

# MOSFET - Power, Single N-Channel, D2PAK-7L

## 650 V, 110 mΩ, 30 A

### NVBG110N65S3F

#### Description

SUPERFET<sup>®</sup> III MOSFET is onsemi's brand-new high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This advanced technology is tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate.

Consequently, SUPERFET III MOSFET is very suitable for the various power system for miniaturization and higher efficiency. SUPERFET III FRFET<sup>®</sup> MOSFET's optimized reverse recovery performance of body diode can remove additional component and improve system reliability.

In addition, the D2PAK 7 lead package offers Kelvin sense. This allows higher switching speeds and gives designers the ability to reduce the overall application footprint.

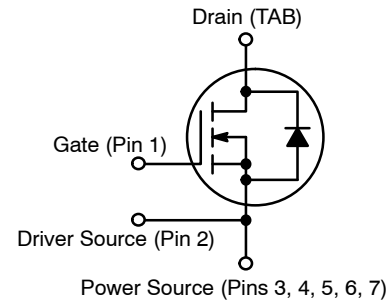
#### Features

- 700 V @ T<sub>J</sub> = 150°C
- Typ. R<sub>DS(on)</sub> = 93 mΩ
- Ultra Low Gate Charge (Typ. Q<sub>g</sub> = 58 nC)
- Low Effective Output Capacitance (Typ. C<sub>oss(eff.)</sub> = 553 pF)
- 100% Avalanche Tested
- AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free and are RoHS Compliant

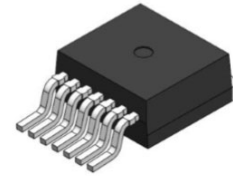
#### Typical Applications

- Automotive On Board Charger
- Automotive DC/DC Converter for BEV

| V <sub>(BR)DSS</sub> | R <sub>DS(ON)</sub> MAX | I <sub>D</sub> MAX |
|----------------------|-------------------------|--------------------|
| 650 V                | 110 mΩ @ 10 V           | 30 A               |

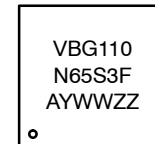


**N-CHANNEL MOSFET**



**D2PAK-7L  
CASE 418BJ**

#### MARKING DIAGRAM



VBG110N65S3F = Specific Device Code  
 A = Assembly Location  
 Y = Year  
 WW = Work Week  
 ZZ = Lot Traceability

#### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

# NVBG110N65S3F

**Table 1. ABSOLUTE MAXIMUM RATINGS** ( $T_C = 25^\circ\text{C}$  unless otherwise stated)

| Symbol         | Parameter  | Value                                      | Unit             |
|----------------|--|--|------------------|
| $V_{DSS}$      | Drain-to-Source Voltage  | 650  | V                |
| $V_{GS}$       | Gate-to-Source Voltage   | - DC                                       | $\pm 30$         |
|                |  | - AC ( $f > 1$ Hz)                         | $\pm 30$         |
| $I_D$          | Drain Current  | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 30               |
|                |  | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 19.5             |
| $I_{DM}$       | Drain Current  | - Pulsed (Note 1)                          | 69               |
| $E_{AS}$       | Single Pulse Avalanche Energy (Note 2)                               | 380  | mJ               |
| $I_{AS}$       | Avalanche Current  | 3.5  | A                |
| $E_{AR}$       | Repeated Avalanche Energy (Note 1)                                   | 2.4  | mJ               |
| dv/dt          | MOSFET dv/dt   | 100  | V/ns             |
|                | Peak Diode Recovery dv/dt (Note 3)                                   | 50   |                  |
| $P_D$          | Power Dissipation  | $T_C = 25^\circ\text{C}$                   | 240              |
|                |  | - Derate Above $25^\circ\text{C}$          | 1.92             |
| $T_J, T_{stg}$ | Operating Junction and Storage Temperature Range                     | -55 to 150                                 | $^\circ\text{C}$ |
| $T_L$          | Maximum Lead Temperature for Soldering, 1/8" from Case for 5 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.

1. Repetitive rating: pulse – width limited by maximum junction temperature.
2.  $I_{AS} = 3.5$  A,  $R_G = 25$   $\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 15$  A,  $di/dt \leq 200$  A/ $\mu\text{s}$ ,  $V_{DD} \leq 400$  V, starting  $T_C = 25^\circ\text{C}$ .

