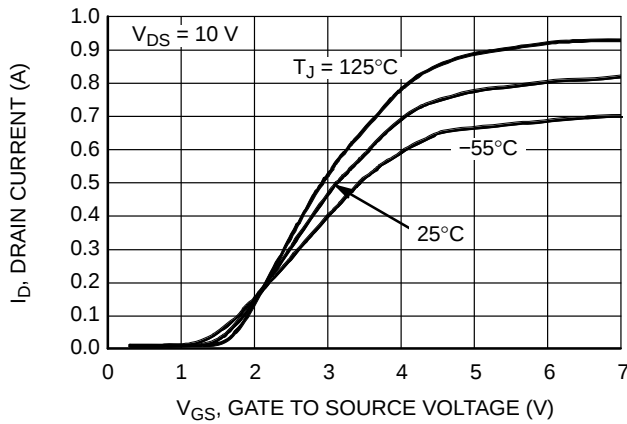


Figure 5. Transfer Characteristics

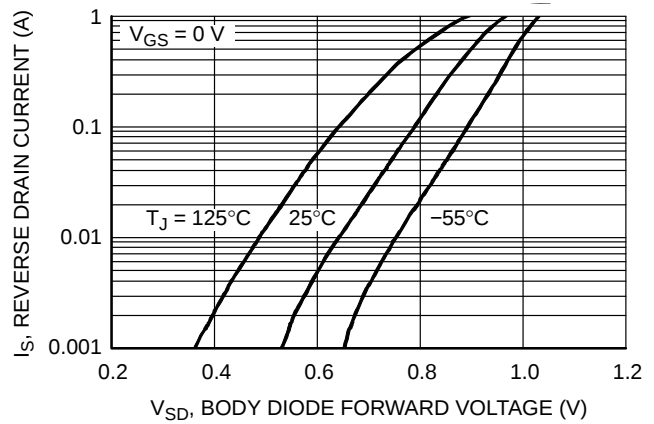


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

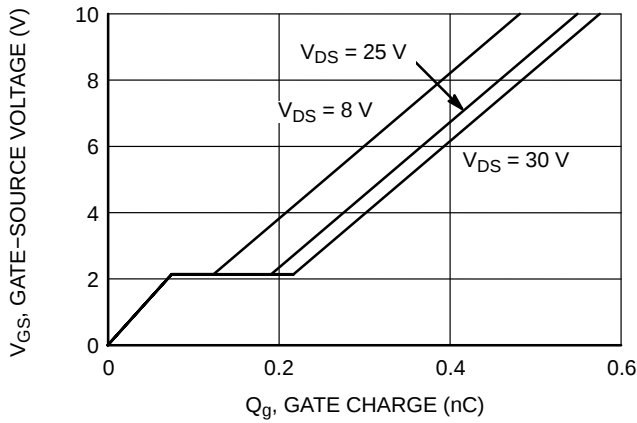


Figure 7. Gate Charge Characteristics

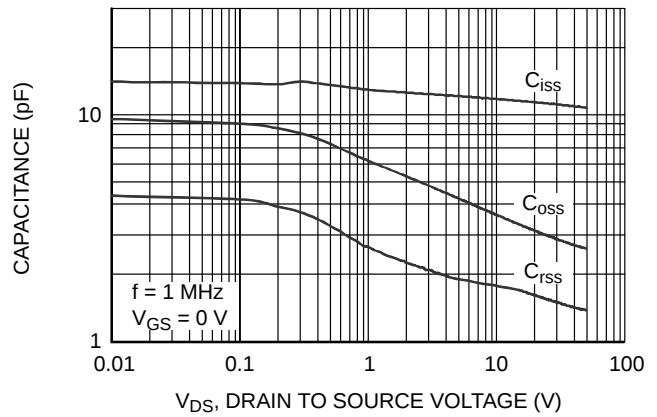


Figure 8. Capacitance Characteristics

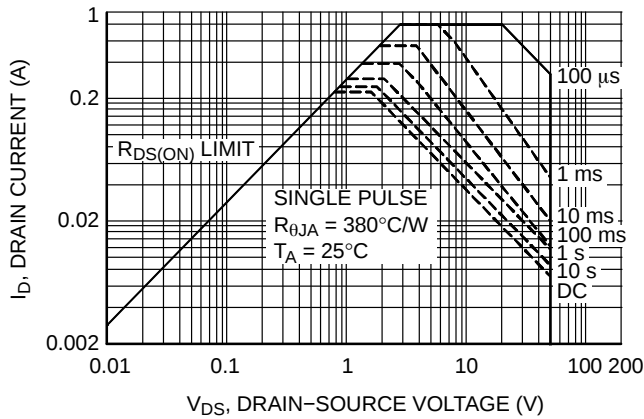


Figure 9. Maximum Safe Operating Area

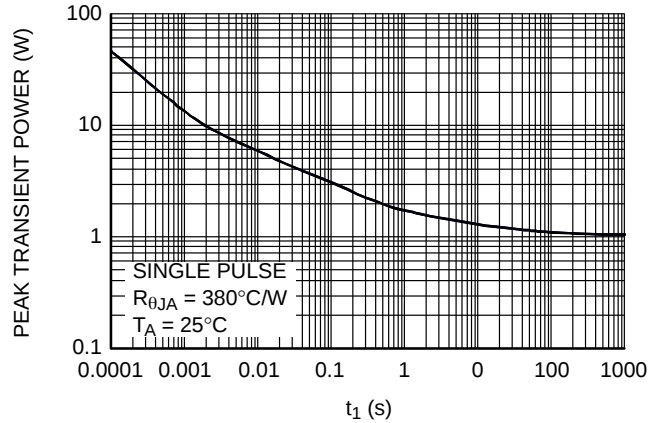


Figure 10. Single Pulse Maximum Power Dissipation

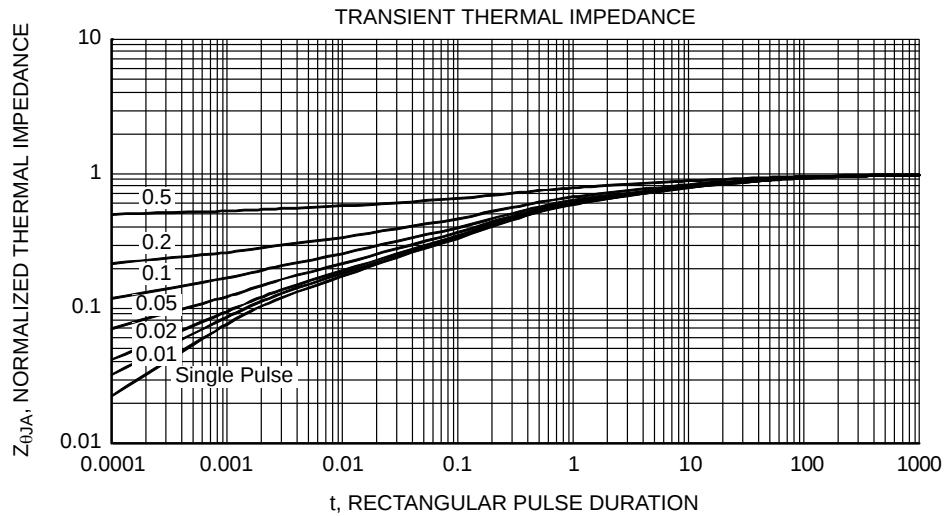


Figure 11. Transient Thermal Response Curve

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