**Table 2. THERMAL RESISTANCE RATINGS**

| Symbol          | Parameter                                     | Max  | Unit                      |
|-----------------|---|------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case, Max.    | 0.52 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient, Max. | 40   |                           |

# NVBG110N65S3F

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

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

### OFF CHARACTERISTICS

|                                     |   |   |     |      |      |      |
|-------------------------------------|---|---|-----|------|------|------|
| BV <sub>DSS</sub>                   | Drain-to-Source Breakdown Voltage         | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 25°C   | 650 | -    | -    | V    |
|                                     |   | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 mA, T <sub>J</sub> = 150°C | 700 | -    | -    | V    |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 20 mA, Referenced to 25°C                            | -   | 0.61 | -    | V/°C |
| I <sub>DSS</sub>                    | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V                        | -   | -    | 10   | μA   |
|                                     |   | V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125°C                       | -   | 128  | -    | μA   |
| I <sub>GSS</sub>                    | Gate-to-Body Leakage Current              | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±30 V                        | -   | -    | ±100 | nA   |

### ON CHARACTERISTICS

|                     |                                      |  |     |    |     |    |
|---------------------|--------------------------------------|--|-----|----|-----|----|
| V <sub>GS(th)</sub> | Gate Threshold Voltage               | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 0.74 mA | 3.0 | -  | 5.0 | V  |
| R <sub>DS(on)</sub> | Static Drain-to-Source On Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 15 A                | -   | 93 | 110 | mΩ |
| g <sub>FS</sub>     | Forward Transconductance             | V <sub>GS</sub> = 20 V, I <sub>D</sub> = 15 A                | -   | 17 | -   | S  |

### DYNAMIC CHARACTERISTICS

|                        |                                   |  |   |      |   |    |
|------------------------|-----------------------------------|--|---|------|---|----|
| C <sub>iss</sub>       | Input Capacitance                 | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz                          | - | 2560 | - | pF |
| C <sub>oss</sub>       | Output Capacitance                |  | - | 50   | - | pF |
| C <sub>oss(eff.)</sub> | Effective Output Capacitance      | V <sub>DS</sub> = 0 to 400 V, V <sub>GS</sub> = 0 V                                | - | 553  | - | pF |
| C <sub>oss(er.)</sub>  | Energy Related Output Capacitance | V <sub>DS</sub> = 0 to 400 V, V <sub>GS</sub> = 0 V                                | - | 83   | - | pF |
| Q <sub>g(total)</sub>  | Total Gate Charge at 10 V         | V <sub>DS</sub> = 400 V, I <sub>D</sub> = 15 A,<br>V <sub>GS</sub> = 10 V (Note 4) | - | 58   | - | nC |
| Q <sub>gs</sub>        | Gate-to-Source Gate Charge        |  | - | 19   | - | nC |
| Q <sub>gd</sub>        | Gate-to-Drain "Miller" Charge     |  | - | 23   | - | nC |
| ESR                    | Equivalent Series Resistance      | F = 1 MHz  | - | 2    | - | Ω  |

### SWITCHING CHARACTERISTICS, V<sub>GS</sub> = 10 V

|                     |                     |   |   |     |   |    |
|---------------------|---------------------|---|---|-----|---|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time  | V <sub>DD</sub> = 400 V, I <sub>D</sub> = 15 A,<br>V <sub>GS</sub> = 10 V, R <sub>G</sub> = 4.7 Ω<br>(Note 4) | - | 31  | - | ns |
| t <sub>r</sub>      | Rise Time           |   | - | 23  | - | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |   | - | 67  | - | ns |
| t <sub>f</sub>      | Fall Time           |   | - | 4.6 | - | ns |

### SOURCE-DRAIN DIODE CHARACTERISTICS

|                 |  |  |   |     |     |    |
|-----------------|--|--|---|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Source-to-Drain Diode Forward Current | -  | - | 30  | A   |    |
| I <sub>SM</sub> | Maximum Pulsed Source-to-Drain Diode Forward Current     | -  | - | 69  | A   |    |
| V <sub>SD</sub> | Source-to-Drain Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 15 A                                    | - | -   | 1.3 | V  |
| t <sub>rr</sub> | Reverse-Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 15 A,<br>dI <sub>F</sub> /dt = 100 A/μs | - | 92  | -   | ns |
| Q <sub>rr</sub> | Reverse-Recovery Charge                                  |  | - | 322 | -   | 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.

4. Essentially independent of operating temperature typical characteristics.

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## TYPICAL CHARACTERISTICS

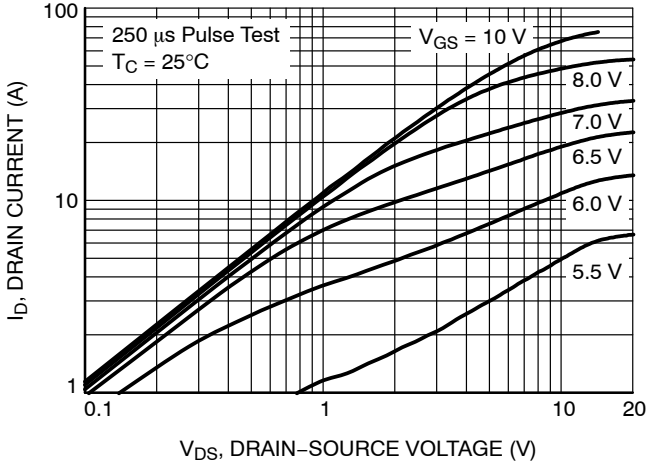


Figure 1. On-Region Characteristics

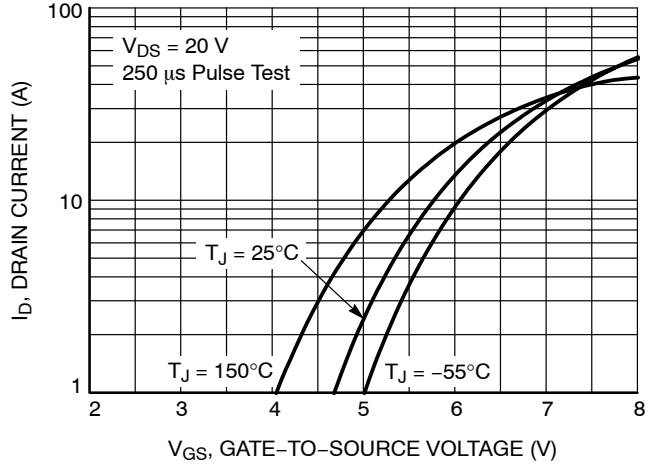


Figure 2. Transfer Characteristics

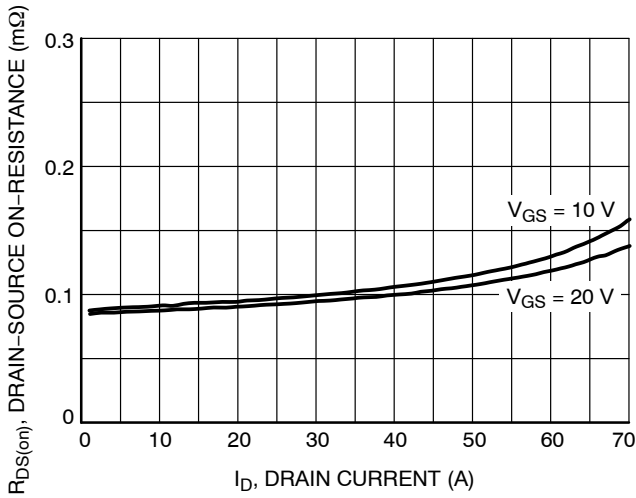


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

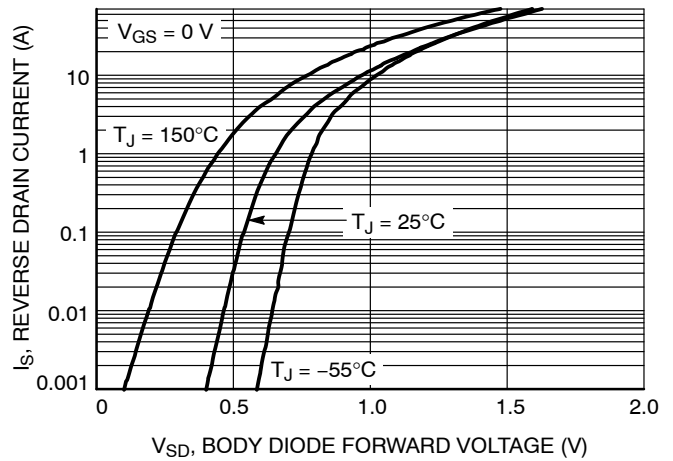


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

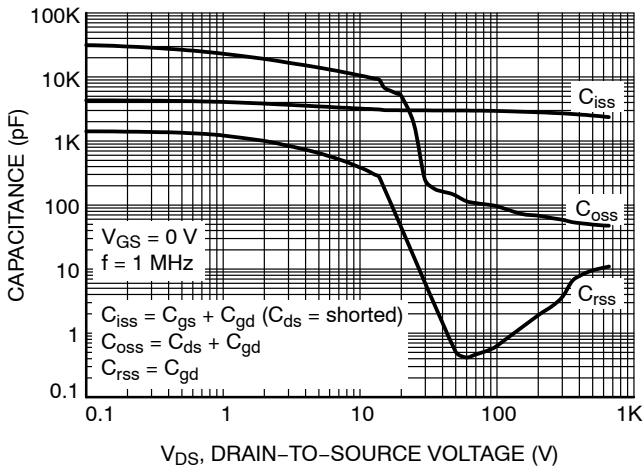


Figure 5. Capacitance Characteristics

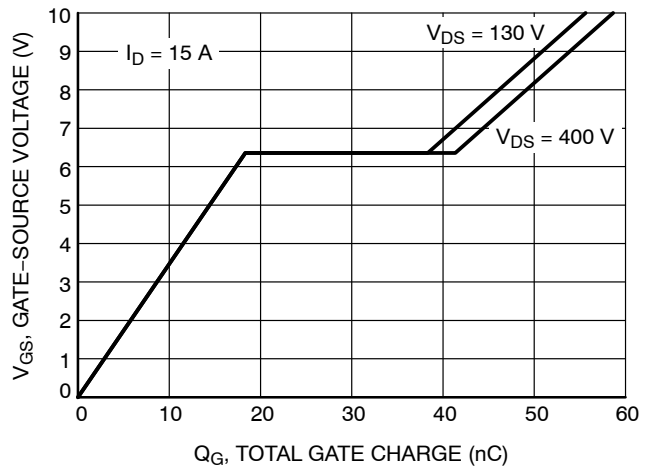
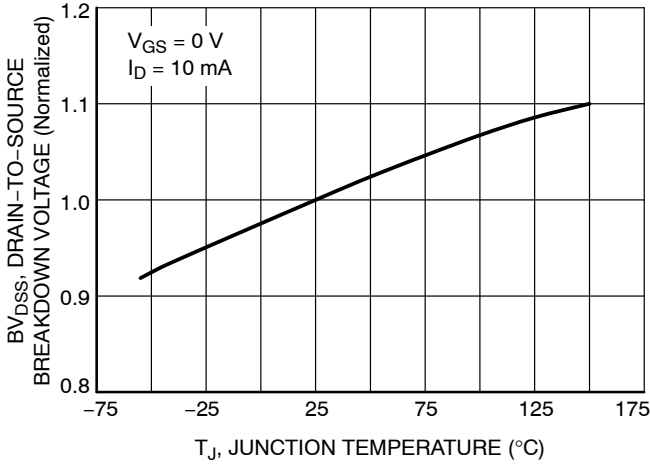


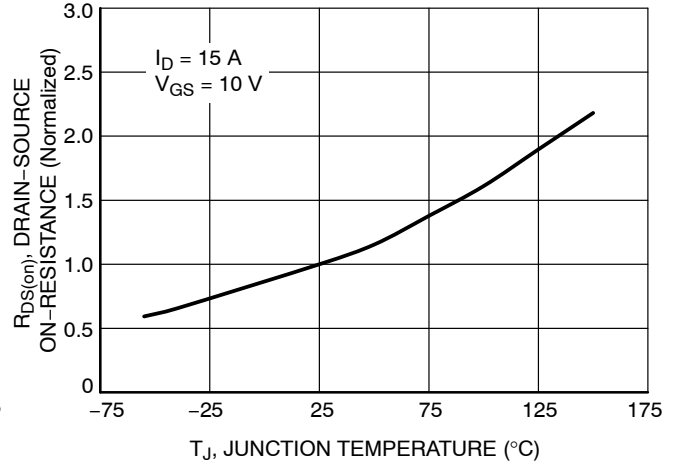
Figure 6. Gate Charge Characteristics

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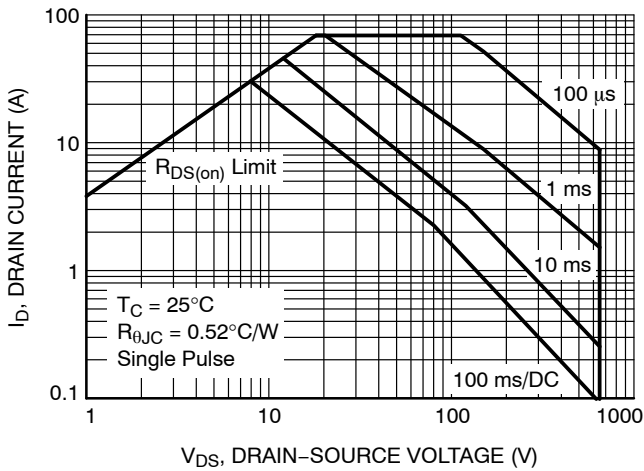
## TYPICAL CHARACTERISTICS



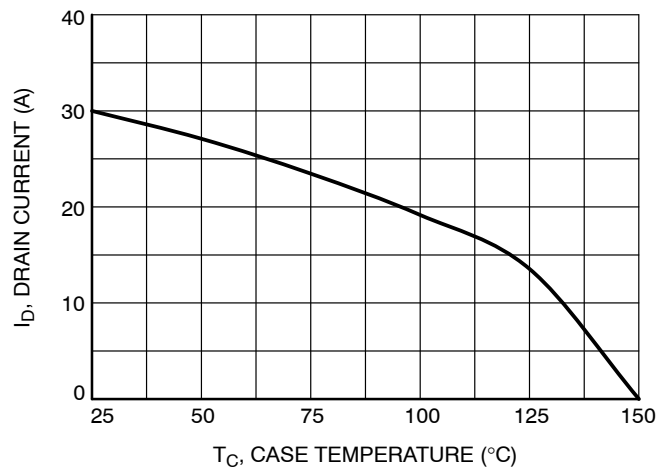
**Figure 7. Breakdown Voltage Variation vs. Temperature**



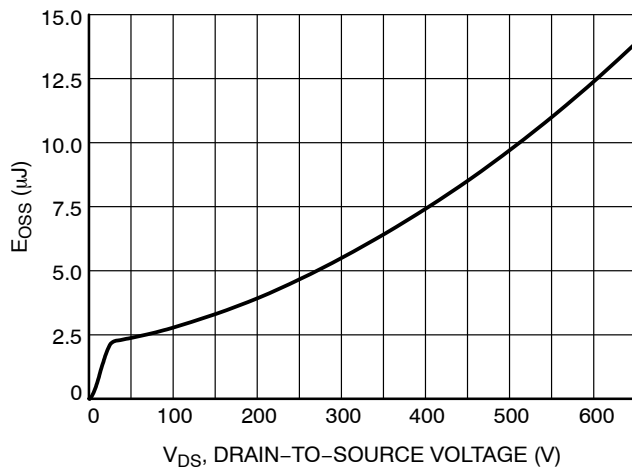
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



**Figure 10. Maximum Drain Current vs. Case Temperature**



**Figure 11. E<sub>OSS</sub> vs. Drain-to-Source Voltage**

# NVBG110N65S3F

## TYPICAL CHARACTERISTICS

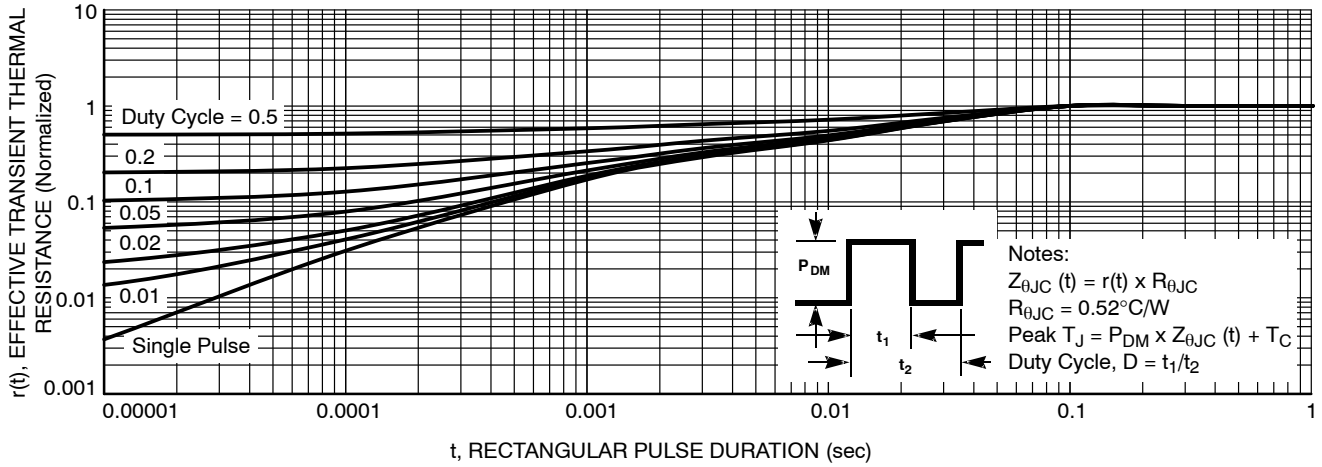


Figure 12. Transient Thermal Response

### DEVICE ORDERING INFORMATION

| Device        | Package  | Shipping <sup>†</sup> |
|---------------|----------|-----------------------|
| NVBG110N65S3F | D2PAK-7L | 800 / 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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Figure 13. Gate Charge Test Circuit & Waveform



Figure 14. Resistive Switching Test Circuit & Waveforms

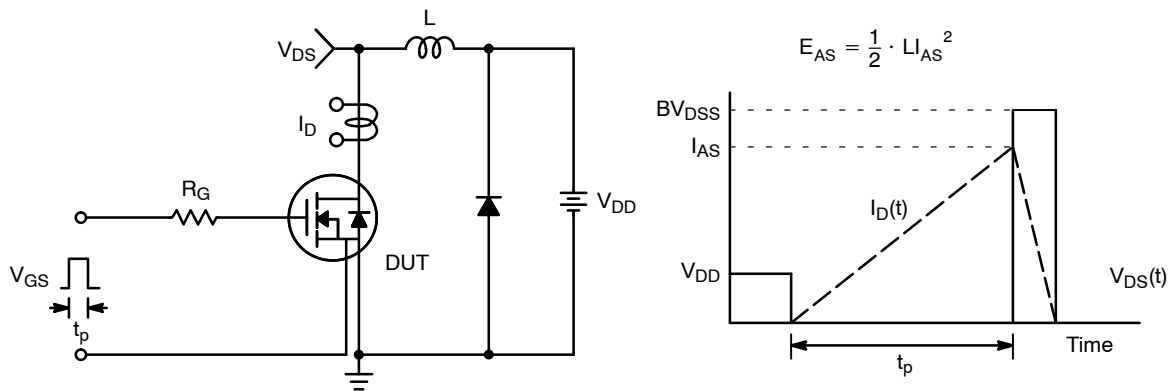
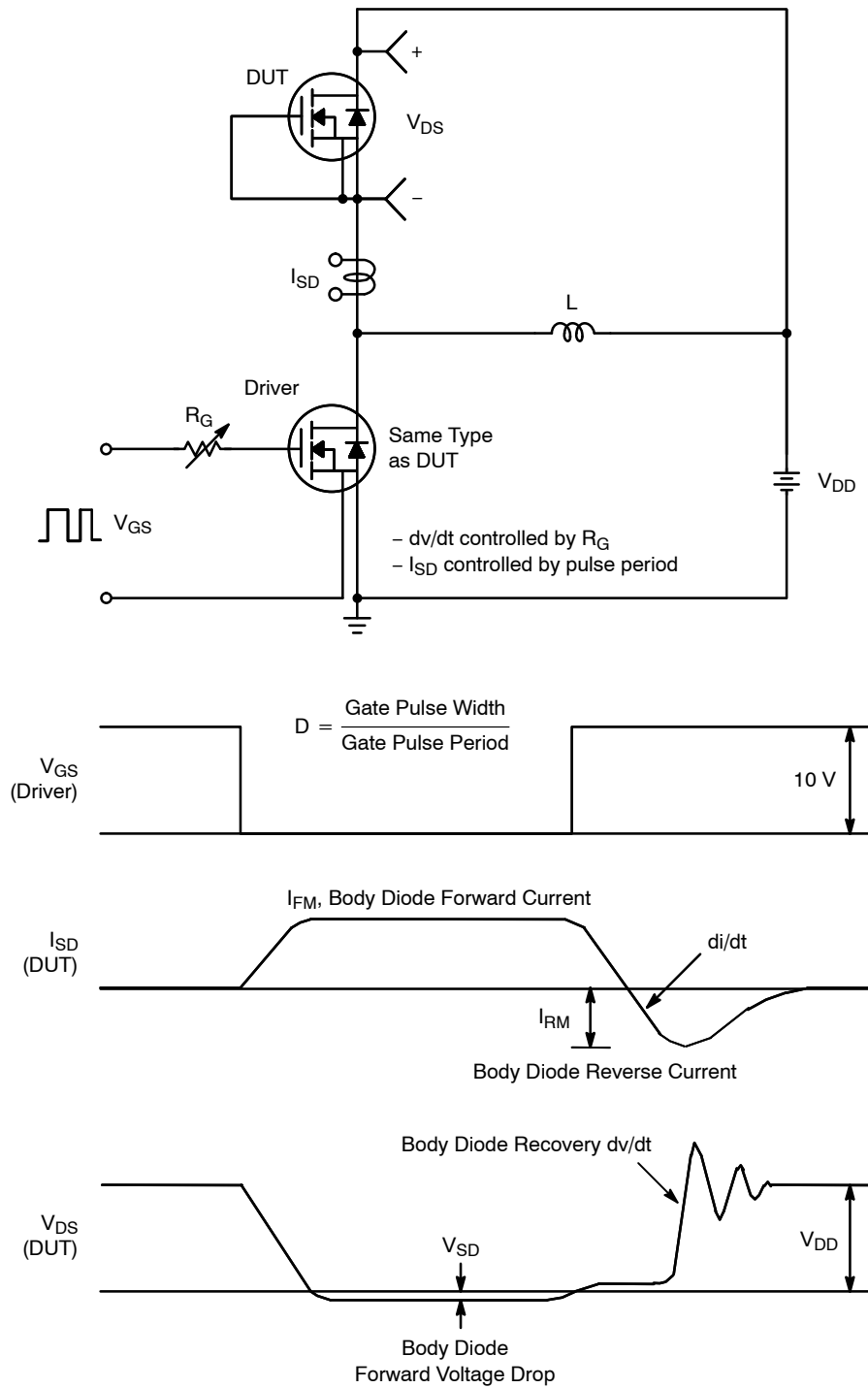


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

# NVBG110N65S3F

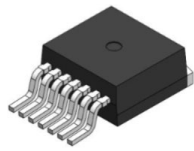


**Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**



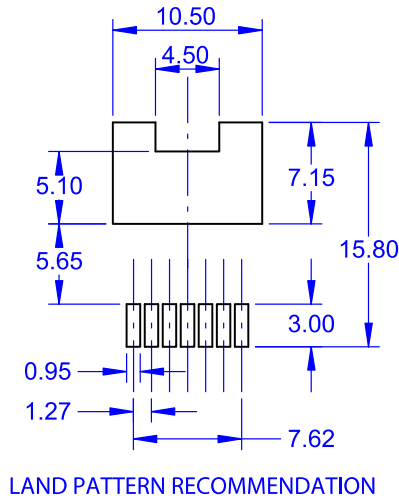
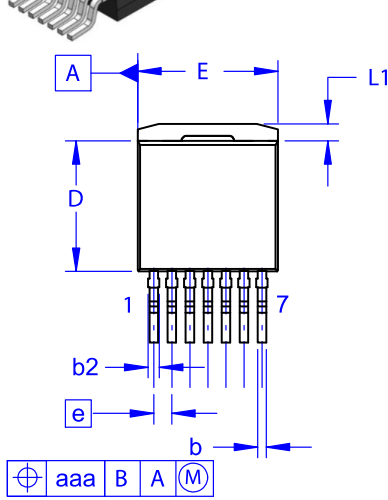
# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS



### D<sup>2</sup>PAK7 (TO-263-7L HV) CASE 418BJ ISSUE B

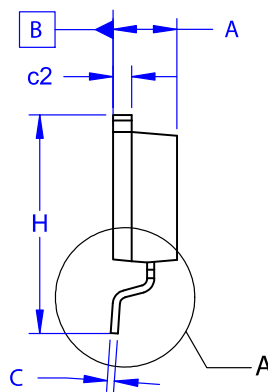
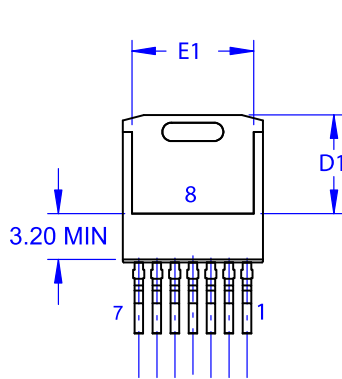
DATE 16 AUG 2019



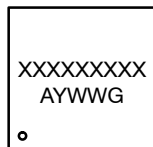
NOTES:

- A. PACKAGE CONFORMS TO JEDEC TO-263 VARIATION CB EXCEPT WHERE NOTED.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- $\triangle$  OUT OF JEDEC STANDARD VALUE.
- D. DIMENSION AND TOLERANCE AS PER ASME Y14.5-2009.
- E. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN         | NOM   | MAX   |
| A   | 4.30        | 4.50  | 4.70  |
| A1  | 0.00        | 0.10  | 0.20  |
| b2  | 0.60        | 0.70  | 0.80  |
| b   | 0.51        | 0.60  | 0.70  |
| c   | 0.40        | 0.50  | 0.60  |
| c2  | 1.20        | 1.30  | 1.40  |
| D   | 9.00        | 9.20  | 9.40  |
| D1  | 6.15        | 6.80  | 7.15  |
| E   | 9.70        | 9.90  | 10.20 |
| E1  | 7.15        | 7.65  | 8.15  |
| e   | ~           | 1.27  | ~     |
| H   | 15.10       | 15.40 | 15.70 |
| L   | 2.44        | 2.64  | 2.84  |
| L1  | 1.00        | 1.20  | 1.40  |
| L3  | ~           | 0.25  | ~     |
| aaa | ~           | ~     | 0.25  |

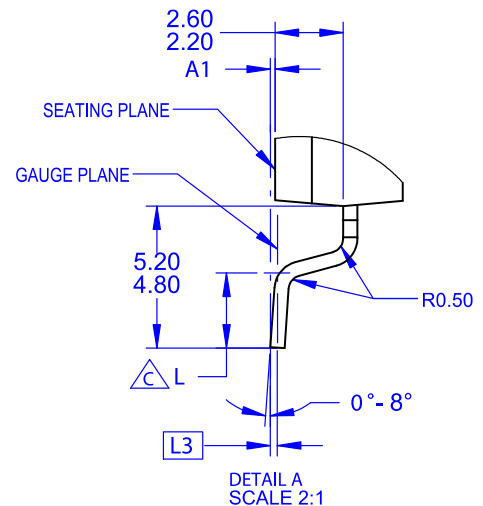


### GENERIC MARKING DIAGRAM\*



- XXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- G = 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.



|                  |                                    |  |
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| DESCRIPTION:     | D <sup>2</sup> PAK7 (TO-263-7L HV) | PAGE 1 OF 1  |

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